LA-UR 17-

USNDP LANL Report

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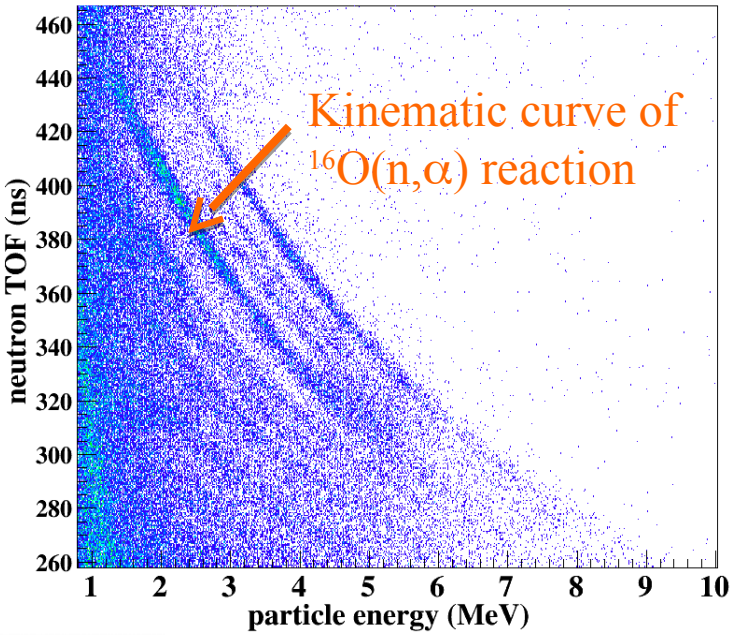
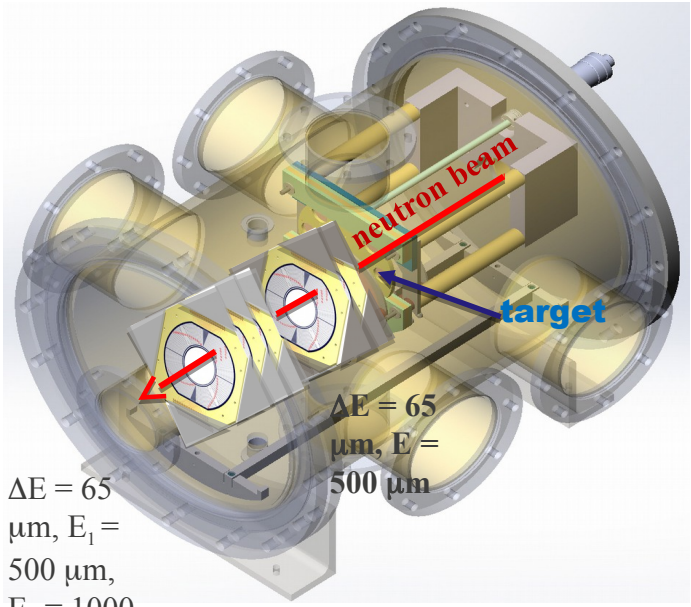
Personnel Changes and National / International Activities

- **Staff Members and Post-Docs**
  - M.R. Mumpower became a staff member of T-2 in Aug. 2017
  - M. Verriere, a new postdoc, hired by T-2 in Sep. 2017 (FIRE collaboration)
  - T. Kawano sabbatical leave at Tokyo Inst. Tech. Jan - May, 2017
- **Conference Organized and Plans**
  - Int. Workshop on Fission Experiments and Theoretical Advance FIESTA 2017
  - Int. Conf. Nuclear Reaction Mechanisms, Varenna, Italy, June 2018
- **IAEA CPRs and Meetings**
  - Cross section standards (G. Hale)
  - Strength function and photo-nuclear data library (T. Kawano)
  - Reference input parameter library, RIPL-4 (T. Kawano)
- **FIRE (Fission In R-process Elements) Topical Collaboratior**
  - Funded by DOE/SC and NNSA
  - LLNL (leading), LANL, BNL
  - University of Notre Dame, North Carolina State University
  - Collaboration meeting at LLNL in June 2017

