Simulations tools for AGATA

On behalf of the

AGATA Simulation Working Group

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20th AGATA week, 15th March 2021

Science & Technology Facilities Council
Nuclear Physics Group

Outline

- **In my talk:**

  - **Generalities**

    - **Code**

    - **Recent tools (Still be added to the distributed version)**

  - **Update on Simulation work supported by STFC-grant**

    - **Planned activities**

    - **Current status**

- **3 additional talks:**

  K. Wimmer :
  "**LISA**: **LI**fetime measurements with **S**olid **A**ctive targets"

  D. Brugnara :
  "Comparison of simulated and measured efficiency for the Cryogenic target and MUGAST setup"

  E. Gamba
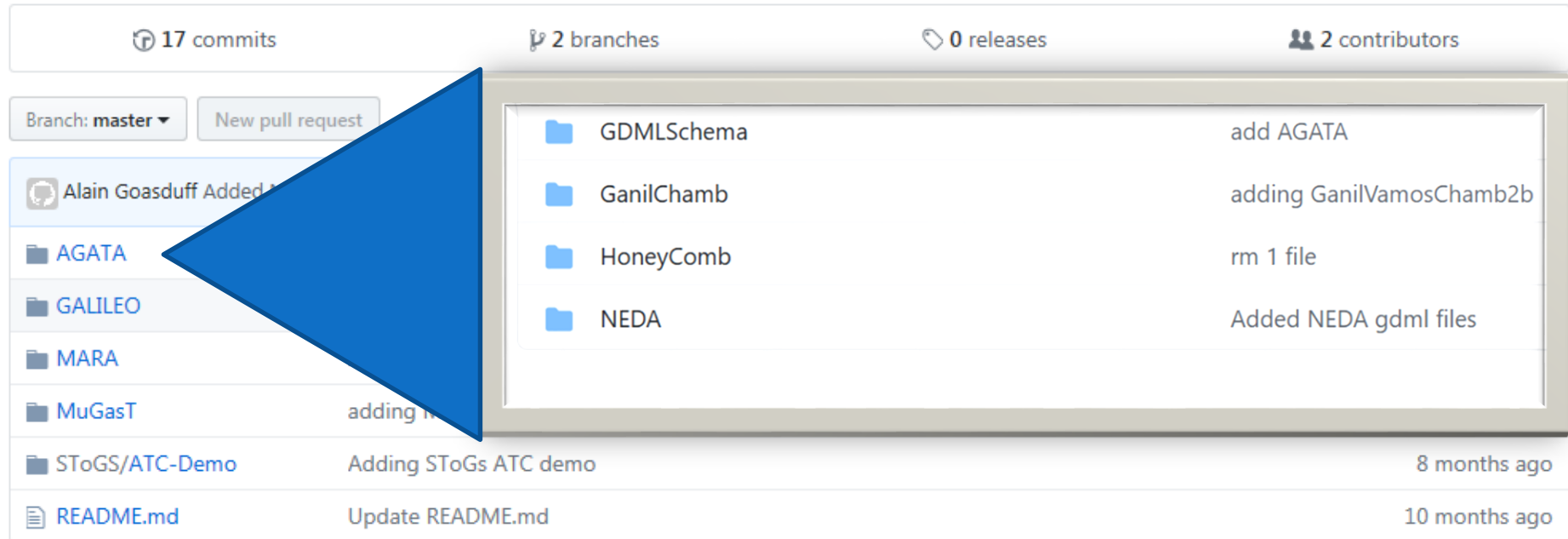 "Implementing the new PRISMA reaction chamber in AGATA code"

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 Geant4.10.5 and prior versions.**

  - Some issues to run with 10.7 (Physics lists)

    - Need to update code to give users the choice of physics lists

    - Still need to set test scripts to check the AGATA code response between between GEANT4 versions.

- **CAD drawing converted in GDML can be imported in AC.**

  - Geant4 must be installed with the GDML option.

