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Summary Report of the Workshop on Compilation of Experimental Nuclear Reaction Data

N. Otuka, B. Pritychenko

September 2023

Nuclear Science and Technology Department
Brookhaven National Laboratory

U.S. Department of Energy
International Atomic Energy Agency

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INDC

INTERNATIONAL NUCLEAR DATA COMMITTEE

Summary Report of the Workshop on

Compilation of Experimental Nuclear Reaction Data

IAEA Headquarters, Vienna, Austria

13 – 16 December 2022

Prepared by

Naohiko Otuka
IAEA Nuclear Data Section, Vienna, Austria

and

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February 2023

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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 13 to 16 December 2022. The meeting was attended by 23 participants representing 12 cooperative Centres from seven Member States (China, Hungary, Japan, Korea, Russia, Ukraine and USA) and two International Organisations (NEA, IAEA) as well as a participant from Mongolia and Spain. A summary of the workshop is given in this report along with the conclusions and actions.

Workshop on Compilation of Experimental Nuclear Reaction Data
IAEA Headquarters, Vienna, Austria, 13 – 16 December 2022

First row (from the left)

Monfero Charisse, IAEA

Vidya Devi, IAEA

Valentina Semkova, Bulgaria

Naohiko Otsuka, IAEA

Viktor Zerkin, IAEA

Sung Chul Yang, Korea

Second row (from the left)

Odsuren Myagmarjav, Mongolia

Atsushi Kimura, Japan

Otto Schwerer, Austria

Boris Pritychenko, USA

Sandor Takács, Hungary

Alberto Rodrigo, Spain

Masayuki Aikawa, Japan

Timur Zholdybayev, Kazakhstan

Remote participants (left, from the top)

Dave Brown, USA (left)

Daniela Foligno, NEA (right)

Olena Gritzay, Ukraine

Sophiya Taova, Svetlana Selyankina, Galina Pikulina, Russia

Remote participants (right, from the top)

Svetlana Dunaeva, 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-Russia 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 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 = 8th NRDC Meeting	INDC(NDS)-178
Vienna, 19-21 Sept 1984	Technical	Memo CP-D/131
Obninsk+Moscow, 17-21 Oct 1983	7th NRDC Meeting	INDC(NDS)-154
Vienna, 3-7 May 1982	6th NRDC Meeting	INDC(NDS)-141
Brookhaven, 29.9 - 2.10.1980	5th NRDC Meeting	INDC(NDS)-125
Karlsruhe, 8-13 Oct 1979	4th NRDC Meeting	INDC(NDS)-110
Paris, 19-23 June 1978	3rd NRDC Meeting	INDC(NDS)-99
Kiev, 11-16 April 1977	2nd NRDC Meeting = 3rd 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

FOREWORD

This report summarizes the IAEA Workshop on Compilation of Experimental Nuclear Reaction Data held at the IAEA Headquarters in Vienna, Austria from 13 to 16 December 2022. The meeting was attended by 22 participants representing 12 cooperative Centres from seven Member States (China, Hungary, Japan, Korea, Russia, Ukraine and USA) and two International Organisations (NEA, IAEA) as well as two participants from Mongolia and Spain (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**).

A series of lectures on a newly developed portable extended EXFOR relational database (X4Pro/SQLite) were delivered including examples of programming in SQL, Fortran and Python, automatic renormalizations and user's data corrections, comparison EXFOR and ENDF data using modern plotting, etc. The participants studied its usage by constructing and executing various queries using "DB Browser for SQLite" and X4Pro examples. The X4Pro database has been used in analysis of experimental isomeric ratios at NDS, and development of a tool processing X4Pro output for isomeric ratio analysis was reported. The data centres consider typing of the bibliography (title, authors, and institutes) must be automated to spend limited resource to physics related part of EXFOR compilation, and automation of the institute typing from article pdf file was discussed. Recently JAEA has started compilation of neutron induced reaction data measured at the J-PARC facility or measured by JAEA members, and we learned overview of the neutron capture measurements performed at the J-PARC ANNRI beam line from the first EXFOR workshop participant from JAEA. Another presentation from Japan covers measurements of medical isotopes including ^{211}Rn (generator of ^{211}At) performed at a RIKEN cyclotron. Reconstruction of excitation function of differential cross section from Legendre coefficients in EXFOR was also discussed in the relation with creation of data inputs to the IBANDL database The procedure to review each preliminary tape at NEA Data Bank by plotting on JANIS was also presented. .The participants were also updated for new features of the EXFOR editor.

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

January 2023

Naohiko Otuka and Boris Pritychenko

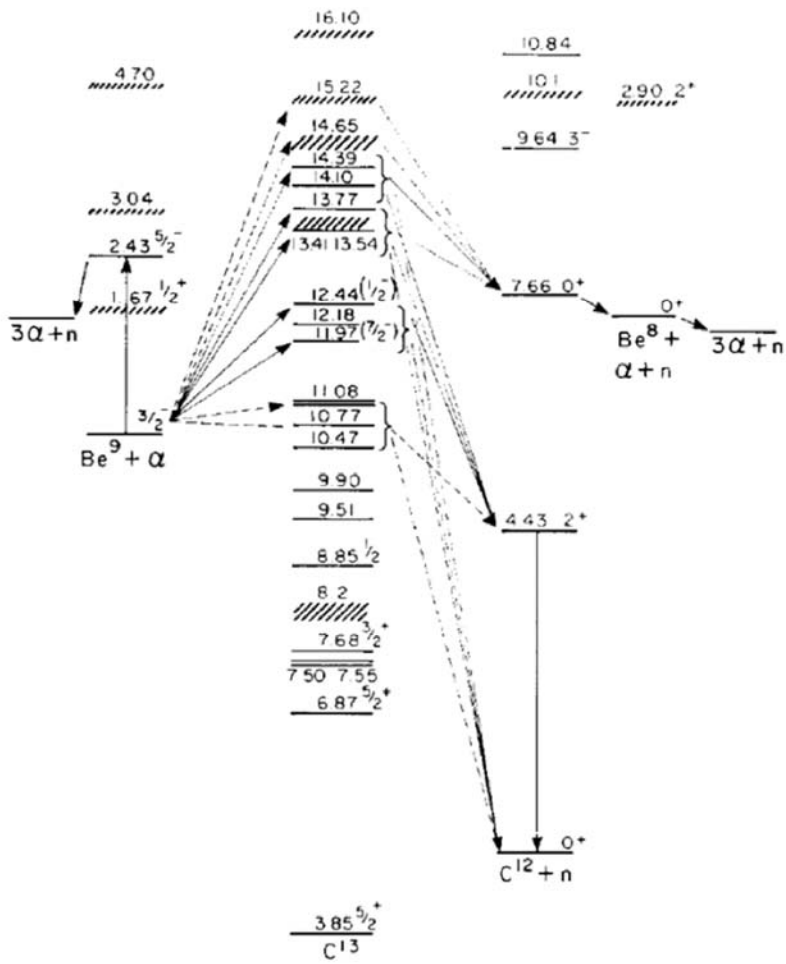
SUMMARY OF PRESENTATIONS

Neutron spectra from Be sources

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

Beryllium targets have been used for neutron production since the 1930s via ^{9}Be(n,a)^{12}C reaction. In early measurements cross sections were reported for different neutron groups from RaBe, RnBe, and PoBe neutron sources. The EXFOR database does not contain the beryllium sources' neutron spectra, and it represents a serious limitation for several users.

The neutron groups originate from the fact that different excited states are populated in ^{13}C compound nucleus after ^{9}Be absorbs alpha particle, as shown in Figure adopted from R.L. Lehman, J,NIM,60,253,1968:



Experimental nuclear reaction data (EXFOR) compilations require the incident particle energy for each data entry, and alpha particle energies are needed. Fortunately, ^{226}Ra, ^{222}Rn, and ^{218}Po are daughter a-decay products in ^{238}U decay chain, a-decay energies are well-defined.

For example, ^{222}Rn a-decay energy is 5.5904 MeV. This fact allows us to compile neutron spectra in EXFOR.

Finally, the beryllium neutron spectra were compiled as the Area #1 entries: C2761, C2762, and C2763. These compiled spectra complement the previously compiled neutron cross section entries: 14696, 14699, 14700, 14701, 14702, and 14703 that were measured with RaBe and RnBe neutron sources.

