



IAEA

60 Years

Atoms for Peace and Development

Tools and data management in the FENDL project

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CM on Further Development of FENDL

1 November 2023

Outline

- Data management at the isotope level
- Data management at the library level
- Proof-of-concept user interaction

Data management at isotope level

Some types of tasks at the isotope level

Checking

- Is the file in the library indeed numerically equivalent to the version in the indicated source library?
- How is an updated file different from a previous version?
- Does the file conform to the ENDF-6 format specification?

Maintenance

- Updating meta information in the ENDF header (MF1/MT451)
- Cleaning up (removing evaluator auxiliary info not part of ENDF-6 standard)

In the future (potentially):

- Consistently merge IRDFF-II and other useful data into transport files
- Remove bumps at transition energy from explicit to lumped representation (i.e. MT5)
- Upgrading files with covariance matrix information

ENDF-6 file interaction

Several publicly available packages and databases for **reading and interpreting** nuclear data in **ENDF-6 format, e.g.***

- **IAEA NDS web interface** (<https://nds.iaea.org/exfor/endl.htm>)
- **ENDFtk** (<https://github.com/njoy/ENDFtk>)
- **Endf-python** (<https://github.com/paulromano/endl-python>)
- **ENDFtables** (<https://www-nds.iaea.org/talys/>)
- **PyNE** (<http://pyne.io/>)

→ **Data consumers are well served**

ENDF-6 file interaction

Several publicly available packages and databases for **reading and interpreting** nuclear data in **ENDF-6 format, e.g.**

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- **ENDFtables** (<https://www-nds.iaea.org/talys/>)
- **PyNE** (<http://pyne.io/>)

→ **Data consumers are well served**

But what about data producers?

ENDF-6 file creation/updating

SANDY (<https://github.com/luca-fiorito-11/sandy>)

Contains functions to update an important subset of the information stored in an ENDF-6 formatted file

ENDFtk (<https://github.com/njoy/ENDFtk>)

Core functionality to write ENDF-6 files probably there but it's not obvious to me from the GitHub website how to use it in Python

FUDGE (<https://github.com/LLNL/fudge>)

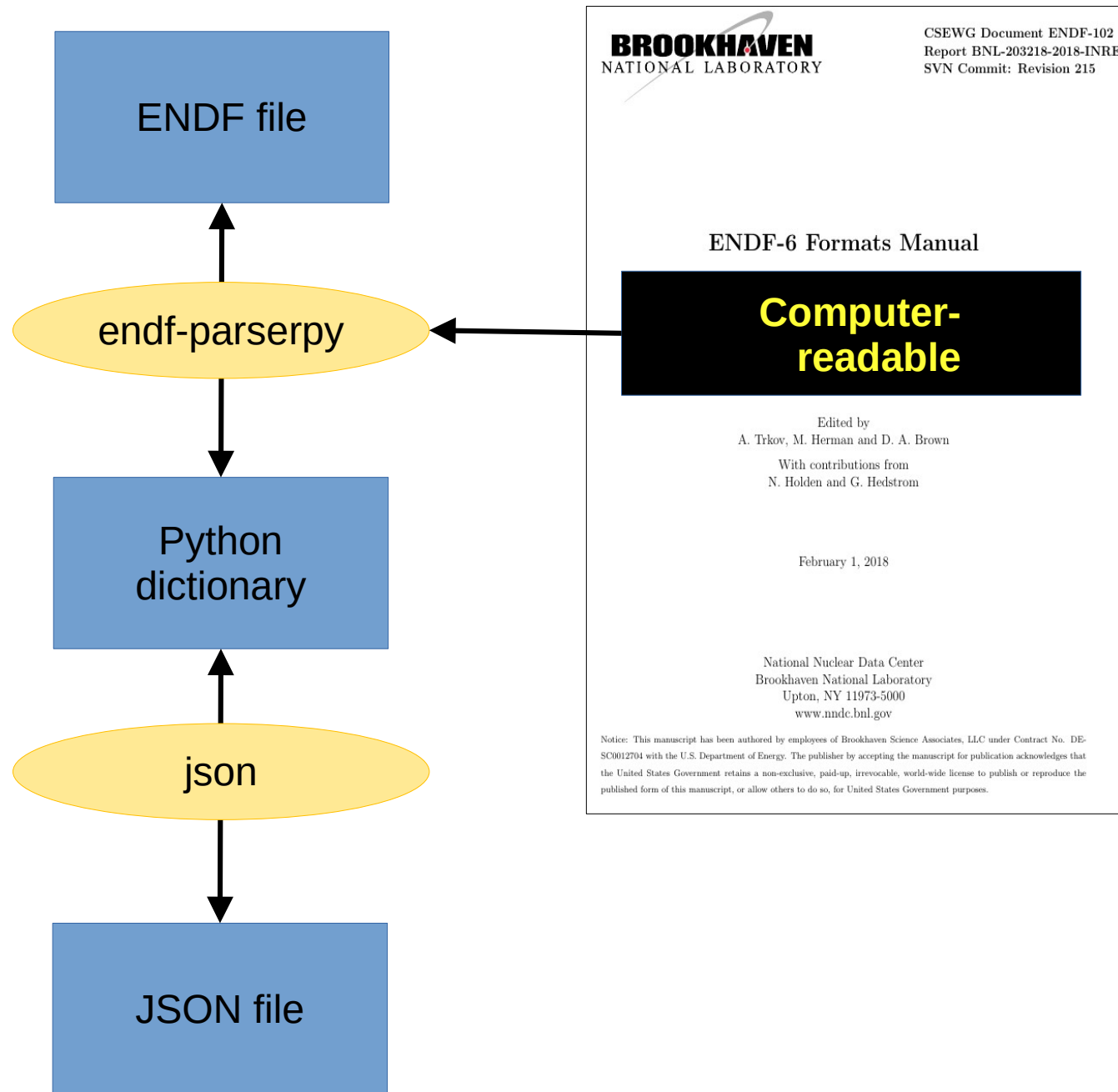
- Translate ENDF-6 file to GNDS format (e.g. in xml format)
- Manipulate the xml file using Python or similar
- Translate the xml file to ENDF-6 format

endf-parserpy

- Python package developed* at the IAEA to **read and write** ENDF-6 formatted files
- Implements the full** ENDF-6 format specification given in the ENDF-6 formats manual (as released in 2018)
- Verified on all major libraries for incident neutrons (other library types presumably also should work)
- At present, only low-level functionality (i.e. no R-matrix reconstruction, self-shielding, covariance matrix reconstruction)
- Implementation approach is unique, greatly reducing the probability for bugs in the package
- Hosted at <https://github.com/iaea-nds/endf-parserpy>

