HEIC-Cube e^- π^- discrimination

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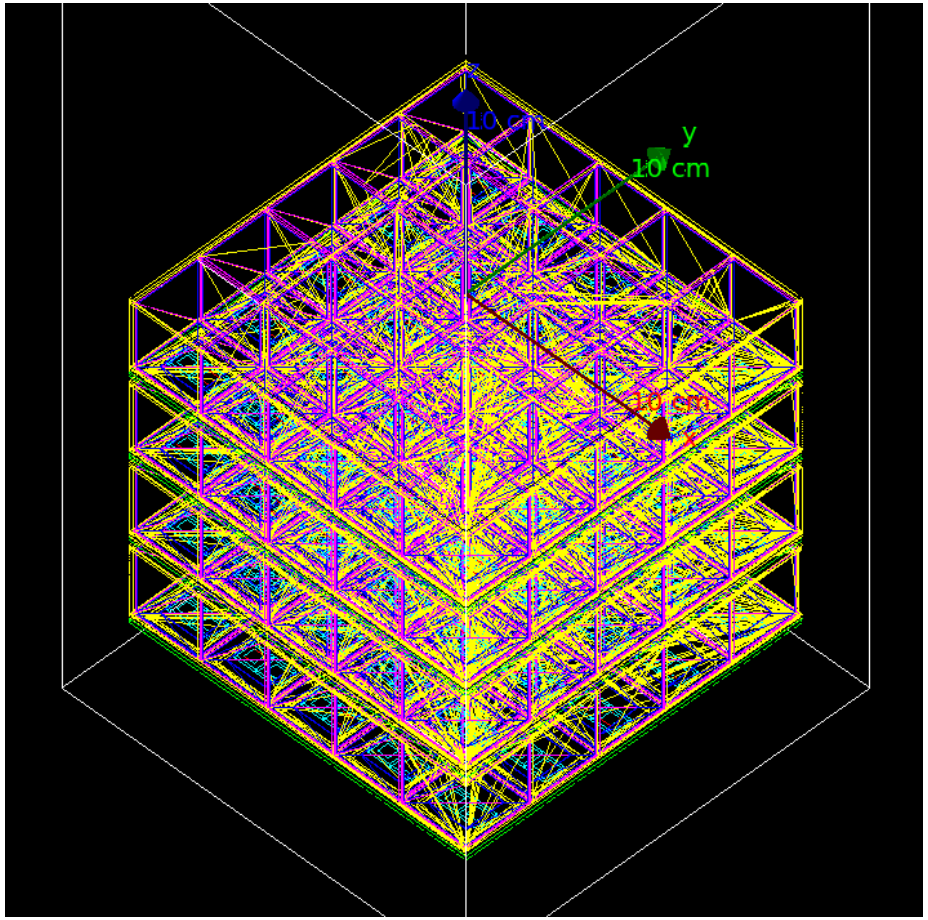
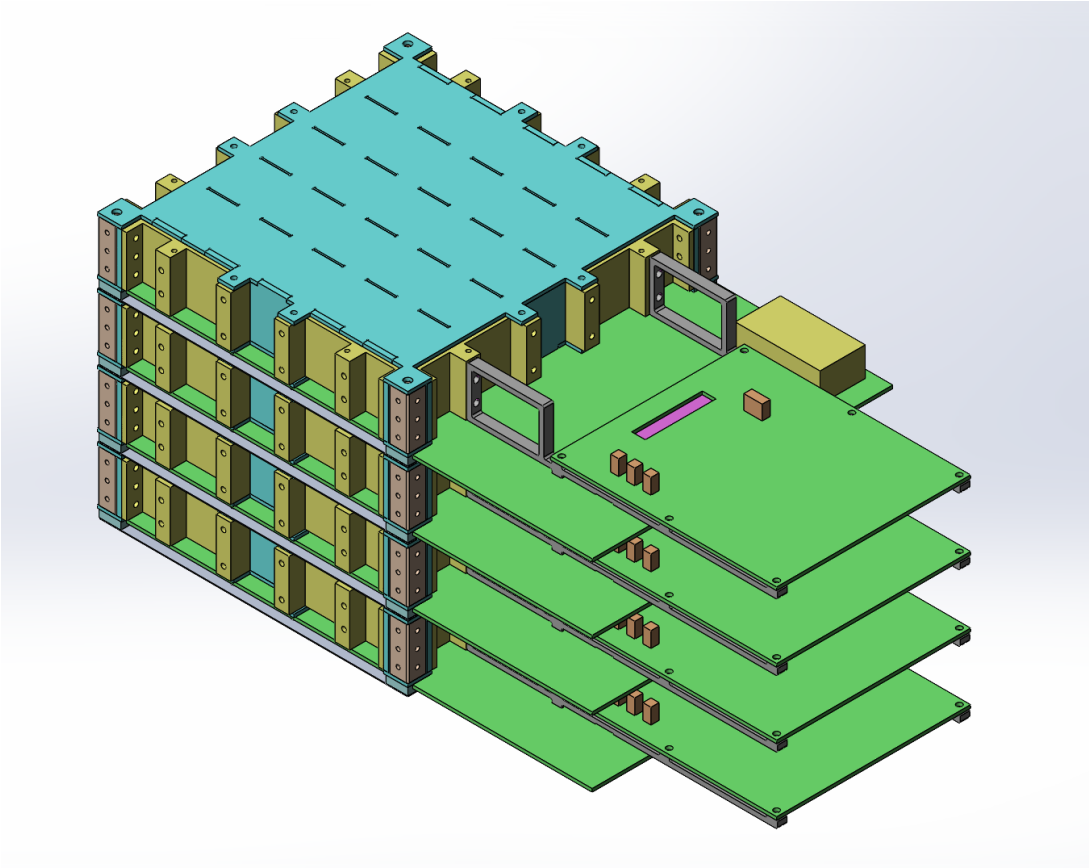
Outline

- 4 层小晶体量能器：
  - 5 GeV/c 的 electron 和 pion Geant4 模拟数据；
  - 5GeV/c 的 electron 束流测试数据；
- 小晶体量能器扩展到 10 层：
  - 5 GeV/c 的 electron 和 pion Geant4 模拟数据；

