Overview of the LaNCETS Flight Experiment and CFD Analysis

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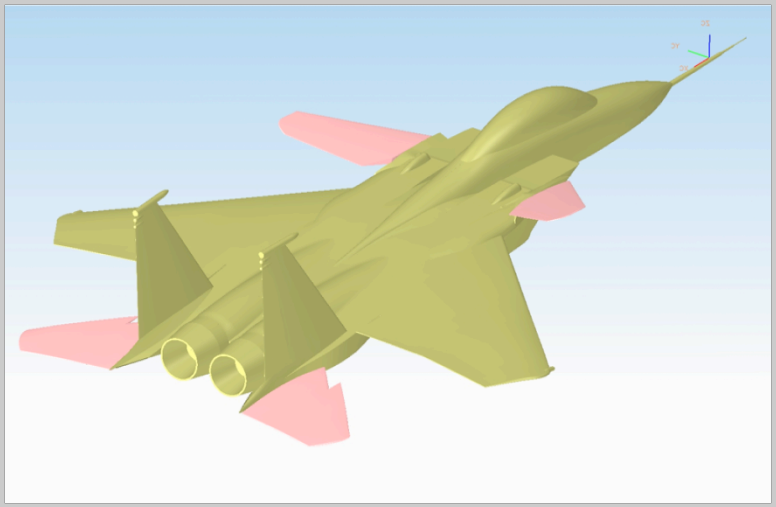
Motivation

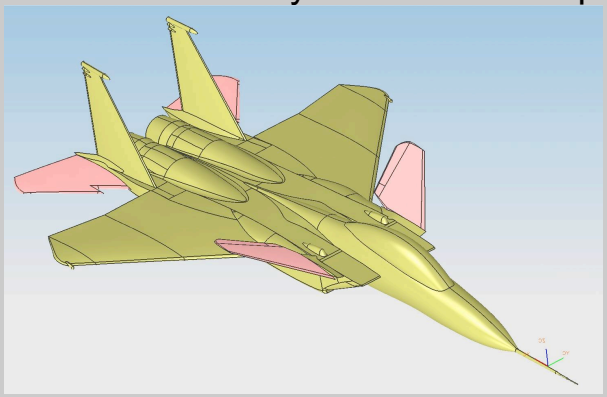
- Wide interest in civilian overland supersonic transportation
- Sonic boom is significant barrier to achieving supersonic transportation goal
- Recent flight research at DFRC has demonstrated
  - ➔ Propagation of shaped sonic boom through the atmosphere to the ground – F-5 Shaped Sonic Boom Demonstrator (SSBD) experiment
  - ➔ Validated design tools for forebody shape modification – F-5 SSBD and Quiet Spike experiments
- Aft region shocks most difficult to predict / design
  - ➔ Tail surfaces
  - ➔ Propulsion systems
- Need to validate design tools for Tail Shock modification
  - ➔ Lift distribution effects
  - ➔ Engine plume effects

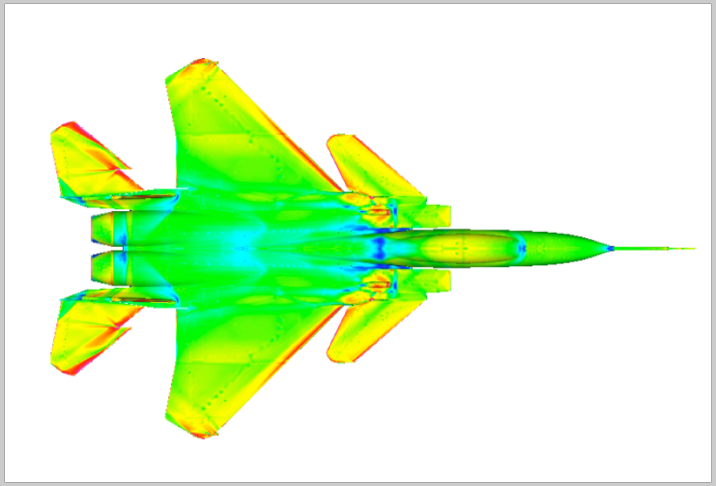
Systems Integration, Assessment, and Validation

Lift and Nozzle Change Effect on Tail Shocks - LaNCETS

- F-15-837 as target aircraft
  - Can change nozzle area ratio (A9/A8) between 1.00-1.50 (1.31 nom.)
  - Can bias canards
  - Can change either or both between probing pairs
  - Nominal flight condition, Mach 1.4, Hp=40,000 ft
- Laser scan of 837 for geometry
  - Cleaned up by GEOLAB at LaRC
- Flew baseline flights June 2008
- US Industry and Academia invited to participate
  - CFD analysis
  - Propagation analysis
  - Peer review
  - Independent assessment
  - Share data and analyses as in SSBD project



