



The BepiColombo Radiation Monitor

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The Space environment is known to be populated by highly energetic particles. These particles originate from three main sources: (1) Galactic Cosmic Rays (GCRs), a low flux of protons (90%), heavy ions, and to some extent electrons, with energies up to 10^{21} eV, arriving from outside of the Solar System; (2) Solar Energetic Particles (SEPs), sporadic and unpredictable bursts of electrons, protons, and heavy ions, travelling much faster than the Space plasma, accelerated in Solar Flares and Coronal Mass Ejections; and (3) planetary trapped particles, a dynamic population of protons and electrons trapped around planetary magnetospheres first discovered at Earth by Van Allen. Solar activity is responsible for transient and long-term variation of the radiation environment. During periods of low activity, the GCR flux increases as a result of the lower heliospheric modulation exerted on charged particle from outside the solar system and the probability of SEP events decreases; vice-versa, during high activity, GCR fluxes decrease, and the probability of SEP events increases. Extreme Solar Events also affect the Earth's magnetosphere and the radiation belts which can lead to ground-level enhancements. These three components of radiation in space combine into a hazardous environment for both manned and unmanned missions and are responsible for several processes in planetary bodies. Therefore, it is important to monitor and comprehend the dynamics of energetic particles in space.

BepiColombo is the first mission of the European Space Agency to the Hermean System. It was launched in 2018 and will enter Mercury's orbit in 2025 with the first flyby to Mercury planned for 2021. It is composed of two Spacecraft, ESA's Mercury Planetary Orbiter (MPO) and JAXA's Mercury Magnetospheric Orbiter (MMO). Both Spacecraft carry a rich suite of scientific instruments to study the planet geology, exosphere, and magnetosphere. In particular, the MPO spacecraft carries the BepiColombo Radiation Monitor (BERM), which is capable of measuring electrons with energies from ~ 100 keV to ~ 10 MeV, protons with energies from 1 MeV to ~ 200 MeV, and heavy ions with a Linear Energy Transfer from 1 to 50 MeV/mg/cm². While BERM is part of the mission housekeeping, it will provide valuable scientific data of the energetic particle population in interplanetary space and at Mercury. Because BERM is in operation during most of the cruise phase, it is able to detect and

characterize SEP events. In fact, two events were already registered and will be included in a multi-spacecraft analysis.

BERM is based on standard silicon stack detectors such as the SREM and the MFS. It consists of a single telescope stack with 11 Silicon detectors interleaved by aluminum and tantalum absorbers. Particle species and energies are determined by charged particle track signals registered in the Si stack. Because of the limited bandwidth, particle events are processed in-flight before being sent to Earth. Particles are then assigned to 18 channels, five corresponding to electrons, eight to protons, and five to heavy ions. In this work, we will present the response of the 18 detector channels obtained by comparing Geant4 simulations with the BERM beam calibration data. The response functions are validated using measurements made during of the BepiColombo Earth flyby and during the cruise phase. Special focus is given to the synergies between BERM and the Solar intensity X-ray and particle Spectrometer (SIXS) instrument signals. The latter measures electrons from ~ 50 keV to ~ 3 MeV and protons from ~ 1 to ~ 30 MeV. The availability of two instruments with overlapping energy ranges allows to validate and cross-calibrate their data, namely during Earth flyby at the radiation belts, and to maximize the scientific output of the mission. In fact, lessons learned during this joint analysis are expected to set the basis for a similar collaboration between the RADiation hard Electron Monitor (RADEM) and the Particle Environment Package (PEP) instruments aboard the future JUICE mission.