# Facility Aerodynamic Validation and Operational Research (FAVOR) Check Standard Comparison Test

## NASA Glenn Research Center
## 8x6-Foot Supersonic Wind Tunnel

C-2010-2394

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# Primary Test Objectives

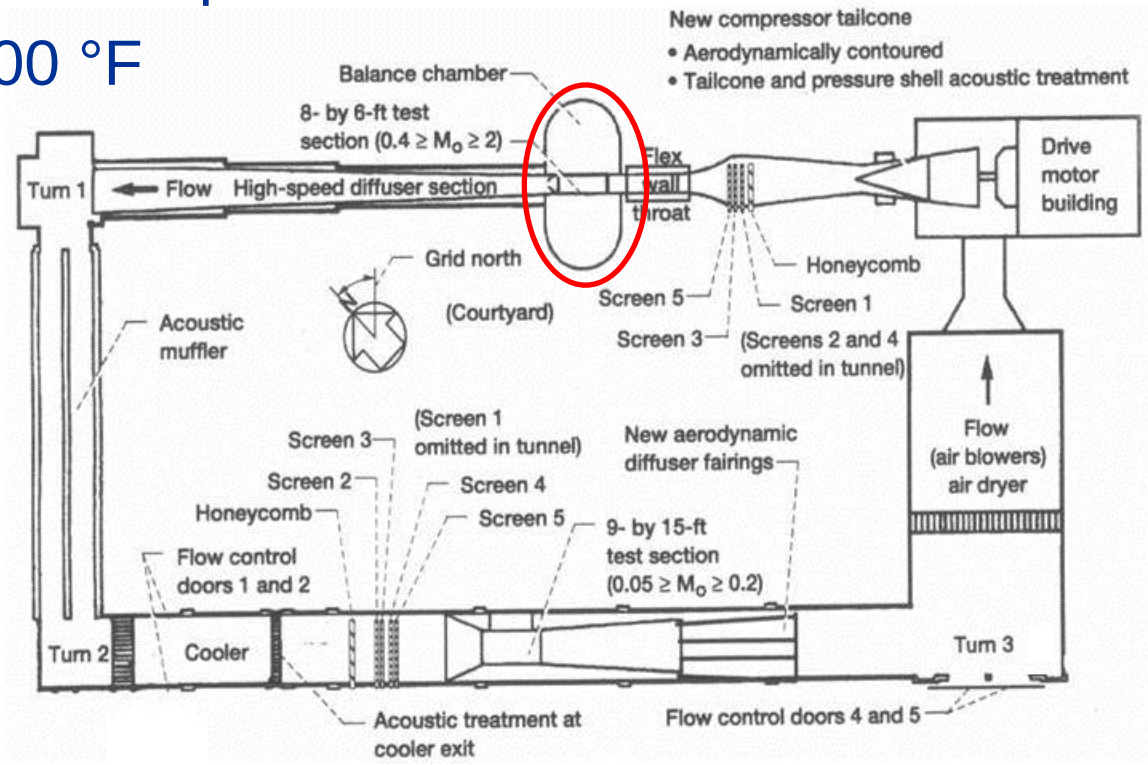
C-2010-2390

National Aeronautics and Space Administration
Glenn Research Center at Lewis Field

- Conduct cooperative wind tunnel tests
  - Facility Processes
  - Data Reduction
  - Flow Quality
  - Comparative data assessment
    - AEDC 16T TWT
    - NASA ARC 11-ft TWT
    - NASA LaRC NTF TWT
    - NASA GRC 8x6-ft SWT
- Learn the methods, techniques, and procedures used at each facility
  - Facilitate sharing information
  - Determine better test methods

# 8x6-Foot Supersonic Wind Tunnel

- Mach Number: 0.25 – 2.0
- Reynolds Number: 1.7 – 5.3 x $10^6$ / ft
- Dynamic Pressure: 90 – 1350 psf
- Total Pressure: 14.9 – 25.4 psia
- Temperature: 60 – 200 °F
- Open/Closed Loop
- Test Section Porosity



