National Aeronautics and Space Administration

Quiet SuperSonic Technology (QueSST) Aircraft Preliminary Design Status and Low-Boom Flight Demonstration (LBFD) Project Update

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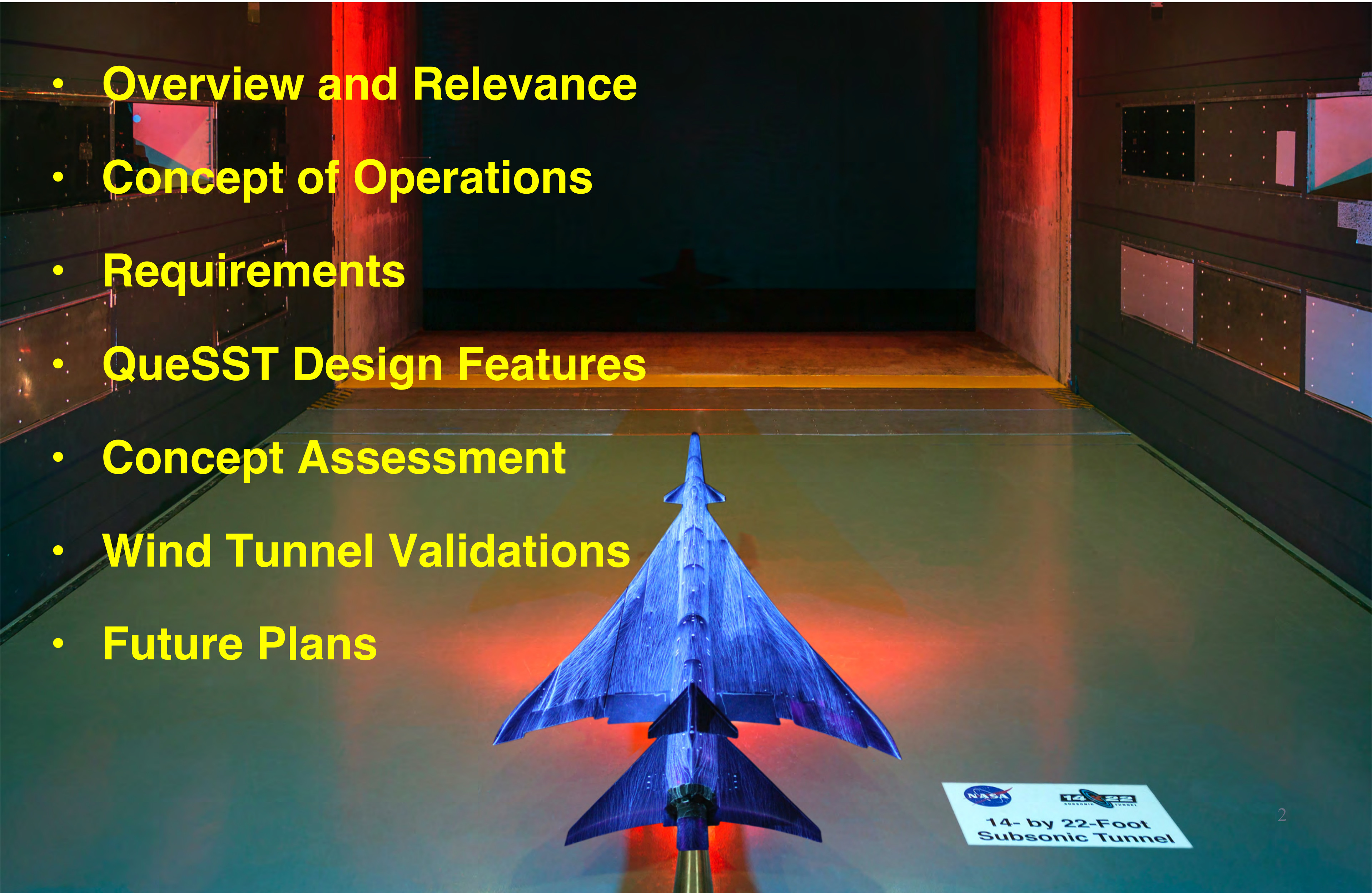
AIAA SciTech 2018
APA-11 Low-Boom Activities
Kissimmee, FL

Credit: Lockheed Martin Corporation

Outline

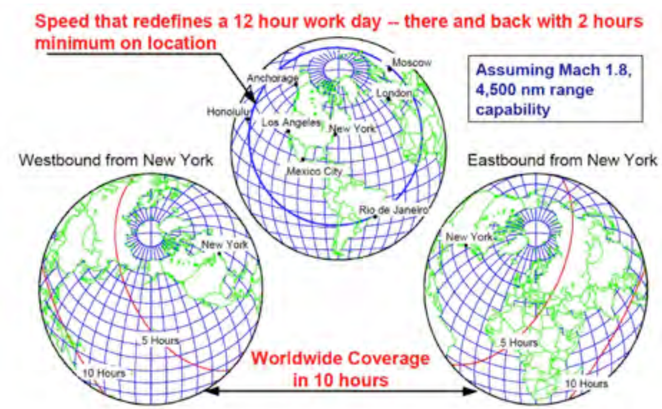
- Overview and Relevance
- Concept of Operations
- Requirements
- QueSST Design Features
- Concept Assessment
- Wind Tunnel Validations
- Future Plans



Innovation in Commercial Supersonic Flight

Why?: Commercial supersonic flight represents a potentially large new market for aircraft manufacturers and operators world-wide

- Global demand for air travel is growing, which places a demand on speed
- Supersonic aircraft will be excellent export products that can be capitalized on by the US to support a positive balance of trade



- New supersonic products lead to more high-quality jobs in the US
  - Large potential market predicted: - business aircraft followed by larger commercial aircraft
  - Technology leadership established through initial products will lead to development of larger, more capable airliners
- The government plays a central role in developing the data needed for regulation change that is essential to enabling this new capability

Barriers to Commercial Supersonic Flight: Sonic Boom Noise and Overland Flight Prohibitions

