

Initial Characterization of Unequal-Length Low-Background Proportional Counters for Absolute Gas-Counting Applications



Pacific Northwest
NATIONAL LABORATORY

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Abstract and Motivation

Abstract: Characterization of two sets of custom unequal length proportional counters is underway at Pacific Northwest National Laboratory (PNNL). These detectors will be used in measurements to determine the absolute activity concentration of gaseous radionuclides (e.g., ^{37}Ar). A set of three detectors has been fabricated based on previous PNNL ultra-low-background proportional counters (ULBPC) designs and now operate in PNNL's shallow underground counting laboratory. A second set of four counters has also been fabricated using clean assembly of OFHC copper components for use in an above-ground counting laboratory. Characterization of both sets of detectors is underway with measurements of background rates, gas gain, energy resolution, and shielding considerations.

Motivation:

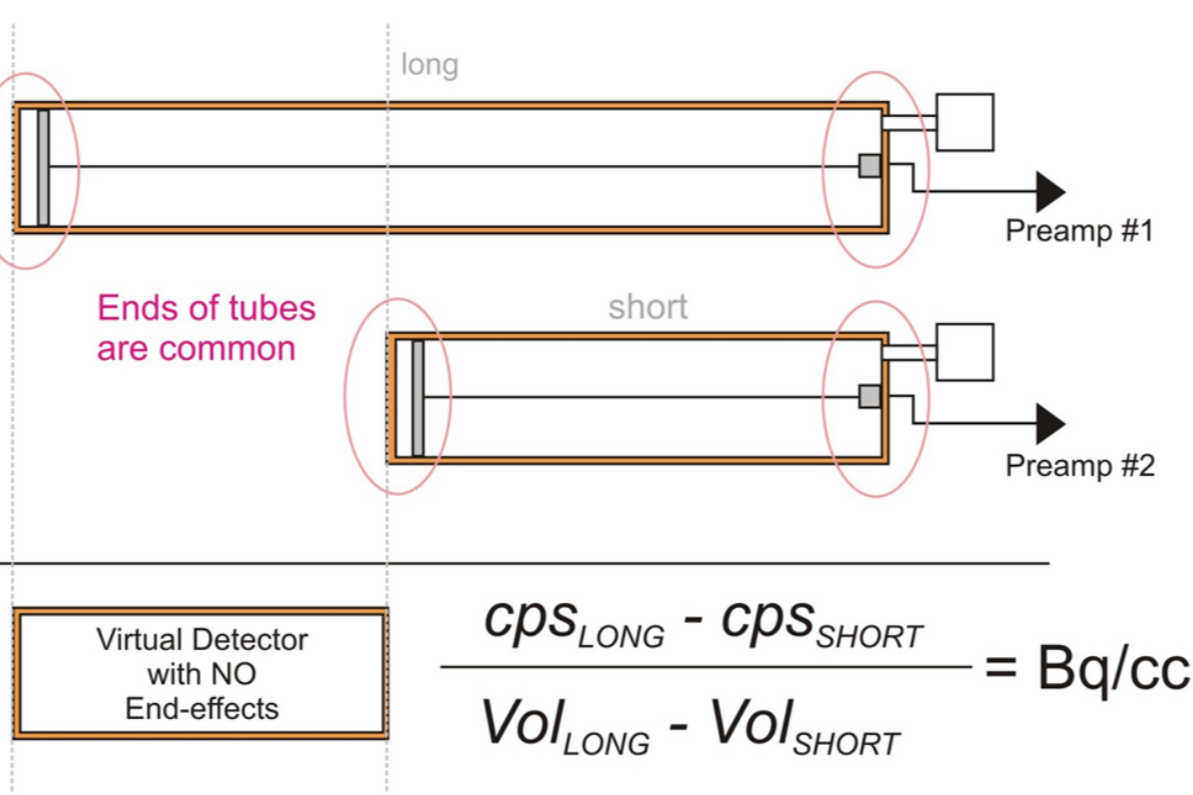
PNNL is developing the capability to measure the *absolute* specific activity of gases with low- to medium- activity (0.05 – 1.0 Bq/cc)

- » Based on length-compensated proportional counting
- » This technique has been used for several decades, but typically for higher activity samples ($>10^3$ Bq/cc)
- » Eliminates the so called 'end-effect' in the counter
- » Leaves the 'wall-effect' and 'threshold-effect'
 - » Estimated by Monte-Carlo detector response simulation
- » Gas blending/uniformity is a major assumption in the analysis model

Background:

"Taking the difference in rates (between two unequal length counters) at a given pressure of gas then gave the true rate for a counter with no end losses and of length equal to the difference in lengths."