# Facility Operations

- Customer facility safety briefing
- Secure test section, build-up building, and control room
- Real-time perpetual batching of data to the customer server.
- Customer accommodations

# Pre-Test

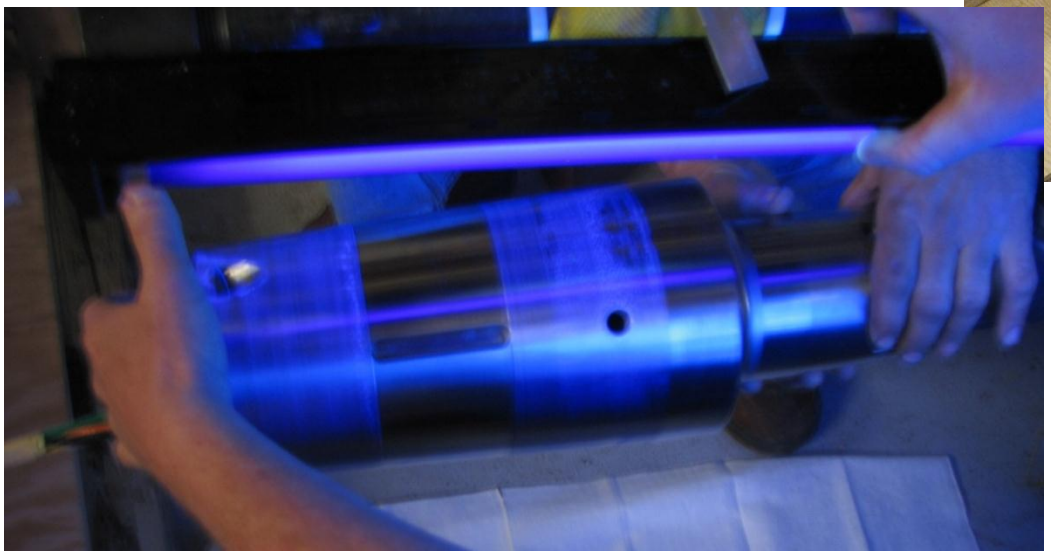
- Weekly pre-test meetings
  - Discussions of requirements
  - Hardware manufacturing status
  - Definition of objectives and requirements
  - Progress tracking
- Computing Requirements
  - Discussions of requirements with Data Systems Branch
  - Initial preparation of facility data systems
  - Custom program built per customer requirements
- Documentation
  - Customer Requirements (Understanding of Requirements)
  - Computing Requirements
  - Work Plan and Test Plan
  - Test Matrix and Daily Test Plan
  - Safety Permit

# Safety Review

- Review of model stress analysis
- Required tunnel unstart analysis if the test matrix calls for speeds above Mach 1.0
- Safety Packet submitted to the Glenn Safety Office
- Safety Review held with a designated committee to assess the model hardware and its test entry
- Approved Safety Permit required prior to wind-on

# Prep Room Activities

- Model arrival documented through photos.
- Check-fitted the NTF taper adaptor to the NTF sting.



- Measured resistance of balance gauges.
- Direct installation into the 8x6-foot test section.

# Tunnel Installation

- Model lifted into the tunnel through a 16-foot hatch downstream of the test section.
- Model mounted to NTF sting adaptor and transonic strut.
- Pitch and Yaw calibrations were performed post-installation.

# Tunnel Installation

- Check loads performed with supplied loading hardware and a facility check load stand
- Standard facility and model leak checks performed to measure leak rate and time constant of pressure instrumentation
- End to end data system check-outs performed
- Model is thoroughly documented through photos and a log book

# Tunnel Operations

- Three model support struts
  - Two floor mounted
  - One ceiling mounted
- Hydraulics available for model attitude control
- Nominal operation is a hydraulically controlled yaw-pitch double knuckle for model attitude
- Electric motors for strut control

