




# PS-SPS2023 HERD beam test electron analysis

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30/04/2024

*“Life is like a beam test, at some point it finishes... but the beam test will never give you any rest”*

Anonymous, stanza 104

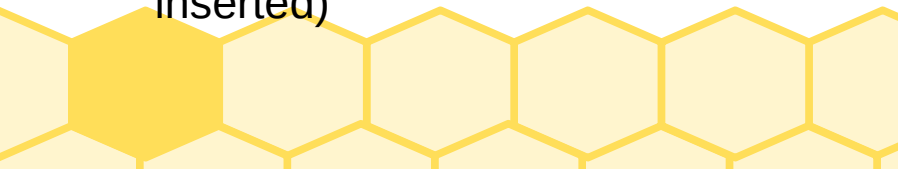
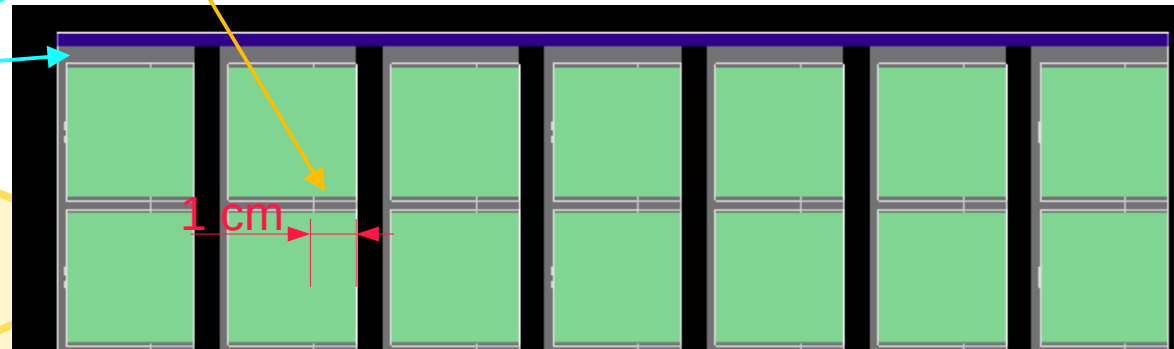
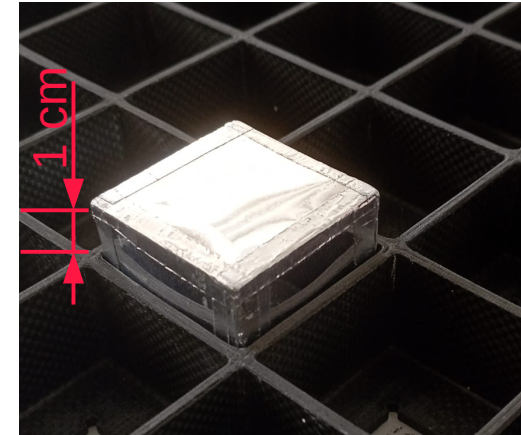
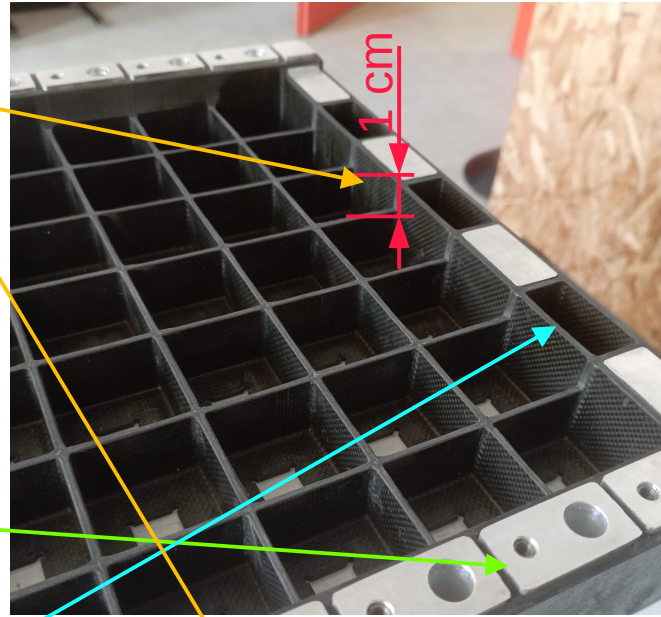


# What's new?

- Update of calo tray geometry
- Tuning of gain change gap for every beam energy
- Add 1 cm of Al (tuned via first layers longitudinal profile for 250 GeV beam)

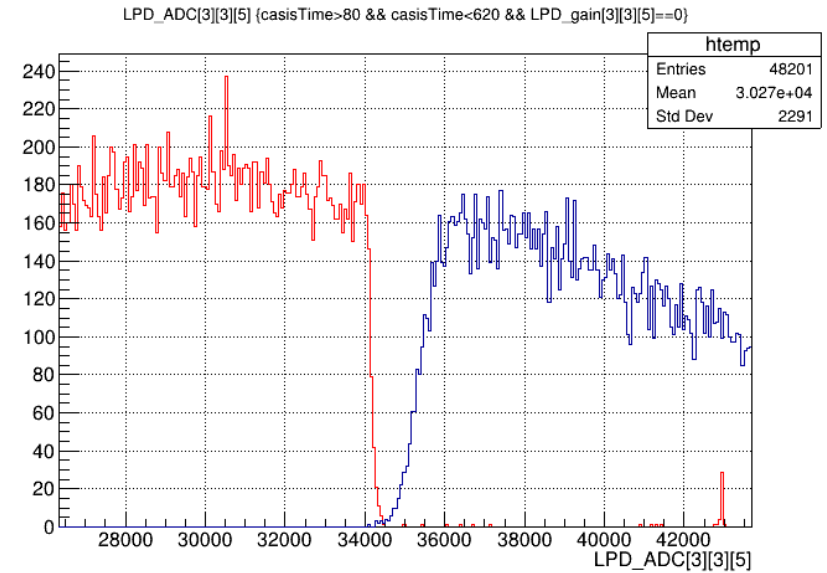
# Update of calo tray geometry

- Up to now approximation: internal walls of the trays same height as the front and rear walls, but in reality they are 1 cm less in height
- Update simulation with real height of internal walls of the trays
- Only approximations left:
  - Lateral border higher and with aluminum inserts
  - Front and rear wall simulates as one with total thickness instead of two separated (in beam test prototype no aluminum was inserted)



# Tuning of gain change jump for every beam energy

Beam energy	Jump value [ADC]
243.48	1800
197.27	1750
149.12	2800
99.83	1750
49.99	1000
20.00	1000



# Check alignment with Centers Of Gravity method

- For every layer of the calorimeter computation of (X;Y) coordinate of the center of gravity

$$x_{reference}^{new} = \frac{1}{E_{tot}} \cdot \sum_{i=layer\ crystals} E_i \cdot (x_i - x_{reference}^{old})$$

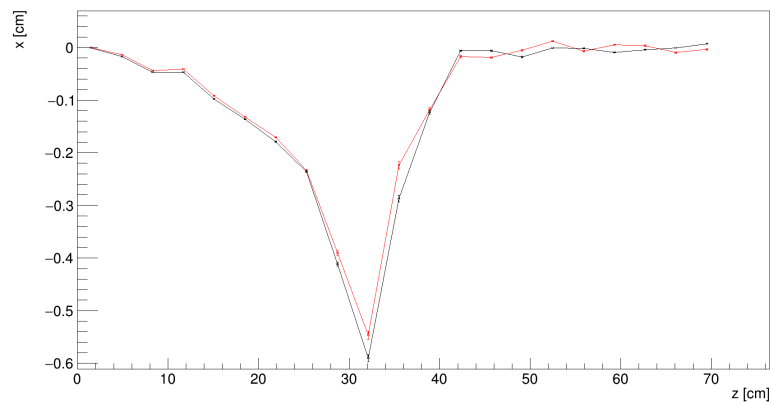
- Iterative method until

$$x_{reference}^{new} - x_{reference}^{old} < 100 \mu m$$

$$y_{reference}^{new} - y_{reference}^{old} < 100 \mu m$$

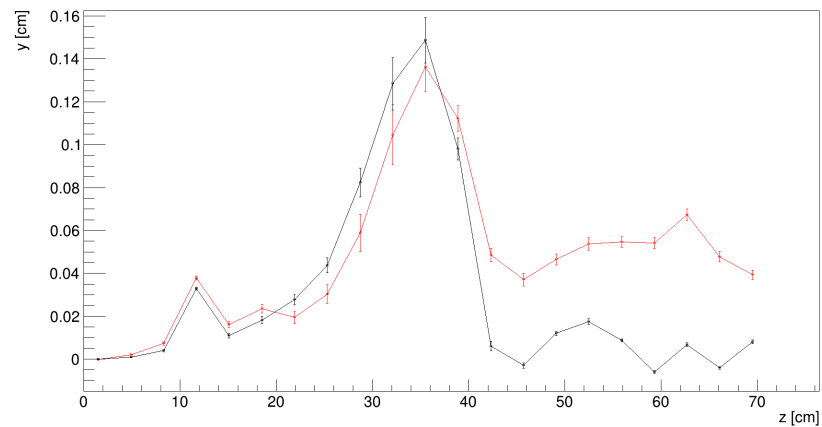
# X coordinate

EDepXZGraph



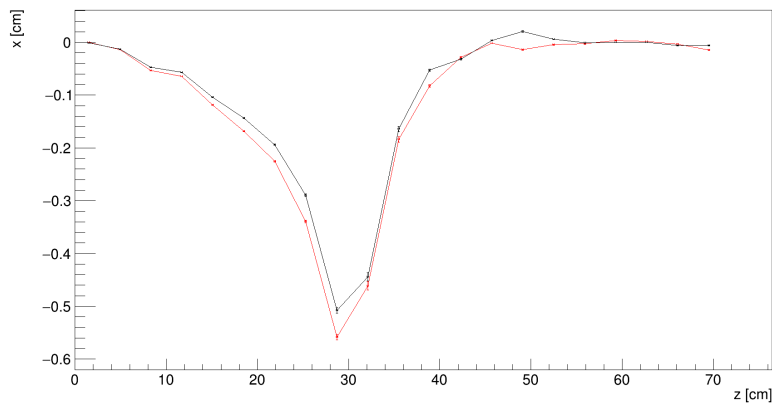
# Y coordinate

EDepYZGraph

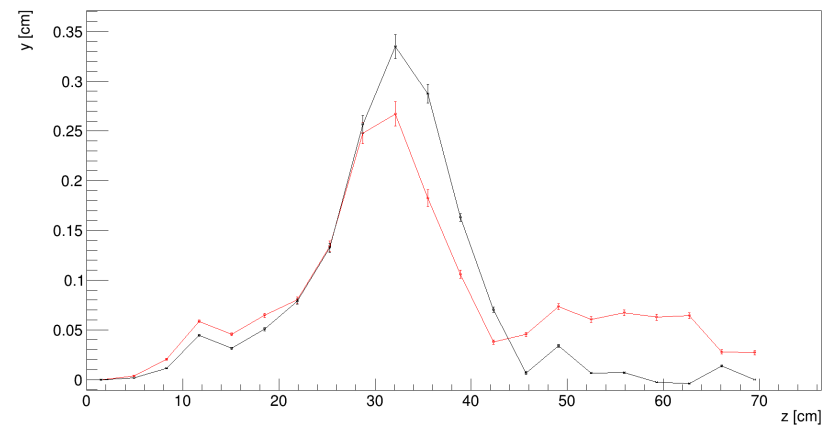


250 GeV

EDepXZGraph



EDepYZGraph

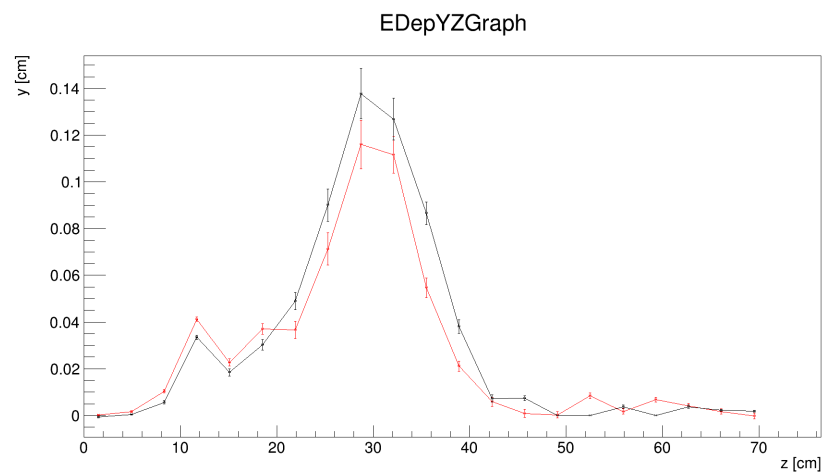
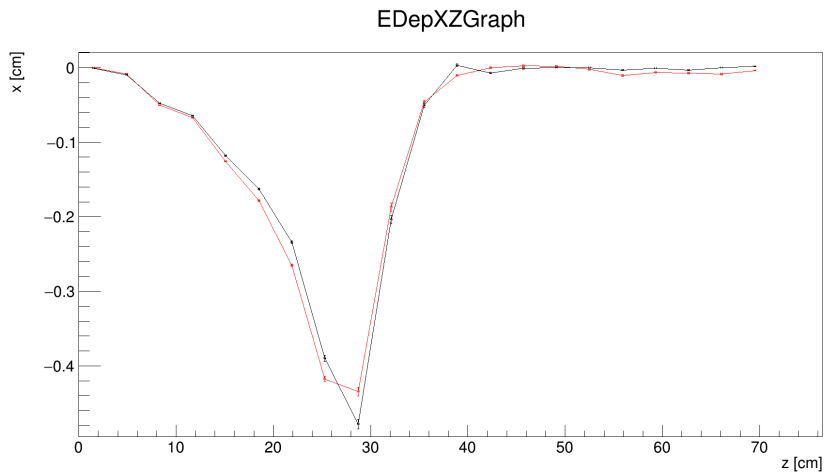


