the AGATA code Alternative Generator (-Gen)

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The AGATA alternative Generator (-Gen)

Allows to...

- Simulate nuclear reaction with subsequent γ decay
  1. Mainly about peak shapes, e.g. Doppler Correction
  2. Often used for lifetime, e.g. RDDS or DSAM
  3. Background can be added during simulation
- Simulation of arbitrarily complicated source
  1. Normalisation for angular correlations/distributions
  2. Include all effects when comparing efficiency
- Simulation taking into account real world time
  1. This can be used to simulate beam structure
  2. Or random coincidence with background
  3. To create data sets that can be analysed using agapro.

The AGATA alternative Generator (-Gen)

How does it work? (first overview then details)

For each event, in AgataAlternativeGenerator.cc,

1. If asked for; add background γ rays (always in coincidence with reaction)
2. If asked for; generate a beam ion (that will do the nuclear reaction, controlled by class Incoming_Beam.cc)
3. If asked for; create decays from additional sources (random time)

The nuclear reaction part (2)

Points to remember

- It does not do cross sections, only kinematics, energy loss in target etc
- Does transfer, fusion evaporation, fusion-fission, and Coulex
- Absolute and differential cross sections can be introduced via data files if needed.

The nuclear reaction part (2)

How have we introduced nuclear reaction into geant4

Remember that there are many nuclear reaction classes in geant4, for all types of nuclear reactions. But they are not (last time I took the time to look) adapted to simulations of this type.

The nuclear reaction part (2)

How have we introduced nuclear reaction into geant4

- Via a physics process called Reaction that inherits from G4VProcess.
- This process checks if ion beam has moved to the point of reaction or not. If yes, set interaction length 0 (forces geant4 to select this process after step), if not set interaction length DBL_MAX (does nothing).
- It is then the job of the class Outgoing_Beam to select type of reaction and populate the reaction products.

The nuclear reaction part (2)

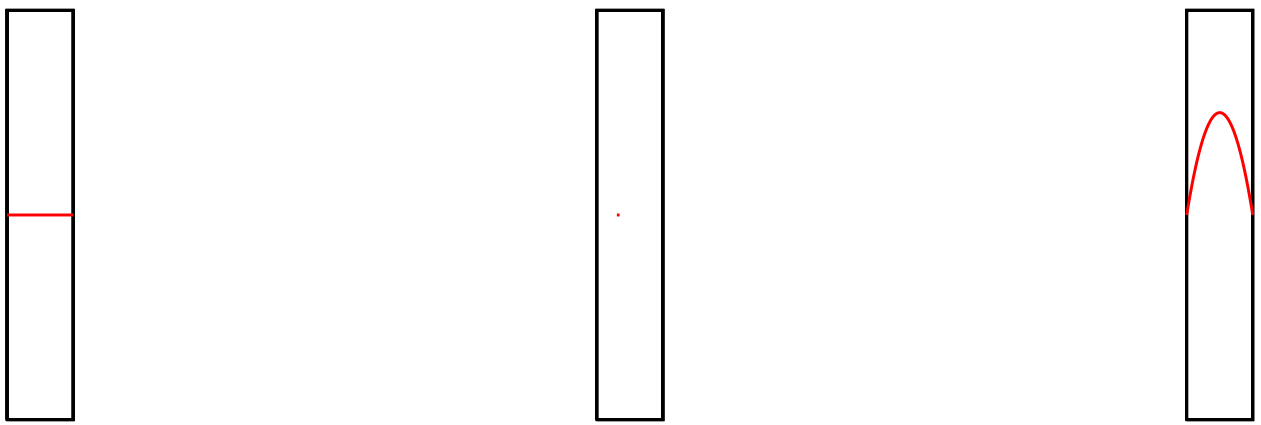
Choosing target, beam and product(s)

- Target ion for reaction given differently from material of target volume.
- Reaction product given with Δ(Z,N) from beam
- Possible to populate several excited states in reaction product
- Possible to populate partner as well (partner either from reaction mechanism or from conservation of four-momentum)

The nuclear reaction part (2)

How is the point of reaction chosen?

- Uniformly distributed in the target
- Or a fixed depth
- Or according to the distribution given in the file profile.dat



The nuclear reaction part (2)

Selecting the reaction mechanism

- The user gives the normalised probability for:
  1. Transfer
  2. Fusion evaporation
  3. Fusion-Fission
  4. Coulex
- One of the mechanisms is chosen, and kinematics for reaction product is calculated. Will only work if beam+target+product(s) make sense of course

The nuclear reaction part (2)

Kinematics

- Full conservation of four-momentum
- For reaction where it is applicable a file with angular distribution of product is needed. Default name aadist.
- Product angle sampled first, then calculation of recoil velocities etc.
- Each reaction mechanism has some limitations. Excitation energy in the products...? Fusion Fission, what part of coulomb energy goes to kinetic or internal...? No strict treatment of particle evaporation and final result (e.g. we don't start with an excited compound and evaporate).

The background γ rays (1)

As many as we want per event from:

- Exponential shaped background
- Discrete energies

This means, we can have 5 background γs per event or 10 events per background γ etc.

This is used to simulate the background in experimental spectra.

The source γ rays (3)

One can add sources with given activities (kBq)

- This will automatically start a "wall clock" in the simulation
- Has only been tested "stand alone" or with a beam with given time structure
- See advanced demonstration

How to (almost always) run the simulation with the -Gen flag

In most cases use

```
G4ENSDFSTATEDATA=$PWD
G4AGATAVACUUMINWORLD=yes Agata -Gen -SN -seed -b
your_cool_macro.mac
```

How to (almost always) run the simulation with the -Gen flag

In most cases use

- *G4ENSDFSTATEDATA=$PWD* we work with a local copy of data file containing the data for excited states.
- *G4AGATAVACUUMINWORLD=yes* environment variable that fills world volume with vacuum and not air (not needed if also using a target chamber "ancillary").
- *-Gen* tells the Agata code to use the Alternative generator
- *-SN* Short for "screened nuclear" for historical reasons. This allows cuts on energies when not to trace recoil ions to speed simulations up.
- *-seed* almost always use this flag. Without it every simulation will be the same as random generator is seeded with 0 every time.

