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IAEA

International Atomic Energy Agency

INDC

INTERNATIONAL NUCLEAR DATA COMMITTEE

Summary Report of the Workshop on

Compilation of Experimental Nuclear Reaction Data

IAEA Headquarters, Vienna, Austria

3 – 6 December 2024

Prepared by

Naohiko Otuka
IAEA Nuclear Data Section, Vienna, Austria

and

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January 2025

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Abstract

This report summarizes the IAEA Workshop on Compilation of Experimental Nuclear Reaction Data held at the IAEA Headquarters in Vienna, Austria from 3 to 6 December 2024. The workshop was attended by 27 participants representing 11 cooperative Centres from seven Member States (China, Hungary, India, Japan, Russia, Ukraine and USA) and two International Organisations (IAEA, NEA) as well as a participant from Austria, Germany, Japan, Mongolia and Ukraine. A summary of the workshop is given in this report along with the recommendations.

Workshop on Compilation of Experimental Nuclear Reaction Data
IAEA Headquarters, Vienna, Austria, 3 – 6 December 2025

From the left

Koki Ono, IAEA

Alejandra Martinez, IAEA

Naohiko Otsuka, IAEA

Masayuki Aikawa, Japan

Ayano Makinaga, Japan

Viktor Zerkin Ukraine

Boris Pritychenko, USA

Sándor Takács, Hungary

Tamas Tornyi, Hungary

Atsushi Kimura, Japan

Vidya Devi, India

Alexander Konobeyev, Germany

Julia Sprenger, NEA

Jimin Wang, China

Yongli Jin, China,

Odsuren Myagmarjav, Mongolia

Remote participants (from the top)

Svetlana Dunaeva, Russia

Olena Gritzay, Ukraine

Galina Pikulina, Svetlana Selyankina and Sophiya Taova, Russia

Marina Mikhailiukova, Russia

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THE INTERNATIONAL NETWORK OF NUCLEAR REACTION DATA CENTRES

National, regional and specialized nuclear reaction data centres, coordinated by the International Atomic Energy Agency, cooperate in the compilation, exchange and dissemination of nuclear reaction data in order to meet the requirements of nuclear data users in all countries. At present, the following data centres participate in the network:

NNDC	US National Nuclear Data Center, Brookhaven National Laboratory, Upton, USA
NEA DB	OECD NEA Data Bank, Boulogne-Billancourt, France
NDS	IAEA Nuclear Data Section, Vienna, Austria
CJD	Russian Nuclear Data Centre, Institute of Physics and Power Engineering, Obninsk, Russia
CNDC	China Nuclear Data Centre, China Institute of Atomic Energy, Beijing, China
ATOMKI	Charged-Particle Nuclear Reaction Data Group, Institute for Nuclear Research (ATOMKI), Debrecen, Hungary
NDPCI	Nuclear Data Physics Centre of India, Bhabha Atomic Research Centre, Trombay, Mumbai, India
JAEA/NDC	Nuclear Data Center, Japan Atomic Energy Agency, Tokai-mura, Japan
JCPRG	Nuclear Reaction Data Centre, Hokkaido University, Sapporo, Japan
KNDC	Nuclear Data Center, Korea Atomic Energy Research Institute, Daejeon, Republic of Korea
CDFE	Centre for Photonuclear Experiments Data, Moscow State University, Moscow, Russia
CNPD	Centre of Nuclear Physics Data, Institute of Nuclear and Radiation Physics, Russian Federal Nuclear Center – All-Russian Research Institute of Experimental Physics, Sarov, Russia
UkrNDC	Ukrainian Nuclear Data Centre, Institute for Nuclear Research, Kyiv, Ukraine

A detailed description of the objectives of the network and the contributions of each Centre to these activities are given in INDC(NDS)-401 (Rev.6), "International Network of Nuclear Reaction Data Centres".

PREVIOUS NRDC MEETINGS

Vienna, 14-17 May 2024	Technical	INDC(NDS)-0902
Vienna, 9-12 May 2023	Centre Heads + Technical	INDS(NDS)-0879
Vienna, 14-17 June 2022	Technical	INDC(NDS)-0857
Virtual, 4-7 May 2021	Technical	INDC(NDS)-0829
Vienna, 9-12 April 2019	Technical	INDC(NDS)-0792
Bahadurgarh, 1-4 May 2018	Centre Heads + Technical	INDC(NDS)-0762
Vienna, 23-26 May 2017	Technical	INDC(NDS)-0736
Beijing, 7-10 June 2016	Centre Heads + Technical	INDC(NDS)-0718
Vienna, 21-23 April 2015	Technical	INDC(NDS)-0686
Smolenice, 6-9 May 2014	Centre Heads + Technical	INDC(NDS)-0661
Vienna, 23-25 April 2013	Technical	INDC(NDS)-0633
Paris, 16-19 April 2012	Centre Heads + Technical	INDC(NDS)-0618
Vienna, 23-24 May 2011	Technical	INDC(NDS)-0593
Sapporo, 20-23 April 2010	Centre Heads + Technical	INDC(NDS)-0573
Vienna, 25-26 May 2009	Technical	INDC(NDS)-0558
Obninsk+Moscow 22-25 Sept. 2008	Centre Heads + Technical	INDC(NDS)-0536
Vienna, 8-10 October 2007	Technical	INDC(NDS)-0519
Vienna, 25-28 September 2006	Centre Heads + Technical	INDC(NDS)-0503
Vienna, 12-14 October 2005	Technical	INDC(NDS)-0480
Brookhaven, 4-7 October 2004	Centre Heads + Technical	INDC(NDS)-464
Vienna, 17-19 June 2003	Technical	INDC(NDS)-446
Paris, 27-30 May 2002	Centre Heads + Technical	INDC(NDS)-434
Vienna, 28-30 May 2001	Technical	INDC(NDS)-427
Obninsk, 15-19 May 2000	Centre Heads + Technical	INDC(NDS)-418
Vienna, 18-20 May 1999	Technical	INDC(NDS)-407
Vienna, 11-15 May 1998	Centre Heads + Technical	INDC(NDS)-383
Vienna, 26-28 May 1997	Technical	INDC(NDS)-374
Brookhaven, 3-7 June 1996	Center Heads + Technical	INDC(NDS)-360
Vienna, 2-4 May 1995	Technical	INDC(NDS)-343
Paris, 25-27 April 1994	Center Heads + Technical	INDC(NDS)-308
Vienna, 1-3 Sept 1992	Technical	INDC(NDS)-279
Obninsk, 7-11 Oct 1991	Center Heads + Technical	INDC(NDS)-0262
Vienna, 13-15 Nov 1990	Technical	Memo CP-D/210
Vienna, 2-4 Oct 1989	Centre Heads + Technical	Memo CP-D/200
Vienna, 4-6 Oct 1988	Technical	Memo CP-D/190
Brookhaven, 27-29 Oct 1987	Center Heads + Technical	INDC(NDS)-204
Vienna, 7-9 Oct 1986	Technical	Memo CP-D/159
Saclay, 9-11 Oct 1985	Center Heads + Technical = 8^{th} NRDC Meeting	INDC(NDS)-178
Vienna, 19-21 Sept 1984	Technical	Memo CP-D/131
Obninsk+Moscow, 17-21 Oct 1983	7^{th} NRDC Meeting	INDC(NDS)-154
Vienna, 3-7 May 1982	6^{th} NRDC Meeting	INDC(NDS)-141
Brookhaven, 29.9 - 2.10.1980	5^{th} NRDC Meeting	INDC(NDS)-125
Karlsruhe, 8-13 Oct 1979	4^{th} NRDC Meeting	INDC(NDS)-110
Paris, 19-23 June 1978	3^{rd} NRDC Meeting	INDC(NDS)-99
Kiev, 11-16 April 1977	2^{nd} NRDC Meeting = 3^{rd} CPND + 13th 4-C	INDC(NDS)-90

