ISS Motion Control System

Operations & Upcoming Events
POIWG External Payloads Splinter

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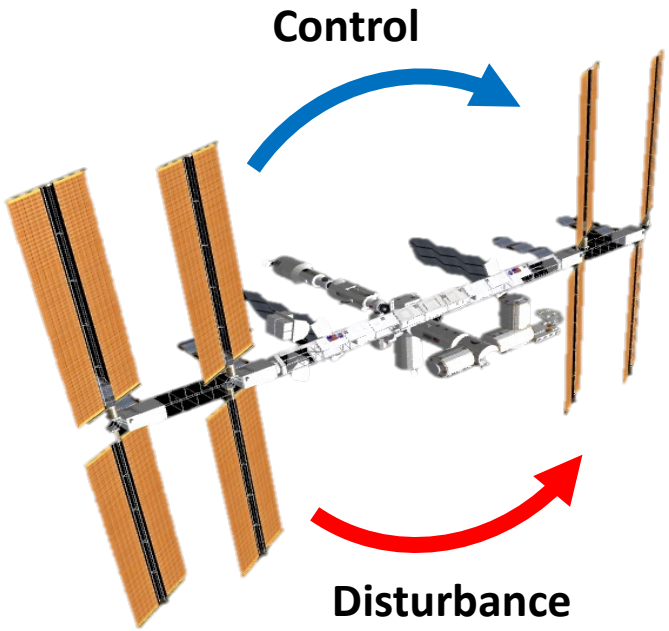
Outline

- Motion Control System (MCS) overview
  - CMG and Attitude Control basics
  - Torque Equilibrium Attitude (TEA) definition
  - MCS control types
  - GPS FDIR
  - Common operations
  - Interpreting the ATL
- Planning products
- Planned Increment 71 events

Attitude Control Basics

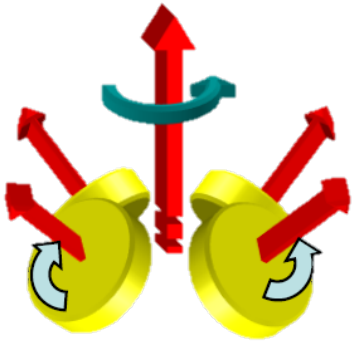
Attitude **D**etermination and **C**ontrol **O**fficer

Attitude Control: The ability to maintain a spacecraft's rotational orientation despite external disturbances.



ISS Attitude Control Effectors

Control Moment Gyroscopes (CMGs)

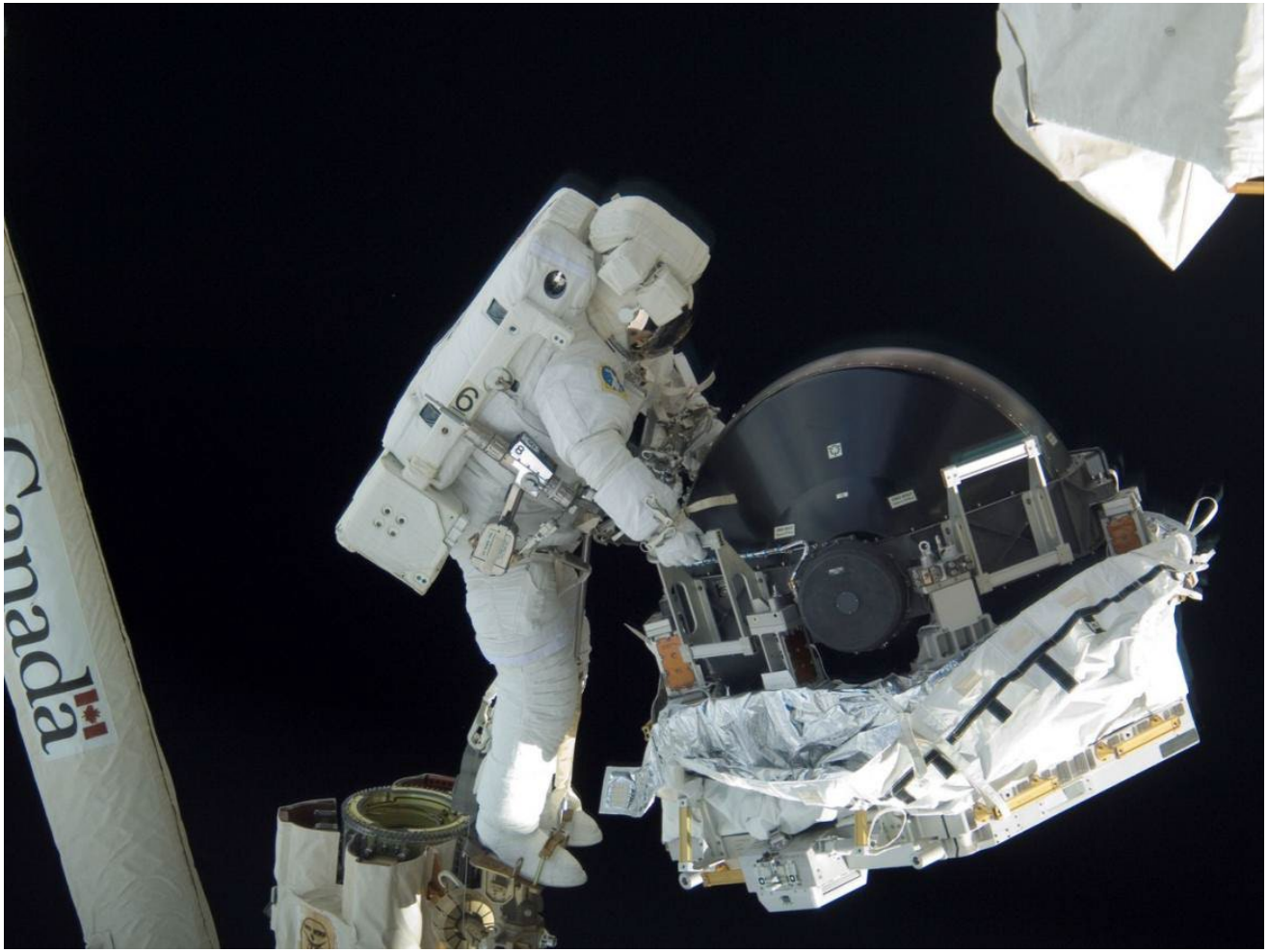


- Non Propulsive Attitude Control
- Provide Microgravity Environment

Thruster Control

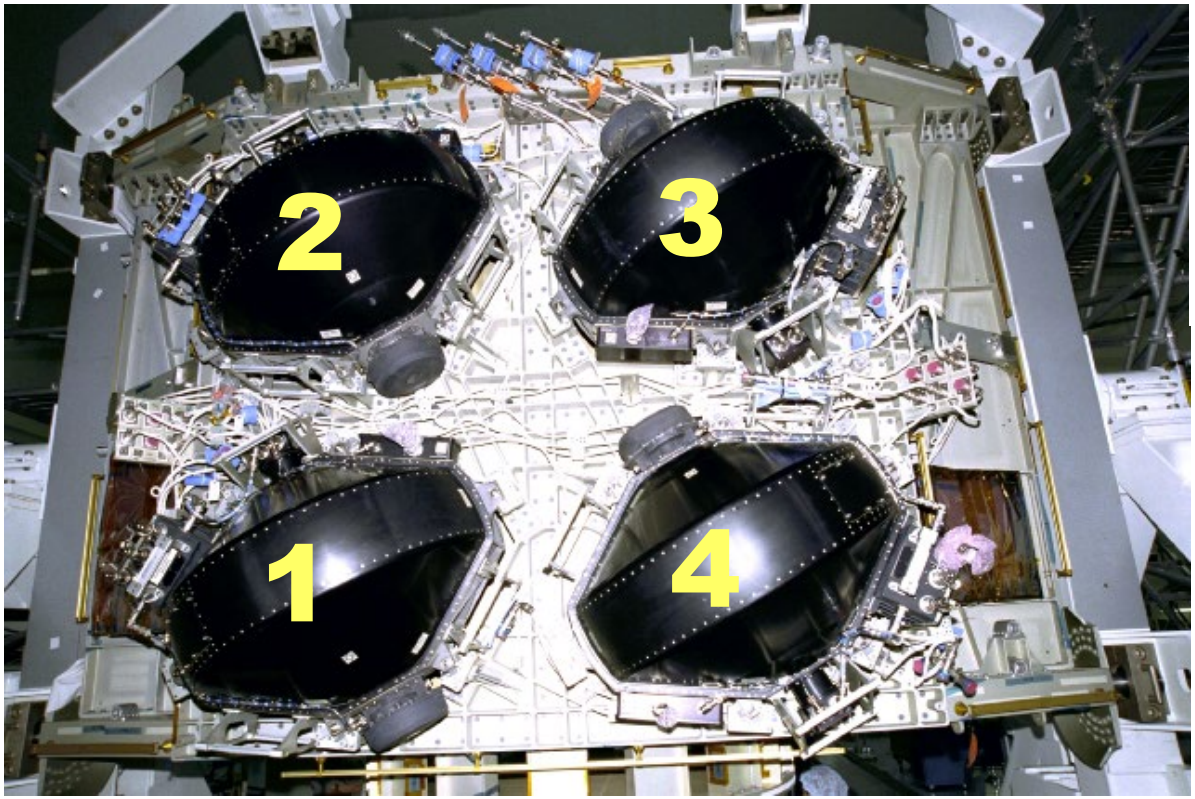
- Propulsive Attitude Control
- Strongest Control Authority

