Preliminary results about gamma imaging with AGATA

Jérémie Dudouet

Institut de Physique des 2 Infinis de Lyon

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Introduction

What is Imaging ?

⇒ The goal is to locate the gamma emission position, using:

- ↪ the Compton diffusion formula,
- ↪ the tracking algorithm results.

Why using Imaging ?

⇒ Imaging can be used for:

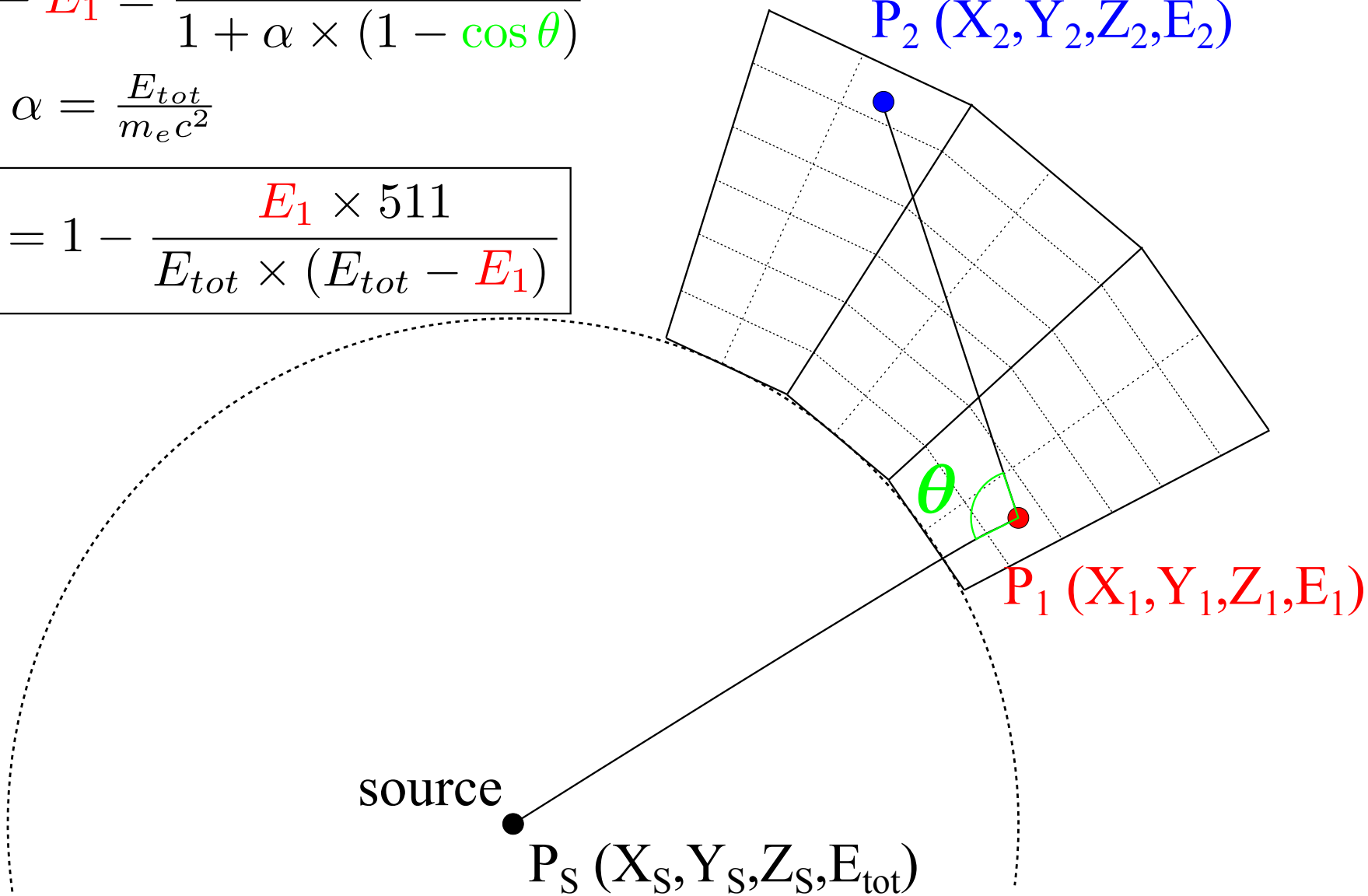
- ↪ distinguish γ-rays coming from the target from background (beam implantion in the target holder, experimental room background)
- ↪ life time measurements
- ↪ PSA accuracy optimization
- ↪ tracking algorithm optimization

How does it works

$$E_{tot} - E_1 = \frac{E_{tot}}{1 + \alpha \times (1 - \cos\theta)}$$

with $\alpha = \frac{E_{tot}}{m_e c^2}$

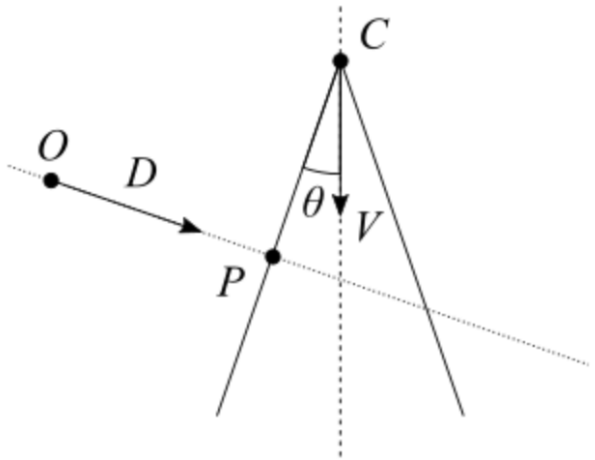
$$\cos\theta = 1 - \frac{E_1 \times 511}{E_{tot} \times (E_{tot} - E_1)}$$



Let's return to school to practice maths !

How to obtain the source position

- Calculation of the intersection of a cone with a line in 3 dimensions
- Application of the result on the experimental area



$$t^2((\vec{D}\cdot\vec{V})^2-\cos^2\theta)+2t((\vec{D}\cdot\vec{V})(\vec{CO}\cdot\vec{V})-\vec{D}\cdot\vec{CO}\cos^2\theta)+(\vec{CO}\cdot\vec{V})^2-\vec{CO}\cdot\vec{CO}\cos^2\theta=0$$

There we go, we have our $at^2+bt+c=0$ equation, with:

$$\begin{cases} a=(\vec{D}\cdot\vec{V})^2-\cos^2\theta \\ b=2\Big((\vec{D}\cdot\vec{V})(\vec{CO}\cdot\vec{V})-\vec{D}\cdot\vec{CO}\cos^2\theta\Big) \\ c=(\vec{CO}\cdot\vec{V})^2-\vec{CO}\cdot\vec{CO}\cos^2\theta \end{cases}$$

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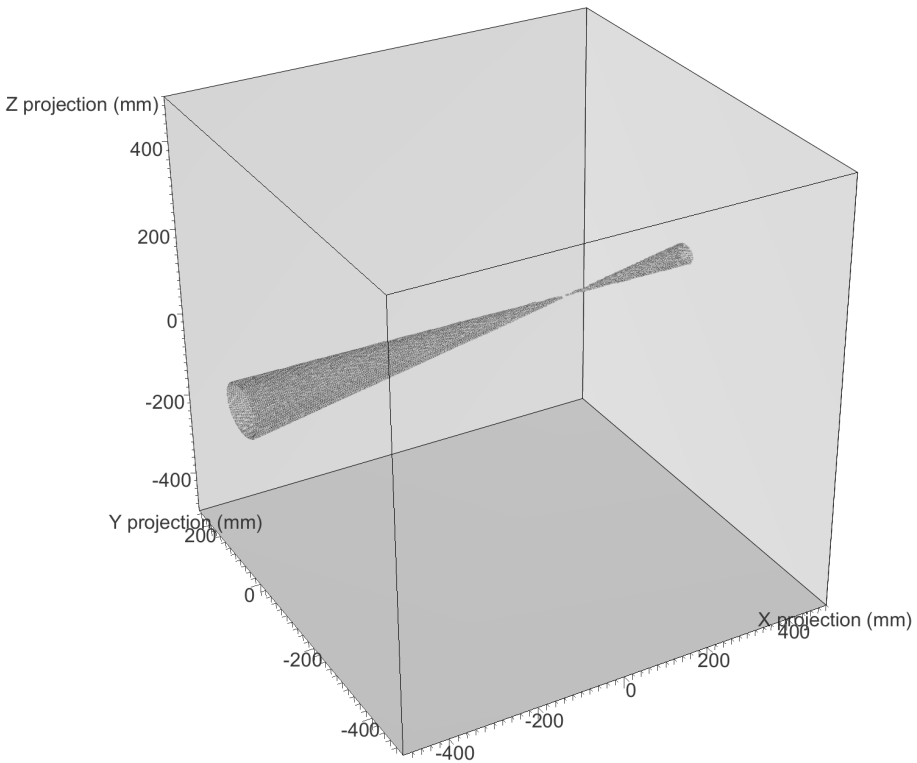

