Extended EXFOR dissemination systems for professional users, data developers and modern applications

/General Overview/

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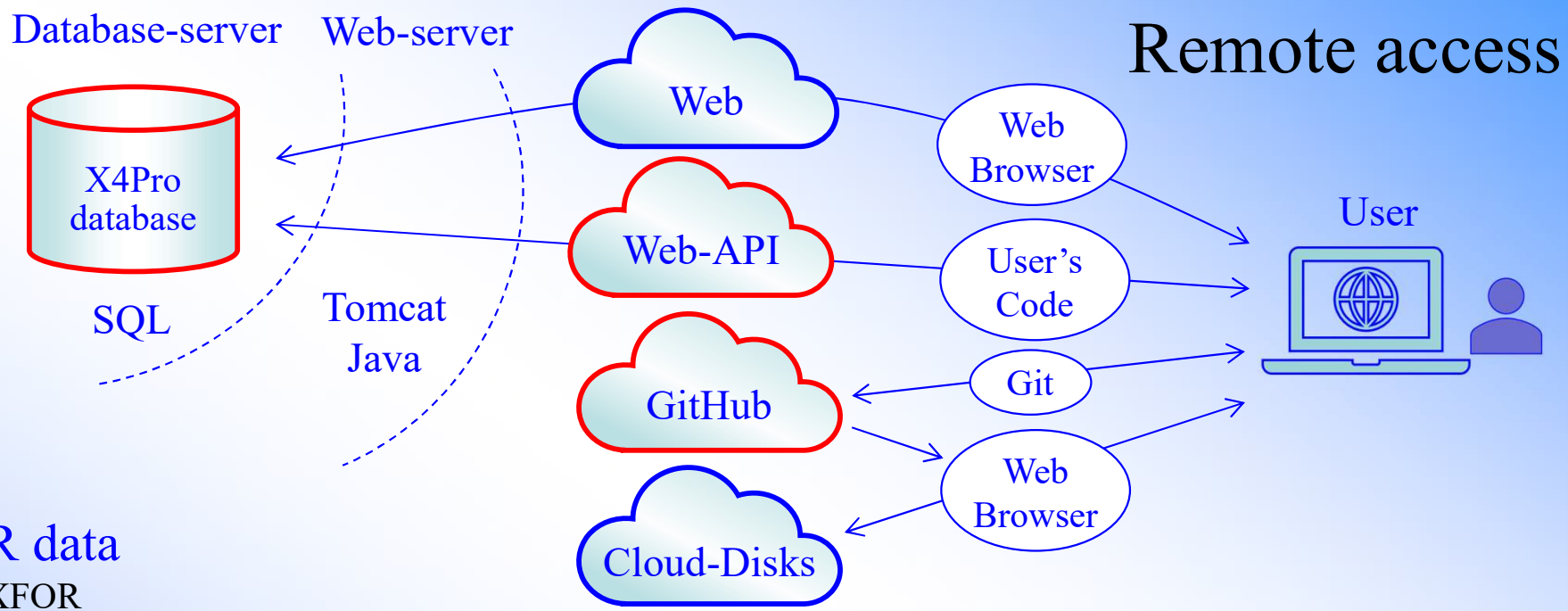
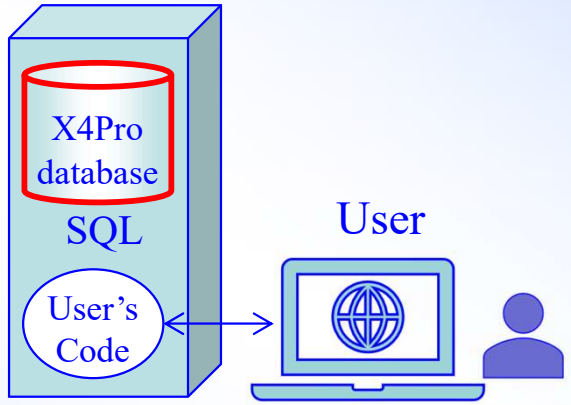
EXFOR data dissemination systems



EXFOR data

- Raw EXFOR
- Interpreted: X4+ //html +dictionaries
- Interactive-tree X4± //html: graph +data
- XML //original and computational data
- Computational C5 //columns +monitors +renormalization
- Computational data points in SQL tables (like C5)
- X5.json //original +computational +renormalization + etc.
- CSV //original and computational data

Local access



User's codes

- X4Pro examples: Python/Fortran +ENDF +renormalization +plotting
- Web-API examples: Python +ENDF +plotting
- GitHub examples in Python: indexing +search +plotting
- Any modern language with SQL/Network support

Data, services, delivery methods

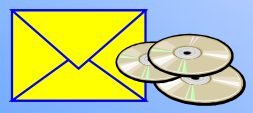
Traditional file distribution
Used by user's codes
Static data, fixed data version

Traditional Web systems
Used remotely via Web-Browser (user saves final data to be used by local codes)
Database and server software: behind scene

X4Pro/SQLite database
Downloaded from cloud-disks
Fixed data version
Used locally by user's codes in any programming language via SQL

API: Application programming interface
Access server database and software
Data always fresh, server-software can do re-formatting and calculations
Used by user's codes via Web
Lightweight codes

