

Nuclear Forensics Sample Identification with Magnetic Microcalorimeters

Ryan Wood

1st year Ph.D. Student, University of Michigan

A.R.L Kavner¹, G.B. Kim², Igor Jovanovic¹

1. Department of Nuclear Engineering and Radiological Sciences, University of Michigan

2. Lawrence Livermore National Laboratory



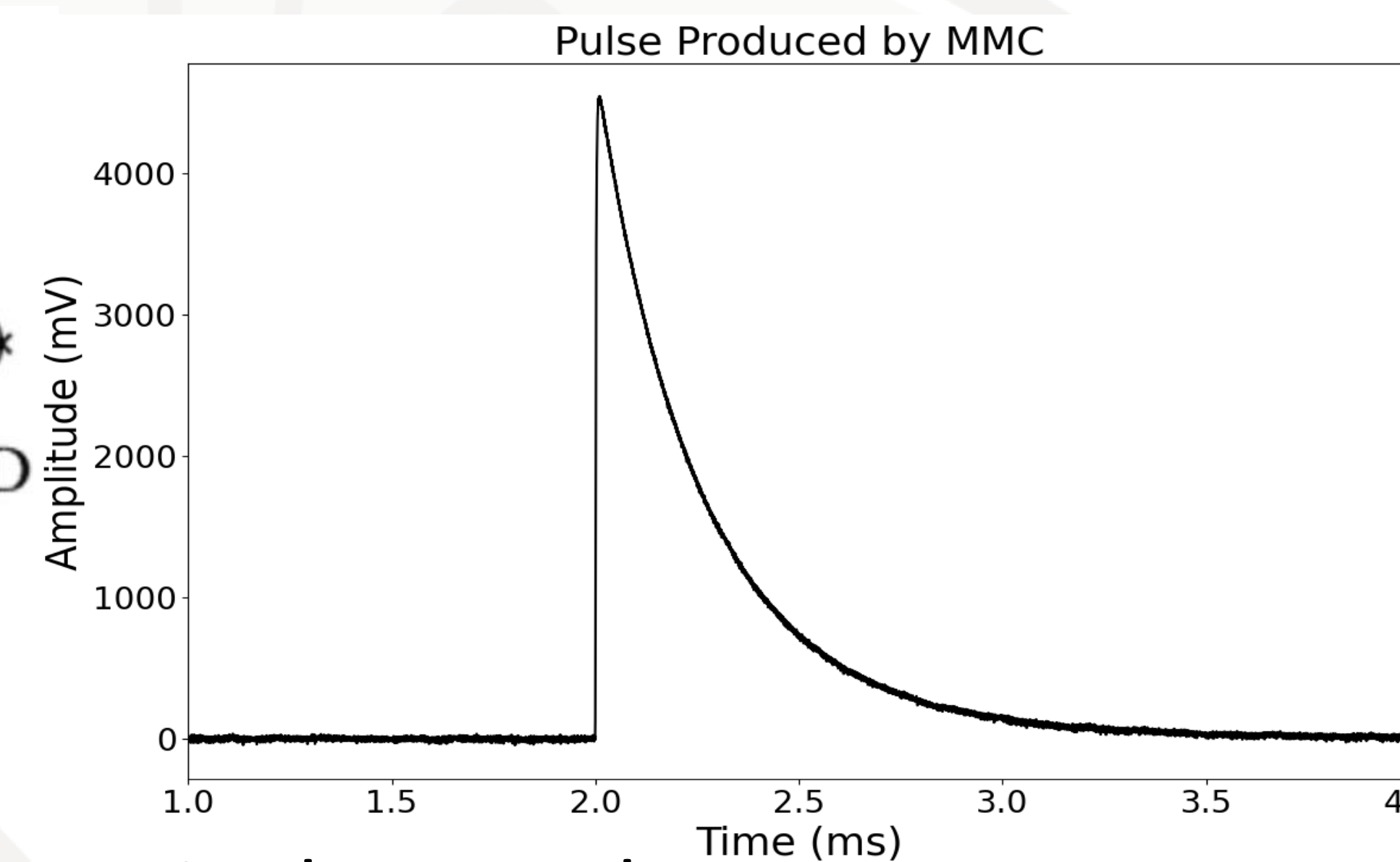
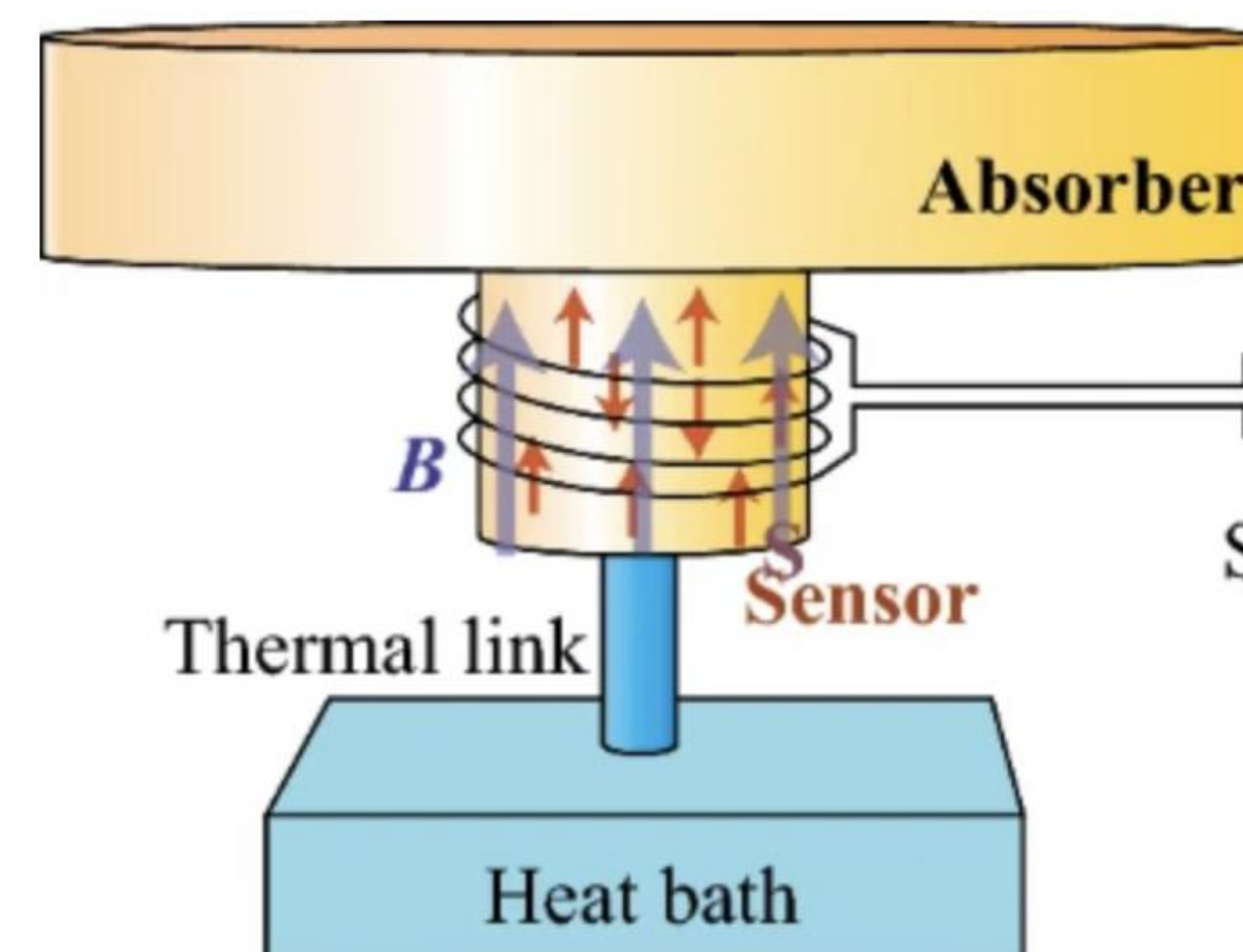
Introduction and Motivation