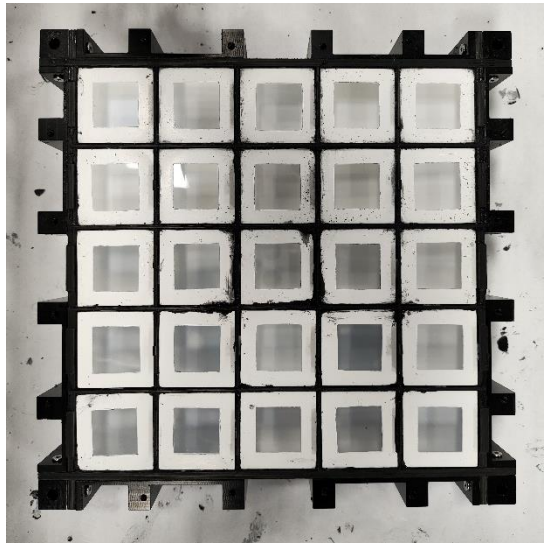
Detector structure



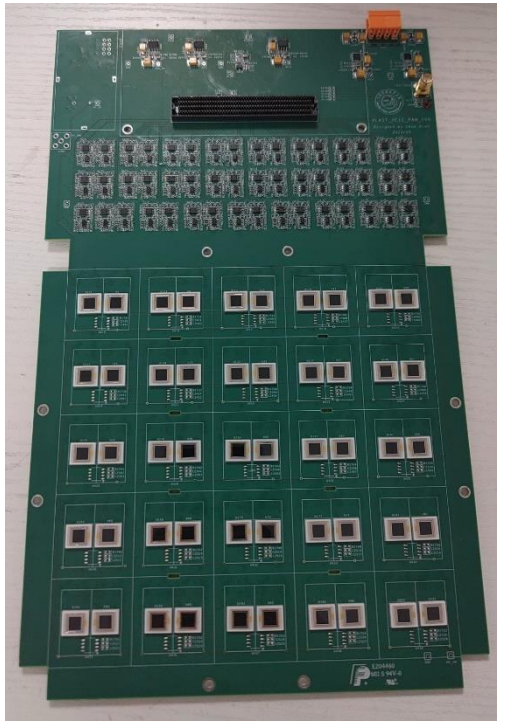


Detector structure

Detectors part

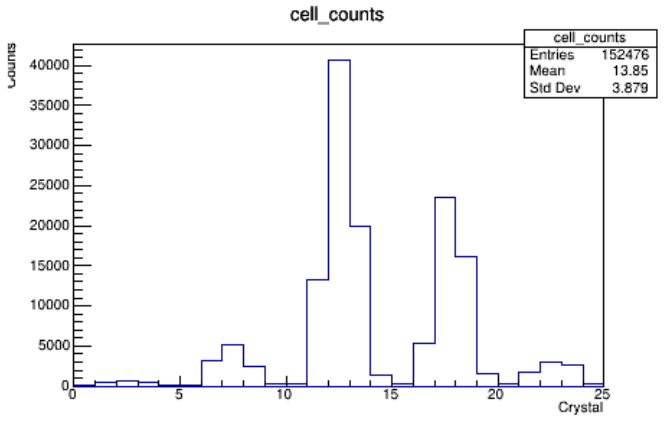


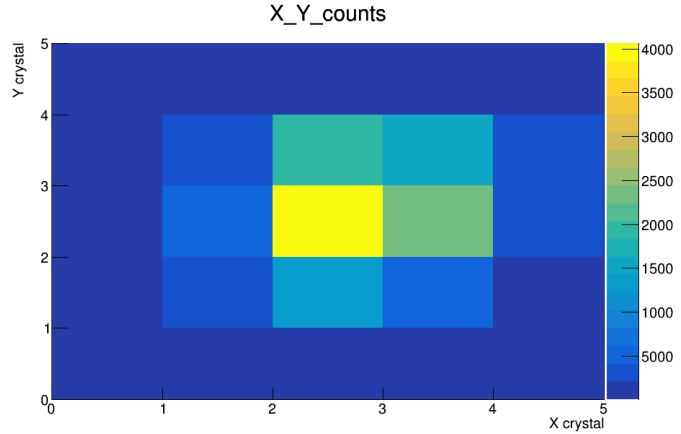
Electronics part

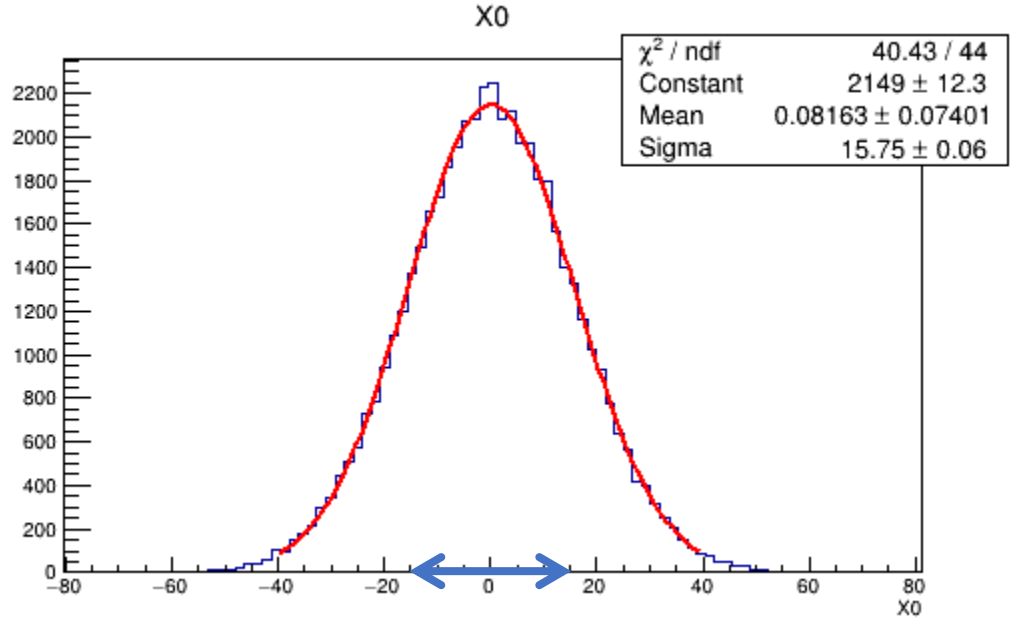


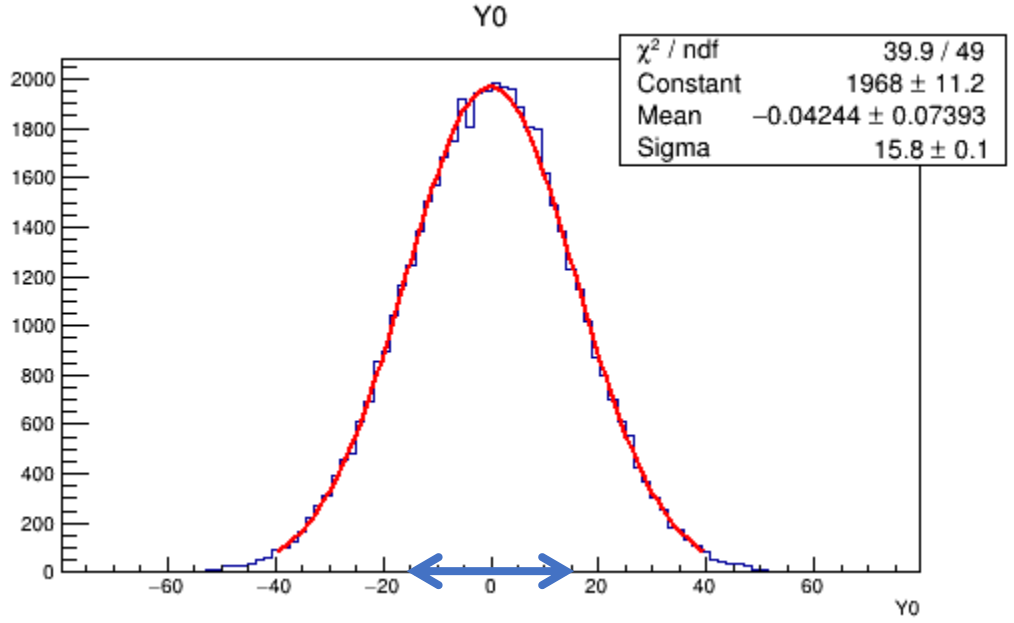
Particle source

Beam test result



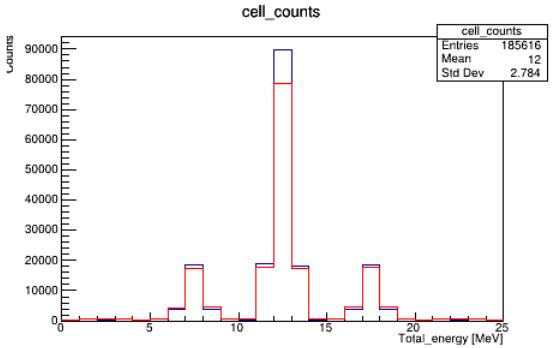




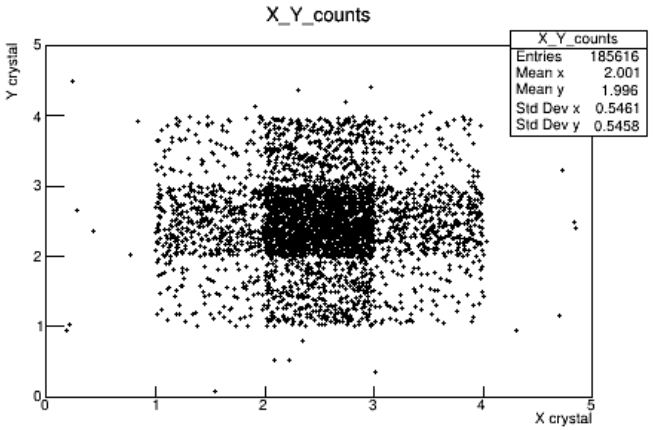


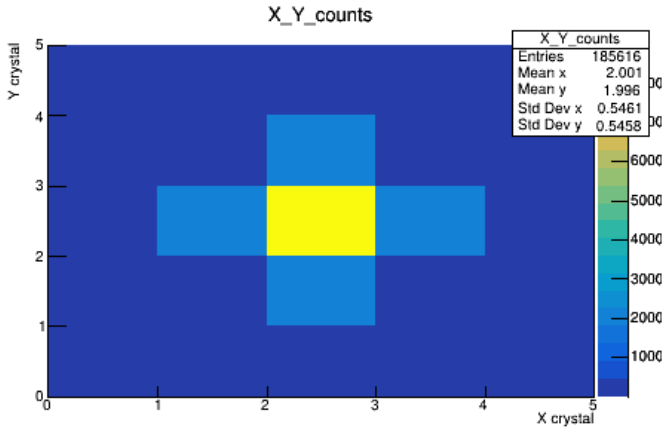
xOy 平面源，在 x 和 y 方向上都符合高斯分布

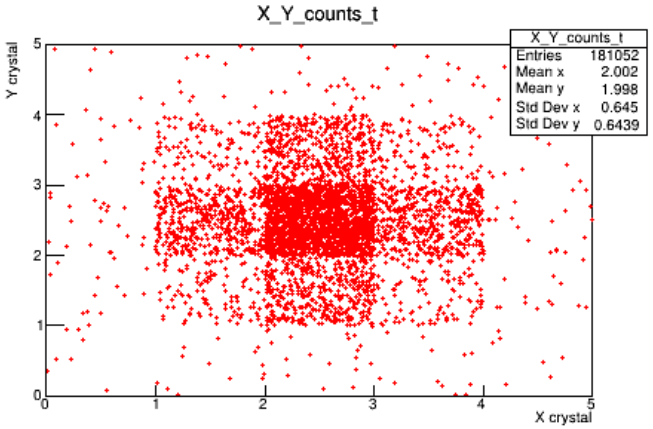
Electron (black); Pion (red)

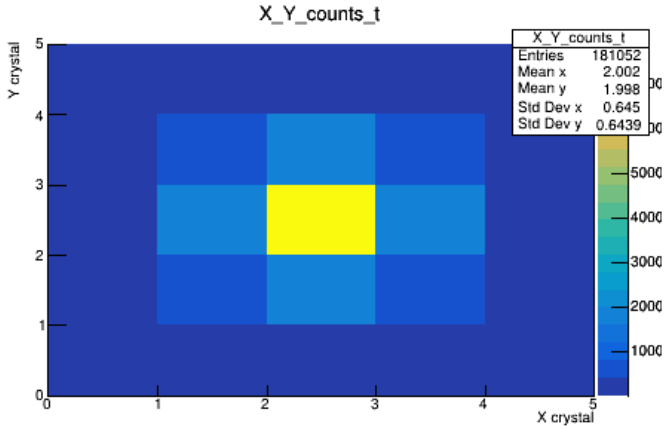


Electron
5 GeV/c
Pion



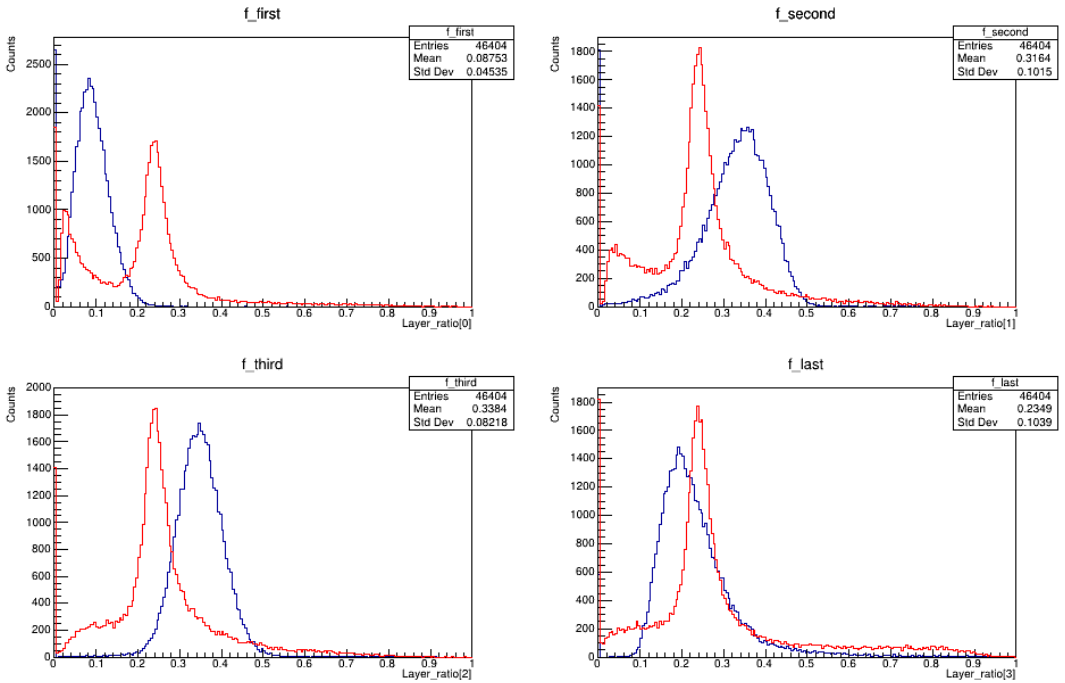




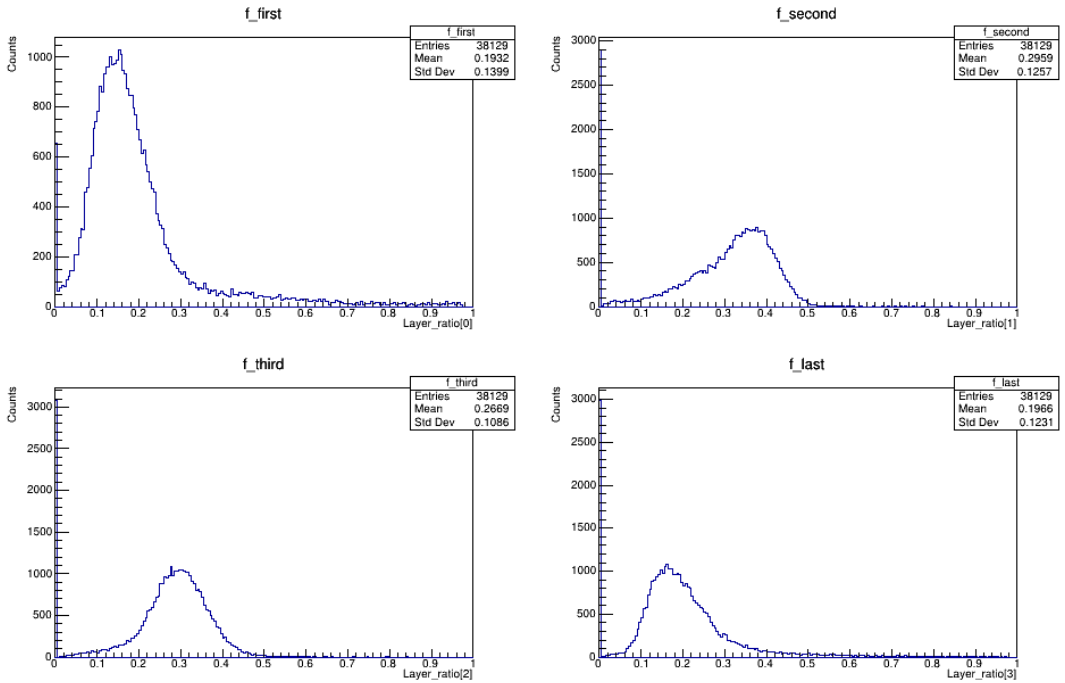


Layer_ratio[]

