



The Case for Silicon in Beta-Gamma Radioxenon Detectors

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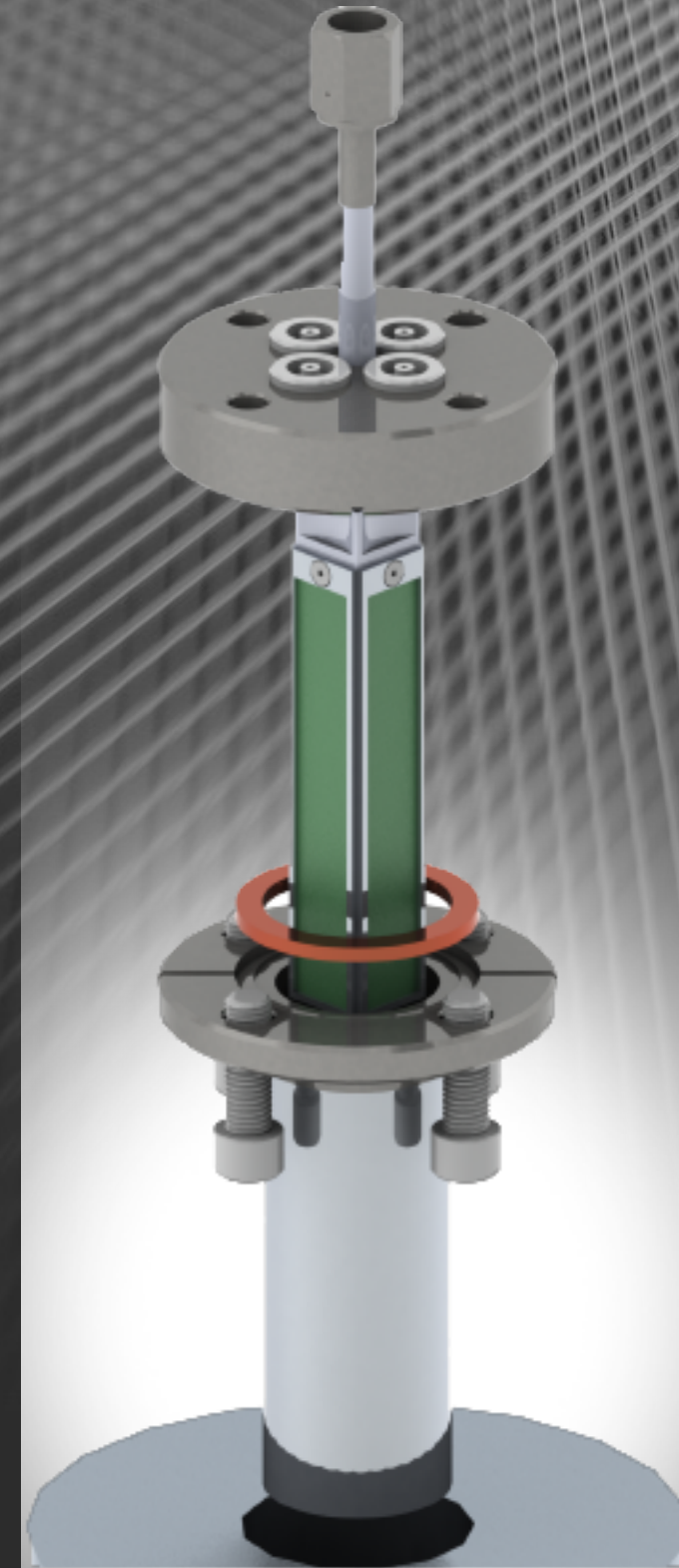
April 28, 2020

Workshop on Signatures of Man-Made Isotope Production (WOSMIP)



