Nuclear Data Pipeline, Part II

From ENDF to Application

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Nuclear Data Pipeline

1. Measurement
2. Theory
3. Evaluation
4. Processing
5. Verification and Validation
6. Applications

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Forms of Nuclear Data

Evaluated Data

Data as produced by an evaluator

- ENDF
- GNDS

Processed Data

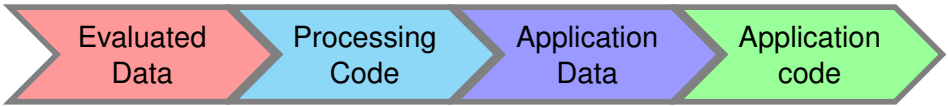
Some (or all) processing is complete

Application Data

Processed data in a form application codes can use

- ACE—Monte Carlo
- NDI—deterministic

Nuclear Data Processing



Processing code:

- *Read evaluated data*
- *Perform physics calculations*
- *Generate code-specific application data*

Physics Calculations in Processing Codes

- Resonance reconstruction
- Doppler Broadening
- Secondary particle generation
- Calculate energy deposition (KERMA) and radiation damage cross section
- Produce probability tables from unresolved resonance range
- Produce self-shielded cross sections in unresolved resonance range
- Calculate multi-group cross sections

Other Processing Tasks

- Generation of covariance matrices
- Plotting data
  - Cross sections
  - Secondary angle and energy distributions
  - Covariance matrices
  - etc.
- Formatting data for application codes
  - Monte Carlo
  - Deterministic

US Nuclear Data Processing Codes

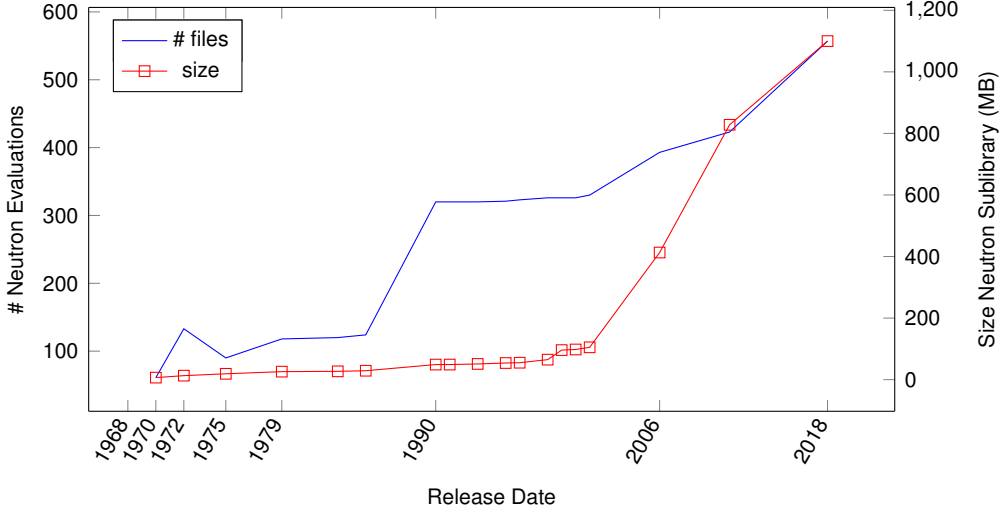
There are three major processing codes being used in the United States:

Los Alamos	Oak Ridge	Livermore
NJOY	AMPX	FUDGE

All codes are undergoing major modernization efforts

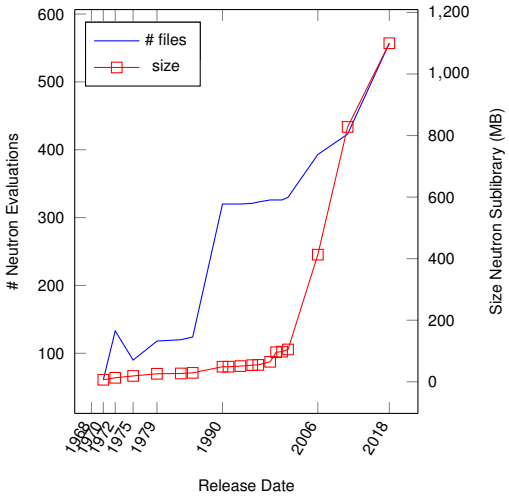
- Adapting for the use of GNDS and ENDF
- Simplifying and automating the generation of application data from evaluated data