Methods of data delivery



Download

Download
+version control

From EXFOR-Relational to X4Pro

EXFOR Relational: NDS-NNDC, 1999-2023

Database Platforms

~2001		~2010		~2015		~2022	
Access	*NDS:CD (since 1999)*	Access	*NDS:CD*	MariaDB	*NDS:CD,Web*	SQLite	*NDS Download*
MySQL	*NDS:CD,Web*	MySQL	*NDS:CD,Web*	MariaDB	*NNDC, Mirrors Web*	MariaDB	*NDS, Mirrors Web*
SyBase	*NNDC:Web*	MySQL	*NNDC:Web*				

X4Pro: NDS, 2021-2024

X4Pro - relational/multi-model* database extends "EXFOR-Relational"

MariaDB *NDS, Mirrors Web*

SQLite *NDS Download*

Code examples: Python Fortran

* supporting data type: JSON

X5-JSON: 2021-2024

X5-JSON presents meta and numerical data from EXFOR and other sources:

1. *data from EXFOR and Dictionaries structured as they are in EXFOR (to be useful by compilers)*
2. *computational data by Datasets (~C5 to be useful for calculations)*
3. *data for automatic correction by new monitor and decay data*
4. *since 2022 included to X4Pro*

Available on Web-EXFOR as [X4Z] and [X5Z], on IAEA-NDS and GitHub: "EXFOR-X5json"

X4Pro offers

1. EXFOR data without EXFOR format + relevant information from other sources
   - *all data points in original and computational form*
   - *monitor and decay data for renormalization*
   - *data and text information from EXFOR Dictionaries (to explain meta-data)*
   - *way to store and use experts data corrections in Python (test cases implemented)*
2. Local EXFOR database for programmatic access
   - *Simple for programming on any language supporting SQL for data search, filtering, sorting, retrieval, renormalization by monitor and decay-data*
3. Examples

   24 examples of Fortran and Python programs provided with source code (MIT licence) and "run-me" scripts retrieving and plotting data from local X4Pro and remote ENDF database via Web-API interface
4. X5-JSON
   - *Comprehensive EXFOR data presentation in JSON form (+data for renormalization)*
   - *Can be used for creating another systems built on JSON objects (e.g. NoSQL databases: example of building CouchDB is provided)*
5. Advantages
   - *no need in original EXFOR for end-users*
   - *no need in new EXFOR parsers/converters for new programming languages*
   - *no need in intermediate files and formats with fixed structure (C5, XML, JSON)*

Suitable for projects requiring access to all experimental data at once, evaluation software requiring data corrections, new Web-Apps and other projects and communities, like SG50

X5 - comprehensive EXFOR in JSON

Another output… Why? What for we need it?

We have interpreted output from EXFOR database and Web retrieval system: X4+, X4±, C4, C5, C5M, two JSON's, two XML's, StdOut, CompOut, etc.

1. X5 should cover all known users' needs in meta data and values incorporating all achievements of all previous outputs, needed data from other sources

2. X5 presents information in consolidated form, can to be used as isolated files and as input to NoSQL DB's

3. To be trivial to read in modern programming languages (JSON) – it provides "automatically readable" EXFOR (based of my experience dealing with SG50)

4. Avoid complexity of distribution/maintenance of EXFOR-Parsers with current (always changing) coding rules, dictionaries and additional files

5. To simplify data EXFOR usage and distribution (as part of X4Pro, Web-systems, Archives)

X5 structure

Two parts, two options of output on Web, two tables in X4Pro:

- x4z: exactly reproducing EXFOR/Subentry structure and logic, oriented to “human” (compilers)
- x5z: based on Dataset concept, transforming data to comparable form, oriented to “machine” (end-users)

Part-1: ~X4

Hierarchy reproduces structure of EXFOR file with extensions:

```
{format, …
  x4entries:[
    {ENTRY, …
      x4subents:[
        {SUBENT, …
          BIB: {
            “FACILITY”:[
              {x4pointer,
                x4codes:[
                  {code,…}
                ]
              },…
            ]
          },
          COMMON: { },
          DATA: { },
          datasets: [ dataset:{} ]
        }
      ]
    }
  ]
}
```

