CUBiX

Grid data sync – TkN - Cubix

Jérémie Dudouet

on behalf of the Data Analysis Working Group

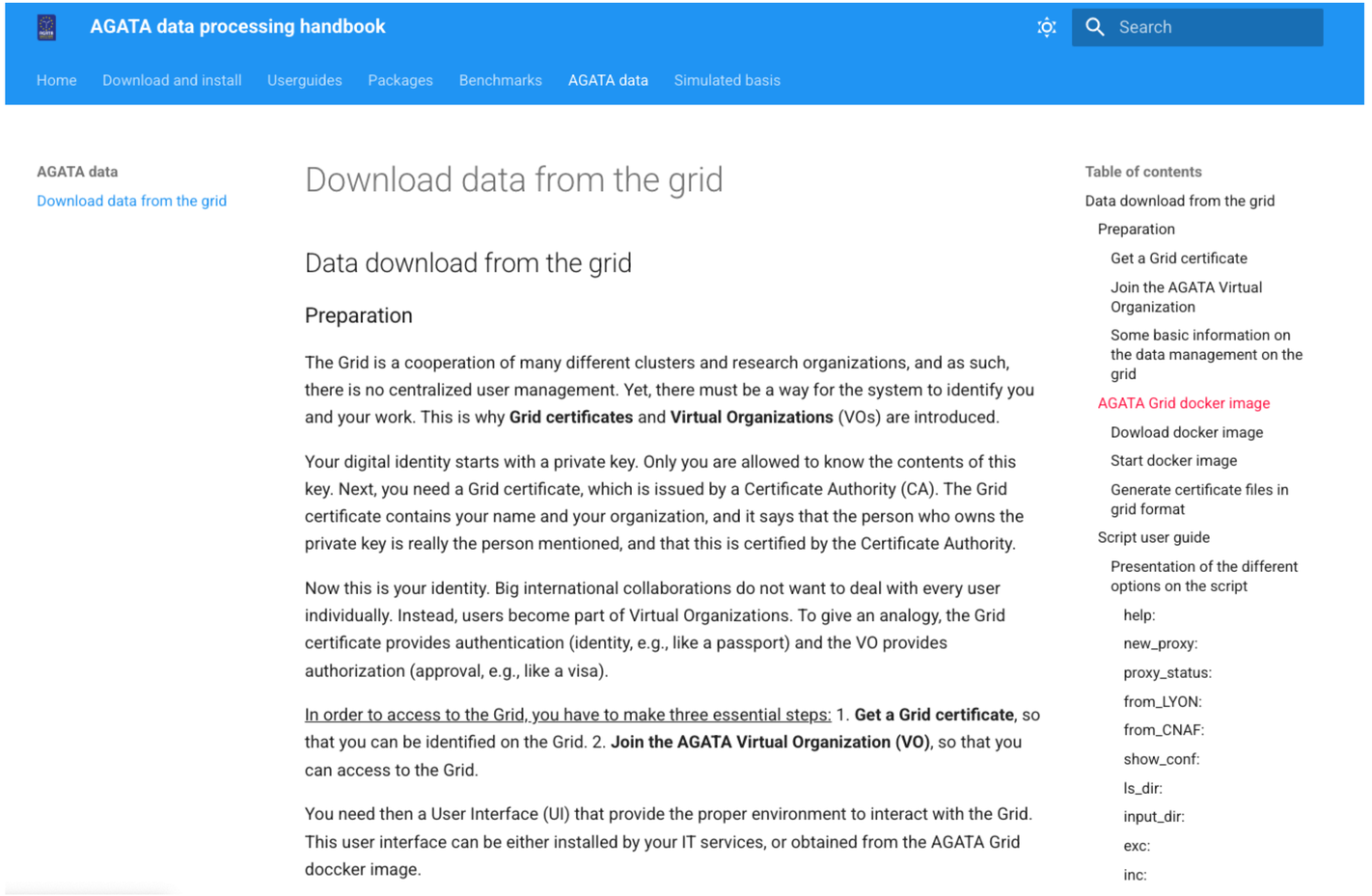
AGATA Analysis School: 17/01/2025, Lyon

The grid script

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

- On LYON CC center
- On Bologna center

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 — 150×29

```
[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 — 150×15

```
[dudouet@lyoserv2:~/GridTests_gfal2$ ./GridDataSync.py --new_proxy

[Enter GRID pass phrase for this identity:
Contacting cclcgvomsli01.in2p3.fr:15007 [/O=GRID-FR/C=FR/O=CNRS/OU=CC-IN2P3/CN=cclcgvomsli01.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 — 150×20

```
[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=cclcgvomsli01.in2p3.fr
attribute : /vo.agata.org/Role=NULL/Capability=NULL
timeleft  : 71:58:49
uri       : cclcgvomsli01.in2p3.fr:15007


dudouet@lyoserv2:~/GridTests_gfal2$
```

Step 2: check the current configuration status

"./GridDataSync.py –show_conf"

- 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 — 154×45

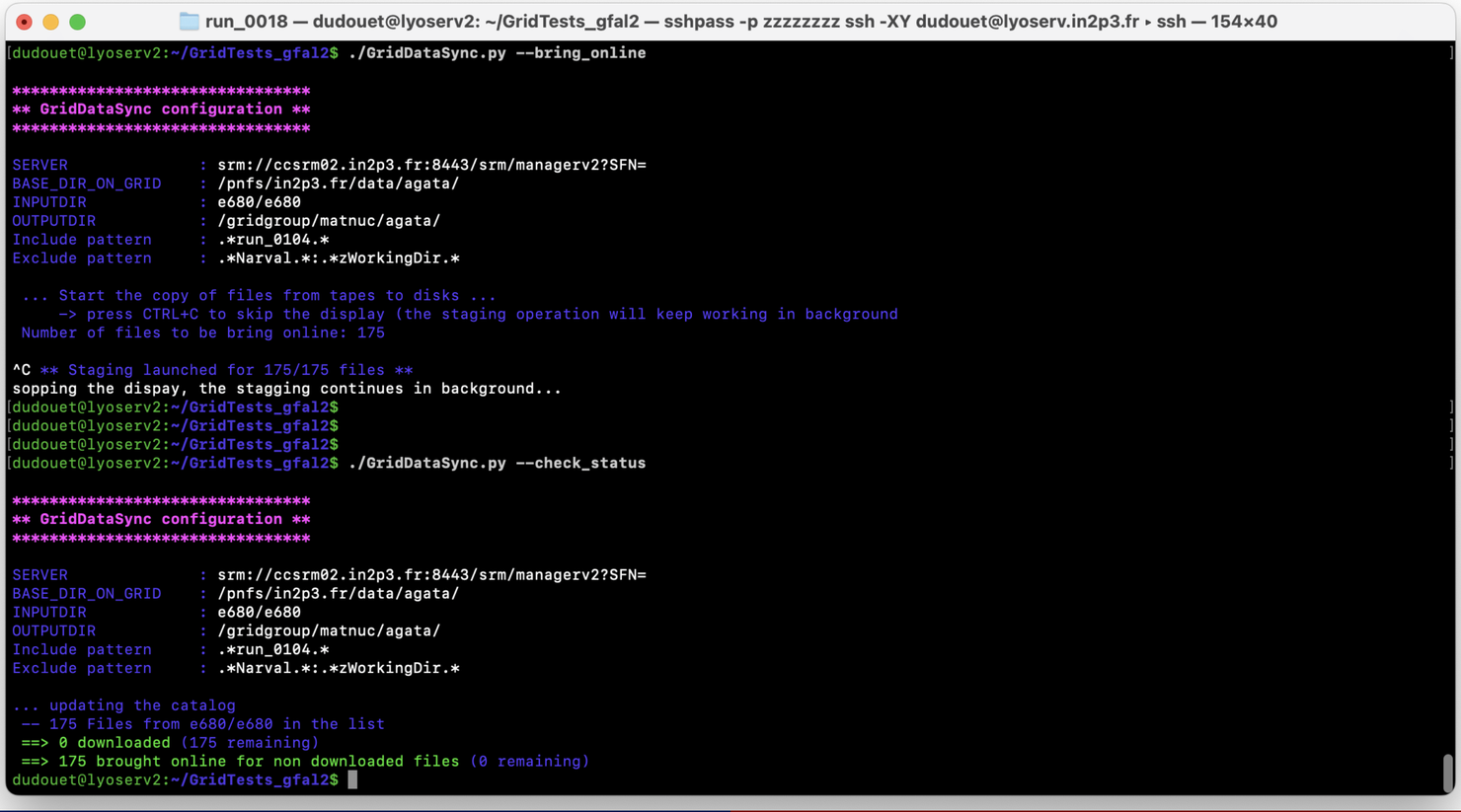
```
=> adding:    3.6 GB e680/e680/run_0104.dat.19-05-15_22h37m08s/Data/12B/SRM_AGATA_event_mezzdata.cdat.0002
=> adding:  160.0 MB e680/e680/run_0104.dat.19-05-15_22h37m08s/Data/12B/SRM_AGATA_event_mezzdata.cdat.0003
=> adding:  310.0 MB e680/e680/run_0104.dat.19-05-15_22h37m08s/Data/12B/SRM_AGATA_psa_0000.adf
=> 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“

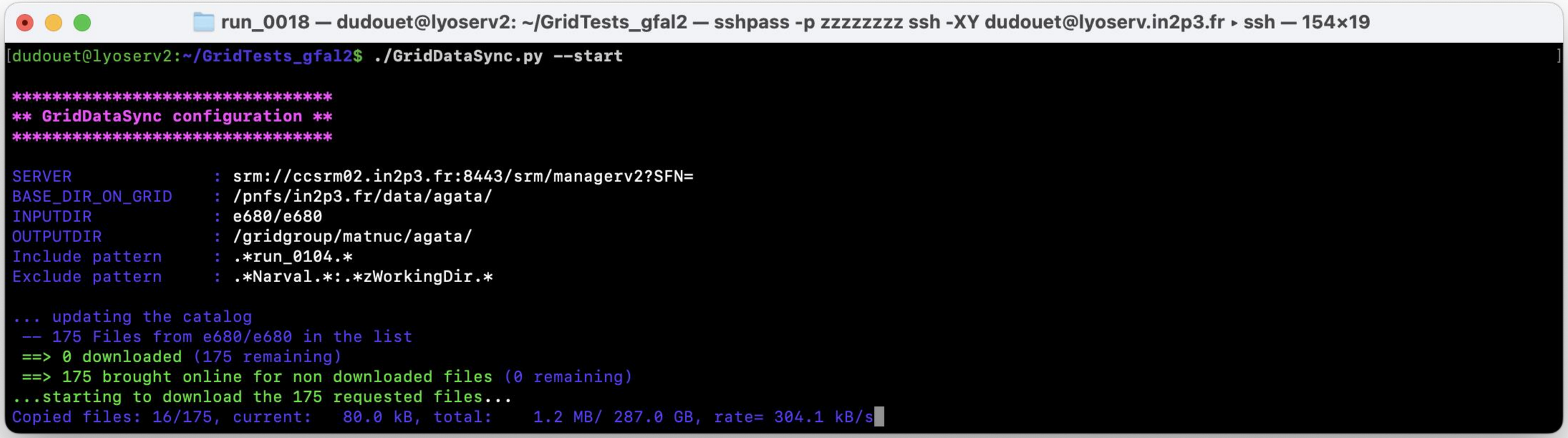
“./GridDataSync.py –check_status“

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



Step 5: data download

"./GridDataSync.py –start"



TkN

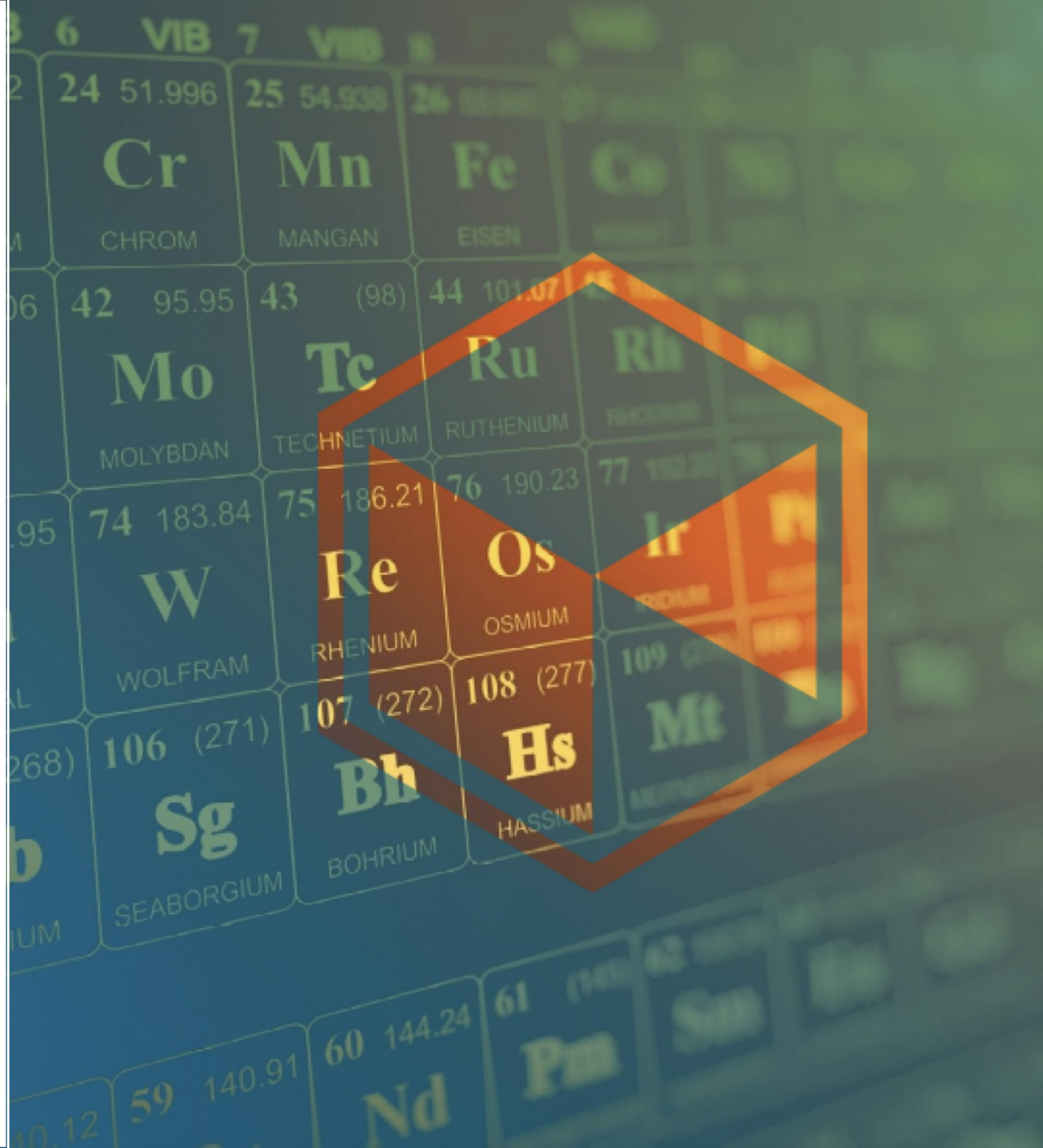
toolkit for nuclei

A C++ interface to nuclear databases

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

tkn.in2p3.fr
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

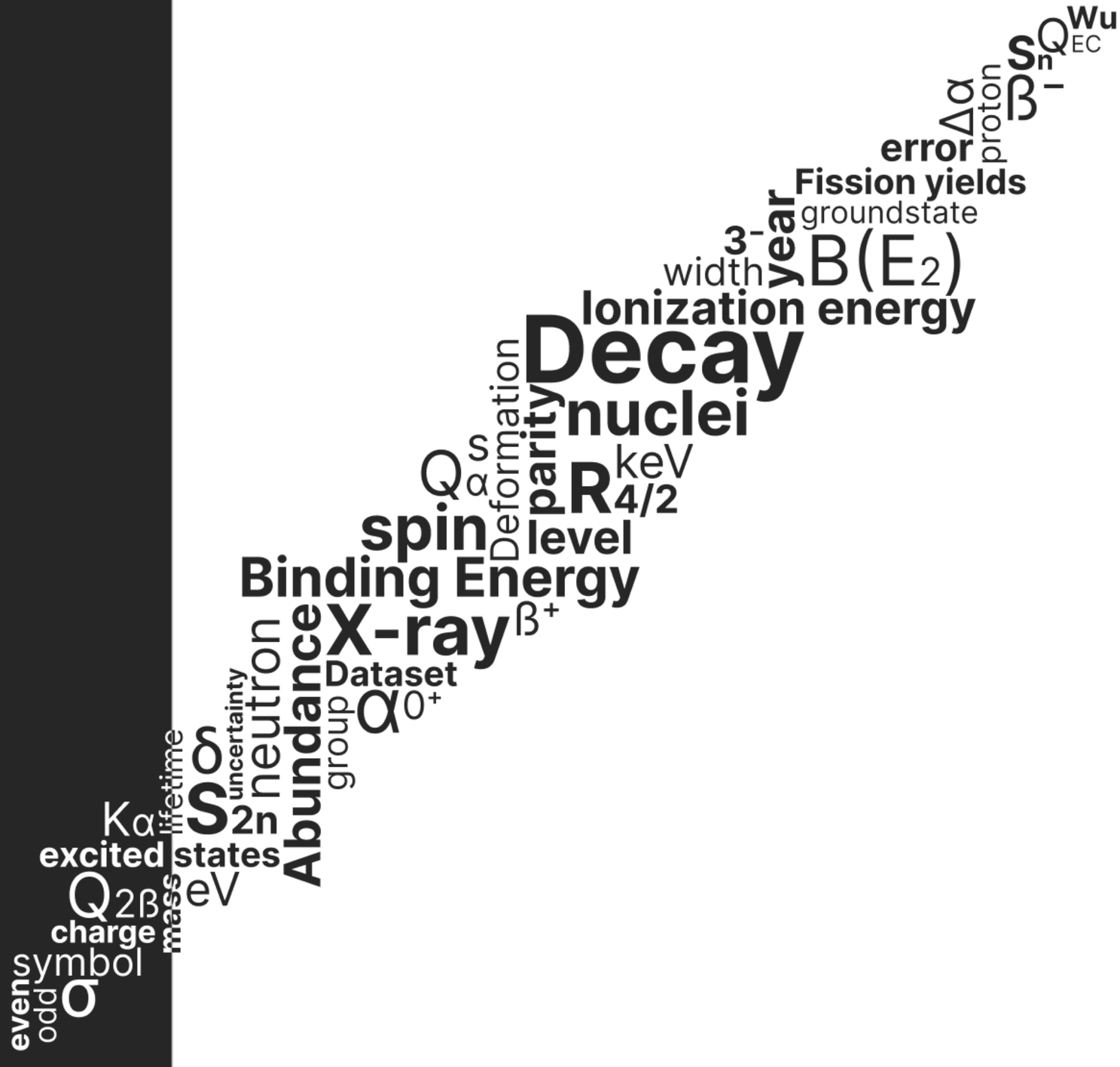
~200 000 excited states

~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=ABDEGHIKMNOPTUWXZacdefijklmopqstuvwxyz123456789
12C   L 4439.82   212+               10.8E-3 EV6
12C 2 L %IT=100 $ ISPIN=0 $MOME2=6 3 (1983Ve01)
12C 3 L XREF=ABDEGHIKMNOPTUWXYacdefijklmopqstuvwxyz12346789
12C  cL E$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 $ %A AP 100
12C 3 L XREF=ABDEGHIJKMNOPTUVWXacdefijklnopqruvwxyz1234789
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 |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 $Decay mechanisms were analyzed in (2017Sm03);
12C 2cL the decay is >99.92% via sequential |a-decay to {+8}Be{-g.s.}
12C 3cL and <0.047% via direct decay into 3|a-particles.
12C 4cL This is relevant for the astrophysical 3|a rate, via detailed balance.
12C 5cL  Also see
12C 6cL (2011Ra43, 2012Ma10, 2012Ki07, 2013Ra20, 2014It01, 2016Mo05, 2017De25)
12C   G 3213.79      100      E2
12C 2 G FL=4439.82
12C 3 G WIDTHG=3.81E-3 EV 39$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.

* 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.

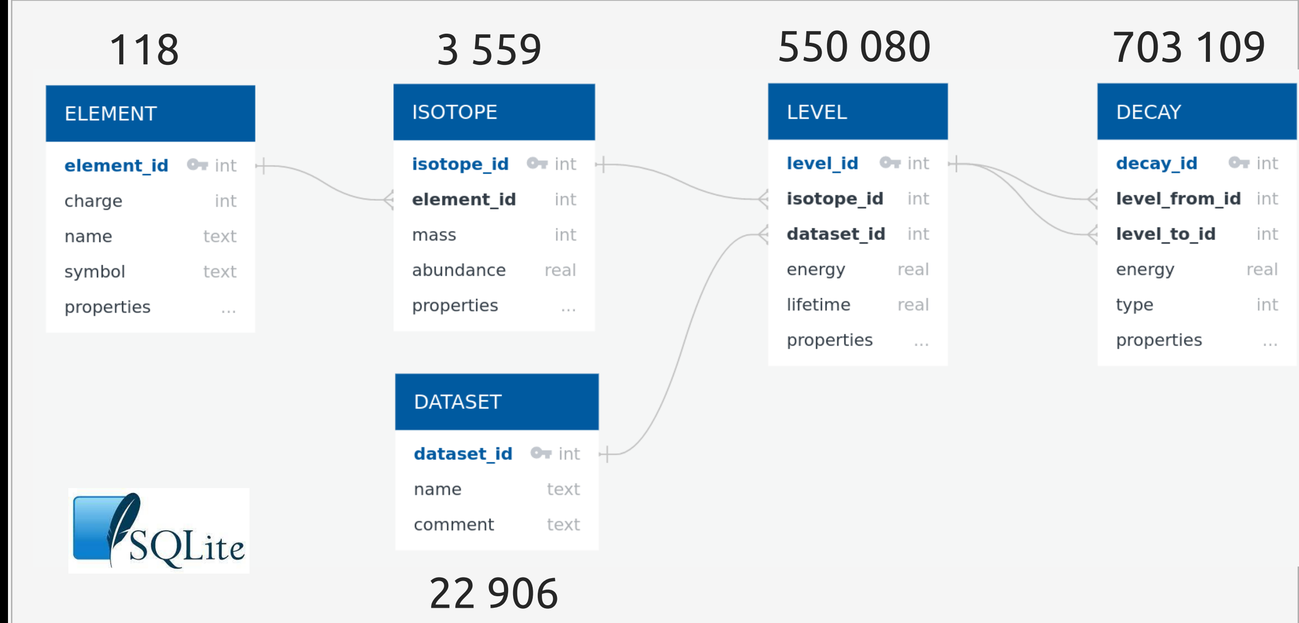
TkN interface
C++ library to access the data and few utility programs. Light, fast, and easy to link or include in other projects. Minimal dependencies. Open source and well documented.

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 (15th of each month)



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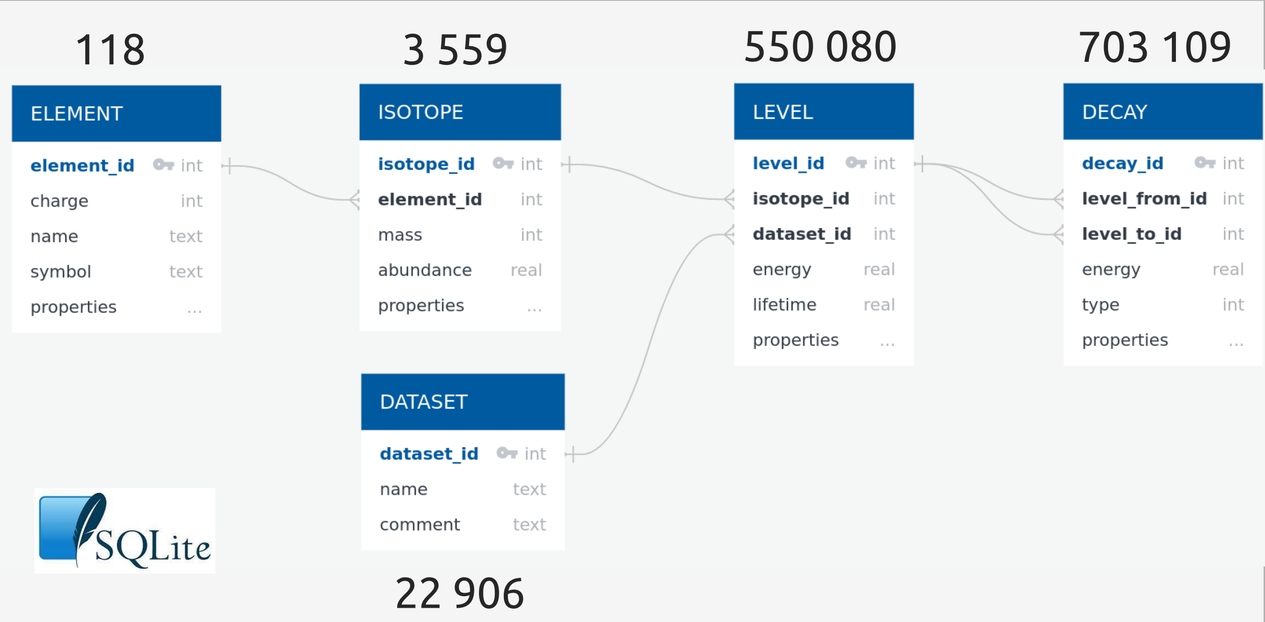


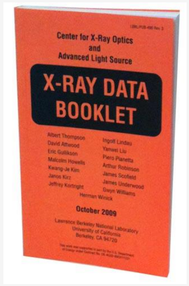
Data sources

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

➥ Full list of properties here : **tkn.in2p3.fr**

PubChem

IAEA API



NuDat 3.0

Performances

Full database read ~ 15s (1rst), 0.02s (2nd)
Extracting randomly 10^8 levels (1 thread) ~ 250s
Extracting randomly 10^8 levels (16 threads) ~ 30s

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 ɣ in current version)

Nuclear decays (only ɣ 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- DECAY (0.200 S) (12588)
[ INFO     ] 132SN IT DECAY (2.080 US) (12589)
[ INFO     ] 133IN B-N DECAY (165 MS) (12590)
[ INFO     ] 248CM SF DECAY (12591)
[ INFO     ] COULOMB EXCITATION (12592)
[ INFO     ] U(N,F):IS,RADIUS:XUNDL-3 (12593)
[ INFO     ] COULOMB EXCITATION:XUNDL-4 (12594)
[ INFO     ] 133IN B-N DECAY:162 MS:XUNDL-5 (12595)
[ INFO     ] 133IN B-N DECAY: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.

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

