LOW BOOM FLIGHT DEMONSTRATOR

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NASA STRATEGIC IMPLEMENTATION PLAN

3 Mega-Drivers

6 Strategic Research & Technology Thrusts

Safe, Efficient Growth in Global Operations
- Enable full NextGen and develop technologies to substantially reduce aircraft safety risks

Innovation in Commercial Supersonic Aircraft
- Achieve a low-boom standard

Ultra-Efficient Commercial Vehicles
- Pioneer technologies for big leaps in efficiency and environmental performance

Transition to Low-Carbon Propulsion
- Characterize drop-in alternative fuels and pioneer low-carbon propulsion technology

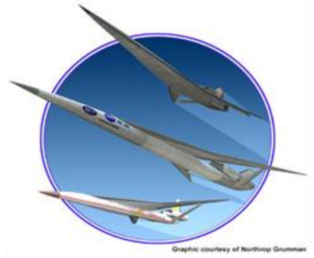
Real-Time System-Wide Safety Assurance
- Develop an integrated prototype of a real-time safety monitoring and assurance system

Assured Autonomy for Aviation Transformation
- Develop high impact aviation autonomy applications

LOW BOOM HISTORY

FAR 91.817 (1960's) -- "No person may operate a civil aircraft . . . at a … flight Mach number greater than 1 . . . unless - {App. B} . . . the flight will not cause a measurable sonic boom overpressure to reach the surface . . ."

Quiet Supersonic Platform 2000



- Supersonic Tech Survey
- 0.3 psf Front Shock

Quiet Supersonic Transport - 2001-2003

- Feasible Low Boom Transportation
- 0.7 – 0.8 psf Front Shock

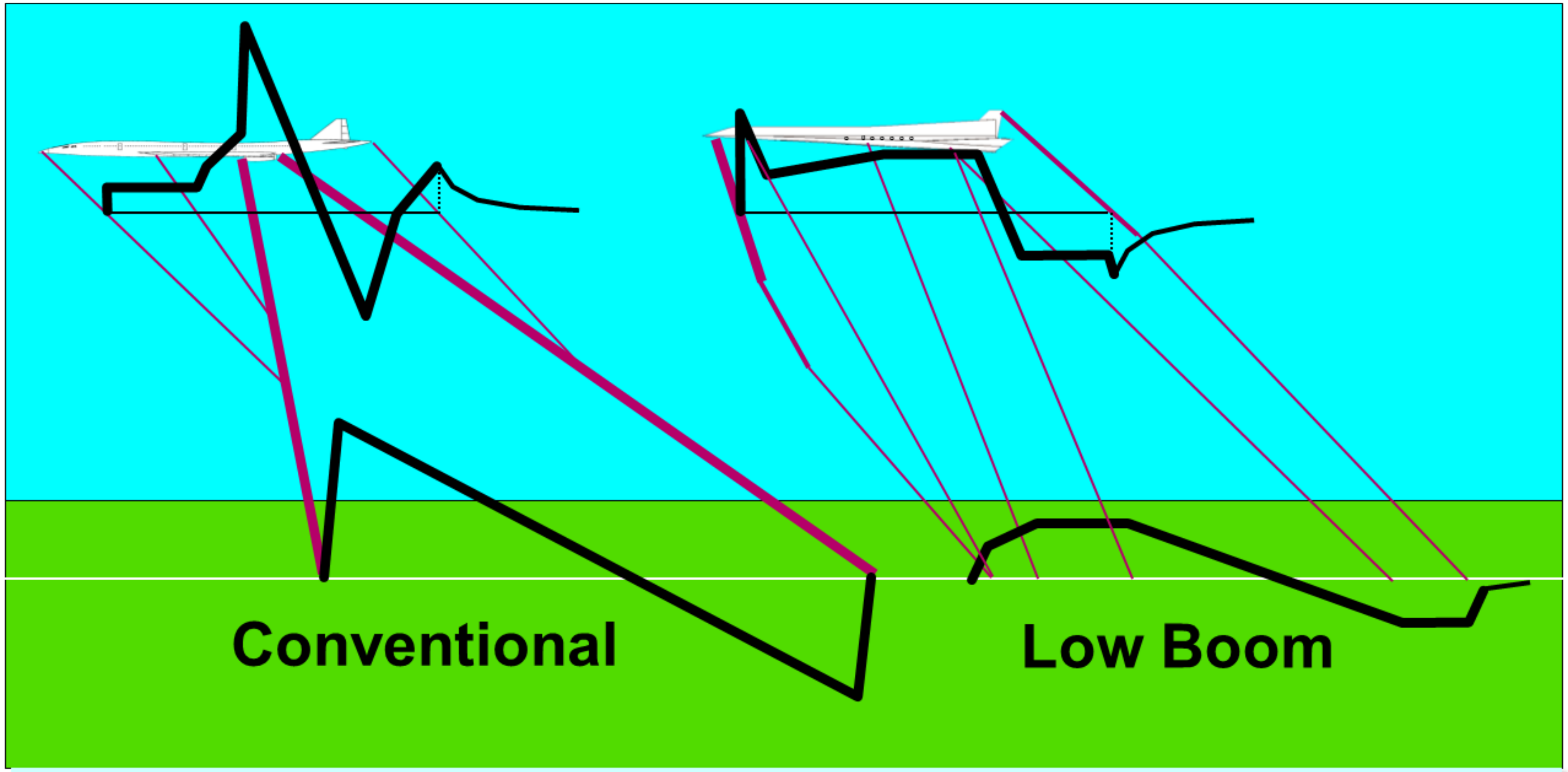
F-5E Shaped Sonic Boom Demonstration - 2003