X4Pro retrieval by SQL sentences

Naohiko Otuka
Nuclear Data Section, International Atomic Energy Agency, 1400 Wien, Austria

X4Pro is collection of tables such as AUTHORS (author names), REACSTR (reaction codes), REFERS (references), x4pro_hdr (headings) and x4pro_x4data (numerical data). Below is the column structure of the table AUTHORS:

…	Entry	…	Author	FullName
…	10002	…	Block	R.C.Block
…	10001	…	Hockenbury	R.W.Hockenbury
…	…	…	…	…

One can extract lines of these tables satisfying a set of conditions by submitting a SQL SELECT sentence. A SELECT sentence looks like

SELECT *X* FROM *Y* WHERE *Z*

where X, Y and Z are the name(s) of table column(s), name(s) of table(s) and condition(s), respectively. For example,

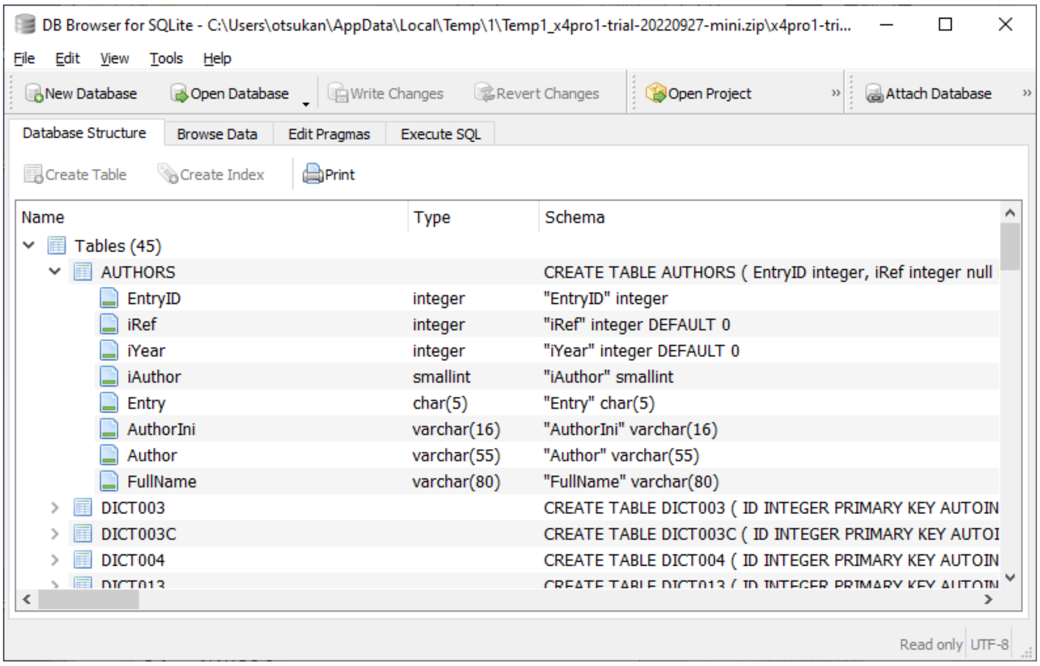
```
SELECT Entry, FullName FROM AUTHORS WHERE Entry = '10001';
```

with the AUTHORS table above returns

```
10001 R.W.Hockenbury
```

as an output.

"DB Browser for SQLite" (https://sqlitebrowser.org/) originally developed by Mauricio Piacentini is a useful tool to see the contents of the X4Pro database (e.g., list of tables, list of columns). The next image shows browsing of the structure of the table "AUTHORS".



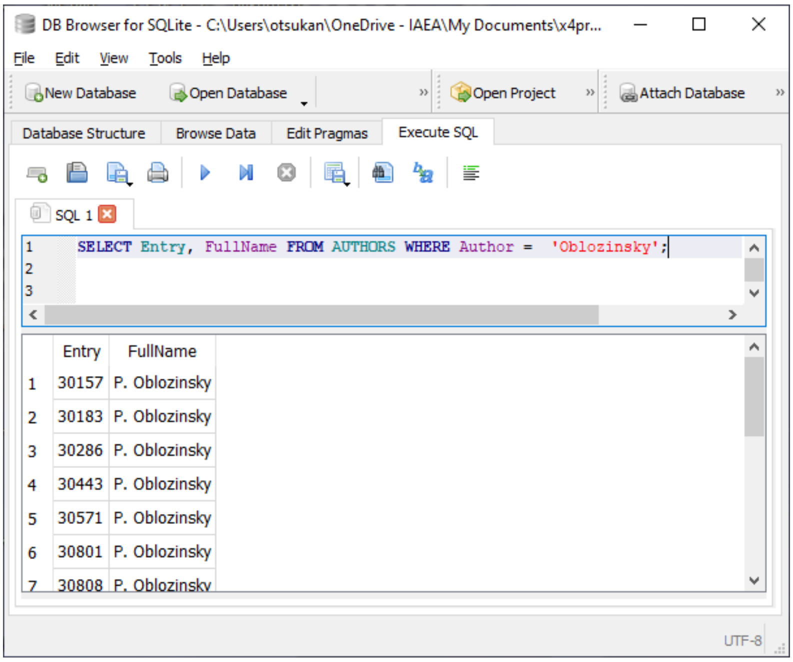
A SQL sentence can be executed on the command line of SQLite, for example

```
[ohtsuka@nds121] sqlite3 x4pro.db
SQLite version 3.31.1 2020-01-27 19:55:54
Enter ".help" for usage hints.

sqlite> SELECT Entry, FullName
        FROM AUTHORS
        WHERE Author = 'Oblozinsky';

30157|P. Oblozinsky
30183|P. Oblozinsky
…
```

. The DB browser for SQLite also provides an environment to execute it:



One can extract the table lines from several tables by linking two tables by a common attribute (e.g., subentry number + pointer, which is defined as “ReacodeID” or “DatasetID” in X4Pro). For example,

```
SELECT REACSTR.ReacodeID, REACSTR.Code
FROM REACSTR, x4pro_hdr
WHERE
      REACSTR.SF3          = 'ABS'
  AND x4pro_hdr.hdr        = 'DATA-CM'
  AND REACSTR.ReacodeID = x4pro_hdr.DatasetID
```

is for extraction of the subentry number and REACTION code from two tables REACSTR and x4pro_hdr for the dataset compiled with REACTION SF3 code ABS and data heading DATA-CM. The last condition connects two tables by setting the subentry number + point as a common value between two tables.

During my presentation in the workshop, I introduced more examples of SQL sentences including practical ones such as extraction of (1) bibliographies for BibTeX entry production and (2) 0th Legendre coefficients of neutron elastic scattering. All sample sentences on my slides can be copy and paste on the DB Browser to execute the retrieval.

Nuclear data measurements and compilation at JAEA

Atsushi Kimura
Nuclear Data Center, Japan Atomic Energy Agency, Ibaraki 319-1195, Japan

This presentation presents an overview of nuclear data measurement in J-PARC (facilities and examples of the experiments), compilation activities in JAEA, and requests for the EXFOR editor.

Accurate neutron capture cross-section data for minor actinides (MAs) and long-lived fission products (LLFPs) are required to develop innovative nuclear systems. The Accurate Neutron-Nucleus Reaction measurement Instrument (ANNRI) has been constructed in the Material and Life Science Experimental Facility of the J-PARC to obtain accurate cross sections taking advantage of the intensive pulsed neutron source of MLF. In the epithermal energy region, the neutron intensity of ANNRI is more than 7 times as high as the values of the other instruments.

Two gamma-ray detector systems for capture cross-section measurements and one Li-Glass detector system for total-cross section measurements are installed in the ANNRI. An array of large germanium (Ge) detectors is installed at a flight length of 21.5m and consists of 22 Ge detectors. The other gamma-ray detector system is a NaI spectrometer located at a flight length of 27.9 m. The Li-glass detector system consists of a ^{6}Li enriched Li-glass detector to detect transmitted neutrons and a ^{7}Li enriched one to deduce background.

As examples of experiments in ANNRI, measurements for Cm-244 (Ref: JNST,49,708 (2012)), Am-243 (Ref: JNST, 56, 479 (2019)) and Sn-112 (Stable) (Ref: Nuclear Data Sheets, 119, 150 (2014)) were presented. In the experiments in ANNRI, systematic uncertainties due to some reasons were reported separately. For example, in the case of capture cross-section measurement of Am-243, statistical uncertainty and uncertainties due to normalization, dead time correction, multiple scattering correction, relative neutron intensity, fission events subtraction, and impurity subtraction were reported.

