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Analysis of leaching on Polytetrafluoroethylene (PTFE) shielding through the detection of alpha particle emissions.

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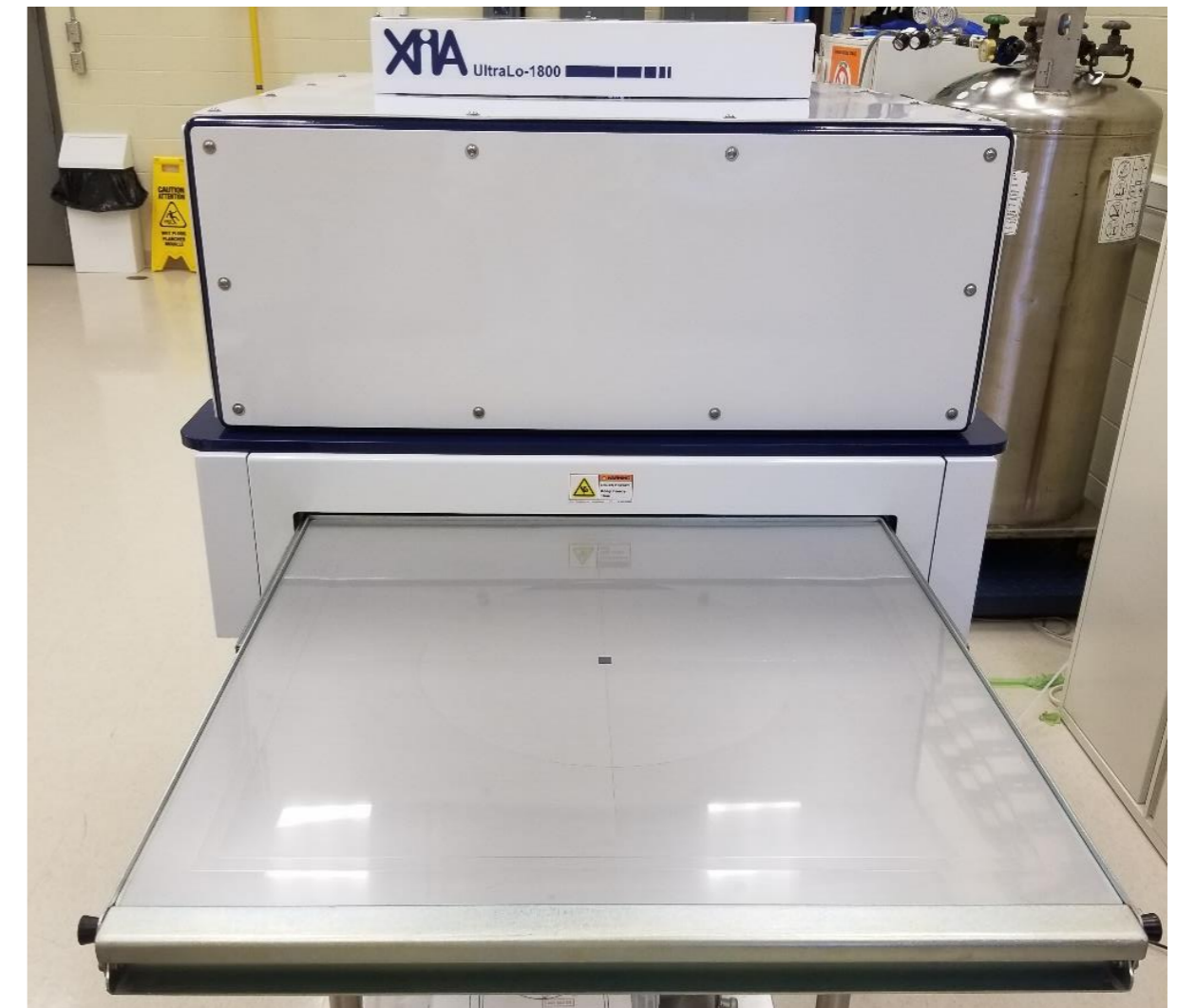
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Supervisor: Dr. Silvia Scorza