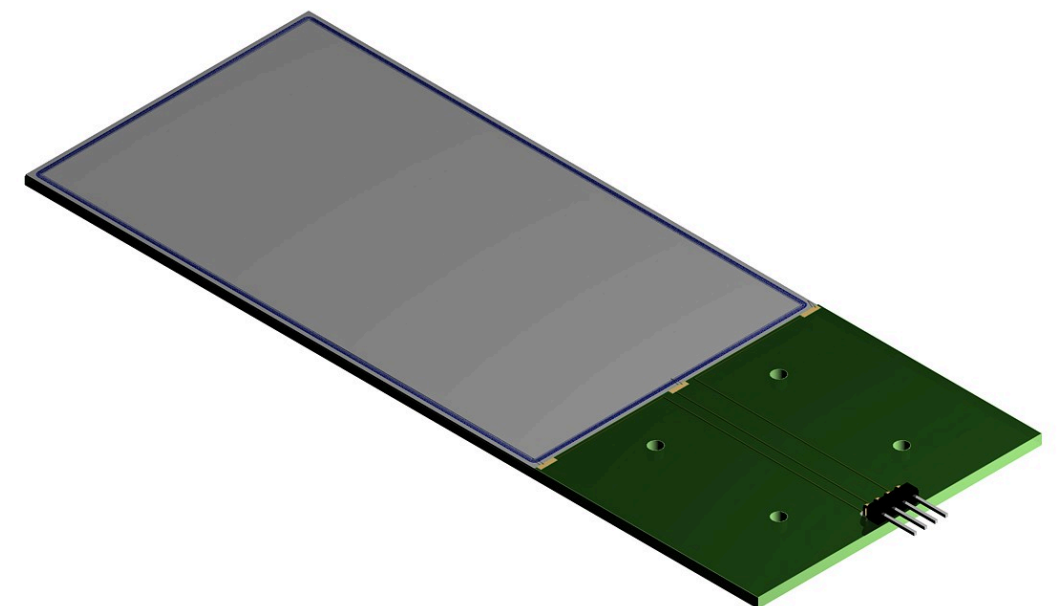
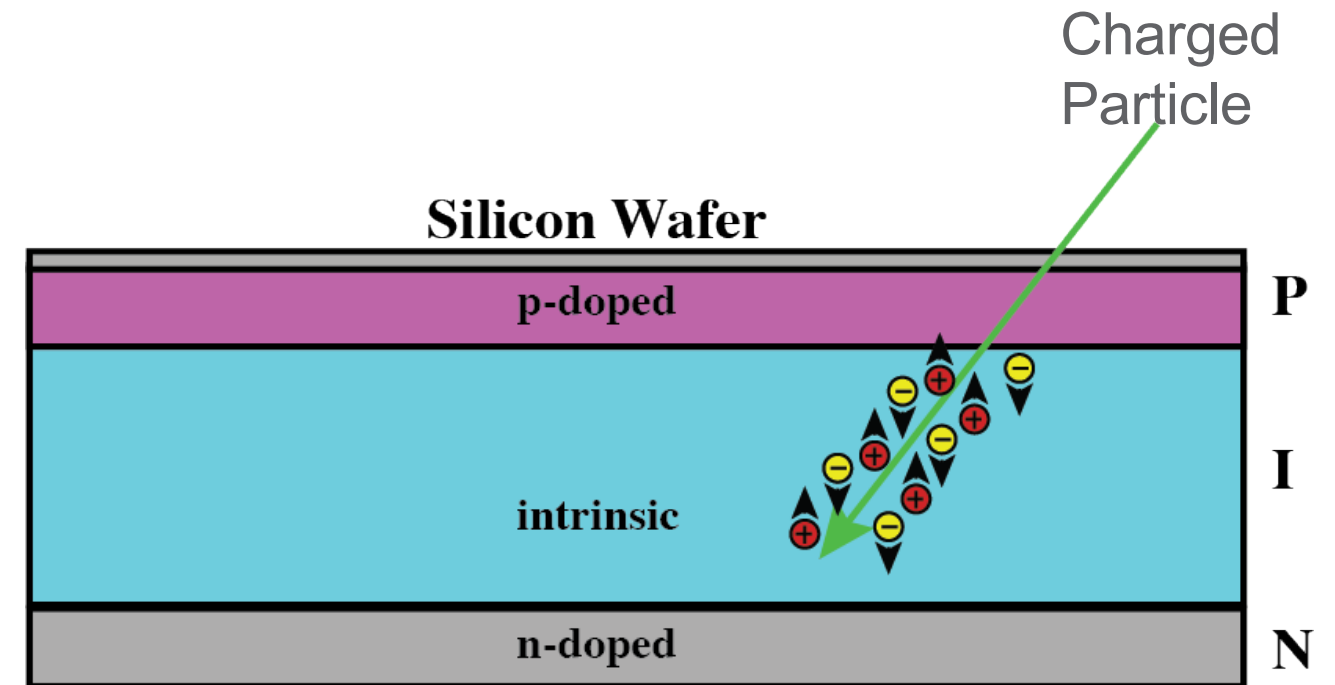
PNNL is operated by Battelle for the U.S. Department of Energy