JAEA is responsible for the compilation of the experiments done by JAEA members and in J-PARC facilities. In 2022, the following 6 entries were compiled at JAEA:

- 23741: Cm-244,246(n,g) in J-PARC by Dr. Kawase
- 23748: Am-243(n,g) in J-PARC by Mr. Kodama
- 23745: Np-237(n,g) in J-PARC by Dr. Rovira
- 23749: Tc-99(n,g) in YAYOI(Reactor) by Dr. Nakamura
- 23601: Np-237(n,g) in J-PARC in keV by Dr. Rovira
- 23602: Nb-93(n,g),(n,tot) in J-PARC by Mr. Endo

Requests for the EXFOR editor about type settings in the free text and a check system for decay gamma data were also presented in the presentation.

Automation of institute codes

Vidya Devi
Nuclear Data Section, International Atomic Energy Agency, 1400 Wien, Austria

Jagjit Singh Matharu
University Institute of Engineering and Technology, Panjab University, Chandigarh-160019, India

We tried to develop a small program "Automation of Institute codes" to extract the INSTITUTE code from the research paper for EXFOR compilation. The purpose of the prototype is to provide a basic idea to extract some fields from the PDF file of the research paper for EXFOR compilation. We used Python programming language to read and scan the data for DOI No. and institutes name from the PDF of research paper. We compared and searched the institute names in the TRANS Dictionary and then wrote the institute codes in the EXFOR format.

Institute name could be extracted in two ways:

1. Scanning DOI number from the PDF or as input from the user and parsing the research paper website.
2. Scanning the whole PDF and search the required data from the text

We choose option 2 as it looks more promising to even scan the FACILITY within the research paper in future.

We run the code few research papers and the output for the example Phys. Rev, C 105,054319,2022 is given below:

```
TITLE       Evolution of the isoscalar giant monopole resonance in
            the Ca isotope chain
AUTHOR      (S.Olorunfunmi, R.Neveling, J.Carter, P.Neumann-Cosel,
            I.Usman, P.Adsley, A.Bahini, L.Baloyi, J.Brümmer, L.Don
            aldson, H.Jivan, N.Kheswa, K.Li, D.Mar{\'{\i}}n-L{\'{a}
            }mbarri, P.Molema, C.Moodley, G.O{\textquotesingle}Neil
            l, P.Papka, L.Pellegri, V.Pesudo, E.Sideras-Haddad, F.S
            mit, G.Steyn, A.Avaa, F.Diel, F.Dunkel, P.Jones, V.Kara
            yonchev)
INSTITUTE   (3SAFITH,2GERTHD,3SAFUSF,2FR PAR,3SAFUWC,2GERKLN)
            (3SAFSAF) School of Physics, University of the Witwater
            srand, Johannesburg 2050, South Africa
```

The code further needs extensive refinement and could improve with testing on various research papers and journals. We have encountered few limitations while compiling the code on four examples. Institute names written in language other than English give error sometimes. The code could not provide author names on files in which DOI is missing. Moreover, TRANS Dictionary file too has few short comes that were faced while running the code for the examples.

Trans Dictionary file could work better if could be modified in form of CSV file with the columns consisting of city names and will be helpful to write the full name of the institute rather than fitting it in 55 columns. In future we wish to work on the code with modification to ask the compiler to choose the best option from the selected institutes provided by the code. We also will try to save the output in the database for future reference to make the code self-learning from the inputs received. For future program could also be modified to search Journal Reference, Facility, Method and Detector etc. codes from Trans Dictionary file.

Direct use of EXFOR exchange files for fast neutron fission cross section evaluation

Naohiko Otuka
Nuclear Data Section, International Atomic Energy Agency, 1400 Wien, Austria

The fast neutron fission cross sections for ^{233,235,238}U and ^{239,240,241}Pu were evaluated by performing fitting to the experimental fission cross sections and their ratios compiled in EXFOR [1]. Experimental inputs to the simultaneous least-squares fitting code SOK (Simultaneous evaluation on Kalman) were prepared by a code SOX (Simple Output of eXfor). The SOX code reads a data list file (list of subentry numbers), EXFOR file (original EXFOR file of the subentry) and HED file (list of heading defining the correlation properties of partial uncertainties) and generate three experimental input files for reading by SOK. As the correlation coefficients of cross sections are provided very seldom by the experimentalists, the correlation coefficients are constructed by the partial uncertainties in EXFOR and correlation properties specified in the HED file.

As the fitting result strongly depends on the correlation coefficients, it is important to record the correlation properties (e.g., uncorrelated, fully correlated) assigned by the evaluator to make the evaluation traceable. SOX tabulates the partial uncertainties and their correlation properties. Below is an example of tabulation for EXFOR 14015.002 where we can see the partial uncertainty coded under ERR-S is treated as uncorrelated (0.0) while the other three partial uncertainties are treated as fully correlated (1.0). The table also provides the lower and upper boundary of the uncertainties in % and the attribute for each partial uncertainty.

```
*  14015.002   20100728  1.0000E+00 1USALAS  A.D.Carlson+,1991
14015.002  :ERR-C     :CT:   : 1.2%: 2.0%:Total uncertainty (calculated)
14015.002  :ERR-S     :  :0.0: 1.0%: 1.9%:Statistics
14015.002  :ERR-1     :  :1.0: 0.1%: 0.2%:Fission fragment counting efficiency
   14015.002  :ERR-2     :  :1.0: 0.3%: 0.3%:Transmission and scattering

14015.002  :ERR-3     :  :1.0: 0.5%: 0.5%:Background
```

The full table was converted to LaTeX and published in the report describing the inputs and outputs of the simultaneous evaluation. Note that SOX can also read the correlation coefficients provided by the experimentalist.

References

[1] N. Otuka, O. Iwamoto, "EXFOR-based simultaneous evaluation of neutron-induced uranium and plutonium fission cross sections for JENDL-5", J. Nucl. Sci. Technol. **59** (2022) 1004 (https://doi.org/10.1080/00223131.2022.2030259).

[2] N. Otuka, O. Iwamoto, "EXFOR-based simultaneous evaluation of neutron-induced uranium and plutonium fission cross sections for JENDL-5: Inputs and outputs" (JAEA-Data/Code 2022-005=INDC(SEC)-0112 (Rev.), 2022. (https://doi.org/10.11484/jaea-data-code-2022-005).

On new features of the EXFOR Editor

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

To enhance functionality of the EXFOR-Editor there were provided the possibilities

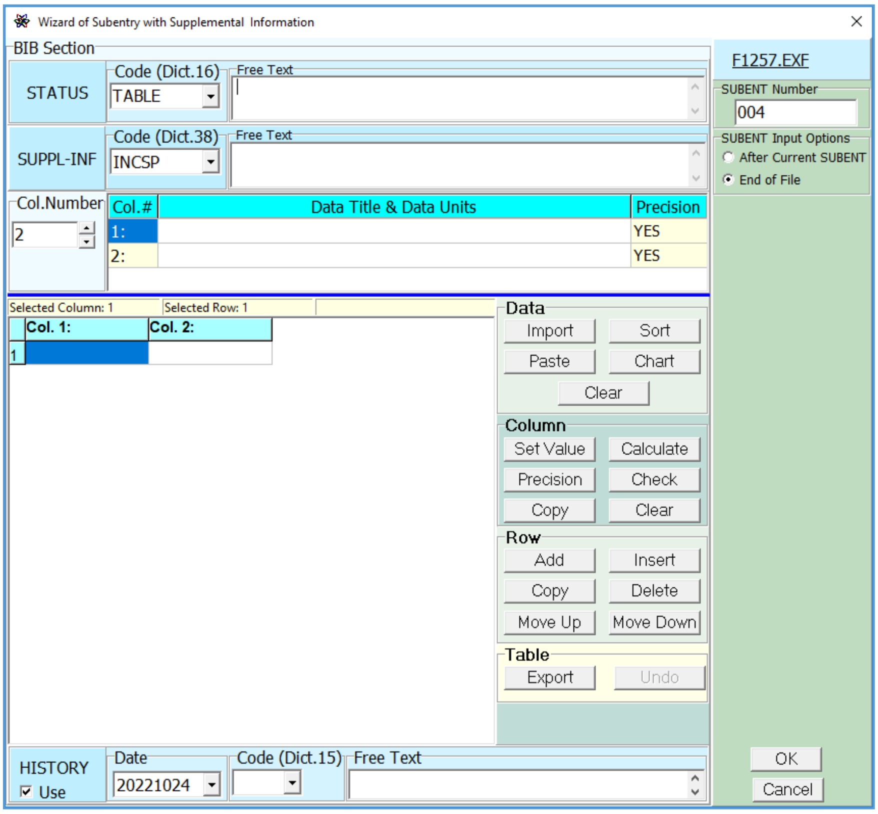
- of entering data on neutron spectra with a keyword SUPPL-INF (Supplemental Information);
- of creating and processing the exchanged file TRANS to transfer the compiled experimental data into NDS.