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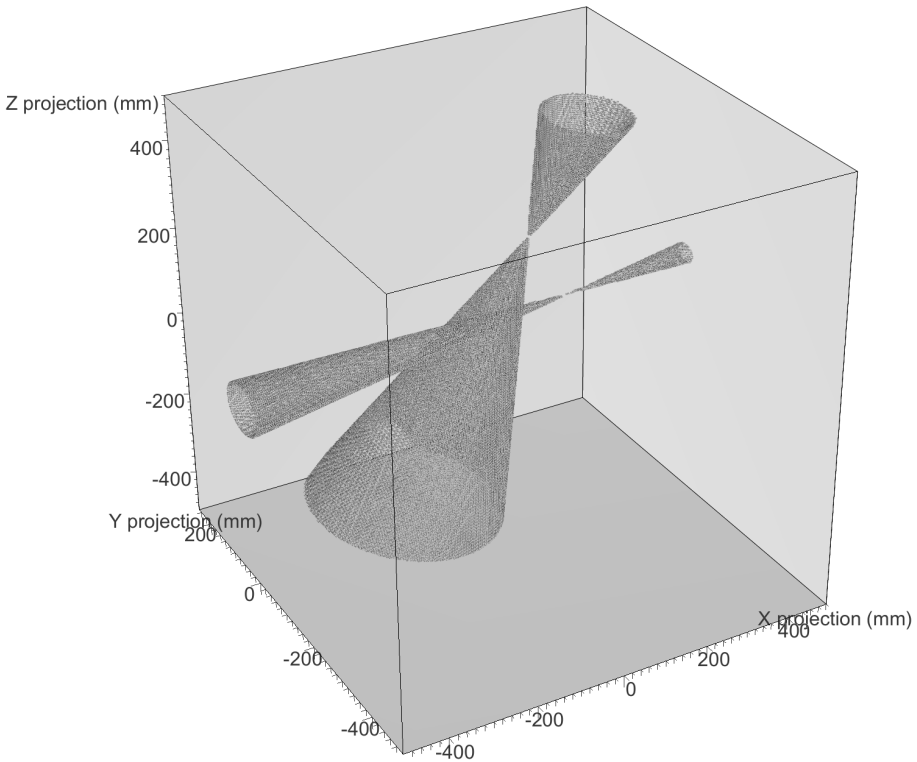
2 event



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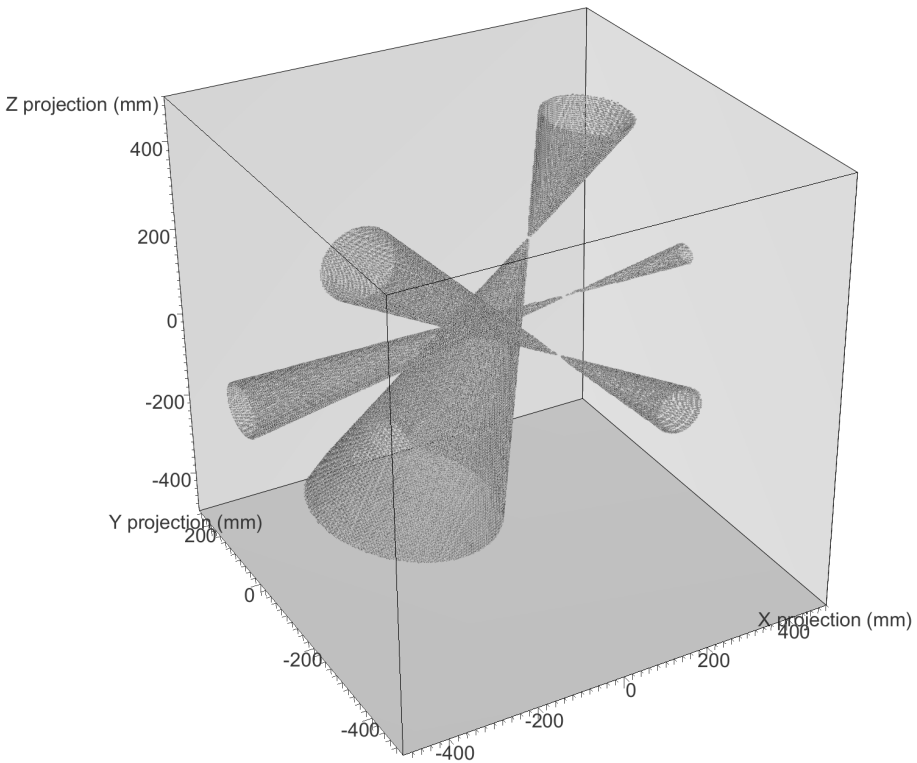
3 event



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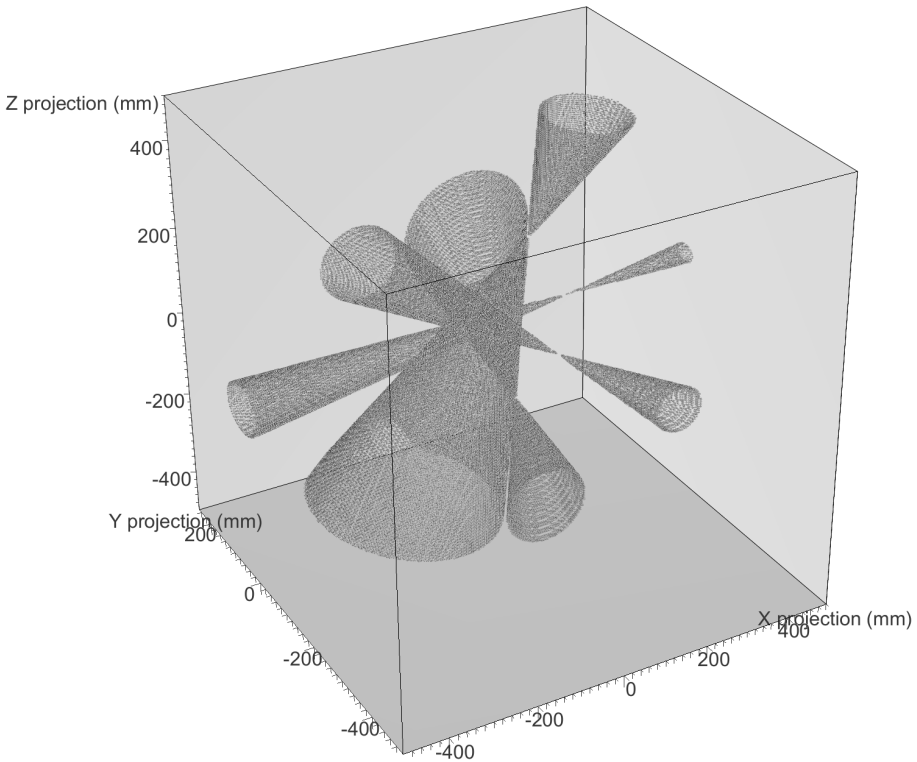

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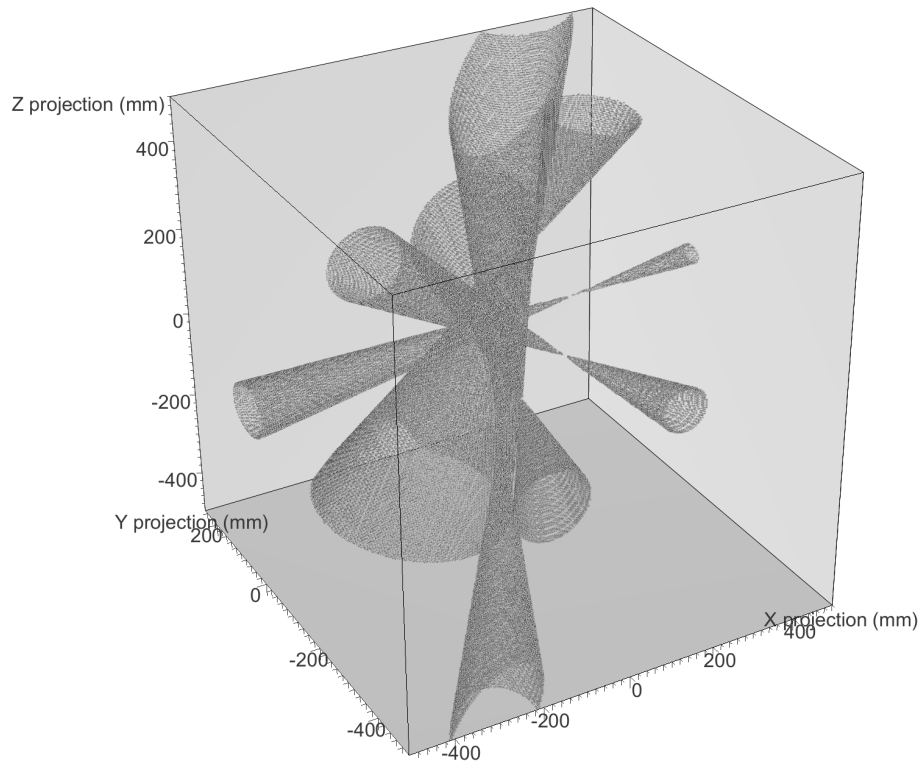
5 event



