



NASA Ames Research Center

Capabilities of the Unitary Plan Wind Tunnel

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January 11, 2015

ARC Unitary Plan Wind Tunnel



NASA Ames Research Center Wind Tunnel Division Facilities

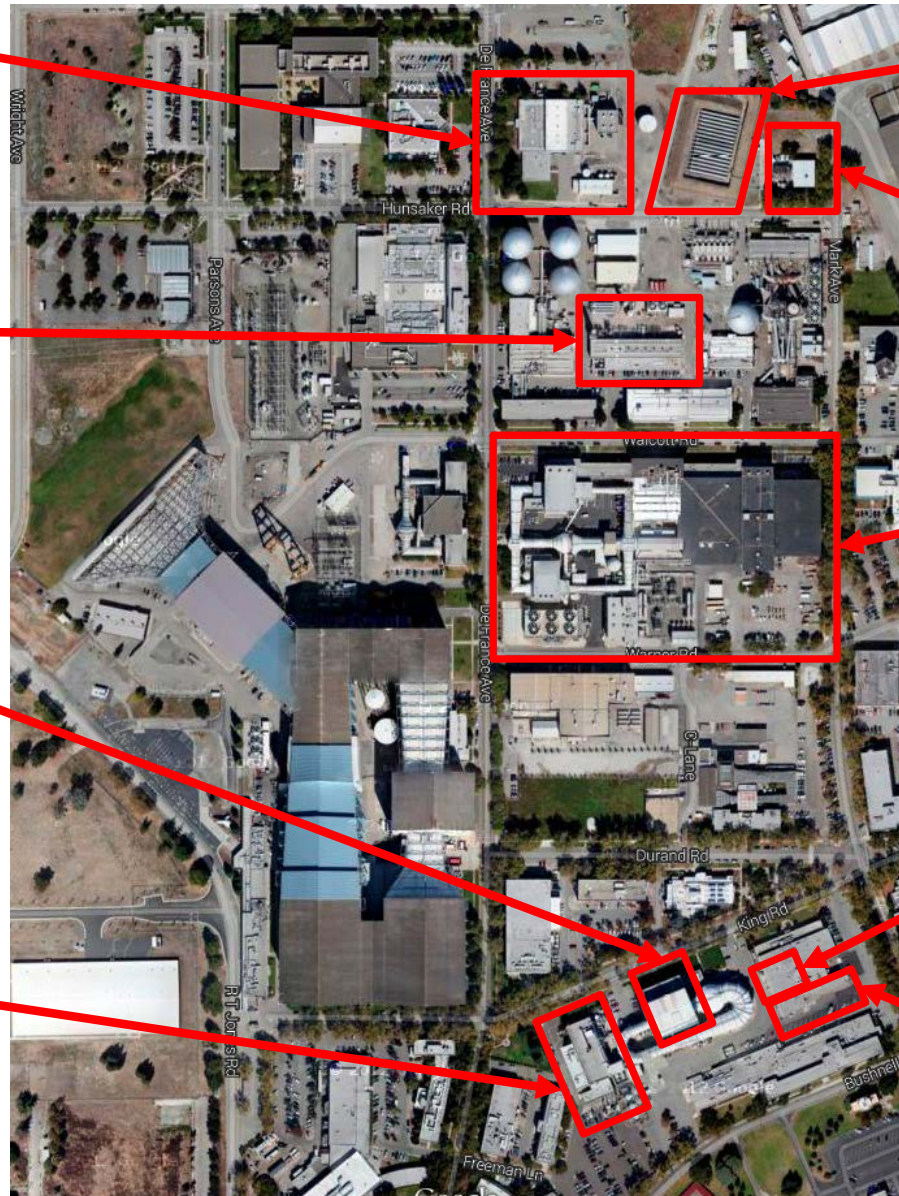


**Fluid Mechanics
Laboratory (FML)**

**High Pressure Air
(HPA) Compressor
C1A & HPA Control
Room**

**12-Ft PWT Model
Preparation Rooms
(MPR)**

**12-Ft PWT
Mitsubishi Makeup
Air (MUA)
Compressor**



**High Pressure Air
(HPA) Storage
Tanks**

**High Pressure Air
(HPA)
Compressor C1D**

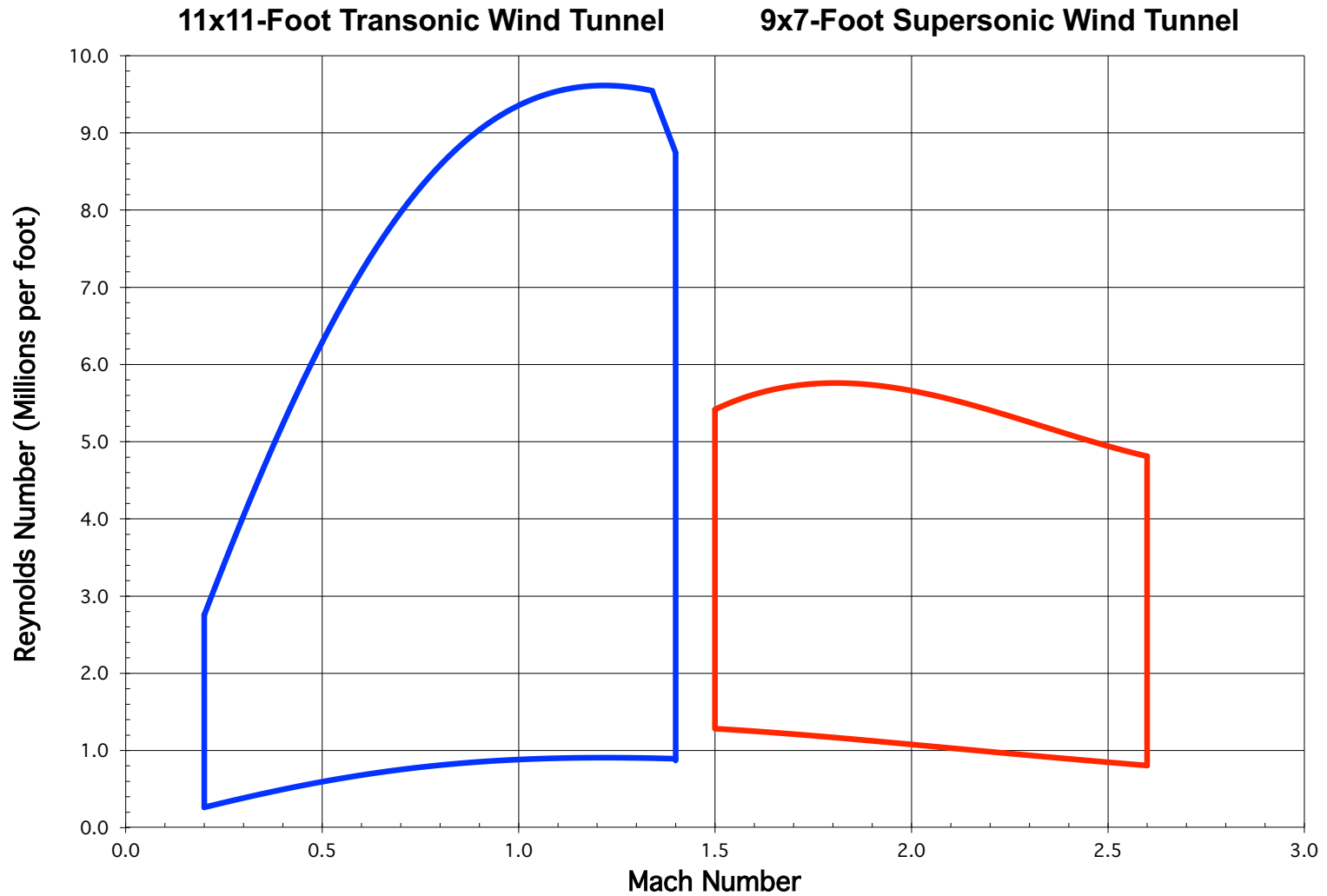
**Unitary Plan
Wind Tunnel
(UPWT)**

**Balance
Calibration
