ASCENT Project 59B

A059B – Experimental Supersonic Jet Noise Reduction

(Original Title: Jet Noise Modeling and Measurements to Support Reduced LTO Noise of Supersonic Aircraft Technology Development)

Georgia Institute of Technology

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Cost Share Partner: Gulfstream Aerospace Corporation (GAC) (POC: Brian Cook)

PM: Sandy Liu and Muni Majjigi

Objective:

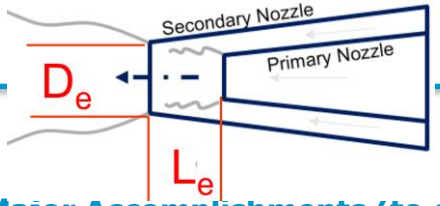
To acquire acoustic and flow measurements to be used by Project 59 jet noise modelers for the validation of low, medium, and high-fidelity jet noise prediction methods for supersonic transport applications (SST).

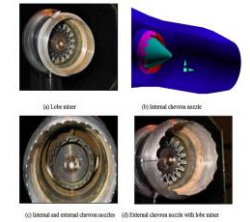
Project Benefits:

The validation of these prediction codes will give confidence in the noise prediction, which will aid in the design of low noise engines for reduced landing and takeoff noise of supersonic aircraft

Research Approach:

- Design and fabricate a simple model-scale test nozzle made of a round core primary nozzle buried in a coaxial secondary flow with the mixed flow exhausting some distance downstream of the primary nozzle exit.
  - Geometry was designed as a scaled model of a paper engine design
- Acquire acoustic and related flow measurements as a function of mixing distance between the primary nozzle exit and the final exhaust nozzle exit
- Provide the measured data to modeling teams for validation of prediction codes
- To simulate increased mixing relevant to realistic situations (Years 2 and 3), GTRI will be applying tabs/ chevrons to the primary nozzle.
- GAC will design and build a simple lobed mixer with a ~2.3-in. equivalent diameter to represent a more realistic primary nozzle. (Current primary nozzle diameter is 1.6 in.)



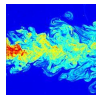


Major Accomplishments (to date):

- The test nozzle designed and fabricated
- The model design shared with the modelers
- Acoustic measurements and unheated primary flow PIV and flow visualization of the simple geometry have been acquired
- All acoustic data and some PIV data have been disseminated to the modelling teams
- Unheated acoustic measurements with two types of tabs have been acquired

Future Work / Schedule:

- Fix Flow facility after second insulation breakage
- Measure remaining acoustic and flow data
- Share all data with modelers and be available for interactions
- Continue experimental investigation on the effects of mixing produced by tabs attached to the primary nozzle and the resulting noise
- Test lobed mixer configuration as designed by GAC



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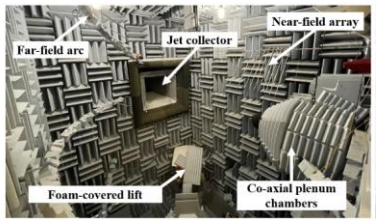
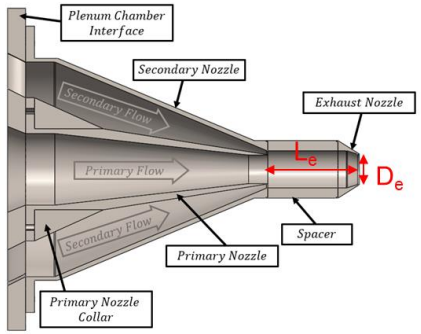
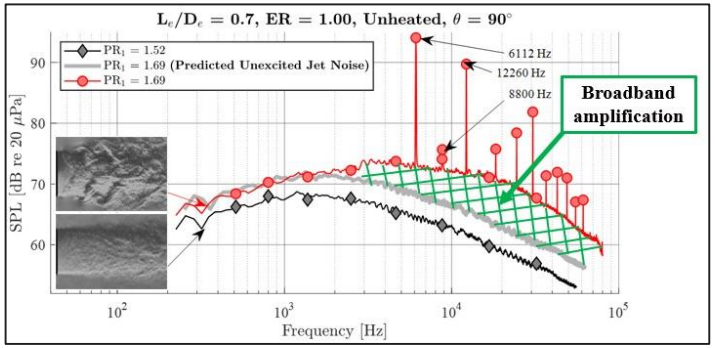
Accomplishments

