Mass Spectrometer for In-Situ Analysis of Organics in Martian Samples

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Overview

The Mars Organic Molecule Analyzer (MOMA) is part of the 2018 ExoMars rover led by the Max Planck Institute in Germany (PI: Dr. Fred Goesmann). A NASA-Goddard-based team contributes the core ion-trap mass spectrometer and electronics. MOMA’s top objective is to seek signs of past and present life Mars. The main requirement of the mass spectrometer is to support the analysis of molecules of interest from both GC and laser sources. Two types of ion traps are under investigation:

1) 3D Ion Trap (First approach)
2) 2D Linear Ion Trap (New approach)

Results prior to 2D ion trap

Acceptable performance, in terms of mass resolution and sensitivity, was achieved with an RF frequency down to 500 kHz.

Parameter Definition Value
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\( r \) internal radius 3 mm
\( V_{\text{op}} \) main RF voltage 1.2 kV
\( f \) main RF frequency 700 kHz
\( V_{\text{aux}} \) aux. RF voltage (pp) 0-10 V
\( f_{\text{aux}} \) aux. RF frequency 15-350 kHz
\( V_{\text{DC}} \) DC end plate bias 0-100 V
\( q_{\text{eject}} \) trap ejection point 0.64

Preliminary data of a 4 mm Thermo Finingan 2D linear trap identical to our scaled down 3 mm 2D ion trap design.

Pulse counting

Pulse-counting has advantages over analog detection: Avoidance of analog noise and drift by digitization; performance degradation can be modeled and remotely diagnosed; low power and small PCB signature. Pulse counting experiments were performed on the 3D ion trap to investigate linearity.

Conclusions

The MOMA mass spectrometer requirements are met with a linear ion trap design that supports introduction and analysis of ions from laser desorption and GC/EI modes. The radial ejection of ions to a dynode and electron multiplier and detection pulse-counting electronics permits MOMA to achieve high analytical performance in a very compact and low-power instrument.

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