

# ECAL simulation studies

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# Introduction

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- Details of simulation
- Energy resolution
- Position reconstruction
- Simulation of optical photons

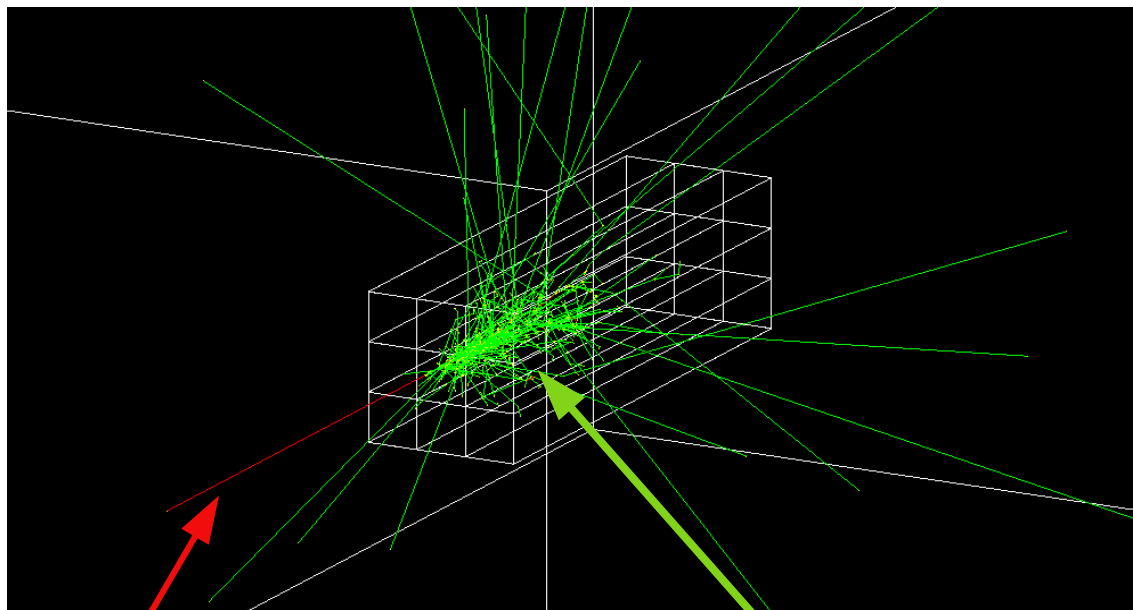
# Simulation details

- Material – PbWO<sub>4</sub>
- Dimensions – 2x2x20 cm
- Matrix size – 3x3 (5x5)
- Gap – 0.01 mm (galactic)

Possibility to change

- Incident particle energy
- Incident particle type
- Polar angle
- Position on the matrix

