



CUBIX

## Grid data sync – TkN - Cubix

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on behalf of the Data Analysis Working Group

AGATA Analysis School: 17/01/2025, Lyon

# The grid script

After each experiment, the data are stored on the grid:

- On LYON CC center
- On Bologna center

The screenshot shows the 'AGATA data processing handbook' website. The main content area is titled 'Download data from the grid'. It includes a navigation menu with links for Home, Download and install, Userguides, Packages, Benchmarks, AGATA data, and Simulated basis. The page content is structured as follows:

- AGATA data**
  - Download data from the grid
- Download data from the grid**
- Data download from the grid**
- Preparation**

The Grid is a cooperation of many different clusters and research organizations, and as such, there is no centralized user management. Yet, there must be a way for the system to identify you and your work. This is why **Grid certificates** and **Virtual Organizations (VOs)** are introduced.

Your digital identity starts with a private key. Only you are allowed to know the contents of this key. Next, you need a Grid certificate, which is issued by a Certificate Authority (CA). The Grid certificate contains your name and your organization, and it says that the person who owns the private key is really the person mentioned, and that this is certified by the Certificate Authority.

Now this is your identity. Big international collaborations do not want to deal with every user individually. Instead, users become part of Virtual Organizations. To give an analogy, the Grid certificate provides authentication (identity, e.g., like a passport) and the VO provides authorization (approval, e.g., like a visa).

In order to access to the Grid, you have to make three essential steps: 1. **Get a Grid certificate**, so that you can be identified on the Grid. 2. **Join the AGATA Virtual Organization (VO)**, so that you can access to the Grid.

You need then a User Interface (UI) that provide the proper environment to interact with the Grid. This user interface can be either installed by your IT services, or obtained from the AGATA Grid doccker image.
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Full documentation on:

<https://agata.pages.in2p3.fr/handbook>

# The grid script

## Prerequisites:

- A grid user interface with the **gfal2 python library** (to be installed by IT services)
  - provide the environment to interact with the Grid
  - A docker image of the user interface is also available (see documentation)
- A Grid certificate
- Join the AGATA Virtual Organization (going to change soon)
- The python3 script for AGATA data download:
  - Included in the AGATA software's packages “script”

# The grid script

```
run_0018 — dudouet@lyoserv2: ~/GridTests_gfal2 — sshpass -p zzzzzzzz ssh -XY dudouet@lyoserv.in2p3.fr > ssh — 150x29
[dudouet@lyoserv2:~/GridTests_gfal2$ ./GridDataSync.py

Usage: GridDataSync.py [options]

Browse and download AGATA data from the grid

Options:
  -h, --help                show this help message and exit
  --new_proxy               create a new proxy
  --proxy_status            print the proxy status
  --from_LYON               download data from CC Lyon (default)
  --from_CNAF               download data from Bologna
  --show_conf               show the current configuration (paths, patterns)
  --ls_dir                  list the content of the given folder
  --input_dir=path          copy grid data from distant path
  --output_dir=path         copy grid data into local path
  --exc=patt                exclude patterns, separated by ":", will skip all files containing exc patterns (none to reset)
  --inc=patt                include patterns, separated by ":", will skip all files not containing inc patterns (none to reset)
                           (check https://regexone.com/references/python for python regexp format)
  --build_list              build the list of files to be downloaded (mandatory before start)
  --bring_online            move files from tape to disks (make the copy of files faster)
  --check_status            check the status of the files to be downloaded (locality, downloaded...)
  --verbose                 increase the verbosity
  --start                   launches the download of the files from the grid
  --force                   force the download of offline files (much slower)
  --nochecksum              remove the checksum on each downloaded file
  --overwrite               Overwrite the already downloaded files
  --release                 release all files from disk

dudouet@lyoserv2:~/GridTests_gfal2$
```

# Step 1: create a new proxy (valid for 72h)

*“./GridDataSync.py --new\_proxy”*

*“./GridDataSync.py --proxy\_status”*

```
run_0018 — dudouet@lyoserv2: ~/GridTests_gfal2 — sshpass -p zzzzzzzz ssh -XY dudouet@lyoserv.in2p3.fr > ssh — 150x15
[dudouet@lyoserv2:~/GridTests_gfal2$ ./GridDataSync.py --new_proxy
[Enter GRID pass phrase for this identity:
Contacting cclcgvomsl01.in2p3.fr:15007 [/O=GRID-FR/C=FR/O=CNRS/OU=CC-IN2P3/CN=cclcgvomsl01.in2p3.fr] "vo.agata.org"...
Remote VOMS server contacted succesfully.

WARNING: VOMS AC validation for VO vo.agata.org failed for the following reasons:
  LSC validation failed: LSC chain description does not match AA certificate chain embedded in the VOMS AC!
  AC signature verification failure: no valid VOMS server credential found.

Created proxy in /tmp/x509up_u2471.

Your proxy is valid until Sat Aug 19 09:47:22 CEST 2023
dudouet@lyoserv2:~/GridTests_gfal2$
```

```
run_0018 — dudouet@lyoserv2: ~/GridTests_gfal2 — sshpass -p zzzzzzzz ssh -XY dudouet@lyoserv.in2p3.fr > ssh — 150x20
[dudouet@lyoserv2:~/GridTests_gfal2$ ./GridDataSync.py --proxy_status

subject   : /O=GRID-FR/C=FR/O=CNRS/OU=IPNL/CN=Jeremie Dudouet/CN=1742975744
issuer    : /O=GRID-FR/C=FR/O=CNRS/OU=IPNL/CN=Jeremie Dudouet
identity  : /O=GRID-FR/C=FR/O=CNRS/OU=IPNL/CN=Jeremie Dudouet
type      : RFC3820 compliant impersonation proxy
strength  : 2048
path      : /tmp/x509up_u2471
timeleft  : 71:58:50
key usage : Digital Signature, Non Repudiation, Key Encipherment, Data Encipherment, Key Agreement
=== VO vo.agata.org extension information ===
VO        : vo.agata.org
subject   : /O=GRID-FR/C=FR/O=CNRS/OU=IPNL/CN=Jeremie Dudouet
issuer    : /O=GRID-FR/C=FR/O=CNRS/OU=CC-IN2P3/CN=cclcgvomsl01.in2p3.fr
attribute : /vo.agata.org/Role=NULL/Capability=NULL
timeleft  : 71:58:49
uri       : cclcgvomsl01.in2p3.fr:15007

dudouet@lyoserv2:~/GridTests_gfal2$
```

## Step 2: check the current configuration status

*“./GridDataSync.py --show\_conf”*

```
run_0018 — dudouet@lyoserv2: ~/GridTests_gfal2 — sshpass -p zzzzzzzz ssh -XY dudouet@lyoserv.in2p3.fr > ssh — 150x14
[dudouet@lyoserv2:~/GridTests_gfal2$ ./GridDataSync.py --show_conf

*****
** GridDataSync configuration **
*****

SERVER          : srm://ccsrm02.in2p3.fr:8443/srm/managerv2?SFN=
BASE_DIR_ON_GRID : /pnfs/in2p3.fr/data/agata/
INPUTDIR        : e680/e680
OUTPUTDIR       : /gridgroup/matnuc/agata/
Include pattern  : .*run_0104.*
Exclude pattern  : .*Narval.*:.*.adf:.*Replay.*:.*zWorkingDir.*:.*Vamos/.*

dudouet@lyoserv2:~/GridTests_gfal2$
```

- Data taken from Lyon CC
- Folder to download: e680 experiment
- Sets of include and exclude patterns to filter the data

# Step 3: update the catalog

*“./GridDataSync.py --build\_list”*

```

run_0018 — dudouet@lyoserv2: ~/GridTests_gfal2 — sshpass -p zzzzzzzz ssh -XY dudouet@lyoserv.in2p3.fr > ssh — 154x45
=> adding: 3.6 GB e680/e680/run_0104.dat.19-05-15_22h37m08s/Data/12B/SRM_AGATA_event_mezzdata.cdat.0002
=> adding: 160.0 MB e680/e680/run_0104.dat.19-05-15_22h37m08s/Data/12B/SRM_AGATA_event_mezzdata.cdat.0003
=> adding: 310.0 MB e680/e680/run_0104.dat.19-05-15_22h37m08s/Data/12B/SRM_AGATA_psa_0000.adf
=> adding: 69.1 MB e680/e680/run_0104.dat.19-05-15_22h37m08s/Data/12B/SRM_AGATA_small_files.tar
=> adding: 3.6 GB e680/e680/run_0104.dat.19-05-15_22h37m08s/Data/12C/SRM_AGATA_event_mezzdata.cdat.0000
=> adding: 3.6 GB e680/e680/run_0104.dat.19-05-15_22h37m08s/Data/12C/SRM_AGATA_event_mezzdata.cdat.0001
=> adding: 3.6 GB e680/e680/run_0104.dat.19-05-15_22h37m08s/Data/12C/SRM_AGATA_event_mezzdata.cdat.0002
=> adding: 640.0 MB e680/e680/run_0104.dat.19-05-15_22h37m08s/Data/12C/SRM_AGATA_event_mezzdata.cdat.0003
=> adding: 334.0 MB e680/e680/run_0104.dat.19-05-15_22h37m08s/Data/12C/SRM_AGATA_psa_0000.adf
=> adding: 69.1 MB e680/e680/run_0104.dat.19-05-15_22h37m08s/Data/12C/SRM_AGATA_small_files.tar
=> adding: 3.6 GB e680/e680/run_0104.dat.19-05-15_22h37m08s/Data/13A/SRM_AGATA_event_mezzdata.cdat.0000
=> adding: 3.6 GB e680/e680/run_0104.dat.19-05-15_22h37m08s/Data/13A/SRM_AGATA_event_mezzdata.cdat.0001
=> adding: 3.6 GB e680/e680/run_0104.dat.19-05-15_22h37m08s/Data/13A/SRM_AGATA_event_mezzdata.cdat.0002
=> adding: 302.0 MB e680/e680/run_0104.dat.19-05-15_22h37m08s/Data/13A/SRM_AGATA_event_mezzdata.cdat.0003
=> adding: 300.0 MB e680/e680/run_0104.dat.19-05-15_22h37m08s/Data/13A/SRM_AGATA_psa_0000.adf
=> adding: 69.1 MB e680/e680/run_0104.dat.19-05-15_22h37m08s/Data/13A/SRM_AGATA_small_files.tar
=> adding: 3.6 GB e680/e680/run_0104.dat.19-05-15_22h37m08s/Data/13B/SRM_AGATA_event_mezzdata.cdat.0000
=> adding: 3.6 GB e680/e680/run_0104.dat.19-05-15_22h37m08s/Data/13B/SRM_AGATA_event_mezzdata.cdat.0001
=> adding: 3.6 GB e680/e680/run_0104.dat.19-05-15_22h37m08s/Data/13B/SRM_AGATA_event_mezzdata.cdat.0002
=> adding: 691.0 MB e680/e680/run_0104.dat.19-05-15_22h37m08s/Data/13B/SRM_AGATA_event_mezzdata.cdat.0003
=> adding: 328.0 MB e680/e680/run_0104.dat.19-05-15_22h37m08s/Data/13B/SRM_AGATA_psa_0000.adf
=> adding: 69.1 MB e680/e680/run_0104.dat.19-05-15_22h37m08s/Data/13B/SRM_AGATA_small_files.tar
=> adding: 3.6 GB e680/e680/run_0104.dat.19-05-15_22h37m08s/Data/13C/SRM_AGATA_event_mezzdata.cdat.0000
=> adding: 3.6 GB e680/e680/run_0104.dat.19-05-15_22h37m08s/Data/13C/SRM_AGATA_event_mezzdata.cdat.0001
=> adding: 3.6 GB e680/e680/run_0104.dat.19-05-15_22h37m08s/Data/13C/SRM_AGATA_event_mezzdata.cdat.0002
=> adding: 336.0 MB e680/e680/run_0104.dat.19-05-15_22h37m08s/Data/13C/SRM_AGATA_event_mezzdata.cdat.0003
=> adding: 330.0 MB e680/e680/run_0104.dat.19-05-15_22h37m08s/Data/13C/SRM_AGATA_psa_0000.adf
=> adding: 69.1 MB e680/e680/run_0104.dat.19-05-15_22h37m08s/Data/13C/SRM_AGATA_small_files.tar
=> adding: 2.0 GB e680/e680/run_0104.dat.19-05-15_22h37m08s/Data/vamos/SRM_AGATA_vamos_0000.adf
=> adding: 2.0 GB e680/e680/run_0104.dat.19-05-15_22h37m08s/Data/vamos/SRM_AGATA_vamos_0001.adf
=> adding: 2.0 GB e680/e680/run_0104.dat.19-05-15_22h37m08s/Data/vamos/SRM_AGATA_vamos_0002.adf
=> adding: 2.0 GB e680/e680/run_0104.dat.19-05-15_22h37m08s/Data/vamos/SRM_AGATA_vamos_0003.adf
=> adding: 2.0 GB e680/e680/run_0104.dat.19-05-15_22h37m08s/Data/vamos/SRM_AGATA_vamos_0004.adf
=> adding: 2.0 GB e680/e680/run_0104.dat.19-05-15_22h37m08s/Data/vamos/SRM_AGATA_vamos_0005.adf
=> adding: 2.0 GB e680/e680/run_0104.dat.19-05-15_22h37m08s/Data/vamos/SRM_AGATA_vamos_0006.adf
=> adding: 2.0 GB e680/e680/run_0104.dat.19-05-15_22h37m08s/Data/vamos/SRM_AGATA_vamos_0007.adf
=> adding: 2.0 GB e680/e680/run_0104.dat.19-05-15_22h37m08s/Data/vamos/SRM_AGATA_vamos_0008.adf
=> adding: 2.0 GB e680/e680/run_0104.dat.19-05-15_22h37m08s/Data/vamos/SRM_AGATA_vamos_0009.adf
=> adding: 2.0 GB e680/e680/run_0104.dat.19-05-15_22h37m08s/Data/vamos/SRM_AGATA_vamos_0010.adf
=> adding: 957.0 MB e680/e680/run_0104.dat.19-05-15_22h37m08s/Data/vamos/SRM_AGATA_vamos_0011.adf
=> adding: 330.0 kB e680/e680/run_0104.dat.19-05-15_22h37m08s/RCC_conf_files/SRM_AGATA_small_files.tar
=> adding: 40.0 kB e680/e680/run_0104.dat.19-05-15_22h37m08s/SRM_AGATA_small_files.tar
-- 175 Files from e680/e680 added to the list of files to be downloaded
--> Total files size: 287.7 GB
dudouet@lyoserv2:~/GridTests_gfal2$

```

# Step 4: data staging

*“./GridDataSync.py --bring\_online”*

*“./GridDataSync.py --check\_status”*

- On the grid, data are stored on **tapes**
- To be downloaded, data need to be temporary move from **tapes to disks** (data staging)

```

run_0018 — dudouet@lyoserv2: ~/GridTests_gfal2 — sshpass -p zzzzzzzz ssh -XY dudouet@lyoserv.in2p3.fr > ssh — 154x40
[dudouet@lyoserv2:~/GridTests_gfal2$ ./GridDataSync.py --bring_online

*****
** GridDataSync configuration **
*****

SERVER          : srm://ccsrm02.in2p3.fr:8443/srm/managerv2?SFN=
BASE_DIR_ON_GRID : /pnfs/in2p3.fr/data/agata/
INPUTDIR        : e680/e680
OUTPUTDIR       : /gridgroup/matnuc/agata/
Include pattern  : *.run_0104.*
Exclude pattern  : *.Narval.*.*zWorkingDir.*

... Start the copy of files from tapes to disks ...
-> press CTRL+C to skip the display (the staging operation will keep working in background)
Number of files to be bring online: 175

^C ** Staging launched for 175/175 files **
stopping the display, the staging continues in background...
[dudouet@lyoserv2:~/GridTests_gfal2$
[dudouet@lyoserv2:~/GridTests_gfal2$
[dudouet@lyoserv2:~/GridTests_gfal2$
[dudouet@lyoserv2:~/GridTests_gfal2$ ./GridDataSync.py --check_status

*****
** GridDataSync configuration **
*****

SERVER          : srm://ccsrm02.in2p3.fr:8443/srm/managerv2?SFN=
BASE_DIR_ON_GRID : /pnfs/in2p3.fr/data/agata/
INPUTDIR        : e680/e680
OUTPUTDIR       : /gridgroup/matnuc/agata/
Include pattern  : *.run_0104.*
Exclude pattern  : *.Narval.*.*zWorkingDir.*

... updating the catalog
-- 175 Files from e680/e680 in the list
==> 0 downloaded (175 remaining)
==> 175 brought online for non downloaded files (0 remaining)
dudouet@lyoserv2:~/GridTests_gfal2$

```



# Step 5: data download

*“./GridDataSync.py --start”*

```
run_0018 — dudouet@lyoserv2: ~/GridTests_gfal2 — sshpass -p zzzzzzzz ssh -XY dudouet@lyoserv.in2p3.fr > ssh — 154x19
[dudouet@lyoserv2:~/GridTests_gfal2$ ./GridDataSync.py --start

*****
** GridDataSync configuration **
*****


SERVER          : srm://ccsrm02.in2p3.fr:8443/srm/managerv2?SFN=
BASE_DIR_ON_GRID : /pnfs/in2p3.fr/data/agata/
INPUTDIR        : e680/e680
OUTPUTDIR       : /gridgroup/matnuc/agata/
Include pattern  : *.run_0104.*
Exclude pattern  : *.Narval.*:.*zWorkingDir.*

... updating the catalog
-- 175 Files from e680/e680 in the list
==> 0 downloaded (175 remaining)
==> 175 brought online for non downloaded files (0 remaining)
...starting to download the 175 requested files...
Copied files: 16/175, current: 80.0 kB, total: 1.2 MB/ 287.0 GB, rate= 304.1 kB/s
```



## A C++ interface to nuclear databases

 Jérémie Dudouet, IP2I Lyon, CNRS  
Diego Gruyer, LPC Caen, CNRS

 [tkn.in2p3.fr](http://tkn.in2p3.fr)  
[gitlab.in2p3.fr/tkn/tkn-lib](https://gitlab.in2p3.fr/tkn/tkn-lib)

 General TkN introduction  
AGATA Analysis school 2025



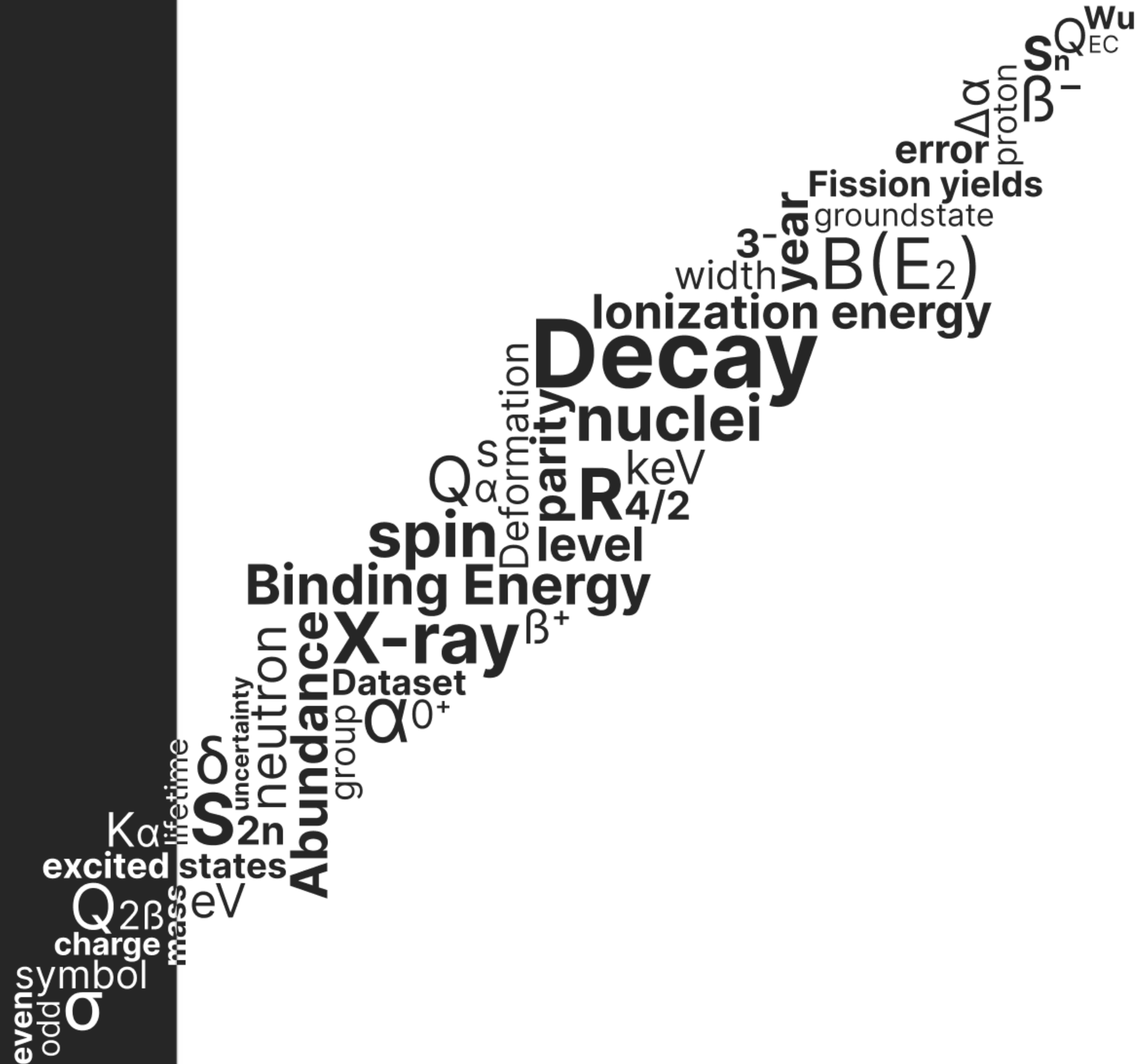
## The nuclear physicist's playground

- ~120 chemical elements
- ~3 000 nuclear isotopes
- ~200 000 excited states
- ~500 000 nuclear decays

## With many properties

Energy, lifetime, Q-values, spin, parity...

