Left-right asymmetry

Fitting algorithm

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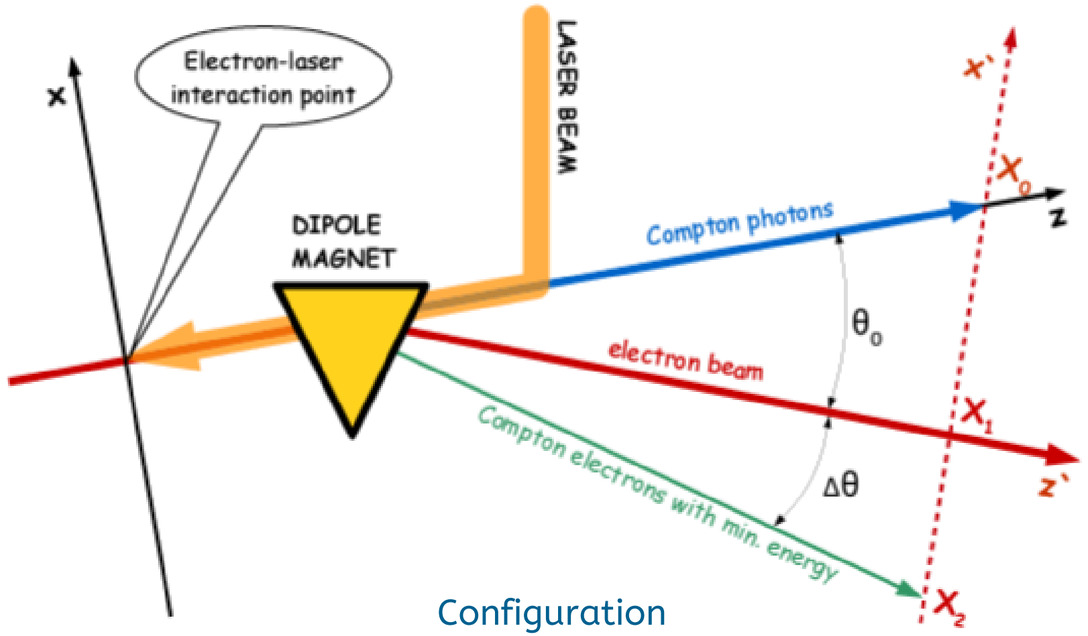
Cross section

$$\frac{d\sigma}{dud\varphi} = \frac{d\sigma_0}{dud\varphi} + \xi_1 \frac{d\sigma_1}{dud\varphi} + \xi_2 \frac{d\sigma_2}{dud\varphi} + \xi_3 \left(\zeta_x \frac{d\sigma_x}{dud\varphi} + \zeta_y \frac{d\sigma_y}{dud\varphi} + \zeta_z \frac{d\sigma_z}{dud\varphi} \right)$$



Configuration

Cross section

$$\frac{d\sigma}{dud\varphi} = \frac{d\sigma_0}{dud\varphi} + \xi_1 \frac{d\sigma_1}{dud\varphi} + \xi_2 \frac{d\sigma_2}{dud\varphi} + \xi_3 \left(\zeta_x \frac{d\sigma_x}{dud\varphi} + \zeta_y \frac{d\sigma_y}{dud\varphi} + \zeta_z \frac{d\sigma_z}{dud\varphi} \right)$$

Unpolarized term

Cross section

$$\frac{d\sigma}{dud\varphi} = \frac{d\sigma_0}{dud\varphi} + \xi_1 \frac{d\sigma_1}{dud\varphi} + \xi_2 \frac{d\sigma_2}{dud\varphi} + \xi_3 \left(\zeta_x \frac{d\sigma_x}{dud\varphi} + \zeta_y \frac{d\sigma_y}{dud\varphi} + \zeta_z \frac{d\sigma_z}{dud\varphi} \right)$$

Unpolarized term

Linear polarization of the laser beam

Cross section

$$\frac{d\sigma}{dud\varphi} = \frac{d\sigma_0}{dud\varphi} + \xi_1 \frac{d\sigma_1}{dud\varphi} + \xi_2 \frac{d\sigma_2}{dud\varphi} + \xi_3 \left(\zeta_x \frac{d\sigma_x}{dud\varphi} + \zeta_y \frac{d\sigma_y}{dud\varphi} + \zeta_z \frac{d\sigma_z}{dud\varphi} \right)$$

Unpolarized term

Linear polarization of the laser beam

Interaction between laser circular polarization and electron beam spin polarization

Measurement strategies

Distribution

$$\frac{d\sigma}{dud\varphi} = \frac{d\sigma_0}{dud\varphi} + \xi_1 \frac{d\sigma_1}{dud\varphi} + \xi_2 \frac{d\sigma_2}{dud\varphi} + \xi_3 \left(\zeta_x \frac{d\sigma_x}{dud\varphi} + \zeta_y \frac{d\sigma_y}{dud\varphi} + \zeta_z \frac{d\sigma_z}{dud\varphi} \right)$$

Monte-Carlo Parameters:

Laser λ_0 = 0.532 um

Electron E_0 = 45.600 GeV

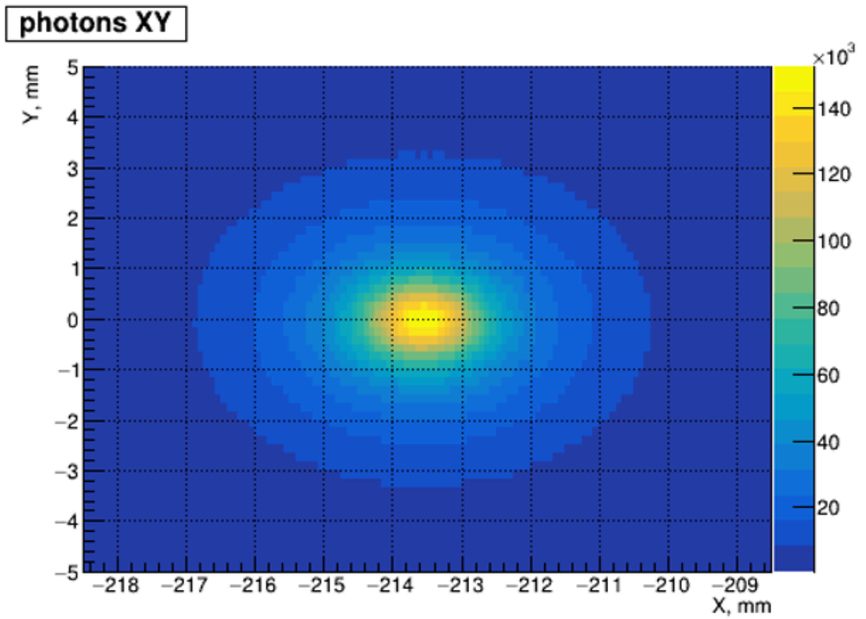
Electron $\gamma = 89.237 \times 10^3$

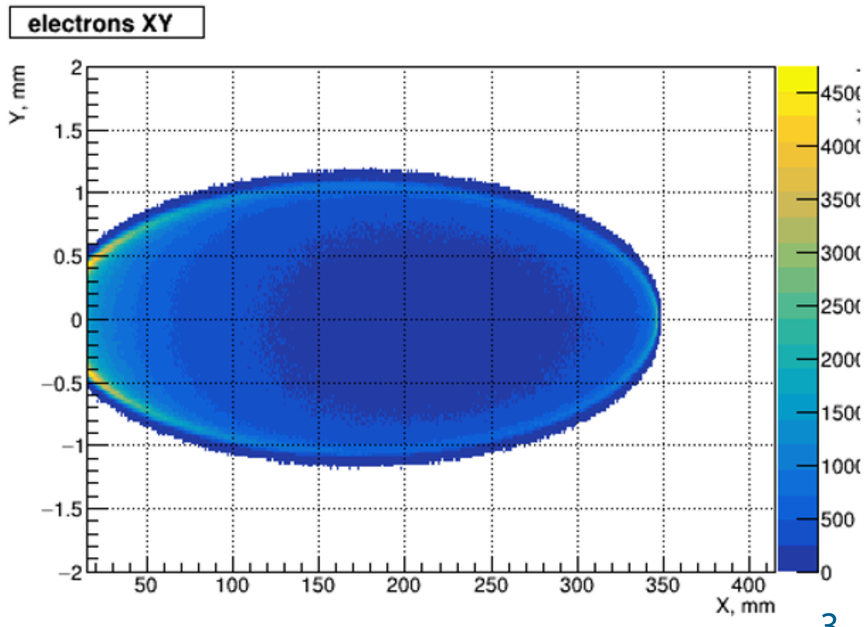
Compton κ = 1.628

Bend: $\gamma\theta_0$ = 190.441

$(\xi_1, \xi_2, \xi_3) = (0.000, 0.000, 1.000)$

$(\zeta_x, \zeta_y, \zeta_z) = (0.100, 0.250, 0.100)$





100 million events

Measurement strategies

Construct asymmetry

More robust against QED corrections

2023 JINST 18 P10001

- $\xi_3 = \pm 1$
- Very same luminosity

$$\frac{\frac{d\sigma^+}{dud\varphi} - \frac{d\sigma^-}{dud\varphi}}{\frac{d\sigma^+}{dud\varphi} + \frac{d\sigma^-}{dud\varphi}} = \frac{\left(\zeta_x \frac{d\sigma_x}{dud\varphi} + \zeta_y \frac{d\sigma_y}{dud\varphi} + \zeta_z \frac{d\sigma_z}{dud\varphi}\right)}{\frac{d\sigma_0}{dud\varphi} + \xi_1 \cancel{\frac{d\sigma_1}{dud\varphi}} + \xi_2 \cancel{\frac{d\sigma_2}{dud\varphi}}}$$

Monte-Carlo Parameters:

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Bend: $\gamma\theta_0$ = 190.441

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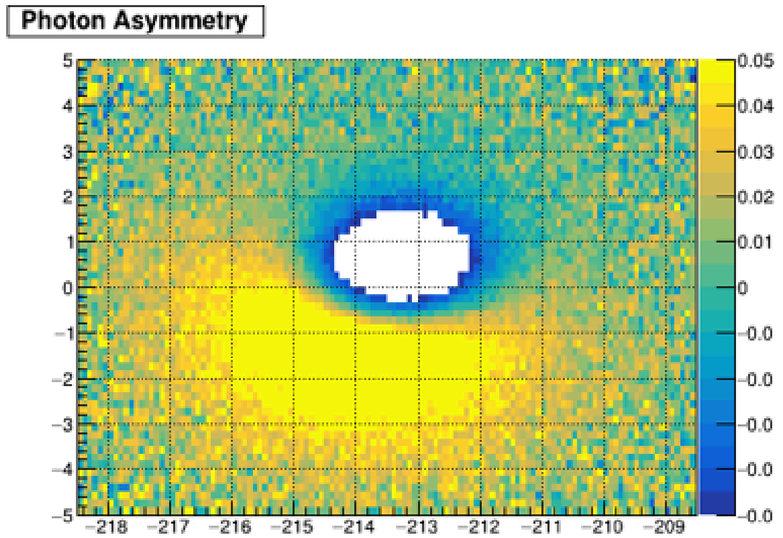
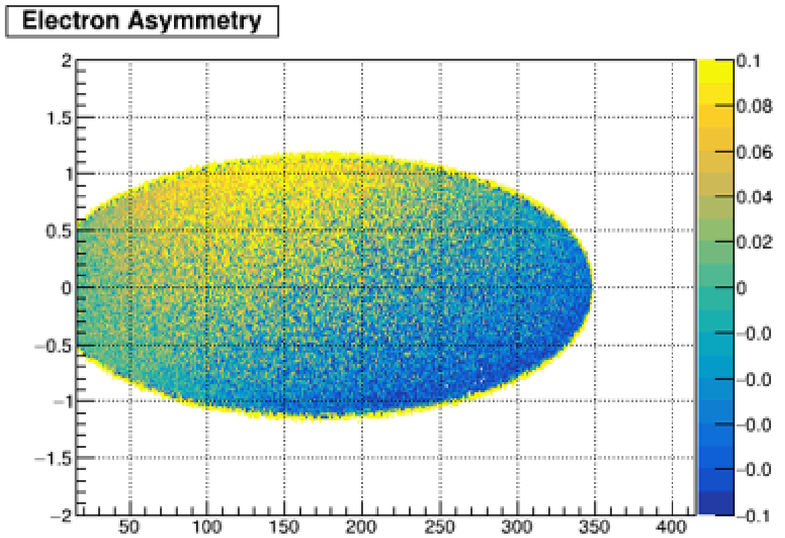




