

Korea Nuclear Data Center (KNDC)

Progress Report for period 2023-2024

Technical Meeting on the International Network of Nuclear Reaction Data Centers (NRDC 2024)
14 - 17 May, 2024

Korea Atomic Energy Research Institute
Daejeon, Korea

Web: <http://atom.kaeri.re.kr/>

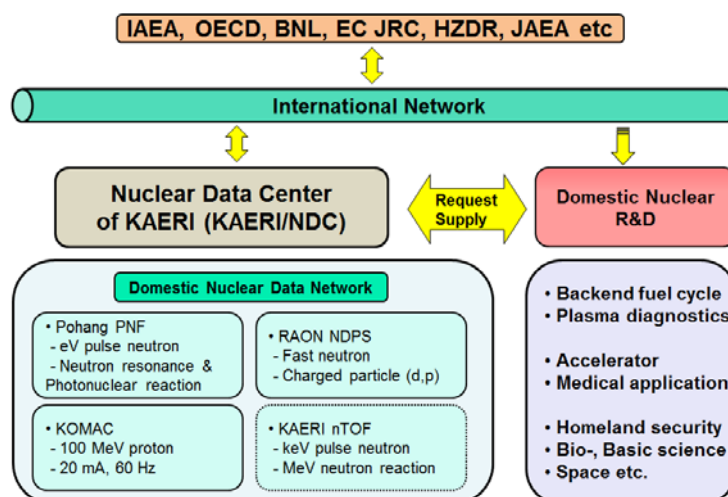
E-mail: kimdh@kaeri.re.kr

1. General

Korea Nuclear Data Center (KNDC, formerly ‘Nuclear Data Evaluation Lab.’) was established in 1997 to start research on nuclear data in Korea and joined the International Network of Nuclear Reaction Data Centers (NRDC) in 2000. KNDC at Korea Atomic Energy Research Institute (KAERI) performs the following main tasks:

- Evaluation and method development for nuclear reaction data
- Establishment of processing and validation system of nuclear reaction/covariance data
- Measurement of nuclear reaction data and establishment of measurement facility
- Production and validation of atomic/molecular collision data

The mission of our center includes disseminating the outcomes of cooperation with international networks as well as promoting nuclear data research activities and supporting nuclear/radiation R&Ds in Korea. KNDC is also coordinating the measurement activities using domestic accelerators for producing various nuclear reaction data.



KNDC continues to cooperate with the international nuclear data network as follows:

- Participating in IAEA CRP, TM, and CM on nuclear data evaluation, nuclear data processing and validation, atomic/molecular data network, etc.
- Collecting nuclear reaction measurement data in Korea for EXFOR compilation under the guidance of IAEA/NDS
- Participating in the JEFF and WPEC subgroups of OECD/NEA
- Conducting joint research on evaluation, measurement, and validation of nuclear data with foreign research institutes

As of 2024, KNDC consists of 8 regular staffs, 2 post-retirement researchers, 2 post-doctoral researchers, and 3 Ph.D. students. The latest staff changes include:

- Dr. Dalho MOON joined as a post-doctoral researcher in August 2023.
- Mr. Dongwan KIM and Ms. Sakshi PATWAL joined as a Ph.D. student in March 2024.

They are working in the following fields:

- Nuclear data evaluation: 2 regular staffs
- Nuclear data measurement: 2 regular staffs, a post-retirement researcher, and a post-doctoral researcher
- Nuclear data processing/validation/application: 2 regular staffs, a post-retirement researcher, and a Ph.D. student
- Atomic/molecular data production: 2 regular staffs, a post-doctoral researcher, and 2 Ph.D. students

2. EXFOR Activity

We are continuing data compilation for nuclear reaction data obtained in Korea under the guidance of IAEA/NDS. Since the last meeting, 10 Entries have been entered into the EXFOR database and 2 entries have been compiled as listed in Table 1.