200 GeV

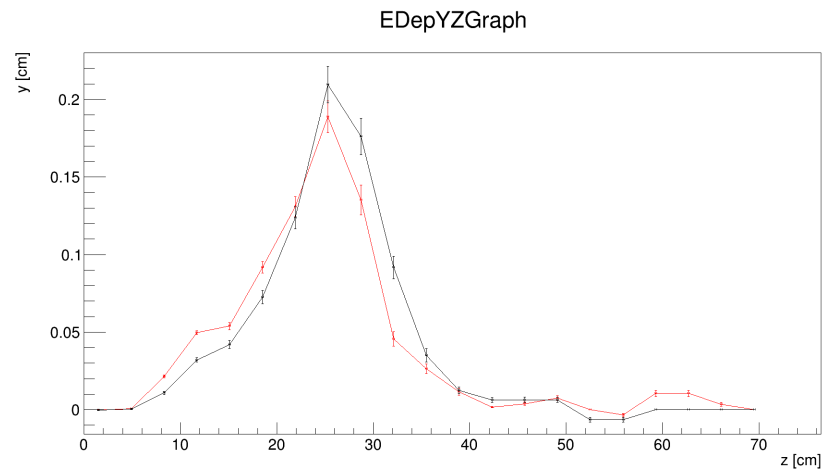
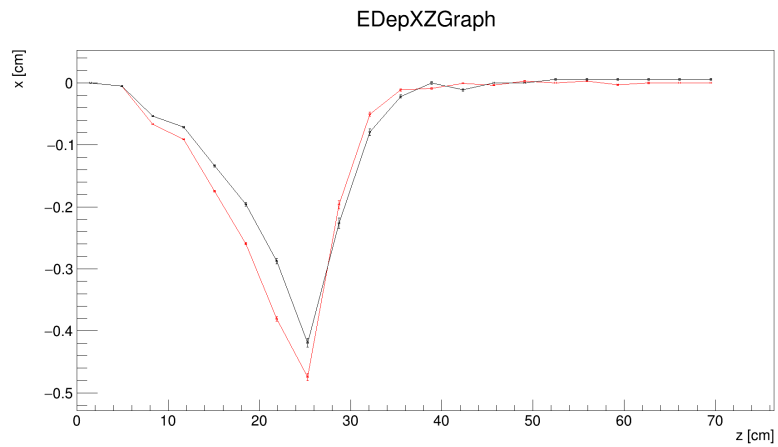
# X coordinate

