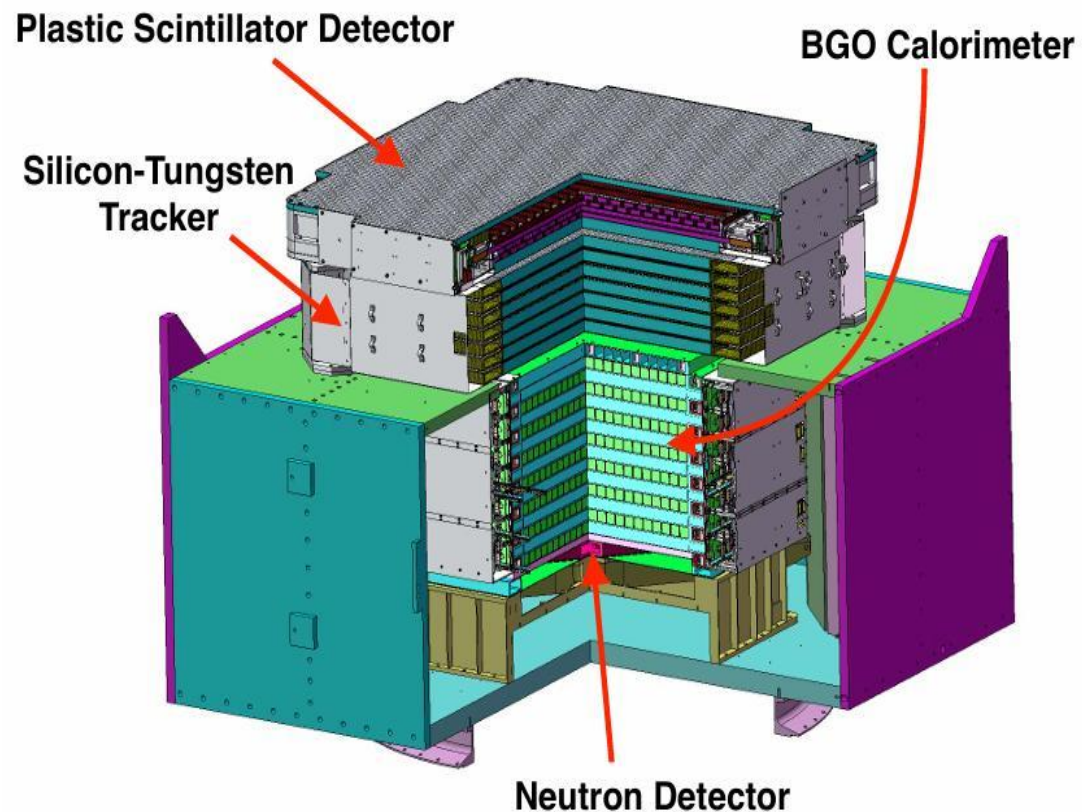




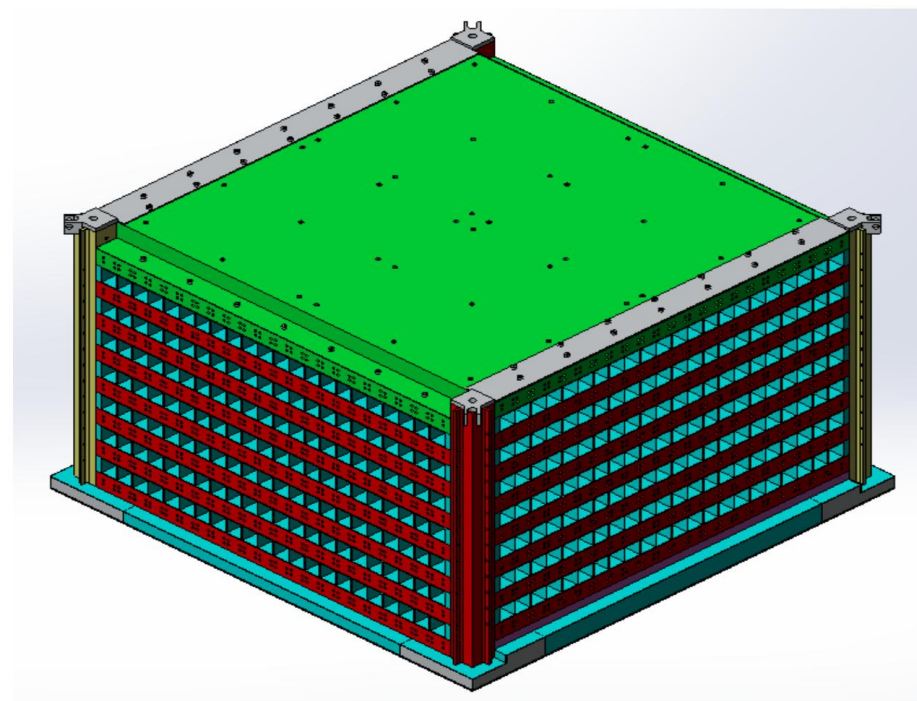
DAMPE- ^{56}Fe 能量重建分析

Lin Zhou

Detector geometry



DAMPE 卫星有效载荷整体示意图



➤ 目前只考虑了14层BGO晶体中沉积的能量

➤ 主要目的是使用机器学习来对粒子经过材料之后沉积的能量进行重建，比较能量分辨率的优劣

MLP



- 粒子经过14层材料，考虑情况：
 - 每个事例在**每层晶体中沉积的能量** (E_{layer})、**每层击中次数** (N)、**每层密度** (E_{layer}/N)、**探测器总的沉积能量**，共有**43**个feature

batch	128
学习率	1e-4
学习率调度	CosineAnnealing, T_max=400, eta_min=1e-7
最大epoch	400

Dropout:

43

$E_{\text{layer}}[14]$

$N_{\text{layer}}^{\text{hits}}[14]$

$\frac{E}{N}[14]$

$E_{\text{BGO}}[1]$

0.30

512

x_1
 x_2
 $\vdots$
 x_{n-1}
 x_n

0.25

256

$\vdots$

0.20

128

$\vdots$

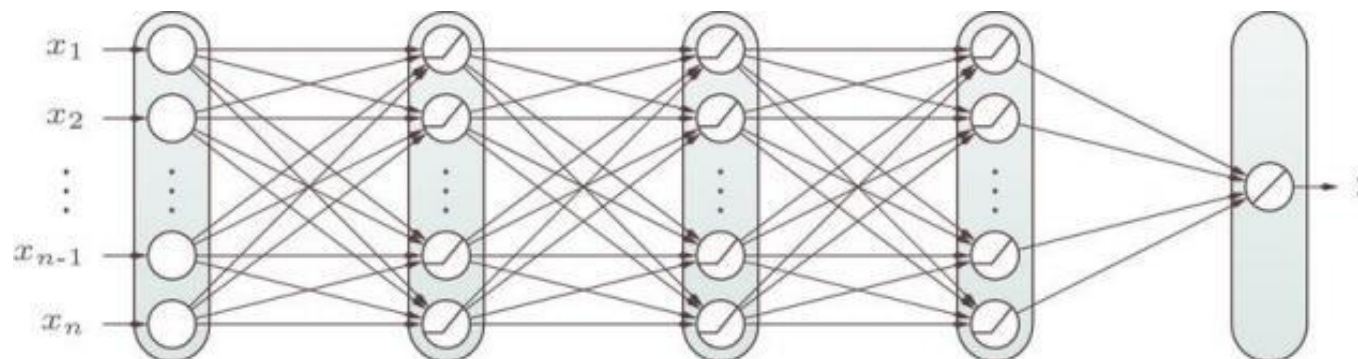
0.15

64

$\vdots$

Predicted
Energy

y



$$\text{Loss} = \frac{1}{N} \sum_{i=1}^N \frac{(\text{pred}_i - \text{target}_i)^2}{\text{target}_i^2 + \epsilon}$$