  - A list of gdml file is 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

🔘 Alain Goasduff Added	
📁 AGATA	
📁 GALILEO	
📁 MARA	
📁 MuGasT	adding
📁 SToGS/ATC-Demo	Adding SToGs ATC demo
📄 README.md	Update README.md

📁 GDMLSchema	add AGATA
📁 GanilChamb	adding GanilVamosChamb2b
📁 HoneyComb	rm 1 file
📁 NEDA	Added NEDA gdml files

8 months ago
10 months ago

New PRISMA reaction chamber expected to be added soon
(See Eugenio's talk)

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

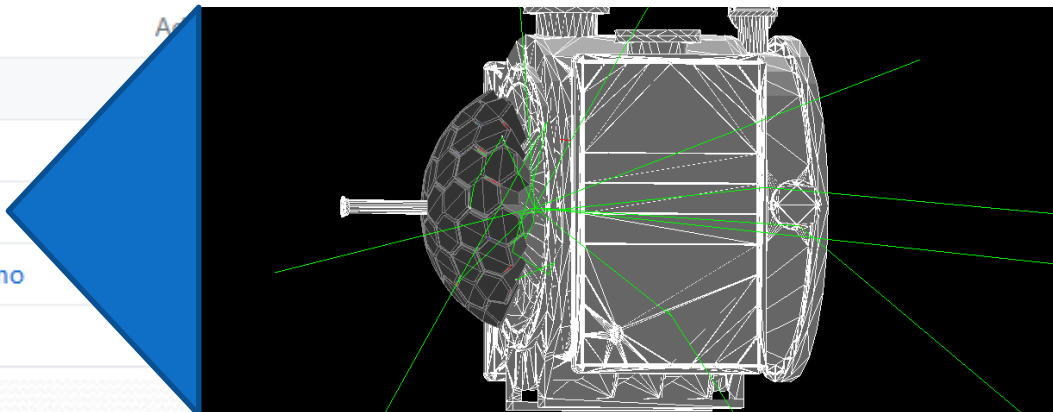| 📁 AGATA		12 days ago
📁 GALILEO		9 months ago
📁 MARA		9 months ago
📁 MuGasT		4 months ago
📁 SToGS/ATC-Demo		8 months ago
📄 README.md		10 months ago