- Planned introduction of supersonic commercial transports in 1970's brought the problem of sonic boom noise to public attention
- Community overflight tests in the US and elsewhere showed sonic boom noise to be unacceptable
- Supersonic overflight restrictions followed
  - US: FAA Regulation (FAR) prohibits supersonic flight over US
  - Worldwide: ICAO Assembly Resolution – "No unacceptable situation for the public due to sonic boom"
- Restriction dramatically limited market potential for supersonic commercial aircraft

Credit: Concorde G-BOAC by Eduard Marmet
https://en.wikipedia.org/wiki/Concorde_aircraft_histories#/,
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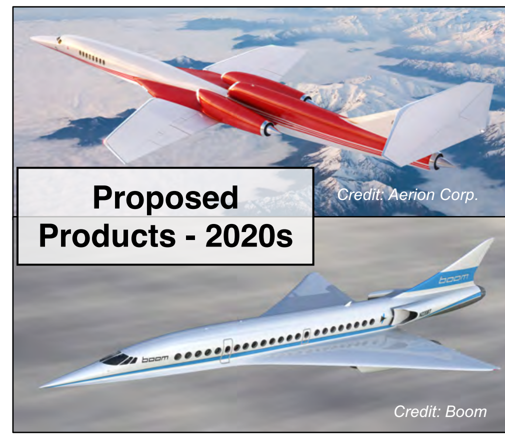


Credit: Aerion Corp.
Credit: Boom

- The vision of the Supersonics Community is a future where fast air travel is available for a broad spectrum of the traveling public.
- Future supersonic aircraft must be able to fly overland without creating an "unacceptable situation" and compared to Concorde, be efficient & green
- The creation of overland certification requirements based on acceptable noise levels will enable this vision

Background and Overview

Overcome the sonic boom barrier and open the door for development of a new generation of environment-friendly supersonic civil transport aircraft

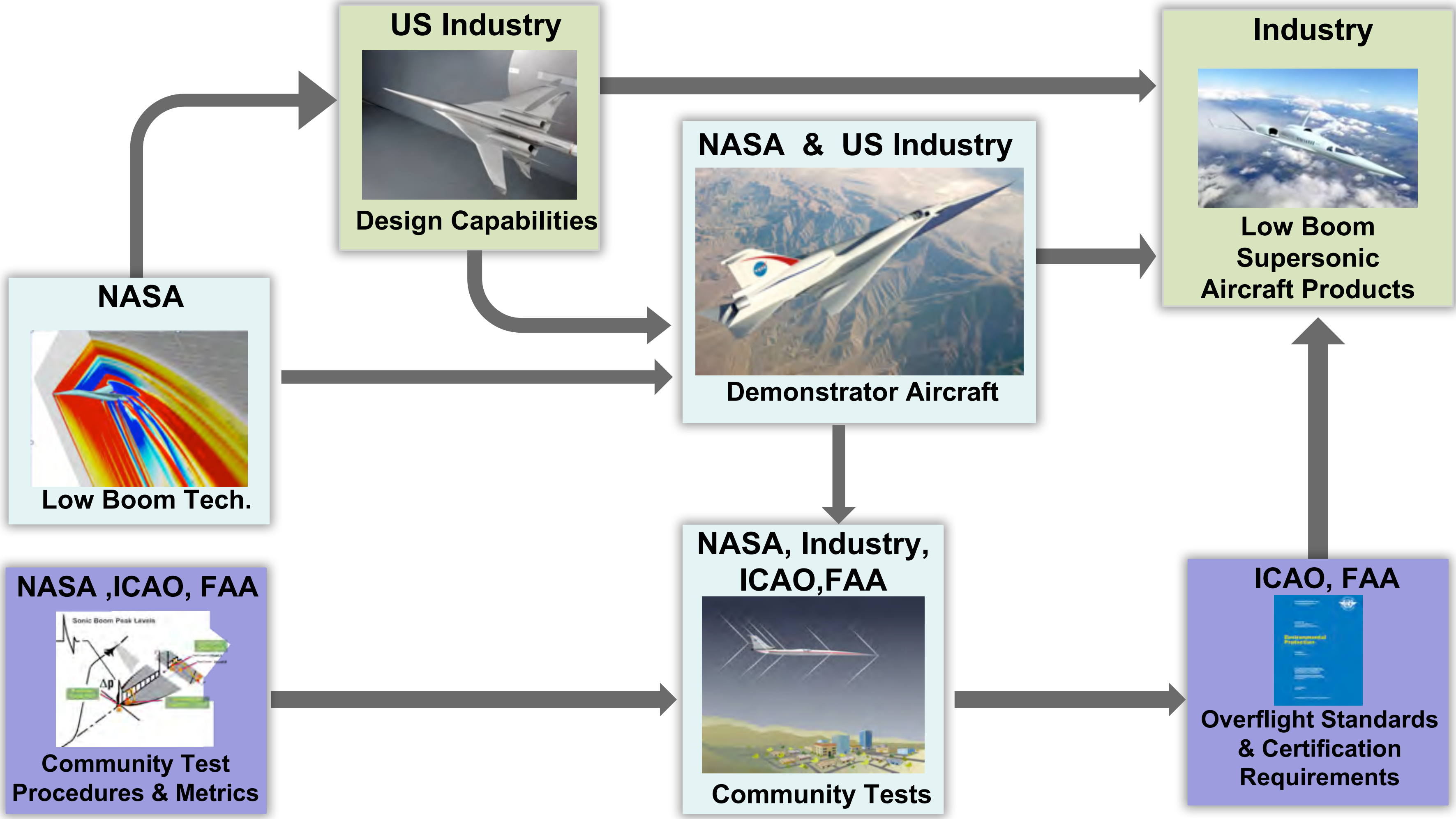
Overall Requirement

- Demonstrate that noise from sonic booms can be reduced to a level acceptable to the population residing under future supersonic flight paths
- Create a community response database that supports an International effort to develop a noise based rule for supersonic overflight

