EIC-India Activities

EIC User Group Meeting

EIC-Smear

in collaboration with

Kolja Kauder

EIC-Smear: IIT Patna

Under: Kolja Kauder

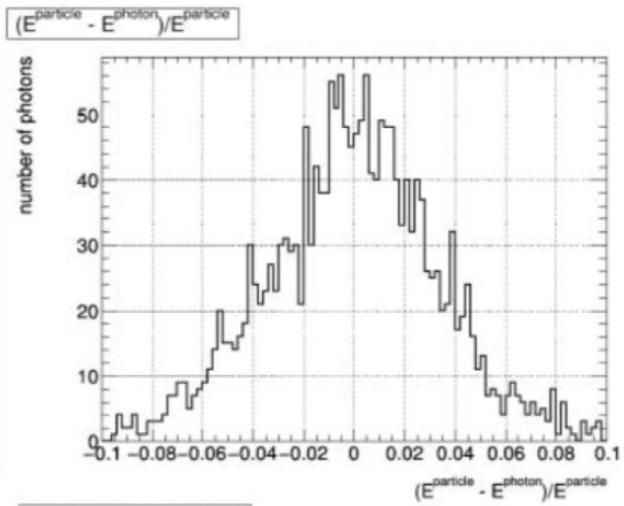
Rajat Aggarwal (Master Student)
Dr. Neha Shah (Faculty)

Comparison of EIC-Smear and Delphes

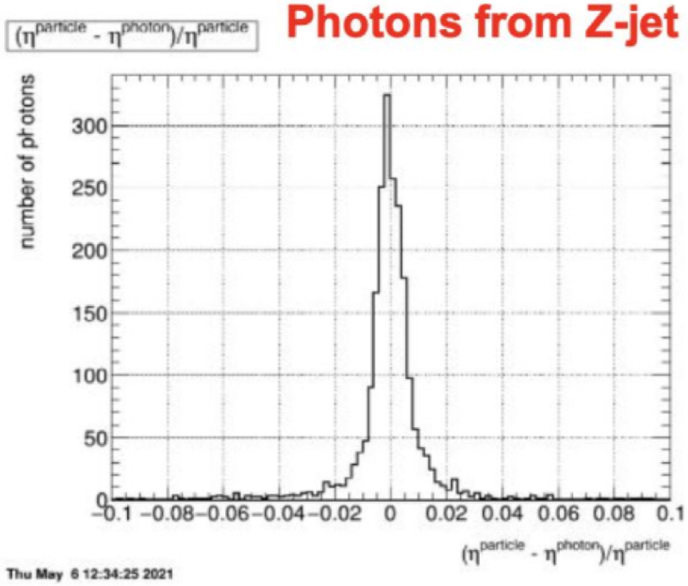
Successfully installed and able to compile examples in Delphes

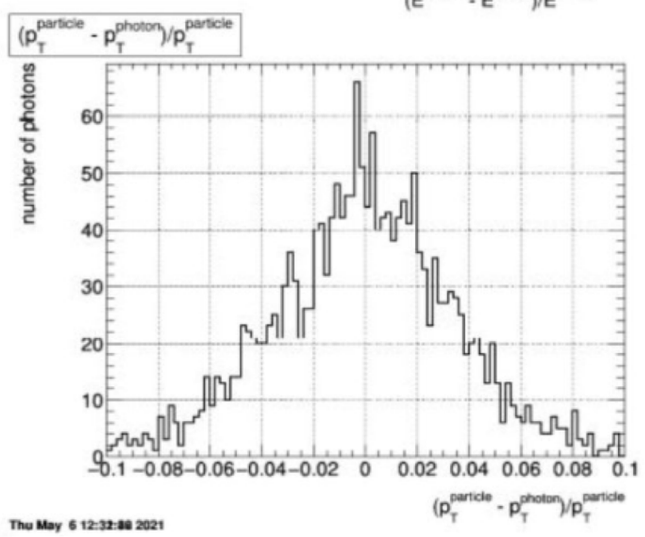
Future task:
write an example for both the methods

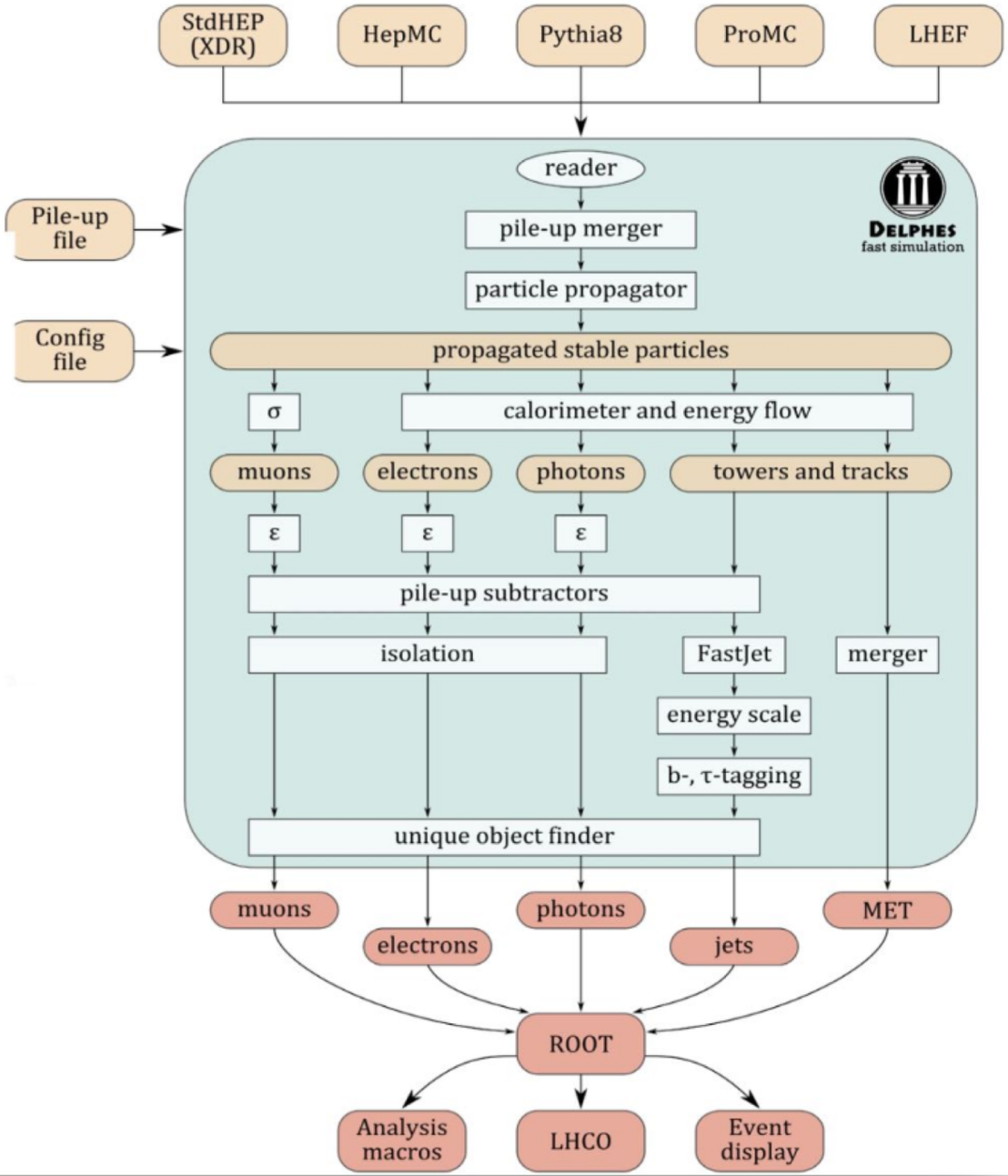
Make comparisons between two



Photons from Z-jet







IIT MADRAS Group

Thakkar Riya (Master student)
Dr. Prabhat Pujahari (Faculty)

Unit Testing

- Learnt catch 2 framework for unit testing.
- Added a sample unit test block to the file kinematics.cxx
- Attempted to integrate catch2 with the standard cmake files to enable automatic compiling of tests, could not accomplish and had to shift focus to other eic task.