Files that are needed - geometry

Without these files in the run directory the simulations crashes...

- asolid describes the four different crystal geometries
- aclust describes the geometry of triple cluster
- aeuler files tells how to put the clusters in the world

You should also add files like

- A180walls.list to get the aluminum cans
- A180slice.list to get a good segmentation of the detectors

But they can be added in the macro, simulation will not crash on start without them

Files that might be used - reaction related

- aadist angular distribution on CM of fragment
- profile.dat profile for reaction in target
- evap[pna].dat files for n,p, and alpha evaporation distribution (if not given there are default Gaussian distribution)
- ENSDFSTATE.dat included in geant4 distribution but modified to suites simulations (a diff file is included in the tar you got for the examples I show).

A few caveats

- Data in the ENSDFSTATE.dat (that you will have to modify simulating exotic nuclei) has to be coherent with data in the $G4LEVELGAMMADATA/z??.a??? file and the $G4RADIOACTIVEDATA/z??.a??? file!

Copy/Create the files where you run the simulation and use the commands

- /process/had/rdm/setRadioactiveDecayFile 28 64 decay64Ni
- /process/had/rdm/setPhotoEvaporationFile 28 64 photons64Ni

A few caveats

photons64Ni

1.345750e+03 1.345840e+03 1.000e+02 -2 8.80e-13 2.00 1.240e-04 8.952e-01 8.468e-02 6.605e-04

8.024e-04 1.250e-02 9.435e-05 1.145e-04 1.871e-08 3.823e-08 4.242e-03 1355.75 10 100 -2 0 0 0 0 0 0 0

0 0 0 0 0 0 2.276560e+03 9.308100e+02 1.000e+02 1 3.03e-12 2.00 1.200e-04 9.000e-01 8.500e-02

4.558e-04 1.042e-03 1.258e-02 6.542e-05 1.483e-04 2.858e-08 7.183e-08 4.250e-03 2286.56 10 100 -2 0 0

0 0 0 0 0 0 0 0 0 0 0 2.610100e+03 1.264300e+03 1.000e+02 -2 3.10e-13 4.00 1.410e-04 9.007e-01

8.511e-02 7.163e-04 8.511e-04 1.255e-02 1.021e-04 1.213e-04 2.106e-08 4.092e-08 4.270e-03 2620.1 10

100 -2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2.867300e+03 1.521500e+03 1.000e+02 -2 4.00e-14 0.00 9.590e-05

8.968e-01 8.509e-02 5.746e-04 7.310e-04 1.251e-02 8.238e-05 1.043e-04 1.502e-08 3.410e-08 4.254e-03

2877.3 10 100 -2 0 0 0 0 0 0 0 0 0 0 0 0 0 2.972080e+03 6.920000e+02 0.000e+00 1 1.30e-13 1.00

2.250e-04 8.978e-01 8.489e-02 5.911e-04 1.218e-03 1.249e-02 8.444e-05 1.733e-04 4.622e-08 9.778e-08

4.249e-03 2.972080e+03 1.626300e+03 1.000e+02 1 1.30e-13 1.00 4.470e-05 8.971e-01 8.479e-02

2.729e-04 7.830e-04 1.255e-02 3.937e-05 1.119e-04 1.136e-08 4.340e-08 4.228e-03 2.972080e+03

2.972040e+03 7.000e+01 1 1.30e-13 1.00 1.870e-05 8.984e-01 8.503e-02 1.658e-04 6.257e-04 1.251e-02

2.380e-05 8.930e-05 4.572e-09 2.936e-08 4.209e-03 2982.08 10 100 -2 0 0 0 0 0 0 0 0 0 0 0 0 0

We start looking at a multi-nucleon transfer example $^{238}U +^{64} Ni \rightarrow^{62} Fe$

Details of the example

- Using AGATA geom. from GANIL (sorry no time to update)
- An example I used to develop many of these features
- Should be simple to adapt to AGATA with PRISMA
- But, there is a "VAMOS" part when sorting the data. Needs to be updated by a PRISMA code.
- I always have to macro files. One called Setup something and one for the actual runs. This is by choice.

We start looking at a multi-nucleon transfer example $^{238}U + ^{64}Ni \rightarrow ^{62}Fe$

Start with the setup file line 1-19 62FeSetup.mac

```
################## Reaction
#Beam Ion goes here
/Agata/generator/emitter/BeamIn/Z 92
/Agata/generator/emitter/BeamIn/A 238
#Beam characteristics goes here
/Agata/generator/emitter/BeamIn/KE 1547 MeV
/Agata/generator/emitter/BeamIn/fcZ -5 cm
/Agata/generator/emitter/BeamIn/bDir 45 180
#Here we decide the product (92-26=66 and 238-62=176)
/Agata/generator/emitter/BeamOut/DZ -66
/Agata/generator/emitter/BeamOut/DA -176
#target in the following (note this is not taken from target material)
/Agata/generator/emitter/BeamOut/Z 28
/Agata/generator/emitter/BeamOut/A 64
#Population of states in product (4+ and 2+ in 62Fe)
/Agata/generator/emitter/BeamOut/ProjectileExcitation 2.175900e+03 1.2 8.768000e+02 1
#Here I say reaction profile flat in target
/Agata/generator/emitter/disableFixDepth
/Agata/generator/emitter/enableUniformDistr
```

We start looking at a multi-nucleon transfer example $^{238}U + ^{64}Ni \rightarrow ^{62}Fe$

