
# Efforts on angular distributions and correlations with AGATA

**Sylvain Leblond**
*GANIL, France*

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# Angular γ-γ correlations with a advance gamma ray tracker

AGATA/GRETINA provide high efficiency and tracking resolution

→ **Ideal tool for angular distribution study ?**

Both position and energy experimental reconstructed values depends on complex algorithms

Two main filters affect angle correlation studies:

- PSA algorithm
- Tracking algorithm

→ **What is the effect of these filters on classical gamma analysis tools ?**

# Angular γ-γ correlations previous work of the collaborations

**With radioactive sources:**

- Good agreement with literature
- Effect of filters at low angles
- Some data published

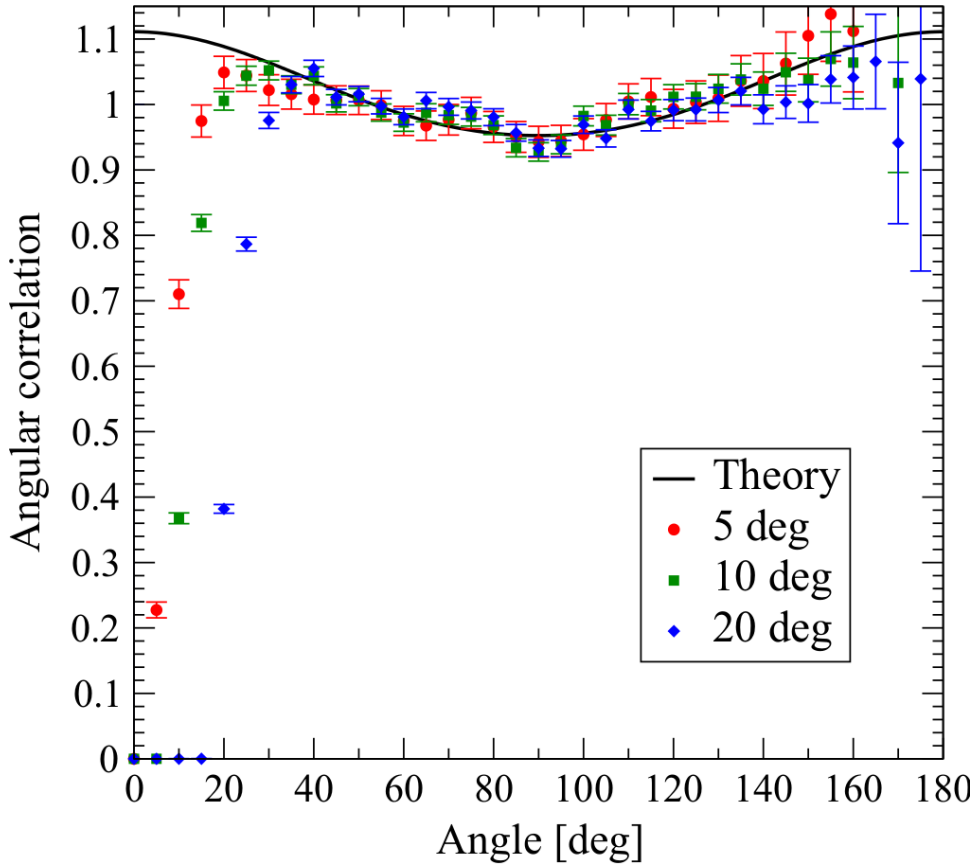
**In-beam data:**

- More difficult
- Several analyses ongoing

**My Starting point:** $^{60}$Co calibration source

- Well known gamma cascade
- Comparison to existing work
- Large amount of existing data

$^{60}$Co γ-γ angular correlation
With GRETINA




*T. Lauritsen et al. NIMA 2016*

# A first look to the data: How to perform normalisation ?

Distribution produced with conditions:

- Tracked energy matching $^{60}Co$
- Angle from positions of tracking + PSA

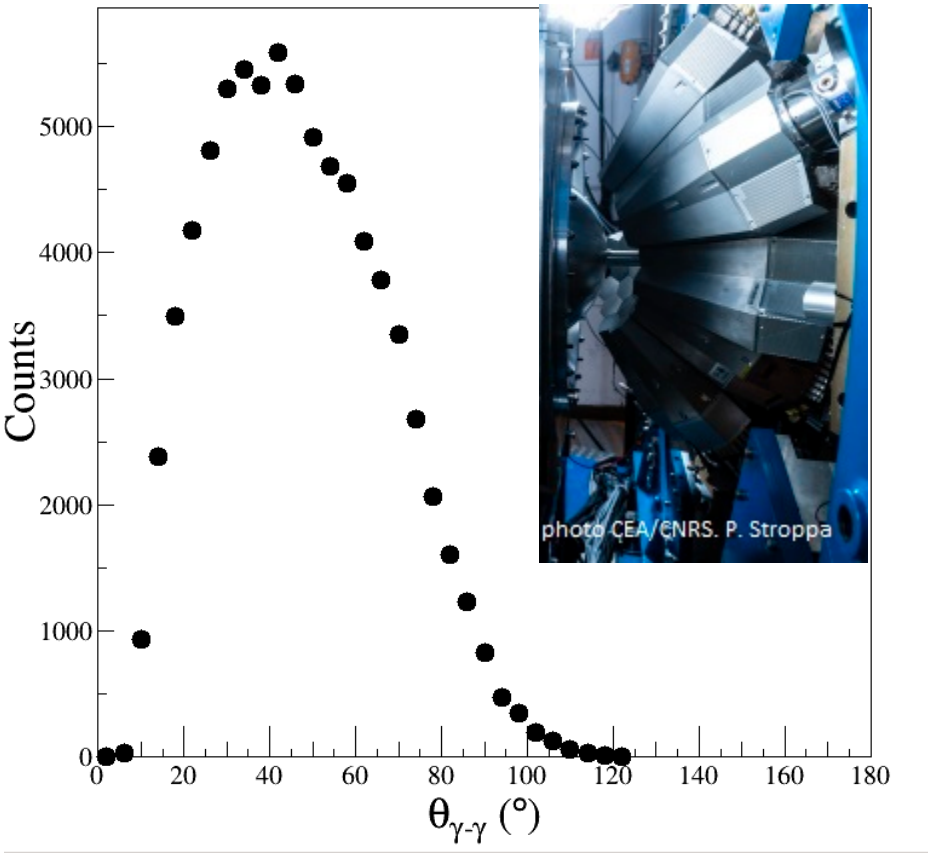
**Experimental distribution is affected by:**