Geant4 simulation

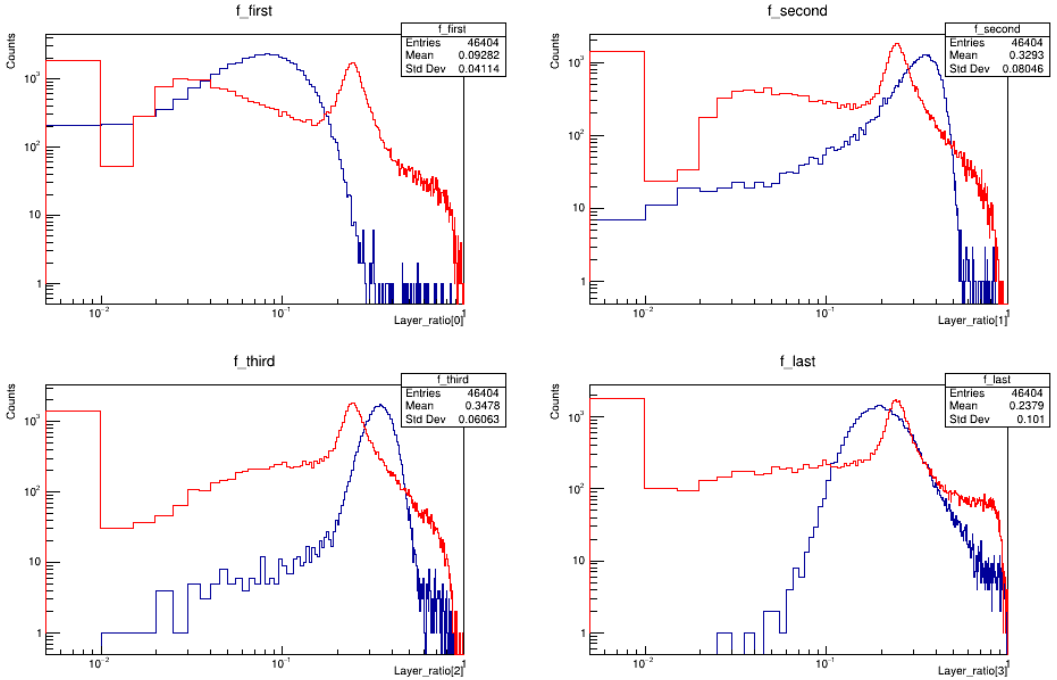


PS beam test data



5 GeV/c Electron (blue); Pion (red)

Geant4 simulation



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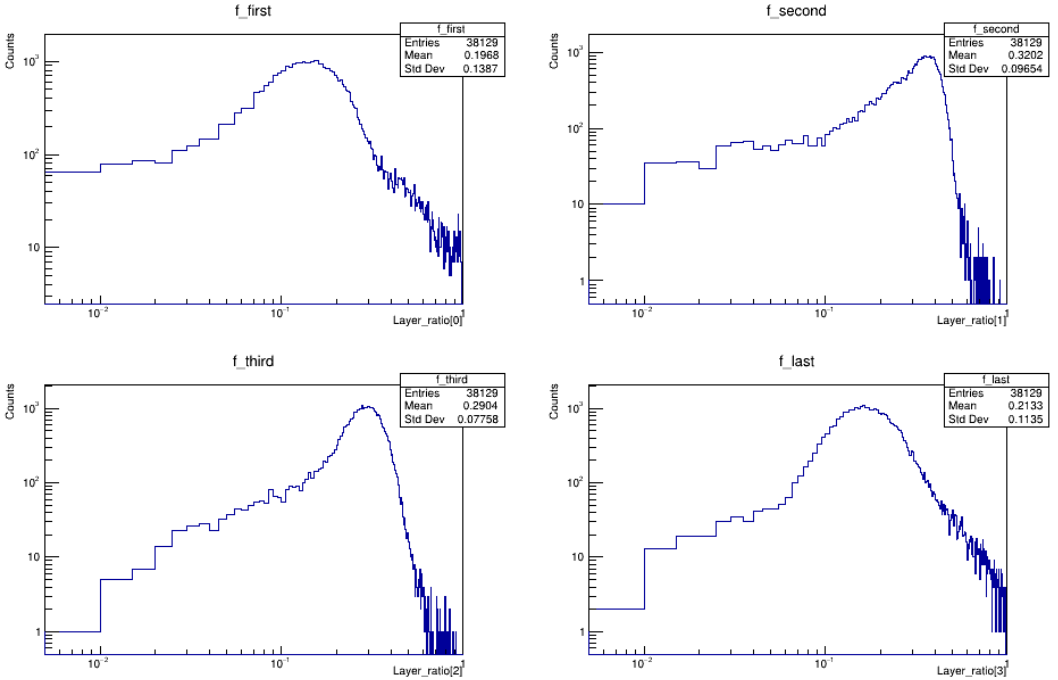
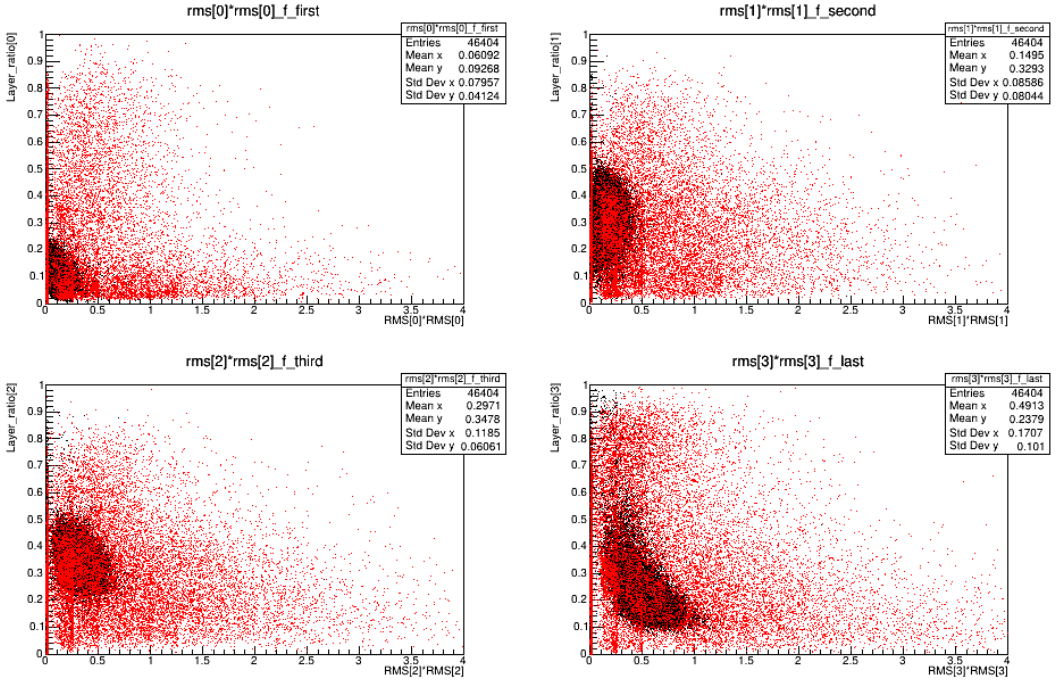
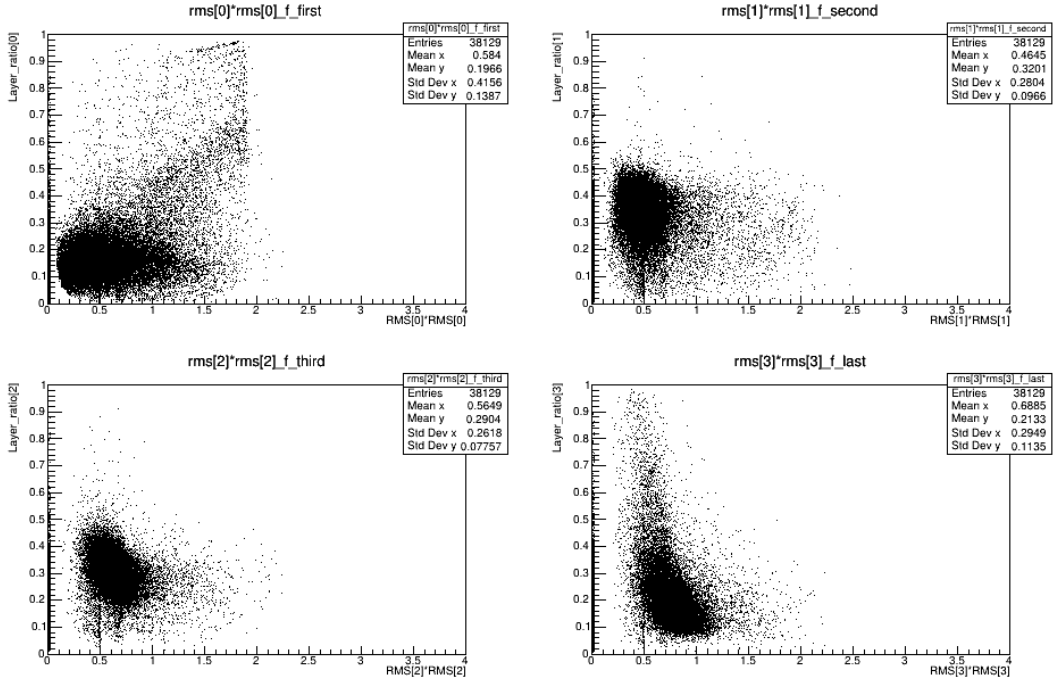


X: RMS[]*RMS[]; Y: layer_ratio[]