# Y coordinate

150 GeV

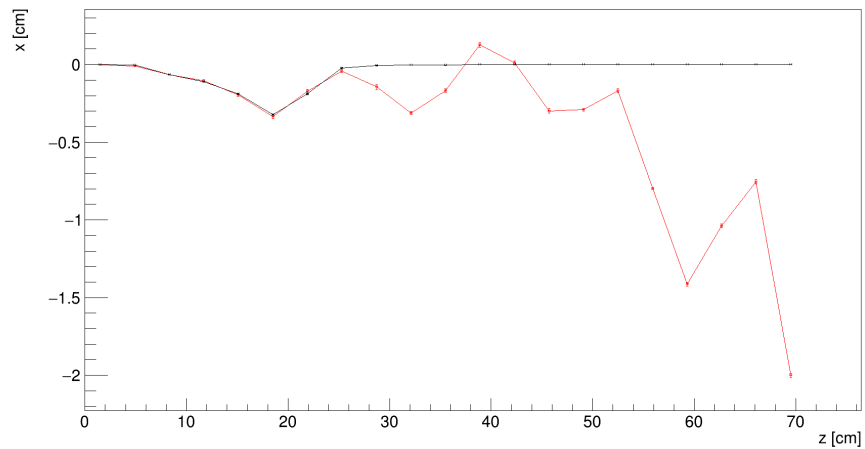


100 GeV



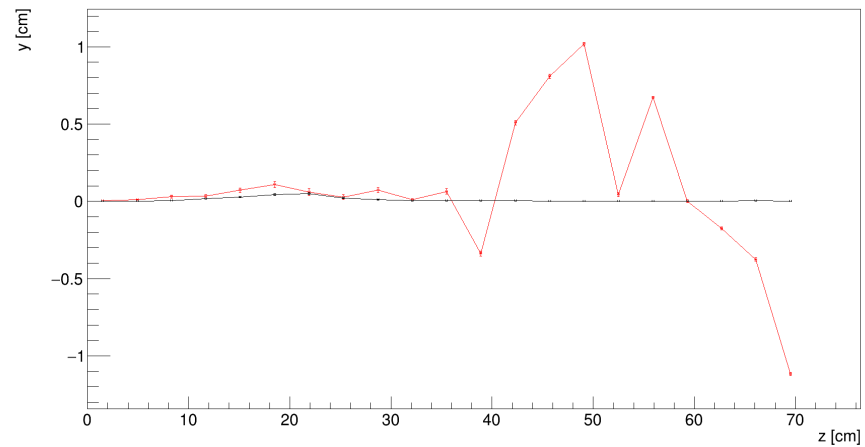
# X coordinate

EDepXZGraph



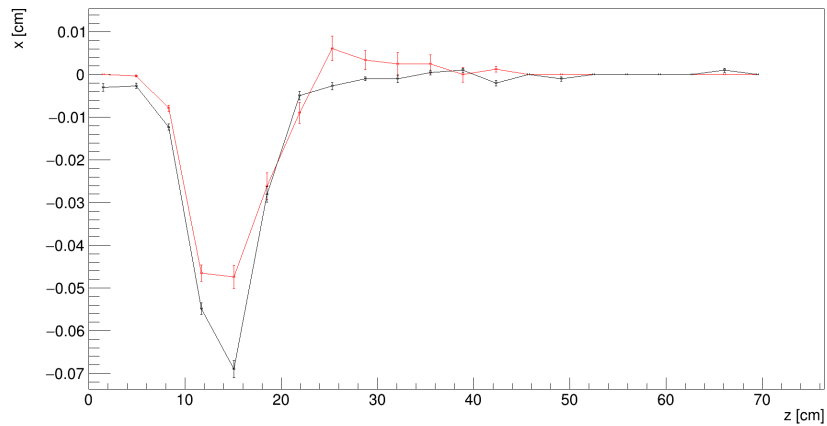
# Y coordinate

EDepYZGraph

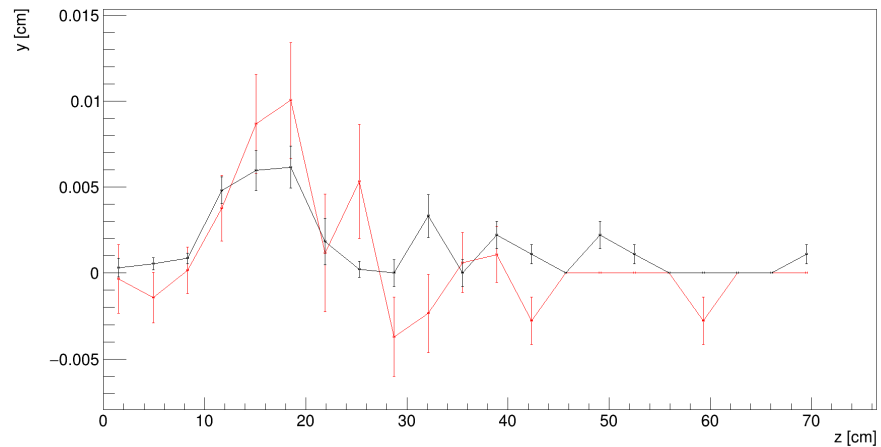


50 GeV

EDepXZGraph



EDepYZGraph



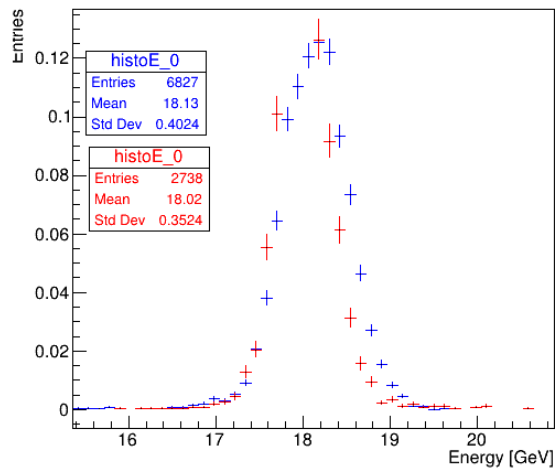
20 GeV



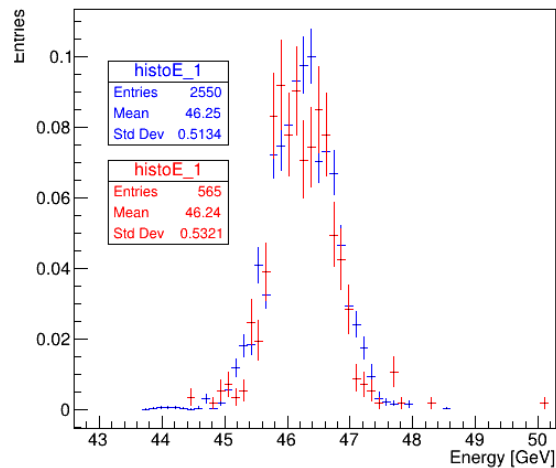
Data  
Simulations

# Energy histograms

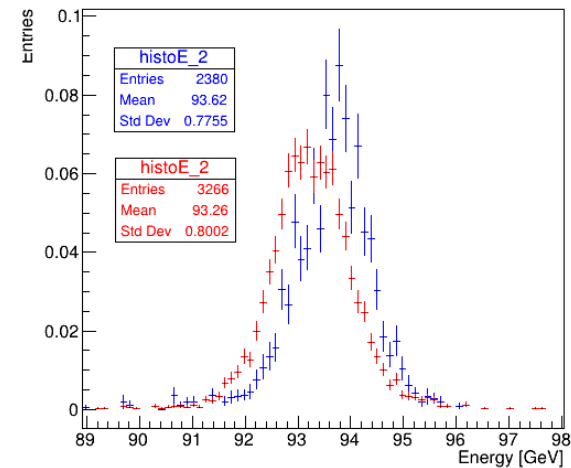
histo\_20GeV



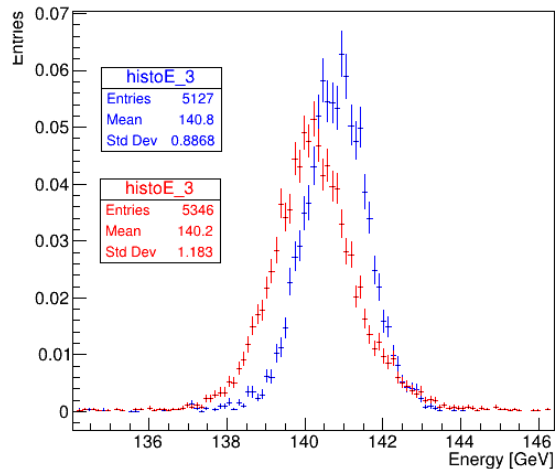
histo\_50GeV



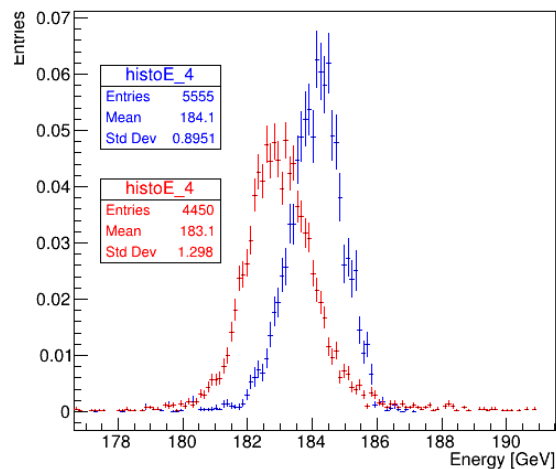
histo\_100GeV



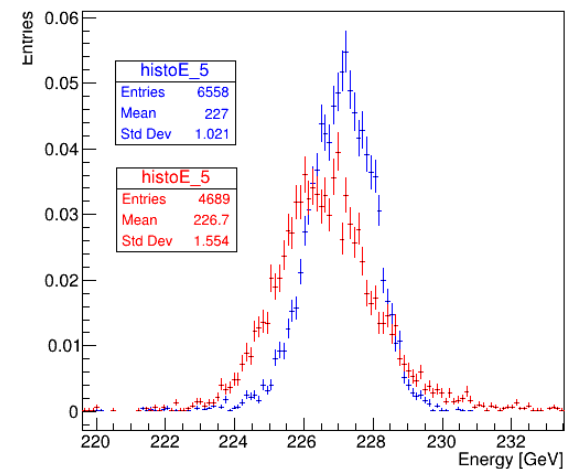
histo\_150GeV



histo\_200GeV



histo\_250GeV

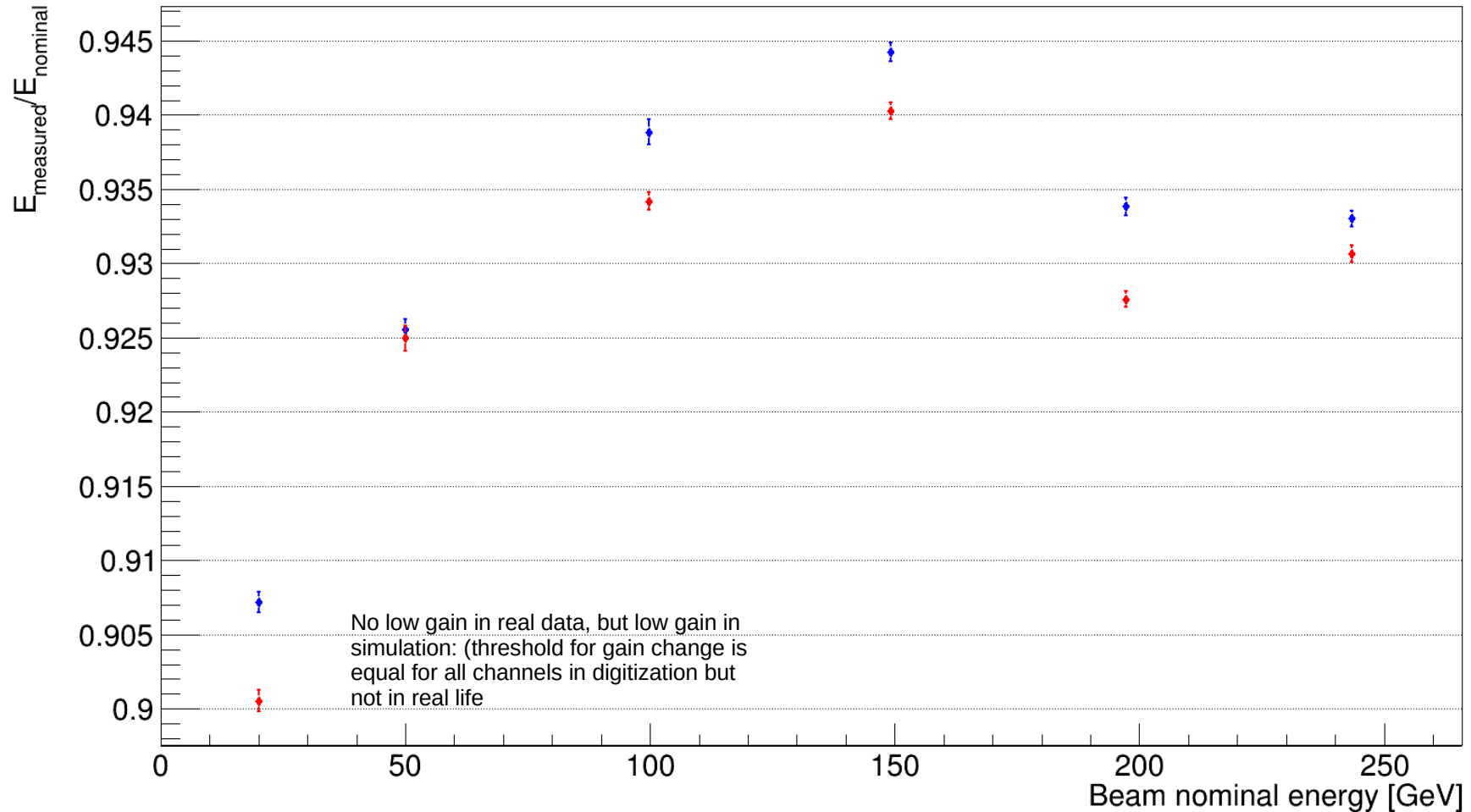


# Fraction of energy revealed

energyEstimationGraph

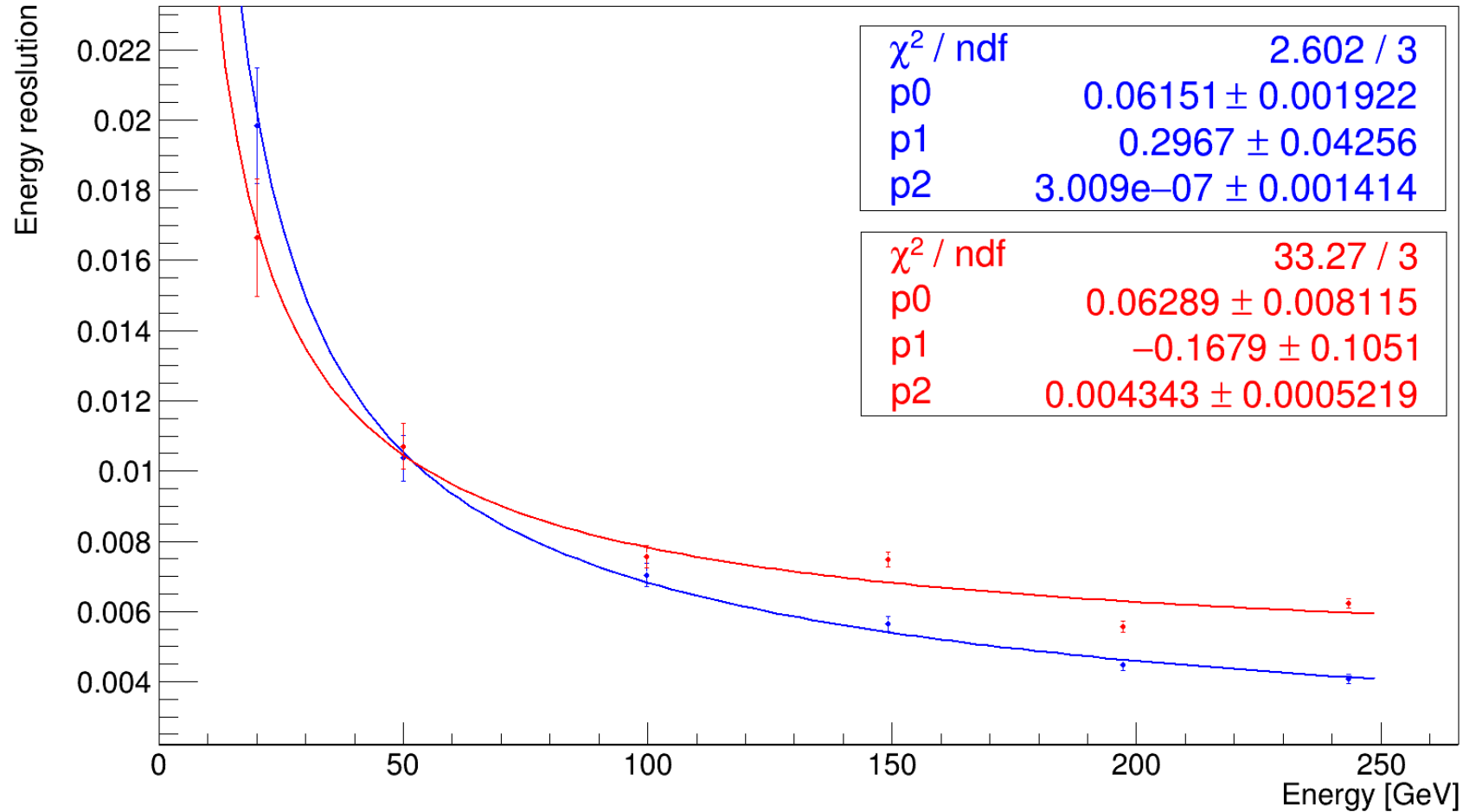
Data

Simulations



# Energy resolution

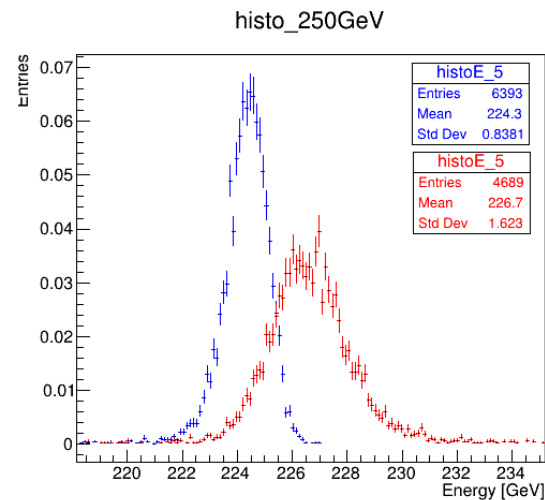
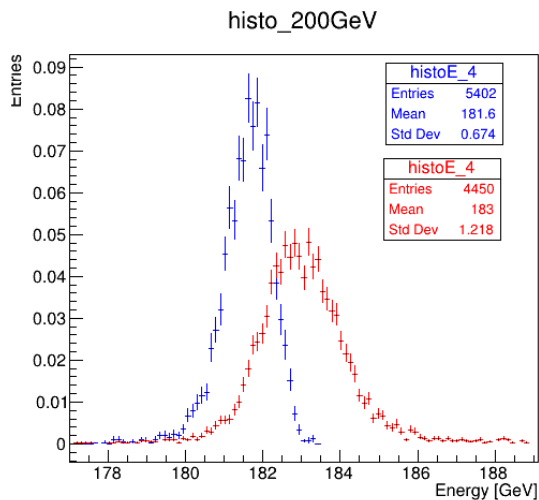
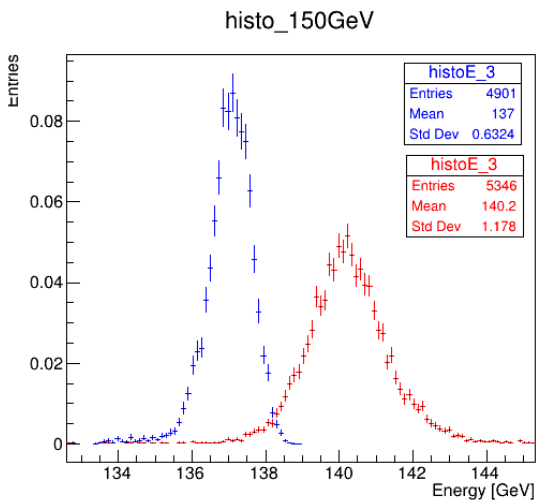
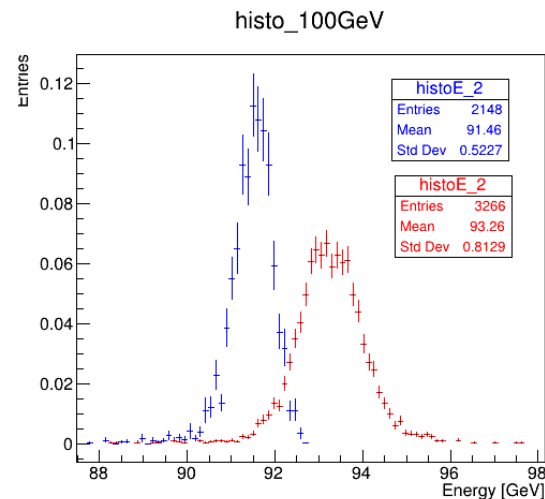
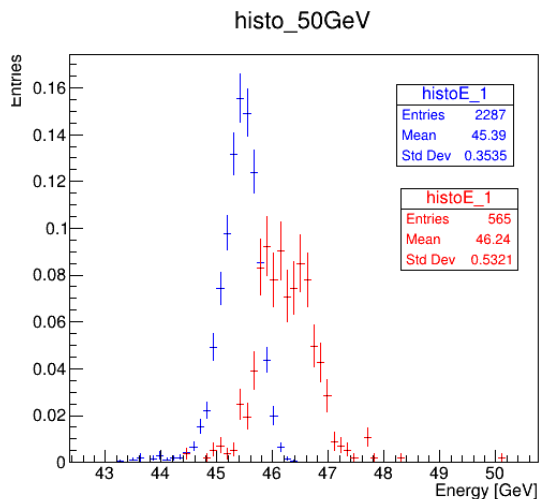
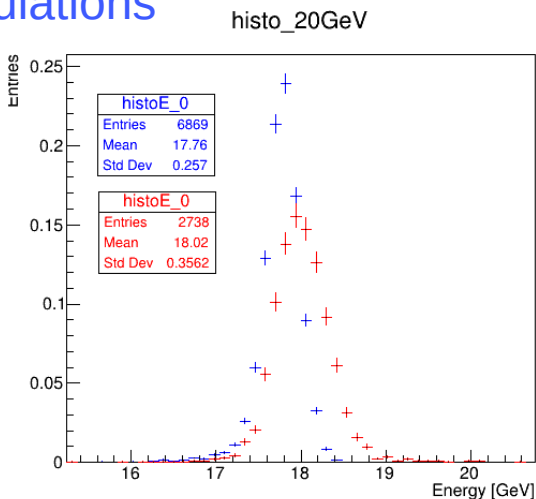
energy resolution graph confidence level



