



Jet Noise Flyover and Scale Model Tests

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Introduction



Motivation/Objective

- Previous system studies for future supersonic aircraft in support of ICAO efforts indicated jet noise was a dominant noise source
- Uncertainty in jet-noise predictions was unacceptably high
- Predictive tools are based on scale-model data
 - Need to improve comparisons between scale-model and flight data
 - Need to improve models – currently using SAE ARP876

Jets of Interest

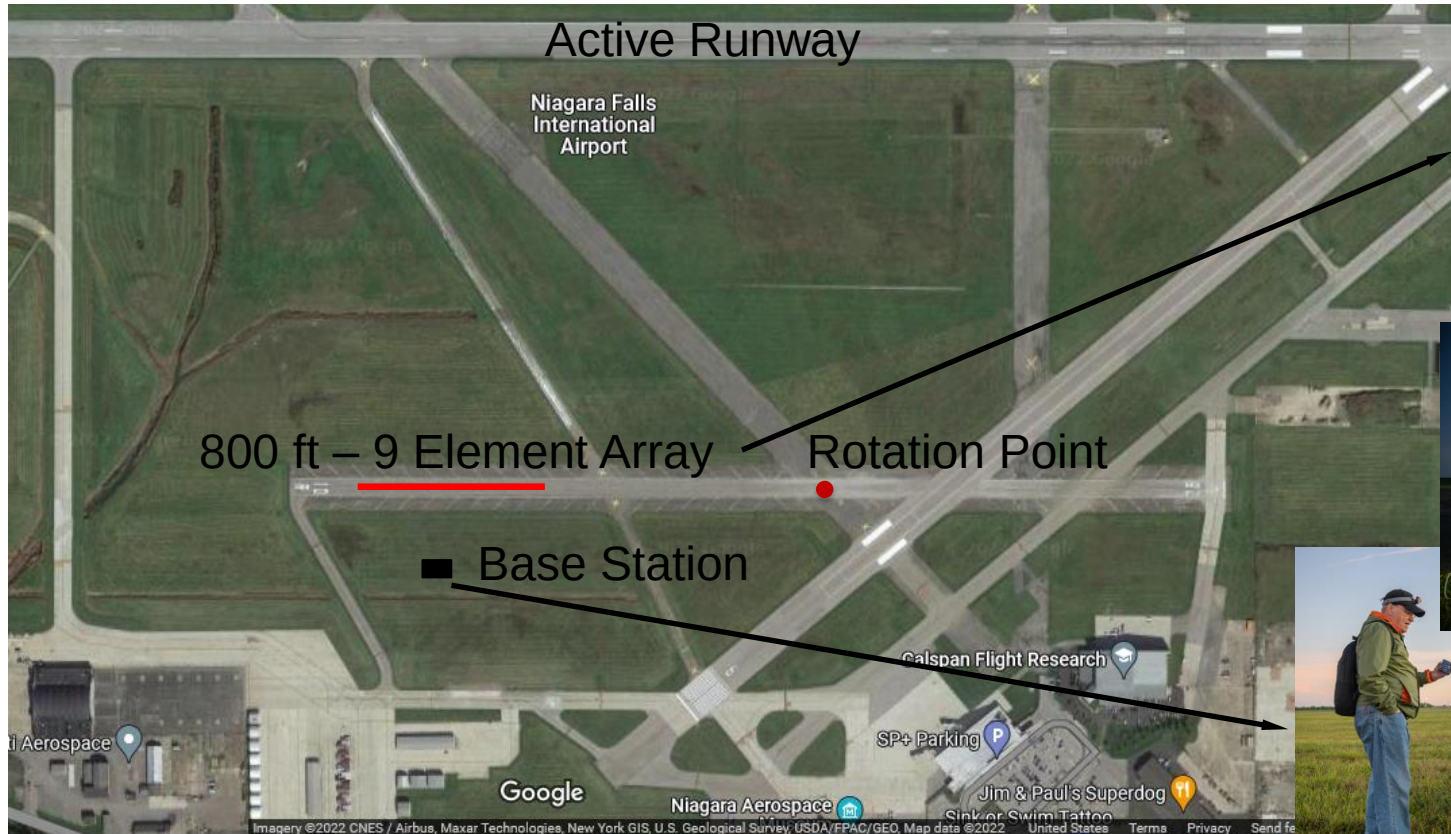
- Single-stream jets
- High subsonic to low supersonic speeds





