# ECAL-E NPOD PID

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28/10/2024 LUXE SAS Meeting

AGENCIA ESTATAL DE INVESTIGACIÓN
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Conselleria de Educación, Universidades y Empleo
Financiado por la Unión Europea
NextGenerationEU
Plan de Recuperación, Transformación y Resiliencia
AITANA

# Collection of simulated events

- Particles: Photon, neutron and pi-
- 50K Events for each particle
- Energies: from 0.5 to 10 GeV

A set of variables to characterize events (useful for MIPs AND showers):

Number of hits, total energy, MIP_Likeness, barycenter…

22 variables were calculated for every event in all samples.

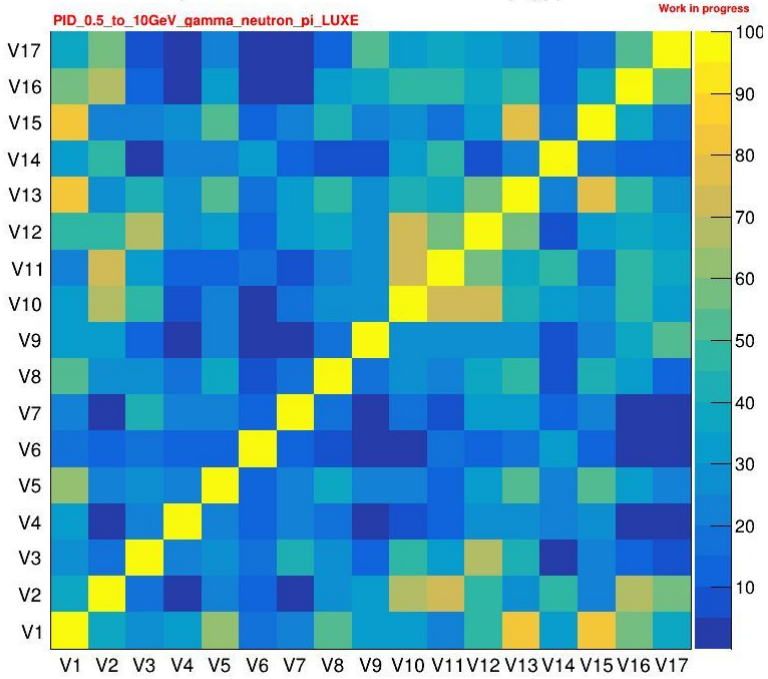
These variables are the input for the BDT for classification of particles

# Results:

- A: Photons
- B: Neutrons
- C: Pions (-)

| Rank | Variable | Variable Importance |
|---|---|---|
| 1 | MIP_Likeness | 1.085e-01 |
| 2 | bar_z | 1.071e-01 |
| 3 | nhit | 1.021e-01 |
| 4 | hits_max_distance | 9.364e-02 |
| 5 | sume_layer_5 | 8.369e-02 |
| 6 | mol | 6.730e-02 |
| 7 | sume_layer_1 | 6.327e-02 |
| 8 | shower_sume_max | 5.459e-02 |
| 9 | radius90_layer_5 | 5.354e-02 |
| 10 | shower_sume_end_10_layer | 4.124e-02 |
| 11 | radius90_layer_10 | 3.966e-02 |
| 12 | sume_layer_10 | 3.836e-02 |
| 13 | shower_sume_start_10_layer | 3.551e-02 |
| 14 | radius90_layer_1 | 3.449e-02 |
| 15 | shower_sume_max_layer | 3.446e-02 |
| 16 | sume_layer_14 | 2.244e-02 |
| 17 | radius90_layer_14 | 2.005e-02 |

|Variable correlation| (γ)




## Variables:

**V1: nhit**
**V2: bar_z**
**V3: mol**
**V4: MIP_Likeness**
**V5: hits_max_distance**
**V6: radius90_layer_1**
**V7: radius90_layer_5**
**V8: radius90_layer_10**
**V9: radius90_layer_14**
**V10: shower_sume_max_layer**
**V11: shower_sume_start_10_layer**
**V12: shower_sume_end_10_layer**
**V13: shower_sume_max**
**V14: sume_layer_1**
**V15: sume_layer_5**
**V16: sume_layer_10**
**V17: sume_layer_14**