→ Tones of published nuclear data



## The nuclear physicist's nightmare

Accessing these data is often non-trivial : web page parsing, pdf file decoding, old database format decoding.

→ Most nuclear physicists have created her/his own macros to (partially) access these data.

12C L 0 0+ STABLE  
12C 2 L ISPIN=0 \$G=2.0010415963 45 (2002Be82)  
12C 3 L XREF=ABDEGHIKMNOPQUWXZacdefijklmopqrstuvwxyz123456789  
12C L 4439.82 212+ 10.8E-3 EV6  
12C 2 L %IT=100 \$ ISPIN=0 \$MOME2=6 3 (1983Ve01)  
12C 3 L XREF=ABDEGHIKMNOPQUWXYacdefijklmopqrstuvwxyz12346789  
12C cL E\$From average of values given in (1967Ch19, 1967Ko14, 1971St22,  
12C 2cL 1974Jo14, 1974No07, 2016Mu06).  
12C 3cL The value is dominated by  $E|g=4438.91$  keV {I31} in (1967Ch19).  
12C cL WIDTH\$From average of (1958Ra14,1967Cr01,1968Ri16,1970Co09,1970St10).  
12C G 4438.94 100 E2  
12C 2 G WIDTHG=10.8E-3 EV 6\$BE2W=4.65 26  
12C L 7654.07 190+ 9.3 EV 9  
12C 2 L ISPIN=0 \$ %IT=4.16E-2 \$ %AAP 100  
12C 3 L XREF=ABDEGHIJKMNOPQUVWXacdefijklmnopqrstuvwxyz1234789  
12C cL E\$See discussion in (1976No02). Note:  $E\{-x\}=7657.8$  keV {I10} is  
12C 2cL obtained from analysis of  $|g$  rays measured in (2016Mu06).  
12C cL WIDTH\$Using  $|G\{-p\}|/G=(6.7 \{I6\})|*10\{+-6\}$  (average of  
12C 2cL 1972Ob01,1977Ro05,1977Al31) and  $|G\{-E0\}|/G\{-p\}=(62.3 \text{ |meV } \{I20\})$   
12C 3cL (see discussion in 2010Ch17,2011Vo16).  
12C cL  $|G\{-rad\}|/G=(|G\{-g\}|+|G\{-p\}|)/G=(4.16 \{I11\})|*10\{+-4\}$ .  
12C 2cL From  $10\{+4\}|*|G\{-rad\}|/G=3.3 \{I9\}$  (1961Al23),  $3.5 \{I12\}$  (1964Ha23),  
12C 3cL  $4.20 \{I22\}$  (1974Ch03),  $4.4 \{I2\}$  (1975Da08),  $4.15 \{I34\}$  (1975Ma34),  
12C 4cL  $4.09 \{I27\}$  (1976Ob03),  $3.87 \{I25\}$  (1976Ma46).  
12C 5cL The value from (1961Al23) has sometimes been miscopied as 3.4, but  
12C 6cL it has no impact on the average. The value of (1975Da08) has been  
12C 7cL corrected, as indicated in (1976Ob03). The value  $(2.82 \{I29\})|*10\{+-4\}$   
12C 8cL (1963Se23) is a statistical outlier; including this value yields  
12C 9cL the average  $(3.99 \{I18\})|*10\{+-4\}$  that is the weighted average  
12C acL using the external uncertainty. The value in (1990Aj01) did not  
12C bcL use the corrected (1975Da08) value. In (2014Fr09), the  
12C ccL value  $(4.19 \{I10\})|*10\{+-4\}$  is deduced by rounding the above  
12C dcL values to the nearest tenth.  
12C cL  $|G\{-rad\}|=3.87$  meV {I39} and  $|G\{-E2\}|/G\{-g\}=3.81$  meV {I39}  
12C cL \$Decay mechanisms were analyzed in (2017Sm03);  
12C 2cL the decay is >99.92% via sequential  $\alpha$ -decay to  $\{+8\}\text{Be}\{-g.s.\}$   
12C 3cL and <0.047% via direct decay into 3 $\alpha$ -particles.  
12C 4cL This is relevant for the astrophysical 3 $\alpha$  rate, via detailed balance.  
12C 5cL Also see  
12C 6cL (2011Ra43, 2012Ma10, 2012Ki07, 2013Ra20, 2014It01, 2016Mo05, 2017De25)  
12C G 3213.79 100 E2  
12C 2 G FL=4439.82  
12C 3 G WIDTHG=3.81E-3 EV 39\$BE2W=8.26 85

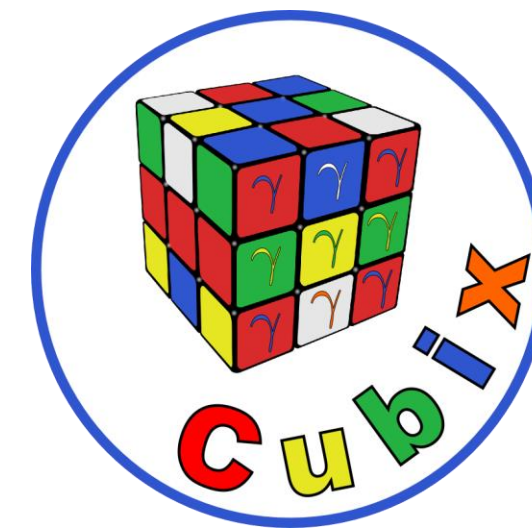
## The nuclear physicist's nightmare

Accessing these data is often non-trivial : web page parsing, pdf file decoding, old database format decoding.

→ Most nuclear physicists have created her/his own macros to (partially) access these data.

## Software

Each nuclear physics software (analysis or simulation codes, models) has its own database implementation, often partial, physics case dependant, and hard to maintain.



gammaware



\* Only software with nice logo have been selected

## **Toolkit for Nuclei**

Provide an easy access to published nuclear physics data to be used in analysis or simulation codes or nuclear models.

## **TkN database**

Comprehensible and frequently updated database gathering nuclear structure data from different official sources.

## **TkN interface**

C++ library to access the data and few utility programs. Light, fast, and easy to link or include in other projects. Minimal dependencies. Open source and well documented.



# TkN database

SQLite (light, stable and cross-platform), directly embedded into the TkN sources.

5 tables linked with foreign keys for fast access.

Automatic update (15<sup>th</sup> of each month)



118

ELEMENT	
<b>element_id</b>	int
charge	int
name	text
symbol	text
properties	...

3 559

ISOTOPE	
<b>isotope_id</b>	int
<b>element_id</b>	int
mass	int
abundance	real
properties	...

DATASET	
<b>dataset_id</b>	int
name	text
comment	text

22 906

550 080

LEVEL	
<b>level_id</b>	int
<b>isotope_id</b>	int
<b>dataset_id</b>	int
energy	real
lifetime	real
properties	...

703 109

DECAY	
<b>decay_id</b>	int
<b>level_from_id</b>	int
<b>level_to_id</b>	int
energy	real
type	int
properties	...

# TkN database

SQLite (light, stable and cross-platform), directly embedded into the TkN sources.

5 tables linked with foreign keys for fast access.

Automatic update (15<sup>th</sup> of each month)

## Data sources

- Chemical element properties
- X-ray data
- Isotopes properties
- Levels and decays properties

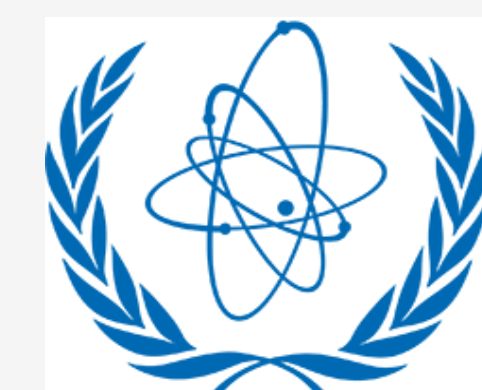
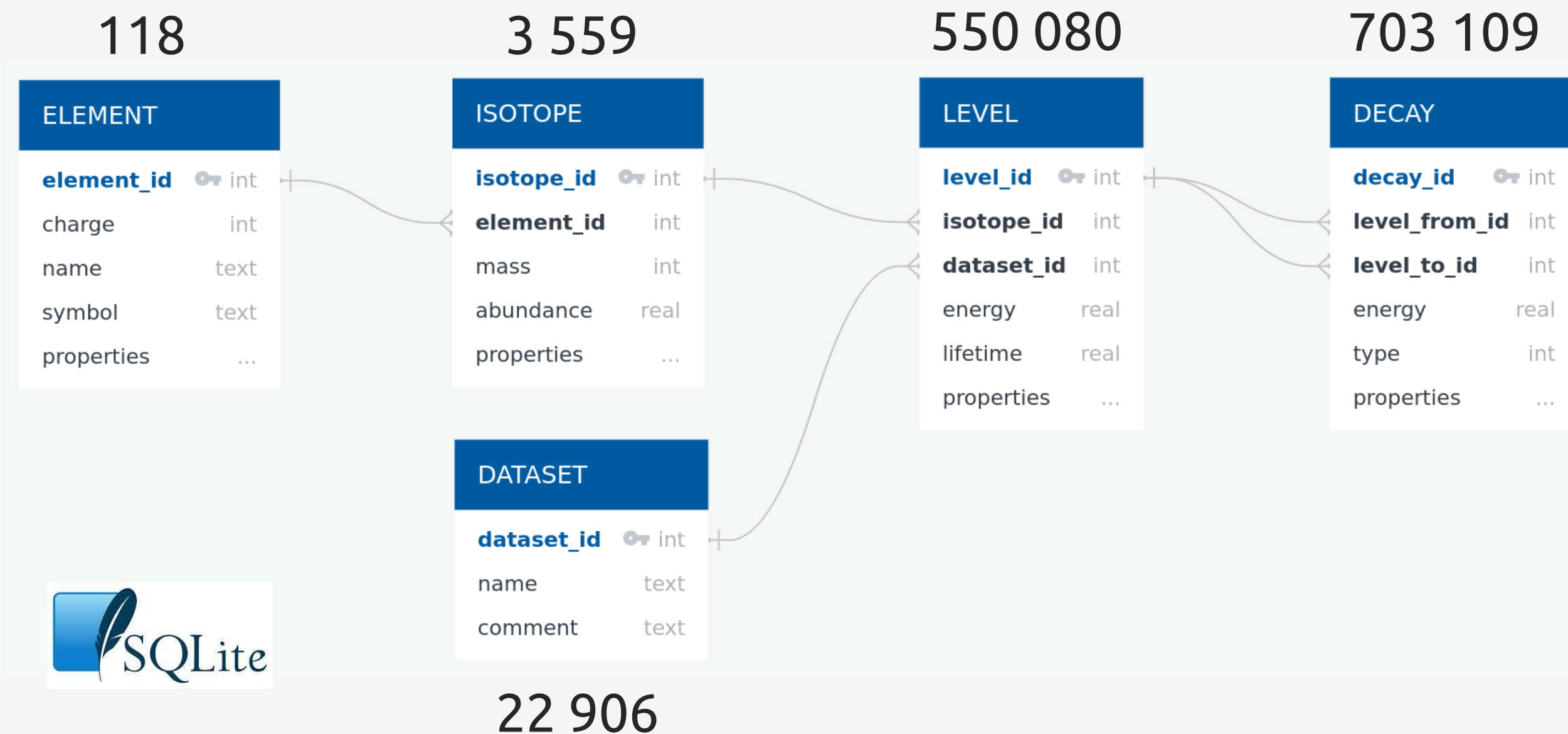
→ Full list of properties here : [tkn.in2p3.fr](http://tkn.in2p3.fr)

## Performances

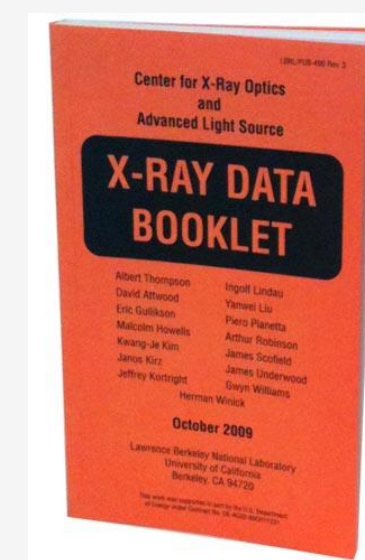
Full database read ~ 15s (1rst), 0.02s (2nd)

Extracting randomly 10<sup>8</sup> levels (1 thread) ~ 250s

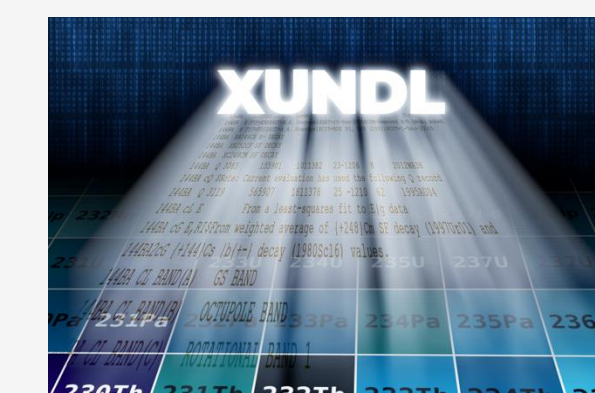
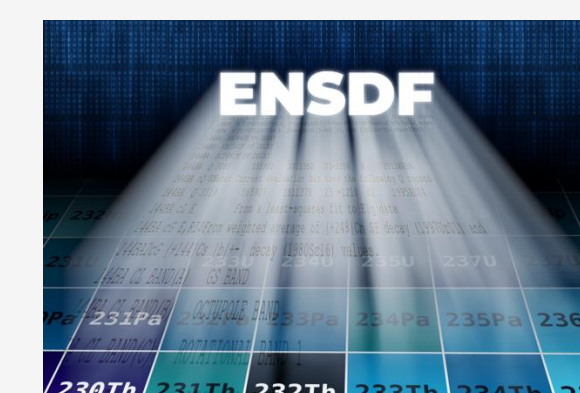
Extracting randomly 10<sup>8</sup> levels (16 threads) ~ 30s



IAEA API



NuDat 3.0





## Some properties (non exhaustive):

### Elements:

- atomic mass
- atomic radius
- ionization energy
- list of X-rays

### Isotopes:

- abundance
- decay mode
- charge radius
- electric quadrupole
- magnetic dipole
- quadrupole deformation
- mass excess

### Nuclear levels:

- energy
- lifetime
- spin and parity
- decays up/down (only  $\gamma$  in current version)

### Nuclear decays (only $\gamma$ in current version):

- energy
- level from/to
- relative intensity
- mixing ratio
- conversion coefficients
- transition probability
- multipolarity

## A dataset manager

For each nucleus, various published datasets are available:

```
tknucleus nuc("132Sn");  
nuc.get_level_scheme()->print("dataset")
```

```
[ INFO      ] Available datasets are :  
[ INFO      ] 132Sn : ADOPTED LEVELS, GAMMAS (12587)  
[ INFO      ] 132IN B- DECA Y (0.200 S) (12588)  
[ INFO      ] 132SN IT DECA Y (2.080 US) (12589)  
[ INFO      ] 133IN B-N DECA Y (165 MS) (12590)  
[ INFO      ] 248CM SF DECA Y (12591)  
[ INFO      ] COULOMB EXCITATION (12592)  
[ INFO      ] U(N,F):IS,RADIUS:XUNDL-3 (12593)  
[ INFO      ] COULOMB EXCITATION:XUNDL-4 (12594)  
[ INFO      ] 133IN B-N DECA Y:162 MS:XUNDL-5 (12595)  
[ INFO      ] 133IN B-N DECA Y:167 MS:XUNDL-6 (12596)  
[ COMMENT   ] Current dataset is '132Sn : ADOPTED LEVELS, GAMMAS' (12587)
```

## A dataset manager

For each nucleus, various published datasets are available:

The ENSDF merged dataset “**ADOPTED LEVEL AND GAMMAS**” is selected by default.

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tknucleus nuc("132Sn");  
nuc.get_level_scheme()->print("dataset")
```

```
[ INFO      ] Available datasets are :  
[ INFO      ] 132Sn : ADOPTED LEVELS, GAMMAS (12587)  
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[ INFO      ] 132SN IT DECAY (2.080 US) (12589)  
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The user can select a dataset corresponding to a specific reaction (**ENSDF evaluation**)

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tknucleus nuc("132Sn");  
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```

```
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[ COMMENT   ] Current dataset is '132Sn : ADOPTED LEVELS, GAMMAS' (12587)
```

## A dataset manager

For each nucleus, various published datasets are available:

The ENSDF merged dataset “**ADOPTED LEVEL AND GAMMAS**” is selected by default.

The user can select a dataset corresponding to a specific reaction (**ENSDF evaluation**)

Or select a **non-evaluated dataset**, published after the last nucleus release (**XUNDL database**)

```
tknucleus nuc("132Sn");  
nuc.get_level_scheme()->print("dataset")
```

```
[ INFO      ] Available datasets are :  
[ INFO      ] 132Sn : ADOPTED LEVELS, GAMMAS (12587)  
[ INFO      ] 132IN B- DECA Y (0.200 S) (12588)  
[ INFO      ] 132SN IT DECA Y (2.080 US) (12589)  
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[ COMMENT   ] Current dataset is '132Sn : ADOPTED LEVELS, GAMMAS' (12587)
```

## TkN C++ classes

**tkmanager** Interface to SQLite database

**tknucleus** Nuclear ground state properties **tklevel**

**tkdecay** Level and decay data

**tkmeasure** Values, (asymmetric) uncertainties, limit values, comments, references

**tkunits\_manager** Units and conversions

## Utility programs

**tkn-root** ROOT environment with TkN loaded

**tkn-db-update** Download/update the database

**tkn-print** CLI tool to explore the TkN database

## Link

TkN is made to be linked/included in other projects that uses cmake or git submodules.