Data  
Simulations

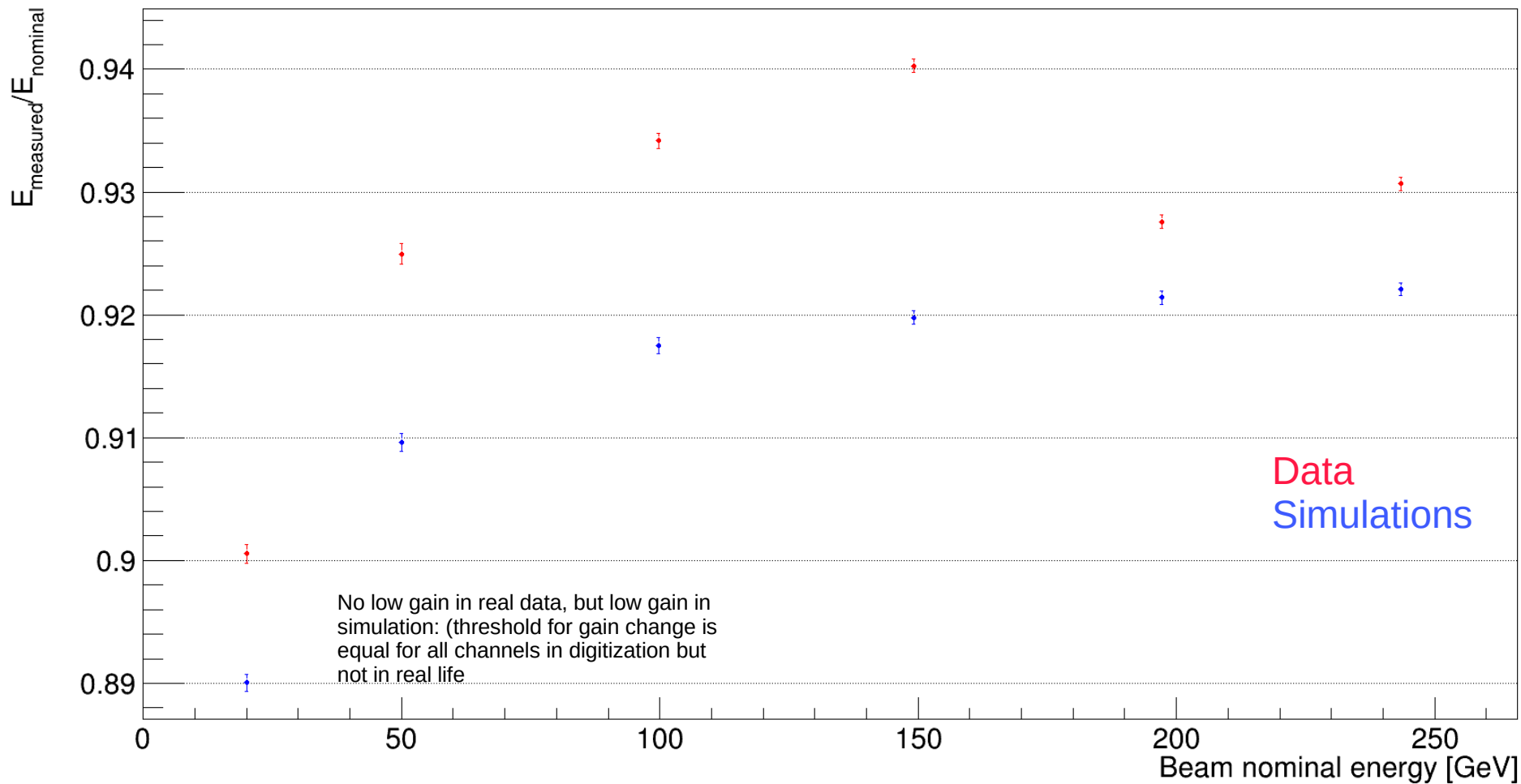
Data  
Simulations

# Results without gain jump effect in digitization



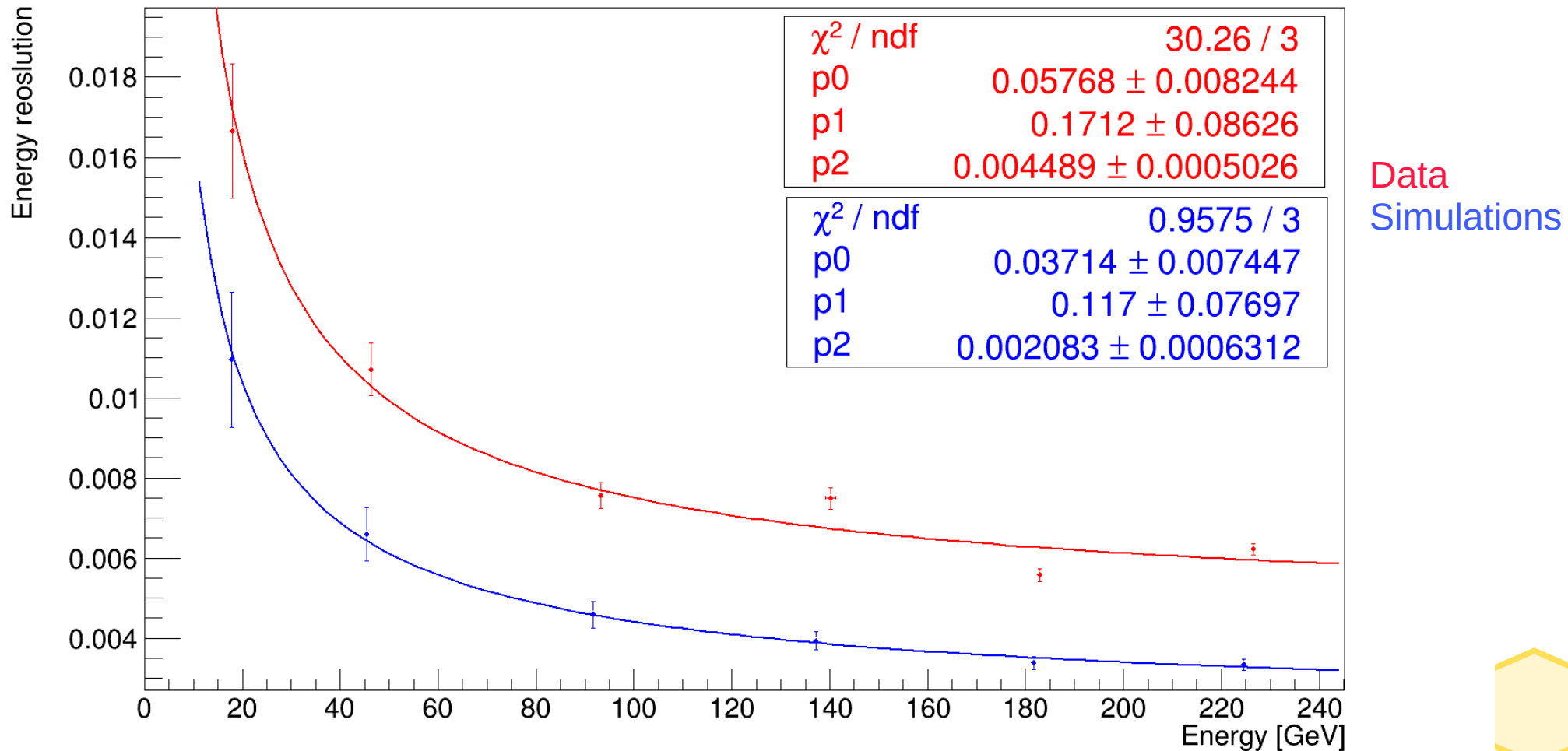
# Results without gain jump effect in digitization

## energyEstimationGraph



# Results without gain jump effect in digitization

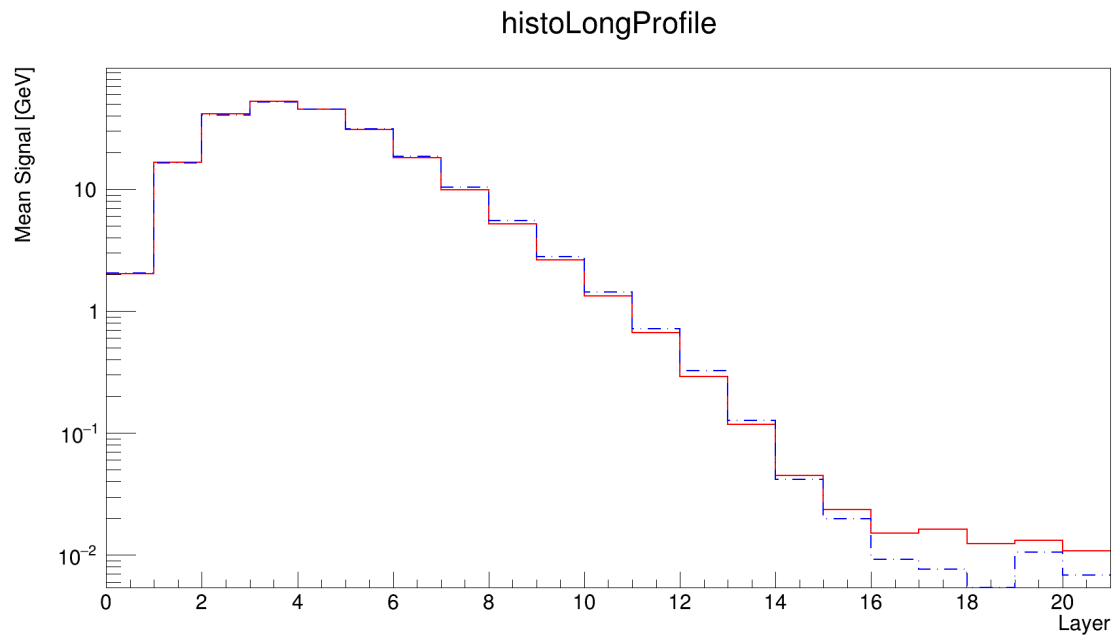
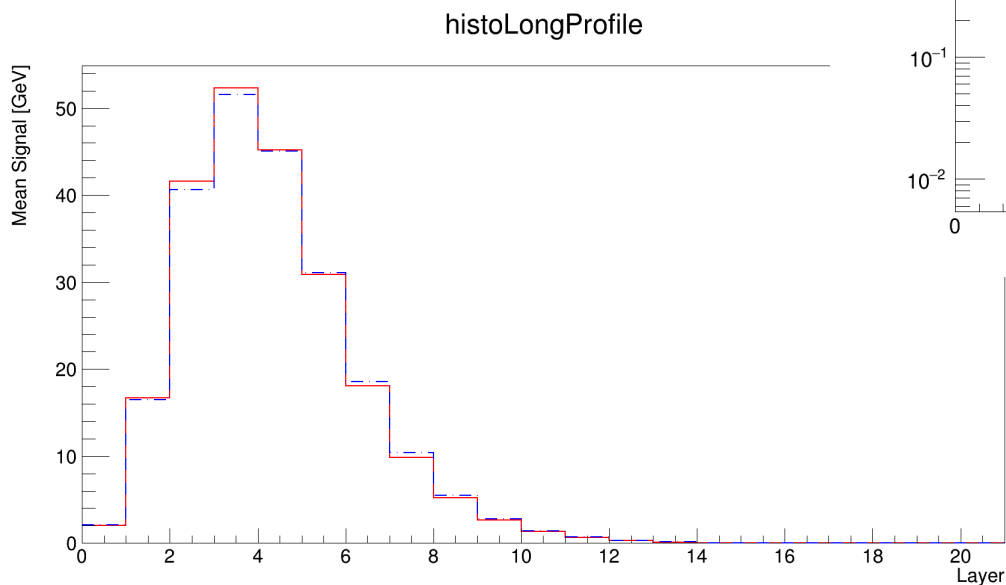
energy resolution graph confidence level



