AGATA Analysis Workshop 2025

PostPSA Calibration

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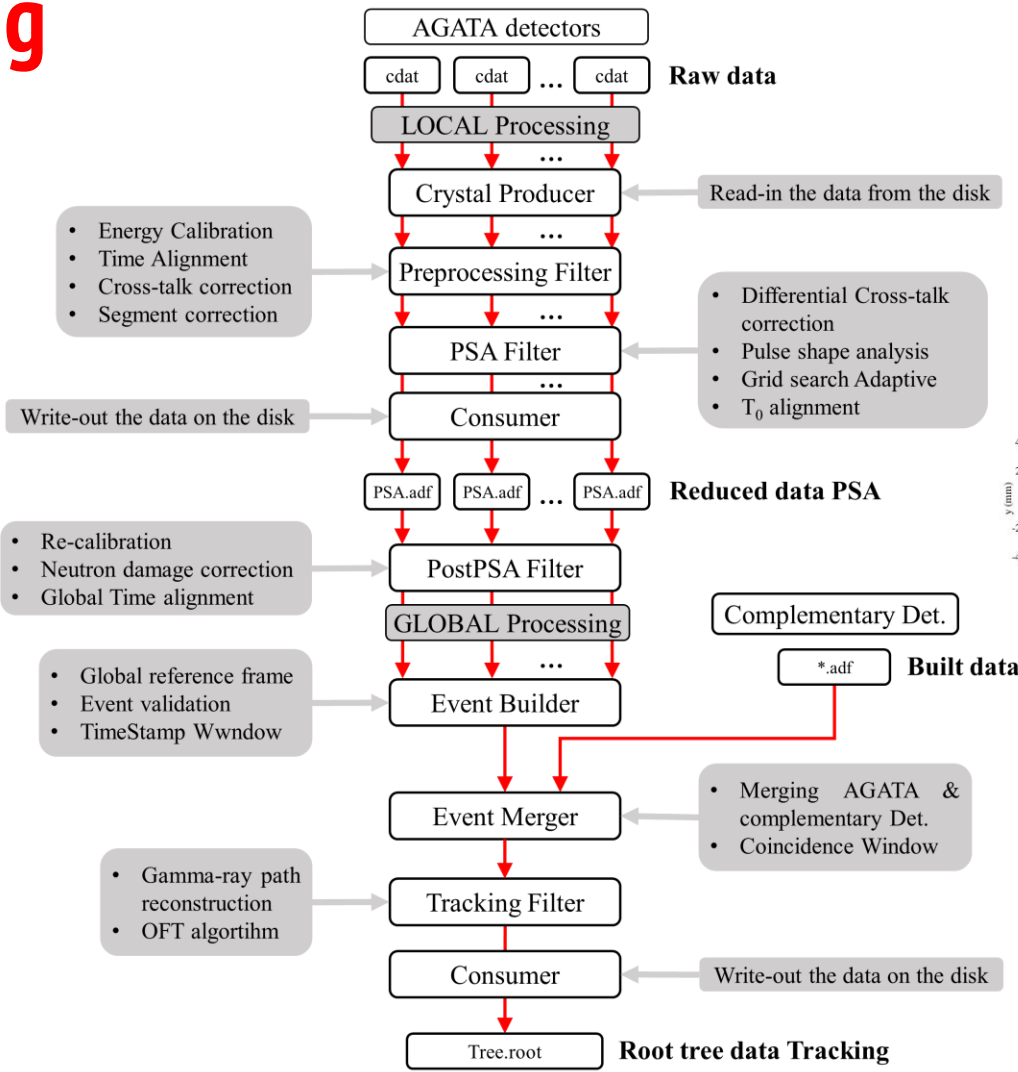
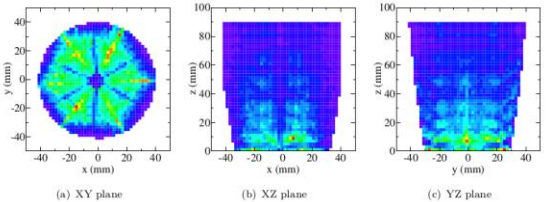
Data Processing