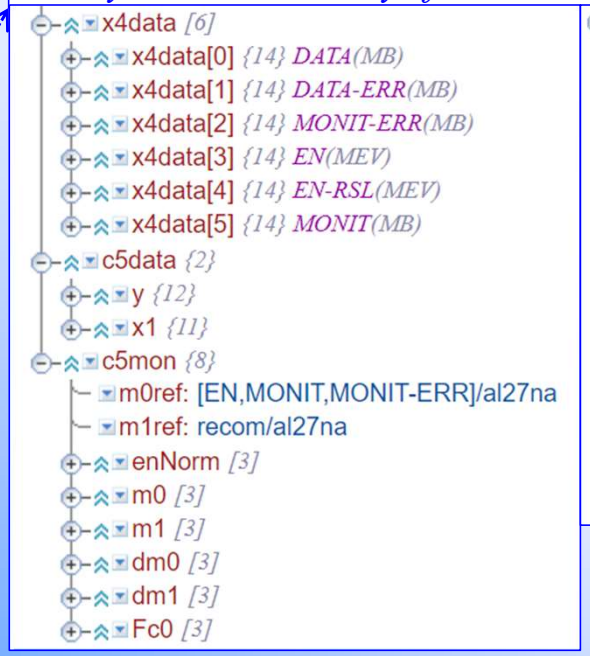
Part-2: ~C5

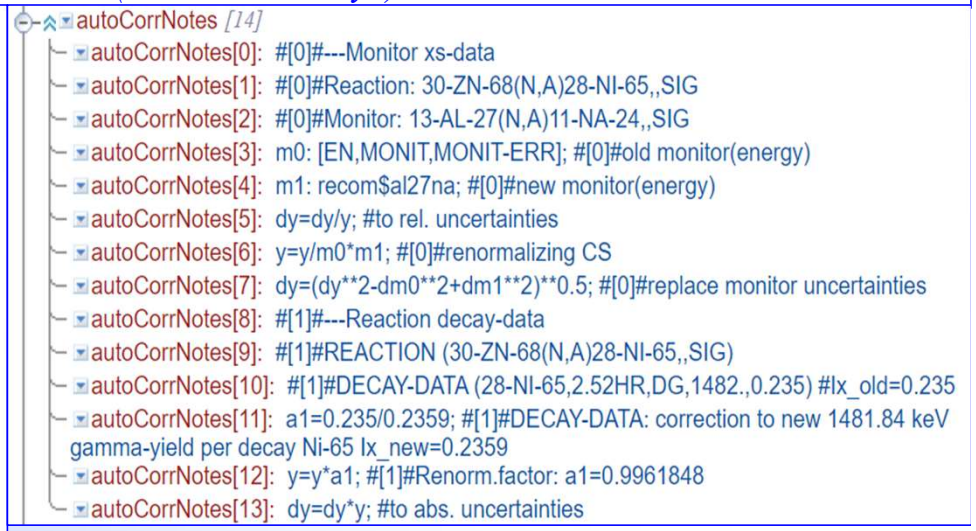
Array datasets[] in x4subent.

Dataset:

- *MF, MT, Reaction-code, type, etc.*
- *x4data[]: headers and data from DATA and COMMON*
- *c5data[]: computational data y:{y, dy, dysys, dystat}, x1:{x,dx}, x2, x3,…*
- *c5mon[]: monitor data – old and new (m0, dm0, m1, dm1, Fc0)*
- *decay data, decay-mon[]: ene0, abu1, ene1, abu1, Fc*
- *Computation notes*
- *Automatic correction notes*

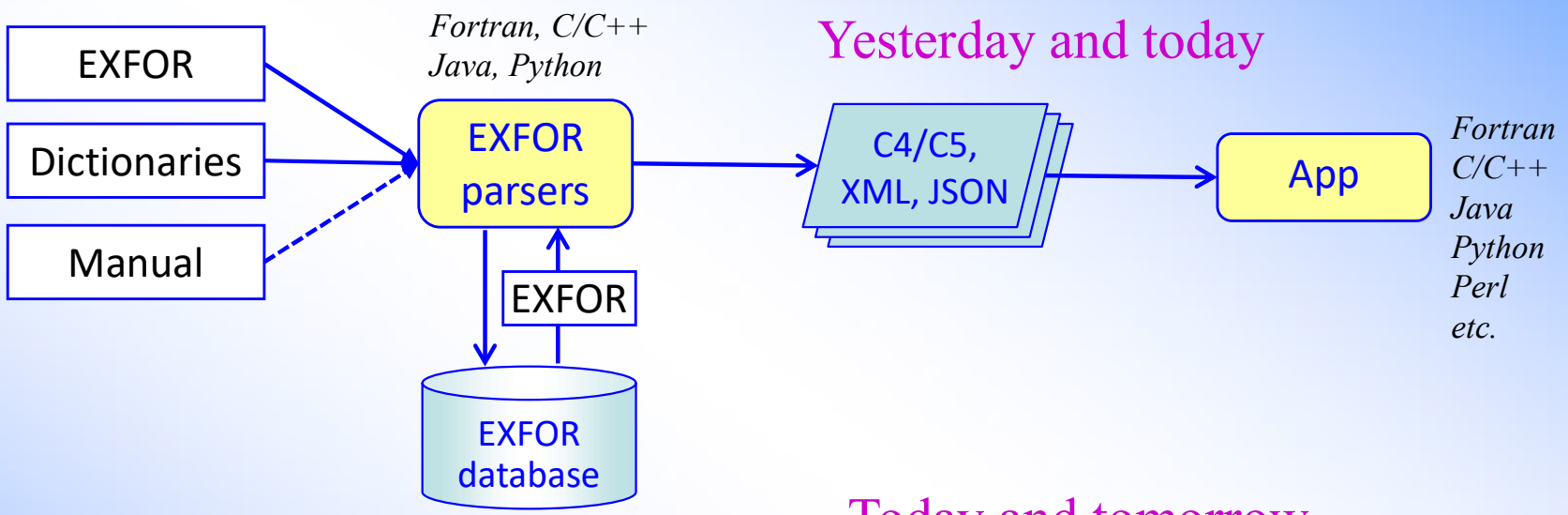
Always uses 1-D arrays for data values (x4z: 2-D arrays)