ENDF Releases



ENDF Releases

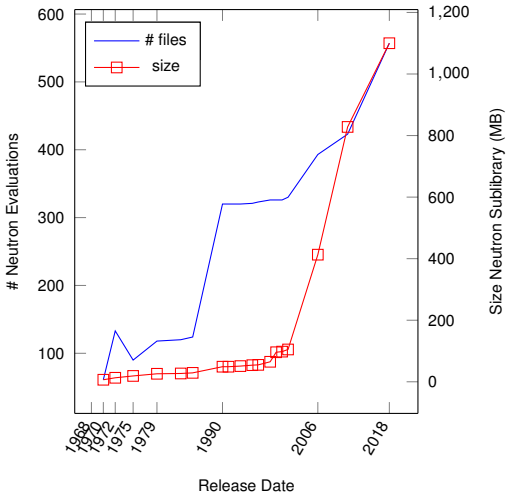
- Number of evaluations is increasing
- Quantity of data is increasing



ENDF Releases

- Number of evaluations is increasing
- Quantity of data is increasing

- We can't continue to process/consume data as we once did.



Verification and Validation of Processed Data

Once the processing has been completed, the data must be verified and validated

- Verify that data fits appropriate format
- Validate that data accurately describes Mother Nature
- Indirectly check that the application codes are using data correctly

Imperfections

- Evaluated data
- Processing codes
- Application codes

Verification and Validation of Processed Nuclear Data

Verification:

- Are cross section values positive?
- Do partial cross sections sum to total?
- Are PDFs positive and normalized?
- $P_0 >= 0$
- $|P_n| < P_0, n = 1, \cdots, n_{\max}$
- etc.

Validation of data against experimental benchmarks

- 1000+ MCNP models of critical assemblies
- Compare calculated k_{eff} to experimental k_{eff}
- Plot change in results with changing input parameters
  - e.g., leakage vs. reflector thickness
- LLNL pulsed spheres

US Application Codes

Los Alamos

- MCNP
- Partisn

Oak Ridge

- SCALE

Livermore

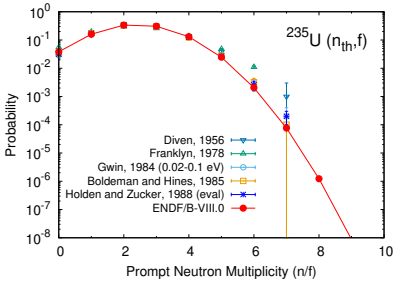
- Mercury
- ARDRA

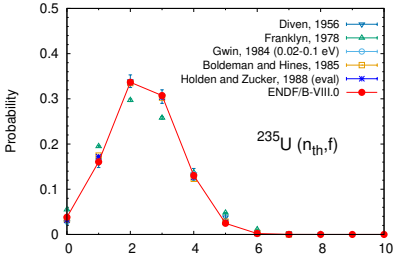
New Data from Evaluations

- $P(\nu)$ data introduced in ENDF/B-VIII.0 for ^{235}U, ^{238}U, ^{239}Pu.
  - Funded in part from NA-22, ASC-PEM, and NCSP

- Processing codes must be updated
- Application formats must be updated
- Application codes must be updated

- New data is (slowly) moving through the pipeline as capabilities are improved and updated





Conclusion

- The quality and quantity of nuclear data is improving.
- In order to take advantage of this increase in knowledge and understanding, we need to make sure that all pieces of the Nuclear Data Pipeline are working together.
- Adding new capabilities to our processing and application codes will help us to better utilize the nuclear data available to us.

Bottom Line

Improving the efficiency of the entire Nuclear Data Pipeline