- Modified F-5E nose to reduce front shock
- 0.7 – 0.8 psf Front Shock

D-SEND- 2011

- Droppped shaped axisymmetric bodies from ~100,000 ft altitude to produce 0.25 psf flattop

FUNDAMENTALS OF SHAPED BOOM DESIGN

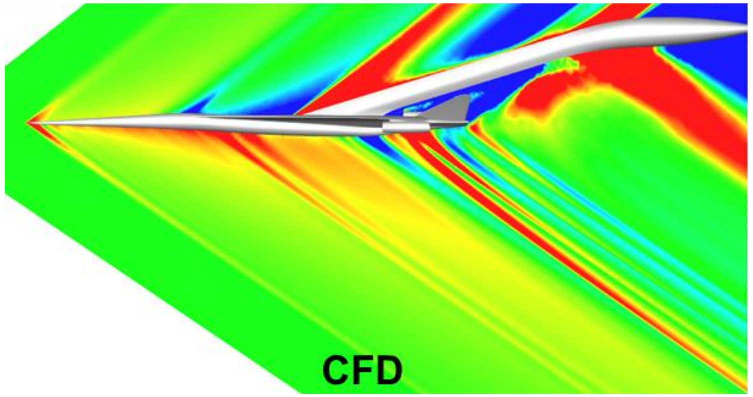


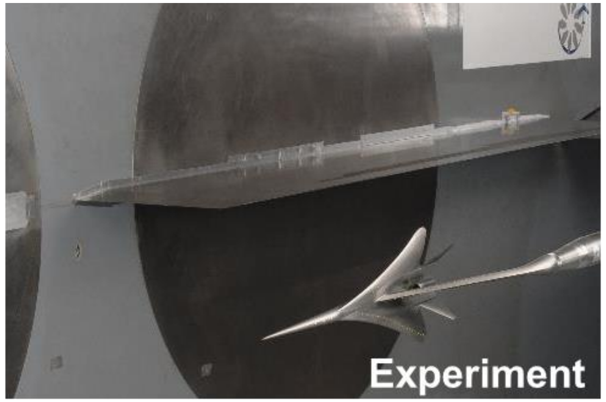
Sonic Boom Reduced by:

- Area Tailoring
- Lift Tailoring
- Lower Weight
- Increased Lifting Length

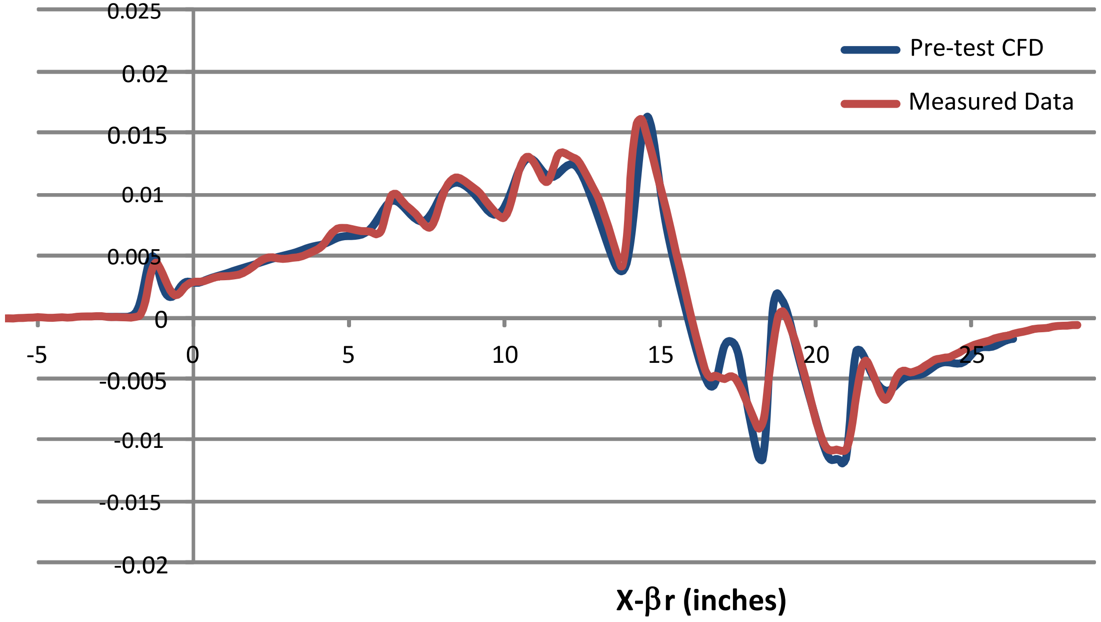
TAILORING THE VOLUME & LIFT DISTRBUTION TO PREVENT COALESCENCE IS THE KEY TO SHAPING SONIC BOOM

NASA STRATEGIC IMPLEMENTATION PLAN





Comparison of Pre-test CFD and Wind Tunnel Measurements @ C_L = 0.142



ENGINEERING WORK DONE ON N+2 SUPERSONIC VALIDATIONS PROGRAM SHOWED THAT MODERN DESIGN TOOLS ARE ADEQUATE FOR SHAPED BOOM DESIGN