1. Entering data on neutron spectra with a keyword SUPPL-INF

There are two ways to input data on neutron spectra to the entry:

- to create a subentry with **SUPPL-INF**;
- to input the **SUPPL-INF** keyword information into the existing subentry.

Click the **SUBENTRY SUPPL-INF** button on a tool panel to create a subentry or select the **Sections|Subentry SUPPL-INF** menu item in the **ENTRY** mode of the EXFOR-Editor. Enter information into the Edit fields of a dialog window.



To input numerical data for the **SUPPL-INF** keyword select data in any file and put them into the clipboard (Copy) and then to the Edit field (Paste). All operations of the **Data Table** mode are available for processing the **SUPPL-INF** numerical data.

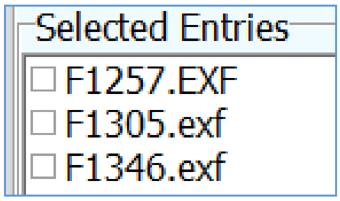
To input the **SUPPL-INF** keyword information to the existing subentry select the **SUPPL-INF** button on the tool panel of the main window or **Keywords|Physics|SUPPL-INF** menu item.

2. Exchange File Processing

Click the **TRANS File** tool button on the tool panel of the main window or select the **TRANS File|New|TRANS File** menu item. In the **New TRANS** window in the **TRANS Number** field perform the following operations:

- select a new file type from the drop-down list: **PRELIM** or **TRANS**;
- input a four-character file identification.

The **Selected Entries** group box initially contains a list of Entries opened in the **ENTRY Mode**.



Use the **Add Entries** button to include additional Entries into the list. Then select necessary Entry filenames saved on a hard disk in the **Select Entries for TRANS** window.

Mark ENTRY filenames for a new TRANS in the **Selected Entries** list and click the **OK** button. A new EXFOR Exchange File should be created in the main window of the **TRANS Mode**. Check and correct this file. Click the **Add ENTRY** button on the tool panel of the main window or select the **TRANS File|Add Entry** menu item to add Entries to the Exchange File.

Click the **Order** button on the tool panel of the main window or select the **Processing|Order** menu item to order the file.

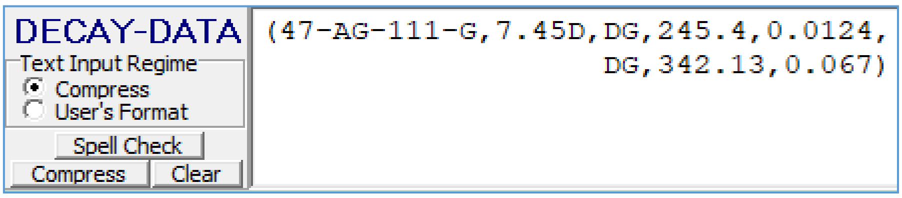
Click the **Check** button on the tool panel of the main window or select the **Processing|Check** menu item to launch the **ZChex** program (developed by V.Zerkin, NDS, IAEA).

Click the **Checker** button on the tool panel of the main window or select the **Processing|Checker** menu item to launch the **Trans Checker** program (developed by N.Soppera, NEA Data Bank).

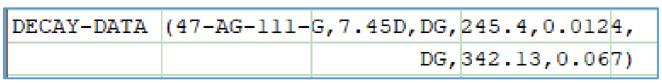
The results are shown in the table on the lower panel of the main window. Click the row containing an error or warning description to highlight the wrong record. Correct all errors and warnings and get the message about zero error.

3. Additional comments on some corrections

Use the **User's Format** option in the **Text Input Regime** group-box to save the author's formatting of text information for input of keywords data (all spaces will be saved).



Text will be inserted without any transformation. This option is available for all keywords.



Transfer of data and compilations between EXFOR and IBANDL

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Both the general-purpose EXFOR database and the Ion Beam Analysis relevant library IBANDL are currently maintained and developed at IAEA NDS. The experimental differential reaction cross section data are in scope of both libraries. However, the format of the compilation is different. The exchange of data and completeness checking improve the quality of the services provided to users. The broad range of journal scanning and data compilation for EXFOR ensure more comprehensive data update for IBANDL while the data provided from the Ion Beam Analysis community for IBANDL supplies EXFOR compilation with of numerical data from authors. Such authors' data are essential since many of the IBANDL data follow a resonance structure. However, this is not the case for old compilations, where data from EXFOR were retrieved for inclusion in IBANDL. The development of tools for automatic retrieval and generation of files improves the effectiveness of the compilation work and consistency of the compiled information. Automatic retrieval developed by V. Zerkin at Nuclear Data Section extracts data for a given reaction at each compiled emission angle and convert the EXFOR file to R33 format. Recently N. Otuka from the Nuclear Data Section has developed a code for compilation of EXFOR file from collection of all IBANDL files containing data for energy dependent differential cross section at various angles from a publication for a given reaction.

Some publications report differential cross section at set of incident energies as a function of emission angle on graphs. Irrelevant on the compilers' efforts to digitize the data precisely the graphs do not provide enough quality to construct data at specific angles for the studied incident projectile energies. However, if the Legendre coefficients were reported those data could be calculated. The data were calculated from the Legendre coefficients reported in the A. Saganek et al., Acta Physica Polonika B2 (1971) 473 by

$$\frac{d\sigma}{d\Omega}(E,\theta) = \frac{\sigma}{4\pi}[1 + \sum_{l=1}^{n} W_l(E)P_l(cos\theta)].$$

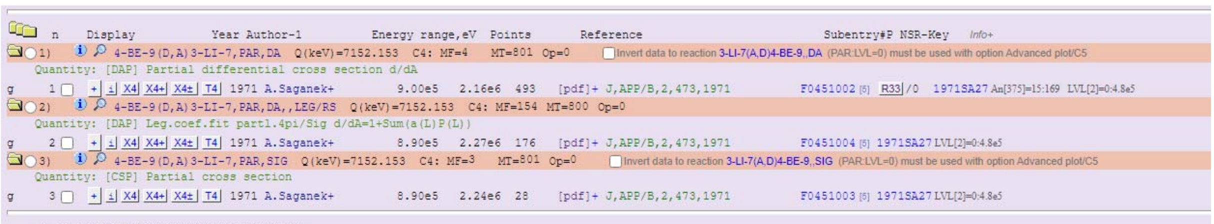

Figure 1. Compilation of A. Saganek et al., Acta Physica Polonika B2 (1971) 473 in EXFOR entry F0451.

The files with the calculated data were uploaded to IBANDL library for comparison with the existing data from other authors.

