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Operational and Simulated Background Characterization of an Ultra-Low Background Liquid Scintillation Counter

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Content

The Ultra-Low Background Liquid Scintillation Counter developed by Pacific Northwest National Laboratory will expand the application of liquid scintillation counting by enabling lower detection limits and smaller sample volumes. Lower background count rates and lower detection limits can reduce the number of steps required for samples that require pre-concentration of the radionuclides. Environmental applications, such as testing of water samples, would particularly benefit from these capabilities. With background rates two orders of magnitude below the ~1 cpm background of commercially available low background liquid scintillation counters, the ULB LSC will push detection limits of a factor of 5 lower than currently achievable. A detection limit for the ULB LSC would be on the order of 0.25 Bq/L for a 10 mL water-borne tritium sample, 1000-minute sample and background count times, 20% counting efficiency for tritium, and a 50 counts per day (or 0.034 cpm) background. For the same parameters, the detection limit in a 1 cpm background instrument would be 1.27 Bq/L. The expected background of ~50 counts per day, based on initial testing and experimentally validated GEANT4 simulations, is achieved through graded passive shielding and active cosmic veto. Improvements to the light collection system will decrease the low energy threshold and increase in low energy (tritium) detection efficiency above the 20% observed with a partial build of the system. Tritium will be one of the benchmark tests for this system - for testing low energy collection efficiency, low energy spectral capabilities, and determining the low energy threshold of the detection system. The capabilities of the ULB LSC will be valuable for a variety of environmental applications, including examples such as the determination and analysis of organically bound tritium for understanding hydrologic and plant growth and intake processes and measurement of radon-222 and radium-226 in drinking water. The operational characteristics and initial test results of the ULB LSC will be presented alongside these examples of the additional capabilities available for radiation detection through liquid scintillation counting with the ULB LSC.

About the Presenter

Jennifer Erchinger is a Post-Master's Research Associate in the Radiation Detection and Nuclear Sciences group at Pacific Northwest National Laboratory, working towards finishing her Ph.D. in Nuclear Engineering with Texas A&M University in 2016. She graduated with by a B.S. in Chemistry from Texas A&M in May 2011, followed by an M.S. in Health Physics, with a focus on Nuclear Security, from Texas A&M in May 2013.

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