

## Comments on Organizing a Subgroup for Intermediate Energy Nuclear Data Evaluation

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### 1. Background

It is well known that many applications, such as accelerator-driven radioactive waste management, medical applications like radiation therapy and RI production, research of cosmic-ray effects on spaceship and astronauts, require the intermediate energy nuclear data, and the evaluation works should be started. The evaluation works, however, have been just started as case-studies, and few experience for the intermediate energy nuclear data evaluation is available.

On the other hand, some experimental data are available for those purposes, for instance, those measured by LAMPF group and KFA group. Several theoretical codes were also developed, such as ALICE, GNASH, LAHET, HETC, NMTC, EXIFON. According to this situation, a few comparisons of benchmark calculation by several codes have been performed by Nagel (NEA/DB, NEANSC task force) and Fukahori et al. (JNDC, to be published by JAERI-M report). Those works are the good examples to make a foundation on the evaluation in this energy region.

### 2. Policy on Organizing Subgroup

The evaluation work can be separated to two tasks, which are to perform a fundamental research and to make a common concept on producing the evaluated intermediate energy nuclear data file. The fundamental research such as model developments and theoretical code productions should be performed individually. The collaboration should be organized to review common problems during a production of the evaluated file and to search the answers for them. It is also important to avoid both unnecessary format conversion and the duplication of evaluation works, which was observed in the process of neutron nuclear data below 20 MeV.

The examples of common questions might be looked over as following.

- What kinds of applications should be focused in consideration to produce the evaluated file?
- How to pick up the required quantities for the intermediate energy nuclear data?
- What kinds of nuclides are needed to considering application?
- How to select the basic data and parameters needed to the evaluation calculation?
- How to compile the evaluated data?

A subgroup (SG) for the intermediate energy nuclear data evaluation should be organized to discuss common concept like above. The results of the benchmark calculations must be also useful for the discussion.

### 3. Subjects of Subgroup

For the subjects of the SG on the intermediate energy nuclear data evaluation, following might be recommended, for example.

- To discuss the necessary quantities to be included in the evaluated file.
- To discuss the common format of files.
- To survey and collect the experimental data, the basic parameters, etc. needed to the calculation of the intermediate energy nuclear data.
- To review the evaluation methods now available.

The subjects of the SG should be common things to produce the evaluated intermediate energy nuclear data files.

The candidates of the SG participant from Japan might be suggested;

- Yasuyuki Kikuchi (JAERI)
- Tokio Fukahori (JAERI)
- Satoshi Chiba (JAERI)
- Hiroshi Takada (JAERI)
- Norio Kishida (CRC Co. Ltd.)
- Yukinobu Watanabe (Kyushu Univ.)

# Japanese Activities on Intermediate Energy Nuclear Data Evaluation

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## 1. Introduction

The intermediate energy nuclear data activity in Japan aims at providing the evaluated data to the following two domains: One is the ESNIT project, a high intensity fusion neutron source of FMIT type using Li(d,n) reaction. The data required are the neutron data up to 50 MeV for the structural and target materials because of the high energy tail of Li(d,n) reaction. The other is the development of high energy proton accelerator which will be used for TRU transmutation. The required data are the proton and neutron induced data up to a few GeV.

## 2. Development of Evaluation Methodologies

### 2.1. Expanding Conventional Theoretical Calculation Codes up to About 50 MeV

- The neutron data up to 50 MeV can be obtained by expanding the conventional method.
- In order to use the evaluation calculations, the research and development of theoretical calculation codes is in progress. The considered codes are based on CASTHY, ELIESE-3, GNASH, EXIFON, SCINFUL, etc.

### 2.2. Developing Theoretical Calculation Codes for Higher Energy

- The ALICE-F code system is under improvement to apply to the intermediate nuclear data evaluation.
- The systematics of intermediate energy fission cross section were produced for the atomic mass range from tungsten to bismuth, and are expanding to both of wide mass range and treating mass distribution and emitted particle spectra.
- Tests of the several codes applicable to the intermediate energy nuclear data evaluation are being performed.
- The code system simulating more rigorously the nuclear reactions in the nucleus using the quantum molecular dynamics theory is now being developed in JAERI. This system can treat not only nucleon induced reactions but also heavy ion induced reactions, and can directly calculate meson production, multi-fragmentation, fission, and fusion, etc.

### 2.3. Intercomparison of the Codes

- The intercomparisons of benchmark calculations were performed for isotope production cross sections with neutron bombardment below 50 MeV, considering ALICE-F, MCEXCITON, EXIFON, SINCROS-II, NUCLEUS and HETC/3STEP.
- The intercomparisons of benchmark calculations were also performed for isotope production cross sections with proton induced reactions below 1 GeV. The considered

codes were ALICE-F, MCEXCITON, NUCLEUS and HETC/3STEP. The results will be published in JAERI-M report near future.

- The calculated results of the double differential neutron and proton emission cross sections by ALICE-F, NUCLEUS, etc. were submitted to the international benchmark calculation organized by Nagel (NEA/DB).

### 3. Evaluation Works

#### 3.1. Evaluation up to 50 MeV

- The evaluation and review works were started. The selection of nuclides has been done. In this year, the tasks are focused to the data below 50 MeV.
- The review method was decided to check format and comparisons the evaluated data with the available experimental data.
- The format of the evaluated file was adopted to be ENDF-6 format just like ENDF/B-VI High Energy file.
- The calculations of activation and isotope production cross sections have been done for structural materials in the neutron energy range below 50 MeV by SINCROS-II code system.

#### 3.2. Evaluation of Higher Energy Data

- The calculations of activation and isotope production cross sections have been done for 137 nuclides from H-1 to Bi-209 of n, p, d, alpha and several heavy ion mainly below 150 MeV by ALICE-F code system.
- The case-studies of evaluation have been performed for Al-27, Cr-52, Ni-58,60, Pb-204,206,207,208 and Bi-209 in the neutron and proton energy range up to 1 GeV by ALICE-F code system.
- The specialists' meeting on high energy nuclear data was held on Oct. 3-4, 1991, and its proceedings is available by JAERI-M 92-039 (INDC(JPN)-158/L).

### 4. Database Production

- The CHESTOR (CHarged particle Experimental data Storage and Retrieval system) were developed by converting EXFOR data. The experimental data of p, d, t, He-3, alpha and gamma-ray incident reactions are included in this system.
- The experimental data of thick target neutron emission yields were collected and compiled for several elements in the EXFOR format.
- The database of nucleon-nucleon scattering is available up to 1 GeV by converting the results of phase-shift analysis to Legendre coefficients.

### 5. Utility Codes Development

- The thick target yield calculation code is now under development. It can calculate the thick target particle emission yield from the evaluated data.
- The code system for calculation of primary knock-on atom (PKA) spectra has been produced. It can convert the particle spectra in the evaluated nuclear data file to PKA spectra, displacement per atom (DPA) cross section, KERMA factor, etc.