```
[ INFO     ] Available datasets are :
[ INFO     ] 132Sn : ADOPTED LEVELS, GAMMAS (12587)
[ INFO     ] 132IN B- DECAY (0.200 S) (12588)
[ INFO     ] 132SN IT DECAY (2.080 US) (12589)
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[ INFO     ] 248CM SF DECAY (12591)
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[ INFO     ] 133IN B-N DECAY: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.

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

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

```
[ INFO     ] Available datasets are :
[ INFO     ] 132Sn : ADOPTED LEVELS, GAMMAS (12587)
[ INFO     ] 132IN B- DECAY (0.200 S) (12588)
[ INFO     ] 132SN IT DECAY (2.080 US) (12589)
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[ INFO     ] COULOMB EXCITATION:XUNDL-4 (12594)
[ INFO     ] 133IN B-N DECAY:162 MS:XUNDL-5 (12595)
[ INFO     ] 133IN B-N DECAY: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.

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- DECAY (0.200 S) (12588)
[ INFO     ] 132SN IT DECAY (2.080 US) (12589)
[ INFO     ] 133IN B-N DECAY (165 MS) (12590)
[ INFO     ] 248CM SF DECAY (12591)
[ INFO     ] COULOMB EXCITATION (12592)
[ INFO     ] U(N,F):IS,RADIUS:XUNDL-3 (12593)
