Simulation of Detector in Geant4

A. Kilic, F. Kocak and I. Tapan
Uludag University,Turkey

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Overview

- Structure of the LHeC Detector
- Geant4 Simulation and Results
- Conclusions

Structure of the LHeC Detector under Study

L1 low Q^2 SetUp

ELLIPTICAL Be BEAM PIPE

TRACKERS

GAS-SI TRACKERs - GOSSIP Type (Gas On Slimmed Silicon Pixels (or Strixels/Pads))

- 5 cylindrical barrel Gas-Si tracker (double) layers
- 2 x 4 cone shape forward/backward Gas-Si tracker (double) layers
- TPC (Time Projection Chambers)
- 2 x 3 forward/backward Gas-Si tracker (2/3) disks

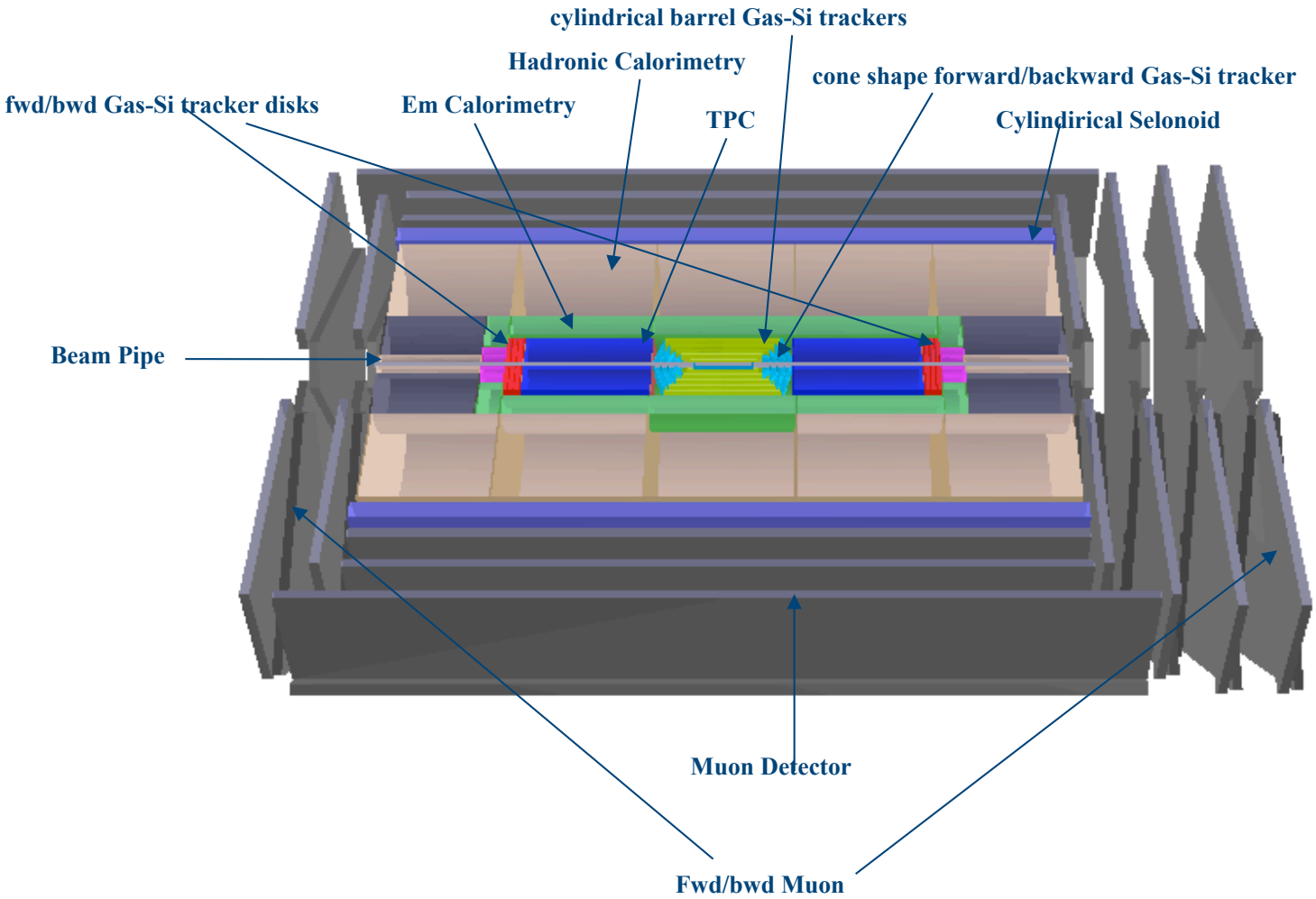
ELECTROMAGNETIC CALORIMETER –CALICE TYPE