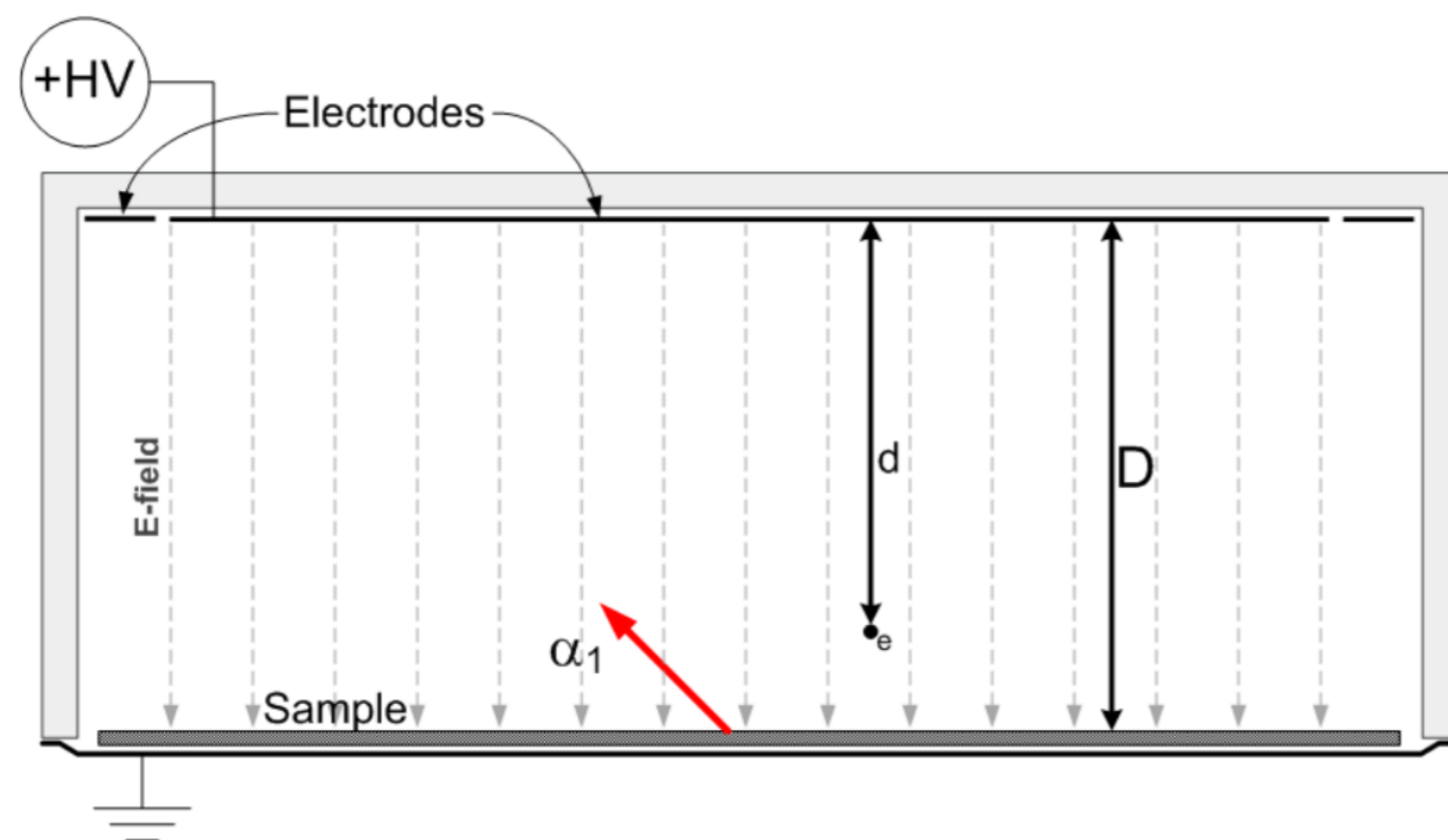


Instrument: XIA Ultra-Lo 1800

- Ionization counter filled with liquid argon boil-off
- Grounded electrode holds sample (a conductive tray)
- Higher pair of counting anodes surrounded by “guard” anode to identify emitted alphas from sidewalls
- Potential of 1100 V applied between tray and positive anode, emitted alpha particles ionize Argon gas releasing electrons
- Electrons drift upwards to induce currents in anode to lead to a count measurement



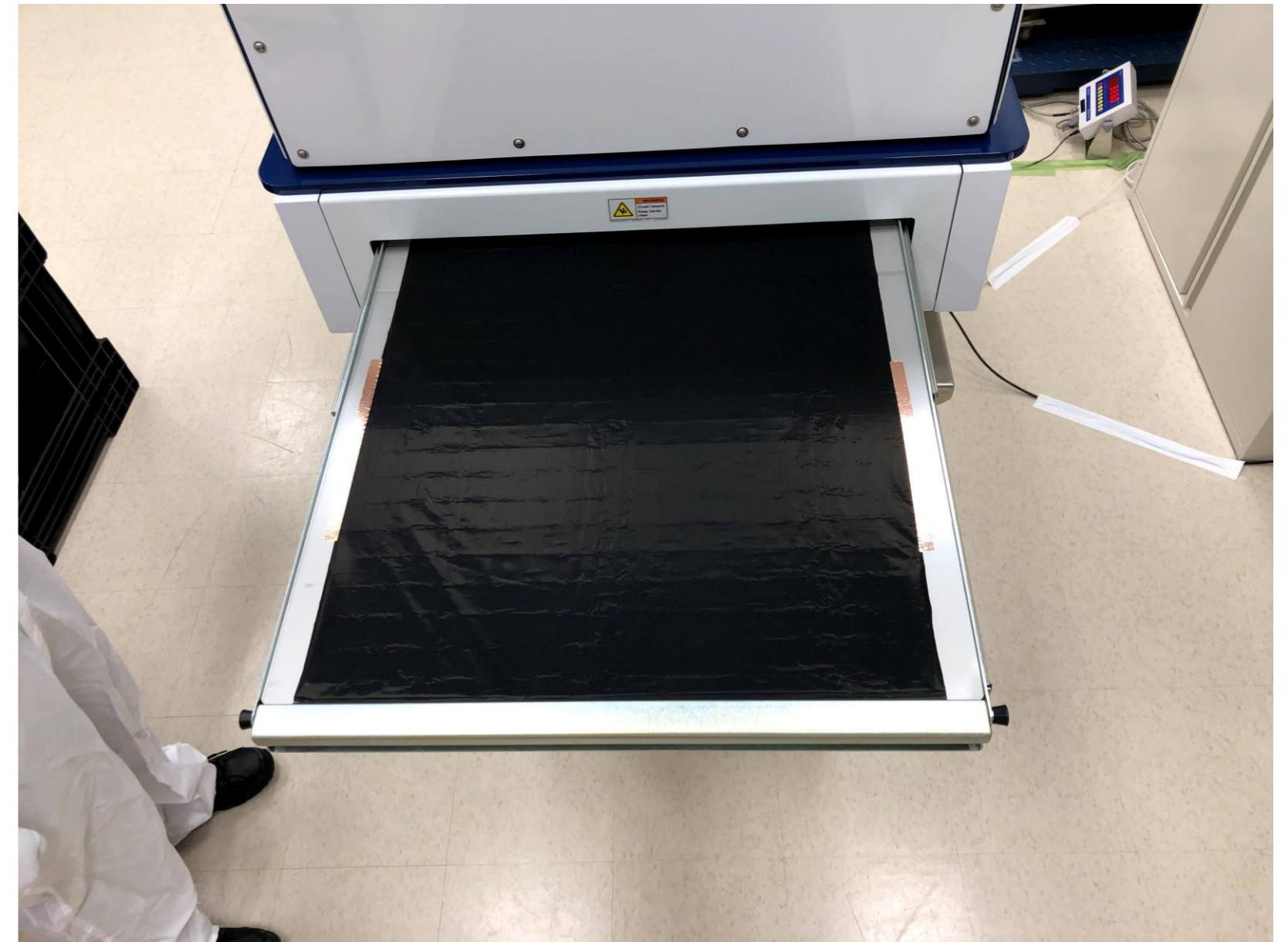
Analysis Information



- Pulse-shape discrimination used for energy of particle & rise time of pulse (height above sample tray)
- Sample Change: purge of minimum 45 minutes using Argon boil off
- Tray background activity taken periodically to account for variability
- Efficiency correction due to random nature of alphas counting from their ionization paths

