Investigating the Effects of Garolite in ArgonCube

Liza Matrecito Salcedo, GEM Fellow, Rochester Institute of Technology
Dr. Louise Suter, Fermilab

FERMILAB-POSTER-23-217-STUDENT

I. Introduction

- ArgonCube is the prototype for the Deep Underground Neutrino Experiment near-detector (DUNE-ND).
- It consists of four independent liquid Argon time projection chamber (LAr-TPC) modules arranged in a 2x2 grid.
- Each module is enclosed by a sleeve of Garolite (G10), isolating the modules from each other and the outer LAr bath[1], FIG. 1.

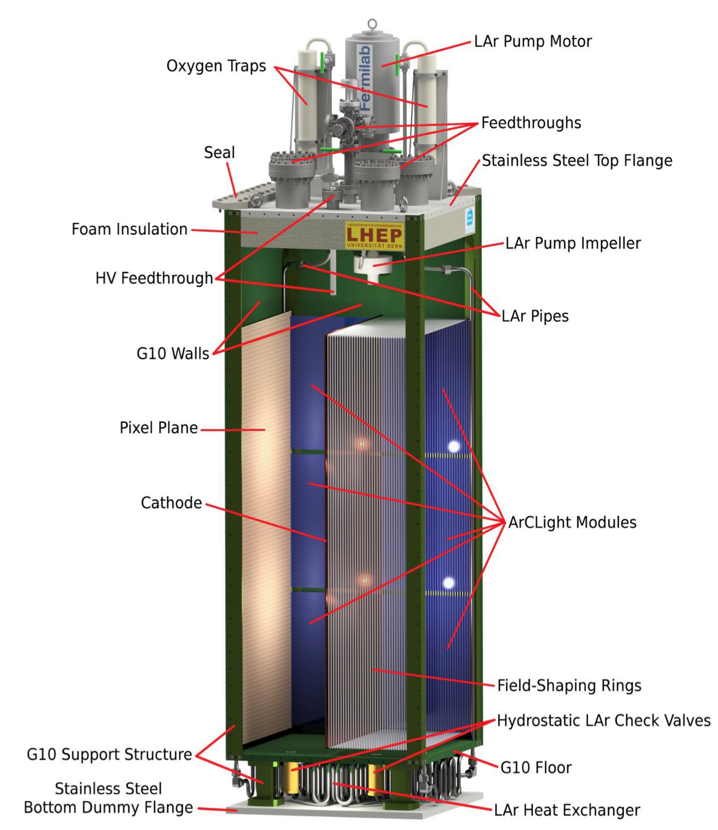

FIG. 1: A cutaway diagram of one of the modules from ArgonCube[1].

II. Motivation

MicroBooNE, which contains G10 struts, observed an increase in low-energy activity around the regions of the detector near the G10. These low-energy events can be a non-reducible background in low-energy searches and impact energy reconstruction.

An example is shown in FIG. 2 showing the location of selected low energy events from MicroBooNE in which the G10 'blips' align with the location of the G10 struts in the detector. The 'blips' are believed to be caused from the radioactive decay of Thorium 232 (Th232) into Thallium 208 (Tl208) at 2.614 MeV.

