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Validation and Reconstruction for the ZDC in DD4hep

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U.S. DEPARTMENT OF ENERGY BATTELLE

PNNL is operated by Battelle for the U.S. Department of Energy

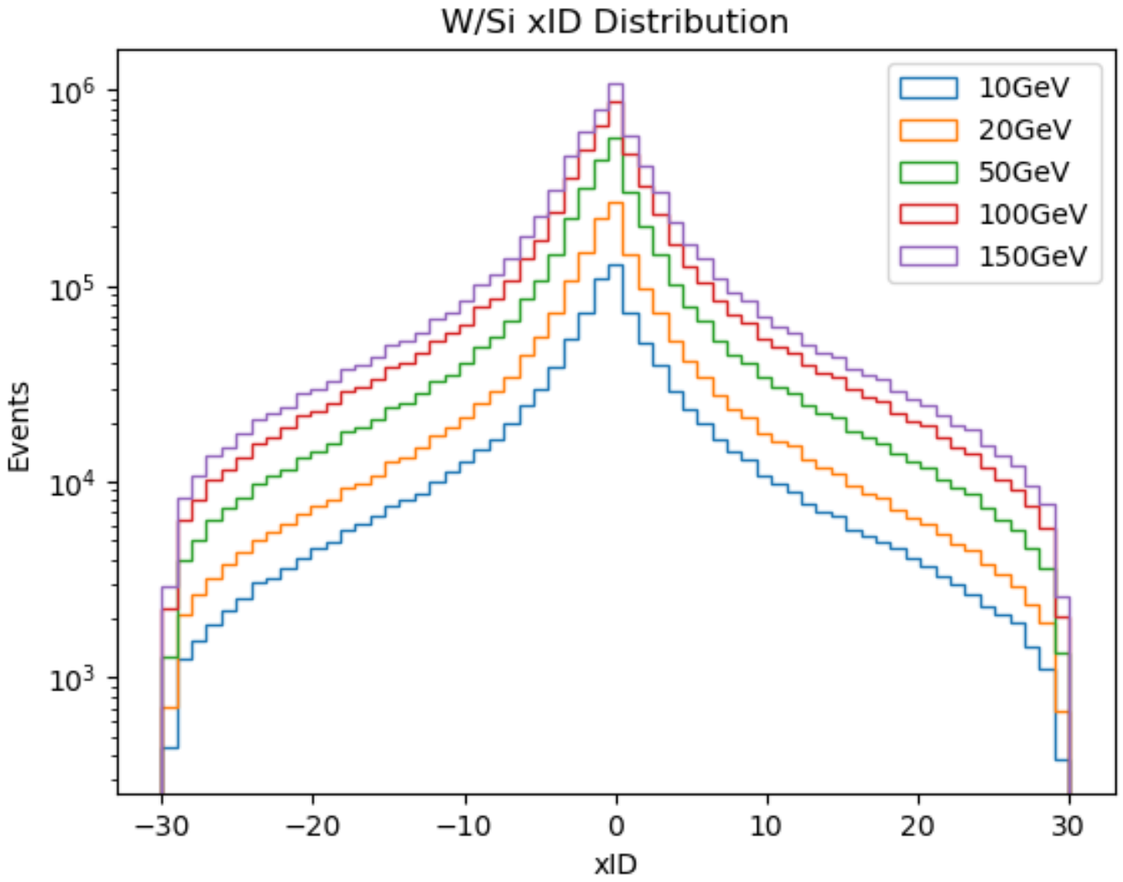
Updates

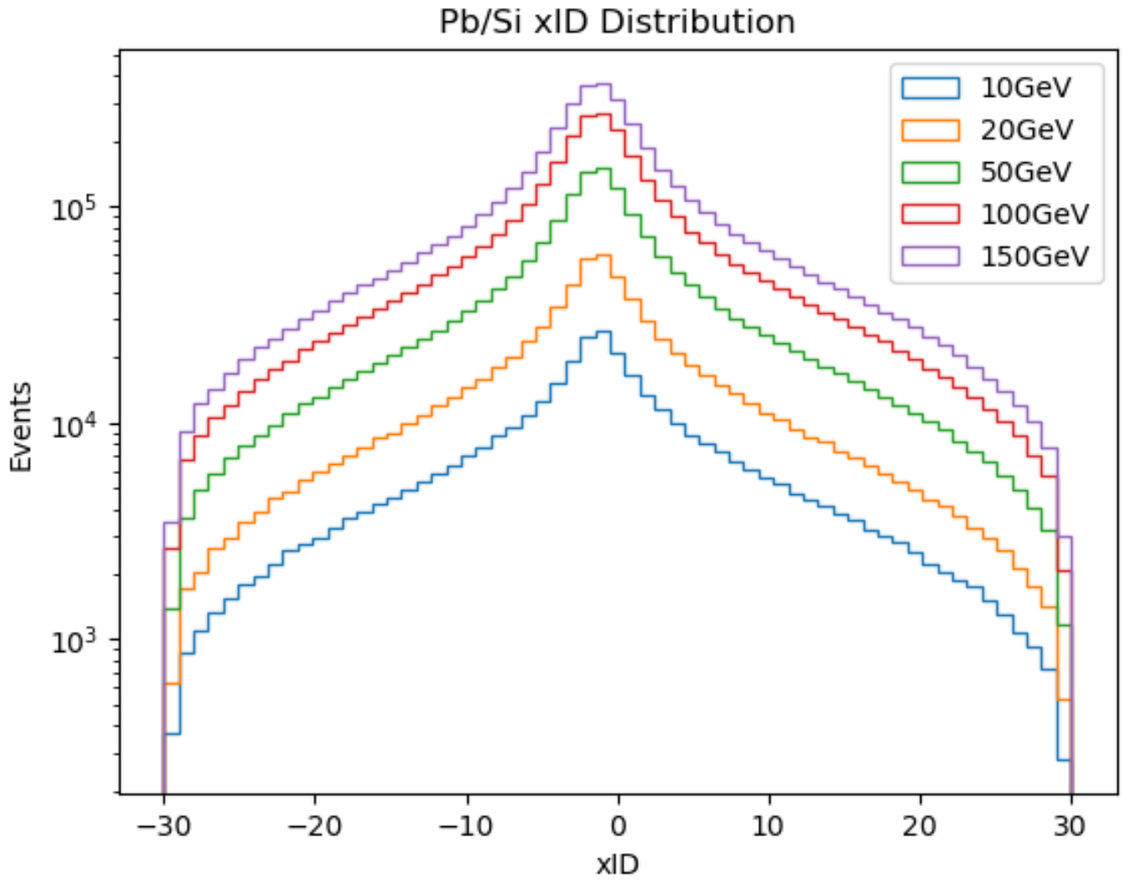
- Detector orientation fixed by Shima
- Bug in DD4hep CartesianGridXY leads to unexpected behavior in transverse plane