Low Energy (n,z) (LENZ): Direct Measurements of (n,p) and (n,α) Cross Section at LANSCE

- Designed for measuring (n,z) reactions with a large solid angle and low detection threshold for various applications
- Twin Frisch grid ionization chamber coupled with silicon strip detectors to measures angles and charged particles as a telescope
- GEANT4 simulation forward propagation analysis performed for ^{16}O





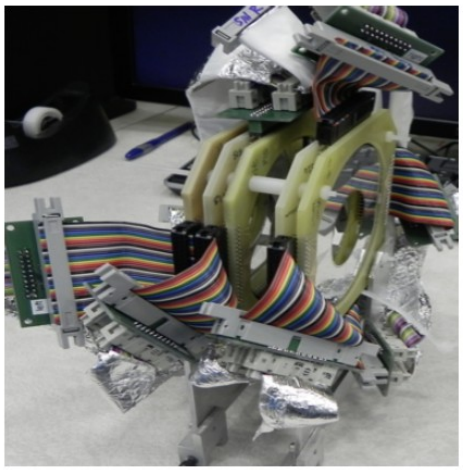
ΔE = 65 μm, E_1 = 500 μm, E_2 = 1000 μm

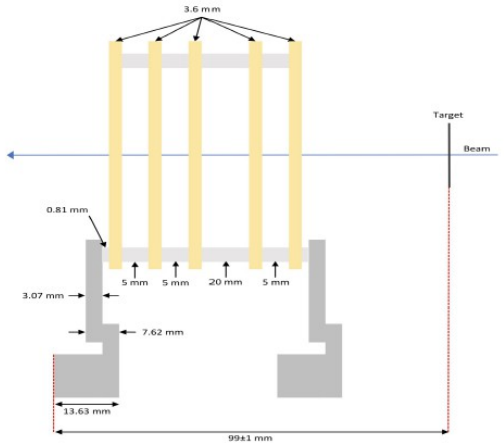
Low Energy (n,z) (LENZ): Direct Measurements of (n,p) and (n,α) Cross Section at LANSCE

- In understanding a materials response under an intense neutron flux, neutron induced cross-sections on each of the composite isotopes must be well known.
- Manganese, to some fraction, is persistent is all commercial steels.
- Current evaluations, along with previous measurements show discrepancies in the 14 MeV region for (n,) and the 6 - 14 MeV region for (n,p).

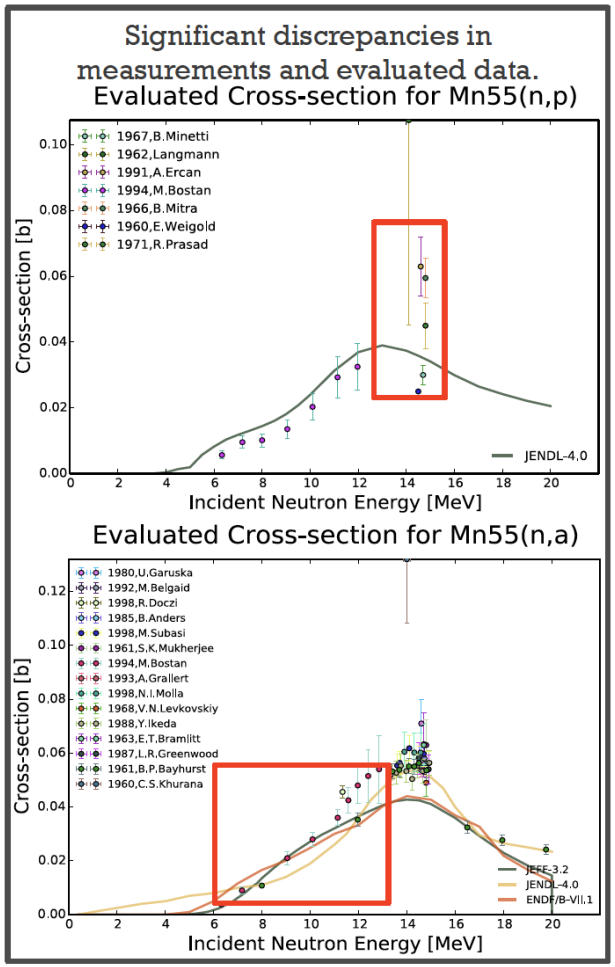
  Goal: Perform high precision measurements of ^{55}Mn(n,p) and ^{55}Mn(n,) over a wide range of incoming neutron energies (E_n = 6 – 18 MeV).

