



National Aeronautics and Space Administration

Propulsion Airframe Aeroacoustics Status

Presented by Russ Thomas
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Acoustics Technical Working Group

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PAA Team

NASA

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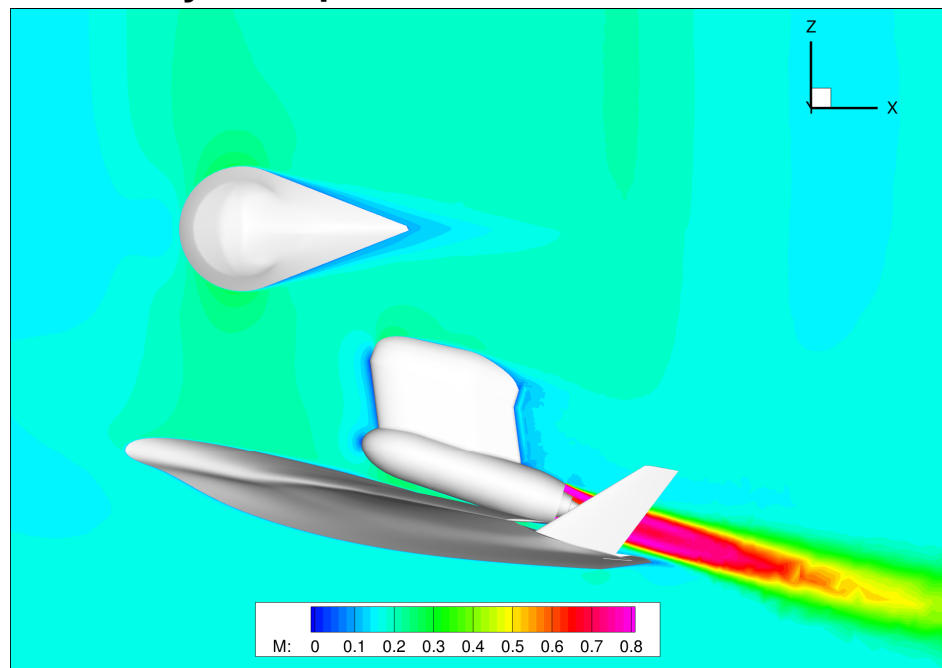
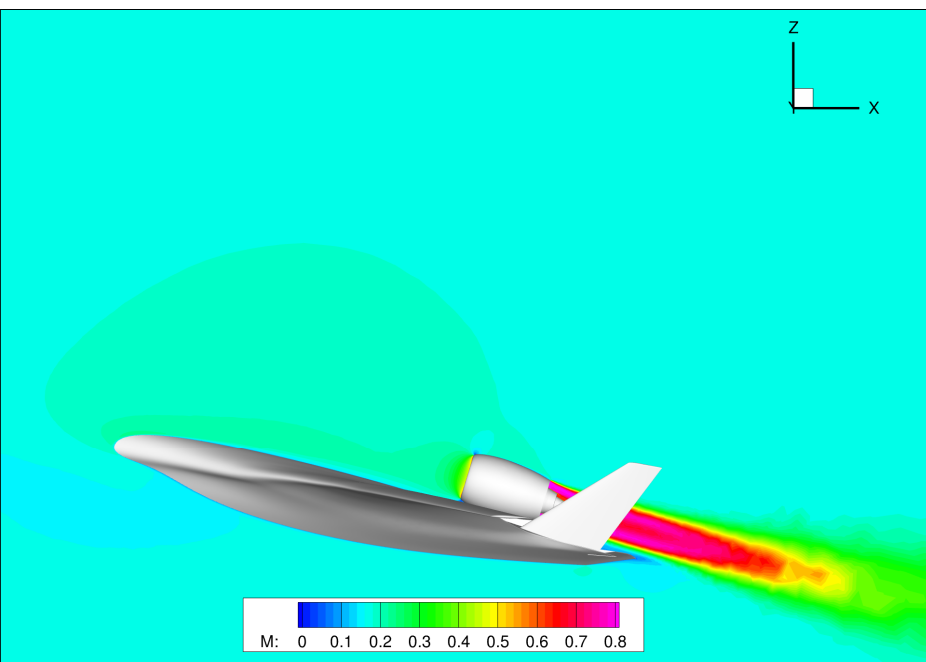
Several Active Collaborations In Progress