均方相对误差(MSRE)

两种拟合方式



使用孙浩然师兄筛选后的连续能量数据 → 对能量分bin, 宽度为100GeV

$$\text{FWHM resolution} = \frac{\text{FWHM}}{|x_{\text{peak}}|} \times 100\%$$

➤ 高斯拟合

➤ 能量分辨率计算公式: $\text{FWHM} = 2.35 \times \sigma$

➤ 峰值横坐标 peak 由拟合得到的

$$\rightarrow \frac{2.35|\sigma|}{|\text{mean}|} \times 100\%$$

➤ Crystal Ball拟合

➤ `crystalball.pdf(x, beta, m, loc=loc, scale=scale)`

➤ 能量分辨率计算公式: FWHM 是拟合曲线在峰值一半高度处的右、左交点之差

$$\rightarrow \text{Resolution} = \frac{\text{FWHM}}{|\text{loc}|} \times 100\%$$

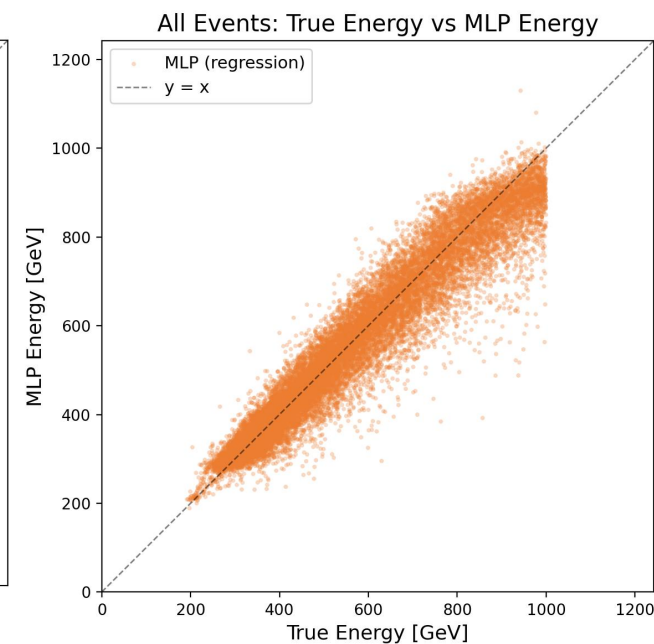
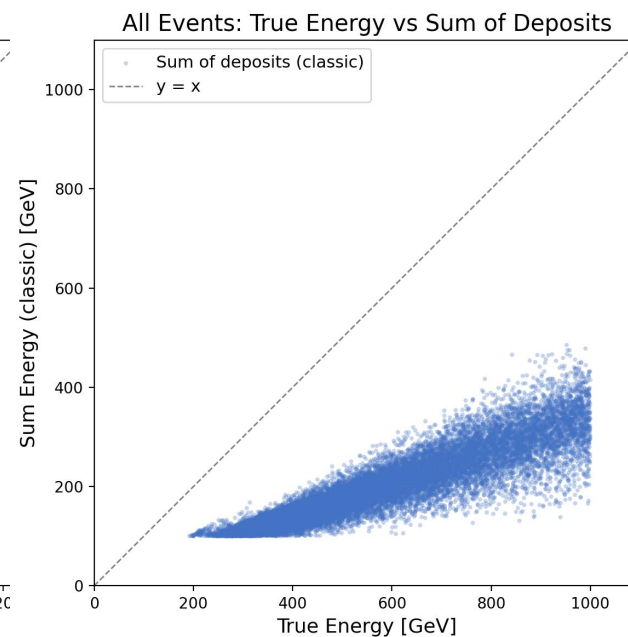
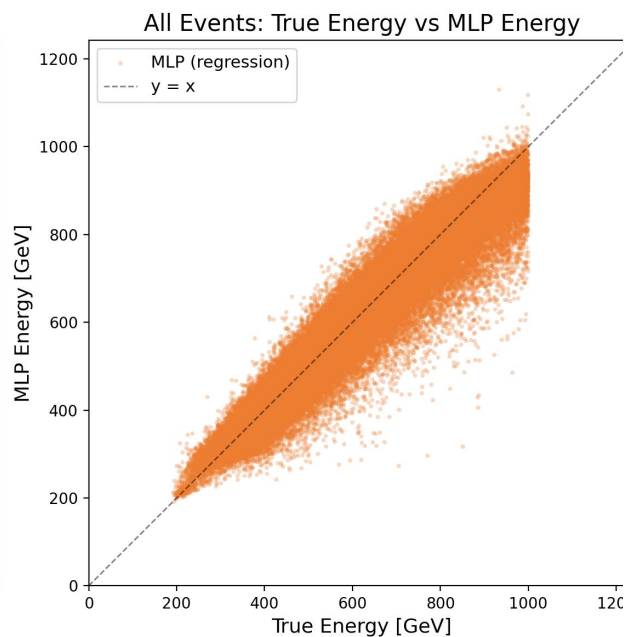
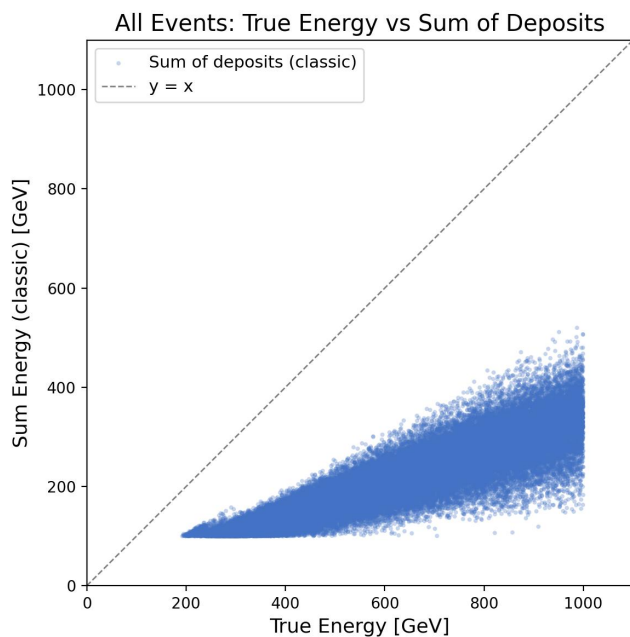
➤ 峰值横坐标是 $\text{loc} - \text{beta} \times \text{scale}$

