Massachusetts Institute of Technology


# DVCS study for ECCE proposal Summary

Detector 1 Exclusive/Diffractive/Tagging WG

July 11, 2022

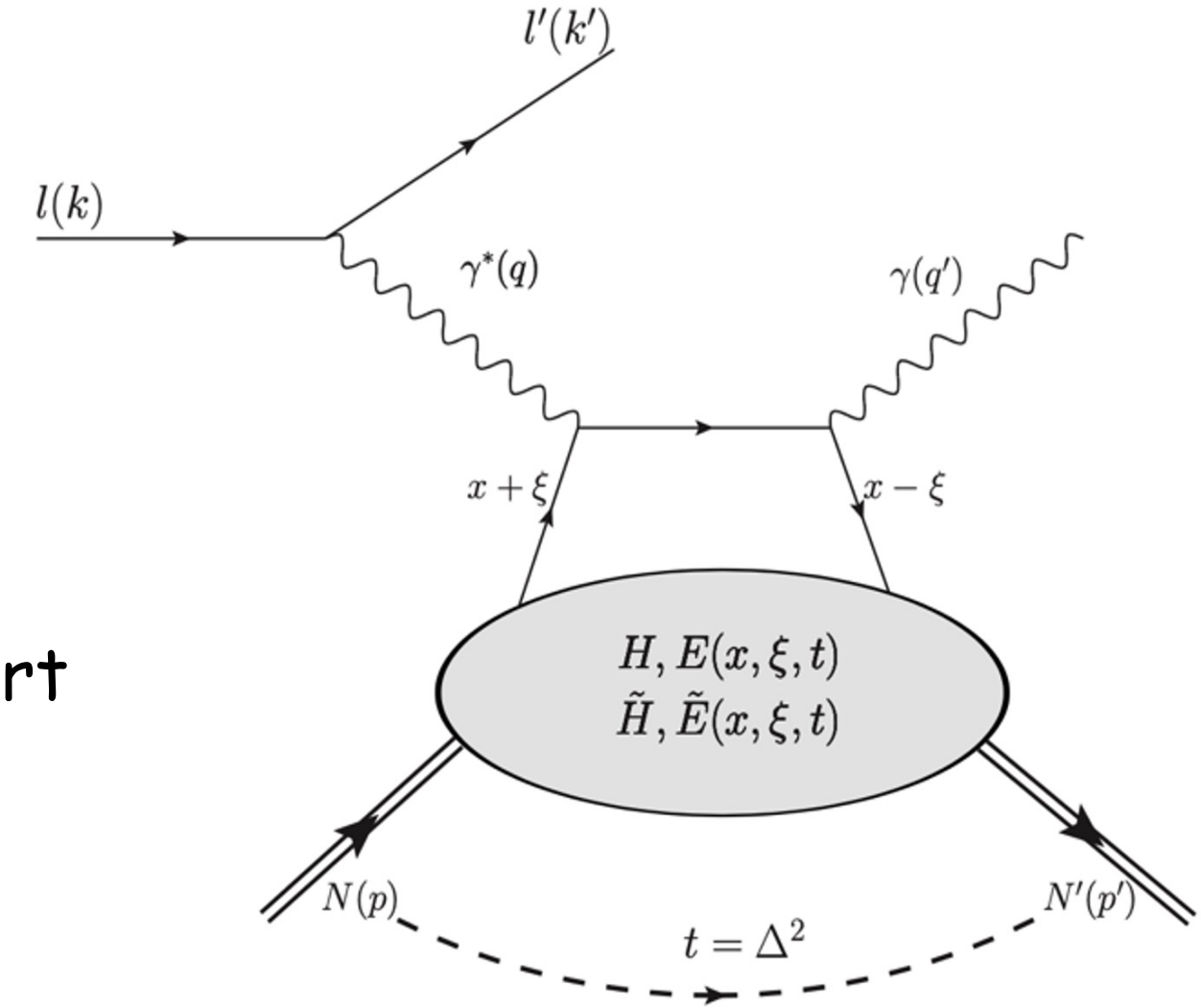
Igor Korover

# DVCS process

$$(ep \to e'p'\gamma)$$

Three particles in Final State

Generator used for Yellow Report



# Simulation tool:
# MILOU - generator

https://arxiv.org/pdf/hep-ph/0411389v1.pdf

$$\frac{d\sigma}{dx_{\mathrm{B}}dyd|t|d\phi d\varphi} = \frac{\alpha^3 x_{\mathrm{B}} y}{16\,\pi^2\,Q^2\sqrt{1+\epsilon^2}}\left|\frac{\mathcal{T}}{e^3}\right|^2$$

Use of two dimensional ($Q^2$,$x_B$) lookup tables for CFF

t-dependence factorized out:

Modeled with exponential or dipole Ansatz

Simulation constrained by HERA data

# Simulation tool:
# MILOU (3D) - generator https://arxiv.org/pdf/hep-ph/0411389v1.pdf

Used for Yellow report arXiv:2103.05419

3D – lookup tables ($Q^2$,$x_B$,t)

KM20 – implemented in GeParD (Nucl.Phys.B794:244-323,2008)

GK – implemented in PARTONS ((arXiv:1512.06174)

Account for an interplay between all three variables

# Simulation tool:
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Account to an interplay between all three variables

# MILOU3d steering card – General settings

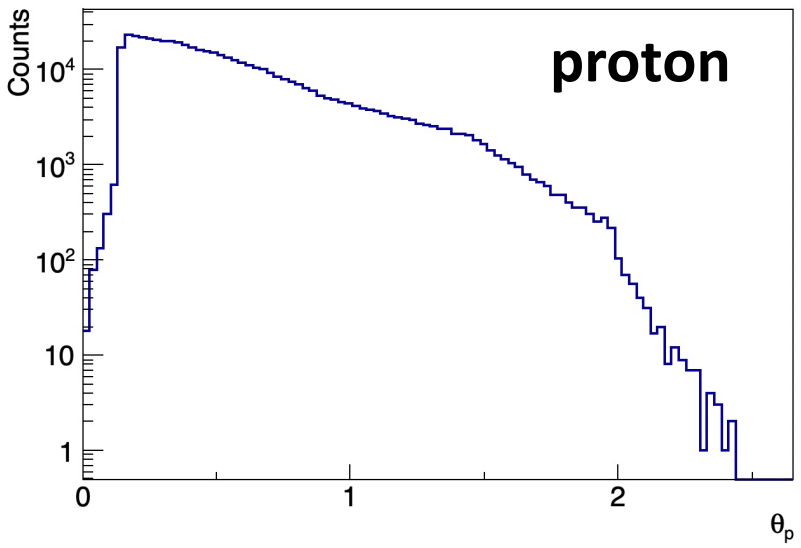
**Kinematic bin**

```
XMIN     5.0e-5
XMAX     0.7
QMIN     1.0
QMAX   1000.0
TMIN     -0.01
TMAX   -2.0
```