Geant4 simulation

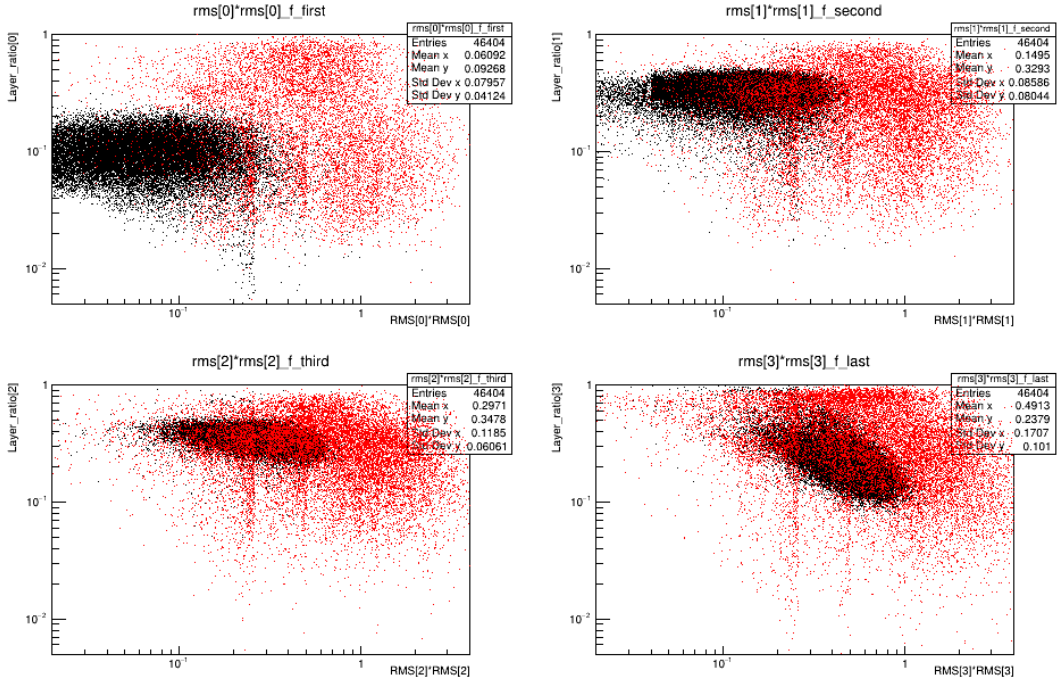


PS beam test data

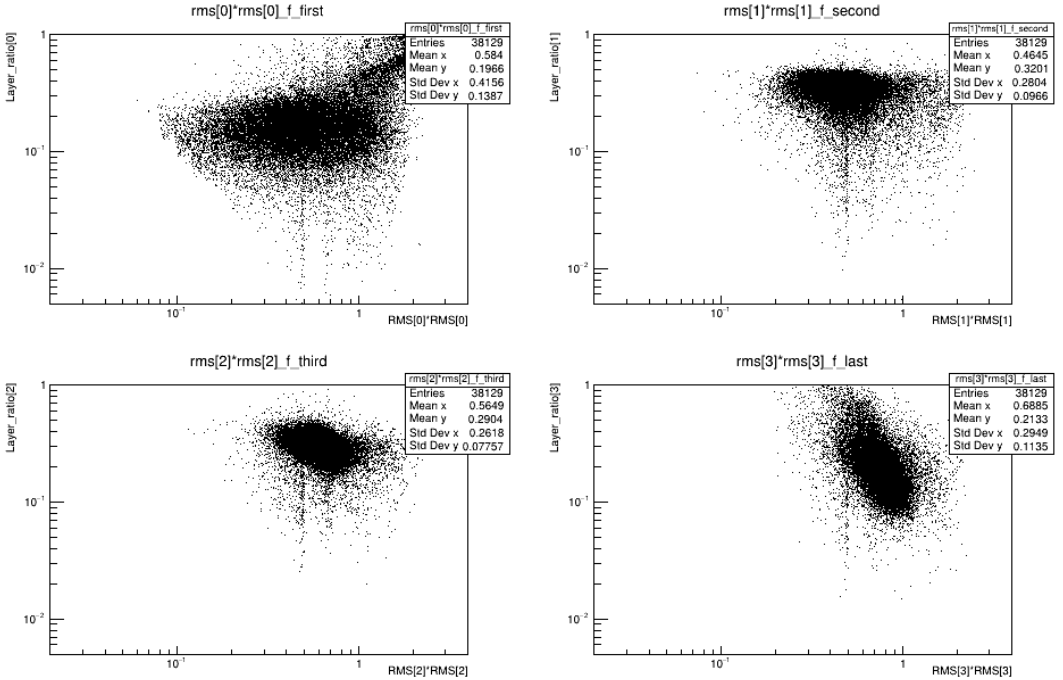


5 GeV/c Electron (black); Pion (red)

Geant4 simulation



PS beam test data



New variables

- **S1ratio**

S1ratio 是利用 e/p 簇射能量的横向展宽比例来区分它们，其定义为：

$$S1ratio = \sum_{L=1}^{14} E_{L\,max\,bar} / E_T \qquad (8.5)$$

其中 $E_{L\,max\,bar}$ 指的是第 L 层上能量沉积最大的晶体的能量，所以 S1ratio 指的是所有层中能量沉积最大的晶体中的能量之和占总能量沉积的比例（如图 7-25，左上图）。

- **横向能量分布展宽（TrWidth）**

定义为：

$$TrWidth = \sum_{L=1}^{14} (nHits)_L \cdot E_L / E_T \qquad (8.6)$$

其中，$(nHits)_L$ 表示第 L 层的击中晶体数；图 7-26 可以看出，TrWidth 也是个很有区分度的变量。仅仅以这一变量为选择条件，我们来看对用不同的 TrWidth

- **nHitsRatio_x%**

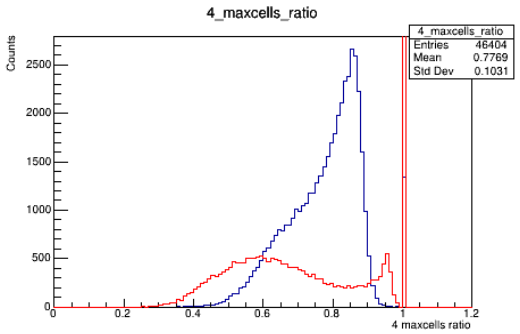
这一变量主要用于描述能量分布的集中程度，定义为能量之和大于总能量 x%的最少晶体数与总击中晶体数的比值。

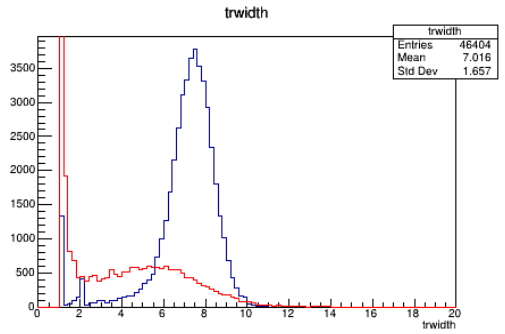
即把所有 BGO 晶体单元按照能量沉积由大到小排列，然后对能量高的晶体能量求和，当求和能量刚刚高于总能量的 x%时，统计求和的晶体数占总击中数的比例。这里 x 通常选在 70 到 90 之间（图 7-25）。