Recent Flight Test (September 2022)

Niagara Falls International Airport



Instrumentation



- Aircraft owned and operated by Calspan Corp. under NASA contract
- Data acquired by Calspan Corp.
 - Engine Pressure Ratio (EPR), Exhaust Gas Temperature (EGT), and engine RPM recorded continuously, pitot tube pressures for air speed
- Data acquired by NASA
 - Aircraft position (and IMU output)
 - Acoustics from 9 element array
 - Wind speed from the LiDAR system
 - Temperature, pressure, and humidity as functions of altitude from NASA Langley drone

All data were acquired with GPS based timestamps



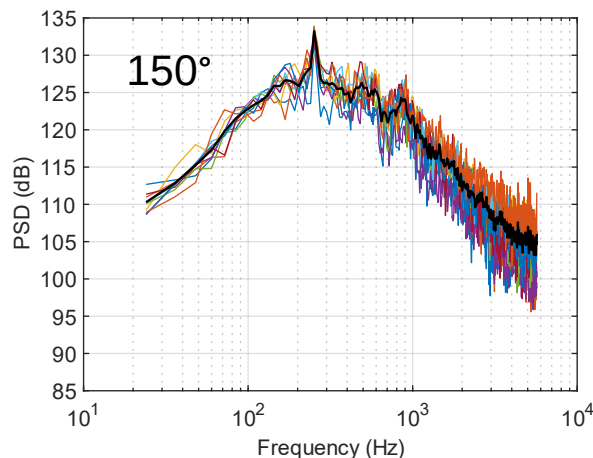
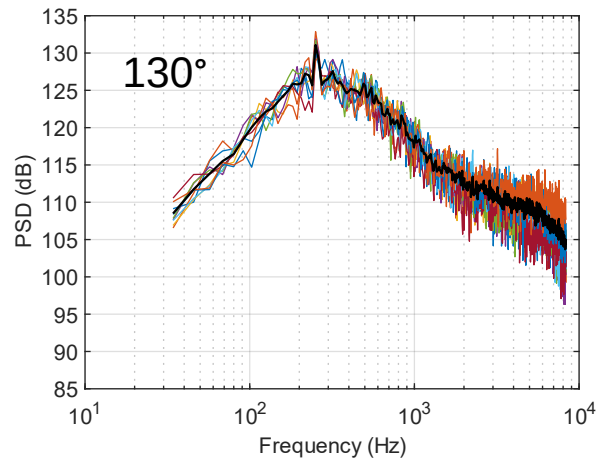
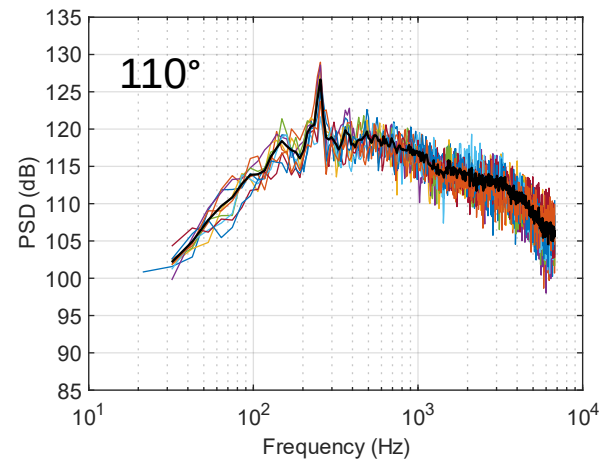
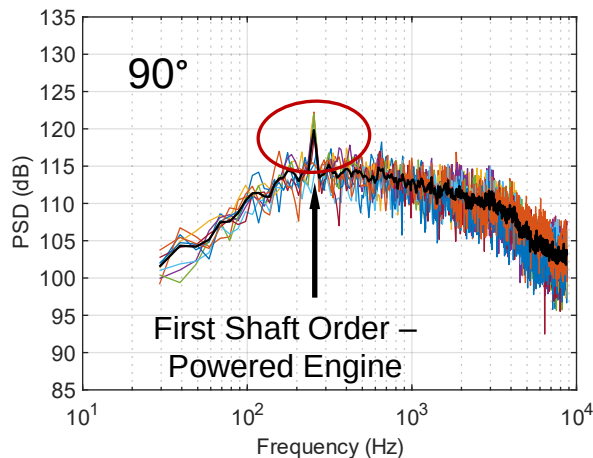
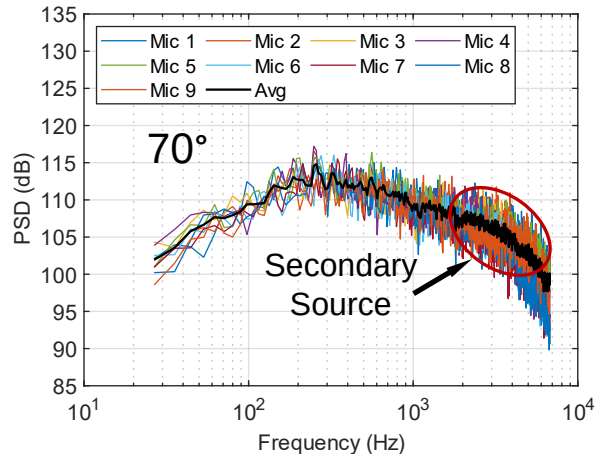
Flight Operations