Vienna, 28-30 April 1976	2nd CPND Meeting	INDC(NDS)-77
Vienna, 26-27 April 1976	12th 4C-Meeting	INDC(NDS)-78
Vienna, 8-12 Sept 1975	CPND Meeting	INDC(NDS)-69+71
Brookhaven, 10-14 March 1975	11th 4C-Meeting	INDC(NDS)-68
Paris, 6-10 May 1974	10th 4C Meeting	INDC(NDS)-58
Vienna, 24-26 April 1974	CPND + PhotoND	INDC(NDS)-59+61
Moscow/Obninsk, 4-8 June 1973	9th 4C Meeting	INDC(NDS)-54
Vienna, 16-20 Oct 1972	8th 4C Meeting	INDC(NDS)-51
Brookhaven, 25-29 Oct 1971	7th 4C Meeting	INDC(NDS)-41
Paris, 5-9 Oct 1970	6th 4C Meeting	INDC(NDS)-28
Moscow, 17-21 Nov 1969	5th 4C Meeting	INDC(NDS)-16

LIST OF ACRONYMS

ATOMKI	Nuclear Research Institute, Debrecen, Hungary
BARC	Bhabha Atomic Research Centre, Trombay, Mumbai, India
BNL	Brookhaven National Laboratory, Upton, New York, USA
BROND	Russian Evaluated Neutron Reaction Data Library
C4	Computational format for EXFOR data
CAJaD	Centre for Nuclear Structure and Reaction Data, Kurchatov Institute, Moscow, Russia
CDFE	Centr Dannykh Fotojad. Eksp., Moscow State University, Russia
CENDL	Chinese Evaluated Neutron reaction Data Library
CHEX	EXFOR check program (originating from NNDC)
CIAE	Chinese Institute of Atomic Energy, Beijing, China
CINDA	A specialized bibliography and data index on nuclear reaction data operated by NRDC
CJD	Russian Nuclear Data Centre, IPPE, Obninsk, Russia
CNDC	China Nuclear Data Centre, CIAE, Beijing, China
CNPD	Centre of Nuclear Physics Data at RFNC-VNIIEF, Sarov, Russia
CP...	Numbering code for memos exchanged within the NRDC
CPND	Charged-particle nuclear reaction data
CRP	Coordinated Research Project (of the IAEA Nuclear Data Section)
CSEWG	US Cross Section Evaluation Working Group
DOI	Digital Object Identifier, *e.g.* for bibliographic references
ENDF-6	International format for evaluated data exchange, version 6
ENDF/B	US Evaluated Nuclear Data File/B
ENSDF	Evaluated Nuclear Structure Data File
EXFOR	Format for the international exchange of nuclear reaction data
GSYS	Data digitizing system by JCPRG
IAEA	International Atomic Energy Agency, Vienna, Austria
IBANDL	Ion Beam Analysis Nuclear Data Library, maintained at IAEA
INDC	International Nuclear Data Committee
IPPE	Institute of Physics and Power Engineering, Obninsk, Russia
IRDFF	International Reactor Dosimetry and Fusion File, maintained by the IAEA-NDS

JAEA	Japan Atomic Energy Agency
JANIS	Java Nuclear Information System of NEA-DB
JCPRG	Nuclear Reaction Data Centre, Hokkaido University, Sapporo, Japan
JEFF	Joint Evaluated Fission and Fusion File, coordinated by NEA-DB
JENDL	Japanese Evaluated Nuclear Data Library
KAERI	Korea Atomic Energy Research Institute, Daejeon, Korea
KNDC	Nuclear Data Center, KAERI, Daejeon, Korea
KINR	Kyiv Institute of Nuclear Research
LEXFOR	Part of the EXFOR manual containing physics information for compilers
MBDAV	Management Board for the Development, Application and Validation of Nuclear Data and Codes
NDS	IAEA Nuclear Data Section, Vienna, Austria
NEA	OECD Nuclear Energy Agency, Boulogne-Billancourt, France
NEA-DB	OECD/NEA Data Bank, Boulogne-Billancourt, France
NEANDC	OECD/NEA Nuclear Data Committee
NNDC	National Nuclear Data Center, Brookhaven National Laboratory, USA
NRDC	International Network of Nuclear Reaction Data Centres
NRDF	Japanese Nuclear Reaction Data File
NSDD	International Network of Nuclear Structure and Decay Data Evaluators
NSR	Nuclear Science References, a bibliographic system
OECD	Organization for Economic Cooperation and Development, Paris, France
ORDER	EXFOR program for addition of record identification
PhND	Photonuclear data
RIKEN	Institute of Physics and Chemistry Research, Wako-Shi, Saitama, Japan
TRANS	Name of transmission tapes for data exchange in the EXFOR system
UKRNDC	Ukraine Nuclear Data Centre at KINR, Kyiv, Ukraine
VNIIEF	Russian Federal Nuclear Centre, Sarov, Russia
WPEC	Working Party on International Nuclear Data Evaluation Co-operation
XTRACT	EXFOR indexing program
X4TOC4	Conversion program from EXFOR to computational format “C4”
ZCHEX	Current version of CHEX, updated and maintained by NDS
4C...	Numbering code of memos exchanged among the four Neutron Data Centres

WORKSHOP SUMMARY

1. Introduction

This report summarizes the IAEA Workshop on Compilation of Experimental Nuclear Reaction Data held at the IAEA Headquarters in Vienna, Austria from 3 to 6 December 2024. The workshop was attended by 27 participants representing 11 cooperative Centres from seven Member States (China, Hungary, India, Japan, Russia, Ukraine and USA) and two International Organisations (IAEA, NEA) as well as participants from Austria, Germany, Japan, Mongolia, Russia and Ukraine. (see **Appendix A**).

The purpose of this workshop was to learn news on the EXFOR compilation and dissemination tool developments as well as to discuss the EXFOR related nuclear data activities carried out by EXFOR compilers, and various relevant technical items were presented and discussed (**Appendix B**).

2. Brief Summary

Alexander Konobeyev shared his experience with the EXFOR library in the relation with his development of the Proton Activation Data File (PADF). His presentation includes proposal on preservation of users' comments, checking of compiled cross sections below the threshold energy, comparison of the compiled cross sections with theoretical or evaluated cross sections near the threshold energy, indication of estimated precursor decay (including isomeric transition) contribution fraction in measured cumulative cross section.

Viktor Zerkin delivered a series of lectures and demonstrations for tools and files developed by him such as JSON Tree Editor, X5json (enriched EXFOR in JSON), EXFOR-C5, ZCHEX and X4Pro.

Boris Pritychenko introduced tabulation of thermal constants, resonance integrals and constants relevant to astrophysical reactions, and demonstrated that the ENDF/B-VIII.1 library demonstrates improvement in description of the ^{140}Ce r-process abundance.

Masayuki Aikawa reported measurement of the Ti(^{7}Li,x)^{54,52g}Mn,^{51}Cr and Cu(^{7}Li,x)^{66,67}Ga,^{65}Zn excitation functions as candidate of monitor reaction cross sections in relation with radioisotope production such as ^{209}Bi(^{7}Li,5n)^{211}Rn$\rightarrow$^{211}At with EXFOR E2785 and E2798 as sample entries.

Devi Vidya presented evaluation the ^{232}Th(n,f) and ^{237}Np(n,f) cross sections in the fast neutron region with adoption of EXFOR files as direct input to the simultaneous least-squares analysis code SOK.

Jin Yongli introduced manipulation of experimental data such as construction of evaluated elemental cross section from the corresponding isotopic cross sections, construction of alpha value from evaluated capture and fission cross sections, construction of the total uncertainty from the partial uncertainties in EXFOR, renormalization of activation cross sections with gamma intensities and half-life and renormalization with the latest standard cross section.

Naohiko Otsuka reported development of various Python scripts for processing of EXFOR files for compilers, library and dictionary managers and evaluators and organized exercises for English spell checking of an EXFOR file, addition of record identification to an EXFOR file, and extraction of a single dataset from several datasets compiled in a subentry by the multiple reaction formalism.

Svetlana Dunaeva presented comparison of deuteron scattering angular differential cross sections obtained by three digitization processes – (1) digitized by the Exfor Digitizer software and compiled in EXFOR F0164, (2) digitized by GSYS and compiled in EXFOR E2254, and (3) newly digitized by GSYS by Dunaeva for the analysis. She found the third dataset can be closer to the first dataset rather than to the second dataset. She concluded that accuracy of digitization may depend on accuracy of scale setting rather than choice of the digitization tool, and reminded the compilers importance to pay attention to the scale setting utilizing the first and last ticks.

