

The future of the DarkSide-20k Dark Matter Search

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The DarkSide-20k liquid-argon dark-matter detector is a two phase TPC currently under construction at Laboratori Nazionali del Gran Sasso (LNGS) in Italy. It is the next phase in the Global Argon dark Matter Collaboration's efforts and will start operations in 2026. The 50-tonne (20-tonne fiducial) mass of low radioactivity underground argon will comprise a two-phase time projection chamber (TPC), instrumented with Silicon Photomultipliers (SiPMs). Underground argon (UAr) is extracted and separated at the Urania natural gas well plant in Colorado, U.S., and purified by cryogenic distillation at the Aria plant in Sardinia. Radiopurity assay of the UAr will be performed with DARt in the ArDM facility at Canfranc. The design of the TPC is inspired by the 50 kg DarkSide-50 experiment, which pioneered the use of UAr and demonstrated world-leading sensitivity to Dark Matter candidates with mass below $3.6 \text{ GeV}/c^2$. DarkSide-20k will be essentially free from all non-neutrino backgrounds for exposures up to and beyond 100 tonnes x year, with a foreseen sensitivity reaching $7.4 \times 10^{-48} \text{ cm}^2$ for a WIMP mass of $1 \text{ TeV}/c^2$ in a 200 t yr run. Furthermore, thanks to the two-phase operation to the light argon mass, DarkSide-20k will have a unique sensitivity to core-collapse supernova neutrinos. This talk will focus on the detector design, photosensor development, the underground argon facilities and the physics program for the experiment.

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