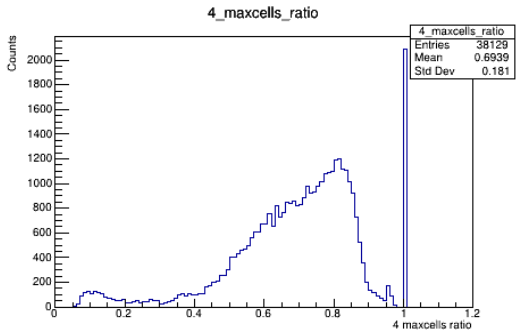
S1ratio; TrWidth

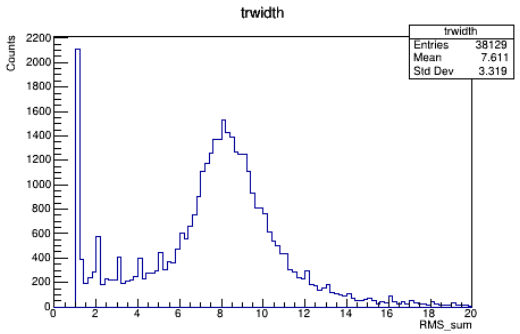
Geant4 simulation

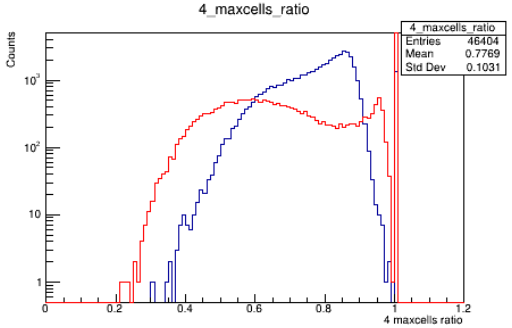
PS beam test data

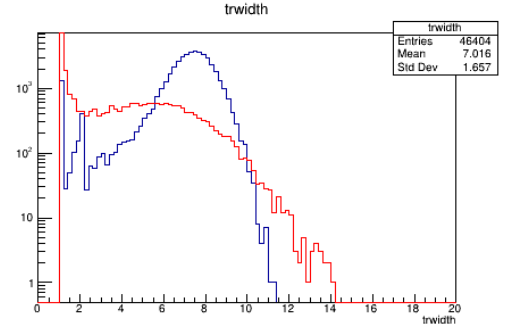


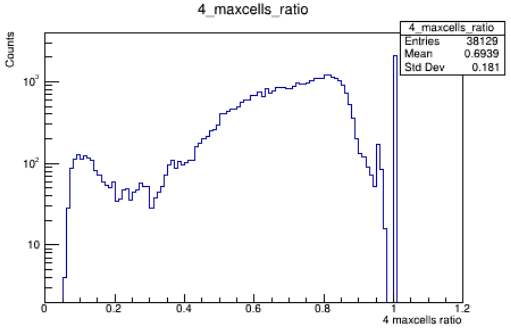


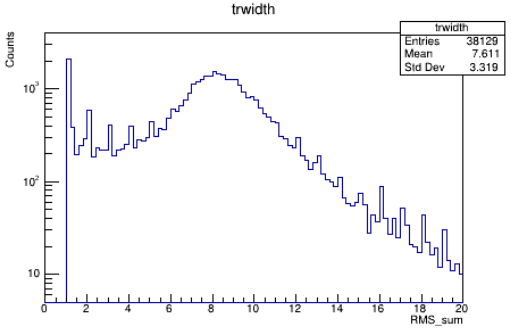






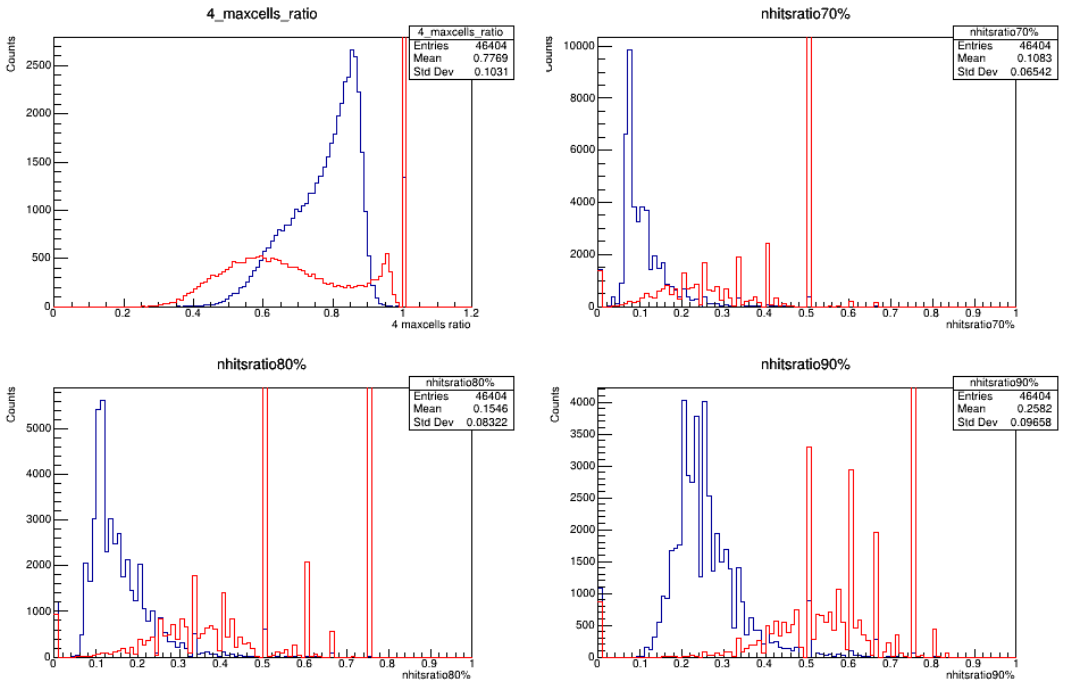




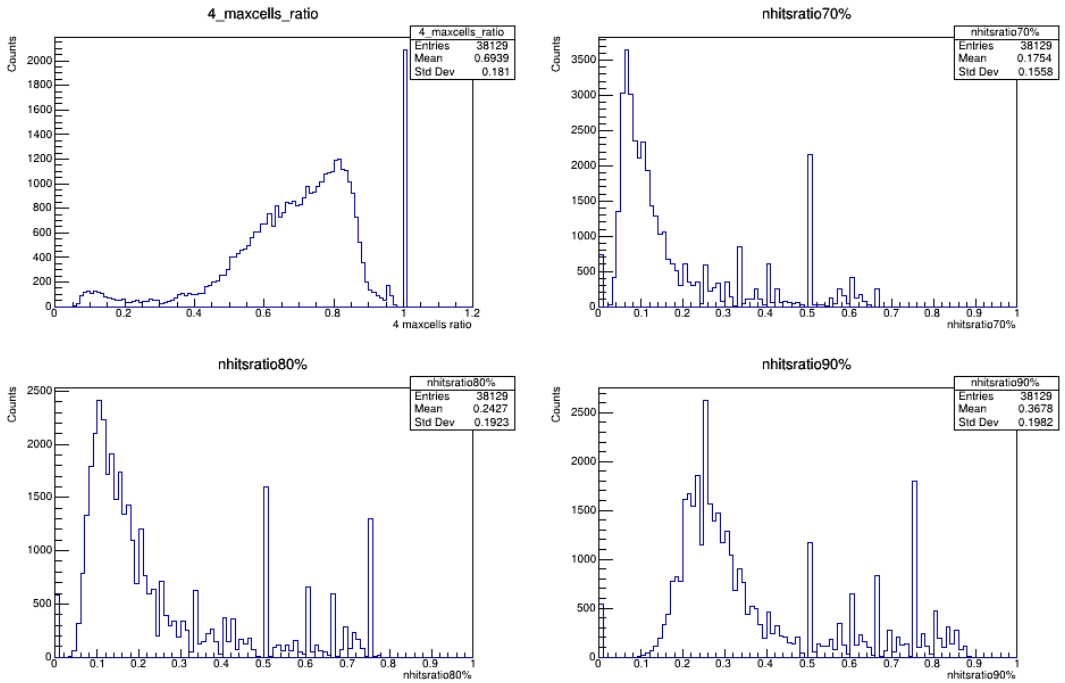


nHitsRatio_x%

Geant4 simulation

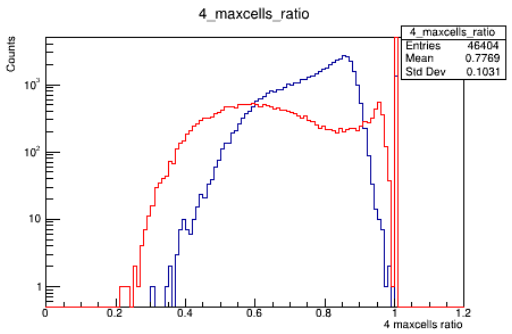


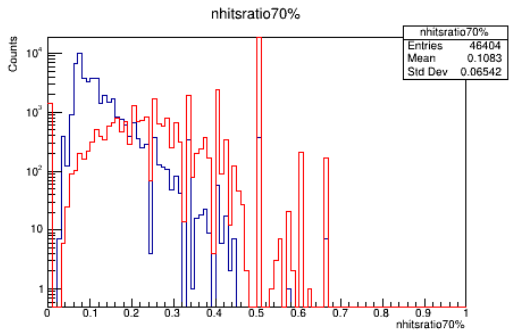
PS beam test data

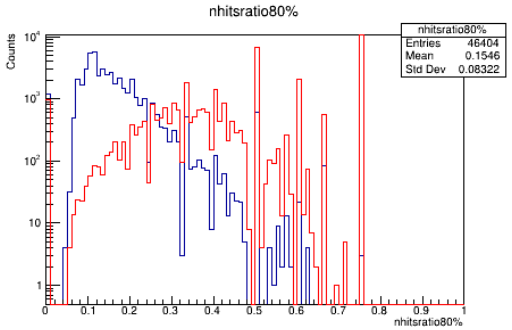


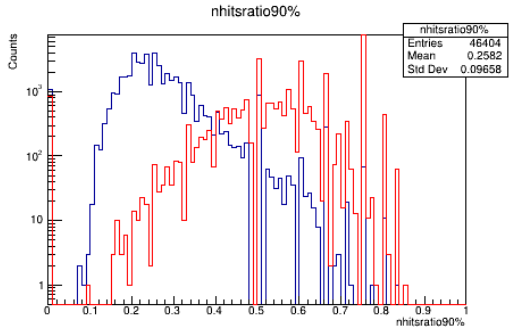
5 GeV/c Electron (blue); Pion (red)

Geant4 simulation









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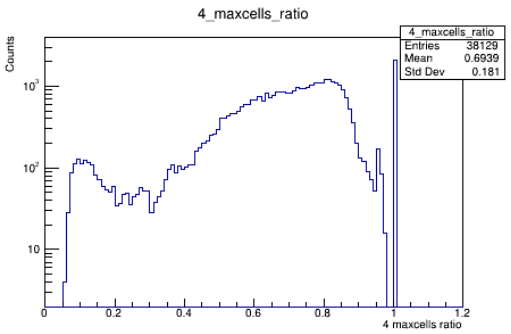
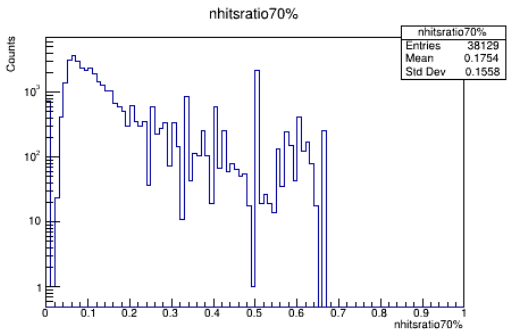
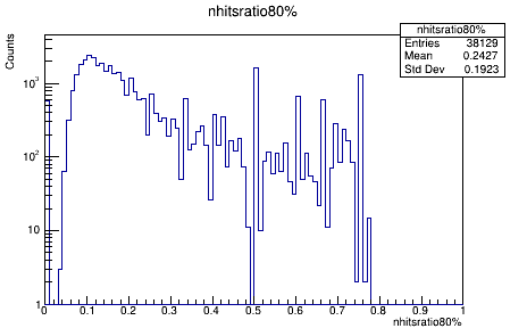
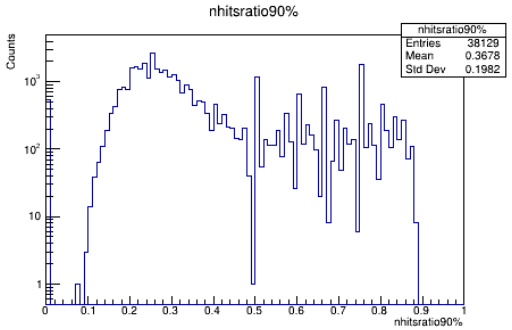


