



High-Fidelity Simulations of Landing Gear Noise

Airframe Noise Group
Computational Aerosciences Branch
NASA Langley Research Center

New Orleans, November 15-18, 2010

NASA's Noise Reduction Goals

Change in noise “footprint” area for a single event landing and takeoff



- **Environmentally Responsible Aviation Project**
- **Subsonic Fixed Wing Project**

- **Relative ground contour areas for notional Stage 4 (current) and future generations of aircraft**

Current Rule: Stage 4
Baseline Area



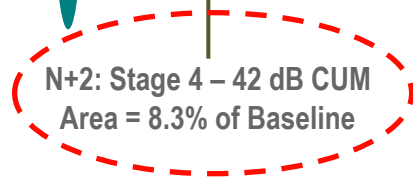
N+1: Stage 4 – 32 dB CUM
Area = 15% of Baseline



N+3: Stage 4 – 71 dB CUM
Area = 1.5% of Baseline



N+2: Stage 4 – 42 dB CUM
Area = 8.3% of Baseline



N: Stage 4 – 10 dB CUM
Area = 55% of Baseline

NASA-Gulfstream Partnership



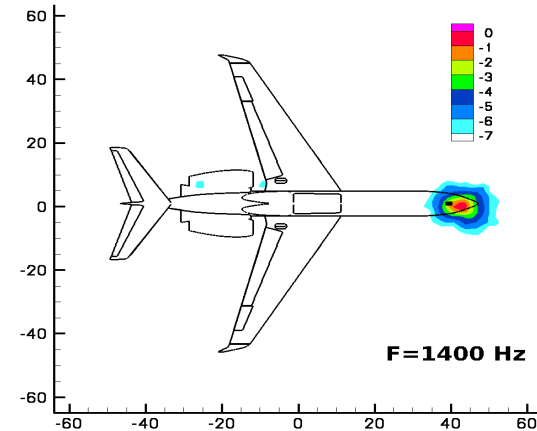
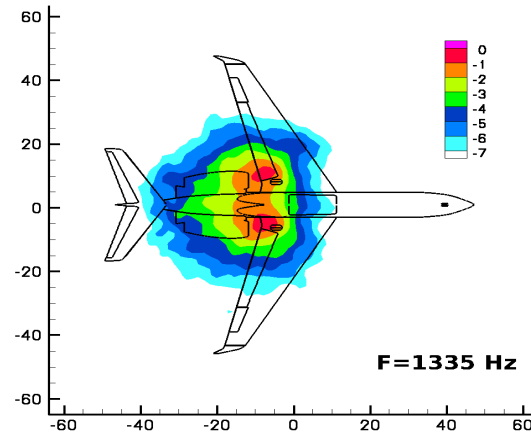
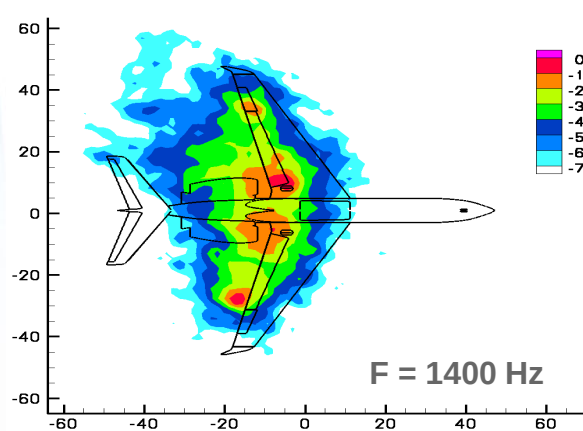
Objectives

- Mitigate radiated airframe noise during aircraft landing
- Develop effective noise reduction (NR) concepts applicable to current and future generation of civil transport

Execution Plan

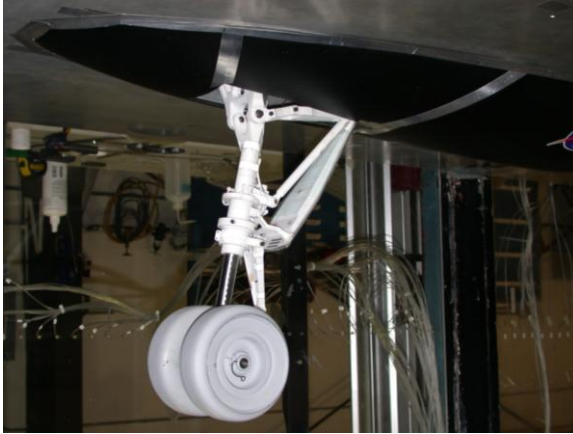
- Utilize flight tests, wind-tunnel experiments, and computational simulations to generate a comprehensive aerodynamic and acoustic database to:
 - » Identify and quantify the prominent airframe noise sources
 - » Better understand the principles of airframe noise generation
 - » Improve airframe noise prediction tools
 - » Develop efficient noise reduction concepts
- Evaluate the most promising noise reduction concepts in a realistic environment (on Gulfstream aircraft)

