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Fine-granularity 3D particle tracking with scintillating fibres (SciFi) readout with a single-photon avalanche diode (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 (SciFi) 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 precisely reconstructing low-momentum protons, pion secondary interactions, and rejecting photon conversion events by having a sub-mm spatial granularity resolution.

SciFi are a natural choice as they can be manufactured with diameters down to 200 μm. Typically, SciFi are coupled to Silicon PhotoMultipliers (SiPMs) however for neutrino active targets, a very large detector mass is required which would result in a prohibitive 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 SciFi can be independently imaged by a single sensor, and provide the timing resolution of SiPMs.

In this study, a proof-of-concept detector instrumented with the SwissSPAD2 sensor has been constructed and exposed to MeV electrons from a Sr-90 source, demonstrating the potential of this technology for the future neutrino experiment requirements. Additionally, active volumes constructed with 200 μm SciFi are currently in the prototype phase.

Working Group

WG 6: Detectors

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