## TkN C++ classes

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## Utility programs

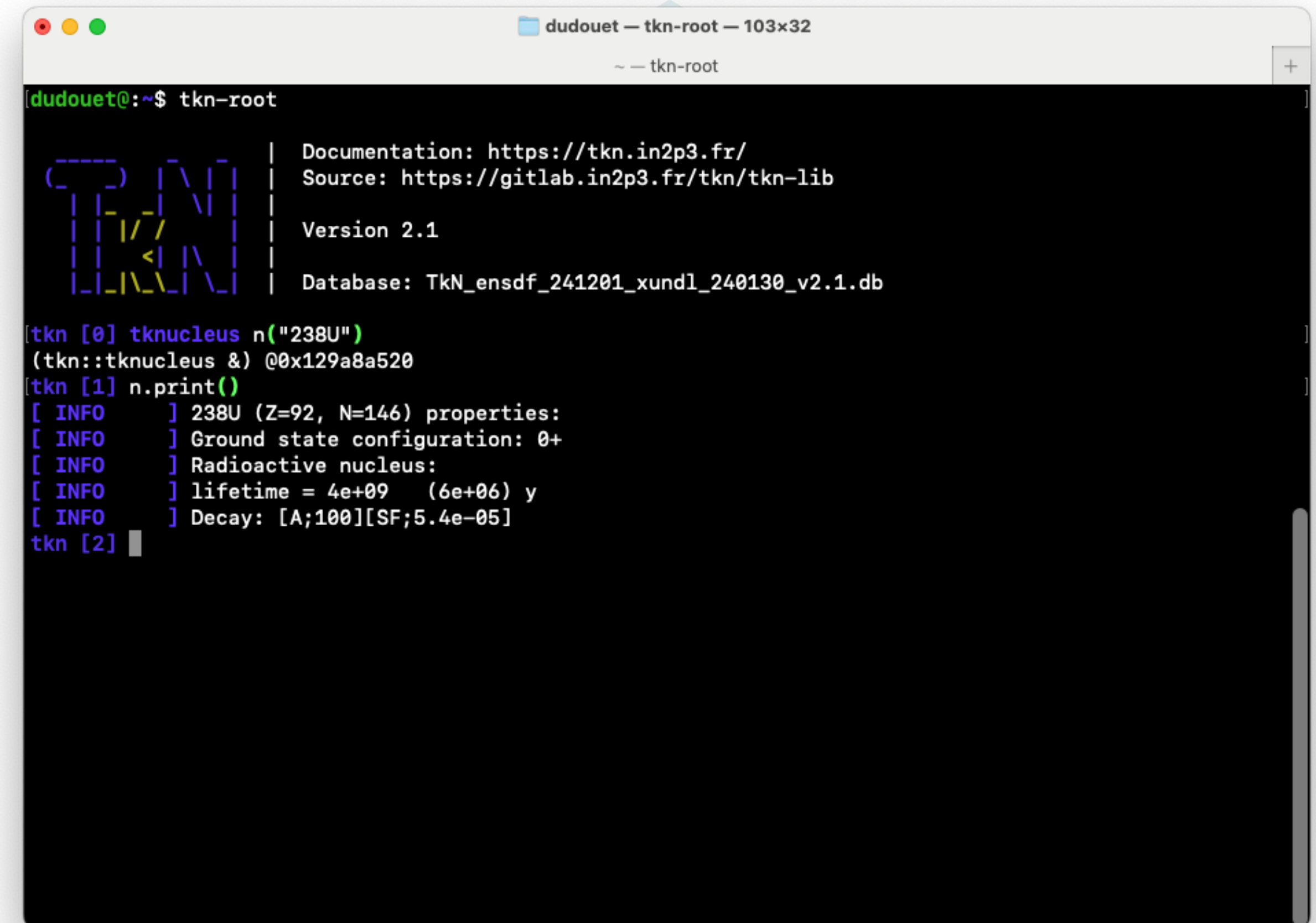
**tkn-root** ROOT environment with TkN loaded

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```
dudouet@:~$ tkn-root

TkN | Documentation: https://tkn.in2p3.fr/
    | Source: https://gitlab.in2p3.fr/tkn/tkn-lib
    |
    | Version 2.1
    |
    | Database: TkN_ensdf_241201_xund1_240130_v2.1.db

[tkn [0] tknucleus n("238U")
(tk::tknucleus &) @0x129a8a520
[tkn [1] n.print()
[ INFO ] 238U (Z=92, N=146) properties:
[ INFO ] Ground state configuration: 0+
[ INFO ] Radioactive nucleus:
[ INFO ] lifetime = 4e+09 (6e+06) y
[ INFO ] Decay: [A;100][SF;5.4e-05]
tkn [2]
```

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```
dudouet — tkn-root — 112x50
-- tkn-root

[tkn [2] n.list_properties()
[ INFO ] nucleus properties:
[ INFO ] Qalpha 4269.858130 keV [FLOAT]
[ INFO ] QbetaMinus -146.865000 keV [FLOAT]
[ INFO ] QbetaMinusOneNeutronEmission -5635.185060 keV [FLOAT]
[ INFO ] QbetaMinusTwoNeutronEmission -12212.998120 keV [FLOAT]
[ INFO ] QdeltaAlpha 357.185000 keV [FLOAT]
[ INFO ] QdoubleBetaMinus 1144.584000 keV [FLOAT]
[ INFO ] QdoubleElectronCapture -5217.268000 keV [FLOAT]
[ INFO ] QelectronCapture -3586.311000 keV [FLOAT]
[ INFO ] QelectronCaptureOneProtonEmission -9936.336064 keV [FLOAT]
[ INFO ] QpositronEmission -4608.308900 keV [FLOAT]
[ INFO ] XRay_Kalpha1 98.439000 keV [FLOAT]
[ INFO ] XRay_Kalpha2 94.665000 keV [FLOAT]
[ INFO ] XRay_Kbeta1 111.300000 keV [FLOAT]
[ INFO ] XRay_Lalpha1 13.614700 keV [FLOAT]
[ INFO ] XRay_Lalpha2 13.438800 keV [FLOAT]
[ INFO ] XRay_Lbeta1 17.220000 keV [FLOAT]
[ INFO ] XRay_Lbeta2 16.428300 keV [FLOAT]
[ INFO ] XRay_Lgamma1 20.167100 keV [FLOAT]
[ INFO ] XRay_Malpha1 3.170800 keV [FLOAT]
[ INFO ] abundance 99.274200 % [FLOAT]
[ INFO ] atomic_mass 238.028900 u [FLOAT]
[ INFO ] atomic_radius_van_der_Waals 240.000000 pm [FLOAT]
[ INFO ] binding_energy_overA 7570.126230 keV [FLOAT]
[ INFO ] boiling_point 4404.000000 K [FLOAT]
[ INFO ] charge 92 [TEXT]
[ INFO ] decay_modes [A;100][SF;5.4e-05] [TEXT]
[ INFO ] density 18.950000 [FLOAT]
[ INFO ] electronic_configuration [Rn]7s2 5f3 6d1 [TEXT]
[ INFO ] element_name Uranium [TEXT]
[ INFO ] group_block Actinide [TEXT]
[ INFO ] ionization_energy 6.194000 eV [FLOAT]
[ INFO ] isotope_year_discovered 1896 [TEXT]
[ INFO ] lifetime 4.468e+09 y [FLOAT]
[ INFO ] mass_excess 47307.732000 keV [FLOAT]
[ INFO ] melting_point 1408.000000 K [FLOAT]
[ INFO ] name [TEXT]
[ INFO ] neutronSeparationEnergy 6153.719060 keV [FLOAT]
[ INFO ] pairingGap 673.668500 keV [FLOAT]
[ INFO ] protonSeparationEnergy 7508.863064 keV [FLOAT]
[ INFO ] quadrupoleDeformation 0.288901 [FLOAT]
[ INFO ] radius 5.857100 fm [FLOAT]
[ INFO ] spin_parity 0+ [TEXT]
[ INFO ] state Solid [TEXT]
[ INFO ] symbol U [TEXT]
[ INFO ] twoNeutronSeparationEnergy 11279.486120 keV [FLOAT]
[ INFO ] twoProtonSeparationEnergy 13525.413128 keV [FLOAT]
[ INFO ] year_discovered 1789 [TEXT]
tkn [3] ]
```



## TkN C++ classes

**tkmanager** Interface to SQLite database

**tknucleus** Nuclear ground state properties **tklevel**

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**tkmeasure** Values, (asymmetric) uncertainties, limit values, comments, references

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## Utility programs

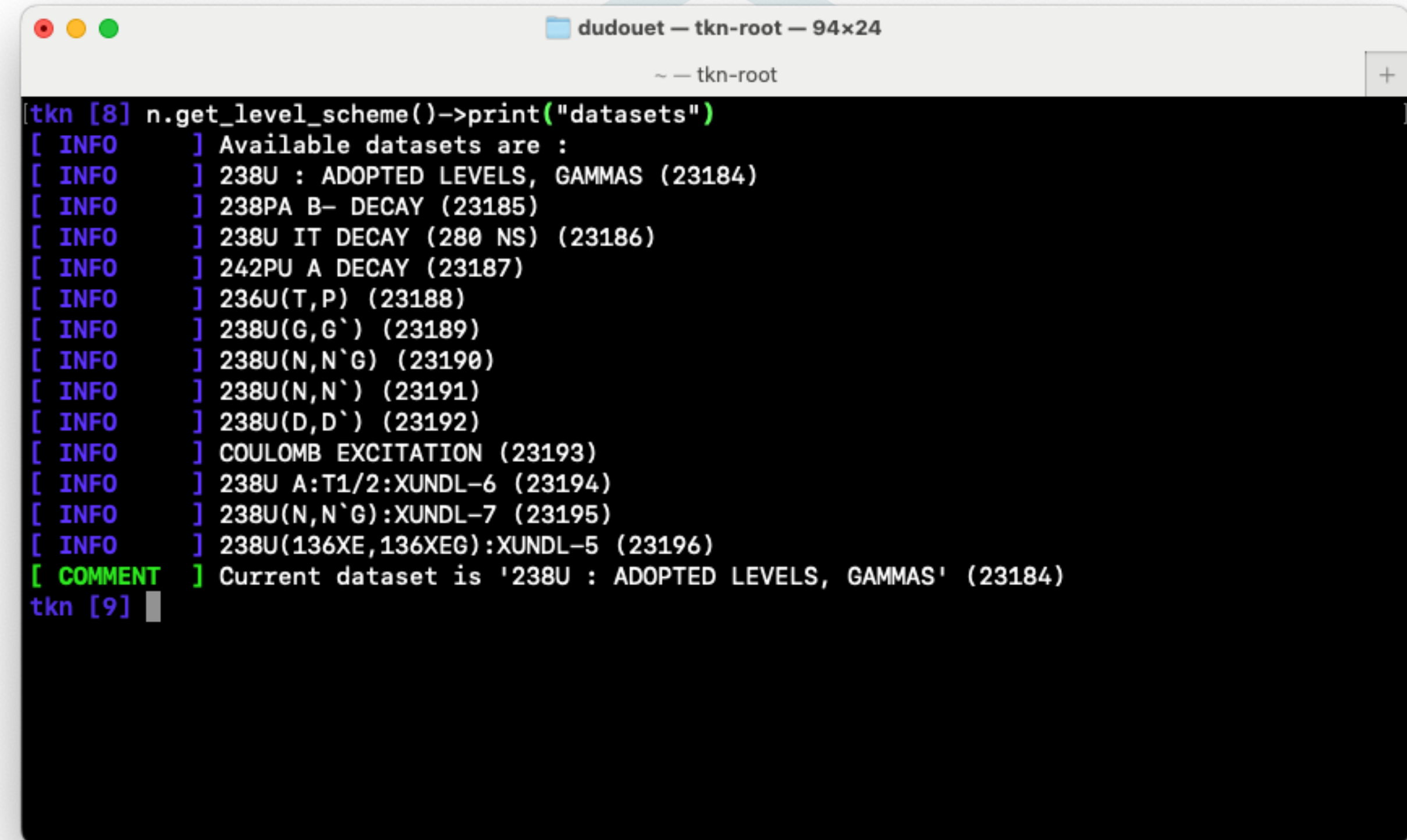
**tkn-root** ROOT environment with TkN loaded

**tkn-db-update** Download/update the database

**tkn-print** CLI tool to explore the TkN database

## Link

TkN is made to be linked/included in other projects that uses cmake or git submodules.

A terminal window titled 'dudouet — tkn-root — 94x24' with a subtitle '~ — tkn-root'. The terminal shows a command 'tkn [8] n.get\_level\_scheme()->print("datasets")' and its output. The output lists various datasets with their IDs and descriptions, such as '238U : ADOPTED LEVELS, GAMMAS (23184)', '238PA B- DECAY (23185)', and '238U IT DECAY (280 NS) (23186)'. A green comment line indicates the current dataset is '238U : ADOPTED LEVELS, GAMMAS' (23184). The prompt 'tkn [9]' is visible at the bottom.

```
tkn [8] n.get_level_scheme()->print("datasets")
[ INFO ] Available datasets are :
[ INFO ] 238U : ADOPTED LEVELS, GAMMAS (23184)
[ INFO ] 238PA B- DECAY (23185)
[ INFO ] 238U IT DECAY (280 NS) (23186)
[ INFO ] 242PU A DECAY (23187)
[ INFO ] 236U(T,P) (23188)
[ INFO ] 238U(G,G`) (23189)
[ INFO ] 238U(N,N`G) (23190)
[ INFO ] 238U(N,N`) (23191)
[ INFO ] 238U(D,D`) (23192)
[ INFO ] COULOMB EXCITATION (23193)
[ INFO ] 238U A:T1/2:XUNDL-6 (23194)
[ INFO ] 238U(N,N`G):XUNDL-7 (23195)
[ INFO ] 238U(136XE,136XEG):XUNDL-5 (23196)
[ COMMENT ] Current dataset is '238U : ADOPTED LEVELS, GAMMAS' (23184)
tkn [9]
```

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## Utility programs

**tkn-root** ROOT environment with TkN loaded

**tkn-db-update** Download/update the database

**tkn-print** CLI tool to explore the TkN database

## Link

TkN is made to be linked/included in other projects that uses cmake or git submodules.

```
dudouet — tkn-root — 112x45
-- tkn-root

[tkn [12] n.get_level_scheme()->print("level")
[ INFO ] dataset '238U : ADOPTED LEVELS, GAMMAS' contains 285 levels:
[ INFO ] Level energy = 0 keV ; Jpi: 0+ ; lifetime = 4e+09 (6e+06) y
[ INFO ] Level energy = 44.916 (0.013) keV ; Jpi: 2+ ; lifetime = 206 (3) ps
[ INFO ] Level energy = 148.38 (0.03) keV ; Jpi: 4+
[ INFO ] Level energy = 307.18 (0.08) keV ; Jpi: 6+
[ INFO ] Level energy = 518.1 (0.3) keV ; Jpi: 8+ ; lifetime = 23 (3) ps
[ INFO ] Level energy = 680.11 (0.04) keV ; Jpi: 1- ; lifetime = 35 (-9 ; +19) fs
[ INFO ] Level energy = 731.93 (0.03) keV ; Jpi: 3-
[ INFO ] Level energy = 775.9 (0.4) keV ; Jpi: 10+ ; lifetime = 9 (1) ps
[ INFO ] Level energy = 826.64 (0.11) keV ; Jpi: 5-
[ INFO ] Level energy = 927.21 (0.19) keV ; Jpi: 0+
[ INFO ] Level energy = 930.55 (0.09) keV ; Jpi: (1-)
[ INFO ] Level energy = 950.12 (0.20) keV ; Jpi: 2-
[ INFO ] Level energy = 966.13 (0.04) keV ; Jpi: 2+ ; lifetime = 2.4 (-0.7 ; +1.7) ps
[ INFO ] Level energy = 966.31 (0.21) keV ; Jpi: 7-
[ INFO ] Level energy = 997.23 (0.24) keV ; Jpi: 0+
[ INFO ] Level energy = 997.58 (0.07) keV ; Jpi: 3-
[ INFO ] Level energy = 1028 keV [no uncertainty] ; Jpi: 4-
[ INFO ] Level energy = 1037.25 (0.07) keV ; Jpi: 2+ ; lifetime = 1.13 (0.12) ps
[ INFO ] Level energy = 1056.38 (0.21) keV ; Jpi: 4+
[ INFO ] Level energy = 1059.66 (0.17) keV ; Jpi: (3+)
[ INFO ] Level energy = 1060.27 (0.14) keV ; Jpi: 2+ ; lifetime = 0.64 (0.04) ps
[ INFO ] Level energy = 1076.7 (0.5) keV ; Jpi: 12+ ; lifetime = 4.4 (0.4) ps
[ INFO ] Level energy = 1105.71 (0.07) keV ; Jpi: 3+
[ INFO ] Level energy = 1128.84 (0.07) keV ; Jpi: (2-)
[ INFO ] Level energy = 1130.75 (0.24) keV ; Jpi: 4+
[ INFO ] Level energy = 1135.7 (0.4) keV ; Jpi: ? uncertain level tag: ?
[ INFO ] Level energy = 1150.7 (0.4) keV ; Jpi: 9-
[ INFO ] Level energy = 1151 keV [no uncertainty] ; Jpi: 6-
[ INFO ] Level energy = 1163 keV [no uncertainty] ; Jpi: (4+)
[ INFO ] Level energy = 1167.99 (0.09) keV ; Jpi: 4+
[ INFO ] Level energy = 1168.88 (0.23) keV ; Jpi: 3-
[ INFO ] Level energy = 1209.3 (0.3) keV ; Jpi: ?
[ INFO ] Level energy = 1223.78 (0.14) keV ; Jpi: 2+ ; lifetime = 3.5 (0.4) ps
[ INFO ] Level energy = 1232 keV [no uncertainty] ; Jpi: 5+
[ INFO ] Level energy = 1239.3 (0.2) keV ; Jpi: ? uncertain level tag: ?
[ INFO ] Level energy = 1242.9 keV [no uncertainty] ; Jpi: ? uncertain level tag: ?
[ INFO ] Level energy = 1260.9 (0.2) keV ; Jpi: ? uncertain level tag: ?
[ INFO ] Level energy = 1269.2 (1.0) keV ; Jpi: 6+
[ INFO ] Level energy = 1278.54 (0.12) keV ; Jpi: 2+ ; lifetime = 2.9 (0.3) ps
[ INFO ] Level energy = 1311 keV [no uncertainty] ; Jpi: 6+
[ INFO ] Level energy = 1318 keV [no uncertainty] ; Jpi: 8-
[ INFO ] Level energy = 1354.79 (0.24) keV ; Jpi: (1,2+)
[ INFO ] Level energy = 1375 keV [no uncertainty] ; Jpi: ?
```

