



Comparison of Computational and Experimental Results for the 18%-Scale, Semi-Span Model in the LaRC 14x22 Tunnel

Mehdi R. Khorrami and David P. Lockard

ERA ITD50A

Aeroacoustic Testing of 18% Scale Aircraft Model



❑ Multiple entries in NASA LaRC 14'x22' tunnel

- Phase1: October 2010 → Aerodynamic measurements
- Phase2: February 2013 → Aero and acoustic measurements

❑ Phase2 test campaign

- Aerodynamic measurements
- Acoustic: Microphone array and free-field microphones
- Off-surface flow: PIV and LV

❑ PIV measurements documented gear-flap interaction effects

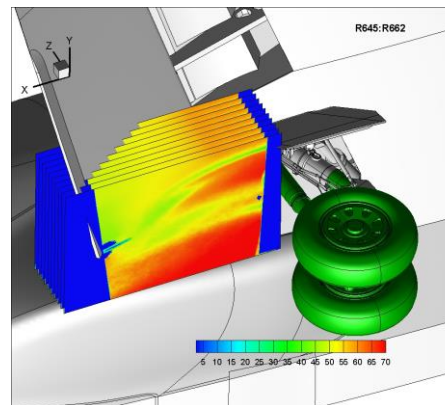
- Processing of PIV database completed
- Measured off-surface flowfield being used to benchmark high-fidelity simulations

PIV Configuration - 2013

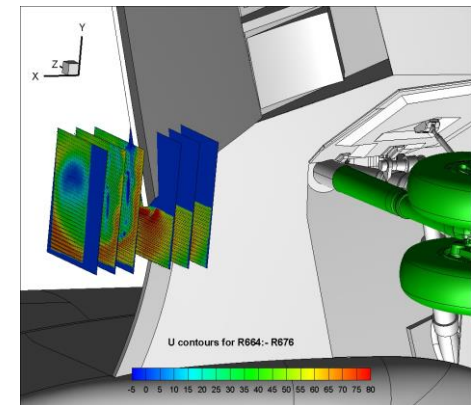


AIAA abstract “On the Accuracy of Simulated Gear-Flap Flow Interaction”

By Mehdi R. Khorrami, Ramond Mineck, Ehab Fares;, Chung-Sheng Yao, Luther N. Jenkins