Table 1. Compilation statistics of KNDC

No.	TRANS	ENTRY	SUBJECT	STATUS
1	D138	D7039	Proton	EXFOR
2	D138	D7040	Proton	EXFOR
3	D138	D7041	Proton	EXFOR

4	D138	D7042	Proton	EXFOR
5	D139	D7043	Proton	EXFOR
6	3210	30851	Neutron	EXFOR
7	3210	30852	Neutron	EXFOR
8	3210	30853	Neutron	EXFOR
9	3210	30854	Neutron	EXFOR
10	3210	30855	Neutron	EXFOR
11		30856	Neutron	Compiled
12		30857	Neutron	Compiled

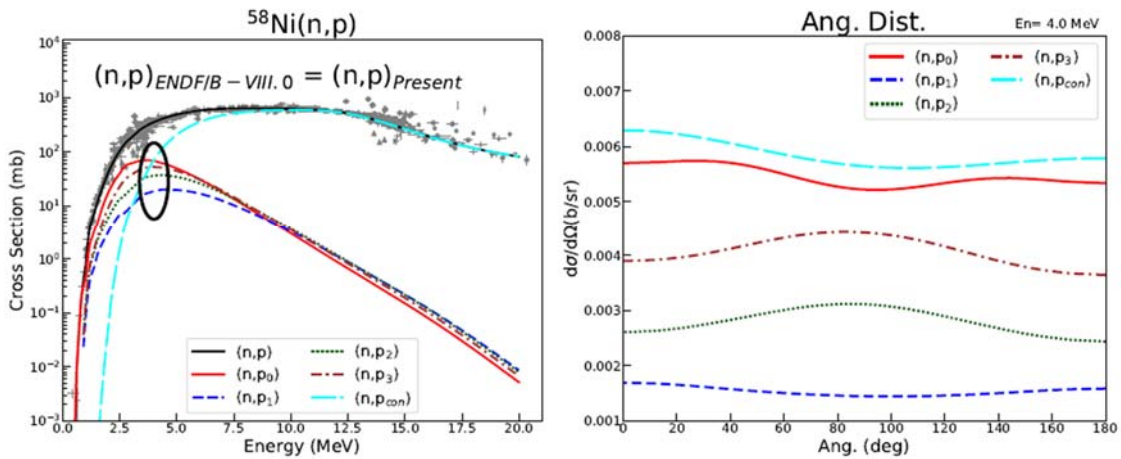
- **Checking Code**

The draft was checked through a tool of JCPRG. (<http://www.jcprg.org/exfor/tool/>)

3. Nuclear Data Activities

3.1 Evaluation

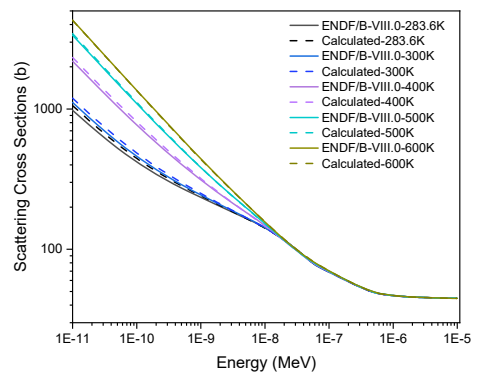
To complete missing angular distributions and energy spectra of secondary particles in the ENDF/B-VIII.0 library, a statistical Hauser-Feshbach code, CoH₃, was used for calculating angular distributions for neutron-induced charged particle reactions including (n,p), (n,a), (n,d), (n,t) and (n,³He) through the collaborative project with Los Alamos National Laboratory (LANL). For instance, the total (n,p) cross section for ⁵⁸Ni is exactly the same as that given in ENDF/B-VIII.0, along with four newly decomposed cross sections of the discrete levels and the continuum part as shown in the left panel of below figure. The additional angular distributions for these levels in the laboratory system are calculated and shown in the right panel of below figure at the neutron incident energy of 4.0 MeV, which corresponds to the black circle in the left panel.



