

Towards a Standard Experimental Nuclear Data Format (SENDF)

Adam Daskalakis
Naval Nuclear Laboratory

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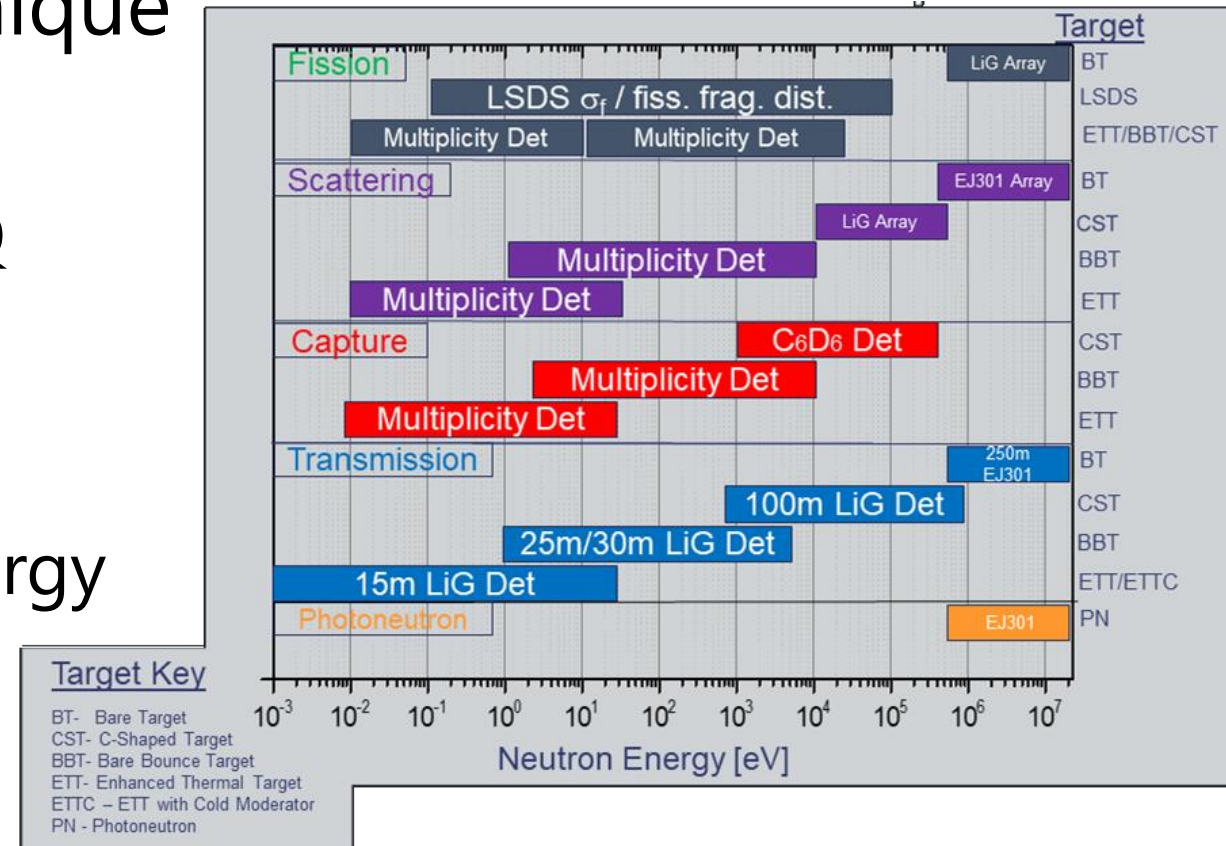
Background

- Nuclear measurements produce data that often requires complex processing and discrimination for the purpose of improving computational models
- Raw experimental nuclear data files are not universal
 - Unique to each facility, and possibly each data acquisition system
 - May not capture all relevant experimental information
 - In-test logs
 - Detector settings, positions, etc.
- Experiments are expensive – goal is to save for posterity all pertinent information to reproduce the analysis
- The EXFOR database
 - Well known collection of measured data that was processed and reported (published)

Challenges in the Modern Landscape

- Each experimental system is unique
 - Liquid scintillators, Li-Glass
 - Analog, 8-bit, 10-bit, 16-bit DAQ
 - Event acquisition length
 - Transmission, scattering, capture
 - Multiple decades of neutron energy
 - <1 meV to 20 MeV

