Recent developments of the AGATA Simulation Code

On behalf of the

Simulation Working Group

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18th AGATA week,
Milano - 11th Oct 2017

Science & Technology Facilities Council
Nuclear Physics Group

Outline

- **Generalities regarding the AGATA code**
- **Recent additions/corrections:**
  - **Minor debugging**
  - **New ancillary detector**
  - **New analysis tools for simulated data (before tracking)**
- **Update on simulated efficiencies and validation with source at rest**

Generalities

- **AGATA Code (AC) still maintained and available here:**
  - http://npg.dl.ac.uk/svn/agata
  - Check it out with command: svn co http://npg.dl.ac.uk/svn/agata
- **AC is compatible with Geant4.10.3 and prior versions.**
  - To use GDML geometry files, Geant4 must be installed with the GDML option.

    (Please, see the INSTALL file in the Agata code svn repository)
- **GDML files available here:**
  - https://github.com/malabi/gdml-files
  - Get it with command: git clone https://github.com/malabi/gdml-files/AGATA

Generalities

- GDML files available:

gdml files for GEANT4 simulations of NP detection suystems

17 commits | 2 branches | 0 releases | 2 contributors

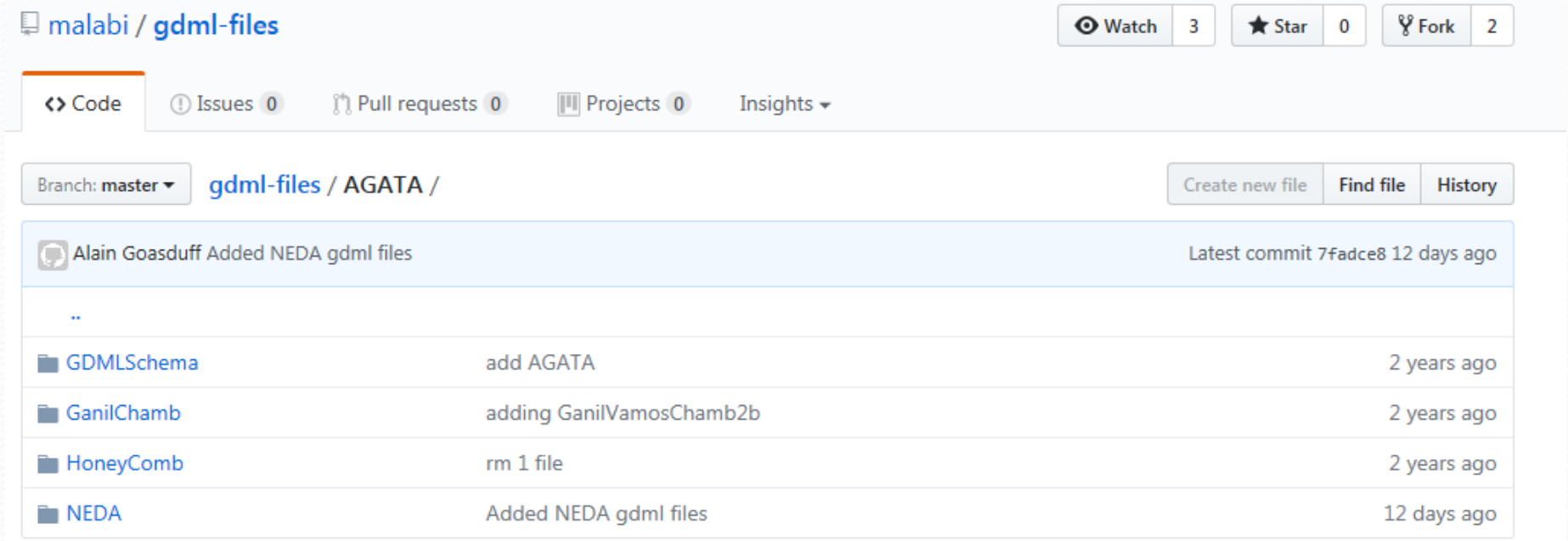
Branch: master ▾ | New pull request | Find file | Clone or download ▾

Alain Goasduff Added NEDA gdml files — Latest commit 7fadce8 12 days ago

AGATA	Added NEDA gdml files	12 days ago
GALILEO	Add gdml files for GALILEO TC / GALILEO Plunger device / GALILEO SPIDER	9 months ago
MARA	Adding MARA folder	9 months ago
MuGasT	adding MuGasT chamber	4 months ago
SToGS/ATC-Demo	Adding SToGs ATC demo	8 months ago
README.md	Update README.md	10 months ago

Generalities

- GDML files available for AGATA:



Users need to edit the trunk/CMakeLists.txt file and set the variable gdmlPATH correct path to the downloaded gdml-files/AGATA/ directory:

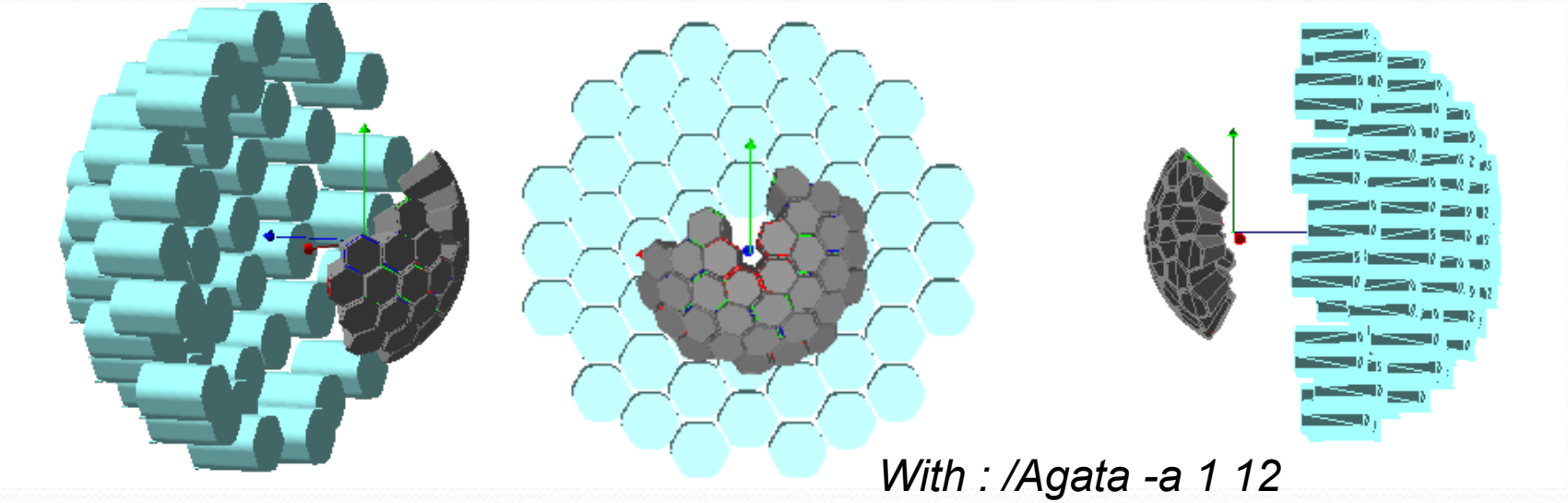
```
set(gdmlPATH "/mnt/hgfs/Echanges/MyGitHubRep/gdml-files/AGATA/")
```

Recent Additions/Modifications

- **Minor bug:**
  - Issue with command /Agata/tracking/verbose x (for x >1):
    - Positions of the Segments were not written in the output file header.
  - Cause:
    Variable named “ns” & “ps” in src/AgataDetectorArray.cc and src/AgataAncillaryADCA.cc were over shadowed by units variables “ns” and “ps” of CLHEP.
  - ➢ So Agata variables have been renamed “Ns” and “Ps” instead.

Recent Additions/Modifications

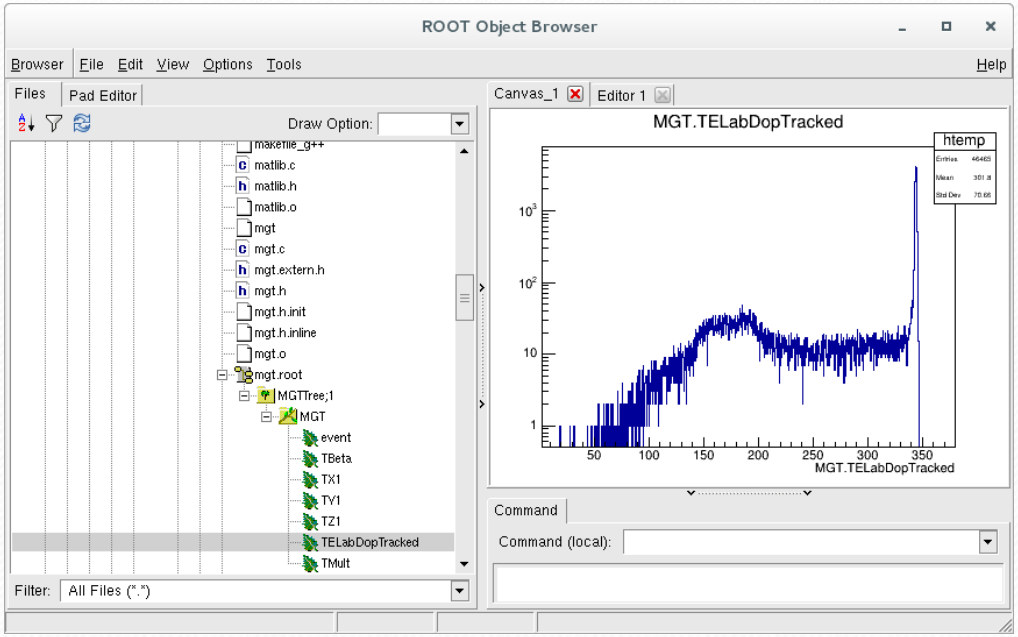
- **New Ancillarys:**
  - NEDA added to the AC package (courtesy of A. Goasduff)
  - NEDA geometry defined with GDML
    - Some issues observed when comparing results with G4.9 & G4.10 under investigations