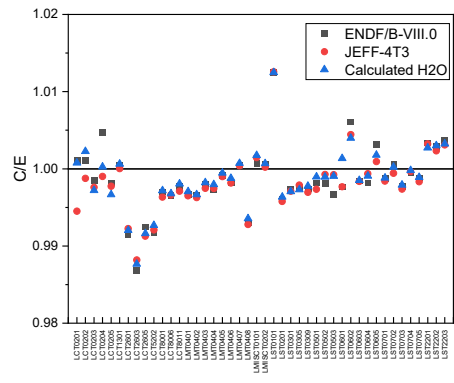
$^{58}\text{Ni}(n,p)$ cross sections and angular distributions

A total of 52 nuclides were updated for missing angular distributions and energy spectra of secondary particles including photon production, created in the EDNF-6 format and submitted to National Nuclear Data Center (NNDC) for upcoming ENDF/B-VIII.1 release.

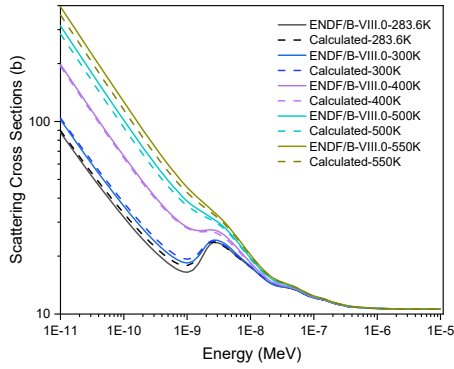
A research on producing thermal neutron scattering data based on molecular dynamics and ab-initio code simulations has been conducted since 2022. Temperature-dependent TSL data of H₂O and D₂O were produced using the frequency spectrum and/or Sköld correction factor obtained by GROMACS code simulations with TIP4P/2005f water models. In addition, TSL data of crystalline graphite was produced based on VASP code simulation. The TSL data were validated to show comparable performances to ENDF/B-VIII.0 through criticality benchmark calculations.