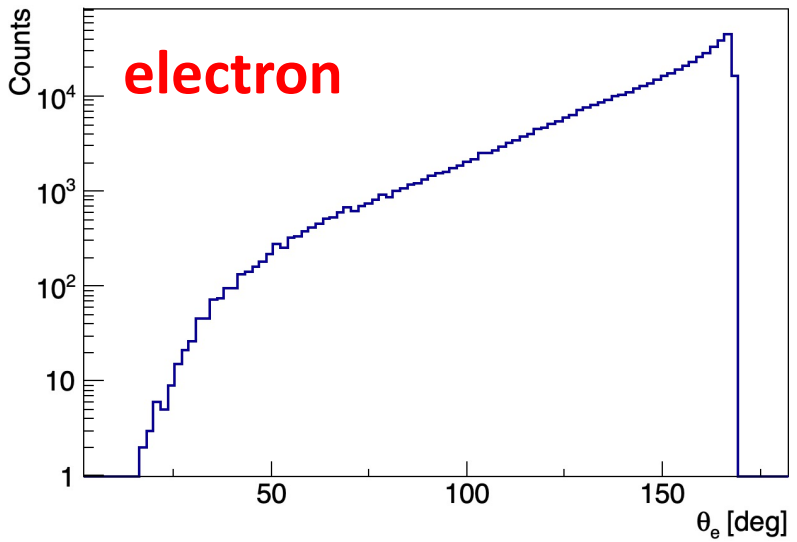
No twist 3
No proton dissociation

# Angular distributions of generated events

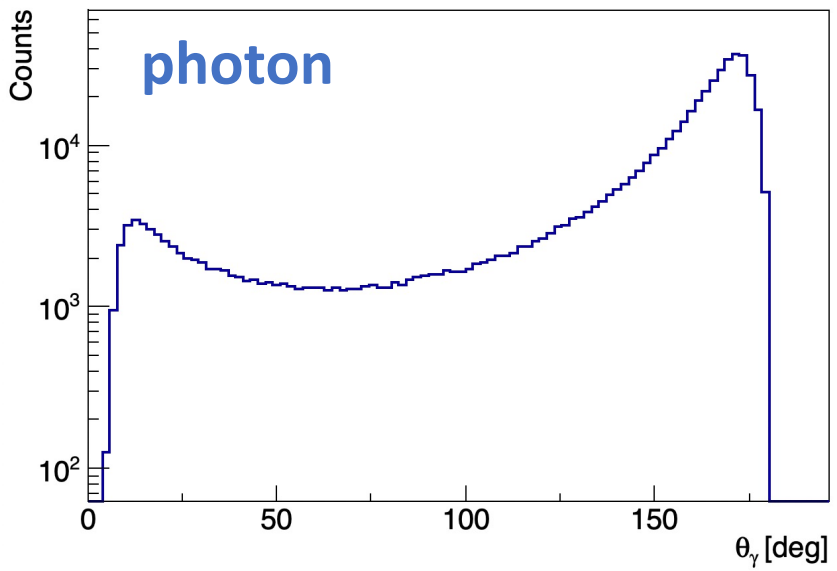
5x41 GeV



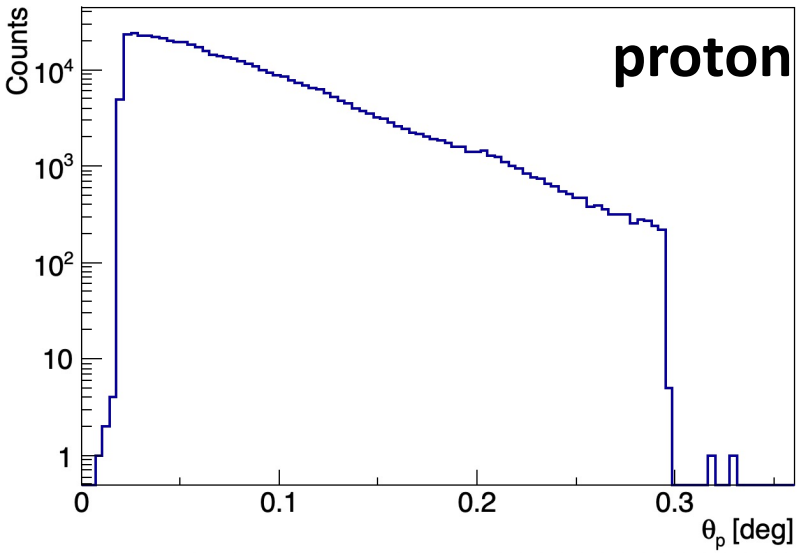

5x41 GeV




5x41 GeV




18x275

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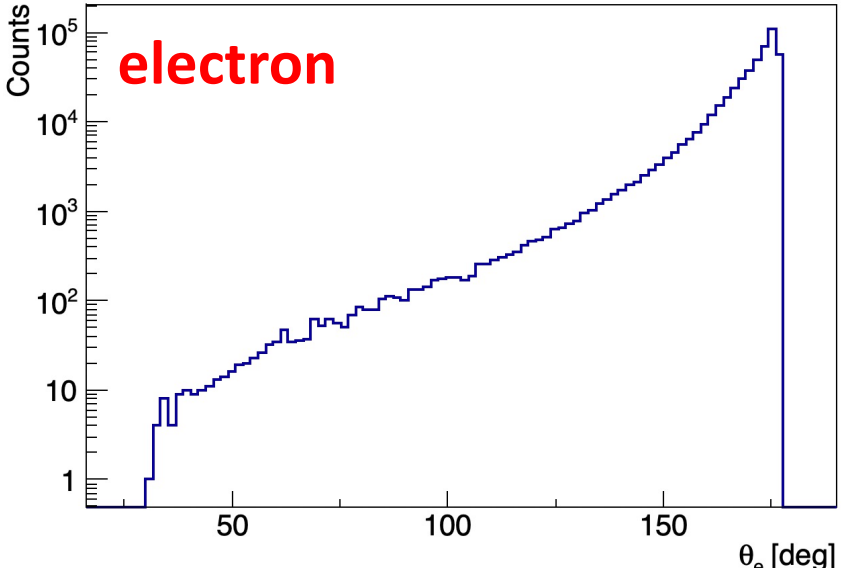


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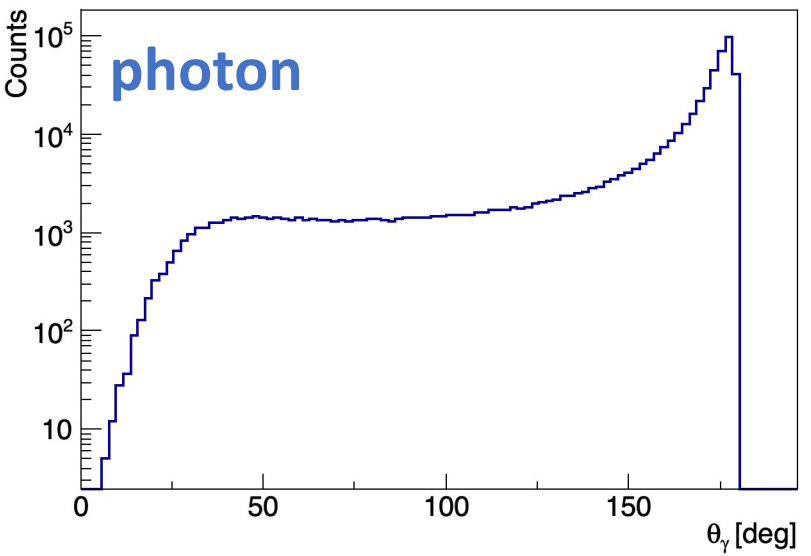
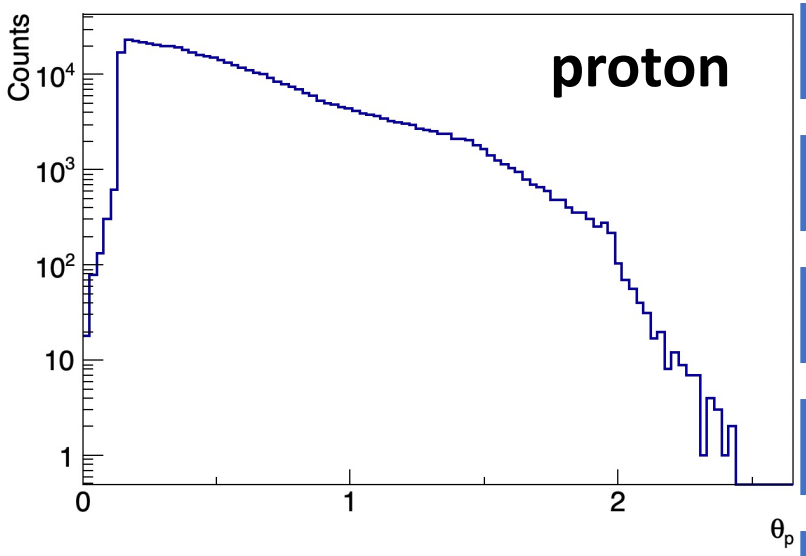


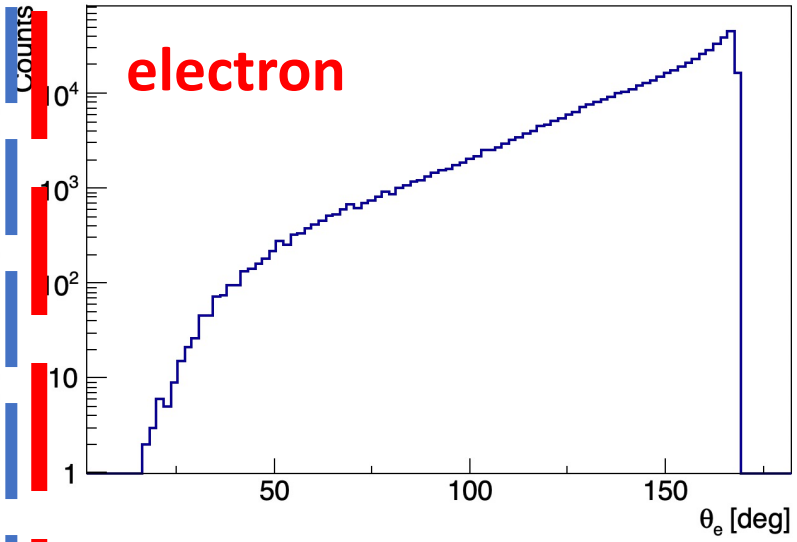
# Far Forward

# Main Barrel

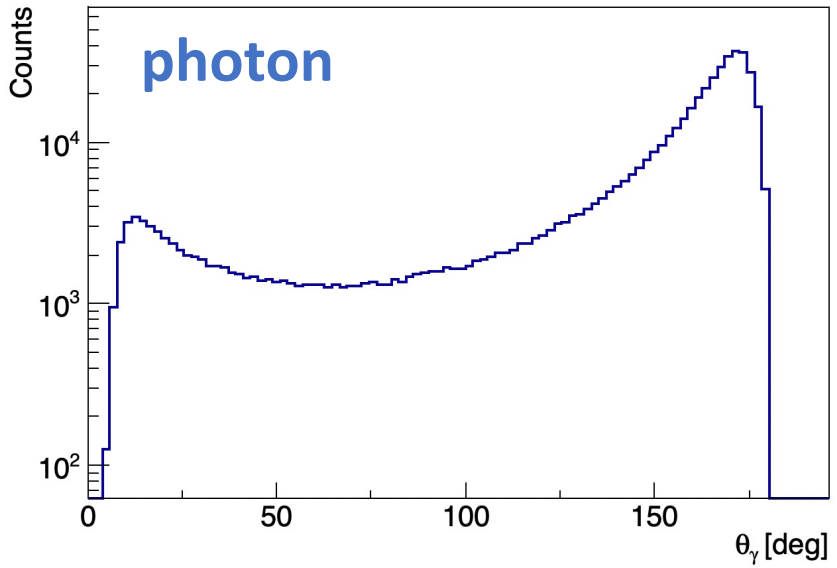
5x41 GeV




5x41 GeV




5x41 GeV

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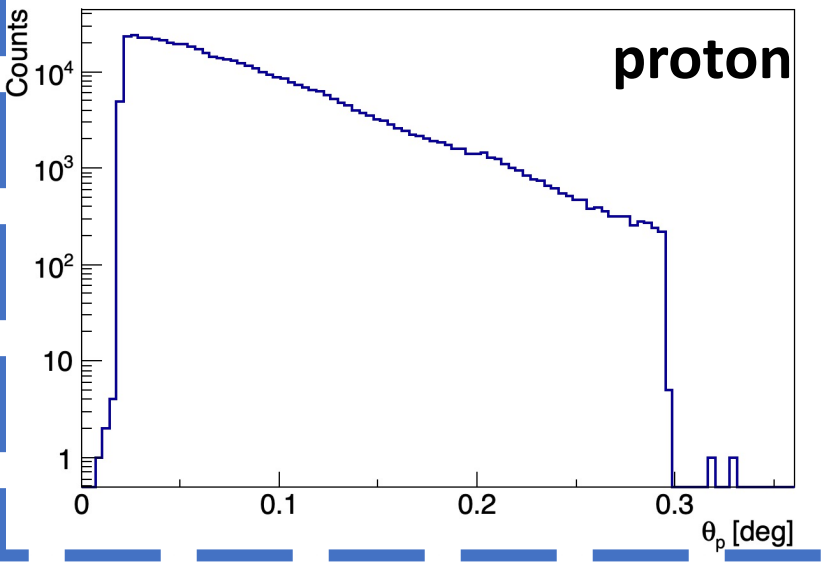


