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First Analysis of Solar Energetic Particles with the BepiColombo Radiation Monitor (BERM)

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December 2019 marked the beginning of Solar Cycle 25. Since then, the Sun´s activity has been ramping up with multiple Coronal Mass Ejections (CMEs), Solar Flares, and Solar Energetic Particle (SEP) events having been registered in the past few years. These events are extremely hazardous to both spacecraft and biological systems. However, due to the lack of multi-point measurements, it is still impossible to predict their occurrence and to accurately model their propagation.

BepiColombo, the first European mission to the Hermean System, was launched in 2018 and is predicted to enter Mercury's orbit in 2025. It is composed of two spacecraft, ESA's Mercury Planetary Orbiter (MPO) and JAXA's Mercury Magnetospheric Orbiter (nicknamed Mio). Given the mission´s close proximity to the Sun, reaching 0.3 AU at multiple points of its trajectory, BepiColombo will provide critical measurements to characterize and model Solar Events. While BepiColombo carries a plethora of scientific instruments, most of them are turned-off during a large part of the cruise phase. However, the BepiColombo Environment Radiation Monitor (BERM) aboard the MPO, is always operational since it is part of the mission´s housekeeping, with the objetive of monitoring radiation hazards so they can be managed in order to prevent possible damage on the spacecraft and instruments. Being in operation during all phases of the mission allows it to detect and characterize SEP events, even when other instruments are switched off.

BERM is based on standard silicon stack detectors. It consists of a single telescope stack with 11 Silicon detectors interleaved by aluminum and tantalum absorbers. It can detect electrons with energies from ~0.1 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/cm^2. Particle species and energies are determined by the track and signal registered in the stack. Because of the limited bandwidth, particle events are processed in-flight before being sent to Earth. Particles are assigned to 18

channels, five are dedicated to electrons, eight to protons, and five to heavy ions. BERM provides daily files with the number of registered counts in each channel integrated over 30 seconds sampling intervals. To provide useful information for scientists, BERM data must be converted into physical units.

This work presents the results of applying the bow-tie method, first introduced by Van Allen in 1979, to obtain the fluxes from BERM's count rates. assuming a power law for the electron and proton spectra. The method considers energy spectra with a range of power-law indices and finds the effective energy measured by each channel and its corresponding geometric factor. We have used this method to analyze the data collected by BERM during the Earth flyby of BepiColombo. We apply the bow tie method to estimate the fluxes of particles during the already detected solar events. So far, two events are worthy of special attention.

During the event on April 17th, 2021, BERM and the Solar Intensity X-ray and Particle Spectrometer (SIXS) instrument were simultaneously operating onboard BepiColombo. The particle detector of SIXS (SIXS-P) can measure electrons from approximately 50 keV to 3 MeV and protons from 1 to 30 MeV. The two instruments measure overlapping particle energy ranges, which allows for validating the results of bow tie analysis of BERM particle channels.

The second event of interest happened on February 16th, 2022. It exhibited fluxes of such high energies that all 8 proton bins registered a signal above the noise levels strong enough to be analyzed.

Results for other events will also be shown.