Machine Learning Refinement of the Calibration of topo-cluster signals in ATLAS
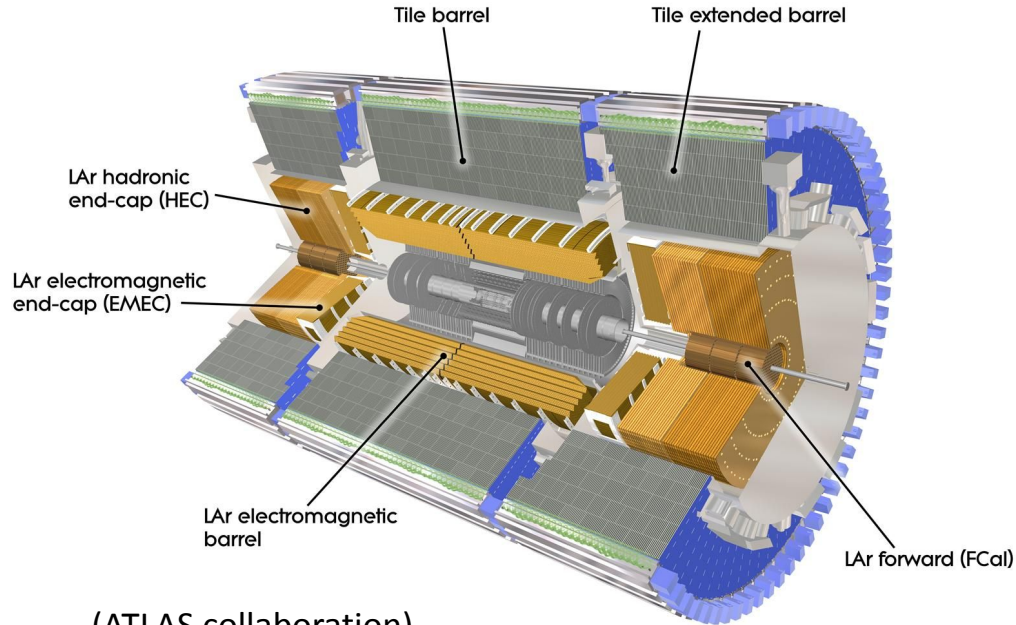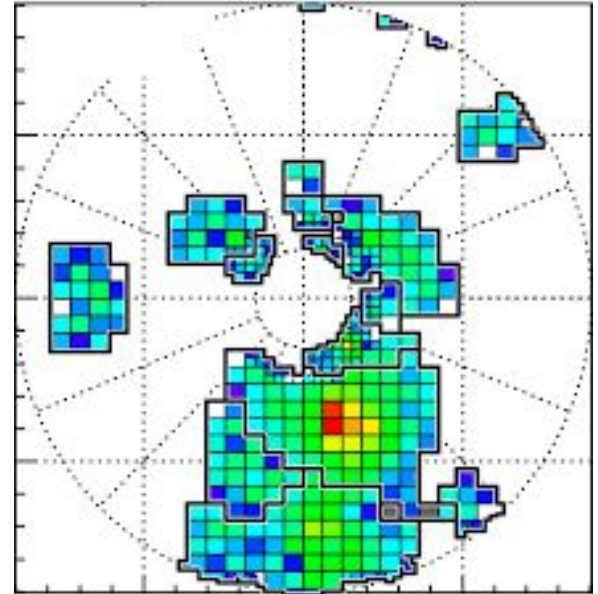
Felix Pat

What are topo-clusters?

Tile barrel

Tile extended barrel

LAr hadronic
end-cap (HEC)

LAr electromagnetic
end-cap (EMEC)

LAr electromagnetic
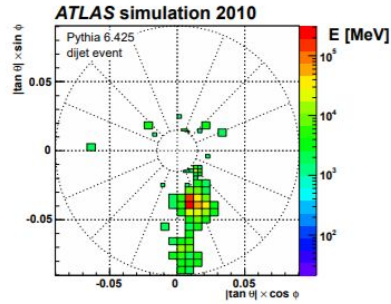barrel

LAr forward (FCal)