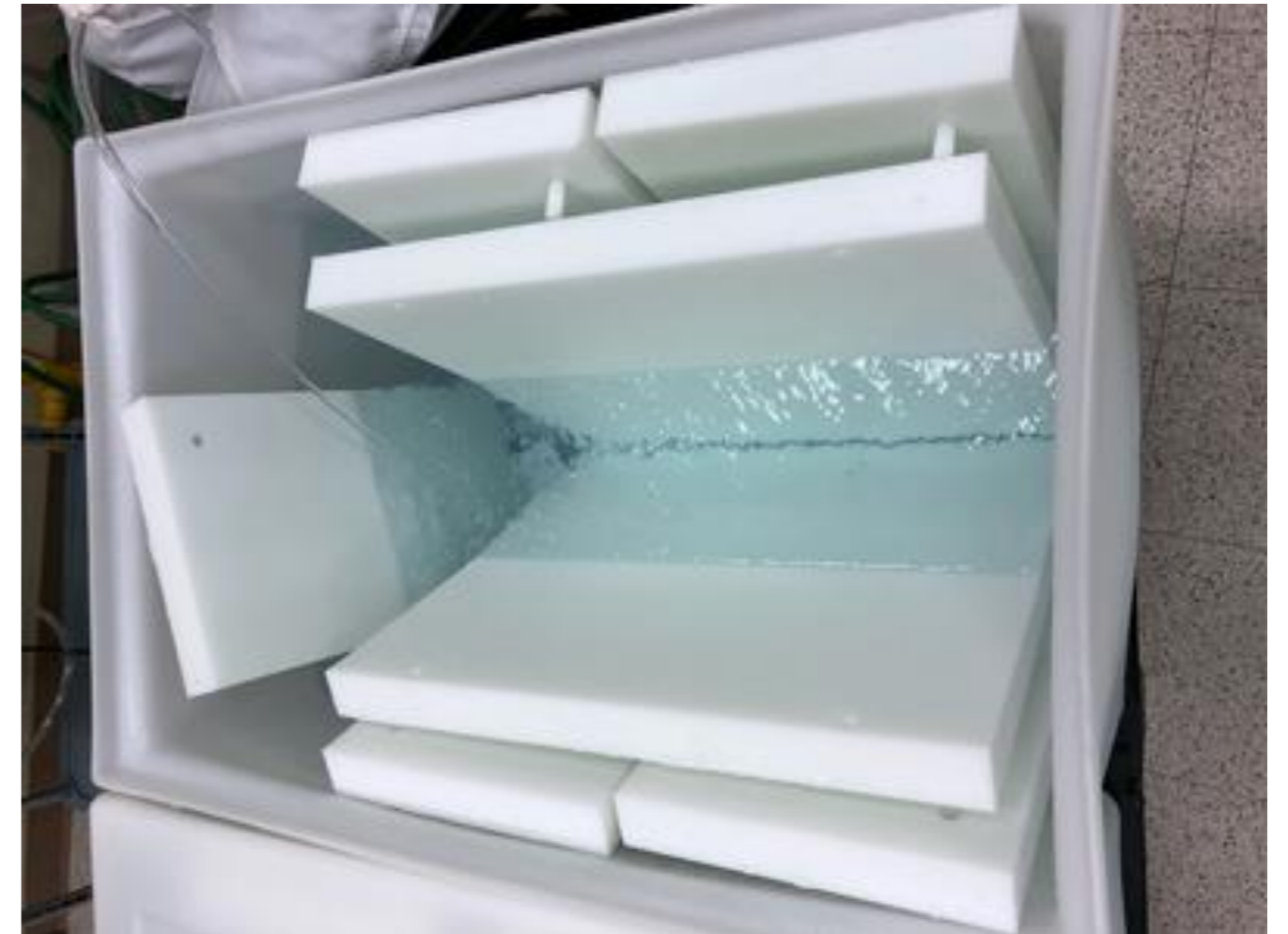
Analysis Pipeline

1. Identification of alphas via the pulse discrimination
2. Subtraction of the background contribution due to count gas / interior surface of chamber
 1. Empty tray readings (Tray Background) have a conductive Teflon liner having lower background rate, scaled by fraction of tray's exposed surface to counting anode
3. Subtraction of the Instrumental Background independent of Tray Background, normalized with relation to the runtime (in hours)
 1. Instrumental Background is independent of sample size, remains constant between runs
4. XIA UltraLo detector experiences efficiency loss of alpha counting due to random nature of ionization paths, detector efficiency table provided by manufacturer