Simulator/Airframe Interference Study

Craig Hunter

Interference Effects Predicted for the HWB 14 by 22 Experiment

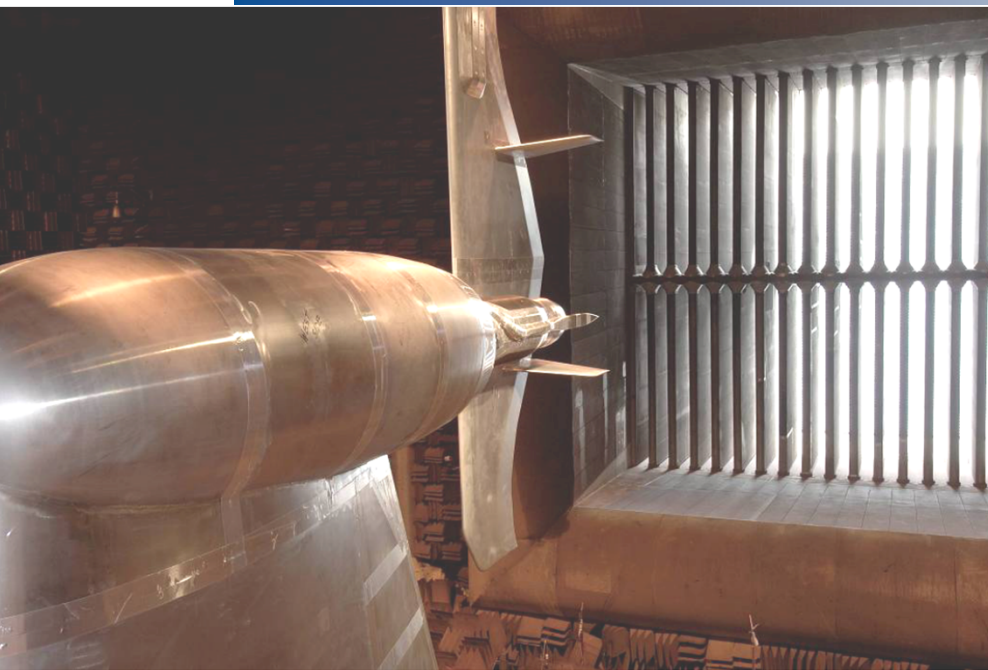




2009 PAA LSAF Experiment: Technology and Experimental Data for Key PAA Effects

Michael Czech, Boeing PI and Russ Thomas, NASA TM

Ref: Czech, Thomas, and Elkoby, "Propulsion Airframe Aeroacoustics Integration Effects for a Hybrid Wing Body Aircraft Configuration," AIAA 2010-3912



HWB Experiment Improves Basic Understanding of Aeroacoustic Sources and Parameters:

- *Effects from Verticals and Elevons*
- Jet-Airframe shielding including source modification
- Broadband point source shielding with flow effect