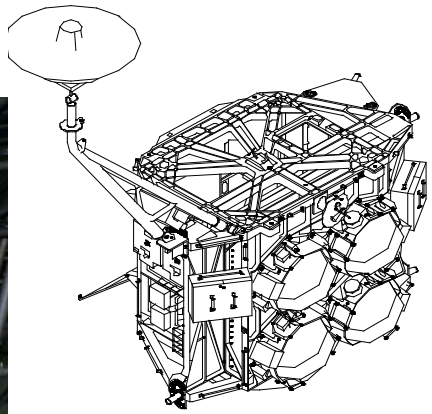
MCS Overview - CMG Basics



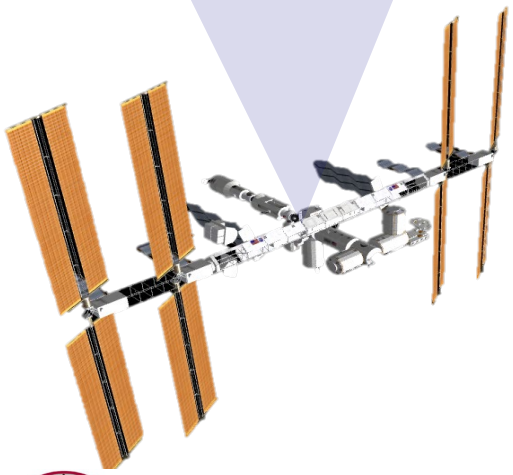
MCS Overview - CMG Basics

CMG : Control Moment Gyroscopes





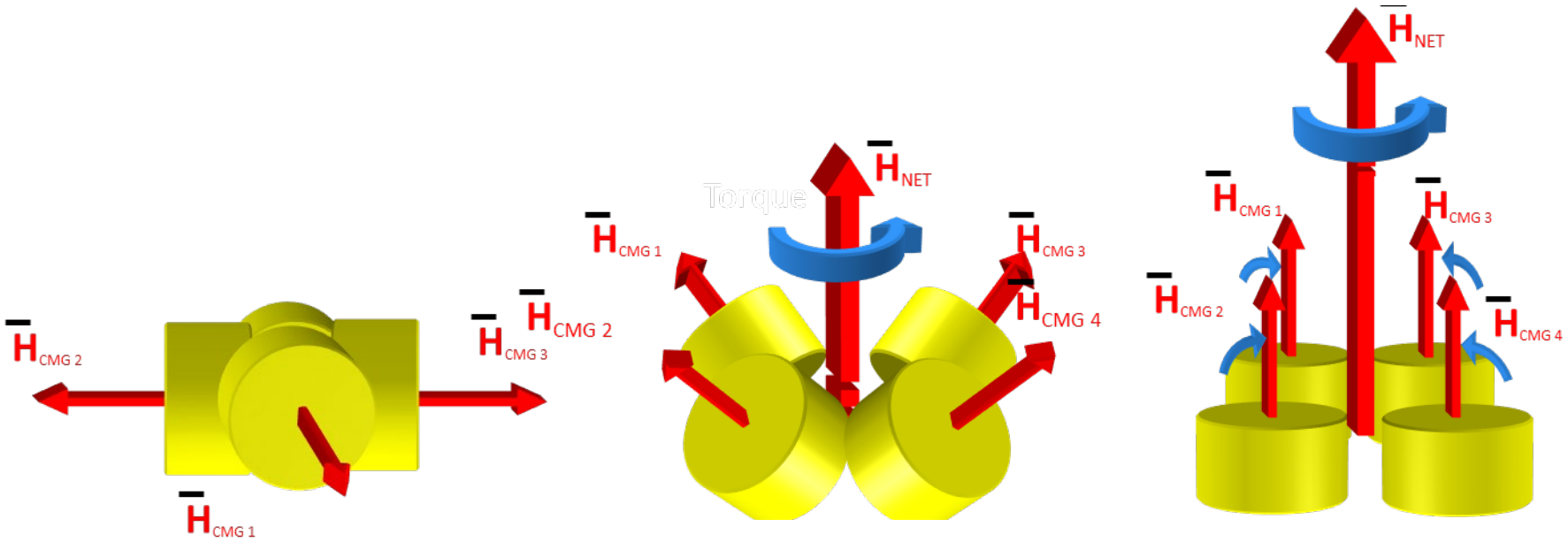
Z1 Truss



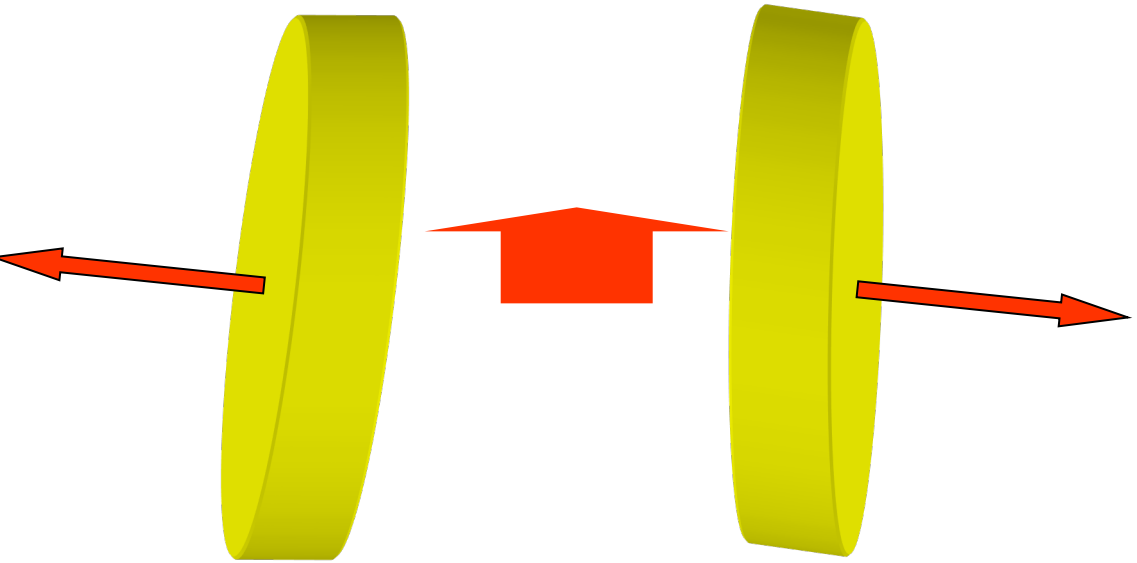
MCS Overview - CMG Basics

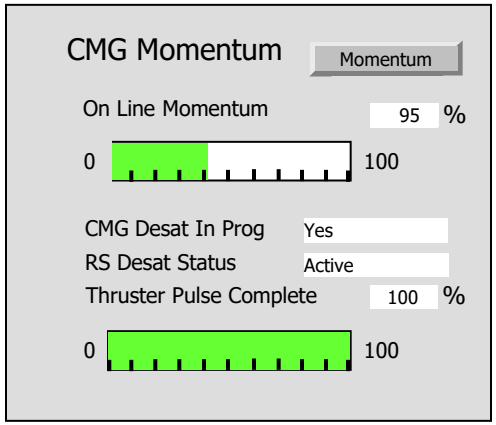
A spinning wheel has angular momentum.

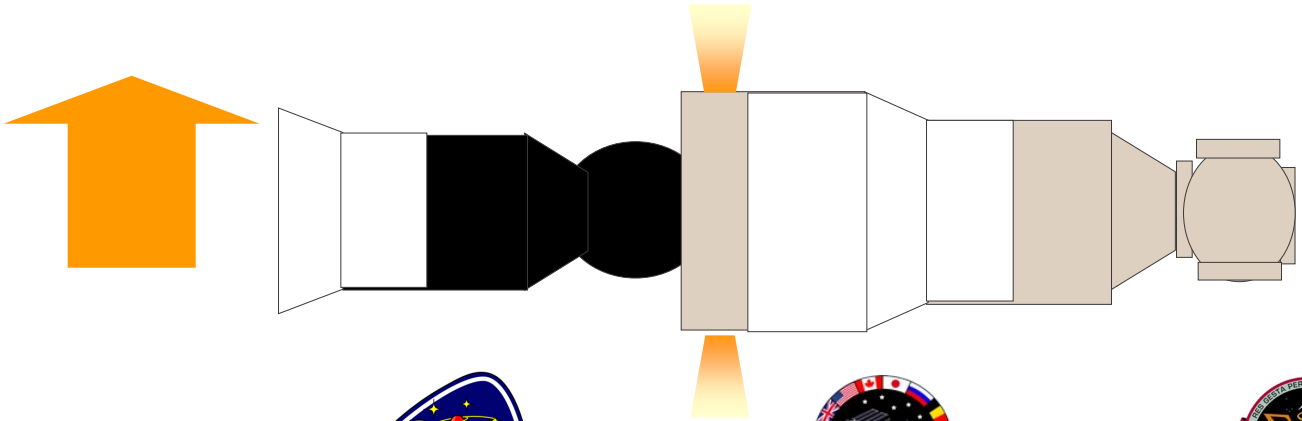
Changing the net angular momentum vector of the CMGs creates a torque.