Core efficiency sim-vs-data

See Daniele's talk for an update

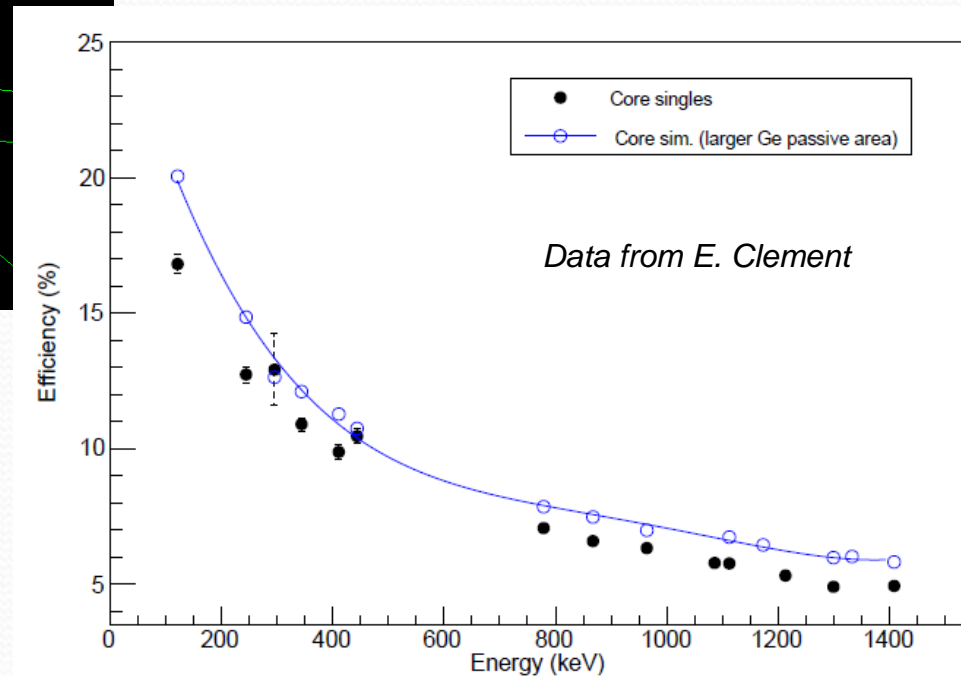*41 crystals*
Core efficiency – without addback
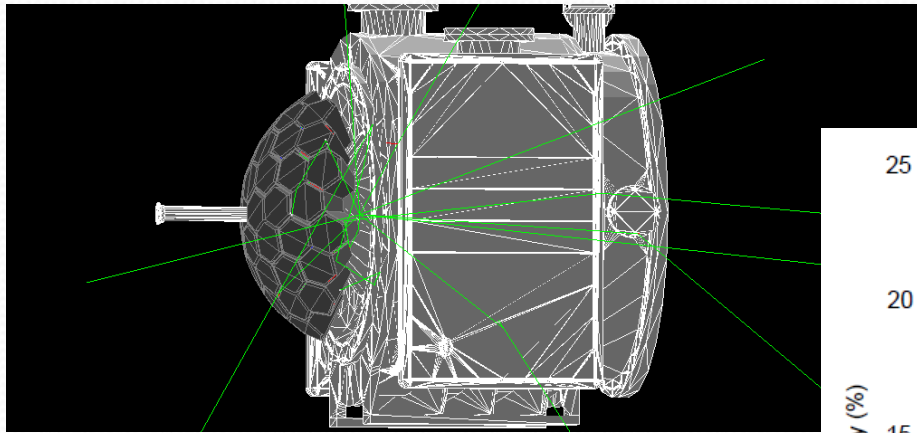
larger Ge passive area used as for the 29-crystals simulations

~ 15-20% discrepancy

MUST2 contribution (not included in the simulation)to be checked .

Data from E. Clement

Preliminary

Generalities - update

- **List of ancillary detector displayed with the help option:**

-a N_anc n_1 ... n_N   select ancillary devices
>   *1 --> Koeln*
>   *2 --> Shell*
>   *3 --> MCP*
>   *4 --> Euclides*
>   *5 --> ADCA*
>   *6 --> Brick (block of material to mimic a dipole)*
>   *7 --> NWall*
>   *8 --> DIAMANT*
>   *9 --> EXOGAM*
>   *10 --> Helena*
>   *11 --> RFD*
>   *12 --> NEDA*
>   *16 --> CASSANDRA*
>   *17 --> AIDA*
>   *18 --> FATIMA*
>   *19 --> PARIS*
>   *20 --> GSI chamber (2015)*
>   *21 --> SPIDER **(gdml)***
>   *23 --> NordBallNDet*

./Agata -h

24 --> Plastic Orsay
>   *25 --> Miniball*
>   *26 --> HoneyComb **(gdml)***
>   *27 --> Vamos Chamber **(gdml)***
>   *28 --> OOPS **(gdml)***
>   *29 --> GALILEO plunger*
>   *30 --> SIGMA*
>   *31 --> Diamant plung **(gdml)***
>   *32 --> Diamant FTgt **(gdml)***
>   *33 --> PRISMA magnets*
>   *34 --> PRISMA FP*
>   *35 --> PRISMA LNL reaction chamber **(gdml)***

Tools developed for AGATA simulation

- Analysis tool for the simulation of high γ-ray multiplicity experiments.
  - Multi-gate analysis of the simulated tracked events (OFT).
  - Search of weakest transitions.
  - Still need some cosmetic touches prior to be distributed.
    - Define the list of measured γ-rays
    - Define the number of γ in the gate
    - available on request until then

SD (I=10⁻⁴)

