Nuclear Data and Deterrence: Summary

Workshop for Applied Nuclear Data Activities (WANDA)

February 10 – 13, 2025

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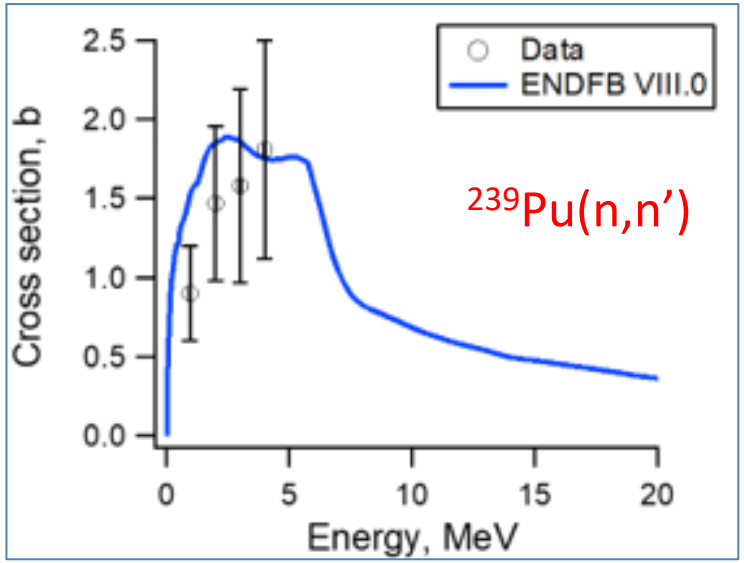
Like any application, connection and communication is key

- Session was divided into two sections, and two subsections
  - Computational/Theoretical focus
    - Defining Directions
    - Computational methods
  - Experimental focus
    - Experimental platforms
    - Diagnostics

Speakers were from the NNSA labs, supporting and strengthening the deterrence mission and nuclear data while connecting to broader scientific communities

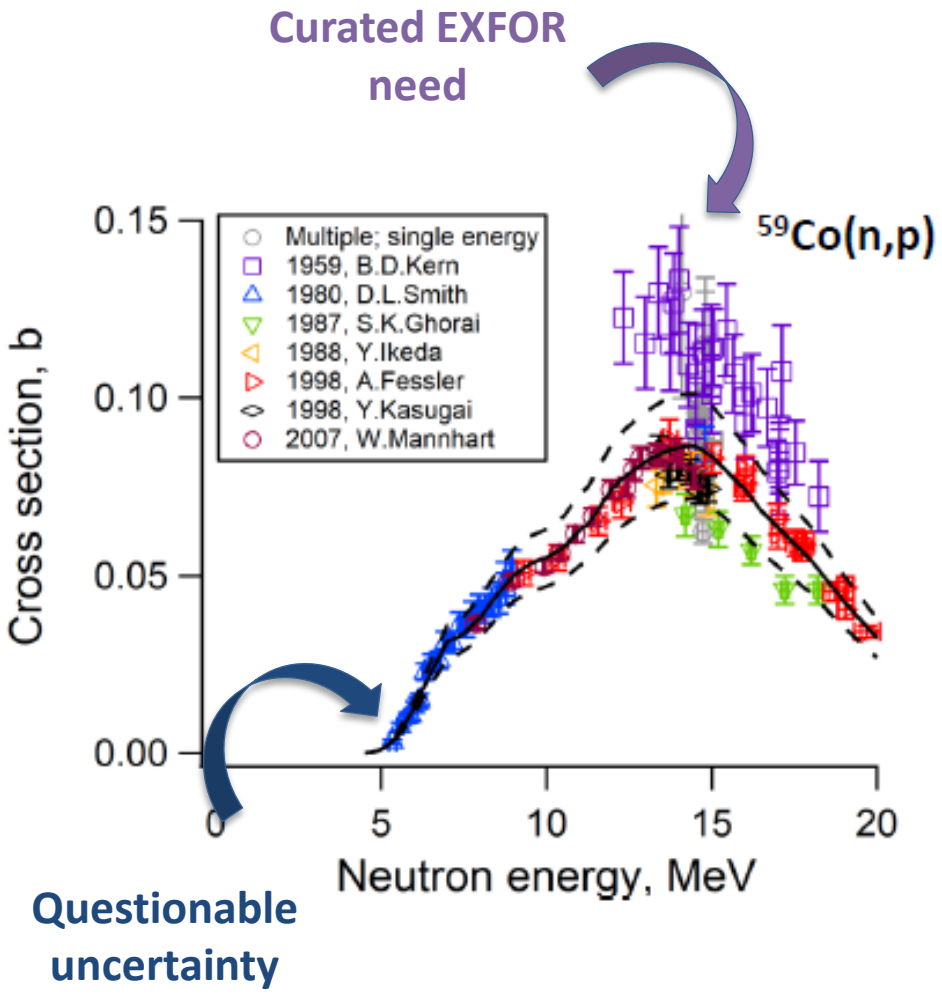
Thanks to Adrien Terricabras for the great notes!