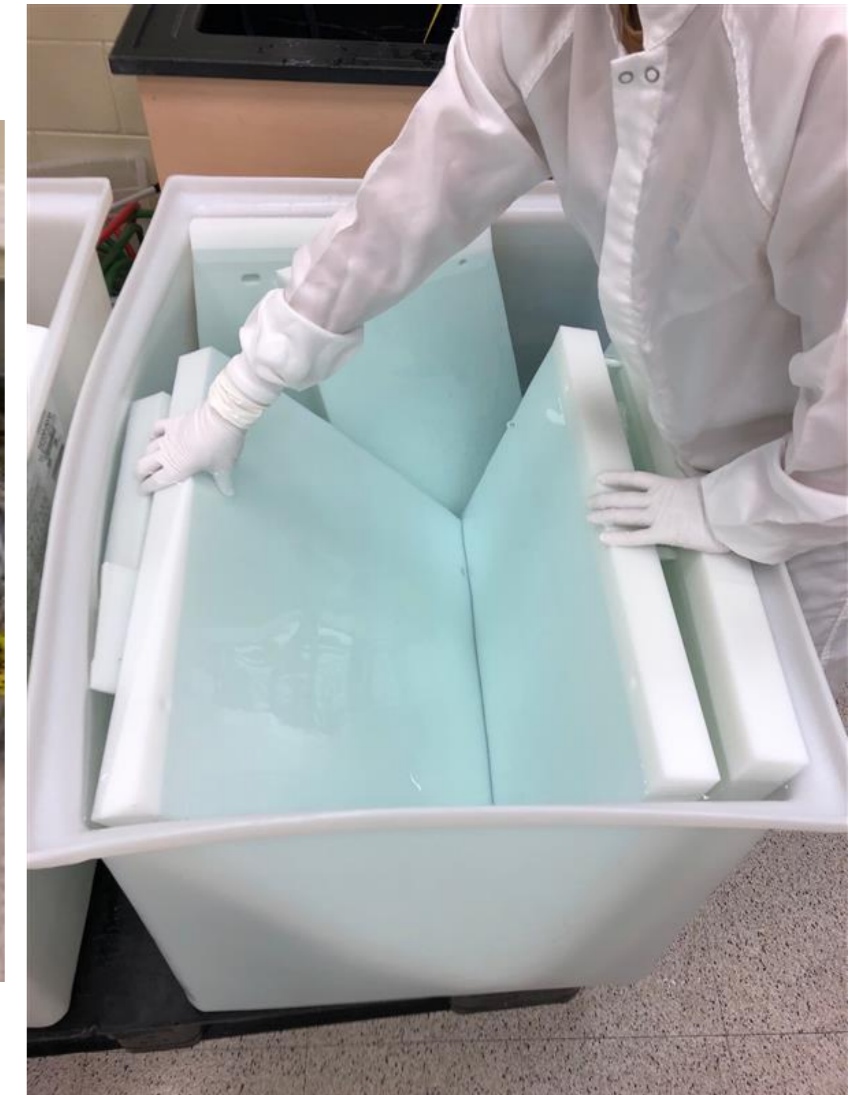
Significance of PTFE Material

- Essential to select radiopure shielding materials
 - Protect and Minimize background radiation
- Polytetrafluoroethylene (PTFE) is the main component of the shielding for the Cryogenic Underground Test Facility (CUTE) neutron source calibration system
 - To be installed soon, likely in October 2022
- Use the XIA detector to analyze alpha emissions of leached PTFE samples to determine effectiveness of shielding



Treatment of PTFE: Leaching Process

- **February 9th, 2022:**
 - PTFE plates leached with UPW (Ultra-Pure Water)
- **February 23rd, 2022:**
 - The side orientation of the plates were flipped (180-degree vertical flip) for uniform leaching, moved out, rinsed, and water was changed
- **March 9th, 2022:**
 - All plates removed
 - Smaller plates treated the same as the overall big plates