SD ($I=10^{-4}$)

ND

4 MeV
$I=10^{-6}$

ND (I=1)
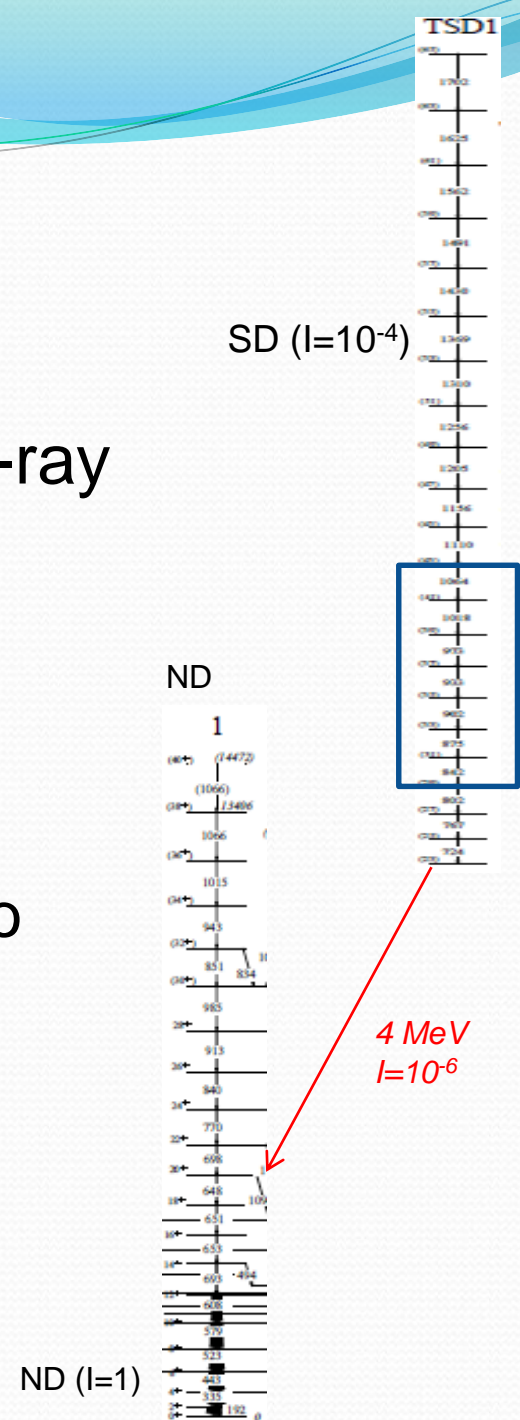
Multi-gating analysis

example:
4-γ gate *from a list of* **20 γ rays known/measured**

Successfully tested against non-automatic procedure

Start with an output tracked event & check the γ-Multiplicity M

$M \leq 4$

$M > 4$, **fill Energy[M] array**

Check all energies in EgamGate[] have a match in Energy[]