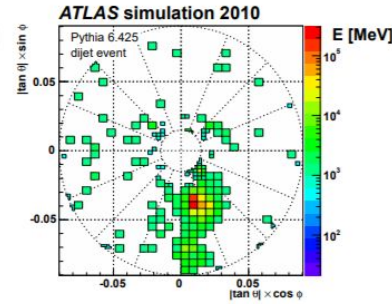(ATLAS collaboration)

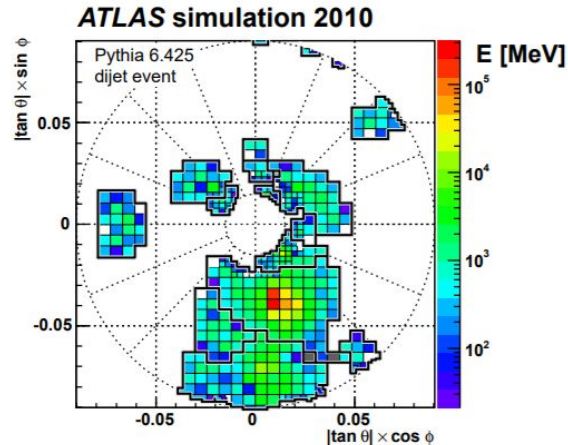# What is local cell weighting calibration (LCW)?

(ATLAS collaboration)

(a) Cells passing selection in Eq. (3)

(b) Cells passing selection in Eq. (4)

(c) All clustered cells

How can Machine Learning (ML) be applied?

Inputs: cluster energy density, pTD, depth, pseudorapidity, significance and second time
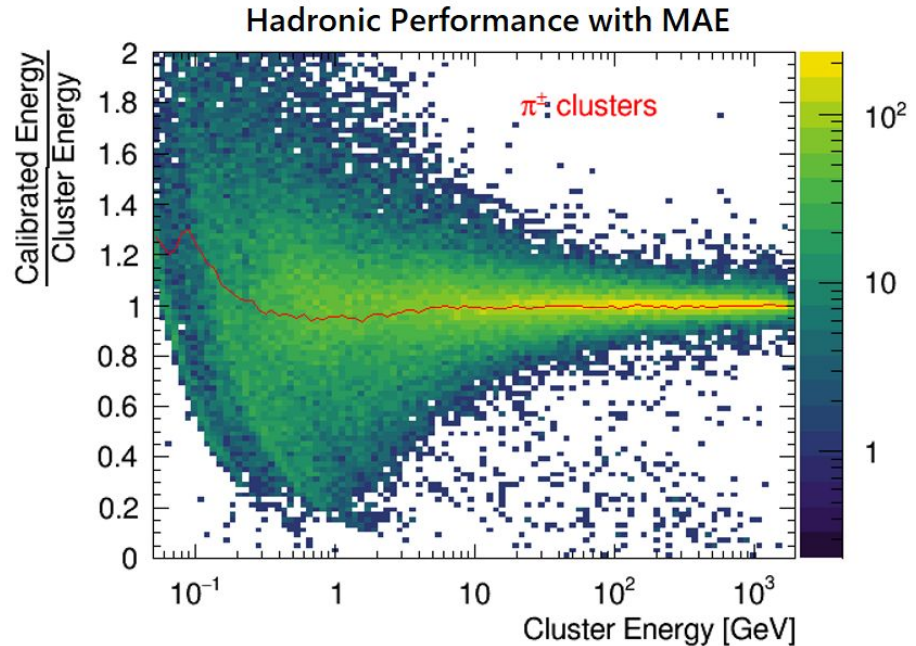
Main loss functions used:
Mean Absolute Percentage Error
Mean Absolute Error

