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Low radioactivity underground argon for low-level radiation detectors

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There is a growing need for argon that has a lower concentration of ³⁹Ar than that found in argon derived from the atmosphere. This isotope is the limiting background for any argon-based low-level radiation detector, such as argon dark matter detectors and low-level argon radiation detectors for environmental measurements (e.g., ³⁹Ar age dating). In the atmosphere, cosmic-ray neutrons and protons produce ³⁹Ar through ⁴⁰Ar(n,2n) and ⁴⁰Ar(p,np) reactions. Deep underground, away from cosmic rays, one would expect to find argon that is free of ³⁹Ar.
For 5 years Princeton University, Fermilab, and PNNL extracted and purified nearly 200 kg of underground argon (UAr) that was shown to have only 0.73 mBq/kg of ³⁹Ar, where atmospheric argon contains 1.0 Bq/kg. This UAr was primarily for the DarkSide-50 dark matter experiment, and the next generation of argon dark matter experiments will require 10s of tons of UAr. Additionally, other UAr needs must be met. In this talk we will describe the success and challenges of the original UAr extraction and purification, and how production challenges were identified later as minor contaminations in the source gas. We will also describe future UAr productions and other possible sources of UAr.

Summary

A comprehensive overview of low radioactivity underground production past, present, and future.

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