QAplots detector file

- Extracted ranges of kinematic variables like Q2 , η, bjorken x etcetera for inclusive reactions from the yellow report.
- Updated steer files with appropriate energy and parameter values to generate ep data.
- Setting up detector software at the bnl guest account, the qaplots file will then be modified with the updated ranges of kinematic variables.
- The updated ep data and detector files to be used for generating qaplots handbook.

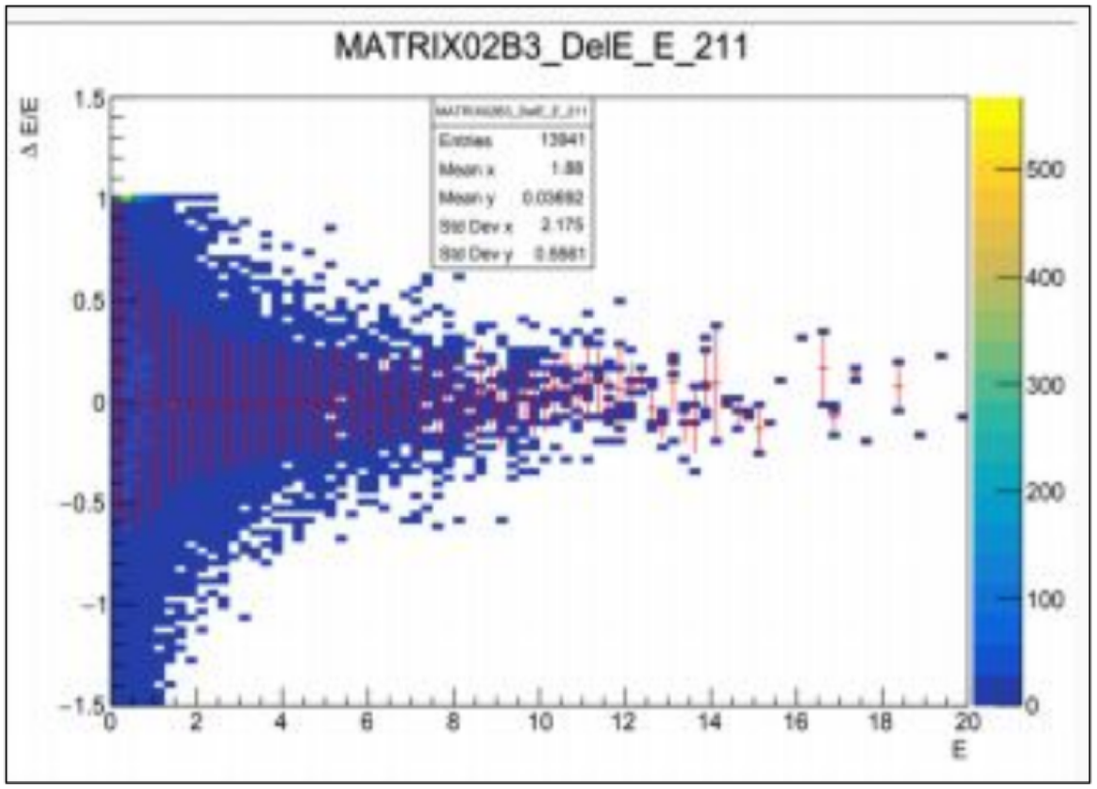


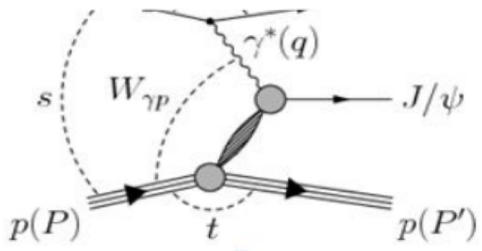
Figure 1: Sample plot from the handbook generated using ./qaplots. A steer file was updated with suitable values of kinematic variables to obtain ep20x250 collision data

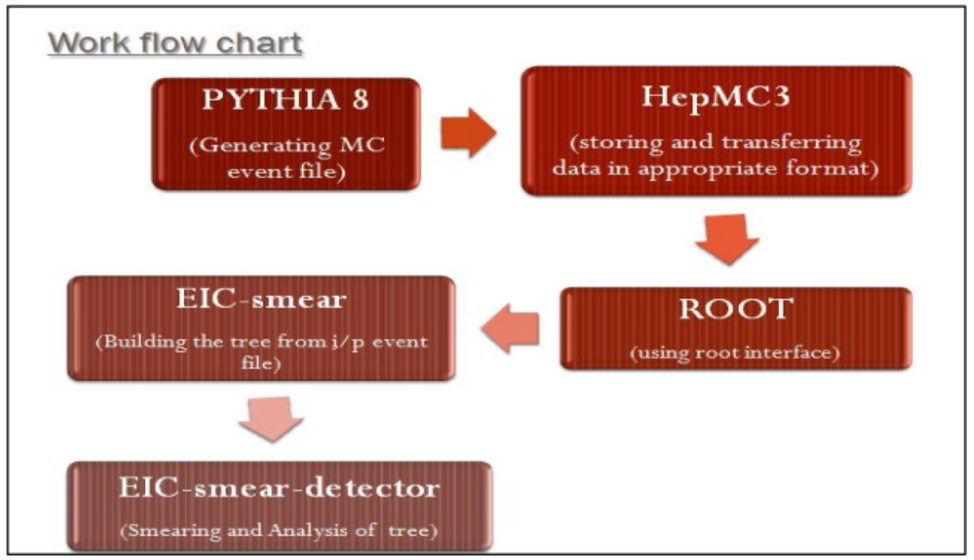
MNIT Jaipur Group:

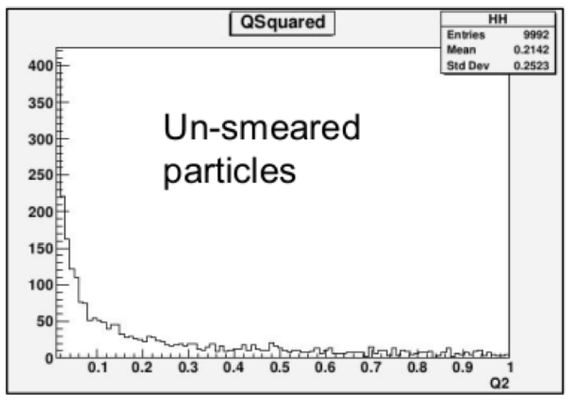
Study the smearing effect for Exclusive Physics at EIC

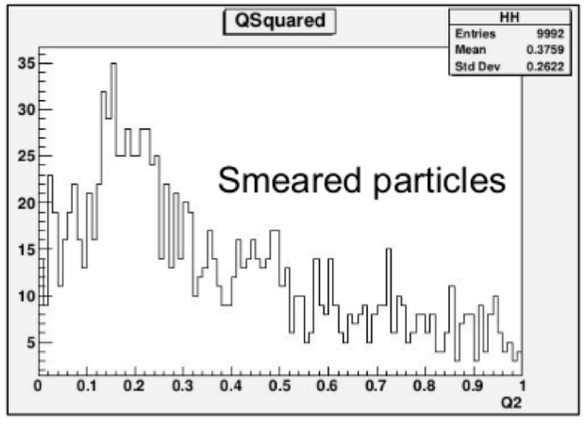
Chitranshi Bakshi (Master student)
Dr. Kavita Lalwani (Faculty)

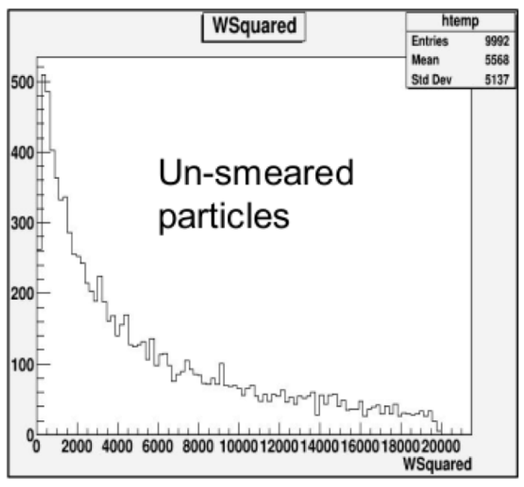
- Input MC event file is generated using Pythia8 giving input parameters corresponding to exclusive reaction i.e J/ψ photo-production .
- Input event file is stored in form of Ttree in ROOT software to ease the reading and smearing process.
- Fast stimulations is performed effectively by using eic-smear software and eic-smear detector scripts.
- Smearing effect on different parameters of exclusive reactions are analyzed .
- Reconstruction of mass of J/ψ (ongoing work).