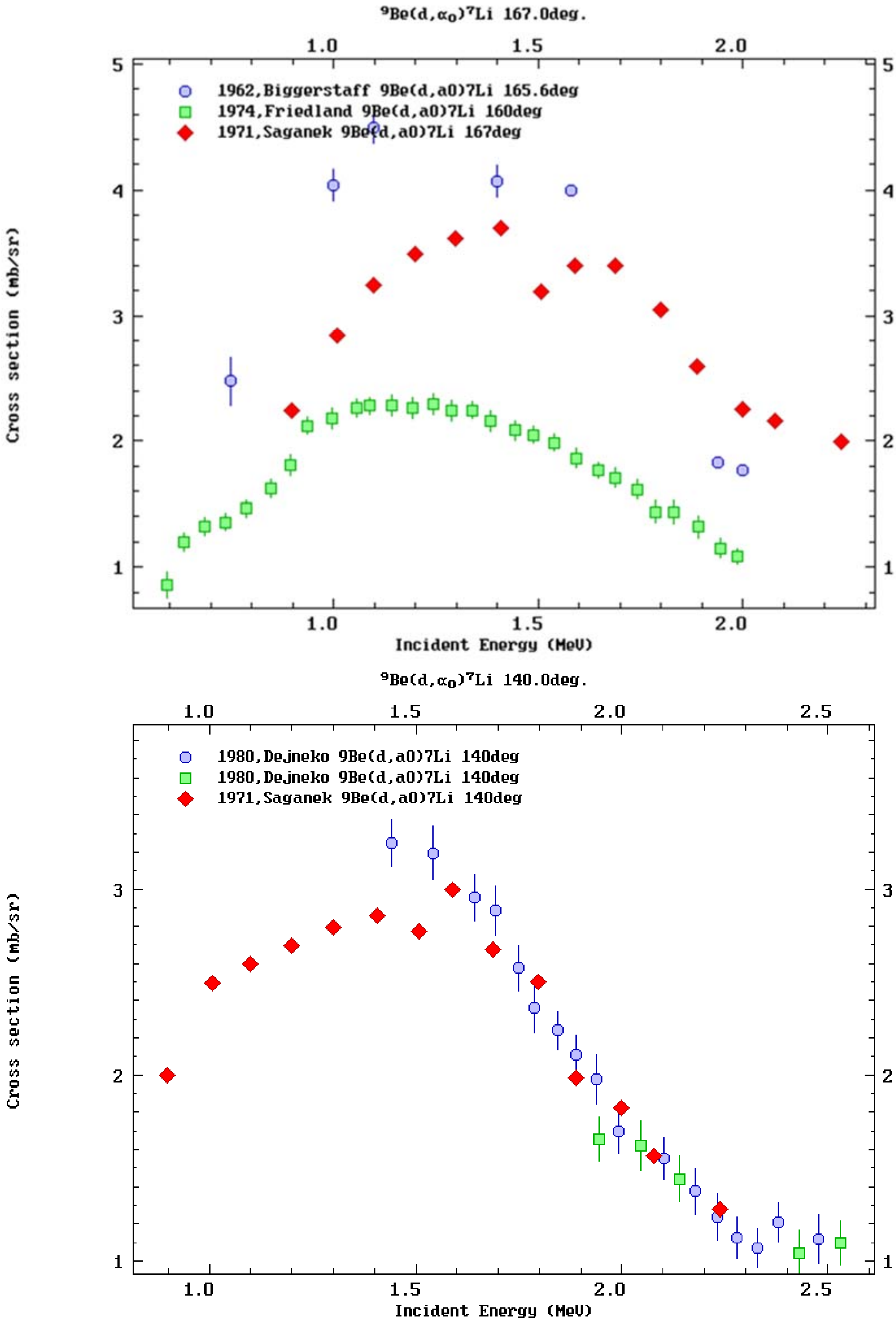

Fig. 2. Differential cross sections for the $^{9}Be(d,a_0)^{7}Li$ reaction at 165 and 140 degrees from IBANDL database and the calculated values using the Legendre coefficients reported in A. Saganek et al., Acta Physica Polonika B2 (1971) 473.

Consistent compilations and regular updates for both EXFOR and IBANDL provide completeness of the experimental databases for users. Developments of software for automatic transformation of the files from both libraries improves the effectiveness of the compilation work and consistency of the compiled information.

Development of experimental database of isomeric ratios

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When cross sections are measured with the ground state activity we often get improper interpretation of the measurements due to the activation formula at the limit when the half-life for the metastable state is much shorter than the half-life for the ground state, this approximation has been used even if it is not appropriate and the purpose of the work is to identify when this approximation works well, for this, Naohiko Otsuka has developed a deviation factor which compares experimental cross section data with the effective cross section, this last one is the result of the application of the activation formula to the ground state activity. This deviation factor depends not only on the isomeric transition probability and the cumulative factor but also of the isomeric ratios, for the extraction of the isomeric ratios we have developed a tool for obtaining a database of experimental isomeric ratios from the EXFOR library.

The data sources which have been used in the development of the tool are the Nubase2020, the c4 Library from x4pro from the last version of the EXFOR master file and TALYS for the addition of a theoretical curve. This tool development has been used for consistency checking of the total and isomer production cross section as well as isomeric ratios compiled in the c4 library, finding the first sources of the problems on the first experimental data which was used in this project, the c5 library with a quasi c4 like file from x4pro for isomeric ratios, during its compilation we found ratios larger than 1 and lower than 0, due to isomer production cross section larger than total production cross section or negative isomer production cross section. 22 datasets were found within this problem, 9 of them were due to compilation errors, the second problem found in this data source would be identified when we had datasets which allowed us the calculation of both parts of the following equations separately:

$$\sigma_T = \sigma_G + \sigma_M$$

$$\mathrm{IR(x/y)} = \sigma_x/\sigma_y \text{ (x, y = G, M or T)}$$

The results would be compared and would not match for 87 datasets, being able to identify 13 EXFOR errors and 1 authors typo. This information is stored in the first memo distributed within this project (CP-D 1058). The second experimental data with the quasi c4 library would again give ratio calculations lower than 0 or higher than 1, thanks to the same problem but due to a different source of the problem, in many cases due to the absence of the g in the nuclide symbol, leading to a misunderstanding between the ground state and the total production cross section, storing the information for this datasets in the second memo distributed for this project (CP-D 1060). The tool also was developed for the addition of the TALYS theoretical curve for visual guiding but not for addition into the tabulation form. Some mathematical operations were developed for obtaining the isomeric ratio deviation for allowing us calculation of the goodness of fit of the TALYS theoretical curve with the experimental data for the isomeric ratios. For the goodness of fit, the chi square and the root mean square F-Factor was calculated developing a preliminary version of it.

After the visualization of the data we encounter that we had a twice appearance of the datapoints from Filatenov´s experiments, the activation cross sections compiled in EXFOR 41424 from RI-258 (2001) were suppressed by the corresponding datasets in EXFOR 41614 compiled from INDC(CCP)-0460 (2016) but few subentries of EXFOR 41424 are still active entailing to compilation of same experimental results twice, the case for this problem could be that the datasets in the two entries are not for direct comparison. The same problem was found in the entry from RI-252 (1999) (The information for these problems are stored in memos CP-D 1061/1062).

As conclusions of the work done, we believe that there might be more errors like described in memos (CP-D/ 1058, 1060) not detectable by us and that the TALYS theoretical curve sometimes overestimates both ground and metastable states but will describe very well the isomeric ratios, reinforcing the main purpose for obtaining the database of experimental isomeric ratios.

Activation cross sections of charged-particle-induced reactions for medical radionuclide generators

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There are many radioisotopes used for nuclear medicine. Among such radioisotopes, positron and γ emitters can be used for diagnosis and β, α, and Auger electron emitters can be used for therapy. The medical radioisotopes are produced using nuclear reactions and generators. The production cross sections of such generators are important nuclear data. We systematically perform experiments at RIKEN to measure the production cross sections. The well-established methods, stacked-foil activation method and γ-ray spectrometry, were adopted for the measurements. In this presentation, some experimental results of activation cross sections to produce radioisotopes for the generators were shown.

The ^{96}Zr(α,n)^{99}Mo reaction can produce ^{99}Mo for the ^{99}Mo/^{99m}Tc generator for single-photon emission computed tomography (SPECT). The cross sections of the reaction measured earlier were found in the EXFOR library, but inconsistent with each other. We therefore performed experiments using 51- and 29-MeV α-particle beams. The results obtained using the two beams were consistent with each other, but different from the previous studies. Our results are positive for the ^{99}Mo production because the peak of the cross sections is larger in amplitude at the lower energy than those of previous studies.

The ^{44}Ti/^{44}Sc generator for positron emission tomography (PET) may be created using proton- and deuteron-induced reactions on ^{45}Sc. The literature data on the former reaction were very scattered and those on the latter were scarce. We measured the cross sections for both reactions. The results were compared with previous studies and found to be consistent with some of them. The proton-induced reaction can be a route to produce the amount enough for the generator.