Myagmarjav Odsuren shared her challenge on digitization of old figure hand drawn figures where symbols belonging to several datasets cannot be clearly distinguished with figures showing heavy-ion induced reaction cross sections being compiled in EXFOR D8609 to D8071 and D8077.

Marina Mikhailiukova reported her analysis on zero and negative values coded under the headings PARITY, EN, ERR-T and DATA-ERR in the relation with an action to her from the network (NRDC2024 A47). She presented a list of subentries including such questionable values identified by X4Pro. After her report, the participants looked into listed entries maintained by their centres, and discussed possible solutions.

Koki Ono and **Mercy Mwakitalima** introduced NADIA (Nuclear Artificial Intelligence for Document Indexing and Analysis), an innovative approach that leverages artificial intelligence (AI) to automate the categorization and analysis of knowledge products, such as scientific publications, using natural language processing (NLP) and machine learning (ML). Traditional methods of data indexing and analysis often struggle to provide timely, accurate, and actionable insights when handling large, complex datasets. AI-driven approaches, including machine learning, NLP, and deep learning, offer a solution by enhancing data processing workflows, improving categorization, retrieval, and interpretation of information. These techniques enable systems to efficiently process both structured and unstructured data, uncovering patterns and relationships that may not be readily apparent. NADIA applies these AI techniques to organize knowledge products according to keywords in the INIS thesaurus, dynamically adapting to evolving data and optimizing searchability and accessibility. They discussed the transformative impact of AI-driven indexing and analytical processes, highlighting their potential while also addressing the challenges and opportunities at present.

Galina Pikulina and **Sophiya Taova** introduced a new version of the EXFOR-Editor especially for (1) preparation of a PRELM or TRANS file from EXFOR entry files, (2) support to the extended format of the STATUS for inclusion of the author and reference code field, and (3) removal of superscripts in the author list copied from an article pdf file to simplify preparation of the AUTHOR record.

Lidija Vrapcenjak updated the participants about the status on collection of electronic copies from the primary references of EXFOR entries. Matching of the EXFOR reference code and electronic copy requires proper EXFOR reference coding and file naming, and correction of the EXFOR reference code is sometimes required for matching. Copies of theses and regional reports are not always easily available, and she welcomes assistance of compilers for improvement of collection.

Alejandra Martinez reported development of a tool archiving electronic copies of EXFOR references in an internal pdf file archive. She is trying to make the tool with several advantages such as easy operation, reduction of processing time and database size.

Julia Sprenger's presentation and demonstration of Git and related platforms generated an engaged discussion among workshop participants. It was recognized that the established workflow and tools established in NRDC enable the currently contributing compilers working together with NRDC in a satisfactory way. Also, a custom system for tracing changes and the visualization of changes is in place. For future developments, it is important to ensure that existing contributors can continue to contribute to NRDCs compilation efforts efficiently and in a way that feels familiar to them. However, while it is important to provide a familiar/efficient workflow to currently active compilers, future-proofing is an important aspect to consider. Future-proofing is understood in two ways: 1) ensure that future compilers will be able to learn as quickly as possible the required technology and skills to make meaningful contributions 2) ensure that the technology stack will be maintainable in the future. The value proposition of adopting Git addresses both points. Git is widely adopted world-wide, maintained by thousands of people and is extensively documented. Git solves the problem of tracking changes. It is not a web service (even though it can be integrated into one, such as GitLab or GitHub). It offers the possibility to use custom tools for visualizing differences, and therefore can possibly be linked to existing tools for displaying differences across file versions.

The participants summarized the following **recommendations**:

To EXFOR compilers:

- Check past version of the EXFOR entries to analyse unusual zeros under the heading DATA, ERR-T etc. since such zeros sometimes appeared during automatic cancellation of the vector common formalism by NNDC.
- Provide the full author name and university in free text for a thesis coded under REFERENCE to make its collection easier.
- Obtain a hard copy of the article if a figure image of an electronic copy is not enough clear for digitization.
- Do not automatically replace "0.0", "0.00" coded as uncertainty with blank since it may still indicate the order of the uncertainty.
- To software engineers:
- Think possibility to check consistency between the total uncertainty (ERR-T) and partial uncertainties (ERR-S, ERR-1, ERR-2 etc.).

To ATOMKI:

- Revise the EXFOR entries compiling data published with the compiler as a coauthor for those listed in Tables 4 and 5 of WS2024-02.

To JCPRG:

- Think about the remarks from Svetlana Dunaeva on GSYS (display of two different datasets, addition of a cross inside the circle for scale marking).

To NDS:

- Register some items in Tables 2 to Table 5 of WS2024-02 to the EXFOR Feedback List.
- Add description on the astrophysical S-factor extrapolated to zero energy in LEXFOR (e.g., addition of SF9=DERIV and description on the extrapolation under ANALYSIS).

To Software developers:

- Continue exploring git-based workflows in combination with tools tailored for interaction with EXFOR formats, which may make working with EXFOR more inclusive in the future.

One behalf of the participants, we appreciate Szende Elias (IAEA Nuclear Data Section) for her support to organization of the workshop.

January 2025

Naohiko Otuka and Vidya Devi

SUMMARY OF PRESENTATIONS

Comments and suggestions related to the use of EXFOR in the preparation of proton activation data file PADF

Alexander Yu. Konobeyev, Dieter Leichtle
Karlsruhe Institute of Technology, Hermann-von-Helmholtz-Platz 1, 76344 Eggenstein-Leopoldshafen, Germany

The purpose of the presentation was to discuss suggestions for optimal use of EXFOR data. The proposals were based on the experience obtained in working with experimental data for evaluation of cross-sections to be included in the new version of Proton Activation Data Files [1], which Karlsruhe Institute of Technology has been preparing for two years. The proposals concern working with different categories of data.

I. Data that raise doubts about their correctness, while the analysis of published details of the experiment does not allow to determine the possible error. To identify such data, one should use the V. Zerkin system with expert opinions, which needs to be popularized and promoted.

II. Data below or near the reaction threshold. Automatic search by EXFOR records can be used to identify such data. It is proposed to supply problematic data with special symbols warning about an error or a possible problem.

III. The problem of identifying independent and cumulative data. To solve the problem, it is proposed i) to accumulate user opinions using V. Zerkin system, ii) enter measurement details into files, facilitating the user's decision-making, iii) additional automatic checking using TALYS and PHITS, iv) to identify the so-called “supracumulative” cross-sections [2] and to introduce new symbols for their designation in the “reaction” line and in data tables recorded with the “ELEM/MASS” key.

IV. Identification of the sums of measured cross-sections for nuclides in the ground and metastable states. Further analysis of publications describing the measurements is necessary. In complex cases and the absence of necessary details, it is proposed to introduce different “probabilities” of data identification, subjectively assessed by the compiler.

The changes made will improve the efficiency of users' work with EXFOR files, reduce the uncertainty of the nature of already compiled data, and facilitate “blind” comparison of experimental data with the results of calculations using nuclear models.

1. A.Yu. Konobeyev, D. Leichtle, KIT SWP, 204 (2022): https://dx.doi.org/10.5445/IR/1000152627, KIT SWP, 227 (2023): https://dx.doi.org/10.5445/IR/1000162040, A.Yu. Konobeyev, D. Leichtle, A. Stankovskiy KIT SWP, 252 (2024), https://doi.org/10.5445/IR/1000176301

2. Yu.E. Titarenko, O.V. Shvedov, V.F. Batyaev et al. Phys. Rev. C, v65, 064610 (2002)

JSON-Tree Editor

Viktor Zerkin
Vienna, Austria

JSON (JavaScript Object Notation) is a lightweight data interchange format. JSON is one of modern methods to present hierarchical data structures and documents – widely used and supported in programming languages. Recently, JSON has begun to be used in nuclear data projects as output format for Web-API, standalone database systems, and basis of large modernization projects. Since many of these projects are under development and JSON format there is not yet fully established, users' community and staff of nuclear data centres need a specialized tool to observe and improve proposed JSON structures in details – this is major reason and purpose of development of JSON-tree editor.