Start with the setup file line 20-41 62FeSetup.mac

```
#And only by transfer (i.e. type of "kinematics")
/Agata/generator/emitter/BeamOut/setPtr 1.
/Agata/generator/emitter/BeamOut/setPfe  0.
/Agata/generator/emitter/BeamOut/setPclx 0.
/Agata/generator/emitter/BeamOut/setPff 0.
#Here I give the file for direction of product in CM
/Agata/generator/emitter/BeamOut/adistFile aadist_45
#Force resampling of angles of outgoing ion until we
#are about sure to be in the acceptance of the
#spectrometer (VAMOS in this case)
/Agata/generator/emitter/BeamOut/phi 170 190
#Here I add background gammas to make realistic
#gamma-ray spectra (this is from comparing with
#data). So 20 gammas each event. The energy
#distribution of these gammas are the default
#taken in the simulation (as this feture was
#developed with this data)
/Agata/generator/emitter/setNumberOfGammaBackground 20
/Agata/generator/emitter/SetNumberOfParticlesPerReaction 1
#Related to decay of excited states
/process/had/rdm/allVolumes
/process/had/rdm/verbose 0
```

We start looking at a multi-nucleon transfer example $^{238}U + ^{64}Ni \rightarrow ^{62}Fe$

Start with the setup file line 42- 62FeSetup.mac

```
############## Geometry
#Target material (used of energy loss straggling etc)
/Agata/detector/targetMaterial G4_Ni
/Agata/detector/targetSize 20 20 1
#Degrader material (plunger experiment)
/Agata/detector/degraderMaterial G4_Mg
/Agata/detector/degraderSize 20 20 5.7
#Target degrader distance
/Agata/detector/separation .1 mm
#We tell the simulation to create a "Spectrometer"
#this is just a volume allowing the scoring of outgoing ions
#to real detection detectors etc.
/Agata/detector/SetBuildSpectrometer true
#This is how the AGATA detectors are positioned.
#Here I use a file corresponding to experiment E663
#at GANIL
/Agata/detector/wallsFile A180/A180walls.list
/Agata/detector/sliceFile A180/A180slice.list
/Agata/detector/angleFile MNTeuler.list
/Agata/detector/rotateArray 0 20
```

We start looking at a multi-nucleon transfer example $^{238}U + ^{64}Ni \rightarrow ^{62}Fe$

Lets have a look at what we just did

Run your simulation in the Fe62 directory in interactive mode

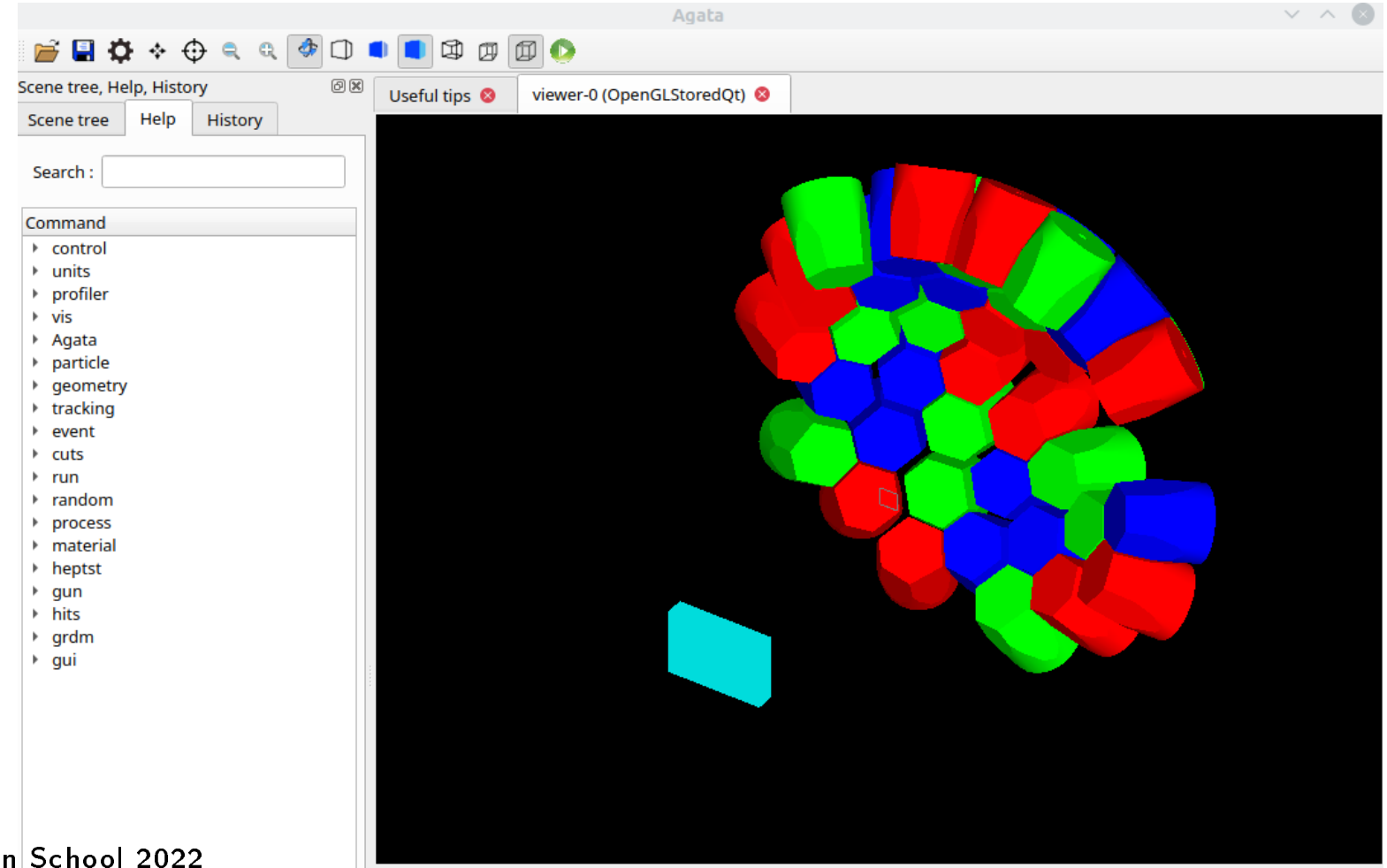
```
G4ENSDFSTATEDATA=$PWD\
    G4AGATAVACUUMINWORLD=yes\
    ~/Disk2/agata/branches/GANIL/trunk/build/Agata -Gen -SN -seed
```

then in Agata simulation run commands

```
/command/control 62FeSetup.mac
/Agata/detector/update
/command/control vis.mac
```