[ INFO     ] COULOMB EXCITATION:XUNDL-4 (12594)
[ INFO     ] 133IN B-N DECAY:162 MS:XUNDL-5 (12595)
[ INFO     ] 133IN B-N DECAY:167 MS:XUNDL-6 (12596)
[ 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, (asymetric) 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

`tkmanager` Interface to SQLite database
`tknucleus` Nuclear ground state properties `tklevel`
`tkdecay` Level and decay data
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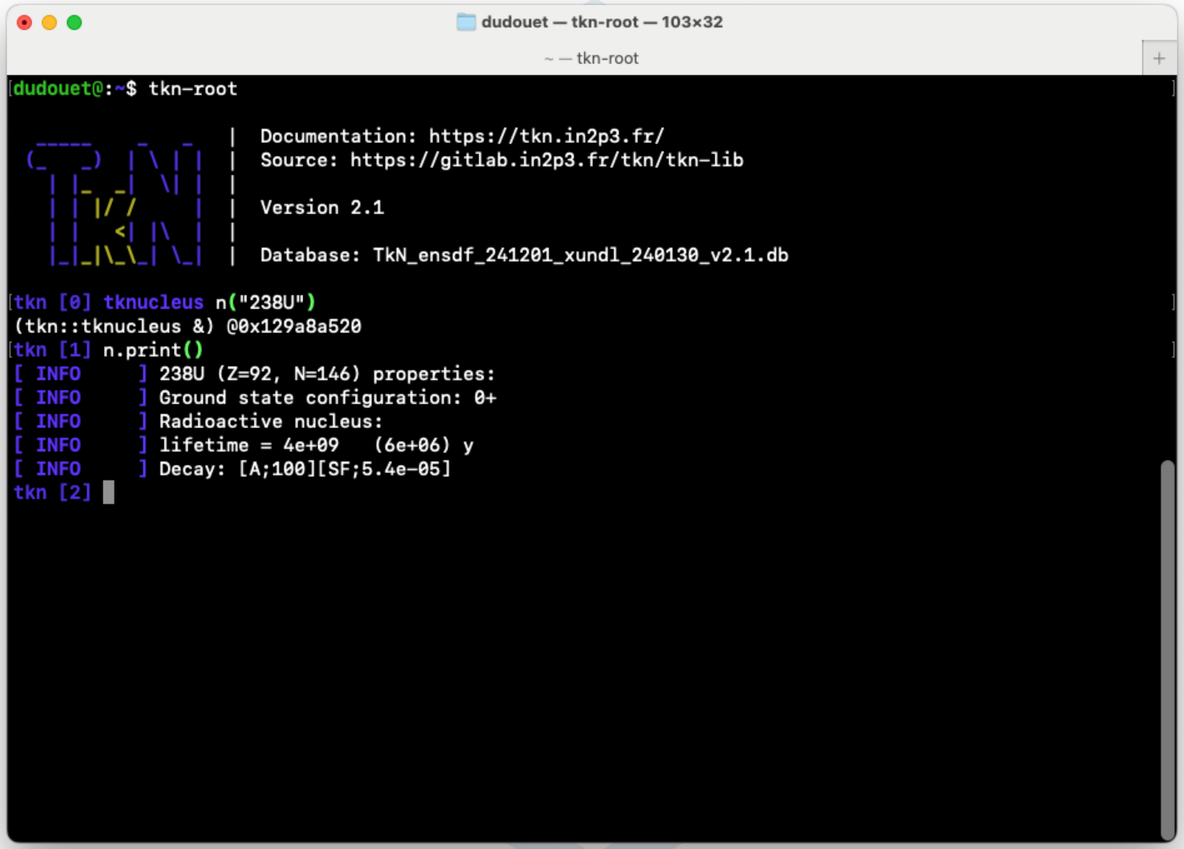

TkN C++ classes

`tkmanager` Interface to SQLite database

`tknucleus` Nuclear ground state properties `tklevel`

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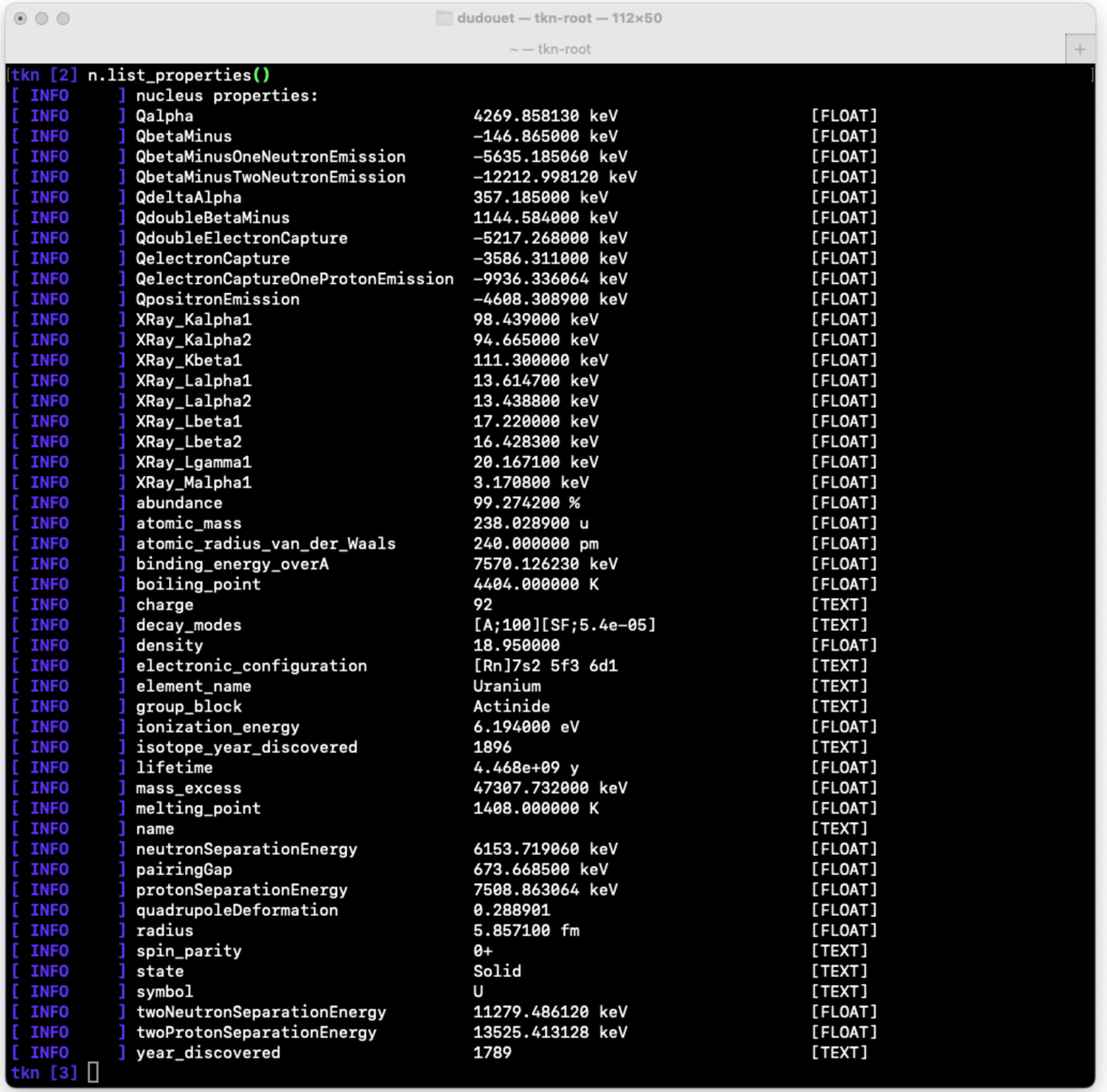

TkN C++ classes

`tkmanager` Interface to SQLite database
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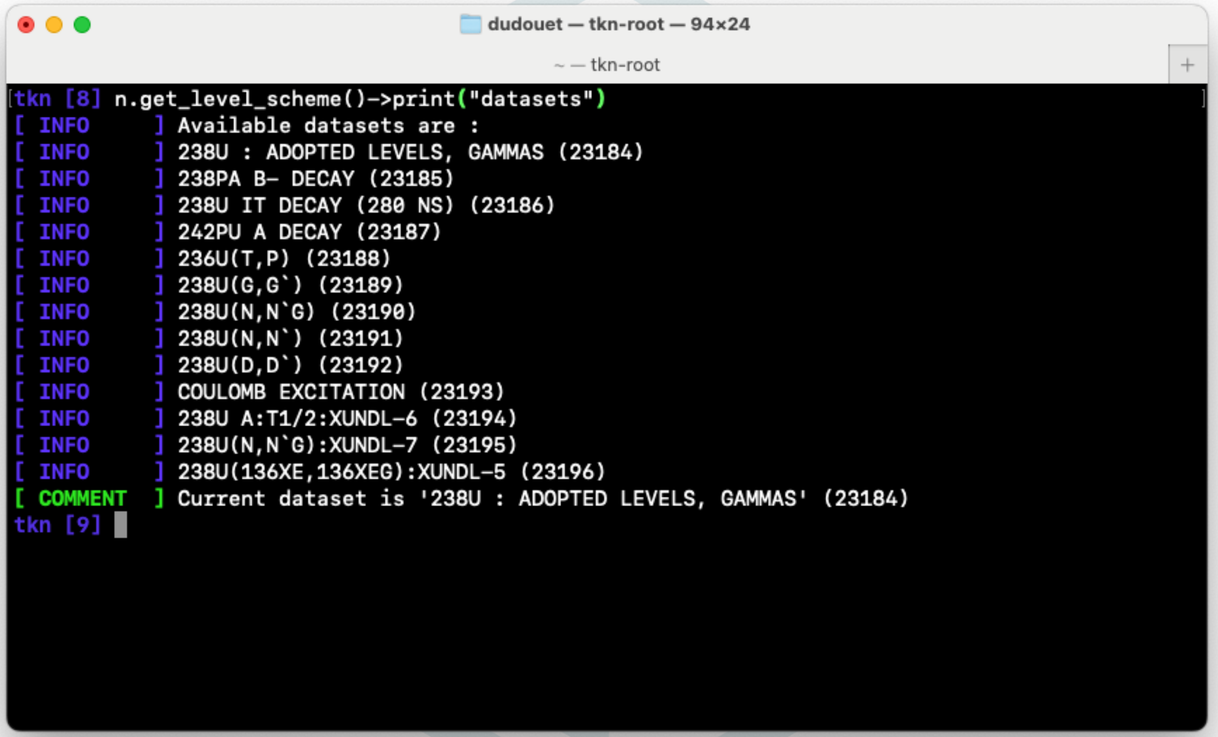

TkN C++ classes

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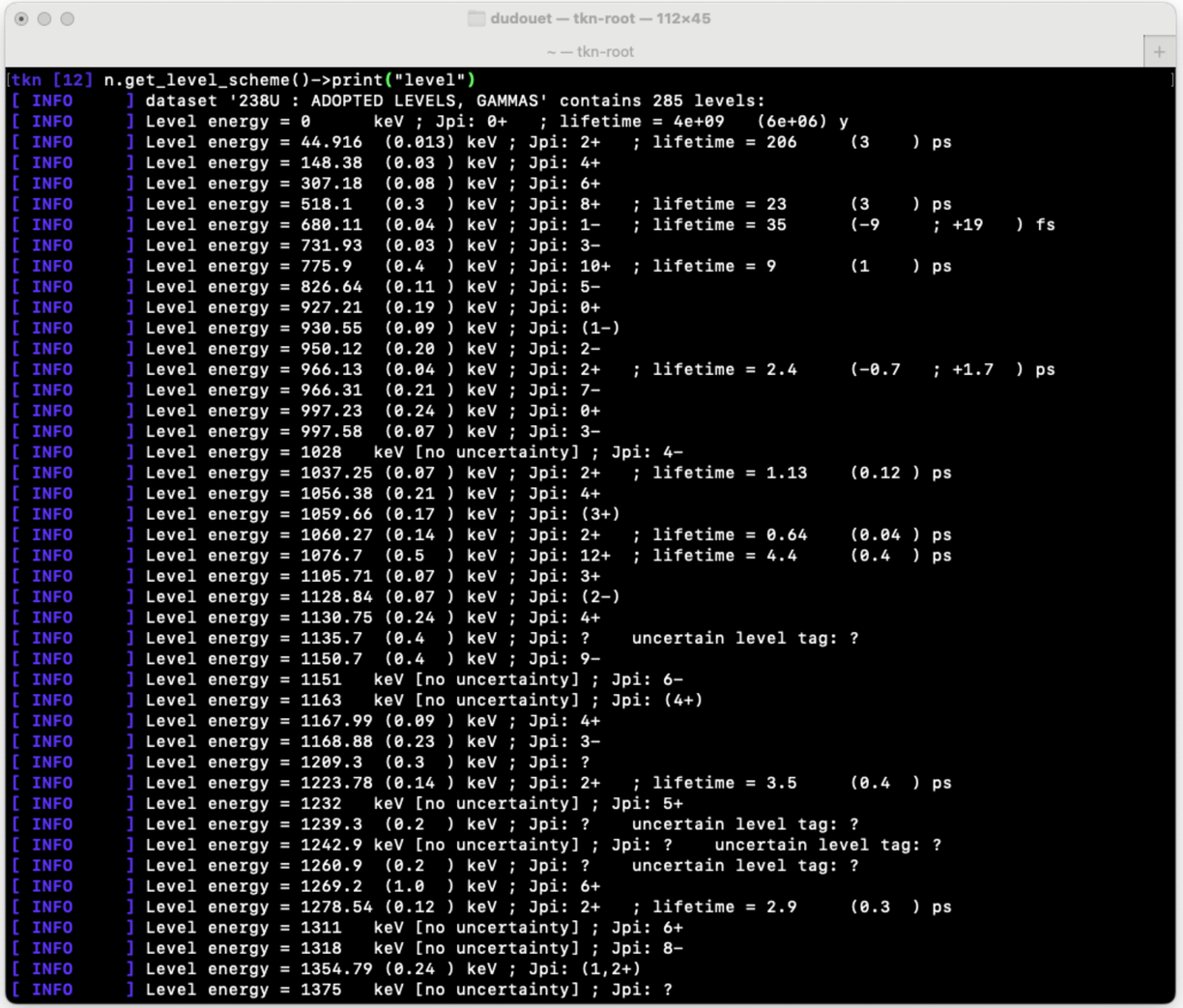
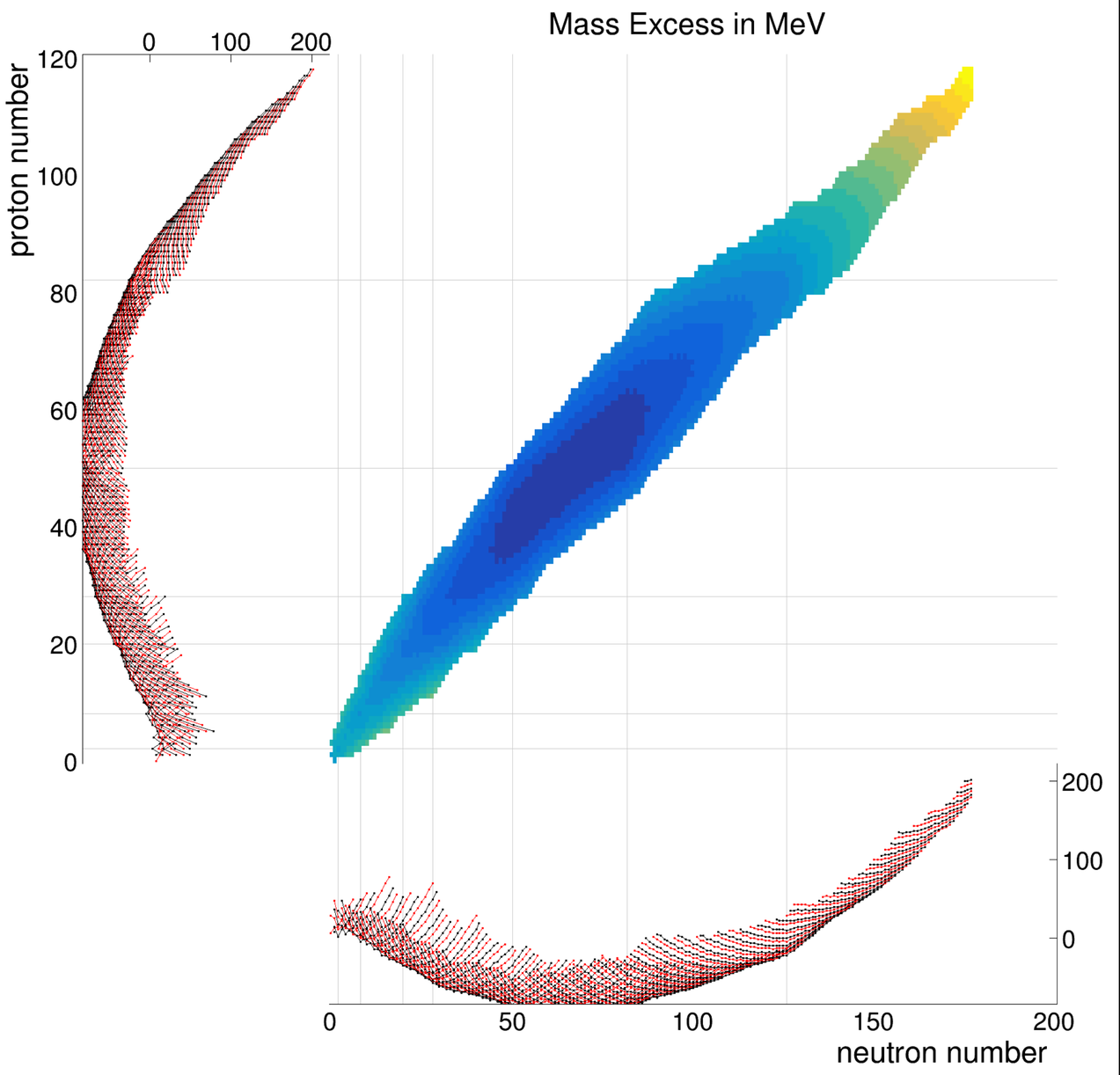


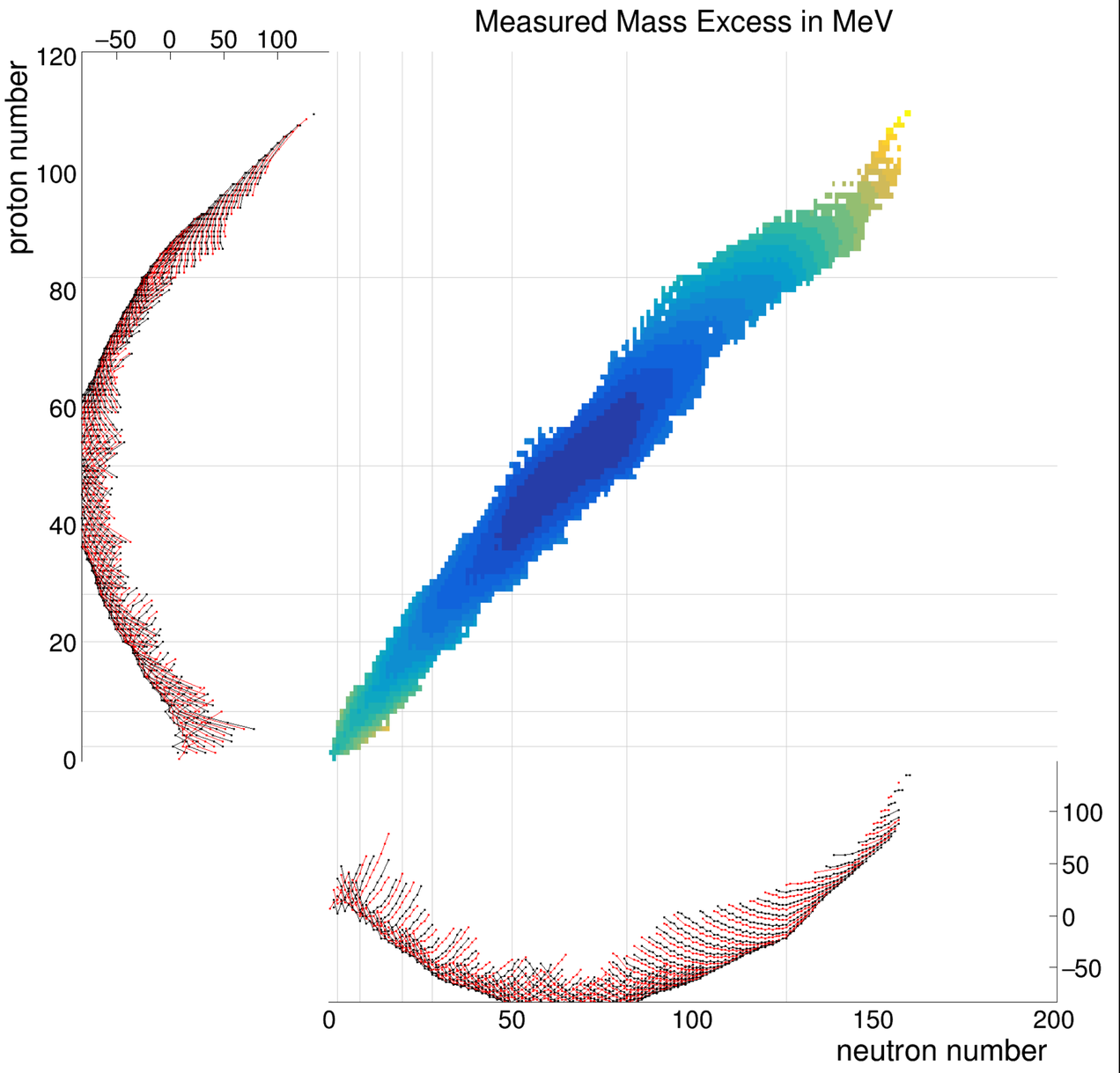
Some simple examples (from tkn.in2p3.fr)

```
#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();
}
```



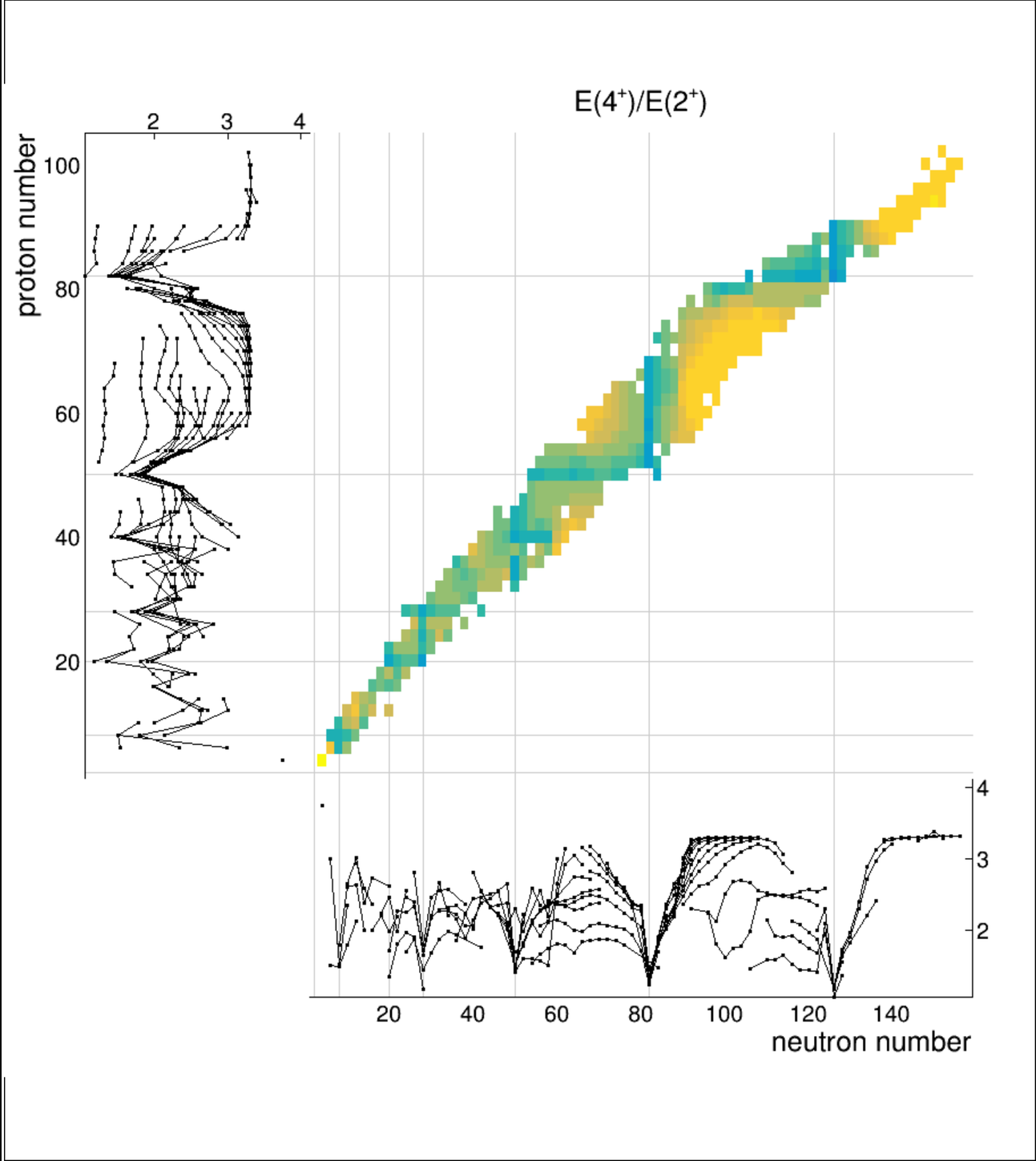
Some simple examples (from tkn.in2p3.fr)