$$MAPE = \frac{1}{n}\sum_{i=1}^{n}\frac{|y_i - \hat{y}_i|}{y_i} \cdot 100\%$$

$$MAE = \frac{1}{n}\sum_{i=1}^{n}\underbrace{|y_i}_{\substack{\text{test set}}} \underbrace{-}_{\text{predicted vaue}} \underbrace{\hat{y}_i|}_{\text{actual value}}$$
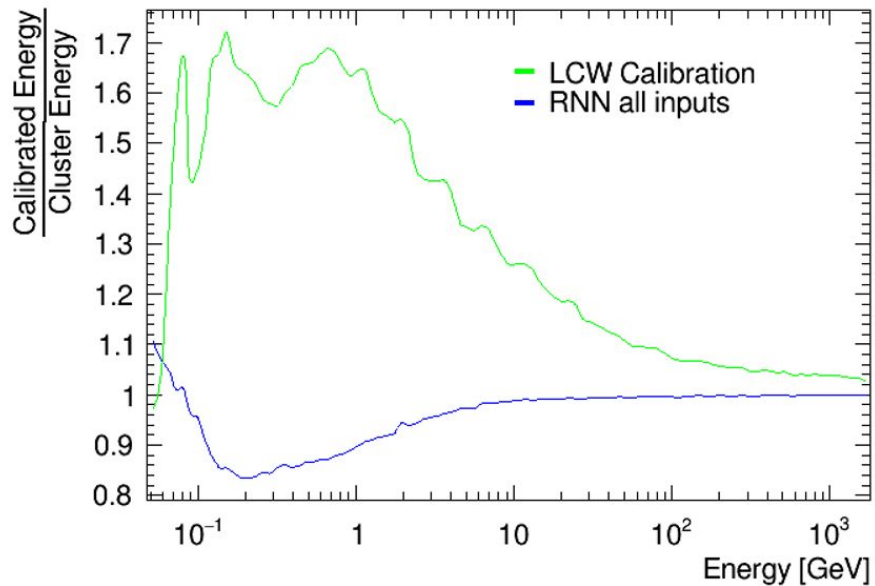

