

NASA “SuperFan” Inlet+Fan Design for Landing and Take-Off (LTO) Noise Assessments

Christopher.J.Miller@nasa.gov

NASA Glenn Research Center

NASA Acoustic Technical Working Group

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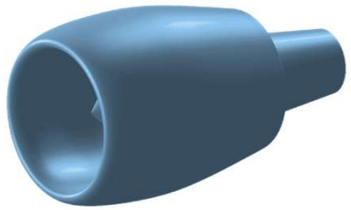
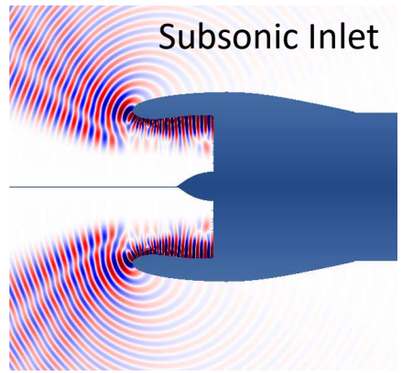
SuperFan Inlet+Fan Design for LTO Noise



Motivation:

Commercial subsonic transport inlet radiated fan noise is well understood:

- Years of experience
- Multiple datasets
- Validated tools (empirical through LES) with acceptable uncertainties

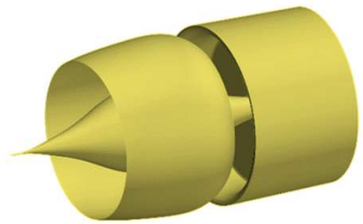


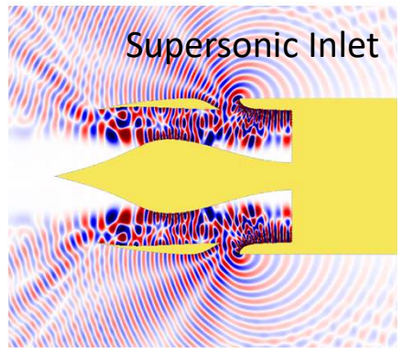
Commercial supersonic transport inlet radiated fan noise has many uncertainties:

- No CST specific public datasets & a limited number of proprietary datasets
- Complex inlet radiation patterns (multiple paths)
- Prediction code uncertainty is unacceptably large

  Prediction uncertainty for supersonic fans is ~4x subsonic

  Greater than **subsonic total** uncertainty from prediction, design, and test
- Government, Industry and Regulators need better predictions





SuperFan Inlet+Fan Design for LTO Noise

Objective

Develop a non-proprietary flow-path and fan design, relevant to a commercial supersonic transport, to enable Landing/Take-Off noise predictions ~~and wind tunnel model development~~.

Approach

RTAPS2 contract task to GE Aviation, awarded Sep 2019

- Relevant: design point for Mach 1.4 cruise
- Non-proprietary, but export controlled
- Period of performance:

  ~~Jan 2020 – Dec 2022 (COVID, descoped)~~

  Jun 2020 – Jun 2022, design by Apr 2021

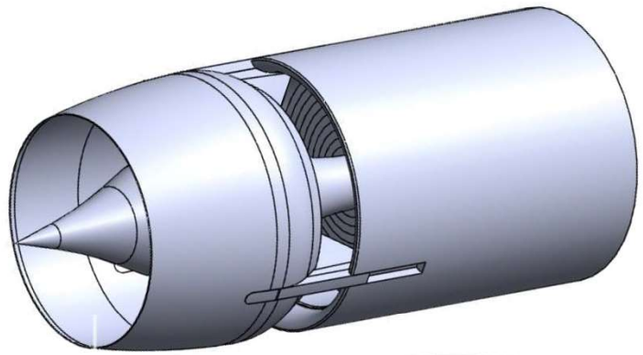


SuperFan Inlet+Fan Design for LTO Noise

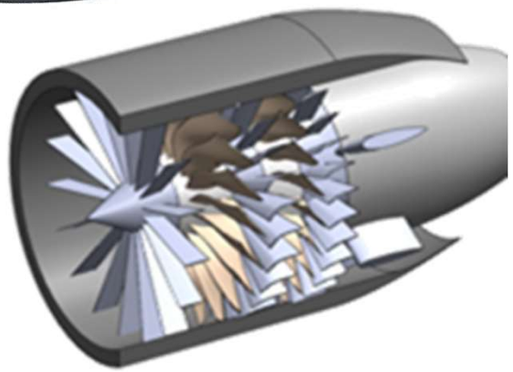
Resulting Design

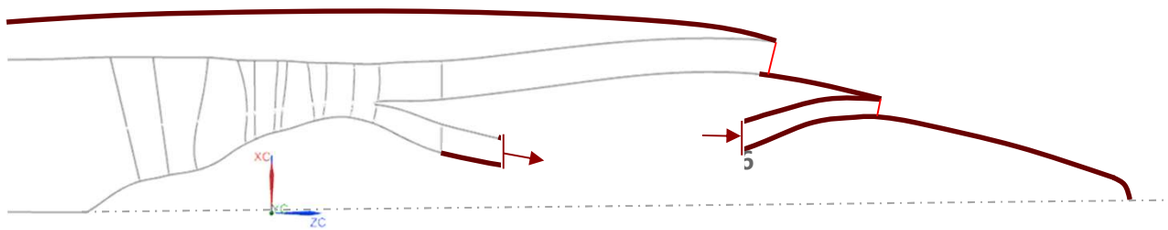
- Axisymmetric inlet slot (ring)
- Asymmetric struts
- Hard-wall, and Inlet acoustic treatment
- 2 stage fan with IGV
- Separate flow nozzles (designed to mixed flow conditions)
- Evaluated at cruise design point, and LTO conditions: Approach, Fly-Over, & Cut Back
- Delivery of
  - CAD flow path surfaces
  - CFD (inlet aero and through the blade rows)
  - Acoustic predictions, and informal reports

LM1044 Concept Supersonic Inlet



NASA Multi-Stage Fan





SuperFan Inlet+Fan Design for LTO Noise

Impact

- First shareable non-proprietary, but exported controlled, geometry
- Enabling tool-chain development & application to a relevant geometry for sensitivities
- Enabling assessment and reduction of prediction uncertainty

Next Steps at NASA

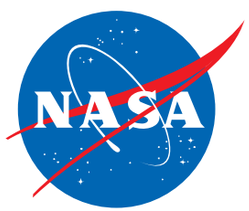
- Aerodynamic analysis and comparisons
  - Inlet design & distortion prediction, FUN3D (John Slater)
  - Unsteady fan aerodynamics, acoustic response, FINE(tm)/Turbo (Ed Envia)
- Acoustic propagation
  - GE's Actran models (David Stephens, Kaiti Stylianides)
  - NASA's Actran (David Stephens, Kaiti Stylianides) & COMSOL (Alexander Svetgoff)

SuperFan Inlet+Fan Design for LTO Noise: Release Process

Release Process for Export Controlled Data

- Informal final reports will be in NASA Scientific and Technical Information Repository, https://ntrs.nasa.gov/
- The release process for geometry and analysis data, also export controlled, is being developed with the NASA GRC Center Export Administrator

QUESTIONS?


NASA

Abstract

The commercial supersonic transport industry needs accurate prediction of landing and take-off propulsion fan noise. To enable improving these predictions, under contract to NASA, GE Aviation designed an inlet, two-stage fan with inlet guide vane, and flow path with separate flow nozzles for a turbofan engine relevant to a commercial supersonic transport application. This non-proprietary, but export controlled, geometry enables cross comparison of predictions, and is a step towards reducing prediction uncertainty. This presentation has the current status of this effort.