Highly correlated variables were removed

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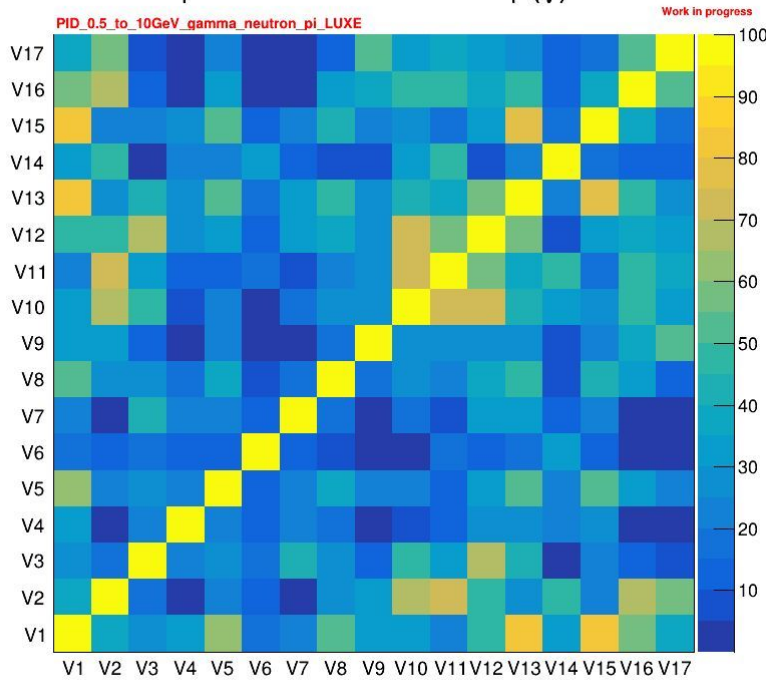
| 15 | shower_sume_max_layer | 3.446e-02 |
| 16 | sume_layer_14 | 2.244e-02 |
| 17 | radius90_layer_14 | 2.005e-02 |

|Variable correlation| (γ)




## Variables:

**V1: nhit**
**V2: bar_z**
**V3: mol**
**V4: MIP_Likeness**
**V5: hits_max_distance**
**V6: radius90_layer_1**
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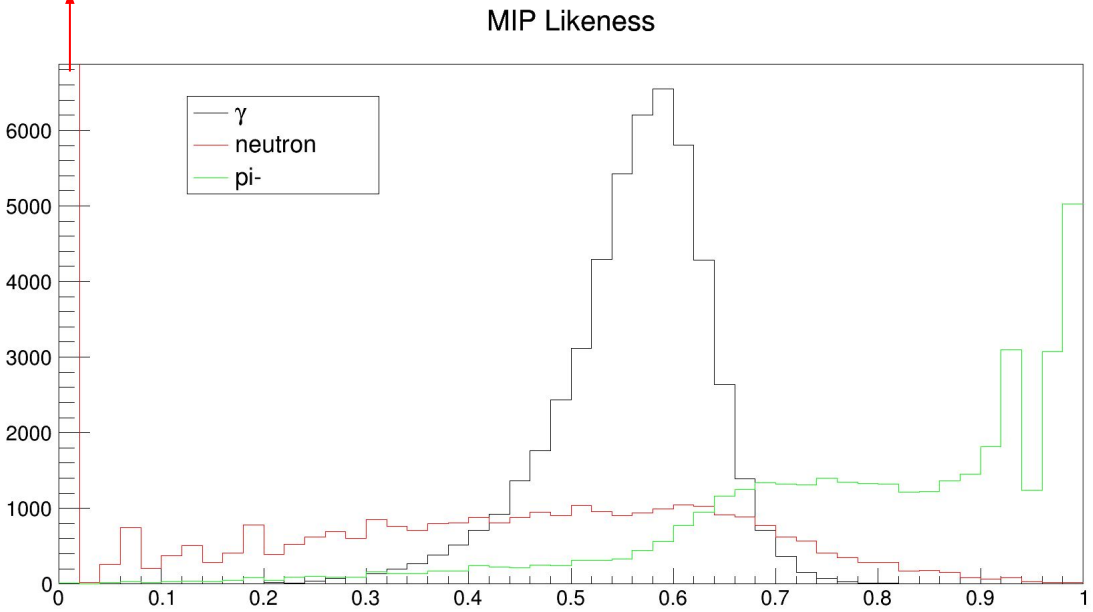
**V9: radius90_layer_14**
**V10: shower_sume_max_layer**
**V11: shower_sume_start_10_layer**
**V12: shower_sume_end_10_layer**
**V13: shower_sume_max**
**V14: sume_layer_1**
**V15: sume_layer_5**
**V16: sume_layer_10**
**V17: sume_layer_14**