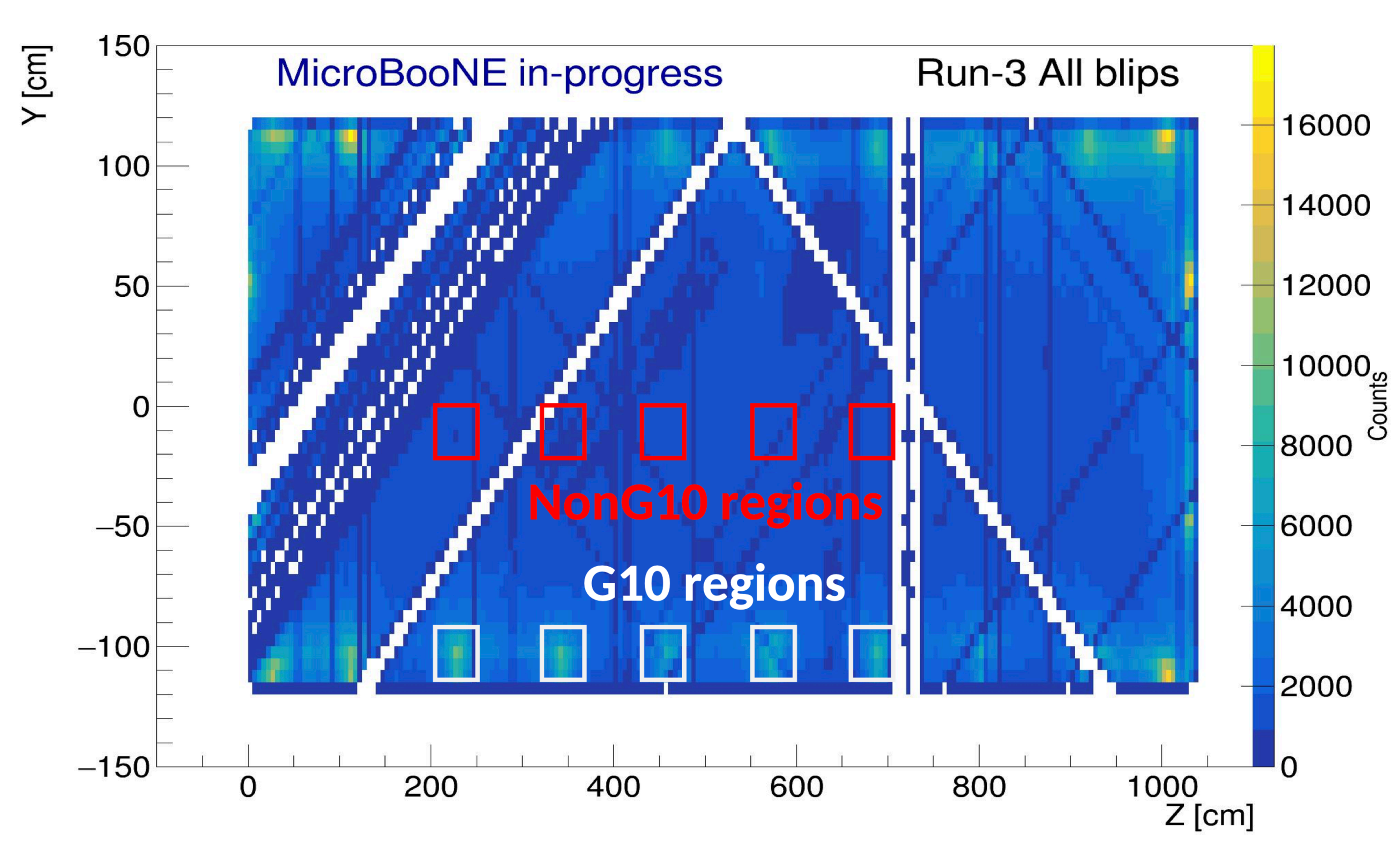

FIG. 2: An event display from MicroBooNE showing the G10 'blips' (white regions)[2].

III. Experiment

- A radioisotope identification device (RIID)[3] was used to take an energy spectrum from 8 – 4000 keV of the G10 in three of the four modules over a 1440-minute time interval, FIG. 3.
- An additional background spectrum was taken with no detector present for calculating the residuals of the present isotopes, specifically Tl208.
- To obtain the emission of Tl208 per gram of G10, the total counts/bin were found from the spectrum and the amount of G10 per module was calculated using Fusion360 CAD models.

FIG. 3: Experimental set-up

IV. Results

Spectra obtained with the RIID are shown in FIG. 4 for the entire energy range and the Tl208 emission is shown in FIG. 5.

- The counts of Tl208 per gram of G10 was found to be:
  - Module 1 = 0.0143 ± 0.0012 counts/g
  - Module 2 = 0.0139 ± 0.0010 counts/g
  - Module 3 = 0.0100 ± 0.0010 counts/g
- The background spectrum has a non-linear shift in which the shift increases at higher energies