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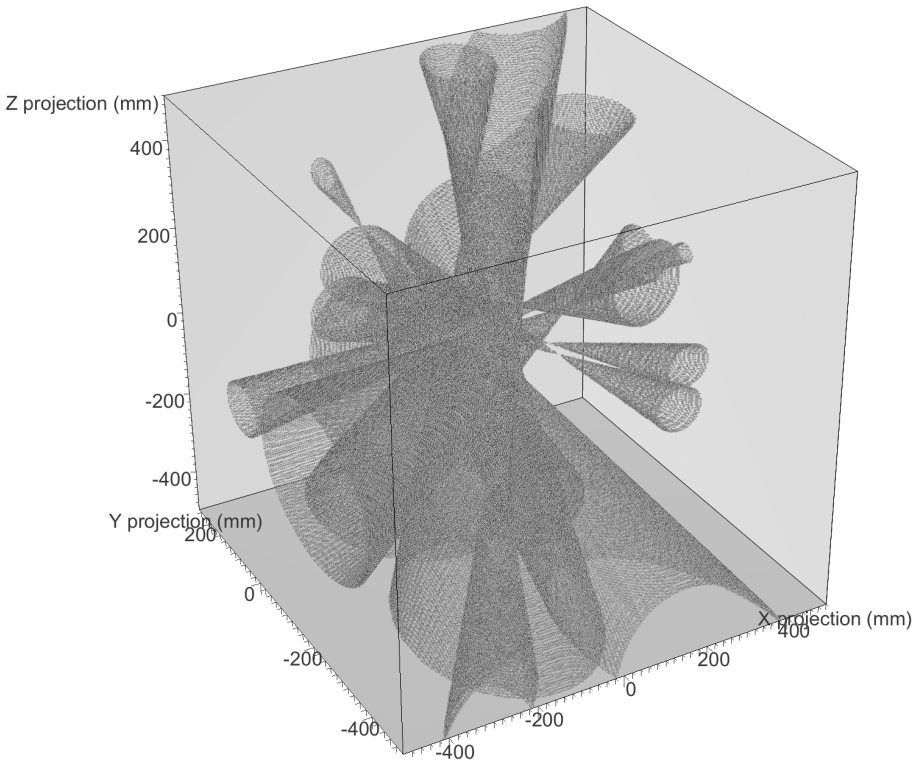
10 event



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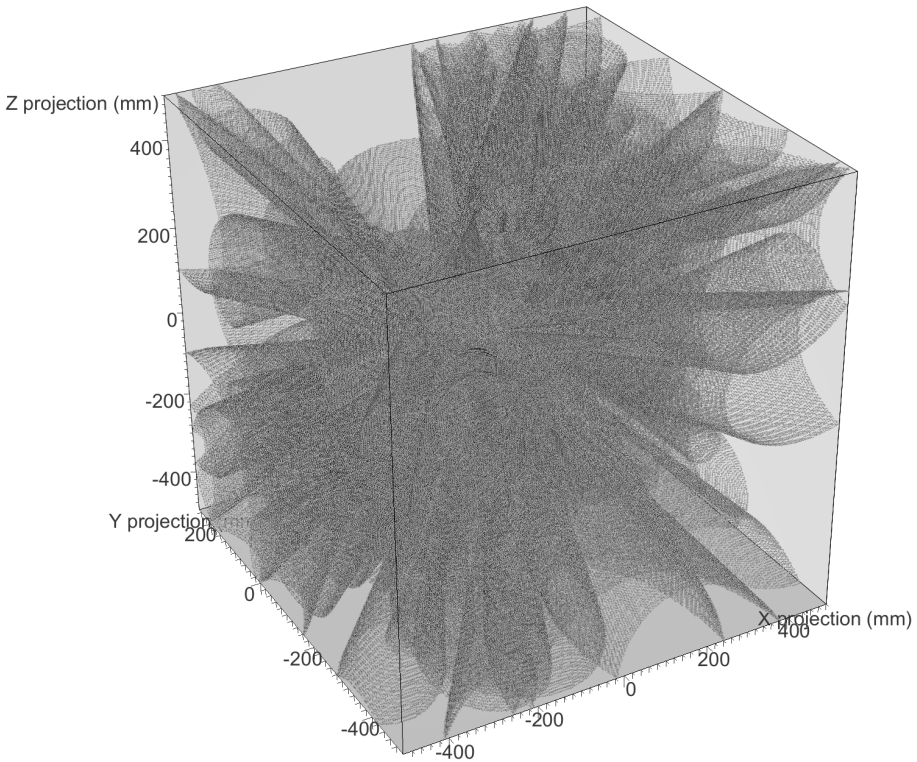

Data processing

2D projections

⇒ Geant4 simulations (using the SToGS package)

↪ ^{137}Cs gamma source, centered (0,0,0)

↪ Smearing of positions with a 5mm resolution

⇒ Tracking of the data threw the agapro package

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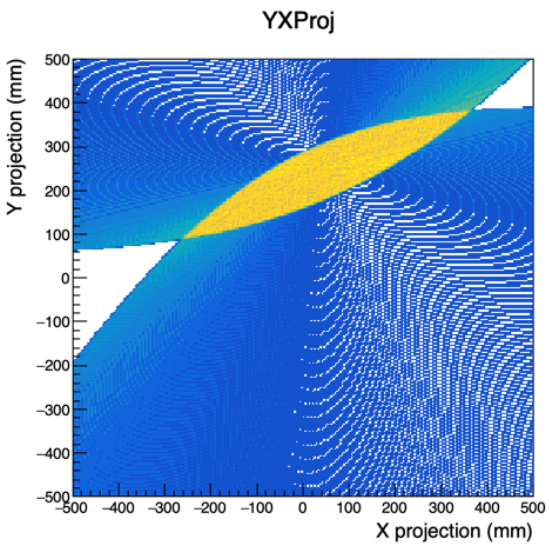

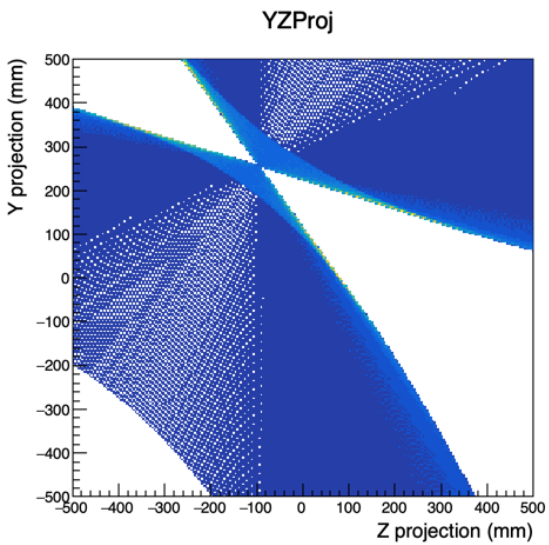

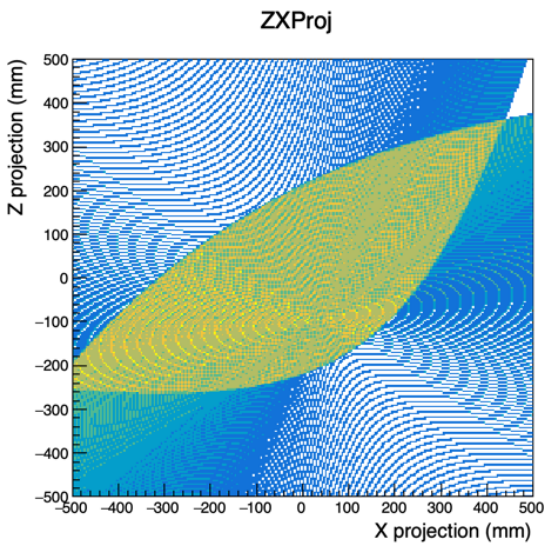

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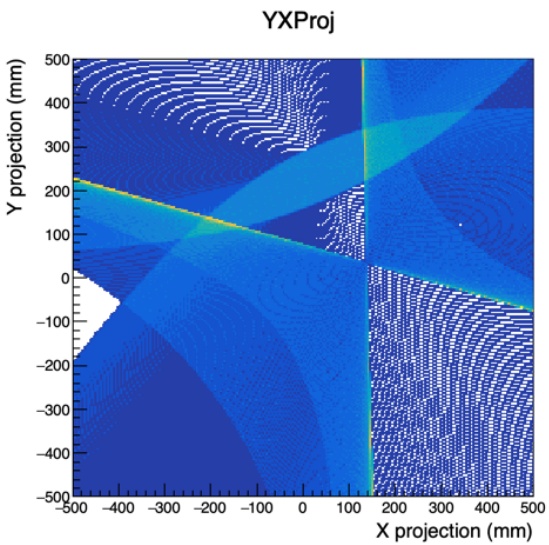

