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DarkSide-20k veto photon-detector units: construction and characterization

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DarkSide-20k, a direct dark matter search experiment, is located at the Gran Sasso National Laboratory (LNGS), Italy. It is designed to achieve groundbreaking 200-tonne-year exposure, nearly free from instrumental backgrounds. The core of the detector is a dual-phase Time Projection Chamber (TPC) containing 50 tonnes (20 tonnes fiducial) of underground liquid argon (UAr) with low levels of cosmogenic 39Ar isotope. The TPC is equipped with large area cryogenic Silicon Photomultiplier array detectors at top and bottom planes covering ~21m2, to acquire the faint signals emitted by the WIMP interaction with the detector. The neutron veto used to tag and veto neutron events is also equipped with SiPM detectors, positioned along the walls of the TPC on the outer side. SiPMs are arranged compactly to reduce the material used for the Printed Circuit Board (PCB), cables, and connectors forming the Veto PhotoDetection Units (vPDUs). Each vPDU consists of SiPMs, front-end electronics, and a motherboard, which distributes voltage and control signals and electrical signal transmission. Additionally, all SiPM materials have been carefully screened for radioactivity to minimize background interference.

This contribution will focus on the production of the vPDUs, emphasizing the rigorous Quality Assurance and Quality Control (QA/QC) procedures, and the final characterization of the first completed prototypes. Extensive testing in liquid nitrogen baths has been conducted on the vPDUs, including at a dedicated facility at Astrocent in Warsaw, aiming to assign a "quality passport" to ensure optimal performance and reliability within the DarkSide-20k experiment."

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