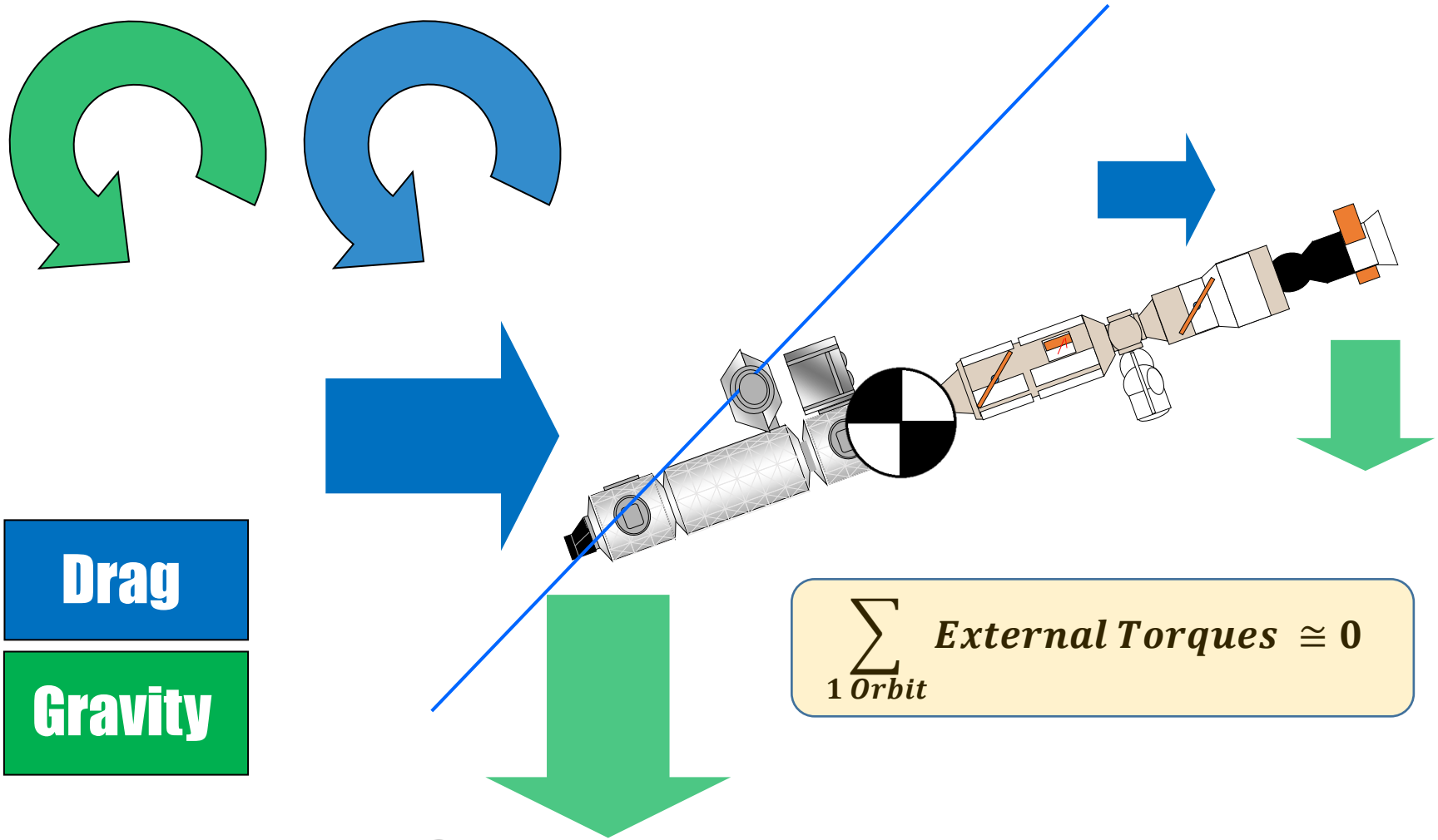
MCS Overview - CMG Desaturations







Torque Equilibrium Attitude



$$\sum_{1\ Orbit} External\ Torques \cong 0$$

Torque Equilibrium Attitude

- The ISS TEA is dependent on what ports have visiting vehicles docked to them
- Current +XVV TEA: (-4, x, 0.9) Yaw, Pitch, Roll
- x (Pitch angle) is between -12.0 and -2.0 deg depending on port configuration
- Typically, ISS is pitched down further than it was prior to the addition of MLM
- A new controller is being incorporated NET May 2024: may see roll errors up to 0.5 deg higher than in the past
- Quiescent total attitude error is within +/- 3 deg
- The analyzed thermal envelope that ISS is cleared to fly in (Flight Rule B2-57) is unchanged

MCS Control Types

Nominal (Quiescent)

Momentum Management (MM)

Maintain attitude while conserving momentum.
Expect attitude error to keep momentum stable.

Dynamic Events and Contingency

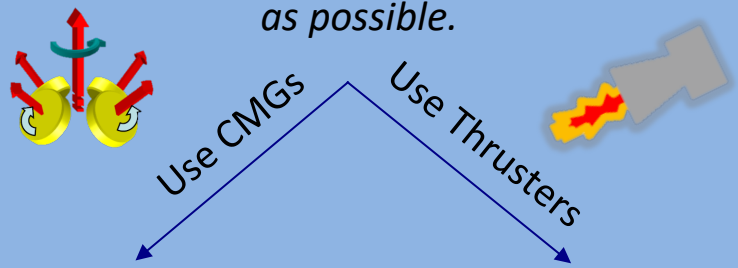
RS Thrusters

Hold attitude with highest control authority

Dynamic Events

Attitude Hold (AH)

Keep attitude error as low as possible.



CMG AH

Hold attitude using CMGS

USTO

Hold attitude using thrusters

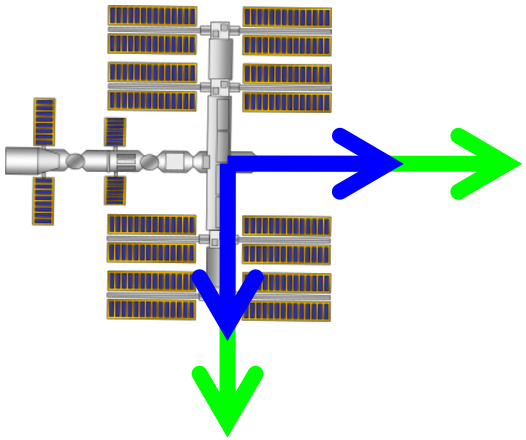
More details on control modes in backup charts.

Momentum Management Control

Momentum Percentage

Att Error: <3°

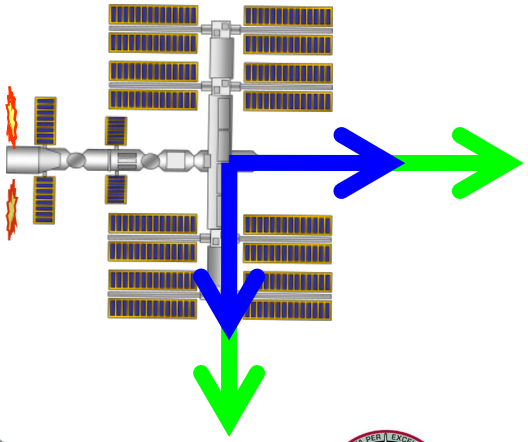
**Note: Performance usually much better at <1 °.*
Roll varies most, usually 0.5 ° up and down per orbit



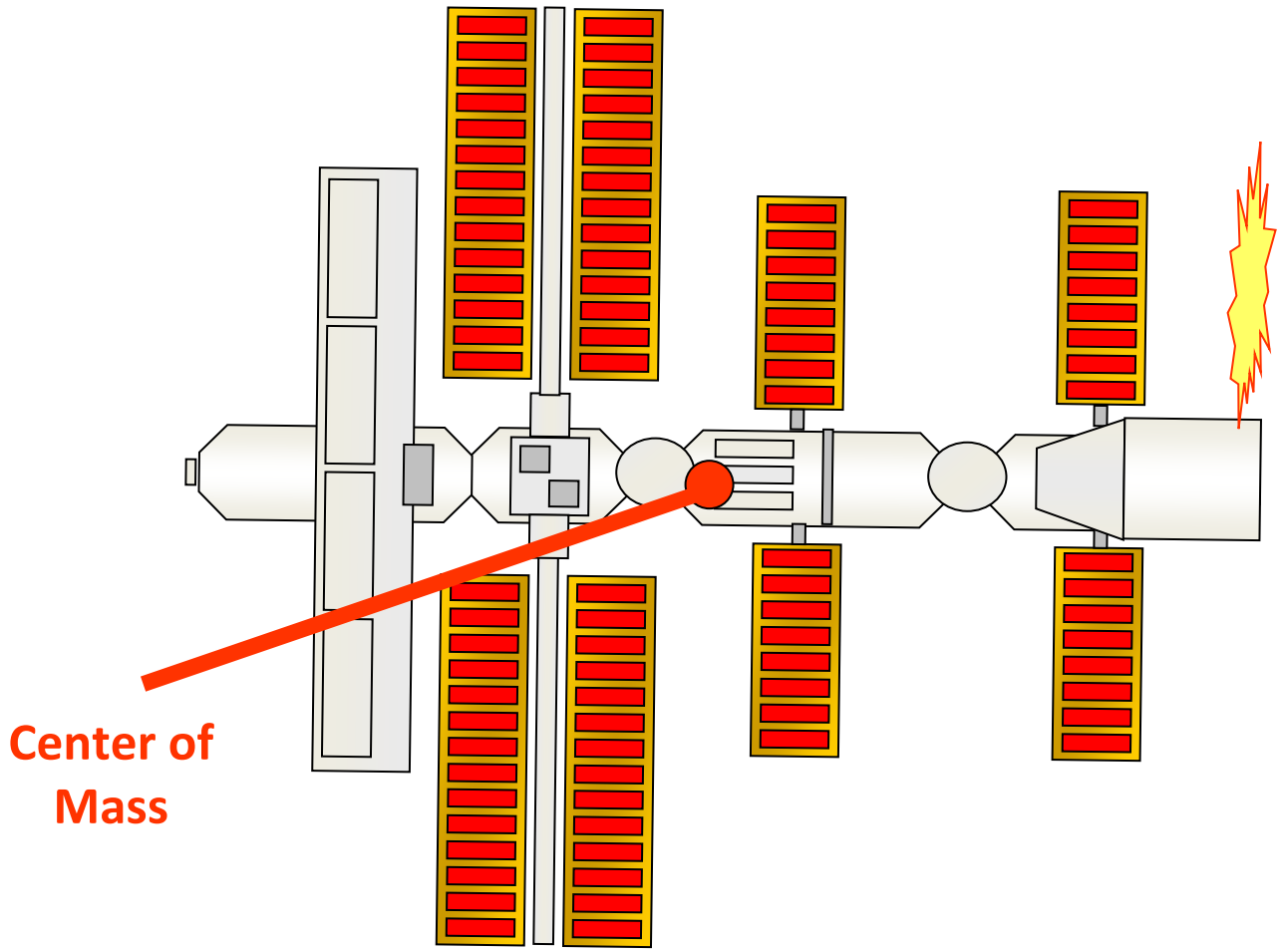
CMG Attitude Hold Control
With Desaturations Enabled

