Geophysical Research Abstracts
Vol. 20, EGU2018-17601, 2018
EGU General Assembly 2018

3D Field-of-view fast plasma spectrometer for planetary exploration

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Understanding electron acceleration mechanisms in planetary magnetospheres or energy dissipation at electron scale in space plasmas requires fast measurement of electron distribution functions on a millisecond time scale. Still, since the beginning of space age, the instantaneous Field Of View (FOV) of plasma spectrometers is limited to a few degrees around their viewing plane. Since most planetary explorers are 3-axis stabilized, this limited FOV is a major limitation to obtain high-time resolution and accurate plasma measurements.

We present the « 3-D donut » electrostatic analyzer concept that can change the game for future space missions because of its instantaneous hemispheric field of view. A set of 2 sensors is sufficient to cover all directions over a wide range of energy. In addition, its high sensitivity compared to state of the art instruments opens the possibility of millisecond time scale measurements in space plasmas with a level of ressources that may be compatible with most planetary missions. We developed a high fidelity prototype (a quarter of the full « 3-D donut » analyzer) that includes all electronic sub-systems. The prototype weights less than a kilogram. The key building block of the instrument is an imaging detector that uses EASIC, a low-power front-end electronics that will fly on the ESA Solar Orbiter and on the NASA Parker Solar Probe missions. Beam tests of the optics confirm the expected 3D FOV of this innovative instrument.