match

No match
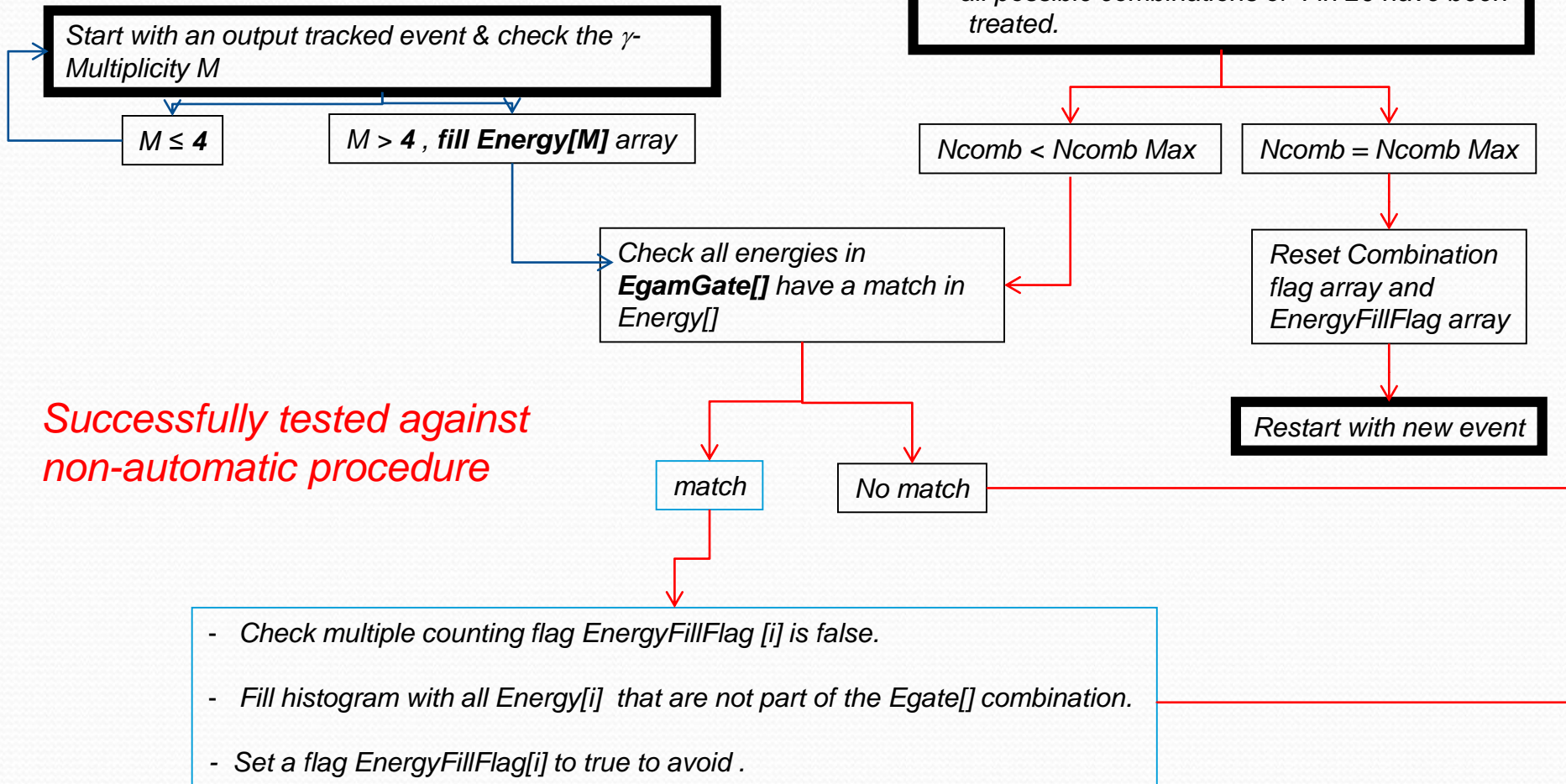
- Choose randomly a combination of 4 γ-ray energies amongst all the 20 γ-ray energies known and fill up the array **EgamGate[4]** .
- A combination Flag is used to confirm this combination of 4 γ-ray energies is new.
- If new, a counter (Ncomb) is incremented until all possible combinations of 4 in 20 have been treated.

Ncomb < Ncomb Max

Ncomb = Ncomb Max

Reset Combination flag array and EnergyFillFlag array

Restart with new event

- Check multiple counting flag EnergyFillFlag [i] is false.

- Fill histogram with all Energy[i] that are not part of the Egate[] combination.

- Set a flag EnergyFillFlag[i] to true to avoid .