Momentum Percentage

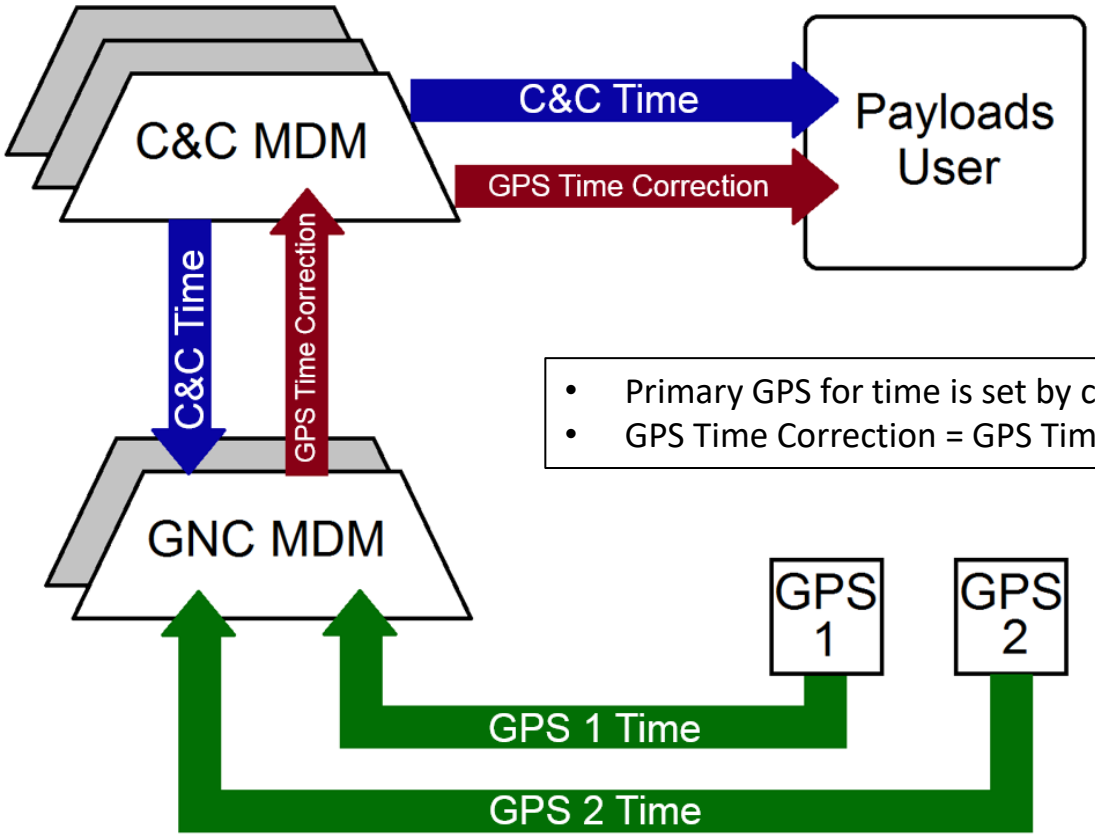
Att Error: <1°



USTO Control / RS Thruster Control

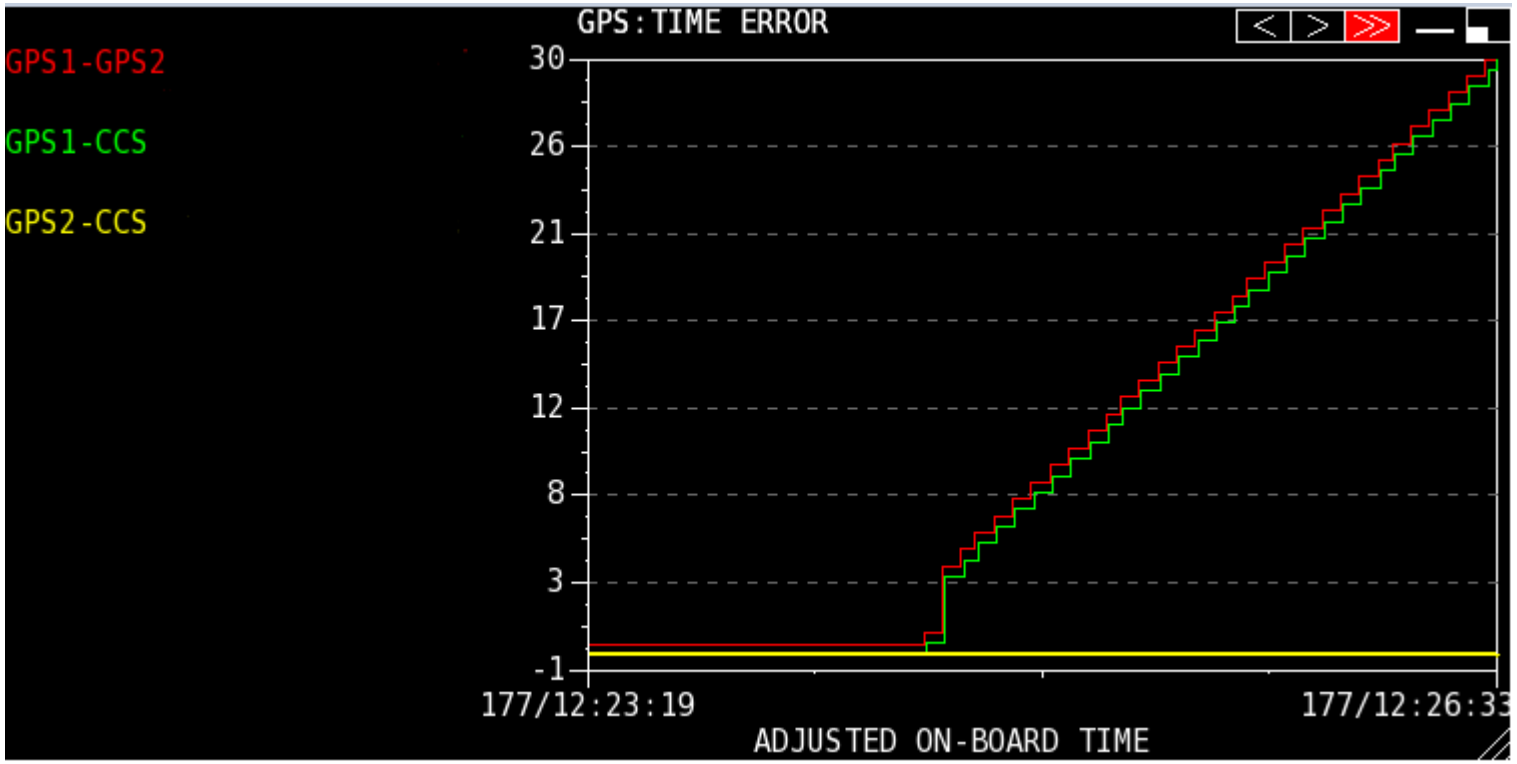


GPS Time Overview



- Primary GPS for time is set by command
- GPS Time Correction = GPS Time – C&C Time

GPS Lock-up Time Impacts



Timeliner Bundle Summary

- Timeliner is software in the C&C MDMs that can monitor given parameters and take action as needed.
- The Timeliner bundle will monitor for anomalies in GPS time data associated with GPS lockup events.
- If the GPS time in use is inaccurate, the Timeliner bundle will command the GNC to use the other GPS for time information.
- The bundle will maintain the C&C BAD GPS Time Correction to an accuracy of 2 seconds for payloads users.
- **Payloads exposure to time errors greater than 2 seconds will be limited to a 2 second window when the bundle is operating.**

Notes on GPS Lock-ups

- Term ‘lock-up’ used when GPS is not outputting state or attitude updates
  - Not all lock-ups result in GPS time error increasing
- In quiescent ops, GPS lock-ups are low-impact to ISS MCS operations
- The state and attitude knowledge in the GNC MDM is propagated, valid, and provided to users
- If the GPS locked up is first priority for time, ADCO will switch time priorities within 50 minutes of the lock-up
  - Timeliner bundle would take action automatically if the GPS time is inaccurate

MCS Overview – Common Operations

- Russian Visiting Vehicle Dockings/Undockings
  - +XVV,-XVV, +ZVV, -ZVV attitudes all possible
  - Can be performed in all mode types; expect thruster firings
- Optimized Propellant Maneuvers
  - Maneuver between +XVV and –XVV using USTO
- USCV Dockings/Undockings (Dragon, CST-100, HTV-X)
- Free-Flyer Capture/Release (Cygnus)
  - Thruster firings and tight attitude hold periods
- EVAs
- Reboosts
  - Can be performed in +XVV or -XVV
- Thruster Disables (Can be requested by IPs/PDs)
- Attitude maneuvers (Can be requested by IPs/PDs)
  - Yaw Bias Maneuver of +/- 8 degrees for High Solar Beta periods lasting from a few days up to 2 weeks.
  - Attitudes must be within defined attitude envelopes (Reference GEN OIP 7.5.4 ISS Attitude Change or Microgravity Request)

ISS Maneuvers

Optimized Propellant Maneuvers (OPMs)

- Between +XVV and –XVV using USTO or RS Thruster Control
- NOT a purely yaw maneuver

ISS Maneuvers

CMG attitude maneuvers

- Slower than thruster maneuvers
- Example: 8 degree CMG maneuver to YPR (-12.0, -1.3, +0.7) took ~1 hour and 7 minutes

ISS Translational Maneuver

- Reboost, Debris Avoidance Maneuver (DAM), or PDAM
- Russian thrusters fire to provide delta v and change ISS orbit
- Often done in or near TEA
- https://www.youtube.com/watch?v=cmHamp0IlyE

ISS Maneuvers

Notes on PDAMs for Payloads

- MCC-H will coordinate with POIC to ensure all payloads are safed appropriately. Typical handover time to RS Thruster control is 70 minutes prior to TIG.
- A small attitude maneuver on RS Thrusters will typically occur 21 minutes prior to TIG.
- Capability now exists to initiate a 180 degree yaw maneuver 65 minutes prior to TIG (a.k.a. 180deg PDAM). Unlike OPMs, this is a pure yaw maneuver on Russian Thrusters.