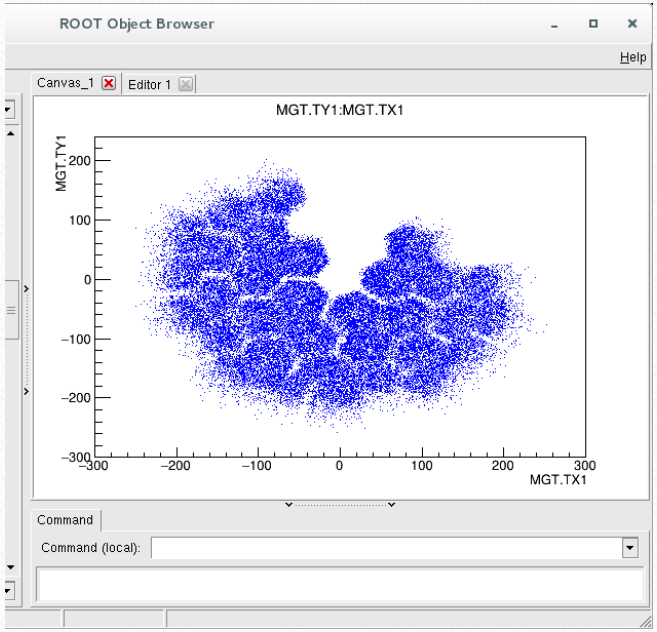


With : /Agata -a 1 12

Recent Additions/Modifications

- **New analysis tools:**
  - trunk/analysis/mgt++
    - Same as mgt/ but producing a root output file “ mgt.root” with a root tree called MGTTree
    - Still need to add all the other histograms mgt can provide.





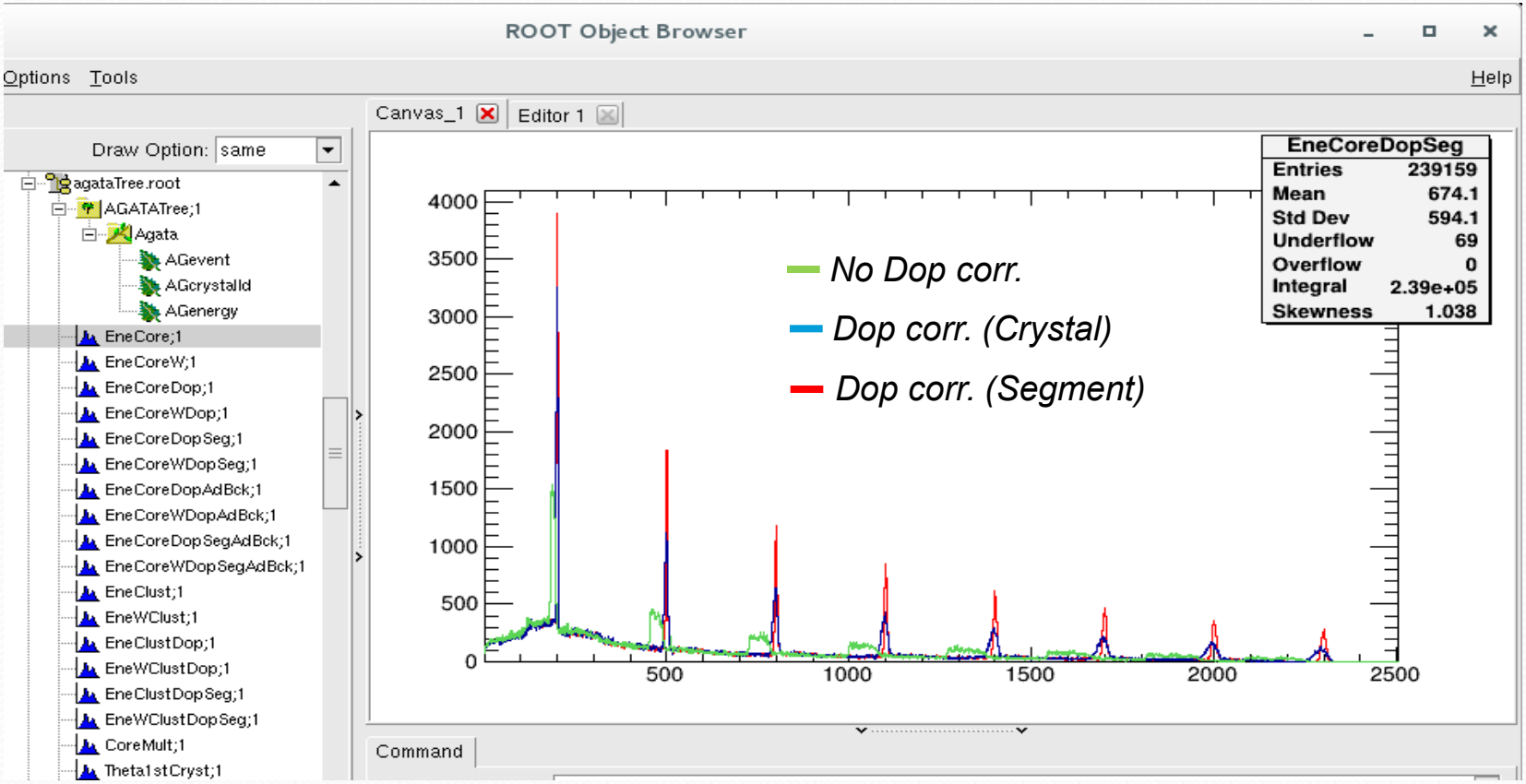
Recent Additions/Modifications

- **New analysis tools:**
  - trunk/analysis/AgataSort/AgataRead.cpp
    - No tracking
    - Just Core Common and Calorimeter analysis
    - includes Doppler correction from both Crystal positions and Segment positions.
    - reads position information in header of simulation output file GammaEvents.xxxx
      - command /Agata/file/verbose 2 *(or 3)* must be used for that.
    - includes Canberra/Geant4 relative efficiency ratio
  - Simple command: ./AgataRead beta (in %)
  - Produce the root file “agataTree.root” with root tree “AGATATree” + histograms

