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PENETRATING PARTICLE ANALYZER (PAN)

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PAN is a scientific instrument suitable for deep space and interplanetary missions. It can precisely measure and monitor the flux, composition, and direction of highly penetrating particles (> ˜100 MeV/nucleon) in deep space, over at least one full solar cycle (˜11 years). A possible mission opportunity is the Deep Space Gateway (DSG). The science program of PAN is multi- and cross-disciplinary, covering cosmic ray physics, solar physics, space weather and space travel. PAN will fill an observation gap of galactic cosmic rays in the GeV region, which is crucial for improving our still limited understanding of the origin of cosmic rays, and of their propagation through the Galaxy and the Solar system. It will provide precise information of the spectrum, composition and timing of energetic particle originated from the Sun, which is essential for studying the physical process of solar activities, in particular the rare but violent solar events that produce intensive flux of penetrating particles. The precise measurement and monitoring of the energetic particles is also a unique contribution to space weather studies, in particular to the development of a predictive solar activity model in a multi-wavelength and multi-messenger approach, using observations both space and ground based. As indicated by the terminology, penetrating particles cannot be shielded effectively. PAN will map the flux and composition of these particles precisely and continuously, providing valuable input for the assessment of the related health risk, and for the development of an adequate mitigation strategy. PAN has the potential to become a standard on-board instrument for deep space human travel.

PAN is based on the proven detection principle of a magnetic spectrometer, but with novel layout and detection concept. It will adopt advanced particle detection technologies and industrial processes optimally for deep space application. The device will require limited mass (˜20 kg) and power (˜20 W) budget. Dipole magnet sectors built from high field permanent magnet Halbach arrays, instrumented in a modular fashion with high resolution silicon strip detectors, allow to reach an energy resolution better than 10% for nuclei from H to Fe at 1 GeV/n. The charge of the particle, from 1 (proton) to 26 (Iron), can be determined by scintillating detectors and silicon strip detectors, with readout ASICs of large dynamic range. Low power pixel detectors will maintain the detection capabilities for even the strongest solar events. A fast scintillator with silicon photomultiplier (SiPM) readout will provide timing information to determine the entering direction of the particle, and some isotope identification capability of light nuclei. Low noise, low power and high density ASIC will be developed to satisfy the stringent requirement of the position resolution and the power consumption of the tracker.

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