Mercury's plasma environement as seen by the ion and electron sensors onboard BepiColombo/Mio during its third flyby

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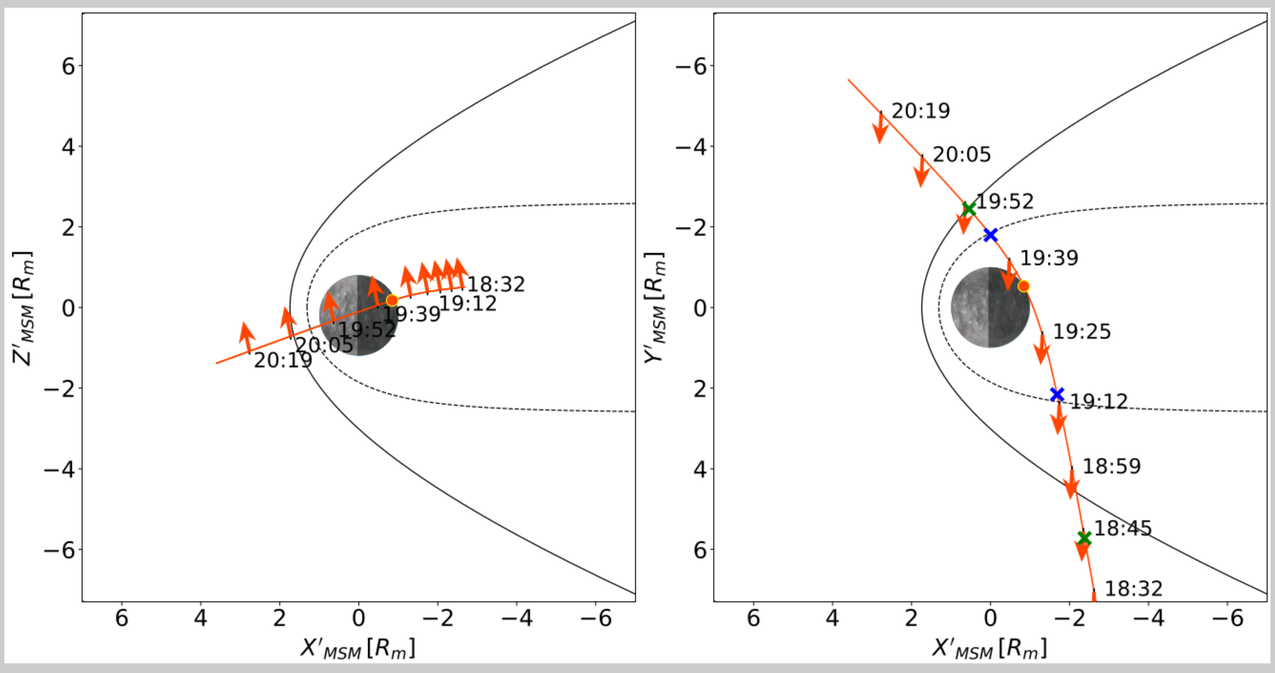
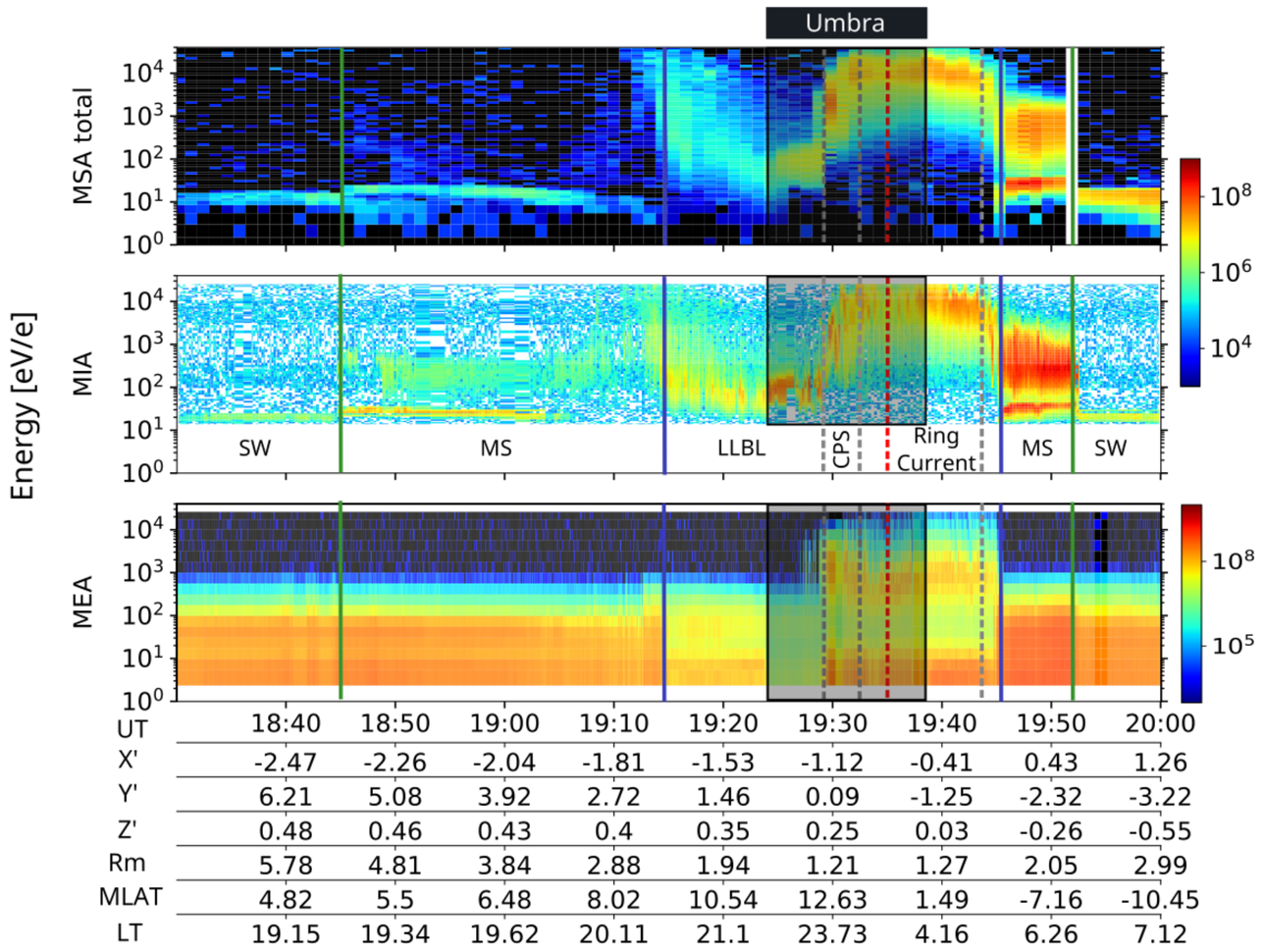
The ESA/JAXA Mercury-bound BepiColombo (BC) spacecraft was launched from Kourou, French Guyana, on October 19, 2018. During its seven year cruise before insertion into Mercury orbit, the spacecraft has been and will be experiencing several Gravitationally Assist Maneuvers (GAM) at Earth (1), then Venus (2), and then Mercury (6). During these flybys many instruments will be operational, in particular the Mass Spectrum Analyser (MSA, Co-PI : D. Delcourt), the Mercury Ion Analyzer (MIA, PI : Y. Saito) and the Mercury Electron Analyzer (MEA, Lead Co-I : N. André).