We start looking at a multi-nucleon transfer example $^{238}U + ^{64}Ni \rightarrow ^{62}Fe$

You got something like



We start looking at a multi-nucleon transfer example $^{238}U + ^{64}Ni \rightarrow ^{62}Fe$

Then the macro file with the different runs line 1-10 runs 62Fe_AGATA.mac

```
#In this file we have comments that are in fact commands
#to the python script RunRunsInParallel.py
#To script creates as many simulations as runs given.
#This is done by creating as many input files as runs
#and then starting a simulations for each. This
#is why the run number has to be changed.
# START COMMON
/control/execute 62FeSetup.mac
/Agata/file/enableLM
# STOP COMMON
```

We start looking at a multi-nucleon transfer example $^{238}U +^{64} Ni \rightarrow^{62} Fe$

Then the macro file with the different runs line 11-17 62Fe_AGATA.mac

```
# START RUN
/Agata/detector/separation .040 mm
#Remeber to update geometry when plunger distance changed!
/Agata/detector/update
/Agata/run/runNumber 3000
/tracking/verbose 0
/run/beamOn 24000
```

We start looking at a multi-nucleon transfer example $^{238}U +^{64} Ni \rightarrow^{62} Fe$

Then the macro file with the different runs line 18-31 62Fe_AGATA.mac

```
# START RUN
/Agata/run/runNumber 3001
#this is look at peak shape components
/Agata/ScreenedElastic/SetKillGammaIfEmittedBeforeDegrader true
/Agata/detector/separation .040 mm
/Agata/detector/update
/run/beamOn 24000
# START RUN
/Agata/run/runNumber 3002
#this is look at peak shape components
/Agata/ScreenedElastic/SetKillGammaIfEmittedAfterDegrader true
/Agata/detector/separation .040 mm
/Agata/detector/update
/run/beamOn 24000
```

We start looking at a multi-nucleon transfer example $^{238}U + ^{64}Ni \rightarrow ^{62}Fe$

Then the macro file with the different runs line 32-62Fe_AGATA.mac

```
# START RUN
/Agata/run/runNumber 3003
/Agata/detector/separation .185 mm
/Agata/detector/update
/run/beamOn 24000
# START RUN
/Agata/run/runNumber 3004
/Agata/detector/separation .250 mm
/Agata/detector/update
/run/beamOn 24000
# START RUN
/Agata/run/runNumber 3005
/Agata/detector/separation .285 mm
/Agata/detector/update
/run/beamOn 24000
# START RUN
/Agata/run/runNumber 3006
/Agata/detector/separation .350 mm
/Agata/detector/update
/run/beamOn 24000
# START RUN
/Agata/run/runNumber 3007
/Agata/detector/separation .385 mm
/Agata/detector/update
```

We start looking at a multi-nucleon transfer example $^{238}U + ^{64}Ni \rightarrow ^{62}Fe$

Next step is to run the simulation

You find this command in a better format in the README.md file. Remember to change the paths. . .

```
../RunRunsInParallel.py\
    -i 62Fe_AGATA.mac\
    -c "G4ENSDFSTATEDATA=$PWD␣G4AGATAVACUUMINWORLD=yes\
␣␣␣␣~/Disk2/agata/branches/GANIL/trunk/build/Agata\
␣␣␣␣-Gen␣-SN␣-seed"
```

This will start 10 simulations in parallel and 11 different output files called GammaEvents.3000-GammaEvents.3010

We start looking at a multi-nucleon transfer example $^{238}U + ^{64}Ni \rightarrow ^{62}Fe$

Let's have a look an output file

```
AGATA 7.3.0
OUTPUT_MASK 111001000
# nDet Energy AbsolutePosition(x y z) RelativePosition(x' y' z')
# RelativePosition for mgs (x'' y'' z'') nSeg time interaction
# 0--> disabled; 1--> enabled
DISTFACTOR 1
ENERFACTOR 1
G4TRACKING 0
DATE Tue Jan 18 17:23:26 2022
GEOMETRY
AGATA
SUMMARY 235.008  329.202  39  3 6 6 6 6 6 6
TRANSFORMATION   0.000   0.000   0.000   0.000  20.000   0.000
PASSIVE 1
CAPSULES 0
ENDGEOMETRY
GENERATOR 1
ENDGENERATOR
```

We start looking at a multi-nucleon transfer example $^{238}U + ^{64}Ni \rightarrow ^{62}Fe$

Let's have a look an output file

```
$
-100          0
 -101    0.10114  0.03583  0.10174  0.99417
 -102      0.000    0.000   -0.057
 -104 295.00000 57680.50055
   -1   1797.178  0.43821  0.82912 -0.34718 0
   11     1.255   -6.646 -102.688 -222.887 05
   11     0.038   -0.864 -105.150 -234.410 10
   11     0.038   -1.586 -124.733 -257.641 30
   11     0.129    1.103 -125.881 -263.162 30
   11     0.038    3.065 -130.892 -263.488 40
   11     0.129   -7.355 -137.207 -269.412 45
   11     0.129  -13.651 -148.992 -268.388 44
   11     0.179  -15.344 -151.659 -269.057 54
   11     0.038  -19.507 -150.337 -262.975 44
   11     0.129  -18.478 -154.972 -267.956 53
   11     1.223  -14.389 -152.289 -272.455 54
   11     0.125  -14.403 -152.267 -272.453 54
   11     9.719  -14.403 -152.267 -272.453 54
   11    62.346  -14.389 -152.290 -272.458 54
   11    11.326  -18.478 -154.972 -267.956 53
   11    37.405  -19.507 -150.337 -262.974 44
   11    36.734  -15.344 -151.660 -269.057 54
   11     2.412  -13.651 -148.992 -268.388 44
   11    13.580   -7.355 -137.207 -269.412 45
```

We start looking at a multi-nucleon transfer example $^{238}U +^{64} Ni \rightarrow^{62} Fe$

Now we will do gamma-ray tracking on the data

```
PATH=$PATH:../OFT/standalone_gamma ../SortRuns 30??
```