Energy Range 100GeV-1TeV

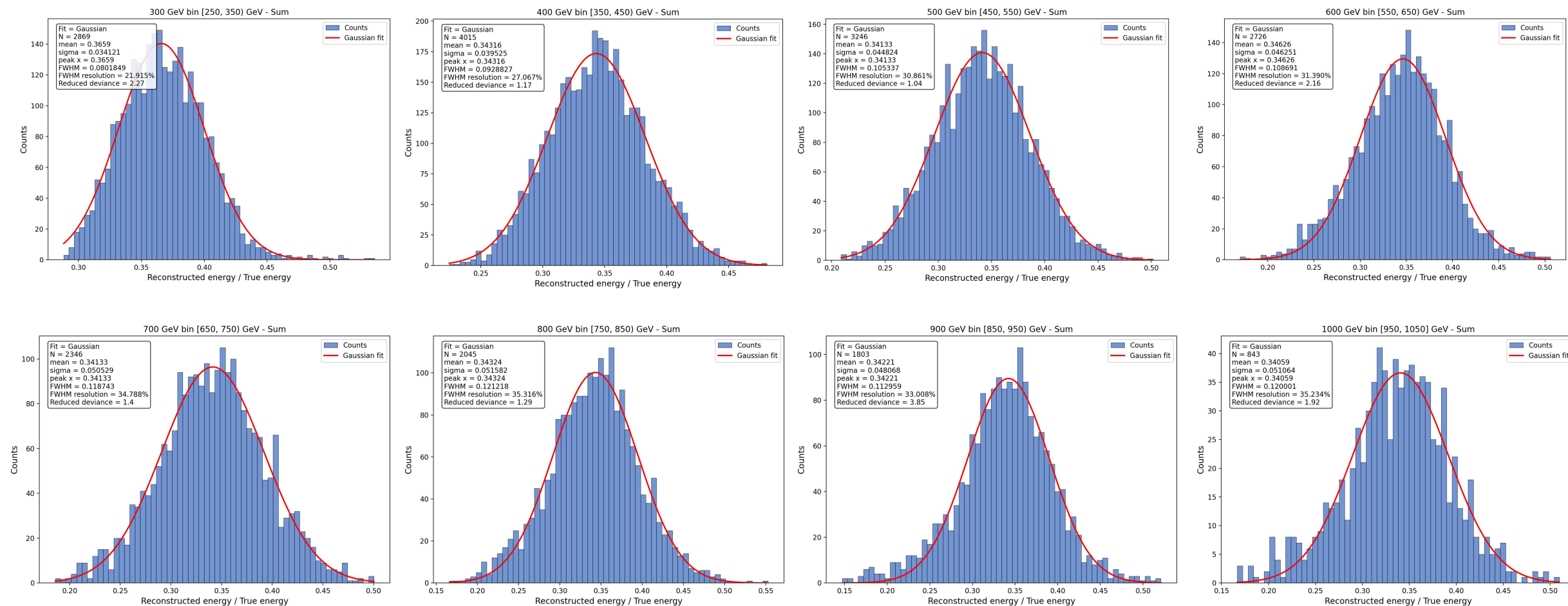


Training Data

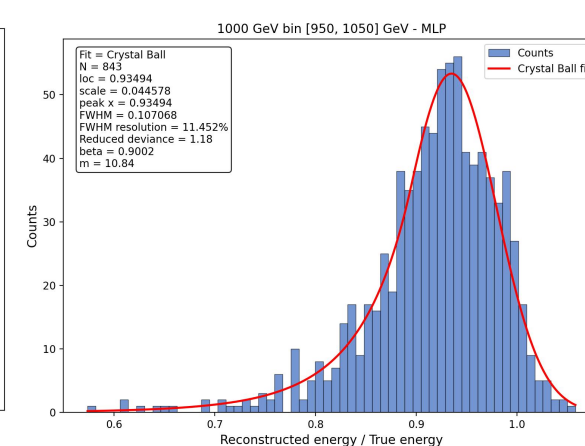
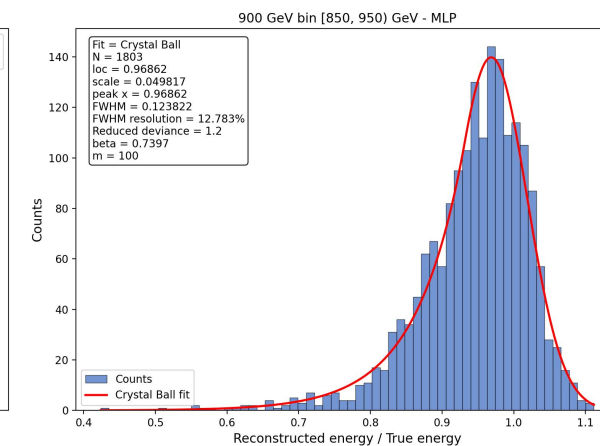
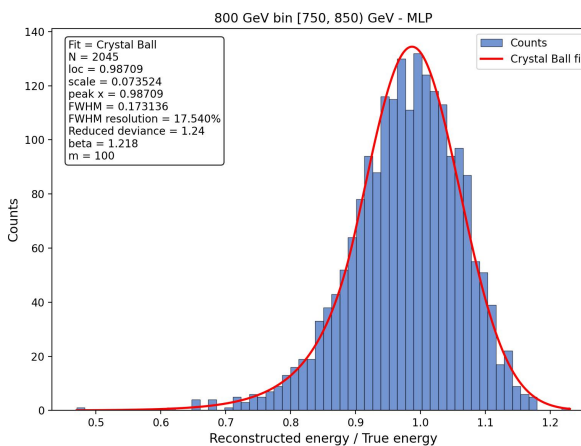
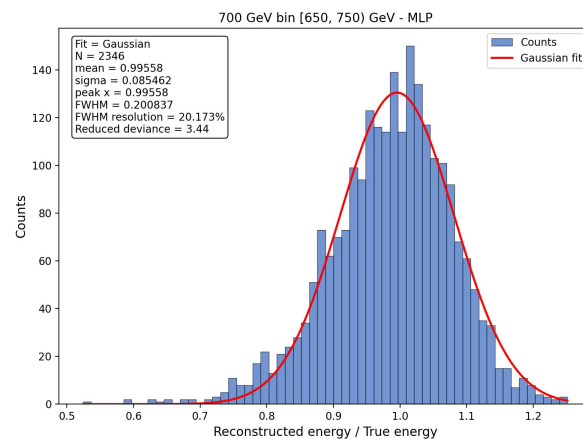
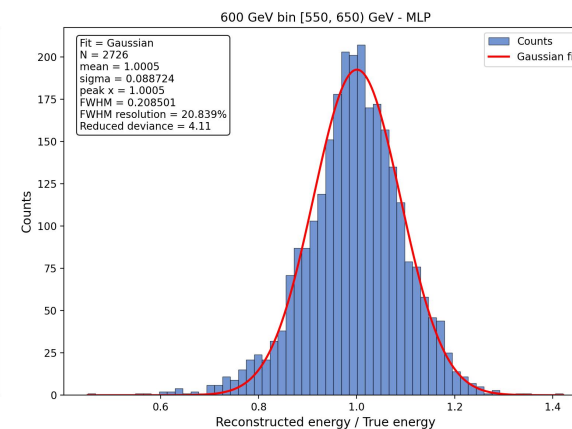
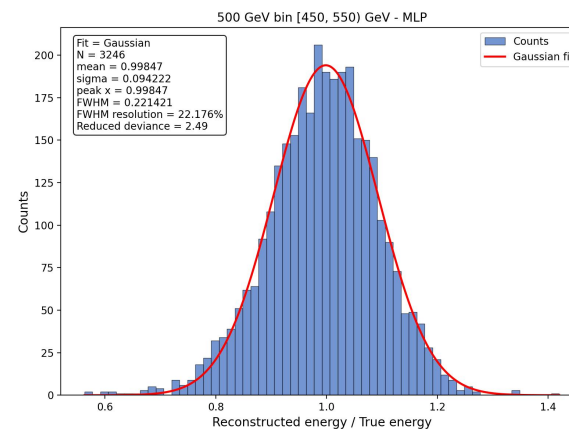
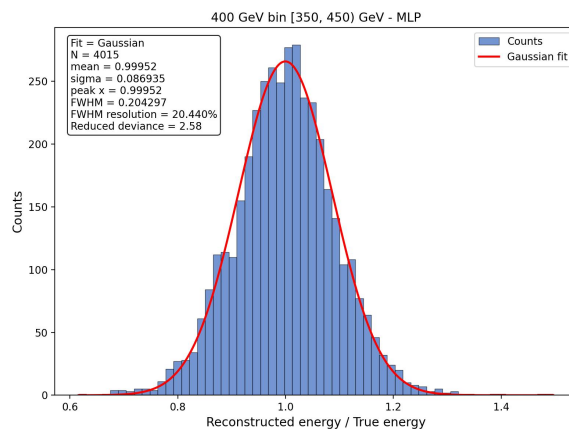
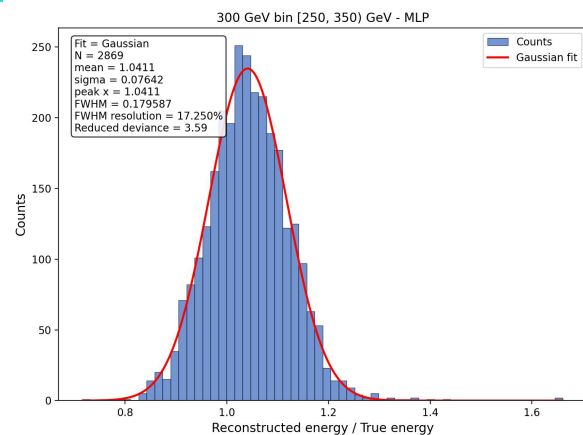
Testing Data



