THE MIA (MERCURY ION ANALYZER) INSTRUMENT ONBOARD BEPI COLOMBO MMO (MERCURY MAGNETOSPHERIC ORBITER). Y. Saito1, W. Miyake2, S. Yokota3, A. Coates4, A. Fazekery5, H. Hasegawa1, A. Ieda3, S. Machida3, T. Nagai6, T. Nagatsuma7, C. Owen4, K. Seki8, I. Shinohara1, and T. Terasawa9, 1Institute of Space and Astronautical Science, 2Tokai University, 3Osaka University, 4MSSL, University College London, 5ISEE, Nagoya University, 6Tokyo Institute of Technology, 7NICT, 8University of Tokyo, 9RIKEN, (Y. Saito: 3-1-1 Yoshinodai, Chuo, Sagamihara, Kanagawa 252-5210, JAPAN, saito@stp.isas.jaxa.jp).

Introduction: Mercury’s plasma/particle environment has gradually become clear thanks to the new observations made by MESSENGER spacecraft orbiting around Mercury. However, it is also true that many questions are left unsolved. In order to elucidate the detailed plasma structure and dynamics around Mercury, an orbiter BepiColombo MMO (Mercury Magnetospheric Orbiter) is going to be launched in 2018 as a joint mission between ESA and ISAS/JAXA. Mercury Plasma/Particle Experiment (MPPE) is a comprehensive instrument package for plasma, high-energy particle and energetic neutral atom measurements[1]. It consists of 7 sensors: two Mercury Electron Analyzers (MEA1 and MEA2), Mercury Ion Analyzer (MIA), Mass Spectrum Analyzer (MSA), High Energy Particle instrument for electron (HEP-ele), High Energy Particle instrument for ion (HEP-ion), and Energetic Neutrals Analyzer (ENA). Currently, the MPPE sensors are on the MMO spacecraft waiting for the launch scheduled in October 2018.

Mercury Ion Analyzer (MIA): The scientific objectives of low energy ion measurement on Mercury orbit are to understand: (1) structure of the Mercury magnetosphere, (2) plasma dynamics of the Mercury magnetosphere, (3) Mercury–solar wind interaction, (4) atmospheric abundances, structure, and generation/loss process, and (5) solar wind between 0.3 and 0.47 AU. In order to realize the required measurements, MIA should measure three-dimensional distribution function of solar wind ions around Mercury (0.3–0.47 AU), and Mercury magnetospheric ions simultaneously.

MIA is a top-hat type electrostatic analyzer with toroidal deflectors. With the spin motion of spacecraft, three-dimensional ion distribution function is observed. The inner toroidal electrode is supplied with high voltage swept between 0V and -5 kV. Ions coming through the collimator are attracted down toward the inner electrode by the applied potential. Only the ions with specific energy range can further travel down to the exit of the electrodes. The ions passing through the toroidal deflectors enter to Z-stack MCP and are intensified to detectable charge pulses. Finally, the charge pulses are received by 63-channel discrete anode. The positions where the charge pulses are detected correspond to the incident azimuthal directions of the ions. MIA uses a newly developed ASIC (application specific integrated circuit) that is installed on the MCP anode. The ASIC consists of 64-channel discriminators, 64-channel fast preamplifiers, and 64-channel counters[2]. The estimated dynamic range of the low-energy ion flux around Mercury including both intense solar wind ions and weak magnetospheric ions is as wide as 10^6[3]. In order to measure both solar wind ions without saturation and Mercury magnetospheric ions with enough counting statistics, MIA has a function to change g-factor electrically. Sensitivity of the analyzer is controlled by changing the high voltage applied to the ‘‘top-hat’’ part. The center of the ‘‘top-hat’’ part is insulated from the surrounding structures. By applying high voltage between 0V and -5 kV, g-factor can be reduced down to 1/50. In addition to the electrical g-factor control, attenuation grid (10% transmission) is placed at limited sector of the entrance part of the analyzer in order to further reduce geometrical factor for solar wind ion measurement[4].

The energy range of MIA is 5 eV/q to 30 keV/q. The maximum number of energy step is 128 that are necessary for distinguishing solar wind alpha particles from solar wind protons. The angular resolution for measuring solar wind ions is 5.625deg., while the angular resolution for measuring Mercury magnetospheric ions is 11.25deg. or 22.5deg., depending on the allocated capacity of the telemetry data. MIA will provide three-dimensional distribution functions of low energy ions in half a spin period (nominal spin period: 4 s) of MMO. According to our knowledge of the Earth’s magnetosphere, full three-dimensional measurements of low-energy ions with high time resolution are indispensable for understanding the structure and dynamics of the magnetosphere. Since no full three-dimensional low-energy ion data have been obtained around Mercury, low-energy ion data obtained by MIA together with MSA on MMO will provide us with unique opportunity to understand detailed structure and dynamics of the Mercury magnetosphere.