SortRuns in a bash script that runs a gamma-ray tracking code over multiple event files in parallel. It will create 11 files like

tracked_energies_3000-tracked_energies_3010

Let's have a look at one of these files

We start looking at a multi-nucleon transfer example $^{238}U + ^{64}Ni \rightarrow ^{62}Fe$

Let's have a look a "tracked_energies" output file

```
# 0.000000 0.000000 -0.057000 0.003624 0.010290 0.100550 295.000000 57680.500550
0 0.548837 0.604479 0.186122 -0.665027 -10.288389 -22.463386 AGATA
1 0.443898 0.475226 0.045094 -19.955154 0.136541 -15.807522 AGATA
2 1.121666 1.228950 0.398803 -11.352716 -0.774613 -20.577410 AGATA
3 1.364424 1.498524 0.157997 -9.545968 -6.475852 -21.427310 AGATA
4 0.572763 0.623752 0.011873 4.766774 12.461482 -24.916803 AGATA
5 0.186122 0.195446 0.963670 -5.724573 25.424996 -16.049904 AGATA
6 0.424175 0.466930 0.040058 6.880144 -7.962332 -25.860121 AGATA
1 0.572763 4.766774 12.461482 -24.916803 CoreEAGATA
7 1.364424 -9.545968 -6.475852 -21.427310 CoreEAGATA
8 1.121666 -11.479510 -1.012310 -20.455676 CoreEAGATA
10 0.606967 7.236777 -8.315823 -26.009936 CoreEAGATA
11 0.593344 -0.547846 -12.523717 -25.423701 CoreEAGATA
21 0.186122 -5.724573 25.424996 -16.049904 CoreEAGATA
27 0.443898 -21.401738 1.343748 -17.055011 CoreEAGATA
# 0.000000 0.000000 -0.057000 -0.007753 -0.000202 0.120140 418.000000 57680.500550
0 1.495146 1.645559 1.071993 -2.343474 17.158961 -21.308649 AGATA
1 0.714308 0.804137 0.182484 2.933438 5.288265 -24.499439 AGATA
0 1.280681 2.650639 5.220078 -25.814409 CoreEAGATA
1 0.144618 -1.387632 15.077857 -28.634846 CoreEAGATA
22 1.350529 -2.370158 16.834887 -22.022013 CoreEAGATA
# 0.000000 0.000000 -0.057000 0.007825 0.006156 0.089528 234.000000 57680.500550
0 1.483255 1.609492 0.241136 -11.985082 -2.817001 -19.748331 AGATA
1 0.473183 0.512373 0.215306 -11.538202 6.071907 -21.295954 AGATA
4 0.016742 -11.538202 6.071907 -21.295954 CoreEAGATA
```

We start looking at a multi-nucleon transfer example $^{238}U + ^{64}Ni \rightarrow ^{62}Fe$

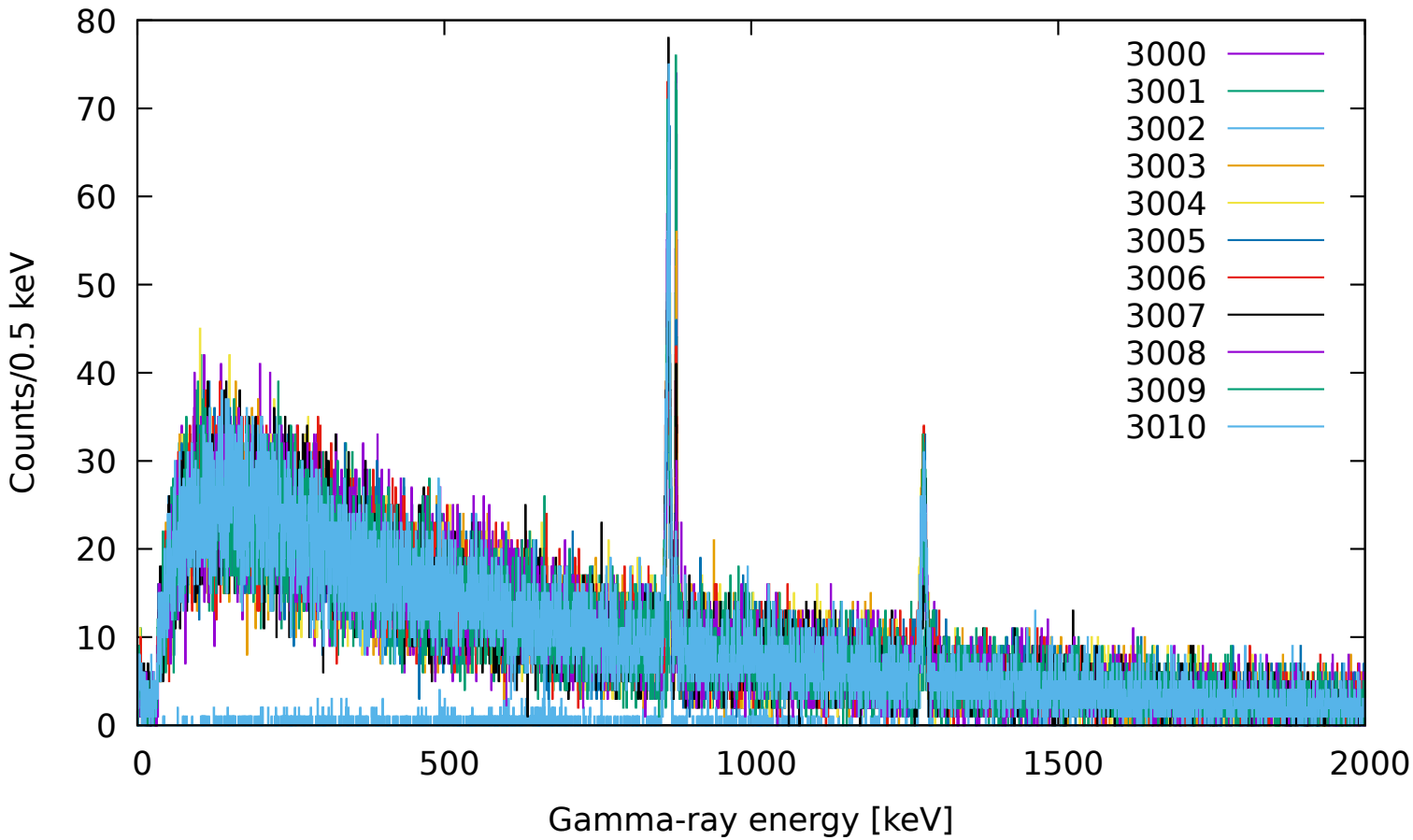
These files are then sorted with a few codes inside root

```
root> .L VamosAcc.cpp+O
root> .L HistoAGATAEXOGAM.cxx+O
root> LoopOverFiles("tracked_energies_30??","","",0.97,6,0,"FP_1013++_Acc.dat
root> SaveHistogramsToFile("Histos62Fe.root") //To save all spectra to file
```