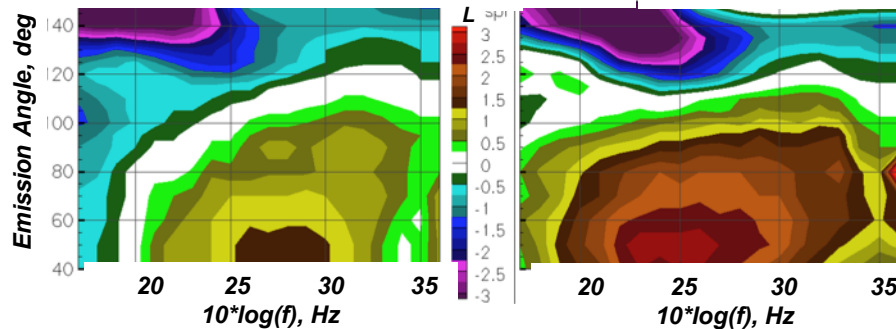
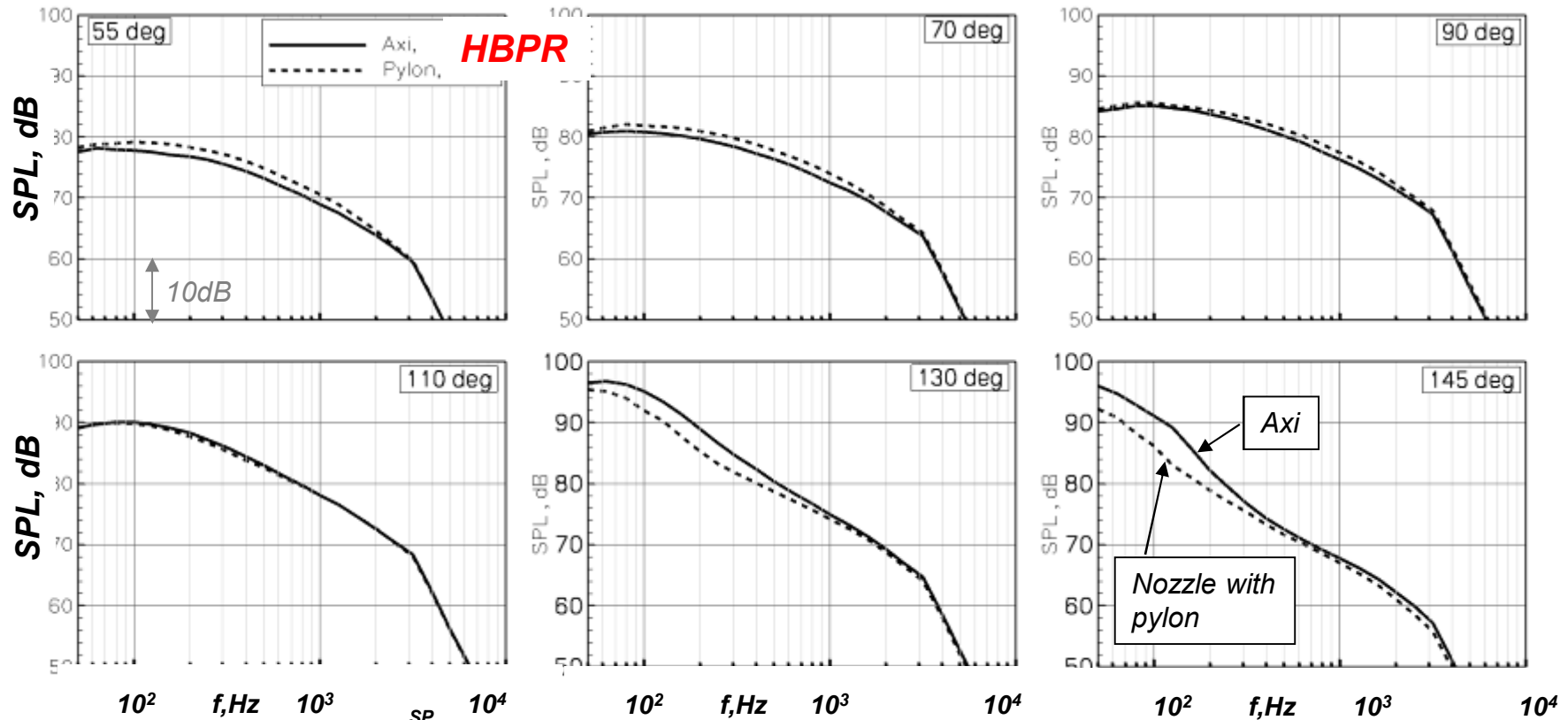
2009 PAA LSAF Test plan - Configurations

- *Axisymmetric nozzle*
- *Nozzle with pylon*
 - *Change of pylon orientation*
 - *Active pylon*
 - *Nozzles with chevrons*
- *Installed testing*
 - *Relative movement of the airframe to the nozzle*
 - *Variations in nozzle configurations*
 - *Airframe changes*



Ref: Czech, Thomas, and Elkoby, "Propulsion Airframe Aeroacoustics Integration Effects for a Hybrid Wing Body Aircraft Configuration," AIAA 2010-3912

Pylon Effect – Nozzle with and without Pylon



LBPR

HBPR

- Nozzles w/ and w/o pylon have same area and thrust
- Pylon has a significant effect at all angles
 - Increase up to 2 dB in forward arc
 - Reduction up to 4 dB in aft arc