Come back at digitization with gain change jump

# Longitudinal profiles – 250 GeV

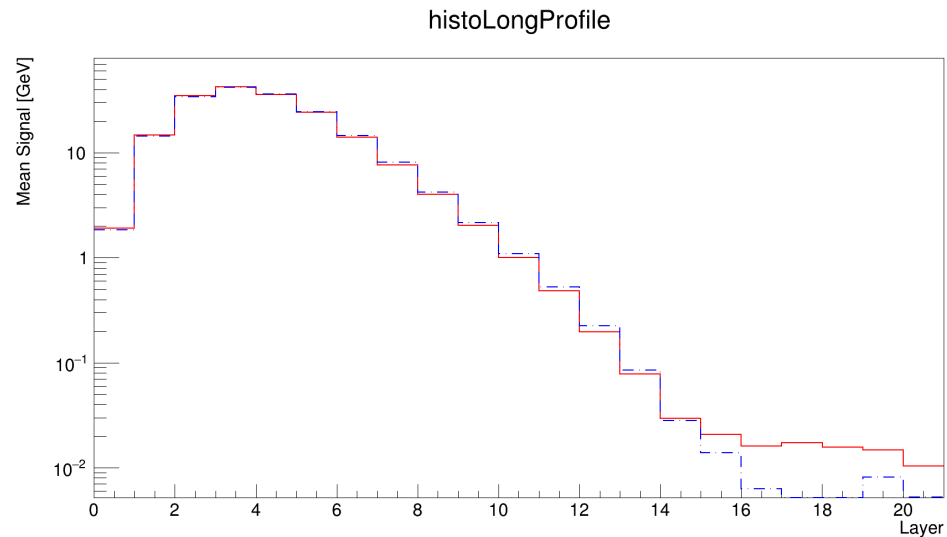
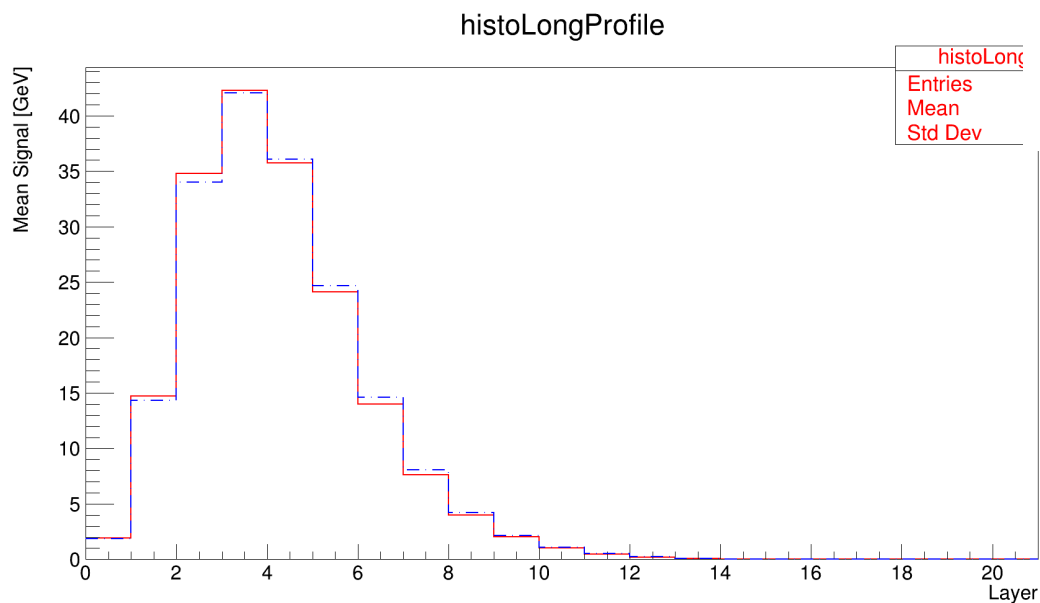
Data  
Simulations





# Longitudinal profiles – 200 GeV

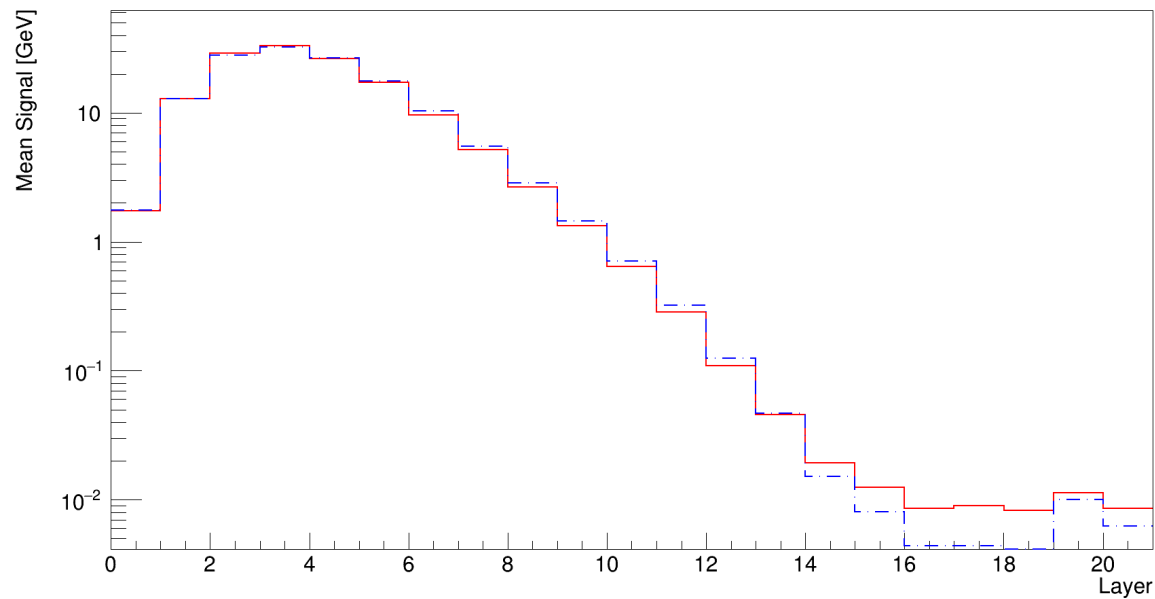
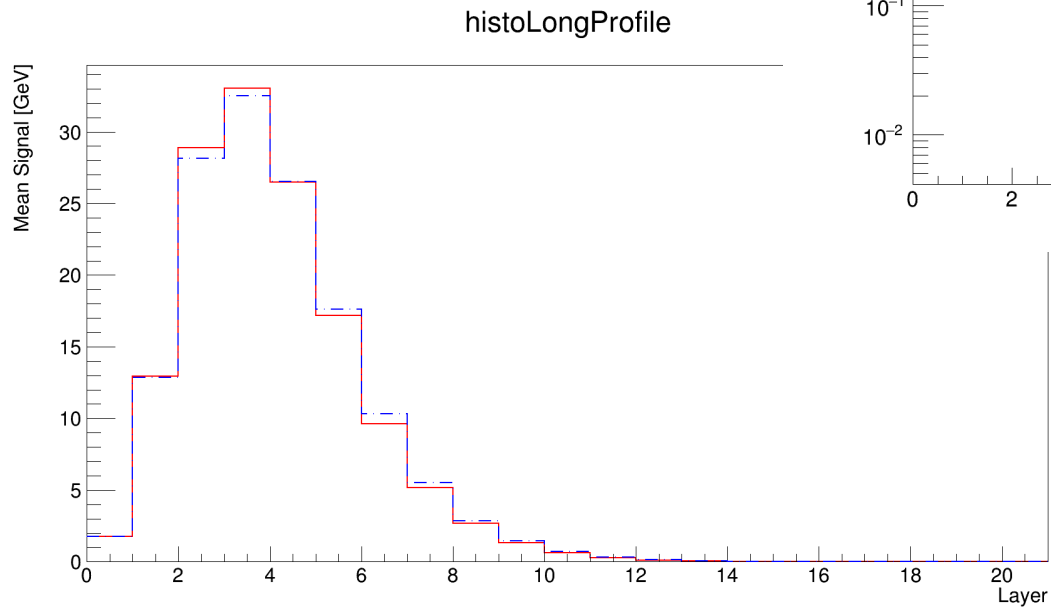
Data  
Simulations



# Longitudinal profiles – 150 GeV

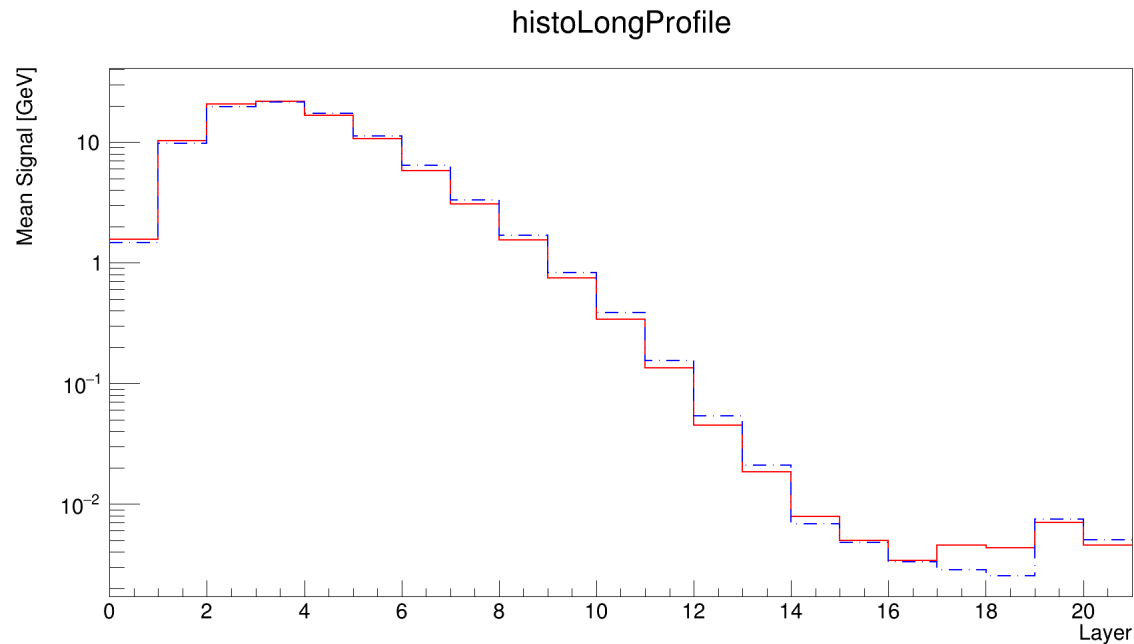
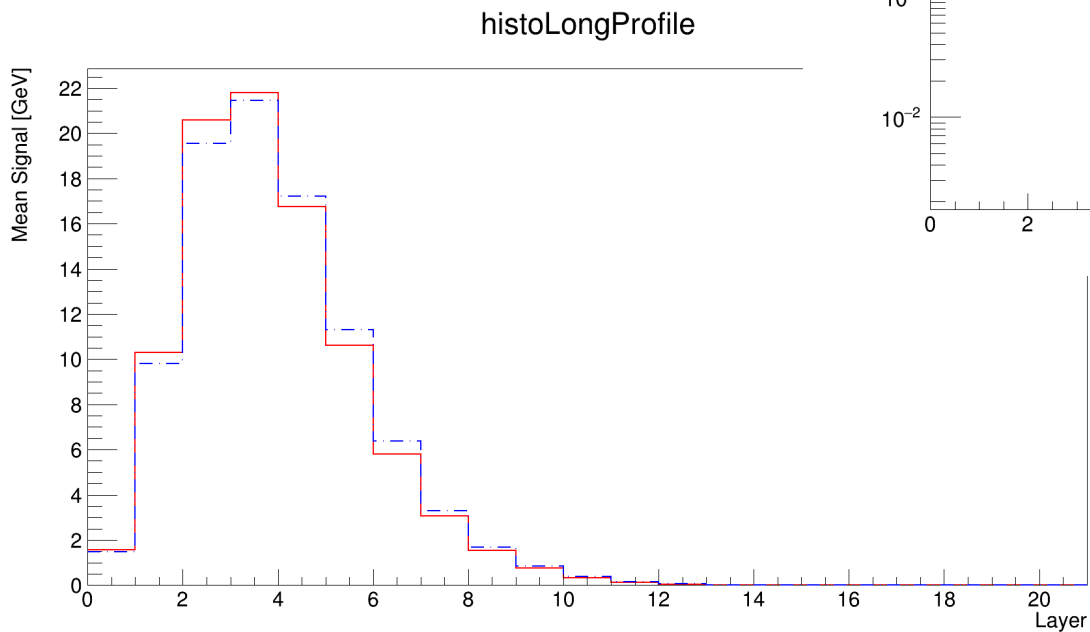
histoLongProfile