Example of simulation

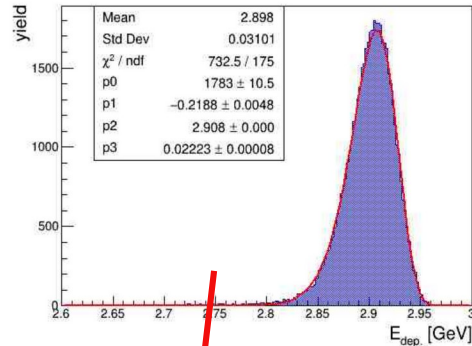


Incident electron

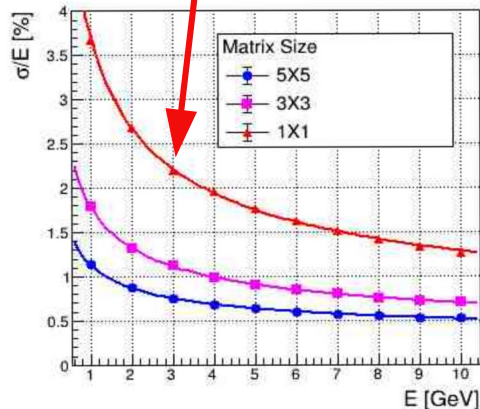
photons

# Energy Resolution

Deposited energy distribution

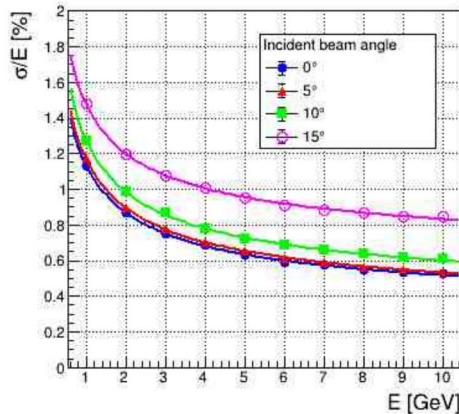


Resolution for different matrices



- 50000 event were generated at (0, 0) position for a given energy
- Total energy deposition in the matrix was fit with Novosibirsk function
- The resolution was fit with  $\frac{\sigma}{E} = \frac{a}{\sqrt{E}} + b$

Resolution as function of polar angle(5x5 matrix)



Angle of electrons	Parameter a [%]	Parameter b [%]
0°	0.901±0.005	0.231±0.002
5°	0.932±0.006	0.236±0.003
10°	0.941±0.006	0.286±0.004
15°	0.988±0.006	0.534±0.004

# Position Reconstruction

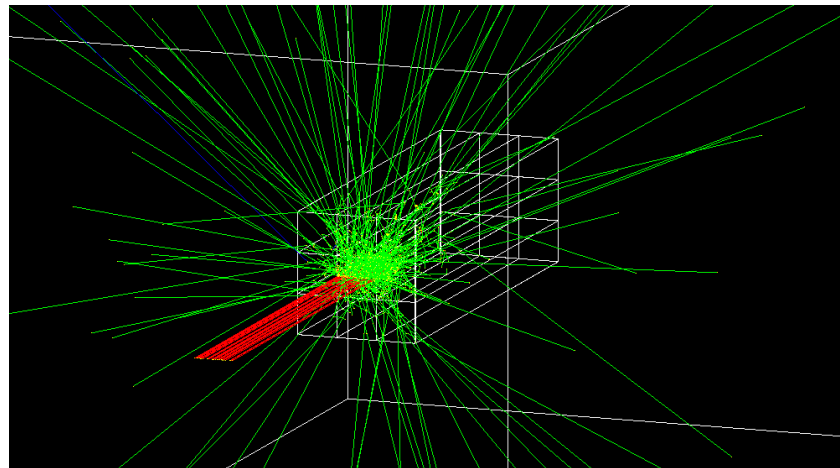
position reconstruction (for 3x3 matrix)

- Fixed  $y=0$  coordinate of incident electron
- Uniformly distributed  $x$  coordinate over the width of central crystal

$$X_{rec} = \frac{\sum_{i=1}^9 w_i x_i}{\sum_{i=1}^9 w_i}$$

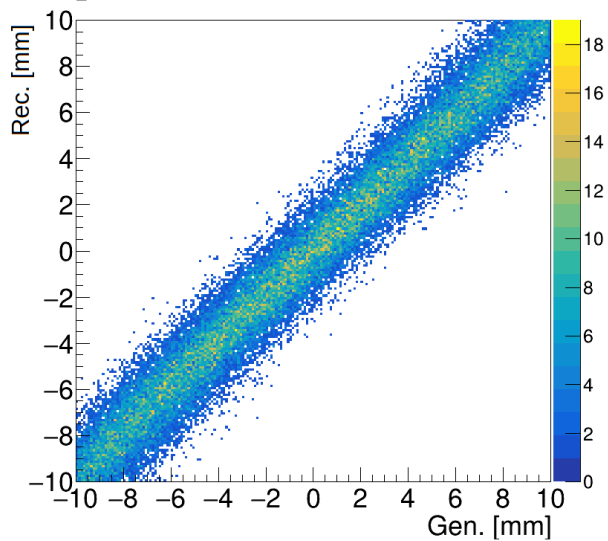
$w_i$  - weight as function of dedeposited energy