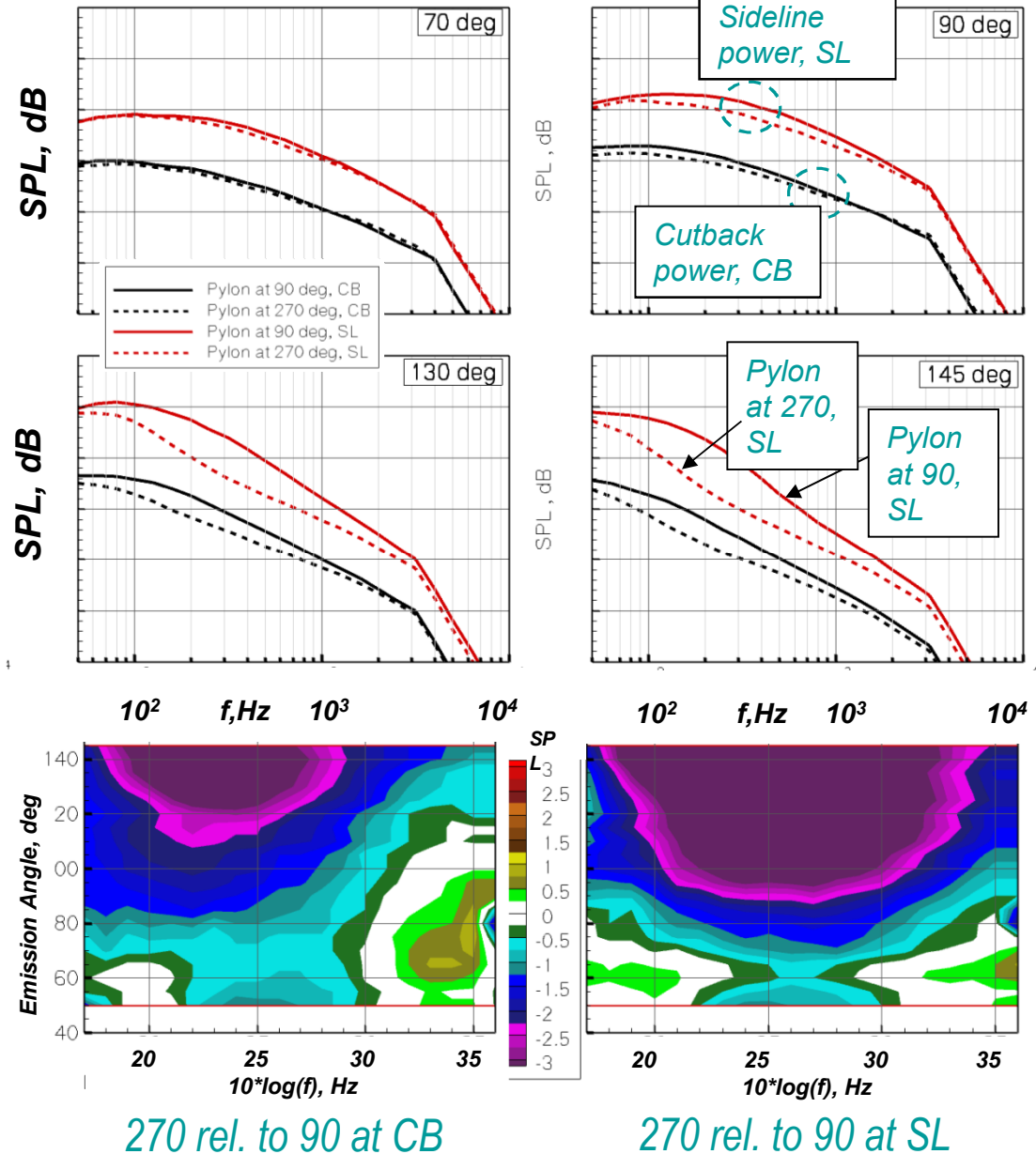
Ref: Czech, Thomas, and Elkoby, "Propulsion Airframe Aeroacoustics Integration Effects for a Hybrid Wing Body Aircraft Configuration," AIAA 2010-3912

Pylon Effect – Orientation

- Rotated the pylon from 270 to 90 degrees
- Effect of pylon orientation increases with power setting
- Azimuthal orientation of pylon has up to 8dB effect in aft arc
- Pylon away from observer (270, crown position) is quieter



