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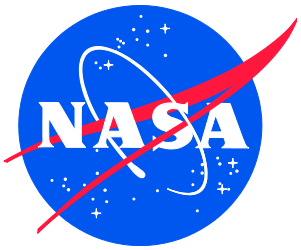

Crew Exploration Vehicle (CEV) (Orion) Occupant Protection

Appendices Part 1

Nancy J. Currie-Gregg/NESC
Langley Research Center, Hampton, Virginia

Michael L. Gernhardt
Johnson Space Center, Houston, Texas

Charles Lawrence
Glenn Research Center, Cleveland, Ohio

Jeffrey T. Somers
KBRwyle, Houston, Texas

September 2016

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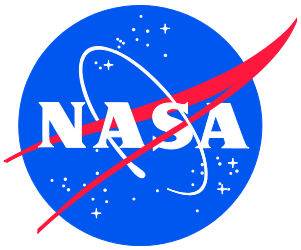

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National Aeronautics and
Space Administration

Langley Research Center
Hampton, Virginia 23681-2199

September 2016

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Appendix A. Occupant Protection Task 1 Orion Charter

National Aeronautics and
Space Administration
Lyndon B. Johnson Space Center
2101 NASA Parkway, TX 77058

Final Approved Version

December 21st, 2007

To: Distribution

From: ZV/Manager, Orion Project Office & Lockheed Martin/Orion Program Manager

Subject: Orion Landing Strategy Tiger Team - Project Plan and Driving Assumptions

The Orion Project is in the early stages of Design Analysis Cycle #2 (DAC#2) and has been challenged with evaluating current 606C vehicle design capability for nominal water landings and contingency land landings during this DAC#2 cycle. In an effort to integrate this technical effort, an Orion Landing Strategy Tiger Team was established per Orion Project Guidance Memo ZV-07-034.

A Tiger Team Steering Committee (hereby known as Steering Committee) has been assembled to oversee the design and analysis activities being performed during DAC#2 for the landing event. These activities include assessing current vehicle design for both water landing and contingency land landing events, assessing the current vehicle design susceptibility to roll control and tip over, reviewing methods for assessing occupant injury during ascent/aborts/landings, developing an alternate seat/attenuation design solution which improves occupant protection and operability, and testing the seat/attenuation system designs to ensure valid results.

This memo establishes the roles and responsibilities for the Steering Committee and sub-tasks, the schedule/expectations, and primary initial conditions to be used for these tasks within the Orion project. The primary initial conditions listed are in coordination with the Constellation Program Contingency Land Landing Guidance Memo CxPO ZF-07-012. Orion Project will report occupant protection status to CxPO at key sync points throughout DAC#2 such that all parties concur on approach well before Orion Project executes DAC#2 Final ERB (currently 8/1/2007) and PDR Board (currently 9/26/2007). Orion Project plans to status landing strategy and re-design recommendations during Orion Project Landing Strategy out-brief planned for 3/7/2008 CxPO Sync TIM.

The redesign teams will evaluate Orion vehicle performance and crew injury susceptibility based upon G-Loads experienced by the crew through each dynamic phase of flight, the rate of onset, and the experienced time duration.

Steering Committee Membership

Members:		**Advisors:**	
Chair:	John Curry	Lockheed Martin:	Blaine Brown (lead)
Co-Chair:	Irene Piatek	Lockheed Martin:	Les Theard
VIO/Ops Lead:	Angela Hart	Lockheed Martin:	Matt Carter
CM SE&I:	Karl Pohl CJ Johnson	Level 2 LRS:	Don Pearson
CB/Crew:	Lee Morin	Level 2 PSE:	Brian Muirhead
HMA ITA:	Mark Jernigan Mihriban Whitmore	Level 2 SE&I:	Eli Rayos Jeff Loechel (Flt Perf SIG)
S&MA ITA:	Jeff Cyphert		
EA ITA:	Julie Kramer		
EVA Project:	Miriam Sargusingh		
NESC:	Nancy Currie		

Steering Committee Roles and Responsibilities

- Develop the best occupant protection system possible that maximizes crew safety during ascent, ascent aborts, landing (water as well as contingency land landing), and through the post landing and recovery phase. This includes evaluation of the current 606C vehicle design as well as any alternate configurations of the various systems involved. The end goal of this activity is to recommend an improved Seat/Attenuation Design which supports DAC#2 schedules.
- Provide management direction regarding driving assumptions, scheduling constraints, and sync point guidance to ensure all tasks and TDS work remains synchronized. Approve driving loads cases to be analyzed by the task teams.
- Coordinate and provide recommendations to the following TDSs

  Integrated Landing Strategy TDSs:

  - TDS-CEVLM-21-1050: Contingency Land Landing (LM led)
    TDS Lead – Rob Hixson
    Steering Committee Task POC – Blaine Brown
  - TDS CEVLM-04-1044: Roll Control
    TDS Lead – Chris Madsen
    Steering Committee Task POC – Chris Johnson
  - TDS CEVLM-11-1043: Reuse Analysis for Water and Land Landing
    TDS Lead – Chip Woods
    Steering Committee Task POC – John Harrison

  Entry and Post-landing recovery TDSs:

  Steering Committee Task POC: Angela Hart/Blaine Brown (for each of these TDSs)

  - TDS IDAC-4 SIG-06-1006 (Level 2 led TDS)

- 36 Hour Post Landing and Comparison of landing regions with environment data

  TDS Lead – Robyn Carrasquillo/Ed Rains supported by E&C SIG/Kristine Cummings Steering Committee Task

- TDS CEV-LM-11_1040: ED-01
  - Entry, Descent, & Landing (EDL) Design Analysis (LM led TDS) - Landing Trajectories Based upon Landing Scenarios

    TDS Lead - Joey Broome and George Chi/JSC GN&C

- TDS CEV-02-001 (NASA led TDS)
  - Development of Off-Nom Landing Scenarios

    TDS Lead - Tom Walker and Ben Sellari/JSC-ZV; Supported by: George Deckhert/SR&QA, Anita Weaver

- TDS CEV LM-11-1028 (LM led)
  - Re-entry Passive Thermal Analysis

    TDS Lead - Tim McCartney

The data from these TDS and other baseline vehicle information such as loads are required to perform the other tasks for this Tiger Team.

♦ Initiate and provide oversight for the following three tasks to be performed during DAC#2:

Task 1: **Modeling Injury Protection** (see Appendix A)
Task Lead – CB/Mike Gernhardt
Steering Committee Task POC – Nancy Currie

Task 2: **Occupant Protection Design Assessment** (see Appendix B)
Task Lead – NESC/Joe Pellicciotti
Steering Committee Task POC – Julie Kramer

Task 3: **Occupant Protection Development Testing** (see Appendix C)
Task Lead – LaRC/Barry Bryant
Steering Committee Task POC – Chris Johnson

- One member of the Steering Committee is responsible for coordinating with each task lead and bringing back status and issues to the regular meeting of the Steering Committee.
- Task leads are responsible for setting up the team with regular membership, expert POCs, advisors, stakeholders etc. They will provide detailed scope and sub-task descriptions and task schedules. They also report to the Steering Committee as noted.
- Each Task Lead participates in meetings at specific times (synch points) with the Steering Committee to provide an extended discussion of their task including accomplishments, issues and task schedule. All task leads are required to attend synch point meetings and be in attendance for the entire meeting, to ensure data exchange between the tasks.

- ♦ LM Steering Committee Advisor(s) provide status, issues and data to the Steering Committee for dissemination to the entire Tiger Team and to assist in providing guidance to the entire Tiger Team.

Products

Products of the Steering Committee are primarily those of the Tasks. These will include analysis reports, conceptual designs, test plans and test hardware. In addition, the Steering Committee will develop and maintain an integrated schedule incorporating key activities and milestones from all the tasks.

Steering Committee Meetings

- The Steering Committee will meet weekly on Tuesdays from 2-3 pm Central time (JSC Building 17, Room 2037) to discuss current status and schedule. Goal is to keep meeting duration to no more than 1 hr.
    - Telecon number/Passcode will be provided in the Outlook meeting announcement.
    - Regular Tuesday meetings will begin on Tuesday, January 8th, 2008.
    - All Task Leads (or a designee) should attend to receive coordinating information and provide brief status of their work.
- A member of the Steering Committee will brief status to the CICP each Friday at 9 am CST (17/1066) to summarize TDS and Task Team work and bring key agreements and to status issues. Task Leads should also attend or tie into CICPs to status their work and get key stakeholder feedback. Specific CICP briefings related to Landing Strategy are planned for January 11th and January 18th CICPs as described in the scheduling portion of this memo.
- Steering Committee meetings and team data will be posted at the following WIKI: https://ice.exploration.nasa.gov/confluence/display/OrionOpsIntDAC2/Landing+Strategy+Tiger+Teams
- WIKI Site and Tiger Team phone/email lists will be maintained by Evelyn Arrington and Angela Hart. Contact information for adding names, contact information, or charts/data to the WIKI site:
    - Evelyn Arrington: JSC
    - Angela Hart: JSC

Additional information and initial guidance

Task 2 is not just a peer review of possible existing alternate concepts. The Task 2 team will be briefed on all alternate concepts that exist today, including the LM baseline. Task 2 team will have the freedom to use any, all, none or any combination of these concepts in their conceptual design.

The Cockpit Working Group will participate as evaluators for all three new tasks as well as evaluation of current ongoing TDS recommendations. The Crew Office and SR&QA input will be incorporated as part of the CWG evaluation.

LM and Task 1/2 teams have flexibility to challenge requirements that may be unnecessarily driving the design. These requirements challenges will be brought to the Steering Committee for discussion.

Vehicle analysis and loads generation shall include driving water impact and contingency land landing cases.

Development Guidelines

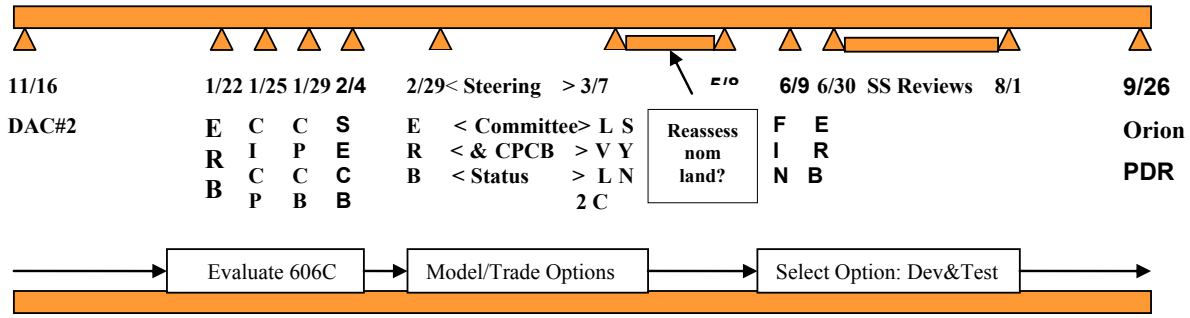
The following operability drivers and guidelines will be considered during 606C re-design efforts:

- Occupant protection system should not be dependent on direction of impact (no roll control).
- Develop design that fits within current Outer Mold Line (OML) configuration.
- High priority to leave Operators 1 and 2 in location of 606C (related to windows/Displays and Controls). Current window location allows for horizon viewing post LAS separation/manual steering. Retain design eye point.
- Develop design that fits within current Inner Mold Line (IML) configuration excluding current attenuation system (Pallet, seat, struts). Identification of proposed changes to IML items (subsystem component location, size, etc) are to be brought to the Steering Committee for evaluation.
- Develop design to meet Orion driving requirements (HSIR, SRD, CARD). Identification of changes to requirements will be brought to Steering Committee for evaluation. Not all requirements are completely off limits.
- Occupant protection system design should minimize impacts into the NHV, on-orbit operations and access to stowage/controls. If the proposed design requires reconfiguration for ingress/egress or to access stowage, the reconfiguration needs to be easy/quick with NO tools required.

Schedule/Expectations

DAC#2 Schedule (with important synch points) is as follows:

DAC#2 Duration (11/16/2007 - 6/9/2008), Road to 9/26/08 PDR Board



1st Third of DAC#2 (11/16/07-1/22/08)

- Orion Vehicle Engineering & Integration Working Group (OVEIWG)
  - Spacecraft redesign options/recommendations will be reviewed by OVEIWG at discreet points during DAC#2 to help ensure an integrated technical solution (e.g. mass allocations).
  - Prior to 1/18 CICP, OVEIWG will review the 20 TDSs coming to 1/22/08 Architecture ERB including each of the Integrated Landing Strategy and Entry/Post Landing TDSs.
    - See Appendix D for a summary of TDS work coming to 1/22/08 ERB
- CEV Integration Control Panel (CICP)
  - Meets every Friday beginning at 9 am CST start (Building 17/1066),
    Chair: NASA/John Curry, Co-Chair: LM/Brian Cuthbert.
  - Friday, 1/11/08 and 1/18/08 CICP (prior to 1/22/08 ERB), Expectations are as follows:
    - Curry/Cuthbert (Piatek/Brown) will brief stakeholders regarding overall plans for working Landing Strategy during DAC#2
    - CAWG Lead/Jim Geffre will summarize status recommendations for the 20 TDSs coming to 1/22/08 ERB (see Apprendix D - 1/22 TDS Summary)
    - TDS and Task Leads will out-brief Landing Strategy related TDS/Task plans/work so that all stakeholders have a clear understanding of the big picture.
    - OVEIWG (with CAWG/MPCP), Ops IWG/CWG, AV&SW IPT, and Reqts IWG will provide recommendations related to Orion 606C Requirements and Technical Baseline in support of 1/22/08 Architecture ERB
- 1/22/08 LM Architecture Engineering Review Board (ERB)
  - LM Outbrief of DAC#2 Architecture related TDSs (20 total including Landing Strategy)
    - 606C Vehicle performance during nominal water and contingency land landings based upon environments data identified per Level 2 guidance memo or this Tiger Team assumptions memo.

        - Emphasis will be on the ISS (Block 1) variant of the Orion spacecraft (6 person de-conditioned crew returning to Earth and landing on water and land).
- 1/25 CICP:
    - Emphasis of reusability will be as it applies to water land landing reuse will be addressed after March 7, 2008.
    - CICP Chair/John Curry will formally poll major stakeholders on GO FORWARD plan and recommendations regarding occupant protection areas of emphasis.
        - Summarize results from 1/22/08 ERB
        - Karl Pohl/CJ Johnson (with Langley LADDERS team) out-brief on recommended areas of emphasis for external vehicle redesign trades (e.g. Heat shield configurations, retros, airbags, parachutes, etc.)
        - Angela Hart outbrief on Entry and Post Landing Recovery TDSs and associated areas of emphasis planned for the remainder of DAC#2
        - CB/Mike Gernhardt outbrief on Task #1 Modeling status and areas of emphasis for providing an updated model to Tiger Team in time for 3/7/08 design downselect.
        - NESC/Joe Pellicciotti outbrief on Task #2 recommended areas of emphasis for occupant protection within cockpit habitable volume.
        - Barry Bryant outbrief on Task #3 status and forward work plans.
- 1/29 CEV Project Control Board: The Orion Project control board, called the CEV Project Control Board (CPCB), meets every Tuesday at 9 am CST (17/1066).
    - CICP Chair/John Curry will status Mark Geyer and the rest of the Orion Project team regarding results of 1/22 Architecture ERB and recommendations from 1/25 CICP regarding areas of emphasis for occupant protection redesign teams.
    - Mr. Curry will also seek approval for recommendations/status to bring forward to SECB.
- Week of 2/4: CxSECB Summary Outbrief (Level 2 sync opportunity)
    - Mr. Curry will status CxSECB regarding current vehicle capabilities as well as forward work recommendations for analyses and potential design modifications which may be assessed during the remainder of DAC#2.
    - Road to 3/7/08 Level 2 Program Sync TIM will also be summarized (Orion plan as well as Ares plans including Thrust Oscillation status)

2nd Third of DAC#2 (2/4 – 3/7/2008)

- Details will be defined during January Tiger Team Steering Committee meeting. Current high level plans are as follows:
  - NASA refine work on 606C capabilities, evaluate structural modifications to improve design (e.g. Retros, Passive Heat Shield)
  - Evaluate parachute designs to allow passive roll control; evaluate structural impacts to eliminate roll control dependency
  - NESC begin to refine Occupant Protection options (No Roll Control, ability to protect crew during tip-over, etc.)
- ERB Outbrief (Mid-Term ERB) on 2/29/2008
- Level 2 Synch TIM on 3/7/2008
  - Summarize 606C vehicle capabilities/limitations (Landings as well as Post Landing Recovery)
  - Summarize Seat/Attenuation Design Downselect to primary option
  - Status Level 2 regarding Orion Project PDR milestones.
  - Development/testing plan for new design
  - Receive CLV status regarding Thrust Oscillation impacts on Orion
  - Discuss Path to Nominal Land Landing (if feasible), which includes reusability and impacts to Life Cycle Cost (LCC)

Last Third of DAC#2 (3/7 – 6/9/2008)

- Manufacture Test Article, Drops Tests to validate design
- NASA Team re-fine structural re-design modifications
- Incorporate Thrust Oscillation effects, validate design works for this
- Evaluate ability to move back to nominal land landing from CLL Re-design. NOTE: Only spend effort on this if folks agree this is worth pursuing at 3/7/2008 TIM

The post 6/9/2008 ERB schedule depends heavily upon agreements made at CxPO TIM and if Orion Project schedule drivers are still 8/1/2008 DAC#2 Final ERB and 9/26/2008 PDR Board.

DAC#2 Landing Event Assumptions

Vehicle Configuration Assumptions

- Orion vehicle design (for initial analysis purposes to support 1/22 Architecture ERB) will be 606C vehicle (6 person configuration) which was approved at the 11/16 DAC#2 POD ERB with the following exception:
  - The heat shield shall remain mated to the vehicle for the landing event. Design options should consider a rigidly attached heat shield with attenuation through the 6 hard points or an unlocked heat shield to allow for more energy attenuation through the heat shield. Analysis should proceed with evaluation of both configurations – a hard attach at the 6 hard points or with the ability to attenuate through the hard point(s).
- The DAC#2 (ISS Mission) mass properties constraint is to keep Crew Module (CM) Effective Payload Mass (EPM) below 21,000 lbs including Mass Growth Allowance (MGA) and MR
- For comparison purposes, the 606C Seat and Pallet masses are assumed to be as follows (per OVEIWG/Wayne Jermstad):
  - ISS 6 person pallet (includes frame and struts) - 511 lb

- Lunar 4 person pallet (includes frame and struts) - 449 lb
- Seats (operators) - 53.2 lb each
- Seats (non-operators) - 36.3 lb each

NOTE: All numbers include Mass Growth Allowance (MGA).

- EVA Suit design configuration is ESR#2 (waist ring eliminated).

Contingency Land Landing (CLL) Assumptions

- Crew Health: For analysis purposes, assume CLL occurs with a de-conditioned long duration crew. H&M ITA ACTION: Provide definition of "Deconditioned crew".
- Contingency Land Landing assessments should utilize the **Brinkley Low** as default criteria for 1/22 analyses. Post 1/22 analyses will use TBD criteria (NOTE: vehicle will continue to be assessed against Brinkley Low unless a modified criteria is approved by Tiger Team).
- Environmental Conditions and Vehicle Assumptions (Design To drivers for 1/22 assessment):

Horizontal Velocity:	0 to 60 fps in 10 fps increments
Land Slope:	0 and 5 deg
Soil:	Hard Packed and Dry Loose Sand per NASA Langley LS/Dyna soil models. Hard Packed representative to hardest dry lake bed conditions. Dry Loose Sand representative to beach conditions.

Notes:

1. Not necessary to assess obstructions, ditches, or ground fires that might result from an abort
2. Initial Orion Project contingency land landing evaluations planned (goal is to have analyses available by 1/22 ERB):
    a. Contingency Land Landing conditions above with nominal vehicle performance (i.e. 3-chutes, 28 deg hang angle, and roll control available with a 6-person configuration).
    b. Contingency Land Landing conditions above with the following "roll control fail" cases:
        i. ±90 deg (side impact), and 180 deg (head first)
3. Future evaluations may be run for single chute out or additional failure cases depending upon 1/22 architecture status ERB results/recommendations.
4. CxPO may also request additional analyses for additional Land Slope/soil/wind speed cases based upon 1/22 ERB results and week of 1/28 or 2/4 SECB Outbrief.
5. Vehicle will likely Tip Over at some point during the 0-60 FPS analyses. When this occurs:
    i. Define what conditions causes it to tip over and provide rationale for the cause of the tip-over (e.g. wind and other environmental constraints and vehicle conditions like 28 deg hang angle) so mitigation methods may be investigated.
    ii. Design-Goal is to develop a solution that protects the crew in the event the vehicle tips over regardless of tip-over mitigation plan.

6. It is desirable to assess a single run where struts may have bottomed out during the run and re-run that same configuration with a different stroke profile such that it doesn't bottom out (so that we can compare results).
7. As part of CLL TDS, Orion to review Level 2 environment conditions and work with Level 2 to define proper engineering models/requirements for landing environment and definition of realistic bounding conditions.

John M. Curry

Tiger Team Chair

Manager, Orion Project Vehicle Integration

NASA Johnson Space Center

Blaine Brown

Tiger Team Lead Advisor

Manager, Crew Module Office

Lockheed Martin

Irene Piatek

Tiger Team Co-Chair

Manager, Orion Project Crew Module Office

NASA Johnson Space Center

Appendix A: Task #1: Modeling Injury Protection

LEAD: CB/Mike Gernhardt

TEAM: NESC, industry and academic experts, key stakeholders (Crew Office, JSC Engineering, JSC Space Medicine and Human Engineering)

STEERING COMMITTEE POC: Nancy Currie, Ph.D.

TASK DESCRIPTION:

Determine appropriate methods for modeling and prediction of potential crew injuries. Activities include conducting data mining of injury databases (NASACAR, CIREN, military, etc); assessment of impact simulation and injury prediction methodologies. Recommend techniques / changes to requirements appropriate for Orion including stated limitations.

- **Data Mining of Injury Databases**
  - Review automobile, NASCAR, military, and other applicable occupant injury databases
- **Review limitations and capabilities of analysis tools/techniques**
  - Review impact simulation techniques appropriate for Orion
  - Review occupant injury prediction techniques
- **Recommend analysis techniques and models appropriate for use by Orion**
- **Recommend appropriate human mass properties data for use by Orion**
- **Provide the necessary mass properties data**
- **Recommend appropriate impact acceleration/occupant injury criteria**
- **Given driving load cases, assess current 606C baseline and alternate designs and recommend potential modifications, if required**

CORE TEAM MEMBERS

Last Name	First	Organization
Begeman	Paul	Wayne State University
Bolte	John	Ohio State University
Brinkley	Jim	Consultant L2 Technology
Daniel	Brian A.	NASA
Gernhardt	Mike	NASA
Feiveson	Alan	NASA
Gohmert	Dustin	NASA
Hubbard	Robert	Michigan State University
Jadwick	Jennifer	Wyle
Jones	Jeff	NASA/SD
Lawrence	Chuck	NASA/GRC
Morin	Lee	MNASA/CB/CWG
Scheuring	Richard	NASA
Stitzel	Joel	Wake Forest University
Whitmore	Mihriban	NASA/VIO
Melvin, Ph.D	John	Wayne State University
Tabiei, Ph.D.	Ala (Al)	University of Cincinnati
Cowley	Matt	LM
Clowers, Ph.D	Kurt	MEI
Rajulu, Ph.D	Sudhakar	NASA-JC

PRODUCTS

- Periodic Briefings to Steering Committee/CEV Project Office
- Given driving load cases (from Orion Project Office)
  - Analyze Orion baseline design (606C) as well as alternate configurations developed by Task #2 team
- Final report to include:
  - Recommendations for standard analysis techniques and models
  - Recommendations for impact acceleration/occupant injury criteria appropriate for use by Orion

Appendix B: Task #2: Seat/Attenuation Design Assessment

LEAD: J. Pellicciotti / NESC

TEAM: NESC (Independent) Team

SUPPORT: Key stake-holders (Crew, CEV Cockpit Working Group, Orion Sys Mgrs, EVA Project Office)

STEERING COMMITTEE POC: Julie Kramer

TASK DESCRIPTION:

Independently develop alternate crew seat/attenuation scheme to increase robustness and minimize risk of crew injuries. Activities include assessment of current and existing alternate designs and investigation of alternative seat/ attenuation systems. Final output will be EDU drawings which will be provided to Task #3 group.

- Assess current CEV 606C and alternative design configurations for occupant protection
  - Review configurations developed to date
  - Develop configuration with emphasis on improving robustness and maximizing crew protection from acceleration forces given requirements / goals. "Improving robustness" defined as:
    - Ability to land without active roll control
    - Ability to withstand/protect against unanticipated conditions such as post-landing tip-over and tumble of the spacecraft
  - Design should be supported by Task #1 analysis
- Recommend occupant protection improvements (if any) by March 7th, 2008 (CxPO Sync TIM)
- Provide Engineering Development Unit (EDU) design to be manufactured by Task #3 Group

The team will consist of vehicle designers and analysts capable of performing design, layout, and performance assessments of alternate seat/attenuation designs. Team will include a physical ergonomist to provide appropriate crew mass and anthropometric data for population range design considerations as well as harness and restraint design. An initial review of concepts explored to date will be provided, but should not limit this task. Due to task scheduling constraints, engineering judgment may be used to allow team to focus on most applicable concepts.

The following crew injury susceptibility metrics should be used as factors in evaluating crew injury susceptibility:

- G-Loads, Rate of Onset, Time Duration

CORE TEAM MEMBERS

Cx ORION Crew Seat Landing Load Attenuation Team **Task #2: Design Evaluation / Alternates**		
Discipline	**Name**	**Org.**
TASK #2 CORE TEAM		
Mechanical Systems Task Lead	Joe Pellicciotti	NESC
Systems Engineering Support	Dan Yuchnovicz	NESC
Apollo Lessons Learned	Jerry McCullough	NASA Retired
Energy Absorption Technology	Jim Corliss	LaRC
Impact Load Evaluation	Dr. David Shemwell	SPA
Impact Load Evaluation	Dr. Marc Adams	JPL
	Dr. James Zwissler	JPL
Mechanism Engineer	Pete Rossoni	GSFC
Mechanism Analysis Engineer	Ryan McClelland	ATK
Dynamics / Shock Analyst	Dan Kaufman	GSFC
Hardware Structural Analysis Ld		Contractor
Designer - CAD - system concepts		Contractor
Designer - CAD		Contractor
CAD Infrastructure Support	Mike Mongilio	ATK

Appendix B: Task #2: Seat/Attenuation Design Assessment, Continued

Cx ORION Crew Seat Landing Load Attenuation Team Task #2: Design Evaluation / Alternates		
Discipline	**Name**	**Org.**
SUPPORT POCs		
Task Steering Committee Interface (CEV Chief Engineer)	Julie Kramer	JSC
NESC Steering Committee Interface	Nancy Currie	NESC/JSC
CEV Cockpit Working Group & Human Factors	Jim Ratliff	JSC
	Dr. Lee Morin	
Crew Office Interface	Dr. Lee Morin	
Dynamic Analyst - Loads Development	Dr. Chuck Lawrence	GRC
Test Program Interface	Barry Bryant	LaRC
CEV Mock-up Hardware Interface	Jeff Fox	JSC
Crew Suit Interface	Miriam Sargusingh	JSC
Health and Medical POC	Mihriban Whitmore	JSC
NESC Project Support		
MTSO (Management & Technical Support Office) Program Analyst	Lisa McAlhaney	NESC
Project Coordinator	Tina Dunn	NESC / ATK
Planner (Scheduler)	Linda Burgess	NESC / ATK
Technical Writer	Eric Pope	NESC / ATK

SCHEDULE

This task is necessary to be performed within the ODAC-2 cycle. The outcome of this assessment may change the design and/or analysis approach to occupant protection, and any changes are necessary before Orion PDR to inform design. Even though Orion PDR is currently schedule for September of 2008, the Task#2 team is expected to provide a primary design option to the Steering Committee in time to support the 3/7/2008 Level 2 Sync TIM. Once a primary option(s) are selected during this TIM, Task#2 team will redirect scope to manufacturing and development of a test article which provides proof of concept re-design validation. Scheduled completion of fabrication drawings with associated analyses is planned for May, 2008.

PRODUCTS

- Concept Design Layouts
- Test Hardware Part Drawings
- Alternate Design Evaluation Report

Appendix C: Task #3: Seat Attenuation System Development Testing

LEAD: Barry Bryant, R. Keith Johnson / LaRC
TEAM: LaDDERS ADP
SUPPORT: Key stake-holders (Task #1 & #2 leads, Orion system managers)
STEERING COMMITTEE POC: Chris Johnson

TASK DESCRIPTION:

Conduct early development testing of the seat attenuation system with the following objectives:

- Provide early identification of system-level performance issues
- Assess modeling techniques and develop future analysis strategies
- Explore testing methods and develop future testing approaches to meet system verification objectives

In addition to evaluating the Orion 606C seat attenuation system, alternate configurations from Task #2 may also be tested as permitted by the available schedule and resources.

The basic objectives of the test would be to assess the performance of the crew impact attenuation system. This should be done at the basic level, isolating the unknowns from the test and evaluating the impact attenuation system on its own. This would allow test procedures to be developed, allow basic performance issues to be identified, and allow model correlation of the crew impact attenuation system. The test setup could be very basic. A simple structure could interface the pallet/strut system, and the impacts could be performed on land given that loading profiles would be representative of nominal and off-nominal conditions for both water and land landings.

SCHEDULE

This task is necessary to be performed within the ODAC-2 cycle. The outcome of this assessment may change the design and/or analysis approach to occupant protection, and any changes are necessary before Orion PDR to inform design. The Orion PDR is currently scheduled for September of 2008. Detailed schedules and milestones are currently being derived by the Orion Project Office and the LaDDERS ADP.

PRODUCTS:

Products provided and performed are described as follows:

- Orion Project
    - Provide Orion seat attenuation system strut hardware
    - Provide Orion seat pallet information (stiffness)
    - Provide Orion seat design information
    - Provide recommendations for evaluation test matrix and instrumentation
    - Provide recommendations for an alternate seat/attenuation concept
- Task #3 Leads
    - Build test platform for drop testing

- Build seat pallet with necessary 606C properties
- Build seat with necessary 606C properties
- Build additional interfacing hardware as necessary
- Build alternate seat/attenuation hardware from Task #2
- Perform drop tests according to test matrix
- Record instrumentation data and provide to Orion

Appendix D: 1/22 Architecture ERB TDS Status

TDSs with System Impacts, planned complete at 1/22/08 ERB

Identifier	Title
CEVLM-04-1041***	ED-03 Entry, Descent, & Landing Preliminary DAC-2 Trajectories
CEVLM-21-1038	Heatshield Material Selection
CEVLM-21-1049	CEV Stability at Drogue Release Trade Study
CEVLM-21-1050*	Contingency Land Landing Analysis
CEVLM-01-1028*	Use of Existing Heritage OMS Assets on Orion
CEVLM-01-1026	Science Instrument Module Definition
CEVLM-01-1023**	ESM hinge configuration options
CEVLM-11-1043	Reuse Analysis for Water Landing and Land Landing
CEVLM-11-1041	Emergency Scenario Capabilities Development

* Additional Coordination Required to Assess 1/22 Completion Risk

** Evaluating whether this analysis is still required. The initial mass savings potential has been determined to be negligible.

*** This analysis is merely a data drop of the preliminary trajectories at the 1/22 ERB. The trajectories will be refined over the course of DAC-2, but other trades/analyses can use this data for preliminary assessments.

x Completed

TDSs Scheduled for update at 1/22 – focus on system level impacts

Identifier	Title	ECD
CEVLM-01-1027	Unpressurized Cargo Definition	2/15/2008
CEVLM-01-1024**	Trisector vs. Bisector Fairing Trade	2/15/2008
CEVLM-04-1035	AA-04 LAV Roll Control	2/15/2008
CEVLM-21-1039	Independent Heatshield Carrier Structure Design Analysis	4/25/2008†
CEVLM-01-1022	Frangible Joint vs. LSC for Lower Horizontal Joint of SM Fairing	4/25/2008†
CEVLM-04-1044	ED-04 Assess CM Touchdown Roll Control Options	5/8/2008†
CEVLM-11-1018***	OG-02 SM RCS Thruster Layout	2/29/2008†
CEVLM-11-1042	Fiber optic feasibility trade study	5/8/2008†
CEVLM-09-1029	Channelized Timephased Electrical Load Analysis	3/20/2008
CEVLM-09-1030	Power Source Sizing	3/20/2008
CEVLM-15-1000	EMI Crosstalk, Shielding, & RS103 Allocation	3/30/2008
CEVLM-15-1001	Lightning Analyses, Direct and Indirect	4/1/2008

* Additional Coordination Required to Assess 1/22 Completion Risk

** Evaluating whether this analysis is still required.

*** Per Bill Johns, this must be complete by 1/22

† The estimated completion dates of these analyses are currently being re-evaluated. PDR deliverable impact and time

TDSs Scheduled for update at 1/22 – focus on system level impacts (Continued)

Identifier	Title	ECD
CEVLM-10-1019	Probabilistic Risk Assessment	5/2/2008†
CEVLM-10-1020	Reliability/Maintainability Analysis - Reliability analysis of rolled up subsystem reliabilities to include power & data contributions	5/2/2008†
CEVLM-11-1023	ED-01 Entry, Descent & Landing (EDL) Design Analysis	5/8/2008†
CEVLM-11-1040	DFI, LFI, and ARFI Instrumentation Analysis	4/17/2008†
CEVLM-11-1017	Mass Properties Update	5/22/2008†
CEVLM-21-1035	Provide input to DRD-CEV-T-045 "CEV Radiation Analysis and Certification Report"	6/1/2008†
CEVLM-11-1031	Dynamic Environments Analysis	6/9/2008†

† The estimated completion dates of these analyses are currently being re-evaluated. PDR deliverable impact and time needed to complete the subsystem MELs must be determined. ECDs will be moved to the left as needed in order to ensure on time delivery of data to the subsystems. Blue highlighted dates reflect those ECDs which have already been moved to the left.

Appendix B. Sprague and Geers Model Correlation Results

B-1. Frontal Impact

Total Error	FTSS	MADYMO	CCIP
Head X Acc (g)	15.5 ± 4.9%	6.8 ± 2.7%	18.5 ± 3.8%
Head Y Acc (g)	87.2 ± 21.0%	100.5 ± 11.9%	76.4 ± 23.1%
Head Z Acc (g)	40.8 ± 10.5%	30.1 ± 4.9%	40.9 ± 11.1%
Head Reslt Acc (g)	15.4 ± 4.8%	11.7 ± 3.8%	16.2 ± 2.0%
Head X Vel (rad/sec)	10.2 ± 5.9%	18.8 ± 8.5%	6.6 ± 2.1%
Head Y Vel (rad/sec)	97.2 ± 15.2%	103.6 ± 19.7%	89.2 ± 23.7%
Head Z Vel (rad/sec)	7.8 ± 7.0%	52.5 ± 10.1%	14.0 ± 7.2%
Head Reslt Vel (rad/sec)	7.7 ± 6.5%	11.3 ± 1.2%	9.4 ± 3.9%
Head X Disp (mm)	54.4 ± 19.3%	8.8 ± 8.6%	14.0 ± 12.4%
Head Y Disp (mm)			
Head Z Disp (mm)	47.6 ± 18.8%	40.1 ± 10.6%	16.8 ± 13.4%
Head Y Rot Acc (g)	45.6 ± 8.0%		90.9 ± 27.5%
Head Y Rot Vel (rad/sec)	30.6 ± 8.2%		25.5 ± 9.9%
Chest X Acc (g)	11.9 ± 4.5%	17.0 ± 2.4%	7.8 ± 2.5%
Chest Y Acc (g)	64.8 ± 11.9%	103.6 ± 10.4%	82.2 ± 19.4%
Chest Z Acc (g)	94.3 ± 15.2%	113.6 ± 62.3%	206.0 ± 84.4%
Chest Reslt Acc (g)	13.9 ± 5.0%	12.3 ± 3.2%	12.0 ± 4.3%
Chest X Disp (mm)			
Chest Y Disp (mm)			
Chest Z Disp (mm)			
Neck Upper X Force (N)	14.2 ± 5.2%	10.9 ± 3.0%	27.7 ± 7.8%
Neck Upper Y Force (N)	72.0 ± 16.4%	83.5 ± 29.2%	63.5 ± 9.6%
Neck Upper Z Force (N)	29.5 ± 6.4%	28.2 ± 4.6%	66.8 ± 12.9%
Neck Upper Reslt Force (N)	19.3 ± 5.9%	10.8 ± 4.5%	48.5 ± 12.1%
Neck Upper X Moment (Nm)	82.1 ± 13.0%	75.1 ± 12.6%	71.3 ± 16.3%
Neck Upper Y Moment (Nm)	48.0 ± 12.5%	16.6 ± 3.9%	60.9 ± 11.6%
Neck Upper Z Moment (Nm)	66.5 ± 16.8%	66.0 ± 14.1%	224.3 ± 159.8%
Neck Upper Reslt Moment (Nm)	40.6 ± 12.3%	14.3 ± 4.7%	54.9 ± 17.6%
Lumbar Lower X Force (N)	96.4 ± 48.3%	48.1 ± 11.4%	114.7 ± 30.4%
Lumbar Lower Z Force (N)	61.7 ± 13.1%	67.1 ± 17.7%	96.3 ± 36.4%
Lumbar Lower Y Moment (Nm)	66.4 ± 34.0%	50.1 ± 19.6%	228.1 ± 57.1%
Pelvis X Disp (mm)	145.7 ± 15.4%	38.7 ± 11.2%	40.0 ± 15.1%
Pelvis Y Disp (mm)			
Pelvis Z Disp (mm)	105.5 ± 4.8%	75.1 ± 4.9%	45.3 ± 15.5%
Left Lap Belt Reslt Force (N)	28.6 ± 12.1%	45.3 ± 4.2%	59.4 ± 3.8%
Right Lap Belt Reslt Force (N)	20.8 ± 11.4%	58.3 ± 5.7%	65.4 ± 3.8%
Left Shoulder Belt Reslt Force (N)	15.9 ± 8.1%	28.4 ± 3.0%	8.2 ± 2.4%
Right Shoulder Belt Reslt Force (N)	9.8 ± 2.8%	9.4 ± 3.9%	12.4 ± 3.4%
Middle Crotch Belt Reslt Force (N)	55.6 ± 31.8%	445.6 ± 136.1%	975.5 ± 546.4%
HIC15	42.5 ± 9.9%	26.1 ± 10.3%	39.8 ± 11.2%
HIC36	41.3 ± 14.1%	19.3 ± 6.0%	17.1 ± 2.1%
Upper NIJ	33.9 ± 7.6%	21.8 ± 4.4%	66.4 ± 6.8%
Nkm	19.4 ± 9.2%	9.3 ± 1.9%	33.0 ± 4.7%

Table B-1: Frontal Impact Total Error

Magnitude Error	FTSS	MADYMO	CCIP
Head X Acc (g)	10.3 ± 8.1%	3.1 ± 3.5%	12.4 ± 6.7%
Head Y Acc (g)	66.3 ± 27.8%	78.6 ± 9.8%	51.1 ± 29.9%
Head Z Acc (g)	38.0 ± 10.8%	27.9 ± 4.4%	36.6 ± 12.7%

Head Reslt Acc (g)	12.2 ± 5.2%	9.8 ± 3.2%	9.0 ± 2.8%
Head X Vel (rad/sec)	9.5 ± 6.3%	18.7 ± 8.5%	5.7 ± 2.5%
Head Y Vel (rad/sec)	81.4 ± 11.1%	75.8 ± 14.9%	59.9 ± 26.3%
Head Z Vel (rad/sec)	6.0 ± 7.1%	52.3 ± 10.0%	13.4 ± 7.1%
Head Reslt Vel (rad/sec)	6.5 ± 7.1%	11.3 ± 1.2%	9.0 ± 4.1%
Head X Disp (mm)	54.3 ± 19.3%	8.0 ± 8.8%	11.8 ± 14.0%
Head Y Disp (mm)			
Head Z Disp (mm)	47.4 ± 18.7%	39.8 ± 10.5%	15.2 ± 14.9%
Head Y Rot Acc (g)	25.5 ± 14.3%		82.0 ± 28.9%
Head Y Rot Vel (rad/sec)	20.9 ± 10.9%		16.1 ± 14.1%
Chest X Acc (g)	5.3 ± 4.0%	16.0 ± 2.2%	3.6 ± 3.3%
Chest Y Acc (g)	33.8 ± 14.0%	70.9 ± 4.1%	50.8 ± 17.7%
Chest Z Acc (g)	89.3 ± 17.1%	103.3 ± 73.1%	203.9 ± 85.8%
Chest Reslt Acc (g)	8.9 ± 5.2%	10.7 ± 3.0%	8.8 ± 5.9%
Chest X Disp (mm)			
Chest Y Disp (mm)			
Chest Z Disp (mm)			
Neck Upper X Force (N)	9.9 ± 6.2%	8.5 ± 4.2%	24.0 ± 9.3%
Neck Upper Y Force (N)	47.7 ± 24.2%	56.7 ± 29.4%	36.5 ± 14.8%
Neck Upper Z Force (N)	25.8 ± 6.1%	26.0 ± 4.3%	64.3 ± 13.6%
Neck Upper Reslt Force (N)	16.6 ± 6.3%	8.7 ± 4.2%	46.5 ± 12.6%
Neck Upper X Moment (Nm)	61.4 ± 16.8%	60.6 ± 19.2%	46.8 ± 28.0%
Neck Upper Y Moment (Nm)	35.0 ± 14.2%	6.4 ± 1.2%	49.2 ± 21.4%
Neck Upper Z Moment (Nm)	34.2 ± 20.2%	24.5 ± 12.1%	210.8 ± 169.8%
Neck Upper Reslt Moment (Nm)	33.6 ± 12.7%	5.2 ± 2.2%	47.9 ± 21.3%
Lumbar Lower X Force (N)	95.2 ± 49.3%	43.0 ± 11.2%	114.0 ± 30.4%
Lumbar Lower Z Force (N)	21.6 ± 14.8%	28.2 ± 18.0%	65.3 ± 51.1%
Lumbar Lower Y Moment (Nm)	55.7 ± 41.9%	44.5 ± 19.5%	227.3 ± 57.6%
Pelvis X Disp (mm)	145.7 ± 15.4%	38.6 ± 11.2%	39.6 ± 15.4%
Pelvis Y Disp (mm)			
Pelvis Z Disp (mm)	74.7 ± 4.6%	75.0 ± 5.0%	40.6 ± 13.6%
Left Lap Belt Reslt Force (N)	27.5 ± 11.8%	45.2 ± 4.2%	58.3 ± 3.9%
Right Lap Belt Reslt Force (N)	19.1 ± 12.2%	57.9 ± 5.6%	64.1 ± 3.8%
Left Shoulder Belt Reslt Force (N)	13.5 ± 9.1%	27.8 ± 2.8%	4.4 ± 3.1%
Right Shoulder Belt Reslt Force (N)	4.9 ± 2.7%	7.9 ± 3.9%	9.3 ± 4.3%
Middle Crotch Belt Reslt Force (N)	50.8 ± 35.0%	445.4 ± 136.2%	975.4 ± 546.5%
HIC15	39.0 ± 9.8%	23.9 ± 9.9%	32.8 ± 11.6%
HIC36	39.4 ± 13.9%	18.1 ± 5.8%	7.3 ± 6.3%
Upper NIJ	31.6 ± 8.0%	17.7 ± 4.1%	65.4 ± 7.0%
Nkm	15.8 ± 9.4%	6.9 ± 2.9%	31.2 ± 4.9%

Table B-2: Frontal Impact Magnitude Error

Phase Error	*FTSS*	*MADYMO*	*CCIP*
Head X Acc (g)	9.7 ± 2.4%	5.3 ± 2.0%	12.6 ± 2.0%
Head Y Acc (g)	53.4 ± 9.8%	61.0 ± 16.9%	51.1 ± 19.2%
Head Z Acc (g)	14.1 ± 4.8%	11.1 ± 3.0%	17.0 ± 3.2%
Head Reslt Acc (g)	9.1 ± 2.1%	6.2 ± 2.3%	13.2 ± 2.5%
Head X Vel (rad/sec)	2.8 ± 0.9%	2.5 ± 0.9%	3.0 ± 1.3%
Head Y Vel (rad/sec)	47.1 ± 28.9%	65.4 ± 31.9%	58.0 ± 33.0%
Head Z Vel (rad/sec)	4.5 ± 2.1%	3.7 ± 1.9%	3.9 ± 1.8%
Head Reslt Vel (rad/sec)	3.1 ± 1.1%	1.0 ± 0.3%	2.2 ± 1.1%
Head X Disp (mm)	2.7 ± 1.0%	2.9 ± 1.2%	4.8 ± 1.0%
Head Y Disp (mm)			

Head Z Disp (mm)	4.0 ± 2.4%	4.9 ± 2.6%	3.9 ± 2.4%
Head Y Rot Acc (g)	36.1 ± 3.4%		37.7 ± 8.0%
Head Y Rot Vel (rad/sec)	20.7 ± 5.6%		17.1 ± 4.1%
Chest X Acc (g)	10.4 ± 3.3%	5.8 ± 1.2%	6.5 ± 1.1%
Chest Y Acc (g)	53.3 ± 14.5%	74.7 ± 15.1%	63.8 ± 13.5%
Chest Z Acc (g)	28.9 ± 6.1%	31.4 ± 6.6%	25.1 ± 4.9%
Chest Reslt Acc (g)	10.2 ± 3.2%	5.9 ± 1.3%	7.3 ± 0.9%
Chest X Disp (mm)			
Chest Y Disp (mm)			
Chest Z Disp (mm)			
Neck Upper X Force (N)	9.4 ± 3.0%	5.9 ± 1.7%	12.8 ± 1.9%
Neck Upper Y Force (N)	50.7 ± 9.8%	58.3 ± 20.7%	50.3 ± 8.7%
Neck Upper Z Force (N)	13.9 ± 4.5%	10.7 ± 3.0%	17.4 ± 2.8%
Neck Upper Reslt Force (N)	9.5 ± 2.1%	6.3 ± 2.3%	13.3 ± 2.3%
Neck Upper X Moment (Nm)	53.3 ± 7.4%	41.3 ± 9.7%	48.4 ± 11.8%
Neck Upper Y Moment (Nm)	31.6 ± 6.6%	15.1 ± 4.4%	31.6 ± 5.8%
Neck Upper Z Moment (Nm)	55.1 ± 11.7%	59.9 ± 15.8%	56.0 ± 5.4%
Neck Upper Reslt Moment (Nm)	22.3 ± 4.0%	13.1 ± 4.9%	24.2 ± 3.4%
Lumbar Lower X Force (N)	12.1 ± 4.1%	20.4 ± 8.2%	11.6 ± 5.7%
Lumbar Lower Z Force (N)	55.6 ± 15.9%	58.9 ± 16.5%	61.3 ± 14.9%
Lumbar Lower Y Moment (Nm)	28.1 ± 4.4%	21.0 ± 10.5%	17.9 ± 2.9%
Pelvis X Disp (mm)	3.1 ± 0.7%	1.9 ± 0.9%	4.8 ± 1.3%
Pelvis Y Disp (mm)			
Pelvis Z Disp (mm)	73.9 ± 10.7%	4.3 ± 1.8%	19.7 ± 8.8%
Left Lap Belt Reslt Force (N)	7.8 ± 3.1%	3.6 ± 0.8%	11.0 ± 1.4%
Right Lap Belt Reslt Force (N)	6.7 ± 2.8%	6.2 ± 1.9%	13.1 ± 2.2%
Left Shoulder Belt Reslt Force (N)	7.3 ± 1.7%	5.5 ± 1.0%	6.5 ± 1.5%
Right Shoulder Belt Reslt Force (N)	8.1 ± 2.6%	4.9 ± 1.1%	7.8 ± 1.5%
Middle Crotch Belt Reslt Force (N)	16.4 ± 8.4%	10.8 ± 4.5%	13.0 ± 6.6%
HIC15	16.3 ± 4.8%	10.4 ± 3.8%	22.0 ± 4.6%
HIC36	12.0 ± 3.5%	6.5 ± 2.4%	14.4 ± 2.1%
Upper NIJ	11.9 ± 3.4%	12.7 ± 2.0%	11.3 ± 1.4%
Nkm	10.6 ± 3.6%	5.7 ± 2.1%	10.6 ± 1.0%

Table B-3: Frontal Impact Phase Error

B-2. Rear Impact

Total Error	FTSS	MADYMO	CCIP
Head X Acc (g)	23.6 ± 8.2%	23.5 ± 8.9%	24.0 ± 7.9%
Head Y Acc (g)	85.2 ± 17.7%	82.8 ± 15.6%	95.3 ± 11.0%
Head Z Acc (g)	76.4 ± 9.7%	26.0 ± 10.2%	33.1 ± 9.2%
Head Reslt Acc (g)	19.8 ± 5.9%	22.2 ± 9.1%	21.6 ± 7.4%
Head X Vel (rad/sec)	19.4 ± 2.2%	5.8 ± 2.6%	14.4 ± 2.7%
Head Y Vel (rad/sec)	122.8 ± 72.2%	156.2 ± 98.8%	93.1 ± 37.0%
Head Z Vel (rad/sec)	410.4 ± 430.9%	202.3 ± 239.2%	354.9 ± 388.6%
Head Reslt Vel (rad/sec)	3.1 ± 1.2%	6.6 ± 5.2%	3.2 ± 1.2%
Head X Disp (mm)			
Head Y Disp (mm)			
Head Z Disp (mm)			
Head Y Rot Acc (g)	68.2 ± 42.2%		149.5 ± 137.2%
Head Y Rot Vel (rad/sec)	90.3 ± 74.0%		194.7 ± 211.3%
Chest X Acc (g)	12.7 ± 7.5%	17.0 ± 4.6%	14.5 ± 7.3%
Chest Y Acc (g)	89.1 ± 7.7%	90.7 ± 12.2%	81.1 ± 10.8%
Chest Z Acc (g)	60.3 ± 33.3%	223.4 ± 118.1%	75.1 ± 42.7%
Chest Reslt Acc (g)	12.1 ± 7.3%	12.0 ± 5.5%	13.8 ± 7.0%
Chest X Disp (mm)			
Chest Y Disp (mm)			
Chest Z Disp (mm)			
Neck Upper X Force (N)	91.2 ± 16.2%	141.1 ± 86.8%	77.3 ± 16.8%
Neck Upper Y Force (N)	78.3 ± 20.3%	100.4 ± 39.9%	73.8 ± 22.7%
Neck Upper Z Force (N)	65.5 ± 11.3%	44.2 ± 12.6%	97.6 ± 36.6%
Neck Upper Reslt Force (N)	27.1 ± 3.0%	63.2 ± 35.3%	45.9 ± 23.1%
Neck Upper X Moment (Nm)	72.6 ± 17.8%	77.1 ± 12.2%	72.2 ± 15.4%
Neck Upper Y Moment (Nm)	191.3 ± 98.2%	216.8 ± 101.1%	259.5 ± 132.5%
Neck Upper Z Moment (Nm)	129.6 ± 98.2%	245.8 ± 217.5%	70.8 ± 28.3%
Neck Upper Reslt Moment (Nm)	137.7 ± 81.2%	157.0 ± 74.9%	190.6 ± 104.8%
Lumbar Lower X Force (N)	20.9 ± 26.3%	79.1 ± 9.7%	23.2 ± 26.5%
Lumbar Lower Z Force (N)	78.3 ± 65.6%	100.1 ± 14.6%	87.4 ± 65.7%
Lumbar Lower Y Moment (Nm)	88.1 ± 16.0%	103.8 ± 7.4%	219.6 ± 73.3%
Pelvis X Disp (mm)			
Pelvis Y Disp (mm)			
Pelvis Z Disp (mm)			
Left Lap Belt Reslt Force (N)	69.0 ± 55.0%	158.9 ± 134.6%	74.2 ± 13.4%
Right Lap Belt Reslt Force (N)	79.1 ± 43.6%	158.4 ± 70.4%	86.2 ± 6.4%
Left Shoulder Belt Reslt Force (N)	39.1 ± 19.8%	330.1 ± 150.8%	83.1 ± 7.8%
Right Shoulder Belt Reslt Force (N)	221.1 ± 192.0%	282.1 ± 197.9%	68.1 ± 16.0%
Middle Crotch Belt Reslt Force (N)	49.3 ± 16.0%	193.8 ± 127.7%	54.8 ± 16.6%
HIC15	34.5 ± 12.1%	45.7 ± 22.4%	36.5 ± 15.2%
HIC36	18.0 ± 12.2%	30.5 ± 18.6%	26.0 ± 18.6%
Upper NIJ	66.7 ± 25.7%	109.0 ± 44.2%	106.5 ± 49.5%
Nkm	31.9 ± 16.2%	152.3 ± 54.5%	38.2 ± 9.9%

Table B-4: Rear Impact Total Error

Magnitude Error	FTSS	MADYMO	CCIP
Head X Acc (g)	8.1 ± 8.6%	15.8 ± 9.7%	7.3 ± 7.9%
Head Y Acc (g)	56.2 ± 33.2%	52.4 ± 36.3%	73.6 ± 17.3%
Head Z Acc (g)	73.2 ± 12.6%	15.3 ± 10.4%	22.0 ± 14.7%
Head Reslt Acc (g)	7.1 ± 5.4%	16.2 ± 10.1%	8.3 ± 7.6%

Head X Vel (rad/sec)	19.3 ± 2.2%	4.7 ± 2.9%	14.2 ± 2.7%
Head Y Vel (rad/sec)	99.5 ± 74.4%	130.5 ± 112.8%	56.3 ± 36.6%
Head Z Vel (rad/sec)	410.3 ± 430.8%	202.2 ± 239.2%	354.9 ± 388.6%
Head Reslt Vel (rad/sec)	2.0 ± 1.6%	5.8 ± 5.4%	1.8 ± 1.5%
Head X Disp (mm)			
Head Y Disp (mm)			
Head Z Disp (mm)			
Head Y Rot Acc (g)	43.5 ± 47.2%		134.3 ± 145.6%
Head Y Rot Vel (rad/sec)	70.0 ± 78.2%		178.9 ± 219.5%
Chest X Acc (g)	9.2 ± 5.7%	13.5 ± 5.9%	11.2 ± 5.9%
Chest Y Acc (g)	49.6 ± 15.4%	61.5 ± 13.1%	50.9 ± 11.4%
Chest Z Acc (g)	49.8 ± 40.6%	219.5 ± 120.9%	58.5 ± 53.2%
Chest Reslt Acc (g)	8.4 ± 5.8%	8.0 ± 4.8%	10.3 ± 6.1%
Chest X Disp (mm)			
Chest Y Disp (mm)			
Chest Z Disp (mm)			
Neck Upper X Force (N)	65.9 ± 14.3%	138.9 ± 84.5%	30.8 ± 18.3%
Neck Upper Y Force (N)	53.4 ± 31.6%	80.8 ± 47.7%	50.7 ± 27.9%
Neck Upper Z Force (N)	45.1 ± 20.9%	17.5 ± 16.2%	81.1 ± 42.7%
Neck Upper Reslt Force (N)	7.1 ± 5.3%	61.1 ± 36.6%	38.4 ± 27.5%
Neck Upper X Moment (Nm)	44.6 ± 31.6%	54.3 ± 21.7%	43.5 ± 28.1%
Neck Upper Y Moment (Nm)	186.0 ± 102.4%	202.6 ± 115.2%	255.8 ± 134.5%
Neck Upper Z Moment (Nm)	104.5 ± 106.7%	239.1 ± 217.0%	41.4 ± 32.5%
Neck Upper Reslt Moment (Nm)	134.8 ± 84.3%	154.4 ± 78.2%	188.6 ± 106.4%
Lumbar Lower X Force (N)	18.6 ± 25.2%	77.3 ± 8.3%	20.7 ± 26.0%
Lumbar Lower Z Force (N)	73.4 ± 59.9%	86.7 ± 10.6%	80.9 ± 62.8%
Lumbar Lower Y Moment (Nm)	85.9 ± 15.5%	60.4 ± 22.0%	200.4 ± 74.9%
Pelvis X Disp (mm)			
Pelvis Y Disp (mm)			
Pelvis Z Disp (mm)			
Left Lap Belt Reslt Force (N)	66.9 ± 56.2%	155.7 ± 137.8%	70.0 ± 14.9%
Right Lap Belt Reslt Force (N)	77.3 ± 43.9%	156.6 ± 71.9%	82.0 ± 8.6%
Left Shoulder Belt Reslt Force (N)	27.9 ± 25.6%	329.3 ± 151.2%	80.1 ± 7.4%
Right Shoulder Belt Reslt Force (N)	219.1 ± 193.3%	280.9 ± 198.5%	64.4 ± 17.8%
Middle Crotch Belt Reslt Force (N)	42.7 ± 18.1%	192.2 ± 128.8%	49.0 ± 20.1%
HIC15	24.6 ± 10.6%	40.6 ± 24.2%	24.6 ± 17.3%
HIC36	15.8 ± 12.3%	26.8 ± 21.1%	24.2 ± 18.5%
Upper NIJ	62.4 ± 29.0%	106.3 ± 45.9%	103.7 ± 51.5%
Nkm	25.0 ± 17.9%	151.6 ± 55.2%	32.4 ± 12.7%

Table B-5: Rear Impact Magnitude Error

Phase Error	***FTSS***	***MADYMO***	***CCIP***
Head X Acc (g)	21.4 ± 5.5%	16.5 ± 4.8%	22.2 ± 5.7%
Head Y Acc (g)	57.5 ± 11.6%	53.9 ± 17.8%	58.7 ± 9.5%
Head Z Acc (g)	19.3 ± 8.0%	19.7 ± 7.4%	20.8 ± 8.5%
Head Reslt Acc (g)	18.1 ± 4.9%	14.2 ± 3.9%	19.3 ± 5.1%
Head X Vel (rad/sec)	1.8 ± 0.8%	2.9 ± 1.4%	2.2 ± 1.3%
Head Y Vel (rad/sec)	62.6 ± 33.8%	59.2 ± 39.3%	68.1 ± 32.2%
Head Z Vel (rad/sec)	4.5 ± 4.1%	6.1 ± 4.1%	4.8 ± 4.0%
Head Reslt Vel (rad/sec)	1.9 ± 1.0%	2.6 ± 1.4%	2.1 ± 1.3%
Head X Disp (mm)			

Head Y Disp (mm)			
Head Z Disp (mm)			
Head Y Rot Acc (g)	47.4 ± 12.8%		47.0 ± 9.0%
Head Y Rot Vel (rad/sec)	49.9 ± 15.5%		52.9 ± 10.1%
Chest X Acc (g)	8.8 ± 5.0%	8.8 ± 4.6%	9.0 ± 4.9%
Chest Y Acc (g)	72.2 ± 11.3%	64.1 ± 19.5%	62.5 ± 9.6%
Chest Z Acc (g)	26.2 ± 3.5%	33.2 ± 6.0%	36.3 ± 5.8%
Chest Reslt Acc (g)	8.5 ± 4.8%	8.5 ± 4.2%	8.8 ± 4.6%
Chest X Disp (mm)			
Chest Y Disp (mm)			
Chest Z Disp (mm)			
Neck Upper X Force (N)	62.4 ± 12.0%	21.0 ± 24.8%	68.3 ± 19.5%
Neck Upper Y Force (N)	52.1 ± 8.0%	54.1 ± 7.3%	50.9 ± 7.9%
Neck Upper Z Force (N)	43.8 ± 8.8%	38.9 ± 7.2%	49.9 ± 7.5%
Neck Upper Reslt Force (N)	25.7 ± 2.3%	12.4 ± 6.4%	20.3 ± 5.7%
Neck Upper X Moment (Nm)	51.7 ± 5.4%	51.6 ± 7.7%	53.2 ± 4.1%
Neck Upper Y Moment (Nm)	34.3 ± 10.8%	56.5 ± 12.2%	36.3 ± 11.9%
Neck Upper Z Moment (Nm)	63.4 ± 21.3%	51.6 ± 29.9%	53.7 ± 14.9%
Neck Upper Reslt Moment (Nm)	18.0 ± 3.8%	19.8 ± 3.6%	21.0 ± 3.1%
Lumbar Lower X Force (N)	8.4 ± 8.7%	15.8 ± 8.2%	8.8 ± 7.8%
Lumbar Lower Z Force (N)	25.5 ± 28.7%	49.2 ± 14.1%	29.8 ± 25.0%
Lumbar Lower Y Moment (Nm)	13.8 ± 15.2%	81.4 ± 12.7%	87.4 ± 16.4%
Pelvis X Disp (mm)			
Pelvis Y Disp (mm)			
Pelvis Z Disp (mm)			
Left Lap Belt Reslt Force (N)	12.1 ± 4.8%	15.4 ± 2.9%	23.7 ± 2.7%
Right Lap Belt Reslt Force (N)	15.1 ± 6.4%	17.8 ± 7.9%	25.7 ± 5.9%
Left Shoulder Belt Reslt Force (N)	22.7 ± 3.4%	20.1 ± 5.1%	21.5 ± 5.0%
Right Shoulder Belt Reslt Force (N)	20.6 ± 3.5%	21.2 ± 7.5%	20.8 ± 2.0%
Middle Crotch Belt Reslt Force (N)	22.2 ± 8.2%	19.1 ± 3.3%	21.6 ± 5.4%
HIC15	23.9 ± 7.3%	18.2 ± 6.1%	25.4 ± 6.0%
HIC36	8.0 ± 3.1%	9.6 ± 6.1%	9.1 ± 4.3%
Upper NIJ	19.8 ± 1.9%	20.9 ± 3.8%	19.9 ± 2.6%
Nkm	18.1 ± 4.4%	12.1 ± 3.1%	18.5 ± 3.0%

Table B-6: Rear Impact Phase Error

B-3. Lateral Impact

Total Error	*FTSS*	*MADYMO*	*CCIP*
Head X Acc (g)	62.8 ± 26.3%	88.8 ± 66.4%	109.0 ± 74.2%
Head Y Acc (g)	64.4 ± 13.3%	71.6 ± 24.2%	67.7 ± 21.7%
Head Z Acc (g)	72.7 ± 36.1%	94.1 ± 63.7%	63.2 ± 36.4%
Head Reslt Acc (g)	50.5 ± 16.9%	59.3 ± 22.9%	51.3 ± 23.6%
Head X Vel (rad/sec)	301.4 ± 298.6%	71.8 ± 59.4%	237.4 ± 278.2%
Head Y Vel (rad/sec)	72.0 ± 14.0%	79.2 ± 20.8%	73.9 ± 14.8%
Head Z Vel (rad/sec)	200.1 ± 276.3%	255.3 ± 320.1%	205.7 ± 241.3%
Head Reslt Vel (rad/sec)	51.4 ± 25.1%	58.7 ± 26.5%	47.1 ± 26.3%
Head X Disp (mm)			
Head Y Disp (mm)			
Head Z Disp (mm)			
Head Y Rot Acc (g)	60.5 ± 17.1%		81.8 ± 59.0%
Head Y Rot Vel (rad/sec)	67.3 ± 19.5%		78.7 ± 70.9%
Chest X Acc (g)	51.8 ± 10.5%	72.4 ± 13.2%	71.9 ± 47.8%
Chest Y Acc (g)	35.1 ± 30.3%	44.5 ± 39.2%	36.3 ± 31.6%
Chest Z Acc (g)	56.7 ± 18.3%	54.9 ± 11.5%	55.8 ± 30.4%
Chest Reslt Acc (g)	17.2 ± 7.9%	29.2 ± 30.7%	17.2 ± 11.3%
Chest X Disp (mm)			
Chest Y Disp (mm)	75.4 ± 56.6%	84.9 ± 34.6%	33.2 ± 29.6%
Chest Z Disp (mm)	136.6 ± 93.5%	69.1 ± 8.6%	130.1 ± 29.0%
Neck Upper X Force (N)	53.9 ± 23.6%	75.0 ± 47.9%	89.2 ± 49.3%
Neck Upper Y Force (N)	90.3 ± 10.5%	193.1 ± 125.3%	141.8 ± 73.0%
Neck Upper Z Force (N)	61.5 ± 26.1%	115.4 ± 91.5%	65.8 ± 41.4%
Neck Upper Reslt Force (N)	41.4 ± 24.5%	121.0 ± 113.8%	65.8 ± 62.2%
Neck Upper X Moment (Nm)	54.3 ± 22.7%	132.4 ± 93.5%	72.4 ± 25.7%
Neck Upper Y Moment (Nm)	66.4 ± 20.8%	78.0 ± 61.5%	100.7 ± 67.4%
Neck Upper Z Moment (Nm)	82.7 ± 54.9%	196.3 ± 206.4%	653.1 ± 560.9%
Neck Upper Reslt Moment (Nm)	34.7 ± 17.0%	123.3 ± 81.6%	81.1 ± 69.7%
Lumbar Lower X Force (N)	59.9 ± 29.8%	103.7 ± 44.0%	84.9 ± 36.7%
Lumbar Lower Z Force (N)	111.2 ± 87.1%	100.8 ± 68.6%	82.9 ± 36.3%
Lumbar Lower Y Moment (Nm)	209.9 ± 187.9%	122.3 ± 65.5%	219.8 ± 157.5%
Pelvis X Disp (mm)			
Pelvis Y Disp (mm)			
Pelvis Z Disp (mm)			
Left Lap Belt Reslt Force (N)	35.4 ± 22.5%	83.0 ± 11.6%	63.4 ± 24.8%
Right Lap Belt Reslt Force (N)	219.7 ± 191.0%	430.9 ± 350.8%	91.9 ± 5.8%
Left Shoulder Belt Reslt Force (N)	87.6 ± 11.5%	87.9 ± 97.2%	64.5 ± 23.6%
Right Shoulder Belt Reslt Force (N)	218.1 ± 347.3%	96.1 ± 78.9%	101.1 ± 122.0%
Middle Crotch Belt Reslt Force (N)	72.8 ± 14.9%	59.9 ± 23.7%	55.4 ± 31.0%
HIC15	78.0 ± 30.6%	84.0 ± 23.7%	84.4 ± 46.5%
HIC36	75.9 ± 35.1%	81.1 ± 21.5%	76.5 ± 32.4%
Upper NIJ	41.3 ± 18.5%	86.9 ± 61.2%	65.4 ± 40.3%
Nkm	33.4 ± 19.6%	80.8 ± 54.7%	85.8 ± 51.6%

Table B-7: Lateral Impact Total Error

Magnitude Error	*FTSS*	*MADYMO*	*CCIP*
Head X Acc (g)	44.8 ± 28.9%	71.5 ± 71.2%	89.9 ± 84.1%
Head Y Acc (g)	47.1 ± 21.2%	55.8 ± 27.7%	48.4 ± 28.5%
Head Z Acc (g)	50.8 ± 40.5%	80.5 ± 65.4%	43.5 ± 42.7%
Head Reslt Acc (g)	43.9 ± 19.0%	52.0 ± 24.6%	43.9 ± 25.4%

Head X Vel (rad/sec)	299.1 ± 298.5%	53.9 ± 60.9%	234.3 ± 278.8%
Head Y Vel (rad/sec)	53.9 ± 26.8%	62.5 ± 28.0%	52.9 ± 28.9%
Head Z Vel (rad/sec)	174.9 ± 284.8%	233.5 ± 330.6%	179.8 ± 252.7%
Head Reslt Vel (rad/sec)	51.2 ± 25.3%	58.6 ± 26.6%	46.6 ± 26.9%
Head X Disp (mm)			
Head Y Disp (mm)			
Head Z Disp (mm)			
Head Y Rot Acc (g)	31.2 ± 17.9%		64.9 ± 66.1%
Head Y Rot Vel (rad/sec)	42.6 ± 23.8%		66.7 ± 74.3%
Chest X Acc (g)	28.9 ± 16.9%	47.0 ± 17.1%	40.6 ± 58.2%
Chest Y Acc (g)	8.4 ± 5.6%	20.9 ± 34.9%	8.9 ± 11.8%
Chest Z Acc (g)	29.7 ± 23.9%	30.6 ± 17.6%	26.7 ± 37.3%
Chest Reslt Acc (g)	7.5 ± 5.1%	19.9 ± 32.8%	8.7 ± 10.6%
Chest X Disp (mm)			
Chest Y Disp (mm)	74.3 ± 57.3%	83.4 ± 33.8%	30.5 ± 32.4%
Chest Z Disp (mm)	113.7 ± 104.6%	48.2 ± 20.9%	117.5 ± 35.1%
Neck Upper X Force (N)	30.7 ± 24.0%	59.5 ± 49.2%	70.3 ± 51.2%
Neck Upper Y Force (N)	46.8 ± 22.6%	163.0 ± 146.2%	99.6 ± 97.6%
Neck Upper Z Force (N)	39.7 ± 27.6%	99.6 ± 97.4%	42.6 ± 46.0%
Neck Upper Reslt Force (N)	35.4 ± 27.0%	116.9 ± 115.6%	60.9 ± 63.7%
Neck Upper X Moment (Nm)	36.0 ± 17.2%	125.0 ± 95.7%	49.1 ± 21.4%
Neck Upper Y Moment (Nm)	37.6 ± 19.9%	60.9 ± 67.1%	91.4 ± 70.0%
Neck Upper Z Moment (Nm)	64.4 ± 59.7%	181.9 ± 213.8%	650.0 ± 562.6%
Neck Upper Reslt Moment (Nm)	28.1 ± 18.5%	119.3 ± 83.3%	77.7 ± 71.8%
Lumbar Lower X Force (N)	36.3 ± 36.0%	86.2 ± 52.7%	57.1 ± 46.3%
Lumbar Lower Z Force (N)	90.4 ± 92.6%	81.1 ± 76.1%	58.9 ± 42.0%
Lumbar Lower Y Moment (Nm)	201.3 ± 191.0%	101.8 ± 72.4%	201.2 ± 170.9%
Pelvis X Disp (mm)			
Pelvis Y Disp (mm)			
Pelvis Z Disp (mm)			
Left Lap Belt Reslt Force (N)	33.6 ± 23.3%	79.6 ± 11.7%	60.4 ± 25.8%
Right Lap Belt Reslt Force (N)	217.2 ± 192.8%	427.8 ± 354.1%	87.8 ± 7.0%
Left Shoulder Belt Reslt Force (N)	83.4 ± 14.0%	82.7 ± 100.1%	58.9 ± 28.5%
Right Shoulder Belt Reslt Force (N)	212.5 ± 350.4%	92.2 ± 80.2%	95.5 ± 124.4%
Middle Crotch Belt Reslt Force (N)	70.7 ± 14.7%	58.0 ± 22.8%	52.1 ± 31.8%
HIC15	74.3 ± 30.3%	77.3 ± 28.1%	81.0 ± 46.2%
HIC36	74.1 ± 35.6%	75.8 ± 28.9%	74.7 ± 32.0%
Upper NIJ	34.6 ± 20.1%	82.1 ± 62.3%	61.3 ± 41.4%
Nkm	27.2 ± 20.7%	76.4 ± 57.7%	81.8 ± 54.4%

Table B-8: Lateral Impact Magnitude Error

Phase Error	***FTSS***	***MADYMO***	***CCIP***
Head X Acc (g)	40.1 ± 15.0%	45.3 ± 11.6%	47.8 ± 8.4%
Head Y Acc (g)	33.6 ± 24.6%	38.2 ± 20.4%	36.5 ± 25.3%
Head Z Acc (g)	44.8 ± 20.7%	42.0 ± 20.9%	37.1 ± 16.5%
Head Reslt Acc (g)	21.8 ± 9.1%	25.3 ± 10.3%	22.9 ± 10.7%
Head X Vel (rad/sec)	23.7 ± 30.0%	35.8 ± 29.7%	24.8 ± 23.5%
Head Y Vel (rad/sec)	21.2 ± 38.7%	24.9 ± 39.2%	24.1 ± 40.4%
Head Z Vel (rad/sec)	60.1 ± 41.3%	53.1 ± 40.7%	55.8 ± 42.2%
Head Reslt Vel (rad/sec)	3.0 ± 2.8%	3.3 ± 1.4%	3.2 ± 2.5%
Head X Disp (mm)			

Head Y Disp (mm)			
Head Z Disp (mm)			
Head Y Rot Acc (g)	50.3 ± 12.3%		38.2 ± 14.9%
Head Y Rot Vel (rad/sec)	48.0 ± 16.1%		31.5 ± 17.7%
Chest X Acc (g)	40.8 ± 5.2%	53.8 ± 5.3%	49.3 ± 8.2%
Chest Y Acc (g)	32.4 ± 31.7%	33.9 ± 27.3%	33.0 ± 32.0%
Chest Z Acc (g)	44.5 ± 12.8%	43.2 ± 6.9%	43.2 ± 10.8%
Chest Reslt Acc (g)	14.8 ± 7.7%	17.1 ± 6.7%	14.0 ± 6.4%
Chest X Disp (mm)			
Chest Y Disp (mm)	9.4 ± 7.0%	12.7 ± 13.3%	7.7 ± 1.9%
Chest Z Disp (mm)	65.1 ± 6.1%	45.2 ± 15.7%	52.3 ± 14.9%
Neck Upper X Force (N)	39.8 ± 19.7%	40.6 ± 18.8%	49.2 ± 21.3%
Neck Upper Y Force (N)	73.7 ± 13.2%	73.0 ± 12.0%	78.7 ± 11.0%
Neck Upper Z Force (N)	43.4 ± 16.5%	45.3 ± 18.8%	42.6 ± 18.7%
Neck Upper Reslt Force (N)	17.9 ± 5.4%	22.5 ± 10.9%	19.2 ± 9.1%
Neck Upper X Moment (Nm)	38.6 ± 19.7%	37.0 ± 13.2%	51.3 ± 20.6%
Neck Upper Y Moment (Nm)	53.0 ± 15.6%	40.3 ± 9.7%	34.6 ± 16.7%
Neck Upper Z Moment (Nm)	42.9 ± 19.4%	46.3 ± 22.3%	45.6 ± 16.5%
Neck Upper Reslt Moment (Nm)	18.1 ± 6.8%	25.3 ± 10.0%	15.2 ± 3.4%
Lumbar Lower X Force (N)	40.0 ± 18.2%	47.9 ± 16.5%	53.7 ± 18.5%
Lumbar Lower Z Force (N)	52.2 ± 25.1%	47.0 ± 20.3%	50.6 ± 21.6%
Lumbar Lower Y Moment (Nm)	42.7 ± 26.4%	56.5 ± 24.0%	56.5 ± 24.1%
Pelvis X Disp (mm)			
Pelvis Y Disp (mm)			
Pelvis Z Disp (mm)			
Left Lap Belt Reslt Force (N)	9.2 ± 2.1%	22.9 ± 4.0%	17.2 ± 4.8%
Right Lap Belt Reslt Force (N)	20.7 ± 5.1%	22.7 ± 5.6%	26.3 ± 4.0%
Left Shoulder Belt Reslt Force (N)	25.2 ± 5.2%	18.3 ± 5.2%	20.4 ± 5.5%
Right Shoulder Belt Reslt Force (N)	20.6 ± 7.4%	22.6 ± 6.7%	22.2 ± 7.5%
Middle Crotch Belt Reslt Force (N)	17.2 ± 3.3%	14.0 ± 8.5%	16.7 ± 5.3%
HIC15	21.0 ± 12.4%	27.2 ± 12.2%	21.2 ± 11.9%
HIC36	12.5 ± 10.2%	18.9 ± 12.0%	13.5 ± 11.2%
Upper NIJ	20.6 ± 5.6%	25.0 ± 8.2%	19.9 ± 6.6%
Nkm	17.5 ± 5.5%	19.3 ± 3.6%	19.9 ± 3.4%

Table B-9: Lateral Impact Phase Error

B-4. Spinal Impact

Total Error	*FTSS*	*MADYMO*	*CCIP*
Head X Acc (g)	32.9 ± 52.7%	62.6 ± 15.9%	32.2 ± 46.9%
Head Y Acc (g)	59.8 ± 11.5%	75.8 ± 14.3%	60.6 ± 16.5%
Head Z Acc (g)	23.7 ± 7.5%	15.0 ± 5.5%	30.2 ± 10.6%
Head Reslt Acc (g)	14.1 ± 9.8%	24.8 ± 10.2%	19.1 ± 14.2%
Head X Vel (rad/sec)	21.7 ± 28.6%	91.6 ± 12.6%	22.9 ± 29.8%
Head Y Vel (rad/sec)	65.3 ± 23.8%	89.5 ± 23.7%	71.2 ± 23.7%
Head Z Vel (rad/sec)	23.1 ± 11.3%	11.6 ± 15.5%	16.2 ± 10.7%
Head Reslt Vel (rad/sec)	11.8 ± 3.9%	10.3 ± 6.4%	10.3 ± 4.4%
Head X Disp (mm)	50.2 ± 1.1%	25.7 ± 14.5%	25.2 ± 0.1%
Head Y Disp (mm)			
Head Z Disp (mm)	28.4 ± 1.4%	51.9 ± 10.1%	11.7 ± 3.9%
Head Y Rot Acc (g)	37.8 ± 23.4%		95.6 ± 87.1%
Head Y Rot Vel (rad/sec)	37.0 ± 40.5%		71.3 ± 46.2%
Chest X Acc (g)	35.6 ± 19.7%	89.1 ± 36.6%	71.1 ± 37.7%
Chest Y Acc (g)	57.4 ± 47.8%	41.2 ± 19.2%	59.3 ± 33.0%
Chest Z Acc (g)	8.8 ± 2.4%	22.5 ± 8.3%	18.6 ± 10.5%
Chest Reslt Acc (g)	7.0 ± 2.2%	14.4 ± 8.4%	18.4 ± 11.5%
Chest X Disp (mm)	391.5 ± 176.5%	104.3 ± 46.9%	186.7 ± 89.6%
Chest Y Disp (mm)			
Chest Z Disp (mm)	248.1 ± 66.8%	88.6 ± 42.3%	259.5 ± 97.9%
Neck Upper X Force (N)	39.0 ± 46.1%	69.7 ± 15.9%	76.2 ± 60.5%
Neck Upper Y Force (N)	158.3 ± 111.5%	99.5 ± 71.4%	134.0 ± 75.9%
Neck Upper Z Force (N)	17.8 ± 5.9%	29.6 ± 10.1%	59.5 ± 28.9%
Neck Upper Reslt Force (N)	18.3 ± 8.7%	17.4 ± 6.8%	58.9 ± 22.7%
Neck Upper X Moment (Nm)	123.9 ± 72.9%	68.7 ± 48.2%	67.0 ± 15.0%
Neck Upper Y Moment (Nm)	36.6 ± 35.2%	53.2 ± 17.8%	69.2 ± 54.2%
Neck Upper Z Moment (Nm)	67.1 ± 12.0%	75.0 ± 20.4%	135.3 ± 79.9%
Neck Upper Reslt Moment (Nm)	35.4 ± 33.8%	45.9 ± 18.9%	65.0 ± 54.1%
Lumbar Lower X Force (N)	44.1 ± 35.9%	82.1 ± 8.9%	92.8 ± 25.3%
Lumbar Lower Z Force (N)	38.6 ± 30.1%	35.9 ± 29.3%	65.3 ± 22.9%
Lumbar Lower Y Moment (Nm)	76.6 ± 26.0%	90.2 ± 9.1%	127.9 ± 31.0%
Pelvis X Disp (mm)	89.7 ± 14.3%	71.8 ± 26.0%	71.2 ± 18.0%
Pelvis Y Disp (mm)			
Pelvis Z Disp (mm)	71.0 ± 3.4%	38.7 ± 29.9%	33.2 ± 6.8%
Left Lap Belt Reslt Force (N)	250.6 ± 168.9%	229.4 ± 134.0%	72.3 ± 26.2%
Right Lap Belt Reslt Force (N)	402.3 ± 243.0%	329.5 ± 220.5%	125.0 ± 137.7%
Left Shoulder Belt Reslt Force (N)	81.6 ± 88.7%	48.6 ± 13.1%	44.8 ± 49.9%
Right Shoulder Belt Reslt Force (N)	97.7 ± 125.5%	68.6 ± 18.0%	118.4 ± 187.8%
Middle Crotch Belt Reslt Force (N)	282.8 ± 223.7%	142.8 ± 114.8%	73.6 ± 27.5%
HIC15	29.5 ± 27.3%	47.9 ± 17.3%	62.7 ± 55.5%
HIC36	126.7 ± 175.3%	46.0 ± 18.8%	114.1 ± 194.3%
Upper NIJ	16.6 ± 5.6%	23.8 ± 10.9%	61.6 ± 38.8%
Nkm	37.3 ± 42.1%	48.6 ± 13.9%	71.6 ± 56.2%

Table B-10: Spinal Impact Total Error

Magnitude E.rror	*FTSS*	*MADYMO*	*CCIP*
Head X Acc (g)	30.2 ± 51.8%	56.6 ± 17.9%	27.8 ± 46.2%
Head Y Acc (g)	40.0 ± 23.6%	64.0 ± 21.5%	44.7 ± 19.3%
Head Z Acc (g)	14.2 ± 6.9%	9.0 ± 4.8%	16.6 ± 14.6%
Head Reslt Acc (g)	10.2 ± 9.9%	21.2 ± 11.5%	14.5 ± 15.2%

Head X Vel (rad/sec)	16.8 ± 15.9%	71.3 ± 10.0%	17.2 ± 15.9%
Head Y Vel (rad/sec)	49.0 ± 26.8%	73.7 ± 17.9%	59.0 ± 25.9%
Head Z Vel (rad/sec)	21.8 ± 10.5%	11.1 ± 15.4%	14.9 ± 11.4%
Head Reslt Vel (rad/sec)	11.5 ± 3.7%	9.6 ± 6.7%	9.4 ± 5.2%
Head X Disp (mm)	50.1 ± 1.1%	25.2 ± 15.1%	24.7 ± 0.3%
Head Y Disp (mm)			
Head Z Disp (mm)	28.3 ± 1.4%	51.7 ± 10.0%	11.0 ± 4.4%
Head Y Rot Acc (g)	31.5 ± 24.6%		90.0 ± 89.0%
Head Y Rot Vel (rad/sec)	32.7 ± 39.8%		68.8 ± 45.6%
Chest X Acc (g)	29.4 ± 23.5%	86.2 ± 38.8%	66.4 ± 39.6%
Chest Y Acc (g)	39.4 ± 47.5%	15.7 ± 17.1%	39.1 ± 36.3%
Chest Z Acc (g)	6.6 ± 2.0%	20.4 ± 9.7%	10.9 ± 10.4%
Chest Reslt Acc (g)	3.6 ± 1.9%	12.2 ± 8.8%	13.3 ± 12.2%
Chest X Disp (mm)	388.7 ± 173.3%	92.5 ± 33.6%	179.8 ± 82.4%
Chest Y Disp (mm)			
Chest Z Disp (mm)	246.9 ± 65.6%	87.5 ± 42.4%	259.1 ± 97.8%
Neck Upper X Force (N)	35.9 ± 46.0%	41.5 ± 18.0%	74.6 ± 59.9%
Neck Upper Y Force (N)	150.2 ± 113.8%	81.3 ± 79.1%	124.6 ± 78.7%
Neck Upper Z Force (N)	9.1 ± 8.2%	24.5 ± 13.4%	52.3 ± 31.1%
Neck Upper Reslt Force (N)	14.7 ± 9.7%	9.9 ± 7.3%	57.8 ± 22.4%
Neck Upper X Moment (Nm)	114.2 ± 74.9%	47.5 ± 54.3%	30.6 ± 21.2%
Neck Upper Y Moment (Nm)	33.3 ± 36.0%	40.6 ± 21.8%	55.2 ± 62.3%
Neck Upper Z Moment (Nm)	47.5 ± 27.5%	53.6 ± 22.3%	127.1 ± 82.9%
Neck Upper Reslt Moment (Nm)	32.6 ± 34.8%	40.5 ± 21.9%	54.4 ± 61.4%
Lumbar Lower X Force (N)	27.9 ± 24.6%	71.8 ± 9.0%	82.1 ± 26.9%
Lumbar Lower Z Force (N)	16.9 ± 12.2%	13.6 ± 10.5%	48.2 ± 24.8%
Lumbar Lower Y Moment (Nm)	74.5 ± 26.5%	35.0 ± 21.3%	94.5 ± 40.6%
Pelvis X Disp (mm)	69.3 ± 24.1%	69.5 ± 28.7%	39.2 ± 38.1%
Pelvis Y Disp (mm)			
Pelvis Z Disp (mm)	70.6 ± 3.1%	38.1 ± 29.6%	29.1 ± 8.7%
Left Lap Belt Reslt Force (N)	249.4 ± 169.4%	228.0 ± 135.0%	65.6 ± 31.6%
Right Lap Belt Reslt Force (N)	401.4 ± 243.2%	327.8 ± 221.6%	119.8 ± 140.3%
Left Shoulder Belt Reslt Force (N)	76.8 ± 91.2%	36.9 ± 17.4%	37.4 ± 53.8%
Right Shoulder Belt Reslt Force (N)	91.0 ± 129.5%	63.5 ± 19.7%	114.1 ± 190.0%
Middle Crotch Belt Reslt Force (N)	281.6 ± 224.5%	137.8 ± 118.5%	63.2 ± 33.8%
HIC15	24.7 ± 27.3%	42.6 ± 16.9%	59.4 ± 56.5%
HIC36	122.9 ± 176.9%	40.4 ± 20.8%	111.5 ± 194.8%
Upper NIJ	12.3 ± 6.7%	18.9 ± 11.8%	59.6 ± 39.5%
Nkm	35.1 ± 42.6%	39.9 ± 16.4%	69.8 ± 57.1%

Table B-11: Spinal Impact Magnitude Error

Phase Error	*FTSS*	*MADYMO*	*CCIP*
Head X Acc (g)	11.2 ± 12.0%	25.4 ± 4.0%	13.2 ± 12.9%
Head Y Acc (g)	34.4 ± 21.6%	35.0 ± 14.4%	34.6 ± 21.0%
Head Z Acc (g)	18.6 ± 4.9%	11.4 ± 4.9%	23.0 ± 5.2%
Head Reslt Acc (g)	9.0 ± 3.7%	11.4 ± 3.2%	10.6 ± 4.3%
Head X Vel (rad/sec)	10.8 ± 25.5%	54.3 ± 21.6%	12.7 ± 26.7%
Head Y Vel (rad/sec)	32.7 ± 27.2%	43.1 ± 32.6%	33.2 ± 21.0%
Head Z Vel (rad/sec)	7.0 ± 5.1%	2.9 ± 2.5%	4.8 ± 2.0%
Head Reslt Vel (rad/sec)	2.4 ± 1.4%	2.9 ± 1.7%	3.1 ± 1.8%
Head X Disp (mm)	3.6 ± 0.5%	4.1 ± 1.7%	4.6 ± 1.0%

Head Y Disp (mm)			
Head Z Disp (mm)	1.4 ± 0.1%	5.1 ± 1.9%	3.6 ± 0.9%
Head Y Rot Acc (g)	18.8 ± 5.6%		27.1 ± 4.2%
Head Y Rot Vel (rad/sec)	14.7 ± 12.2%		16.9 ± 11.0%
Chest X Acc (g)	16.0 ± 1.7%	18.5 ± 4.7%	22.1 ± 6.1%
Chest Y Acc (g)	36.6 ± 22.0%	34.1 ± 20.0%	39.0 ± 17.3%
Chest Z Acc (g)	5.7 ± 1.8%	7.5 ± 3.6%	14.1 ± 5.7%
Chest Reslt Acc (g)	5.8 ± 1.7%	6.6 ± 3.0%	11.5 ± 4.1%
Chest X Disp (mm)	43.9 ± 39.4%	45.7 ± 38.9%	49.0 ± 39.0%
Chest Y Disp (mm)			
Chest Z Disp (mm)	23.0 ± 16.5%	13.6 ± 2.8%	13.6 ± 5.2%
Neck Upper X Force (N)	12.6 ± 9.3%	54.1 ± 12.4%	13.4 ± 12.0%
Neck Upper Y Force (N)	41.0 ± 19.9%	43.7 ± 19.9%	44.4 ± 10.8%
Neck Upper Z Force (N)	13.8 ± 3.9%	13.1 ± 6.1%	25.8 ± 5.7%
Neck Upper Reslt Force (N)	9.6 ± 3.1%	13.7 ± 3.9%	11.3 ± 4.1%
Neck Upper X Moment (Nm)	42.6 ± 16.1%	42.8 ± 8.7%	57.3 ± 9.5%
Neck Upper Y Moment (Nm)	12.5 ± 4.8%	32.0 ± 4.7%	29.3 ± 8.8%
Neck Upper Z Moment (Nm)	37.1 ± 18.9%	48.2 ± 20.3%	40.4 ± 10.4%
Neck Upper Reslt Moment (Nm)	11.1 ± 3.6%	18.7 ± 1.9%	22.4 ± 5.4%
Lumbar Lower X Force (N)	28.6 ± 32.9%	37.7 ± 13.2%	33.4 ± 28.0%
Lumbar Lower Z Force (N)	29.2 ± 34.0%	31.2 ± 29.9%	34.6 ± 27.5%
Lumbar Lower Y Moment (Nm)	17.3 ± 2.4%	81.0 ± 4.8%	82.5 ± 4.2%
Pelvis X Disp (mm)	55.1 ± 6.9%	14.4 ± 9.1%	54.4 ± 3.9%
Pelvis Y Disp (mm)			
Pelvis Z Disp (mm)	7.8 ± 2.4%	6.9 ± 4.1%	15.4 ± 1.8%
Left Lap Belt Reslt Force (N)	21.7 ± 3.7%	18.8 ± 6.4%	25.4 ± 2.5%
Right Lap Belt Reslt Force (N)	24.1 ± 5.9%	25.2 ± 7.2%	24.7 ± 6.1%
Left Shoulder Belt Reslt Force (N)	18.5 ± 4.3%	29.4 ± 4.6%	15.4 ± 4.1%
Right Shoulder Belt Reslt Force (N)	18.1 ± 4.2%	24.7 ± 3.9%	15.0 ± 6.7%
Middle Crotch Belt Reslt Force (N)	18.8 ± 2.3%	25.1 ± 4.7%	32.0 ± 7.5%
HIC15	14.2 ± 8.2%	21.2 ± 6.4%	16.6 ± 5.7%
HIC36	18.3 ± 12.0%	19.8 ± 5.5%	16.7 ± 12.9%
Upper NIJ	10.3 ± 2.8%	13.2 ± 4.2%	13.5 ± 3.4%
Nkm	10.1 ± 4.6%	26.3 ± 4.0%	12.1 ± 5.2%

Table B-12: Spinal Impact Phase Error

B-5. Overall Model Performance

Total Error	FTSS	MADYMO	CCIP
Head X Acc (g)	37.7 ± 35.9%	54.9 ± 52.0%	58.9 ± 65.7%
Head Y Acc (g)	68.3 ± 17.0%	79.8 ± 20.6%	73.1 ± 22.1%
Head Z Acc (g)	54.3 ± 31.3%	49.2 ± 52.1%	45.8 ± 28.0%
Head Reslt Acc (g)	27.7 ± 19.9%	34.8 ± 24.7%	32.0 ± 22.9%
Head X Vel (rad/sec)	112.3 ± 215.7%	54.6 ± 49.9%	104.2 ± 204.9%
Head Y Vel (rad/sec)	82.9 ± 45.2%	101.4 ± 53.9%	79.7 ± 24.7%
Head Z Vel (rad/sec)	161.5 ± 287.4%	147.3 ± 240.6%	159.4 ± 257.4%
Head Reslt Vel (rad/sec)	22.4 ± 25.5%	27.7 ± 29.2%	23.4 ± 25.7%
Head X Disp (mm)	53.0 ± 15.1%	14.4 ± 12.8%	17.7 ± 11.2%
Head Y Disp (mm)			
Head Z Disp (mm)	41.2 ± 17.6%	44.1 ± 11.2%	15.1 ± 10.9%
Head Y Rot Acc (g)	55.0 ± 29.2%		100.1 ± 83.6%
Head Y Rot Vel (rad/sec)	63.2 ± 48.5%		91.1 ± 115.7%
Chest X Acc (g)	31.9 ± 21.0%	56.1 ± 36.8%	49.3 ± 45.3%
Chest Y Acc (g)	56.5 ± 36.0%	63.0 ± 37.1%	58.4 ± 33.0%
Chest Z Acc (g)	41.7 ± 35.1%	90.3 ± 92.4%	76.9 ± 75.3%
Chest Reslt Acc (g)	12.7 ± 7.2%	19.1 ± 20.5%	15.9 ± 9.6%
Chest X Disp (mm)	391.5 ± 176.5%	104.3 ± 46.9%	186.7 ± 89.6%
Chest Y Disp (mm)	75.4 ± 56.6%	84.9 ± 34.6%	33.2 ± 29.6%
Chest Z Disp (mm)	181.2 ± 96.0%	76.9 ± 24.5%	181.9 ± 88.5%
Neck Upper X Force (N)	50.5 ± 37.5%	75.9 ± 61.9%	73.3 ± 47.1%
Neck Upper Y Force (N)	109.8 ± 72.1%	131.7 ± 97.3%	113.0 ± 67.3%
Neck Upper Z Force (N)	44.6 ± 26.3%	64.1 ± 68.1%	70.9 ± 35.8%
Neck Upper Reslt Force (N)	28.1 ± 17.8%	63.9 ± 84.4%	57.3 ± 42.1%
Neck Upper X Moment (Nm)	82.2 ± 53.5%	95.1 ± 67.4%	71.0 ± 19.6%
Neck Upper Y Moment (Nm)	81.4 ± 76.0%	88.9 ± 88.8%	118.5 ± 104.1%
Neck Upper Z Moment (Nm)	89.7 ± 63.7%	152.7 ± 170.1%	344.8 ± 439.3%
Neck Upper Reslt Moment (Nm)	57.8 ± 58.4%	91.5 ± 79.4%	94.8 ± 83.1%
Lumbar Lower X Force (N)	54.0 ± 41.3%	83.7 ± 33.4%	79.5 ± 42.8%
Lumbar Lower Z Force (N)	75.4 ± 65.5%	78.2 ± 52.3%	82.1 ± 40.9%
Lumbar Lower Y Moment (Nm)	121.6 ± 124.5%	98.0 ± 47.5%	200.2 ± 112.7%
Pelvis X Disp (mm)	127.0 ± 32.0%	49.7 ± 22.4%	50.4 ± 21.5%
Pelvis Y Disp (mm)			
Pelvis Z Disp (mm)	94.0 ± 18.2%	63.0 ± 23.4%	41.3 ± 13.9%
Left Lap Belt Reslt Force (N)	100.0 ± 129.8%	131.8 ± 111.9%	66.9 ± 21.0%
Right Lap Belt Reslt Force (N)	203.5 ± 217.7%	293.2 ± 278.4%	93.8 ± 65.7%
Left Shoulder Belt Reslt Force (N)	62.6 ± 54.2%	118.6 ± 141.6%	54.0 ± 36.7%
Right Shoulder Belt Reslt Force (N)	148.0 ± 236.0%	114.4 ± 133.5%	83.2 ± 119.8%
Middle Crotch Belt Reslt Force (N)	136.7 ± 163.4%	166.1 ± 158.7%	217.2 ± 408.7%
HIC15	49.1 ± 31.2%	57.1 ± 29.5%	62.2 ± 44.1%
HIC36	71.2 ± 99.0%	51.4 ± 30.5%	64.8 ± 97.8%
Upper NIJ	38.6 ± 23.7%	63.9 ± 55.3%	72.9 ± 40.8%
Nkm	31.6 ± 25.8%	74.6 ± 61.8%	64.0 ± 47.0%

Table B-13: Overall Model Total Error

Magnitude Error	FTSS	MADYMO	CCIP
Head X Acc (g)	10.3 ± 8.0%	27.3 ± 26.3%	9.9 ± 7.2%
Head Y Acc (g)	47.1 ± 21.2%	55.8 ± 27.7%	48.4 ± 28.5%
Head Z Acc (g)	14.2 ± 6.9%	9.0 ± 4.8%	16.6 ± 14.6%
Head Reslt Acc (g)	8.1 ± 5.2%	15.5 ± 8.7%	9.3 ± 8.7%

Head X Vel (rad/sec)	14.0 ± 7.4%	31.2 ± 29.5%	10.8 ± 5.4%
Head Y Vel (rad/sec)	53.9 ± 26.8%	62.5 ± 28.0%	52.9 ± 28.9%
Head Z Vel (rad/sec)	21.8 ± 10.5%	11.1 ± 15.4%	14.9 ± 11.4%
Head Reslt Vel (rad/sec)	6.2 ± 5.3%	7.9 ± 4.9%	5.7 ± 4.3%
Head X Disp (mm)	52.9 ± 15.1%	13.8 ± 13.1%	16.1 ± 12.8%
Head Y Disp (mm)			
Head Z Disp (mm)	41.1 ± 17.5%	43.8 ± 11.1%	13.8 ± 11.9%
Head Y Rot Acc (g)	31.2 ± 17.9%	0	64.9 ± 66.1%
Head Y Rot Vel (rad/sec)	42.6 ± 23.8%	0	66.7 ± 74.3%
Chest X Acc (g)	20.6 ± 18.8%	45.0 ± 35.6%	34.3 ± 46.5%
Chest Y Acc (g)	29.4 ± 33.0%	29.1 ± 31.5%	27.3 ± 27.8%
Chest Z Acc (g)	27.2 ± 29.8%	73.0 ± 101.9%	30.0 ± 39.9%
Chest Reslt Acc (g)	6.9 ± 4.9%	14.0 ± 20.6%	10.1 ± 9.4%
Chest X Disp (mm)	388.7 ± 173.3%	92.5 ± 33.6%	179.8 ± 82.4%
Chest Y Disp (mm)	74.3 ± 57.3%	83.4 ± 33.8%	30.5 ± 32.4%
Chest Z Disp (mm)	167.0 ± 109.0%	63.9 ± 33.7%	174.1 ± 95.0%
Neck Upper X Force (N)	35.8 ± 33.0%	62.0 ± 63.5%	55.5 ± 47.8%
Neck Upper Y Force (N)	83.0 ± 82.2%	117.8 ± 114.7%	94.7 ± 83.0%
Neck Upper Z Force (N)	30.0 ± 23.5%	51.2 ± 69.8%	56.2 ± 39.7%
Neck Upper Reslt Force (N)	20.3 ± 19.8%	59.6 ± 85.6%	53.2 ± 43.5%
Neck Upper X Moment (Nm)	64.3 ± 58.1%	83.9 ± 79.4%	42.6 ± 23.6%
Neck Upper Y Moment (Nm)	67.4 ± 79.7%	74.7 ± 92.8%	108.8 ± 108.7%
Neck Upper Z Moment (Nm)	69.2 ± 68.8%	155.9 ± 187.7%	358.9 ± 481.5%
Neck Upper Reslt Moment (Nm)	53.0 ± 60.3%	86.5 ± 82.0%	89.5 ± 86.5%
Lumbar Lower X Force (N)	41.0 ± 42.1%	73.3 ± 35.5%	65.3 ± 46.3%
Lumbar Lower Z Force (N)	54.3 ± 67.4%	55.8 ± 56.4%	61.9 ± 44.8%
Lumbar Lower Y Moment (Nm)	115.8 ± 125.5%	66.5 ± 54.1%	181.1 ± 124.0%
Pelvis X Disp (mm)	120.2 ± 42.6%	48.9 ± 22.2%	39.5 ± 20.8%
Pelvis Y Disp (mm)			
Pelvis Z Disp (mm)	73.4 ± 4.4%	62.7 ± 23.5%	36.8 ± 12.7%
Left Lap Belt Reslt Force (N)	98.4 ± 130.3%	129.5 ± 113.0%	63.2 ± 22.8%
Right Lap Belt Reslt Force (N)	201.7 ± 218.5%	291.1 ± 279.7%	89.9 ± 66.6%
Left Shoulder Belt Reslt Force (N)	57.1 ± 56.3%	113.2 ± 144.4%	48.9 ± 39.2%
Right Shoulder Belt Reslt Force (N)	143.0 ± 238.4%	111.0 ± 134.5%	78.7 ± 121.3%
Middle Crotch Belt Reslt Force (N)	133.7 ± 164.7%	115.1 ± 104.7%	54.4 ± 29.6%
HIC15	43.8 ± 31.9%	51.9 ± 29.9%	56.5 ± 45.9%
HIC36	68.7 ± 99.4%	47.0 ± 32.3%	61.4 ± 98.7%
Upper NIJ	33.9 ± 24.8%	59.6 ± 56.3%	70.1 ± 41.8%
Nkm	26.8 ± 26.5%	70.1 ± 64.1%	60.5 ± 48.5%

Table B-14: Overall Model Magnitude Error

Phase Error	***FTSS***	***MADYMO***	***CCIP***
Head X Acc (g)	22.7 ± 16.9%	27.5 ± 17.0%	28.8 ± 18.1%
Head Y Acc (g)	40.1 ± 22.8%	44.4 ± 20.0%	43.0 ± 22.4%
Head Z Acc (g)	26.7 ± 18.1%	24.4 ± 19.2%	27.2 ± 14.0%
Head Reslt Acc (g)	15.2 ± 8.3%	16.2 ± 10.0%	17.7 ± 9.0%
Head X Vel (rad/sec)	11.7 ± 23.0%	28.3 ± 29.6%	13.8 ± 21.4%
Head Y Vel (rad/sec)	35.8 ± 36.8%	43.4 ± 38.5%	40.8 ± 37.3%
Head Z Vel (rad/sec)	23.7 ± 35.0%	22.3 ± 34.2%	25.0 ± 36.5%
Head Reslt Vel (rad/sec)	2.6 ± 1.9%	2.7 ± 1.6%	2.8 ± 1.9%
Head X Disp (mm)	3.0 ± 0.9%	3.3 ± 1.4%	4.7 ± 0.9%

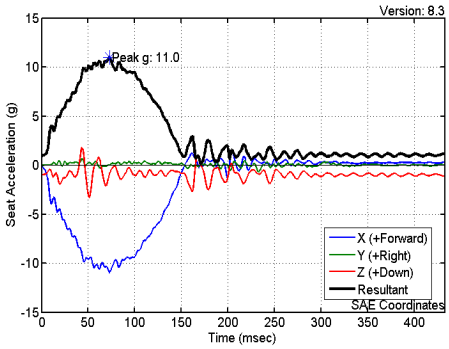
Head Y Disp (mm)			
Head Z Disp (mm)	3.1 ± 2.3%	4.9 ± 2.2%	3.8 ± 1.9%
Head Y Rot Acc (g)	39.0 ± 17.9%		37.3 ± 12.5%
Head Y Rot Vel (rad/sec)	37.4 ± 21.7%		30.0 ± 18.5%
Chest X Acc (g)	21.7 ± 14.5%	27.5 ± 21.5%	27.7 ± 19.7%
Chest Y Acc (g)	44.2 ± 29.3%	47.0 ± 27.6%	45.5 ± 26.2%
Chest Z Acc (g)	26.8 ± 18.8%	30.0 ± 15.3%	32.1 ± 14.1%
Chest Reslt Acc (g)	10.2 ± 6.2%	10.8 ± 6.8%	11.2 ± 5.5%
Chest X Disp (mm)	43.9 ± 39.4%	45.7 ± 38.9%	49.0 ± 39.0%
Chest Y Disp (mm)	9.4 ± 7.0%	12.7 ± 13.3%	7.7 ± 1.9%
Chest Z Disp (mm)	48.3 ± 24.9%	32.5 ± 20.6%	36.8 ± 23.8%
Neck Upper X Force (N)	31.7 ± 24.4%	34.2 ± 23.8%	38.6 ± 27.7%
Neck Upper Y Force (N)	57.2 ± 20.4%	59.1 ± 18.9%	60.4 ± 18.1%
Neck Upper Z Force (N)	30.1 ± 18.3%	29.8 ± 19.8%	35.9 ± 17.2%
Neck Upper Reslt Force (N)	15.8 ± 7.4%	15.4 ± 9.5%	16.6 ± 7.4%
Neck Upper X Moment (Nm)	43.3 ± 16.3%	42.1 ± 11.5%	52.6 ± 14.6%
Neck Upper Y Moment (Nm)	34.1 ± 19.1%	37.1 ± 15.5%	33.2 ± 12.6%
Neck Upper Z Moment (Nm)	46.3 ± 21.7%	50.2 ± 22.1%	47.8 ± 14.3%
Neck Upper Reslt Moment (Nm)	16.9 ± 6.2%	20.4 ± 7.8%	19.5 ± 5.3%
Lumbar Lower X Force (N)	25.1 ± 23.7%	34.1 ± 18.4%	32.9 ± 26.2%
Lumbar Lower Z Force (N)	40.9 ± 29.2%	45.4 ± 22.8%	44.6 ± 24.7%
Lumbar Lower Y Moment (Nm)	27.0 ± 20.4%	61.7 ± 27.1%	62.0 ± 29.4%
Pelvis X Disp (mm)	20.4 ± 27.0%	6.1 ± 7.6%	21.3 ± 25.7%
Pelvis Y Disp (mm)			
Pelvis Z Disp (mm)	51.9 ± 35.1%	5.2 ± 2.7%	18.2 ± 7.2%
Left Lap Belt Reslt Force (N)	13.0 ± 6.5%	17.4 ± 7.7%	19.3 ± 6.2%
Right Lap Belt Reslt Force (N)	17.9 ± 8.0%	19.9 ± 8.7%	23.6 ± 6.7%
Left Shoulder Belt Reslt Force (N)	19.6 ± 7.6%	19.7 ± 8.8%	17.1 ± 7.0%
Right Shoulder Belt Reslt Force (N)	17.7 ± 6.8%	20.3 ± 8.6%	17.8 ± 7.8%
Middle Crotch Belt Reslt Force (N)	18.5 ± 5.7%	17.5 ± 8.0%	20.5 ± 9.0%
HIC15	18.9 ± 9.7%	21.0 ± 10.3%	21.1 ± 8.9%
HIC36	13.0 ± 9.3%	15.2 ± 9.8%	13.5 ± 9.6%
Upper NIJ	16.0 ± 6.1%	19.0 ± 7.8%	17.0 ± 5.9%
Nkm	14.4 ± 5.9%	17.3 ± 7.9%	16.3 ± 5.3%

Table B-15: Overall Model Phase Error

Appendix C. Wright-Patterson Sled Test Model Results

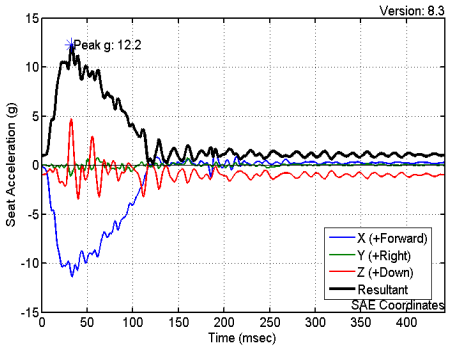
C.1 Frontal Impact

C.1.1 Seat Accelerations



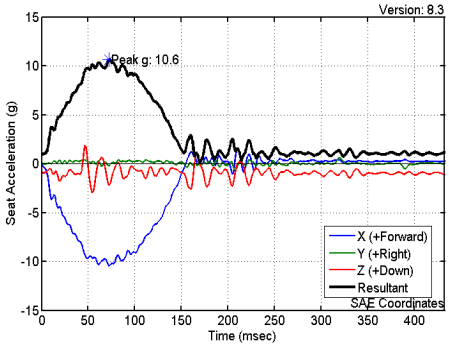
10G 70ms -X

Figure C-1-1: 8201 Seat Accelerations



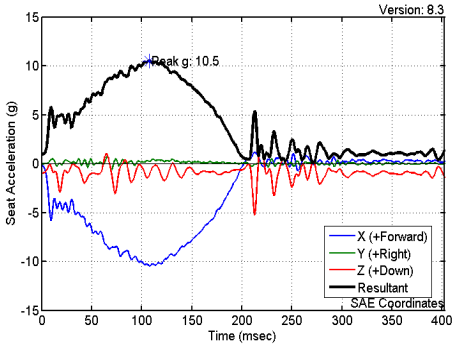
10G 30ms -X

Figure C-1-4: 8192 Seat Accelerations



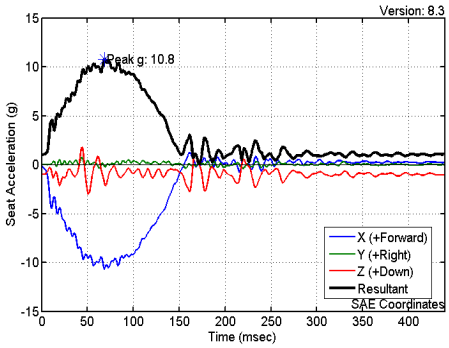
10G 70ms -X

Figure C-1-2: 8202 Seat Accelerations



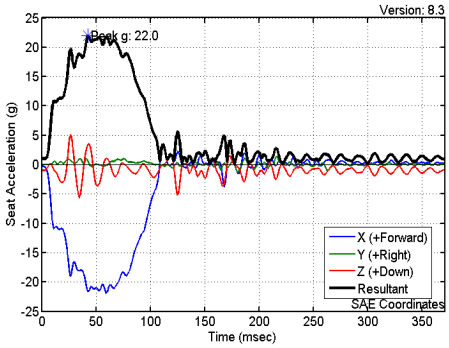
20G 110ms -X

Figure C-1-5: 8200 Seat Accelerations



10G 70ms -X

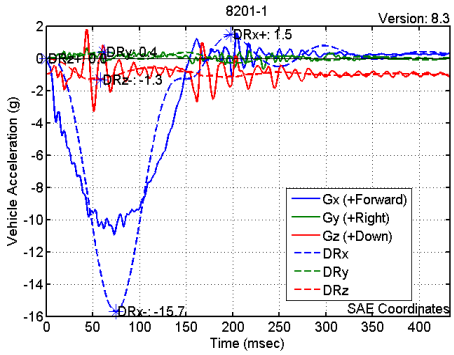
Figure C-1-3: 8204 Seat Accelerations



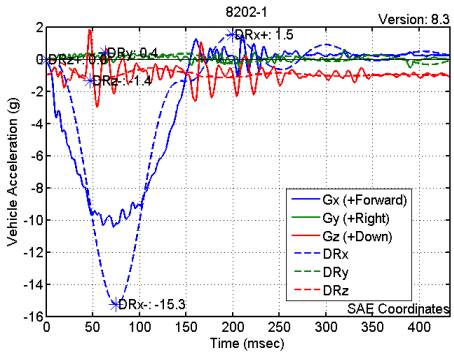
10G 110ms -X

Figure C-1-6: 8205 Seat Accelerations

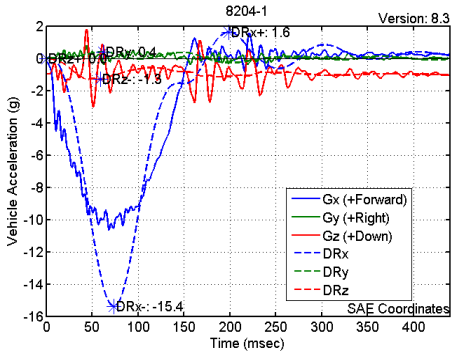
C.1.2 Dynamic Response Index



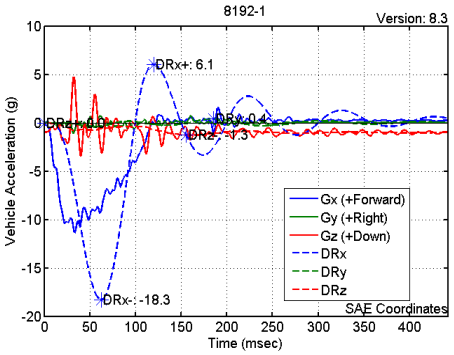
10G 70ms -X
Figure C-1-7: 8201 Dynamic Response Index



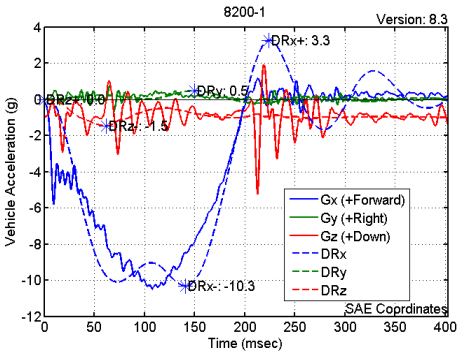
10G 70ms -X
Figure C-1-8: 8202 Dynamic Response Index



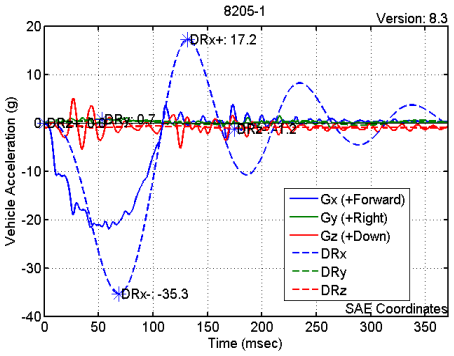
10G 70ms -X
Figure C-1-9: 8204 Dynamic Response Index



10G 30ms -X
Figure C-1-10: 8192 Dynamic Response Index

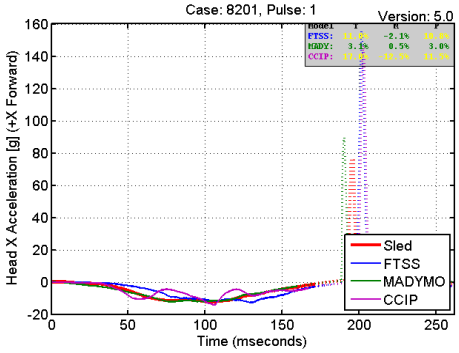


20G 110ms -X
Figure C-1-11: 8200 Dynamic Response Index

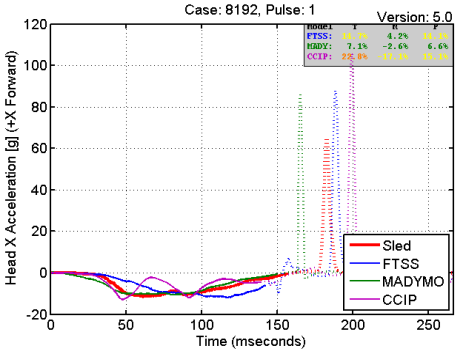


10G 110ms -X
Figure C-1-12: 8205 Dynamic Response Index

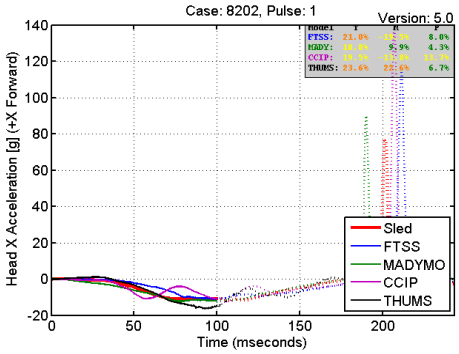
C.1.3 Head X Translational Acceleration



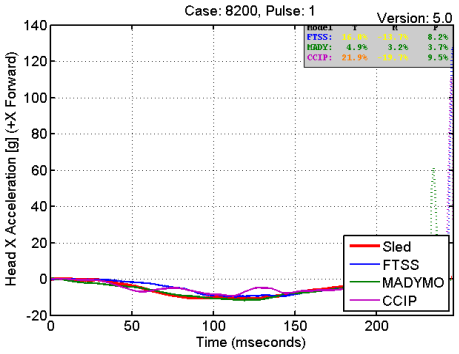
10G 70ms -X
Figure C-1-13: 8201 Head X Translational Acceleration



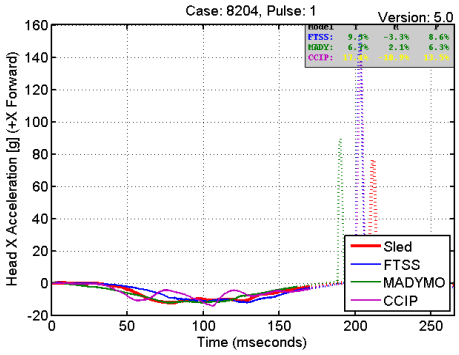
10G 30ms -X
Figure C-1-16: 8192 Head X Translational Acceleration



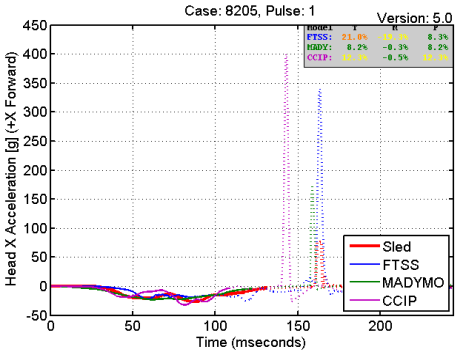
10G 70ms -X
Figure C-1-14: 8202 Head X Translational Acceleration



20G 110ms -X
Figure C-1-17: 8200 Head X Translational Acceleration

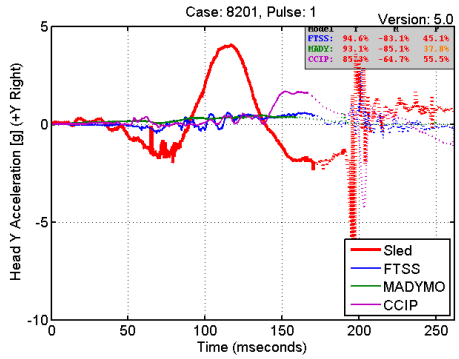


10G 70ms -X
Figure C-1-15: 8204 Head X Translational Acceleration

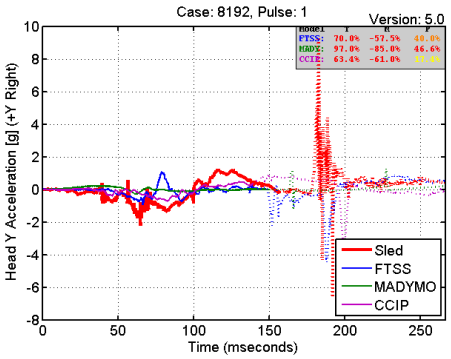


10G 110ms -X
Figure C-1-18: 8205 Head X Translational Acceleration

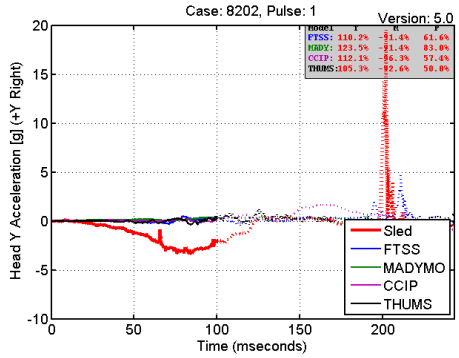
C.1.4 Head Y Translational Acceleration



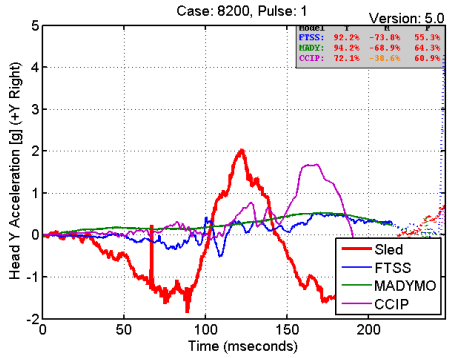
10G 70ms -X
Figure C-1-19: 8201 Head Y Translational Acceleration



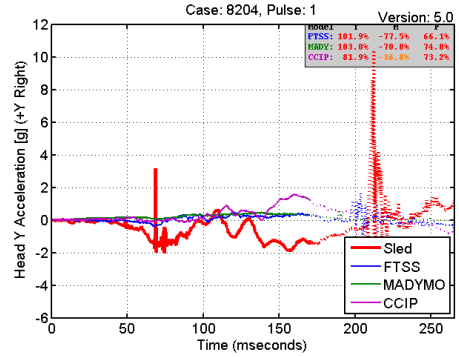
10G 30ms -X
Figure C-1-22: 8192 Head Y Translational Acceleration



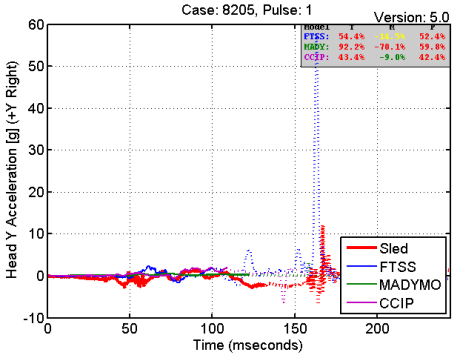
10G 70ms -X
Figure C-1-20: 8202 Head Y Translational Acceleration



20G 110ms -X
Figure C-1-23: 8200 Head Y Translational Acceleration

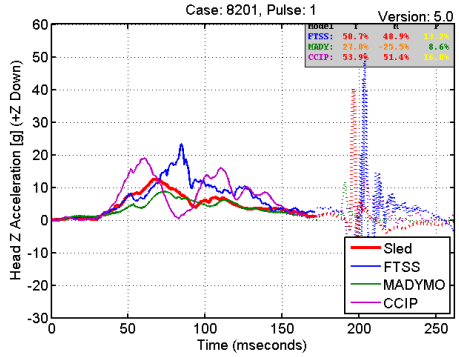


10G 70ms -X
Figure C-1-21: 8204 Head Y Translational Acceleration

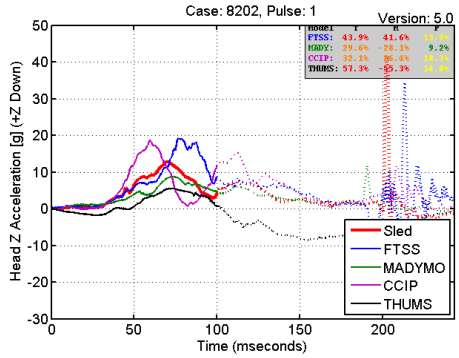


10G 110ms -X
Figure C-1-24: 8205 Head Y Translational Acceleration

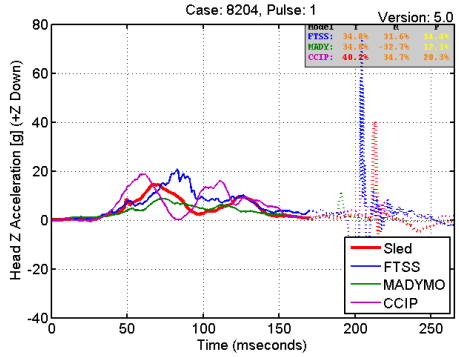
C.1.5 Head Z Translational Acceleration



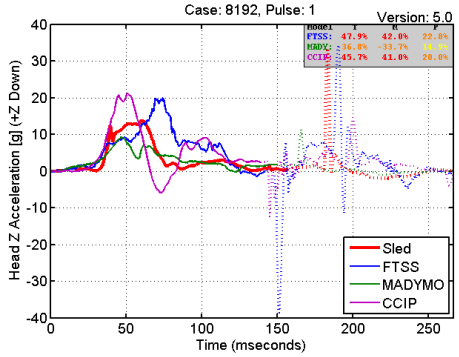
10G 70ms -X
Figure C-1-25: 8201 Head Z Translational Acceleration



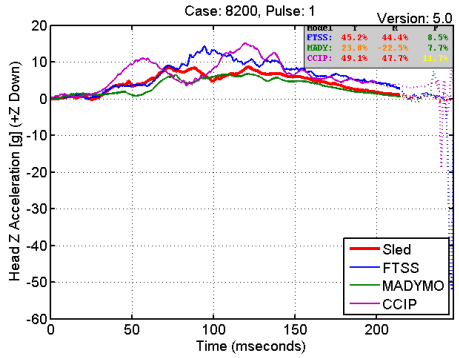
10G 70ms -X
Figure C-1-26: 8202 Head Z Translational Acceleration



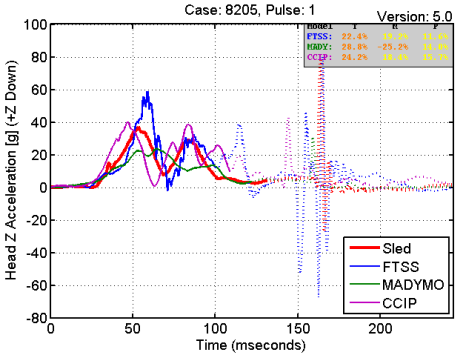
10G 70ms -X
Figure C-1-27: 8204 Head Z Translational Acceleration



10G 30ms -X
Figure C-1-28: 8192 Head Z Translational Acceleration

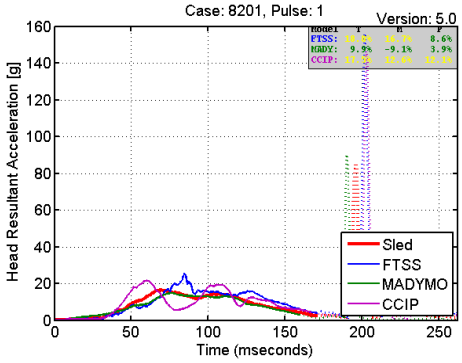


20G 110ms -X
Figure C-1-29: 8200 Head Z Translational Acceleration

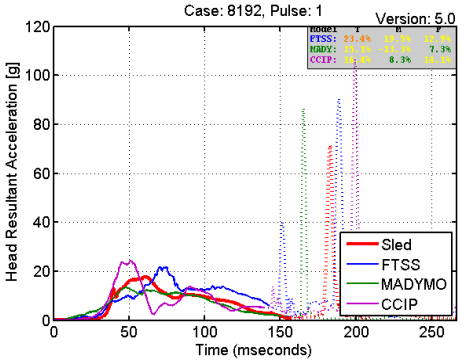


10G 110ms -X
Figure C-1-30: 8205 Head Z Translational Acceleration

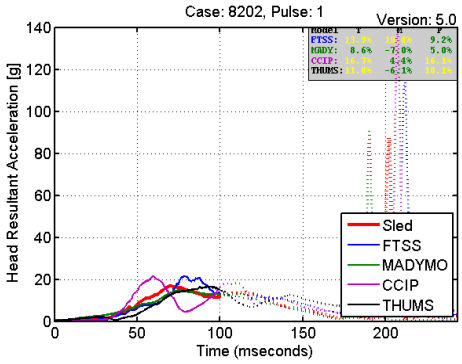
C.1.6 Head Resultant Translational Acceleration



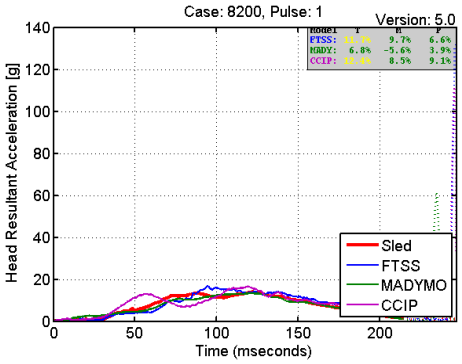
10G 70ms -X
Figure C-1-31: 8201 Head Resultant Translational Acceleration



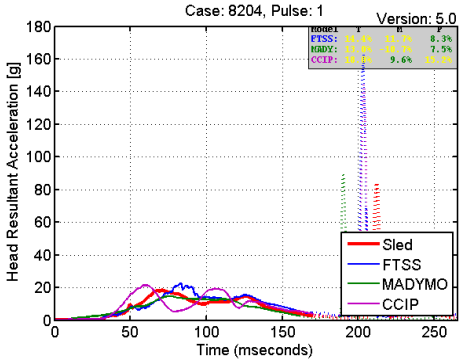
10G 30ms -X
Figure C-1-34: 8192 Head Resultant Translational Acceleration



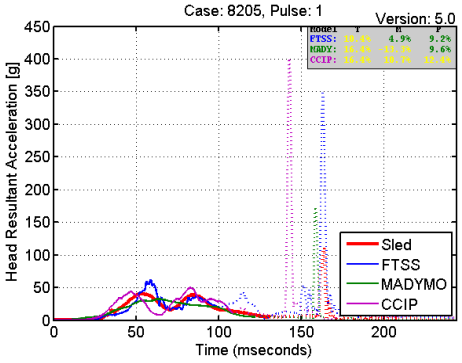
10G 70ms -X
Figure C-1-32: 8202 Head Resultant Translational Acceleration



20G 110ms -X
Figure C-1-35: 8200 Head Resultant Translational Acceleration

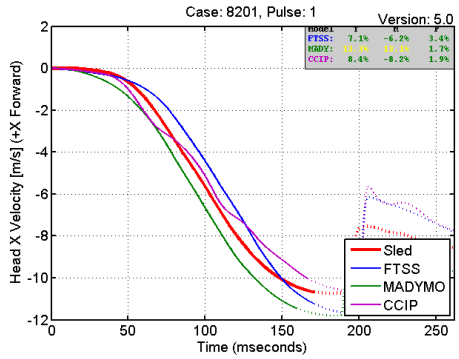


10G 70ms -X
Figure C-1-33: 8204 Head Resultant Translational Acceleration

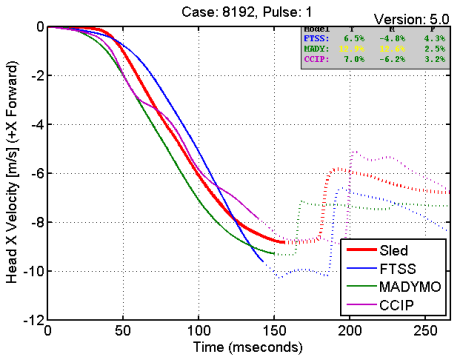


10G 110ms -X
Figure C-1-36: 8205 Head Resultant Translational Acceleration

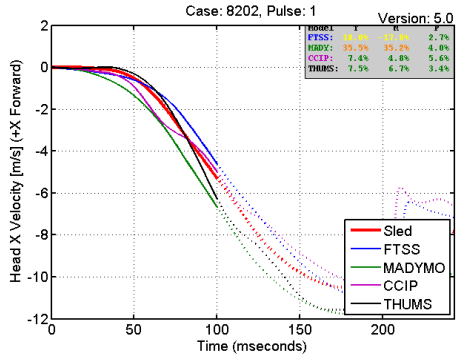
C.1.7 Head X Translational Velocity



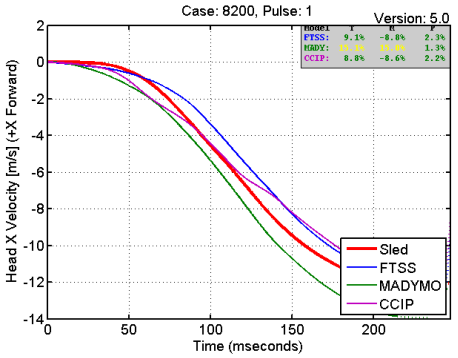
10G 70ms -X
Figure C-1-37: 8201 Head X Translational Velocity



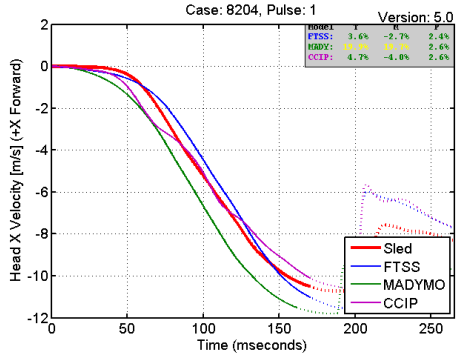
10G 30ms -X
Figure C-1-40: 8192 Head X Translational Velocity



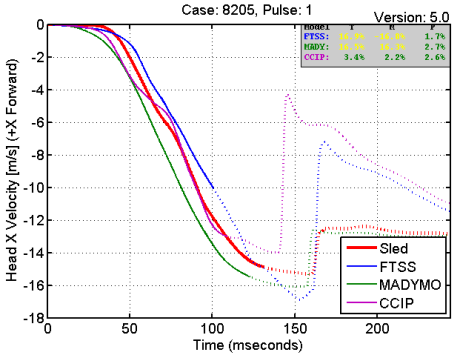
10G 70ms -X
Figure C-1-38: 8202 Head X Translational Velocity



20G 110ms -X
Figure C-1-41: 8200 Head X Translational Velocity

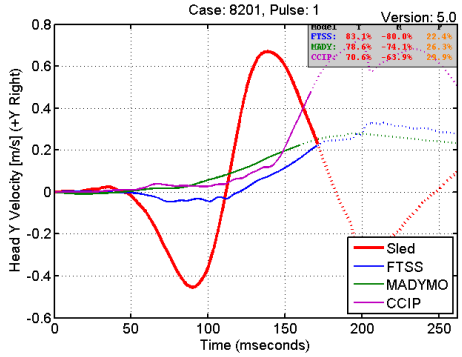


10G 70ms -X
Figure C-1-39: 8204 Head X Translational Velocity

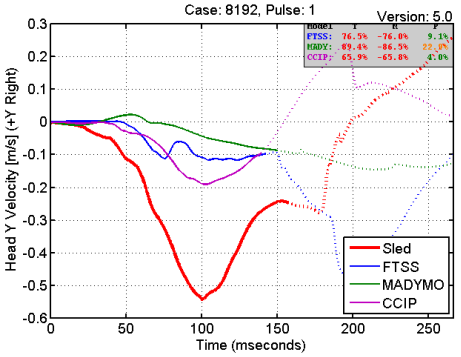


10G 110ms -X
Figure C-1-42: 8205 Head X Translational Velocity

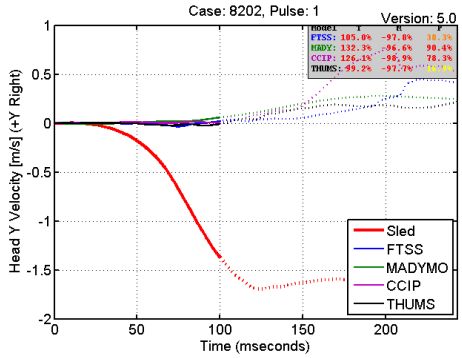
C.1.8 Head Y Translational Velocity



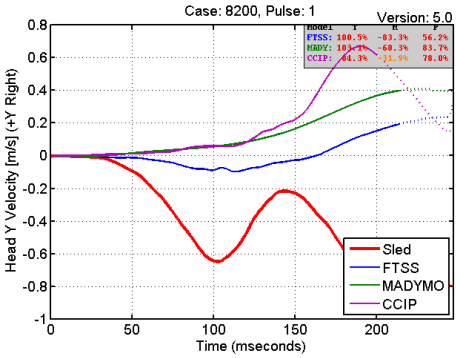
10G 70ms -X
Figure C-1-43: 8201 Head Y Translational Velocity



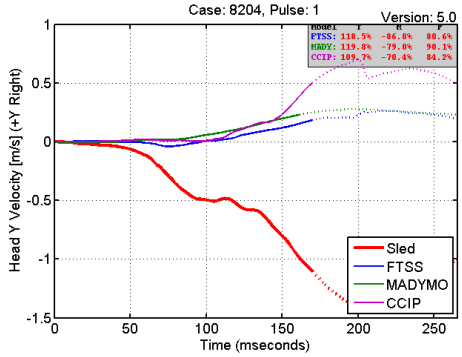
10G 30ms -X
Figure C-1-46: 8192 Head Y Translational Velocity



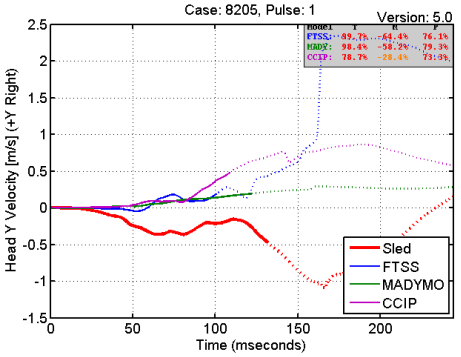
10G 70ms -X
Figure C-1-44: 8202 Head Y Translational Velocity



20G 110ms -X
Figure C-1-47: 8200 Head Y Translational Velocity

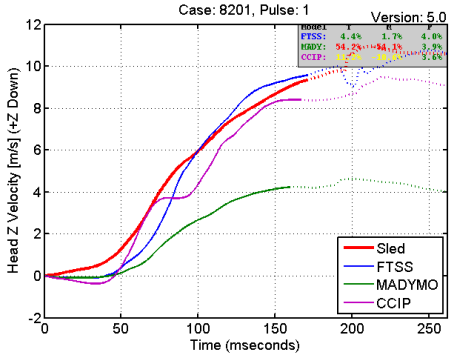


10G 70ms -X
Figure C-1-45: 8204 Head Y Translational Velocity

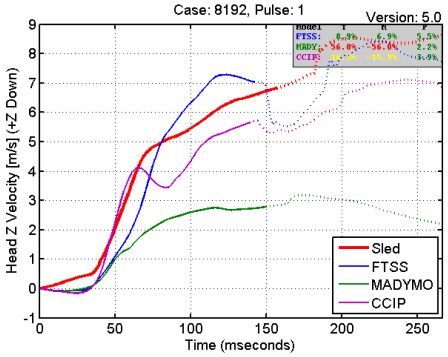


10G 110ms -X
Figure C-1-48: 8205 Head Y Translational Velocity

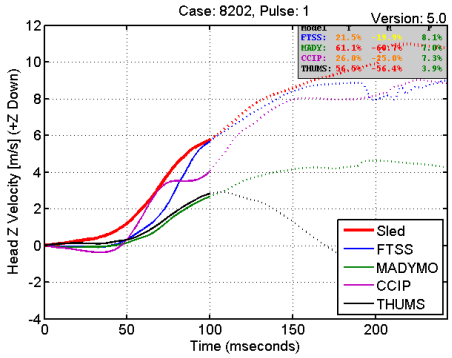
C.1.9 Head Z Translational Velocity



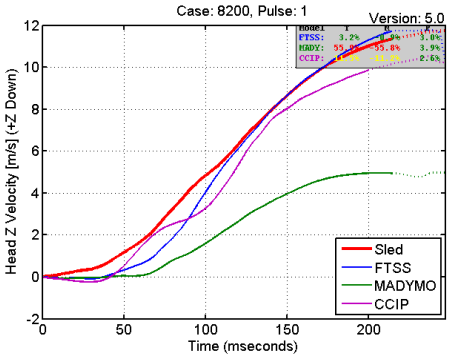
10G 70ms -X
Figure C-1-49: 8201 Head Z Translational Velocity