PNNL-SA-153019



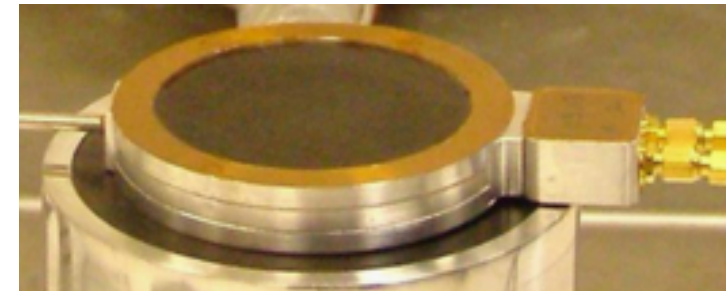
Silicon PIN Detectors

- Semiconductor based-detector
 - Charged particles traversing through Si
 - ✓ High Z material – fully absorbed particle
 - Create electron hole pairs
 - ✓ Typical ionization energy – 1-5 eV
- Available since the 1960 but costly
 - Use in HEP, cameras, satellites, computers
- This project is developing the next-generation beta detector
 - Increased resolution ~10%
 - ✓ Plastic scintillator is ~30%
 - ✓ Improved isotope discrimination
 - ✓ Better detection limits
 - Decreased memory effect
 - ✓ Faster time between measurements
 - ✓ Improve accuracy of measurements

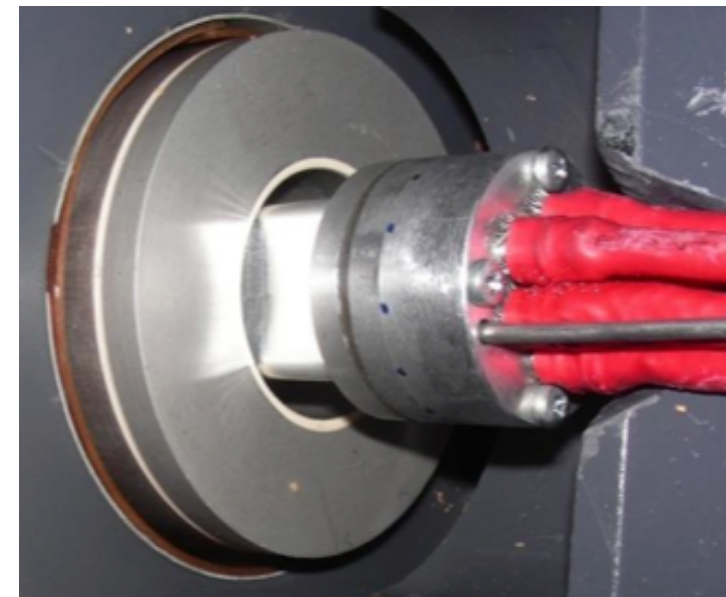


Beta-Gamma Detection with a Si-PIN Beta Cell

- Intrinsic properties of silicon
 - Lower memory effect
 - Higher energy resolution
 - Better detection limits
 - Improved isotopic discrimination
- Two commercially available detectors for current and future radioxenon systems
 - Canberra PIPSBox
 - Lares Ltd-developed
- PNNL version to fit in Xenon International NaI detectors



