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Production and characterization of Photosensors for the DarkSide-20k Dark Matter Experiment

The DarkSide-20k is a next-generation dark matter experiment aiming at a direct detection of Weakly Interacting Massive Particles (WIMPs) via nuclear recoils in liquid argon. The detector, currently under construction at the Gran Sasso National Laboratory (LNGS), Italy, will benefit from the natural shielding against cosmic rays provided by the lab's underground location. It will employ a dual-phase time projection chamber (TPC) with a 50-tonne of underground-sourced argon acting as an active volume. DarkSide-20k is designed to operate in an "instrumental background-free" regime over a planned exposure of 200 tonne-years.

A key element in reaching this goal is the photon detection system based on custom-developed cryogenic Silicon Photomultiplier (SiPM) arrays, designed to provide high photon detection efficiency, low noise, and stable operation in liquid argon conditions. These photosensors instrument both the active veto detectors and the top and bottom planes of the TPC, covering a total active optical surface of about 28 m².

The TPC photosensors are currently being produced, assembled, and characterized by the DarkSide collaboration at Nuova Officina Assergy in LNGS and at the Photodetector Test Facility (PTF) in Naples. This contribution will present the strategy adopted for the large-scale production and validation of the SiPM arrays, including testing procedures, quality control protocols, and performance characterization at cryogenic temperature.

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