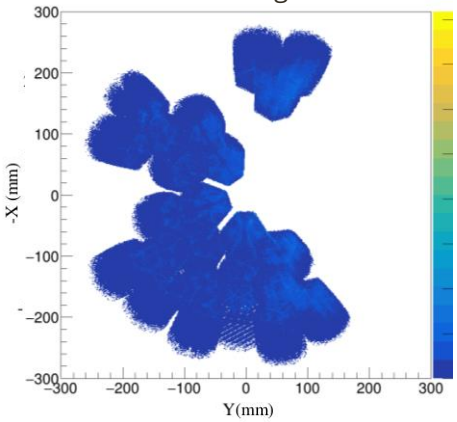
Narval actors



Pulse Shape Analysis



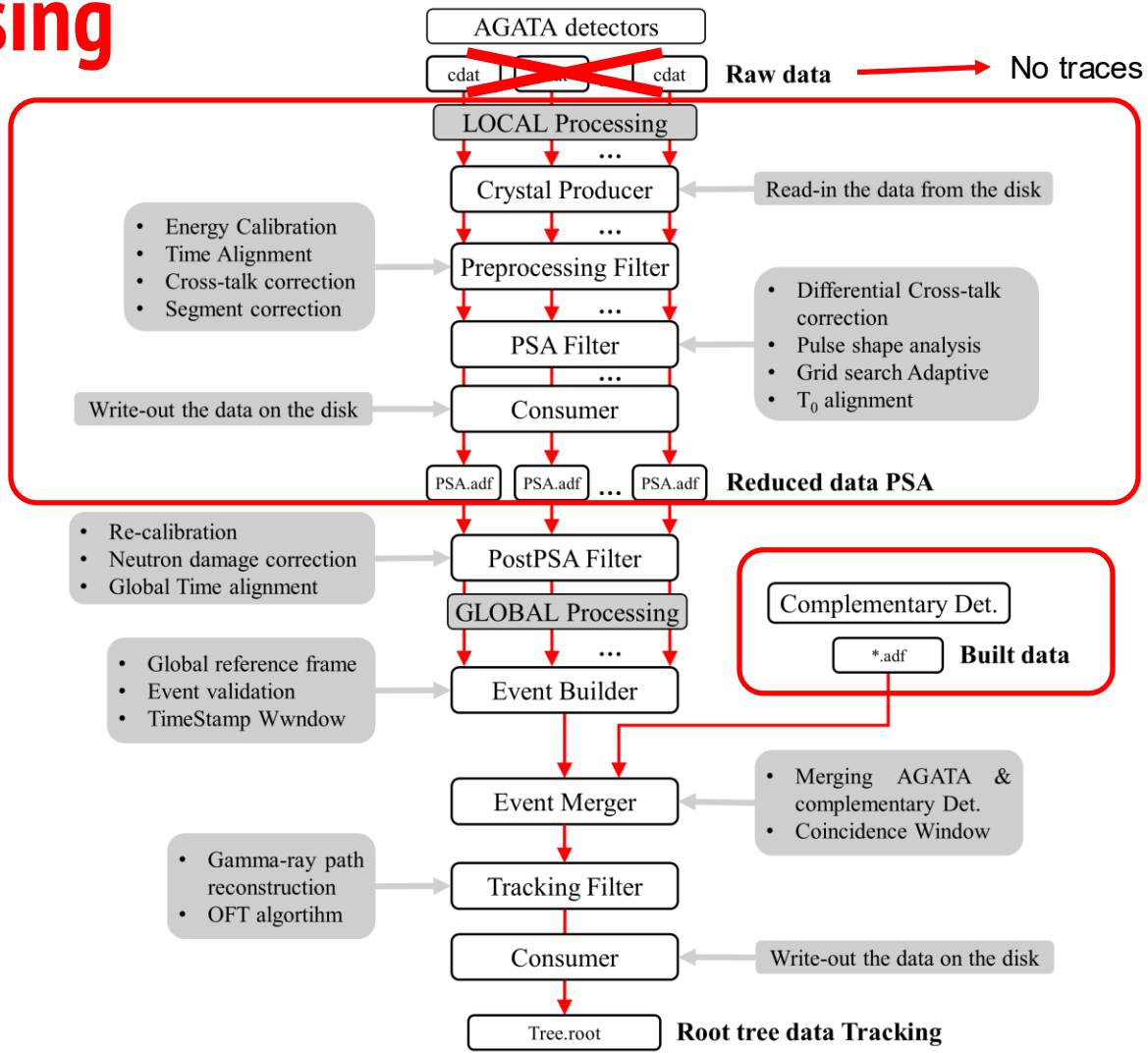
Tracking



First Interaction pattern

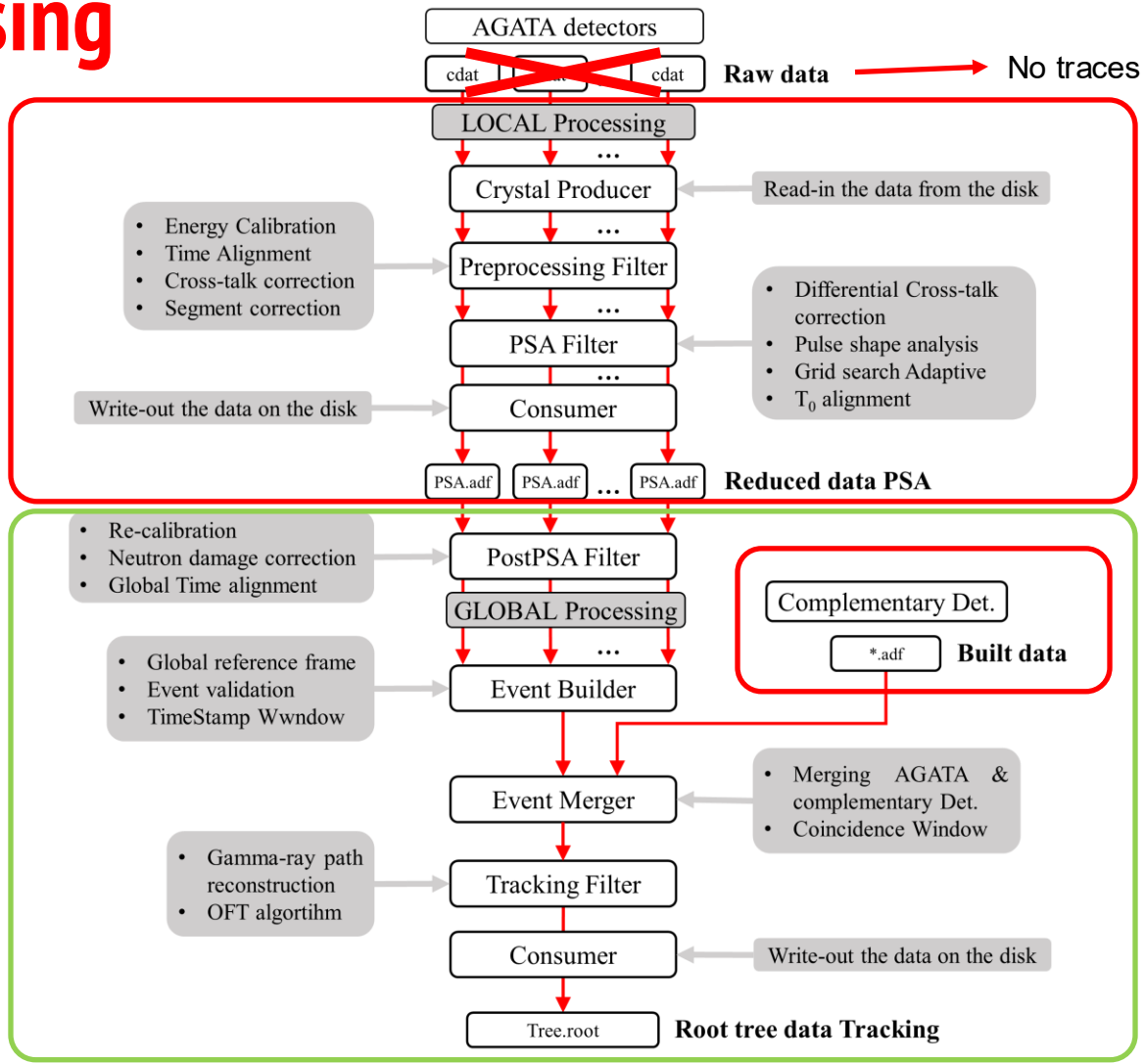
Data Processing

Narval actors



Data Processing

Narval actors

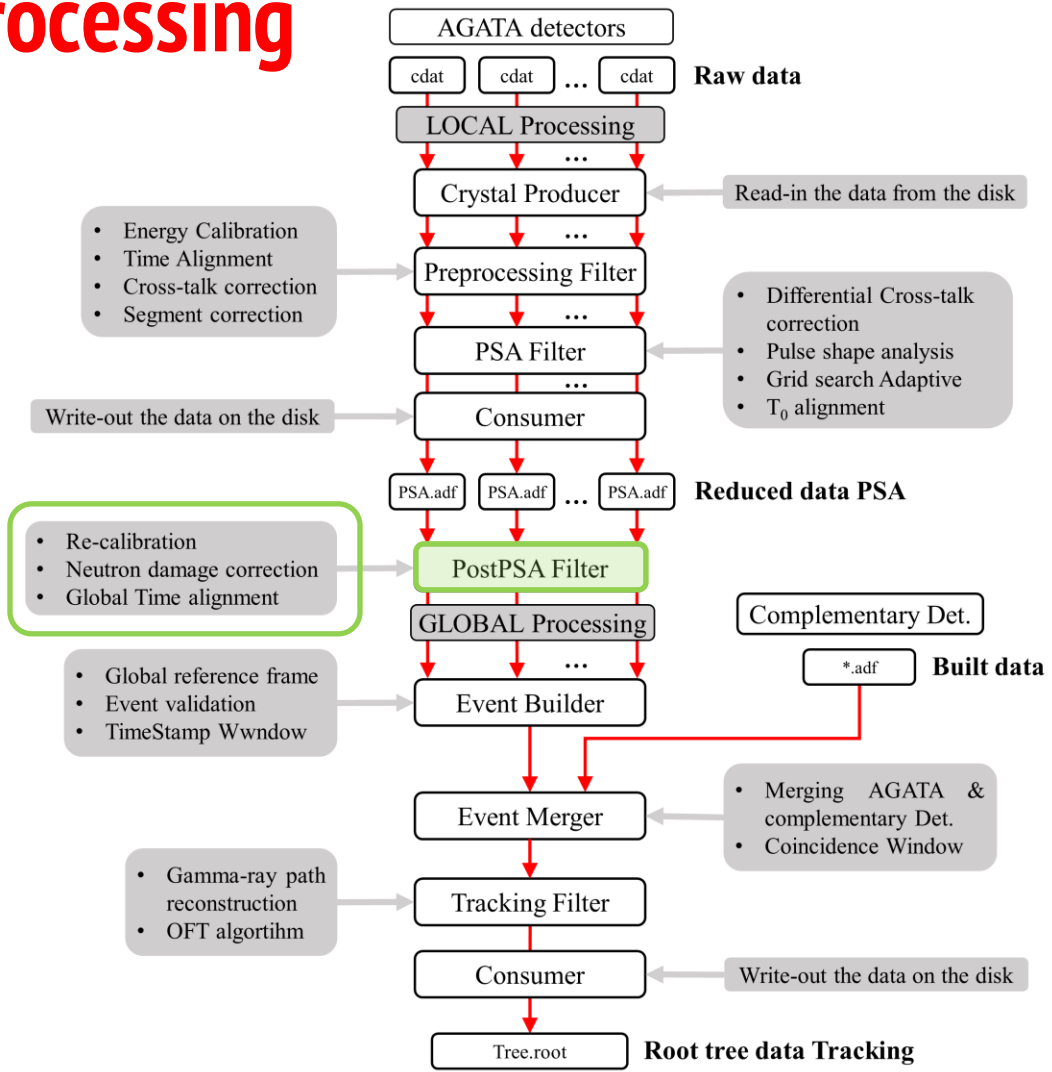


Online
Configuration prepared before the experiment

Nearline/Offline
Configuration prepared after the experiment

Local Level Processing

Narval actors



Local Level Processing

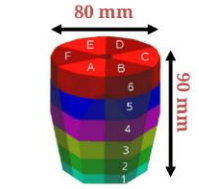
PostPSA Filter

- Performs:
  - Recovery (partial) of neutron damage using info from PSA: **Trapping.cal**
  - Realibration over time (core): **TimeEvoCC.conf**
  - Final energy calibrations with offset: **RecalEnergy2.cal, gen_conf.py**
  - Force segments to core (optional) : **gen_conf.py**
  - Global Time alignment: **gen_conf.py**
- **Configuration for this actor can be done by users during/after the experiment**
- Generates one file:
  - Post__5-40-16384-UI__Ener.spec → **File in Out/00A e.g.**

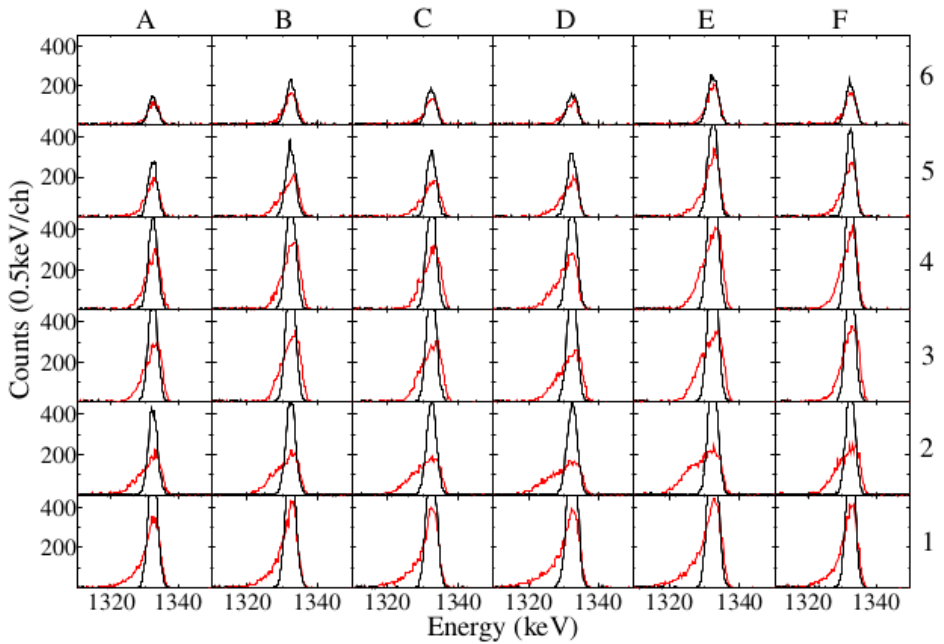
Files in Conf/00A e.g. gen_conf.py its outside the configuration directory

PostPSA Filter

1. Neutron Damage correction



- **Fast neutrons** are well known to produce specific lattice defects in germanium crystals which act as **efficient hole traps.**
- Reduction in the charge collection efficiency of the detectors observable by **a low energy tailing** on the energy line shape
- AGATA crystals are n-type HPGe detectors, which are found to be less sensitive to the neutron radiation in terms of central contact signals
- The energy deficit can be **corrected using the position information obtained by the PSA**



SortPsaHits program applies to the PSA hits a grid of **correction parameters for the electron and hole trapping**, determining the optimum set parameters for all the detector channels **that minimizes the FWHM and the tail on the left** side of the energy peaks in the spectra.

PostPSA Filter

1. Neutron Damage correction

Replay to generate Psa__0-16-F__Hits.fdat files
femul key in PSAFilter: `"WritePSAHits",`

What is needed:

- Long 60Co run
- PSA hits file : Data/{crystalID}/**Psa__0-16-F__Hits.fdat**
- Conf File: **Trapping.cal, gen_conf.py**
- Auxiliary files: Pso__2-4-40-2048-UI__Ener.spec
- Programs/scripts:

femul key in PostPSAFilter:
`"Trapping Trapping.cal",`
Add it in gen_conf.py

SortPsaHits: get the optimum lambdaE lambadaH parameters and generates Pso__2-4-40-2048-UI__Ener.spec

```
SortPsaHits  -f  Psa__0-16-F__Hits.fdat  -best 1300 1350  -bpar 1 10000 0
SortPsaHits -f ../Data/{crystalID}/Psa__0-16-F__Hits.fdat -gain 5 -offs 5000 -fcal Trapping.cal
```

RecalEnergy: generate calibration coefficients for the different columms of Trapping.conf

```
RecalEnergy -spe Pso__2-4-40-2048-UI__Ener.spec -num 40 -sub 0 -offs -5000 -gain 5 -noTR -dwa 25 2 | tee Recal_SG_orig.txt
```

colupdate.py: add these coefficients to the different columns of Trapping.conf

```
./colupdate.py -c 1 13 Trapping.cal Recal_SG_orig.txt -o Trapping.cal
```

3 steps process

1. RecalEnergy, SortPSAHits (Check) [Optional]
2. SortPSAHits (Check)
3. RecalEnergy, SortPSAHits (Check)

The Trapping.cal file has 36 lines, one per segment:

```
#SG gainSG_orig gainCC_orig lambdaE lambdaH gainSG_corr gainCC_corr
 0          1.          1.   51.6     6.6          1.          1.
 1          1.          1.  269.3     6.6          1.          1.
 2          1.          1.   51.6     6.6          1.          1.
...
 35         1.          1.  104.4     8.9          1.          1.
```

More details in AGATA_LLP_UsersGuide

PostPSA Filter

1. Neutron Damage correction

Replay to generate Psa__0-16-F__Hits.fdat files
femul key in PSAFilter: `"WritePSAHits",`

What is needed:

- Long 60Co run
- PSA hits file : Data/{crystalID}/**Psa__0-16-F__Hits.fdat**
- Conf File: **Trapping.cal, gen_conf.py**
- Auxiliary files: Pso__2-4-40-2048-UI__Ener.spec
- Programs/scripts:

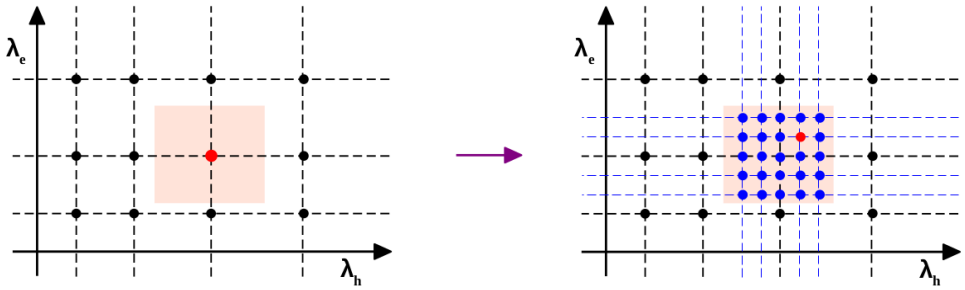
femul key in PostPSAFilter:
`"Trapping Trapping.cal",`
Add it in gen_conf.py

NEW!