Canberra PIPSBox

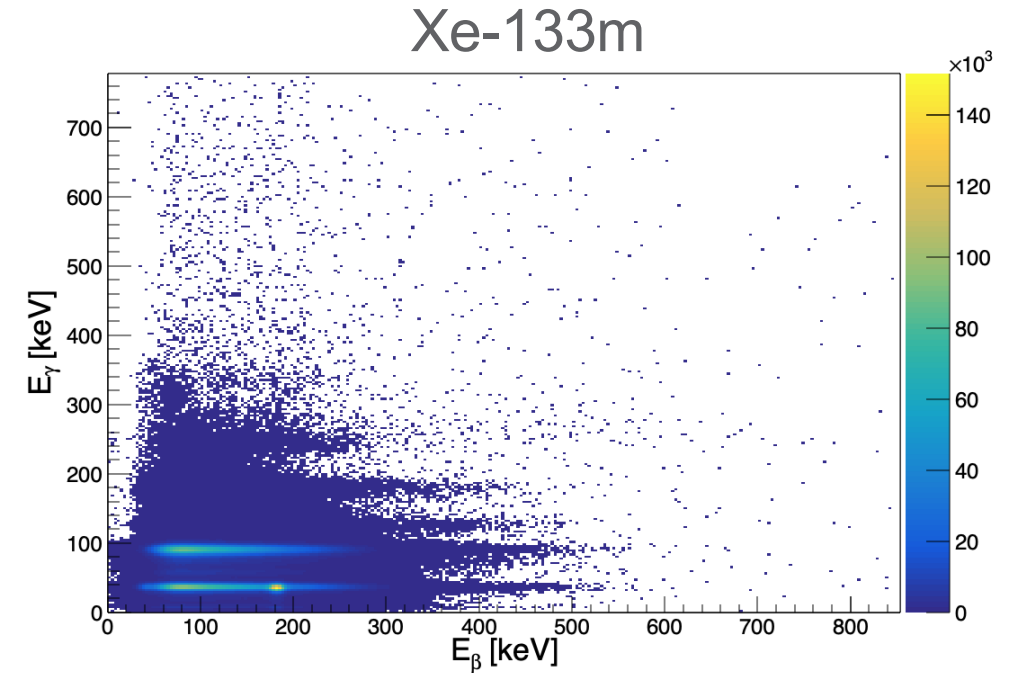
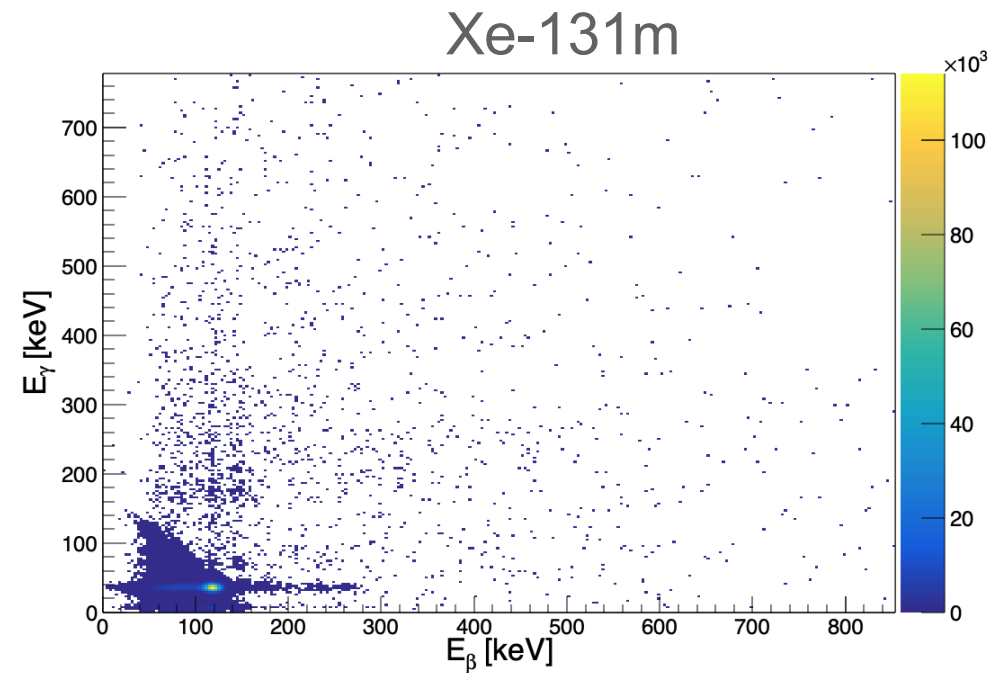
