Improved modeling of (electric) fields in AGATA type detectors

Joa Ljungvall

September 17, 2025

Present status of Signal Basis for AGATA

The market for a signal basis

- Basis used for AGATA "in production" calculated by ADL.
- Basis made using the MGS code tried long time ago.
- Has JAZZ basis ever been used on experimental data?
- AGATAGeFEM basis recently tested.

Short summary of how they perform

- You could say they perform well (i.e. FWHM $<$ 5 mm)
- One can also state not so well (clustering)
- χ^2 fitting does not work $\rightarrow$ basis signal (or something else) generates signals that are not good models of the experimental signals

Why do we not like this situation?

It is commonly believed that with a HiFi basis…

- … we will be able to disentangle multiple hits in one segment.
- … we will be able to extract meaningful errors on a event-by-event basis for the positions given by PSA.

… and that with this extra information we will be able to…

- … improve on peak-to-total because γ-ray tracking works better with the correct number of interactions
- … include the actual errors on positions (e.g. angles/energies) when doing γ-ray tracking and be able to use a real χ^2 for discrimination of good and bad tracks.

First the result (although not fully dissected)
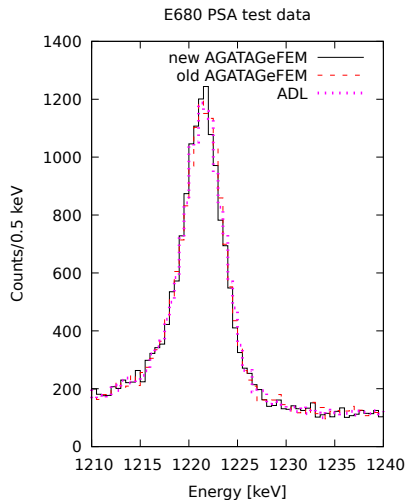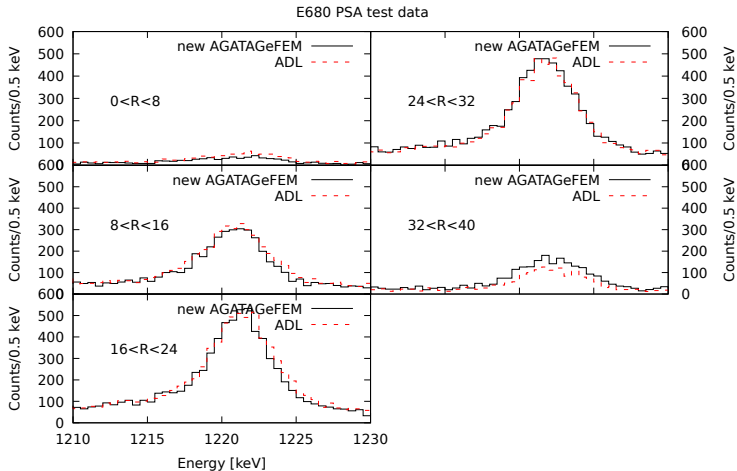

E680 PSA test data
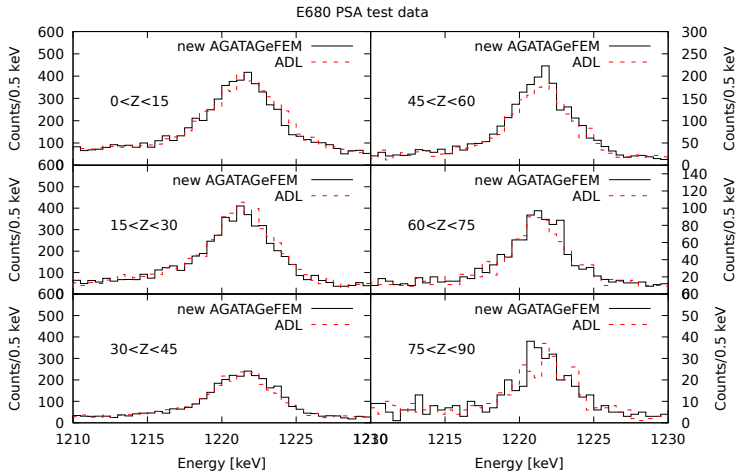
First the result (although not fully dissected)