RPI Capability Matrix

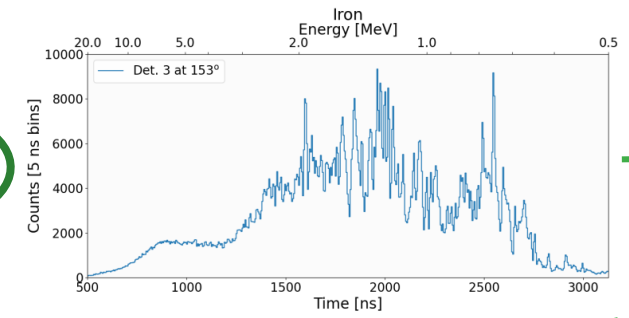
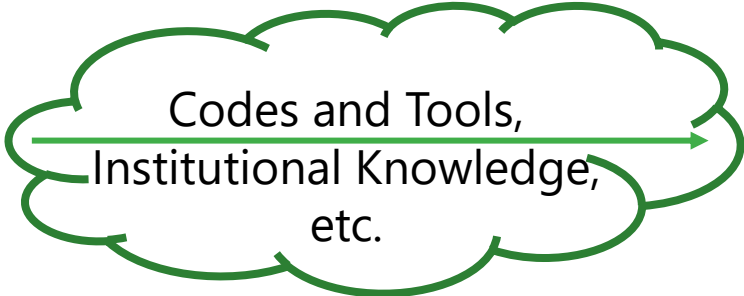


Flow of Experiment Nuclear Data

Institute I

- 250m EJ301 (n) Analog
- LiG Array (γ) 10-bit
- EJ301 Array (n and γ) 8-bit
- Multiplicity (γ) 14-bit

Subject Matter Experts



Quasi-differential elastic and inelastic neutron scattering from iron in the MeV energy range

A.M. Daskalakis^{a,*}, E.J. Blair^b, R.J. McDermott^c, R.M. Bahrani^d, V. Danon^e, D.P. Barry^f, R.C. Block^g, M.J. Rapp^h, R.E. Eppingⁱ, C. Laitenberger^j

^aCenter for Dark Matter Research, Department of Physics, The University of Texas at Austin, Austin, TX 78712, United States

^bNeutron Scattering, ORNL, PO Box 6108, Knoxville, TN 37932, United States

^cDepartment of Physics, University of Tennessee, Knoxville, TN 37996, United States

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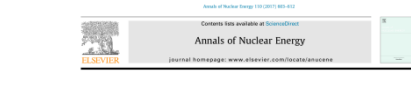
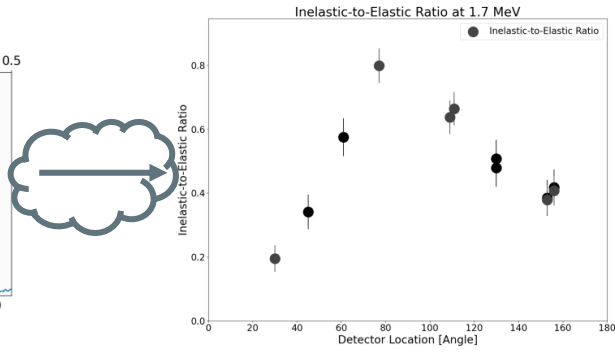
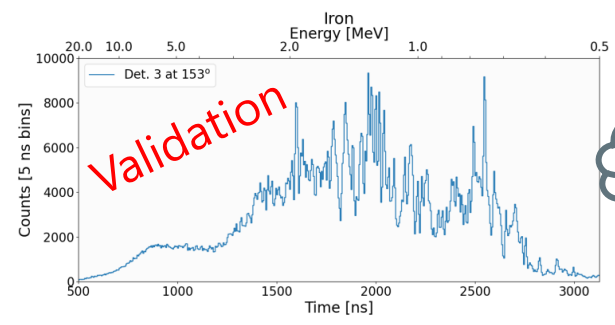
^jDepartment of Physics, University of Tennessee, Knoxville, TN 37996, United States

ARTICLE INFO

ABSTRACT

Subatomic experiments performed with the Reaktor Polytechn Institute Linear Accelerator measured quasi-differential elastic and inelastic neutron scattering from iron in the MeV energy range. The data were analyzed using a novel method for the extraction of the quasi-differential elastic and inelastic neutron scattering cross sections. The data were compared with nuclear models to develop evaluated nuclear data evaluations such as ENDF/B-VI. The experimental data are used with nuclear models to develop evaluated nuclear data evaluations such as ENDF/B-VI. The experimental data are used with nuclear models to develop evaluated nuclear data evaluations such as ENDF/B-VI. The experimental data are used with nuclear models to develop evaluated nuclear data evaluations such as ENDF/B-VI.