```
#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();
}
```



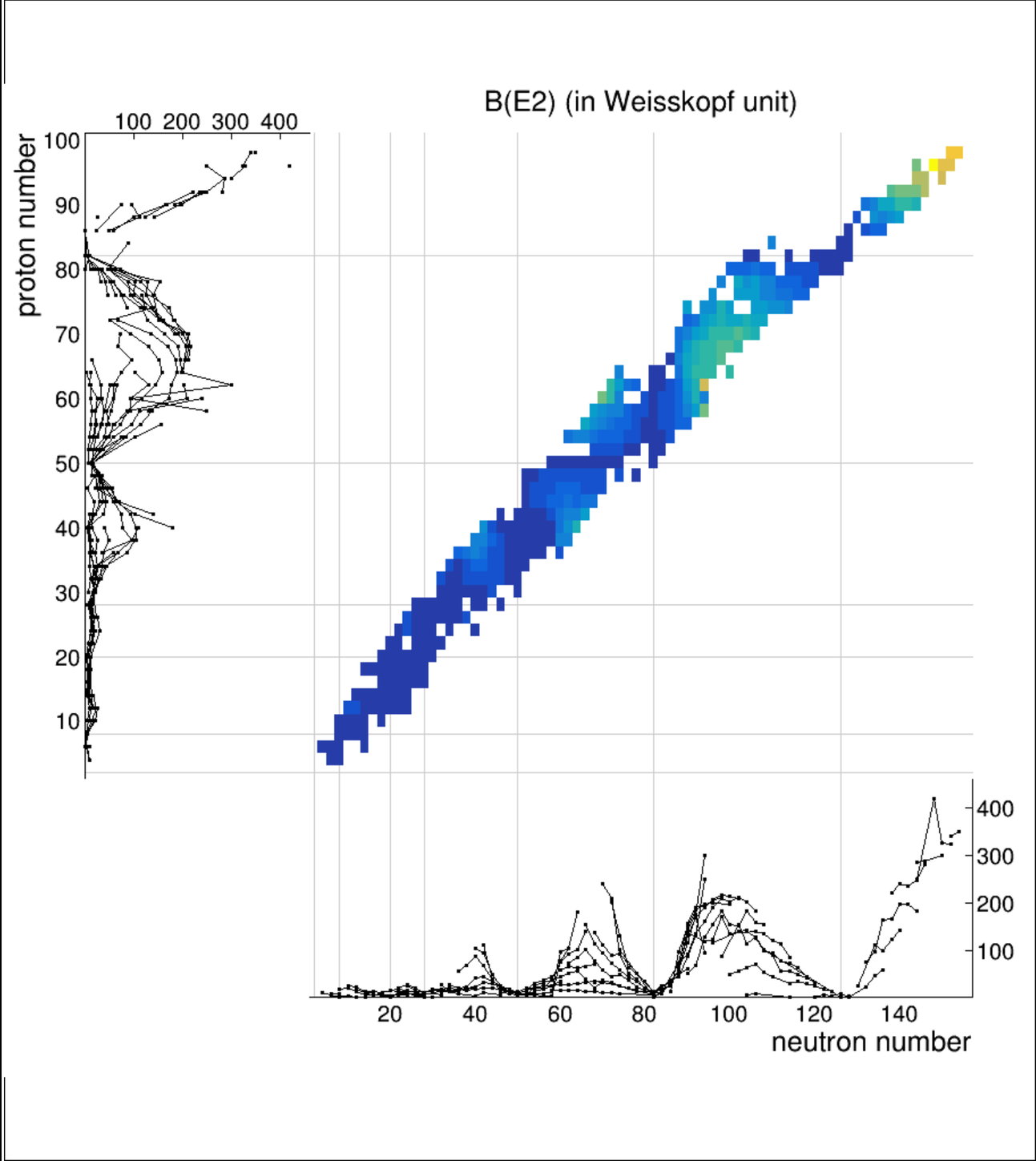
Some simple examples (from tkn.in2p3.fr)

```
#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)

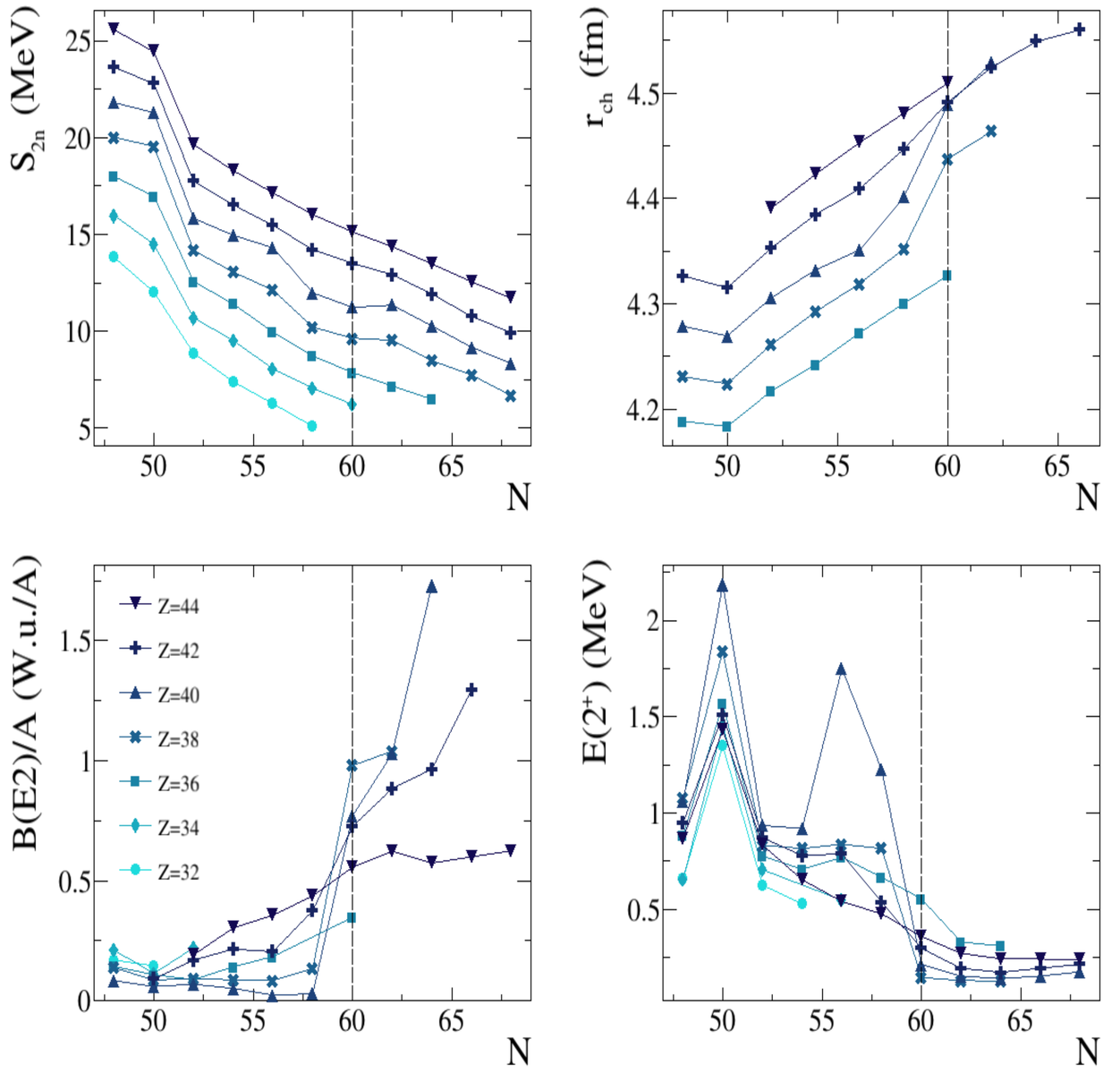
```
#include “tkmanager.h”
#include “tknuclear_chart.h”

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)

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

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.

When citing TkN, please use the DOI specific to your TkN version available on Zenodo DOI 10.5281/zenodo.10255692.

All the references used by TkN (PubChem, X-RAY DATA BOOKLET, IAEA-NDS, NUDAT3, ENSDF, XUNDL) are detailled 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

TkN

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

Regular Article | Published: 21 July 2024
Volume 139, article number 641, (2024) Cite this article

Jérémie Dudouet & Diego Gruyer

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

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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 ( )
```

