FRENDY: A New Nuclear Data Processing System being Developed at JAEA

Japan Atomic Energy Agency

Kenichi Tada, Yasunobu Nagaya,
Satoshi Kunieda, Kenya Suyama,
Tokio Fukahori

Outline

- Background
- Development of FRENDY
  - Features of FRENDY
  - Structure of FRENDY
- Verification of FRENDY
  - Comparison of processing results
  - Comparison of k_{eff} values of integral experiments
- Conclusions

Present situation of the nuclear data processing in Japan

- JAEA provides nuclear data library and nuclear application codes
- The nuclear data processing system had not been developed
  - Imported nuclear data processing systems are used
  - JAEA cannot release the nuclear data processing system for JAEA's nuclear application codes
- Development of domestic nuclear data processing system were desired

Development of nuclear data processing system FRENDY

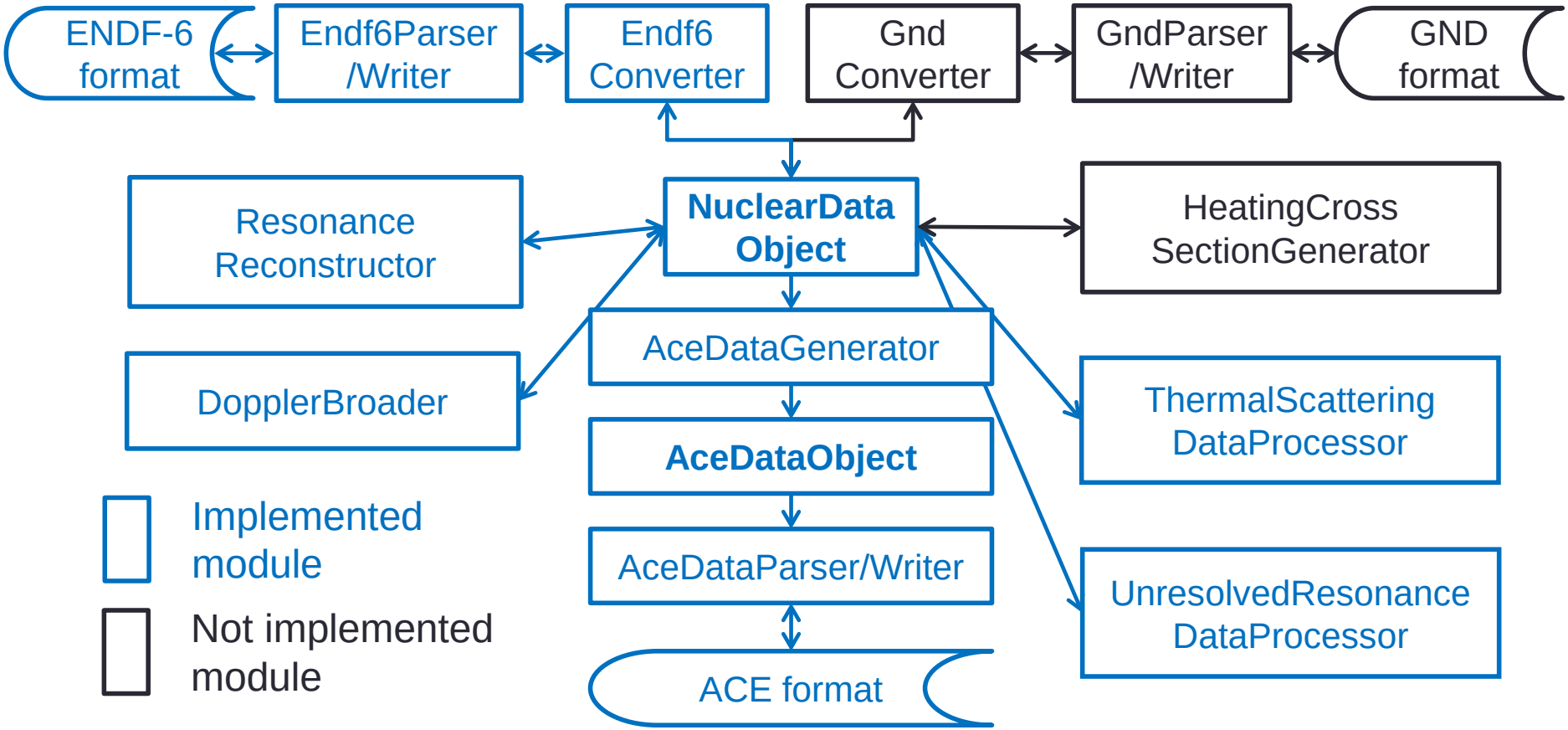
- JAEA started developing a new nuclear data processing system FRENDY in 2013
  - **FR**om **E**valuated **N**uclear **D**ata librar**Y** to any application
  - To process the nuclear data library by JAEA's nuclear application codes users
- The first goal is processing the nuclear data for continuous energy Monte Carlo codes
  - For MVP, PHITS of JAEA and MCNP of LANL