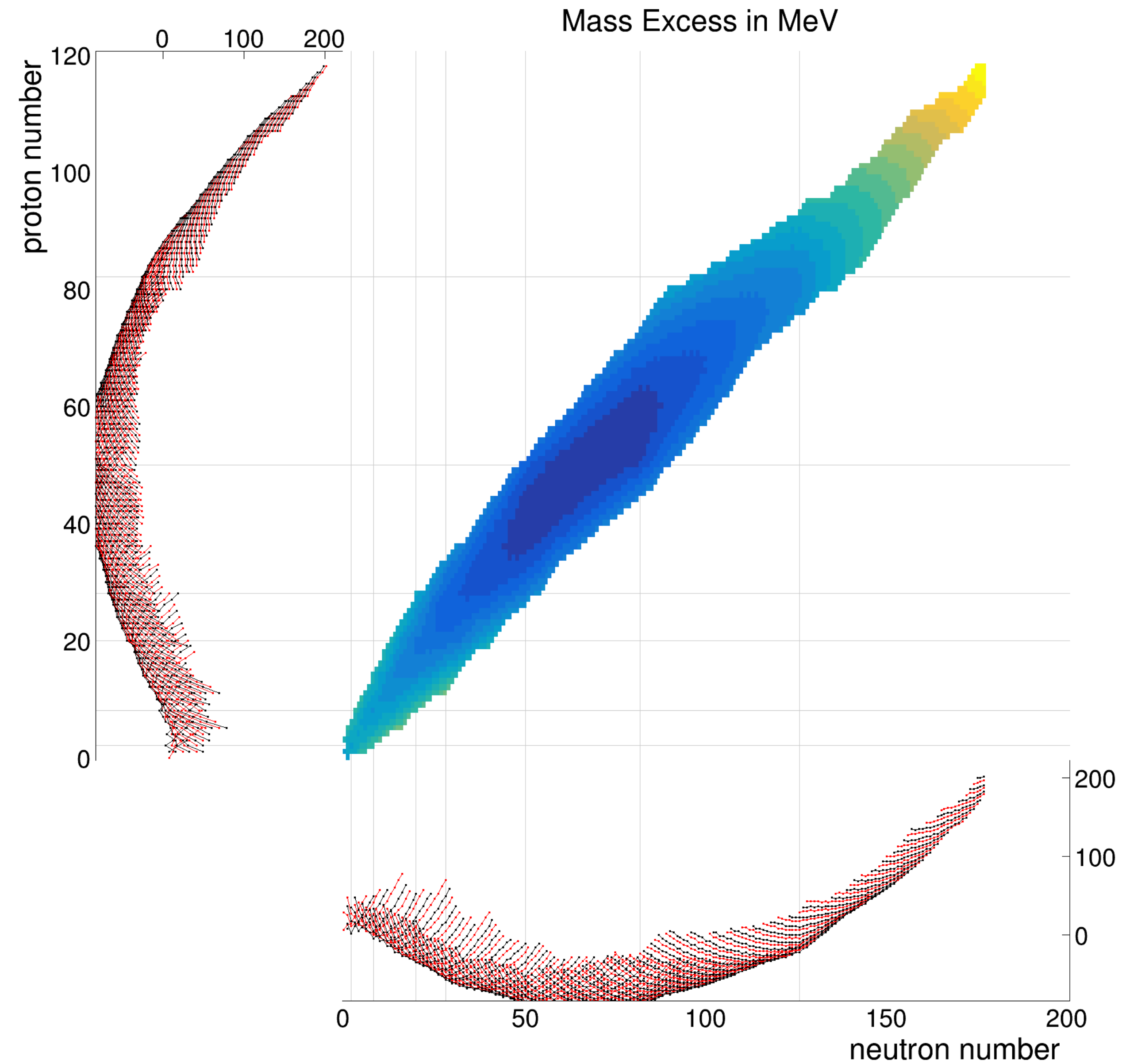
# Some simple examples (from tkn.in2p3.fr)

```
#include "tkmanager.h"
#include "tknuclear_chart.h"

void draw_mass_excess()
{
tkmanager dtm;
tknuclear_chart nn("Mass Excess in MeV");

for(const auto &nuc : dtm.get_nuclei())
{
int zz = nuc->get_z();
int nn = nuc->get_n();
double yy = nuc->get_mass_excess();
nn.set_value(zz, nn, yy);
}

nn.draw();
}
```



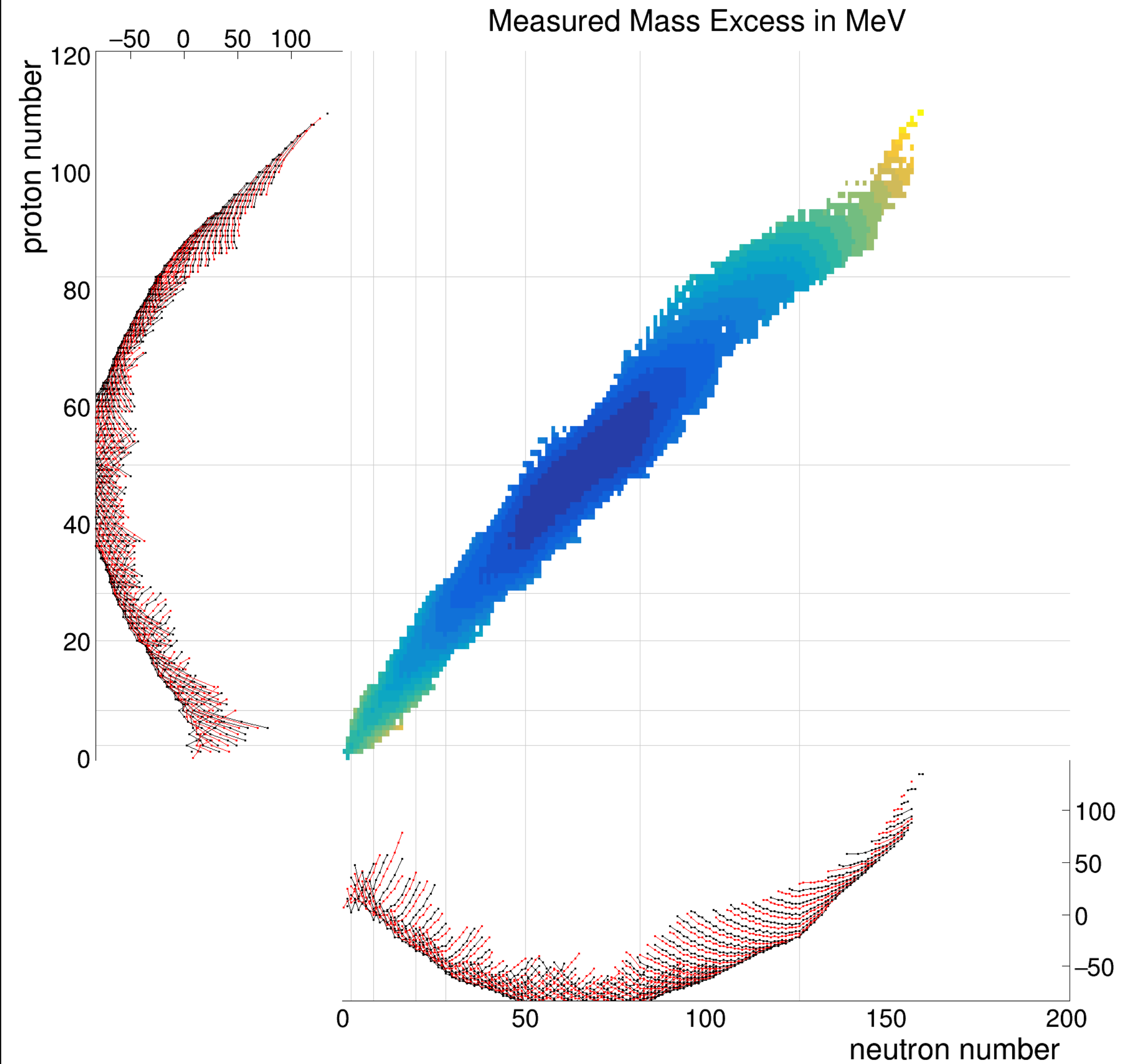
# Some simple examples (from tkn.in2p3.fr)

```
#include "tkmanager.h"
#include "tknuclear_chart.h"

void draw_mass_excess()
{
tkmanager dtm;
tknuclear_chart nn("Mass Excess in MeV");

for(const auto &nuc : dtm.get_nuclei())
{
int zz = nuc->get_z();
int nn = nuc->get_n();
double yy = nuc->get_mass_excess();
if(mass_excess->get_info() != kSystematic)
nn.set_value(zz, nn, yy);
}

nn.draw();
}
```



## Some simple examples (from tkn.in2p3.fr)

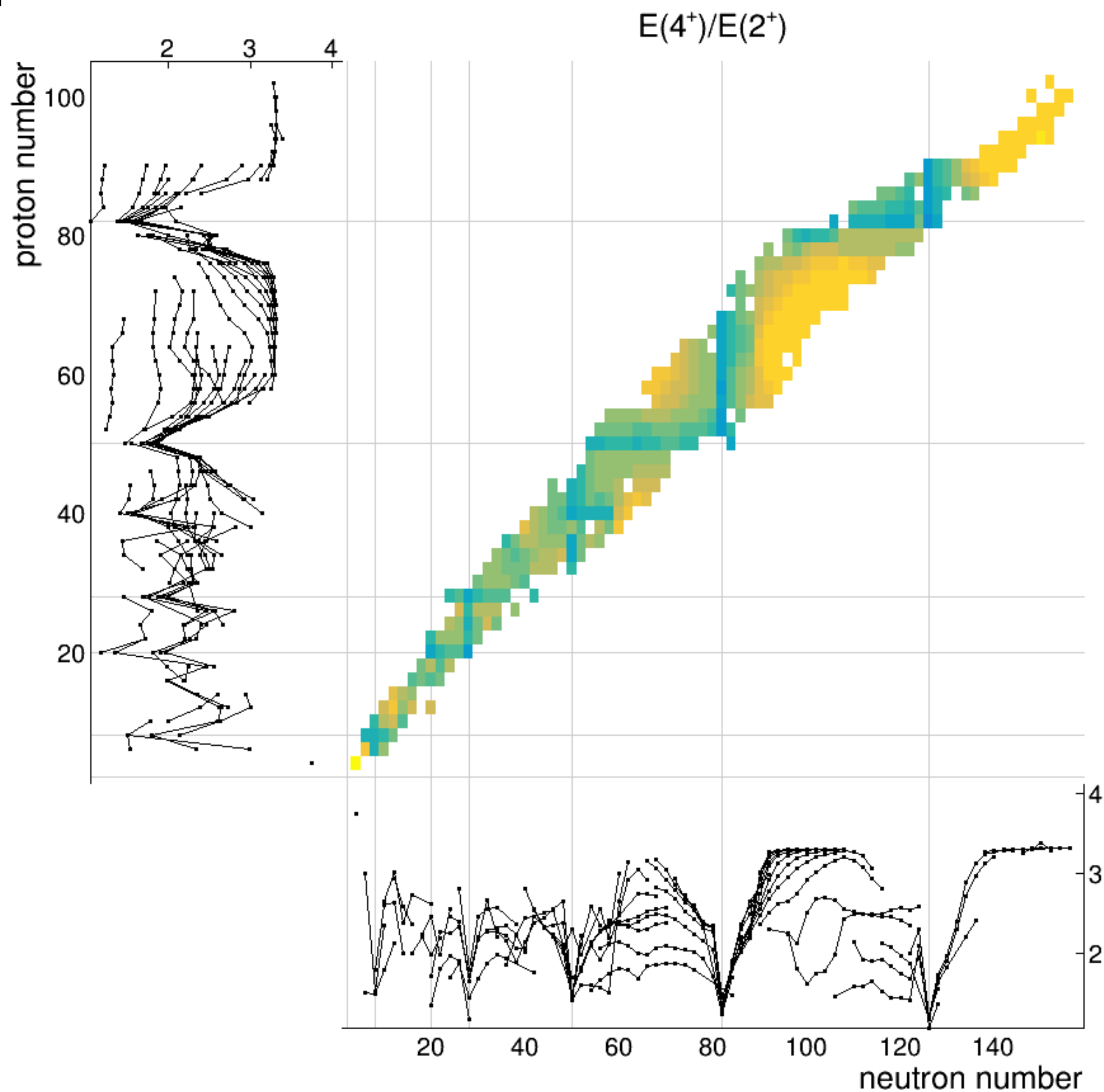
```
#include "tkmanager.h"
#include "tknuclear_chart.h"

void draw_r42()
{
tkmanager dtm;
tknuclear_chart nn("E4+/E2+",kEven);

for(const auto &nuc : dtm.get_nuclei(
    [](auto n) {return (n->get_z()%2==0
    && n->get_n()%2==0);}))
{
    auto ll = nuc->get_level_scheme();
    auto lvl2 = ll->get_level("2+1",true);
    auto lvl4 = ll->get_level("4+1",true);

    double e2 = lvl2->get_energy();
    double e4 = lvl4->get_energy();
    double r42 = e4/e2;
    nn.set_value(nuc->get_z(), nuc->get_n(), r42);
}

nn.draw();
}
```