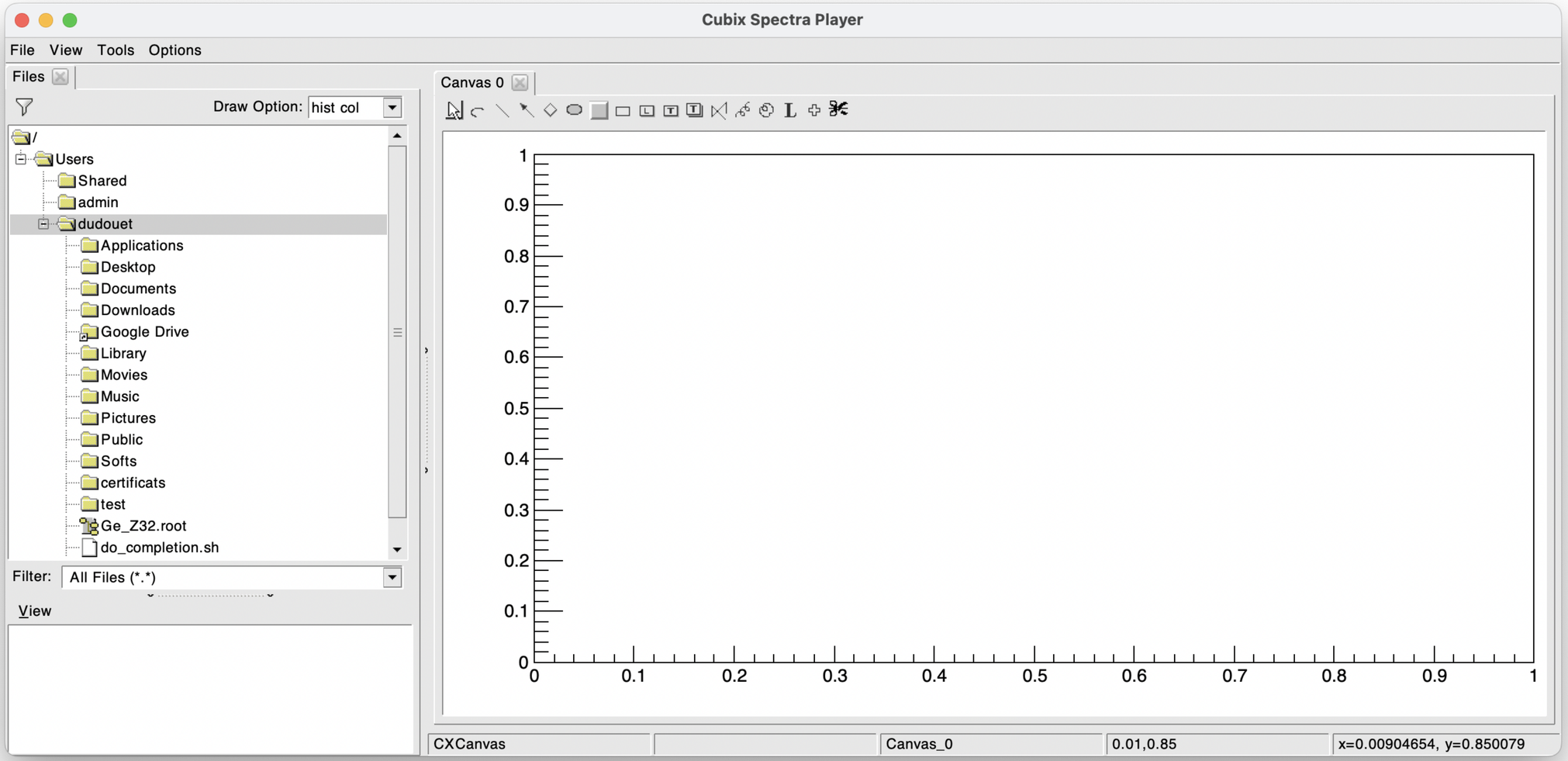
inline

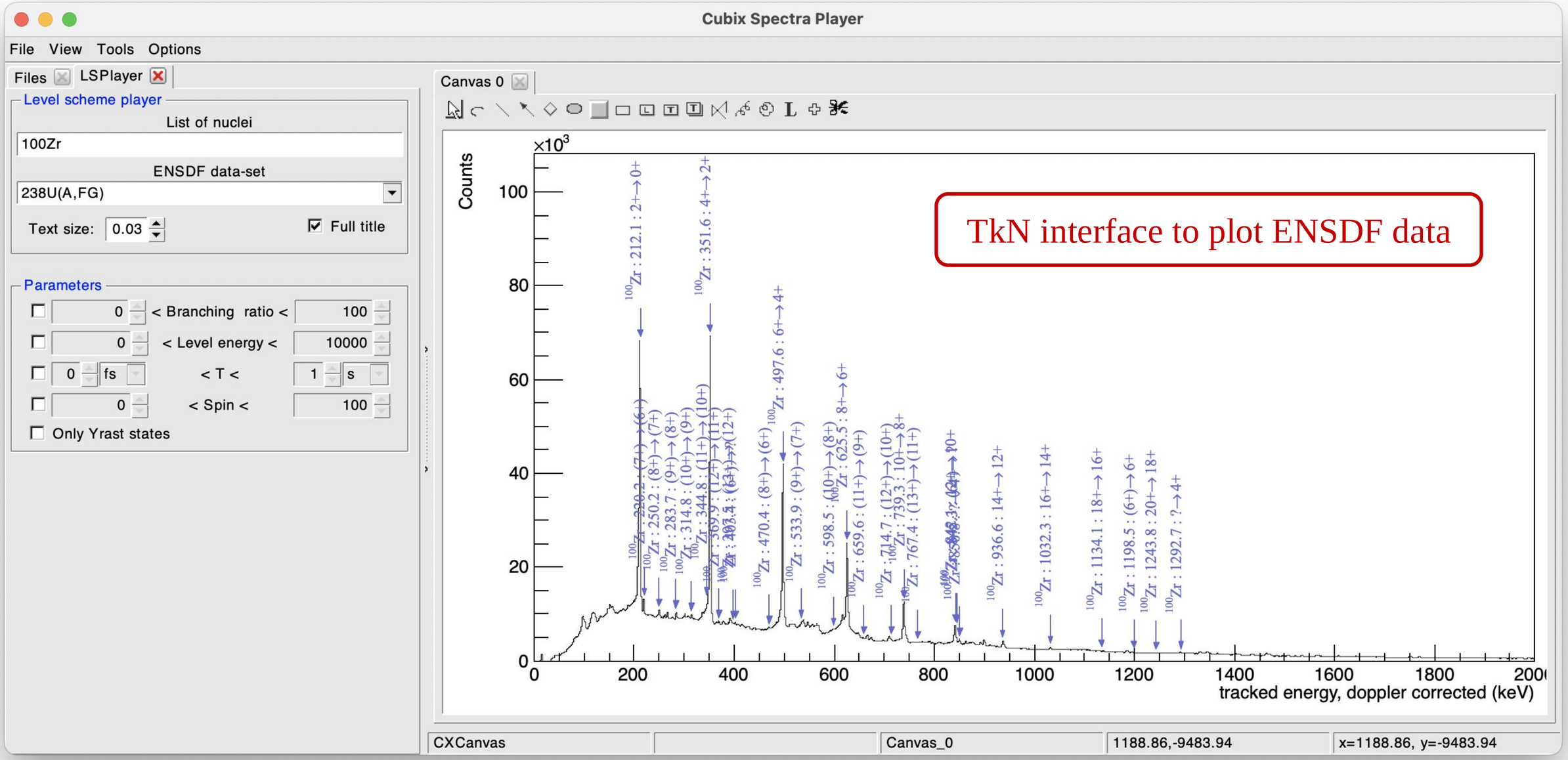
returns the energy tkmeasure object

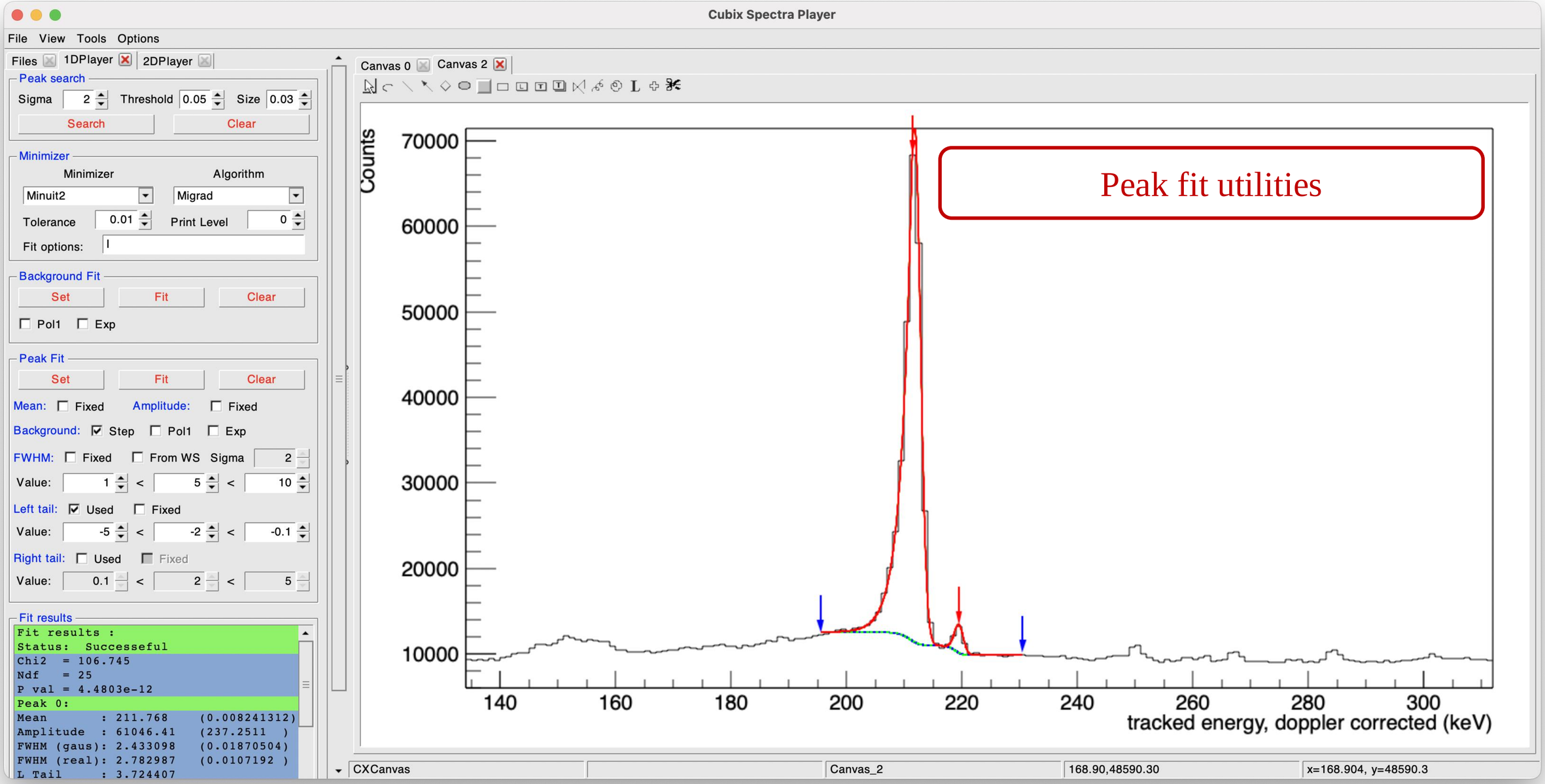
Definition at line 87 of file tklevel.h.

◆ get_isomer_level()

The Cubix software




Cubix Spectra Player
File View Tools Options
Files LSPlayer
Level scheme player
List of nuclei
100Zr
ENSDF data-set
238U(A,FG)
Text size: 0.03
Full title
Parameters
0 < Branching ratio < 100
0 < Level energy < 10000
0 fs < T < 1 s
0 < Spin < 100
Only Yrast states
Canvas 0
TkN interface to plot ENSDF data
Counts
×10^3
tracked energy, doppler corrected (keV)
CXCanvas
Canvas_0
1188.86,-9483.94
x=1188.86, y=-9483.94


Cubix Spectra Player
File View Tools Options
Files 1DPlayer 2DPlayer
Peak search
Sigma 2 Threshold 0.05 Size 0.03
Search Clear
Minimizer
Minimizer Algorithm
Minuit2 Migrad
Tolerance 0.01 Print Level 0
Fit options: I
Background Fit
Set Fit Clear
Pol1 Exp
Peak Fit
Set Fit Clear
Mean: Fixed Amplitude: Fixed
Background: Step Pol1 Exp
FWHM: Fixed From WS Sigma 2
Value: 1 < 5 < 10
Left tail: Used Fixed
Value: -5 < -2 < -0.1
Right tail: Used Fixed
Value: 0.1 < 2 < 5
Fit results
Fit results :
Status: Successful
Chi2 = 106.745
Ndf = 25
P val = 4.4803e-12
Peak 0:
Mean : 211.768 (0.008241312)
Amplitude : 61046.41 (237.2511)
FWHM (gaus): 2.433098 (0.01870504)
FWHM (real): 2.782987 (0.0107192)
L Tail : 3.724407
Canvas 0 Canvas 2
Counts
70000
60000
50000
40000
30000
20000
10000
140 160 180 200 220 240 260 280 300
tracked energy, doppler corrected (keV)
Peak fit utilities
CXCanvas Canvas_2 168.90,48590.30 x=168.904, y=48590.3

Cubix Spectra Player

File View Tools Options

Files 1DCalib

Sources

Input data

152Eu

Energy: From 0 To 10000 Apply

Intensity: From 1 To 100 Apply

Show available sources

Fit properties

Verbose level 1

Calibration order 1 No offset

FWHM 15 Amplitude 5

Range: From 0 To 32000 Current

Left tail Right tail

Use 2nd-derivative search

Energy calibration

Calibrate Apply Save

FWHM fit

FWHM Calib Save

Canvas 0

Automatic calibration tools

Calibration Results

Help

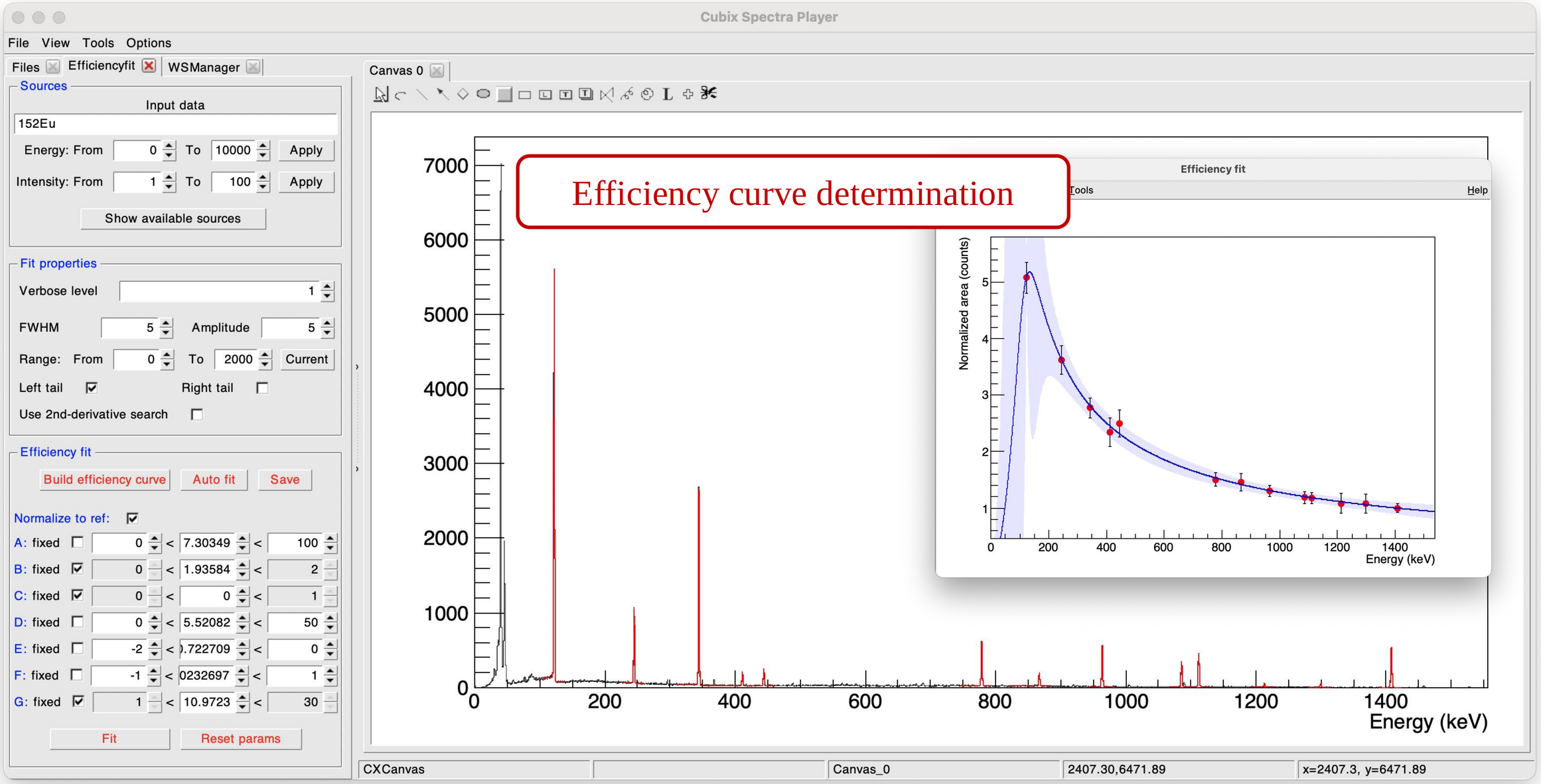
Energy (channels)

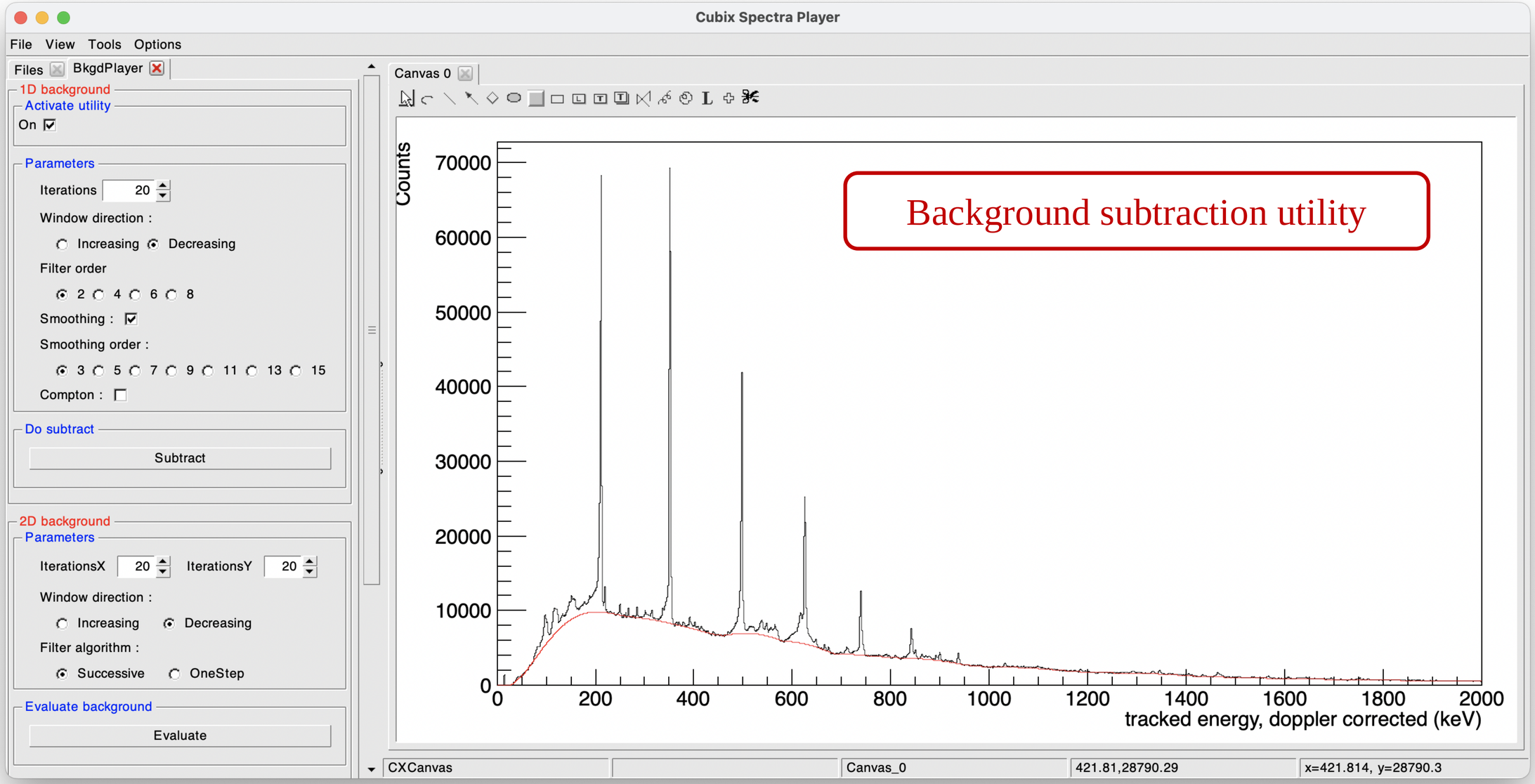
Residue (keV)

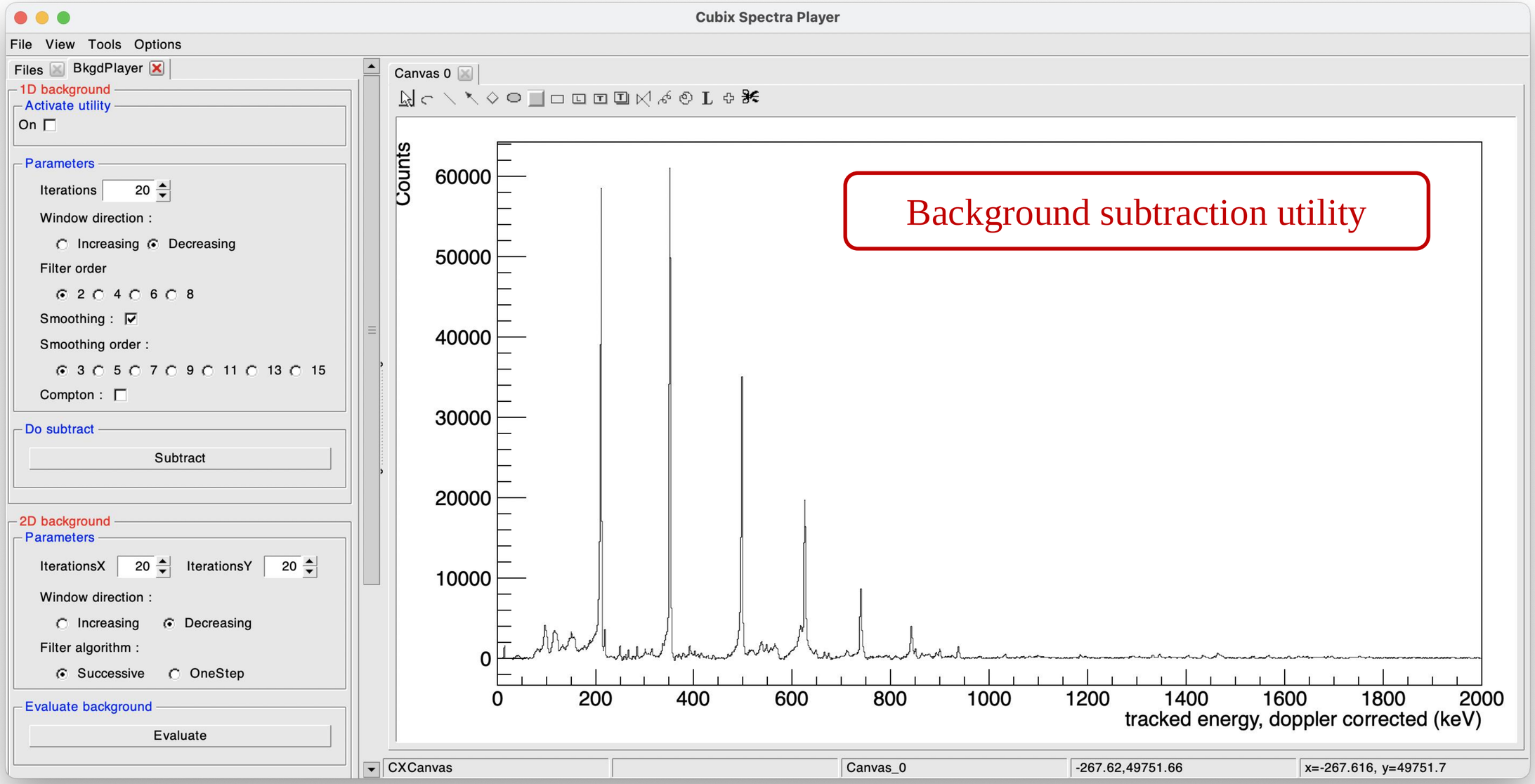
Energy (keV)