Features of FRENDY

- Utilization of modern programming techniques
  - C++, BoostTest library, Git
  - Improvement of quality and reliability
- Consideration of maintainability, modularity, portability and flexibility
  - Encapsulate all classes
  - Minimize the function
  - Maintain the independence of each module
- Processing methods of FRENDY is similar to NJOY99
  - The modification of the processing methods and implementation of the original functions will be investigated in the future
- Reflecting requests of nuclear data processing system users
  - Development of FRENDY is supported by many organizations and companies in Japan

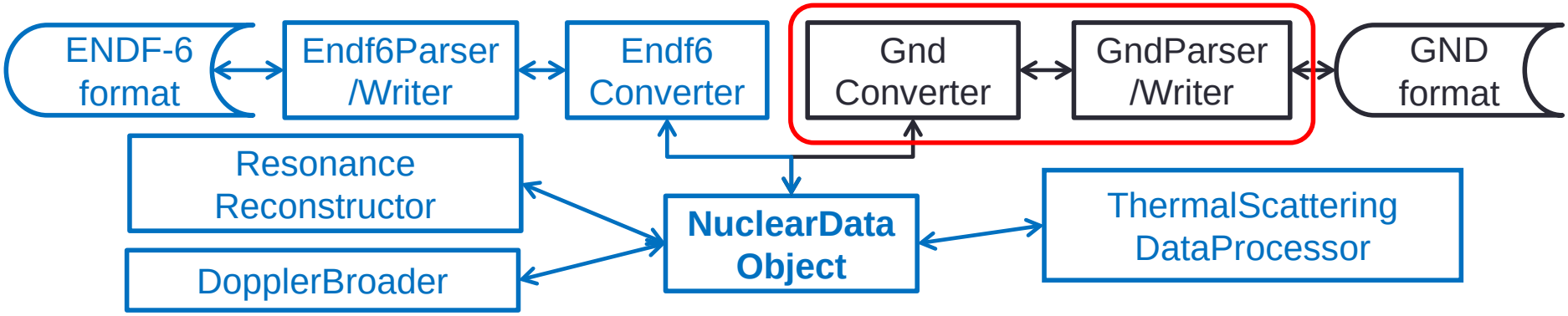
Structure of FRENDY

- Modularity is carefully considered
  - Modules of FRENDY can be used other calculation code by adding only a few lines



Advantage for using the FRENDY's original nuclear data format

- FRENDY uses independent internal nuclear data format
  - NuclearDataObject class
- Minimizing the impact by the change of nuclear data format
  - Developer and users are not necessary to consider the nuclear data format
  - Consideration of a new data format GND
    - GND format can be addressed if another set of parser, writer and converter classes are implemented

