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Sandia National Laboratories

Calibration of a compact recoil spectrometer for experiments on Z

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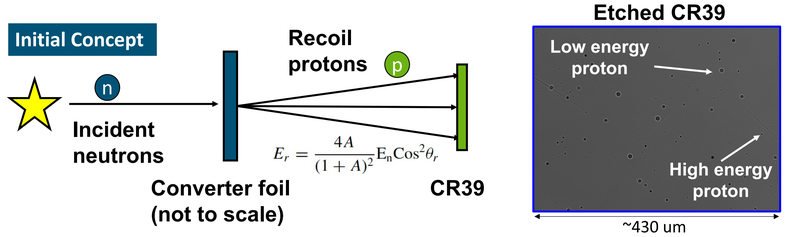
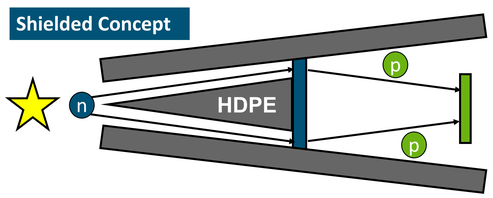
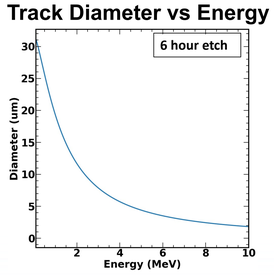
Introduction

- A compact recoil spectrometer (CRS) [1] designed to measure the primary fusion yield and areal density of magnetized liner inertial fusion experiments performed on Z has been calibrated at the Ion Beam Laboratory (IBL) at Sandia National Laboratories
- The diagnostic utilizes a HDPE (C_2H_4) foil which converters incident neutrons into recoil protons which are then measured using a solid-state CR39 nuclear track detector
- The recoil proton energy spectrum is inferred from the proton track diameter distribution present in the CR39 [2,3] and can be related back to the incident neutron energy spectrum
- The CRS was fielded at IBL and was irradiated by 2.45 MeV and 3.0 MeV neutrons