Simulations

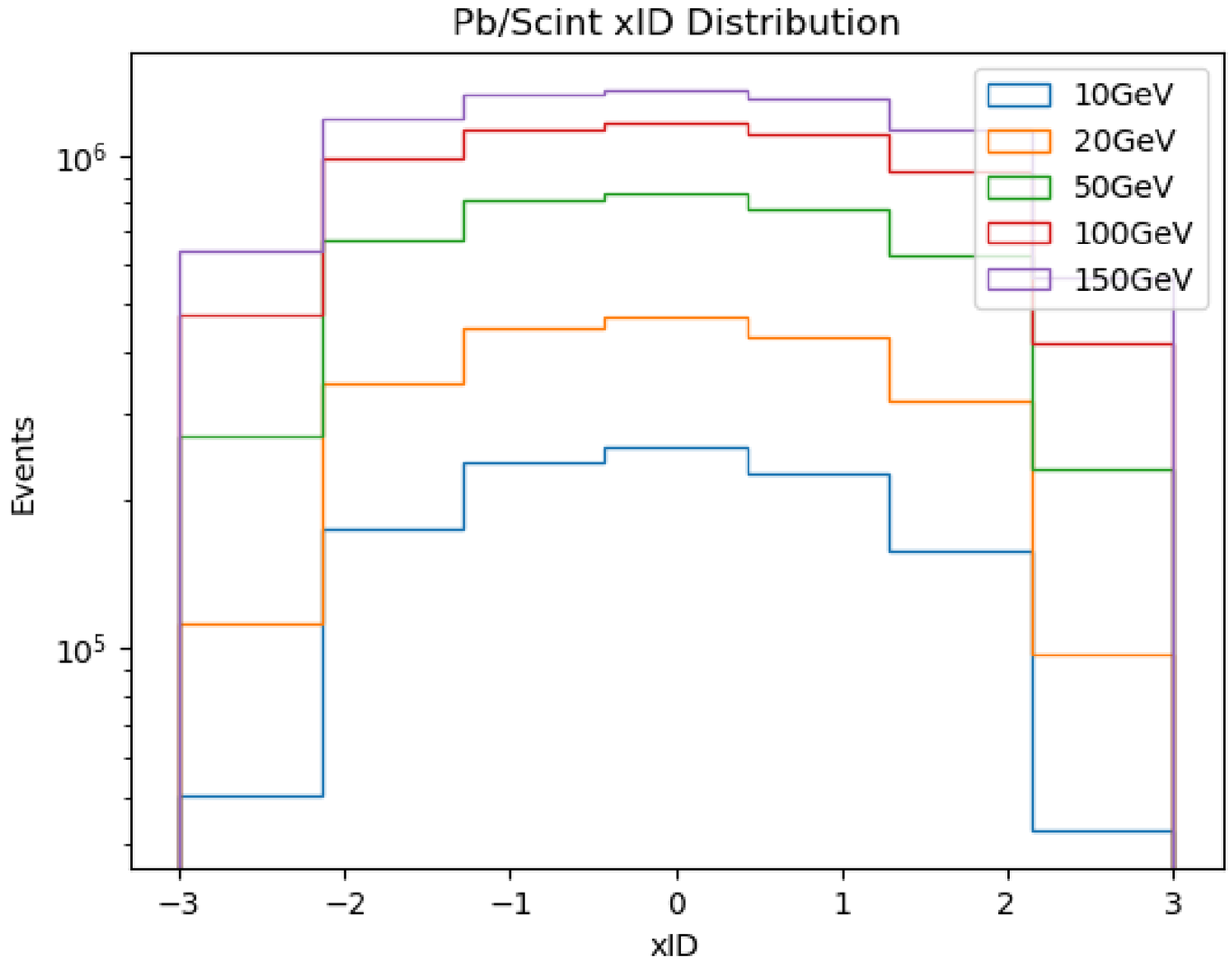
- All simulations performed utilizing the EIC DD4hep software stack
- Single particle trajectories along detector z-axis
- Current focus is on high energy neutrons
  - 10 GeV, 20 GeV, 50 GeV, 100 GeV, 150 GeV

Transverse Hit Distributions





Transverse Hit Distributions



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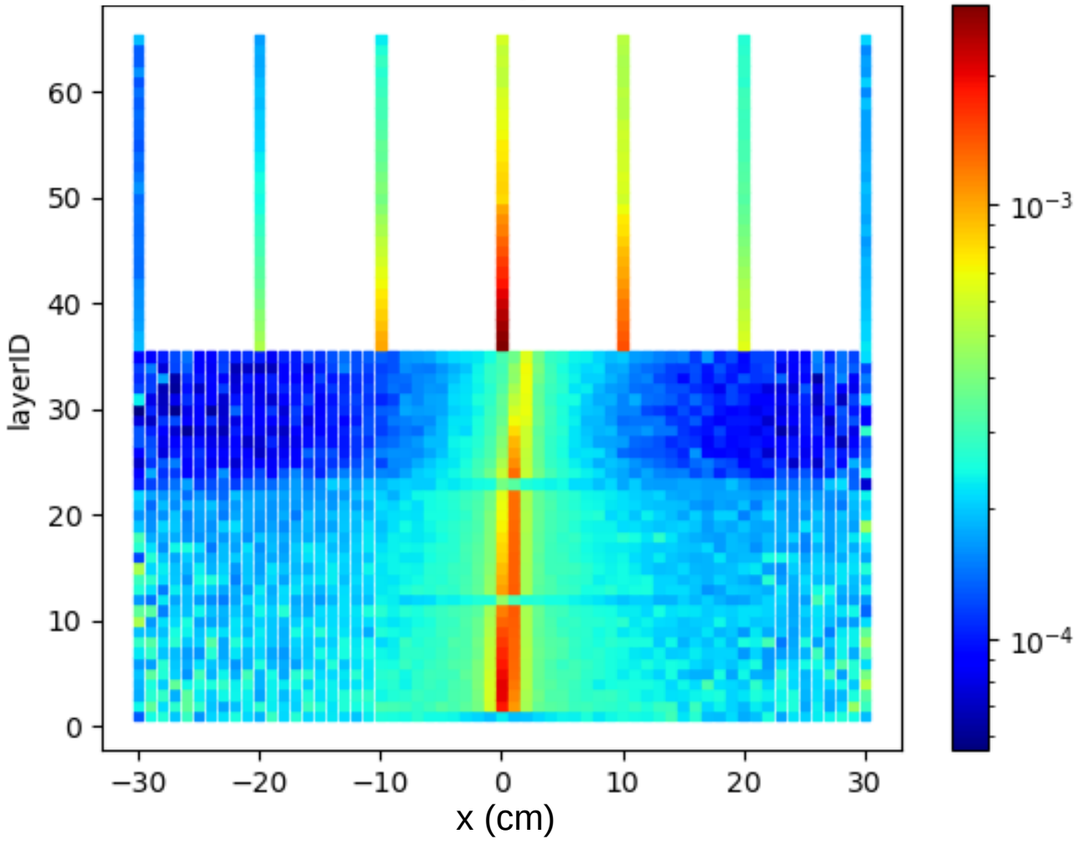
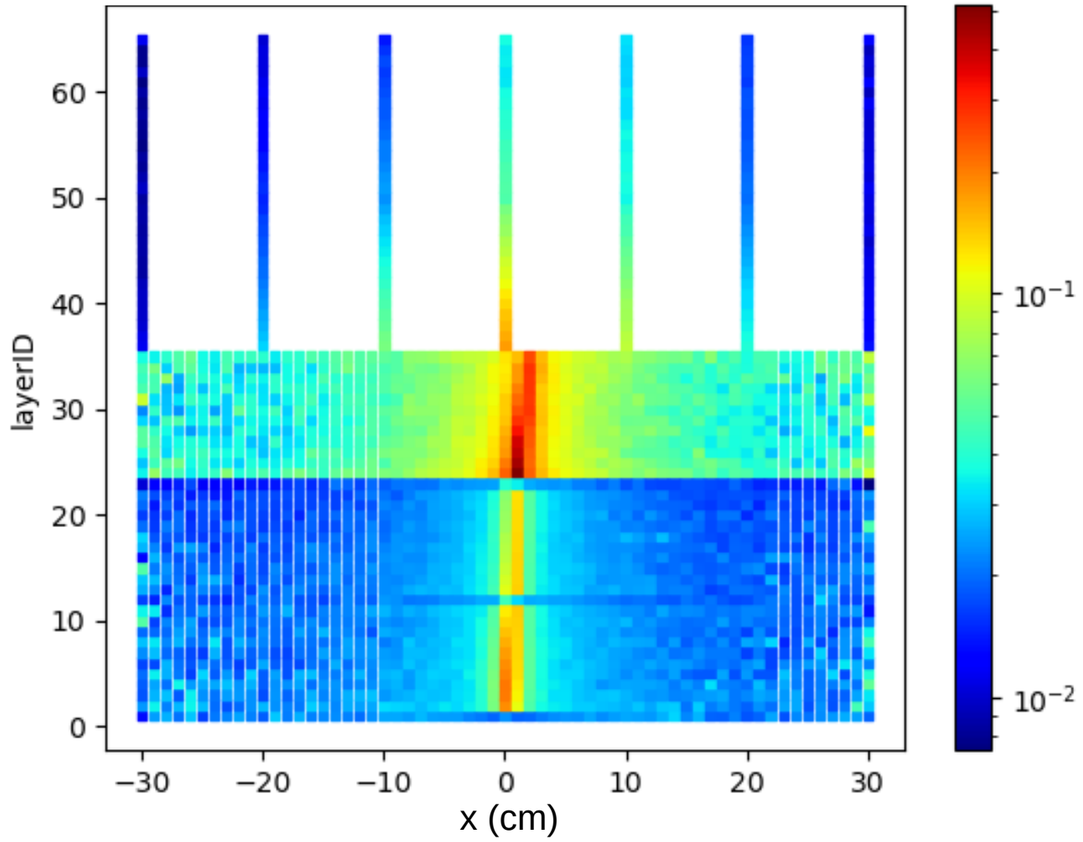
Energy Distributions