Institute II



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Subatomic experiments performed with the Reaktor Polytechn Institute Linear Accelerator measured quasi-differential elastic and inelastic neutron scattering from iron in the MeV energy range. The data were analyzed using a novel method for the extraction of the quasi-differential elastic and inelastic neutron scattering cross sections. The data were compared with nuclear models to develop evaluated nuclear data evaluations such as ENDF/B-VI. The experimental data are used with nuclear models to develop evaluated nuclear data evaluations such as ENDF/B-VI. The experimental data are used with nuclear models to develop evaluated nuclear data evaluations such as ENDF/B-VI.

Motivation for a Standard Experimental Nuclear Data Format

- Maximizes appropriate sharing of federally funded scientific data found in peer-reviewed publications and the underlying scientific data contributing to those results
- Benefits from nuclear instruments that rely on similar mechanics to acquire data, which is normally processed to similar products, i.e., cross sections, yields, etc.
- Provides a mechanism for the community to more easily process complex analytical work
 - Easily stored in a machine-readable format
- Allows for the generation of a publicly accessible, open-source analysis tools
- Supports accelerated extraction and long-term governance of measurement data for commercial and national security applications
 - Lifecycles may last decades, i.e., commercial reactors, naval reactors, nuclear weapons

SENDF Example



- Extract channel and trigger
- Calculate time
- Pulse analysis
 - Calculate area
 - ...
 - Perform PSD



- Extract channel, area
- Calculate time
- Pulse analysis
 - ...
 - PSD



- Extract channel
- Locate pre-trigger
- Calculate time
- Pulse analysis
 - Calculate area
 - ...

| | Channel | Trigger | Time | Area | Type/PCA |
|------------|---------|---------|------|------|----------|
| 8-bit HES | X | | X | X | X |
| 10-bit MES | X | | X | X | |
| MULT. | X | X | X | X | |
| 10-bit MEC | X | | X | X | |
| 14-bit MES | X | | X | X | |

Recent Files | C:\Users\adamd\Desktop\repos\fe-hes-wins\YAML\BeWeek2.h5

BeWeek2.h5

- Be
 - Carbon
 - Run_1
 - Run_10
 - Run_11
 - Run_12
 - Run_13
 - detector_data
 - monitor_data
 - Run_14
 - Run_15
 - Run_16
 - Run_17
 - Run_18
 - Run_19
 - Run_2
 - Run_20
 - Run_21
 - Run_22
 - Run_23
 - Run_24
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 - Run_29
 - Run_3
 - Run_30
 - Run_31
 - Run_32
 - Run_33