- Magnetic microcalorimeters (MMC) offer unparalleled energy resolution and can be used to identify radioactive nuclides present in a forensics sample.
- NDA method to analyze safeguards or forensics samples.
- Determine the plutonium or uranium isotopic composition.
- Examine the viability of using MMCs to analyze radioactive samples.

Results

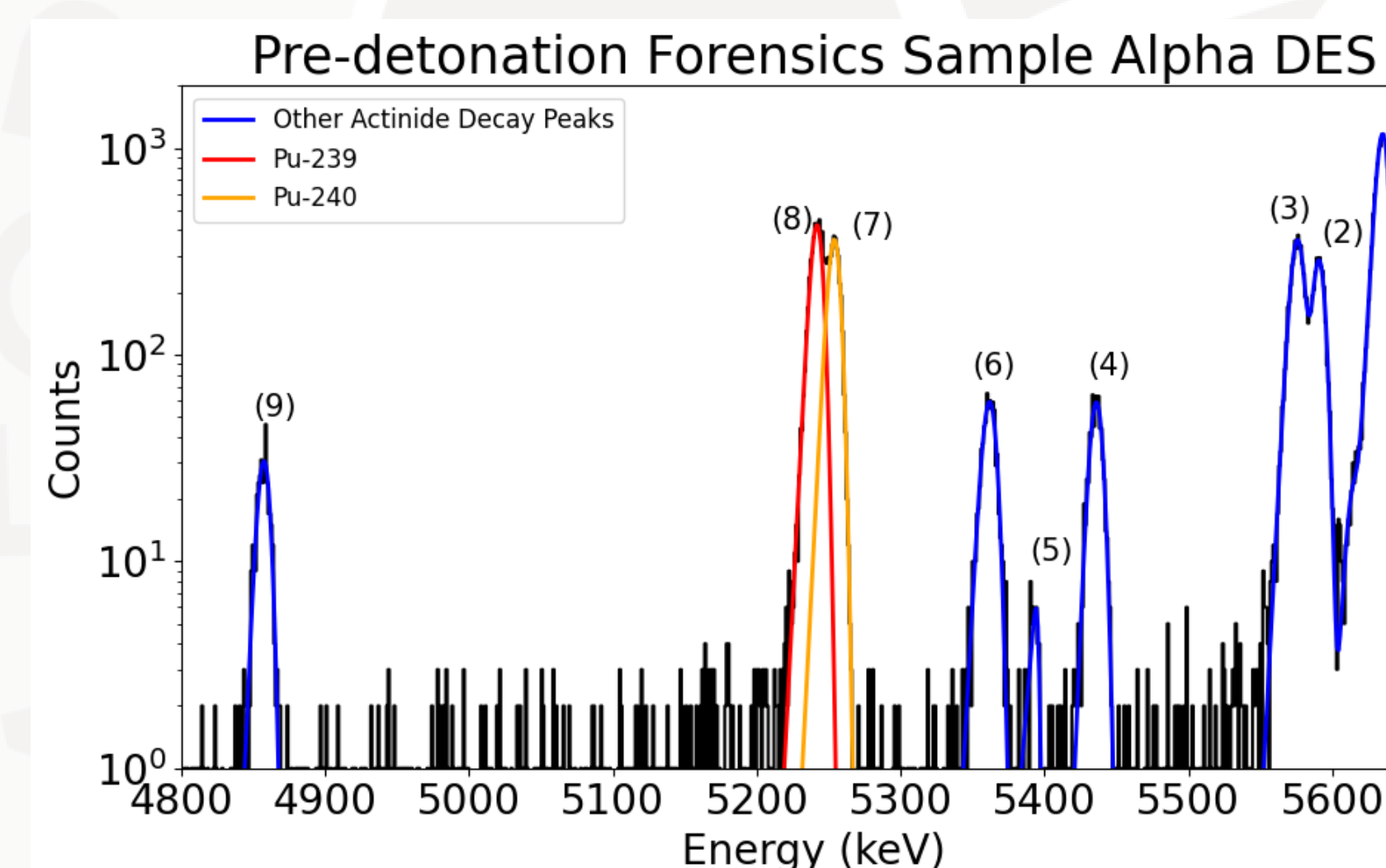
MMC operated at 50 mK

Alpha decay causes a change in the absorber's temperature

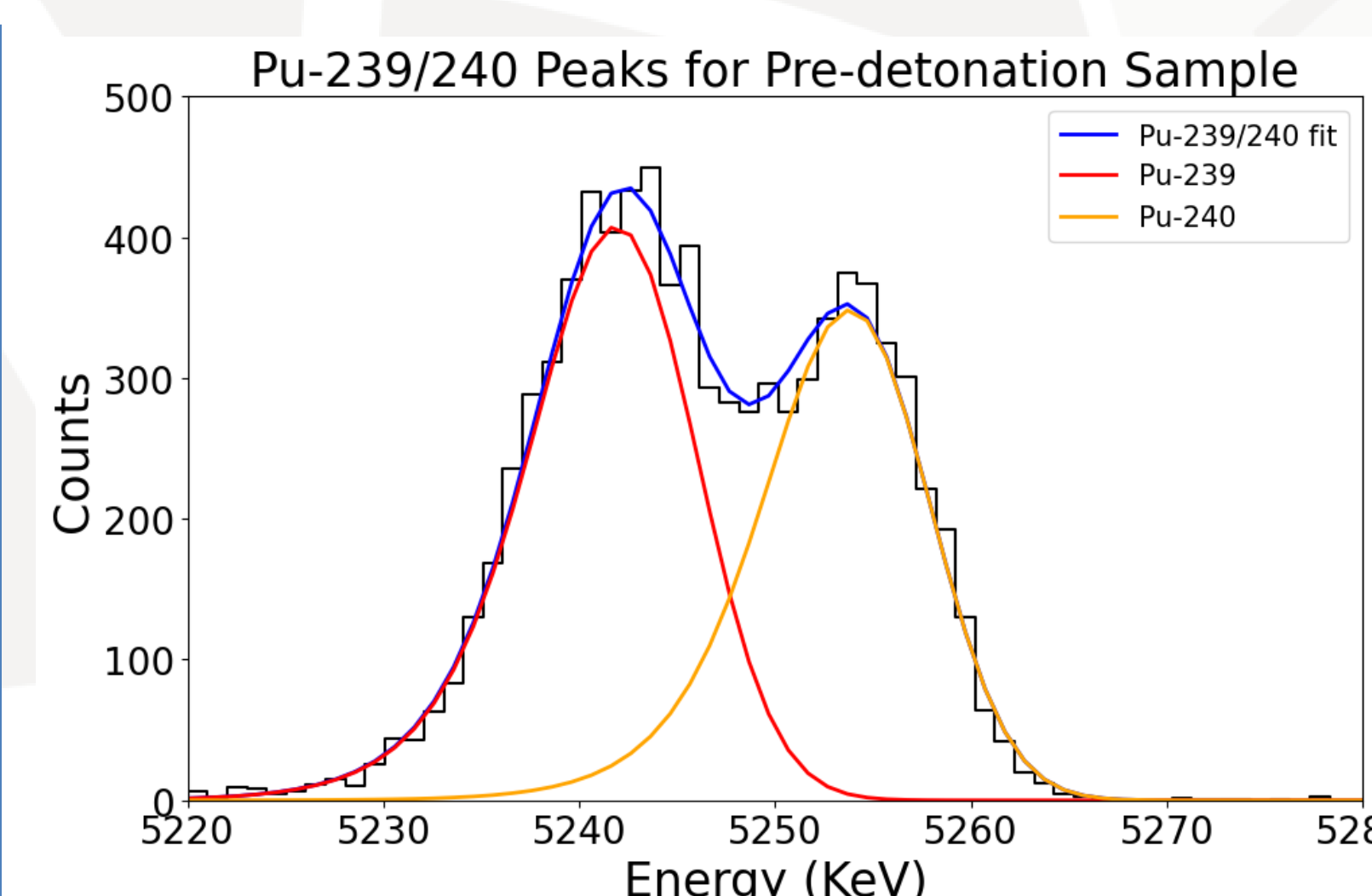


Several actinides are present in the sample.