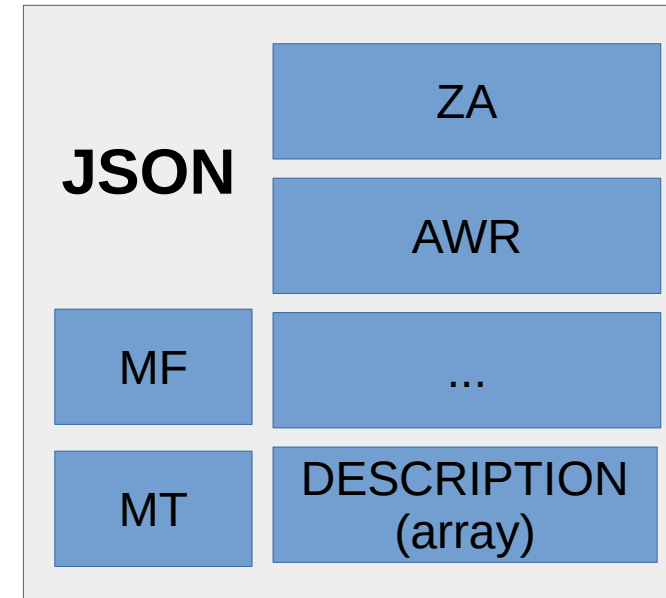
*in collaboration with Daniel Lopez Aldama
**ok, let's say 95%

Basic design



Using ENDF-6 recipe files

```
[MAT, 1,451/ ZA, AWR, LRP, LFI, NLIB, NMOD]HEAD  
[MAT, 1,451/ ELIS, STA, LIS, LISO, 0, NFOR]CONT  
[MAT, 1,451/ AWI, EMAX, LREL, 0, NSUB, NVER]CONT  
[MAT, 1,451/ TEMP, 0.0, LDRV, 0, NWD, NXC]CONT  
for i=1 to NWD:  
    [MAT, 1,451/ DESCRIPTION[i]]TEXT  
endfor
```

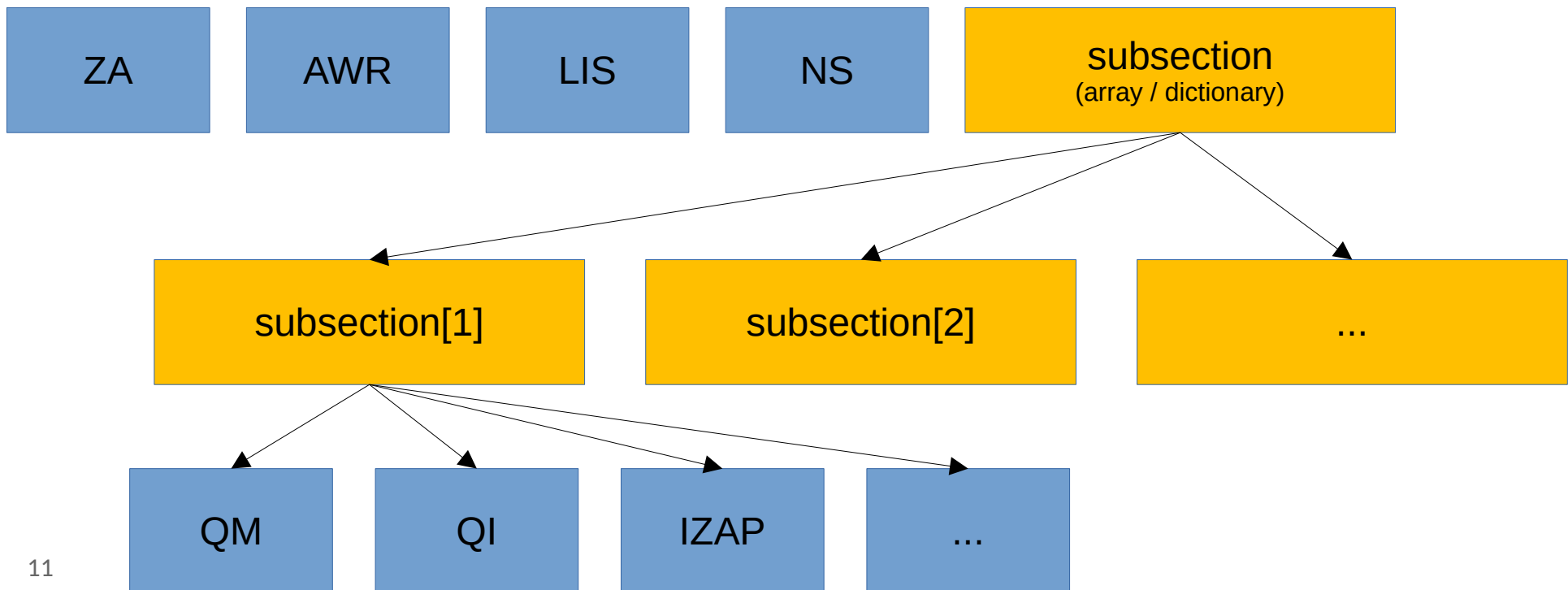


endf-
parserpy

```
2.906300+4 6.238900+1      1      0      0      52925 1451  
0.000000+0 0.000000+0      0      0      0      62925 1451  
1.000000+0 1.500000+8      8      0     10      72925 1451  
0.000000+0 0.000000+0      0      0     481     1152925 1451  
29-Cu- 63 LANL,ORNL  EVAL-FEB98 A.Koning,M.Chadwick,Hetrick      2925 1451  
CH98,CH99      DIST-DEC06 REV4-      20011108      2925 1451  
----ENDF/B-VII      MATERIAL 2925      REVISION 4      2925 1451  
-----INCIDENT NEUTRON DATA      2925 1451  
-----ENDF-6 FORMAT      2925 1451
```

Hierarchical representation

```
[MAT, 10, MT/ ZA, AWR, LIS, 0, NS, 0]HEAD
for k=1 to NS:
  (subsection[k])
    [MAT, 10, MT/ QM, QI, IZAP, LFS, NR, NP/ E / sigma ]TAB1
  (/subsection[k])
endfor
SEND
```



Detailed debug output on failure (here: inconsistent variable assignment)

```
Failed: BasicEndfParser failed on file 18-Ar-40g.endf with exception
Here is the parser record log until failure:

----- Line 0 -----
Template: [ MAT , 4 , MT / ZA , AWR , 0 , LTT , 0 , 0 ] HEAD
Line:     " 1.804000+ 3.961910+1 0 1 0 01837 4 2 1"

----- Line 1 -----
Template: [ MAT , 4 , MT / 0.0 , AWR , LI , LCT , 0 , 0 ] CONT
Line:     " 0.000000+ 3.965640+1 0 2 0 01837 4 2 2"

Error message: Expected 39.6191 in the ENDF file but got 39.6564. The value was encountered
```