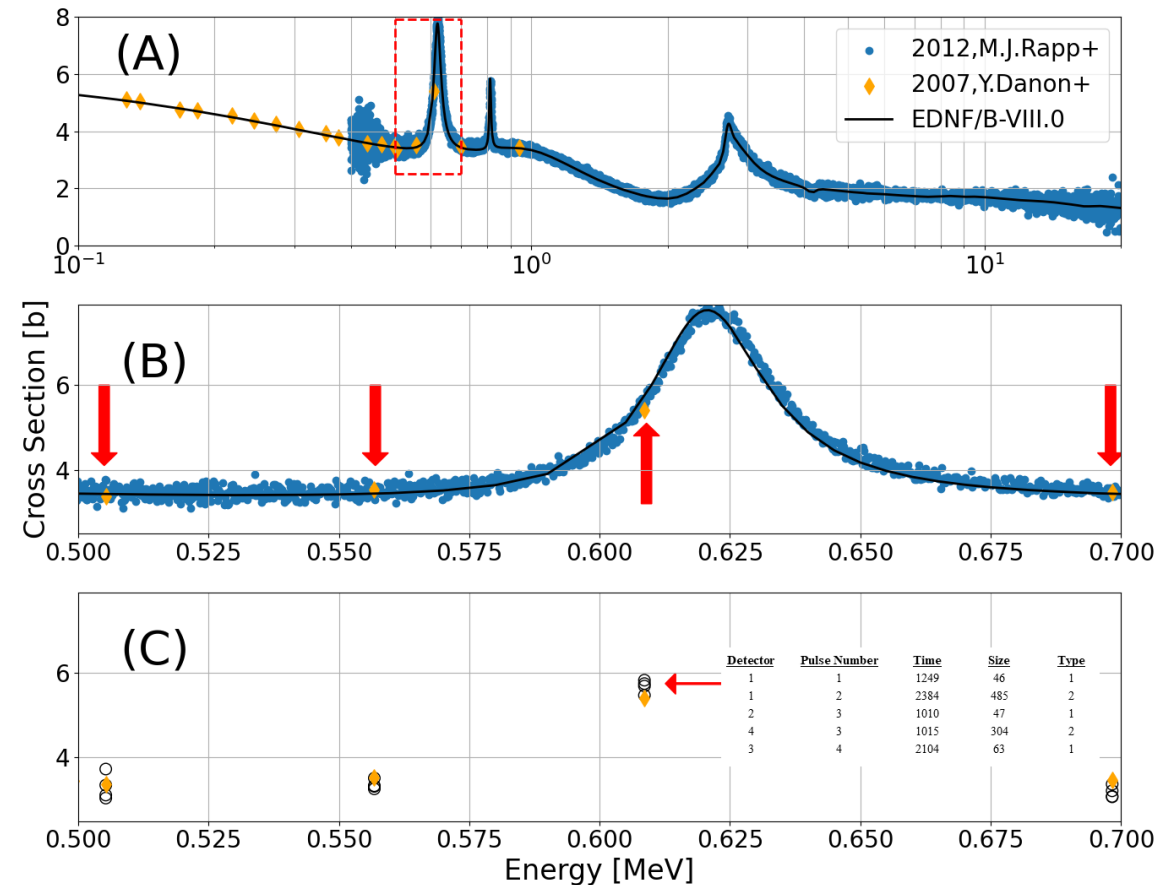
Table Import/Export Data

0-based

| | detector | trigger | time | area | pca |
|----|----------|---------|-------------|-----------|-----|
| 0 | 1 | 0 | 709.2626... | 1249.3333 | 2 |
| 1 | 1 | 0 | 703.1825... | 6471.3345 | 9 |
| 2 | 1 | 0 | 1598.194... | 479.66656 | 1 |
| 3 | 1 | 0 | 705.2893... | 6160.3345 | 9 |
| 4 | 1 | 1 | 707.2058... | 6834.333 | 9 |
| 5 | 1 | 1 | 705.1421... | 10134.336 | 9 |
| 6 | 1 | 1 | 705.0358... | 3379.9993 | 2 |
| 7 | 1 | 1 | 710.0584... | 2850.6655 | 2 |
| 8 | 1 | 1 | 2812.215... | 354.99988 | 1 |
| 9 | 1 | 1 | 704.1231... | 7491.3345 | 9 |
| 10 | 1 | 1 | 703.2281... | 10352.666 | 9 |
| 11 | 1 | 2 | 704.3865... | 6446.3345 | 9 |
| 12 | 1 | 2 | 704.1399... | 8888.0 | 9 |
| 13 | 1 | 2 | 707.0646... | 3780.0 | 2 |
| 14 | 1 | 2 | 705.2633... | 5776.331 | 9 |
| 15 | 1 | 3 | 703.3401... | 11008.669 | 9 |
| 16 | 1 | 3 | 708.1284... | 3927.9993 | 2 |
| 17 | 1 | 3 | 704.3209... | 11639.334 | 9 |
| 18 | 1 | 3 | 1521.399... | 621.9999 | 1 |

Integration with the Broader Community

- These files should complement information found in databases like EXFOR
 - SENDF data are at a more granular level
 - Data that contributes to final and/or published results