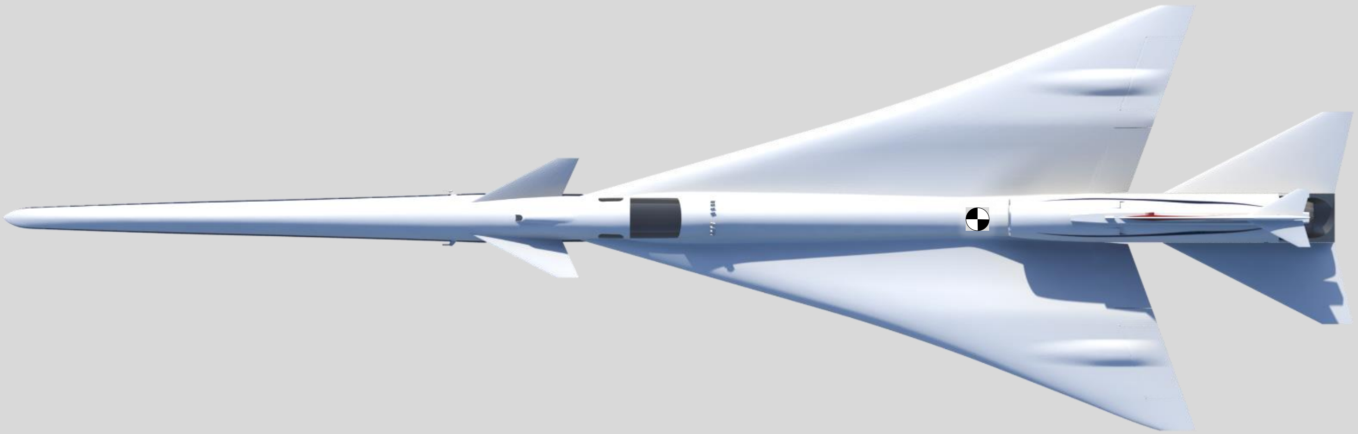
LBFD – PROGRAM OBJECTIVES

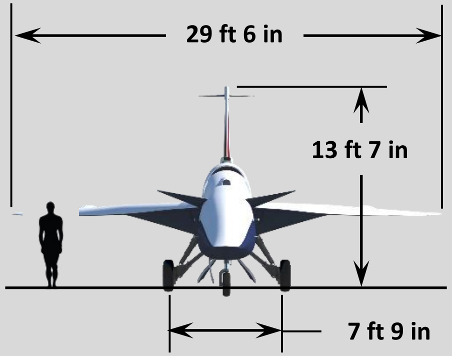
- Develop, build, and flight test a clean-sheet X-plane that can be used to support future regulatory change efforts
- Demonstrate that noise from sonic booms can be reduced to a level acceptable to the population residing under future supersonic flight paths

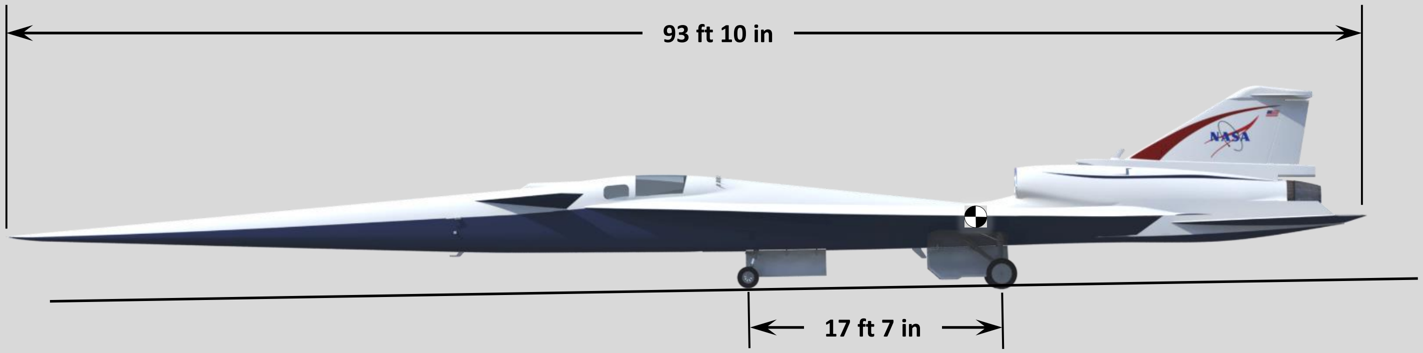
Requirement Name		Requirement	C608.1
MR-1	Boom Traceability	Scaled dP & PLdB	✓
MR-2	Shaped Signature	<75 PLdB, max energy < 10 Hz	74.3 PLdB, ✓
MR-3	Boom Variability	70-80 PLdB	70-80 PLdB ✓
MR-4	Cruise Deviations	<76 PLdB mean, <1.4 PL RMS	74.5 PLdB, ✓
MR-5	Mach Number	>1.4 for low boom	1.4 ✓
MR-6	Pass Length	2 x 50 nm	✓
MR-7	Flight Rate	3 flights in 9 hours	✓
MR-8	Day/Night Ops.	Equipped	✓
MR-9	Flight Ops.	Day/night VFR, ILS, transit IMC	✓
MR-11	Climb Rate	climb/accelerate cooncurrently	3,000 FPM at top of climb ✓

CONFIGURATION C607 OVERVIEW

Configuration C607	
MTOW	24,300 lb
Empty Weight	14,000 lb
Maximum Fuel	8,000 lb
Payload	500 lb
S_{ref}	486 sq ft
W/S	46 lb/ft^2
T/W	~0.9
Engine	1xGE F414
Design Mach	1.42
Loudness	<75 PLdB