HADRON CALORIMETER-CALICE TYPE

MUON DETECTORS

Structure of the LHeC Detector

LHeC Root Geometry of L1 low Q2 SetUp



Simulation

- As the LHeC doesn't exist yet, it was simulated using Monte Carlo (MC) methods based on the knowledge gained at HERA.

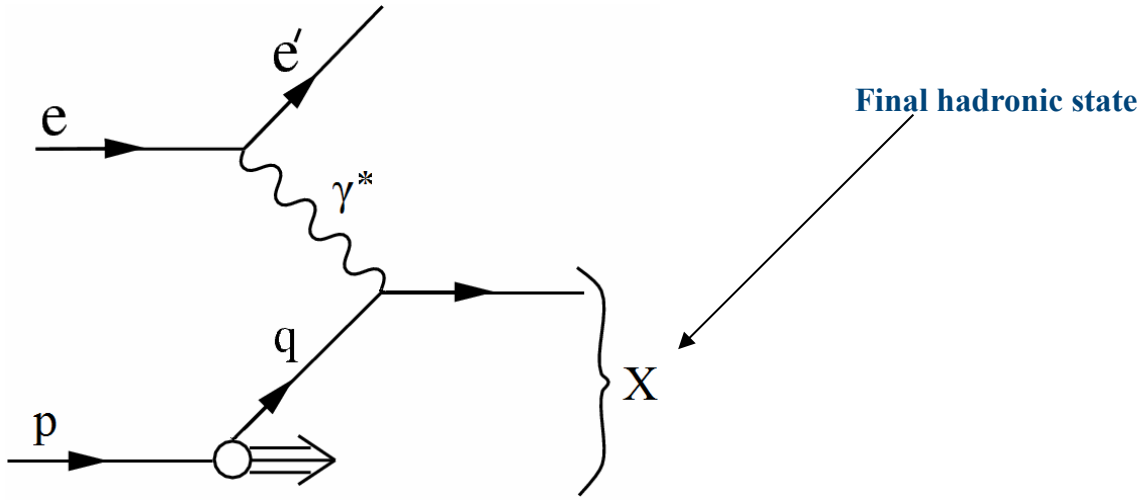
- The data produced by Monte Carlo provides details of all the observed particles in each event. This includes the particle type, where it originated from, its momentum, energy and mass.

- There are software packages such as **PYTHIA**, **CalcHEP** to produce event data. CalcHEP data was used in this simulation.

- As a MC toolkit for the simulation of the passage of particles through matter, Geant4 was used. QGSP (The Quark-Gluon String Precompound Model) physics list was used in this simulation.

- Data analysis have been made by ROOT.

