Application of In Situ Techniques for Exploration of Planetary Environments

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Mass Spectrometry and Separation Science for Planetary Environments

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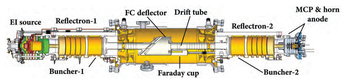
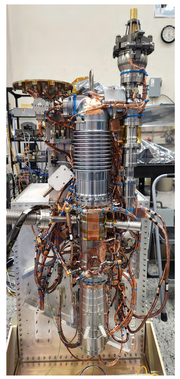
MASPEX-Europa



MASPEX is a multi-bounce time-of-flight mass spectrometer that uses two coaxial reflectrons to trap ions in the drift tube region to extend their flight path and increase mass resolution.

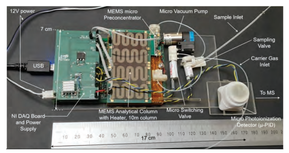
The MAss Spectrometer for Planetary EXploration (MASPEX) instrument will launch in October 2024 as part of the Europa Clipper payload. MASPEX is a neutral gas mass spectrometer with the highest mass resolution of any spaceflight mass spectrometer to date. At Europa, MASPEX will search for and identify organic molecules as well as neutral gases in the exosphere and in the torus. In Situ group members have been involved in definition of the Science Traceability Matrix (Glein); radiation modeling to determine background noise levels and cryo-cooler lifetime testing (Blase); and calibration of the flight instrument (Miller).



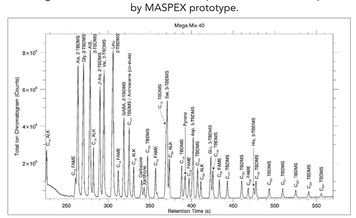
Micro-electro-mechanical system (MEMS) Gas Chromatography (GC)

Ryan Blase

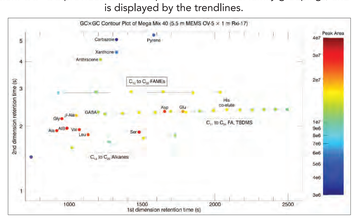
MEMS-GC can be utilized in future landed missions for standalone detection of organic compounds or as a front-end separation technique paired with a mass spectrometer. Our group (Blase, Glein, Miller) has worked with colleagues at SwRI and at University of Michigan to develop MEMS-GC hardware as a prototype for future flight applications.



40-component mixture including organics, polycyclic aromatic hydrocarbons (PAHs), and chemically derivatized amino and fatty acids separated on 5 m length MEMS GC column with mass spectrometric detection provided by MASPEX prototype.

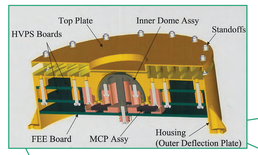


40-component mixture separated by comprehensive two-dimensional gas chromatography (GC×GC) with 5 m MEMS GC column in the 1st dimension. GC×GC provides chemical speciation (chemical family groupings) and is displayed by the trendlines.

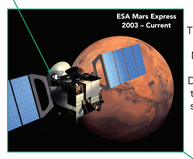


Electron Spectroscopy of Plasmas in Planetary Environments

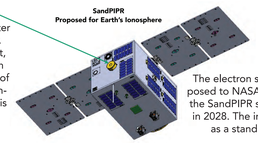
Rudy A. Frahm (rudy.frahm@swri.org)



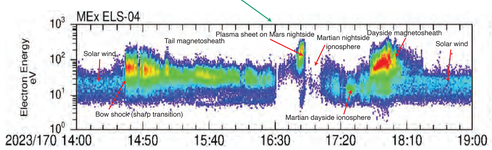
The electron spectrometer was included on the ESA Venus Express spacecraft, which arrived at Venus in 2006 and operated until 2014 when the spacecraft was destroyed in the Venus atmosphere. The instrument head was part of the ASPERA-4 plasma instrument package.



The electron spectrometer is included on the ESA Mars Express spacecraft, which arrived at Mars in December 2003 as part of the ASPERA-3 plasma instrument package, and is still operating today.

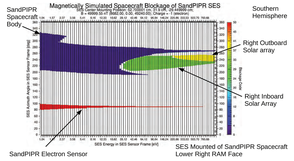


The electron spectrometer is proposed to NASA as an instrument on the SandPIPR spacecraft for launch in 2028. The instrument is offered as a stand alone package.



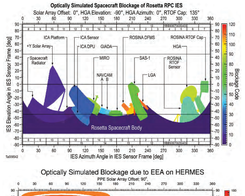
The spectrogram is taken from one sector of the spectrometer flying in orbit around Mars. This demonstrates that the electron spectrometer is able to measure electron plasma in the solar wind, through the bow shock, magnetosheath, magnetosphere, and ionosphere.

Analysis of Instrument Field-of-View Accommodation



Electrons in the magnetic field follow helical paths that are position and energy dependent. Analysis of where in the SandPIPR orbit certain look directions will measure electrons from the spacecraft rather than the environment will help decide on the optimal instrument accommodation on the spacecraft. The pattern of where the spacecraft is imaged changes depending on the electron energy, the orientation of the magnetic field, and hemisphere of planet Earth.

Optical trace of the Ion and Electron Spectrometer field-of-view on the Rosetta spacecraft showing that other Rosetta science and engineering instruments blocked and interfered with the plasma being measured at various locations. Note: Blockage codes are different for each component on the spacecraft.



The optical tracing technique is applied to the Electron Electrostatic Analyzer of the HERMES experiment suite to show that the Lunar Gateway will protrude into the instrument's field-of-view when it launches in the 2028 time frame.