ISS Loss of Attitude Control Review

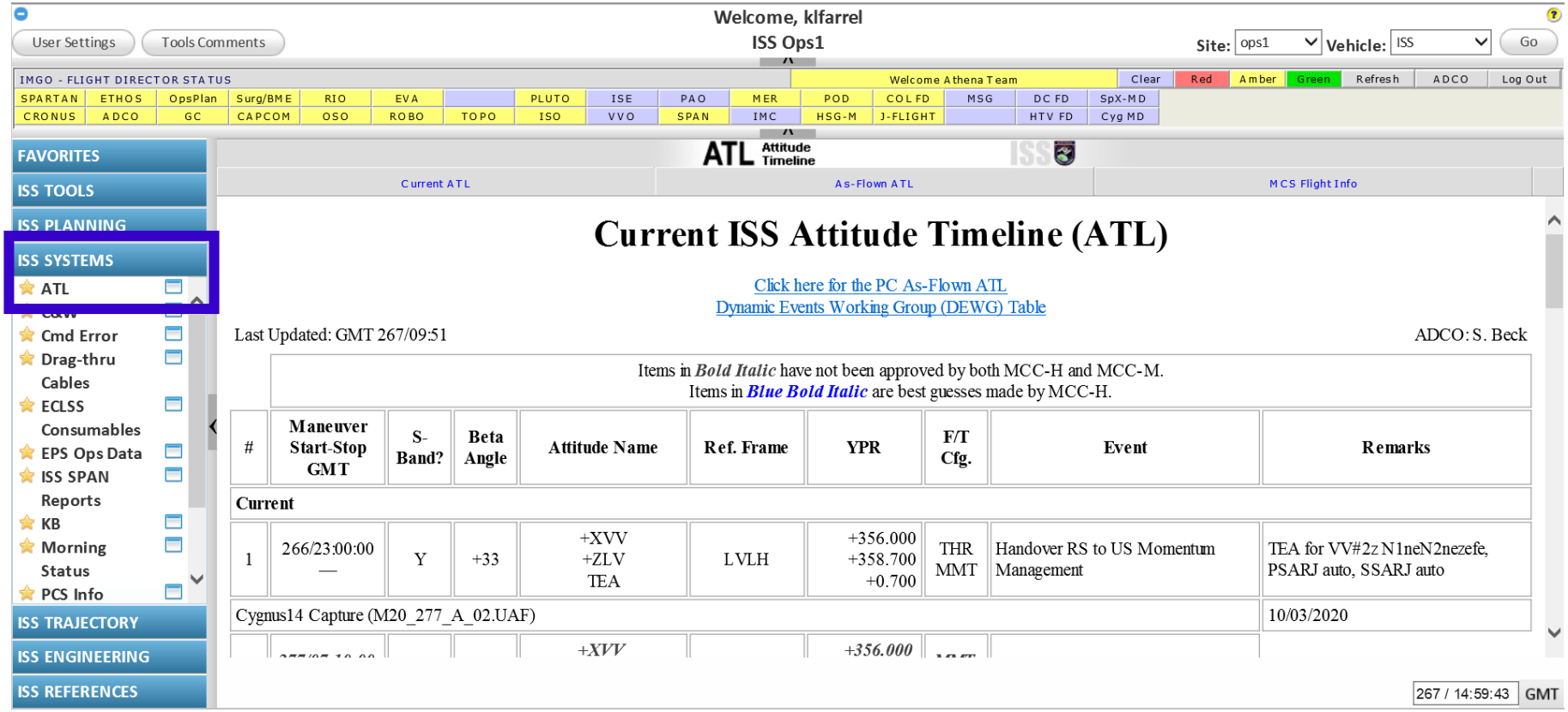
- ISS lost attitude control twice in 2021
  - One due to a stuck on MLM thruster shortly after MLM docking
  - One due to an unintended long duration thruster firing during 64S Thruster Test

- Result of LoACs (generally)
  - ISS will be free drift for an indeterminate amount of time while ground and crew work together to safe ISS for recovery on RS thrusters
  - ISS could leave the typical analyzed attitude envelope during this time, will return to nominal attitude once control is regained
  - Expect rates to build on ISS until attitude control is regained
  - Recovery back to Momentum Management in the nominal attitude could be on the order of hours

- GJOP work
  - Crew is prime to execute the LoAC response
  - Procedure updates being made to LoAC procedure to ensure that crew does not initiate control on RS Thrusters prior to the vehicle being safed

Interpreting the ATL

Attitude Timeline (ATL) accessible through ISS Gateway



Interpreting the ATL

Attitude Timeline (ATL) shows upcoming events involving changes to the MCS.

	Items in *Bold Italic* have not been approved by both MCC-H and MCC-M. Items in ***Blue Bold Italic*** are best guesses made by MCC-H.								
#	**Maneuver Start-Stop GMT**	**S-Band?**	**Beta Angle**	**Attitude Name**	**Ref. Frame**	**YPR**	**F/T Cfg.**	**Event**	**Remarks**
Thruster Disable ERA and 65P Hatch Opening (H15_115_A_01.UAF)									04/20/2015
1	*115/10:50:00* —	*Y*	*-10*	*+XVV* *+ZLV* *TEA*	*LVLH*	*+357.000* *+355.200* *+0.910*	*MMT* *SAT*	*Disable Thrusters*	***Thrusters disabled via software inhibits***
2	*115/19:20:00* —/	*Y*	*-12*	*+XVV* *+ZLV* *TEA*	*LVLH*	*+356.000* *+355.200* *+0.910*	*SAT* *MMT*	*Enable Thrusters*	
RS EVA 25 Depress US Control (M15_120_A_02.UAF)									04/25/2015
3	*120/23:22:10* —	*Y*	*-29*	*+XVV* *+ZLV* *TEA*	*LVLH*	*+357.000* *+355.200* *+0.910*	*MMT* *AHT*	*Transition to Att Hold with Desats Enabled*	***Depress - 00:10-01:10***
4	*120/01:45:12* —	*Y*	*-31*	*+XVV* *+ZLV* *TEA*	*LVLH*	*+356.000* *+355.200* *+0.910*	*AHT* *MMT*	*Transition to Momentum Management*	***TEA for VV#2, PSARJ auto, SSARJ auto***

Interpreting the ATL

Time of event (GMT)

Thruster Disable ERA and 65P Hatch Opening (H15_115_A_01.UAF)									04/20/2015
1	*115/10:50:00* —	*Y*	*-10*	*+XVV +ZLV TEA*	*LVLH*	*+357.000 +355.200 +0.910*	*MMT SAT*	*Disable Thrusters*	*Thrusters disabled via software inhibits*
2	*115/19:20:00* —/	*Y*	*-12*	*+XVV +ZLV TEA*	*LVLH*	*+356.000 +355.200 +0.910*	*SAT MMT*	*Enable Thrusters*	
RS EVA 25 Depress US Control (M15_120_A_02.UAF)									04/25/2015
3	*120/23:22:10* —	*Y*	*-29*	*+XVV +ZLV TEA*	*LVLH*	*+357.000 +355.200 +0.910*	*MMT AHT*	*Transition to Att Hold with Desats Enabled*	*Depress - 00:10-01:10*
4	*120/01:45:11* —	*Y*	*-31*	*+XVV +ZLV TEA*	*LVLH*	*+356.000 +355.200 +0.910*	*AHT MMT*	*Transition to Momentum Management*	*TEA for VV#2, PSARJ auto, SSARJ auto*

For maneuvers, start and stop time shown.

Interpreting the ATL

Attitude name in Velocity Vector, Local Vertical nomenclature
TEA designation if applicable

Thruster Disable ERA and 65P Hatch Opening (M15_115_A_01.UAF)									04/20/2015
1	*115/10:50:00* —	*Y*	*-10*	*+XVV +ZLV TEA*	*LVLH*	*+357.000 +355.200 +0.910*	*MMT SAT*	*Disable Thrusters*	*Thrusters disabled via software inhibits*
2	*115/19:20:00* —/	*Y*	*-12*	*+XVV +ZLV TEA*	*LVLH*	*+356.000 +355.200 +0.910*	*SAT MMT*	*Enable Thrusters*	
RS EVA 25 Depress US Control (M15_120_A_01.UAF)									04/25/2015
3	*120/23:22:10* —	*Y*	*-29*	*+XVV +ZLV TEA*	*LVLH*	*+357.000 +355.200 +0.910*	*MMT AHT*	*Transition to Att Hold with Desats Enabled*	*Depress - 00:10-01:10*
4	*120/01:45:12* —	*Y*	*-31*	*+XVV +ZLV TEA*	*LVLH*	*+356.000 +355.200 +0.910*	*AHT MMT*	*Transition to Momentum Management*	*TEA for VV#2, PSARJ auto, SSARJ auto*

Interpreting the ATL

Reference frame and commanded attitude in YPR

Thruster Disable ERA and 65P Hatch Opening (H15_[illegible]5_A_01.UAF)									04/20/2015
1	*115/10:50:00 —*	*Y*	*-10*	*+XVV +ZLV TEA*	*LVLH*	*+357.000 +355.200 +0.910*	*MMT SAT*	*Disable Thrusters*	*Thrusters disabled via software inhibits*
2	*115/19:20:00 —/*	*Y*	*-12*	*+XVV +ZLV TEA*	*LVLH*	*+356.000 +355.200 +0.910*	*SAT MMT*	*Enable Thrusters*	
RS EVA 25 Depress US Control (M15_120_A_0[illegible].UAF)									04/25/2015
3	*120/23:22:10 —*	*Y*	*-29*	*+XVV +ZLV TEA*	*LVLH*	*+357.000 +355.200 +0.910*	*MMT AHT*	*Transition to Att Hold with Desats Enabled*	*Depress - 00:10-01:10*
4	*120/01:45:12 —*	*Y*	*-31*	*+XVV +ZLV TEA*	*LVLH*	*+356.000 +355.200 +0.910*	*AHT MMT*	*Transition to Momentum Management*	*TEA for VV#2, PSARJ auto, SSARJ auto*

Interpreting the ATL

From/to config – see backup slides for full decoder

Some common ones:
MMT – Momentum Management with desats enabled
SAT – Momentum Management with desats inhibited
THR – Russian thruster control
UST – USTO control

T						F)			04/20/2015
1							*MMT SAT*	*Disable Thrusters*	*Thrusters disabled via software inhibits*
2	*115/19:20:00 —/*	*Y*	*-12*	*+XVV +ZLV TEA*	*LVLH*	*+356.000 +355.200 +0.910*	*SAT MMT*	*Enable Thrusters*	
RS EVA 25 Depress US Control (M15_120_A_02.UAF)									04/25/2015
3	*120/23:22:10 —*	*Y*	*-29*	*+XVV +ZLV TEA*	*LVLH*	*+357.000 +355.200 +0.910*	*MMT AHT*	*Transition to Att Hold with Desats Enabled*	*Depress - 00:10-01:10*
4	*120/01:45:12 —*	*Y*	*-31*	*+XVV +ZLV TEA*	*LVLH*	*+356.000 +355.200 +0.910*	*AHT MMT*	*Transition to Momentum Management*	*TEA for VV#2, PSARJ auto, SSARJ auto*