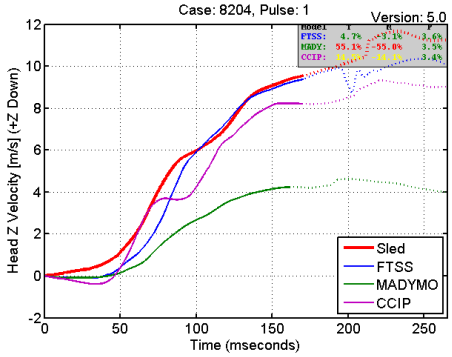
10G 30ms -X
Figure C-1-52: 8192 Head Z Translational Velocity



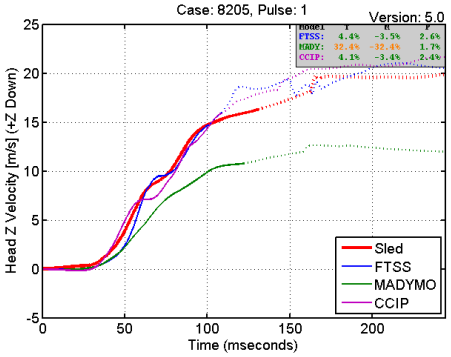
10G 70ms -X
Figure C-1-50: 8202 Head Z Translational Velocity



20G 110ms -X
Figure C-1-53: 8200 Head Z Translational Velocity

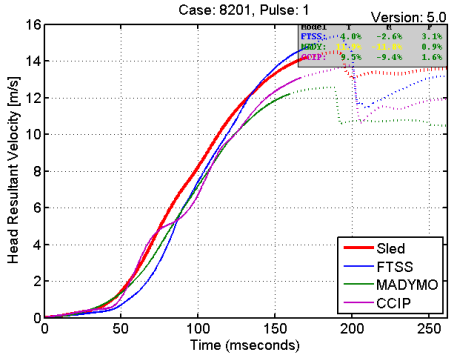


10G 70ms -X
Figure C-1-51: 8204 Head Z Translational Velocity

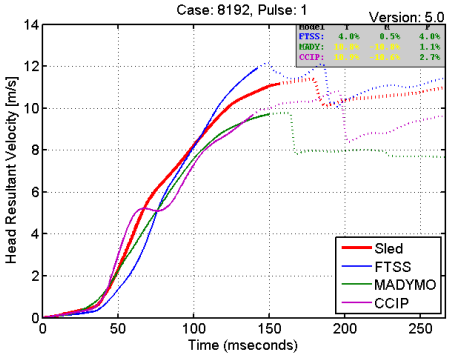


10G 110ms -X
Figure C-1-54: 8205 Head Z Translational Velocity

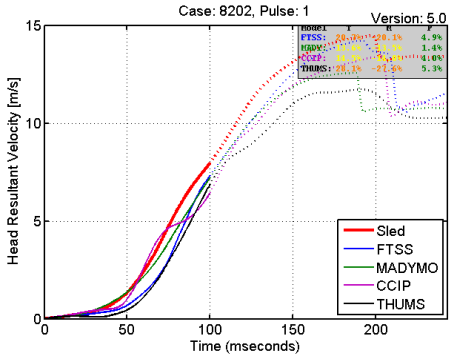
C.1.10 Head Resultant Translational Velocity



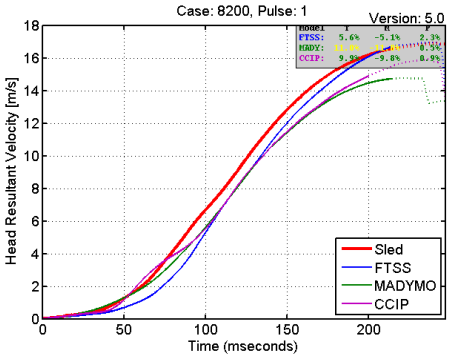
10G 70ms -X
Figure C-1-55: 8201 Head Resultant Translational Velocity



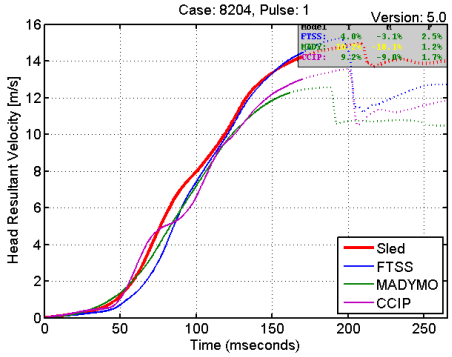
10G 30ms -X
Figure C-1-58: 8192 Head Resultant Translational Velocity



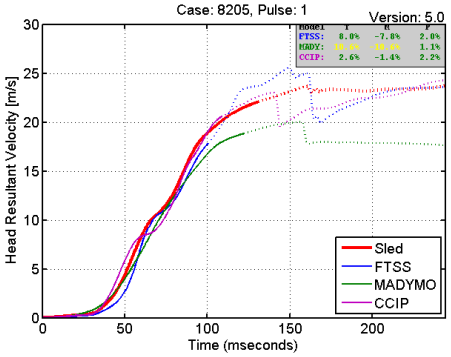
10G 70ms -X
Figure C-1-56: 8202 Head Resultant Translational Velocity



20G 110ms -X
Figure C-1-59: 8200 Head Resultant Translational Velocity

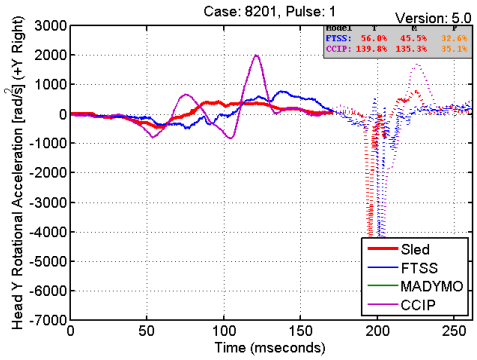


10G 70ms -X
Figure C-1-57: 8204 Head Resultant Translational Velocity

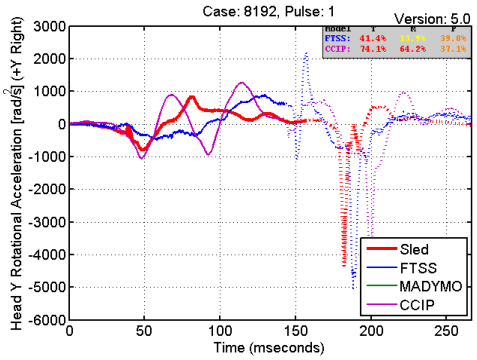


10G 110ms -X
Figure C-1-60: 8205 Head Resultant Translational Velocity

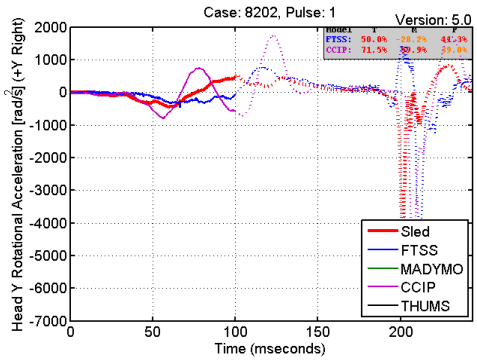
C.1.11 Head Y Rotational Acceleration



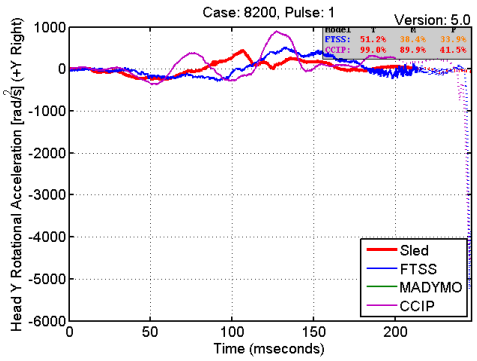
10G 70ms -X
Figure C-1-61: 8201 Head Y Rotational Acceleration



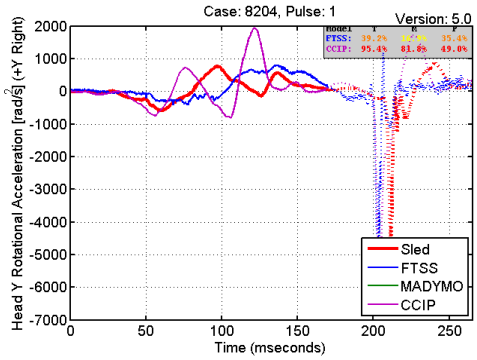
10G 30ms -X
Figure C-1-64: 8192 Head Y Rotational Acceleration



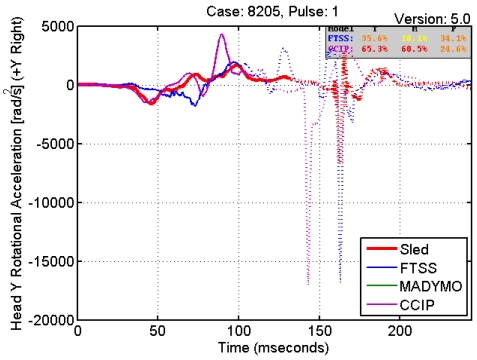
10G 70ms -X
Figure C-1-62: 8202 Head Y Rotational Acceleration



20G 110ms -X
Figure C-1-65: 8200 Head Y Rotational Acceleration

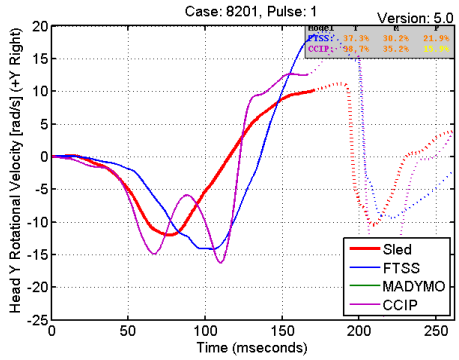


10G 70ms -X
Figure C-1-63: 8204 Head Y Rotational Acceleration

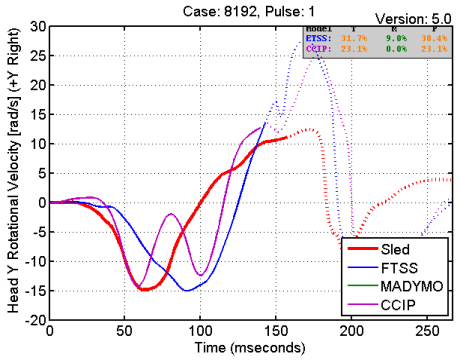


10G 110ms -X
Figure C-1-66: 8205 Head Y Rotational Acceleration

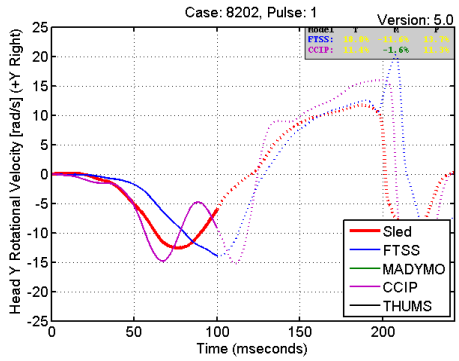
C.1.12 Head Y Rotational Velocity



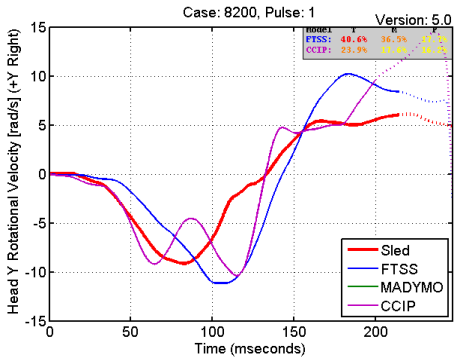
10G 70ms -X
Figure C-1-67: 8201 Head Y Rotational Velocity



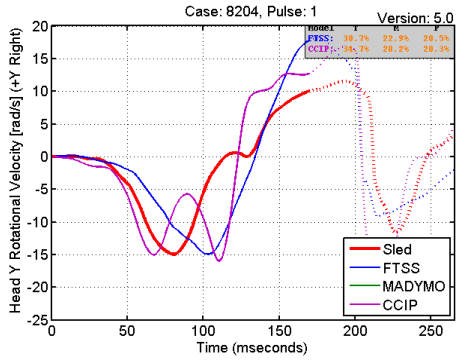
10G 30ms -X
Figure C-1-70: 8192 Head Y Rotational Velocity



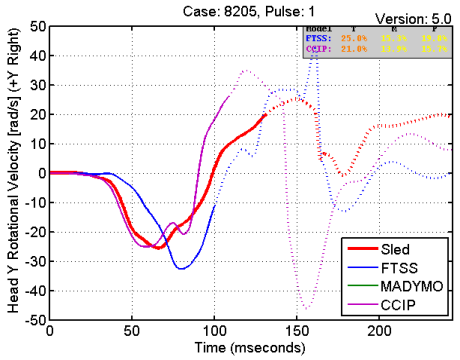
10G 70ms -X
Figure C-1-68: 8202 Head Y Rotational Velocity



20G 110ms -X
Figure C-1-71: 8200 Head Y Rotational Velocity

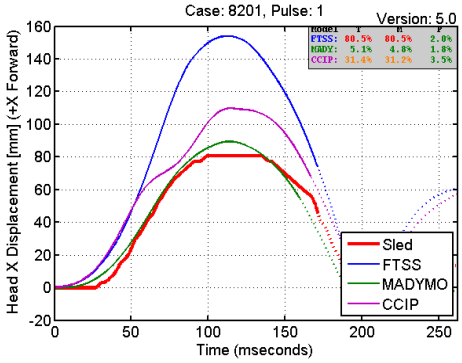


10G 70ms -X
Figure C-1-69: 8204 Head Y Rotational Velocity

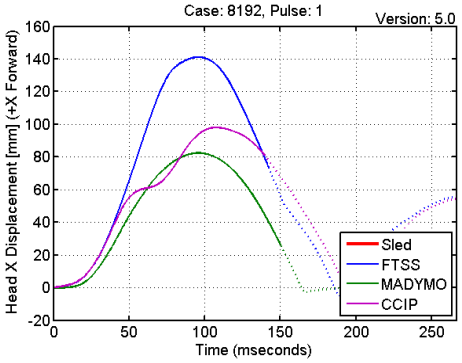


10G 110ms -X
Figure C-1-72: 8205 Head Y Rotational Velocity

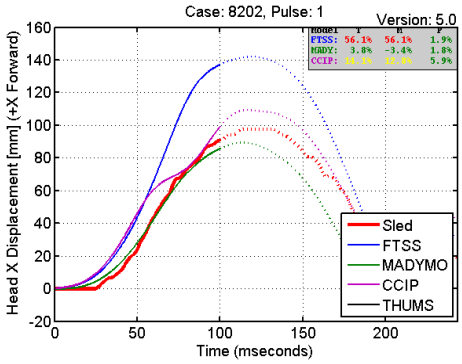
C.1.13 Head X Movement



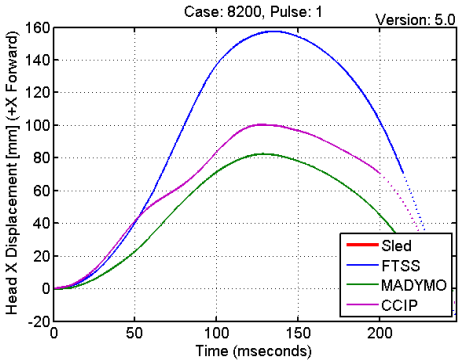
10G 70ms -X
Figure C-1-73: 8201 Head X Movement



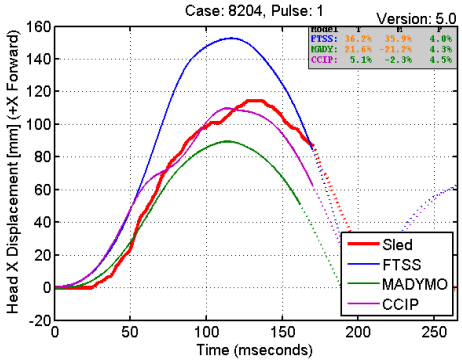
10G 30ms -X
Figure C-1-76: 8192 Head X Movement



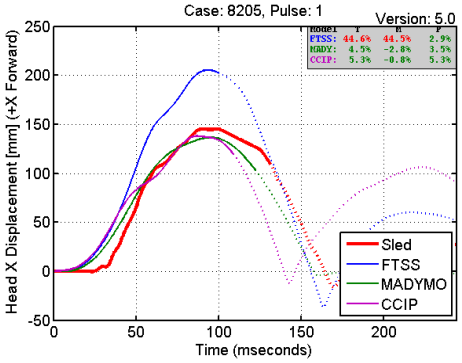
10G 70ms -X
Figure C-1-74: 8202 Head X Movement



20G 110ms -X
Figure C-1-77: 8200 Head X Movement

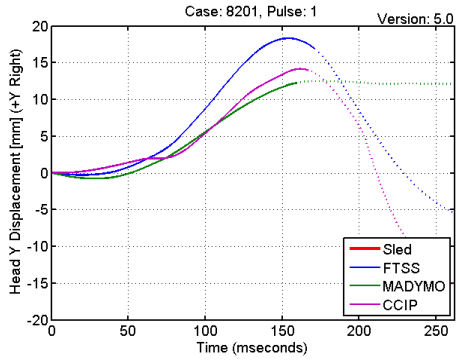


10G 70ms -X
Figure C-1-75: 8204 Head X Movement

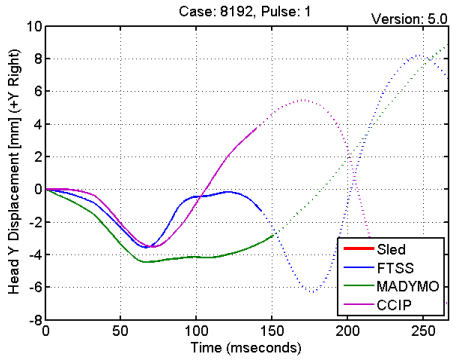


10G 110ms -X
Figure C-1-78: 8205 Head X Movement

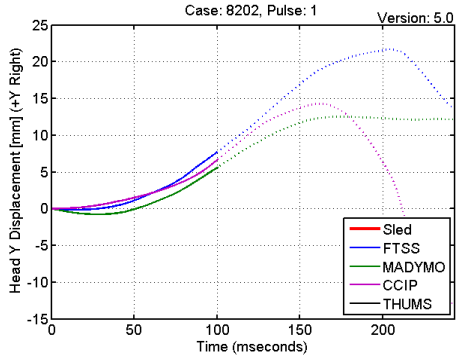
C.1.14 Head Y Movement



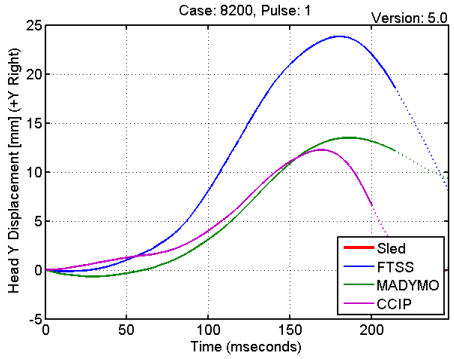
10G 70ms -X
Figure C-1-79: 8201 Head Y Movement



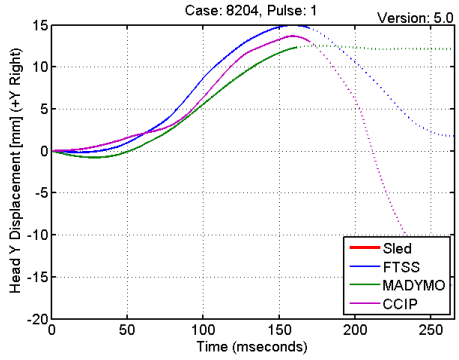
10G 30ms -X
Figure C-1-82: 8192 Head Y Movement



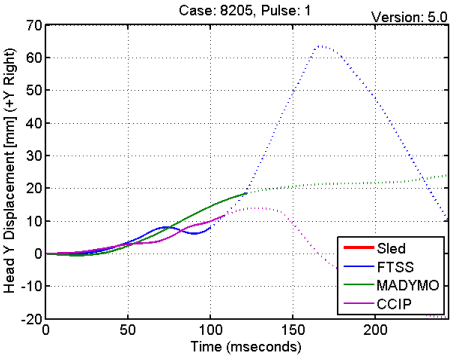
10G 70ms -X
Figure C-1-80: 8202 Head Y Movement



20G 110ms -X
Figure C-1-83: 8200 Head Y Movement

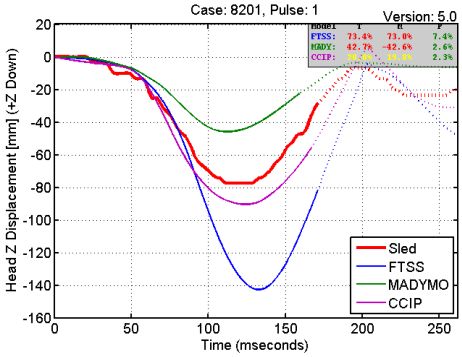


10G 70ms -X
Figure C-1-81: 8204 Head Y Movement

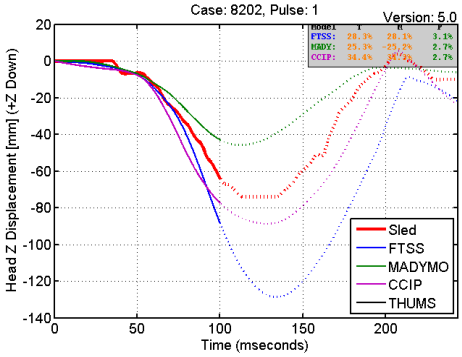


10G 110ms -X
Figure C-1-84: 8205 Head Y Movement

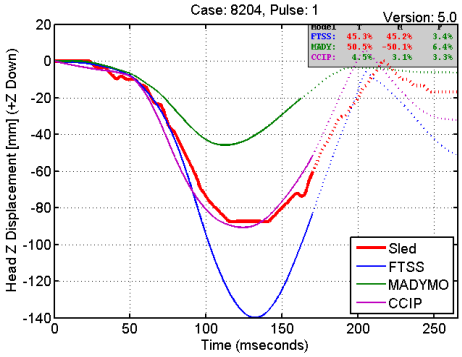
C.1.15 Head Z Movement



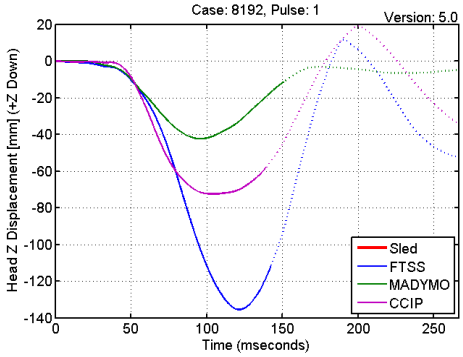
10G 70ms -X
Figure C-1-85: 8201 Head Z Movement



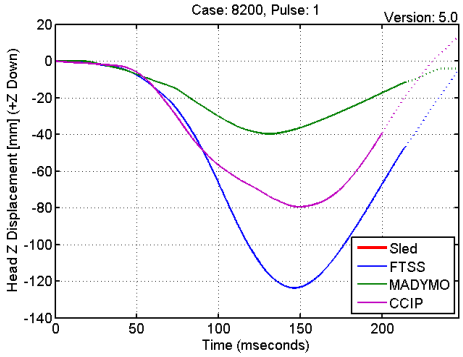
10G 70ms -X
Figure C-1-86: 8202 Head Z Movement



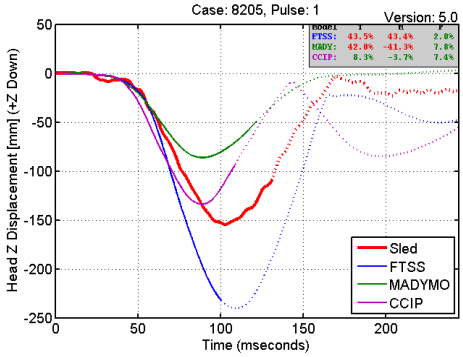
10G 70ms -X
Figure C-1-87: 8204 Head Z Movement



10G 30ms -X
Figure C-1-88: 8192 Head Z Movement

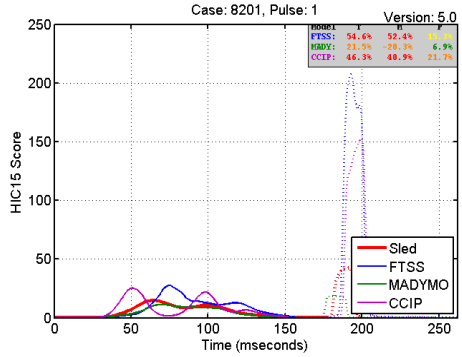


20G 110ms -X
Figure C-1-89: 8200 Head Z Movement

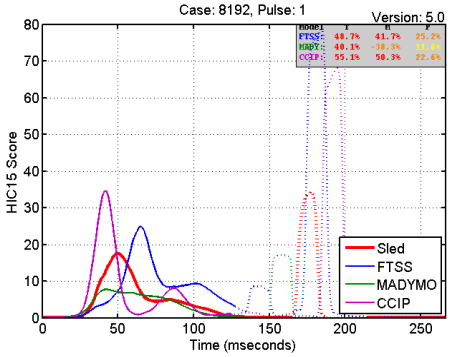


10G 110ms -X
Figure C-1-90: 8205 Head Z Movement

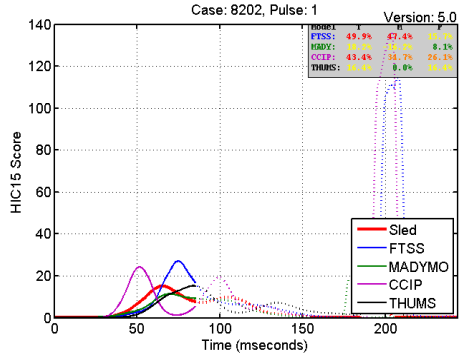
C.1.16 HIC 15



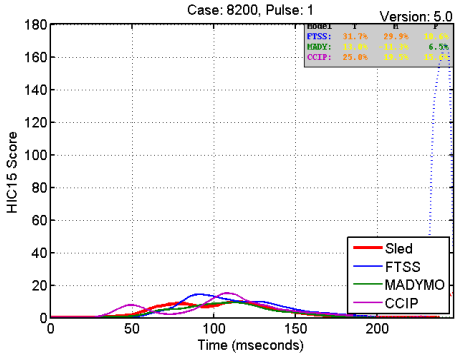
10G 70ms -X
Figure C-1-91: 8201 HIC 15



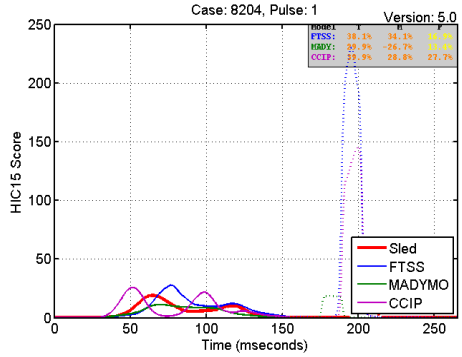
10G 30ms -X
Figure C-1-94: 8192 HIC 15



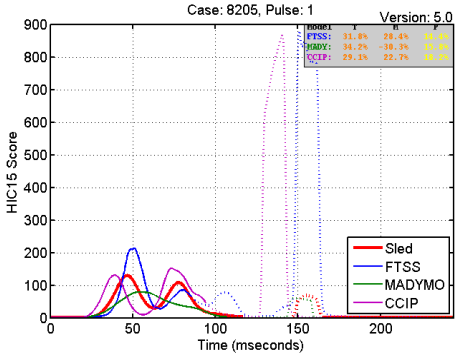
10G 70ms -X
Figure C-1-92: 8202 HIC 15



20G 110ms -X
Figure C-1-95: 8200 HIC 15

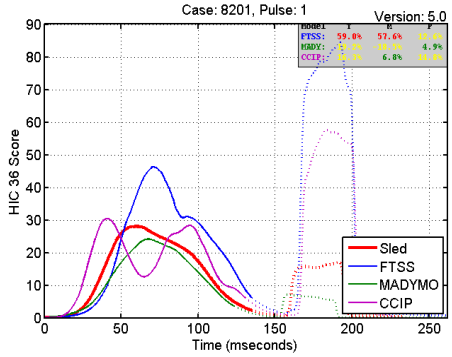


10G 70ms -X
Figure C-1-93: 8204 HIC 15

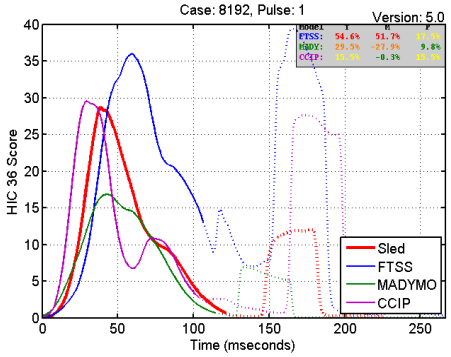


10G 110ms -X
Figure C-1-96: 8205 HIC 15

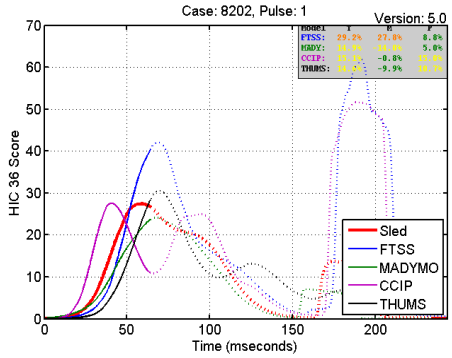
C.1.17 HIC 36



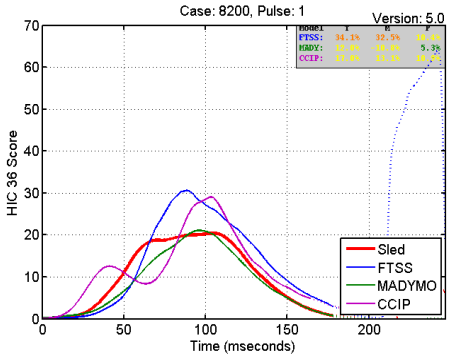
10G 70ms -X
Figure C-1-97: 8201 HIC 36



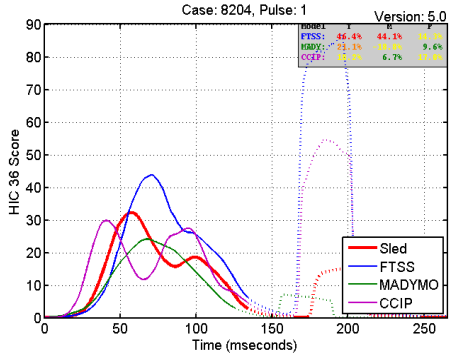
10G 30ms -X
Figure C-1-100: 8192 HIC 36



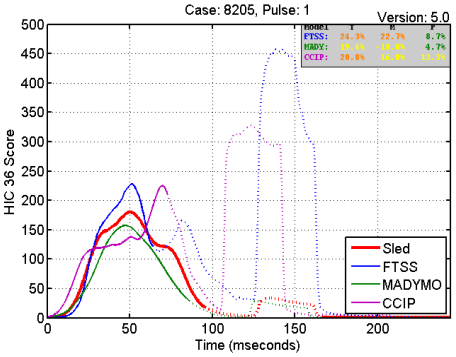
10G 70ms -X
Figure C-1-98: 8202 HIC 36



20G 110ms -X
Figure C-1-101: 8200 HIC 36

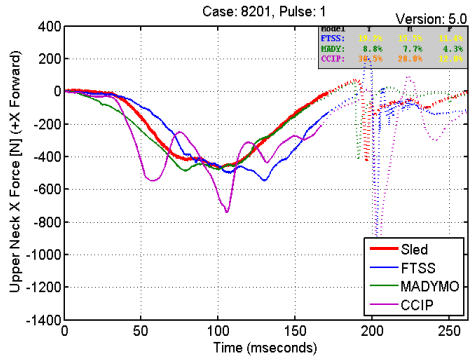


10G 70ms -X
Figure C-1-99: 8204 HIC 36

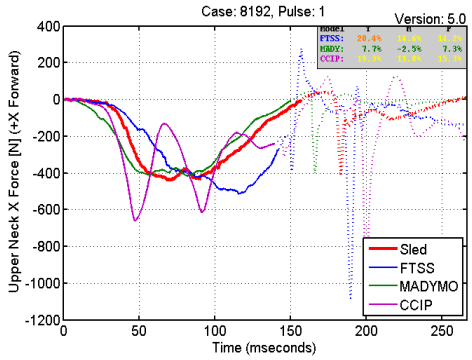


10G 110ms -X
Figure C-1-102: 8205 HIC 36

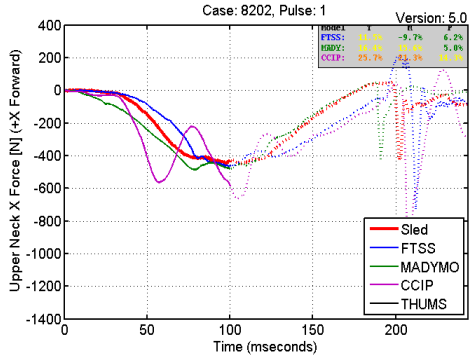
C.1.18 Neck X Force



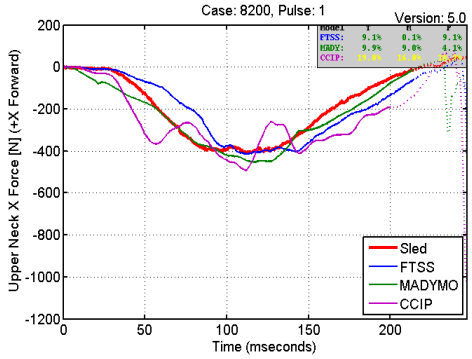
10G 70ms -X
Figure C-1-103: 8201 Neck X Force



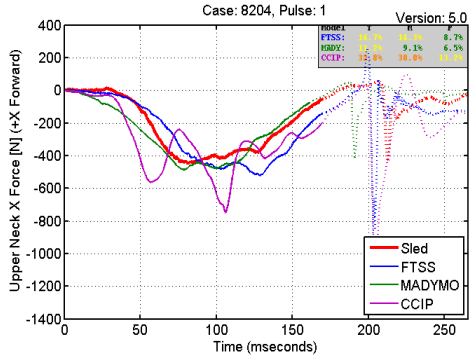
10G 30ms -X
Figure C-1-106: 8192 Neck X Force



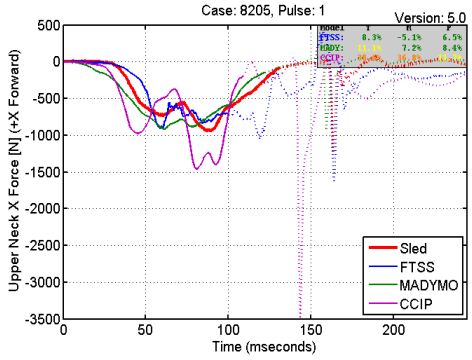
10G 70ms -X
Figure C-1-104: 8202 Neck X Force



20G 110ms -X
Figure C-1-107: 8200 Neck X Force

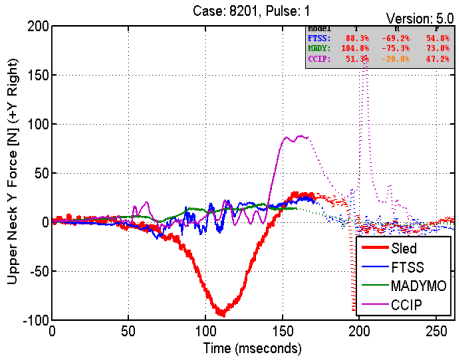


10G 70ms -X
Figure C-1-105: 8204 Neck X Force

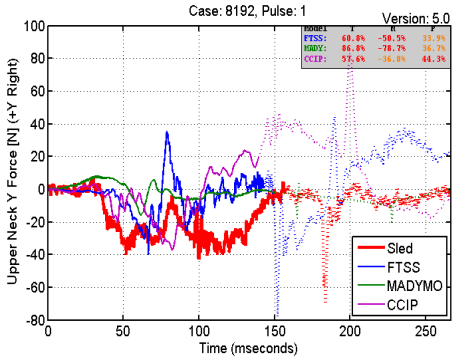


10G 110ms -X
Figure C-1-108: 8205 Neck X Force

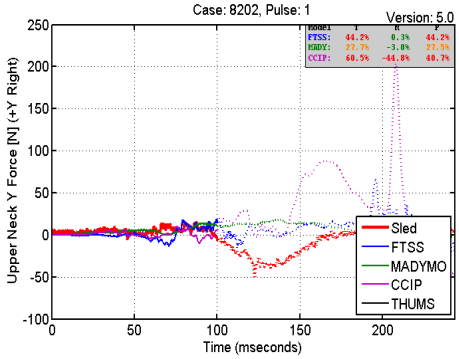
C.1.19 Neck Y Force



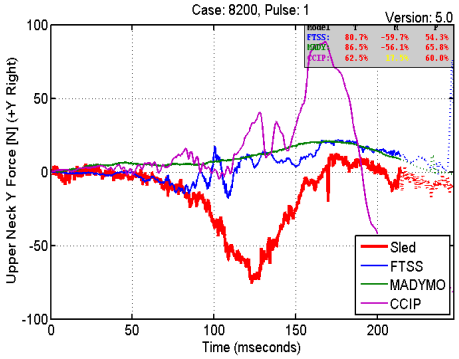
10G 70ms -X
Figure C-1-109: 8201 Neck Y Force



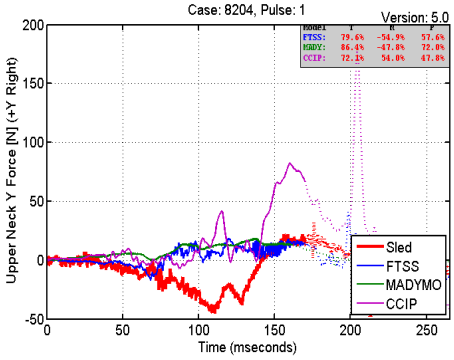
10G 30ms -X
Figure C-1-112: 8192 Neck Y Force



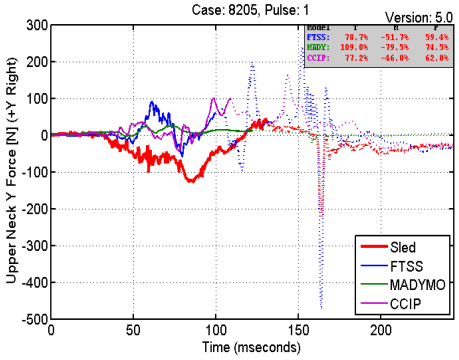
10G 70ms -X
Figure C-1-110: 8202 Neck Y Force



20G 110ms -X
Figure C-1-113: 8200 Neck Y Force

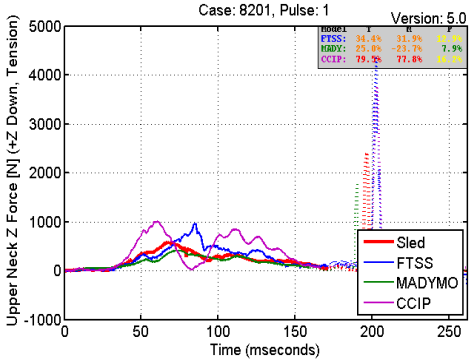


10G 70ms -X
Figure C-1-111: 8204 Neck Y Force

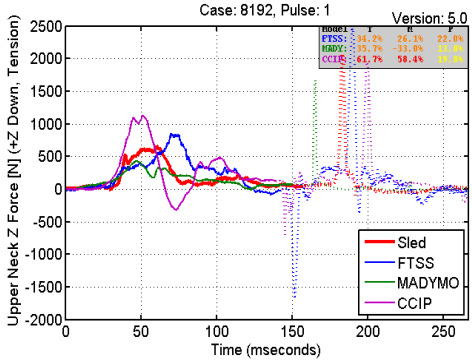


10G 110ms -X
Figure C-1-114: 8205 Neck Y Force

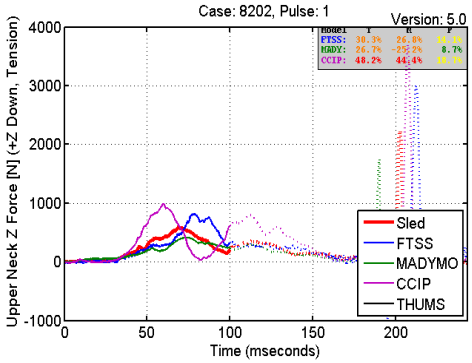
C.1.20 Neck Z Force



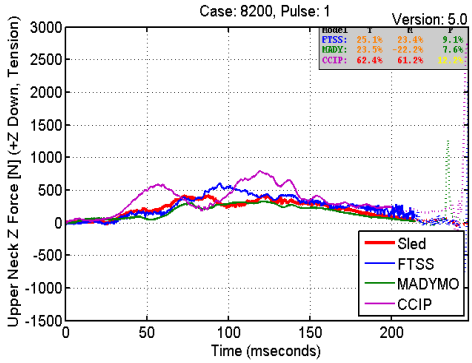
10G 70ms -X
Figure C-1-115: 8201 Neck Z Force



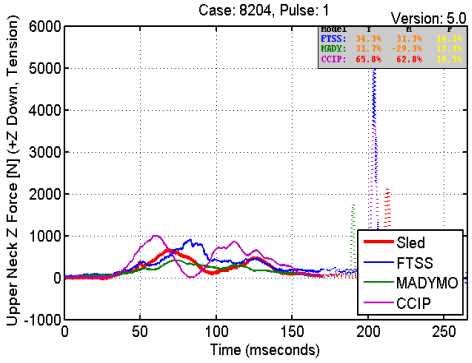
10G 30ms -X
Figure C-1-118: 8192 Neck Z Force



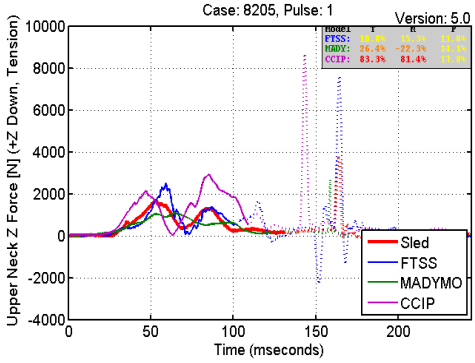
10G 70ms -X
Figure C-1-116: 8202 Neck Z Force



20G 110ms -X
Figure C-1-119: 8200 Neck Z Force

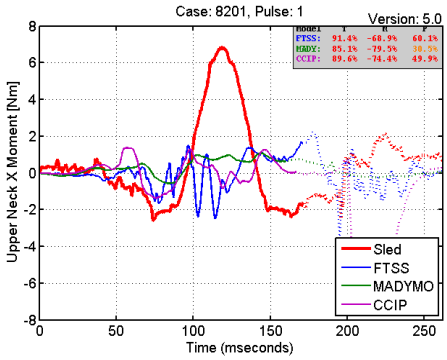


10G 70ms -X
Figure C-1-117: 8204 Neck Z Force

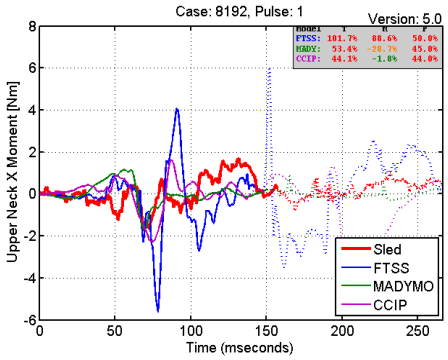


10G 110ms -X
Figure C-1-120: 8205 Neck Z Force

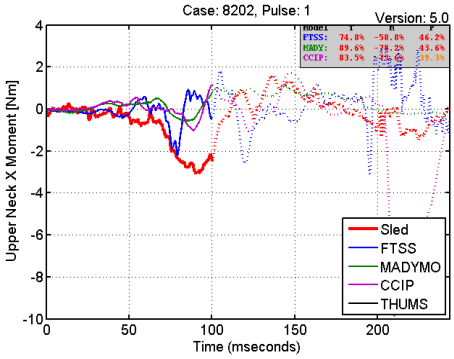
C.1.21 Neck X Moment



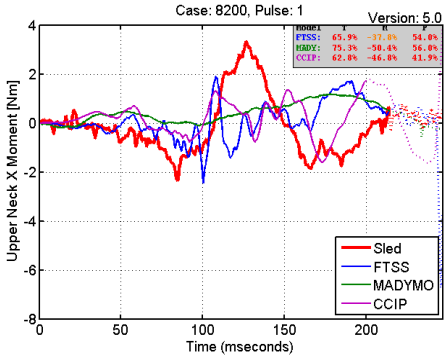
10G 70ms -X
Figure C-1-121: 8201 Neck X Moment



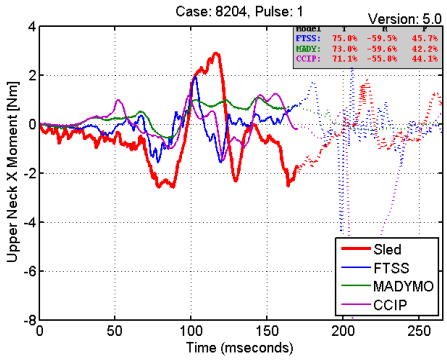
10G 30ms -X
Figure C-1-124: 8192 Neck X Moment



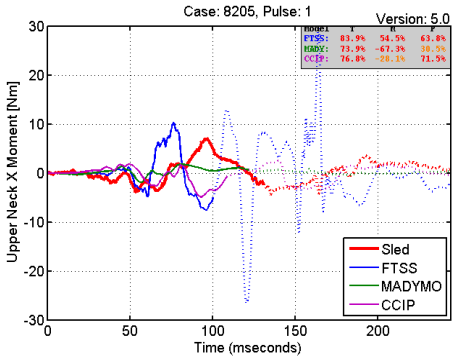
10G 70ms -X
Figure C-1-122: 8202 Neck X Moment



20G 110ms -X
Figure C-1-125: 8200 Neck X Moment

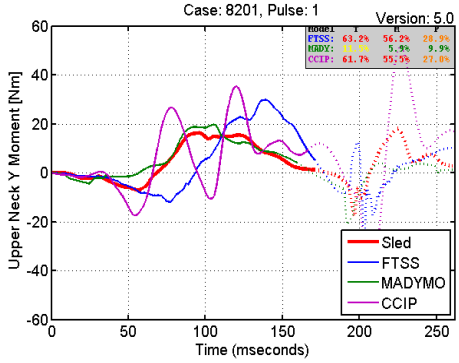


10G 70ms -X
Figure C-1-123: 8204 Neck X Moment

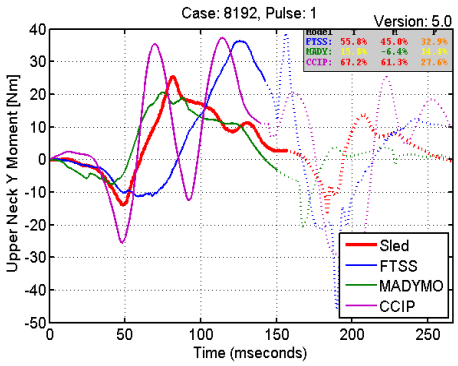


10G 110ms -X
Figure C-1-126: 8205 Neck X Moment

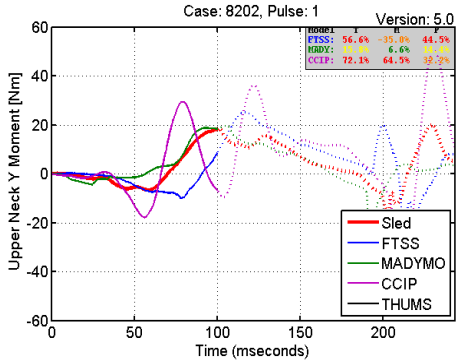
C.1.22 Neck Y Moment



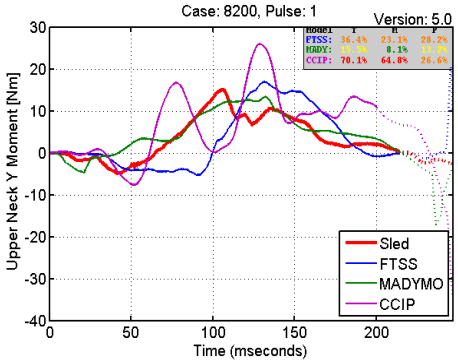
10G 70ms -X
Figure C-1-127: 8201 Neck Y Moment



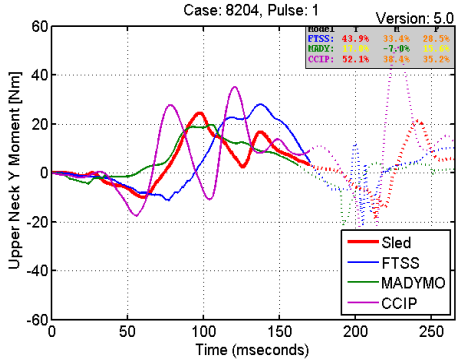
10G 30ms -X
Figure C-1-130: 8192 Neck Y Moment



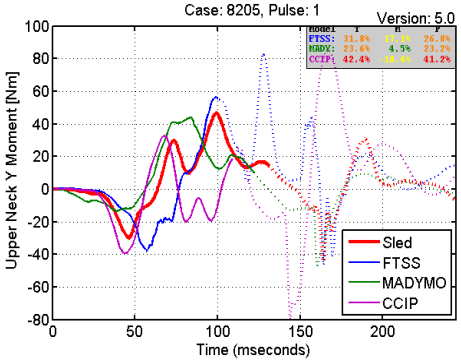
10G 70ms -X
Figure C-1-128: 8202 Neck Y Moment



20G 110ms -X
Figure C-1-131: 8200 Neck Y Moment

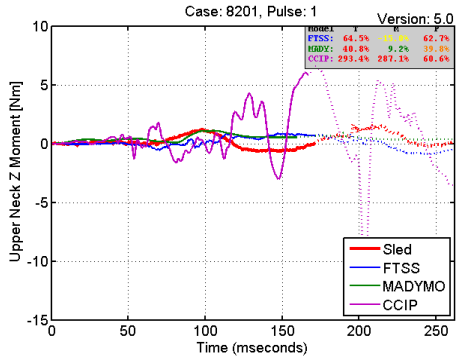


10G 70ms -X
Figure C-1-129: 8204 Neck Y Moment

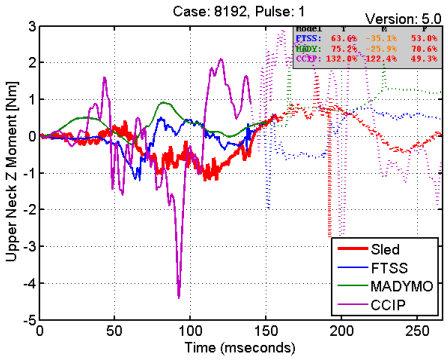


10G 110ms -X
Figure C-1-132: 8205 Neck Y Moment

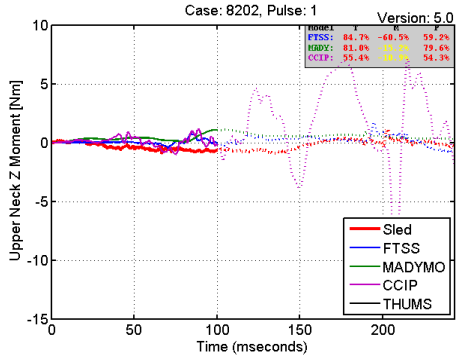
C.1.23 Neck Z Moment



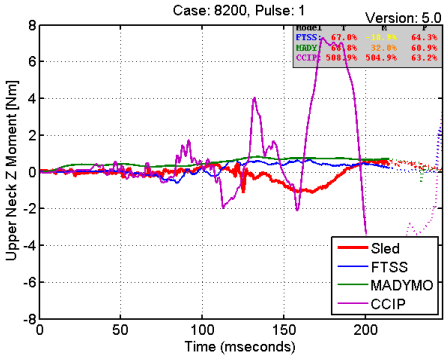
10G 70ms -X
Figure C-1-133: 8201 Neck Z Moment



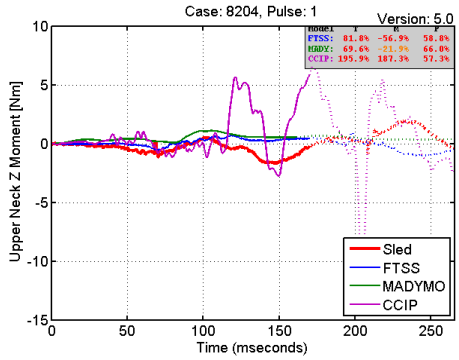
10G 30ms -X
Figure C-1-136: 8192 Neck Z Moment



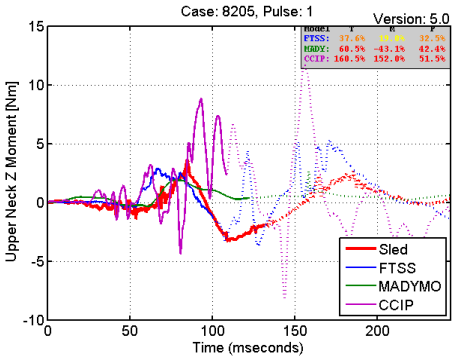
10G 70ms -X
Figure C-1-134: 8202 Neck Z Moment



20G 110ms -X
Figure C-1-137: 8200 Neck Z Moment

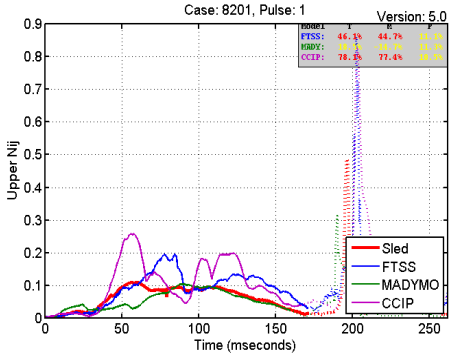


10G 70ms -X
Figure C-1-135: 8204 Neck Z Moment

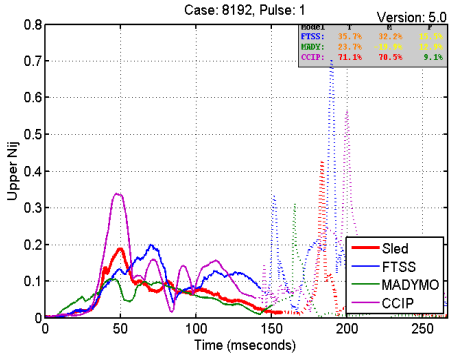


10G 110ms -X
Figure C-1-138: 8205 Neck Z Moment

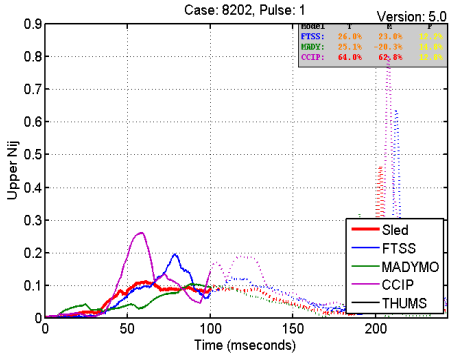
C.1.24 Nij



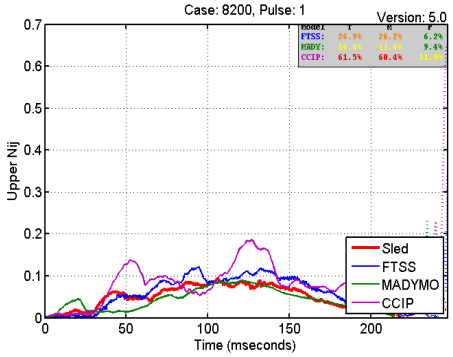
10G 70ms -X
Figure C-1-139: 8201 Nij



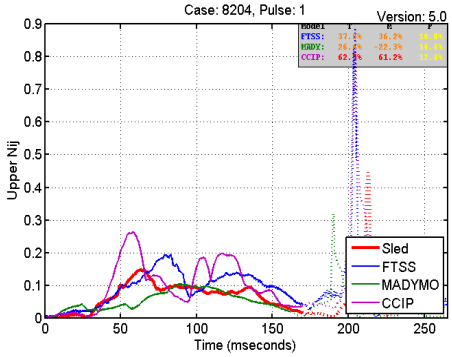
10G 30ms -X
Figure C-1-142: 8192 Nij



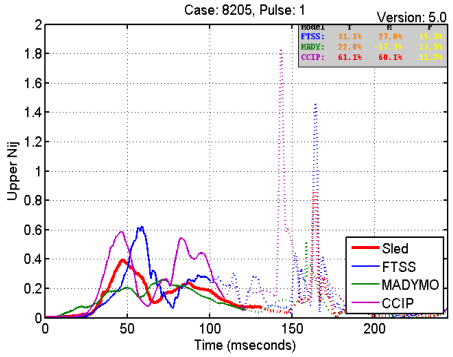
10G 70ms -X
Figure C-1-140: 8202 Nij



20G 110ms -X
Figure C-1-143: 8200 Nij

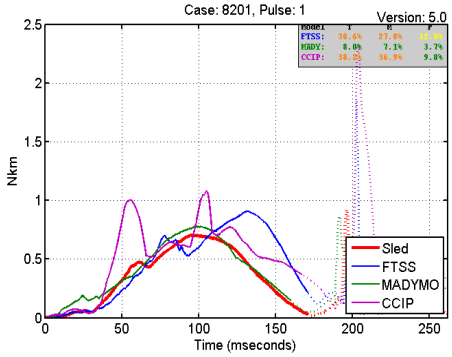


10G 70ms -X
Figure C-1-141: 8204 Nij

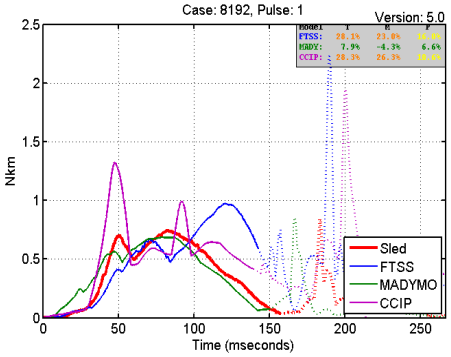


10G 110ms -X
Figure C-1-144: 8205 Nij

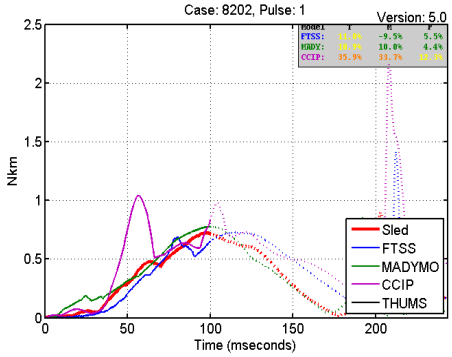
C.1.25 Nkm



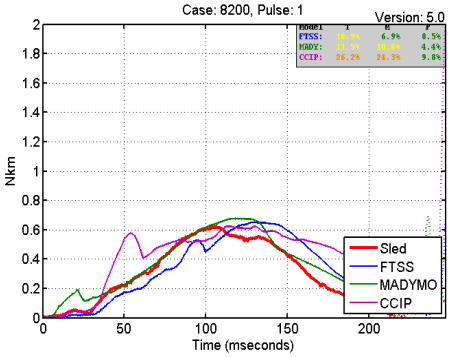
10G 70ms -X
Figure C-1-145: 8201 Nkm



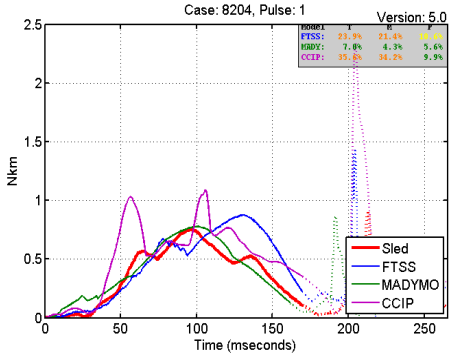
10G 30ms -X
Figure C-1-148: 8192 Nkm



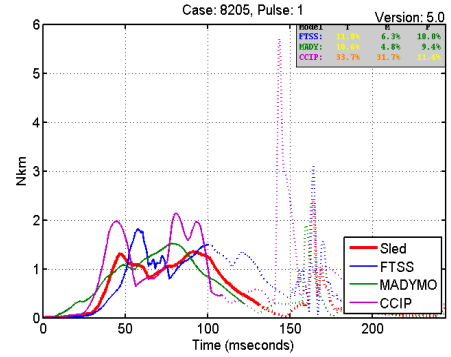
10G 70ms -X
Figure C-1-146: 8202 Nkm



20G 110ms -X
Figure C-1-149: 8200 Nkm

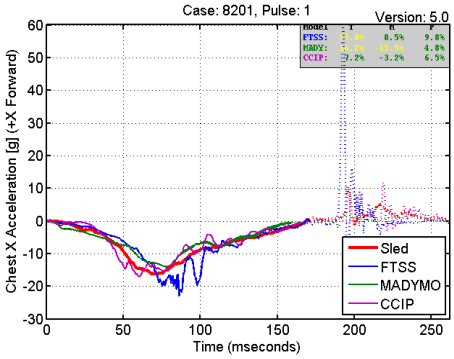


10G 70ms -X
Figure C-1-147: 8204 Nkm

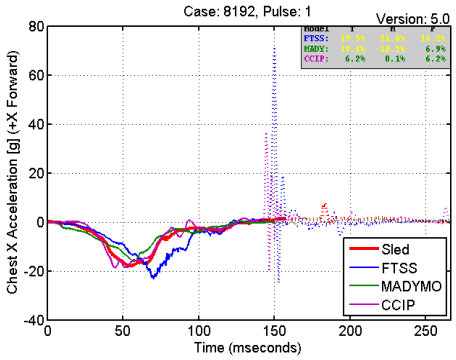


10G 110ms -X
Figure C-1-150: 8205 Nkm

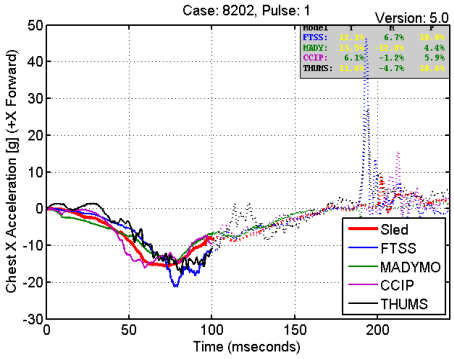
C.1.26 Chest X Acceleration



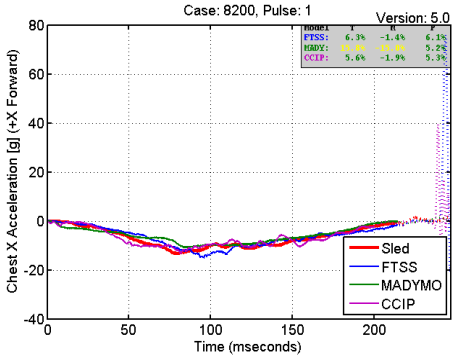
10G 70ms -X
Figure C-1-151: 8201 Chest X Acceleration



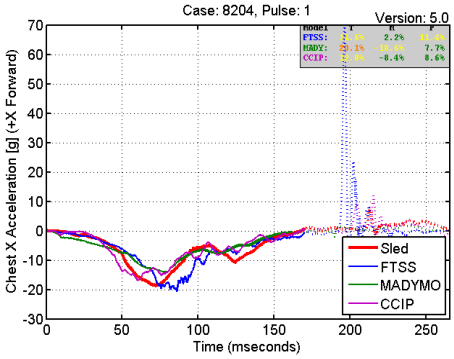
10G 30ms -X
Figure C-1-154: 8192 Chest X Acceleration



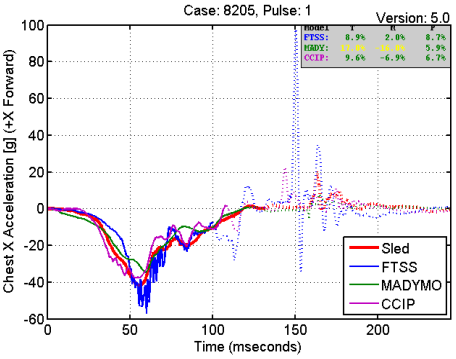
10G 70ms -X
Figure C-1-152: 8202 Chest X Acceleration



20G 110ms -X
Figure C-1-155: 8200 Chest X Acceleration

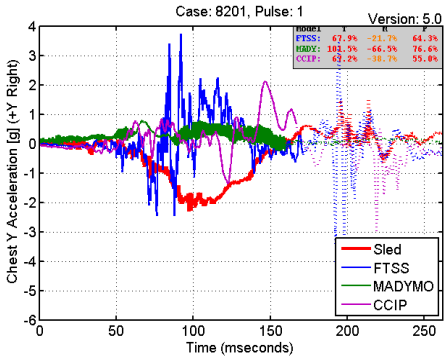


10G 70ms -X
Figure C-1-153: 8204 Chest X Acceleration

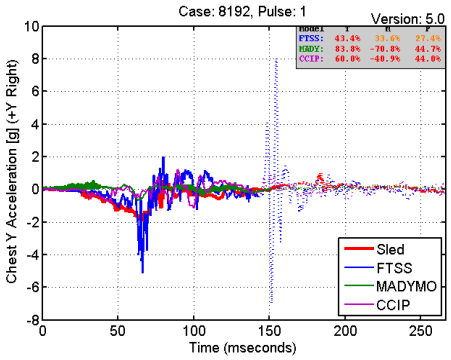


10G 110ms -X
Figure C-1-156: 8205 Chest X Acceleration

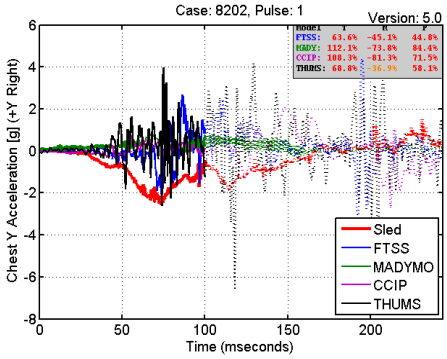
C.1.27 Chest Y Acceleration



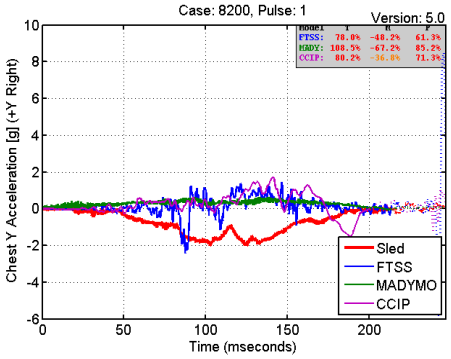
10G 70ms -X
Figure C-1-157: 8201 Chest Y Acceleration



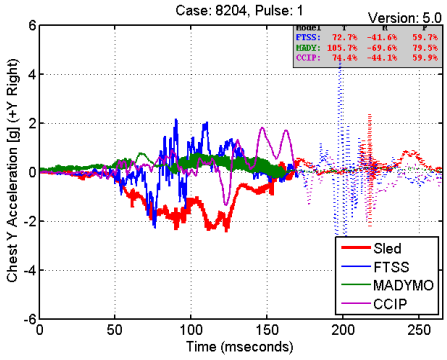
10G 30ms -X
Figure C-1-160: 8192 Chest Y Acceleration



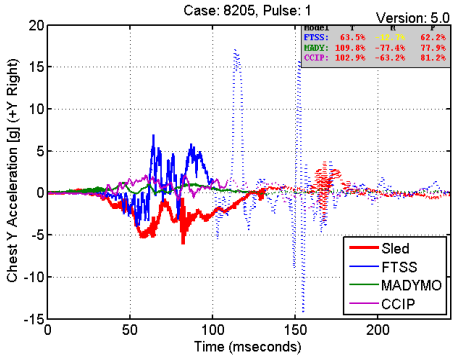
10G 70ms -X
Figure C-1-158: 8202 Chest Y Acceleration



20G 110ms -X
Figure C-1-161: 8200 Chest Y Acceleration

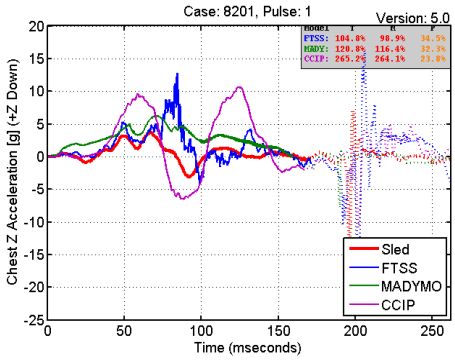


10G 70ms -X
Figure C-1-159: 8204 Chest Y Acceleration

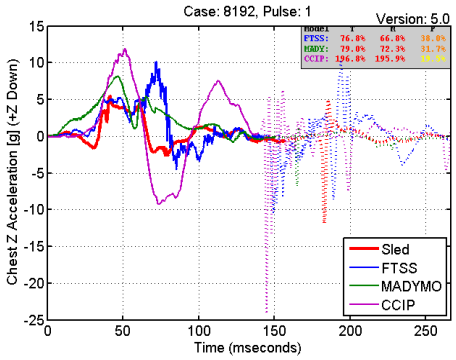


10G 110ms -X
Figure C-1-162: 8205 Chest Y Acceleration

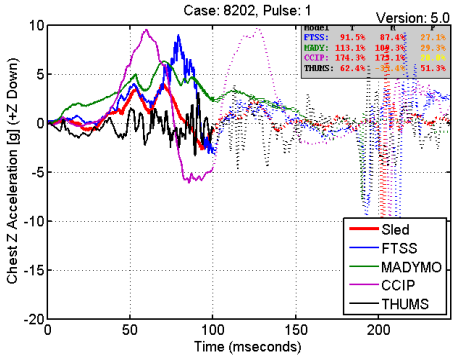
C.1.28 Chest Z Acceleration



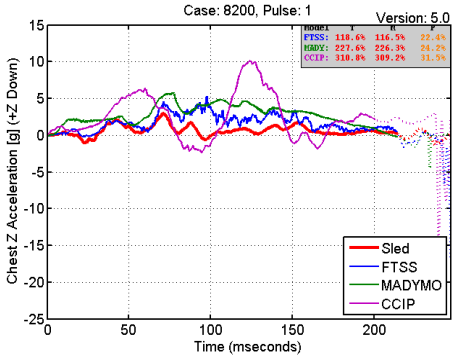
10G 70ms -X
Figure C-1-163: 8201 Chest Z Acceleration



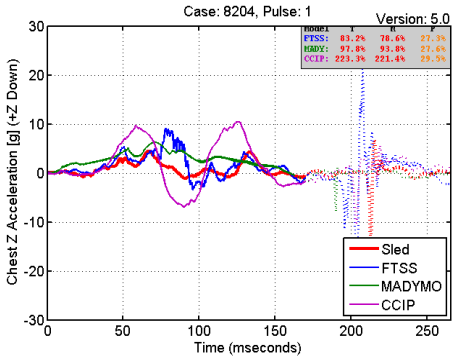
10G 30ms -X
Figure C-1-166: 8192 Chest Z Acceleration



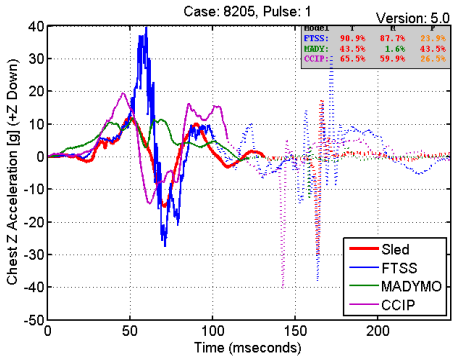
10G 70ms -X
Figure C-1-164: 8202 Chest Z Acceleration



20G 110ms -X
Figure C-1-167: 8200 Chest Z Acceleration

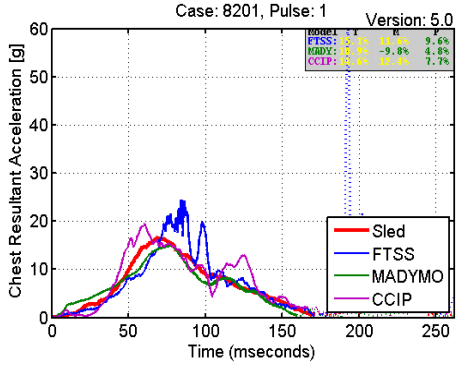


10G 70ms -X
Figure C-1-165: 8204 Chest Z Acceleration

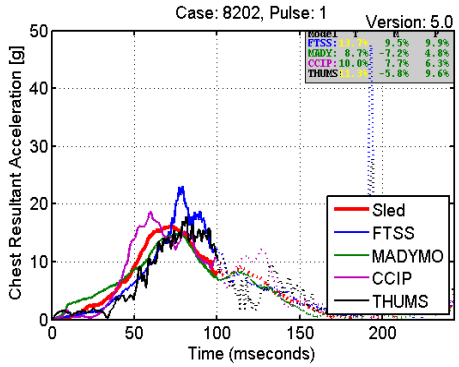


10G 110ms -X
Figure C-1-168: 8205 Chest Z Acceleration

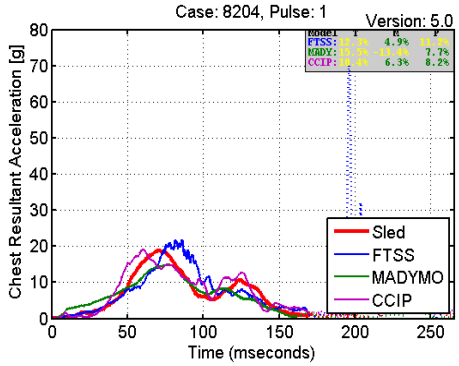
C.1.29 Chest Resultant Acceleration



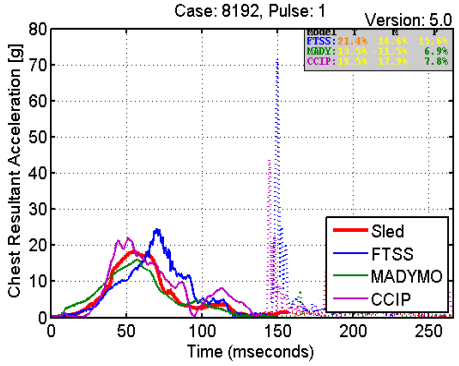
10G 70ms -X
Figure C-1-169: 8201 Chest Resultant Acceleration



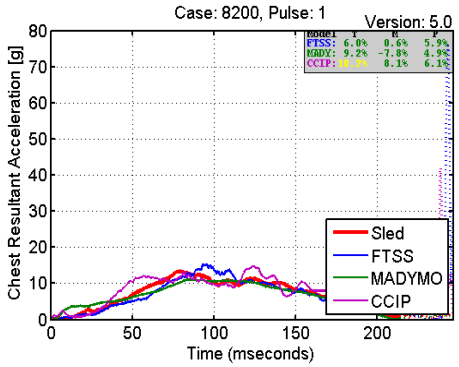
10G 70ms -X
Figure C-1-170: 8202 Chest Resultant Acceleration



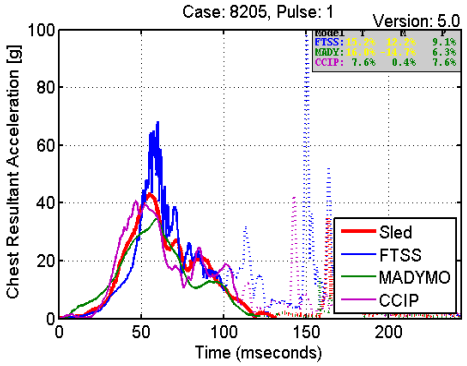
10G 70ms -X
Figure C-1-171: 8204 Chest Resultant Acceleration



10G 30ms -X
Figure C-1-172: 8192 Chest Resultant Acceleration

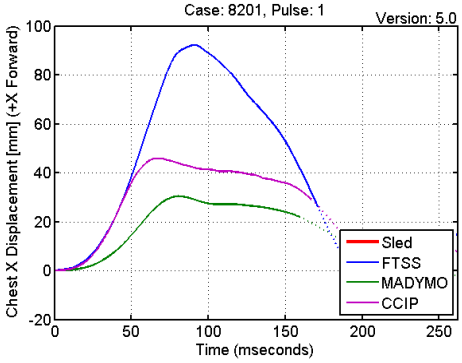


20G 110ms -X
Figure C-1-173: 8200 Chest Resultant Acceleration

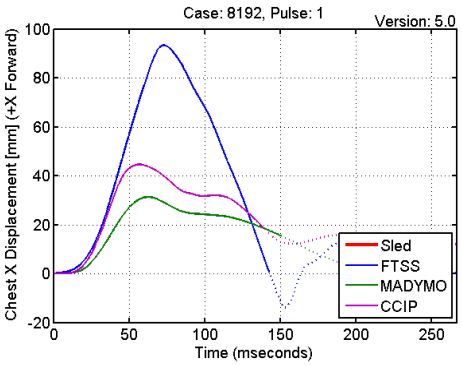


10G 110ms -X
Figure C-1-174: 8205 Chest Resultant Acceleration

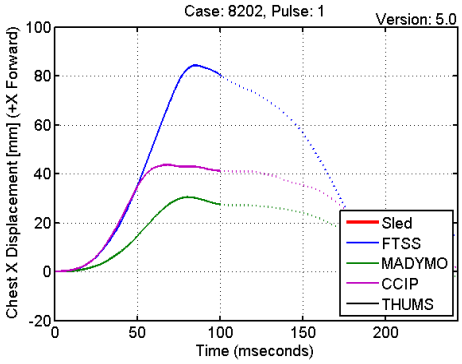
C.1.30 Chest X Movement



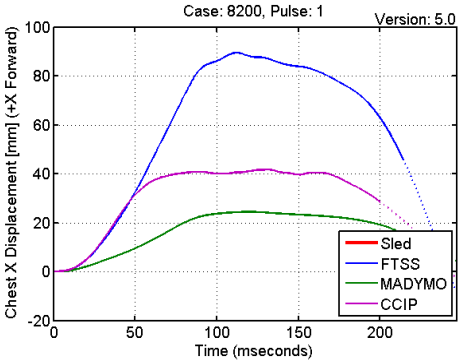
10G 70ms -X
Figure C-1-175: 8201 Chest X Movement



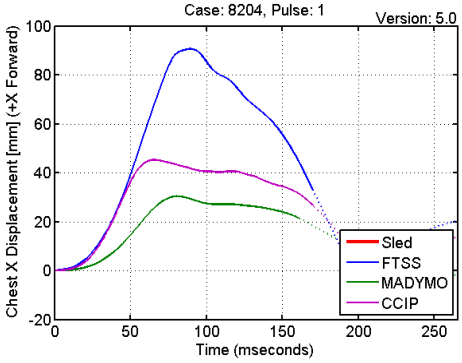
10G 30ms -X
Figure C-1-178: 8192 Chest X Movement



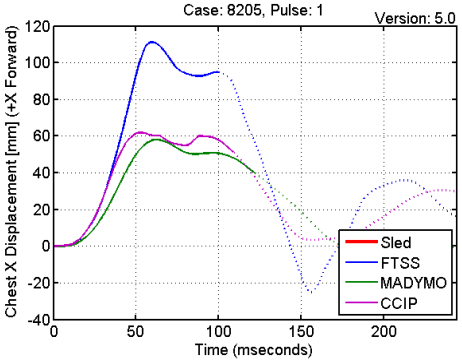
10G 70ms -X
Figure C-1-176: 8202 Chest X Movement



20G 110ms -X
Figure C-1-179: 8200 Chest X Movement

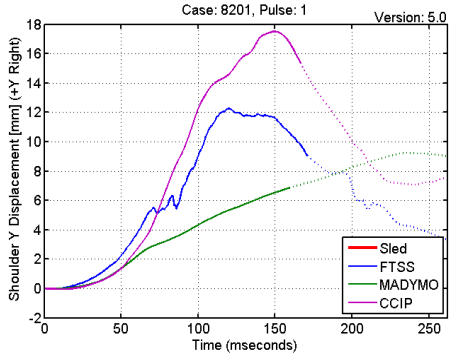


10G 70ms -X
Figure C-1-177: 8204 Chest X Movement

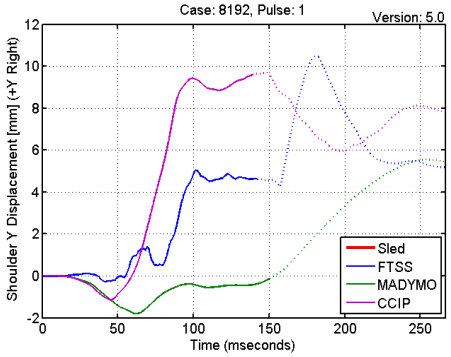


10G 110ms -X
Figure C-1-180: 8205 Chest X Movement

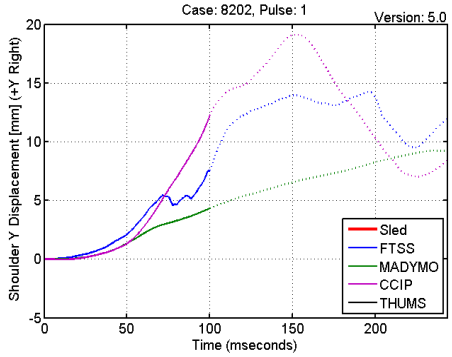
C.1.31 Shoulder Y Movement



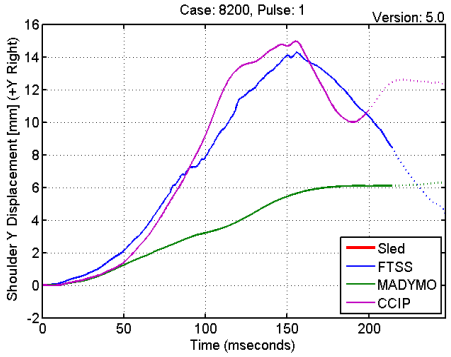
10G 70ms -X
Figure C-1-181: 8201 Shoulder Y Movement



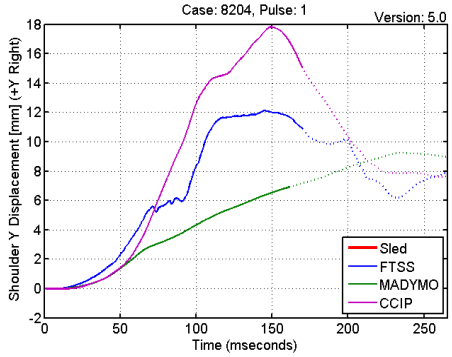
10G 30ms -X
Figure C-1-184: 8192 Shoulder Y Movement



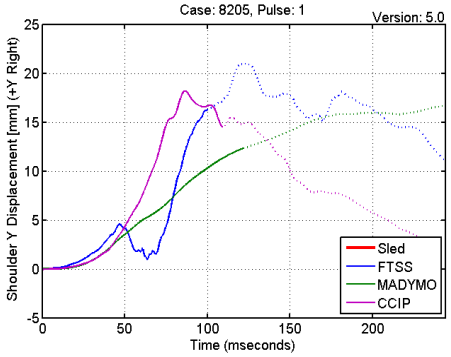
10G 70ms -X
Figure C-1-182: 8202 Shoulder Y Movement



20G 110ms -X
Figure C-1-185: 8200 Shoulder Y Movement

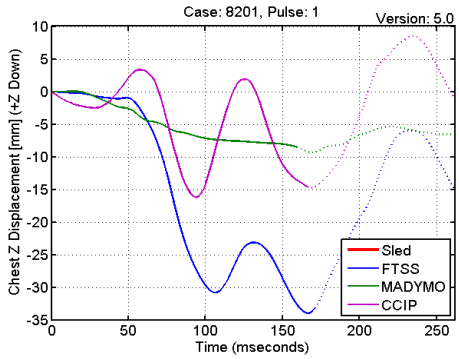


10G 70ms -X
Figure C-1-183: 8204 Shoulder Y Movement

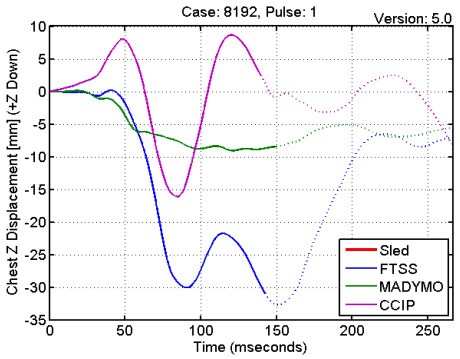


10G 110ms -X
Figure C-1-186: 8205 Shoulder Y Movement

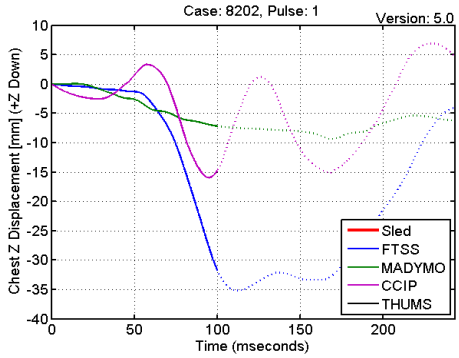
C.1.32 Chest Z Movement



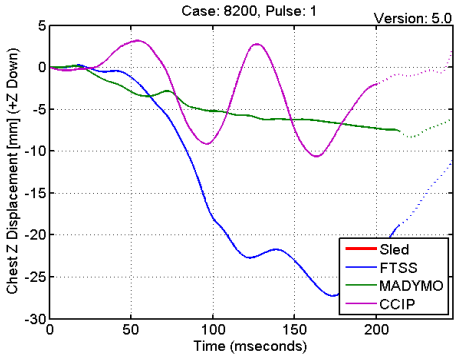
10G 70ms -X
Figure C-1-187: 8201 Chest Z Movement



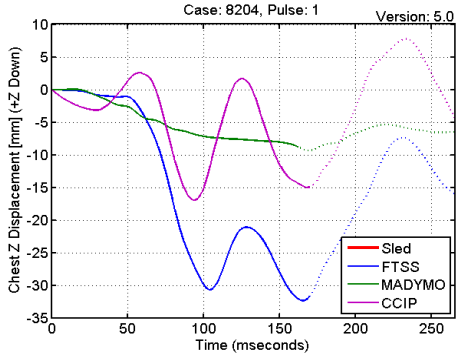
10G 30ms -X
Figure C-1-190: 8192 Chest Z Movement



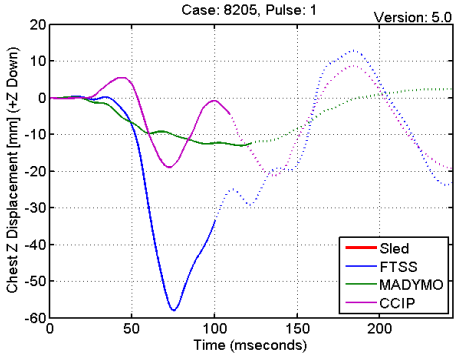
10G 70ms -X
Figure C-1-188: 8202 Chest Z Movement



20G 110ms -X
Figure C-1-191: 8200 Chest Z Movement

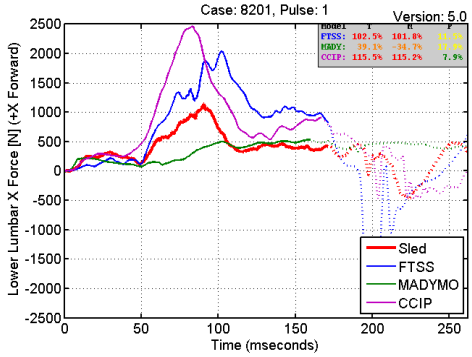


10G 70ms -X
Figure C-1-189: 8204 Chest Z Movement

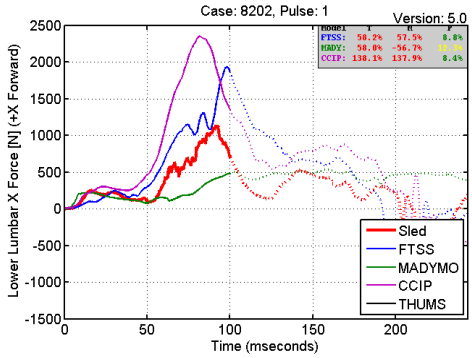


10G 110ms -X
Figure C-1-192: 8205 Chest Z Movement

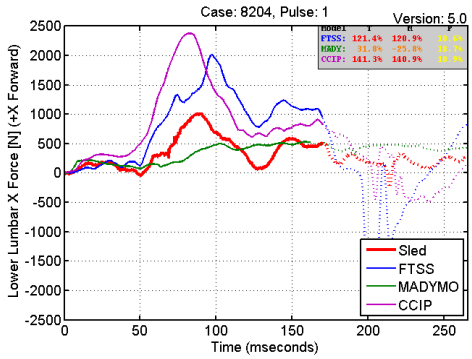
C.1.33 Lumbar X Force



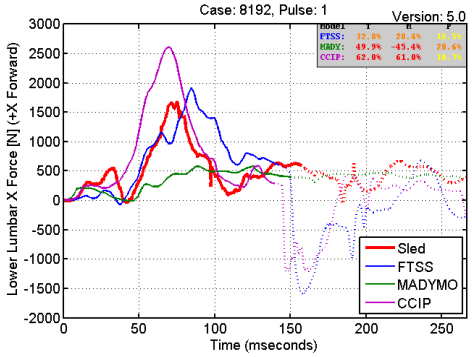
10G 70ms -X
Figure C-1-193: 8201 Lumbar X Force



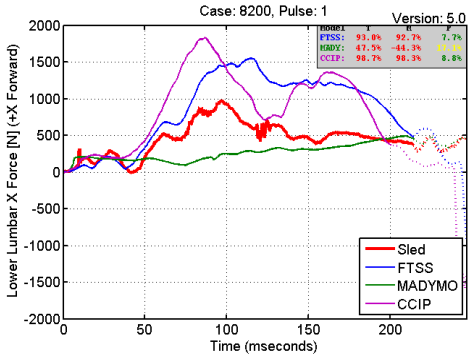
10G 70ms -X
Figure C-1-194: 8202 Lumbar X Force



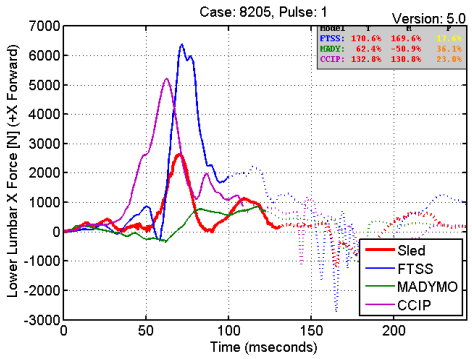
10G 70ms -X
Figure C-1-195: 8204 Lumbar X Force



10G 30ms -X
Figure C-1-196: 8192 Lumbar X Force

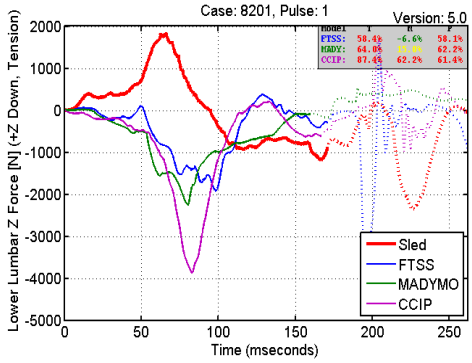


20G 110ms -X
Figure C-1-197: 8200 Lumbar X Force

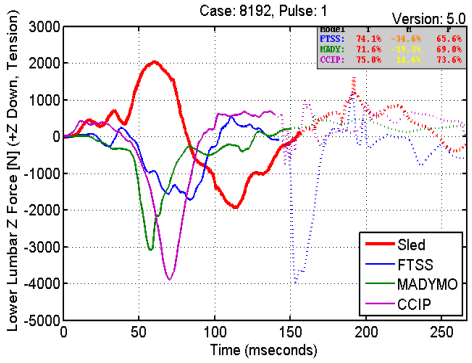


10G 110ms -X
Figure C-1-198: 8205 Lumbar X Force

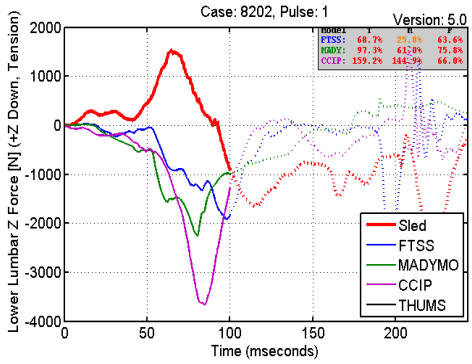
C.1.34 Lumbar Z Force



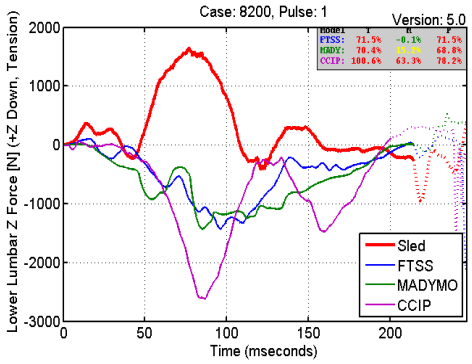
10G 70ms -X
Figure C-1-199: 8201 Lumbar Z Force



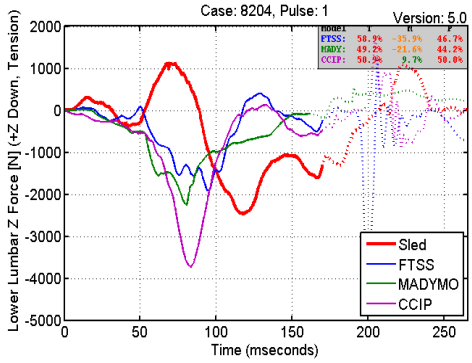
10G 30ms -X
Figure C-1-202: 8192 Lumbar Z Force



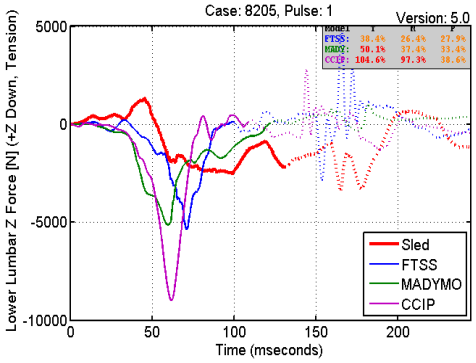
10G 70ms -X
Figure C-1-200: 8202 Lumbar Z Force



20G 110ms -X
Figure C-1-203: 8200 Lumbar Z Force

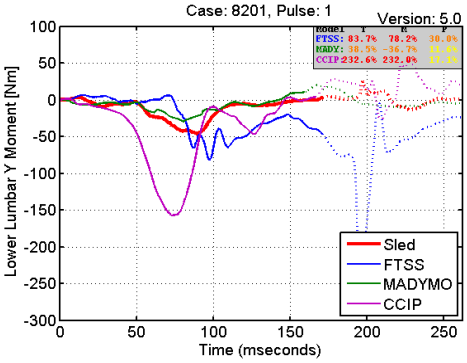


10G 70ms -X
Figure C-1-201: 8204 Lumbar Z Force

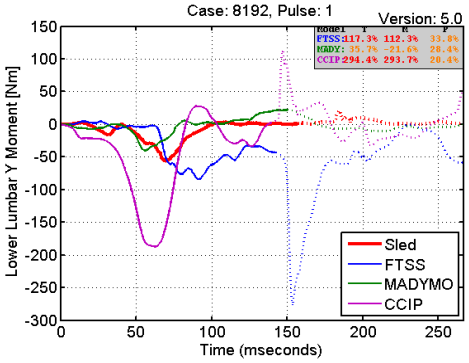


10G 110ms -X
Figure C-1-204: 8205 Lumbar Z Force

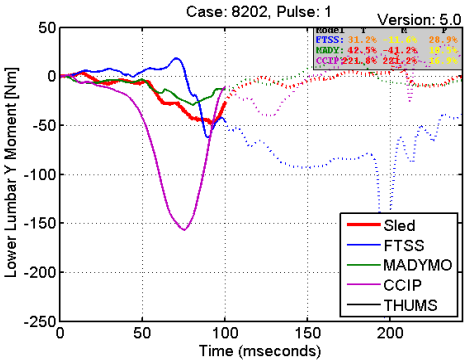
C.1.35 Lumbar Y Moment



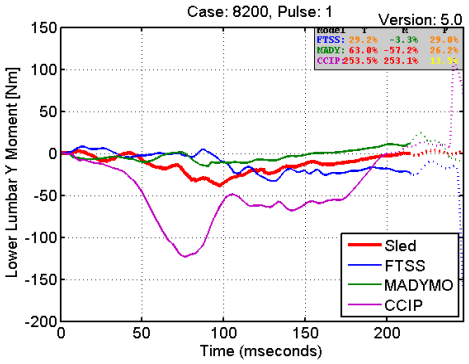
10G 70ms -X
Figure C-1-205: 8201 Lumbar Y Moment



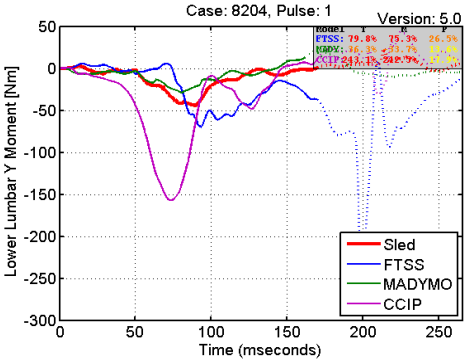
10G 30ms -X
Figure C-1-208: 8192 Lumbar Y Moment



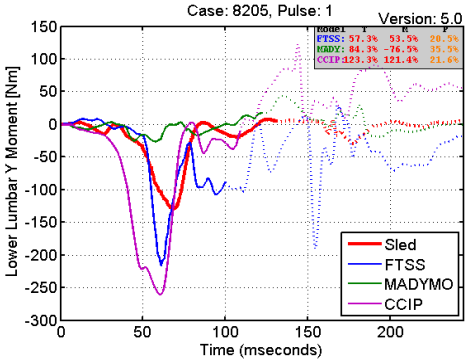
10G 70ms -X
Figure C-1-206: 8202 Lumbar Y Moment



20G 110ms -X
Figure C-1-209: 8200 Lumbar Y Moment

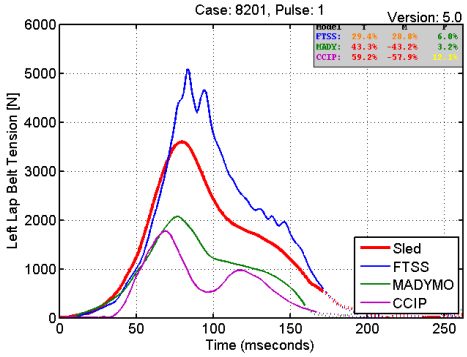


10G 70ms -X
Figure C-1-207: 8204 Lumbar Y Moment

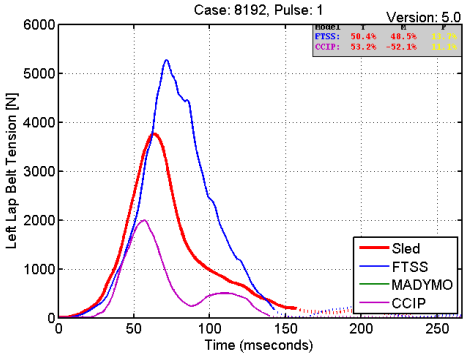


10G 110ms -X
Figure C-1-210: 8205 Lumbar Y Moment

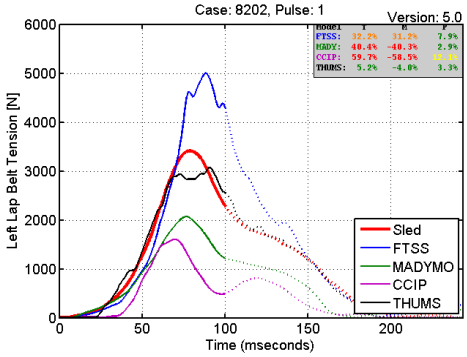
C.1.36 Left Lap Belt Force



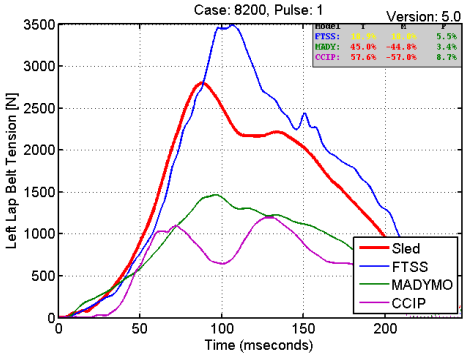
10G 70ms -X
Figure C-1-211: 8201 Left Lap Belt Force



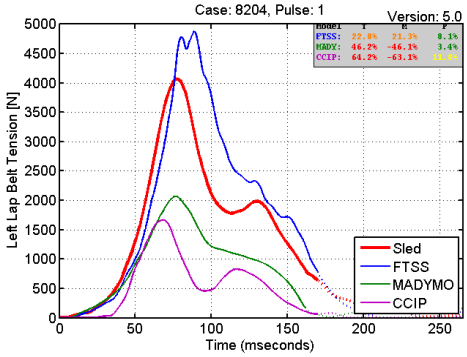
10G 30ms -X
Figure C-1-214: 8192 Left Lap Belt Force



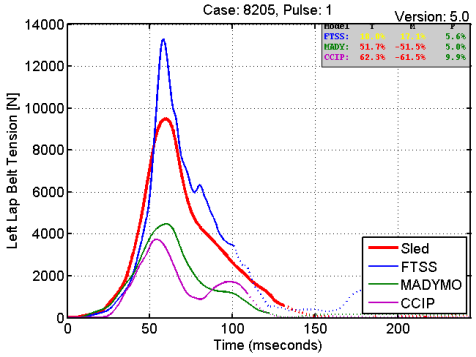
10G 70ms -X
Figure C-1-212: 8202 Left Lap Belt Force



20G 110ms -X
Figure C-1-215: 8200 Left Lap Belt Force

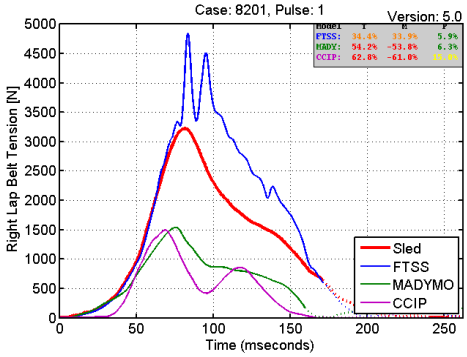


10G 70ms -X
Figure C-1-213: 8204 Left Lap Belt Force

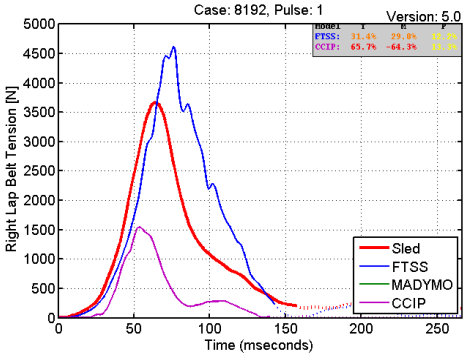


10G 110ms -X
Figure C-1-216: 8205 Left Lap Belt Force

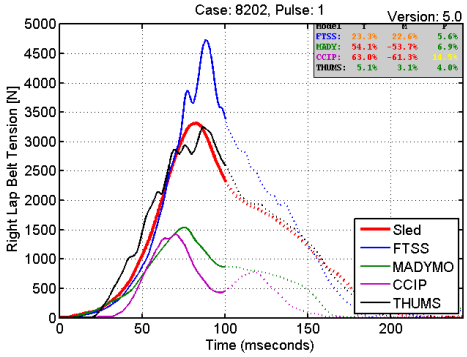
C.1.37 Right Lap Belt Force



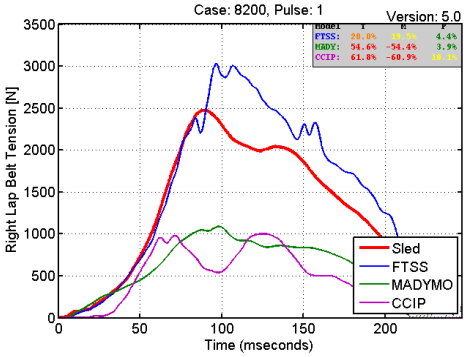
10G 70ms -X
Figure C-1-217: 8201 Right Lap Belt Force



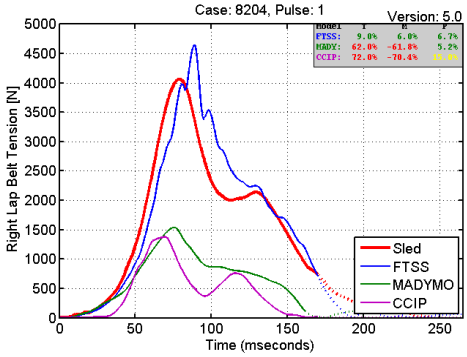
10G 30ms -X
Figure C-1-220: 8192 Right Lap Belt Force



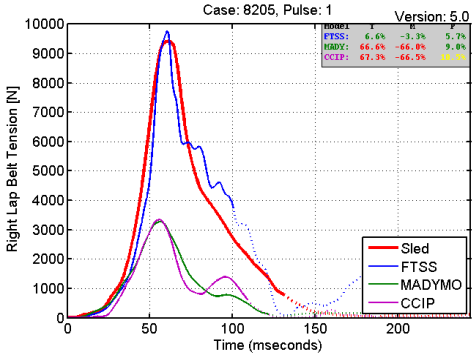
10G 70ms -X
Figure C-1-218: 8202 Right Lap Belt Force



20G 110ms -X
Figure C-1-221: 8200 Right Lap Belt Force

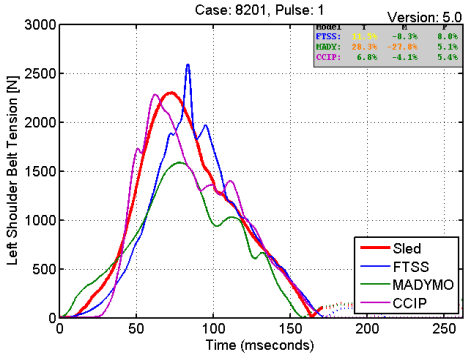


10G 70ms -X
Figure C-1-219: 8204 Right Lap Belt Force

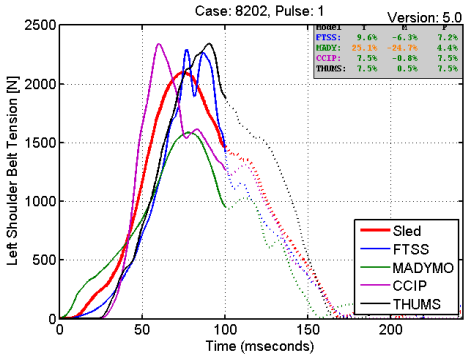


10G 110ms -X
Figure C-1-222: 8205 Right Lap Belt Force

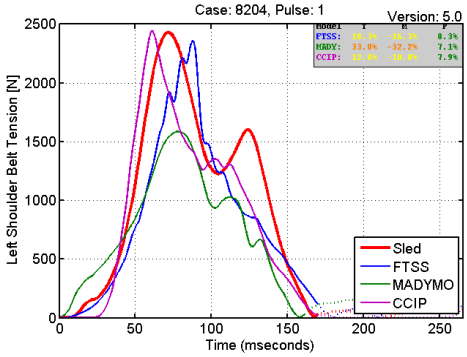
C.1.38 Left Shoulder Belt Force



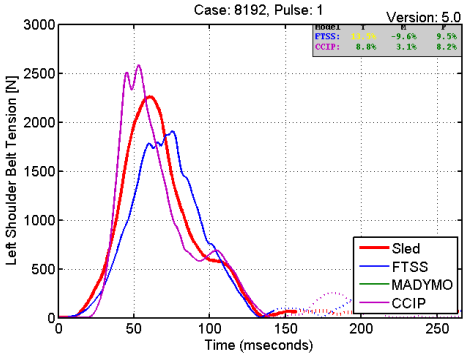
10G 70ms -X
Figure C-1-223: 8201 Left Shoulder Belt Force



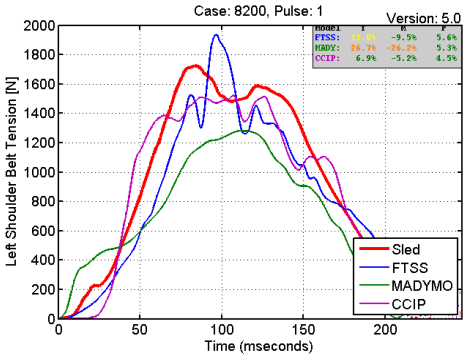
10G 70ms -X
Figure C-1-224: 8202 Left Shoulder Belt Force



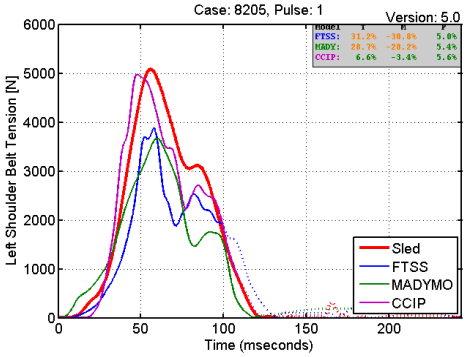
10G 70ms -X
Figure C-1-225: 8204 Left Shoulder Belt Force



10G 30ms -X
Figure C-1-226: 8192 Left Shoulder Belt Force

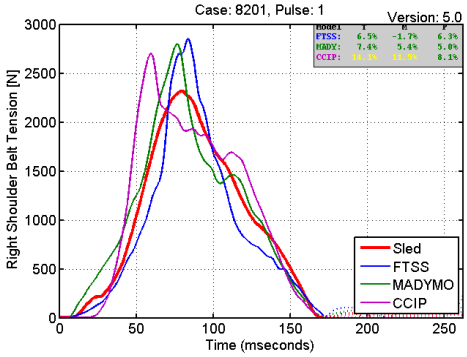


20G 110ms -X
Figure C-1-227: 8200 Left Shoulder Belt Force

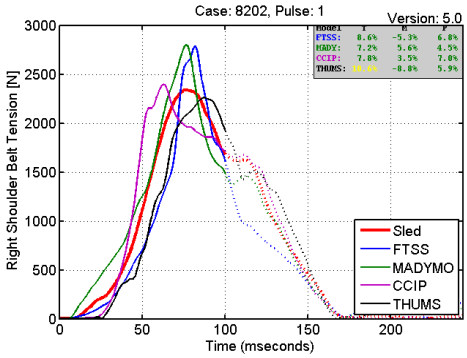


10G 110ms -X
Figure C-1-228: 8205 Left Shoulder Belt Force

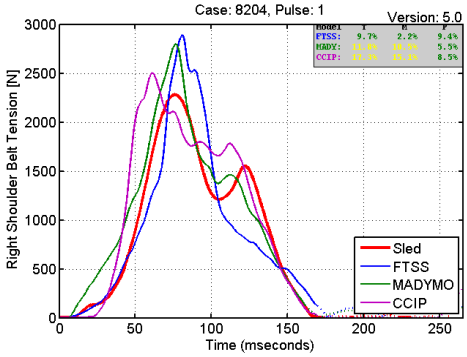
C.1.39 Right Shoulder Belt Force



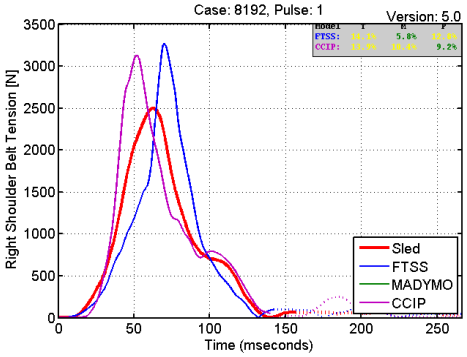
10G 70ms -X
Figure C-1-229: 8201 Right Shoulder Belt Force



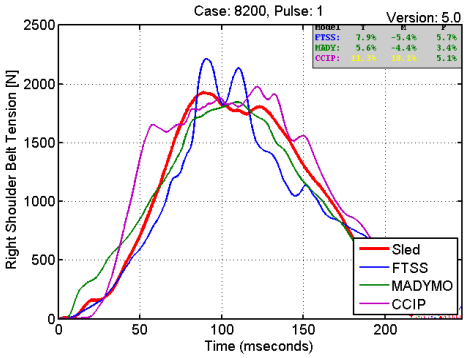
10G 70ms -X
Figure C-1-230: 8202 Right Shoulder Belt Force



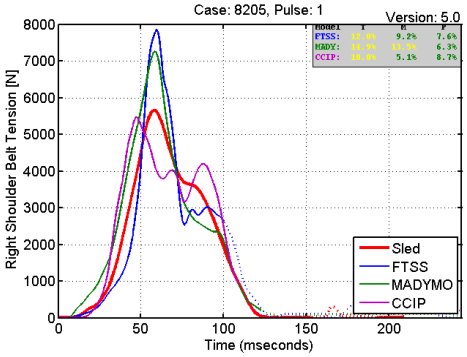
10G 70ms -X
Figure C-1-231: 8204 Right Shoulder Belt Force



10G 30ms -X
Figure C-1-232: 8192 Right Shoulder Belt Force

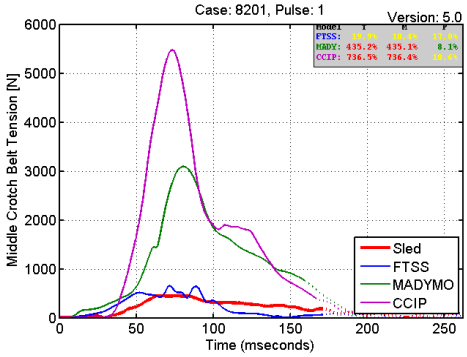


20G 110ms -X
Figure C-1-233: 8200 Right Shoulder Belt Force

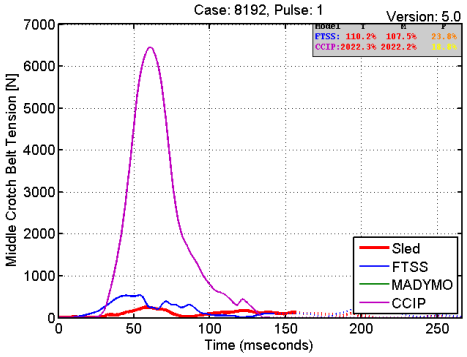


10G 110ms -X
Figure C-1-234: 8205 Right Shoulder Belt Force

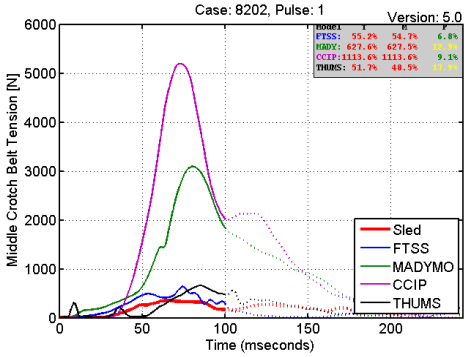
C.1.40 Crotch Belt Force



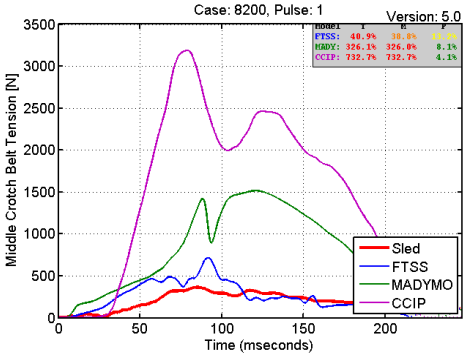
10G 70ms -X
Figure C-1-235: 8201 Crotch Belt Force



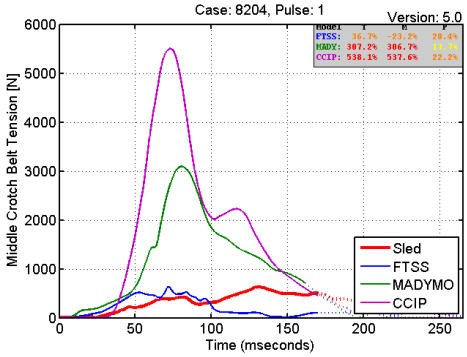
10G 30ms -X
Figure C-1-238: 8192 Crotch Belt Force



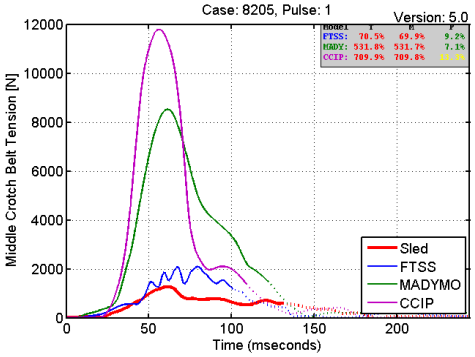
10G 70ms -X
Figure C-1-236: 8202 Crotch Belt Force



20G 110ms -X
Figure C-1-239: 8200 Crotch Belt Force



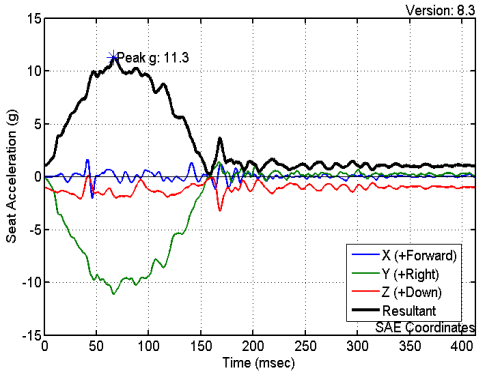
10G 70ms -X
Figure C-1-237: 8204 Crotch Belt Force



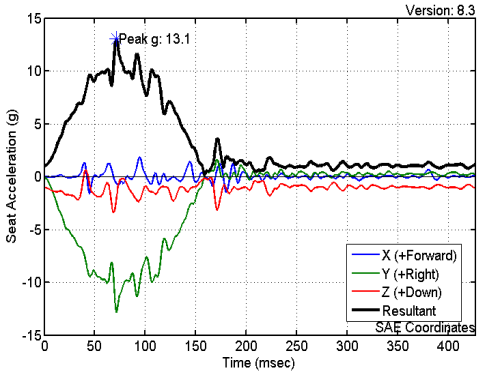
10G 110ms -X
Figure C-1-240: 8205 Crotch Belt Force

C.2 Lateral Impact

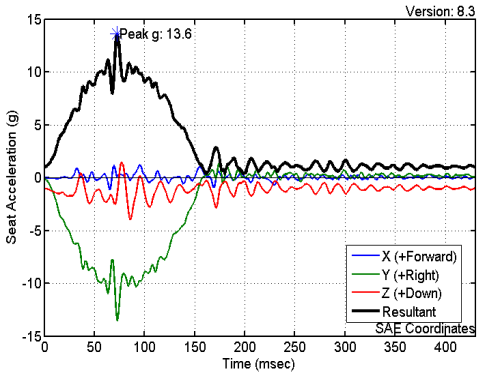
C.2.1 Seat Accelerations



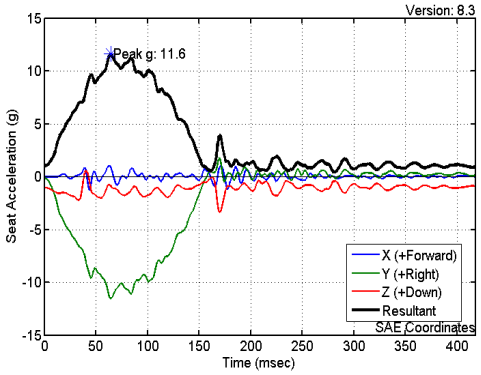
10G 70ms -Y No Side Support
Figure C-2-1: 8239 Seat Accelerations



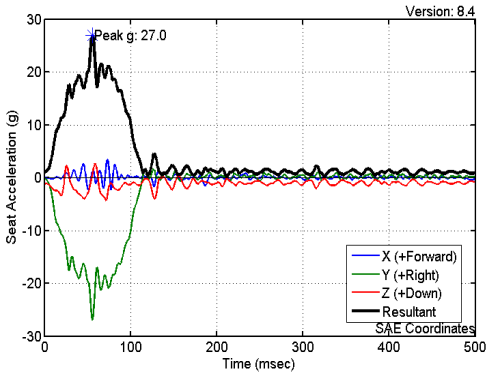
10G 70ms -Y No Head Support
Figure C-2-2: 8240 Seat Accelerations



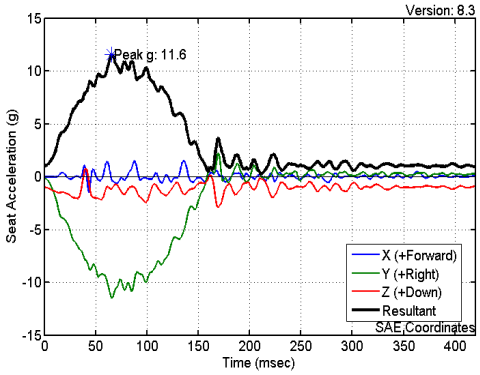
10G 70ms -Y 100% Gap
Figure C-2-3: 8248 Seat Accelerations



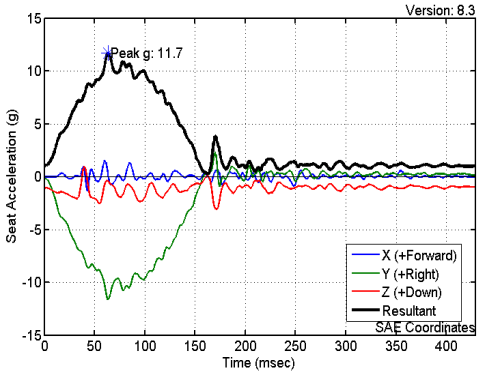
10G 70ms -Y No Head Support
Figure C-2-4: 8241 Seat Accelerations



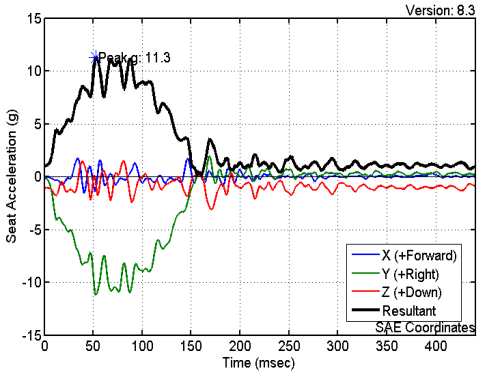
20G 70ms -Y 100% Gap
Figure C-2-5: 8249 Seat Accelerations



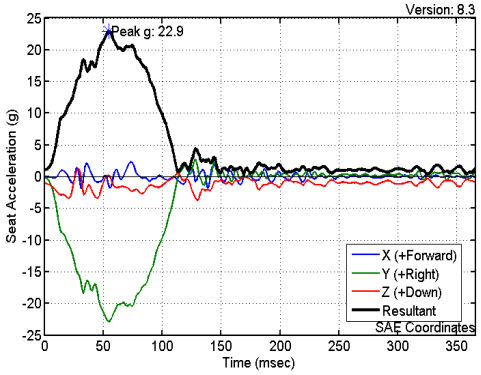
10G 70ms -Y 50% Gap
Figure C-2-6: 8244 Seat Accelerations



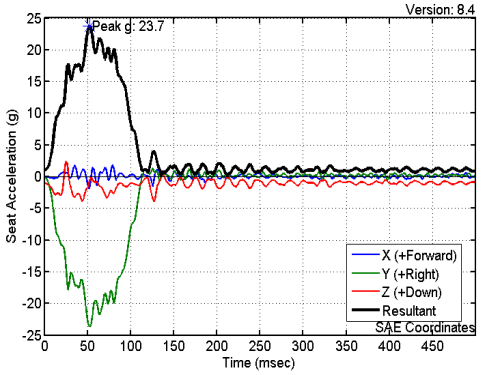
10G 70ms -Y 50% Gap
Figure C-2-7: 8245 Seat Accelerations



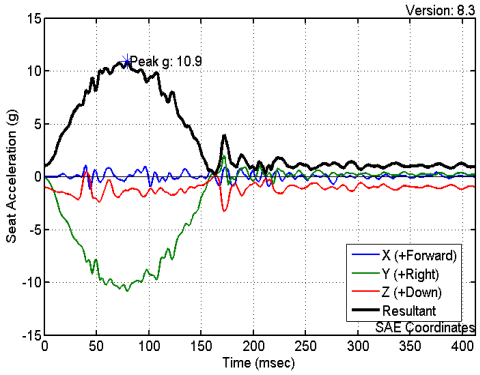
10G 70ms -Y 50% Gap
Figure C-2-8: 8295 Seat Accelerations



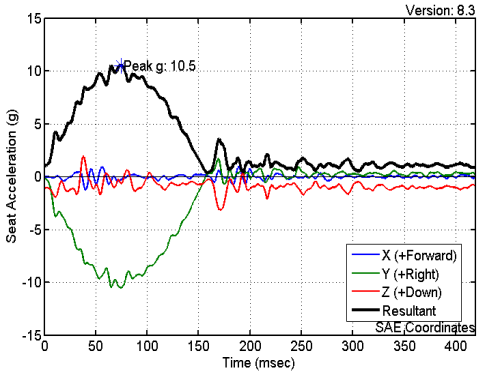
20G 70ms -Y 50% Gap
Figure C-2-9: 8246 Seat Accelerations



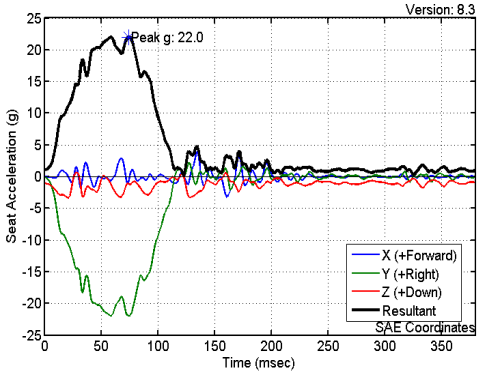
20G 70ms -Y 50% Gap
Figure C-2-10: 8247 Seat Accelerations



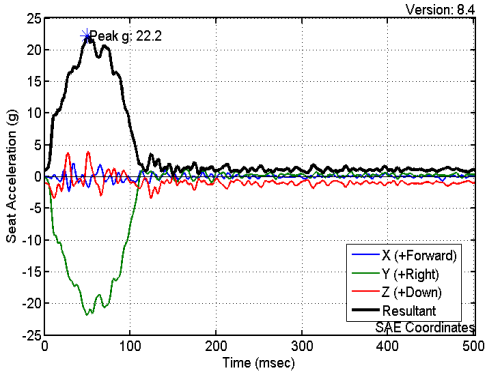
10G 70ms -Y No Gap
Figure C-2-11: 8242 Seat Accelerations



10G 70ms -Y No Gap
Figure C-2-12: 8294 Seat Accelerations

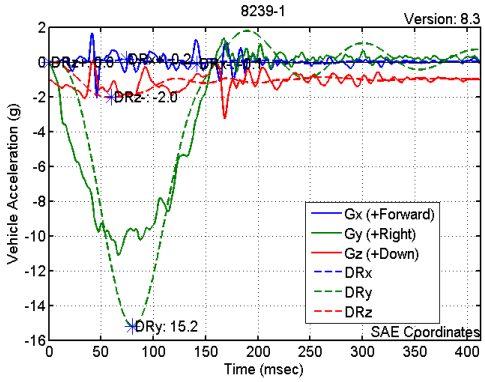


20G 70ms -Y No Gap
Figure C-2-13: 8243 Seat Accelerations

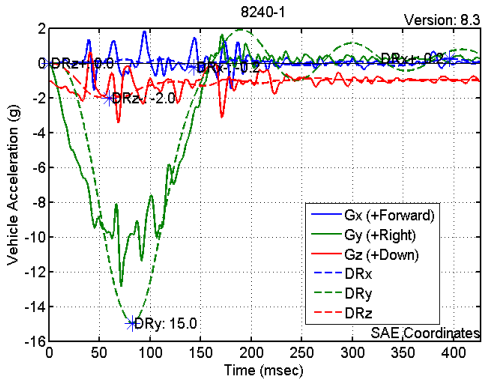


20G 70ms -Y No Gap
Figure C-2-14: 8296 Seat Accelerations

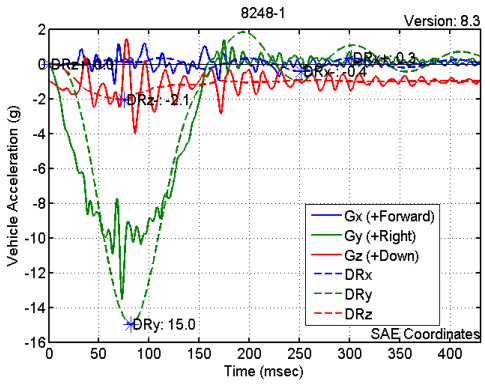
C.2.2 Dynamic Response Index



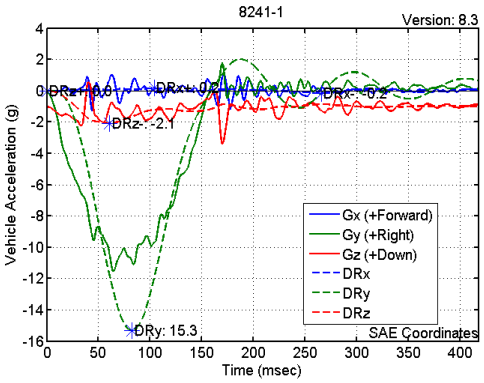
10G 70ms -Y No Side Support
Figure C-2-15: 8239 Dynamic Response Index



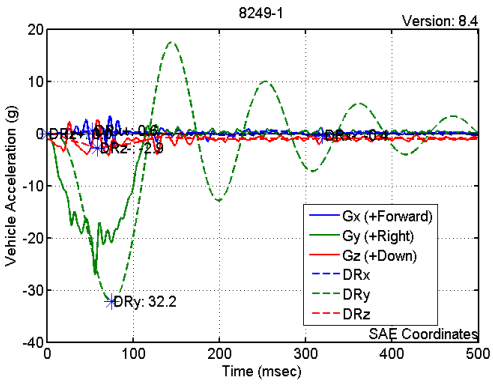
10G 70ms -Y No Head Support
Figure C-2-16: 8240 Dynamic Response Index



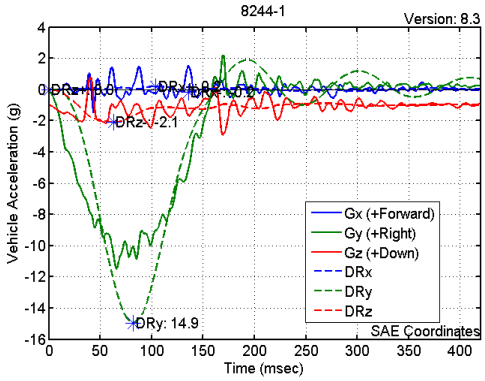
10G 70ms -Y 100% Gap
Figure C-2-17: 8248 Dynamic Response Index



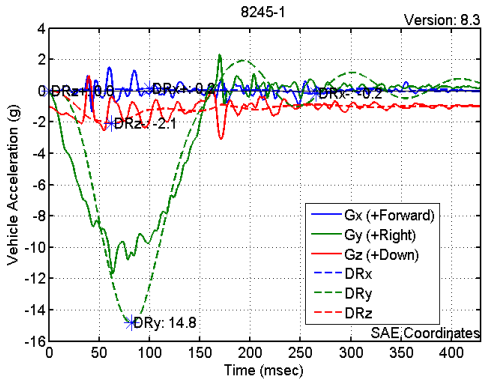
10G 70ms -Y No Head Support
Figure C-2-18: 8241 Dynamic Response Index



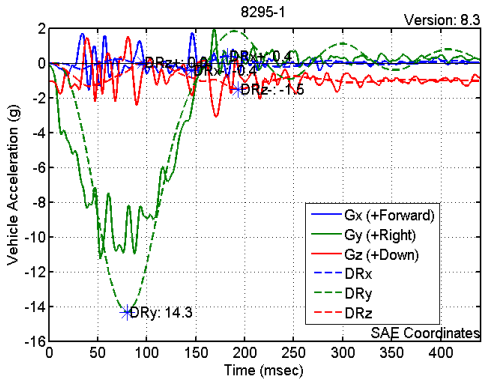
20G 70ms -Y 100% Gap
Figure C-2-19: 8249 Dynamic Response Index



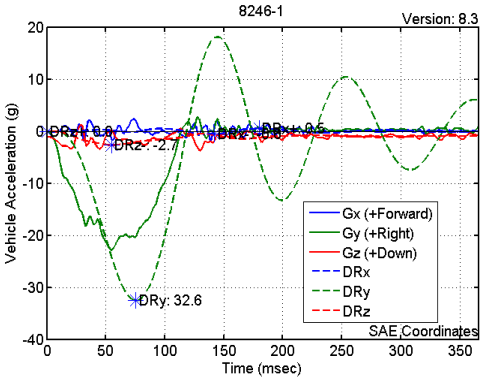
10G 70ms -Y 50% Gap
Figure C-2-20: 8244 Dynamic Response Index



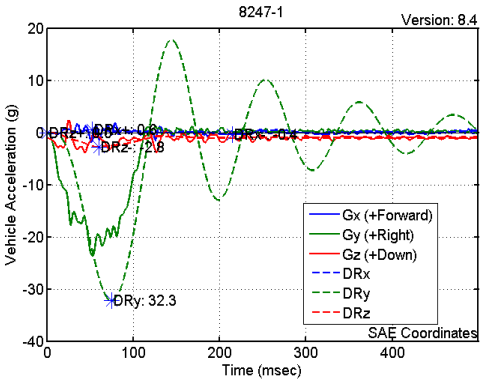
10G 70ms -Y 50% Gap
Figure C-2-21: 8245 Dynamic Response Index



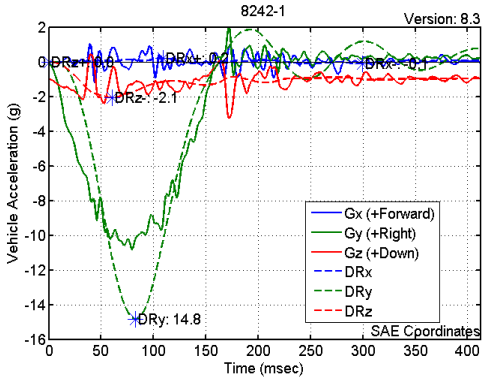
10G 70ms -Y 50% Gap
Figure C-2-22: 8295 Dynamic Response Index



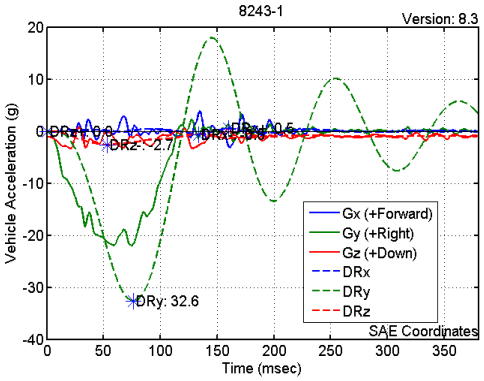
20G 70ms -Y 50% Gap
Figure C-2-23: 8246 Dynamic Response Index



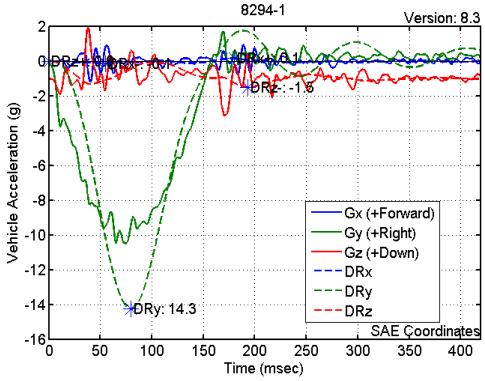
20G 70ms -Y 50% Gap
Figure C-2-24: 8247 Dynamic Response Index



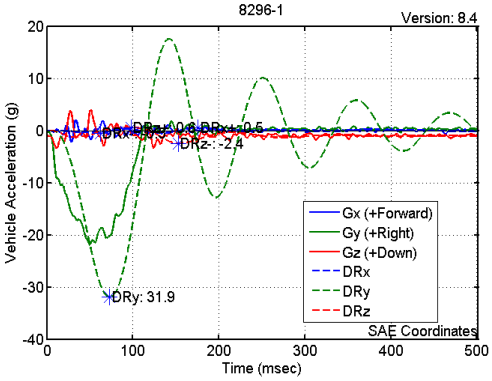
10G 70ms -Y No Gap
Figure C-2-25: 8242 Dynamic Response Index