- Cross-discipline partnerships are imperative: anything that facilitates communication is helpful
  - Producers and users
    - Security and need-to-know is no different than proprietary, export-control, etc
    - Users do not necessarily know they are using nuclear data, do not know who to ask
  - Scientific communities outside of nuclear data: statistics, computer and software engineering, radiochemistry



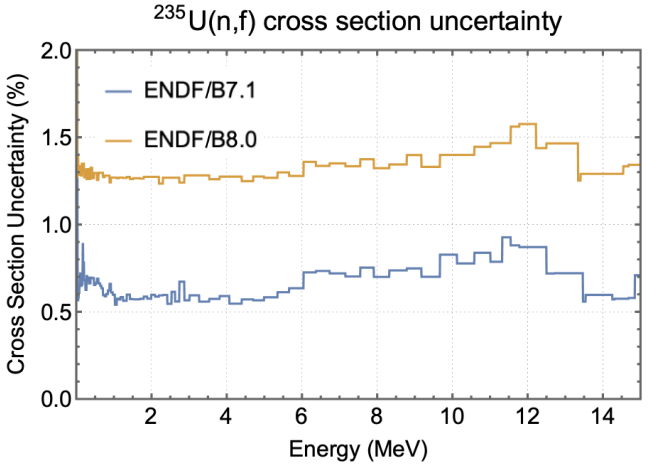
Common “need” themes

- Need for trust-worthy covariances, with no gaps
  - Robust, transparent, and defensible
  - Conservative
- “Curated EXFOR” supporting users, automation, and ML/AI methods across databases
- Theory to support ML/AI: physics constraints, training data
- Data improvements
  - Photon data: atomic, photonuclear
  - Neutron data: scatter and transmutation
  - Secondary particle production
- Differential and integral data need to be developed and used together
- “State-of-the art” requires connections including academic institutions, industry, and non-nuclear fields



Defining directions

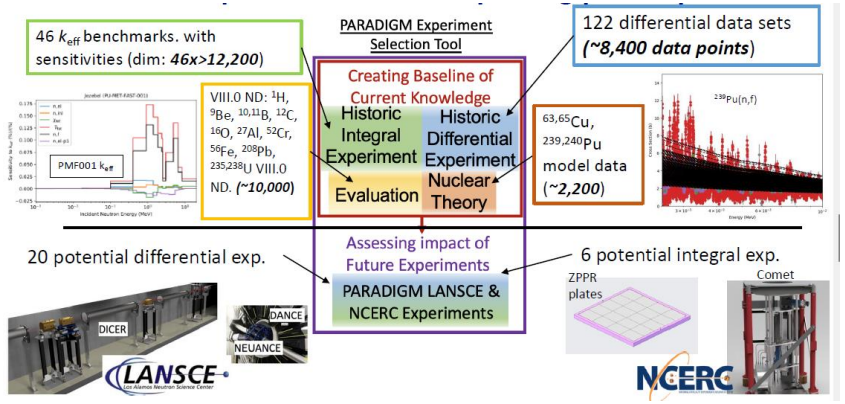
- Ali Dreyfuss (LLNL)



- Sensitivity and UQ studies can prioritize nuclear data needs by propagating covariances
- Inaccurate covariances – notably too small – can have significant implications
- Are there other applications that have developed Baysian methods for high-consequence decisions?

