

DEVELOPMENT OF ION AND NEUTRAL MASS SPECTROMETERS (INMS) FOR HELIOPHYSICS AND PLANETARY MISSIONS. E. C. Sittler Jr.¹, N. Paschalidis², J. F. Cooper³, E. Zesta⁴, A. Ali⁵, D. Chornay⁶, D. R. Durachka⁷, C. K. Bramboa⁸, M. Benna⁹, P. Mahaffy¹⁰ and R. Katz¹¹, ¹NASA Goddard Space Flight Center, Code 673, 8800 Greenbelt Road, Greenbelt, MD, 20771, Edward.c.sittler@nasa.gov, ²NASA Goddard Space Flight Center, Code 670, 8800 Greenbelt Road, Greenbelt, MD, 20771, Nikolaos.paschalidis@nasa.gov, ³NASA Goddard Space Flight Center, Code 672, 8800 Greenbelt Road, Greenbelt, MD, 20771, john.f.cooper@nasa.gov, ⁴NASA Goddard Space Flight Center, Code 673, 8800 Greenbelt Road, Greenbelt, MD, 20771, eftyhia.zesta@nasa.gov, ⁵University of Maryland, College Park, MD/NASA Goddard Space Flight Center, Code 673, 8800 Greenbelt Road, Greenbelt, MD, 20771, ashraf.ali-1@nasa.gov, ⁶University of Maryland, College Park, MD/NASA Goddard Space Flight Center, Code 673, 8800 Greenbelt Road, Greenbelt, MD, 20771, dennis.j.chornay@nasa.gov, ⁷NASA Goddard Space Flight Center, Code 564, 8800 Greenbelt Road, Greenbelt, MD, 20771, david.r.durachka@nasa.gov, ⁸NASA Goddard Space Flight Center, Code 564, 8800 Greenbelt Road, Greenbelt, MD, 20771, Clifford.k.brambora@nasa.gov, ⁹University of Maryland, Baltimore County (UMBC), Baltimore, MD, 21250/NASA Goddard Space Flight Center, Code 699, 8800 Greenbelt Road, Greenbelt, MD, 20771, Mehdi.benna-1@nasa.gov, ¹⁰NASA Goddard Space Flight Center, Code 699, 8800 Greenbelt Road, Greenbelt, MD, 20771, paul.r.mahaffy@nasa.gov, ¹¹NASA Goddard Space Flight Center, Code 564, 8800 Greenbelt Road, Greenbelt, MD, 20771, Richard.b.katz@nasa.gov.

Introduction: Goddard's Geospace Physics Laboratory is developing INMS concepts that can be used for future Geospace missions to the Earth's ionosphere and for future planetary missions to bodies with atmospheres and ionospheres, in collaboration with the Planetary Environments Laboratory. Our group is designing ion mass spectrometers (IMS) for energy-per-charge range 1 V to 50 kV that can be used for solar wind ion composition measurements, the Earth's magnetosphere, lunar orbiters, and planetary magnetospheres. We will focus on a High Precision Electric Gate (HPEG) design that can be used with a reflectometer to achieve very high mass resolution capability. The HPEG design has been patented by Goddard with E. C. Sittler Jr. as inventor. The HPEG design allows for low power miniaturization so it is ideally suited to CubeSat missions, it can gate 450 V ions with only ± 6 V pulses (i.e., effective analyzer constant of $450/6 \sim 75$), and HPEG is also an ion velocity filter so when combined with energy analyzer and/or ion pre-acceleration provides capability of separating major ions from minor ions. Engineers at Goddard's Instrument Electronics Development Branch have prototyped a pulse generator that can deliver a required train of pulses with precision placement of pulse edges \sim ns relative to each other within the pulse train onto a Field Programmable Gate Array (FPGA) platform that will allow miniature designs of the HPEG; one can put the pulse generator into an ASIC platform for Total Ionizing Dose TID \sim Mrad resistance for high radiation environment requirements. The burst of pulses can be triggered at MHz rates and individual gates can be stacked for higher sensitive area (i.e., subsets can be selected for variable sensitive area capability). We will

present initial and more recent lab results of our HPEG design.