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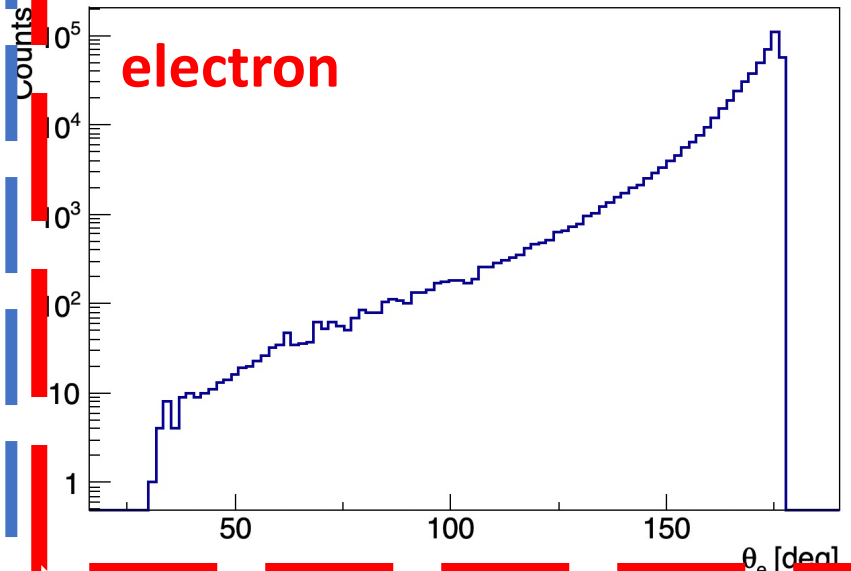


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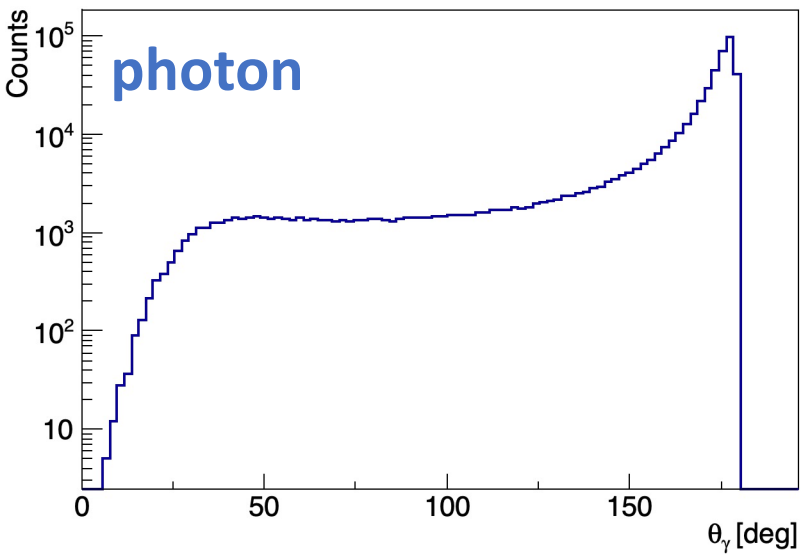


# Fun4all – Geant4 simulation framework

## Main barrel

Electron – realistic reconstruction
based on tracking detectors

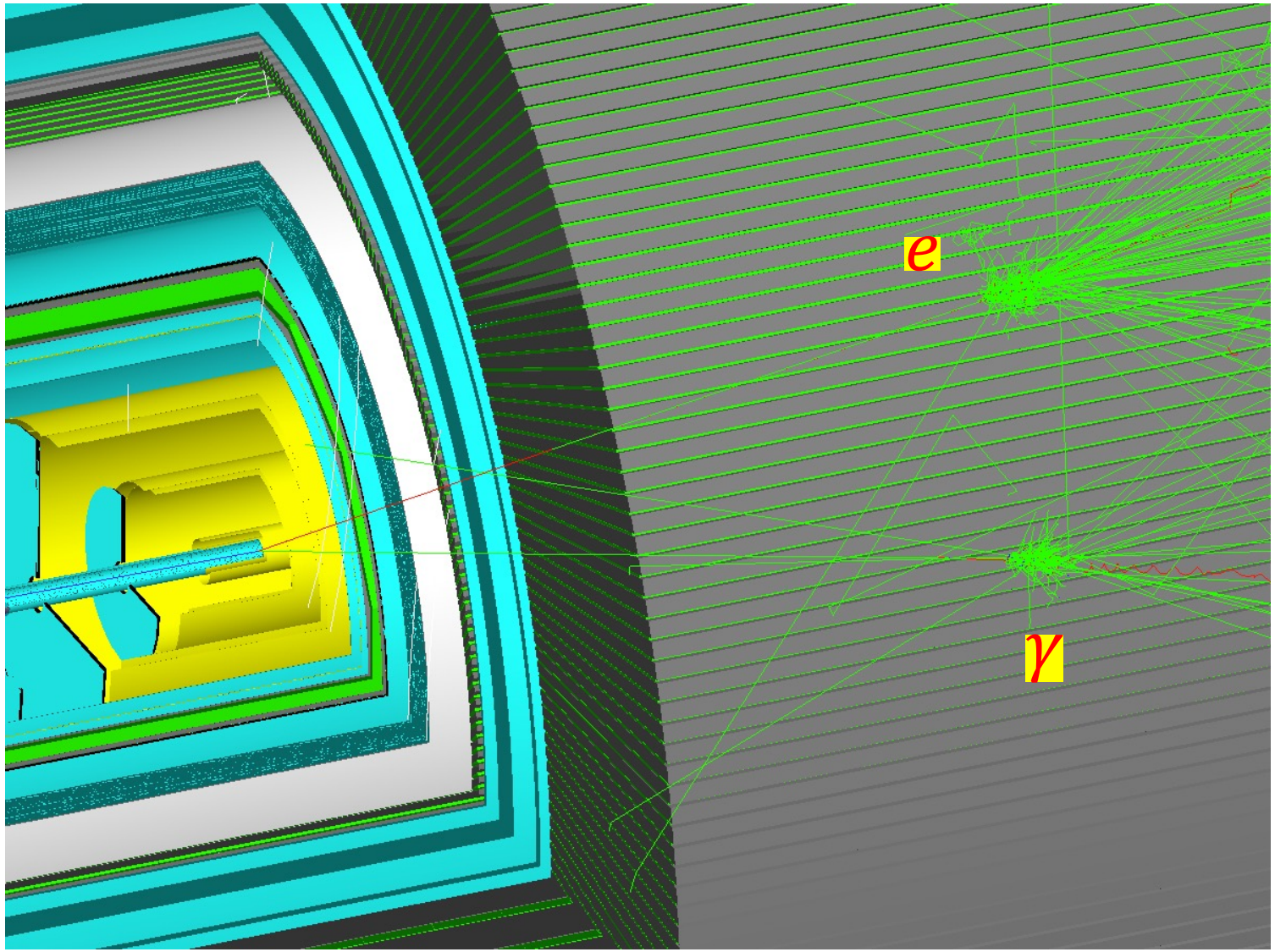
Photons – realistic reconstruction
based on calorimeters

## Far Forward

***Roman Pots***
***B0 spectrometer***

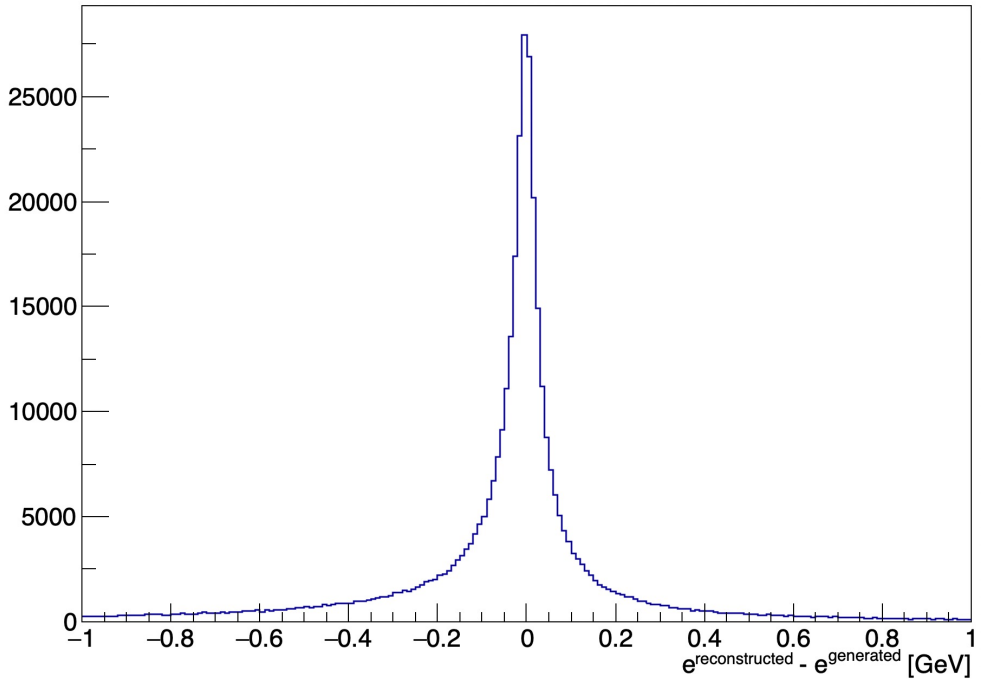
Protons – Geant4 true values
with momentum smearing of 1%