100 million events

Fit procedure

Center of each pixel

Resolution function for the beam divergence

Number of hits

$$\frac{N^+(x,y) - N^-(x,y)}{N^+(x,y) + N^-(x,y)} = \frac{(\frac{d\sigma^+}{dxdy} - \frac{d\sigma^-}{dxdy}) * G(x,y)}{(\frac{d\sigma^+}{dxdy} + \frac{d\sigma^-}{dxdy}) * G(x,y)}$$

Cross section in the plane of recoil electrons

Spread

σx: 300-200 um

σy: 35-25 um

Photon Detector

x pixel size: 83 um
y pixel size: 166 um

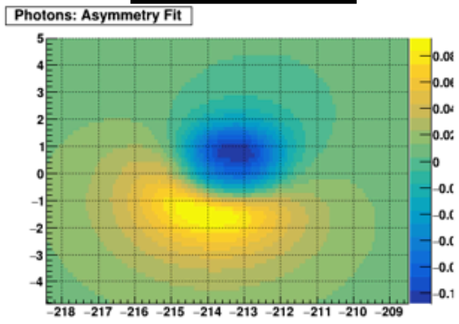
Electron Detector

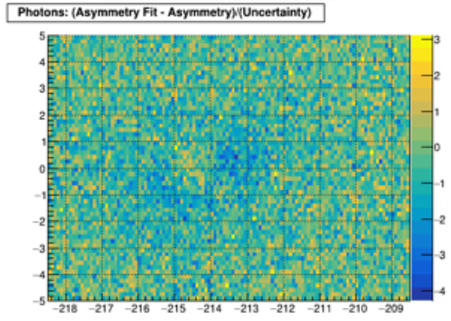
x pixel size: 130 um
y pixel size: 200 um

Fit

Residuals

Results

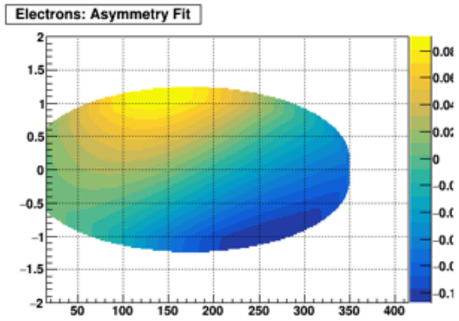


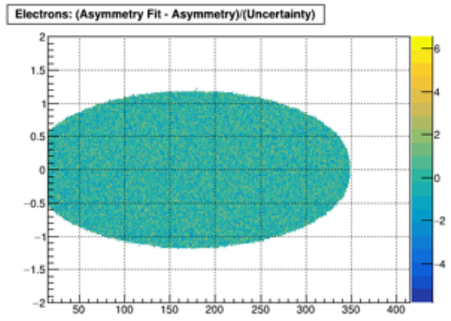


Intel(R) Xeon(R) CPU E5-2650 v4 @ 2.20GHz
Photons fit: t = 374 s (CPU 227 s)
χ^2/NDF = 9171.3/7200 | Prob = 0.0000
X_0 = -213.496 ± 0.003
ξ_1 = 0.000 ± 0.000
ξ_2 = 0.000 ± 0.000
$\xi_3\zeta_x$ = 0.092 ± 0.001
$\xi_3\zeta_y$ = 0.250 ± 0.001
$\xi_3\zeta_z$ = 0.099 ± 0.000
σ_x = 217.255 ± 4.659
σ_y = 26.431 ± 0.000

χ2/NDF = 9171.3/7200

Photons



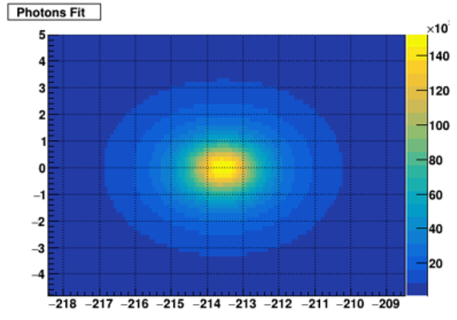


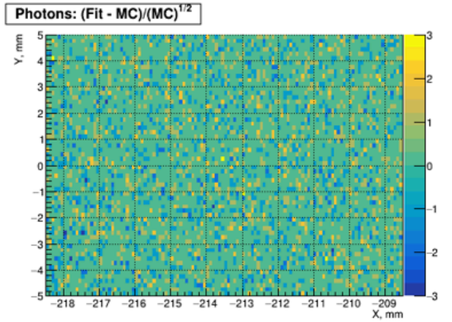
Intel(R) Xeon(R) CPU E5-2650 v4 @ 2.20GHz
Electrons fit: t = 1464 s (CPU 1250 s)
χ^2/NDF = 220825.7/217297 | Prob = 0.0000
X_1 = -0.012 ± 0.000
X_2 = 347.634 ± 0.000
ξ_1 = 0.000 ± 0.000
ξ_2 = 0.000 ± 0.000
$\xi_3\zeta_x$ = 0.100 ± 0.000
$\xi_3\zeta_y$ = 0.250 ± 0.001
$\xi_3\zeta_z$ = 0.098 ± 0.000
σ_x = 315.000 ± 0.000
σ_y = 26.431 ± 0.000
E_{beam} = 45.613 ± 0.001