Approach

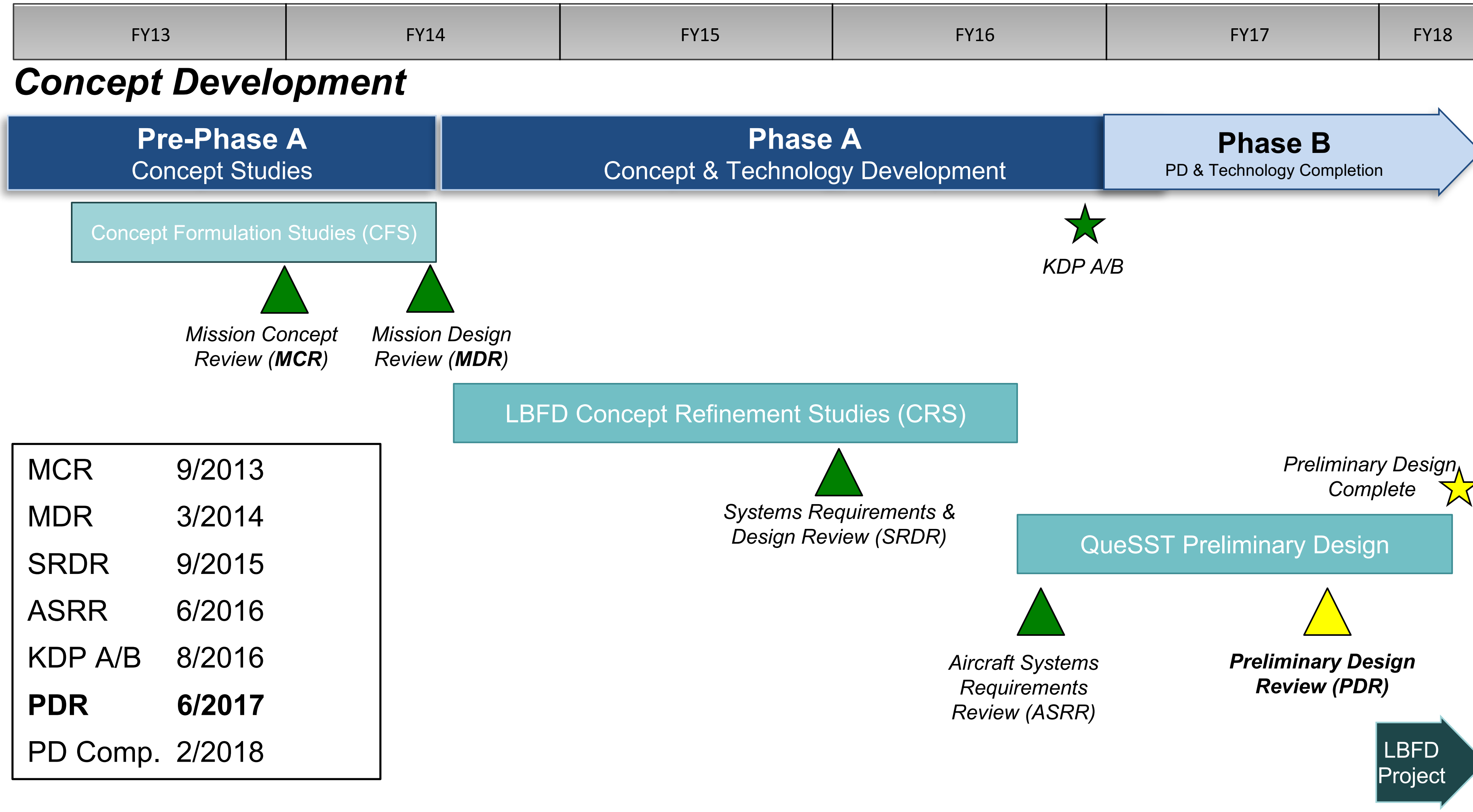
- Partner with regulatory agencies and communities to create a roadmap for community response study and rule development – with Commercial Supersonic Technology (CST) Project in Phase 3
- Revitalize the excitement of manned X-Planes using a focused and cost-effective approach to design and operate a low boom research aircraft
- Partner with industry and OGAs to formulate, obtain approval and execute

Roles - Supersonic Overland Flight



- NASA has invested in supersonic tools and technologies in partnership with US industry
- Unique NASA role in development of demonstrator
- NASA leadership provides the key data required to determine certification standards for supersonic overland flight