Data  
Simulations



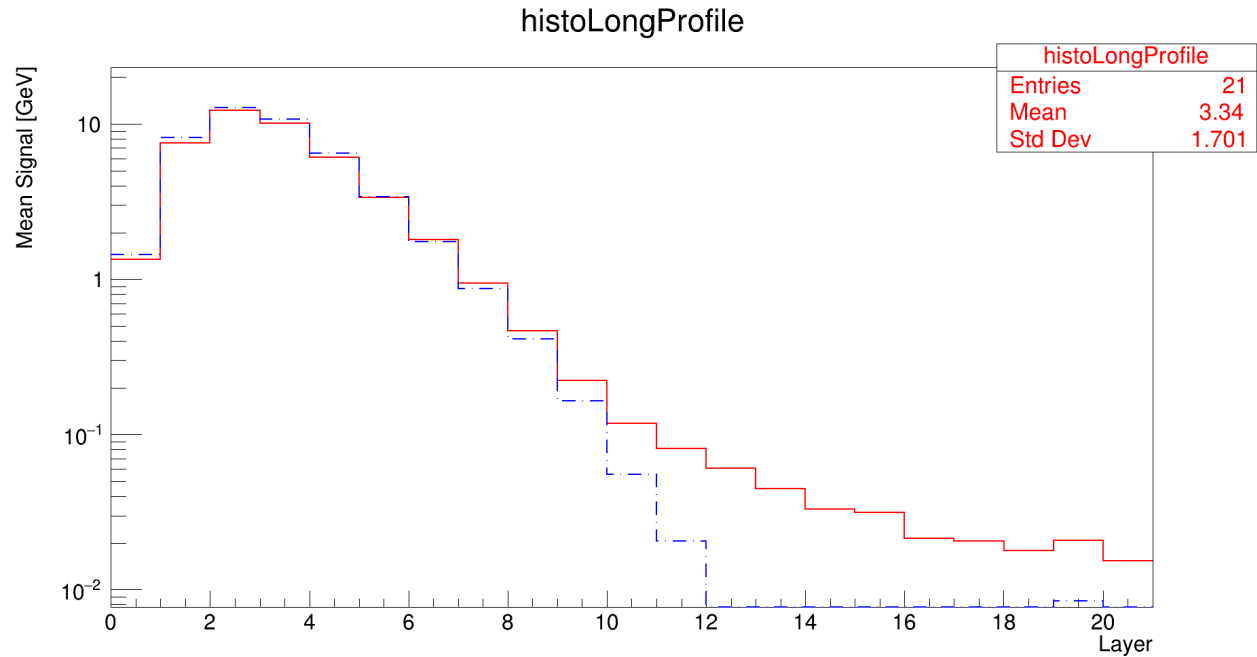
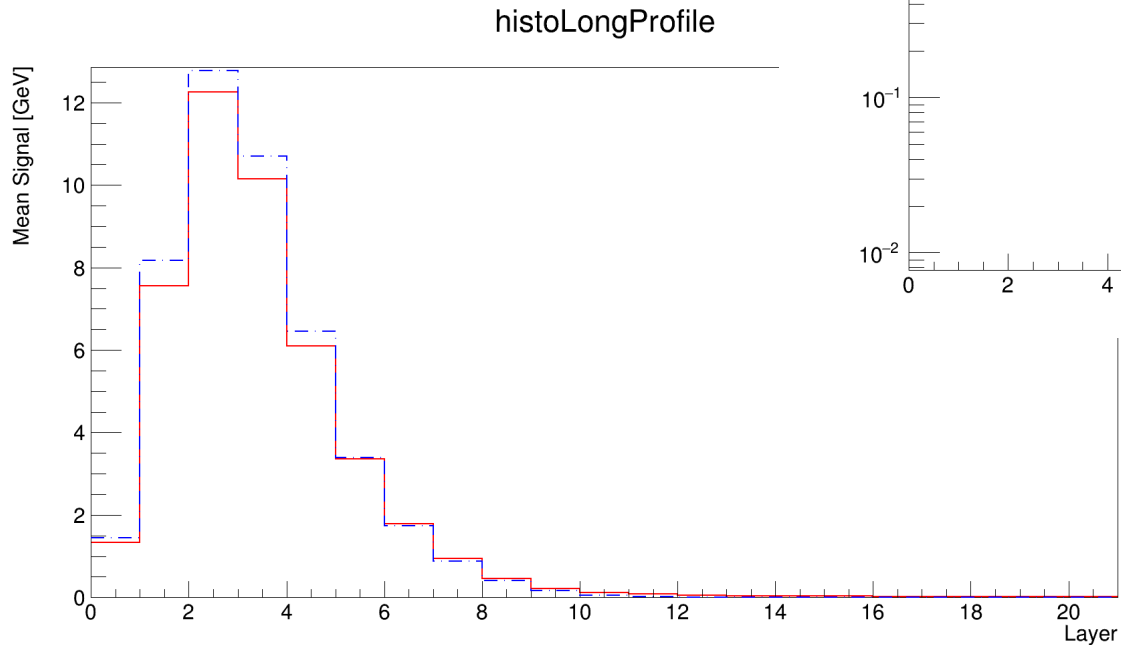
# Longitudinal profiles – 100 GeV

Data  
Simulations



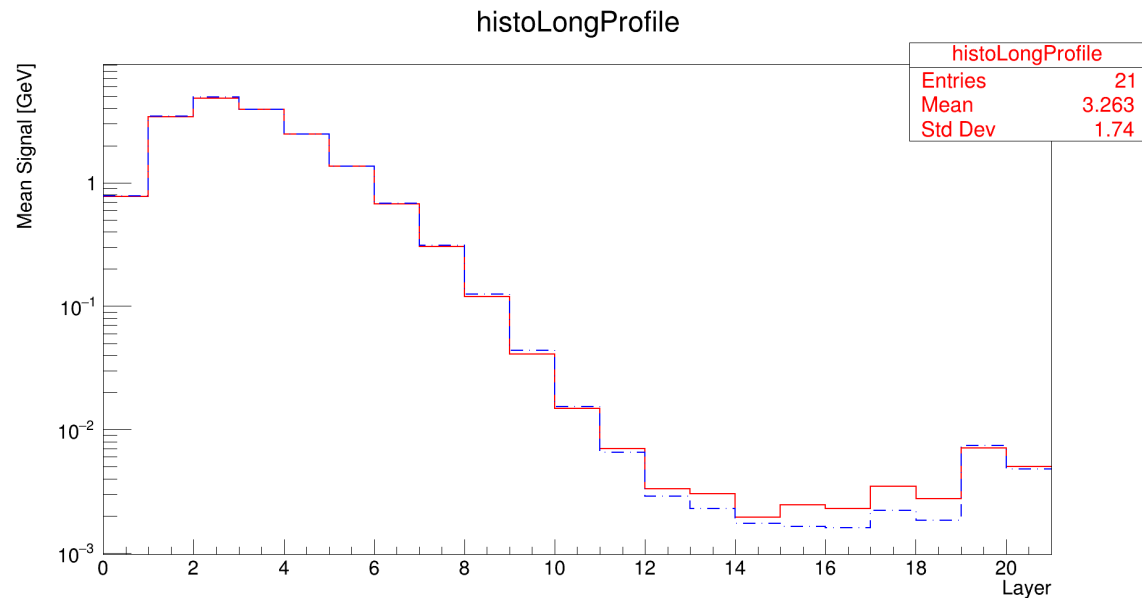
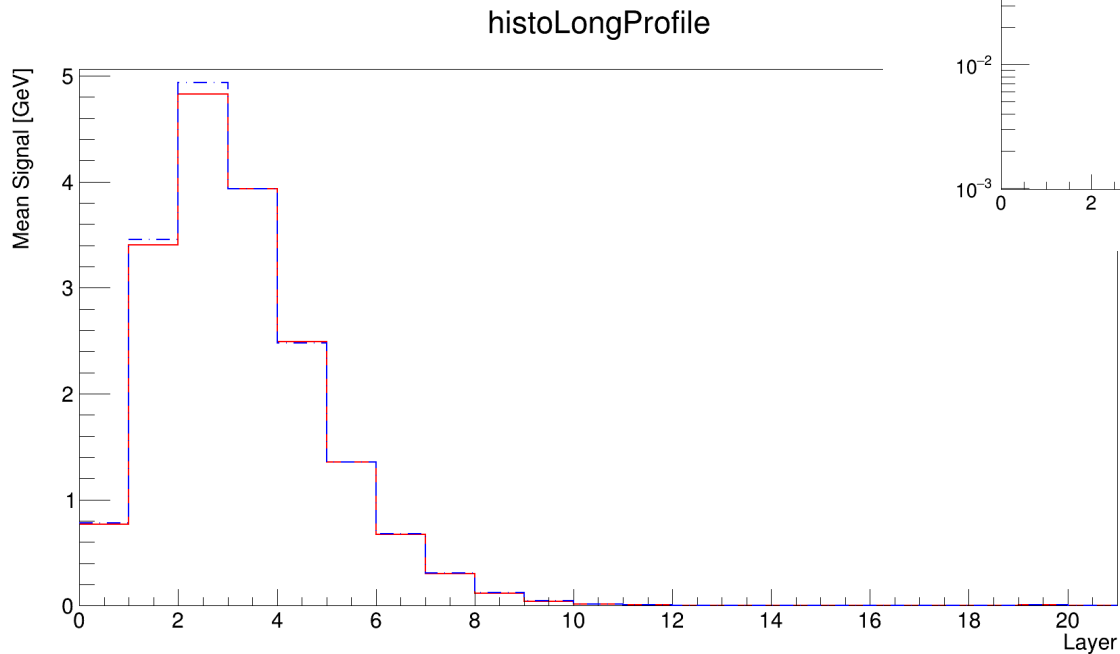
# Longitudinal profiles – 50 GeV

Data  
Simulations



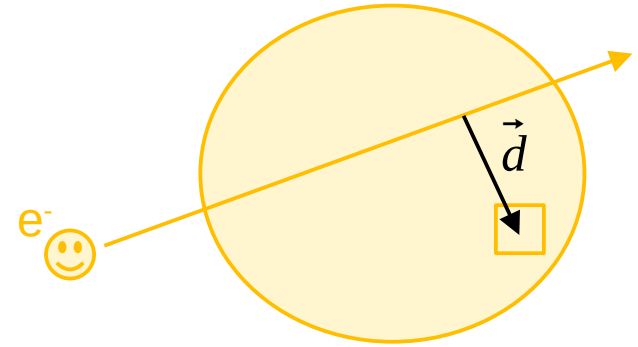
# Longitudinal profiles – 20 GeV

Data  
Simulations



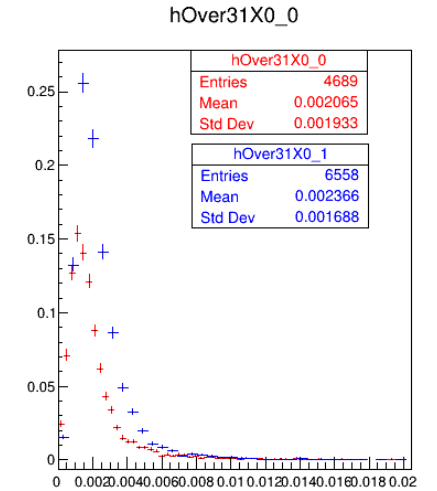
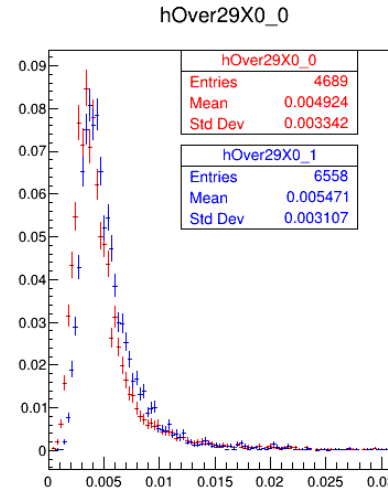
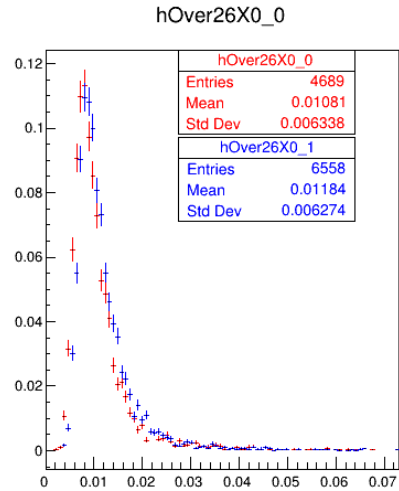
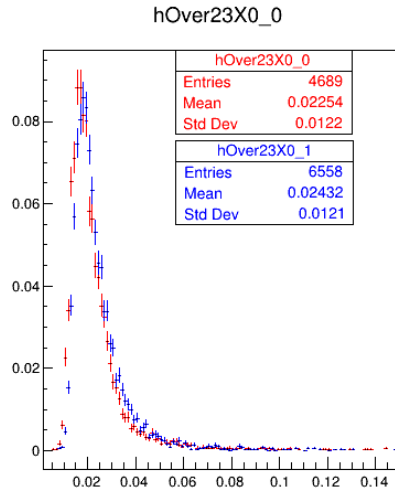
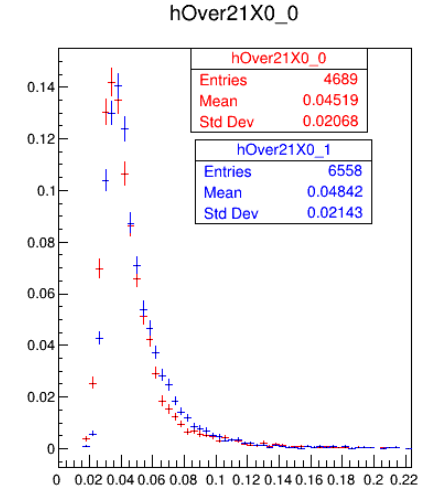
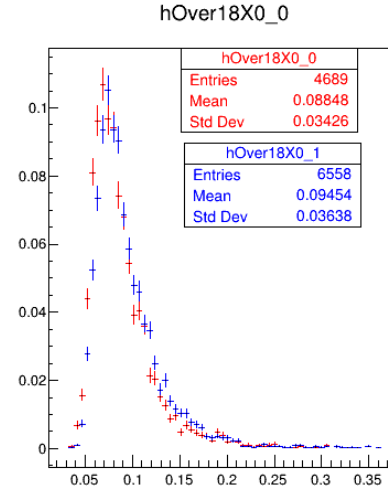
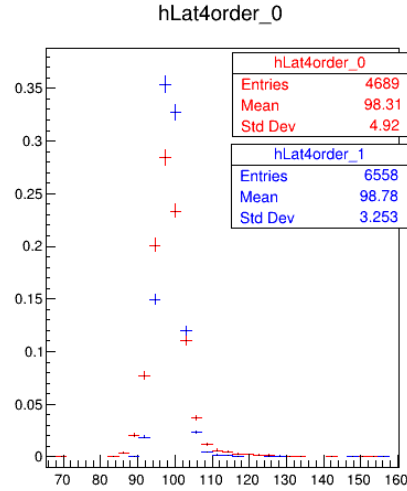
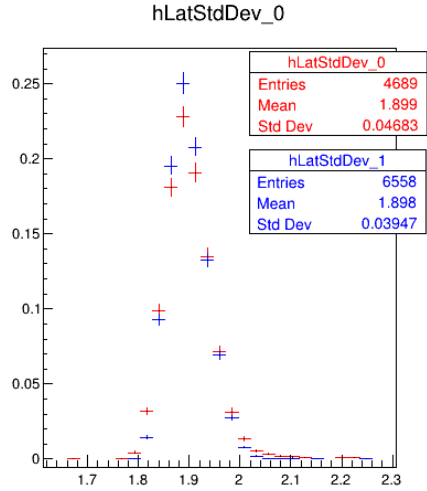
# Rejection variables