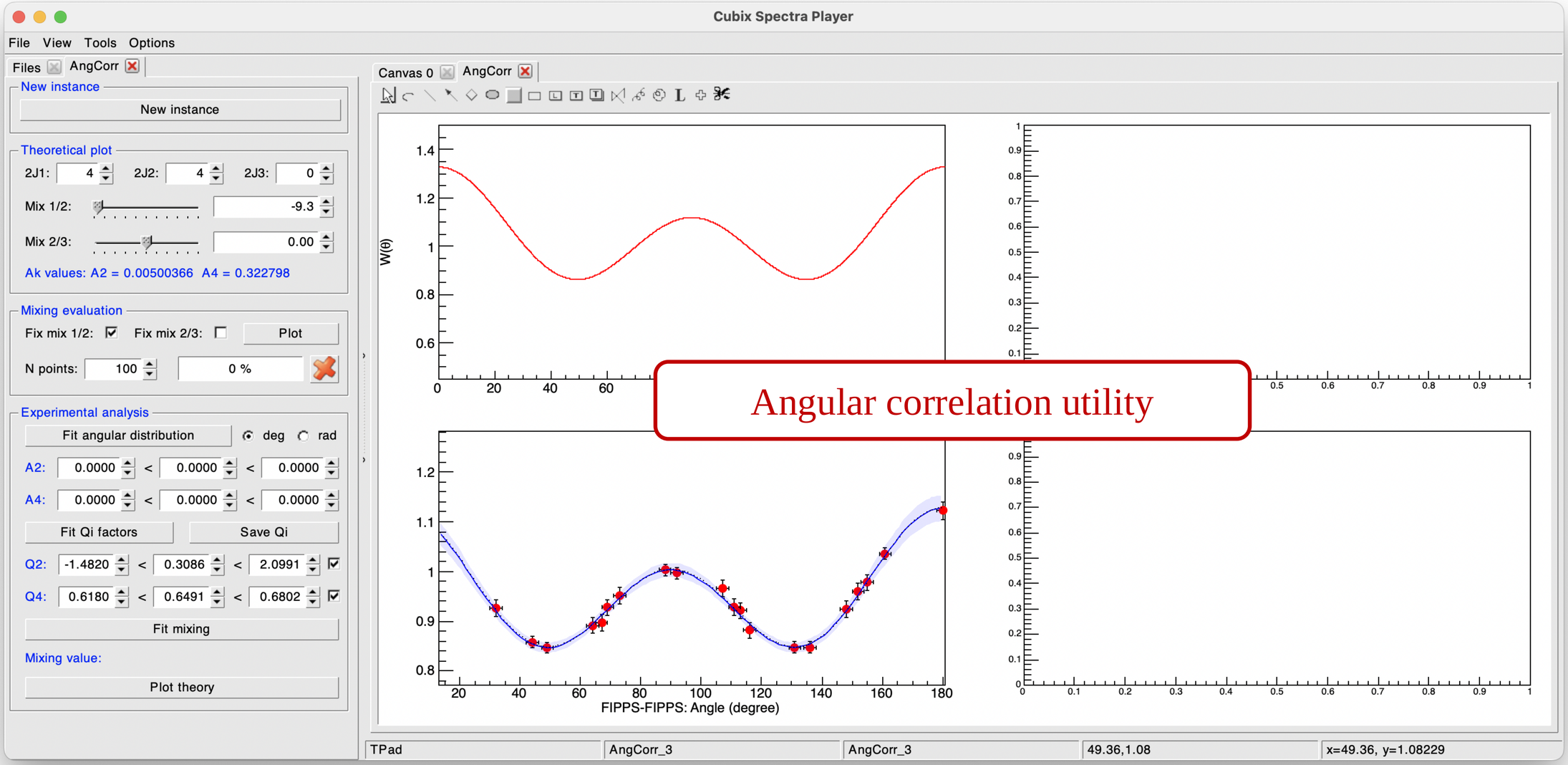
CXCanvas Canvas_0 2877.13,8113.83 x=2877.13, y=8113.83

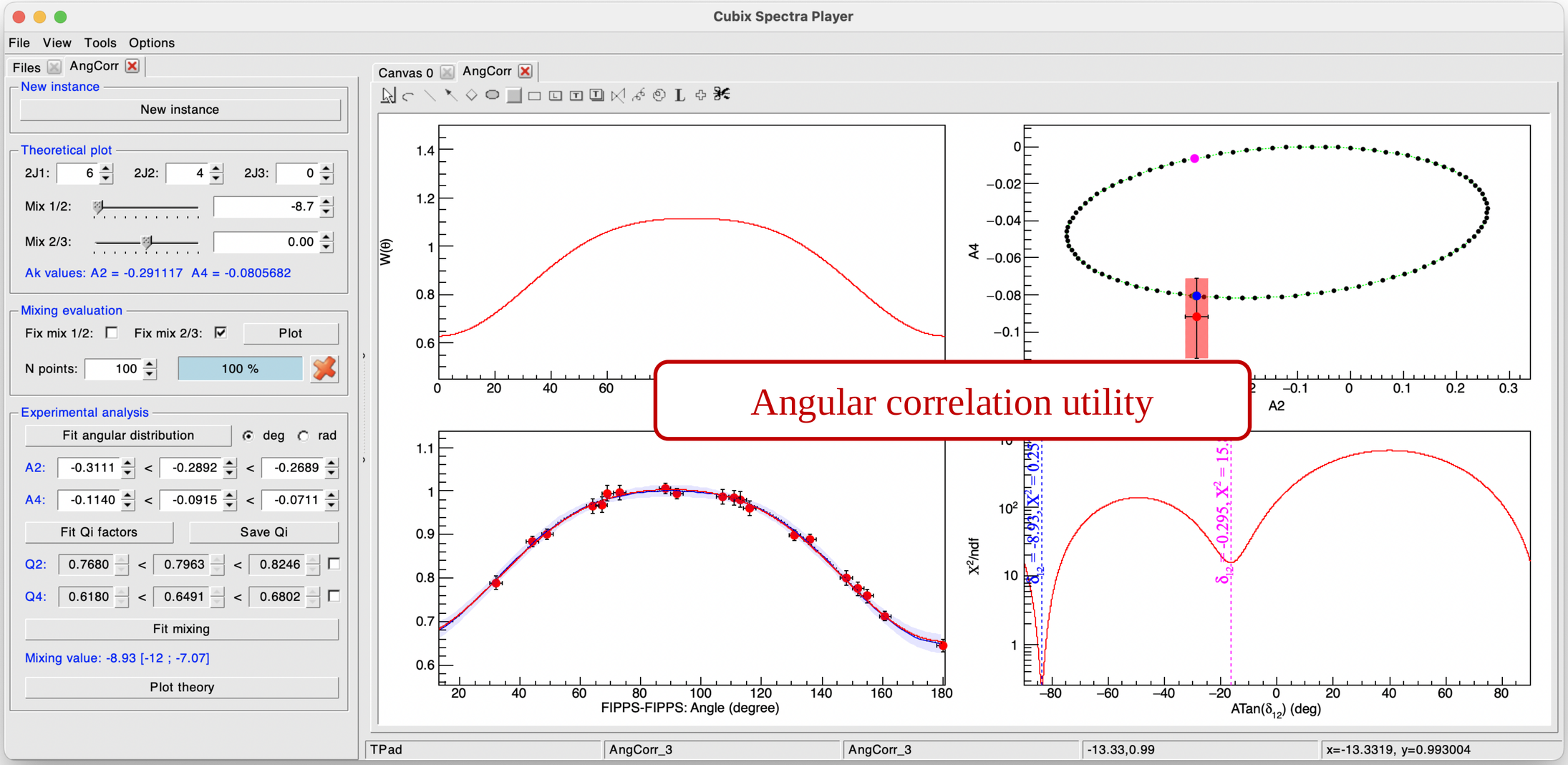
Efficiency curve determination



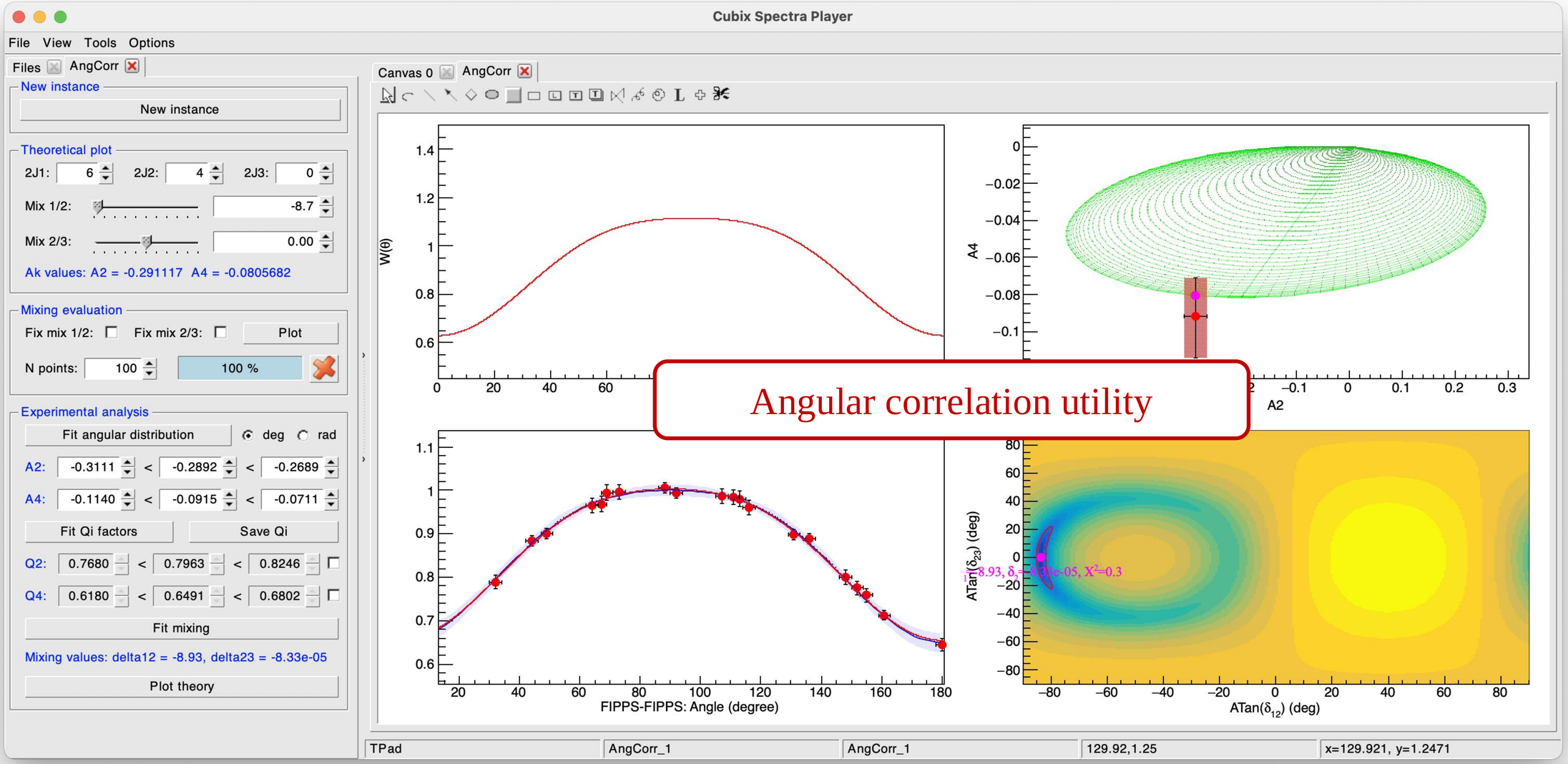

Cubix Spectra Player
File View Tools Options
Files
BkgdPlayer
1D background
Activate utility
On
Parameters
Iterations 20
Window direction :
Increasing Decreasing
Filter order
2 4 6 8
Smoothing :
Smoothing order :
3 5 7 9 11 13 15
Compton :
Do subtract
Subtract
2D background
Parameters
IterationsX 20 IterationsY 20
Window direction :
Increasing Decreasing
Filter algorithm :
Successive OneStep
Evaluate background
Evaluate
Canvas 0
Counts
70000
60000
50000
40000
30000
20000
10000
0
0 200 400 600 800 1000 1200 1400 1600 1800 2000
tracked energy, doppler corrected (keV)
Background subtraction utility
CXCanvas
Canvas_0
421.81,28790.29
x=421.814, y=28790.3


Cubix Spectra Player
File View Tools Options
Files
BkgdPlayer
1D background
Activate utility
On
Parameters
Iterations 20
Window direction :
Increasing Decreasing
Filter order
2 4 6 8
Smoothing :
Smoothing order :
3 5 7 9 11 13 15
Compton :
Do subtract
Subtract
2D background
Parameters
IterationsX 20
IterationsY 20
Window direction :
Increasing Decreasing
Filter algorithm :
Successive OneStep
Evaluate background
Evaluate
Canvas 0
Counts
60000
50000
40000
30000
20000
10000
0
0 200 400 600 800 1000 1200 1400 1600 1800 2000
tracked energy, doppler corrected (keV)
Background subtraction utility
CXCanvas
Canvas_0
-267.62,49751.66
x=-267.616, y=49751.7

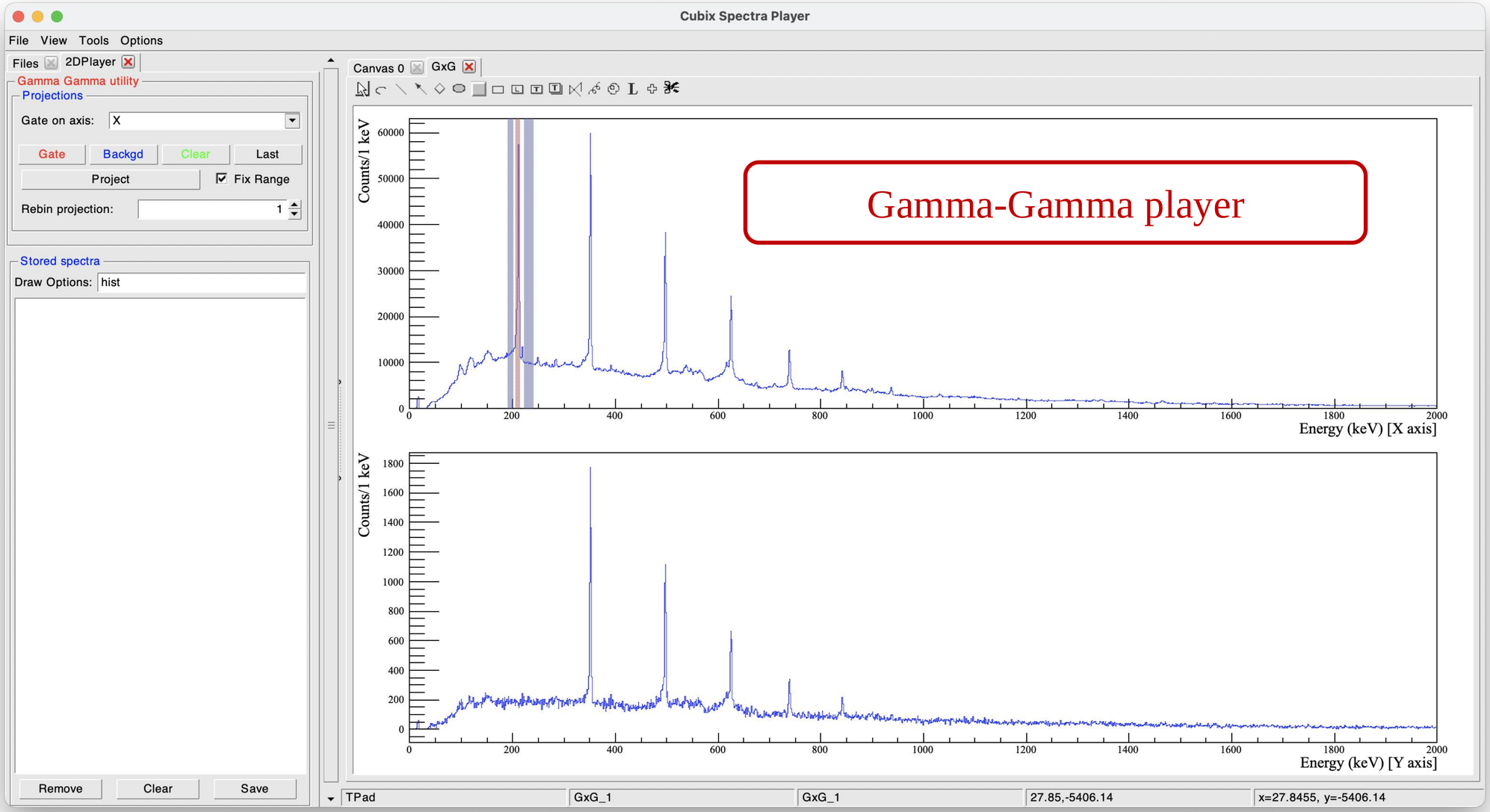

Cubix Spectra Player
File View Tools Options
Files AngCorr
New instance
New instance
Theoretical plot
2J1: 4 2J2: 4 2J3: 0
Mix 1/2: -9.3
Mix 2/3: 0.00
Ak values: A2 = 0.00500366 A4 = 0.322798
Mixing evaluation
Fix mix 1/2: Fix mix 2/3: Plot
N points: 100 0 %
Experimental analysis
Fit angular distribution deg rad
A2: 0.0000 < 0.0000 < 0.0000
A4: 0.0000 < 0.0000 < 0.0000
Fit Qi factors Save Qi
Q2: -1.4820 < 0.3086 < 2.0991
Q4: 0.6180 < 0.6491 < 0.6802
Fit mixing
Mixing value:
Plot theory
Canvas 0 AngCorr
W(θ)
FIPPS-FIPPS: Angle (degree)
Angular correlation utility
TPad AngCorr_3 AngCorr_3 49.36,1.08 x=49.36, y=1.08229