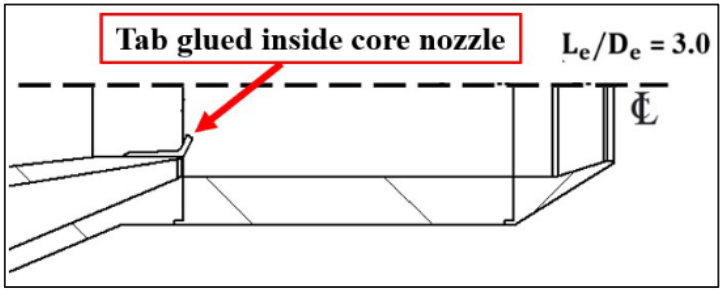




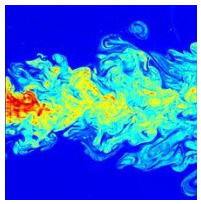
- **Resolved the source of tones in the measurements at High Subsonic Conditions**
  - Have managed to understand the underlying phenomenon
  - Also can eliminate the tones (See typical results later)

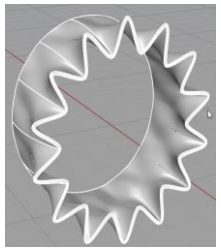


- **Testing Mechanical Tabs as a Simple Forced Mixer**
  - Based on analysis thus far, D tabs decrease noise at low frequencies, but increase noise at high frequencies. This is typical of most mixing enhancement devices



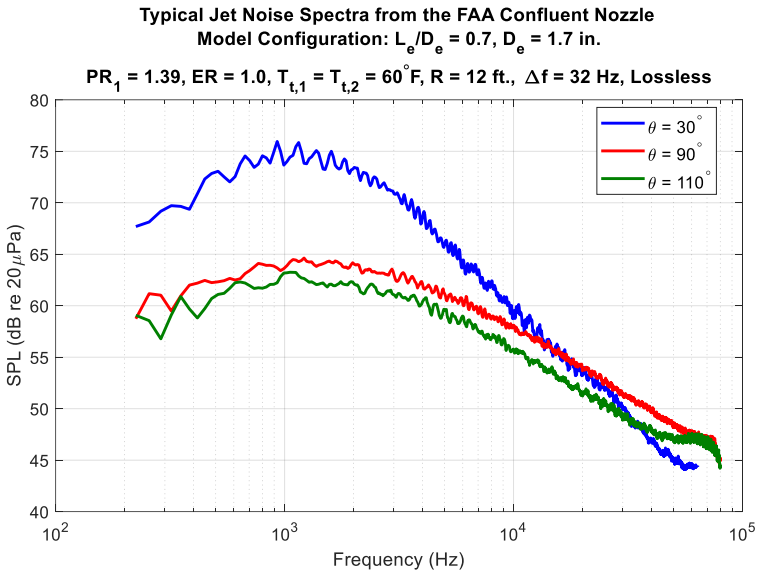
- **Collaborations with GAC**
  - GAC has been using the GTRI PIV and schlieren to validate CFD
  - GAC has designed a new model for the ASCENT 59 program which will have lobed mixer as the core nozzle
    - This new model will be the focus of the Year 3 efforts