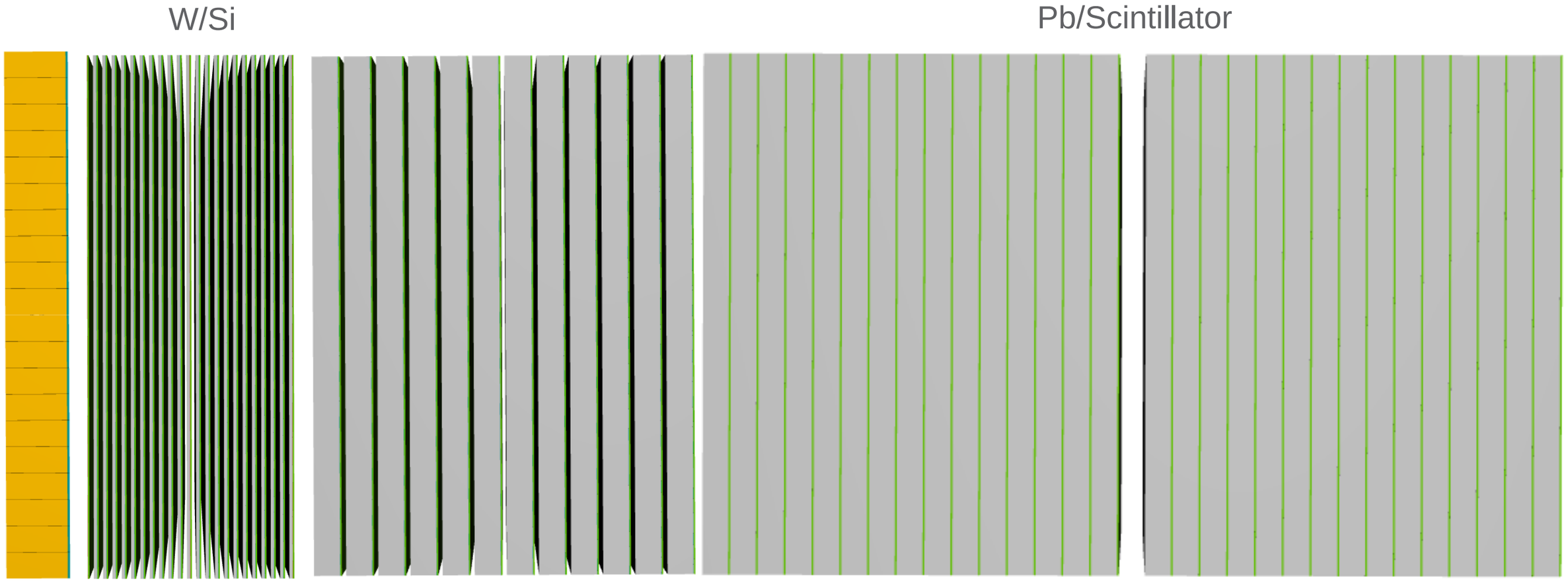
Raw Signal



Calibrated Signal (Linear Calibration)



Calibration



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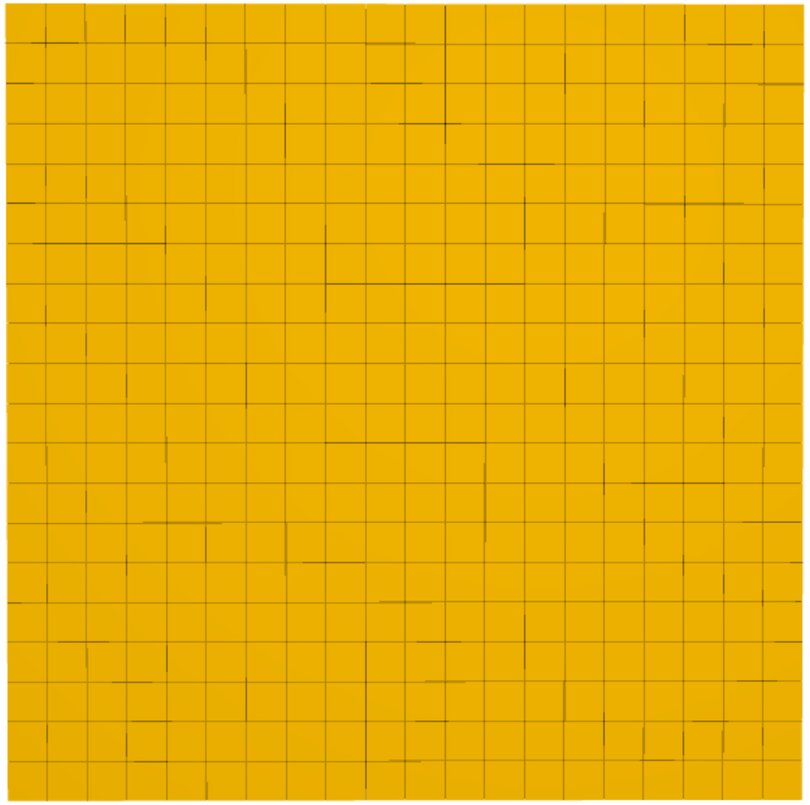
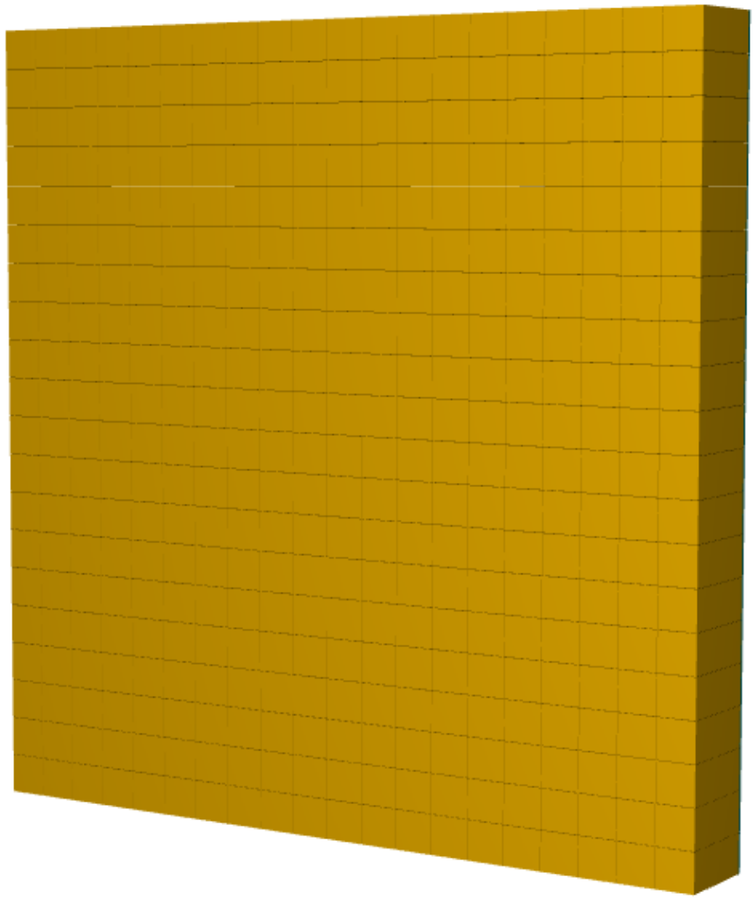
Calibration