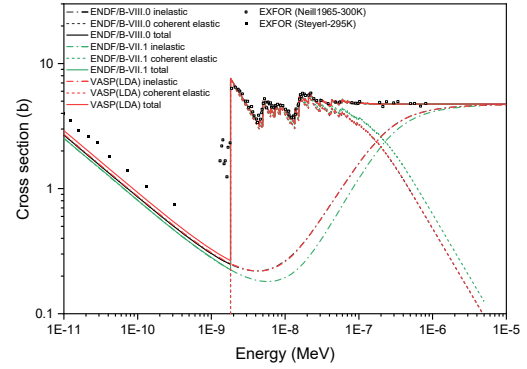
Scattering Cross Sections of H₂O



Criticality Benchmark (LEU) Results for H₂O TSL Data



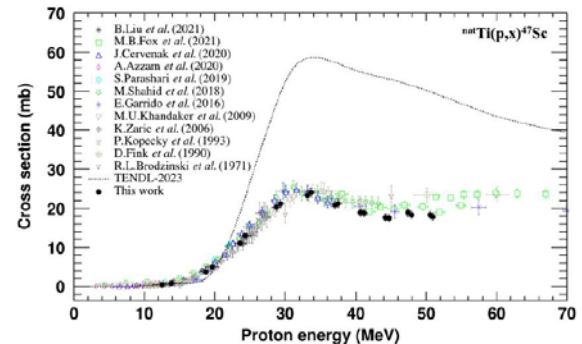
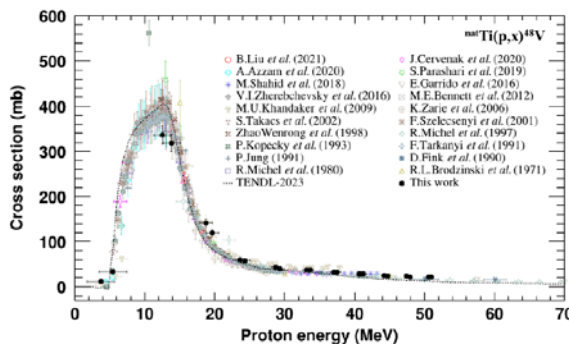
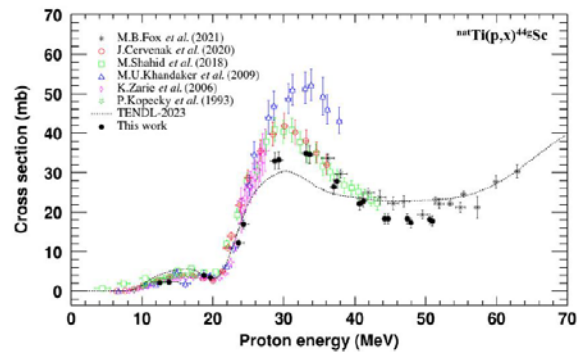
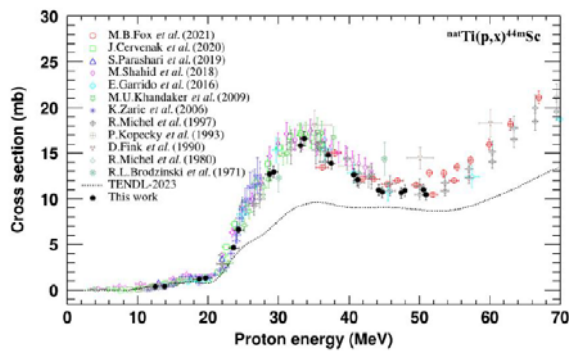
Scattering Cross Sections of D₂O



Scattering Cross Sections of Crystalline Graphite

3.2 Measurement

The production cross sections of $^{nat}\text{Ti}(p,x)$ reactions were measured using off-line γ -ray spectrometry and a stacked-foil activation technique. The activation experiment was performed using a proton energy of 57 MeV at the Korea multi-purpose accelerator complex (KOMAC). The measured cross sections were compared with the experimental data of the literature and the data from the TENDL-2023 library. The production cross section for $^{44,47}\text{Sc}$ produced through the $^{nat}\text{Ti}(p,x)$ reactions can be used as medical isotopes, while $^{nat}\text{Ti}(p,x)^{48}\text{V}$ reaction can be utilized for proton monitoring reaction.




3.3 Cooperation


We continue to cooperate with the following experimental groups for nuclear data production in Korea:

- Kyungpook National University (KNU)
- Sungkyunkwan University (SKKU)
- Institute for Basic Science (IBS)

Since the last meeting, an event has been held in cooperation with KNDC.

- The “4th Reactor Physics Asia Conference (RPHA 2023)” was held in Gyeongju, Korea from October 24 to 26, 2023. This conference was hosted by the Reactor Physics and Computational Science Division of the Korean Nuclear Society, cosponsored by the counterpart divisions of the Chinese Nuclear Society and the Atomic Energy Society of Japan. In the nuclear data field, a total of 14 papers were presented in two sessions. (The total number of submitted papers was 67.)





4th Reactor Physics Asia Conference (RPHA 2023)
2023. 10.24(Tue)-26(Thu)
Gyeongju Hwalbaek International Convention Center (HICO), Gyeongju, Korea