The ^{211}Rn/^{211}At generator is expected for therapy using α-particles emitted from ^{211}At. ^{211}Rn can be produced using the ^{209}Bi(^{7}Li,5n)^{211}Rn reaction. Three previous studies of the reaction were found in the EXFOR library and showed inconsistency among them. Three targets, two for cross sections and one for a thick target yield, were prepared and irradiated with ^{7}Li beams. The results of the cross sections were slightly scattered because of the thicknesses uncertainty of the targets that were evaporated on ^{27}Al backing foils. The experimental thick target yield was compared with the calculated one using the measured cross sections and found to be consistent.

The production cross sections and production yields are necessary for medical radioisotope generators. Our experimental studies on the cross sections and yields are expected to contribute to nuclear medicine.

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

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Compilation of heavy ion-induced reaction data from Western European countries between 2019 and 2022 was presented. At the beginning of her presentation, she mentioned that the compilation of heavy ion-induced reactions started since 2014 at the Nuclear Research Center (NRC) of the National University of Mongolia (NUM). Her presentation listed 39 articles in the EXFOR library as EXFOR entries.

In 2019, photofission data measured in NRC, NUM using electron cycle accelerator microtron MT-22 were compiled as G0065. This was the first compilation article from Mongolia to make measurements in NRC, NUM in 2005. Compiling G0065 in the EXFOR library created several new codes for institute (3MGLNUM) and reference (C,2005 ULAANB). She also pointed out that it was the first compilation experience for compiling the proceedings article for her.

Between 2019 and 2022, we (with N. Otsuka) have compiled 39 EXFOR entries from articles published in 2005-2022 (please see table 1). It can be seen from table 1 that they mainly compiled heavy-ion induced reaction data measured at the LNL-INFN, Italy and few data have compiled by us which measured at the GANIL France, GSI, Darmstadt, Germany, CERN Geneva and LNS-INFN, Italy.

Table 1. List of compiled articles

Entry number	First author	Journal volume, page and publication year+	Laboratory, country	Year of compilation	Status
D0920	R.Linares	J,PR/C,98,054615,2018	LNS, INFN, Italy	2019	in EXFOR
D0923	R.Briselet	J,PR/C,99,024614,2019	Jyvaeskylae, University, Finland	2019	in EXFOR
D0931	B.Fernandez-Dominguez	J,PL/B,779,124,2018	GANIL, France	2019	in EXFOR
D0932	E.Prasad	J,PR/C,96,034608,2017	Australian Natl.Univ., Canberra	2019	in EXFOR
D0935	I.Stefan	J,PL/B,779,456,2018	GANIL, France	2019	in EXFOR
D0941	S.Bagchi	J,PL/B,790,251,2019	GSI, Darmstadt, Germany	2019	in EXFOR
D0955	D.Perez-Loureiro	J,PR/C,99,054606,2019	GSI, Darmstadt, Germany	2019	in EXFOR
D8001	A.Spatafora	J,PR/C,100,034620,2019	LNS, INFN, Italy	2019	in EXFOR
D8006	A.M.Stefanini	J,PR/C,100,044619,2019	LNL, INFN, Italy	2019	in EXFOR
G0065	N.Norov	C,2005ULAANB,,30,2005	NUM, Mongolia	2019	in EXFOR
D8007	J.Khuyagbaatar	J,NP/A,994,121662,2020	GSI, Darmstadt, Germany	2020	in EXFOR
D8008	L.M.Fonseca	J,PR/C,100,014604,2019	LNS, INFN, Italy	2020	in EXFOR

D8010	A.K.Mistry	J,NP/A,987,337,2019	GSI, Darmstadt, Germany	2020	in EXFOR
D8018	A.N.Andreyev	J,JP/G,37,035102,201	GSI, Darmstadt, Germany	2020	in EXFOR
D8022	G.Colucci	J,EPJ/A,55,111,2019	LNS, INFN, Italy	2020	in EXFOR
D8023	E.Vardaci	J,EPJ/A,43,127,2010	LNL, INFN, Italy	2020	in EXFOR
D8024	B.Blank	J,EPJ/A,31,267,2007	GANIL, France	2020	in EXFOR
D8025	J.A.Heredia	J,EPJ/A,46,337,2010	GSI, Darmstadt, Germany	2020	in EXFOR
D8028	G.Montagnoli	J,PR/C,101,044608,2020	LNL, INFN, Italy	2020	in EXFOR
D8031	J.Diaz-Cortes	J,PL/B,811,135962,2020	GSI, Darmstadt, Germany	2021	in EXFOR
D8032	X.Pereira-Lopez	J,PL/B,811,135939,2020	GANIL, France	2021	in EXFOR
D8033	F.Cappuzzello	J,EPJ/A,57,34,2021	LNS, INFN, Italy	2021	in EXFOR
D8035	J.L.Ferreira	J,PR/C,103,054604,2021	LNS, INFN, Italy	2021	in EXFOR
D8036	J.Khuyagbaatar	J,PR/C,102,064602,2020	GSI, Darmstadt, Germany	2021	in EXFOR
D8037	J.Khuyagbaatar	J,PR/C,103,064303,2021	GSI, Darmstadt, Germany	2021	in EXFOR
D8038	H.M.Devaraja	J,EPJ/A,55,25,2019	GSI, Darmstadt, Germany	2021	in EXFOR
D8039	J.Khuyagbaatar	J,PR/C,104,L031303,2021	GSI, Darmstadt, Germany	2021	in EXFOR
D8040	O.Sgouros	J,PR/C,104,034617,2021	LNS, INFN, Italy	2021	in EXFOR
D8041	L.La Fauci	J,PR/C,104,054610,2021	LNS, INFN, Italy	2022	in EXFOR
D8043	A.M.Stefanini	J,JP/G,48,055101,2021	LNL, INFN, Italy	2022	in EXFOR
D8046	S.Pirrone	J,EPJ/A,55,22,2019	LNS, INFN, Italy	2022	in EXFOR
D8047	S.Burrello	J,PR/C,105,024616,2022	LNS, INFN, Italy	2022	in EXFOR
D8048	I.Ciraldo	J,PR/C,105,044607,2022	LNS, INFN, Italy	2022	in EXFOR
D8050	GJKhuyagbaatar	J,PR/C,106,024309,2022	GSI, Darmstadt, Germany	2022	in EXFOR
D8051	G.Montagnoli	J,JP/G,49,095101,2022	LNL, INFN, Italy	2022	in EXFOR
D8052	S.Kaur	J,PRL,129,142502,2022	GSI, Darmstadt, Germany	2022	in EXFOR
D8053	F.Kh.Ergashev	J,APP/B,53,A5,2022	Poland, Warszawa	2022	in EXFOR
D8054	A.Bronis	J,PR/C,106,014602,2022	GSI, Darmstadt, Germany	2022	Compiling

Validation of datasets in preliminary transmission by plotting on JANIS

Daniela Foligno
Data Bank, Nuclear Energy Agency (NEA), 92100 Boulogne-Billancourt, France

Daniela Foligno presented the review process performed by the NEA on EXFOR preliminary tapes. The NEA Data Bank Review Process includes:

1) Bibliography checks
2) TRANS checker
3) Text clarity
4) JANIS checks

Bibliography checks

The Bibliography checks are performed by Manuel Bossant, and include misspelled author's names, upper-lower cases in the title, authors' order, etc. It must be noted that the review done by Manuel and the one done by Daniela are not simultaneous.

TRANS Checker

TRANS checker is very easy to use. It can be found at the following link: https://www.oecd-nea.org/janisweb/trans-checker. The web-based application allows to upload any file stored on the local computer. The code gives errors and warnings (e.g. Unknown quantity, Unknown institute), as shown in Fig.1. Naohiko Otsuka asked how often the JANIS TRANS checker dictionary is updated, and Daniela agreed to ask Nicolas Soppera.