Goas of JSON-Tree Editor:

- to understand proposed JSON based nuclear data formats on examples
- test JSON files (investigate structure, evaluate rationality), find mistakes, report bugs
- to discuss and modify JSON files to make counterproposals and improve formats
- to accept proposed JSON formats and make sure that it is common agreed format

Concept, technology, features:

1. JSON-Tree Editor presents JSON as interactive tree
2. application running in a Web browser on any operating system
    a. written in JavaScript
    b. work from Web server and locally (no server needed)
    c. platform independent (running "inside" Web browser on any OS)
    d. input: select local JSON file or copy/paste to a text-area
    e. output: save JSON to browser's download area
3. looks and operates like "native" App, intuitive for users
4. implements traditional editor's functionality including undo/redo operations
5. allows to edit in single text area: simple value and large complex JSON object
6. provides extra functionality for known nuclear data formats (see on Fig.1: display meaning of EXFOR abbreviations and data from nested objects)
7. easy for extensions

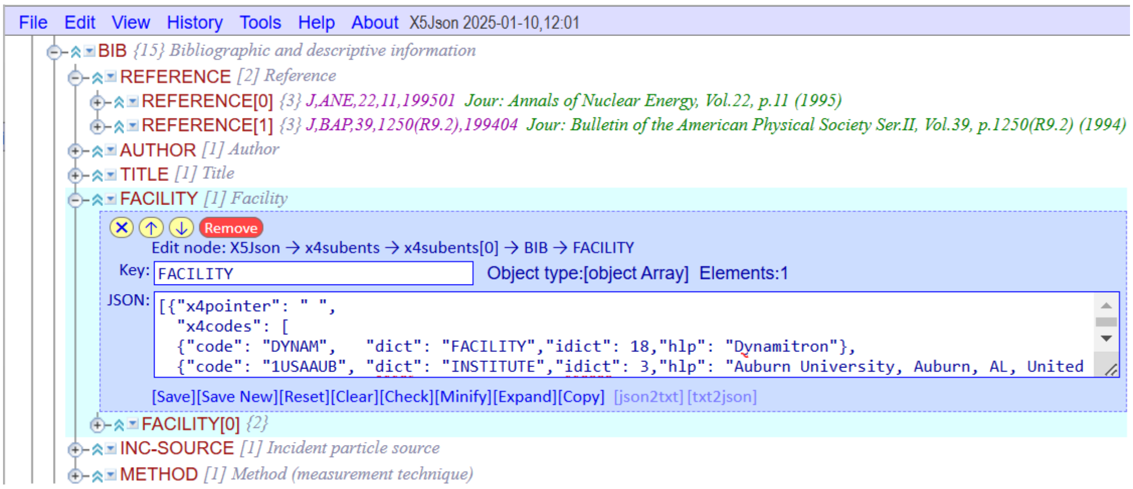

Fig.1 View: interactive tree, editing area, specialized data display

Links.

1. https://vzerkin.github.io/
2. https://zerkin.usite.pro/edit-json-tree/

X5: Enriched EXFOR in JSON

Viktor Zerkin
Vienna, Austria

Today NDS Web database retrieval system providing EXFOR data search, retrievals, plotting, comparison with evaluated data, data presentation in various forms, methods and formats: X4+, X4±, C4, C5, C5M, several versions of JSON and XML's, etc. EXFOR Dictionaries and whole EXFOR data library in original form and translated in XC4, C5 with optional automatic renormalization to new standards are available for downloading from archives as plain text files and also as standalone database with retrieval systems. Every format, method of distribution, specialized software serves various users' needs and purposes. Many of them require additional data imported from other nuclear databases and data sources, such as: old monitor cross sections, new standards, ENSDF decay data, RIPL, etc. X5 is an attempt to consolidate all useful features of the data mentioned above in a form easily accessible for user.

X5 presents EXFOR data in JSON, enriched by information from dictionaries and other data sources to cover known user needs to allow convenient access to all potential power of EXFOR including computational data with possibility of renormalizations, explicit presentation of data coded in keywords, link EXFOR reaction-code to ENDF reaction definitions (MF-MT), etc.

X5Json file includes two parts:

Part-I. Original data: reproducing EXFOR file structure ENTRY/SUBENT ("human" oriented)

1) structured meta-data (keywords/codes/free text) with dictionary-information

   + REACTION: split to Strings and further to SF1..SF9 with dictionary-info

   + REFERENCE: interpreted parameters (volume, report number, page, etc.)

   + COVARIANCE: data extracted from free-text to JSON arrays

2) original EXFOR data from COMMON and DATA sections: 2-D array

   + Header and Units given with interpretation and classification

Part-II. Computational data by Datasets (SUBENT+Pointer)

1) computational EXFOR data values: 1-D arrays in original and basic units

   + only data relevant to given Dataset

   + sorted and classified according to EXFOR dictionaries

2) computational data ~C5: {y, Δy, Δy_{stat}, Δy_{sys}, Δy_{part}, x1, Δx1, x2, Δx2, etc.}
3) MF, MT for data compatible with ENDF evaluated data
4) description of automatic-renormalization
5) data for automatic-renormalization: monitor cross sections and standards
6) decay data for renormalization from ENSDF

Program translating EXFOR to X5 is implemented on Java as part of NDS EXFOR package.

Structure of X5 files can be analysed (see NRDC-2024/A71) using JSON-Tree Editor:

https://zerkin.usite.pro/edit-json-tree/#1

https://zerkin.usite.pro/edit-json-tree/#1u

X5 is available via NDS Web retrieval system since 2022 (interactive and Web-API):

https://nds.iaea.org/exfor/x4guide/API/ (description)

https://nds.iaea.org/exfor/x4get?sub=23114002&plus=5 (example)

Full EXFOR translated to X5 is available on GitHub and on NDS download area:

https://github.com/vzerkin/EXFOR-X5json

https://nds.iaea.org/cdroms/#x5json

C5: Recent development

Viktor Zerkin
Vienna, Austria

C5 is a computational format for EXFOR data [1]. Recently x4toc5 program was extended to convert cross section ratios to cross sections using recent neutron cross-section standards [2] and IRDFF data library. So, CS-ratio:MF203 is converted to CS:MT3 if "recommended" data for reaction-denominator exist.

Reaction-denominator can be given explicitly in the EXFOR Reaction-code, for example:
`(13-AL-27(N,A)11-NA-24,,SIG)/(92-U-238(N,F),,SIG)`

or implicitly: **`92-U-235(N,ABS),,ALF`**
(where ABS: Absorption, ALF: Alpha = capture/fission cross-section ratio)

EXFOR to C5 translation statistics without and with option Ratio2CS (as of 2024-12-02):

#	Original	with option "Ratio2CS"
1	MF3: 70,791	MF3: 71,703 (+912 +1.3%)
2	MF4: 28,911	MF4: 28,911
3	MF402: 9,840	MF402: 9,840
4	MF6: 7,651	MF6: 7,651
5	MF203: 3,180	MF2: 2,499
6	MF2: 2,499	MF213: 2,450
7	MF213: 2,450	MF203: 2,268 (-912 -28.7%)

Fig.1 shows data foung in EXFOR and converted to C5 for reaction 92-U-235(N,G)92-U-236,,SIG (left) and data (right) when option Ratio2CS applied: so, data coded in EXFOR as 92-U-235(N,ABS),,ALF converted to 92-U-235(N,G)92-U-236,,SIG