Laboratory**

**Compressor
Blade Shop**



Reynolds Number Range



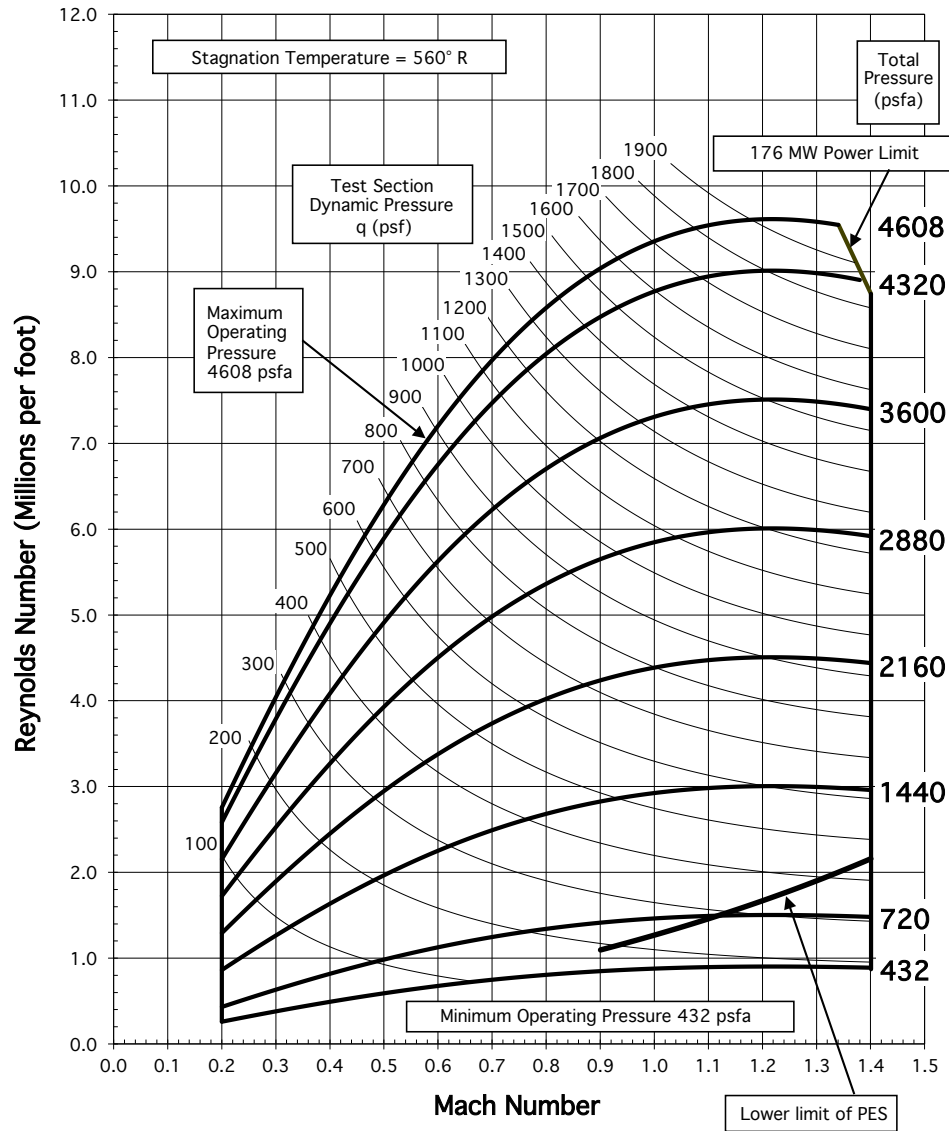
11-by 11-Foot Transonic Test Section



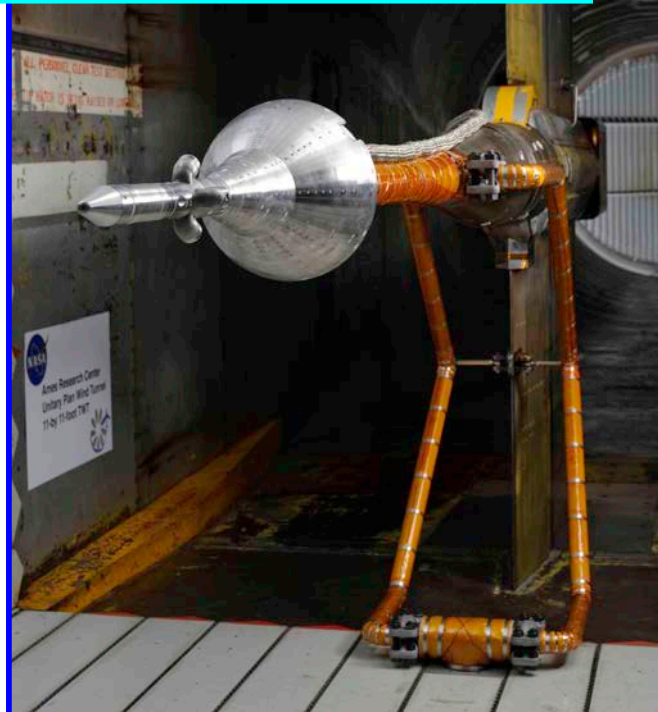
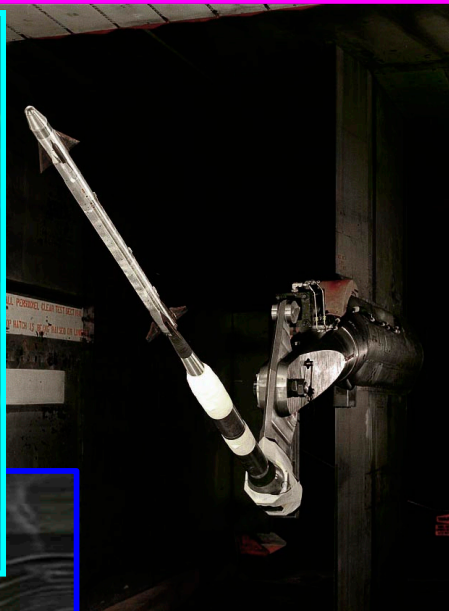
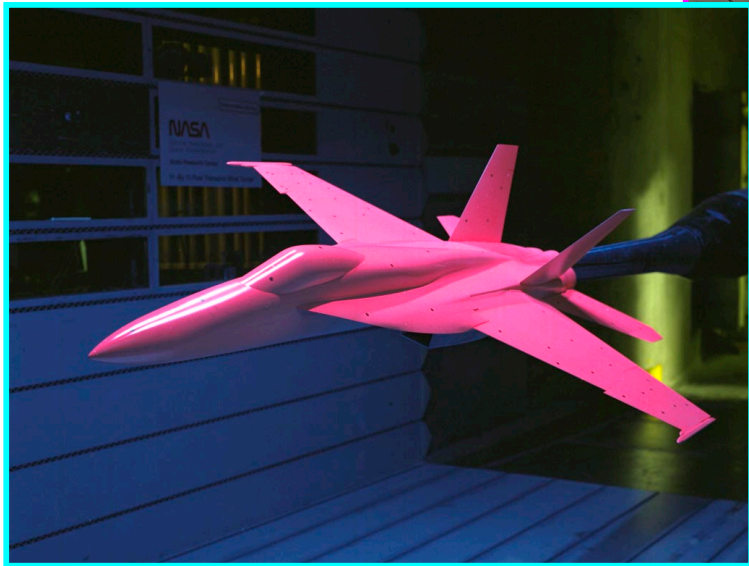
- **Excellent Flow Quality**
 - **Turbulence Reduction System**
- **Excellent optical access**
- **Wall interference correction system**
- **Sting mount and turntable model supports**
- **Complete automation of tunnel and model support operations**
- **Modern control room**
- **Slotted-wall test section (22') with baffles and 6% porosity**
- **3-stage compressor and variable camber inlet guide vanes**