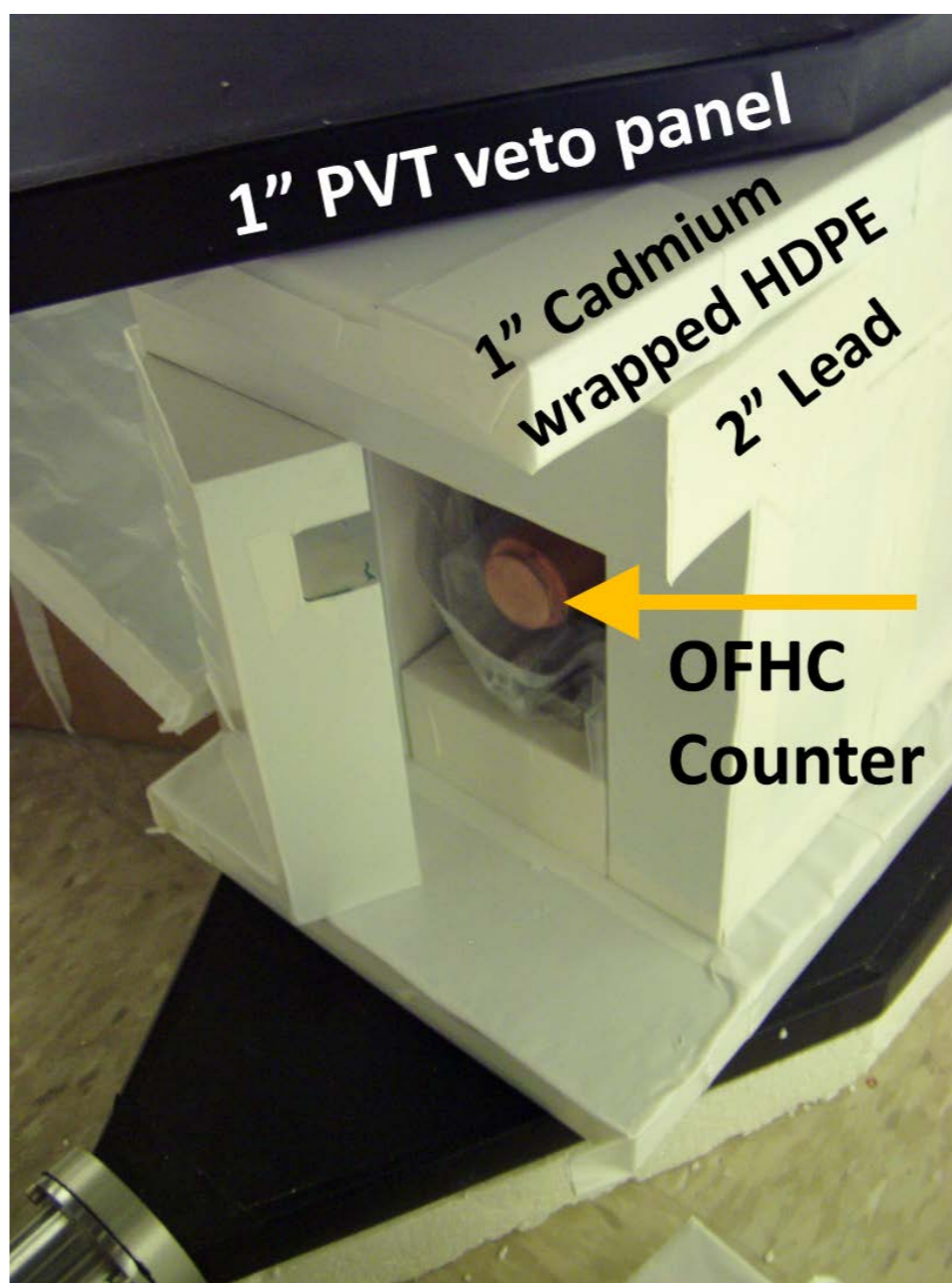
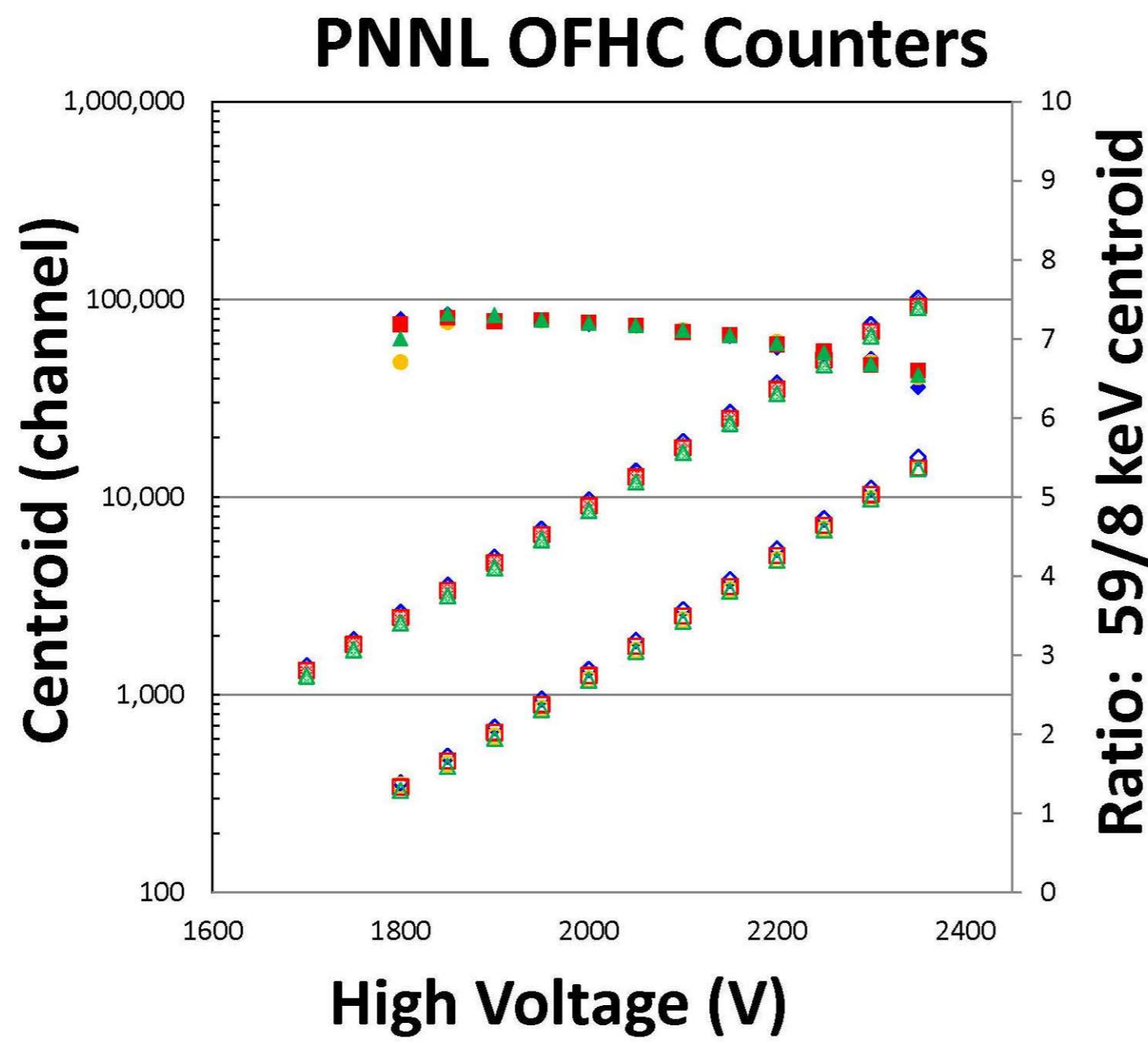
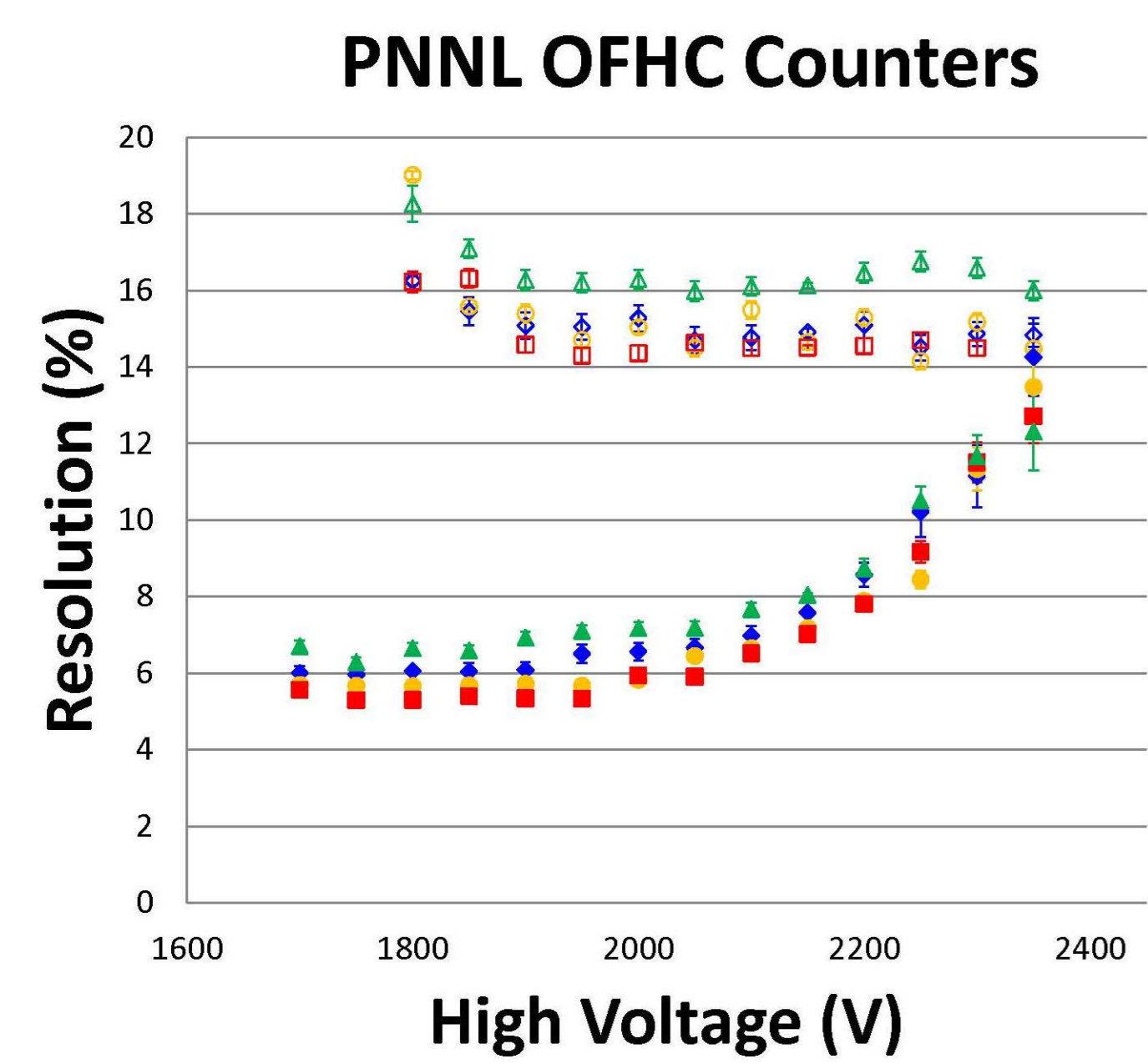
E. C. Anderson, W. F. Libby, S. Weinhouse, A. F. Reid, A. D. Kirshenbaum, and A. V. Grosse, Physical Review 72 (1947) 931