Experimental setup included 5 DSSD silicon detectors.



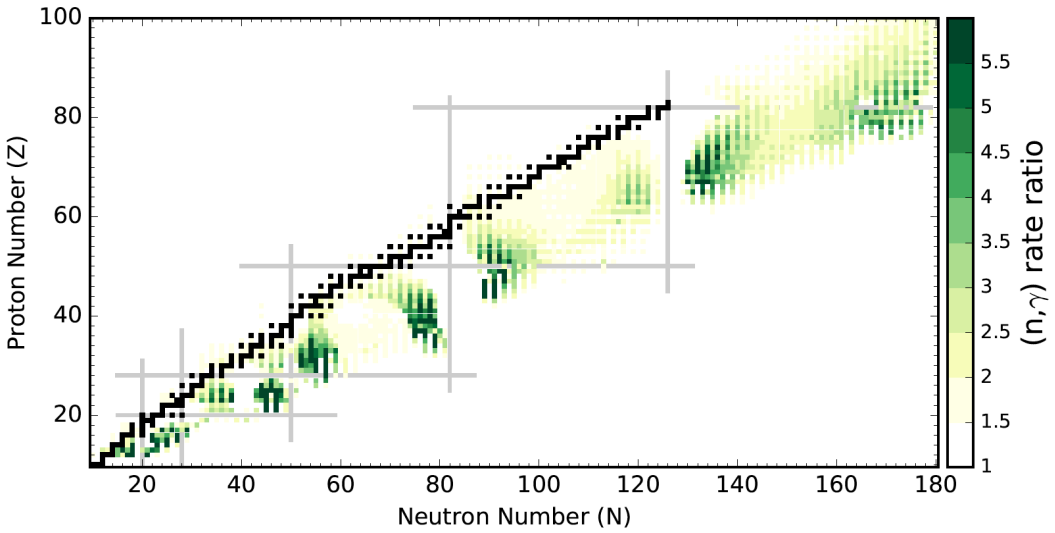


Significant discrepancies in measurements and evaluated data.



Nuclear Reaction Theory and Modeling Highlights

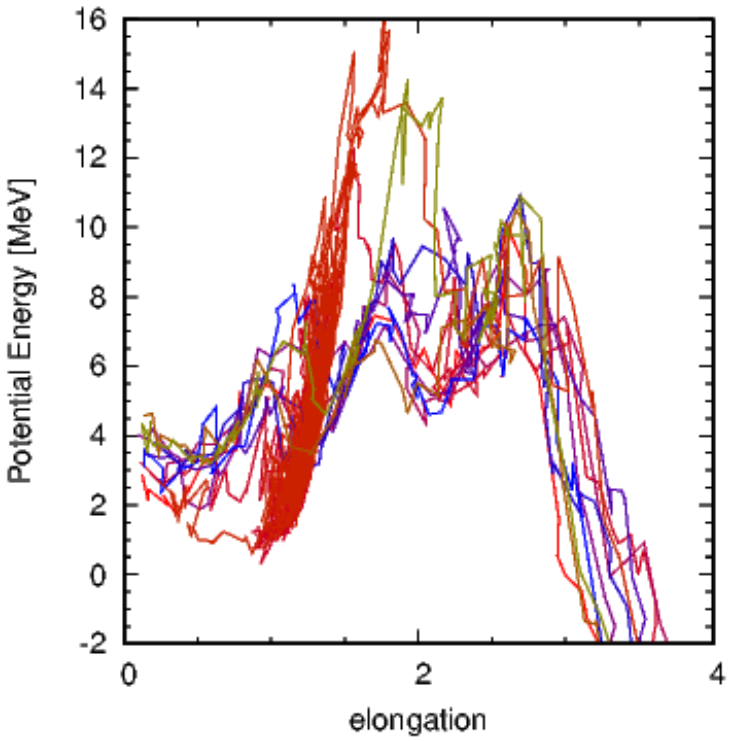
- **Estimation of the M1 photon strength function (scissors mode)**
  - Mumpower, et al. PRC **96**, 024612 (2017)
  - Applied to DANCE data (actinide region), two publications
  - Baramsai, et al. PRC **96**, 024619 (2017
  - Ullmann, et al. PRC **96**, 024627 (2017)
- **Dynamical fission study with FRLDM**
  - Grid-free random walk technique developed
  - Neutron and proton number distributions with the single-particle densities