20G 70ms -Y No Gap
Figure C-2-27: 8243 Dynamic Response Index

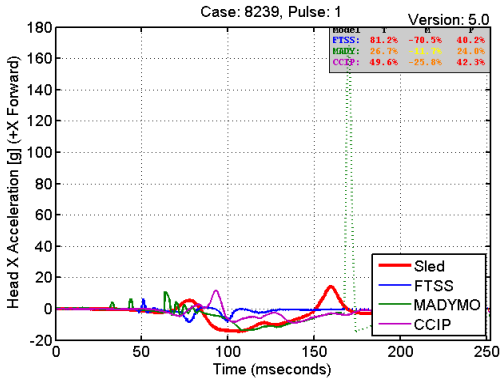


10G 70ms -Y No Gap
Figure C-2-26: 8294 Dynamic Response Index

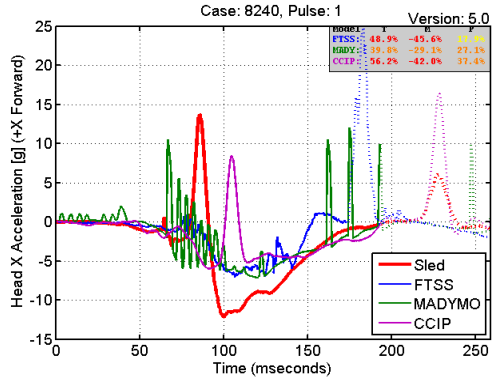


20G 70ms -Y No Gap
Figure C-2-28: 8296 Dynamic Response Index

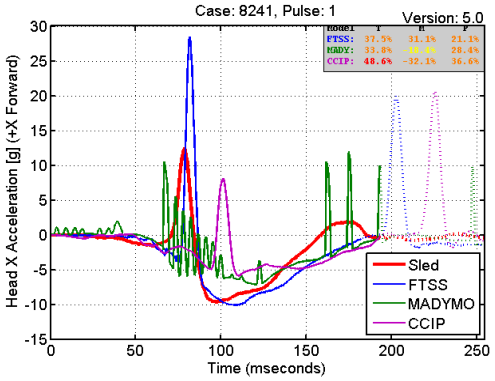
C.2.3 Head X Translational Acceleration



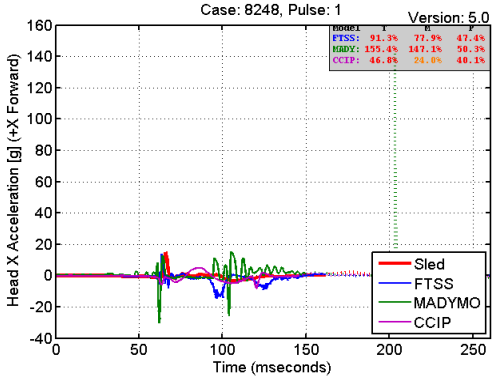
10G 70ms -Y No Side Support
Figure C-2-29: 8239 Head X Translational Acceleration



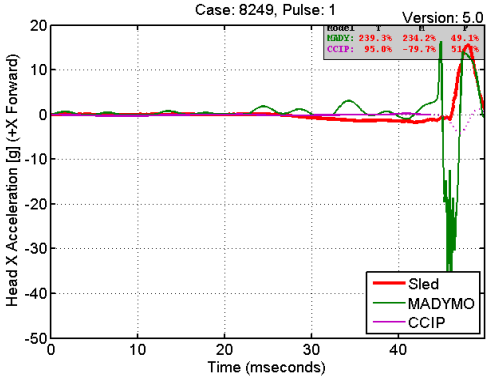
10G 70ms -Y No Head Support
Figure C-2-30: 8240 Head X Translational Acceleration



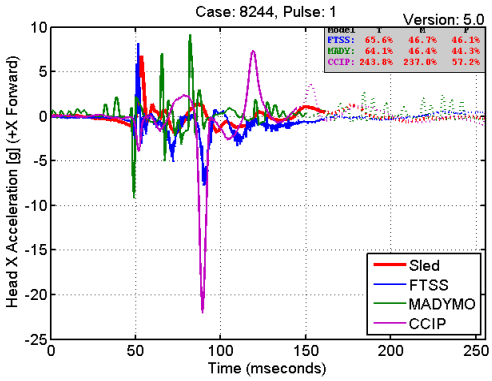
10G 70ms -Y No Head Support
Figure C-2-32: 8241 Head X Translational Acceleration



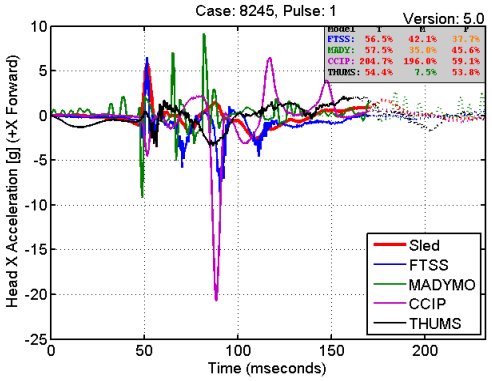
10G 70ms -Y 100% Gap
Figure C-2-31: 8248 Head X Translational Acceleration



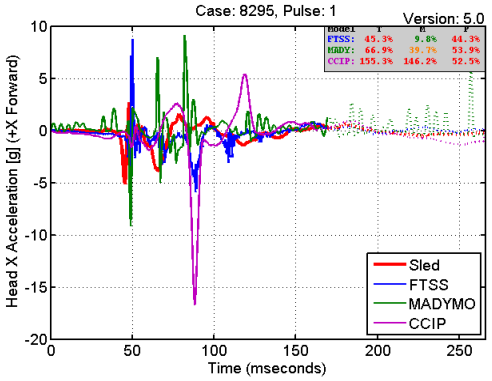
20G 70ms -Y 100% Gap
Figure C-2-33: 8249 Head X Translational Acceleration



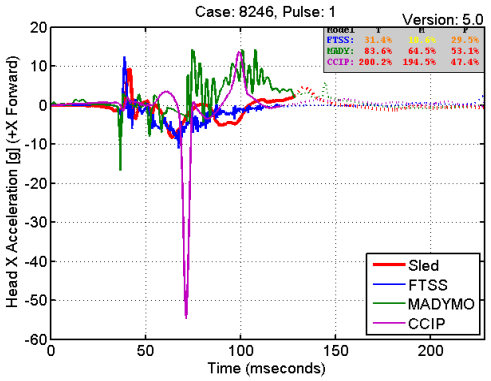
10G 70ms -Y 50% Gap
Figure C-2-34: 8244 Head X Translational Acceleration



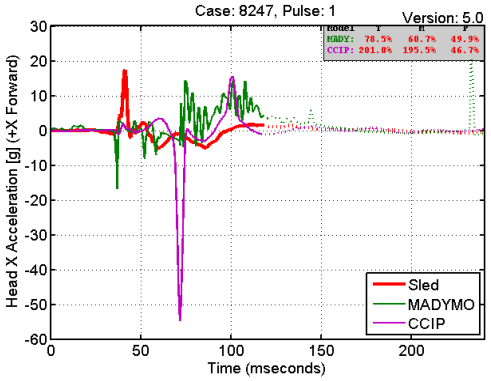
10G 70ms -Y 50% Gap
Figure C-2-35: 8245 Head X Translational Acceleration



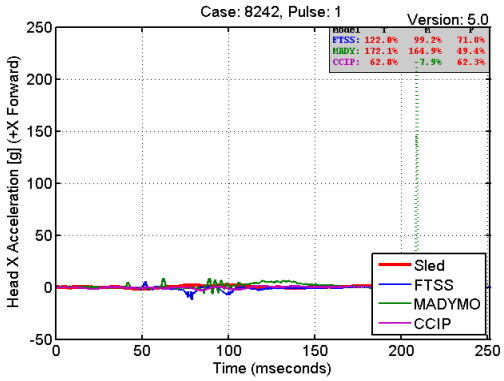
10G 70ms -Y 50% Gap
Figure C-2-36: 8295 Head X Translational Acceleration



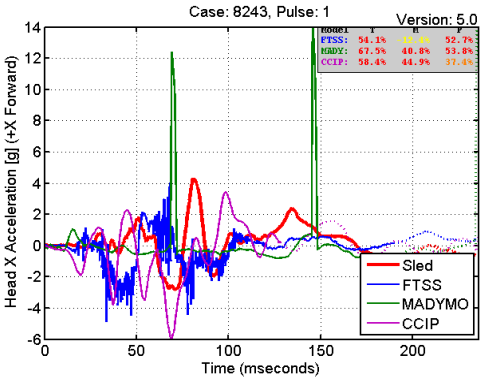
20G 70ms -Y 50% Gap
Figure C-2-37: 8246 Head X Translational Acceleration



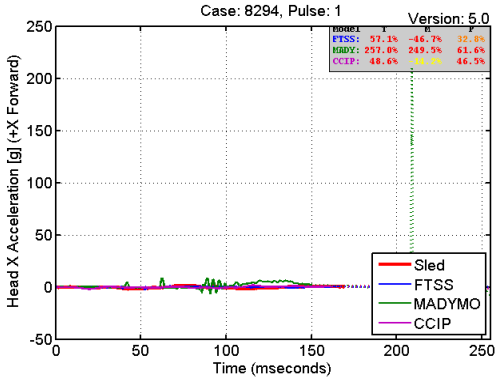
20G 70ms -Y 50% Gap
Figure C-2-38: 8247 Head X Translational Acceleration



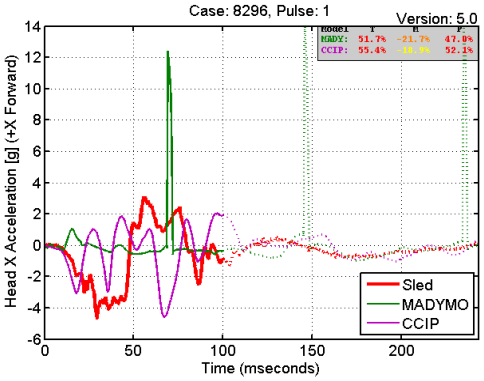
10G 70ms -Y No Gap
Figure C-2-39: 8242 Head X Translational Acceleration



20G 70ms -Y No Gap
Figure C-2-41: 8243 Head X Translational Acceleration

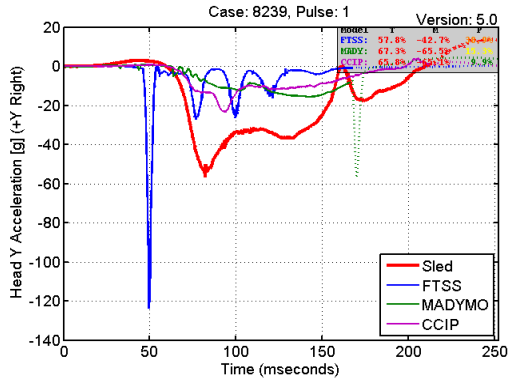


10G 70ms -Y No Gap
Figure C-2-40: 8294 Head X Translational Acceleration

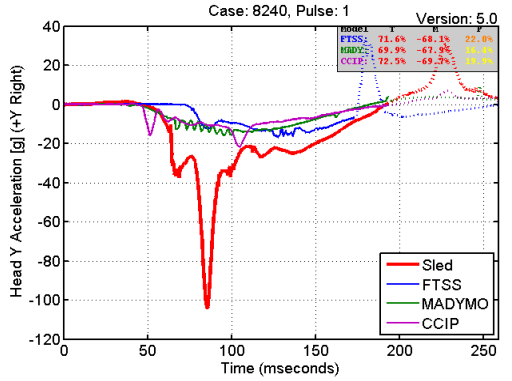


20G 70ms -Y No Gap
Figure C-2-42: 8296 Head X Translational Acceleration

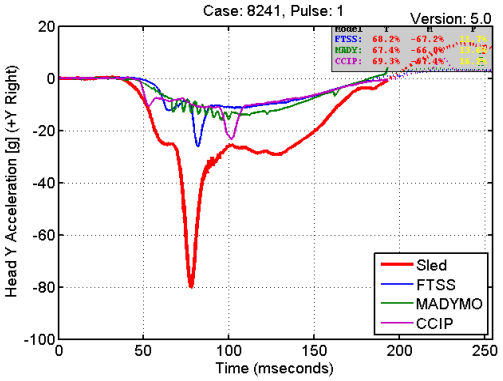
C.2.4 Head Y Translational Acceleration



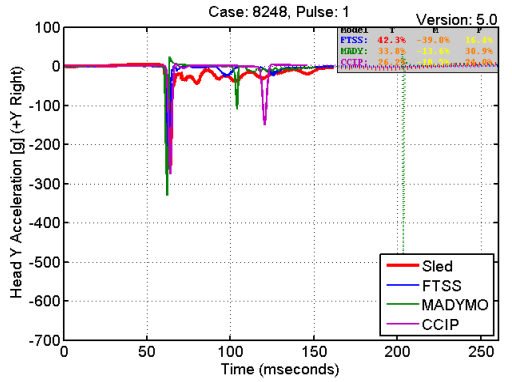
10G 70ms -Y No Side Support
Figure C-2-43: 8239 Head Y Translational Acceleration



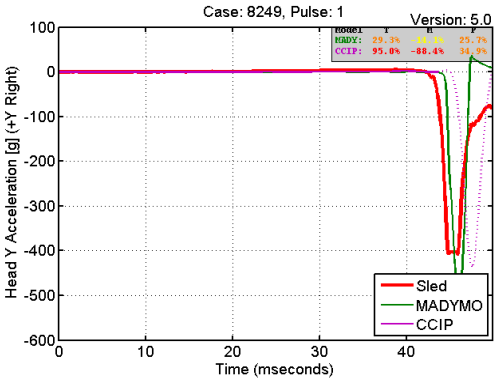
10G 70ms -Y No Head Support
Figure C-2-44: 8240 Head Y Translational Acceleration



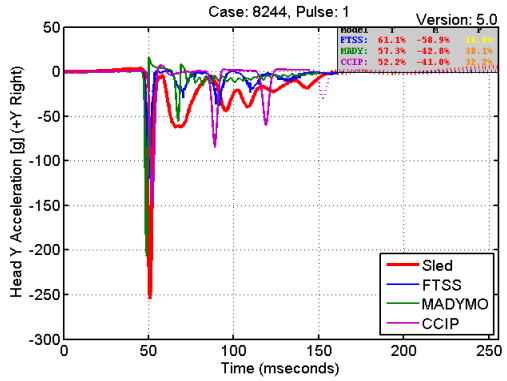
10G 70ms -Y No Head Support
Figure C-2-46: 8241 Head Y Translational Acceleration



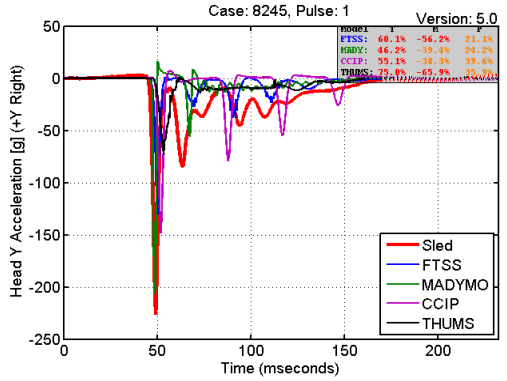
10G 70ms -Y 100% Gap
Figure C-2-45: 8248 Head Y Translational Acceleration



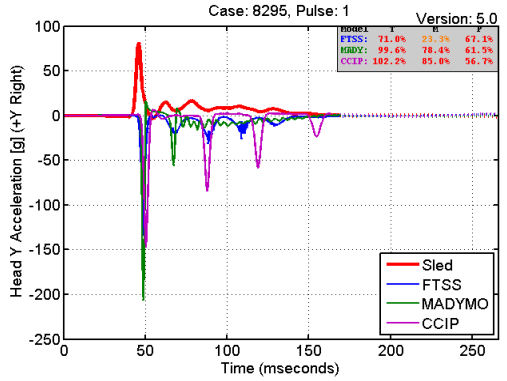
20G 70ms -Y 100% Gap
Figure C-2-47: 8249 Head Y Translational Acceleration



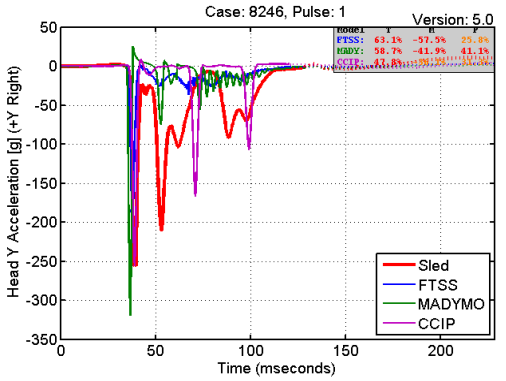
10G 70ms -Y 50% Gap
Figure C-2-48: 8244 Head Y Translational Acceleration



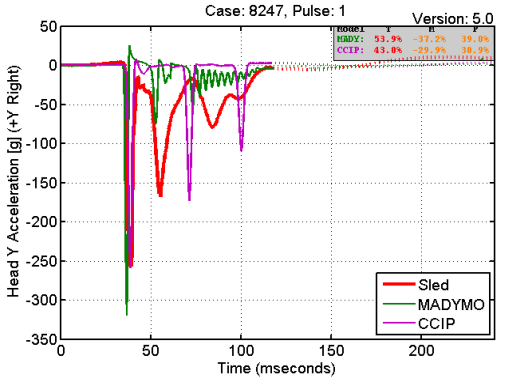
10G 70ms -Y 50% Gap
Figure C-2-49: 8245 Head Y Translational Acceleration



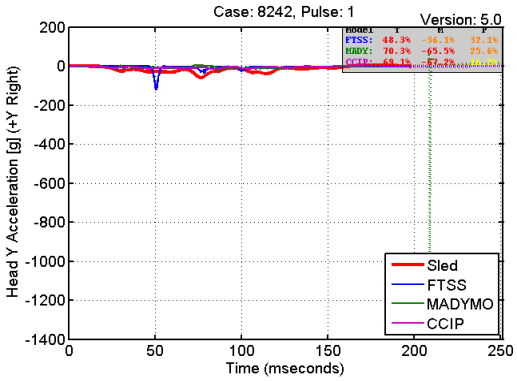
10G 70ms -Y 50% Gap
Figure C-2-50: 8295 Head Y Translational Acceleration



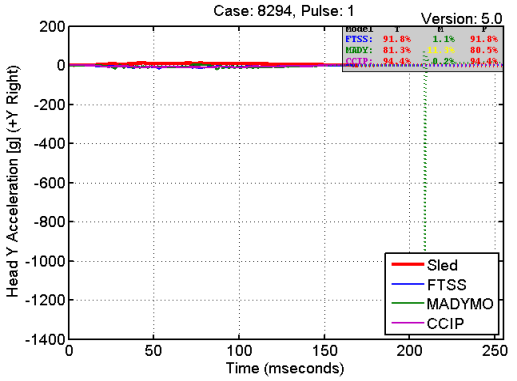
20G 70ms -Y 50% Gap
Figure C-2-51: 8246 Head Y Translational Acceleration



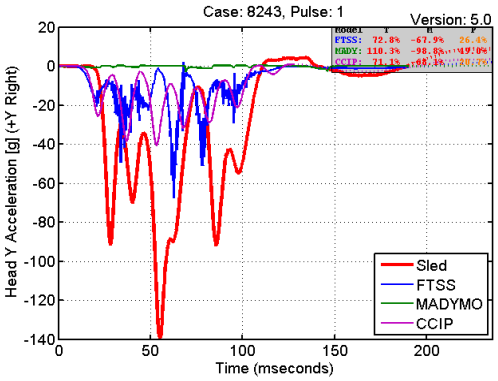
20G 70ms -Y 50% Gap
Figure C-2-52: 8247 Head Y Translational Acceleration



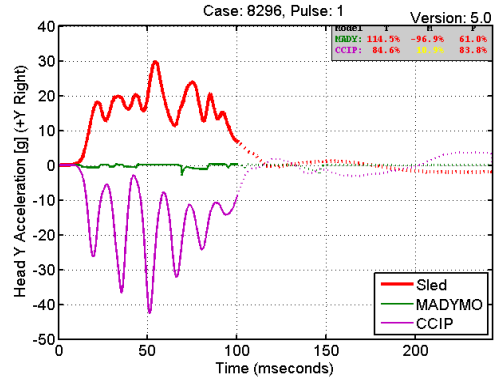
10G 70ms -Y No Gap
Figure C-2-53: 8242 Head Y Translational Acceleration



10G 70ms -Y No Gap
Figure C-2-54: 8294 Head Y Translational Acceleration

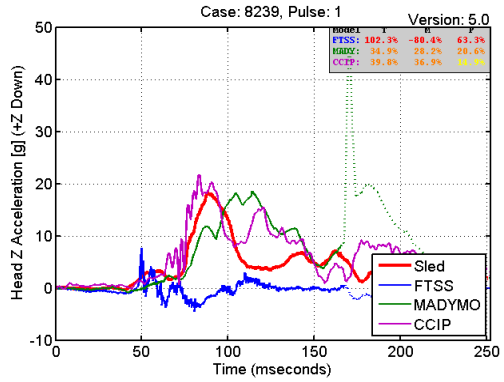


20G 70ms -Y No Gap
Figure C-2-55: 8243 Head Y Translational Acceleration

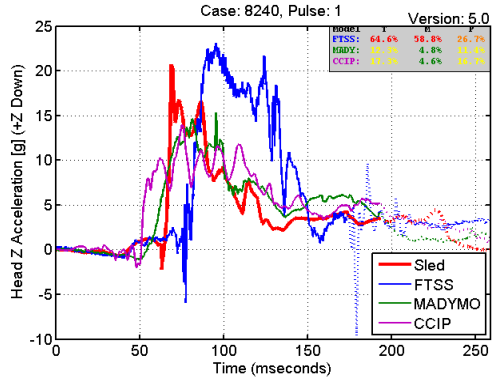


20G 70ms -Y No Gap
Figure C-2-56: 8296 Head Y Translational Acceleration

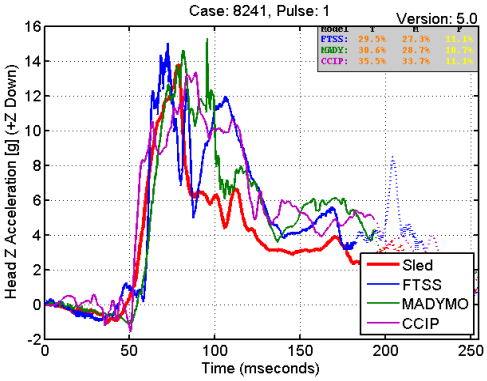
C.2.5 Head Z Translational Acceleration



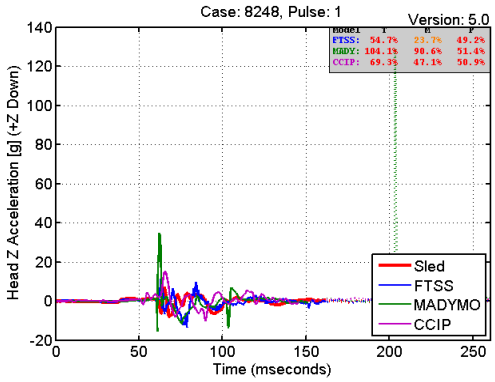
10G 70ms -Y No Side Support
Figure C-2-57: 8239 Head Z Translational Acceleration



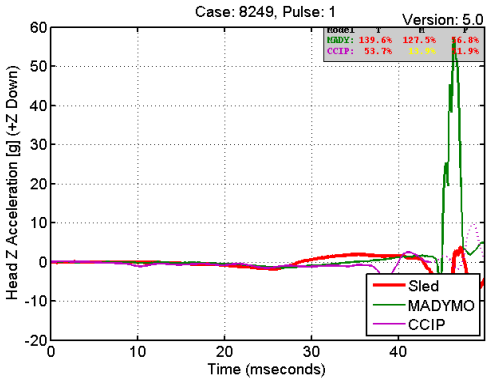
10G 70ms -Y No Head Support
Figure C-2-58: 8240 Head Z Translational Acceleration



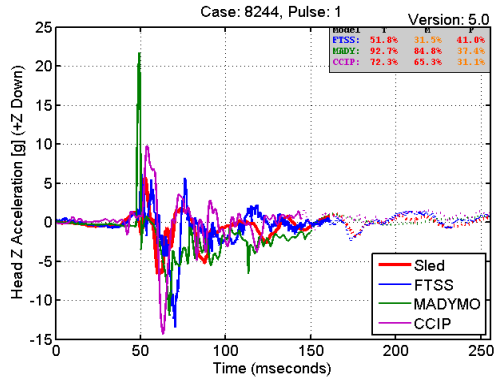
10G 70ms -Y No Head Support
Figure C-2-60: 8241 Head Z Translational Acceleration



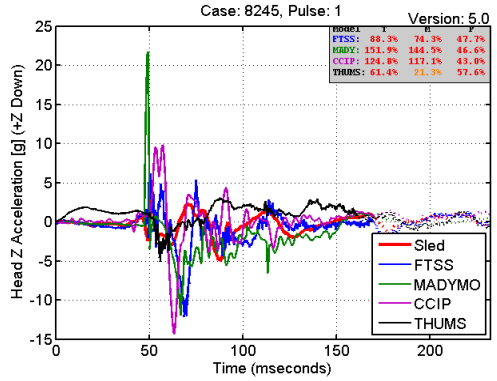
10G 70ms -Y 100% Gap
Figure C-2-59: 8248 Head Z Translational Acceleration



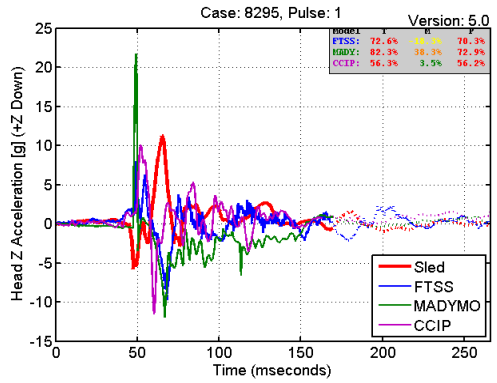
20G 70ms -Y 100% Gap
Figure C-2-61: 8249 Head Z Translational Acceleration



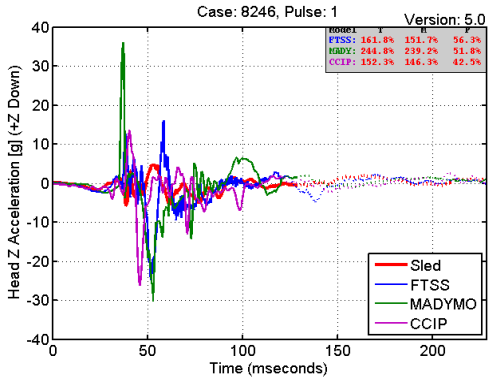
10G 70ms -Y 50% Gap
Figure C-2-62: 8244 Head Z Translational Acceleration



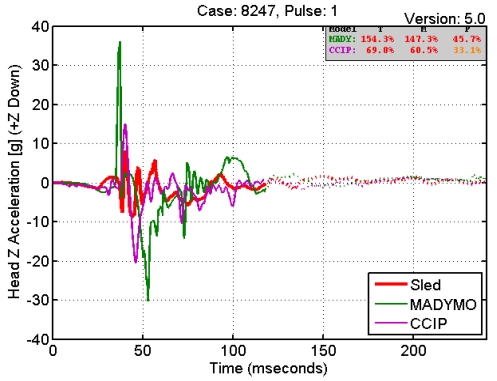
10G 70ms -Y 50% Gap
Figure C-2-63: 8245 Head Z Translational Acceleration



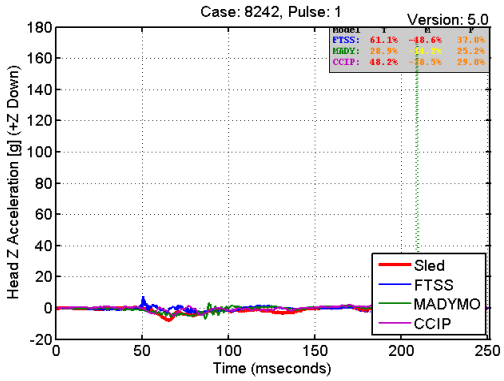
10G 70ms -Y 50% Gap
Figure C-2-64: 8295 Head Z Translational Acceleration



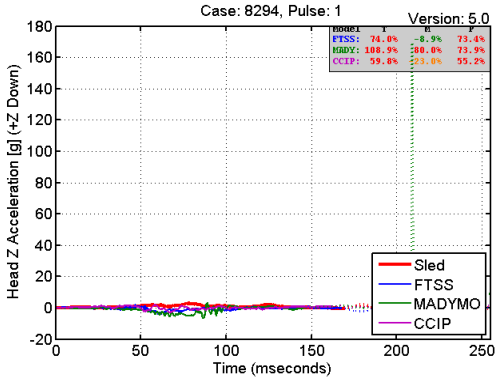
20G 70ms -Y 50% Gap
Figure C-2-65: 8246 Head Z Translational Acceleration



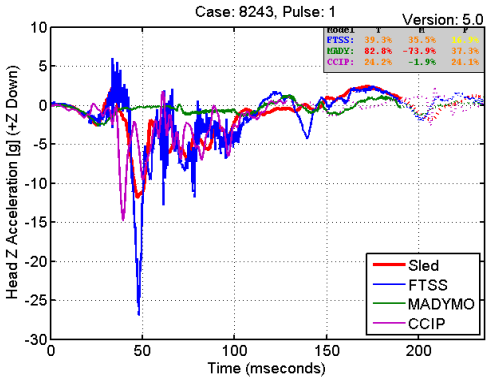
20G 70ms -Y 50% Gap
Figure C-2-66: 8247 Head Z Translational Acceleration



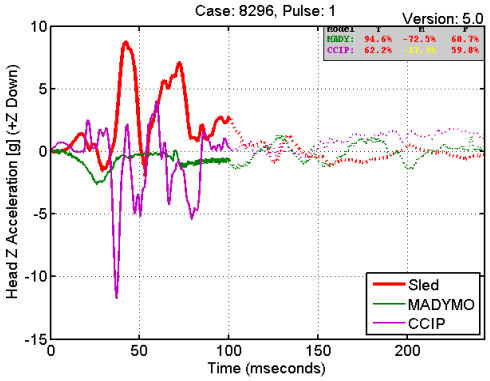
10G 70ms -Y No Gap
Figure C-2-67: 8242 Head Z Translational Acceleration



10G 70ms -Y No Gap
Figure C-2-68: 8294 Head Z Translational Acceleration

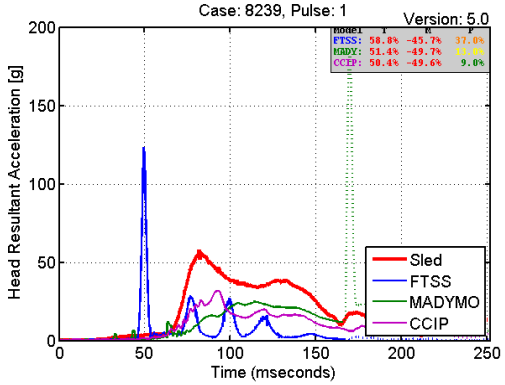


20G 70ms -Y No Gap
Figure C-2-69: 8243 Head Z Translational Acceleration

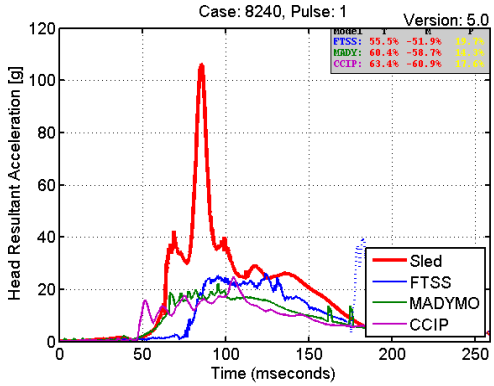


20G 70ms -Y No Gap
Figure C-2-70: 8296 Head Z Translational Acceleration

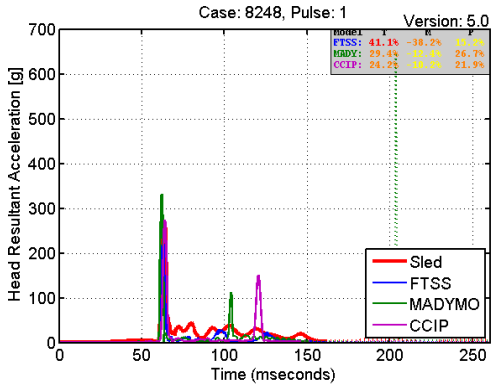
C.2.6 Head Resultant Translational Acceleration



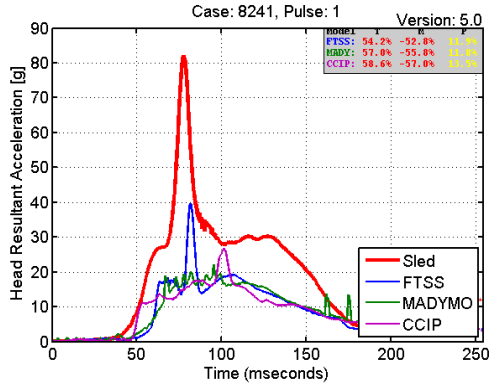
10G 70ms -Y No Side Support
Figure C-2-71: 8239 Head Resultant Translational Acceleration



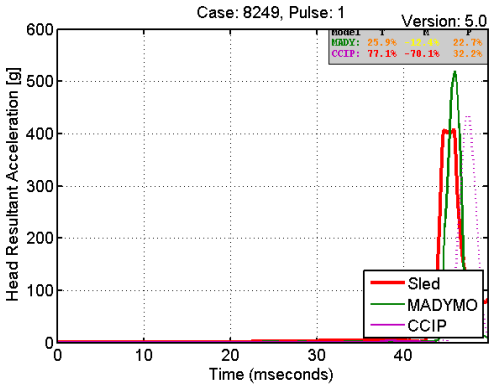
10G 70ms -Y No Head Support
Figure C-2-72: 8240 Head Resultant Translational Acceleration



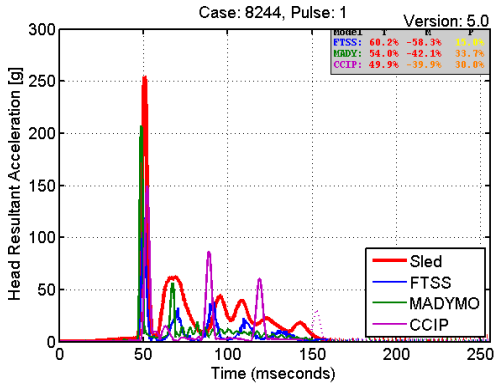
10G 70ms -Y 100% Gap
Figure C-2-73: 8248 Head Resultant Translational Acceleration



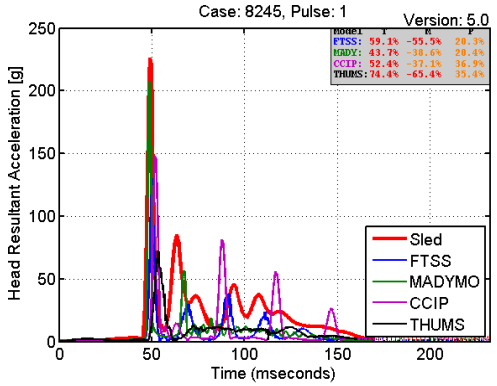
10G 70ms -Y No Head Support
Figure C-2-74: 8241 Head Resultant Translational Acceleration



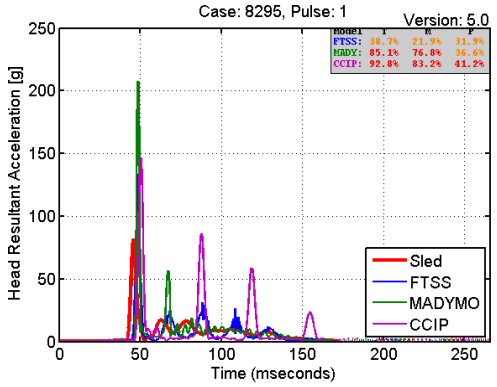
20G 70ms -Y 100% Gap
Figure C-2-75: 8249 Head Resultant Translational Acceleration



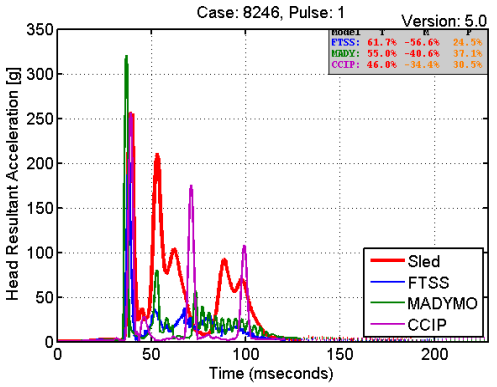
10G 70ms -Y 50% Gap
Figure C-2-76: 8244 Head Resultant Translational Acceleration



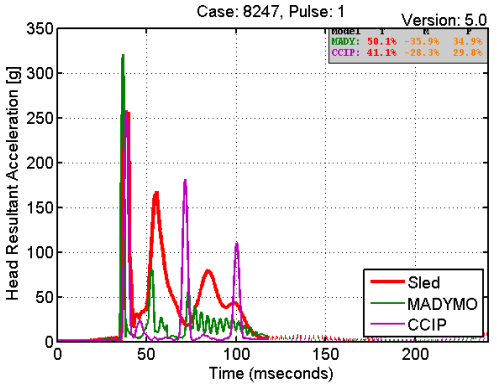
10G 70ms -Y 50% Gap
Figure C-2-77: 8245 Head Resultant Translational Acceleration



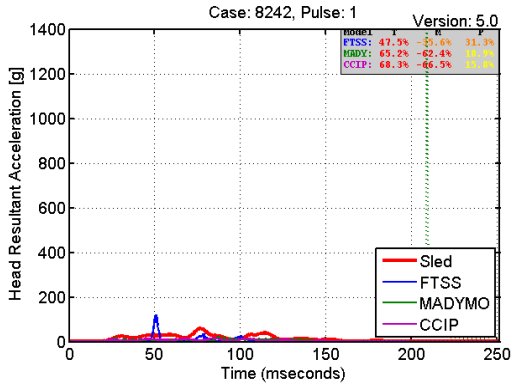
10G 70ms -Y 50% Gap
Figure C-2-78: 8295 Head Resultant Translational Acceleration



20G 70ms -Y 50% Gap
Figure C-2-79: 8246 Head Resultant Translational Acceleration

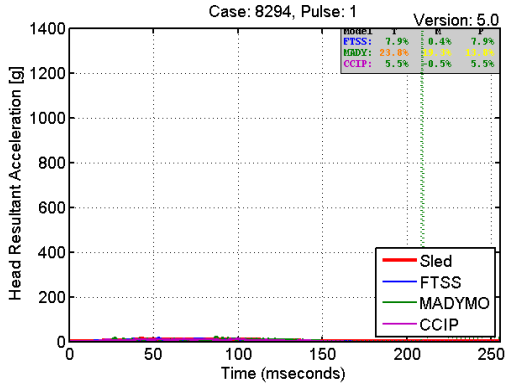


20G 70ms -Y 50% Gap
Figure C-2-80: 8247 Head Resultant Translational Acceleration



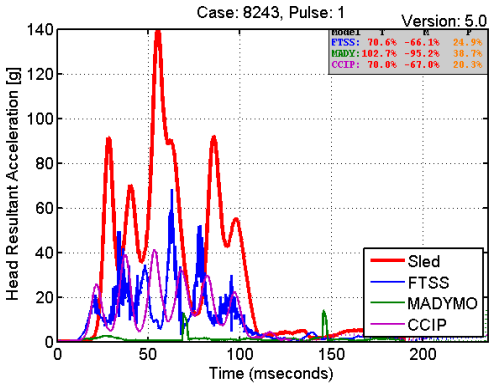
10G 70ms -Y No Gap

Figure C-2-81: 8242 Head Resultant Translational Acceleration



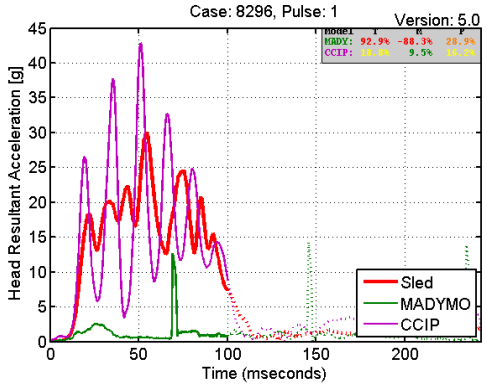
10G 70ms -Y No Gap

Figure C-2-82: 8294 Head Resultant Translational Acceleration



20G 70ms -Y No Gap

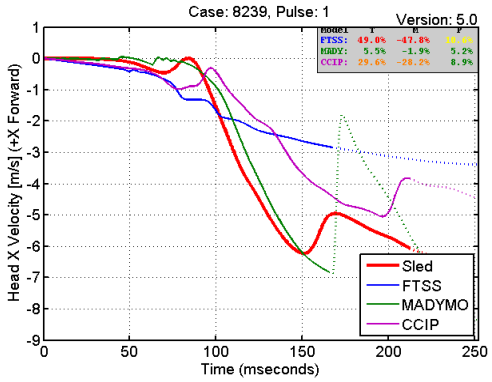
Figure C-2-83: 8243 Head Resultant Translational Acceleration



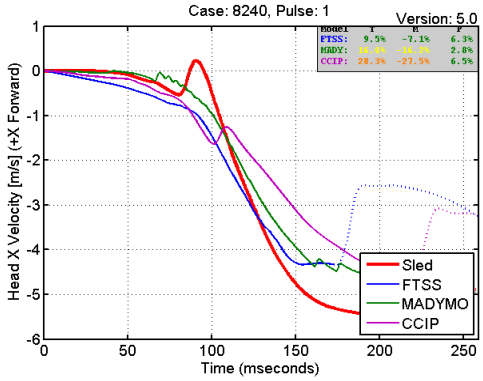
20G 70ms -Y No Gap

Figure C-2-84: 8296 Head Resultant Translational Acceleration

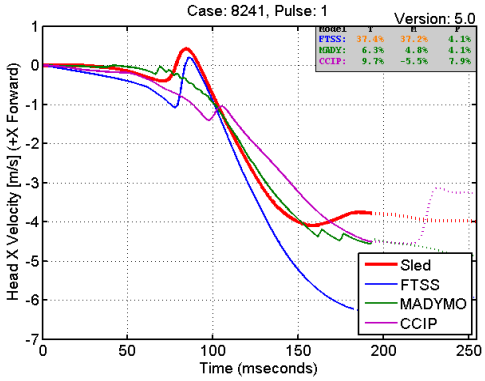
C.2.7 Head X Translational Velocity



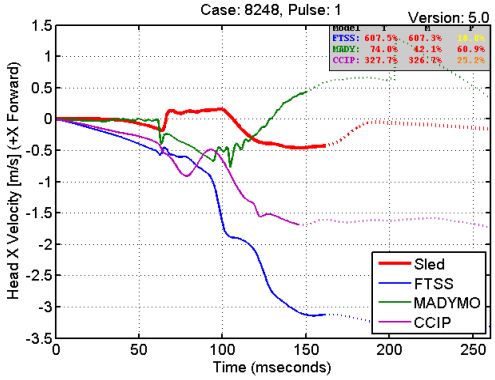
10G 70ms -Y No Side Support
Figure C-2-85: 8239 Head X Translational Velocity



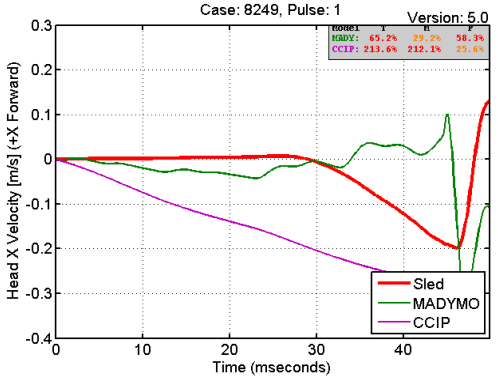
10G 70ms -Y No Head Support
Figure C-2-86: 8240 Head X Translational Velocity



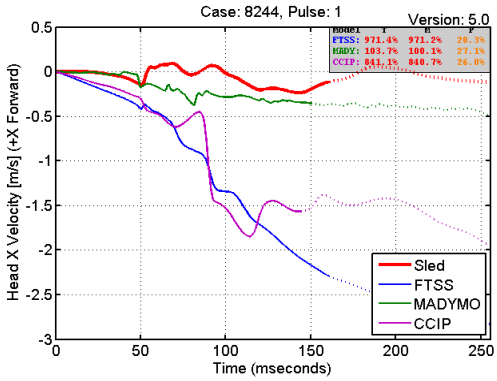
10G 70ms -Y No Head Support
Figure C-2-88: 8241 Head X Translational Velocity



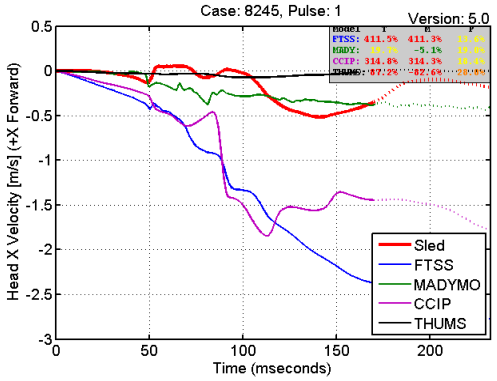
10G 70ms -Y 100% Gap
Figure C-2-87: 8248 Head X Translational Velocity



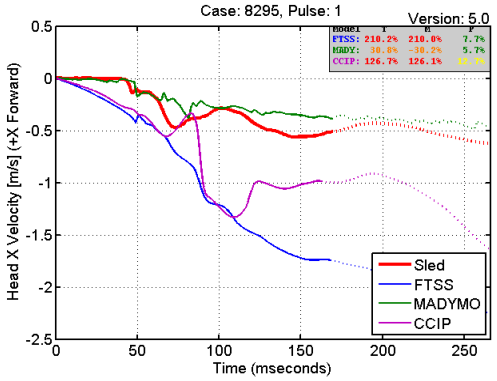
20G 70ms -Y 100% Gap
Figure C-2-89: 8249 Head X Translational Velocity



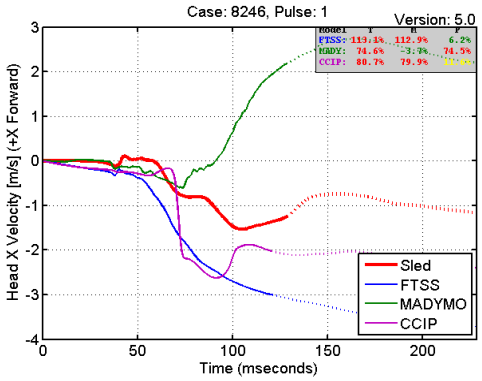
10G 70ms -Y 50% Gap
Figure C-2-90: 8244 Head X Translational Velocity



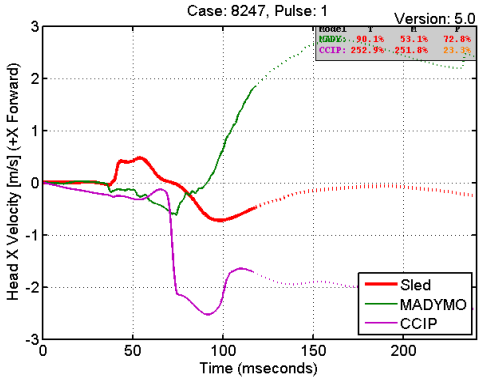
10G 70ms -Y 50% Gap
Figure C-2-91: 8245 Head X Translational Velocity



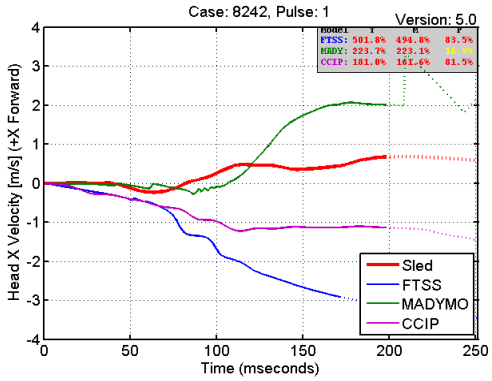
10G 70ms -Y 50% Gap
Figure C-2-92: 8295 Head X Translational Velocity



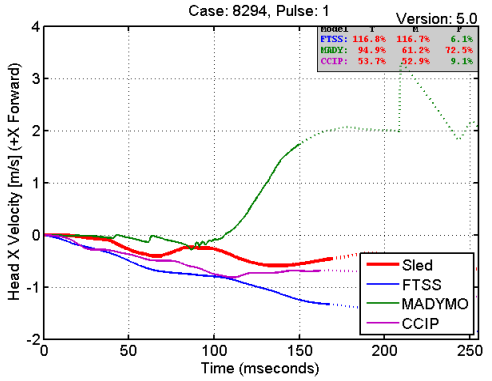
20G 70ms -Y 50% Gap
Figure C-2-93: 8246 Head X Translational Velocity



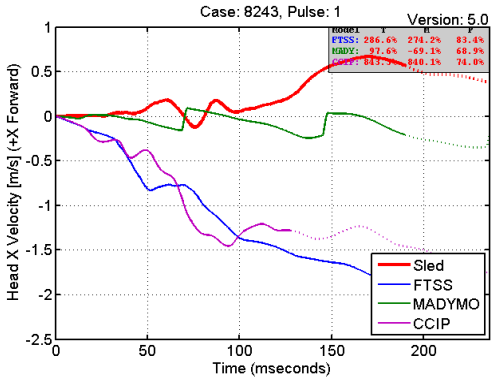
20G 70ms -Y 50% Gap
Figure C-2-94: 8247 Head X Translational Velocity



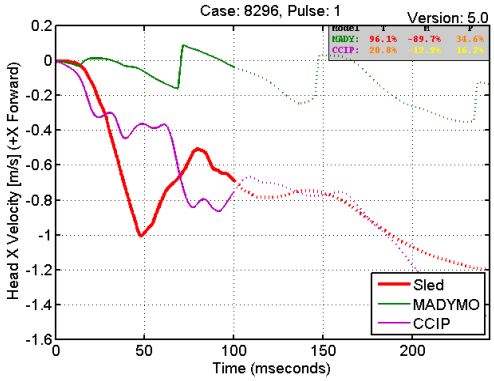
10G 70ms -Y No Gap
Figure C-2-95: 8242 Head X Translational Velocity



10G 70ms -Y No Gap
Figure C-2-96: 8294 Head X Translational Velocity

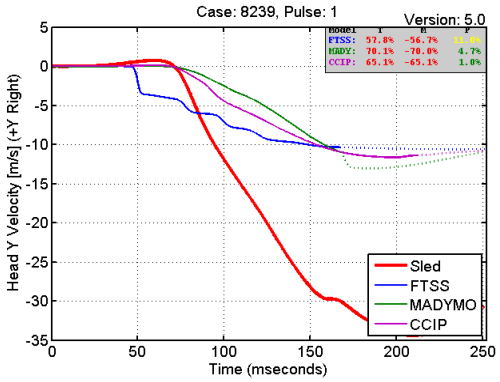


20G 70ms -Y No Gap
Figure C-2-97: 8243 Head X Translational Velocity

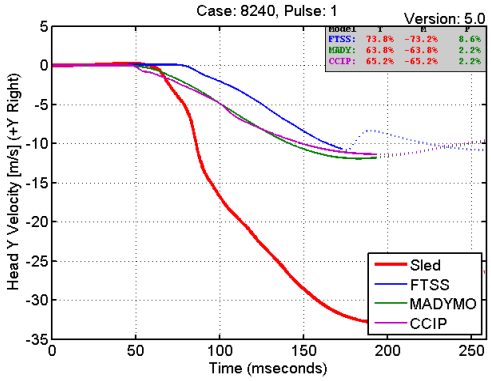


20G 70ms -Y No Gap
Figure C-2-98: 8296 Head X Translational Velocity

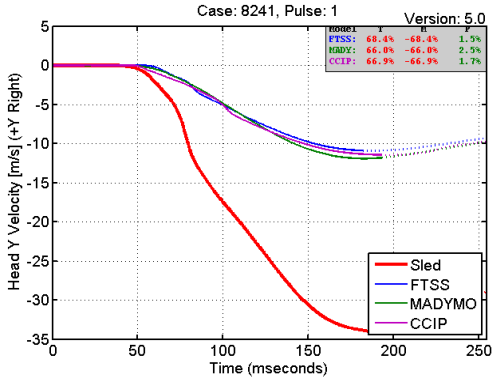
C.2.8 Head Y Translational Velocity



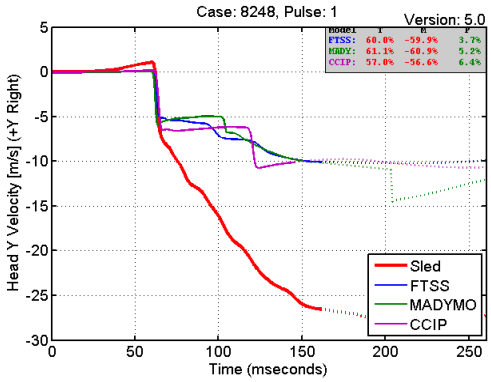
10G 70ms -Y No Side Support
Figure C-2-99: 8239 Head Y Translational Velocity



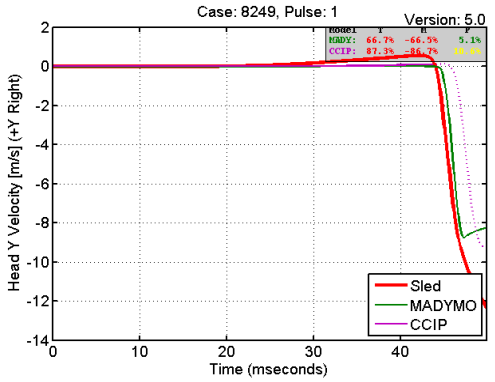
10G 70ms -Y No Head Support
Figure C-2-100: 8240 Head Y Translational Velocity



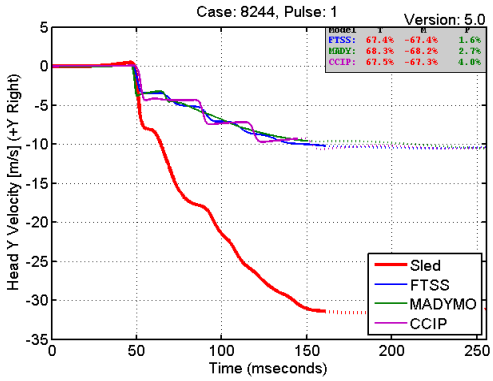
10G 70ms -Y No Head Support
Figure C-2-102: 8241 Head Y Translational Velocity



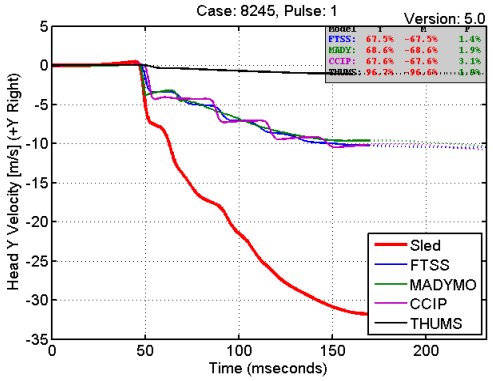
10G 70ms -Y 100% Gap
Figure C-2-101: 8248 Head Y Translational Velocity



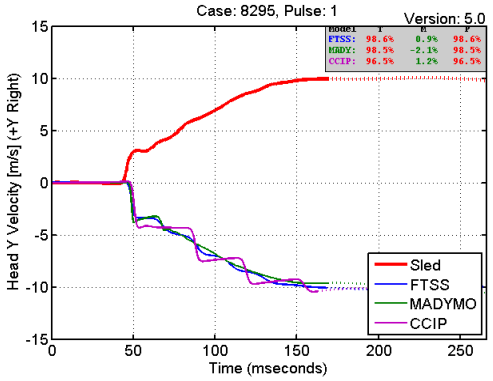
20G 70ms -Y 100% Gap
Figure C-2-103: 8249 Head Y Translational Velocity



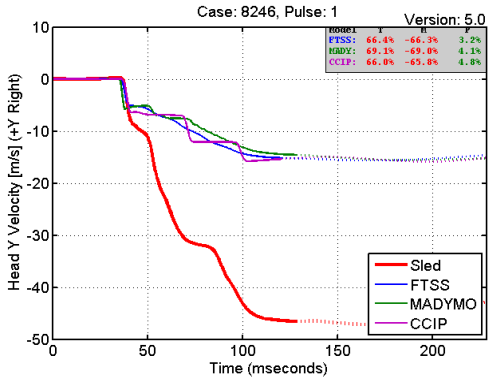
10G 70ms -Y 50% Gap
Figure C-2-104: 8244 Head Y Translational Velocity



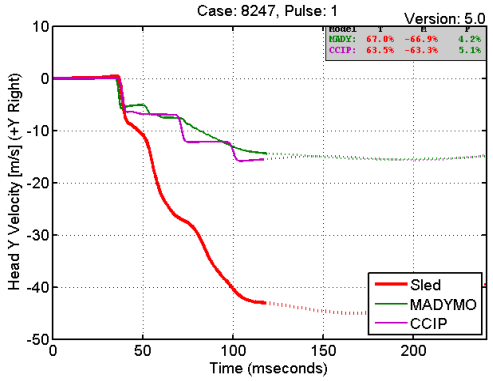
10G 70ms -Y 50% Gap
Figure C-2-105: 8245 Head Y Translational Velocity



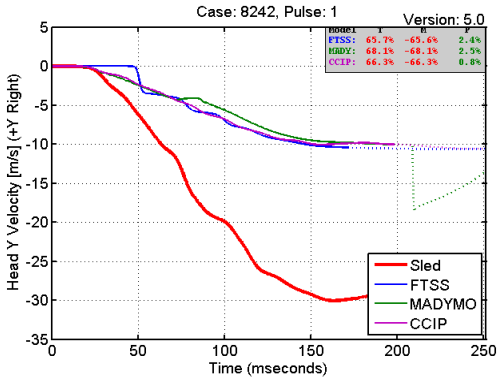
10G 70ms -Y 50% Gap
Figure C-2-106: 8295 Head Y Translational Velocity



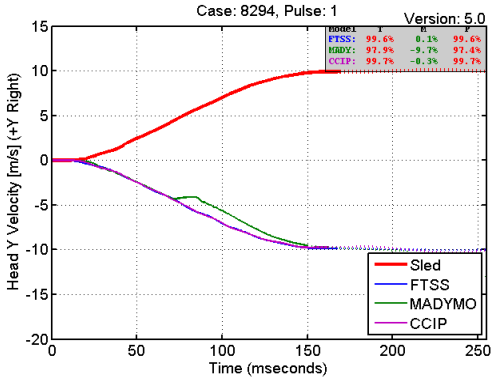
20G 70ms -Y 50% Gap
Figure C-2-107: 8246 Head Y Translational Velocity



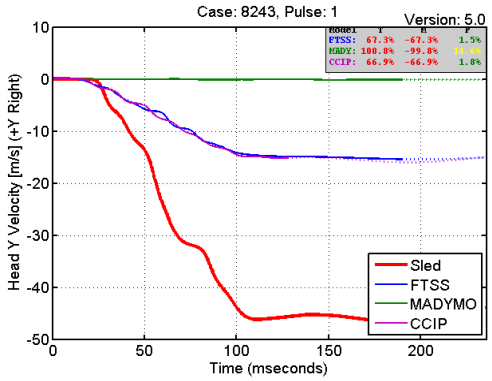
20G 70ms -Y 50% Gap
Figure C-2-108: 8247 Head Y Translational Velocity



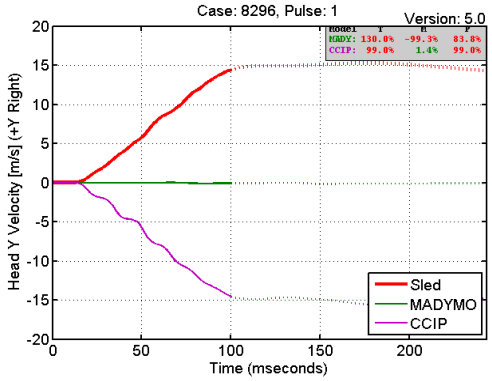
10G 70ms -Y No Gap
Figure C-2-109: 8242 Head Y Translational Velocity



10G 70ms -Y No Gap
Figure C-2-110: 8294 Head Y Translational Velocity

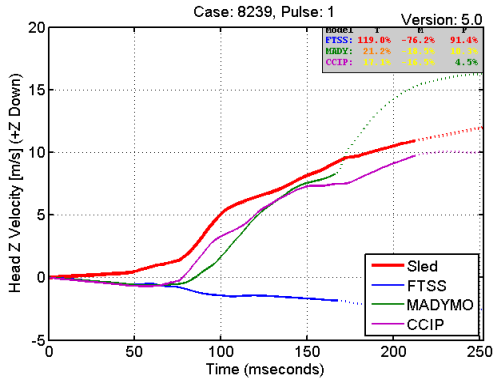


20G 70ms -Y No Gap
Figure C-2-111: 8243 Head Y Translational Velocity

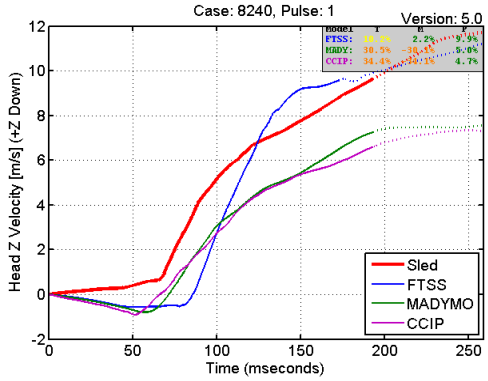


20G 70ms -Y No Gap
Figure C-2-112: 8296 Head Y Translational Velocity

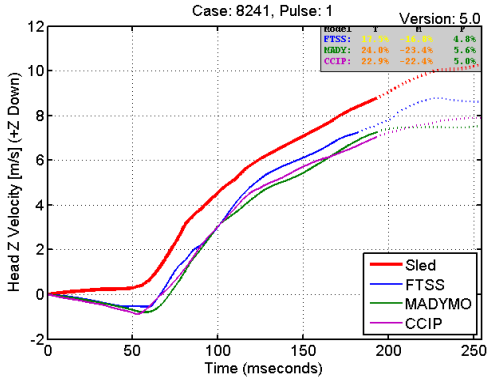
C.2.9 Head Z Translational Velocity



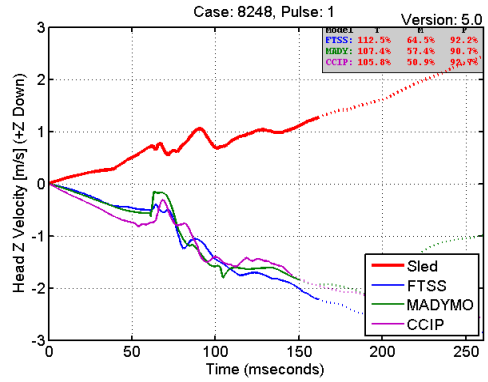
10G 70ms -Y No Side Support
Figure C-2-113: 8239 Head Z Translational Velocity



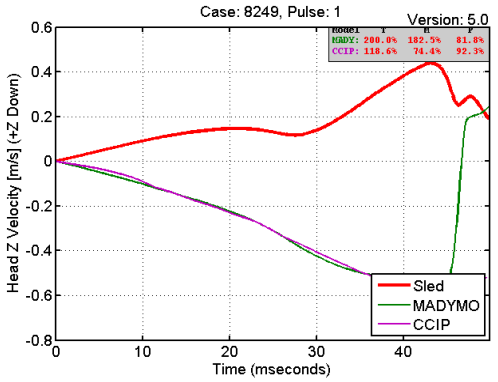
10G 70ms -Y No Head Support
Figure C-2-114: 8240 Head Z Translational Velocity



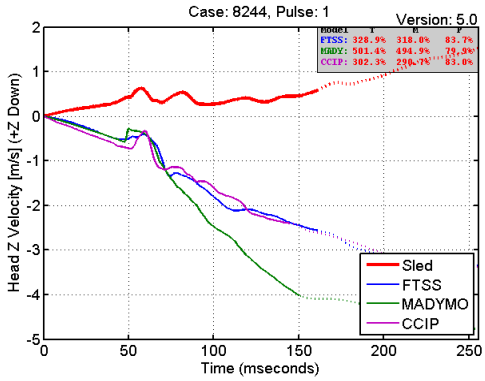
10G 70ms -Y No Head Support
Figure C-2-116: 8241 Head Z Translational Velocity



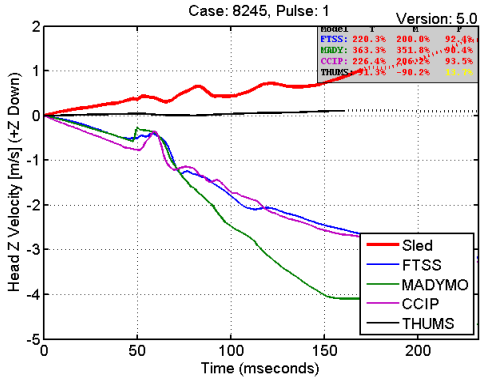
10G 70ms -Y 100% Gap
Figure C-2-115: 8248 Head Z Translational Velocity



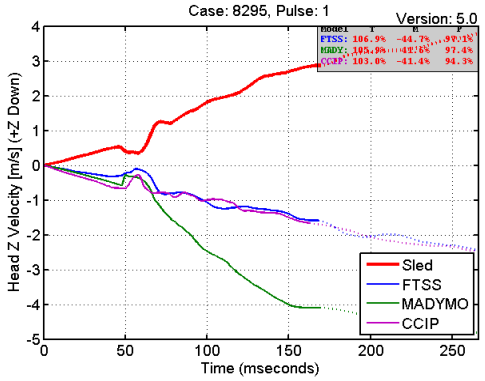
20G 70ms -Y 100% Gap
Figure C-2-117: 8249 Head Z Translational Velocity



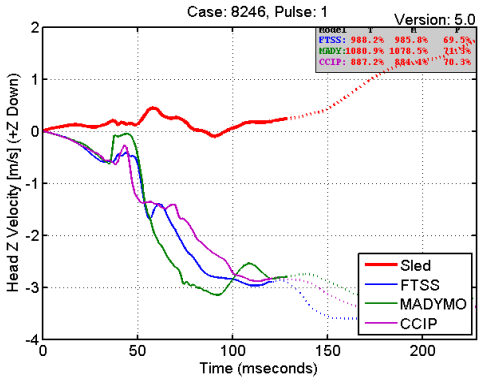
10G 70ms -Y 50% Gap
Figure C-2-118: 8244 Head Z Translational Velocity



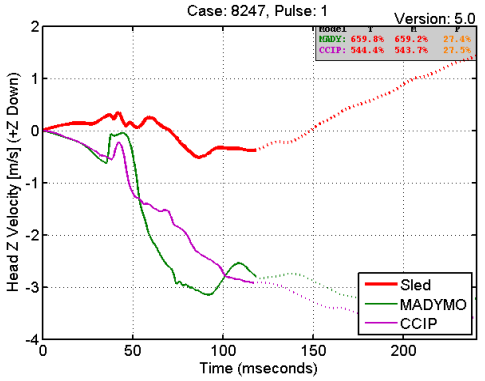
10G 70ms -Y 50% Gap
Figure C-2-119: 8245 Head Z Translational Velocity



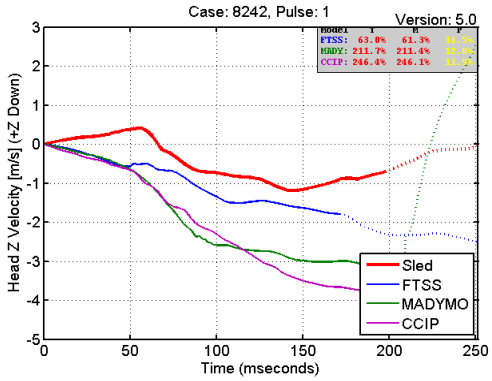
10G 70ms -Y 50% Gap
Figure C-2-120: 8295 Head Z Translational Velocity



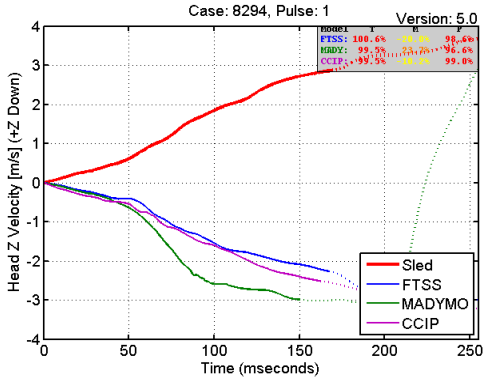
20G 70ms -Y 50% Gap
Figure C-2-121: 8246 Head Z Translational Velocity



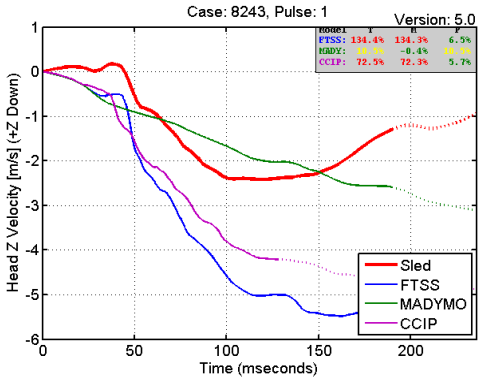
20G 70ms -Y 50% Gap
Figure C-2-122: 8247 Head Z Translational Velocity



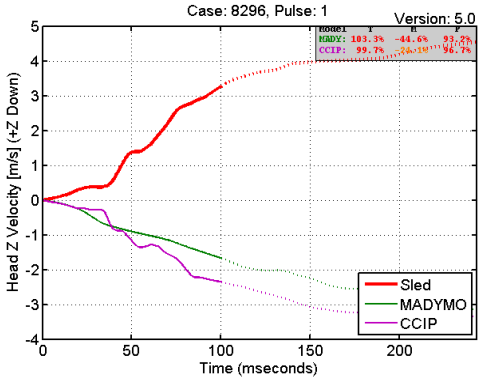
10G 70ms -Y No Gap
Figure C-2-123: 8242 Head Z Translational Velocity



10G 70ms -Y No Gap
Figure C-2-124: 8294 Head Z Translational Velocity

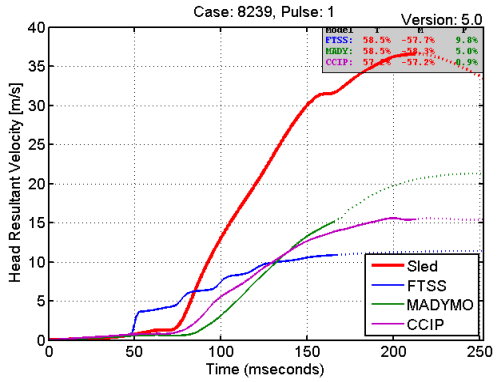


20G 70ms -Y No Gap
Figure C-2-125: 8243 Head Z Translational Velocity

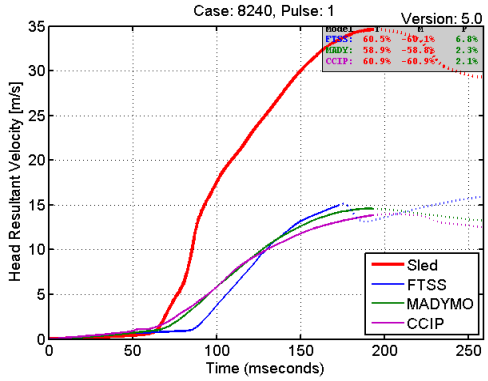


20G 70ms -Y No Gap
Figure C-2-126: 8296 Head Z Translational Velocity

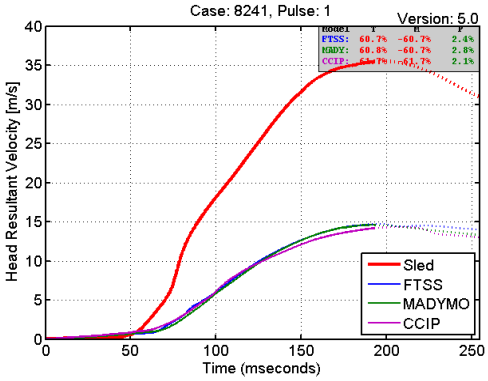
C.2.10 Head Resultant Translational Velocity



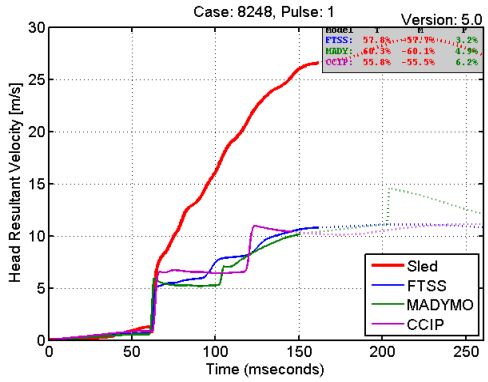
10G 70ms -Y No Side Support
Figure C-2-127: 8239 Head Resultant Translational Velocity



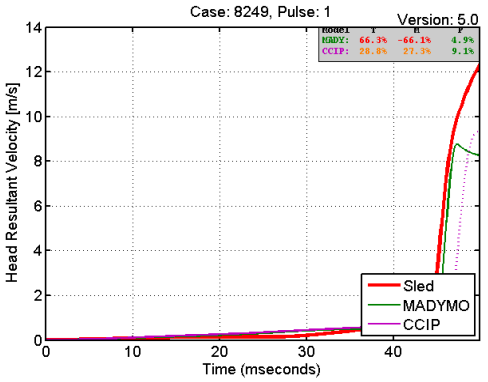
10G 70ms -Y No Head Support
Figure C-2-128: 8240 Head Resultant Translational Velocity



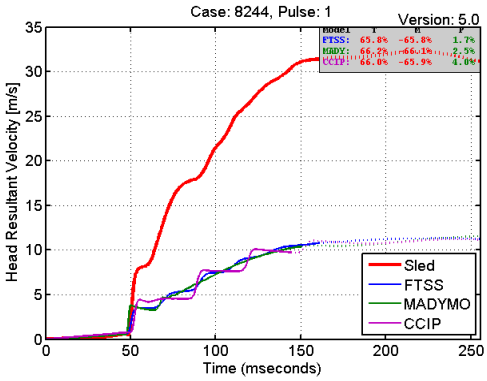
10G 70ms -Y No Head Support
Figure C-2-130: 8241 Head Resultant Translational Velocity



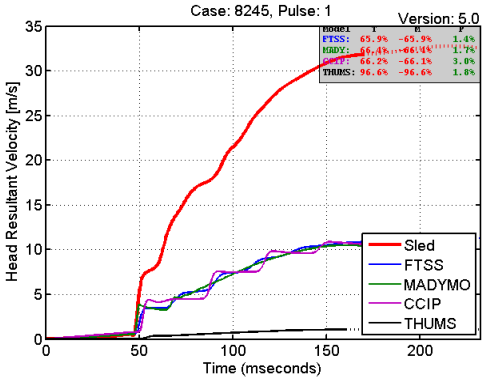
10G 70ms -Y 100% Gap
Figure C-2-129: 8248 Head Resultant Translational Velocity



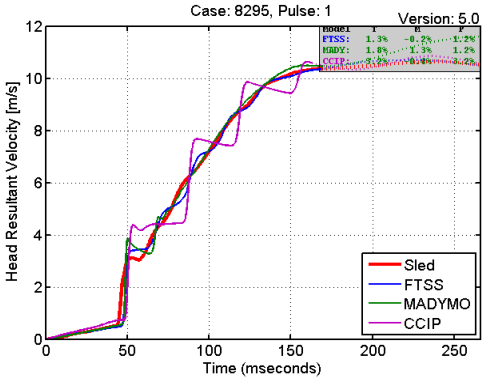
20G 70ms -Y 100% Gap
Figure C-2-131: 8249 Head Resultant Translational Velocity



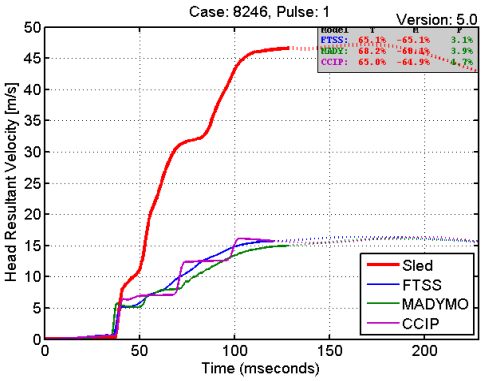
10G 70ms -Y 50% Gap
Figure C-2-132: 8244 Head Resultant Translational Velocity



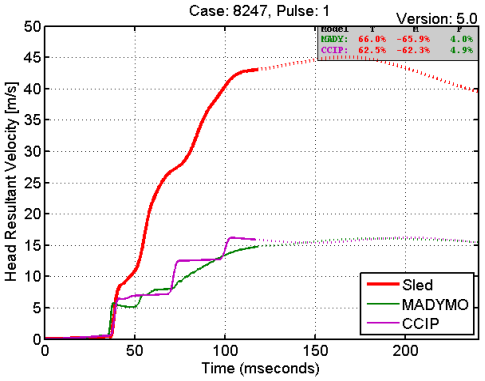
10G 70ms -Y 50% Gap
Figure C-2-133: 8245 Head Resultant Translational Velocity



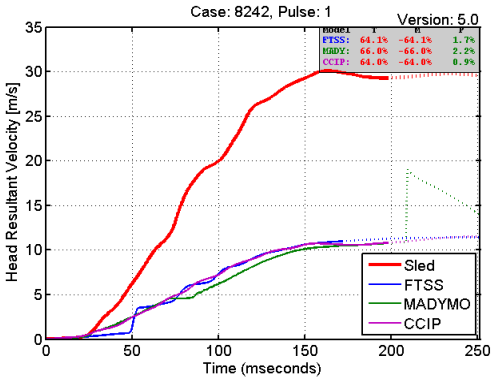
10G 70ms -Y 50% Gap
Figure C-2-134: 8295 Head Resultant Translational Velocity



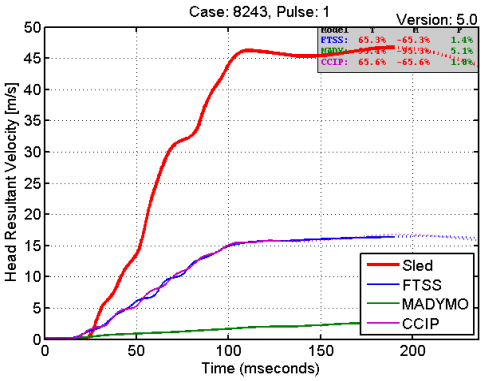
20G 70ms -Y 50% Gap
Figure C-2-135: 8246 Head Resultant Translational Velocity



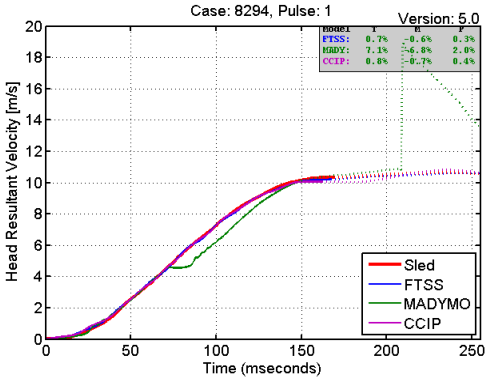
20G 70ms -Y 50% Gap
Figure C-2-136: 8247 Head Resultant Translational Velocity



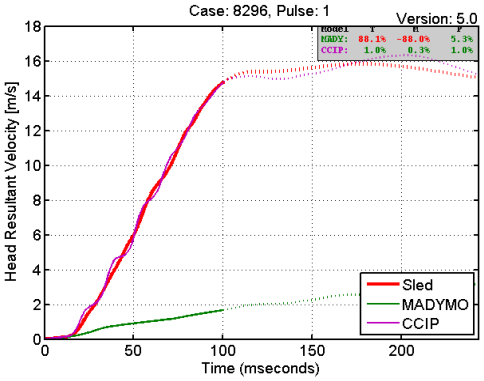
10G 70ms -Y No Gap
Figure C-2-137: 8242 Head Resultant Translational Velocity



20G 70ms -Y No Gap
Figure C-2-139: 8243 Head Resultant Translational Velocity

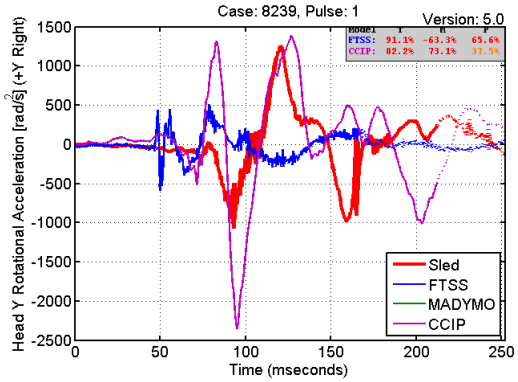


10G 70ms -Y No Gap
Figure C-2-138: 8294 Head Resultant Translational Velocity

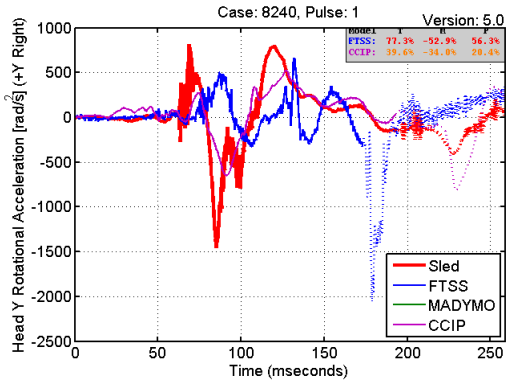


20G 70ms -Y No Gap
Figure C-2-140: 8296 Head Resultant Translational Velocity

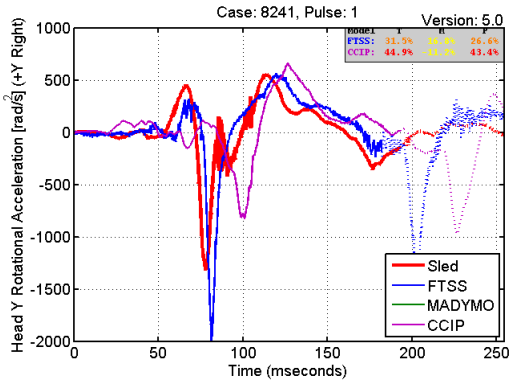
C.2.11 Head Y Rotational Acceleration



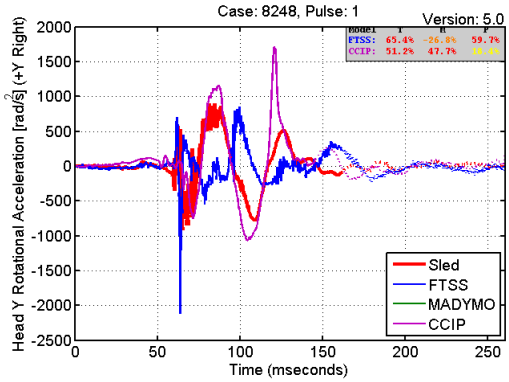
10G 70ms -Y No Side Support
Figure C-2-141: 8239 Head Y Rotational Acceleration



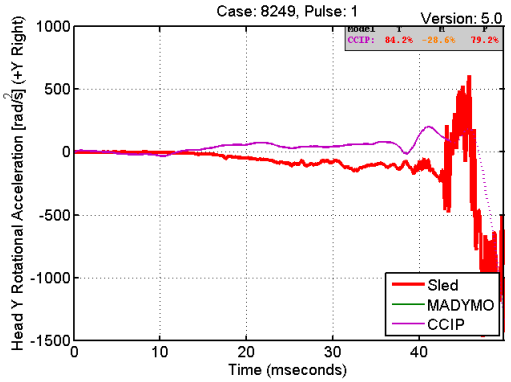
10G 70ms -Y No Head Support
Figure C-2-142: 8240 Head Y Rotational Acceleration



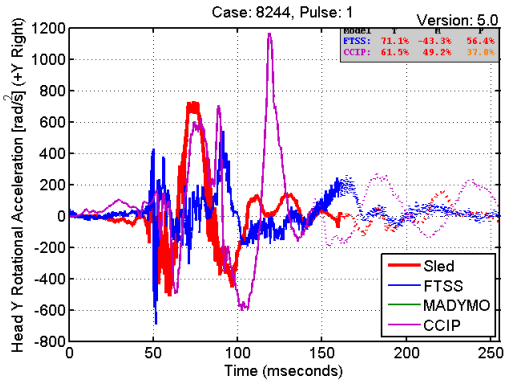
10G 70ms -Y No Head Support
Figure C-2-144: 8241 Head Y Rotational Acceleration



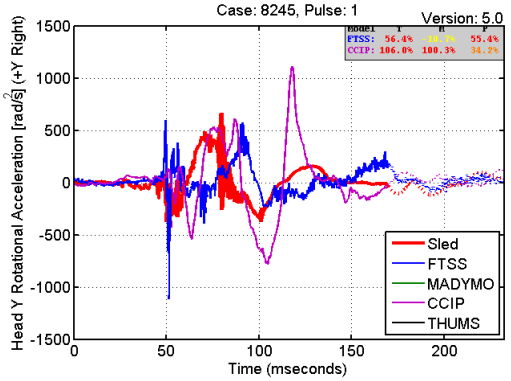
10G 70ms -Y 100% Gap
Figure C-2-143: 8248 Head Y Rotational Acceleration



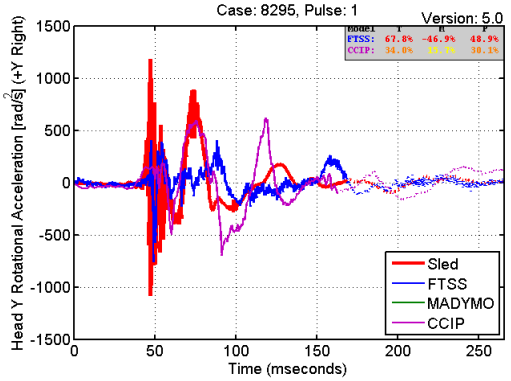
20G 70ms -Y 100% Gap
Figure C-2-145: 8249 Head Y Rotational Acceleration



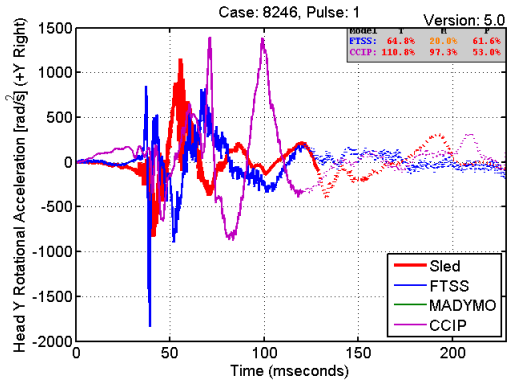
10G 70ms -Y 50% Gap
Figure C-2-146: 8244 Head Y Rotational Acceleration



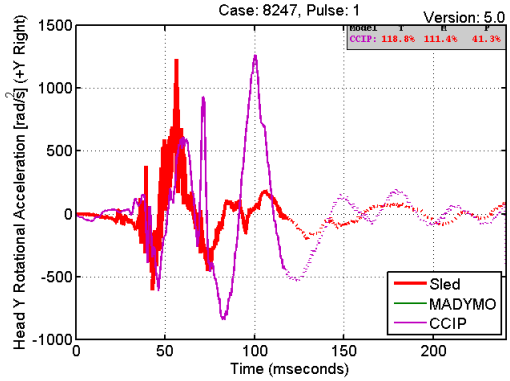
10G 70ms -Y 50% Gap
Figure C-2-147: 8245 Head Y Rotational Acceleration



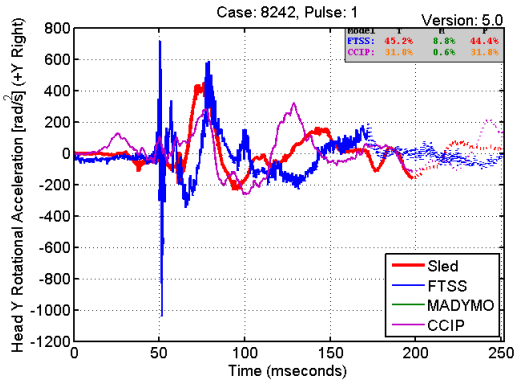
10G 70ms -Y 50% Gap
Figure C-2-148: 8295 Head Y Rotational Acceleration



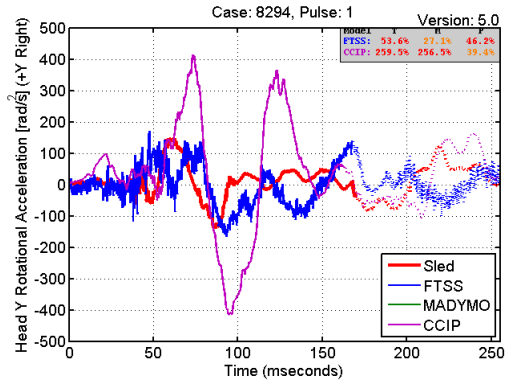
20G 70ms -Y 50% Gap
Figure C-2-149: 8246 Head Y Rotational Acceleration



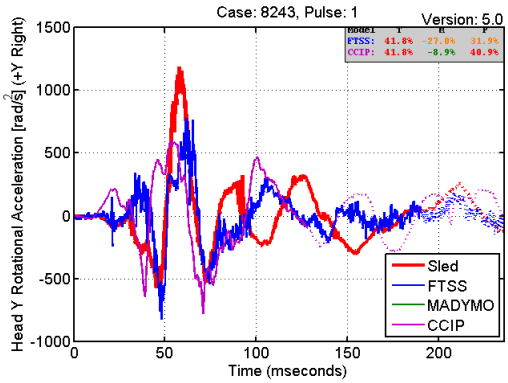
20G 70ms -Y 50% Gap
Figure C-2-150: 8247 Head Y Rotational Acceleration



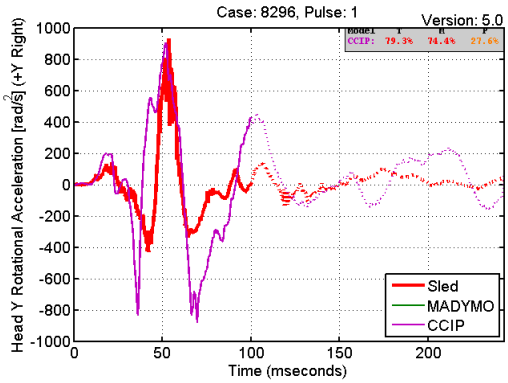
10G 70ms -Y No Gap
Figure C-2-151: 8242 Head Y Rotational Acceleration



10G 70ms -Y No Gap
Figure C-2-152: 8294 Head Y Rotational Acceleration

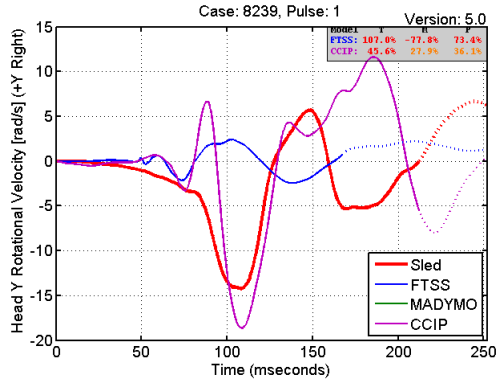


20G 70ms -Y No Gap
Figure C-2-153: 8243 Head Y Rotational Acceleration

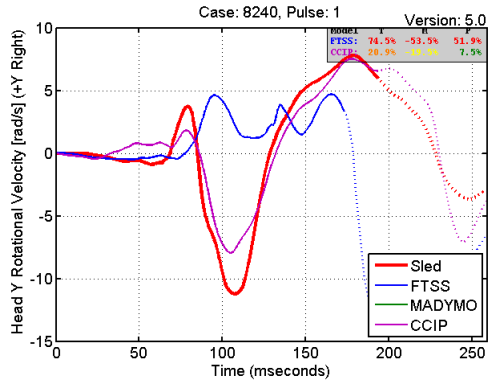


20G 70ms -Y No Gap
Figure C-2-154: 8296 Head Y Rotational Acceleration

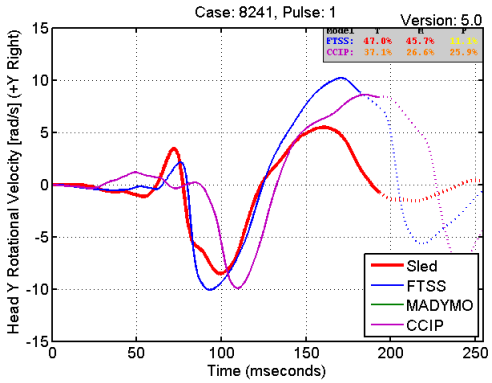
C.2.12 Head Y Rotational Velocity



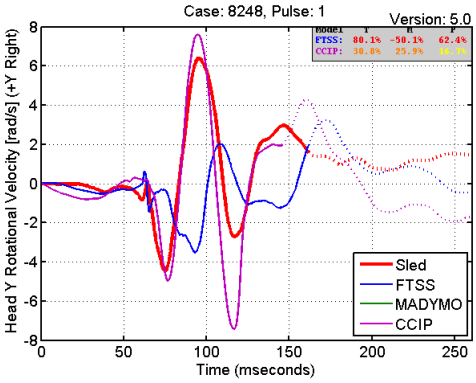
10G 70ms -Y No Side Support
Figure C-2-155: 8239 Head Y Rotational Velocity



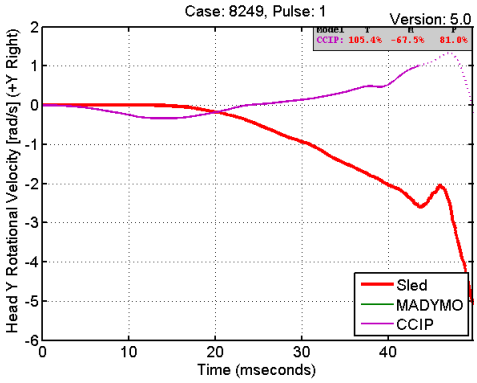
10G 70ms -Y No Head Support
Figure C-2-156: 8240 Head Y Rotational Velocity



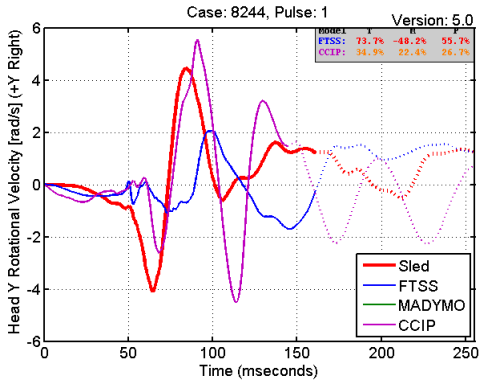
10G 70ms -Y No Head Support
Figure C-2-158: 8241 Head Y Rotational Velocity



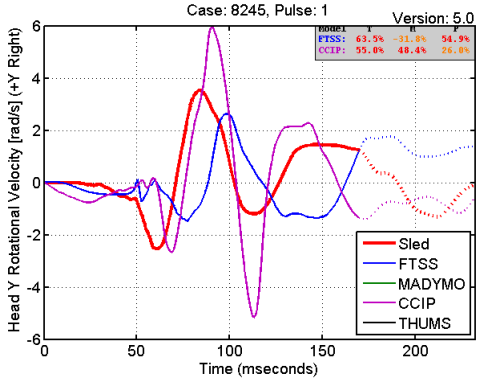
10G 70ms -Y 100% Gap
Figure C-2-157: 8248 Head Y Rotational Velocity



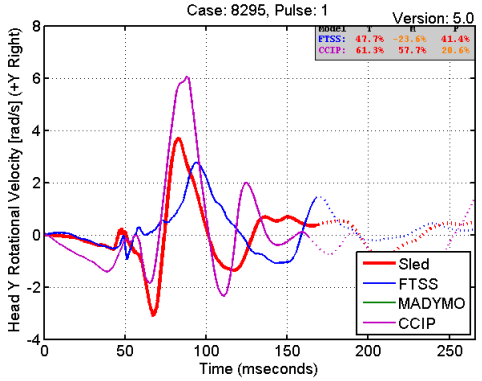
20G 70ms -Y 100% Gap
Figure C-2-159: 8249 Head Y Rotational Velocity



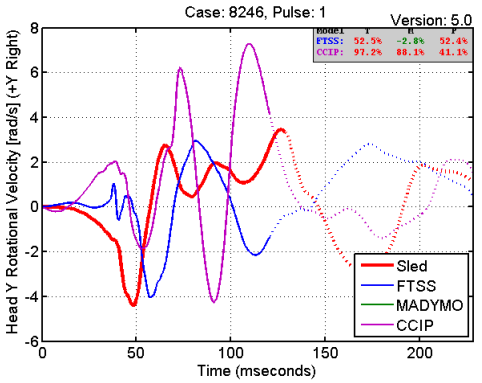
10G 70ms -Y 50% Gap
Figure C-2-160: 8244 Head Y Rotational Velocity



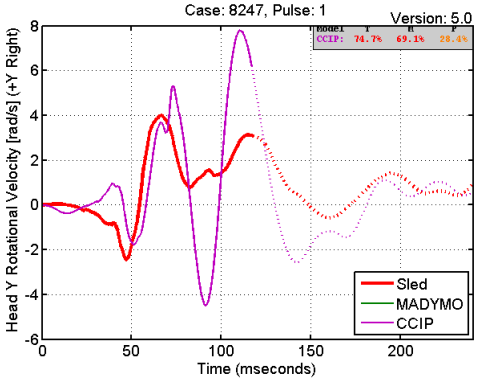
10G 70ms -Y 50% Gap
Figure C-2-161: 8245 Head Y Rotational Velocity



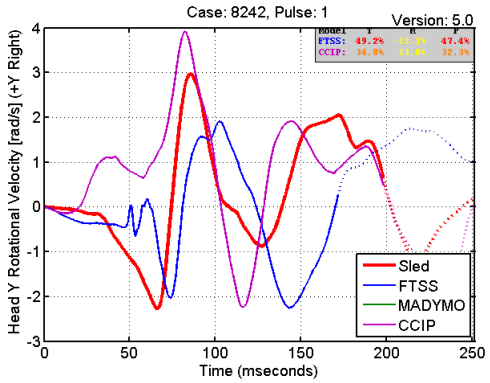
10G 70ms -Y 50% Gap
Figure C-2-162: 8295 Head Y Rotational Velocity



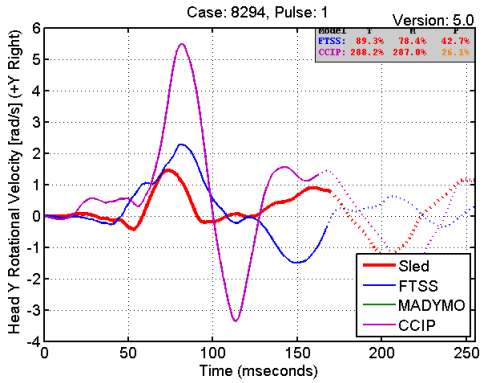
20G 70ms -Y 50% Gap
Figure C-2-163: 8246 Head Y Rotational Velocity



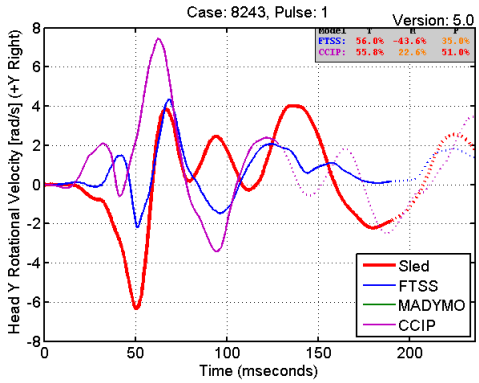
20G 70ms -Y 50% Gap
Figure C-2-164: 8247 Head Y Rotational Velocity



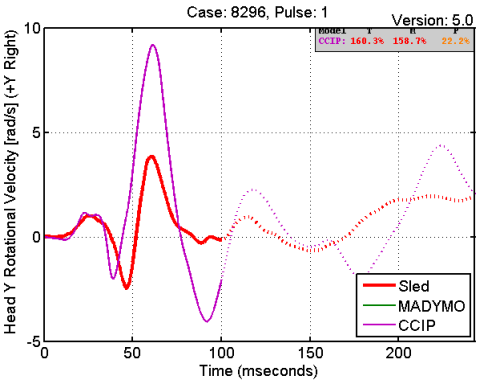
10G 70ms -Y No Gap
Figure C-2-165: 8242 Head Y Rotational Velocity



10G 70ms -Y No Gap
Figure C-2-166: 8294 Head Y Rotational Velocity

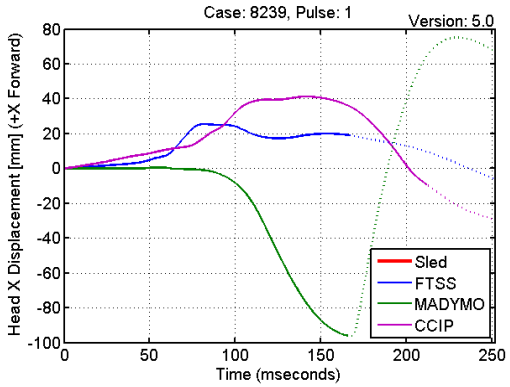


20G 70ms -Y No Gap
Figure C-2-167: 8243 Head Y Rotational Velocity

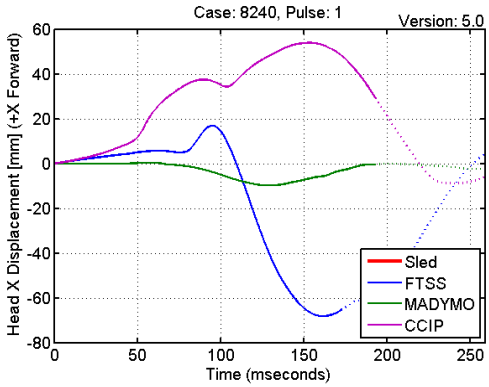


20G 70ms -Y No Gap
Figure C-2-168: 8296 Head Y Rotational Velocity

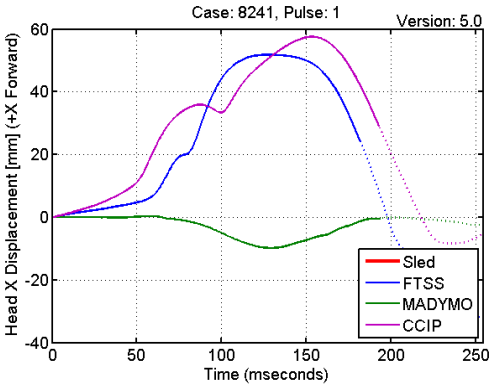
C.2.13 Head X Movement



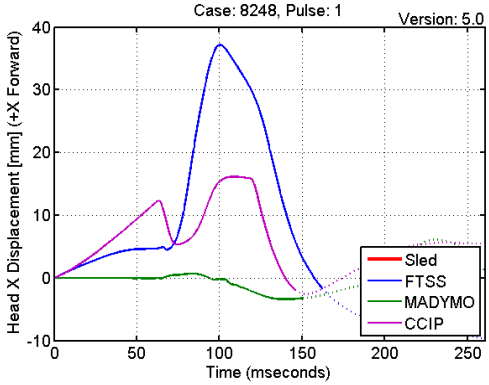
10G 70ms -Y No Side Support
Figure C-2-169: 8239 Head X Movement



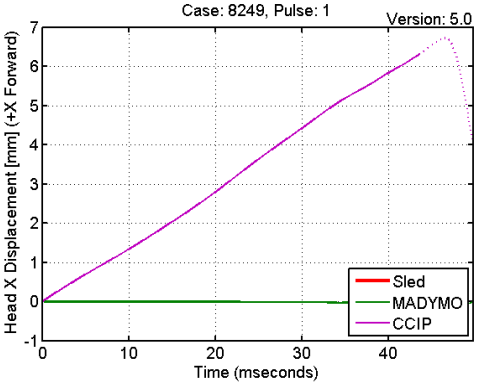
10G 70ms -Y No Head Support
Figure C-2-170: 8240 Head X Movement



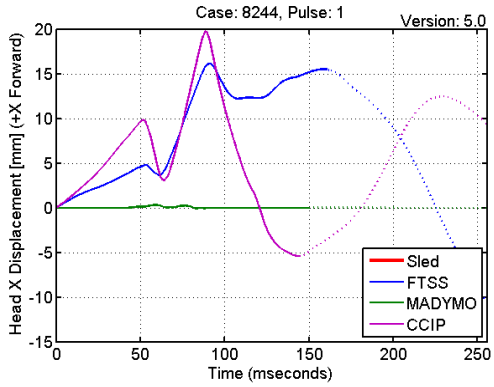
10G 70ms -Y No Head Support
Figure C-2-172: 8241 Head X Movement



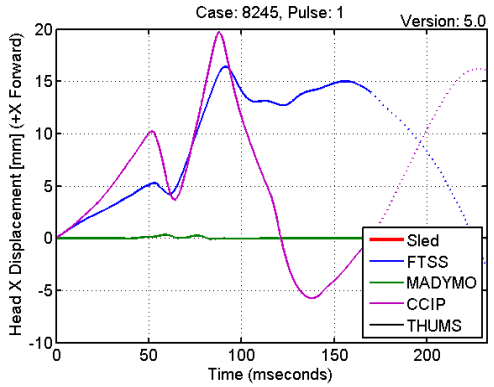
10G 70ms -Y 100% Gap
Figure C-2-171: 8248 Head X Movement



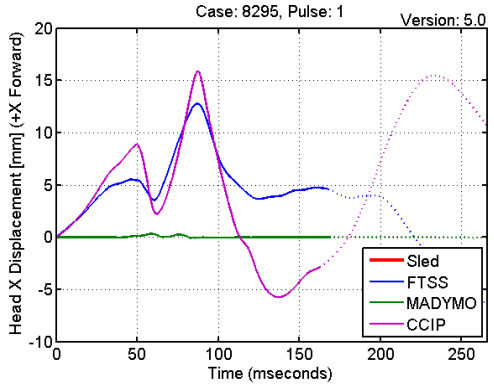
20G 70ms -Y 100% Gap
Figure C-2-173: 8249 Head X Movement



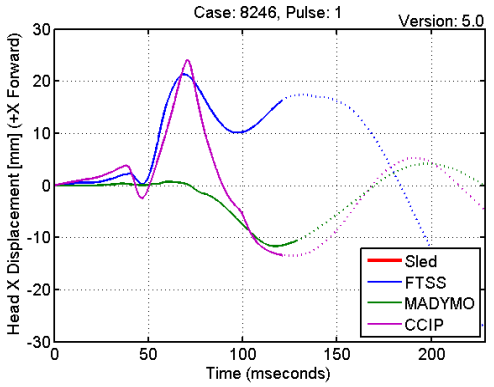
10G 70ms -Y 50% Gap
Figure C-2-174: 8244 Head X Movement



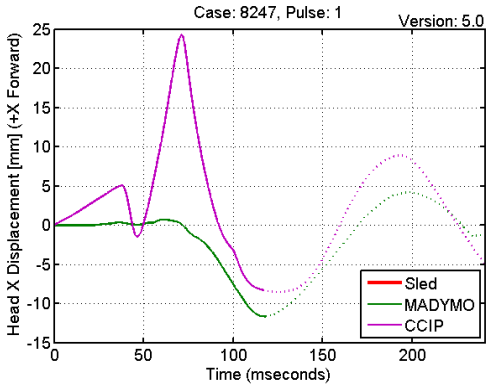
10G 70ms -Y 50% Gap
Figure C-2-175: 8245 Head X Movement



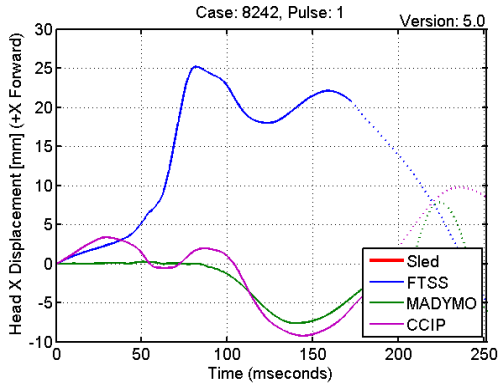
10G 70ms -Y 50% Gap
Figure C-2-176: 8295 Head X Movement



20G 70ms -Y 50% Gap
Figure C-2-177: 8246 Head X Movement

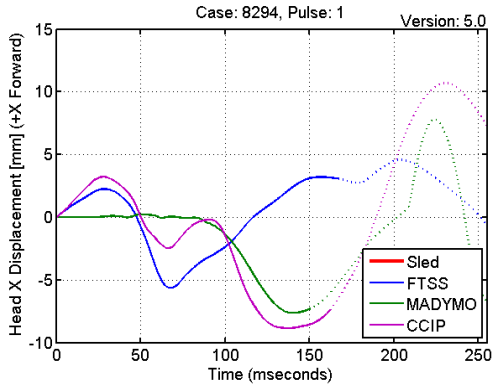


20G 70ms -Y 50% Gap
Figure C-2-178: 8247 Head X Movement



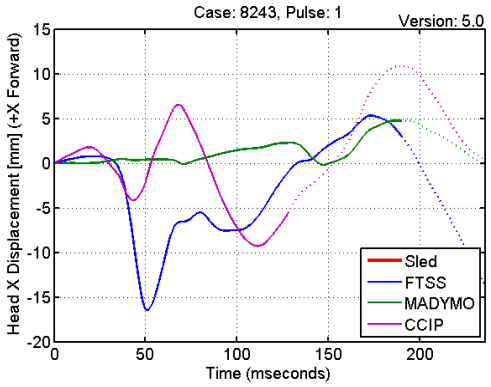
10G 70ms -Y No Gap

Figure C-2-179: 8242 Head X Movement



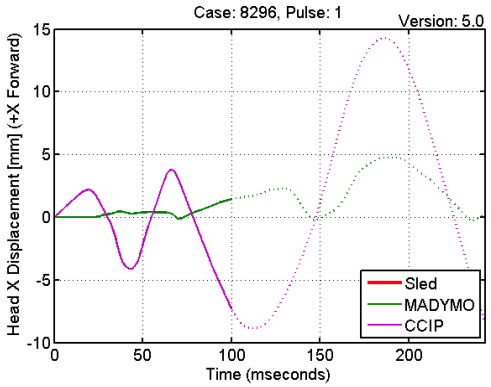
10G 70ms -Y No Gap

Figure C-2-180: 8294 Head X Movement



20G 70ms -Y No Gap

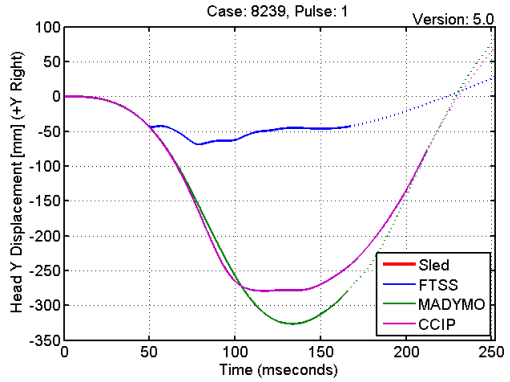
Figure C-2-181: 8243 Head X Movement



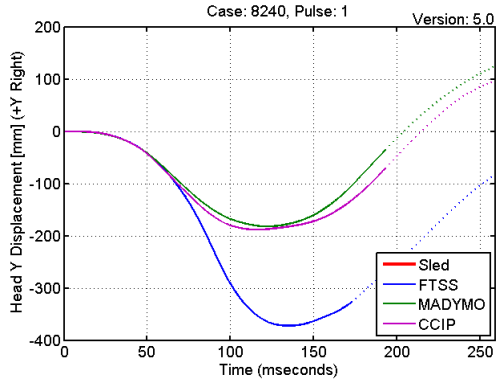
20G 70ms -Y No Gap

Figure C-2-182: 8296 Head X Movement

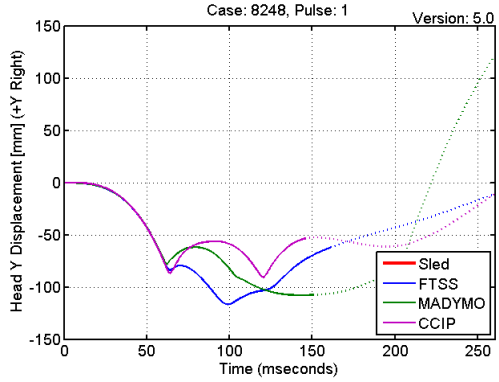
C.2.14 Head Y Movement



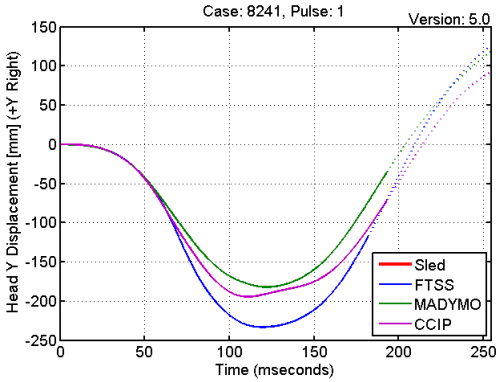
10G 70ms -Y No Side Support
Figure C-2-183: 8239 Head Y Movement



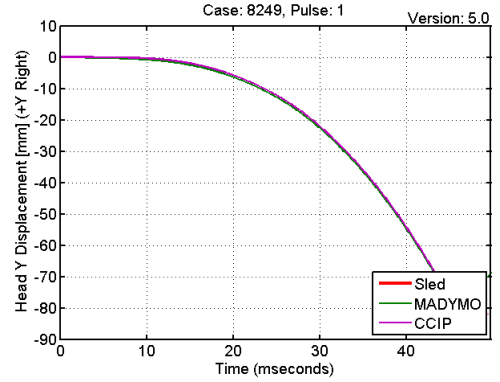
10G 70ms -Y No Head Support
Figure C-2-184: 8240 Head Y Movement



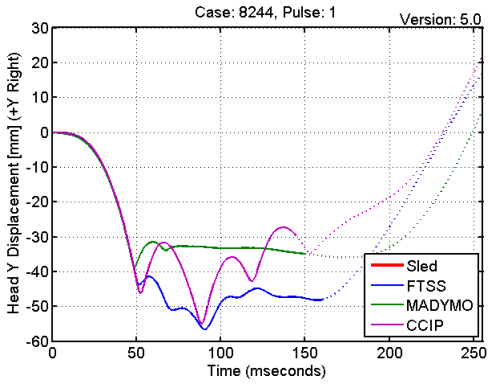
10G 70ms -Y 100% Gap
Figure C-2-185: 8248 Head Y Movement



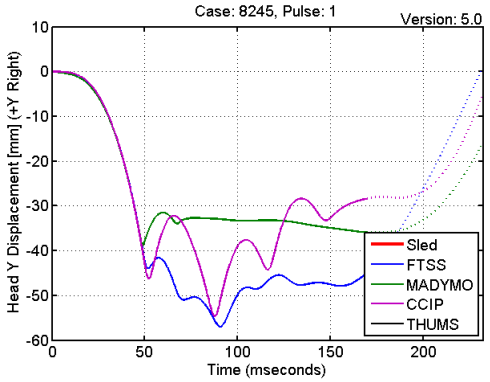
10G 70ms -Y No Head Support
Figure C-2-186: 8241 Head Y Movement



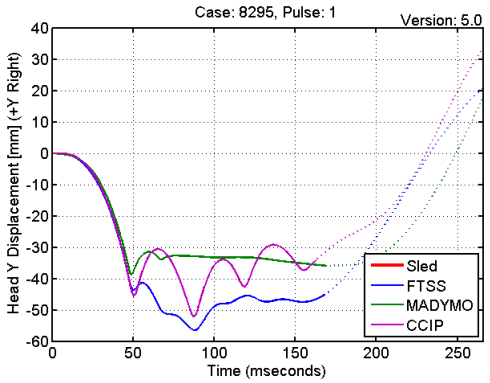
20G 70ms -Y 100% Gap
Figure C-2-187: 8249 Head Y Movement



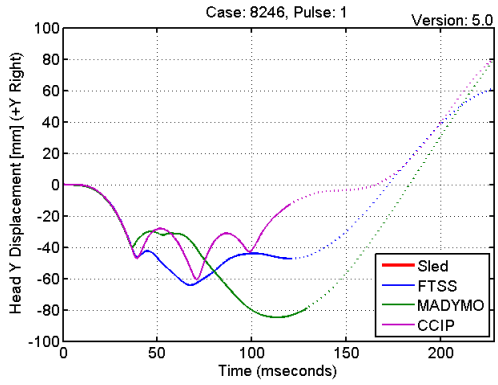
10G 70ms -Y 50% Gap
Figure C-2-188: 8244 Head Y Movement



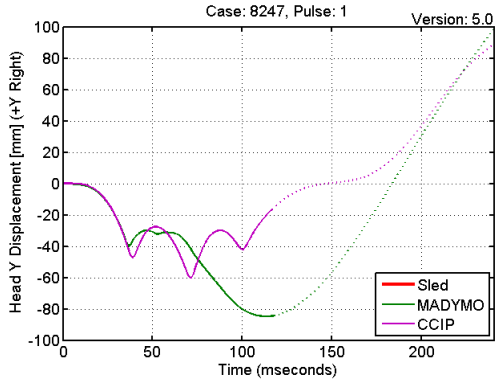
10G 70ms -Y 50% Gap
Figure C-2-189: 8245 Head Y Movement



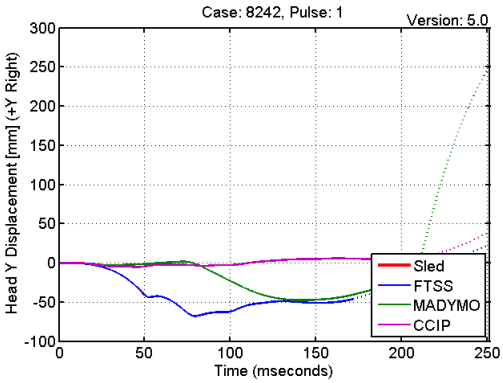
10G 70ms -Y 50% Gap
Figure C-2-190: 8295 Head Y Movement



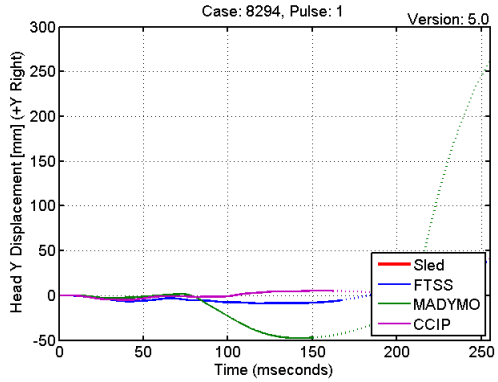
20G 70ms -Y 50% Gap
Figure C-2-191: 8246 Head Y Movement



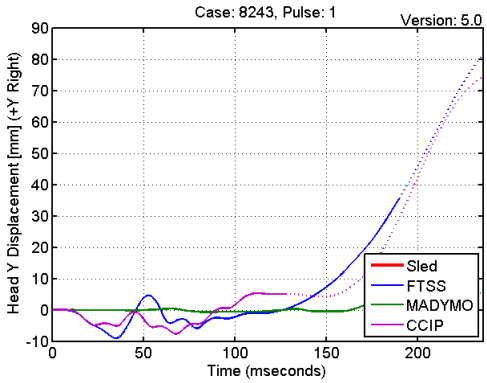
20G 70ms -Y 50% Gap
Figure C-2-192: 8247 Head Y Movement



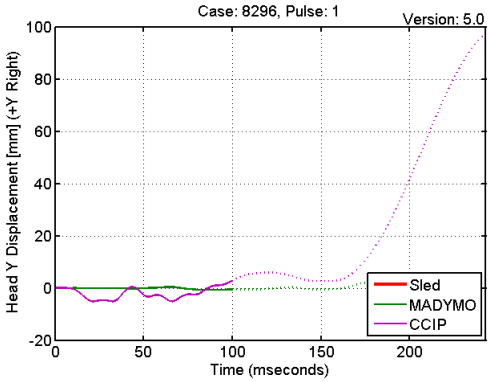
10G 70ms -Y No Gap
Figure C-2-193: 8242 Head Y Movement



10G 70ms -Y No Gap
Figure C-2-194: 8294 Head Y Movement

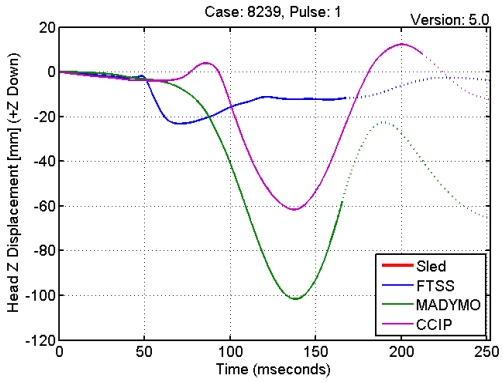


20G 70ms -Y No Gap
Figure C-2-195: 8243 Head Y Movement

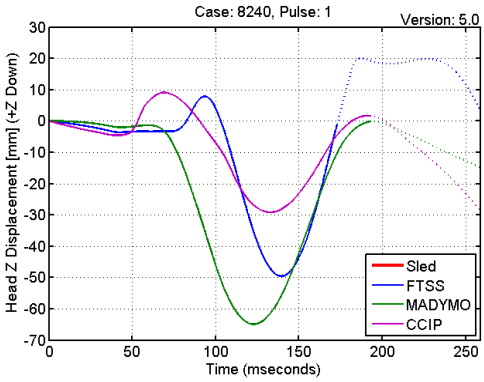


20G 70ms -Y No Gap
Figure C-2-196: 8296 Head Y Movement

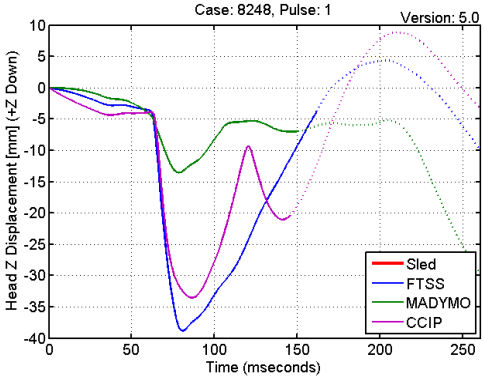
C.2.15 Head Z Movement



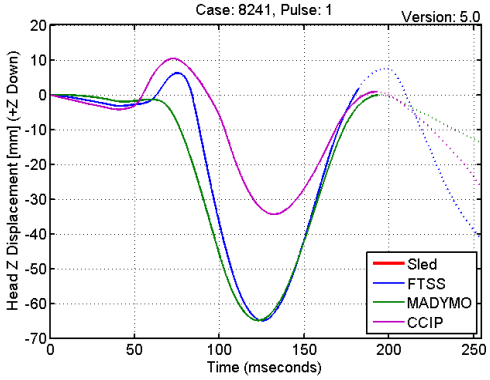
10G 70ms -Y No Side Support
Figure C-2-197: 8239 Head Z Movement



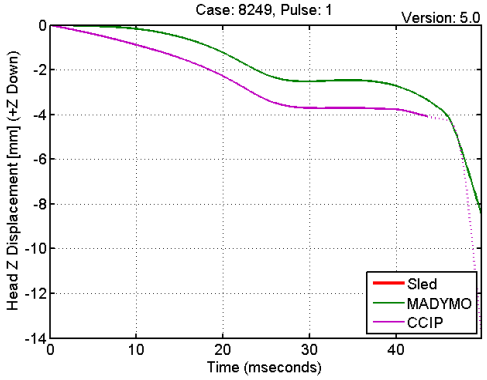
10G 70ms -Y No Head Support
Figure C-2-198: 8240 Head Z Movement



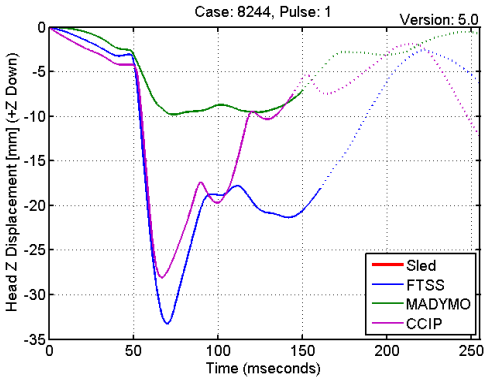
10G 70ms -Y 100% Gap
Figure C-2-199: 8248 Head Z Movement



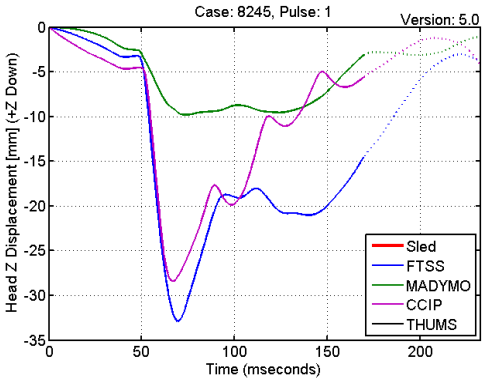
10G 70ms -Y No Head Support
Figure C-2-200: 8241 Head Z Movement



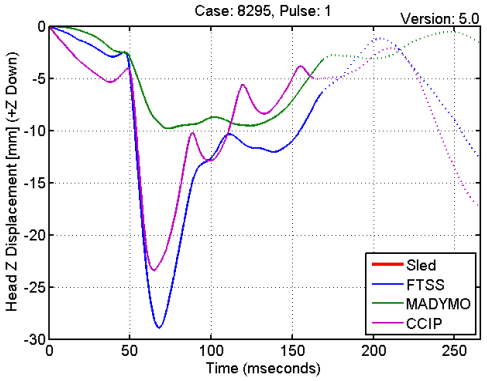
20G 70ms -Y 100% Gap
Figure C-2-201: 8249 Head Z Movement



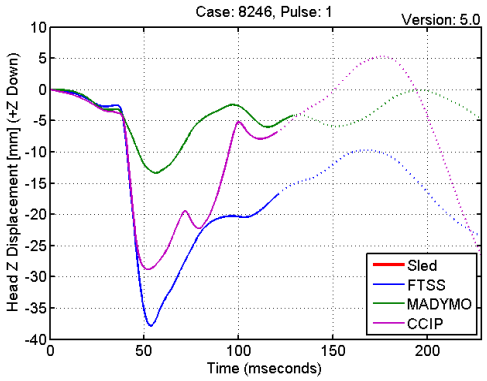
10G 70ms -Y 50% Gap
Figure C-2-202: 8244 Head Z Movement



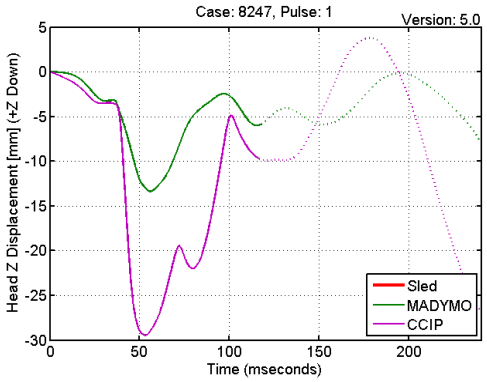
10G 70ms -Y 50% Gap
Figure C-2-203: 8245 Head Z Movement



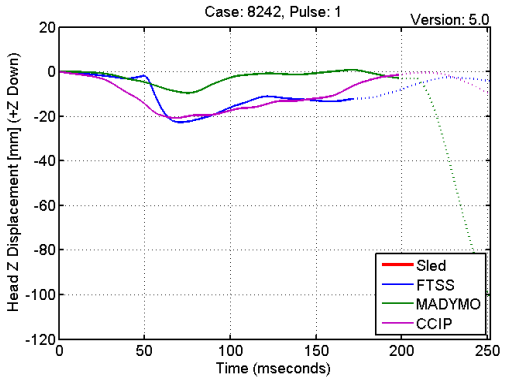
10G 70ms -Y 50% Gap
Figure C-2-204: 8295 Head Z Movement



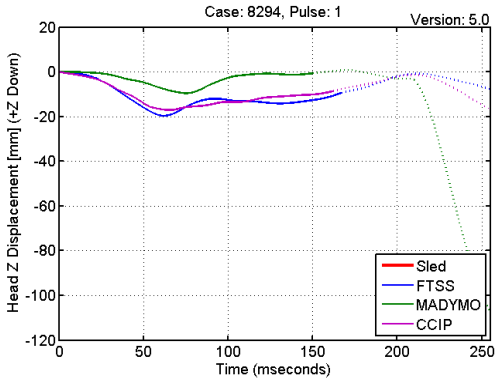
20G 70ms -Y 50% Gap
Figure C-2-205: 8246 Head Z Movement



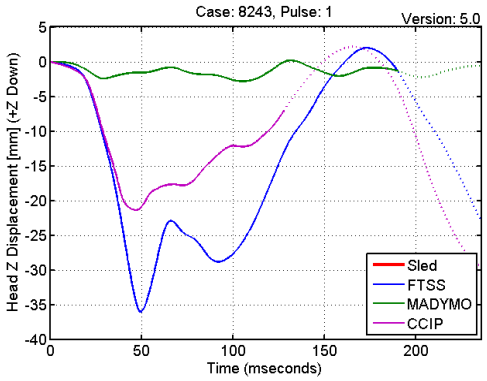
20G 70ms -Y 50% Gap
Figure C-2-206: 8247 Head Z Movement



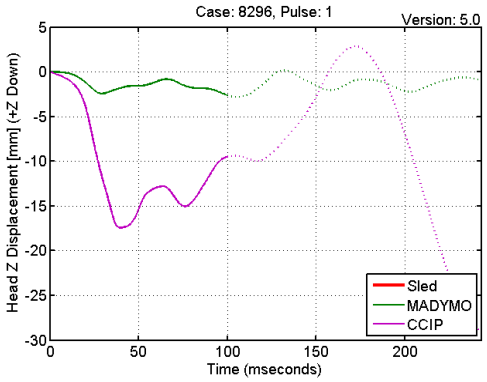
10G 70ms -Y No Gap
Figure C-2-207: 8242 Head Z Movement



10G 70ms -Y No Gap
Figure C-2-208: 8294 Head Z Movement

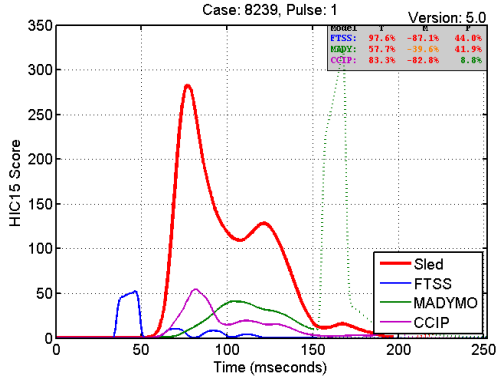


20G 70ms -Y No Gap
Figure C-2-209: 8243 Head Z Movement

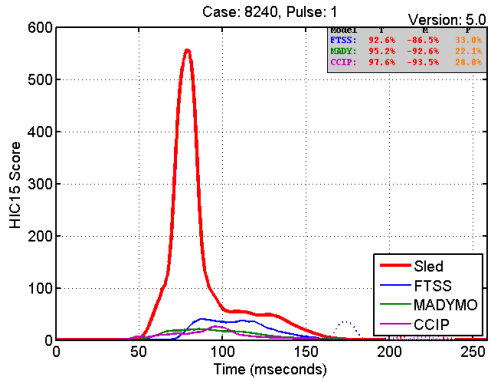


20G 70ms -Y No Gap
Figure C-2-210: 8296 Head Z Movement

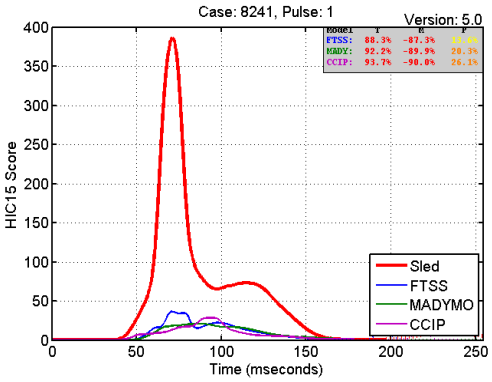
C.2.16 HIC 15



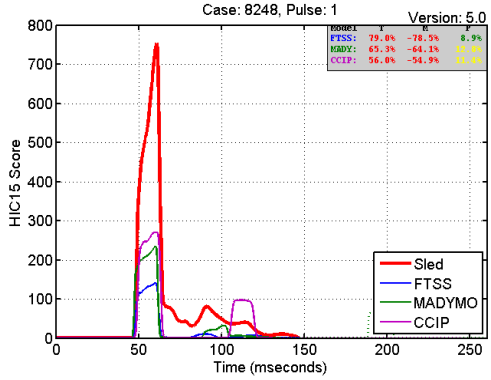
10G 70ms -Y No Side Support
Figure C-2-211: 8239 HIC 15



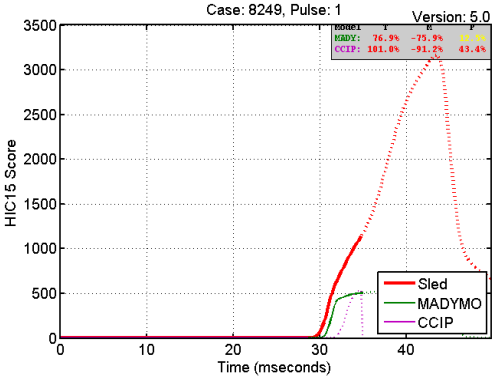
10G 70ms -Y No Head Support
Figure C-2-212: 8240 HIC 15



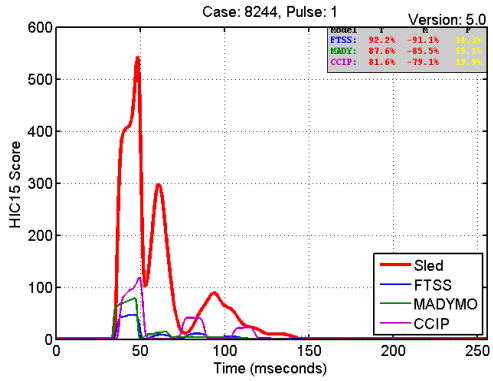
10G 70ms -Y No Head Support
Figure C-2-214: 8241 HIC 15



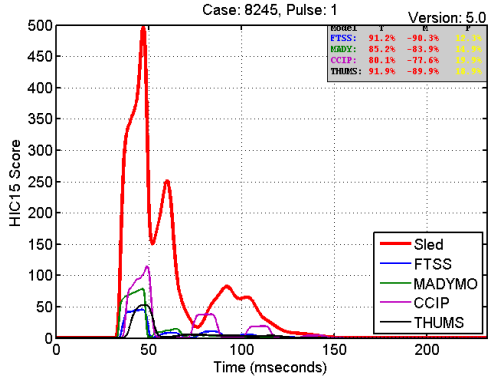
10G 70ms -Y 100% Gap
Figure C-2-213: 8248 HIC 15



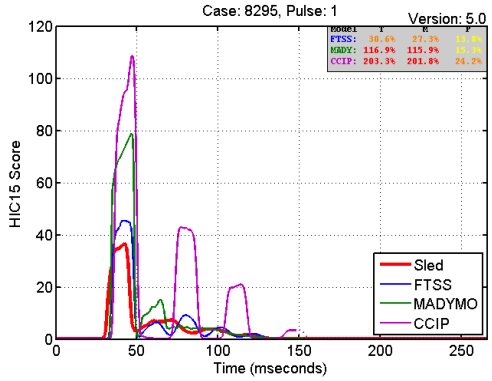
20G 70ms -Y 100% Gap
Figure C-2-215: 8249 HIC 15



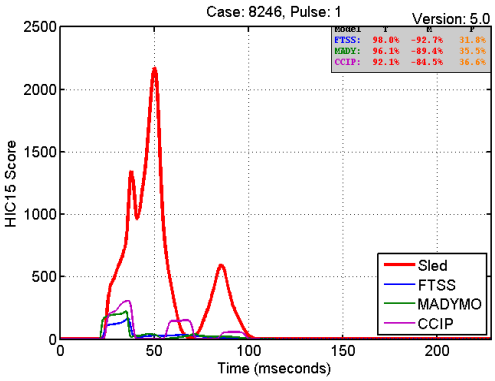
10G 70ms -Y 50% Gap
Figure C-2-216: 8244 HIC 15



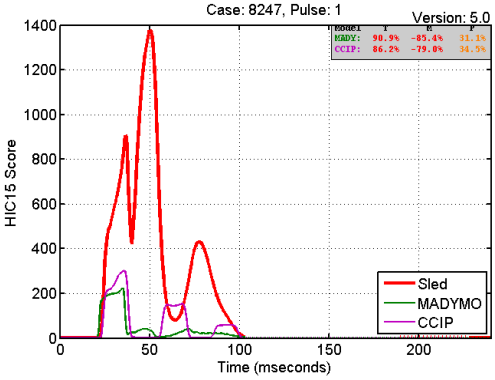
10G 70ms -Y 50% Gap
Figure C-2-217: 8245 HIC 15



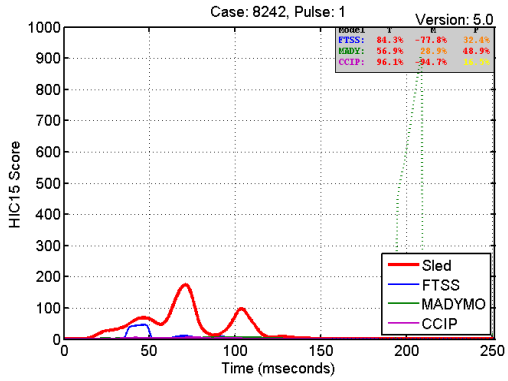
10G 70ms -Y 50% Gap
Figure C-2-218: 8295 HIC 15