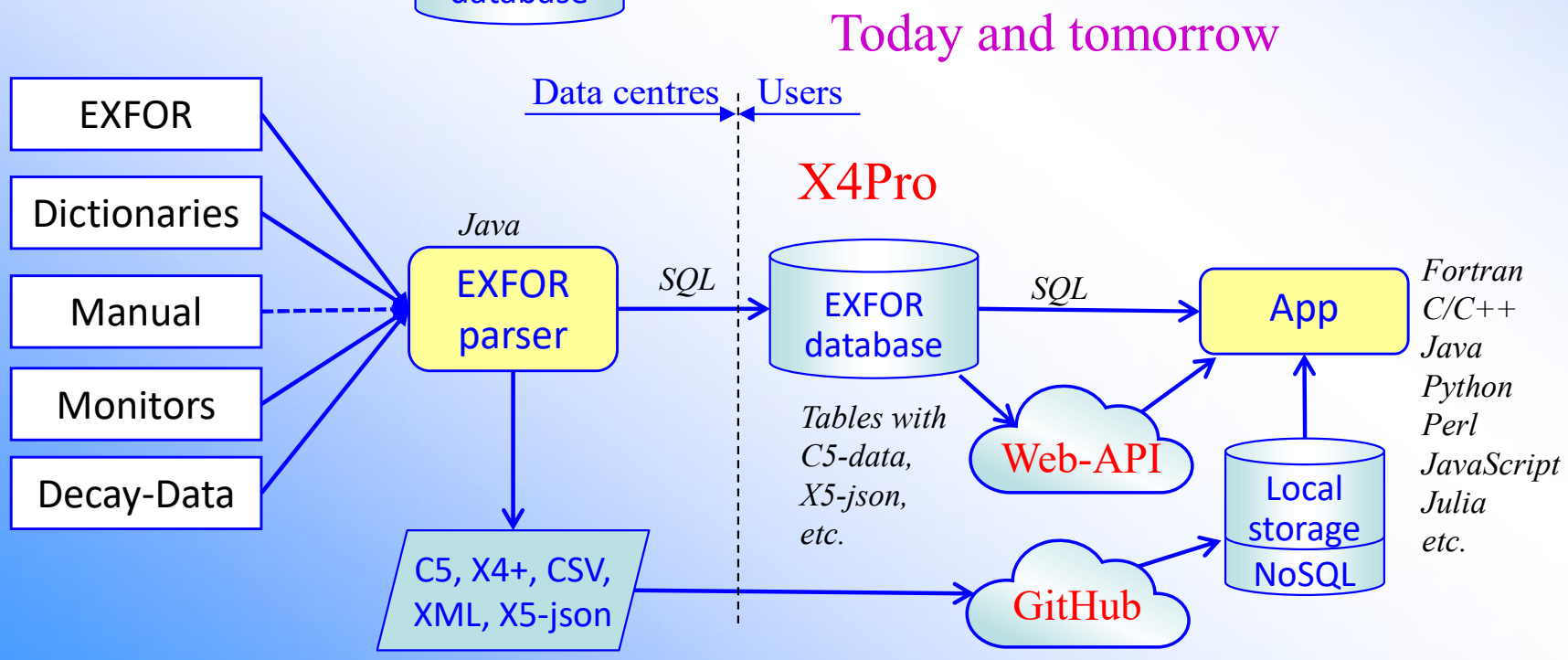




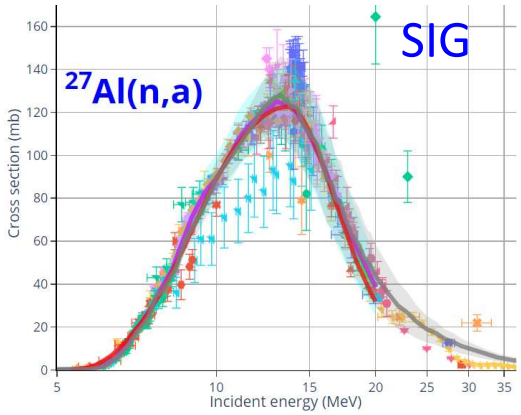
Key point of X4Pro and X5-json

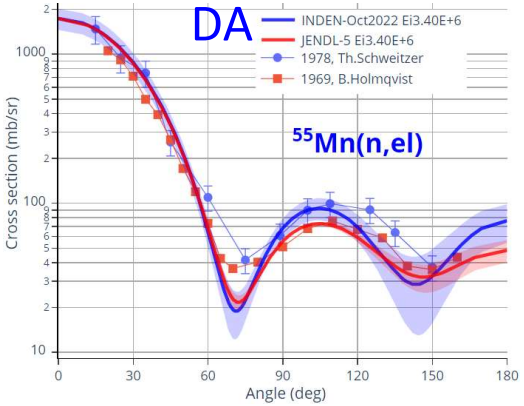
X4Pro makes every data point directly accessible via SQL commands (like, C5 in SQL).
X5-json provides "automatically readable" and extended/enhanced EXFOR.
X4Pro with X5 and experts' corrections in it provides universal mechanism for data storage/access/correction.

