TRANSIENT PLASMA ANALYZER FOR HYPERVELCOTY IMPACT EXPERIMENTS

David S. Lauben[1]*, Sigrid Close[1], Ashish Goel[1], Paul Tarantino[1]

[1]Stanford University STAR Laboratory, Stanford, CA

We describe a novel flat panel electrostatic Transient Plasma Analyzer (TPA) designed for Cubesat-based measurements of micrometeoroid hypervelocity impact (HVI) plasma plumes from intentional targets.

The impulsive, transient, non-repeating, and unpredictable nature of HVI plasma plumes calls for an instrument capable of making one-shot comprehensive measurements of the warm (10's of eV), expanding (10's of km/s) electron and ion distributions over all energies simultaneously and with sub-microsecond time resolution. Previous experiments indicate the total mass release and fractional ionization depends strongly on particle impact velocity and shows pronounced velocity threshold; properties which push the required sensitivity, dynamic range, and amplifier noise floor to the limits of charge amplifier performance, especially within tight Cubesat power and data constraints.

The TPA design consists of a compact array of millimeter scale electrostatic analyzer cells which are sized and biased to cover the energy range 0 to > 300 eV for electrons and also low Z ion species. Cells are clustered into distinct energy groups providing nominal energy resolution +/- 33%. The use of multiple small electrostatic analyzer cells as opposed to one larger cell of the same net aperture allows the TPA to be much thinner and to operate at lower voltages for a given energy resolution, albiet at somewhat reduced sensitivity and detection efficiency.

The Cubesat experiment plan calls for several TPA panels mounted at various distances and angles from the designated micrometeoroid target to measure HVI plasma plume expansion velocity and spatial asymmetry. This paper reviews the TPA development progress and planned proof-of-concept test flight through LEO and auroral fluxes aboard a technology demonstrator Cubesat.