Energy resolution and absolute efficiency calibration facility for Low-energy plasma sensor for Venus Mission

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Synopsis Development of an automated ground calibration system for the RPA payload for the upcoming Venus mission. The facility is designed to satisfy the need to produce a well defined energy and intensity distribution low energy ions and electrons using electron impact ionization and VUV photo-ionization of inert gas target.

A Retarding Potential Analyzer (RPA) is a plasma diagnostic instrument used to measure the energy distribution of charged particles and determine plasma parameters such as ion and electron density, temperature, and flow characteristics. RPAV is designed to investigate the plasma environment of Venus, with a particle concentration measurement range of 10–10^6 cm^{-3}.

The system will characterize ion and ionospheric electron populations at 100–5000 K and solar-wind electrons at 25,000–500,000 K. Accurate low-energy measurements require calibration for thermal dimensional changes, magnetic-field interference, secondary-electron contamination, and grid misalignment, which affect particle transmission and energy resolution.

A dedicated ground calibration system is being developed to characterize the RPA's energy response, transmission efficiency, density response, and secondary-electron effects under controlled vacuum conditions. Measured current–retarding potential characteristics will be fitted with appropriate particle-distribution models to determine energy distributions and derive plasma parameters, including temperature and density, ensuring reliable measurements through instrumental-response calibration.

An inert gas will be introduced into a localized interaction region through a slit-jet mechanism. Electron-impact and VUV photo-ionization will generate charged particles with well-characterized energy distributions. The VUV source must provide a focused photon flux of at least 10^{11} photons $s^{-1}\,mm^{-2}$,with a beam diameter below 0.5 mm at a distance of approximately 10 cm or greater, for energy calibration. An electron source operating at 100 eV–10 keV, with an energy spread of approximately 0.5 eV and adjustable beam current of 10 nA–100 μA, will provide higher particle fluxes for density calibration. Extractor grids on both sides of the interaction region will direct electrons and ions towards the sensor.

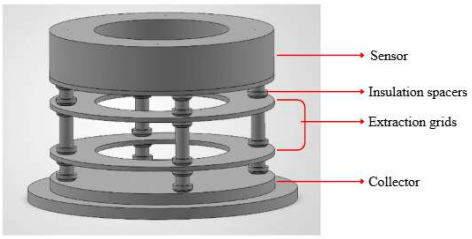

Figure 1. Grid arrangement for ion,electron extraction.

Gas-flow simulations and SIMION-based electrostatic particle-trajectory simulations are being conducted to optimize gas injection, extraction geometry, beam profiles, and particle transmission. The system will incorporate automated control and data acquisition to facilitate systematic characterization of the instrumental response of RPAV and support reliable and frequently reproducible low-energy plasma measurements for Venusian ionospheric investigations.

References

[1] Knudsen W C *et al.* 1980 *IEEE Trans. Geosci. Remote Sens.* **18** 54–59

[2] Denieffe K, Mahony C M O, Maguire P D, Gahan D and Hopkins M B 2011 *J. Phys. D: Appl. Phys.* **44** 075205

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