- Denise Neudecker (LANL)

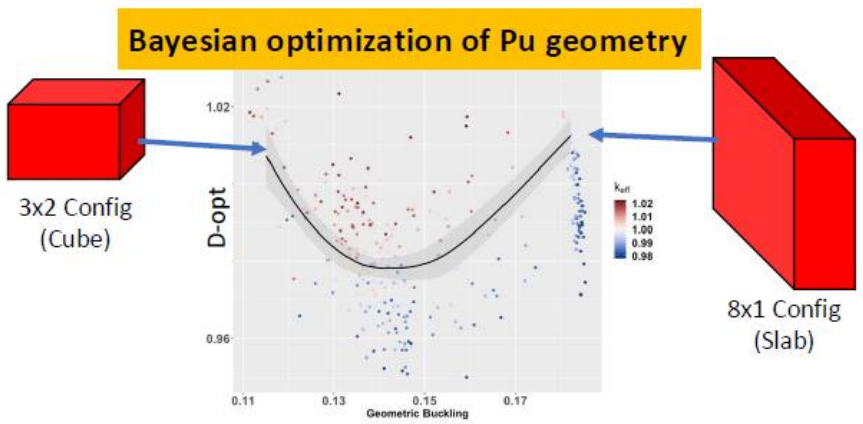
Demonstrated with PARADIGM



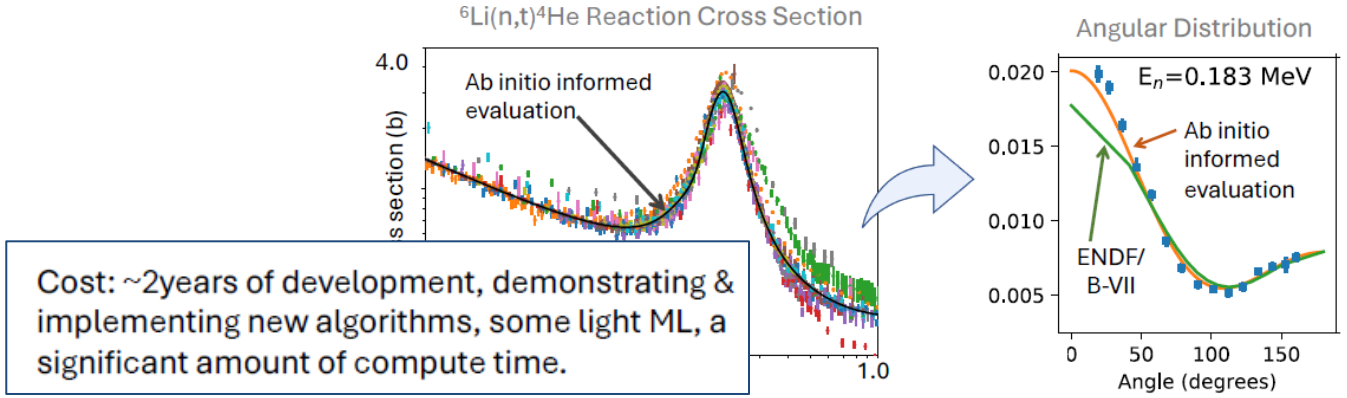
- AI/ML capabilities can prioritize nuclear data experiments, maximizing impact
- Defining both differential and integral experiments together provides the highest impact
- Requires an investment across a diverse team

Advancing computational methods

- Scott Vander Wiel (LANL)



- Kostas Kravvaris (LLNL)



Cost: ~2years of development, demonstrating & implementing new algorithms, some light ML, a significant amount of compute time.

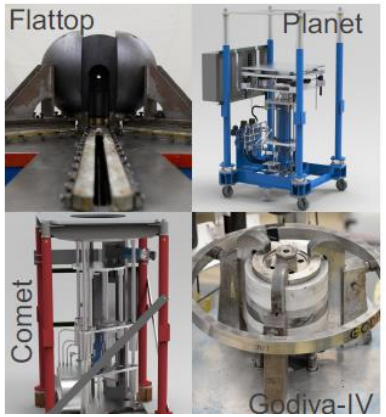
- ML/AI provides multiple opportunities to improve data, identify bias, accelerate timeline
- Integration of data from different sources is needed, but challenging
- ML/AI is game-changing (accuracy/time) and needs data, theory and methods investments

- Advancements in computing platforms – and theory codes that take advantage of them - are providing higher-fidelity data and UQ capabilities
- Refactoring codes requires significant time, effort, foresight and computational knowledge
- Emerging capabilities (e.g. QIS) show promise; need to be involved despite no immediate impact