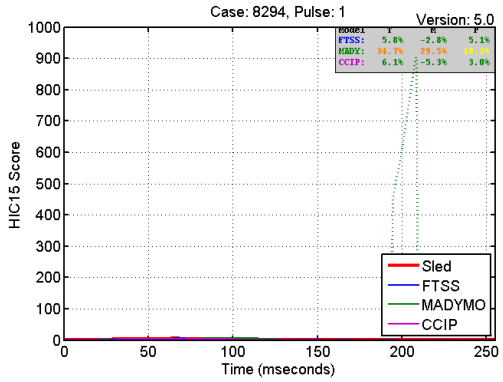
20G 70ms -Y 50% Gap
Figure C-2-219: 8246 HIC 15



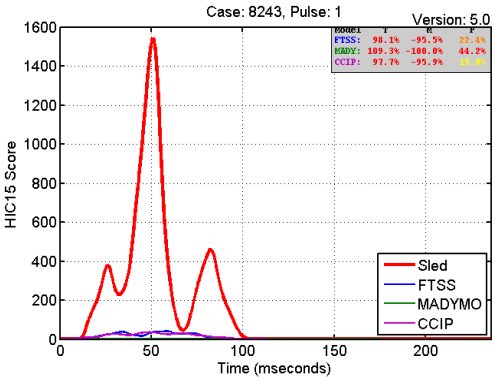
20G 70ms -Y 50% Gap
Figure C-2-220: 8247 HIC 15



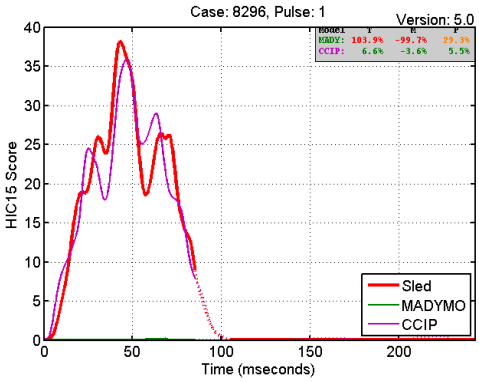
10G 70ms -Y No Gap
Figure C-2-221: 8242 HIC 15



10G 70ms -Y No Gap
Figure C-2-222: 8294 HIC 15

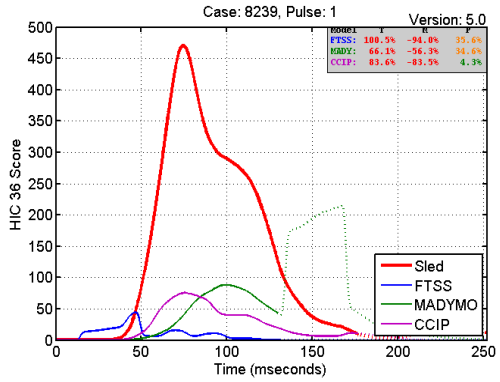


20G 70ms -Y No Gap
Figure C-2-223: 8243 HIC 15

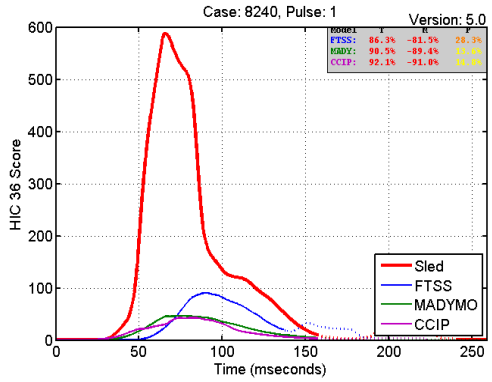


20G 70ms -Y No Gap
Figure C-2-224: 8296 HIC 15

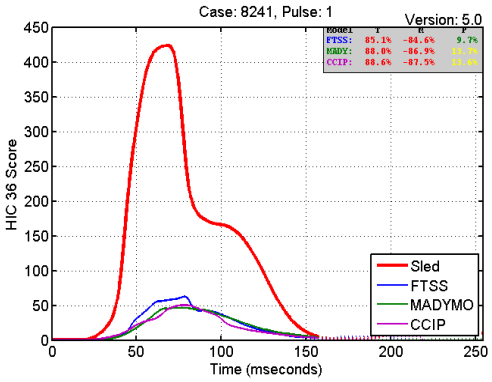
C.2.17 HIC 36



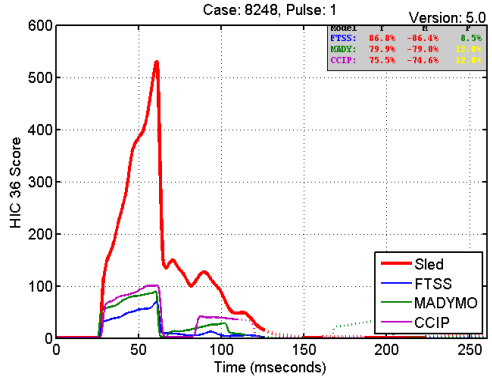
10G 70ms -Y No Side Support
Figure C-2-225: 8239 HIC 36



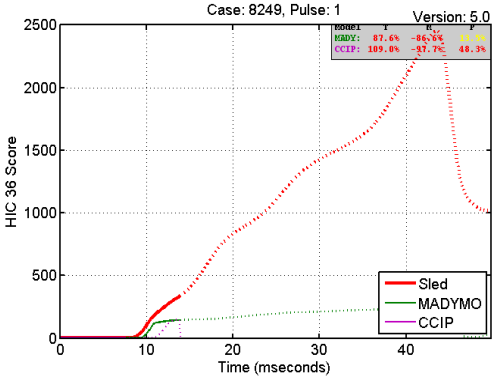
10G 70ms -Y No Head Support
Figure C-2-226: 8240 HIC 36



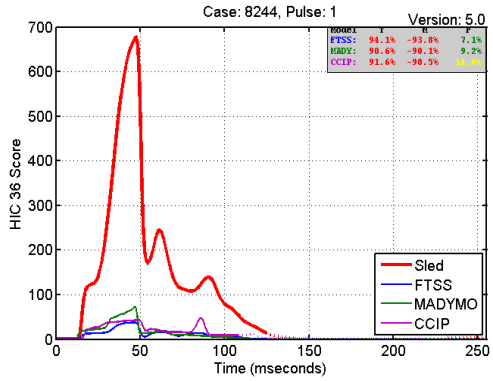
10G 70ms -Y No Head Support
Figure C-2-228: 8241 HIC 36



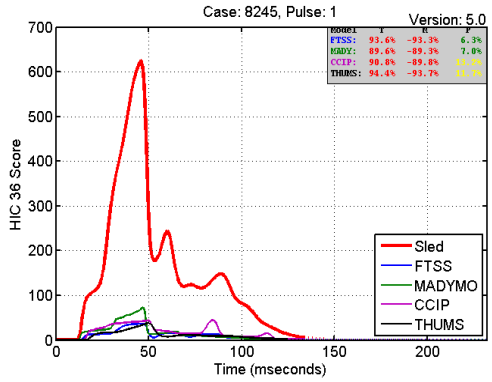
10G 70ms -Y 100% Gap
Figure C-2-227: 8248 HIC 36



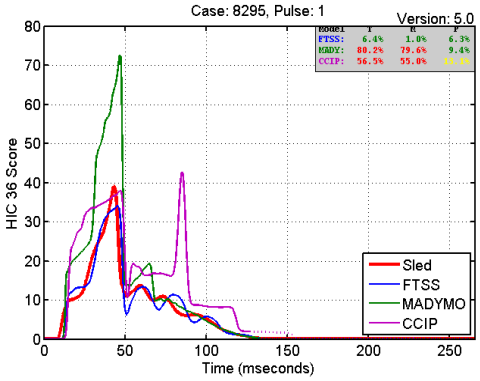
20G 70ms -Y 100% Gap
Figure C-2-229: 8249 HIC 36



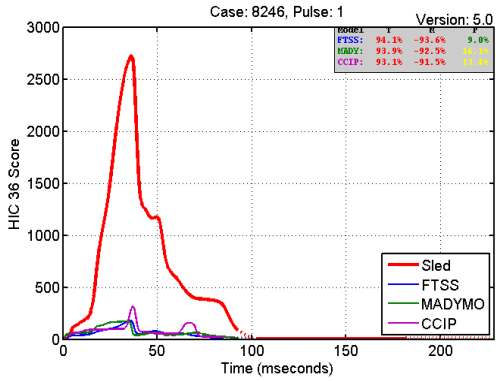
10G 70ms -Y 50% Gap
Figure C-2-230: 8244 HIC 36



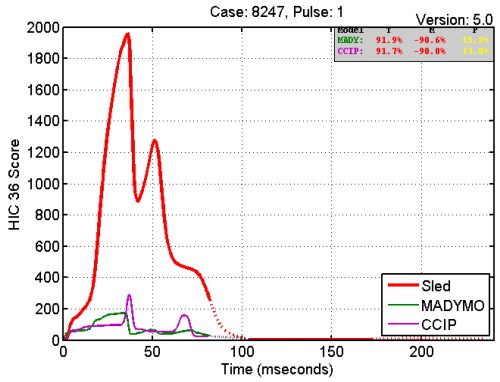
10G 70ms -Y 50% Gap
Figure C-2-231: 8245 HIC 36



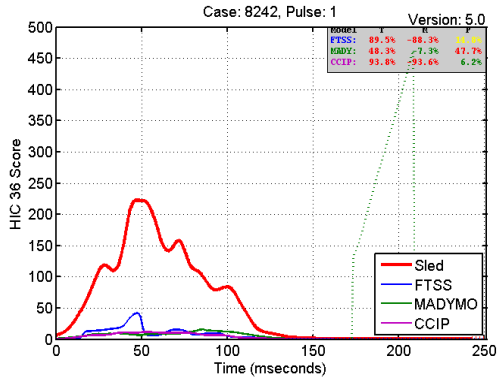
10G 70ms -Y 50% Gap
Figure C-2-232: 8295 HIC 36



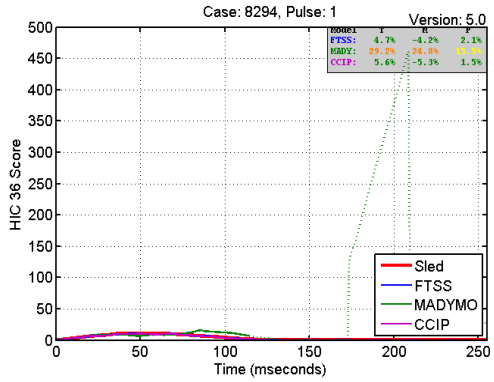
20G 70ms -Y 50% Gap
Figure C-2-233: 8246 HIC 36



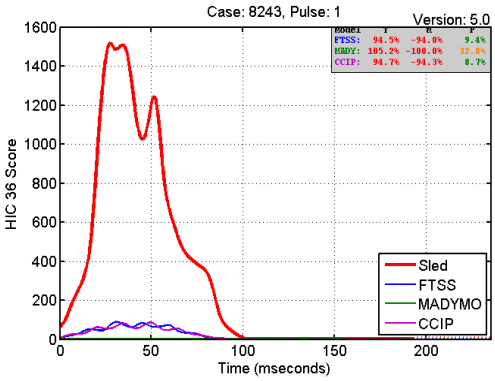
20G 70ms -Y 50% Gap
Figure C-2-234: 8247 HIC 36



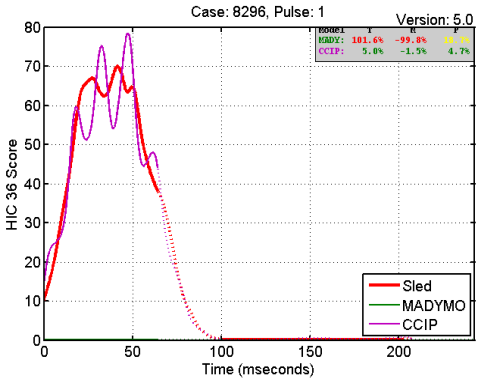
10G 70ms -Y No Gap
Figure C-2-235: 8242 HIC 36



10G 70ms -Y No Gap
Figure C-2-236: 8294 HIC 36

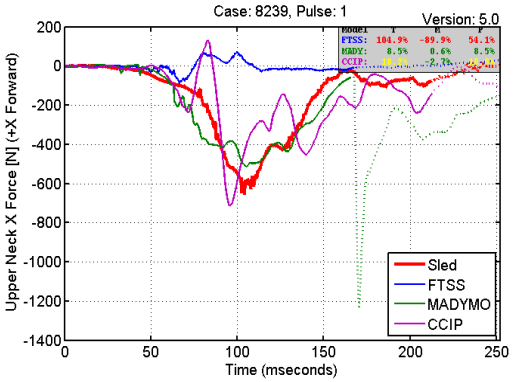


20G 70ms -Y No Gap
Figure C-2-237: 8243 HIC 36

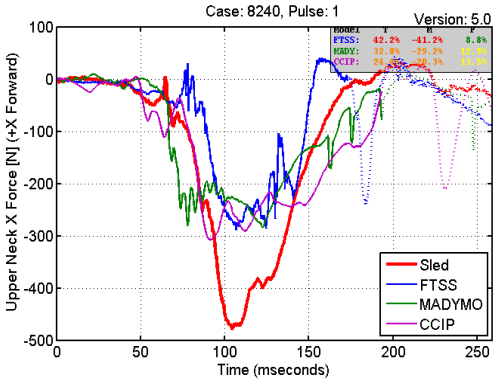


20G 70ms -Y No Gap
Figure C-2-238: 8296 HIC 36

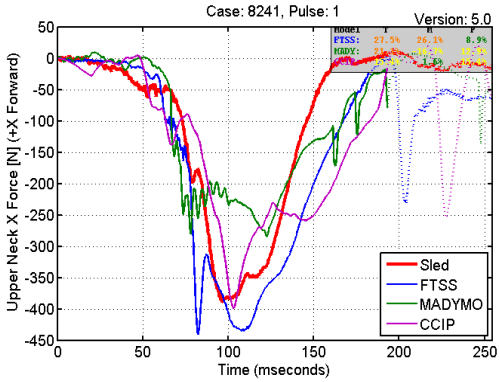
C.2.18 Neck X Force



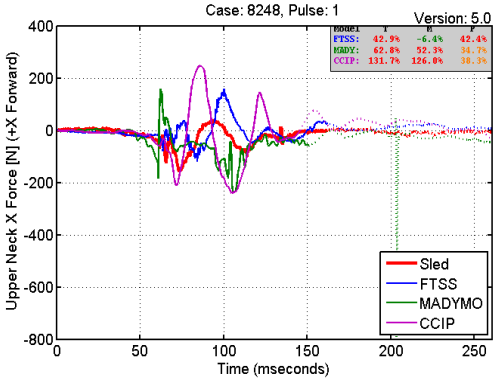
10G 70ms -Y No Side Support
Figure C-2-239: 8239 Neck X Force



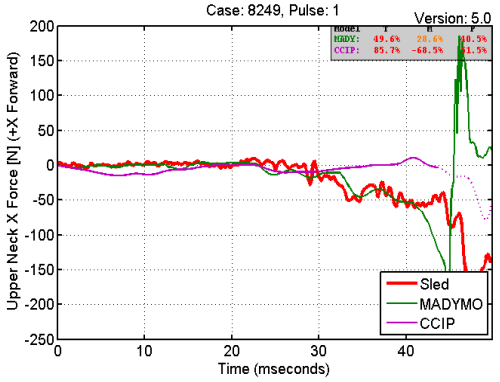
10G 70ms -Y No Head Support
Figure C-2-240: 8240 Neck X Force



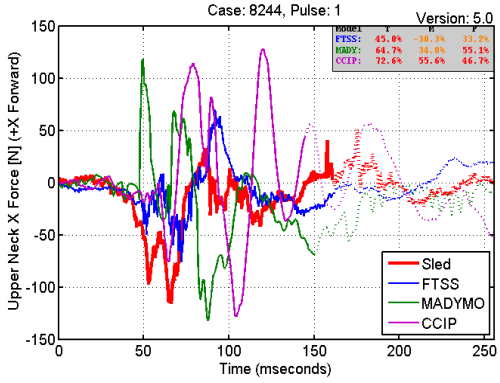
10G 70ms -Y No Head Support
Figure C-2-242: 8241 Neck X Force



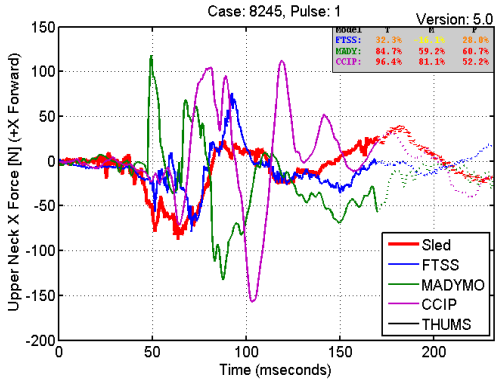
10G 70ms -Y 100% Gap
Figure C-2-241: 8248 Neck X Force



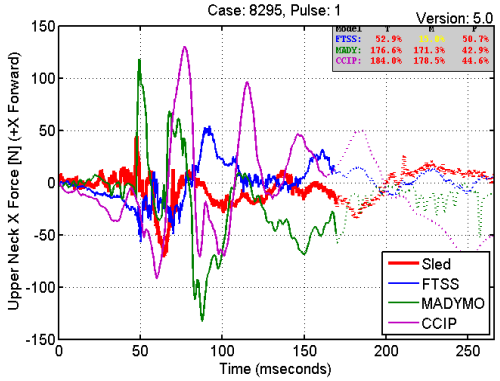
20G 70ms -Y 100% Gap
Figure C-2-243: 8249 Neck X Force



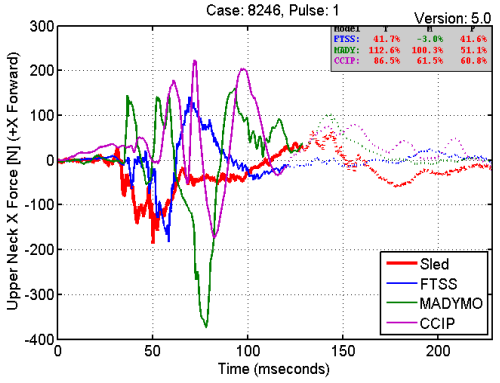
10G 70ms -Y 50% Gap
Figure C-2-244: 8244 Neck X Force



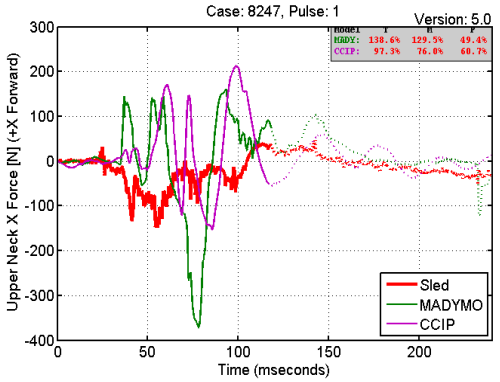
10G 70ms -Y 50% Gap
Figure C-2-245: 8245 Neck X Force



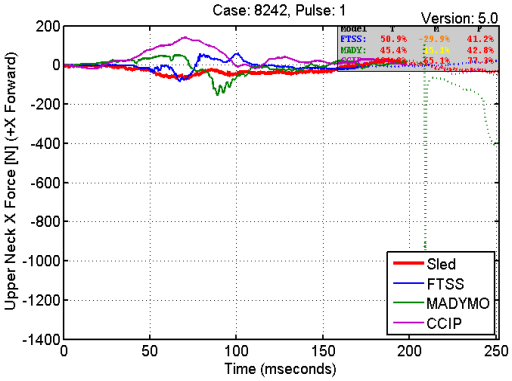
10G 70ms -Y 50% Gap
Figure C-2-246: 8295 Neck X Force



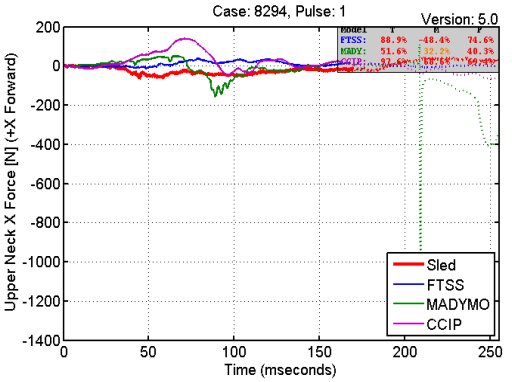
20G 70ms -Y 50% Gap
Figure C-2-247: 8246 Neck X Force



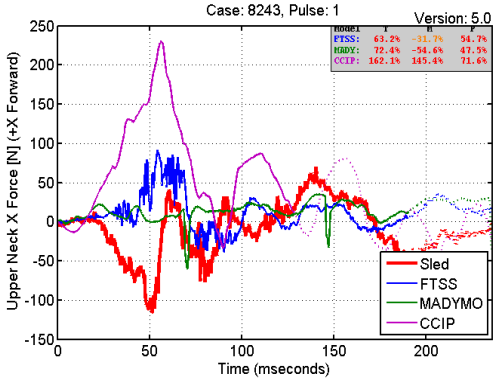
20G 70ms -Y 50% Gap
Figure C-2-248: 8247 Neck X Force



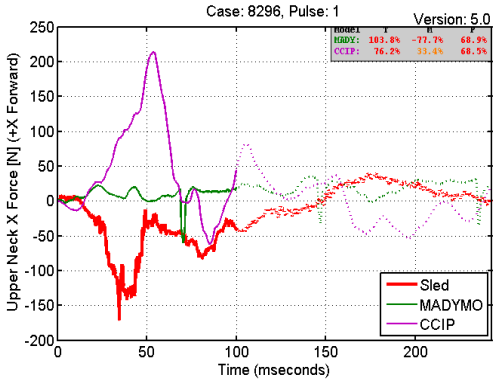
10G 70ms -Y No Gap
Figure C-2-249: 8242 Neck X Force



10G 70ms -Y No Gap
Figure C-2-250: 8294 Neck X Force

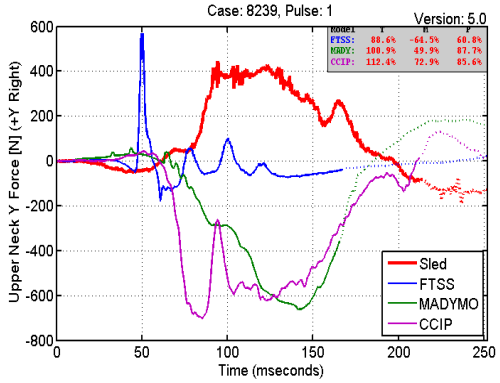


20G 70ms -Y No Gap
Figure C-2-251: 8243 Neck X Force

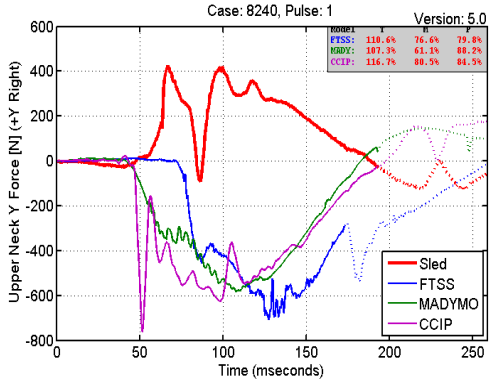


20G 70ms -Y No Gap
Figure C-2-252: 8296 Neck X Force

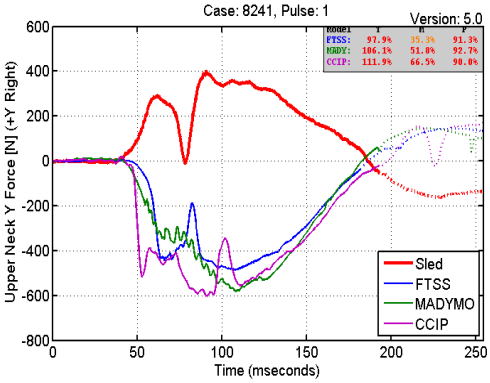
C.2.19 Neck Y Force



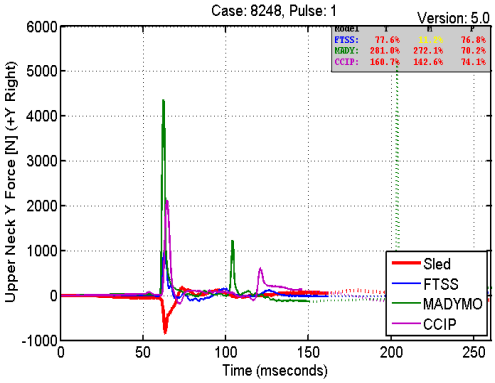
10G 70ms -Y No Side Support
Figure C-2-253: 8239 Neck Y Force



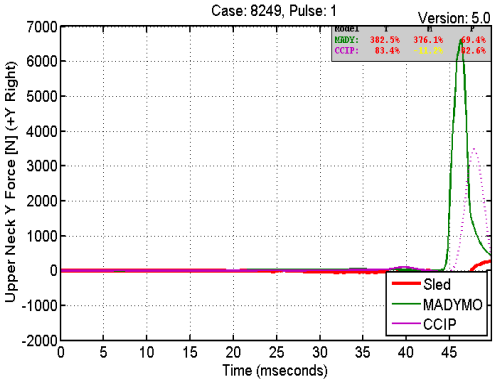
10G 70ms -Y No Head Support
Figure C-2-254: 8240 Neck Y Force



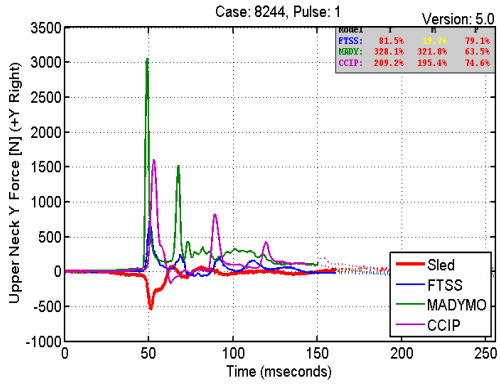
10G 70ms -Y No Head Support
Figure C-2-256: 8241 Neck Y Force



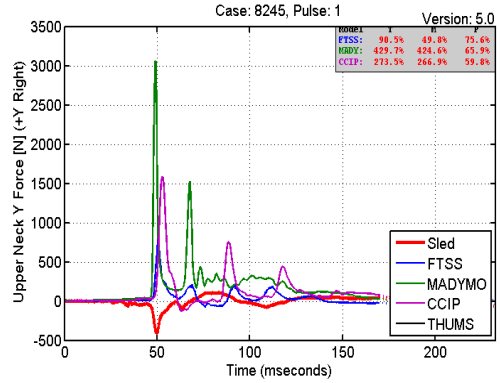
10G 70ms -Y 100% Gap
Figure C-2-255: 8248 Neck Y Force



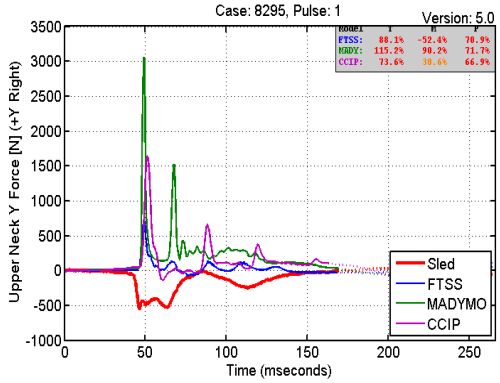
20G 70ms -Y 100% Gap
Figure C-2-257: 8249 Neck Y Force



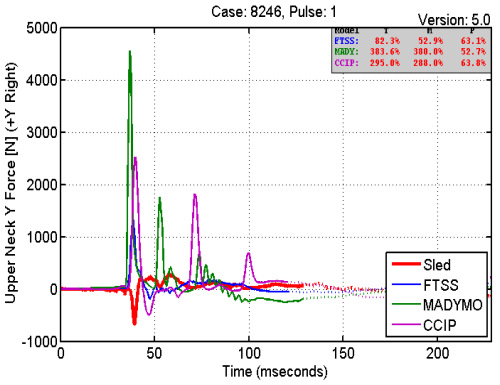
10G 70ms -Y 50% Gap
Figure C-2-258: 8244 Neck Y Force



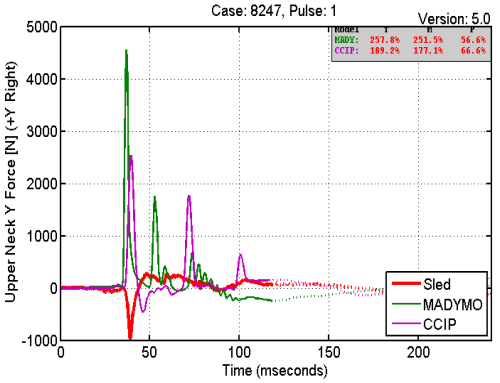
10G 70ms -Y 50% Gap
Figure C-2-259: 8245 Neck Y Force



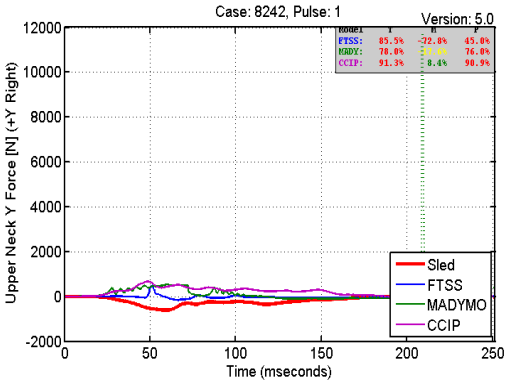
10G 70ms -Y 50% Gap
Figure C-2-260: 8295 Neck Y Force



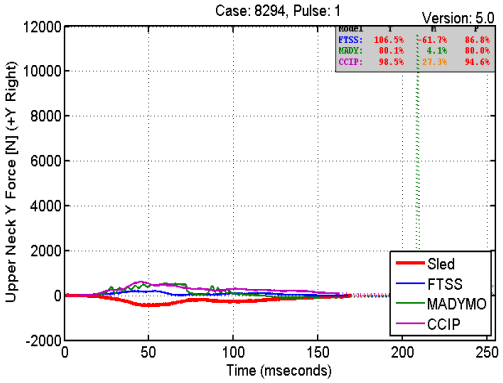
20G 70ms -Y 50% Gap
Figure C-2-261: 8246 Neck Y Force



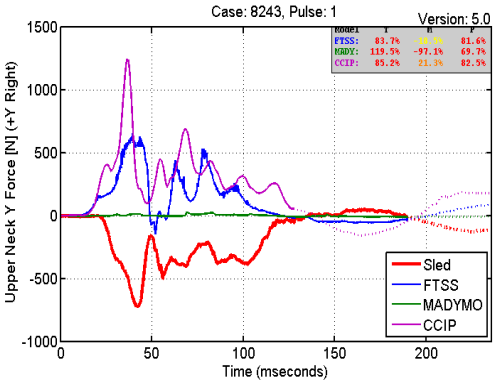
20G 70ms -Y 50% Gap
Figure C-2-262: 8247 Neck Y Force



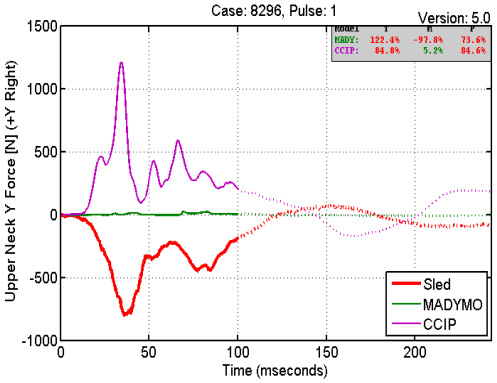
10G 70ms -Y No Gap
Figure C-2-263: 8242 Neck Y Force



10G 70ms -Y No Gap
Figure C-2-264: 8294 Neck Y Force

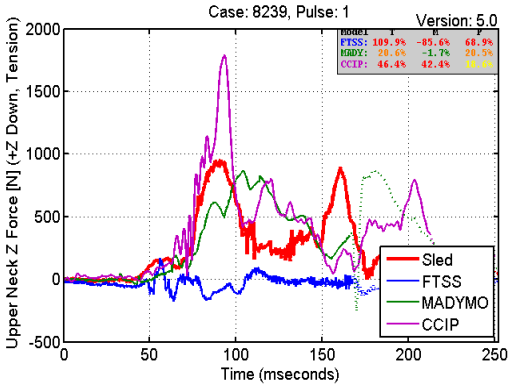


20G 70ms -Y No Gap
Figure C-2-265: 8243 Neck Y Force

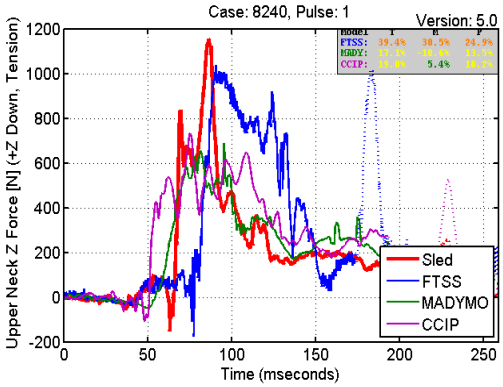


20G 70ms -Y No Gap
Figure C-2-266: 8296 Neck Y Force

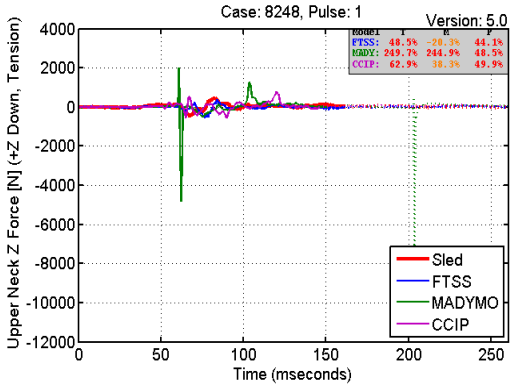
C.2.20 Neck Z Force



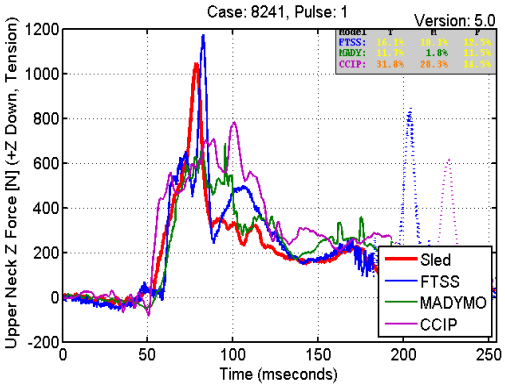
10G 70ms -Y No Side Support
Figure C-2-267: 8239 Neck Z Force



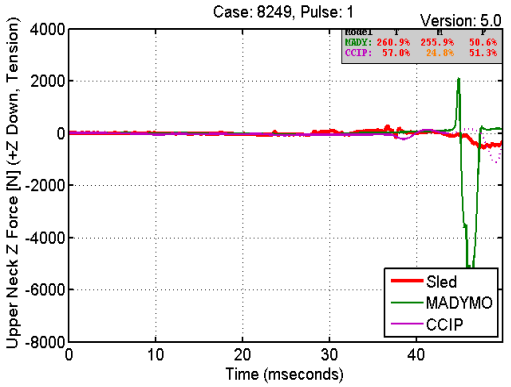
10G 70ms -Y No Head Support
Figure C-2-268: 8240 Neck Z Force



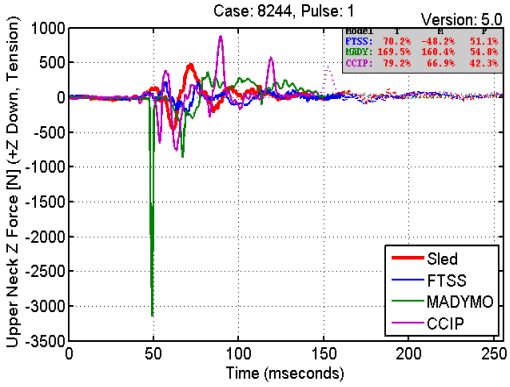
10G 70ms -Y 100% Gap
Figure C-2-269: 8248 Neck Z Force



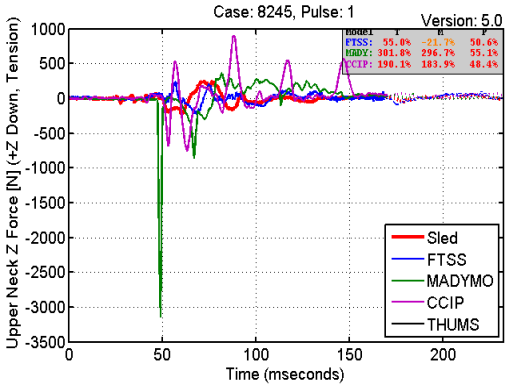
10G 70ms -Y No Head Support
Figure C-2-270: 8241 Neck Z Force



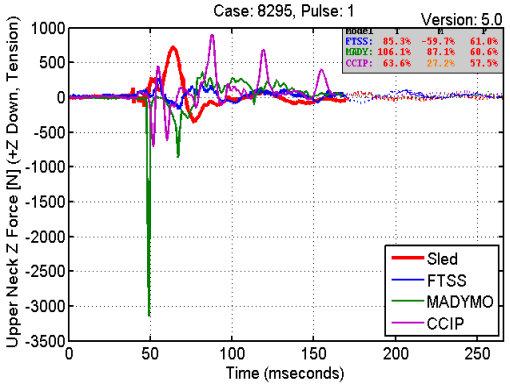
20G 70ms -Y 100% Gap
Figure C-2-271: 8249 Neck Z Force



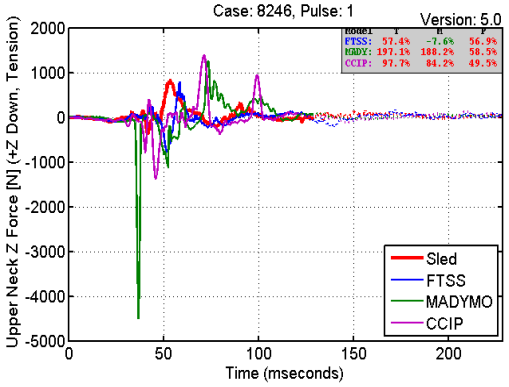
10G 70ms -Y 50% Gap
Figure C-2-272: 8244 Neck Z Force



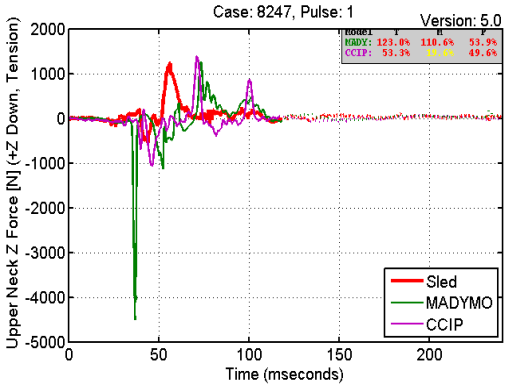
10G 70ms -Y 50% Gap
Figure C-2-273: 8245 Neck Z Force



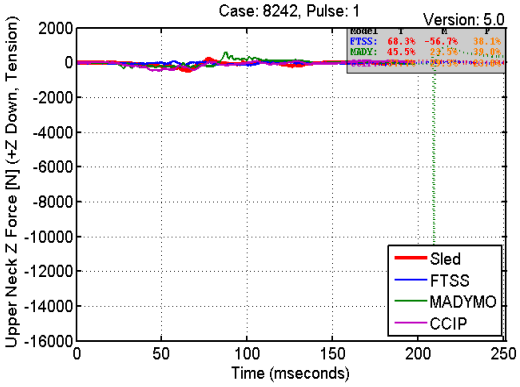
10G 70ms -Y 50% Gap
Figure C-2-274: 8295 Neck Z Force



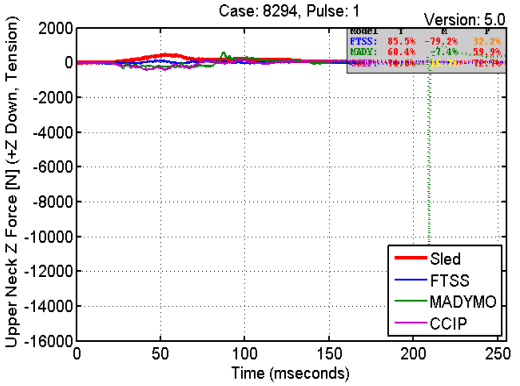
20G 70ms -Y 50% Gap
Figure C-2-275: 8246 Neck Z Force



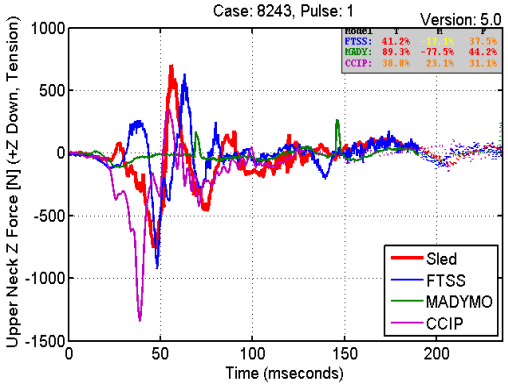
20G 70ms -Y 50% Gap
Figure C-2-276: 8247 Neck Z Force



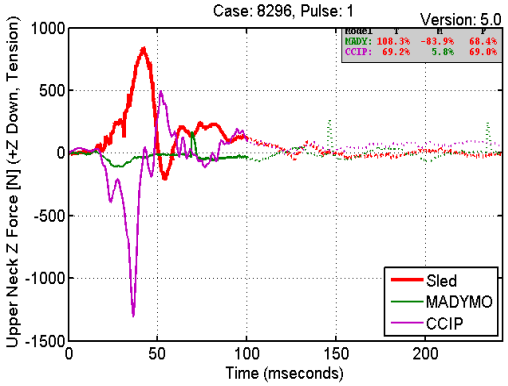
10G 70ms -Y No Gap
Figure C-2-277: 8242 Neck Z Force



10G 70ms -Y No Gap
Figure C-2-278: 8294 Neck Z Force

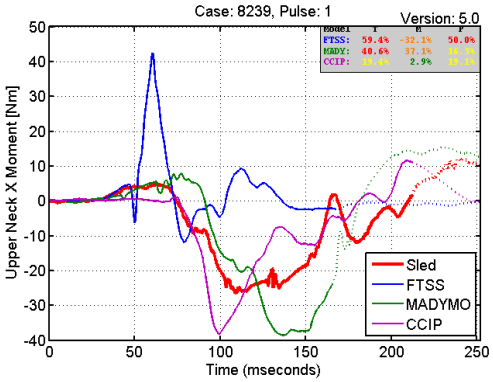


20G 70ms -Y No Gap
Figure C-2-279: 8243 Neck Z Force

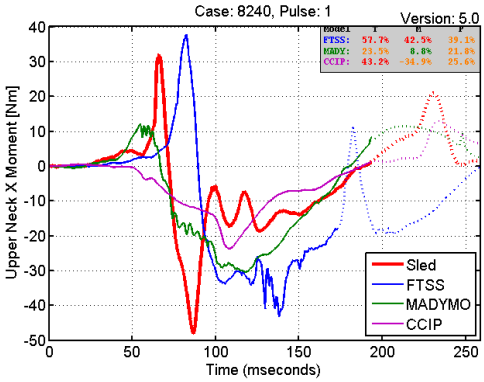


20G 70ms -Y No Gap
Figure C-2-280: 8296 Neck Z Force

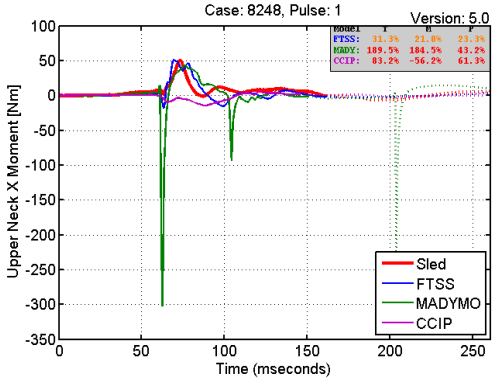
C.2.21 Neck X Moment



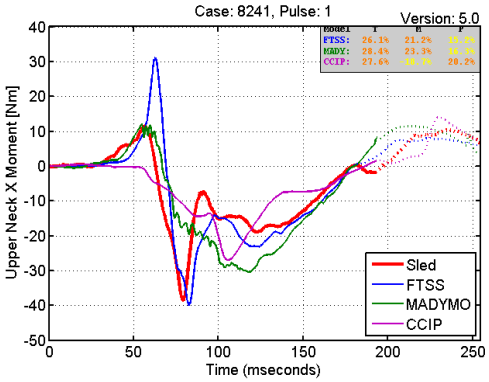
10G 70ms -Y No Side Support
Figure C-2-281: 8239 Neck X Moment



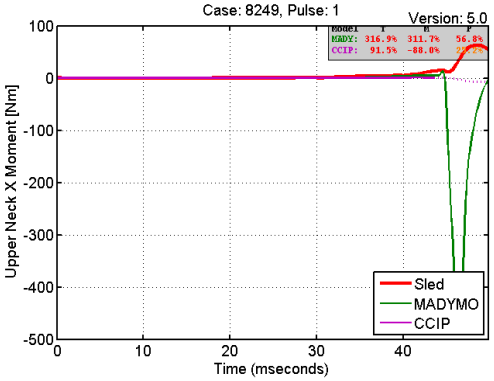
10G 70ms -Y No Head Support
Figure C-2-282: 8240 Neck X Moment



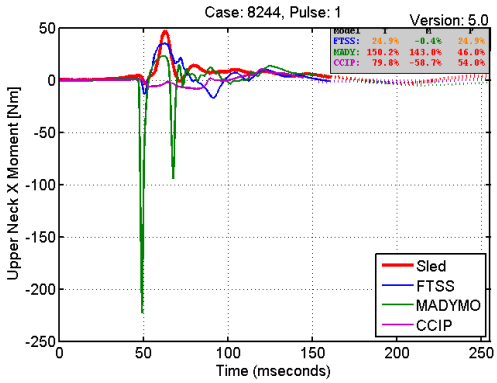
10G 70ms -Y 100% Gap
Figure C-2-283: 8248 Neck X Moment



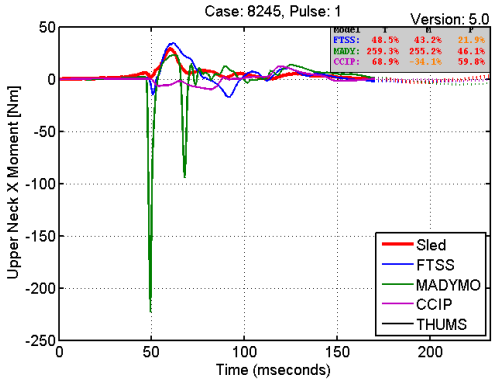
10G 70ms -Y No Head Support
Figure C-2-284: 8241 Neck X Moment



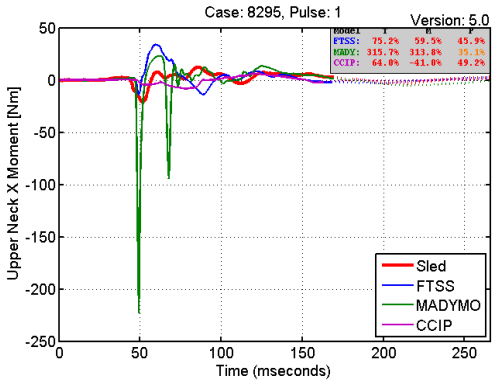
20G 70ms -Y 100% Gap
Figure C-2-285: 8249 Neck X Moment



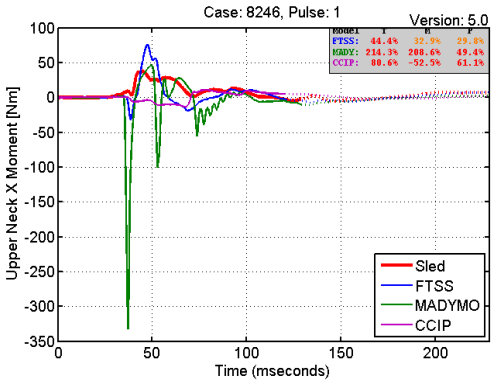
10G 70ms -Y 50% Gap
Figure C-2-286: 8244 Neck X Moment



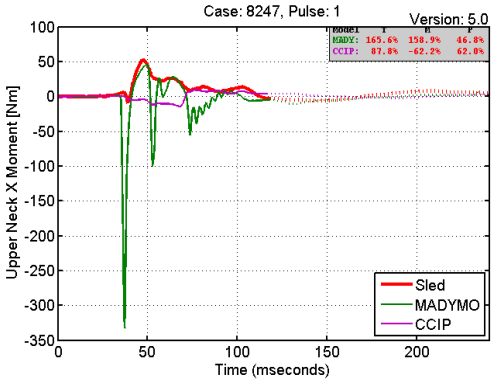
10G 70ms -Y 50% Gap
Figure C-2-287: 8245 Neck X Moment



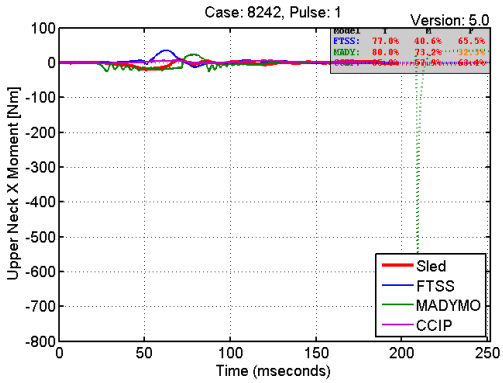
10G 70ms -Y 50% Gap
Figure C-2-288: 8295 Neck X Moment



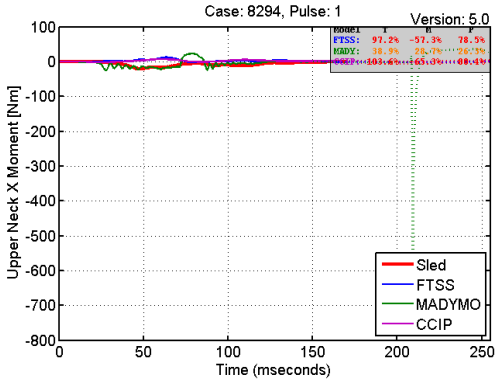
20G 70ms -Y 50% Gap
Figure C-2-289: 8246 Neck X Moment



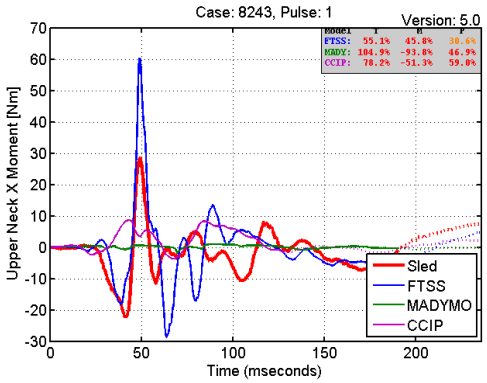
20G 70ms -Y 50% Gap
Figure C-2-290: 8247 Neck X Moment



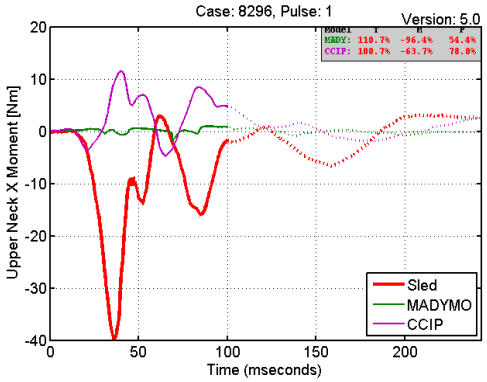
10G 70ms -Y No Gap
Figure C-2-291: 8242 Neck X Moment



10G 70ms -Y No Gap
Figure C-2-292: 8294 Neck X Moment

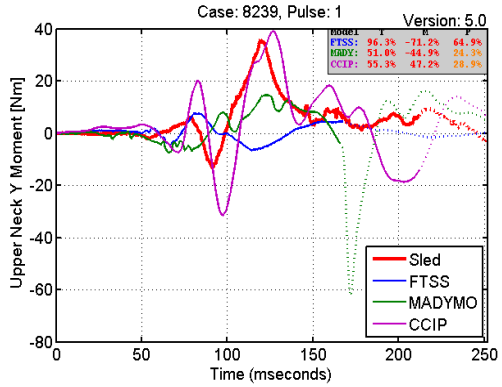


20G 70ms -Y No Gap
Figure C-2-293: 8243 Neck X Moment

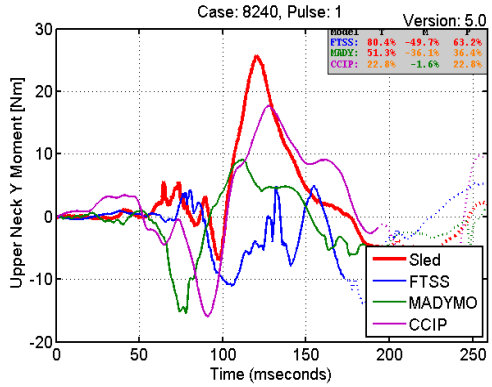


20G 70ms -Y No Gap
Figure C-2-294: 8296 Neck X Moment

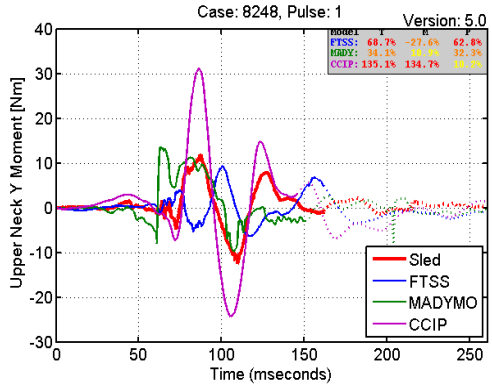
C.2.22 Neck Y Moment



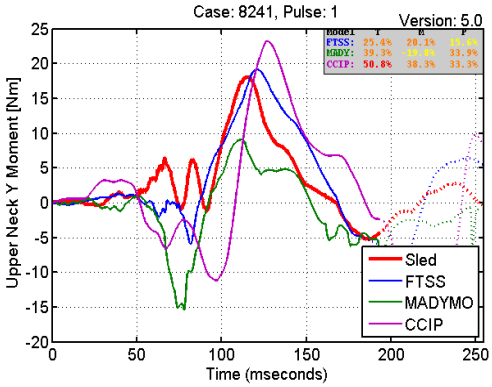
10G 70ms -Y No Side Support
Figure C-2-295: 8239 Neck Y Moment



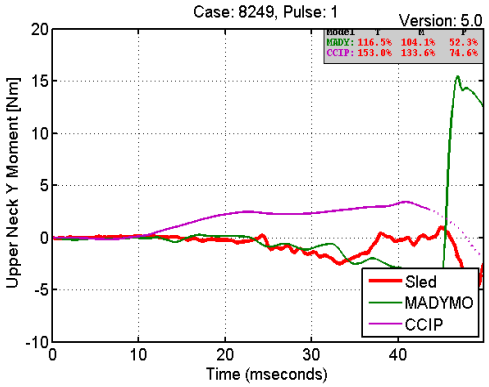
10G 70ms -Y No Head Support
Figure C-2-296: 8240 Neck Y Moment



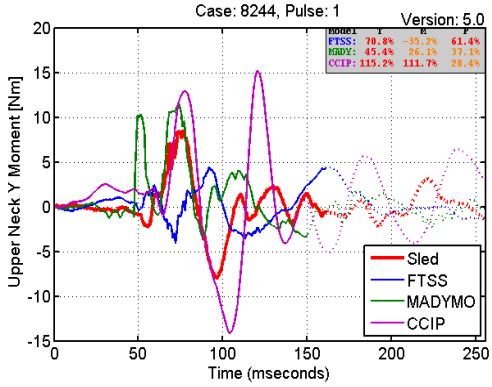
10G 70ms -Y 100% Gap
Figure C-2-297: 8248 Neck Y Moment



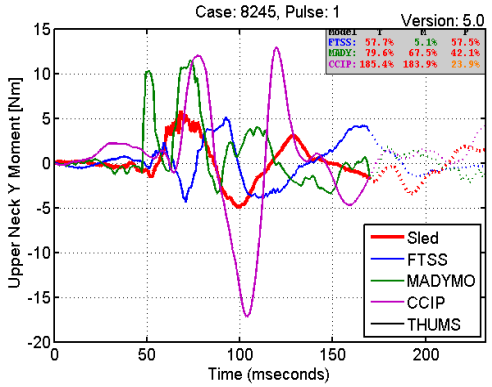
10G 70ms -Y No Head Support
Figure C-2-298: 8241 Neck Y Moment



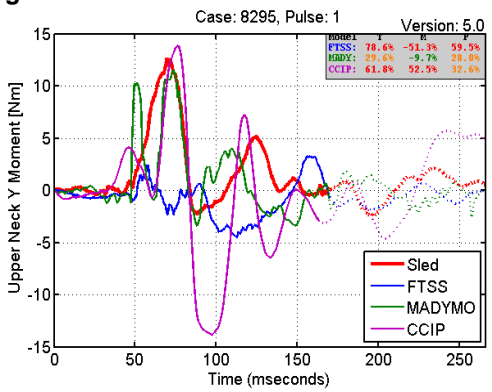
20G 70ms -Y 100% Gap
Figure C-2-299: 8249 Neck Y Moment



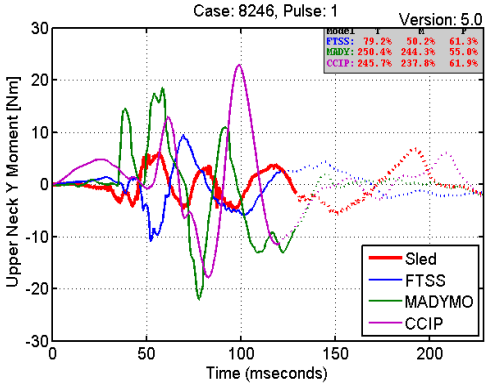
10G 70ms -Y 50% Gap
Figure C-2-300: 8244 Neck Y Moment



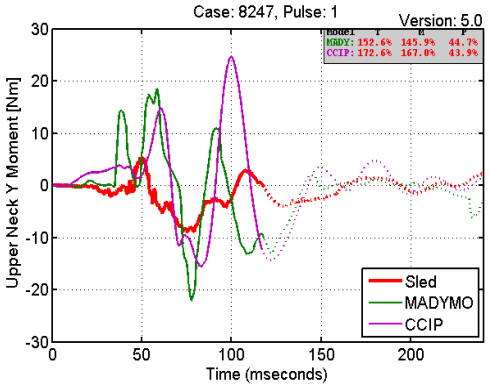
10G 70ms -Y 50% Gap
Figure C-2-301: 8245 Neck Y Moment



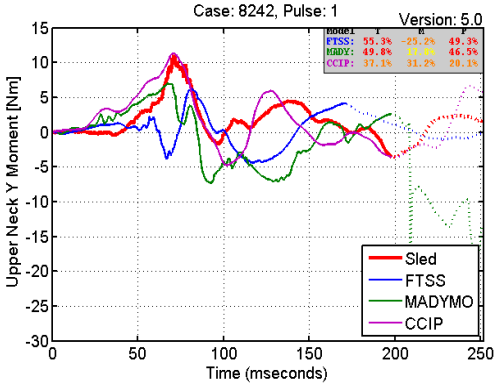
10G 70ms -Y 50% Gap
Figure C-2-302: 8295 Neck Y Moment



20G 70ms -Y 50% Gap
Figure C-2-303: 8246 Neck Y Moment

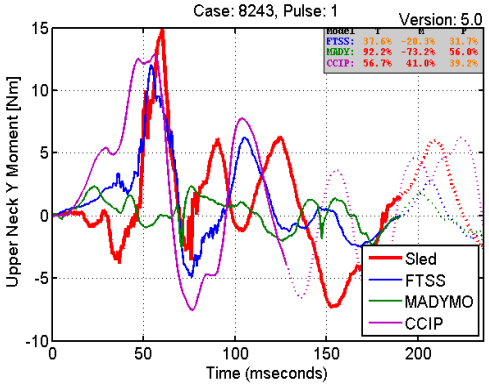


20G 70ms -Y 50% Gap
Figure C-2-304: 8247 Neck Y Moment



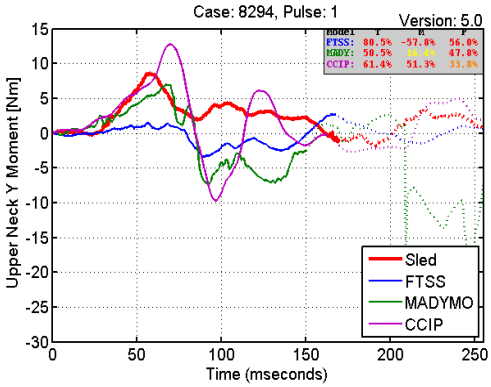
10G 70ms -Y No Gap

Figure C-2-305: 8242 Neck Y Moment



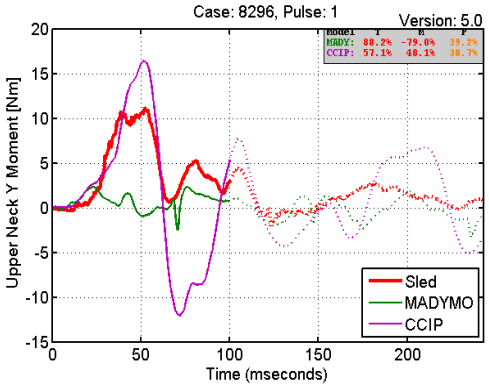
20G 70ms -Y No Gap

Figure C-2-307: 8243 Neck Y Moment



10G 70ms -Y No Gap

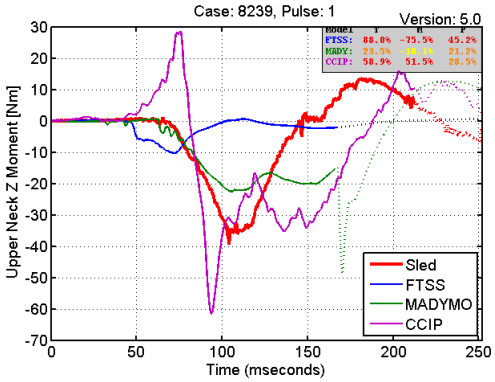
Figure C-2-306: 8294 Neck Y Moment



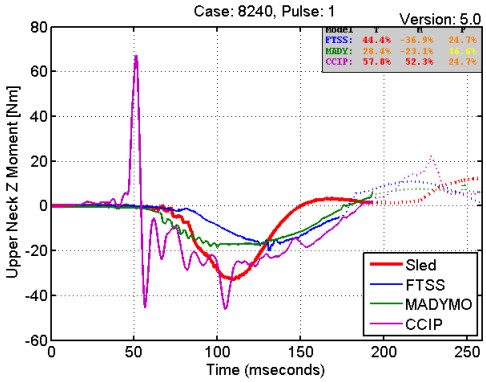
20G 70ms -Y No Gap

Figure C-2-308: 8296 Neck Y Moment

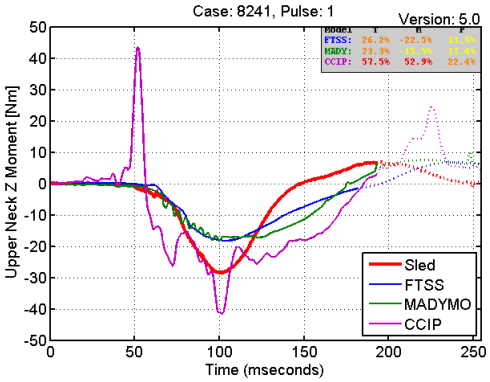
C.2.23 Neck Z Moment



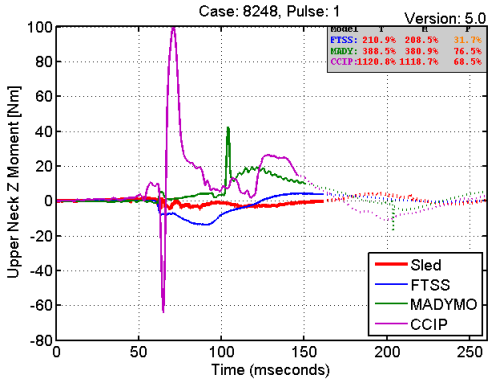
10G 70ms -Y No Side Support
Figure C-2-309: 8239 Neck Z Moment



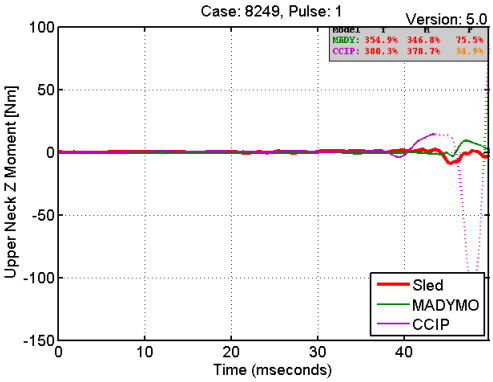
10G 70ms -Y No Head Support
Figure C-2-310: 8240 Neck Z Moment



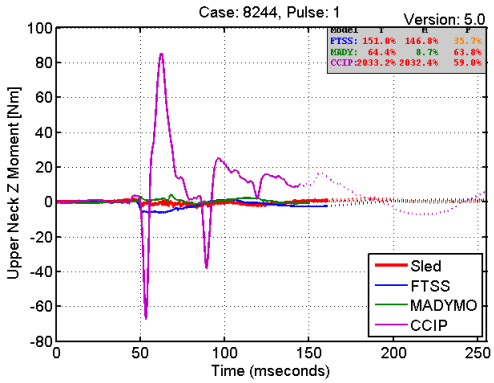
10G 70ms -Y No Head Support
Figure C-2-312: 8241 Neck Z Moment



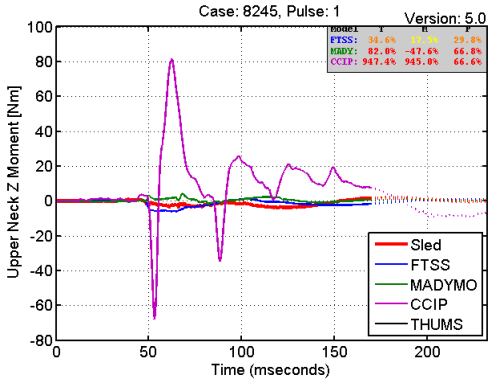
10G 70ms -Y 100% Gap
Figure C-2-311: 8248 Neck Z Moment



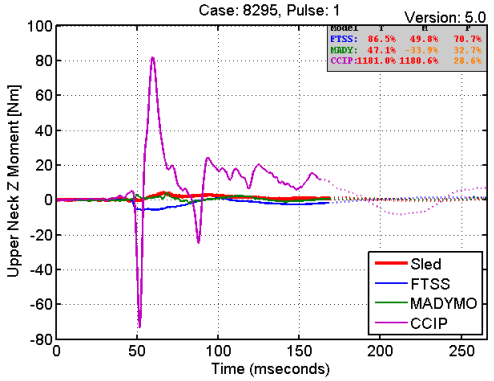
20G 70ms -Y 100% Gap
Figure C-2-313: 8249 Neck Z Moment



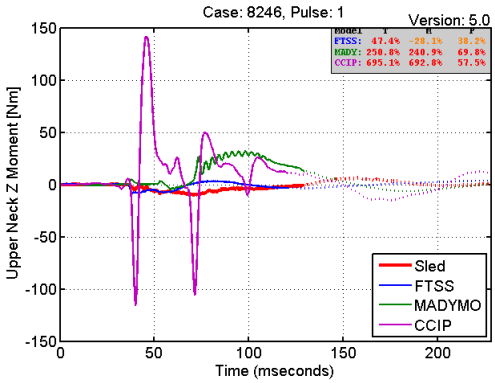
10G 70ms -Y 50% Gap
Figure C-2-314: 8244 Neck Z Moment



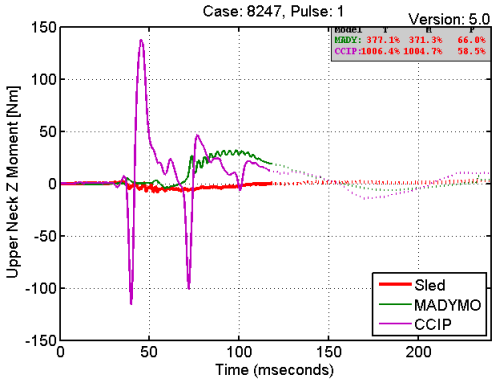
10G 70ms -Y 50% Gap
Figure C-2-315: 8245 Neck Z Moment



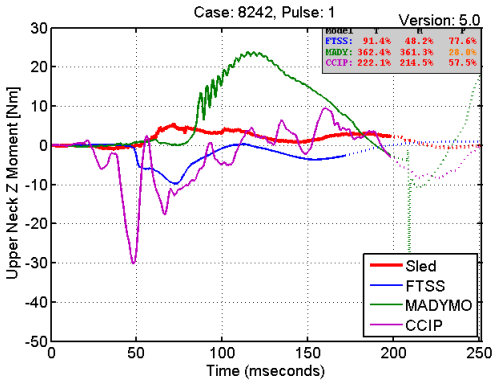
10G 70ms -Y 50% Gap
Figure C-2-316: 8295 Neck Z Moment



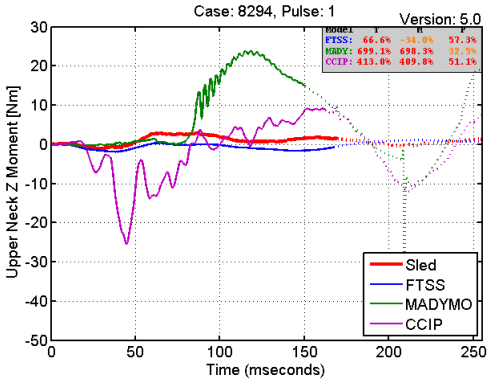
20G 70ms -Y 50% Gap
Figure C-2-317: 8246 Neck Z Moment



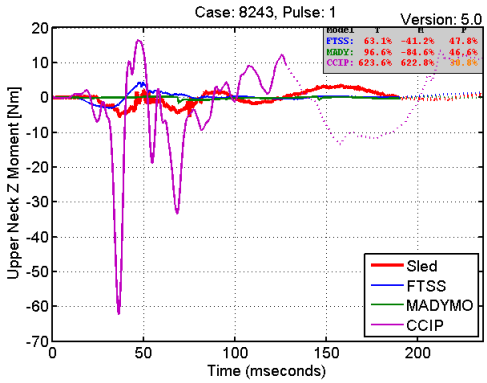
20G 70ms -Y 50% Gap
Figure C-2-318: 8247 Neck Z Moment



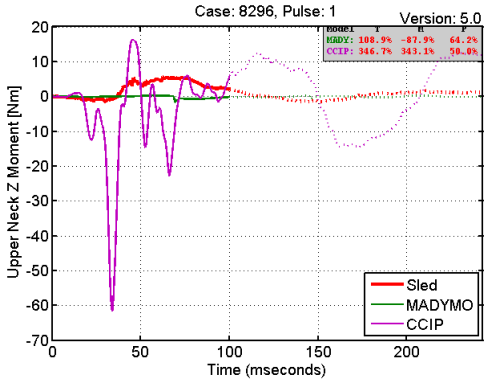
10G 70ms -Y No Gap
Figure C-2-319: 8242 Neck Z Moment



10G 70ms -Y No Gap
Figure C-2-320: 8294 Neck Z Moment

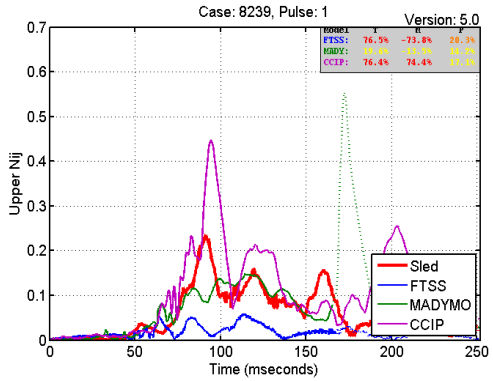


20G 70ms -Y No Gap
Figure C-2-321: 8243 Neck Z Moment

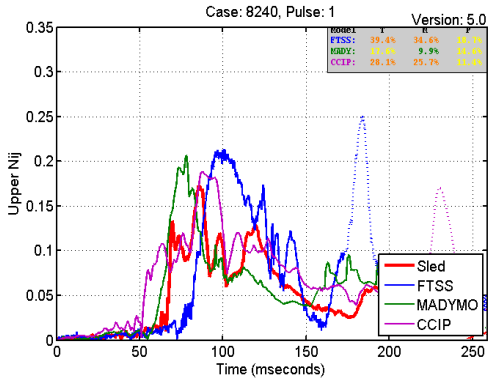


20G 70ms -Y No Gap
Figure C-2-322: 8296 Neck Z Moment

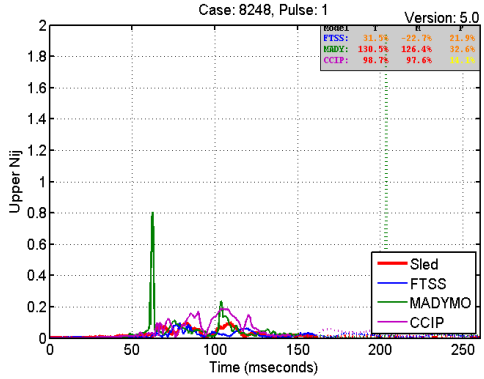
C.2.24 Nij



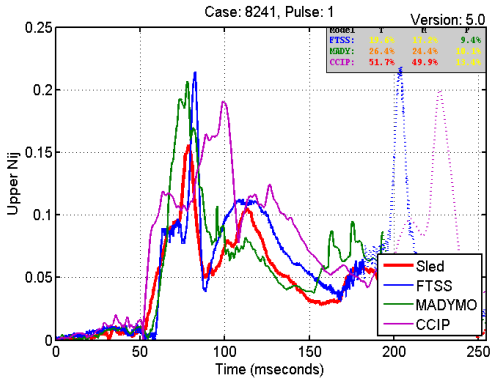
10G 70ms -Y No Side Support
Figure C-2-323: 8239 Nij



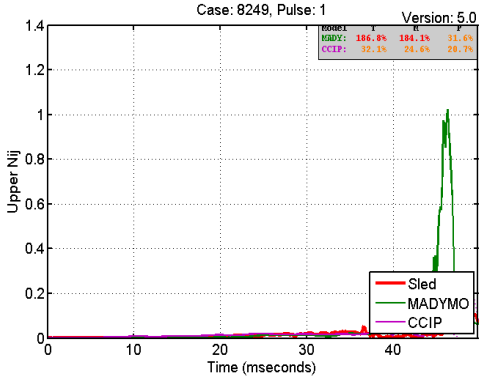
10G 70ms -Y No Head Support
Figure C-2-324: 8240 Nij



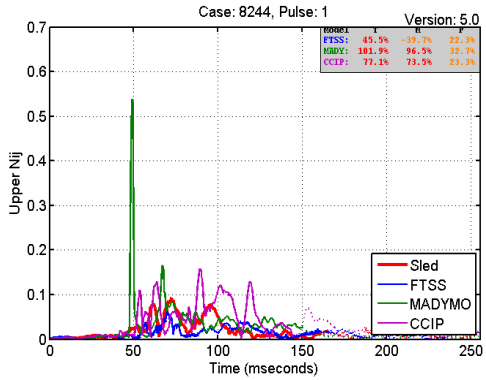
10G 70ms -Y 100% Gap
Figure C-2-325: 8248 Nij



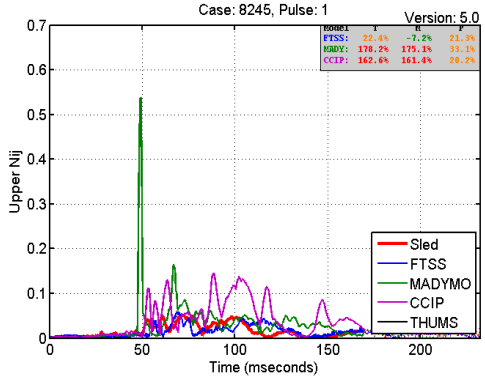
10G 70ms -Y No Head Support
Figure C-2-326: 8241 Nij



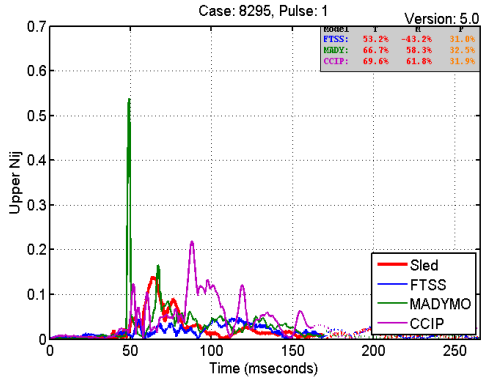
20G 70ms -Y 100% Gap
Figure C-2-327: 8249 Nij



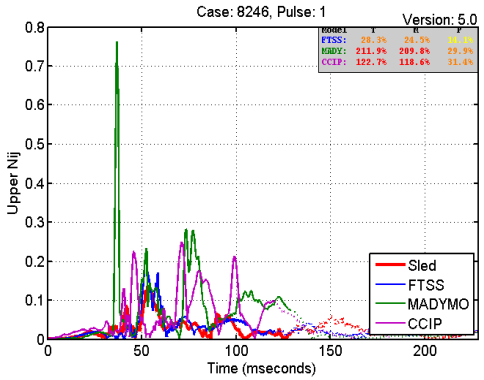
10G 70ms -Y 50% Gap
Figure C-2-328: 8244 Nij



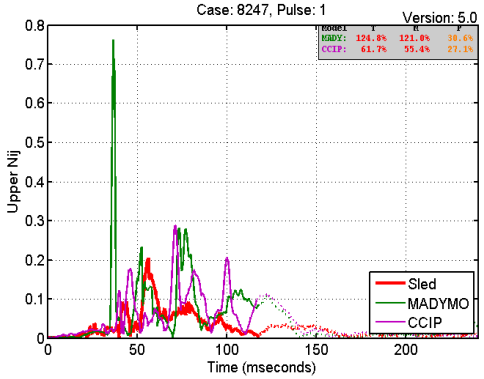
10G 70ms -Y 50% Gap
Figure C-2-329: 8245 Nij



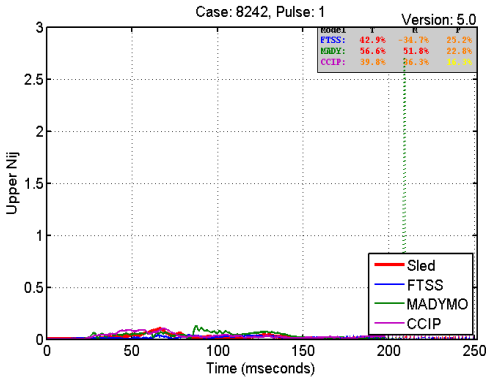
10G 70ms -Y 50% Gap
Figure C-2-330: 8295 Nij



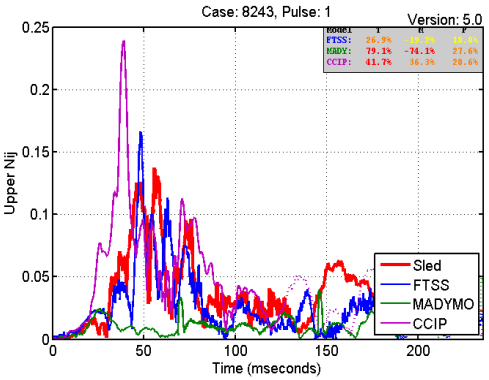
20G 70ms -Y 50% Gap
Figure C-2-331: 8246 Nij



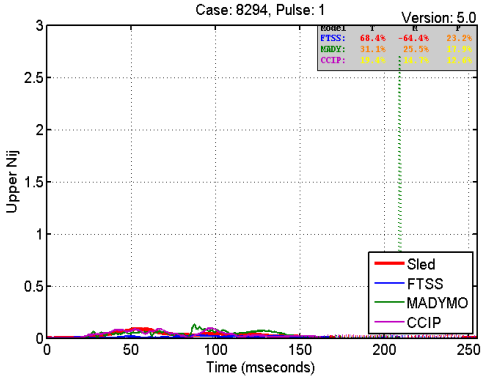
20G 70ms -Y 50% Gap
Figure C-2-332: 8247 Nij



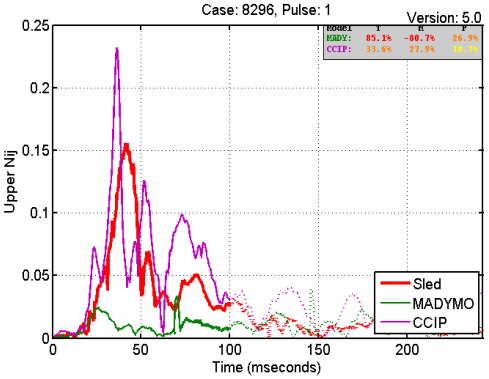
10G 70ms -Y No Gap
Figure C-2-333: 8242 Nij



20G 70ms -Y No Gap
Figure C-2-335: 8243 Nij

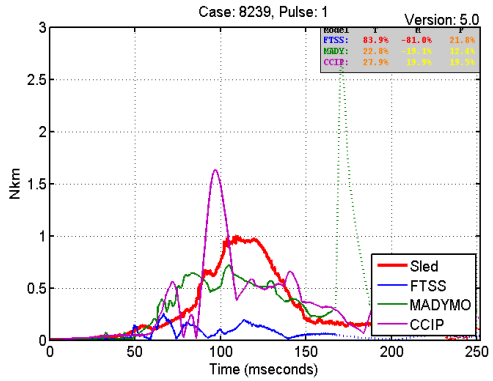


10G 70ms -Y No Gap
Figure C-2-334: 8294 Nij

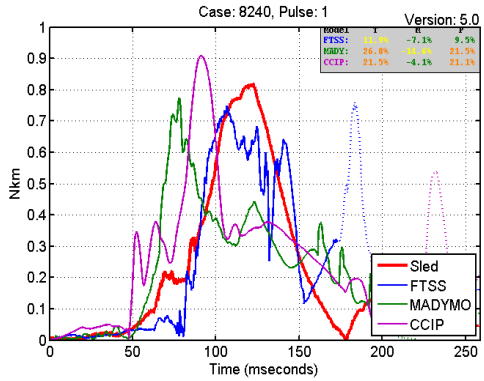


20G 70ms -Y No Gap
Figure C-2-336: 8296 Nij

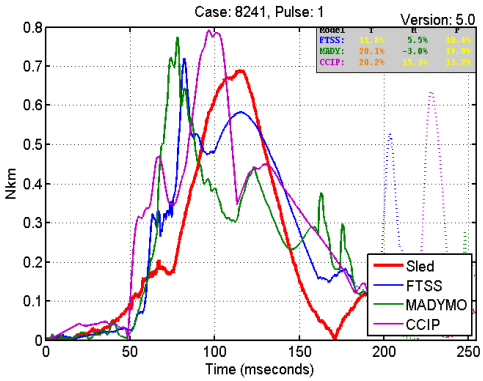
C.2.25 Nkm



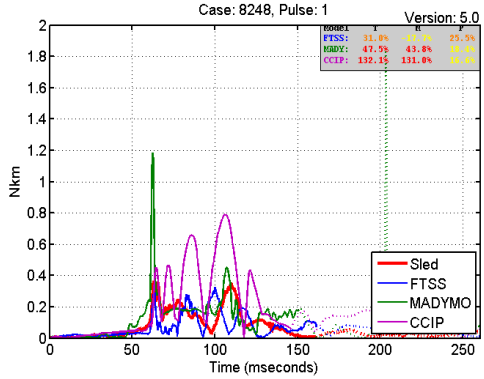
10G 70ms -Y No Side Support
Figure C-2-337: 8239 Nkm



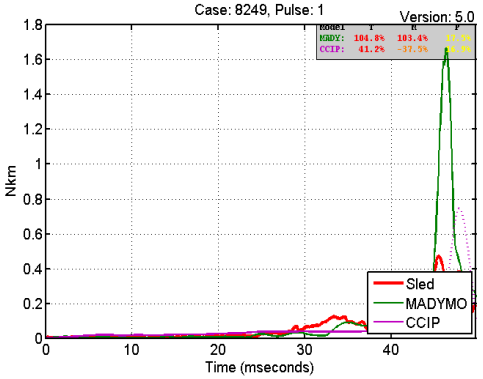
10G 70ms -Y No Head Support
Figure C-2-338: 8240 Nkm



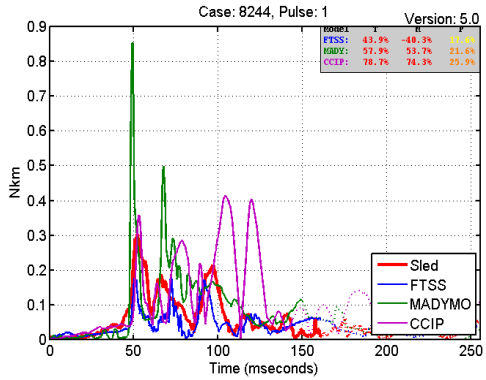
10G 70ms -Y No Head Support
Figure C-2-340: 8241 Nkm



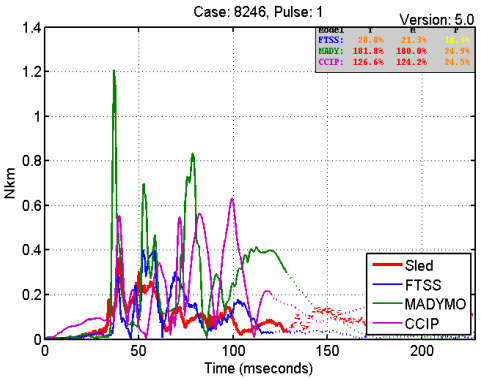
10G 70ms -Y 100% Gap
Figure C-2-339: 8248 Nkm



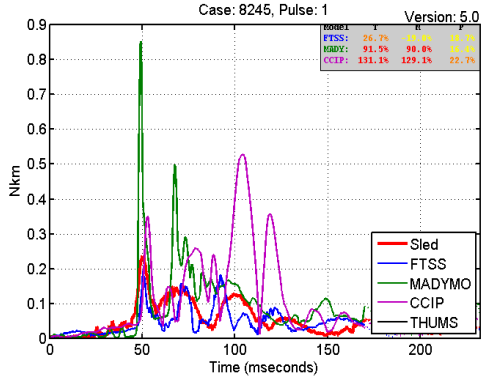
20G 70ms -Y 100% Gap
Figure C-2-341: 8249 Nkm



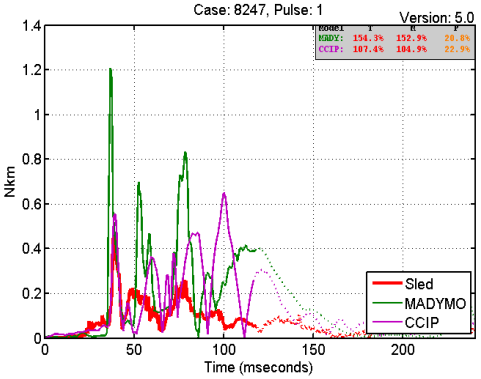
10G 70ms -Y 50% Gap
Figure C-2-342: 8244 Nkm



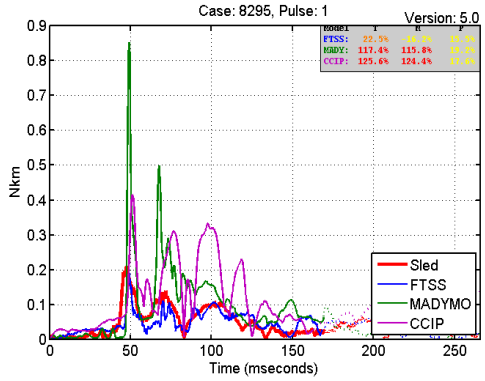
20G 70ms -Y 50% Gap
Figure C-2-345: 8246 Nkm



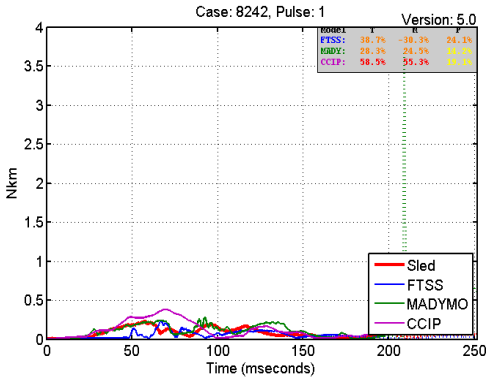
10G 70ms -Y 50% Gap
Figure C-2-343: 8245 Nkm



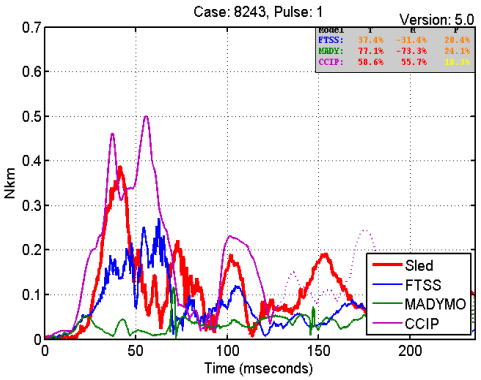
20G 70ms -Y 50% Gap
Figure C-2-346: 8247 Nkm



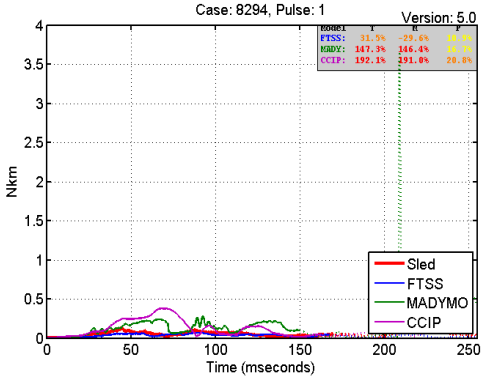
10G 70ms -Y 50% Gap
Figure C-2-344: 8295 Nkm



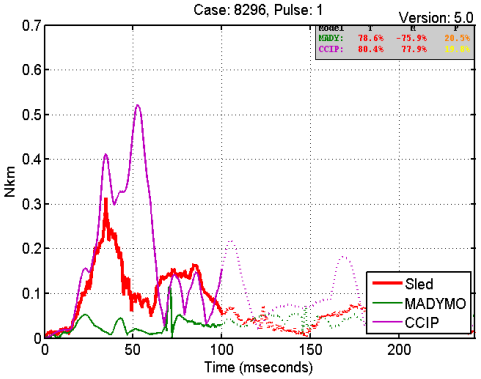
10G 70ms -Y No Gap
Figure C-2-347: 8242 Nkm



20G 70ms -Y No Gap
Figure C-2-349: 8243 Nkm

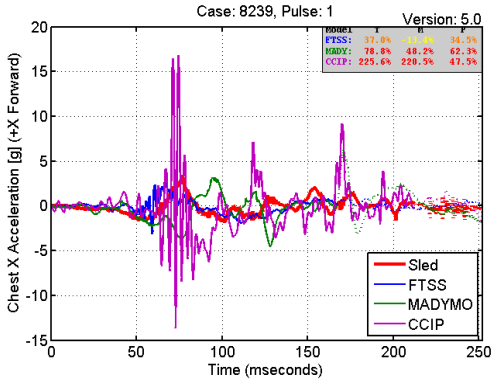


10G 70ms -Y No Gap
Figure C-2-348: 8294 Nkm

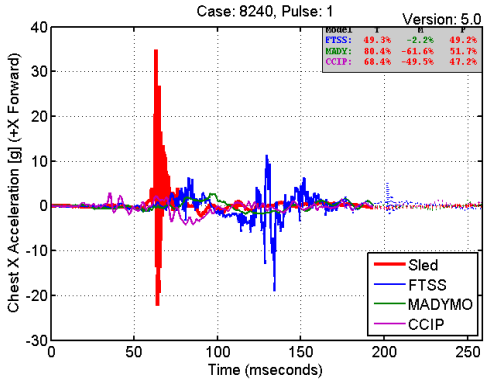


20G 70ms -Y No Gap
Figure C-2-350: 8296 Nkm

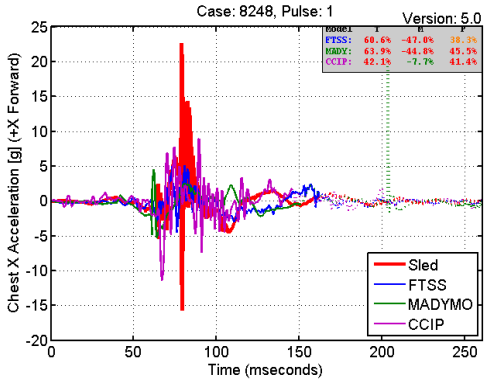
C.2.26 Chest X Acceleration



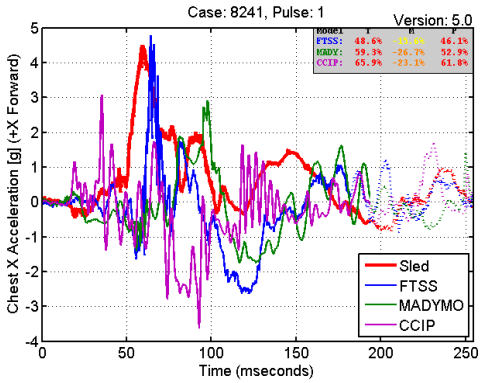
10G 70ms -Y No Side Support
Figure C-2-351: 8239 Chest X Acceleration



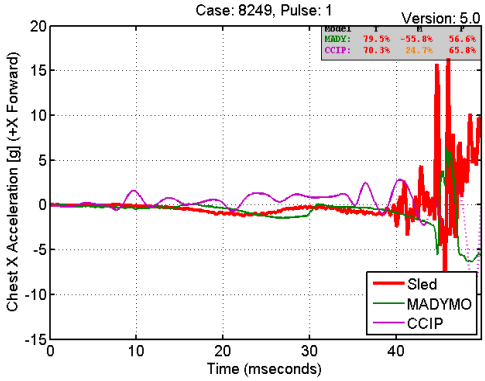
10G 70ms -Y No Head Support
Figure C-2-352: 8240 Chest X Acceleration



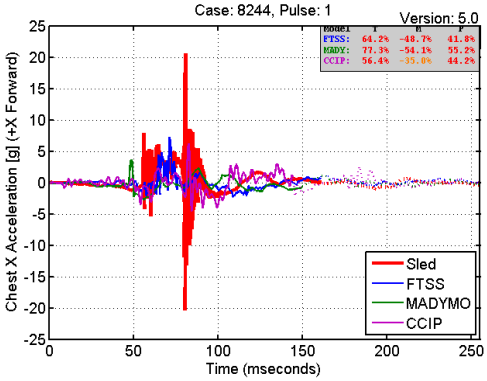
10G 70ms -Y 100% Gap
Figure C-2-353: 8248 Chest X Acceleration



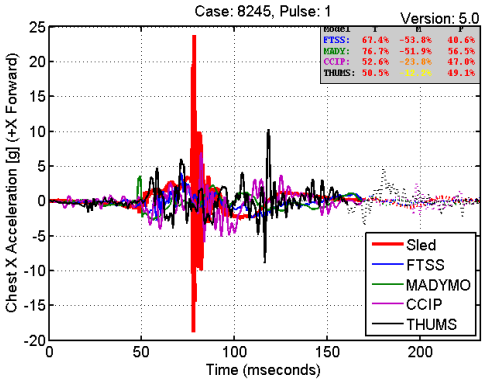
10G 70ms -Y No Head Support
Figure C-2-354: 8241 Chest X Acceleration



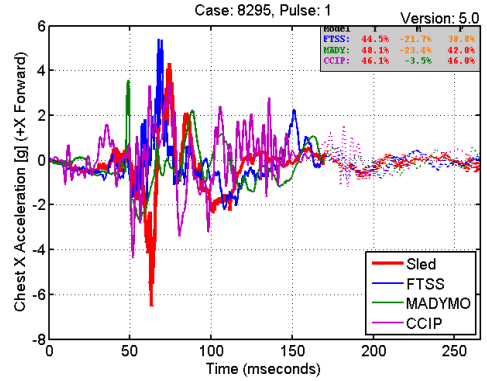
20G 70ms -Y 100% Gap
Figure C-2-355: 8249 Chest X Acceleration



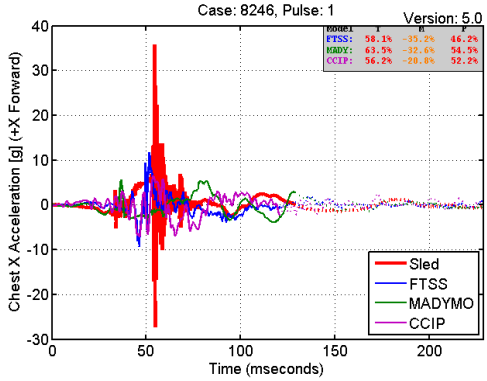
10G 70ms -Y 50% Gap
Figure C-2-356: 8244 Chest X Acceleration



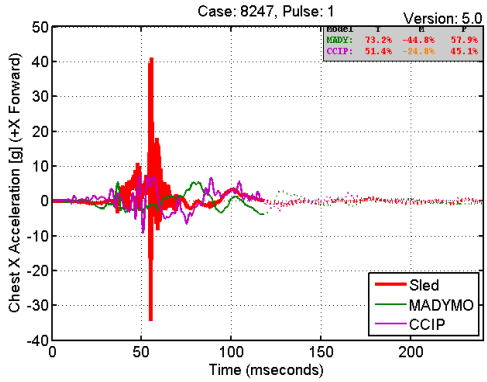
10G 70ms -Y 50% Gap
Figure C-2-357: 8245 Chest X Acceleration



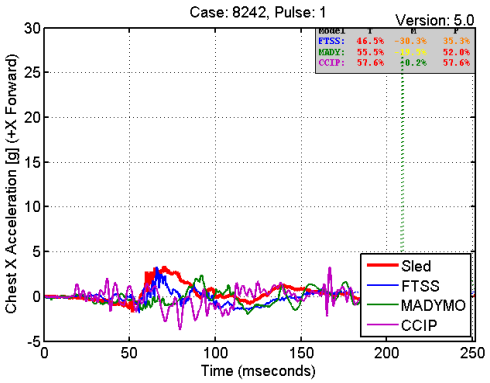
10G 70ms -Y 50% Gap
Figure C-2-358: 8295 Chest X Acceleration



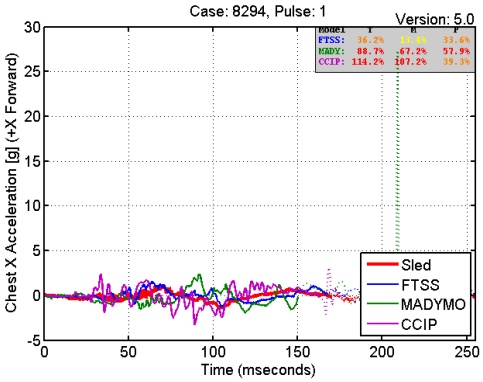
20G 70ms -Y 50% Gap
Figure C-2-359: 8246 Chest X Acceleration



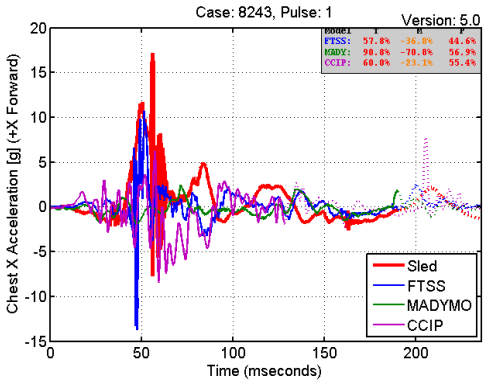
20G 70ms -Y 50% Gap
Figure C-2-360: 8247 Chest X Acceleration



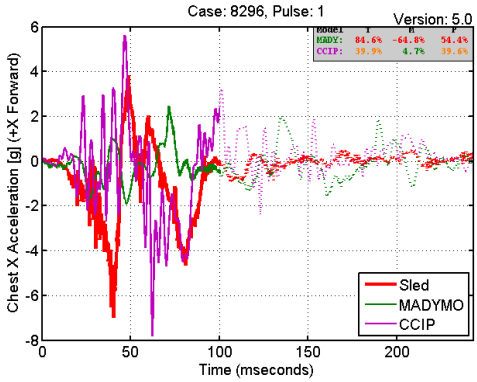
10G 70ms -Y No Gap
Figure C-2-361: 8242 Chest X Acceleration



10G 70ms -Y No Gap
Figure C-2-362: 8294 Chest X Acceleration

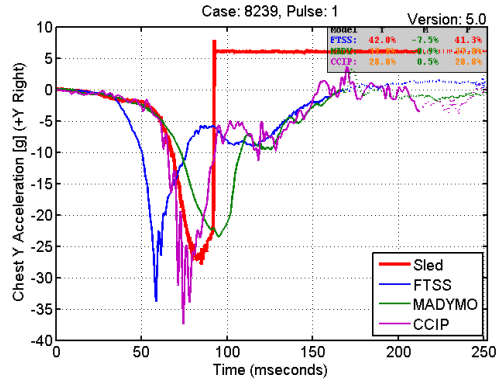


20G 70ms -Y No Gap
Figure C-2-363: 8243 Chest X Acceleration

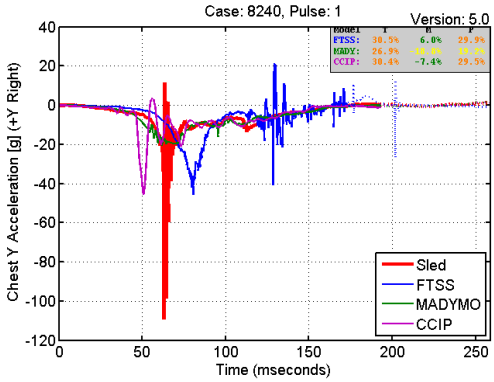


20G 70ms -Y No Gap
Figure C-2-364: 8296 Chest X Acceleration

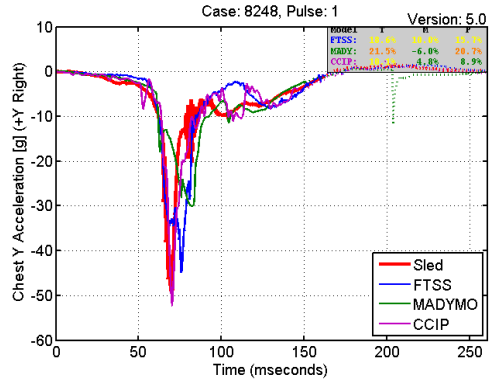
C.2.27 Chest Y Acceleration



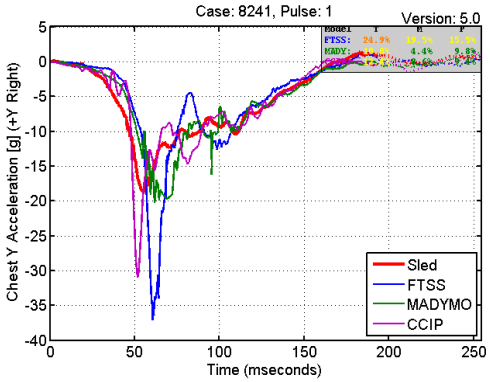
10G 70ms -Y No Side Support
Figure C-2-365: 8239 Chest Y Acceleration



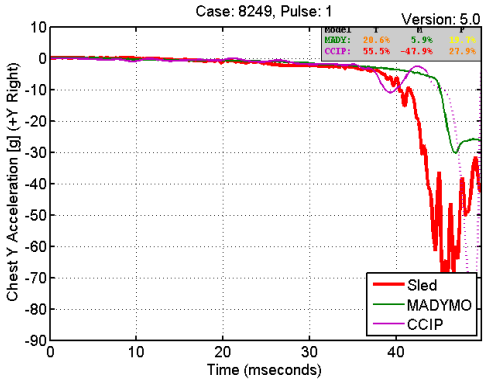
10G 70ms -Y No Head Support
Figure C-2-366: 8240 Chest Y Acceleration



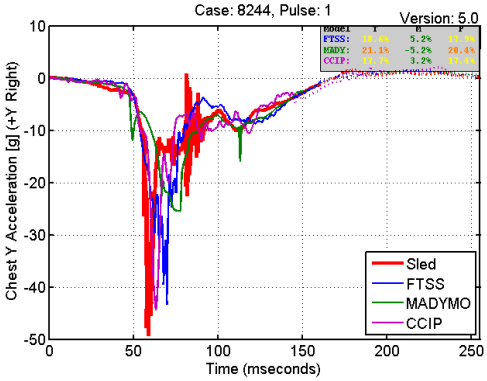
10G 70ms -Y 100% Gap
Figure C-2-367: 8248 Chest Y Acceleration



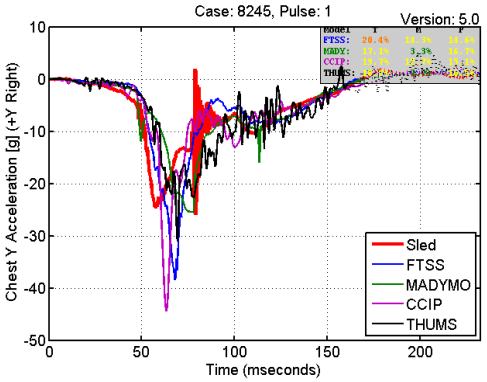
10G 70ms -Y No Head Support
Figure C-2-368: 8241 Chest Y Acceleration



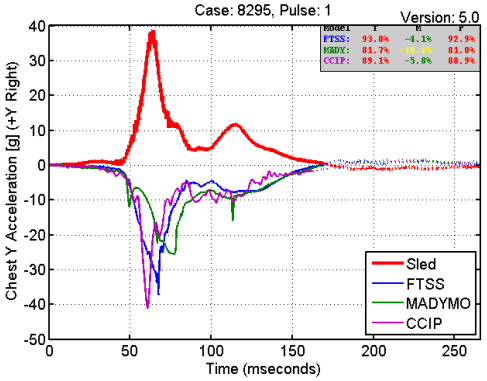
20G 70ms -Y 100% Gap
Figure C-2-369: 8249 Chest Y Acceleration



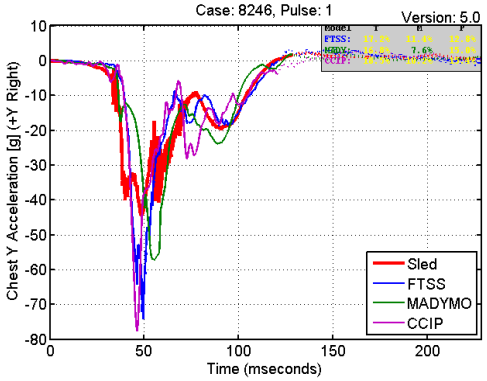
10G 70ms -Y 50% Gap
Figure C-2-370: 8244 Chest Y Acceleration



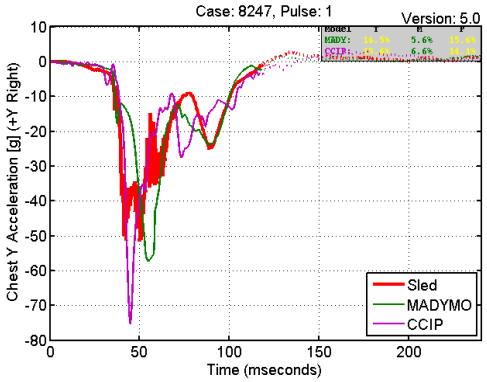
10G 70ms -Y 50% Gap
Figure C-2-371: 8245 Chest Y Acceleration



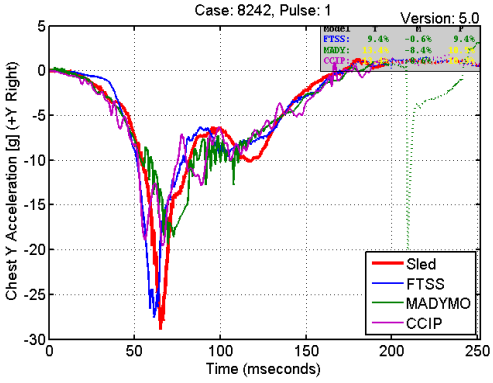
10G 70ms -Y 50% Gap
Figure C-2-372: 8295 Chest Y Acceleration



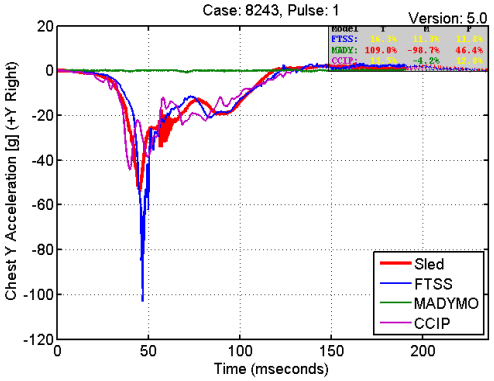
20G 70ms -Y 50% Gap
Figure C-2-373: 8246 Chest Y Acceleration



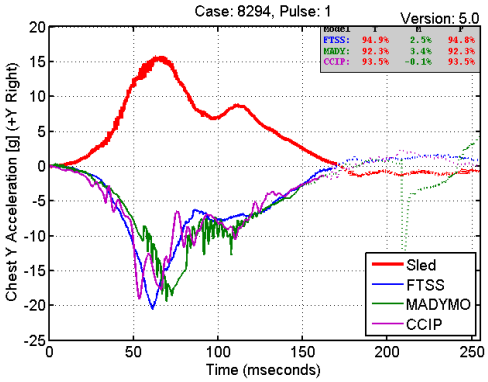
20G 70ms -Y 50% Gap
Figure C-2-374: 8247 Chest Y Acceleration



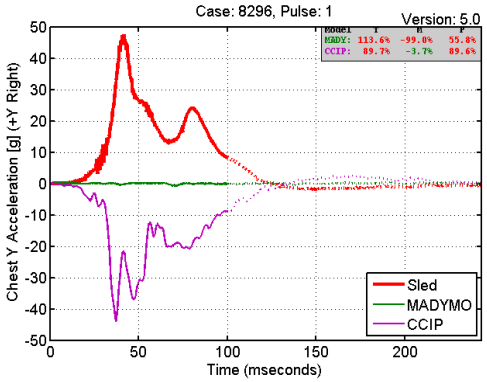
10G 70ms -Y No Gap
Figure C-2-375: 8242 Chest Y Acceleration



20G 70ms -Y No Gap
Figure C-2-377: 8243 Chest Y Acceleration

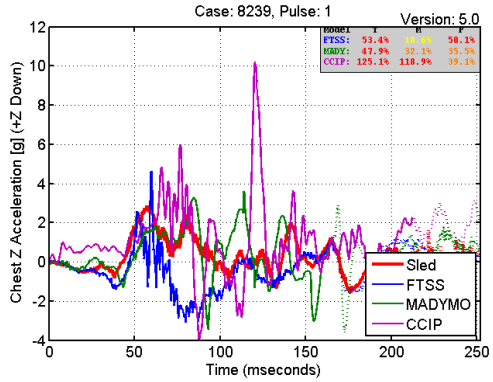


10G 70ms -Y No Gap
Figure C-2-376: 8294 Chest Y Acceleration

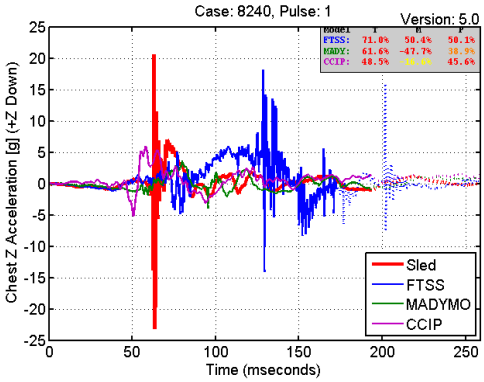


20G 70ms -Y No Gap
Figure C-2-378: 8296 Chest Y Acceleration

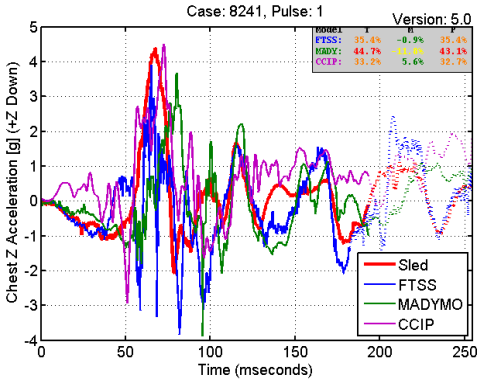
C.2.28 Chest Z Acceleration



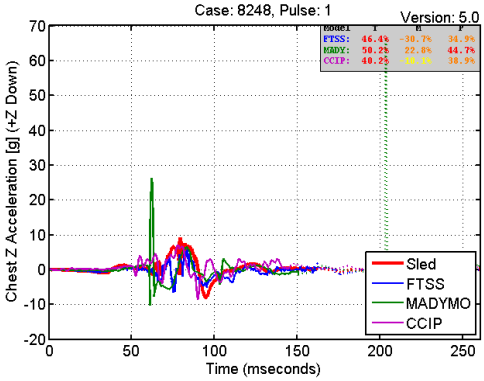
10G 70ms -Y No Side Support
Figure C-2-379: 8239 Chest Z Acceleration



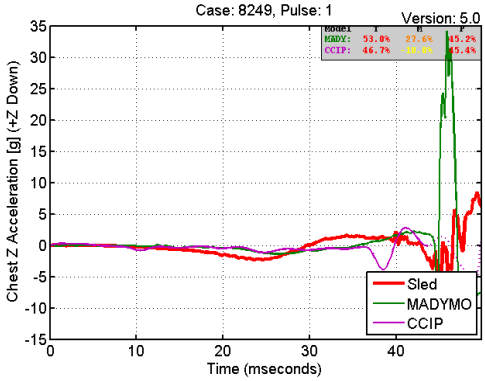
10G 70ms -Y No Head Support
Figure C-2-380: 8240 Chest Z Acceleration



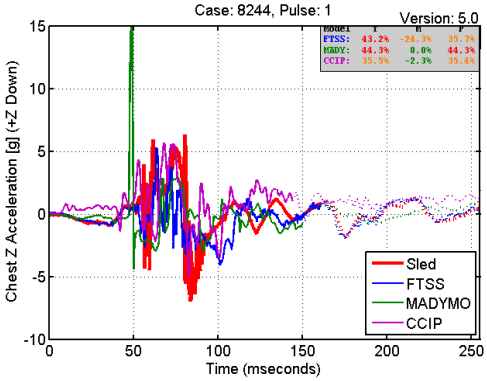
10G 70ms -Y No Head Support
Figure C-2-382: 8241 Chest Z Acceleration



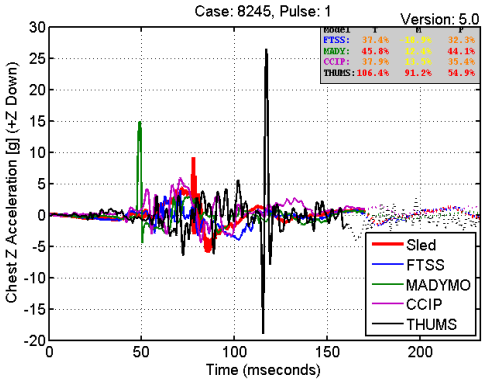
10G 70ms -Y 100% Gap
Figure C-2-381: 8248 Chest Z Acceleration



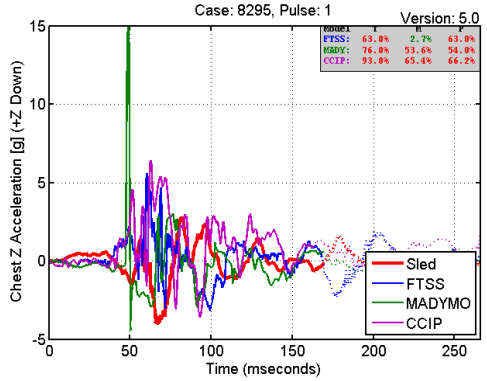
20G 70ms -Y 100% Gap
Figure C-2-383: 8249 Chest Z Acceleration



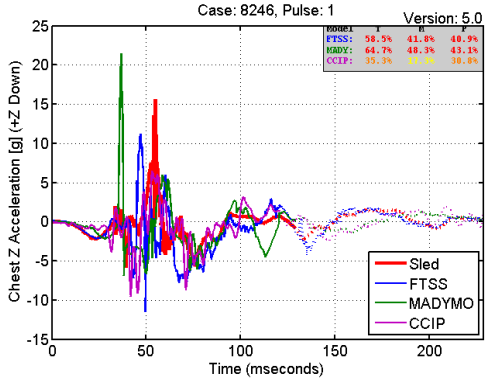
10G 70ms -Y 50% Gap
Figure C-2-384: 8244 Chest Z Acceleration



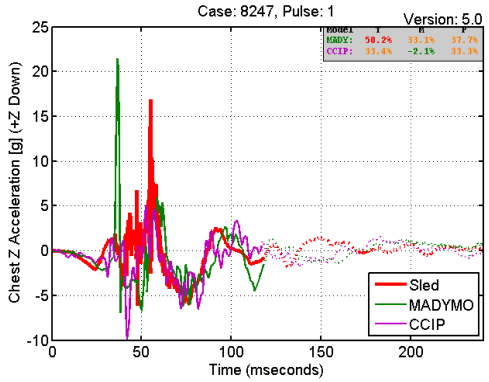
10G 70ms -Y 50% Gap
Figure C-2-385: 8245 Chest Z Acceleration



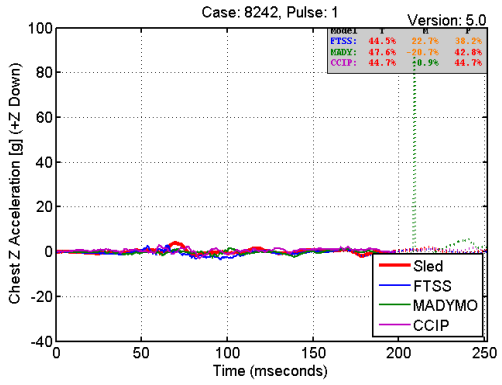
10G 70ms -Y 50% Gap
Figure C-2-386: 8295 Chest Z Acceleration



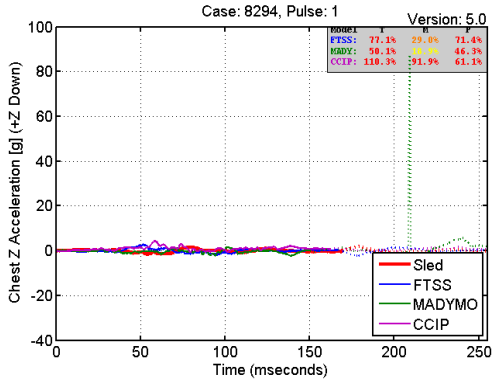
20G 70ms -Y 50% Gap
Figure C-2-387: 8246 Chest Z Acceleration



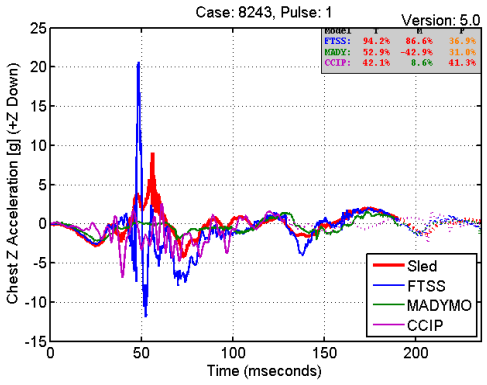
20G 70ms -Y 50% Gap
Figure C-2-388: 8247 Chest Z Acceleration



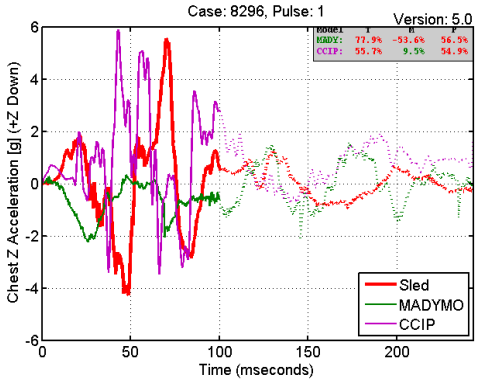
10G 70ms -Y No Gap
Figure C-2-389: 8242 Chest Z Acceleration



10G 70ms -Y No Gap
Figure C-2-390: 8294 Chest Z Acceleration

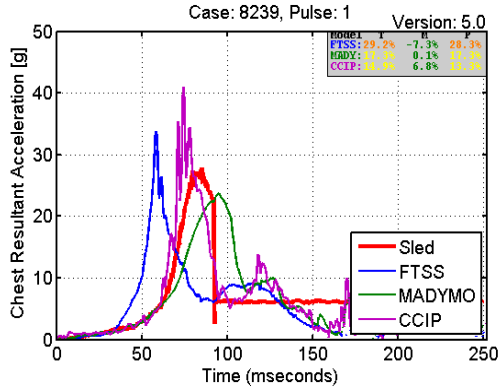


20G 70ms -Y No Gap
Figure C-2-391: 8243 Chest Z Acceleration

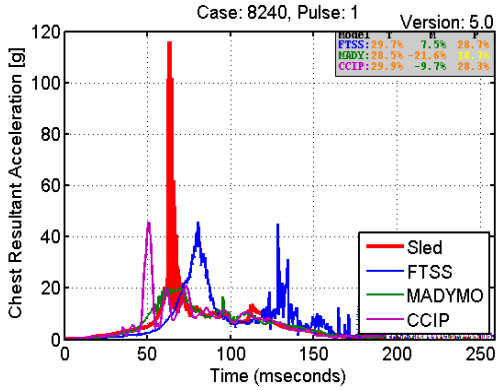


20G 70ms -Y No Gap
Figure C-2-392: 8296 Chest Z Acceleration

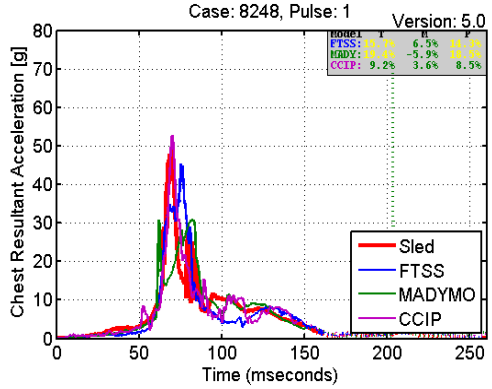
C.2.29 Chest Resultant Acceleration



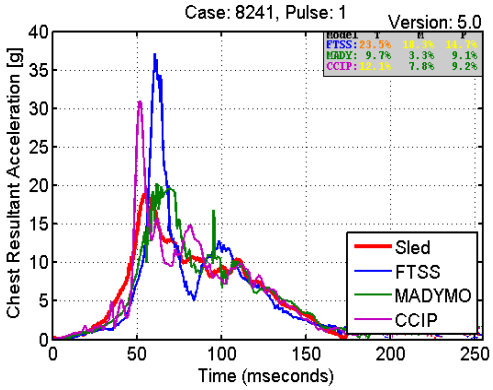
10G 70ms -Y No Side Support
Figure C-2-393: 8239 Chest Resultant Acceleration



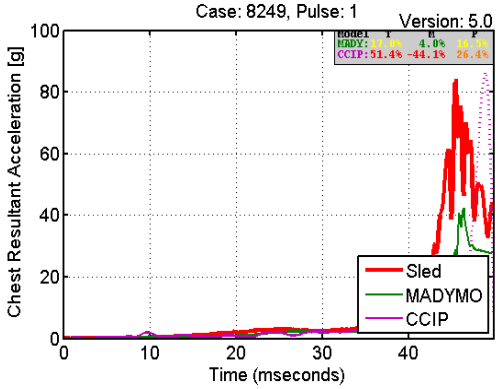
10G 70ms -Y No Head Support
Figure C-2-394: 8240 Chest Resultant Acceleration



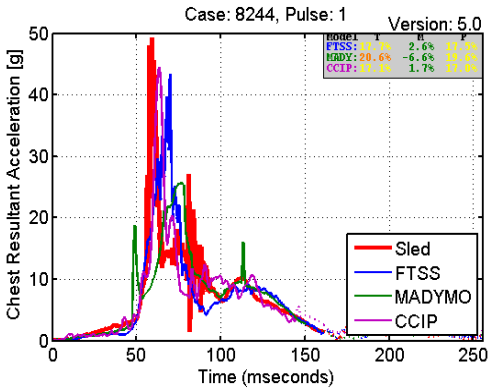
10G 70ms -Y 100% Gap
Figure C-2-395: 8248 Chest Resultant Acceleration



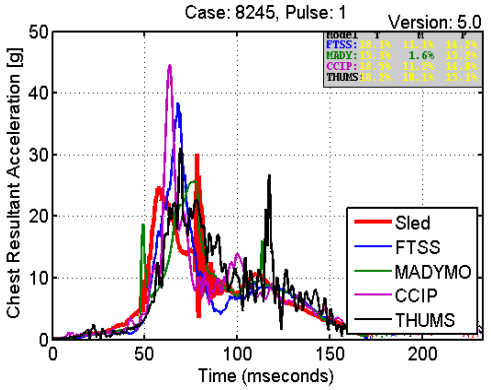
10G 70ms -Y No Head Support
Figure C-2-396: 8241 Chest Resultant Acceleration



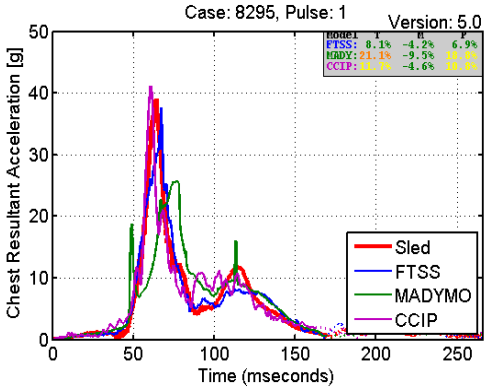
20G 70ms -Y 100% Gap
Figure C-2-397: 8249 Chest Resultant Acceleration



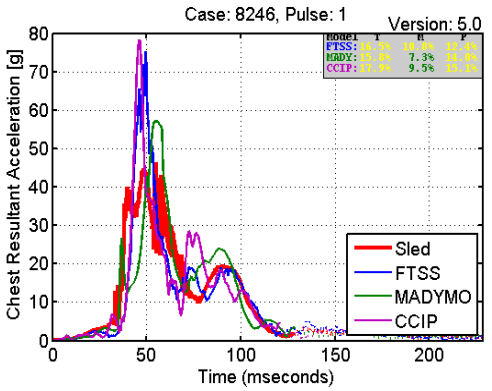
10G 70ms -Y 50% Gap
Figure C-2-398: 8244 Chest Resultant Acceleration



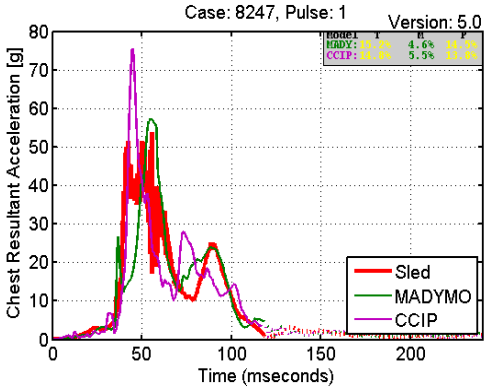
10G 70ms -Y 50% Gap
Figure C-2-399: 8245 Chest Resultant Acceleration



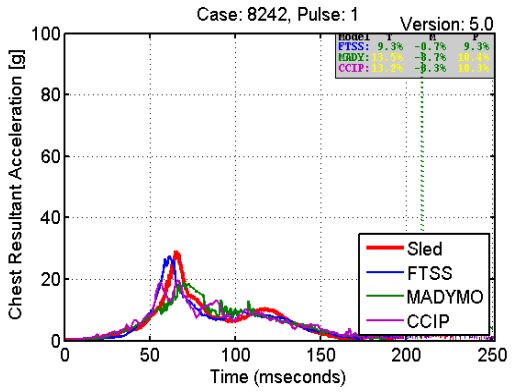
10G 70ms -Y 50% Gap
Figure C-2-400: 8295 Chest Resultant Acceleration



20G 70ms -Y 50% Gap
Figure C-2-401: 8246 Chest Resultant Acceleration

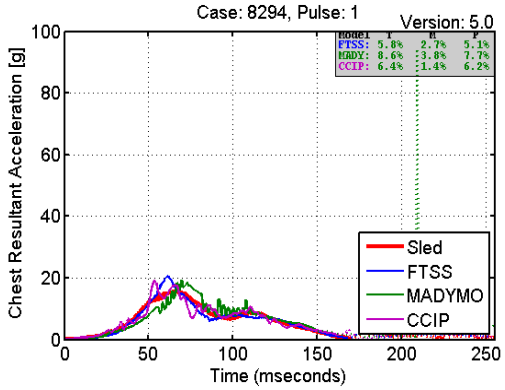


20G 70ms -Y 50% Gap
Figure C-2-402: 8247 Chest Resultant Acceleration



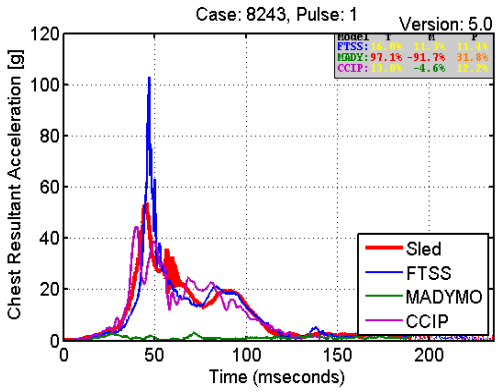
10G 70ms -Y No Gap

Figure C-2-403: 8242 Chest Resultant Acceleration



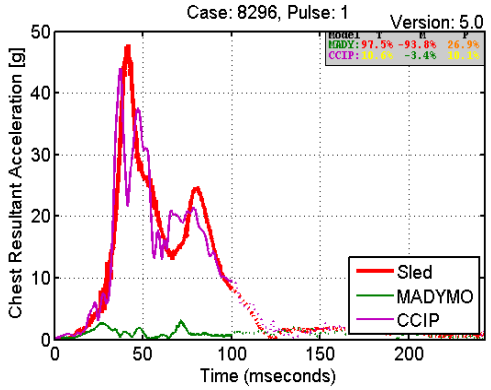
10G 70ms -Y No Gap

Figure C-2-404: 8294 Chest Resultant Acceleration



20G 70ms -Y No Gap

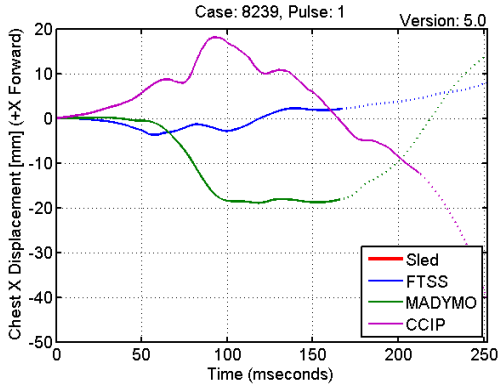
Figure C-2-405: 8243 Chest Resultant Acceleration



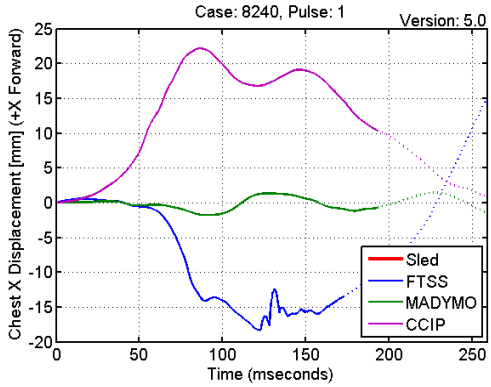
20G 70ms -Y No Gap

Figure C-2-406: 8296 Chest Resultant Acceleration

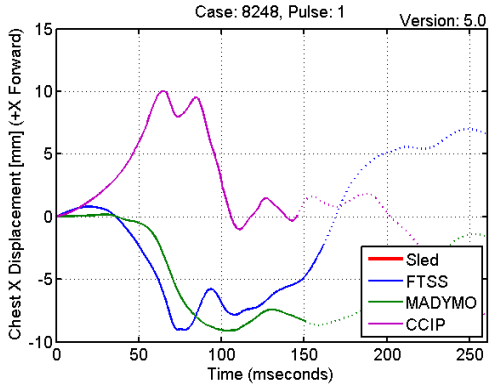
C.2.30 Chest X Movement



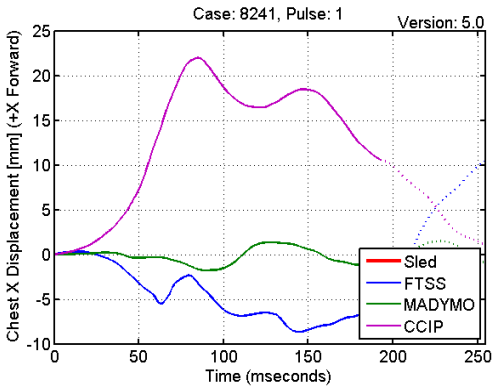
10G 70ms -Y No Side Support
Figure C-2-407: 8239 Chest X Movement



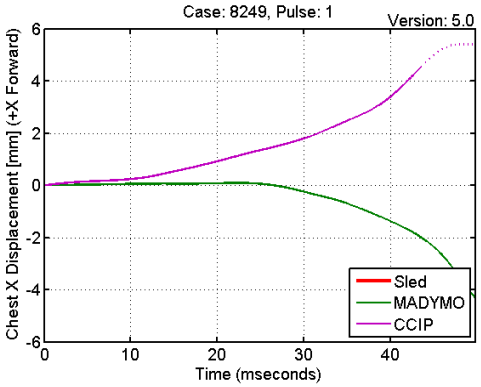
10G 70ms -Y No Head Support
Figure C-2-408: 8240 Chest X Movement



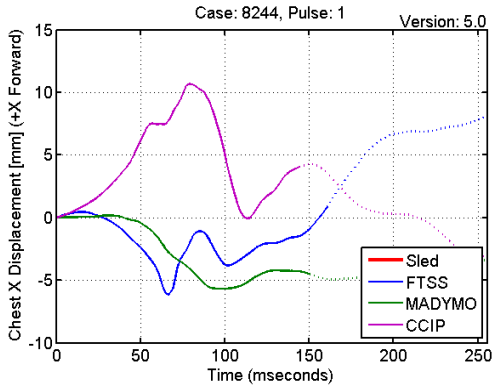
10G 70ms -Y 100% Gap
Figure C-2-409: 8248 Chest X Movement



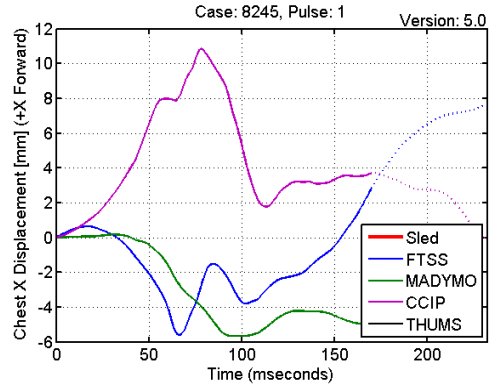
10G 70ms -Y No Head Support
Figure C-2-410: 8241 Chest X Movement



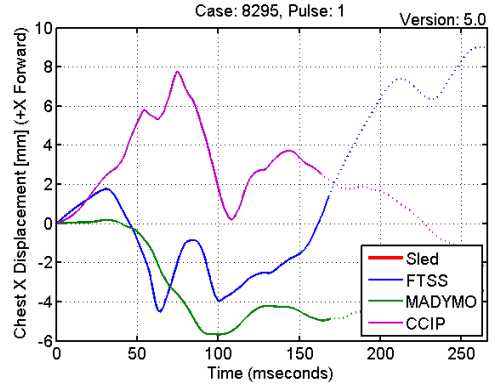
20G 70ms -Y 100% Gap
Figure C-2-411: 8249 Chest X Movement



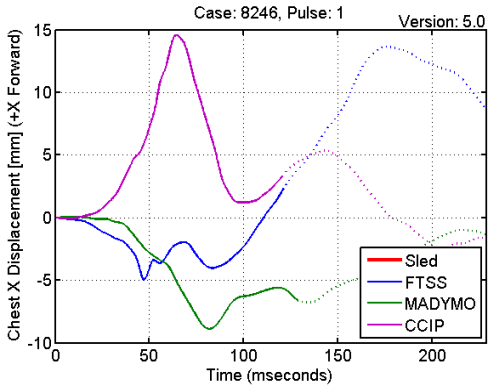
10G 70ms -Y 50% Gap
Figure C-2-412: 8244 Chest X Movement