$x_i$  - the centroid position of corresponding crystal



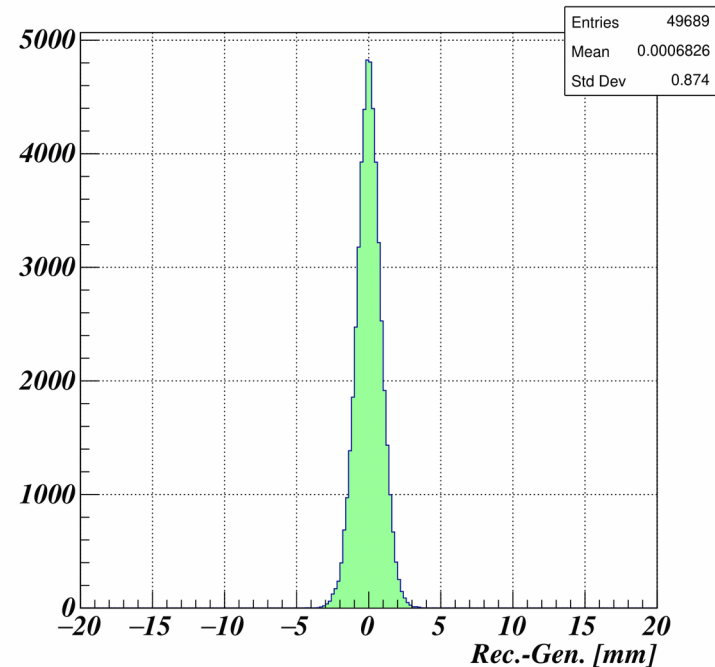
# Position Reconstruction

Correlation between reconstructed and generated  
x position of the incident electrons



For the  $w_i = \max\{0, W_0 + \ln \frac{E_i}{\sum E_i}\}$ .

The difference between reconstructed  
and generated positions(10Gev)



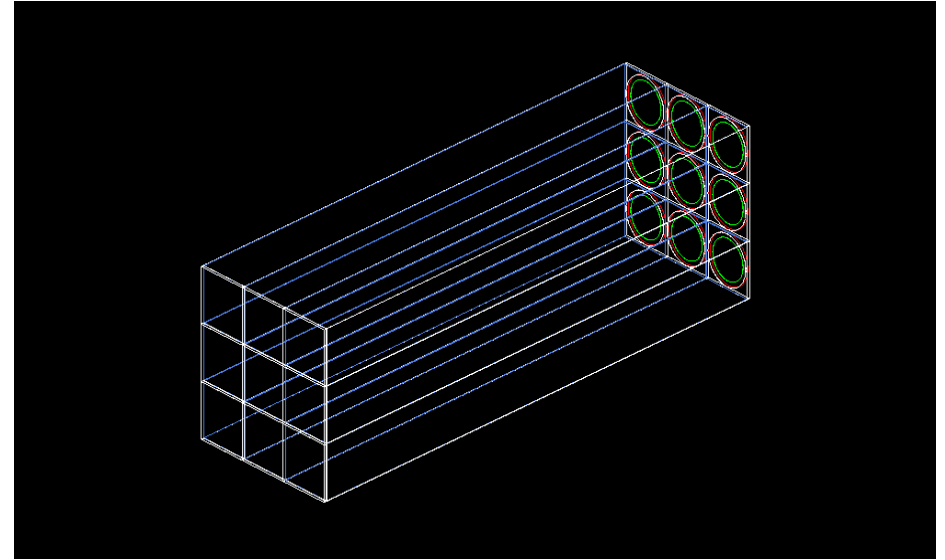
# Simulation of optical photons

## Added Volumes

- Cathode\_diam = 1.5cm      Material = Bialcali
- Cathode\_thick = 0.1mm
- PMT\_diameter = 1.86cm      Material = Glass
- PMTWin\_thick = 1mm
- tedlar\_thick = 0.040mm      Material = Polymer
- mylar\_thick = 0.025mm
- glue\_thick = 0.035mm      Material = Silgard
- air\_gap = 0.035mm