Asymmetry

χ2/NDF = 220825.7/217297

Electrons

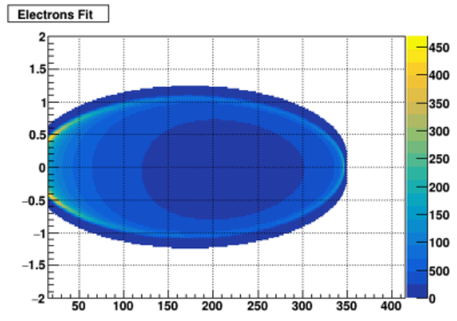


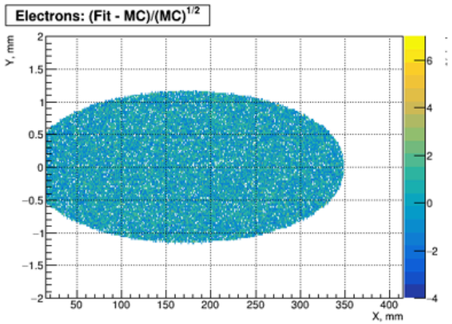


Intel(R) Xeon(R) CPU E5-2650 v4 @ 2.20GHz
Photons fit: t = 338 s (CPU 338 s)
χ^2/NDF = 7274.1/7190 | Prob = 0.2406
X_0 = -213.538 ± 0.001
ξ_1 = 0.000 ± 0.001
ξ_2 = 0.000 ± 0.000
$\xi_3\zeta_x$ = 0.101 ± 0.002
$\xi_3\zeta_y$ = 0.248 ± 0.002
$\xi_3\zeta_z$ = 0.099 ± 0.001
σ_x = 255.354 ± 1.020
σ_y = 34.820 ± 5.791

χ2/NDF = 7274.1/7190

Photons





Intel(R) Xeon(R) CPU E5-2650 v4 @ 2.20GHz
Electrons fit: t = 21199 s (CPU 21196 s)
χ^2/NDF = 215915.1/216089 | Prob = 0.6040
X_1 = -0.011 ± 0.002
X_2 = 347.631 ± 0.001
ξ_1 = -0.000 ± 0.001
ξ_2 = 0.000 ± 0.000
$\xi_3\zeta_x$ = 0.100 ± 0.000
$\xi_3\zeta_y$ = 0.250 ± 0.001
$\xi_3\zeta_z$ = 0.101 ± 0.000
σ_x = 316.905 ± 1.217
σ_y = 26.435 ± 0.009
E_{beam} = 45.603 ± 0.001

Distribution

χ2/NDF = 215915.1/216089

Electrons

100 experiments
100 million events

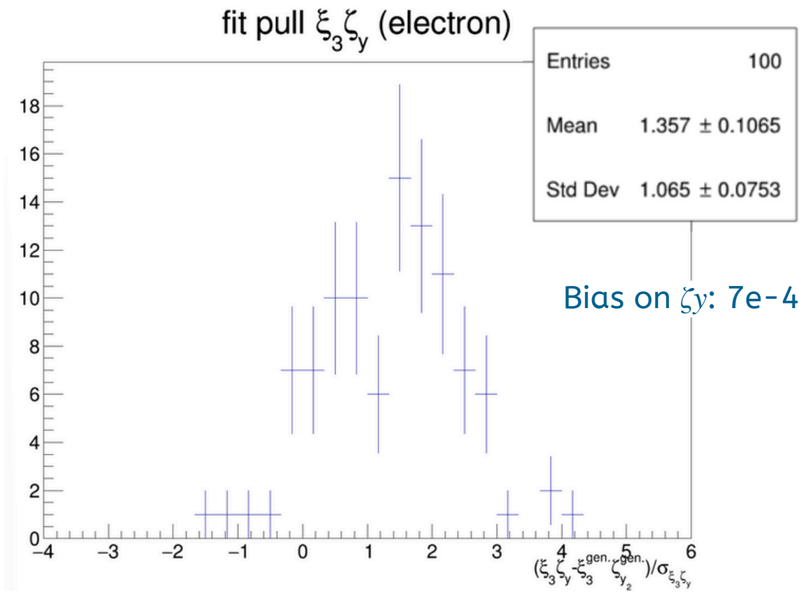
Electrons

$$\text{pull} := \frac{\text{fitted value} - \text{generated value}}{\text{uncertainty}}$$

