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# Low-radiactivity argon for dark matter searches and beyond

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The DarkSide-20k experiment seeks to detect dark matter by observing interactions of Weakly Interacting Massive Particles (WIMPs) within a 50-ton target of liquid argon, utilizing double-phase time projection chamber technology. A pivotal element of the experiment is the utilization of low-radioactivity argon depleted in the isotope 39.

The argon's supply chain originates at the Urania plant in Colorado, where low-radioactivity argon is obtained from a $CO_2$ stream sourced from a deep well, at a rate of approximately 250 kg/day. The plant, comprising distillation columns and a pressure swing absorption stage, has already been constructed, with site construction currently underway. Following this initial purification phase, the argon will be transported to Sardinia, Italy, where the Aria plant, featuring a 350 m cryogenic distillation column, will further reduce residual impurities to detector-grade levels. The Aria plant has already been fully constructed and is presently undergoing installation. A smaller-scale version, standing approximately 26 meters tall, has been tested over recent years with highly positive results validating the cryogenic distillation technology.

The significance of this supply chain and the associated techniques extends well beyond DarkSide-20k. Specifically, thirty tonnes of low-radioactivity argon will be supplied to the LEGEND-1000 experiment at LNGS for the veto detector, with an additional tonne earmarked for the COHERNT experiment at ORNL. In a broader perspective, these technologies serve as critical enablers for the ARGO experiment, representing the pinnacle of dark matter search endeavors utilizing argon. Moreover, they have captured the interest of the DUNE collaboration for incorporation into its Module of Opportunity.

**Primary authors:** STEFANIZZI, Riccardo (Istituto Nazionale di Fisica Nucleare); BONIVENTO, Walter M. (INFN Cagliari)

**Presenter:** STEFANIZZI, Riccardo (Istituto Nazionale di Fisica Nucleare)

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