A new scenario for widespread solar energetic particle events based on multi-spacecraft observations of the 13 March 2023 event

Nina Dresing¹, Immanuel Jebaraj¹, Erika Palmerio², Christian Palmroos¹, Christian Cohen³, Grant Mitchell⁴, Christina Lee⁵, Wenwen Wei⁵, Eleanna Asvestari⁶, Manon Jarry⁷, Gabriel Muro³, Laura Rodríguez-García⁸, and Nicola Wijsen⁹

¹University of Turku, Finland (nina.dresing@utu.fi)
²Predictive Science Inc., San Diego, CA, United States
³Caltech, Pasadena, United States
⁴NASA Goddard Space Flight Center, Greenbelt, MD, United States
⁵Space Sciences Lab, UC Berkeley, United States
⁶University of Helsinki, Finland
⁷IRAP, CNRS, Université de Toulouse III-Paul Sabatier, Toulouse, France
⁸Universidad de Alcalá, Department of Physics, Space Research Group, Alcalá de Henares, Spain
⁹Department of Mathematics, KU Leuven, Leuven, Belgium

We report on multi-spacecraft measurements of a solar energetic particle (SEP) event that occurred on 13 March 2023. The Parker Solar Probe (PSP) mission was situated on the far side of the Sun as seen from Earth at a radial distance of only 49 solar radii and observed a very strong event including the associated CME and its shock passing over the spacecraft only four hours after the solar eruption. Solar Orbiter, BepiColombo, STEREO A, near-Earth spacecraft, and MAVEN at Mars were all situated within 50 degrees in longitude, and observed the event as well, proving its widespread character. Clear signatures of shock-driven energetic storm particle events were present at Solar Orbiter, BepiColombo, STEREO A, and near-Earth spacecraft suggesting that the interplanetary CME-driven shock had a longitudinal extent of about 160 degrees. However, the solar event was accompanied by a series of pre-event CMEs and comparison with ENLIL simulation results suggest that the ESP events were associated with shocks driven by other CMEs. This scenario of particle re-acceleration at different pre-event-associated shocks, provides a new scenario for the generation of widespread SEP events.