Microphones are at 90 degrees

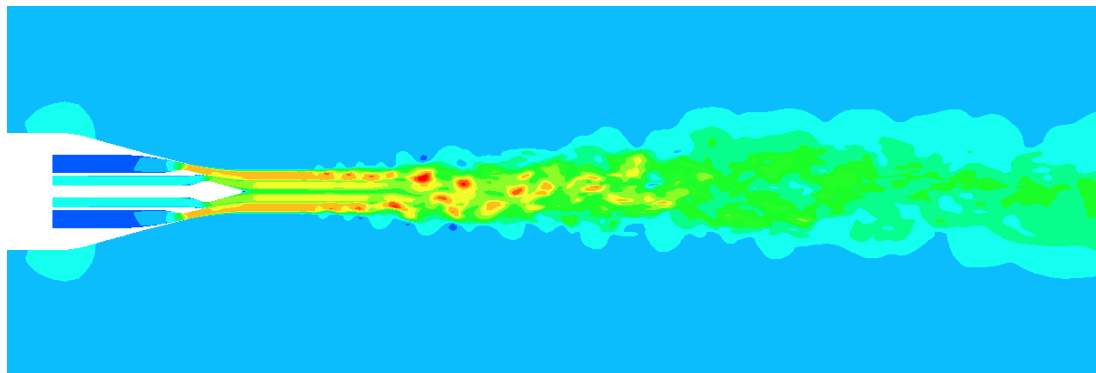


Ref: Czech, Thomas, and Elkoby, "Propulsion Airframe Aeroacoustics Integration Effects for a Hybrid Wing Body Aircraft Configuration," AIAA 2010-3912



JET3D-UNS (*Unsteady Navier Stokes*)