NASA-Gulfstream Airframe Noise Flight Test

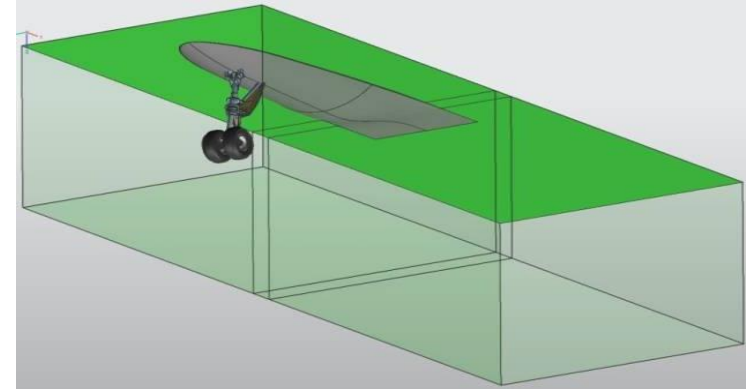


Nose Gear Tests & Corresponding Simulations

1/4th Scale Nose Landing Gear Model

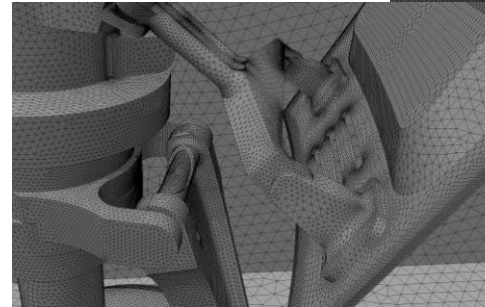
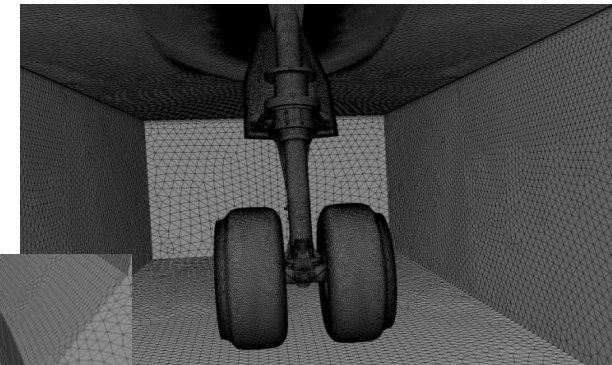
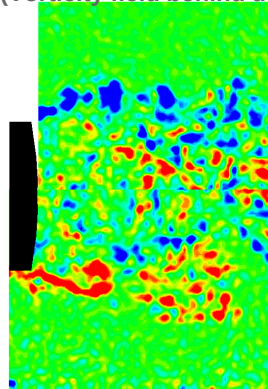
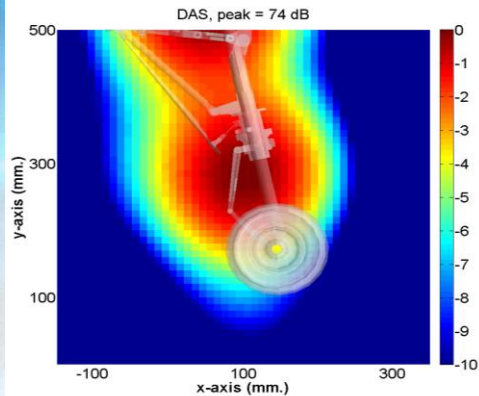