# MIP_Likeness

22.3k neutron events w/o shower

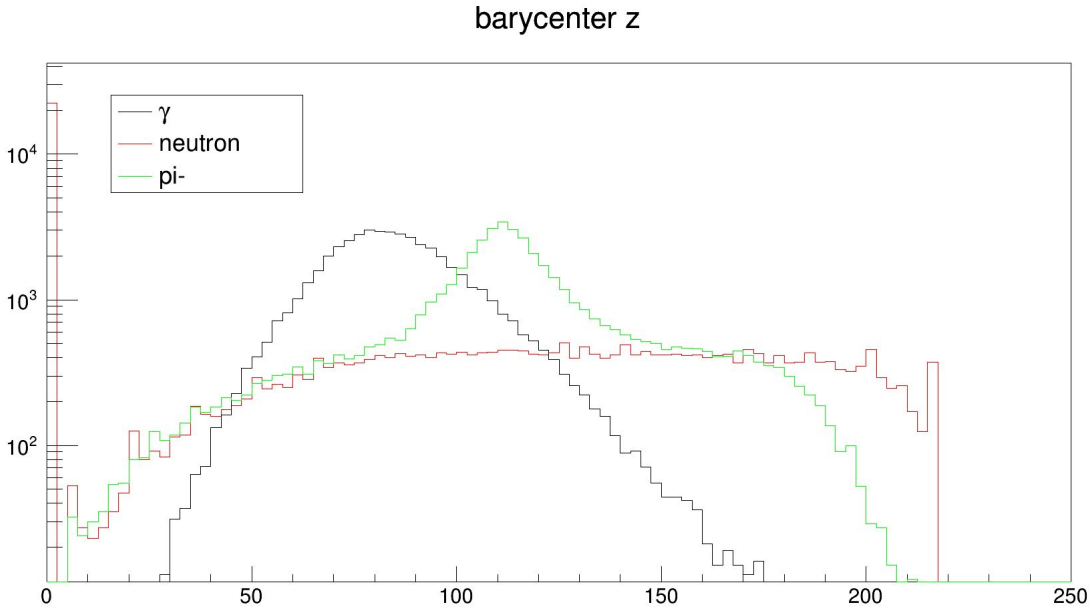



For all layers:

- If hits in layer == 0:
  - MIP score -= 1
- If hits in layer > 0:
  - MIP score += 1/(nhits in layer)

