

Reliable MVP input files preparation

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Motivation

- Many staff retired or moved after we released JENDL-4.0.
 - They have expert knowledge of nuclear data validation using integral experiments.
 - Human resources development and skill transfer are the issues.
 - We also have to consider reduction of workload.
- JAEA and JENDL committee set up a working group to prepare reliable input files for our Monte Carlo calculation code MVP.
 - Young researchers make input files of integral experiments.
 - Experts support their work.



Skill transfer

About MVP^{*)}

- Standard continuous energy Monte Carlo calculation code for reactor physics in Japan.
 - 1st ver.-1994, 2nd ver.-2005, 3rd ver.-2016
 - MVP can be downloaded from NEA/Data-Bank (NEA-1673).
 - <https://www.oecd-nea.org/tools/abstract/detail/nea-1673/>
- Input format (including geometry) is considerably different.
 - ☺ An MVP input file can be used as an independent verification of an MCNP input file.
 - ☹ A large effort is required to translate input file from MVP to MCNP.

*) Y. Nagaya, et al., JAEA-Data/Code 2016-018.

<https://jopss.jaea.go.jp/search/servlet/search?5055551&language=1>

How to make reliable MVP input files?

- Preparation of documentations
 - We prepared format of input file documentations.
 - People can understand how to make this input file and attention.
- Cross check
 - Calculation results are compared to other calculation results.
 - Benchmark documents
 - Benchmark results of each nuclear data library
 - Third party check (but not enough...)



Input file documents

- Some input files are released as JAEA report
 - JAEA-Data/Code 2017-006
 - This report contains input files and input information being prepared
 - Excel is used to describe input information
- Other input files are now preparing.



[Example of input information]

2013年10月17~22日 石川

<共通事項>
 Critical Mass Laboratory at Pacific North Laboratories (PNL)
 UO 35 O₂燃料
 燃料管外形: 1.27cm, 厚さ: 0.0762cm, 長さ: 97.73cm
 燃料管外径: 1.175cm, 長さ: 91.44cm
 下部炭柱: 1.27cm, 上部炭柱: 5.08cm
 四角クラス、ピンピッチ: 2.032cm
 アクリル支持板厚さ: 2.54cm
 水反射体の厚さ-径方向: 30cm, 上方: 9.92cm, 下方: 15.3cm
 水温度: 22°C

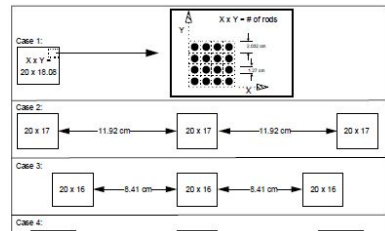
<計算条件>
 MVPライブラリ: JENDL-4.0
 オプション: RUSSIAN-ROULETTE
 10,000ヒストリ/バッチ
 2,100バッチ
 (内、100バッチ捨て)

* MCNP誤差 < 0.00015

JENS T論文	参考O/E値		平均値との差	
	ENDF/B-VII.0	ENDF/B-VII.1	VII.0	VII.1
1	1.0005	0.9987	0.00110	0.00110
2	0.9988	0.9982	0.00054	0.00054
3	0.9981	0.9901	-0.00017	-0.00017
4	0.9992	0.9956	0.00066	0.00066
5	0.9974	0.9973	-0.00135	-0.00135
6	0.9980	0.9987	0.00048	0.00048
7	0.9987	0.9957	-0.00020	-0.00020
8	0.9978	0.9976	-0.00104	-0.00104
平均値	0.9989	0.9947		
標準偏差	0.00094	0.00086		

ケース	今回の解析* (JENDL-4.0)	参考O/E値			平均値との差		
		JNST論文** (JENDL-4.0)	ENDF/B-VII.0***	ENDF/B-VII.1***	今回の解析	VII.0	VII.1
1	1.0000	1.0005	1.0001	0.9998	0.0016	0.0011	0.0011
2	0.9988	—	0.9984	0.9982	0.0004	0.0005	0.0005
3	0.9985	—	0.9890	0.9885	0.0001	-0.0002	-0.0002
4	0.9992	—	0.9995	0.9993	0.0007	0.0007	0.0007
5	0.9967	—	0.9974	0.9973	-0.0017	-0.0014	-0.0014
6	0.9980	—	0.9984	0.9981	0.0005	0.0005	0.0005
7	0.9980	—	0.9986	0.9985	-0.0004	-0.0002	-0.0002
8	0.9978	—	0.9977	0.9976	-0.0012	-0.0010	-0.0010
平均値	0.9985	—	0.9989	0.9987			
標準偏差	0.0011	—	0.0009	0.0009			