History – Formulation and Concept Studies

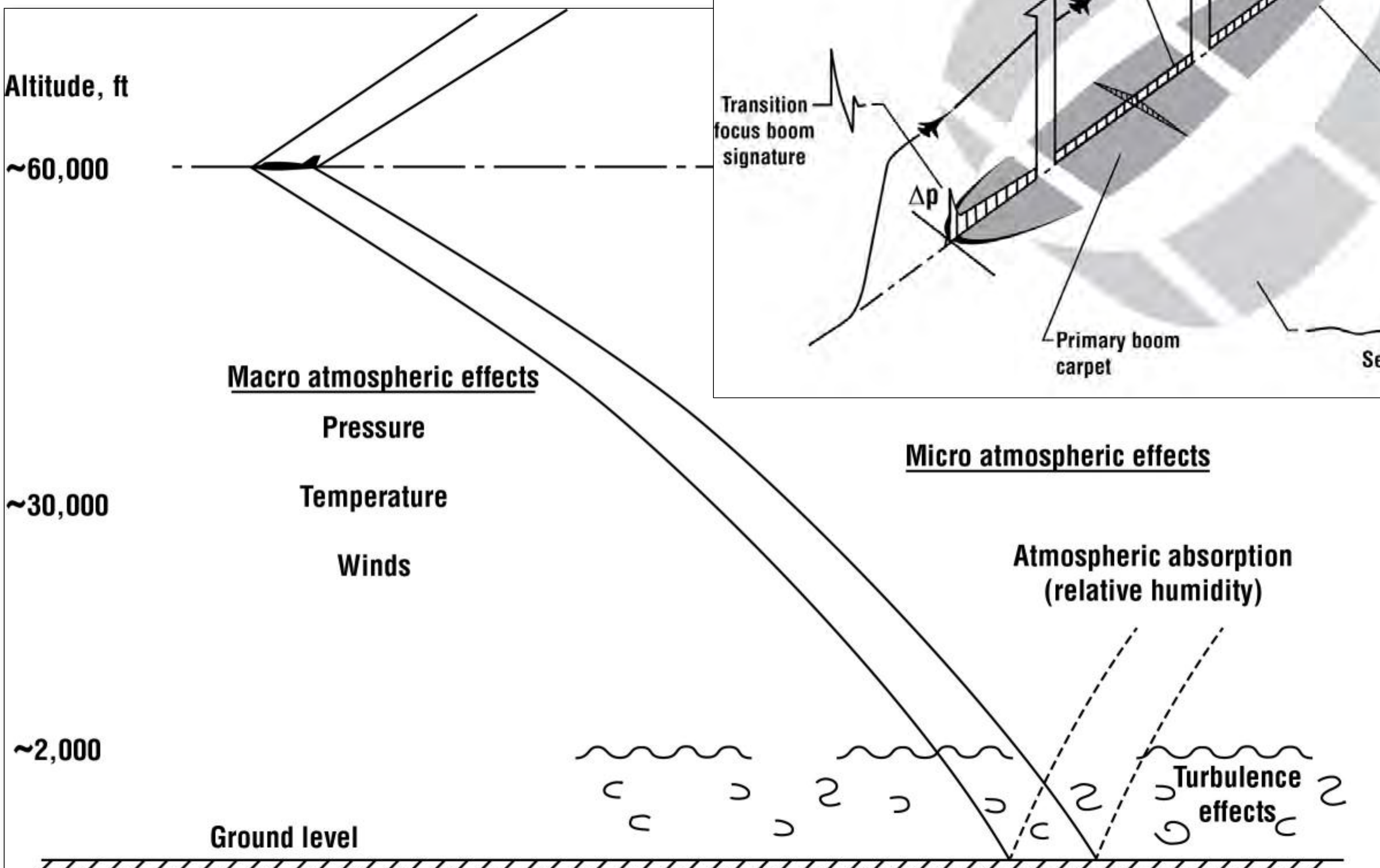


MCR	9/2013
MDR	3/2014
SRDR	9/2015
ASRR	6/2016
KDP A/B	8/2016
PDR	**6/2017**
PD Comp.	2/2018

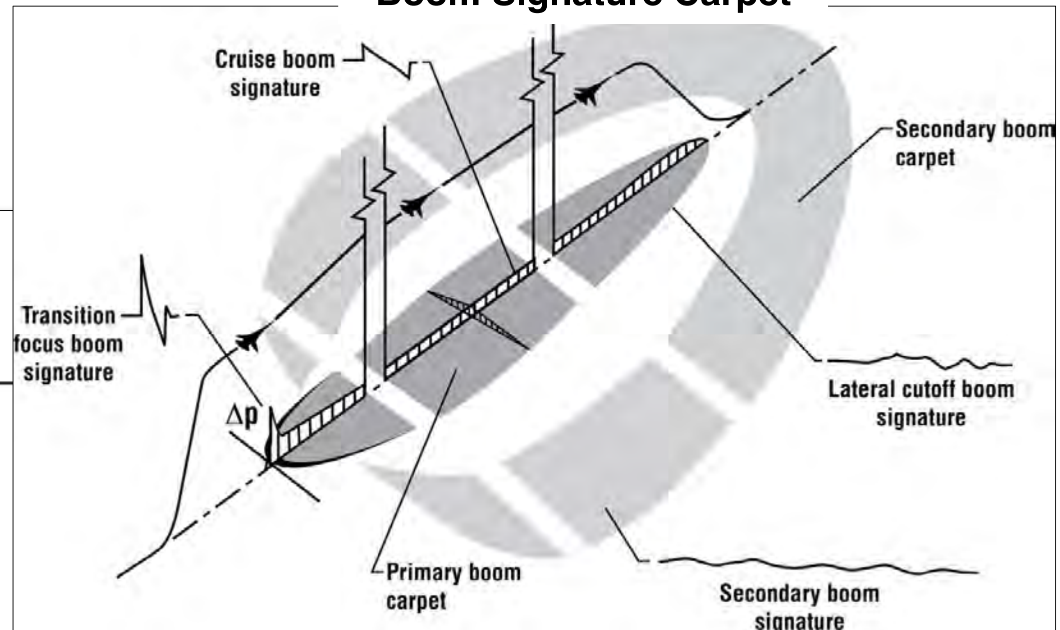
Quiet SuperSonic Technology (QueSST) preliminary design has built a solid technical foundation moving forward with the Low-Boom Flight Demonstration (LBFD)