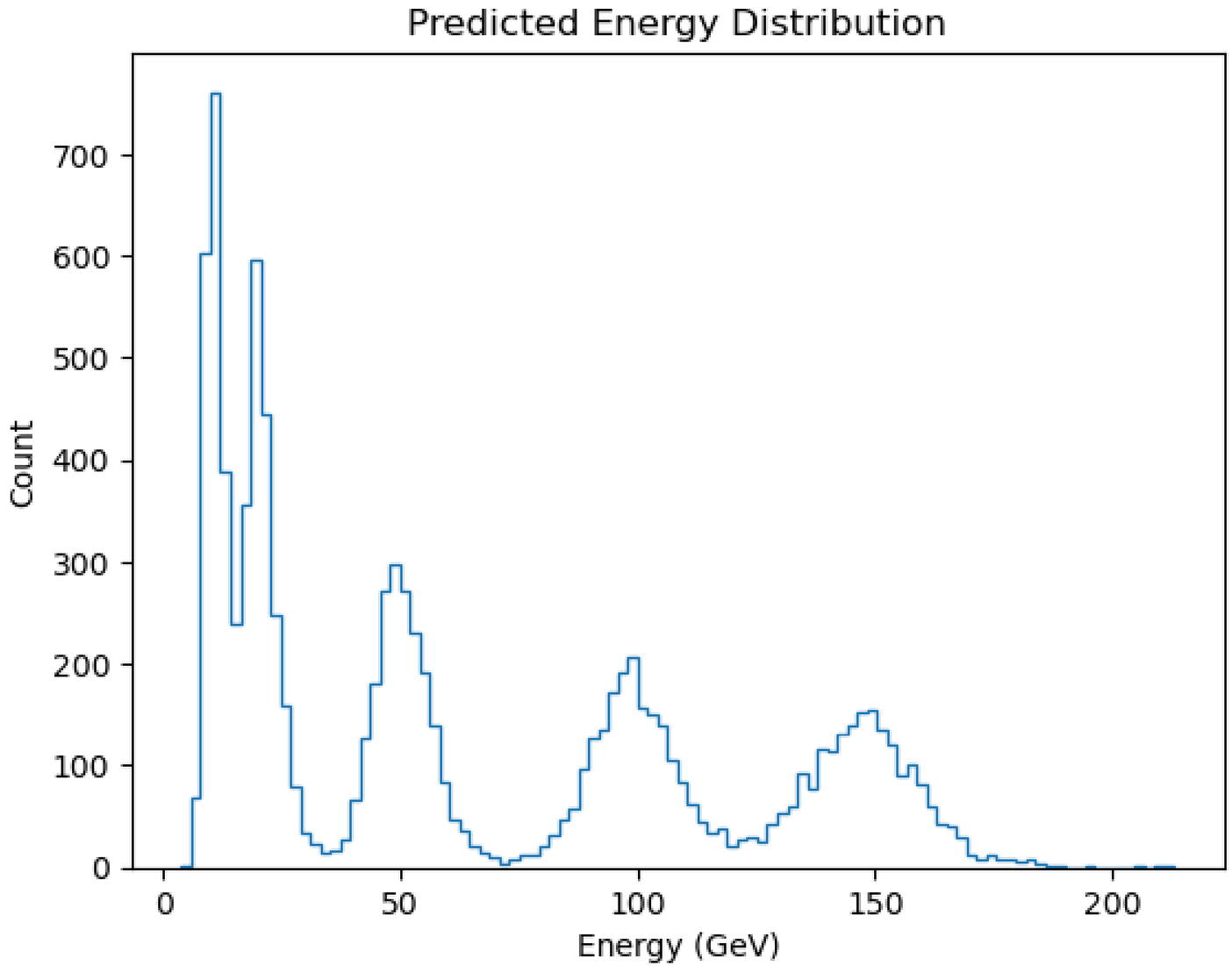
PbWO4 Crystal



Calibration with Linear Regression

$$E_{rec.} = c_1 E_{SiPix} + c_2 E_{Crystal} + c_3 E_{WSi} + c_4 E_{PbSi} + c_5 E_{PbScint} + b$$