4.2.1 Legendre Polynomial Coefficients (LTT=1, LI=0)

When LTT=1 (angular distributions given in terms of Legendre polynomial coefficients), the structure of the section is:

```
[MAT, 4, MT/ ZA, AWR, 0, LTT, 0, 0]HEAD (LTT=1)
[MAT, 4, MT/ 0.0, AWR, LI, LCT, 0, 0]CONT (LI=0)
[MAT, 4, MT/ 0.0, 0.0, 0, 0, NR, NE/  $E_{int}$ ]TAB2
[MAT, 4, MT/ T,  $E_1$ , LT, 0, NL, 0/  $a_l(E_1)$ ]LIST
[MAT, 4, MT/ T,  $E_2$ , LT, 0, NL, 0/  $a_l(E_2)$ ]LIST
```

Example of use: Changing (n,tot) cross section

```
from endf_parserpy import ExtEndfParser
```

```
parser = ExtEndfParser()
```

```
endf_dict = parser.parsefile("input.endf")
```

```
parser.writefile("output.endf", endf_dict)
```

Example of use: Changing (n,tot) cross section

```
from endf_parserpy import ExtEndfParser
```

```
parser = ExtEndfParser()  
endf_dict = parser.parsefile("input.endf")
```

```
updated_energies = np.linspace(1e6, 1e8, 100)
```

```
endf_dict[3][1]['xstable']['E'] = updated_energies  
endf_dict[3][1]['xstable']['xs'] = np.sin(updated_energies) + 2
```

```
endf_dict[3][1]['xstable']['NBT'] = [len(updated_energies)]  
endf_dict[3][1]['xstable']['INT'] = [2]
```

```
parser.writefile("output.endf", endf_dict)
```

Data management at library level

Keeping track of ENDF files (evaluated data)



Which ENDF files changed?
When were the files changed?
Why were the changes effected?
What are the exact differences?

Version tracking with git

Commits

 main ▾

 Commits on Jun 21, 2022

make library designation more precise for Au-197 ...


Changed the low energy library designation from ENDF/B-VII to ENDF/B-VII.0 and changed the high energy library designation from JENDL-HE to JENDL/HE-2007.

 **gschnabel** committed on Jun 21, 2022

 d67ee41 



update library designation of W-186 ...

 **gschnabel** committed on Jun 21, 2022

 1982231 



updated library designation of W-184 ...

 **gschnabel** committed on Jun 21, 2022

 9ffba48 

update library designation of W-183 ...

 **gschnabel** committed on Jun 21, 2022

 7491ee9 

Version tracking with git

Commits

main ▾

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 **gschnabel** committed on Jun 21, 2022

 `d67ee41` 



update library designation of W-186 ...

 **gschnabel** committed on Jun 21, 2022

 `1982231` 



updated library designation of W-184 ...

 **gschnabel** committed on Jun 21, 2022

 `9ffba48` 

update library designation of W-183 ...

 **gschnabel** committed on Jun 21, 2022


 `7491ee9` 




Hosted on IAEA-NDS GitHub account

IAEA-NDS / FENDL-ENDF Public Noti

[Code](#) [Issues](#) [Pull requests](#) [Actions](#) [Projects](#) [Security](#) [Insights](#)

[main](#) [5 branches](#) [8 tags](#) [Go to file](#) [Code](#)

 **gschnabel** make library designation more precise for Au-197 ... d67ee41 on Jun 21, 2022 🕒 56 commits

 activation	adopt TENDL-2017 as activation library	2 years ago
 general-purpose	make library designation more precise for Au-197	last year
 README.md	update README with info on git-annex	last year

README.md

Fusion Evaluated Nuclear Data Library [↗](#)

This repository keeps track of updates to the ENDF files of the Fusion Evaluated Nuclear Data Library (FENDL) whose different versions are published on the IAEA-NDS website at <https://www-nds.iaea.org/fendl/>.

Git is not enough for FENDL

- Git was designed for the tracking of code projects
- It is **not** suited for tracking **tens of thousands of files with a total size of hundreds of gigabytes with numerical data**

→ Decouple version tracking and content storage

Use fingerprints



Use fingerprints

File

```
$Rev:: 257      $ $Date:: 2011-03-08#$          1 0 0 0
7.418400+4 1.823710+2          1      0      0      17437 1451 1
0.000000+0 0.000000+0          0      0      0      67437 1451 2
1.000000+0 1.500000+8          1      0      10     77437 1451 3
0.000000+0 0.000000+0          0      0      567    1407437 1451 4
74-W -184 IAEA      Eval090806          7437 1451 5
                          7437 1451 6
----ENDF/B-VII.1      MATERIAL 7437      7437 1451 7
-----INCIDENT NEUTRON DATA      7437 1451 8
-----ENDF-6 FORMAT      7437 1451 9
                          7437 1451 10
*****              7437 1451 11
                          7437 1451 12
Comment in June 2022 by G. Schnabel:      7437 1451 13
                          7437 1451 14
This IAEA evaluation with the original library      7437 1451 15
designation INDL/V-3 was later adopted in ENDF/B-VII.1.      7437 1451 16
The library designation in the ENDF header was therefore      7437 1451 17
updated to ENDF/B-VII.1.      7437 1451 18
                          7437 1451 19
                          7437 1451 20
*****              7437 1451 21
FAST ENERGY REGION      7437 1451 22
Authors: R. Capote, A. Trkov, E. Soukhovitskii      7437 1451 23
                          7437 1451 24
CROSS-SECTION EVALUATION PROCEDURE      7437 1451 25
                          7437 1451 26
Adopted procedure is based on careful theoretical      7437 1451 27
analysis utilizing available experimental data and      7437 1451 28
nuclear reaction model calculations.      7437 1451 29
                          7437 1451 30
```



```
cce8ef57d8837cf23e87f7
7f34834dc90d0a607b7ec
8a9a89cac8ba3f536c458
```

Compress file content into a world-wide unique number (64 digits hexadecimal number)
(SHA256 hash)

Decoupling

- Git repository contains symbolic links pointing to a file containing the unique number in the filename
- Store the content elsewhere using the unique number as filename