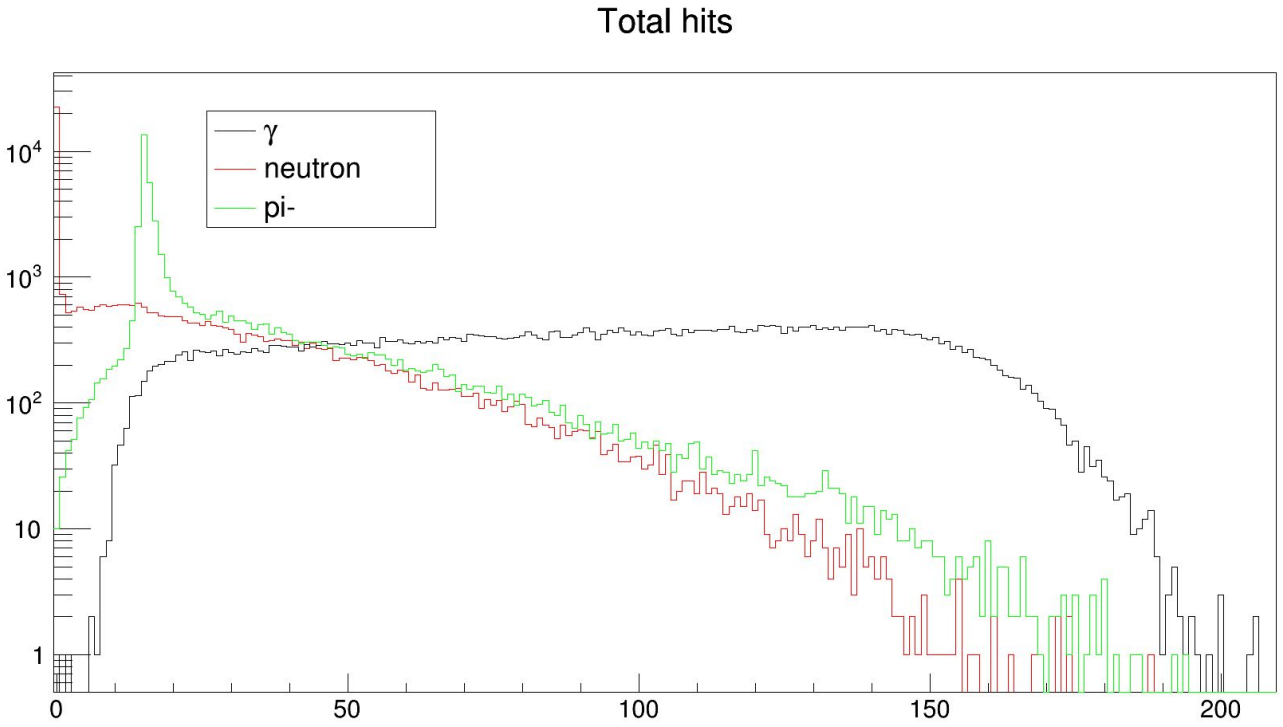
$$MIP\_Likeness = \frac{\frac{MIP\ score}{N_{Layers}} + 1}{2}$$