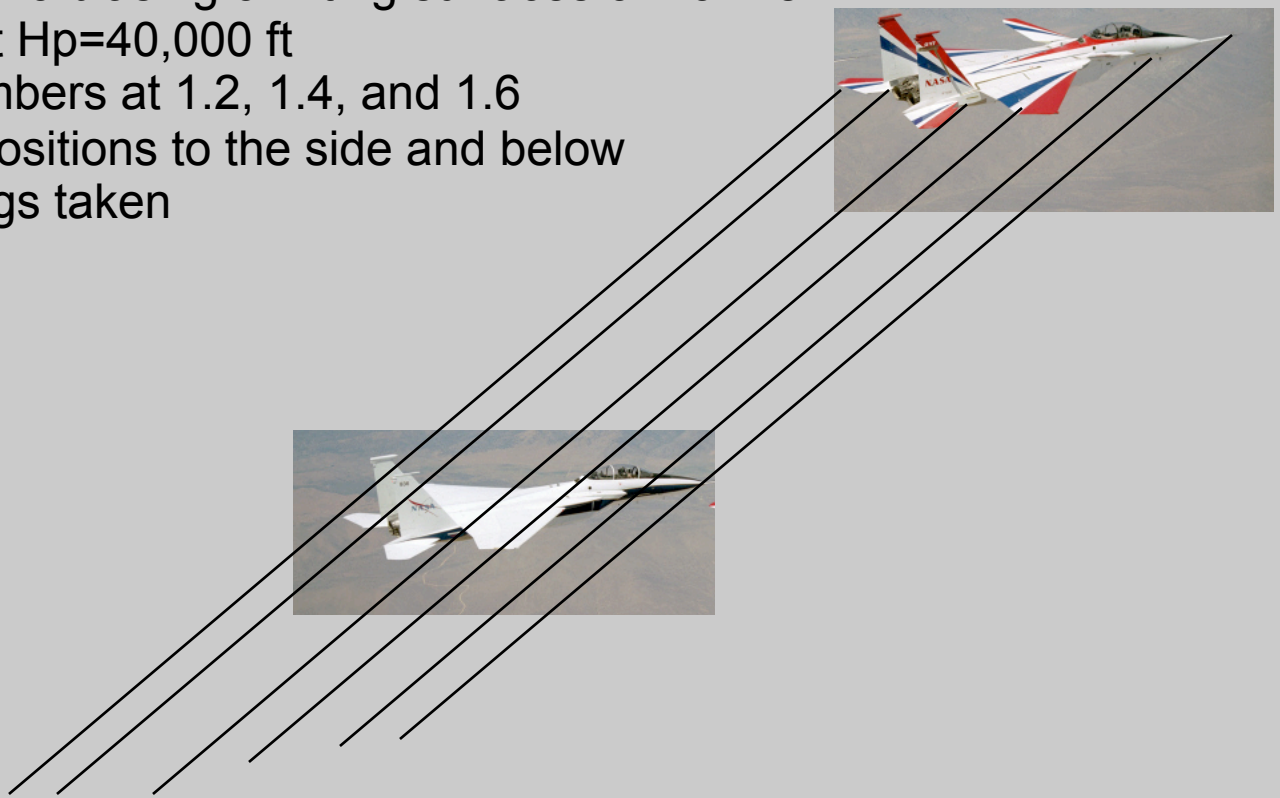




Annual Performance Goal (APG) 8AT12	Lift & Nozzle Change Effects on Tail Shocks (LANCETS)	Demonstrate a high fidelity analysis technique for assessing the impact of nozzle plume effects on the off body flow field of supersonic aircraft and validate predicted results within 5% of flight data	End of FY08

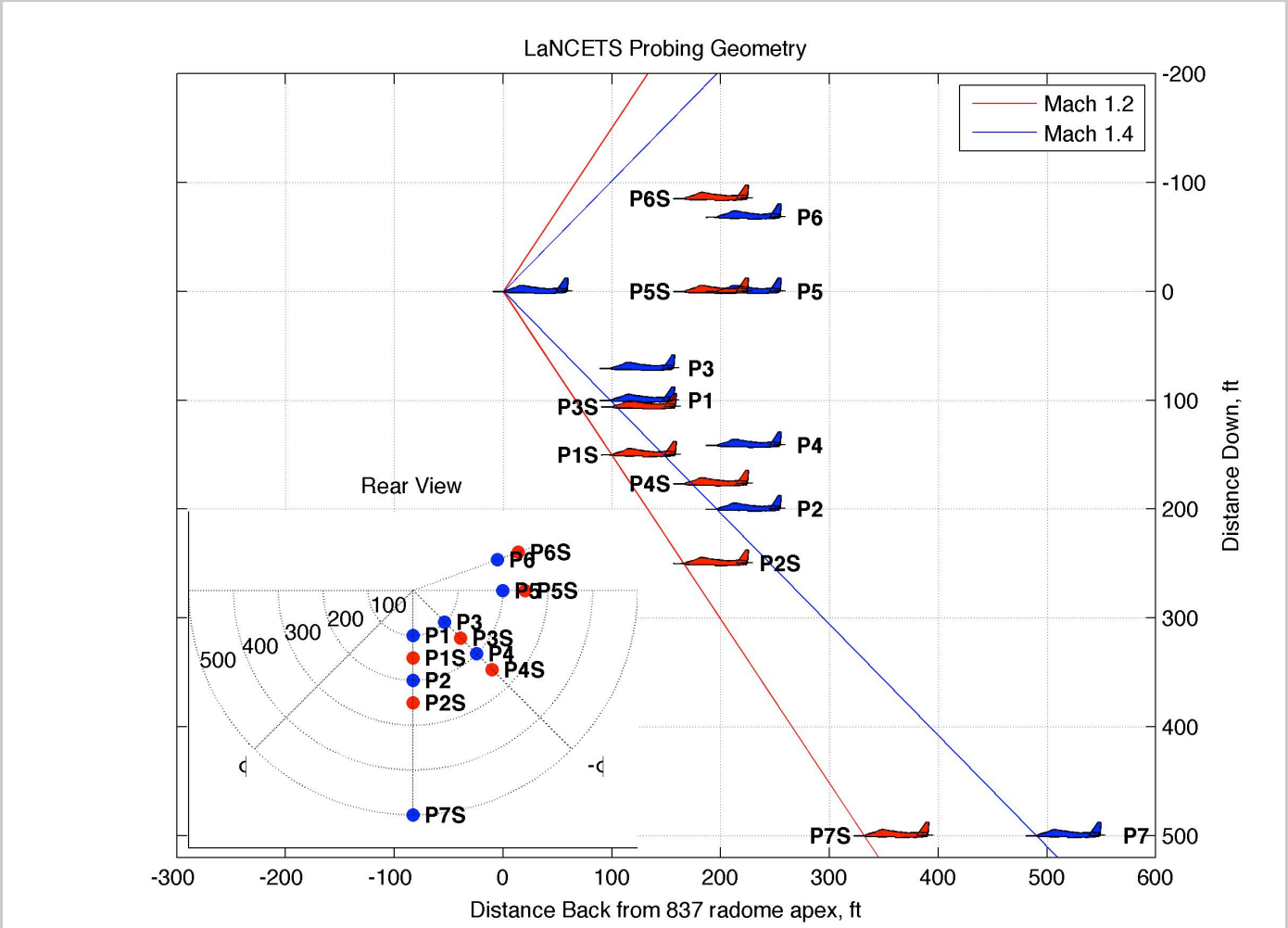
Overview, LaNCETS Phase I

- Measure near-field shock structure of F-15-837 with F-15B-836
- Validate CFD and pre-flight prediction tools
- Probing aircraft noseboom measures pressures
- GPS measures positions
- Three flights flown June 17-19, 2008
  - Baseline: no biasing of lifting surfaces or nozzle
  - All data at Hp=40,000 ft
  - Mach numbers at 1.2, 1.4, and 1.6
  - Probing positions to the side and below
  - 29 probings taken

