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MASPEX-Europa aboard Clipper: A mass spectrometer for investigating the habitability of Europa

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Abstract

The MAss Spectrometer for Planetary Exploration Europa is a high-resolution mass spectrometer that will fly onboard the Europa Clipper mission to explore the habitability of Europa. The inclusion of a cryotrap sampling system provides over three order of sensitivity enhancement over previous mass spectrometers flown onboard space missions.

1. Introduction

MASPEX uses a multi-bounce time-of-flight (MBTOF) mass spectrometry technique to provide a variable resolution up to 50,000 FWHM. A Ricor cryo-cooler provides cryo-trapping of volatiles from the exosphere of Europa that occurs simultaneously with the in-situ sampling during the flyby thereby increasing the sensitivity to trace volatiles by over three orders of magnitude.

1.1 Science Objectives

The primary science objectives for the investigation are: 1) Determine the distribution of major volatiles and key organic compounds in Europa's exosphere/plumes and their association with geological features, and 2) Determine the relative abundances of key compounds to constrain the chemical conditions of Europa's ocean.

MASPEX can detect volatiles and organic compounds in plumes or the neutral atmosphere to reveal important processes and associated conditions in the subsurface. We are beginning to understand the geochemical space of the subsurface using a simple model. Cycles of redox species in the Europa system lay the groundwork for habitability of European environments (see Figure 3). Merging MASPEX data with quantitative geochemical analysis will be key to addressing habitability.

2. Configuration and Performance

The MBTOF is approximately one-half meter in length with the ion source on the front end and a radiation-shielded microchannel plate detector on the aft end (see Figure 1). A pair of pulsed (~50 nanoseconds) electrostatic mirrors allow ions extracted from the closed electron impact storage source to be introduced into the reflectron system, trapped for multiple laps, and allowed to exit to the detector. An off-axis Faraday cup provides switched access for absolute calibration and monitoring of in-flight gain changes in the detector. Most of the electronics with the exception of the high-speed source pulsers (~10 nanosecond) are housed in an electronics box inside the radiation-hardened spacecraft vault. The instrument has a gas inlet system that contains the sampling antechamber, the gas calibration system, and the cryotrap. A low leak rate high conductance valve isolates the instrument from the external environment to allow the cryo-sample to be carried out to the lower radiation environment near apoapsis before analysis without the need for continuous running of the cryotrap.

A full engineering model of the instrument has been completed and tested. Performance data is shown in Figure 2. The high sensitivity of the instrument necessitates that attention must be paid to the effects of spacecraft contamination. The instrument developers are working with the NASA JPL contamination control group to execute an extensive

contamination control simulation that will be addressed in the presentation.

3. Summary and Conclusions

The Engineering model of MASPEX for the Clipper mission is completed and tested. The results are reported in this presentation.

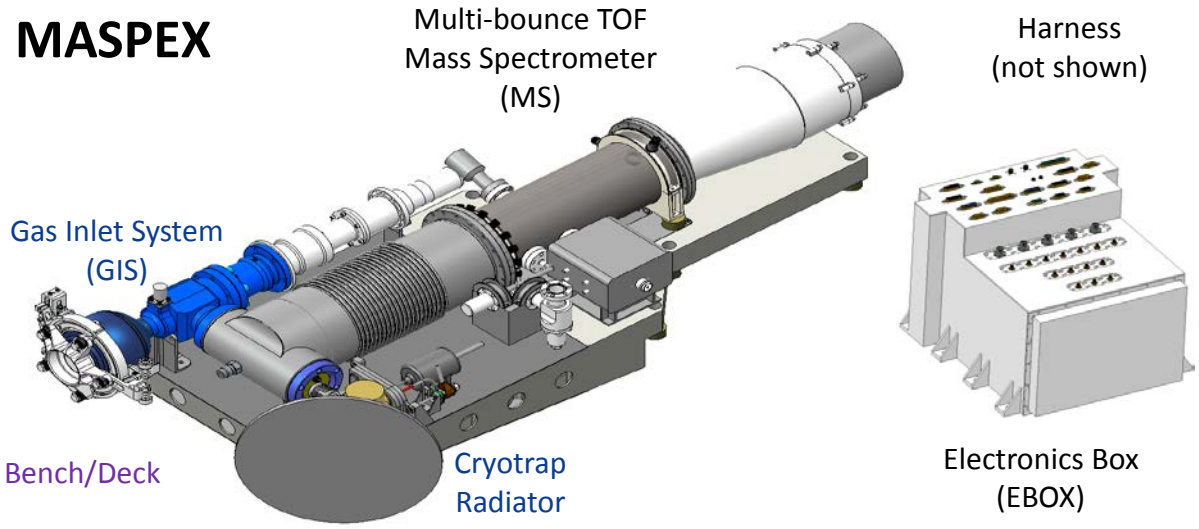

Figure 1 CAD drawing of the MASPEX Europa Engineering Model for the Clipper mission.

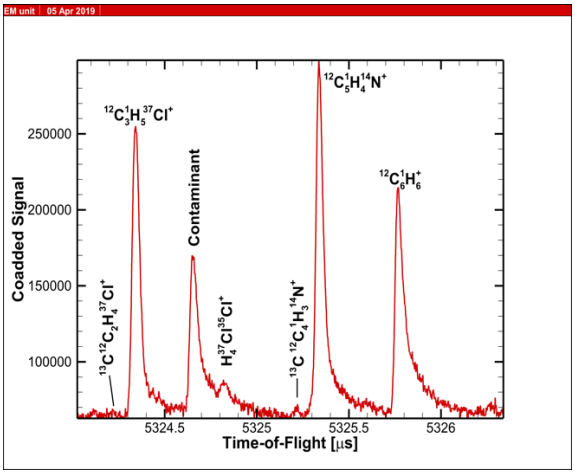

Figure 2 Resolving Mass 78 Triplet for a Mixture of 1,2-Dichloropropane, Pyridine and Benzene at a mass resolution of 55,000.