Recent Additions/Modifications

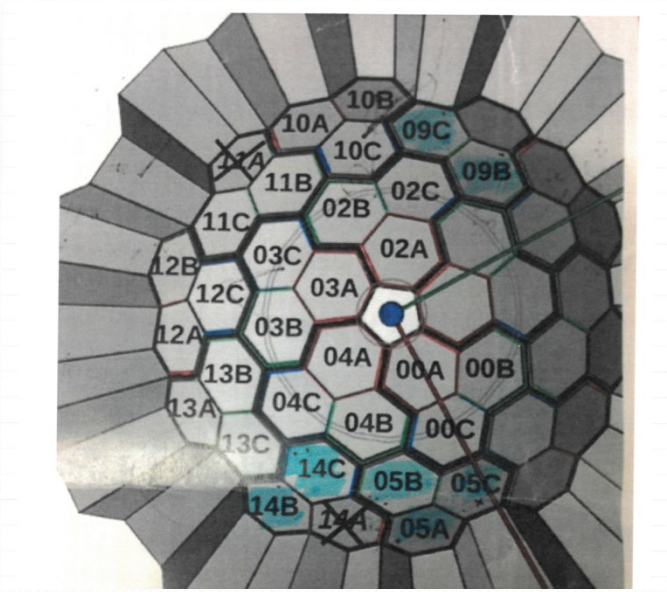
- **New analysis tools:**

Simulation with: /Agata/generator/recoil/beta 10.0
/Agata/generator/gamma/band 200 300 8



Recent Additions/Modifications

- **New analysis tools:**



Crystal Location	Crystal Name	Measured Relative Efficiency (Canberra)	Geant4 Relative Efficiency (E. Clement)	Ratio
00A	a001	0.84	0.86	0.98
00B	b004	0.782	0.87	0.90
00C	c010	0.78	0.858	0.91
01A	a010	0.76	0.86	0.88
01B	b012	0.816	0.87	0.94
01C	c014	0.78	0.858	0.91
02A	a009	0.821	0.86	0.95
02B	b005	0.8	0.87	0.92
02C	c008	0.778	0.858	0.91
03A	a005	0.79	0.86	0.92
03B	b002	0.872	0.87	1.00
03C	c009	0.811	0.858	0.95
04A	a004	0.78	0.86	0.91
.....				

Ratio values are used as input in the AgataRead file and applied when filling histograms as follow:

For singles mode : $histo \rightarrow fill(Energy[cryst], Ratio[cryst])$

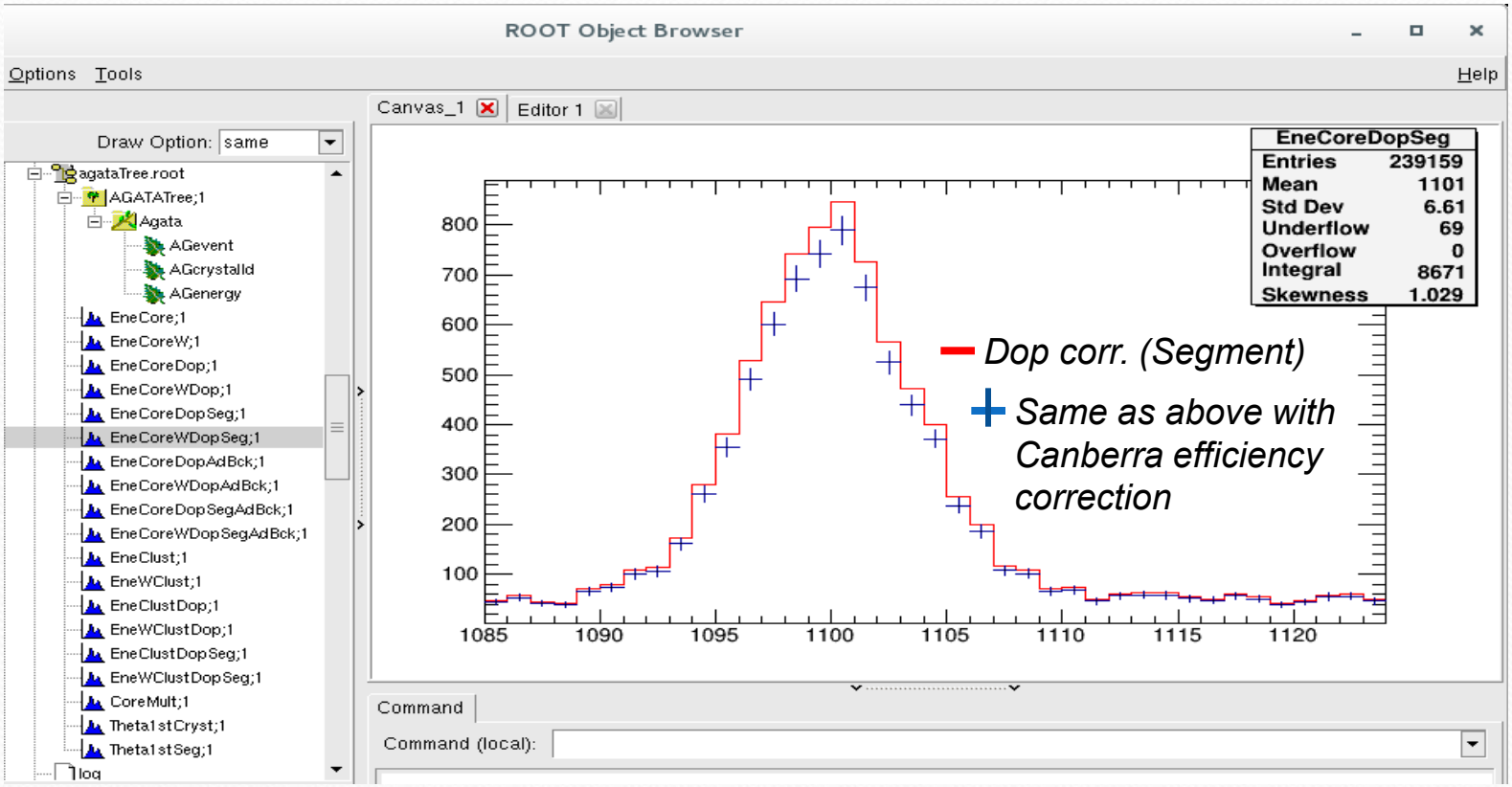
For calorimeter mode: $histo \rightarrow fill(\sum Energy[cryst] , \prod Ratio[cryst])$