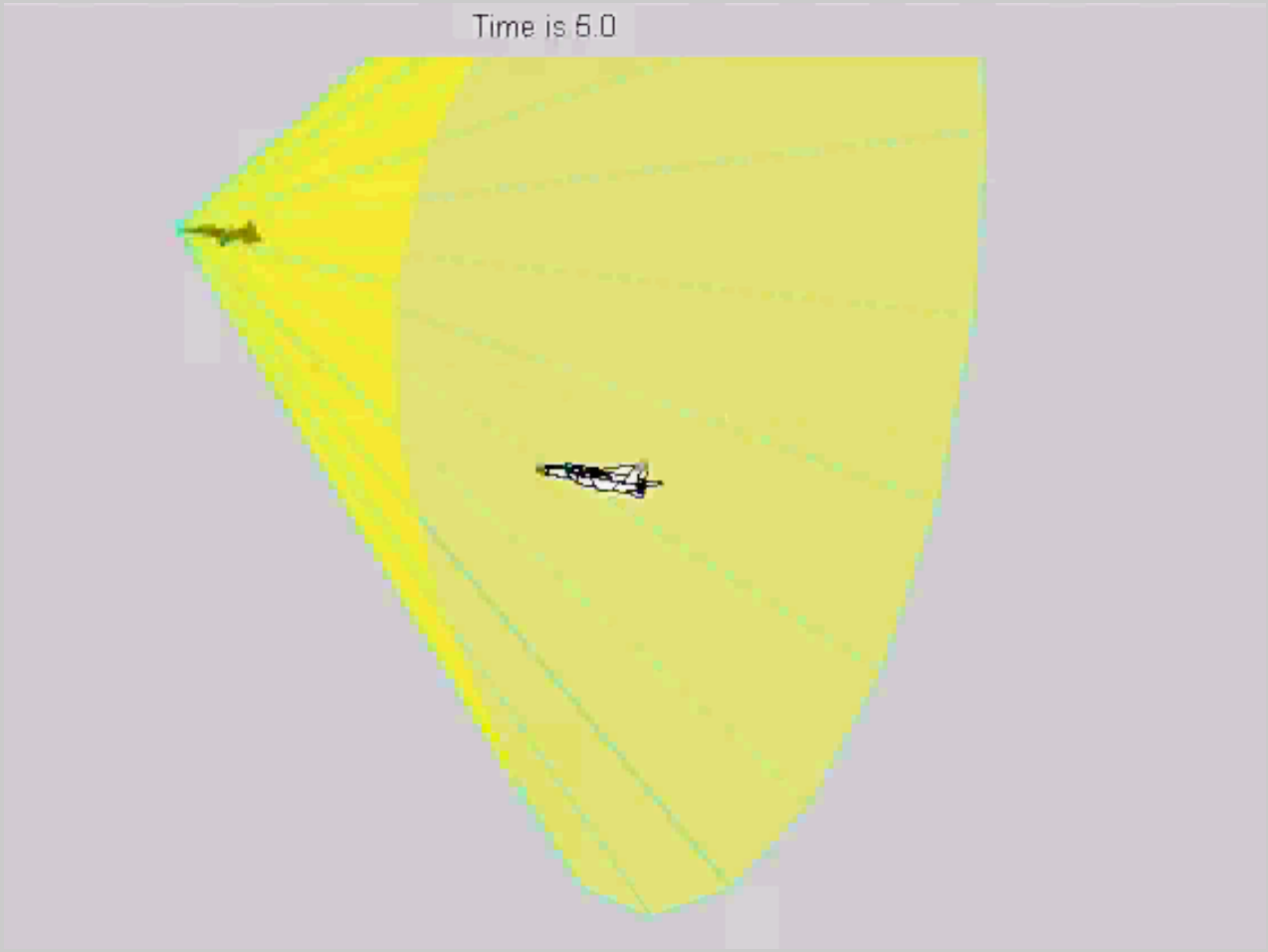


Shock Probing Orientations

- F-15B-836 probes below and to side of 837, 100 to 500 ft flightpath separation
- F-15B-836 nose always behind 837 tail for supersonic probing underneath