Sample Information



Sample 1

Name: Polyspacer Leaching Baseline

Acquisition Date Range: May 5, 2022 to May 10, 2022

Purge Time: 45 minutes

Total Acquisition Time: 113 hours

Sample Area: 76 cm²

Sample 2

Name: Poly Plate Leaching – Bin 00001

Acquisition Date Range: May 10, 2022 to May 17, 2022

Purge Time: 45 minutes

Total Acquisition Time: 162 hours

Sample Area: 105 cm²

Sample 3

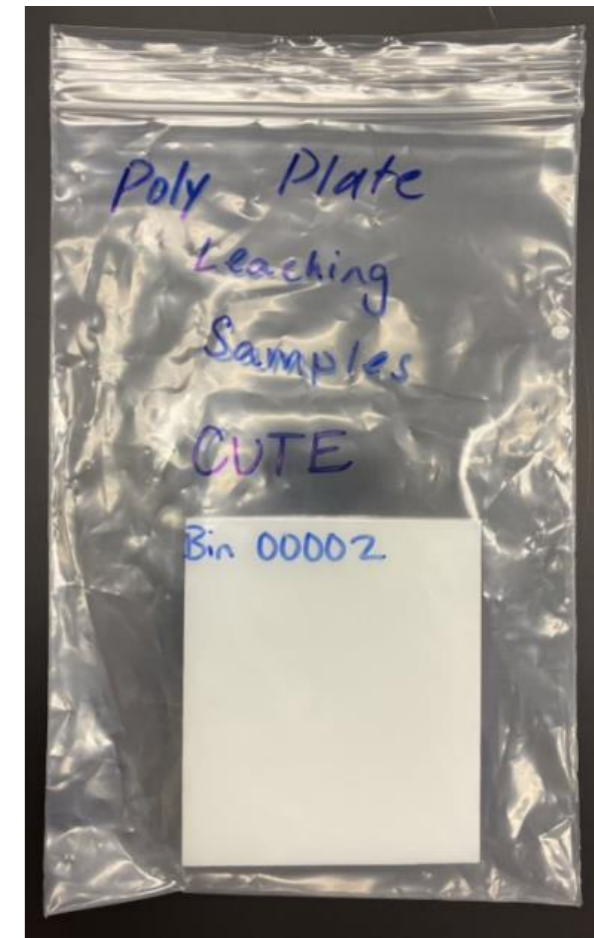
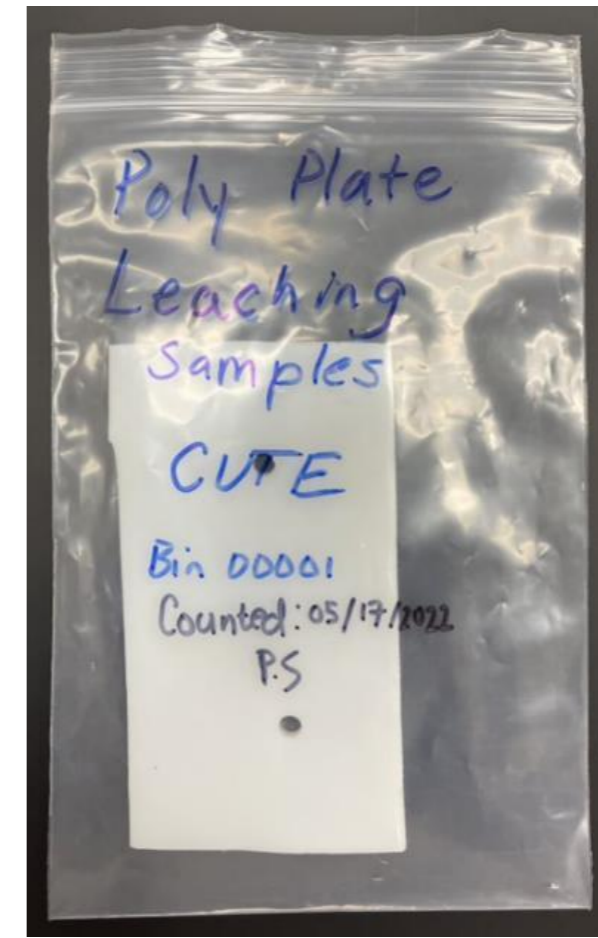
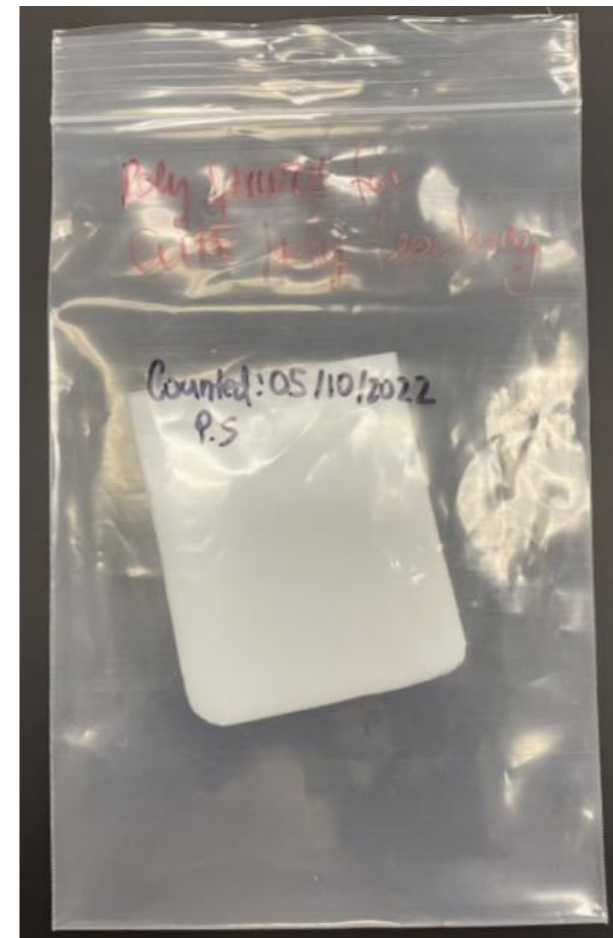
Name: Poly Plate Leaching – Bin 00002