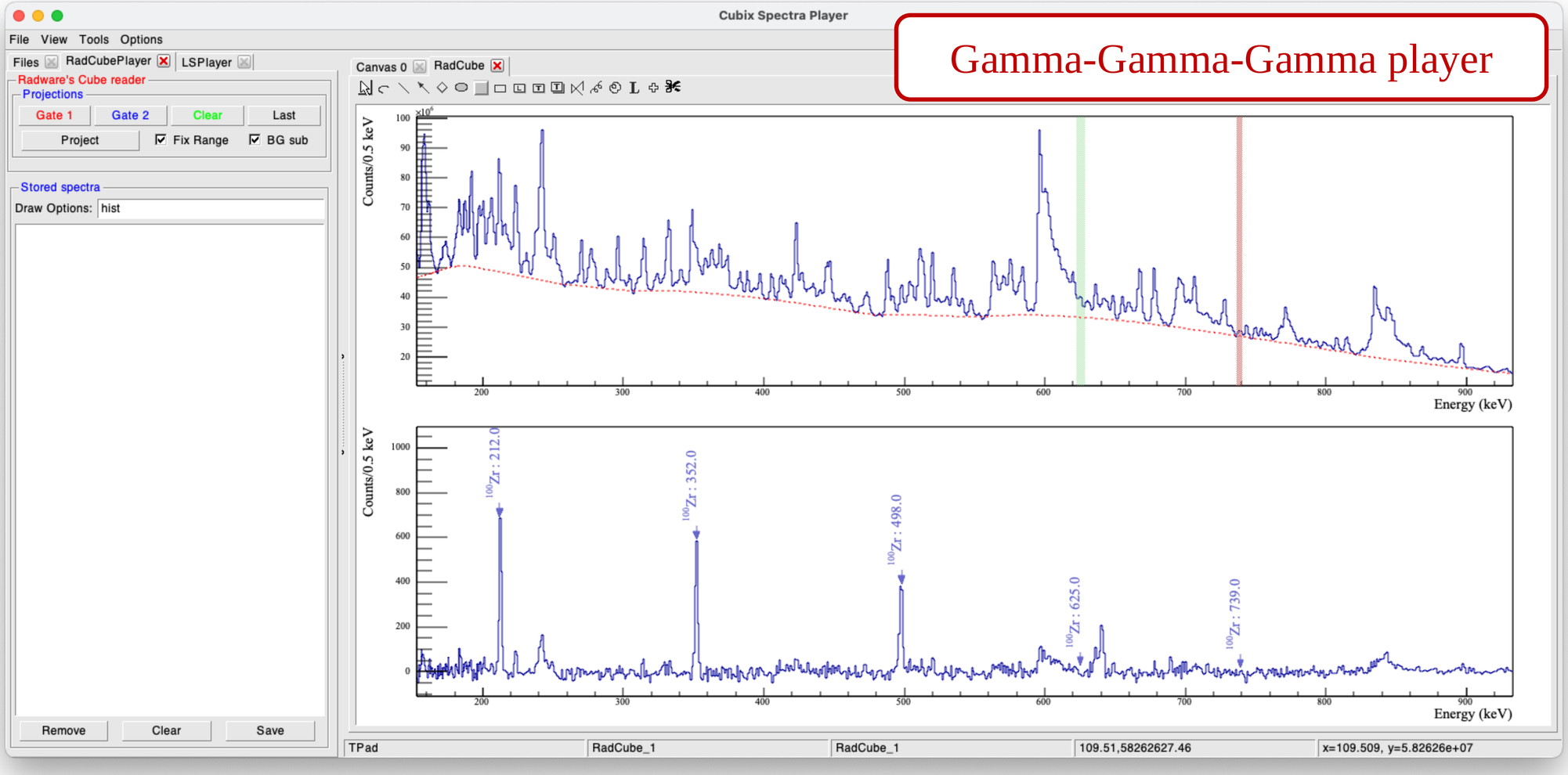


Angular correlation utility

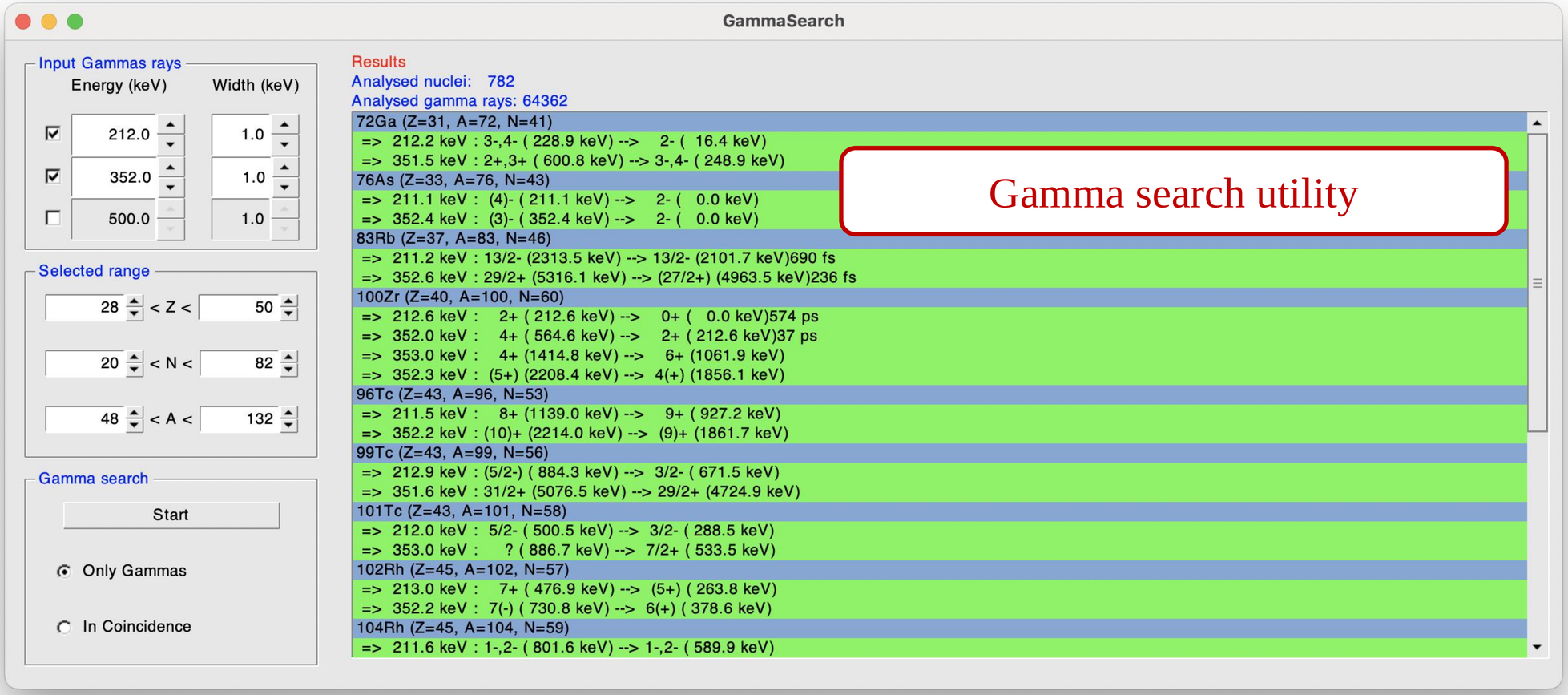


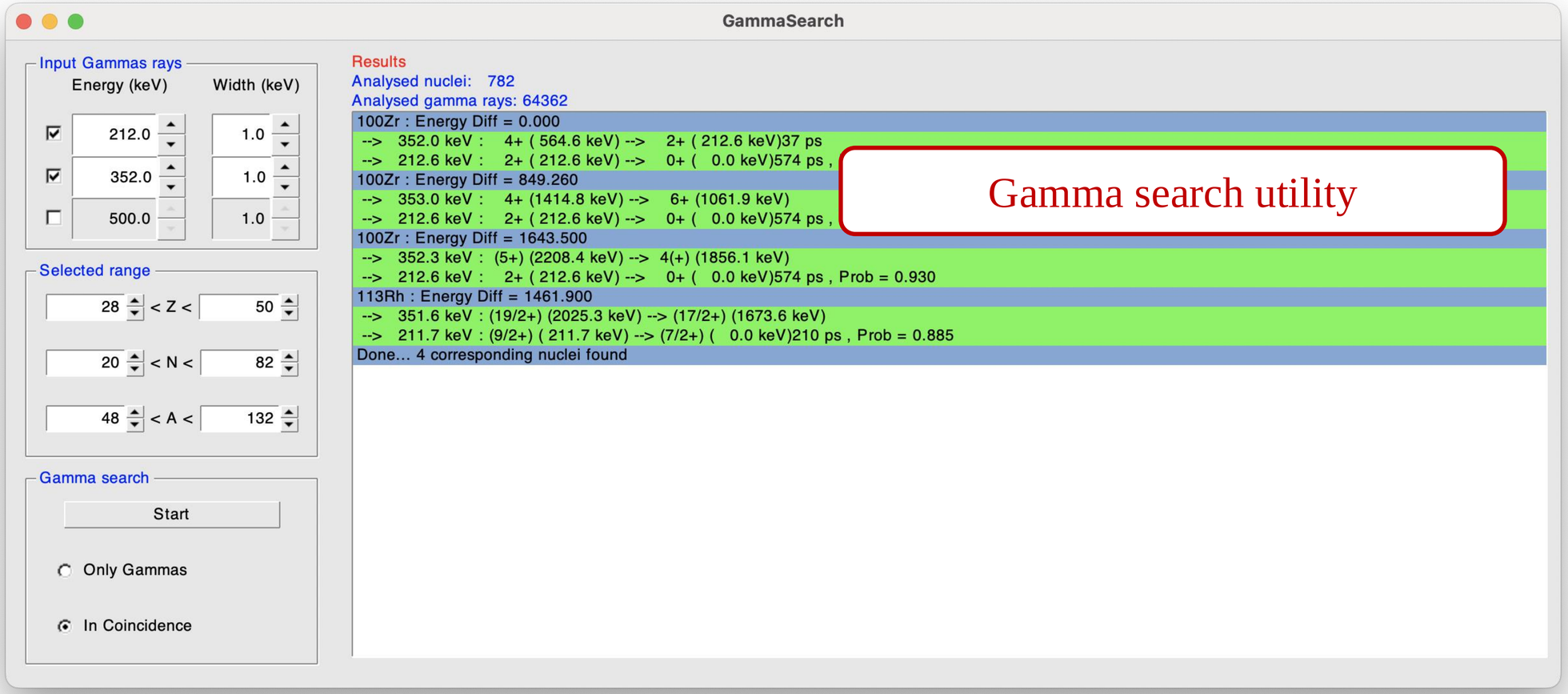
Angular correlation utility

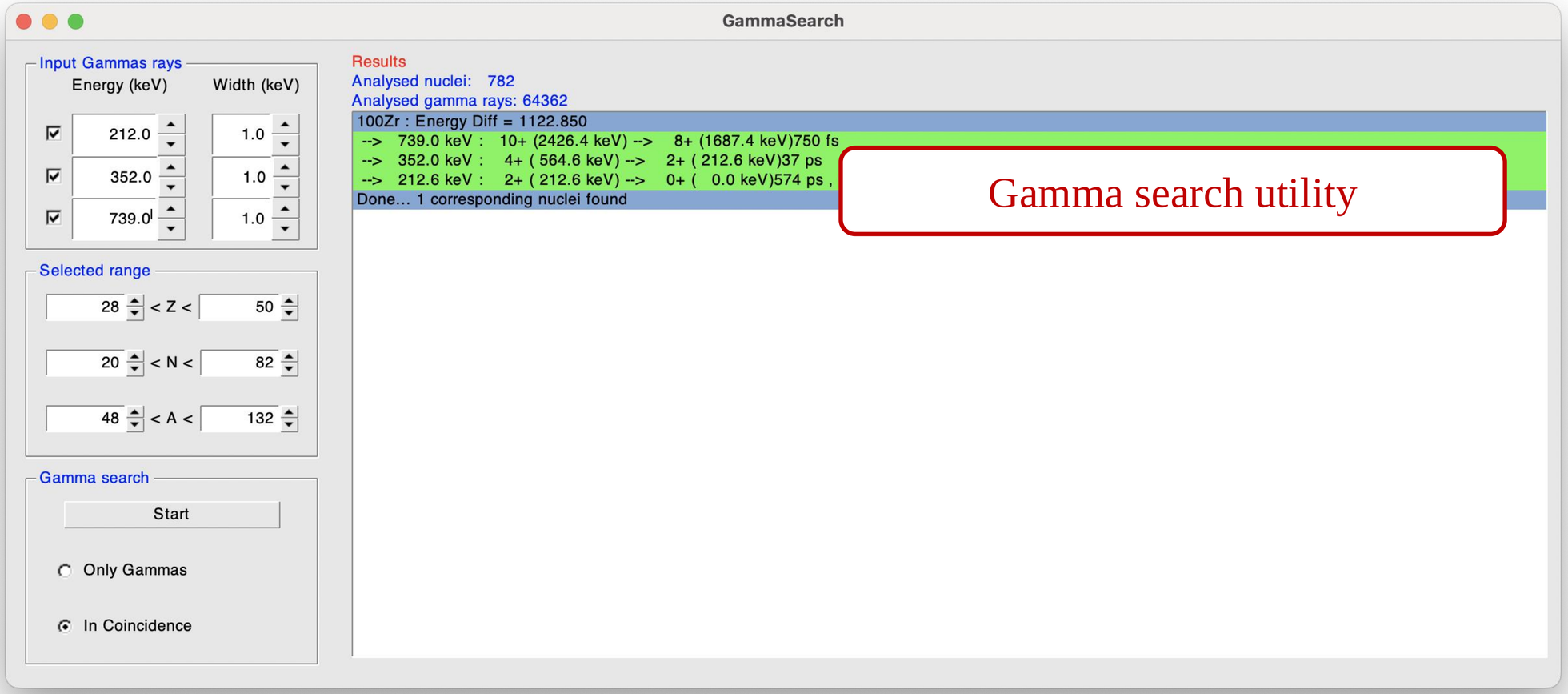

Cubix Spectra Player
File View Tools Options
Files 2DPlayer
Gamma Gamma utility
Projections
Gate on axis: X
Gate Backgd Clear Last
Project Fix Range
Rebin projection: 1
Stored spectra
Draw Options: hist
Remove Clear Save
Canvas 0 GxG
Gamma-Gamma player
Counts/1 keV
Energy (keV) [X axis]
Energy (keV) [Y axis]
TPad GxG_1 GxG_1 27.85,-5406.14 x=27.8455, y=-5406.14