## Some simple examples (from tkn.in2p3.fr)

```
#include "tkmanager.h"
#include "tknuclear_chart.h"

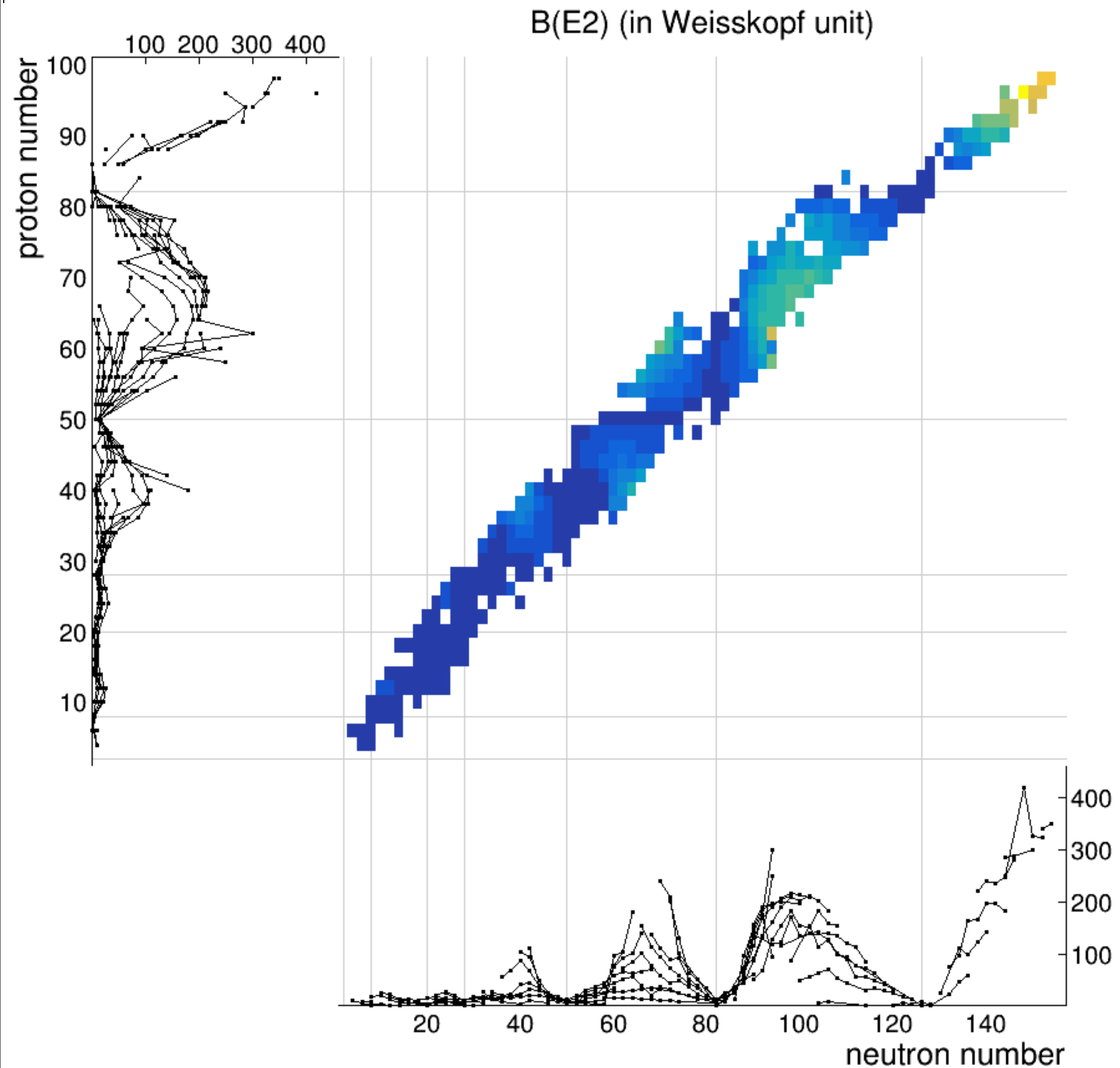
void draw_BE2()
{
  tkmanager dtm;
  tknuclear_chart nn("B(E2)",kEven);

  for(const auto &nuc : dtm.get_nuclei(
    [](auto n) {return (n->get_z()%2==0
    && n->get_n()%2==0);}))
  {
    auto ll = nuc->get_level_scheme();
    auto gg = ll->get_decay<tkgammadecay>("2+1->0+1");

    auto BE2W = gg->get_trans_prob(true,2,true);

    nn.set_value(nuc->get_z(), nuc->get_n(), BE2W);
  }

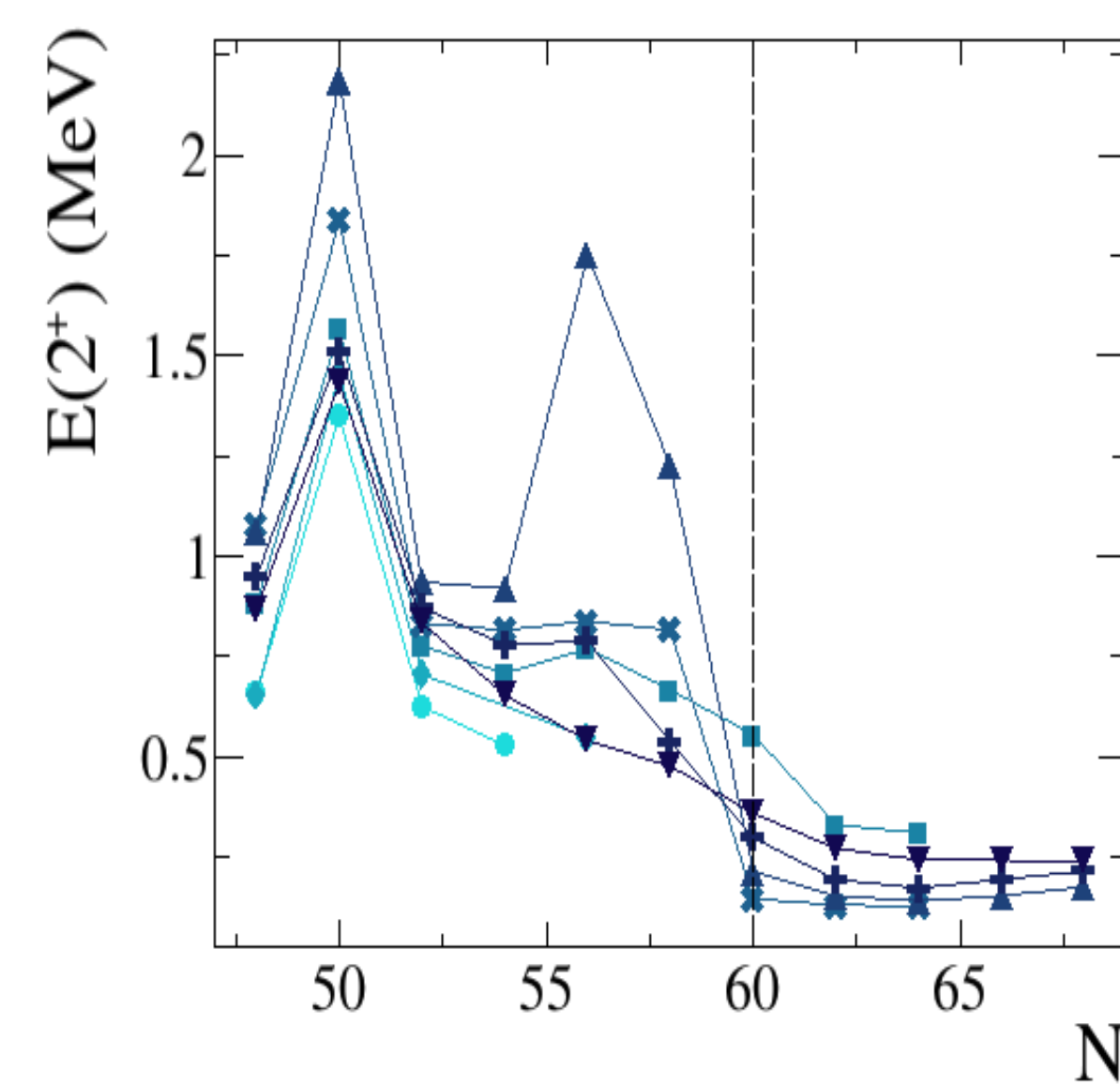
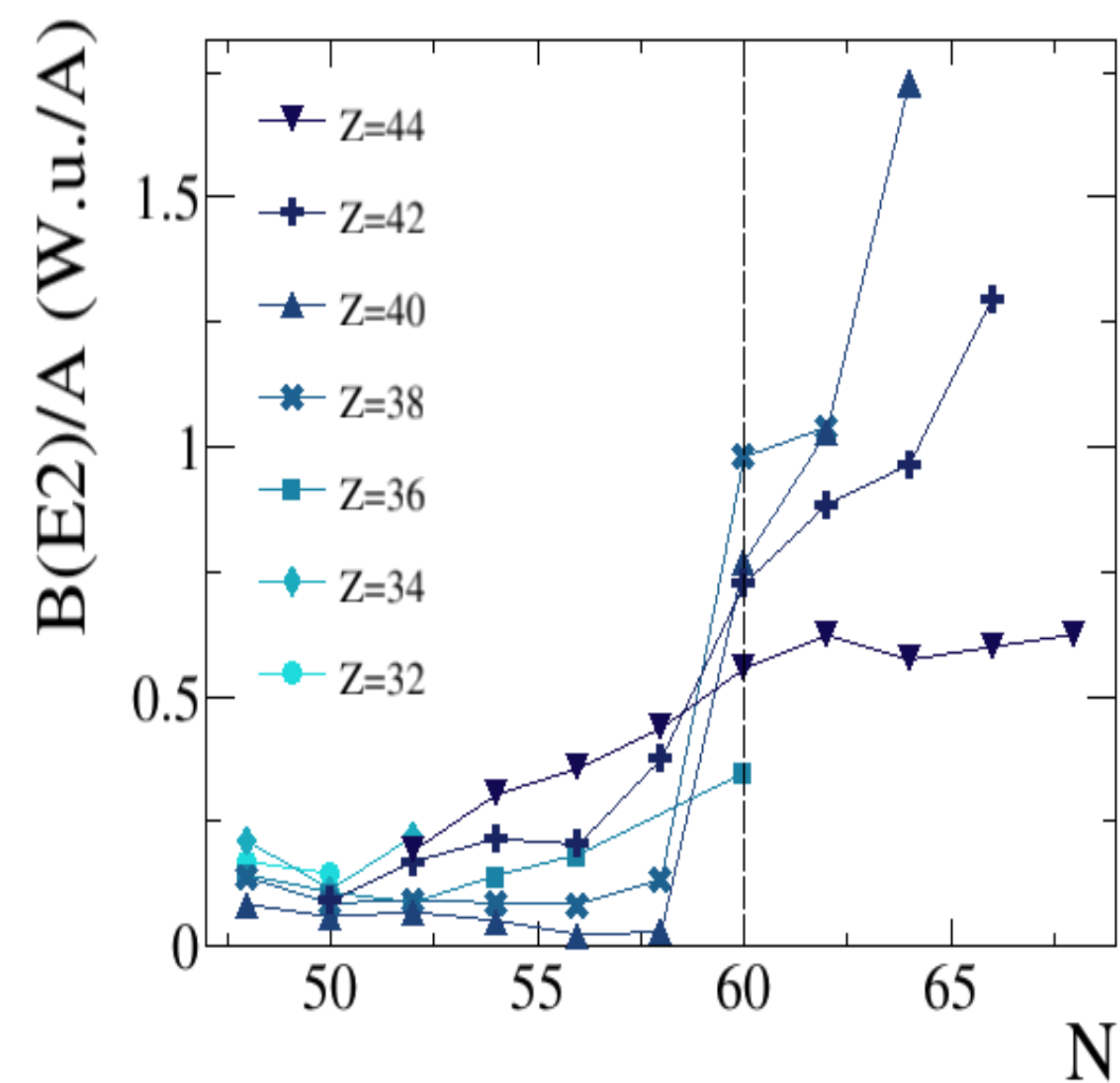
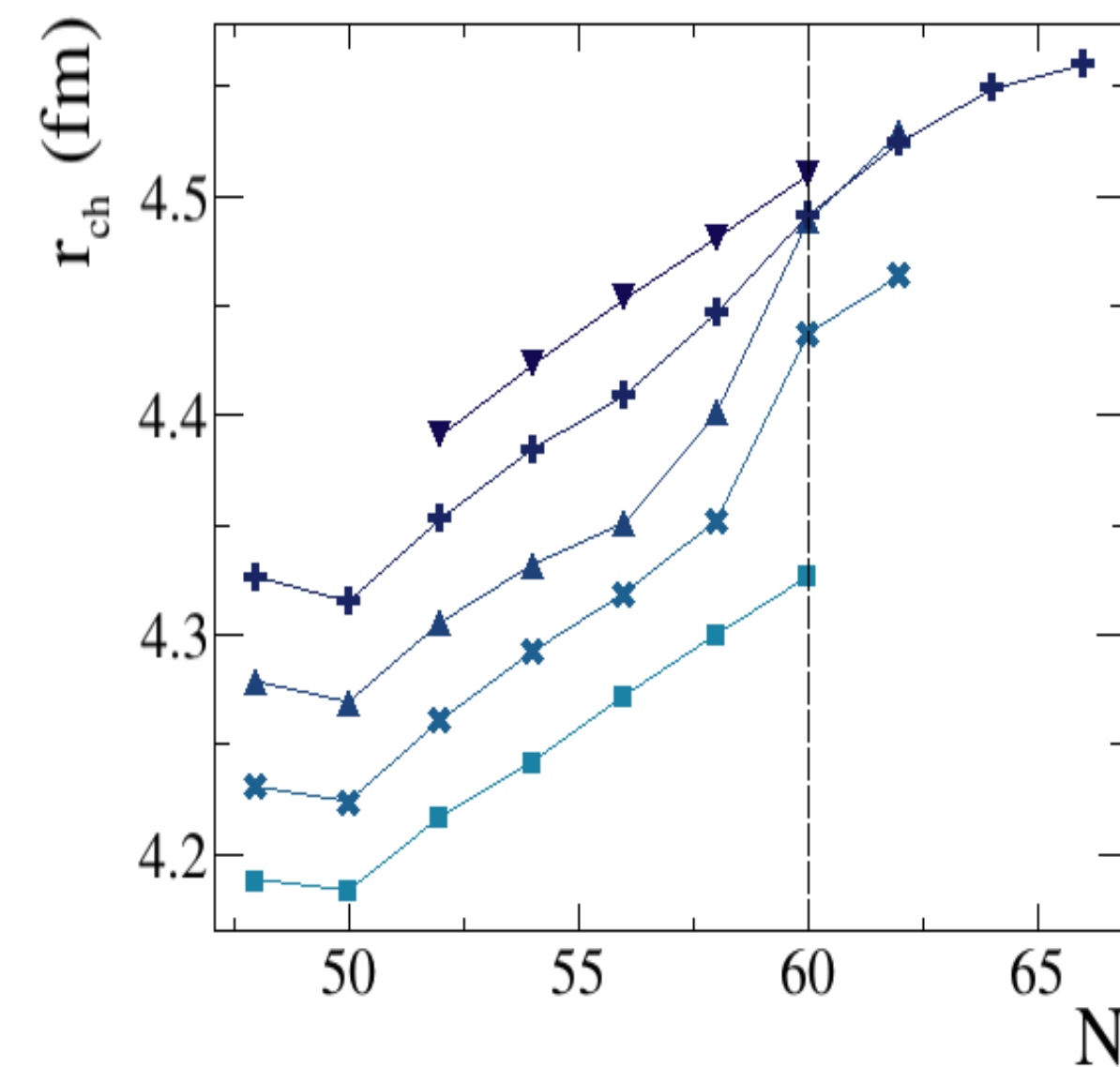
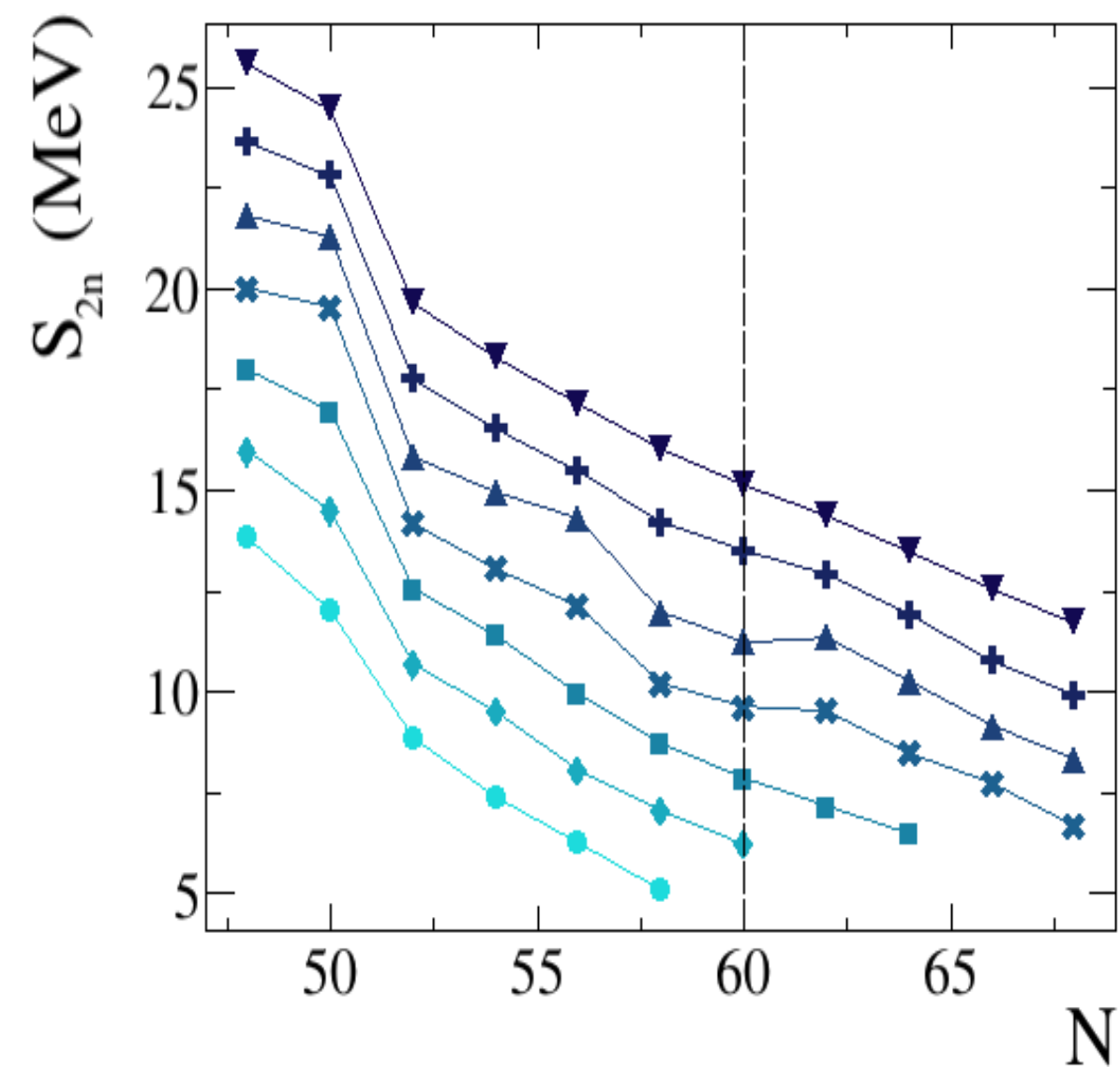
  nn.draw();
}
```



Or more complex examples  
(from [tkn.in2p3.fr](http://tkn.in2p3.fr))

Representation of the N=60 island of  
deformation linking:

- two neutron separation energies
- charge radius
- $B(E2: 2^+ \rightarrow 0^+)$  in W.u./A
- $2^+$  state energy





## TkN

- Download and Install
- Use TkN in your project
- Data sources
- Programs
- Release notes
- TkN user guide
- Modules
- Classes
- Examples
- Gallery



Toolkit for Nuclei (TkN) is a C++ library providing an easy and fast access to a large variety of nuclear data measurements. It allows for example to access to ground state properties, level excited states energies and decay characteristics.

TkN can be used linked with ROOT, allowing to explore the TkN database interactively in the ROOT prompt terminal. It can also be compiled without any dependencies for lighter integration in simulation codes or theoretical nuclear models.

The source code is available on [GitLab](#).

## TkN Talks

- [Open Science practices in Nuclear Physics, 5-6 December 2022, online](#)

## License and references

The TkN project is governed by the CeCILL-B license under French law and abiding by the rules of distribution of free software. You can use, modify and/or redistribute the software under the terms of the CeCILL-B license as circulated by CEA, CNRS and INRIA at the following link [www.cecill.info](http://www.cecill.info).

When citing TkN, please use the DOI specific to your TkN version available on Zenodo [DOI 10.5281/zenodo.10255692](https://doi.org/10.5281/zenodo.10255692).

All the references used by TkN ([PubChem](#), [X-RAY DATA BOOKLET](#), [IAEA-NDS](#), [NUDAT3](#), [ENSDF](#), [XUNDL](#)) are detailed in the [Data sources section](#).

## Contacts

- A **TkN users channel** is available on the [IN2P3's Rocket.Chat](#). To join it, please send a request by mail to the developer team
- [Join the mailing list to be informed on any release or updates regarding the TkN project: TkN mailing list](#)





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# The toolkit for nuclei library (TkN): a C++ interface to nuclear databases



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### ◆ get\_decays\_up()

```
vector< shared_ptr< tkdecay > > get_decays_up ( )
```

inline

return a vector of tkdecay containing the upward decays

Definition at line 111 of file [tklevel.h](#).

### ◆ get\_energy()

```
double get_energy ( const tkunit_manager::units_keys _unit = tkunit_manager::units_keys::keV ,
                   bool _with_offset = false
                   )
```

returns the energy in keV by default

#### Parameters

**\_unit** unit of the returned result. keV is used by default  
**\_with\_offset** if energy known only relatively to an offset, returns the relative energy

This method returns the level energy in unit of `_units`. If the level is only known relatively to an offset value (ex: E=X, or E=X+100), a nan is returned if the option `_with_offset` is not specified. Use in this case [get\\_offset\\_bandhead\(\)](#) to obtain the band ground state (X) If the option `_with_offset` is defined, the relative energy is returned (0. or 100 in the previous example)

Definition at line 111 of file [tklevel.cpp](#).

### ◆ get\_energy\_measure()

```
shared_ptr< tkmeasure > get_energy_measure ( )
```

inline

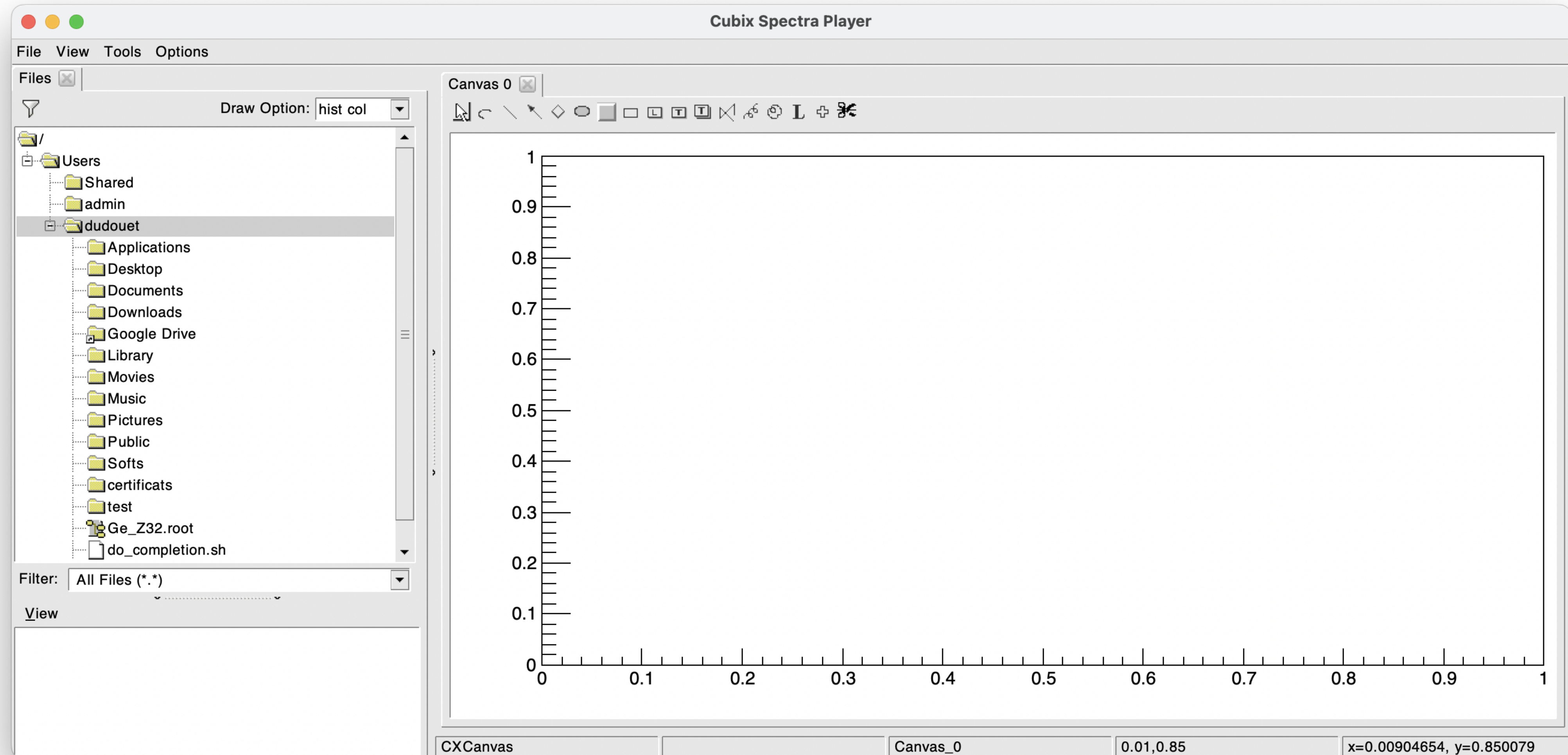
returns the energy tkmeasure object

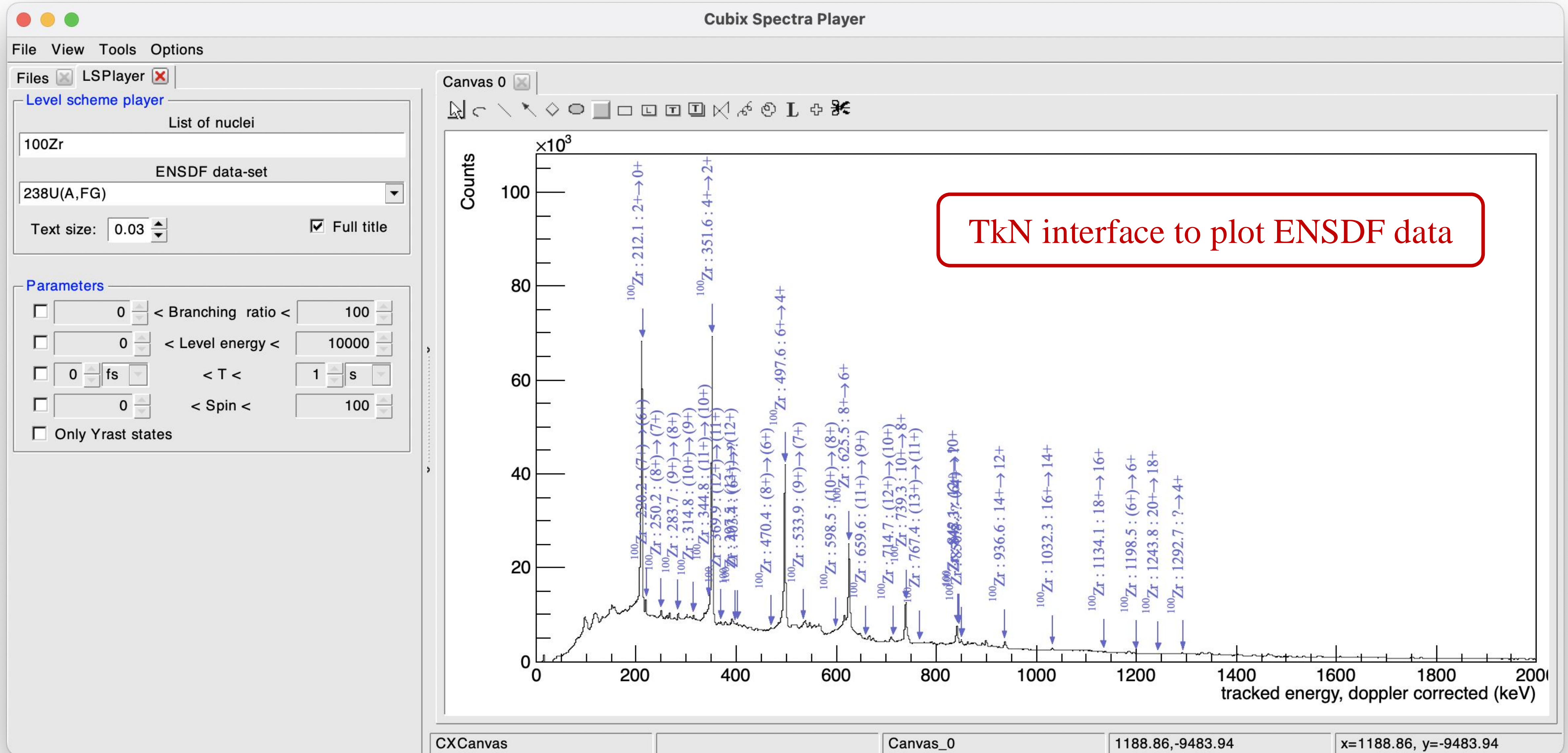
Definition at line 87 of file [tklevel.h](#).

