AGATA Simulation Code (ASC)

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On behalf of the A.S.W.G.

Outlines:

1. Study of AGATA core efficiencies with sources - update
2. Status for γ-ray angular distributions in ASC
3. Recent ancillary/mechanical structure additions to ASC
4. Future work for the AS Working Group.

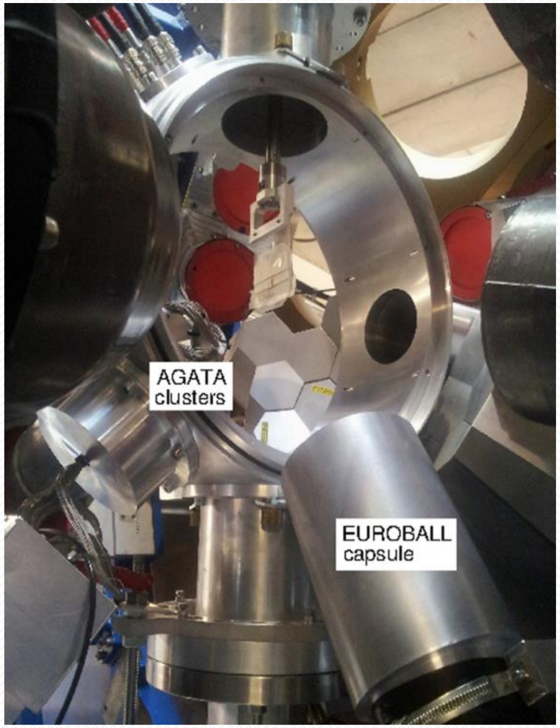
Some general information

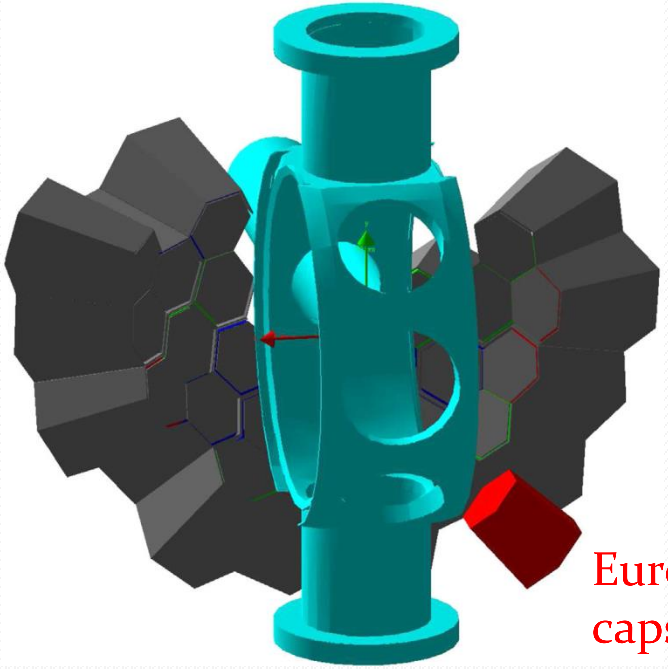
- **AGATA Code (AC) still maintained and available here:**
  - **http://npg.dl.ac.uk/svn/agata**
  - Check it out with command: svn co http://npg.dl.ac.uk/svn/agata
- **AC is compatible with Geant4.10.5 and prior versions.**
  - To use GDML geometry files, Geant4 must be installed with the GDML option.

    (Please, see the INSTALL file in the svn repository)

Core efficiency Study

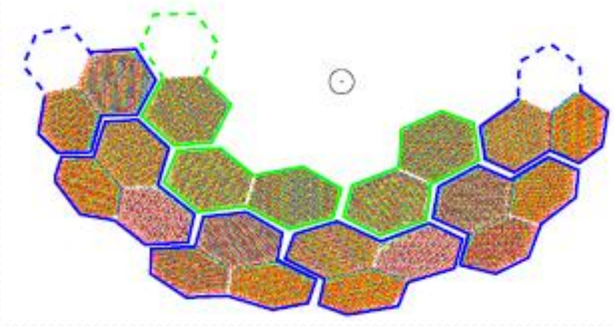
- Long standing issue: Simulation overestimating core efficiency measurements
- Crystal effective size or passive Ge area are questioned.
- Try to determine this passive Ge area based on measured efficiency at 1.172 MeV with the GSI setup:





Geometry included in the simulation

21 operational crystals



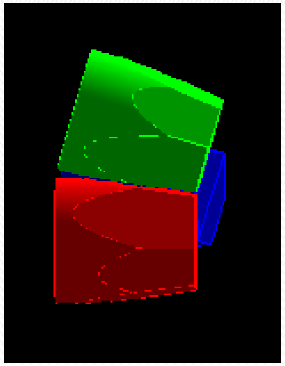
Increasing Ge Passive area

- Thickness of Ge Passive Area around the coaxial contact and at the back of the crystals can be adjusted in file A180Solid.list

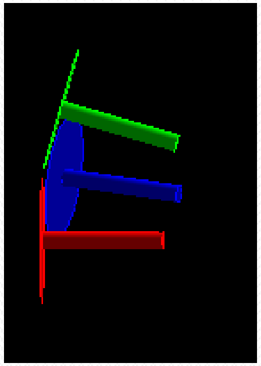
- Simulations have been carried out with several sets of passive area parameters and compared with the measured efficiency at 1.172 MeV at GSI

Ge dead area from:

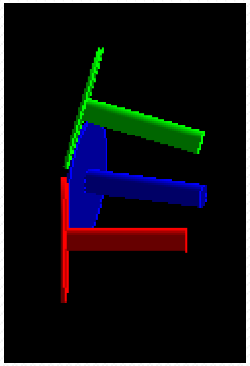
To:



1 ATC

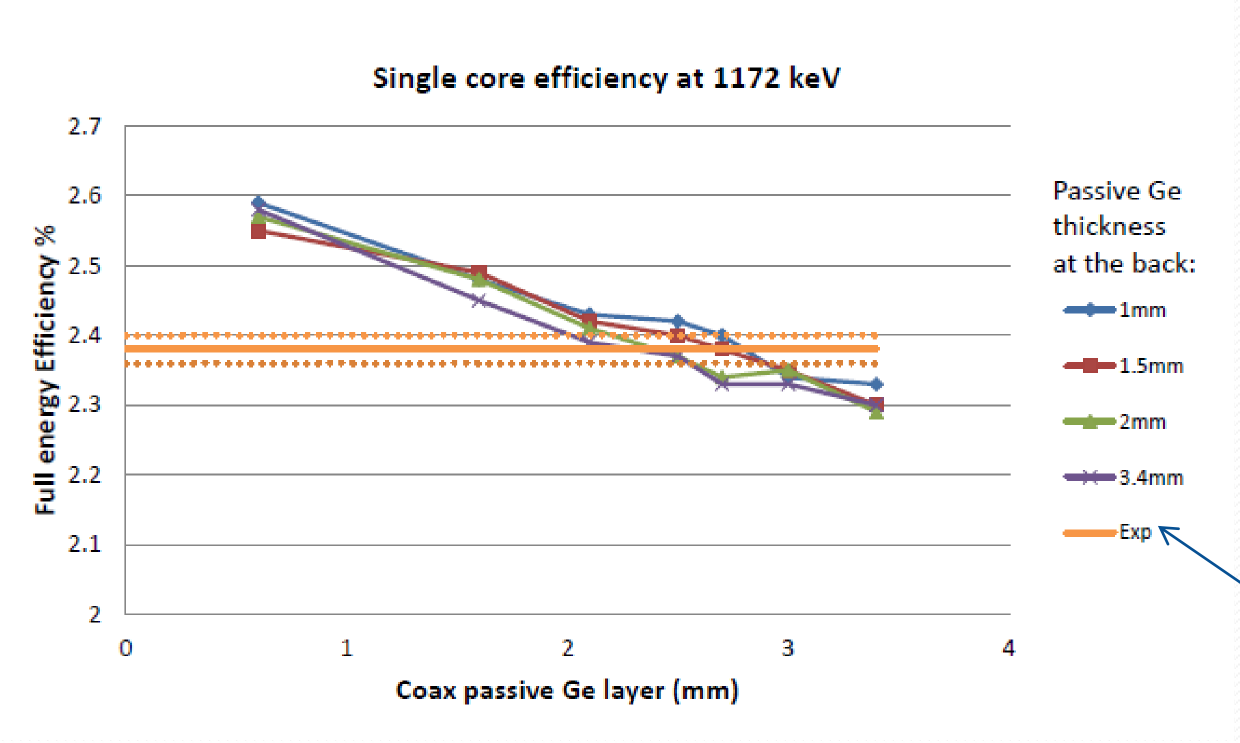


Coax / Back
0.6 / 1 mm
(=default values)