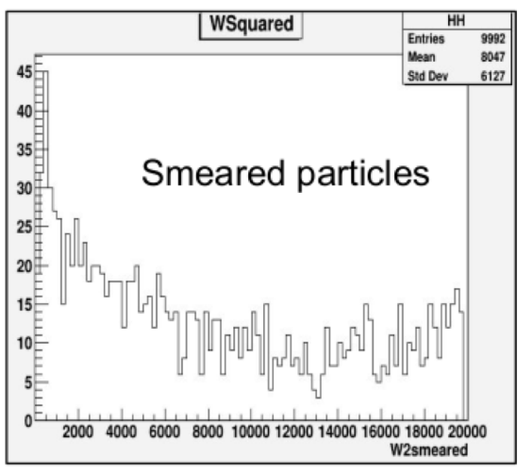












Smearing effect on Q^2 and W^2 Distributions for proton, electron beam collision with energies 275 , 18 GeV respectively.

Fun4All

in collaboration with

Christopher Pinkenburg and Kolja Kauder

EICUG Summer 2021 Meeting

Status of Fun4All Simulation

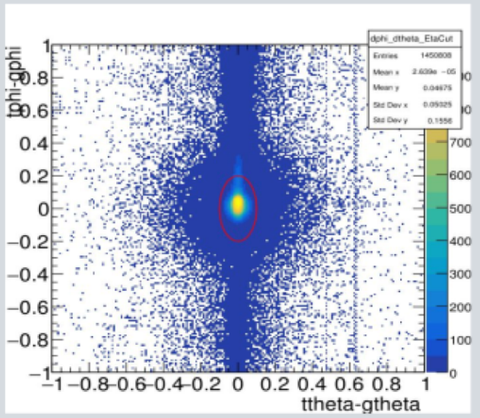
Simran Kaur, Panjab University | Sagar Joshi, IIT Indore | Siddhant Rathi, IIT Indore
In collaboration with Christopher Pinkenburg and Kolja Kauder

Parameterization of the Energy Resolution of Calorimeters:

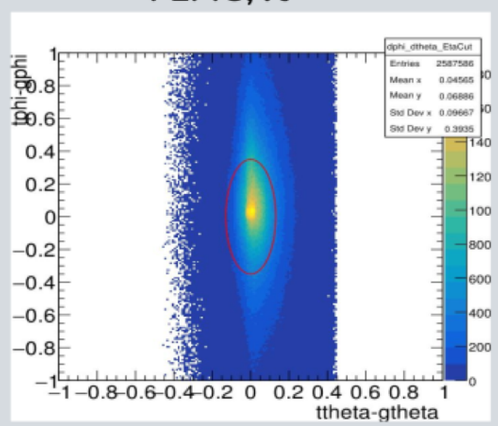
- Simplest case for calorimeters:
  - With photon digitization turned off
  - Manual Clustering on towers
- Particles: e^-, π^-
- Energy cut (>100 MeV) on total energy
- Recalibration of energy

Manual Clustering of Towers

CEMC, e^-

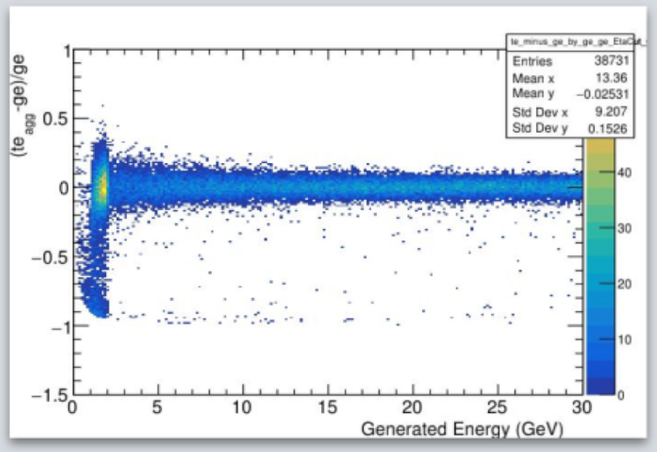


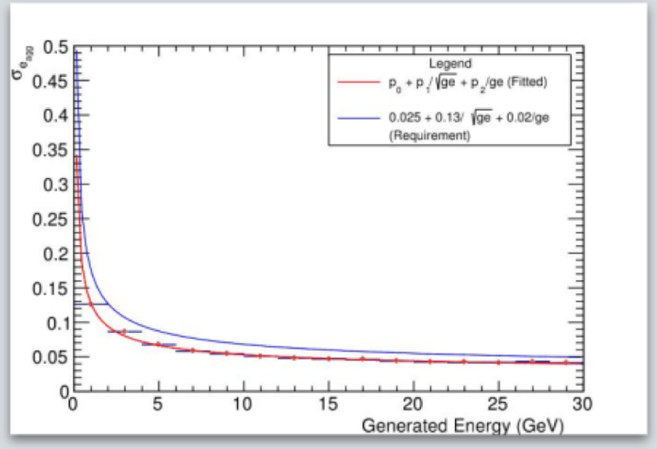
FEMC, π^-



Electron

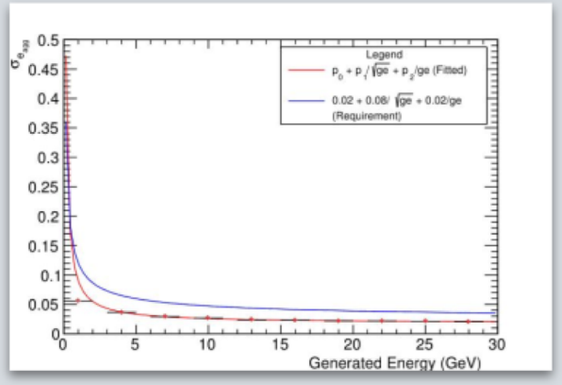
CEMC Energy Resolution





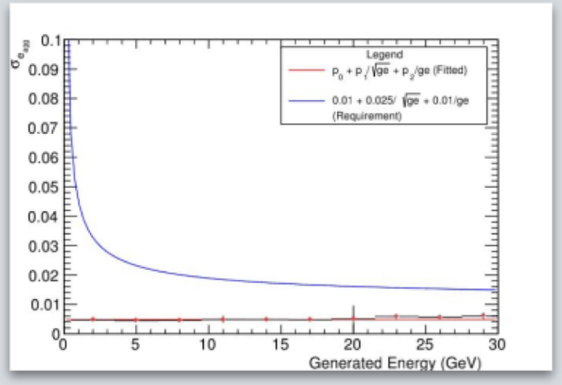
$\sigma_E/E = 22.8\% + 1.2\%/E + 9.1\%/\sqrt{E}$