This will create lots and lots of spectra. . . But this time we will only look at the AGATAEnergies_tracked_energies_30[01][0-9]

We start looking at a multi-nucleon transfer example $^{238}U + ^{64}Ni \rightarrow ^{62}Fe$

Spectra



Next example is Coulex of ^{58}Fe

Details of the example

- Here I use geometry of AGATA@LNL
- Together with SPIDER (gdml+ancillary)
- Gamma-ray tracking code is the same
- A code to Doppler Correction etc included in the example. The idea is that starting from these it should be easy to simulate other experiments

Next example is Coulex of ^{58}Fe

Start with the setup file line 1-21 58FeSetup.mac

```
################## Reaction
/Agata/generator/emitter/BeamIn/Z 26
/Agata/generator/emitter/BeamIn/A 58
/Agata/generator/emitter/BeamIn/KE 222 MeV
/Agata/generator/emitter/BeamIn/fcZ -5 cm
/Agata/generator/emitter/BeamOut/DZ 0
/Agata/generator/emitter/BeamOut/DA 0
#target in the following
/Agata/generator/emitter/BeamOut/Z 82
/Agata/generator/emitter/BeamOut/A 208
#Population of states in 58Fe (based on CLX cross section calculations)
/Agata/generator/emitter/BeamOut/ProjectileExcitation 0 0.754158E+00 810.7662 0.224783E+00 1674.731  0
#Here I say reaction profile flat in target
/Agata/generator/emitter/disableFixDepth
/Agata/generator/emitter/enableUniformDistr
#And only by coulex (i.e. type of "kinematics")
/Agata/generator/emitter/BeamOut/setPtr 0.
/Agata/generator/emitter/BeamOut/setPfe  0.
/Agata/generator/emitter/BeamOut/setPclx 1.
/Agata/generator/emitter/BeamOut/setPff 0.
/Agata/generator/emitter/BeamOut/adistFile aadist
```

Next example is Coulex of ^{58}Fe

Start with the setup file line 22-31 58FeSetup.mac

```
#We don't track ions all the way to zero energy
#to save time. In practice we don't track
#recoils of target ions
/Agata/ScreenedElastic/SetEnergyLimitCreatedByScreenedElastic 0.01 MeV
/Agata/ScreenedElastic/SetEnergyLimitHeavyIons 1 MeV
/Agata/ScreenedElastic/SetEnergyLimitHeavyIonsInSensitiveVolume 1 MeV
#Related to decay of excited states
/process/had/rdm/allVolumes
/process/had/rdm/verbose 0
```

Next example is Coulex of ^{58}Fe

Start with the setup file line 32- 58FeSetup.mac

```
############## Geometry
/Agata/detector/targetMaterial G4_Pb
/Agata/detector/targetSize 20 20 1
/Agata/detector/degraderMaterial Vacuum
/Agata/detector/degraderSize 20 20 0
/Agata/detector/separation .05 mm
/Agata/detector/SetBuildSpectrometer false
/Agata/detector/degraderMaterial Vacuum
/Agata/detector/solidFile A180/A180solid.list
/Agata/detector/wallsFile A180/A180walls.list
/Agata/detector/clustFile A180/A180clust.list
/Agata/detector/sliceFile A180/A180slice.list
/Agata/detector/angleFile LNLeuler.list
/Agata/detector/rotateArray -50. 0
/Agata/detector/enableCapsules
/Agata/detector/enableAncillary
/Agata/detector/update
```

Next example is Coulex of ^{58}Fe

Lets have a look at what we just did

Run your simulation in the Fe58 directory in interactive mode
You find this command in a better format in the README.md file. Remember to change the paths. . .