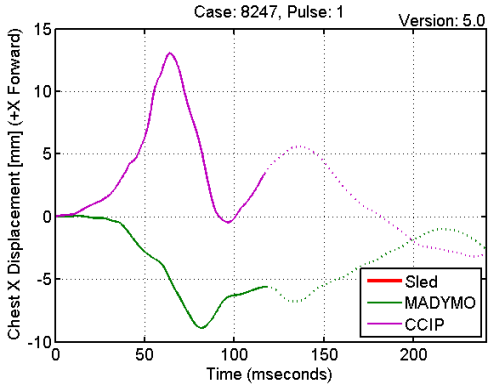
10G 70ms -Y 50% Gap
Figure C-2-413: 8245 Chest X Movement



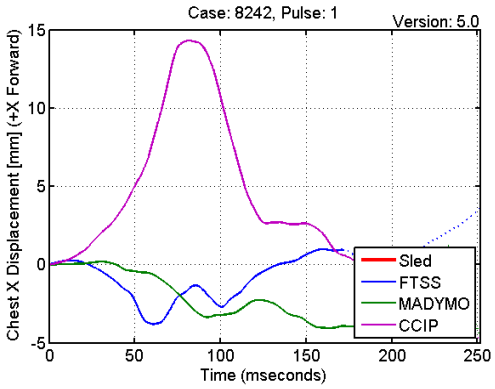
10G 70ms -Y 50% Gap
Figure C-2-414: 8295 Chest X Movement



20G 70ms -Y 50% Gap
Figure C-2-415: 8246 Chest X Movement

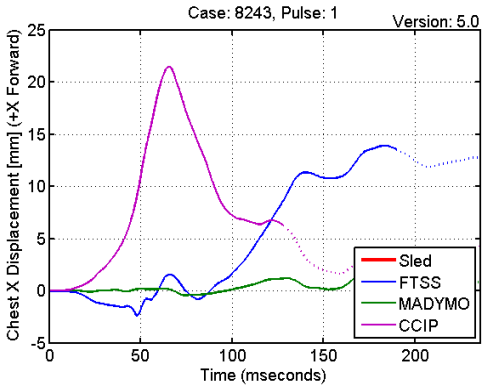


20G 70ms -Y 50% Gap
Figure C-2-416: 8247 Chest X Movement



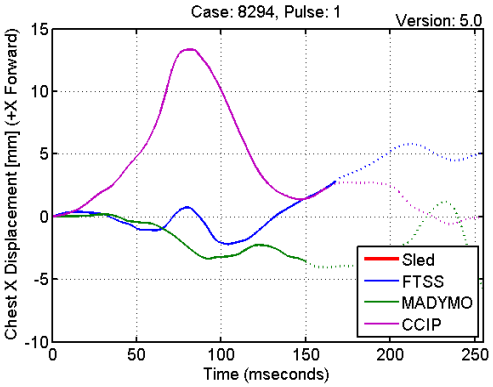
10G 70ms -Y No Gap

Figure C-2-417: 8242 Chest X Movement



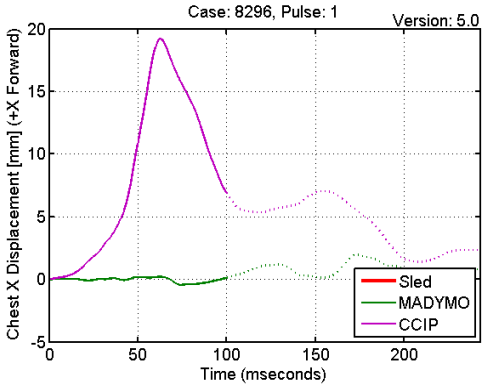
20G 70ms -Y No Gap

Figure C-2-419: 8243 Chest X Movement



10G 70ms -Y No Gap

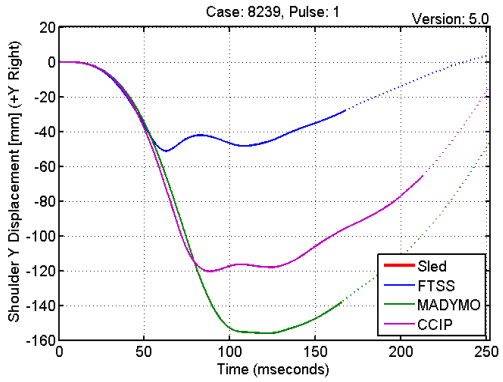
Figure C-2-418: 8294 Chest X Movement



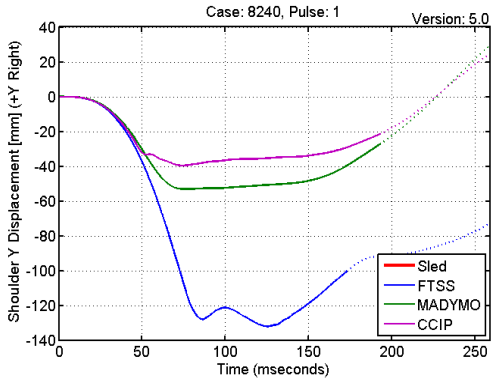
20G 70ms -Y No Gap

Figure C-2-420: 8296 Chest X Movement

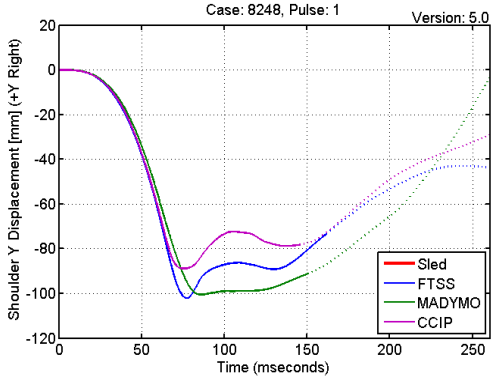
C.2.31 Shoulder Y Movement



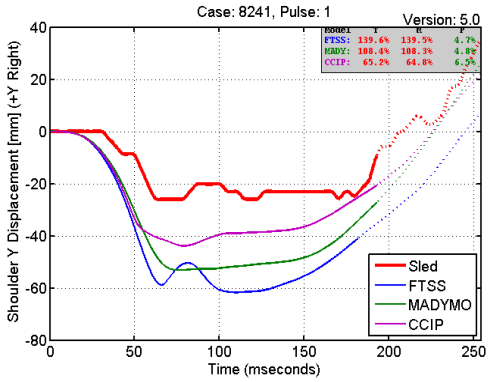
10G 70ms -Y No Side Support
Figure C-2-421: 8239 Shoulder Y Movement



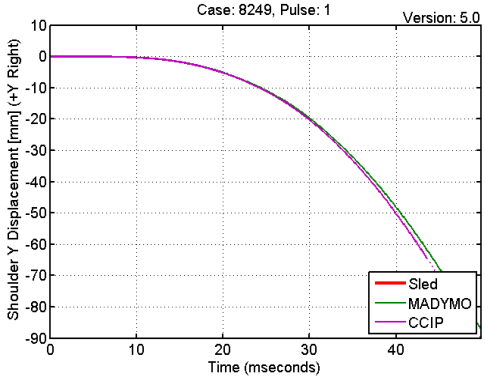
10G 70ms -Y No Head Support
Figure C-2-422: 8240 Shoulder Y Movement



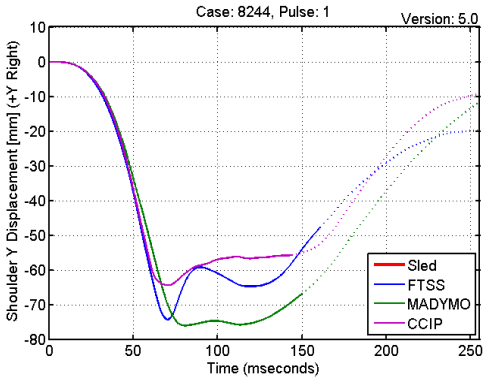
10G 70ms -Y 100% Gap
Figure C-2-423: 8248 Shoulder Y Movement



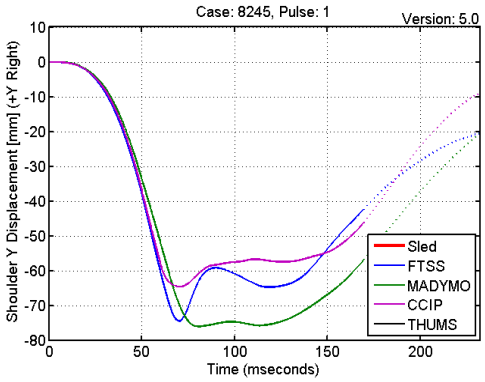
10G 70ms -Y No Head Support
Figure C-2-424: 8241 Shoulder Y Movement



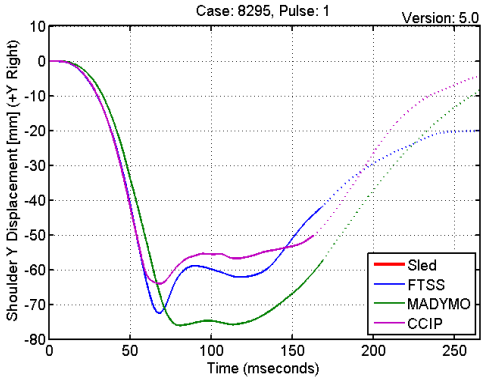
20G 70ms -Y 100% Gap
Figure C-2-425: 8249 Shoulder Y Movement



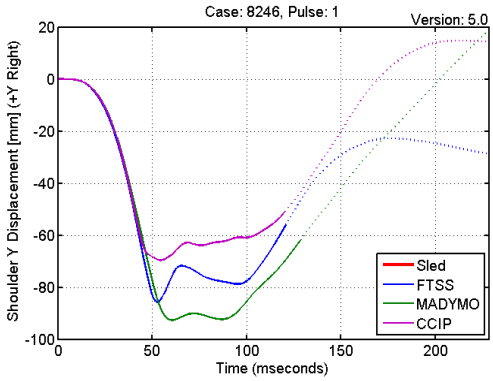
10G 70ms -Y 50% Gap
Figure C-2-426: 8244 Shoulder Y Movement



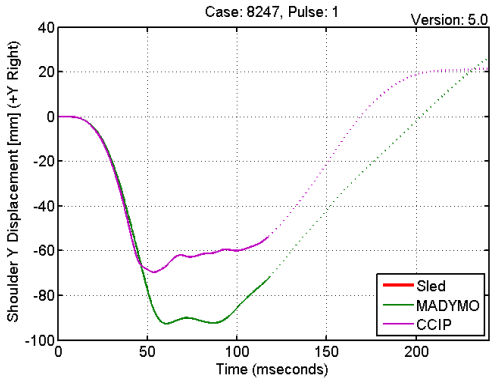
10G 70ms -Y 50% Gap
Figure C-2-427: 8245 Shoulder Y Movement



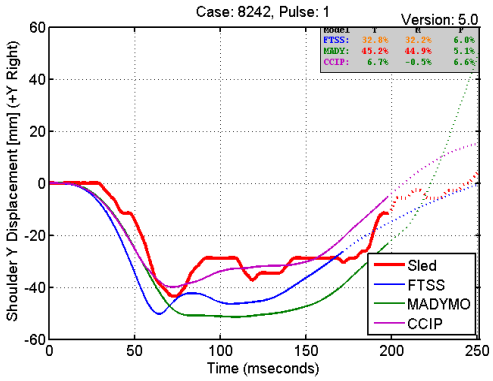
10G 70ms -Y 50% Gap
Figure C-2-428: 8295 Shoulder Y Movement



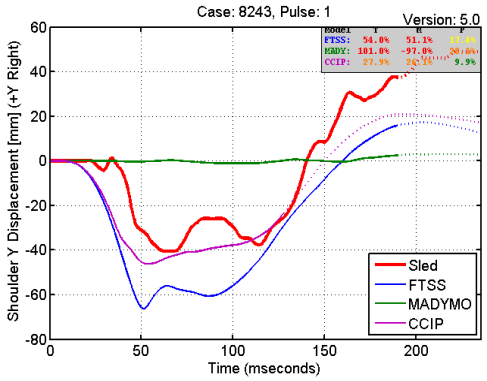
20G 70ms -Y 50% Gap
Figure C-2-429: 8246 Shoulder Y Movement



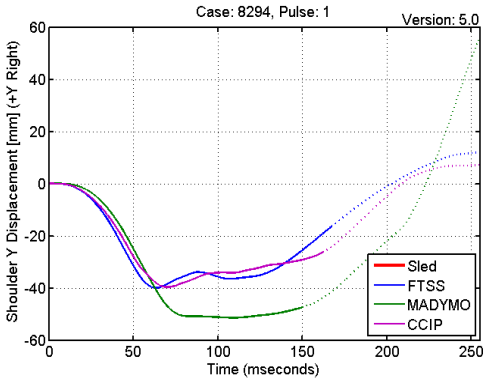
20G 70ms -Y 50% Gap
Figure C-2-430: 8247 Shoulder Y Movement



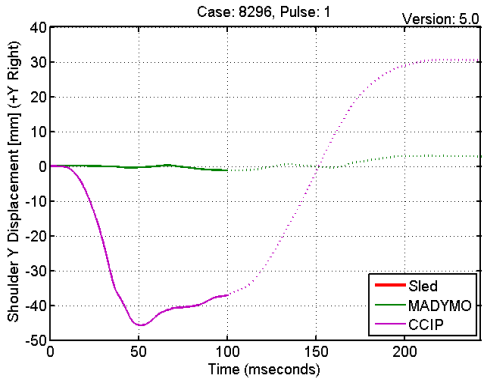
10G 70ms -Y No Gap
Figure C-2-431: 8242 Shoulder Y Movement



20G 70ms -Y No Gap
Figure C-2-433: 8243 Shoulder Y Movement

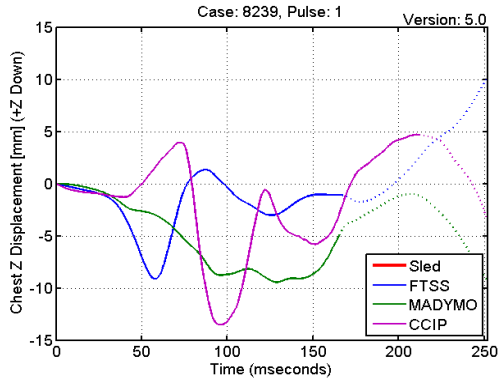


10G 70ms -Y No Gap
Figure C-2-432: 8294 Shoulder Y Movement

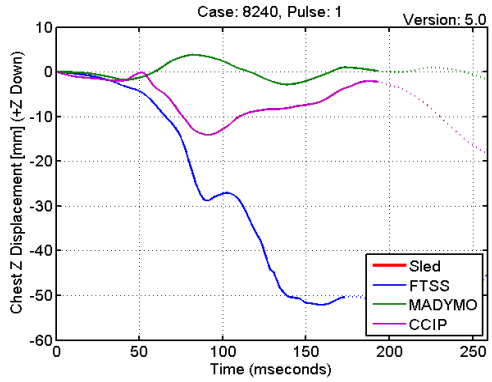


20G 70ms -Y No Gap
Figure C-2-434: 8296 Shoulder Y Movement

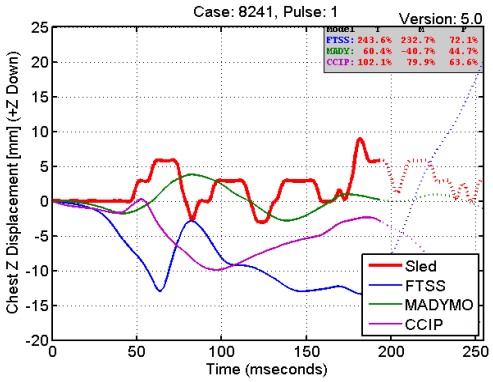
C.2.32 Chest Z Movement



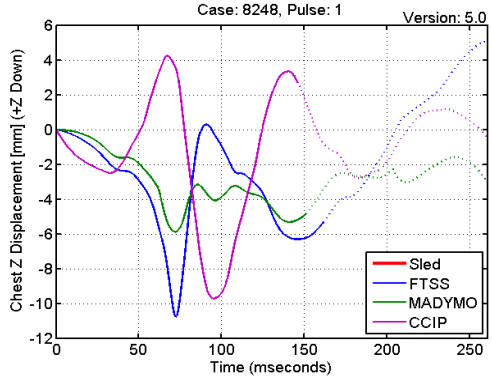
10G 70ms -Y No Side Support
Figure C-2-435: 8239 Chest Z Movement



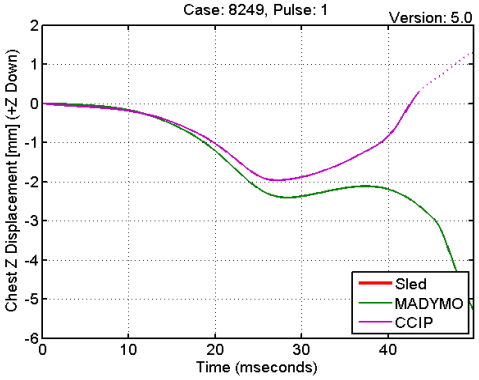
10G 70ms -Y No Head Support
Figure C-2-436: 8240 Chest Z Movement



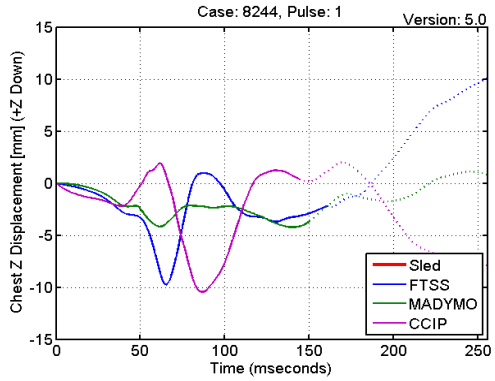
10G 70ms -Y No Head Support
Figure C-2-438: 8241 Chest Z Movement



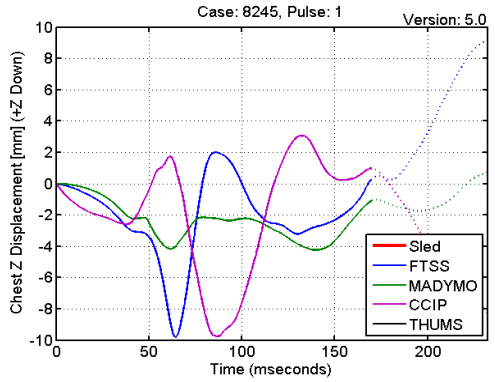
10G 70ms -Y 100% Gap
Figure C-2-437: 8248 Chest Z Movement



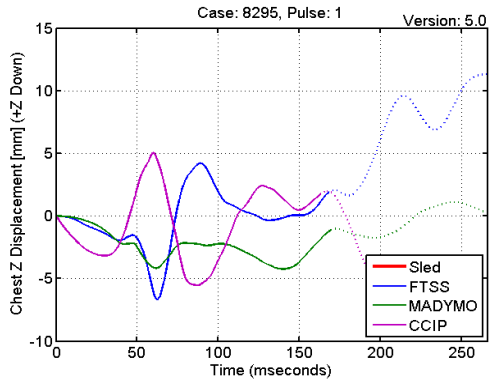
20G 70ms -Y 100% Gap
Figure C-2-439: 8249 Chest Z Movement



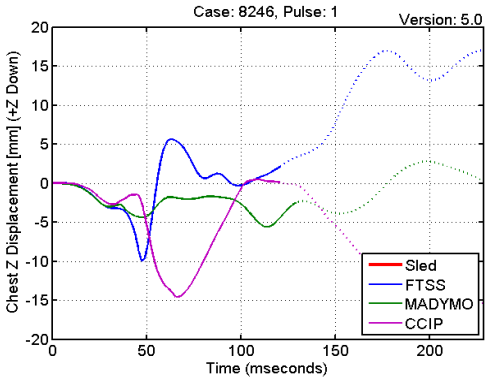
10G 70ms -Y 50% Gap
Figure C-2-440: 8244 Chest Z Movement



10G 70ms -Y 50% Gap
Figure C-2-441: 8245 Chest Z Movement

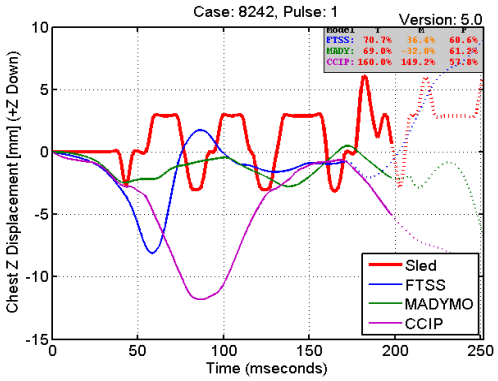


10G 70ms -Y 50% Gap
Figure C-2-442: 8295 Chest Z Movement

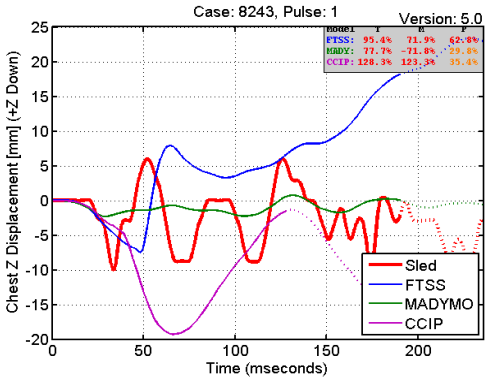


20G 70ms -Y 50% Gap
Figure C-2-443: 8246 Chest Z Movement

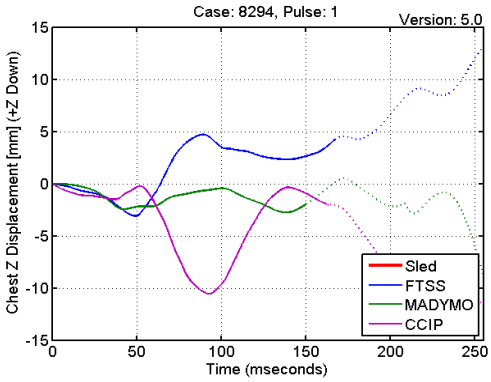
20G 70ms -Y 50% Gap
Figure C-2-444: 8247 Chest Z Movement



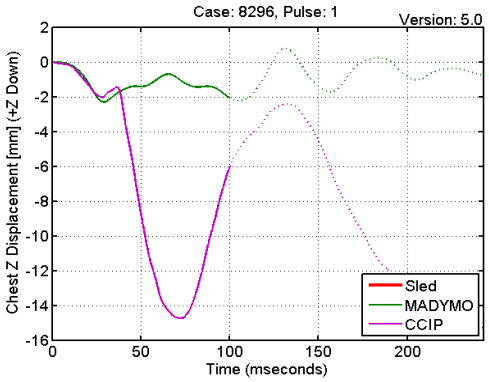
10G 70ms -Y No Gap
Figure C-2-445: 8242 Chest Z Movement



20G 70ms -Y No Gap
Figure C-2-447: 8243 Chest Z Movement

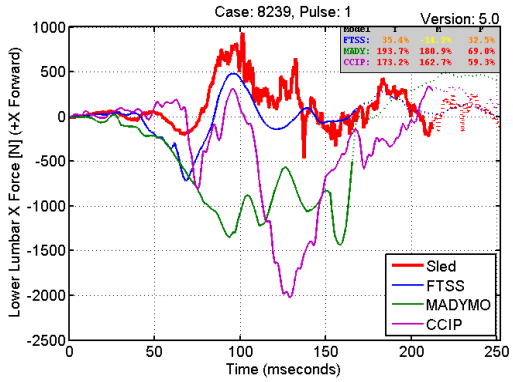


10G 70ms -Y No Gap
Figure C-2-446: 8294 Chest Z Movement

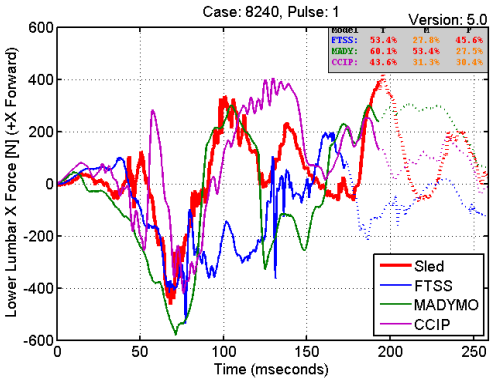


20G 70ms -Y No Gap
Figure C-2-448: 8296 Chest Z Movement

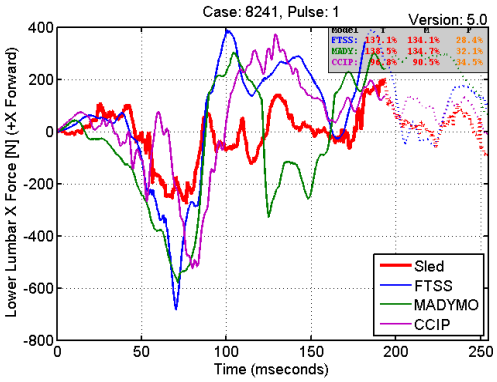
C.2.33 Lumbar X Force



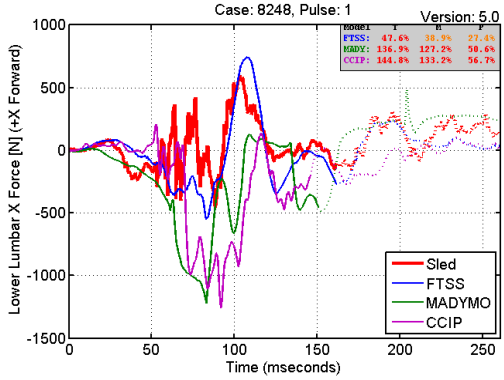
10G 70ms -Y No Side Support
Figure C-2-449: 8239 Lumbar X Force



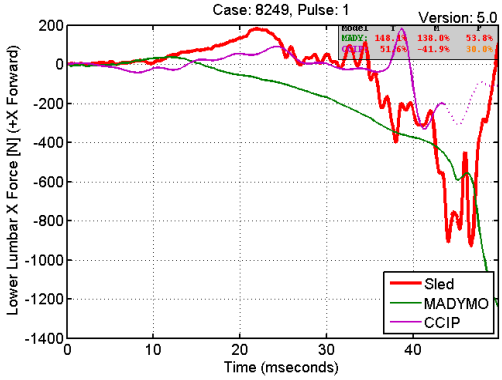
10G 70ms -Y No Head Support
Figure C-2-450: 8240 Lumbar X Force



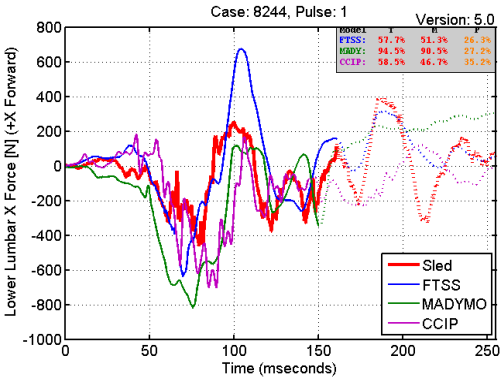
10G 70ms -Y No Head Support
Figure C-2-452: 8241 Lumbar X Force



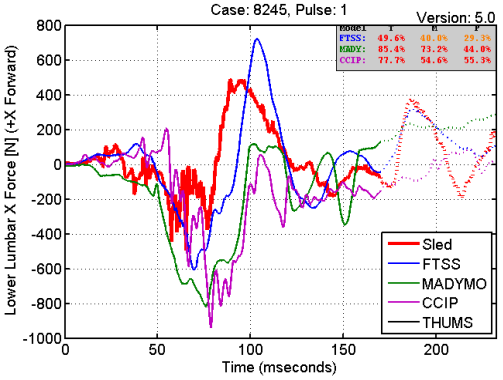
10G 70ms -Y 100% Gap
Figure C-2-451: 8248 Lumbar X Force



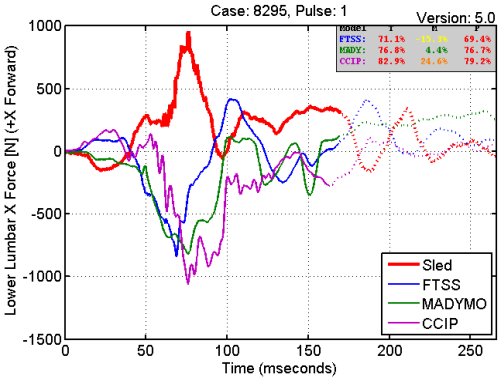
20G 70ms -Y 100% Gap
Figure C-2-453: 8249 Lumbar X Force



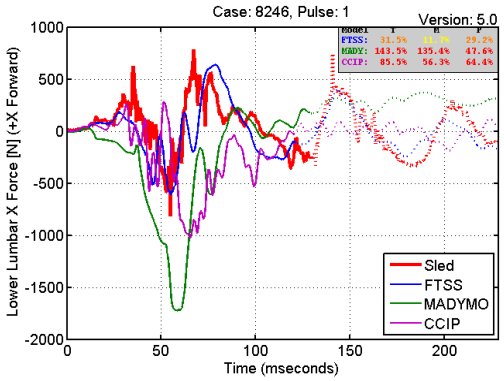
10G 70ms -Y 50% Gap
Figure C-2-454: 8244 Lumbar X Force



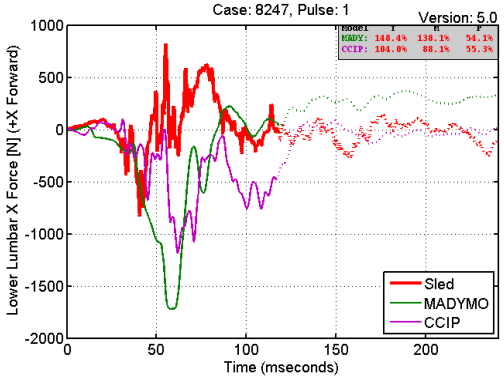
10G 70ms -Y 50% Gap
Figure C-2-455: 8245 Lumbar X Force



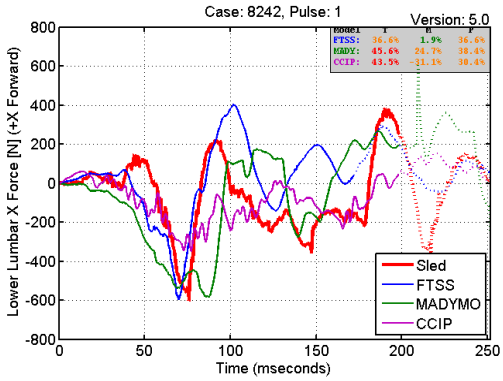
10G 70ms -Y 50% Gap
Figure C-2-456: 8295 Lumbar X Force



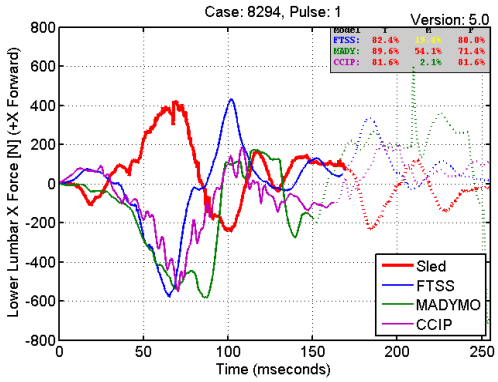
20G 70ms -Y 50% Gap
Figure C-2-457: 8246 Lumbar X Force



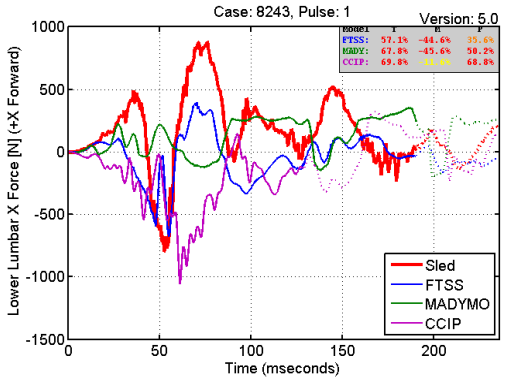
20G 70ms -Y 50% Gap
Figure C-2-458: 8247 Lumbar X Force



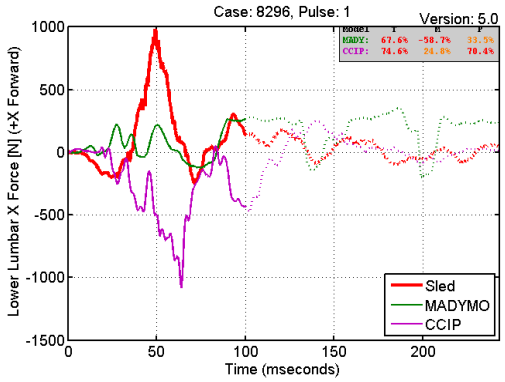
10G 70ms -Y No Gap
Figure C-2-459: 8242 Lumbar X Force



10G 70ms -Y No Gap
Figure C-2-460: 8294 Lumbar X Force

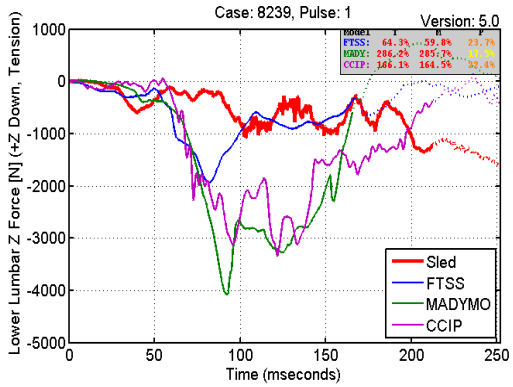


20G 70ms -Y No Gap
Figure C-2-461: 8243 Lumbar X Force

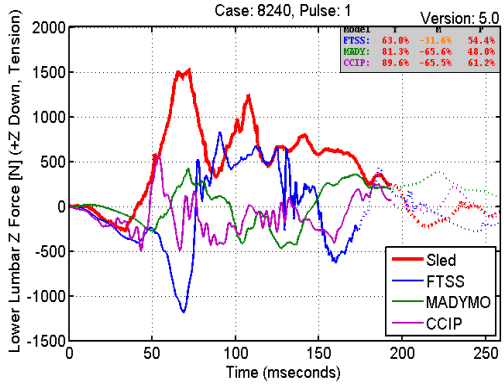


20G 70ms -Y No Gap
Figure C-2-462: 8296 Lumbar X Force

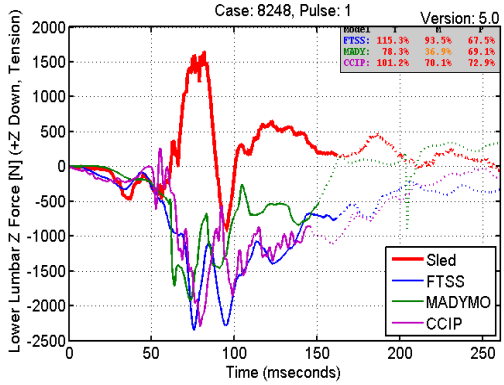
C.2.34 Lumbar Z Force



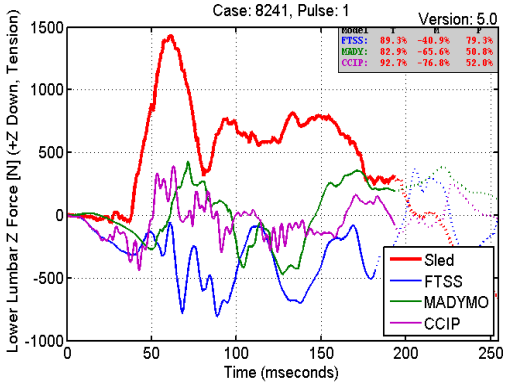
10G 70ms -Y No Side Support
Figure C-2-463: 8239 Lumbar Z Force



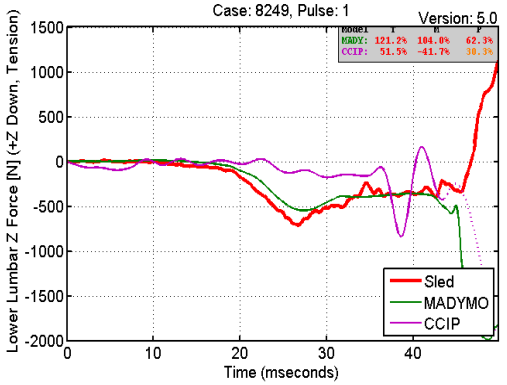
10G 70ms -Y No Head Support
Figure C-2-464: 8240 Lumbar Z Force



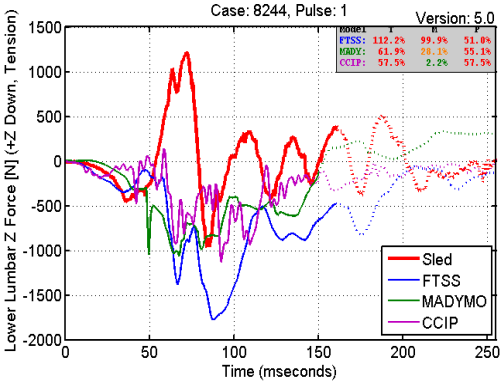
10G 70ms -Y 100% Gap
Figure C-2-465: 8248 Lumbar Z Force



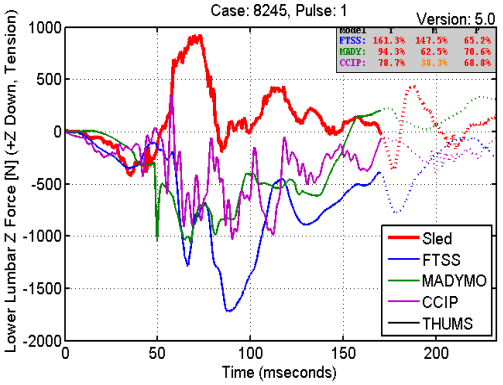
10G 70ms -Y No Head Support
Figure C-2-466: 8241 Lumbar Z Force



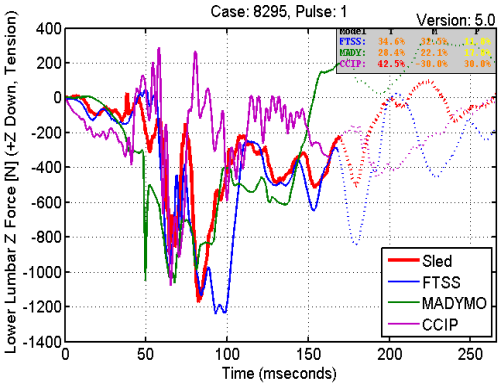
20G 70ms -Y 100% Gap
Figure C-2-467: 8249 Lumbar Z Force



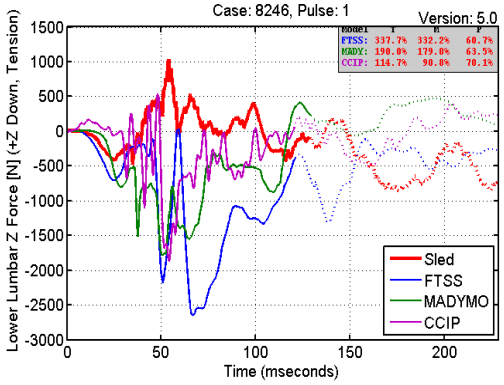
10G 70ms -Y 50% Gap
Figure C-2-468: 8244 Lumbar Z Force



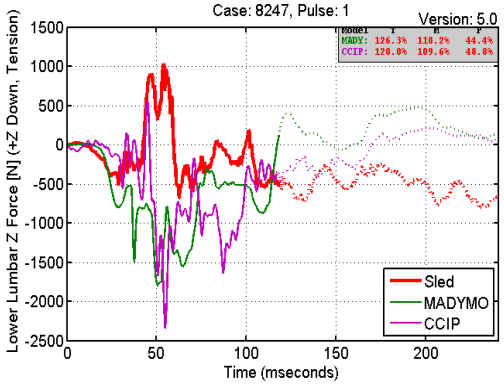
10G 70ms -Y 50% Gap
Figure C-2-469: 8245 Lumbar Z Force



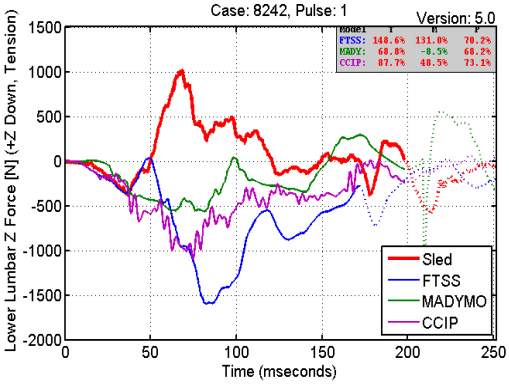
10G 70ms -Y 50% Gap
Figure C-2-470: 8295 Lumbar Z Force



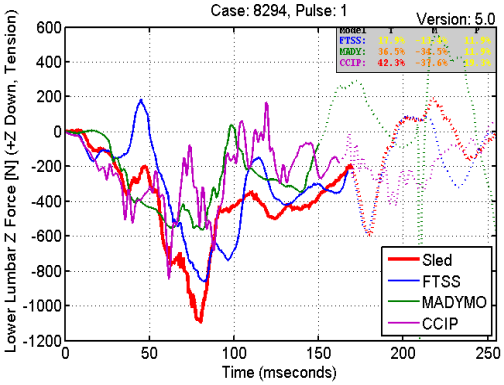
20G 70ms -Y 50% Gap
Figure C-2-471: 8246 Lumbar Z Force



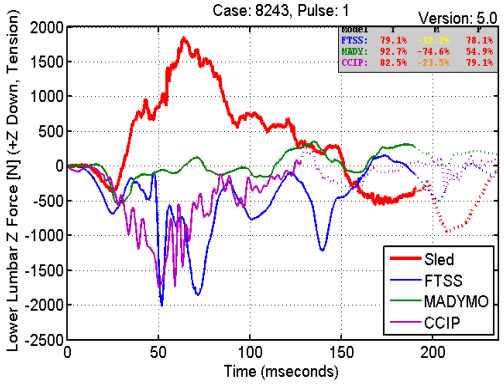
20G 70ms -Y 50% Gap
Figure C-2-472: 8247 Lumbar Z Force



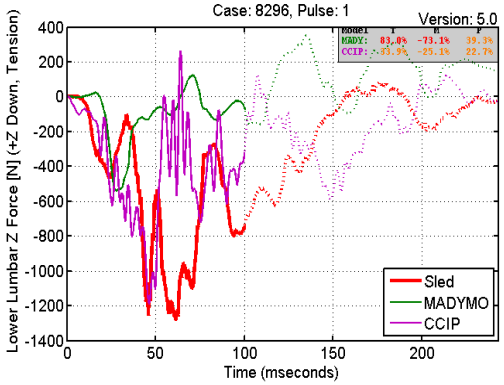
10G 70ms -Y No Gap
Figure C-2-473: 8242 Lumbar Z Force



10G 70ms -Y No Gap
Figure C-2-474: 8294 Lumbar Z Force

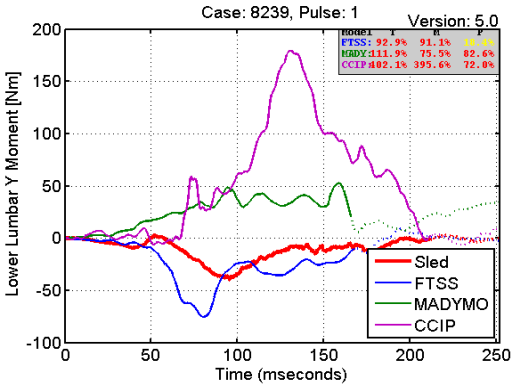


20G 70ms -Y No Gap
Figure C-2-475: 8243 Lumbar Z Force

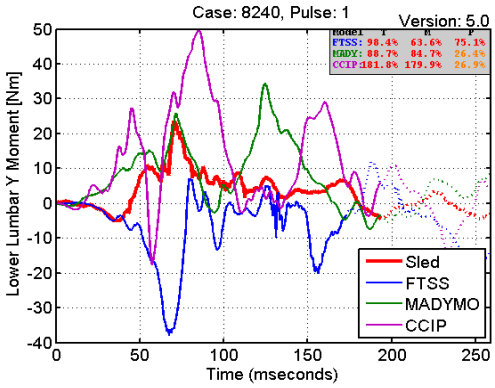


20G 70ms -Y No Gap
Figure C-2-476: 8296 Lumbar Z Force

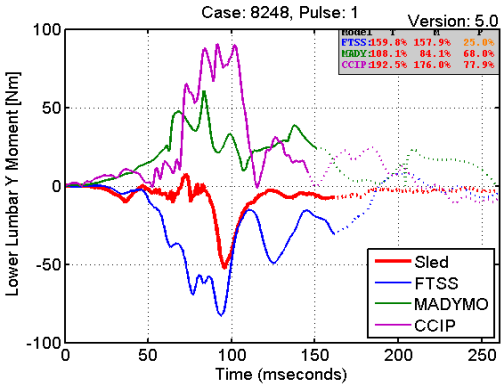
C.2.35 Lumbar Y Moment



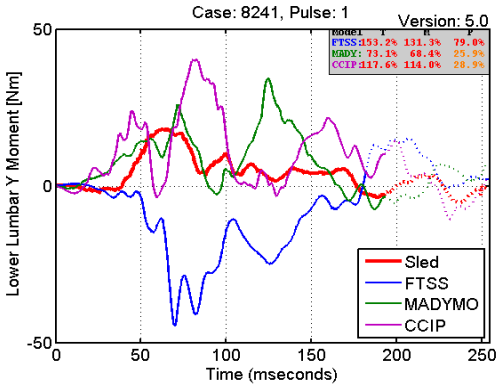
10G 70ms -Y No Side Support
Figure C-2-477: 8239 Lumbar Y Moment



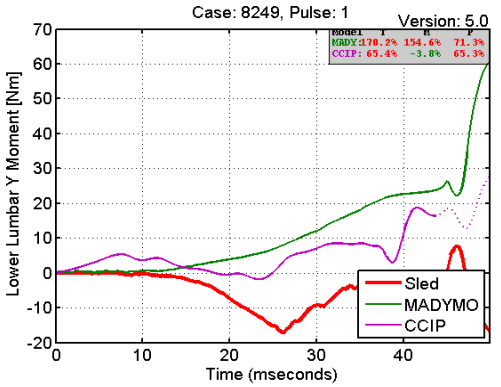
10G 70ms -Y No Head Support
Figure C-2-478: 8240 Lumbar Y Moment



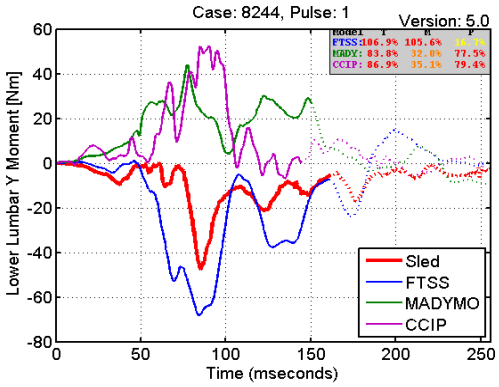
10G 70ms -Y 100% Gap
Figure C-2-479: 8248 Lumbar Y Moment



10G 70ms -Y No Head Support
Figure C-2-480: 8241 Lumbar Y Moment

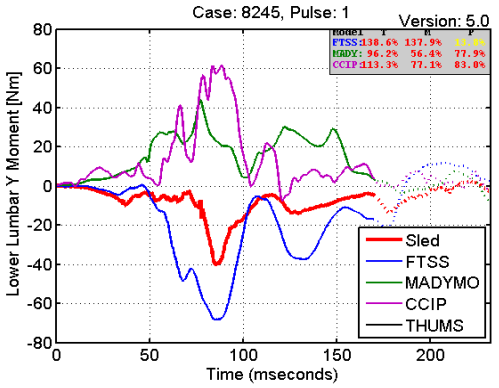


20G 70ms -Y 100% Gap
Figure C-2-481: 8249 Lumbar Y Moment



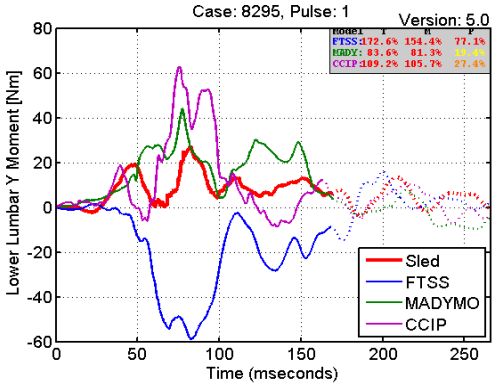
10G 70ms -Y 50% Gap

Figure C-2-482: 8244 Lumbar Y Moment



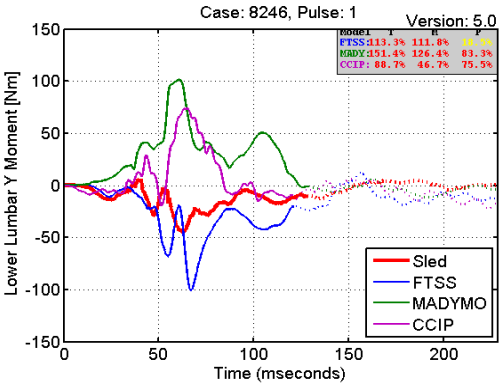
10G 70ms -Y 50% Gap

Figure C-2-483: 8245 Lumbar Y Moment



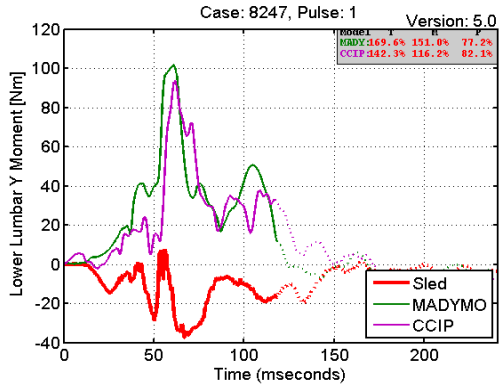
10G 70ms -Y 50% Gap

Figure C-2-484: 8295 Lumbar Y Moment



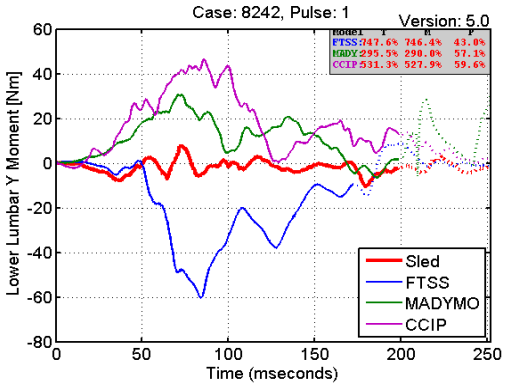
20G 70ms -Y 50% Gap

Figure C-2-485: 8246 Lumbar Y Moment



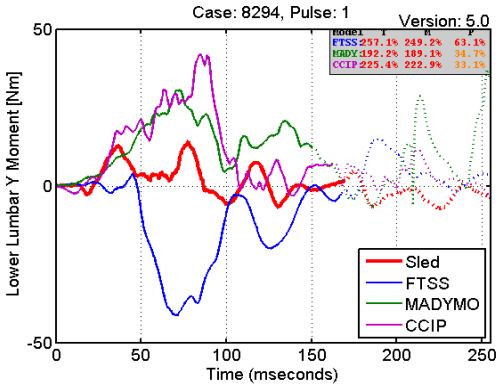
20G 70ms -Y 50% Gap

Figure C-2-486: 8247 Lumbar Y Moment



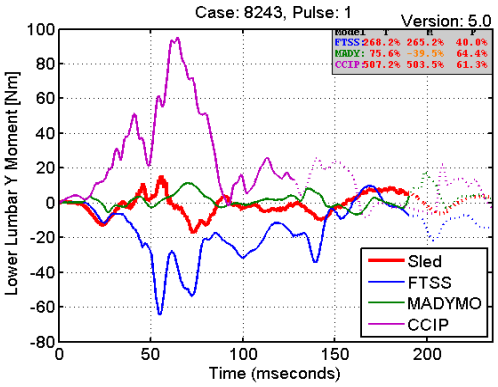
10G 70ms -Y No Gap

Figure C-2-487: 8242 Lumbar Y Moment



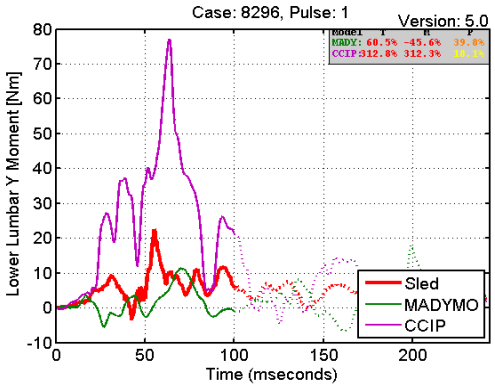
10G 70ms -Y No Gap

Figure C-2-488: 8294 Lumbar Y Moment



20G 70ms -Y No Gap

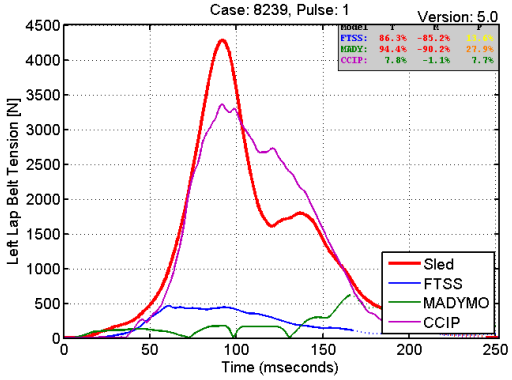
Figure C-2-489: 8243 Lumbar Y Moment



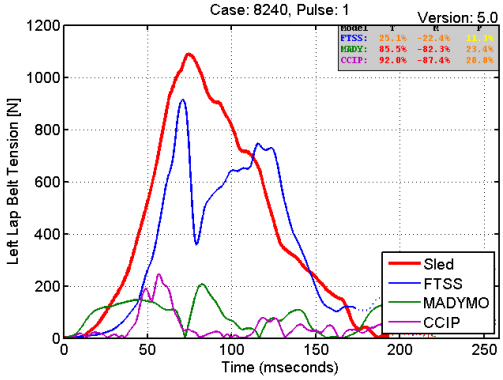
20G 70ms -Y No Gap

Figure C-2-490: 8296 Lumbar Y Moment

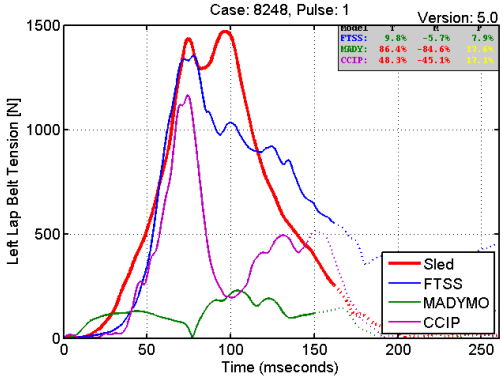
C.2.36 Left Lap Belt Force



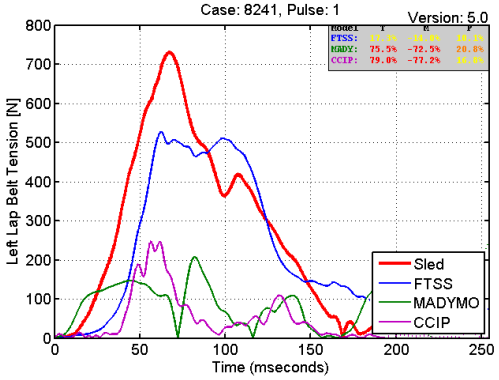
10G 70ms -Y No Side Support
Figure C-2-491: 8239 Left Lap Belt Force



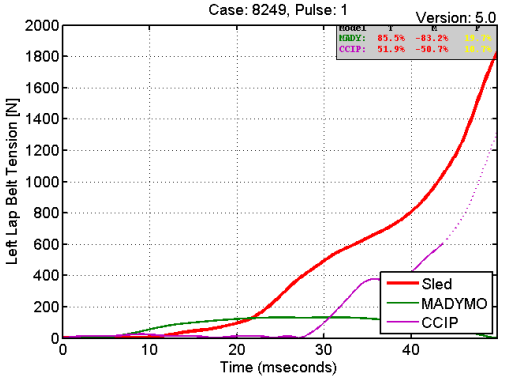
10G 70ms -Y No Head Support
Figure C-2-492: 8240 Left Lap Belt Force



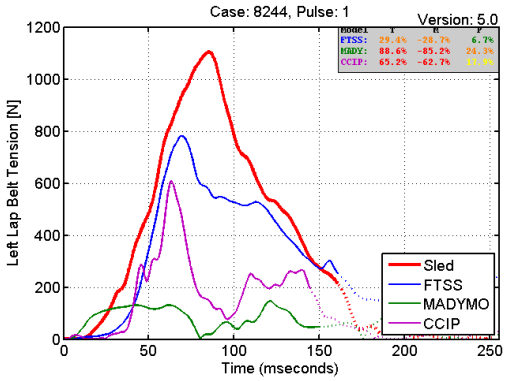
10G 70ms -Y 100% Gap
Figure C-2-493: 8248 Left Lap Belt Force



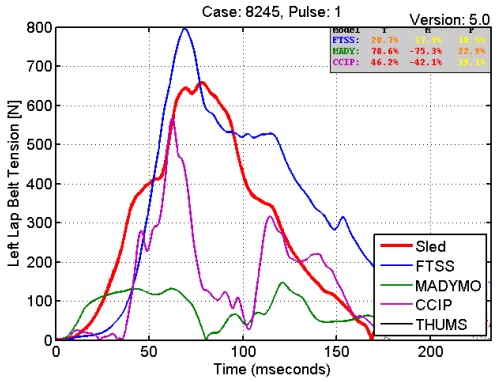
10G 70ms -Y No Head Support
Figure C-2-494: 8241 Left Lap Belt Force



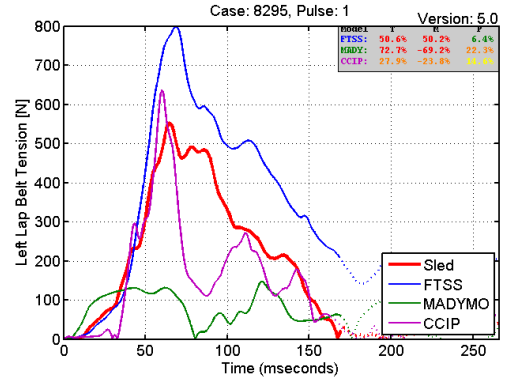
20G 70ms -Y 100% Gap
Figure C-2-495: 8249 Left Lap Belt Force



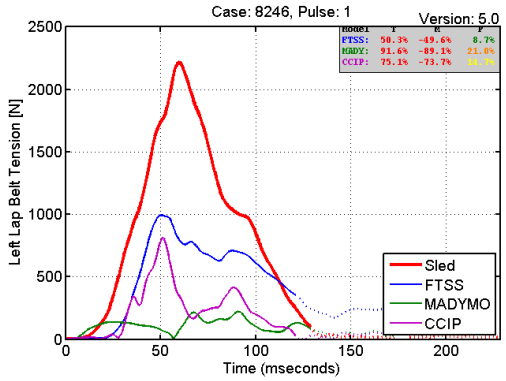
10G 70ms -Y 50% Gap
Figure C-2-496: 8244 Left Lap Belt Force



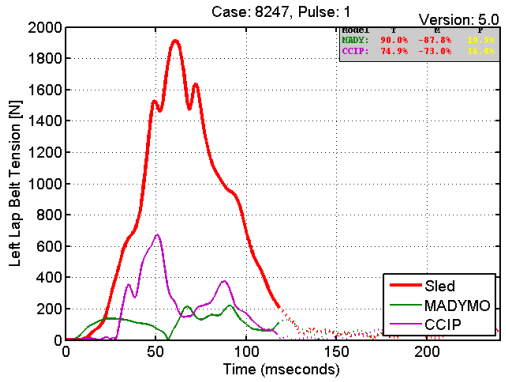
10G 70ms -Y 50% Gap
Figure C-2-497: 8245 Left Lap Belt Force



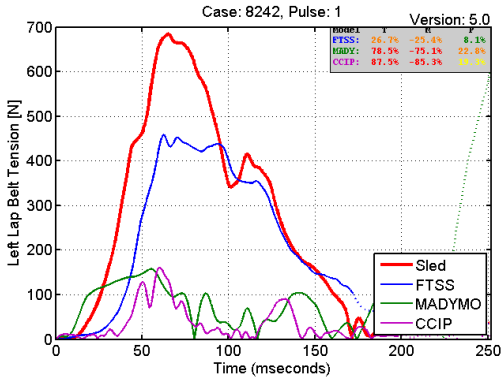
10G 70ms -Y 50% Gap
Figure C-2-498: 8295 Left Lap Belt Force



20G 70ms -Y 50% Gap
Figure C-2-499: 8246 Left Lap Belt Force

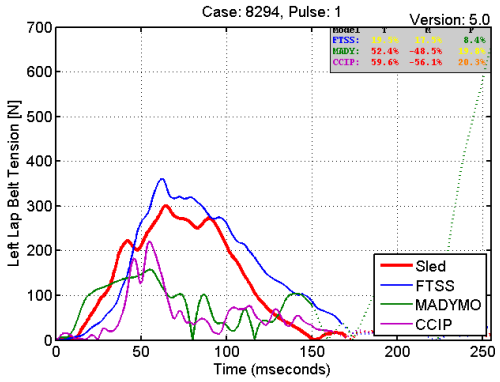


20G 70ms -Y 50% Gap
Figure C-2-500: 8247 Left Lap Belt Force



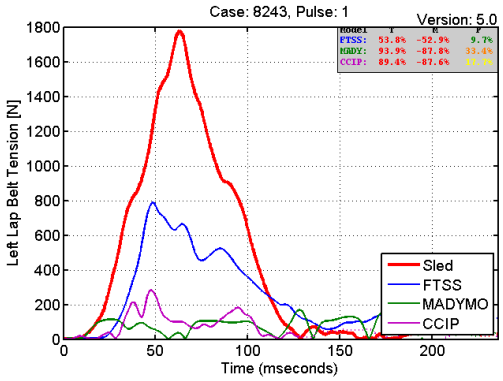
10G 70ms -Y No Gap

Figure C-2-501: 8242 Left Lap Belt Force



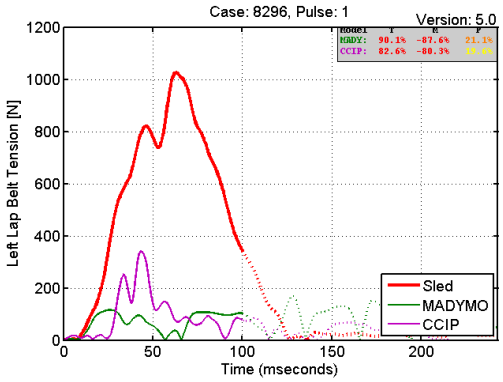
10G 70ms -Y No Gap

Figure C-2-502: 8294 Left Lap Belt Force



20G 70ms -Y No Gap

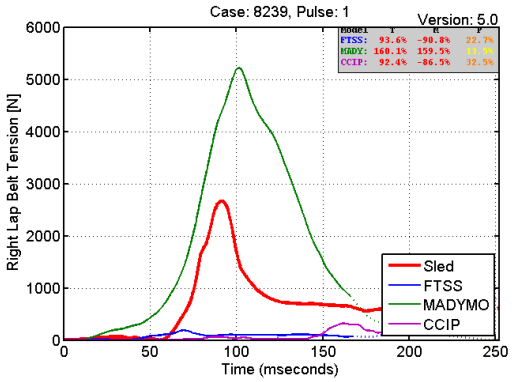
Figure C-2-503: 8243 Left Lap Belt Force



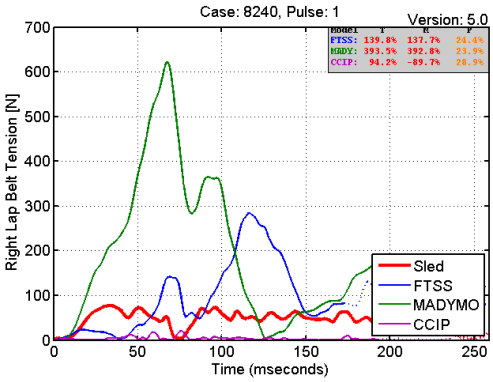
20G 70ms -Y No Gap

Figure C-2-504: 8296 Left Lap Belt Force

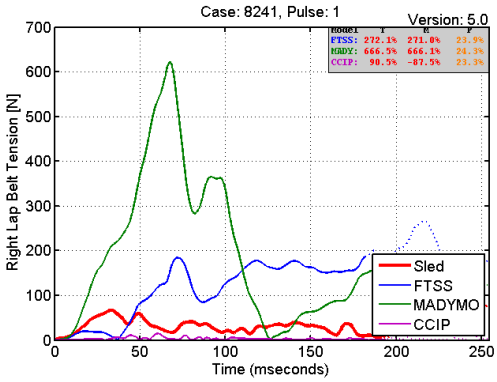
C.2.37 Right Lap Belt Force



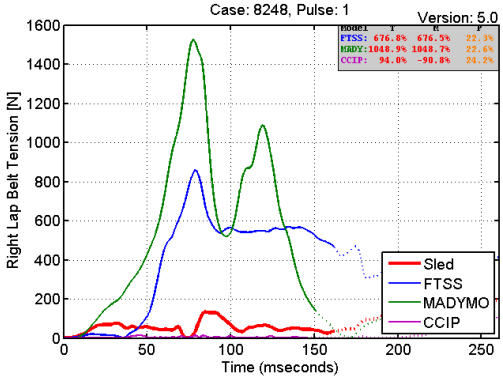
10G 70ms -Y No Side Support
Figure C-2-505: 8239 Right Lap Belt Force



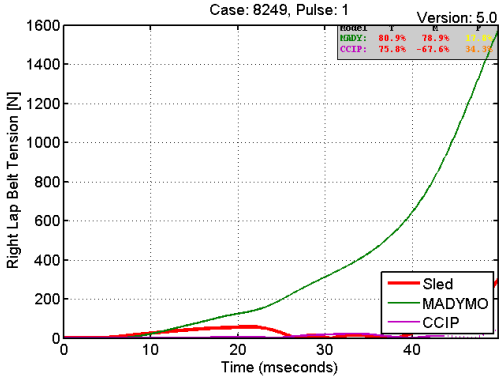
10G 70ms -Y No Head Support
Figure C-2-506: 8240 Right Lap Belt Force



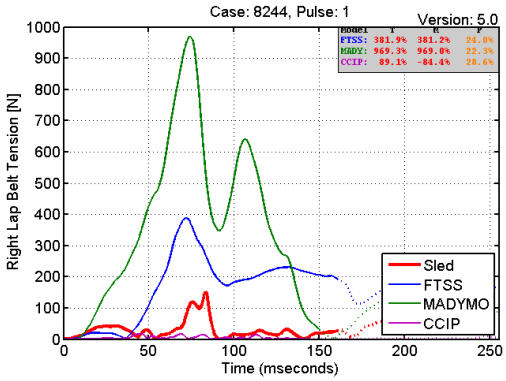
10G 70ms -Y No Head Support
Figure C-2-508: 8241 Right Lap Belt Force



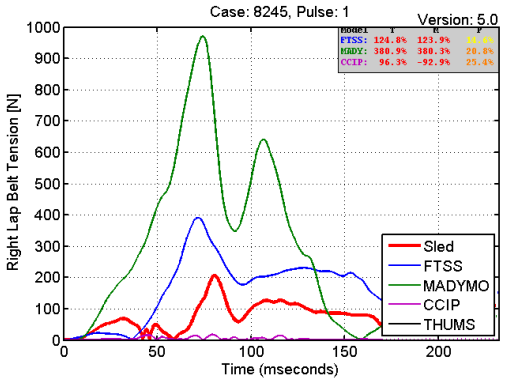
10G 70ms -Y 100% Gap
Figure C-2-507: 8248 Right Lap Belt Force



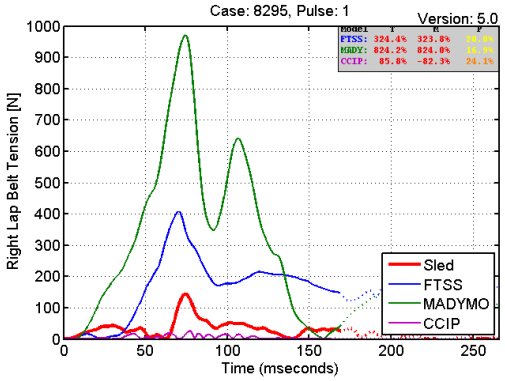
20G 70ms -Y 100% Gap
Figure C-2-509: 8249 Right Lap Belt Force



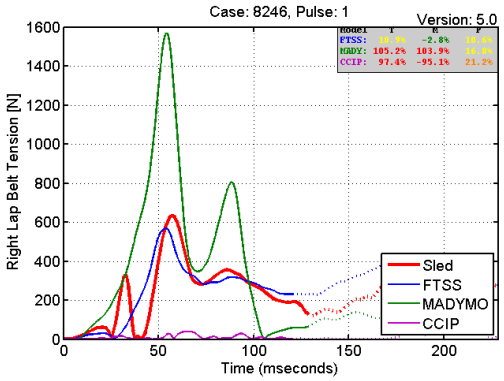
10G 70ms -Y 50% Gap
Figure C-2-510: 8244 Right Lap Belt Force



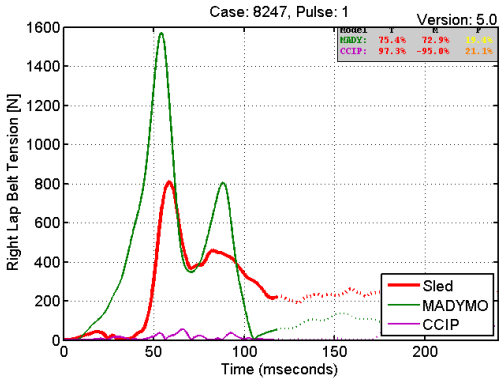
10G 70ms -Y 50% Gap
Figure C-2-511: 8245 Right Lap Belt Force



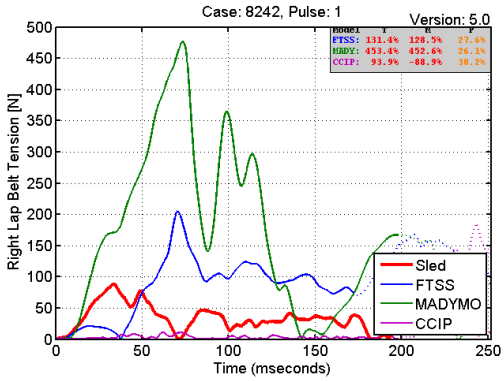
10G 70ms -Y 50% Gap
Figure C-2-512: 8295 Right Lap Belt Force



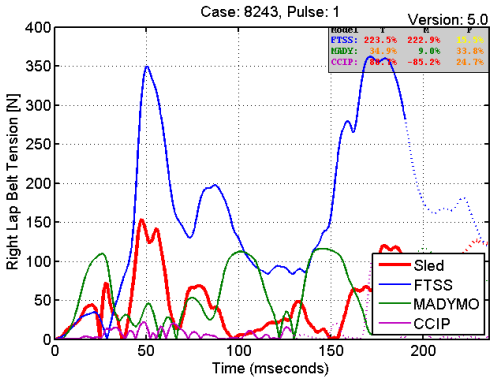
20G 70ms -Y 50% Gap
Figure C-2-513: 8246 Right Lap Belt Force



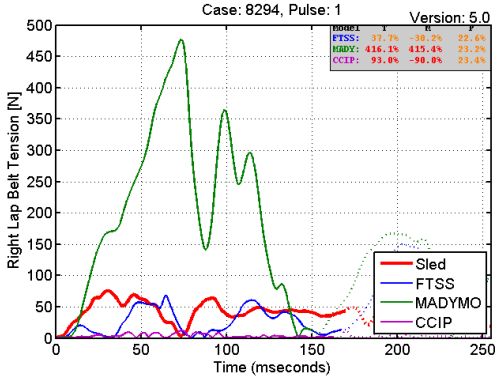
20G 70ms -Y 50% Gap
Figure C-2-514: 8247 Right Lap Belt Force



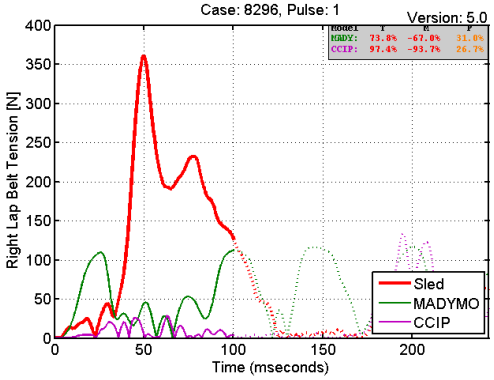
10G 70ms -Y No Gap
Figure C-2-515: 8242 Right Lap Belt Force



20G 70ms -Y No Gap
Figure C-2-517: 8243 Right Lap Belt Force

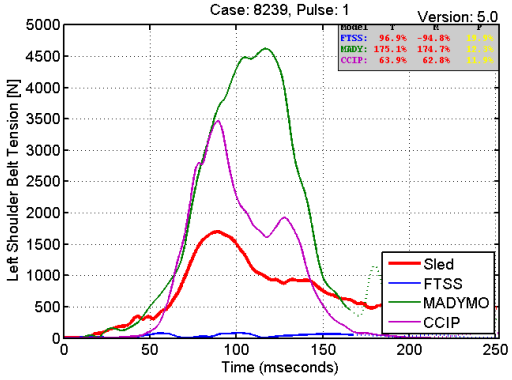


10G 70ms -Y No Gap
Figure C-2-516: 8294 Right Lap Belt Force

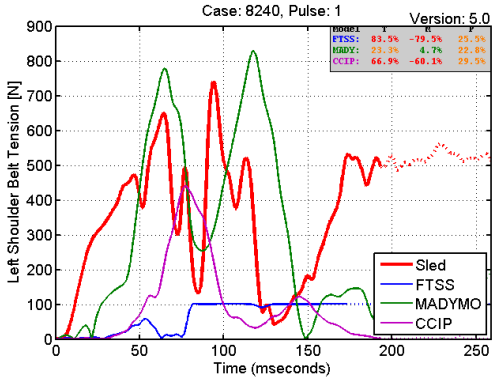


20G 70ms -Y No Gap
Figure C-2-518: 8296 Right Lap Belt Force

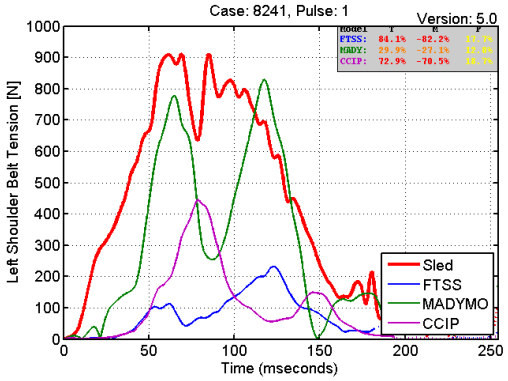
C.2.38 Left Shoulder Belt Force



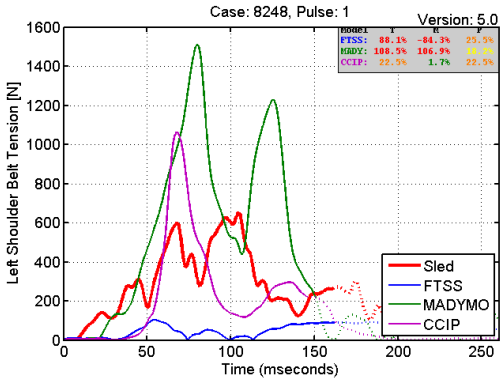
10G 70ms -Y No Side Support
Figure C-2-519: 8239 Left Shoulder Belt Force



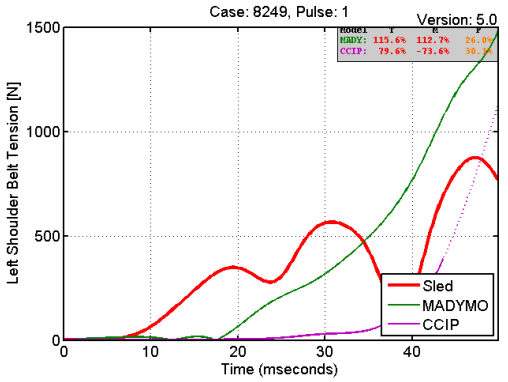
10G 70ms -Y No Head Support
Figure C-2-520: 8240 Left Shoulder Belt Force



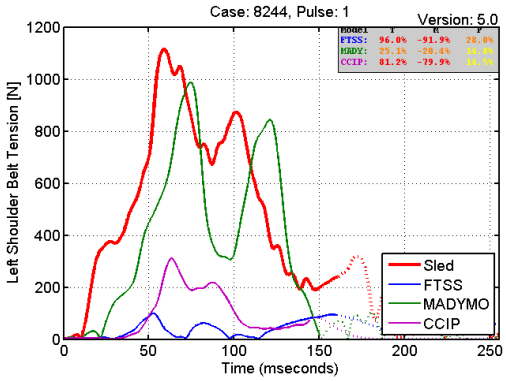
10G 70ms -Y No Head Support
Figure C-2-522: 8241 Left Shoulder Belt Force



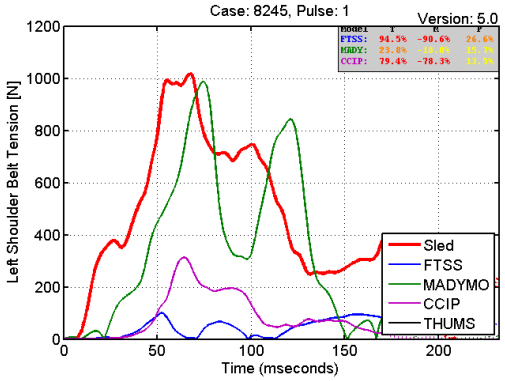
10G 70ms -Y 100% Gap
Figure C-2-521: 8248 Left Shoulder Belt Force



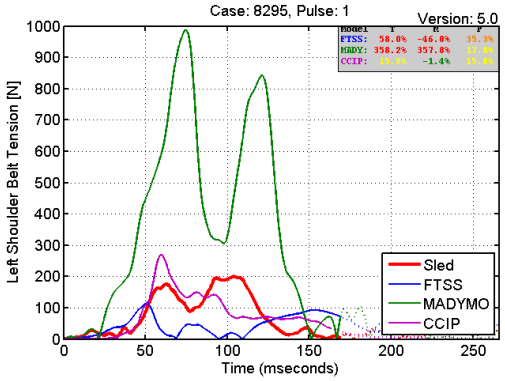
20G 70ms -Y 100% Gap
Figure C-2-523: 8249 Left Shoulder Belt Force



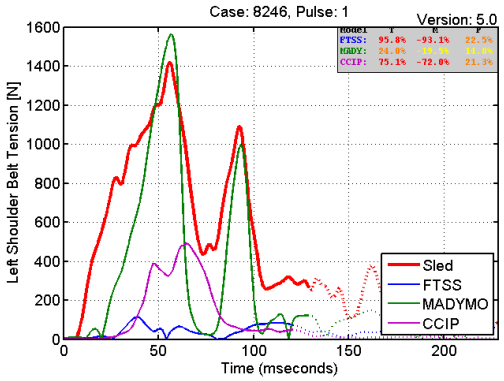
10G 70ms -Y 50% Gap
Figure C-2-524: 8244 Left Shoulder Belt Force



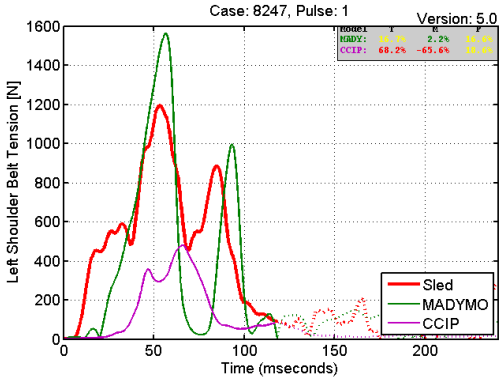
10G 70ms -Y 50% Gap
Figure C-2-525: 8245 Left Shoulder Belt Force



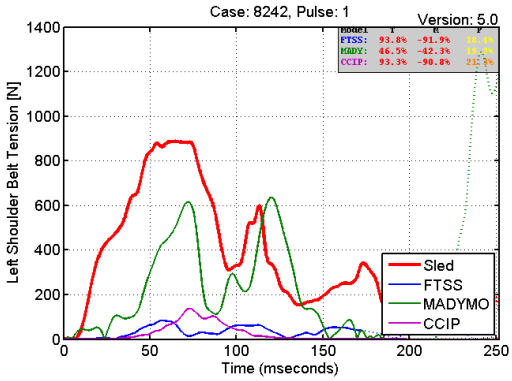
10G 70ms -Y 50% Gap
Figure C-2-526: 8295 Left Shoulder Belt Force



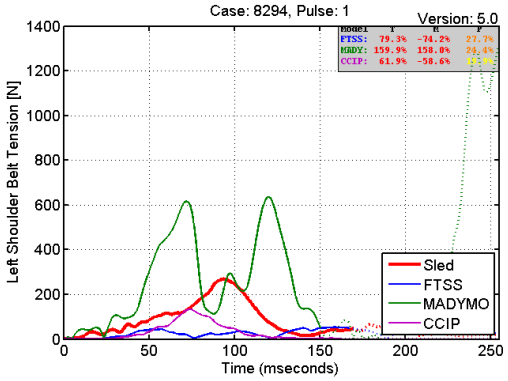
20G 70ms -Y 50% Gap
Figure C-2-527: 8246 Left Shoulder Belt Force



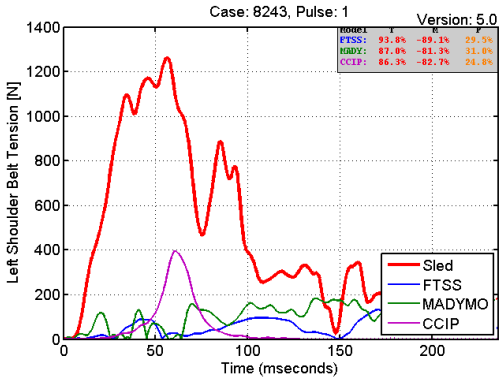
20G 70ms -Y 50% Gap
Figure C-2-528: 8247 Left Shoulder Belt Force



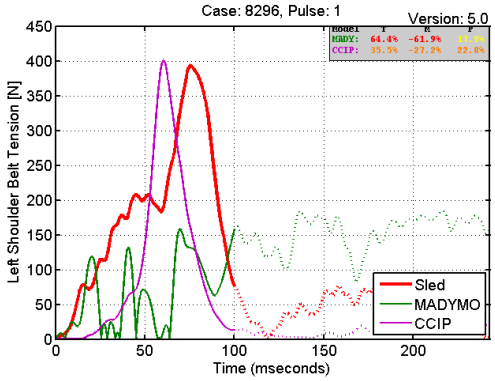
10G 70ms -Y No Gap
Figure C-2-529: 8242 Left Shoulder Belt Force



10G 70ms -Y No Gap
Figure C-2-530: 8294 Left Shoulder Belt Force

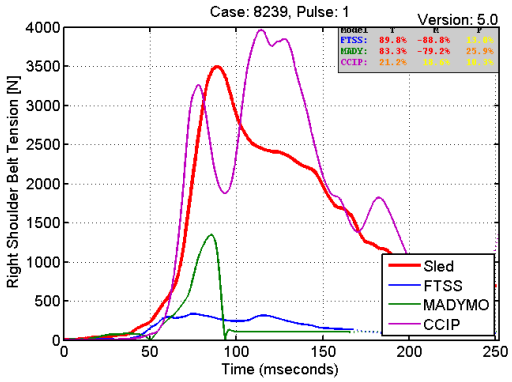


20G 70ms -Y No Gap
Figure C-2-531: 8243 Left Shoulder Belt Force

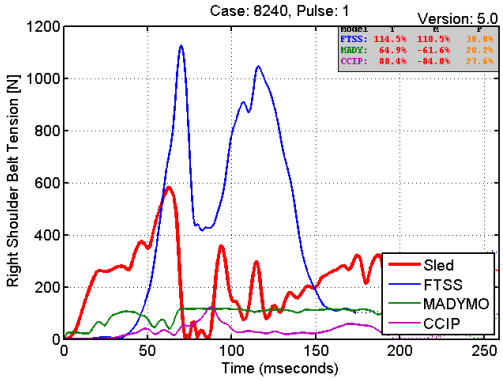


20G 70ms -Y No Gap
Figure C-2-532: 8296 Left Shoulder Belt Force

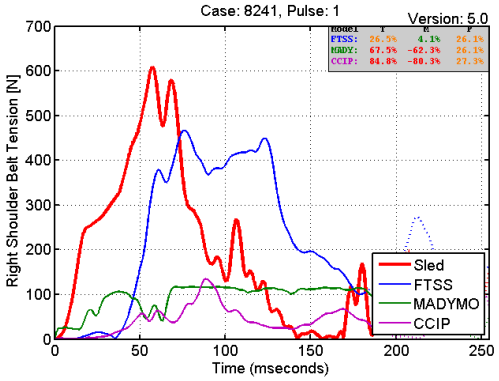
C.2.39 Right Shoulder Belt Force



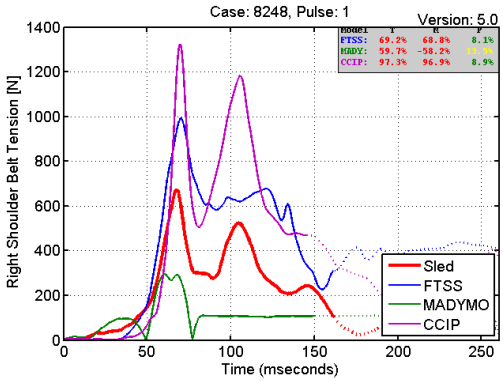
10G 70ms -Y No Side Support
Figure C-2-533: 8239 Right Shoulder Belt Force



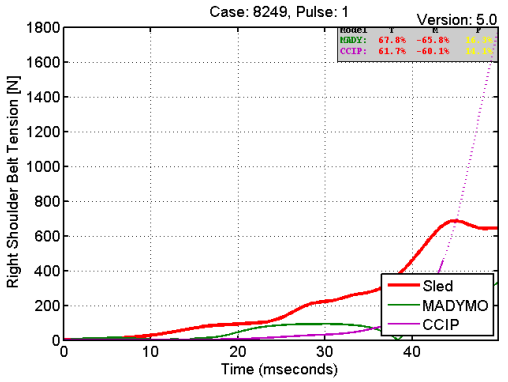
10G 70ms -Y No Head Support
Figure C-2-534: 8240 Right Shoulder Belt Force



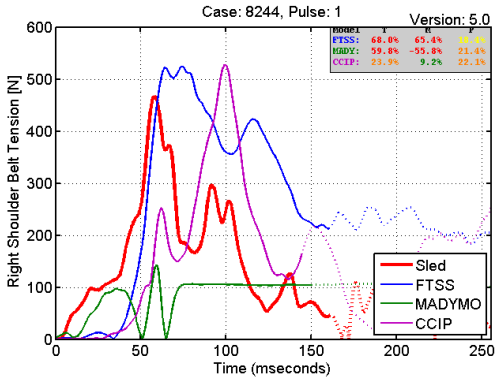
10G 70ms -Y No Head Support
Figure C-2-536: 8241 Right Shoulder Belt Force



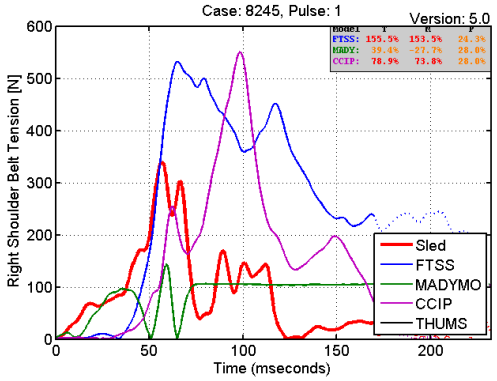
10G 70ms -Y 100% Gap
Figure C-2-535: 8248 Right Shoulder Belt Force



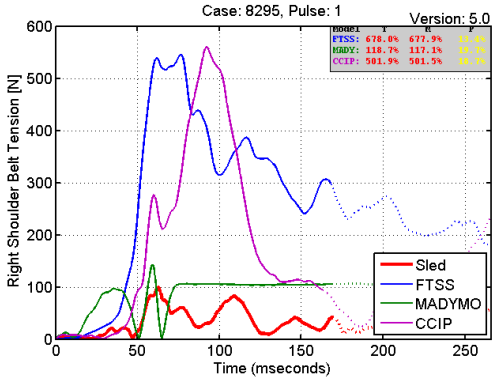
20G 70ms -Y 100% Gap
Figure C-2-537: 8249 Right Shoulder Belt Force



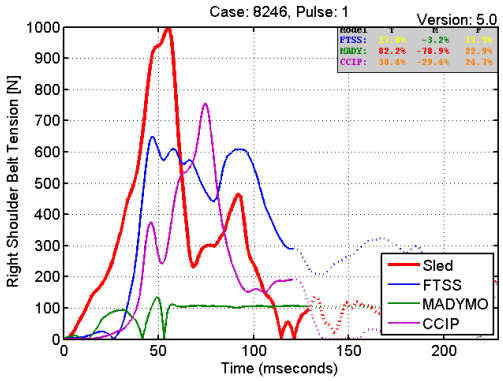
10G 70ms -Y 50% Gap
Figure C-2-538: 8244 Right Shoulder Belt Force



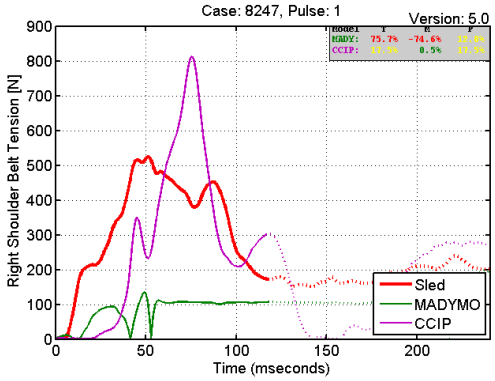
10G 70ms -Y 50% Gap
Figure C-2-539: 8245 Right Shoulder Belt Force



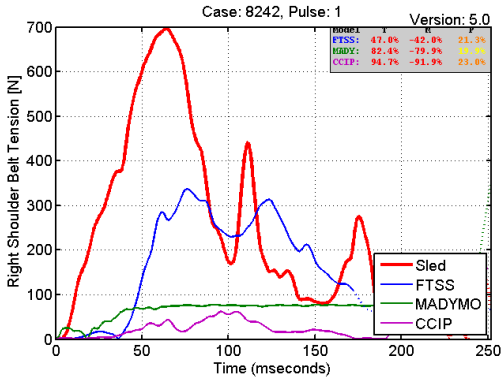
10G 70ms -Y 50% Gap
Figure C-2-540: 8295 Right Shoulder Belt Force



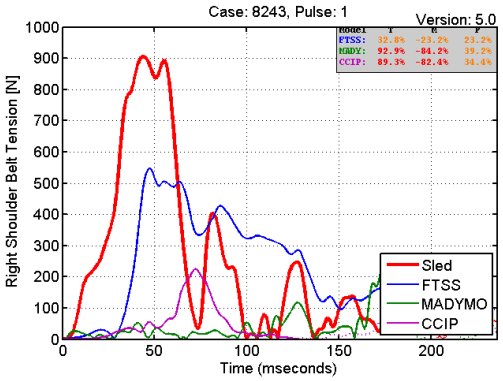
20G 70ms -Y 50% Gap
Figure C-2-541: 8246 Right Shoulder Belt Force



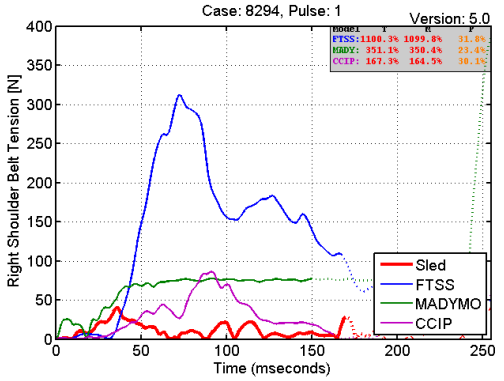
20G 70ms -Y 50% Gap
Figure C-2-542: 8247 Right Shoulder Belt Force



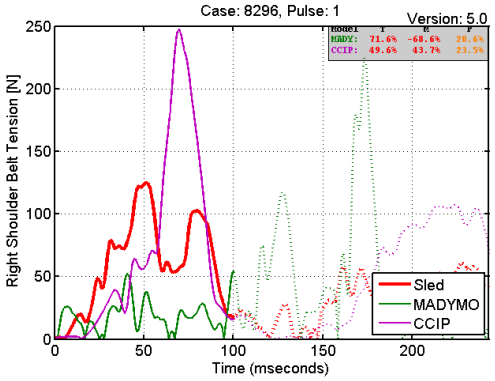
10G 70ms -Y No Gap
Figure C-2-543: 8242 Right Shoulder Belt Force



20G 70ms -Y No Gap
Figure C-2-545: 8243 Right Shoulder Belt Force

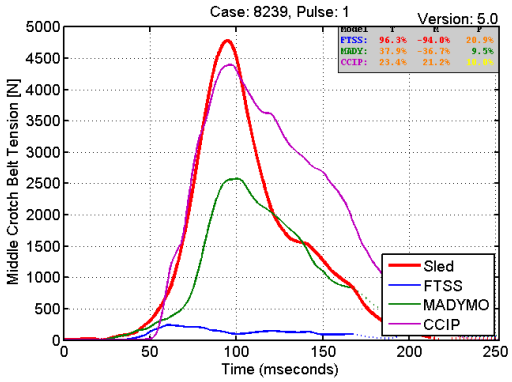


10G 70ms -Y No Gap
Figure C-2-544: 8294 Right Shoulder Belt Force

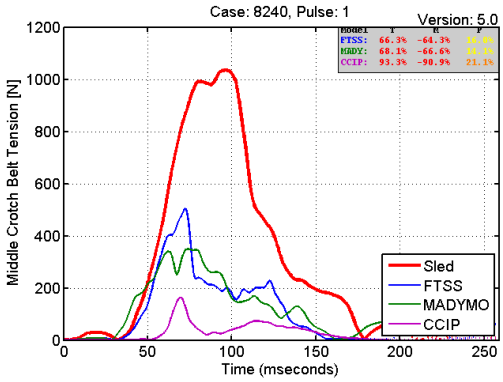


20G 70ms -Y No Gap
Figure C-2-546: 8296 Right Shoulder Belt Force

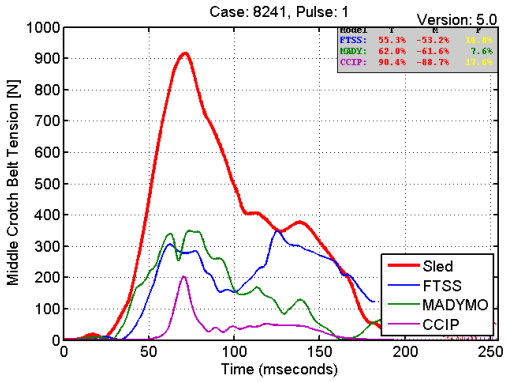
C.2.40 Crotch Belt Force



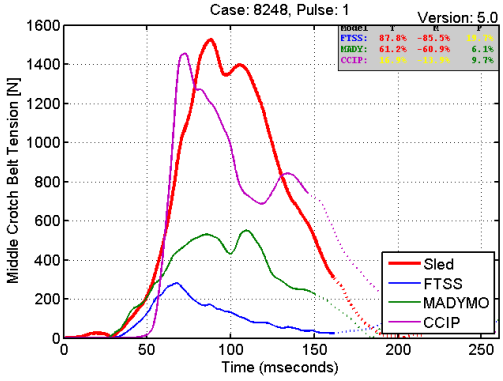
10G 70ms -Y No Side Support
Figure C-2-547: 8239 Crotch Belt Force



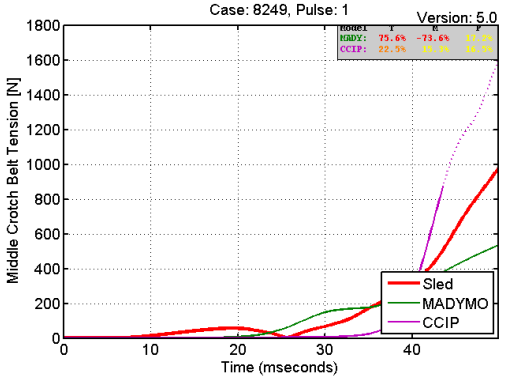
10G 70ms -Y No Head Support
Figure C-2-548: 8240 Crotch Belt Force



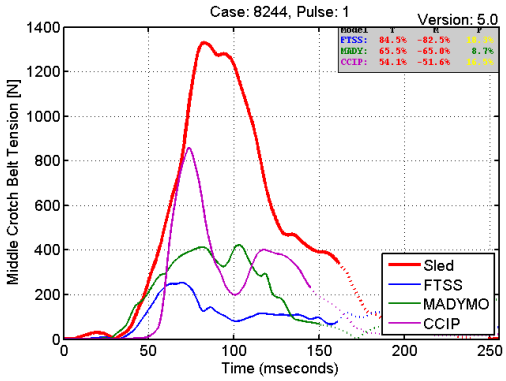
10G 70ms -Y No Head Support
Figure C-2-550: 8241 Crotch Belt Force



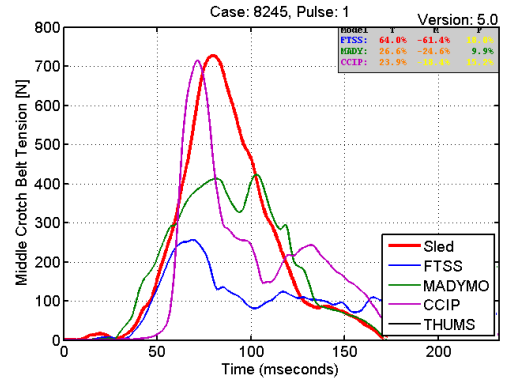
10G 70ms -Y 100% Gap
Figure C-2-549: 8248 Crotch Belt Force



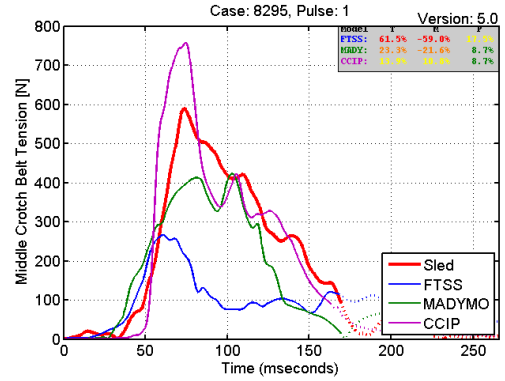
20G 70ms -Y 100% Gap
Figure C-2-551: 8249 Crotch Belt Force



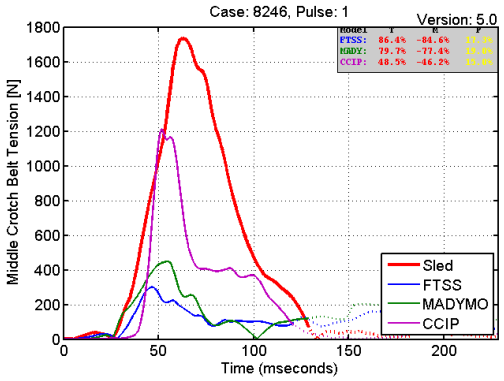
10G 70ms -Y 50% Gap
Figure C-2-552: 8244 Crotch Belt Force



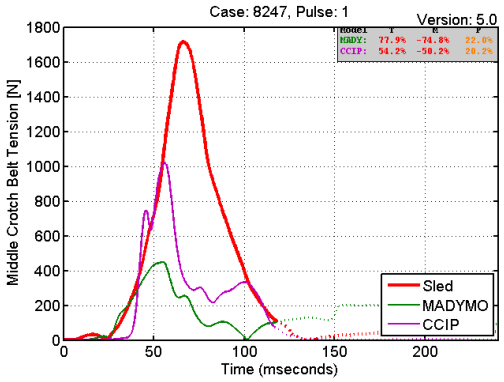
10G 70ms -Y 50% Gap
Figure C-2-553: 8245 Crotch Belt Force



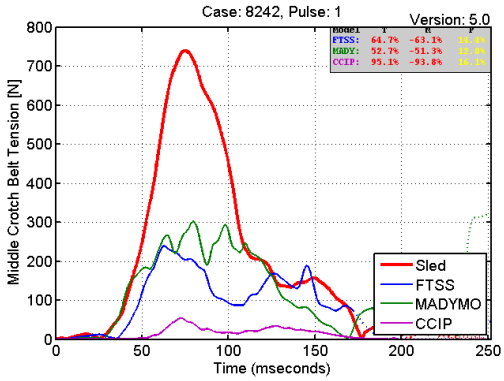
10G 70ms -Y 50% Gap
Figure C-2-554: 8295 Crotch Belt Force



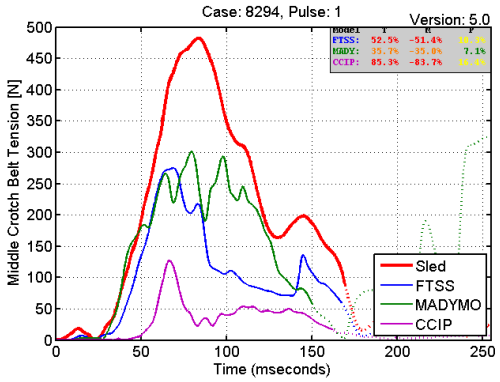
20G 70ms -Y 50% Gap
Figure C-2-555: 8246 Crotch Belt Force



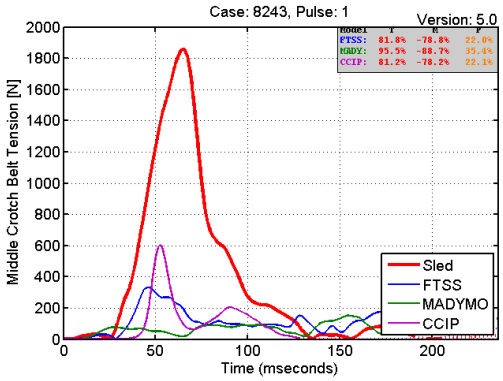
20G 70ms -Y 50% Gap
Figure C-2-556: 8247 Crotch Belt Force



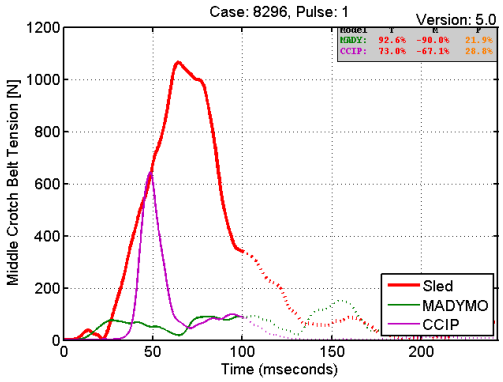
10G 70ms -Y No Gap
Figure C-2-557: 8242 Crotch Belt Force



10G 70ms -Y No Gap
Figure C-2-558: 8294 Crotch Belt Force



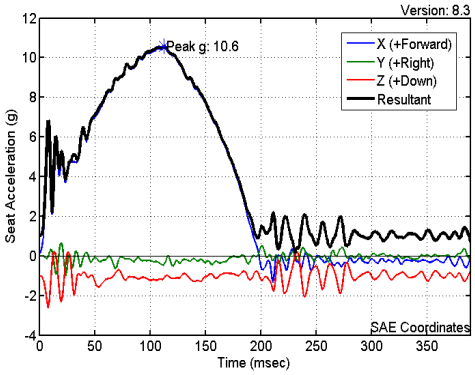
20G 70ms -Y No Gap
Figure C-2-559: 8243 Crotch Belt Force



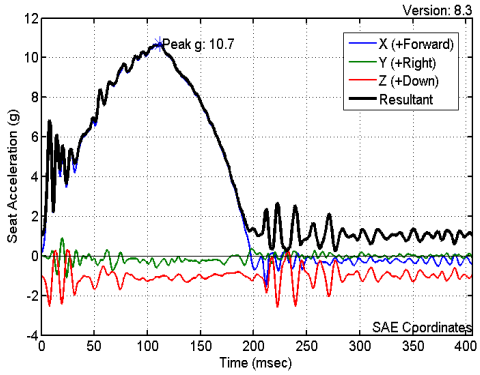
20G 70ms -Y No Gap
Figure C-2-560: 8296 Crotch Belt Force

C.3 Rear Impact

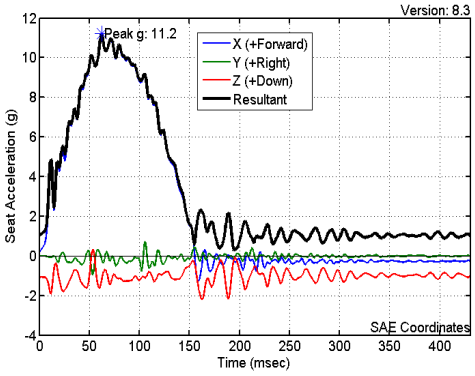
C.3.1 Seat Accelerations



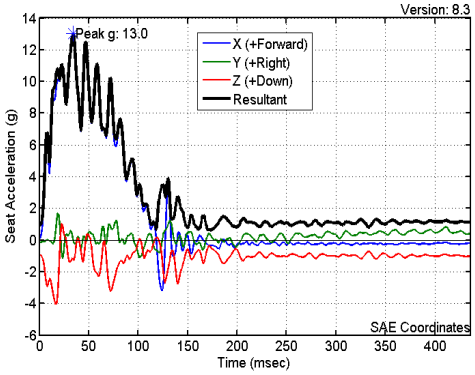
10G 110ms +X
Figure C-3-1: 8196 Seat Accelerations



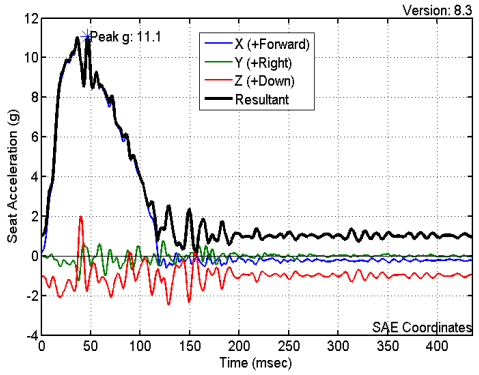
10G 110ms +X
Figure C-3-4: 8197 Seat Accelerations



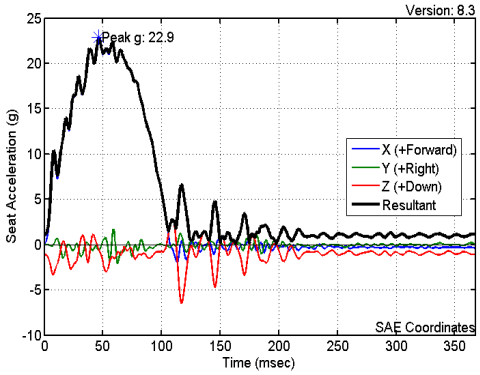
10G 70ms +X
Figure C-3-2: 8210 Seat Accelerations



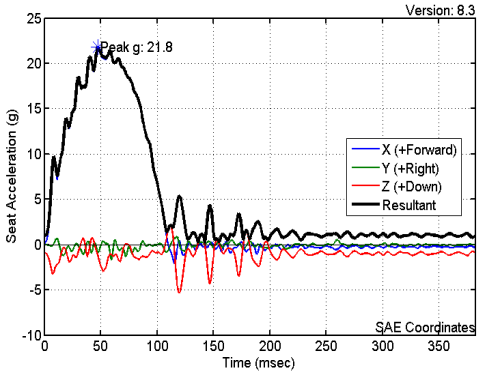
10G 30ms +X
Figure C-3-3: 8194 Seat Accelerations



10G 30ms +X
Figure C-3-5: 8195 Seat Accelerations

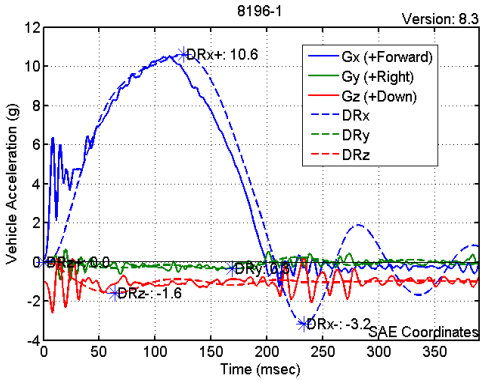


20G 70ms +X
Figure C-3-6: 8211 Seat Accelerations

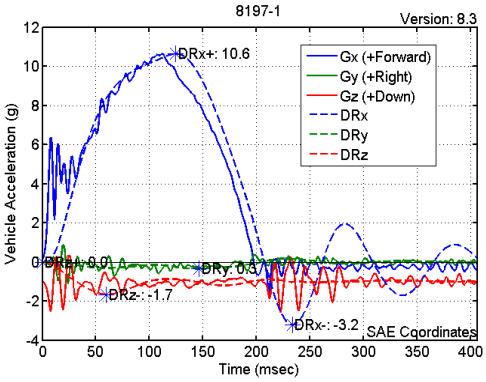


20G 70ms +X
Figure C-3-7: 8212 Seat Accelerations

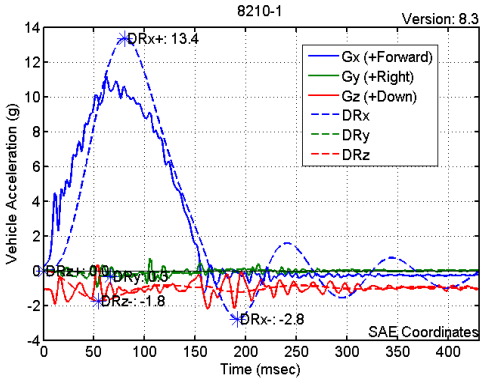
C.3.2 Dynamic Response Index



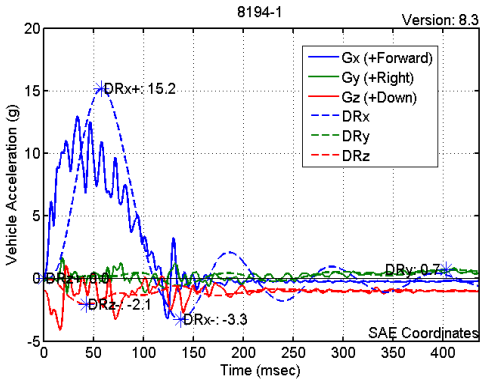
10G 110ms +X
Figure C-3-8: 8196 Dynamic Response Index



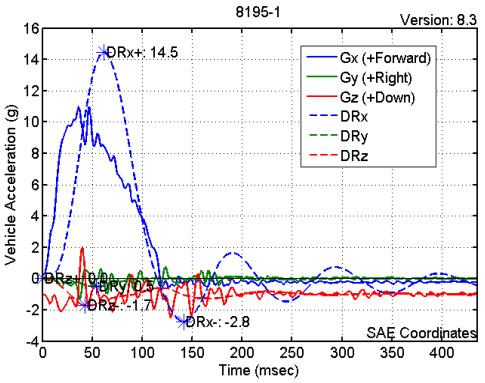
10G 110ms +X
Figure C-3-11: 8197 Dynamic Response Index



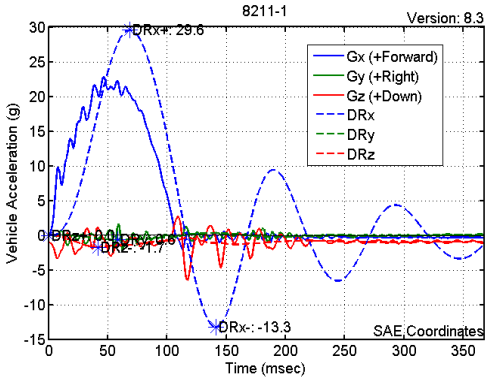
10G 70ms +X
Figure C-3-9: 8210 Dynamic Response Index



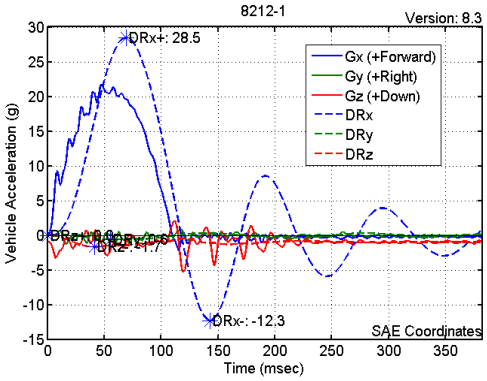
10G 30ms +X
Figure C-3-10: 8194 Dynamic Response Index



10G 30ms +X
Figure C-3-12: 8195 Dynamic Response Index

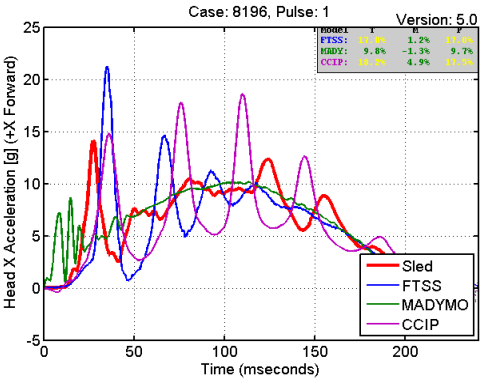


20G 70ms +X
Figure C-3-13: 8211 Dynamic Response Index

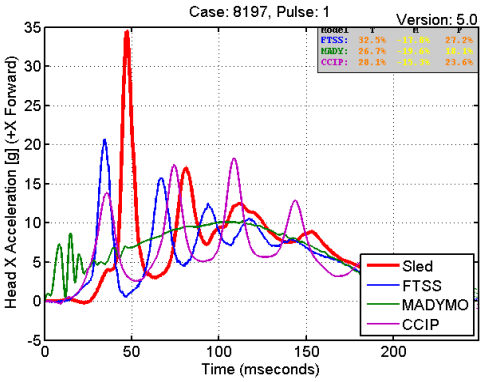


20G 70ms +X
Figure C-3-14: 8212 Dynamic Response Index

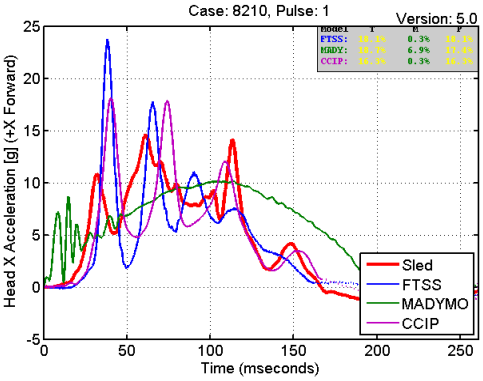
C.3.3 Head X Translational Acceleration



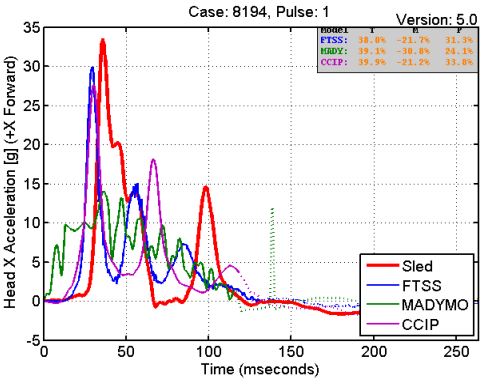
10G 110ms +X
Figure C-3-15: 8196 Head X Translational Acceleration



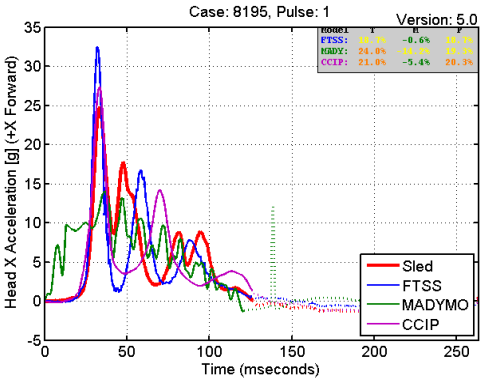
10G 110ms +X
Figure C-3-18: 8197 Head X Translational Acceleration



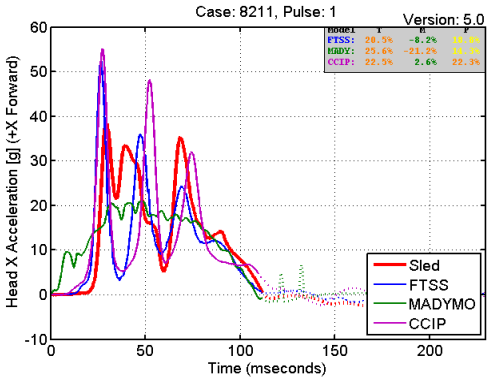
10G 70ms +X
Figure C-3-16: 8210 Head X Translational Acceleration



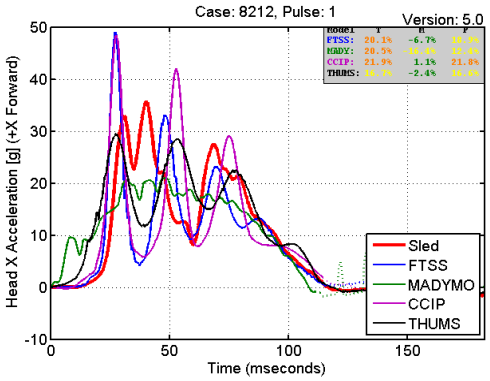
10G 30ms +X
Figure C-3-17: 8194 Head X Translational Acceleration



10G 30ms +X
Figure C-3-19: 8195 Head X Translational Acceleration

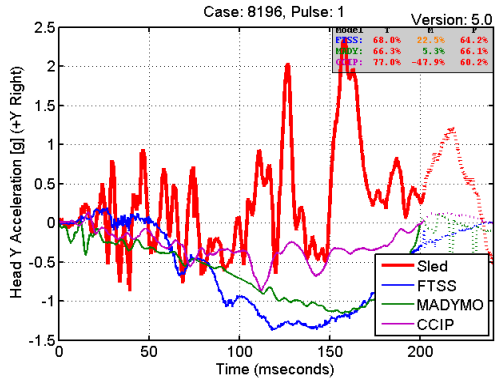


20G 70ms +X
Figure C-3-20: 8211 Head X Translational Acceleration



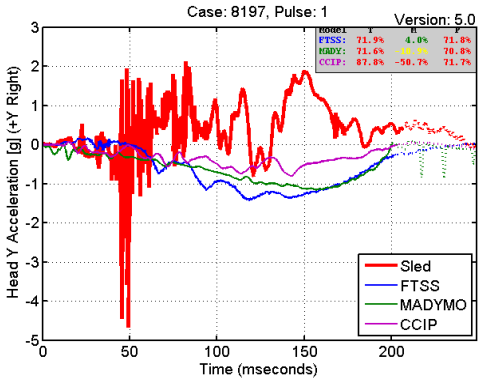
20G 70ms +X
Figure C-3-21: 8212 Head X Translational Acceleration

C.3.4 Head Y Translational Acceleration



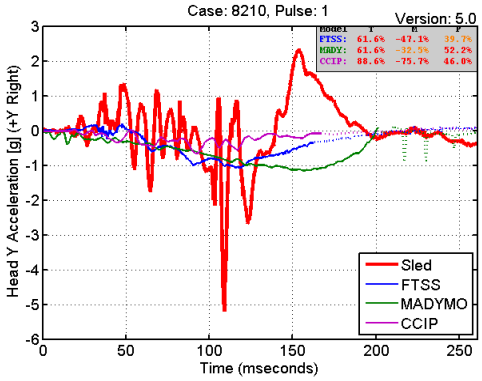
10G 110ms +X

Figure C-3-22: 8196 Head Y Translational Acceleration



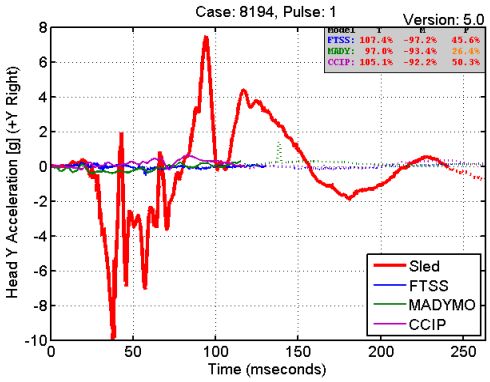
10G 110ms +X

Figure C-3-25: 8197 Head Y Translational Acceleration



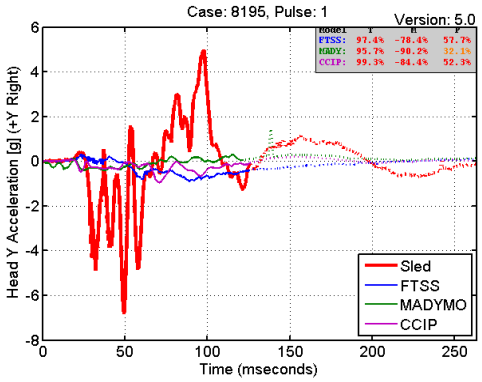
10G 70ms +X

Figure C-3-23: 8210 Head Y Translational Acceleration



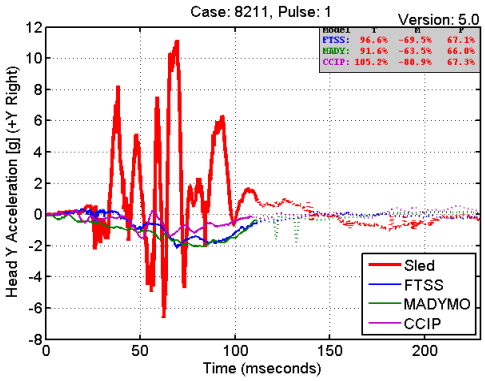
10G 30ms +X

Figure C-3-24: 8194 Head Y Translational Acceleration



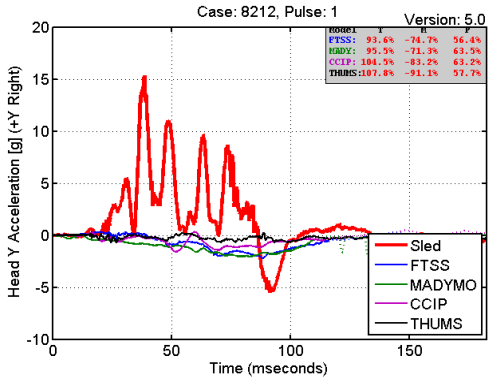
10G 30ms +X

Figure C-3-26: 8195 Head Y Translational Acceleration



20G 70ms +X

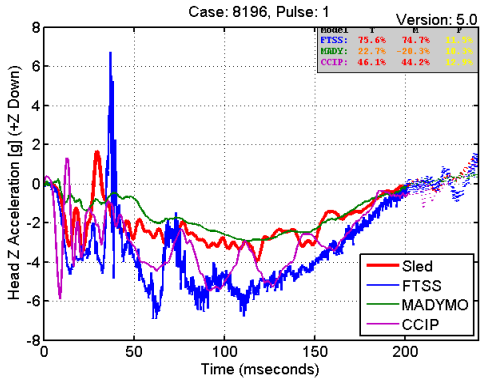
Figure C-3-27: 8211 Head Y Translational Acceleration



20G 70ms +X

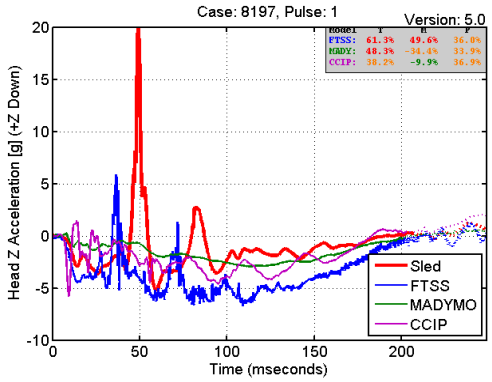
Figure C-3-28: 8212 Head Y Translational Acceleration

C.3.5 Head Z Translational Acceleration



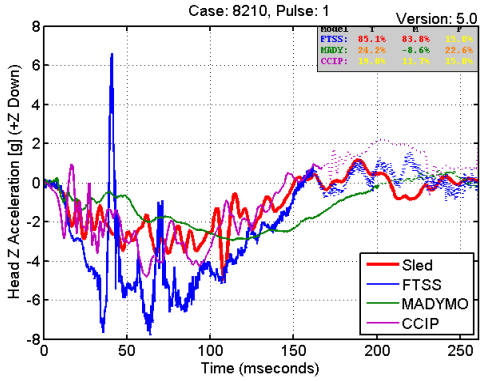
10G 110ms +X

Figure C-3-29: 8196 Head Z Translational Acceleration



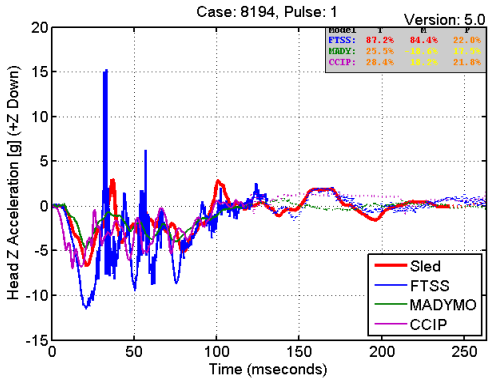
10G 110ms +X

Figure C-3-32: 8197 Head Z Translational Acceleration



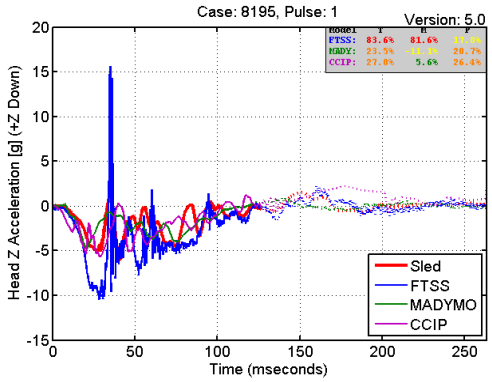
10G 70ms +X

Figure C-3-30: 8210 Head Z Translational Acceleration



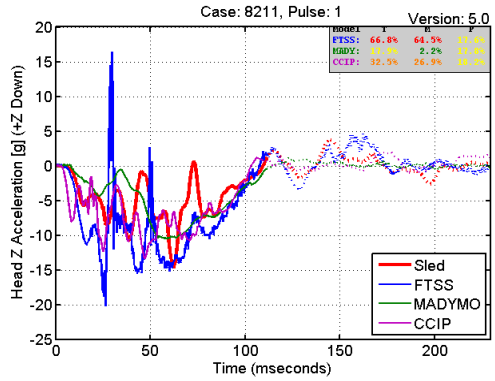
10G 30ms +X

Figure C-3-31: 8194 Head Z Translational Acceleration

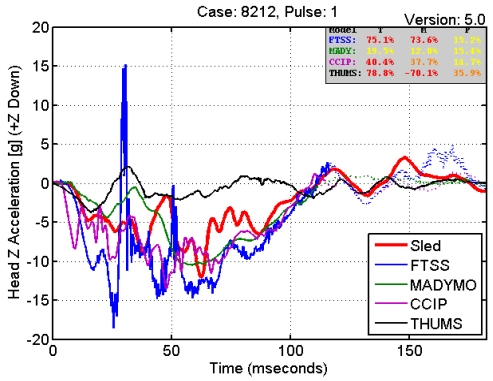


10G 30ms +X

Figure C-3-33: 8195 Head Z Translational Acceleration

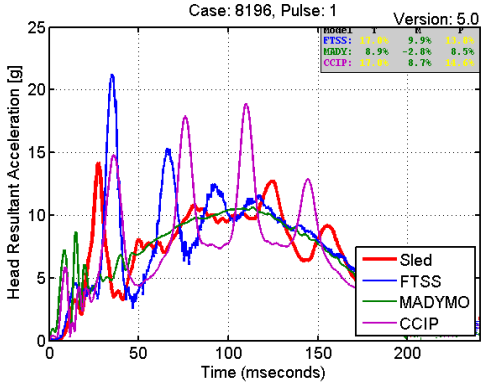


20G 70ms +X
Figure C-3-34: 8211 Head Z Translational Acceleration



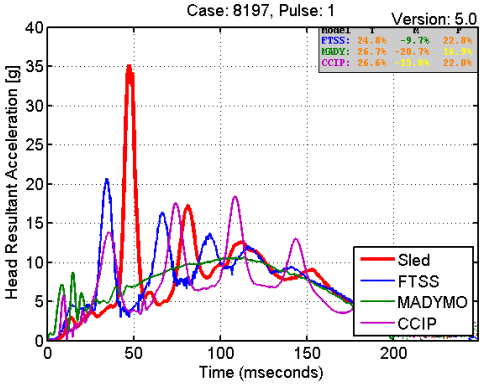
20G 70ms +X
Figure C-3-35: 8212 Head Z Translational Acceleration

C.3.6 Head Resultant Translational Acceleration



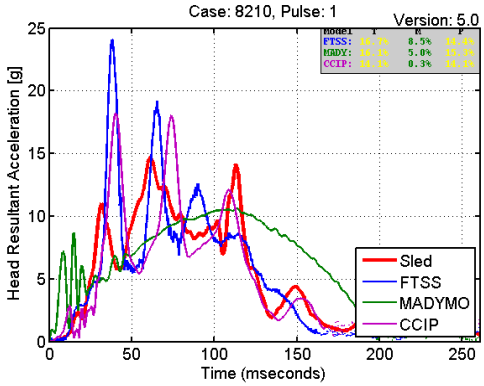
10G 110ms +X

Figure C-3-36: 8196 Head Resultant Translational Acceleration



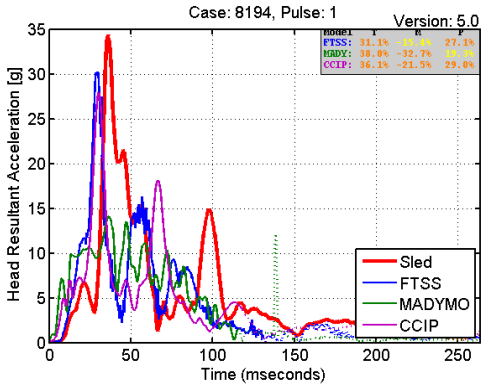
10G 110ms +X

Figure C-3-39: 8197 Head Resultant Translational Acceleration



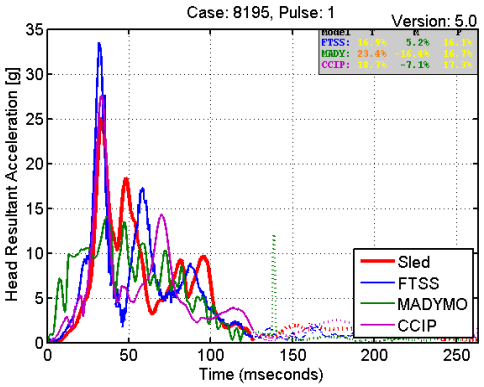
10G 70ms +X

Figure C-3-37: 8210 Head Resultant Translational Acceleration



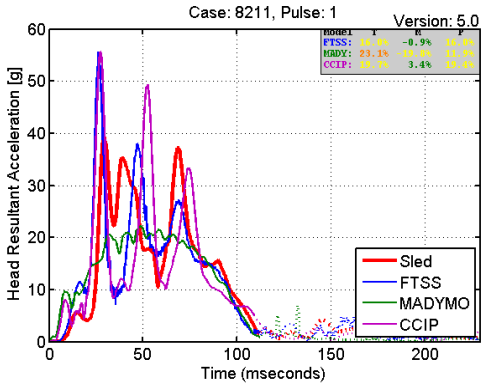
10G 30ms +X

Figure C-3-38: 8194 Head Resultant Translational Acceleration



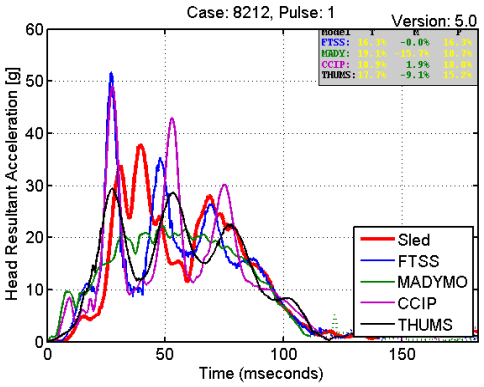
10G 30ms +X

Figure C-3-40: 8195 Head Resultant Translational Acceleration



20G 70ms +X

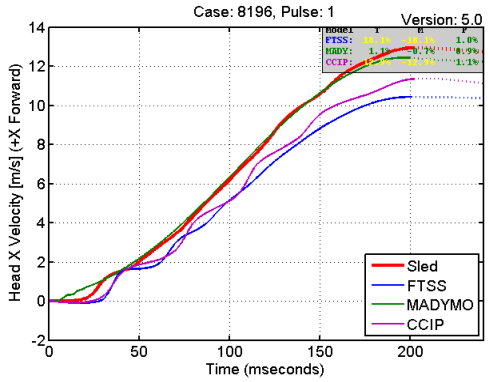
Figure C-3-41: 8211 Head Resultant Translational Acceleration



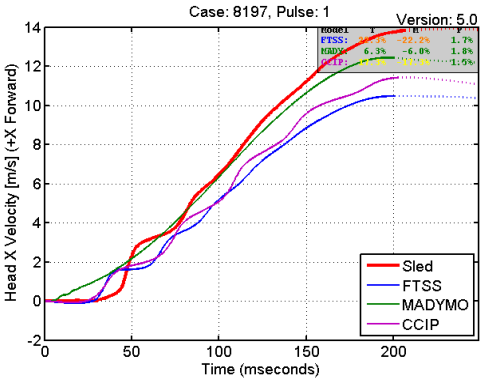
20G 70ms +X

Figure C-3-42: 8212 Head Resultant Translational Acceleration

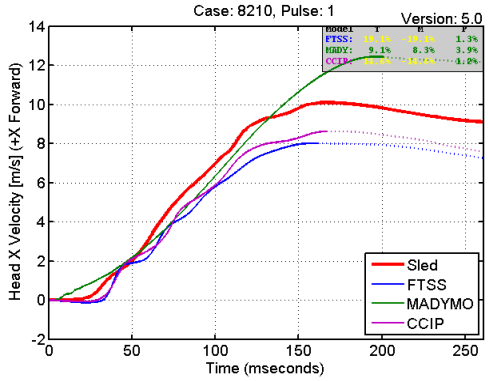
C.3.7 Head X Translational Velocity



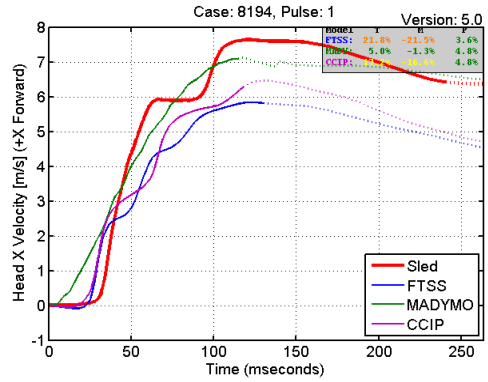
10G 110ms +X
Figure C-3-43: 8196 Head X Translational Velocity



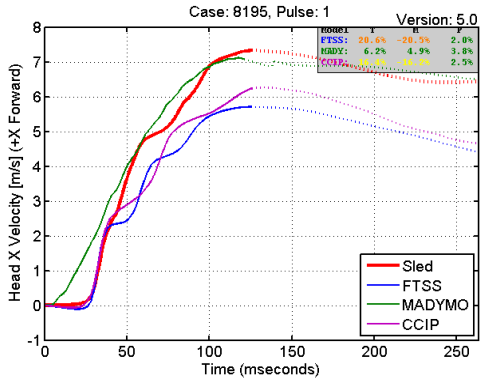
10G 110ms +X
Figure C-3-46: 8197 Head X Translational Velocity



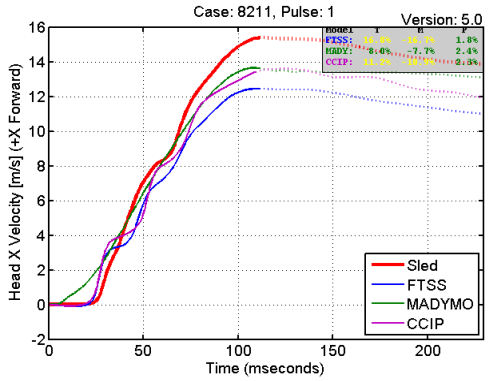
10G 70ms +X
Figure C-3-44: 8210 Head X Translational Velocity



10G 30ms +X
Figure C-3-45: 8194 Head X Translational Velocity

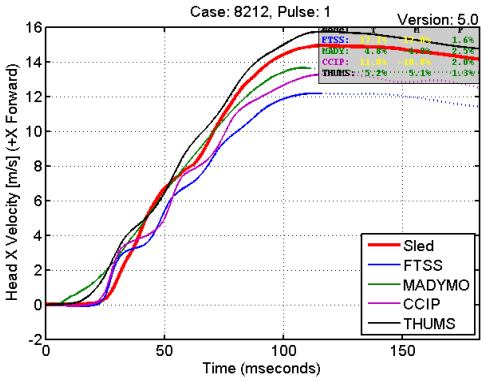


10G 30ms +X
Figure C-3-47: 8195 Head X Translational Velocity



20G 70ms +X

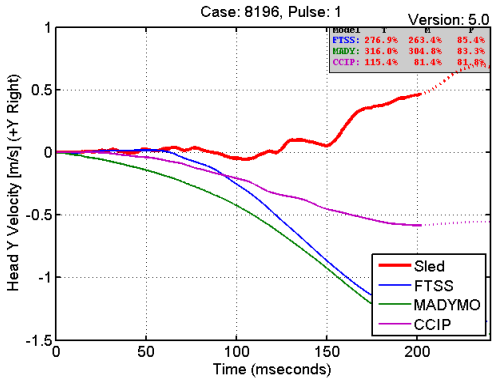
Figure C-3-48: 8211 Head X Translational Velocity