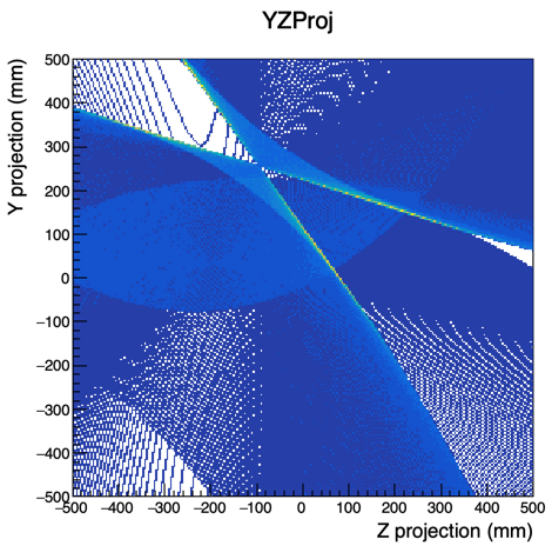

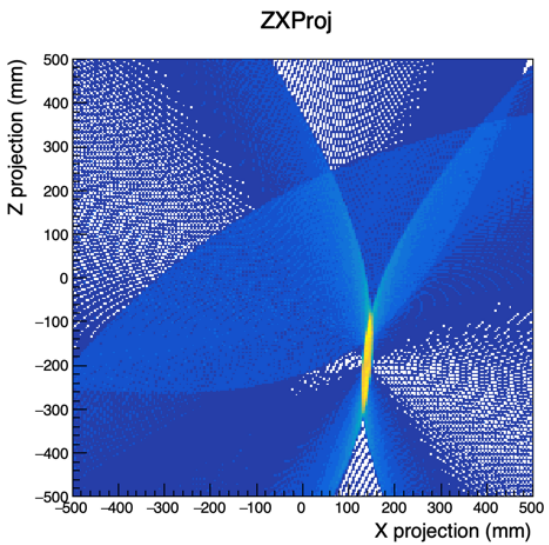

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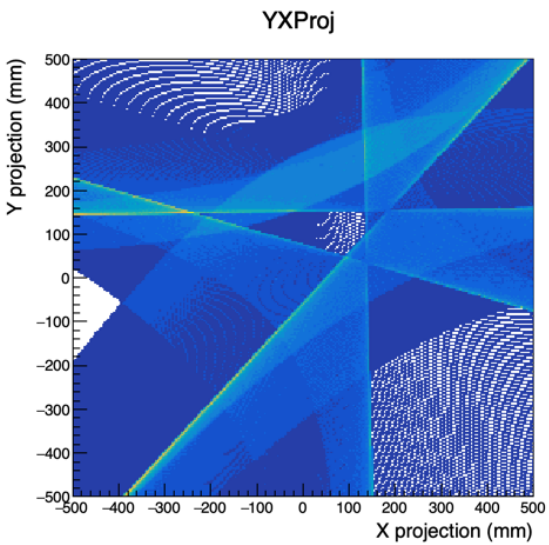

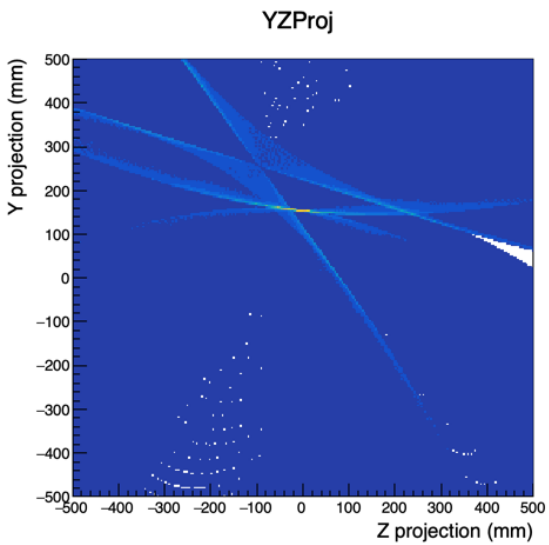

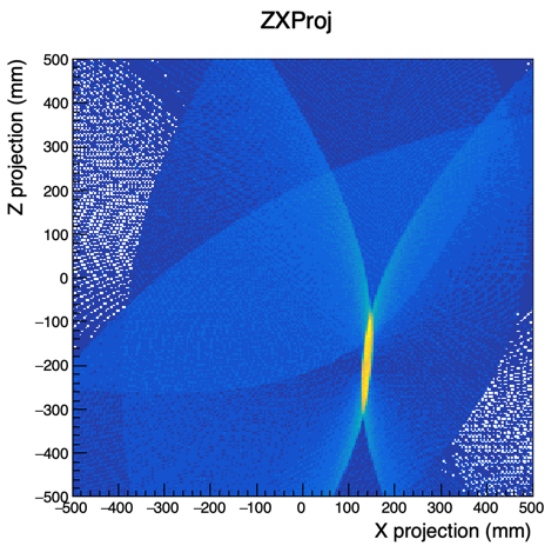

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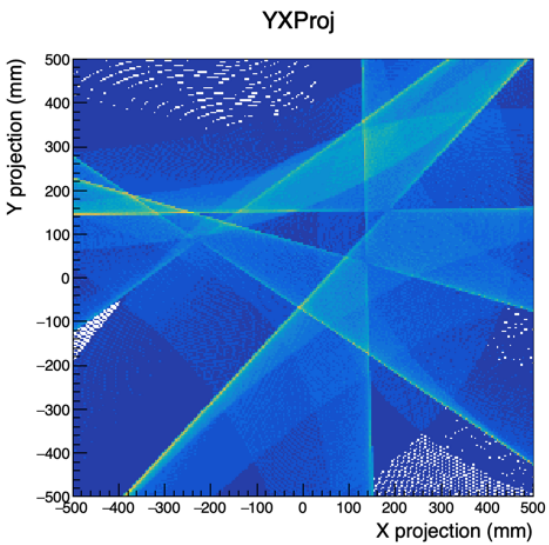

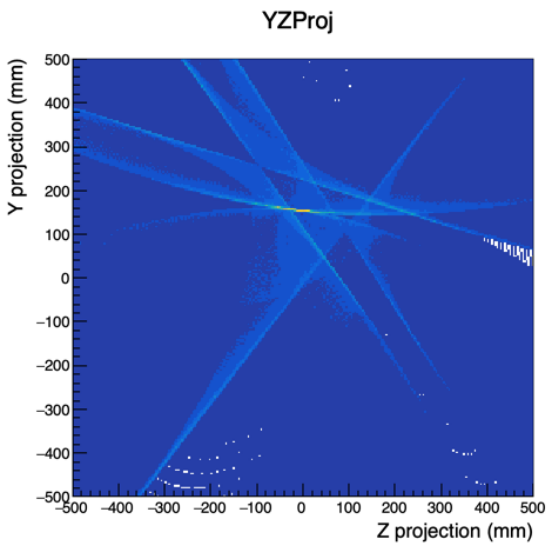

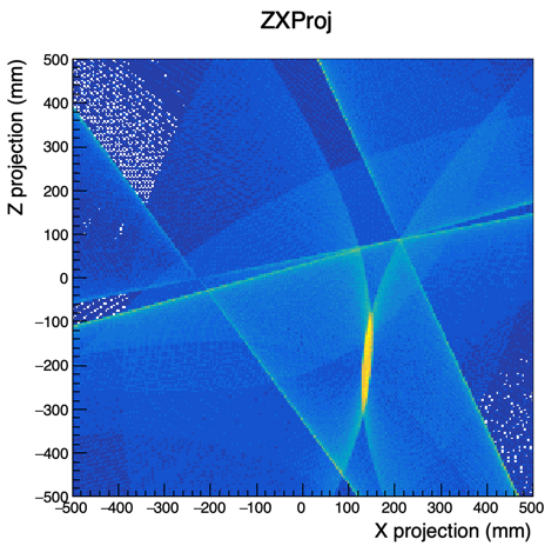

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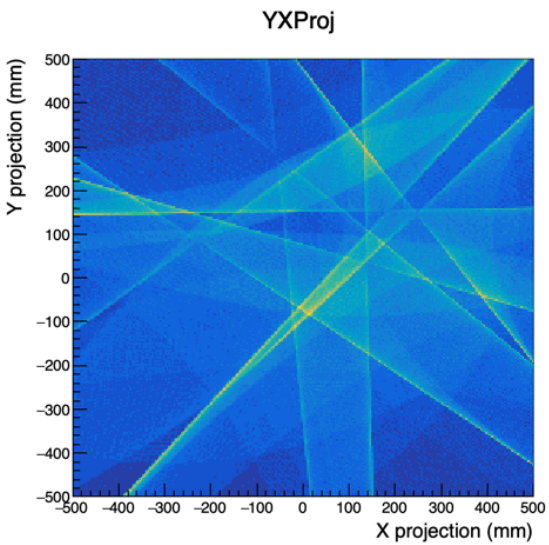