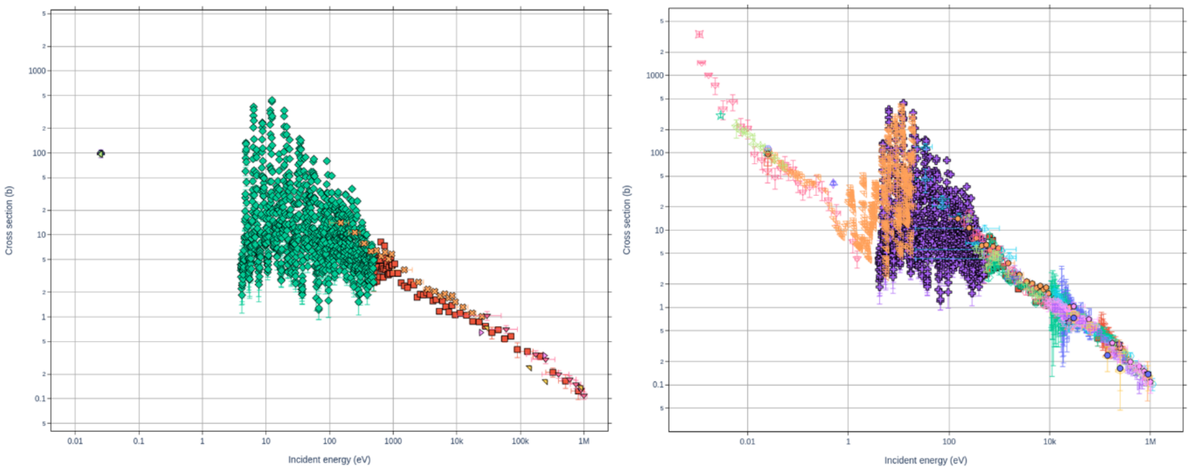

Fig.1. U-235(n,g) cross section from EXFOR without (10 datasets)
and with option Ratio2CS (52 datasets).

Reference.
1. Program x4toc5, by V.Zerkin, DOI:10.61092/iaea.gxra-p855
2. IAEA Neutron Data Standards: https://nds.iaea.org/standards/

Tables of neutron thermal cross sections, Westcott factors, resonance integrals, Maxwellian averaged cross sections, astrophysical reaction rates, and r-process abundances calculated from the ENDF/B-VIII.1, JEFF-3.3, JENDL-5.0, BROND-3.1, and CENDL-3.2 evaluated data libraries

Boris Pritychenko
National Nuclear Data Center, Brookhaven National Laboratory, Upton, NY 11973-5000, USA

We present calculations of neutron thermal cross sections, Westcott factors, resonance integrals, Maxwellian-averaged cross sections, astrophysical reaction rates, and solar system *r*-process abundances using the latest data from the major evaluated nuclear libraries for 849 ENDF target materials. The recent release of ENDF/B-VIII.1 library, progress in ^{252}Cf(SF) evaluation, extensive analysis of newly evaluated neutron reaction cross sections, neutron covariances, and improvements in data processing techniques motivated us to calculate the nuclear industry and neutron physics parameters, produce *s*-process Maxwellian-averaged cross sections and astrophysical reaction rates, extract *r*-process abundances, systematically calculate uncertainties, and provide additional insights on currently available neutron-induced reaction data.

Activation cross section measurements for ^{7}Li-induced monitor reactions

Masayuki Aikawa
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Charged-particle-induced reactions are widely employed to produce radionuclides for nuclear medicine applications, including imaging and therapy. Among the possible reactions, lithium-induced reactions are also promising for medical radionuclide production. Determining optimal beam parameters is critical for maximizing the yield of desired radionuclides while minimizing by-products, making monitor reactions indispensable. However, no established monitor reactions currently exist for both stable lithium isotopes, ^{6}Li and ^{7}Li. To address this gap, we conducted a systematic investigation to identify suitable target materials for potential lithium-induced monitor reactions.

Copper and titanium are commonly used as target materials in monitor reactions induced by charged particles such as protons, deuterons, ^{3}He, and alpha particles. These materials also show potential as targets for lithium-induced monitor reactions. However, a literature survey using the EXFOR database identified insufficient experimental data on such reactions. To address this, we performed activation cross-section measurements of these reactions [1,2].

Experiments were conducted using 72-MeV ^{7}Li beams to measure activation cross sections on ^{nat}Cu and ^{nat}Ti targets at the AVF cyclotron in RIKEN. Physical thick target yields were also measured to validate the obtained cross sections. Gamma-ray spectrometry was employed to identify the radioactive products, while the stacked-foil activation technique was utilized for excitation function measurements. Three experiments were performed for each target material: two to determine excitation functions and one to measure thick target yields.

The cross sections for ^{nat}Cu(^{7}Li,x) reactions producing ^{69,68}Ge, ^{67,66}Ga, and ^{69m,65}Zn and ^{nat}Ti(^{7}Li,x) reactions producing ^{54,52g}Mn, ^{51,49,48}Cr, ^{48}V, and ^{48,47,46}Sc were determined. Consistent results were obtained across the two experiments with the same target materials. Physical thick target yields for ^{nat}Cu(^{7}Li,x) and ^{nat}Ti(^{7}Li,x) reactions were experimentally determined and compared with yields calculated using the measured cross sections. The agreement between experimental and calculated yields supports the reliability of the measured cross sections. Based on the results, six reactions were identified as suitable for monitor reactions: ^{nat}Cu(^{7}Li,x)^{66,67}Ga,^{65}Zn and ^{nat}Ti(^{7}Li,x)^{54,52g}Mn,^{51}Cr. The obtained data were already transmitted to the NRDC members for registration into the EXFOR library [1,2]. Future work will focus on accumulating additional data for these reactions and investigating other potential targets, such as ^{27}Al, ^{nat}Ni, and ^{nat}Fe.

[1] Aikawa et al., Nucl. Instrum. Methods B 554 (2024) 165441. (E2785)
[2] Aikawa et al., Nucl. Instrum. Methods B 559 (2025) 165579. (E2798)

EXFOR-Trans2Master

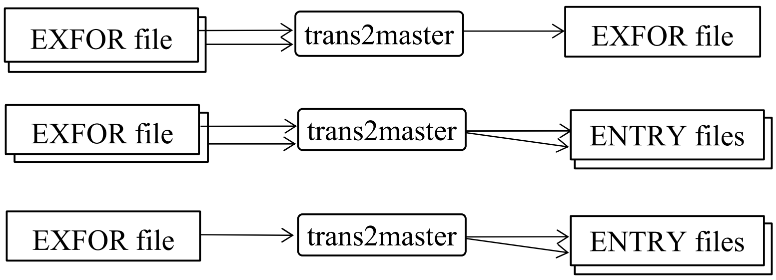
Viktor Zerkin
Vienna, Austria

The main task of the code “trans2master” is to read an old EXFOR Master/backup file, one or many TRANS files, and produces joined EXFOR file. The code is written in Java and can work on any operating system (tested on Windows, Linux, MacOS).

The program works in one step without intermediate storage of EXFOR files.

Program can also:

1) be used for merging any EXFOR files
2) split EXFOR file(s): store Entries by files (instead of output to joined EXFOR file)
3) correct/setup N2, N3 and file-header if necessary (see “help” in Appendix of [1])



Program trans2master.java operates via internal buffer and may require additional memory in Java Virtual Machine (-Xmx4000M to set maximum Java heap size) when used for full EXFOR Master file.

Reference.

1. Description: https://nds.iaea.org/nrdc/nrdc_2024/working/wp2024-32.pdf
2. Download: https://github.com/vzerkin/EXFOR-trans2master

Simultaneous evaluation of ^{232}Th and ^{237}Np fast neutron-induced fission cross sections up to 200 MeV using EXFOR library

Vidya Devi[a], Naohiko Otuka[b]
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The neutron-induced fission cross sections for ^{232}Th (500 keV to 200 MeV) and ^{237}Np (70 keV to 200 MeV) were evaluated by analyzing experimental data, as well as their ratio to the ^{233,235,238}Uand ^{239,240,241}Pu fission cross section in the EXFOR library, were reviewed and analyzed using least squares method. Accurate fission cross-section data for isotopes such as ^{232}Th and ^{237}Np are critical for the development of nuclear reactors, including Accelerator Driven Subcritical Systems (ADSS) and fast reactors. However, discrepancies in existing data, particularly in certain energy ranges, introduce uncertainties in nuclear modeling. To address these gaps, incorporating new experimental data and advanced evaluation techniques is essential. The neutron-induced fission cross sections of ^{237}Np and ^{238}U are small in the keV region but have been proposed as candidates for neutron data standards in the MeV range. While the IAEA treats ^{237}Np as a dosimetry reaction, accurate fission data for non-fissile and minor actinides are crucial for fast reactor design.