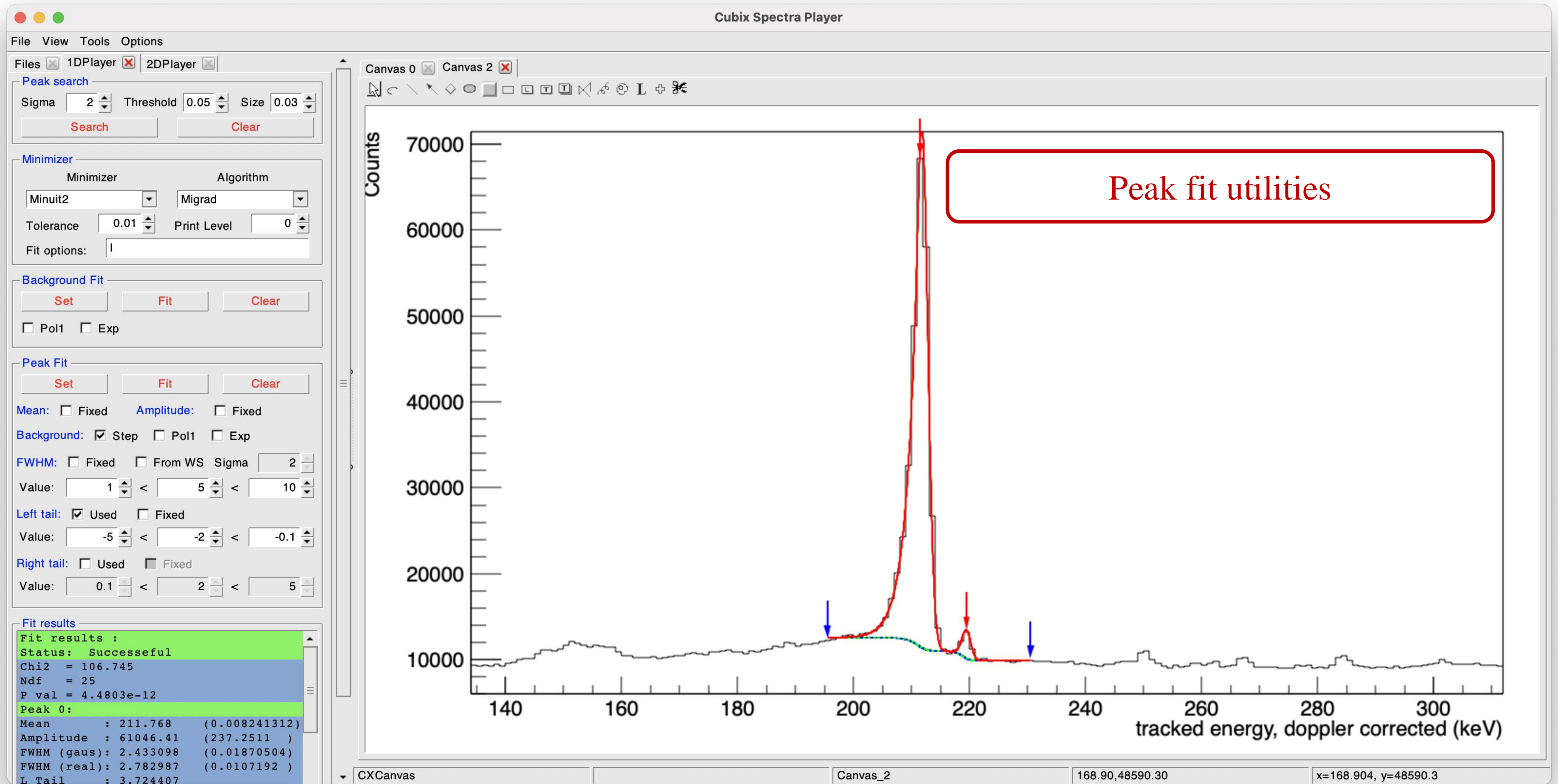
### ◆ get\_isomer\_level()