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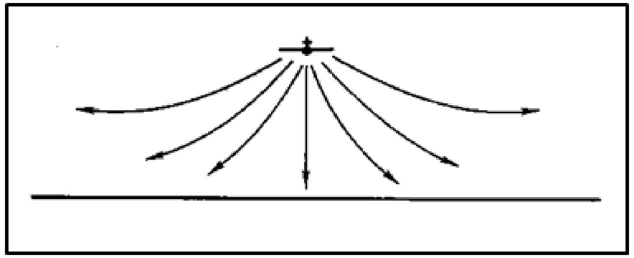
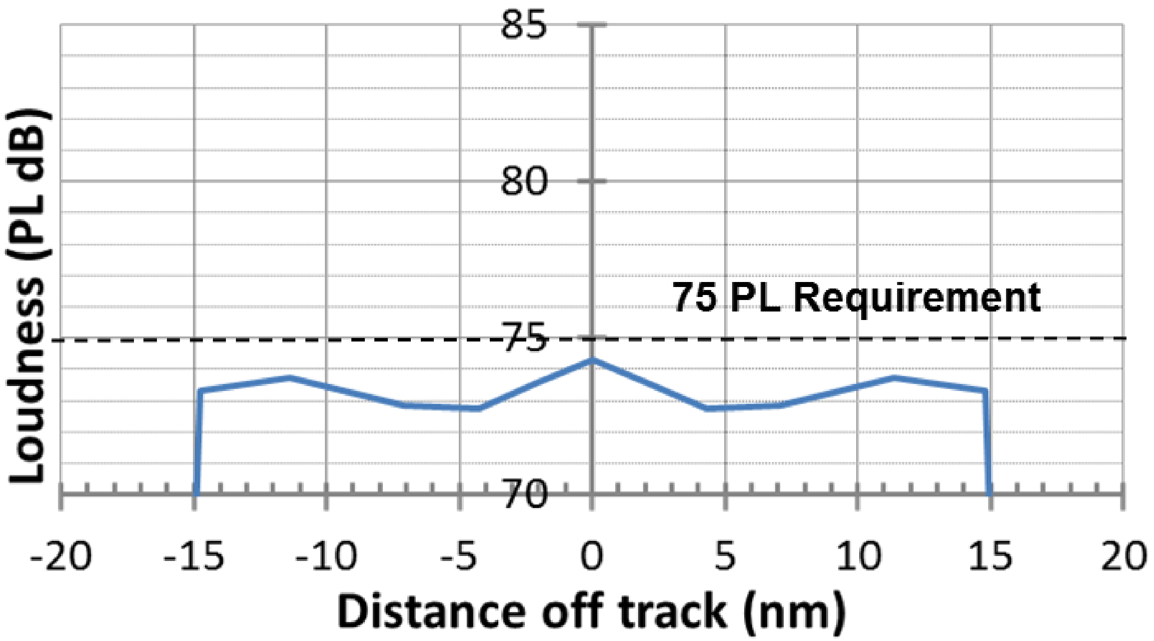
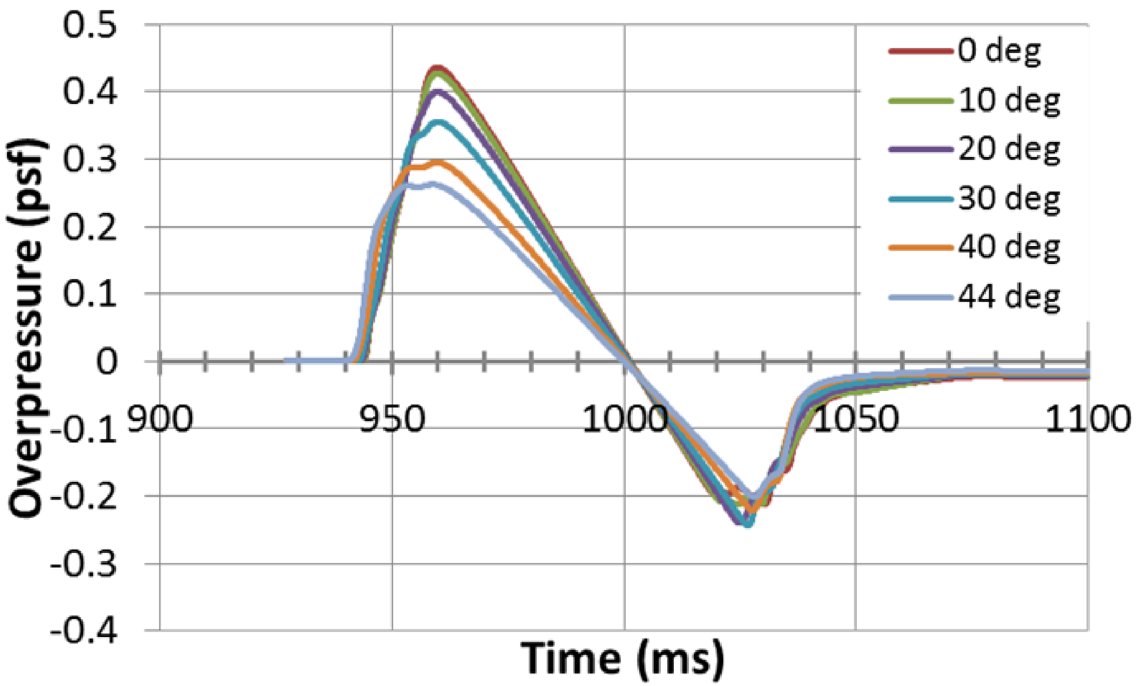
DESIGN FEATURES