Hadronic Performance with MAE

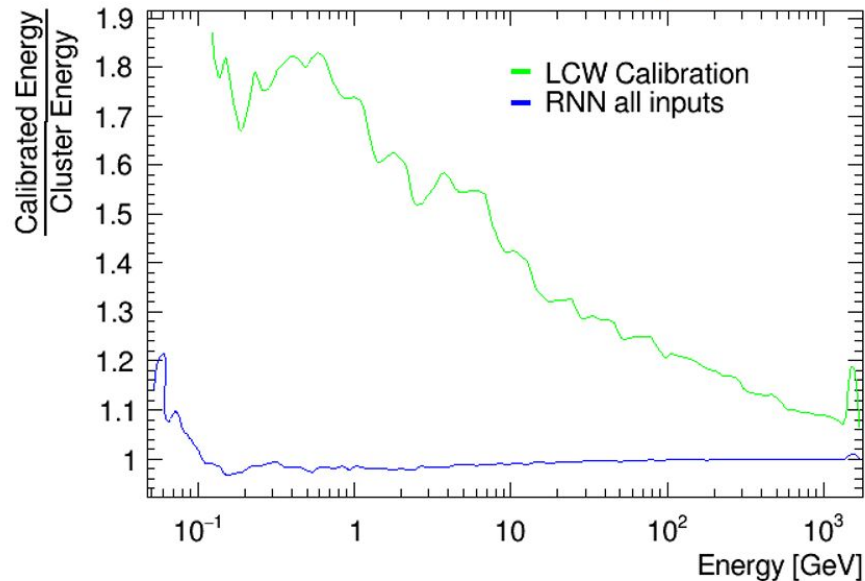$\pi^{\pm}$ clusters

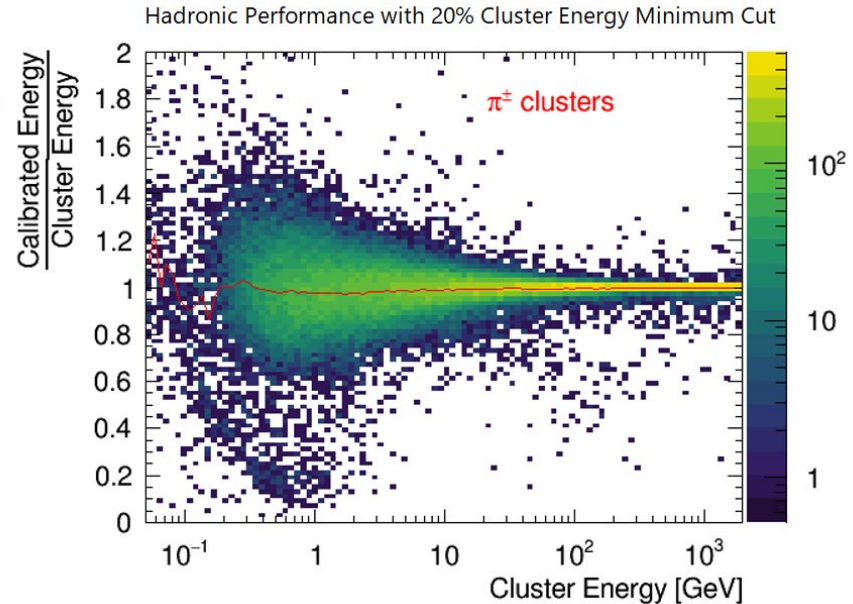# How did LCW compare to ML with MAPE?

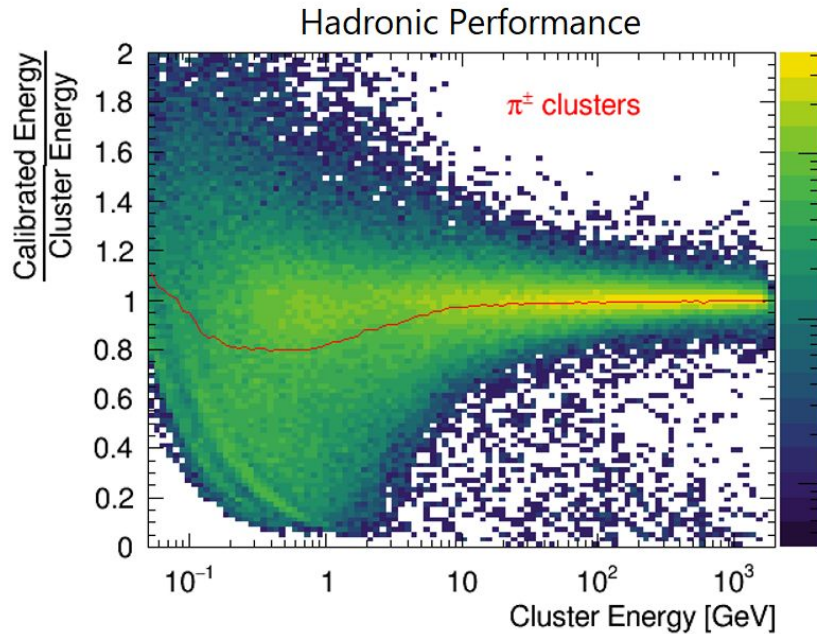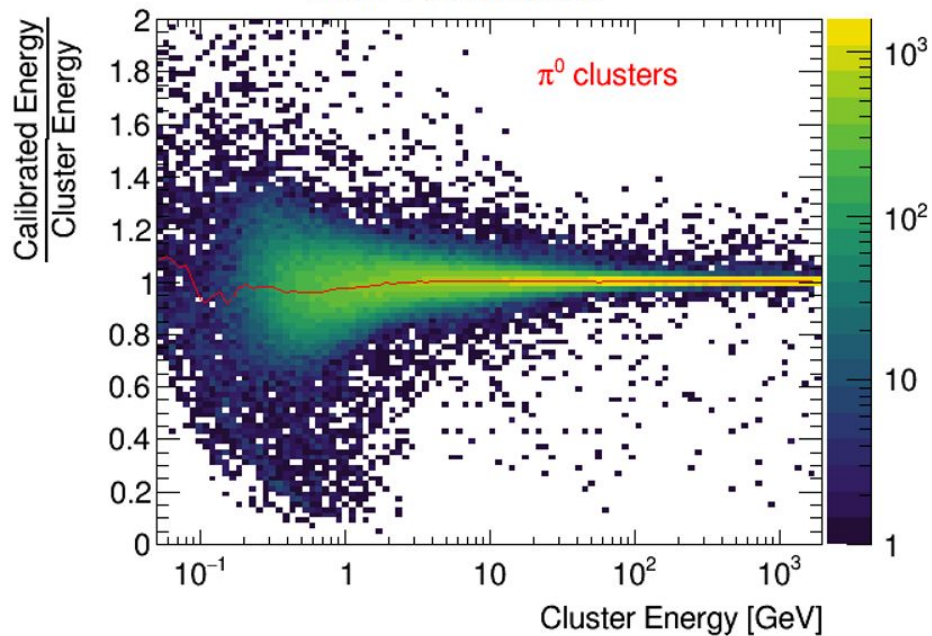2020

