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DarkSide Proto-0: Recent Insights from the DarkSide-20k Prototype Programme

DarkSide-20k, currently under construction at LNGS, is a next-generation dual-phase liquid argon Time Projection Chamber designed for the direct search of WIMP dark matter. Within the DarkSide-20k program, Proto-0 is a dedicated prototype developed to validate key detector technologies, study signal formation, and support the development and commissioning of detector subsystems for the final experiment. Following the completion of its first physics data-taking campaign, Proto-0 has provided a unique platform for the characterization of novel technologies foreseen for DarkSide-20k, including cryogenic SiPM-based Photon Detection Units, acrylic detector components, and transparent conductive polymer coatings for electric-field generation. The detector also features a configurable extraction and electroluminescence region, enabling dedicated studies of proportional scintillation in gaseous argon under varying geometrical and operating conditions. In this contribution, we present an update on the Proto-0 program, including the status of the analysis of the first physics dataset, long-term detector operation and stability studies, recent developments from the ongoing experimental campaign, and the implications of these activities for the commissioning of DarkSide-20k.

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