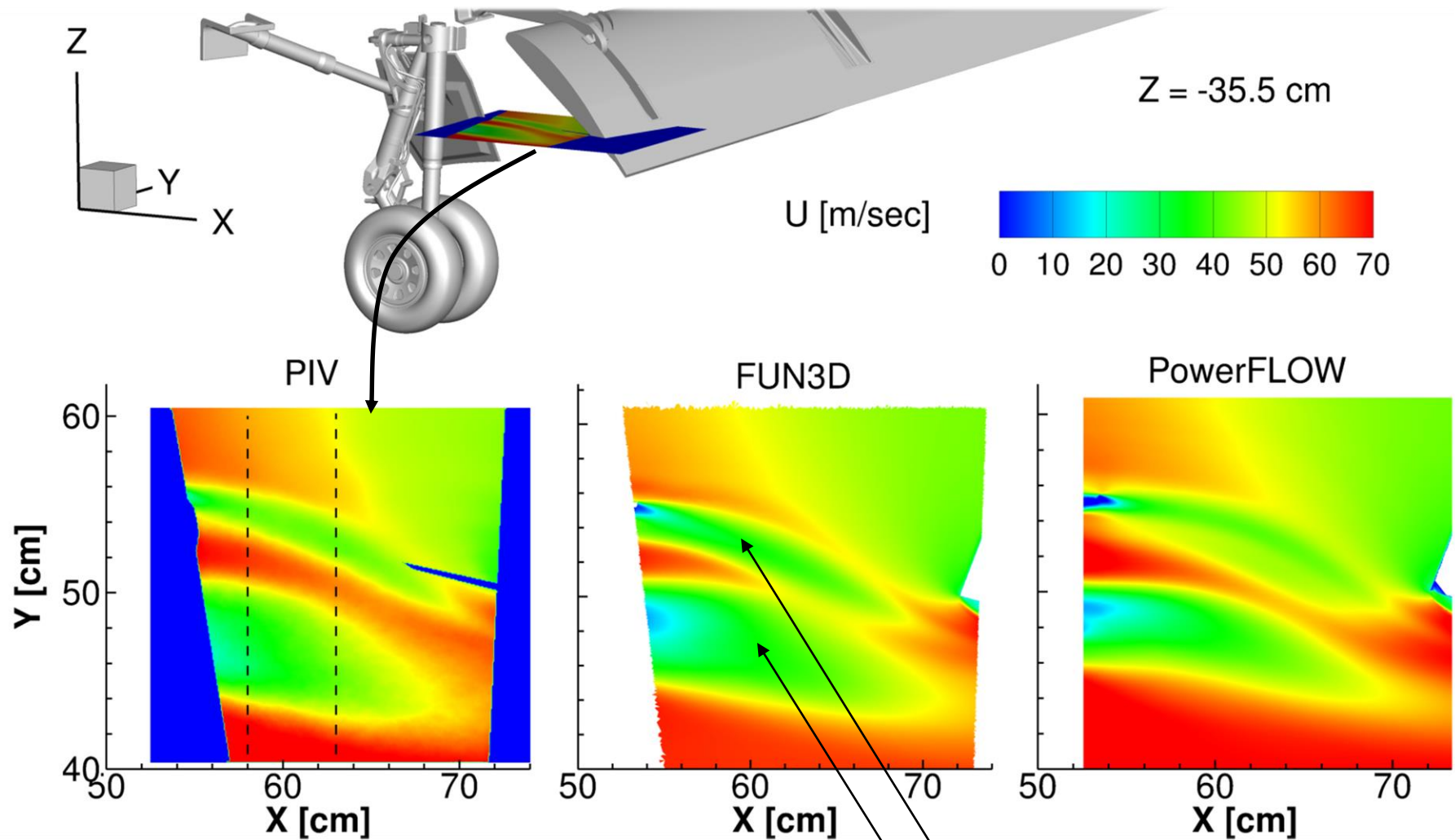


2D-PIV setup capturing gear wake and gear-flap interaction



Stereo PIV setup capturing gear effects on flap tip vortex

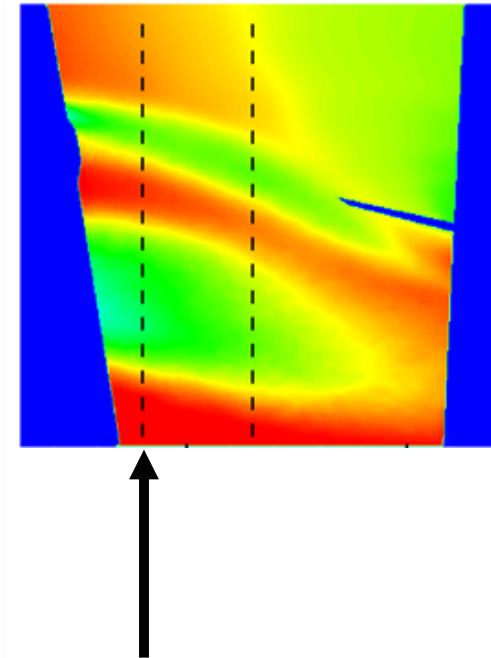
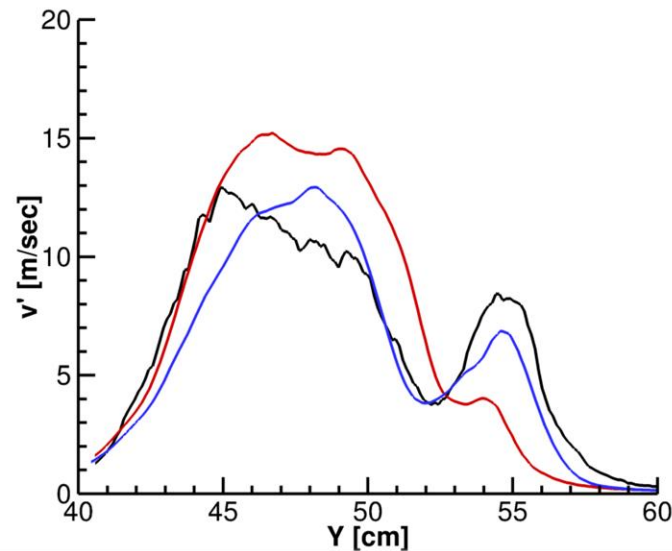
