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Calibration of an Ultra-Low-Background Proportional Counter for Measuring Ar-37

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A new ultra-low-background proportional counter (ULBPC) design was recently developed at Pacific Northwest National Laboratory (PNNL) using clean materials, primarily electrochemically-purified copper. This detector, along with an ultra-low-background counting system (ULBCS), has been developed to complement a new shallow underground laboratory (30 meters water-equivalent) constructed at PNNL. The ULBCS design includes passive neutron and gamma shielding, along with an active cosmic-veto system. This system provides a capability for making ultra-sensitive measurements to support applications like radon emanation assay of low-background materials, age-dating of groundwater tritium, and soil-gas assay for Ar-37 to support On-Site Inspection (OSI). On-Site Inspection is a key component of the verification regime for the Comprehensive Nuclear-Test-Ban Treaty (CTBT). Measurements of radionuclides created by an underground nuclear explosion are a valuable signature of a Treaty violation. For OSI, the 35-day half-life of Ar-37, produced from neutron interactions with calcium in soil, provides both high specific activity and sufficient time for inspection before decay limits sensitivity. This work describes the calibration techniques and analysis methods developed to enable quantitative measurements of Ar-37 samples over a broad range of pressures. These efforts, along with parallel work in progress on gas chemistry separation, are expected to provide a significant new capability for Ar-37 soil gas background studies.

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