Interpreting the ATL

Event – what is happening

Thruster Disable ERA and 65P Hatch Opening (H15_115_A_01.UAF)									04/20/2015
1	*115/10:50:00 —*	*Y*	*-10*	*+XVV +ZLV TEA*	*LVLH*	*+357.000 +355.200 +0.910*	*MMT SAT*	*Disable Thrusters*	*Thrusters disabled via software inhibits*
2	*115/19:20:00 —/*	*Y*	*-12*	*+XVV +ZLV TEA*	*LVLH*	*+356.000 +355.200 +0.910*	*SAT MMT*	*Enable Thrusters*	
RS EVA 25 Depress US Control (M15_120_A_02.UAF)									04/25/2015
3	*120/23:22:10 —*	*Y*	*-29*	*+XVV +ZLV TEA*	*LVLH*	*+357.000 +355.200 +0.910*	*MMT AHT*	*Transition to Att Hold with Desats Enabled*	*Depress - 00:10-01:10*
4	*120/01:45:12 —*	*Y*	*-31*	*+XVV +ZLV TEA*	*LVLH*	*+356.000 +355.200 +0.910*	*AHT MMT*	*Transition to Momentum Management*	*TEA for VV#2, PSARJ auto, SSARJ auto*

Interpreting the ATL

Remarks – additional information

Thruster Disable ERA and 65P Hatch Opening (H15_115_A_01.UAF)									04/20/2015
1	*115/10:50:00 —*	*Y*	*-10*	*+XVV +ZLV TEA*	*LVLH*	*+357.000 +355.200 +0.910*	*MMT SAT*	*Disable Thrusters*	*Thrusters disabled via software inhibits*
2	*115/19:20:00 —/*	*Y*	*-12*	*+XVV +ZLV TEA*	*LVLH*	*+356.000 +355.200 +0.910*	*SAT MMT*	*Enable Thrusters*	
RS EVA 25 Depress US Control (M15_120_A_02.UAF)									04/25/2015
3	*120/23:22:10 —*	*Y*	*-29*	*+XVV +ZLV TEA*	*LVLH*	*+357.000 +355.200 +0.910*	*MMT AHT*	*Transition to Att Hold with Desats Enabled*	*Depress - 00:10-01:10*
4	*120/01:45:12 —*	*Y*	*-31*	*+XVV +ZLV TEA*	*LVLH*	*+356.000 +355.200 +0.910*	*AHT MMT*	*Transition to Momentum Management*	*TEA for VV#2, PSARJ auto, SSARJ auto*

Maneuvers in the ATL

RS OPM from +XVV to -XVV

RS OPM to nXVV (H19_305_A_05.UAF)									10/27/2022
1	305/15:12:00 —	Y	+25	+XVV +ZLV TEA	LVLH	+359.000 +358.700 +0.300	MMT THR	Handover US to RS	
2	305/15:17:00 305/15:22:00	Y	+25	+XVV +ZLV TEA	LVLH	+359.000 +358.700 +0.300	THR THR	Quaternion Update	
3	305/15:27:00 305/16:58:40	Y	+25	-XVV +ZLV	LVLH	+176.000 +345.123 +1.251	THR THR	Mnvr to -XVV using RS OPM	
4	305/17:03:40 305/17:08:40	Y	+25	-XVV +ZLV TEA	LVLH	+172.000 +358.000 +1.900	THR THR	Mnvr to LVLH TEA	
5	305/17:09:00 —	Y	+25	-XVV +ZLV TEA	LVLH	+172.000 +358.000 +1.900	THR MMT	Handover RS to US Momentum Management	TEA for VV#1, PSARJ Auto, SSARJ Auto

OPMs can look misleading in attitude name and the commanded attitude. Remarks remind users that this is not a pure Eigen axis rotation.

Maneuvers in the ATL

CMG Maneuvers

Momentum Management used for maneuver

CMG Maneuver to High-Beta Yaw Bias Attitude (M12_105_A_02.UAF)									12/10/2022
33	105/14:10:00 105/15:20:00	Y	-70	+XVV +ZLV	LVLH	+5.000 +357.800 +1.900	MMT MMT	Mnvr to Yaw Bias Attitude	Maneuver rate 0.002 deg/s

Maneuver rate provided in Remarks column

Maneuvers in the ATL

Reboost

ISS attitude not changing – reboost in the TEA.

81P Reboost (H11_205_A_06.UAF)									10/01/2011
17	205/10:15:00 —	Y	-10	+XVV +ZLV TEA	LVLH	+358.000 +355.800 +1.900	MMT THR	Handover US to RS	
18	205/10:20:00 205/10:25:00	Y	-10	+XVV +ZLV TEA	LVLH	+358.000 +355.800 +1.900	THR THR	Quaternion Update for Reboost in TEA (Prog on SM Aft)	TIG 11:05 DUR 11:59
19	205/11:17:00 205/11:22:00	Y	-10	+XVV +ZLV TEA	LVLH	+358.000 +355.800 +1.900	THR THR	Quaternion Update	
20	205/12:00:00 —	Y	-10	+XVV +ZLV TEA	LVLH	+358.000 +355.800 +1.900	THR MMT	Handover RS to US Momentum Management	TEA for VV#1z, PSARJ Auto, SSARJ Auto

Time of Ignition (TIG) and duration included in Remarks column

Planning Products

Long-range planning

- Flight Program Integration Panel (FPIP)*
- Only dock/undock dates are generally known long-term

Medium-range planning

- Dynamics Events Working Group (DEWG)*
- DEWG table published ~6 months ahead
- Adds events such as prop purges, thruster tests, EVAs, and maneuvers

**See backup slide for more info*

Planning Products

Short-range planning

- Attitude Timeline (ATL)
- Per agreement with Moscow, ATL published at E-30 days
- Adds *more* events such as reboosts, thruster disables, or anything that comes up late

Payload inputs (Gen OIP 7.5.4)

- OIP 7.5.4 ISS Attitude Change or Microgravity Request
- Allows payloads to request thruster disable or attitude maneuver

Increment 71 Dynamic Events

	RS VV Dockings/ Undockings	US Docking/ Undockings	US & RS EVAs	Free-Flyer Capture/ Release
Expected Events	➢ 71S Docking ➢ 86P Undocking ➢ 88P Docking ➢ 87P Undocking ➢ 89P Docking ➢ 72S Docking ➢ 71S Undocking	➢ SpX-30 Undocking ➢ Crew-8 Port Relocate ➢ Crew-9 Docking ➢ Crew-8 Undocking ➢ SpX-31 Docking	➢ RS EVA 62 ➢ US RFG 2.5 EVA ➢ US CP9 EHDC R&R EVA ➢ US IROSA Prep 2A EVA	➢ DCC-1 Docking ➢ DCC-1 Undocking ➢ NG-20 Undocking ➢ NG-21 Docking
Control Type	Can be performed in all mode types; expect thruster firings	Can be performed in all mode types; expect thruster firings	CMG Momentum Management; Thrusters Disabled*	USTO & CMG Attitude Hold
Expected Attitudes	+XVV,-XVV, +ZVV, -ZVV attitudes all possible	Expect +XVV	+XVV	+XVV

Trade Fair

Trade Fair Booth

- ADCO, POINTING, and TOPO available for questions

Q&A

Presentation Resources

- MCS flight info page
  Access to these links may be restricted.
- Crew Training Notebook – pages 4 & 5, 8-10 ,12 & 13
- The data incorporated in this presentation is from the DEWG website. Please refer to the following website for the latest 6 month attitude plan:
  - Viperweb.jsc.nasa.gov/team_viper/web/DEWGTable.shtml
- The current VIPER Baseplate can be found at:
  - viperweb.jsc.nasa.gov/team_viper/web/baseplate.shtml
  - "Reading the BASEPLATE Tutorial" and "Test Your BASEPLATE knowledge" can be found at:
    - viperweb.jsc.nasa.gov/team_viper/web/tutorials.shtml
- The current ISS Flight Plan Graphic can be found at:
  - https://iss-www.jsc.nasa.gov/nwo/mio/riit/fpwg/web/
- The data in this presentation is in the planning stages and is therefore subject to change, please confirm using the published ISS operational products

Control Type Details

ISS attitude control is performed by Control Moment Gyroscopes (CMGs), Russian Segment (RS) thruster firings, or a combination

CMG Momentum Management (MM)

- CMGs are used to balance and manage external torques on ISS
- ISS controls to the Torque Equilibrium Attitude (TEA)
- Some attitude error is allowed to keep momentum vector stable
- RS thrusters available to provide desaturation firings (desats) to the CMGs

CMG Attitude Hold (AH)

- Tight attitude tolerances
- Time-limited without thruster assist
- Desats may or may not be available, depending on operation

USTO (US Thrusters Only)

- US segment software controls attitude using RS thrusters
- CMGs do not provide attitude control torques

RS Thruster Control

- RS in complete attitude control of ISS
- CMGs do not provide attitude control torques

Navigation and Control
Performance Envelopes

How accurately does ISS navigate?

- Depends on source of navigation data (US GPS, Russian GPS, or propagation)
- ISS attitude data provided to BAD* is typically accurate to within ±0.3 deg

How accurate does ISS control?

- Depends on control mode (see previous slides) – quiescent ops is CMG MM
- CMG MM certified to ±3 deg but performance is usually ±1 deg or less

Nominal Attitude Performance

- Total attitude accuracy is summation of instantaneous control error and nav error
- Expect accuracy up to ±1 deg (several miles of ground pointing error)

What attitudes do we fly?

- Flight Rule B2-57 defines thermally analyzed attitude envelopes for LVLH ±XVV, ±YVV and ±ZVV attitudes
- Quiescent microgravity operations are in the LVLH ±XVV +ZLV envelope

Can the envelopes or attitudes change?