Sonic Boom 101

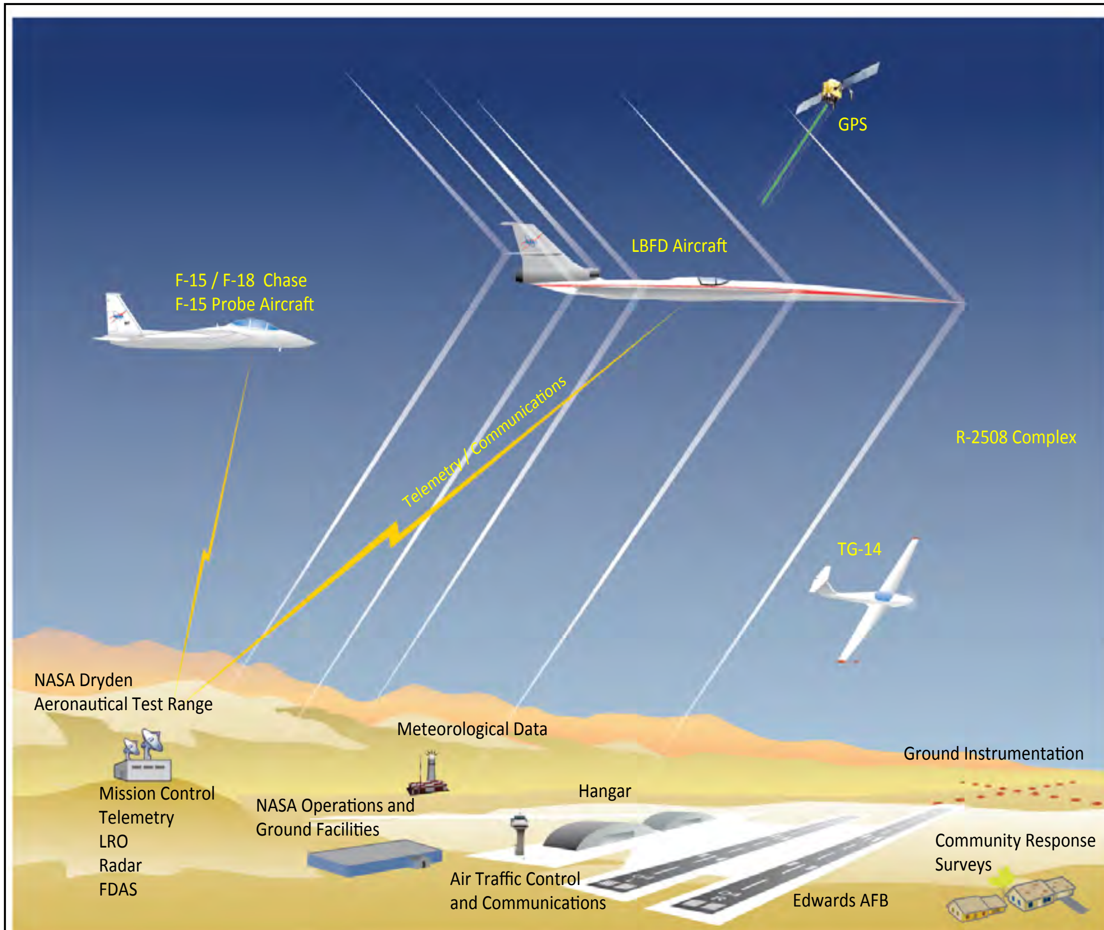
Sonic Boom with Atmospheric Effects



Boom Signature Carpet



Concept of Operations



Project Phases

Concept Studies

QueSST Preliminary Design

Phase 1 - Aircraft Development (LBFD)
- Detailed Design
- Fabrication, Integration, Ground Test
- Checkout Flights
- Subsonic Envelope Expansion
- Supersonic Envelope Expansion

Phase 2 – Acoustic Validation
- Aircraft Operations / Facilities (LBFD)
- Research Measurements (CST)

Proposed follow-on under CST
Phase 3 – Community Response
- Initial community response overflight study
- Multiple campaigns (4 to 6) over representative communities and weather across the U.S.

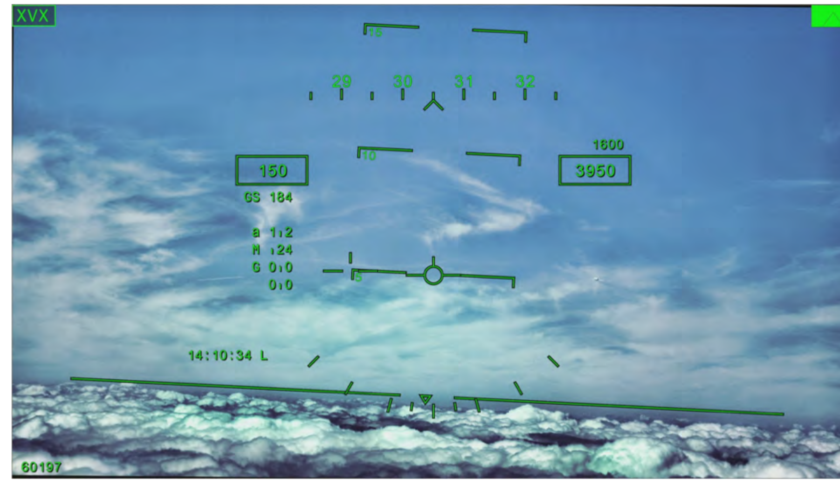
Mission Requirements

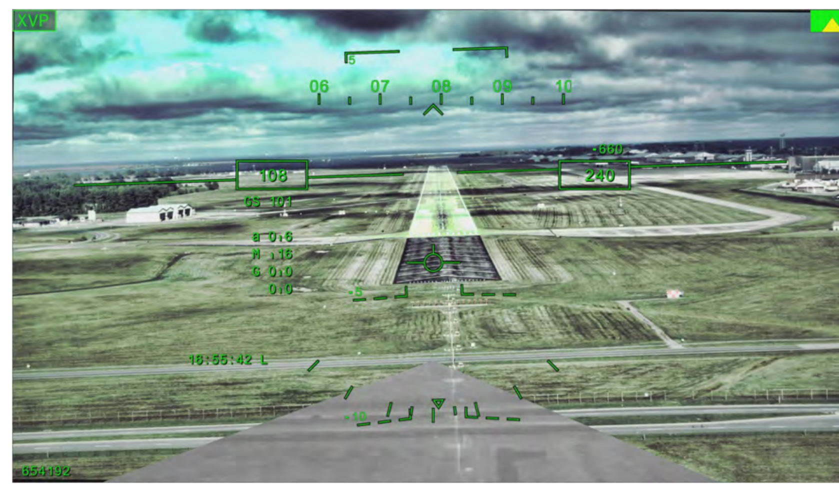
Key Mission Requirements
Ground signature traceability (indoor) - with peak acoustic energy ≤ 10 Hz
Ground signature loudness (outdoor) ≤ 75 PLdB throughout boom carpet
Ground signature variability 70 - 80 PLdB
Cruise deviations (turbulence) - ground signature ≤ 76 PLdB and ≤ 1.4 PLdB RMS
Cruise Mach ≥ 1.4
Two passes ≥ 50 nm in length per flight, passes ≥ 20 minutes apart
Three flight operations / day
Day and night flight operations in the public airspace
IFR flight operations
Forward visibility (see-to-avoid/land)
Low/no-focus supersonic acceleration/climb performance
Mission performance (hot day)
Potential for alternate fuels

QueSST Aircraft Preliminary Design Overview

eXternal Vision System (XVS)