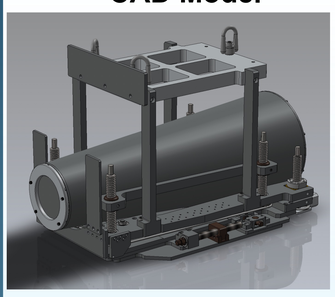
CRS Design



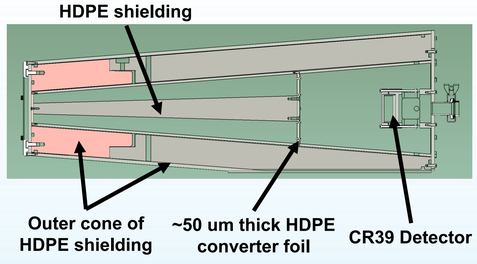




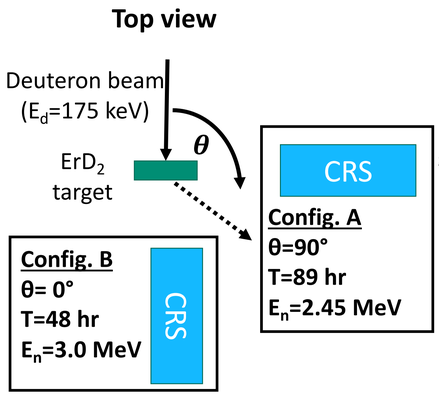
CAD Model

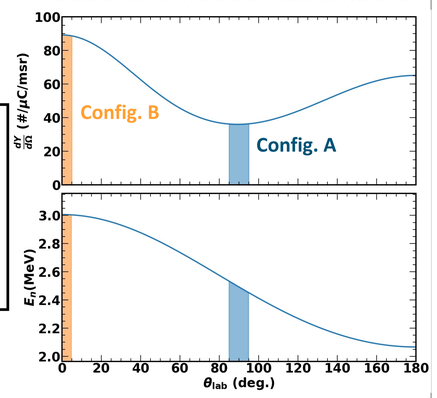


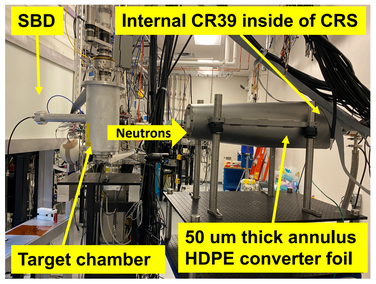
CAD Model Cross Section

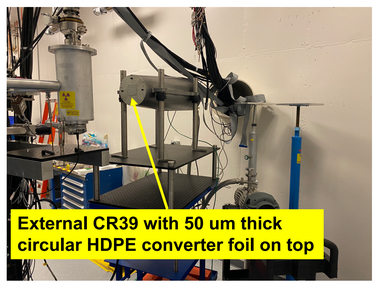


Experimental Configuration

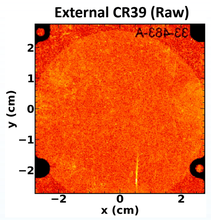


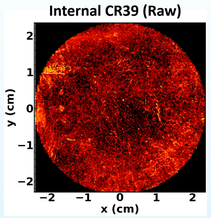


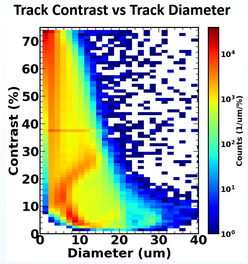




CR39 Data

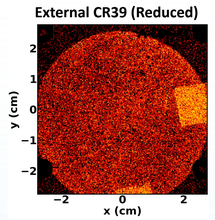


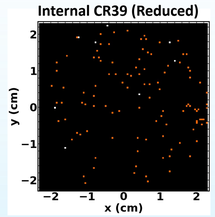




Reduced data selection criteria

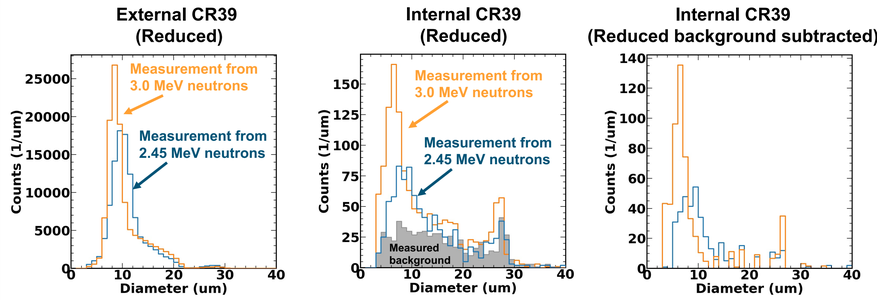
1. Contrast < 8%
2. Ellipticity < 10%
3. Diameter > 3 um



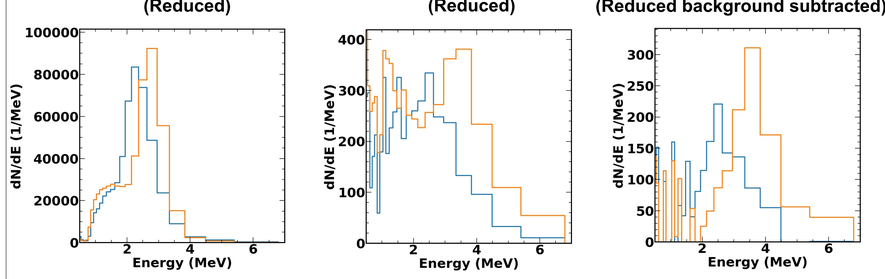


Results

Track diameter distribution data



Inferred proton energy spectra



Conclusions

- A compact recoil spectrometer has been calibrated at the ion beam laboratory in preparation of commissioning the diagnostic for use on the Z machine
- Initial analysis of the measured proton track distributions shows the expected shift between the 2.45 MeV and 3.0 MeV neutron data
- An MCNP model is being developed to accurately model the detector instrument response function and the effect of scattering on the measured signal
- More advanced CR39 analysis techniques [3] will be used in future work to infer the recoil proton energy distribution

References

[1] B. Lahmann, et al., Rev Sci Instrum 91 (7), 073501 (2020).
[2] D. G. Hicks, Massachusetts Institute of Technology, 1999.
[3] B. Lahmann, et al., Rev Sci Instrum 91 (5), 053502 (2020).
[4] C. L. Ruiz, et al., Review of Scientific Instruments 63 (10), 4889-4891 (1992).

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National Nuclear Security Administration

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