- Lateral momenta: 
$$M_n = \left| \sum_{i=\text{crystals}} E_i \cdot (\vec{d})^n \right|$$

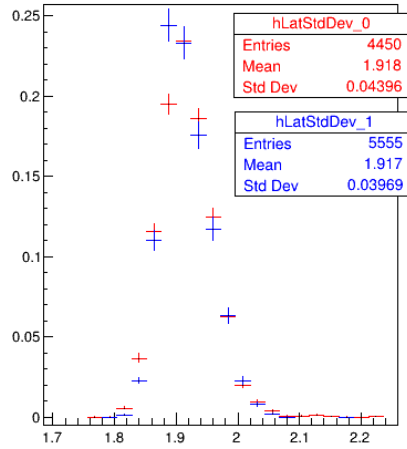


- Fraction of energy over X0 track length

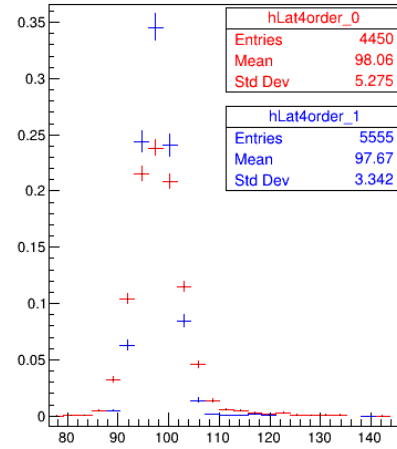
# 250 GeV



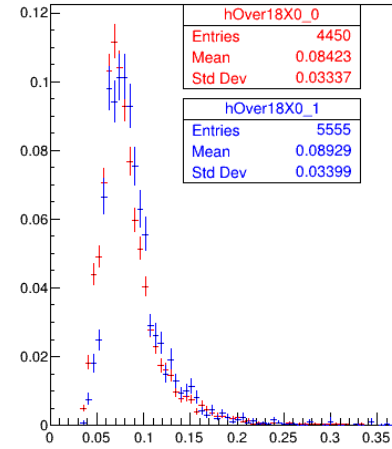
hLatStdDev\_0



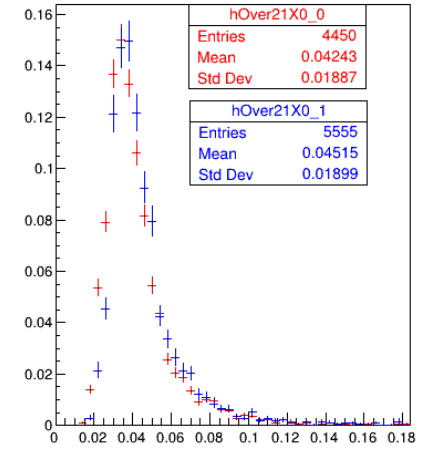
hLat4order\_0



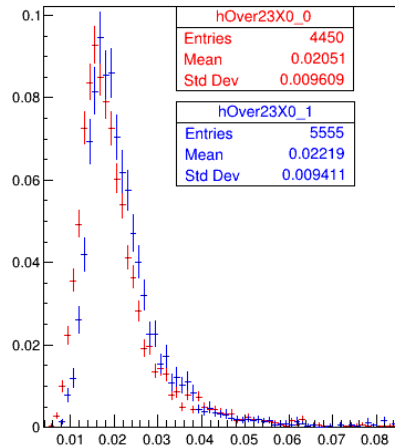
hOver18X0\_0



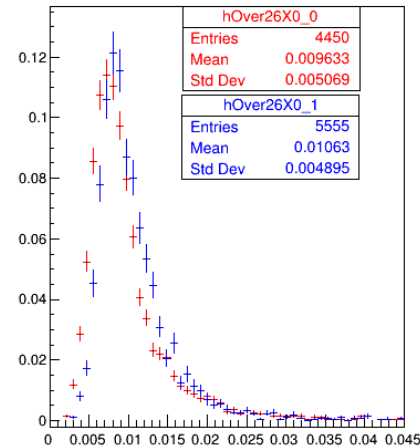
hOver21X0\_0



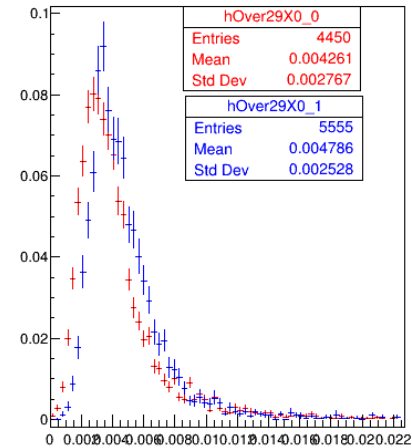
hOver23X0\_0



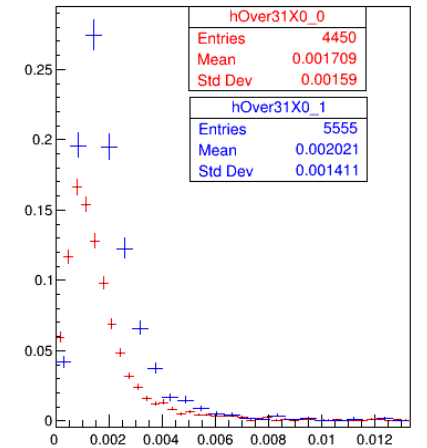
hOver26X0\_0



hOver29X0\_0

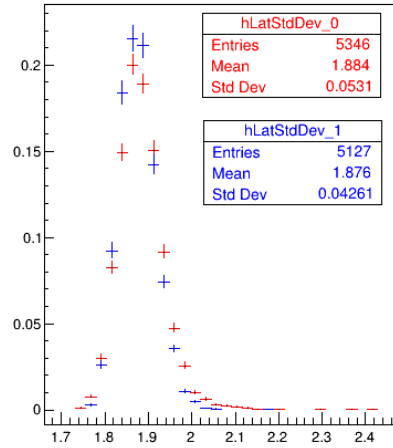


hOver31X0\_0

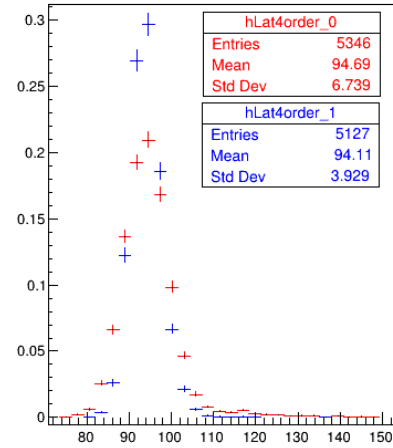




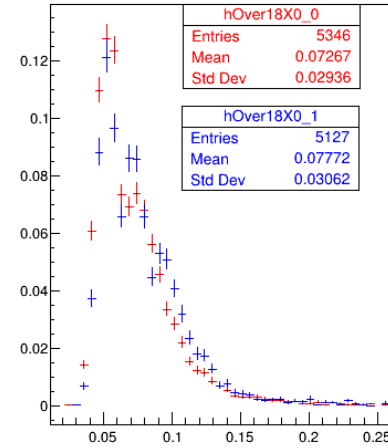
hLatStdDev\_0



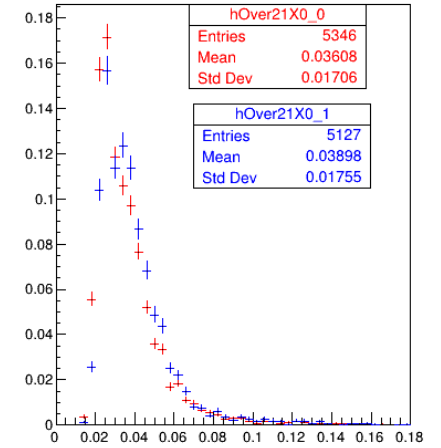
hLat4order\_0



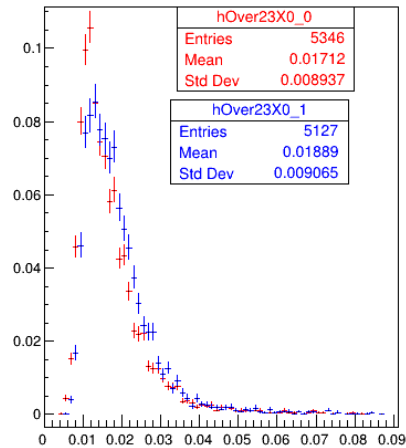
hOver18X0\_0



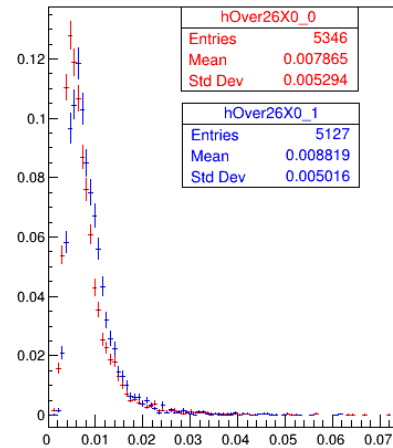
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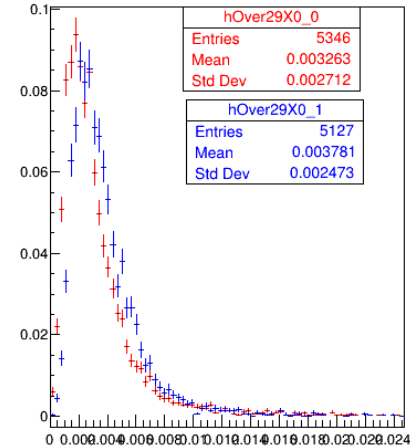
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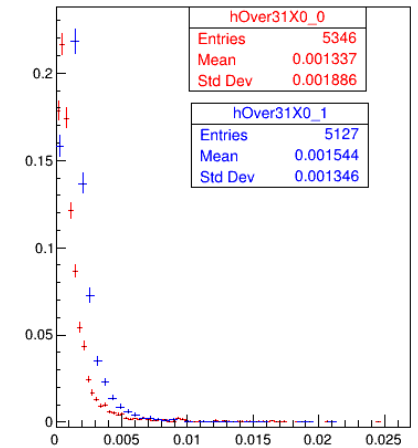
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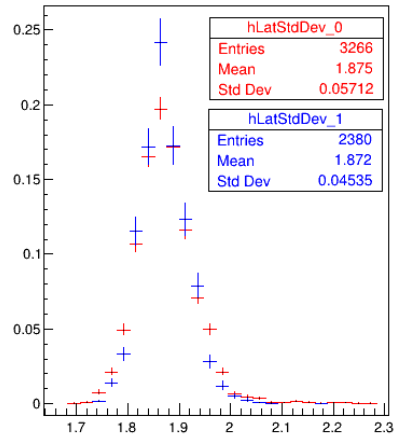
hOver29X0\_0