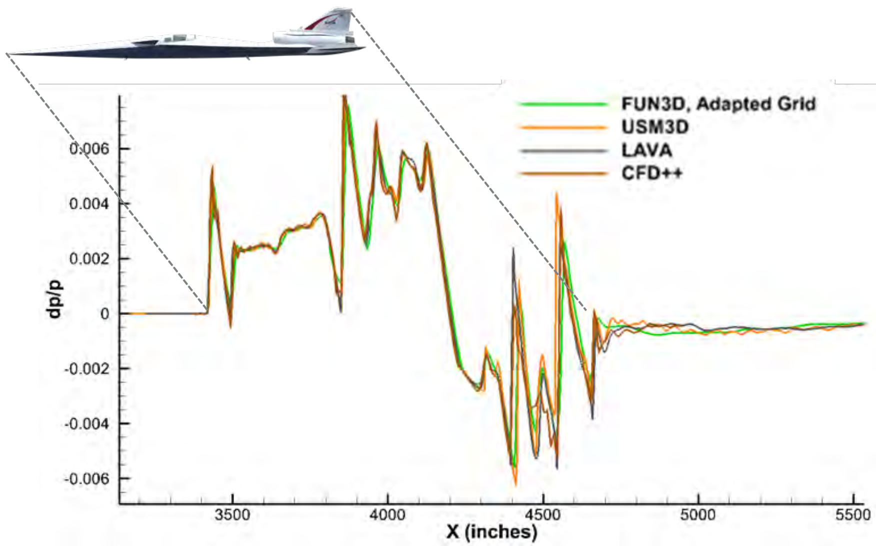
XVS - enabling technology - combination of Ultra-High -Definition (UHD) sensor, display, and image processing technologies to provide visibility of the external scene for the flight crew and comparable to forward-facing windows in conventional aircraft