- 4 sorties over 2 days, 17 – 20 flyovers per sortie
 - Total of 73 flyovers
- No flaps or landing gear
- One engine at idle
- Drone was deployment 3 times per sortie – beginning, middle, and end
- Sortie time ~ 2 hours



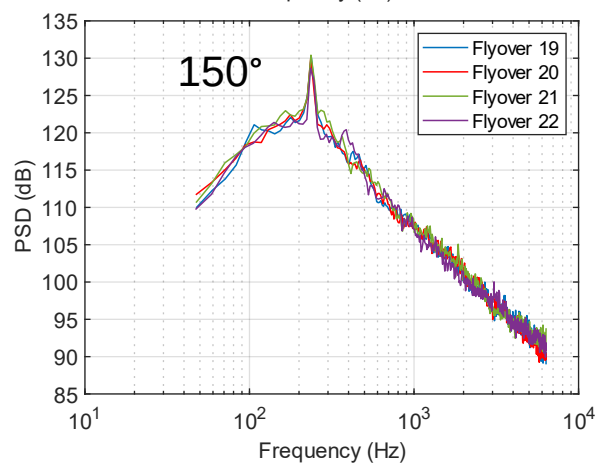
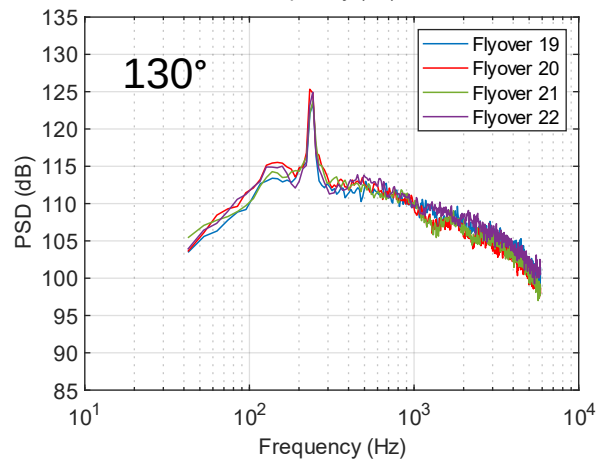
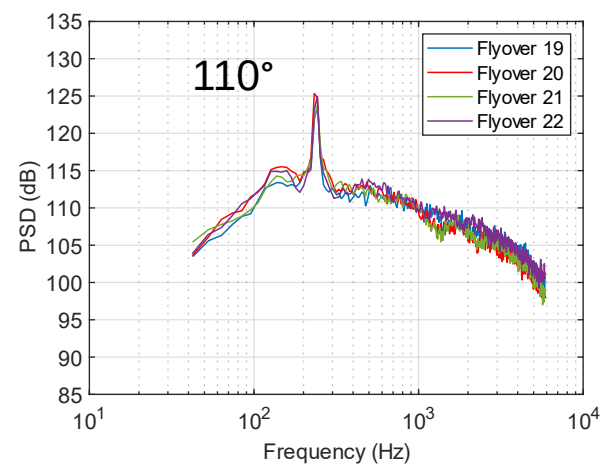