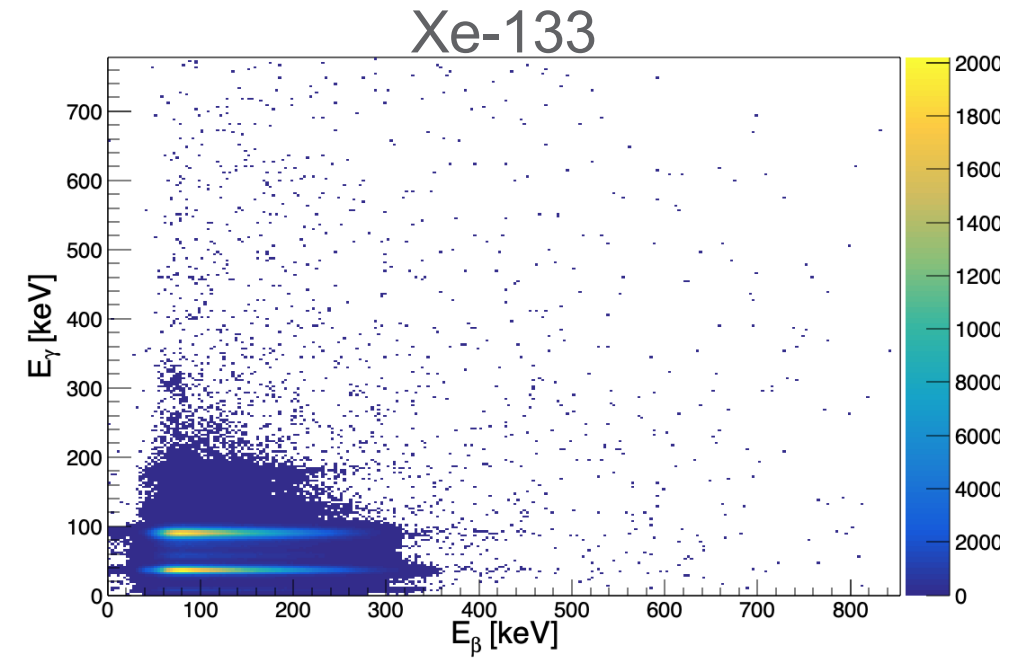
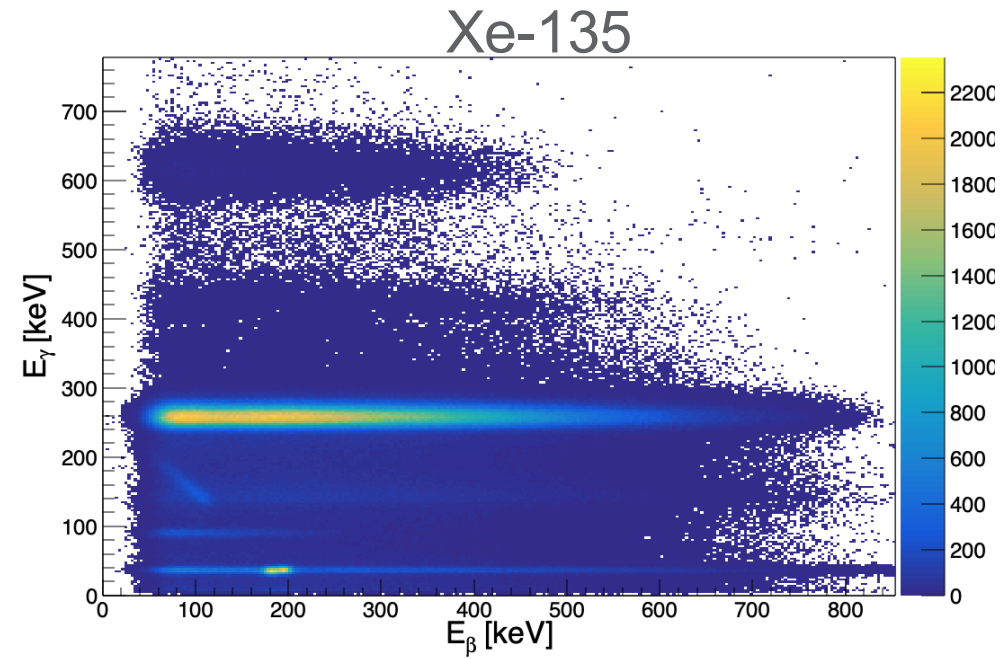


