JOHNS HOPKINS
Center for Environmental
& Applied Fluid Mechanics

Weekly CEAFM Seminar: Spring 2014

Date:	**Friday, February 7, 2014**
Time:	11:00 AM
Location:	Gilman # 50 (Marjorie M. Fisher Hall)
Speaker:	**Dr. Joseph W. Nichols** (University of Minnesota)
Title:	***"Prediction of Supersonic Jet Noise Using High Fidelity Large Eddy Simulation on Unstructured Meshes"***

Abstract

The aeroacoustics of supersonic jets are intricately connected to turbulence in the jet shear layers and just downstream of the potential core. For pressure-mismatched jets, the interplay between turbulence and shocks is also important. Despite significant scientific investigation, jet noise remains a large component of the overall noise generated by supersonic aircraft. This is of particular concern on aircraft carriers, where it is necessary for deck personnel to be in close proximity to aircraft at takeoff and landing. In such harsh acoustics environments (150 dB), even the most advanced hearing protection cannot offer complete protection from long-term exposure.

Experiments, however, have shown that it is possible to reduce jet noise at its source through modification of the nozzle geometry such as the addition of chevrons along the nozzle lip. In this seminar, we assess a large-eddy simulation (LES) solver for unstructured meshes (charles), coupled to a Ffowcs Williams-Hawkings (FWH) solver, as a predictive computational tool for the design and understanding of geometry-based noise reduction techniques. Through comparison to experimental measurements, we demonstrate that this methodology indeed captures the three main components of supersonic jet noise: turbulent mixing noise, broadband shock-associated noise, and screech tones. The code was scaled to more than one million processors enabling high fidelity simulations revealing how alterations to nozzle geometry affect the mechanisms of supersonic noise generation. In addition, the resolution of the simulations was sufficient to observe the formation of N-shaped waves associated with the phenomenon of "crackle" occurring in hot supersonic jets (Ffowcs Williams et al., 1975). I will also briefly discuss aeroacoustic post-processing techniques for "big data."

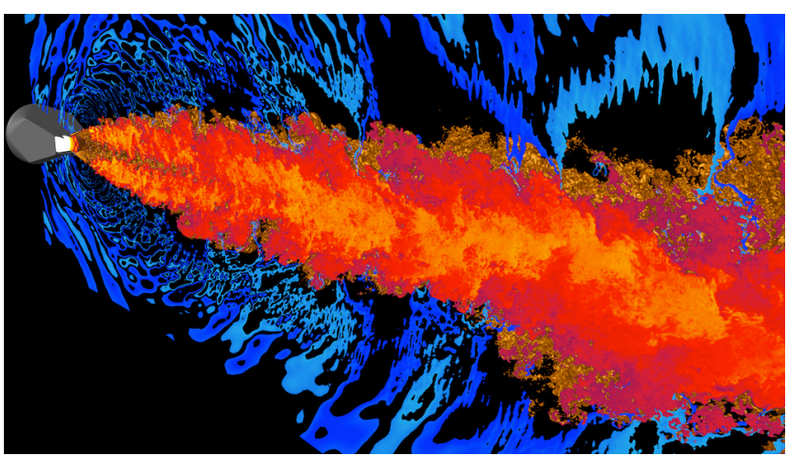

Figure: A snapshot of an LES of a supersonic jet issuing from a rectangular nozzle with chevrons. Temperature contours are shown in red and yellow while the resulting acoustic field is visualized by contours shown in blue.