Simulated Configuration



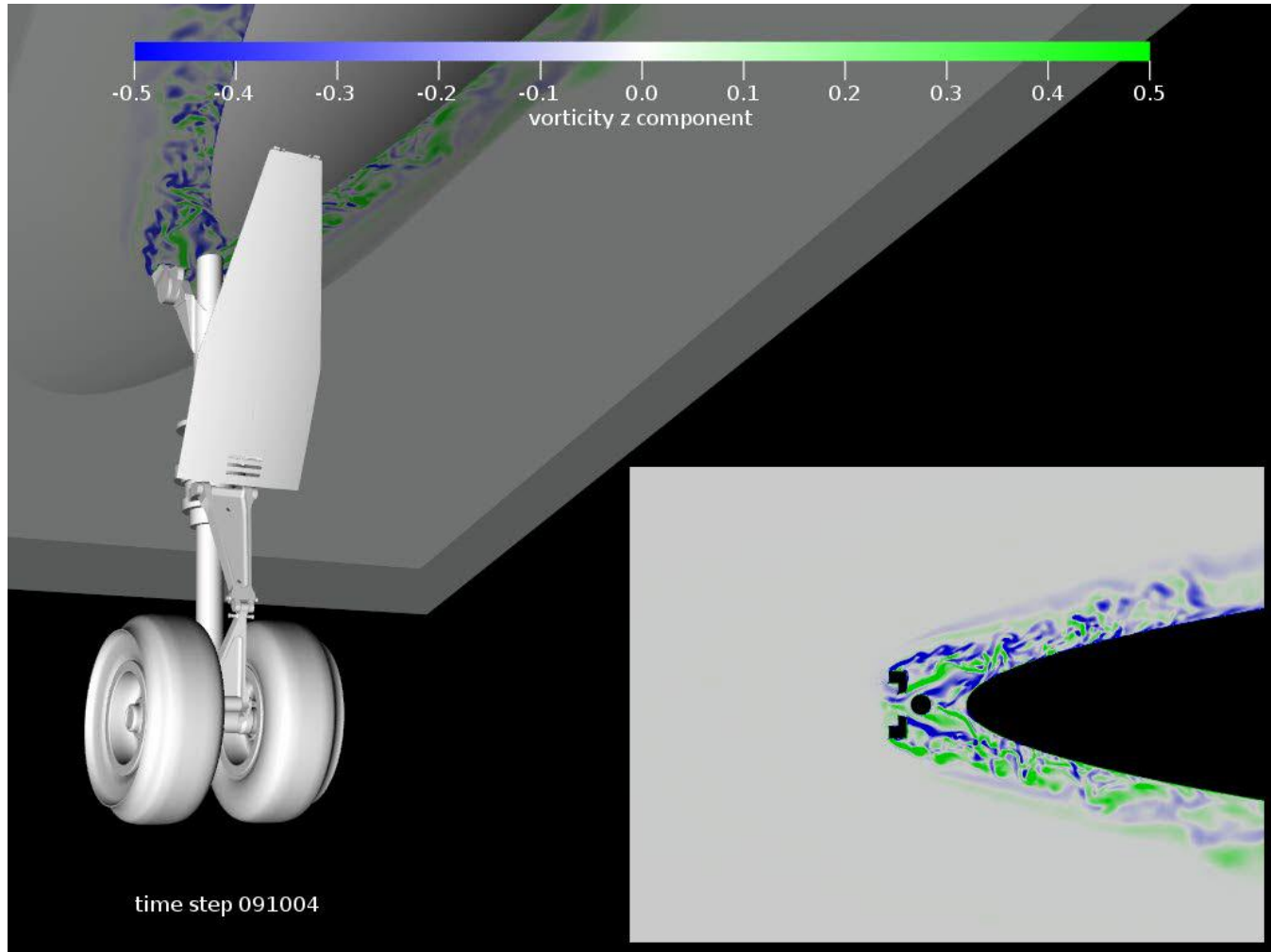
University of Florida

NASA Langley
(Vorticity field behind door)