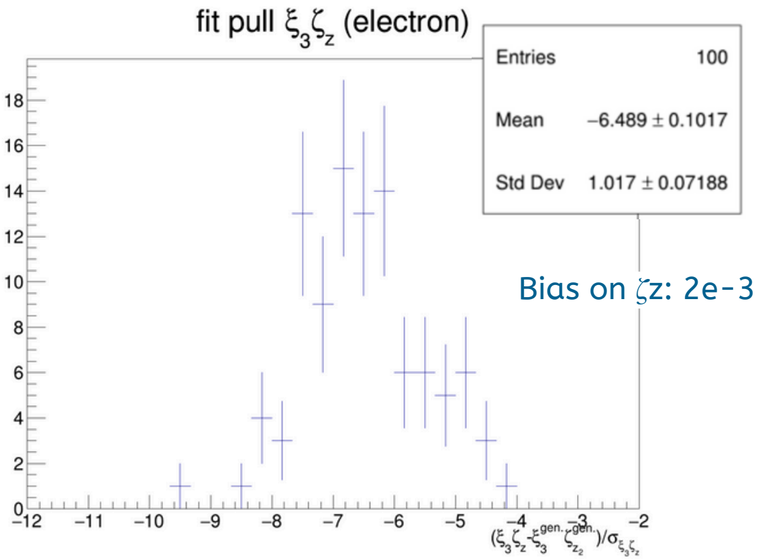
ζy

ζz

Asymmetry

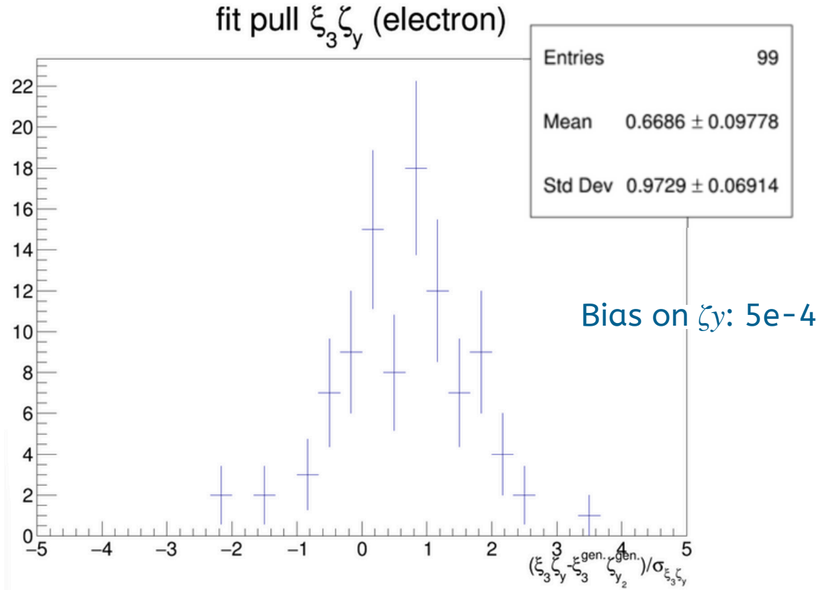


Bias on ζy: 7e-4

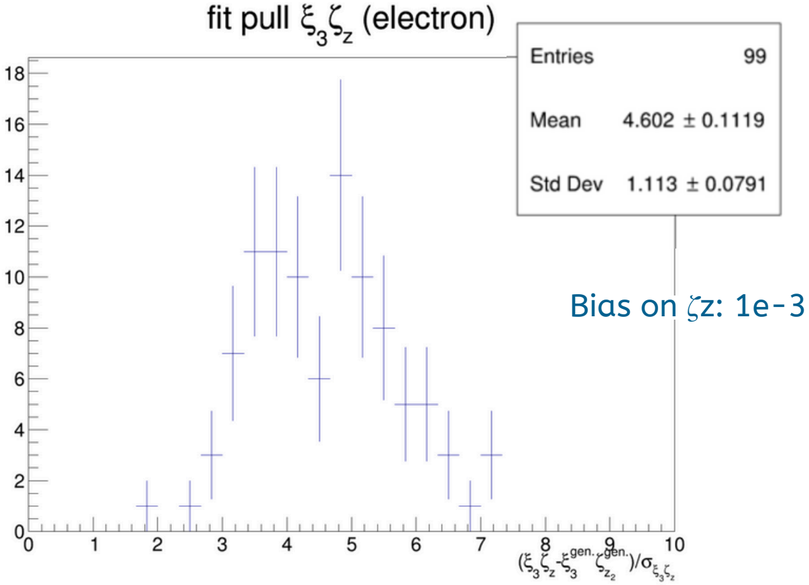


Bias on ζz: 2e-3

Distribution



Bias on ζy: 5e-4



Bias on ζz: 1e-3

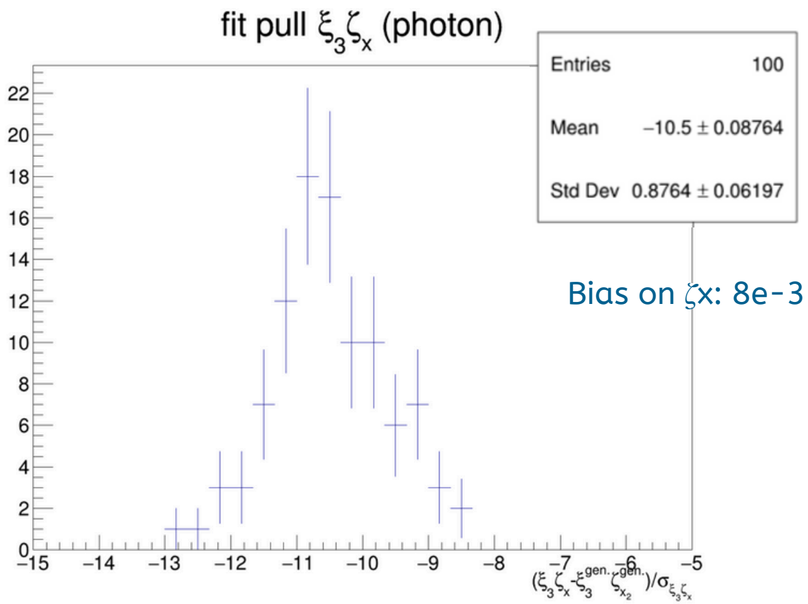
Photons

Pull of ζy is well behaved