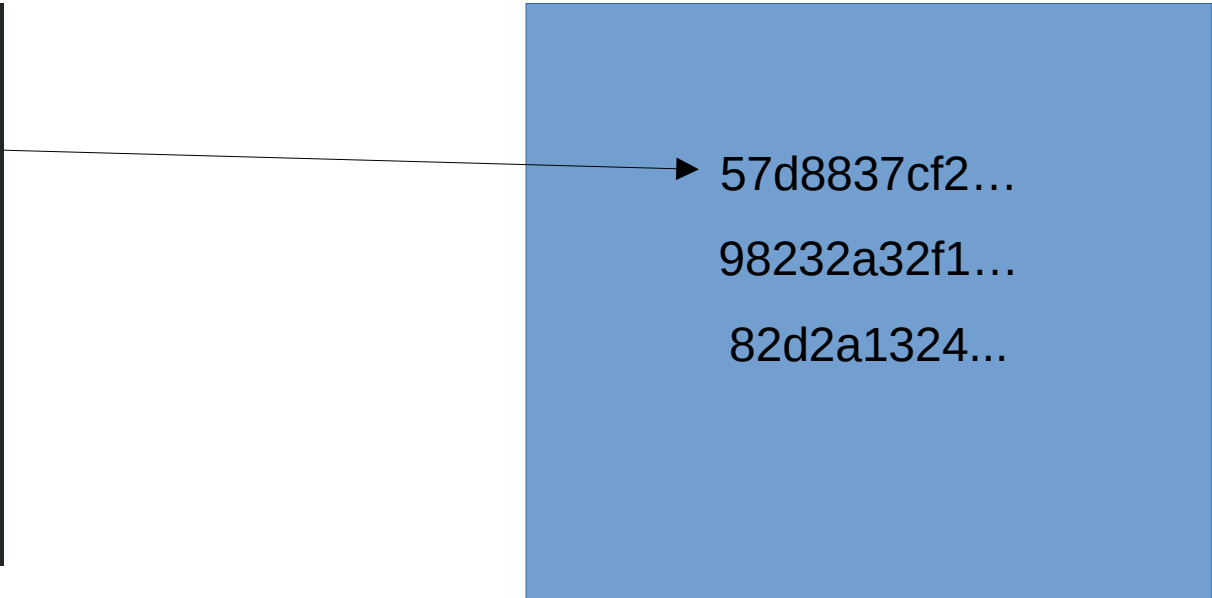
Decoupling

- Git repository contains symbolic links pointing to a file containing the unique number in the filename
- Store the content elsewhere using the unique number as filename

GitHub repository
(with symbolic links)

```
n_1731_17-Cl-37.endf  
n_1825_18-Ar-36.endf  
n_1831_18-Ar-38.endf  
n_1837_18-Ar-40.endf  
n_1925_19-K-39.endf  
n_1928_19-K-40.endf  
n_1931_19-K-41.endf  
n_2025_20-Ca-40.endf  
n_2031_20-Ca-42.endf  
n_2034_20-Ca-43.endf
```

Directory on IAEA-NDS webserver
(with files named like...)



57d8837cf2...
98232a32f1...
82d2a1324...

git-annex

git-annex

search


Edit RecentChanges History Preferences Branchable

git-annex allows managing large files with git, without storing the file contents in git. It can sync, backup, and archive your data, offline and online. Checksums and encryption keep your data safe and secure. Bring the power and distributed nature of git to bear on your large files with git-annex.

git-annex is designed for git users who love the command line. For everyone else, the [git-annex assistant](#) turns git-annex into an easy to use folder synchroniser.

To get a feel for git-annex, see the [walkthrough](#).

~/annex/ Make Repository



- [install](#)
- [assistant](#)
- [walkthrough](#)
- [tips](#)
- [bugs](#)
- [todo](#)
- [forum](#)
- [comments](#)
- [contact](#)
- [thanks](#)

key concepts	the details	other stuff
<ul style="list-style-type: none">• git-annex man page• how it works• special remotes• workflows• sync	<ul style="list-style-type: none">• encryption• key-value backends• bare repositories• submodules• internals• scalability• design	<ul style="list-style-type: none">• testimonials• privacy• what git annex is not• related software• public git-annex repos• thanks• sitemap



Joey Hess

<https://git-annex.branchable.com/>

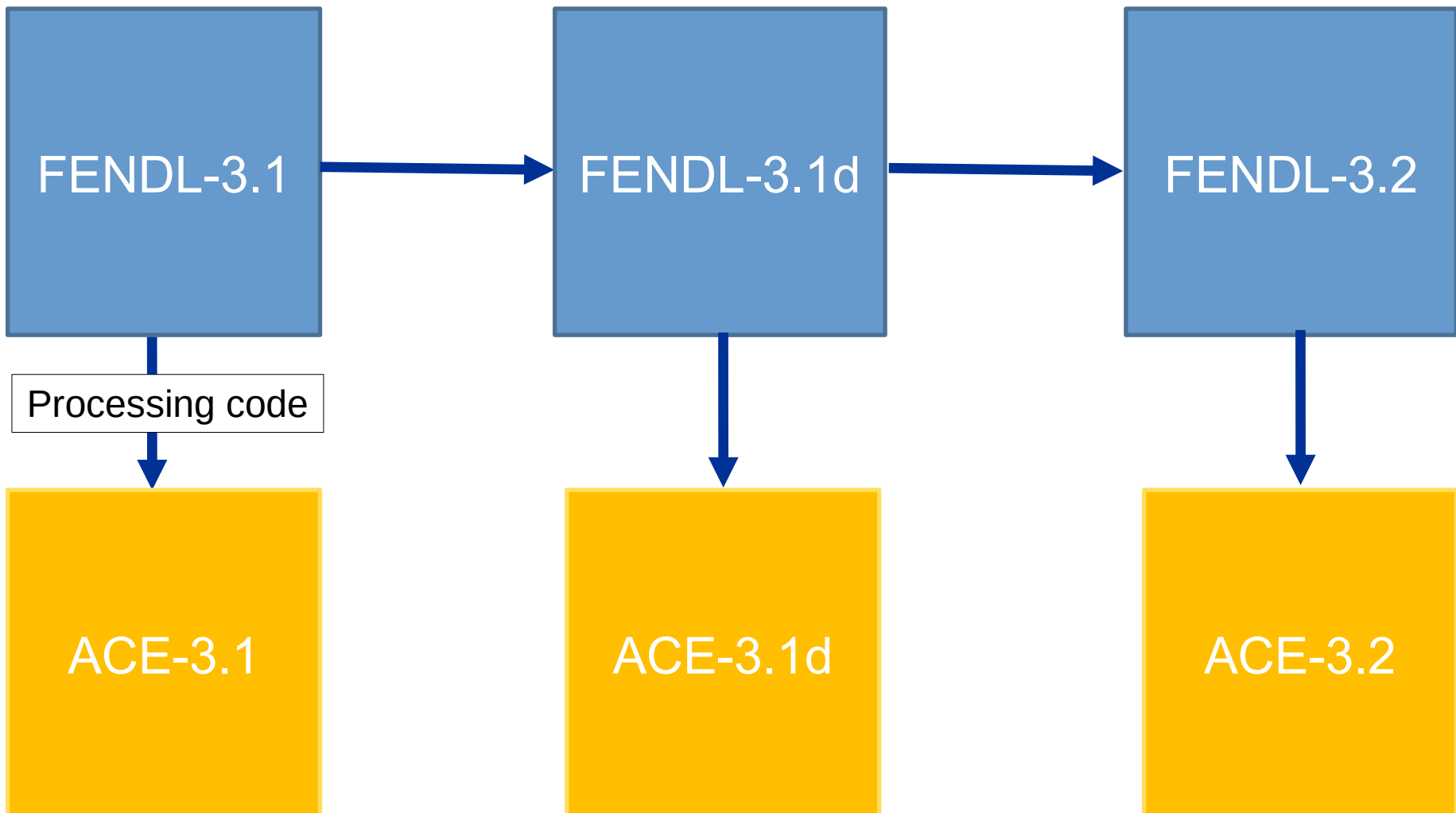
Picture from Interview at <https://lwn.net/Articles/672352/>

How does it work from the git user point of view?