FEMC Energy Resolution



$\sigma_E/E = 1.7\% + 0.5\%/\sqrt{E} + 6.5\%/E$

EEMC Energy Resolution

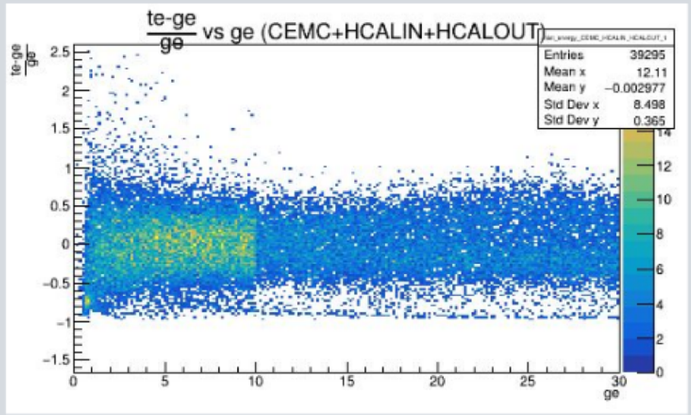


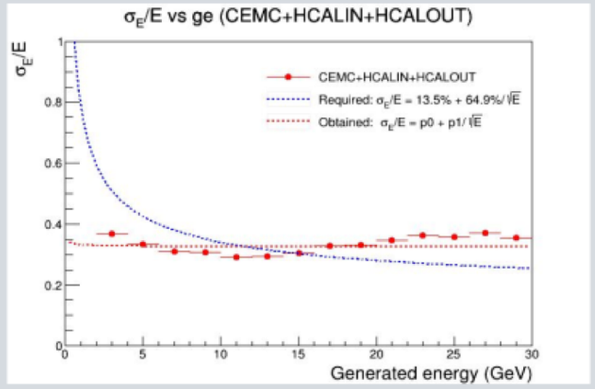
$\sigma_E/E = 0.48\%$

Status of Fun4All Simulation

Pion

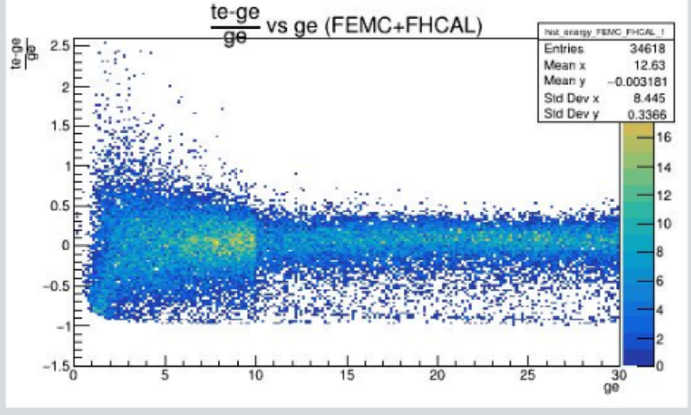
Energy Resolution: **Barrel calorimeters**

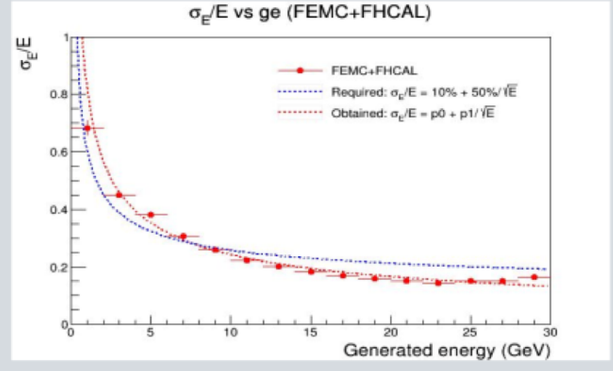




$\sigma_E/E = 32\% + 1\%/E$

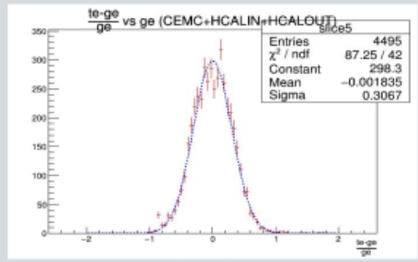
Energy Resolution: **Forward calorimeters**



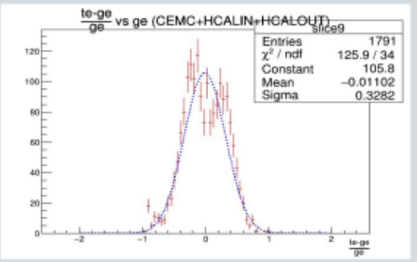


$\sigma_E/E = 2\% + 83\%/E$

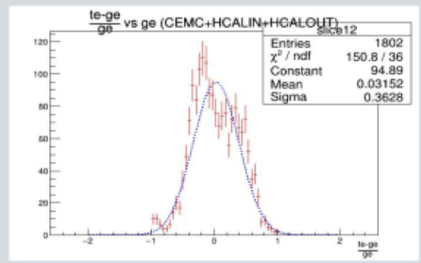
Second peak appearing at high energies worsening the resolution