**T11-0245/0255 - NASA ERA UHB
Powered Semi-span Test**

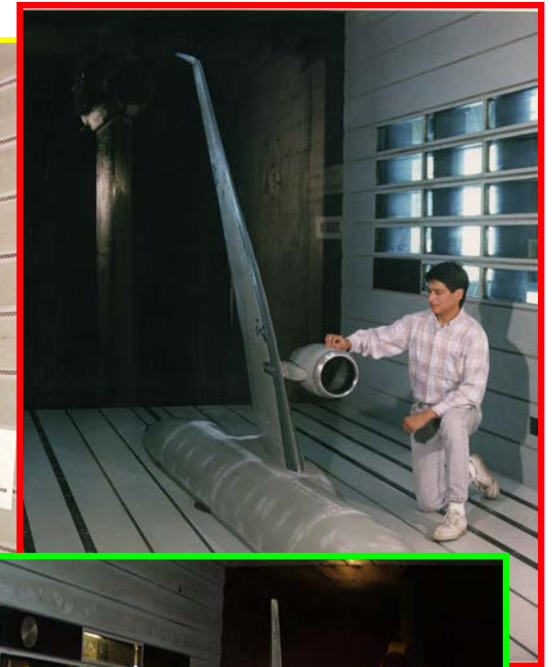
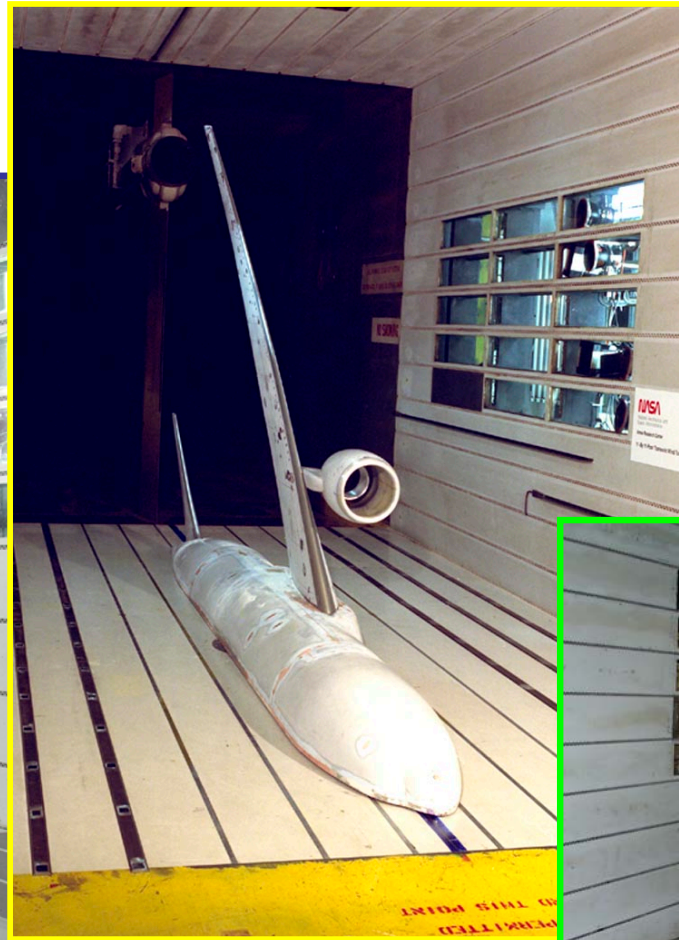
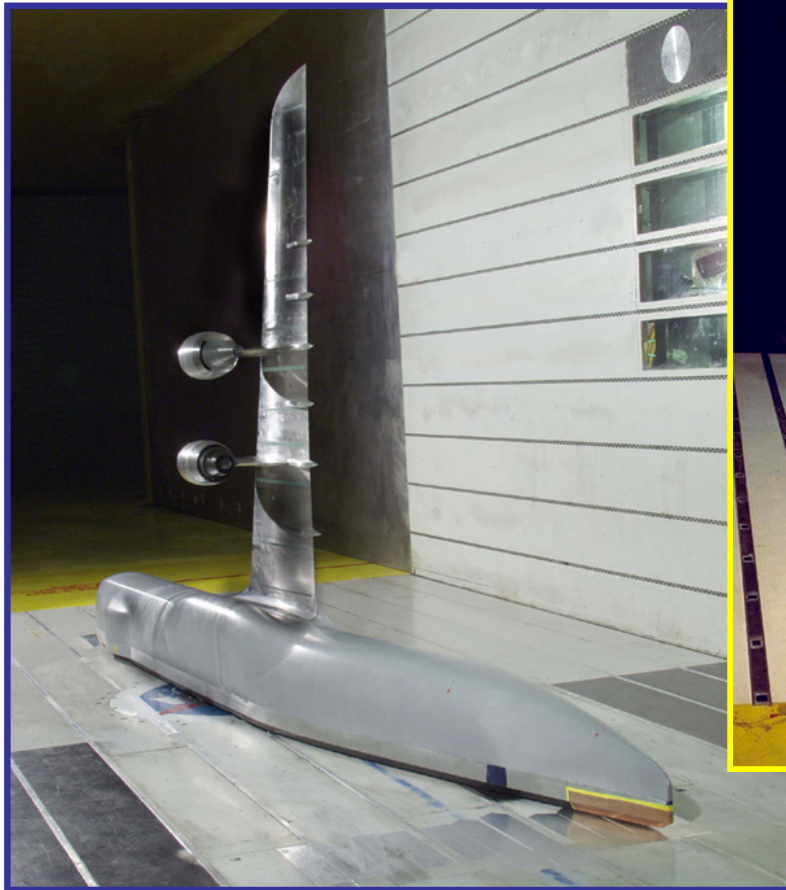
OPERATING CHARACTERISTICS OF THE NASA AMES RESEARCH CENTER 11-BY 11-FOOT TRANSONIC WIND TUNNEL



Sting Mounted Models in 11x11-Foot Transonic Test Section



Semi-Span Models in 11x11-Foot Transonic Test Section



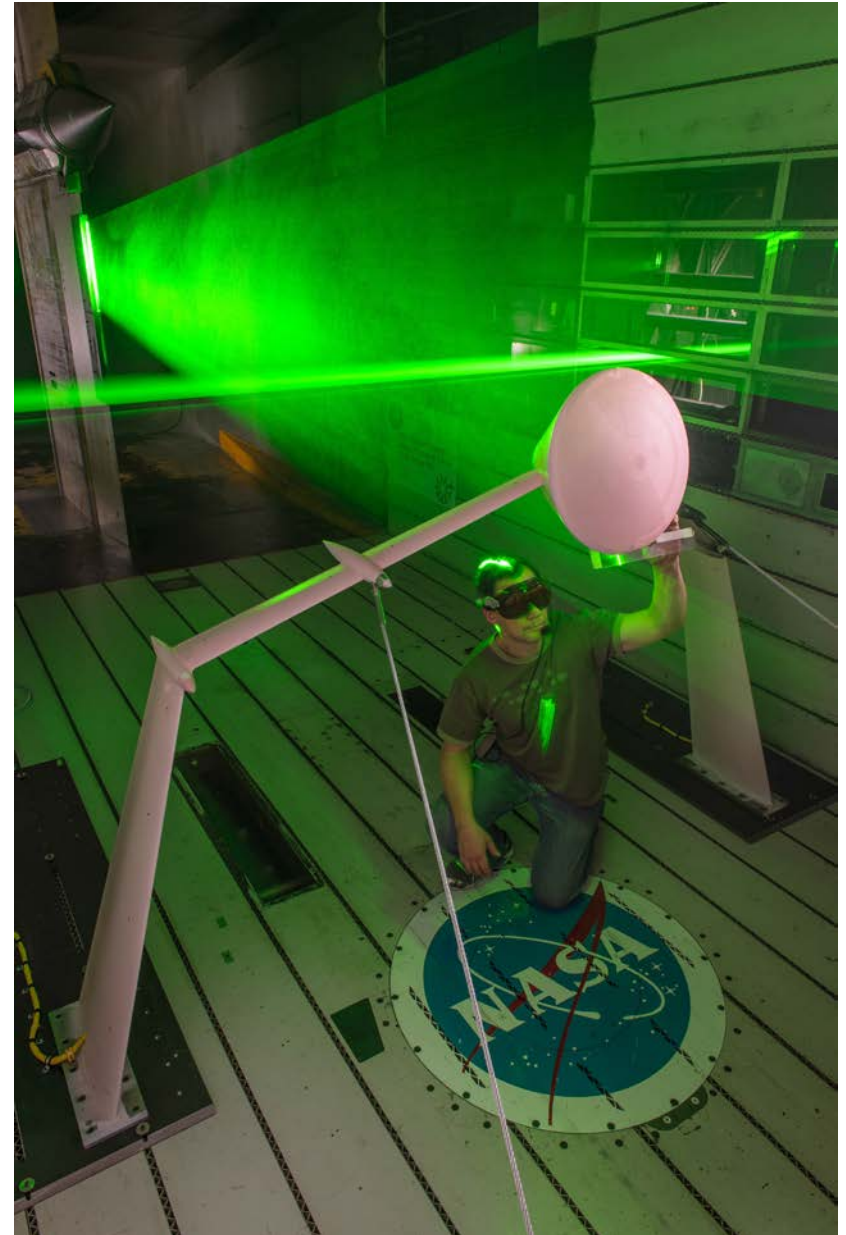
PIV in the 11x11-Foot Transonic Test Section