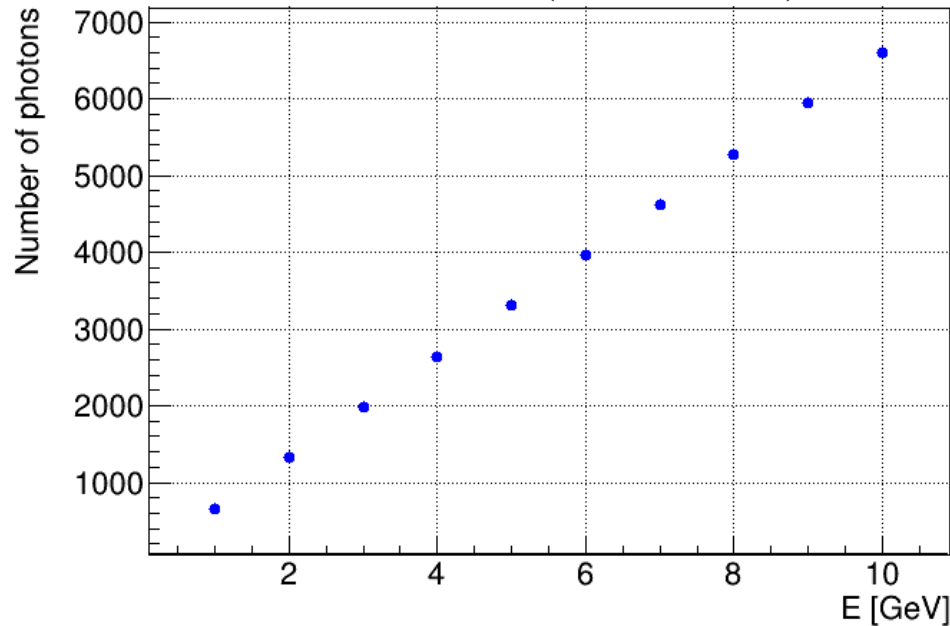
## Reflector Settings that the program allows to declare

- Type – specular,diffuse
- Finish – groundfrontpainted,polished
- the reflection coefficient for each wavelength of the falling photon



# Simulation of optical photons

Dependence of number of optical photons in PMT for incident electron energies of 1-10 GeV(1000 events)



Number of photons as a percentage for each crystal

1.2%	3.3%	1.2%
3.4%	81.6%	3.3%
1.2%	3.4%	1.2%

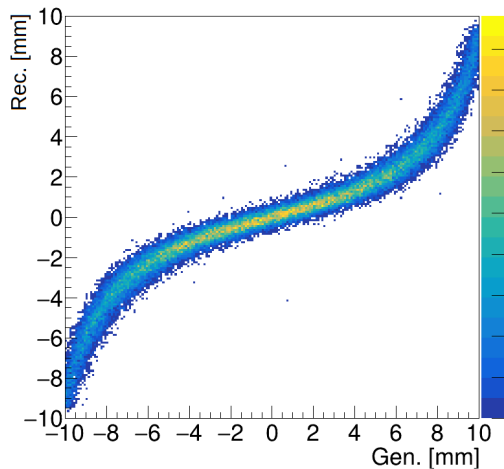


# Backup

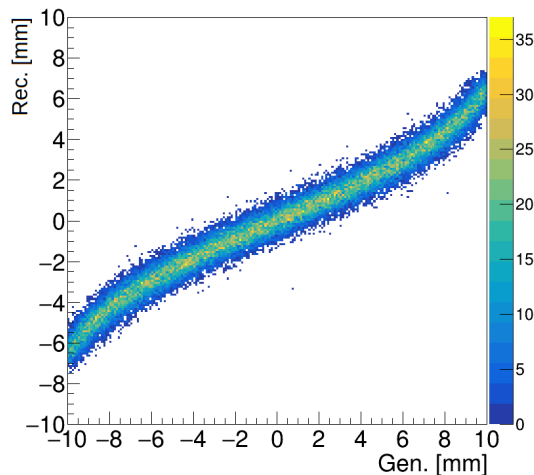
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# Position Reconstruction

Correlation between reconstructed and generated x positions of the incident electrons

