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# Development of a novel sweeping Langmuir probe instrument for monitoring the upper ionosphere on board a pico-satellite

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A novel Langmuir probe instrument, which will fly on board the Pico-Satellite for Atmospheric and Space Science Observations (PICASSO), is under development at the Belgian Institute for Space Aeronomy. PICASSO was initiated to join the QB50 project as scientific in-orbit demonstrator.
The sweeping Langmuir probe (SLP) instrument is designed to measure both plasma density and electron temperature at an altitude varying from about 400 km up to 700 km from a high inclination orbit. Therefore, the plasma density is expected to fluctuate over a wide range, from about 1e6/$m^3$ at high latitude and high altitude up to 1e12/$m^3$ at low/mid latitude and low altitude. The electron temperature is expected to lie between approximately 1000 K and 3000 K.
Given the high inclination of the orbit, the SLP instrument 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 1) the ionosphere-plasmasphere coupling, 2) the subauroral ionosphere and corresponding magnetospheric features, 3) auroral structures, 4) polar caps, and 5) ionospheric dynamics via coordinated observations with EISCAT's heating radar.
To achieve the scientific objectives described above, the instrument includes four thin cylindrical probes whose electrical potential is swept in such a way that both plasma density and electron temperature can be derived. In addition, since at least two probes will be out of the spacecraft's wake at any given time, differential measurements can be performed to increase the accuracy.
Along the orbit, the Debye length is expected to vary from a few millimetres up to a few meters. Due to the tight constraints in terms of mass and volume inherent to pico-satellites, the use of long booms, which would guarantee that the probes are outside the sheath of the spacecraft (several Debye lengths away), is not possible. Consequently, the probes might be in the sheath of the spacecraft in polar regions. Extensive modelling and simulations of the sheath effects on the measured current/voltage characteristics will be performed to ensure an accurate parameter extraction from the measured data. Another issue implied by the use of a pico-satellite platform for a Langmuir probe instrument is the limited conducting area of the spacecraft which can lead to spacecraft charging. In order to avoid this problem, the probes are swept in a particular way with a duty cycle of the order of a few percent. The resulting measurement data rate is compatible with the limited telemetry bandwidth available on PICASSO, which will have an S-band downlink session when it passes over the ground station every few orbits.