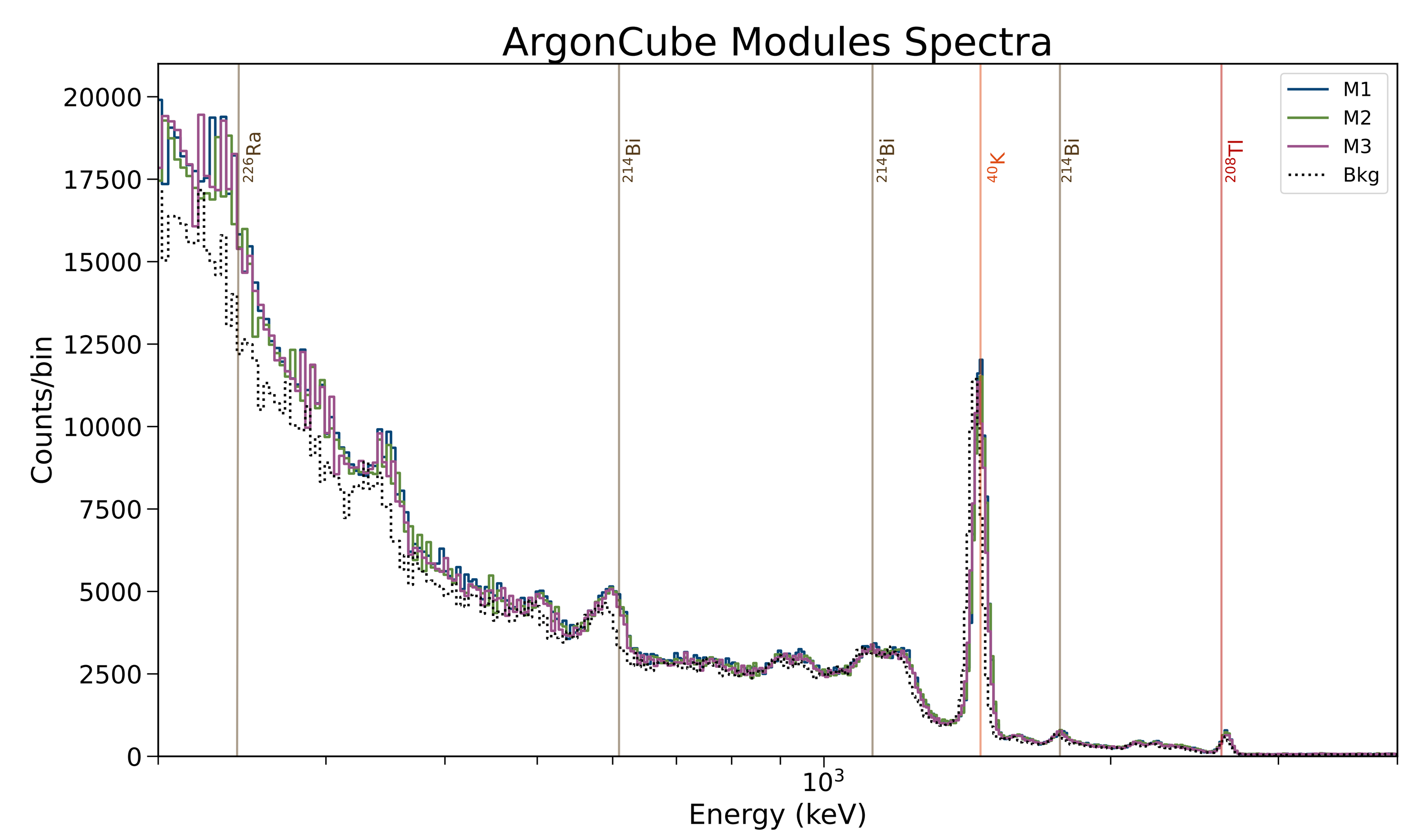

FIG. 4: Spectra obtained for the three modules (M1, M2, M3) and the background spectrum (Bkg). Other known isotopes are shown as vertical lines. The energy range is 200 keV – 4000 keV due to RIID interference at around 30 keV.