Sum-Energy Resolution



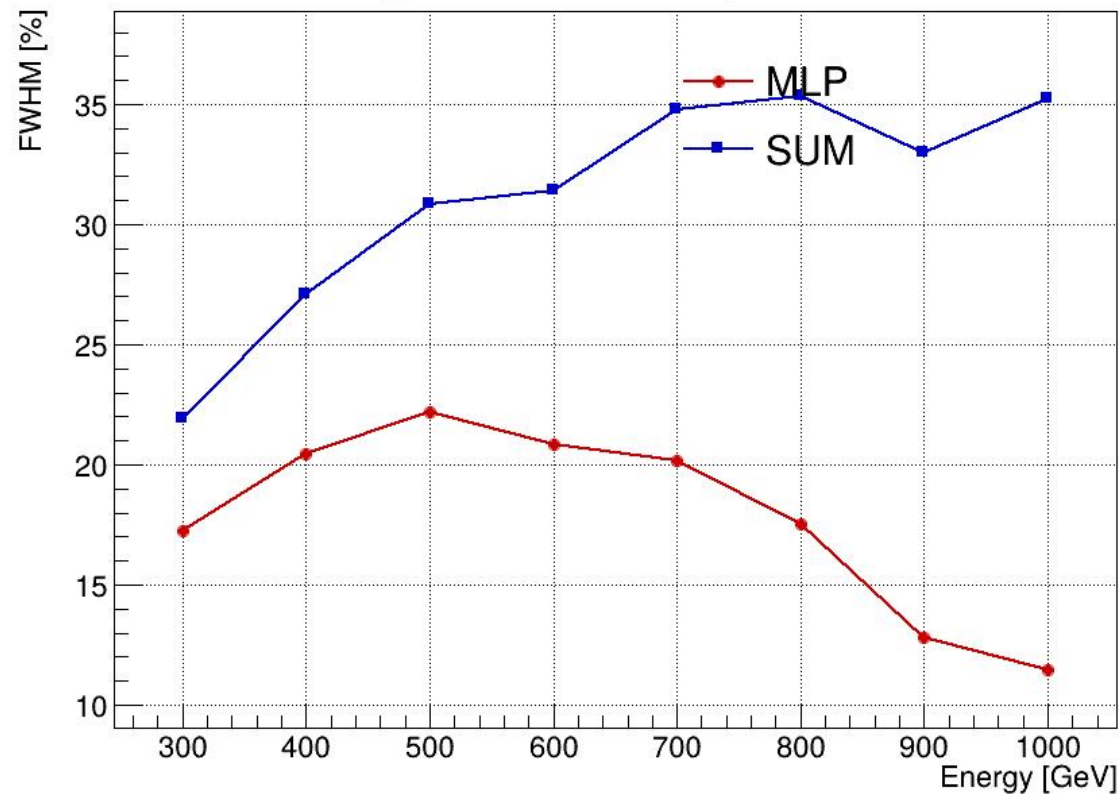
MLP-Energy Resolution



Results

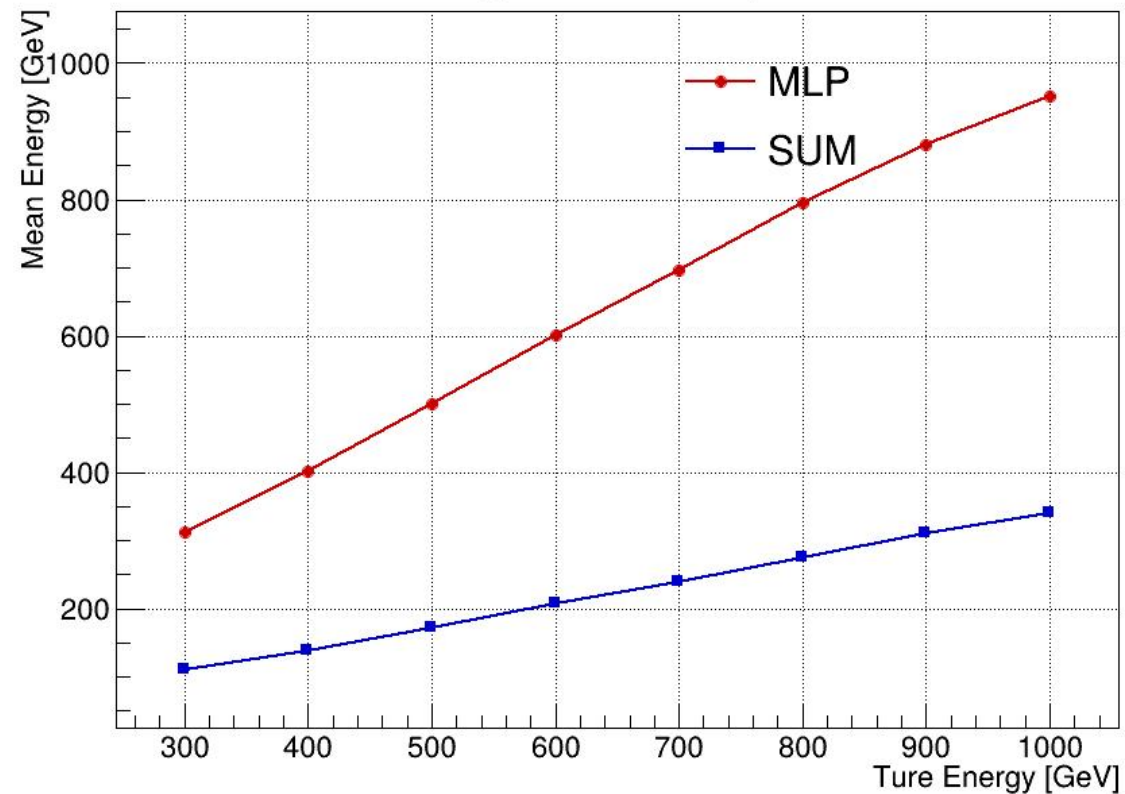


Energy resolution comparison



能量分辨率

Mean Energy Linear comparison