Coax / Back
2.5 / 3 mm

Ge passive/dead area determination



Exp. data:
Courtesy of
N. Lalovic
(GSI 2014 setup)

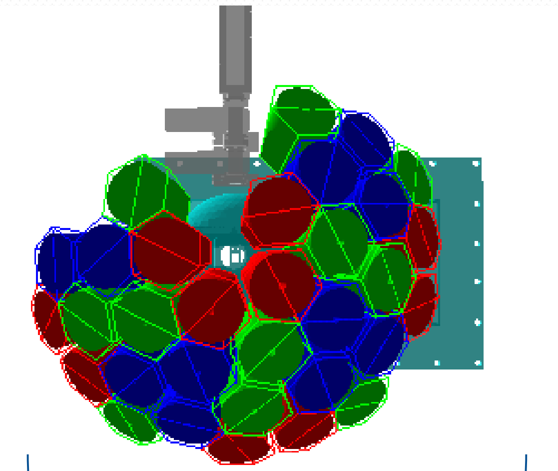
Several set of thicknesses can provide a result that agrees with the measured one.

First assumption: 2.5 mm (Coax) & 3 mm (Back)

Note: in GRETINA 2.1 mm (Coax) & 3.4 mm (Back)

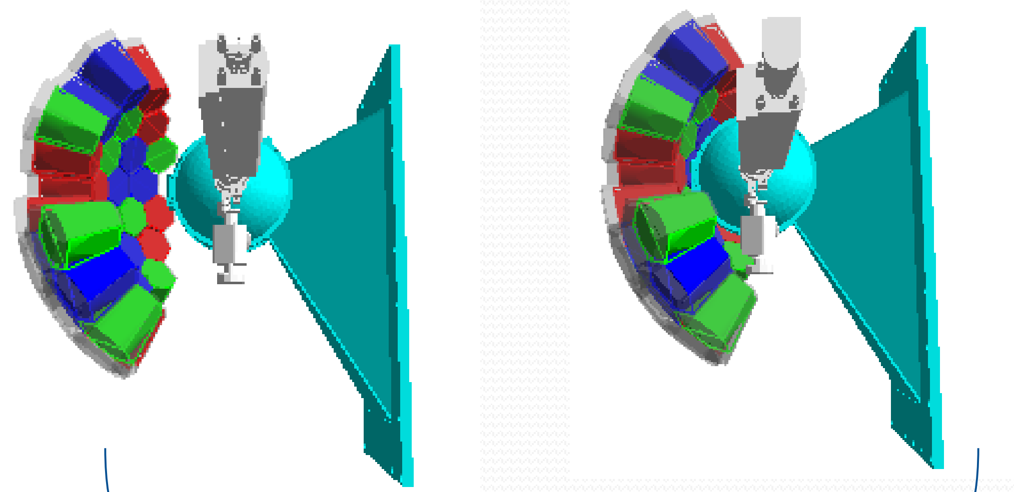
GANIL Source measurements – Simulated Setup

32 AGATA crystals + VAMOS chamber (Aluminium only)



Nominal

(view in beam direction)



Nominal (left) and Compact* (right)

(view from above)

- 2 of the 32 crystals not operational at the time of the source measurement.
- 1 more was later removed from the analysis (Electronics issue)
- So 32 crystals included in the simulation but 29 kept for the analysis