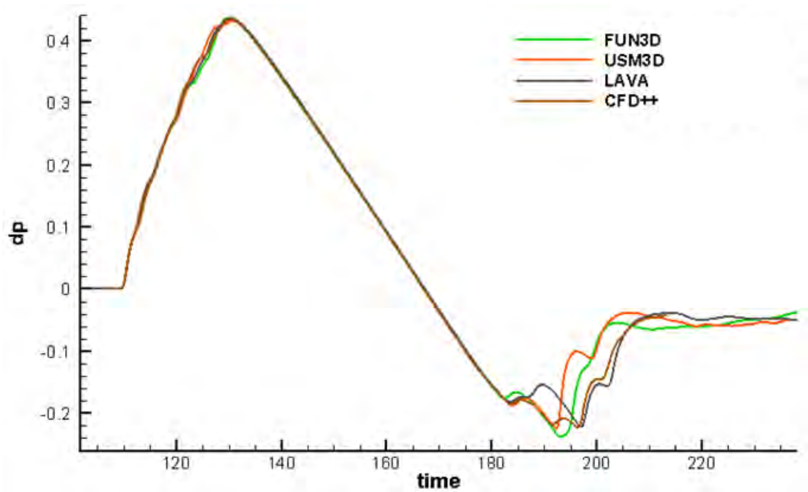




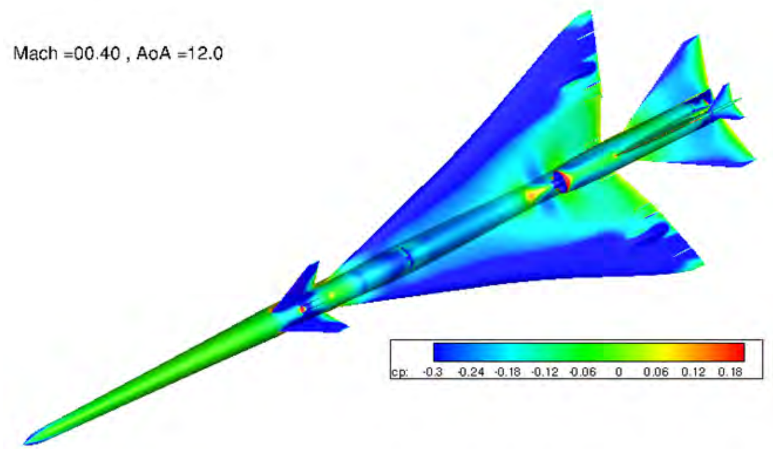
Concept Assessments

Sonic Boom

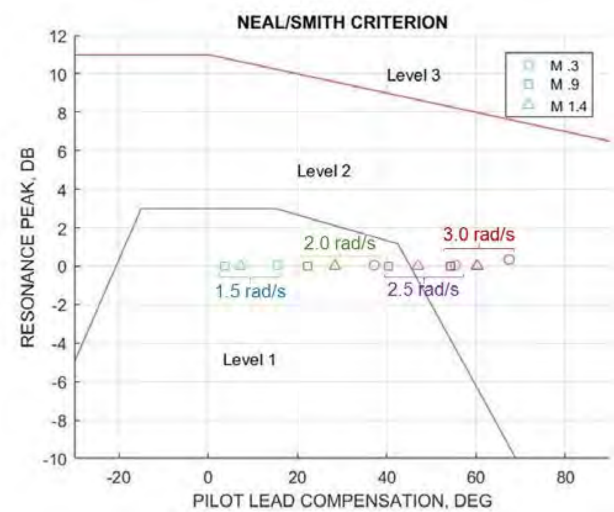




Aerodynamic Performance

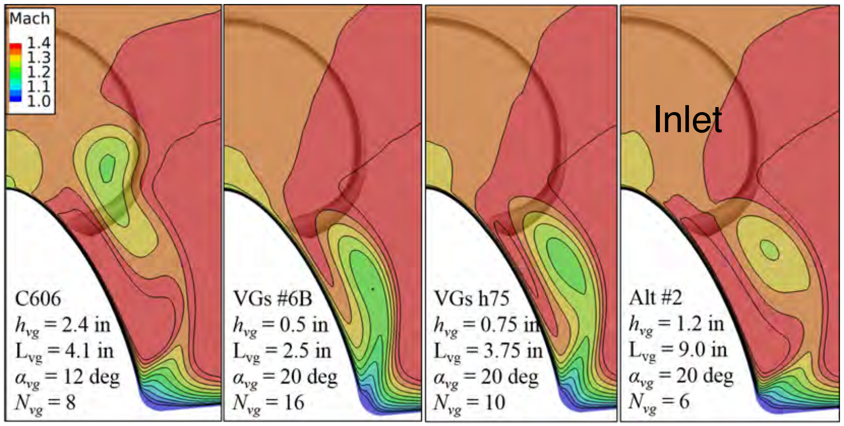


Handling Qualities

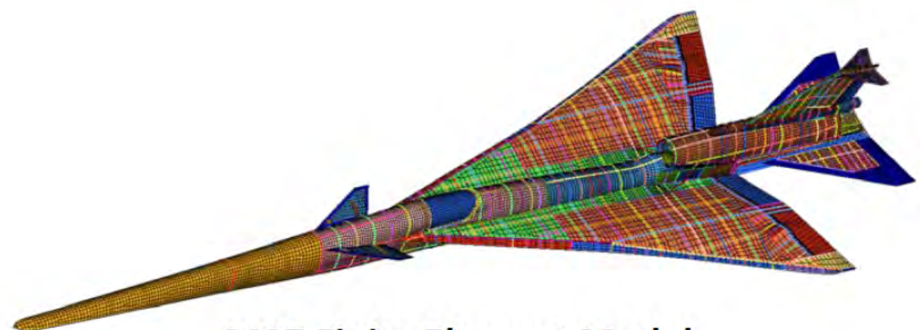


Other Concept Assessments

Inlet Flow / Vortex Generators

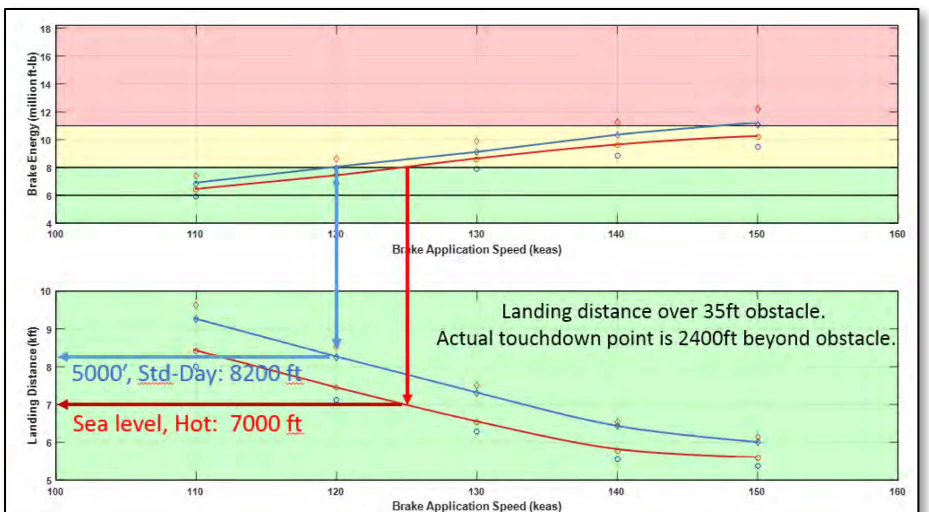


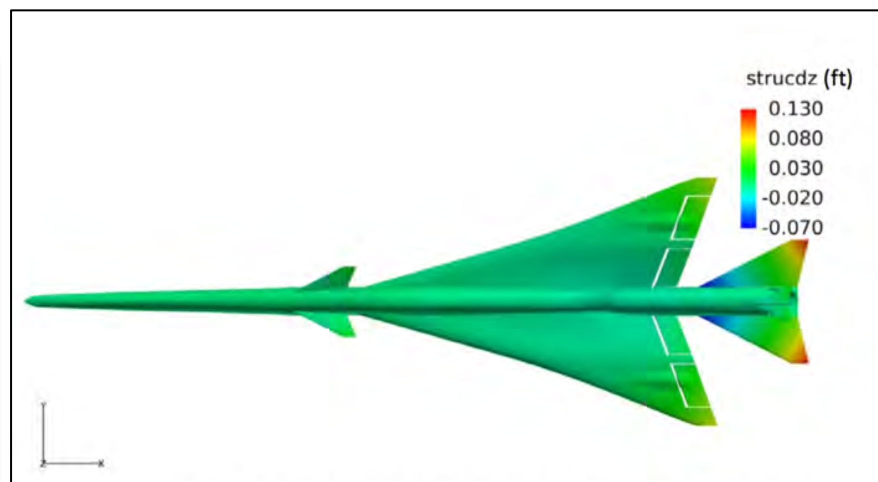
Structural Modeling



C607 Finite Element Model

Trade Studies (Brake vs Drag Chute)

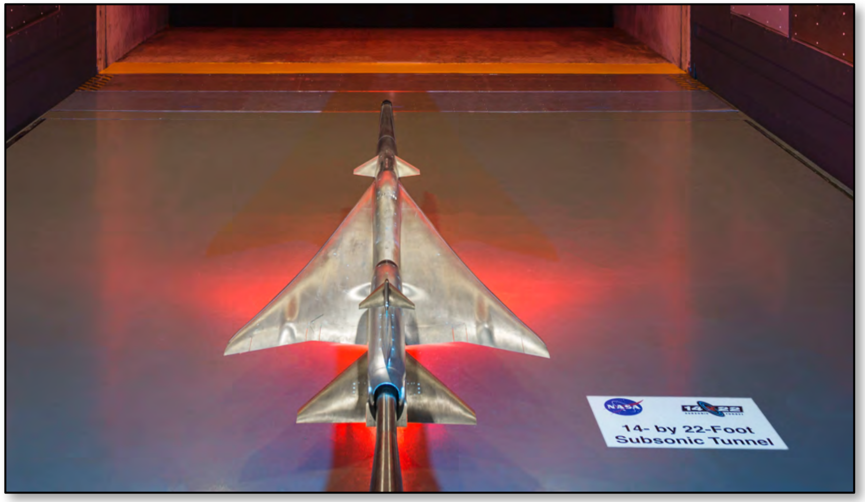


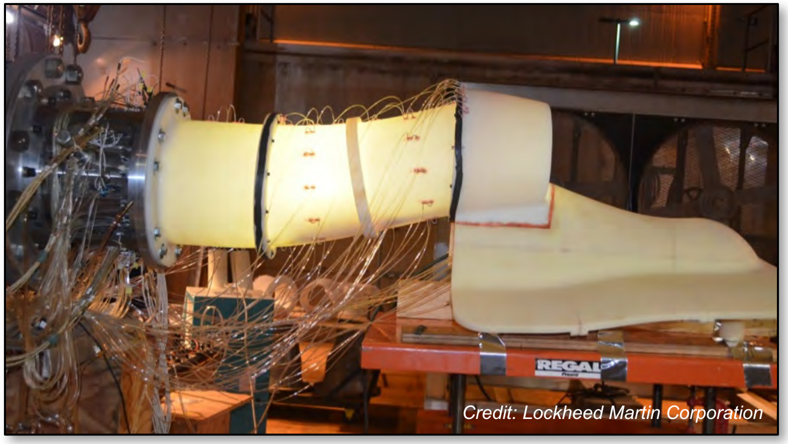


Aeroelastic deformation under 1-g cruise condition used to derive jig shape.