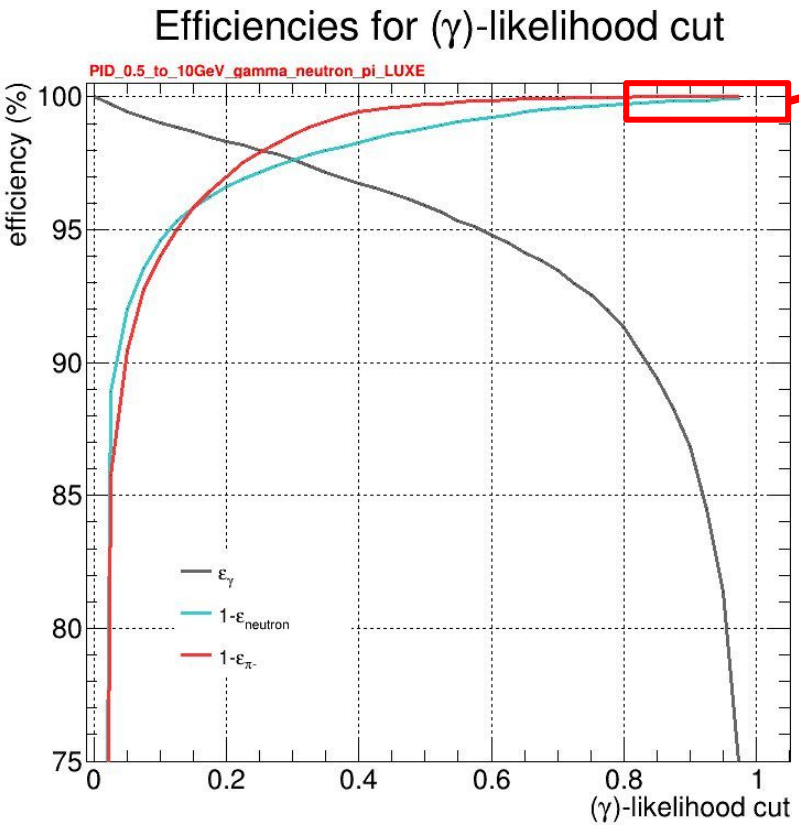
# bar_z

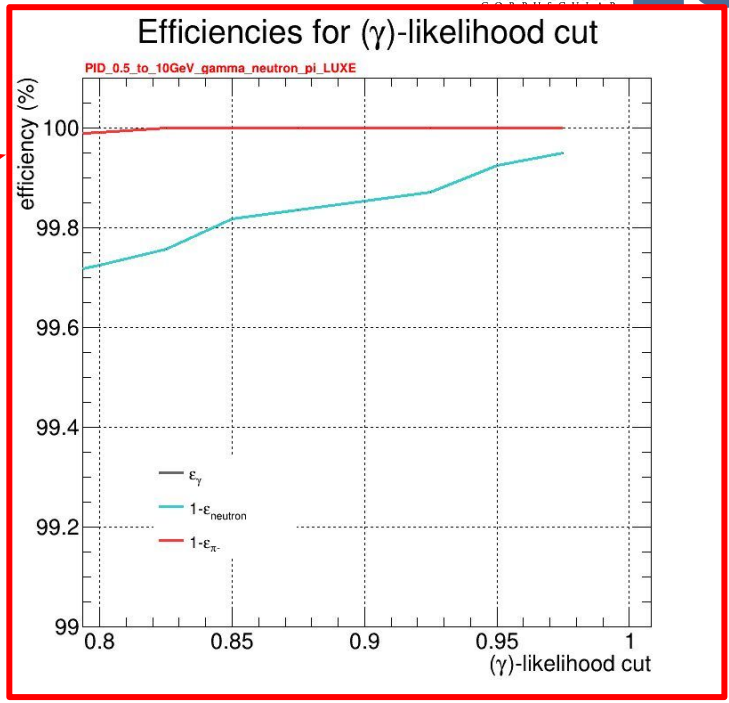



$$bar\_z = \frac{\sum^{Hits} z_{hit} \times Energy_{hit}}{\sum^{Hits} Energy_{hit}}$$