Note: Table re-ordered in the AgataRead input file so that the first crystal in the table correspond to the first crystal positioned in the simulation.

Recent Additions/Modifications

- **New analysis tools:**

Simulation with: /Agata/generator/recoil/beta 10.0
/Agata/generator/gamma/band 200 300 8



Recent Additions/Modifications

- **New analysis tools:**
  - Next step is to produce the event file after this ratio correction for the tracking algorithms.
  - Alternatively, one can increase coaxial and back passive areas in Ge crystals.
    - Pros:
      - Effect propagated all the way through tracking algorithm
      - Same for any incoming energy.
  - Increasing the Ge passive area is done in A180Solid.list

Recent Additions/Modifications

```
# 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
     0   0   1   13.000000    3.000000    2.500000     0.400000    0.800000    1.300000
     0   0   2    1.000000    0.000000    0.000000     0.000000    0.000000    0.000000
#
     1   6   0   34.768773    0.000000   -0.000000    49.689796    0.721528   90.000000
     1   6   1   15.189995   29.100143   -0.000000    21.480233   42.649698   90.000000
     1   6   2  -21.610036   27.946520    0.000000   -29.959278   41.037150   90.000000
     1   6   3  -34.515980    1.715443    0.000000   -48.660064    3.028171   90.000000
     1   6   4  -17.845056  -29.899266    0.000000   -24.681675  -42.444404   90.000000
     1   6   5   21.121422  -28.647387   -0.000000    29.962271  -40.688852   90.000000
     1   0   0    5.000000   40.000000   90.000000     0.000000    0.000000    0.000000
     1   0   1   13.000000    3.000000    2.500000     0.400000    0.800000    1.300000
     1   0   2    0.000000    1.000000    0.000000     0.000000    0.000000    0.000000
#
     2   6   0   34.368758    0.000000   -0.000000    49.303402   -0.337546   90.000000
     2   6   1   20.008679   28.248525    0.000000    28.536919   40.513380   90.000000
     2   6   2  -16.582470   29.653241   -0.000000   -22.688267   42.479888   90.000000
     2   6   3  -33.870627    1.539298    0.000000   -47.639755    1.903863   90.000000
     2   6   4  -17.834223  -30.216677    0.000000   -24.533605  -43.851923   90.000000
     2   6   5   15.063353  -29.838670    0.000000    21.492077  -43.323070   90.000000
     2   0   0    5.000000   40.000000   90.000000     0.000000    0.000000    0.000000
     2   0   1   13.000000    3.000000    2.500000     0.400000    0.800000    1.300000
     2   0   2    0.000000    0.000000    1.000000     0.000000    0.000000    0.000000
```