LCW versus Mixed Pions Performance

2021

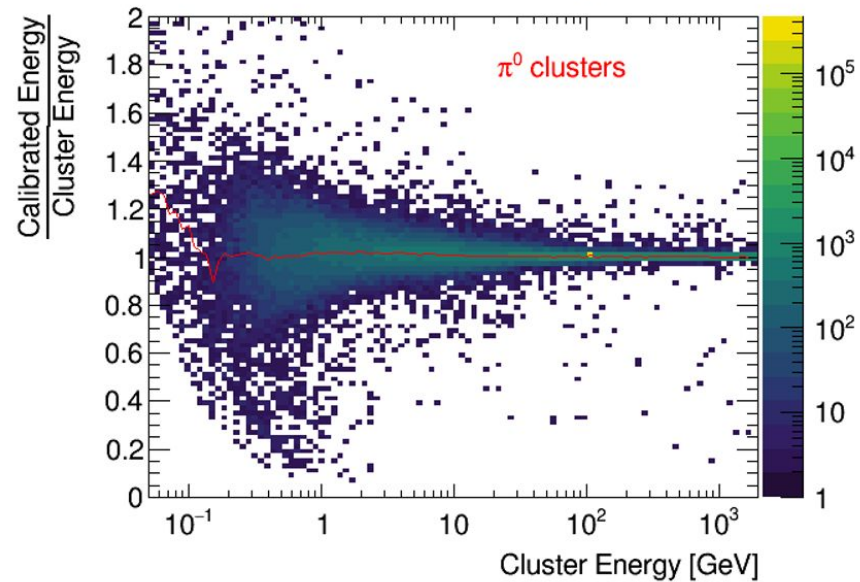LCW versus Mixed Pions with 20% Cluster Energy Minimum Cut
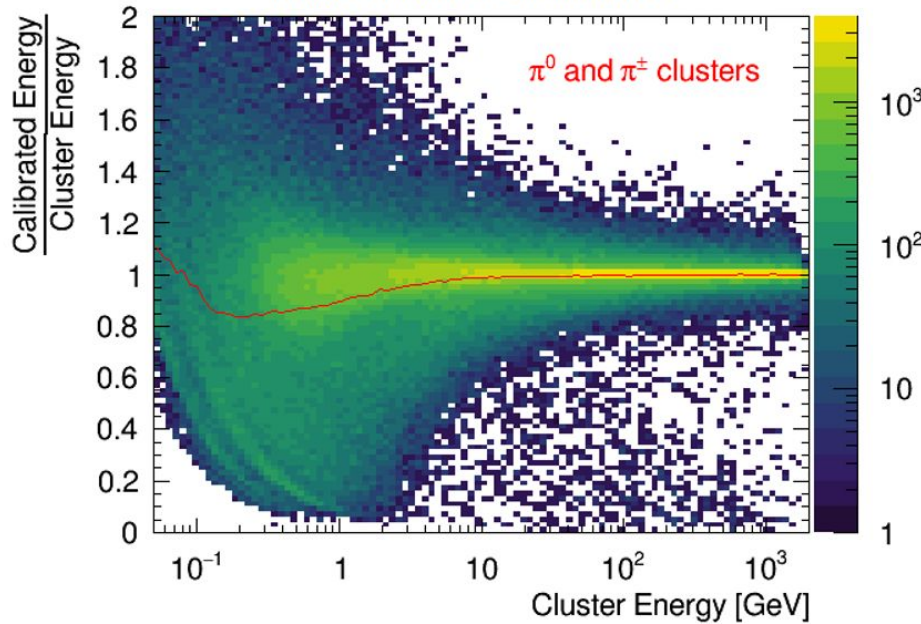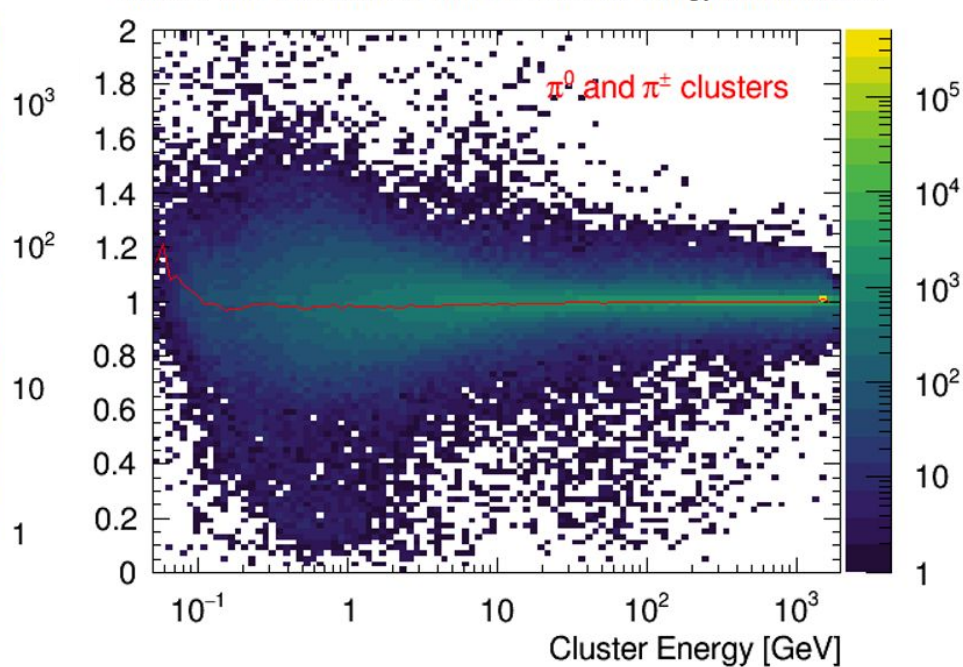
What improvements are made in 2021?