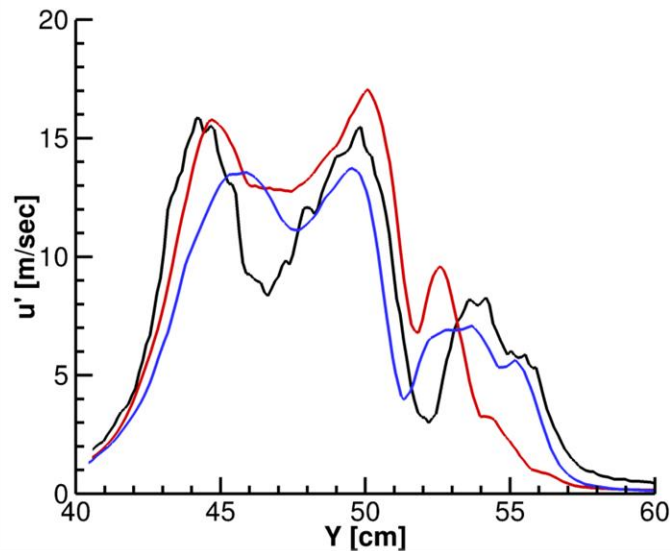
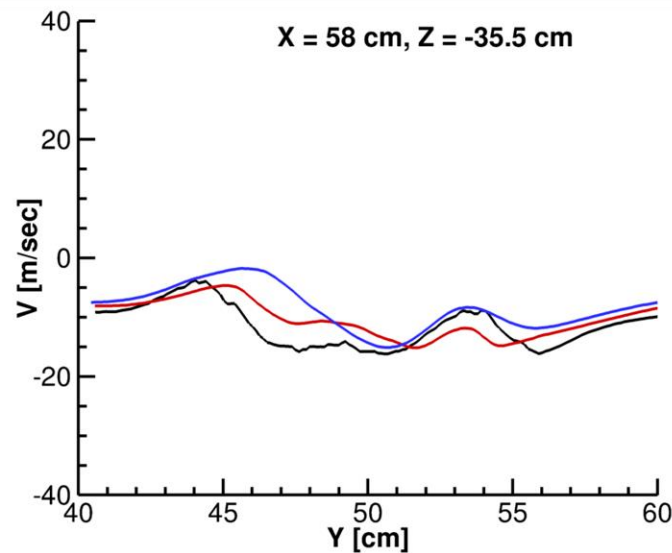
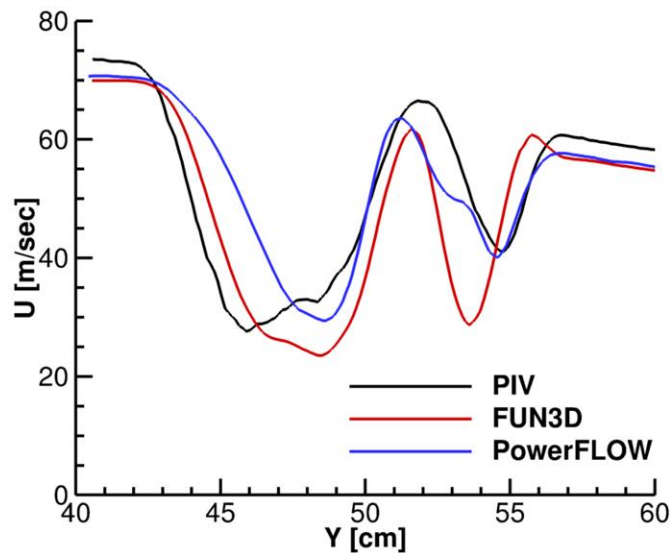
Comparison of Simulated vs. Measured Flowfield (Mean Streamwise Velocity Contours in the Gear Wake)