* MVP誤差 < 0.00017
 ** MVP誤差 < 0.00025
 *** MCNP誤差 < 0.00015



Benchmark cases

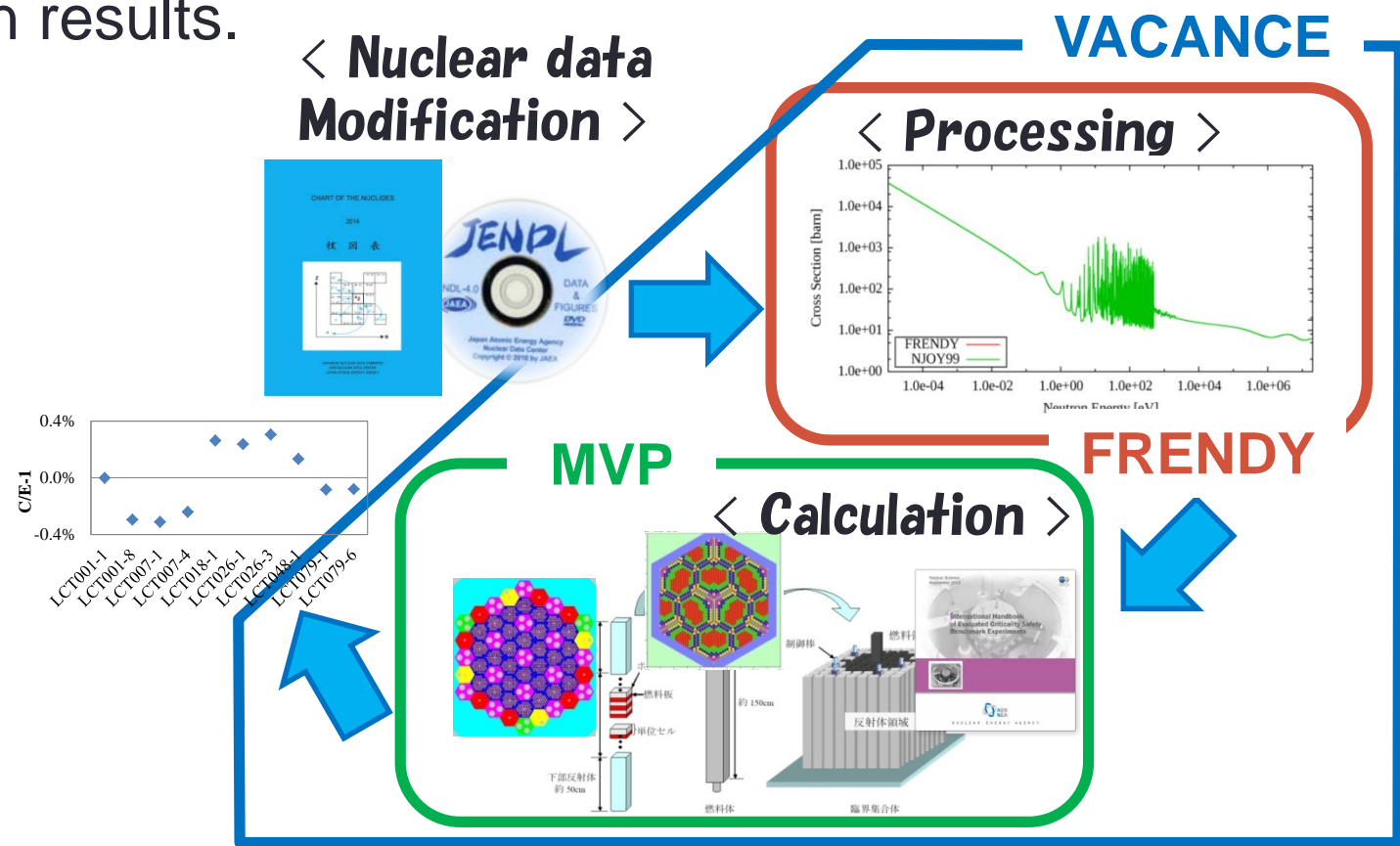
- Uploaded MVP input files mainly focus on intermediate and thermal spectrum.
 - Closed experimental results of JOYO, Monju, FCA, and ZPPR are mainly used for fast spectrum.
- We selected ICSBEP benchmarks which are used for the validation of nuclear data library.
 - JENDL-4.0, ENDF/B-VII.0, -VII.1
- Future works
 - Mosteller suite
 - To compare JEFF library
 - MIT BEAVRS Benchmark

Number of ICSBEP benchmark cases

	COMP	METAL	SOL	Total
PU			159	159
HEU	7	62	42	111
IEU	6			6
LEU	249	10	8	267
MOX	63			63
U233	9	10	147	166
Total	334	82	356	772

Automation of nuclear data validation

- Consideration of workload reduction
 - Development of automatic calculation system **VACANCE**
 - **VACANCE** automatically runs **FRENDY** and **MVP** and edits calculation results.