Simulation for AGATA 4π Physics white-paper

γ-γ-γ-γ-γ **SD1 spectrum**

AGATA

EuroBall
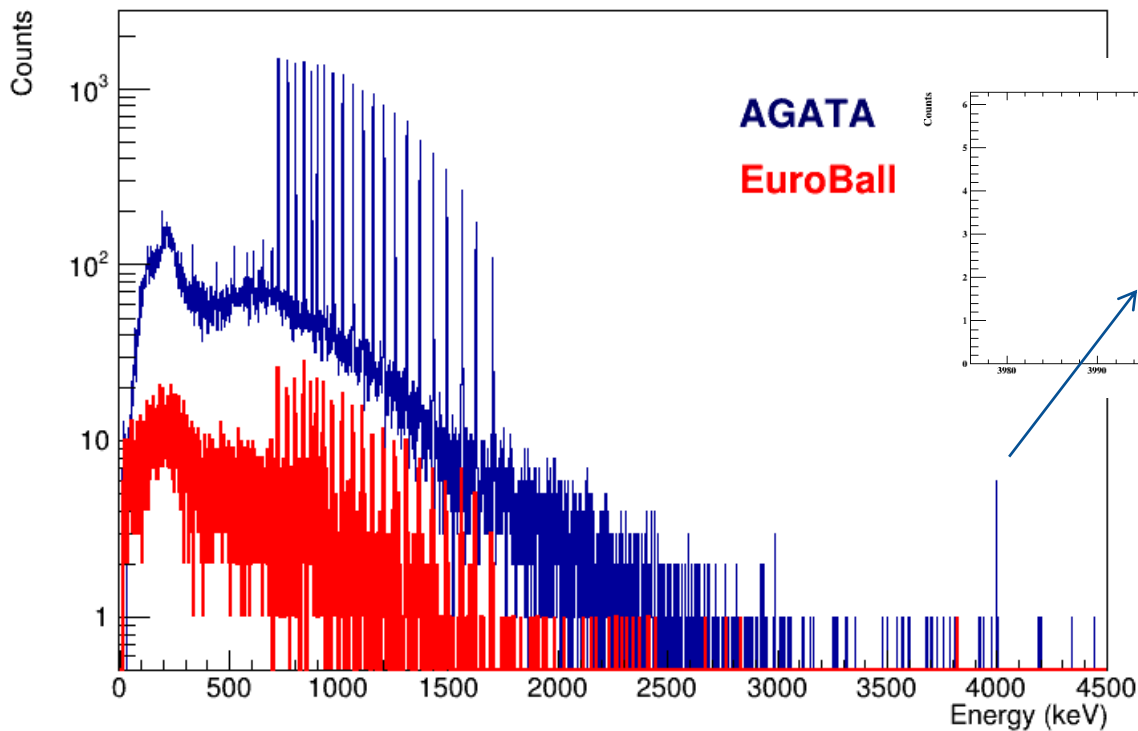
SD (I=10^{-4})

*4 MeV
I=10^{-6}*

ND (I=1)

Simulation work – STFC grant

- Experiment Design and Performance WP (WP5)

- 2 main objectives

  - *Couple AGATA to the experimental facilities at SPES and FAIR,*

  - *Deliver a suite of event-generators, analysis tools and simulation results to allow scientists to plan novel experiments at those facilities.*

Simulation work – STFC grant

- Workplan - (Apr. 2020 – Sept. 2023)