The results indicate a consistent reduction in the ^{232}Th fission cross section compared to the JENDL-5 library, especially in the 2-6 MeV plateau region, where the cross section was approximately 4% lower. A more significant decrease was observed in the subthreshold fission region. Additionally, the fission cross section of ^{232}Th averaged over the ^{252}Cf spontaneous fission neutron spectrum was found to be 4% lower than the value in JENDL-5, aligning more closely with other general-purpose libraries but underestimating measurements from Grundl et al. by 11%.

Future work will involve completing the simultaneous evaluation of the ^{237}Np(n,f) cross section, along with those for ^{233}U, ^{235}U, ^{238}U, and $^{239-241}$Pu. The results will then be validated against spectrum-averaged cross-section measurements from the ^{252}Cf spontaneous fission neutron field.

Manipulation of experimental data with NDPlot

Jin Yongli, Wang Jimin, Tao Xi
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NDPlot is a nuclear data analysis and visualization tool that developed on the basis of the API of the data service system of China Nuclear Data Center, which enhancing development efficiency and simplifying maintenance tasks. This tool supports all-in-one project files and is capable of managing data in ENDF, EXFOR, and free format. It offers a suite of analytical functions, including ratio calculation, summation, integration, spectral analysis, and so on. The most recent advancements in NDPlot enable the tool to perform data correction on EXFOR data. It utilizes error source terms to accurately correct cross-section errors and is also equipped to make adjustments to standard cross-sections, half-lives (or decay constants), and the absolute intensities of gamma rays. These corrections are seamlessly integrated, allowing for the simultaneous visualization of the results.

ForEX: Utility codes for EXFOR

Naohiko Otuka
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ForEX (Utility codes for EXFOR) is a collection of tools (Python scripts) to process EXFOR related information by compilers, library managers, dictionary managers and users. The current version (Ver. 2024-12-01) distributed from the NRDC Software website (https://nds.iaea.org/nrdc/nrdc_sft/) contains the following fifteen tools:

- DIC227: Produce Archive Dictionary 227 from a NUBASE file.
- DICA2J: Convert Archive dictionaries to a JSON Dictionary.
- DICDIS: Prepare Archive and Backup dictionaries for distribution.
- DICJ2A: Convert a JSON Dictionary to Archive dictionaries.
- DICJ2T: Convert a JSON Dictionary to a Transmission dictionary.
- DIRINI: Split an EXFOR library tape into EXFOR entry files.
- DIRUPD: Update the EXFOR entry files with an EXFOR transmission tape.
- EXTMUL: Extraction of a dataset from a multiple reaction formalism subentry.
- J4TOX4: Convert a J4 file to an EXFOR file.
- MAKCOV: Produce a data table and covariance matrix from a J4 file.
- MAKLIB: Merge EXFOR entry files into a single library tape.
- POIPOI: Remove pointers from a J4 file.
- SEQADD: Add record identification to an EXFOR file.
- SPELLS: Check English spell in free text in EXFOR format.
- X4TOJ4: Convert an EXFOR file to a J4 file.

To utilize JSON as an intermediate file for processing with some of these tool, I developed EXFOR in JSON ((https://nds.iaea.org/nrdc/exfor-master/j4/) and EXFOR/CINDA Dictionary in JSON (https://nds.iaea.org/nrdc/file/dson.html) and utilize them as shown in Fig. 1.

In the workshop, I provided the following three exercises:

1. Perform spell check of EXFOR B0101.003 with SPELLS.
2. Add the record identification numbers etc. to EXFOR B0101.003 with SEQADD.
3. Extraction of a dataset (EXFOR B0101.003.1 or B0101.003.2) with EXTMUL.

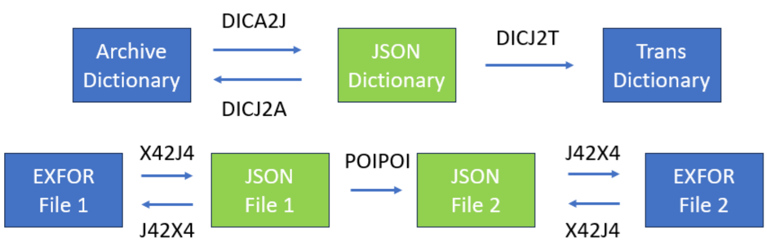

Figure 1. Example of operations by ForEX tools with JSON as an intermediate file

Reference

[1] N. Otuka, "ForEX: Utility Codes for EXFOR", Report IAEA-NDS-0244 Rev. 2024/11. Doi: https://doi.org/10.61092/iaea.hz1z-0dx3 .

Comparison of two different data digitization presented in E2254 and F0164

Svetlana Dunaeva
Moscow, Russia

Analysis of the main source of error in digitizing data was made. For this goal two different datasets were compared. Examples were taken from E2254 and F0164 entries. In both entries the same digitized datasets were presented. For this goal, two software tools were used: InpGraph (F0164) and GSYS (E2254). As it was shown on the figures, the points from E2254 do not coincide with the points on the graph. In percentage it varied from 0.5% till ~9%. To check the situation two datasets were digitized by author (one with logarithmic scale and another with linear) using GSYS. It was almost no difference between new digitization and dataset presented in F0164. So, the digitizing error doesn't depend on software that used for digitizing data. Then the dependence on setting scale points was checked. For this goal new result of digitized dataset was reproduce using GSYS but with different scale marks. The deviation of dataset from the points on figure was clearly seen. So, it is clearly seen that the most important to accurately digitize scale marks. This recommendation was already given in: https://www-nds.iaea.org/nrdc/nrdc_sft/digitization/ .

Compilation of heavy-ion induced reaction data from West European countries

M. Odsuren
School of Engineering and Applied Sciences and Nuclear Research Center, National University of Mongolia, Ulaanbaatar 210646, Mongolia

M. Odsuren gave her presentation entitled "From Paper to Data: GSYS and the Digital Transformation". She began with an introduction to the main steps in the preservation of data from paper to digital format, such as scanning technology (1930s-1950s), optical character recognition (1960s), microfilm and microfiche (1970s) and digital libraries and cloud storage (1990s).

In her presentation, she pointed out that the International Atomic Energy Agency (IAEA) established a special database for nuclear science and technology called INIS in 1969. INIS is unique in that it focuses specifically on nuclear science and technology. There are several similar specialized libraries and digital repositories that focus on the preservation and dissemination of scientific and technical data in various fields such as medicine, engineering, health, physics and agriculture.

The main objective of her presentation was related to the digitization of data and includes two main tasks: converting experimental results into formats that are understandable by computers and organizing the data for easy retrieval and analysis. She focused on 5 EXFOR datasets (D8069, D8070, D8071, D8073, D8077) created in 2024 in collaboration with N. Otsuka and L. Vrapcenjak.

These five EXFOR datasets, old articles in the EXFOR library and all data reported by the authors were digitized. M. Odsuren reported that the choice of scale for the particle axes of the digitized data and the quality of the reported data in the old articles because some of the data are not easy to recognize their symbol clearly. In such cases, the compiler should mention in the entry that some data is missing because it was not easy to distinguish between different data points.

At the end of her presentation, she pointed out that digitizing this type of information is labor-intensive and requires skilled personnel to ensure accuracy. With the increasing demand for accessible data, the EXFOR community could consider the application of AI to improve data processing, analysis and utilization in the future.

Zero and negative values coded under the headings PARITY, EN, ERR-T and DATA-ERR in the EXFOR library (NRDC2024 A47)

Marina Mikhailiukova

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387 Entries with suspicious data were found, 40 Entries were analyzed (checking of articles, Tables, Figures, archival files, relative literature (e.g. S.Mughabghab Atlas)) and proposals of correction are given in Tables 2-3. 14 Entries (area 4) were already corrected in final trances. 4 Tables with suspicious Entries/Subents were presented and proposed to check the listed Subents in the responsible centers and correct if it needs, taking into account comments in 4^{th} column of Tables 2-5. Compilation of astrophysical factor for zero energy and correction of negative and zero values of ERR-T and DATA-ERR were discussed. Proposal was done to insert in checking codes these checking options: parity =0., EN < or = 0., ERR-T < or = 0., DATA-ERR < or =0. Importance of usage of archival files (initial compilation of Entries) at correction was emphasized. 8 exercises were proposed for correction by participants.