- Envelope: updated thermal analysis or ISS Module additions (both rare)
- Attitude: slight tweak to attitude as vehicles come and go (frequent)

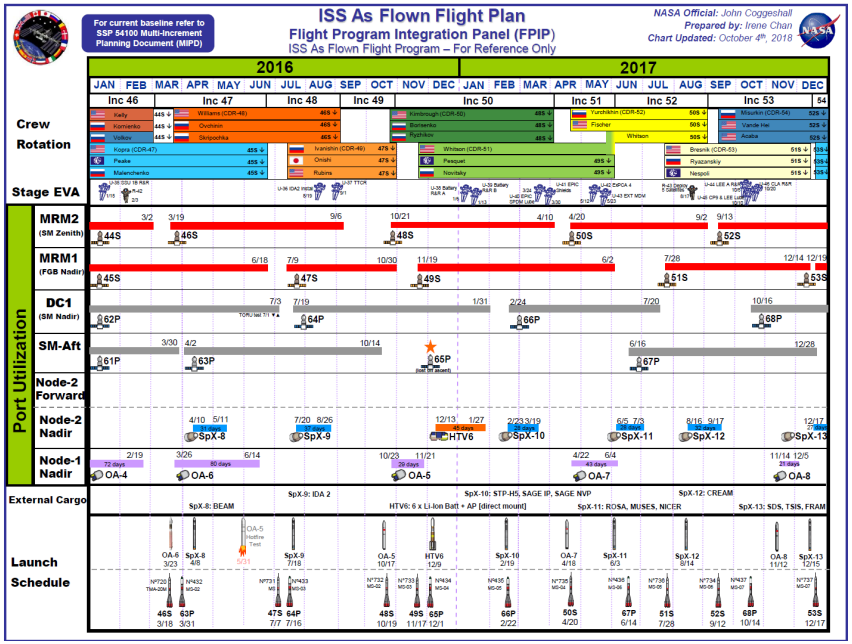
DISCLAIMER: Navigation Data my be impacted by GPS failures. Subscribers to NAV Data should be aware of and prepared for periodic dropouts in NAV Data.


ATL From/To Config Decoder

SAT	110% MM controller in CMG Only or CMG TA with Desat Req Inh
MMT	MM Desat Req Ena (US Master)
MMC	99% MM controller in CMG Only or CMG TA with Desat Req Inh
UST	USTO (US Master)
THR	Russian thruster control (RS Master) with the CMGs providing no help (CMGs in Drift/Inertial)
THC	Russian thruster control (RS Master) with the CMGs holding specific gimbal angles (CMGs in Drift/Body or UDG/Position Servo)
FDO	Free Drift (either US or RS Master) with the CMGs providing no help (CMGs in Drift/Inertial)
FDC	Free Drift (either US or RS Master) with the CMGs holding specific gimbal angles (CMGs in Drift/Body or UDG/Position Servo)
AHC	Traditional Attitude Hold controller (US Master) with desats inhibited (used for FF vehicle)
AHT	Traditional Attitude Hold controller (US Master) with desats enabled

Planning Product Process References

FPIP = Flight Program Integration Panel sets the flight plan (ie, when are vehicles coming and going) and creates the useful graphic to show it



DEWG = Dynamic Events Working Group Bi-lateral working group to determine details for upcoming events: docking attitude, thruster configuration, solar array angles, etc. (see https://home.iss.nasa.gov/om/team-viper/index-4/dewgtable/)

MCS Flight Info

Access to MCS Flight Info and associated links may be restricted.

Links include:

- Current ATL
- Backup ATL
  - Same format as ATL, but for contingency events
- As-Flown ATL
- MCS Ops Timeline
- Thruster Reconfiguration Timeline (TRTL)
- Contingency TRTL
- As-Flown TRTL
- Prop Consumption Spreadsheet
- RAC form and database
- TOPO Data File

ISS Motion Control Systems - Flight Info

Current Flight Status

ISS Attitude Timeline (ATL)	Current ATL *ATL for Current Increment events* Backup ATL *ATL for backup/reserve Current Increment events* As-Flown ATL *This file tracks the past events ISS attitude timeline for the current flight/stage - see as flown information below for previous as flown Attitude timelines.*	Status Reports	Latest ODU Status Report *Received weekly on Tuesday* ATV Health Status Report *Latest report posted by HSG ATV (scroll to section 3 for Prop and Refueling info)*
		Consumables	Prop Consumption Tracking
		International Partners* and Payloads Customers - Requests for Attitude Changes (RAC) ** IPRussia excluded.	Form for Requesting an Attitude Change (RAC) (Click OK when template message appears, then proceed) RAC Database *This file tracks the Requests for Attitude changes received by ADCO.* OIP 7.5.4 ISS Attitude Change or Microgravity Request
MCS Ops Timeline	Current MCS Ops Timeline *This file tracks the current increment MCS Ops Timeline which is used by ADCO to coordinate GNC configuration with Boeing.*	TOPO Data	TOPO Data File *This file contains Beta angle & Orbit Noon information.*
Thruster Reconfiguration Timeline (TRTL)	Current TRTL *This file tracks the Russian Segment thruster configuration.* Contingency TRTL *This file tracks the Russian Segment thruster configuration for contingency situations, such as a Loss of Attitude Control (LoAC) free-drift recovery.* As-Flown TRTL *This file tracks the Russian Segment thruster configuration for past events during the current increment. For older events see as flown information below.*	GNC R11CMD Whiteboard	Current CMD Whiteboard *This file tracks the current GNC PPLs and commands and future GNC Uplinks.* Poseidon *This links to the Poseidon website which documents the current PPLs onboard.*
		Dynamic Events	Dynamic Events Working Group (DEWG) Table *attitudes, thruster configuration, SARJ angles, etc* for next 6 months Dynamic Events Sharepoint *ADCO/SPARTAN/VIPER/MER Events coordination* Flight Director RS VV Docking SharePoint *RS VV Planning Document and Presentations* ISS Baseplate *This link contains the VIPER baseplate.*

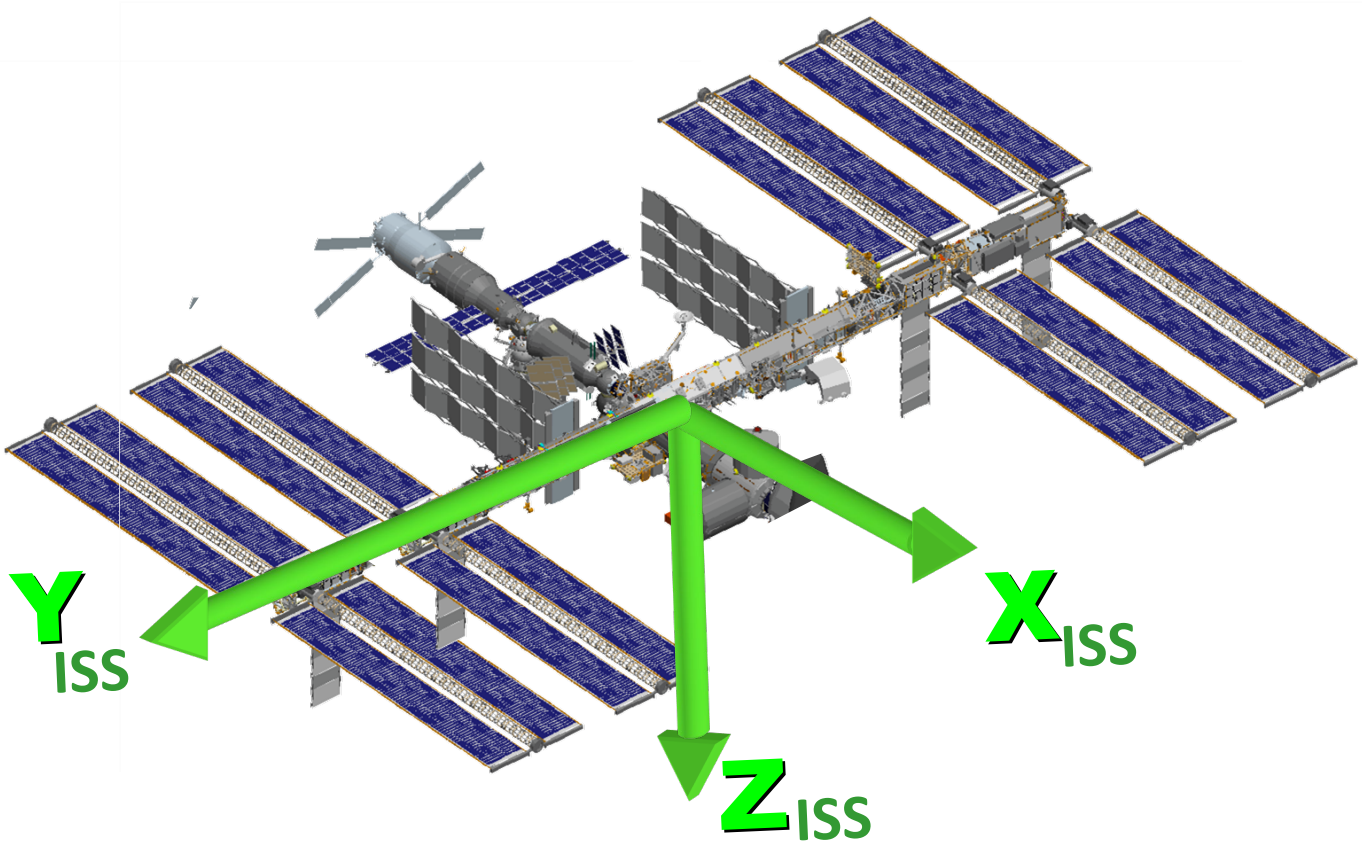
OIP 7.5.4 – Request for Attitude Change

"It may be necessary for Payload Developers (PD) or IPs to request changes to the ISS Attitude Timeline (ATL). There are three types of changes that can be requested:

1. Specific ISS LVLH commanded attitude
2. Microgravity operations (thruster inhibit)
3. CCDB parameter update

Justification for a request will come through the Program Office and will be documented in the IDRD or CSRD depending on the timing of the request. The process for implementing these changes is documented below. Requests approved through the Attitude Change Request or Thruster inhibit procedures require an Attitude Change Request (ACR) be sent to MCC-M using Generic OIP 7.5.6, Attitude Plan Coordination and Notification During ISS Operations. This data exchange is required to occur per OIP by 30 days prior to execution."