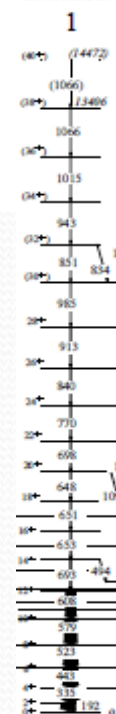| ID	Task Name	Duration	Start	Finish
1	**WP5 Experiment Design and Array performance**	866 days	Wed 01/04/20	Wed 26/07/23
2	**Facility specific development - (task 2)**	848 days	Wed 01/04/20	Fri 30/06/23
3	AGATA-PRISMA merging starts with current PDRA	0 days	Wed 01/04/20	Wed 01/04/20
4	AGATA-PRISMA code merging	174 days	Wed 01/04/20	Mon 30/11/20
5	AGATA-PRISMA merged	0 days	Mon 30/11/20	Mon 30/11/20
6	New PDRA appointed	0 days	Tue 01/12/20	Tue 01/12/20
7	Merge AGATA with MOCADI and LYCCA in framework	390 days	Mon 03/01/22	Fri 30/06/23
8	MOCADI-AGATA-LYCCA framework completed	0 days	Fri 30/06/23	Fri 30/06/23
9	**Generic development of AGATA code - (task 1)**	105 days	Mon 09/08/21	Fri 31/12/21
10	Smearing map production with existing scanning table data	60 days	Mon 09/08/21	Fri 29/10/21
11	Smearing map completed	0 days	Fri 29/10/21	Fri 29/10/21
12	Position smearing algorithm development	85 days	Wed 01/09/21	Tue 28/12/21
13	New position Smearing algorithm completed	0 days	Fri 31/12/21	Fri 31/12/21
14	**Experiment design and Physics performance - (task 3)**	669 days	Fri 01/01/21	Wed 26/07/23
15	Performance optimisation at SPES	30 days	Fri 01/01/21	Thu 11/02/21
16	Experiment design at SPES completed	0 days	Sun 28/02/21	Sun 28/02/21
17	Performance optimisation at FAIR	30 days	Thu 15/06/23	Wed 26/07/23
18	Experiment design at FAIR completed	0 days	Wed 26/07/23	Wed 26/07/23

Simulation work – STFC grant

- Merging AGATA-PRISMA

  - Most work carried out by Julien Bordes – (York)
    - Understanding both the PRISMA code and AGATA code.
    - Propose solutions to merge both codes
    - Adopted solution:
      - Use calculated Magnetic fields from PRISMA and export them into AGATA code (✓)
      - Add geometry of quadrupole, dipole and FP plan detectors as new ancillary.   (✓)
      - Testing / comparison with PRISMA code   (on-going)

  - Several challenges had to be addressed
    - Different frame coordinate used in PRISMA code for the field map.
    - Transport of heavy ions in vacuum and low density gas in GEANT4
      is not realistically implemented.
      - GEANT4 calculates an effective charge state that is energy dependant and therefore trajectories in a magnetic field are affected.
      - Solution was found in G4Transportation class to bypass the calculated effective charge and
        assigned a correct value in vacuum/low density gas