E&M Performance

E&M Performance with 20% Cluster Energy Minimum Cut

π^0 clusters

Mixed Pions Performance
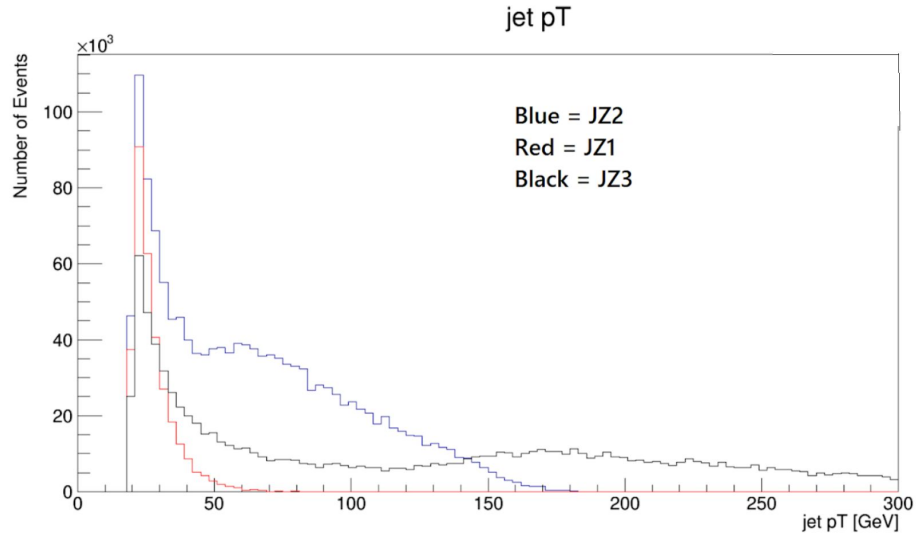
π^0 and $\pi^{\pm}$ clusters

Mixed Pions Performance with 20% Cluster Energy Minimum Cut

π^0 and $\pi^{\pm}$ clusters

Calibrated Energy / Cluster Energy

Cluster Energy [GeV]

How can ML be applied to jet reconstruction?