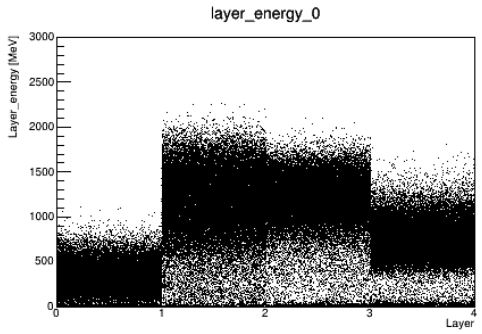


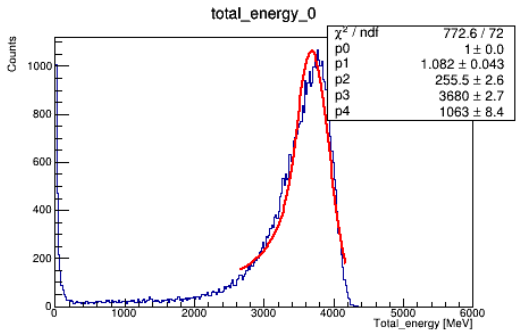


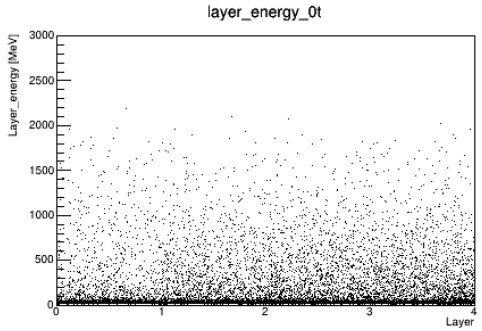


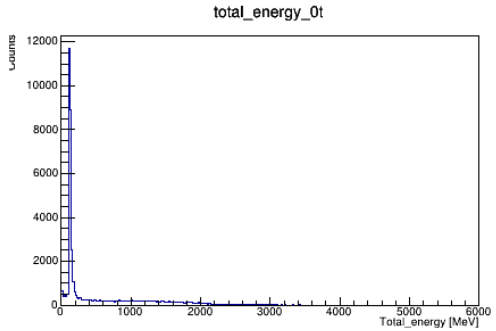
Energy resolution

Geant4 simulation



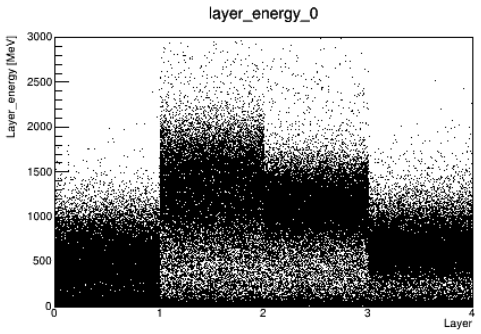


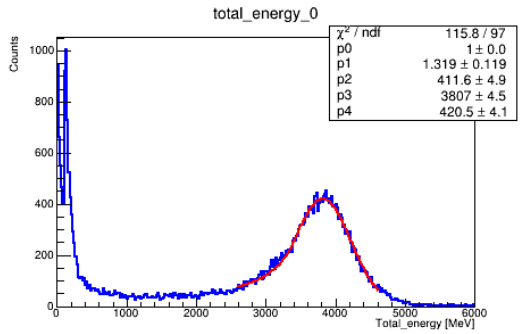




Energy resolution: 255.53 / 3680.03 = 6.94%

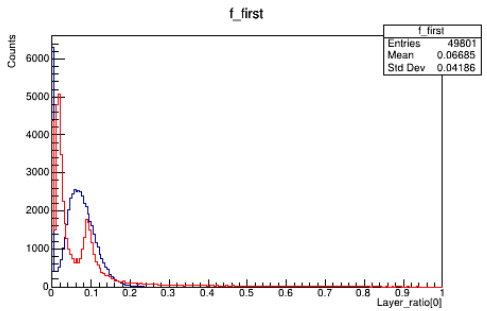
PS beam test data

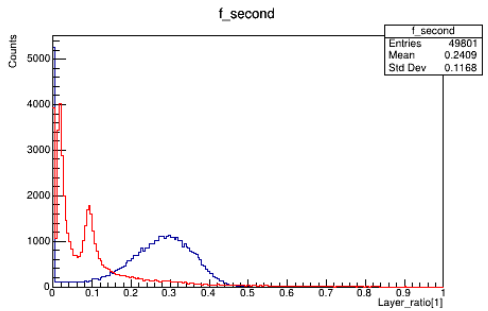


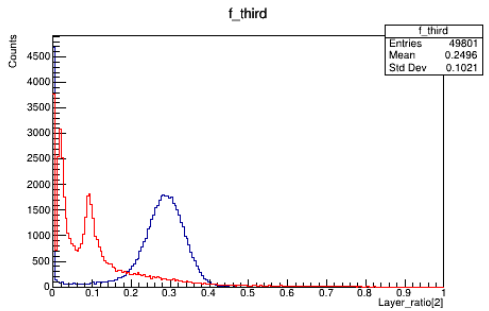


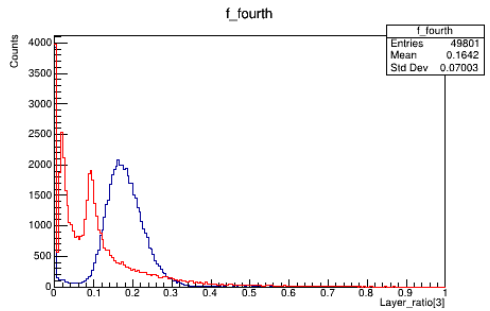
Energy resolution: 411.59 / 3807.49 = 10.81%

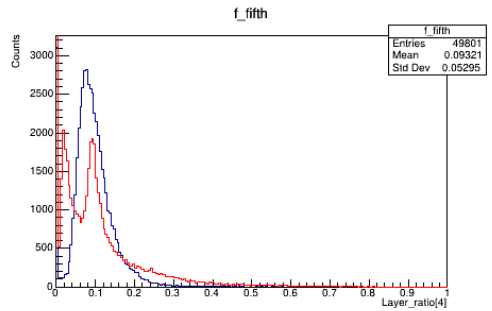
10 layers; layer_ratio[]

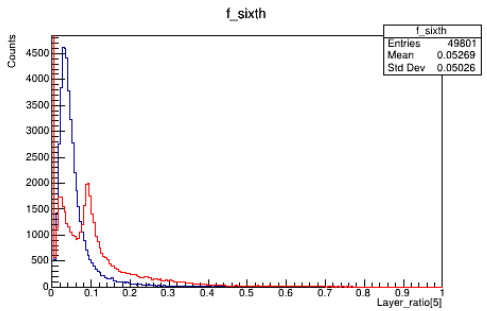


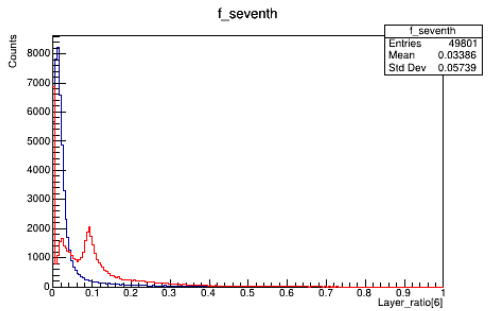


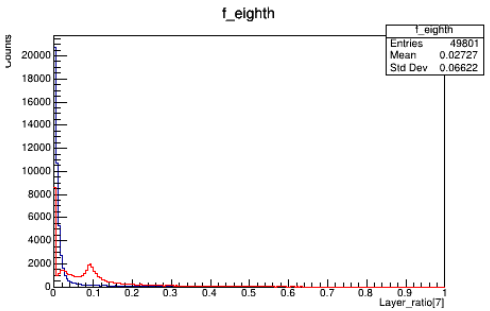


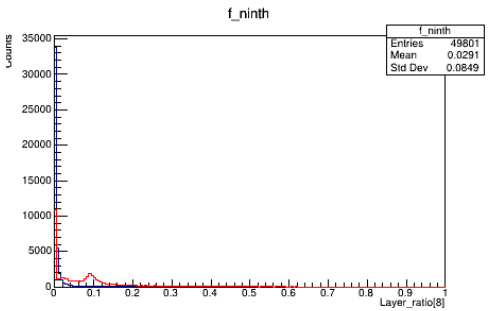


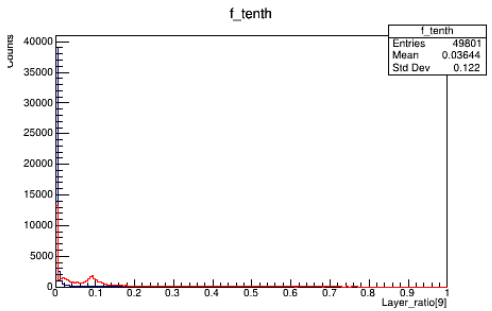




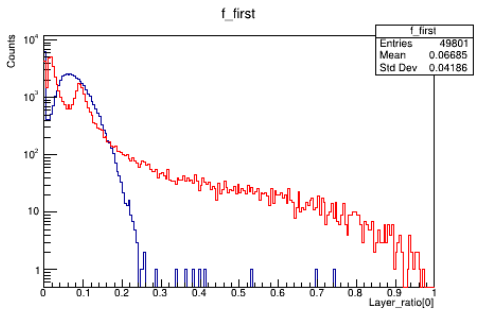


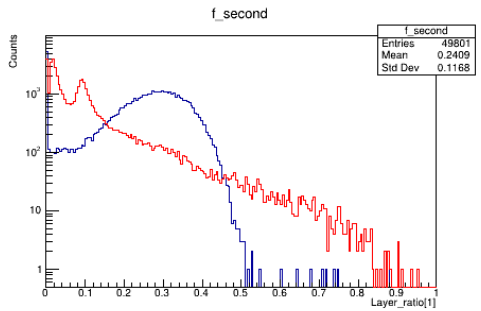


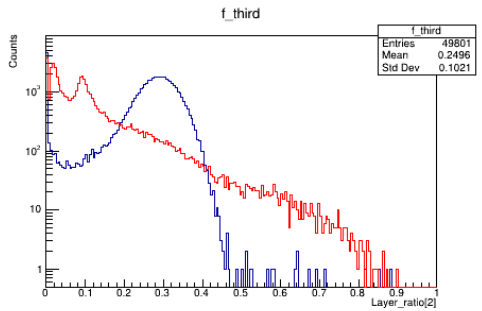


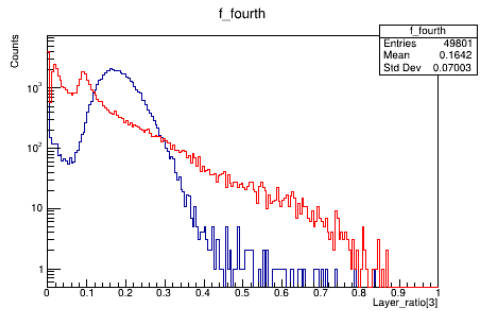


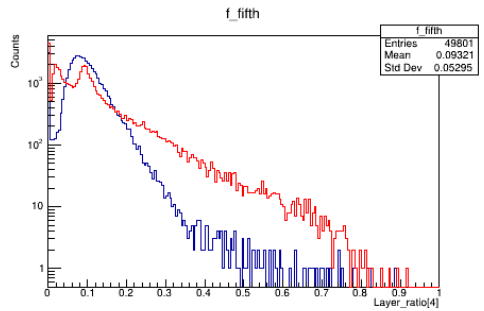
10 layers; 5 GeV/c Electron (blue); Pion (red)