AI-driven approaches to indexing and analytical insights

Koki Ono
Division of Planning, Information and Knowledge Management, Department of Nuclear Energy, International Atomic Energy Agency, 1400 Vienna, Austria

The International Nuclear Information System (INIS) hosts one of the world's largest collections of published information on peaceful uses of nuclear science and technology. It contains 4.85 million knowledge products and 634.000 full texts PDFs since 1950 in 50 languages from 120 countries. INIS is one of the most visited websites at the agency, with about 1.8 million unique users in 2023, from every country in the world. The huge variety of standards, languages, scientific vocabularies, and information management traditions makes the subject classification and indexing of the documents one of the most important and complex. Nuclear experts carefully review each product, selecting an appropriate category based on its title and abstract. They then choose a minimum of three, ideally eight to twenty, relevant keywords from the INIS Thesaurus, which contains 23.000 terms, to accurately classify the product. This process is time -consuming, and while the experts could be dedicating their efforts to other important tasks. We want to continue the 54 years tradition of categorizing and tagging knowledge products. At the same time, we want to replace that human labour with automation by using Natural language processing and machine learning. The project Nuclear Artificial intelligence for Document Indexing and Analysis (NADIA) was begun to save experts' time.

One of the first steps in any natural language processing is word vectorization, which transforms words into a spatial representation where closely related words are positioned closer together. In case of NADIA, this space consists of 768dimensions, a scale that is difficult for humans to imagine. For the nuclear domain, we retrained the model to include terms commonly used in nuclear science and technology. In addition, the INIS Nuclear BERT (Bidirectional Encoder Representations from Transformers) model has the potential to be useful and applicable outside of this project.

In June 2023, NADIA was put into production, and there were some advantages. The first is that consistent and reliable tagging had been successfully achieved in about 90% of cases so that experts can do other task by automation. The seconds is it is possible to update the INIS Thesaurus without model retraining. The last is it runs on CPUs so that we can save costs.

In conclusion, the implementation of the NADIA project represents a significant step forward in information management. By leveraging advanced natural language processing techniques and machine learning, we have not only streamlined the categorization and tagging of knowledge products but also ensured that experts can focus on more critical tasks. As we continue to build on this progress, NADIA has the potential to further transform how nuclear science information is indexed, ultimately benefiting researchers and stakeholders worldwide.

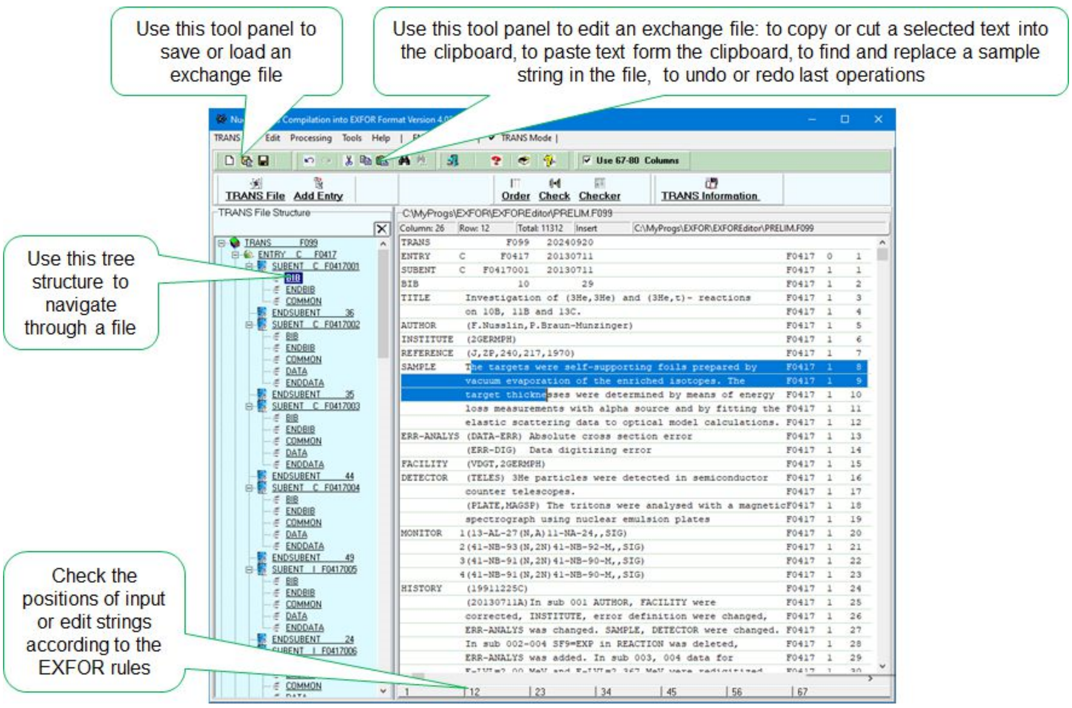
Examples of exchange file processing by EXFOR-Editor 4.02

Galina Pikulina and Sophiya Taova
All-Russian Research Institute of Experimental Physics, Russian Federal Nuclear Center, Sarov, Nizhny Novgorod oblast, 607188 Russia

New features of the EXFOR-Editor 4.02 (released on https://nds.iaea.org/nrdc/nrdc_sft/) were presented. The ExfData program provides now two modes of data processing: the ENTRY mode and the TRANS mode. The TRANS mode was significantly updated in the ExfData new version. It helps a compiler to create a PRELIM or TRANS file using the existing entries.

To start the work in the TRANS mode first set the **TRANS Mode** flag in the main menu of the ExfData window. If it is needed to add an entry to a PRELIM or TRANS file click the **Add Entry** button and select entry files in a standard window.

There is a possibility to edit the context of an exchange file in the edit area of the TRANS mode window. Editing and deleting of a separate entry are also available.



There is a possibility to order an exchange file. To check a PRELIM or TRANS file with the help of ZChex or Trans Checker use the **Check** or **Checker** buttons.

In the new ExfData version, the updates due to the new format introduction of the **STATUS** keyword have been made. The **STATUS** keyword input and edit window is modified in accordance with the new rules. To include the **STATUS** record into all Subentries simultaneously there is the «**STATUS to each SUBENT**» button on the toolbar of the ENTRY mode main window.

One more possibility is to delete footnotes and service chars automatically when entering or editing authors list in a special window. It is useful if you paste information from a PDF file.

Status of references collection project for EXFOR - Overview and progress

Lidija Vrapcenjak
Nuclear Data Section, International Atomic Energy Agency, 1400 Wien, Austria

The main aim of the project was to collect all first references from EXFOR entries and make them available to the compilers and Network members. After the initial scanning and collection, long list of missing ones was compiled. The effort is made to obtain the majority of missing references, mainly through the IAEA library. For the foreign reports and thesis this is a lengthy and, many times not successful, process. For that reason, the help from the Centres is needed in providing whenever possible the foreign reports.

New tools are being developed to improve the current process of matching the available references with the EXFOR entries. Major issues were with naming conventions in place, in particular where there is page number and paper number involved. In number of cases the parts of the reference were not correct which is why we need to stress the importance of correct coding of references.

EXFOR PDFs archiving improvements

Alejandra Martinez
Nuclear Data Section, International Atomic Energy Agency, 1400 Vienna, Austria

The objective of this presentation is to propose an improvement to the current process of the EXFOR PDF database update. The display of the publications in the EXFOR PDF database is available to a very restricted set of users through the EXFOR web retrieval system. Some problems were identified in this update process, such as: Some PDFs are updated while others are not; it depends on a specific folder structure and Operating System (currently Windows); several scripts are involved, making it hard to control and maintain; there's no version control for the publications, nor the update code; there's low security for the update, meaning as if someone has access to the scripts, they can have access to database credentials and other delicate data; and lastly, it's not ideal to store PDFs in a database as it utilizes space and it's not optimal for this purpose.