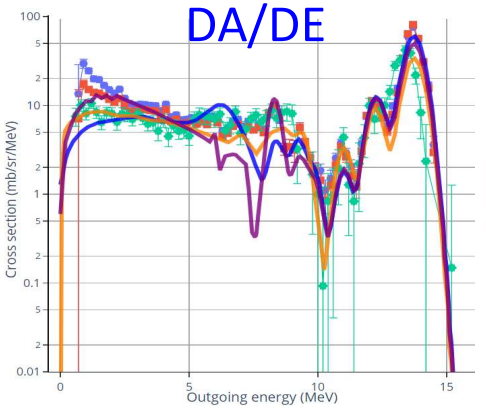


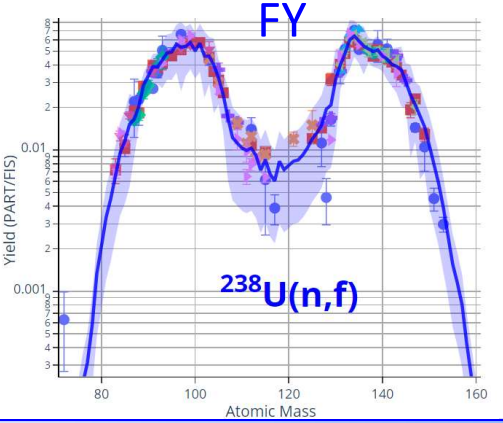


X4Pro examples: EXFOR + ENDF/Web-API

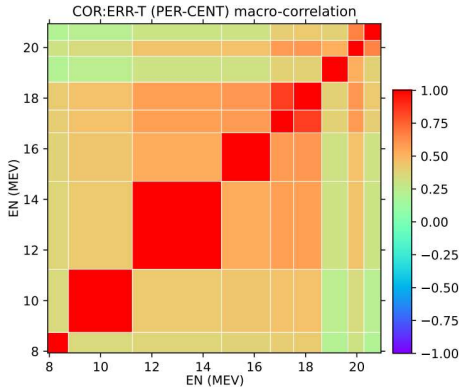


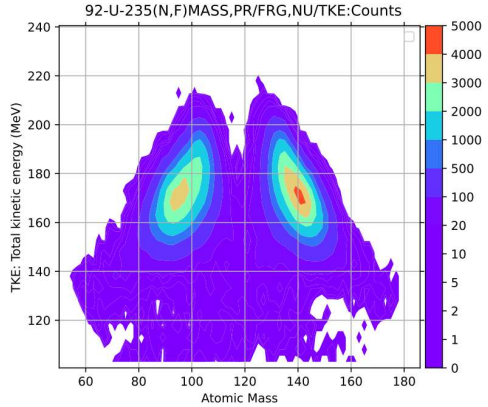


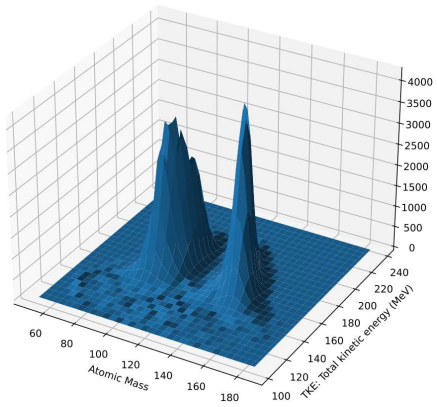