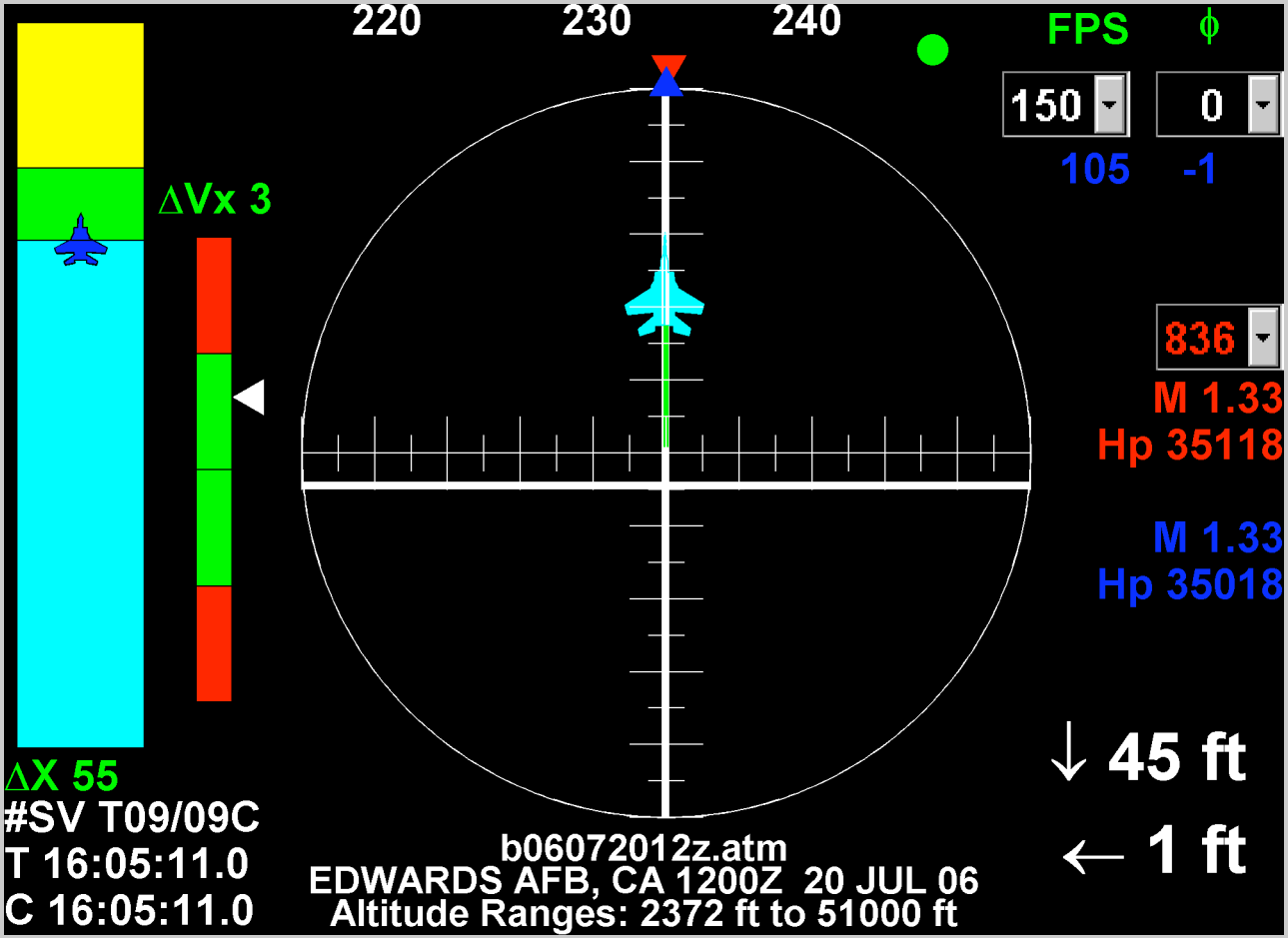


Nearfield Probing



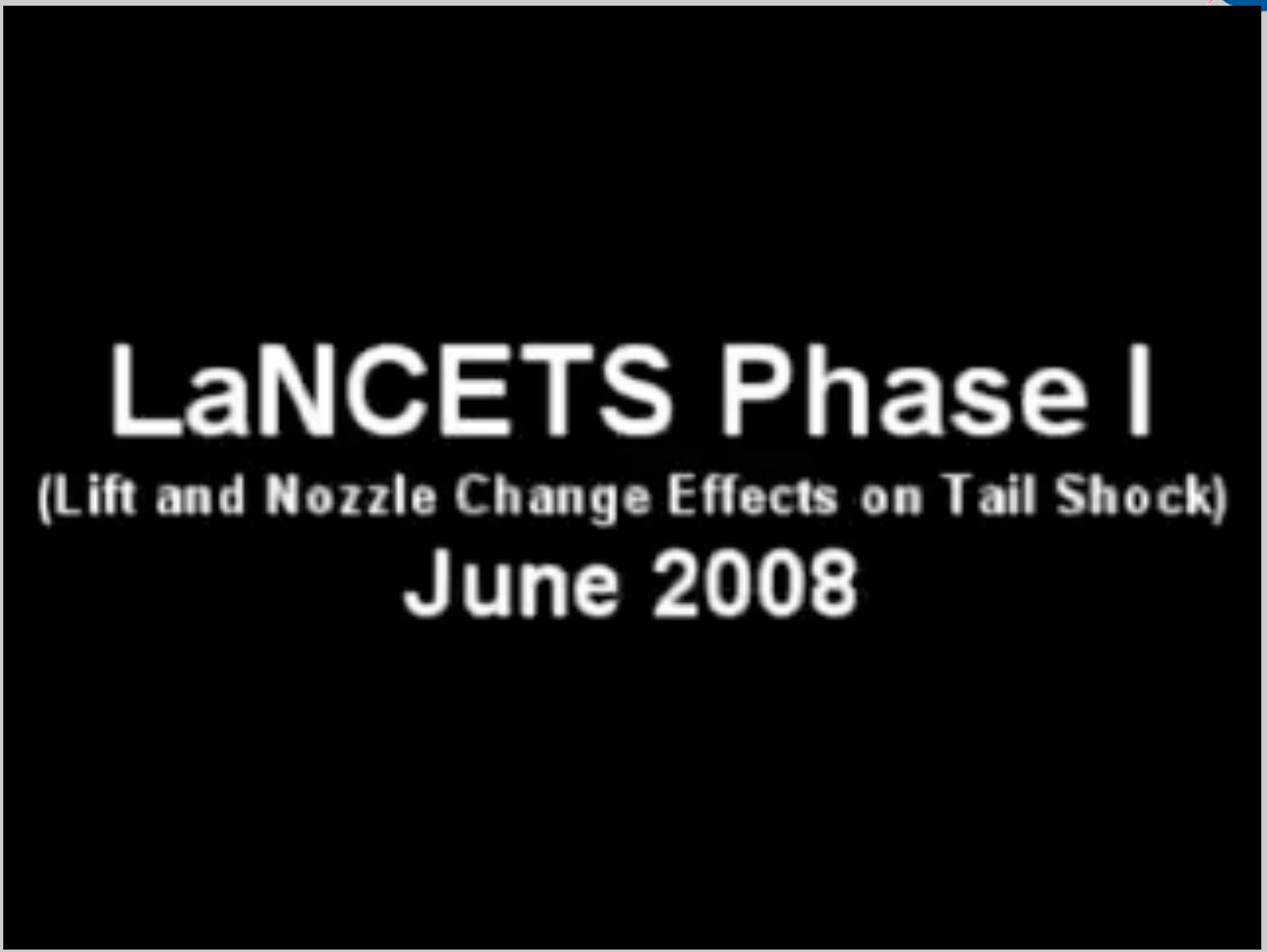
Cockpit Shockwave Position Display

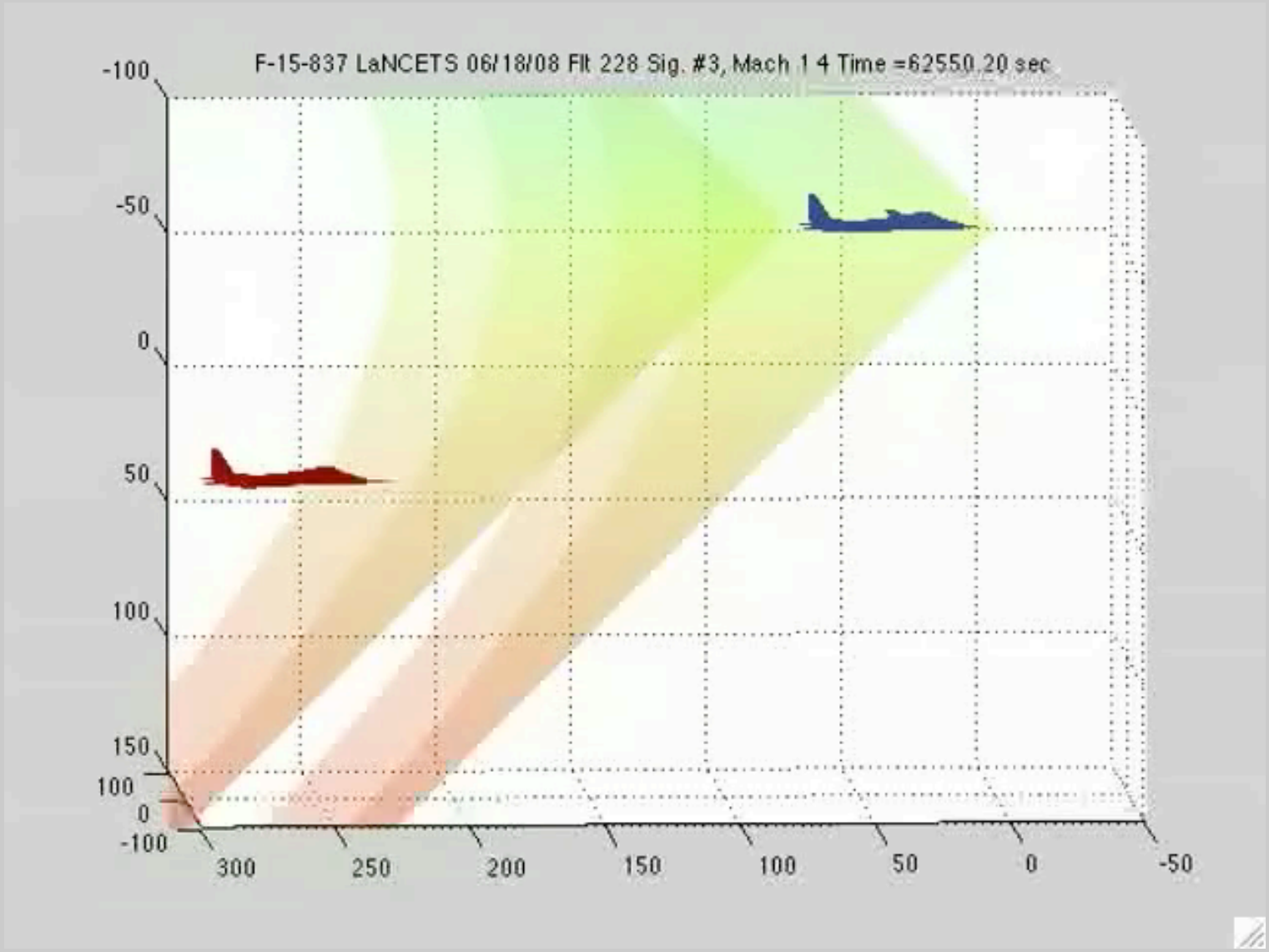
- Computer mounted in rear cockpit of F-15B-836
- Rear-seater can suggest fine position and rate adjustments
- Enhances test point efficiency and quality, not required for flight



