AI/ML Workflow for BHCal Calibration
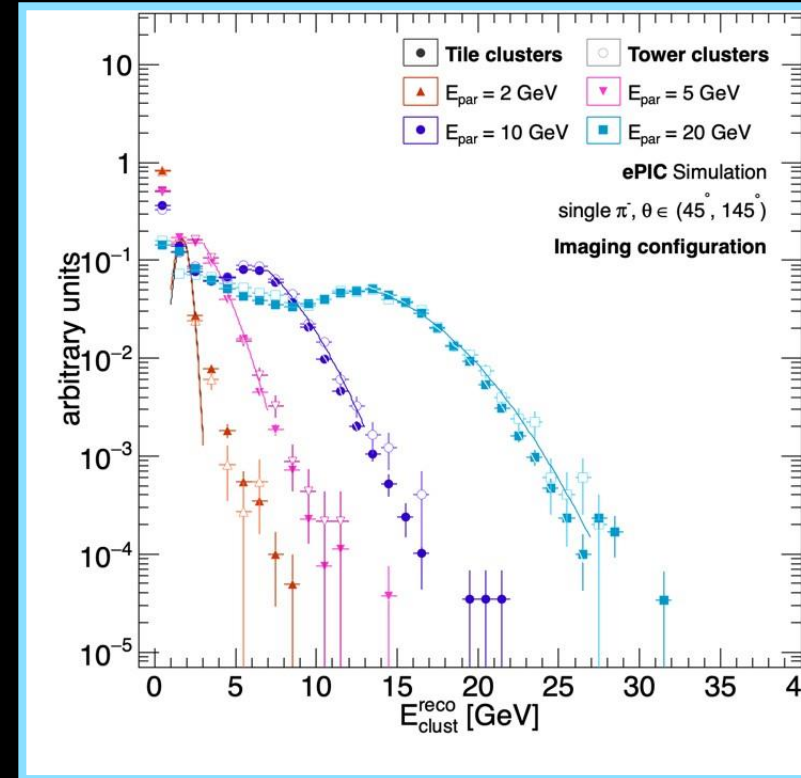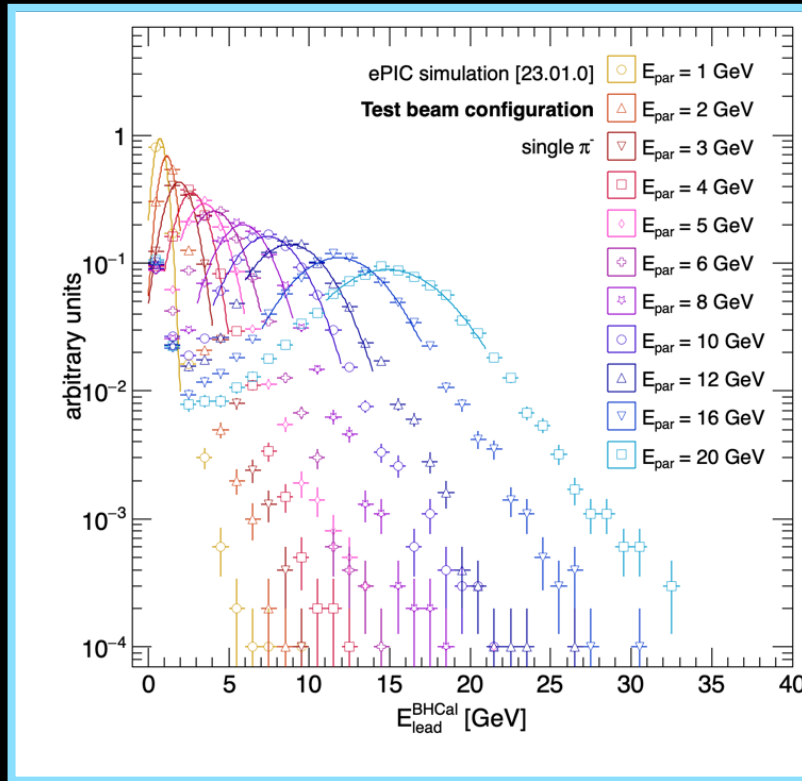
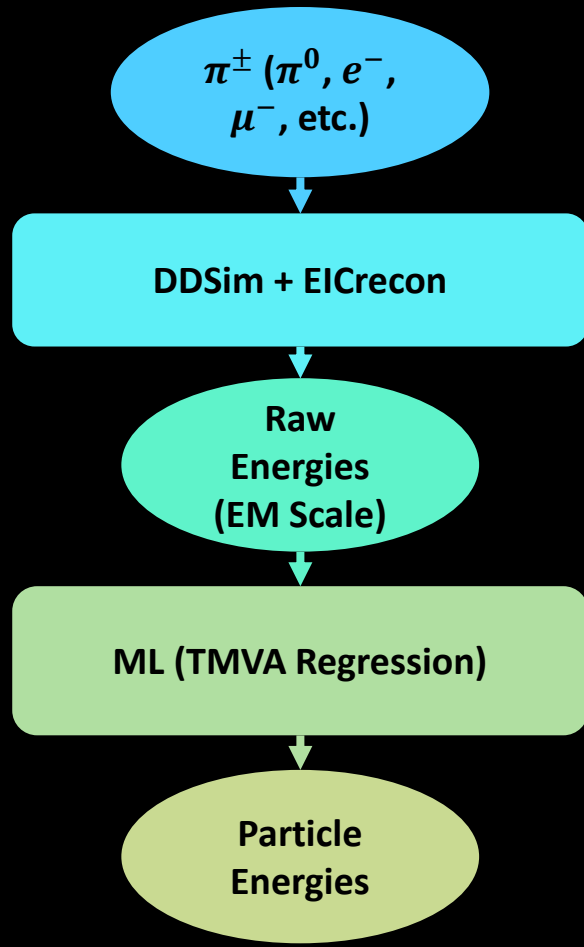ePIC AI Townhall Meeting
August 30th, 2023
Derek Anderson