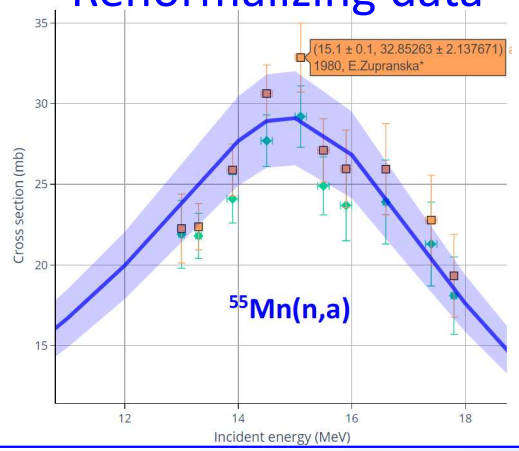
"Hidden" data



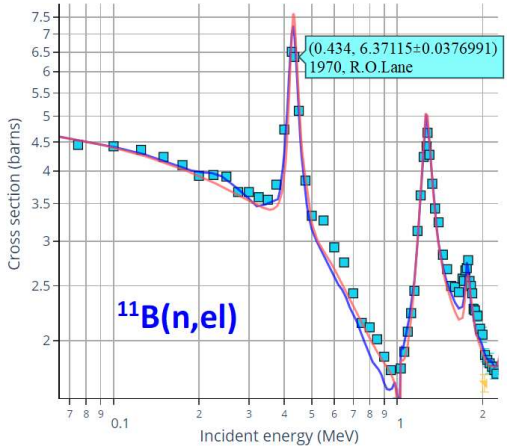


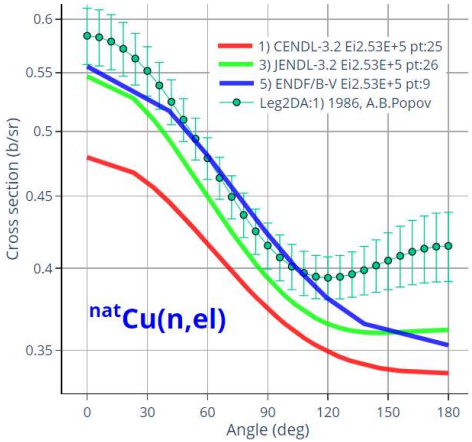


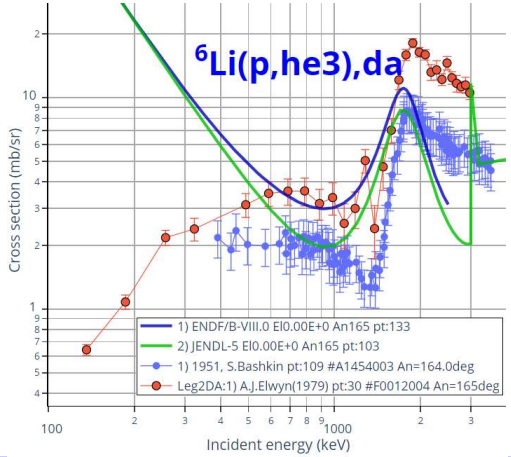
Renormalizing data



"Recalculating" data: LEG→SIG, LEG/RS+SIG→DA, LEG→DA:R33



