Abstract Submitted
for the DFD10 Meeting of
The American Physical Society

Coherent Structures in a Supersonic Jet Excited by Plasma Actuators DATTA GAITONDE, Air Force Research Laboratory, MO SAMIMY, The Ohio State University — Simulations are used in conjunction with experimental measurements to understand the coherent structures generated by excitation of a Mach 1.3 jet by eight localized arc filament plasma actuators uniformly distributed just upstream of the nozzle exit. Several modes are excited, including the axisymmetric (m=0), helical (m=1-3), and mixed modes (m=$\pm$1, $\pm$2) modes. The Strouhal number for all cases is fixed at 0.3, which corresponds to the most amplified frequency. The simulations reproduce the distinct coherent structures measured in the experiment for each azimuthal mode. Detailed analysis of instantaneous, time- and phase-averaged quantities highlights a complex coherent structure generation, evolution and dissipation process. A key feature observed is the initiation of hairpin-like structures with tips/heads in the outer region of the jet shear layer and legs extending forward and slightly inclined in the direction of the jet axis, where the velocity is higher. The subsequent interactions of these structures yield different composite structures in the downstream region. For example, for m=0, adjacent hairpin structures merge to yield axisymmetric rings, with the legs connecting successive structures in the form of ribs in the braid region; and with m=1 and 2 mode excitation, distinct helical and double-helical structures are observed, respectively, with the hairpins forming substructures in the coils.

Mo Samimy
Gas Dynamics and Turbulence Laboratory, The Ohio State University

Date submitted: 05 Aug 2010 Electronic form version 1.4