o Energy measured by BHCal degraded by, e.g.
  – Fluctuations in hadronic and EM parts of shower
  – Energy loss in inactive material
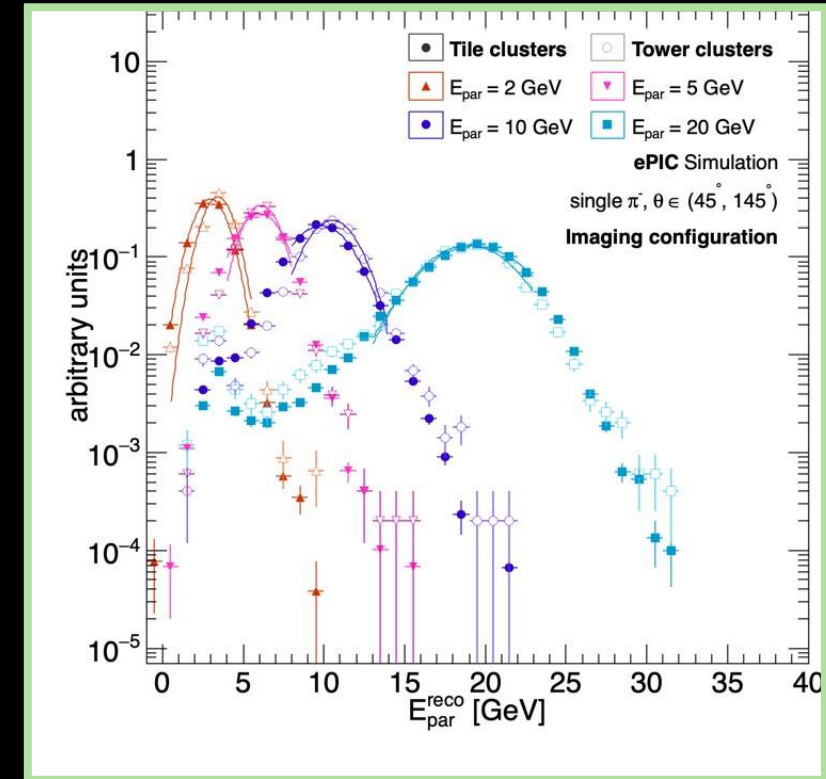 – Loss due to nuclear-binding energies
  – Etc.

∴ Energy needs to be calibrated
  ☞ **Good target for ML!**

o Single π^- energies in BHCal only **(left)** vs. in full ePIC simulation **(right)**

Workflow

o **Used TMVA:**
  - Train on single particle events
  - Run regression analysis
    › **Target:** particle energy
    › **Input:** BECal + BHCal information
  - (More details in backup)

o **Plenty of room for improvement!**
  - Scan hyperparameters
  - Incorporate more sub-systems
  - Extend model to deal with realistic DIS events (cluster splitting)

o Now thinking about how to integrate workflow into EICrecon...
  ☞ Particle flow?

o **Right:** calibrated energies

Workflow diagram (left):
- $\pi^{\pm}$ (π^0, e^-, μ^-, etc.)
- DDSim + EICrecon
- Raw Energies (EM Scale)
- ML (TMVA Regression)
- Particle Energies

Parameters
```
    –   Regression analysis
    –   3 methods (all out-of-the-box):
        a) Linear Discriminant (shown)
        b) MLP (neural network)
        c) Boosted Decision Tree
```
Training Variables
```
    –   Energy of leading BHCal and BEMC clusters
    –   Eta, phi of leading BHCal and BEMC clusters
    –   No. of hits in lead BHCal and BEMC clusters
    –   Sum of energy in imaging and SciFi layers
    –   Sum of energy in individual imaging layers (not shown here)
```
Target
```
    –   particle energy
```