Acquisition Date Range: May 17, 2022 to May 24, 2022

Purge Time: 45 minutes

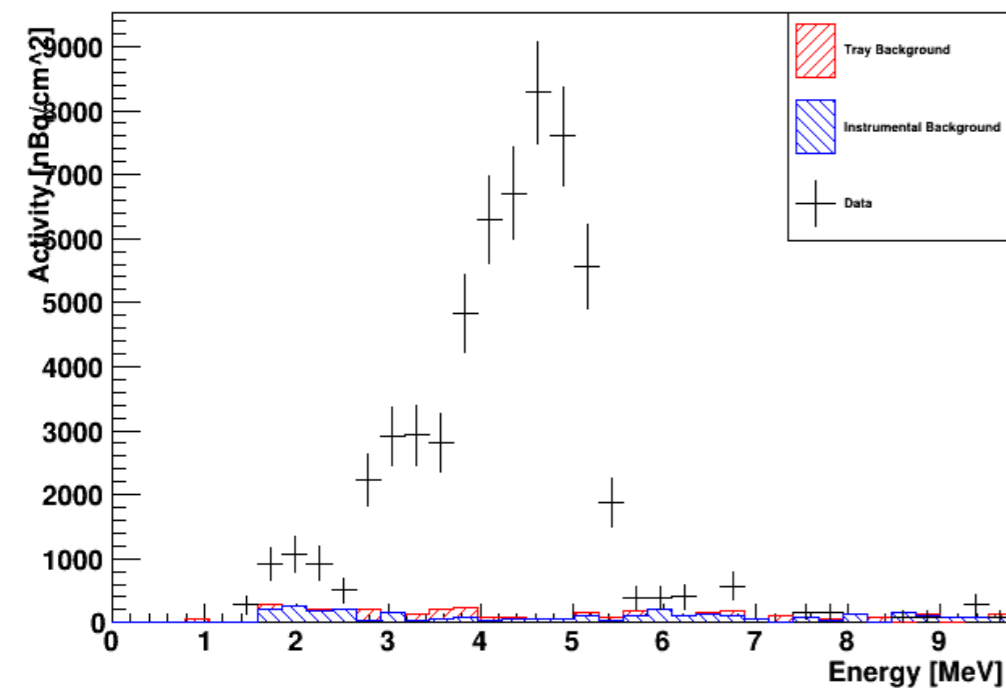
Total Acquisition Time: 168 hours

Sample Area: 64 cm²



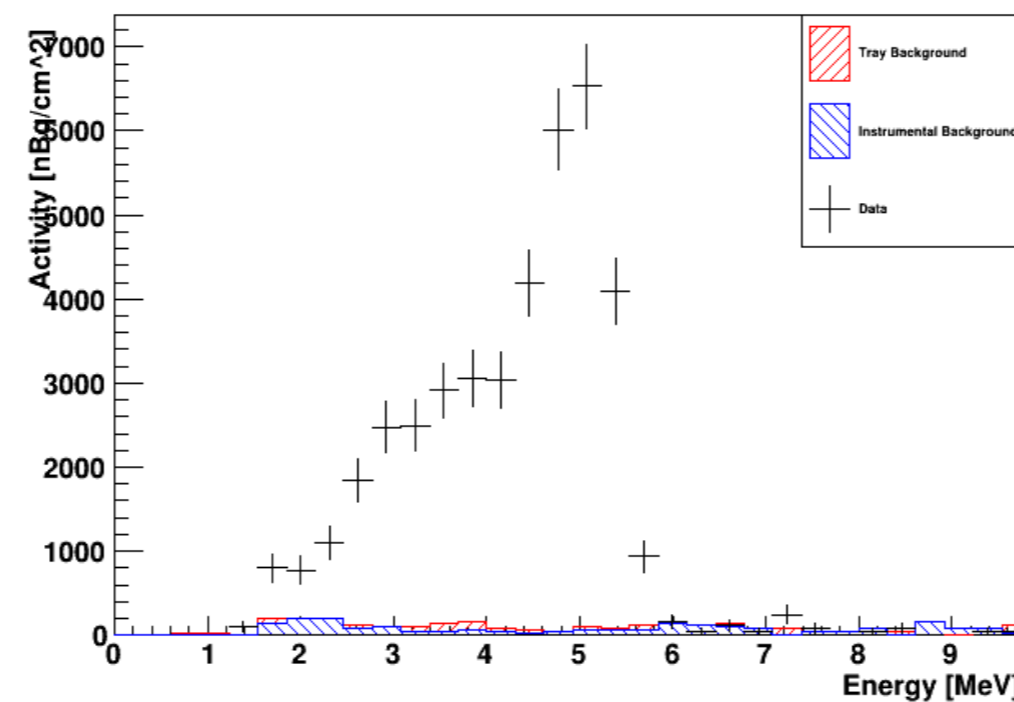
Analysis Results: Energy Spectra

Alpha Energy Spectrum



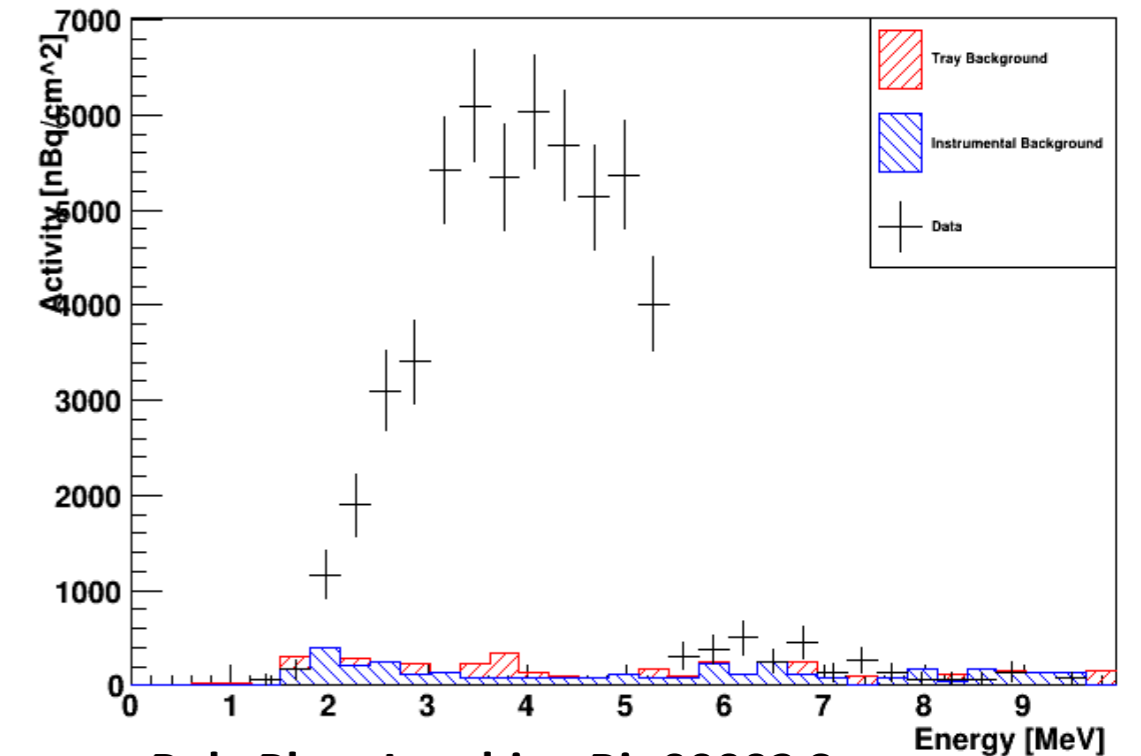
Polyspacer Leaching Baseline Spectrum

Alpha Energy Spectrum