Advancing experimental platforms

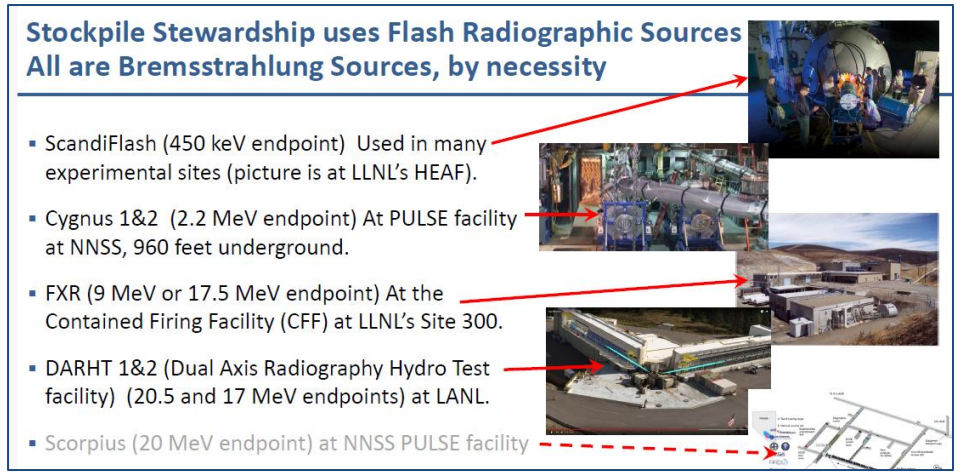
- Aaron Couture (LANL)

Components and materials under test include Pu, U, Np and many other materials



- Measurements often utilize large facilities that are both producers and users of nuclear data
- Number of facilities are limited; time is competitive and less training capabilities
- New facilities are being proposed to meet challenging data needs

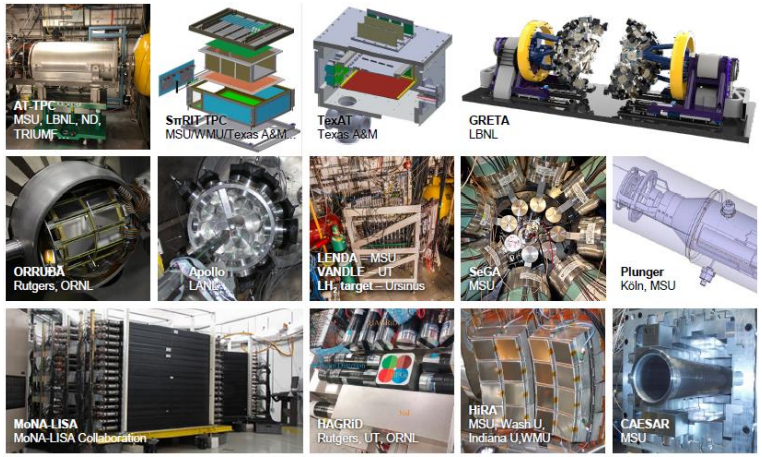
- Maurice Aufderheide (LLNL)



- Integrated, multi-physics, application-specific experiments use nuclear data
- Radiography is a common diagnostic that utilizes atomic, photonuclear, neutron, and proton data
- Need for detectors and data (+ covariances) for experiment design & analysis

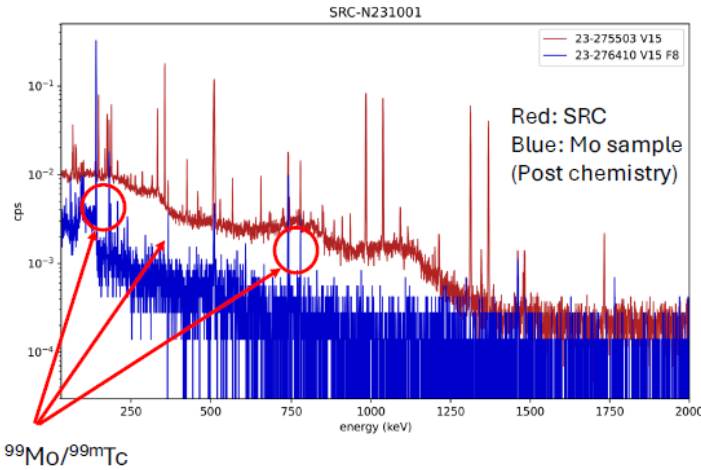
Diagnostic use and development

- Keegan Kelly (LANL)



- Measurements often use large, complex arrays; challenging data reduction but more complete
- New materials, analysis methods, and capabilities (e.g. microcals) provide opportunities for increasing accuracy, identifying correlations, and drawing out data from large datasets

- Samantha Labb (LLNL)



- Activation reactions are used as a diagnostic for extreme environments; retrieving samples can be a challenge
- Embedded tracers and material foils/wires are examples
- Advancements in radiochemistry, data, and methods (unfolding) will support accuracy and broader use