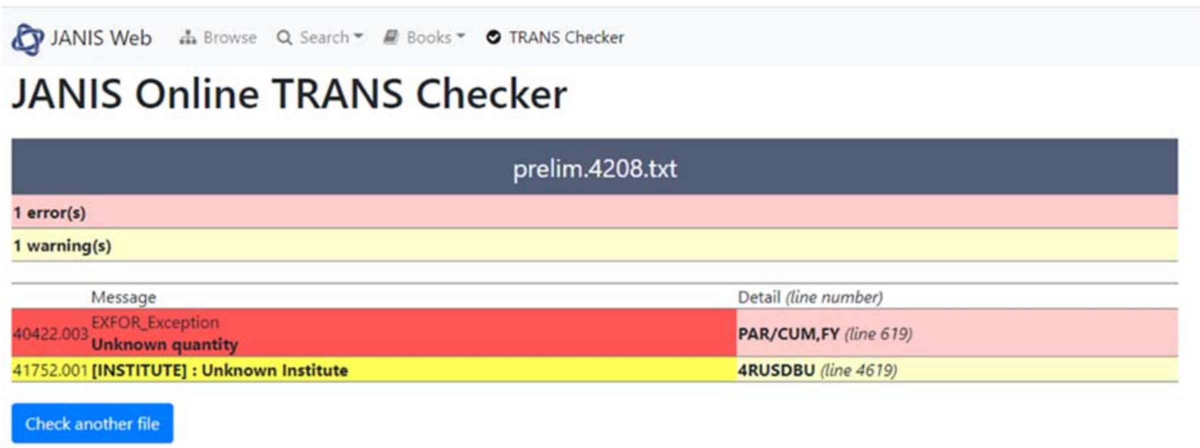

Figure 1: Example of TRANS Checker output

Text clarity

The Text clarity is done using a classic editor spelling checking tool. Misspelled words are highlighted and easy to identify. Daniela Foligno specifies the line number and proposes corrections.

JANIS Checks

The most relevant and time-consuming review is done using the JANIS tool, developed by the NEA. In order to upload a preliminary tape, the standalone version of JANIS must be downloaded at the following link: https://www.oecd-nea.org/janis/webstart/janis.jnlp. To upload a preliminary tape from the local computer, one has to launch the application, and then click on **File → Open → Select File**.

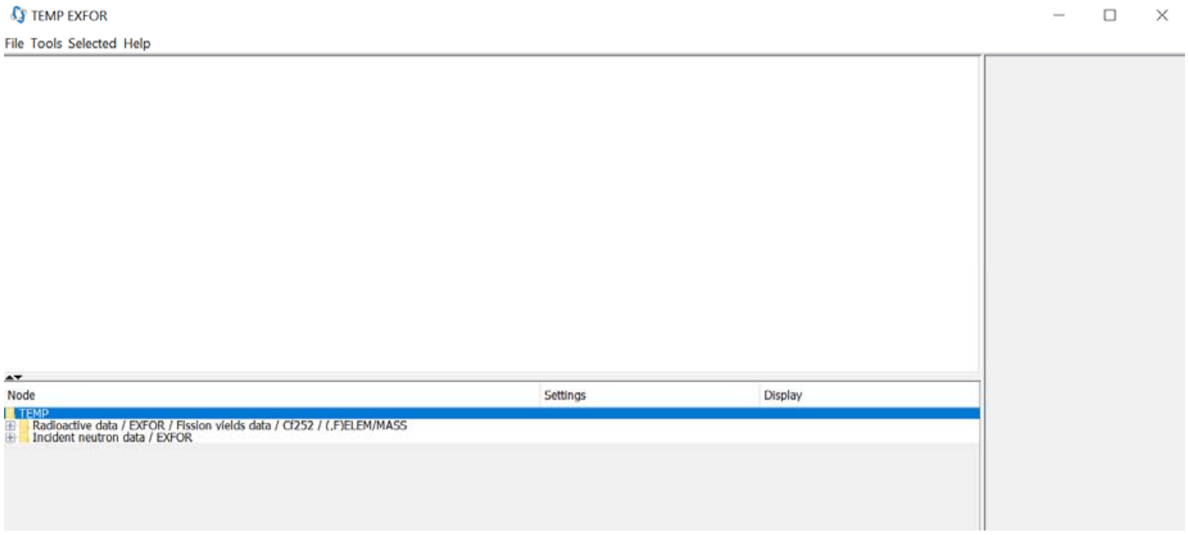

Figure 2: JANIS interface

It is possible to change the way data is sorted. In order to do that, **right click on TEMP and go to settings**. A new window listing the levels order will open. Daniela Foligno generally prefers to change the level orders (see Fig 3).

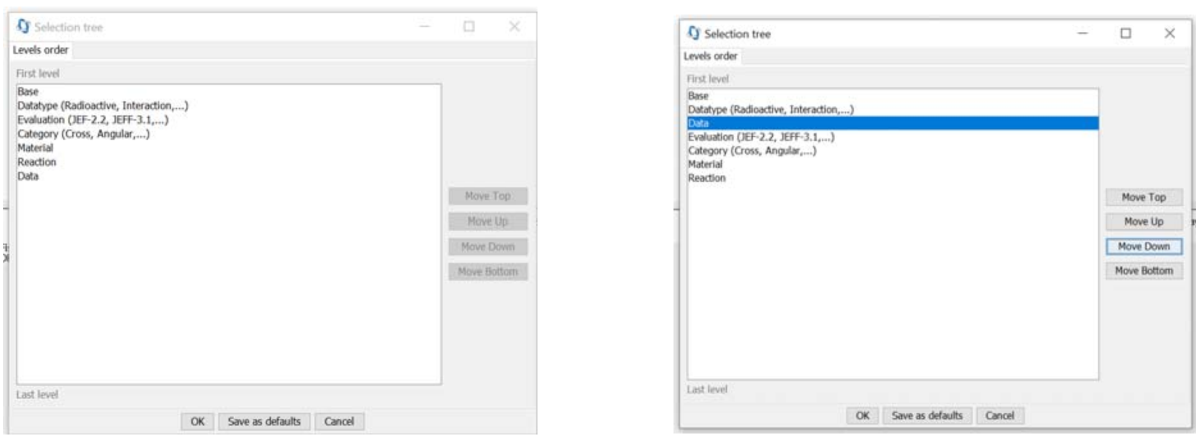

Figure 3: From default sorting to updated sorting (Data was moved up four times)

Here are some helpful tips to plot all the data at once:

- click on **Shift + 8** to open all the folders and subfolders at once
- click on **Ctrl + A** to select all the items
- click on **P** to plot the selected items

One important thing to keep in mind is that, whenever the data section is stored in a table containing more than two columns, only part of the dataset is plotted. To show it all, one needs to manually select the remaining data subsets. Once all the data points are plotted, the reviewer has to visualize them and look for outliers. Outliers can be a single data point (see Fig. 4) or a whole dataset (see Fig. 5).