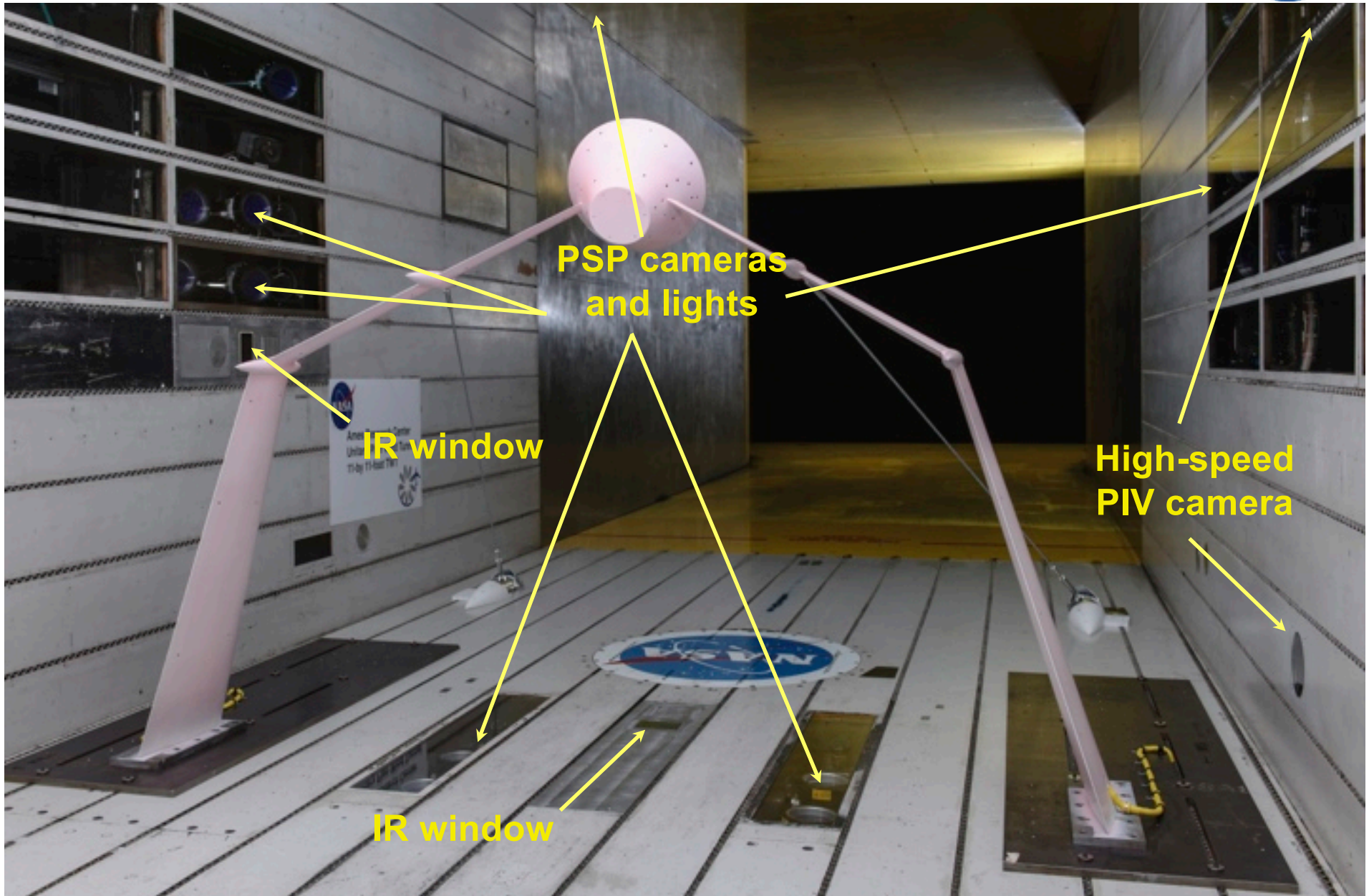
T11-0247 NESC 120-CA CPAS

Comprehensive Study of the Flow Around a Simplified Orion Capsule Model

- Wind-tunnel testing of Orion showed boundary-layer state on heat shield significantly affected Crew Module aerodynamics
- Agreement between CFD and experiments was poor below $\sim M 0.8$
- Study initiated by NASA Engineering and Safety Center (NESC) to reduce uncertainty in Orion wake flow
- Comprehensive measurement suite
 - Particle Image Velocimetry (PIV)
 - Pressure Sensitive Paint (PSP)
 - Infrared (IR) thermography to locate transition and separation lines
 - Unsteady pressures around heat-shield shoulder and in back shell
 - Boundary-layer measurements at one location on the heat shield
 - High-speed shadowgraph videos (6,000 frames per second)



11x11-Foot TWT Optical Access



UPWT Production PSP Capability



- **PSP Objectives**
 - Provides global pressure distributions for CFD validation
 - Provides an alternative for surface pressure measurement on thin model surfaces
 - Provides integrated loads on model surfaces
- **PSP Deliverables**
 - *Preliminary* processed data is available in near-time during test
 - Final data is delivered 4-6 weeks post-test
- **PSP System**
 - 8 Photometric CoolSnap Cameras
 - 40 ISSI 400nm LED lamps
 - 1 Linux cluster containing 9 computers
 - Custom Steady-State Lifetime PSP Data Processing Suite
 - 3-10 second acquisition time
 - Automated data acquisition coordinated with SDS
- **Active Collaboration with AEDC**



**T11-0307- NASA AATT
SUGAR TRUSS BRACED
WING**

Production Infrared Flow Visualization

Multi-camera infrared data systems provide real-time flow visualization with no impact on test productivity