Melissa Carter, Alaa Elmiligui and Craig Hunter

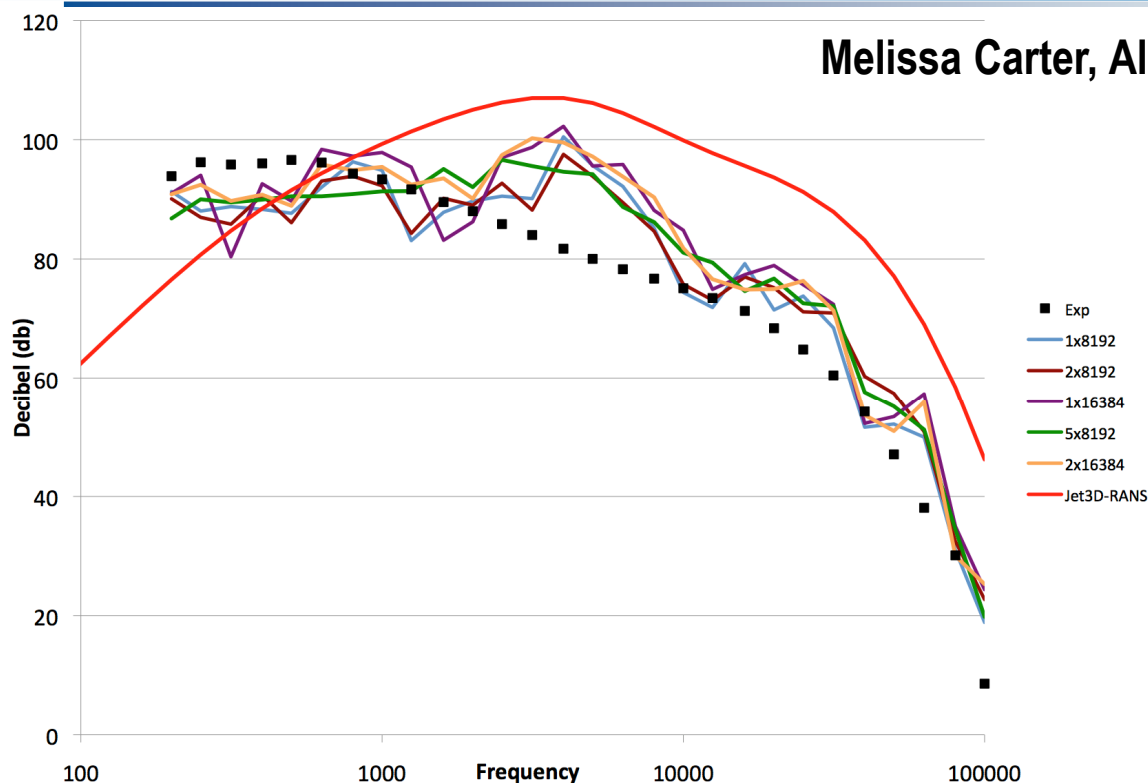


- *JET3D-RANS has historically had trouble calculating the noise at downstream angles*
- *This is due to the limitations of RANS and use of steady state two-point correlations*
- *To improve results, JET3D is being incorporated directly into the PAB3D N-S solver*
- *The new code computes Lighthill's Acoustic Analogy time accurate with PANS/LES.*
- *Method uses no two point correlations, has no calibration constants.*
- *Initial results show good agreement at downstream angles*
- *Code is in final testing.*



JET3D-UNS (*Unsteady Navier Stokes*)

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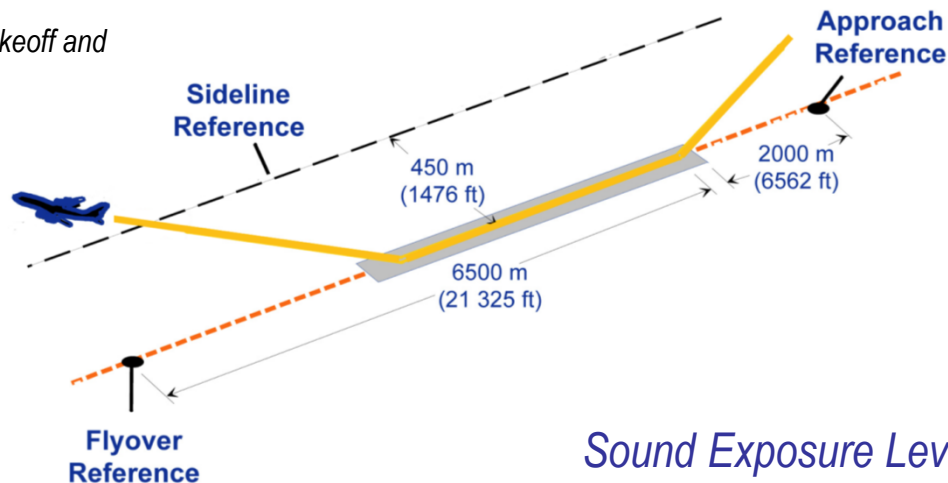


- *Graph compares experimental results with JET3D and JET3D-UNS at an observer location of 152-degrees downstream for case shown on previous chart.*
- *The different lines for JET3D-UNS represent the number of iterations used*
- *Since JET3D-UNS is unsteady, additional data is needed to average the results*
- *Grid size ~28 million cells and took ~24 hours to get 8192 iterations*

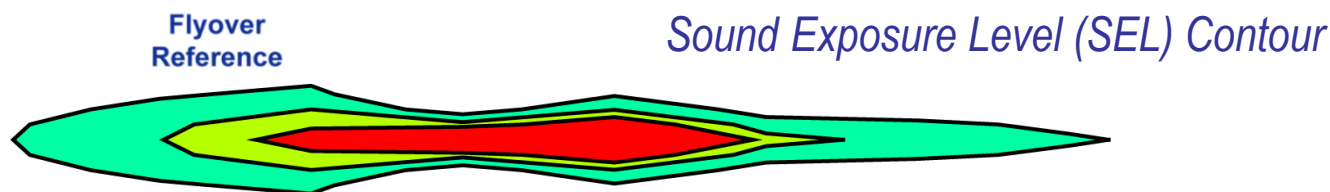
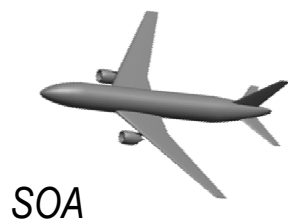


Results of HWB/Turbofan System Noise Assessment

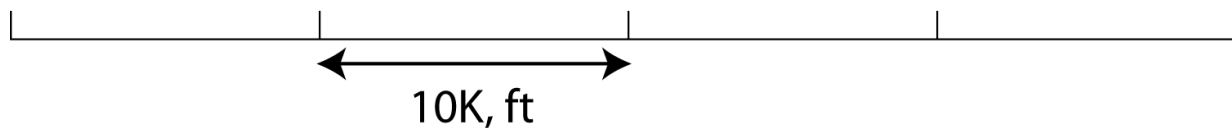
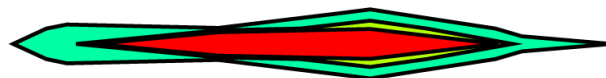
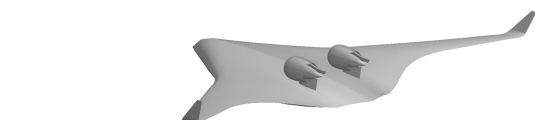
For a simulated (FAR 36) takeoff and landing