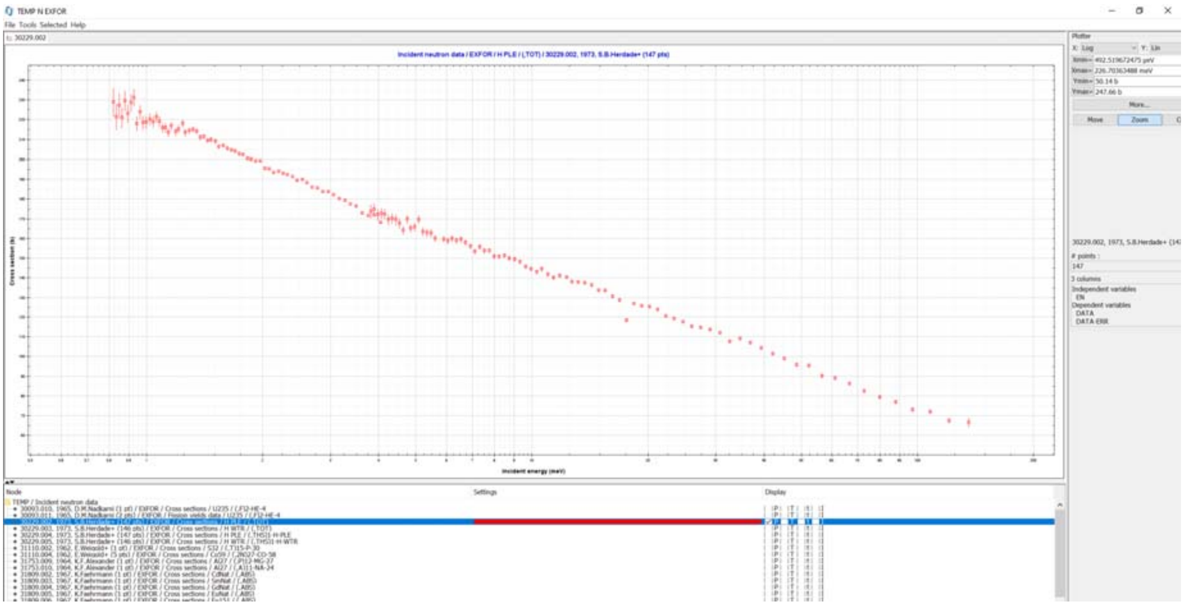

Figure 4: Suspected data point outlier

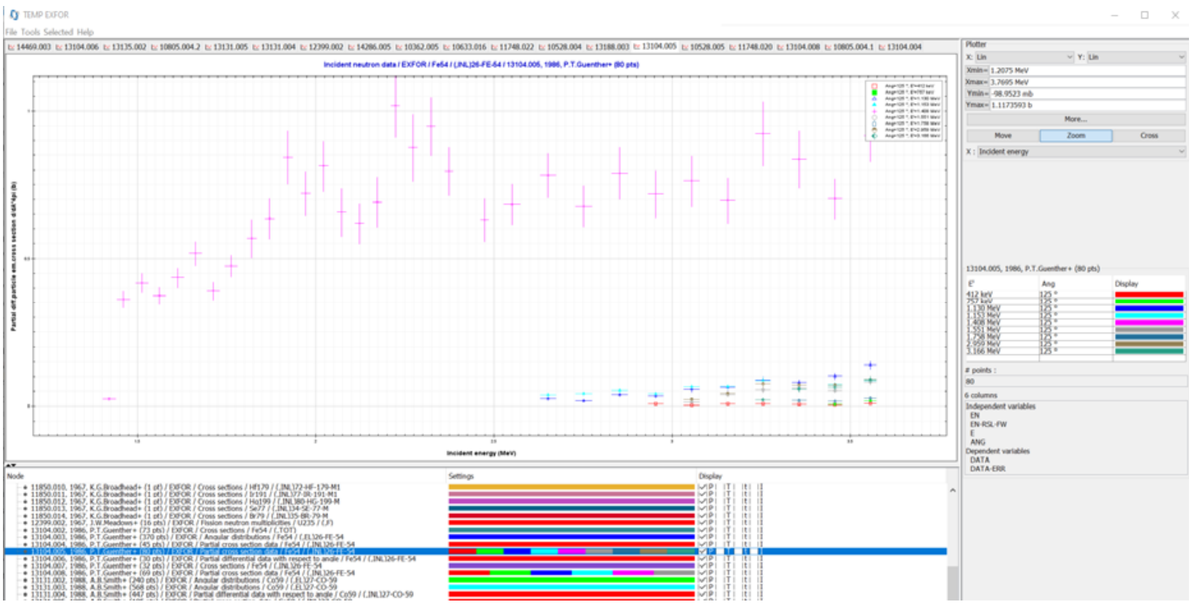

Figure 5: Suspected dataset outlier

Conclusions

The time required to review a preliminary tape (TRANS checker, Text clarity, JANIS checks) can go from minutes to hours depending on the file, to which one needs to add Manuel's bibliography checks. The Data Bank responsibility is to review, with such level of detail, tapes from area O and area 2 (19 in 2021 and 14 in 2022). In addition to that, since 2021, the Data Bank reviewed, on average, 78 preliminary tapes per year.

The checks performed by the Data Bank (bibliography checks excluded) are pretty straightforward and can be done by the **reviewer of each specific area**. Daniela Foligno is willing to help other reviewers to learn the NEA review process. She commits to perform a detailed review of files from area O and area 2, as they are her responsibility. However, preliminary tapes from other centers will be treated according to her priorities. This could imply a faster and less detailed review. To conclude, she suggests not to wait for her feedbacks to publish the files as trans on NDS open area.

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Appendix B

AGENDA

Tuesday, 13 December 2022

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	C. Monfero
1.4	Election of chairperson and rapporteur, adoption of the agenda	5 min	N. Otsuka
2	**Presentation 1**		
2.1	Introduction to X4Pro	90 min	V. Zerkin
2.2	Neutron spectra from Be sources	30 min	B. Pritychenko

14:00 – 17:00

2	**Presentation 1 – Cont.**		
2.3	X4Pro retrieval by SQL sentences	60 min	N. Otsuka
2.4	Overview of IT technologies used in X4Pro (SQL, Python, Fortran)	30 min	V. Zerkin
3	**Exercise 1**		
3.1	X4Pro. Installation and running tests: Windows, Linux, MacOS	60 min	V. Zerkin

Wednesday, 14 December 2022

9:00 – 13:00

3	**Exercise 1 (Cont.)**		
3.2	Review of Exercise 1	30 min	V. Zerkin
4	**Presentation 2**		
4.1	Nuclear data measurements and compilation at JAEA	30 min	A. Kimura
4.2	Automation of institute code	30 min	V. Devi
4.3	Structure of programs in X4Pro	60 min	V. Zerkin
4.4	ENDF Web-API used in X4Pro	20 min	V. Zerkin
4.4	Automatic renormalization in X4Pro	30 min	V. Zerkin

14:00 – 17:00

5	**Exercise 2**		
5.1	Retrieval SIG, DA, DAP, DE, DAE	30 min	V. Zerkin
5.2	Automatic renormalization with X4Pro	60 min	V. Zerkin

19:00 –
Social diner (“Centimeter am Spittelberg”, Stiftgasse 4/Ecke Siebensterngasse, 1070 Wien. Near the Christmas market on Spittelberggasse.)

Thursday, 15 December 2022

9:00 – 13:00

5	**Exercise 2 (Cont.)**		
5.3	Review of Exercise 2	30 min	V. Zerkin
6	**Presentation 3**		
6.1	New features of Exfor-Editor program code (1)	15 min	S. Taova
6.2	New features of Exfor-Editor program code (2)	15 min	G. Pikulina
6.3	Transfer of data and compilations between EXFOR and IBANDL	30 min	V. Semkova
6.4	Direct use of EXFOR exchange files for fast neutron fission cross section evaluation	30 min	N. Otsuka
6.5	Development of experimental database of isomeric ratios	30 min	A. Rodrigo
6.6	Activation cross sections of charged-particle-induced reactions for medical radionuclide generator	30 min	M. Aikawa

14:00 – 17:00

6	**Presentation 3 (Cont.)**		
6.7	User’s and expert’s renormalization in X4Pro	60 min	V. Zerkin
7	**Exercise (3)**		
7.1	User’s and expert’s renormalization with X4Pro	90 min	V. Zerkin

Friday, 16 December 2022

9:00 – 13:00

7	**Exercise 3 (Cont.)**		
7.2	Review of Exercise 3	30 min	V. Zerkin
8	**Presentation (4)**		
8.1	Compilation of heavy-ion induced reaction data from West European countries	20 min	M. Odsuren
8.2	Validation of datasets in preliminary transmission by plotting on JANIS (including exercise)	40 min	D. Foligno
11.	**Closing**		
11.1	Review of workshop summary	30 min	Chairperson
11.2	Closing address	10 min	

Appendix C

LIST OF WORKING PAPERS

Number	Title	Presented by
WS2022-01	On new features of the EXFOR-editor	S. Taova G. Pikulina

Note: These working papers are available online: http://nds.iaea.org/nrdc/wksp_2022/.

Appendix D

LIST OF PRESENTATIONS

TITLE	Presented by
X4Pro: introduction and overview	V.Zerkin
Neutron spectra from Be sources	B.Pritychenko
X4Pro retrieval by SQL sentences	N.Otsuka
Overview of IT technologies used in X4Pro	V.Zerkin
Nuclear data measurements and compilation at JAEA	A.Kimura
Automation of institute code	V.Devi
Structure of programs in X4Pro	V.Zerkin
ENDF Web-API used in X4Pro	V.Zerkin
Automatic renormalization in X4Pro	V.Zerkin
On new features of the EXFOR-Editor	S. Taova, G.Pikulina
Transfer of data and compilations between EXFOR and IBANDL	V.Semkova
Direct use of EXFOR exchange files for fast neutron fission cross section evaluation	N.Otsuka
Development of experimental database of isomeric ratios	A.Rodrigo
Activation cross sections of charged particle-induced reactions for medical radionuclide generator	M.Aikawa
User's and experts' data corrections in X4Pro	V.Zerkin
Compilation of heavy-ion induced reaction data from West European countries	M.Odsuren
Validation of datasets in preliminary transmission by plotting on JANIS	D.Foligno

Note: These presentations are available online: http://nds.iaea.org/nrdc/wksp_2022/.

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