•Example Data from
•850/837

In-flight video from probing aircraft, rear seat




F-15-837 LaNCETS 06/18/08 Flt 228 Sig. #3, Mach 1.4 Time =62550.20 sec
-100
-50
0
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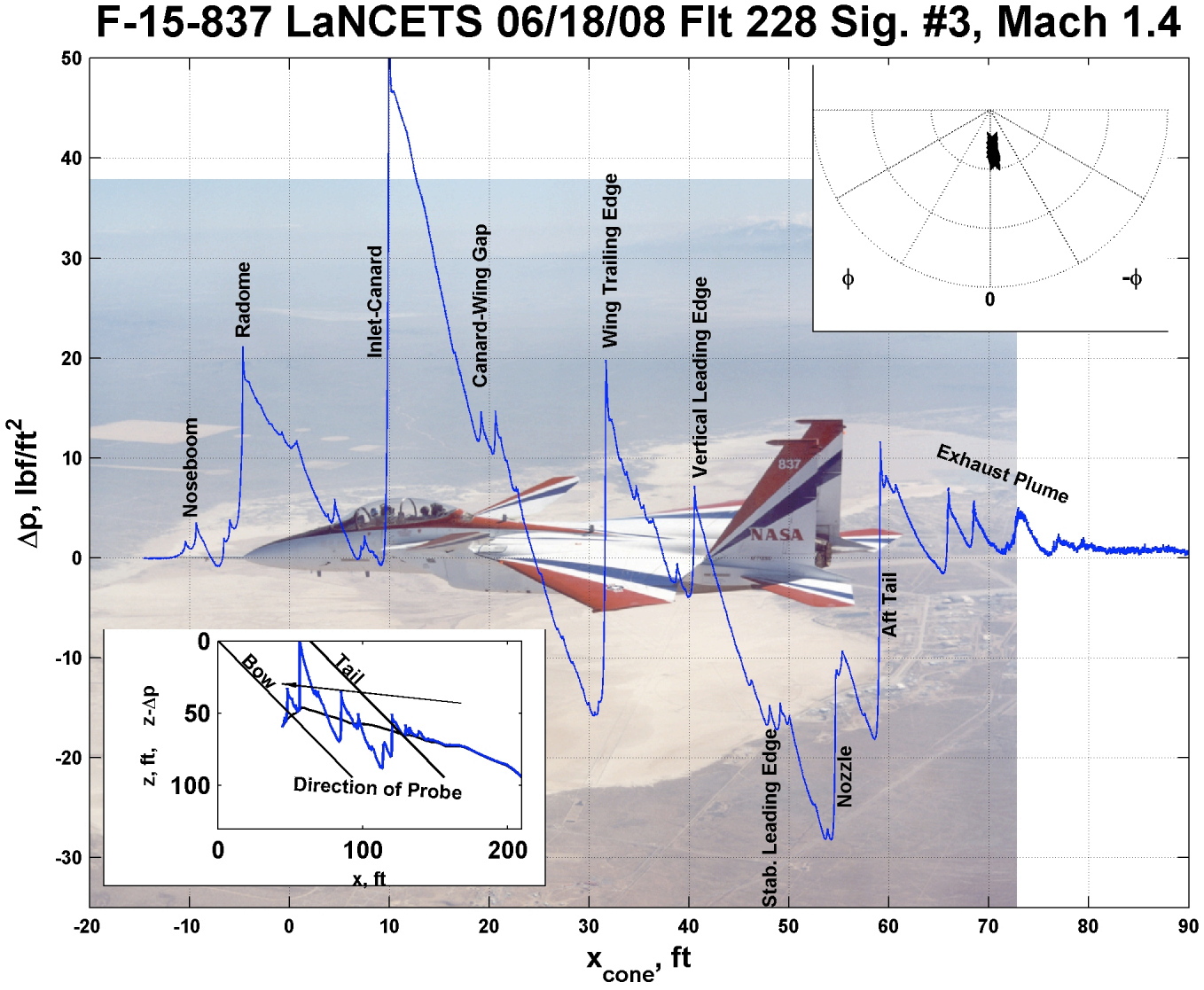
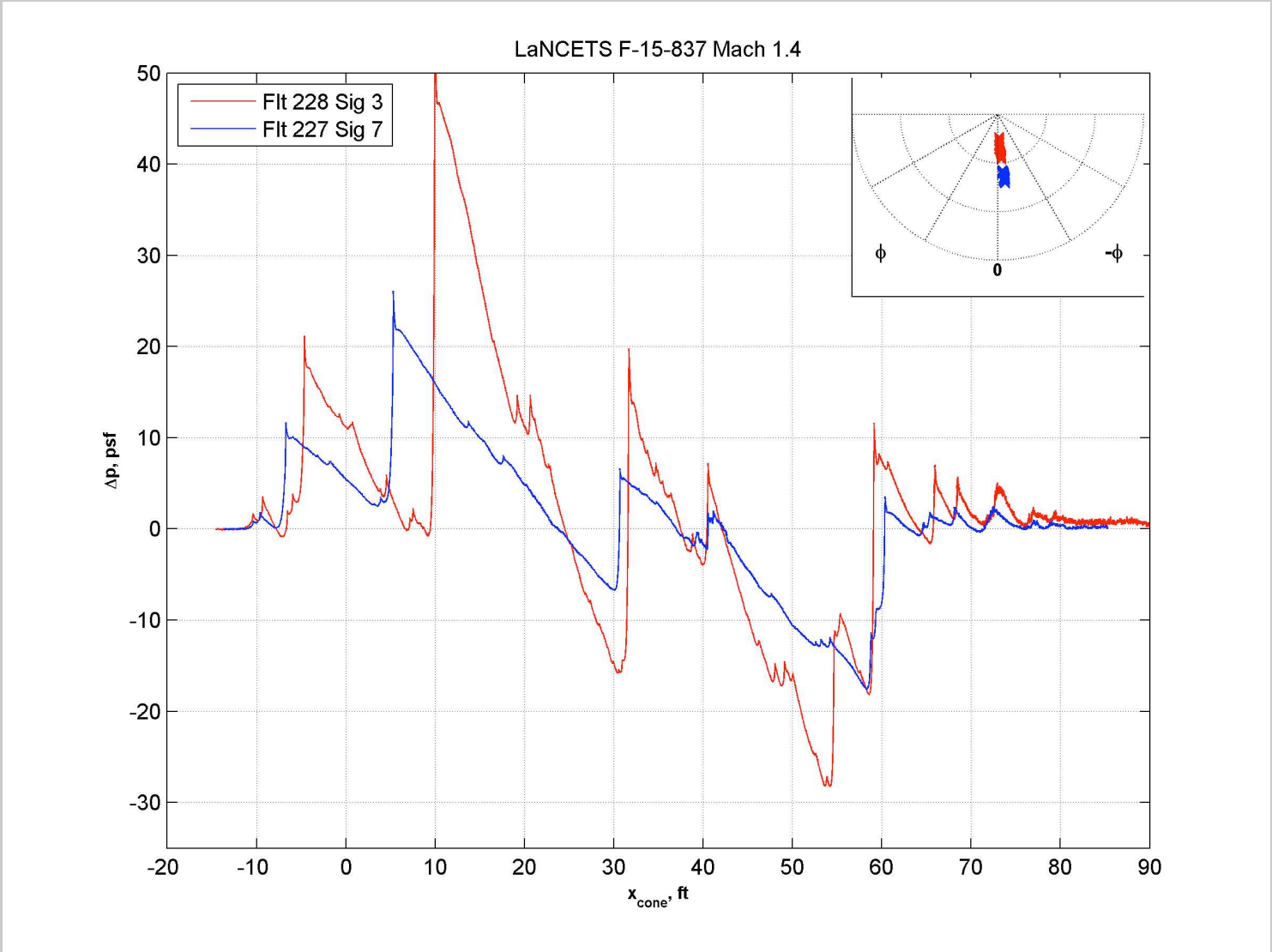
LaNCETS Phase I Flight Data