Potential Improvement for Information Flow

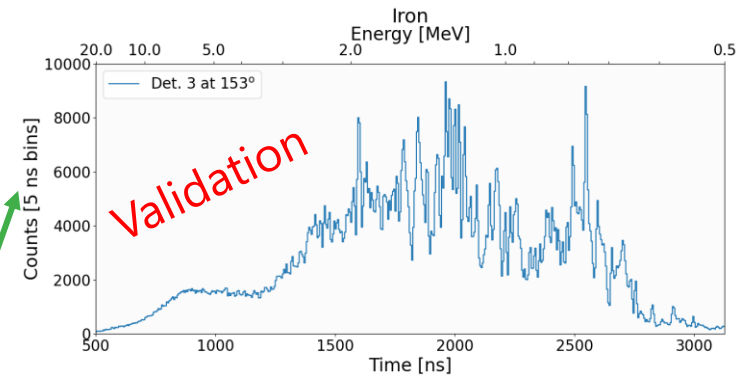
Institute I

EJ301 Array (n and γ) 8-bit

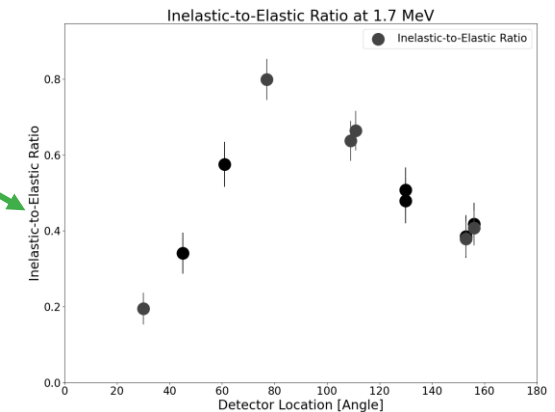


| | detector | trigger | time | area | pca |
|----|----------|---------|------------|-----------|-----|
| 0 | 1 | 0 | 709.080... | 144.66661 | 2 |
| 1 | 1 | 0 | 704.191... | 10608.334 | 9 |
| 2 | 1 | 2 | 710.050... | 964.3336 | 2 |
| 3 | 1 | 2 | 704.224... | 7102.667 | 9 |
| 4 | 1 | 2 | 705.110... | 4827.0 | 9 |
| 5 | 1 | 2 | 705.028... | 4449.001 | 2 |
| 6 | 1 | 2 | 707.384... | 255.6666 | 1 |
| 7 | 1 | 2 | 708.217... | 4848.002 | 9 |
| 8 | 1 | 2 | 702.121... | 10797.0 | 9 |
| 9 | 1 | 3 | 708.049... | 4979.669 | 9 |
| 10 | 1 | 3 | 708.275... | 2491.6665 | 2 |
| 11 | 1 | 3 | 703.218... | 8088.669 | 9 |
| 12 | 1 | 3 | 708.278... | 4751.669 | 9 |
| 13 | 1 | 3 | 705.408... | 5323.333 | 9 |
| 14 | 1 | 8 | 710.083... | 2179.9995 | 2 |
| 15 | 1 | 8 | 705.370... | 8966.334 | 9 |
| 16 | 1 | 8 | 706.014... | 258.00003 | 2 |
| 17 | 1 | 8 | 703.510... | 13980.998 | 9 |
| 18 | 1 | 9 | 706.255... | 1893.3328 | 2 |
| 19 | 1 | 10 | 707.132... | 5250.667 | 9 |
| 20 | 1 | 13 | 711.055... | 1457.0 | 2 |
| 21 | 1 | 13 | 706.322... | 999.3336 | 2 |
| 22 | 1 | 13 | 706.266... | 5584.669 | 9 |
| 23 | 1 | 13 | 709.399... | 332.0 | 2 |
| 24 | 1 | 13 | 2725.10... | 481.66656 | 1 |

Open
Toolset



Institute II



Going Forward

- SENDF allows the community to make productive use of measurement data sooner and longer, eliminating the need to periodically recreate the wheel
 - Justifying the investment creating a common format and developing analysis tools.
- Additional Challenges
 - Is this the right way forward? Community feedback needed!
 - Identify critical experimental information
 - Implement modern practices that ensures accessibility and versatility
 - Who will develop downstream tools for analysis and validation
 - Who maintain documentation and decide on format, structure, etc.?
 - How will files be stored and/or disseminated?
 - Where will funding come from?

Thank You