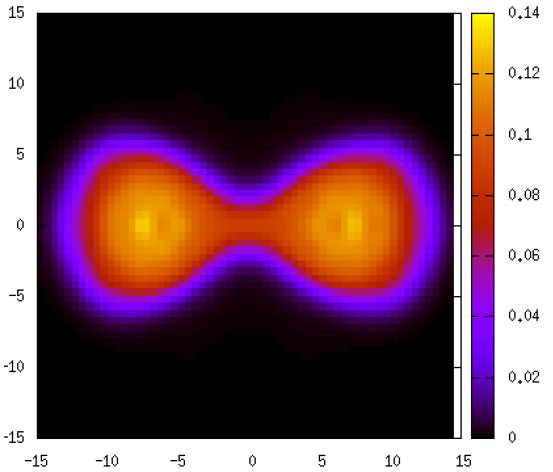


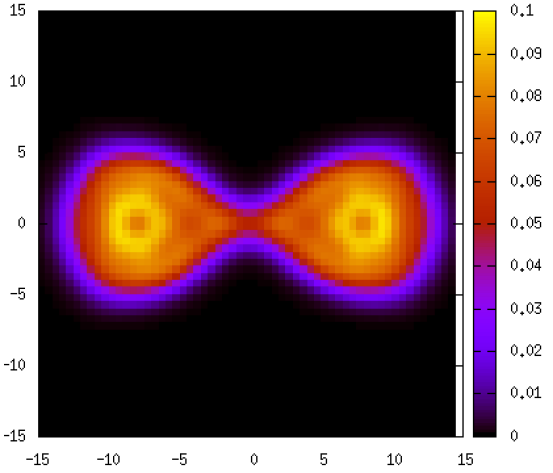
- **Deterministic Hauser-Feshbach statistical decay of fission fragments**
  - Consistent description of many fission observables
  - Toward new evaluations of
    - prompt fission neutron spectrum
    - fission product yields (independent and cumulative)

Grid-Free Random Walk for Dynamical Fission Model

- Finite Range Liquid Drop Model (FRLDM) for the potential energy surface
- The lowest fission path gives the saddle point and fission barriers
- At the scission point, the mass and charge distributions can be calculated

