Design and Fabrication of Liquid Scintillator Counter

Andrea Calderon Saucedo[1], John L. Orrell[2]
[1]California State University, Long Beach
[2]Pacific Northwest National Laboratory

Pacific Northwest NATIONAL LABORATORY
Proudly Operated by Battelle Since 1965

Introduction

Shallow Underground Laboratory

Pacific Northwest National Laboratory (PNNL) is home to one of the few underground laboratories specializing in ultra-low background measurements. Built at a depth of 35-meters water-equivalent, the underground laboratory shields against cosmic-ray by-products, including but not limited to, protons, neutrons, and muons. One of the functions of the facility is to measure ultra-low concentrations of radioactive isotopes.

Ultra-Low Background Liquid Scintillator Counter

Inside the shallow underground laboratory, PNNL houses an Ultra-low Background Liquid Scintillator Counter (ULB LSC) in a clean room facility. Liquid scintillation counting is used to detect and measure ionizing radiation. To decrease the contributions of terrestrial and intrinsic background, the ULB LSC is made up of various layered materials including plastic scintillator veto panels, borated polyethylene, lead and copper.

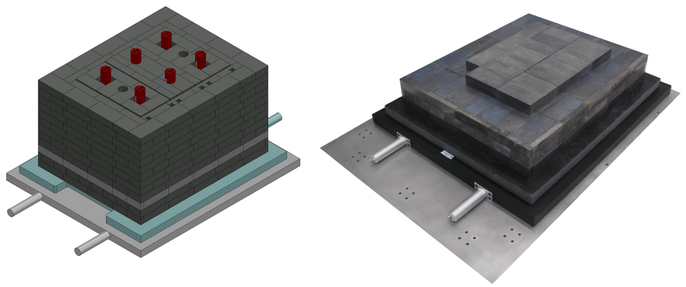


Figure 1: Ultra-low Background Liquid Scintillator Counter
Solidworks design (left) and Underground build (right)

Design and Fabrication

Rapid Prototyping

A pulley-like design will be used to lower a sample into the light guide for testing. The pulley system, composed of two parts, was designed using Solidworks and 3D printed using Acrylonitrile Butadiene Styrene (ABS) plastic.
Due to design constraints, a simplified version of the original pulley was essential for the acceleration of the underground testing.

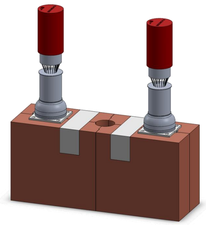


Figure 2: Copper Light Guide

Test Vial Basket

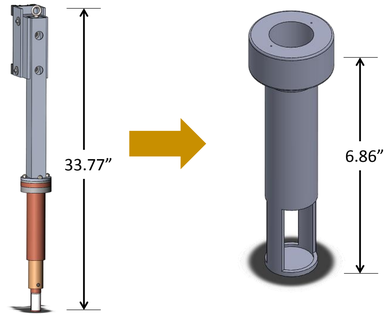
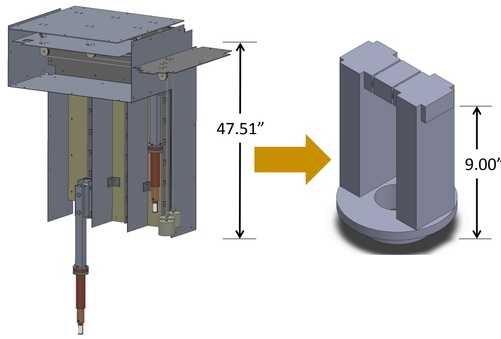


Figure 3: The original test basket (left), made of copper, is attached to a copper plug which is then lowered into the light guide. The redesigned test basket (right) is a simplified version made with ABS plastic.

Basket Holder

Figure 4: The original pulley system is a highly complex mechanism with counter weights which help lower the test basket into the light guide. The redesigned basket holder simply assists with the lowering of the test basket by using a filament (attached to the test basket).



Discussion

Final Assembly

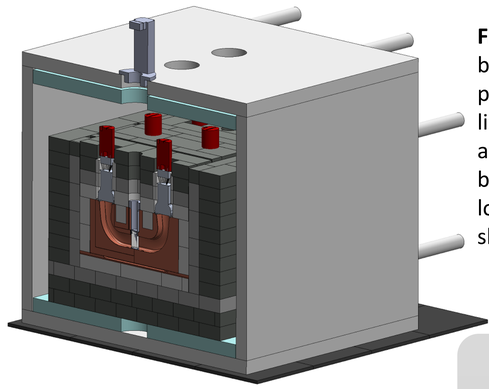


Figure 5: The 3D printed basket holder will be placed on the top of the liquid scintillator counter as shown. The test vial basket will then be lowered and placed as shown on the diagram.

Future Testing

After the completion of the ultra-low background liquid scintillator counter, the first liquid scintillation sample will be tested using the pulley-like design.

Acknowledgments

Special thanks to:
John Orrell, Jennifer Erchinger, Derek Neal, Erin Fuller, Cory Overman, Brian Glasgow
STAR Program of California Polytechnic State University, San Luis Obispo
Chevron Corporation (www.chevron.com)
California State University, Long Beach

The research described in the poster is funded by the Ultra-Sensitive Nuclear Measurements (USNM) Initiative at Pacific Northwest National Laboratory. It was conducted under the Laboratory Directed Research and Development Program at the Pacific Northwest National Laboratory, a multi-program national laboratory operated by Battelle for the U.S. Department of Energy.

ABOUT Pacific Northwest National Laboratory

The Pacific Northwest National Laboratory, located in southeastern Washington State, is a U.S. Department of Energy Office of Science laboratory that solves complex problems in energy, national security, and the environment, and advances scientific frontiers in the chemical, biological, materials, environmental, and computational sciences. The Laboratory employs nearly 5,000 staff members, has an annual budget in excess of $1 billion, and has been managed by Ohio-based Battelle since 1965.

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

Andrea Calderon Saucedo
andrea.calderon@student.csulb.edu

John L. Orrell
Pacific Northwest National Laboratory
P.O. Box 999, MS-J4: 65
Richland, WA 99352
(509) 375-1899
John.orrell@pnnl.gov

This material is based upon work supported by the Chevron Corporation, Howard Hughes Medical Institute, National Marine Sanctuary Foundation, National Science Foundation, and S.D. Bechtel, Jr. Foundation. Any opinions, findings, and conclusions or recommendations do not necessarily reflect the views of the funders.

The STAR program is administered by the Cal Poly Center for Excellence in STEM Education (CESAME) on behalf of the California State University.

www.pnnl.gov

PNNL-SA-112082