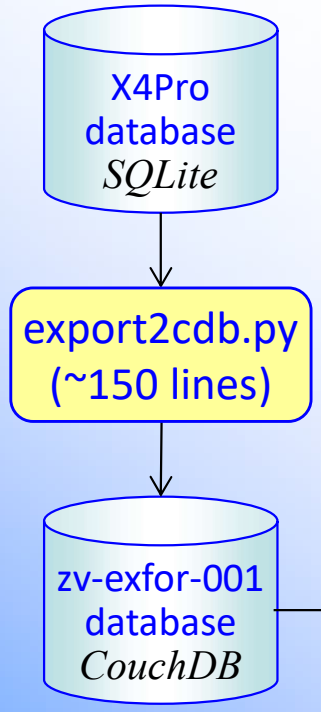


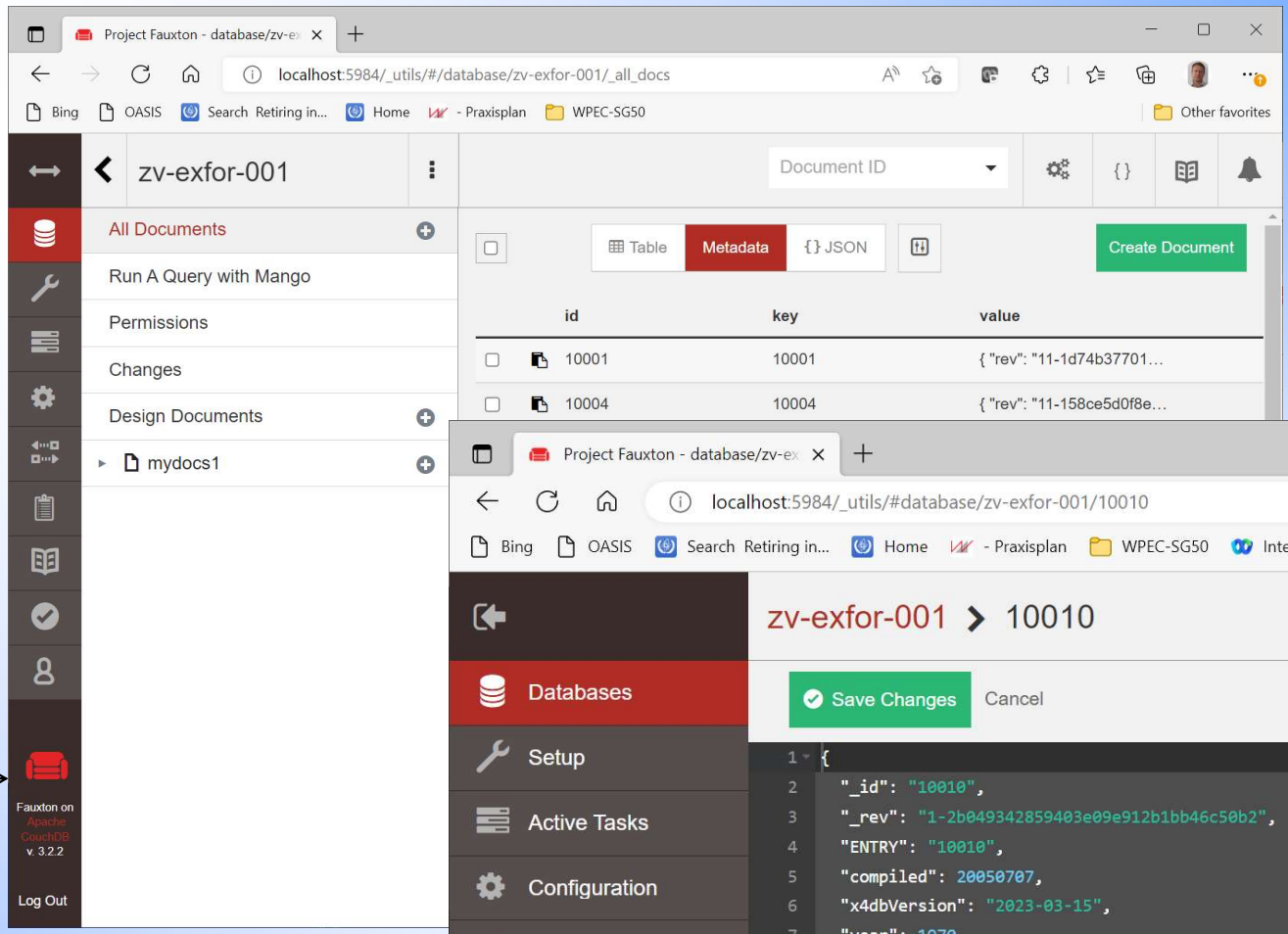


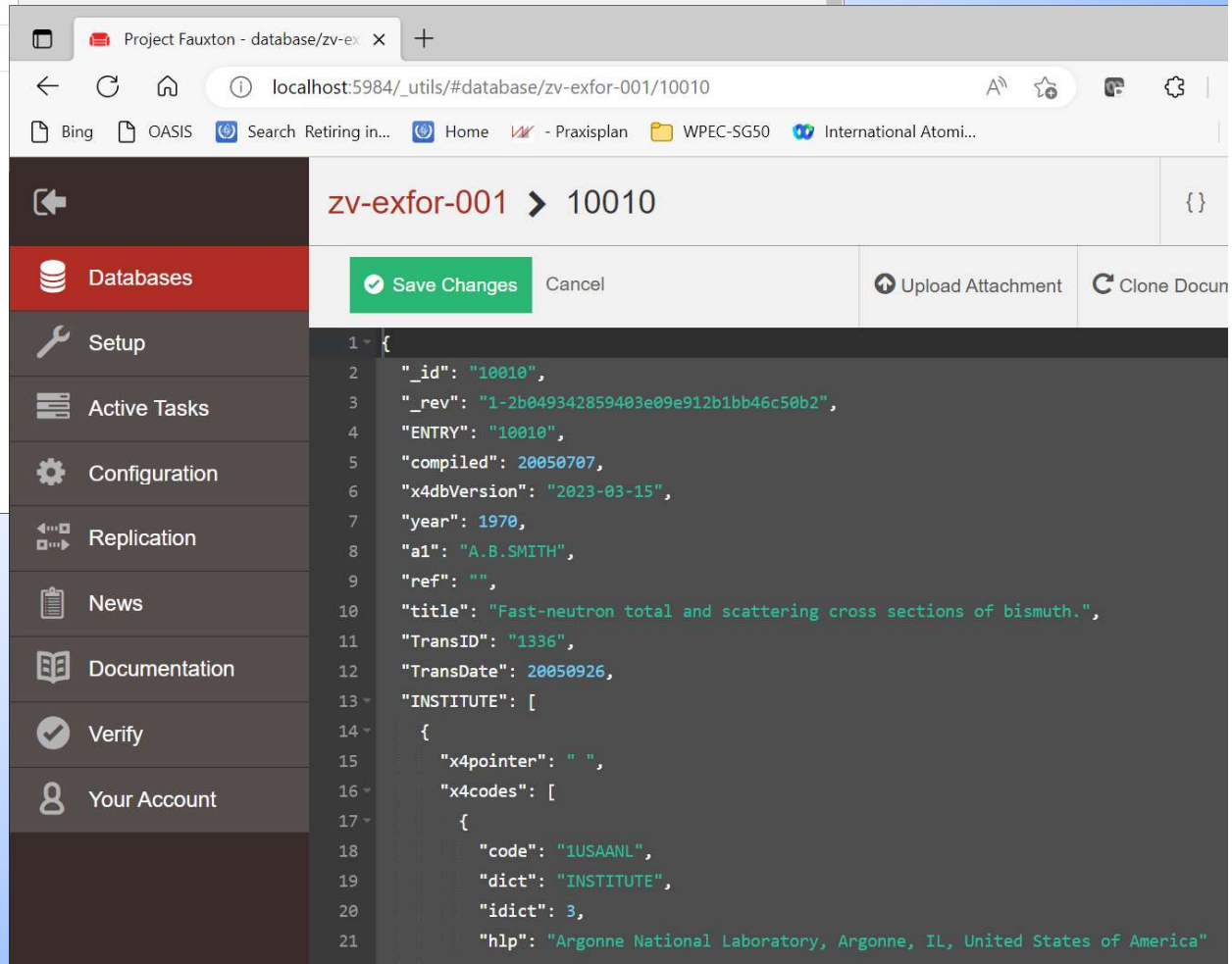
Since 2022 X4Pro includes

a) X5-JSON b) Python example: export X5 to CouchDB

Example in X4Pro:

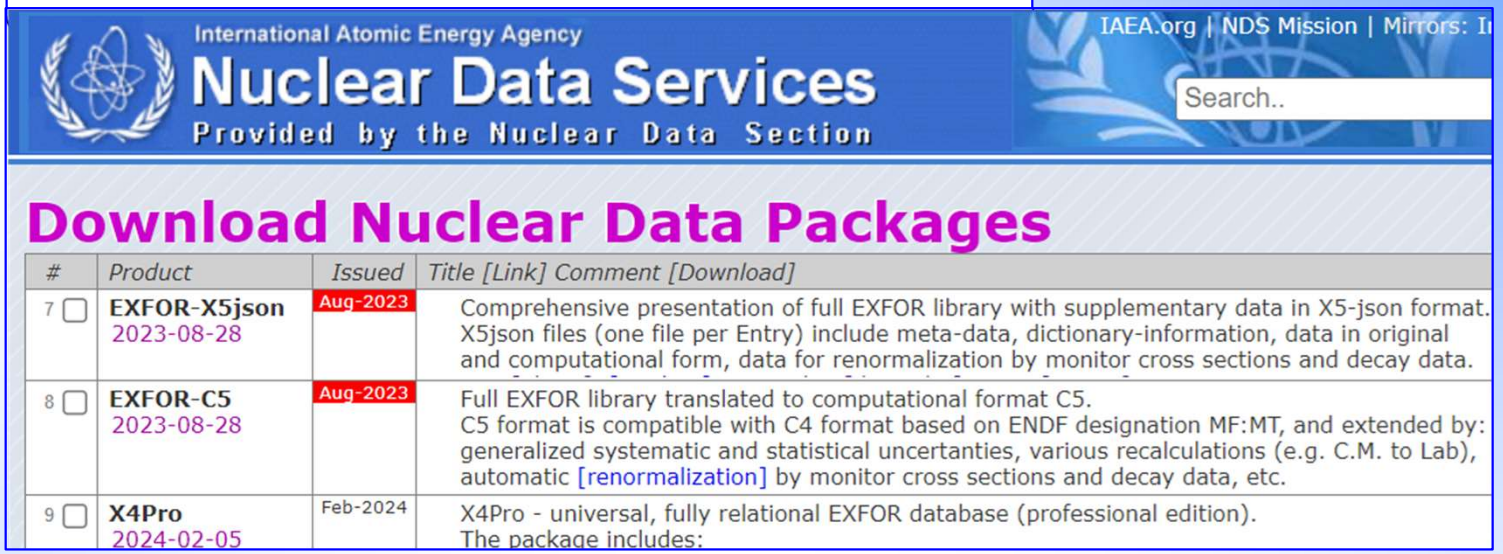






Distribution from IAEA-NDS and GitHub

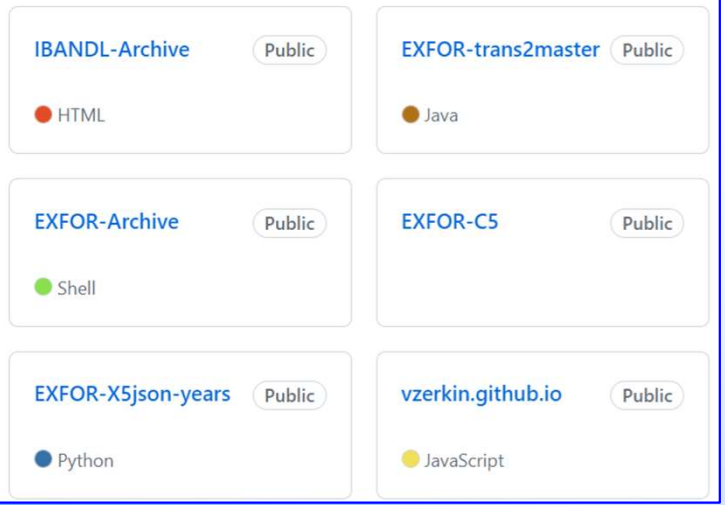
IAEA-NDS Download: https://nds.iaea.org/cdroms/



GitHub: https://github.com/vzerkin

vzerkin

Popular repositories



Basic principles

Data provided:

- with data index (CSV, JSON)
- meaningful comments on files/folders
- with examples in Python: data search, filtering, calculations, plot
- with result of example codes: PNG, Html, CSV, JSON
- with script(s) for data restructuring

Distribution from GitHub and IAEA-NDS

1. X4Pro (only from IAEA-NDS)
   - X4Pro/SQLite database: mini-version with examples, full database

2. EXFOR-Archive, EXFOR-Backup
   - all versions: Entries 2005-2024
   - CSV index of Entries
   - script producing complete EXFOR file at any time in history since 2005-06-16

3. EXFOR-X5json
   - CSV and JSON index of Entries and Datasets
   - 3 Python codes for data search, retrieval and plotting original and automatically renormalized data

4. EXFOR-C5
   - CSV and JSON index of Entries and Datasets
   - 4 Python codes for indexing, search, retrieval and plotting original and automatically renormalized data
   - bash script producing single C5 file, compatible with XC4 distribution 2007-2022
   - 6 versions for downloading generated with different options

Web-API for EXFOR, ENDF, IBANDL

Web page - https://nds.iaea.org/exfor/x4guide/API/

Web API for EXFOR, ENDF, IBANDL

/under development by V.Zerkin, IAEA, 2023, v.2023-10-19/

Web API service is implemented via GET requests to Web server using URL
https://nds.iaea.org/exfor/program? followed by parameters separated by '&'.
Parameter could be given as pair 'name=value' or just 'name' (flag).

EXFOR API

· Usually two steps: find data (get list) and download data.
· Data types: original/interpreted EXFOR (Entry/Subentry) and Datasets (Subentry+Pointer).
· Archival versions: previous versions of Entry/Subentry can be downloaded using date of update.
· Output data: plain text, Html, JSON, XML, CSV.

Examples

Some examples of programs request parameters:

----Get List of Datasets----

1. x4list?Target=PB-204;pb-0&Reaction=n,g&Quantity=SIG&txt try
   Find data, get list of Datasets in plain text.
2. x4list?Target=PB-*&Reaction=n,*&Quantity=SIG&Author1=Michel&xml try
   Find data, get list of Datasets in XML.
3. x4list?Target=PB-204&Reaction=n,g&Quantity=SIG&json try
   Find data, get list of Datasets as JSON output.
4. x4list?Target=Li-6*&Reaction=he3,p&Quantity=dap&csv try
   Find data, get list of Datasets in CSV.

----Get data from individual Dataset----

5. x4get?DatasetID=11679024&op=c4 try
   Get data from Dataset in C4 format.
6. x4get?DatasetID=13597002&op=c5 try
   Get data from Dataset in C5 format.

Concluding remarks

1. X4Pro – EXFOR data distribution for professional use and advanced applications
2. X5json – comprehensive presentation of EXFOR + additional data
3. Web-API provides access to central databases for lightweight users' applications (which can impose server calculations)
4. Code examples should be included to off-line data distribution
5. Clouds provide well-known way of data dissemination (download X4Pro, X5, C5)
6. GitHub provides alternative way of data dissemination with version control; can be used for EXFOR, X5, C5.
7. X4Pro and X5json can be used as a starting point for user communities (like SG50) to build own specialized systems

Thank you.