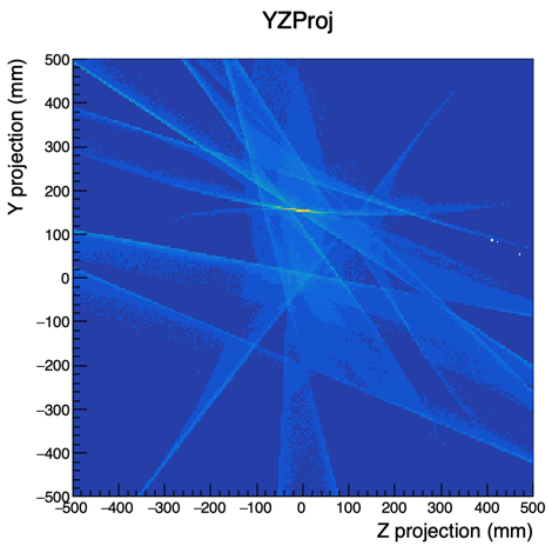

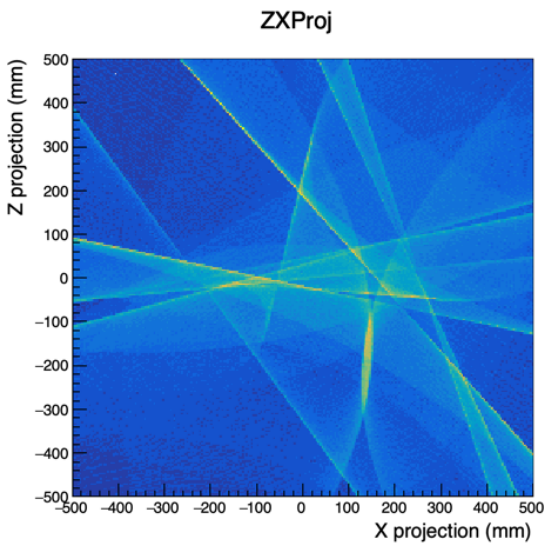

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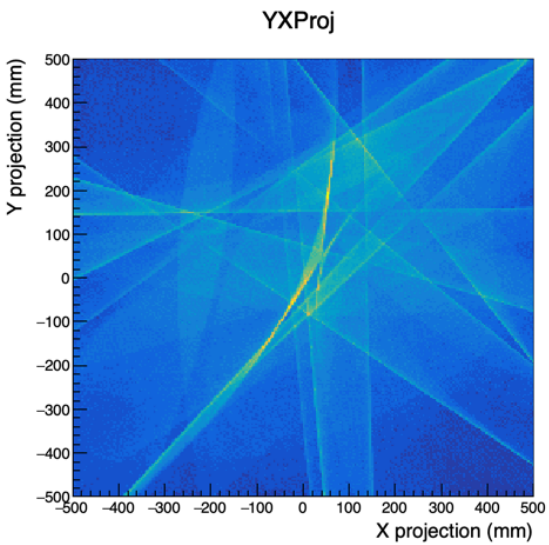

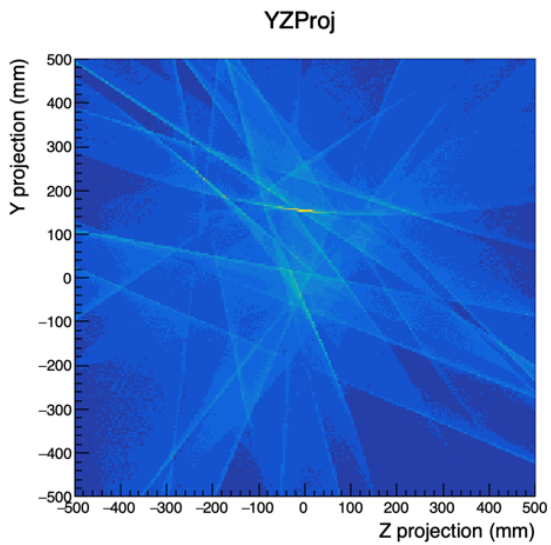

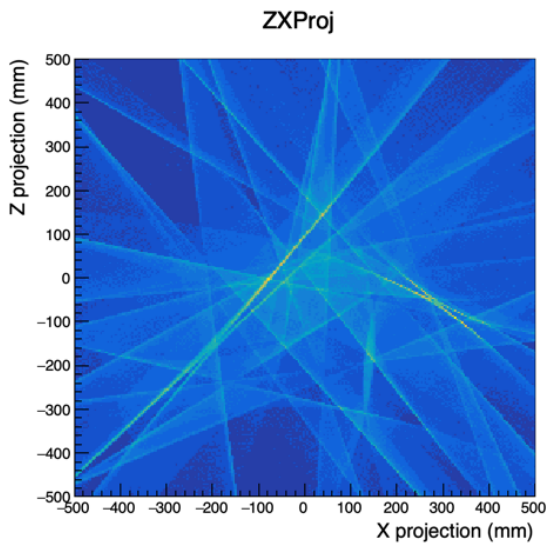

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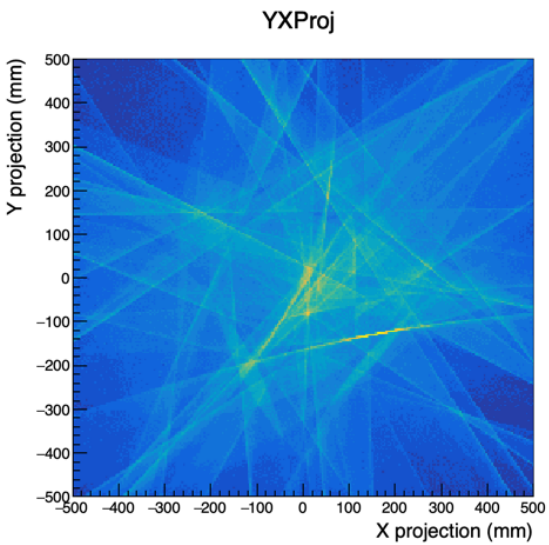