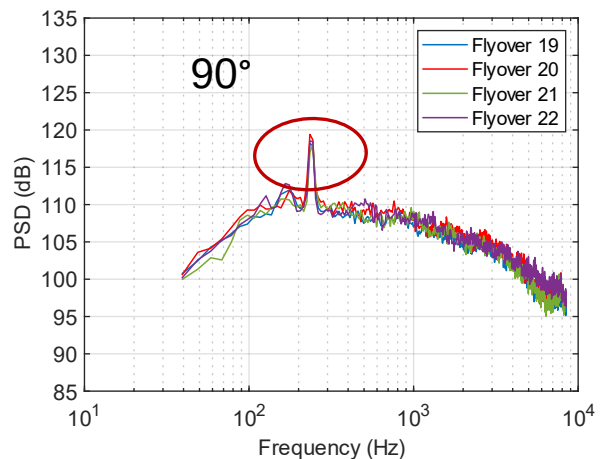
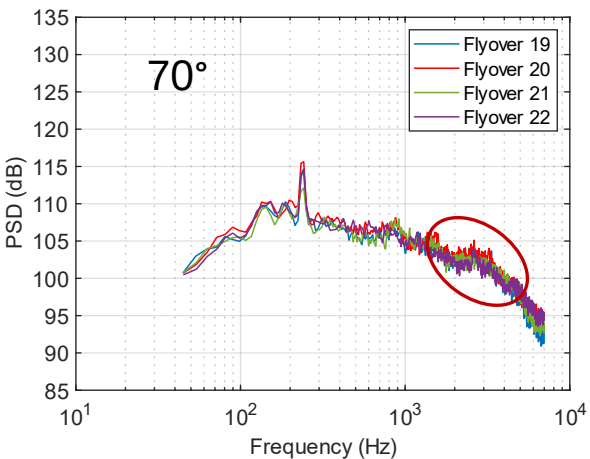
Results for 9 Microphones at NPR = 1.91



- Depropagated to 1' arc
- DeDopplerized

Comparisons Between Multiple Flyovers

NPR = 1.56



Average data

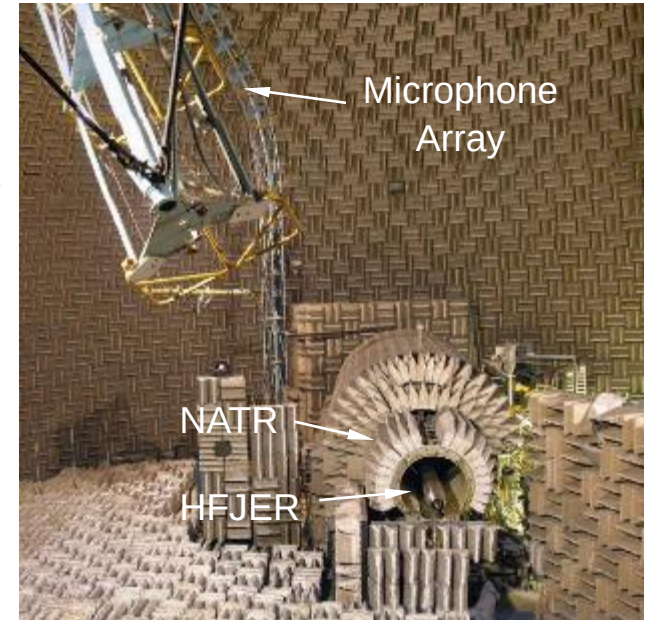


Scale Model Tests (September – October 2022)