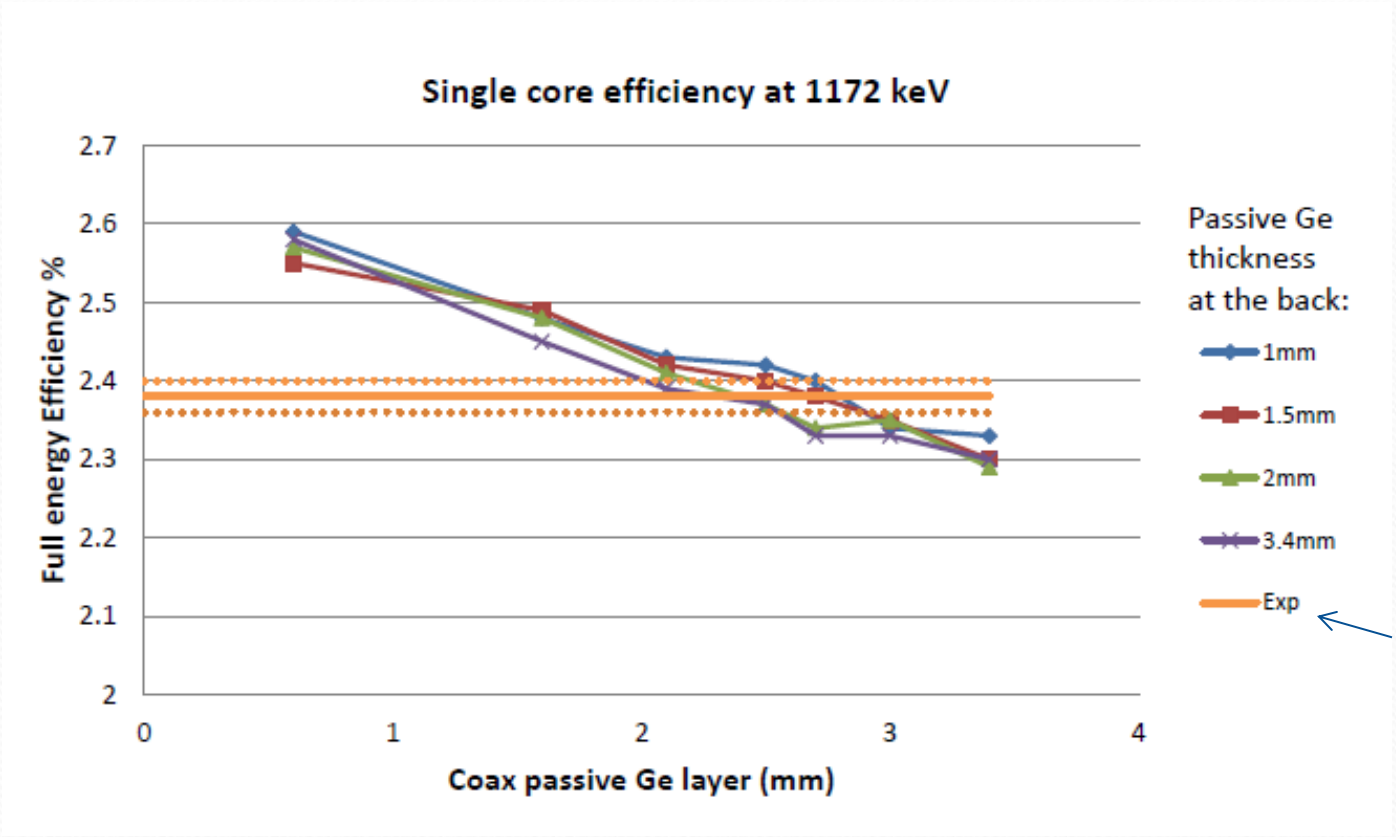
Ex: A180/A180SolidExp.list

Passivated Ge areas are:

2.5mm thick at central contact (0.6mm in A180Solid.list)

3.mm thick at the back (1mm in A180Solid.list)

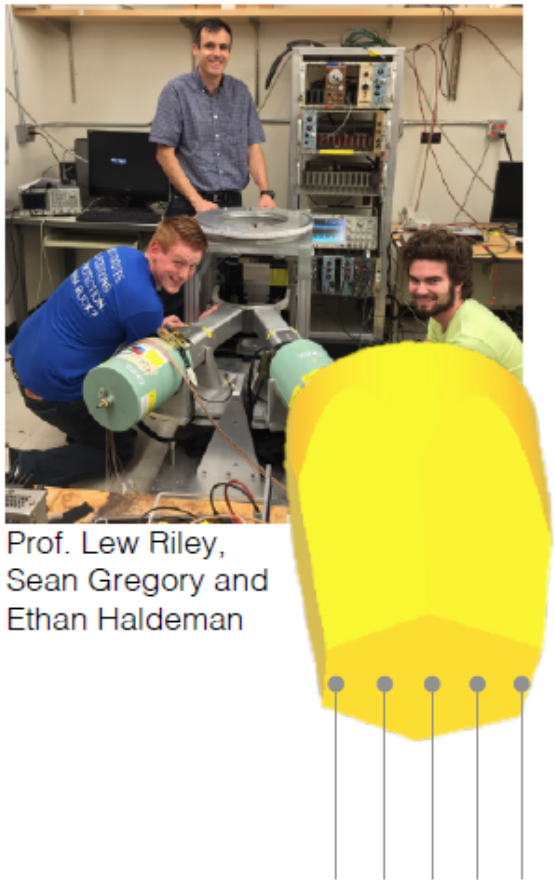
Recent Additions/Modifications



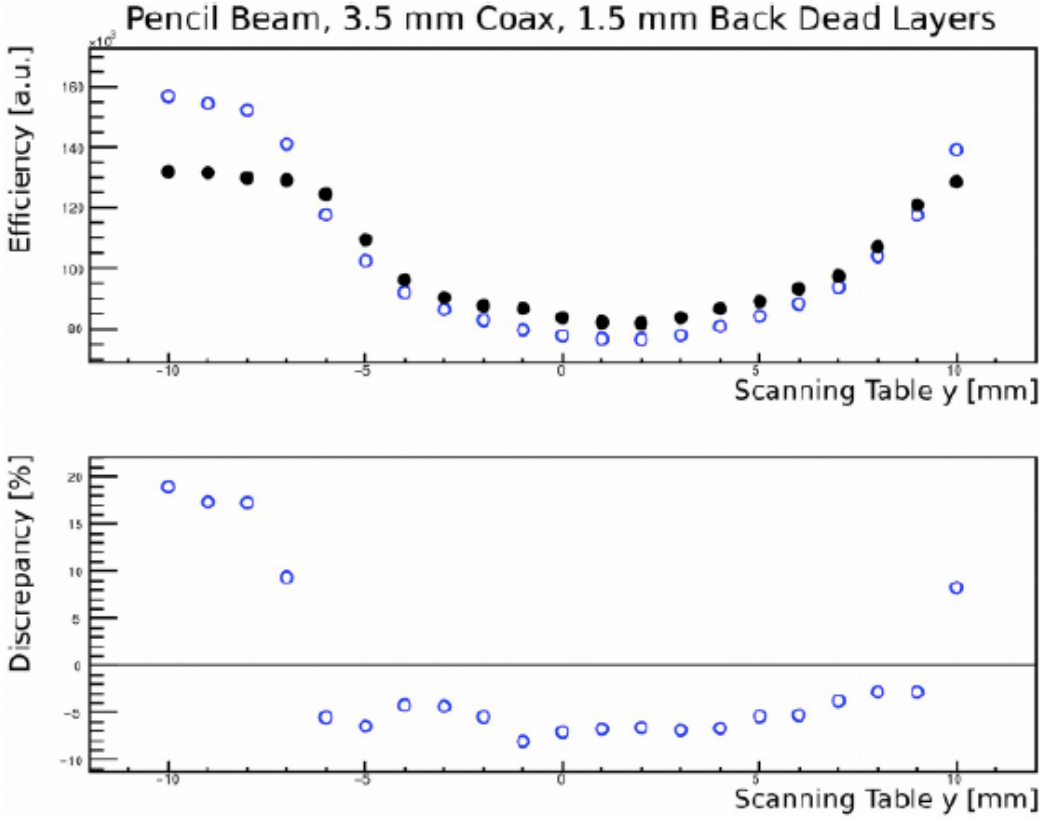
Several set of thicknesses can provide a simulated efficiency that agrees with the measured one.
So, which one ?