- Geometrical acceptance
- Individual efficiencies
- Pairs angular distribution

Need to normalize the data by the response of AGATA to an isotropic distribution

**How to produce such distributions ?**

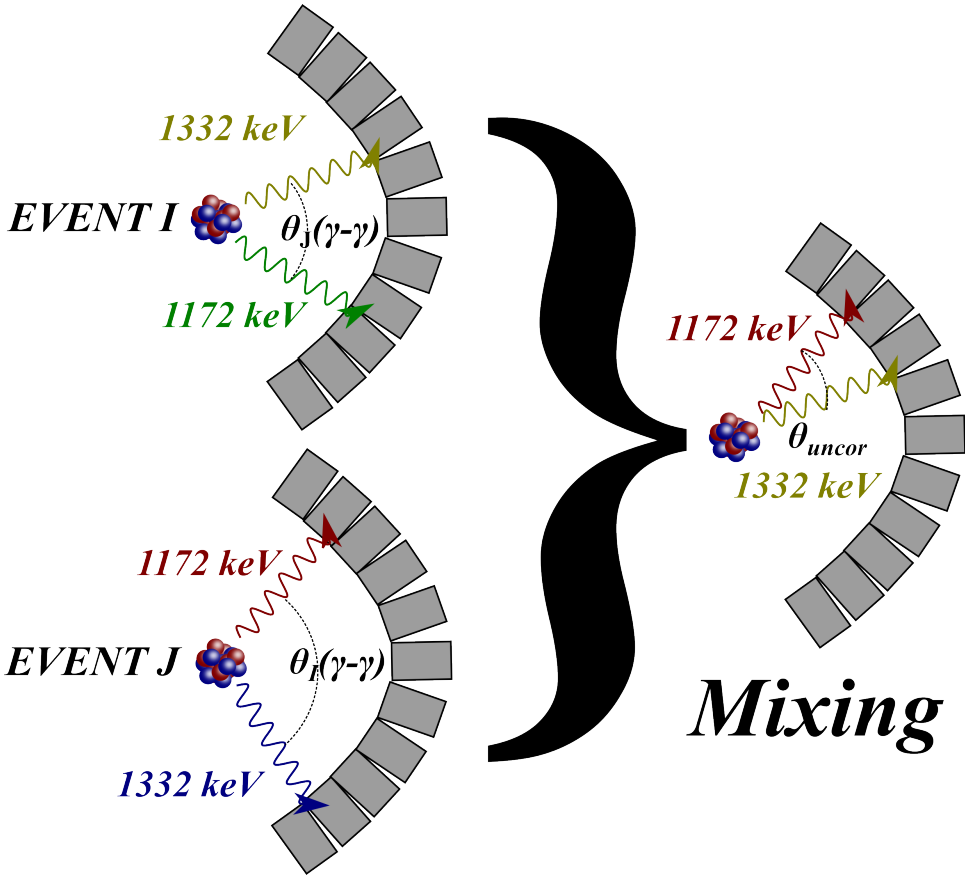
- Simulation
- Event mixing



# Data normalization procedure: Event mixing

**Basic concept**:
Construct an uncorrelated angular distribution from artificial γ-γ pairs

- An artificial pair will not exhibit angular correlation
- From detected events: include array response function




**Normalizing Procedure:**

- Loop over all data
- Find two random γ-γ events e1 & e2
- Reconstruct artificial angles:
  $\theta(e1_{1333} - e2_{1173})$
  $\theta(e1_{1333} - e2_{1173})$
- Normalize data by mixing distribution

# AGATA as tracking array: Normalisation with event mixing

Using AGATA with **all filters:**

- Tracking
- PSA

**Normalisation with event mixing**

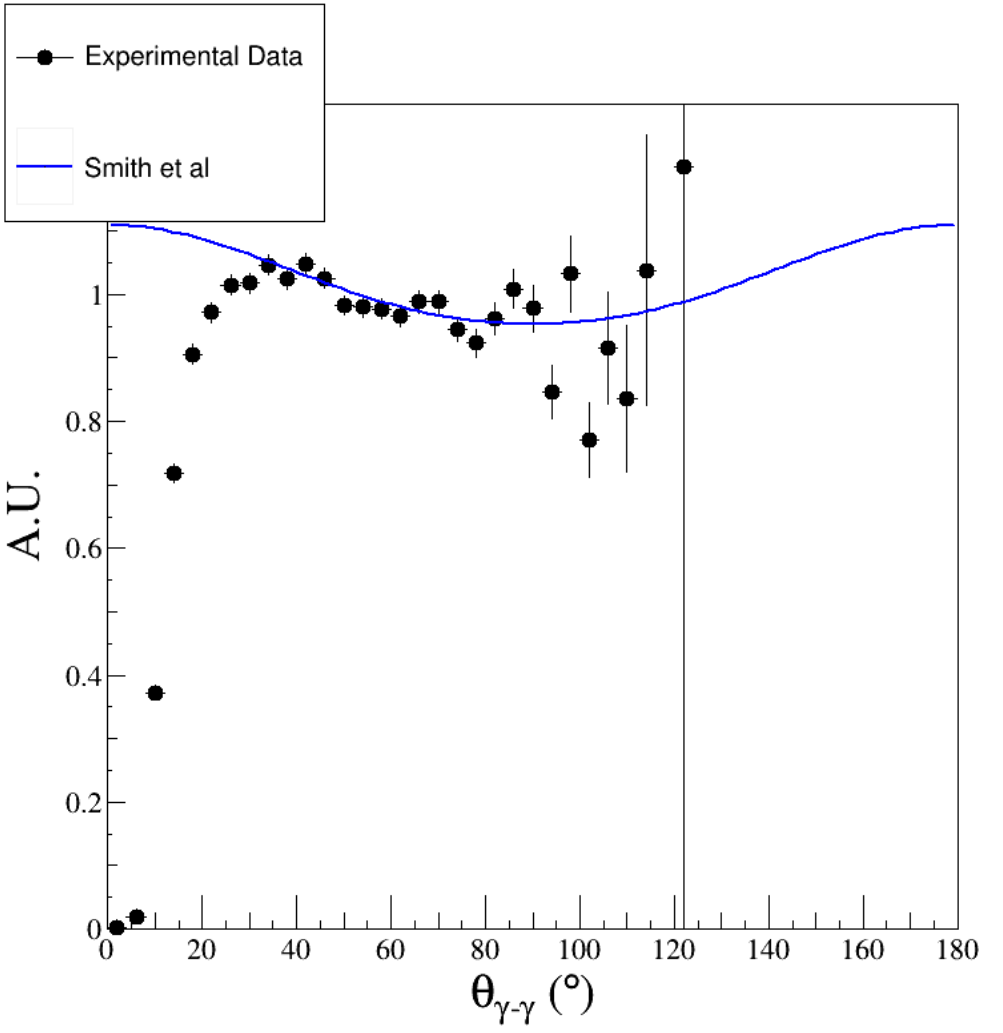
**Results & comments**

- Similar to T. Lauritsen NIMA
- Compatible with Smith et al.
- Deviation at large angle

→ Statistical effect ?