20G 70ms +X

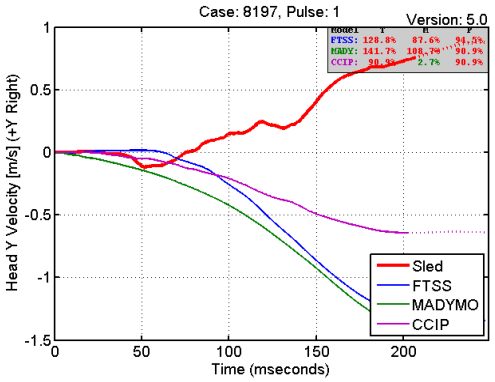
Figure C-3-49: 8212 Head X Translational Velocity

C.3.8 Head Y Translational Velocity



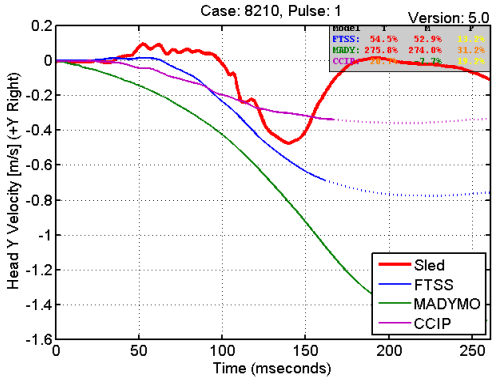
10G 110ms +X

Figure C-3-50: 8196 Head Y Translational Velocity



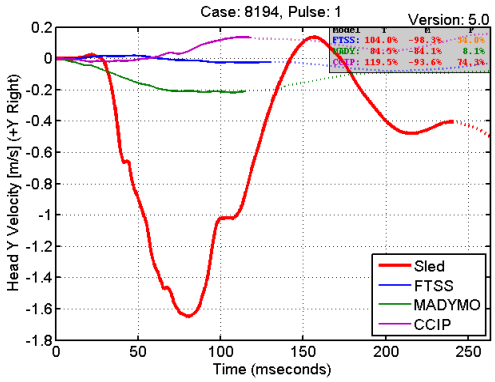
10G 110ms +X

Figure C-3-53: 8197 Head Y Translational Velocity



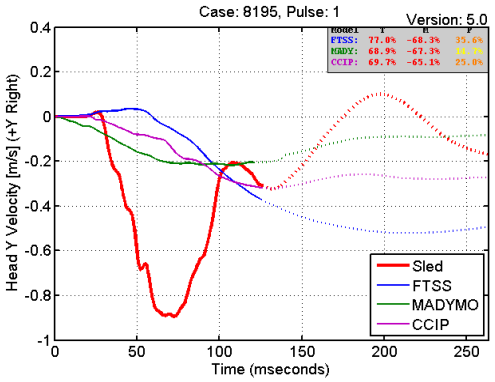
10G 70ms +X

Figure C-3-51: 8210 Head Y Translational Velocity



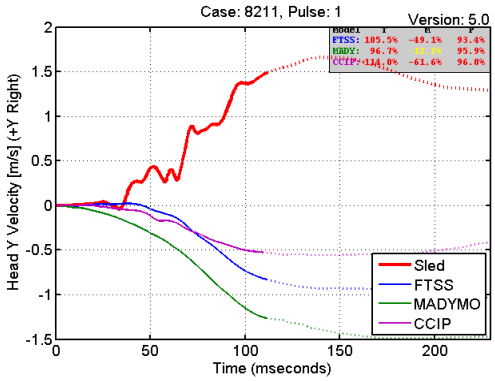
10G 30ms +X

Figure C-3-52: 8194 Head Y Translational Velocity



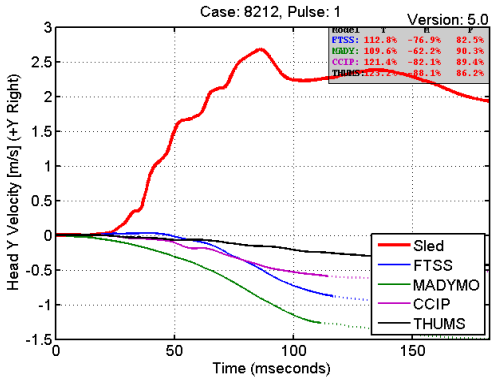
10G 30ms +X

Figure C-3-54: 8195 Head Y Translational Velocity



20G 70ms +X

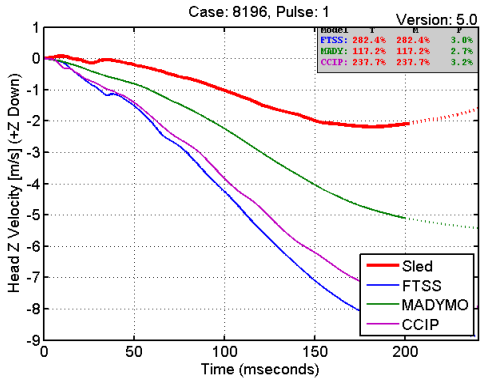
Figure C-3-55: 8211 Head Y Translational Velocity



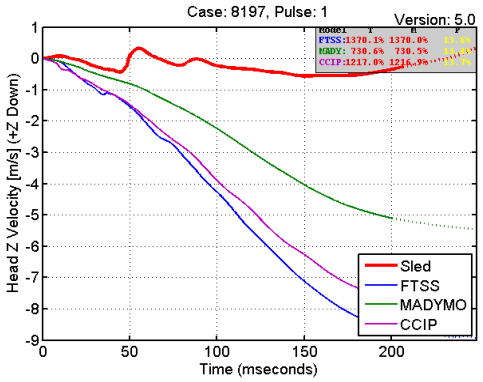
20G 70ms +X

Figure C-3-56: 8212 Head Y Translational Velocity

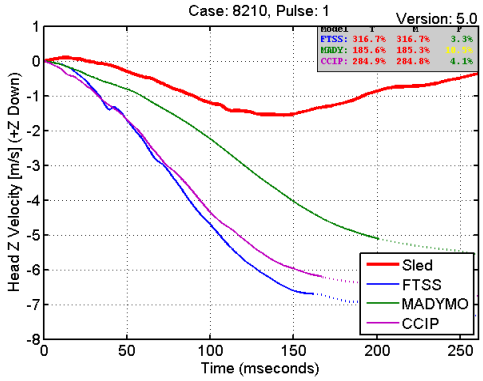
C.3.9 Head Z Translational Velocity



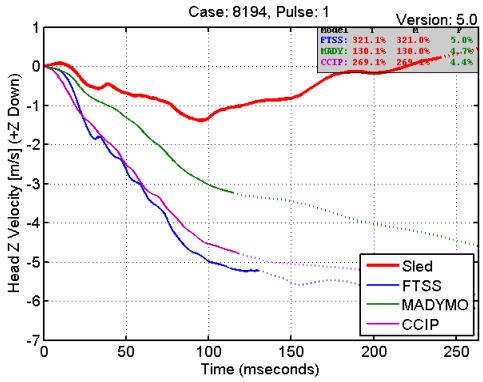
10G 110ms +X
Figure C-3-57: 8196 Head Z Translational Velocity



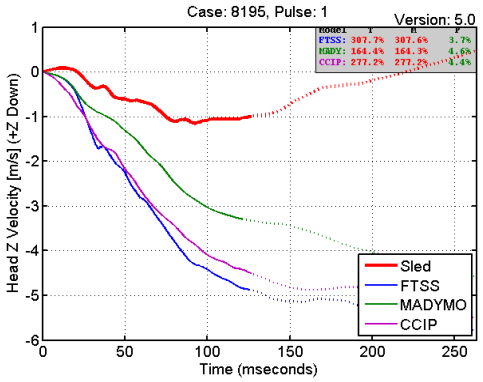
10G 110ms +X
Figure C-3-60: 8197 Head Z Translational Velocity



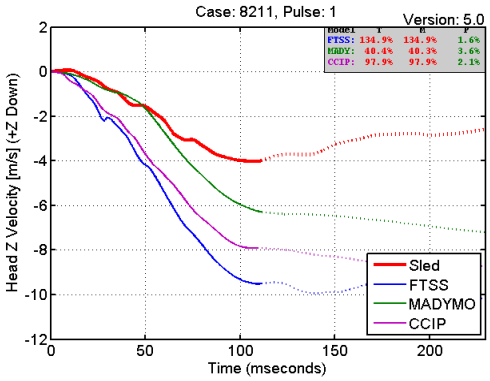
10G 70ms +X
Figure C-3-58: 8210 Head Z Translational Velocity



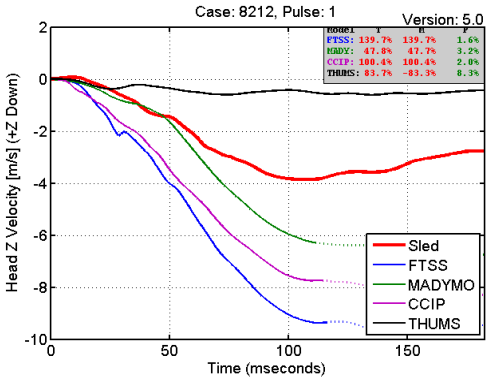
10G 30ms +X
Figure C-3-59: 8194 Head Z Translational Velocity



10G 30ms +X
Figure C-3-61: 8195 Head Z Translational Velocity

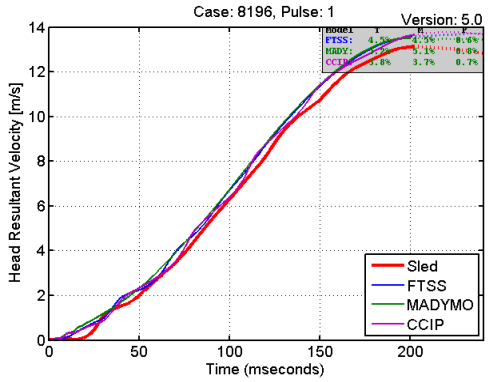


20G 70ms +X
Figure C-3-62: 8211 Head Z Translational Velocity

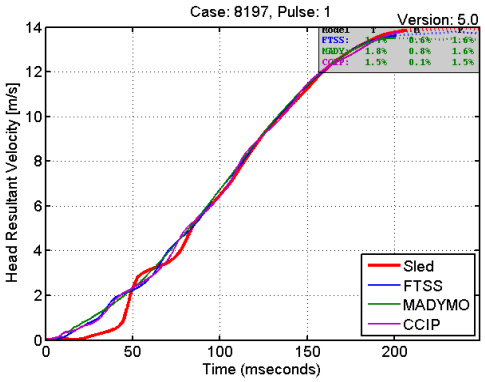


20G 70ms +X
Figure C-3-63: 8212 Head Z Translational Velocity

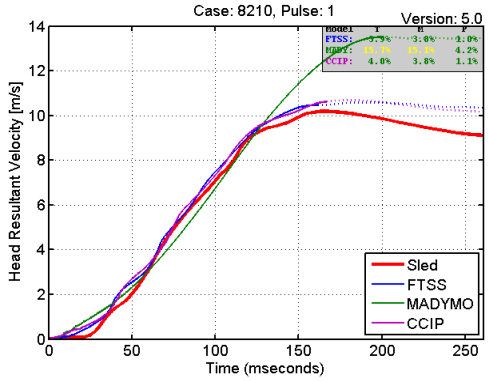
C.3.10 Head Resultant Translational Velocity



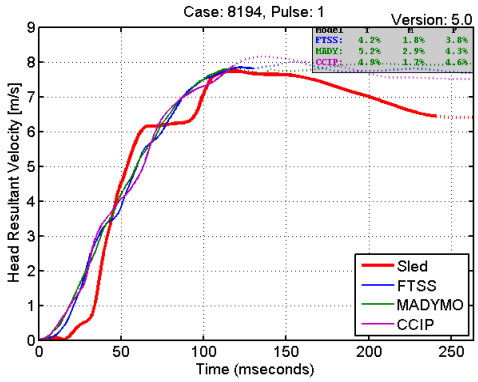
10G 110ms +X
Figure C-3-64: 8196 Head Resultant Translational Velocity



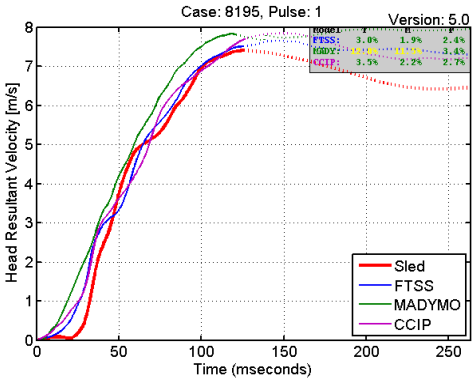
10G 110ms +X
Figure C-3-67: 8197 Head Resultant Translational Velocity



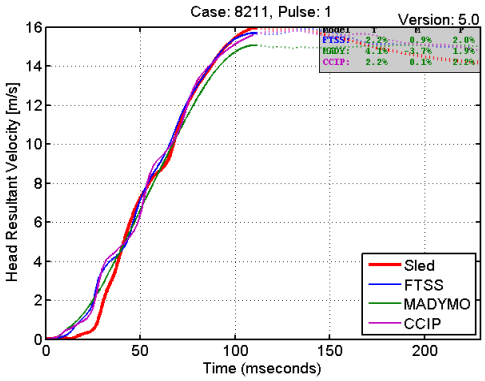
10G 70ms +X
Figure C-3-65: 8210 Head Resultant Translational Velocity



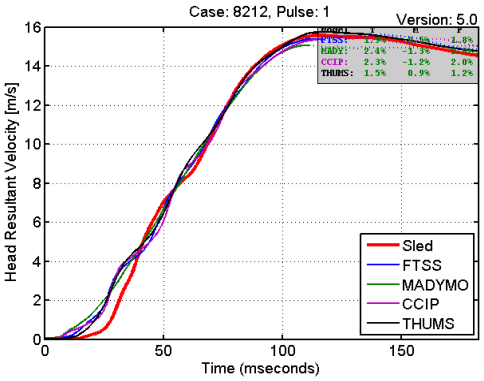
10G 30ms +X
Figure C-3-66: 8194 Head Resultant Translational Velocity



10G 30ms +X
Figure C-3-68: 8195 Head Resultant Translational Velocity

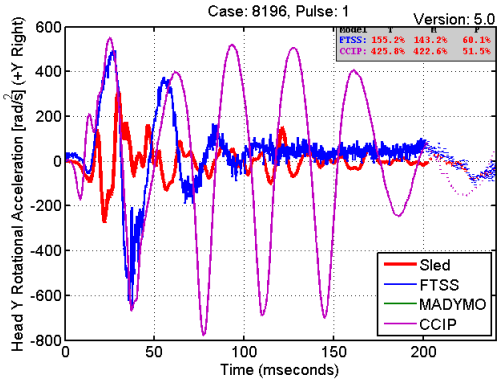


20G 70ms +X
Figure C-3-69: 8211 Head Resultant Translational Velocity

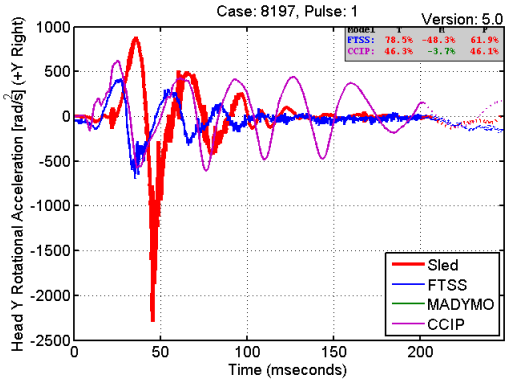


20G 70ms +X
Figure C-3-70: 8212 Head Resultant Translational Velocity

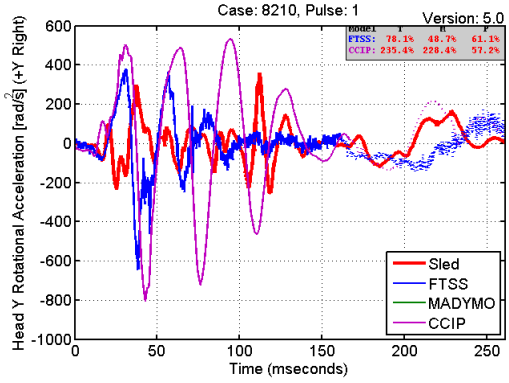
C.3.11 Head Y Rotational Acceleration



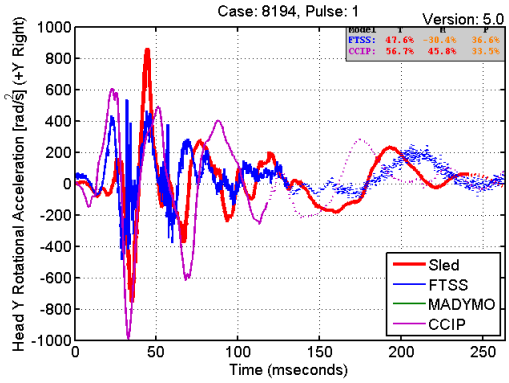
10G 110ms +X
Figure C-3-71: 8196 Head Y Rotational Acceleration



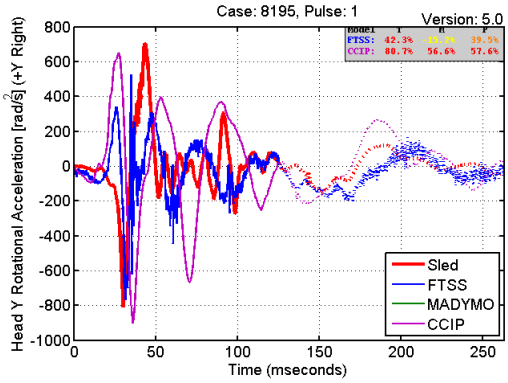
10G 110ms +X
Figure C-3-74: 8197 Head Y Rotational Acceleration



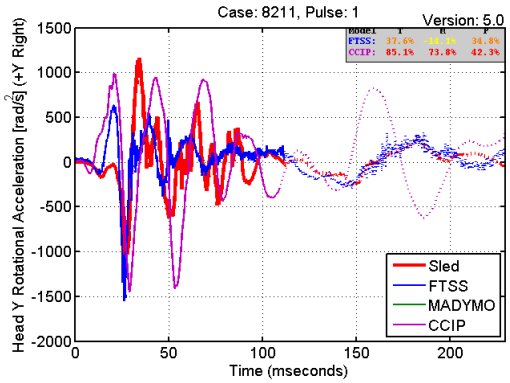
10G 70ms +X
Figure C-3-72: 8210 Head Y Rotational Acceleration



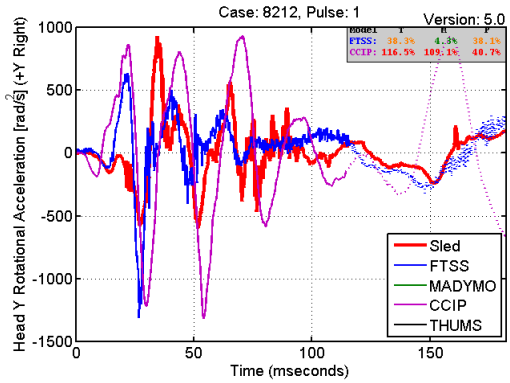
10G 30ms +X
Figure C-3-73: 8194 Head Y Rotational Acceleration



10G 30ms +X
Figure C-3-75: 8195 Head Y Rotational Acceleration

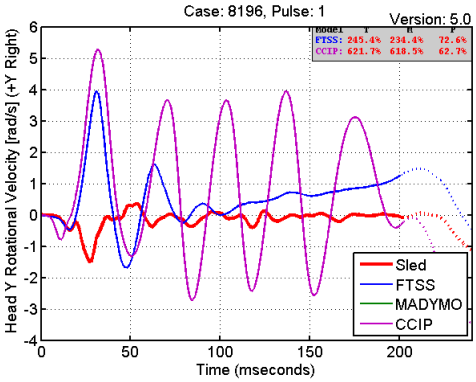


20G 70ms +X
Figure C-3-76: 8211 Head Y Rotational Acceleration

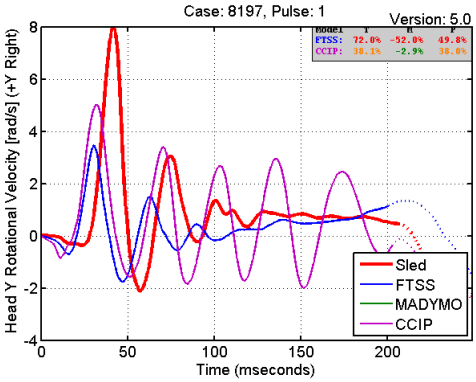


20G 70ms +X
Figure C-3-77: 8212 Head Y Rotational Acceleration

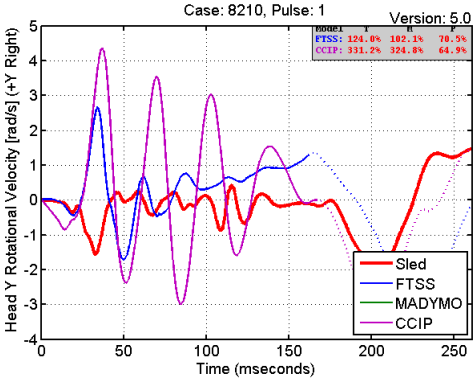
C.3.12 Head Y Rotational Velocity



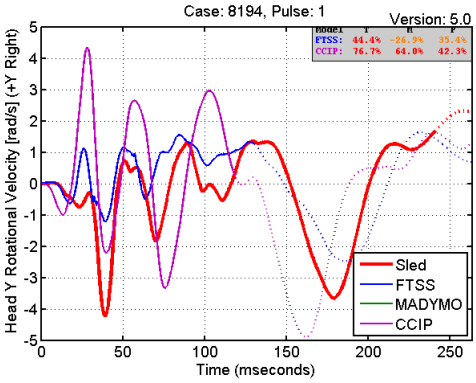
10G 110ms +X
Figure C-3-78: 8196 Head Y Rotational Velocity



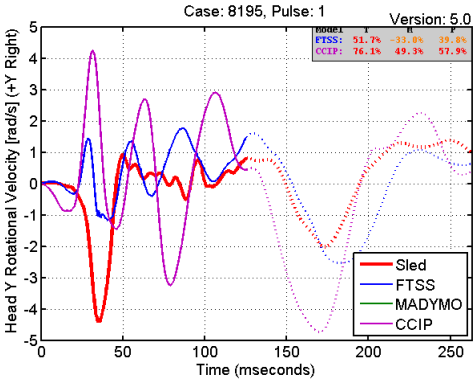
10G 110ms +X
Figure C-3-81: 8197 Head Y Rotational Velocity



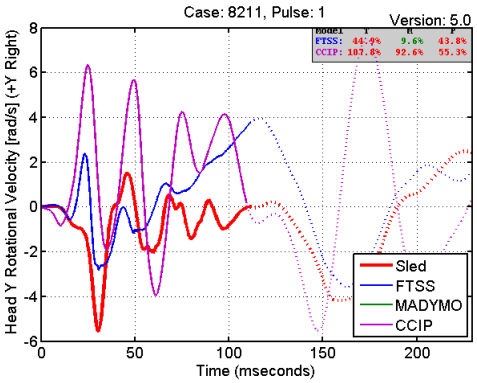
10G 70ms +X
Figure C-3-79: 8210 Head Y Rotational Velocity



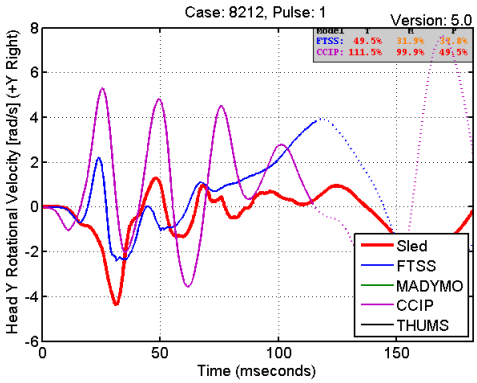
10G 30ms +X
Figure C-3-80: 8194 Head Y Rotational Velocity



10G 30ms +X
Figure C-3-82: 8195 Head Y Rotational Velocity

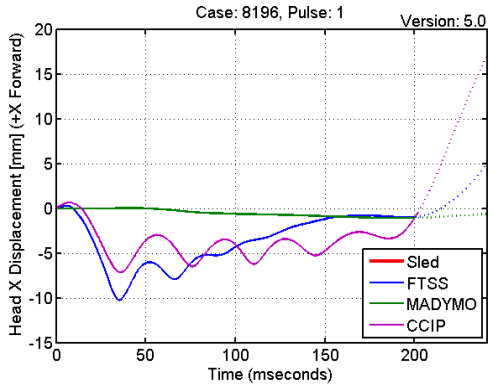


20G 70ms +X
Figure C-3-83: 8211 Head Y Rotational Velocity



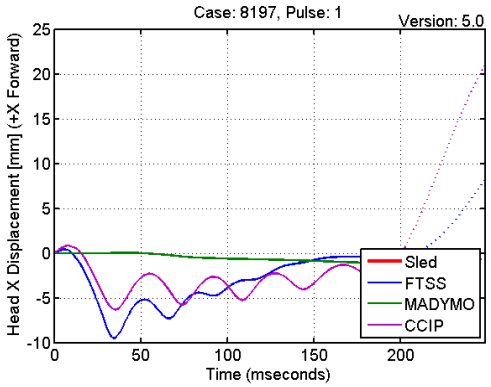
20G 70ms +X
Figure C-3-84: 8212 Head Y Rotational Velocity

C.3.13 Head X Movement



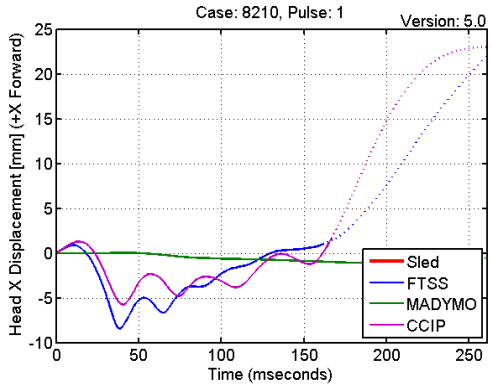
10G 110ms +X

Figure C-3-85: 8196 Head X Movement



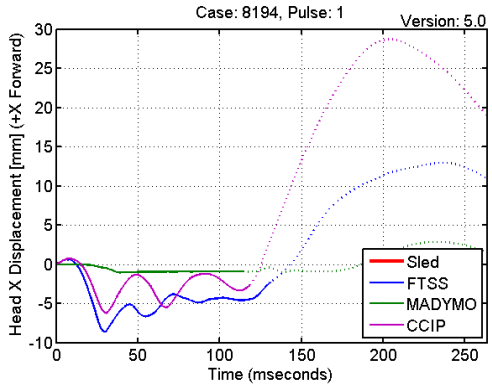
10G 110ms +X

Figure C-3-88: 8197 Head X Movement



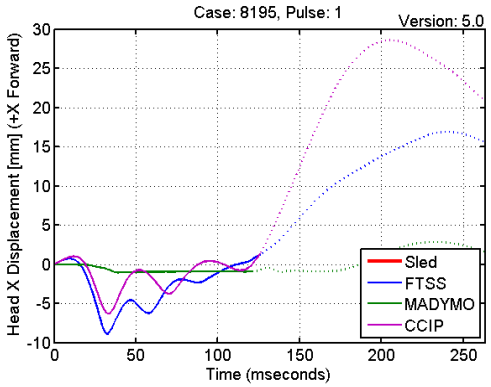
10G 70ms +X

Figure C-3-86: 8210 Head X Movement



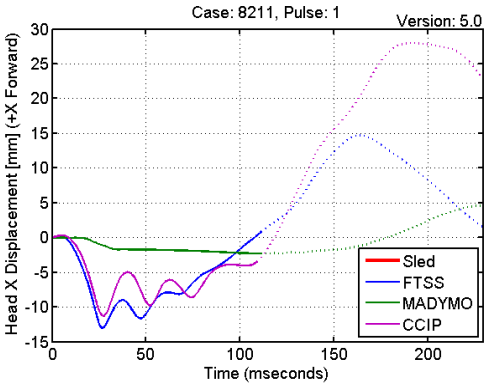
10G 30ms +X

Figure C-3-87: 8194 Head X Movement



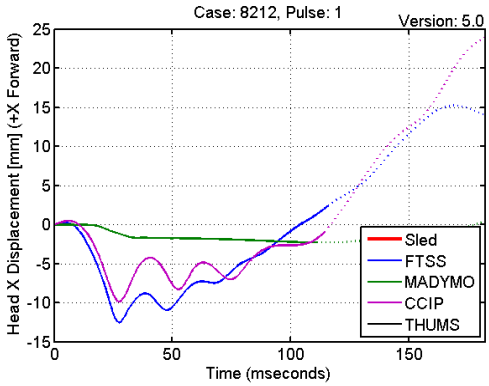
10G 30ms +X

Figure C-3-89: 8195 Head X Movement



20G 70ms +X

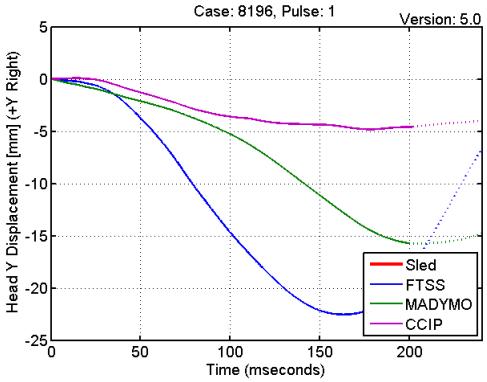
Figure C-3-90: 8211 Head X Movement



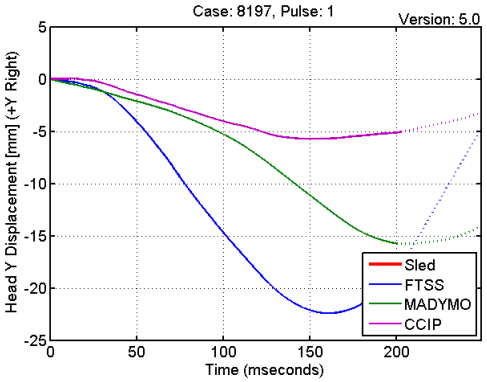
20G 70ms +X

Figure C-3-91: 8212 Head X Movement

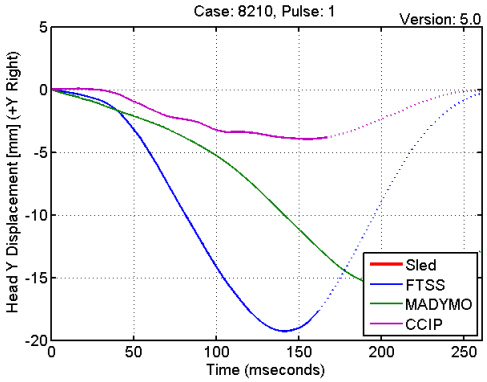
C.3.14 Head Y Movement



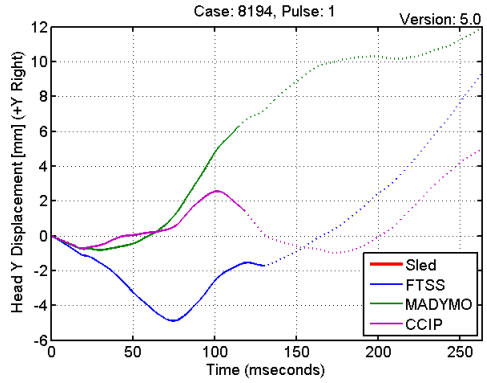
10G 110ms +X
Figure C-3-92: 8196 Head Y Movement



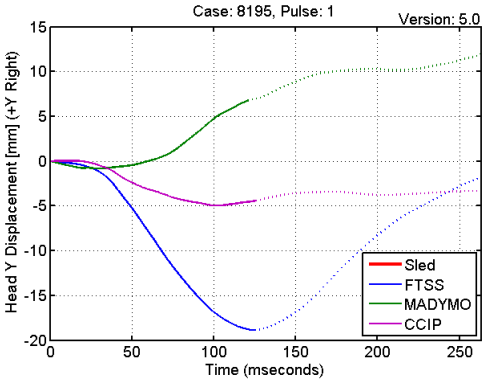
10G 110ms +X
Figure C-3-95: 8197 Head Y Movement



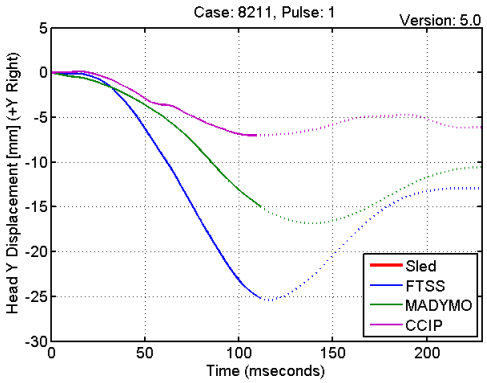
10G 70ms +X
Figure C-3-93: 8210 Head Y Movement



10G 30ms +X
Figure C-3-94: 8194 Head Y Movement

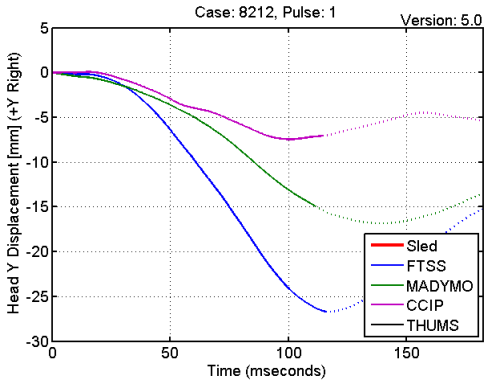


10G 30ms +X
Figure C-3-96: 8195 Head Y Movement



20G 70ms +X

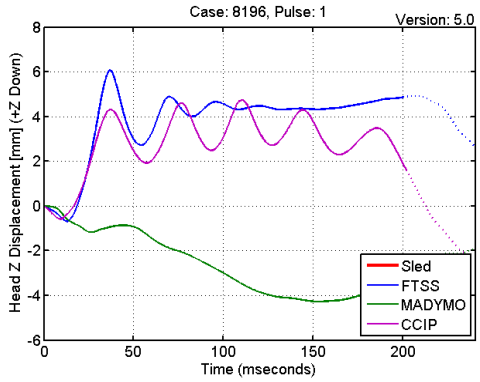
Figure C-3-97: 8211 Head Y Movement



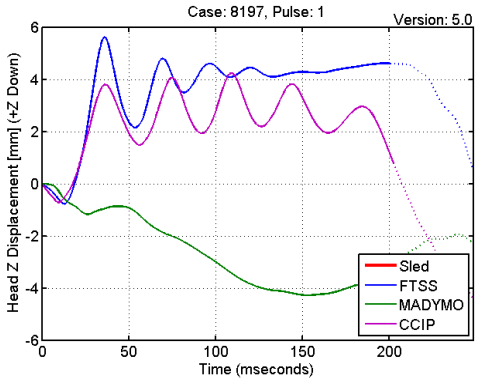
20G 70ms +X

Figure C-3-98: 8212 Head Y Movement

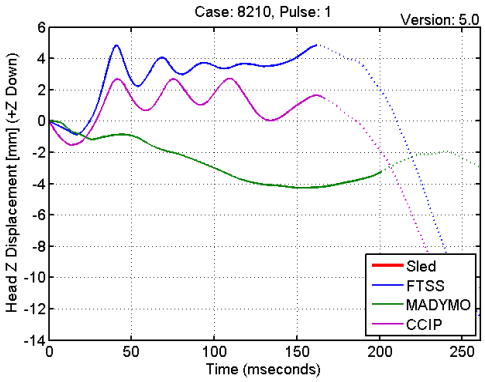
C.3.15 Head Z Movement



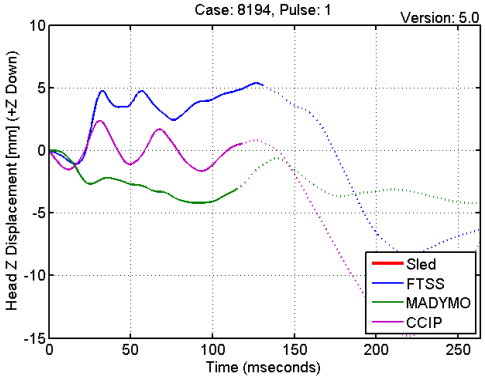
10G 110ms +X
Figure C-3-99: 8196 Head Z Movement



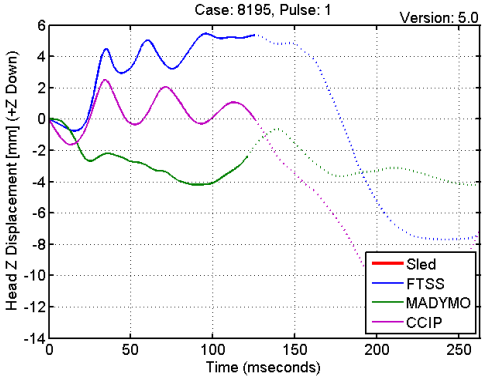
10G 110ms +X
Figure C-3-102: 8197 Head Z Movement



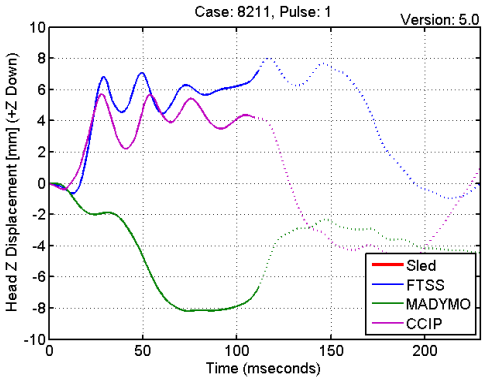
10G 70ms +X
Figure C-3-100: 8210 Head Z Movement



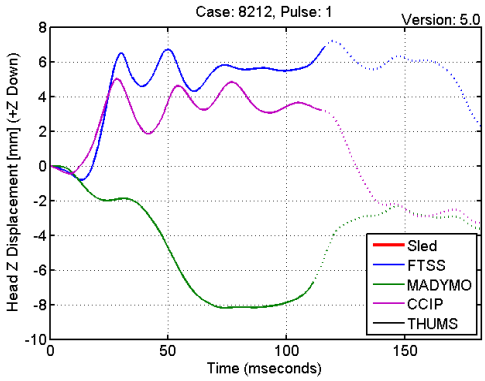
10G 30ms +X
Figure C-3-101: 8194 Head Z Movement



10G 30ms +X
Figure C-3-103: 8195 Head Z Movement

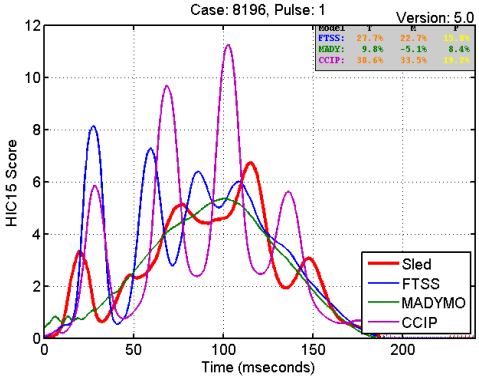


20G 70ms +X
Figure C-3-104: 8211 Head Z Movement

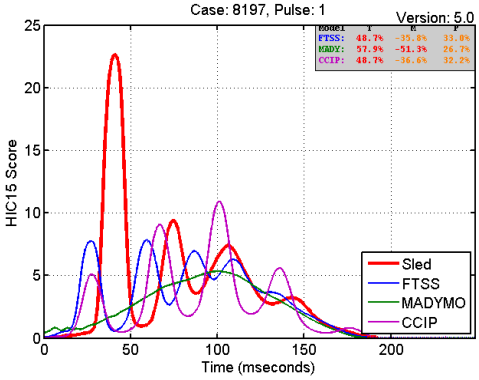


20G 70ms +X
Figure C-3-105: 8212 Head Z Movement

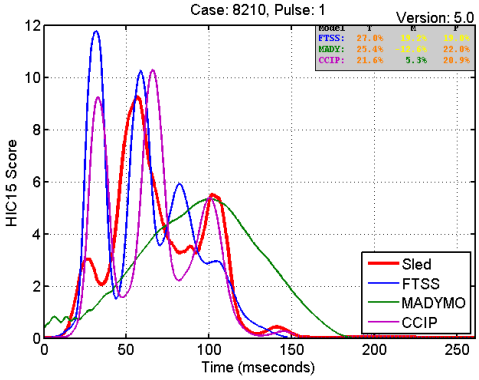
C.3.16 HIC 15



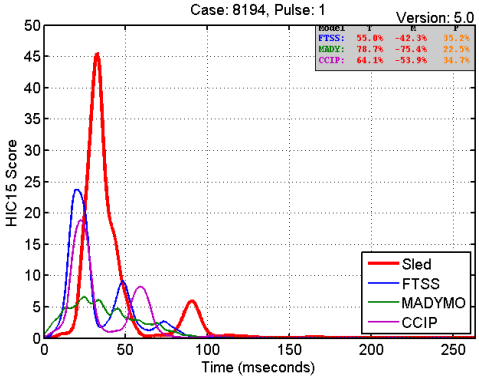
10G 110ms +X
Figure C-3-106: 8196 HIC 15



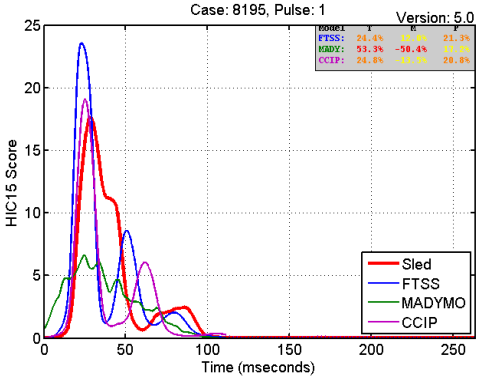
10G 110ms +X
Figure C-3-109: 8197 HIC 15



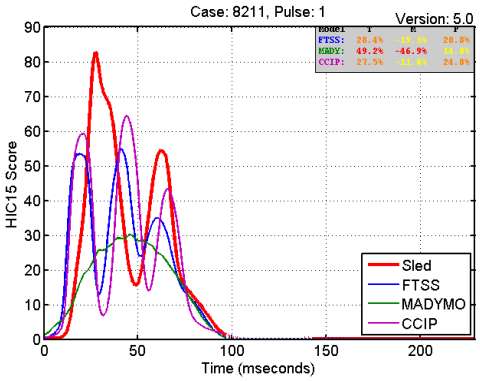
10G 70ms +X
Figure C-3-107: 8210 HIC 15



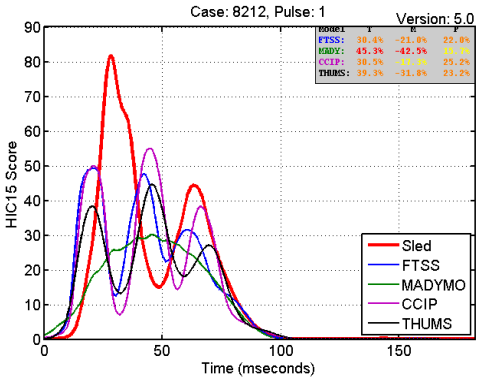
10G 30ms +X
Figure C-3-108: 8194 HIC 15



10G 30ms +X
Figure C-3-110: 8195 HIC 15

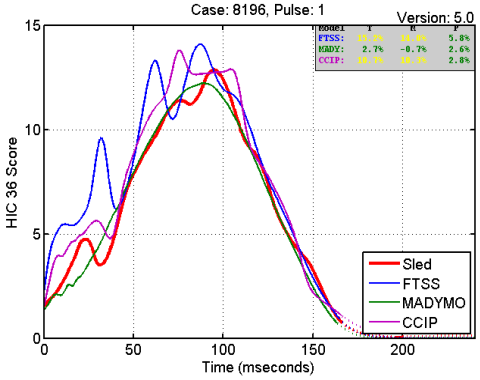


20G 70ms +X
Figure C-3-111: 8211 HIC 15

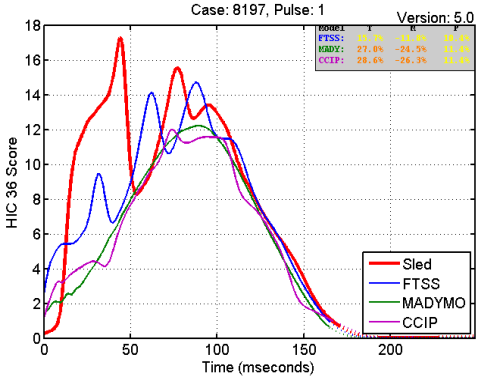


20G 70ms +X
Figure C-3-112: 8212 HIC 15

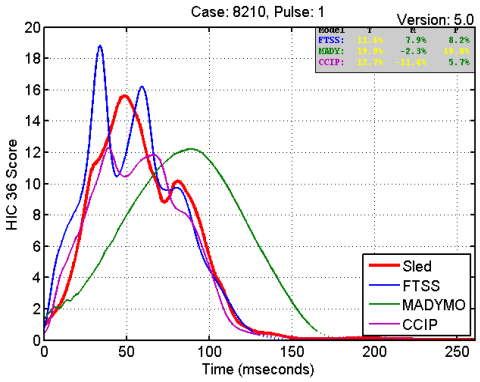
C.3.17 HIC 36



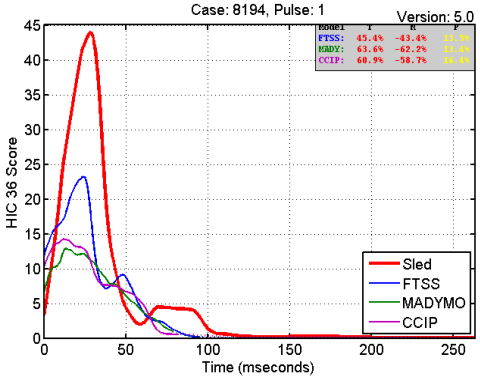
10G 110ms +X
Figure C-3-113: 8196 HIC 36



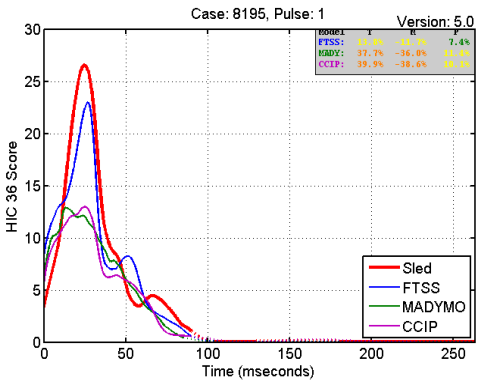
10G 110ms +X
Figure C-3-116: 8197 HIC 36



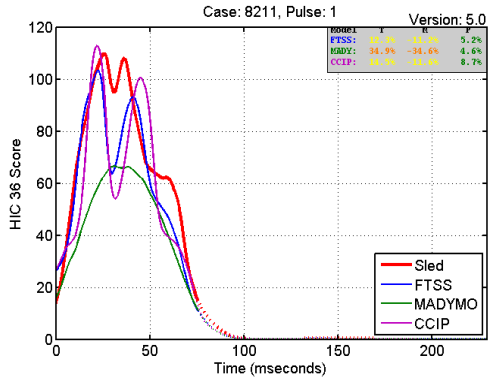
10G 70ms +X
Figure C-3-114: 8210 HIC 36



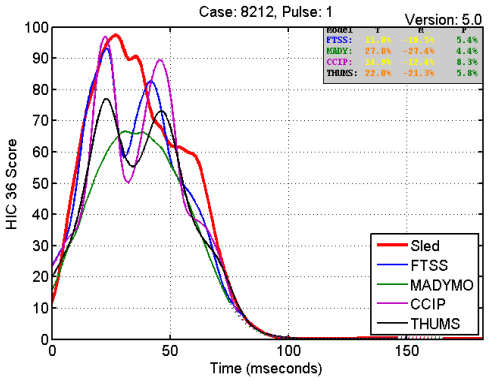
10G 30ms +X
Figure C-3-115: 8194 HIC 36



10G 30ms +X
Figure C-3-117: 8195 HIC 36

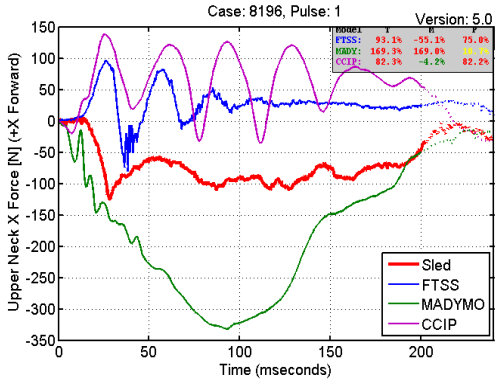


20G 70ms +X
Figure C-3-118: 8211 HIC 36

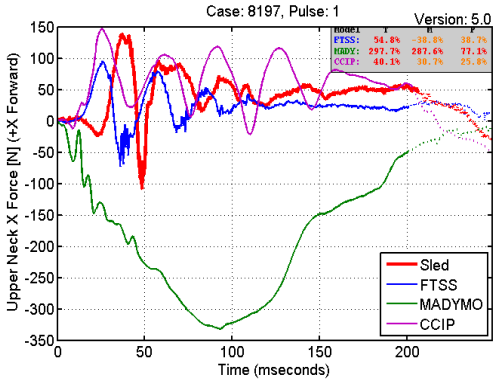


20G 70ms +X
Figure C-3-119: 8212 HIC 36

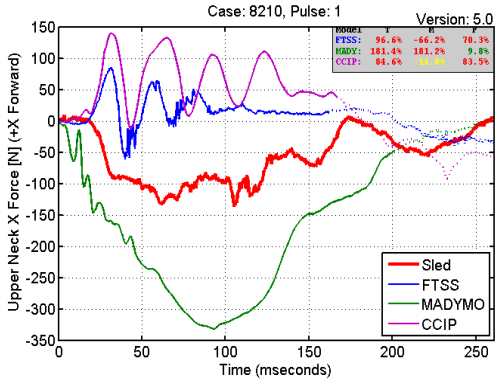
C.3.18 Neck X Force



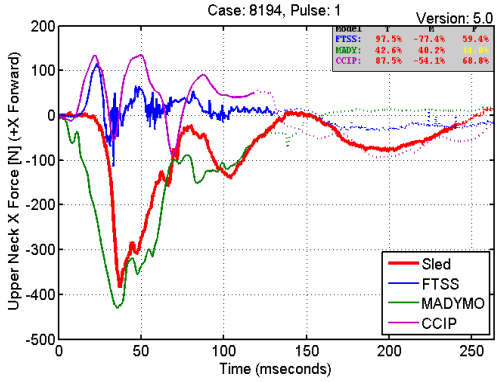
10G 110ms +X
Figure C-3-120: 8196 Neck X Force



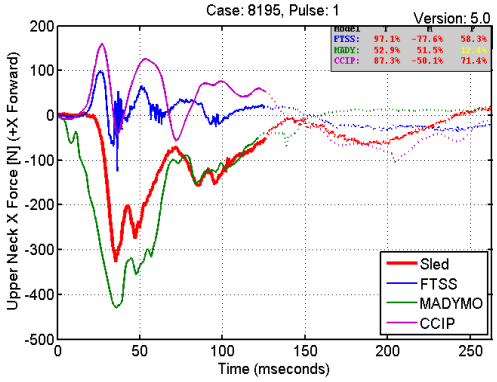
10G 110ms +X
Figure C-3-123: 8197 Neck X Force



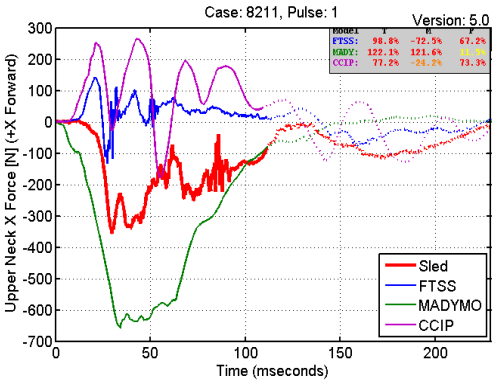
10G 70ms +X
Figure C-3-121: 8210 Neck X Force



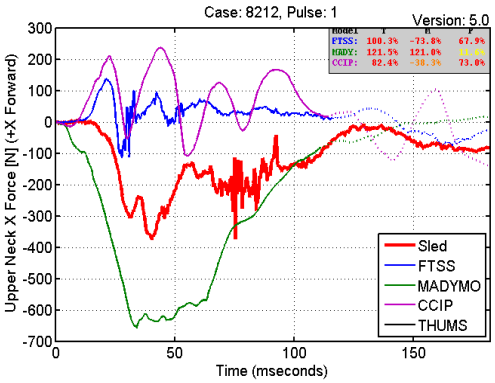
10G 30ms +X
Figure C-3-122: 8194 Neck X Force



10G 30ms +X
Figure C-3-124: 8195 Neck X Force

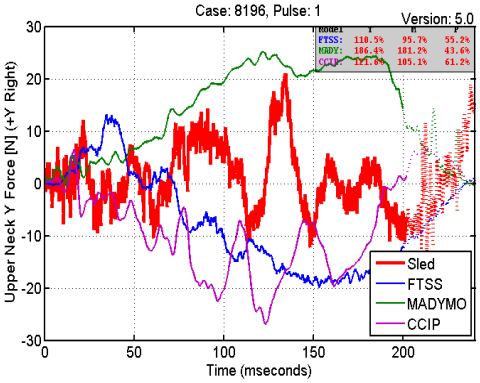


20G 70ms +X
Figure C-3-125: 8211 Neck X Force

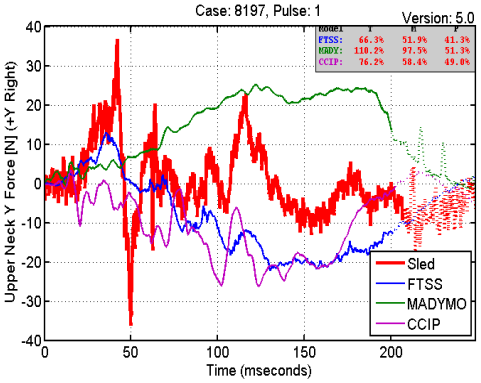


20G 70ms +X
Figure C-3-126: 8212 Neck X Force

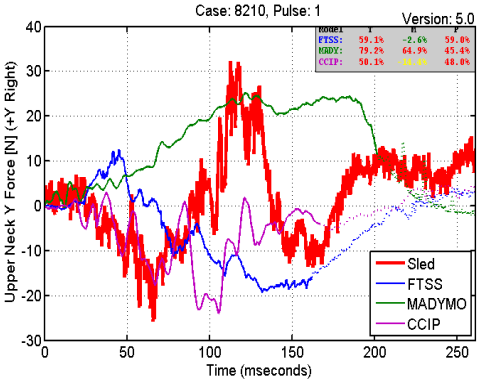
C.3.19 Neck Y Force



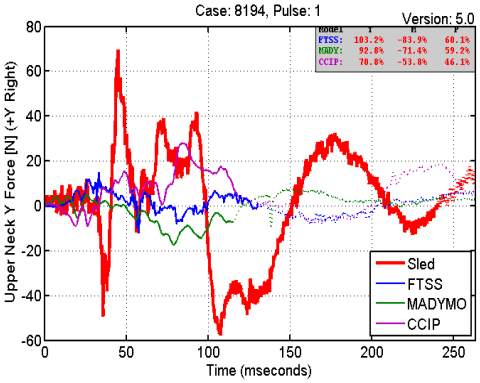
10G 110ms +X
Figure C-3-127: 8196 Neck Y Force



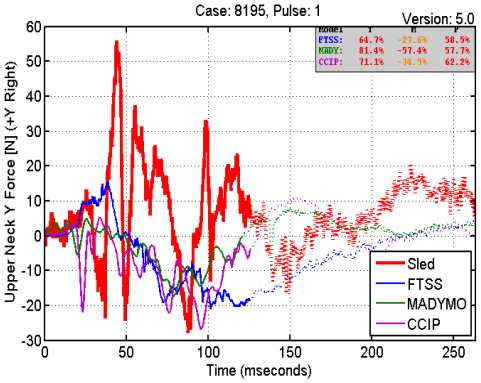
10G 110ms +X
Figure C-3-130: 8197 Neck Y Force



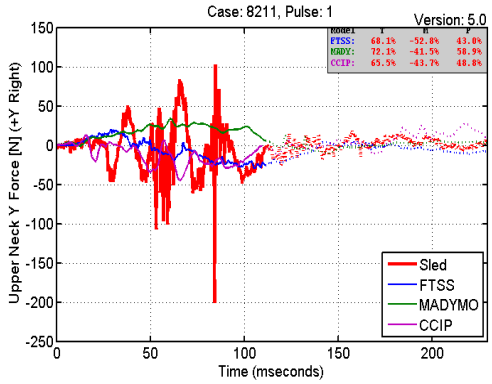
10G 70ms +X
Figure C-3-128: 8210 Neck Y Force



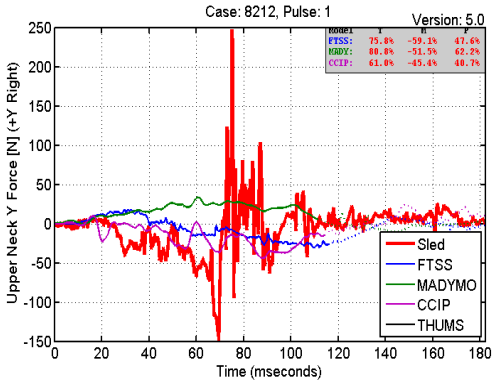
10G 30ms +X
Figure C-3-129: 8194 Neck Y Force



10G 30ms +X
Figure C-3-131: 8195 Neck Y Force

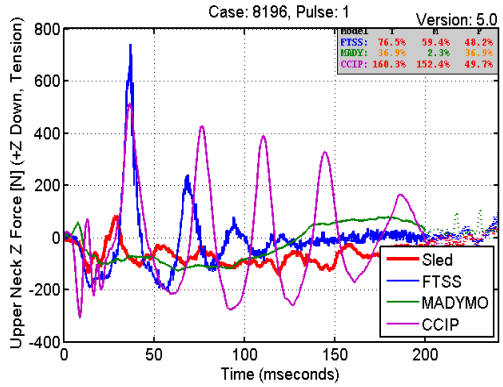


20G 70ms +X
Figure C-3-132: 8211 Neck Y Force



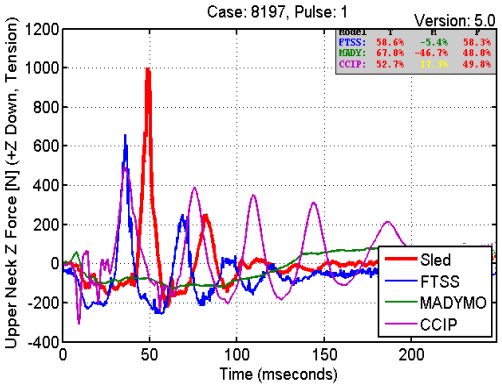
20G 70ms +X
Figure C-3-133: 8212 Neck Y Force

C.3.20 Neck Z Force



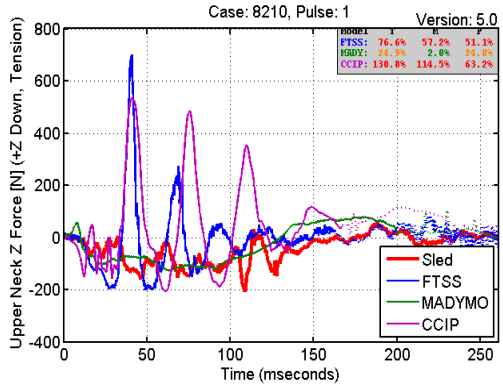
10G 110ms +X

Figure C-3-134: 8196 Neck Z Force



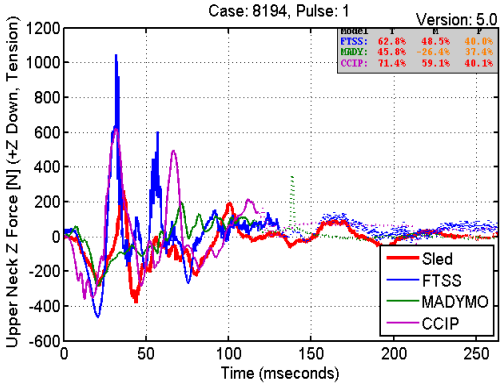
10G 110ms +X

Figure C-3-137: 8197 Neck Z Force



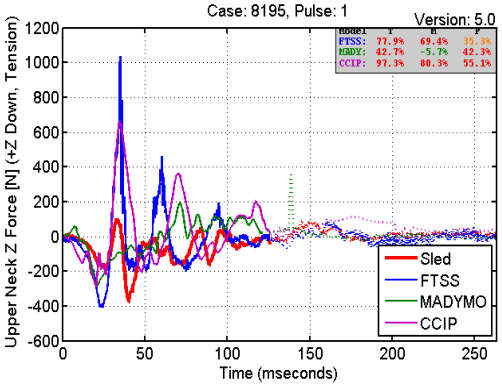
10G 70ms +X

Figure C-3-135: 8210 Neck Z Force



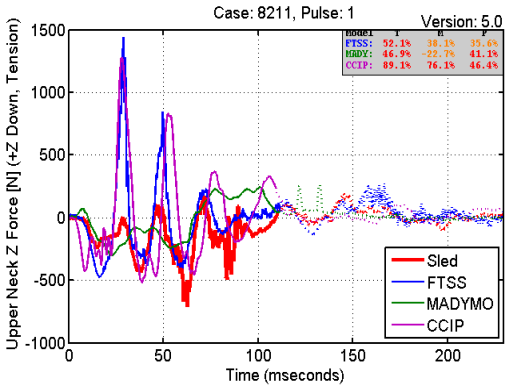
10G 30ms +X

Figure C-3-136: 8194 Neck Z Force

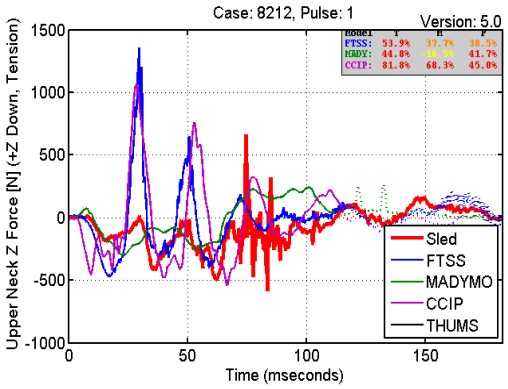


10G 30ms +X

Figure C-3-138: 8195 Neck Z Force

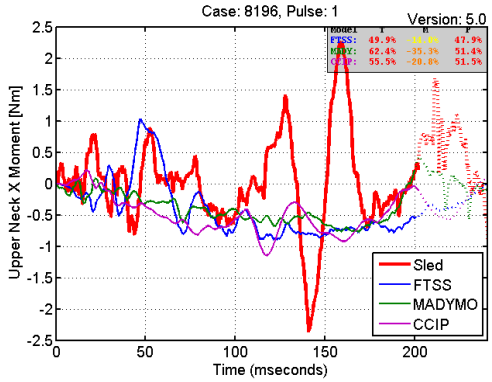


20G 70ms +X
Figure C-3-139: 8211 Neck Z Force



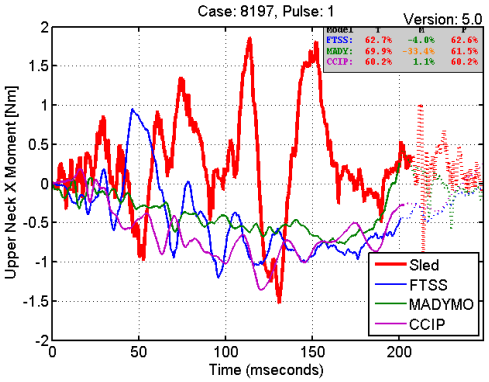
20G 70ms +X
Figure C-3-140: 8212 Neck Z Force

C.3.21 Neck X Moment



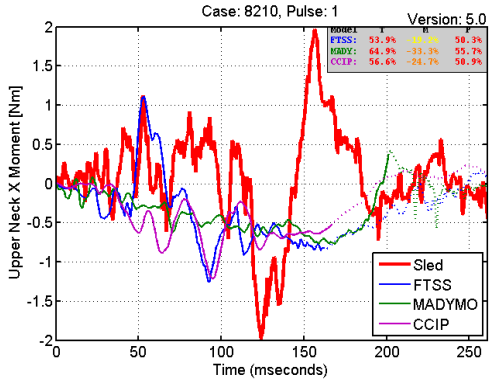
10G 110ms +X

Figure C-3-141: 8196 Neck X Moment



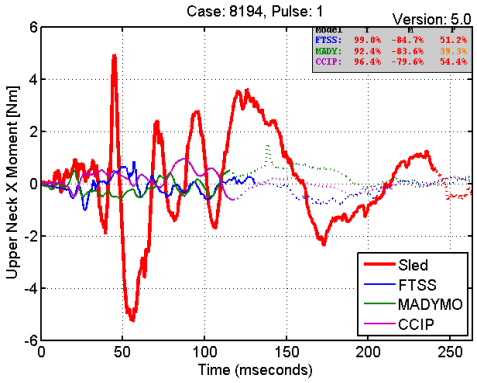
10G 110ms +X

Figure C-3-144: 8197 Neck X Moment



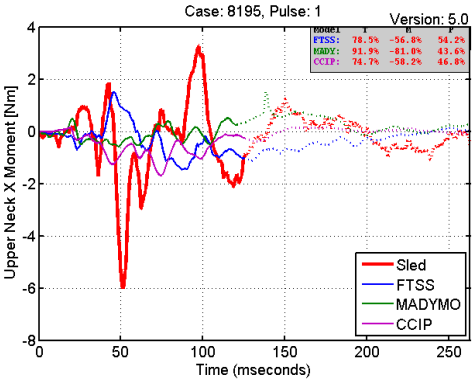
10G 70ms +X

Figure C-3-142: 8210 Neck X Moment



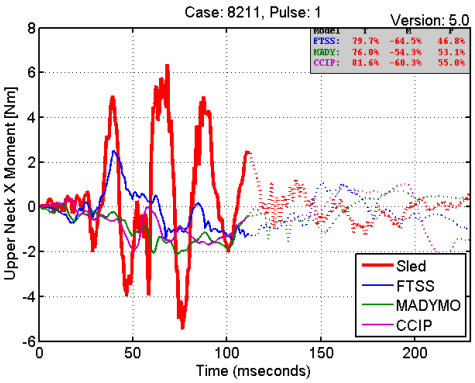
10G 30ms +X

Figure C-3-143: 8194 Neck X Moment

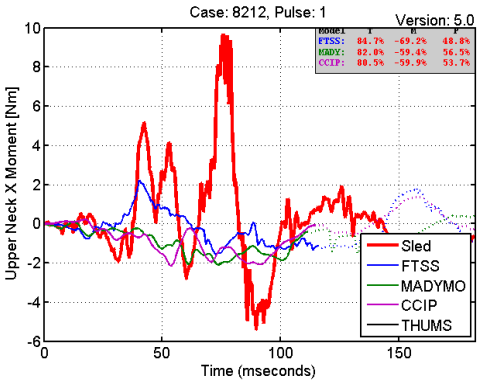


10G 30ms +X

Figure C-3-145: 8195 Neck X Moment

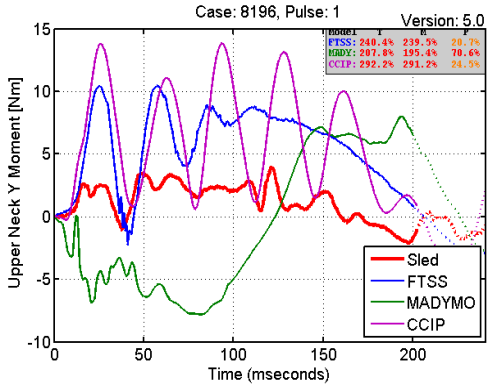


20G 70ms +X
Figure C-3-146: 8211 Neck X Moment



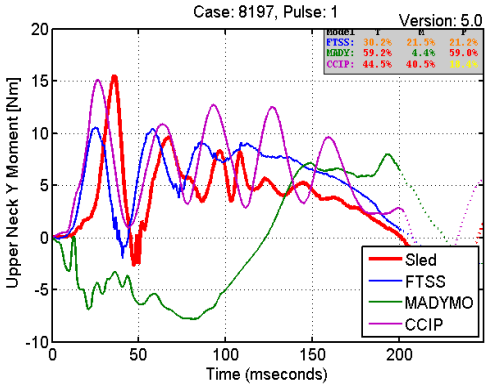
20G 70ms +X
Figure C-3-147: 8212 Neck X Moment

C.3.22 Neck Y Moment



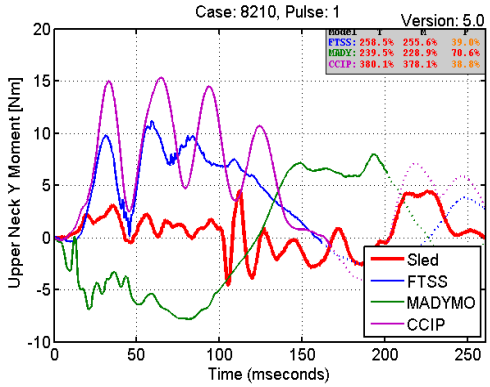
10G 110ms +X

Figure C-3-148: 8196 Neck Y Moment



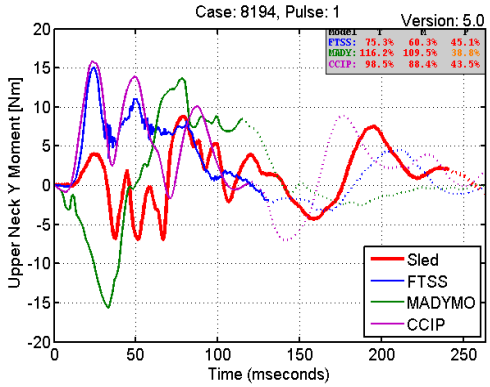
10G 110ms +X

Figure C-3-151: 8197 Neck Y Moment



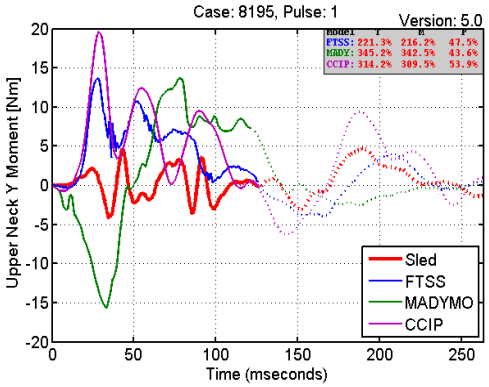
10G 70ms +X

Figure C-3-149: 8210 Neck Y Moment



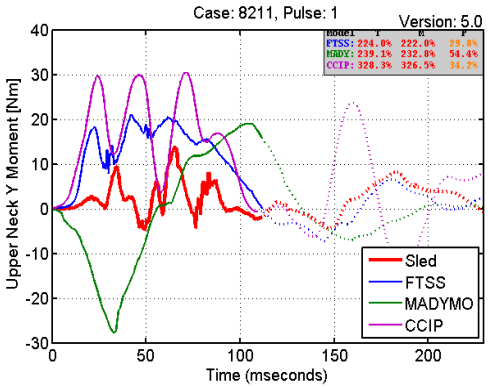
10G 30ms +X

Figure C-3-150: 8194 Neck Y Moment



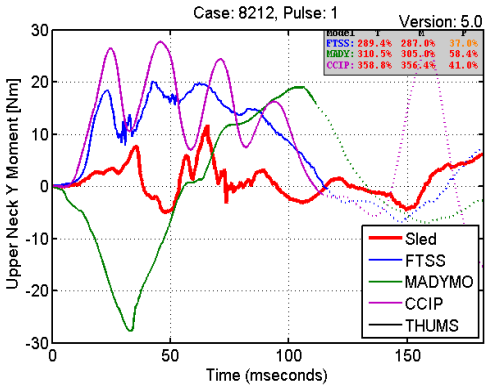
10G 30ms +X

Figure C-3-152: 8195 Neck Y Moment



20G 70ms +X

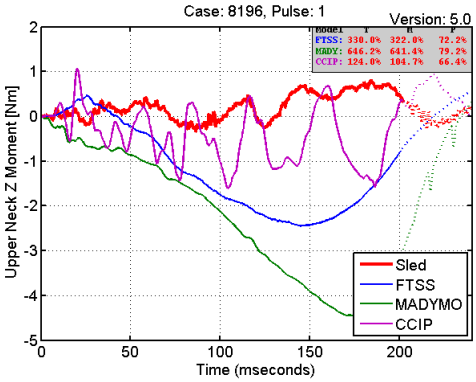
Figure C-3-153: 8211 Neck Y Moment



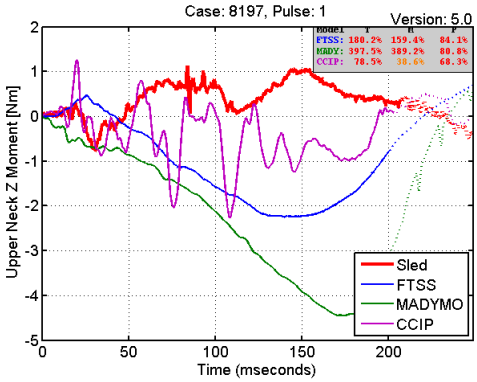
20G 70ms +X

Figure C-3-154: 8212 Neck Y Moment

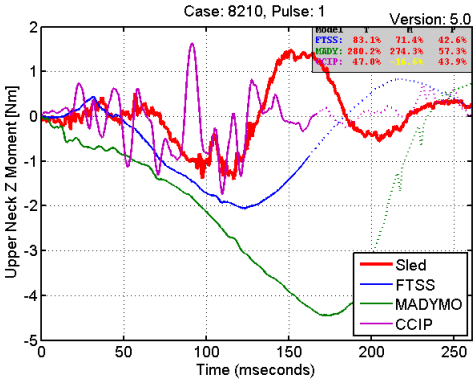
C.3.23 Neck Z Moment



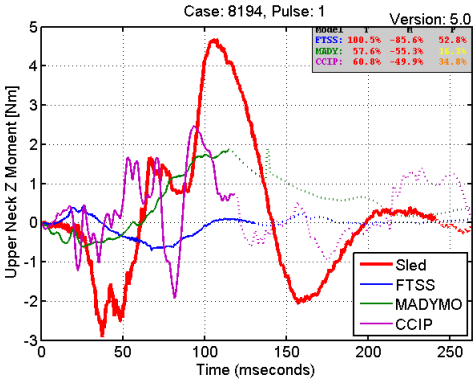
10G 110ms +X
Figure C-3-155: 8196 Neck Z Moment



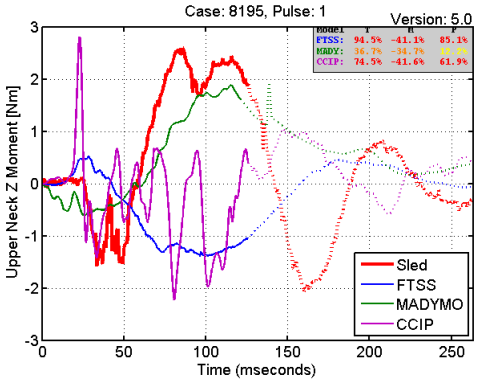
10G 110ms +X
Figure C-3-158: 8197 Neck Z Moment



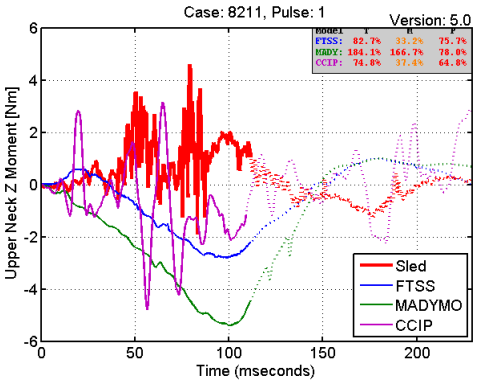
10G 70ms +X
Figure C-3-156: 8210 Neck Z Moment



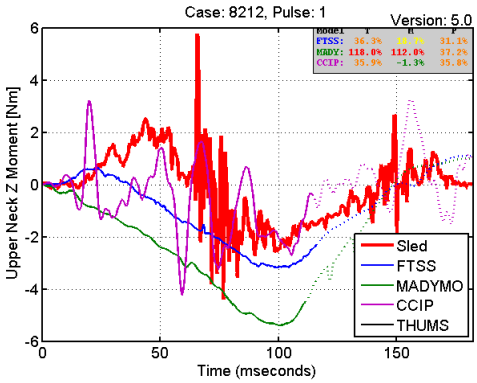
10G 30ms +X
Figure C-3-157: 8194 Neck Z Moment



10G 30ms +X
Figure C-3-159: 8195 Neck Z Moment

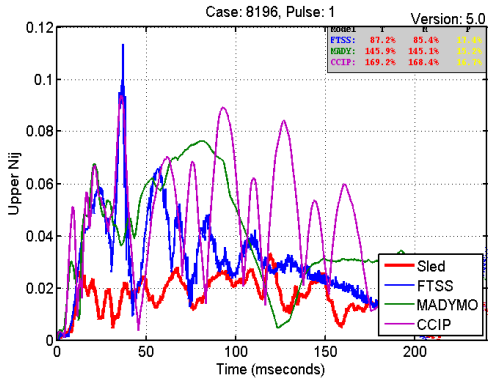


20G 70ms +X
Figure C-3-160: 8211 Neck Z Moment

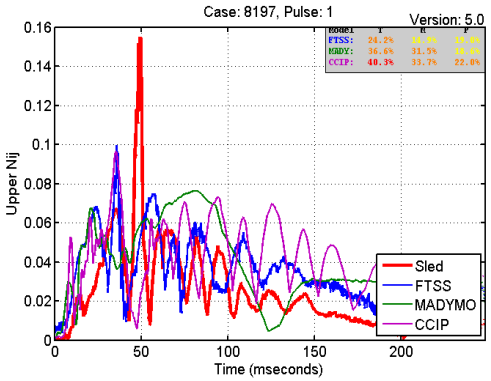


20G 70ms +X
Figure C-3-161: 8212 Neck Z Moment

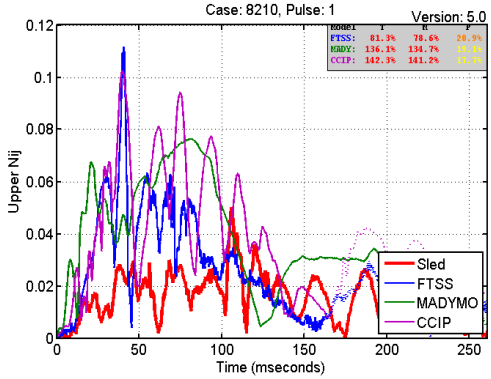
C.3.24 Nij



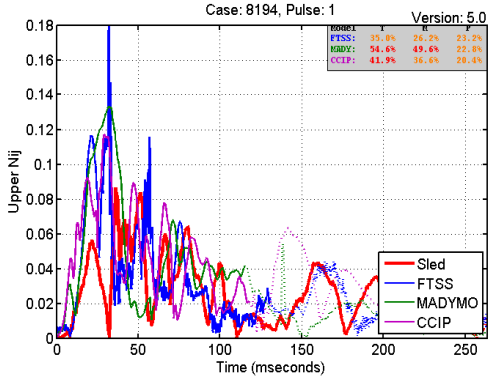
10G 110ms +X
Figure C-3-162: 8196 Nij



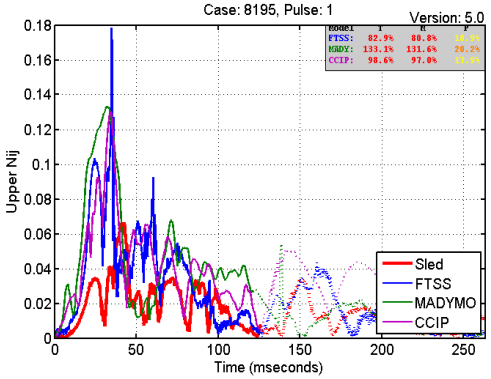
10G 110ms +X
Figure C-3-165: 8197 Nij



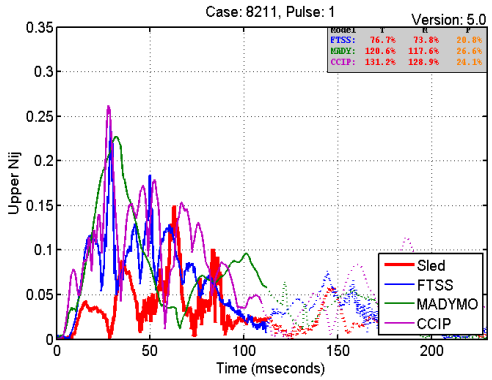
10G 70ms +X
Figure C-3-163: 8210 Nij



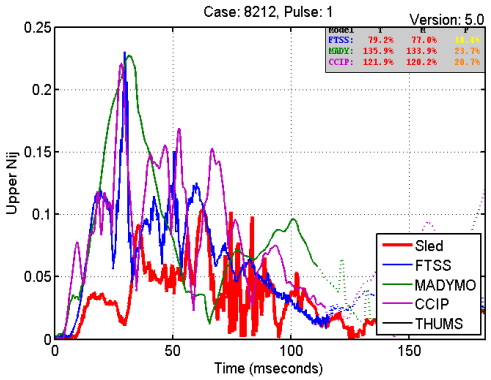
10G 30ms +X
Figure C-3-164: 8194 Nij



10G 30ms +X
Figure C-3-166: 8195 Nij

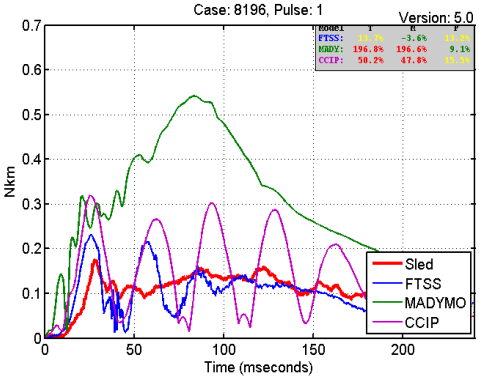


20G 70ms +X
Figure C-3-167: 8211 Nij

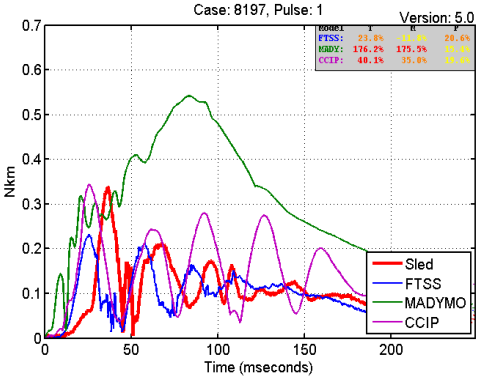


20G 70ms +X
Figure C-3-168: 8212 Nij

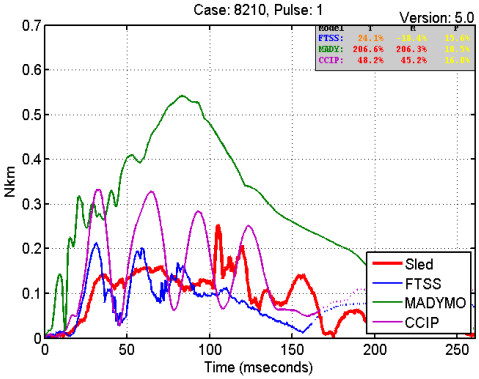
C.3.25 Nkm



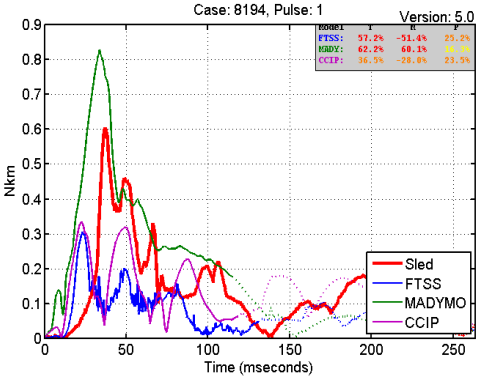
10G 110ms +X
Figure C-3-169: 8196 Nkm



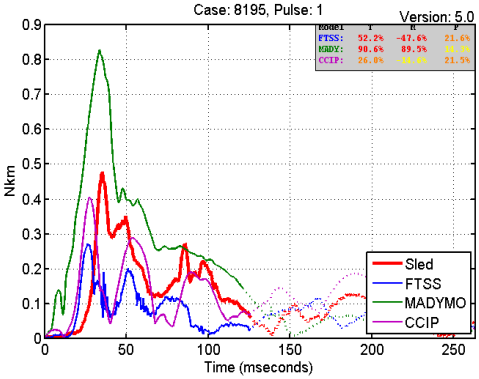
10G 110ms +X
Figure C-3-172: 8197 Nkm



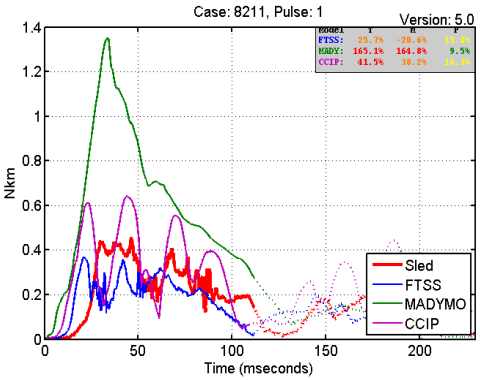
10G 70ms +X
Figure C-3-170: 8210 Nkm



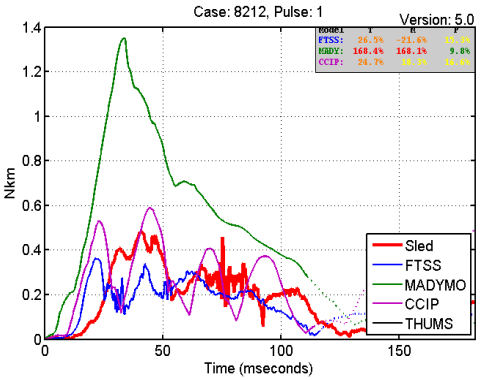
10G 30ms +X
Figure C-3-171: 8194 Nkm



10G 30ms +X
Figure C-3-173: 8195 Nkm

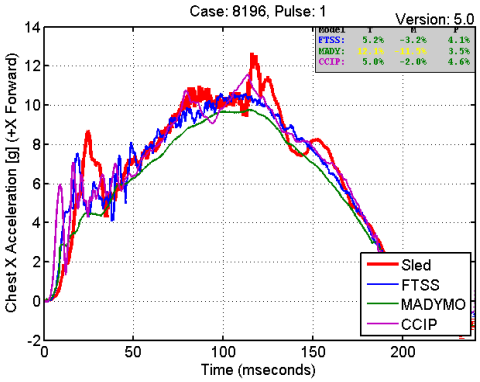


20G 70ms +X
Figure C-3-174: 8211 Nkm



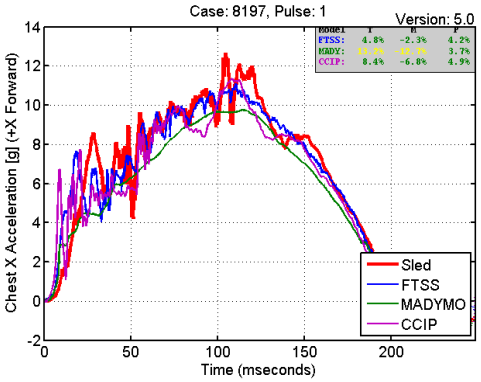
20G 70ms +X
Figure C-3-175: 8212 Nkm

C.3.26 Chest X Acceleration



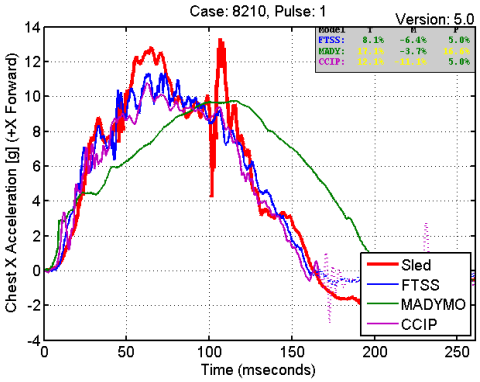
10G 110ms +X

Figure C-3-176: 8196 Chest X Acceleration



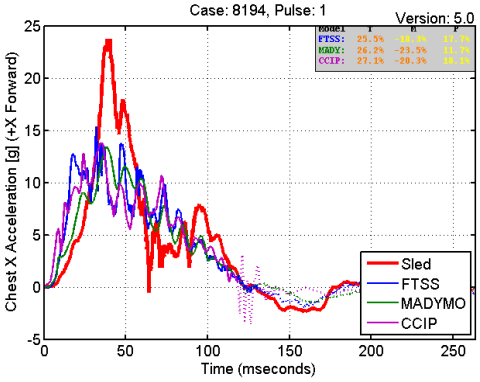
10G 110ms +X

Figure C-3-179: 8197 Chest X Acceleration



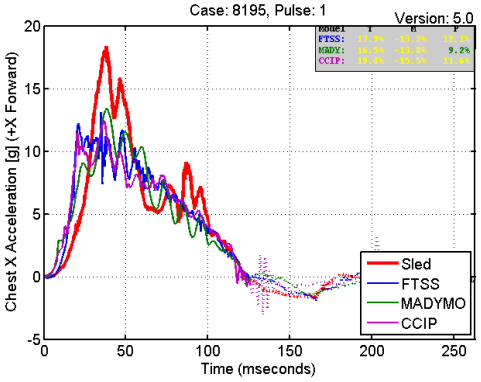
10G 70ms +X

Figure C-3-177: 8210 Chest X Acceleration



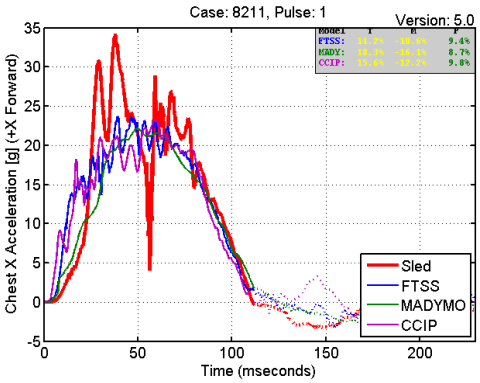
10G 30ms +X

Figure C-3-178: 8194 Chest X Acceleration

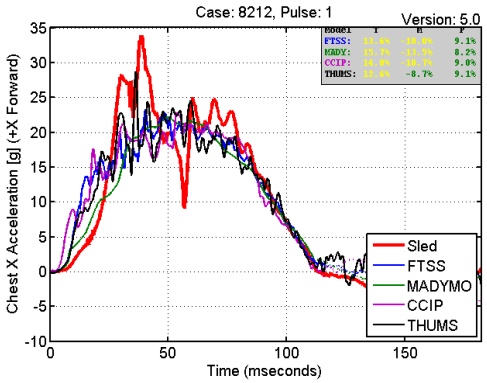


10G 30ms +X

Figure C-3-180: 8195 Chest X Acceleration

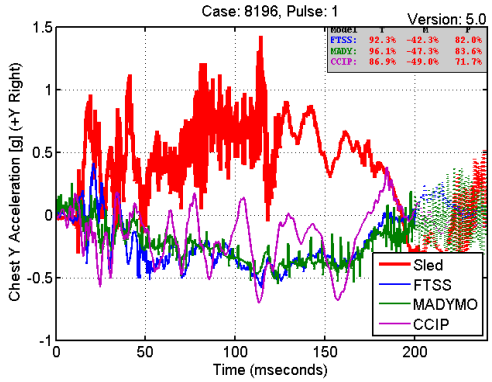


20G 70ms +X
Figure C-3-181: 8211 Chest X Acceleration



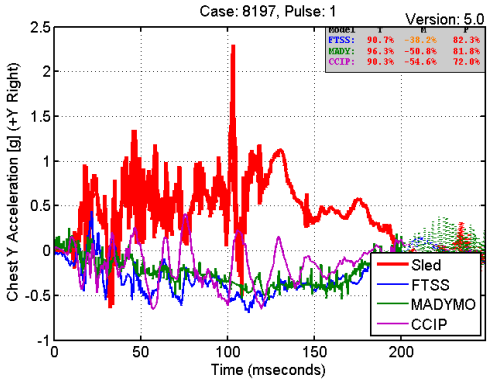
20G 70ms +X
Figure C-3-182: 8212 Chest X Acceleration

C.3.27 Chest Y Acceleration



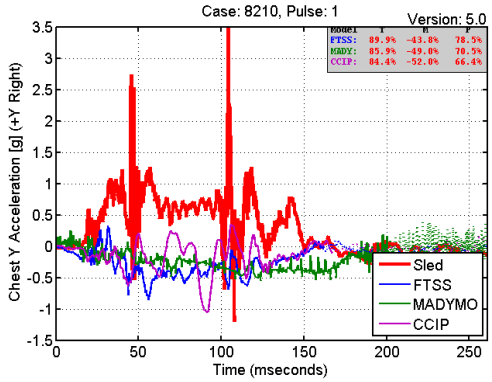
10G 110ms +X

Figure C-3-183: 8196 Chest Y Acceleration



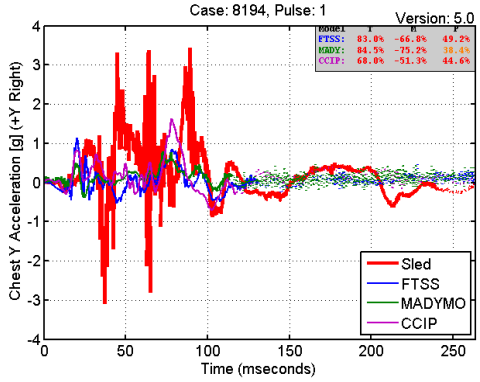
10G 110ms +X

Figure C-3-186: 8197 Chest Y Acceleration



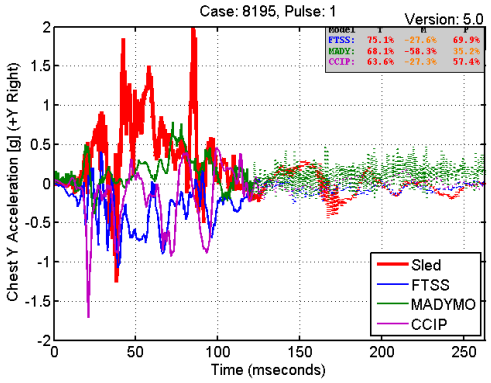
10G 70ms +X

Figure C-3-184: 8210 Chest Y Acceleration



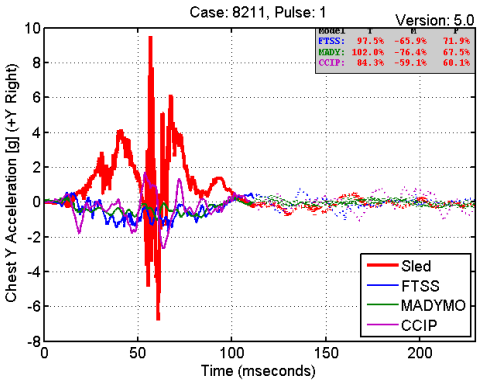
10G 30ms +X

Figure C-3-185: 8194 Chest Y Acceleration

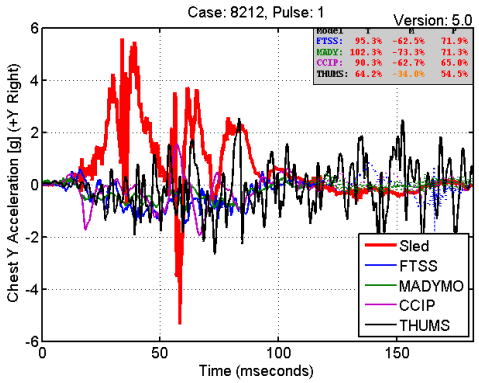


10G 30ms +X

Figure C-3-187: 8195 Chest Y Acceleration

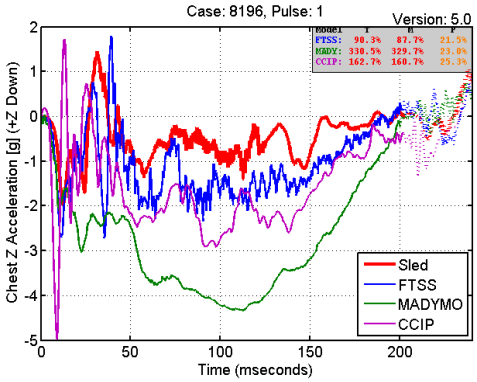


20G 70ms +X
Figure C-3-188: 8211 Chest Y Acceleration



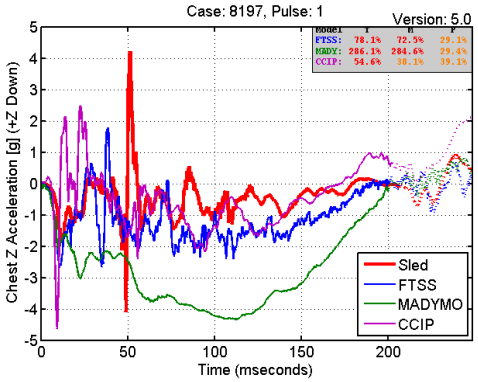
20G 70ms +X
Figure C-3-189: 8212 Chest Y Acceleration

C.3.28 Chest Z Acceleration



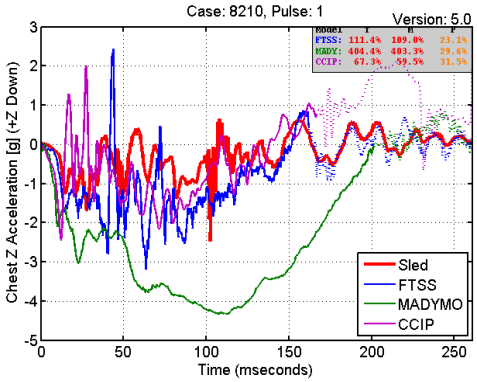
10G 110ms +X

Figure C-3-190: 8196 Chest Z Acceleration



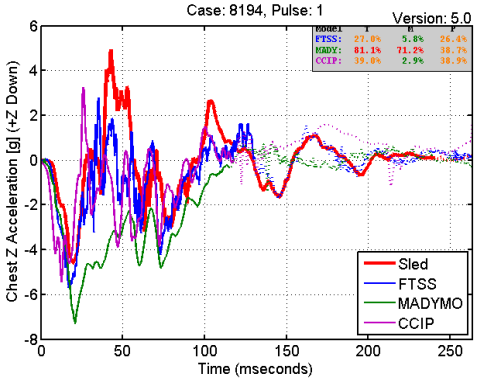
10G 110ms +X

Figure C-3-193: 8197 Chest Z Acceleration



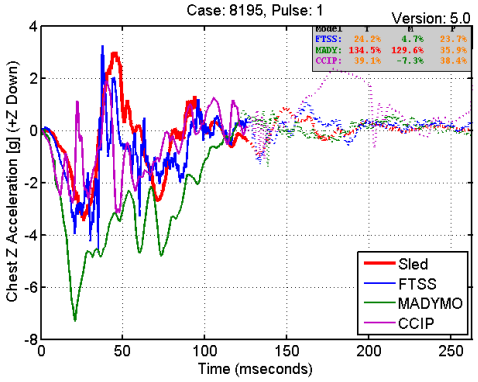
10G 70ms +X

Figure C-3-191: 8210 Chest Z Acceleration



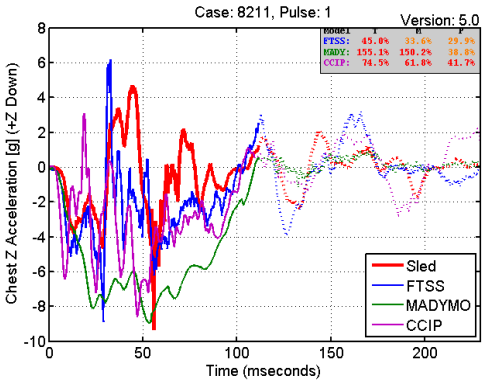
10G 30ms +X

Figure C-3-192: 8194 Chest Z Acceleration

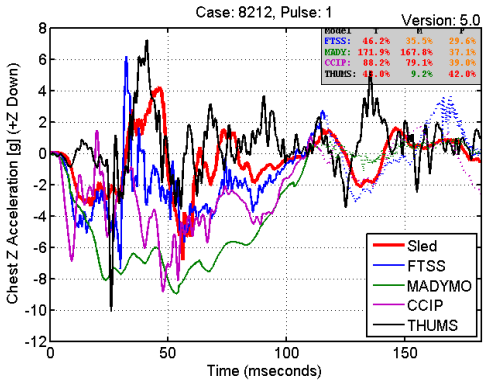


10G 30ms +X

Figure C-3-194: 8195 Chest Z Acceleration

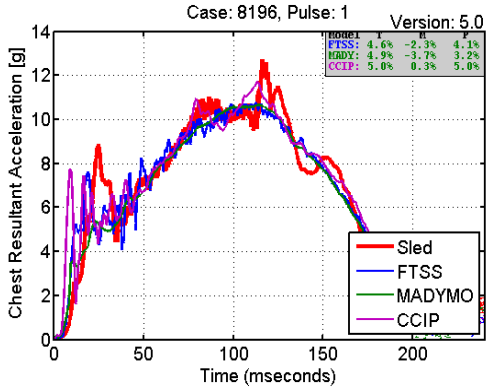


20G 70ms +X
Figure C-3-195: 8211 Chest Z Acceleration



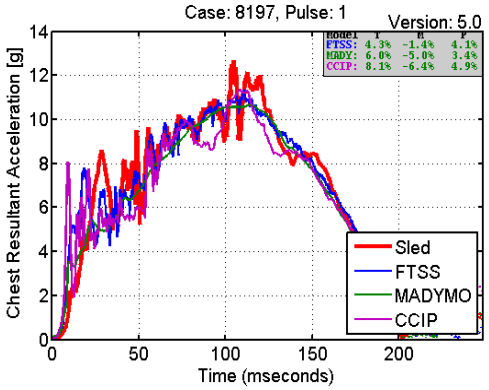
20G 70ms +X
Figure C-3-196: 8212 Chest Z Acceleration

C.3.29 Chest Resultant Acceleration



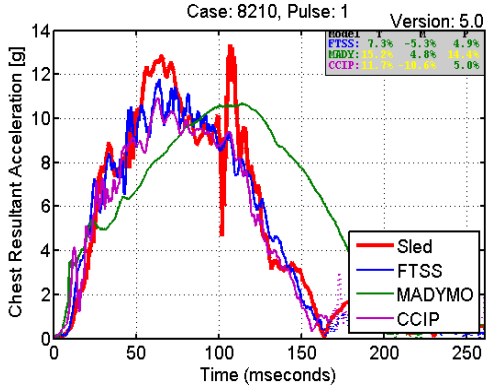
10G 110ms +X

Figure C-3-197: 8196 Chest Resultant Acceleration



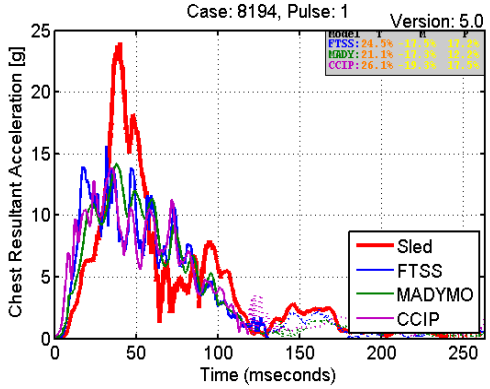
10G 110ms +X

Figure C-3-200: 8197 Chest Resultant Acceleration



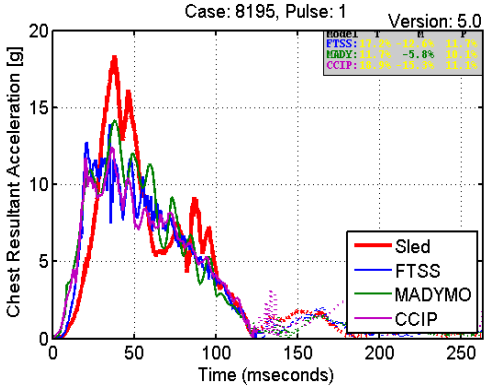
10G 70ms +X

Figure C-3-198: 8210 Chest Resultant Acceleration



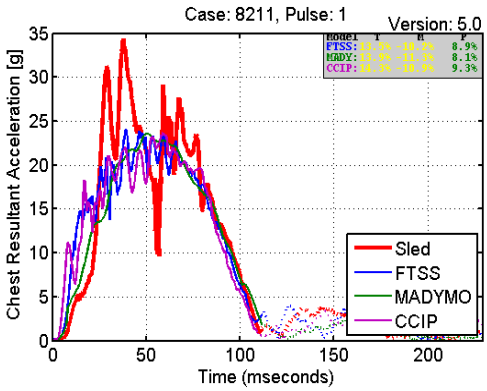
10G 30ms +X

Figure C-3-199: 8194 Chest Resultant Acceleration

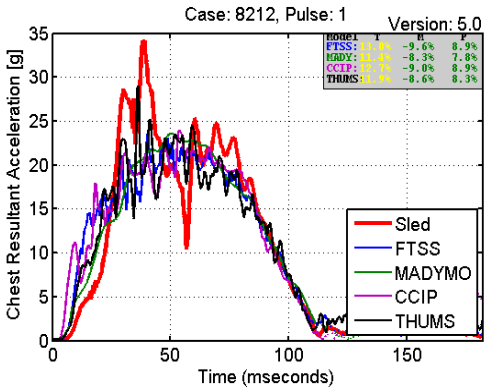


10G 30ms +X

Figure C-3-201: 8195 Chest Resultant Acceleration

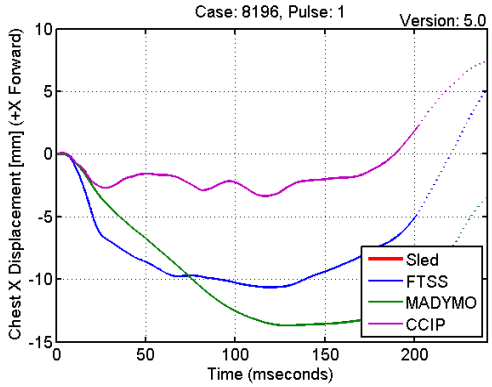


20G 70ms +X
Figure C-3-202: 8211 Chest Resultant Acceleration



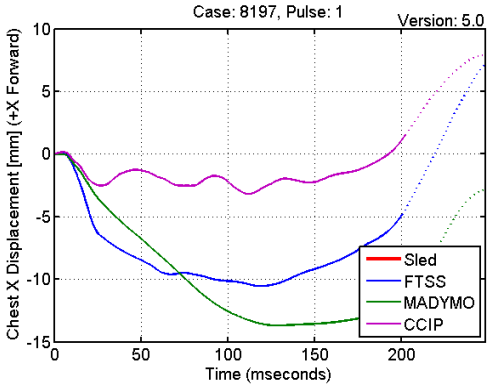
20G 70ms +X
Figure C-3-203: 8212 Chest Resultant Acceleration

C.3.30 Chest X Movement



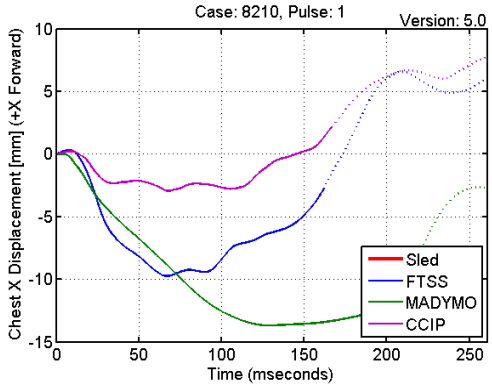
10G 110ms +X

Figure C-3-204: 8196 Chest X Movement



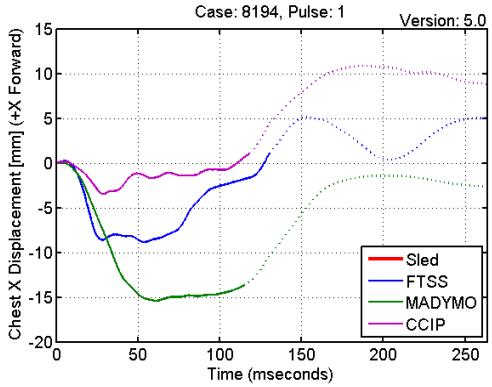
10G 110ms +X

Figure C-3-207: 8197 Chest X Movement



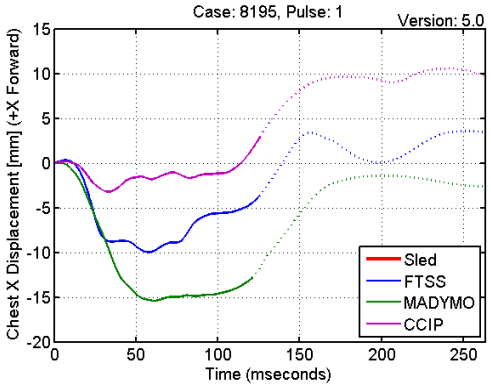
10G 70ms +X

Figure C-3-205: 8210 Chest X Movement



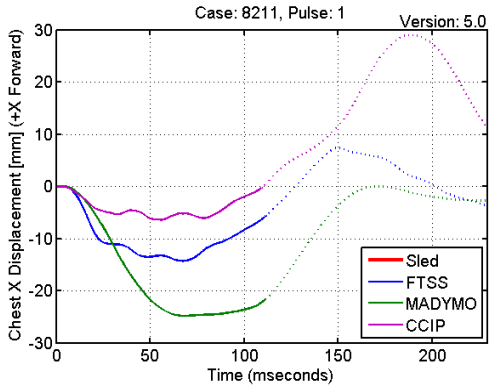
10G 30ms +X

Figure C-3-206: 8194 Chest X Movement



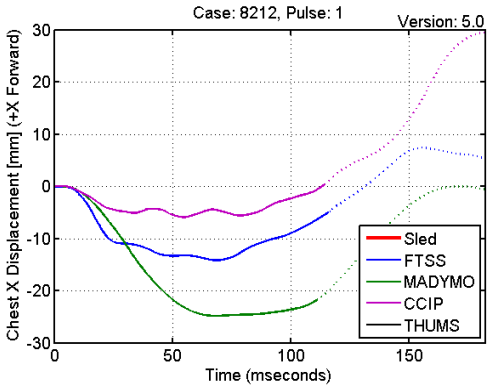
10G 30ms +X

Figure C-3-208: 8195 Chest X Movement



20G 70ms +X

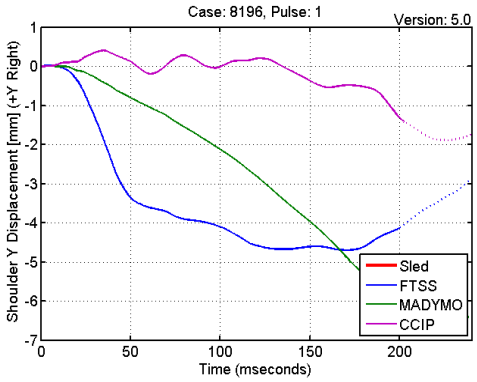
Figure C-3-209: 8211 Chest X Movement



20G 70ms +X

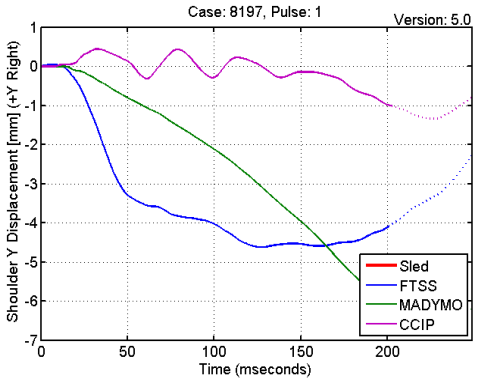
Figure C-3-210: 8212 Chest X Movement

C.3.31 Shoulder Y Movement



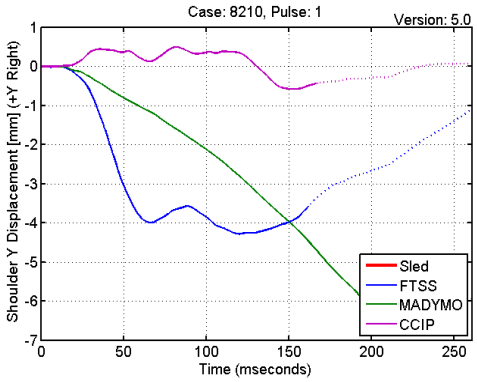
10G 110ms +X

Figure C-3-211: 8196 Shoulder Y Movement



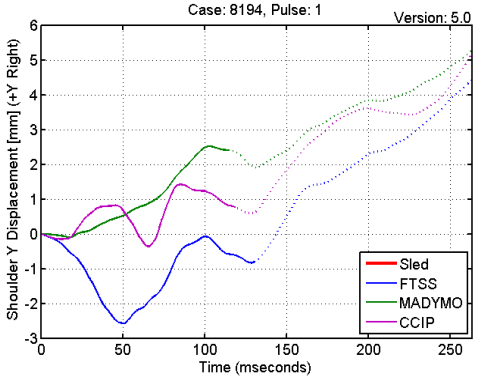
10G 110ms +X

Figure C-3-214: 8197 Shoulder Y Movement



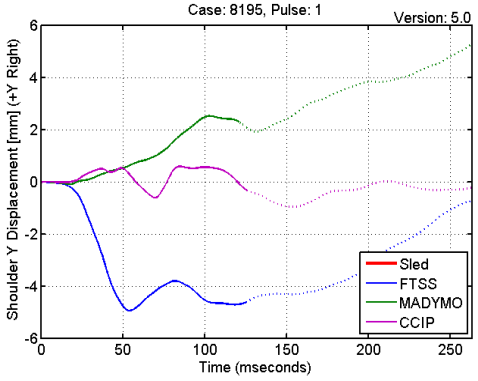
10G 70ms +X

Figure C-3-212: 8210 Shoulder Y Movement



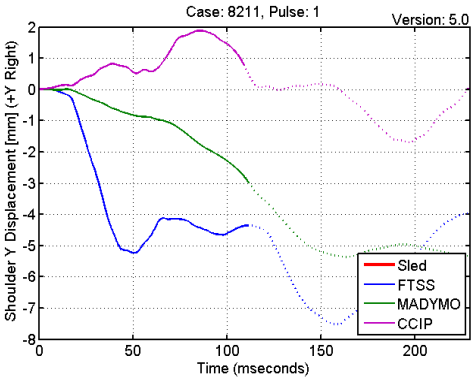
10G 30ms +X

Figure C-3-213: 8194 Shoulder Y Movement

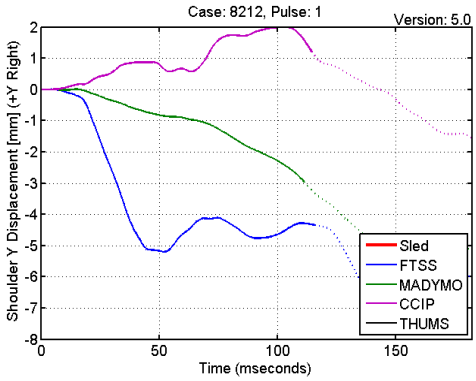


10G 30ms +X

Figure C-3-215: 8195 Shoulder Y Movement

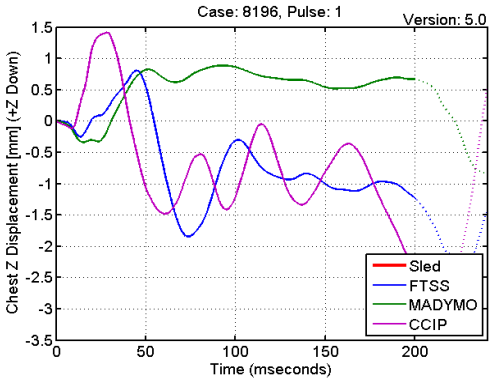


20G 70ms +X
Figure C-3-216: 8211 Shoulder Y Movement

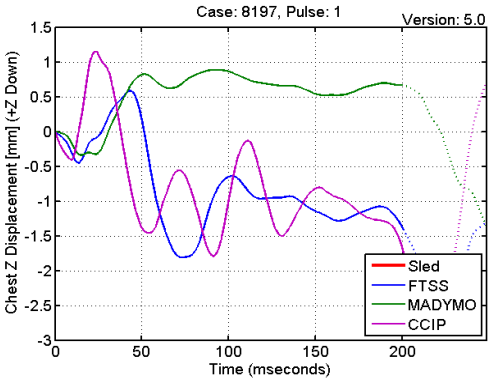


20G 70ms +X
Figure C-3-217: 8212 Shoulder Y Movement

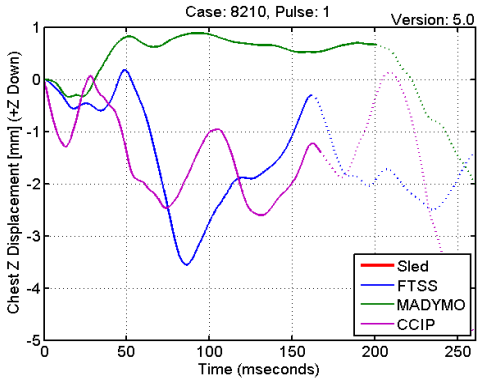
C.3.32 Chest Z Movement



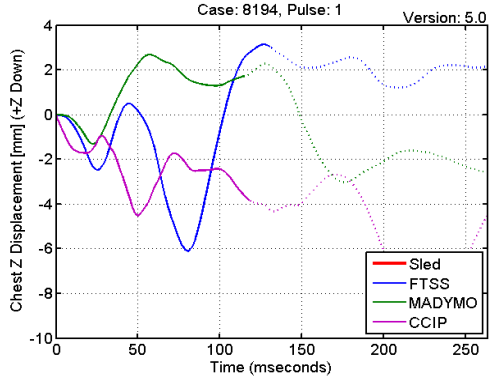
10G 110ms +X
Figure C-3-218: 8196 Chest Z Movement



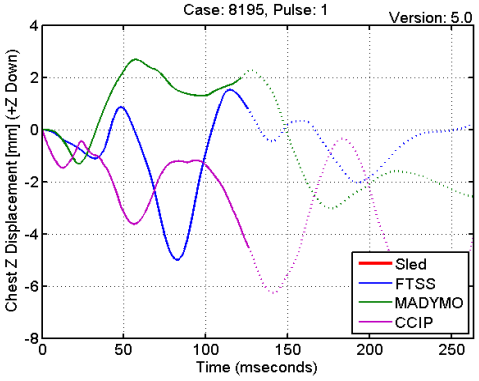
10G 110ms +X
Figure C-3-221: 8197 Chest Z Movement



10G 70ms +X
Figure C-3-219: 8210 Chest Z Movement

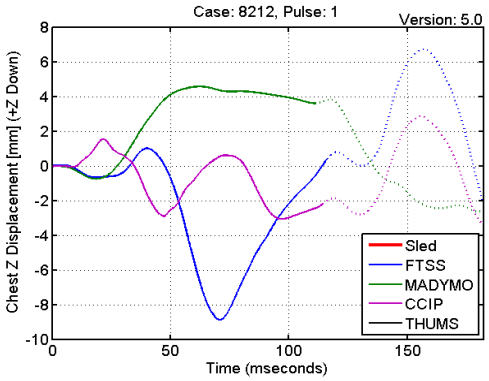


10G 30ms +X
Figure C-3-220: 8194 Chest Z Movement



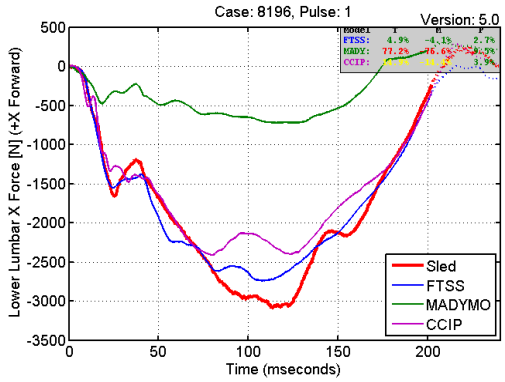
10G 30ms +X
Figure C-3-222: 8195 Chest Z Movement

20G 70ms +X
Figure C-3-223: 8211 Chest Z Movement

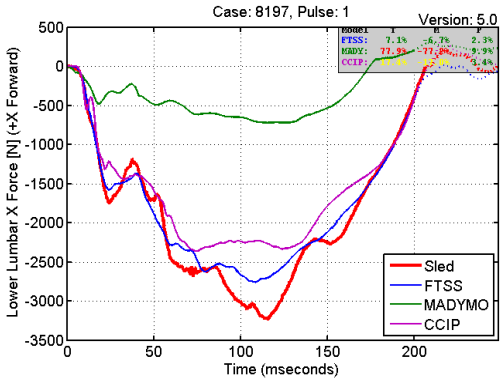


20G 70ms +X
Figure C-3-224: 8212 Chest Z Movement

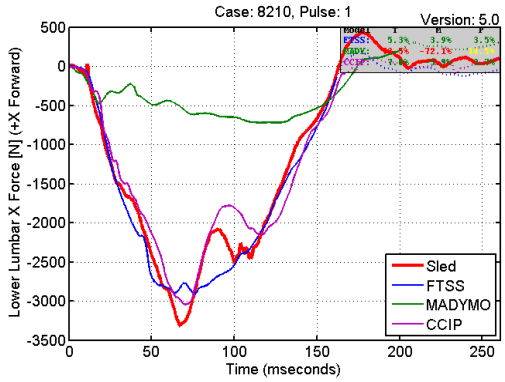
C.3.33 Lumbar X Force



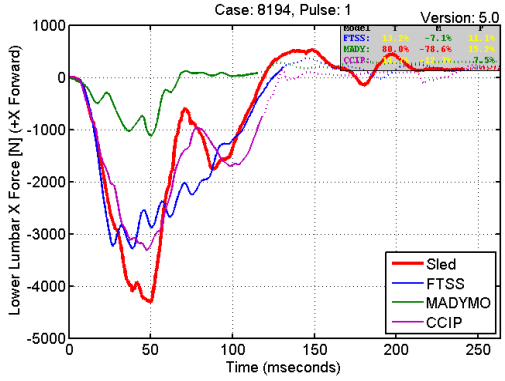
10G 110ms +X
Figure C-3-225: 8196 Lumbar X Force



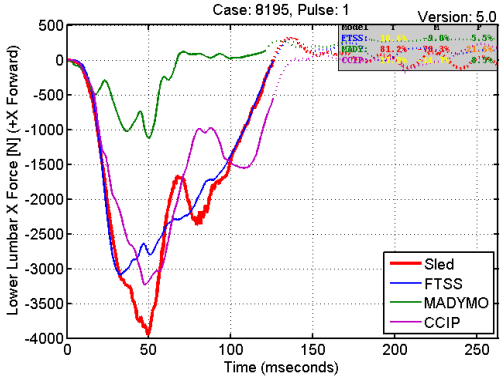
10G 110ms +X
Figure C-3-228: 8197 Lumbar X Force



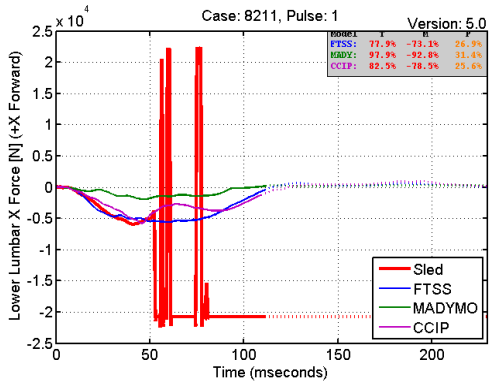
10G 70ms +X
Figure C-3-226: 8210 Lumbar X Force



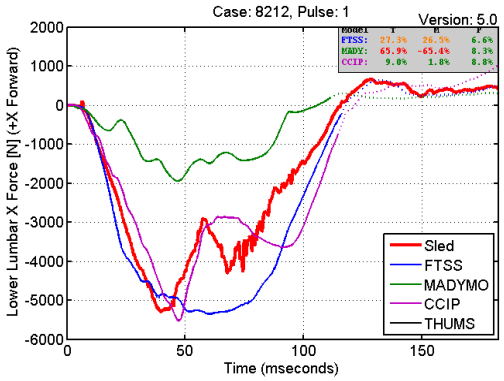
10G 30ms +X
Figure C-3-227: 8194 Lumbar X Force



10G 30ms +X
Figure C-3-229: 8195 Lumbar X Force

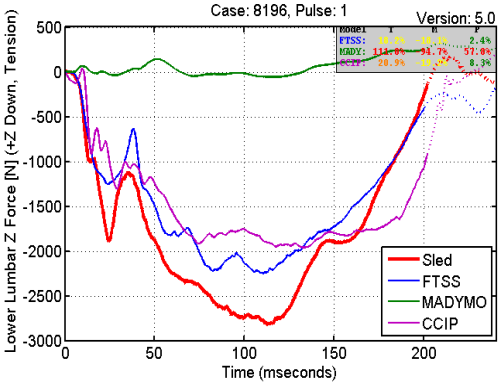


20G 70ms +X
Figure C-3-230: 8211 Lumbar X Force



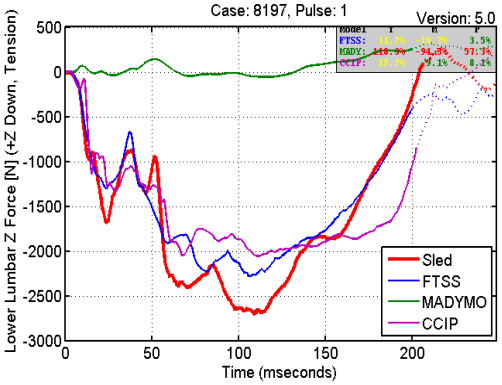
20G 70ms +X
Figure C-3-231: 8212 Lumbar X Force

C.3.34 Lumbar Z Force



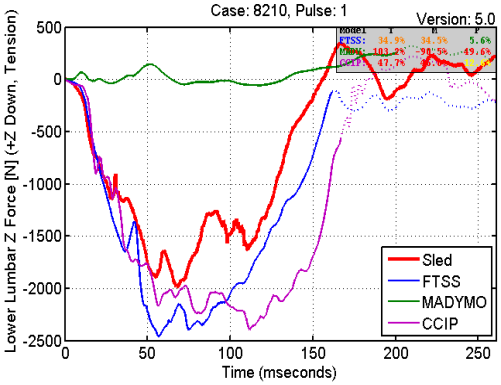
10G 110ms +X

Figure C-3-232: 8196 Lumbar Z Force



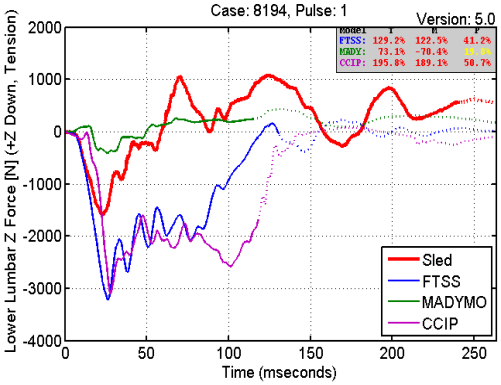
10G 110ms +X

Figure C-3-235: 8197 Lumbar Z Force



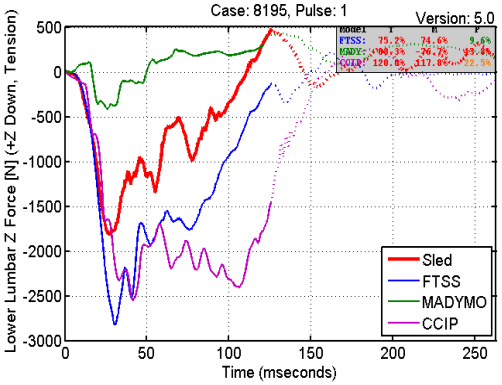
10G 70ms +X

Figure C-3-233: 8210 Lumbar Z Force



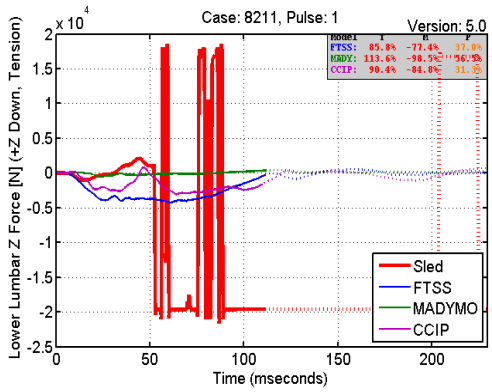
10G 30ms +X

Figure C-3-234: 8194 Lumbar Z Force

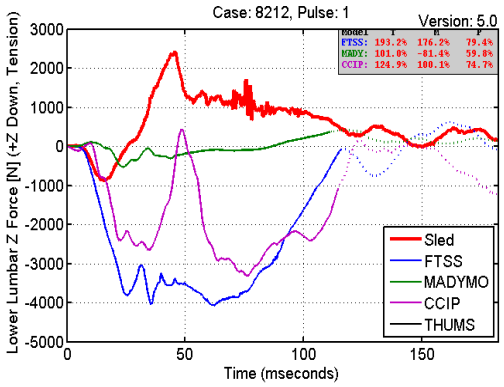


10G 30ms +X

Figure C-3-236: 8195 Lumbar Z Force

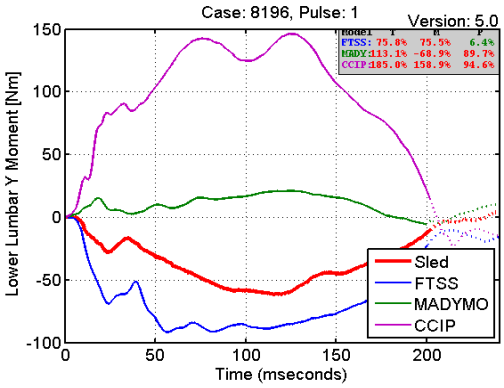


20G 70ms +X
Figure C-3-237: 8211 Lumbar Z Force



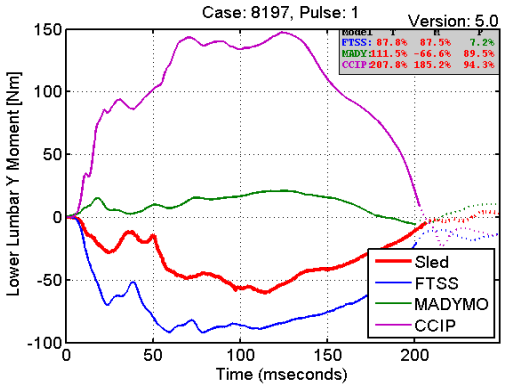
20G 70ms +X
Figure C-3-238: 8212 Lumbar Z Force

C.3.35 Lumbar Y Moment



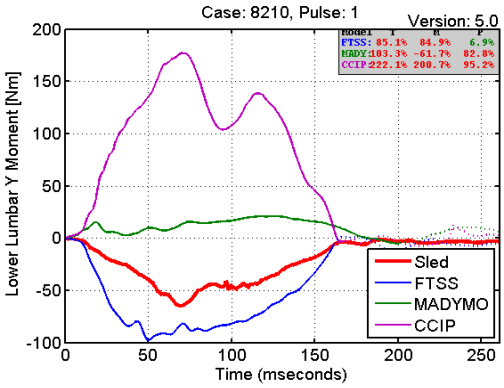
10G 110ms +X

Figure C-3-239: 8196 Lumbar Y Moment



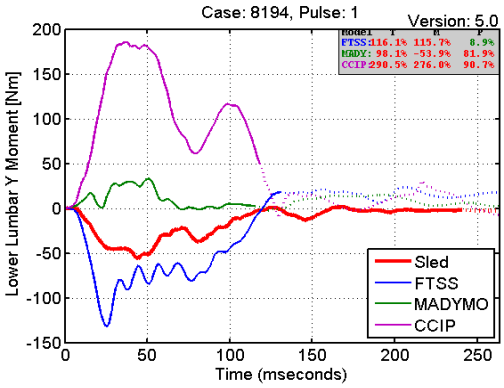
10G 110ms +X

Figure C-3-242: 8197 Lumbar Y Moment



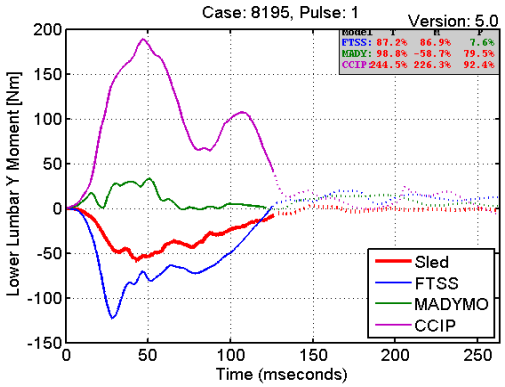
10G 70ms +X

Figure C-3-240: 8210 Lumbar Y Moment



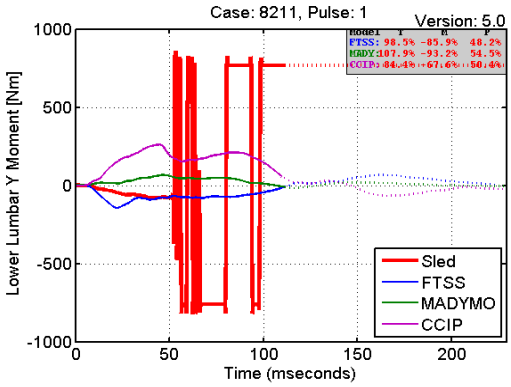
10G 30ms +X

Figure C-3-241: 8194 Lumbar Y Moment



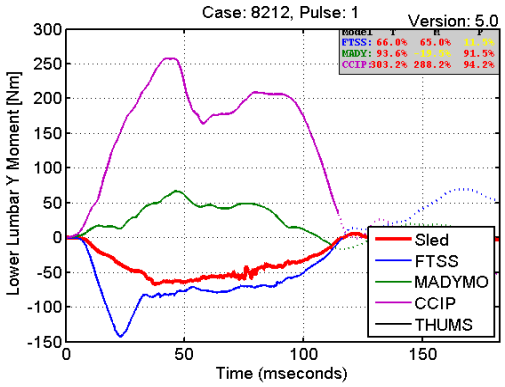
10G 30ms +X

Figure C-3-243: 8195 Lumbar Y Moment



20G 70ms +X

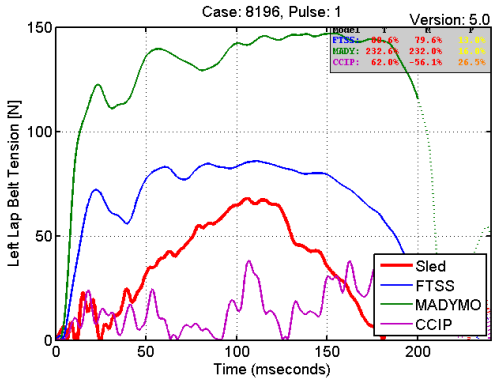
Figure C-3-244: 8211 Lumbar Y Moment



20G 70ms +X

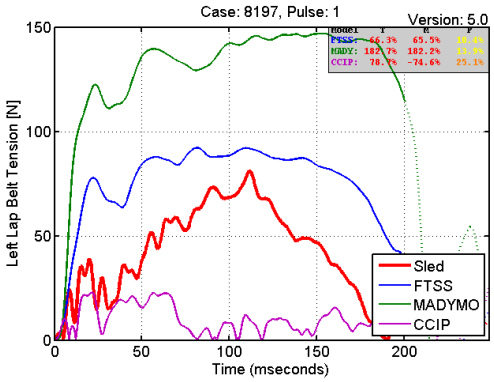
Figure C-3-245: 8212 Lumbar Y Moment

C.3.36 Left Lap Belt Force



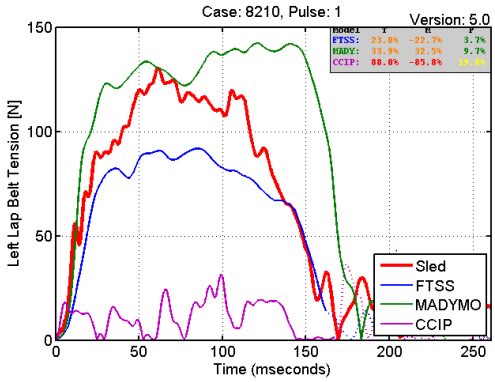
10G 110ms +X

Figure C-3-246: 8196 Left Lap Belt Force



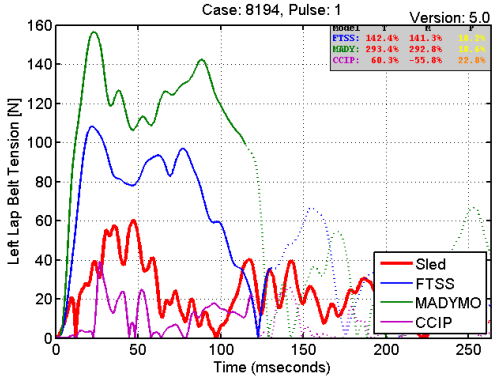
10G 110ms +X

Figure C-3-249: 8197 Left Lap Belt Force



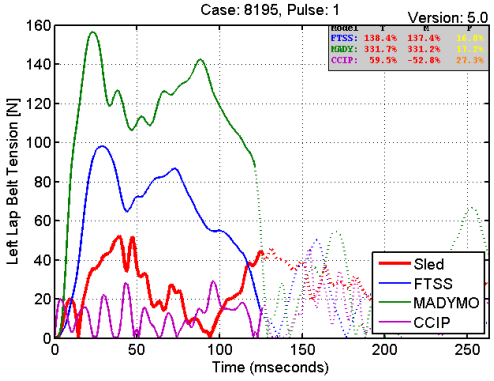
10G 70ms +X

Figure C-3-247: 8210 Left Lap Belt Force



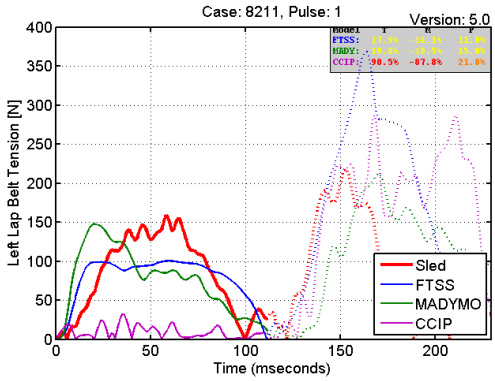
10G 30ms +X

Figure C-3-248: 8194 Left Lap Belt Force



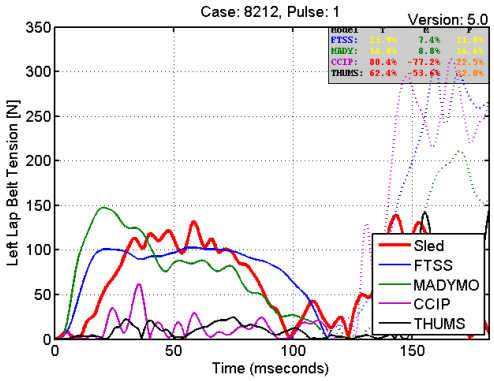
10G 30ms +X

Figure C-3-250: 8195 Left Lap Belt Force



20G 70ms +X

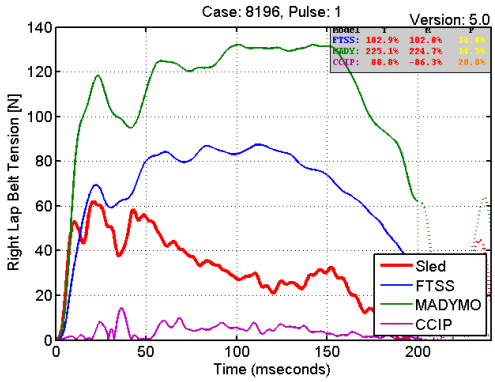
Figure C-3-251: 8211 Left Lap Belt Force