Simulation

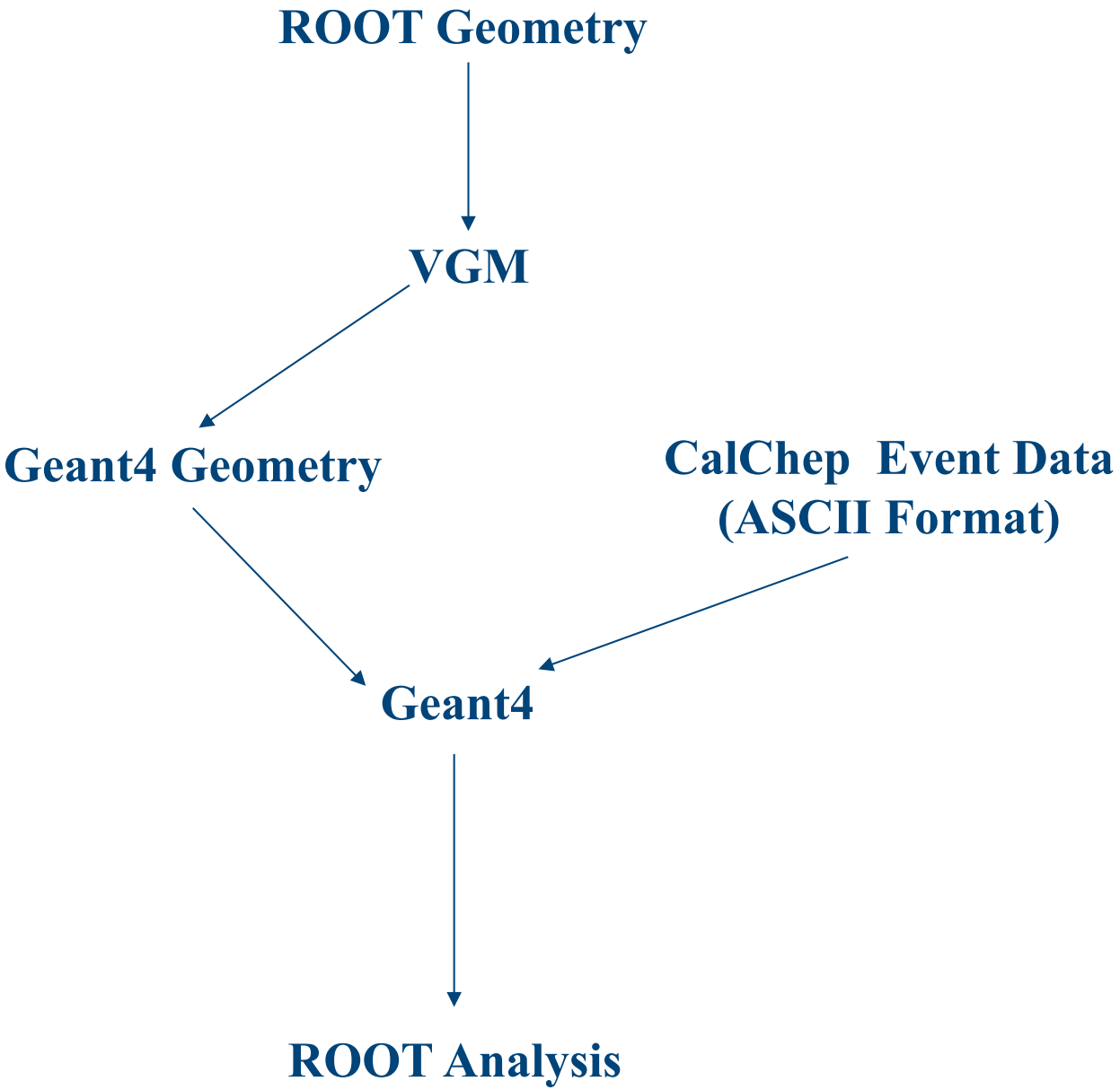


Feynman Diagram of a General Deep Inelastic Scattering Process ($ep \rightarrow e' X$)

