Report of Workshop on EXFOR Compilation 2014

DAGVADORJ Ichinkhorloo
Meme Media Laboratory, Hokkaido University

Abstract

The Workshop on The Experimental Nuclear Reaction Data Database compilation was held at International Atomic Energy Agency in Vienna, Austria from 6 to 10 October 2014. This report summarizes the contents of the workshop on the EXFOR compilation process including compilation rules, different techniques for nuclear reaction data measurements, software developments, etc.

1 Introduction

The workshop on The Experimental Nuclear Reaction Data Database (EXFOR) was held at International Atomic Energy Agency (IAEA) in Vienna, Austria from 6 to 10 October 2014. The workshop aims to discuss various aspects of the EXFOR compilation process including compilation rules, different techniques for nuclear reaction data measurements, software developments, etc. Eleven participants from different Nuclear Reaction Data Centres and four staff from the IAEA attended the Workshop which is national, regional and specialized centres, coordinated in the compilation by the IAEA, about exchange and dissemination of nuclear reaction data in order to meet the requirements of nuclear data users in all countries. There were several presentations and compilation exercises including EXFOR compilation rules, different techniques for nuclear reaction data measurements, software developments, etc. scheduled 5 days of the workshop.

2 Objectives

In the welcome address, S. Simakov (IAEA) and R. Forrest (IAEA) greeted participants of the Workshop on EXFOR compilation. N. Otsuka was Chairperson of the Workshop. During the Workshop participants discussed several presentations and carried out compilation exercises.

2.1 Main Topics of the Agenda

The agenda covered in the EXFOR workshop is discussed below:

- Some comments on EXFOR compilation:

Technical remarks from the reviewers were discussed by N.Otsuka. Many of them are treated as recommendations rather than (proposals of) new rules. Some of them could be further discussed and added to the manuals if appropriate. The goal is to make key information more visible in a simple and concise EXFOR database.

- Compilation of beta-delayed neutron emission data:

Compilation of beta-delayed neutron emission data were presented by V. Semkova. The main characteristics of the beta-delay neutron emission, the measurement techniques and the compilation rules were discussed in accordance with the decision of the NRDC Meeting 2014 to include beta-delayed neutron spectra from specific precursors in the scope of the EXFOR compilation. The rules for the compilation of the emission probabilities have been revised in order to take into account the probability of the emission of more than one beta-delayed neutron from a precursor.

- Results of the ^{100}Mo(p, $2n$)^{99m}Tc cross section measurements and possible systematic errors:

S. Takacs introduced about results of the ^{100}Mo(p, $2n$)^{99m}Tc cross section measurements. The nuclear medicine community are expressing concerns regarding potential shortages of ^{99m}Tc supply based on the fission production of ^{99}Mo from highly-enriched uranium (HEU) to prepare ^{99}Mo/^{99m}Tc generators. As an alternative to a reactor-produced ^{99}Mo/^{99m}Tc generator technology, the direct accelerator production of ^{99m}Tc is considered. However, the most of the available experimental cross section data for ^{100}Mo(p, $2n$)^{99m}Tc reaction have the same general shape while their amplitudes are different. The aim of this study was to determine the absolute amplitude of the excitation function of ^{100}Mo(p, $2n$)^{99m}Tc reaction. The excitation function of the ^{100}Mo(p, $2n$)^{99m}Tc reaction determined in the three independent irradiations using analytically derived equations and the data evaluation are in perfect agreement. This agreement proves that the main discrepancy among the published experimental cross section data of the ^{100}Mo(p, $2n$)^{99m}Tc reaction could originate from the data evaluation methods.

- Definition of radioisotope thick target yields:

S. Takacs also presented problems and confusions about definitions of yields. There is some confusion among the different definitions and use of the experimental yields of charged particle induced reactions in everyday use. Different physical quantities like production rates, EOB activity (activity at the end of bombardment) are called yield and the applied units are mixed up as well which make proper compilation of the reported data difficulty.