# nhits






- 85% Efficiency for photon → 0% pi- and 0.15% neutron contamination

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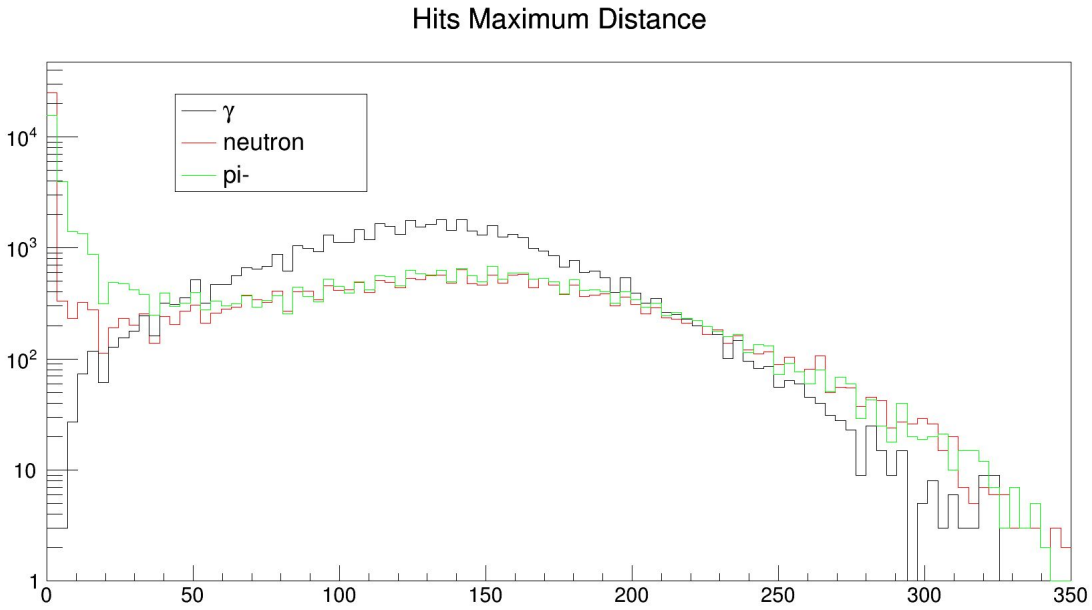
Thank you for your attention!