# Tunnel Operations

- Sting length not optimal for test section length
  - Single-knuckle used for FAVOR model
- FAVOR model size in 8x6
  - Primary purpose of FAVOR: Procedures and Practices
  - Blockage as high as 3.5%
  - Blockage not to exceed 5%
  - Required operators to track Mach through pitch sweeps
- FAVOR data acquired at a rate of 40 – 60 seconds
  - Due to sting length, hydraulics could not be used for pitch control
  - Tight standard deviation limits
  - 10 second averaged data recording
  - Many other options for data acquisition

# Tunnel Operations

- ESCORT steady-state data system
  - Acquired all model analog instrumentation through NEFF 600
  - All Pressure instrumentation through ESP system
- Dewetron dynamic data system
  - Acquired subset of model instrumentation
- Model attitude set and data points recorded automatically
- Tunnel conditions set and maintained by facility operators

# Data Processing

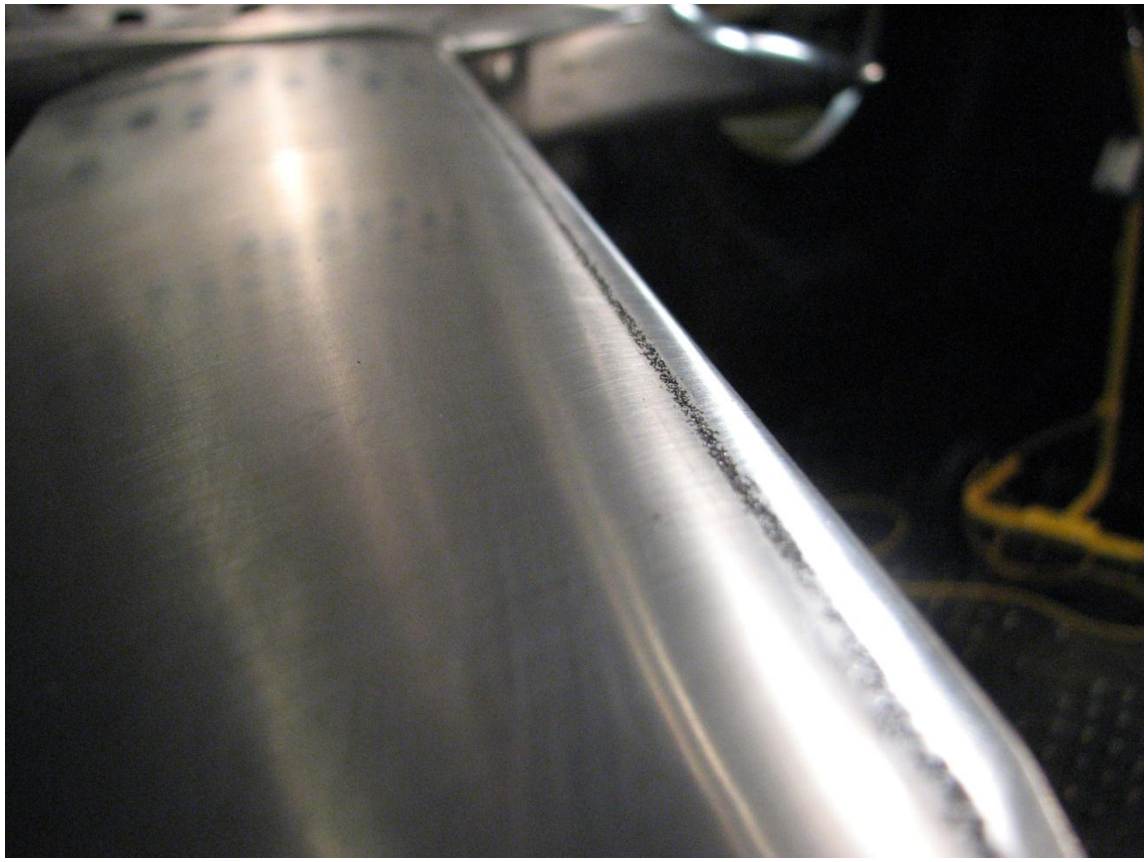
- ESCORT data system
  - ESCORT computations were verified through SIMSCAN
    - SIMSCAN supplies known inputs to the data system
    - Input data was provided from Ames and AEDC data sets to the calculation routines and close agreement was achieved.
    - SIMSCAN verifies online data displays and plots prior to running.
  - ESCORT constants and even computations can be modified and data reprocessed during testing.
- Dewetron dynamic data system
  - Dewetron computations were verified in a manner similar to SIMSCAN.

