DFD16-2016-020027

Abstract for an Invited Paper
for the DFD16 Meeting of
the American Physical Society

Turbulent Flow Physics and Noise in High Reynolds Number Compressible Jets

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In this talk I will present a snapshot of our ongoing research in high Reynolds number turbulent compressible jets. The high speed axisymmetric jet work (Mach 0.6 – 1.1) has been jointly performed with Spectral Energies LLC through AFRL support and involves 10 kHz and large window PIV data extracted from the near field jet plume, simultaneously sampled with near field pressure and far field noise. We have learned from the simultaneously sampled 10 kHz PIV near field plume and far field noise data, using POD/OID and Wavelet filtering, that there are certain "loud" velocity modes that have low averaged turbulent kinetic energy content but strongly correlate with the far field noise. From the large window PIV data obtained at Mach 1.0 and 1.1, specific POD modes were found to contain important physics of the problem. For example, the large-scale structure of the jet, shock-related fluctuations, and turbulent mixing regions of the flow were isolated through POD. By computing cross correlations, particular POD modes were found to be related to particular noise spectra. I will conclude with a description of our complex nozzle work which uses the multi-stream supersonic single expansion rectangular nozzle (SERN) recently installed in our large anechoic chamber at SU. This work is funded from both AFOSR (joint with OSU with a primary focus on flow physics) and Spectral Energies LLC (via AFRL funds with a focus on noise). Particular emphasis will be on insight gained into this complex 3D flow field (and its relationship to the far field noise) from applications of POD, Wavelet filtering and DMD to various numerical (LES) and experimental (PIV, high speed schlieren, near and far field pressure) data sets, at a core nozzle Mach number of 1.6 and a second stream Mach number of 1.0.