Poly Plate Leaching Bin00001 Spectrum

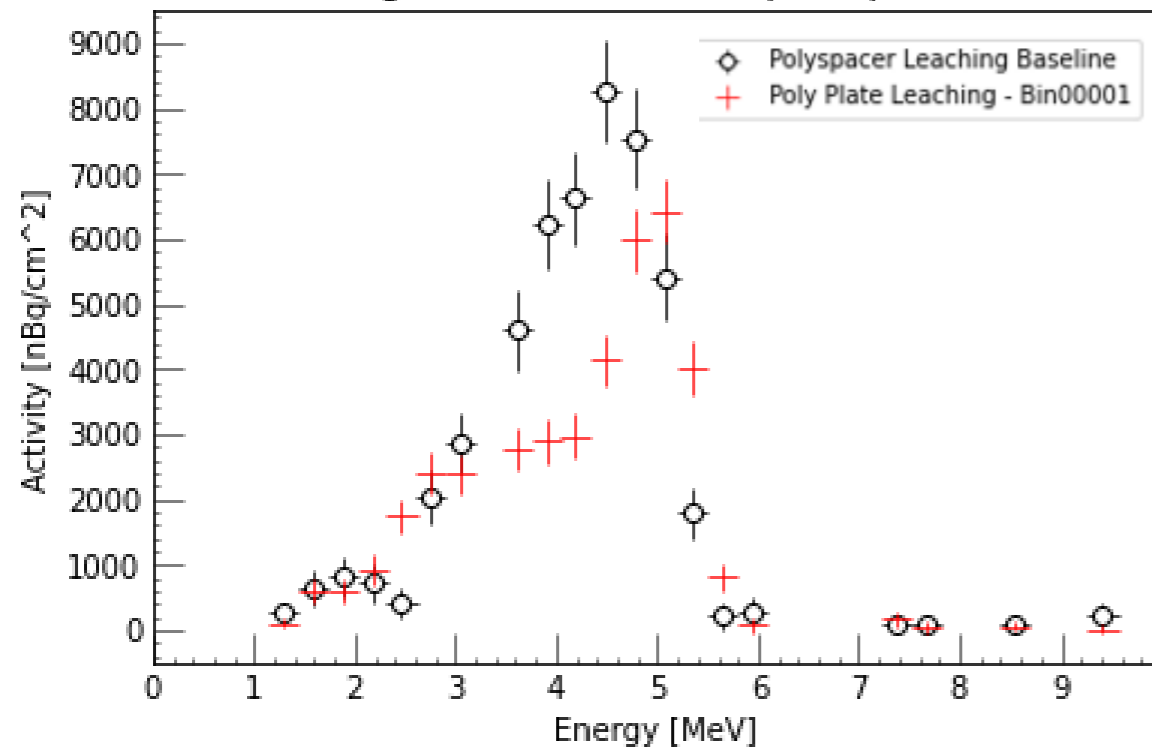
Alpha Energy Spectrum



Poly Plate Leaching Bin00002 Spectrum

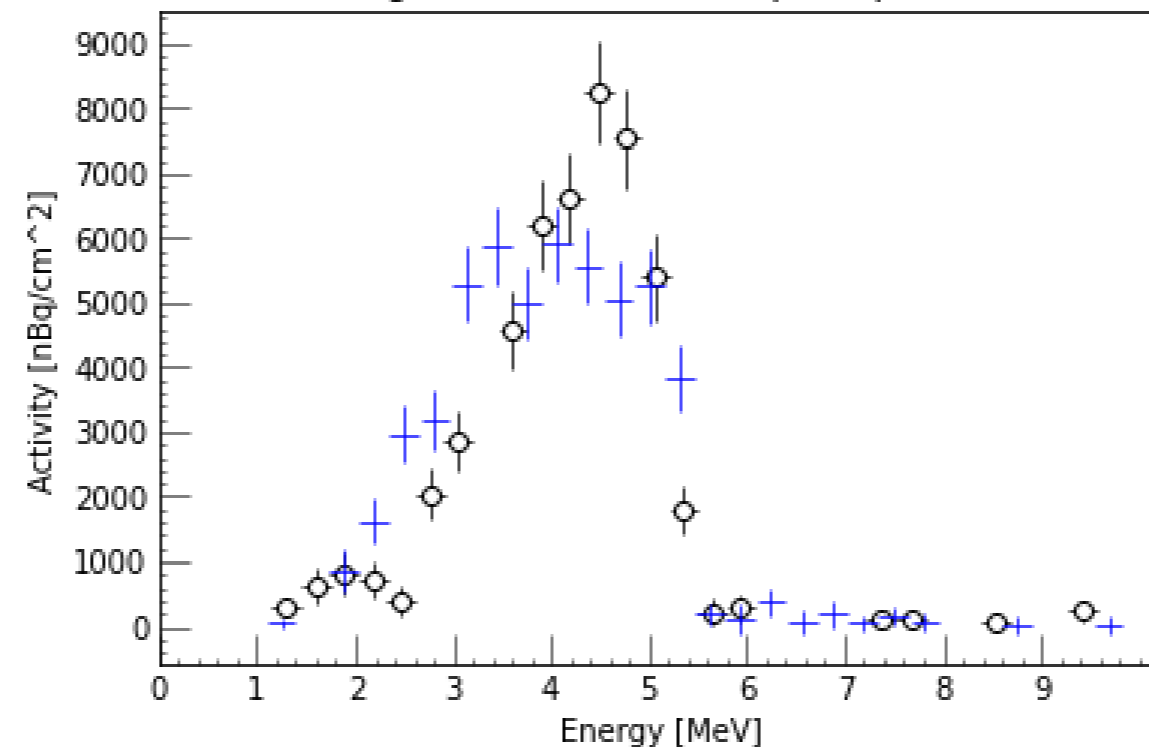
Comparison between Baseline and Leached Samples

Background Subtracted Alpha Spectrum



- Bin00001 sample sees reduction in area of surface alpha activity (4-6 MeV)
- Less bulk and surface level activity