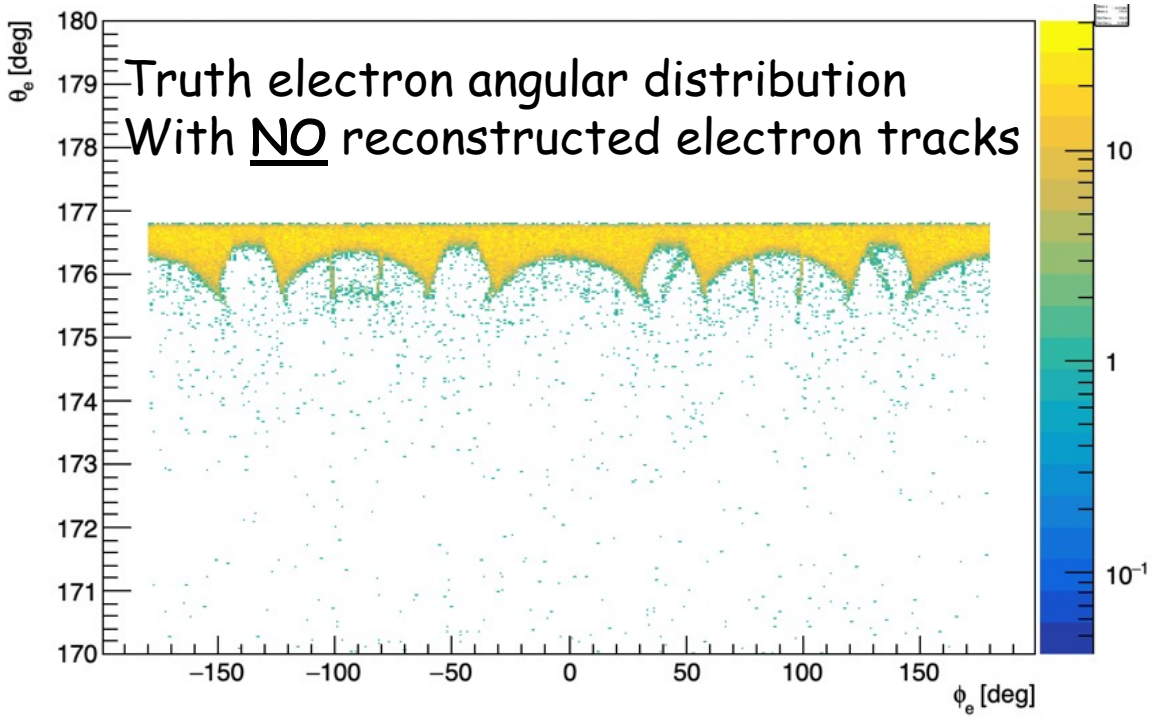
# Event example

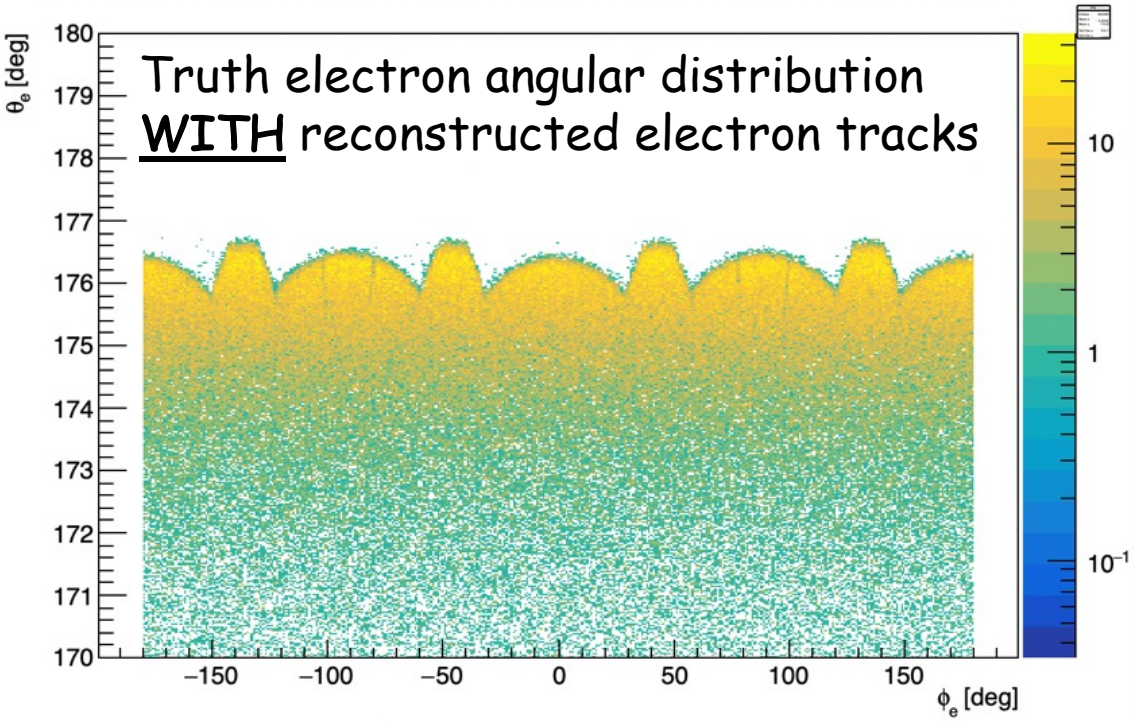


# Electron Reconstruction

In the study, tracking algorithm "ignoring" calorimeter information

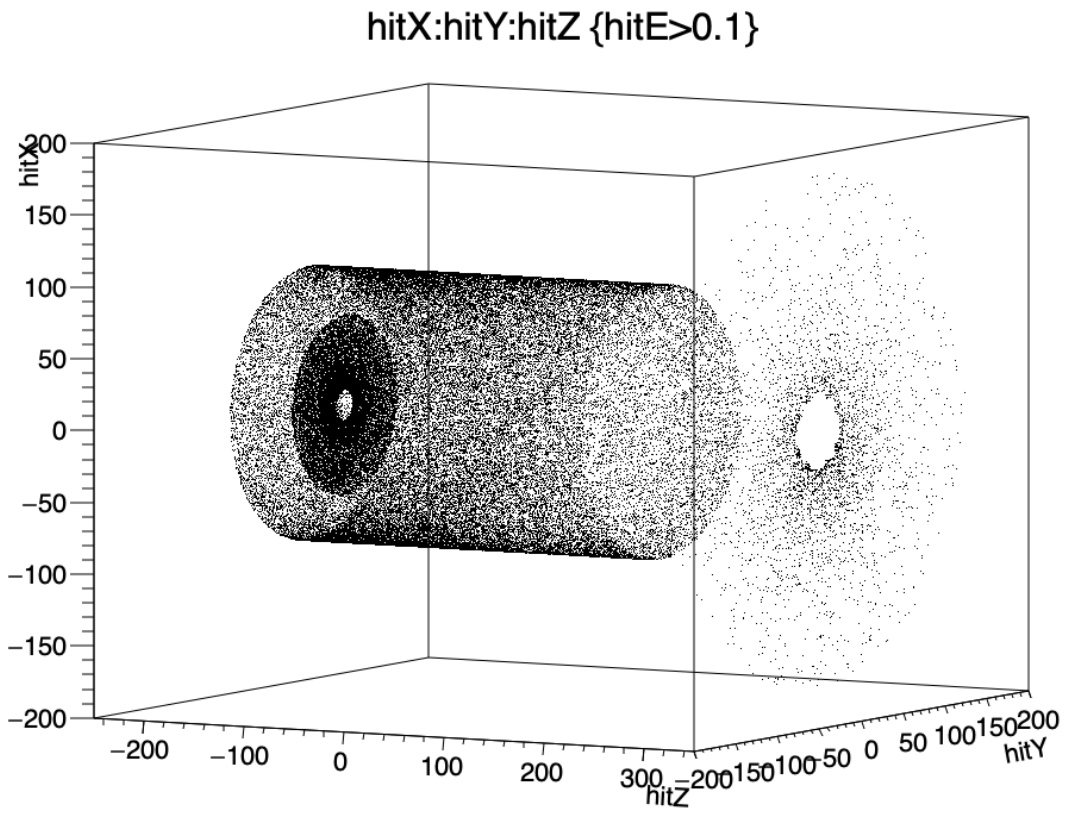


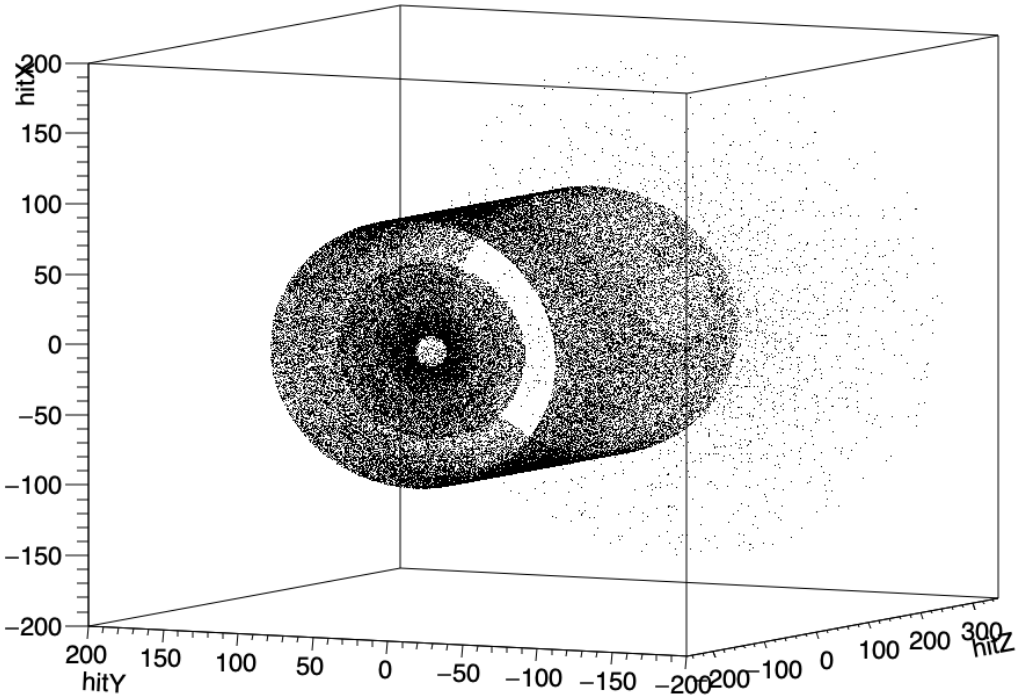



# Photon detection

Extraction of photon energy from hits in EM calorimeters.




Hits in 3 different calorimeters

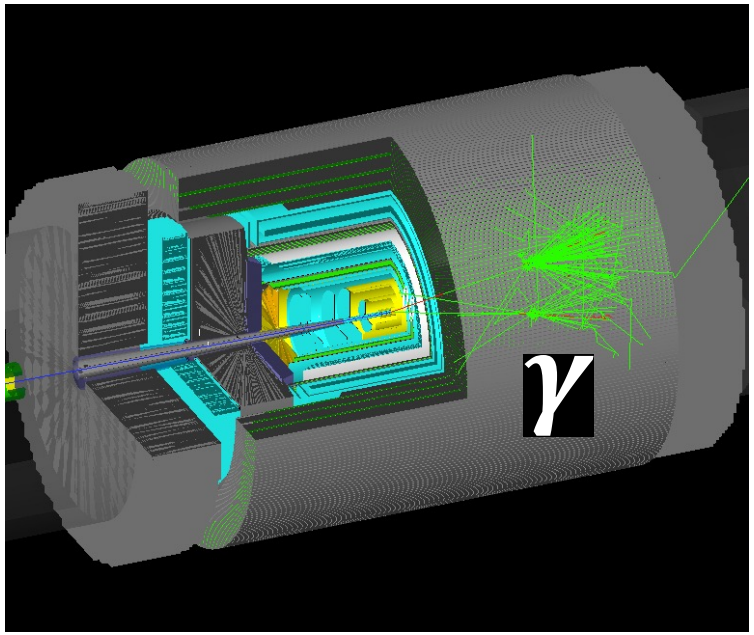
# Photon detection

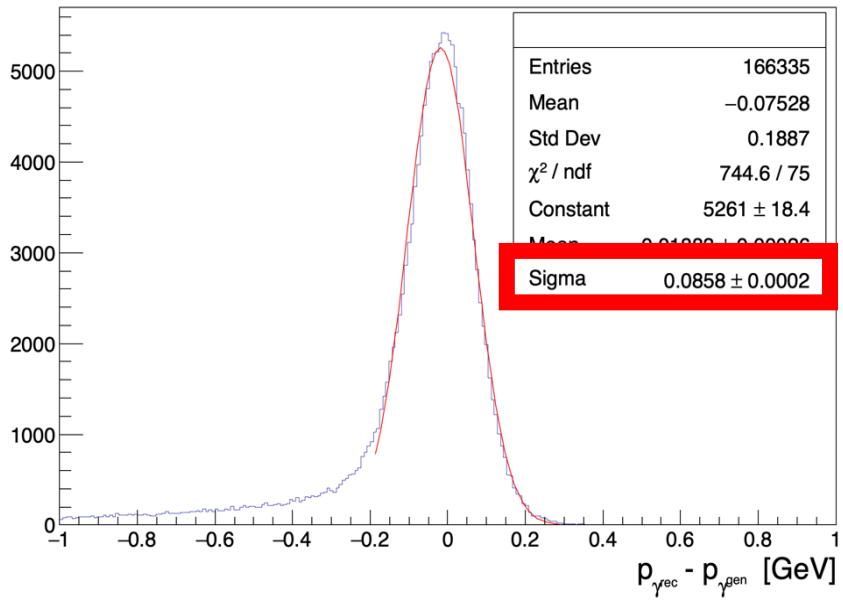
Extraction of photon energy from hits in EM calorimeters.