GRETINA case

Pencil Beams and Coaxial Dead Layers



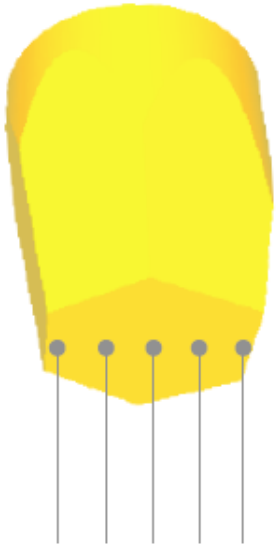
Prof. Lew Riley, Sean Gregory and Ethan Haldeman

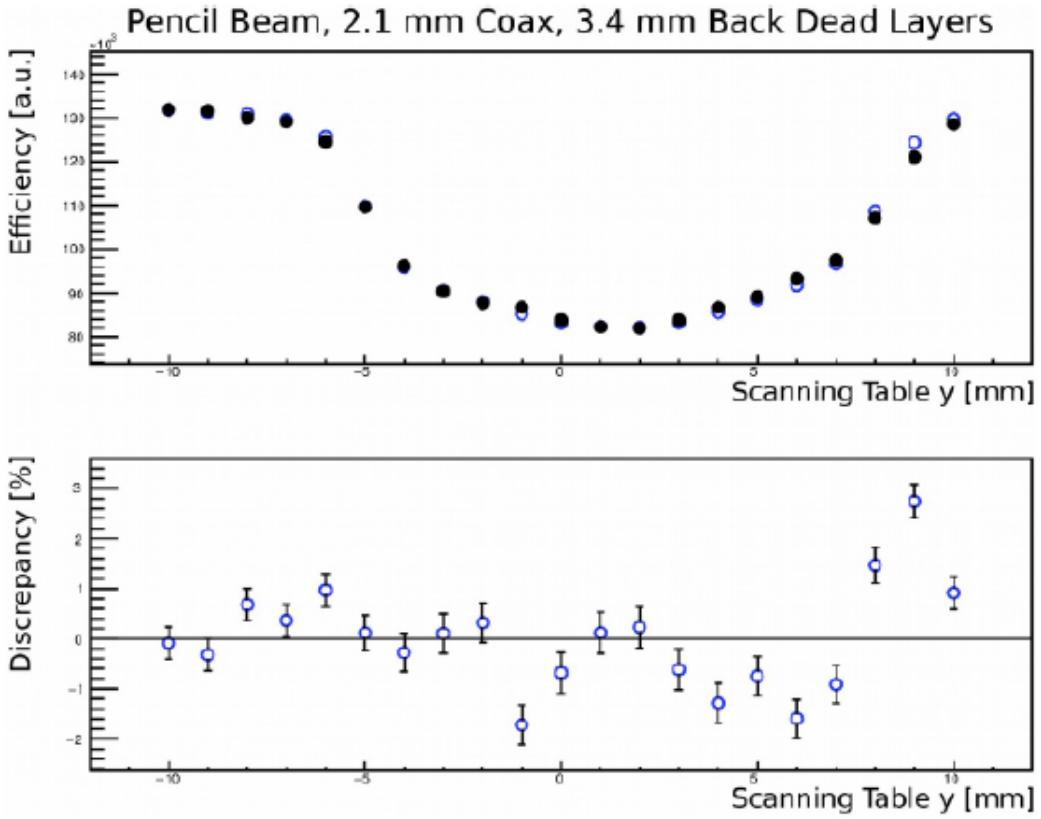


Courtesy of Heather Crawford, Lew Riley et al.