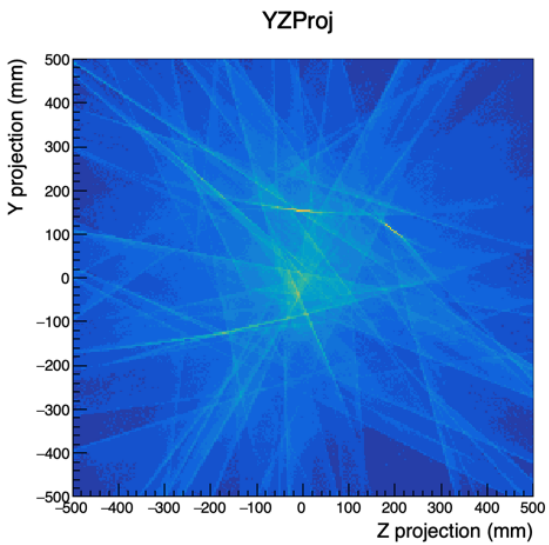

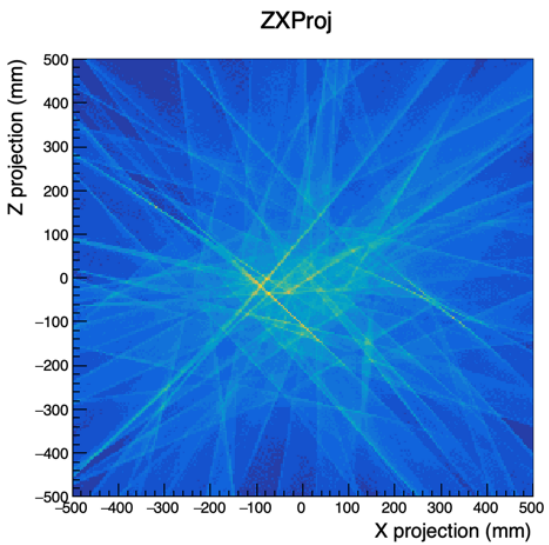

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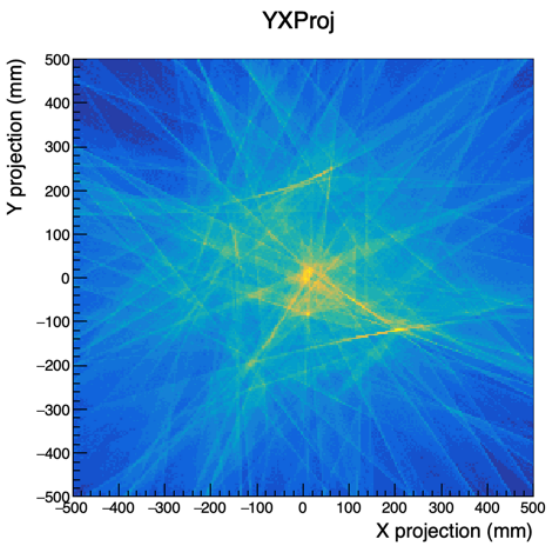
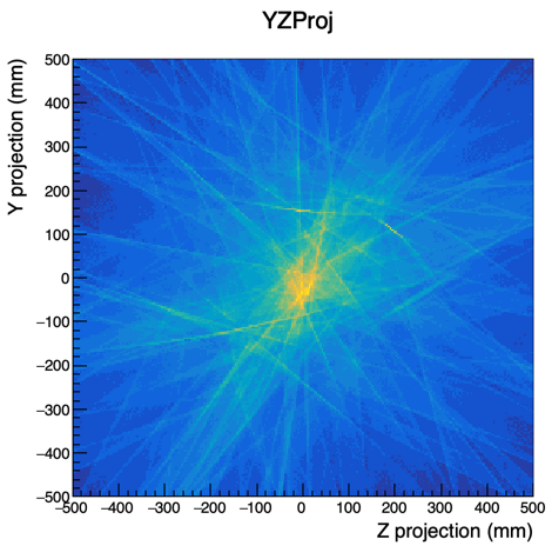
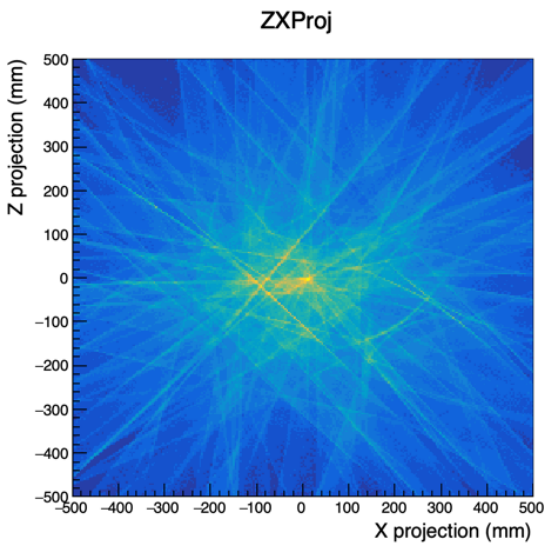
100 event







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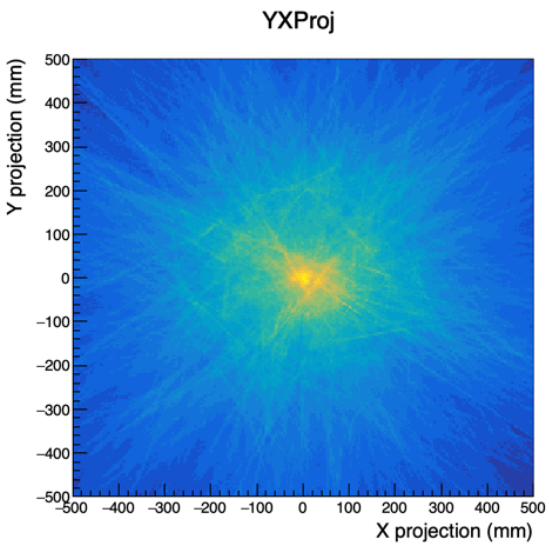
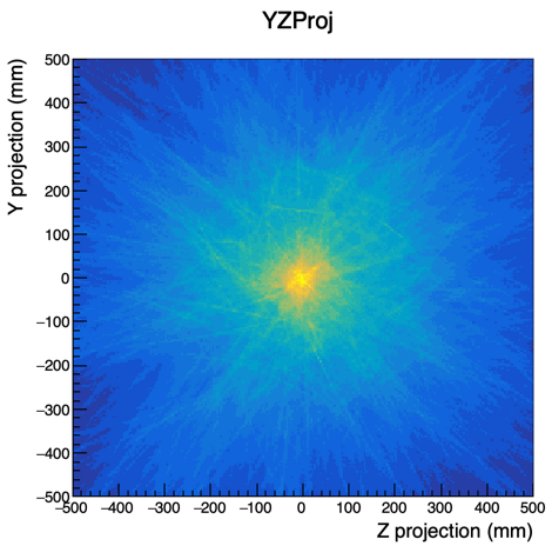
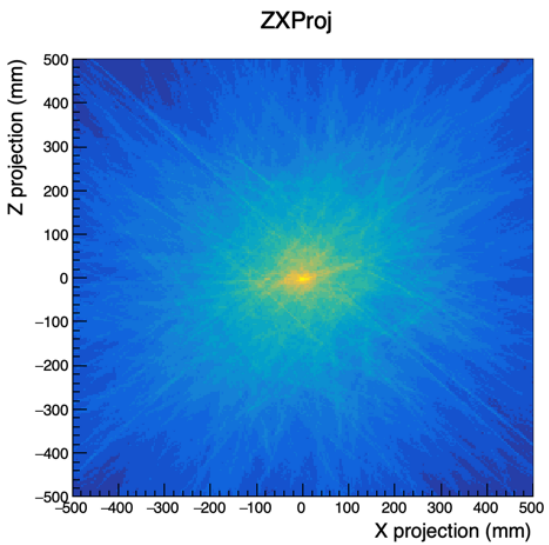
500 event







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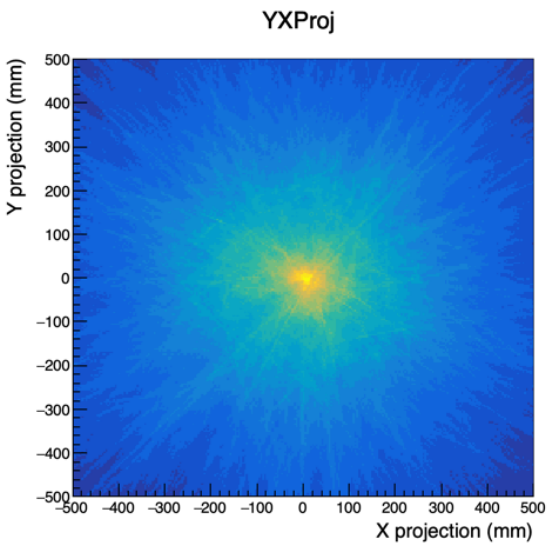
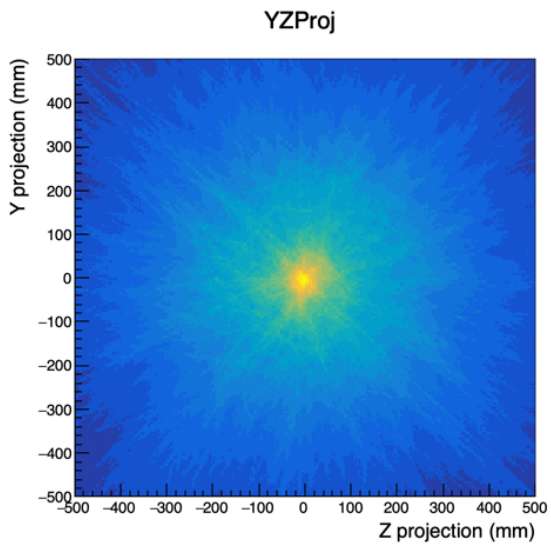
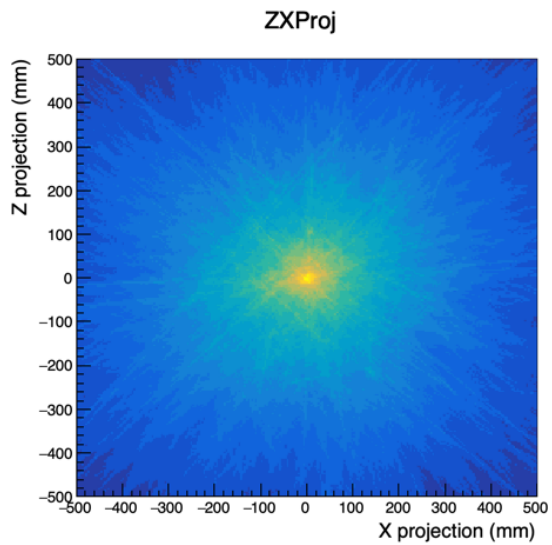
1000 event







