Forecasting Shock-associated Energetic Particle Intensities in the Inner Heliosphere: A Proof-of-Concept Capability for the PUNCH Mission

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Solar energetic particles (SEPs) associated with shocks driven by fast coronal mass ejections (CMEs) or shocks developed by corotating interaction regions (CIRs) often extend to high energies, and are thus key elements of space weather. The PUNCH mission, set to be launched in 2025, is equipped with photometric that enables 3D tracking of solar wind structures in the interplanetary space through polarized light. Tracking techniques are used to estimate speeds and speed gradients of solar structures, including speed jumps at fast shocks. We report on a strong and a robust relation between the shock speed jump magnitude at CME and CIR shocks and the peak fluxes of associated energetic particles from the analysis of 59 CME-driven shocks and 74 CIRs observed by Wind/STEP between 1997-2023. We demonstrate that this relation, along with PUNCH anticipated observations of solar structures can be used to forecast shock-associated particle events close to the Sun; thus, advancing and providing a crucial input to forecasting of SEP fluxes in the heliosphere.

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