Abstract Submitted
for the GEC09 Meeting of
The American Physical Society

Nonequilibrium Supersonic Flow Field Measurements in a Mach 5 Plasma Wind Tunnel MUNETAKE NISHIHARA, KEISUKE TAKASHIMA, NAIBO JIANG, WALTER LEMPERT, IGOR ADAMOVICH, J. WILLIAM RICH, The Ohio State University — The effect of molecular energy transfer in nonequilibrium gas dynamic flows on supersonic/hypersonic flow field is studied using a Mach 5 nonequilibrium plasma wind tunnel. The tunnel uses a high pressure (0.5-1.0 atm) stabilized glow discharge in its plenum to load energy into internal molecular modes. The electric discharge system incorporates a repetitive nanosecond pulse discharge which weakly ionizes the flow and transverse DC discharge to load power into the vibrational energy mode of nitrogen. Translational temperature of the flow in the discharge remains low, 350-400 K, while vibrational temperature of nitrogen is up to 2,000 K. Vibration-translation (V-T) relaxation of nitrogen downstream of the discharge is accelerated by injecting hydrogen into the flow. The effect of partial vibrational relaxation of nitrogen on a shock wave stand-off distance in front of a cylinder model in a Mach 5 flow is studied by schlieren imaging and by NO Planar Laser-Induced Florescence (PLIF) using a pulse burst laser operating at a pulse repetition rate of 20 kHz.

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Date submitted: 15 Jun 2009 Electronic form version 1.4