Features of VACANCE

- Can treat FRENDY, NJOY, MVP, and MCNP
- Automatic input file search
 - VACANCE automatically searches all input files in the user specified directories.
- Automatic input file modification
 - To easily change the input option and nuclear data library
 - Number of histories, batch size, flux output option, ...
 - JENDL → ENDF/B, JEFF, TENDL, ...
- Enables a parallel computation using OpenMP
 - To efficiently run hundreds of calculations

Concluding remarks

- JAEA and JENDL committee set up a working group to prepare reliable MVP input files.
 - For skill transfer and workload reduction
 - Preparing documentations and cross check contribute quality enhancement.
- About JAEA MVP input suite
 - Fast spectrum experiments without U-233 are not covered.
 - We selected ICSBEP benchmarks which are used in the validation of nuclear data library.
- Automation of nuclear data validation system is developed for workload reduction.

Input files list (1/2)

HEU-COMP-INTER-003	7	HEU-METAL-THERM-031	1	LEU-COMP-THERM-009	27
HEU-METAL-FAST-015	1	HEU-METAL-THERM-033	1	LEU-COMP-THERM-010	30
HEU-METAL-FAST-016	2	HEU-METAL-THERM-050	11	LEU-COMP-THERM-011	15
HEU-METAL-FAST-065	1	HEU-SOL-THERM-002	14	LEU-COMP-THERM-017	29
HEU-METAL-INTER-001	1	HEU-SOL-THERM-010	4	LEU-COMP-THERM-018	1
HEU-METAL-INTER-006	3	HEU-SOL-THERM-013	4	LEU-COMP-THERM-019	3
HEU-METAL-THERM-001	1	HEU-SOL-THERM-032	1	LEU-COMP-THERM-022	7
HEU-METAL-THERM-003	7	HEU-SOL-THERM-042	8	LEU-COMP-THERM-024	2
HEU-METAL-THERM-006	23	HEU-SOL-THERM-050	11	LEU-COMP-THERM-025	4
HEU-METAL-THERM-008	1	INTER-COMP-THERM-002	6	LEU-COMP-THERM-026	4
HEU-METAL-THERM-009	1	LEU-COMP-THERM-001	8	LEU-COMP-THERM-027	4
HEU-METAL-THERM-010	2	LEU-COMP-THERM-002	5	LEU-COMP-THERM-030	2
HEU-METAL-THERM-012	1	LEU-COMP-THERM-003	23	LEU-COMP-THERM-033	6
HEU-METAL-THERM-013	2	LEU-COMP-THERM-005	16	LEU-COMP-THERM-035	3
HEU-METAL-THERM-014	1	LEU-COMP-THERM-006	18	LEU-COMP-THERM-048	5
HEU-METAL-THERM-016	1	LEU-COMP-THERM-007	10	LEU-COMP-THERM-064	1
HEU-METAL-THERM-018	1	LEU-COMP-THERM-008	5	LEU-COMP-THERM-079	10

Input files list (2/2)

LEU-COMP-THERM-080	11	PU-SOL-THERM-002	7	U233-METAL-FAST-004	2
LEU-METAL-THERM-001	1	PU-SOL-THERM-003	8	U233-METAL-FAST-005	2
LEU-METAL-THERM-006	3	PU-SOL-THERM-004	13	U233-METAL-FAST-006	1
LEU-METAL-THERM-007	6	PU-SOL-THERM-007	8	U233-SOL-INTER-001	30
LEU-SOL-THERM-020	4	PU-SOL-THERM-008	29	U233-SOL-MIDDLE-001	3
LEU-SOL-THERM-ERM-021	4	PU-SOL-THERM-009	6	U233-SOL-MIDDLE-002	5
MOX-COMP-THERM-001	4	PU-SOL-THERM-011	12	U233-SOL-THERM-001	5
MOX-COMP-THERM-002	6	PU-SOL-THERM-012	23	U233-SOL-THERM-002	17
MOX-COMP-THERM-003	6	PU-SOL-THERM-018	9	U233-SOL-THERM-003	10
MOX-COMP-THERM-004	11	PU-SOL-THERM-021	6	U233-SOL-THERM-004	8
MOX-COMP-THERM-005	7	PU-SOL-THERM-022	17	U233-SOL-THERM-005	2
MOX-COMP-THERM-006	6	PU-SOL-THERM-028	15	U233-SOL-THERM-008	1
MOX-COMP-THERM-007	5	U233-COMP-THERM-001	8	U233-SOL-THERM-009	4
MOX-COMP-THERM-008	6	U233-COMP-THERM-004	1	U233-SOL-THERM-012	8
MOX-COMP-THERM-009	6	U233-METAL-FAST-001	1	U233-SOL-THERM-013	21
MOX-COMP-THERM-011	6	U233-METAL-FAST-002	2	U233-SOL-THERM-015	26
PU-SOL-THERM-001	6	U233-METAL-FAST-003	2	U233-SOL-THERM-017	7