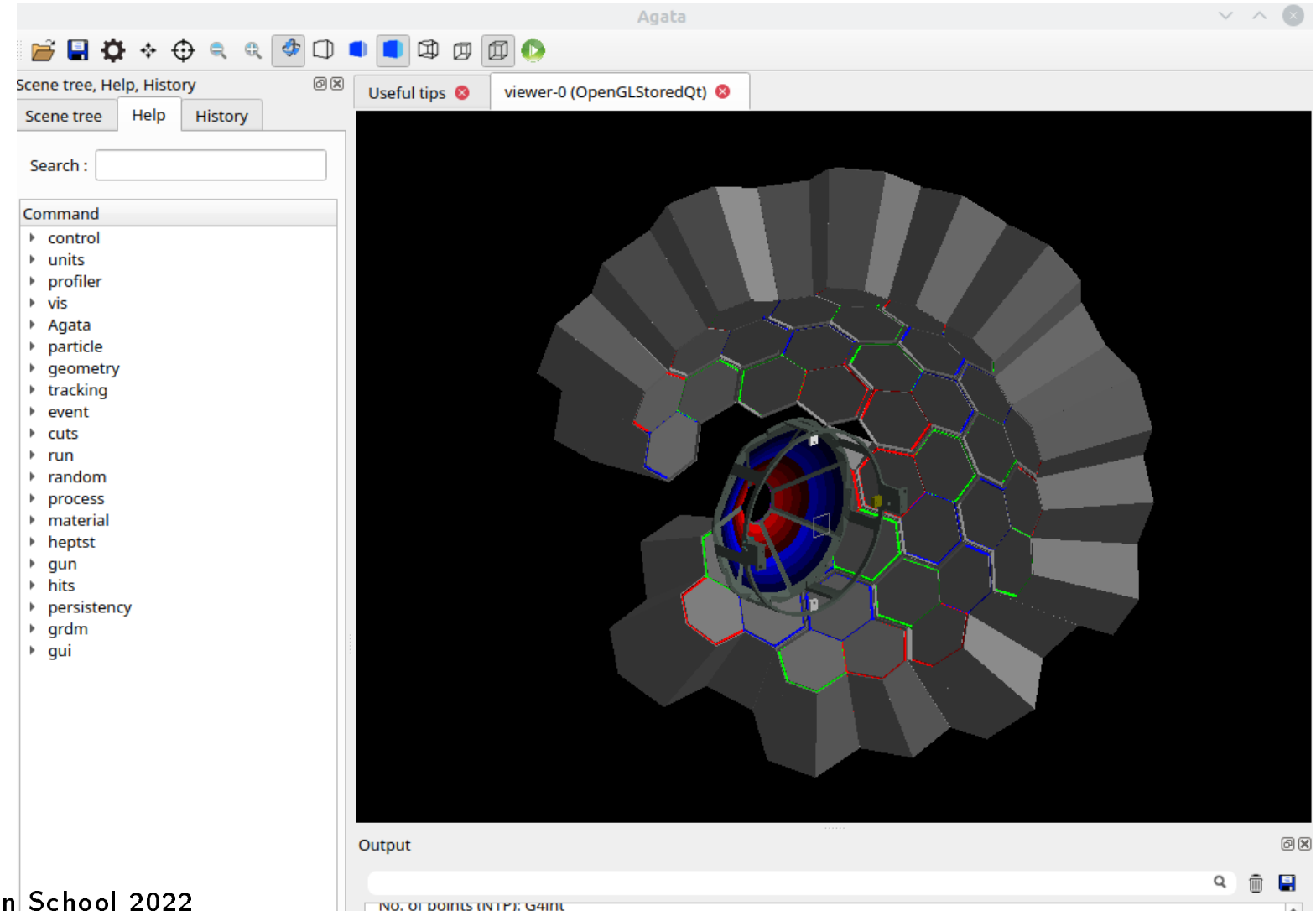
```
G4GDMLPATH=/home/joa/Disk2/AGATA/gdml-files\
      G4AGATAVACUUMINWORLD=yes\
      G4ENSDFSTATEDATA=$PWD\
      ~/Disk2/agata/branches/GANIL/trunk/build/Agata\
      -Gen -SN -seed -a 1 21 -b 58Fe.mac
```

then in Agata simulation run commands

```
/command/control 58FeSetup.mac
/command/control vis.mac
```

Next example is Coulex of ^{58}Fe

You got something like



Next example is Coulex of ^{58}Fe

Then the macro file with the run 58Fe.mac

```
# START COMMON
/control/execute 58FeSetup.mac
/Agata/detector/update
/Agata/file/enableLM
/Agata/file/info/enableTime
/Agata/file/verbose 1
/tracking/verbose 0
/Agata/generator/emitter/SetNumberOfParticlesPerReaction 1
# STOP COMMON
# START RUN
/Agata/run/runNumber 1000
/run/beamOn 5000000
```

Next example is Coulex of ^{58}Fe

Next step is to run the simulation

You find this command in a better format in the README.md file. Remember to change the paths. . .

```
G4GDMLPATH=/home/joa/Disk2/AGATA/gdml-files\
G4AGATAVACUUMINWORLD=yes G4ENSDFSTATEDATA=$PWD\
~/Disk2/agata/branches/GANIL/trunk/build/Agata\
                              -Gen -SN -seed -a 1 21 -b 58Fe.mac
```

This will start 1 rather long simulations (so coffee break) that once finished will have created the files GammaEvents.1000 and GammaEvents.1000.01

Next example is Coulex of ^{58}Fe

Lets have a look at the output file

```
AGATA 7.3.0
OUTPUT_MASK 111001100
# nDet Energy AbsolutePosition(x y z) RelativePosition(x' y' z')
# RelativePosition for mgs (x'' y'' z'') nSeg time interaction
# 0--> disabled; 1--> enabled
DISTFACTOR 1
ENERFACTOR 1
G4TRACKING 0
DATE Mon Jan 17 15:36:53 2022
GEOMETRY
AGATA
SUMMARY 235.008  329.202  39  3 6 6 6 6 6 6
TRANSFORMATION   0.000   0.000   0.000 -50.000   0.000   0.000
PASSIVE 1
CAPSULES 1
ANCIL SPIDER 1 20000
SOLID A180/A180solid.list
# The 3 independent crystals of the clusters *** for AGATA-MC ***
#    Cylinder centered on z-axis and front face on z=0
#     cr  #s  p#         x y z of the Inner face                  x y z of the Outer face
#
       0   6   0    33.906177    -0.000000     0.000000      48.844467    -0.070710    90.000000
       0   6   1    15.358631    30.461479     0.000000      22.153453    43.765160    90.000000
       0   6   2   -20.780862    27.320467    -0.000000     -28.562085    39.357292    90.000000
       0   6   3   -33.865099    -3.186191    -0.000000     -47.398084    -4.559934    90.000000
       0   6   4   -20.861304   -27.597830    -0.000000     -28.566730   -39.911479    90.000000
       0   6   5    15.586726   -29.970097    -0.000000      22.461366   -43.232708    90.000000
       0   0   0     5.000000    40.000000    90.000000       0.000000     0.000000     0.000000
```