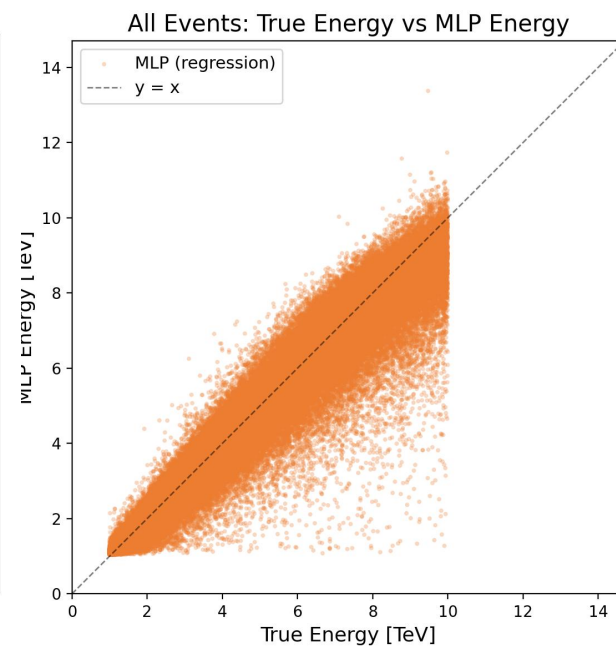
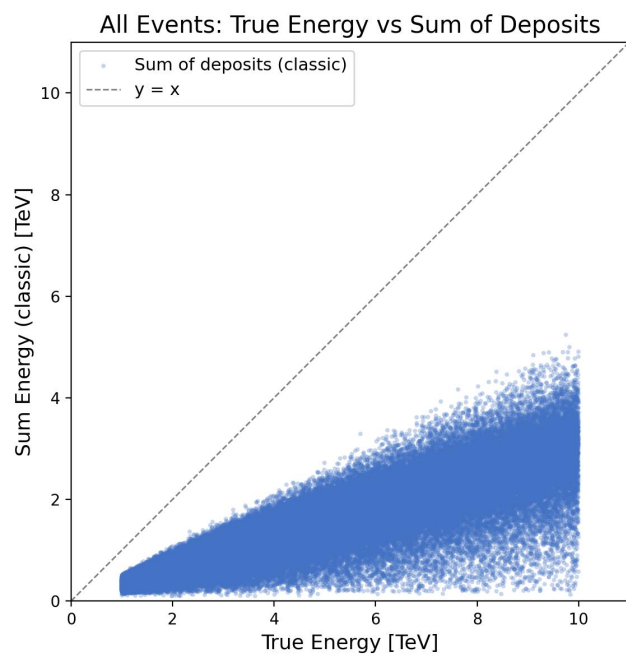


能量线性响应

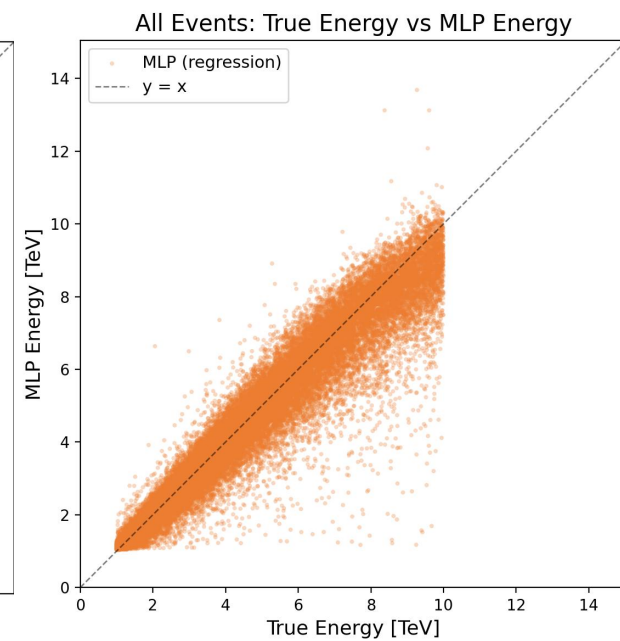
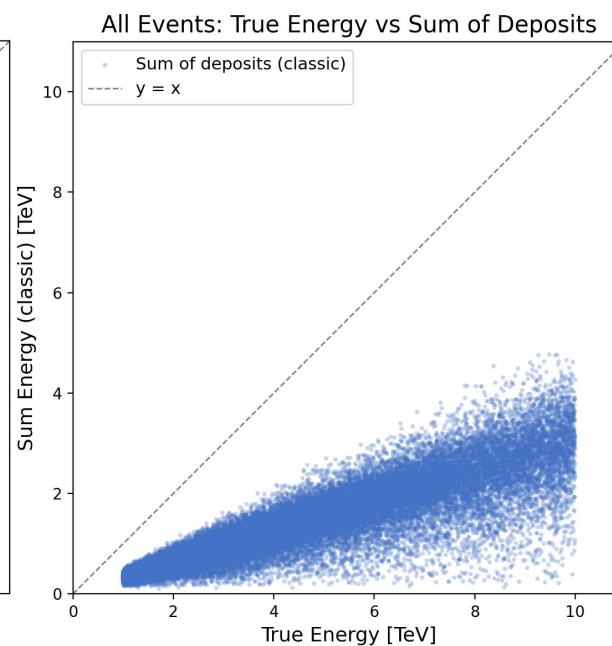
Energy Range 1TeV-10TeV