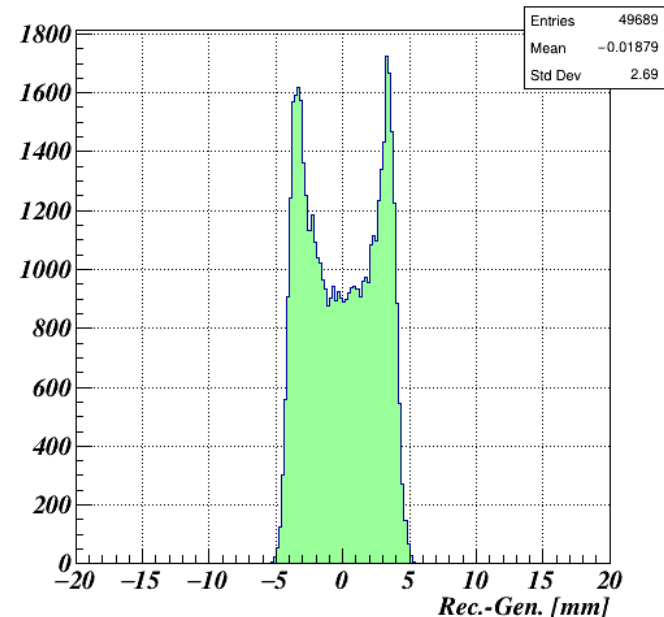


*For the case  $\omega_i = E_i$*



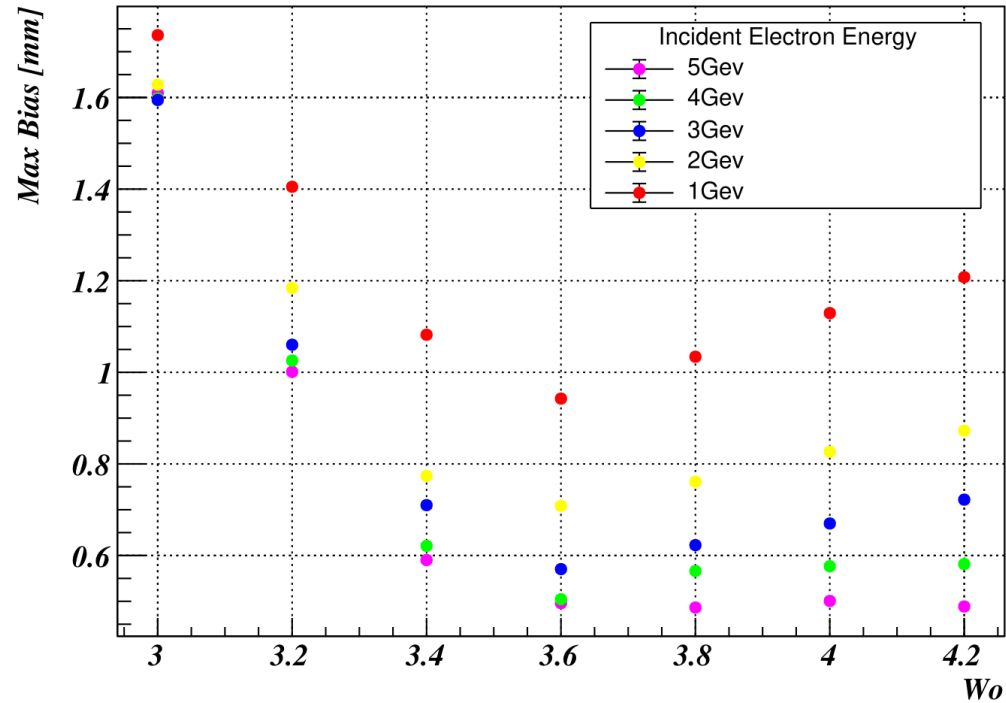
*For the case  $\omega_i = \sqrt{E_i}$*

The difference between reconstructed and generated positions



# Position Reconstruction

Dependence of maximum bias on cutoff parameter  $W_0$  for incident electron energies of 1-5 GeV.



# Position Reconstruction

Std Dev of the difference between reconstructed and generated positions