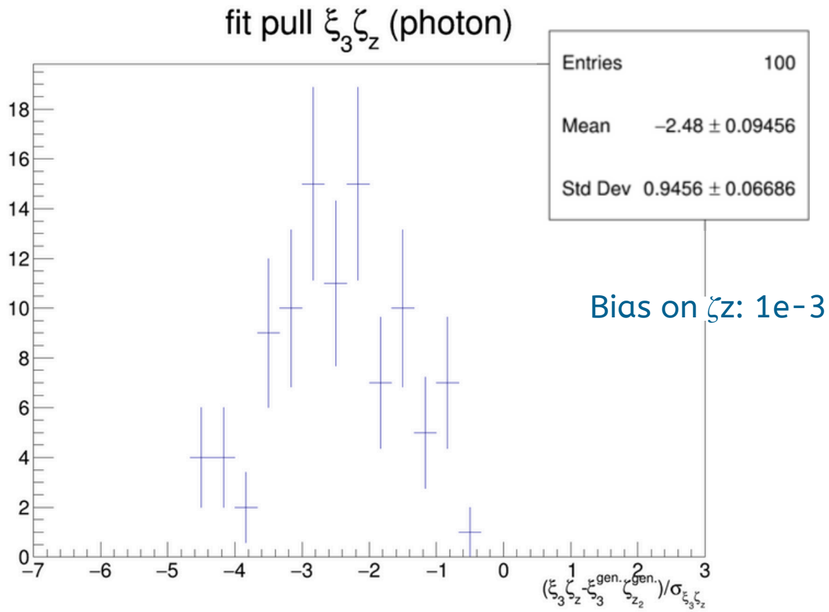
ζx

ζz

Asymmetry

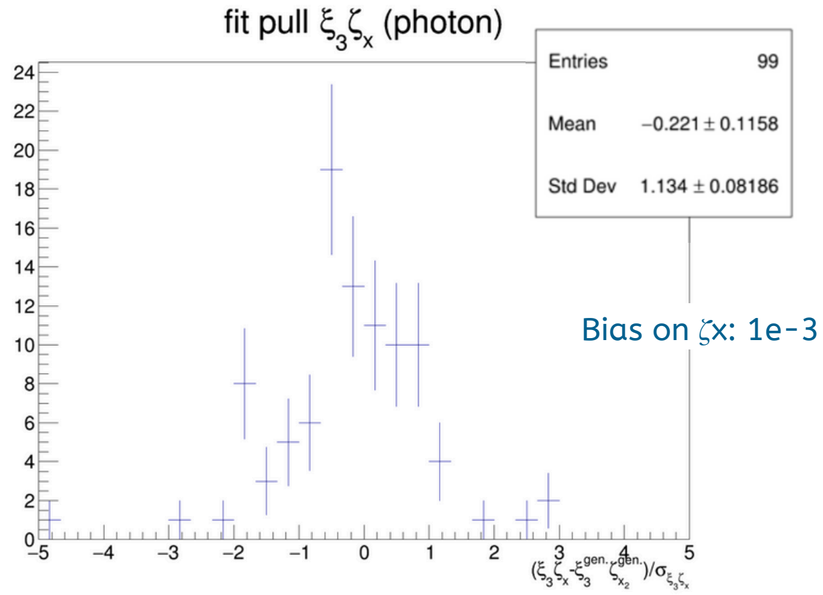


Bias on ζx: 8e-3

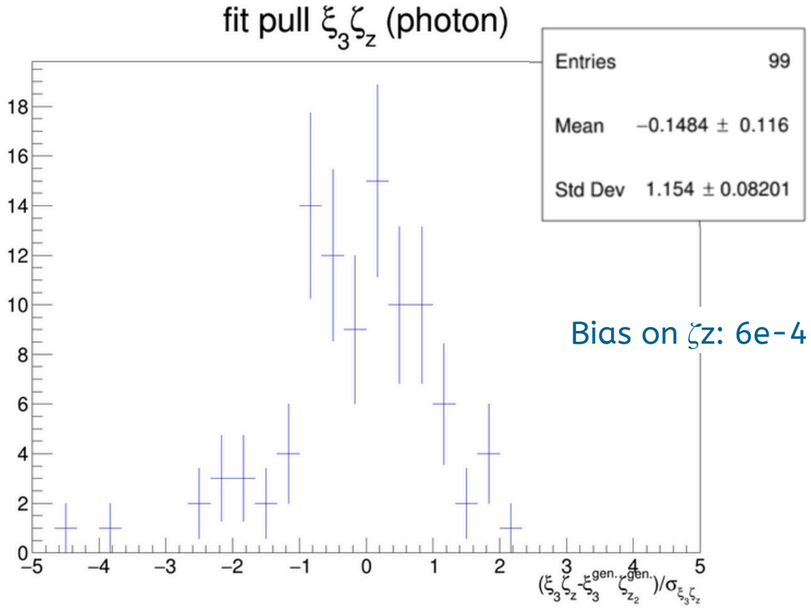


Bias on ζz: 1e-3

Distribution



Bias on ζx: 1e-3



Bias on ζz: 6e-4

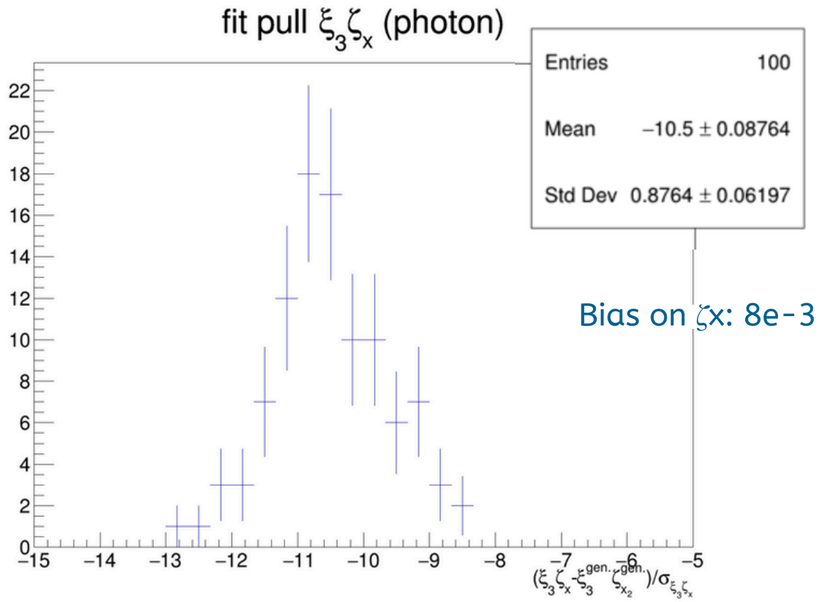
Photons Asymmetry

⟵ fixed params.

