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Calibration test of an ion energy mass spectrum analyzer onboard the Martian Moons eXploration (MMX) spacecraft

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We will report the results of the calibration test of the ion energy mass spectrum analyzer for the Martian Moons eXploration (MMX) mission. The MMX mission is a sample return project planned by the Japan Aerospace Exploration Agency (JAXA) to investigate the origin of the Martian moons and physical processes in the Martian environment. The ion analyzer is a component of the mass spectrum analyzer (MSA), along with the two magnetometers, which measures distribution functions and mass distributions of low-energy (<10s keV) ions. The MSA will measure ions emitted from Phobos and its torus as well as escaping ions from the Martian atmosphere with monitoring the solar wind to address the MMX science goals.

The ion analyzer employs nearly the same measurement techniques as that of Ion energy Mass Analyzer (IMA) for the Kaguya mission and mass spectrum analyzer (MSA) for BepiColombo/MIO. The ion analyzer is cylindrically symmetric in shape and consists of an energy analyzer and a mass analyzer (see the figure). The aperture of 360 degrees near the sensor top and neighboring angular scanning deflectors provide a 2-pi steradian field-of-view (FOV). The energy analyzer measures energy/charge using a top-hat electrostatic method in which the inner spherical electrode is applied with a sweeping negative high voltage. In the mass analyzer, mass/charge is measured by a time-of-flight (TOF) method that uses a linear-electric field (LEF) for the higher mass resolution. At the entrance of the mass analyzer, ultra-thin carbon foil is mounted on a metal grid to emit secondary electrons for start signals. The TOF chamber is longer than that of the previous analyzers and is optimized to achieve a high mass resolution ($m/dm \sim 100$).

Calibration tests of the ion analyzer were conducted at JAXA's Sagami-hara Campus from Fall 2022 to Winter 2024. When acquiring detailed calibration data, the tests were separated into the energy analysis section and the mass spectrometry section, and each performance test was conducted. Through a series of tests, it was confirmed that all performance requirements were met.