Calibration with Linear Regression

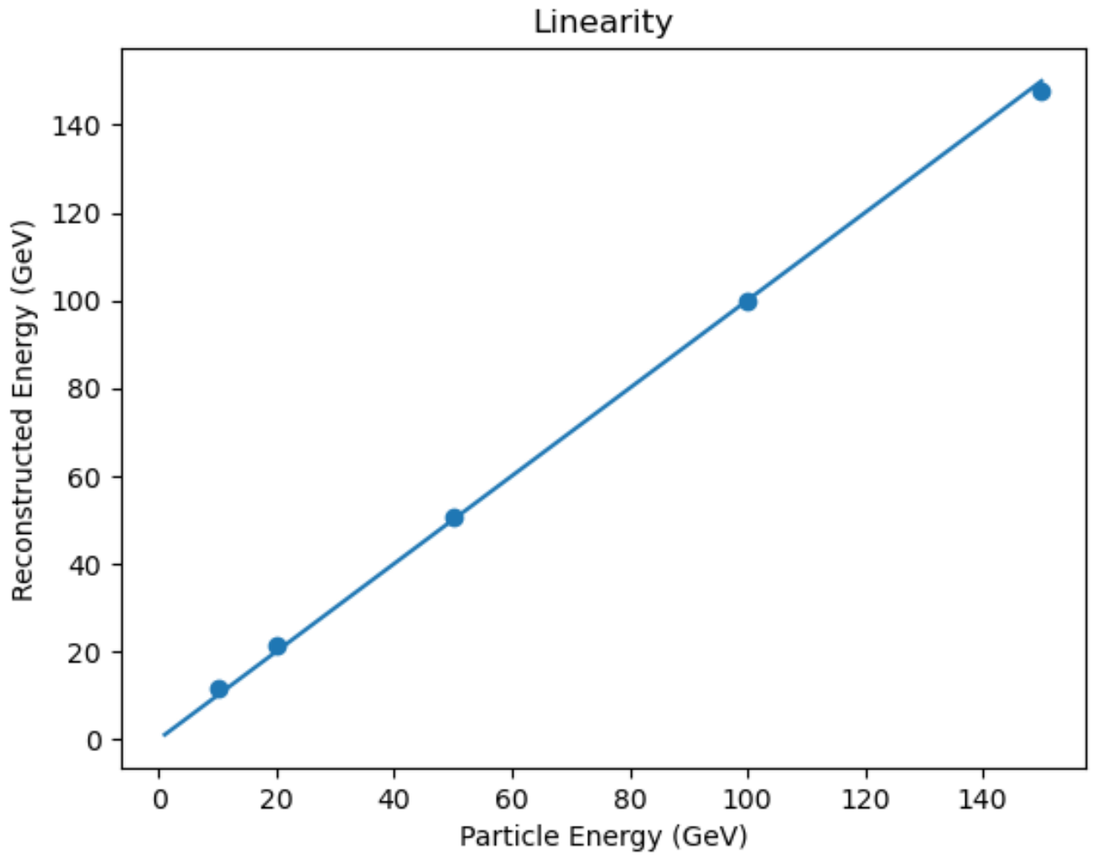


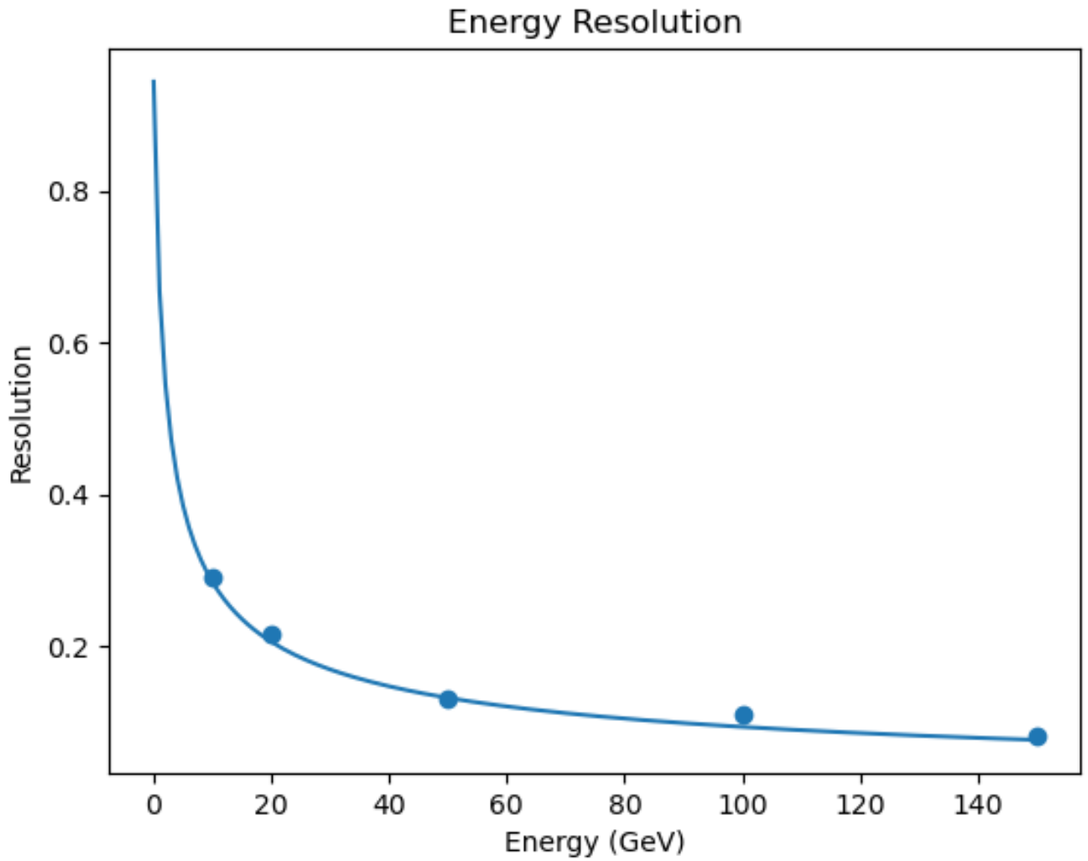
Calibration with Linear Regression

Two-Parameter Fit: $\sigma_E/E = a/\sqrt{E}$ + b

$a = 0.9438$

$b = 0.0005$





Resolution: ~94.9%/$\sqrt{E}$

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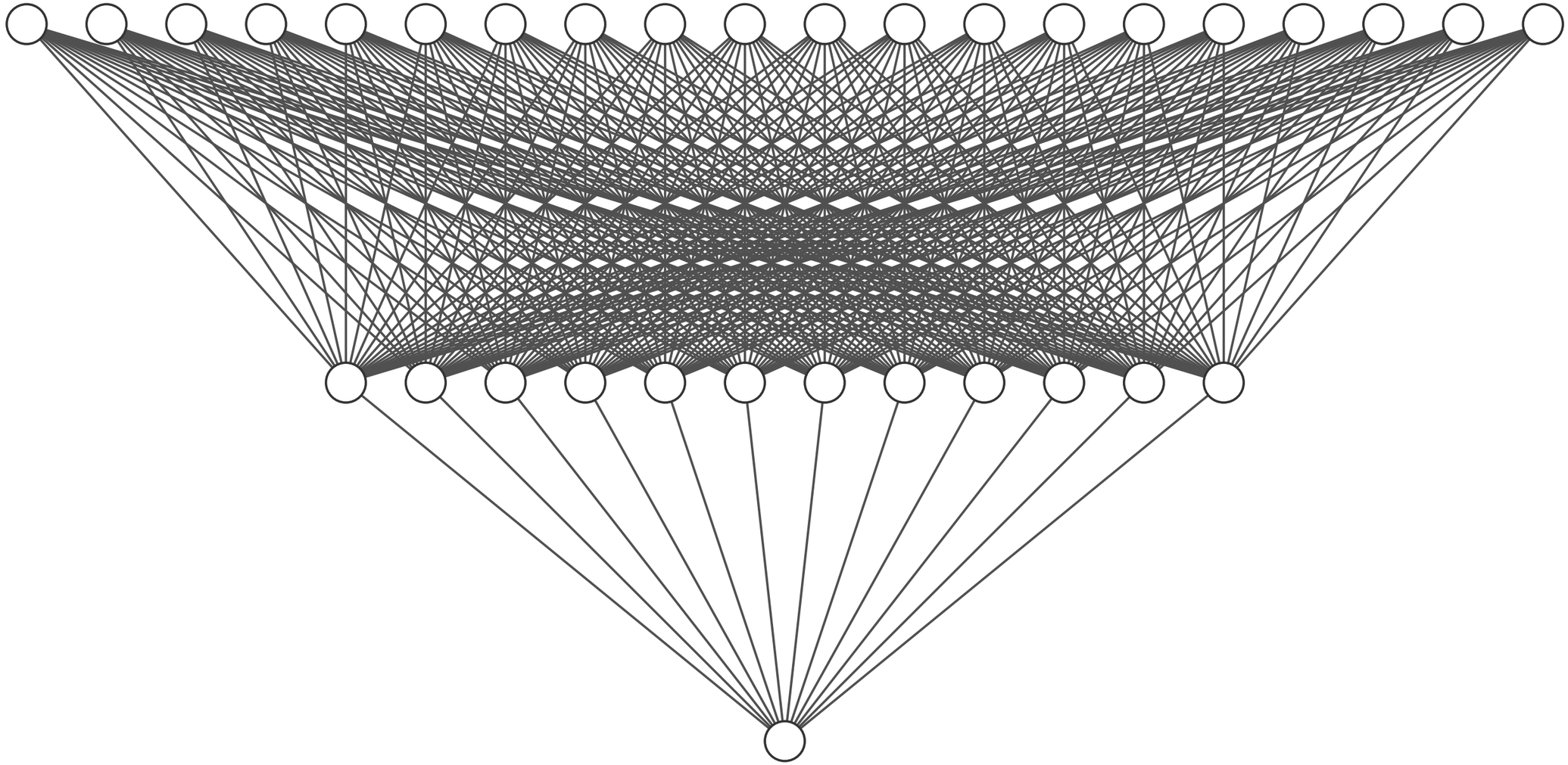
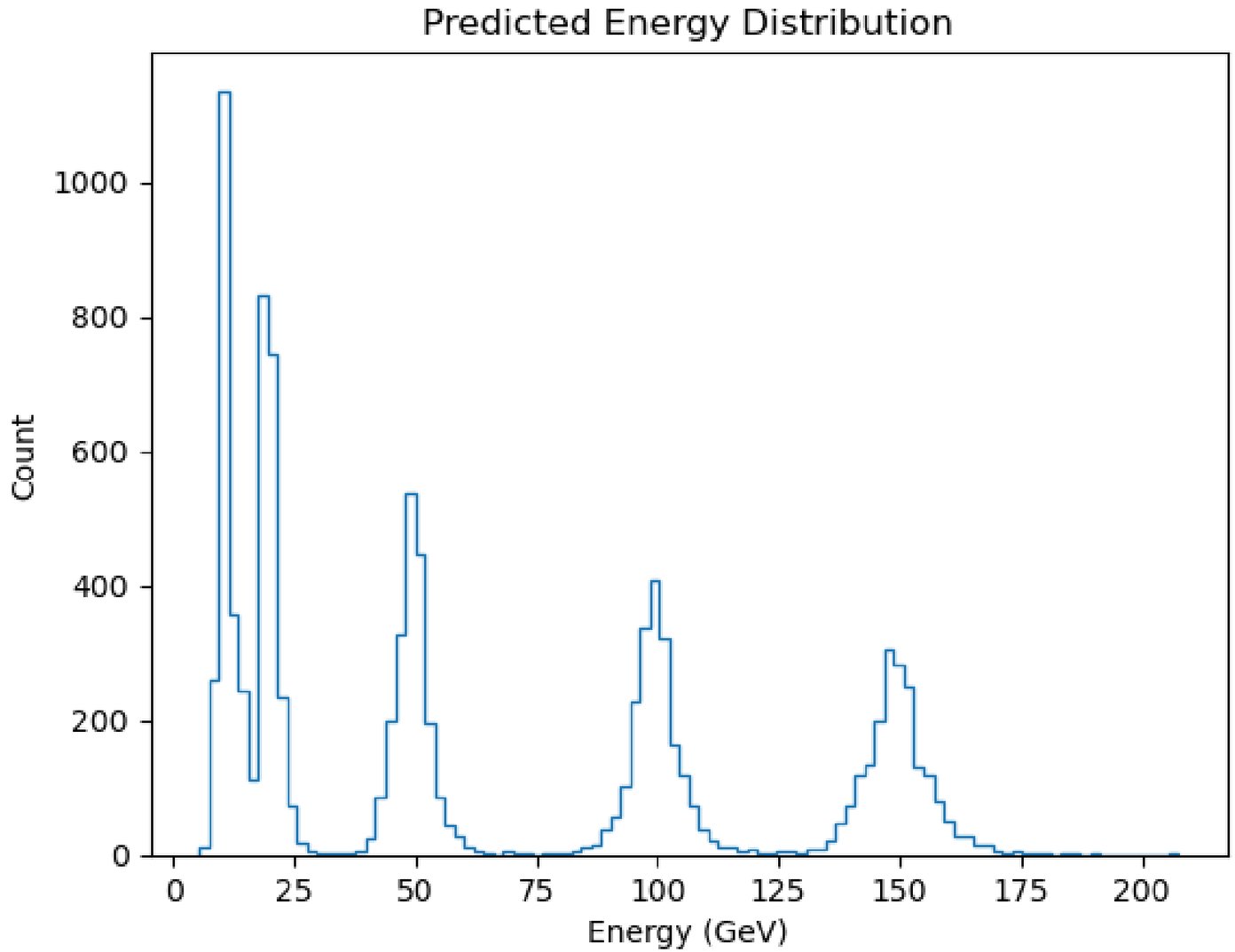
Calibration with Deep Neural Network



