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The Quality Assurance test setup for DUNE SiPMs characterization

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The Deep Underground Neutrino Experiment (DUNE) is an upcoming neutrino physics experiment that will answer some of the most compelling questions in particle physics and cosmology. DUNE comprises a high-intensity neutrino source located at Fermilab, a massive far detector (FD) situated 1.5 km underground at the Sanford Underground Research Facility (SURF) in South Dakota, and a composite near detector (ND) installed just downstream of the neutrino source.
The DUNE FD exploits silicon photomultipliers (SiPMs) to detect scintillation photons produced by the interaction of charged particles in a liquid Argon time projection chamber (LArTPC). The FD is composed of four modules, each with a fiducial mass of 10 kt. The first module (HD-FD) is a LArTPC with electrons drifting horizontally toward modular Anode wire-Plane Assembly (APA), inside where the Photon Detection System (PDS) is located.
The SiPMs are photosensors consisting of a matrix of single-photon avalanche diodes (SPAD) operating in the Geiger-Mueller region. Their high sensitivity and dynamic range, as well as the possibility to fill large surfaces with high-granularity sensors, makes them an ideal choice for the DUNE FD photodetection system. An international consortium of research groups is currently engaged in systematic quality assurance tests of all the sensors that will be installed in the HD-FD to control their specifications. A custom setup, CACTUS (Cryogenic Apparatus for Continuous Tests Upon SiPMs), has been developed at Ferrara and Bologna Universities-INFN sites to automatically perform the tests for a large number of sensors in parallel. This system can characterize up to 120 SiPM simultaneously both testing their mechanical and thermal resistance, and measuring the current-voltage curve for each sensor at room and cryogenic temperatures. These data allow to extrapolate the quenching resistor (R_q) and the breakdown voltage (V_bd), the key operating parameters of the SiPMs. Furthermore, the CACTUS test facility allows to perform dark noise assessment through a custom-made fixed threshold amplifier-discriminator system.
The CACTUS system will operate in the next years in 5 laboratories (in Bologna, Ferrara, Granada, Milano Bicocca and Prague) allowing the test of at least 120 sensor per day per site with the aim of quality assurance and determine the sensors operating voltage of the whole DUNE HD-FD productions. Preliminary results of the measurements already performed on ~4000 sensors for ProtoDUNE2-HD and in progress on the first batches of more than 25000 sensors for the DUNE HD-FD will be presented.

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