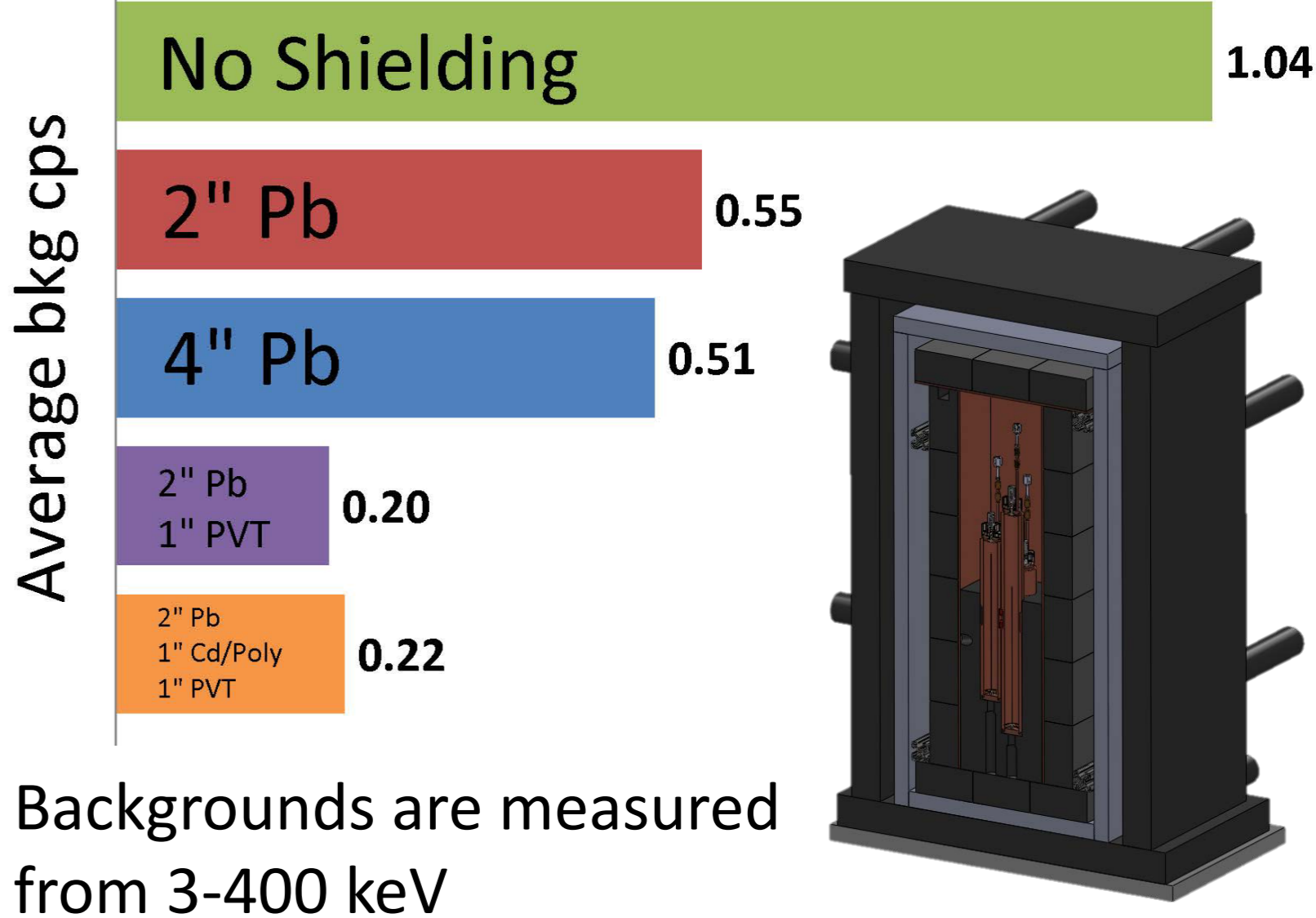
The difference between the counting rates of the two counters is considered to be the counting rate coming from an "ideal" counter whose length is equal to length difference of the two proportional counters (PCs).



