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Neutron Capture Response of EJ-254 and a New Boron-Loaded Organic Glass Scintillator

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Introduction

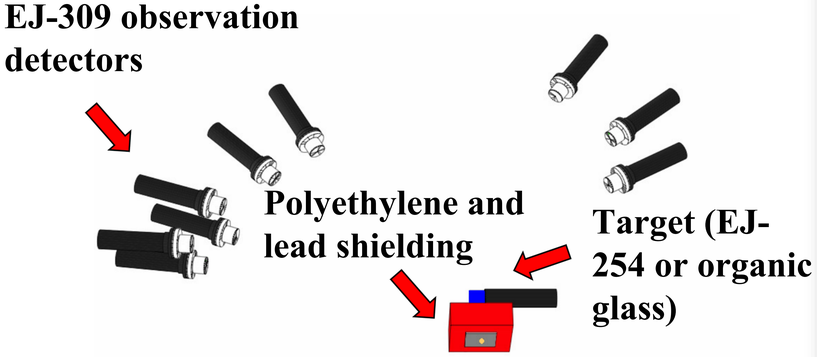
- Organic scintillators doped with boron provide a detectable signal for fast and slow neutrons
- **Slow neutrons** are captured by the boron and produce a lithium ion and an **alpha particle**

$$^{10}_{5}\mathrm{B} + ^{1}_{0}n \rightarrow ^{4}_{2}\mathrm{He} + ^{7}_{3}\mathrm{Li}$$

- With a 94% branching ratio, the lithium nucleus is left in the first excited state and decays via prompt emission of a **477.6 keV gamma ray** which is detected by an array of observation detectors
- Boron-loaded scintillators have applications in antineutrino detection, dark matter search, homeland security, nonproliferation, and neutron capture therapy

Experiment

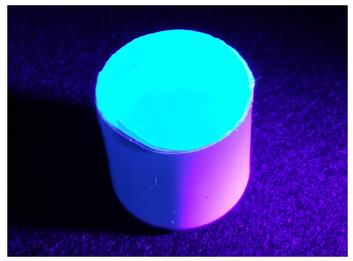
- Organic glass composed of a 90:10 mixture of bis(9,9-dimethyl-9H-fluoren-2-yl) diphenylsilane : tris(9,9-dimethyl-9H-fluoren-2-yl)phenylsilane with .2% bis-MSB and .6% natural boron by weight



Schematic of the experimental setup; target scintillator in blue, AmBe source in gold, lead shielding in gray, and polyethylene moderator in red

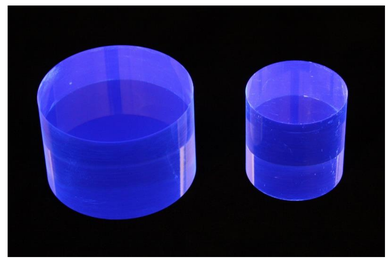
Results

Boron-loaded Organic Glass

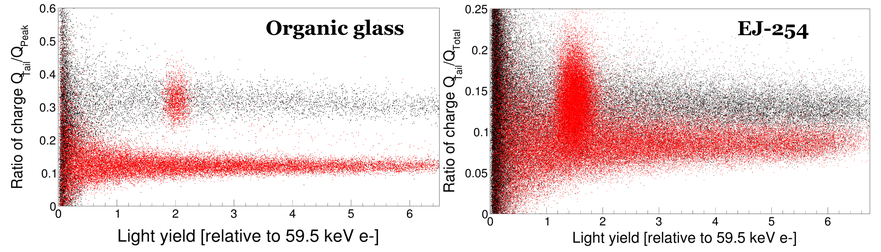


Boron-loaded organic glass developed by Sandia National Laboratories

EJ-254 Boron-loaded Plastic Scintillator



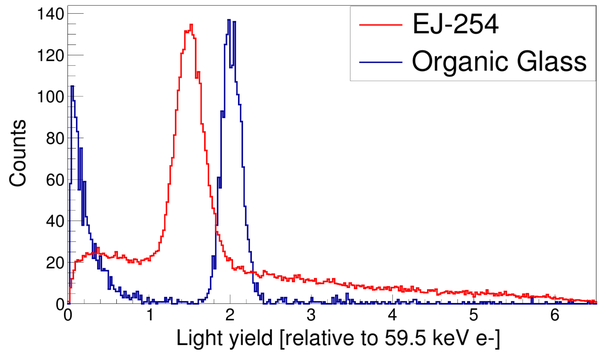
EJ-254 is a commercial boron-doped plastic from Eljen Technology



PSD plots with TOF constraints for both materials. Red points correspond to **neutron capture and γ ray scattering** events; black to **neutron scatters**.

- The neutron capture feature in EJ-254 overlaps with both the γ ray and neutron bands

	EJ-254	Organic Glass
Neutron Capture Light Yield (keVee)	89.4 ± 1.1	120.4 ± 3.7

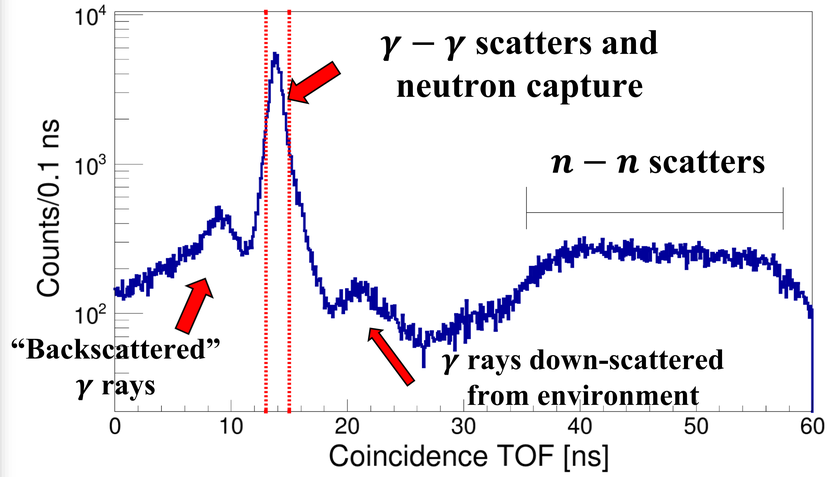


Neutron capture light yield histograms projected from PSD plots (arbitrarily normalized)

- Relative scintillation efficiency of α particles is higher for the organic glass

Coincidence TOF profile

- **Time-of-flight (TOF)** was used to separate $n-n$ scattering events from neutron capture and $\gamma-\gamma$ scattering events



- Events within a 2 ns window (dashed lines) include alpha recoils from neutron capture in the target in coincidence with 477.6 keV γ ray in an observation detector and $\gamma-\gamma$ scatters

Conclusion

- The lower ionization quenching and PSD properties of the boron-loaded organic glass make it a promising alternative to existing materials and a good candidate for a wide range of detection scenarios

Acknowledgements

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