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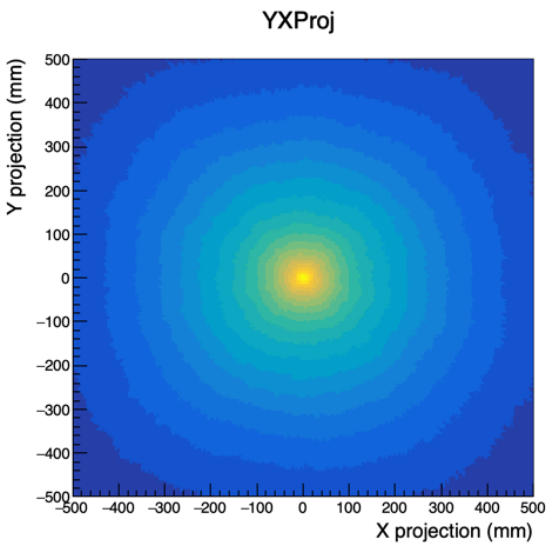
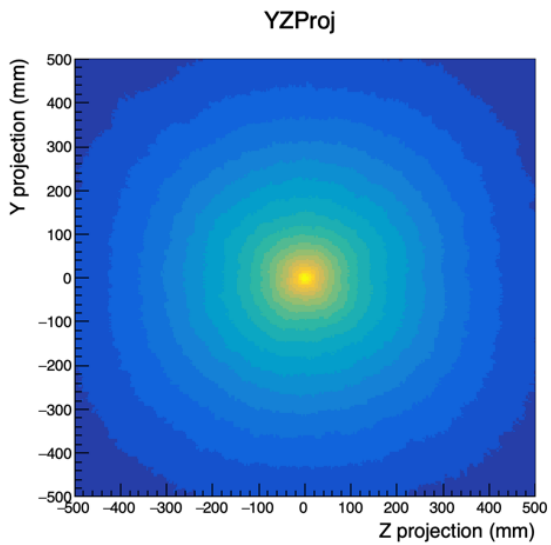
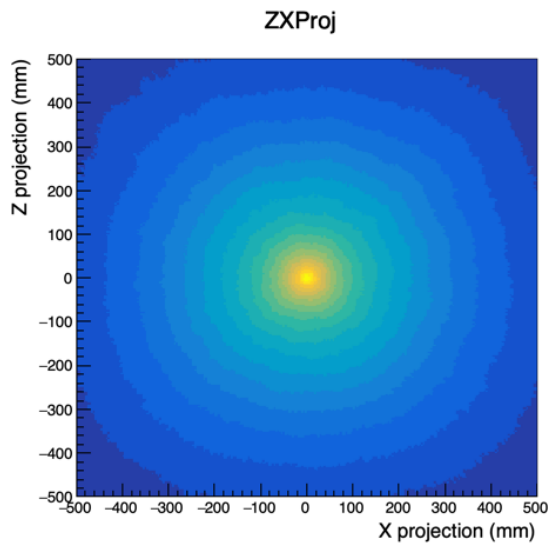
1×10^6 event







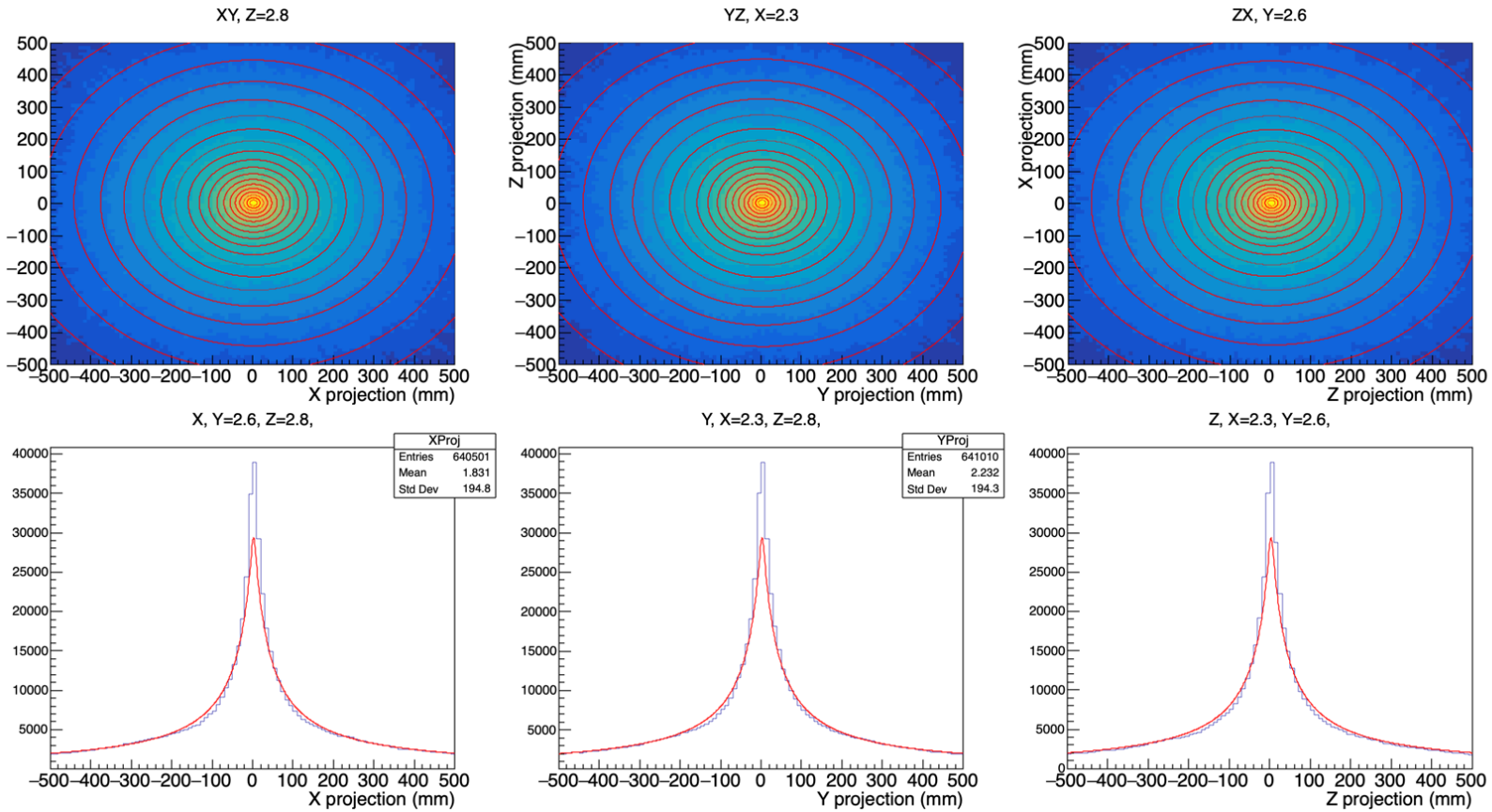
Data processing

How to fit the result ?

⇒ First trials using a 3 dimensional double tailled gaussian fonction

↪ Position: X=2.3 mm, Y=2.6 mm, Z=2.8 mm (binning effect)