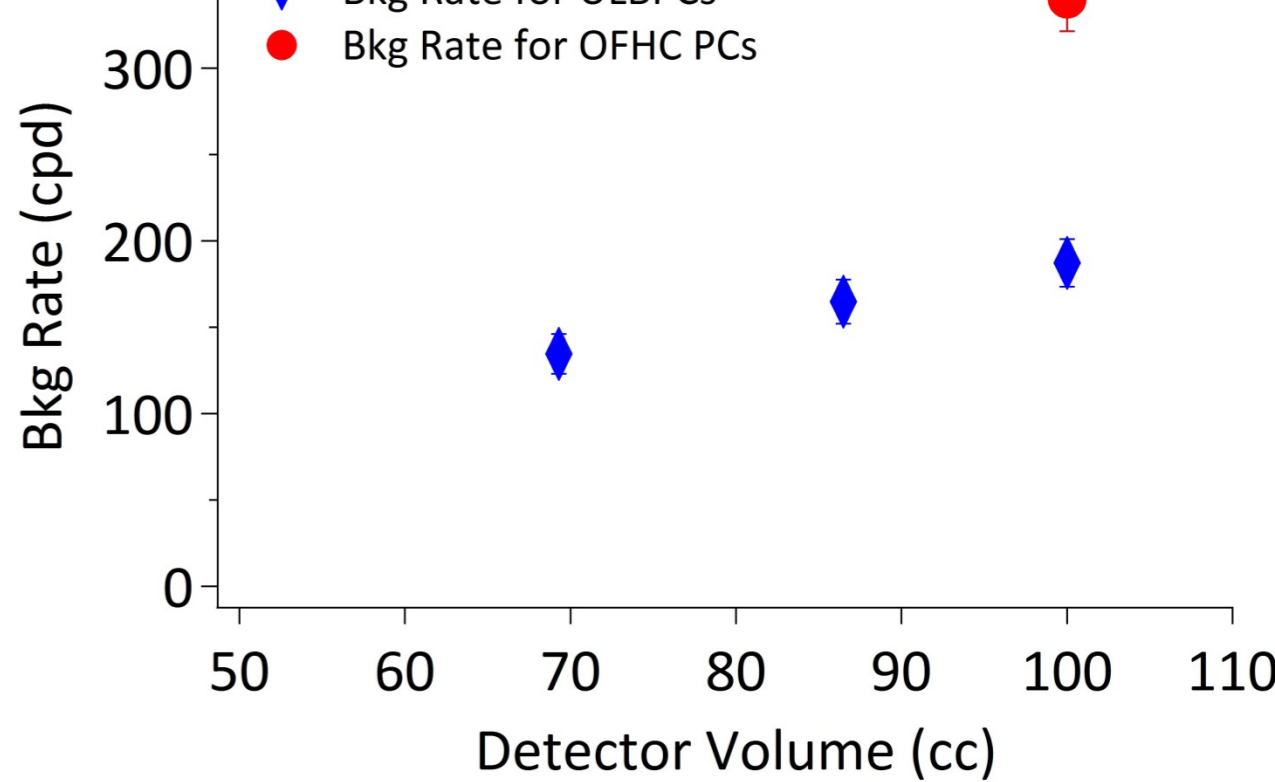
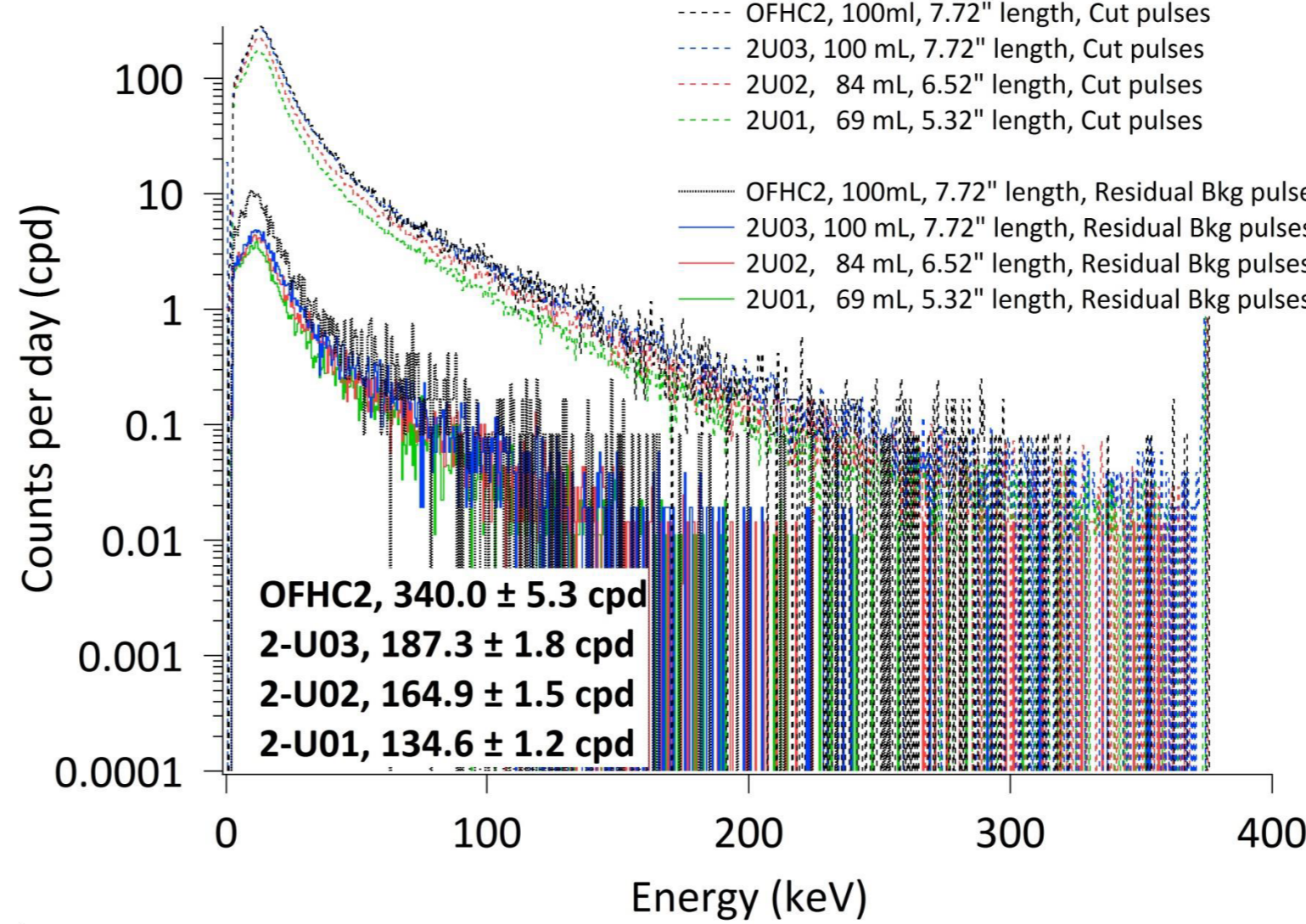