- Open-jet CFD simulations (floor only)
- Higher resolution grid used in PowerFLOW

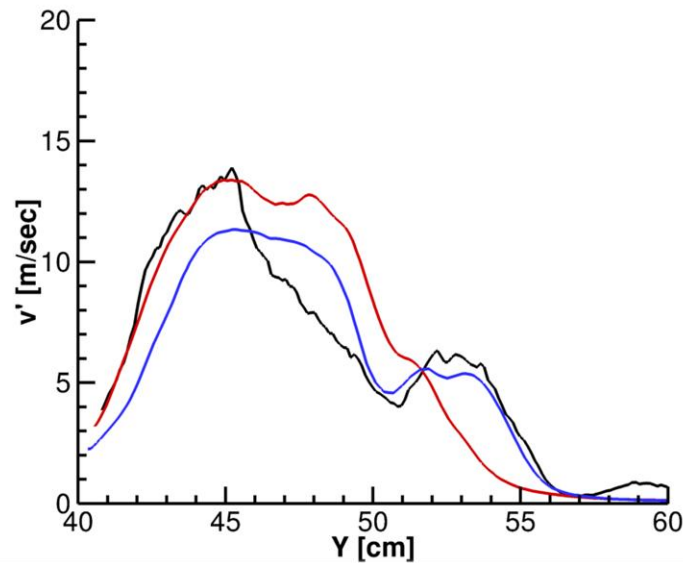
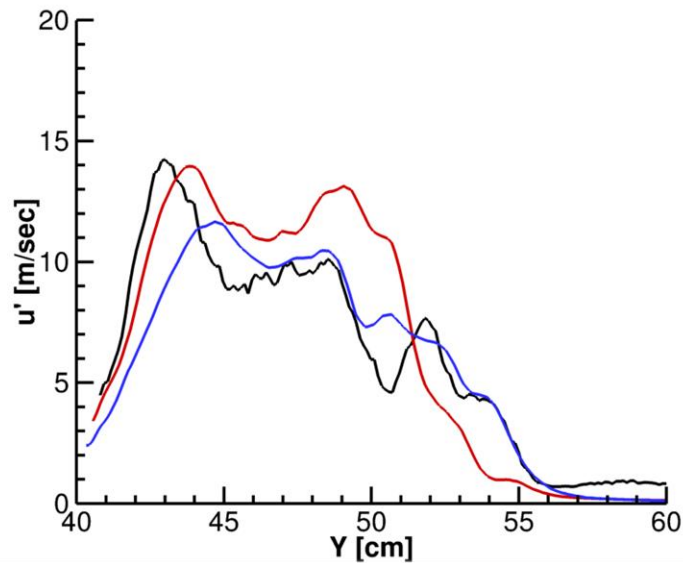
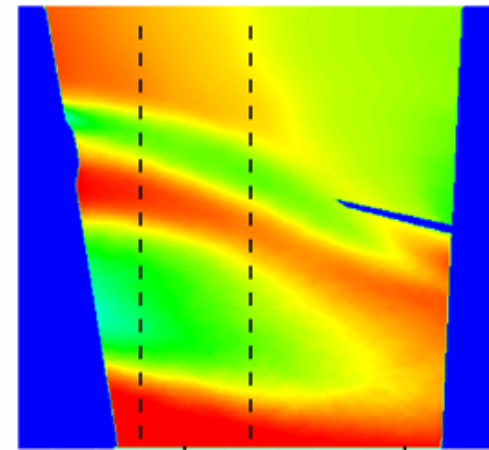
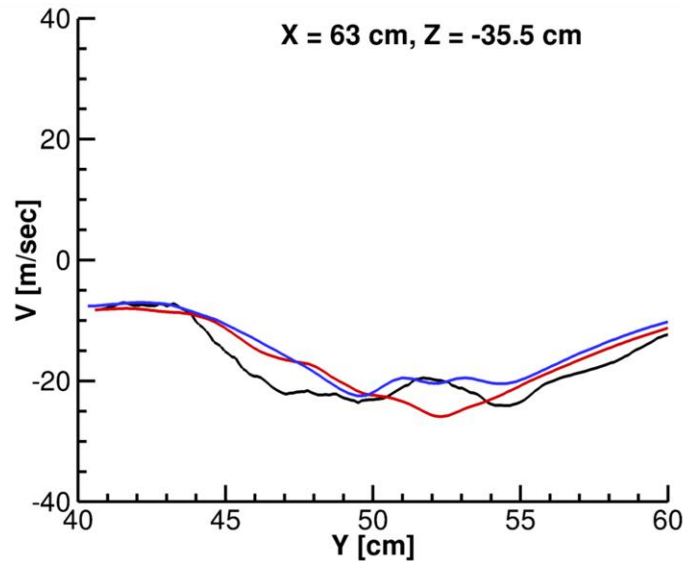
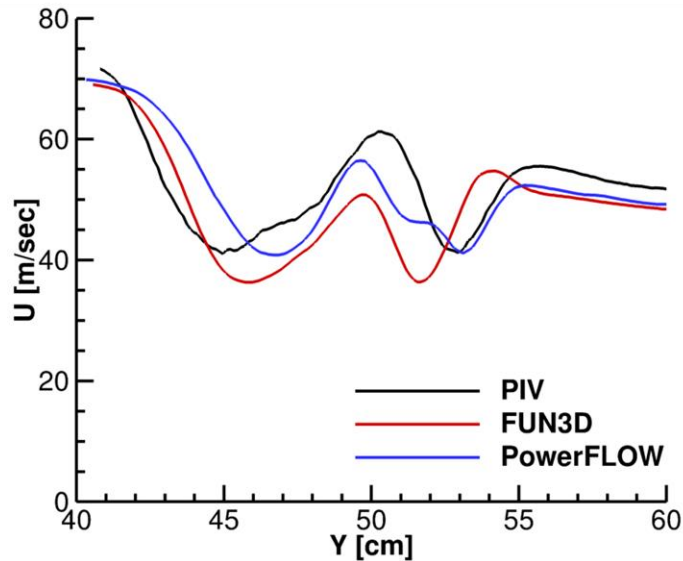
Comparison of Simulated vs. Measured Flowfield I