Calibration with Deep Neural Network

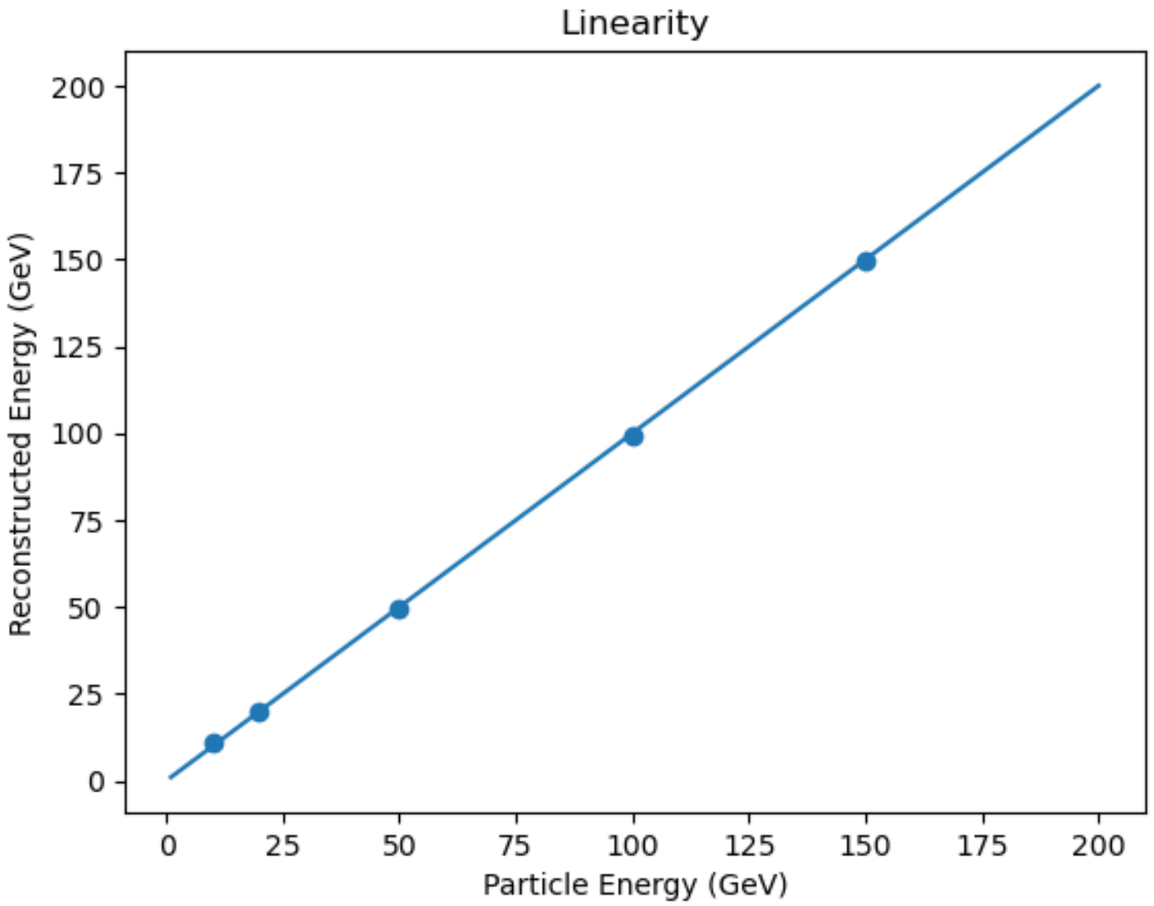


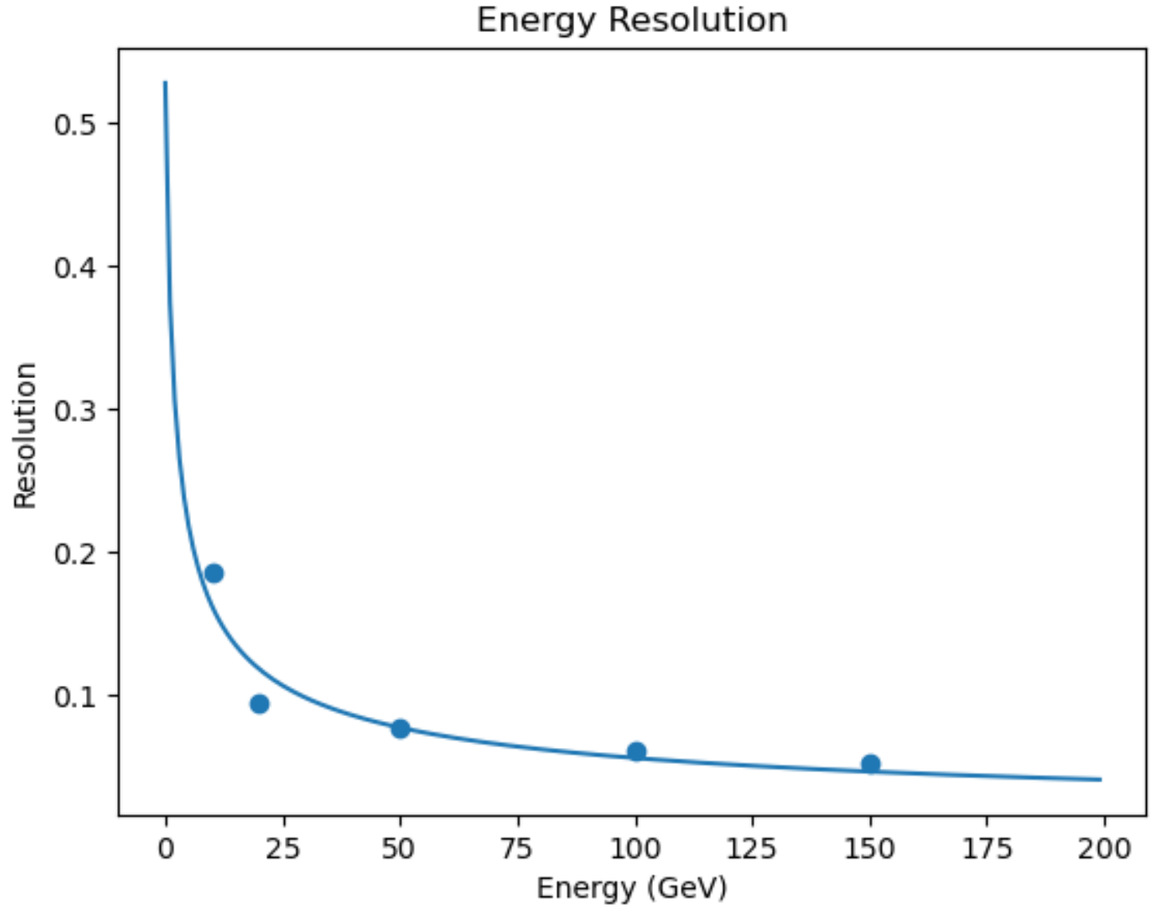
Calibration with Deep Neural Network

Two-Parameter Fit: $\sigma_E/E = a/\sqrt{E} + b$

$a = 0.5236$

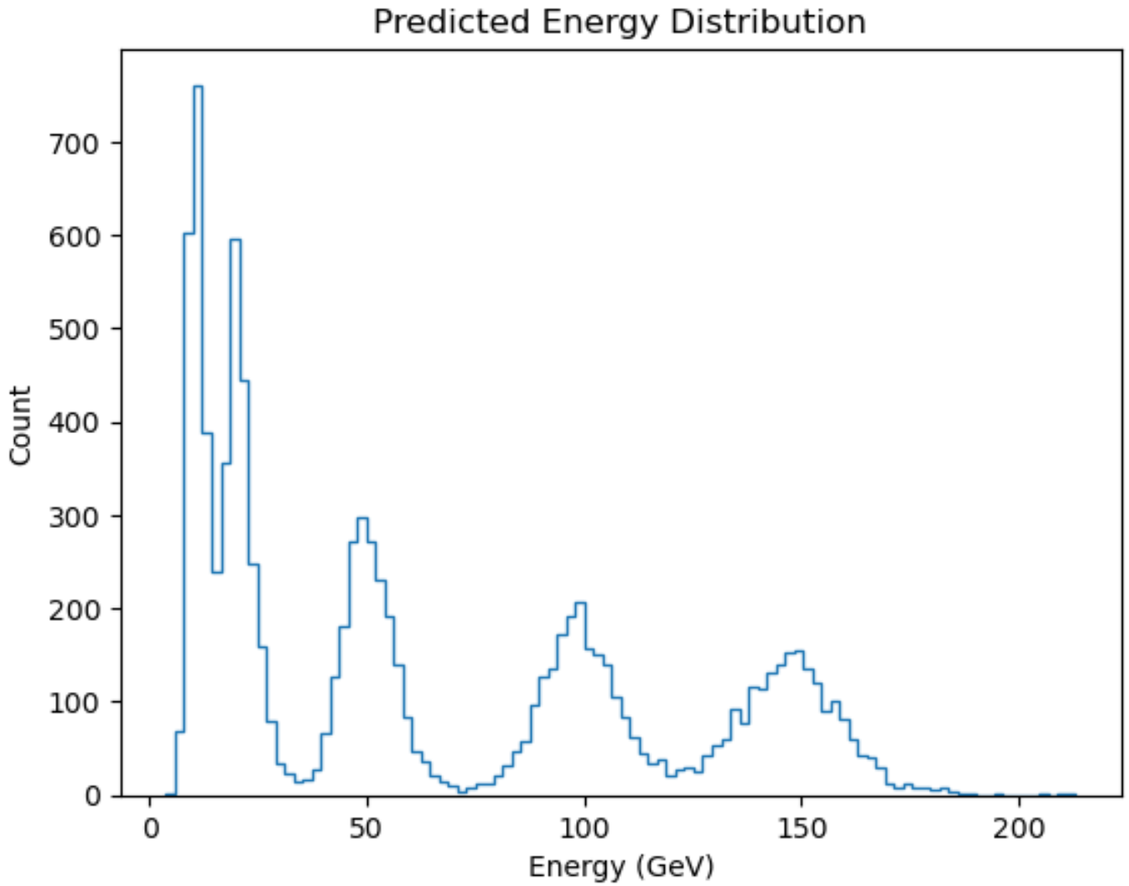
$b = 0.0043$