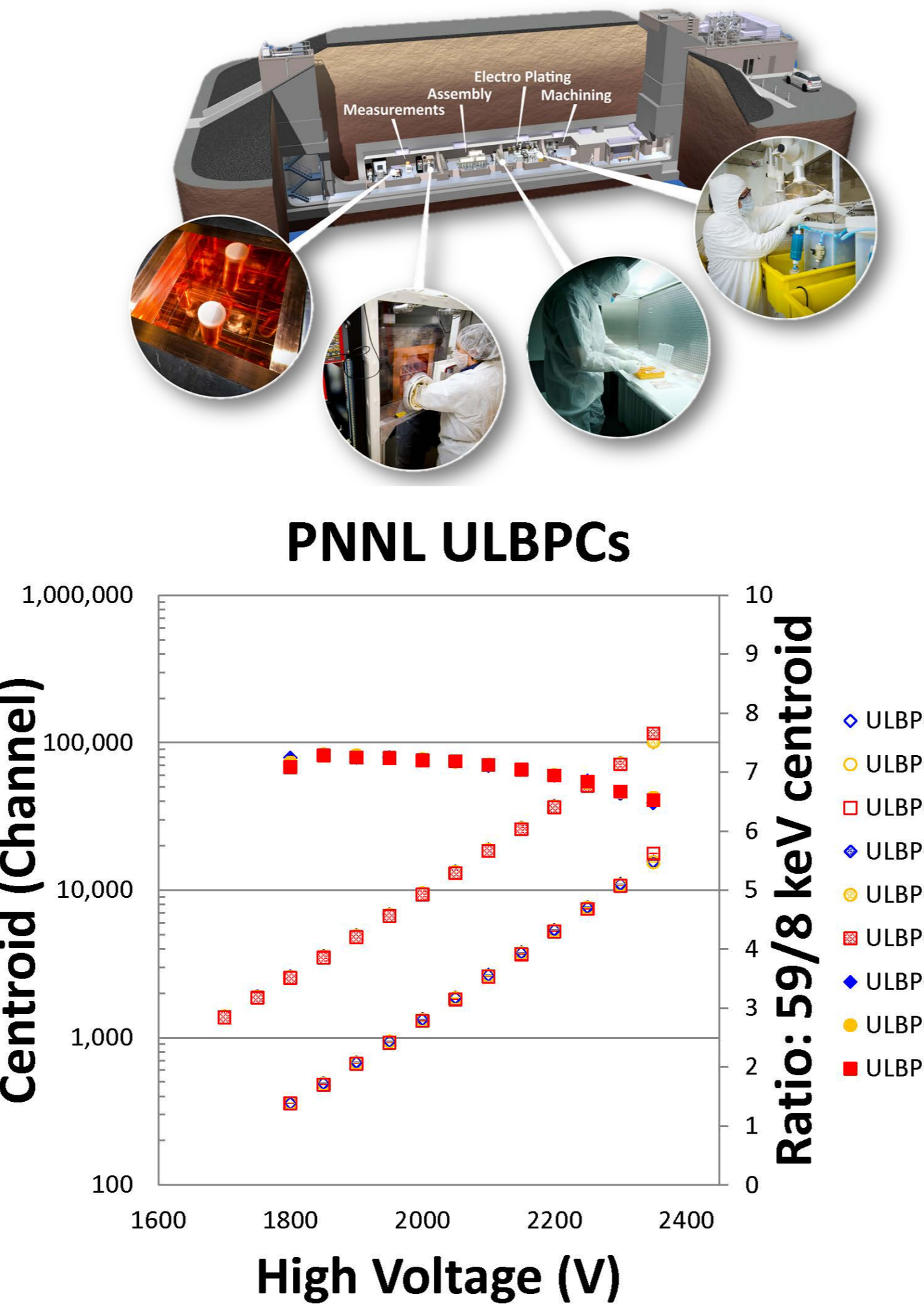