Neutron damage correction improvements:

- For SG+CC, we employ a normalization of the whole grid of FOMs (such that the highest FOM has value 1) before calculating the average
- Implementation of an Adaptive Grid – Search

"-size" option: variable grid size, default is kept at nH=100, nE=50
"-algo" option: user must choose number of iterations and which spectra to optimize (0=SG, 1=CC or 2=SG+CC). Default values are 1 2
"zoom" option: user can specify the magnification factor M between iterations. Default is 0.25



Elia Pilotto Agata Week 2024

Example of command:

```
SortPsaHits -f Psa__0-16-F__Hits.fdat -best 1300 1350 -bpar 1 10000 0 -size 50 30 -algo 3 2
```

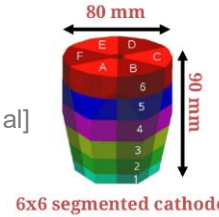
More details in AGATA_LLP_UsersGuide

PostPSA Filter

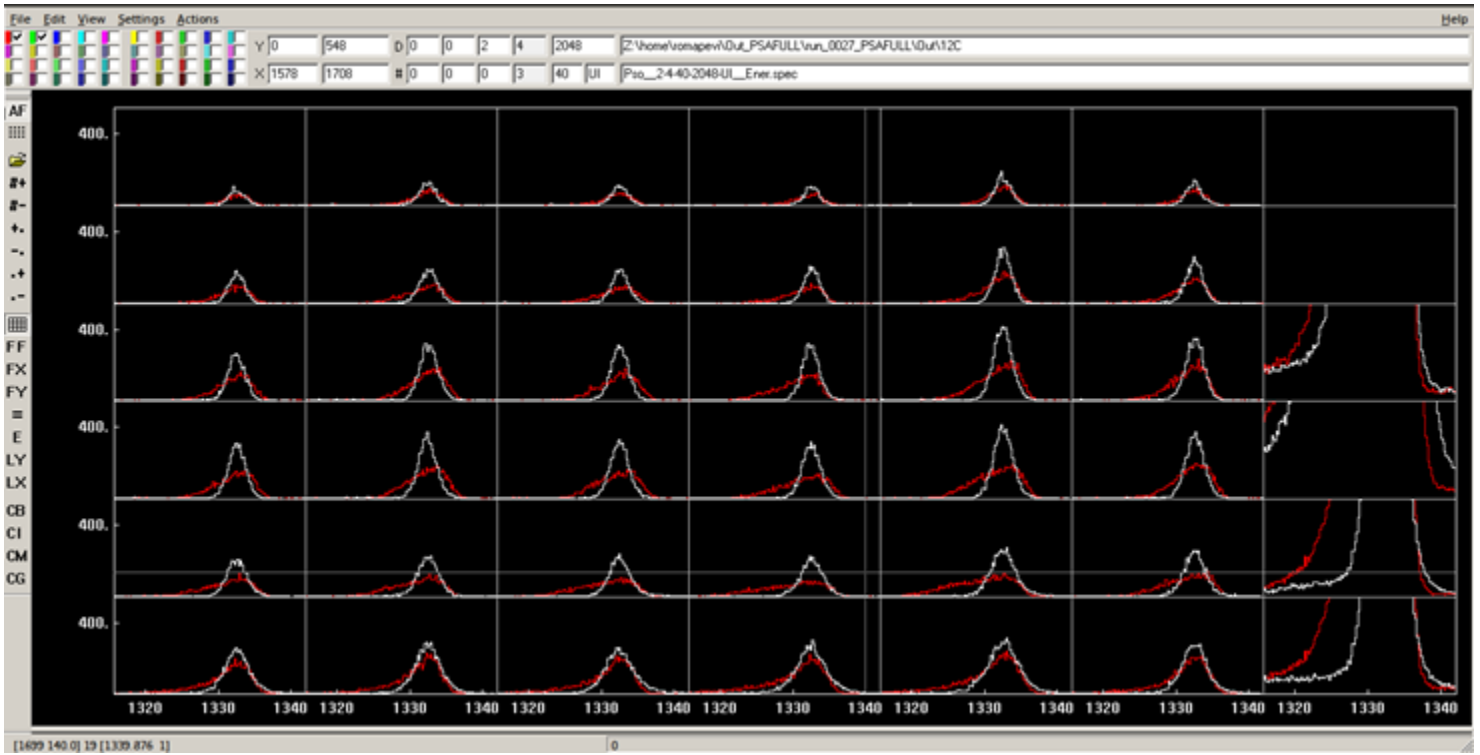
1. Neutron Damage correction

3 steps process

1. RecalEnergy, SortPSAHits (Check) [Optional]
2. SortPSAHits (Check)
3. RecalEnergy, SortPSAHits (Check)



Pso__2-4-40-2048-UI__Ener.spec [0][1][all] before (red) and [0][3][all] after (white) the neutron correction



[0-SG,1-CC]
[0-orig,1-orig+recal,2-corr,3-corr+recal]
[0-39]:

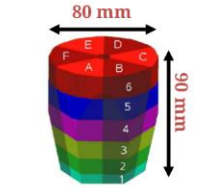
- 0-35 segments
- 36 Or of segments/cores
- 37 Or of segments/cores M=1
- 38 Sum of segments/cores
- 39 Average SumSegs+SumCC

#SG	gainSG_orig	gainCC_orig	lambdaE	lambdaH	gainSG_corr	gainCC_corr
0	1.	1.	51.6	6.6	1.	1.
1	1.	1.	269.3	6.6	1.	1.
2	1.	1.	51.6	6.6	1.	1.
...						
35	1.	1.	104.4	8.9	1.	1.

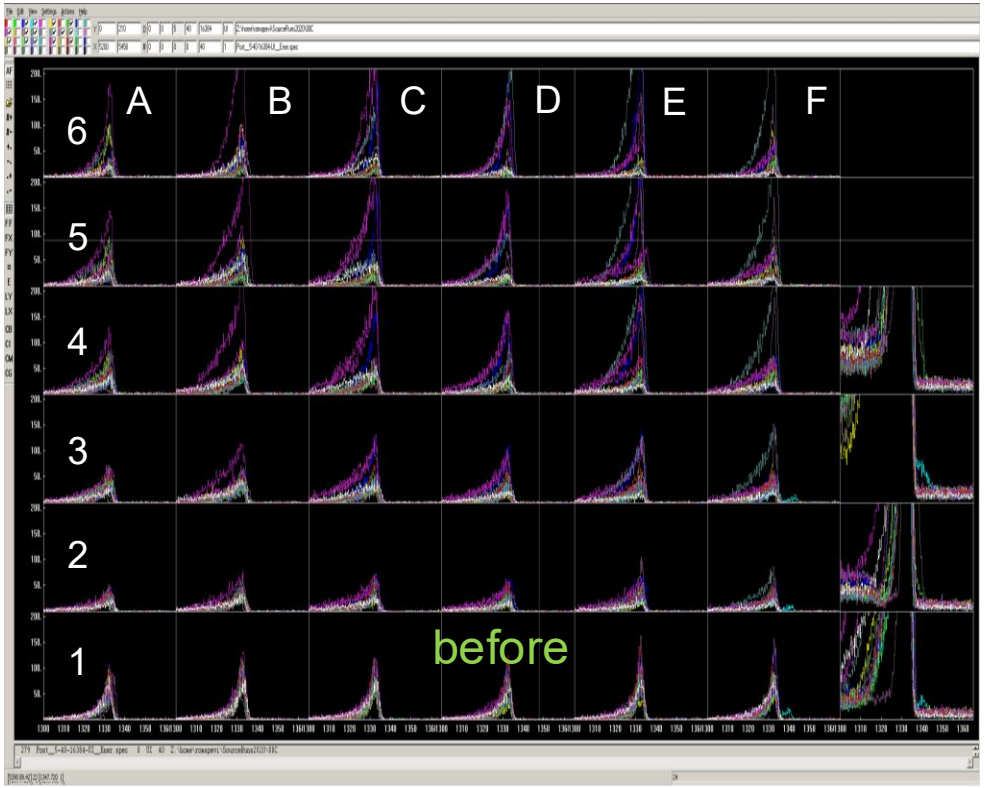
PostPSA Filter

1. Neutron Damage correction

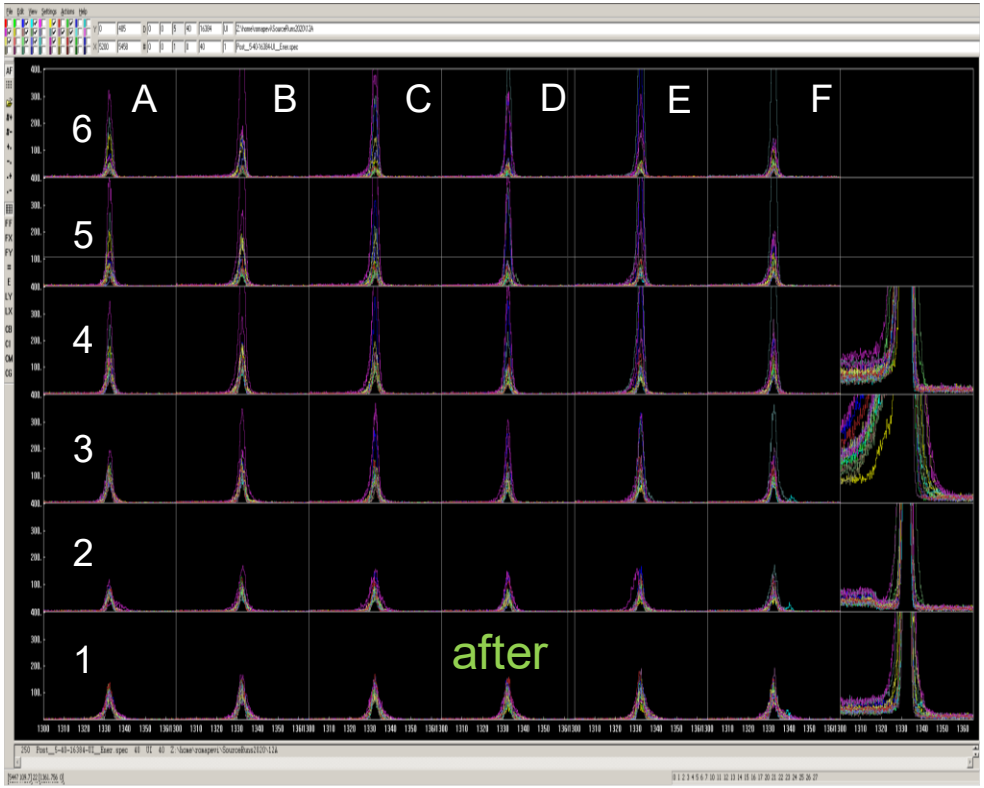
Verification with femul replay



Post__5-40-16384-UI__Ener.spec [0] [0-39]