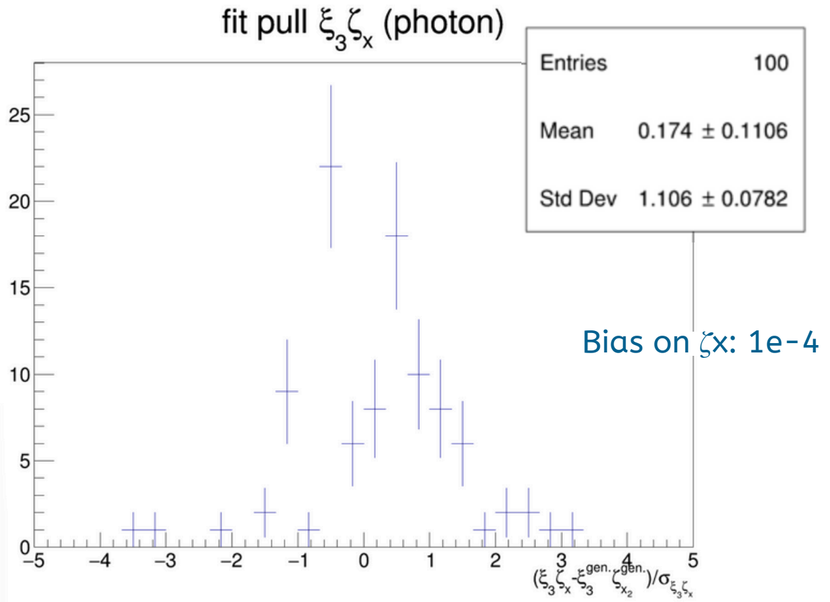
- X0
- σx

- X0
- σx

ζx

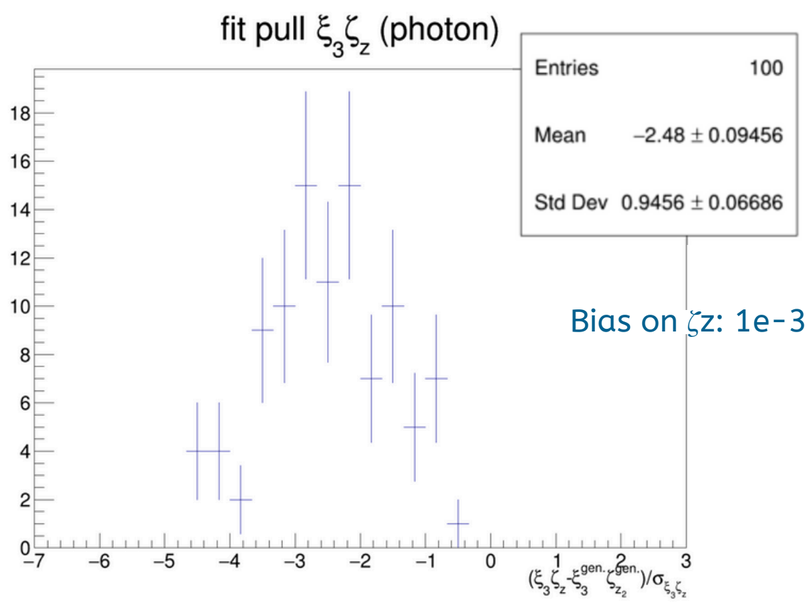


Bias on ζx: 8e-3

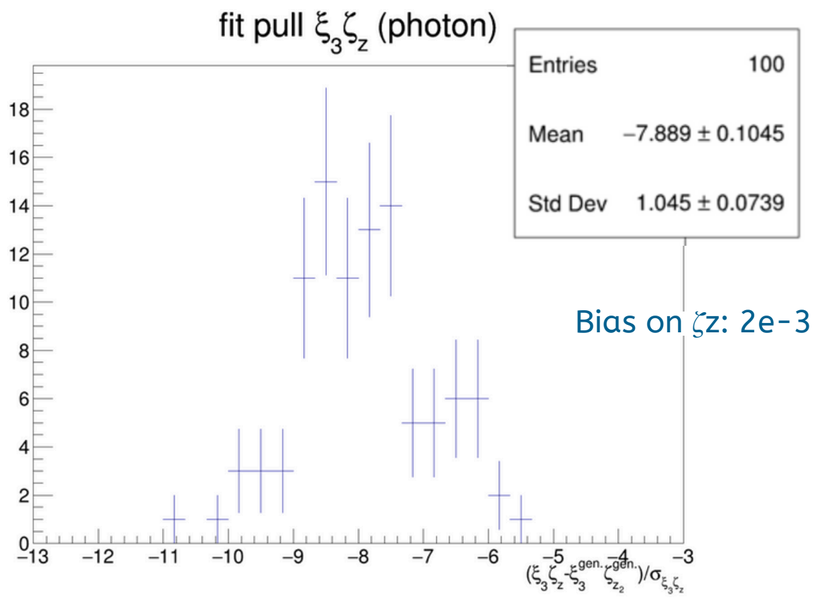


Bias on ζx: 1e-4

ζz



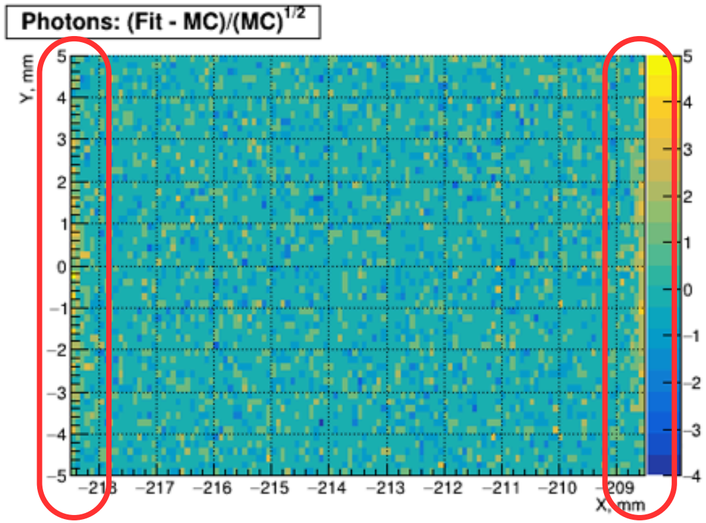
Bias on ζz: 1e-3



Bias on ζz: 2e-3

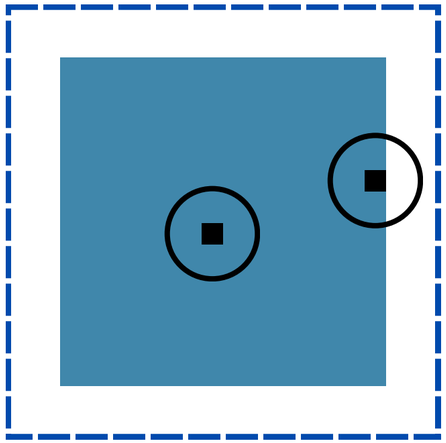
Global improvements

- Optimized pythonization: 25% faster
- Refined fit of distribution



Intel(R) Xeon(R) CPU E5-2650 v4 @ 2.20GHz
Photons fit: t = 278 s (CPU 278 s)
χ^2/NDF = 7820.4/7190 | Prob = 0.0000
X_0 = -213.539 $\pm$ 0.001
ξ_1 = 0.001 $\pm$ 0.001
ξ_2 = -0.000 $\pm$ 0.000
$\xi_3\zeta_x$ = 0.096 $\pm$ 0.002
$\xi_3\zeta_y$ = 0.249 $\pm$ 0.002
$\xi_3\zeta_z$ = 0.101 $\pm$ 0.001
σ_x = 250.574 $\pm$ 1.022
σ_y = 30.401 $\pm$ 6.268

Convolution



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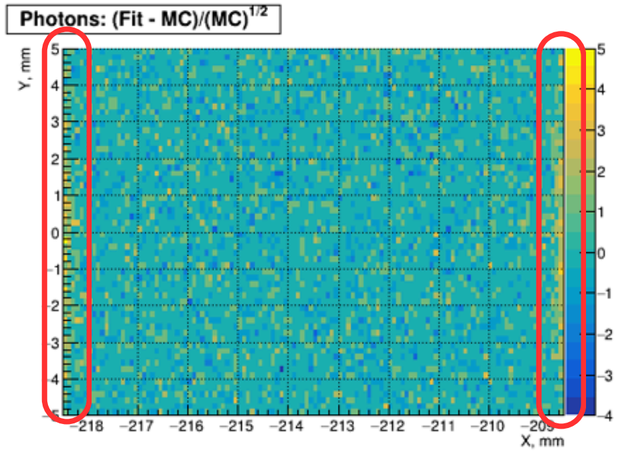