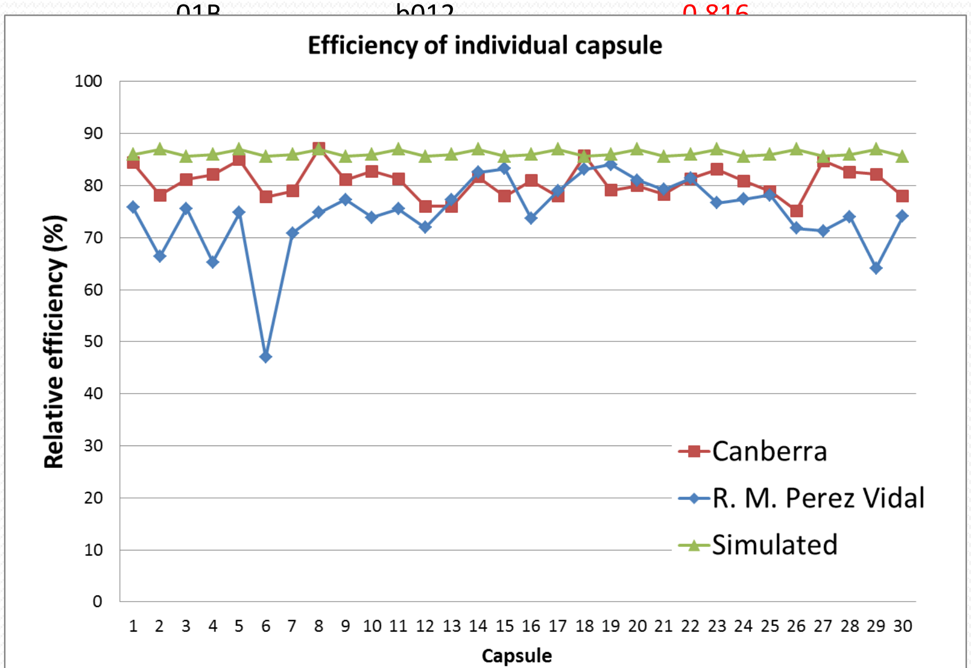
*Compact =10cm shift along z

Capsule relative efficiency at 1.332 MeV

Thanks to E. Clement & R. M. Perez Vidal

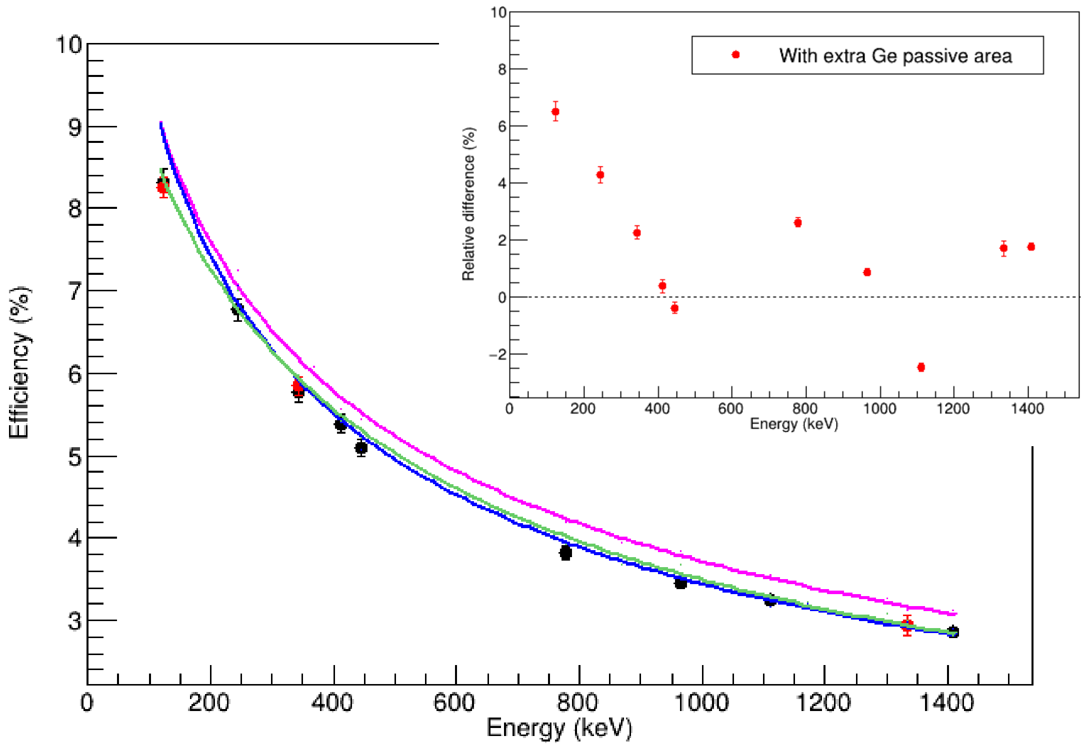
Crystal Location	Crystal Name	Measured Relative Efficiency (Canberra)	Measured Relative Efficiency (R. M. Perez Vidal)	Geant4 Relative Efficiency (E. Clement)
00A	a001	0.844	0.758	0.86
00B	b004	0.782	0.664	0.87
00C	c010	0.78	0.756	0.858
01A	a010	0.76	0.772	0.86
01B	b012	0.816	0.885	0.87
			0.653	0.86
			0.748	0.87
			0.47	0.858
			0.708	0.86
			0.748	0.87
			0.773	0.858
			0.739	0.86

without additional passive area !