Next example is Coulex of ^{58}Fe

Lets have a look at the output file

```
$
-100          0
 -101    0.03993 -0.62720 -0.75562 -0.18882
 -102      0.000    0.000    0.000
   -8 222000.000  0.00000  0.00000  1.00000 0
-100          1
 -101    0.06942 -0.07756 -0.94303  0.32356
 -102      0.000    0.000    0.000
   -8 222000.000  0.00000  0.00000  1.00000 1
-100          2
 -101    0.07773 -0.26837 -0.74473  0.61103
 -102      0.000    0.000    0.000
   -8 222000.000  0.00000  0.00000  1.00000 2
-100          3
 -101    0.07580 -0.49577 -0.70044  0.51342
 -102      0.000    0.000    0.000
   -8 222000.000  0.00000  0.00000  1.00000 3
-100          4
 -101    0.05513 -0.27910  0.85322 -0.44059
 -102      0.000    0.000    0.000
   -8 222000.000  0.00000  0.00000  1.00000 4
-100          5
 -101    0.08214 -0.10190 -0.60538  0.78939
 -102      0.000    0.000    0.000
   -8 222000.000  0.00000  0.00000  1.00000 5
   44     0.179  238.790  -76.250   -9.121 12     2.689
   44   381.869  238.849  -76.244   -9.101 12     2.689
 -100          6
```

Next example is Coulex of ^{58}Fe

Lets have a look at the output file

```
-100         30
 -101    0.05094  0.16637 -0.54850 -0.81943
 -102      0.000    0.000    0.000
   -8 222000.000  0.00000  0.00000  1.00000 30
20006   268.244   14.535  -47.869  -71.498 00     7.547
20006   268.690   14.535  -47.869  -71.498 00     7.547
20006    96.520   14.535  -47.869  -71.498 00     7.547
20006   491.555   14.535  -47.869  -71.498 00     7.547
20006   792.943   14.535  -47.869  -71.498 00     7.547
20006     1.722   14.535  -47.869  -71.498 00     7.547
20006   368.783   14.535  -47.869  -71.498 00     7.547
20006   268.768   14.535  -47.869  -71.498 00     7.547
20006   556.775   14.535  -47.869  -71.498 00     7.547
20006   166.096   14.535  -47.869  -71.498 00     7.547
20006   154.705   14.535  -47.869  -71.498 00     7.547
20006   150.134   14.535  -47.869  -71.498 00     7.547
20006   842.250   14.535  -47.869  -71.498 00     7.547
20006   189.362   14.535  -47.869  -71.498 00     7.547
20006    67.598   14.535  -47.869  -71.498 00     7.547
20006   236.285   14.535  -47.869  -71.498 00     7.547
20006   449.500   14.535  -47.869  -71.498 00     7.547
20006   320.293   14.535  -47.869  -71.498 00     7.547
20006    59.247   14.535  -47.869  -71.498 00     7.547
20006   387.120   14.535  -47.869  -71.498 00     7.547
20006    19.020   14.535  -47.869  -71.498 00     7.547
20006    47.048   14.535  -47.869  -71.498 00     7.547
20006  1011.083   14.536  -47.869  -71.499 00     7.547
20006   162.003   14.536  -47.869  -71.499 00     7.547
```

Next example is Coulex of ^{58}Fe

Now we will do gamma-ray tracking on the data

```
mkfifo GammaEvents.2000 ;\
    ../CatGammaEvents 100* > GammaEvents.2000 &\
    tracking_EmissionCode=-8 PATH=$PATH:../OFT/standalone_gamma ../SortRuns 2
    rm -f GammaEvents.2000;\
    mv tracked_energies_2000 tracked_energies_1000
```

This looks a bit complicated but it uses a bash script to merge the two GammaEvents files, dumps this on a fifo (GammaEvents.2000) that is read by the tracking program. The output is then renamed to the correct name (tracked_energies_1000)

Next example is Coulex of ^{58}Fe

Let's have a look a the "tracked_energies_1000" output file

```
# 0.000000 0.000000 0.000000 0.031228 -0.017734 0.077780 0.000000 0.000000
# 0.000000 0.000000 0.000000 -0.037326 -0.016666 0.074548 0.000000 0.000000
# 0.000000 0.000000 0.000000 0.026702 -0.049008 -0.013584 0.000000 0.000000
0 1.078596 1.037057 1.078596 22.760527 -9.361154 4.604830 AGATA
43 1.078596 22.760527 -9.361154 4.604830 CoreEAGATA
# 0.000000 0.000000 0.000000 0.007044 0.038808 -0.032237 0.000000 0.000000
0 70.229961 1.294270 7.130071 -5.922812 35 0 SPIDER
# 0.000000 0.000000 0.000000 0.025966 -0.048920 -0.022179 0.000000 0.000000
# 0.000000 0.000000 0.000000 0.005829 -0.057863 -0.005340 0.000000 0.000000
# 0.000000 0.000000 0.000000 0.031440 0.053628 -0.008101 0.000000 0.000000
# 0.000000 0.000000 0.000000 0.008475 -0.027941 -0.041742 0.000000 0.000000
0 70.400628 1.453710 -4.787381 -7.150478 6 0 SPIDER
# 0.000000 0.000000 0.000000 0.049016 -0.040427 0.045194 0.000000 0.000000
# 0.000000 0.000000 0.000000 -0.019117 -0.004401 0.012311 0.000000 0.000000
# 0.000000 0.000000 0.000000 0.015293 0.040642 -0.033966 0.000000 0.000000
0 0.267157 0.253423 0.267157 2.997115 14.058499 -19.406305 AGATA
24 0.267157 2.997115 14.058499 -19.406305 CoreEAGATA
0 82.106798 2.684181 7.132998 -5.960515 27 0 SPIDER
# 0.000000 0.000000 0.000000 0.044419 0.006400 -0.034259 0.000000 0.000000
0 86.791618 7.457017 1.074385 -5.751520 17 0 SPIDER
```

Next example is Coulex of ^{58}Fe

This file is then sorted with a few codes inside root

```
root> .L HistoAGATASPIDER_CLX.cxx+O
root> HistoAGATASPIDER_CLX("tracked_energies_1000")
root> AGATADC_tracked_energies_1000->ProjectionY()
root> SaveHistogramsToFile("Histos58Fe.root")
```

Next example is Coulex of ^{58}Fe

Spectra