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σ_x = 250.574 ± 1.022
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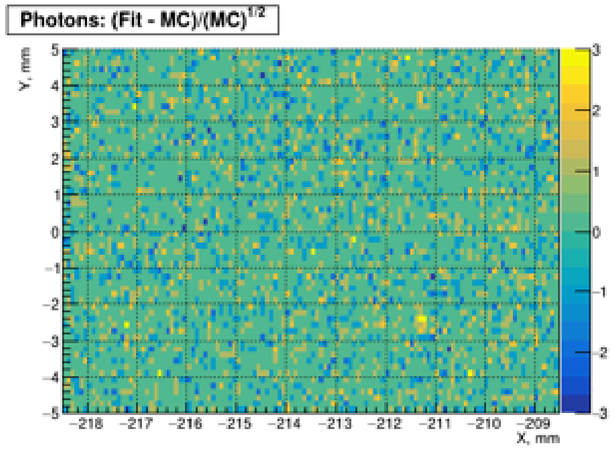
χ2/NDF = 7820.4/7190



Intel(R) Xeon(R) CPU E5-2650 v4 @ 2.20GHz
Photons fit: t = 464 s (CPU 463 s)
χ^2/NDF = 6981.9/7190 Prob = 0.9596
X_0 = -213.539 ± 0.001
ξ_1 = 0.001 ± 0.001
ξ_2 = -0.000 ± 0.000
$\xi_3\zeta_x$ = 0.099 ± 0.002
$\xi_3\zeta_y$ = 0.247 ± 0.002
$\xi_3\zeta_z$ = 0.099 ± 0.001
σ_x = 254.946 ± 1.022
σ_y = 41.104 ± 4.908

χ2/NDF = 6981.9/7190

Conclusions

- Succesfully implemented the fit of the asymmetry
- Very first results of fitting the asymmetry including tools for toy Monte Carlo studies
- Most of the geometrical parameters have to be fixed for the fit of asymmetry to work, requiring a careful study with varying parameters.
- Comparison of asymmetry with distribution show increase of biases in nearly all parameters, to be further studied