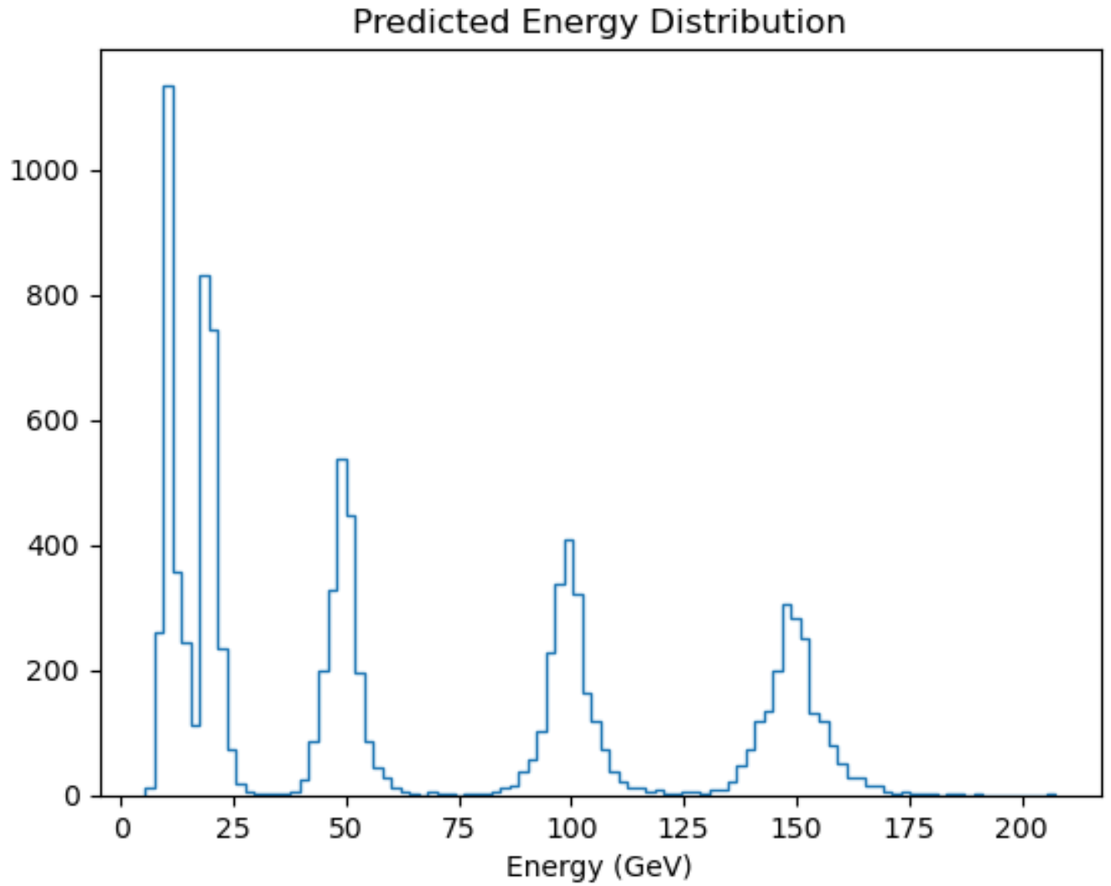


Resolution: ~52.4%/$\sqrt{E}$

Summary & Conclusion

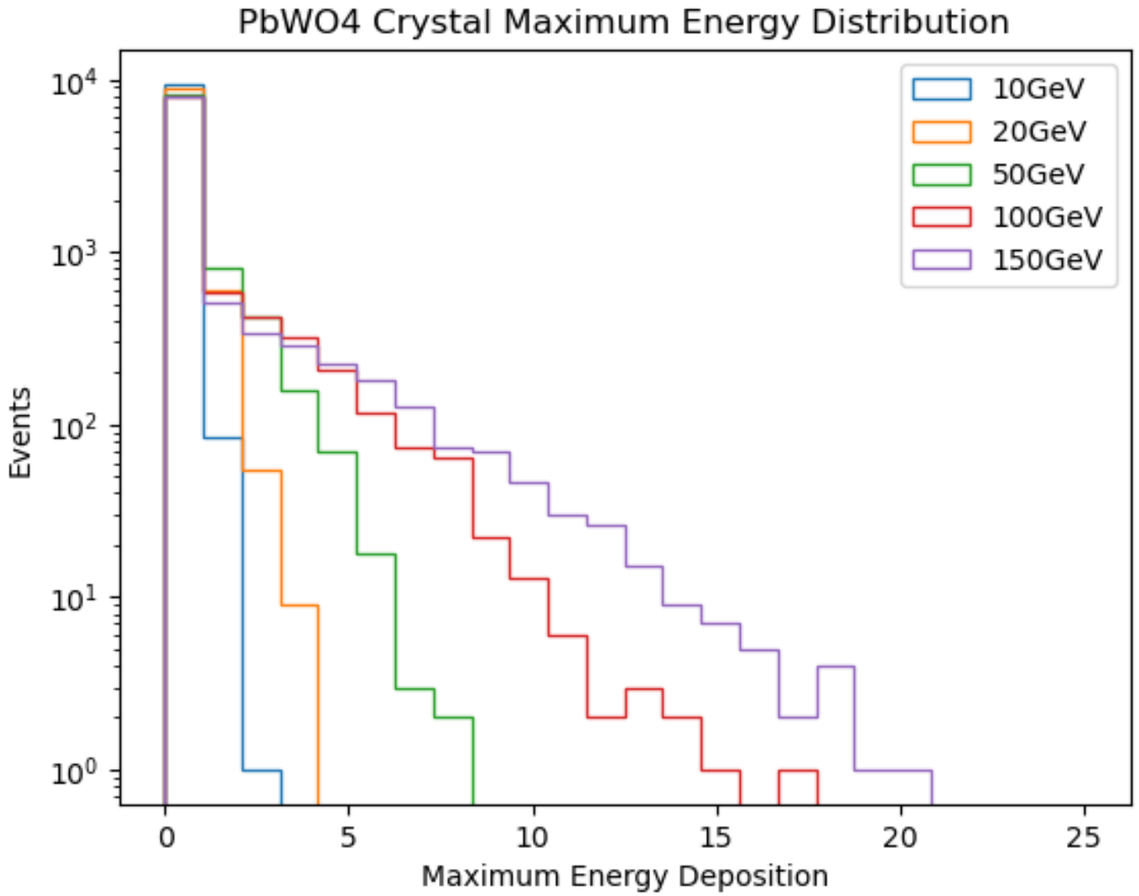


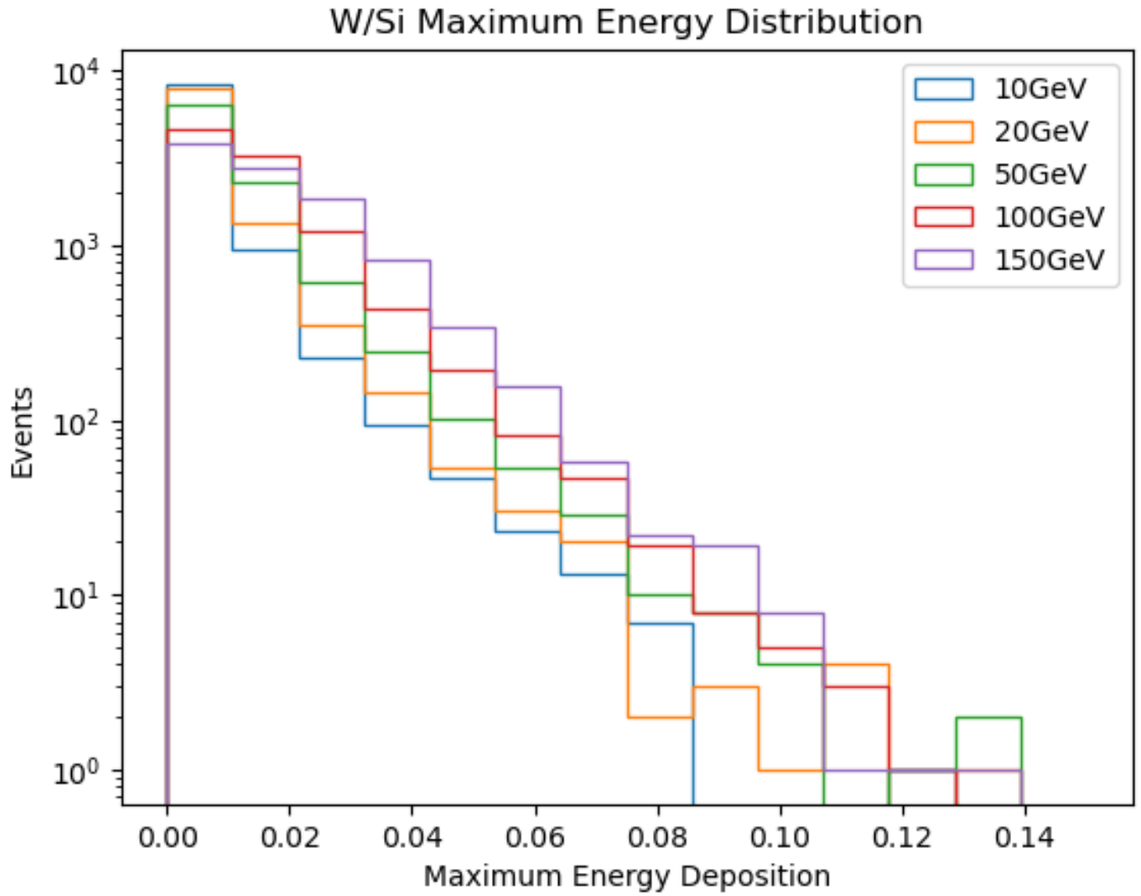
Linear Regression



DNN

Dynamic Range





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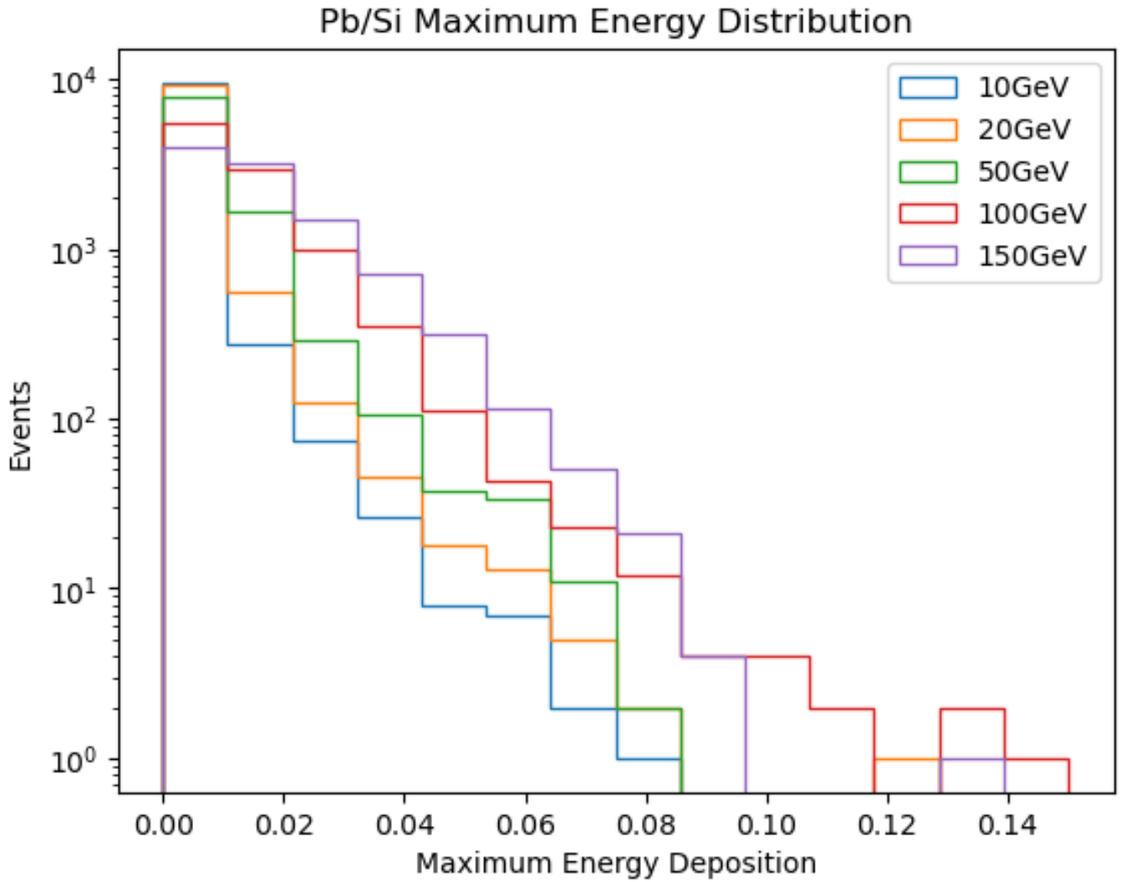