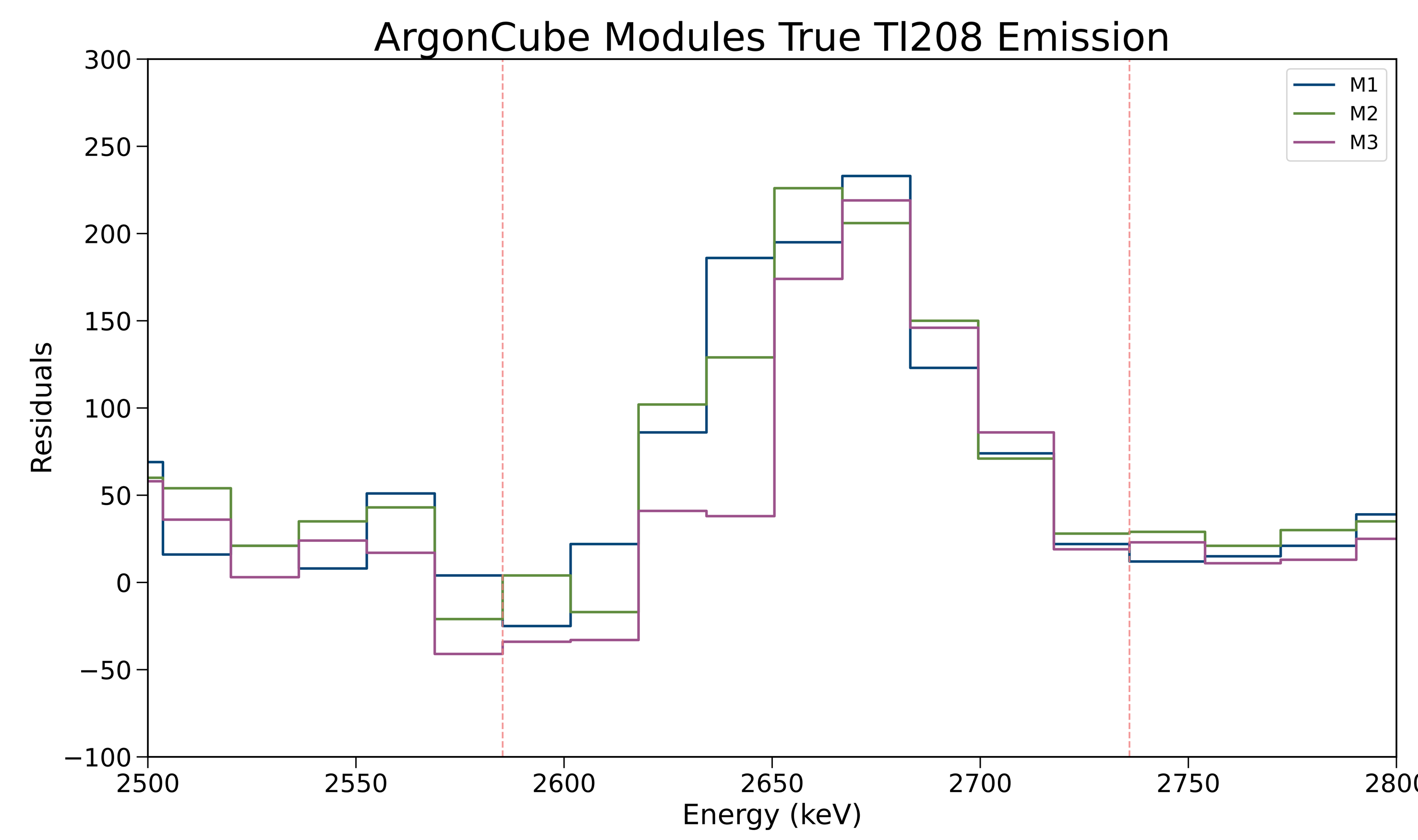

FIG. 5: Same as FIG. 4, but showing the bkg subtracted Tl208 emission for all three modules and the integration interval (dashed lines).

V. Conclusion

The purpose of this work was to identify possible radiation sources for the DUNE-ND prototype, ArgonCube, by measuring the spectrum and amount of G10 in each module. One possible source is the decay of Th232 to Tl208, which emits a ɣ-ray at 2.614 MeV. Main results are summarized below:

- Th232 was determined to be present in the G10 at an average rate of 0.0127 ± 0.0011 counts/g.
- The MicroBooNE observed rate is 0.0116 ± 0.0016 counts/g, consistent with our findings[2].
- Tl208 ɣ-rays are expected to contribute to low-energy events in ArgonCube, and possibly in the DUNE-ND.

[1] A. Ereditato et al. *ProtoDUNE-ND: proposal to place the ArgonCube 2x2 Demonstrater on-axis in NuMI.*
[2] D. Andrade. *Demonstrating Calorimetry and Particle Discrimination at MeV Energy Scales with Ambient Backgrounds in the MicroBooNE LArTPC.* New Perspectives, Fermilab. 2023.
[3] Berkeley Nucleonics Corporation. 2007. *Instruction Manual, Model 940.*

This manuscript has been authored by Fermi Research Alliance, LLC under Contract No. DE-AC02-07CH11359 with the U.S. Department of Energy, Office of Science, Office of High Energy Physics.