SHAPED BOOM PERFORMANCE

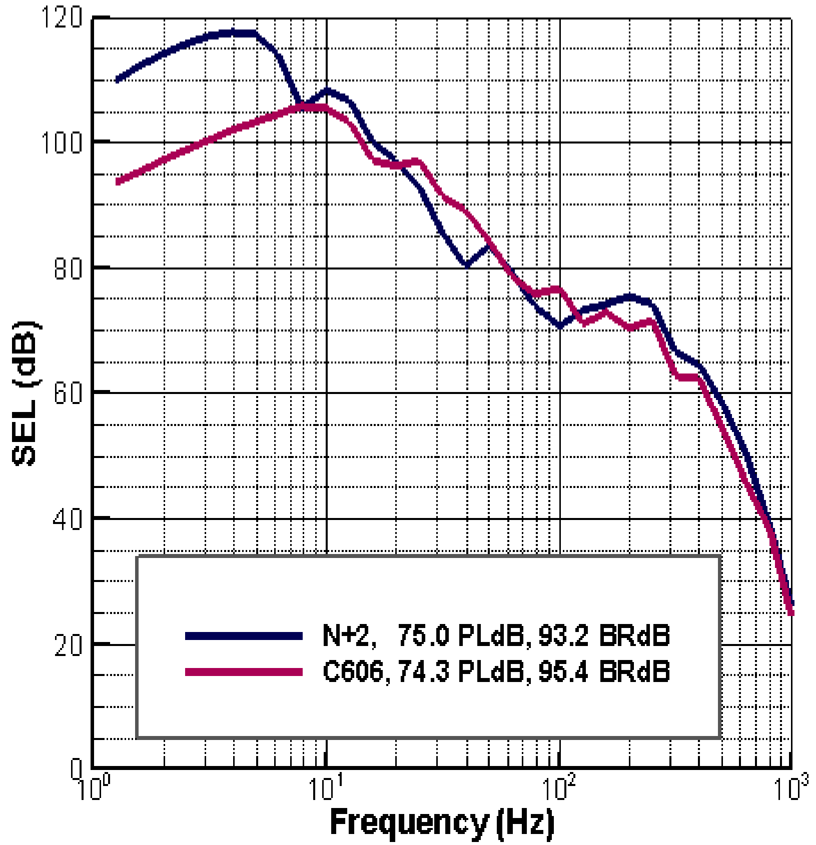


C606 trimmed at Wt=18,800 lb
M1.42 Alt=54,000 ft AOA=1.70 deg CGLOC=844 in PC=122 Tail Incidence=2.60 deg