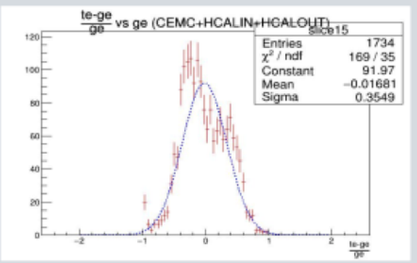
8-10 GeV



16-18 GeV

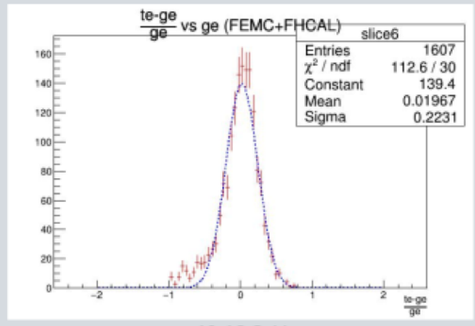


22-24 GeV

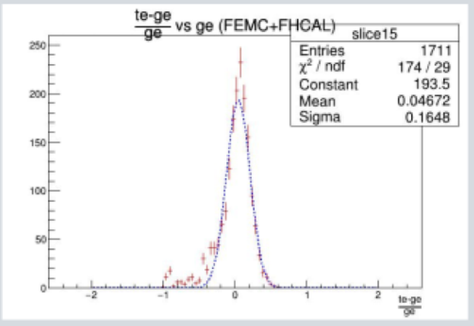


28-30 GeV

No such issue in case of forward calorimeters



10-12 GeV



28-30 GeV

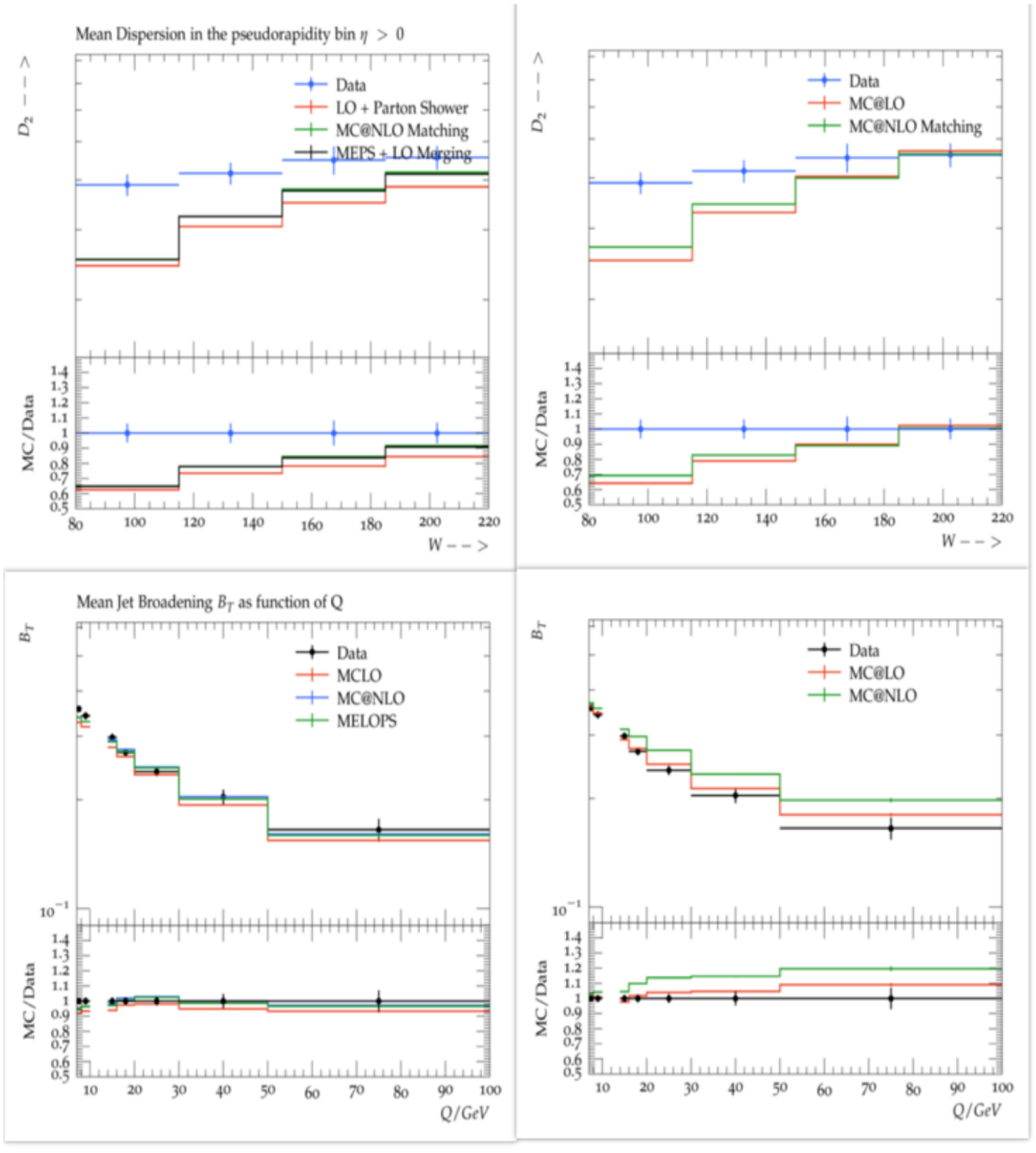
Summary:
- *Study of the energy resolution for the simplest case*
- *Electron gives acceptable results*
- *Pion energy distribution problem in barrel region*

Next Steps: - Find a solution for second peak appearing for barrel calorimeters' resolution
- Turn on photon digitization and study its impact on the energy resolution.
Future plans: - Study different input generators (Pythia8, Pythia6, SARTRE) for actual physics signals

MC-data Validation

in collaboration with
Markus Diefenthaler

Multiplicity and Event shape Studies

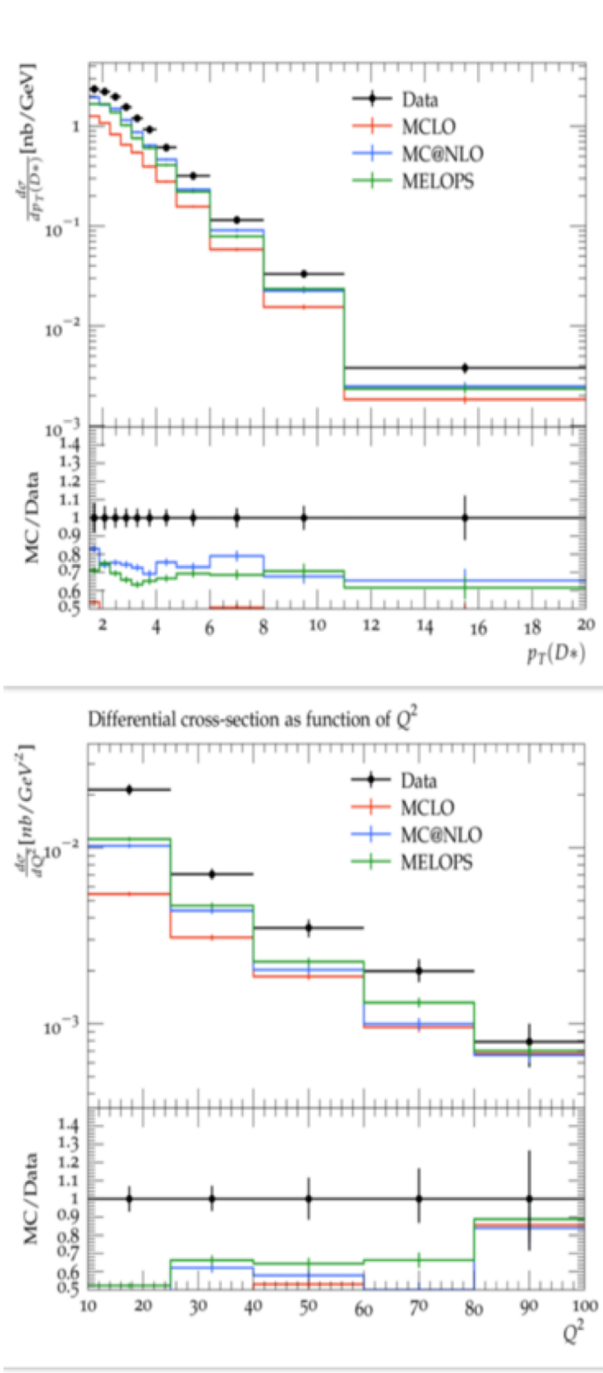


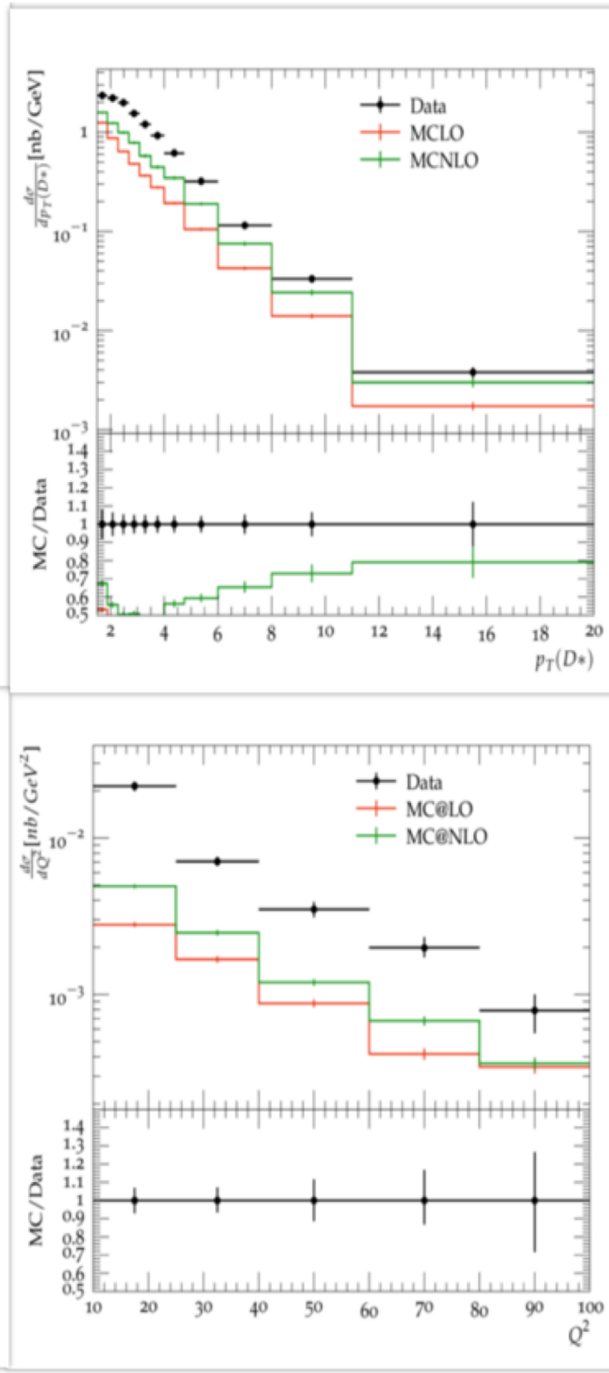
(IIT Bombay)