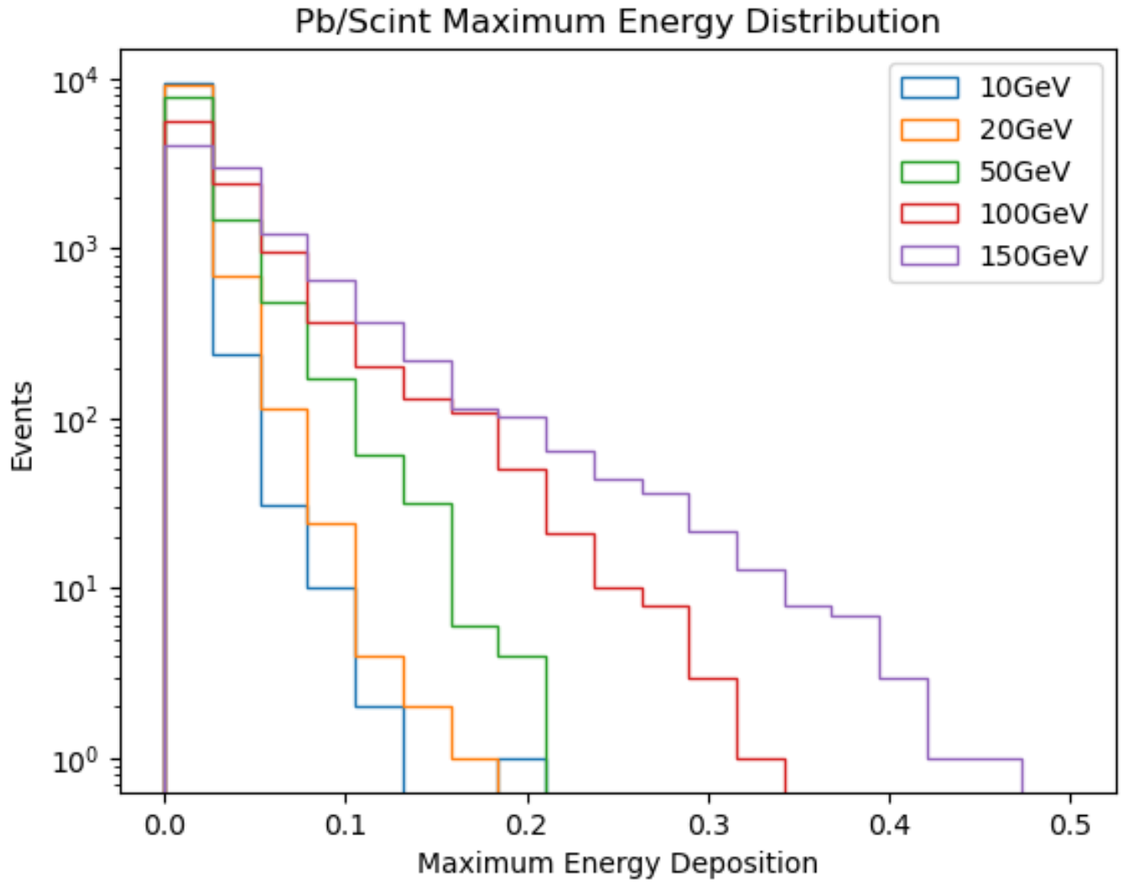
Dynamic Range





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Future Work

- Analysis of angular distributions
- Energy & angle reconstruction with graph neural networks

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Thank you