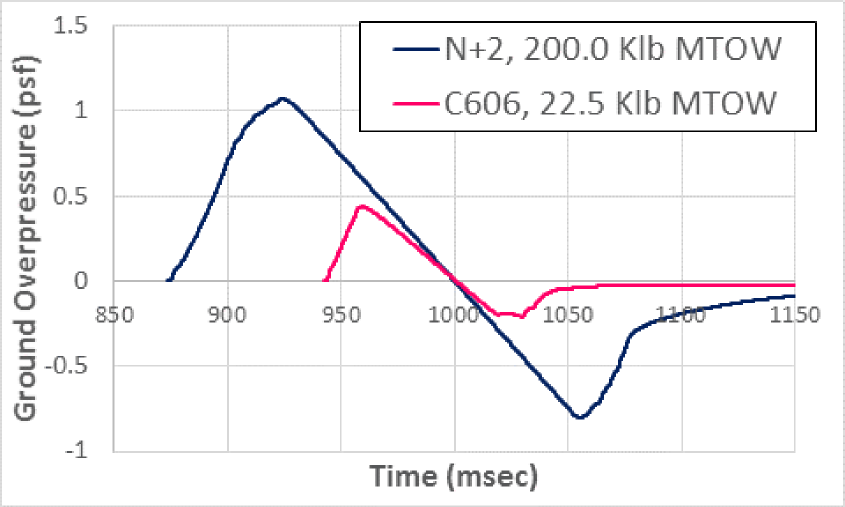




SIGNATURE TRACEABILITY



- N+2 frequency content matched at all frequencies over 8 Hz
- Variability at all frequencies and/or increased high frequencies to match a range of possible products



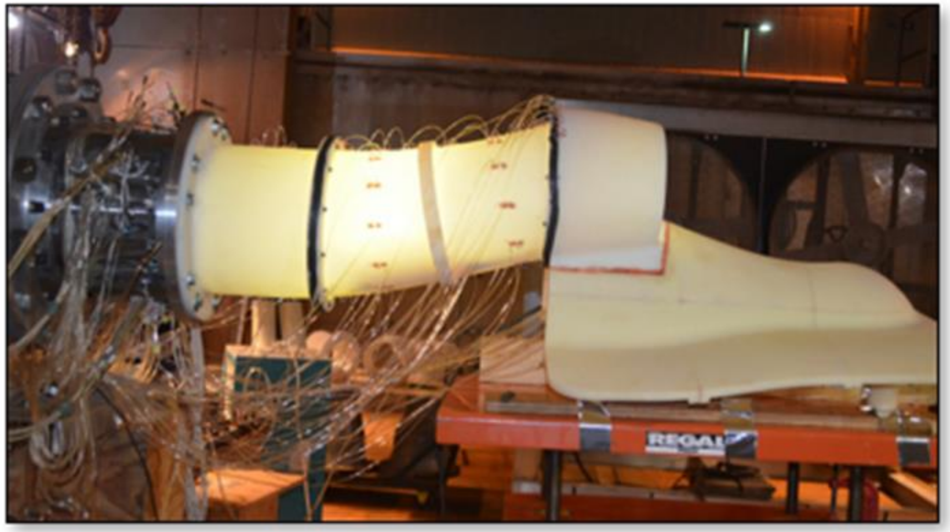
PRELIMINARY DESIGN ACCOMPLISHMENTS

- Design maturation
- Subsystem integration
- Control law development
- High Speed Wind tunnel aerodynamic and inlet performance validation