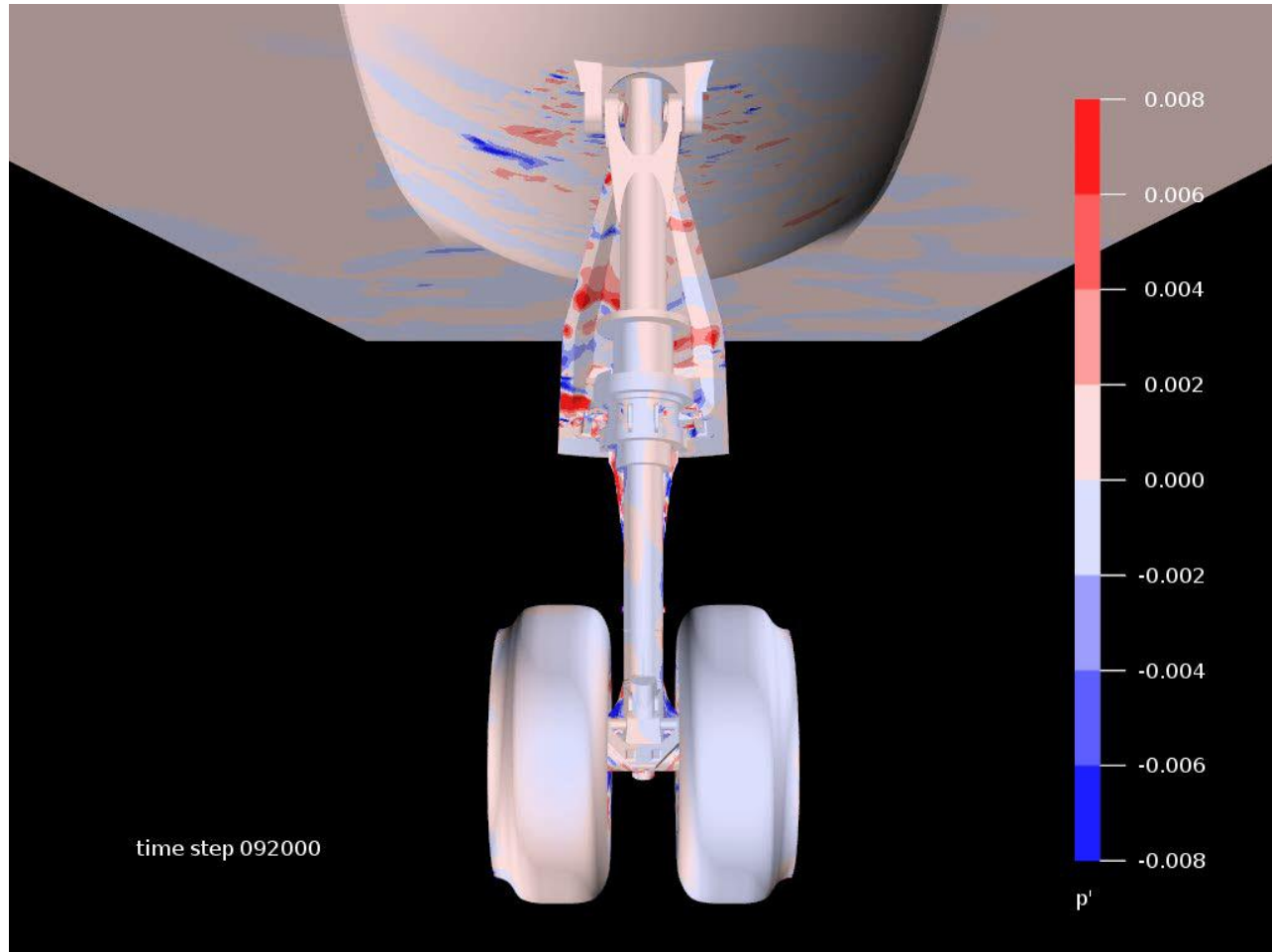


- NASA Langley FUN3D Code
- Executed on 1200 CPUs
- 1.7 million CPU hours used (two months)
- Animations by NAS Visualization Group

