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Cryogenic Silicon-based photosensors: the Photon Detection Units for dark matter detection in DarkSide-20k

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DarkSide-20k (DS-20k) is the next stage of the DarkSide program and will be a new generation experiment involving a global collaboration from all the current argon-based detectors. The experiment is designed as a 20-tonne fiducial mass dual phase liquid argon time projection chamber (LAr-TPC) filled with low radioactivity argon and instrumented with SiPM-based cryogenic photosensors. The detector will be housed underground at the INFN Gran Sasso National Laboratory (LNGS) and is expected to be free of any instrumental background for an exposure of 100 tonne \times year.

The DarkSide collaboration started a dedicated development and customization of SiPM technology for its specific needs resulting in the design, production, and assembly of large surface modules of 20 \times 20 cm² readout as 4 DAQ channels, named Photo Detection Unit (PDU) for the DS-20k experiment. PDUs will be mass-produced in the following years to integrate both the two optical planes for the TPC (~21 m² total SiPM surface) and the photosensors for the veto system (~5 m²) of DarkSide-20k detector.

To this purpose a dedicated facility has been built at INFN Naples Cryogenic Laboratory with the aim of characterize the PDUs. The main characteristics of the first Photon Detection Unit prototype have been measured in liquid nitrogen. The PDU was tested for varying overvoltage values and different readout configurations by measuring the main photosensor parameters for each of them. The results of the tests will be reported, and the study of the performances will be discussed.

Primary author: DI CAPUA, Francesco (Università di Napoli "Federico II")

Presenter: DI CAPUA, Francesco (Università di Napoli "Federico II")

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