20G 70ms +X

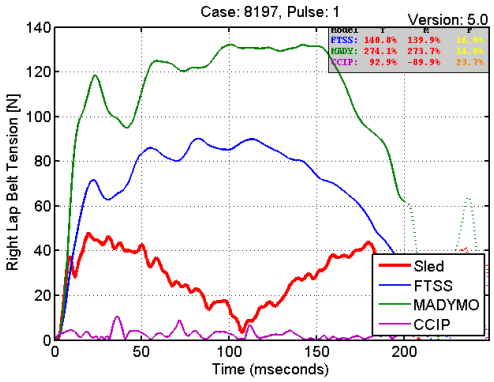
Figure C-3-252: 8212 Left Lap Belt Force

C.3.37 Right Lap Belt Force



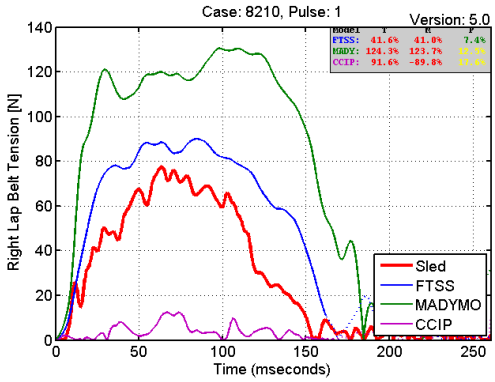
10G 110ms +X

Figure C-3-253: 8196 Right Lap Belt Force



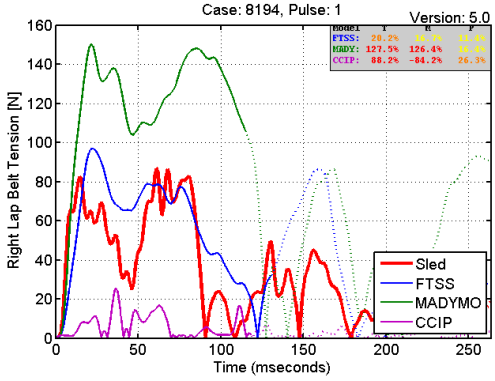
10G 110ms +X

Figure C-3-256: 8197 Right Lap Belt Force



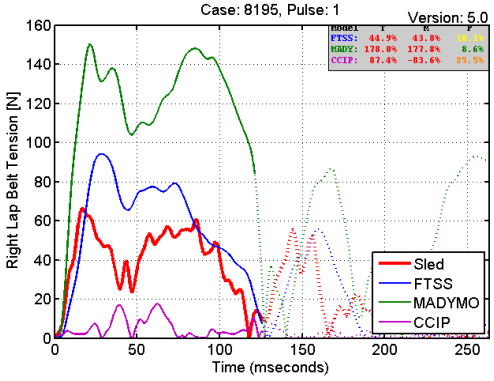
10G 70ms +X

Figure C-3-254: 8210 Right Lap Belt Force



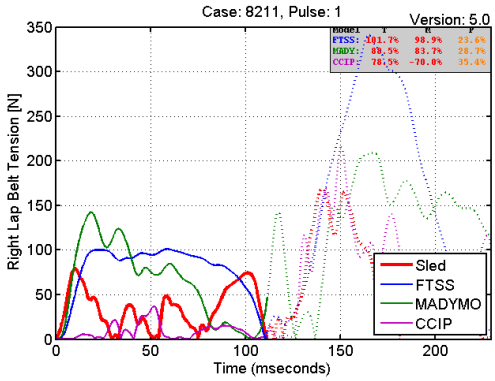
10G 30ms +X

Figure C-3-255: 8194 Right Lap Belt Force

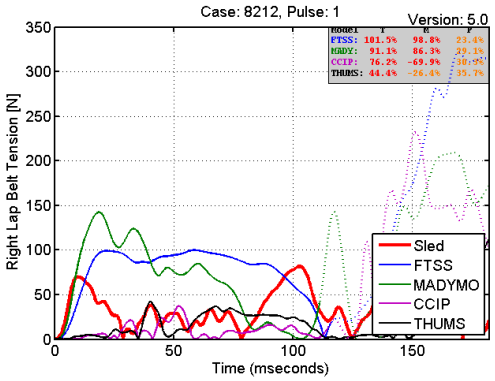


10G 30ms +X

Figure C-3-257: 8195 Right Lap Belt Force

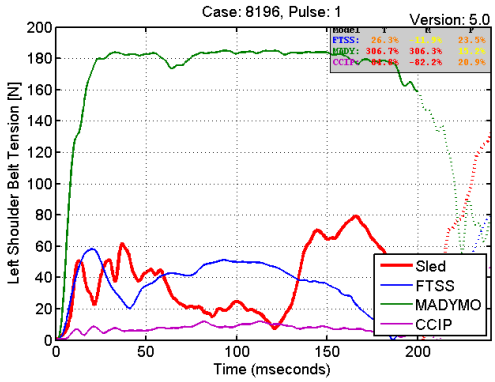


20G 70ms +X
Figure C-3-258: 8211 Right Lap Belt Force

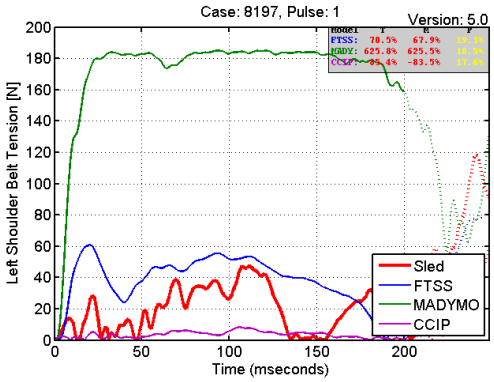


20G 70ms +X
Figure C-3-259: 8212 Right Lap Belt Force

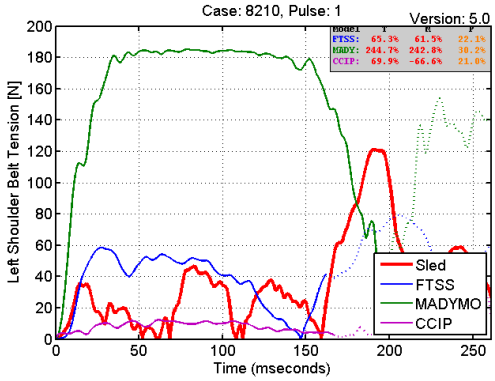
C.3.38 Left Shoulder Belt Force



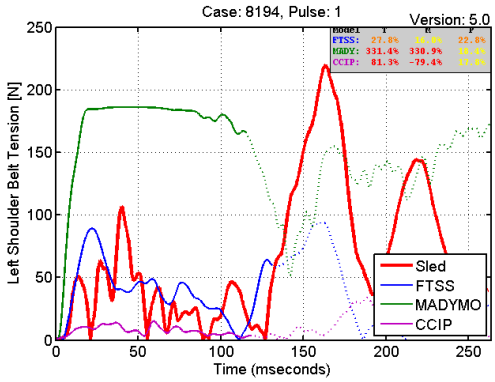
10G 110ms +X
Figure C-3-260: 8196 Left Shoulder Belt Force



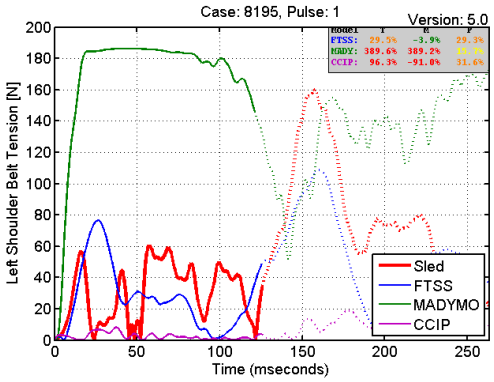
10G 110ms +X
Figure C-3-263: 8197 Left Shoulder Belt Force



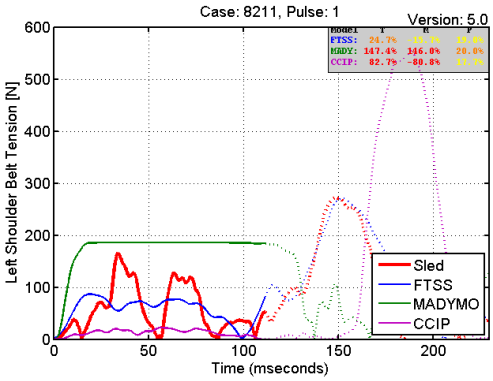
10G 70ms +X
Figure C-3-261: 8210 Left Shoulder Belt Force



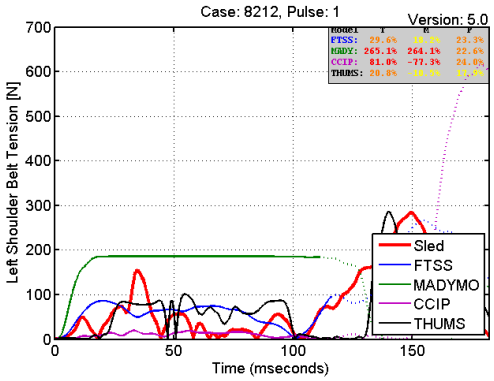
10G 30ms +X
Figure C-3-262: 8194 Left Shoulder Belt Force



10G 30ms +X
Figure C-3-264: 8195 Left Shoulder Belt Force

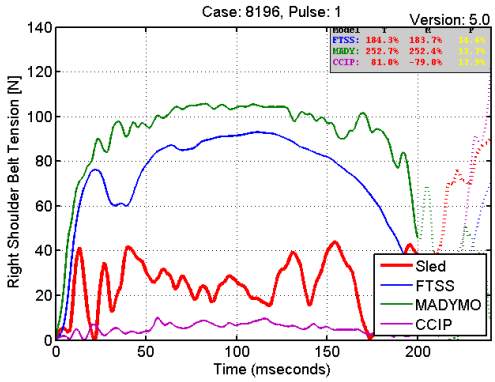


20G 70ms +X
Figure C-3-265: 8211 Left Shoulder Belt Force

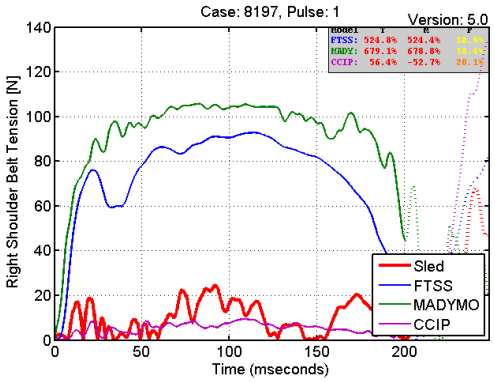


20G 70ms +X
Figure C-3-266: 8212 Left Shoulder Belt Force

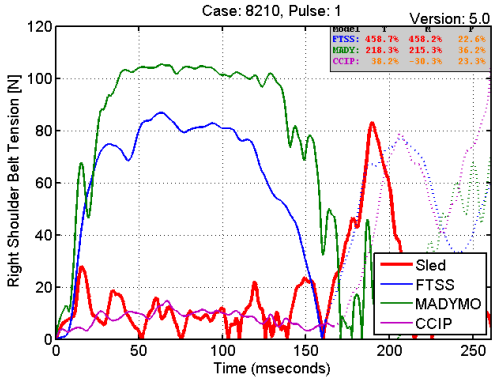
C.3.39 Right Shoulder Belt Force



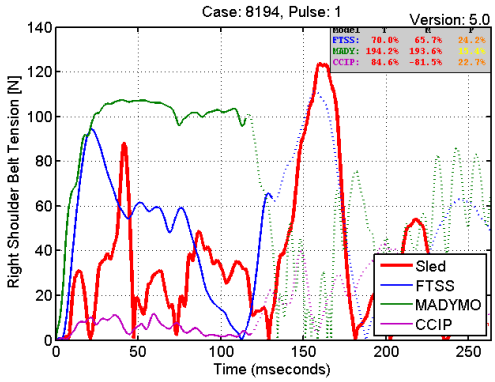
10G 110ms +X
Figure C-3-267: 8196 Right Shoulder Belt Force



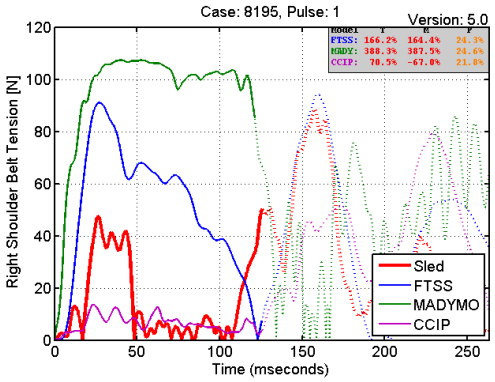
10G 110ms +X
Figure C-3-270: 8197 Right Shoulder Belt Force



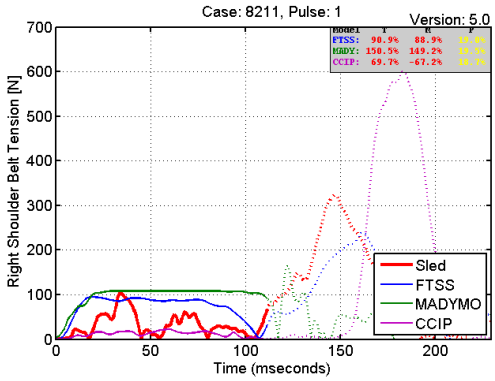
10G 70ms +X
Figure C-3-268: 8210 Right Shoulder Belt Force



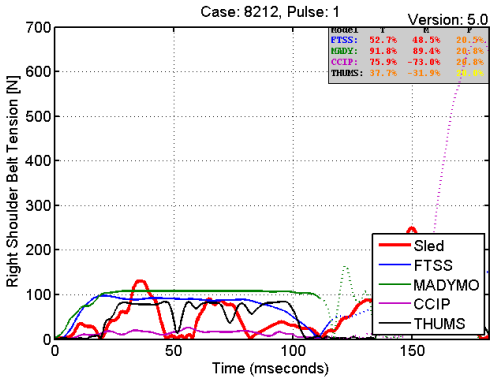
10G 30ms +X
Figure C-3-269: 8194 Right Shoulder Belt Force



10G 30ms +X
Figure C-3-271: 8195 Right Shoulder Belt Force

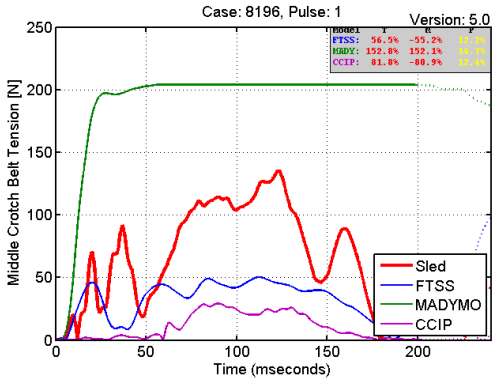


20G 70ms +X
Figure C-3-272: 8211 Right Shoulder Belt Force



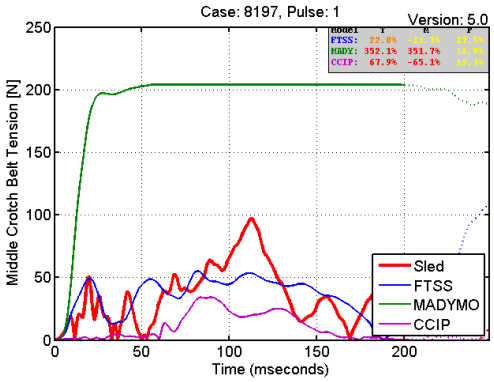
20G 70ms +X
Figure C-3-273: 8212 Right Shoulder Belt Force

C.3.40 Crotch Belt Force



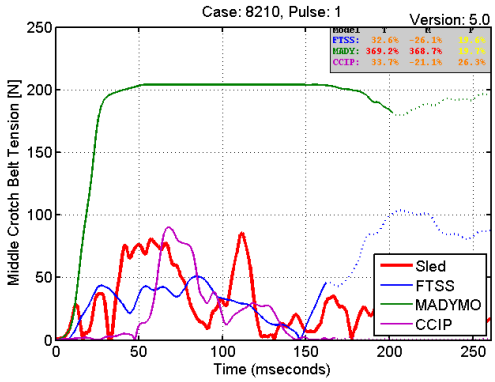
10G 110ms +X

Figure C-3-274: 8196 Crotch Belt Force



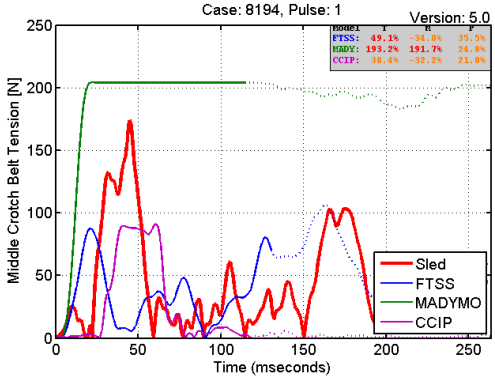
10G 110ms +X

Figure C-3-277: 8197 Crotch Belt Force



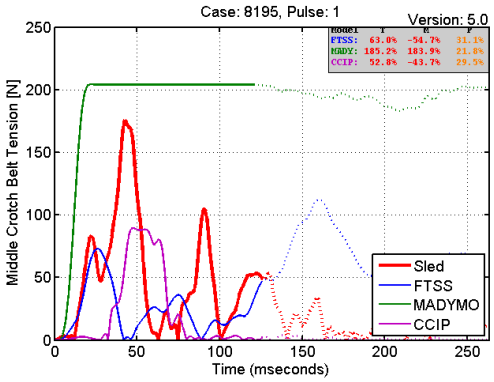
10G 70ms +X

Figure C-3-275: 8210 Crotch Belt Force



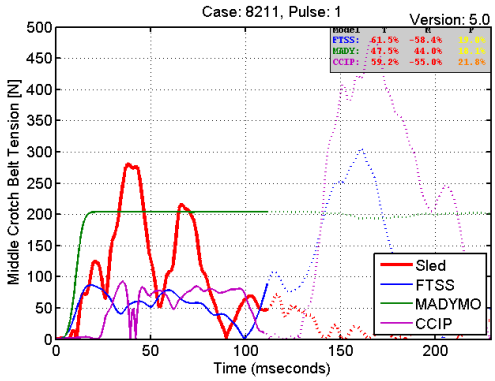
10G 30ms +X

Figure C-3-276: 8194 Crotch Belt Force

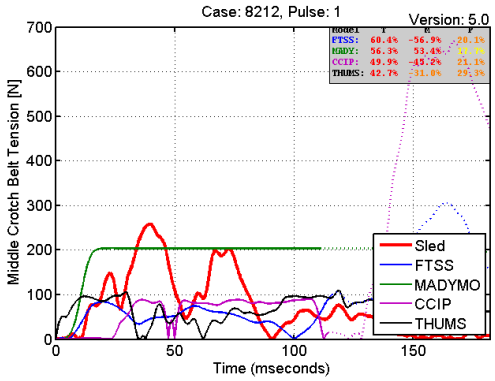


10G 30ms +X

Figure C-3-278: 8195 Crotch Belt Force



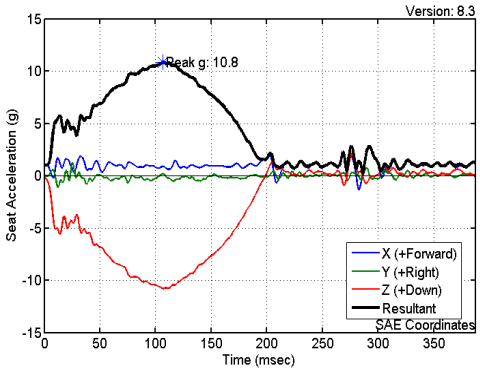
20G 70ms +X
Figure C-3-279: 8211 Crotch Belt Force



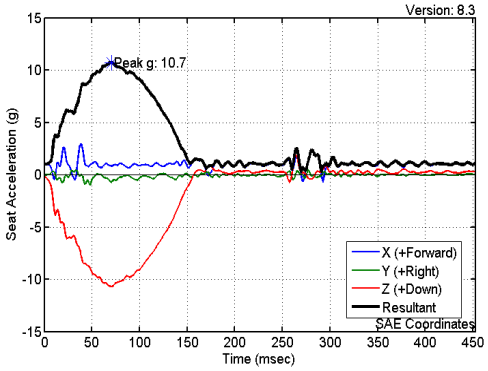
20G 70ms +X
Figure C-3-280: 8212 Crotch Belt Force

C.4 Spinal Impact

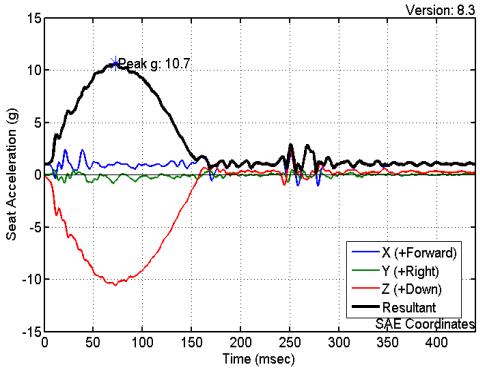
C.4.1 Seat Acceleration



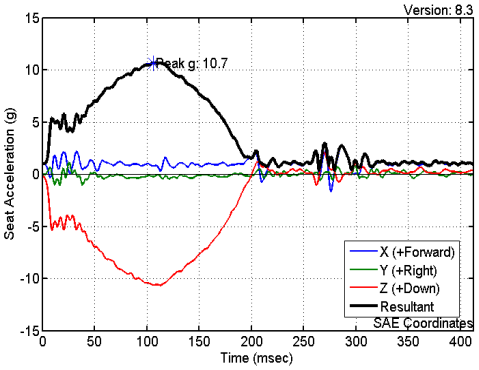
10G 110ms +Z
Figure C-4-1: 8198 Seat Accelerations



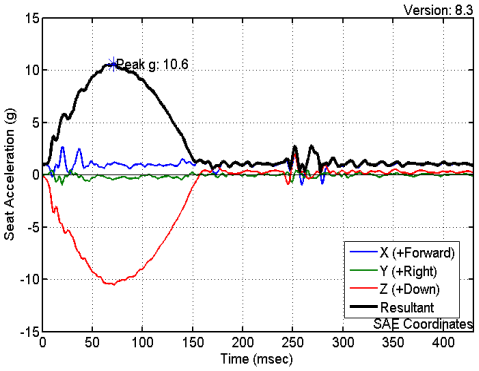
10G 70ms +Z
Figure C-4-2: 8207 Seat Accelerations



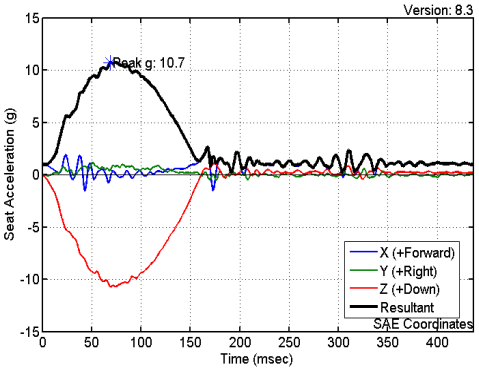
10G 70ms +Z
Figure C-4-3: 8209 Seat Accelerations



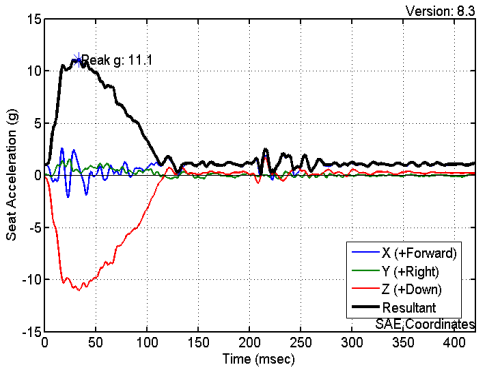
10G 110ms +Z
Figure C-4-4: 8199 Seat Accelerations



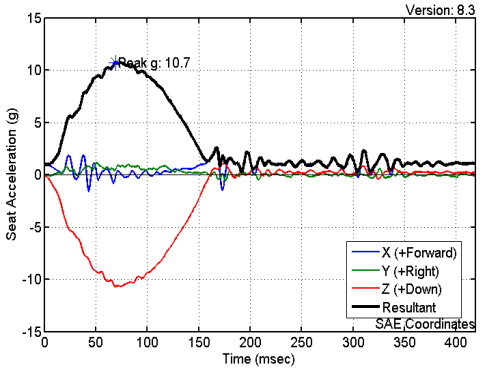
10G 70ms +Z
Figure C-4-5: 8208 Seat Accelerations



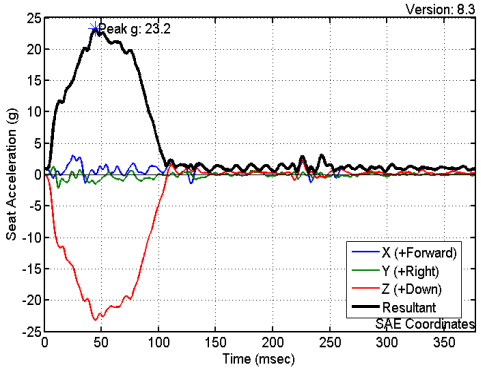
10G 70ms +Z
Figure C-4-6: 8258 Seat Accelerations



10G 30ms +Z
Figure C-4-7: 8193 Seat Accelerations

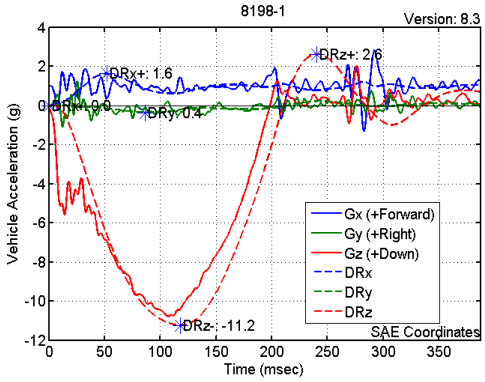


15G 70ms +Z
Figure C-4-8: 8257 Seat Accelerations



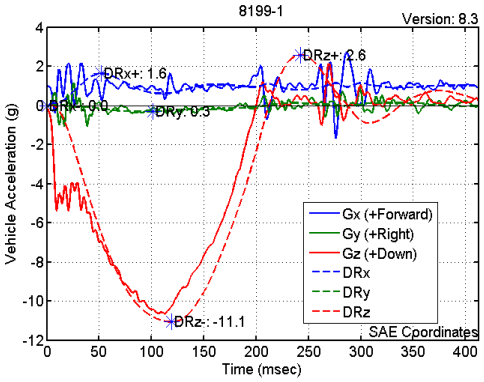
20G 70ms +Z
Figure C-4-9: 8206 Seat Accelerations

C.4.2 Dynamic Response Index



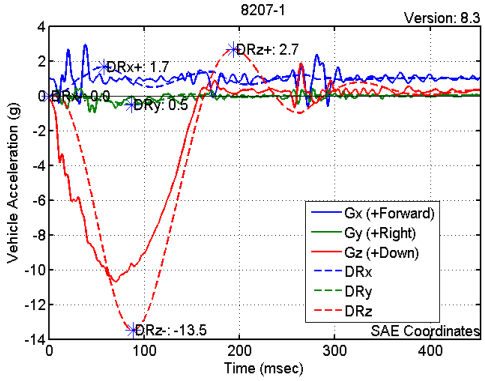
10G 110ms +Z

Figure C-4-10: 8198 Dynamic Response Index



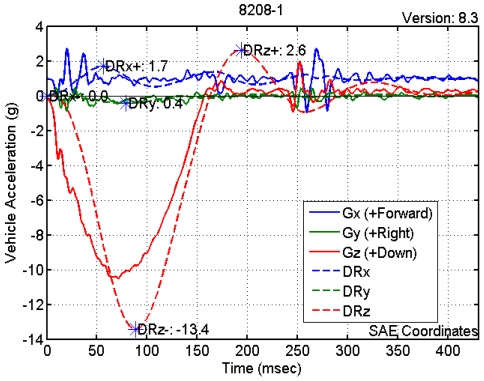
10G 110ms +Z

Figure C-4-13: 8199 Dynamic Response Index



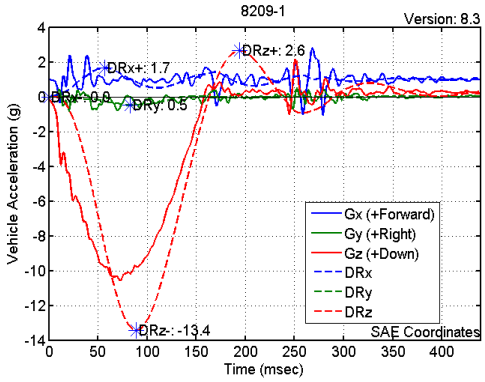
10G 70ms +Z

Figure C-4-11: 8207 Dynamic Response Index



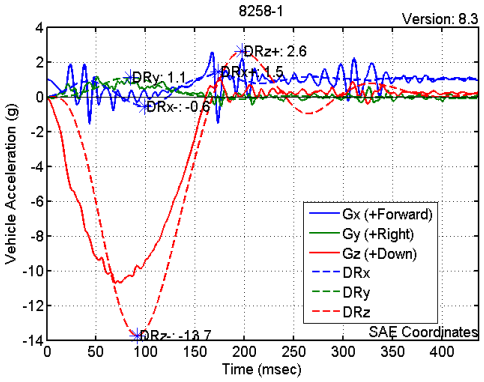
10G 70ms +Z

Figure C-4-14: 8208 Dynamic Response Index



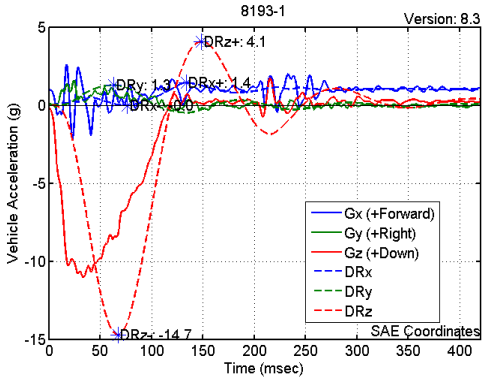
10G 70ms +Z

Figure C-4-12: 8209 Dynamic Response Index



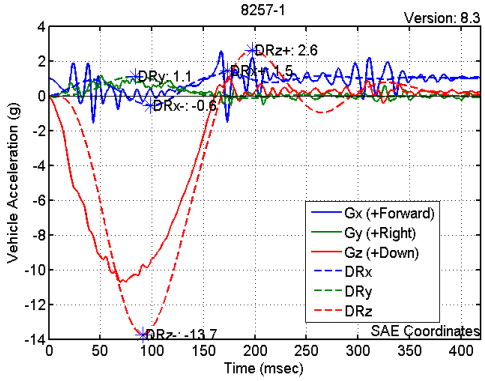
10G 70ms +Z

Figure C-4-15: 8258 Dynamic Response Index



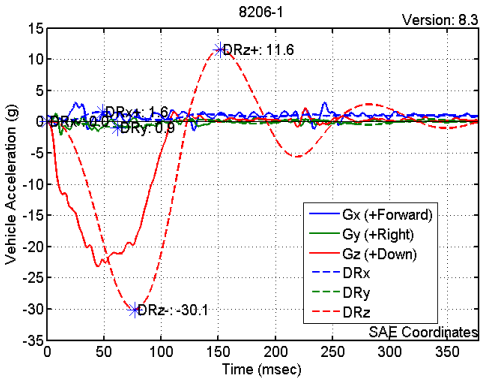
10G 30ms +Z

Figure C-4-16: 8193 Dynamic Response Index



15G 70ms +Z

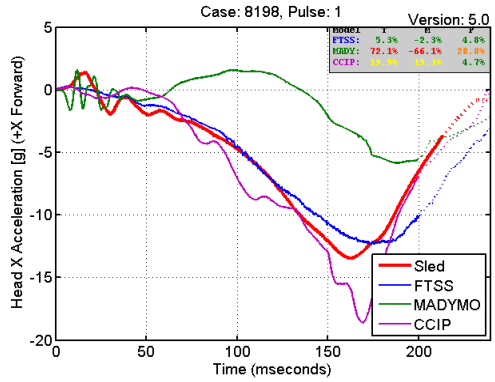
Figure C-4-17: 8257 Dynamic Response Index



20G 70ms +Z

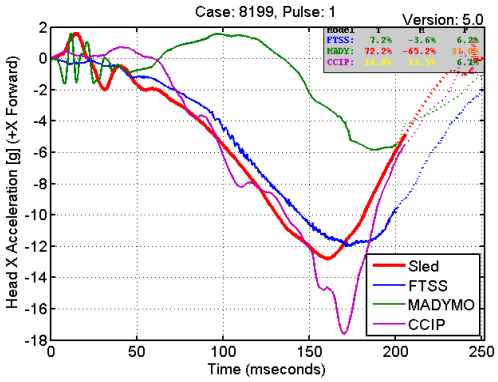
Figure C-4-18: 8206 Dynamic Response Index

C.4.3 Head X Translational Acceleration



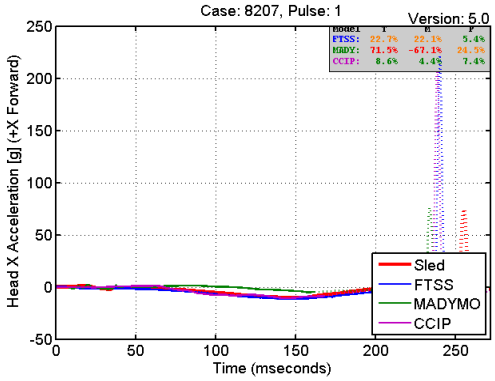
10G 110ms +Z

Figure C-4-19: 8198 Head X Translational Acceleration



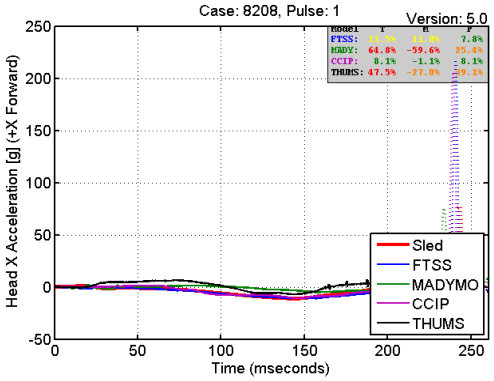
10G 110ms +Z

Figure C-4-22: 8199 Head X Translational Acceleration



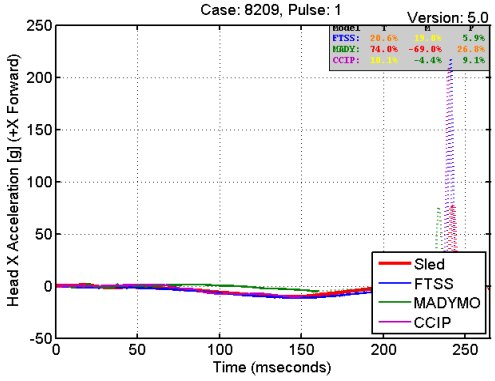
10G 70ms +Z

Figure C-4-20: 8207 Head X Translational Acceleration



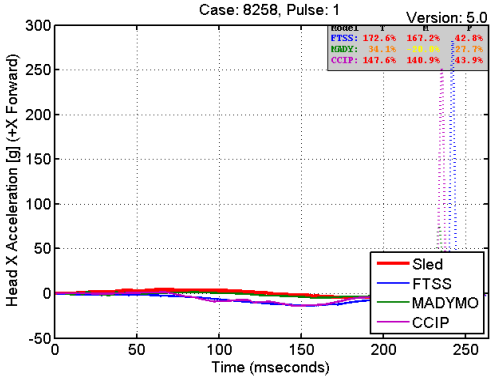
10G 70ms +Z

Figure C-4-23: 8208 Head X Translational Acceleration



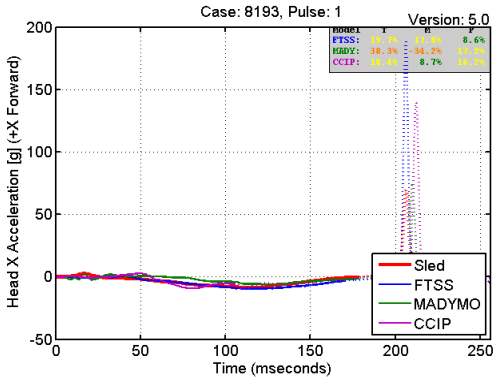
10G 70ms +Z

Figure C-4-21: 8209 Head X Translational Acceleration



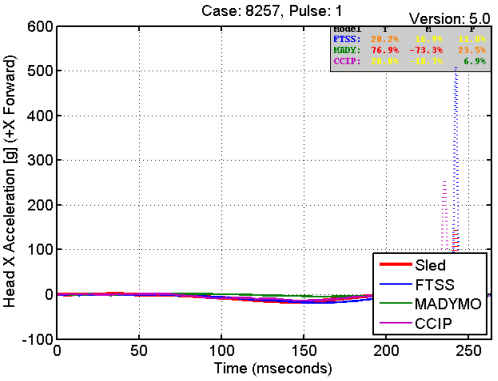
10G 70ms +Z

Figure C-4-24: 8258 Head X Translational Acceleration



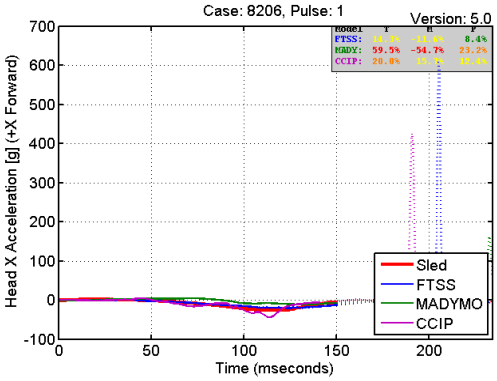
10G 30ms +Z

Figure C-4-25: 8193 Head X Translational Acceleration



15G 70ms +Z

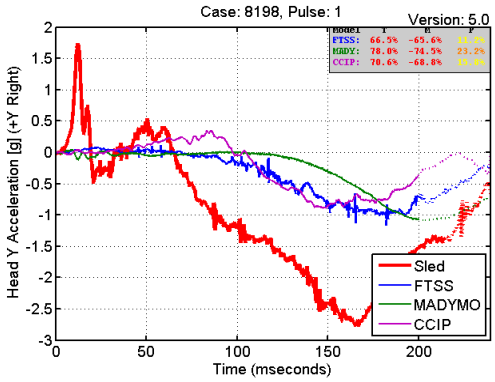
Figure C-4-26: 8257 Head X Translational Acceleration



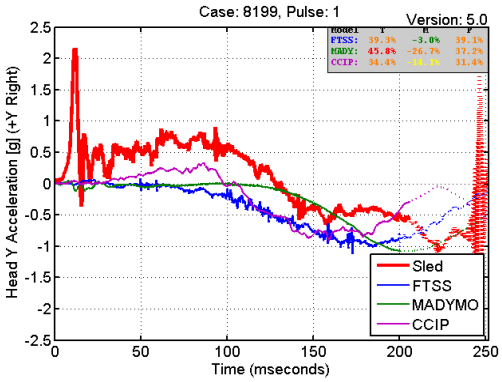
20G 70ms +Z

Figure C-4-27: 8206 Head X Translational Acceleration

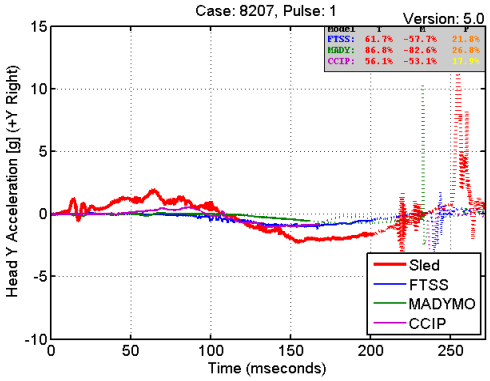
C.4.4 Head Y Translational Acceleration



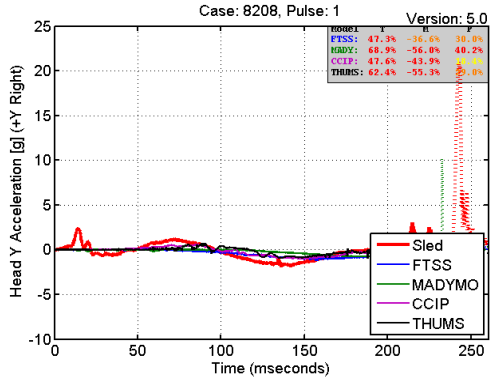
10G 110ms +Z
Figure C-4-28: 8198 Head Y Translational Acceleration



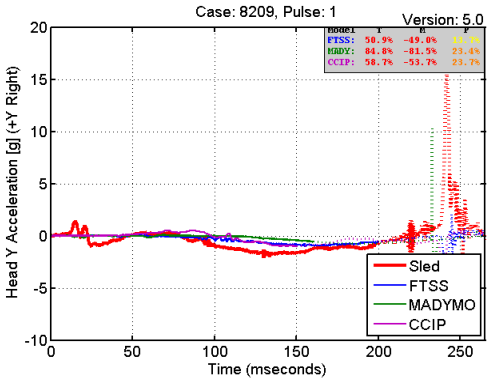
10G 110ms +Z
Figure C-4-31: 8199 Head Y Translational Acceleration



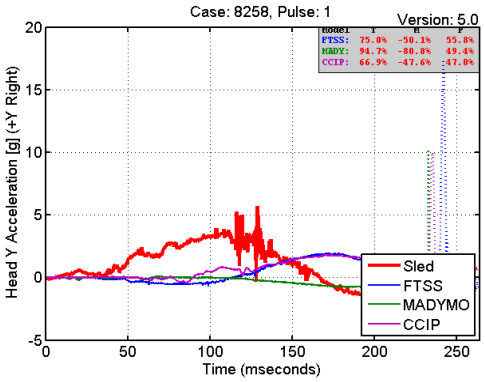
10G 70ms +Z
Figure C-4-29: 8207 Head Y Translational Acceleration



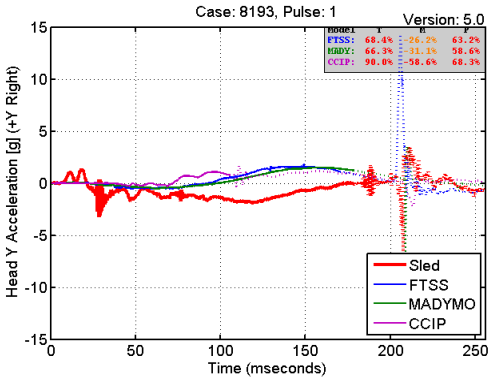
10G 70ms +Z
Figure C-4-32: 8208 Head Y Translational Acceleration



10G 70ms +Z
Figure C-4-30: 8209 Head Y Translational Acceleration

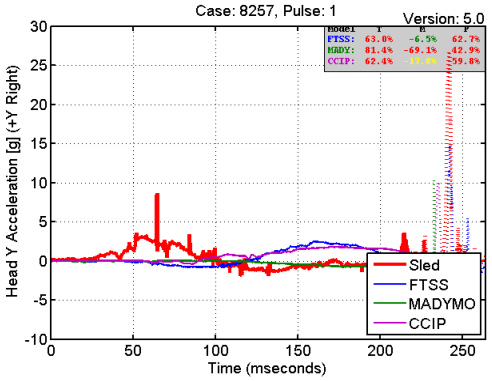


10G 70ms +Z
Figure C-4-33: 8258 Head Y Translational Acceleration



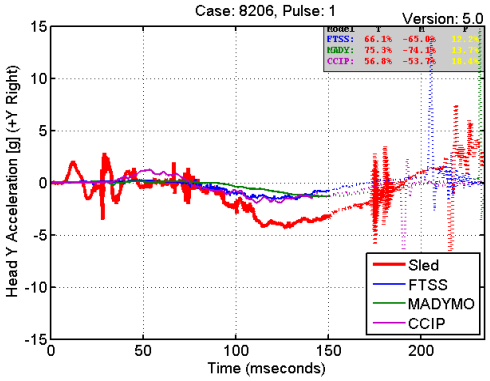
10G 30ms +Z

Figure C-4-34: 8193 Head Y Translational Acceleration



15G 70ms +Z

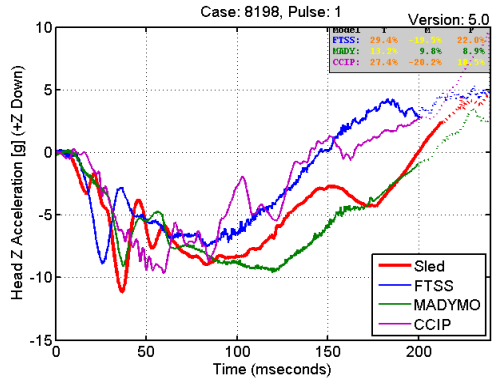
Figure C-4-35: 8257 Head Y Translational Acceleration



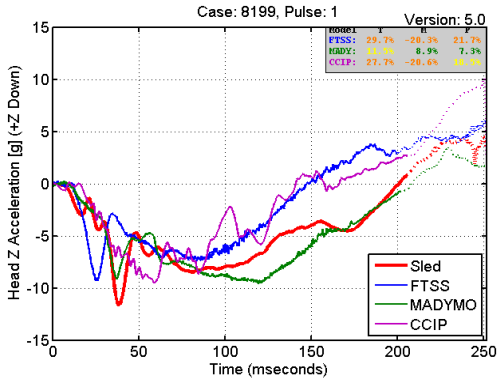
20G 70ms +Z

Figure C-4-36: 8206 Head Y Translational Acceleration

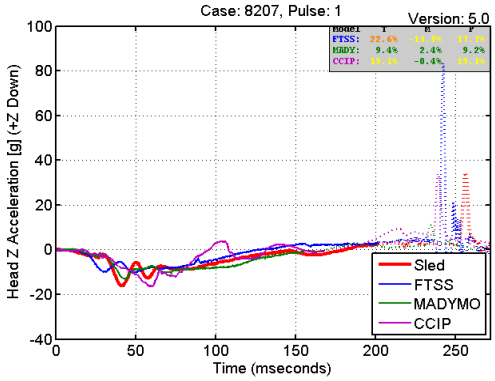
C.4.5 Head Z Translational Acceleration



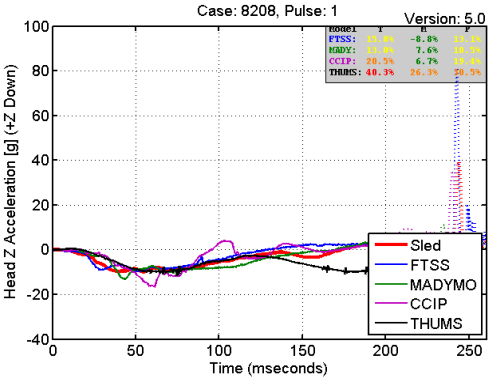
10G 110ms +Z
Figure C-4-37: 8198 Head Z Translational Acceleration



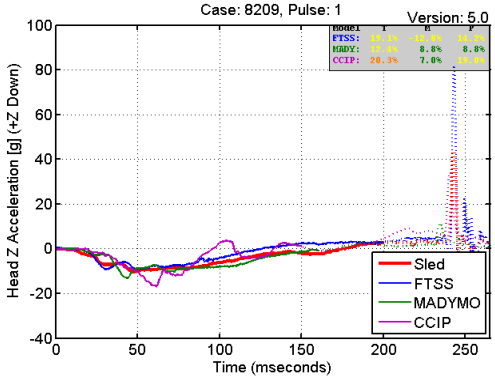
10G 110ms +Z
Figure C-4-40: 8199 Head Z Translational Acceleration



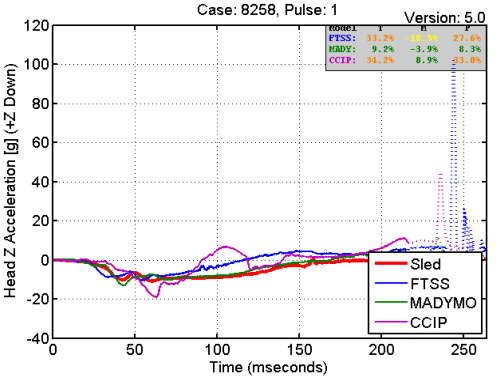
10G 70ms +Z
Figure C-4-38: 8207 Head Z Translational Acceleration



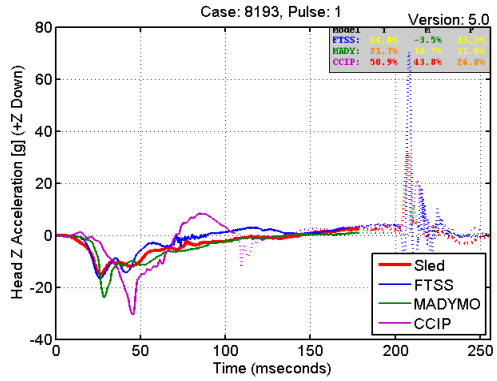
10G 70ms +Z
Figure C-4-41: 8208 Head Z Translational Acceleration



10G 70ms +Z
Figure C-4-39: 8209 Head Z Translational Acceleration

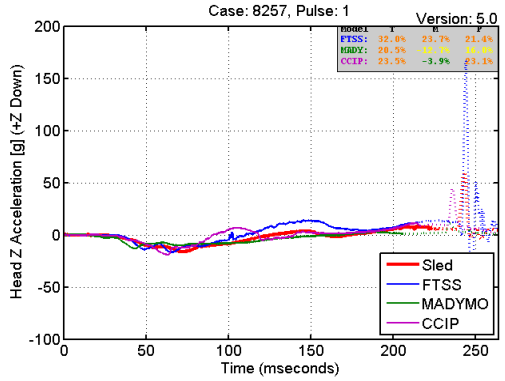


10G 70ms +Z
Figure C-4-42: 8258 Head Z Translational Acceleration



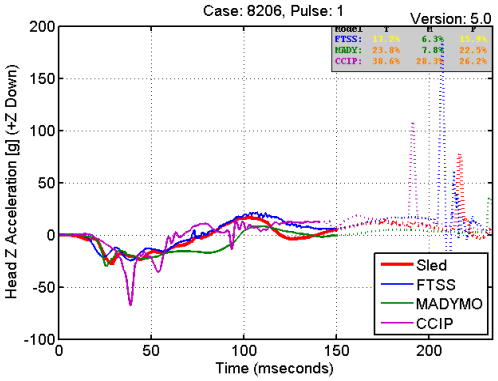
10G 30ms +Z

Figure C-4-43: 8193 Head Z Translational Acceleration



15G 70ms +Z

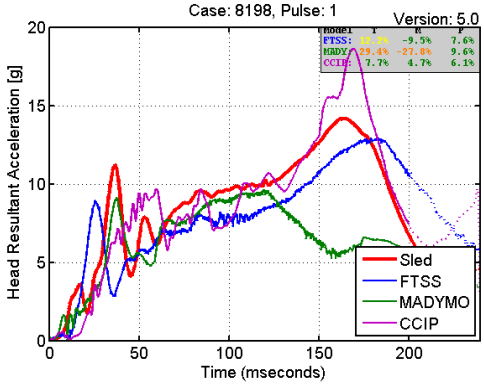
Figure C-4-44: 8257 Head Z Translational Acceleration



20G 70ms +Z

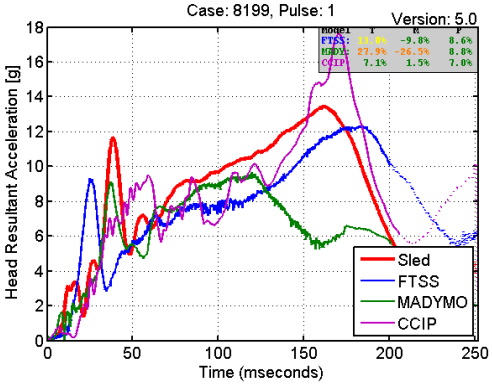
Figure C-4-45: 8206 Head Z Translational Acceleration

C.4.6 Head Resultant Translational Acceleration



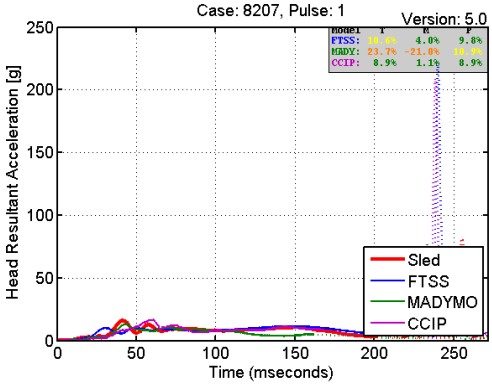
10G 110ms +Z

Figure C-4-46: 8198 Head Resultant Translational Acceleration



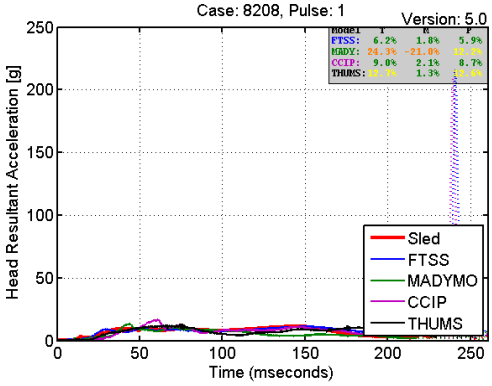
10G 110ms +Z

Figure C-4-49: 8199 Head Resultant Translational Acceleration



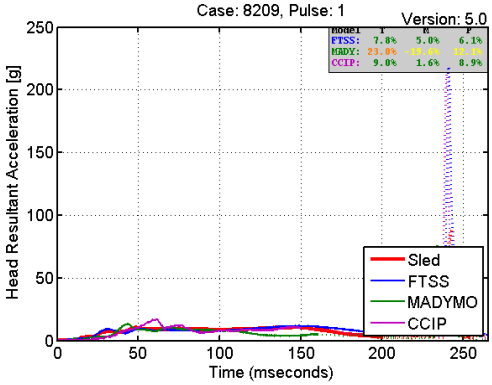
10G 70ms +Z

Figure C-4-47: 8207 Head Resultant Translational Acceleration



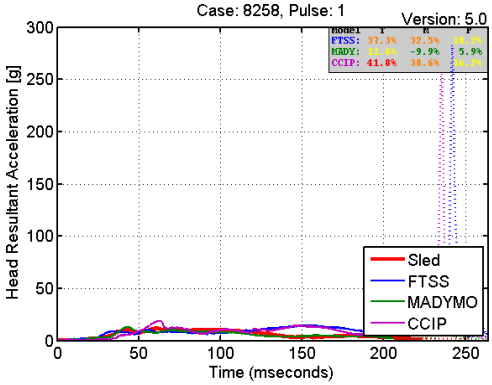
10G 70ms +Z

Figure C-4-50: 8208 Head Resultant Translational Acceleration



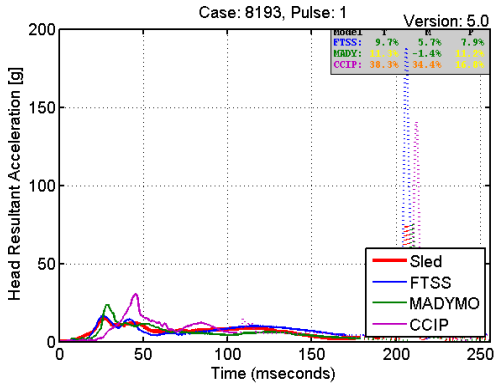
10G 70ms +Z

Figure C-4-48: 8209 Head Resultant Translational Acceleration



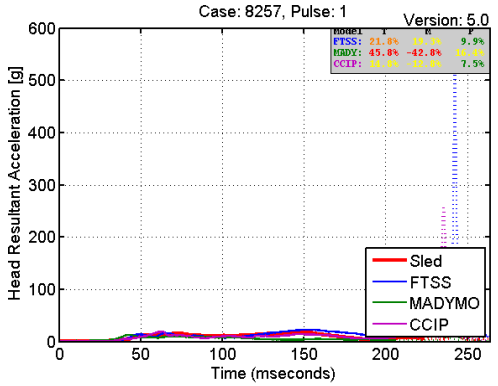
10G 70ms +Z

Figure C-4-51: 8258 Head Resultant Translational Acceleration



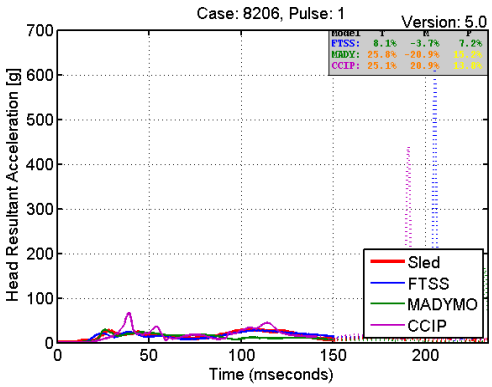
10G 30ms +Z

Figure C-4-52: 8193 Head Resultant Translational Acceleration



15G 70ms +Z

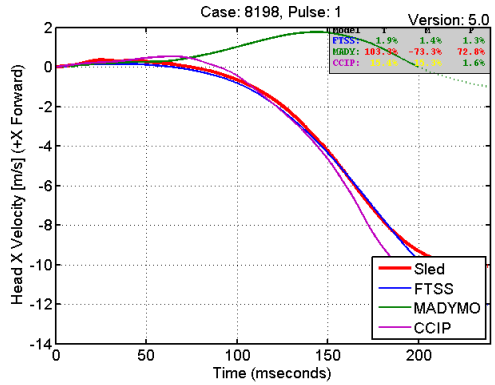
Figure C-4-53: 8257 Head Resultant Translational Acceleration



20G 70ms +Z

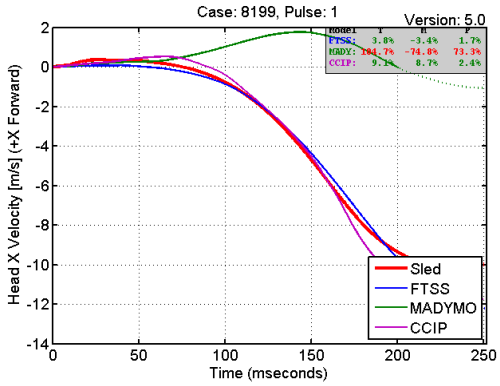
Figure C-4-54: 8206 Head Resultant Translational Acceleration

C.4.7 Head X Translational Velocity



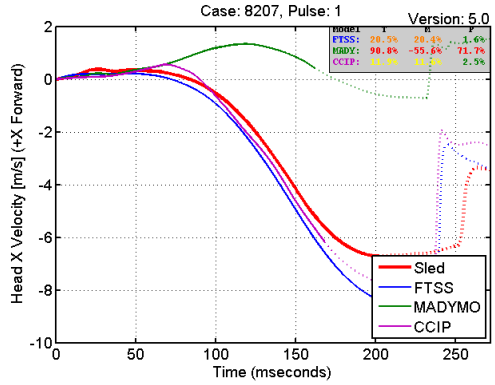
10G 110ms +Z

Figure C-4-55: 8198 Head X Translational Velocity



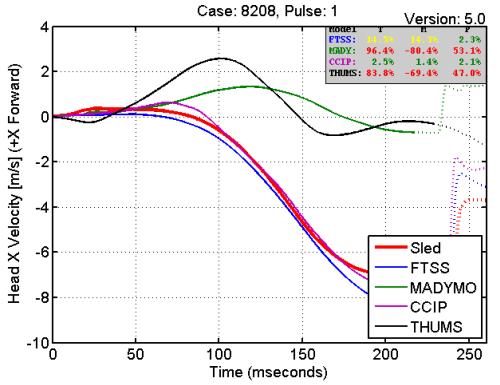
10G 110ms +Z

Figure C-4-58: 8199 Head X Translational Velocity



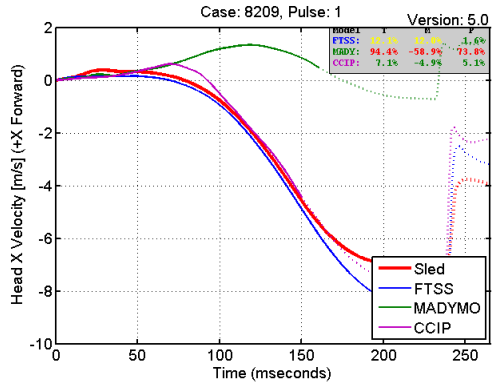
10G 70ms +Z

Figure C-4-56: 8207 Head X Translational Velocity



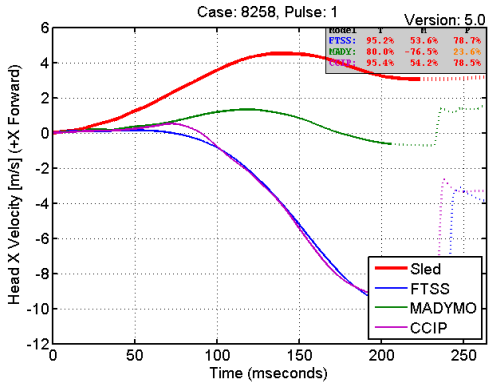
10G 70ms +Z

Figure C-4-59: 8208 Head X Translational Velocity



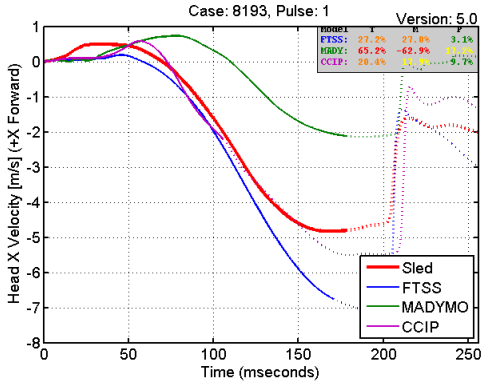
10G 70ms +Z

Figure C-4-57: 8209 Head X Translational Velocity



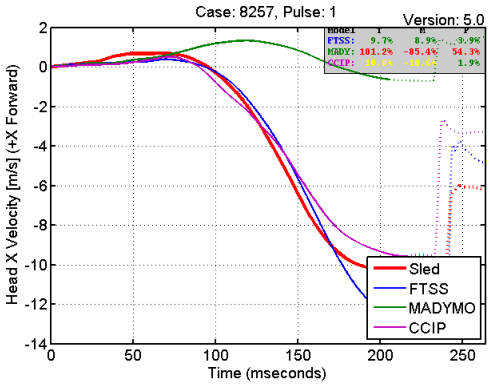
10G 70ms +Z

Figure C-4-60: 8258 Head X Translational Velocity



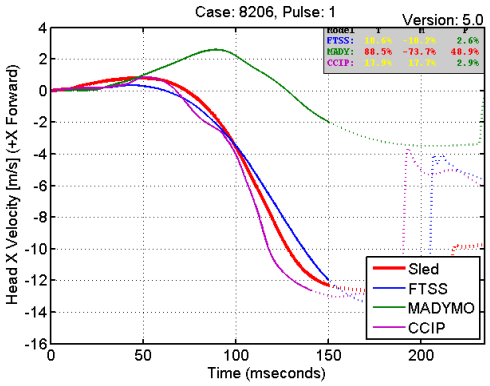
10G 30ms +Z

Figure C-4-61: 8193 Head X Translational Velocity



15G 70ms +Z

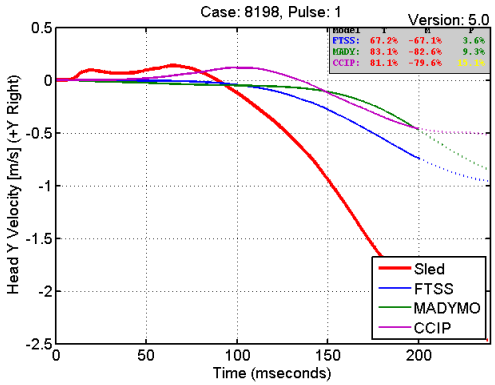
Figure C-4-62: 8257 Head X Translational Velocity



20G 70ms +Z

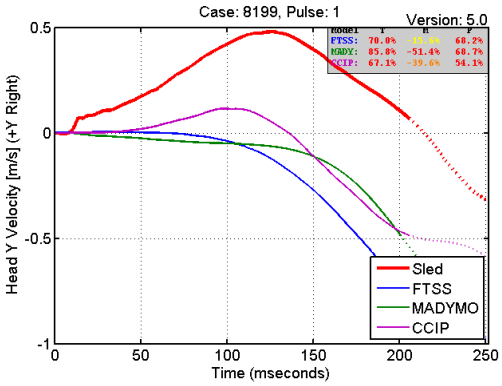
Figure C-4-63: 8206 Head X Translational Velocity

C.4.8 Head Y Translational Velocity



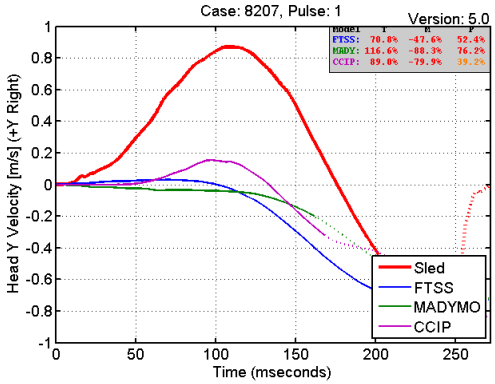
10G 110ms +Z

Figure C-4-64: 8198 Head Y Translational Velocity



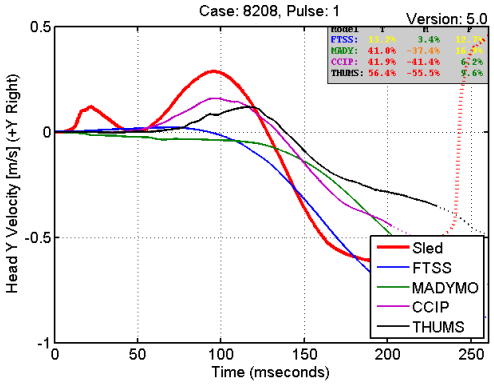
10G 110ms +Z

Figure C-4-67: 8199 Head Y Translational Velocity



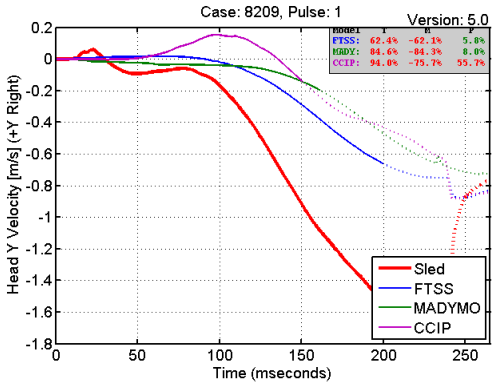
10G 70ms +Z

Figure C-4-65: 8207 Head Y Translational Velocity



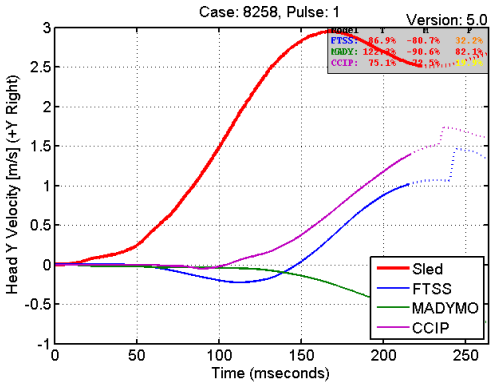
10G 70ms +Z

Figure C-4-68: 8208 Head Y Translational Velocity



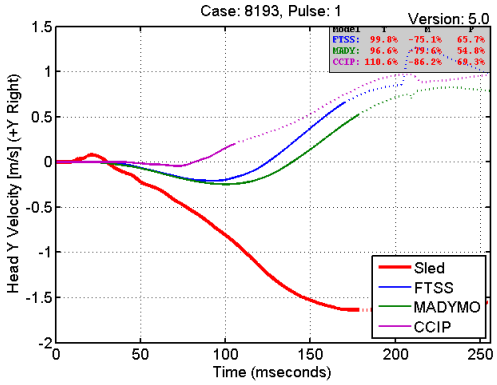
10G 70ms +Z

Figure C-4-66: 8209 Head Y Translational Velocity



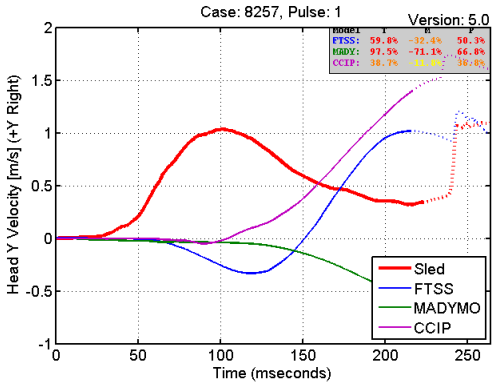
10G 70ms +Z

Figure C-4-69: 8258 Head Y Translational Velocity



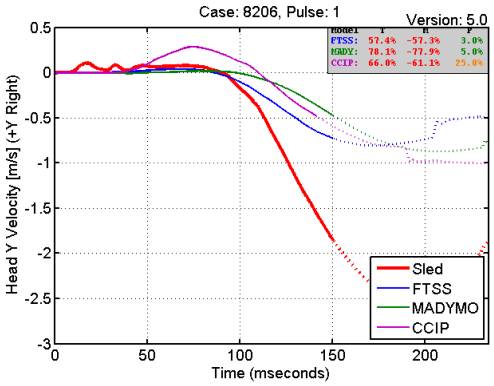
10G 30ms +Z

Figure C-4-70: 8193 Head Y Translational Velocity



15G 70ms +Z

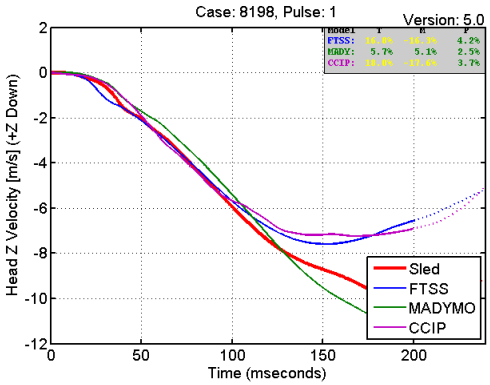
Figure C-4-71: 8257 Head Y Translational Velocity



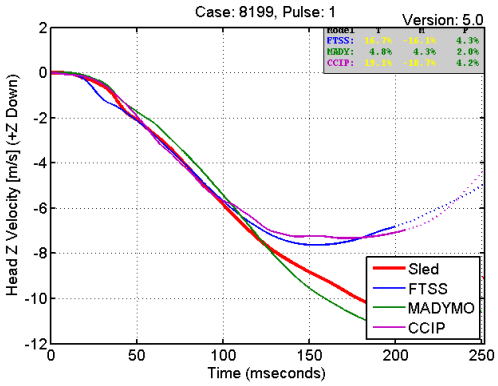
20G 70ms +Z

Figure C-4-72: 8206 Head Y Translational Velocity

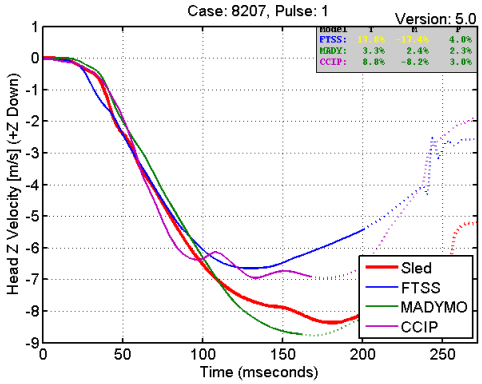
C.4.9 Head Z Translational Velocity



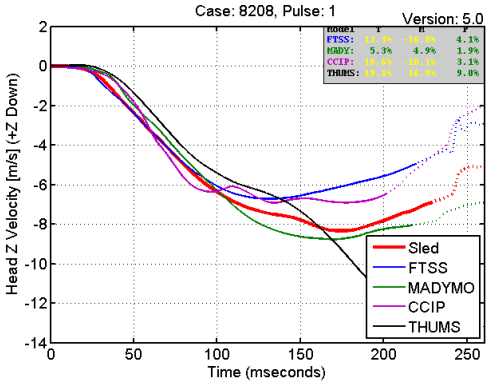
10G 110ms +Z
Figure C-4-73: 8198 Head Z Translational Velocity



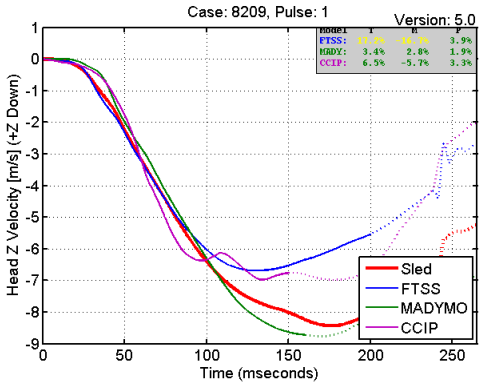
10G 110ms +Z
Figure C-4-76: 8199 Head Z Translational Velocity



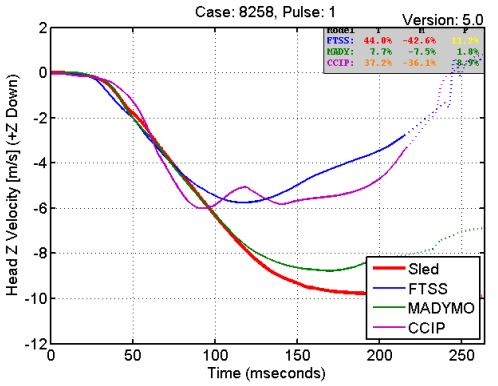
10G 70ms +Z
Figure C-4-74: 8207 Head Z Translational Velocity



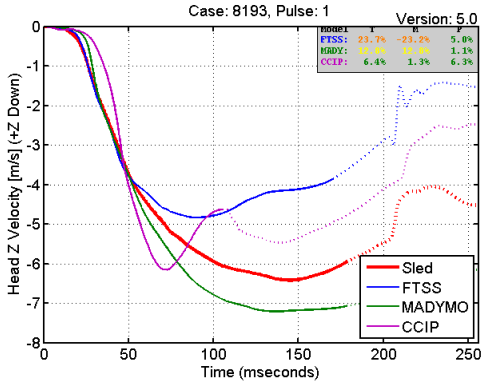
10G 70ms +Z
Figure C-4-77: 8208 Head Z Translational Velocity



10G 70ms +Z
Figure C-4-75: 8209 Head Z Translational Velocity

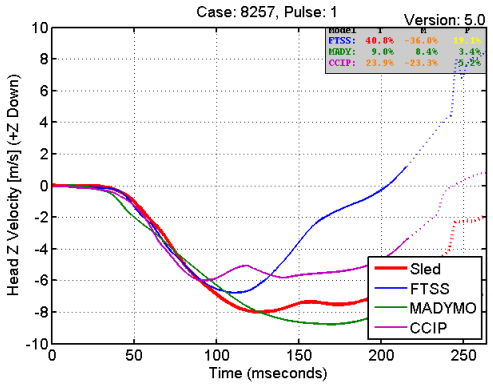


10G 70ms +Z
Figure C-4-78: 8258 Head Z Translational Velocity



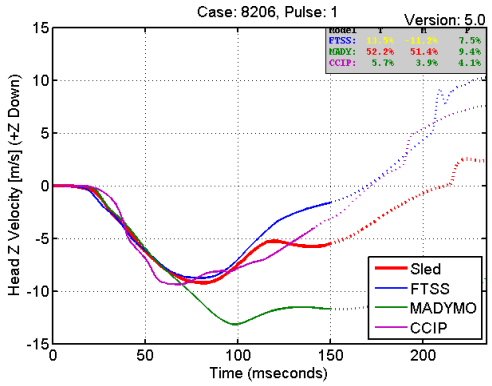
10G 30ms +Z

Figure C-4-79: 8193 Head Z Translational Velocity



15G 70ms +Z

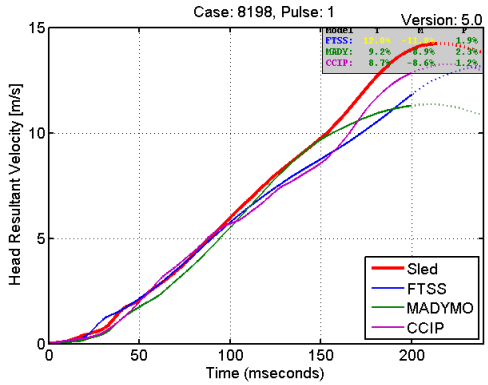
Figure C-4-80: 8257 Head Z Translational Velocity



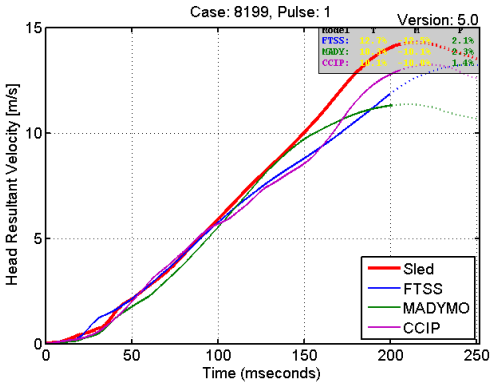
20G 70ms +Z

Figure C-4-81: 8206 Head Z Translational Velocity

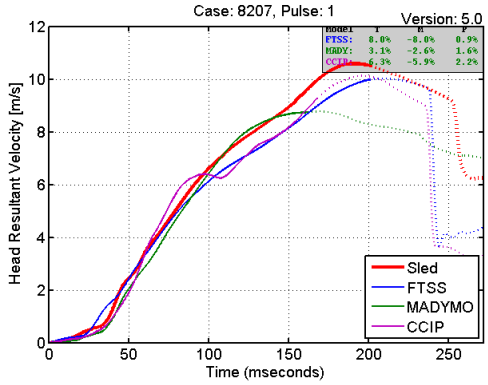
C.4.10 Head Resultant Translational Velocity



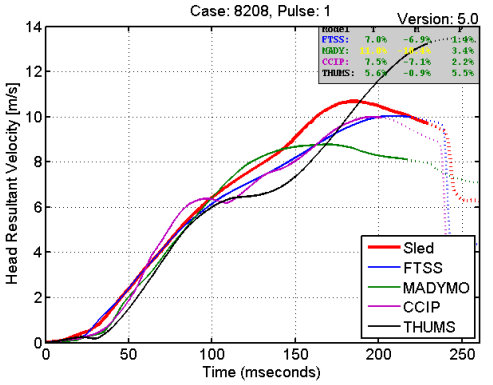
10G 110ms +Z
Figure C-4-82: 8198 Head Resultant Translational Velocity



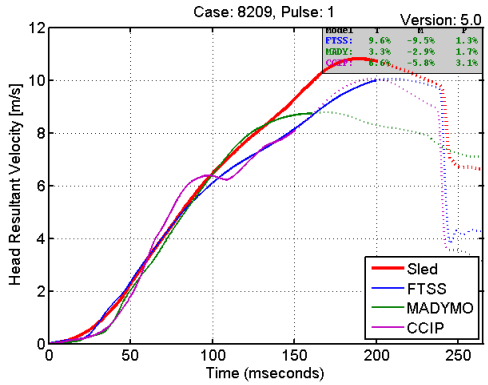
10G 110ms +Z
Figure C-4-85: 8199 Head Resultant Translational Velocity



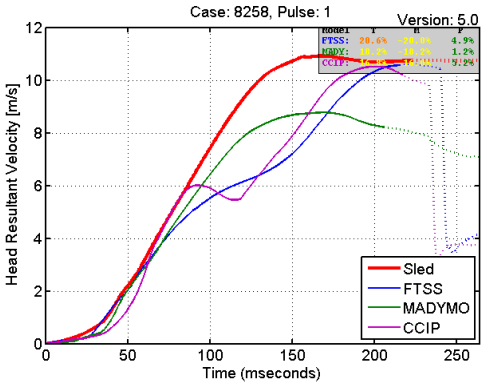
10G 70ms +Z
Figure C-4-83: 8207 Head Resultant Translational Velocity



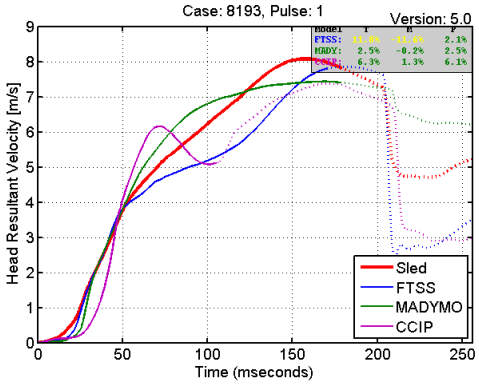
10G 70ms +Z
Figure C-4-86: 8208 Head Resultant Translational Velocity



10G 70ms +Z
Figure C-4-84: 8209 Head Resultant Translational Velocity

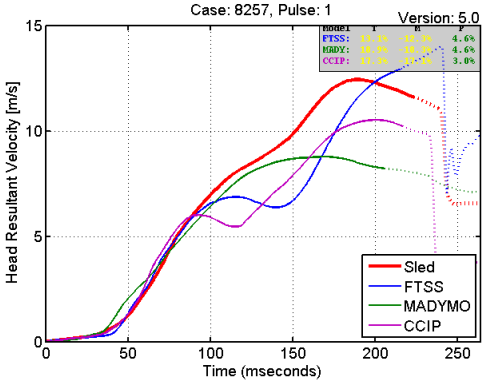


10G 70ms +Z
Figure C-4-87: 8258 Head Resultant Translational Velocity



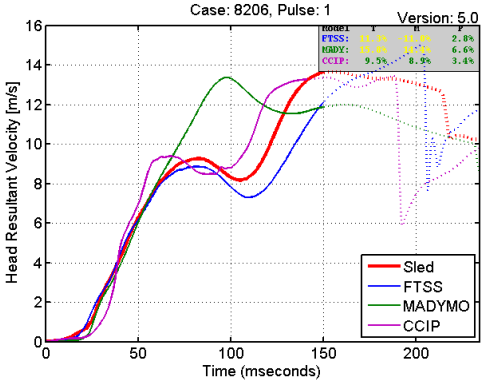
10G 30ms +Z

Figure C-4-88: 8193 Head Resultant Translational Velocity



15G 70ms +Z

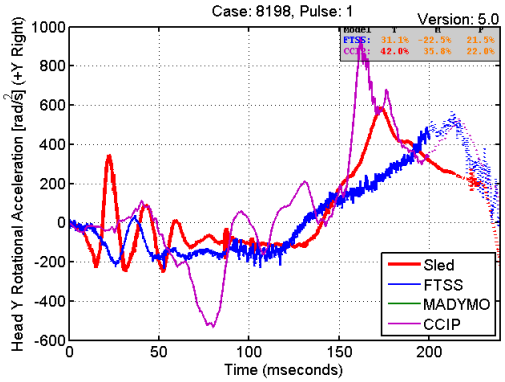
Figure C-4-89: 8257 Head Resultant Translational Velocity



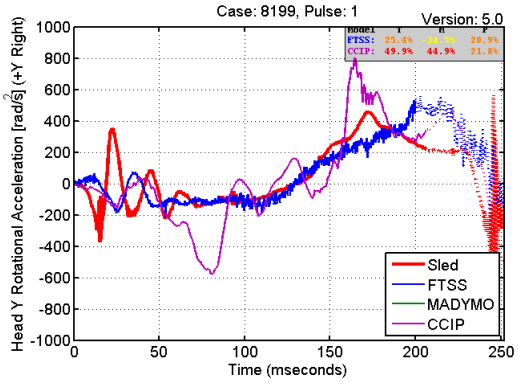
20G 70ms +Z

Figure C-4-90: 8206 Head Resultant Translational Velocity

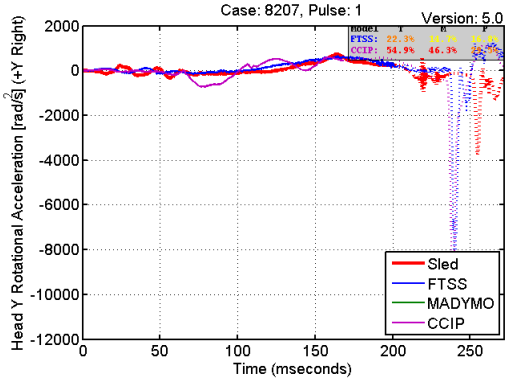
C.4.11 Head Y Rotational Acceleration



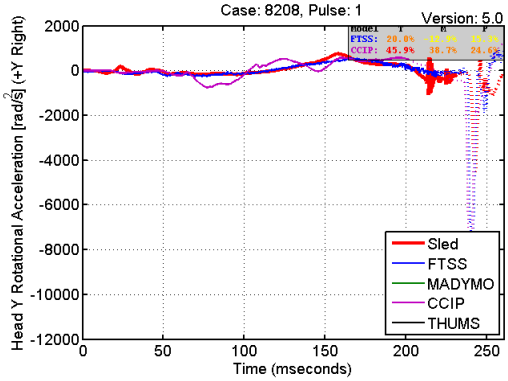
10G 110ms +Z
Figure C-4-91: 8198 Head Y Rotational Acceleration



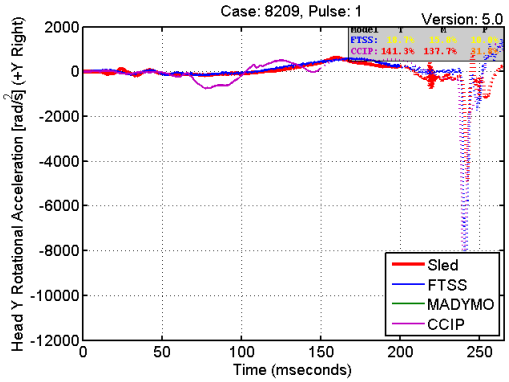
10G 110ms +Z
Figure C-4-94: 8199 Head Y Rotational Acceleration



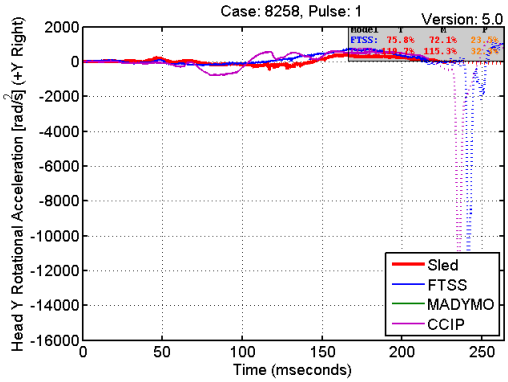
10G 70ms +Z
Figure C-4-92: 8207 Head Y Rotational Acceleration



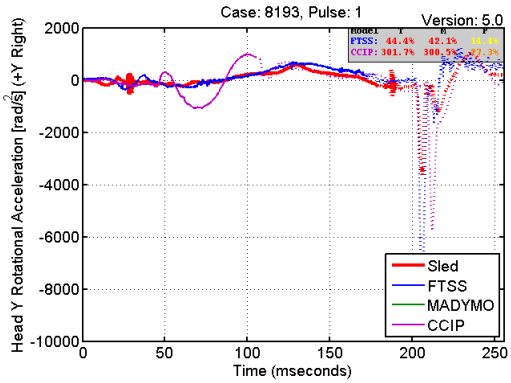
10G 70ms +Z
Figure C-4-95: 8208 Head Y Rotational Acceleration



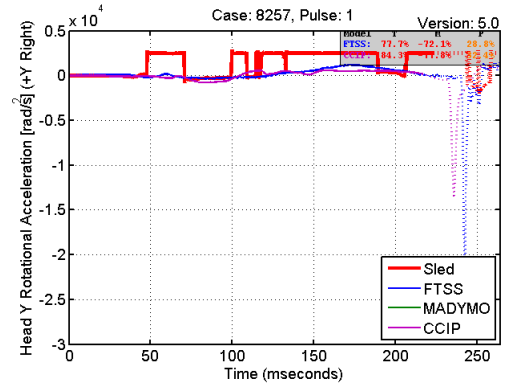
10G 70ms +Z
Figure C-4-93: 8209 Head Y Rotational Acceleration



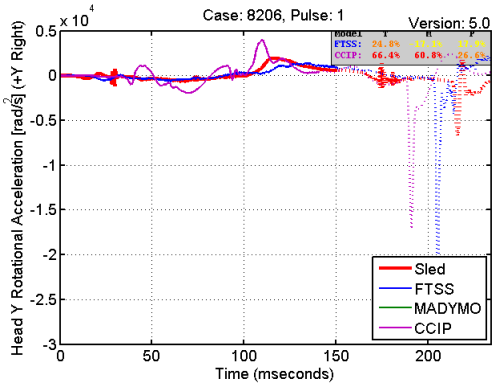
10G 70ms +Z
Figure C-4-96: 8258 Head Y Rotational Acceleration



10G 30ms +Z
Figure C-4-97: 8193 Head Y Rotational Acceleration

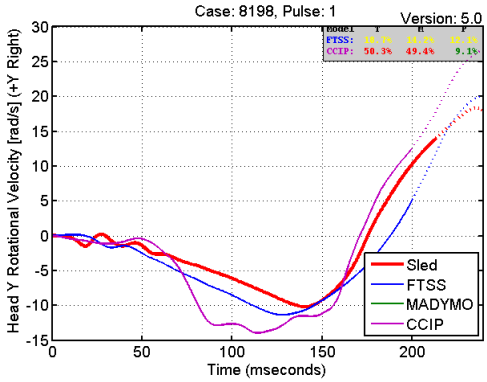


15G 70ms +Z
Figure C-4-98: 8257 Head Y Rotational Acceleration



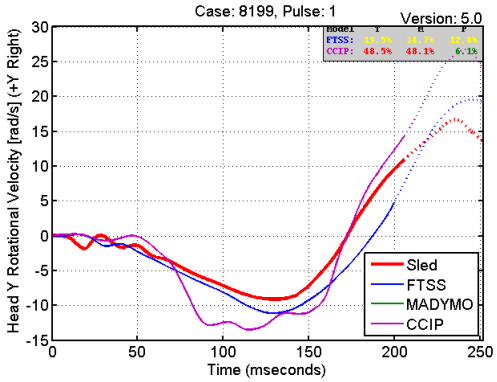
20G 70ms +Z
Figure C-4-99: 8206 Head Y Rotational Acceleration

C.4.12 Head Y Rotational Velocity



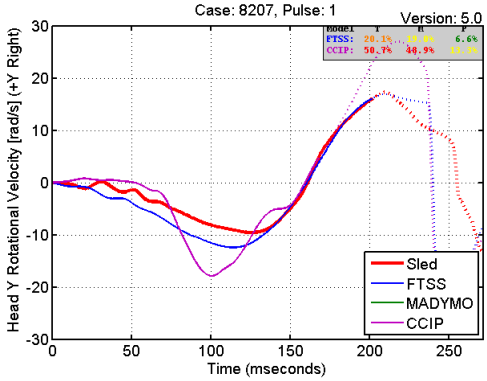
10G 110ms +Z

Figure C-4-100: 8198 Head Y Rotational Velocity



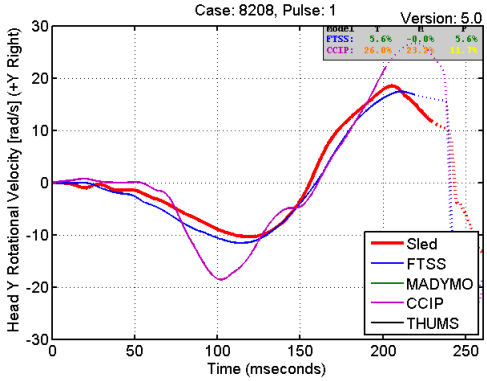
10G 110ms +Z

Figure C-4-103: 8199 Head Y Rotational Velocity



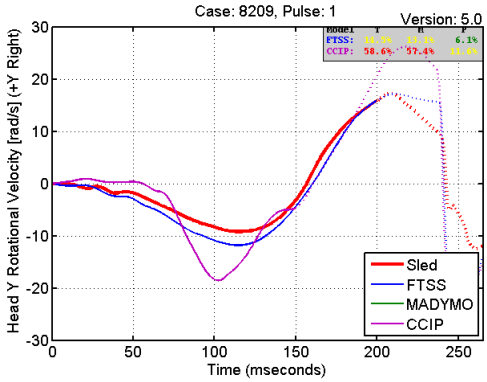
10G 70ms +Z

Figure C-4-101: 8207 Head Y Rotational Velocity



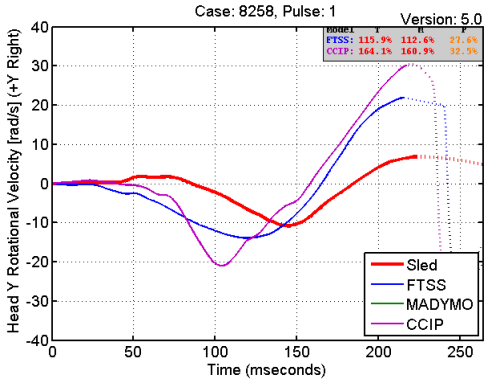
10G 70ms +Z

Figure C-4-104: 8208 Head Y Rotational Velocity



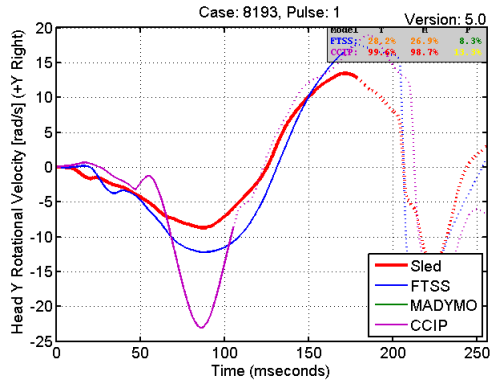
10G 70ms +Z

Figure C-4-102: 8209 Head Y Rotational Velocity



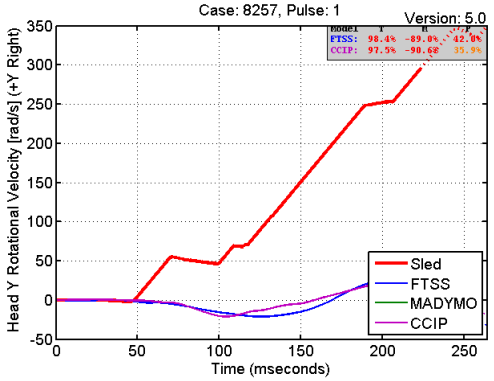
10G 70ms +Z

Figure C-4-105: 8258 Head Y Rotational Velocity



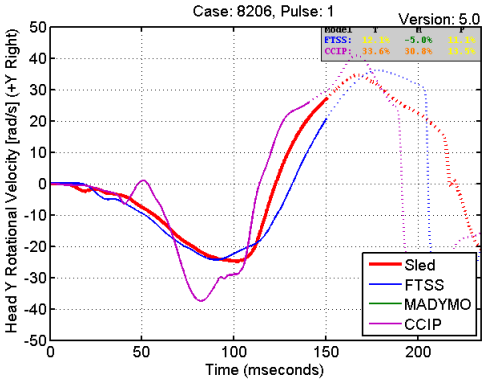
10G 30ms +Z

Figure C-4-106: 8193 Head Y Rotational Velocity



15G 70ms +Z

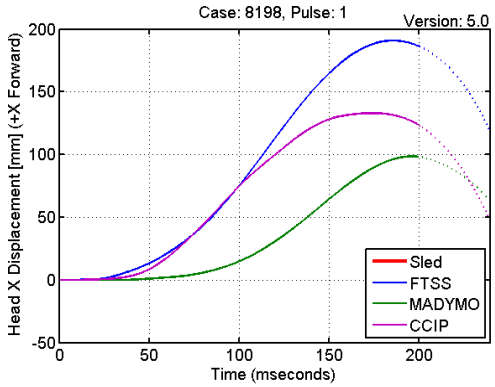
Figure C-4-107: 8257 Head Y Rotational Velocity



20G 70ms +Z

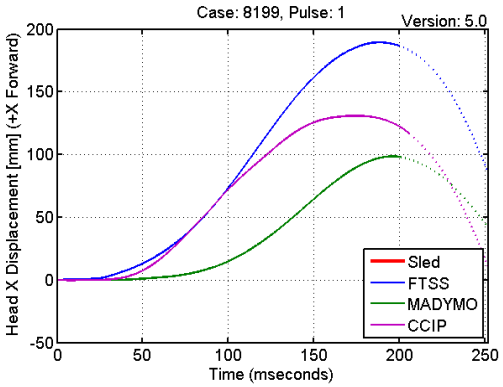
Figure C-4-108: 8206 Head Y Rotational Velocity