Vertex position is based on electron track.

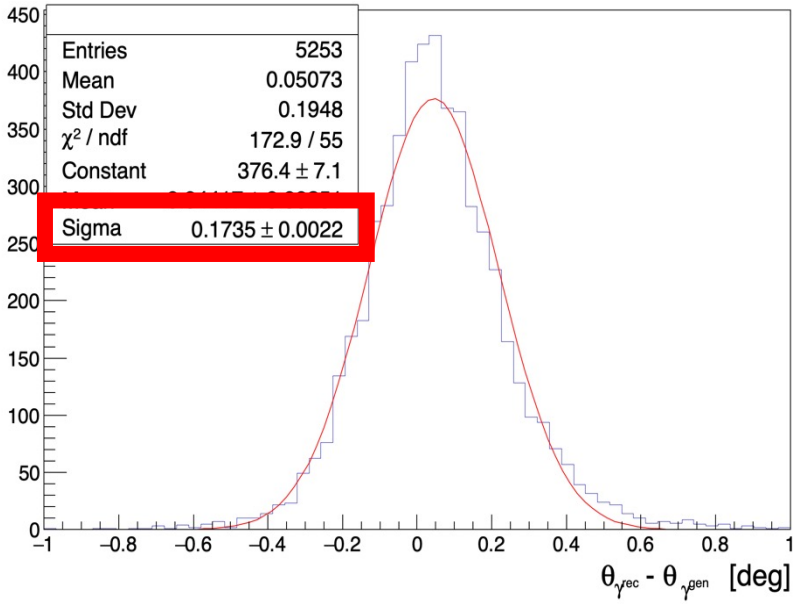
Angular resolution: < 0.5 deg

Energy resolution: ~ 0.1 GeV



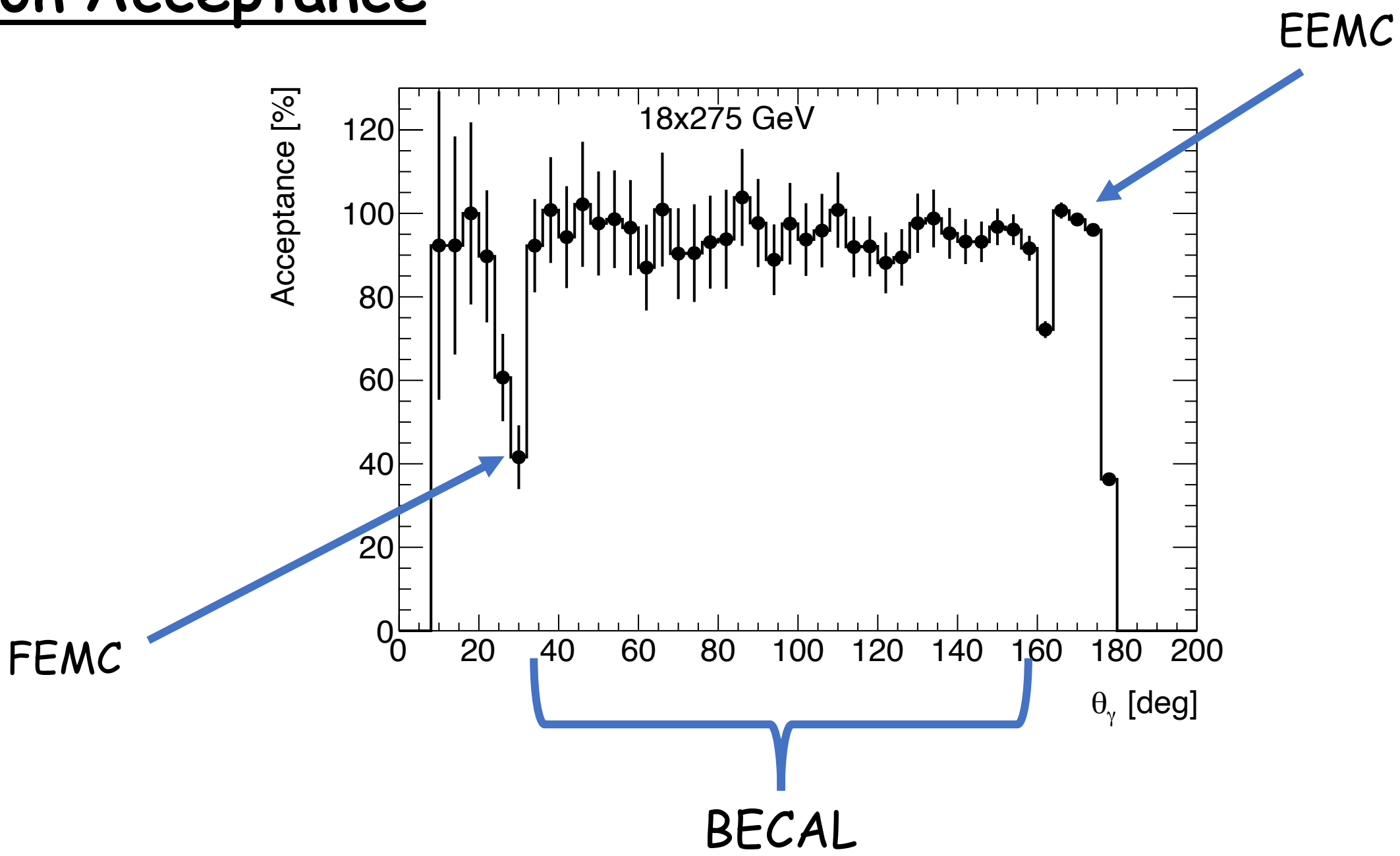




Momentum Resolution



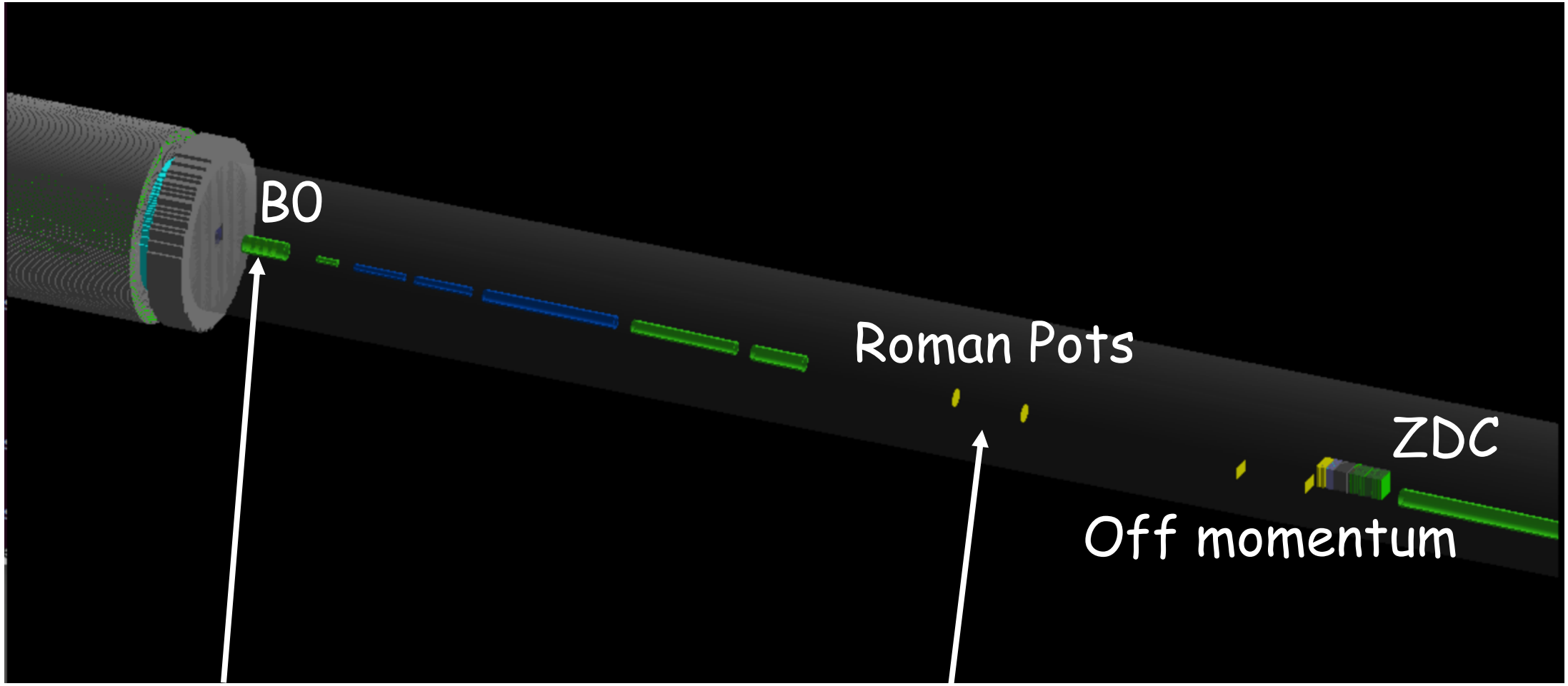

Angular resolution

# Photon Acceptance



All protons (for DVCS) escape through endcup opening

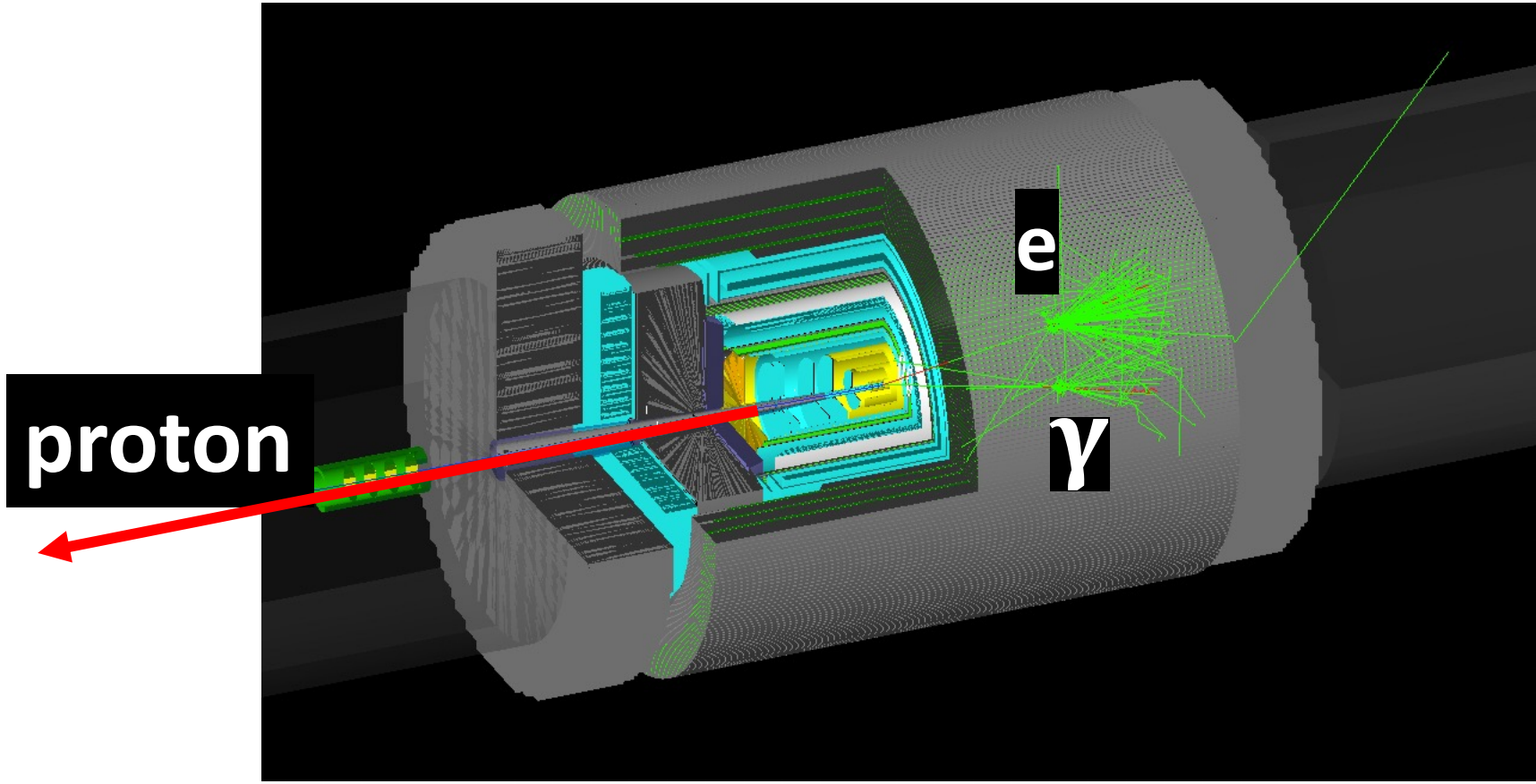