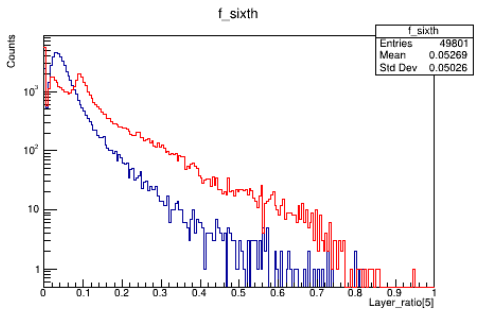


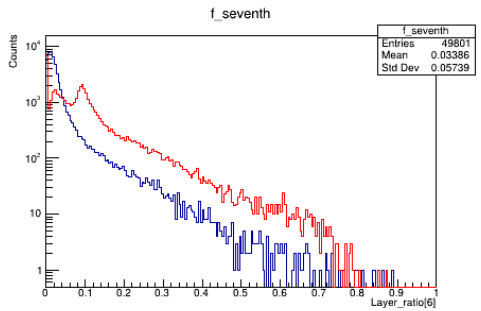


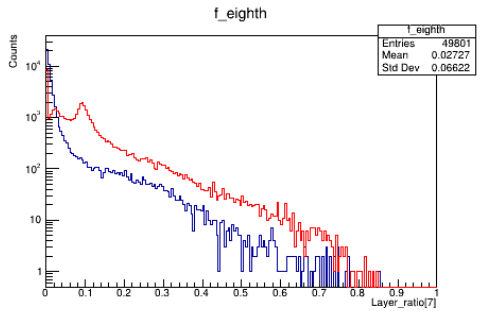


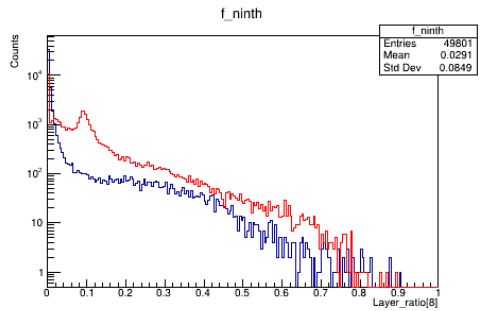


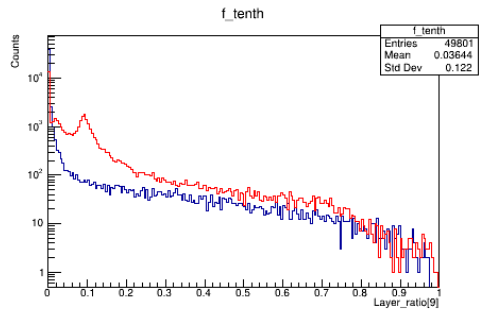












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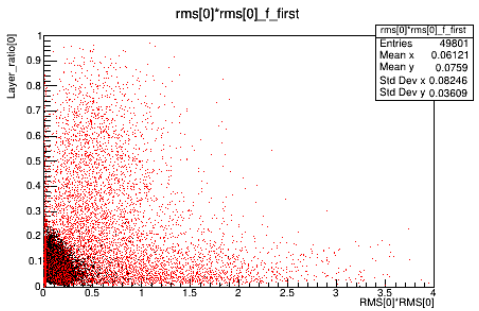
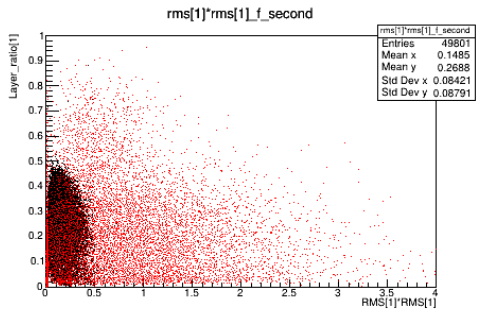
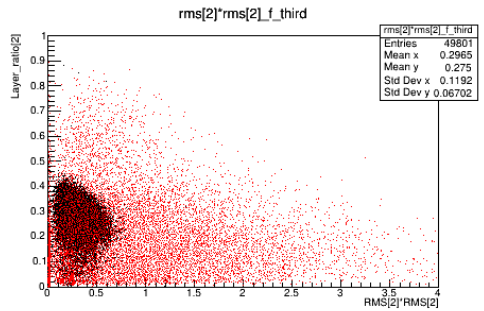
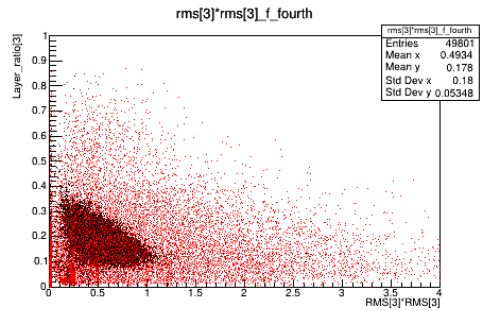
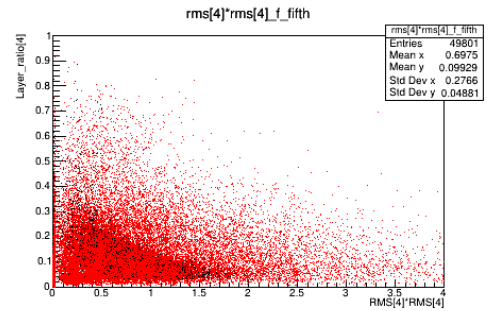
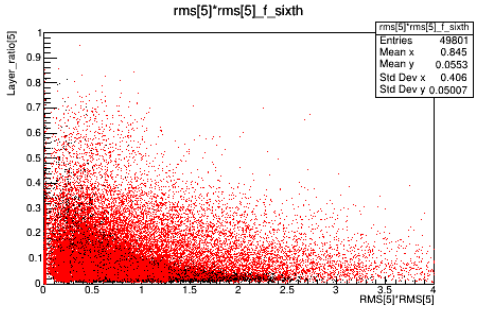


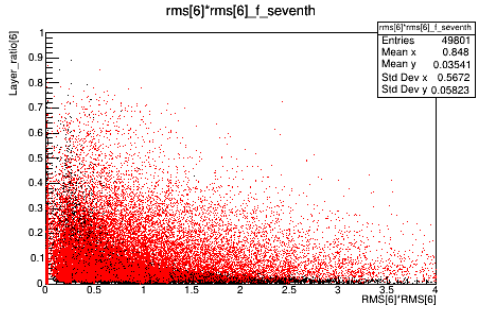


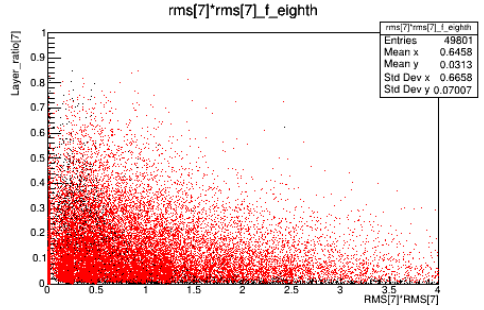


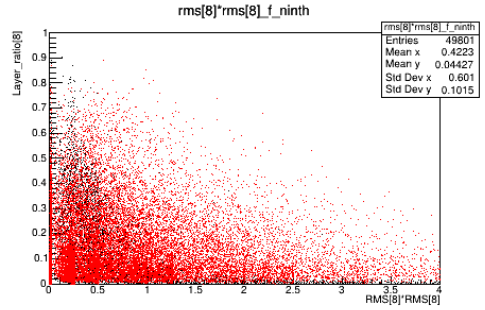


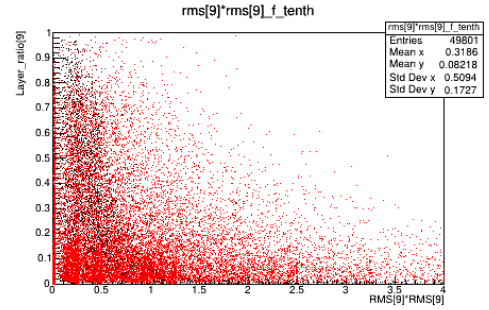




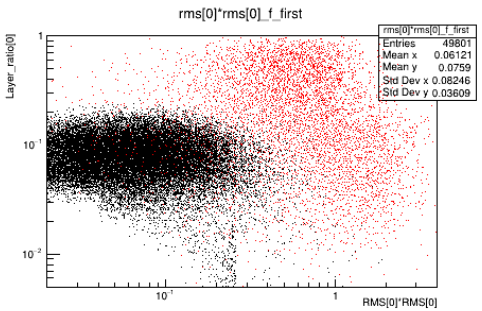


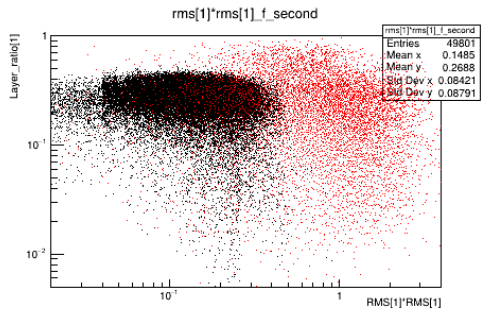


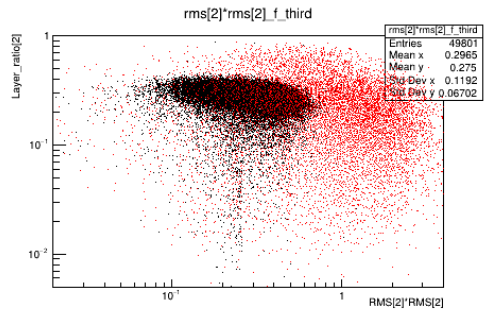


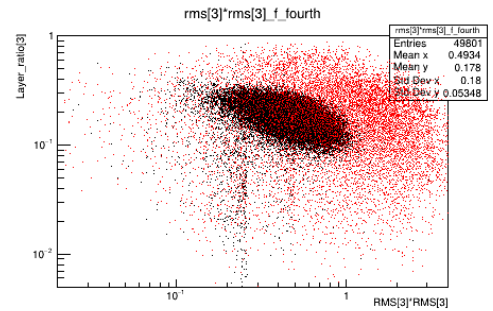


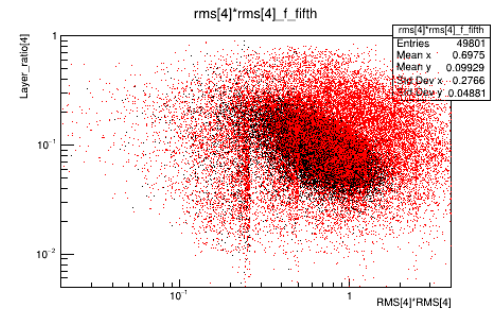
10 layers; 5 GeV/c Electron (black); Pion (red)