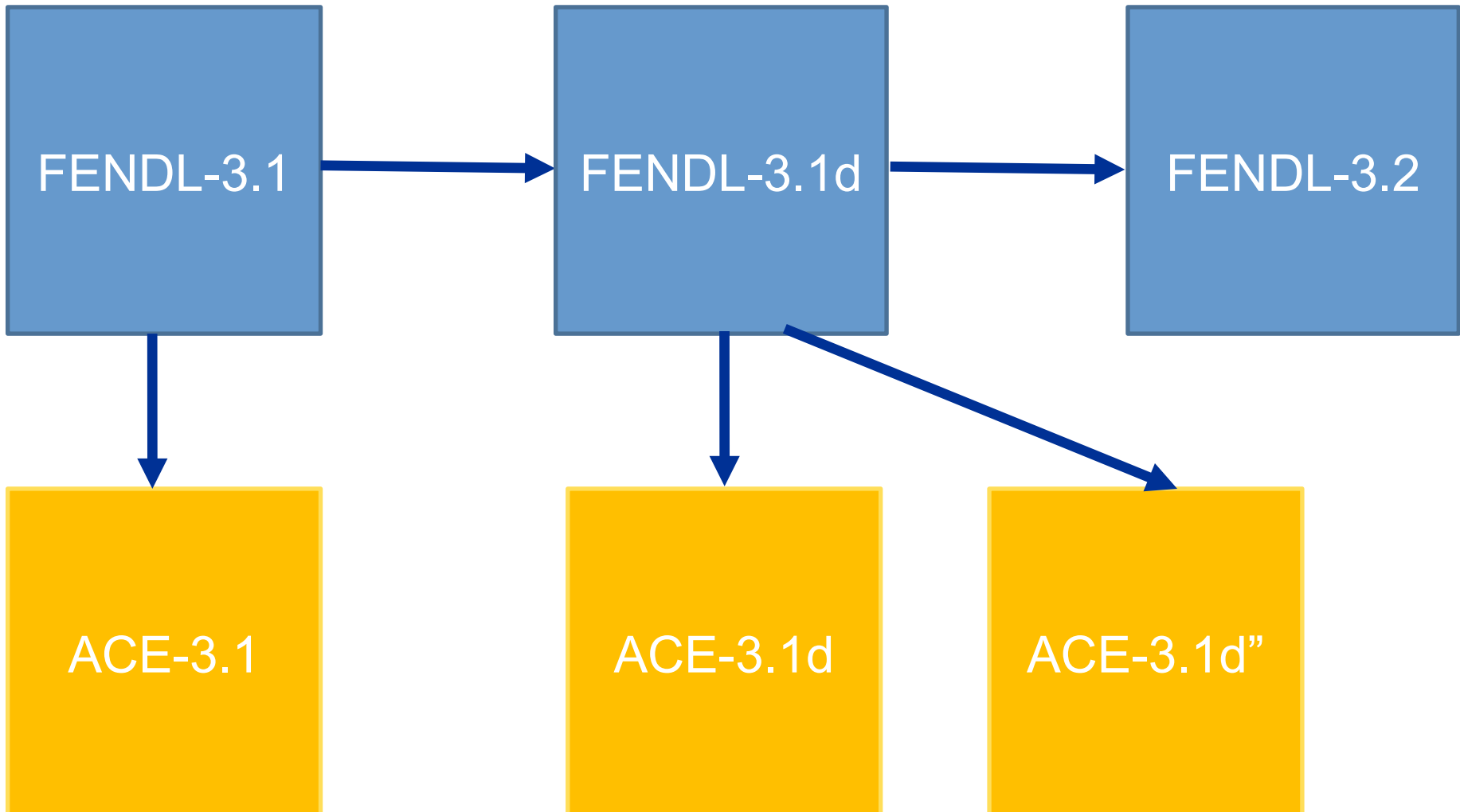
```
git clone https://github.com/iaea-nds/fendl-endf.git
```

```
cd fendl-endf/activation/neutron-activ/endlf  
git annex get .
```

Keeping track of (derived) ACE files



Changes in processing (e.g. bugs fixed in NJOY16)



Some inspiring resources

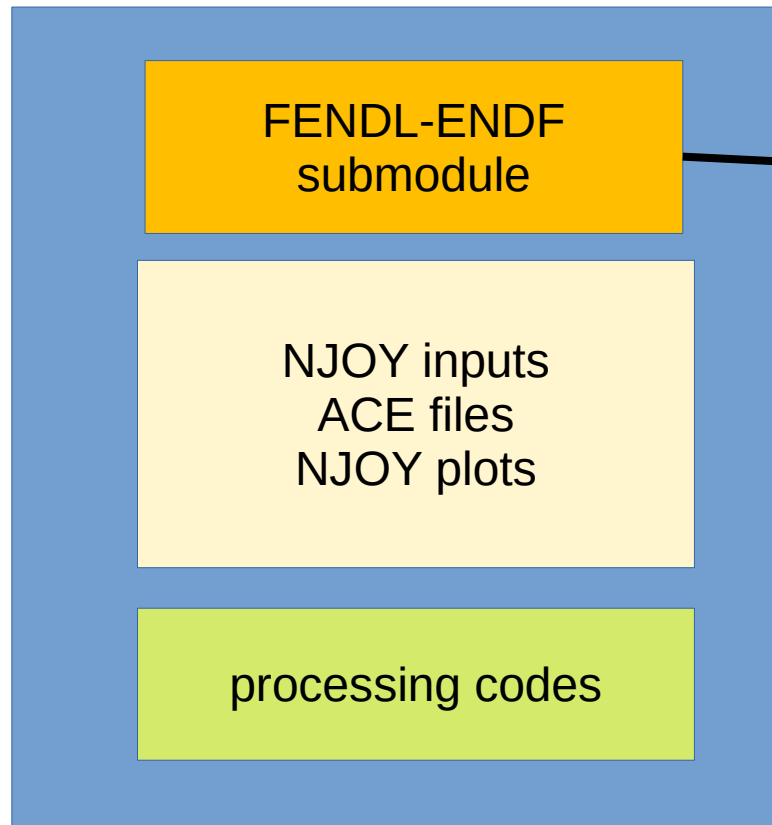


- DataLad: <https://www.datalad.org/>
- YODA principles*
- YODAs Organigram on Data Analysis
- How to organize data, processing codes and processed data