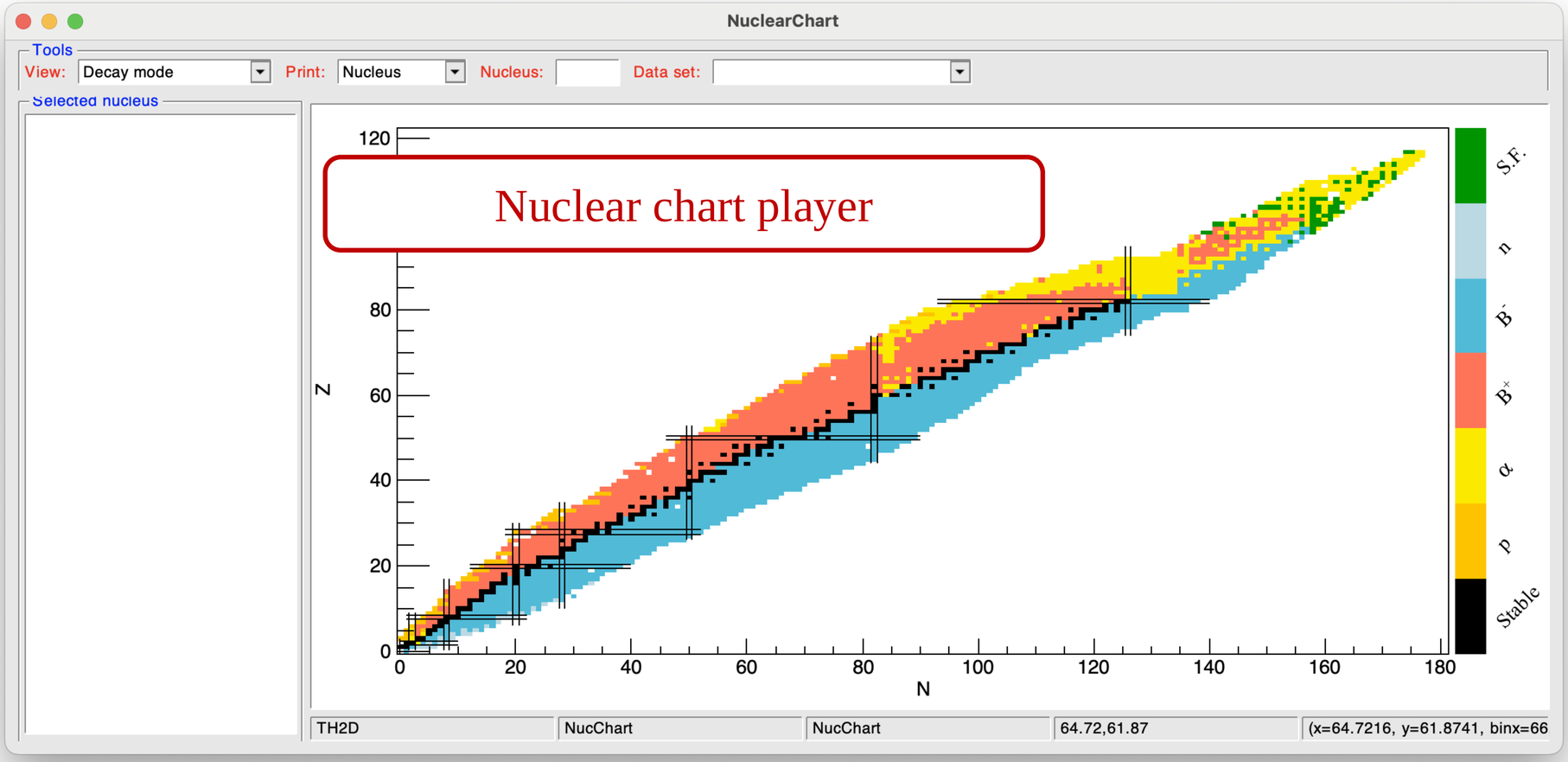


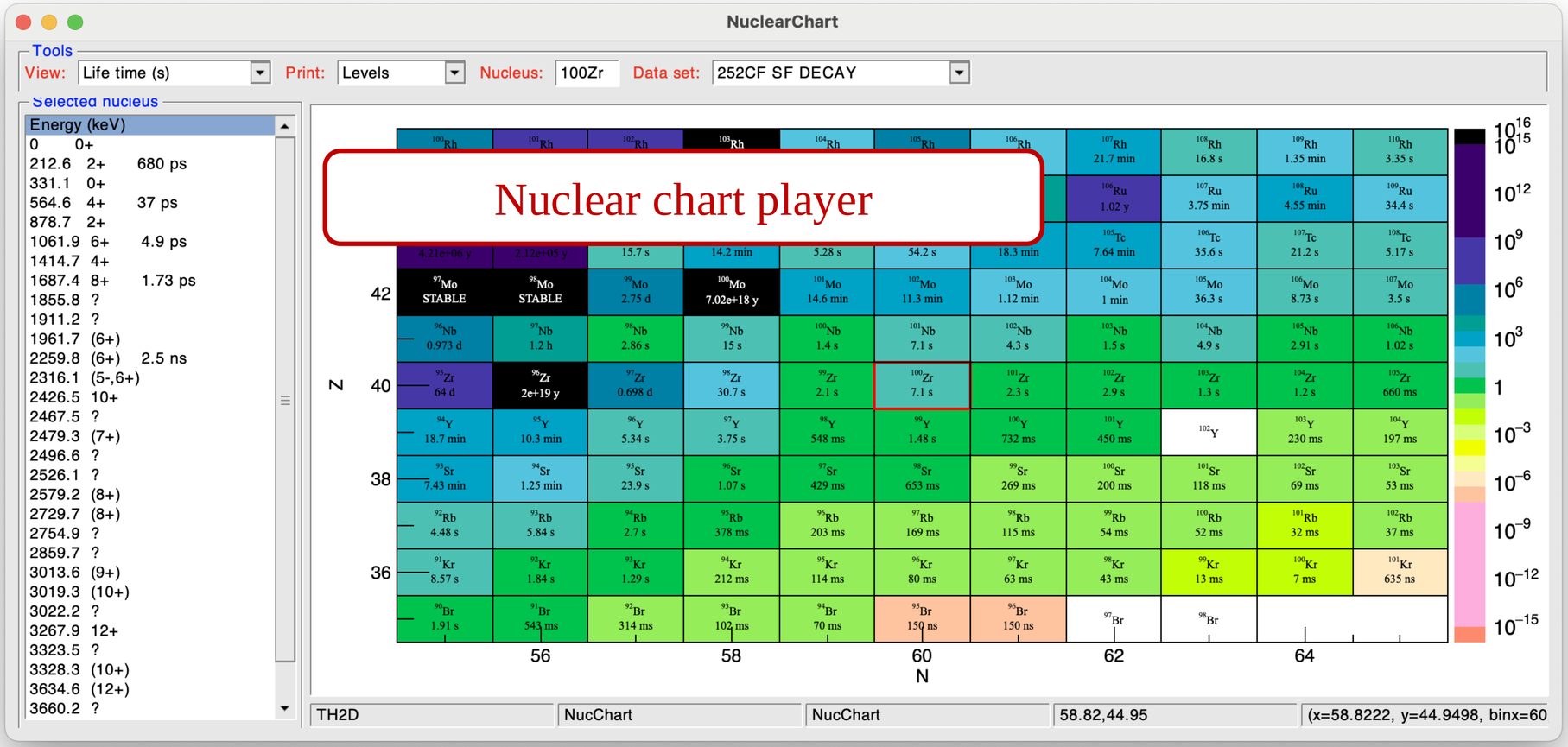
Gamma-Gamma-Gamma player


GammaSearch
Input Gammas rays
Energy (keV)
Width (keV)
212.0
1.0
352.0
1.0
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
72Ga (Z=31, A=72, N=41)
=> 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)
76As (Z=33, A=76, N=43)
=> 211.1 keV : (4)- (211.1 keV) --> 2- (0.0 keV)
=> 352.4 keV : (3)- (352.4 keV) --> 2- (0.0 keV)
83Rb (Z=37, A=83, N=46)
=> 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
100Zr (Z=40, A=100, N=60)
=> 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)
96Tc (Z=43, A=96, N=53)
=> 211.5 keV : 8+ (1139.0 keV) --> 9+ (927.2 keV)
=> 352.2 keV : (10)+ (2214.0 keV) --> (9)+ (1861.7 keV)
99Tc (Z=43, A=99, N=56)
=> 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)
101Tc (Z=43, A=101, N=58)
=> 212.0 keV : 5/2- (500.5 keV) --> 3/2- (288.5 keV)
=> 353.0 keV : ? (886.7 keV) --> 7/2+ (533.5 keV)
102Rh (Z=45, A=102, N=57)
=> 213.0 keV : 7+ (476.9 keV) --> (5+) (263.8 keV)
=> 352.2 keV : 7(-) (730.8 keV) --> 6(+) (378.6 keV)
104Rh (Z=45, A=104, N=59)
=> 211.6 keV : 1-,2- (801.6 keV) --> 1-,2- (589.9 keV)
Gamma search utility


GammaSearch
Input Gammas rays
Energy (keV)
Width (keV)
212.0
1.0
352.0
1.0
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


GammaSearch
Input Gammas rays
Energy (keV)
Width (keV)
212.0
1.0
352.0
1.0
739.0
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 = 1122.850
--> 739.0 keV : 10+ (2426.4 keV) --> 8+ (1687.4 keV)750 fs
--> 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 ,
Done... 1 corresponding nuclei found
Gamma search utility


NuclearChart
Tools
View: Decay mode
Print: Nucleus
Nucleus:
Data set:
Selected nucleus
Nuclear chart player
Z
N
S.F.
n
β⁻
β⁺
α
p
Stable
TH2D
NucChart
NucChart
64.72,61.87
(x=64.7216, y=61.8741, binx=66


NuclearChart
Tools
View: Life time (s)
Print: Levels
Nucleus: 100Zr
Data set: 252CF SF DECAY
Selected nucleus
Energy (keV)
0 0+
212.6 2+ 680 ps
331.1 0+
564.6 4+ 37 ps
878.7 2+
1061.9 6+ 4.9 ps
1414.7 4+
1687.4 8+ 1.73 ps
1855.8 ?
1911.2 ?
1961.7 (6+)
2259.8 (6+) 2.5 ns
2316.1 (5-,6+)
2426.5 10+
2467.5 ?
2479.3 (7+)
2496.6 ?
2526.1 ?
2579.2 (8+)
2729.7 (8+)
2754.9 ?
2859.7 ?
3013.6 (9+)
3019.3 (10+)
3022.2 ?
3267.9 12+
3323.5 ?
3328.3 (10+)
3634.6 (12+)
3660.2 ?
Nuclear chart player
N
42
40
38
36
56
58
60
62
64
N
TH2D
NucChart
NucChart
58.82,44.95
(x=58.8222, y=44.9498, binx=60

Cubix user's guide

https://cubix.in2p3.fr

Courants Boulot Labo Publications Physique Paperasse Séries/Films Recettes finance Running Crevette

CUBiX

Cubix user's guide

Search

ip2igamma/cubix

☆0 1

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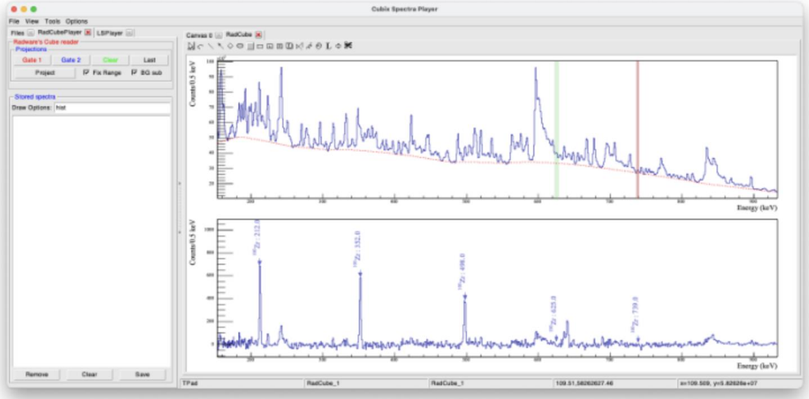
Home

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



It is linked with the TkN library to provide a direct access to nuclear databases.

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License and references

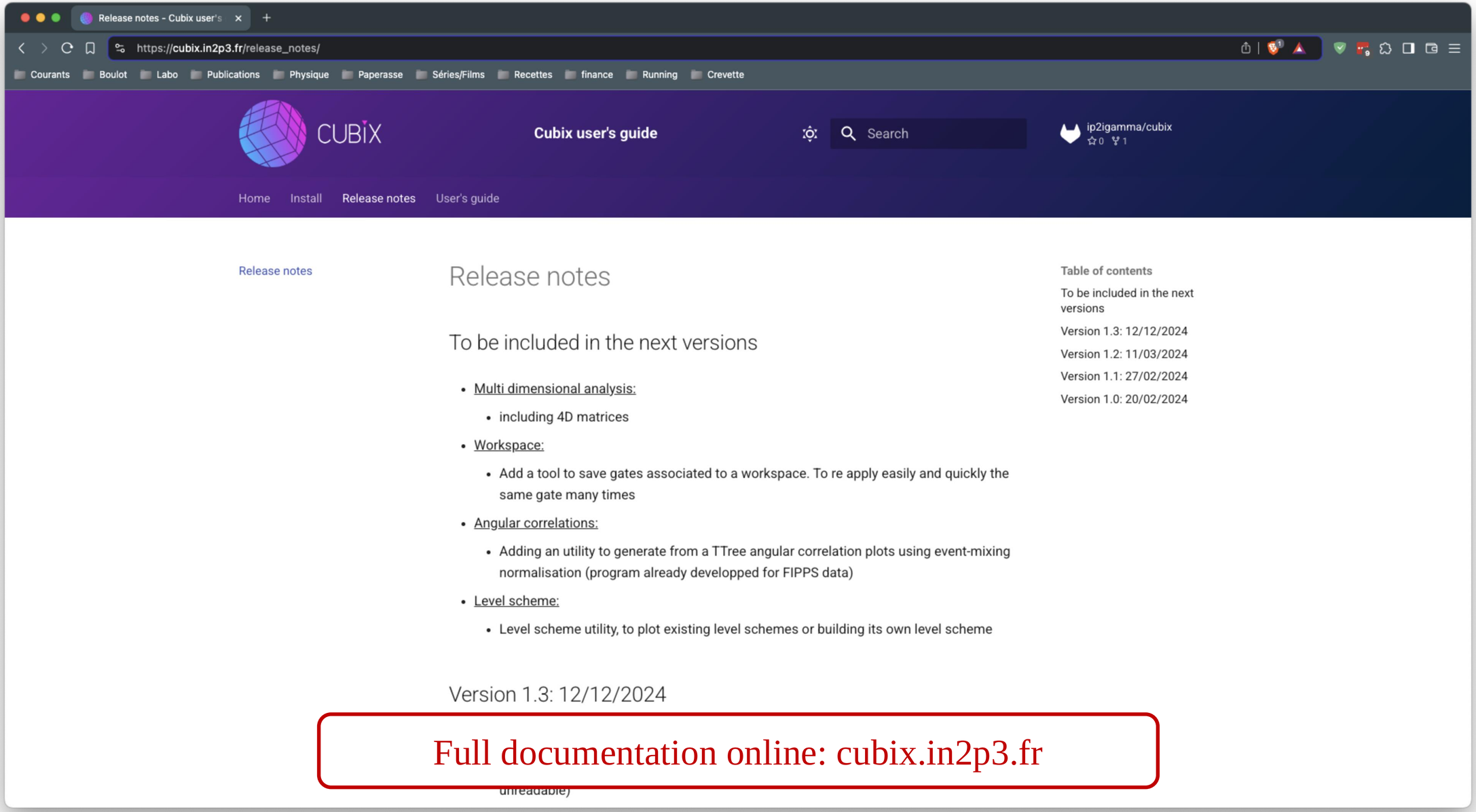
Contacts

Contributions

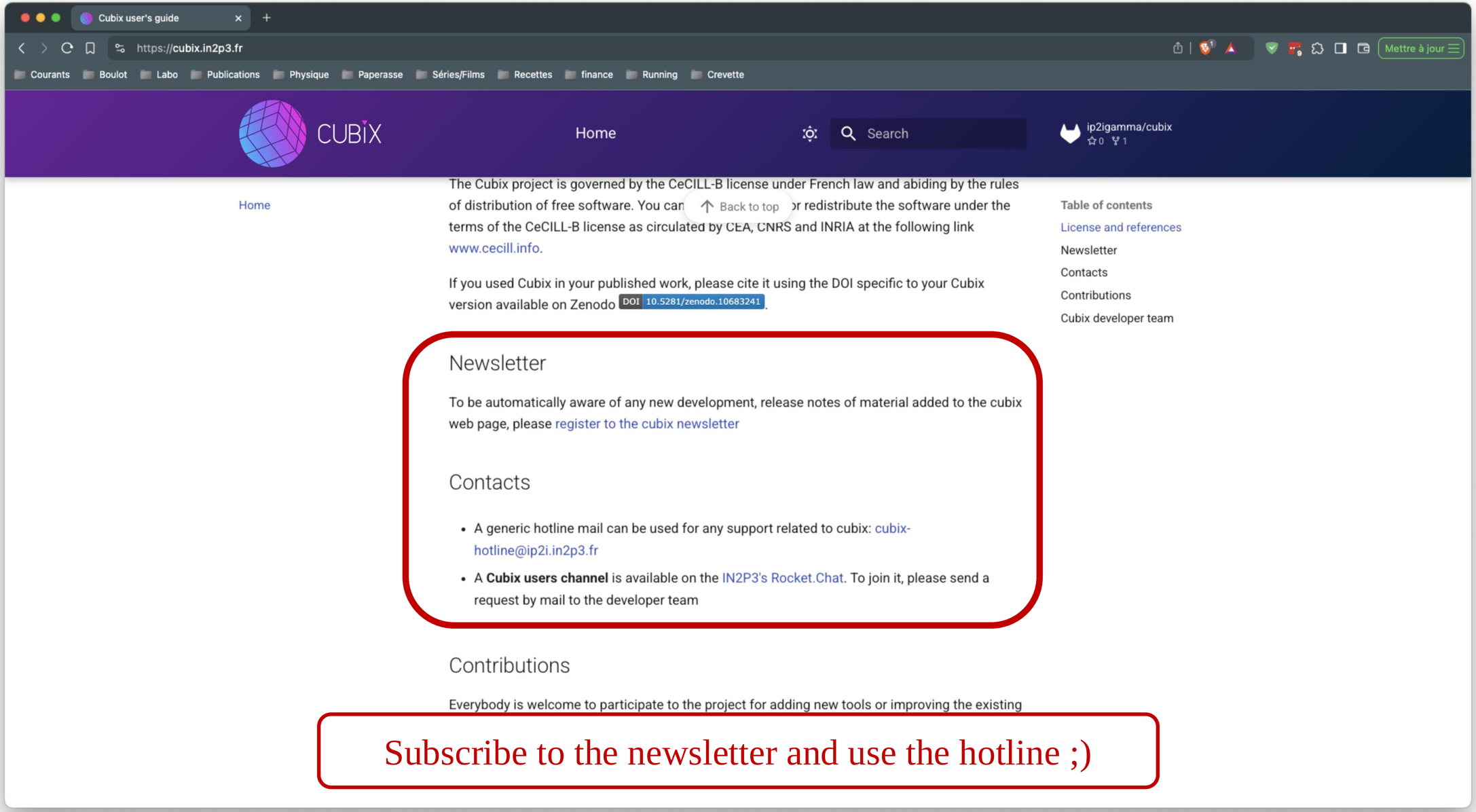
Cubix developer team

Full documentation online: cubix.in2p3.fr

- fit peaks, perform coincidence analysis, estimate backgrounds



Full documentation online: cubix.in2p3.fr



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