Design and Fabrication of Liquid Scintillator Counter

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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

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.

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.

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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.

Discussion

Final Assembly

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).

Figure 6: Basket Holder

Test Vial Basket

3.37" 6.06"

47.51" 9.60"

33.77"