- **Mean Dispersion and and jet broadening as function of final state energy for total current hemisphere.**
- **For dispersion the agreement is better at higher energy and multiplicity ranges.**

Vector meson cross-section studies

(IIT Bombay)



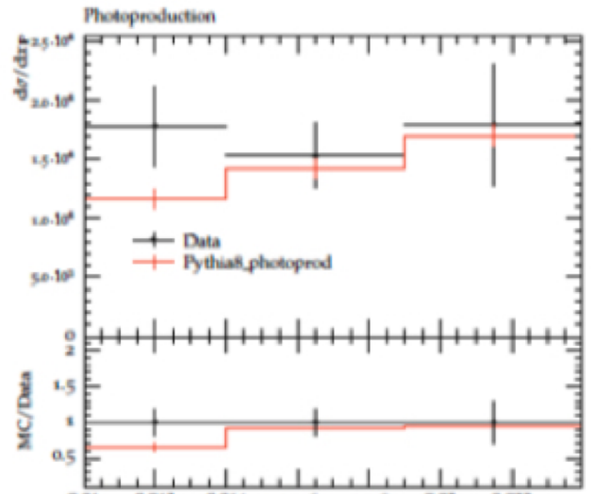


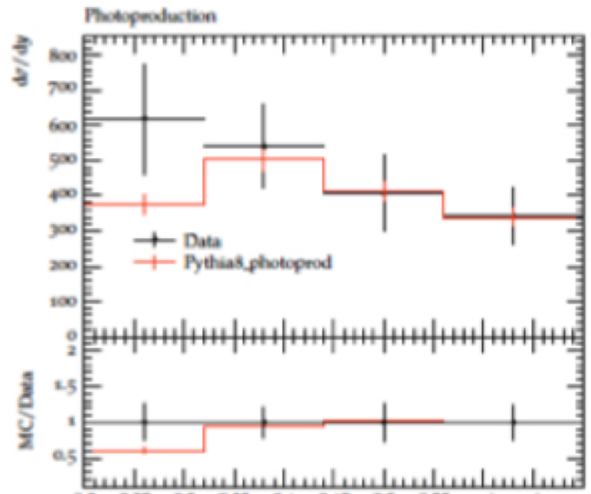
- **The single-differential cross-section of D* and phi meson are compared as functions of transverse momenta for D* and phi mesons.**

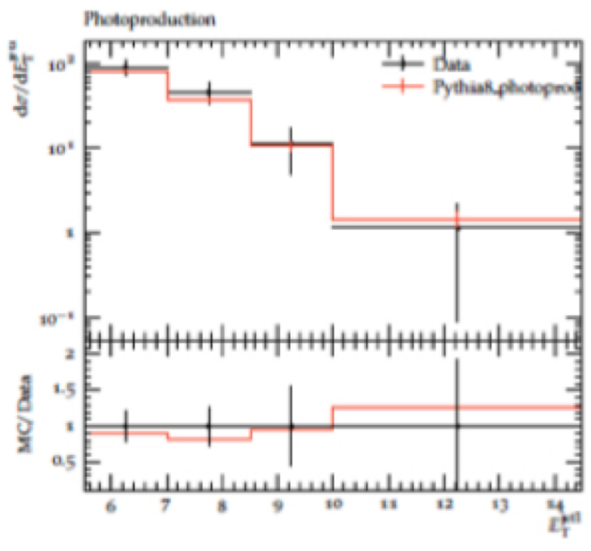
Diffractive Dijets in Photoproduction - HERA Data

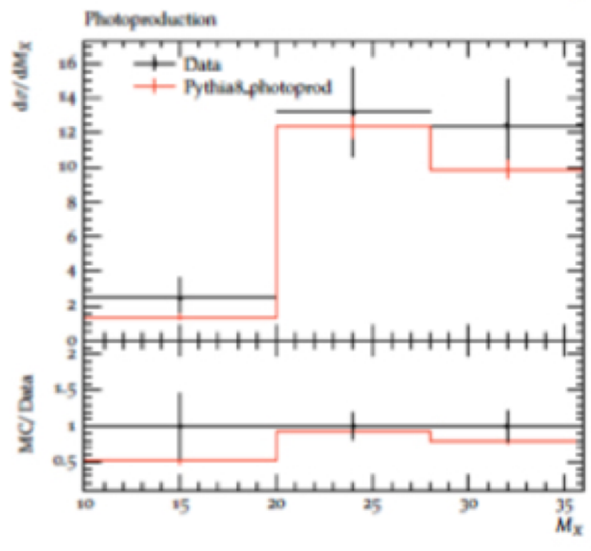
Goa University

- Fraction of the proton momentum carried by Pomeron ($x_{\mathbb{P}}$) & Inelasticity
- Transverse energy of the leading jet and invariant mass of remanants



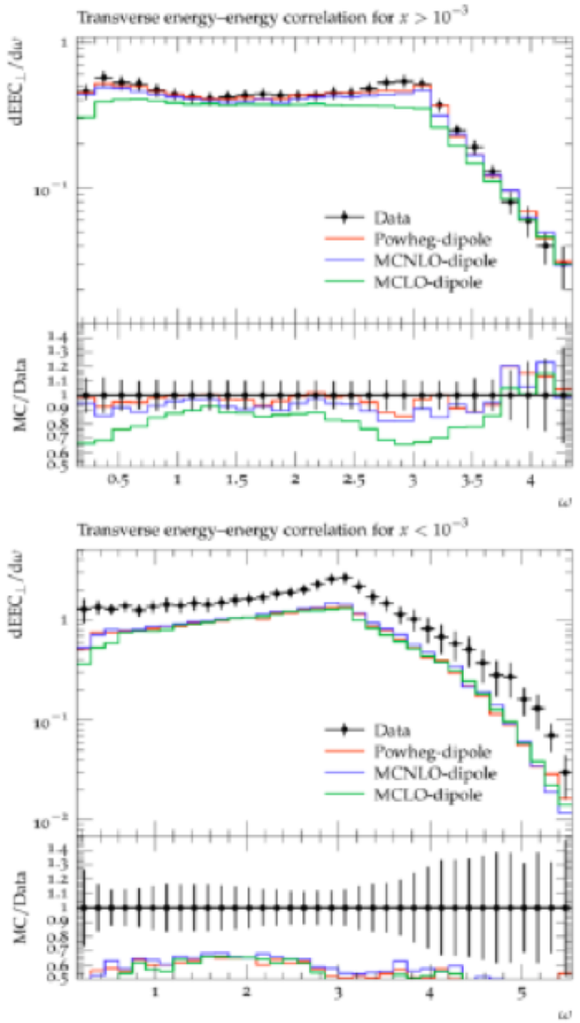


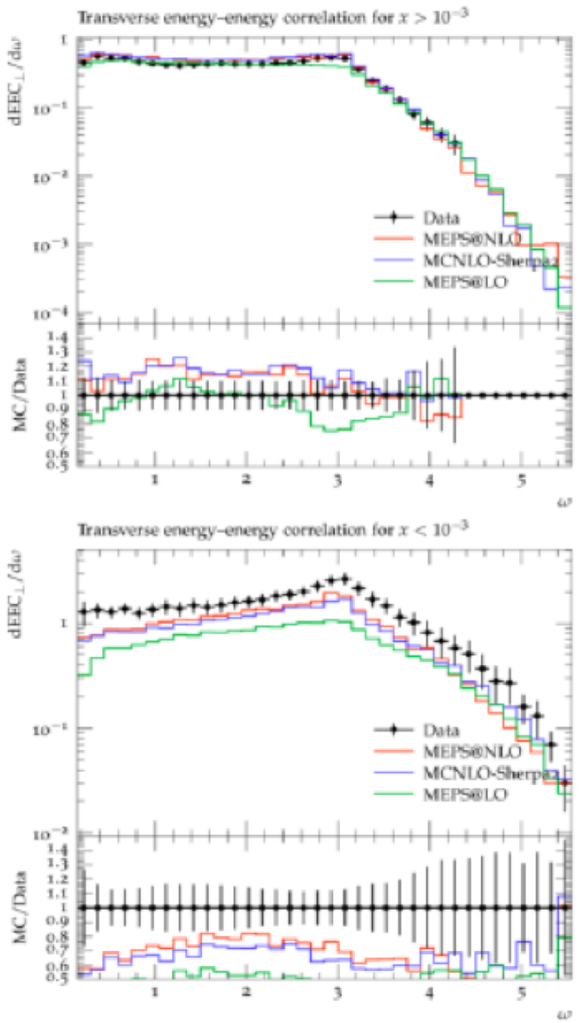




Transverse Energy-Energy Correlation

(IIT Madras)