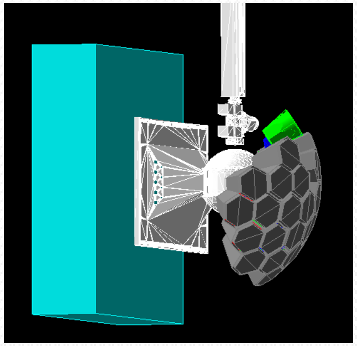


Suggest a smaller effective crystal size than the one used in the simulation.

Simulation vs Source Measurements - NOMINAL

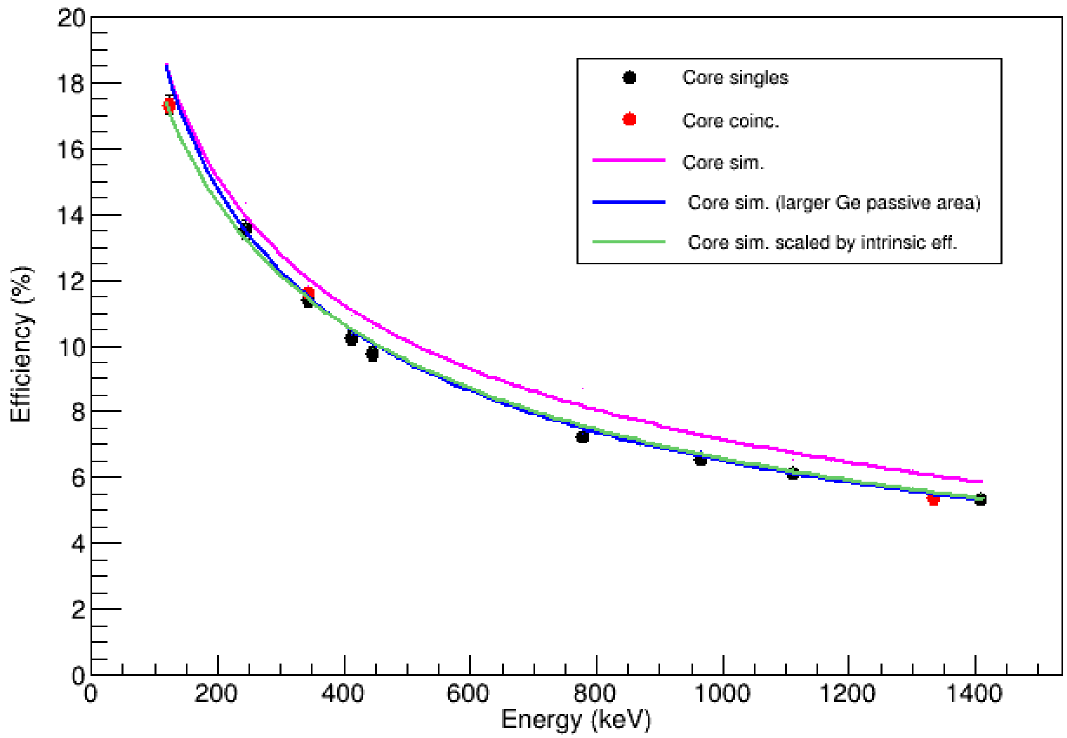


Data:
Courtesy of
Rosa Maria
Vidal-Perez



- Good match when weighting by the measured relative efficiency of each crystal !
    - But correction difficult to apply to the simulated tracked efficiency.
- The increase of Ge passive area from 0.6mm (Coax) / 1mm (Back) to 2.5mm (Coax)/ 3 mm (Back) results in a better agreement except at 121 keV.