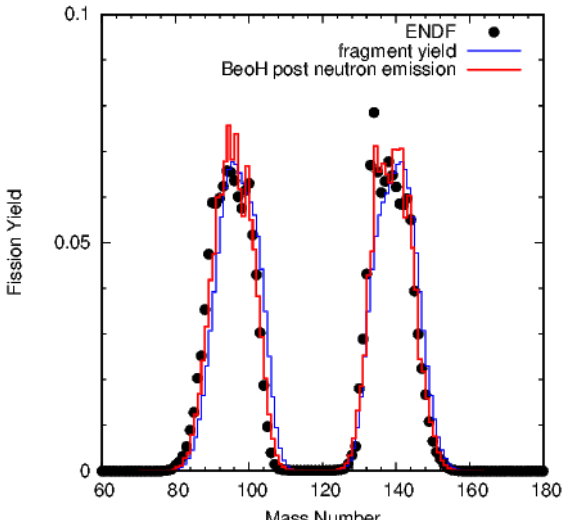


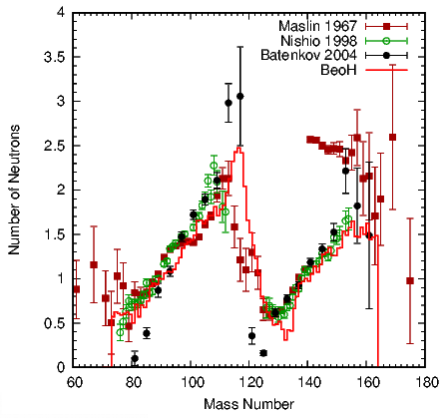


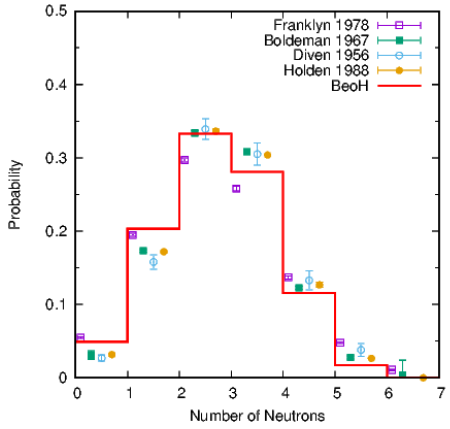


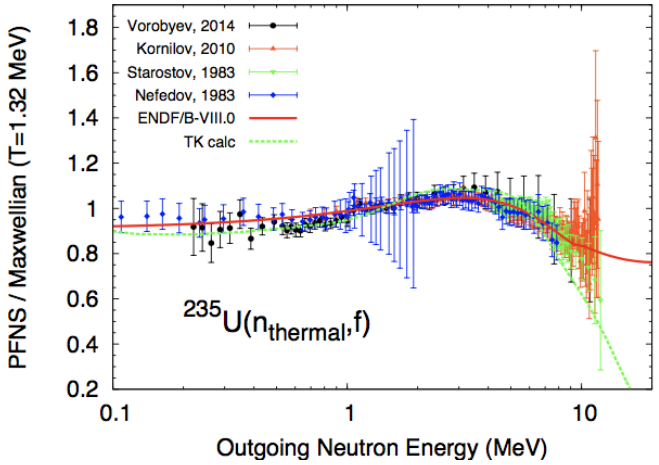
Deterministic Fission Fragment Decay Model

- Instead of performing a Monte Carlo Hauser-Feshbach decay, like CGMF, a numerical integration is performed for all the initial fragment configurations (excitation energy, spin, and parity distributions)
- This technique gives very accurate calculations for many fission observable data, such as
  - neutron and photon multiplicity distributions and spectra
  - independent fission product yield
  - isomeric state production, etc
- We made significant speed-up for this technique to explore wider model parameter space









Perspective

- Dynamical fission process and deterministic fission fragment decay technique
  - provide important inputs for the fission cycle in r-process (FIRE collaboration)
  - nuclear data evaluations
    - independent and cumulative fission product yields
    - prompt fission neutron and photon spectra
    - isomer productions
  - assessment of the decay heat and anti-neutrino spectrum calculations
  - connection with the LANSCE programs, SPIDER and CHINU
- LENZ
  - resolve $^{16}O(n,\alpha)$ issue for the ENDF evaluation and the R-matrix analysis
  - provide important charged particle production cross sections for structural materials
    - to investigate deficiencies in the statistical and pre-equilibrium models
- DANCE
  - study on the photon strength function continues
  - production of neutron capture cross section data for actinides