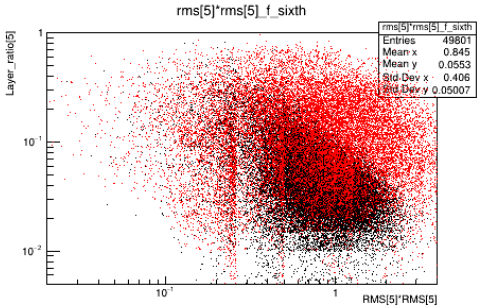


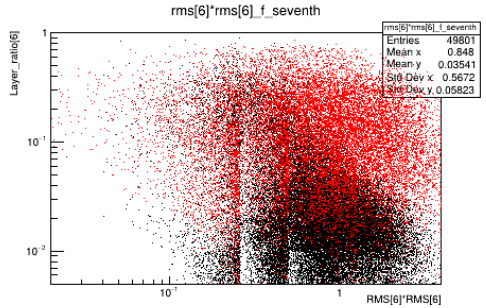


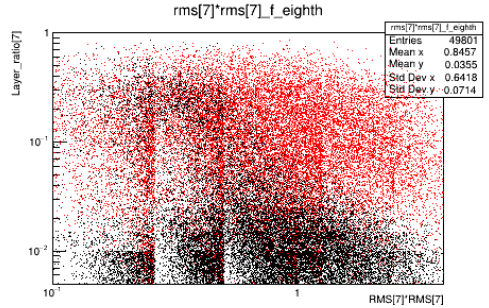


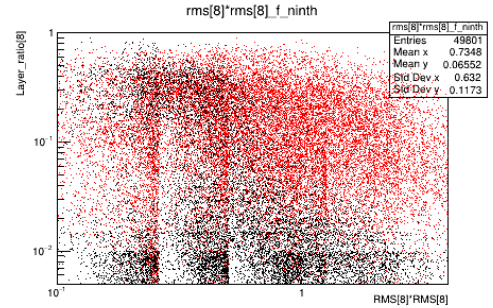


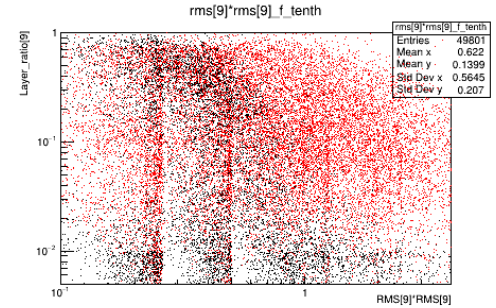




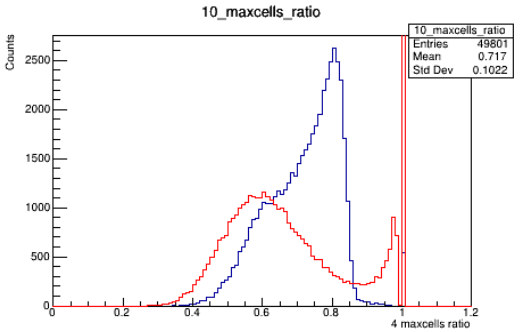


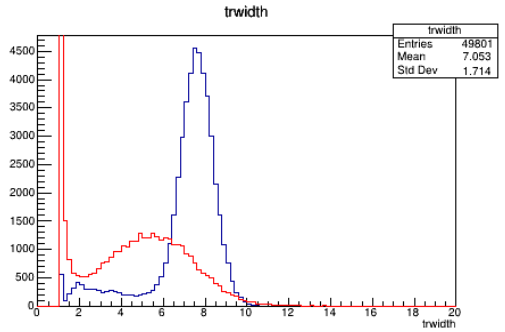


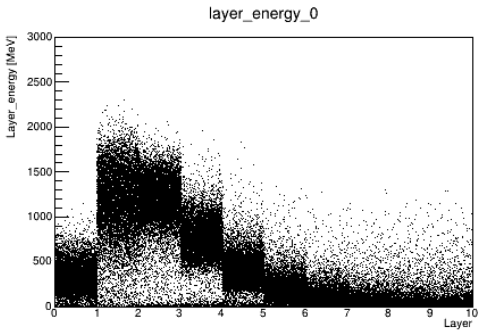


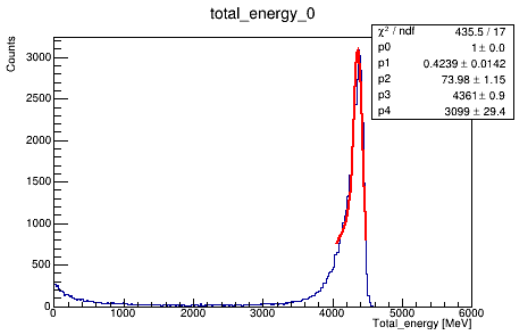


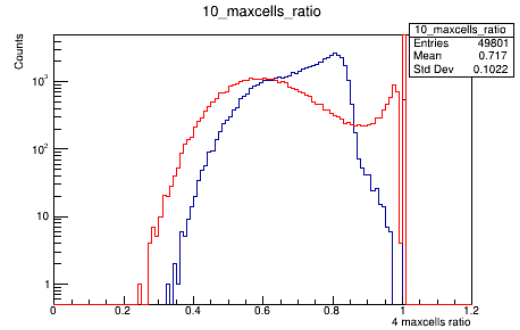
10 layers; S1ratio; TrWidth; energy resolution

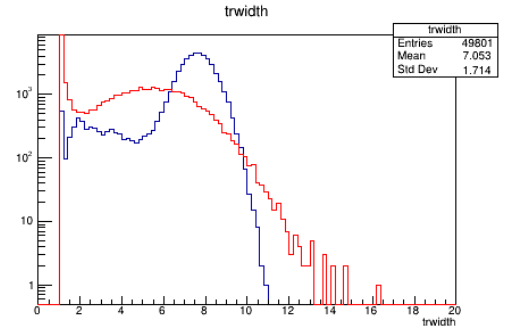


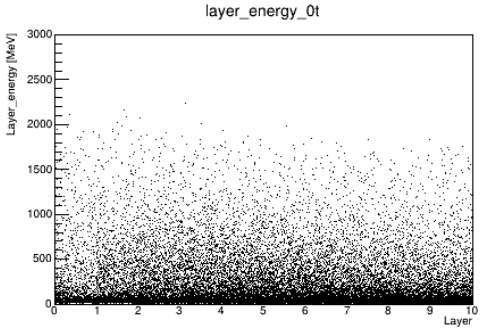


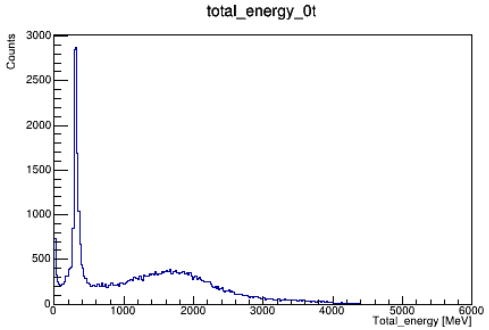






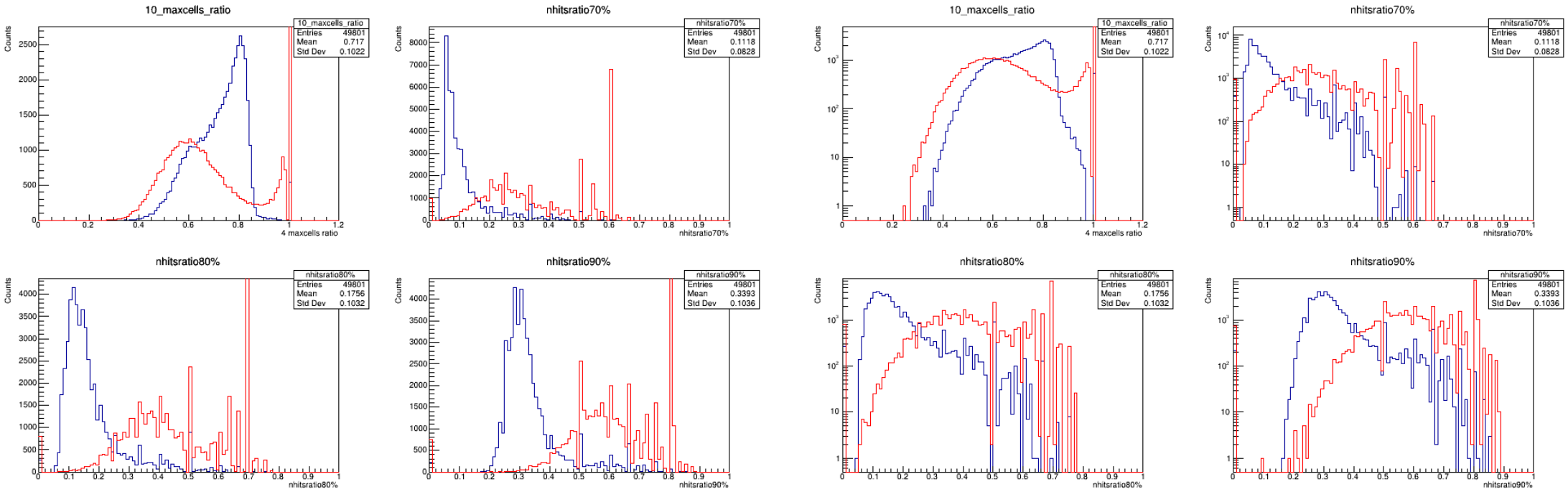




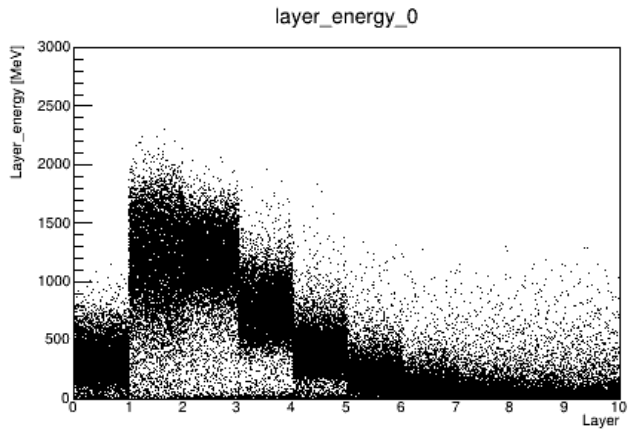


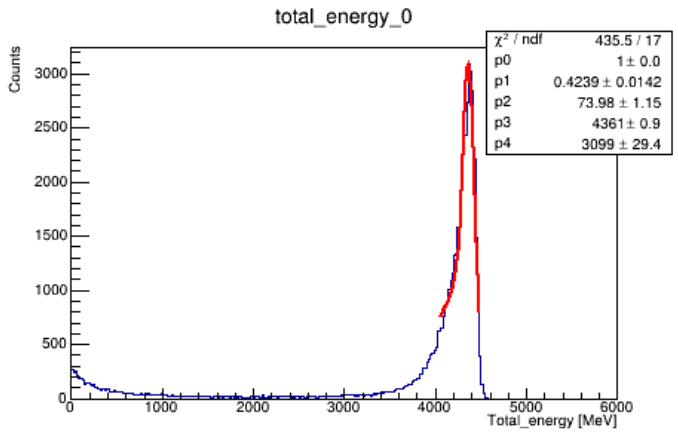
Energy resolution: 73.98 / 4361.35 = 1.70%

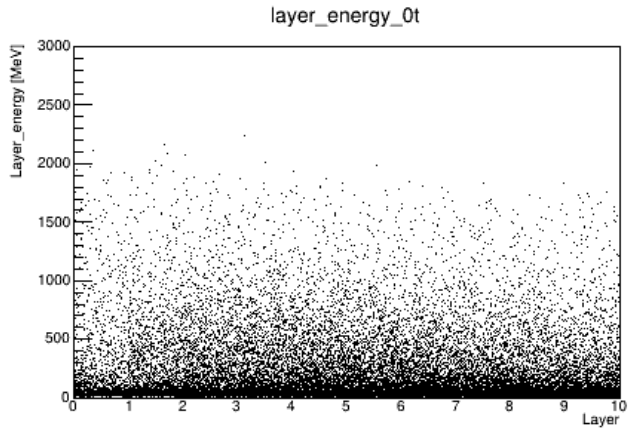
10 layers; nHitsRatio_x%

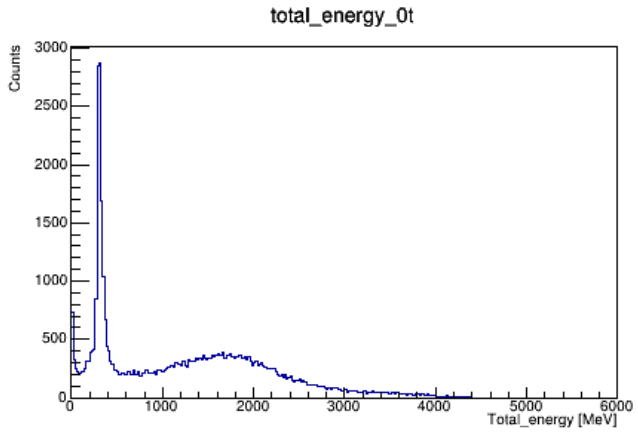


10 layers; Energy resolution









Energy resolution: 73.98 / 4361.35 = 1.70%