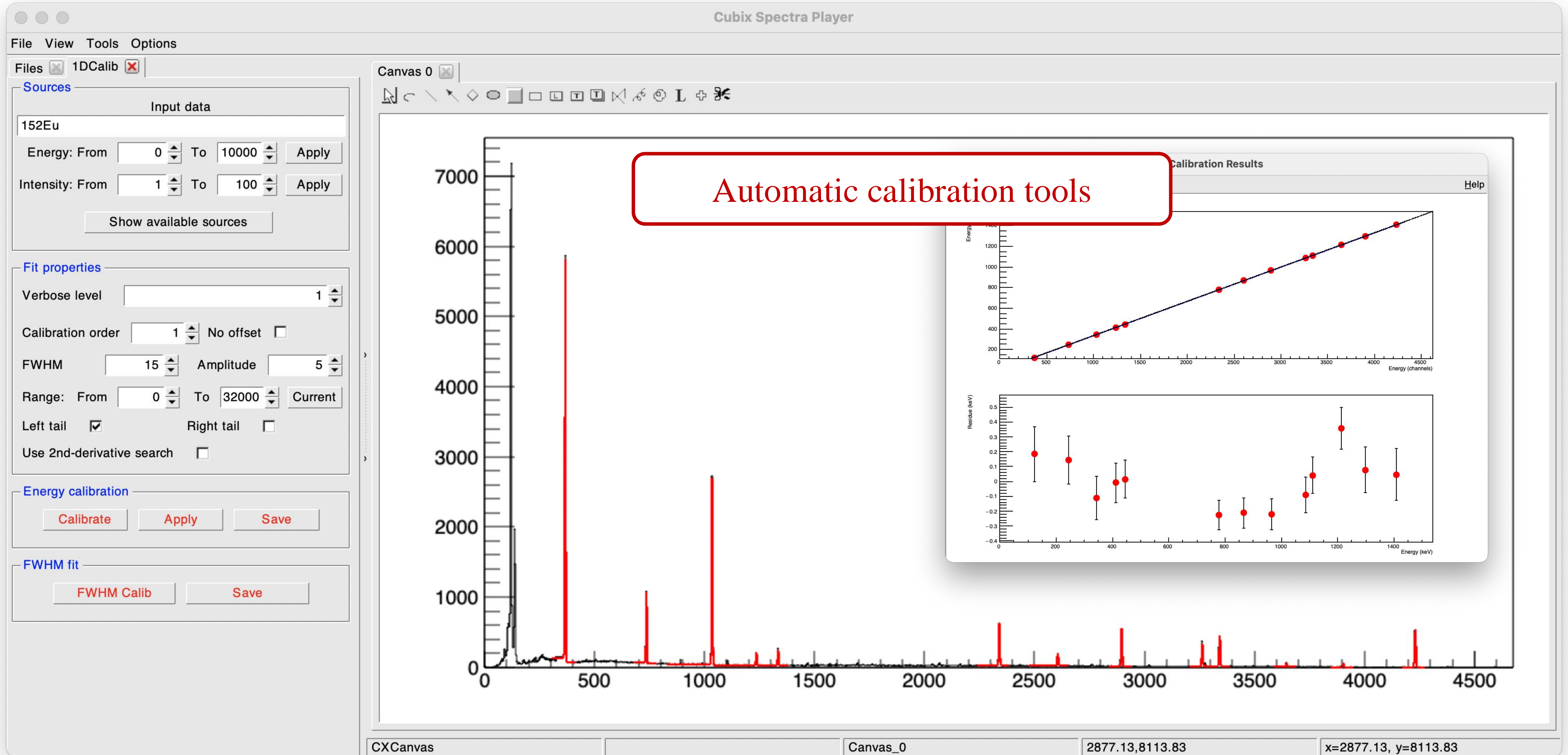


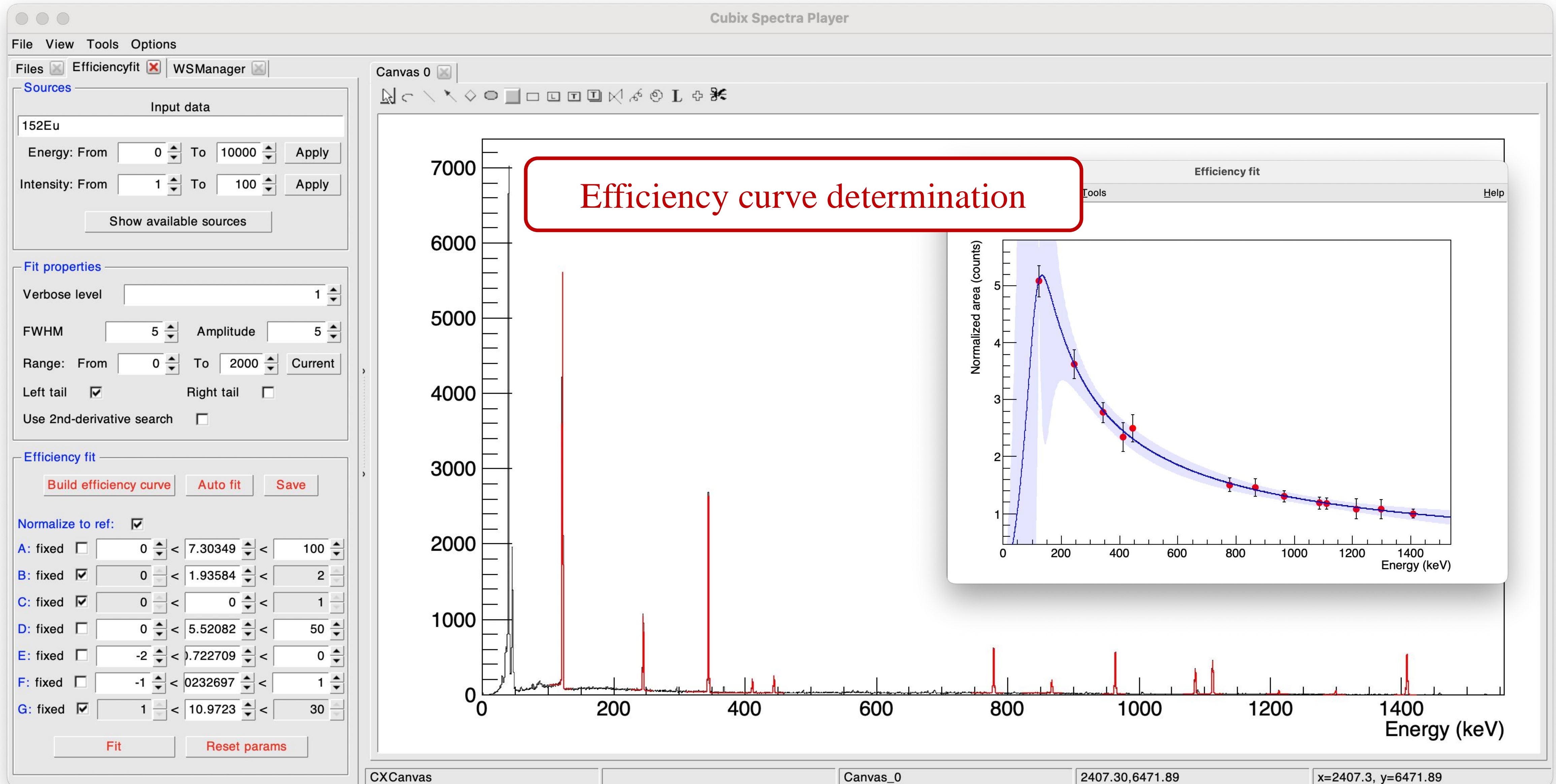
# The Cubix software

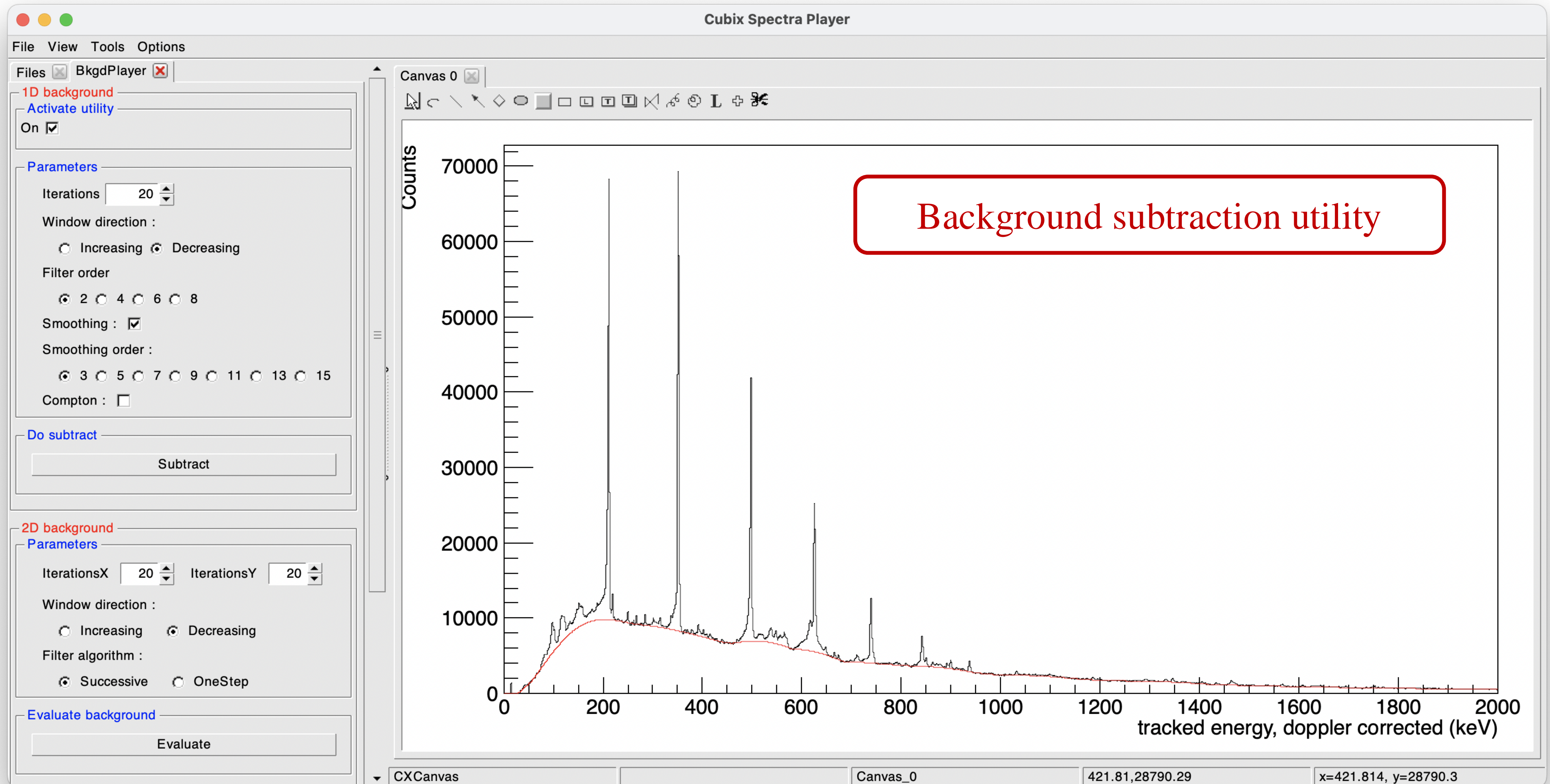




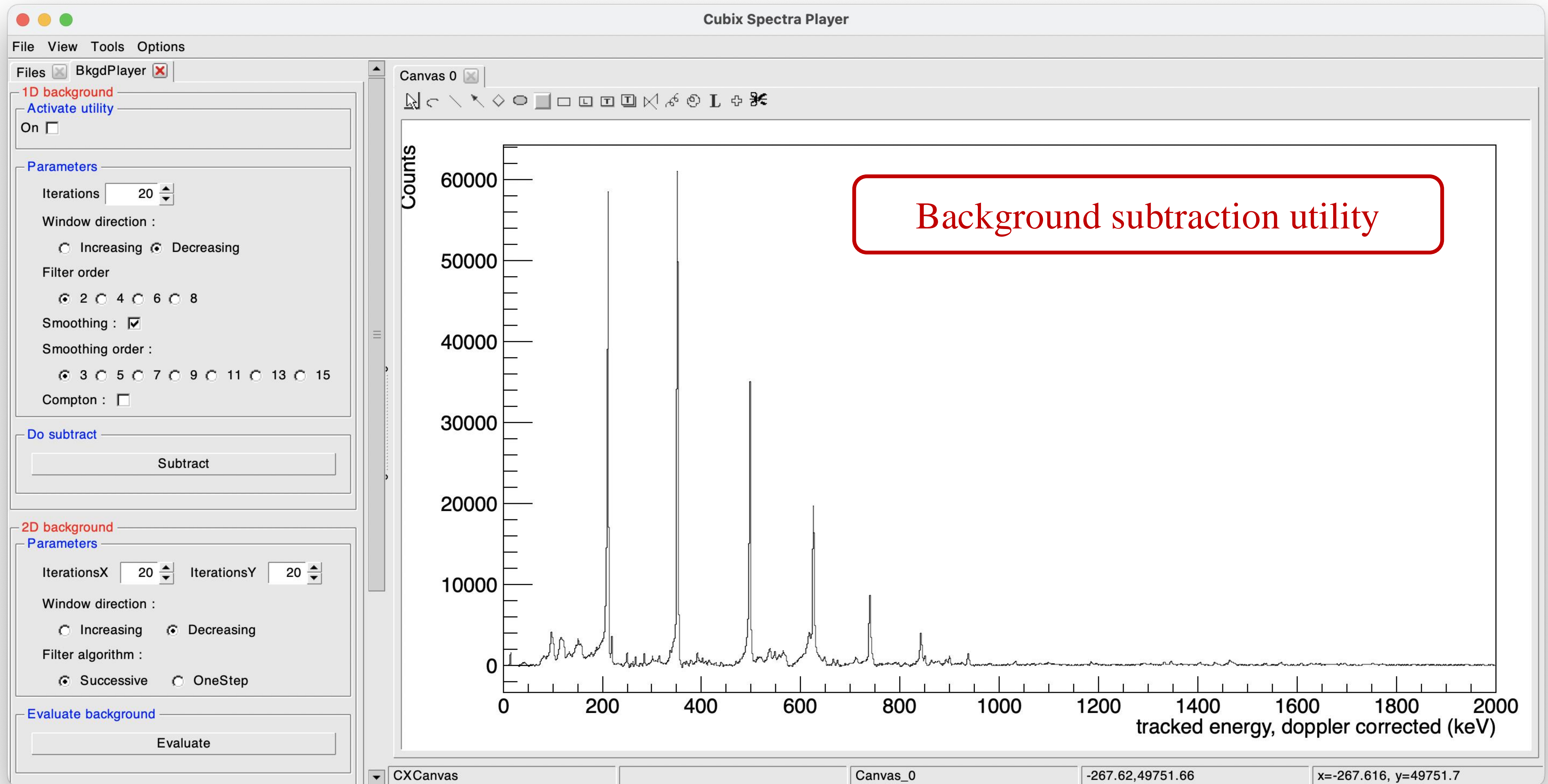


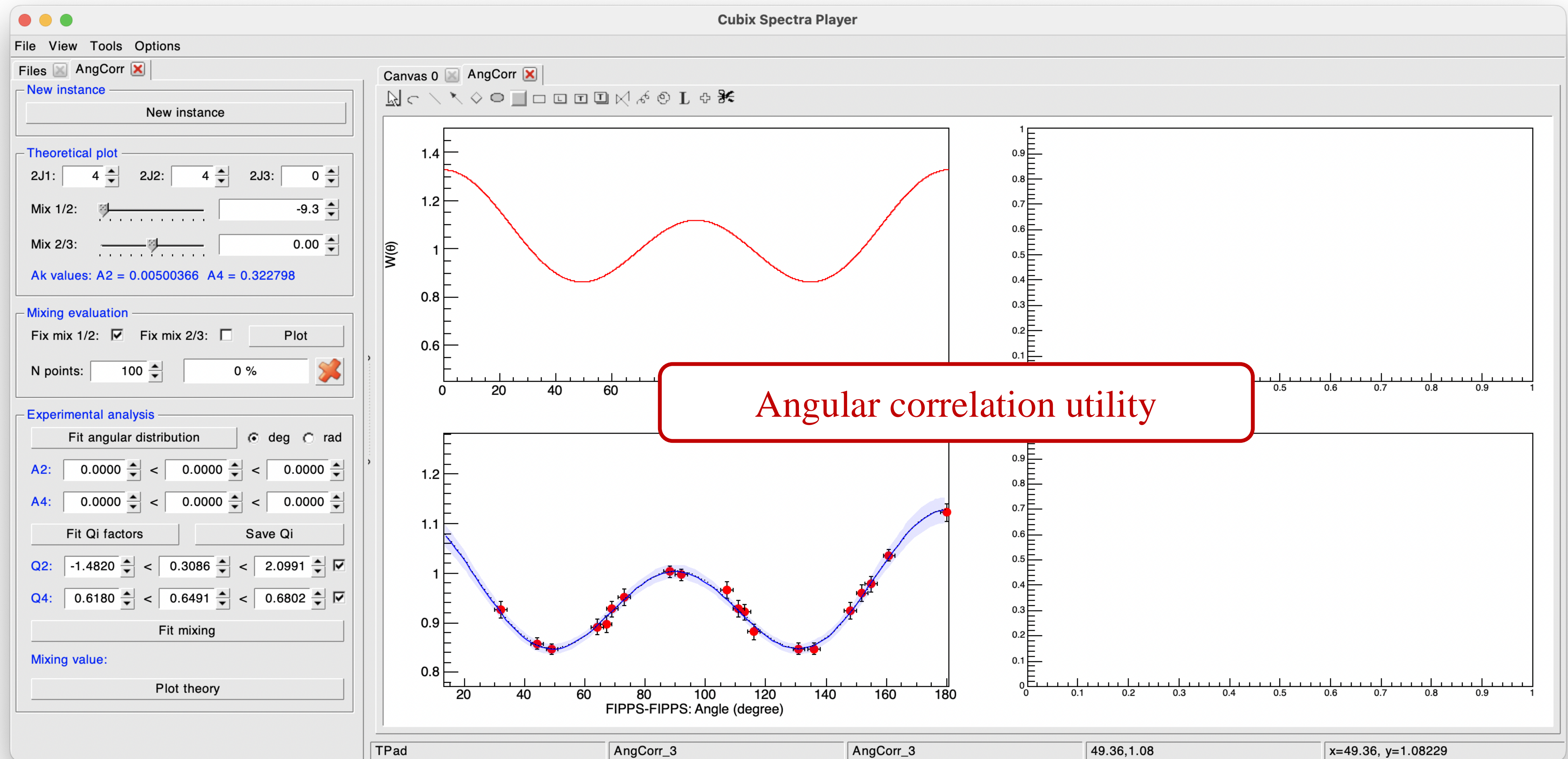


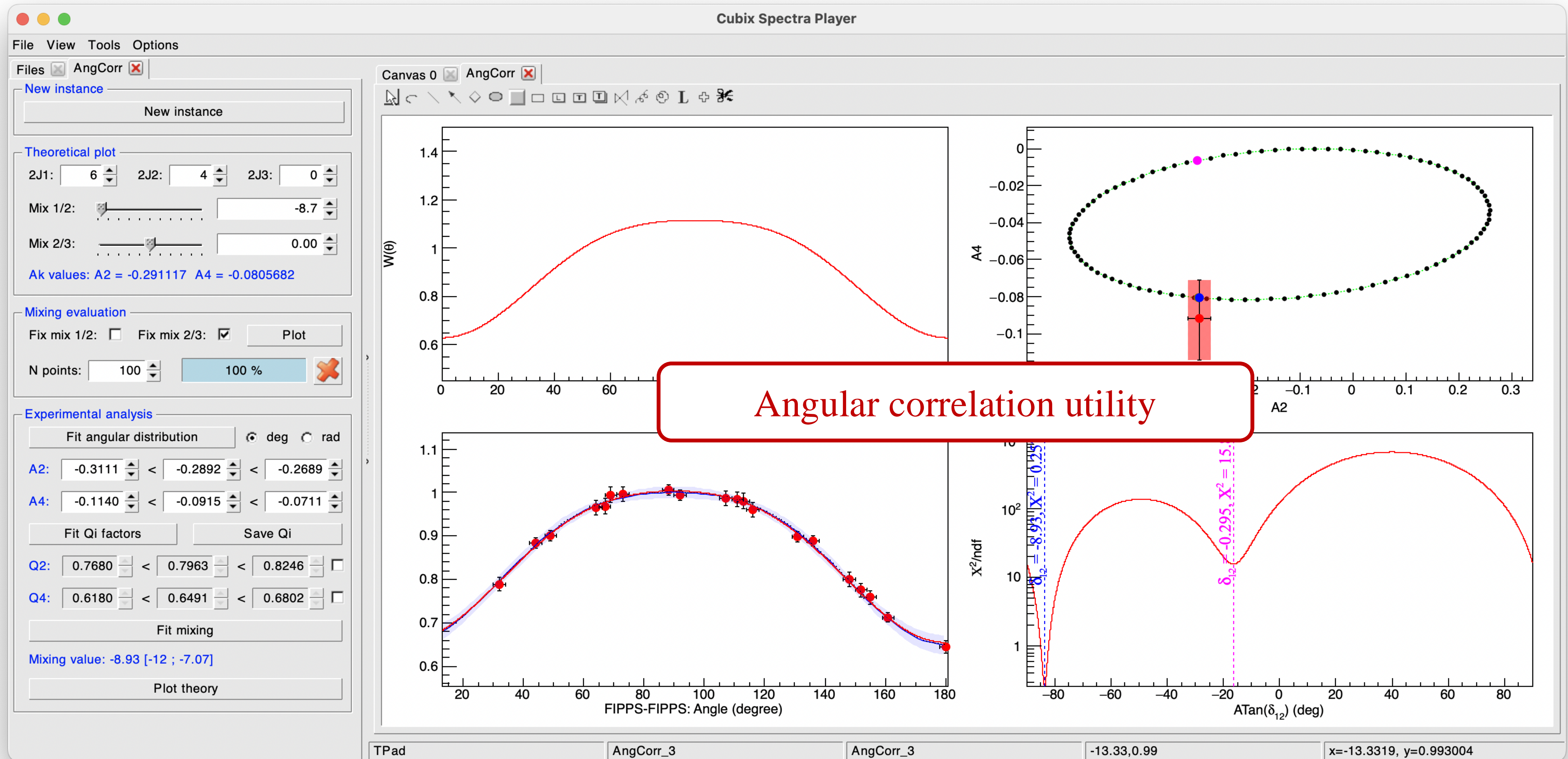


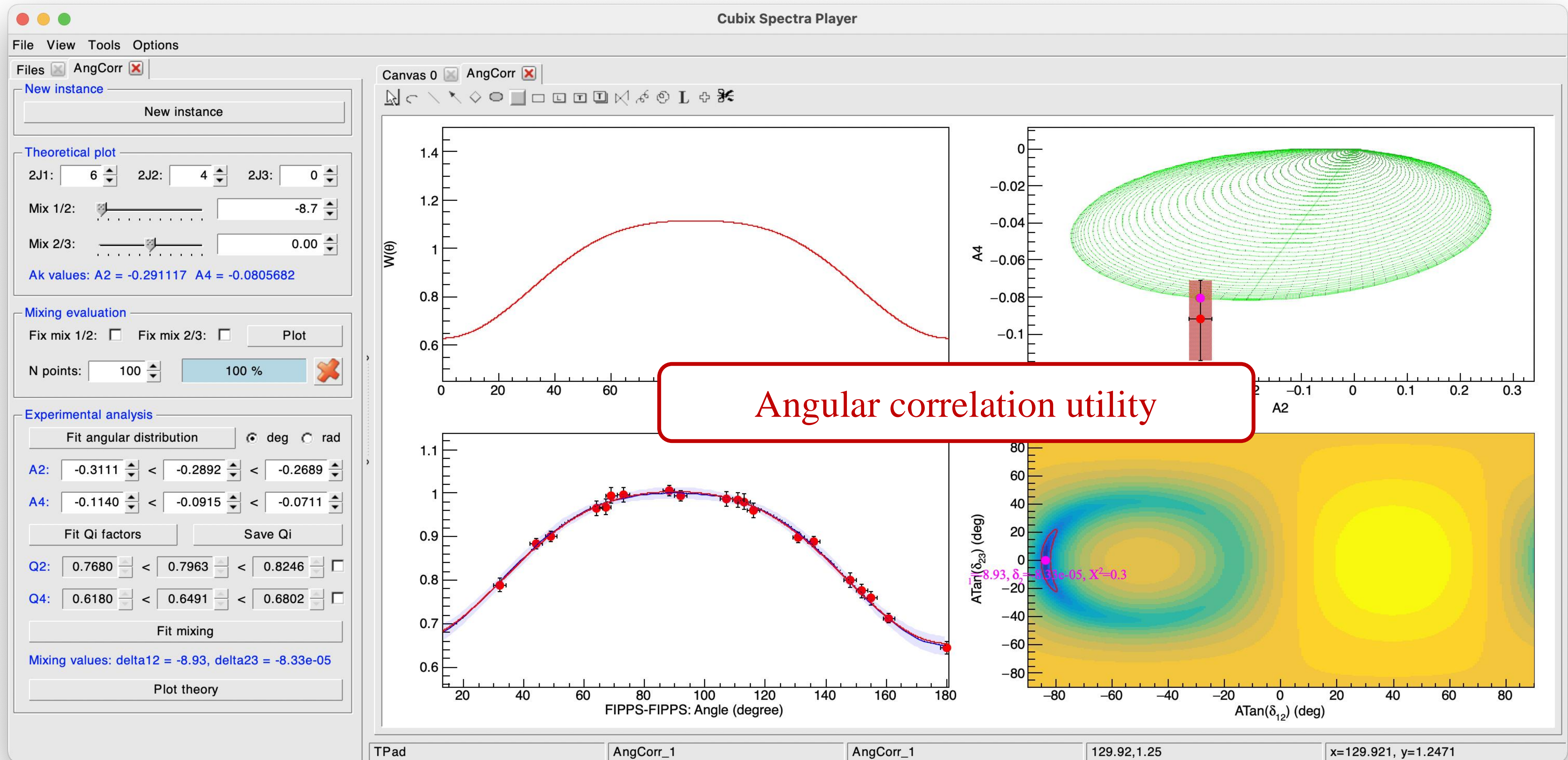


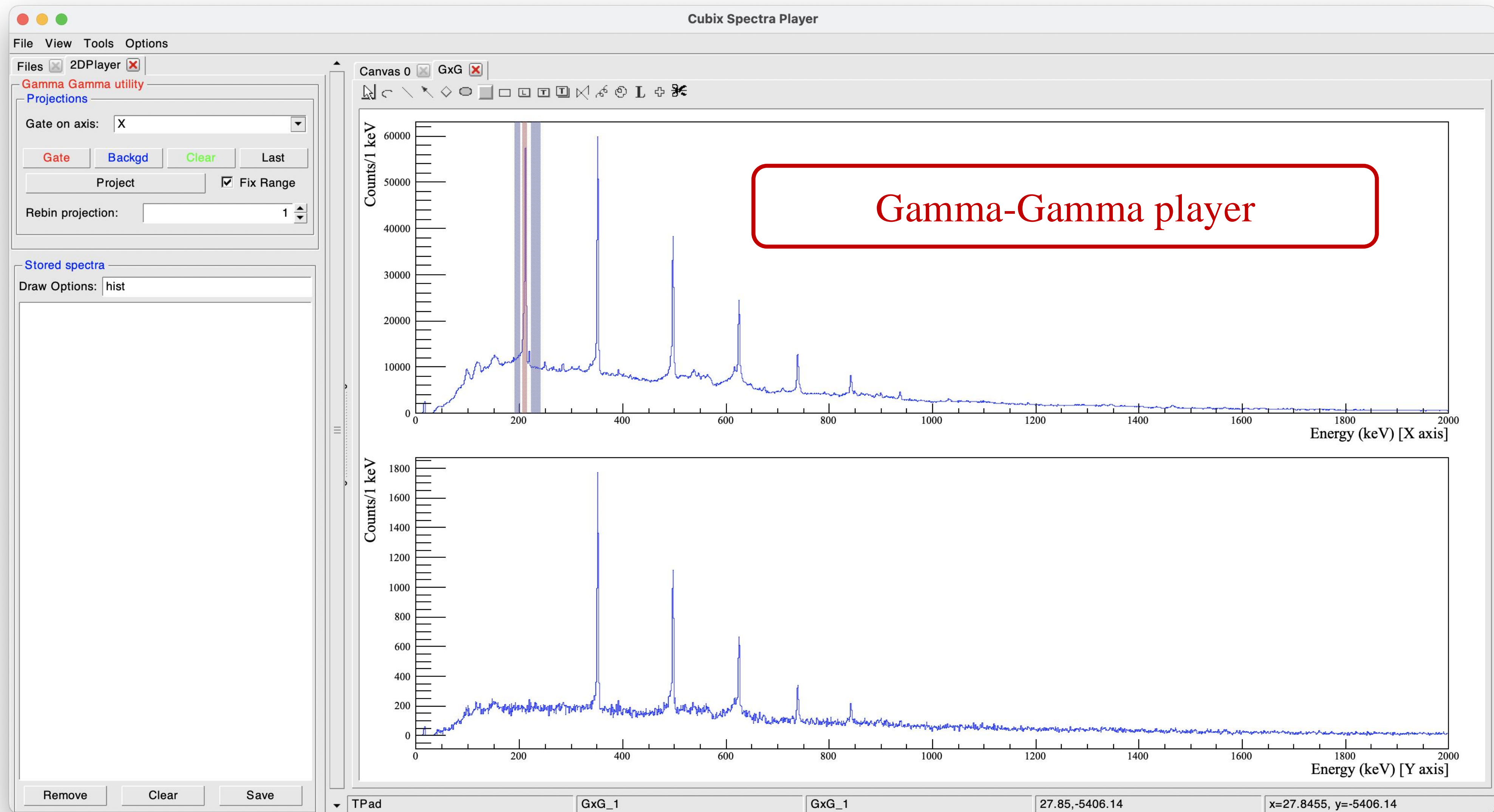




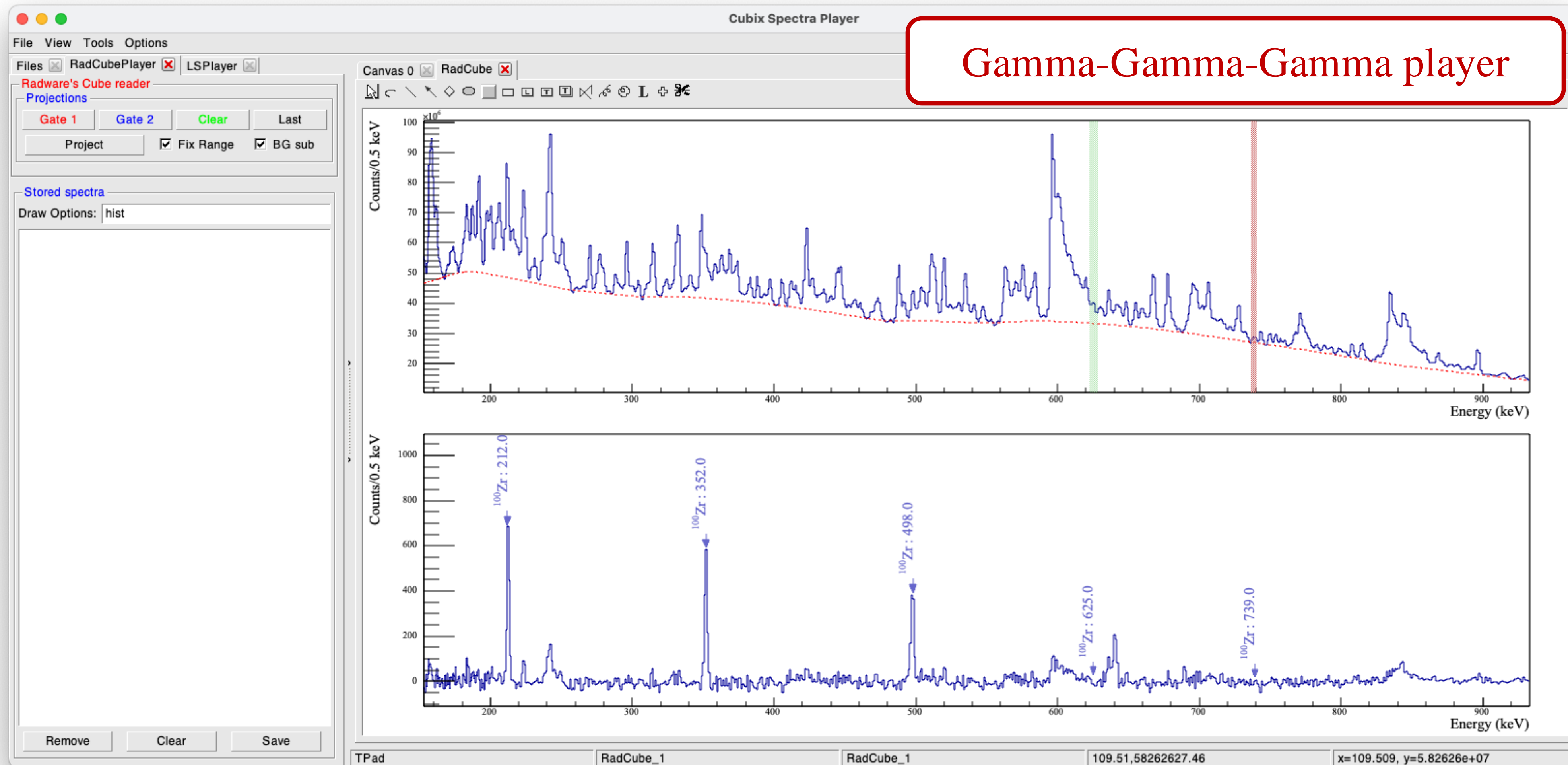








Gamma-Gamma-Gamma player



GammaSearch

**Input Gammas rays**

	Energy (keV)	Width (keV)
<input checked="" type="checkbox"/>	212.0	1.0
<input checked="" type="checkbox"/>	352.0	1.0
<input type="checkbox"/>	500.0	1.0