Simulation work – STFC-grant

$^{90}_{40}Zr^{40+}$

Dipole/quadrupole field for q=30+

$^{90}_{40}Zr^{30+}$
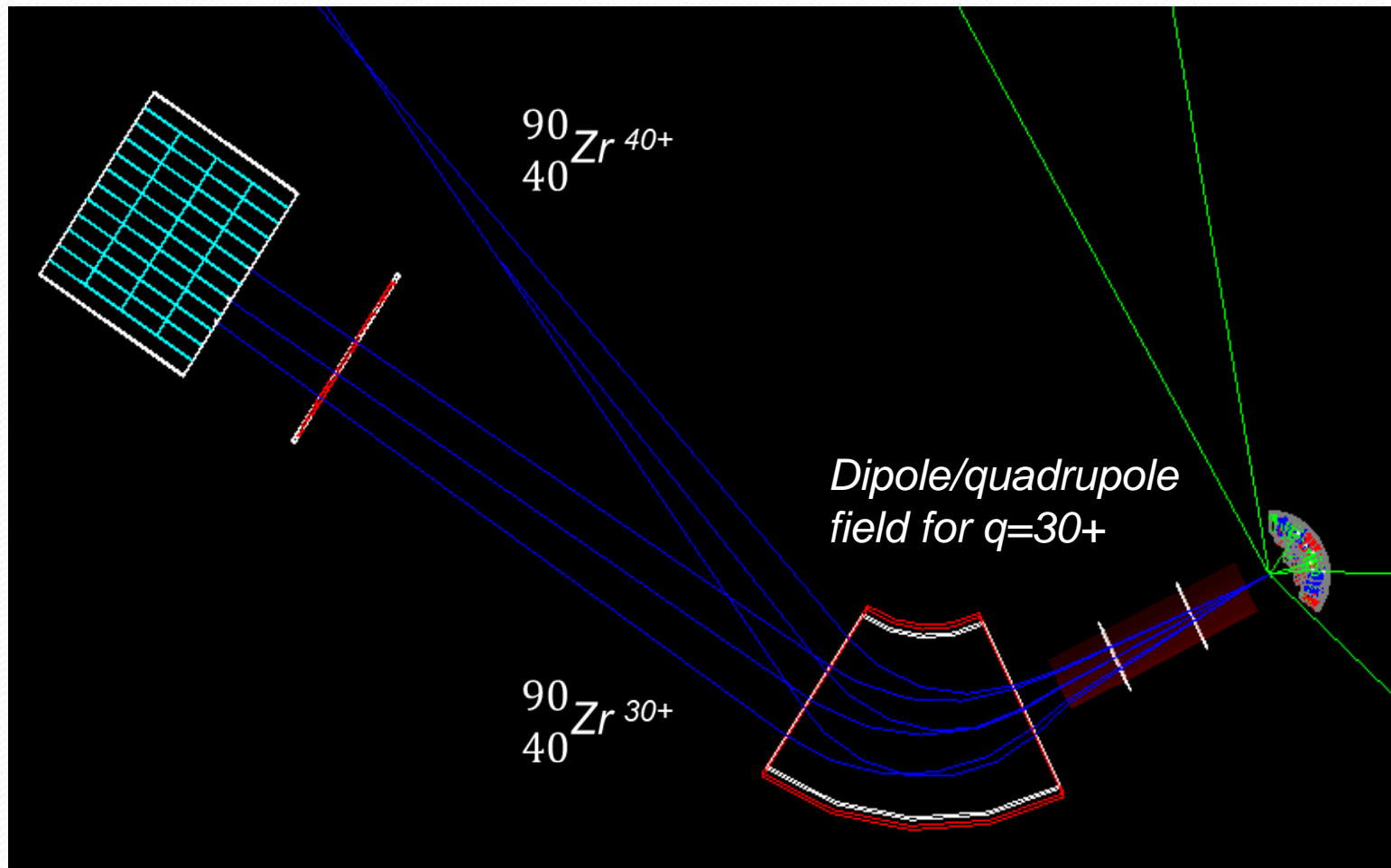
AGATA-PRISMA package

^{90}Zr event file:

How to run (currently):

Need Vacuum in World (for now):
G4AGATAVACUUMINWORLD set to 1

Run Agata with options
– *n*   *(hadrons / heavy ions)*
– *a 2 33 34*   *(2 ancillaries)*
– *Ext*   *(read input event file)*

```
$
-101   40      90   30   345.000    0.000   0.000    1.0000
  1 1000.000
$
-101   40      90   30   345.000   -0.032   0.000    0.99948
  1 1000.000
$
-101   40      90   30   345.000    0.032   0.000    0.99948
  1 1000.000
$
-101   40      90   40   345.000    0.000   0.000    1.000
  1 1000.000
$
-101   40      90   40   345.000   -0.032   0.000    0.99948
  1 1000.000
$
-101   40      90   40   345.000    0.032   0.000    0.99948
  1 1000.000
```

In macros:
/Agata/generator/emitter/eventFile path_to/90Zr.evt

Charge State added

Field in Dipole defined in GEANT4 as uniform magnetic field.

Field in quadrupole imported from PRISMA code.
 Read field map file calculated in PRISMA code.

What's next ?

- Need to solve the issue to run with geant4 10.7.

  - Support the idea of a Physics list per geant4 version.

- More development to come within the UK grant activities.

  - New PDRA will start later this spring.

- Measured/ simulated efficiency discrepancies will continue to be addressed.

- Any specific request for the preparation of future campaigns at Legnaro, please send to me.

- Anyone willing to join this WG is also welcome !

Thank you