The solution consists in a user-friendly simplified web interface to upload PDFs received from NSR, and PDFs that are part of the EXFOR repository.

The architecture for this solution is made of three main parts: a web frontend, an authentication layer, and API based backend. The frontend is being developed in Angular, a JavaScript framework for building fast, scalable, and reliable web applications; the authentication is based on JWT (JSON Web Tokens), an open, industry standard RFC 7519 method for way for securely transmitting information between parties; and the backend is being developed in Python – Flask, a lightweight WSGI web application framework.

The next steps, which are to be discussed with the development team are, first, the decision of moving the storage from database to the filesystem; the improvement of the propagation pipeline for the PDFs updates; and the strategy for file versioning and traceability of the publications. The continuation of development efforts into this solution will also depend on its priority, compared to other development needs.

Introduction to collaboration and automation tools - Getting the most out of the git ecosystem

Julia Sprenger
OECD Nuclear Energy Agency, 75775 Paris, France

See https://doi.org/10.5281/zenodo.14283405 for slides and abstract.

Appendix A

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Appendix B

AGENDA

Tuesday, 3 December 2024

9:30 – 13:00

1	**Opening**		
1.1	Welcome address	10 min	A. Koning
1.2	Self-introduction	10 min	All
1.3	Announcement	5 min	L. Vrapcenjak
1.4	Election of chairperson and rapporteur, adoption of the agenda	5 min	N. Otsuka
2	**Presentation and Exercise**		
2.1	Comments and suggestions related to the use of EXFOR in the preparation of proton activation data file PADF	40 min	A. Konobeyev
2.2	JSON-Tree Editor: Lecture	50 min	V. Zerkin
2.3	JSON-Tree Editor: Exercises - Using JSON -Tree Editor for nuclear data	50 min	V. Zerkin

14:00 – 17:00

2	**Presentation and Exercise (cont)**		
2.4	GitHub for exchange of tools	10 min	N. Otsuka
2.5	EXFOR-X5json: Lecture - Introduction of X5json	30 min	V. Zerkin
2.6	EXFOR-X5json: Exercises - Using X5json from GitHub	90 min	V. Zerkin
2.7	EXFOR-X5json: Discussion – Future of x5json	30 min	V. Zerkin

Wednesday, 4 December 2024

9:00 – 13:00

2	**Presentation and Exercise (cont.)**		
2.8	EXFOR-C5: recent development, versions, distribution	50 min	V. Zerkin
2.9	Tables of neutron thermal cross sections, Westcott factors, resonance integrals, Maxwellian averaged cross sections, astrophysical reaction rates, and r-process abundances calculated from the ENDF/B-VIII.1, JEFF-3.3,	30 min	B. Pritychenko

	JENDL-5.0, BROND-3.1, and CENDL-3.2 evaluated data libraries			
2.10	Activation cross section measurements for ^{7}Li-induced monitor reactions	30 min		M. Aikawa
2.11	Simultaneous evaluation of ^{232}Th and ^{237}Np fast neutron fission cross sections up to 200 MeV using EXFOR library	30 min		V. Devi
2.12	Manipulation of experimental data with NDPlot	30 min		Y.L. Jin
2.13	Installation of Python3 and ForEX	30 min		N. Otsuka

14:00 – 17:00

2	**Presentation and Exercise (cont.)**			
2.14	ForEX - Utility Codes for EXFOR: Lecture	30 min		N. Otsuka
2.15	ForEX - Utility Codes for EXFOR: Exercise	30 min		N. Otsuka
2.16	EXFOR-Trans2Master: Exercise	30 min		V. Zerkin

19:00 –

Social dinner ("7Stern Bräu", Siebensterngasse 19, 1070. Near the Christmas market on Spittelberggasse.)

Thursday, 5 December 2024

9:00 – 13:00

2	**Presentation and Exercise (cont.)**			
2.17	Comparison of two different data digitization presented in E2254 and F0164	30 min	WS2024-01	S. Dunaeva
2.18	From paper to data: GSYS and the digital transformation	30 min		M. Odsuren
2.19	Zero values coded under the headings PARITY, EN, ERR-T and DATA-ERR in the EXFOR library (NRDC A47) – *TBC*	30 min	WS2024-02	M. Mikhailiukova
2.20	Exercise: Zero values coded under the headings PARITY, EN, ERR-T and DATA-ERR in the EXFOR library (NRDC A47) - *TBC*	120 min	WS2024-03	M. Mikhailiukova

14:00 – 17:00

2	**Presentation and Exercise (cont.)**

2.21	AI-driven approaches to indexing and analytical insights	20 min		K. Ono, M. Mwakitalima
2.22	New features of EXFOR Editor (including exercises)	60 min	WS2024-04	G. Pikulina
2.23	Checking items – What must be checked by checking codes?	30 min	WS2024-05	N. Otsuka
2.24	ZCHEX: Exercise	60 min		V. Zerkin

Friday, 6 December 2024

9:00 – 13:00

2	**Presentation and Exercise (cont.)**			
2.25	Status of references collection project for EXFOR - Overview and progress	10 min		L. Vrapcenjak
2.26	EXFOR PDFs archiving improvements	20 min		A. Martinez
2.27	Discussion on corrections of entries with illegal zero values	30 min		M. Mikhailkukova
2.28	Introduction to collaboration and automation tools - Getting the most out of the git ecosystem	30 min		J. Sprenger
2.29	X4Pro: Exercise	60 min		V. Zerkin
3.	**Drafting**			
3.1	Drafting of inputs to workshop summary report	60 min		All
4.	**Closing**			
4.1	Review of workshop summary	30 min		Chairperson
4.2	Closing address	10 min		

Appendix C

LIST OF WORKING PAPERS

Number	Title	Presented by
WS2024-01	Comparison of digitized datasets presented in E2254 and F0164	S. Dunaeva
WS2024-02	Zero and negative values coded under the headings PARITY, EN, ERR-T and DATA-ERR in the EXFOR library (NRDC2024 A47)	M. Mikhailiukova
WS2024-03	Exercises at EXFOR Workshop 3-6 December 2024 (Agenda 2.20)	M. Mikhailiukova
WS2024-04	Examples of exchange file processing by EXFOR-Editor 4.02	G. Pikulina
WS2024-05	EXFOR check items	N. Otsuka

Note: These working papers are available online: http://nds.iaea.org/nrdc/wksp_2024/.

Appendix D

LIST OF PRESENTATIONS

TITLE	**Presented by**
Comments and suggestions related to the use of EXFOR in the preparation of proton activation data file PADF	A. Konobeyev
JSON Tree Editor	V. Zerkin
X5 - Enriched EXFOR in JSON	V, Zerkin
X5json discussion - future of x5json	V. Zerkin
EXFOR-C5: recent development, versions, distribution	V. Zerkin
Tables of neutron thermal cross sections, Westcott factors, resonance integrals, Maxwellian averaged cross sections, astrophysical reaction rates, and r-process abundances calculated from the ENDF/B-VIII.1, JEFF-3.3, JENDL-5.0, BROND-3.1, and CENDL-3.2 evaluated data libraries	B. Pritychenko
Activation cross section measurements for ^{7}Li-induced monitor reactions	M. Aikawa
Simultaneous evaluation of ^{232}Th and ^{237}Np fast neutron-induced fission cross sections up to 200 MeV using EXFOR library	V. Devi
Manipulation of experimental data with NDPlot	Y.L. Jin
ForEX: Utility Codes for EXFOR	N. Otsuka
Comparison of two different data digitization presented in E2254 and F0164	S. Dunaeva
From Paper to data: GSYS and the digital transformation	M. Odsuren
AI-driven approaches to indexing and analytical insights	K. Ono
Examples of exchange file processing by EXFOR-Editor 4.02	G. Pikulina
Status of references collection project for EXFOR - Overview and progress	L. Vrapcenjak
EXFOR PDFs archiving improvements	A. Martinez
Introduction to collaboration and automation tools - Getting the most out of the git ecosystem	J. Sprenger

Note: These presentations are available online: http://nds.iaea.org/nrdc/wksp_2024/ (except for Sprenger's one)

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