Ref: Thomas, Burley, and Olson, "Hybrid Wing Body Aircraft System Noise Assessment with Propulsion Airframe Aeroacoustics Experiment," AIAA 2010-3913.



SEL, dB
90 95 100



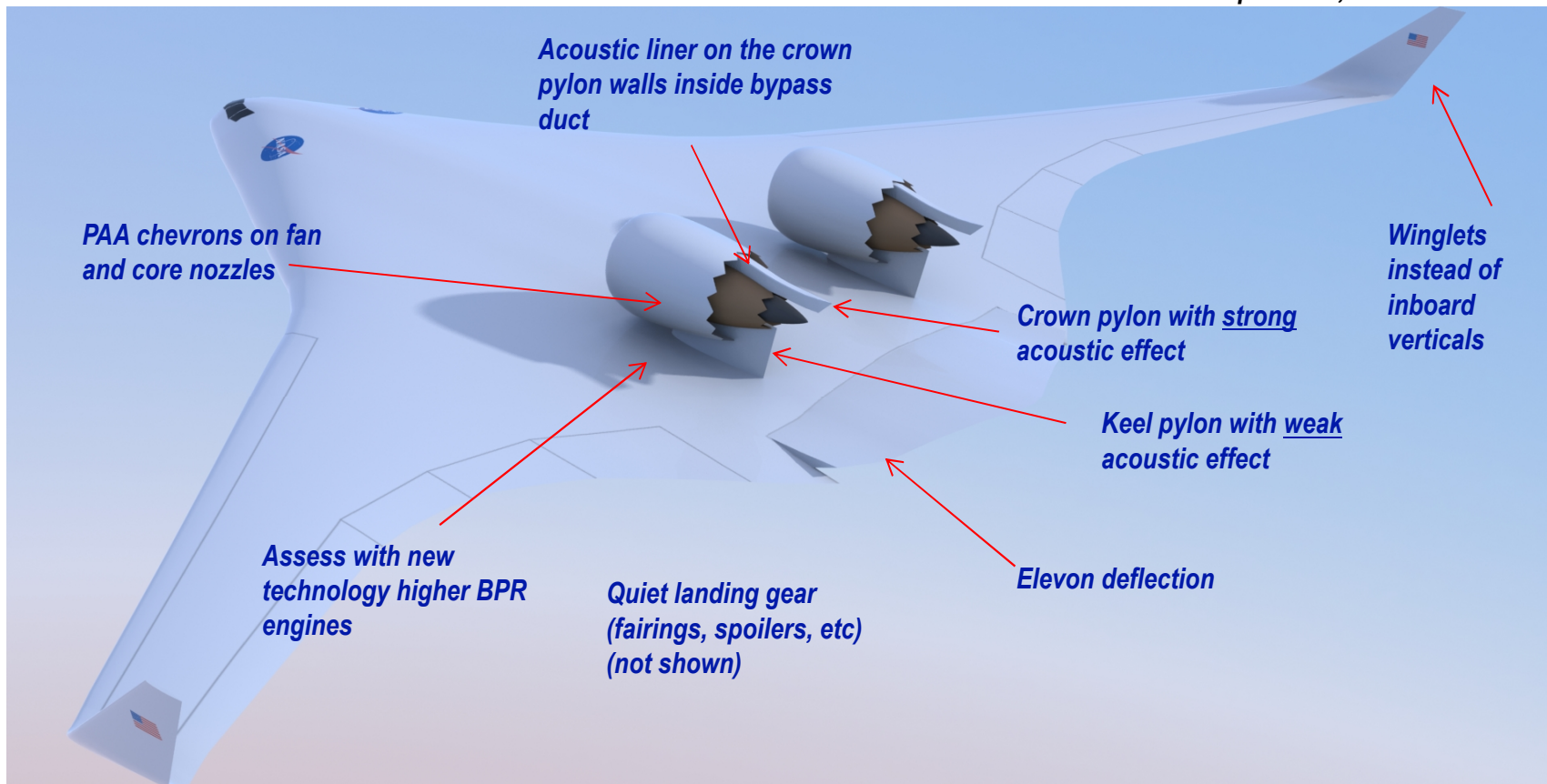
Impact is a 66% reduction in ground area