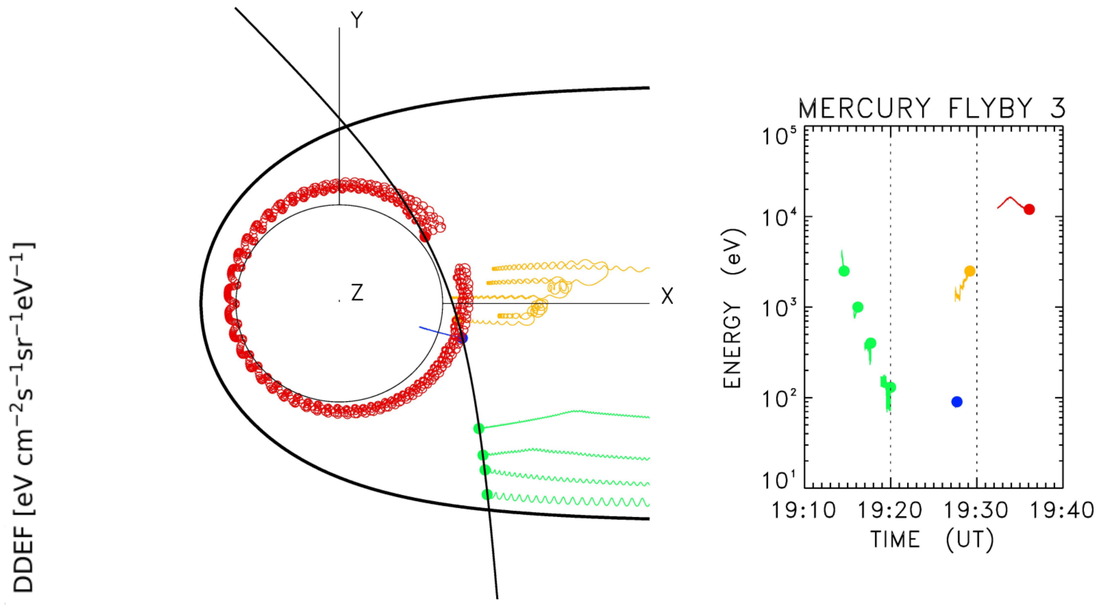


On June 22, 2023, BepiColombo performed its third flyby around Mercury. During this flybys, MSA, MIA and MEA instruments, revealed new insights into the planet's plasma environment including additional evidence of the ring current observations made by previous Spacecraft. This evidence comes from the first identification of trapped energetic ions with energies of around 20 keV/e consisting of hydrogen (H+) and helium (He+) ions. Cold ion plasma with energies below 50 eV has also been detected for the first time.
In addition, the observations revealed the existence of a Low-Latitude Boundary Layer (LLBL), which is a region of turbulent plasma at the edge of the magnetosphere.
Similar to Earth, the LLBL at Mercury appears to be associated with impulsive injection processes that lead to the formation of ion beamlets.

These recent observations made during cruise phase, provide a tantalizing glimpse of the new discoveries that are expected from the particles instruments after orbit insertion in December 2025 [*Hadid et al., Nature Communications, under review*].

Energy-time spectrograms of ions measured by MSA, MIA and MEA sensors.





Model H+ trajectories. The left panel shows various trajectory projections in the equatorial plane. The right panel shows the particle kinetic energy versus time. The ions are launched from different locations (closed circles) along BepiColombo's orbit and their trajectories are traced backward in time. The color code depicts the different magnetospheric regions, viz., LLBL (green), the umbra (blue), CPS (yellow) and ring current (red).

Spatial distribution of ion species during Mercury flyby 3.

Mass-to-charge ratio versus ion energy for different locations along BepiColombo orbit. The m/q ratios are derived from MSA TOF measurements integrated over ∼1024 s. The observation sequences of the TSTL spectra are shown by the different colors along BepiColombo's trajectory numbered from 1 to 5. The black crosses denote the observed bow- shock and magnetopause crossings. The trajectory of the BepiColombo is shown in MSM coordinate system projected in the X-Y plane defined as: the X-axis and Z-axis point to the sun and north pole, respectively, and the Y-axis completes a right-hand system.