# Final Data Delivery

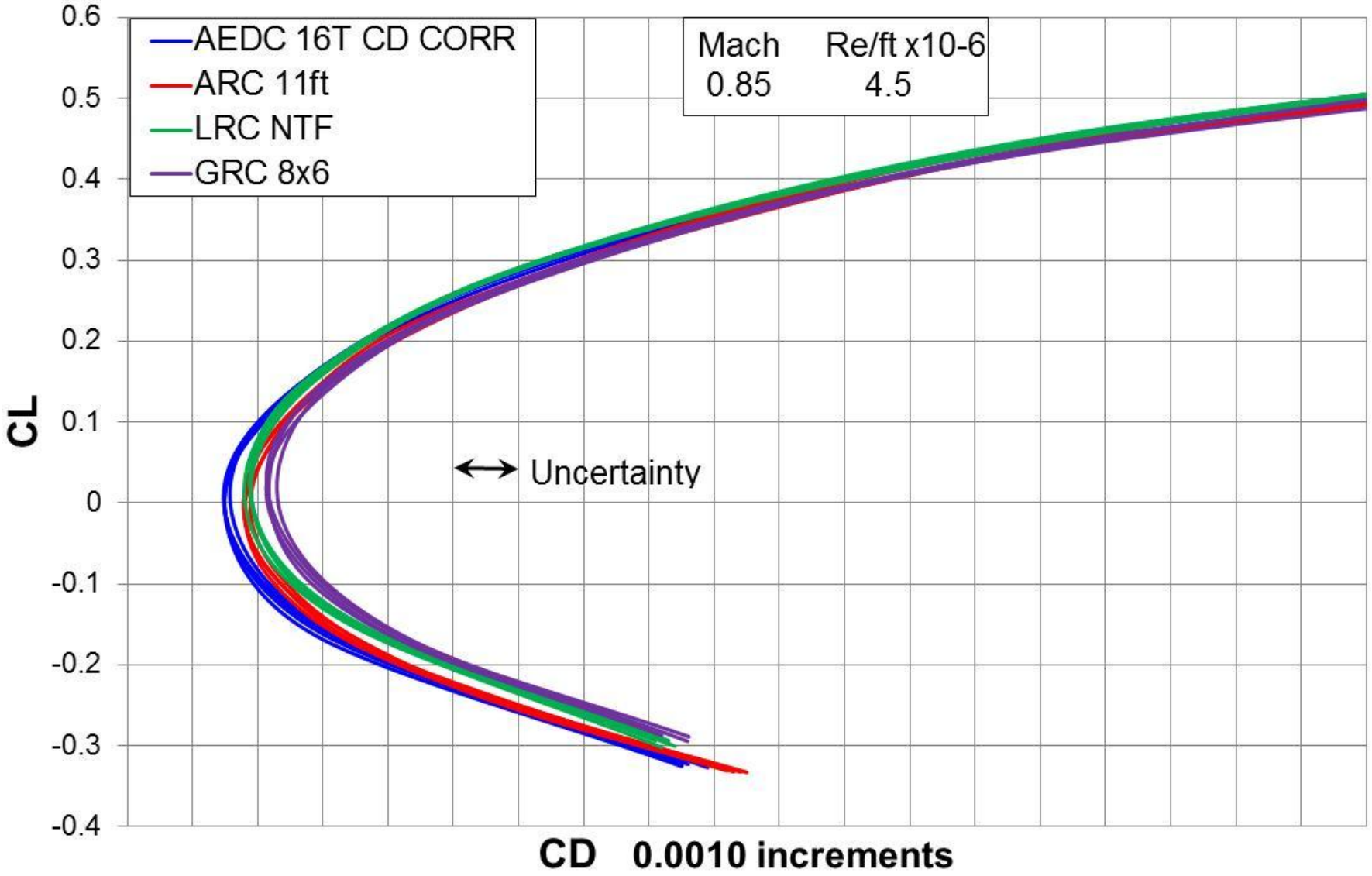
- ESCORT and Dewetron data were made available in near-time to customers
  - Re-reduced ESCORT data, incorporating flow angularity and various other corrections, were provided post test.
- ESCORT data
  - Tab-delimited files compatible with PyDatamine
  - Customer request
- Post-run, Dewetron data
  - Excel
  - MatLAB
  - Text files
- Checksums were calculated for all data files immediately following creation and were copied with data file to ensure data did not become corrupted.