Future Directions

- *Better suppression map with more realistic fan noise simulation*
- *Flight path and aircraft model*
- *Maturation of specific PAA and aircraft system technology targeted for noise reduction*

Ref: Thomas, Burley, and Olson, "Hybrid Wing Body Aircraft System Noise Assessment with Propulsion Airframe Aeroacoustics Experiment," AIAA 2010-3913.



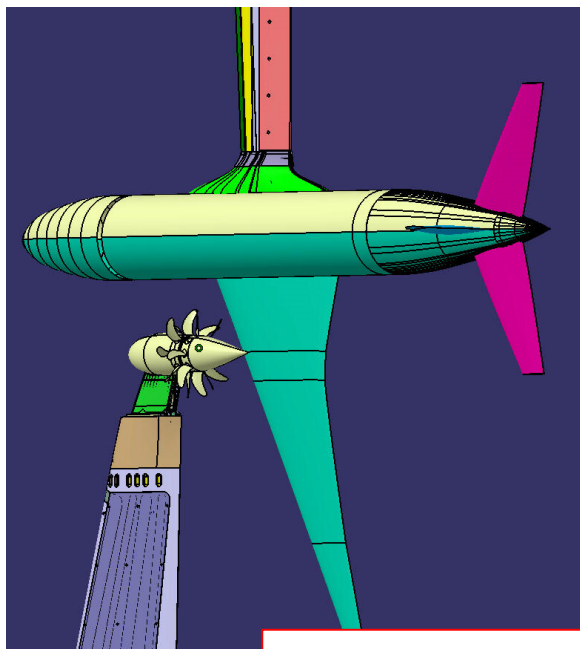
Critical step toward higher fidelity HWB aeroacoustic capabilities



Open Rotor Propulsion Airframe Aeroacoustics (PAA)

Study of open rotor PAA effects for both HWB and Tube-and-Wing aircraft types in Boeing's LSAF, **currently in progress**

Dr. Michael Czech, Boeing PI & Dr. Russ Thomas, NASA TM

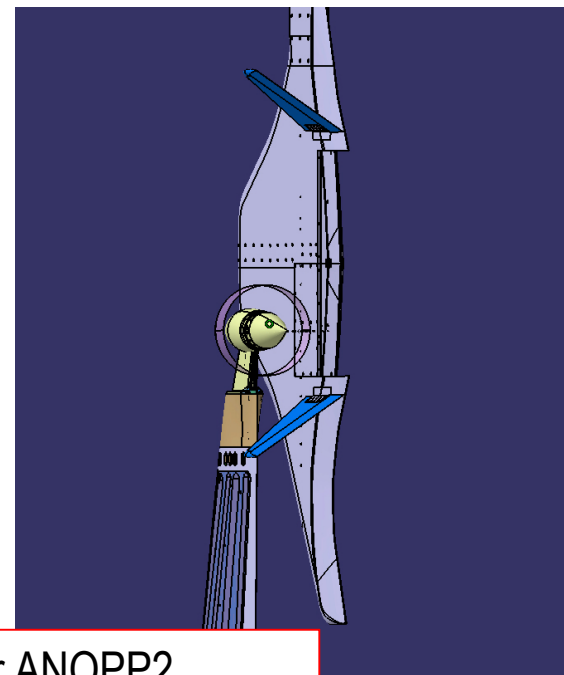


Parameters/Effects:

- Airframe/Rotor Spacing
- R1/R2 Speed Variation
- Angle-of-attack

Instrumentation:

- Far Field Mic
- Near Field Mic Traverse
- Flow Field Survey
- Phased Array Traverse
- Surface Unsteady Pressure



- To be used in prediction method validation for ANOPP2
- To be used for NASA assessment of the system noise of aircraft configurations with open rotor engines

Funded by the NASA Environmentally Responsible Aviation Project, Dr. Fay Collier, Project Manager



Discussion