Mach 1.4

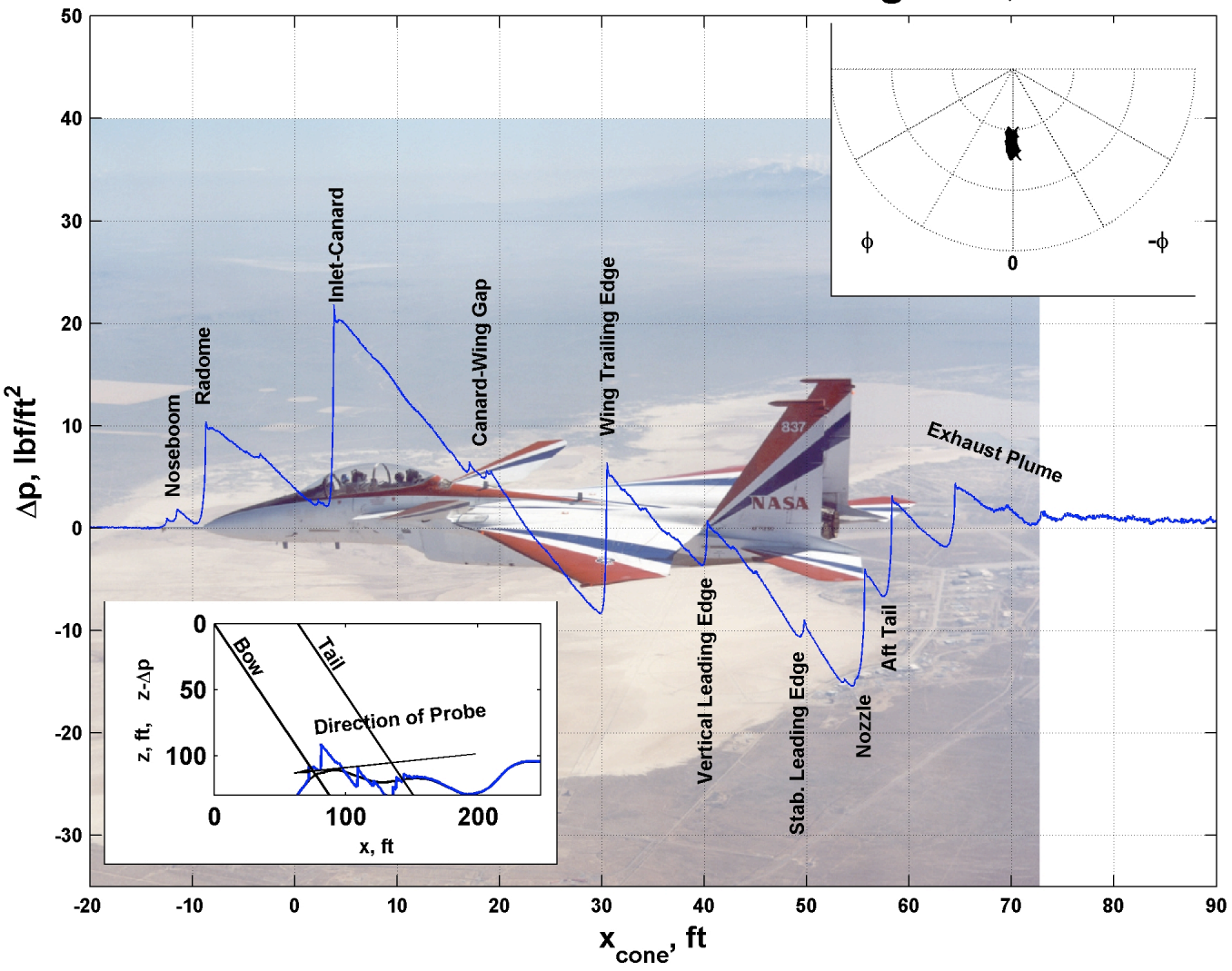


Mach 1.4 Propagation



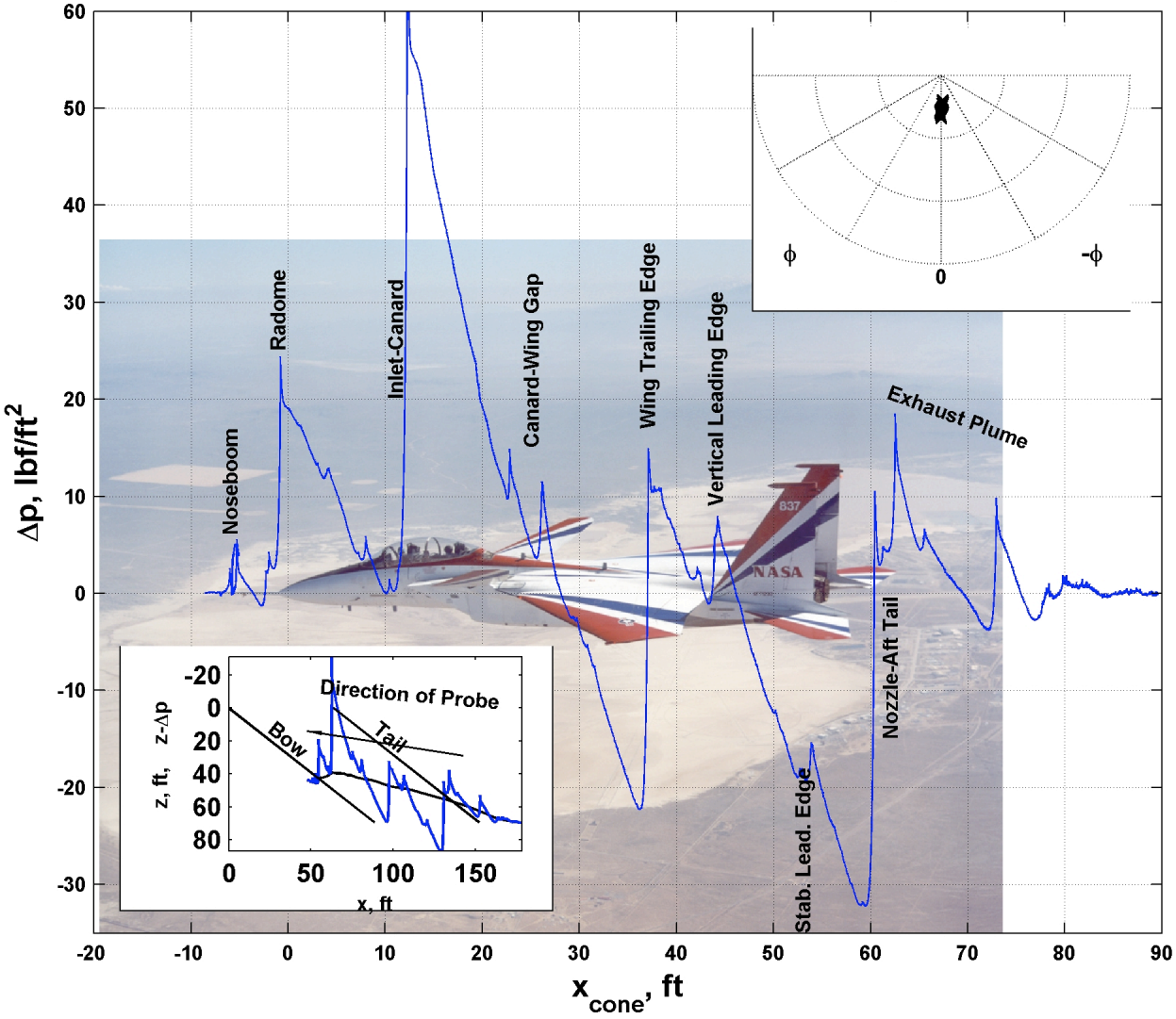
LaNCETS Phase I Flight Data

Mach 1.2

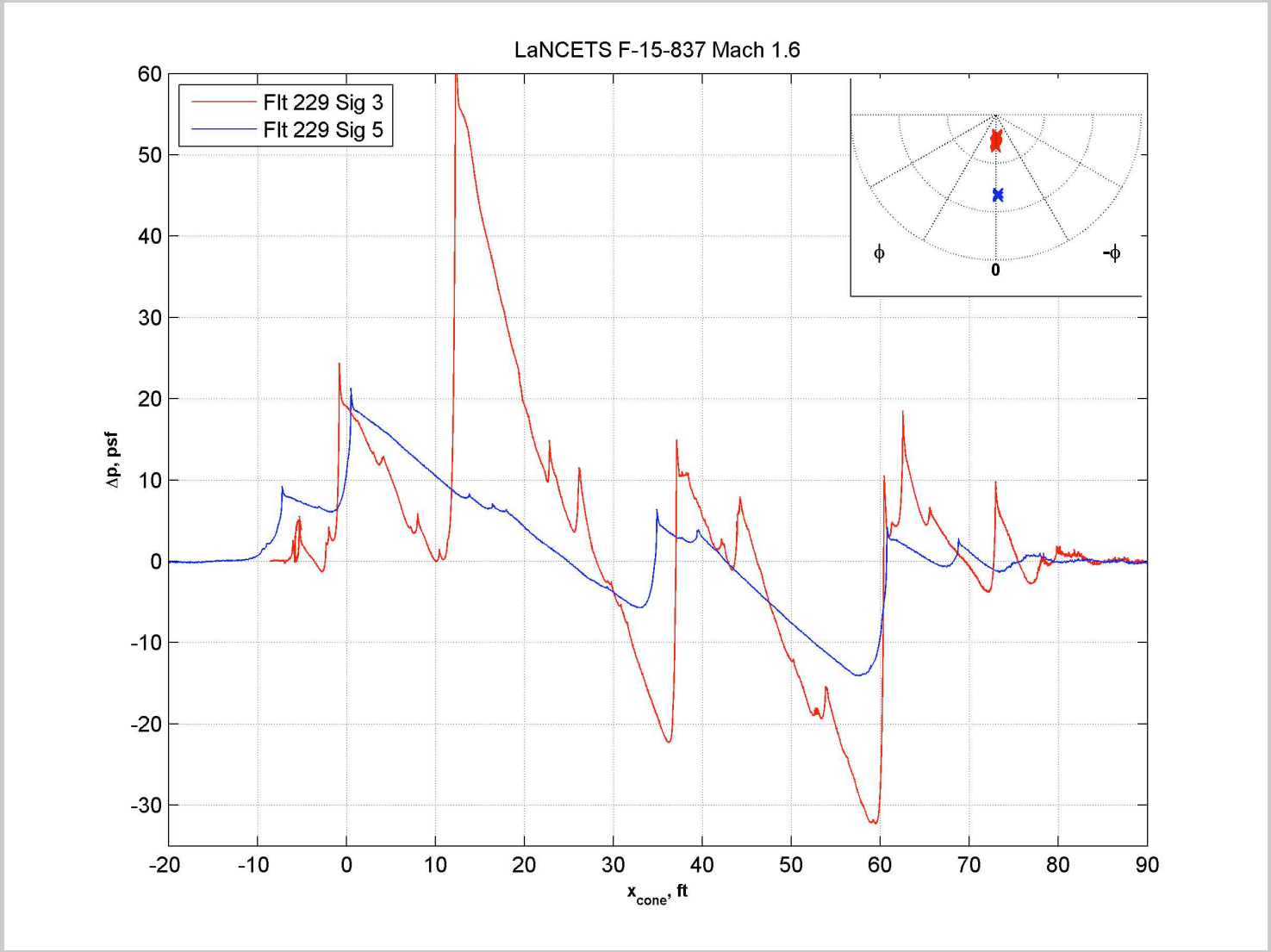


LaNCETS Phase I Flight Data

Mach 1.6

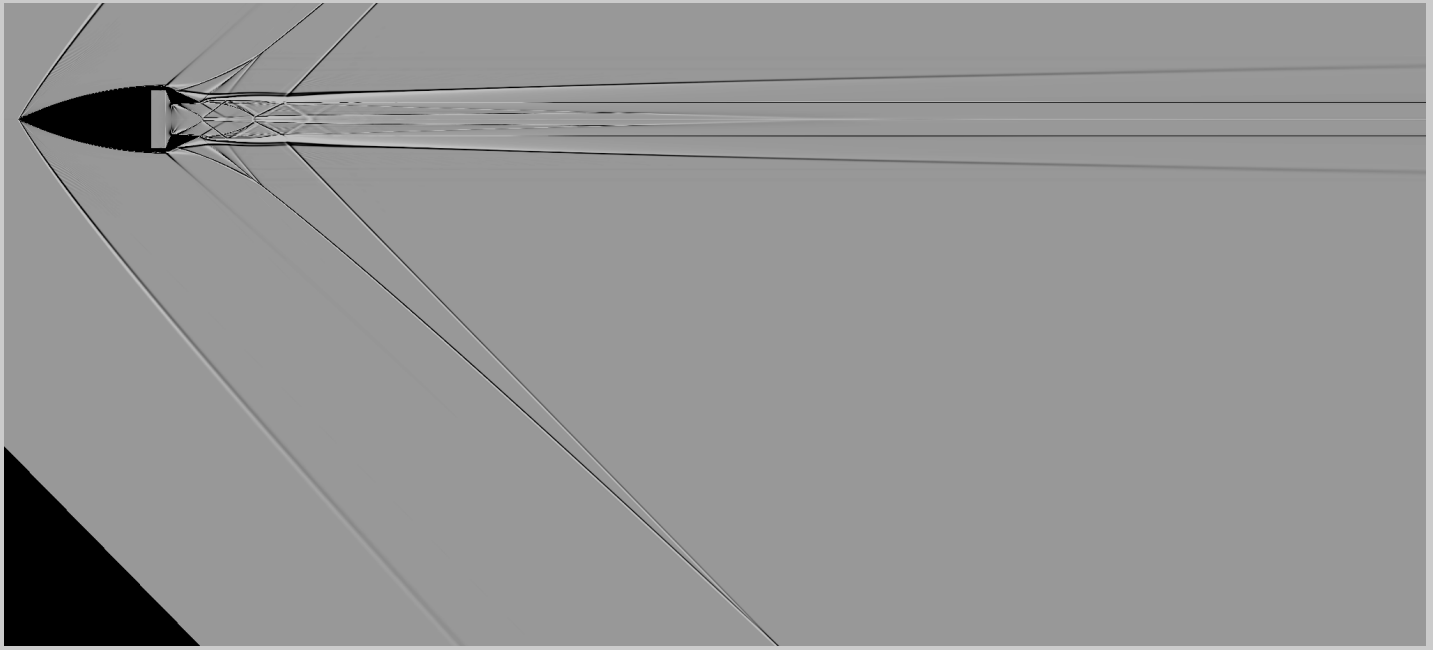


Mach 1.6 Propagation



Dryden Detailed Nozzle Flow Physics CFD Study

- Conducted axisymmetric CFD simulations for a simplified F-15B jet nozzle to determine how the detailed nozzle flow physics affect the sonic boom signature.
  - Vulcan structured, finite-volume Navier-Stokes CFD code
- Plume shock structures seen is similar to flight data