Reference Frames: ISS Body

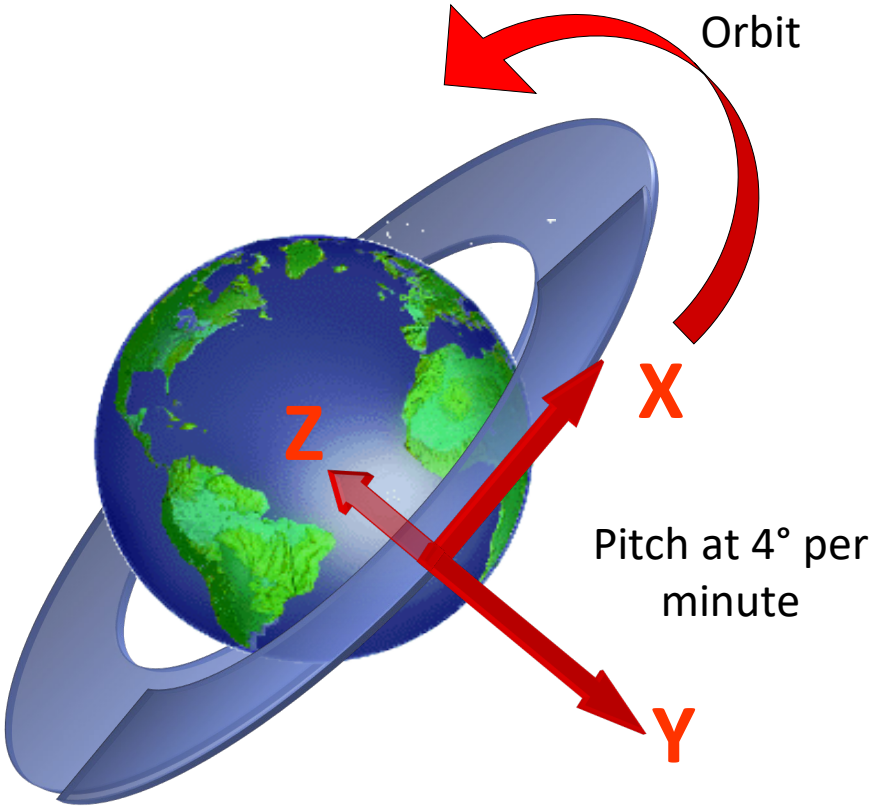


X-axis: Forward, runs parallel with ISS stack

Y-axis: Starboard, runs parallel with truss

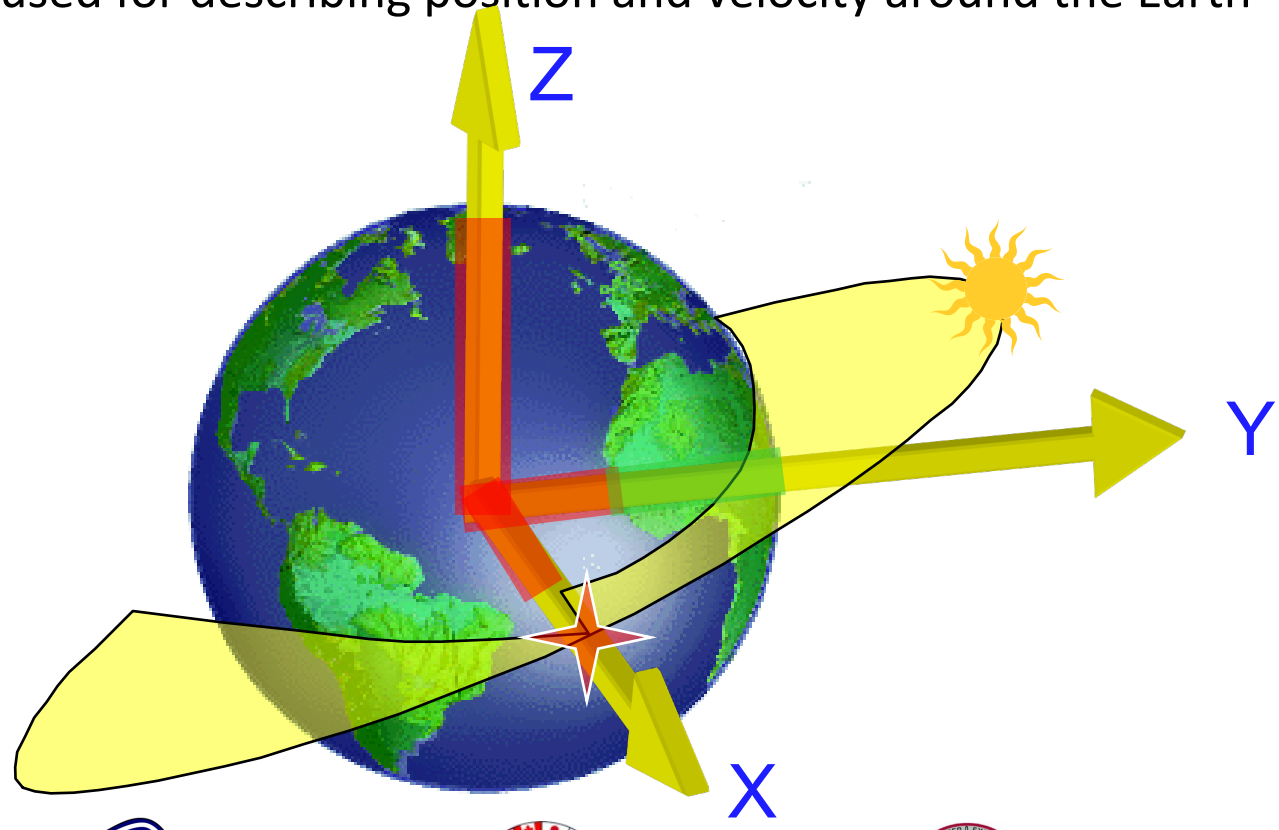
Z-axis: Deck, completes RHR

Reference Frames: LVLH



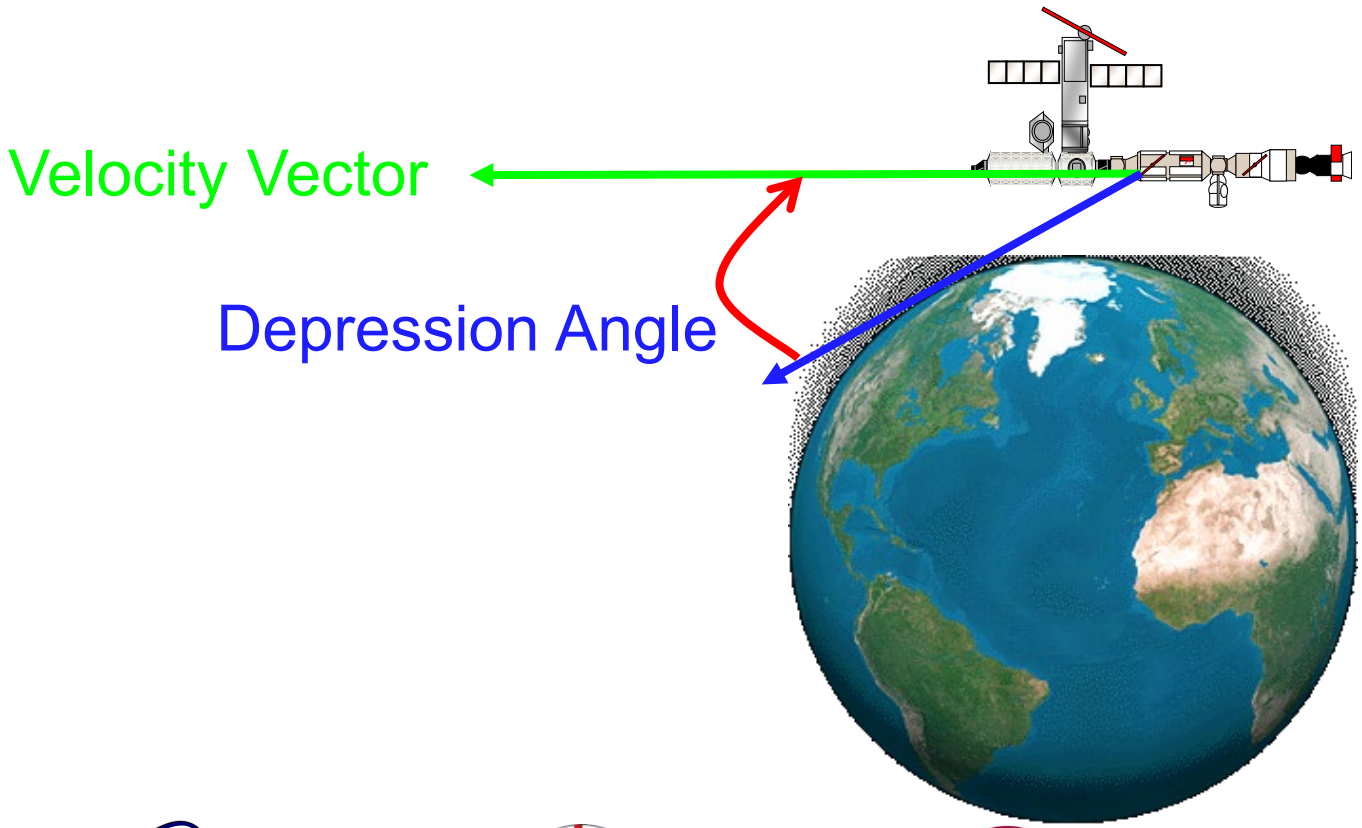
Reference Frames: Inertial

- There are a couple of inertial reference frames used in ISS program
- They are Earth-centered and not very useful for describing attitudes
- They are used for describing position and velocity around the Earth



Reference Frames: Depression Angle

- ISS depression angle is about 18 degrees
- Thus there are periods when the station is in sunlight all orbit



New Rapid Depress FDIR

- New software automatically configures the ISS Solar Arrays and Motion Control System in the event of a Rapid Depress
- SARJs parked at an accelerated rate
- Automatic Attitude Control Handover to Russian segment enabled when SARJs locked **or** ISS inertial rate exceeds 1 deg/sec
  - Handover to Russian thruster control will occur if the ISS LoACs due to rates > 0.1 deg/sec or attitude error > 10 degrees