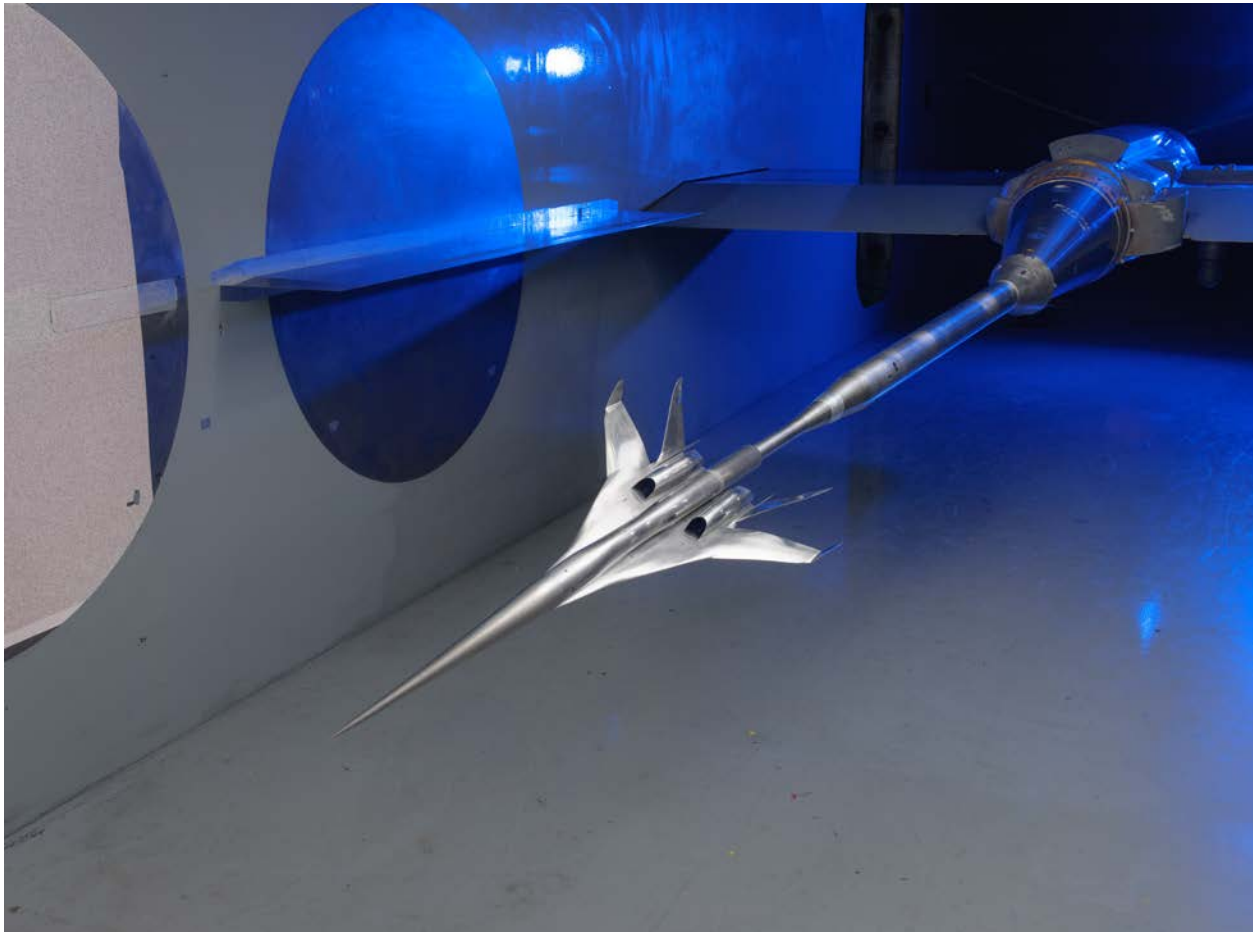
- Four megapixel research grade IR cameras.
- No need for tunnel temperature ramps.
- Optical modeling for simulation of views / test planning.
- Laboratory setup to quantify coating IR effectiveness.
- Synchronized, automatic acquisition with in-line image processing and real-time video feeds.
- Image processing routines adapted from medical imaging and cockpit display.
- Secure deliver of data products as they are processed.

Standard Configuration Data Products:

- **1 megapixel movie (.avi) per camera recorded throughout the duration of a pitch-pause vector or continuous sweep.**
- **Series of still images (.tiff) rendered at each pause point.**
- **Any test parameter computed by the data system (SDS) may be overlaid onto image data real-time.**
- **IRIG-B timing.**
- **All image data named and organized based on Run and Sequence number.**



9-by 7-Foot Supersonic Test Section

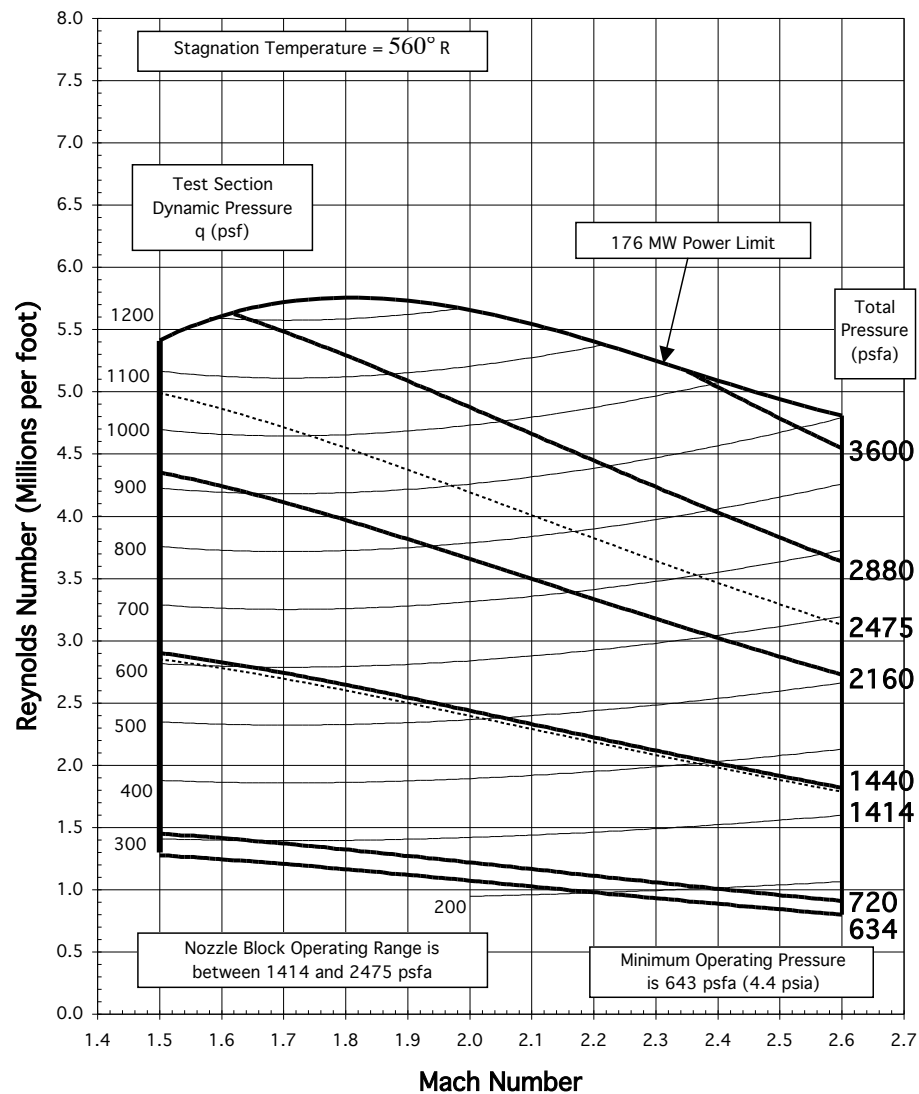


- Complete automation of tunnel and model support systems
- Good optical access
- Sting mount model support system
- Modern control room
- Contoured sliding block nozzle
- 11-stage compressor