# Far-Forward simulation



# Proton reconstruction

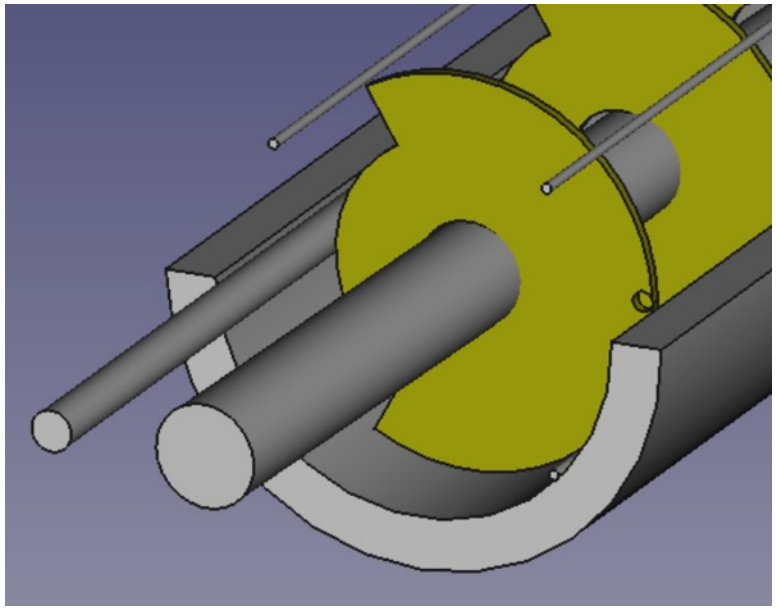
Acceptance determined by full Geant4 simulation

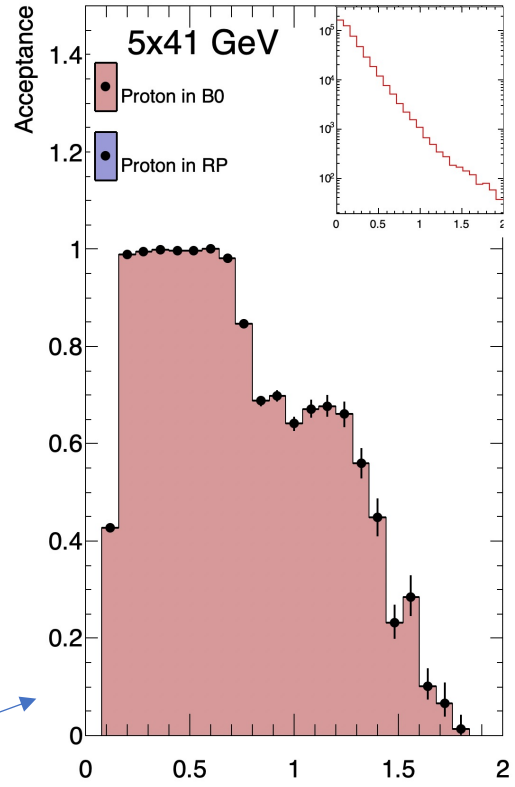
Proton Momentum smeared by 1%

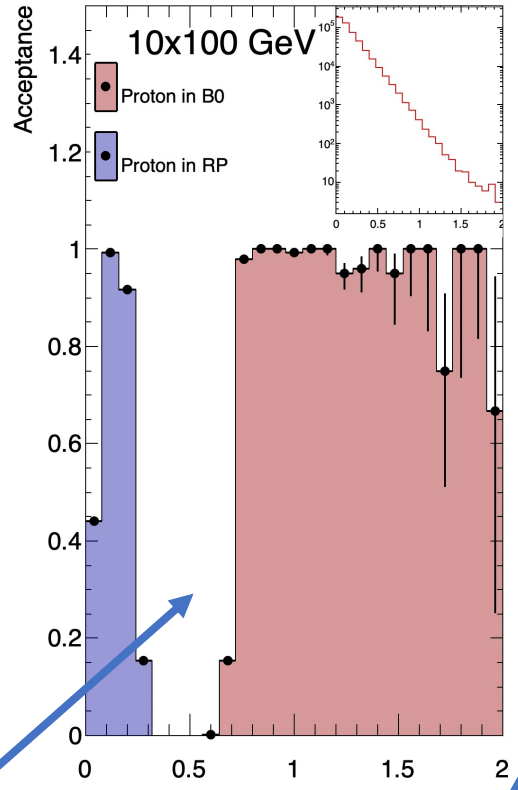


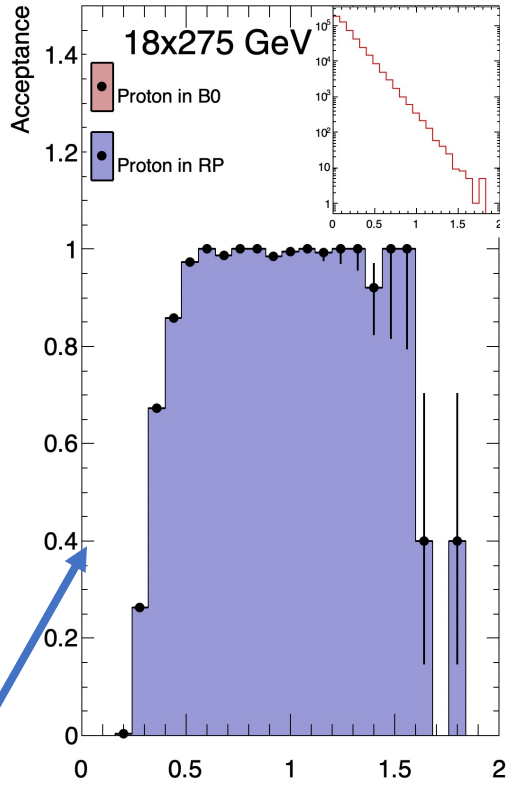
# Protons Acceptance

Detection of the protons in far forward region:





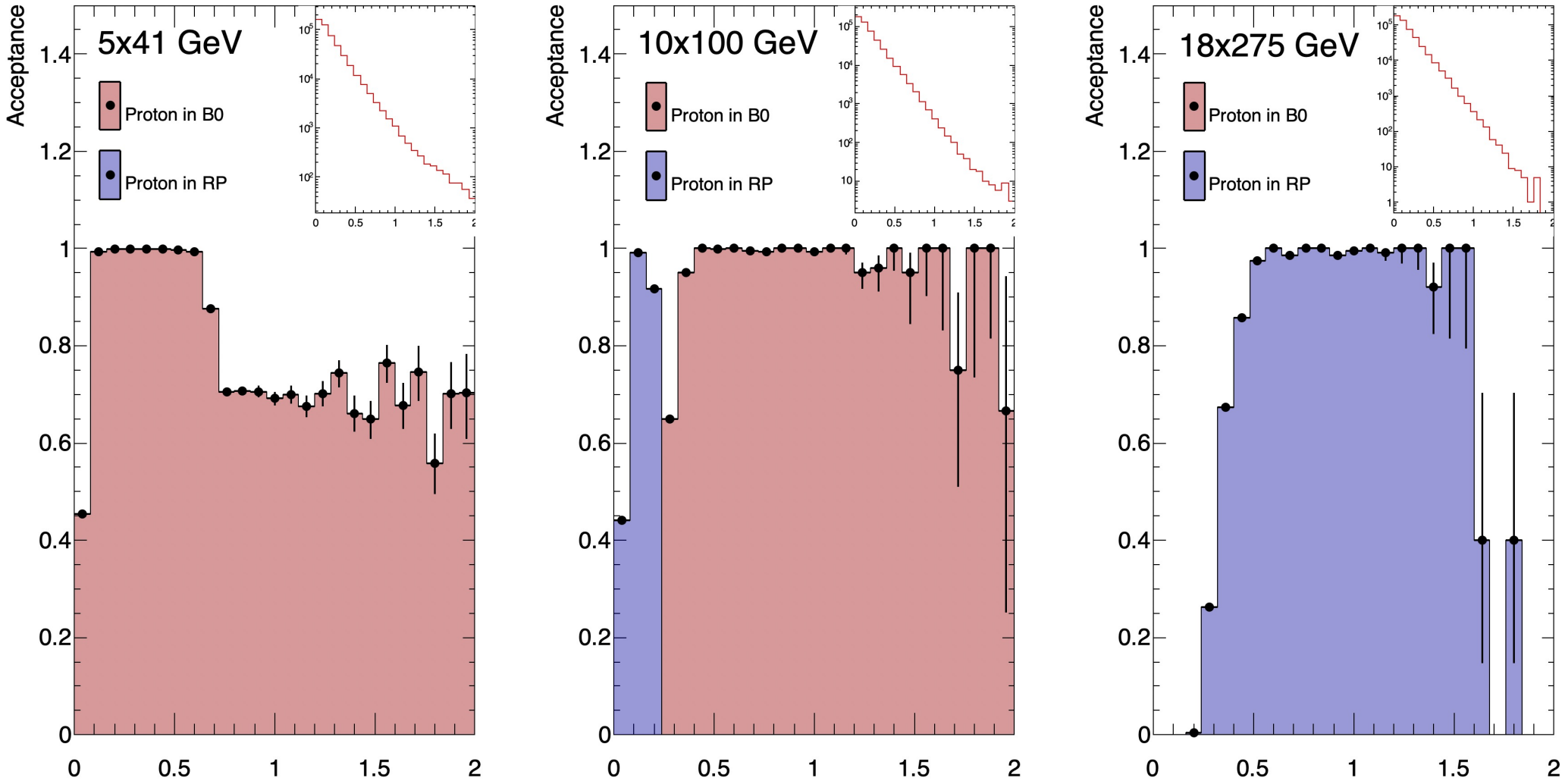

-t [GeV$^2$]