(Extracted Mean and Fluctuation Velocity Profiles in the Wake)

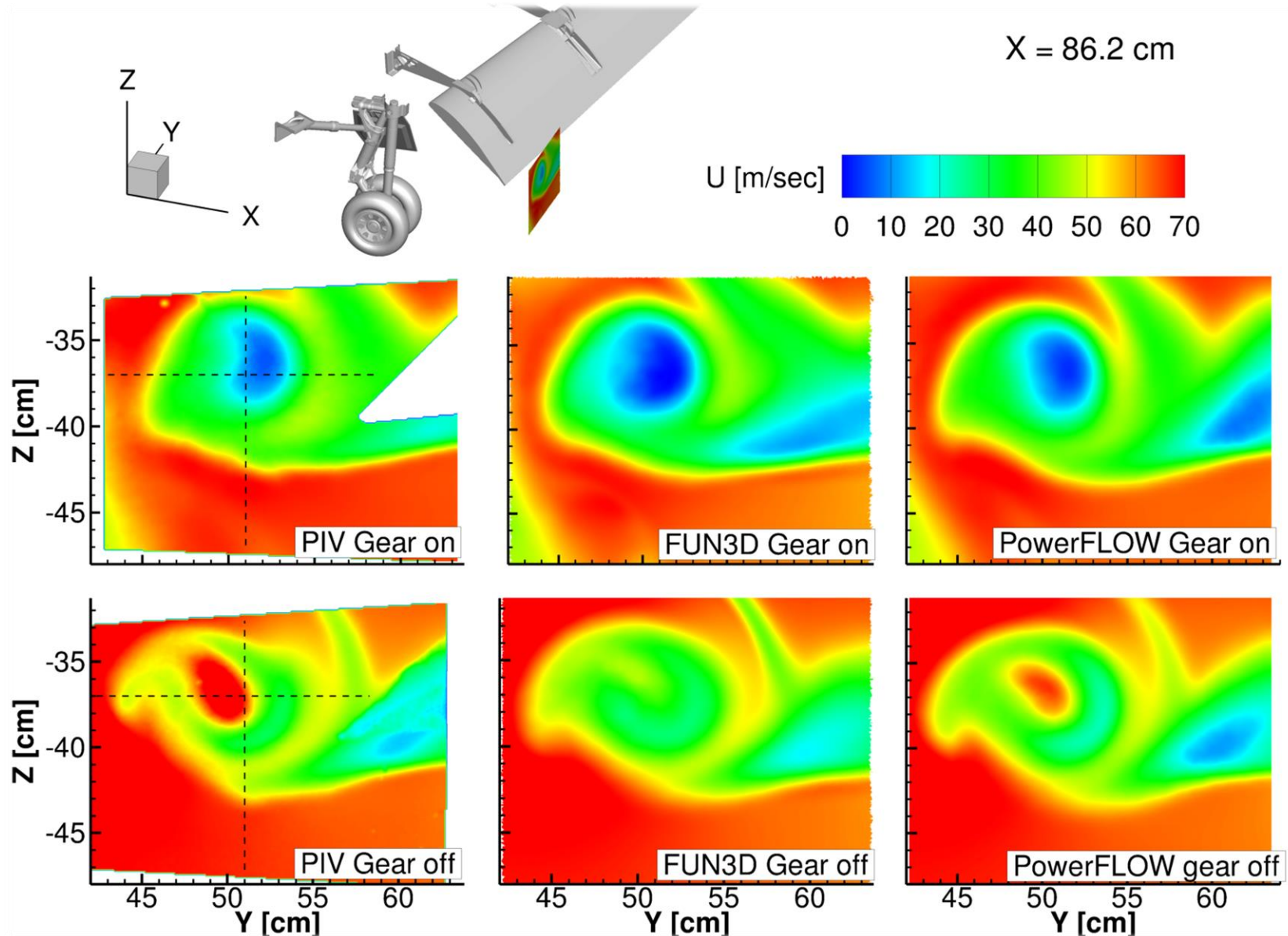


Comparison of Simulated vs. Measured Flowfield II

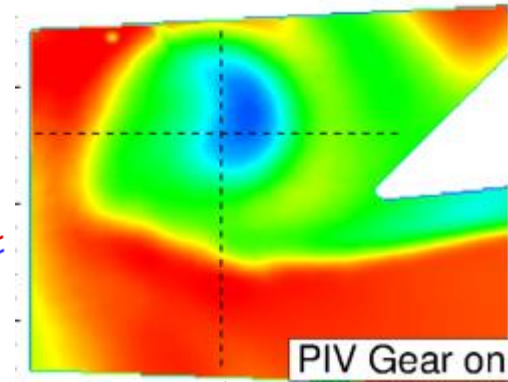
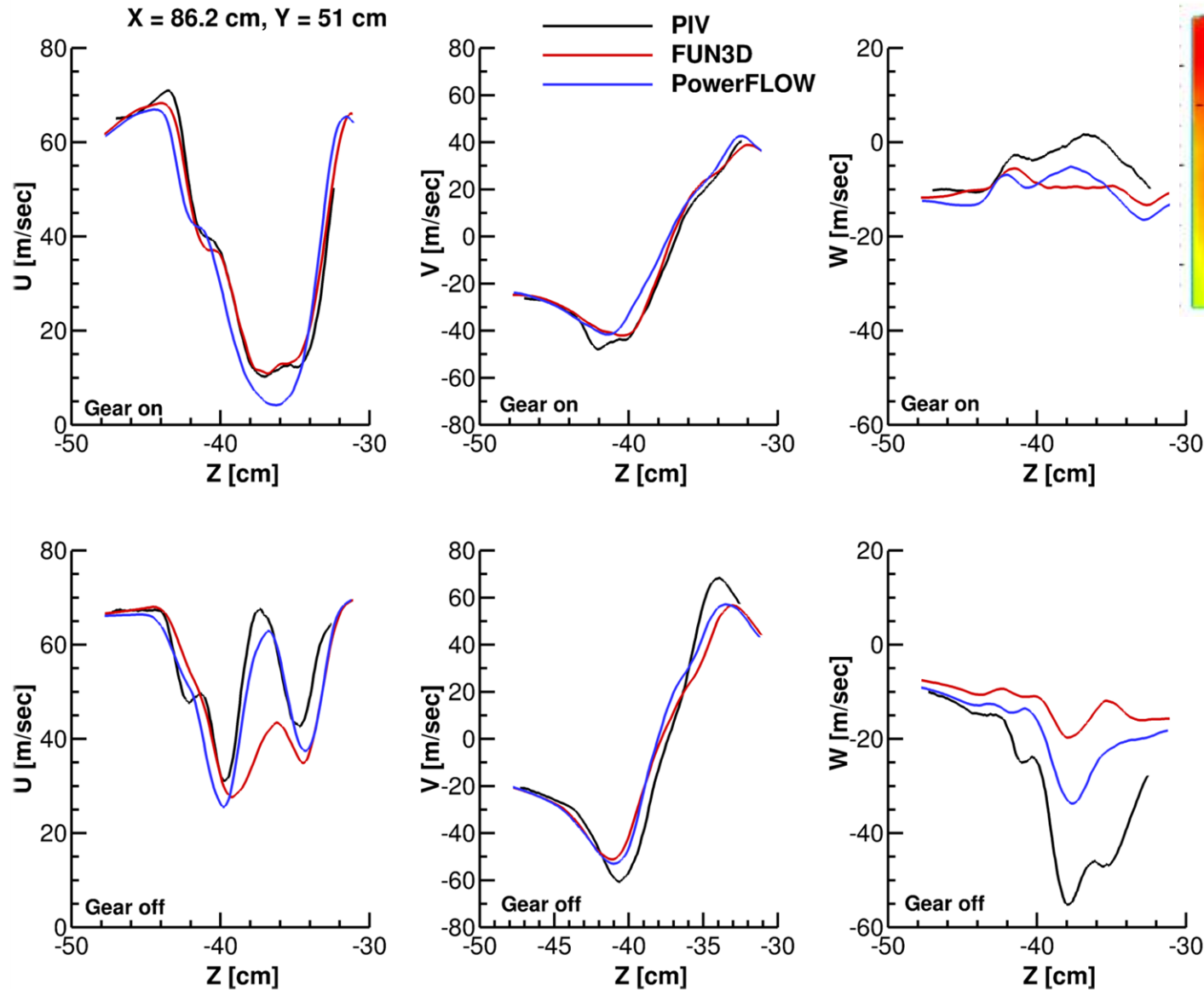
(Extracted Mean and Fluctuation Velocity Profiles in the Wake)



