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THE SWEEPING LANGMUIR PROBE (SLP) INSTRUMENT ON BOARD PICASSO

Abstract

Langmuir probe instruments have been used for decades on board large/medium-size satellites to measure ambient plasma properties (electron density and temperature together with ion density) but their operation on board smaller platforms, such as nano-satellites, raises several issues in addition to miniaturisation and drastic reduction of power consumption. The limited conducting area of the spacecraft leads to spacecraft charging and drift of the instrument's electrical ground during the measurements, which can lead to unusable data. Furthermore, the usually limited telemetry bandwidth available on nano- to small satellites requires the use of untraditional measurement and data processing approaches. The Sweeping Langmuir Probe (SLP) instrument, that uses a novel measurement technique, has been developed at the Royal Belgian Institute for Space Aeronomy to overcome the above mentioned issues. SLP is currently flying on board the ESA scientific in-orbit demonstrator PICASSO together with the hyper-spectral imager VISION. PICASSO, a triple unit CubeSat, flies on a quasi-polar orbit at an altitude of about 540 km, with an inclination of 97 degrees. It was launched with an Arianespace Vega rocket in September 2020. The goal of the mission is to prove the feasibility of performing true science (with limited extent) with a nano-satellite and demonstrate the very low cost / science ratio with respect to big missions. SLP will allow a global monitoring of the ionosphere with a maximum spatial resolution of the order of 150 m. The main goals are to study the ionosphere-plasmasphere coupling, the subauroral ionosphere and corresponding magnetospheric features, together with auroral structures and the polar caps, by combining SLP data with other complementary data sources (space- or ground-based instruments). SLP can measure plasma density from 1e8/m3 up to 1e13/m3 and electron temperature between 1000 K and 15 000 K. Given its capabilities, miniaturisation and low power consumption, SLP can be easily accommodated in any (2U Cubesat or larger) satellite either as a plasma diagnostic instrument or as an accurate spacecraft potential monitor. We will present the main results of the SLP measurements acquired during the first months of the PICASSO mission as well as comparisons with ground-based measurements (performed in a plasma chamber at ESA/ESTEC, NL) and particle-in-cell (PIC) simulations performed with SPIS (Spacecraft Plasma Interaction System). Finally, we will present the first lessons learned from the mission.