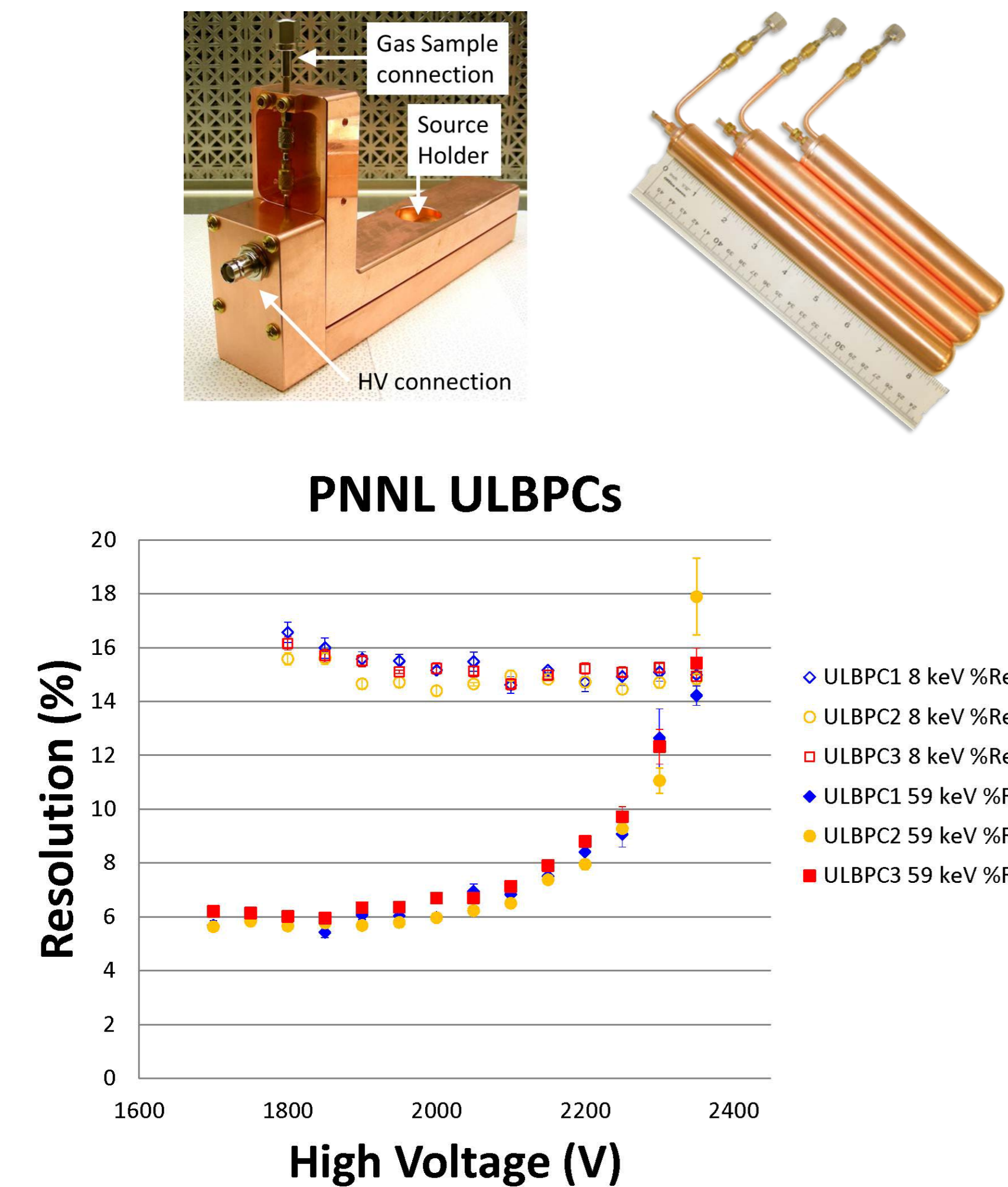
OFHC Copper Proportional Counters