- Huge drop at low angle

**Investigate the relation with AGATA filters ?**



# If AGATA was not a tracking array: back to basic crystal information

Using AGATA as **simple HpGe array**

- No PSA
- No tracking

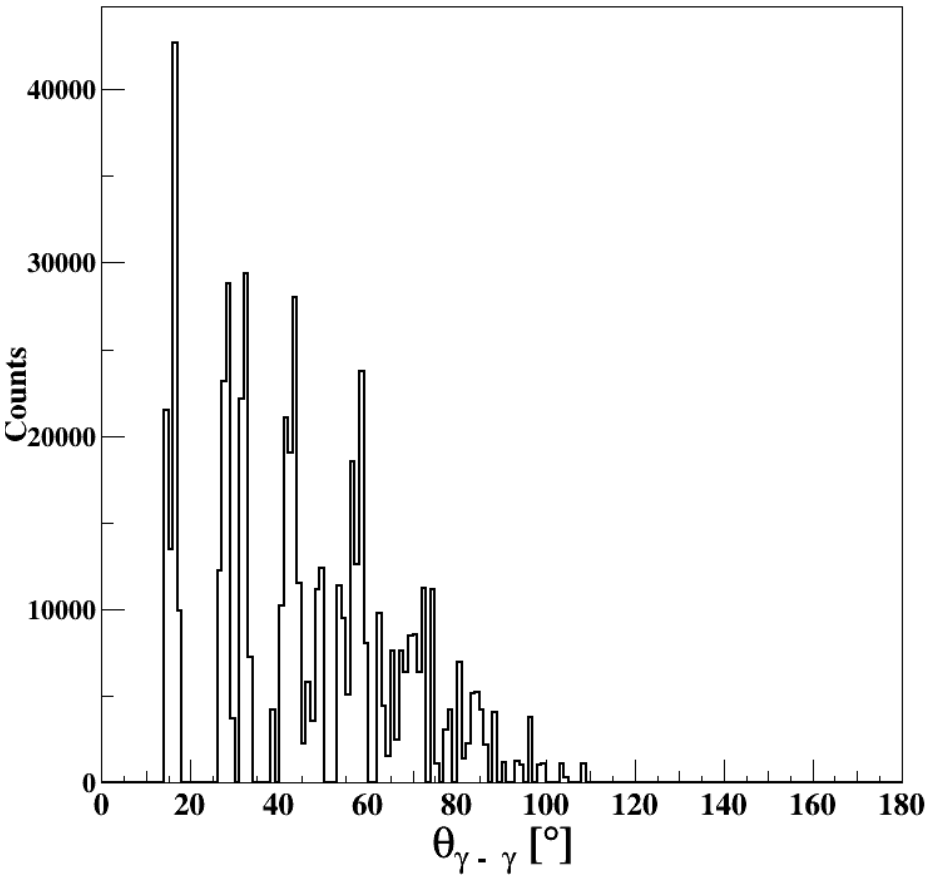
Looking for $^{60}$Ni γ-γ events:

- Using core energy
- Interaction position is the middle of the triggered crystal

Finite number of detectors:

- Minimum angle ~ 14°
- Maximum angle ~ 108°

**Comparable with tracking?**



# If AGATA was not a tracking array: looking at the crystal level

Using AGATA as **simple HpGe array:**

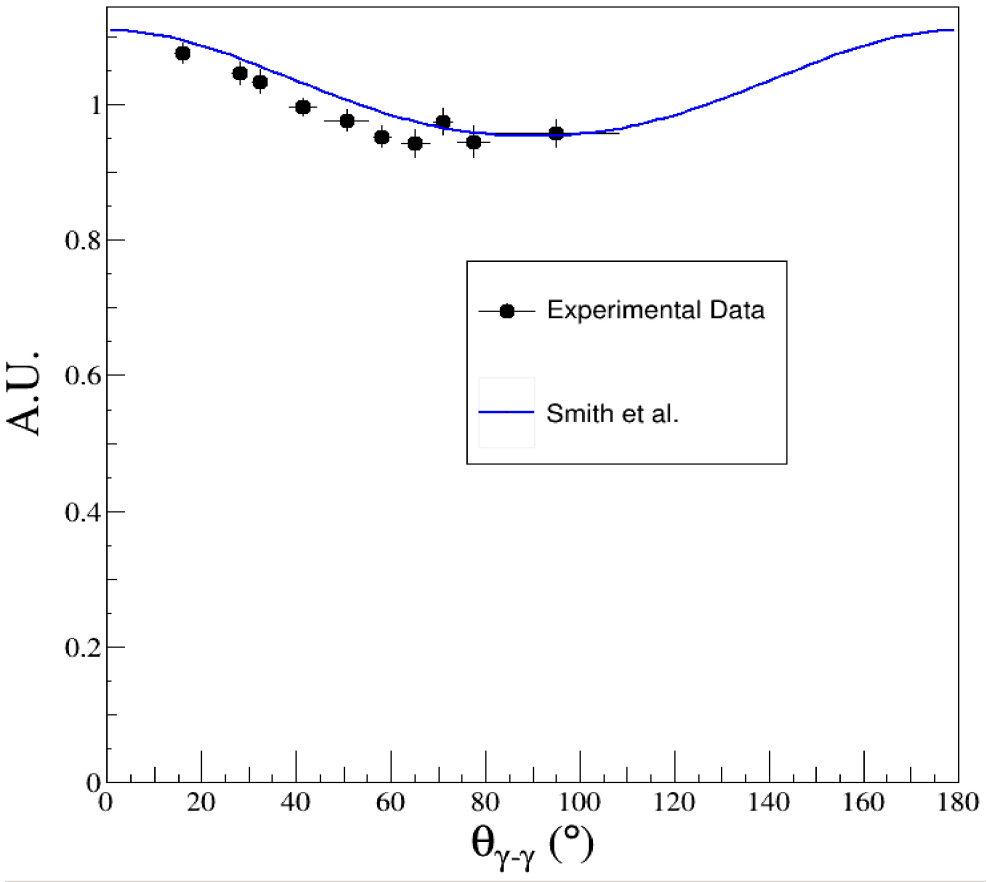
- Crystal level
- No tracking
- No PSA

**Normalisation with event mixing**

**Results & comments**

- Trend is well reproduced
- Slight offset in amplitude
- No drop at low angle

→ Drop at low angle due to AGATA filters ?



# AGATA as tracking array: Crystal VS PSA + Tracking

Two angle reconstruction:

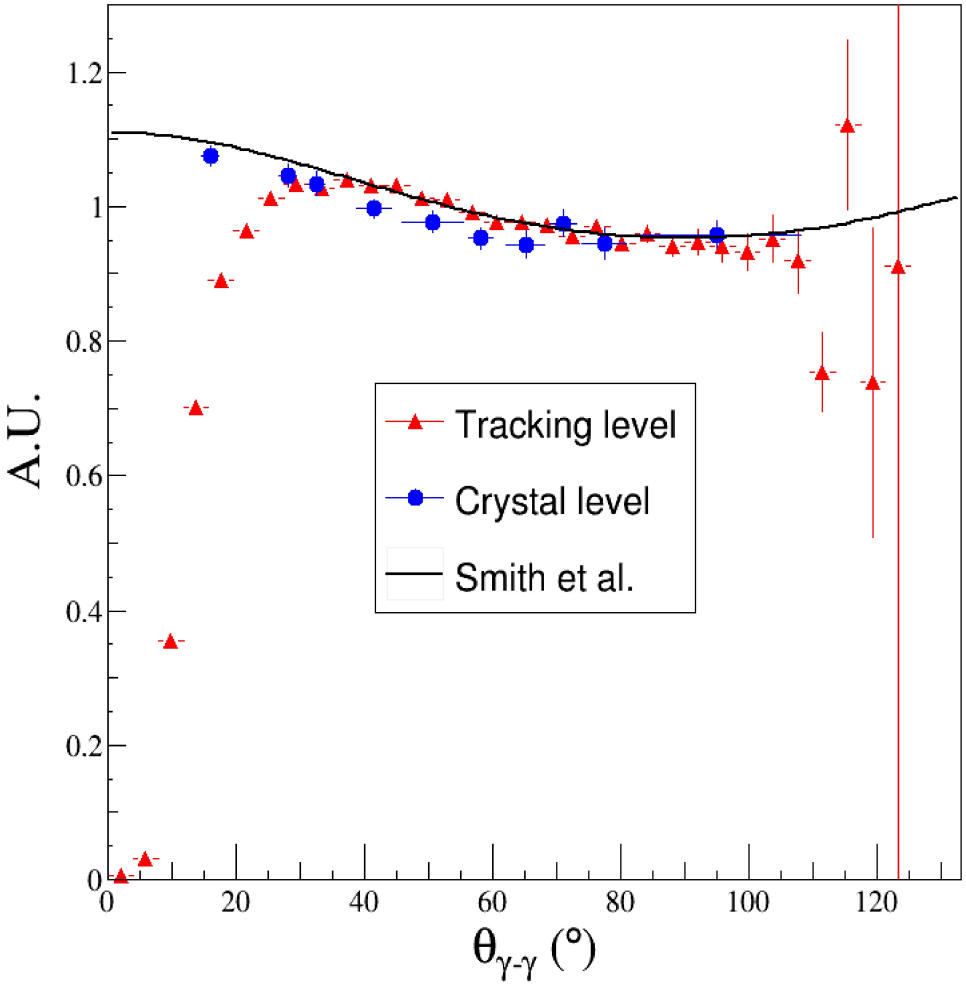
- Crystal level
- PSA + tracking

General:

- Both reproduce expected trend
- Tracking+PSA cut at low relative angle
- Not in Crystal distributions !

→ This effect has to be correlated with the filters

**Can we understand the origin of the effect ?**



# AGATA tracking filter effect: Event mixing with tracking

## Event mixing reminder

Construct an uncorrelated angular distribution from artificial γ-γ pairs

- An artificial pair will not exhibit angular correlation
- From detected events: include array response function

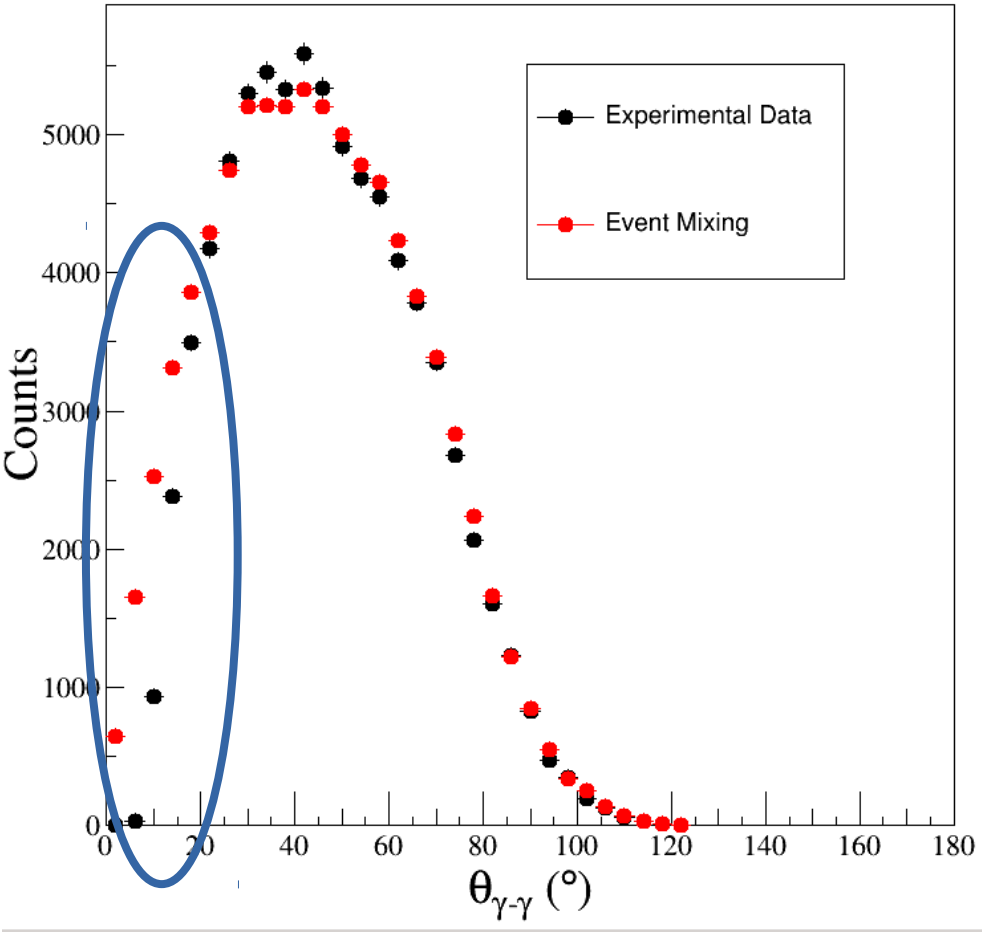
**Underlying assumption**

Artificially reconstructed pairs should be detectable by the tracking array

## At low γ-γ relative angle

Several cut can affect the data:

- Pile up
- PSA efficiency
- Tracking clustering angle
- ...