Simulation vs Source Measurements - COMPACT



Data: Courtesy of Rosa Maria Vidal-Perez

- Same conclusions than for the nominal configuration

Simulation vs Source Measurements

- Conclusion:
  - Much better agreement between simulation and measurement when Coaxial & Back dead layer thickness are increased to 2.5 & 3mm, respectively
  - But is it the right thicknesses for all crystals ?
    - In reality it will be different for each crystal as suggested by the measured relative efficiency
    - If we assumed all crystal of a given shape are the same:
      - How does that affect the simulated tracked efficiency ?
      - Will we need to adjust the size of each crystals in the simulation ?

Reviewed basic performance of a 4π Array

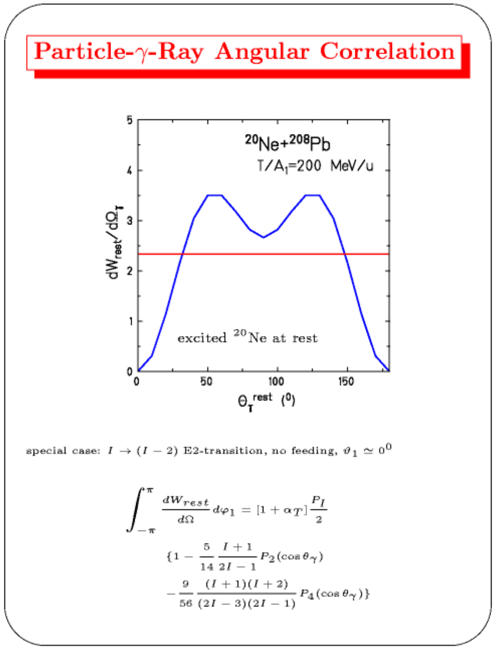
Detector properties specified for		Ideal Ge-shell	AGATA (OFT 2018)	AGATA & extended passive Ge (OFT 2018)
Efficiency (P_{fe})	E_γ = 0.1 MeV, M_γ = 1, $0 < \beta < 0.5$	99.5%	67-70 %	67-70%
	E_γ = 1.0 MeV, M_γ = 1, $0 < \beta < 0.5$	65-76%	35-40 %	34-38%
	E_γ = 10. MeV, M_γ = 1, $0 < \beta < 0.5$	10-14%	6-8%	3.5- 5 %
	E_γ = 1.0 MeV, M_γ = 30, $0 < \beta < 0.5$ *	36%	23-27%	21-25%
Peak-to-total ratio (P/T)	E_γ = 1.0 MeV, M_γ = 1, $0 < \beta < 0.5$	82%	51-57%	49-54%
	E_γ = 1.0 MeV, M_γ = 30 , $0 < \beta < 0.5$ *	55%	38-43%	37-41%

Note: No material between source and array (no chamber and no ancillary!)

γ-ray angular distribution in ASC

- Inside the Built-in generator (since GSI campaign)
- Only pure E2 : $2^+ \rightarrow 0^+$ is implemented
  - /Agata/generator/gamma/gunType int
  - int =
    - 0 $\rightarrow$ Monochromatic gammas (Default)
    - 1 $\rightarrow$ Equally spaced gammas Eg= Offset+ Delta*n
    - 2 $\rightarrow$ Discrete energies from file
    - 3 $\rightarrow$ Flat energy distribution
    - 4 $\rightarrow$ Energy sampled from Spectrum
    - 5 $\rightarrow$ Discrete energies from file (weighted with intensities)
    - 6 $\rightarrow$ E2 transition (it is currently hard-coded)

γ-ray angular distribution in ASC

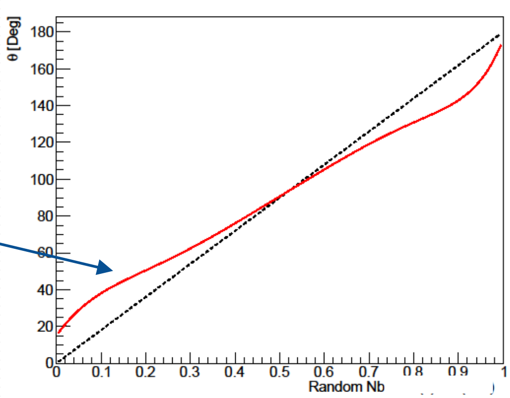


In file AgataEmitted.cc:

void AgataEmitted::EmitE2DirCM()