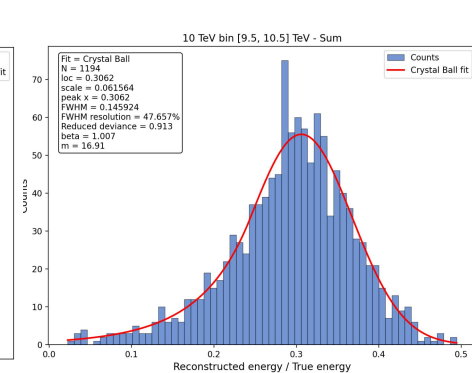
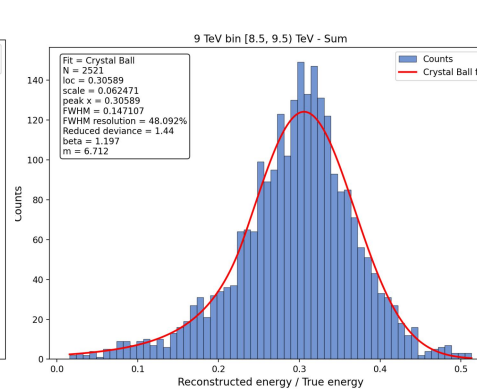
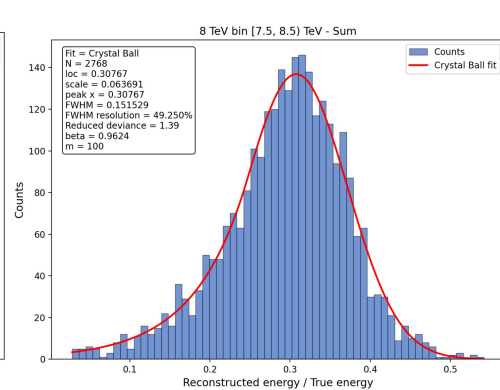
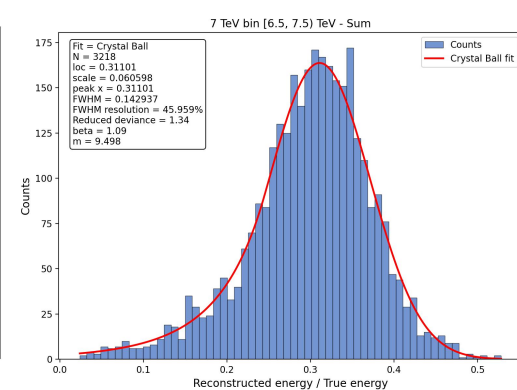
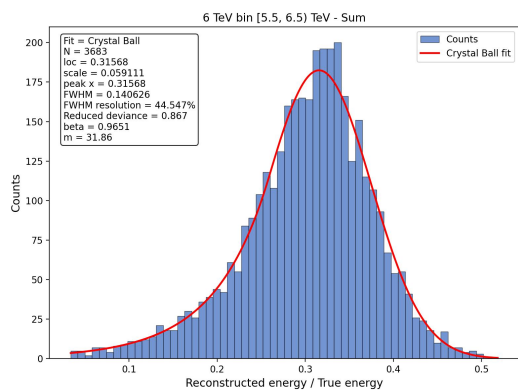
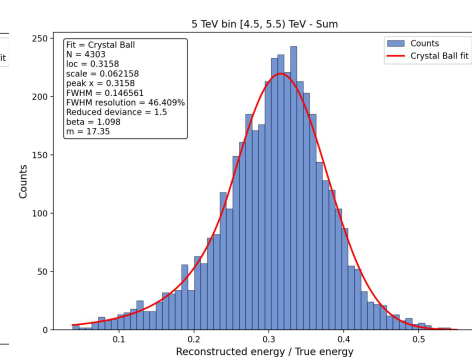
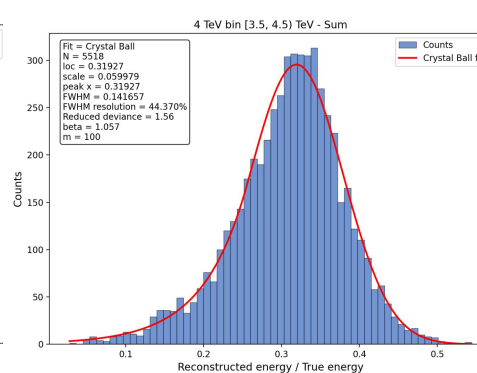
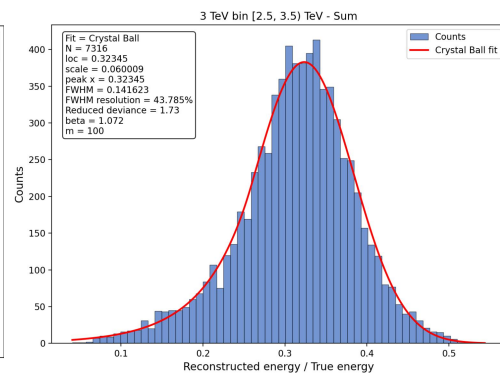
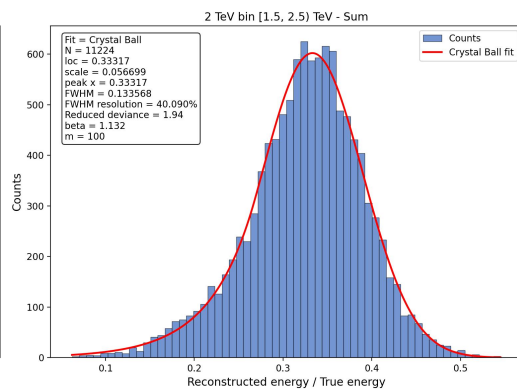
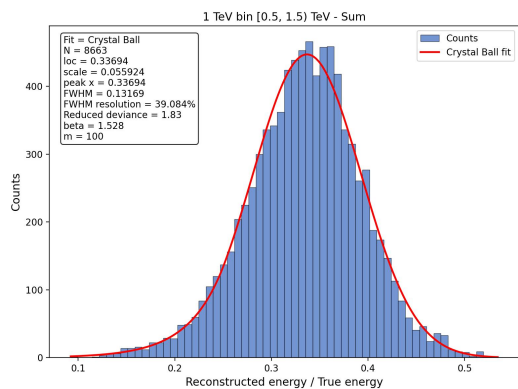
Training Data