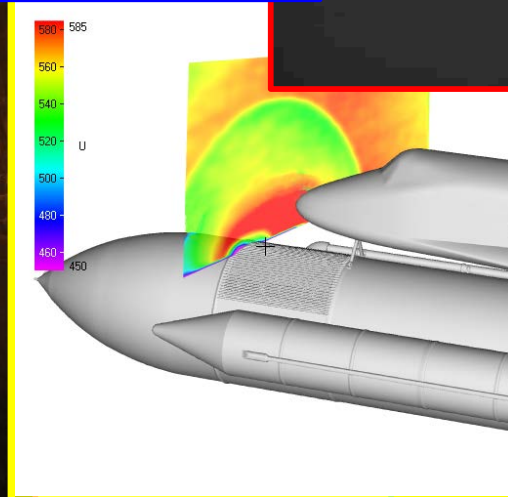
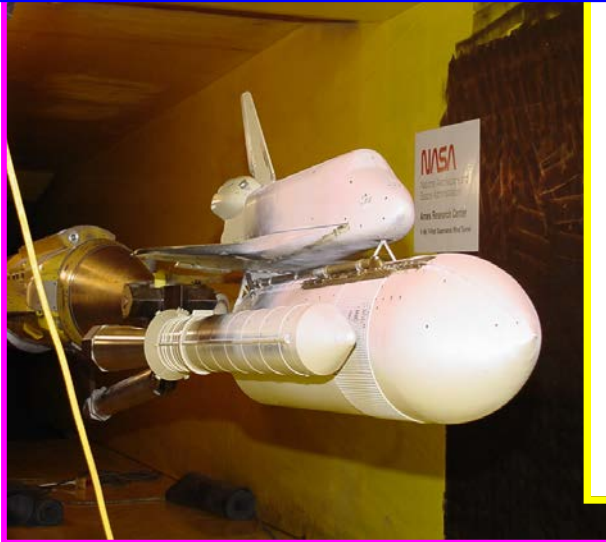
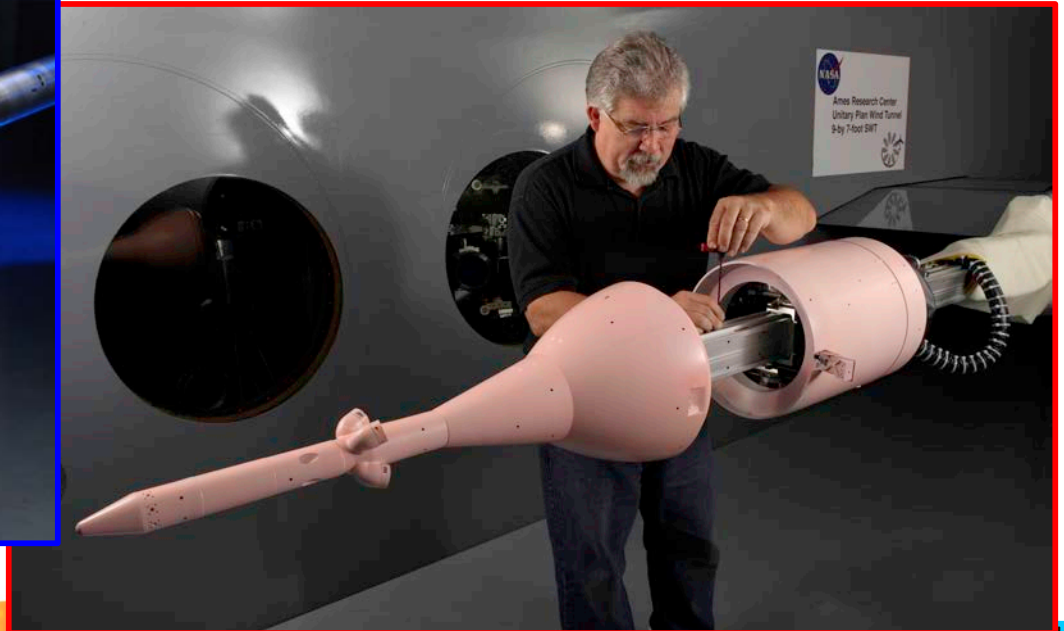
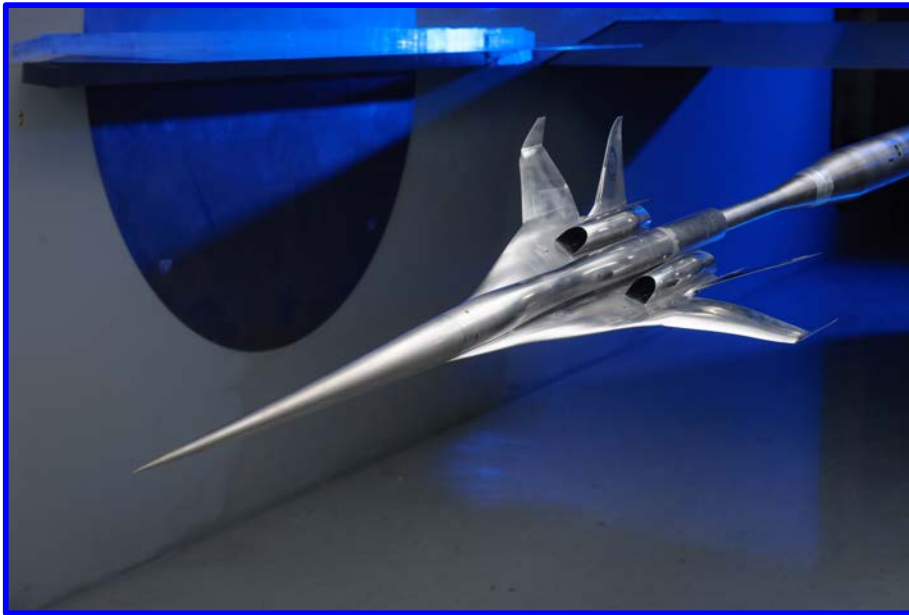
T97-0259 – Boeing N+2 Phase II Validation Test



OPERATING CHARACTERISTICS OF THE NASA AMES RESEARCH CENTER 9-BY 7-FOOT SUPERSONIC WIND TUNNEL



Models in 9x7-Foot Supersonic Test Section



Production High-Speed Shadowgraph/Schlieren

Dual shadowgraph systems provide simultaneous low-speed and high-speed image acquisition



- State-of-the-art high-speed cameras.
- High-powered pulsed LED light sources.
- Automatic acquisition with in-line image processing and real-time video feeds.
- Secure deliver of data products as they are processed.

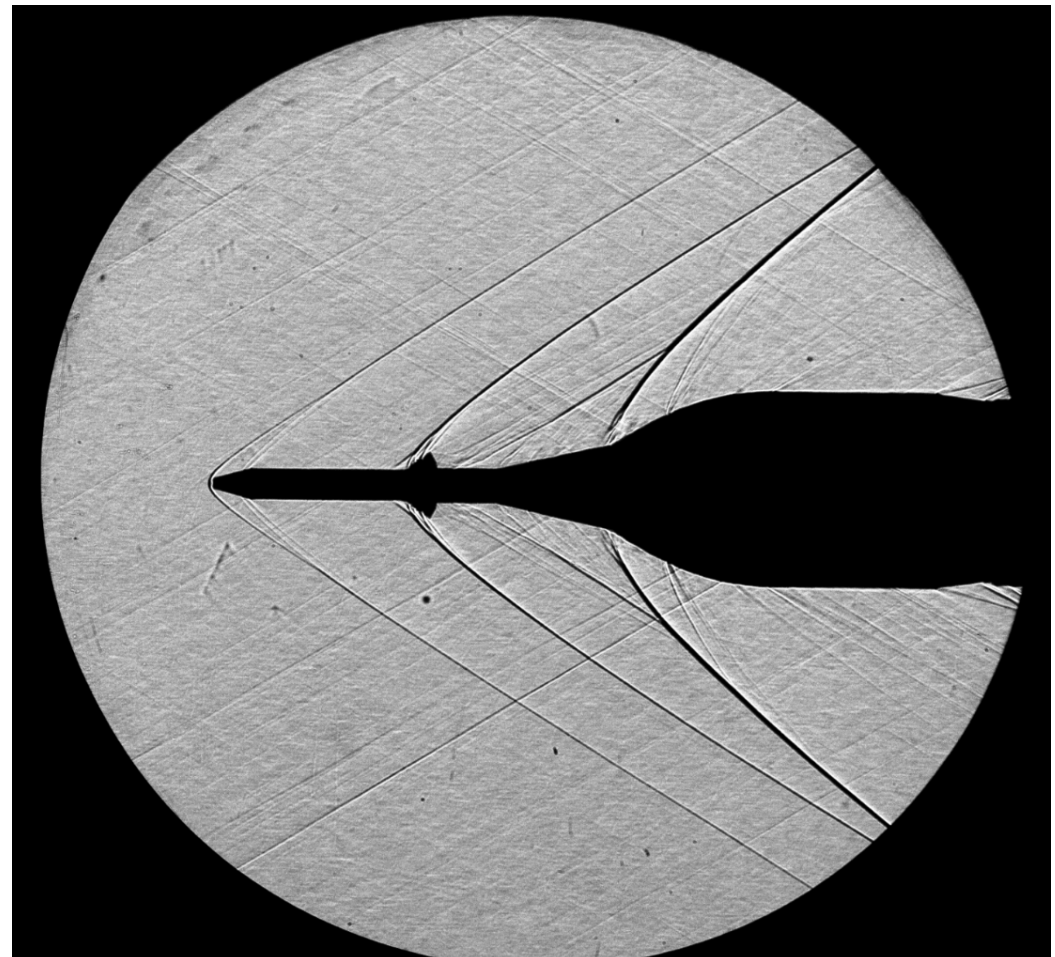
Standard Configuration Data Products:

•Low-Speed:

- ~4 megapixel 20 FPS movie (.avi) recorded throughout the duration of a pitch-pause vector or continuous sweep.
- Series of high-resolution still images (.tiff) rendered at each pause point.