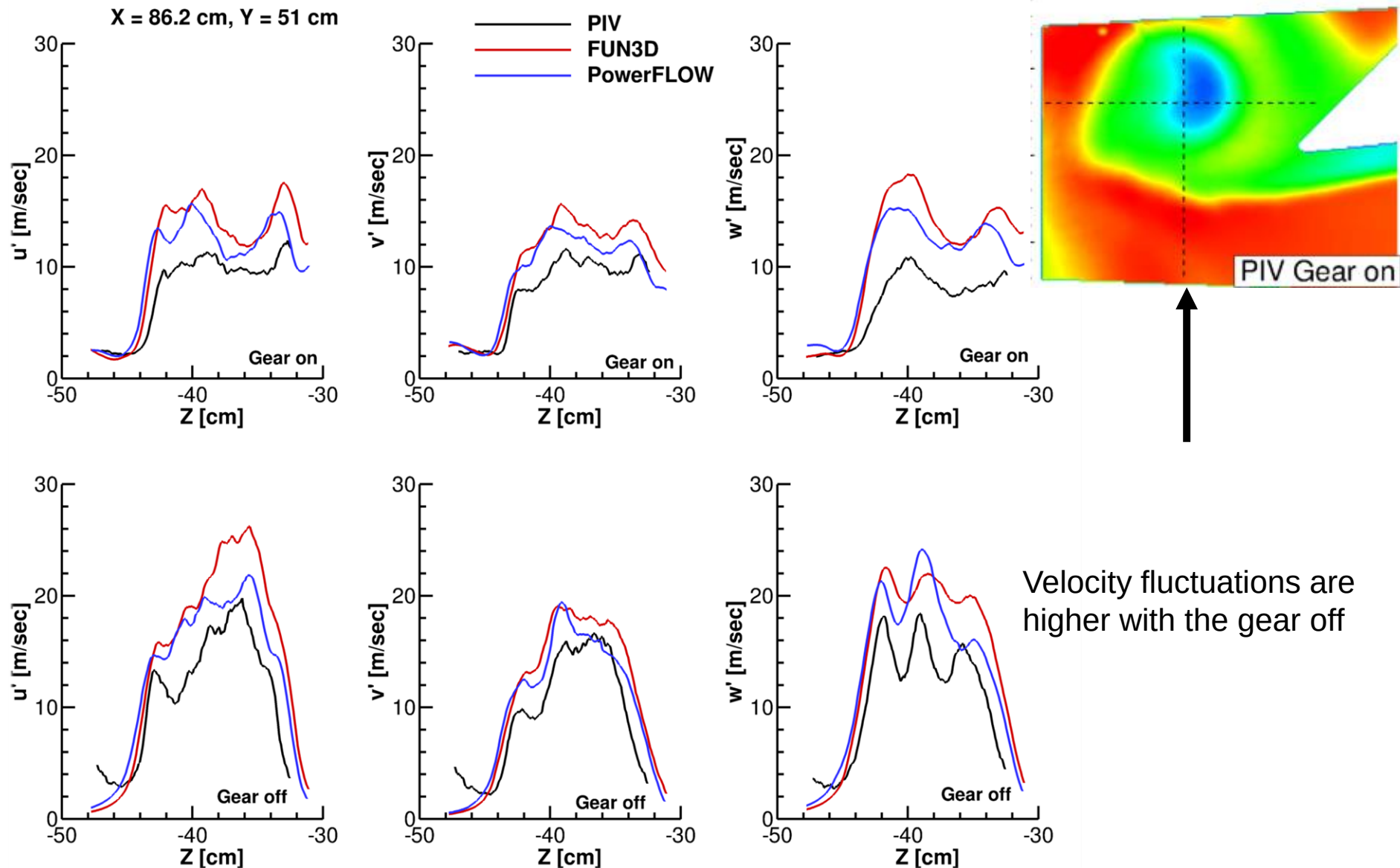
Comparison of Simulated vs. Measured Flowfield (Landing Gear Effects on Flap Tip Vortex Formation)



Comparison of Simulated vs. Measured Flowfield (Extracted Mean Velocity Profiles Near Flap Trailing Edge)



Comparison of Simulated vs. Measured Flowfield (Extracted Fluctuation Velocity Profiles Near Flap Trailing Edge)



Acoustic Comparisons

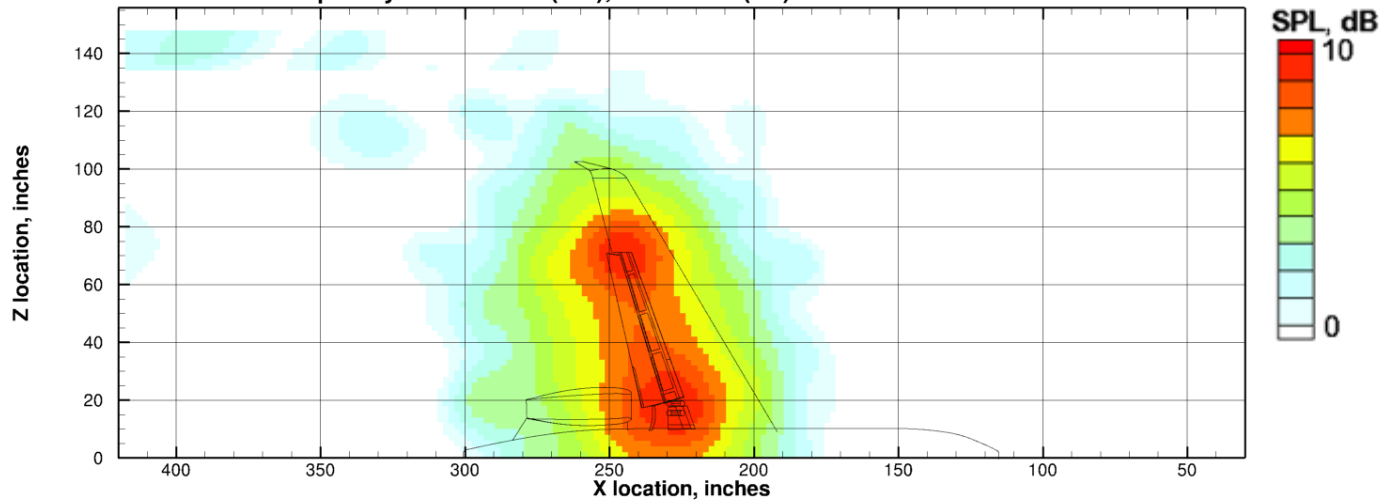


- Computations and experiments are in good agreement in the near field
 - Mean and fluctuating surface pressure
 - Flow velocities at the locations of PIV data
- Acoustic predictions from CFD use solid surface pressure data + Acoustic Analogy (Ffowcs Williams-Hawkings Equation)
 - Predicted signal at array center compared with experimental microphone array output
 - Good agreement up to moderate frequencies
 - New comparisons involve using CFD to predict the signals at all microphone locations and applying the same array processing to those signals
 - Signals from CFD do not suffer from extraneous noise but are extremely short in time duration compared with experiment