Herwig

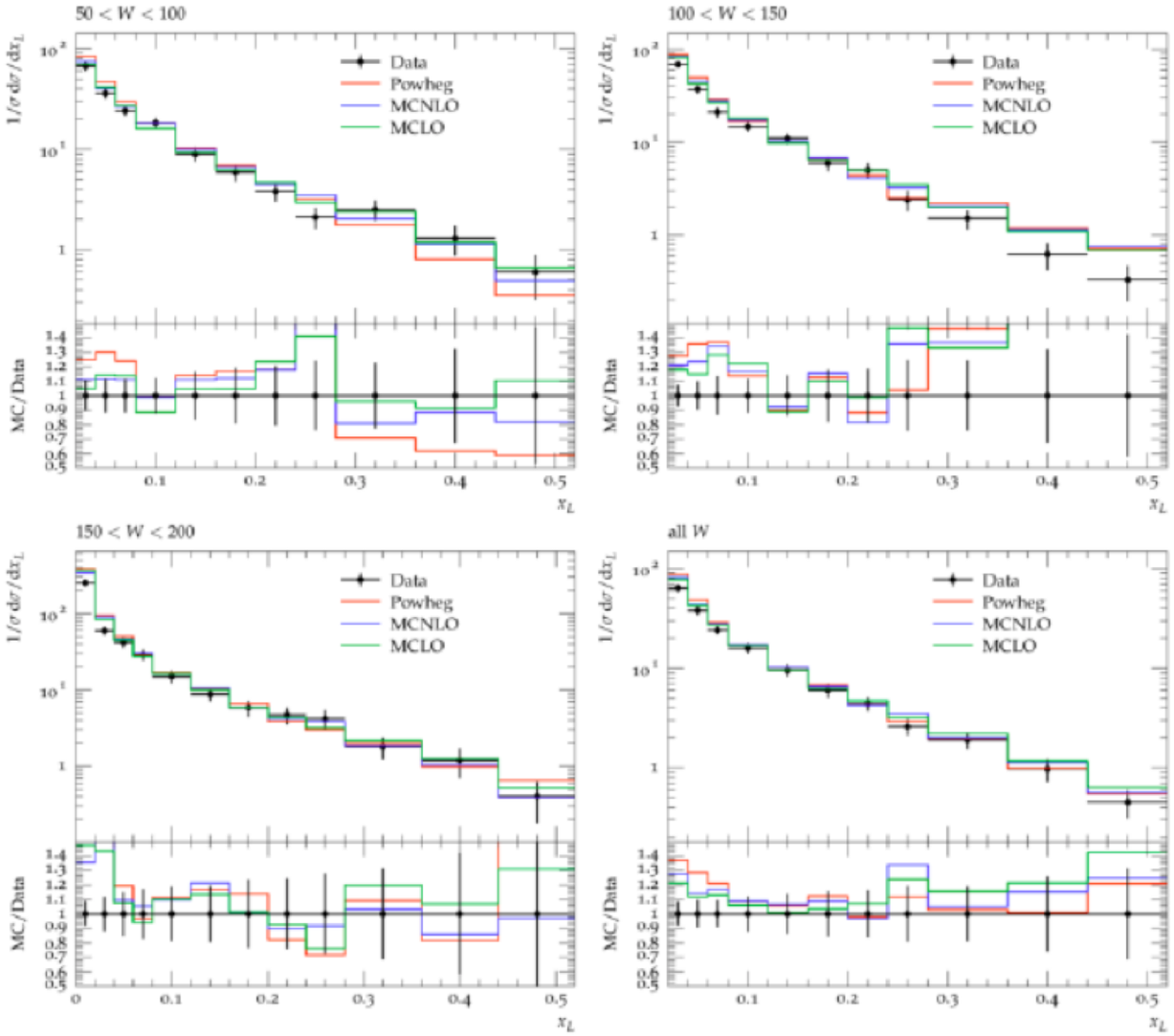
Sherpa

We compare the HERWIG7 and SHERPA2 event generators by plotting the Energy-Energy Correlation with different process selections.

- Powheg, MCNLO, MCLO dipole shower comparison in Herwig.
- Matrix-Element Parton Showers in Sherpa.
- In the high-x regions, the MC data matches quite well with the experimental data.
- In the low x regime QCD effects owing to high parton densities are expected. Hence, the transverse energy correlation plots, do not fit the data exactly.

Scaled charged particle spectra

(IIT Madras)



- We compare Scaled charged particle spectra in different W ranges with different process selections.
- Powheg, MCNLO, MCLO dipole shower comparison in Herwig.
- Matrix-Element Parton Showers in Sherpa
- All MC models fit the data quite well in lower x_L regions. The causes of deviations in high x_L region need to be explored.

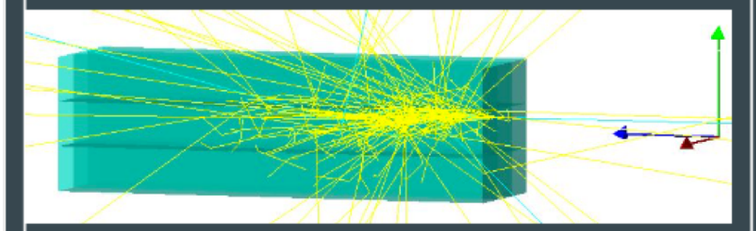
Escalate-ML

in collaboration with

Dmitry Romanov

Overview of e-pi separation task

The Setup



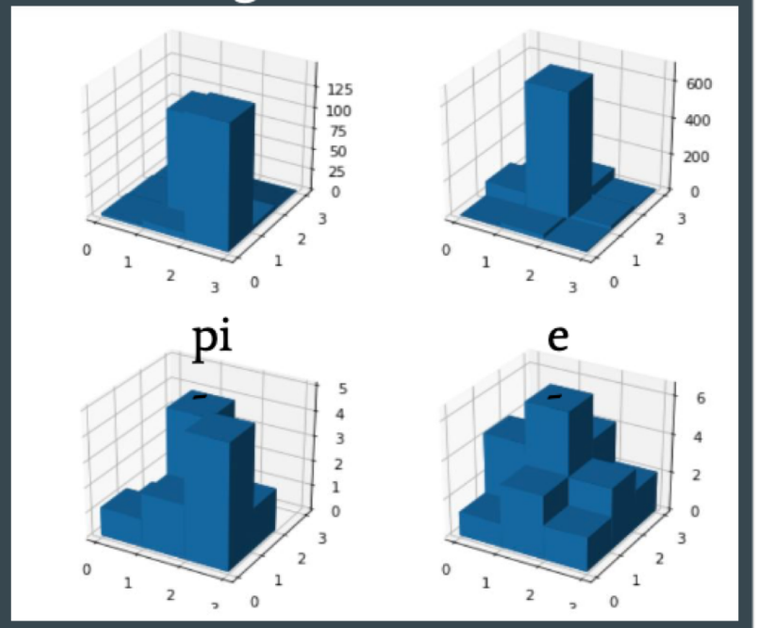
Hits in a 3x3 calorimeter are simulated using g4e. ADC values(in MeV) of hits are recorded for each cell. These adc values correspond to the energy deposited in the cell.