↪ FWHM: X=3.4 cm, Y=3.4 cm, Z=3.4 cm



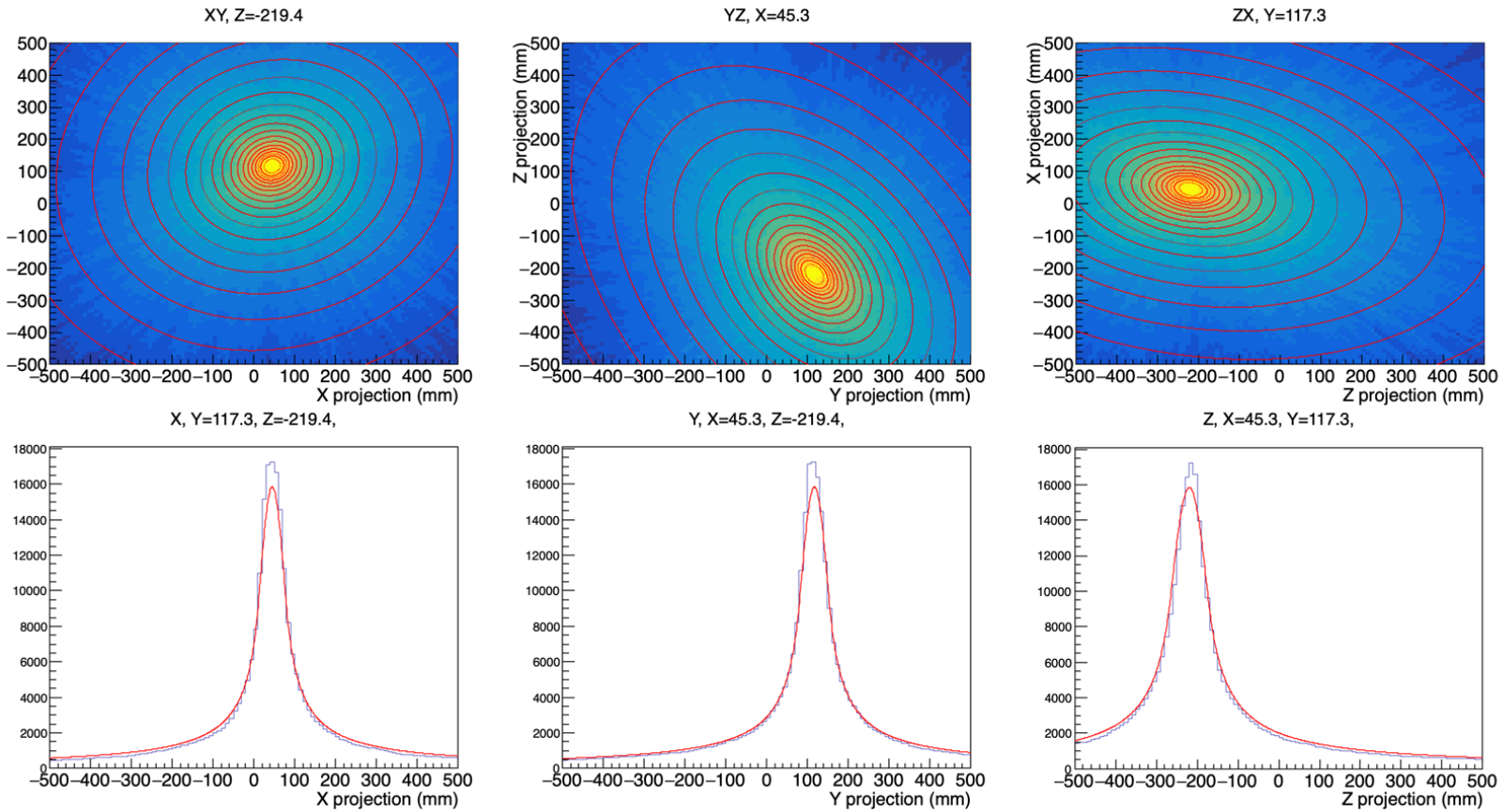
Data processing

Application on experimental data

⇒ ^{152}Eu run of the current e793s experiment

↪ Position: X=4.5 cm, Y=11.7 cm, Z=-21.9 cm

↪ FWHM: X=7 cm, Y=8 cm, Z=11 cm

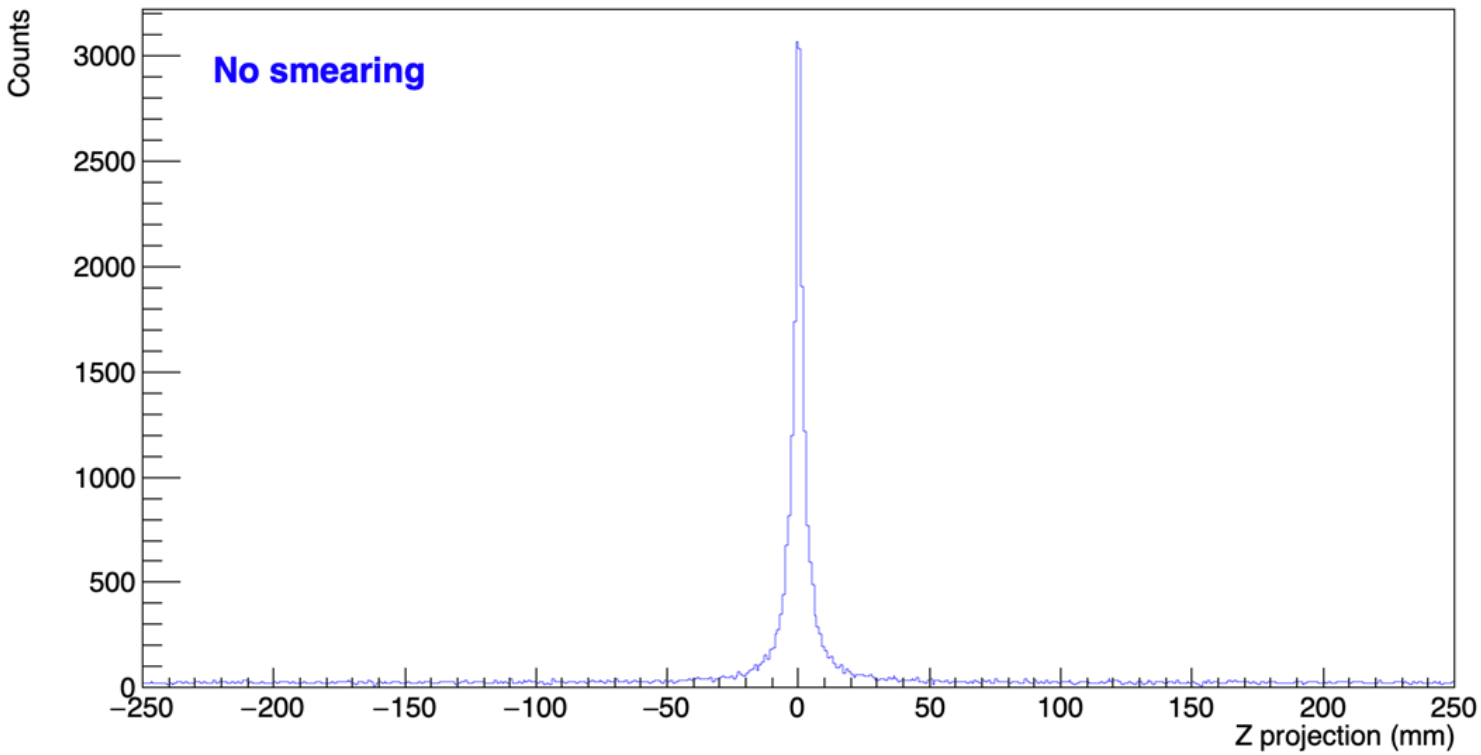


PSA characterization

How Imaging can be use for PSA optimization

⇒ Projection on z axis of a centered source, no smearing.

⇒ Projection on z axis of a centered source, 5mm smearing.



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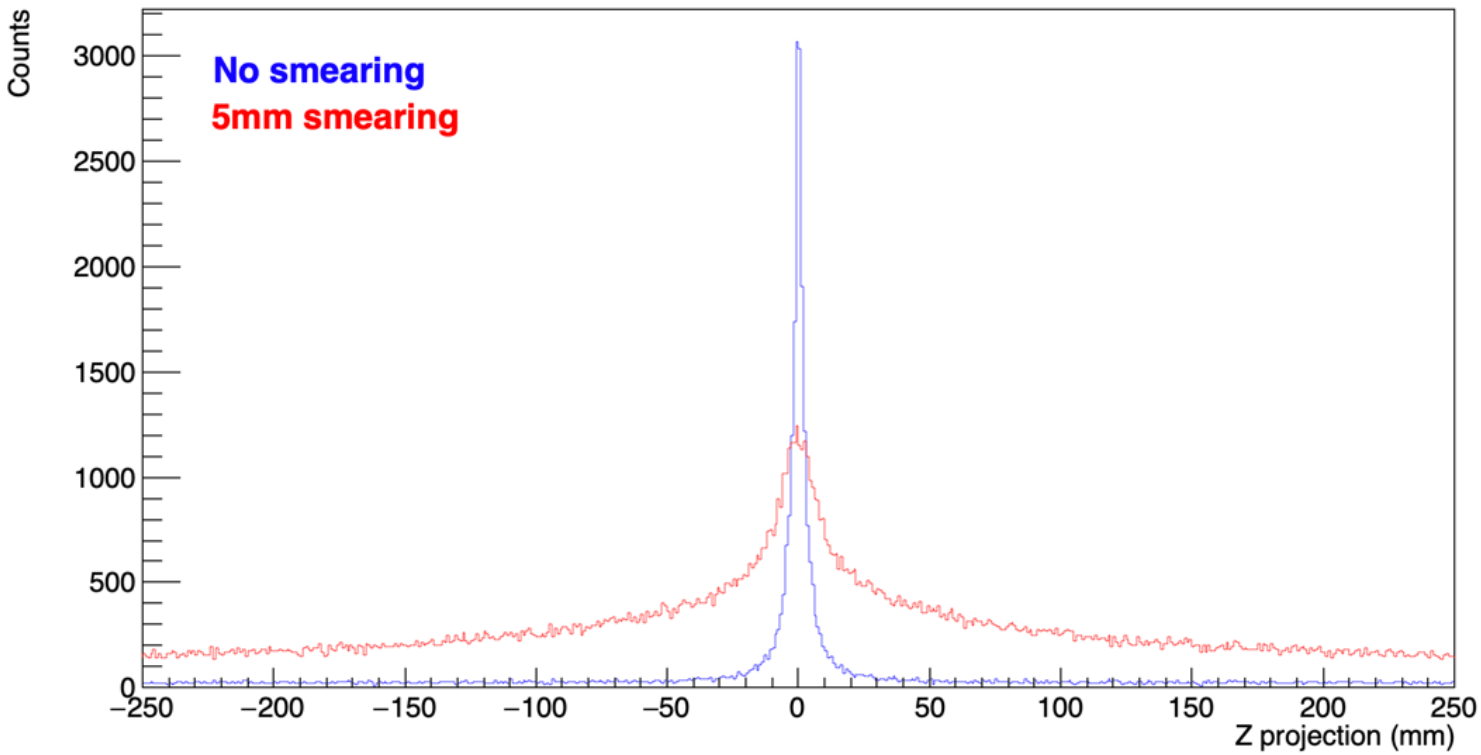

What next ?

Work to be done

- $\Rightarrow$ Study the sensitivity to tracking parameters
- $\Rightarrow$ Study the sensitivity to γ-ray energy
- $\Rightarrow$ Study the sensitivity to $\overrightarrow{P_1P_2}$ properties (Z_1, $|\overrightarrow{P_1P_2}|$, θ)
- $\Rightarrow$ Study Imaging capabilities using neural networks
- $\Rightarrow$ Apply the algorithms on the dedicated source measurements that have been taken last autumn.

Thank you for your attention !