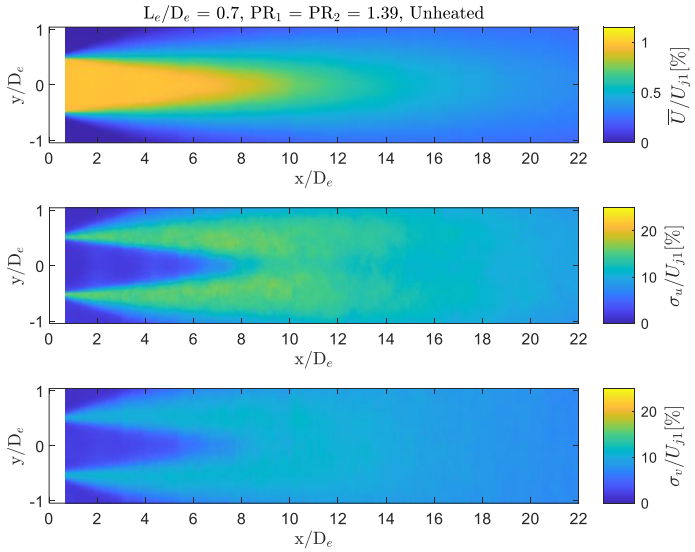


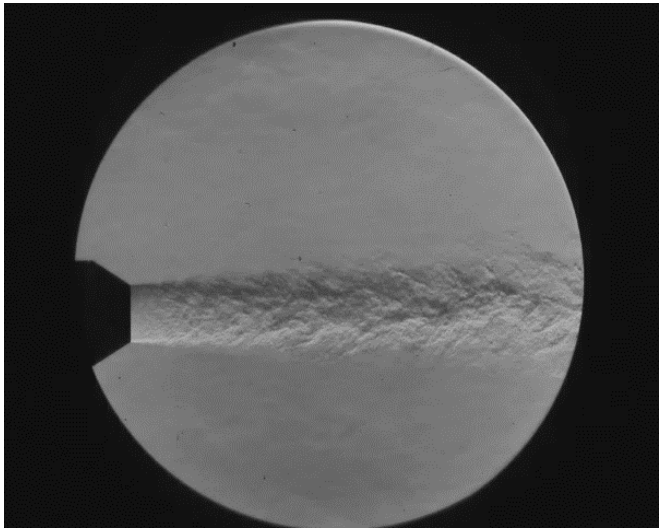


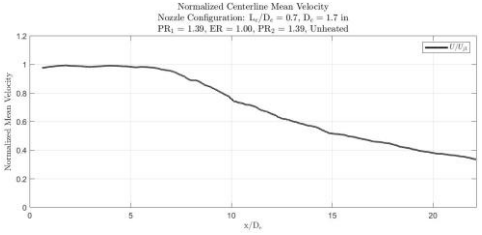
- **Collaborations with Modelers**
  - Supplied data to modelers