Post__5-40-16384-UI__Ener.spec [1] [0-39]



PostPSA Filter

2. Recalibration

The recalibration of segments and cores is a several steps process and one must be careful of the possible redundant calibration done by the PostPSA filter actor:

0) Recalibration of Segments from file RecalEnergy1

1) Recalibration of Segments and Cores from the Trapping file

Filling histograms libraries 0 to 3 in PostSpecEner

2) Correction for energy drifting over time (Core energy)

3) Recalibration of Segments from file RecalEnergy2

4) Core recalibration from RecalCC and Segments recalibration from RecalSG

6) Force segments to core

Filling histograms library 4 in PostSpecEner

More details in AGATA_LLP_UsersGuide

PostPSA Filter

2. Recalibration

The recalibration of segments and cores is a several steps process and one must be careful of the possible redundant calibration done by the PostPSA filter actor:

~~Recalibration of Segments from file RecalEnergy1~~ ➡ Typically not used

~~Recalibration of Segments and Cores from the Trapping file~~ ➡ performed in the neutron damage correction

Filling histograms libraries 0 to 3 in PostSpecEner

0) Correction for energy drifting over time (Core energy) **NEW!**

1) Recalibration of Segments from file RecalEnergy2

2) Core recalibration from RecalCC and Segments recalibration from RecalSG

3) Force segments to core

Filling histograms library 4 in PostSpecEner

More details in AGATA_LLP_UsersGuide

PostPSA Filter

Replay to generate ROOT files
femul Topology_Global_Tree.conf

2.0 Recalibration: Correction for energy drifting over time

What is needed:

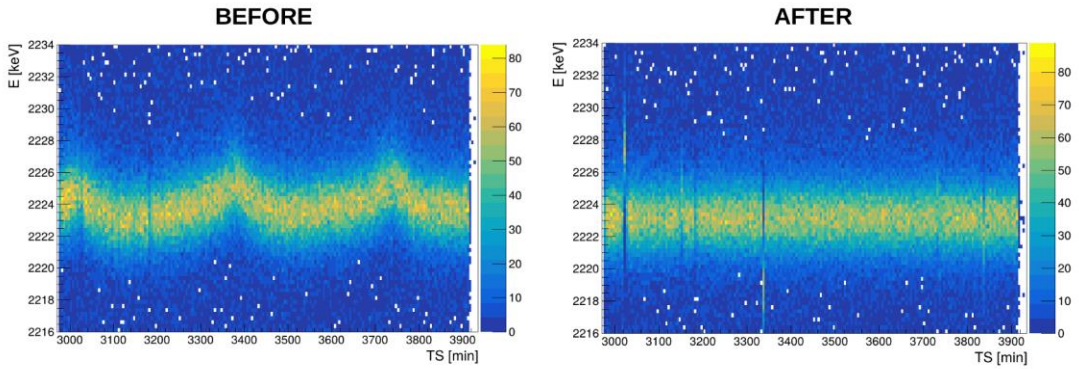
- Long run with high energy transitions
- Root file : Out/Analysis/**Tree_0000.root**
- Conf File: **TimeEvoCC.conf, gen_conf.py**
- Programs/scripts:

NEW!

Cross – correlation Correction Method (CCM)

[Matus Balogh NIM paper]
[GitHub code]

- Create a matrix Core energy versus time and divide in slices
- For each a projection, calculate product between a reference spectrum and the shifted projection
- Perform a scan for each slice



- It has been observed that especially when using the lower energy gain of the core contact gain oscillations of the order of 1/1000 can occur
- Pseudo – periodic with 6h period (AGATA filling)
- More pronounced in detectors placed in the lower part of Agata, pointing upwards
- To be corrected before the recalibration with offset of the core (RecalCC)

The TimeEvoCC.conf file must contain three columns with the following format:

```
#TS_start            TS_stop             gain
6150000000000        6210000000000       0.999948755522396
6210000000000        6270000000000       0.999887585155303
…
```

femul key in PostPSAFilter:
"TimeEvoCCFile TimeEvoCC.conf","
Add it in gen_conf.py

More details in [AGATA_LLP_UsersGuide] and [Elia Pilotto Agata Week 2024]

PostPSA Filter

2.1 Recalibration: RecalEnergy2

3 steps process

Verification with femul replay each step

1. RecalEnergy2 (Check)
2. RecalCC and RecalSG (Check)
3. ForceSegmentstoCore (Check)[Optional]

What is needed:

- Long 152Eu run
- PostPSA file : Out/{crystalID}/**Post__5-40-16384-UI__Ener.spec**
- Conf File: **RecalEnergy2.cal, gen_conf.py**
- Auxiliary files: Recal2.txt
- Programs/scripts:

RecalEnergy: generate calibration coefficients

The RecalEnergy2.cal file has 36 lines, one per segment:

```
#segm %d(id)      %f(offset)    %f(egain)
 segm     0         0.216        1.001157
 segm     1         7.040        0.996854
 segm     2        -0.732        1.003805
 ...
 segm    35        -1.083        1.002038
```

```
RecalEnergy -spe Out_norecal/{crystalID}/Post__5-40-16384-UI__Ener.spec -sub 160 -num 36 -gain 4 -poly1 -152Eu
```

```
# indx  #spec #pks #ok   rEnergy     FW05      FW01       Area  Position  Width   Ampli    WTML    WTMR  slope*gain rChi2%   offs1*g   slope1*g rChi2%
#
    0     40   32  10   1408.15    5.032    12.662       4294   5624.78   16.5     171   4.320   1.823    1.001387   1.74     0.216   1.001157   0.42
    1     41   18   8   1409.43    9.080    18.768       2425   5614.94   36.0      59   2.329   1.823    1.004054 999.99     7.040   0.996854  91.65
    2     42   24  10   1407.05    7.637    17.111       3068   5611.22   29.1      85   2.861   1.823    1.003023  52.70    -0.732   1.003805  41.66
    3     43   25   9   1407.38    5.256    13.774       3854   5624.43   15.7     144   5.210   1.823    1.000901  29.62    -1.073   1.001038   2.44
    4     44   20   9   1408.21    4.658    12.739       2799   5621.39   12.1     116   6.562   1.823    1.002036   6.53     0.213   1.001812   6.24
    5     45   14   9   1408.15    4.126    10.131       1331   5623.55   14.1      65   3.909   1.823    1.001609  37.60    -0.389   1.002013  38.46
    6     46   29  10   1407.69    5.470    13.087       4393   5626.02   19.5     165   3.546   1.823    1.000845   9.79     0.293   1.000532   8.18
    7     47   22  10   1408.45    6.756    17.530       2612   5619.43   20.6      76   4.964   1.823    1.002556  21.86     0.213   1.002329  23.10
    8     48   22  10   1406.20    7.643    17.149       3859   5615.23   29.2     107   2.873   1.823    1.001704  58.23    -0.356   1.002085  61.32
    9     49   27   5   1408.70    7.257    18.956       4738   3839.23   17.0     186   3.888   2.197    1.467693 919.64     3.908   1.461898 601.93
```

colupdate.py: add these coefficients to the 3rd and 4th columns of RecalEnergy2.cal

```
./colupdate.py -c 2 14 RecalEnergy2.cal Recal2.txt -o RecalEnergy2.cal
./colupdate.py -c 3 15 RecalEnergy2.cal Recal2.txt -o RecalEnergy2.cal
```

More details in AGATA_LLP_UsersGuide

femul key in PostPSAFilter:
"RecalEnergy2 RecalEnergy2.cal",
Add it in gen_conf.py

PostPSA Filter

2.2 Recalibration: RecalCC & RecalSG

3 steps process

Verification with femul replay each step

1. RecalEnergy2 (Check)
2. RecalCC and RecalSG (Check)
3. ForceSegmentstoCore (Check)[Optional]

What is needed:

- Long 152Eu run
- PostPSA file : Out/{crystalID}/**Post__5-40-16384-UI__Ener.spec**
- Conf File: **gen_conf.py**
- Auxiliary files: Recal2.txt
- Programs/scripts:

RecalEnergy: generate calibration coefficients

- For the **core** recalibration with offset

```
RecalEnergy -spe Out_norecal/{crystalID}/Post__5-40-16384-UI__Ener.spec -sub 199 -num 1 -gain 4 -poly1 -152Eu

# indx  #spec #pks #ok   rEnergy     FW05     FW01      Area  Position  Width   Ampli    WTML    WTMR  slope*gain rChi2%   offs1*g   slope1*g rChi2%
#
     0    199   90  10   1408.00    3.048    6.491    214459   5629.83   12.1   15148   2.432   1.869    1.000385   0.32    -0.050   1.000438  0.28
```

- For the s**um of segments** recalibration with ofset **(one gain and offset for all the segments, optional)**

```
RecalEnergy -spe Out_norecal/{crystalID}/Post__5-40-16384-UI__Ener.spec -sub 198 -num 1 -gain 4 -poly1 -152Eu

# indx  #spec #pks #ok   rEnergy     FW05     FW01      Area  Position  Width   Ampli    WTML    WTMR  slope*gain rChi2%   offs1*g   slope1*g rChi2%
#
     0    198   67  10   1408.17    5.674   14.718    179916   5639.15   20.0    6174   2.245   3.643    0.998854   7.87     0.454   0.998371  2.04
```

Add these coefficients to gen_conf.py

femul key in PostPSAFilter:

```
"RecalCC offset egain",
"RecalSG offset egain",
```

More details in AGATA_LLP_UsersGuide

PostPSA Filter

2.3 Recalibration: Force Segments to core

3 steps process

Verification with femul replay each step

1. RecalEnergy2 (Check)
2. RecalCC and RecalSG (Check)
3. ForceSegmentstoCore (Check)[Optional]

- Energy of segments scaled in such a way that their sum equals Energy of Core
- Optional/Experiment dependent

What is needed:

- Source and In-beam data
- PostPSA file and Track files : Out/{crystalID}/**Post__5-40-16384-UI__Ener.spec**
  Out/Merger/**Track__2-24-16384-UI__EC.spec**
  Out/Merger/**Track__2-15-16384-UI__EE.spec**
- Conf File: **gen_conf.py**

femul key in PostPSAFilter:
`"ForceSegmentstoCore",`
Add it in gen_conf.py

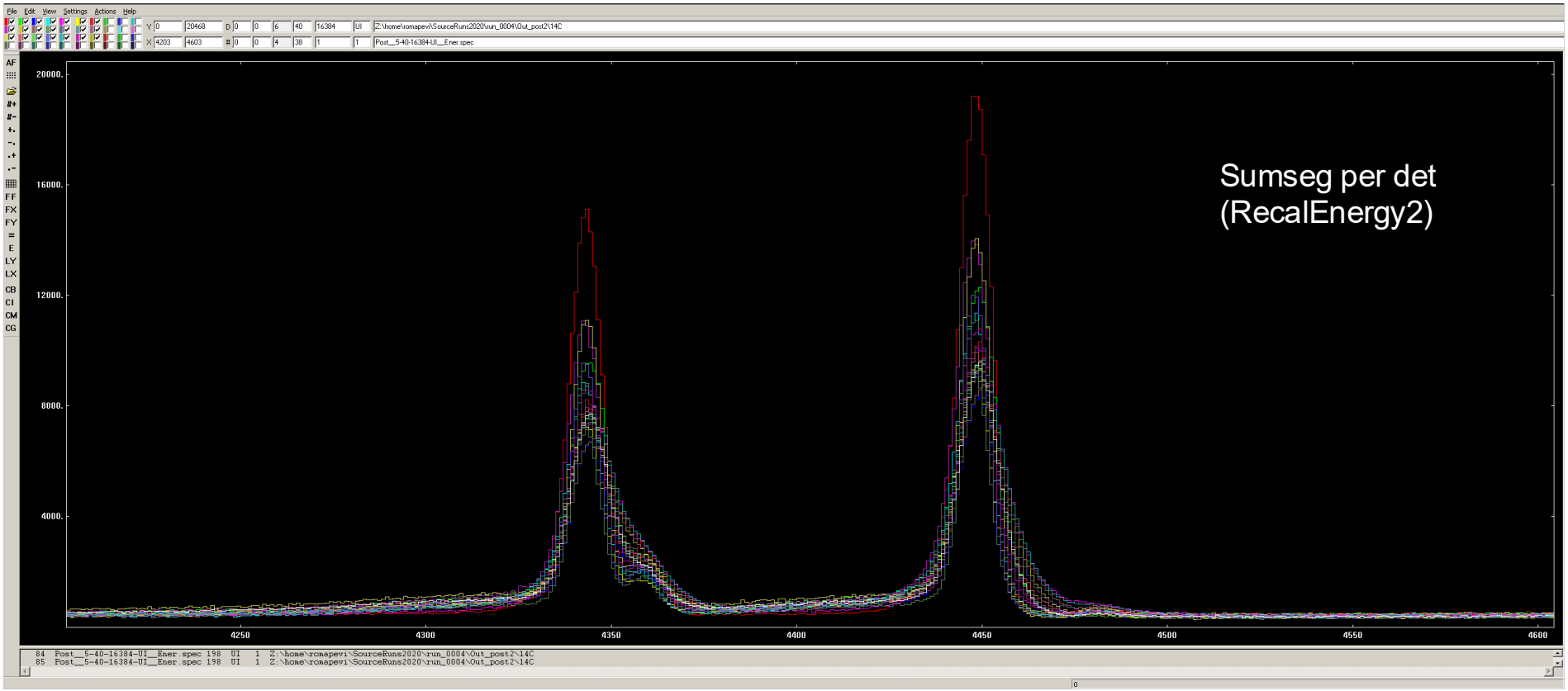
More details in AGATA_LLP_UsersGuide

PostPSA Filter

Verification with femul replay each step

2. Recalibration

Post__5-40-16384-UI__Ener.spec [4] [38]

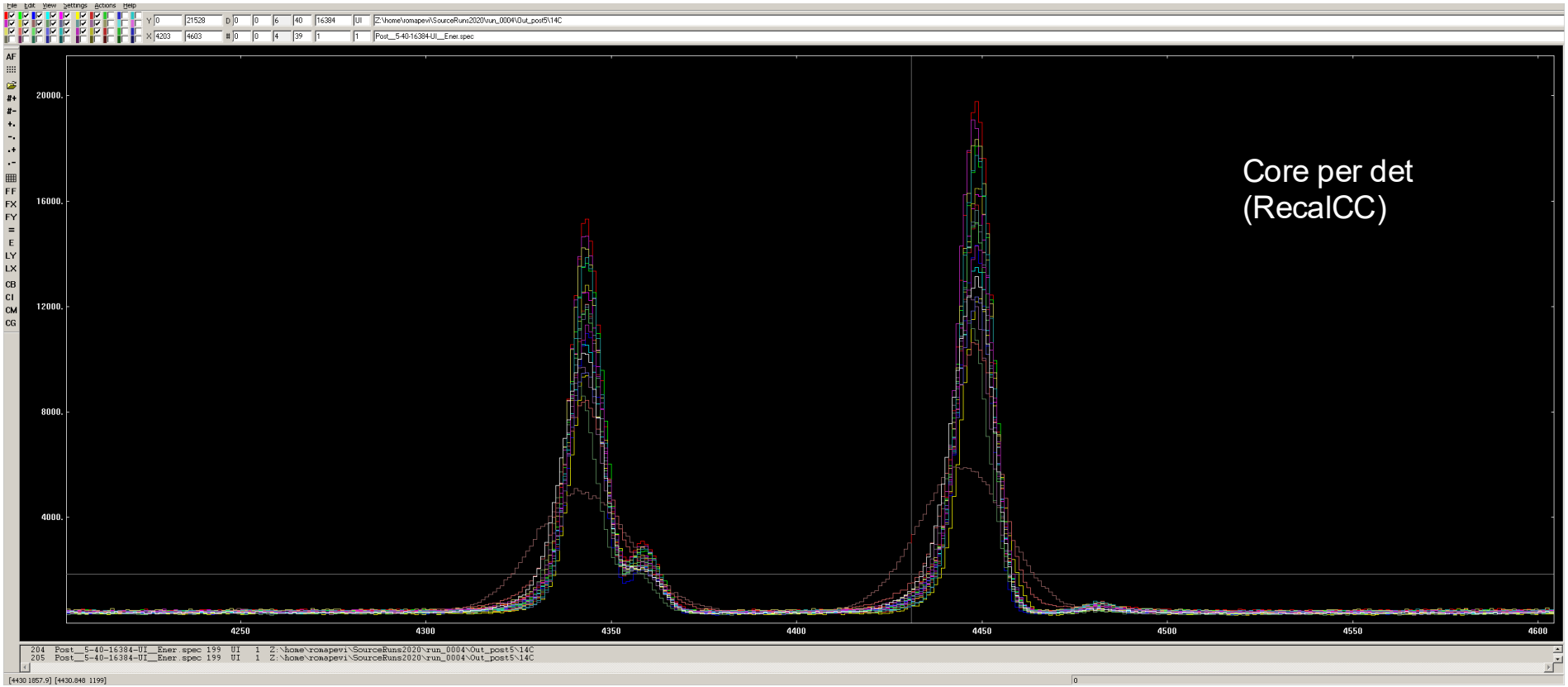


PostPSA Filter

Verification with femul replay each step

2. Recalibration

Post__5-40-16384-UI__Ener.spec [4] [39]

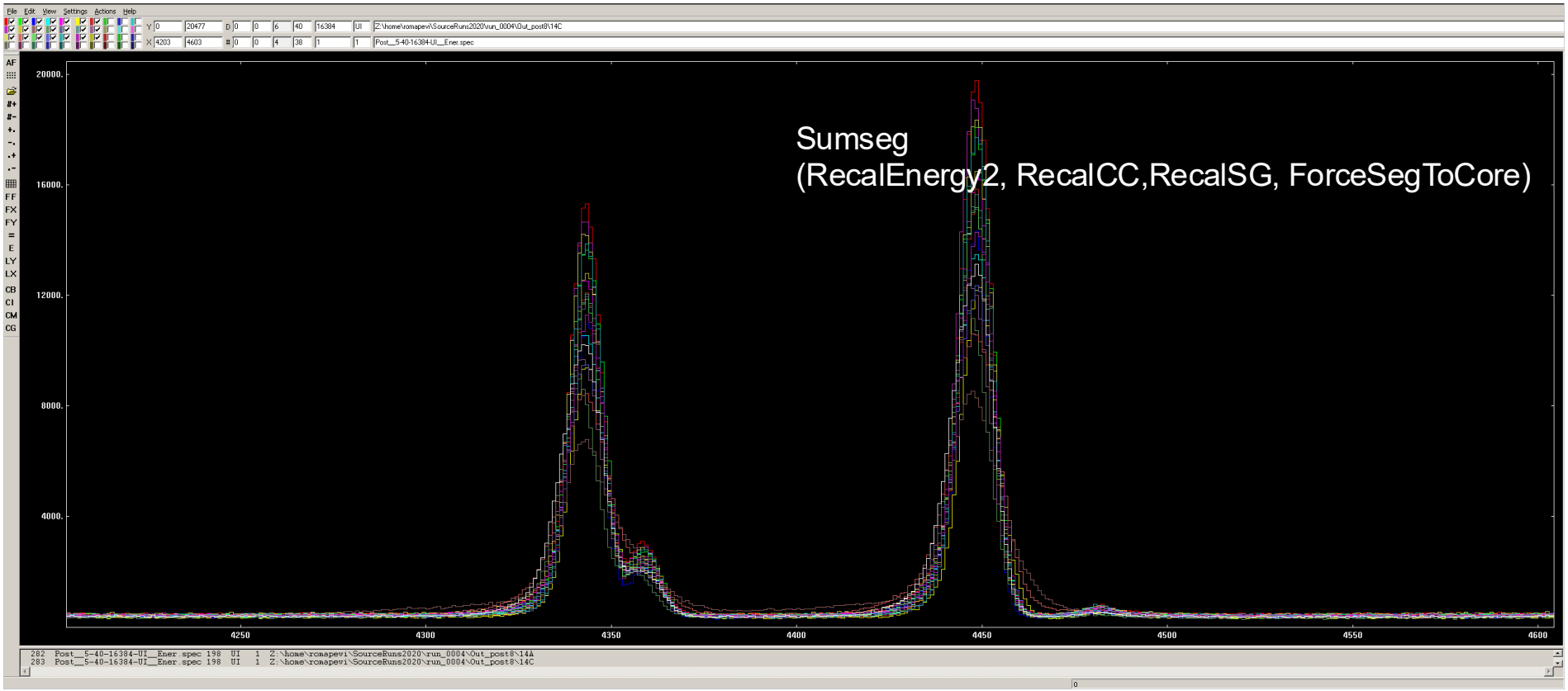


PostPSA Filter

Verification with femul replay each step

2. Recalibration

Post__5-40-16384-UI__Ener.spec [4] [38]