# AGATA tracking filter effect: How to perform event mixing ?

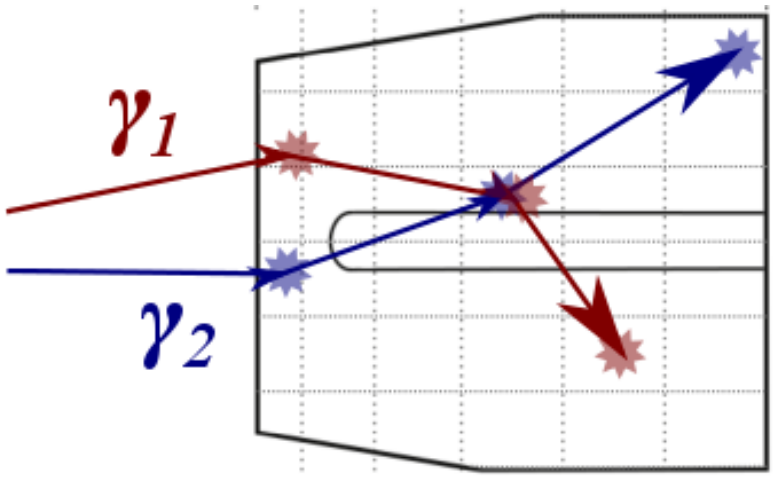
Creating non-physical pairs

Mixing do not prevent us from creating a pair that wouldn't pass the filters (PSA or tracking)

→ Affect mainly small relative angles

Solution to avoid this issue ?

→ Perform event mixing before going to filters




But...

- Tedious
- Non trivial
- Time consuming

**Does it worth it ?**

# Investigating the PSA filter: individual segment information

Using AGATA as **simple HpGe array**

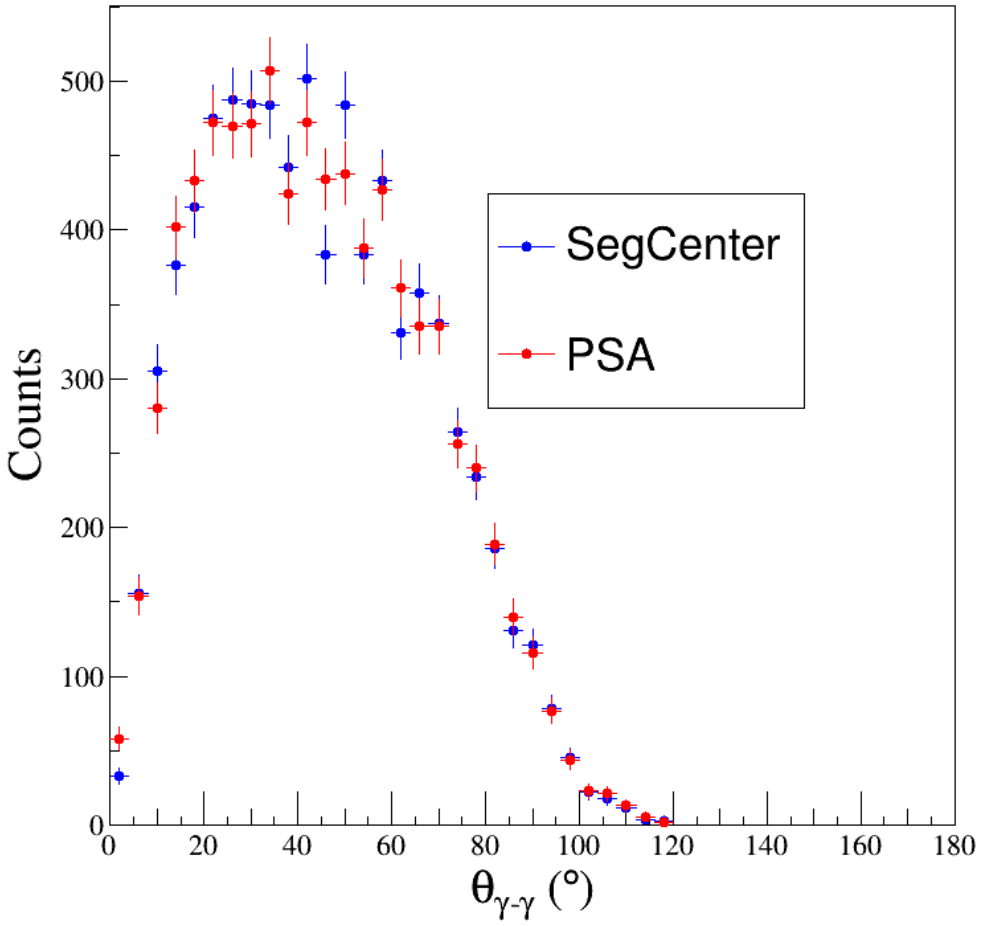
- No PSA
- No tracking

Looking for $^{60}$Ni γ-γ events:

- Using segment single energy
- Interaction position:
  - Middle of segment
  - PSA

Finite number of detectors:

- Minimum angle ~ 14°
- Maximum angle ~ 108°



# If AGATA was not a tracking array: looking at the segment level

Using AGATA as **simple HpGe array:**

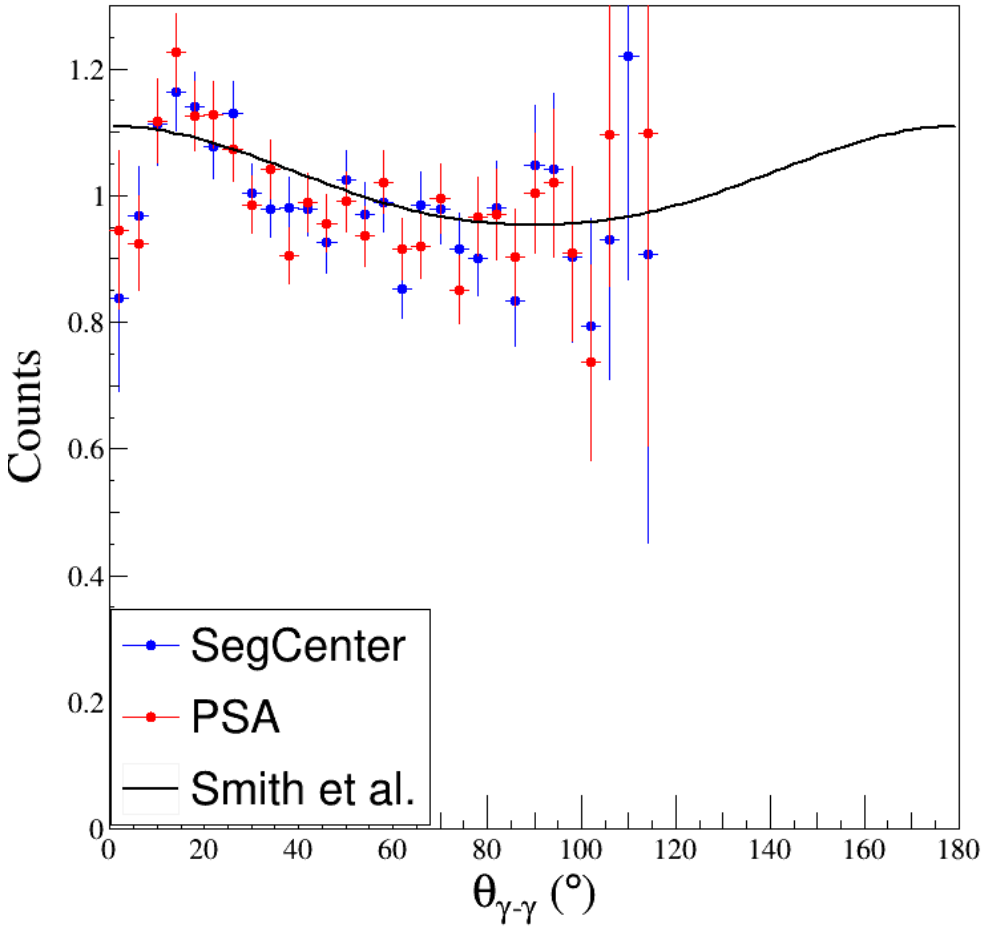
- Segment level
- No tracking
- No PSA

**Normalisation with event mixing**

**Results & comments**

- Trend is well reproduced
- No major effect of PSA
- Low drop at small angles

➡ Segment pile-up effect ?



# Conclusions & outlooks

I. Investigation of AGATA angular response function with $^{60}$Co source

- AGATA as classical HPGe array
  - Crystal level
  - Segment level
- AGATA as a tracking array
  - PSA & tracking

II. Preliminary observations

- Normalisation with event mixing seems to provide reasonable results
- Yet is affected, at small relative angles, by AGATA detection response
- Should be overcome by performing event mixing before applying the data filters

III. Outlooks

- Perform properly the event mixing before the tracking
- Look at in-beam data & to residual correlations