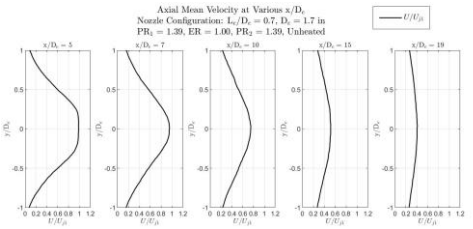
Typical Data Released to Modelers

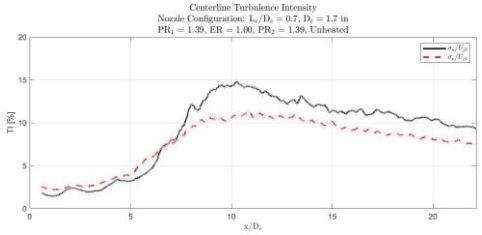


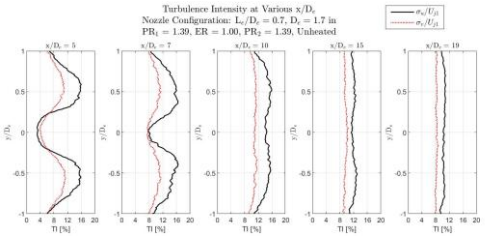




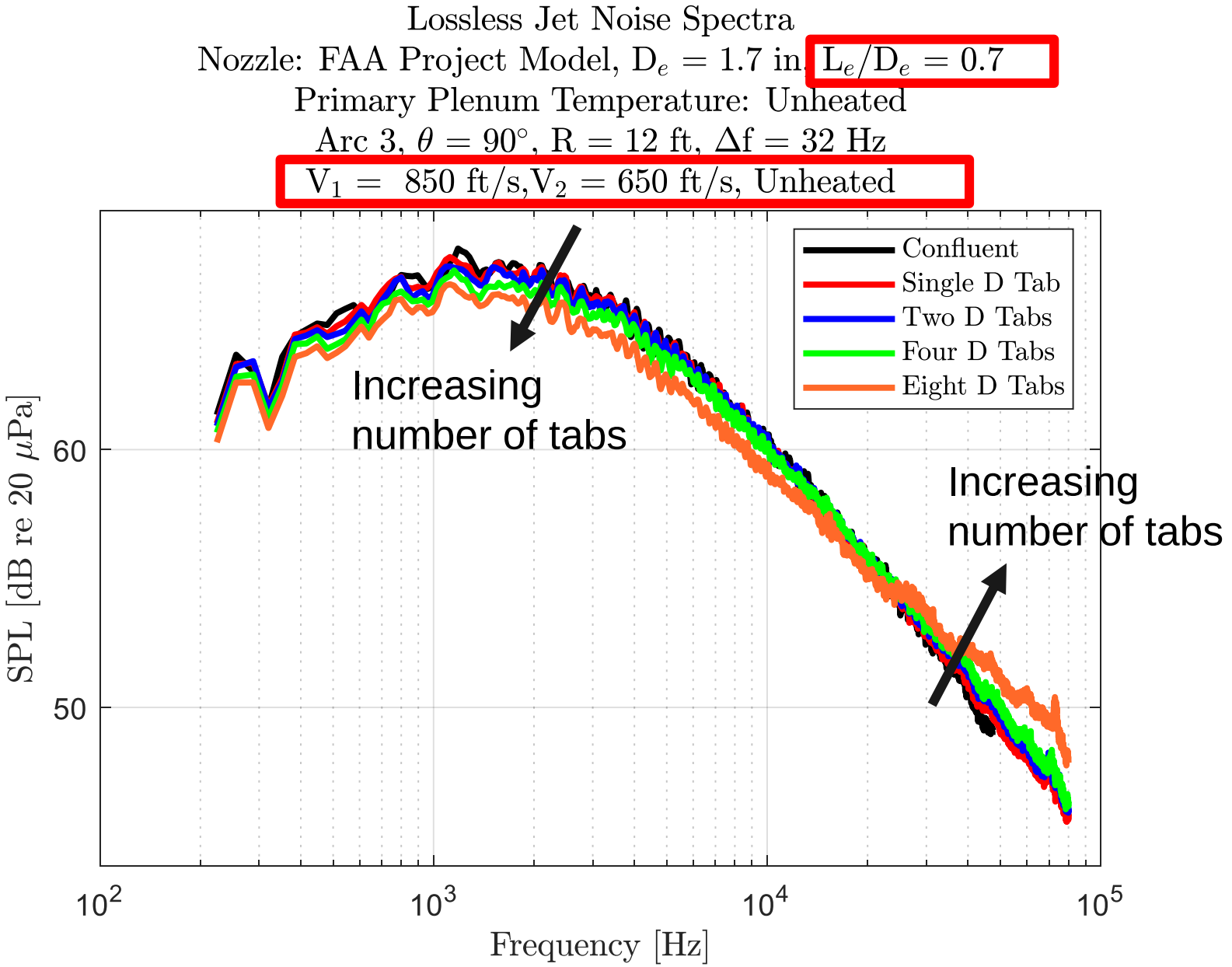






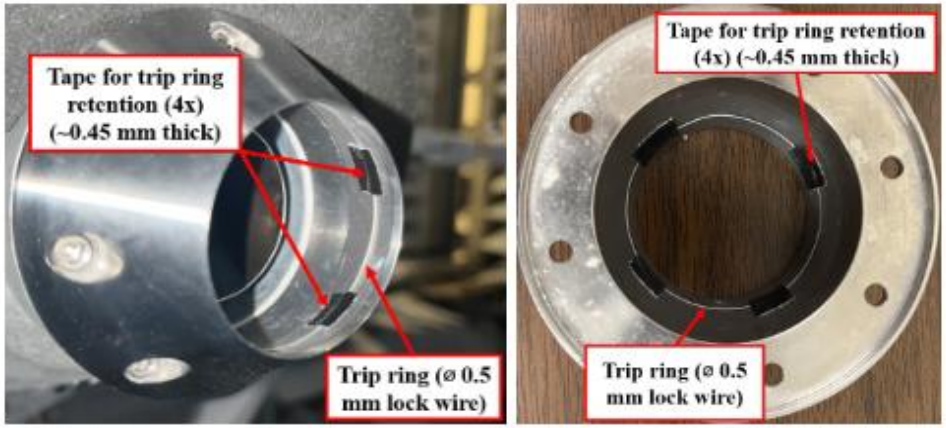


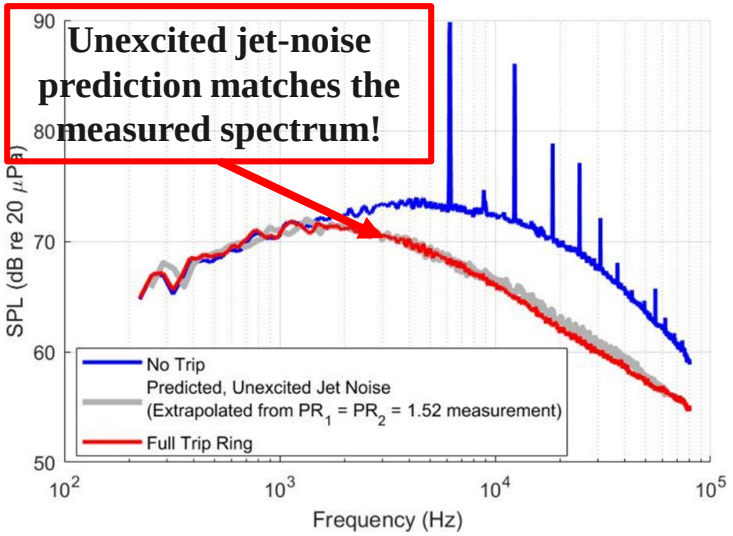
Noise Changes via Tab Mixing (Data being Analyzed)



BL Trip Suppresses Resonance (NSF Supported Effort)

- A trip ring to thicken the exhaust-nozzle exit boundary layer eliminates the resonance and associated broadband amplification.
- The resonance seems likely to be rooted in boundary-layer separation.
- Not rig-noise related!
- This is part of ongoing work by Dr. Ahuja's GRA Nate Ramsey on the nozzle's resonances.

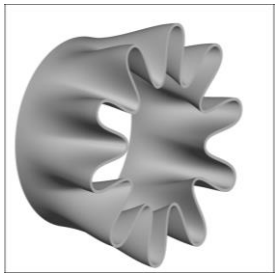




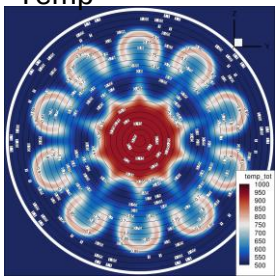
Mixer Design for Year 3 Testing by GT Industrial Partner Gulfstream