Facility



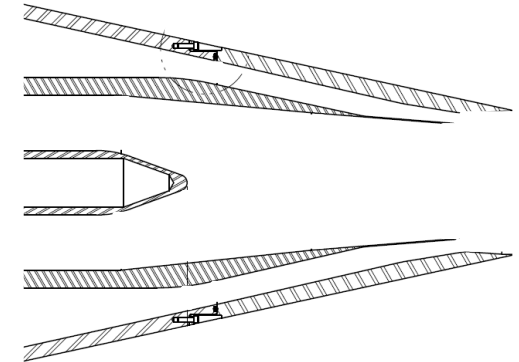
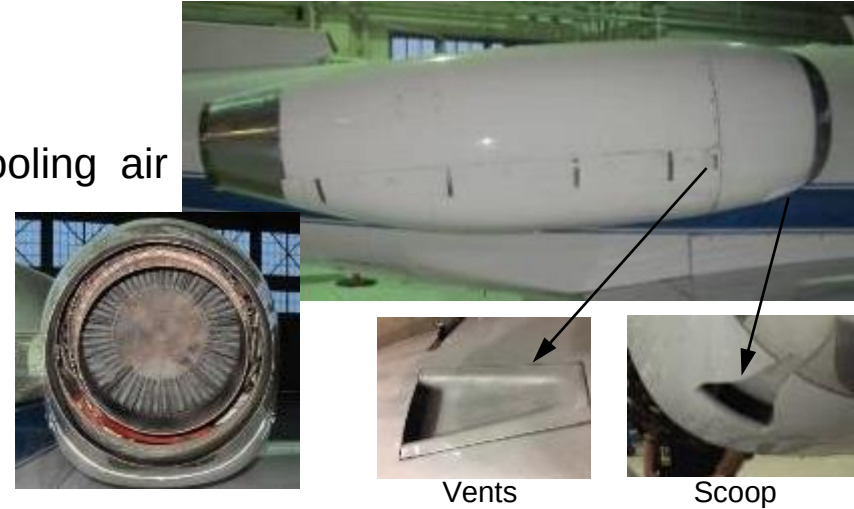
- Aero-Acoustics Propulsion Laboratory
 - 65 ft geodesic dome
 - Acoustic wedges on walls and floor
 - Far-field microphone array at ~ 45 ft from jet centerline
 - Houses the Nozzle Acoustic Test Rig (NATR)
- NATR
 - 53" simulated flight stream
 - Reaches Mach numbers up to 0.35
 - Houses the High Flow Jet Exit Rig (HFJER)
- HFJER
 - Three-stream jet engine simulator
 - Capable of producing temperatures and pressures of most commercial aircraft engines



Scale-Model Nozzles



- CJ610 Engine
 - Secondary non-powered stream used to exhaust cooling air
 - Secondary nozzle not circular
- Scale-models
 - Lear model
 - 3.21 physical scale factor
 - Duplicated inner nozzle contours
 - Secondary stream geometry captured
 - Flow through secondary nozzle expected to be low