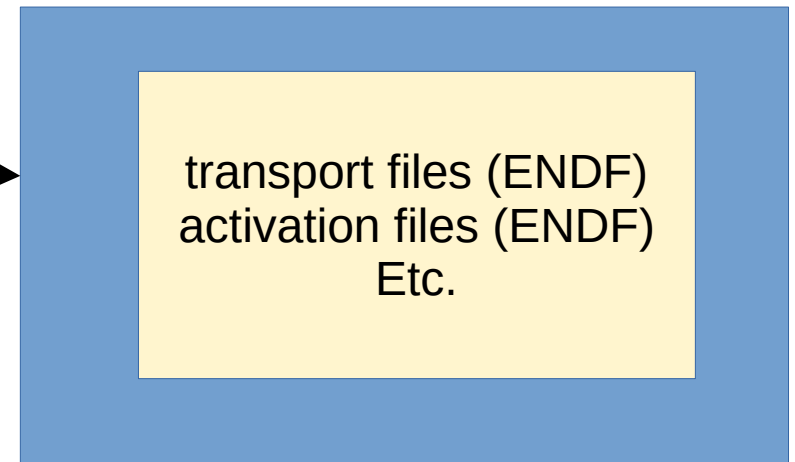
* <https://handbook.datalad.org/en/latest/basics/101-127-yoda.html>

Using git submodules

FENDL-Processed git repository



FENDL-ENDF repository



FENDL-Processed GitHub repository

IAEA-NDS / FENDL-Processed Public

Code Issues Pull requests Actions Projects Security Insights

main 3 branches 3 tags Go to file Code

gschnabel update README with note on git-annex f5b149e on May 13, 2022 31 commits

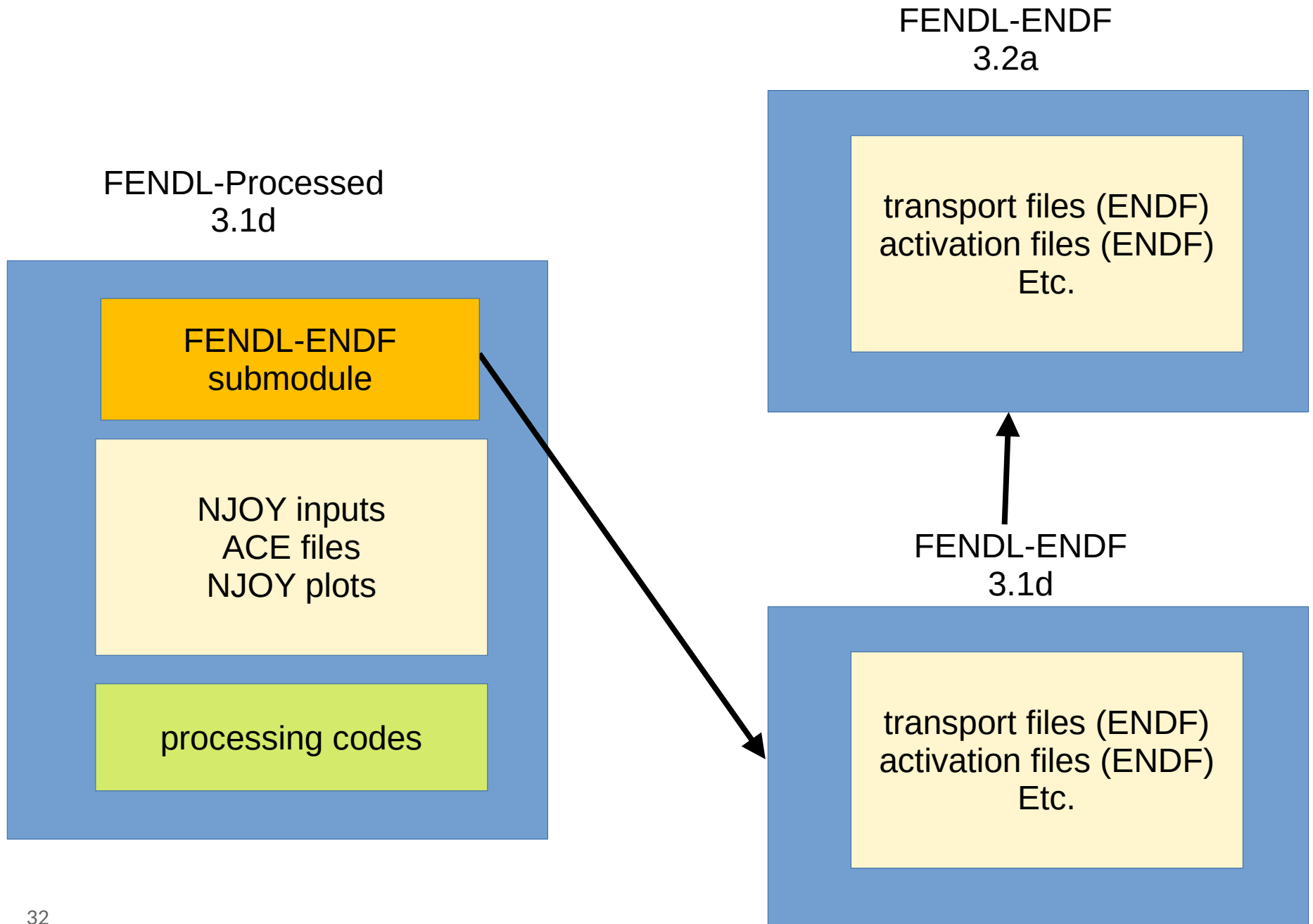
code	include construct_xsd_file.py in aptainer def file	last year
fendl-endf @ 8ef6d1c	processed FENDL-3.2b	last year
general-purpose	correct 05B_010.xsd file	last year
.gitmodules	added ENDF submodule with FENDL-3.1	2 years ago
README.md	update README with note on git-annex	last year