E680 PSA test data, gate on 2_1^+
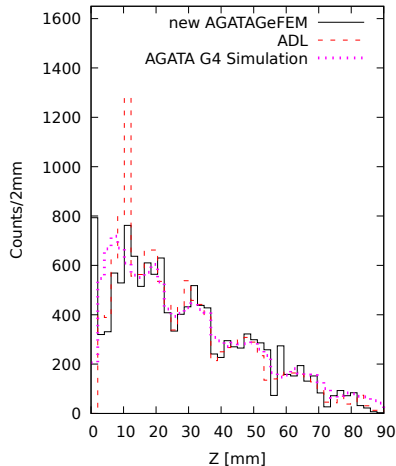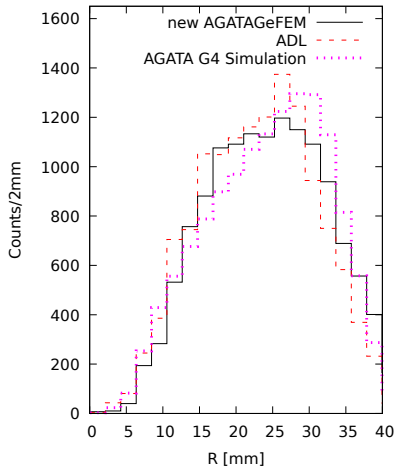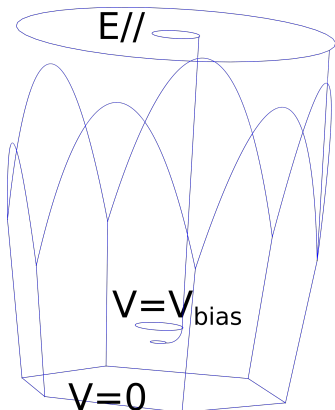
First the result (although not fully dissected)
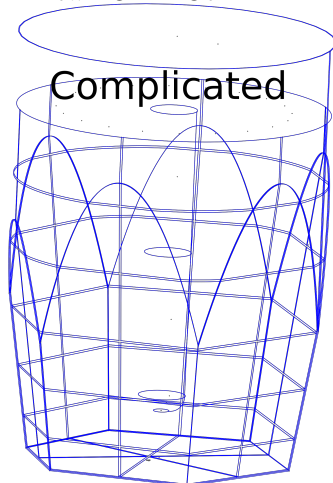
First the result (although not fully dissected)

What have I actually done?

Boundary conditions for the electric field

Old AGATAGeFEM
and ADL etc.
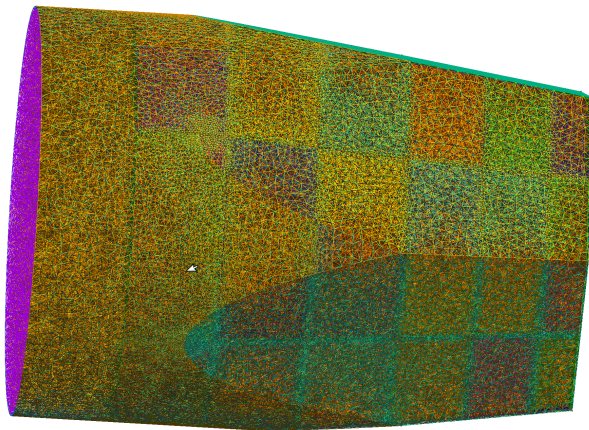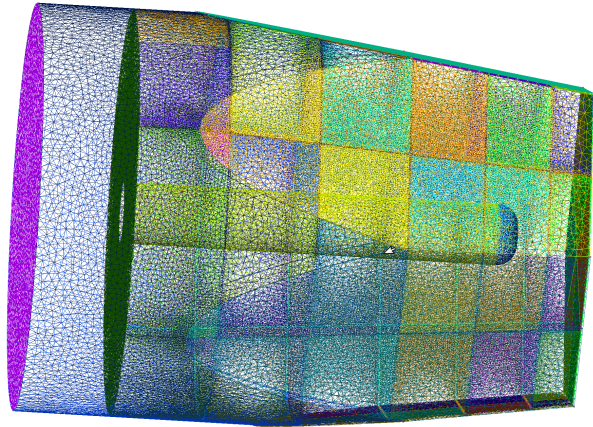
new AGATAGeFEM