Background Subtracted Alpha Spectrum

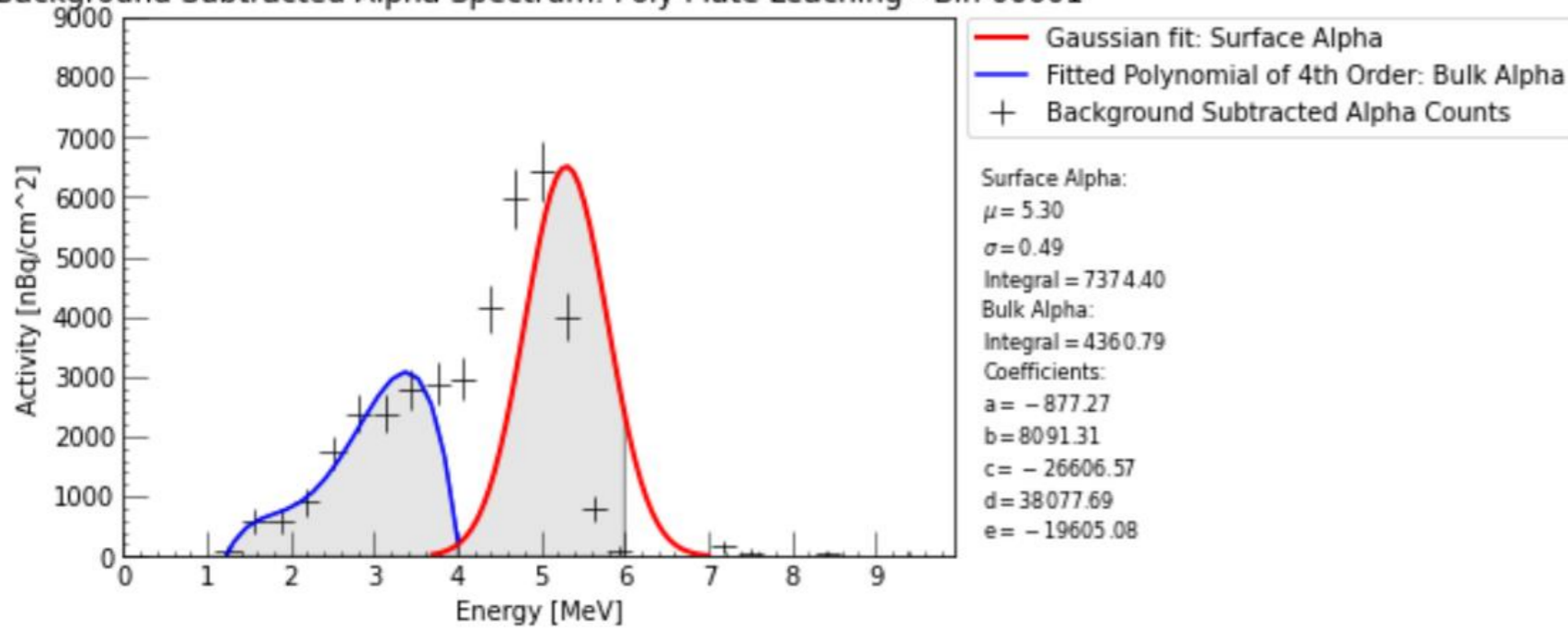


- Bin00002 sample maintains agreeability with baseline
- Alpha contamination in the bulk and surface regions are statistically compatible

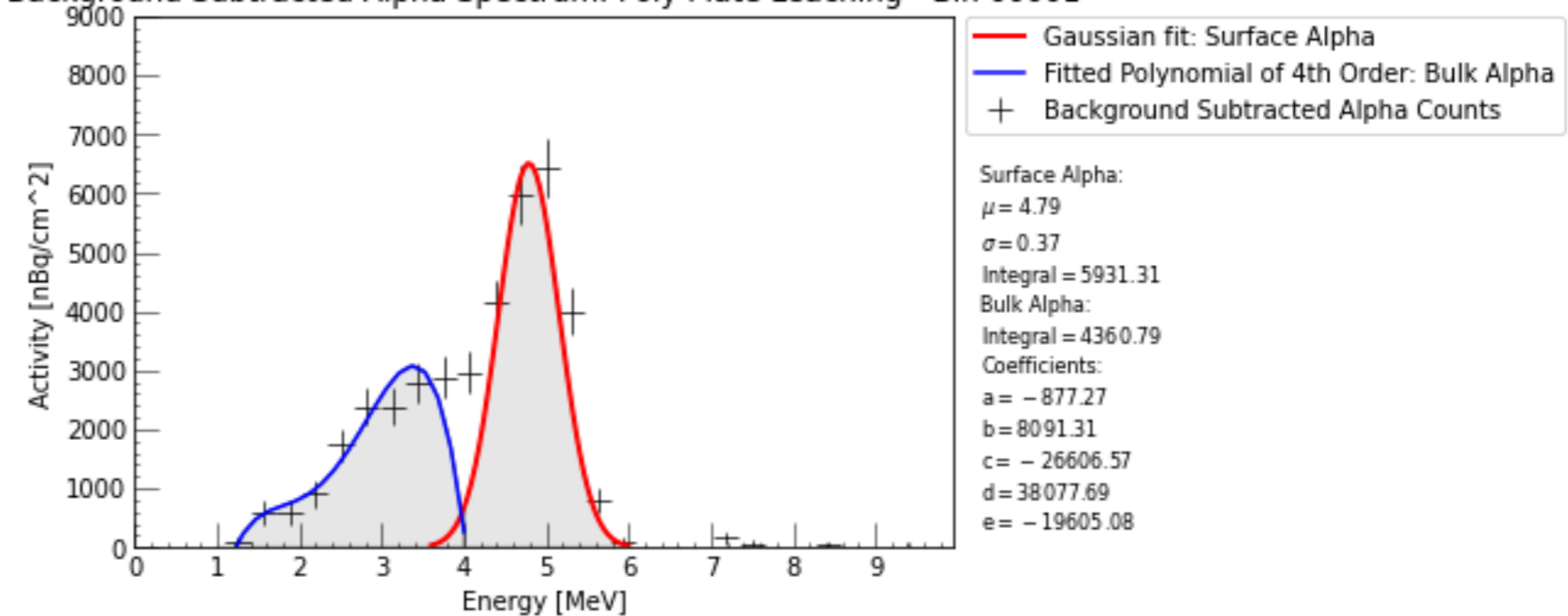
- Between 3-5 MeV Range, the activity levels were:
 - **Baseline:** $38\,611 \pm 1700$ nBq/cm²
 - **Bin 00001:** $21\,106 \pm 910$ nBq/cm²
 - **Bin 00002:** $32\,715 \pm 1400$ nBq/cm²
- Percentage reduction between **baseline** and **samples:**
 - **Bin 00001:** 45%
 - **Bin 00002:** 15%

Analysis Results: Bin 00001 Energy Spectra

Background Subtracted Alpha Spectrum: Poly Plate Leaching - Bin 00001



Background Subtracted Alpha Spectrum: Poly Plate Leaching - Bin 00001



Fitting comparison conducted at **5.3 MeV** for **Rn-222** as compared to **4.8 MeV** for **Th-232**

Thank you, any questions?
