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Demonstration of particle tracking with scintillating fibres read out by SPAD array sensor

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In this contribution, we present a proof-of-concept, fine-granularity particle detector constructed from plastic scintillating fibres (SFs) readout with a Single-Photon Avalanche Diode (SPAD) array sensor, intended for the next generation of neutrino experiments. These experiments will be limited by systematic uncertainties, of which many can be constrained by having a precise knowledge of the vertex activity and measuring the neutrino-nucleus cross-section. This includes tracking pions, low-momentum protons, rejecting photon conversion events, and a precise energy reconstruction. All the mentioned requirements are strongly aided by having a fine granularity detector, with sub-mm spatial resolution.

SFs are a natural choice for fine-granularity, plastic scintillation detectors as they can be manufactured with diameters down to 200 μm. Typically, SFs are coupled to Silicon PhotoMultipliers (SiPMs) however, for neutrino active targets a very large detector mass is required which would lead to a very large number of readout channels. Therefore, a new type of readout is necessary. SPAD array sensors fabricated using commercial CMOS Image Sensor (CIS) technologies would significantly reduce the required number of readout channels whilst maintaining the granularity of the detector as multiple SFs can be independently imaged by a single sensor.

In this study, a proof-of-concept detector has been constructed making use of sixteen 1 mm diameter SFs bundled together in a 4 × 4 array and coupled to the SwissSPAD2 sensor. Low-energy electrons from a Sr-90 source were directed through the SF bundle and particle tracks have been imaged from the generated scintillation photons, demonstrating the potential of this technology for the future neutrino experiment requirements.

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