# GRC Test Observations

- Little to no model dynamics in the 8x6 SWT.
- Wing flutter noted at Mach 0.90, 10° AoA . Did not go as high in AoA at Mach 0.95.
- Observed higher drag at Mach 1.10 than seen at other facilities.
- The supplied trip-dots did not survive temperature, so grit was used.



# Tunnel Preliminary Data Comparisons



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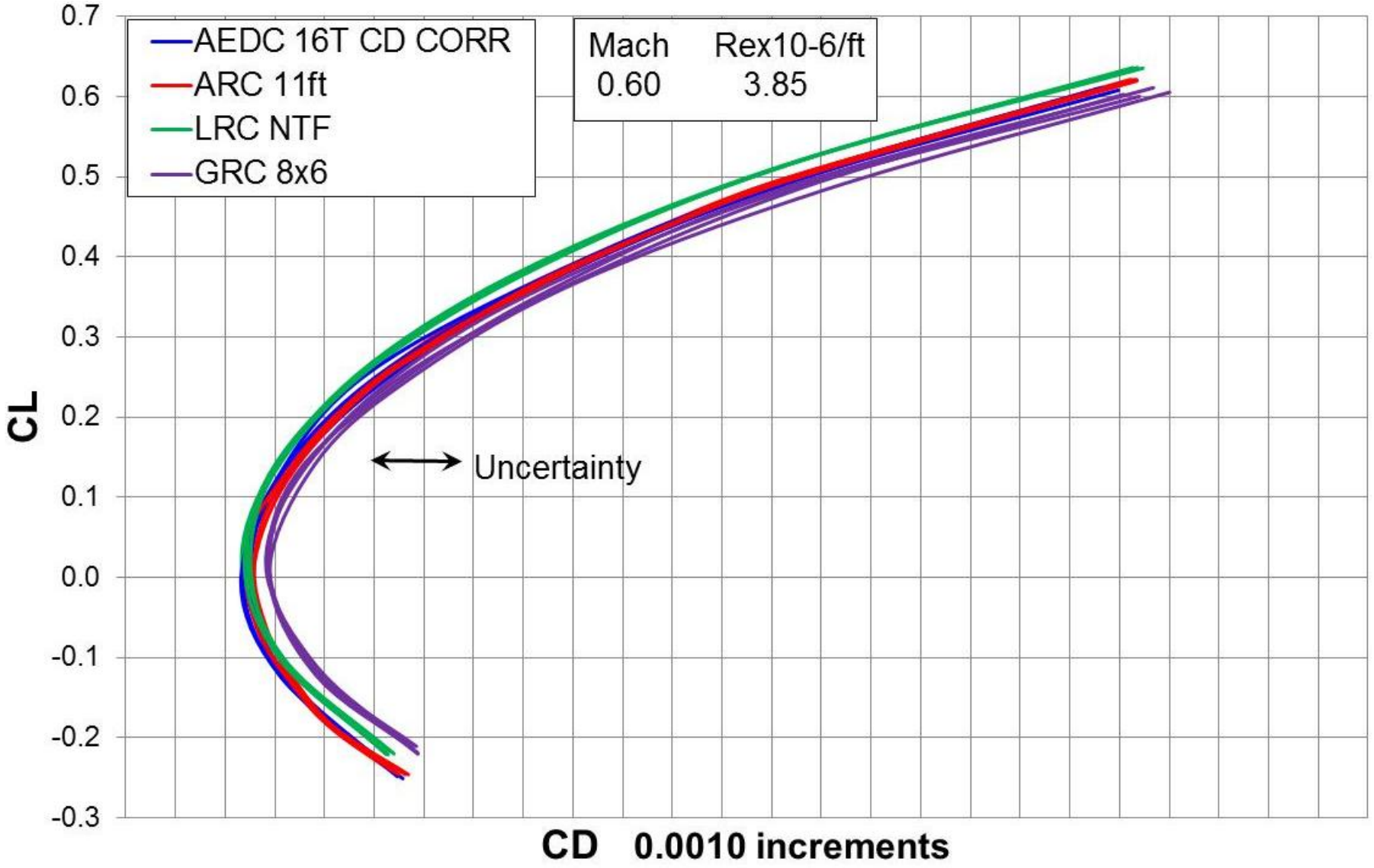
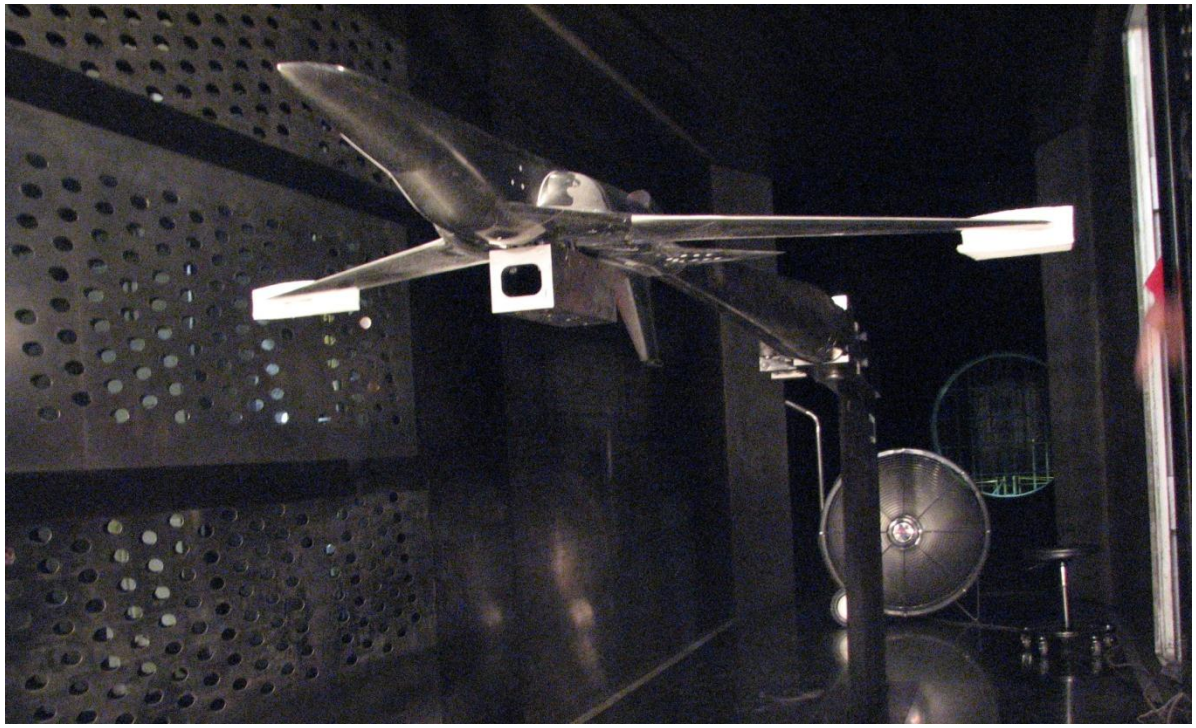


