Calibration of $CeBr_3$ Scintillators for Gamma-ray Spectroscopy in a Zero-power Reactor

Andrew Lucas[1]

3rd Year Undergraduate Student, University of Michigan

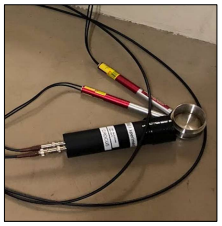
Coauthors: F. B. Darby[1], O. V. Pakari[1], M. Y. Hua[1], V. Lamirand[2], S. D. Clarke[1], A. Pautz[2], S. A. Pozzi[1]

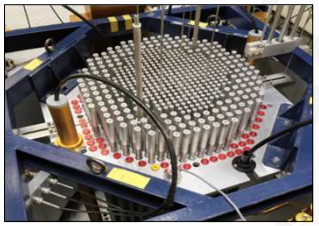
[1] Department of Nuclear Engineering and Radiological Sciences, University of Michigan, Ann Arbor

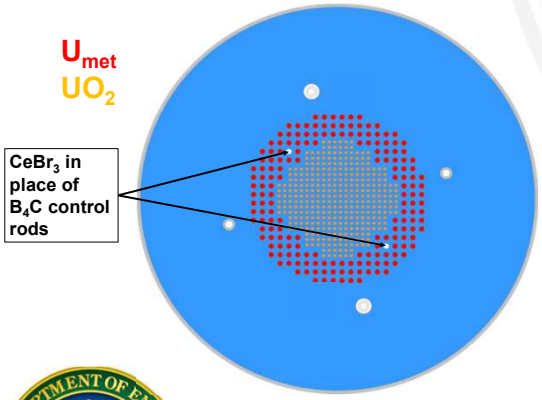
[2] Laboratory of Reactor Physics and Systems Behaviour, Ecole Polytechnique Fédérale de Lausanne

Intro and Motivation

- Reactor monitoring is a useful tactic for nonproliferation
- In this work, we plan to analyze in-core reactor data from the CROCUS zero-power reactor
- To calibrate $CeBr_3$, we measured ^{152}Eu in the setup below

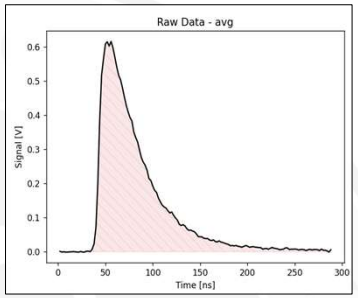




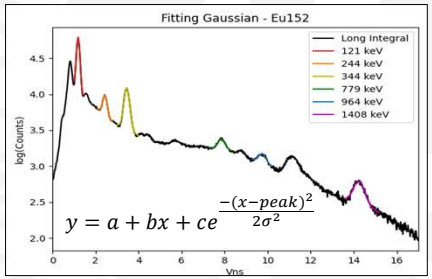


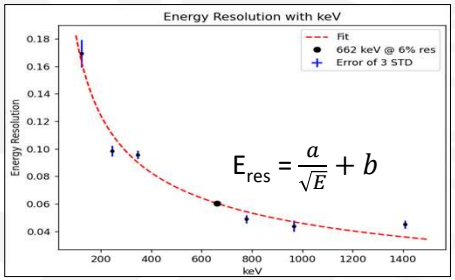
Technical Approach

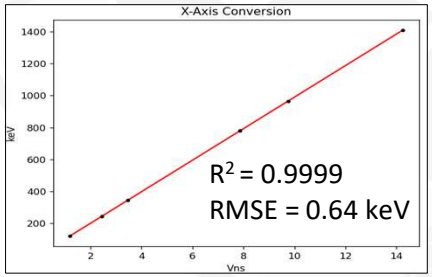
- Our ^{152}Eu data are first in the form of V against ns. Taking the integral of this waveform, we get a value which can be plotted on a histogram
- We then matched the peaks of this histogram (in Vns) using the means of fitted Gaussians, subtracting the Compton continuum underneath, to known peaks of ^{152}Eu (in keV)

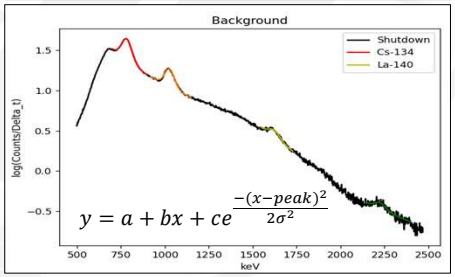


Results









Discussion

- We found a linear relation between the pulse integral and energy, providing a calibration for future work when analyzing our nuclear reactor data from CROCUS
- As a preliminary in-reactor result, we see that our calibration indicates ^{140}La and ^{134}Cs photopeaks. These serve as a measure of recent reactor use, and therefore, possible ways to monitor proliferation

Impact

- Possible future publication on reactor spectroscopy in tandem with organic scintillators
- MTV fosters connection with EPFL
- MTV funded undergraduate fellowship

Conclusion and Next Steps

- We can successfully calibrate $CeBr_3$ detectors for in-reactor gamma spectroscopy
- Future work will include:

  i) Half-life analysis of ^{140}La as well as the analysis/calibration of organic scintillators

  ii) Reactor noise analysis of organic scintillators and $CeBr_3$

This work was funded in-part by the Consortium for Monitoring, Technology, and Verification under DOE-NNSA award number DE-NA0003920

National Nuclear Security Administration