A Multiple-Reflection Time-of-Flight Mass Spectrometer for the ROSETTA Space Craft

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For the ROSETTA space mission to a comet head a new type of high resolving time-of-flight mass spectrograph has been designed, built, integrated in the PHILAE lander of the ROSETTA space craft and landed remotely operated on the Comet Tschurjumow-Gerassimenko. The system a “multi-reflection time-of-flight mass analyzer” or MR-TOF-MA consists of two grid-free ion mirrors between which the ions shuttle back and forth multiple times [1,2], which increases the length of the ion flight path while keeping the time isochronicity and thus for a given preselected length of the initial ion pulse the achievable mass resolving power.

The MR-TOF-MA is not equipped with a vacuum system. It has an overall length of 43cm, a weight of 1150 grams and a power consumption of 3.5W. The ions are formed in an electron impact source and detected in a channel plate detector. The ion mirrors, between which the ions are multiple times reflected, are constructed as twice 6 short aluminum tubes, which are covered by thin gold layers. The electrodes are housed in an insulated aluminium tube. This design made the system construction so rugged that it could tolerate the required tests with 9 G.

The potentials on the mirror electrodes are chosen so that the ions experience electric reflecting fields in both mirrors as well as an electric round lens to match the phase space of the ion beam to the transport optics. During the times, when the ions enter or leave the time-of-flight mass analyzer, the potentials on the mirror electrodes are switched off. The fast pulse generators that achieve the necessary fast high voltage pulses are mounted directly at the mirror electrodes with only mm long wires to the last active elements, which reduced the pulse rise times and the necessary power consumptions.

References:
[1] Wollnik, H. et al., 47th ASMS Conference, Dallas, Texas (2001)
[2] Wollnik, H. et al., 48th ASMS Conference, Long Beach, California (2000).