- For pure E2: $2^+ \rightarrow 0^+$ transition
- Based on particle-gamma angular correlation (in ^{20}Ne):
  http://www-linux.gsi.de/~wolle/EB_at_GSI/FRS-WORKING/index.html
- Using Inverse Cumulative Probability method
  - Fitted with a polynomial of order 8
    - 9 Parameters (hard-coded)
    - θ= par[0]+ par[1]*x+ par[2]*x^2+ … + par[8]*x^8
    - Where:

      x=G4UniformRand();



γ-ray angular distribution in ASC

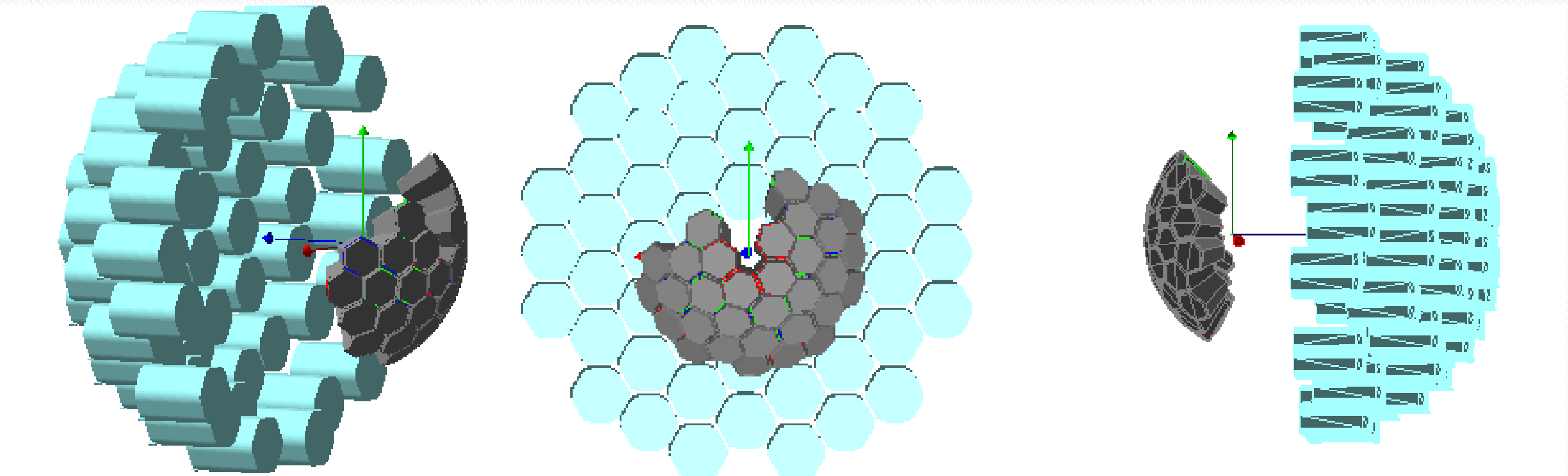
Still to do:

- Make it more generic and user-friendly
  - Interactive commands for the user to input:
    - Particle-gamma angular correlation function
    - or inverse cumulative probablity function
    - or fit function, Nb of parameters, parameter values.

- Extend to other type of transitions: E1, M1.
  - As proposed in the update of the Project Definition Document, for 2020-30.

Recent Additions

- **New Ancillarys:**
  - NEDA added to the AC package (courtesy of A. Goasduff)
  - NEDA geometry defined with GDML



Other GDML files

- Available here: https://github.com/malabi/gdml-files

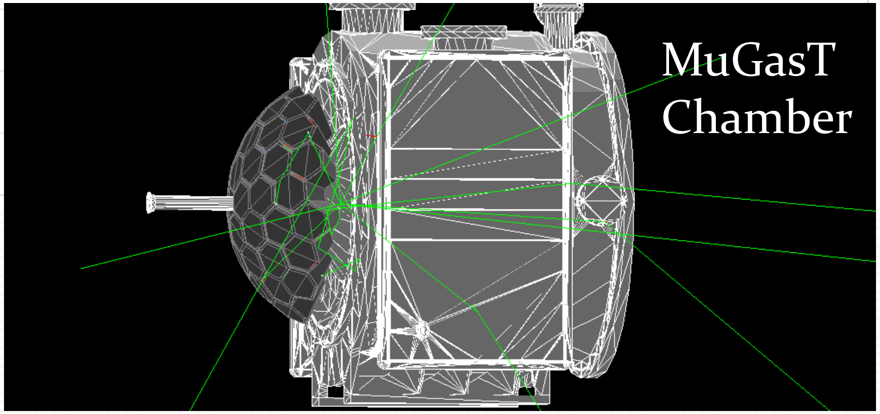
gdml files for GEANT4 simulations of NP detection suystems