Measured Array: Source Strength Maps

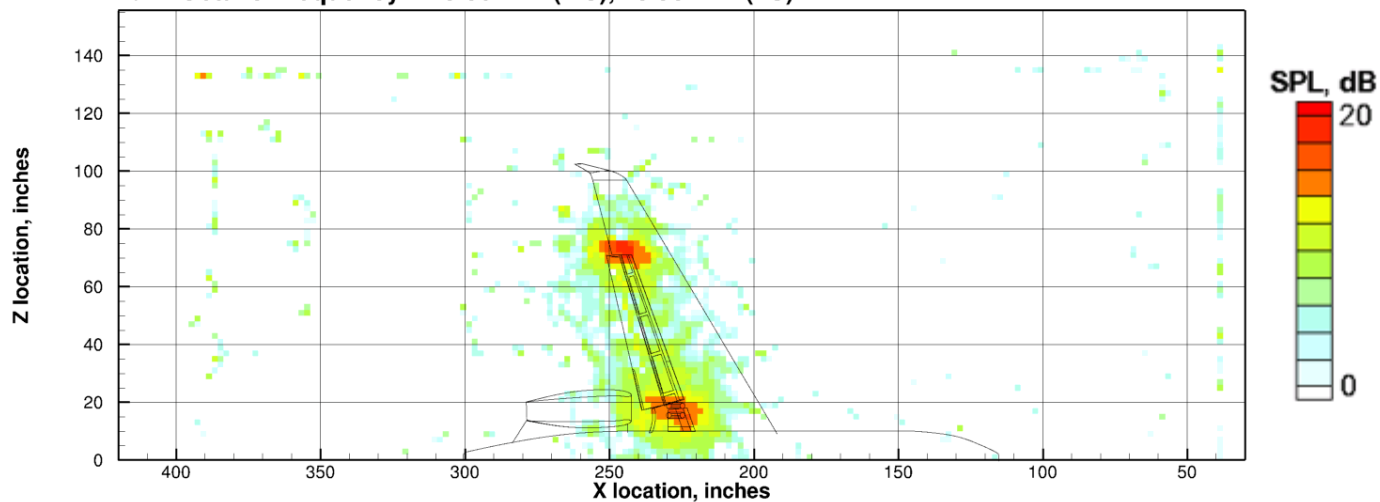


Conventional DS Beamform Response
1/12-Octave Frequency = 5.00 kHz (MS), 0.90 kHz (FS)



M=0.2, AoA = 3 deg
Gear on
Flap at 39 deg
Array at 90 deg to model

Unified DAMAS Deconvolved Response
1/12-Octave Frequency = 5.00 kHz (MS), 0.90 kHz (FS)