•High-Speed:

- ~1 megapixel movie (.avi) ~50,000 FPS typical recorded at each point in pitch-pause vector.
- Mean and variance still images (.tiff) computed and rendered at each pause point.
- Any test parameter computed by the data system (SDS) may be overlaid onto image data real-time.
- IRIG-B timing.
- All image data named and organized based on Run and Sequence number.



9x7-Foot SWT Control Room Operations Area



Steady-State Standard Data System (SDS)



SDS is a multi-tasking, multi-user steady-state data system:

- Flexible, robust, distributed data platform implemented on open systems architecture.
- Real-time processing, data recording, numerical and graphical displays.
- Concurrent data acquisition & re-compute capabilities.
- User definable displays.
- On-line diagnostic tools for trouble shooting and data quality checks.
- Interfaces with facility control system, customer analysis computers, test dependent data systems, and model controls.
- Secure (isolated) network.
- Expandable to match test specific requirements.
- Supports multiple 6-component balances (5 standard).
- Support up to 2048 static pressure measurements.
- 48 channels of general purpose strain gage measurements.
- Supports RTD, thermocouples, & thermistor temperature measurements
- Measures tunnel conditions and test article attitude.
- Optional real-time wall corrections (up to Mach 0.9).



Dynamic Data System (DDS)



The Dynamic Data System (DDS) provides high speed simultaneous acquisition and analysis of fluctuating pressures, acoustics, vibrations, buffet, and other dynamic signals.

Functions and Features

- **Real-time graphical display in time and frequency domain.**
- **Concurrent signal monitoring and recording.**
- **Simultaneous Signal Sampling on all channels.**
 - 1kS/sec – 204.8kS/sec (DC – 80KHz)
- **Expandable PXI based architecture:**
 - 300+ channel capability.
 - 24 Bit Delta-sigma Analog to Digital Converter
 - Fully anti-aliased $32f_s$ – $128f_s$ oversample rate
 - ± 0.316 Vpk to ± 42 Vpk input Ranges
 - AC/DC coupling (AC cutoff 3dB point: 3.4Hz)
 - Built-in IEPE signal conditioning (4 & 10 mA)
- **Interfaced with Standard Data System.**
 - Dynamic data linked to tunnel conditions & point ID.
 - Supports automated data acquisition.
- **Near Time Signal Processing:**
 - Time domain statistics (Min, Mean, Max, RMS, nSamples, etc.)
 - Frequency domain results (PSD's, Third Octave, ect.)
- **Custom fixed gain (50x) pre-amplifier/line-drivers for Kulite® style transducers.**





UPWT Model Support Systems

- **Sting Model Support System**
 - **Knuckle-Sleeve Device**
 - **15° cone and changeable adaptors**
- **Kick-Sting for Increased Angle of Attack**
- **Roll capability**
- **Data acquisition modes**
 - **Move-pause mode**
 - **Continuous pitch, yaw or roll mode**
 - **Hybrid mode**
- **Turntable model support systems in 11' by 11'**

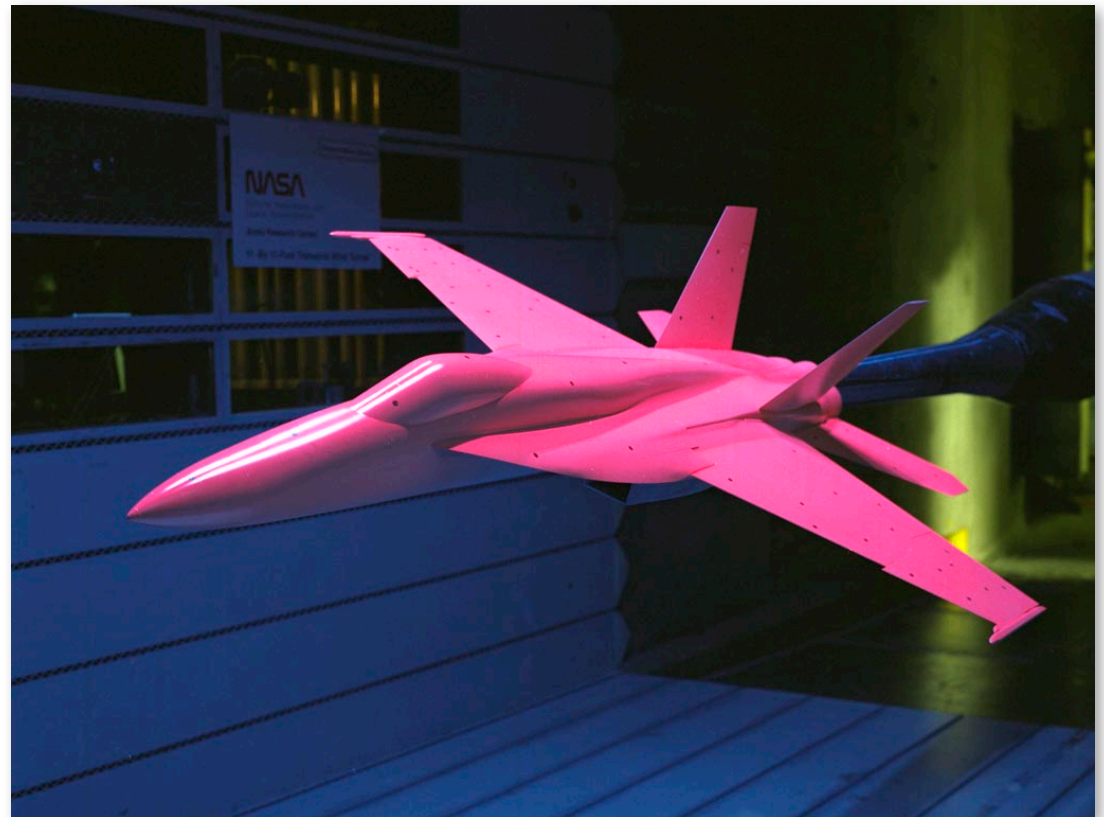


AIM-9 using roll mechanism and kick sting



Additional UPWT Systems

- **Precision Instrumentation**
 - QA-2000 Angle sensors
 - Flow Reference System
 - DTC ESP surface pressure scanners
- **Flow Visualization**
 - Pressure Sensitive Paint
 - High-Speed Schlieren
 - IR Thermography
 - Particle Image Velocimetry
 - Oil flows
 - Mini-tufts
 - Laser Vapor Screen
- **Balance Alarm System (BLAMS)**
- **Video Systems**