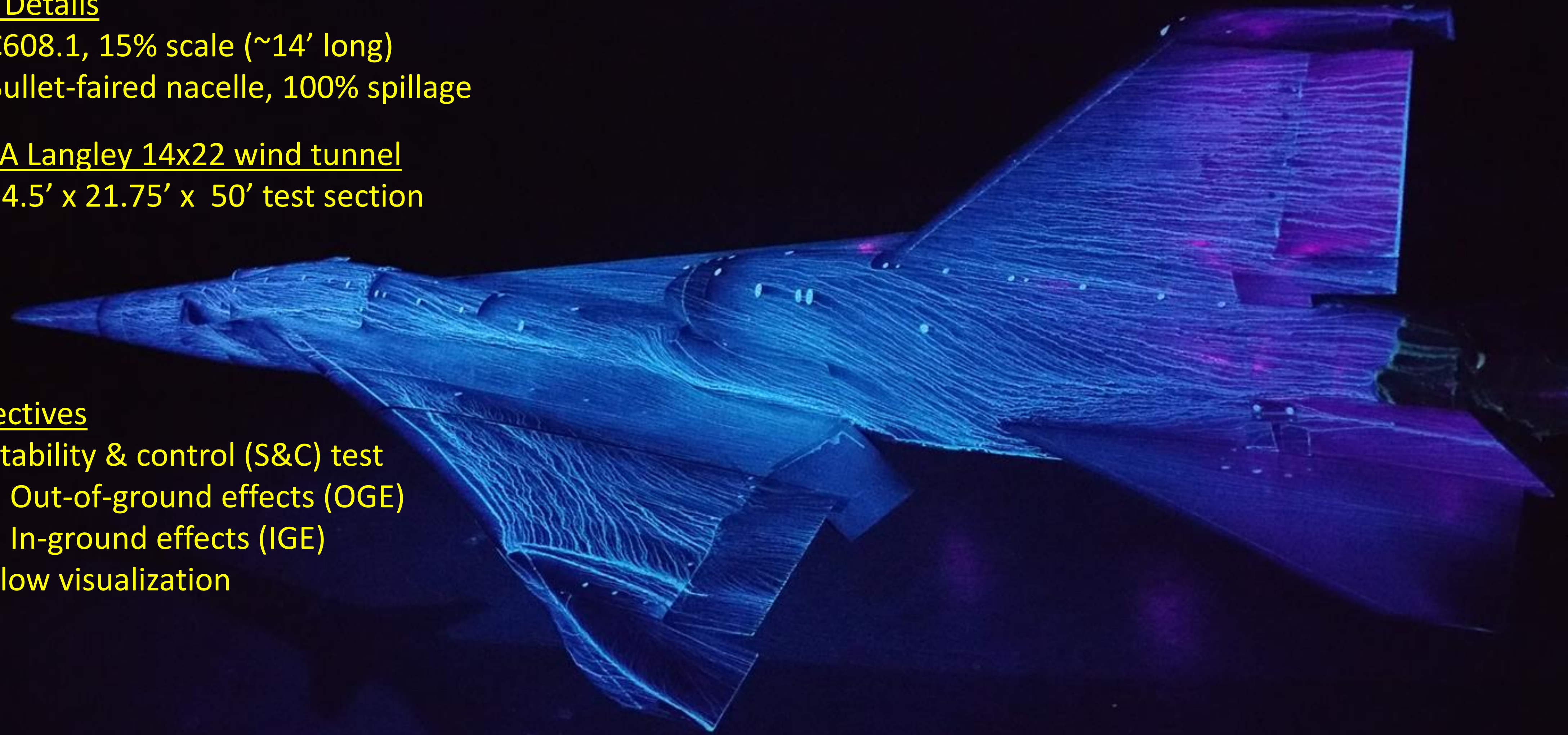
Photo Credit: Bridget Caswell, NASA

PRELIMINARY DESIGN ACCOMPLISHMENTS

- Low speed wind tunnel model test - Validation of low speed stability and control predictions
- Static inlet test – Validation of static and low speed inlet performance
- Cockpit Mock-Up fabrication



LOW SPEED WIND TUNNEL TEST OVERVIEW



Test Details
- C608.1, 15% scale (~14’ long)
- Bullet-faired nacelle, 100% spillage

NASA Langley 14x22 wind tunnel
- 14.5’ x 21.75’ x 50’ test section

Objectives
- Stability & control (S&C) test
  - Out-of-ground effects (OGE)
  - In-ground effects (IGE)
- Flow visualization

Questions?

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