README.md

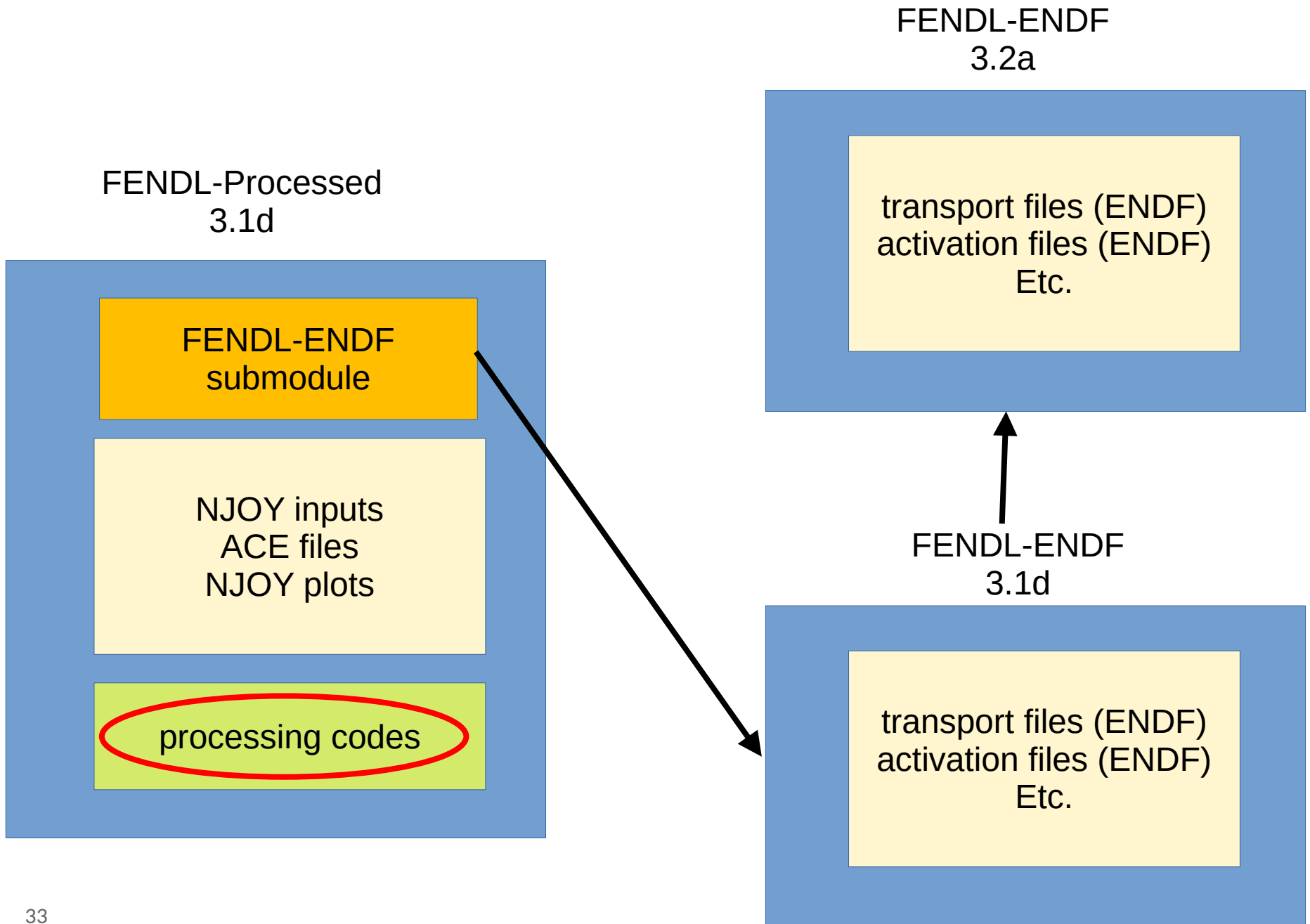
Fusion Evaluated Nuclear Data Library [↗](#)

This repository keeps track of updates to the processed files of the Fusion Evaluated Nuclear Data Library

Version of submodule is pinned



Reproducible processing



Codes in FENDL-Processed repo

IAEA-NDS / FENDL-Processed Public

Code Issues Pull requests Actions Projects Security Insights

main 3 branches 3 tags Go to file Code

gschnabel update README with note on git-annex f5b149e on May 13, 2022 31 commits

code	include construct_xsd_file.py in aptainer def file	last year
fendl-endf @ 8ef6d1c	processed FENDL-3.2b	last year
general-purpose	correct 05B_010.xsd file	last year
.gitmodules	added ENDF submodule with FENDL-3.1	2 years ago
README.md	update README with note on git-annex	last year

README.md

Fusion Evaluated Nuclear Data Library








This repository keeps track of updates to the processed files of the Fusion Evaluated Nuclear Data Library

Codes in FENDL-Processed repo

FENDL-Processed / code / 

 **gschnabel** include construct_xsd_file.py in aptainer def file

788eb96 · last year

Name	Last commit message	Las
 ..		
 comparison-tools	add code and trackdb	
 trackdb	update trackdb with new hash of B-10	
 construct_xsd_file.py	make construct_xsd_file.py usable as module	
 process-fendl.def	include construct_xsd_file.py in aptainer def file	
 process-fendl.py	process-fendl.py now also creates xsd file	
 process-fendl.sif	include construct_xsd_file.py in aptainer def file	

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Apptainer image

Apptainer definition file

Apptainer



Apptainer

THE CONTAINER SYSTEM FOR SECURE HIGH PERFORMANCE COMPUTING

Apptainer/Singularity is the most widely used container system for HPC. It is designed to execute applications at bare-metal performance while being secure, portable, and 100% reproducible. Apptainer is an open-source project with a friendly community of developers and users. The user base continues to expand, with Apptainer/Singularity now used across industry and academia in many areas of work.

[Get Started](#)

[Need help?](#)

Apptainer definition file (for NJOY2016 in FENDL)

FENDL-Processed / code / process-fendl.def

```
9      %post
10
11      apt update &&
12      apt install -y git=1:2.17.1-1ubuntu0.9 &&
13      apt install -y cmake=3.10.2-1ubuntu2.18.04.2 &&
14      apt install -y gfortran=4:7.4.0-1ubuntu2.3 &&
15      apt install -y python3.7=3.7.5-2ubuntu1~18.04.2 &&
16      apt install -y ghostscript=9.26~dfsg+0-0ubuntu0.18.04.15 &&
17      cd /opt &&
18      git clone https://github.com/IAEA-NDS/NJOY2016.git &&
19      cd NJOY2016 &&
20      git checkout 304a3e92bc037982126b6c7ab3cea4baabf597b1 &&
21      mkdir bin && cd bin &&
22      cmake -D CMAKE_BUILD_TYPE=Release .. &&
23      make &&
24      cd /usr/local/bin &&
25      ln -s /opt/NJOY2016/bin
```

Apptainer definition file (for NJOY2016 in FENDL)

FENDL-Processed / code / process-fendl.def

```
9      %post
10
11      apt update &&
12      apt install -y git=1:2.17.1-1ubuntu0.9 &&
13      apt install -y cmake=3.10.2-1ubuntu2.18.04.2 &&
14      apt install -y gfortran=4:7.4.0-1ubuntu2.3 &&
15      apt install -y python3.7=3.7.5-2ubuntu1~18.04.2 &&
16      apt install -y ghostscript=9.26~dfsg+0-0ubuntu0.18.04.15 &&
17      cd /opt &&
18      git clone https://github.com/IAEA-NDS/NJOY2016.git &&
19      cd NJOY2016 &&
20      git checkout 304a3e92bc037982126b6c7ab3cea4baabf597b1 &&
21      mkdir bin && cd bin &&
22      cmake -D CMAKE_BUILD_TYPE=Release .. &&
23      make &&
24      cd /usr/local/bin &&
25      ln -s /opt/NJOY2016/bin
```

Local NJOY2016 repository


IAEA-NDS / NJOY2016 Public Notific





forked from [njoy/NJOY2016](#)

[Code](#) [Pull requests](#) [Actions](#) [Projects](#) [Security](#) [Insights](#)

nds-iaea-njoy2... 28 branches 44 tags [Go to file](#) [Code](#)

This branch is [20 commits ahead](#), [418 commits behind](#) njoy:master.

