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Author: Mr. Gwendal Hénaff
Laboratoire de Physique des Plasmas (LPP), France, gwendal.henaff@gmail.com

Dr. Matthieu Berthomier
Laboratoire de Physique des Plasmas (LPP), France, matthieu.berthomier@lpp.polytechnique.fr
Mr. Frédéric Leblanc
Laboratoire de Physique des Plasmas (LPP), France, frederic.leblanc@lpp.polytechnique.fr
Dr. Jean-Denis Techer
Laboratoire de Physique des Plasmas (LPP), France, jean-denis.techer@lpp.polytechnique.fr
Mr. Gabriel Degret
CNRS, France, gabriel.degret@cnrs.fr
Mr. Sylvain Pledel
Laboratoire de Physique des Plasmas (LPP), France, sylvain.pledel@lpp.polytechnique.fr

DESIGN AND LABORATORY TESTING OF A 4U 3D-PRINTED ION/ELECTRON SPECTROMETER WITH AN INSTANTANEOUS 3D FIELD OF VIEW FOR SMALL SATELLITES.

Abstract

One of the challenges in instrumentation for space plasma physics is to measure the 3D distribution and energy spectrum of charged particles while keeping a limited mass and volume budget.

Current reference instruments aim to detect positive ions and electrons up to tens of keV with high temporal resolutions. These instruments have a 2D filed of view and need to swipe through several elevation angles to get the 3D distribution around a spacecraft. Reference missions use 8 of these instruments per platform per type of particles to reach the performances objectives: such a configuration is impossible on small and micro satellites and therefore limits missions' concepts and cost effectiveness.

We developed an instrument that allow measurement of both the energy and instantaneous 3D field of view of charged particles at high speed, therefore getting rid of the need to swipe through the elevation: only two of these instruments are needed per spacecraft. We converged towards a 4U solution with a diameter below 20cm and less than 2Kg. Thanks to an innovative ion/electron system, we can detect both species with a single instrument. This design is possible due to additive technology and new electrostatic geometries.

Thanks to several innovations both in the scientific design and in the manufacturing processes, we show that we reach mass, power, size and cost requirements to fit on small and micro satellites while keeping performances requirements that satisfy the needs of complex scientific missions. We compare laboratory performances to current reference designs and explore the new perspectives it opens for deep-space exploration missions based on small platforms.