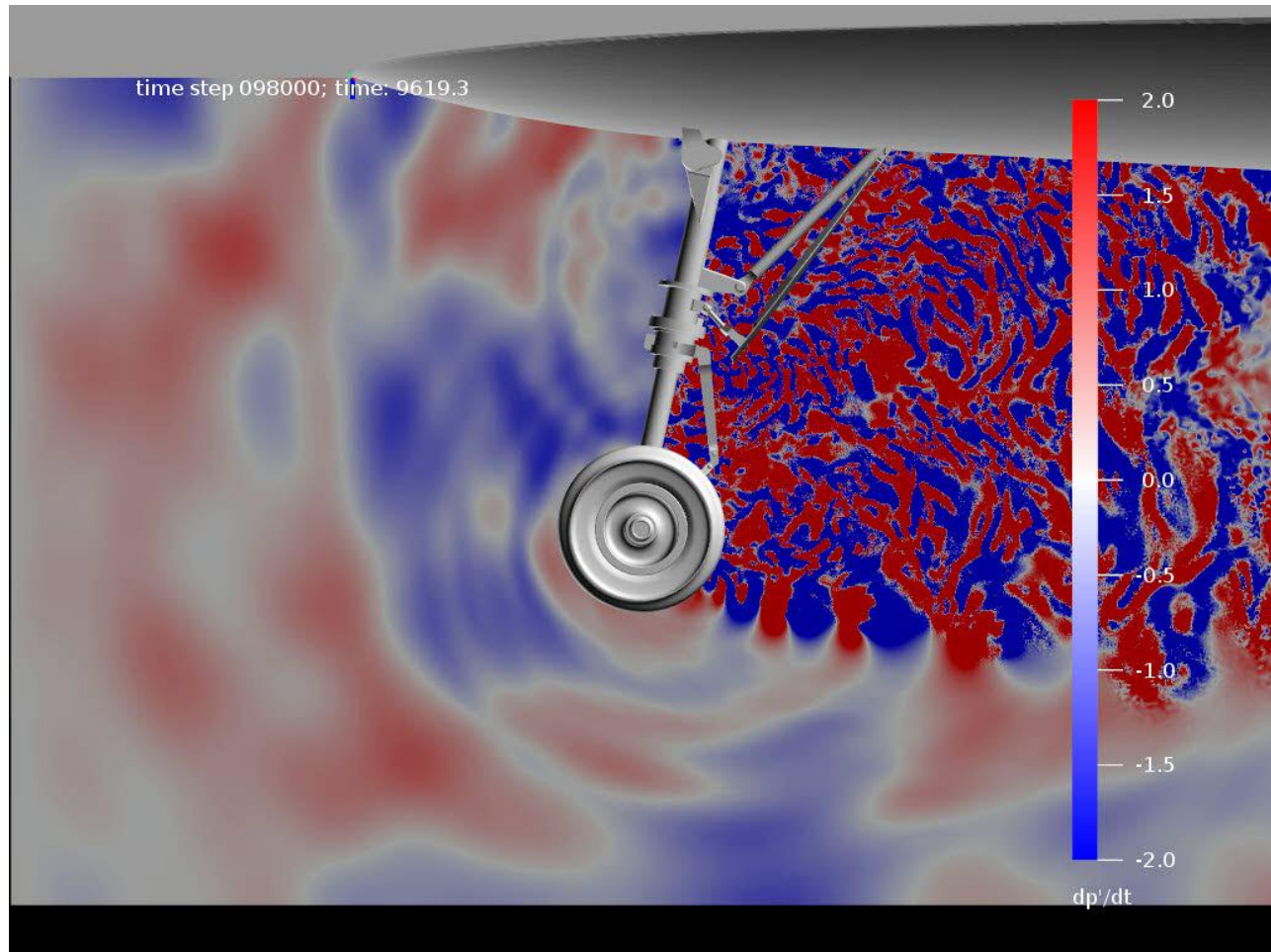
Simulated Flow Field



Surface Pressure Fluctuations (Noise Sources)



Radiated Acoustic Field



Back Up Charts



NASA's Noise Reduction Goals – Idealized Impact

Change in noise “footprint” area for a single event landing and takeoff



Current Rule: Stage 4

Baseline Area



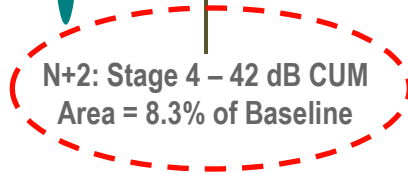
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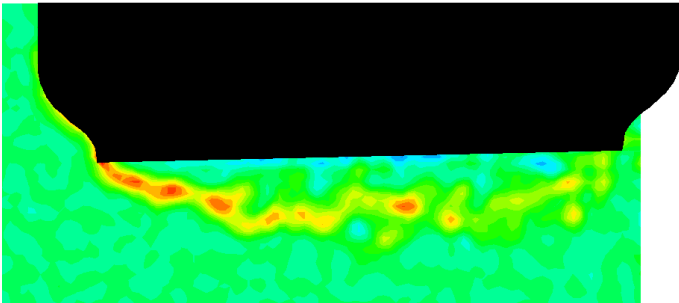
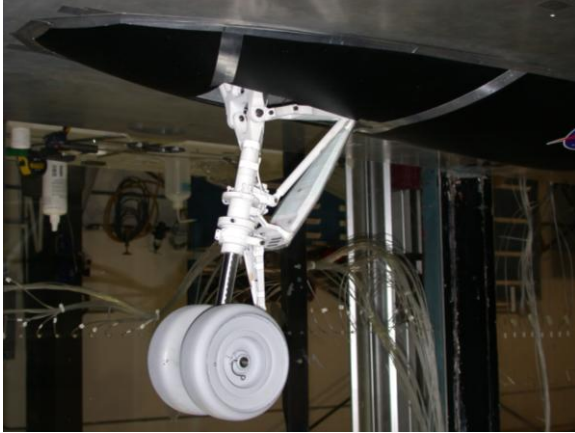
N: Stage 4 – 10 dB CUM
Area = 55% of Baseline

and

- Relative ground contour areas for notional Stage 4 and N+1, N+2, and N+3 aircraft
 - Independent of aircraft type/weight
 - Independent of baseline noise level
- Noise reduction assumed to be evenly distributed between the three certification points
- Simplified model: Effects of source directivity, wind, etc. not included

Volumetric Grid

1/4th Scale Nose Landing Gear Model



Simulated Configuration