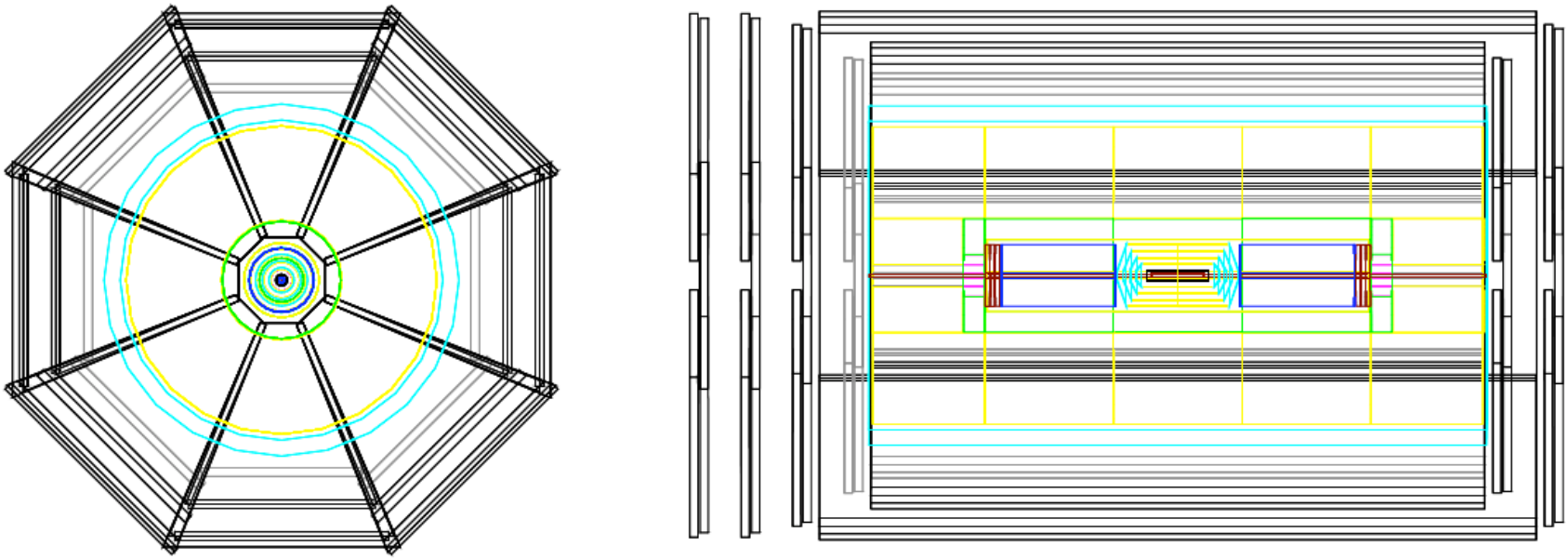
70 GeV e^- + 7 TeV proton ⟶ e^- + jet

1.4 TeV CMS Energy

Simulation

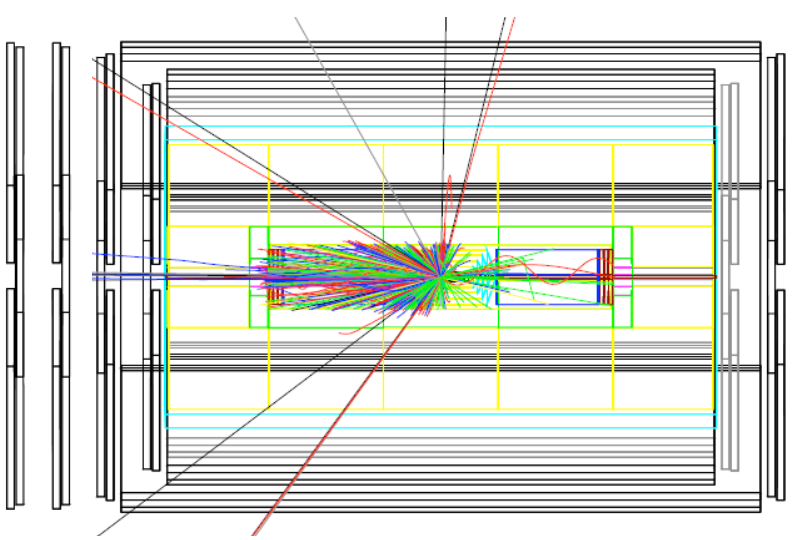

ROOT Geometry
VGM
Geant4 Geometry
CalChep Event Data
(ASCII Format)
Geant4
ROOT Analysis