**Selected range**

28 < Z < 50

20 < N < 82

48 < A < 132

**Gamma search**

Start

Only Gammas

In Coincidence

**Results**

Analysed nuclei: 782  
Analysed gamma rays: 64362

<b>72Ga (Z=31, A=72, N=41)</b>
=> 212.2 keV : 3-,4- ( 228.9 keV ) --> 2- ( 16.4 keV )
=> 351.5 keV : 2+,3+ ( 600.8 keV ) --> 3-,4- ( 248.9 keV )
<b>76As (Z=33, A=76, N=43)</b>
=> 211.1 keV : (4)- ( 211.1 keV ) --> 2- ( 0.0 keV )
=> 352.4 keV : (3)- ( 352.4 keV ) --> 2- ( 0.0 keV )
<b>83Rb (Z=37, A=83, N=46)</b>
=> 211.2 keV : 13/2- (2313.5 keV) --> 13/2- (2101.7 keV)690 fs
=> 352.6 keV : 29/2+ (5316.1 keV) --> (27/2+) (4963.5 keV)236 fs
<b>100Zr (Z=40, A=100, N=60)</b>
=> 212.6 keV : 2+ ( 212.6 keV ) --> 0+ ( 0.0 keV)574 ps
=> 352.0 keV : 4+ ( 564.6 keV ) --> 2+ ( 212.6 keV)37 ps
=> 353.0 keV : 4+ (1414.8 keV) --> 6+ (1061.9 keV)
=> 352.3 keV : (5+) (2208.4 keV) --> 4(+) (1856.1 keV)
<b>96Tc (Z=43, A=96, N=53)</b>
=> 211.5 keV : 8+ (1139.0 keV) --> 9+ ( 927.2 keV )
=> 352.2 keV : (10)+ (2214.0 keV) --> (9)+ (1861.7 keV)
<b>99Tc (Z=43, A=99, N=56)</b>
=> 212.9 keV : (5/2-) ( 884.3 keV ) --> 3/2- ( 671.5 keV )
=> 351.6 keV : 31/2+ (5076.5 keV) --> 29/2+ (4724.9 keV)
<b>101Tc (Z=43, A=101, N=58)</b>
=> 212.0 keV : 5/2- ( 500.5 keV ) --> 3/2- ( 288.5 keV )
=> 353.0 keV : ? ( 886.7 keV ) --> 7/2+ ( 533.5 keV )
<b>102Rh (Z=45, A=102, N=57)</b>
=> 213.0 keV : 7+ ( 476.9 keV ) --> (5+) ( 263.8 keV )
=> 352.2 keV : 7(-) ( 730.8 keV ) --> 6(+) ( 378.6 keV )
<b>104Rh (Z=45, A=104, N=59)</b>
=> 211.6 keV : 1-,2- ( 801.6 keV ) --> 1-,2- ( 589.9 keV )

Gamma search utility

GammaSearch

**Input Gammas rays**

	Energy (keV)	Width (keV)
<input checked="" type="checkbox"/>	212.0	1.0
<input checked="" type="checkbox"/>	352.0	1.0
<input type="checkbox"/>	500.0	1.0

**Selected range**

28 < Z < 50

20 < N < 82

48 < A < 132

**Gamma search**

Start

Only Gammas

In Coincidence

**Results**

Analysed nuclei: 782  
Analysed gamma rays: 64362

100Zr : Energy Diff = 0.000

--> 352.0 keV : 4+ ( 564.6 keV ) --> 2+ ( 212.6 keV)37 ps

--> 212.6 keV : 2+ ( 212.6 keV ) --> 0+ ( 0.0 keV)574 ps ,

100Zr : Energy Diff = 849.260

--> 353.0 keV : 4+ (1414.8 keV) --> 6+ (1061.9 keV)

--> 212.6 keV : 2+ ( 212.6 keV ) --> 0+ ( 0.0 keV)574 ps ,

100Zr : Energy Diff = 1643.500

--> 352.3 keV : (5+) (2208.4 keV) --> 4(+) (1856.1 keV)

--> 212.6 keV : 2+ ( 212.6 keV ) --> 0+ ( 0.0 keV)574 ps , Prob = 0.930

113Rh : Energy Diff = 1461.900

--> 351.6 keV : (19/2+) (2025.3 keV) --> (17/2+) (1673.6 keV)

--> 211.7 keV : (9/2+) ( 211.7 keV ) --> (7/2+) ( 0.0 keV)210 ps , Prob = 0.885

Done... 4 corresponding nuclei found

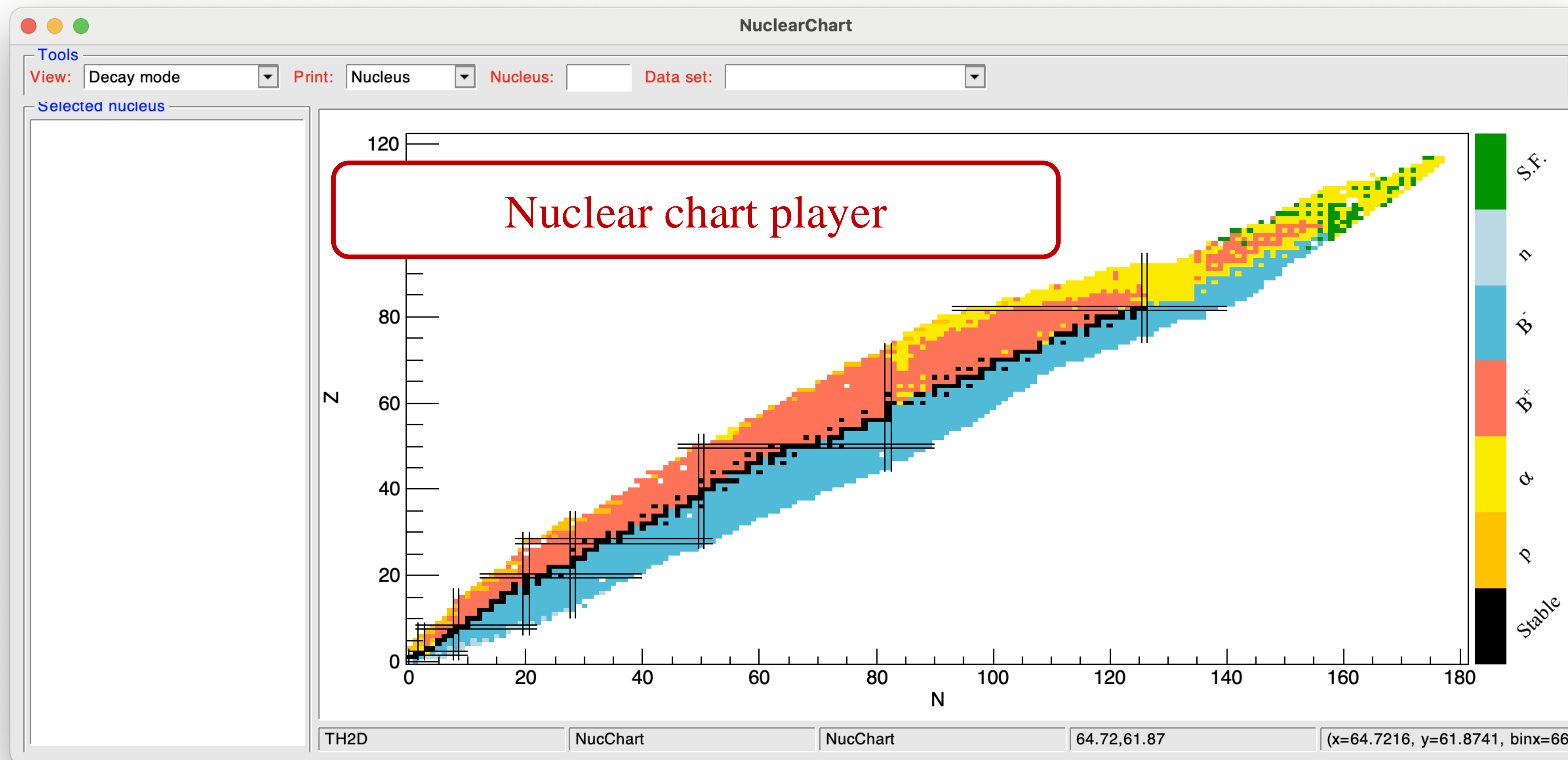
Gamma search utility

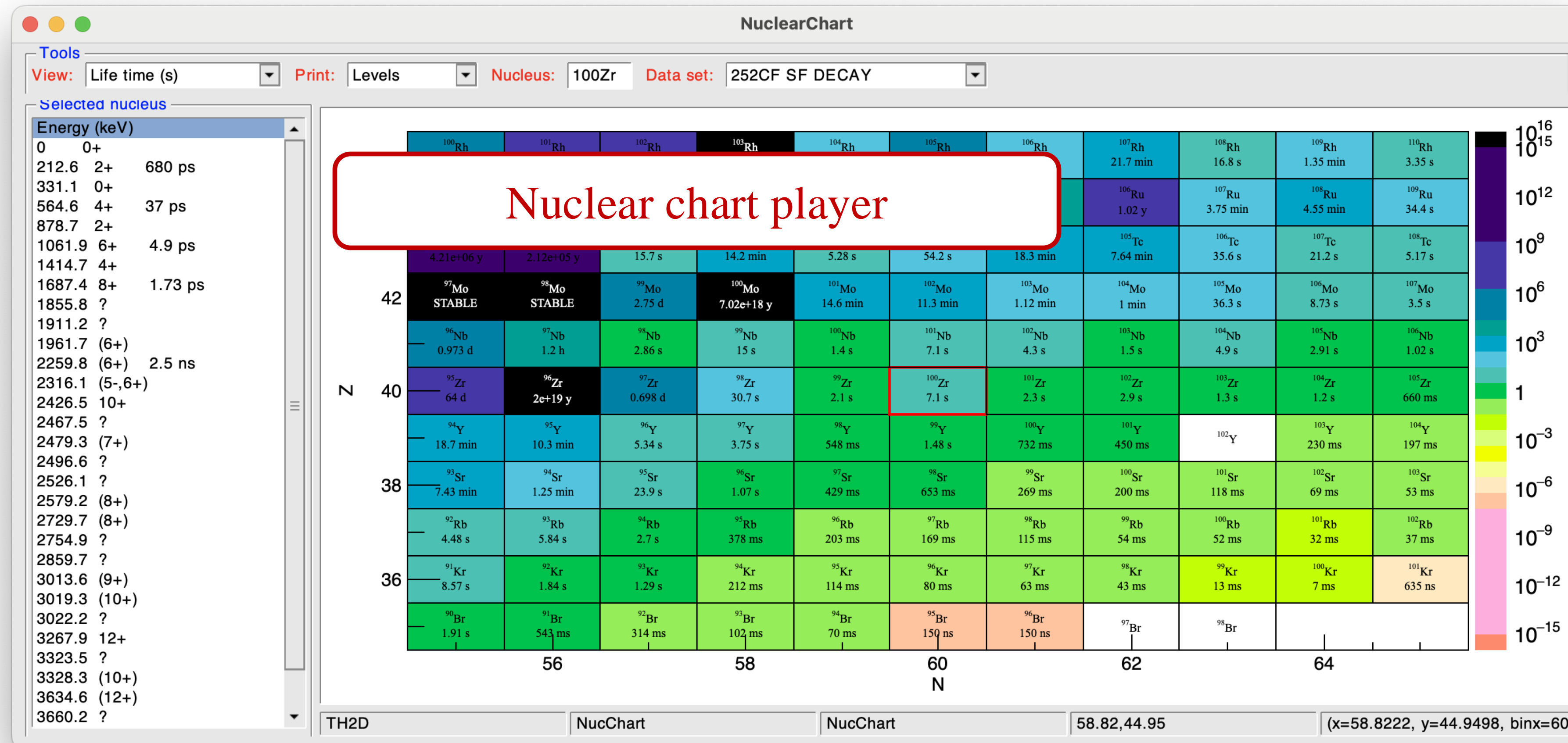
Jérémie Dudouet: [j.dudouet@ip2i.in2p3.fr](mailto:j.dudouet@ip2i.in2p3.fr)

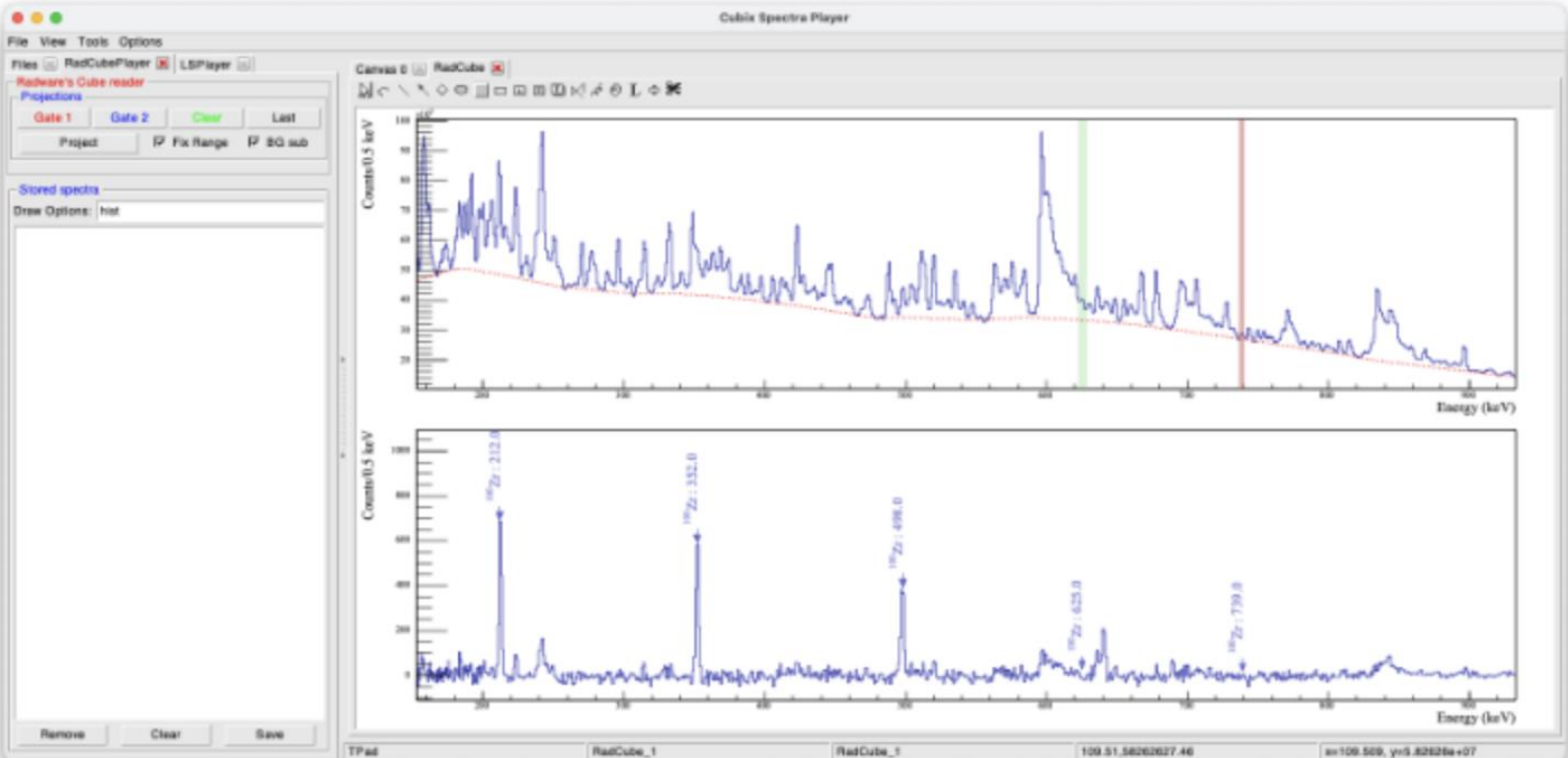
AGATA Analysis School: 17/01/2025, Lyon



The screenshot shows the GammaSearch application window. On the left, there are three sections: 'Input Gammas rays' with three rows of energy and width values (212.0, 352.0, 739.0 keV), 'Selected range' with Z (28-50), N (20-82), and A (48-132) filters, and 'Gamma search' with a 'Start' button and radio buttons for 'Only Gammas' and 'In Coincidence'. The right side shows 'Results' for '100Zr : Energy Diff = 1122.850', listing three decay paths with their respective energies and half-lives. A red-bordered box highlights the text 'Gamma search utility' on the right side of the interface.







Home

## Home

Cubix is a ROOT based graphical interface providing a large number of tools for gamma-ray spectroscopy analysis.

- Table of contents
- License and references
- Contacts
- Contributions
- Cubix developer team

It is linked with the [TkN](#) library to provide a direct access to nuclear databases.

**Full documentation online: [cubix.in2p3.fr](https://cubix.in2p3.fr)**

• fit peaks, perform coincidence analysis, estimate backgrounds

The screenshot shows a web browser window with the URL [https://cubix.in2p3.fr/release\\_notes/](https://cubix.in2p3.fr/release_notes/). The page features a purple header with the CUBIX logo, navigation links (Home, Install, Release notes, User's guide), a search bar, and a GitHub repository link for ip2igamma/cubix. The main content area is titled "Release notes" and lists features to be included in the next versions:

- Multi dimensional analysis:
  - including 4D matrices
- Workspace:
  - Add a tool to save gates associated to a workspace. To re apply easily and quickly the same gate many times
- Angular correlations:
  - Adding an utility to generate from a TTree angular correlation plots using event-mixing normalisation (program already developped for FIPPS data)
- Level scheme:
  - Level scheme utility, to plot existing level schemes or building its own level scheme

Version 1.3: 12/12/2024

Table of contents

- To be included in the next versions
- Version 1.3: 12/12/2024
- Version 1.2: 11/03/2024
- Version 1.1: 27/02/2024
- Version 1.0: 20/02/2024

unreliable)

Full documentation online: [cubix.in2p3.fr](https://cubix.in2p3.fr)

The screenshot shows the homepage of the Cubix project. The browser address bar displays <https://cubix.in2p3.fr>. The website header includes the Cubix logo, a search bar, and a GitHub repository link for `ip2igamma/cubix`. The main content area contains the following text:

The Cubix project is governed by the CeCILL-B license under French law and abiding by the rules of distribution of free software. You can [Back to top](#) or redistribute the software under the terms of the CeCILL-B license as circulated by CEA, CNRS and INRIA at the following link [www.cecill.info](http://www.cecill.info).

If you used Cubix in your published work, please cite it using the DOI specific to your Cubix version available on Zenodo [DOI 10.5281/zenodo.10683241](https://doi.org/10.5281/zenodo.10683241).

**Newsletter**

To be automatically aware of any new development, release notes of material added to the cubix web page, please [register to the cubix newsletter](#)

**Contacts**

- A generic hotline mail can be used for any support related to cubix: [cubix-hotline@ip2i.in2p3.fr](mailto:cubix-hotline@ip2i.in2p3.fr)
- A **Cubix users channel** is available on the [IN2P3's Rocket.Chat](#). To join it, please send a request by mail to the developer team

**Contributions**

Everybody is welcome to participate to the project for adding new tools or improving the existing

**Table of contents**

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- [Cubix developer team](#)

A red rounded rectangle highlights the "Newsletter" and "Contacts" sections. Below the screenshot, a red rounded rectangle contains the text: "Subscribe to the newsletter and use the hotline ;)"