C.4.13 Head X Movement



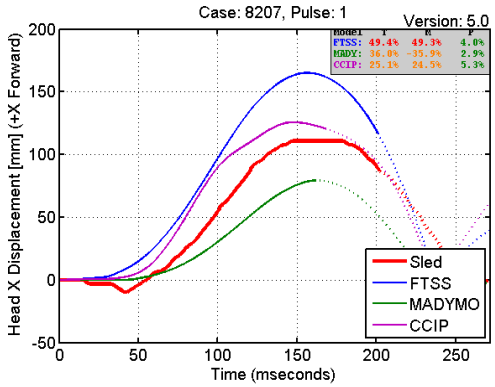
10G 110ms +Z

Figure C-4-109: 8198 Head X Movement



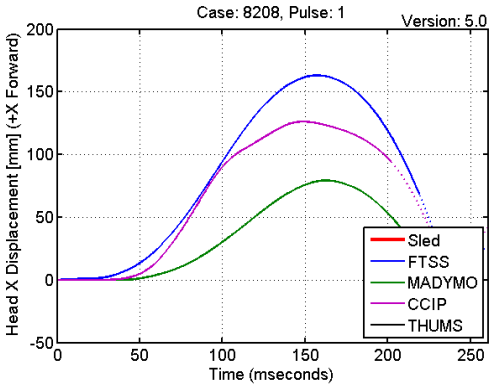
10G 110ms +Z

Figure C-4-112: 8199 Head X Movement



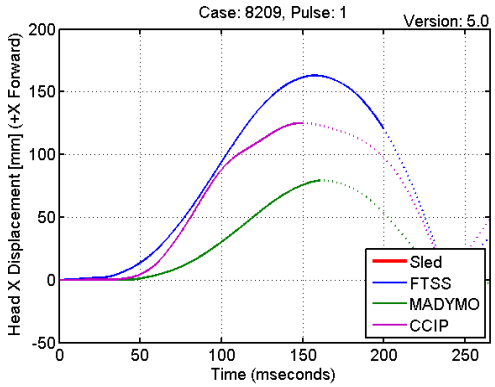
10G 70ms +Z

Figure C-4-110: 8207 Head X Movement



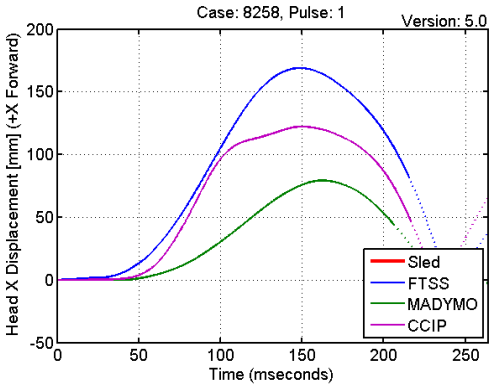
10G 70ms +Z

Figure C-4-113: 8208 Head X Movement



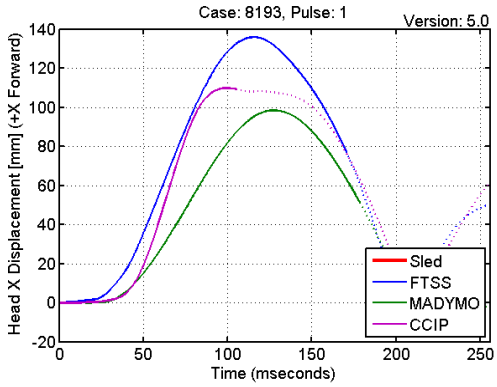
10G 70ms +Z

Figure C-4-111: 8209 Head X Movement



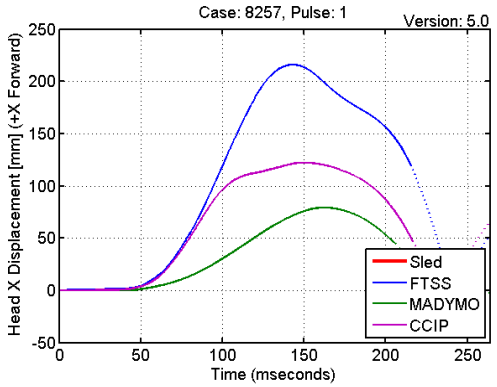
10G 70ms +Z

Figure C-4-114: 8258 Head X Movement



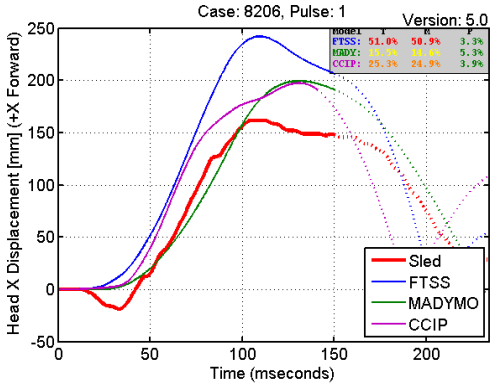
10G 30ms +Z

Figure C-4-115: 8193 Head X Movement



15G 70ms +Z

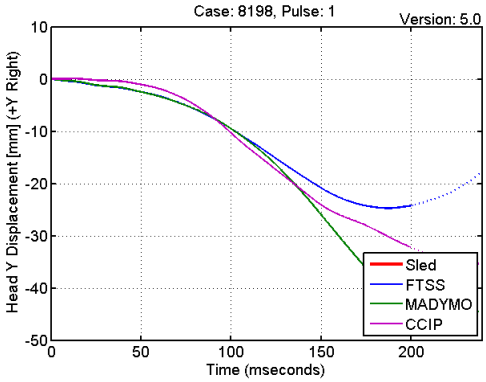
Figure C-4-116: 8257 Head X Movement



20G 70ms +Z

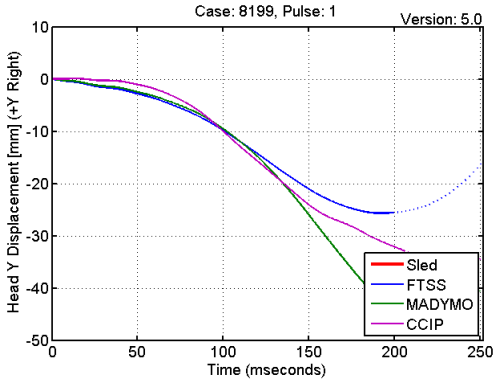
Figure C-4-117: 8206 Head X Movement

C.4.14 Head Y Movement



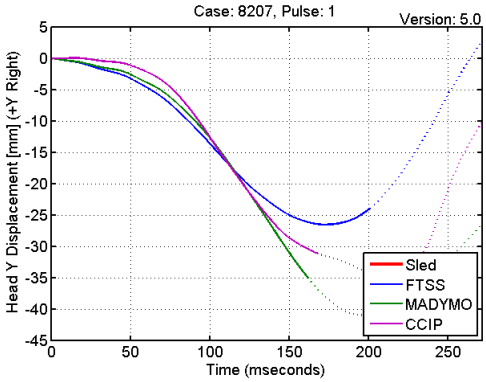
10G 110ms +Z

Figure C-4-118: 8198 Head Y Movement



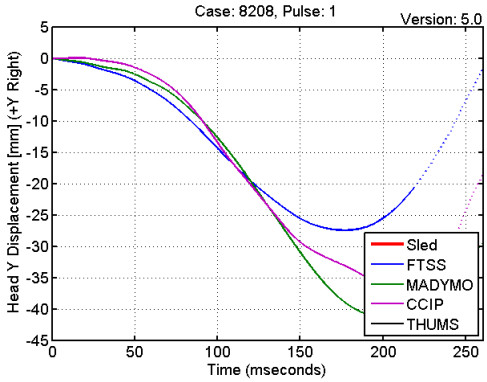
10G 110ms +Z

Figure C-4-121: 8199 Head Y Movement



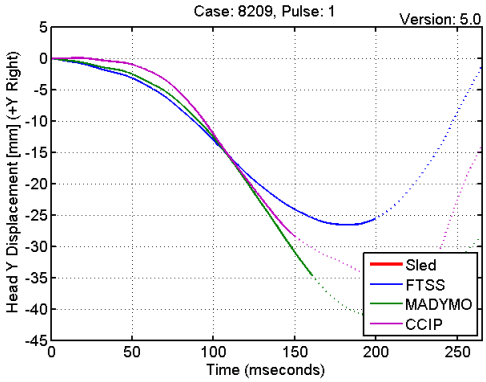
10G 70ms +Z

Figure C-4-119: 8207 Head Y Movement



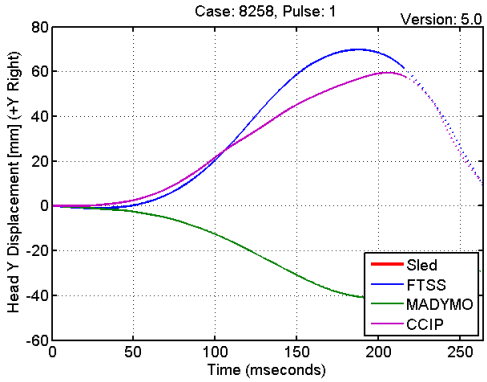
10G 70ms +Z

Figure C-4-122: 8208 Head Y Movement



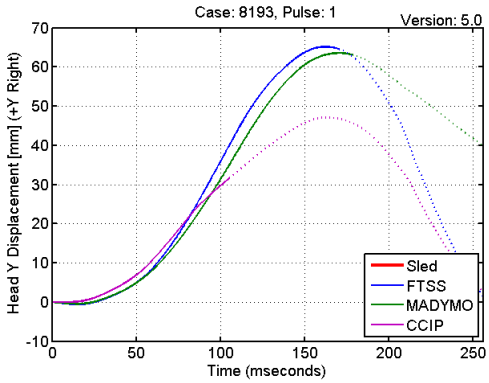
10G 70ms +Z

Figure C-4-120: 8209 Head Y Movement



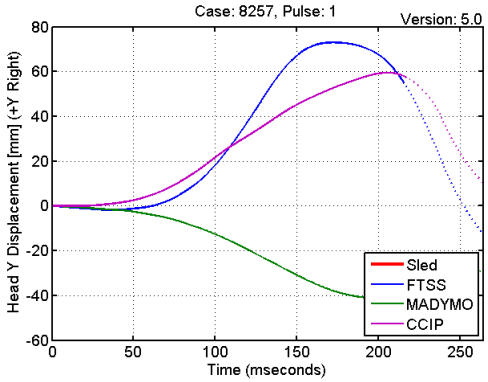
10G 70ms +Z

Figure C-4-123: 8258 Head Y Movement



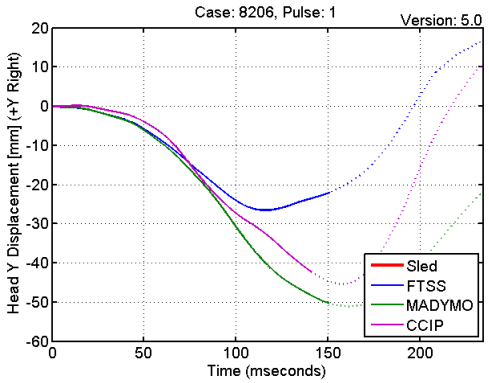
10G 30ms +Z

Figure C-4-124: 8193 Head Y Movement



15G 70ms +Z

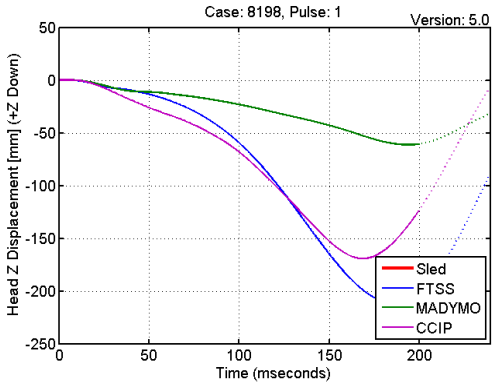
Figure C-4-125: 8257 Head Y Movement



20G 70ms +Z

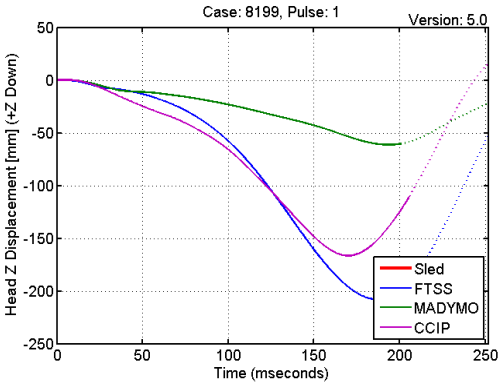
Figure C-4-126: 8206 Head Y Movement

C.4.15 Head Z Movement



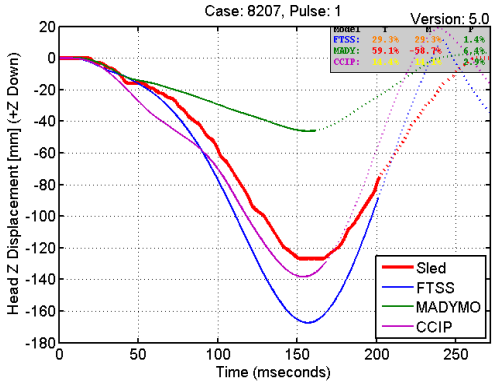
10G 110ms +Z

Figure C-4-127: 8198 Head Z Movement



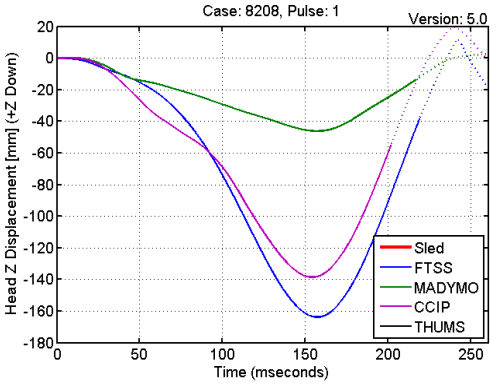
10G 110ms +Z

Figure C-4-130: 8199 Head Z Movement



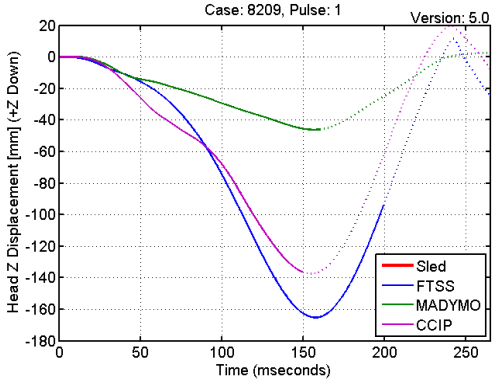
10G 70ms +Z

Figure C-4-128: 8207 Head Z Movement



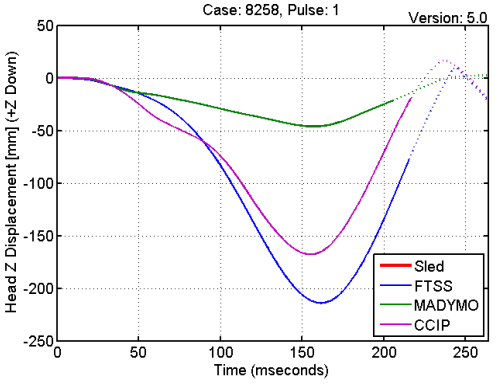
10G 70ms +Z

Figure C-4-131: 8208 Head Z Movement



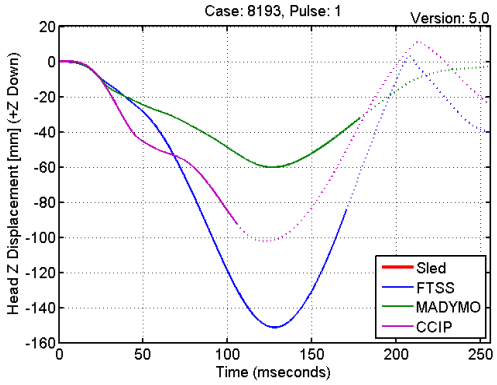
10G 70ms +Z

Figure C-4-129: 8209 Head Z Movement



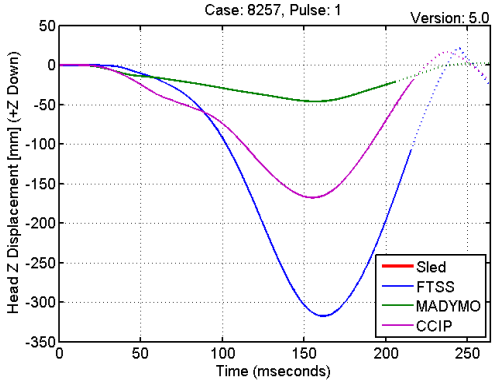
10G 70ms +Z

Figure C-4-132: 8258 Head Z Movement



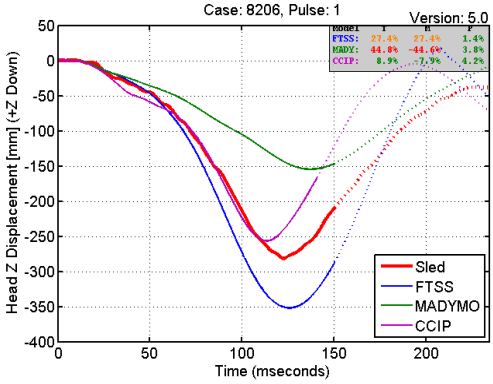
10G 30ms +Z

Figure C-4-133: 8193 Head Z Movement



15G 70ms +Z

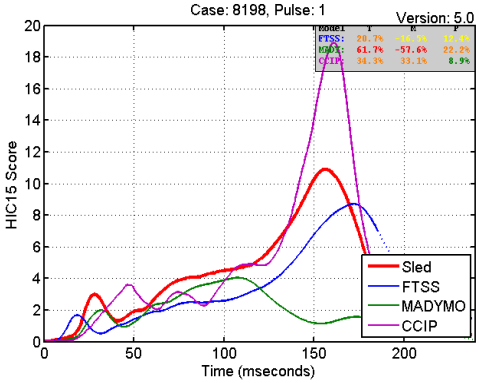
Figure C-4-134: 8257 Head Z Movement



20G 70ms +Z

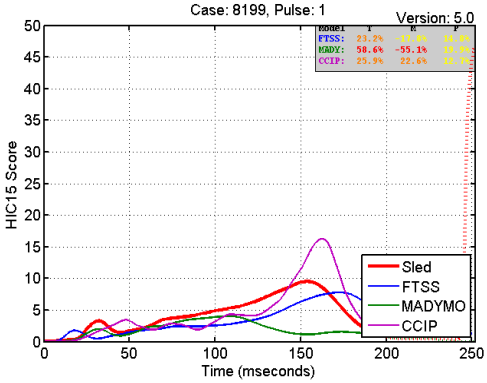
Figure C-4-135: 8206 Head Z Movement

C.4.16 HIC 15



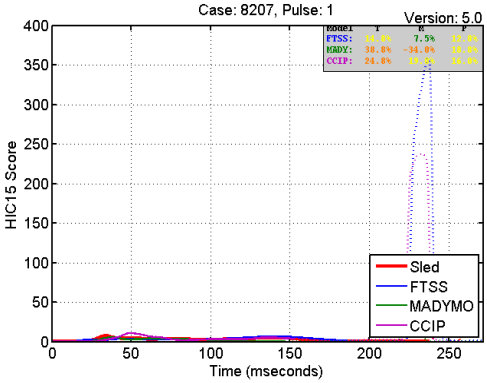
10G 110ms +Z

Figure C-4-136: 8198 HIC 15



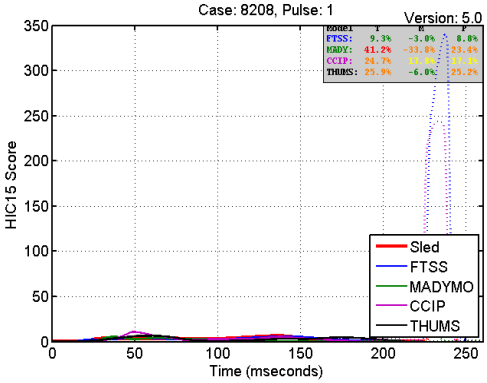
10G 110ms +Z

Figure C-4-139: 8199 HIC 15



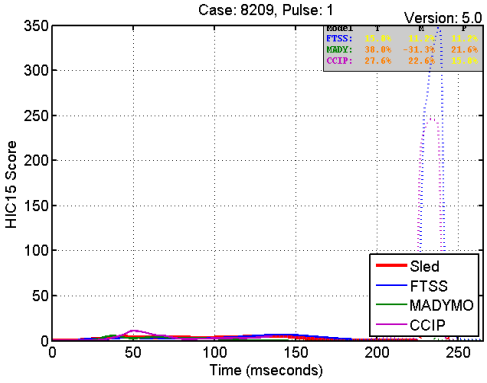
10G 70ms +Z

Figure C-4-137: 8207 HIC 15



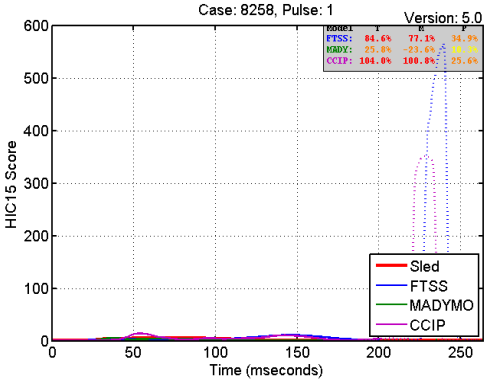
10G 70ms +Z

Figure C-4-140: 8208 HIC 15



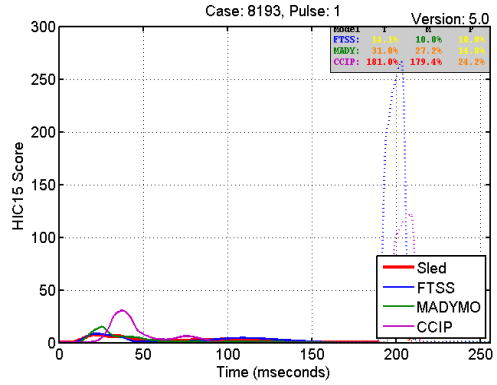
10G 70ms +Z

Figure C-4-138: 8209 HIC 15



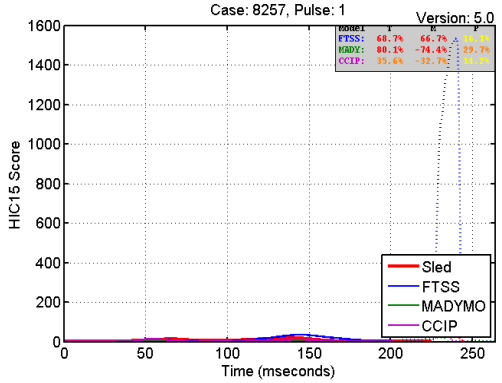
10G 70ms +Z

Figure C-4-141: 8258 HIC 15



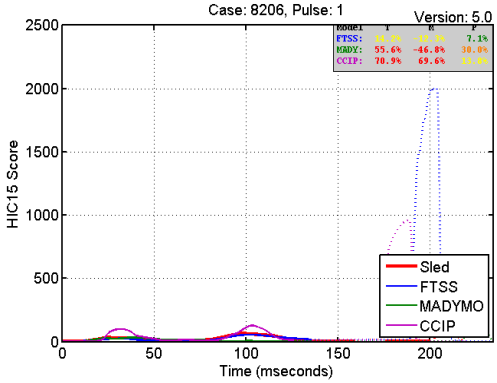
10G 30ms +Z

Figure C-4-142: 8193 HIC 15



15G 70ms +Z

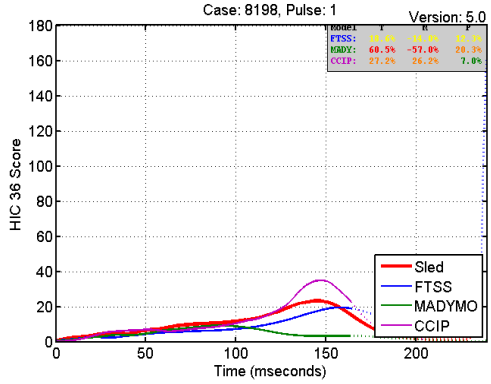
Figure C-4-143: 8257 HIC 15



20G 70ms +Z

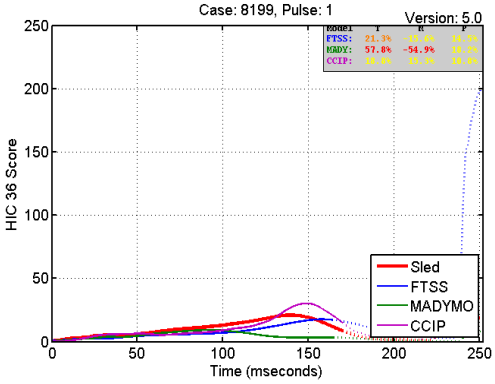
Figure C-4-144: 8206 HIC 15

C.4.17 HIC 36



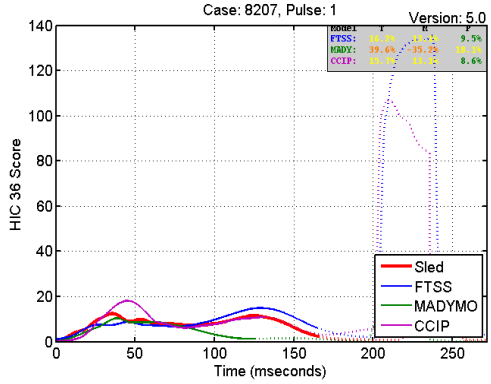
10G 110ms +Z

Figure C-4-145: 8198 HIC 36



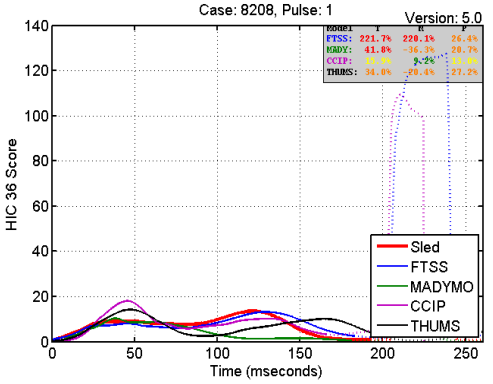
10G 110ms +Z

Figure C-4-148: 8199 HIC 36



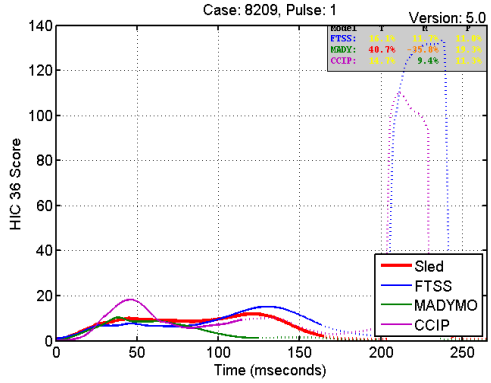
10G 70ms +Z

Figure C-4-146: 8207 HIC 36



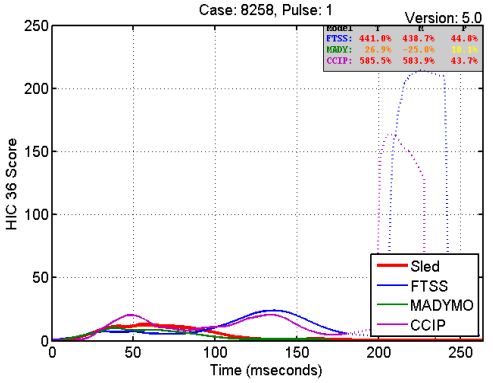
10G 70ms +Z

Figure C-4-149: 8208 HIC 36



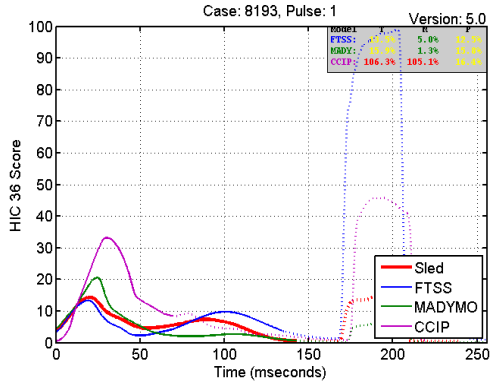
10G 70ms +Z

Figure C-4-147: 8209 HIC 36



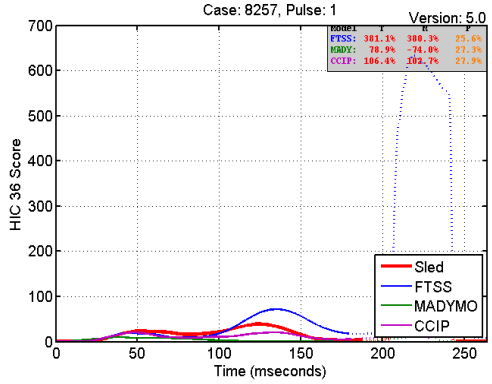
10G 70ms +Z

Figure C-4-150: 8258 HIC 36



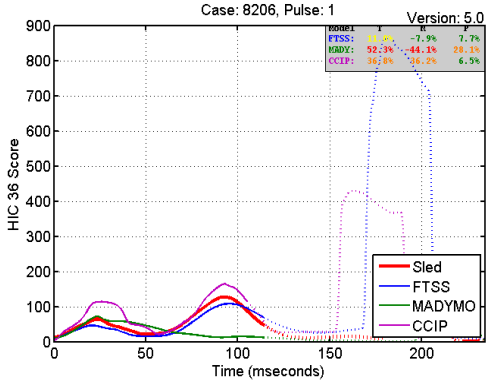
10G 30ms +Z

Figure C-4-151: 8193 HIC 36



15G 70ms +Z

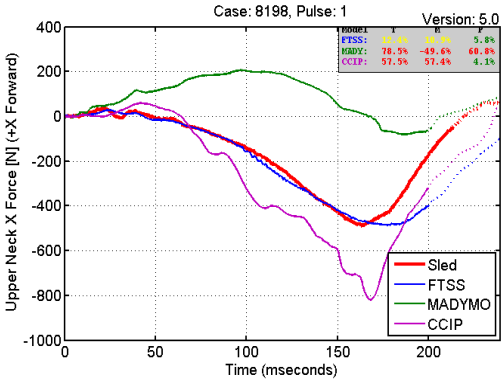
Figure C-4-152: 8257 HIC 36



20G 70ms +Z

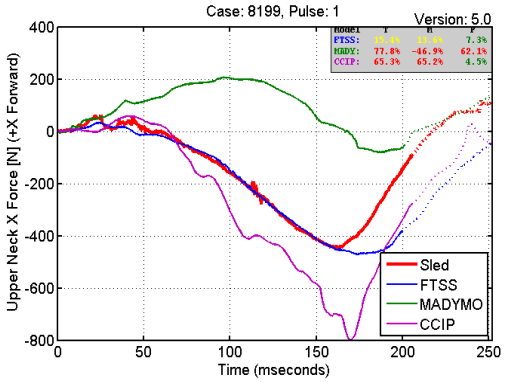
Figure C-4-153: 8206 HIC 36

C.4.18 Neck X Force



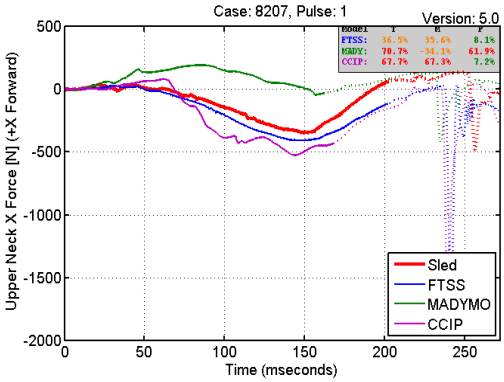
10G 110ms +Z

Figure C-4-154: 8198 Neck X Force



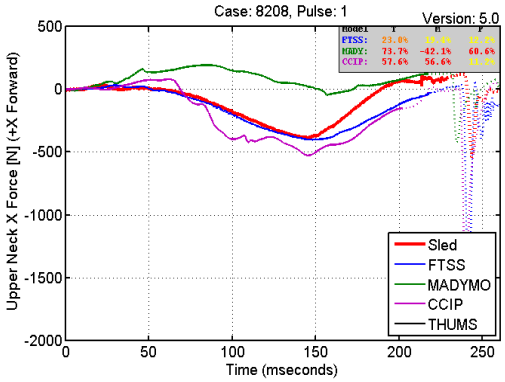
10G 110ms +Z

Figure C-4-157: 8199 Neck X Force



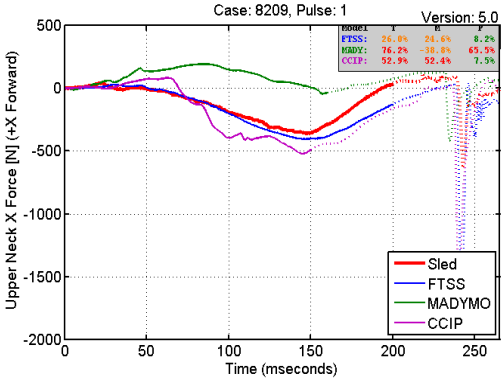
10G 70ms +Z

Figure C-4-155: 8207 Neck X Force



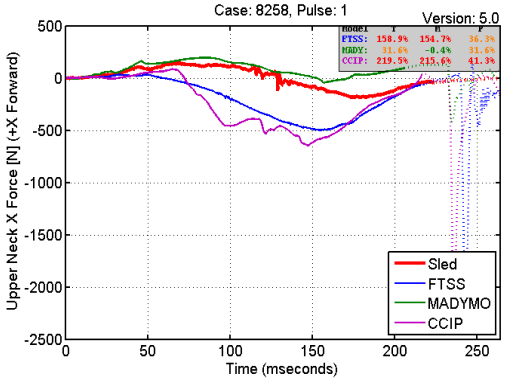
10G 70ms +Z

Figure C-4-158: 8208 Neck X Force



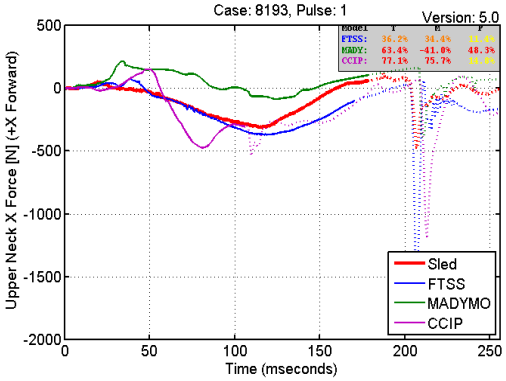
10G 70ms +Z

Figure C-4-156: 8209 Neck X Force



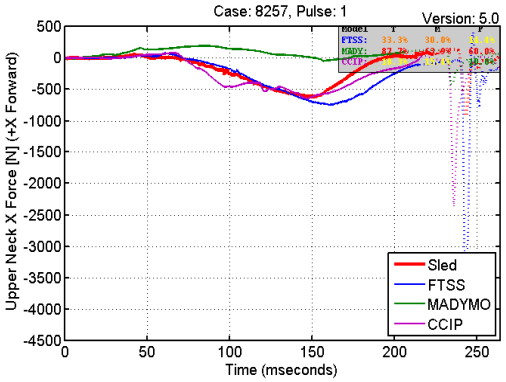
10G 70ms +Z

Figure C-4-159: 8258 Neck X Force



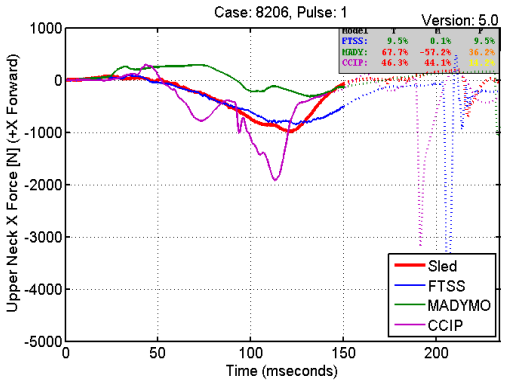
10G 30ms +Z

Figure C-4-160: 8193 Neck X Force



15G 70ms +Z

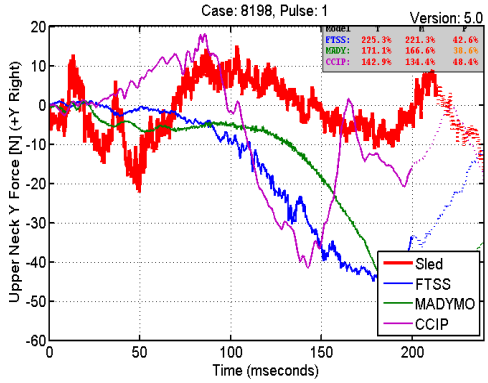
Figure C-4-161: 8257 Neck X Force



20G 70ms +Z

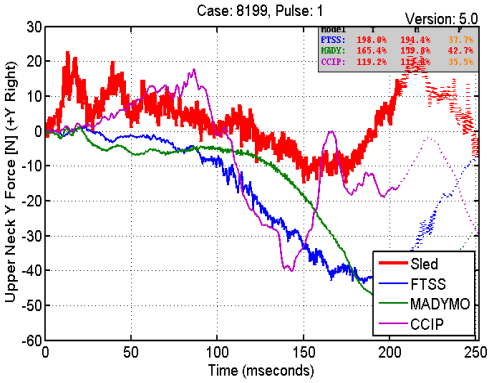
Figure C-4-162: 8206 Neck X Force

C.4.19 Neck Y Force



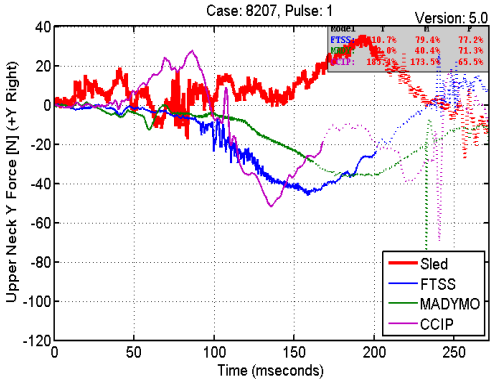
10G 110ms +Z

Figure C-4-163: 8198 Neck Y Force



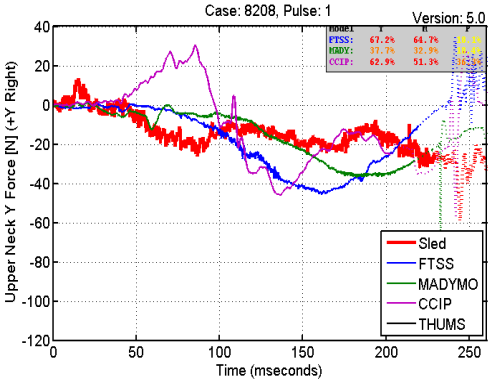
10G 110ms +Z

Figure C-4-166: 8199 Neck Y Force



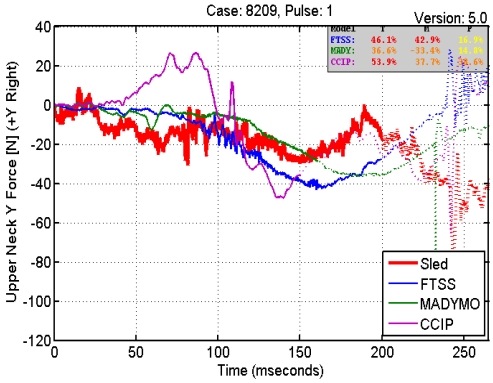
10G 70ms +Z

Figure C-4-164: 8207 Neck Y Force



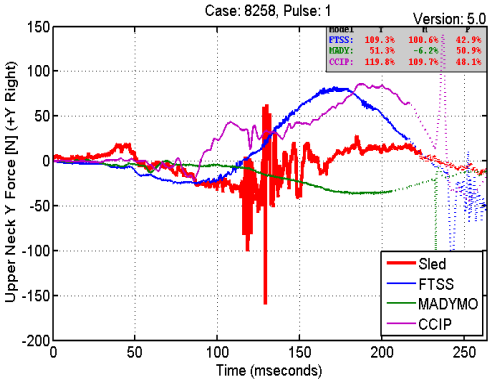
10G 70ms +Z

Figure C-4-167: 8208 Neck Y Force



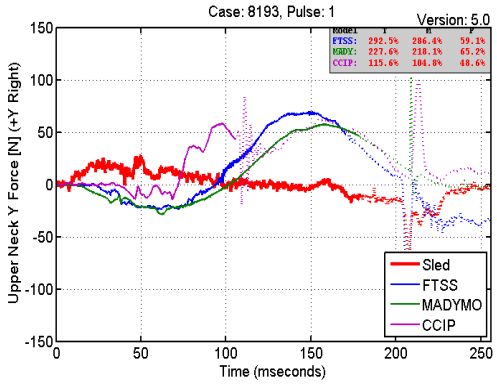
10G 70ms +Z

Figure C-4-165: 8209 Neck Y Force



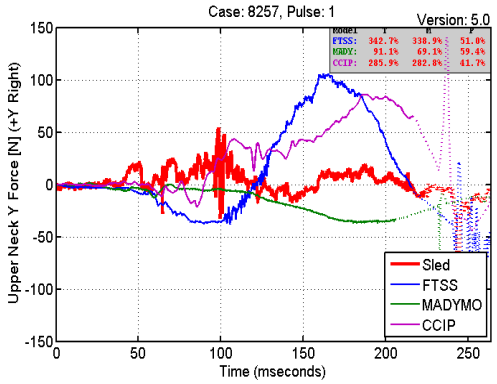
10G 70ms +Z

Figure C-4-168: 8258 Neck Y Force



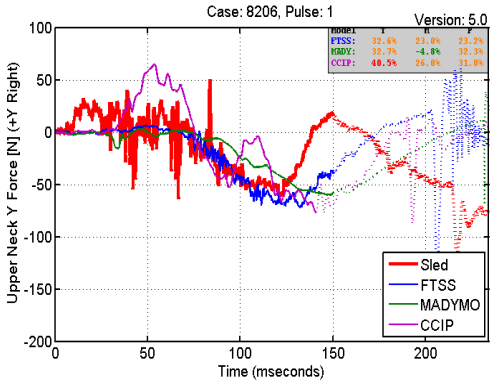
10G 30ms +Z

Figure C-4-169: 8193 Neck Y Force



15G 70ms +Z

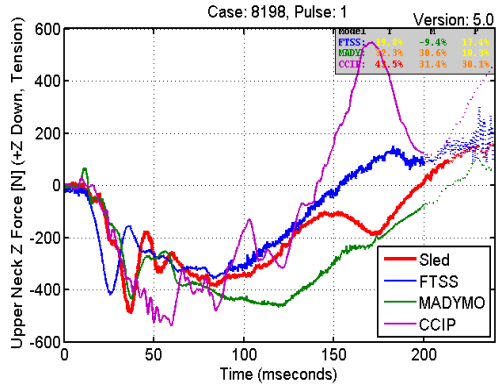
Figure C-4-170: 8257 Neck Y Force



20G 70ms +Z

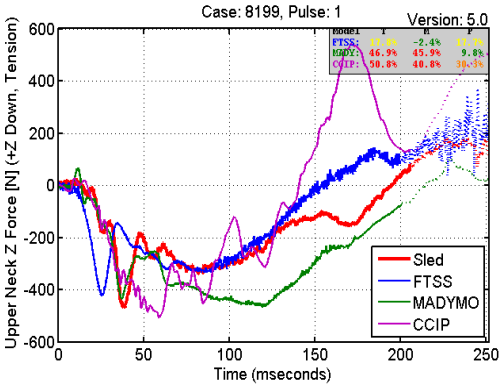
Figure C-4-171: 8206 Neck Y Force

C.4.20 Neck Z Force



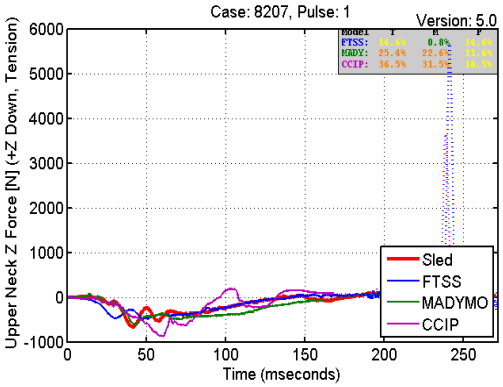
10G 110ms +Z

Figure C-4-172: 8198 Neck Z Force



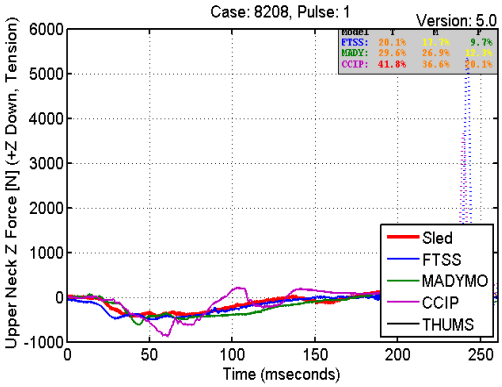
10G 110ms +Z

Figure C-4-175: 8199 Neck Z Force



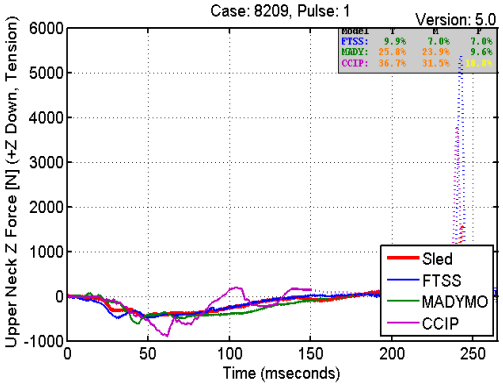
10G 70ms +Z

Figure C-4-173: 8207 Neck Z Force



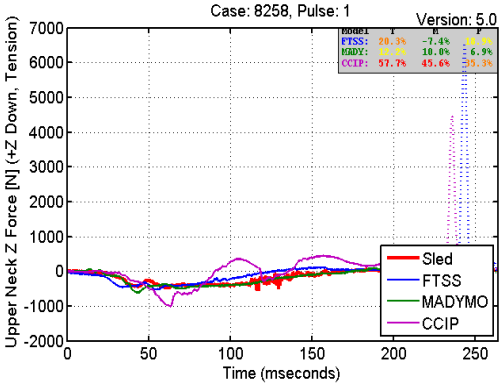
10G 70ms +Z

Figure C-4-176: 8208 Neck Z Force



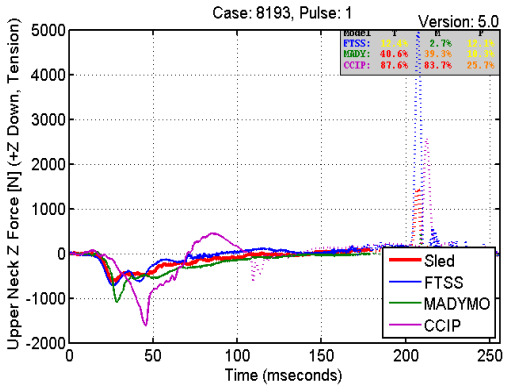
10G 70ms +Z

Figure C-4-174: 8209 Neck Z Force



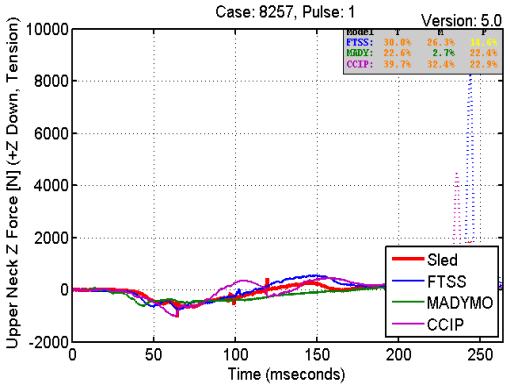
10G 70ms +Z

Figure C-4-177: 8258 Neck Z Force



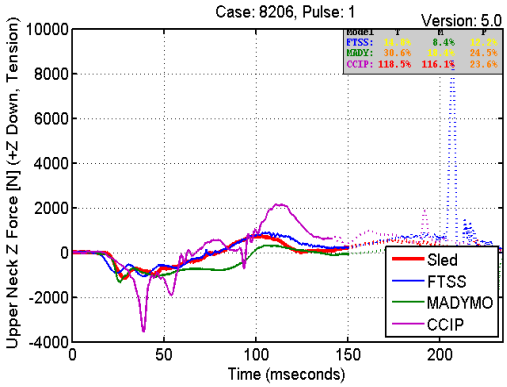
10G 30ms +Z

Figure C-4-178: 8193 Neck Z Force



15G 70ms +Z

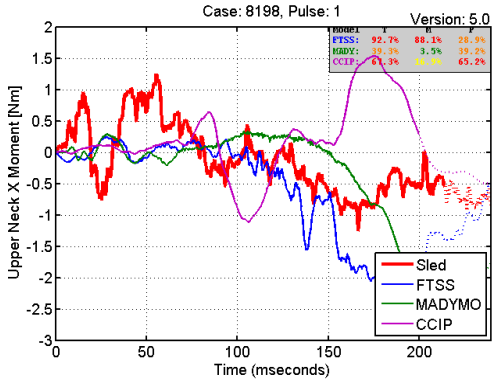
Figure C-4-179: 8257 Neck Z Force



20G 70ms +Z

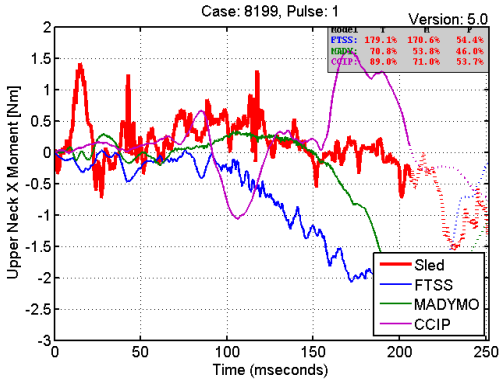
Figure C-4-180: 8206 Neck Z Force

C.4.21 Neck X Moment



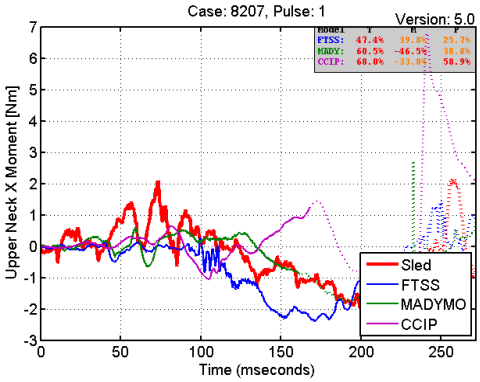
10G 110ms +Z

Figure C-4-181: 8198 Neck X Moment



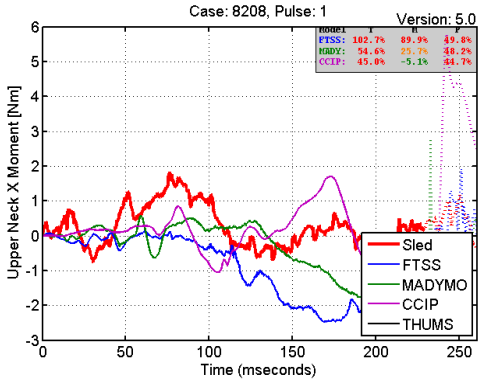
10G 110ms +Z

Figure C-4-184: 8199 Neck X Moment



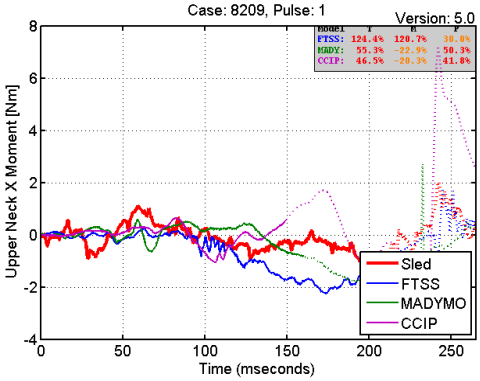
10G 70ms +Z

Figure C-4-182: 8207 Neck X Moment



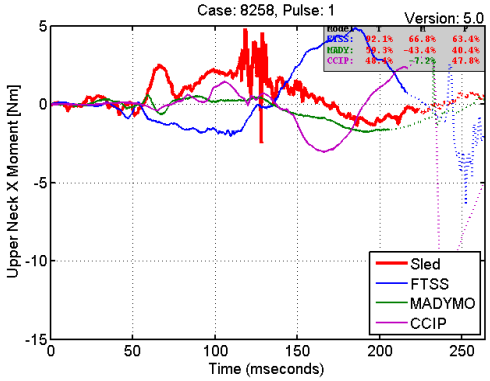
10G 70ms +Z

Figure C-4-185: 8208 Neck X Moment



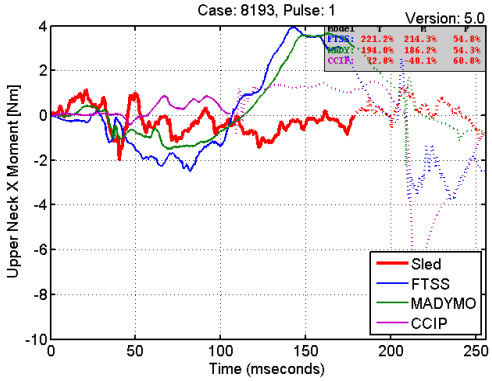
10G 70ms +Z

Figure C-4-183: 8209 Neck X Moment



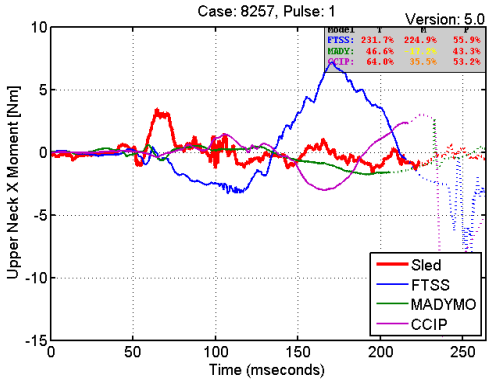
10G 70ms +Z

Figure C-4-186: 8258 Neck X Moment



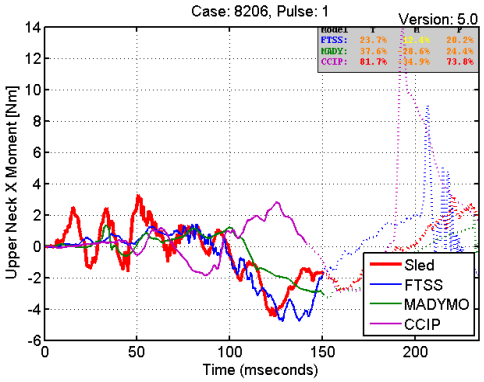
10G 30ms +Z

Figure C-4-187: 8193 Neck X Moment



15G 70ms +Z

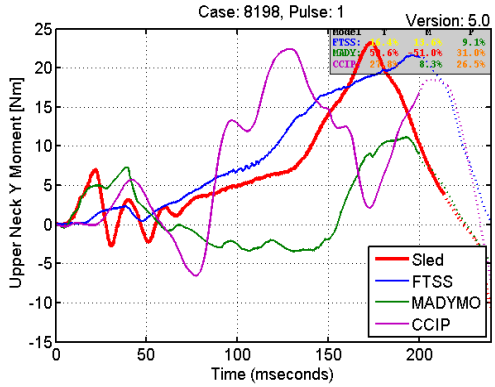
Figure C-4-188: 8257 Neck X Moment



20G 70ms +Z

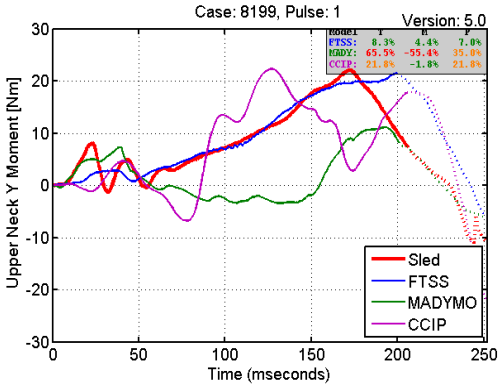
Figure C-4-189: 8206 Neck X Moment

C.4.22 Neck Y Moment



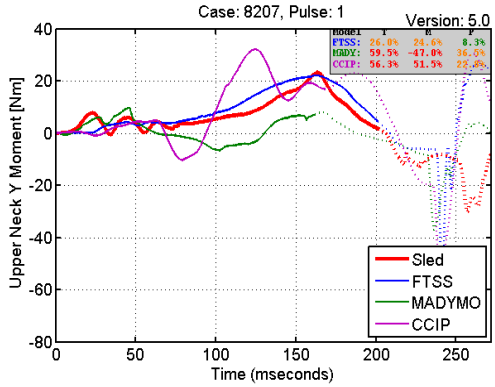
10G 110ms +Z

Figure C-4-190: 8198 Neck Y Moment



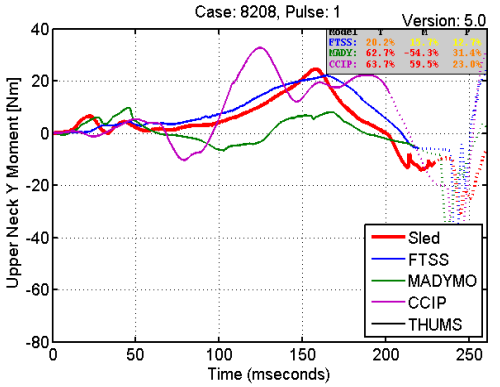
10G 110ms +Z

Figure C-4-193: 8199 Neck Y Moment



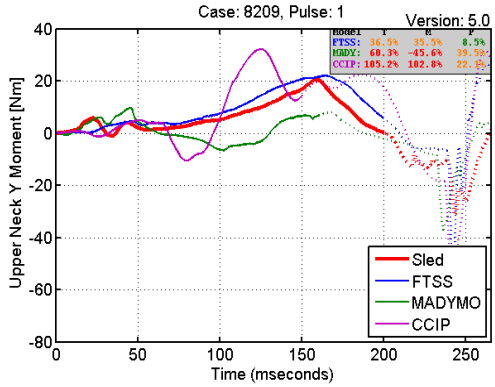
10G 70ms +Z

Figure C-4-191: 8207 Neck Y Moment



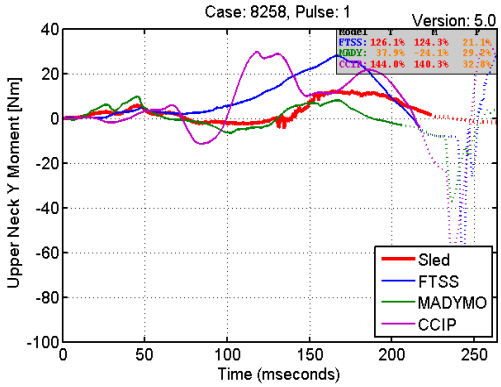
10G 70ms +Z

Figure C-4-194: 8208 Neck Y Moment



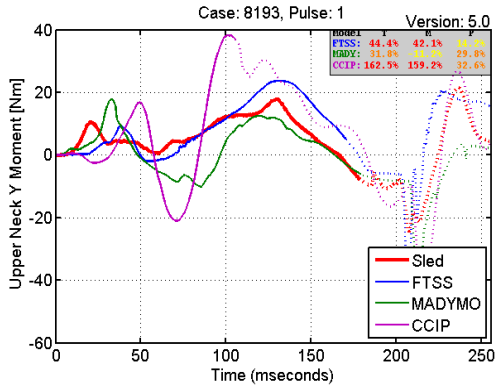
10G 70ms +Z

Figure C-4-192: 8209 Neck Y Moment



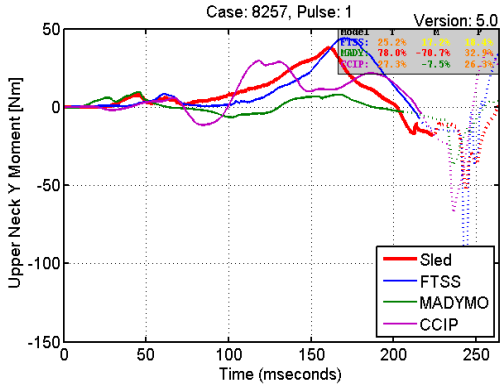
10G 70ms +Z

Figure C-4-195: 8258 Neck Y Moment



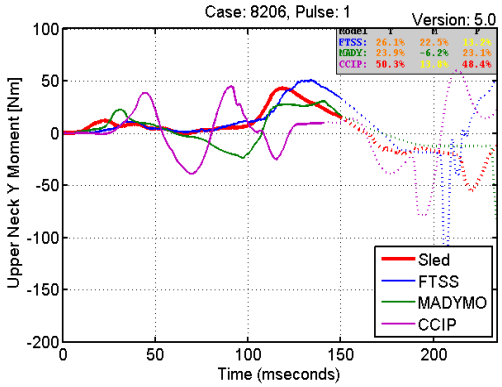
10G 30ms +Z

Figure C-4-196: 8193 Neck Y Moment



15G 70ms +Z

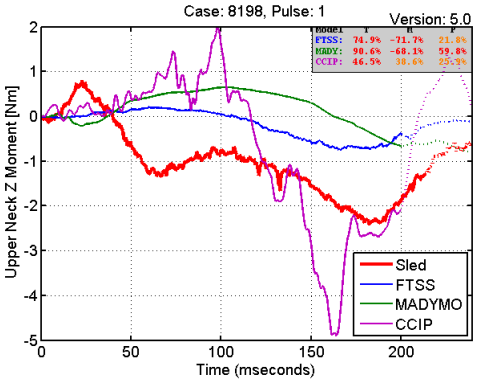
Figure C-4-197: 8257 Neck Y Moment



20G 70ms +Z

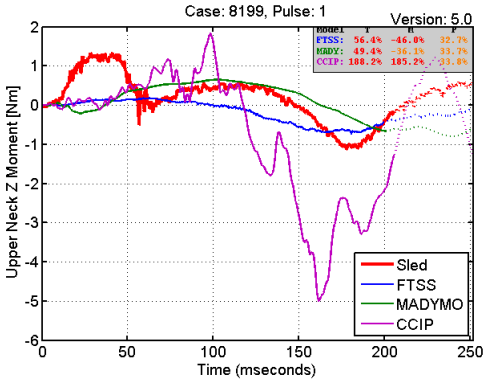
Figure C-4-198: 8206 Neck Y Moment

C.4.23 Neck Z Moment



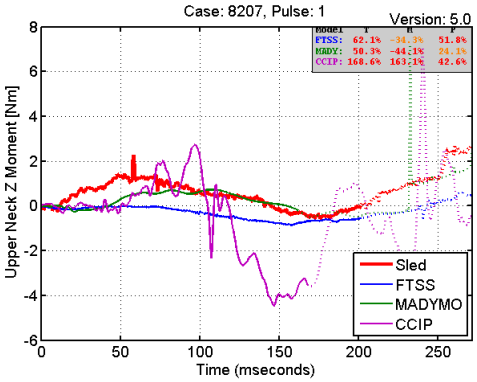
10G 110ms +Z

Figure C-4-199: 8198 Neck Z Moment



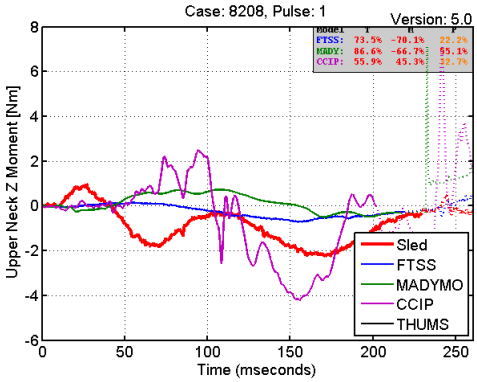
10G 110ms +Z

Figure C-4-202: 8199 Neck Z Moment



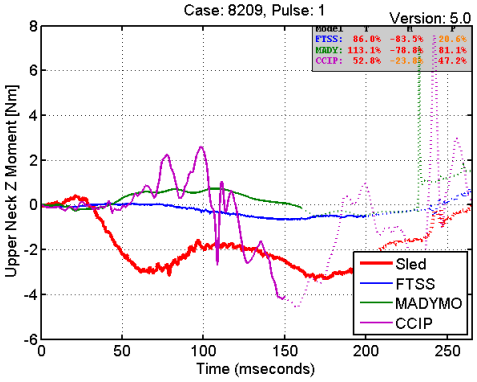
10G 70ms +Z

Figure C-4-200: 8207 Neck Z Moment



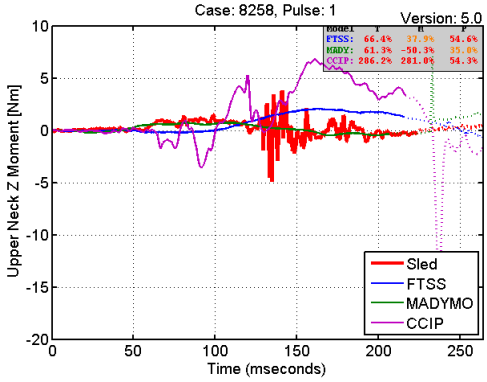
10G 70ms +Z

Figure C-4-203: 8208 Neck Z Moment



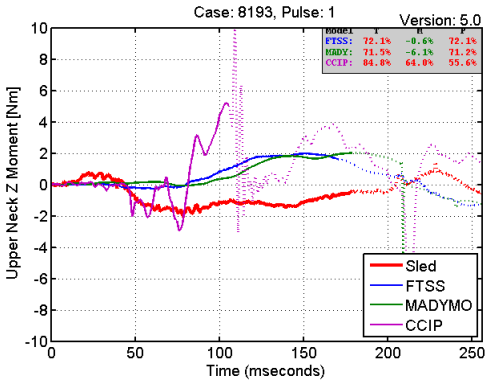
10G 70ms +Z

Figure C-4-201: 8209 Neck Z Moment



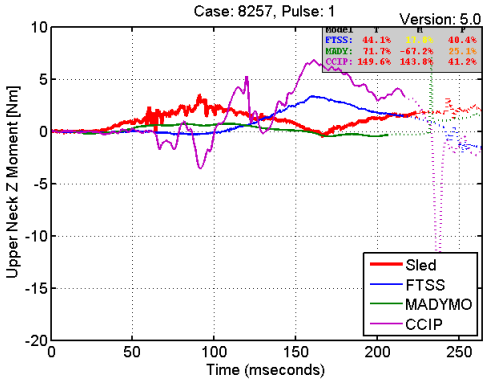
10G 70ms +Z

Figure C-4-204: 8258 Neck Z Moment



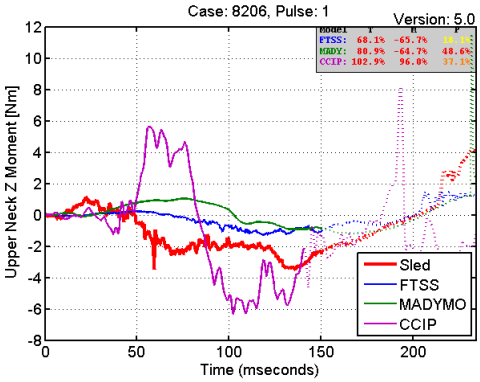
10G 30ms +Z

Figure C-4-205: 8193 Neck Z Moment



15G 70ms +Z

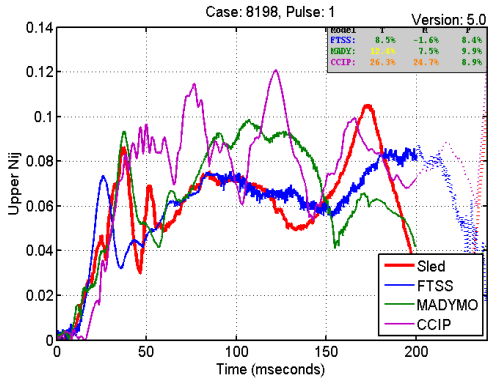
Figure C-4-206: 8257 Neck Z Moment



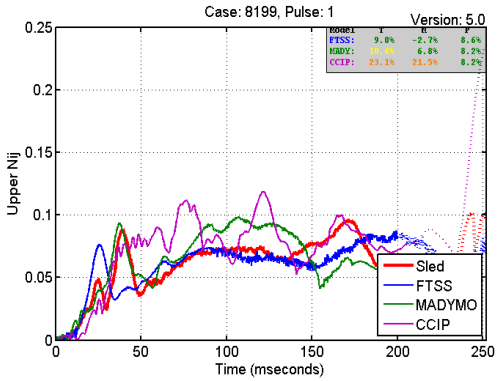
20G 70ms +Z

Figure C-4-207: 8206 Neck Z Moment

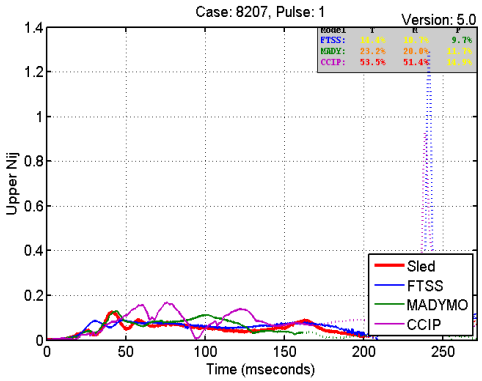
C.4.24 Nij



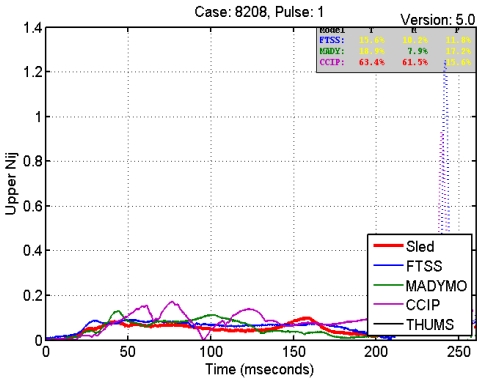
10G 110ms +Z
Figure C-4-208: 8198 Nij



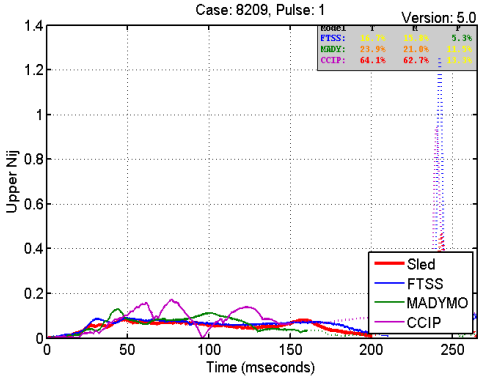
10G 110ms +Z
Figure C-4-211: 8199 Nij



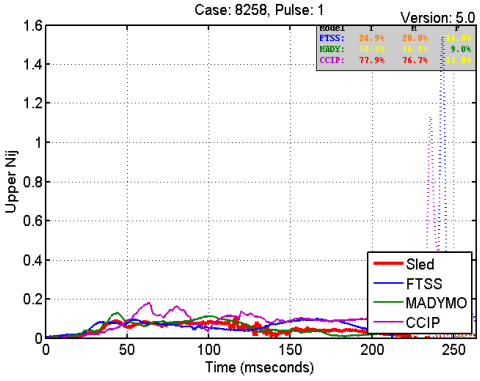
10G 70ms +Z
Figure C-4-209: 8207 Nij



10G 70ms +Z
Figure C-4-212: 8208 Nij

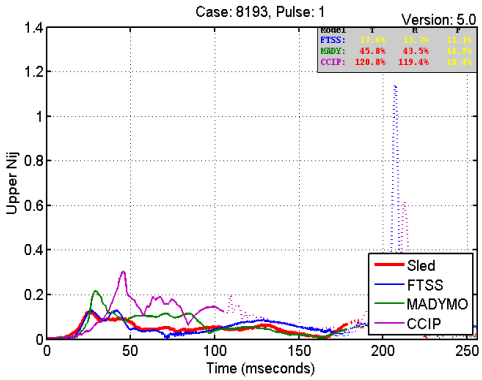


0G 70ms +Z
Figure C-4-210: 8209 Nij

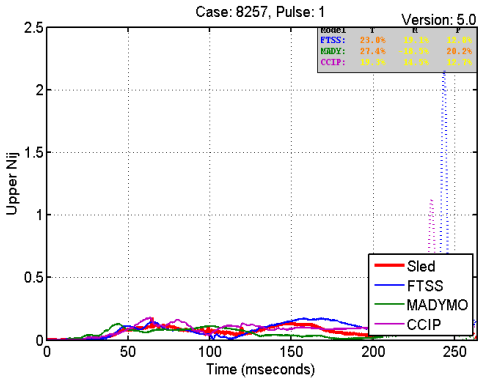


10G 70ms +Z
Figure C-4-213: 8258 Nij

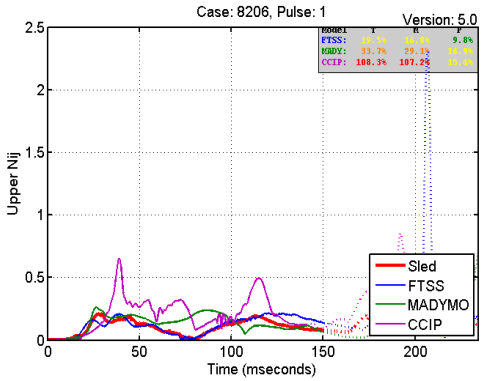
1



10G 30ms +Z
Figure C-4-214: 8193 Nij

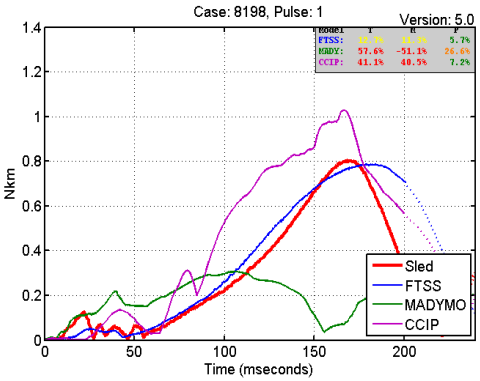


15G 70ms +Z
Figure C-4-215: 8257 Nij

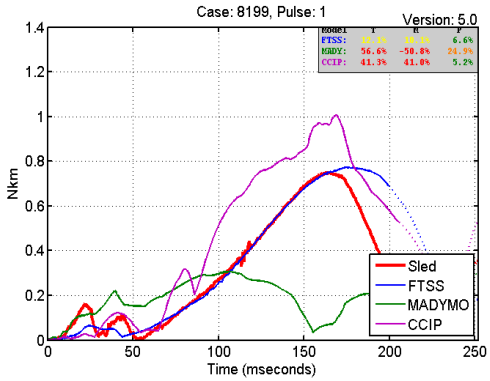


20G 70ms +Z
Figure C-4-216: 8206 Nij

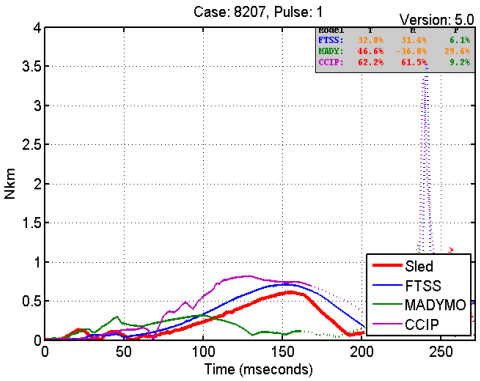
C.4.25 Nkm



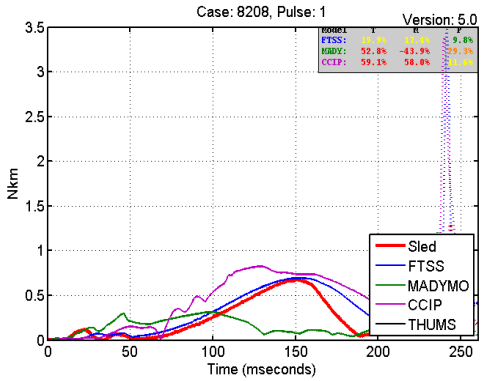
10G 110ms +Z
Figure C-4-217: 8198 Nkm



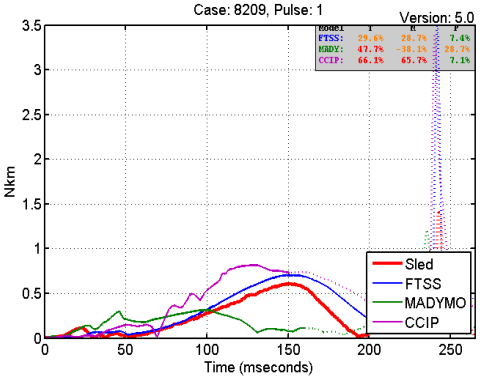
10G 110ms +Z
Figure C-4-220: 8199 Nkm



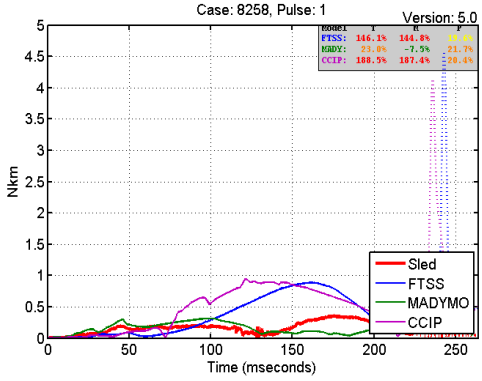
10G 70ms +Z
Figure C-4-218: 8207 Nkm



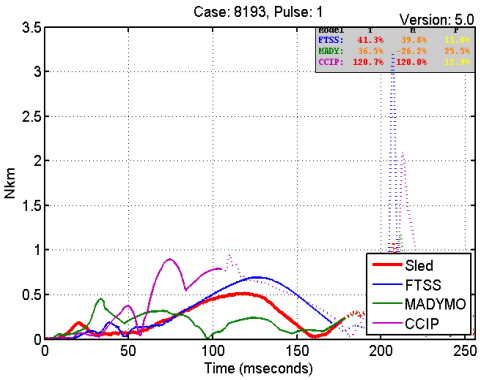
10G 70ms +Z
Figure C-4-221: 8208 Nkm



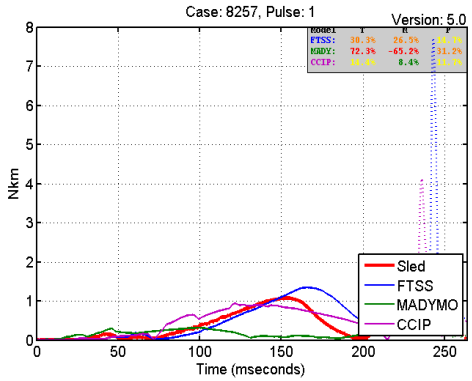
10G 70ms +Z
Figure C-4-219: 8209 Nkm



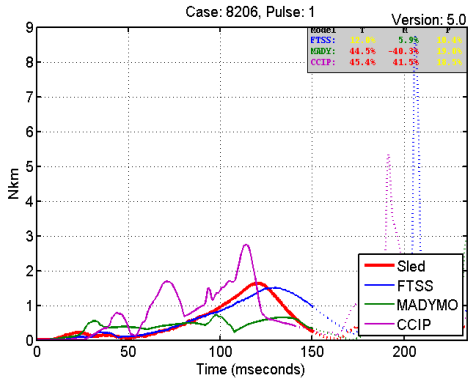
10G 70ms +Z
Figure C-4-222: 8258 Nkm



10G 30ms +Z
Figure C-4-223: 8193 Nkm

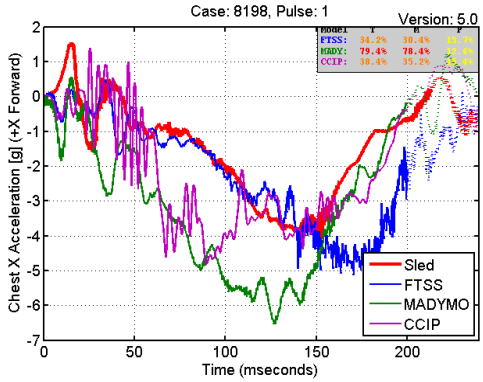


15G 70ms +Z
Figure C-4-224: 8257 Nkm



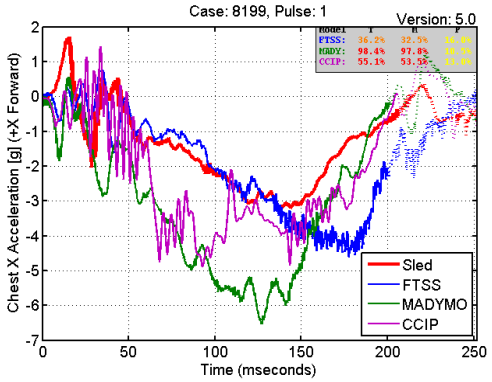
20G 70ms +Z
Figure C-4-225: 8206 Nkm

C.4.26 Chest X Acceleration



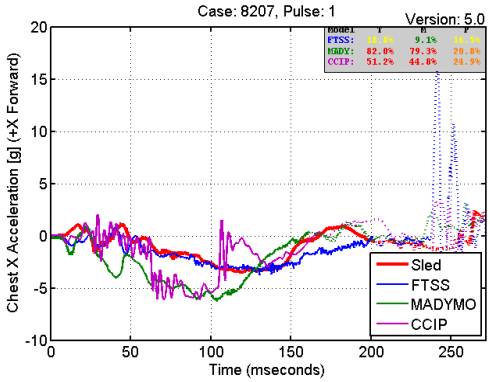
10G 110ms +Z

Figure C-4-226: 8198 Chest X Acceleration



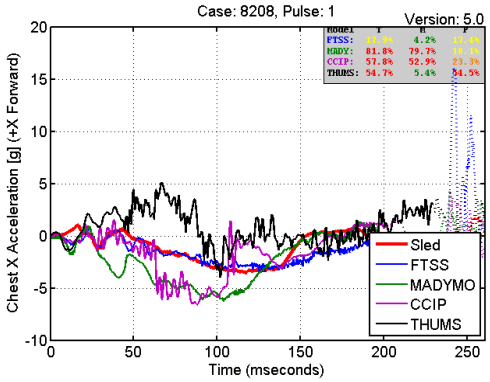
10G 110ms +Z

Figure C-4-229: 8199 Chest X Acceleration



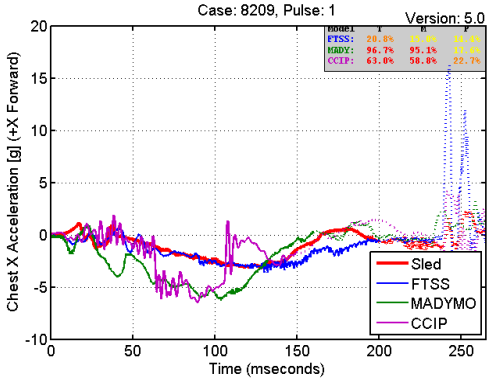
10G 70ms +Z

Figure C-4-227: 8207 Chest X Acceleration



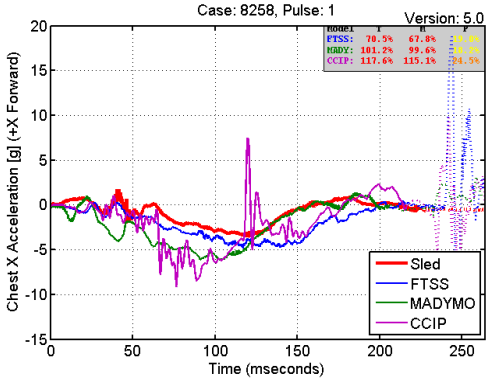
10G 70ms +Z

Figure C-4-230: 8208 Chest X Acceleration



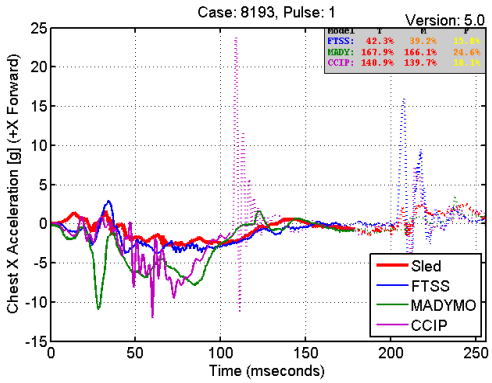
10G 70ms +Z

Figure C-4-228: 8209 Chest X Acceleration



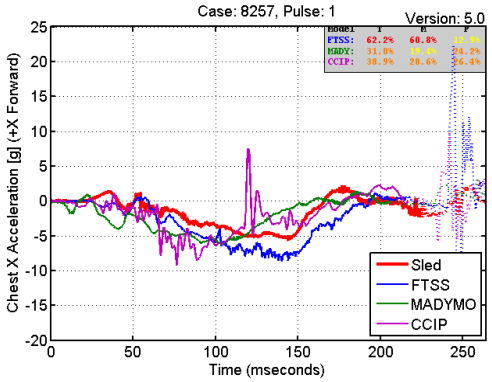
10G 70ms +Z

Figure C-4-231: 8258 Chest X Acceleration



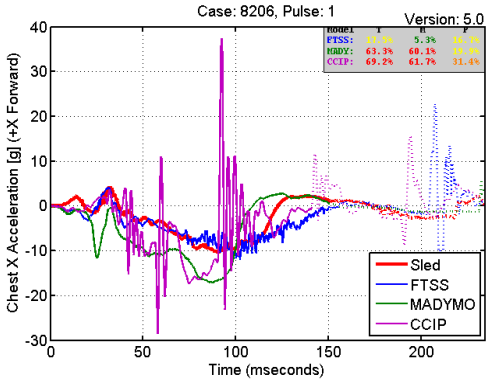
10G 30ms +Z

Figure C-4-232: 8193 Chest X Acceleration



15G 70ms +Z

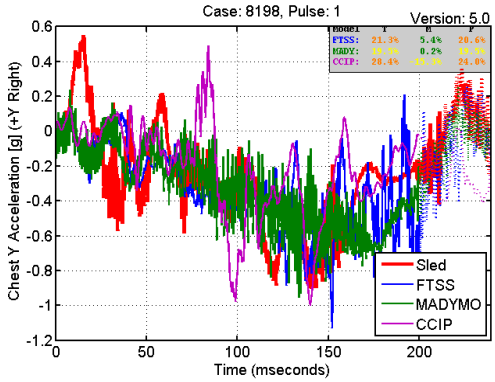
Figure C-4-233: 8257 Chest X Acceleration



20G 70ms +Z

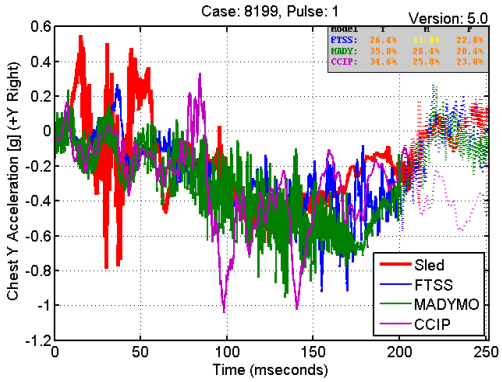
Figure C-4-234: 8206 Chest X Acceleration

C.4.27 Chest Y Acceleration



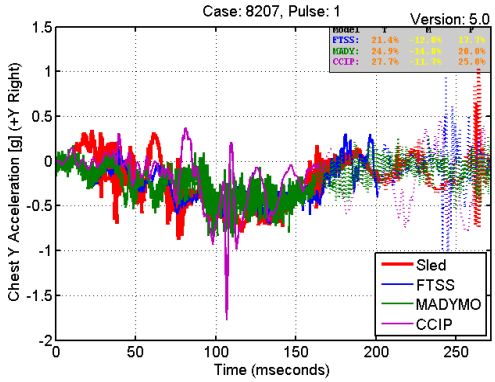
10G 110ms +Z

Figure C-4-235: 8198 Chest Y Acceleration



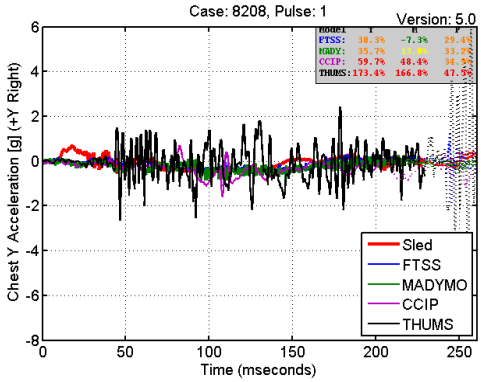
10G 110ms +Z

Figure C-4-238: 8199 Chest Y Acceleration



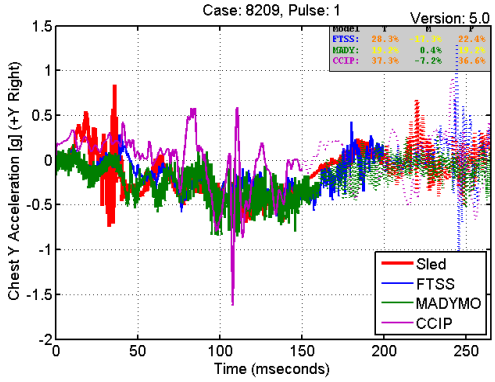
10G 70ms +Z

Figure C-4-236: 8207 Chest Y Acceleration



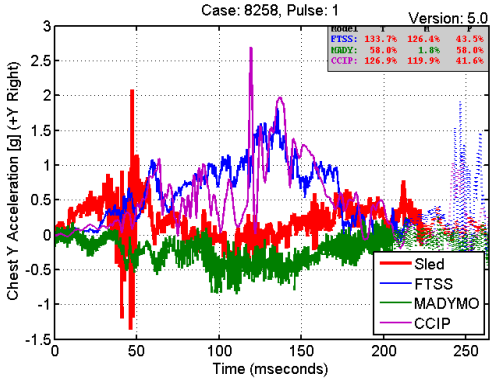
10G 70ms +Z

Figure C-4-239: 8208 Chest Y Acceleration



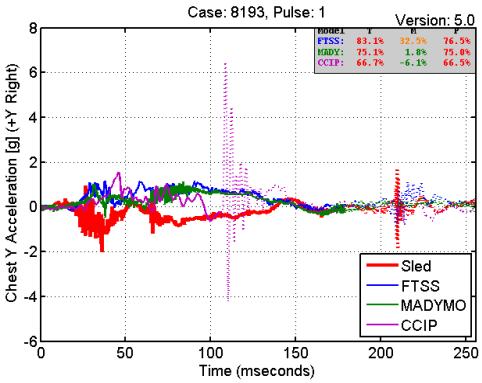
10G 70ms +Z

Figure C-4-237: 8209 Chest Y Acceleration



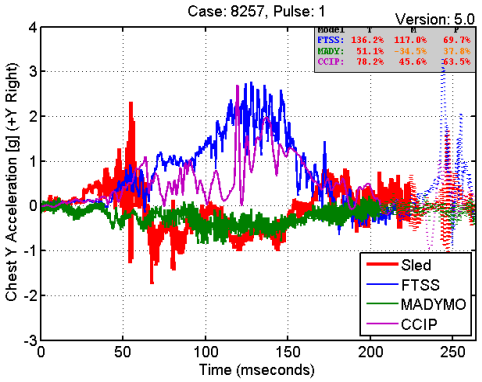
10G 70ms +Z

Figure C-4-240: 8258 Chest Y Acceleration



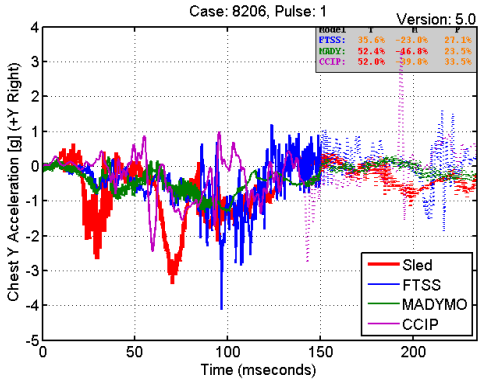
10G 30ms +Z

Figure C-4-241: 8193 Chest Y Acceleration



15G 70ms +Z

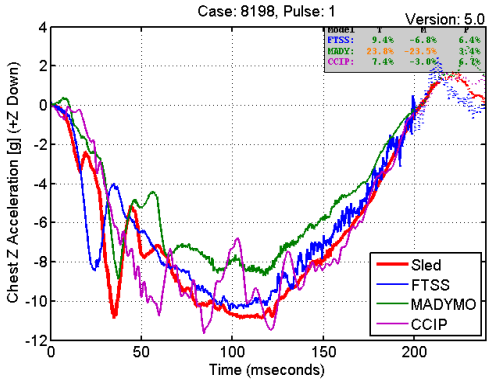
Figure C-4-242: 8257 Chest Y Acceleration



20G 70ms +Z

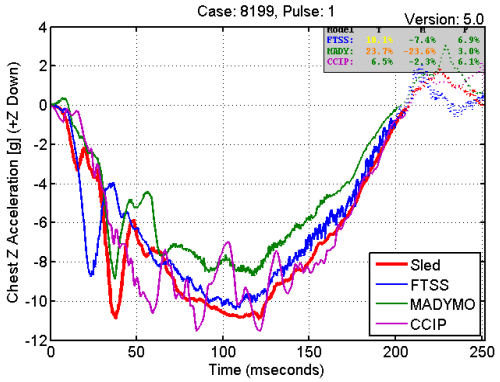
Figure C-4-243: 8206 Chest Y Acceleration

C.4.28 Chest Z Acceleration



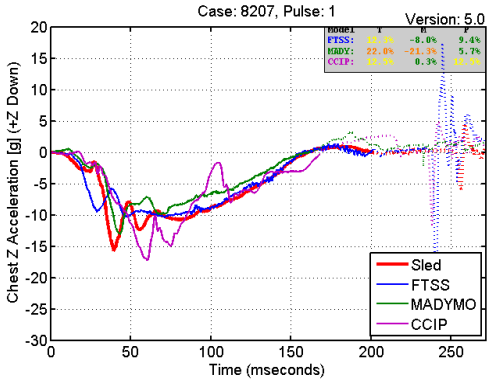
10G 110ms +Z

Figure C-4-244: 8198 Chest Z Acceleration



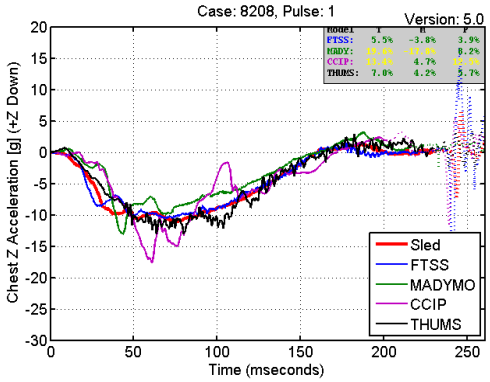
10G 110ms +Z

Figure C-4-247: 8199 Chest Z Acceleration



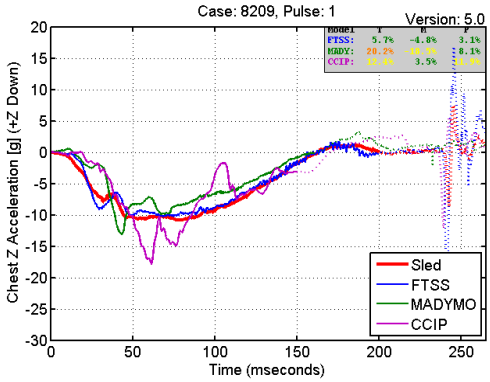
10G 70ms +Z

Figure C-4-245: 8207 Chest Z Acceleration



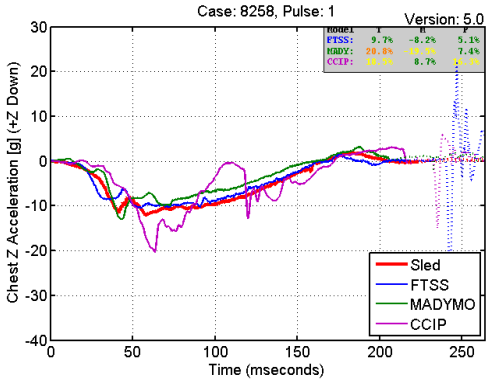
10G 70ms +Z

Figure C-4-248: 8208 Chest Z Acceleration



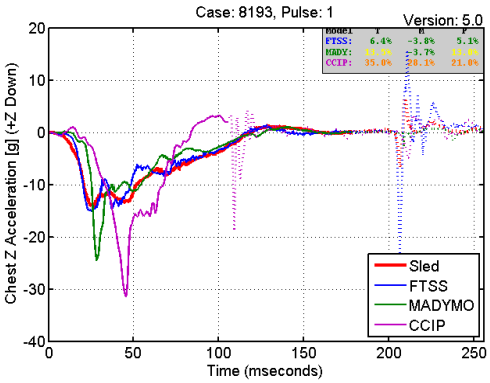
10G 70ms +Z

Figure C-4-246: 8209 Chest Z Acceleration



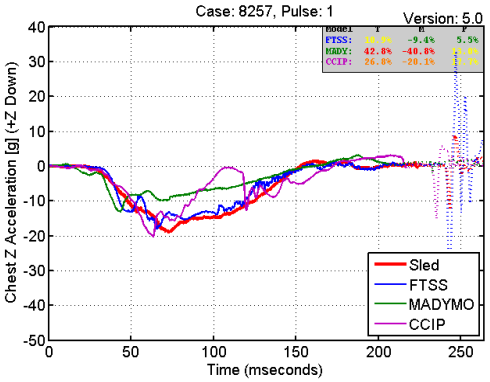
10G 70ms +Z

Figure C-4-249: 8258 Chest Z Acceleration



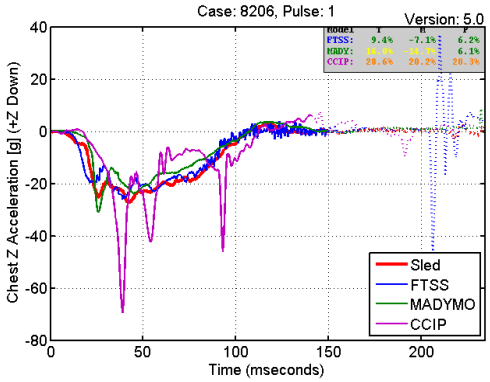
10G 30ms +Z

Figure C-4-250: 8193 Chest Z Acceleration



15G 70ms +Z

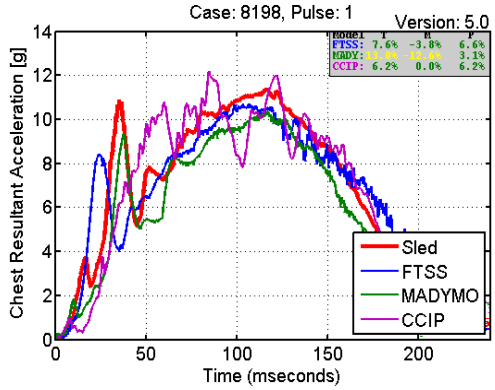
Figure C-4-251: 8257 Chest Z Acceleration



20G 70ms +Z

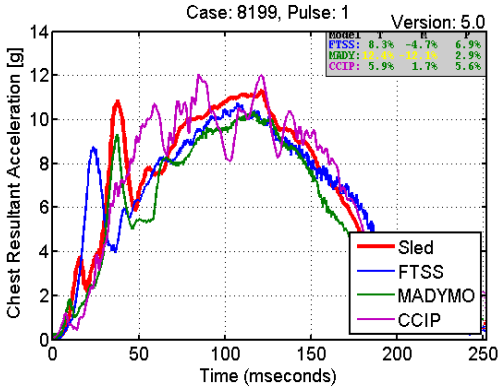
Figure C-4-252: 8206 Chest Z Acceleration

C.4.29 Chest Resultant Acceleration



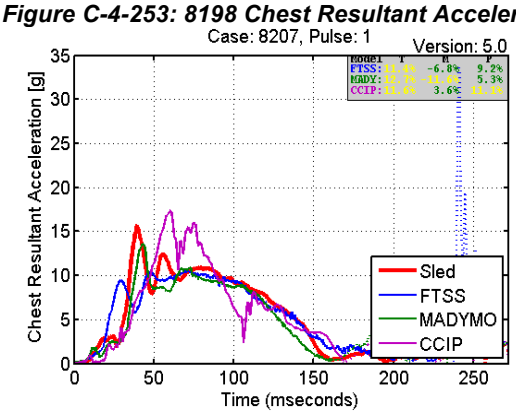
10G 110ms +Z

Figure C-4-253: 8198 Chest Resultant Acceleration



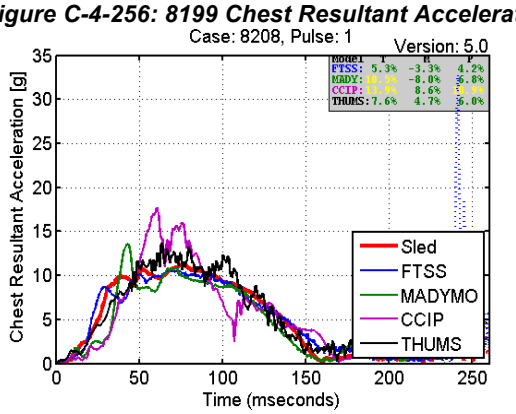
10G 110ms +Z

Figure C-4-256: 8199 Chest Resultant Acceleration



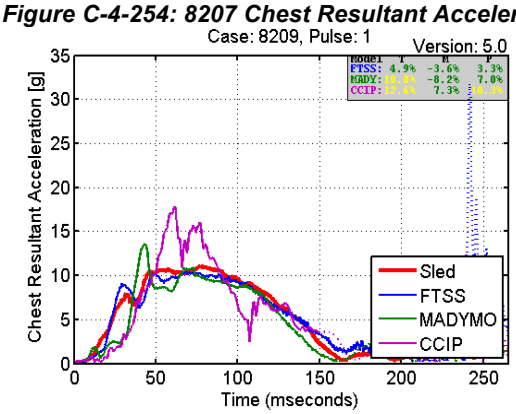
10G 70ms +Z

Figure C-4-254: 8207 Chest Resultant Acceleration



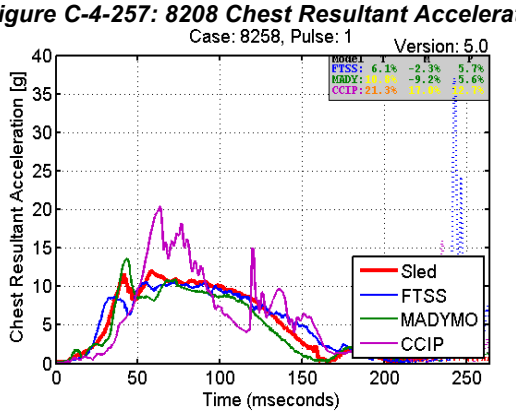
10G 70ms +Z

Figure C-4-257: 8208 Chest Resultant Acceleration



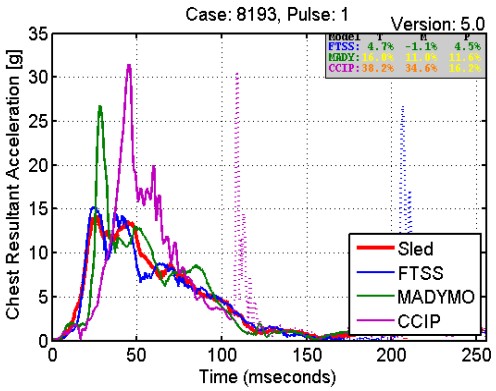
10G 70ms +Z

Figure C-4-255: 8209 Chest Resultant Acceleration



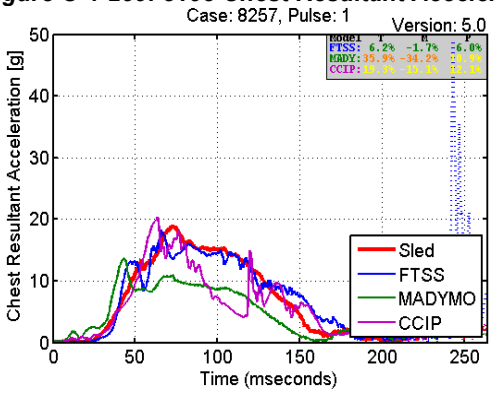
10G 70ms +Z

Figure C-4-258: 8258 Chest Resultant Acceleration



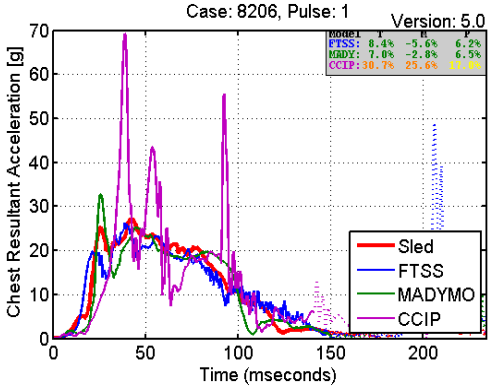
10G 30ms +Z

Figure C-4-259: 8193 Chest Resultant Acceleration



15G 70ms +Z

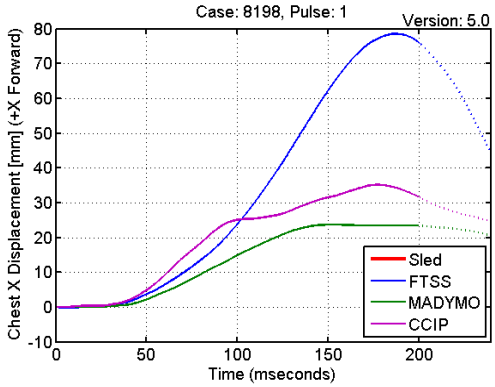
Figure C-4-260: 8257 Chest Resultant Acceleration



20G 70ms +Z

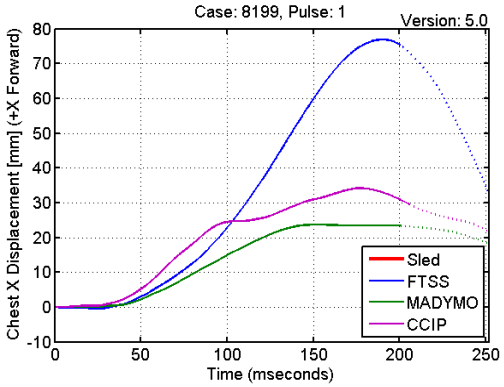
Figure C-4-261: 8206 Chest Resultant Acceleration

C.4.30 Chest X Movement



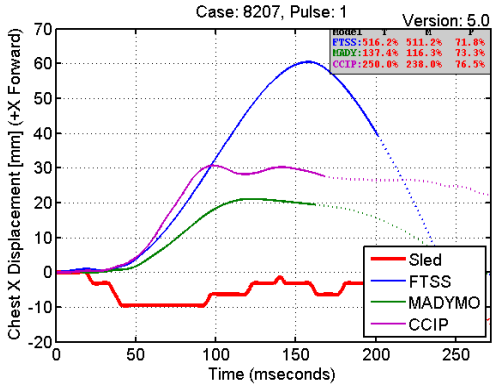
10G 110ms +Z

Figure C-4-262: 8198 Chest X Movement



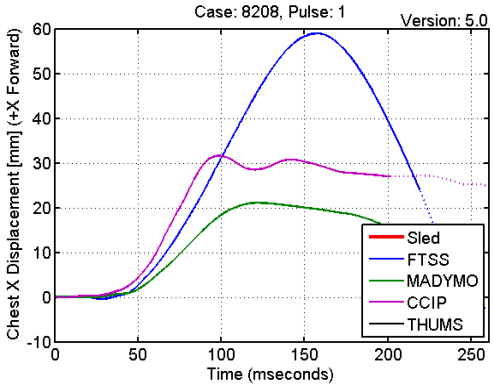
10G 110ms +Z

Figure C-4-265: 8199 Chest X Movement



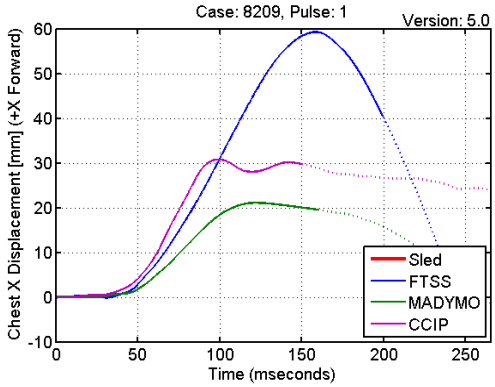
10G 70ms +Z

Figure C-4-263: 8207 Chest X Movement



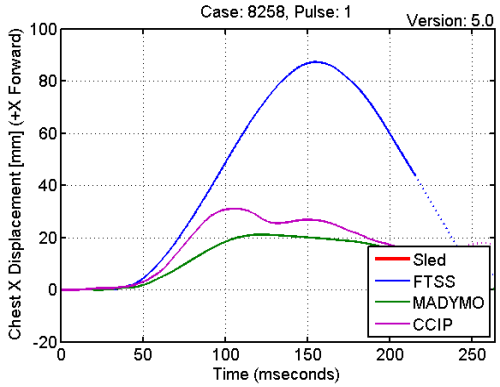
10G 70ms +Z

Figure C-4-266: 8208 Chest X Movement



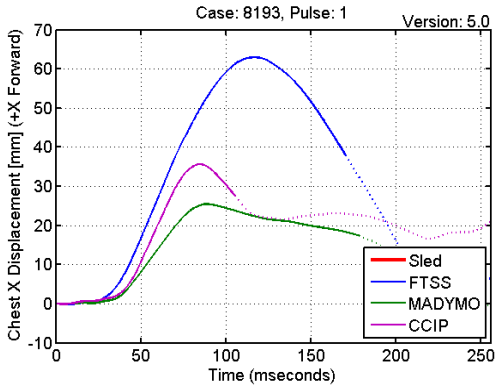
10G 70ms +Z

Figure C-4-264: 8209 Chest X Movement



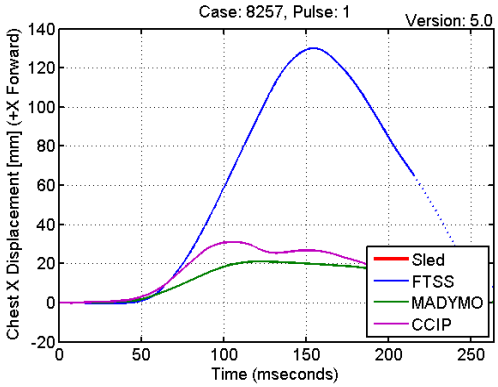
10G 70ms +Z

Figure C-4-267: 8258 Chest X Movement



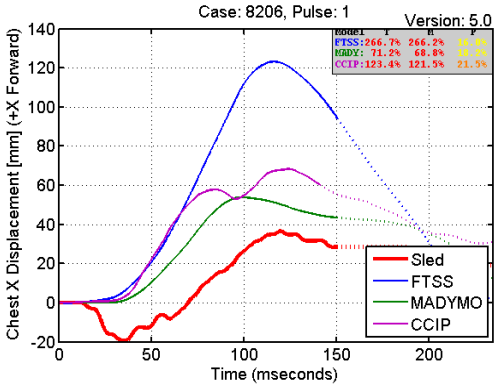
10G 30ms +Z

Figure C-4-268: 8193 Chest X Movement



15G 70ms +Z

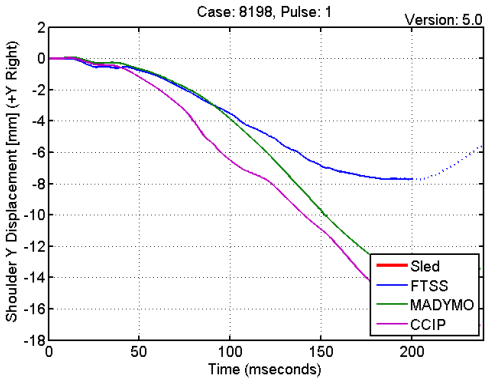
Figure C-4-269: 8257 Chest X Movement



20G 70ms +Z

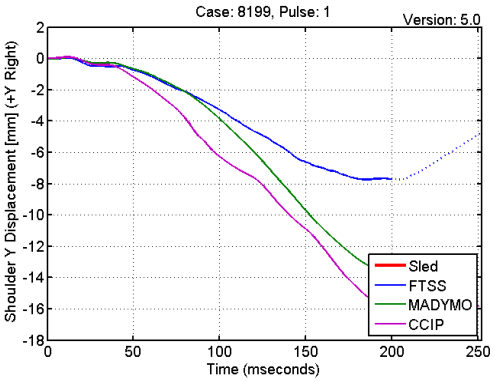
Figure C-4-270: 8206 Chest X Movement

C.4.31 Shoulder Y Movement



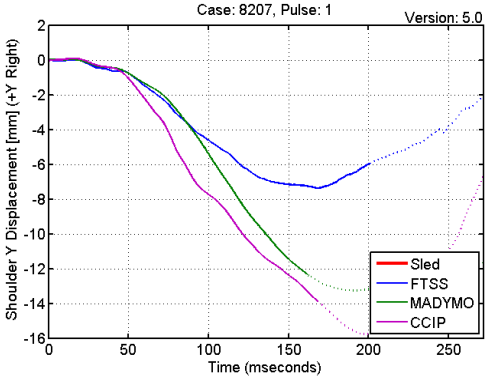
10G 110ms +Z

Figure C-4-271: 8198 Shoulder Y Movement



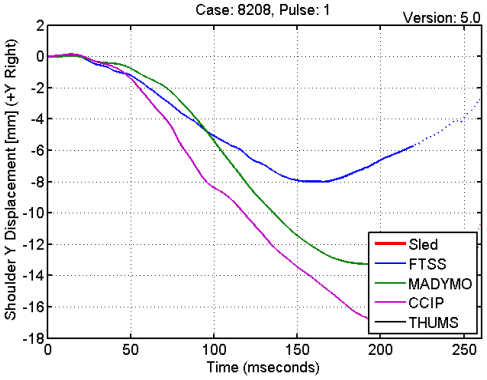
10G 110ms +Z

Figure C-4-274: 8199 Shoulder Y Movement



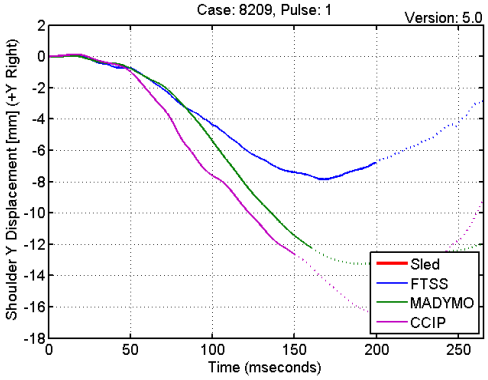
10G 70ms +Z

Figure C-4-272: 8207 Shoulder Y Movement



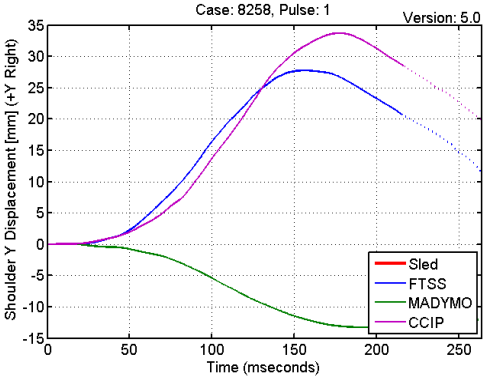
10G 70ms +Z

Figure C-4-275: 8208 Shoulder Y Movement



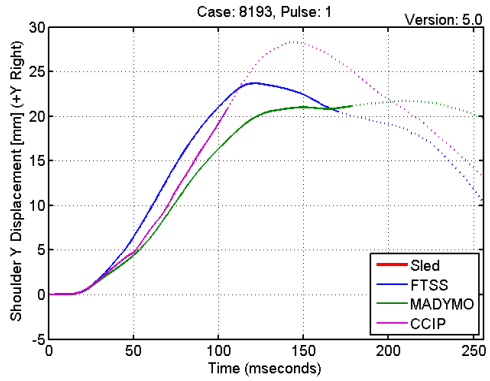
10G 70ms +Z

Figure C-4-273: 8209 Shoulder Y Movement



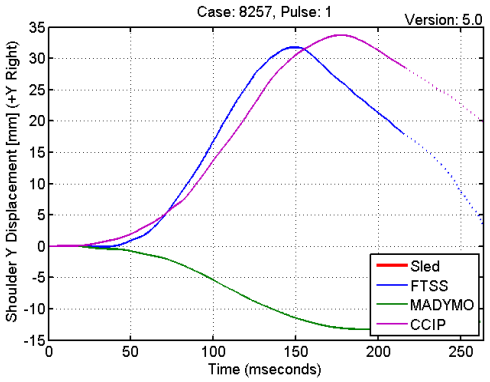
10G 70ms +Z

Figure C-4-276: 8258 Shoulder Y Movement



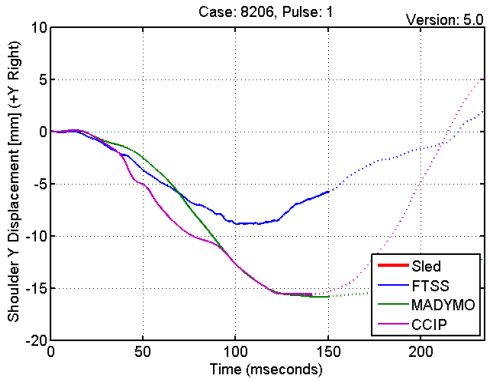
10G 30ms +Z

Figure C-4-277: 8193 Shoulder Y Movement



15G 70ms +Z

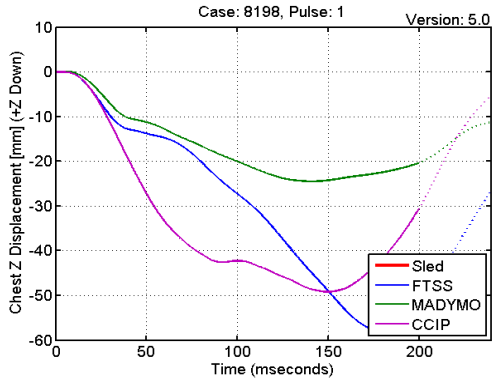
Figure C-4-278: 8257 Shoulder Y Movement



20G 70ms +Z

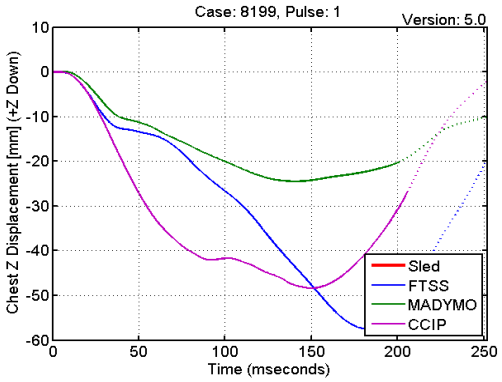
Figure C-4-279: 8206 Shoulder Y Movement

C.4.32 Chest Z Movement



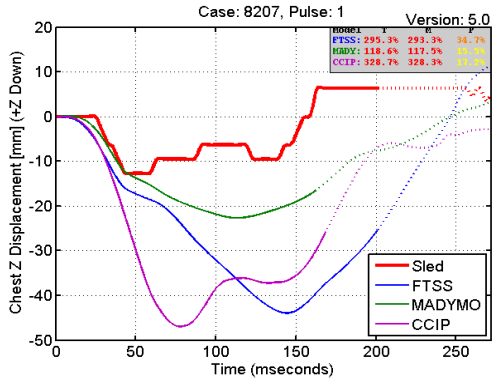
10G 110ms +Z

Figure C-4-280: 8198 Chest Z Movement



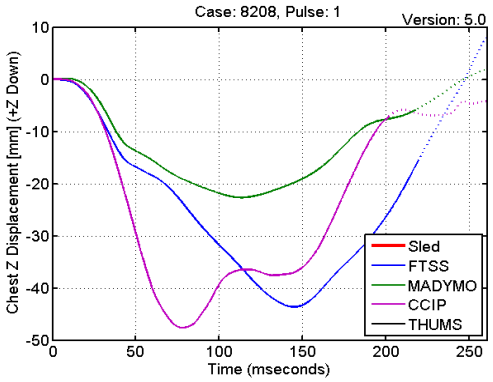
10G 110ms +Z

Figure C-4-283: 8199 Chest Z Movement



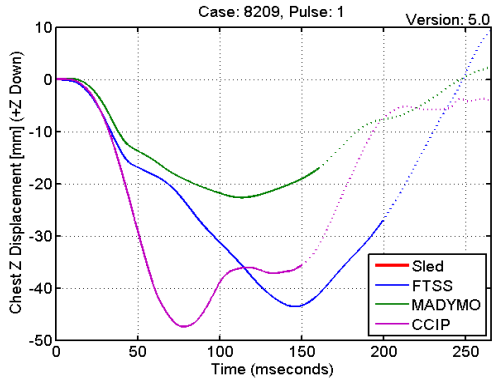
10G 70ms +Z

Figure C-4-281: 8207 Chest Z Movement



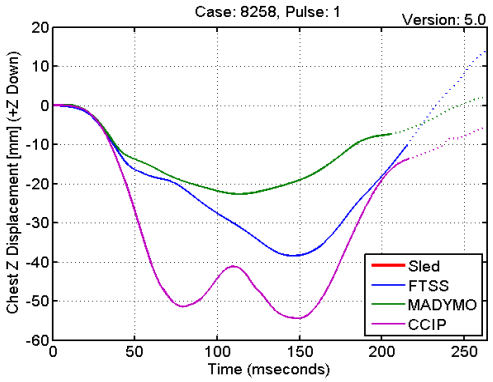
10G 70ms +Z

Figure C-4-284: 8208 Chest Z Movement



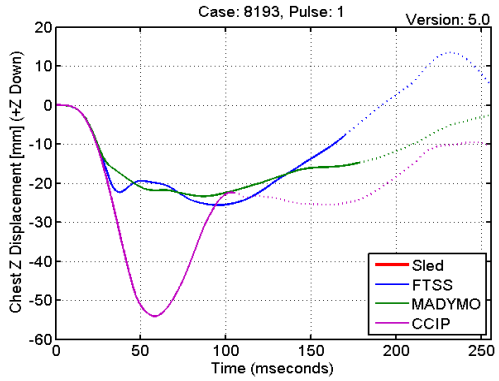
10G 70ms +Z

Figure C-4-282: 8209 Chest Z Movement



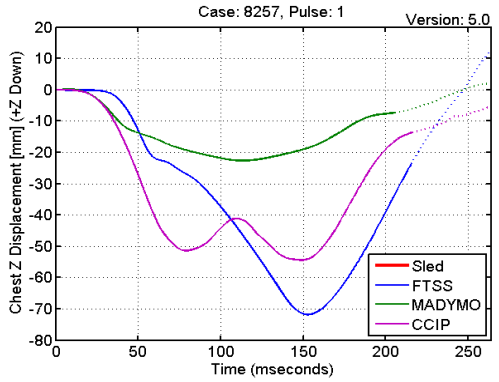
10G 70ms +Z

Figure C-4-285: 8258 Chest Z Movement



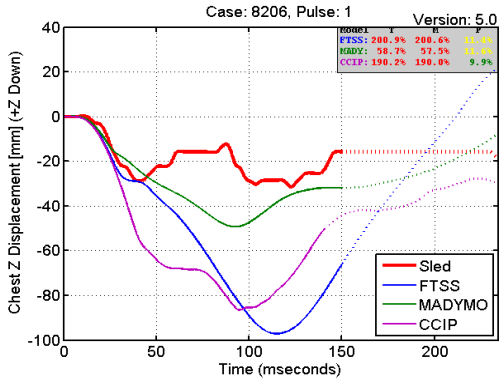
10G 30ms +Z

Figure C-4-286: 8193 Chest Z Movement



15G 70ms +Z

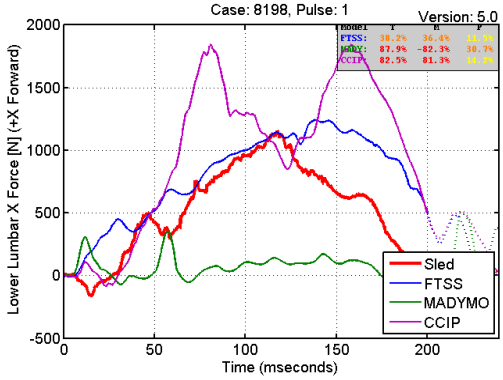
Figure C-4-287: 8257 Chest Z Movement



20G 70ms +Z

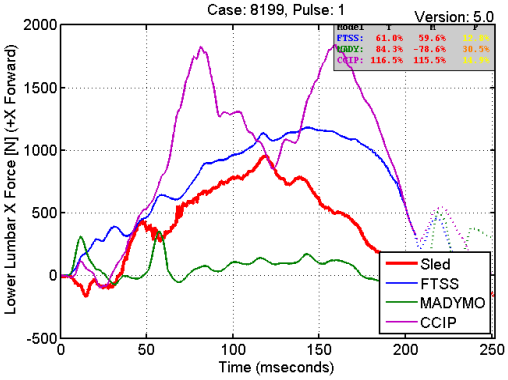
Figure C-4-288: 8206 Chest Z Movement

C.4.33 Lumbar X Force



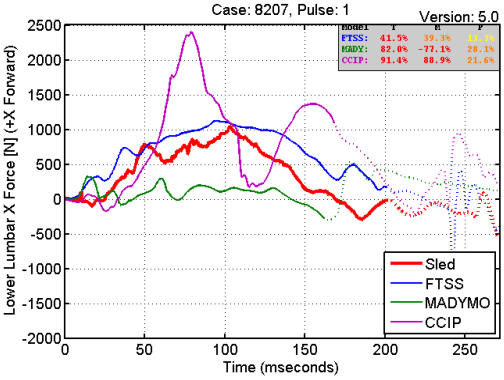
10G 110ms +Z

Figure C-4-289: 8198 Lumbar X Force



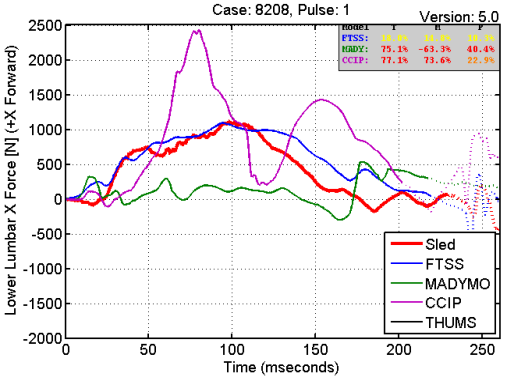
10G 110ms +Z

Figure C-4-292: 8199 Lumbar X Force



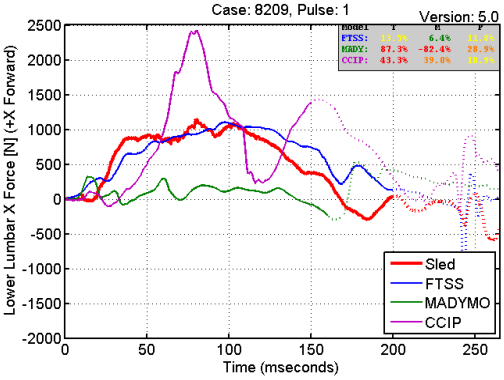
10G 70ms +Z

Figure C-4-290: 8207 Lumbar X Force



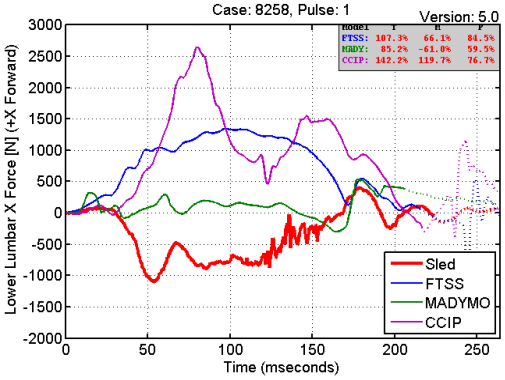
10G 70ms +Z

Figure C-4-293: 8208 Lumbar X Force



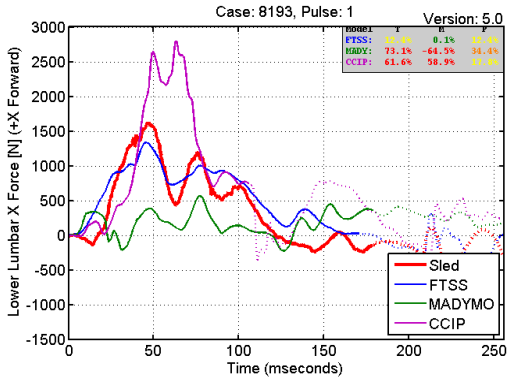
10G 70ms +Z

Figure C-4-291: 8209 Lumbar X Force



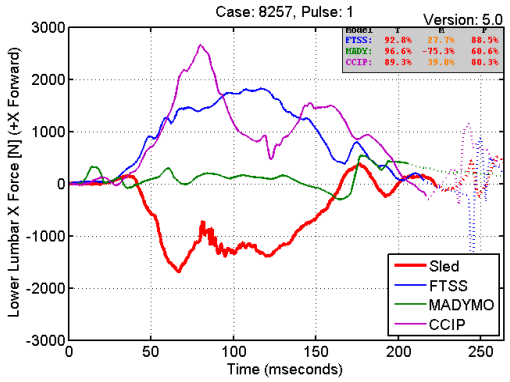
10G 70ms +Z

Figure C-4-294: 8258 Lumbar X Force



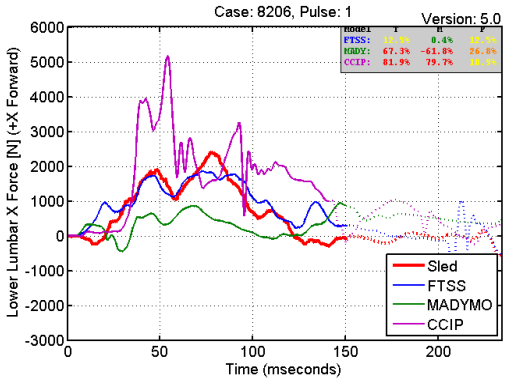
10G 30ms +Z

Figure C-4-295: 8193 Lumbar X Force



15G 70ms +Z

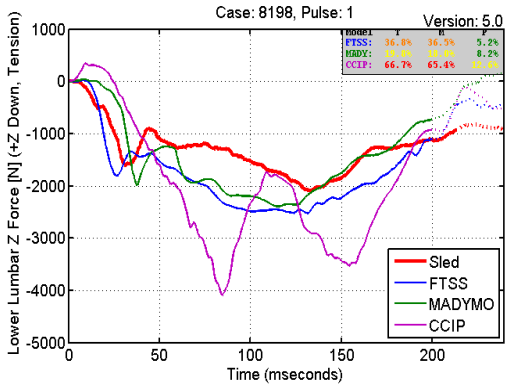
Figure C-4-296: 8257 Lumbar X Force



20G 70ms +Z

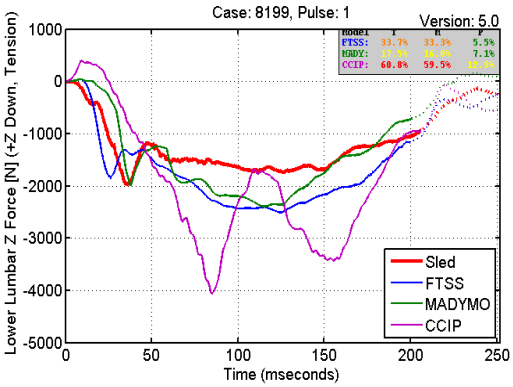
Figure C-4-297: 8206 Lumbar X Force

C.4.34 Lumbar Z Force



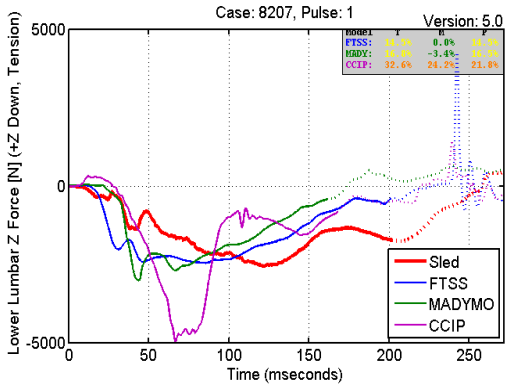
10G 110ms +Z

Figure C-4-298: 8198 Lumbar Z Force



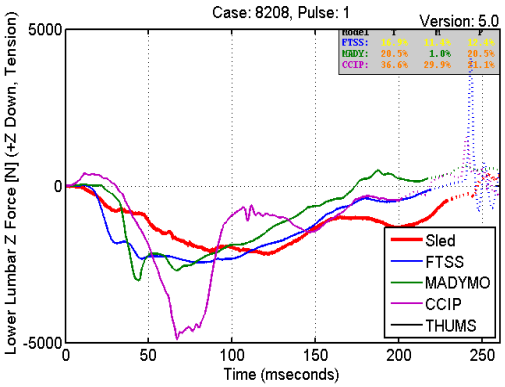
10G 110ms +Z

Figure C-4-301: 8199 Lumbar Z Force



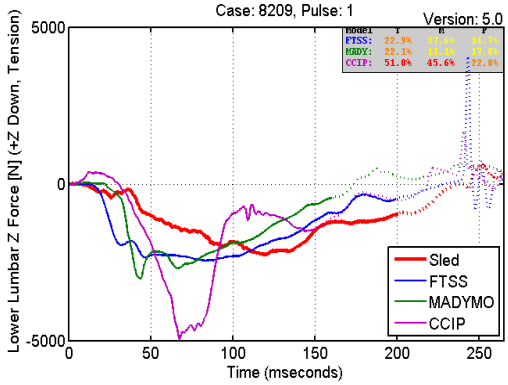
10G 70ms +Z

Figure C-4-299: 8207 Lumbar Z Force



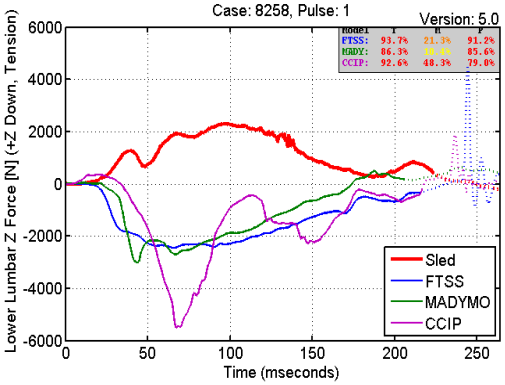
10G 70ms +Z

Figure C-4-302: 8208 Lumbar Z Force



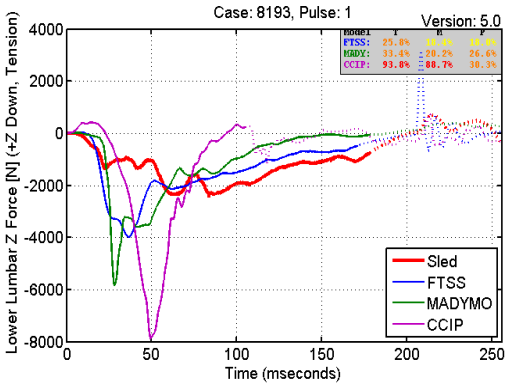
10G 70ms +Z

Figure C-4-300: 8209 Lumbar Z Force



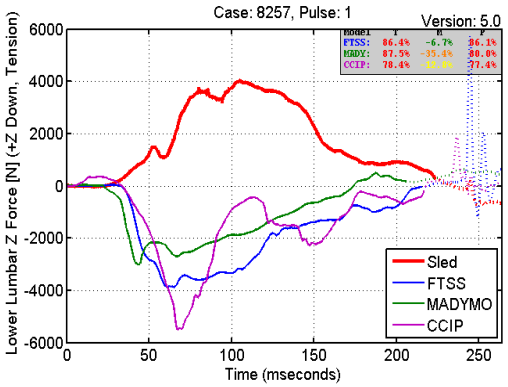
10G 70ms +Z

Figure C-4-303: 8258 Lumbar Z Force



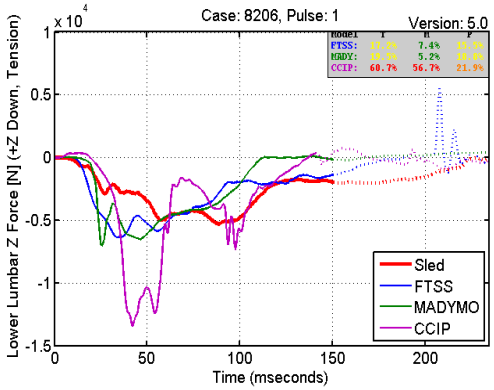
10G 30ms +Z

Figure C-4-304: 8193 Lumbar Z Force



15G 70ms +Z

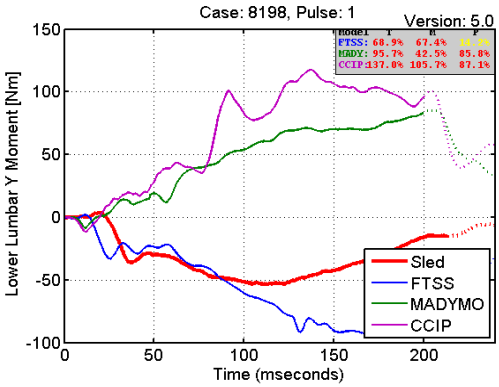
Figure C-4-305: 8257 Lumbar Z Force



20G 70ms +Z

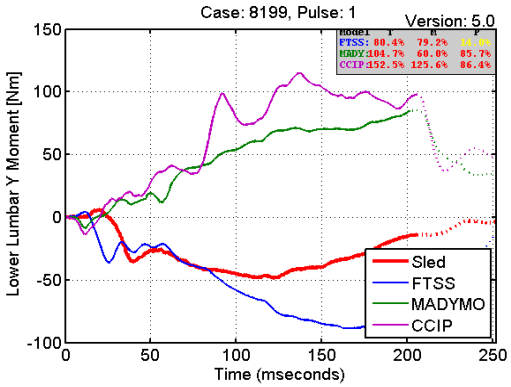
Figure C-4-306: 8206 Lumbar Z Force

C.4.35 Lumbar Y Moment



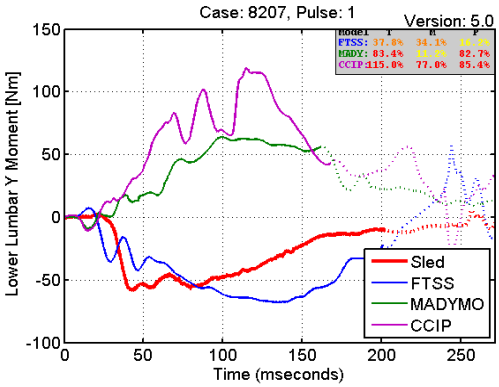
10G 110ms +Z

Figure C-4-307: 8198 Lumbar Y Moment



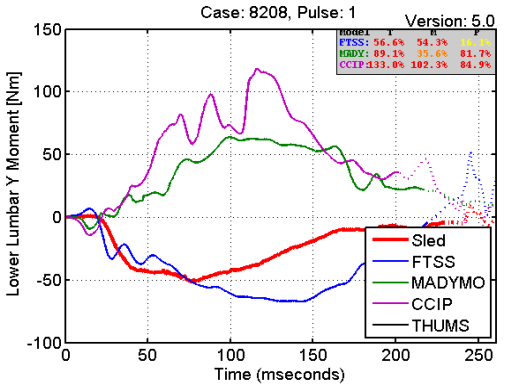
10G 110ms +Z

Figure C-4-310: 8199 Lumbar Y Moment



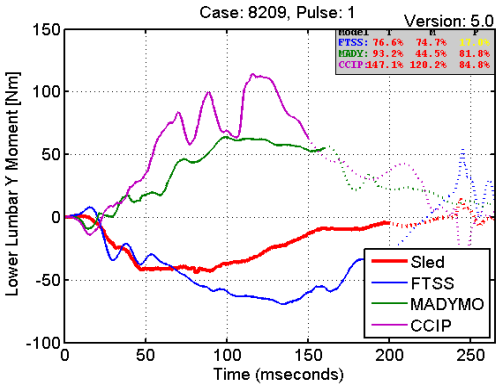
10G 70ms +Z

Figure C-4-308: 8207 Lumbar Y Moment



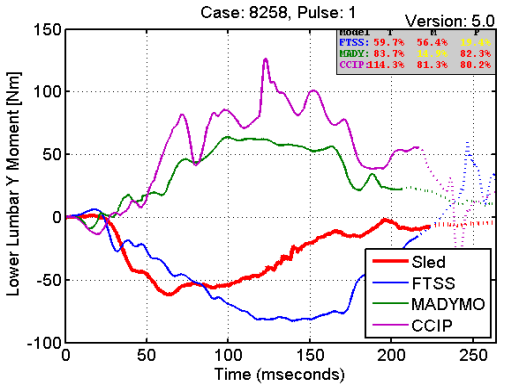
10G 70ms +Z

Figure C-4-311: 8208 Lumbar Y Moment



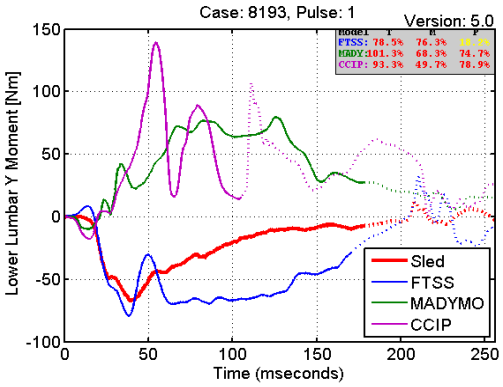
10G 70ms +Z

Figure C-4-309: 8209 Lumbar Y Moment



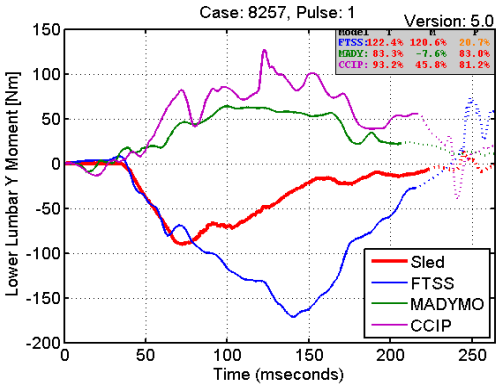
10G 70ms +Z

Figure C-4-312: 8258 Lumbar Y Moment



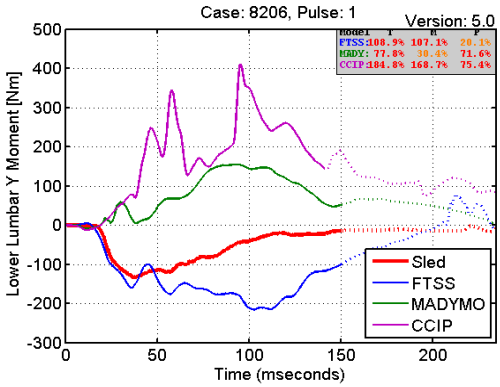
10G 30ms +Z

Figure C-4-313: 8193 Lumbar Y Moment



15G 70ms +Z

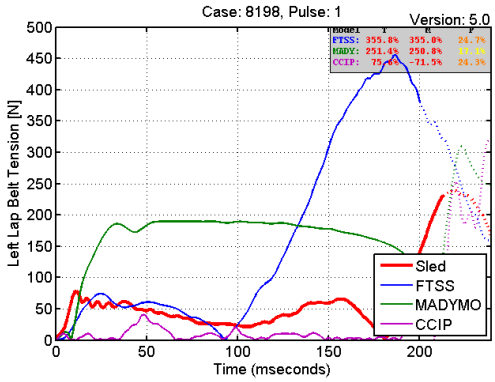
Figure C-4-314: 8257 Lumbar Y Moment



20G 70ms +Z

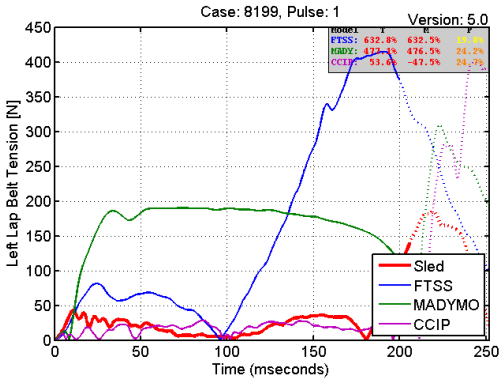
Figure C-4-315: 8206 Lumbar Y Moment

C.4.36 Left Lap Belt Force



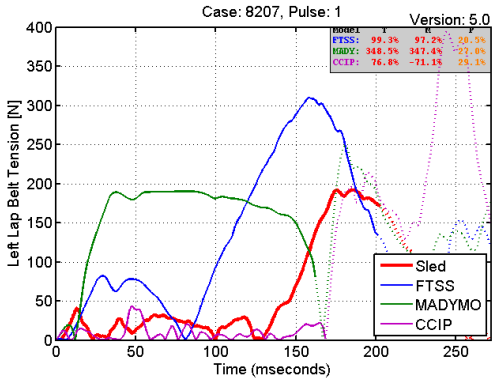
10G 110ms +Z

Figure C-4-316: 8198 Left Lap Belt Force



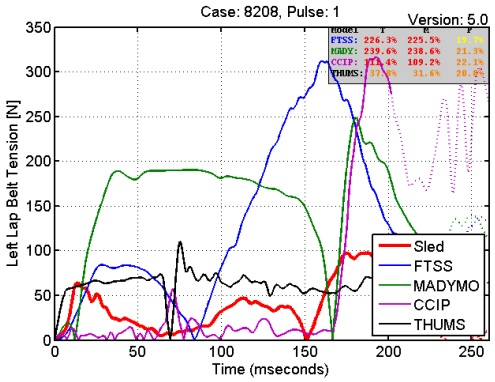
10G 110ms +Z

Figure C-4-319: 8199 Left Lap Belt Force



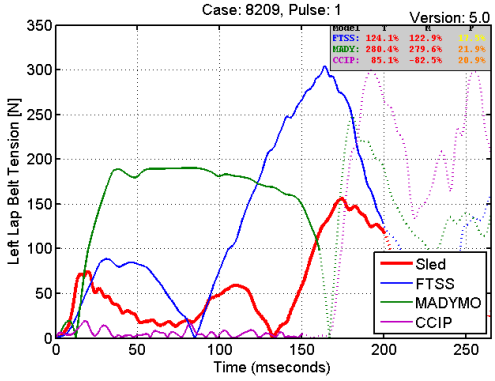
10G 70ms +Z

Figure C-4-317: 8207 Left Lap Belt Force



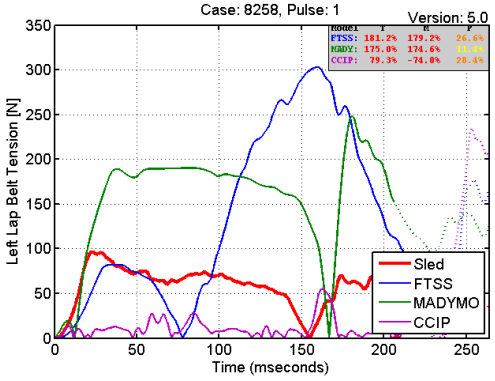
10G 70ms +Z

Figure C-4-320: 8208 Left Lap Belt Force



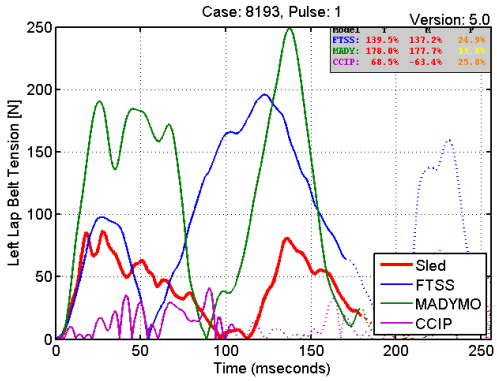
10G 70ms +Z

Figure C-4-318: 8209 Left Lap Belt Force



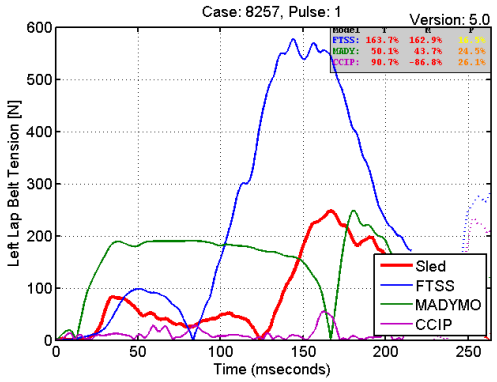
10G 70ms +Z

Figure C-4-321: 8258 Left Lap Belt Force



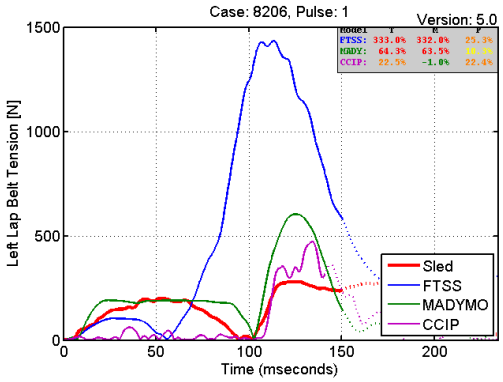
10G 30ms +Z

Figure C-4-322: 8193 Left Lap Belt Force



15G 70ms +Z

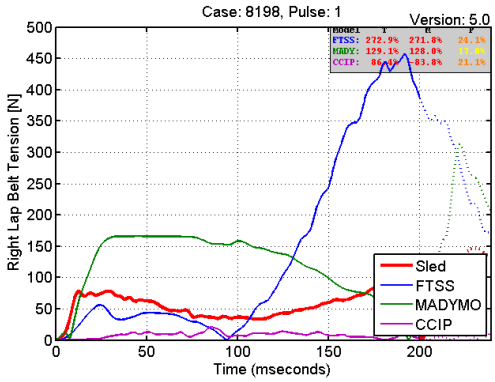
Figure C-4-323: 8257 Left Lap Belt Force



20G 70ms +Z

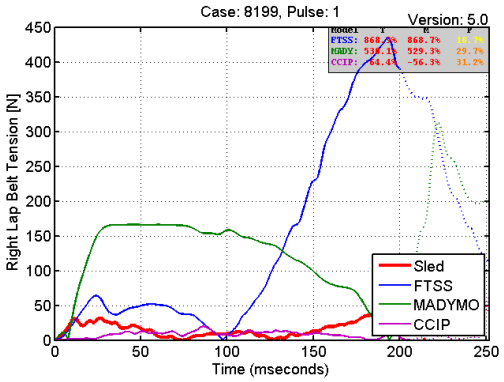
Figure C-4-324: 8206 Left Lap Belt Force

C.4.37 Right Lap Belt Force



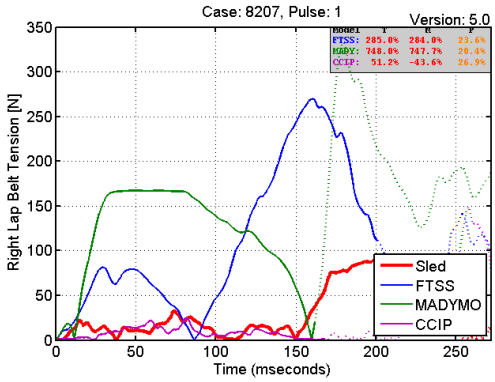
10G 110ms +Z

Figure C-4-325: 8198 Right Lap Belt Force



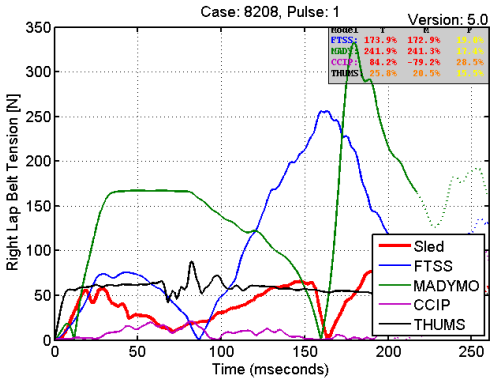
10G 110ms +Z

Figure C-4-328: 8199 Right Lap Belt Force



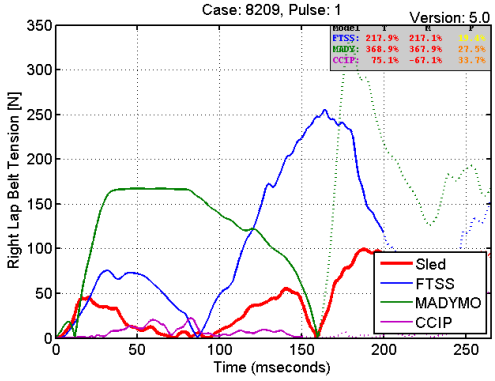
10G 70ms +Z

Figure C-4-326: 8207 Right Lap Belt Force



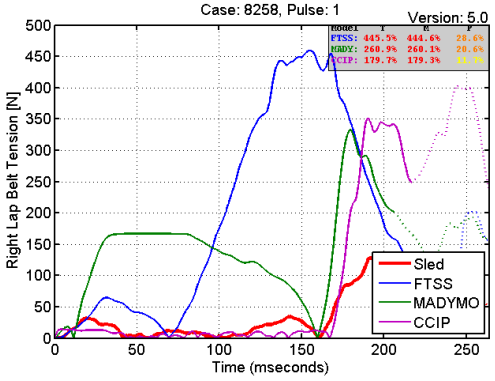
10G 70ms +Z

Figure C-4-329: 8208 Right Lap Belt Force



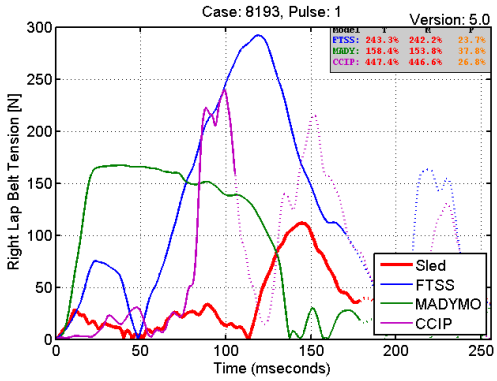
10G 70ms +Z

Figure C-4-327: 8209 Right Lap Belt Force



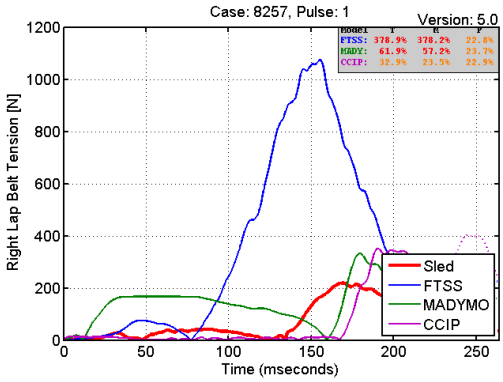
10G 70ms +Z

Figure C-4-330: 8258 Right Lap Belt Force



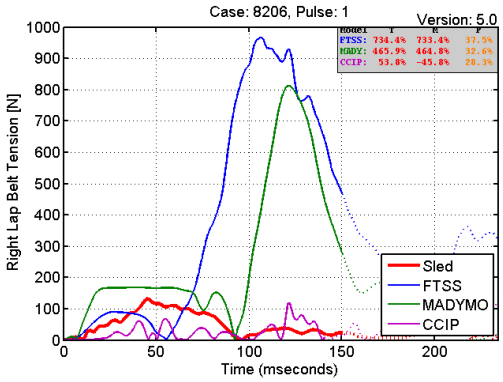
10G 30ms +Z

Figure C-4-331: 8193 Right Lap Belt Force



15G 70ms +Z

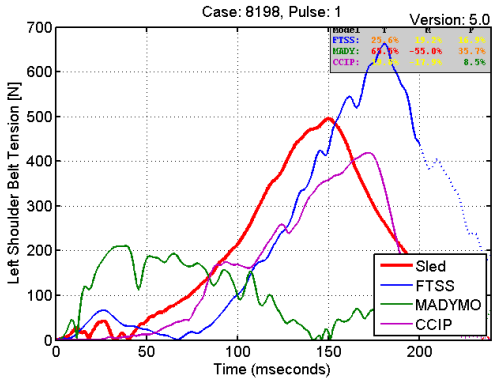
Figure C-4-332: 8257 Right Lap Belt Force



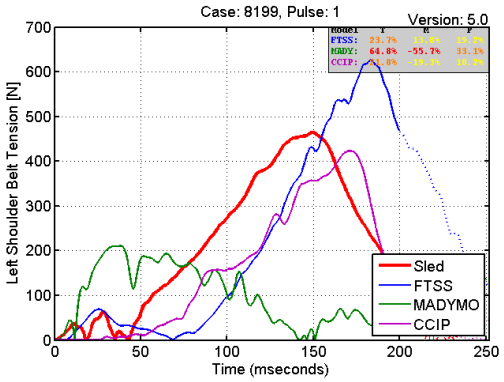
20G 70ms +Z

Figure C-4-333: 8206 Right Lap Belt Force

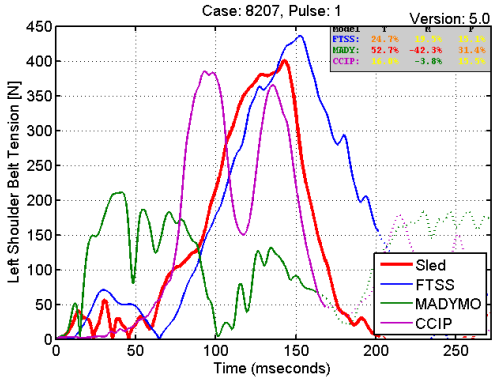
C.4.38 Left Shoulder Belt Force



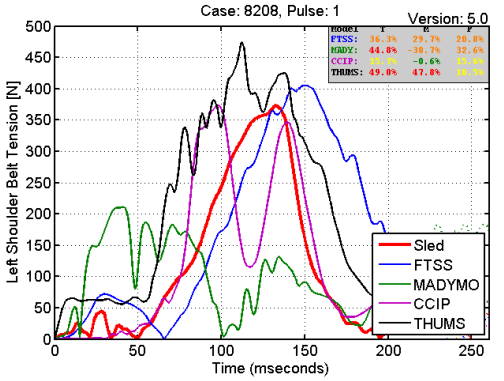
10G 110ms +Z
Figure C-4-334: 8198 Left Shoulder Belt Force



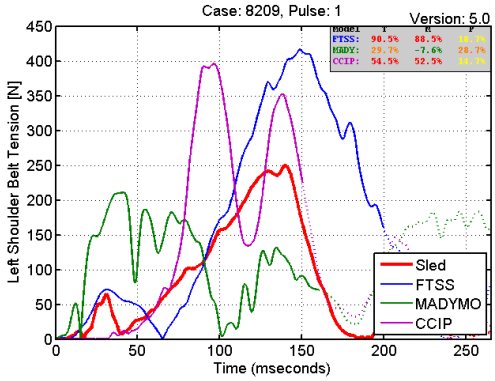
10G 110ms +Z
Figure C-4-337: 8199 Left Shoulder Belt Force



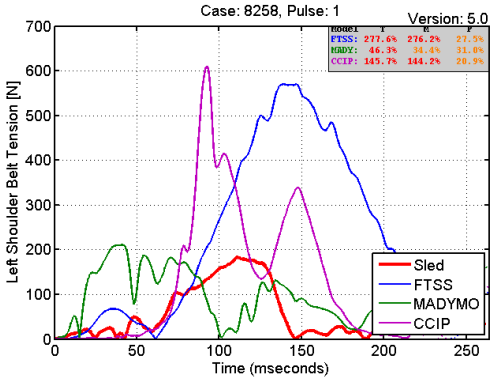
10G 70ms +Z
Figure C-4-335: 8207 Left Shoulder Belt Force



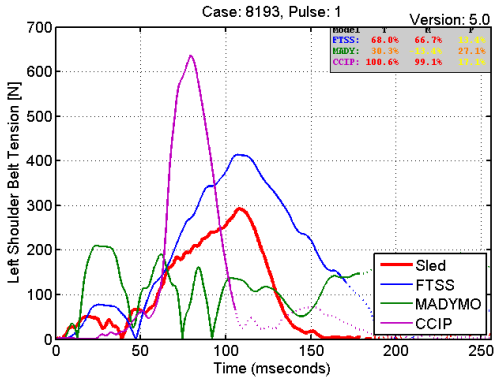
10G 70ms +Z
Figure C-4-338: 8208 Left Shoulder Belt Force



10G 70ms +Z
Figure C-4-336: 8209 Left Shoulder Belt Force

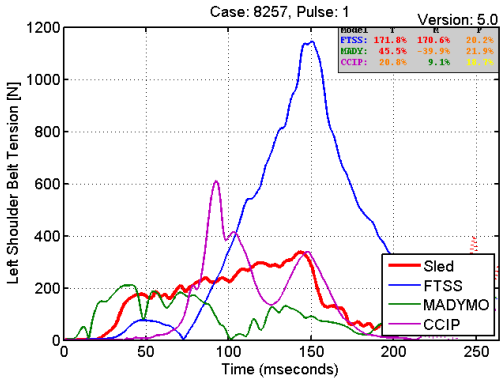


10G 70ms +Z
Figure C-4-339: 8258 Left Shoulder Belt Force



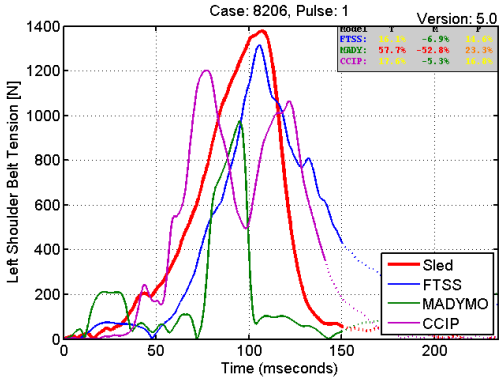
10G 30ms +Z

Figure C-4-340: 8193 Left Shoulder Belt Force



15G 70ms +Z

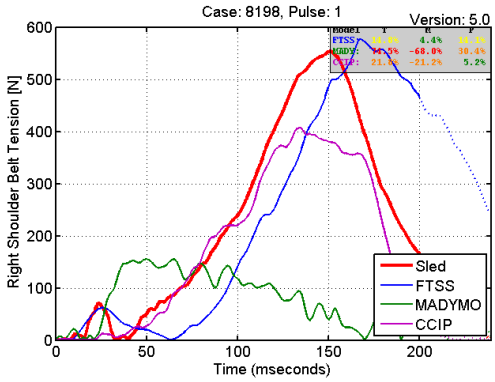
Figure C-4-341: 8257 Left Shoulder Belt Force



20G 70ms +Z

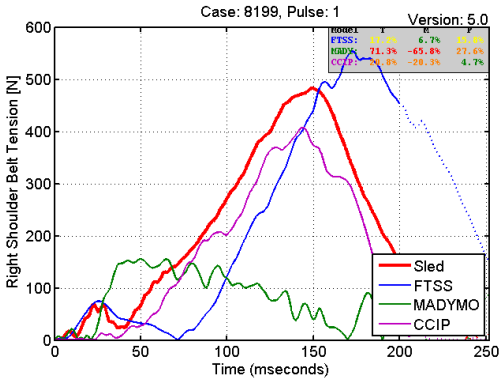
Figure C-4-342: 8206 Left Shoulder Belt Force

C.4.39 Right Shoulder Belt Force



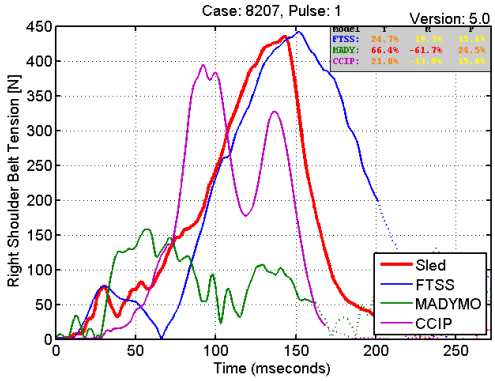
10G 110ms +Z

Figure C-4-343: 8198 Right Shoulder Belt Force



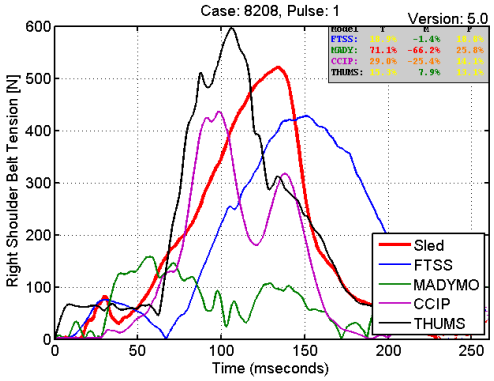
10G 110ms +Z

Figure C-4-346: 8199 Right Shoulder Belt Force



10G 70ms +Z

Figure C-4-344: 8207 Right Shoulder Belt Force



10G 70ms +Z

Figure C-4-347: 8208 Right Shoulder Belt Force

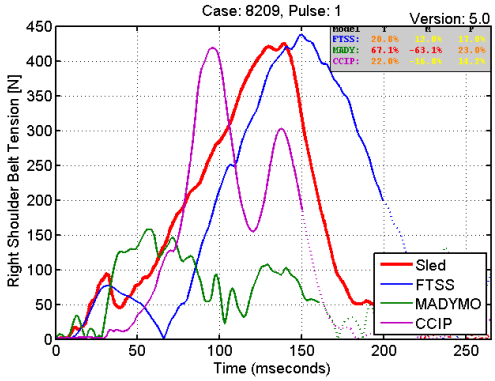


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Figure C-4-345: 8209 Right Shoulder Belt Force

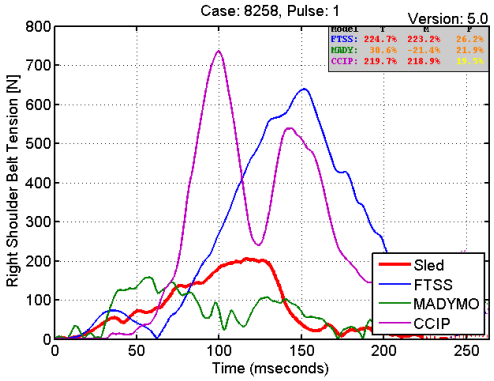

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Figure C-4-348: 8258 Right Shoulder Belt Force

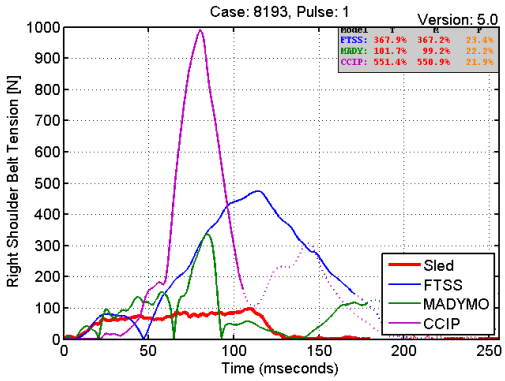

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Figure C-4-349: 8193 Right Shoulder Belt Force

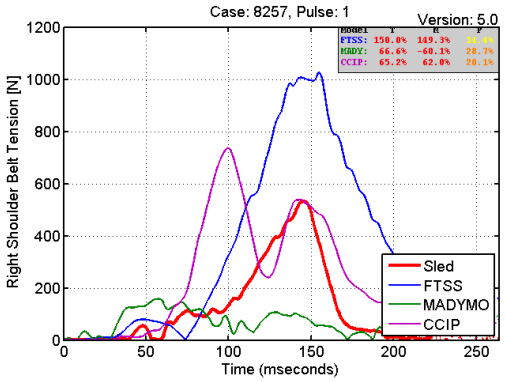

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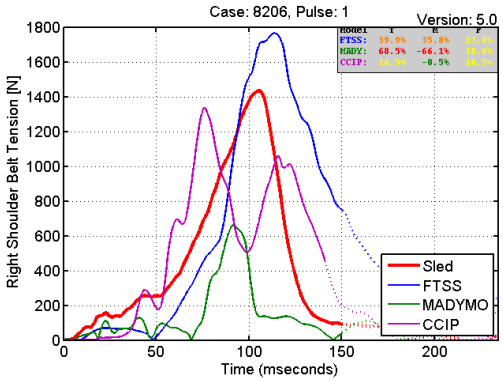
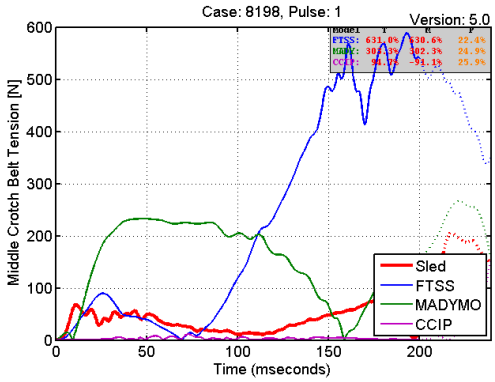
Figure C-4-350: 8257 Right Shoulder Belt Force



20G 70ms +Z

Figure C-4-351: 8206 Right Shoulder Belt Force

C.4.40 Crotch Belt Force



10G 110ms +Z
Figure C-4-352: 8198 Crotch Belt Force

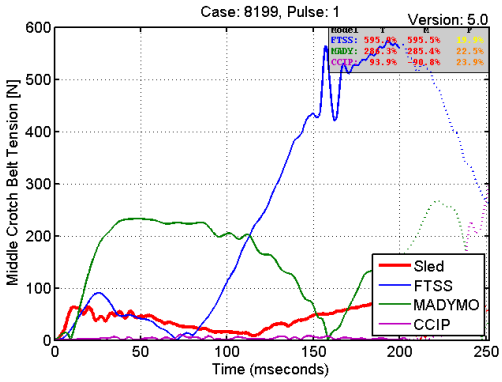


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Figure C-4-355: 8199 Crotch Belt Force

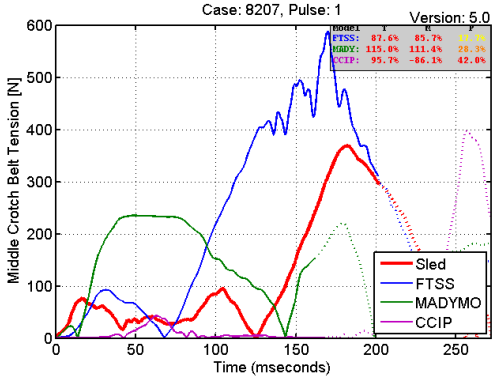

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Figure C-4-353: 8207 Crotch Belt Force

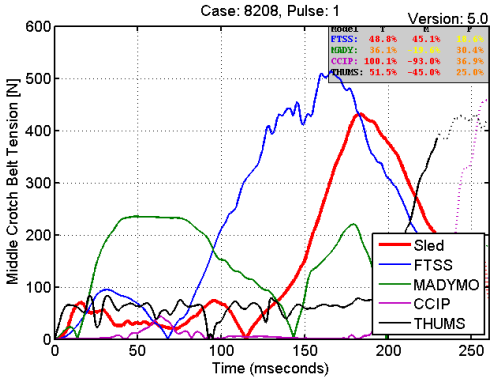

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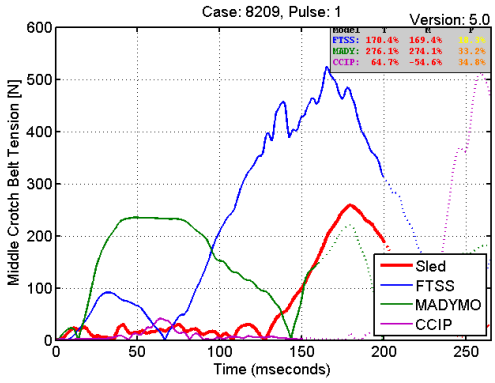
Figure C-4-356: 8208 Crotch Belt Force



10G 70ms +Z
Figure C-4-354: 8209 Crotch Belt Force

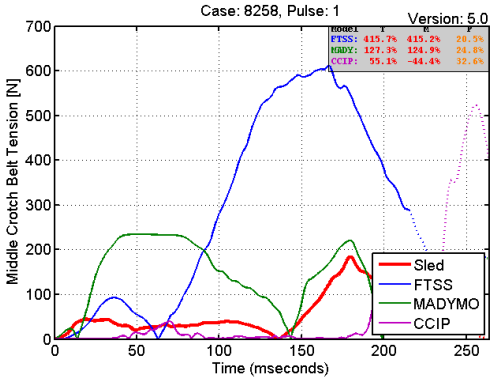


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Figure C-4-357: 8258 Crotch Belt Force

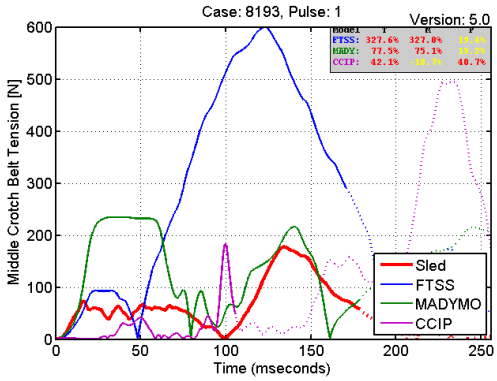

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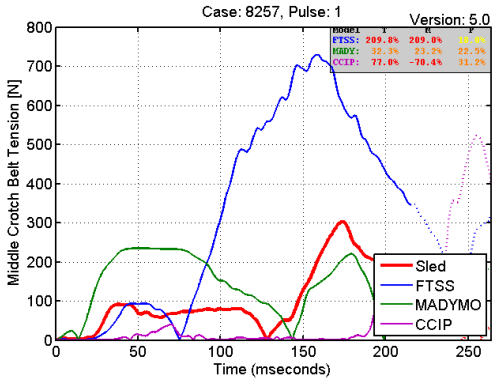
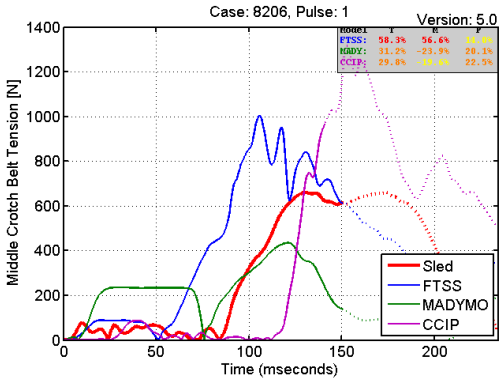
Figure C-4-358: 8193 Crotch Belt Force



15G 70ms +Z

Figure C-4-359: 8257 Crotch Belt Force



20G 70ms +Z

Figure C-4-360: 8206 Crotch Belt Force

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14. ABSTRACT

Dr. Nancy J. Currie, of the NASA Engineering and Safety Center (NESC), Chief Engineer at Johnson Space Center (JSC), requested an assessment of the Crew Exploration Vehicle (CEV) occupant protection as a result of issues identified by the Constellation Program and Orion Project. The NESC, in collaboration with the Human Research Program (HRP), investigated new methods associated with occupant protection for the Crew Exploration Vehicle (CEV), known as Orion. The primary objective of this assessment was to investigate new methods associated with occupant protection for the CEV, known as Orion, that would ensure the design provided minimal risk to the crew during nominal and contingency landings in an acceptable set of environmental and spacecraft failure conditions. This documents contains the Appendices to the main NESC assessment report. NASA/TM-2013-217380, "Application of the Brinkley Dynamic Response Criterion to Spacecraft Transient Dynamic Events." supercedes this document.

15. SUBJECT TERMS
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