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Cryogenic SiPMs for the DUNE experiment

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DUNE is the most ambitious long-baseline experiment under construction in the US for the study of neutrino oscillation and astroparticle physics. The DUNE far detector will employ the Liquid Argon TPC technology, enhanced by a powerful Photon Detection System that records the 128 nm scintillation light emitted by argon. The basic devices of this system are custom SIPMs.
A dedicated development program has been performed over the last three years by the DUNE PDS Consortium together with Hamamatsu Photonics (HPK) and Fondazione Bruno Kessler (FBK).
The technology employed by Hamamatsu benefits from a low terminal capacitance and a new type of metallic resistance with a tuneable thermal coefficient and an high quenching resistance system to suppress large-amplitude afterpulses. This allows for careful tuning of the signal shape and recovery time at 87 K to match the dynamic range needed in DUNE.
Similarly, FBK employed a well-established technology (NUV-HD-CRYO) as the backbone for the customized SiPMs, using enlarged tranches to reduce cross talk.
The tests were performed in several labs in Europe and the US and investigated both performance and cryo-reliability. The results include the complete characterization of the sensors (Dark Count Rate, correlated noise, photon detection efficiency, etc.) and the most relevant phenomena that drive the detector behaviour at cryogenic temperature (thermal behaviour, signal bandwidth evolution, scaling of DCR, etc.).

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