Lares Ltd



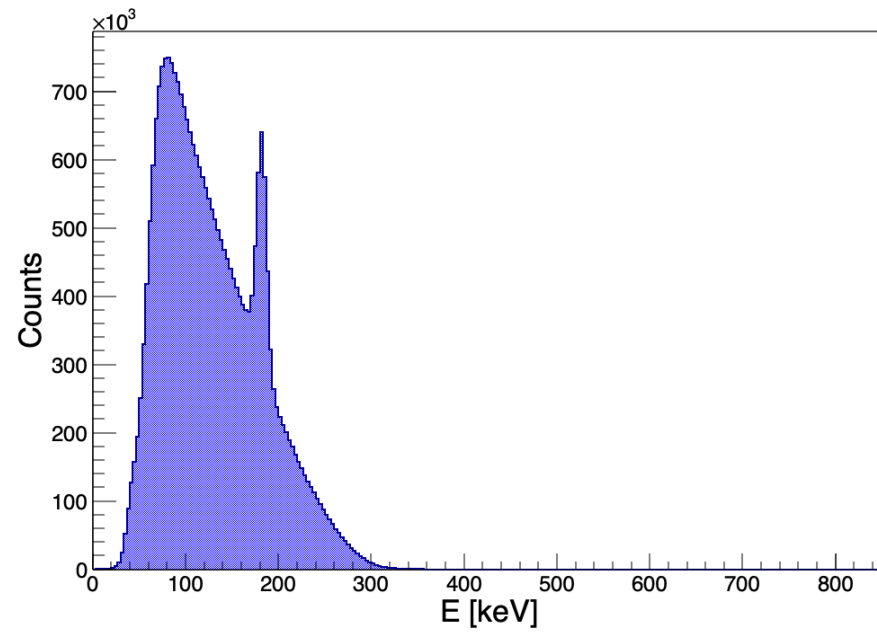
PNNL SiPIN

Initial Silicon Calibration

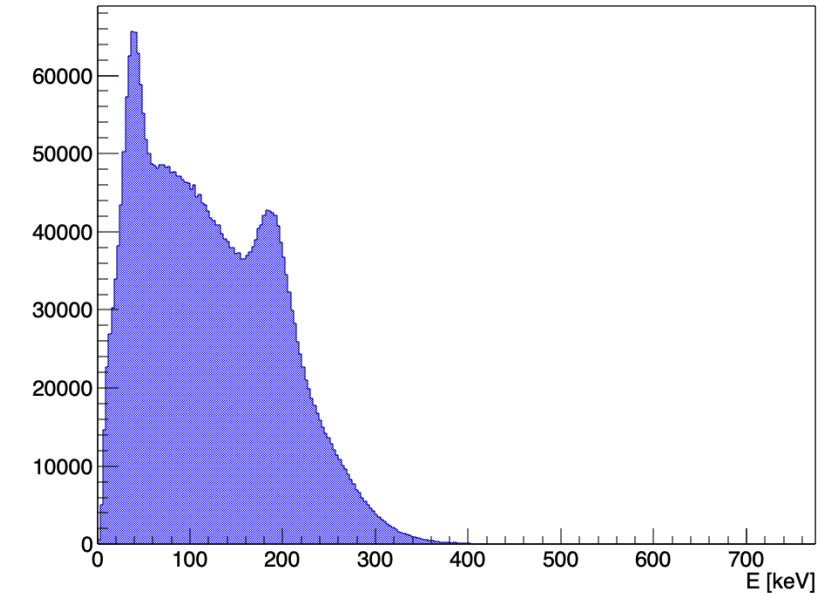


Improved Energy Resolution – Xe-133m

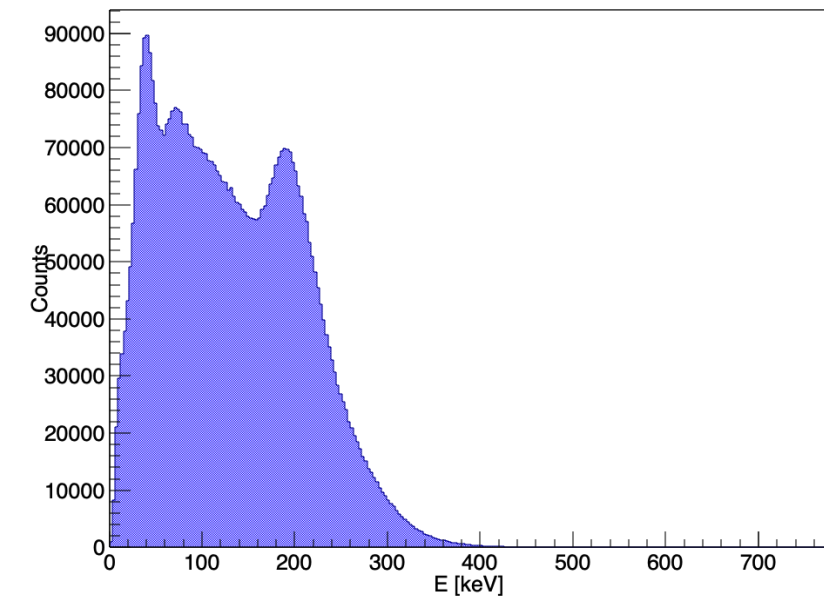
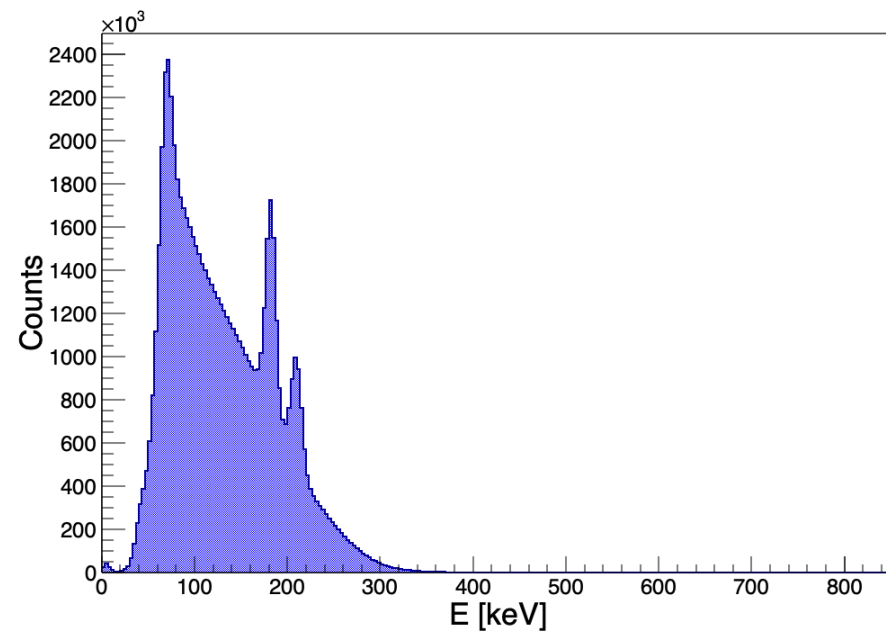
Silicon



Plastic



Beta Coincidence



Beta Singles

Summary and Potential Impact

- PNNL long box design was best for Xenon International configuration
 - Eliminates memory effect
 - ✓ Housing design optimization
 - Commercially available parts
 - Second design iteration is underway
 - ✓ Improved robustness and sensitivity
- Improved isotopic discrimination would allow for sources of radioxenon to be better identified (e.g. reactor versus medical isotope production versus nuclear explosion).
 - Improved energy resolution has demonstrated the ability to better distinguish the metastable conversion electron peaks
 - Still a need to experimentally establish the sensitivity comparison for a variety of activity concentrations



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Thank you