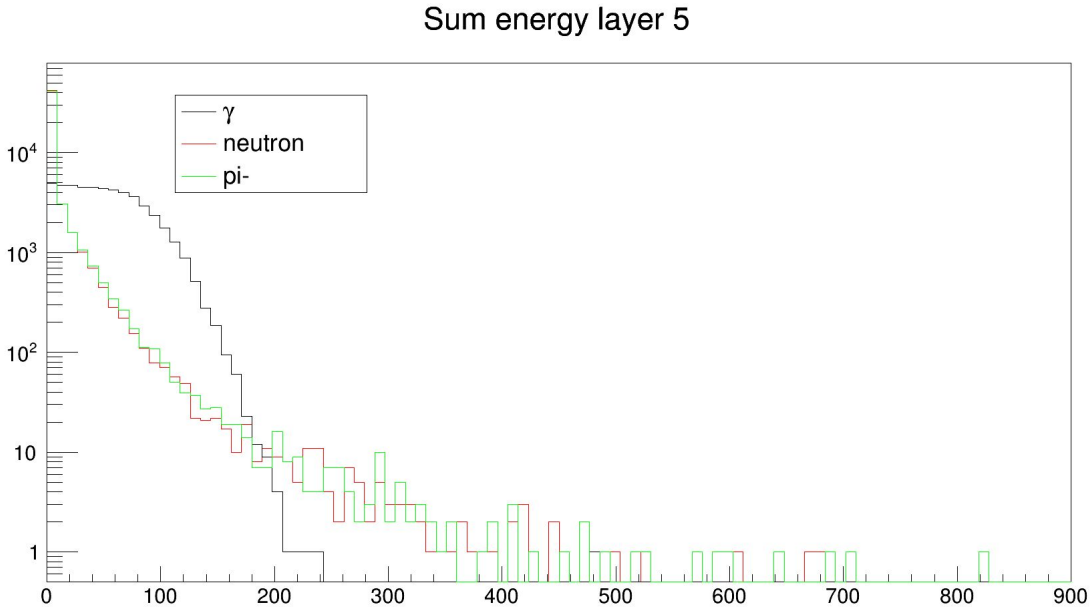
# Backup

# hits_max_distance



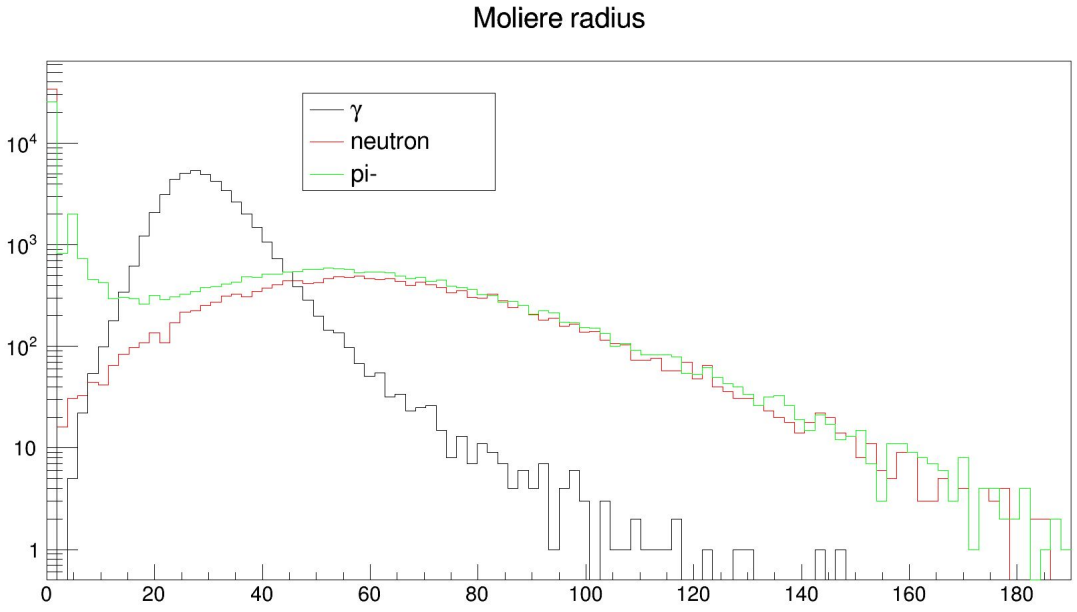

Maximum distance in the XY plane between two hits in one event

# sume_layer_5




Total energy deposited in layer 5

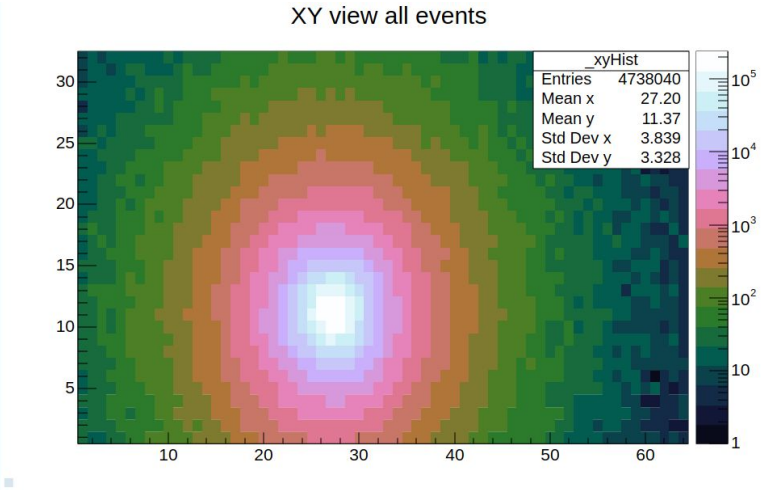
# mol

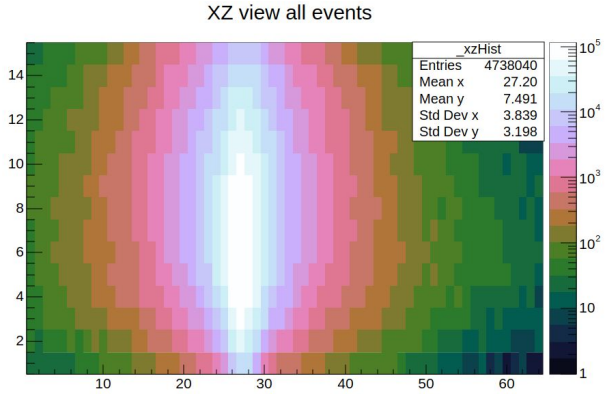


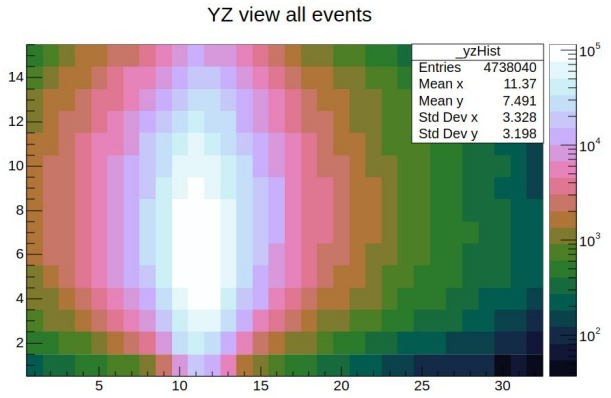