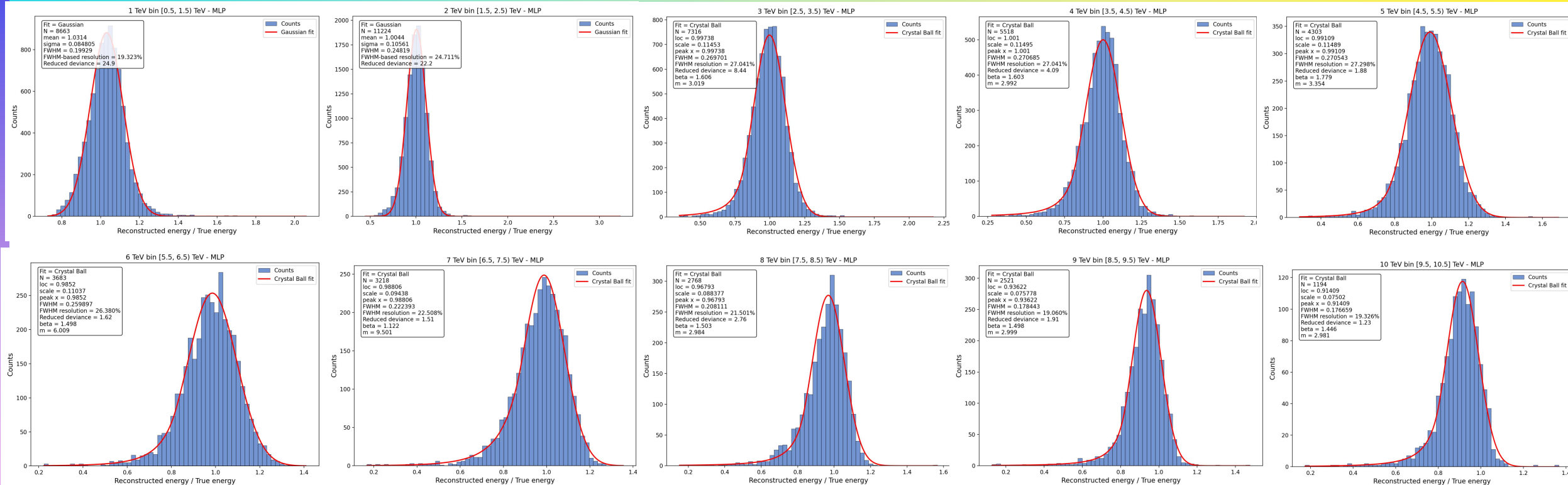
Testing Data



Sum-Energy Resolution



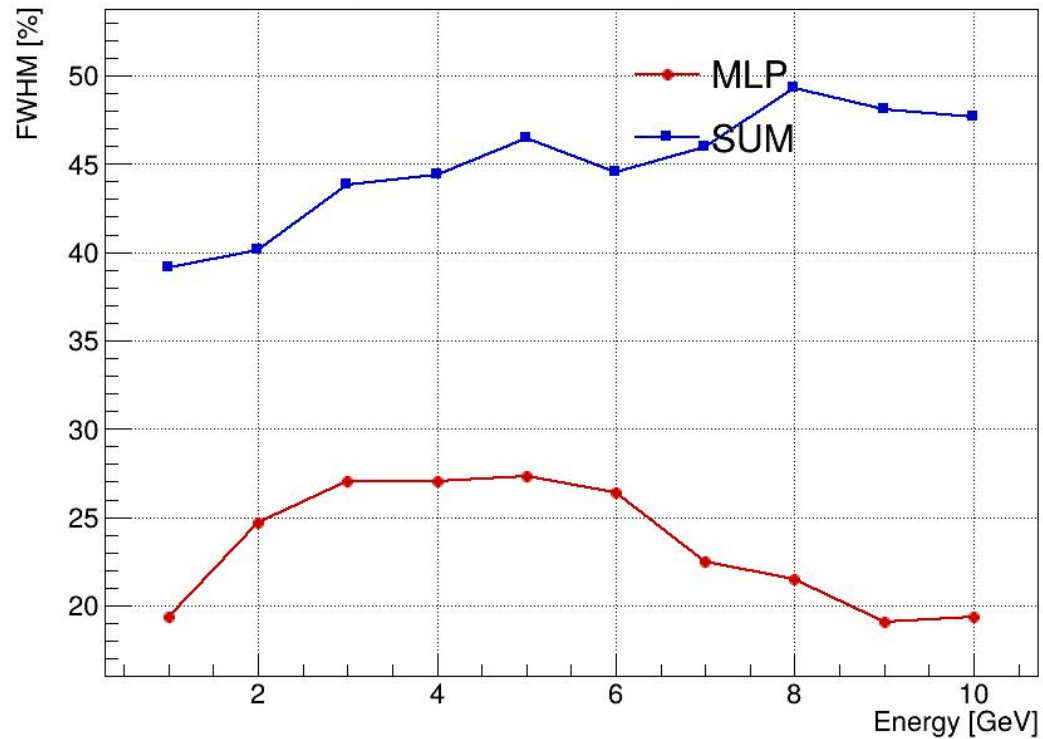
MLP-Energy Resolution



Results

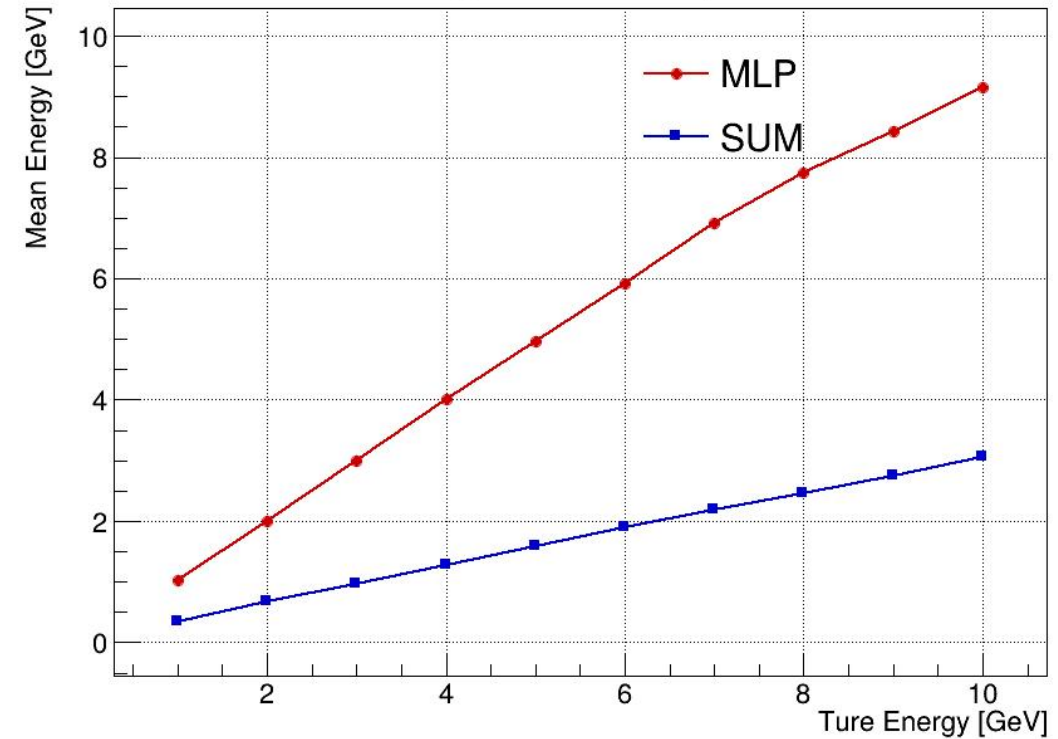


Energy resolution comparison



能量分辨率

Mean Energy Linear comparison

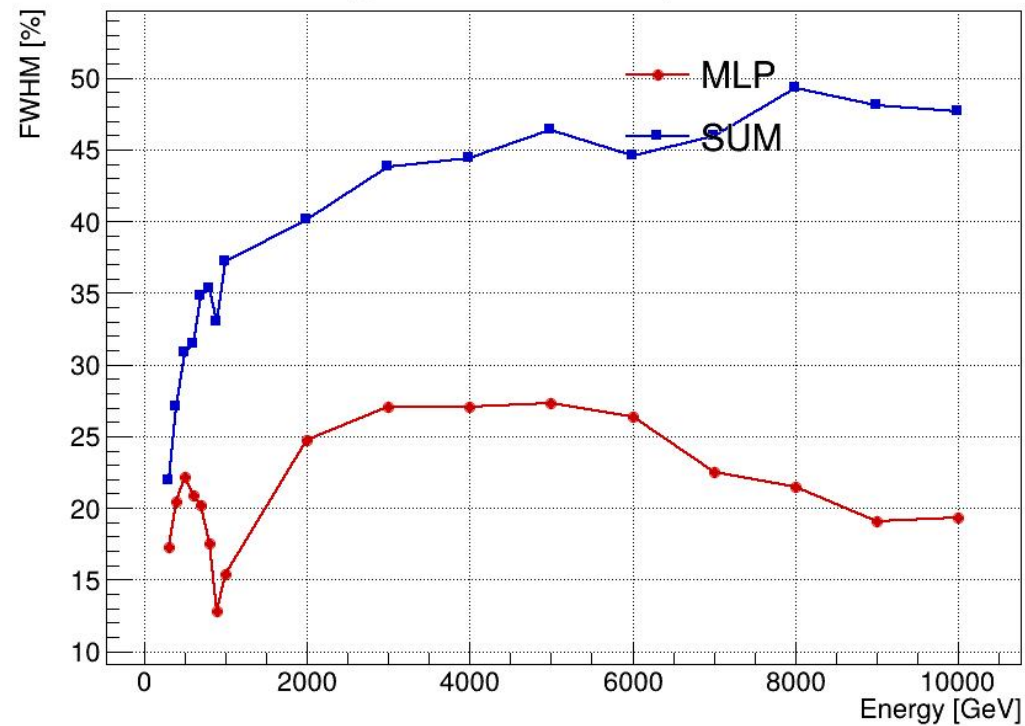


能量线性响应