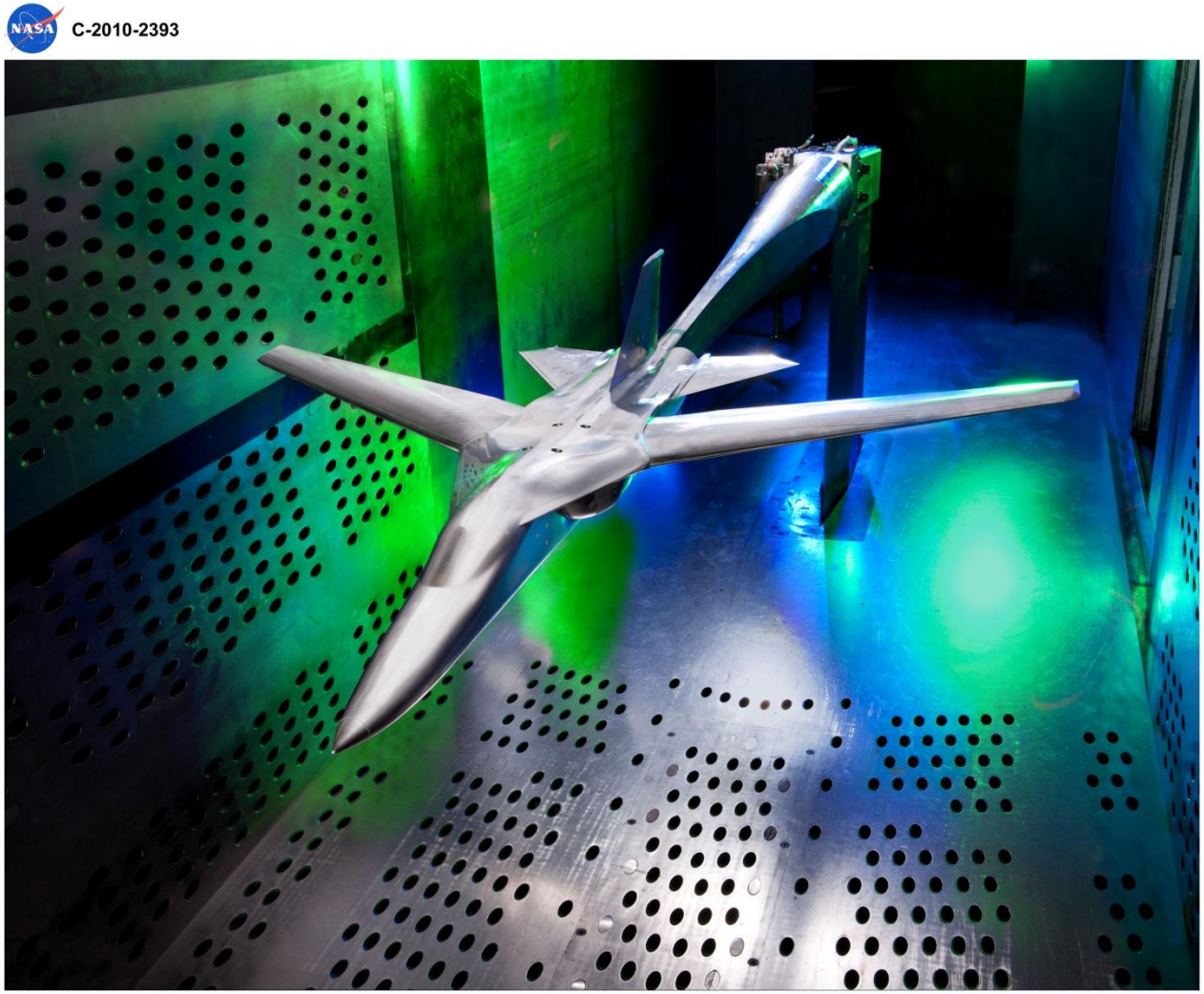
# Improvements out of FAVOR

- Improved Balance routine
- Establishment of a set of computing tools for use during aerodynamic balance testing



- Larger knowledge base in regard to balance testing at GRC facilities
- Improvements on dynamic model loads monitoring – In Progress
- Improvements on the check load stand – In Progress

# Questions?

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