Future Work

Works Cited

https://arxiv.org/abs/1603.02934

https://cds.cern.ch/record/2138166/files/scoap3-fulltext.pdf

https://cds.cern.ch/record/1951815/files/nppp273-1121.pdf
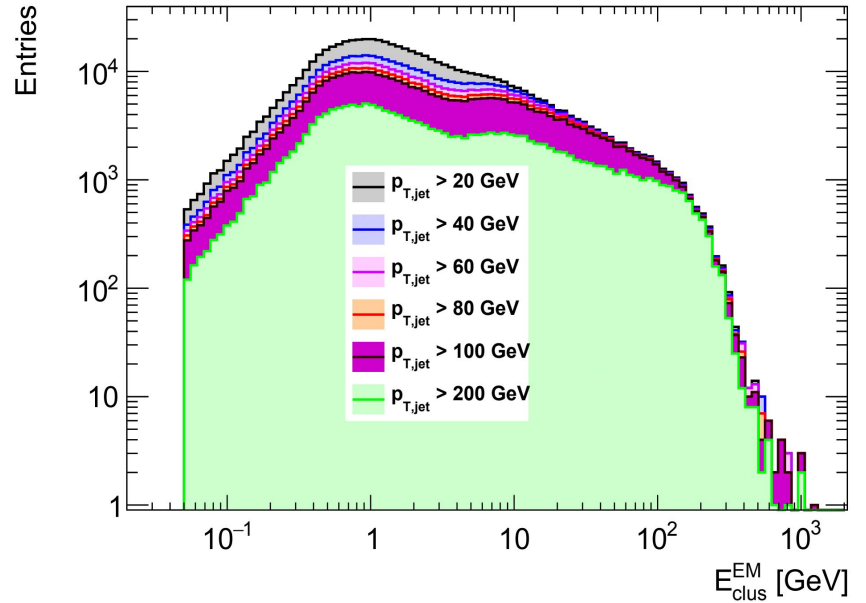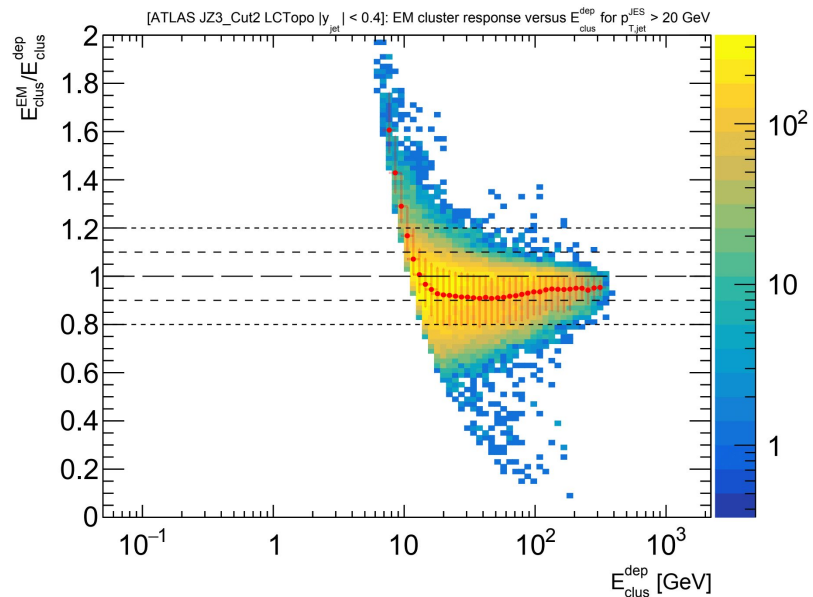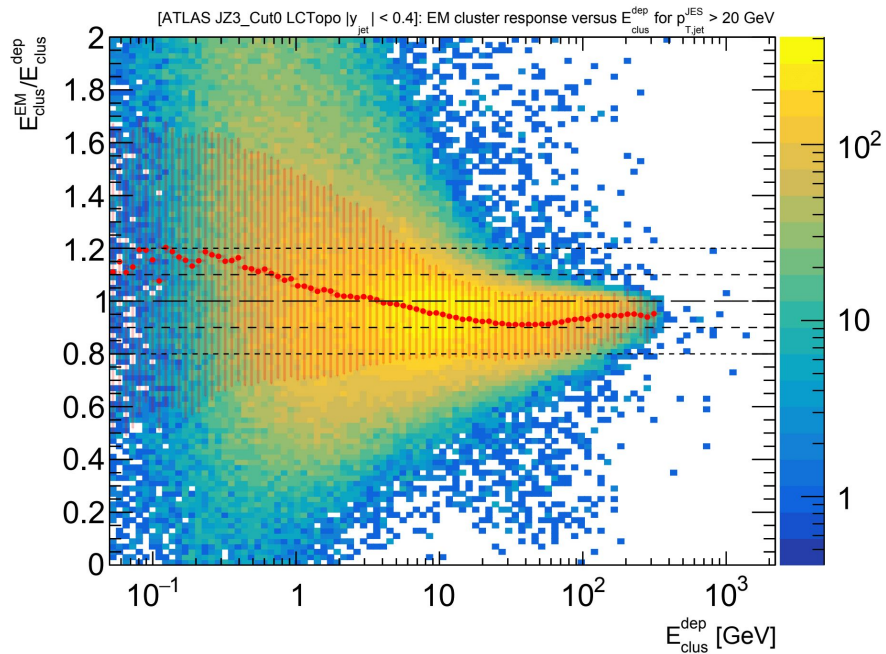
Backup slides