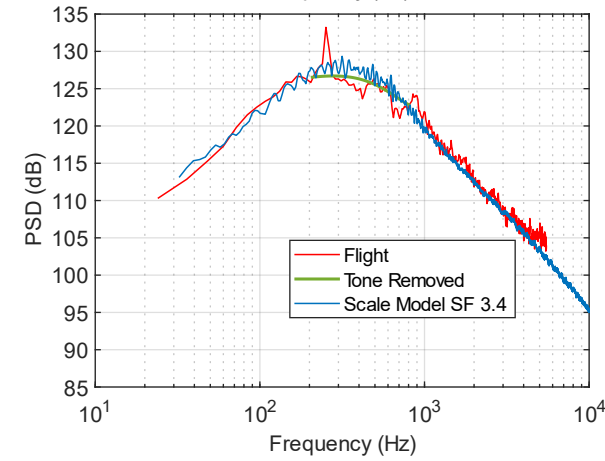
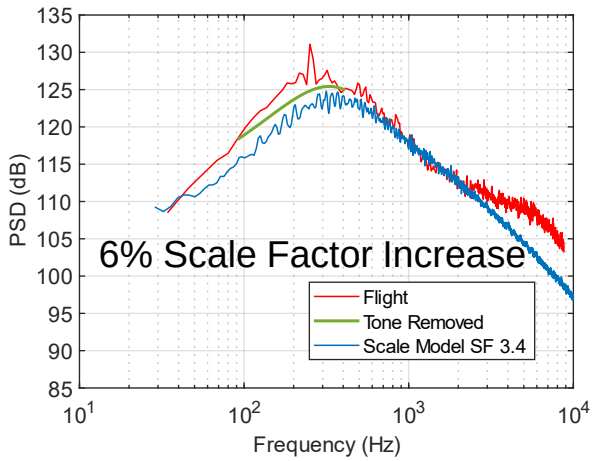
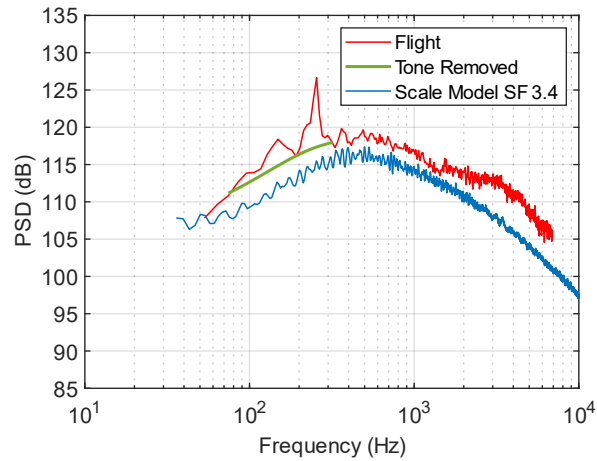
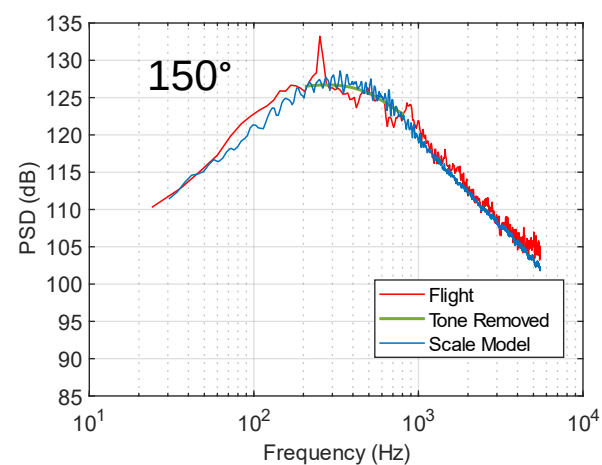
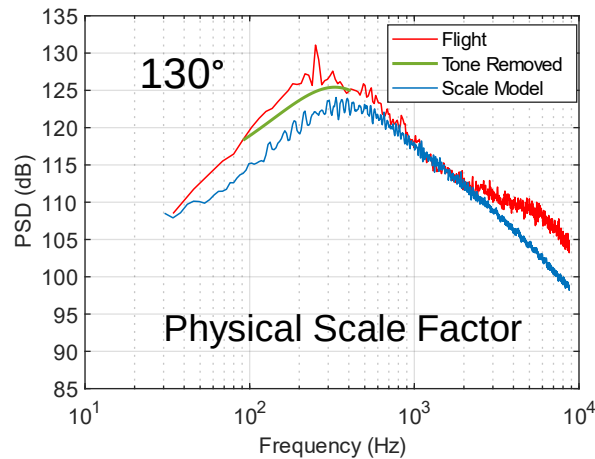
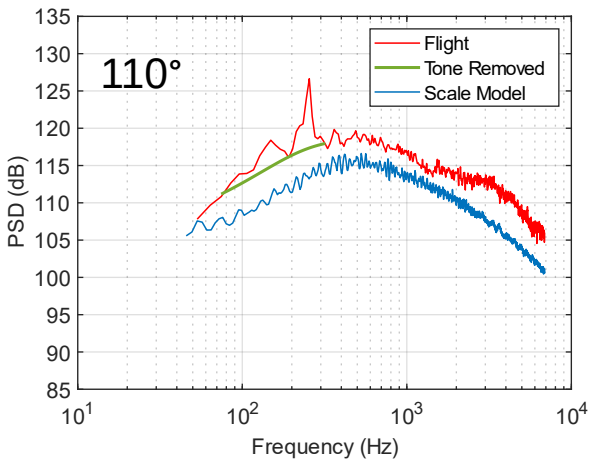