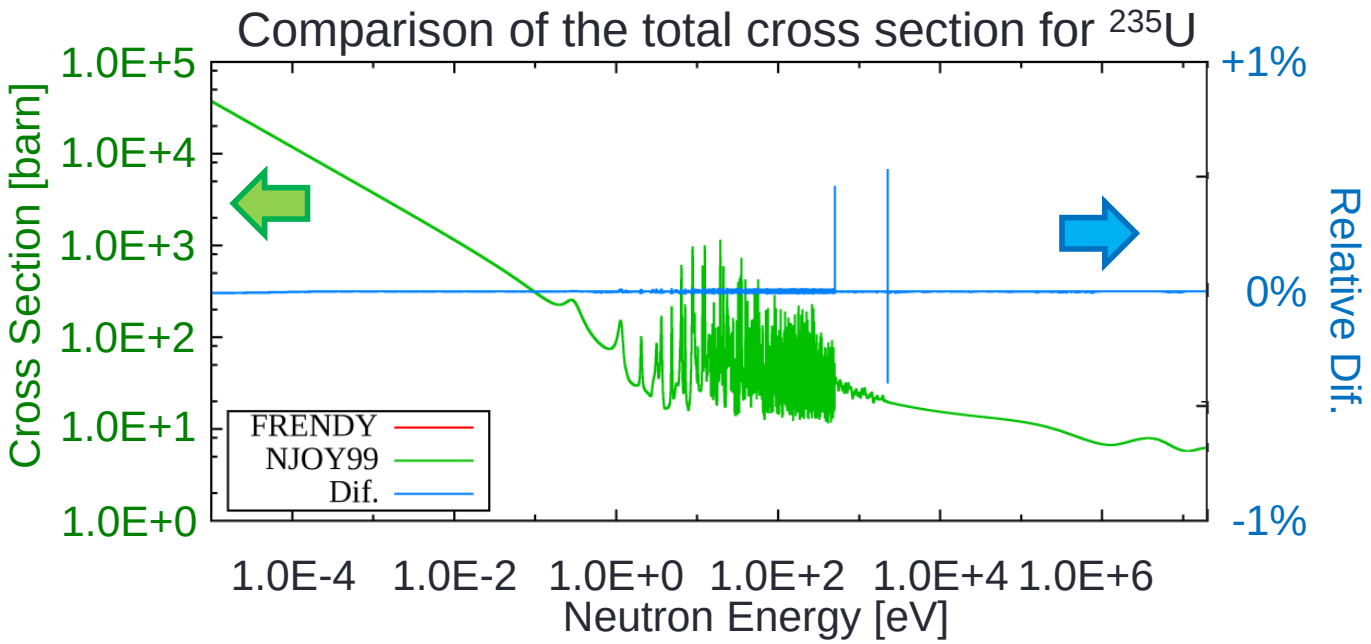


Verification of FRENDY

- Processing results of FRENDY are compared to that of NJOY99.393
  - All nuclei in JENDL-3.3 and JENDL-4.0 are compared
    - Processing results of ^{235}U and ^{1}H in H_2O from JENDL-4.0 are shown in this presentation
- Calculation conditions
  - Temperature : 296.0 [K]
  - Tolerance value
    - 0.01% for verification of each module
    - 0.10% for generating ACE file

Verification of Doppler broadening module

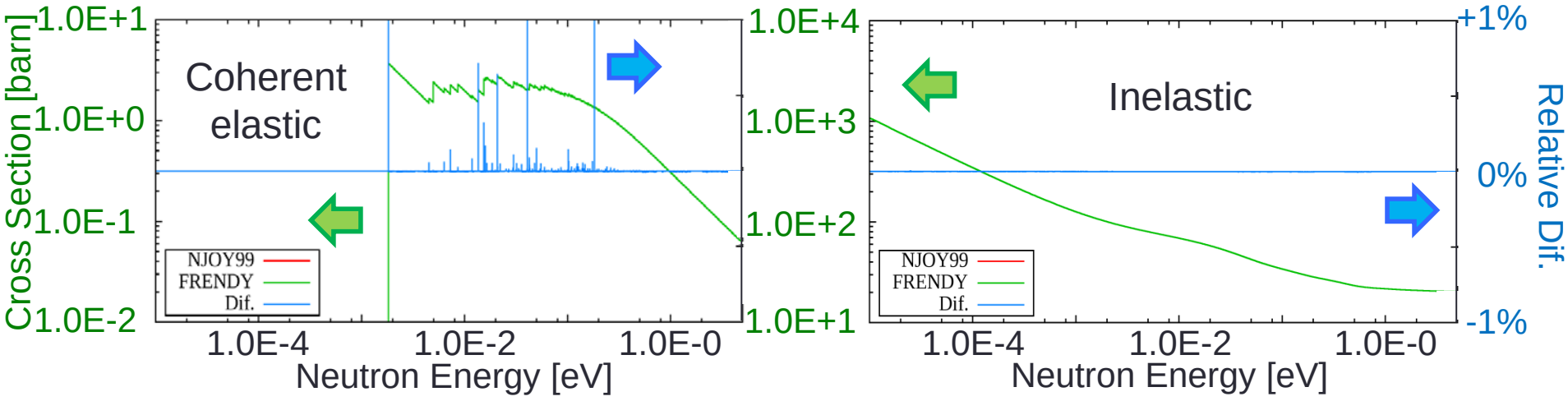
- Differences are only found in discontinuity regions
  - Boundary of resolved and unresolved resonance regions
- Other reaction types and nuclei also exhibit similar difference
  - Resonance reconstruction and Doppler broadening process of FRENDY is appropriate



Verification of TSL data processing module

- Differences are only found in discontinuity regions
- Other materials also exhibit similar difference
  - Processing thermal scattering law data with FRENDY is appropriate

Comparison of the coherent elastic and inelastic scattering cross sections for ^{1}H in H_2O



