Correlations Between γ-ray Multiplicity and Incident Neutron Energy in $^{239}\mathrm{Pu}(n,f)$

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Introduction and Motivation

Correlations between gamma radiation released in nuclear fission and incident neutron energy are virtually unknown. They are important for nuclear data for fission applications and insights into the fission process for producing better fission models

Nuclear Data

- Gamma-ray heating in fast fission systems
- Improving evaluated data libraries

Modeling Fission

- More accurate signatures in simulations for instrument development for nonproliferation
- Detailed models for stockpile stewardship
- **CGMF** (LANL), **FREYA** (LLNL)

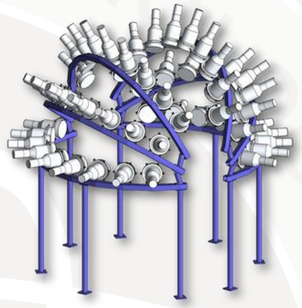
Mission Relevance

- Help prevent proliferation by providing accurate signatures for special nuclear material
- Maintain the U.S. stockpile through detailed simulation capabilities
- Support the next generation of nuclear reactors with data on gamma-ray heating from fast fission

Technical Approach

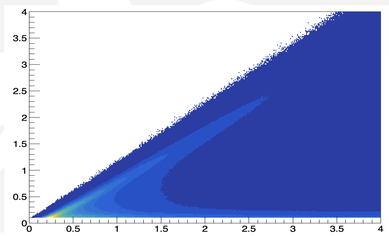
Experiment

- Broad spectrum neutron beam at Los Alamos Neutron Science Center
- Pu-239 foils in ion chamber
- Chi-Nu organic scintillator array



Analysis

- Isolate fission events ✓
- Calculate incident neutron energy with time-of-flight ✓
- Invert system response matrix to unfold emitted gamma-ray multiplicity and gamma-ray spectrum ✓

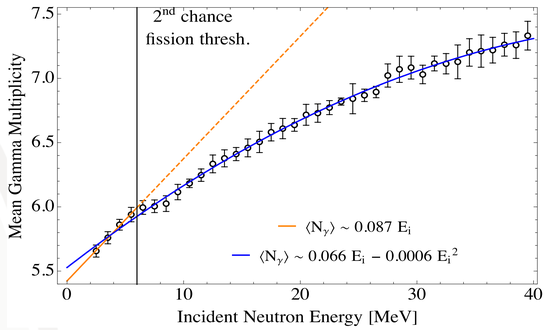


MTV Impact

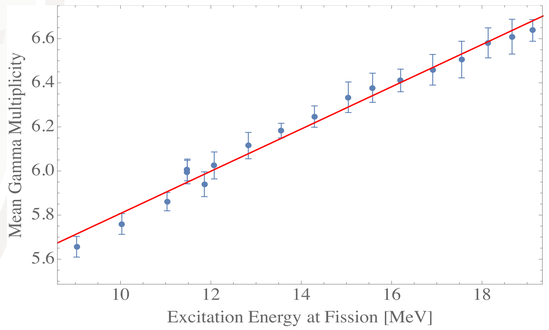
- Collaboration with scientists at LANL
  - Experimental corrections
  - Interpreting the complex data set
- Discussions with expert theorists at LANL and LLNL
- Follow-up experiment (ongoing!) at Argonne National Lab

Results

- We measured gamma-ray multiplicity for incident neutron energy up to 40 MeV
- Mean multiplicity increases by less than 1 per 10 MeV of incident energy



- Transforming to nuclear excitation energy reveals approximately linear relationship



Conclusion & Impact

- We measured gamma rays emitted by $^{239}\mathrm{Pu}(n,f)$ and observed a multiplicity increase with incident neutron energy
- These results will improve nuclear data and help theorists develop better fission models to advance NNSA missions

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