Use of only 1$^{st}$ tracking layer

Gap due to interface between B0 and RP

Gap due to beam pipe ~ 10 sigma

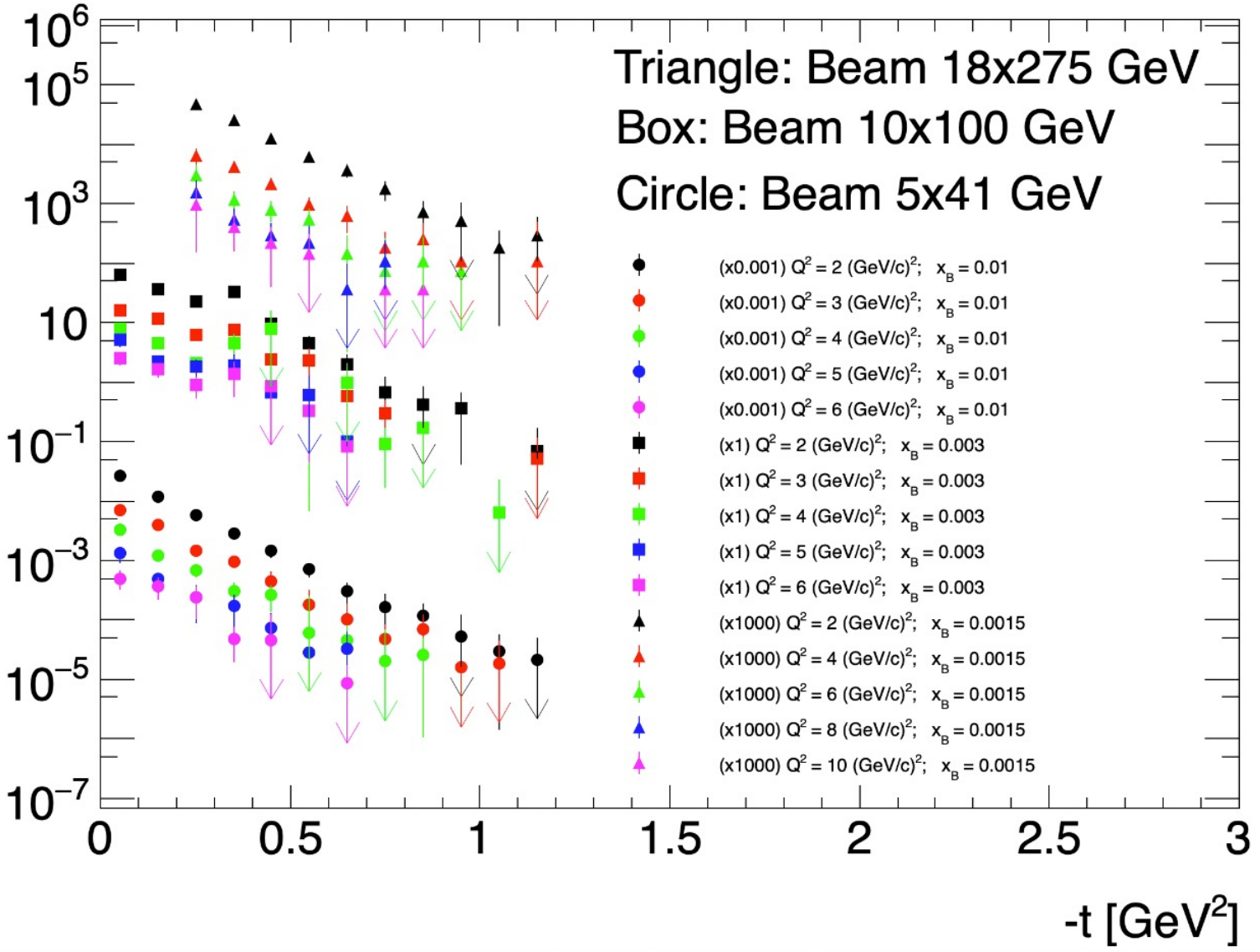
# Strong dependence on beam pipe size



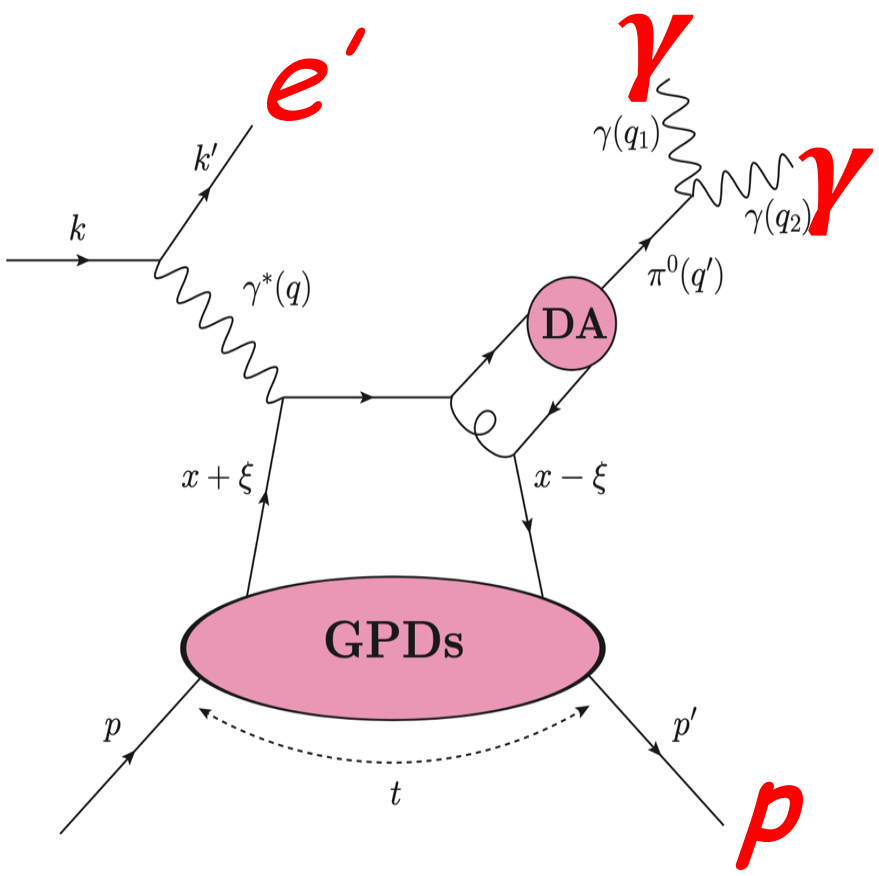

Use of all 4 tracking layers off B0

# Cross section

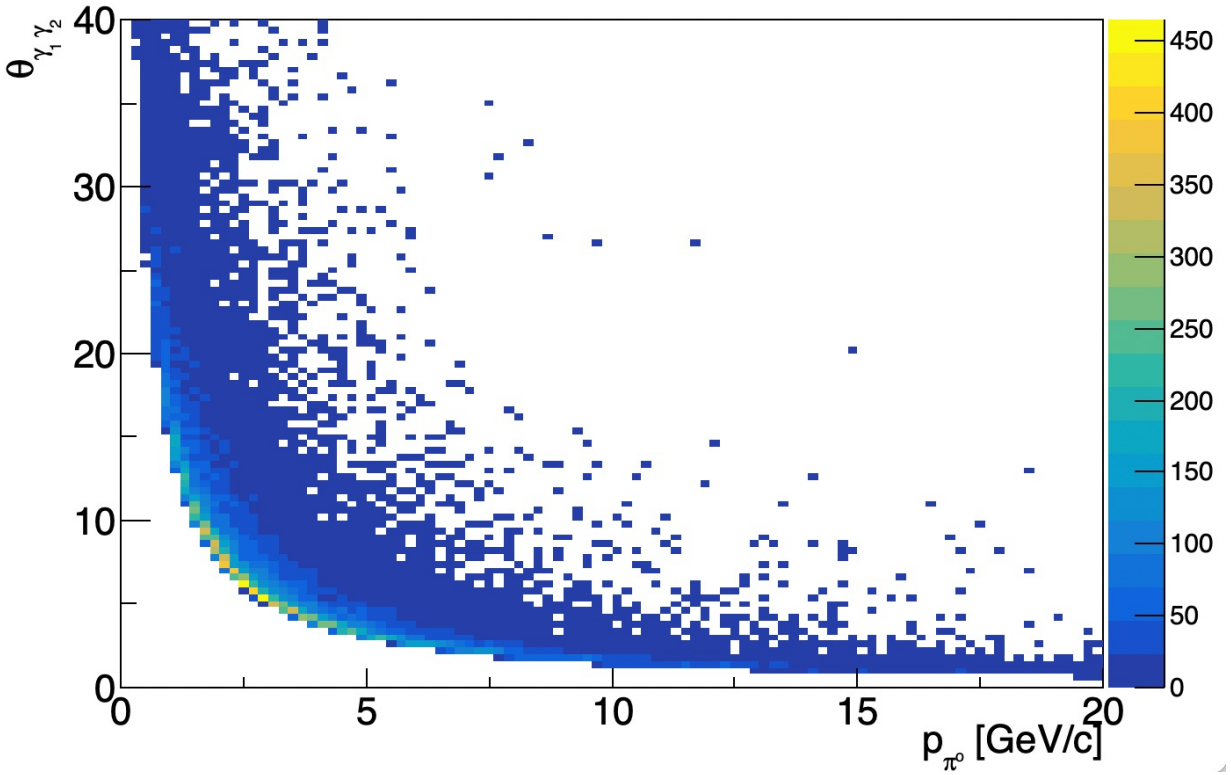
- Corrected to acceptance
- Bin Volume
- Integrated luminosity 10 $fb^{-1}$



# $\pi^o$ Background



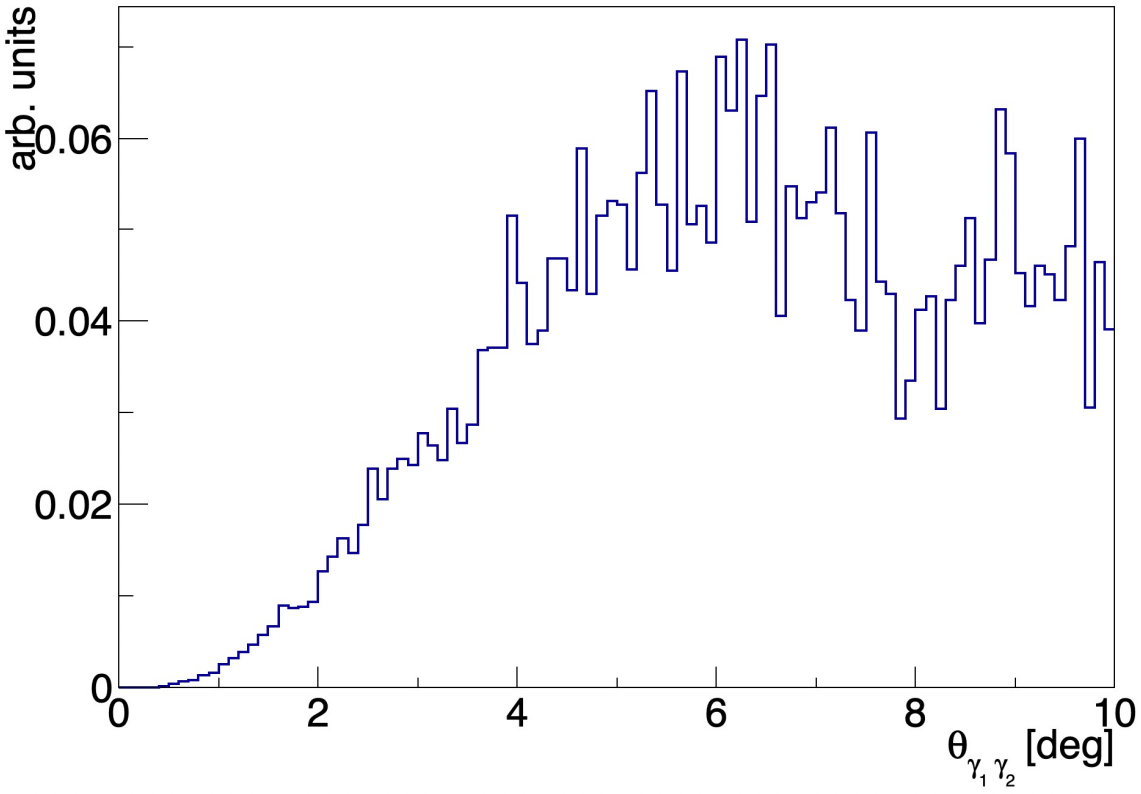

Example for 18x275 GeV beam



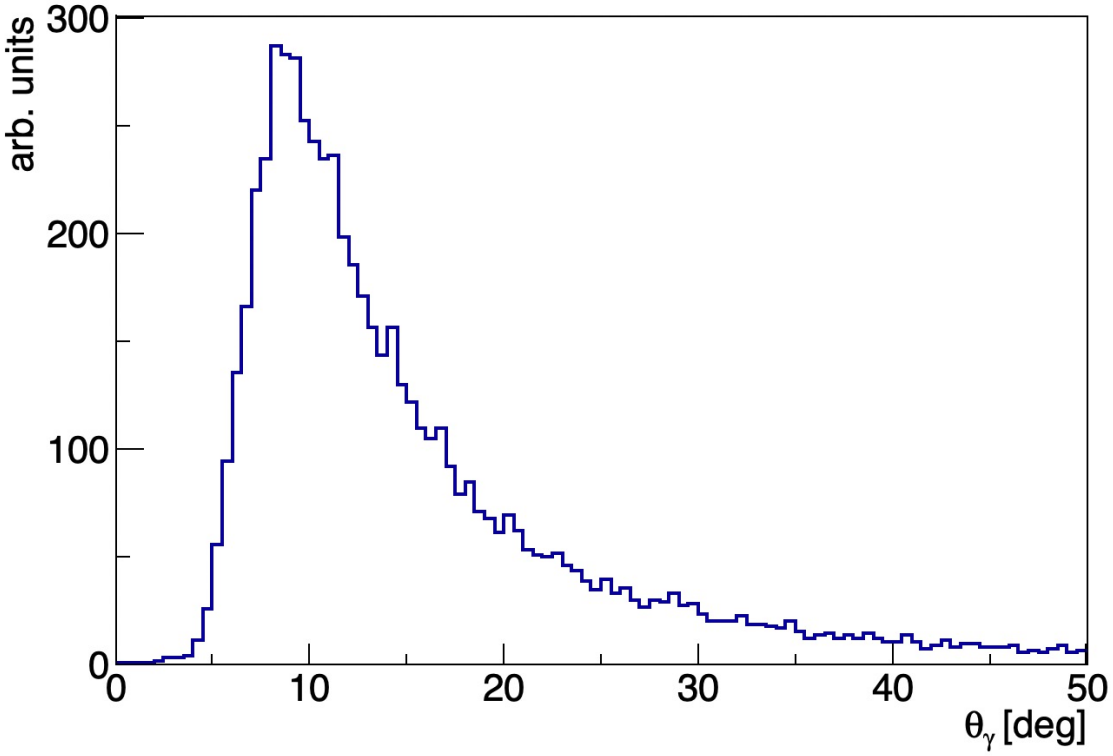
# Initial study of $\pi^o$ channel using EPiC generator

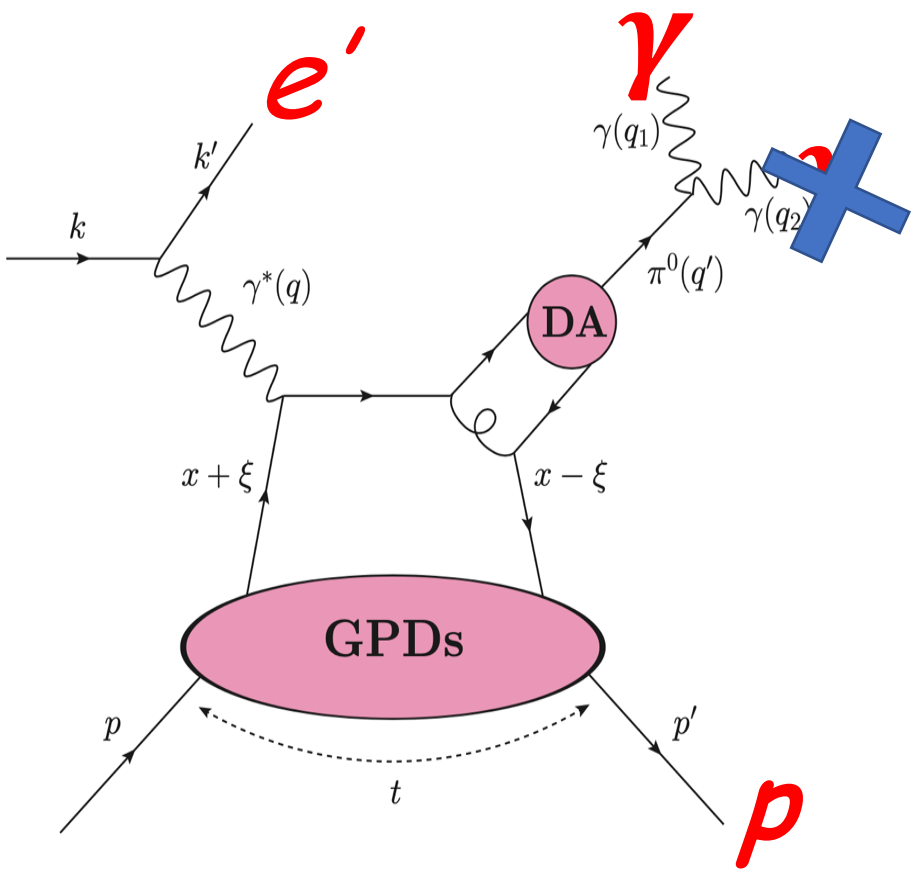
- Photon angular resolution good enough to separate two photons event
- Large acceptance
- High detection efficiency

Example for 18x275 GeV beam



# $\pi^o$ Background




Small fraction of photons that escape detection through endcup gap

# Summary

- Realistic implementation of the detector reproduce: Large acceptance and High efficiency for all three particles.
- Neutral meson background expected to be under control.
- Combination of high luminosity beam will reduce statistical uncertainties.
- EIC detector 1 will enable precision study of exclusive reaction at low $x_B$.

## Future:

- Implement new EPiC generator
- Improve electron and photon reconstruction
- Protons – realistic reconstruction
- Beam divergence study
- Quantify $\pi^0$background.