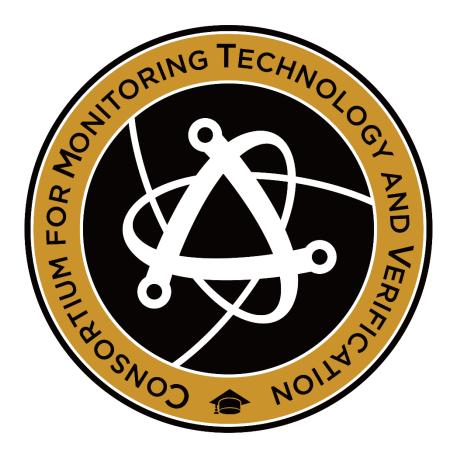
Predicting Angular Momentum of Fission Fragments Using Machine Learning



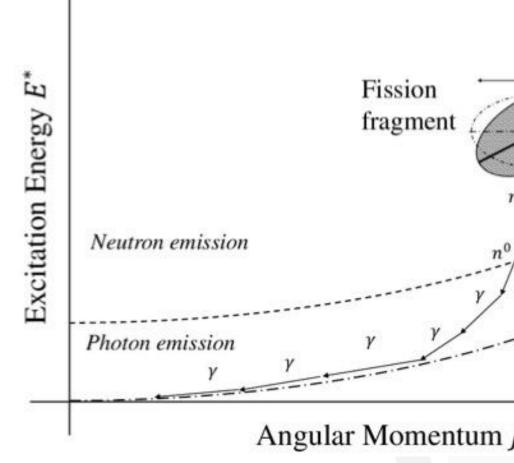
Introduction and Motivation

Daughter fragments in fission are observed to have angular momentum. Understanding the production of angular momentum contributes to:

- Insights on gamma-ray production
- Isotope identification
- NDA screening techniques
- Directional distribution of a particle

The Manchester Spin Method is used to determine angular momentum of a fragment using *discrete* gamma spectra.

Incorporating machine learning techniques will expand analysis to statistical/continuum gamma-rays.



Mission Relevance

NNSA Mission: Preventing nuclear weapons proliferation and reducing the threat of nuclear and radiological terrorism around the world.

Analyzing the gamma ray spectra from the rotation of fission observables will further our understanding of fission in SNM, particularly when it comes to isotope identification and NDA screening techniques. This will contribute to NNSA's nonproliferation objectives.



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Yrast Band



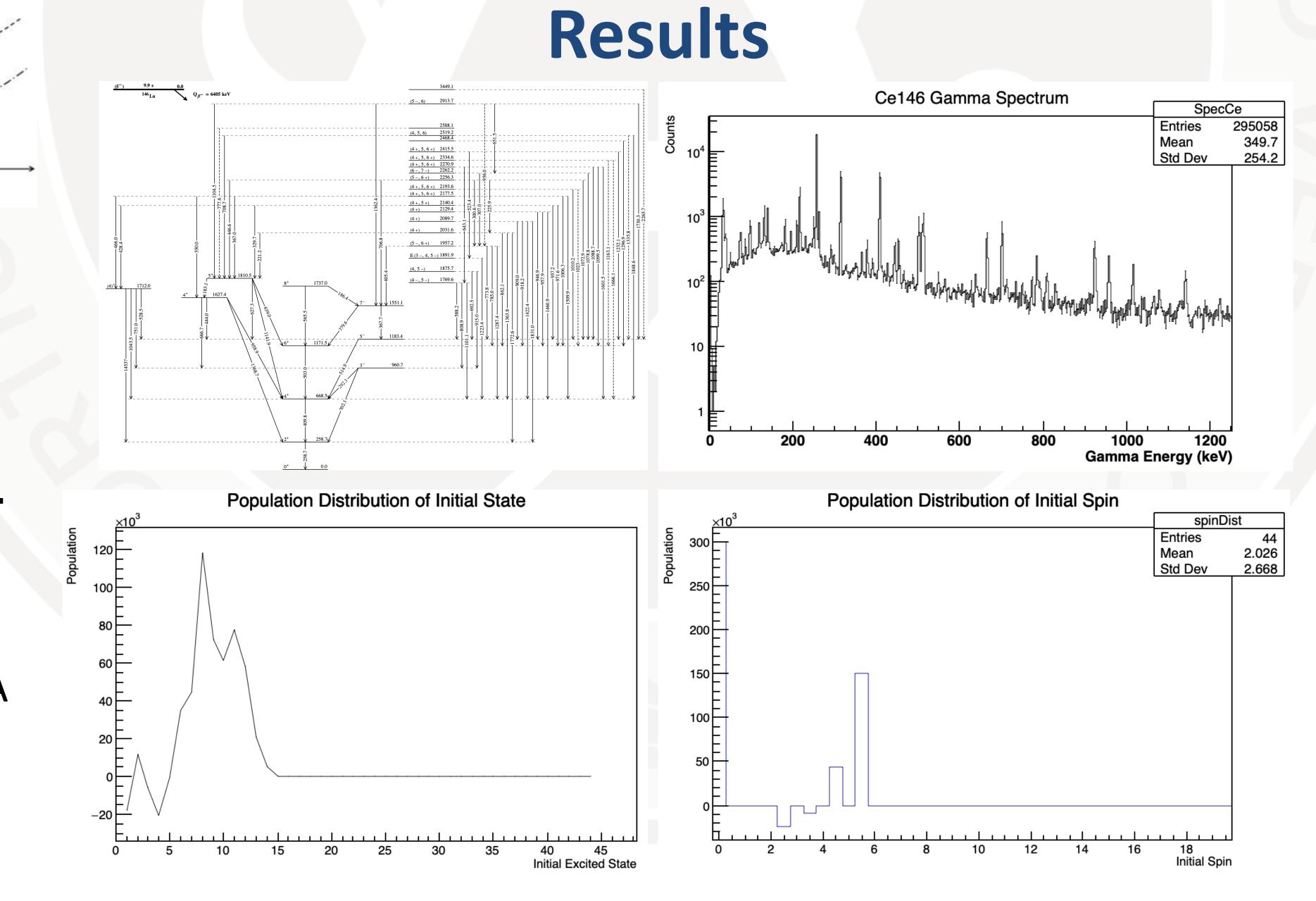
Verify the MSM initial level and spin population distribution