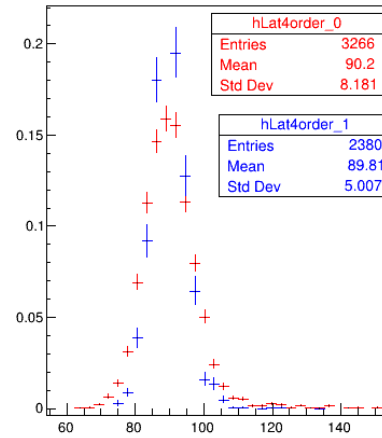
hOver31X0\_0



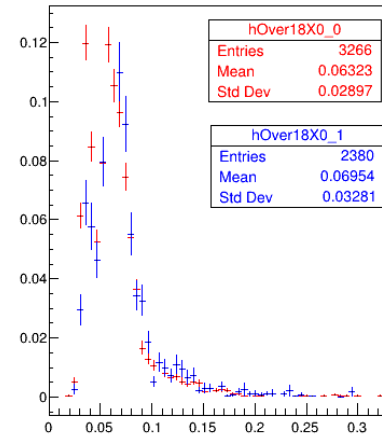
hLatStdDev\_0



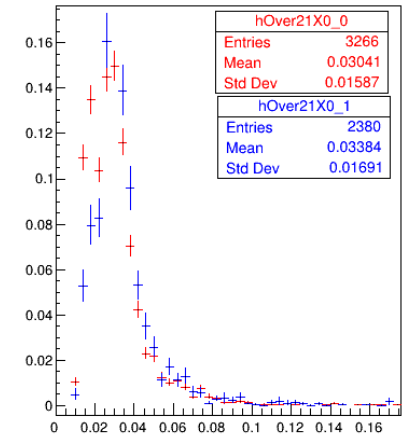
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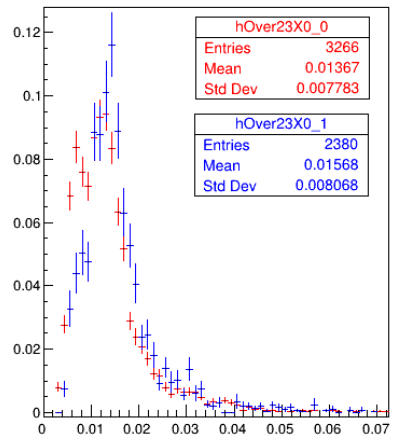
hOver18X0\_0



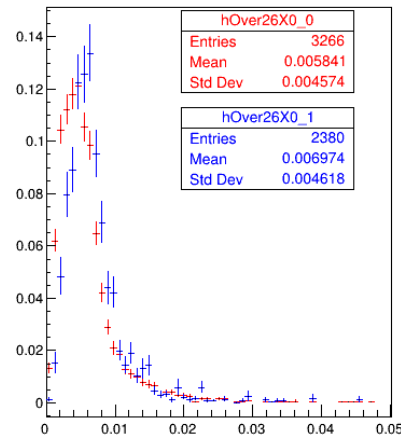
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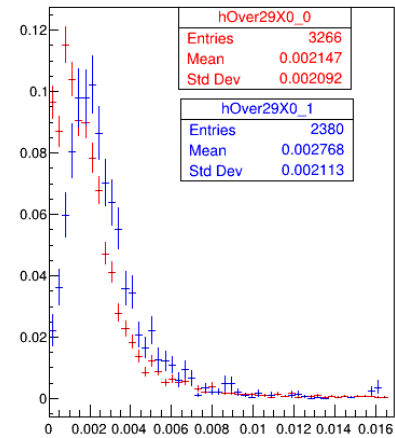
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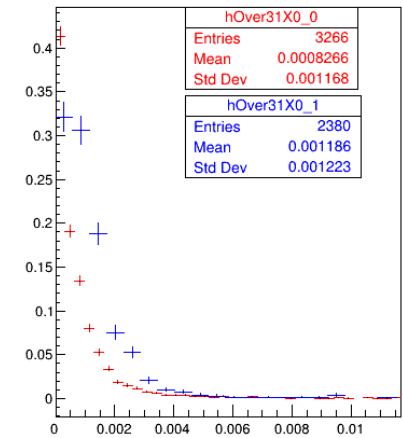
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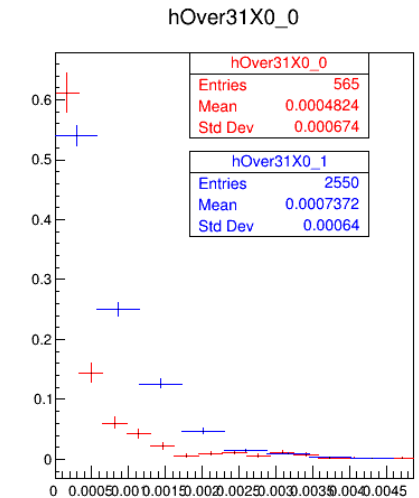
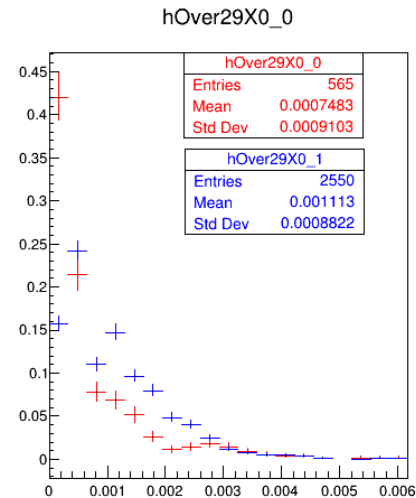
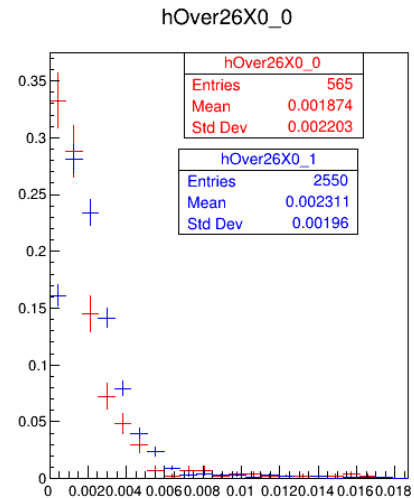
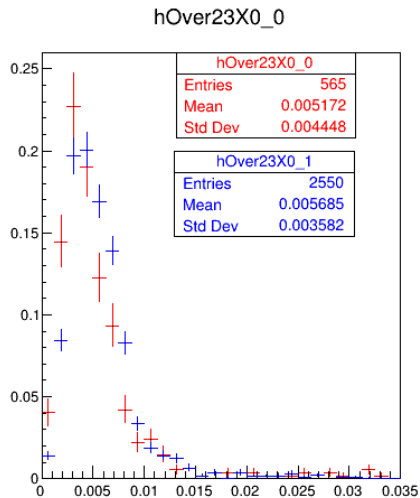
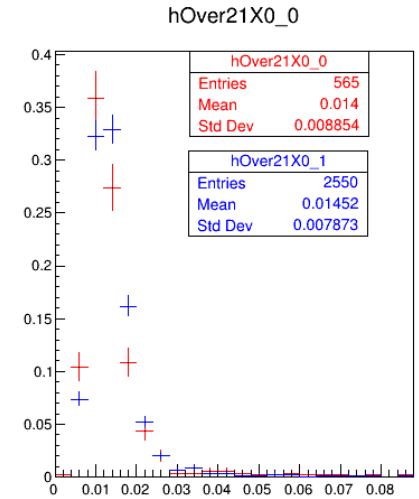
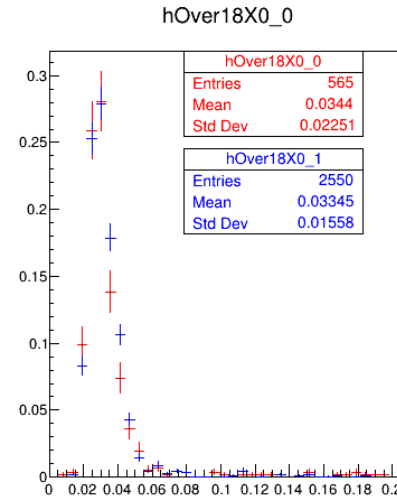
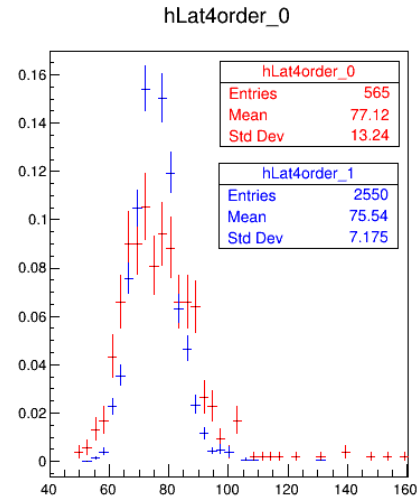
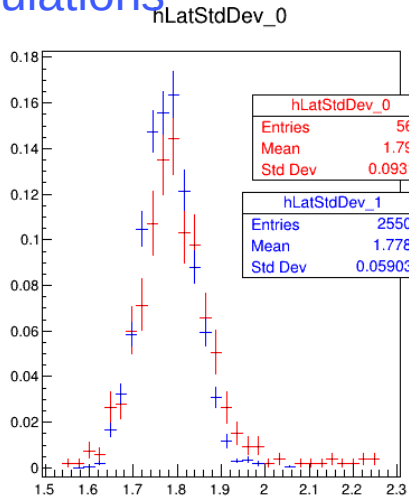
hOver29X0\_0



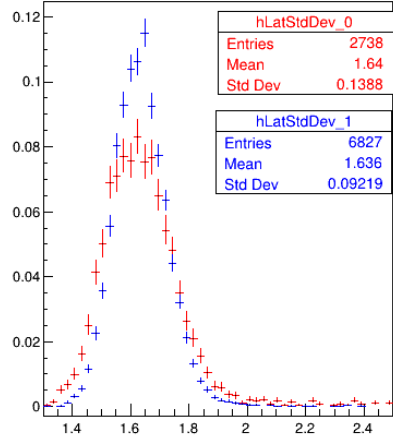
hOver31X0\_0



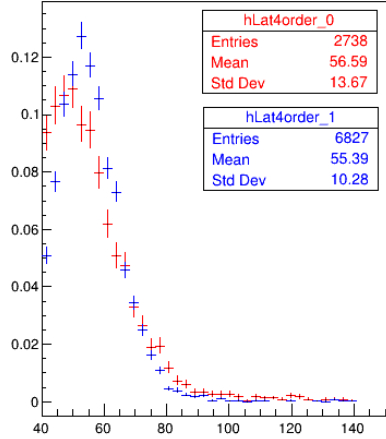
# 50 GeV



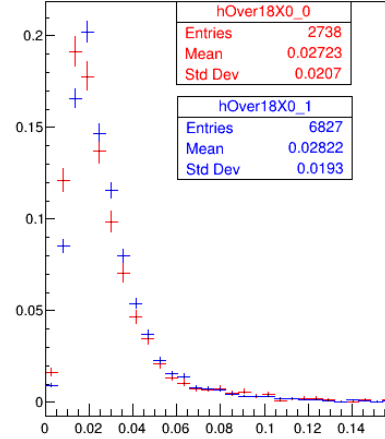
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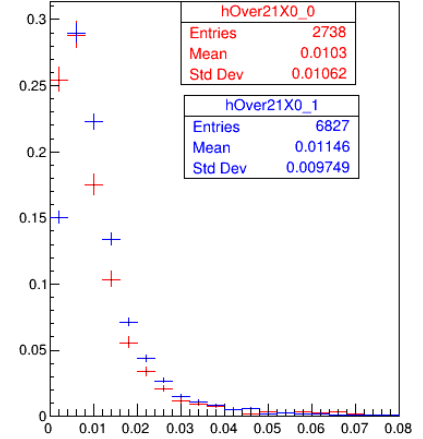
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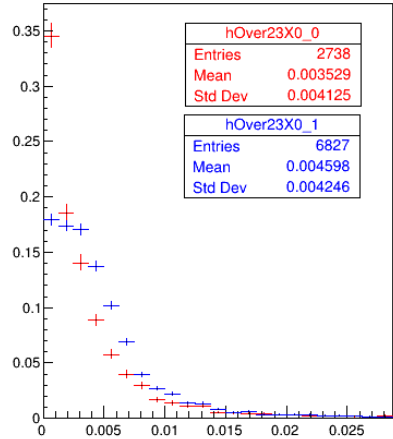
hOver18X0\_0



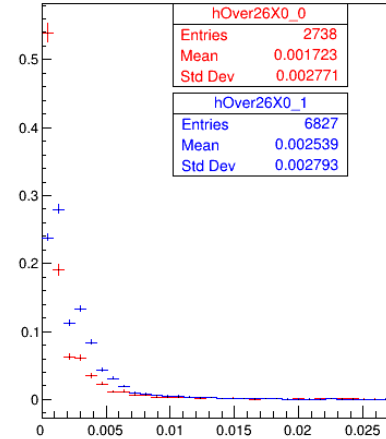
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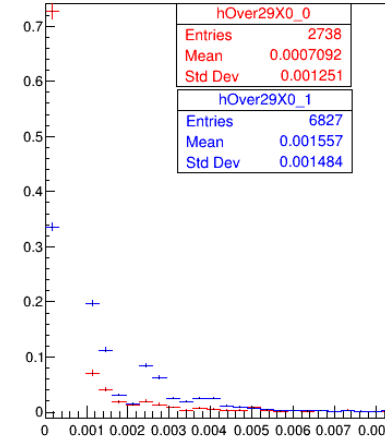
hOver23X0\_0



hOver26X0\_0



hOver29X0\_0



hOver31X0\_0