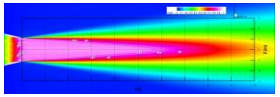
- Scale mixer designed for industry relevance
  - Confluent (not shown)
  - Forced
  - Scarfed
- Secondary nozzle recontoured
  - Eliminates sharp edge and resulting tone from Years 1 and 2 experiments

Forced Mixer

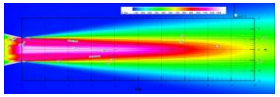


Temp

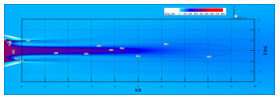




Mach

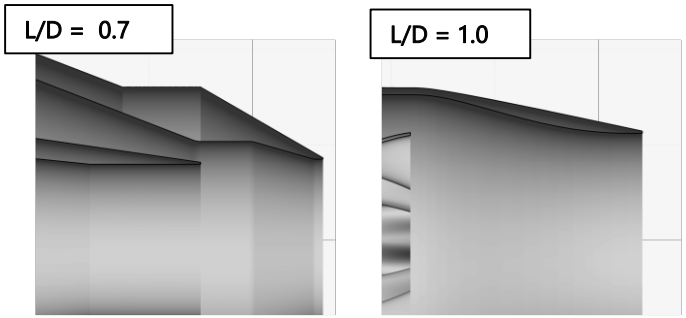


Velocity

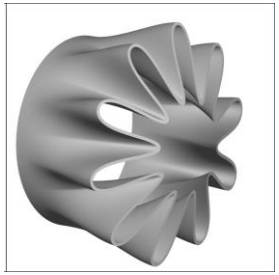


Temp

Secondary Nozzle



Scarfed Mixer



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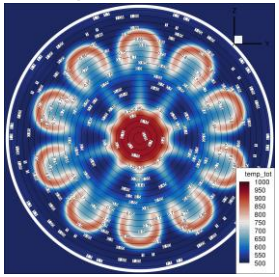

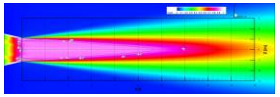

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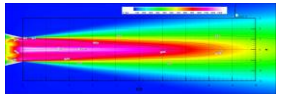
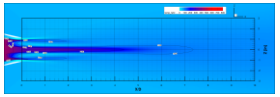


Velocity



Temp

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