Inputs: ENSDF level scheme, gamma spectrum Outputs: E_v matrix, GSF matrix, initial level/spin population distribution Verified by simulated and experimental data

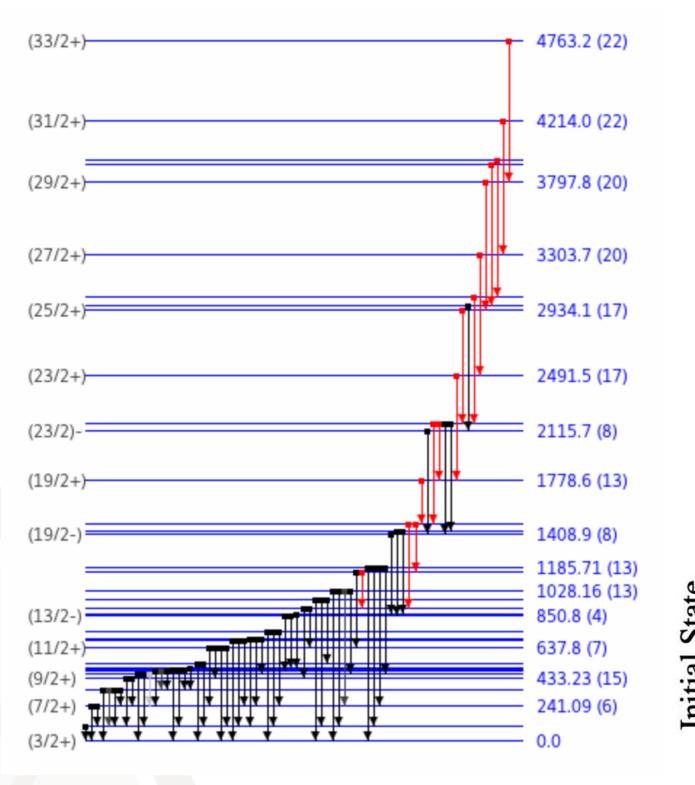
Use RAINIER to isolate and analyze statistical gamma-ray data

RAINIER generated gamma spectrum, neutron and gamma-ray energy/multiplicity

3. Develop machine learning script to reconstruct angular momentum distributions Training set: RAINIER generated time-dependent event list



Experimental data from ANL Gammasphere using ¹⁴⁶La beta-decay to ¹⁴⁶Ce This work was funded in-part by the Consortium for Monitoring, Technology, and Verification under **Department of Energy National Nuclear Security Administration award number DE-NA0003920**



National Laboratory Collaborations: **Argonne National Laboratory** Gammasphere Lawrence Berkeley National Laboratory **RAINIER Simulation Tool** MTV MCNP/MCNPX-PoliMi Workshop

This work shows the validity of the MSM to determine a fragments initial spin distribution, and includes preliminary work that incorporates statistical contributions towards the angular momentum of fission fragments Future work includes:

- analysis





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MTV Impact

Conclusion

Modifying RAINIER for event-by-event

Creating analysis algorithms to determine spin distributions of fragments