Combined Results

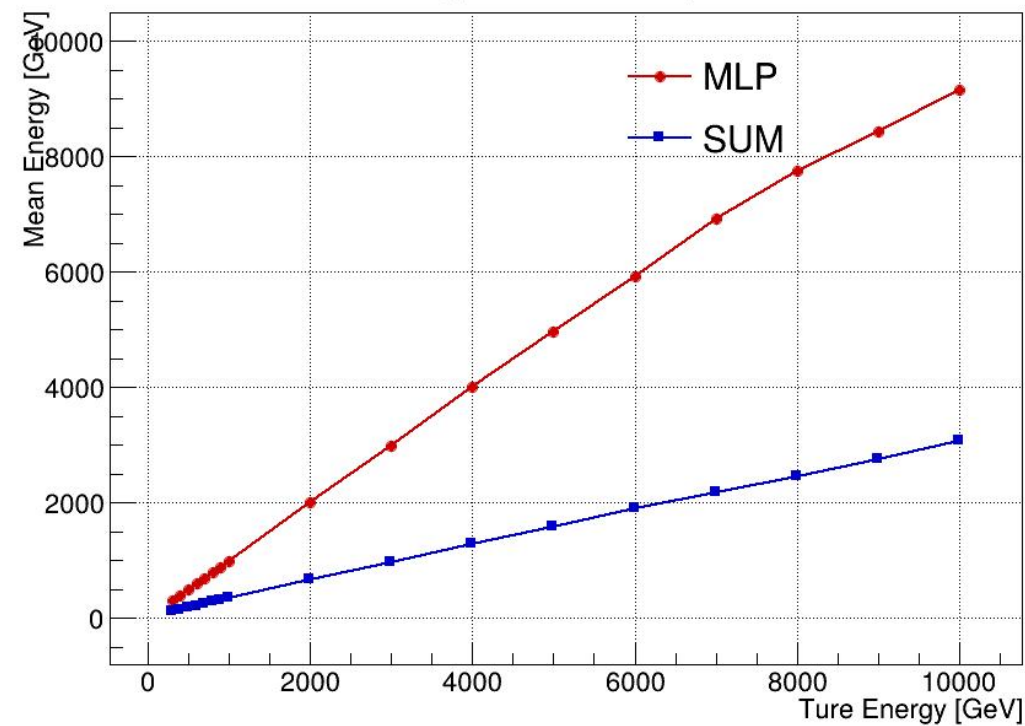


Energy resolution comparison



能量分辨率

Mean Energy Linear comparison

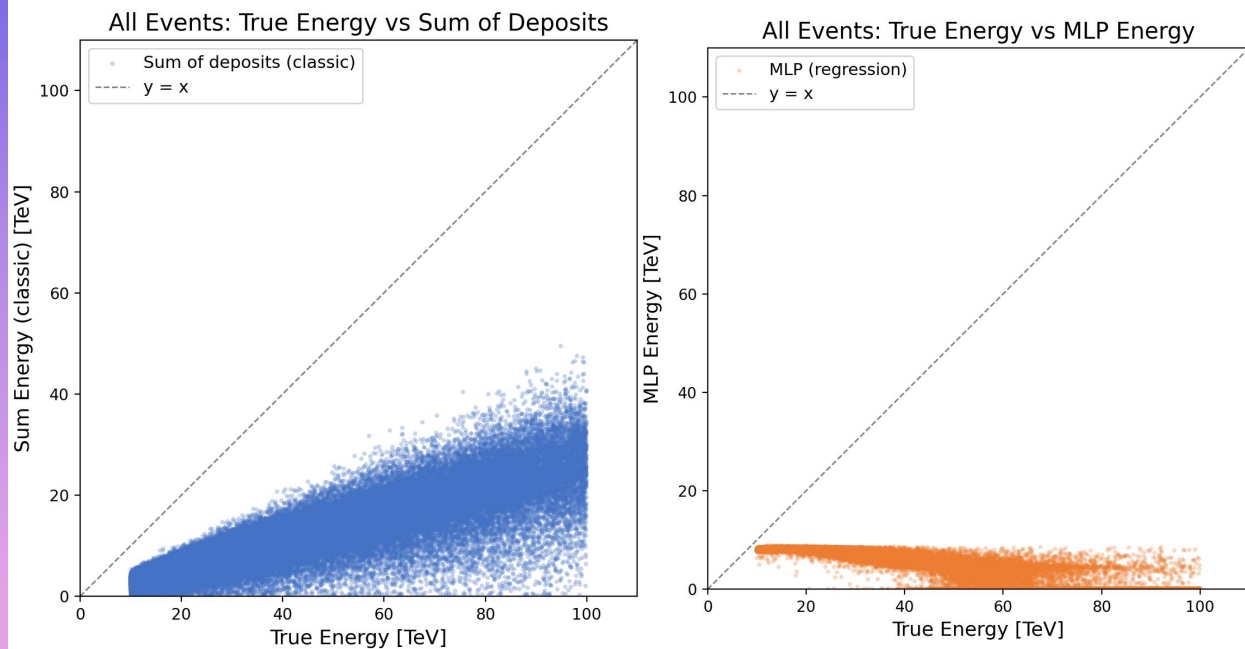


能量线性响应

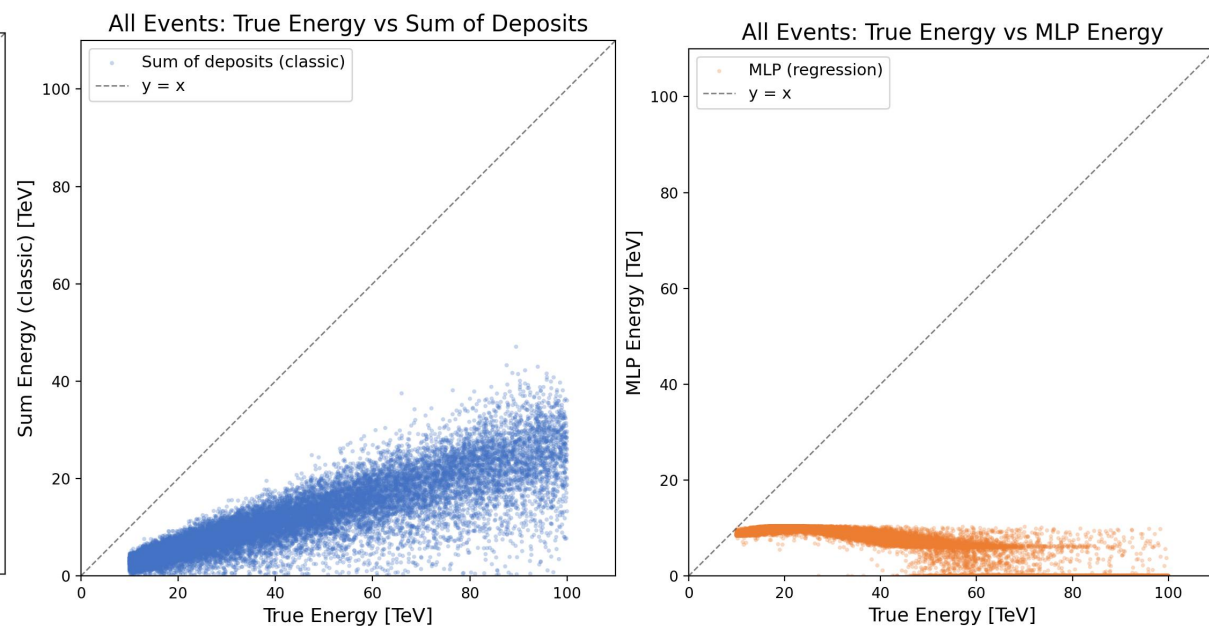
Energy Range 10TeV-100TeV



Training Data



Testing Data



Future plan



➤ 尝试新的模型?

➤

Thanks