Training & Test Data

- 100,000 Events(10,000 events for each energy and class of particles) were generated using g4e.
- 20% of the events were used to make the test set, remaining 80% used as the training set.
- ONE Feature containing 3x3 adc responses was extracted and recorded (in GeV as shown in figure) from each event.
- Data augmentation was performed on this data set
  - Log Transformation
  - Normalization of data
- Neural network was trained separately; first on original data and then augmented data.
- Categorical Cross Entropy loss was minimized in the training
- Model's predictions were tested with test data

By Vineet Tripathi & Hasan Mustafa, IIT Indore
Under Dr. Dmitry Romanov and Dr. Ankhi Roy

Original Data



Log Transformed Data

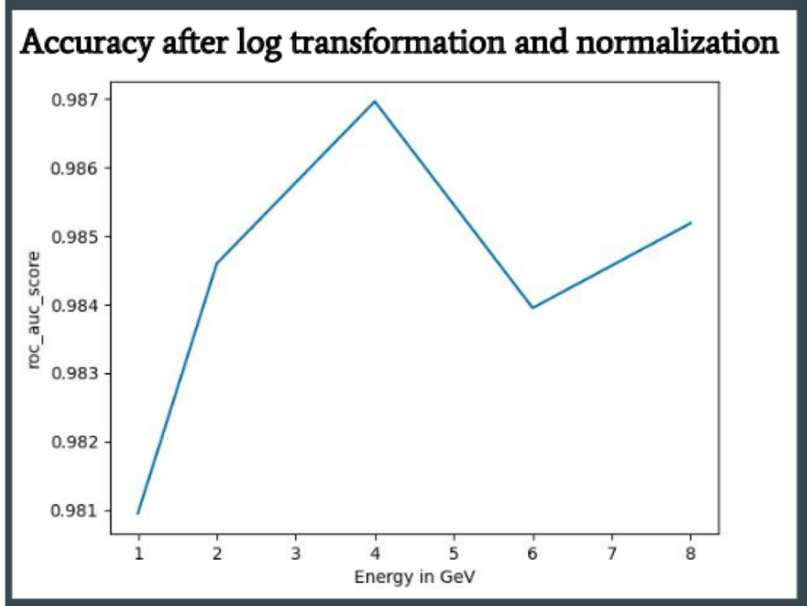
```
Model: "sequential"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
dense (Dense)                (None, 32)                3232
_________________________________________________________________
dense_1 (Dense)              (None, 20)                660
_________________________________________________________________
dense_2 (Dense)              (None, 16)                336
_________________________________________________________________
dense_3 (Dense)              (None, 10)                170
_________________________________________________________________
dense_4 (Dense)              (None, 5)                 55
_________________________________________________________________
dense_5 (Dense)              (None, 2)                 12
=================================================================
Total params: 4,465
Trainable params: 4,465
Non-trainable params: 0
_________________________________________________________________
```

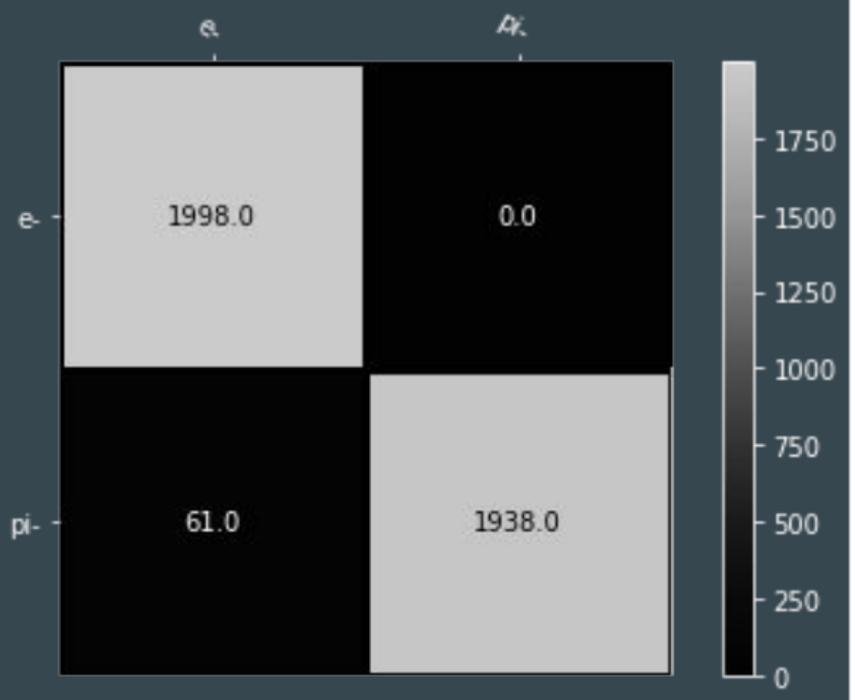
Network Summary

Results

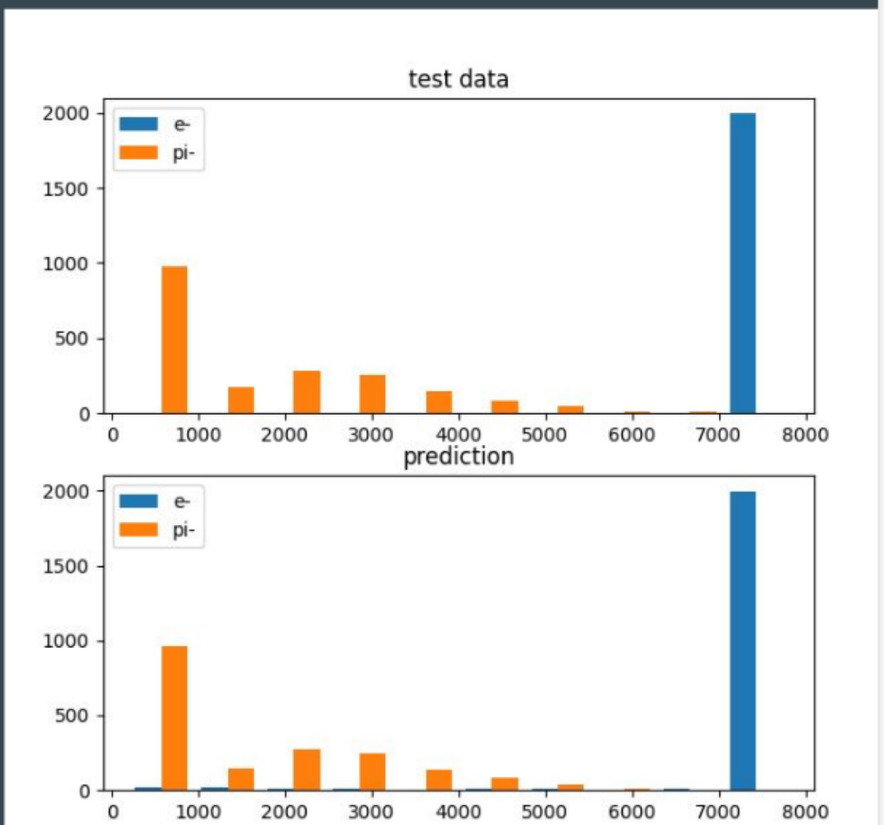
Neural Network with augmented data

- Neural Network Trained on Augmented Data
- Accuracy Independent of Energy
- Considerably less number of misclassified pions.





Confusion matrix for 8 GeV particles



Total adc distribution

Project eAST

in collaboration with

Makoto Asai

Project eAST (IITB, IITM, Goa University)

- Present task: Work on interface to MCEGs (HepMC3) and help with validation of test-beam data.
- Vashishtha Kochar, Aryan Borker, Pranjal Verma, Chinmay Seth, Suvarna Patil, and other colleagues are getting familiar with HepMC3 and Geant4 tutorials.
- They will test the interface to MCEGs for the supported formats.
- Thanks to Makoto Asai for introductory lecture with some excellent hands-on exercises to get familiar with Geant4. This would help in development of eAST (following pictures are from some basic examples)