A multi-foil sensor: Pulse height distributions of secondary electrons for ion mass separation with time of flight in space particle instruments.

N. Paschalidis (1), S. Livi (1), D. Mitchell (1), K. Nelson (1), G. Ho (1), S. Jaskulek (1) and B. Mauk (1)

(1) The Johns Hopkins University-Applied Physics Laboratory, Laurel, Maryland, USA (nick.paschalidis@jhuapl.edu / FAX: 001 – 240 –2281093)

A prototype multi-foil sensor has been developed to study the secondary electron distributions generated by ions penetrating multiple thin foils. The sensor includes a mechanical support for one to four foils, electrostatic deflection, microchannel plate (MCP) for the secondary electron detection and amplification, adjustable high voltage (HV) biasing for foils, electrostatics, and MCPs, and pulse height analysis (PHA) on an event-to-event basis. A UV light source is used to provide the reference single electron PHA distribution containing the statistics of MCP gain and other noise sources. The UV distribution is then compared to the PHA distributions of 10KeV protons and 160KeV oxygen on the basis of same ion speed. The results for the single foil and the four foil cases are summarizes below:

(a) In the single foil case the proton distributions peak at about the same location as the reference UV, with the protons having similar roll-off before the peak but with more extended tail; on the other hand the oxygen distribution has a broad peak at $\sim$8 electrons and extended tail. Although the UV, proton and oxygen distributions have well separated peaks, it is likely to have a significant overlap in the area of 2-4 electrons in cases of high UV/proton fluxes that are typical in the space environment.

(b) In the four-foil case – 3 foils penetrated by 160KeV Ox – the 10KeV proton distribution peaks at $\sim$1.4 electrons whereas the 160KeV oxygen distribution peaks at $\sim$24 electrons, and both distributions are wider by the corresponding gain factor; the peak value of the oxygen distribution drastically moved to the right side greatly minimizing the overlap of the proton and oxygen populations.

In all cases the UV, proton and oxygen distributions are consistent with Poisson statistics of secondary electron generation with mean value at the corresponding peak values. The multi-foil sensor results suggest that one could replace the relatively high energy dead layer SSD system with one or more foils, for PHA based mass separation, with much lower energy threshold for heavy ions, with much lower noise, higher counting rate/statistics and simplicity. Other applications of the multi-foil sensor are also possible such as deltaV/V ion separation with precise time of flight.