GRETINA case

Pencil Beams and Coaxial Dead Layers

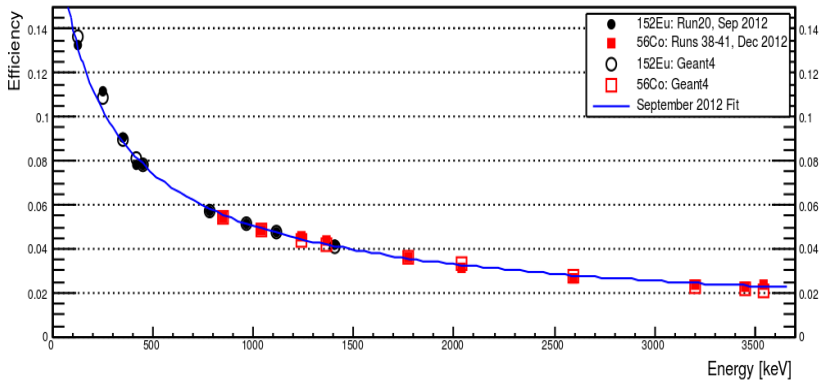


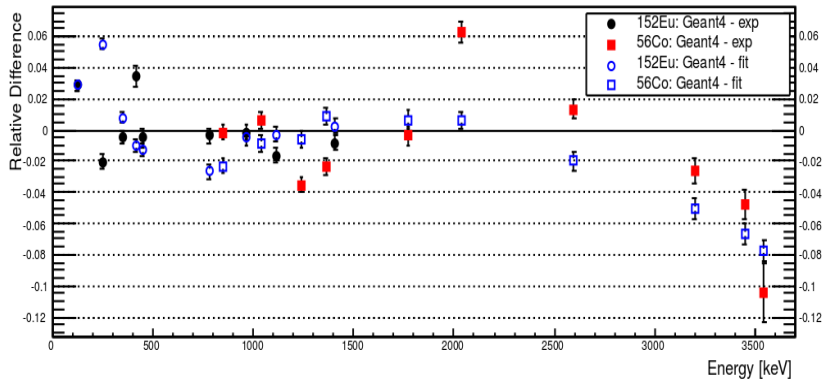


Courtesy of Heather Crawford, Lew Riley et al.

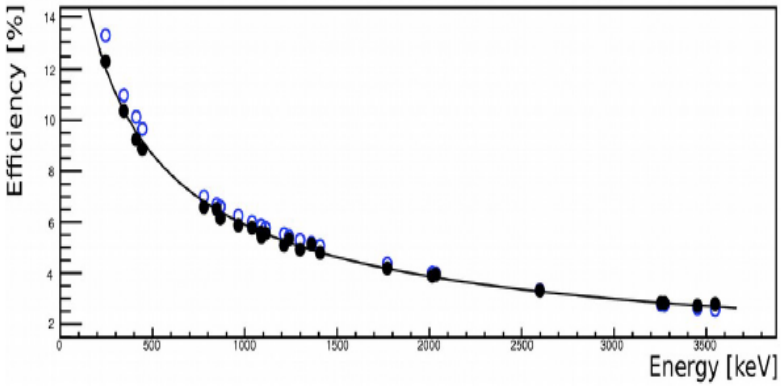
GRETINA case

3.5mm Coax and 1.5mm Back dead layer

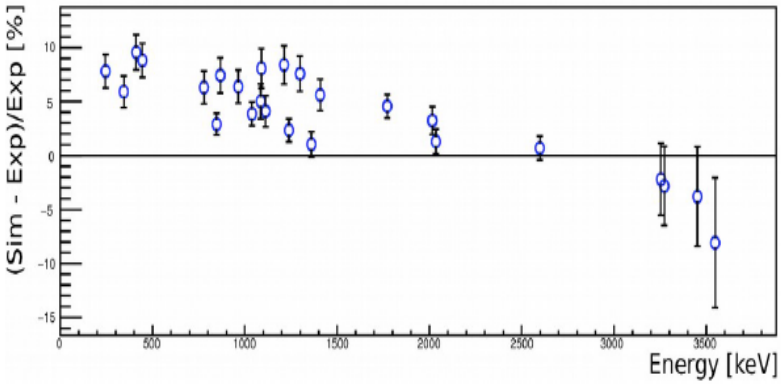




8 Quads, 2.1 mm Coax, 3.4 mm Back Dead Layers



Relative Discrepancy



Courtesy of Heather Crawford, Lew Riley et al.

Recent Additions/Modifications

- **Enhanced Ge passive area Vs "Canberra" normalised efficiencies :**

Core Efficiency for 32 crystals in Compact configuration, Mγ=1

Energy:	1112 keV
Original passive areas:	8.1*
Enhanced Passive areas:	7.3
Applying Canberra efficiency factor :	7.6*
Measured (E661):	7.3*

** Courtesy of E. Clement*

Simulated Core efficiency and Validation

Table 5: Measured AGATA efficiencies

Energy (keV)	Ref	Measured in single/core	GEANT4 Single efficiency /core	GEANT4 $Single_{scaled}$ efficiency /core
1.1 MeV	N. Lalović, NIMA 806 (2016)	0.113% in nominal	0.13%	0.12%
1.4 MeV	E. Clément, NIMA 855 (2017)	0.097% in nominal	0.11%	0.10%
1.3 MeV	R. Perez, AGATA Week 2016	0.095% in nominal	0.12%	0.11%
1.3 MeV	R. Perez, AGATA Week 2016	0.173% in compact	0.22%	0.21%
1.1 MeV	E661	0.228% in compact	0.253%	0.234%

Courtesy of E. Clement

Still room for improvements:
- check simulations with a realistic chamber geometry
- add angular correlation effects
- check with an optimised/measured set of thickness parameters for the Ge passive areas

Summary

- Ancillary detector NEDA added to the Agata code package
- An analysis code of ASC output file for Core common and calorimeter analysis mode () is now provided
  - analysis/AgataSort
- An new version of mgt+ROOT (mgt++) in preparation
  - Analysis/mgt++
- Simulated efficiency improved by either scaling with ratio canberra/Geant4 relative efficiency factor, or by the increase of the passive areas in the Ge crystals.

Thank you