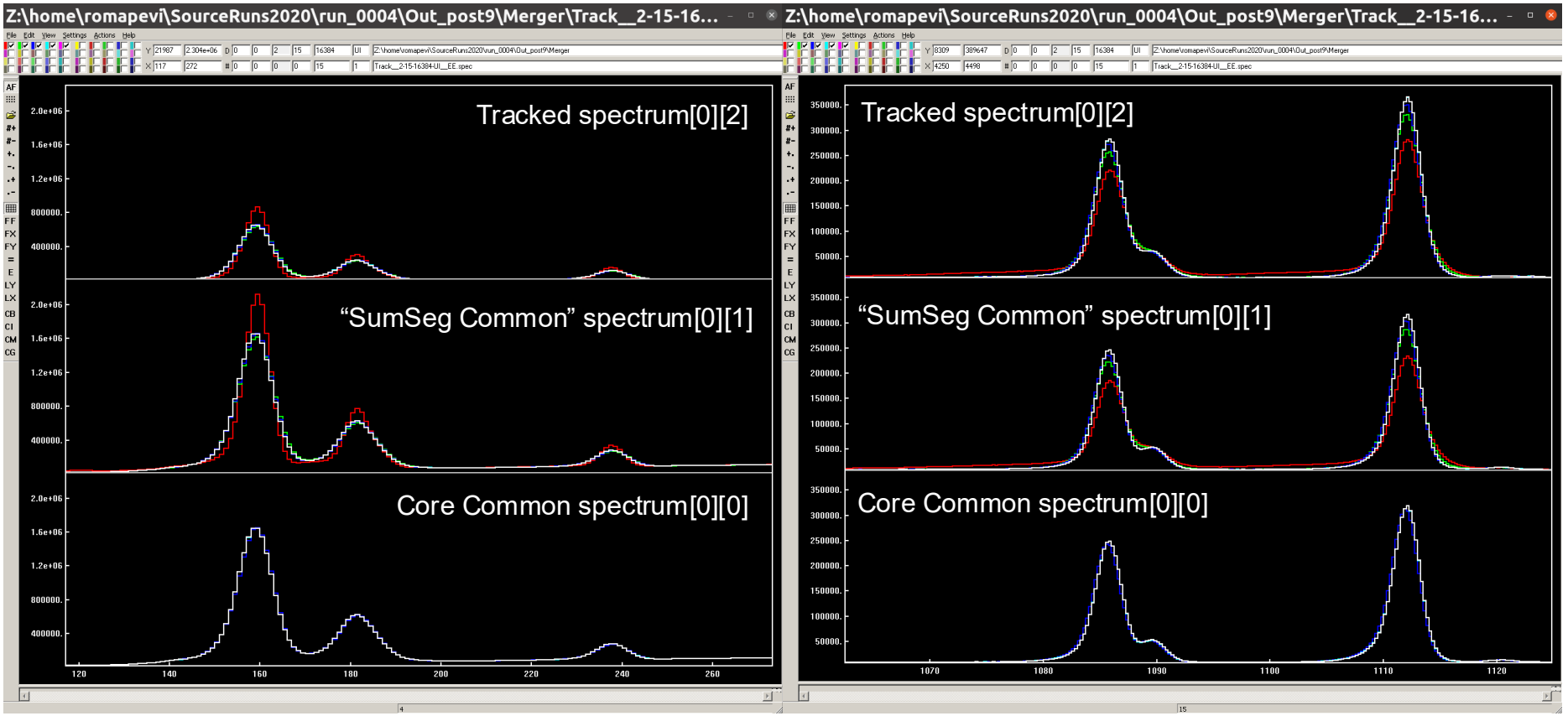


PostPSA Filter

2. Recalibration

No ForceSeg, RecalEnergy2
ForceSeg, RecalEnergy2, RecalCC RecalSG
ForceSeg, RecalEnergy2 no offset, RecalCC RecalSG

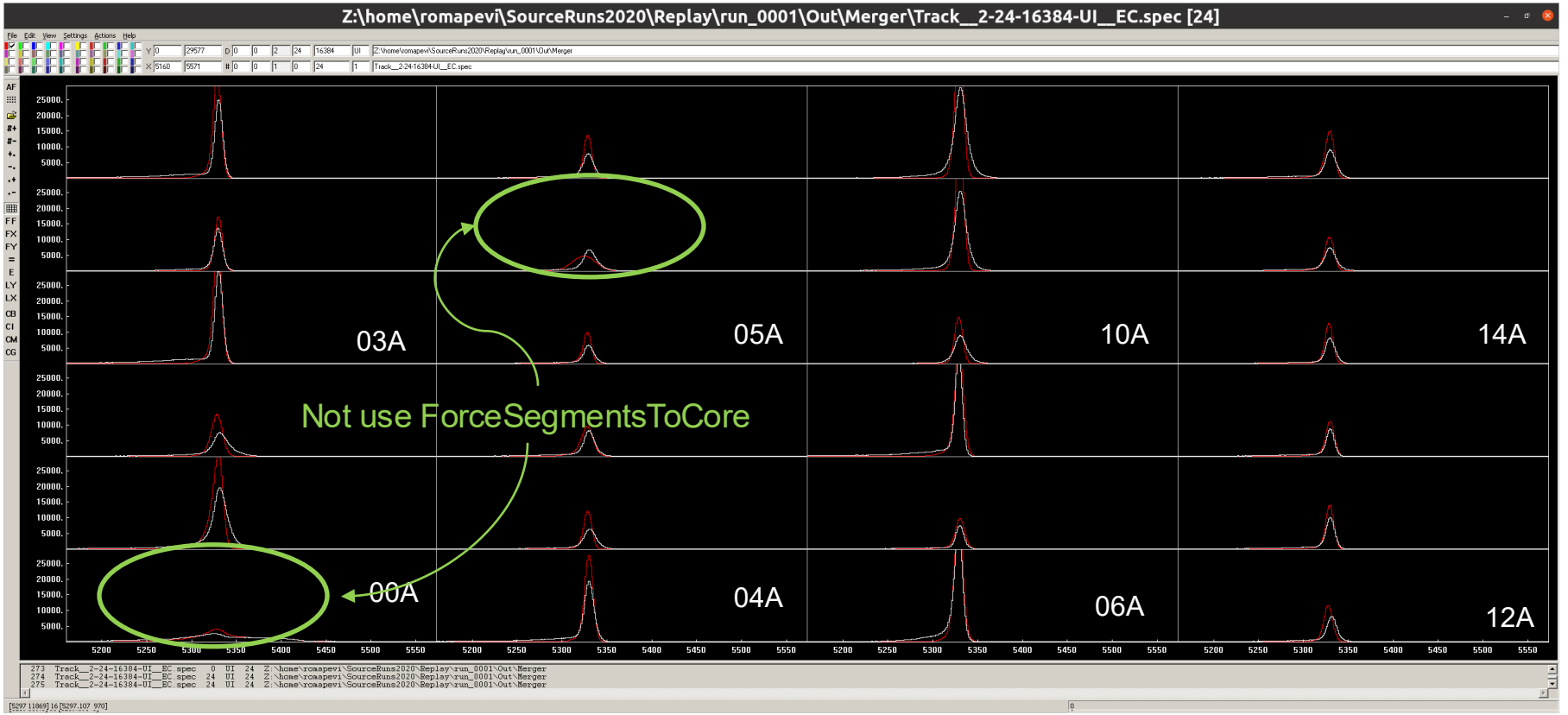
Track__2-15-16384-UI__EE.spec [0][0-2]



PostPSA Filter

2. Recalibration

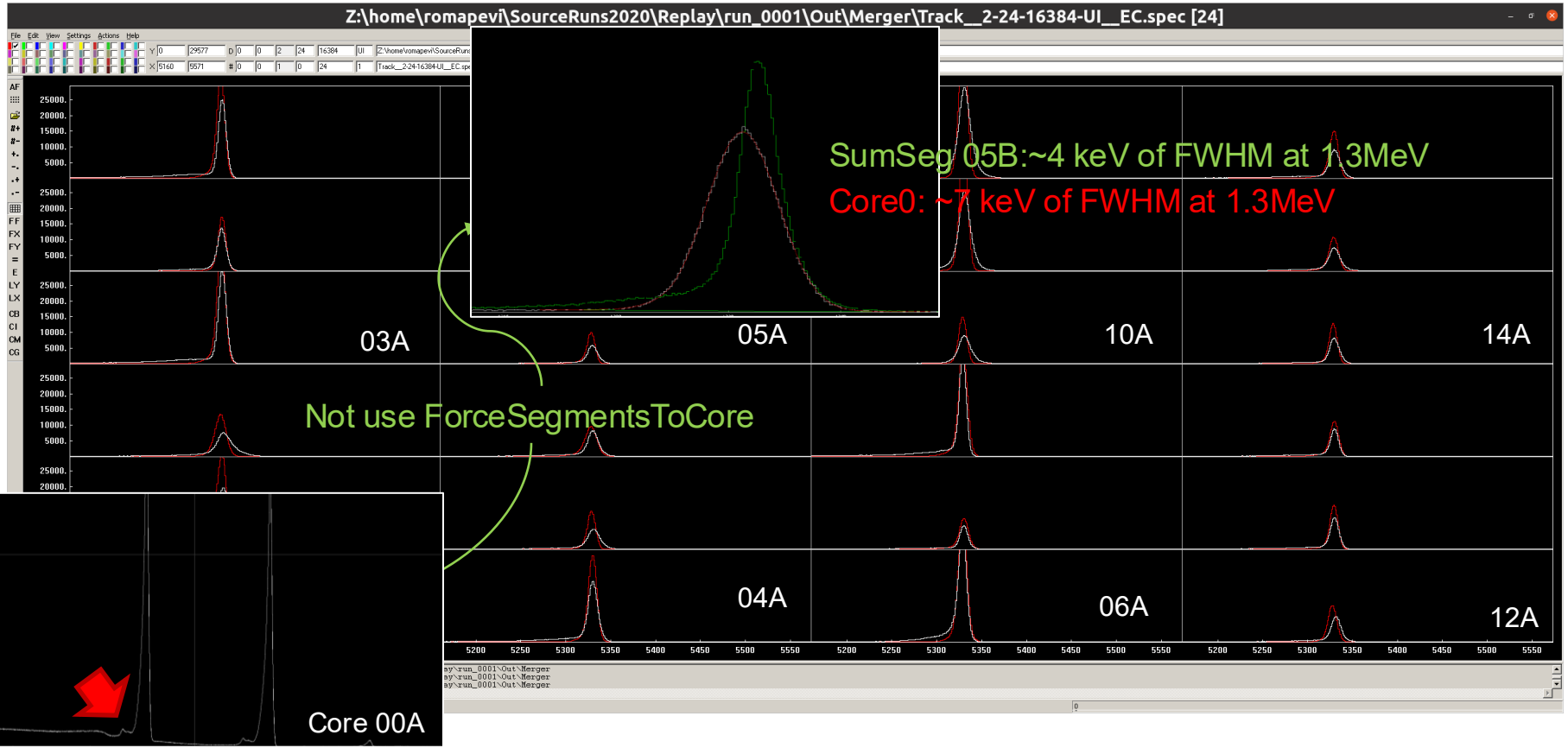
Track__2-24-16384-UI__EC.spec



PostPSA Filter

2. Recalibration

Track__2-24-16384-UI__EC.spec



PostPSA Filter

3. Global time alignment

To be done every time that there is a GTS alignment

2 steps process

1. Replay without coeff
2. Replay with coeff

What is needed:

- Any run
- Spectra file : Data/Merger/**Track__35-35-1000-UI__TT.spec**
- Conf File: **gen_conf.py**
- Auxiliary files: recalT.dat
- Programs/scripts:

RecalEnergy: generate shift coefficients for the N*N time spectra

```
RecalEnergy -spe ../Out/Merger/Track__${N}-${N}-1000-UI__TT.spec -T 500 -num ${NN} | tee recalT.dat
```

```
# indx  #spec #pks #ok   rEnergy     FW05     FW01      Area  Position  Width   Ampli    WTML    WTMR  shift*gain
#
    0      0    1   1    0.00       0.000    0.000        0     0.00      0.0     0      0.000   0.000       0.000
    1      1    1   1    503.37    19.629   44.382     9422     500.85   19.5    400    2.382   2.171      -0.850
    2      2    1   1    501.04    16.180   36.094    11042     500.47   15.8    574    2.604   1.955      -0.473
    3      3    1   1    502.67    16.667   36.949    10726     499.84   16.4    543    2.558   1.958       0.164
    4      4    1   1    503.28    17.366   40.384     8202     499.65   17.1    388    2.484   2.231       0.350
   ...
```

solveTT.py:find the best shift combination.

```
${pathSoftware}/solveTT.py -f recalT.dat -n ${N} -c 13 -p 500
```

```
Shifts that minimize Chi2
0.001
-0.181
0.004
-0.087
0.040
-0.239
...
```

femul key in PostPSAFilter:
"TimeShiftCC coeff",

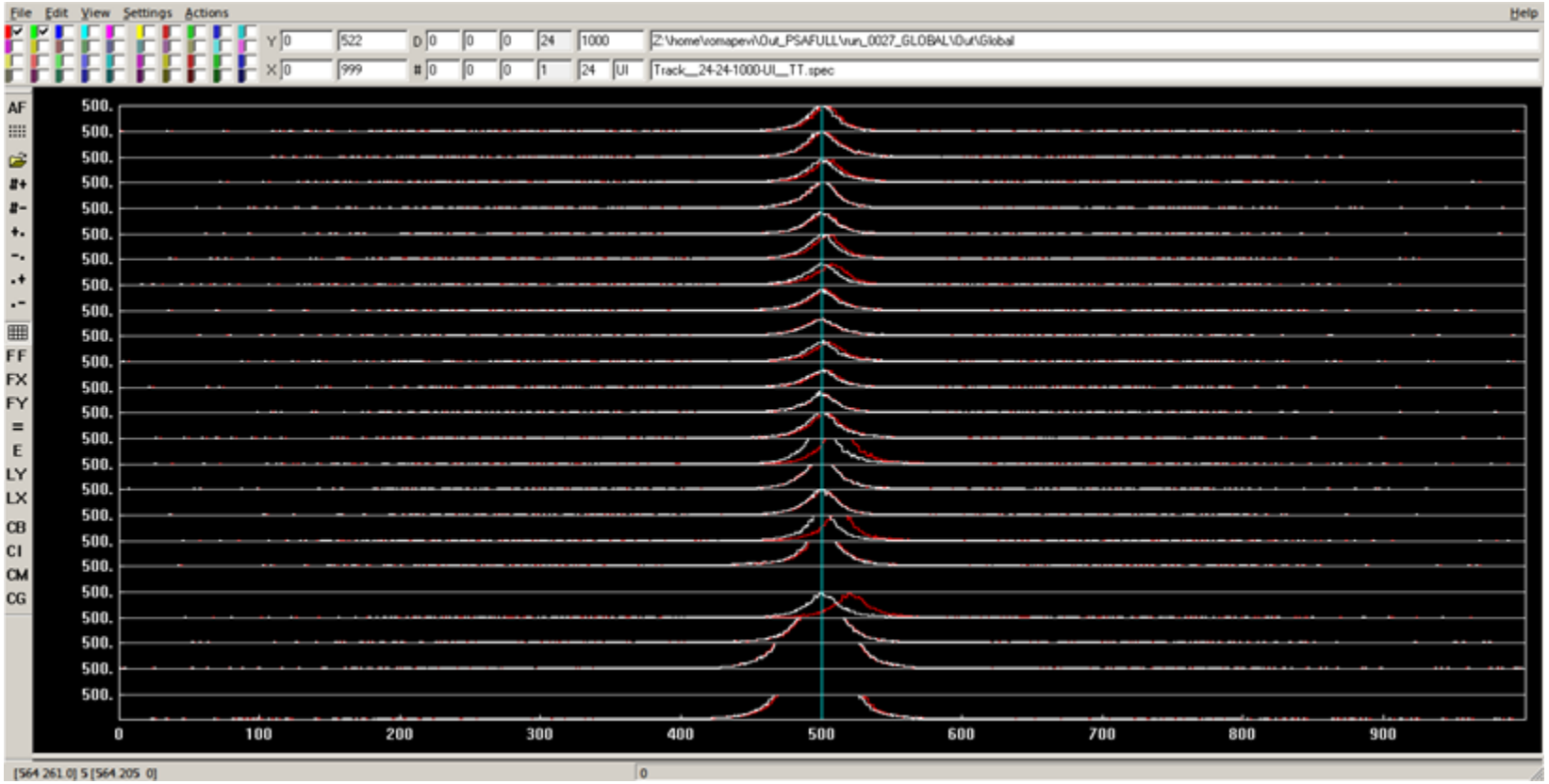
More details in AGATA_LLP_UsersGuide

PostPSA Filter

Verification with femul replay

3. Global Time Alignment

Track__24-24-1000-UI__TT.spec example detector 00B [0][all] red before, white after time alignment

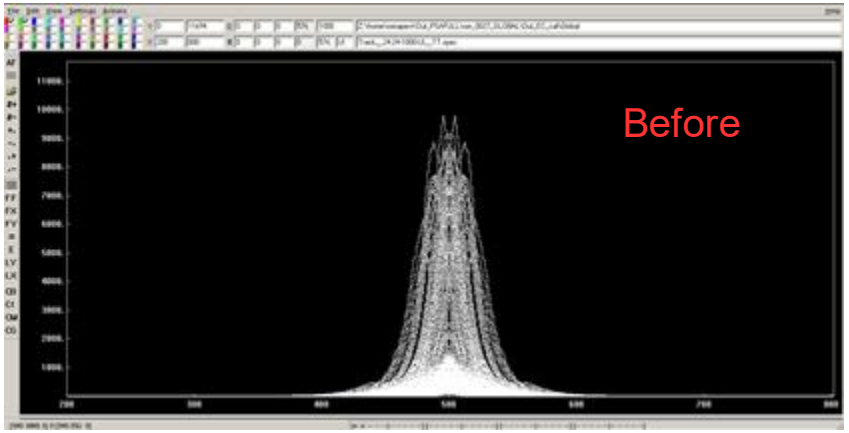


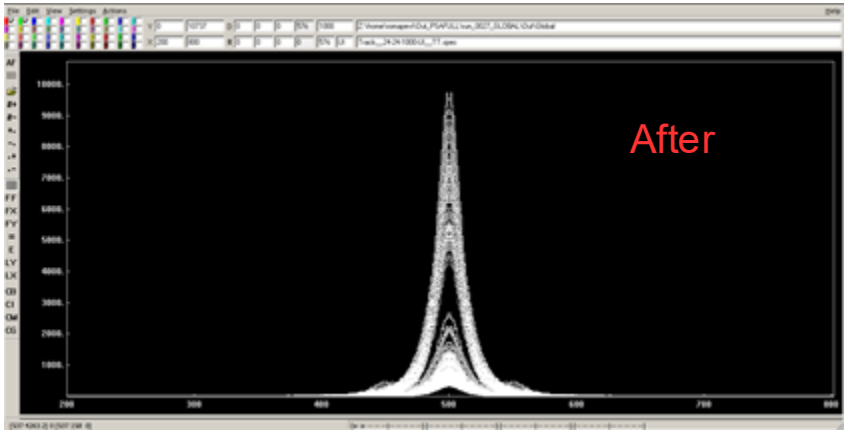
PostPSA Filter

Verification with femul replay

3. Global Time Alignment

Track__24-24-1000-UI__TT.spec all [all][all]



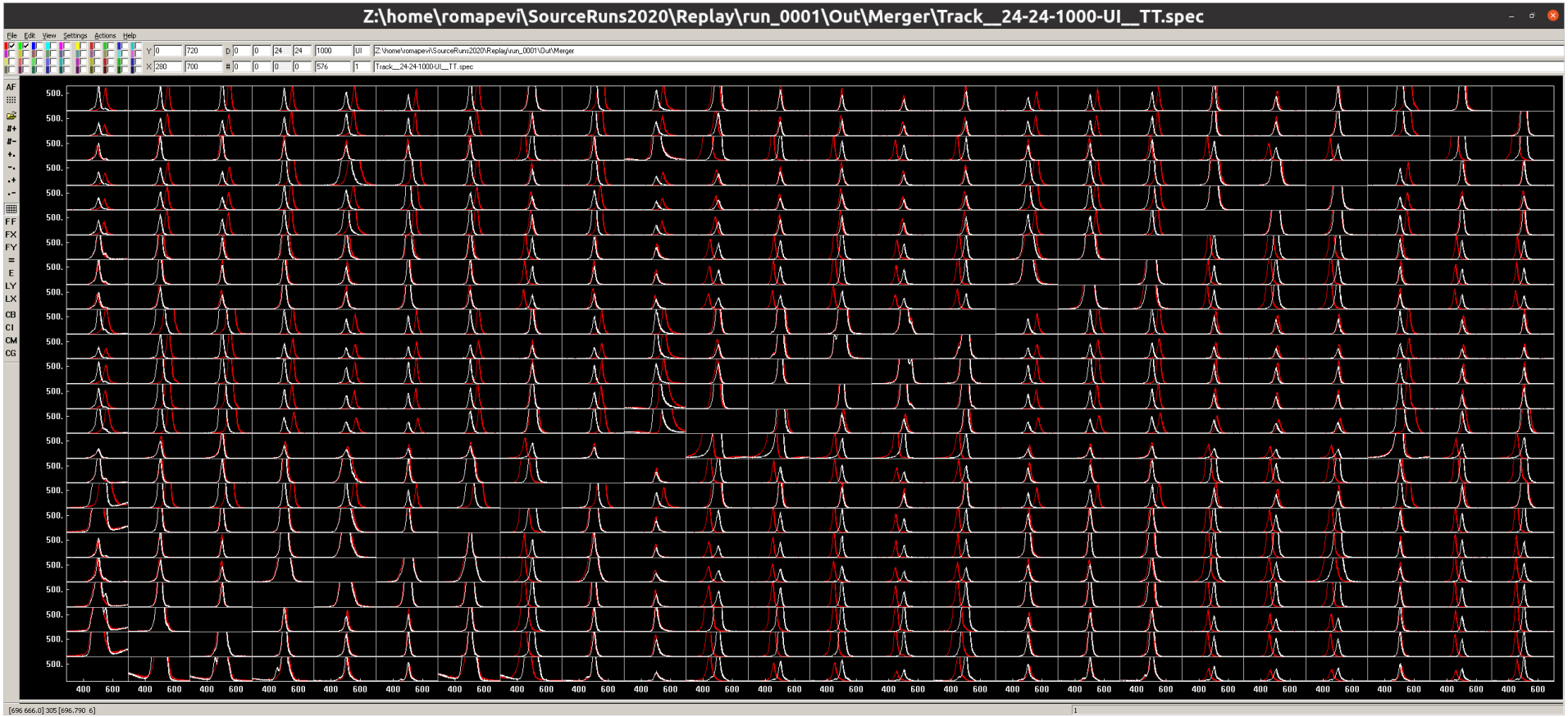


PostPSA Filter

Verification with femul replay

3. Global Time Alignment

. Track__24-24-1000-UI__TT.spec all [all][all] red before, white after time alignment