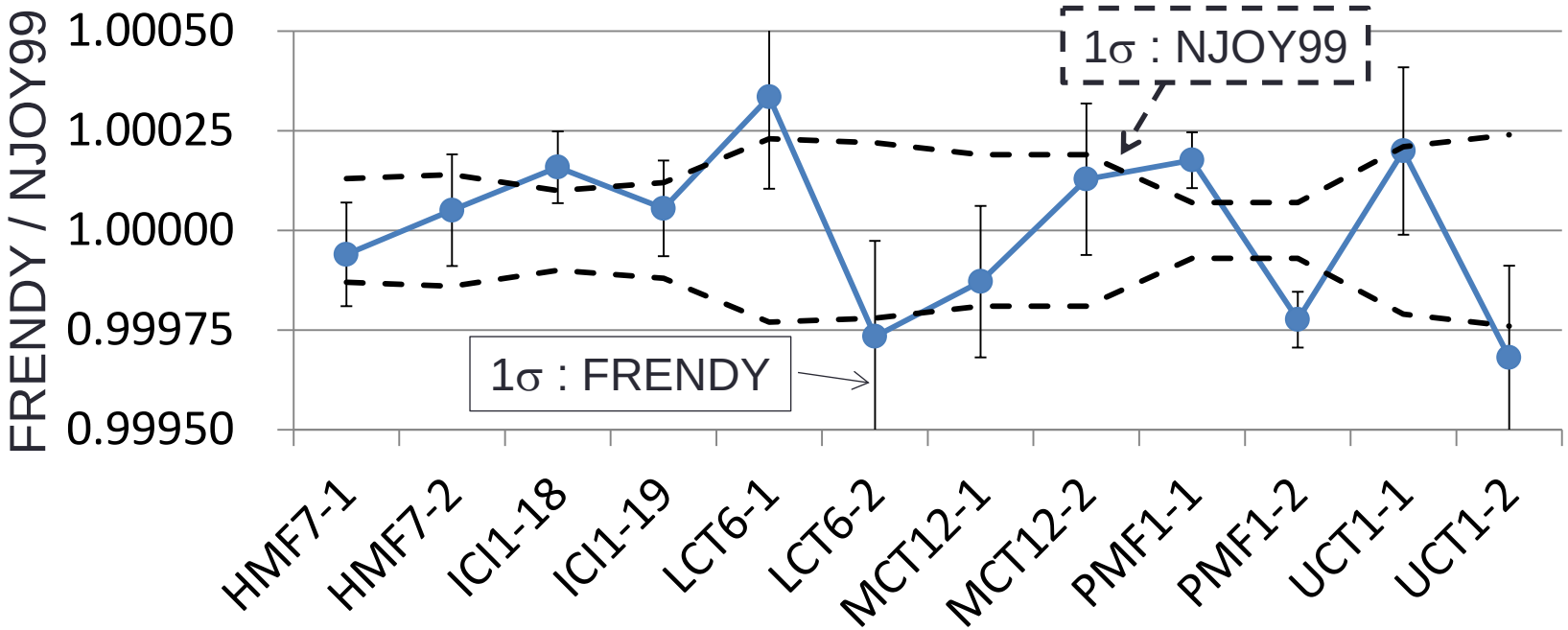
Comparison of processing time

- The processing time to generate ACE files are compared
  - Processing time of FRENDY is 2-3 times longer than that of NJOY99
- Cause of difference
  - Programming language
  - Adopting dynamic array
- Processing time of FRENDY will be acceptable
  - From the view point of computer performance improvement

	FRENDY	NJOY99	FRENDY /NJOY99
^{1}H	0.09	0.20	0.5
^{16}O	1.83	0.70	2.6
^{56}Fe	18.00	9.10	2.0
^{235}U	944.28	435.80	2.2
^{238}U	581.94	437.40	1.3
^{239}Pu	400.92	279.80	1.4
^{1}H in H_2O	49.03	15.30	3.2
graphite	36.96	9.50	3.9

Comparison for integral experiments

- k_{eff} values of ICSBEP benchmark are compared
  - MCNP sample input files in ICSBEP hand book are used
- k_{eff} values of FRENDY are similar to that of NJOY99
  - Differences are not so varied with the neutron spectra and the major fissile materials
- FRENDY properly generates ACE files



Conclusions

- Overview of FRENDY
  - Features of FRENDY
    - Utilization of modern programming technique
    - Consideration of maintainability, modularity, portability and flexibility
  - Structure of FRENDY
    - Consideration of modularity
    - Consideration of new nuclear data format, e.g., GND
- Verification of FRENDY
  - Comparison of the processing results
    - Processing results of FRENDY are similar to that of NJOY99
    - Processing time of FRENDY is 2-3 times longer than that of NJOY99
  - Comparison of integral experiments
    - k_{eff} values of FRENDY are similar to that of NJOY99
    - FRENDY is properly process ACE files

Development schedule of FRENDY