  - Results to be published in an AIAA conference paper and presented at the 47th AIAA Aerospace Sciences Meeting, January 2009



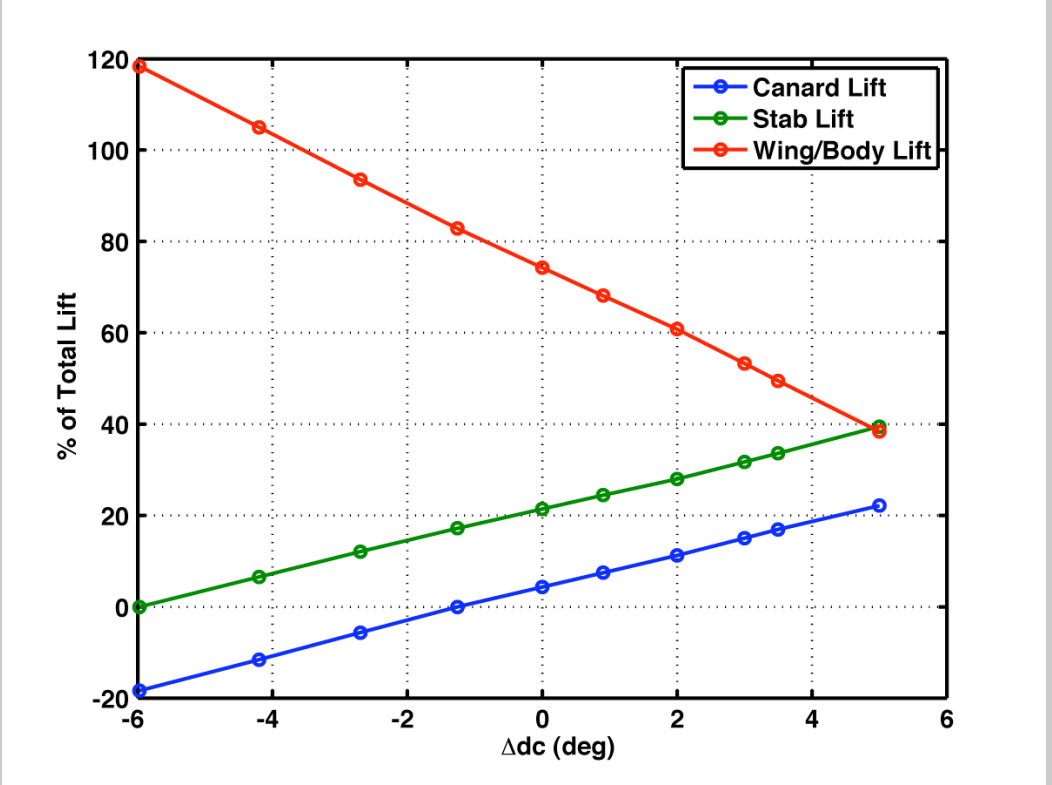
LaNCETS Phase II Preview Research Objectives -

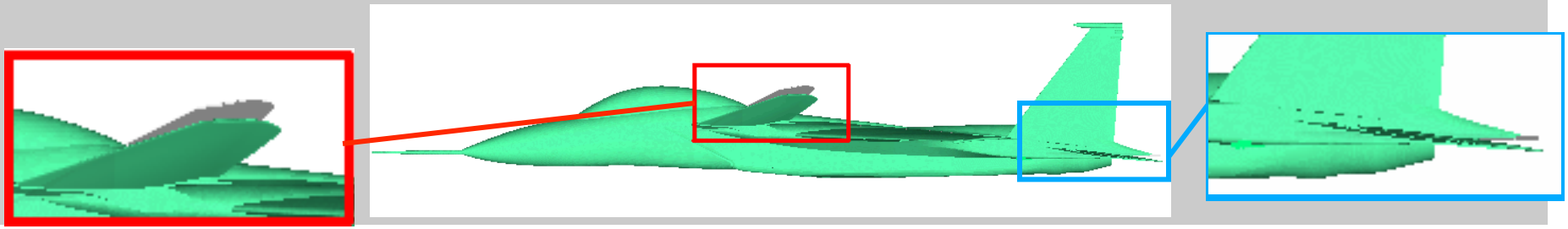
- Alter the shock structure of NASA 837 by:
  - Changing the lift distribution by biasing the canard deflection
  - Plume shape can be affected by under- and over-expanding the nozzle
- Measure resulting shocks with a probing aircraft (NASA 836)
- Use results to validate / update predictive tools

- Plume shape can be altered by changing the nozzle area ratio (the area of the exit divided by the area of the throat)
  - Change nozzle area ratio (A9/A8) between 1.00-1.50 (1.31 nom.)

LaNCETS Phase II - Preview
Research Objectives

- Canard position can be used to alter the lift distribution longitudinally over the aircraft
  - Trailing edge down offloads wing/increases lift on stabilizers
  - Trailing edge up increases wing loading/offloads on stabilizers





LaNCETS Phase I (Baseline) Summary

- 29 high-quality nearfield shock structure probings at three Mach numbers
- Shocks in exhaust plume measured
- CFD study of simplified nozzle shows similar plume structures as flight data
- Phase II flights scheduled for October 2008
- US Industry and Academia invited to participate in analysis, review, and assessment of LaNCETS data