 **gschnabel** Merge newest updates into nds-iaea-njoy-2016-dev 925e642 on Dec 2, 2022 🕒 649 commits

 .github/workflows	Limiting pull requests tests to master only.	3 years ago
 .travis	Adding command to update pip before running coveralls.	6 years ago
 docs	Updated test documentation	3 years ago
 metaconfigure	Appveyor testing.	6 years ago

<https://github.com/iaea-nds/njoy2016>

Recreate all processed files

```
git clone --recurse-submodules https://github.com/iaea-nds/fendl-processed.git
cd fendl-processed/fendl-endf/general-purpose
git annex get .
cd ../../
git annex get code/ general-purpose/neutron/njoy/*.nji
apptainer run code/process-fendl.sif
```


Proof-of-concept user interaction

Without git & git-annex: Viewing in web browser

[FENDL/7fef6b6\[FENDL-3.2\]/fendl-endf/data/general-purpose/](#) [\[up\]](#)

[atom/](#) imported photo-atomic ENDF files of FENDL-3.2
[deuteron/](#) imported ENDF files of FENDL-3.1
[neutron/](#) imported neutron ENDF files of FENDL-3.2
[neutron-shadow/](#) imported ENDF files of FENDL-3.1
[proton/](#) imported ENDF files of FENDL-3.1

[FENDL/7fef6b6\[FENDL-3.2\]/fendl-endf/data/general-purpose/neutron/](#) [\[up\]](#)

[Default-View](#)

Meaning of row colors:

green	current version in library
red	current version in library (newly added)
blue	superseded version

FENDL version	Mat	Material	Lab.	Date	Authors	Source	E _{max} (eV)	Header	File	short-diff	full-diff
FENDL-3.2	125	1-H-1	LANL	EVAL-OCT05	G.M.Hale	FENDL-3.0	1.50E+08	[header]	[endf]		
FENDL-3.2	128	1-H-2	LANL	EVAL-FEB97	P.G.Young,G.M.Hale,M.B.Chadwick	ENDF/B-VII	1.50E+08	[header]	[endf]		
FENDL-3.2	131	1-H-3	LANL	EVAL-NOV01	G.M.Hale	ENDF/B-VII	6.00E+07	[header]	[endf]		
FENDL-3.2	225	2-He-3	JAERI	EVAL-JUN87	K.SHIBATA	JENDL-4	6.00E+07	[header]	[endf]		
FENDL-3.2	228	2-He-4	LANL	EVAL-SEP10	Hale	ENDF/B-VII	6.00E+07	[header]	[endf]		
FENDL-3.2	325	3-Li-6	LANL	EVAL-APR06	G.M.Hale, P.G.Young	FENDL-3.0	2.00E+08	[header]	[endf]		
FENDL-3.2	328	3-Li-7	LANL	EVAL-AUG88	P.G.Young	FENDL-3.0	2.00E+08	[header]	[endf]		
FENDL-3.2	425	4-Be-9	LLNL,LANL	EVAL-OCT09	G.HALE,PERKINS ET AL,FRANKLE	FENDL-3.0	2.00E+08	[header]	[endf]		
FENDL-3.2	525	5-B-10	LANL	EVAL-APR06	G.M.Hale,P.G.Young	FENDL-3.0	2.00E+08	[header]	[endf]		
FENDL-3.1d	525	5-B-10	LANL	EVAL-APR06	G.M.Hale,P.G.Young	FENDL-3.0	2.00E+08	[header]	[endf]	[short-diff]	[full-diff]
FENDL-3.2	528	5-B-11	LANL	EVAL-MAY89	P.G.Young	FENDL-3.0	2.00E+08	[header]	[endf]		

#	Material	Source	Emax [MeV]
1	1-H-1	JENDL-1	3000
2	1-H-2	ENDF/B-VII	150
3	1-H-3	ENDF/B-VII	20
4	2-He-3	ENDF/B-VII	20
5	3-Li-6	JENDL-4.0/HE	200
6	3-Li-7	JENDL-4.0/HE	200
7	4-Be-9	ENDF/B-VII	113
8	5-B-10	ENDF/B-VII	3
9	5-B-11	ENDF/B-?????	200

```

from endf_parserpy.endf_parser import BasicEndfParser
from endf_parserpy.debugging_utils import compare_objects
parser = BasicEndfParser()
fendl_endf = parser.parsefile(fendl_filename)
other_endf = parser.parsefile(other_endffile)
del fendl_endf[1][451]
del other_endf[1][451]
compare_objects(fendl_endf, other_endf, fail_on_diff=False)

```

```

---- difference for MAT 125 -----
at path .3: only obj2 contains {208, 209, 210}
at path .6: only obj2 contains {208, 209, 210}

```

JENDL-2007/HE

Advanced diff functionality (Provenance checking in FENDL)

#	Material	Source	E _{max} [MeV]
1	1-H-1	JENDL-1	3000
2	1-H-2	ENDF/B-VII	150
3	1-H-3	ENDF/B-VII	20
4	2-He-3	ENDF/B-VII	20
5	3-Li-6	JENDL-4.0/HE	200
6	3-Li-7	JENDL-4.0/HE	200
7	4-Be-9	ENDF/B-VII	113
8	5-B-10	ENDF/B-VII	3
9	5-B-11	ENDF/B-?????	200

```
from endf_parserpy.endf_parser import BasicEndfParser
from endf_parserpy.debugging_utils import compare_objects
parser = BasicEndfParser()
fendl_endf = parser.parsefile(fendl_filename)
other_endf = parser.parsefile(other_endffile)
del fendl_endf[1][451]
del other_endf[1][451]
compare_objects(fendl_endf, other_endf, fail_on_diff=False)
```

FENDL 3.2b = ENDF/B.VII.0

```
---- difference for MAT 131 ----
Value mismatch at .3.50.QI (-0.76387 vs -763870.0)
Value mismatch at .3.50.QM (-0.76387 vs -763870.0)
Value mismatch at .3.650.QI (-4.0329 vs -4032900.0)
Value mismatch at .3.650.QM (-4.0329 vs -4032900.0)
```

Comparison with ENDF/B-VII.1

Summary

- Data management at the isotopic level with endf-parserpy
- Data management at the library level using git and git-annex
- Association between processed files, processing code and endf files achieved via git submodules and Apptainer images (~VM image file)
- Proof-of-concept visualization interface for users
- Update of NDS IAEA website not discussed. Semi-automated, see at <https://github.com/iaea-nds/fendl-code>