- Neutron Kerma factors in EXFOR: actual status and missing published results:

Neutron Kerma factors were discussed by S. Simakov. KERMA (K) is a Kinetic Energy Released in Matter per mass unit, K = dE/dm. K accounts for the energy deposition from all charged p, d, α and e of nuclear reaction including heavy recoils which deposit their energy locally, respectively.. However, it excludes neutral reaction products (n, γ) which deposit energy non-locally, i.e. at large distance from collision. Here, we discussed and made proposal for Kerma data available in EXFOR and published in the literature.

- Some problems of photonuclear data compilation and evaluation:

Experimental photonuclear data research is a complicated problem for several reasons. Those were discussed by V. Varlamov. As a result there are many data with significant systematic uncertainties obtained with the different experimental measurement methods and data processing procedures. Therefore, there are many problems in photonuclear data compilation and evaluation.

- Compilation of neutron data in the resolved resonance region measured by TOF method. Spectrometers ' response function

V. Semkova reported about the nuclear data for the neutron-induced reaction in the resonance range which have been extensively compiled in EXFOR. The time-of-flight spectra are valuable for future analysis and compilation of them has been desired of the NRCD community for many decades. The spectrometers response functions are needed for comparison of data measured at different experimental facilities. The resolution broadening has to be applied to evaluated data in order to compare experimental data with the evaluation. During the meeting, possibilities for the compilation in EXFOR of the TOF spectrometer response functions were discussed, which can be required for the neutron spectroscopy applications.

- Neutron source spectra format

Neutron source spectra with EXFOR format rules, present status and proposals for neutron source data storage were discussed by O. Gritzay.

- Nuclear astrophysics data. Calculations of nuclear astrophysics and californium neutron cross section uncertainties using ENDF/B-VII.1, JEFF-3.1.2, JENDL-4.0 and low-fidelity covariances.

The calculations of nuclear astrophysics and californium neutron cross section uncertainties using ENDF/B-VII.1, JEFF-3.1.2, JENDL-4.0 and low-fidelity covariance were introduced by B. Pritychenko. Nuclear astrophysics and californium fission neutron spectrum averaged cross sections and their uncertainties for ENDF materials have been calculated. Absolute values were deduced with Maxwellian and Mannhart spectra, while uncertainties are based on ENDF/B-VII.1, JEFF-3.1.2, JENDL-4.0 and Low-Fidelity covariance. These quantities are compared with available data, independent benchmarks, EXFOR library, and analyzed for a wide range of cases. Recommendations for neutron cross section covariance are given and implications are discussed.

- Structure of software on graphic data processing for the EXFOR data library.

The software on graphic data processing for the EXFOR data library was presented by G. Pikulina, S.Taova and S. Dunaeva. The previous version of InpGraph was designed more than 10 years ago. It was developed for internal needs. The main advantage of this version is a special processing procedure that provides compilation of image data of old images into EXFOR format. But the old version of InpGraph demands additional training of users as a strict order of digitizing operations. This fact decreases the number of its potential users. More friendly interface with modern trends was created in the present version.

- Introduction to the digitization software GDgraph

The digitization software GDgraph 5.0 was introduced by Guochang Chen. GDgraph is software for digitization. Since 1997, the digitization software GDgraph has been developed to fit the requirements of evaluation, measurement and EXFOR compilation.

- Digitization software GSYS

D.Ichinkhorloo introduced last version of digitization software, GSYS 2.4.7. She explained the main features of GSYS2.4.7 and using for reading the numerical data from an image file.

3 Participants

Eleven participants from different Nuclear Reaction Data Centres and four staff from the IAEA attended the Workshop (Appendix I) . Group photo of all the participants in shown in Fig.1.

Fig. 1: Group photo of the conference

4 Summary

The Workshop on EXFOR Compilation 2014 was successfully held in IAEA. Total 15 participants joined the workshop. Several presentations have given to extensive discussions, and produced valuable suggestions. In addition to discussions, several compilation and digitization exercises were carried out.