Session Schedule 1 st Day(24 th)				Session Schedule 2 nd Day(25 th)			
#/Schedule	begin	end	Detail	schedule	begin	end	Detail
08:30-09:10	8:30	9:10	Registration	08:30-09:40	8:30	9:40	(C-1) Reactor Analysis Methods (Room 201)
08:10-09:20	8:10	9:20	Opening Remarks (or Welcome Address)	09:40-10:00	9:40	10:00	(A-2) Nuclear Data & Experiment (Lounge meeting room)
08:30-08:50	8:30	8:50	Chinese Plenary Session Presentation	10:00-10:20	10:00	10:20	
08:50-10:20	8:50	10:20	Japanese Plenary Session Presentation	10:20-10:40	10:20	10:40	
10:30-10:50	10:30	10:50	Korean Plenary Session Presentation	10:40-11:00	10:40	11:00	Break Time
10:30-11:00	10:30	11:00	Break Time	11:00-11:30	11:00	11:30	
11:00-11:20	11:00	11:20	(A-1) Nuclear Data & Multi-Group Cross Section (Lounge meeting room)	11:30-11:40	11:30	11:40	(C-1) Reactor Analysis Methods (Room 201)
11:40-12:00	11:40	12:00	(B-1) Radiation Shielding (Lounge meeting room)	11:40-12:00	11:40	12:00	(A-2) Nuclear Data & Experiment (Lounge meeting room)
12:00-12:40	12:00	12:40	Lunch Time	12:00-12:20	12:00	12:20	
12:40-13:00	12:40	13:00	Lunch Time	12:30-12:40	12:30	12:40	
14:00-14:20	14:00	14:20	(A-2) Monte Carlo Method & Codes (Room 201)	12:40-14:00	12:40	14:00	Lunch Time
14:20-14:40	14:20	14:40	Measurement & Reactor Analysis (Lounge meeting room)	14:00-14:20	14:00	14:20	
14:40-15:00	14:40	15:00	Measurement & Reactor Analysis (Lounge meeting room)	14:20-14:40	14:20	14:40	(C-2) Computational Methods & Reactor Design (Lounge meeting room)
15:00-15:20	15:00	15:20	Break Time	14:40-15:00	14:40	15:00	(A-4) Advanced Reactor Core Design (Lounge meeting room)
15:20-15:40	15:20	15:40	Break Time	15:00-15:20	15:00	15:20	
15:40-16:00	15:40	16:00	(A-3) Monte Carlo Method & Codes (Room 201)	15:20-15:40	15:20	15:40	
16:00-16:20	16:00	16:20	Data Measurement & Reactor Analysis (Lounge meeting room)	15:40-16:00	15:40	16:00	Break Time
16:20-16:40	16:20	16:40	Measurement & Reactor Analysis (Lounge meeting room)	16:00-16:20	16:00	16:20	
16:40-17:00	16:40	17:00	Measurement & Reactor Analysis (Lounge meeting room)	16:20-16:40	16:20	16:40	(C-2) Computational Methods & Reactor Design (Lounge meeting room)
17:00-17:20	17:00	17:20	Measurement & Reactor Analysis (Lounge meeting room)	16:40-17:00	16:40	17:00	(A-4) Advanced Reactor Core Design (Lounge meeting room)
17:20-17:40	17:20	17:40	Measurement & Reactor Analysis (Lounge meeting room)	17:00-17:20	17:00	17:20	
				17:20-17:40	17:20	17:40	

Meal place	
2023.10.24 (Tue) Lunch	3000
2023.10.24 (Tue) Dinner	3000
2023.10.25(Wed) Lunch	4th floor Cafeteria

3.4 Web Service

KNDC provides the following three main web services. These websites are constantly being updated.

- Nuclear Data Chart (<http://atom.kaeri.re.kr/nuchart/>): nuclide information, nuclear reaction data, cross section data plot and comparison

- Application Library (<http://atom.kaeri.re.kr/NDVG/>): processed nuclear data library for Monte Carlo (ACE) and deterministic (MATXS) neutron transport codes, processed covariance data (COVFIL), fission product yield and decay data for SCALE
- Atomic Data (<http://pearl.kaeri.re.kr/pearl/>): atomic database including photoionization cross section, electron impact ionization (EII) rate coefficient, and dielectronic recombination (DR) rate coefficient

3.5 Support for Nuclear/Radiation R&Ds

KNDC supports domestic and foreign nuclear/radiation R&Ds by providing nuclear data related information, how to process nuclear data, working libraries for application, etc. The main support details for 2023 were as follows:

- Advice on the use of thermal neutron reaction cross section of Xe-133m (Hanyang Univ.)
- Support for dose distribution analysis using the latest nuclear data for cyclotron-based neutron irradiation tests of semiconductors (KAERI)
- Advisory on the use of cumulative fission product yield data of U-235 in JEFF-3.1 (Ministry of Food and Drug Safety)