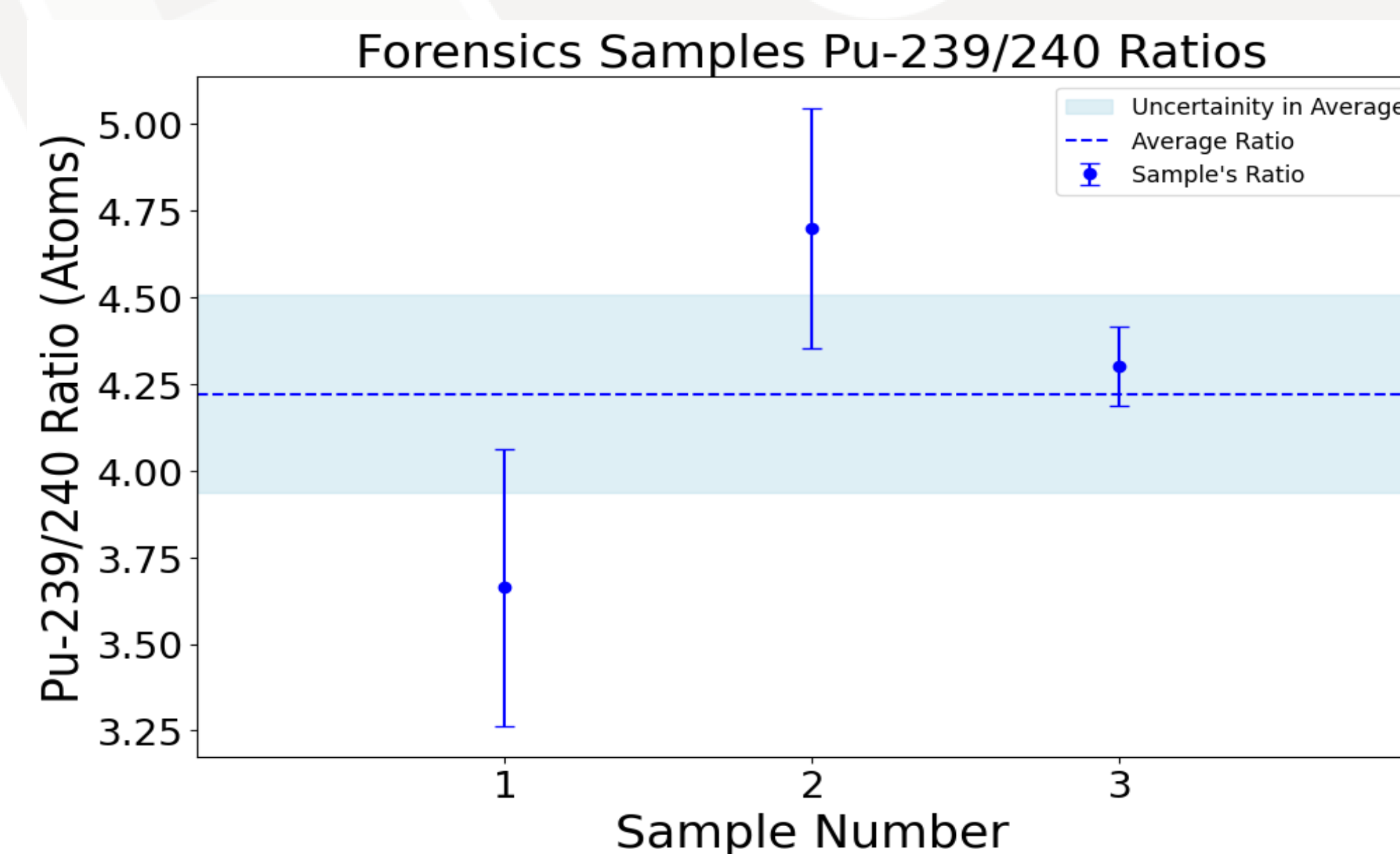
Some actinides produce multiple peaks in the spectrum



Peak	Isotope
(1)	Am-241
(2)	Pu-238
(3)	Am-241
(4)	
(5)	Am-243
(6)	
(7)	Pu-240
(8)	Pu-239
(9)	U-234



Obtained ratio of Pu-239 to Pu-240 for number of atoms in sample for 1 pre-detonation and 2 post-detonation forensics samples



Sample	Pu-239/240 Ratio (Atoms)	Average Ratio
Post-Det 1	3.7±0.4	4.2±0.3
Post-Det 2	4.7±0.3	
Pre-Det	4.3±0.1	

Expected Impact

MMC's have the potential to enable accurate and rapid identification of various alpha-emitting isotopes, along with sample enrichment crucial for safeguarding against nuclear proliferation.

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Impact and Relevance

- Collaborating with LLNL to improve upon MMC detection and sample analysis techniques.
- A novel detection technique for identifying nuclides and assessing sample enrichment with unparalleled resolution, ~8 keV FWHM at 5640 keV.
- Data analysis techniques for pile-up may translate to other detection technologies using in nonproliferation

Conclusion and Future Work

- MMCs have shown promise in identifying alpha-decaying nuclides present in safeguards or forensics samples.
- Ratio of Pu-239 to Pu-240 is obtainable from the high resolution of MMCs
- Obtain mass spectrometry ratio of Pu-239 and Pu-240 and determine viability of using MMCs to determine enrichment
- Intern at LLNL in the near future to gain hands-on experience with preparing and measuring samples with MMCs.