E//

Complicated

V=V_bias

V=0

What have I actually done?
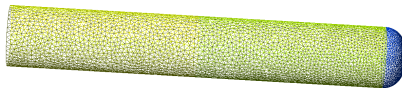
So let us look in detail

What have I actually done?
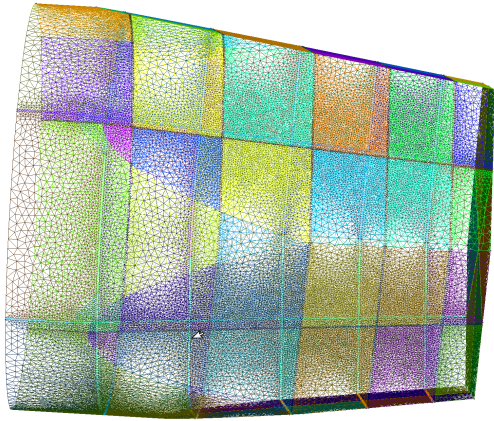
All defined surfaces

What have I actually done?

Core forced to V_{bias}

What have I actually done?
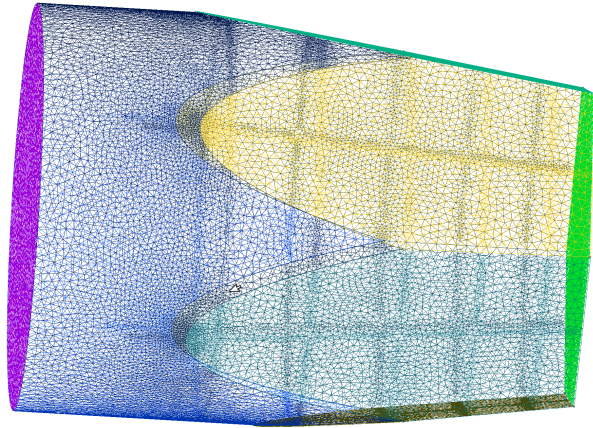
Segments forced to 0 V (note 0.5 mm gaps)

What have I actually done?

Back of crystal left without constraints (more on this later)
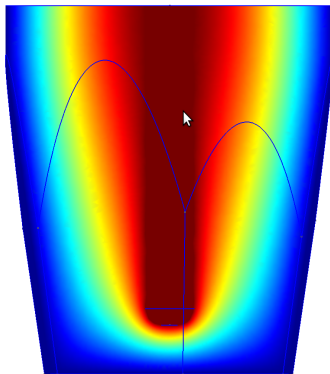
What have I actually done?
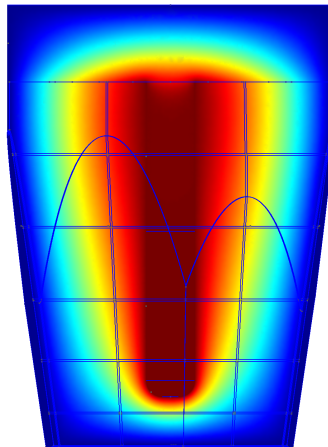
All of capsule set to 0 V

Do the Electric potentials differ?
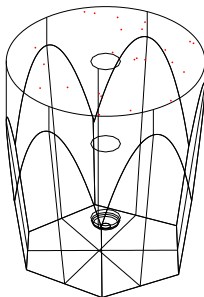
Cut through yz plane in A001

Old AGATAGeFEM
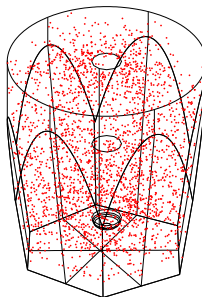
new AGATAGeFEM

Random pulses, what do they give?