Comparisons

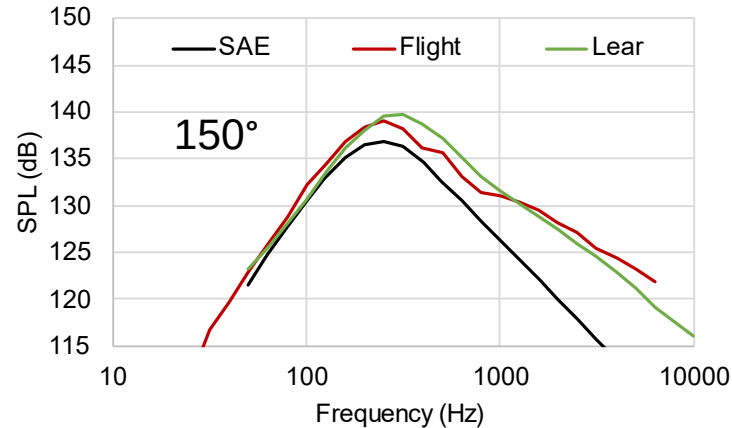
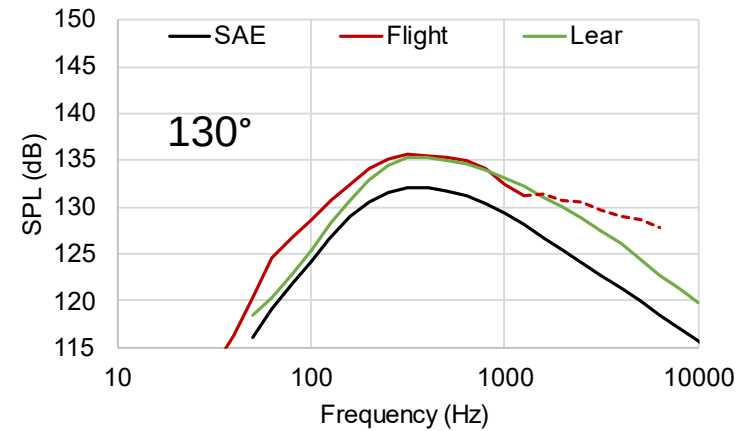
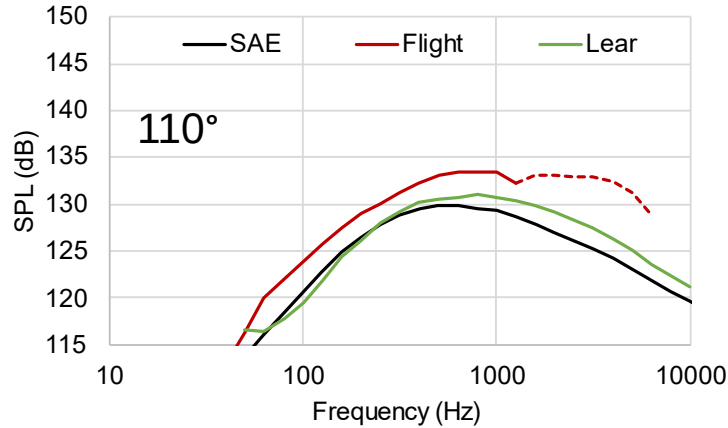
Comparisons Between Scale Model and Flight

NPR = 1.91



Comparisons with SAE Predictions

NPR = 1.91



Conclusions



- Good frequency alignment between the flight and scale model data is achieved with a 6% increase of the physical scale factor.
- With increased scale factor, flight and scale-model peak levels were within ~ 1 dB
- Levels for flight data were above those for the scale-model data for $90^\circ \leq \theta \leq 110^\circ$
- The SAE ARP model did not match the flight or scale model data at most emission angles