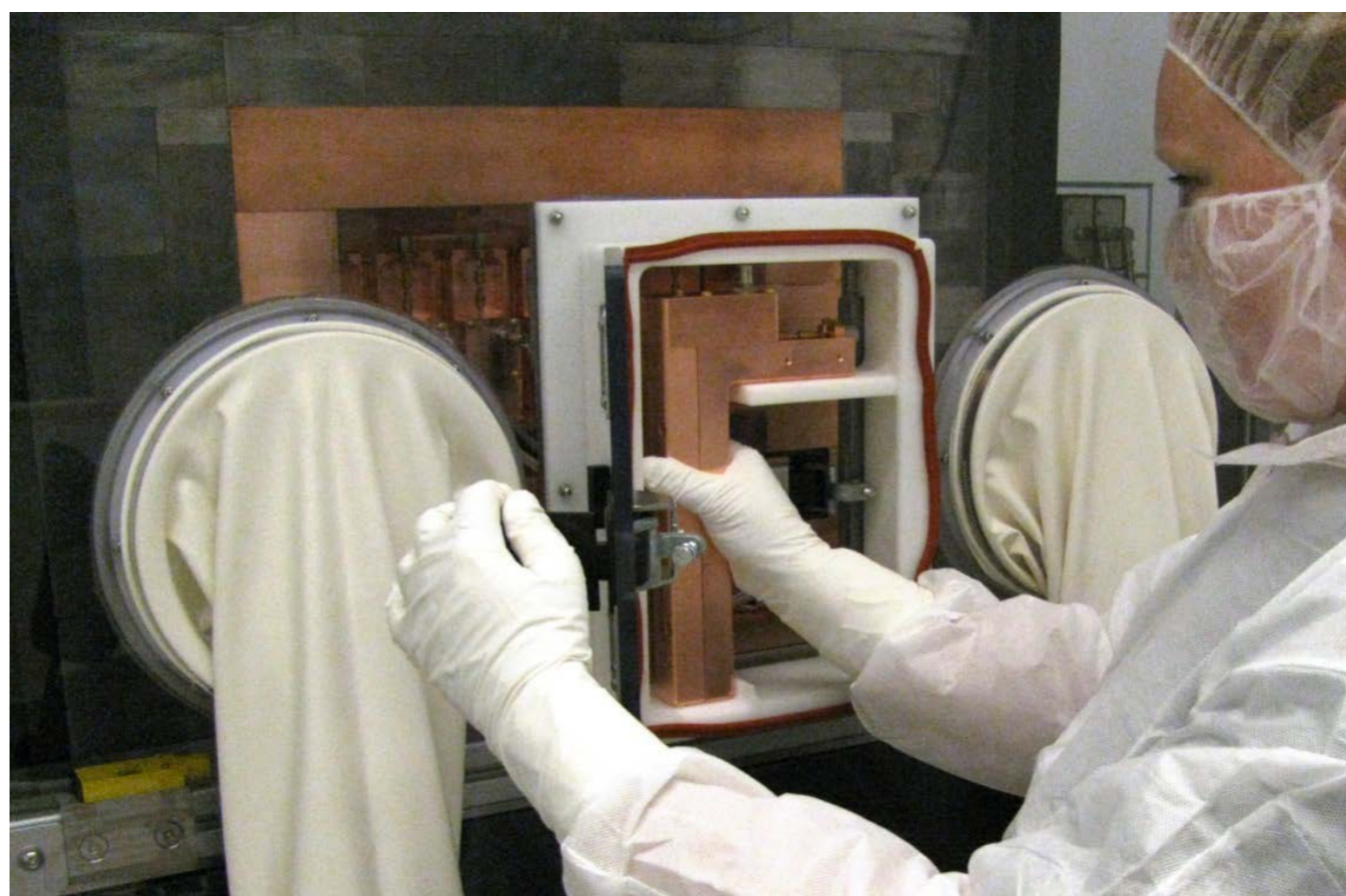
Shielding Study



Ultra-Low-Background Proportional Counters



The background rate (as measured from 3-400 keV) is ~50% lower for ULBPCs than for OFHC counters in PNNL's Shallow Underground Lab



For more information on the science you see here, please contact:

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