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Annex. I

List of Participants

NAME	AFFILIATION
Otto Schwerer	AUSTRIA
Sandor Takacs	Hungarian Academy of Sciences, HUNGARY
Nurzat Kenzhebayev	Al-Farabi Kazakh National University, KAZAKHSTAN
Galina Pikulina	Institute of Experimental Physics, RUSSIAN FEDERATION
Sophiya Taova	Institute of Experimental Physics, RUSSIAN FEDERATION
Marina Mikhailiukova	Institute for Physics and Power Engineering, RUSSIAN FEDERATION
Vladimir Varlamov	Lomonosov Moscow State University, RUSSIAN FEDERATION
Guochang Chen	China Institute of Atomic Energy, CHINA
Dagvadorj Ichinkhorloo	Hokkaido University, JAPAN
Boris Pritychenko	Brookhaven National Laboratory, UNITED STATES OF AMERICA
Olena Gritzay	Institute for Nuclear Research, UKRAINE
Valentina Semkova	Nuclear Data Section, IAEA
Naohiko Otsuka	Nuclear Data Section, IAEA
Stanislav Simakov	Nuclear Data Section, IAEA
Viktor Zerkin	Nuclear Data Section, IAEA

Annex. II

Program

	Monday, 6 October 2014	
9:30-12:30		
10 min.	Welcome Address	R. Forrest
15 min.	Self-introduction	All
5 min.	Announcement	K. Nathani
10 min.	Objectives of the workshop	V. Semkova
150 min.	Some comments on EXFOR compilation	N. Otsuka
12:30-14:00	Lunch	
14:00-18:00		
60 min.	Compilation of beta-delayed neutron emission data	V. Semkova
180 min.	Compilation exercises on beta-delayed neutron emission data	All
	Tuesday, 7 October 2014	
9:00-13:00		
30 min.	Review of the compilation exercise of 6th October .	V. Semkova
30 min.	EXFOR compilations for CIELO project .	B. Pritychenko
60 min.	Results on the ^{100}Mo(p, $2n$)^{99m}Tc cross section measurements and possible systematic errors. Definition of radioisotope thick target yields	S. Takacs
60 min.	Kerma factors in EXFOR: actual and missing published results	S.P. Simakov
13:00-14:00	Lunch	
14:00-18:00		
240 min.	Compilation exercises on charged particle-induced data and Kerma factors	All
	Wednesday, 8 October 2014	
9:00-13:00		
45 min.	Review of the compilation exercise of 7th October .	S. Takacs S.P. Simakov N. Otsuka

45 min.	Some problems of photonuclear data compilation and evaluation	V. Varlamov
45 min.	Compilation of neutron data in resolved resonance region measured by TOF method. Spectrometers response function	V. Semkova
45 min.	Neutron source spectra format .	O. Gritzay
13:00-14:00	Lunch	
14:00-18:00		
240 min.	Compilation exercises on neutron-induced and photonuclear data	All
	Thursday, 9 October 2014	
9:00-13:00		
60 min.	Nuclear astrophysics data. Calculations of nuclear . astrophysics and californium neutron cross section uncertainties using ENDF/B-VII.1, JEFF-3.1.2, JENDL-4.0 and low-fidelity covariances	B. Pritychenko
30 min.	Structure of software on graphic data processing for . the EXFOR data library	G. Pikulina
30 min.	Users interface of a program on graphic data processing for the EXFOR data library: approaches, solutions, capabilities	S. Taova
30 min.	Introduction of digitization software GDgraph Chen Guochang	
30 min.	Digitization software GSYS .	D. Ichinkhorloo
30 min.	Digitization capabilities of Origin 9.0	B. Marcinkevicius
13:00-14:00	Lunch	
14:00-18:00		
240 min.	Digitization tools and compilation exercises on nuclear astrophysics data	All
	Friday, 10 October 2014	
9:00-13:00		
1.	Review of the compilation exercises of 8th and 9th October	B. Pritychenko V. Varlamov N. Otsuka
2.	Discussions	
3.	Closing of the meeting	