17 commits | 2 branches | 0 releases | 2 contributors

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

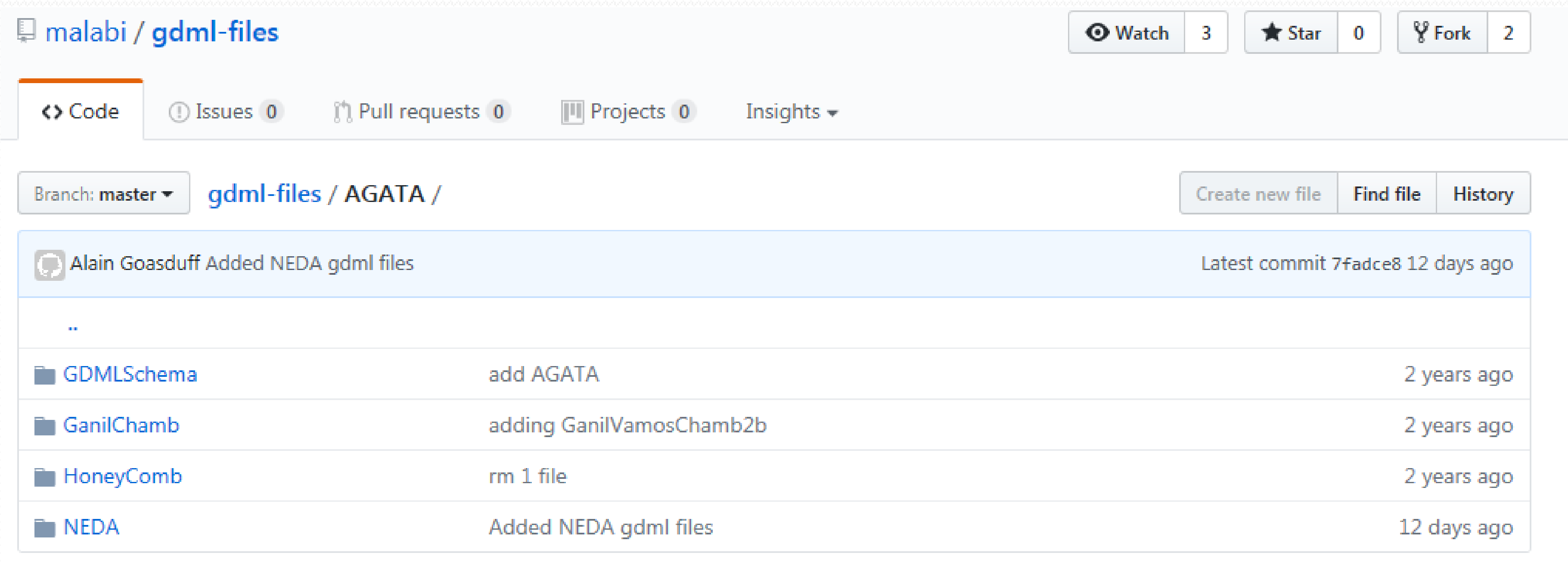
Alain Goasduff Added NEDA gdml files — Latest commit 7fadce8 12 days ago

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	
SToGS/ATC-Demo	Adding SToGs ATC demo	
README.md	Update README.md	



Other GDML Files

- GDML files available for AGATA:



Some are STEP files converted to GDML using FastRad application
(License valid till march 2020 at Daresbury)

Future work

- Update of the Project Definition Document (2020-30) is on-going.
- Simulation section includes:
  - Code maintenance and dissemination
  - Update generic performance predictions w/r of the number of detector, at the different facilities, low and high multiplicity
  - Implement new CAD Mec. Struc. as required
  - Use crystal characterisation information (Ge passive area measurement) as input to the simulation geometry.
  - Create a map of the position sensitivity in a crystal and use this as input in the simulation.
  - Develop/complete event generators (ex: γ-ray angular distribution).
  - Simulate array performance as polarimeter.
  - Migrate to a more “user-friendly” framework (STOGS, NPTool, FAIRROOT)

Thank you