00A 03A 04A 05A 06A 10A 12A 14A

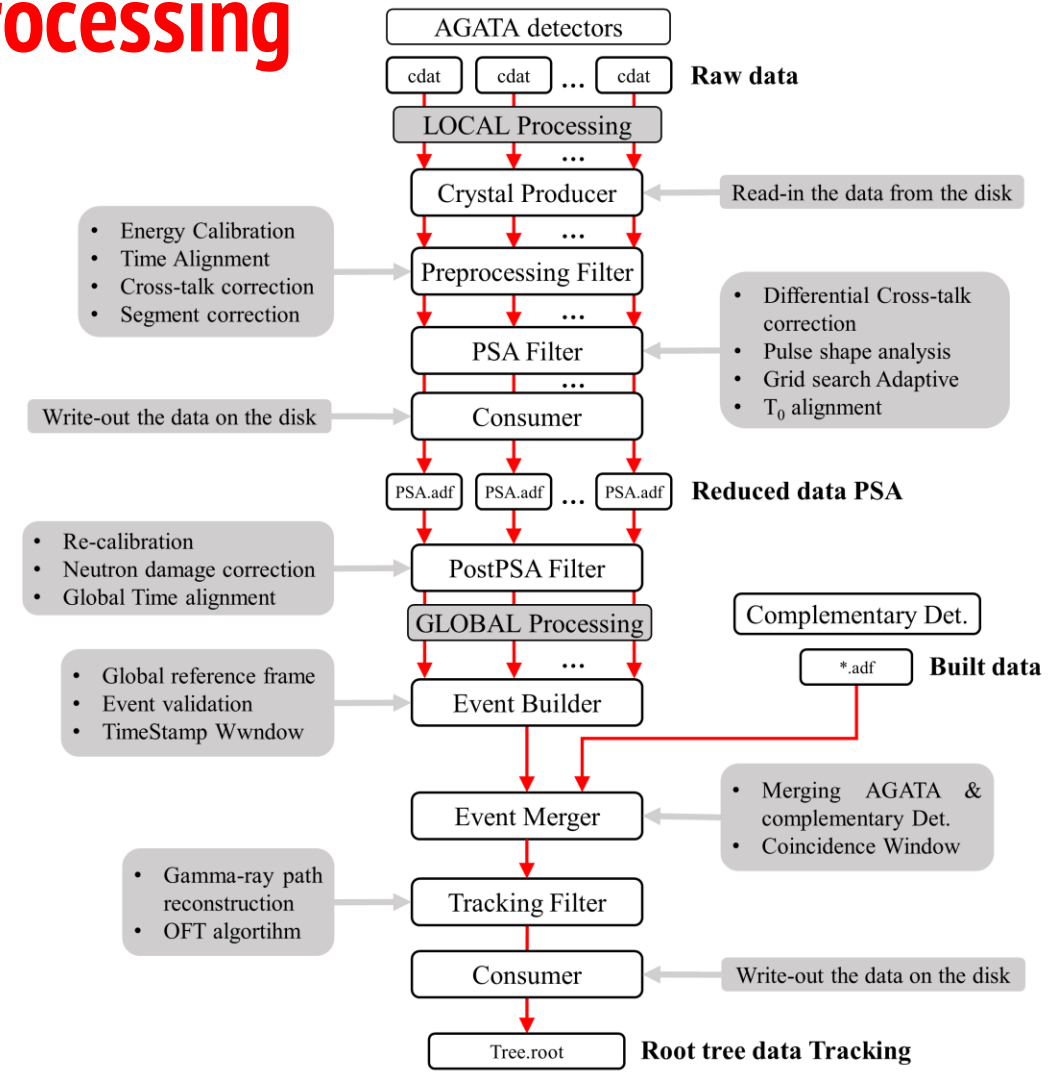
Local Level Processing

PostPSA Filter

- Follow the order given here.
- Be careful of the possible redundant calibration done by the PostPSA filter actor.
- The PostPSA is the last chance to have properly calibrated segments.
- The calibration offset can only be set at this level of the analysis.
- ForceSegToCore! final correction, only when the core resolution is good.
- Keep track of the GTS alignment for the Global Time alignment (important to reduce random coincidences)

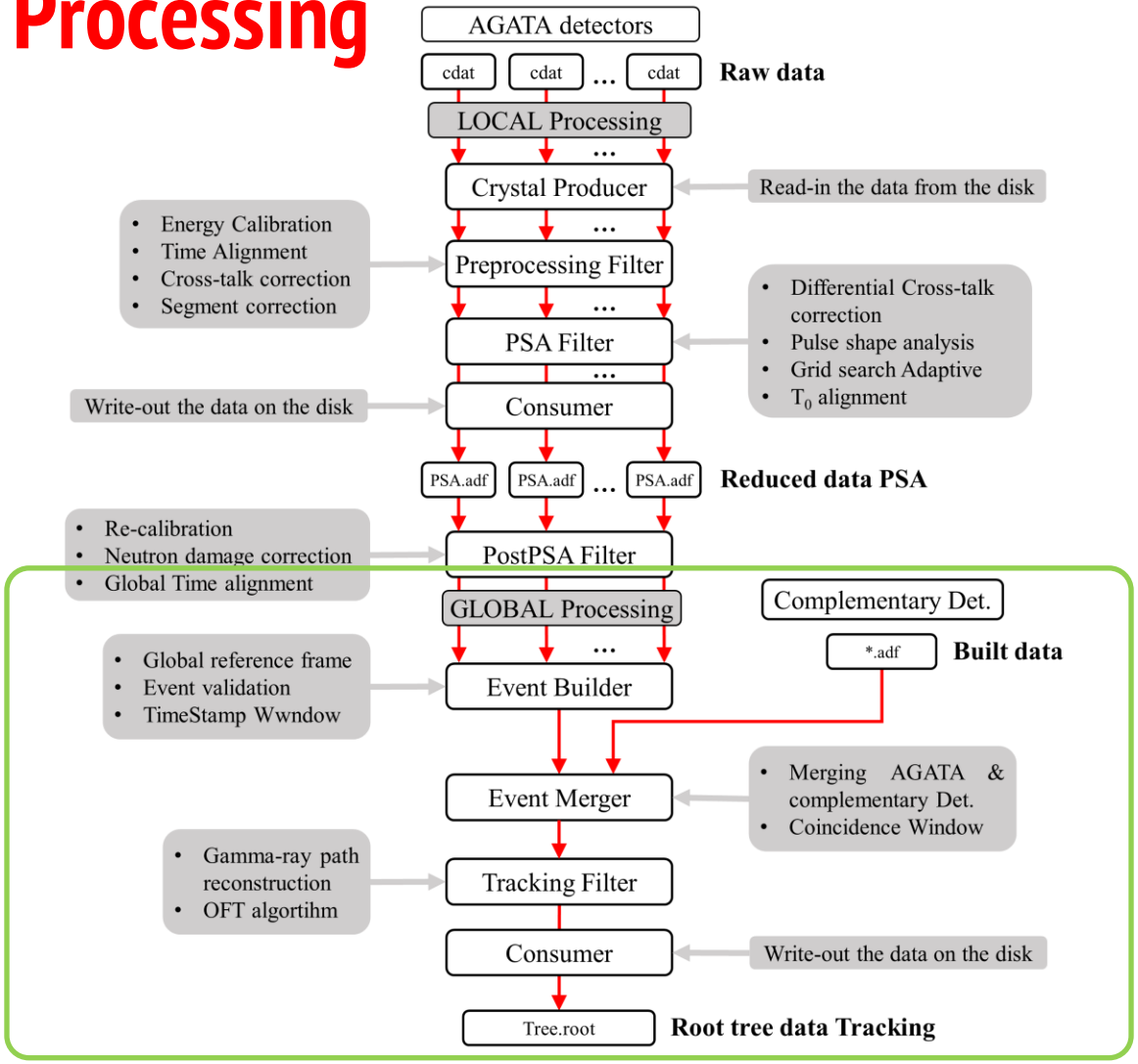
Local Level Processing

Narval actors



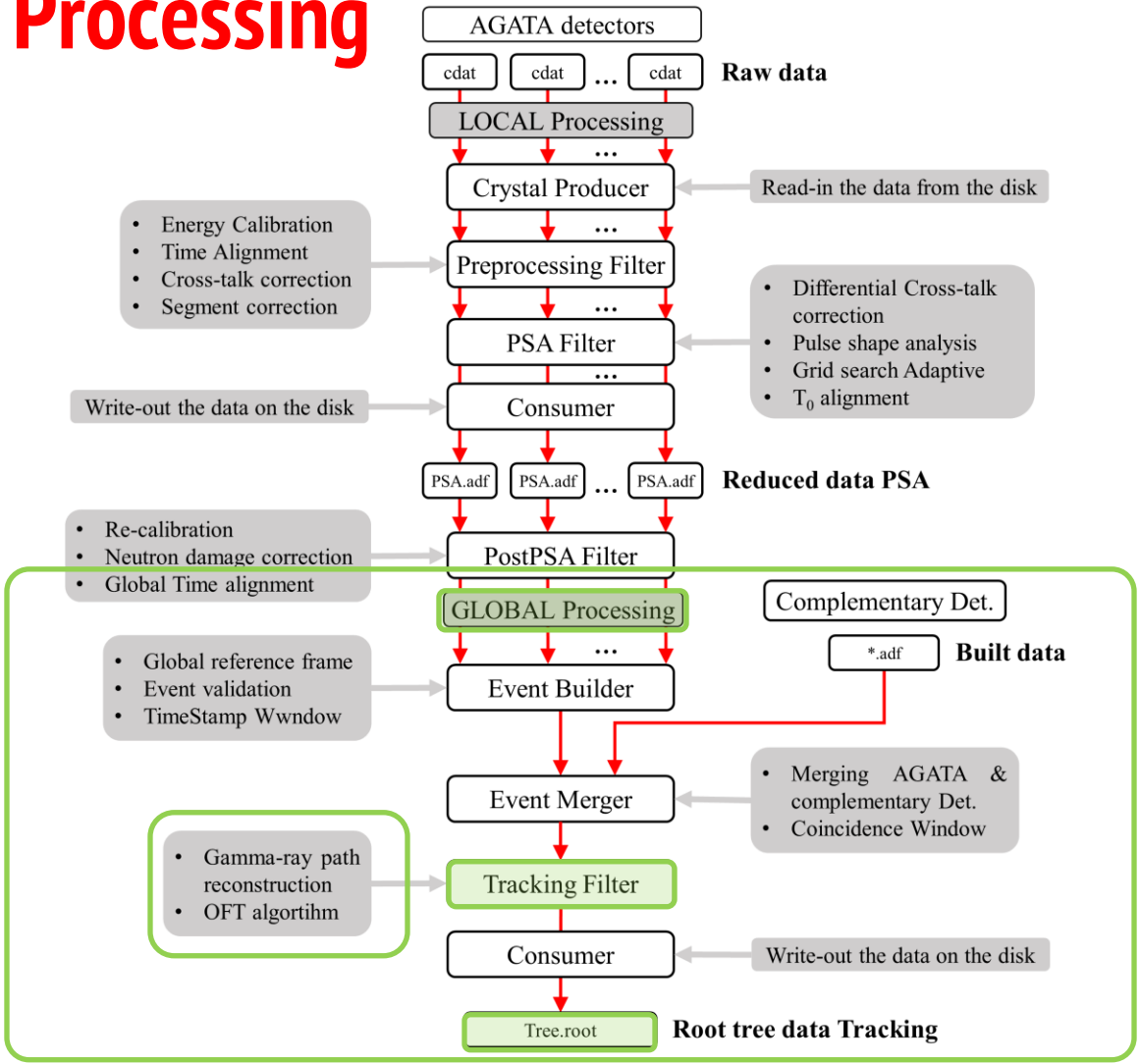
Global Level Processing

Narval actors



Global Level Processing

Narval actors



Tracking
Speaker: **Araceli López Martens**
Friday

Global data replay
Speaker: **Jérémie Dudouet**
Wednesday

Selector
Speaker: **Daniele Brugnara**
Wednesday

Thank you!

AGATA Analysis Workshop 2025

PostPSA Calibration

R.M. Pérez-Vidal

14/01/2025, Lyon

Questions?

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