Re-Establishing Radioactive Gas Calibration Services at NIST: Current Progress

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Radioactive gas standards are critical to ensuring accurate measurements in fields such as environmental monitoring, nonproliferation testing, and medical imaging. While gas calibration services at NIST have been offline for several years, recent interest has prompted the development of a new length-compensated proportional gas counting (LCPC) system. The gas counting system consists of a set of three gas filled, electrically biased, cylindrical chambers. Potential loss of counting efficiency near the ends of the chambers is accounted for by using multiple counters of varying length; the volumes are subtracted from each other to observe the net activity per volume without end effects.

Initially, simulations were conducted using the Monte Carlo program TOPAS to explore the efficacy of several design modifications, including chamber geometry, material, and signal isolation. The model was based on descriptions and images of the previous LCPC system at NIST. The sources modeled were those commonly used by stakeholders, including Xenon-127, Xenon-133, Krypton-85, and Argon-37. Of the design modifications explored, simulation results indicated that having a smaller canister containing the counters would decrease background; crosstalk between the counters was largely unaffected by the counter material; and increasing the counter wall thickness decreased the crosstalk between the counters. These results informed the design of a system that has been recently fabricated by the NIST shops.

Work is underway to develop a protocol for quantitatively transferring and measuring gas in this system. To measure activity concentration, the amount of a source gas and counting gas are measured separately in a known volume, then quantitatively transferred to a cryogenic volume where they are mixed. The gas mixture is expanded into a manifold containing the proportional counters. The gas is introduced into the counters through a baffle at either end. As the source decays in the counters, charge multiplication with the counting gas creates a signal that is read out through a central wire. Preliminary measurements using this system are expected during the summer of 2024.

Figure 1: CAD drawing of length-compensated proportional gas counters at NIST. This system will be placed in a manifold and exposed to a combination of source and counting gases.

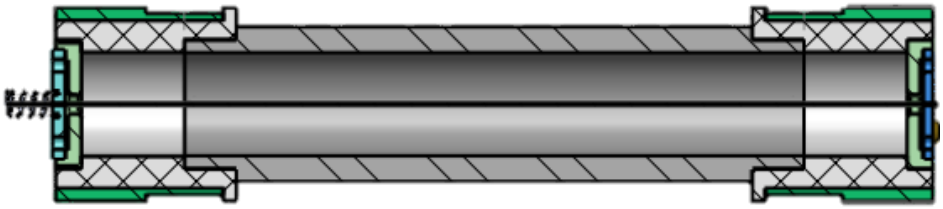

Figure 2: CAD drawing and cross-sectional view of an individual length-compensated proportional gas counter. The mixed source and counting gases are introduced through a baffle at either end of the counter, shown in blue. As the source decays, it creates ion pairs that are read out through the central wire.