Network Architecture

- ❖ 9 inputs
- ❖ 2 hidden layers
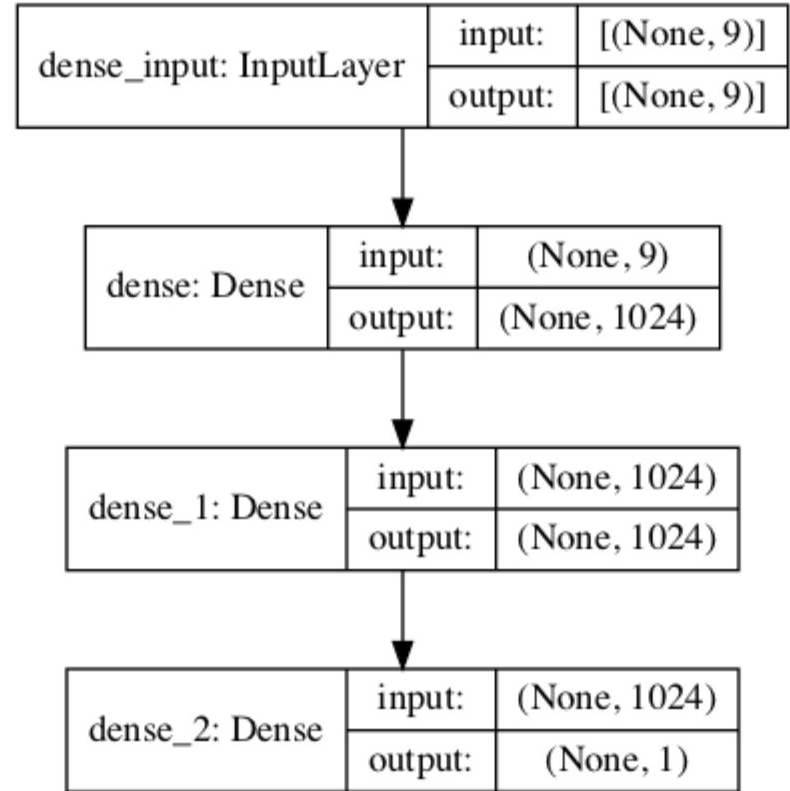 - ➢ 1024 nodes each
- ❖ Rectified linear activation function

Figure 1: NN Architecture for Energy Calibration