Seeing Helios electron data through the eyes of Solar Orbiter: modelling the angular response of EPD/EPT and its application to the full inversion of Helios events

Daniel Pacheco\textsuperscript{1,2}, Angels Aran\textsuperscript{2}, Raúl Gomez-Herrero\textsuperscript{3}, Neus Agueda\textsuperscript{2}, David Lario\textsuperscript{4}, Bernd Heber\textsuperscript{1}, Blai Sanahuja\textsuperscript{2}, Nicolas Wijser\textsuperscript{5}, and Robert F. Wimmer-Schweingruber\textsuperscript{1}

\textsuperscript{1}Christian-Albrecht University of Kiel, Institute of Experimental and Applied Physics (IEAP), Extraterrestrial Physics, Germany (pacheco@physik.uni-kiel.de)
\textsuperscript{2}Universitat de Barcelona, Física Quàntica i Astrofísica, Institut de Ciències del Cosmos (ICCUB), Barcelona, Spain
\textsuperscript{3}University of Alcalá, Alcalá de Henares, Spain
\textsuperscript{4}NASA Goddard Space Flight Center, Heliophysics Science Division, Greenbelt, MD, United States
\textsuperscript{5}KU Leuven, Centre for Mathematical Plasma-Astrophysics, Leuven, Belgium

The pitch-angle distribution of electron intensities is an essential piece of information in order to understand the transport processes undergone by the particles in their journey from their acceleration sites to the spacecraft and, to infer properties of the particle sources such as their intensity and duration.

In a previous work, we modelled fifteen solar relativistic electron events observed at different heliocentric radial distances by the Helios spacecraft (Pacheco et al. 2019). We used a Monte-Carlo transport model and an inversion procedure to fit the in-situ observations, and inferred both the electron mean free path in the interplanetary space and the injection histories of the electrons at two solar radii from the Sun. We applied a full inversion procedure, that is, we considered both the angular and the energetic responses of the Helios/E6 particle experiment in the modelling of the electron events.

By using the same methodology as previously employed for ACE/EPAM, STEREO/SEPT and Helios/E6 instruments, we have modelled the angular response of the Electron Proton Telescope (EPT) of the Energetic Particle Detector (EPD) on board Solar Orbiter. Here, we present the study of the modelled angular response and its application to several of the solar energetic particle (SEP) events previously modelled as if Solar Orbiter were located at the Helios position. We compare the pitch-angle distributions measured by Solar Orbiter and Helios at different phases of the intensity-time profile of the SEP events, that is, near the particle onset, peak and on the decay of the event, and for different interplanetary magnetic field orientations provided by the Helios measurements.

We found that despite Helios were spinning spacecraft which gathered electron information from eight angular sectors, the four Solar Orbiter/EPD/EPT fields of view will often offer similar angular coverage. We also found that, under specific circumstances, EPT can obtain better pitch angle distribution information than Helios, specifically when the interplanetary magnetic field points
away from the ecliptic.

We expect, then, that Solar Orbiter will provide us with numerous and valuable observations that will permit us to untangle the transport effects that electrons, protons and ions suffer in their journey through interplanetary space.