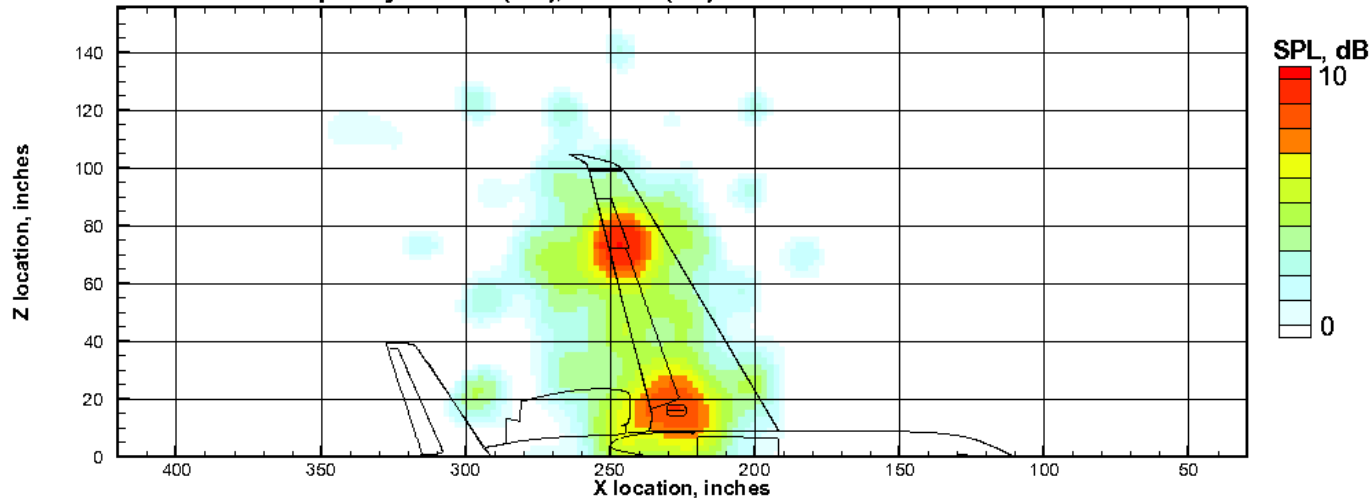


0.9 kHz model scale
5 kHz full scale
Unified DAMAS V10R2

Synthetic Array: Source Strength Maps

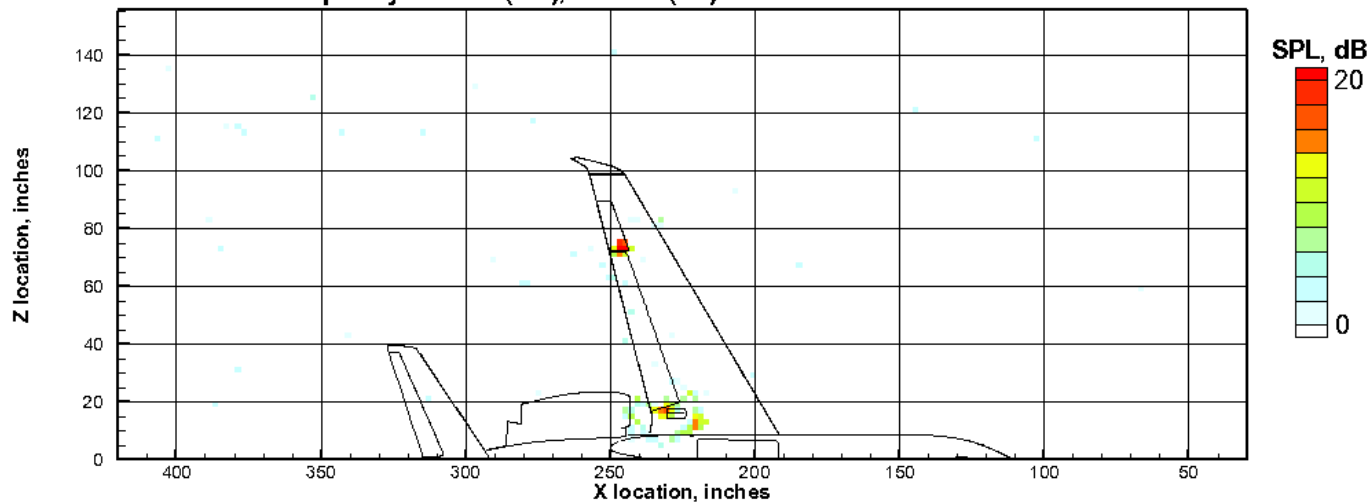


Conventional DS Beamform Response
1/12-Octave Frequency = 5 kHz (MS), 0.9 kHz (FS)



M=0.2, AoA = 3 deg
Gear on
Flap at 39 deg
Array at 90 deg to model

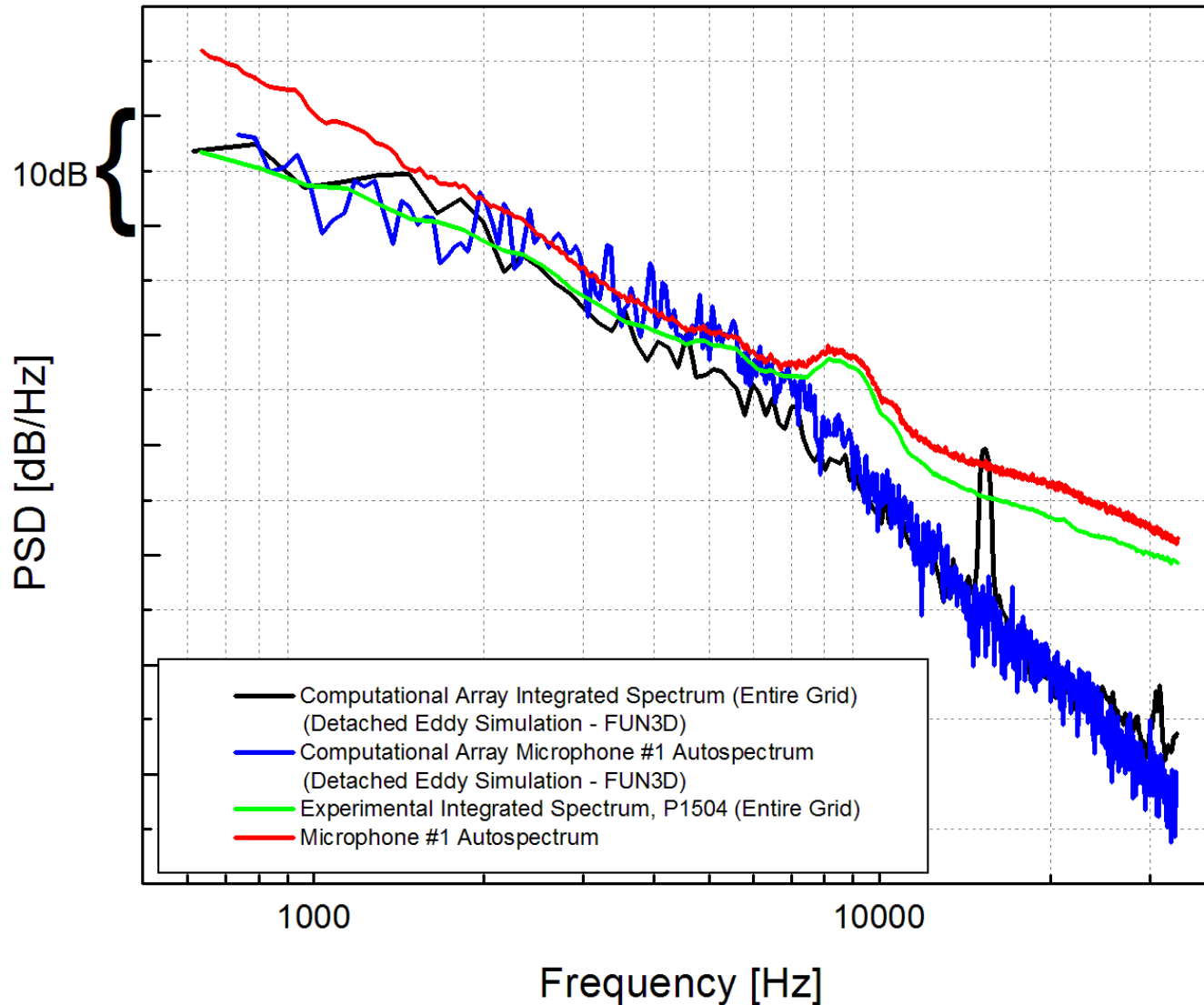
Unified DAMAS Deconvolved Response, 250 Iterations
1/12-Octave Frequency = 5 kHz (MS), 0.9 kHz (FS)



0.9 kHz model scale
5 kHz full scale

Unified DAMAS V10R2

Spectral Comparison



M=0.2, AoA = 3 deg
Gear on
Flap at 39 deg
Array at 90 deg to model

Unified DAMAS V10R2

Summary



- Good comparisons between CFD and PIV in the wake of the landing gear and inboard flap despite differences in configuration
 - Closed-wall experiment and floor only in computations
 - Flow angularity in experiment
- Synthetic array results look reasonable despite short time records
 - More detailed analysis is underway