Radius of cylinder containing 90% of the total energy.

Center of cylinder is at barycenter of shower.

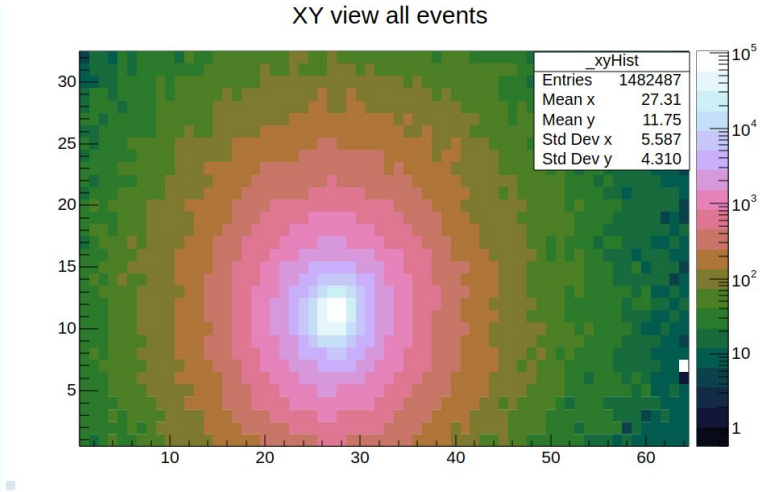
# Shower profiles 0.5 to 10 GeV: Photon

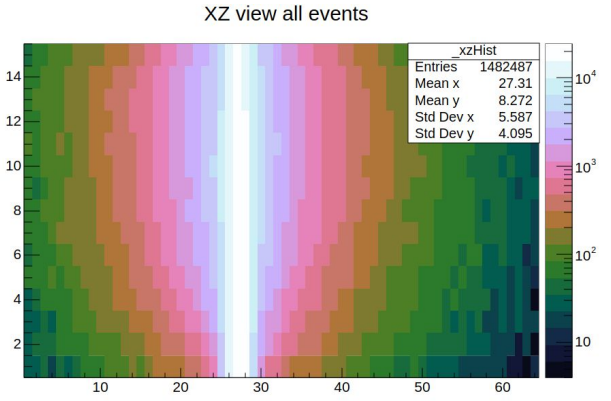


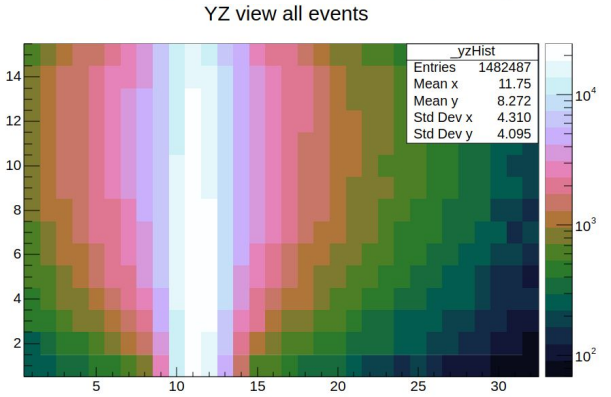



# Shower profiles 0.5 to 10 GeV: pi-



# Shower profiles 0.5 to 10 GeV: neutron