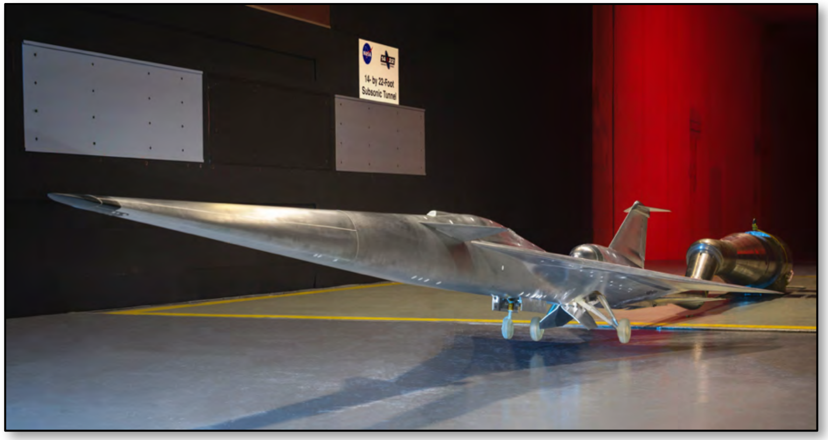
Wind Tunnel Validations

Low-and high-speed Aerodynamic and Propulsion Airframe Interaction (PAI) wind-tunnel tests to validate predictions/data and ensure readiness of the QueSST Preliminary Design

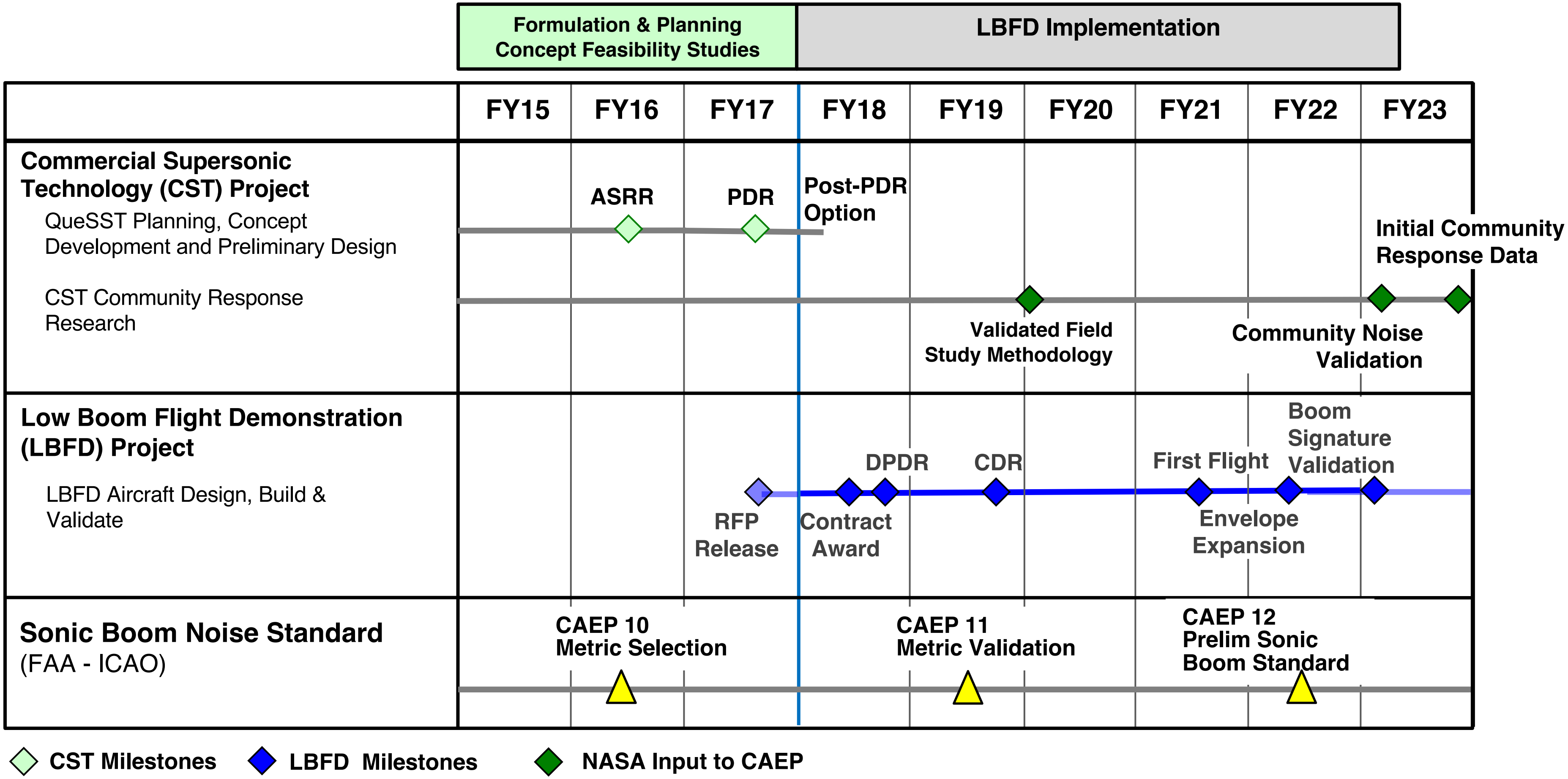




Credit: Lockheed Martin Corporation



LBFD – Future Plans



CAEP – Committee on Aviation and Environmental Protection
ICAO – International Civil Aviation Organization
ASRR – Aircraft Systems Requirement Review

Any Questions?