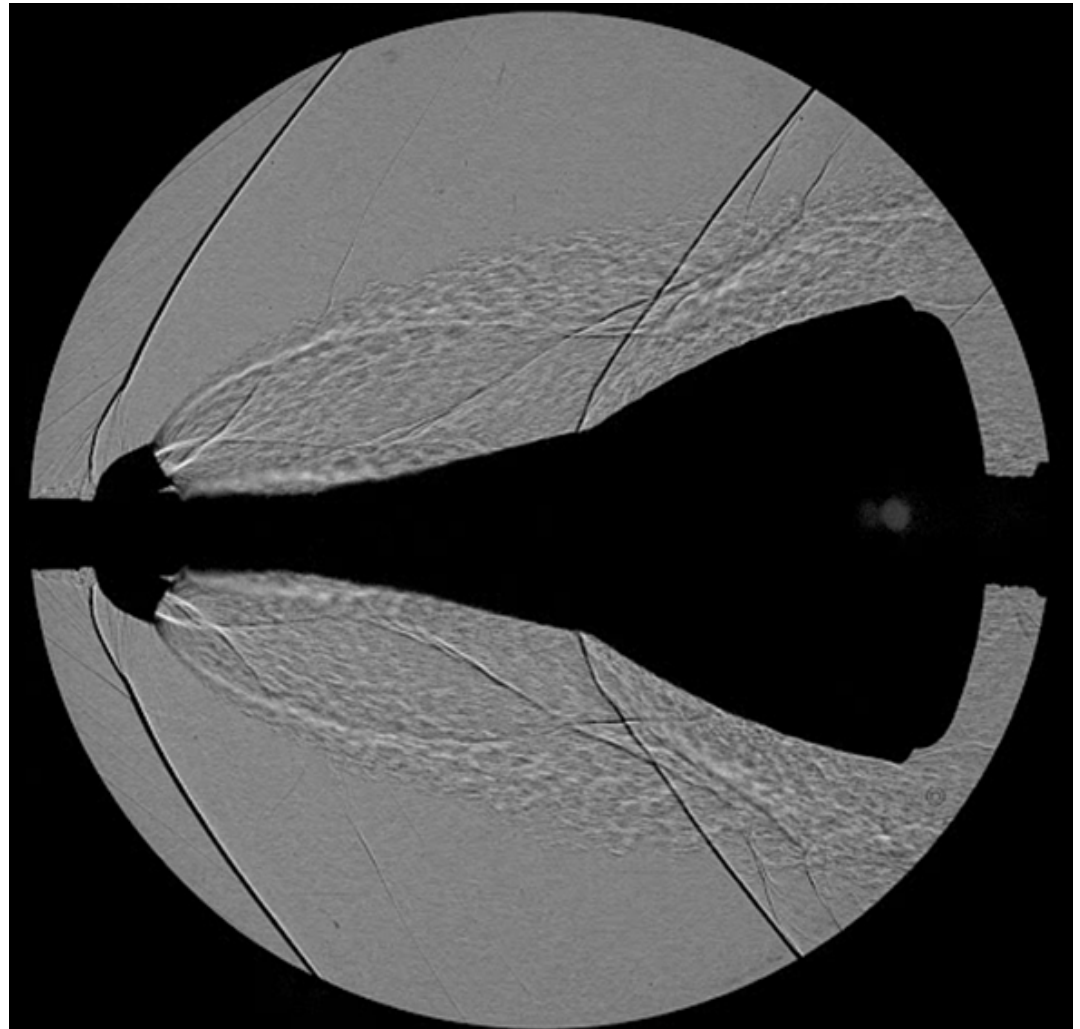


F-18 with pressure sensitive paint



High Pressure Air (HPA)

- **Typical uses of High Pressure Air**
 - Turbine propulsion simulators
 - Ejector systems
 - Plume simulations
- **Air storage capacity of 7.8 million SCF at 3000 psig**
- **HPA Capabilities**
 - Computer controlled mass flow, pressure and temperature
 - Two 3,000 psia lines delivered at up to 80 lbm/sec.
 - 1 MW heater capable of heating air to 400° F

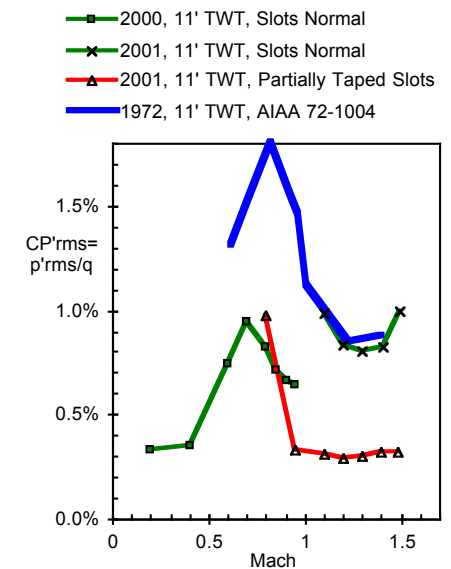
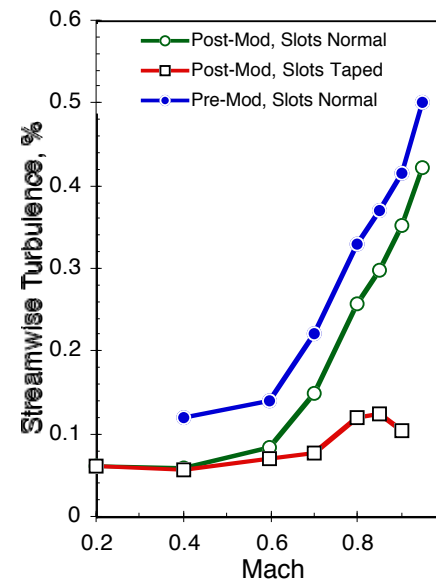
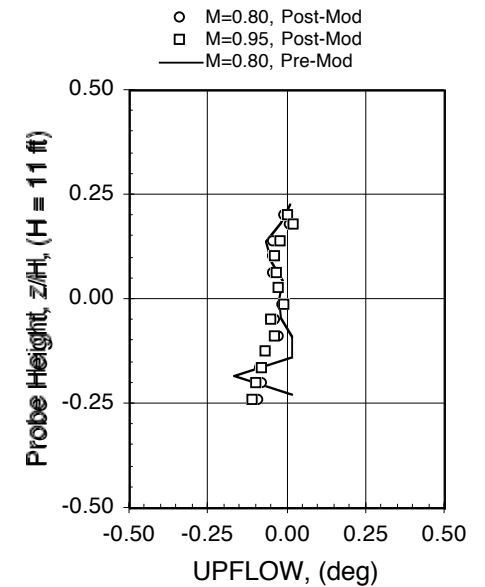
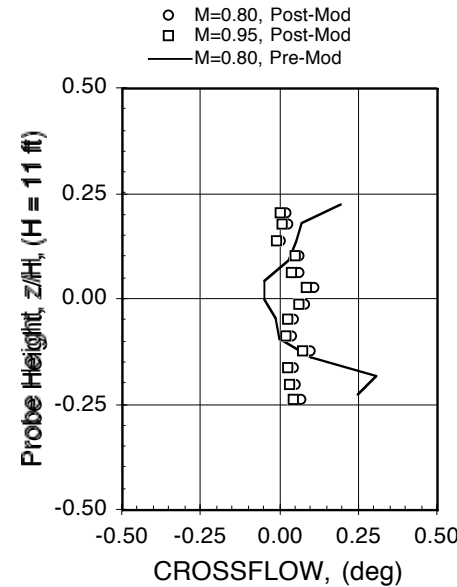


T97-0186 - CEV 51AS ORION Launch Abort Test

Flow Quality and Calibration



- **11x11-Foot TWT Calibration**
 - **Static Pipe**
 - **Flow Uniformity Survey**
 - **Turbulence and Acoustics Survey (AIAA 2000-2681)**
 - **LB-435 Calibration Model**
- **9x7-Foot SWT Calibration**
 - **Flow Survey**
 - **Acoustics Measurements**





NASA Ames UPWT

- Ames UPWT has an outstanding history of serving the aerospace community
- Ames UPWT offers high Reynolds number testing over a broad range of Mach numbers
- Our modernized tunnels are extremely capable, reliable and productive
- Validation and calibration tests have demonstrated outstanding data quality
- Ames UPWT staff are capable and eager to respond to the needs of wind tunnel customers

NASA Ames UPWT



QUESTIONS ?