Positions from "bad" pulseshapes are marked

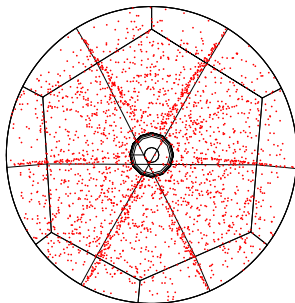Old AGATAGeFEM

New AGATAGeFEM

ratio good/bad $4*10^{-4}$
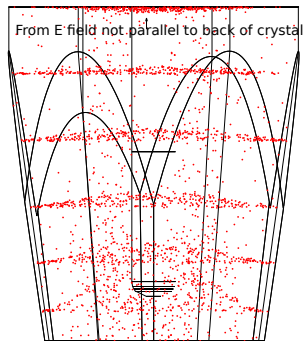
ratio good/bad $4*10^{-2}$

Random pulses, what do they give?

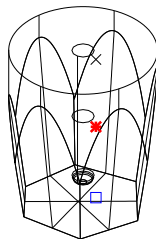Mainly from charge carriers not being collected due too segmentation lines, i.e. physical!

yx projection

yz projection

From E field not parallel to back of crystal
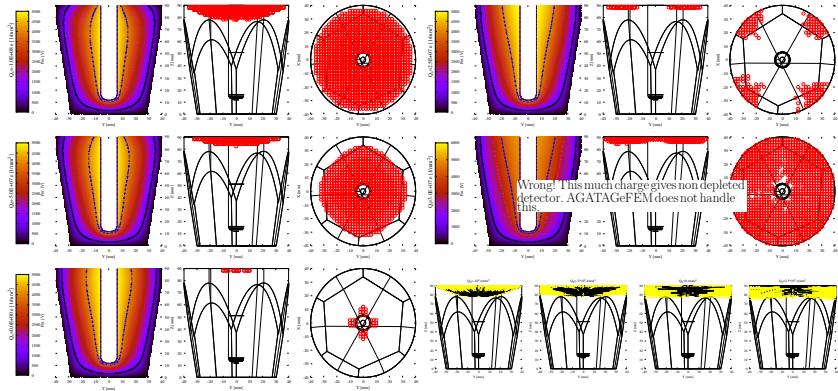
Comparing pulses with ADL, old and new AGATAGeFEM for A001
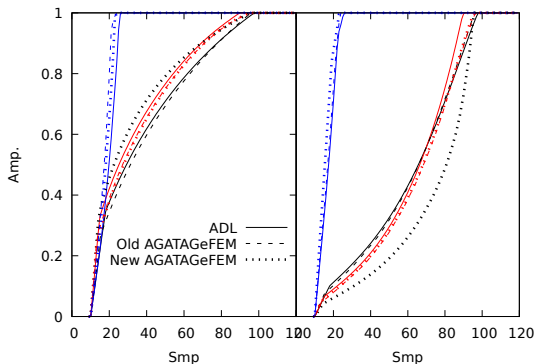
Charge at back of crystal

$$Q_S = -1.0 * 10^8, -5 * 10^7, 0.0 * 10^0, 2.5 * 10^7, 3.0 * 10^7 \text{ e/mm}^2$$

Wrong! This much charge gives non depleted detector. AGATAGeFEM does not handle this.

Summary, Conclusions, and Outlook

- The aluminum Capsule and segmentation have been added to AGATAGeFEM.
- Test suggests some modest improvements for PSA.
- Real change of pulse shapes at the back of detector.
- A 4% loss in efficiency noted because of charges ending up "inter strip".
- More detailed analysis of PSA res.
- Repeat AGATAG4+AGATAGeFEM+agapro to verify efficiencies.
- Use basis from AGATAGeFEM at INFN Legnaro (they are available).

To try AGATAGeFEM

Docker

Thanks to J. Dudouet there is a Docker image
https://agata.pages.in2p3.fr/handbook/simulated_
basis/agatagefem/

Starting from the code

https://gitlab.in2p3.fr/joa-ljungvall/agatagefem