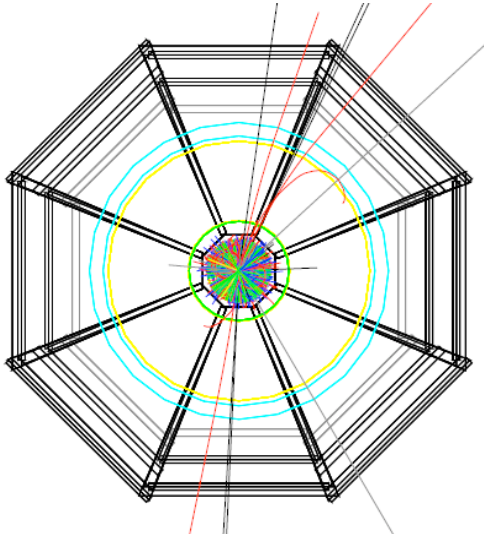
Simulation



Geant4 Geometry for LHeC Detector of LowQ2

Simulation



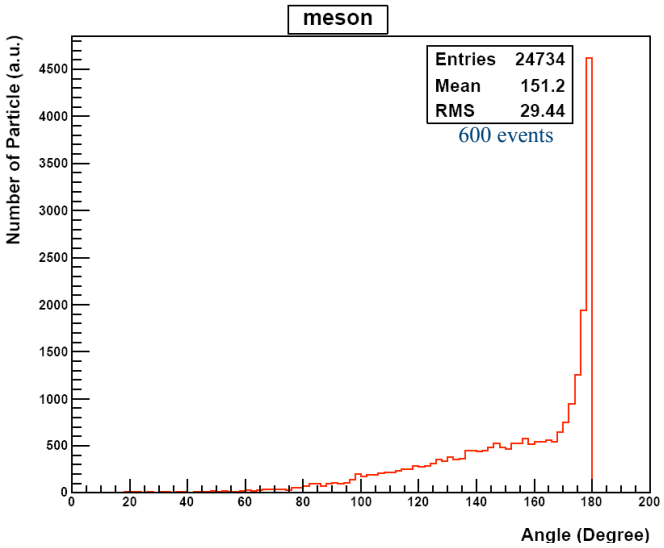


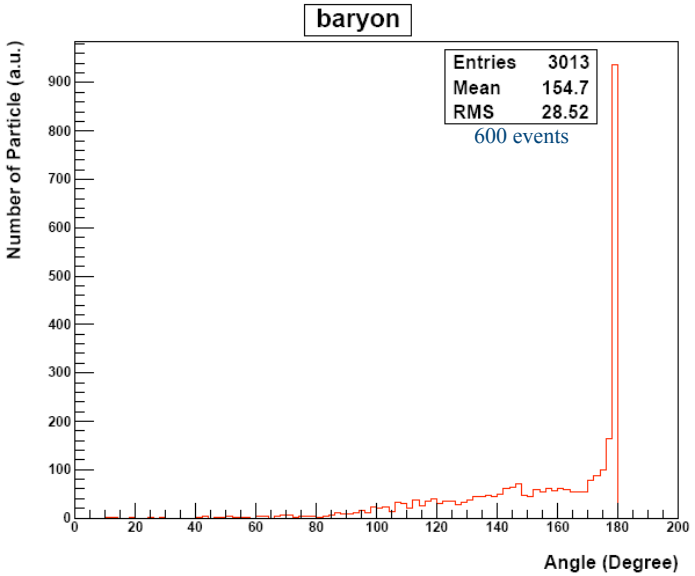
kaon- blue, kaon+ red, kaon0 black, kaon0S black, kaon0L black, kaon0 green,
e- blue,e+ red, pi+ red, pi- blue, mu+ red, mu- blue, nu_mu black, gamma green,neutron yellow

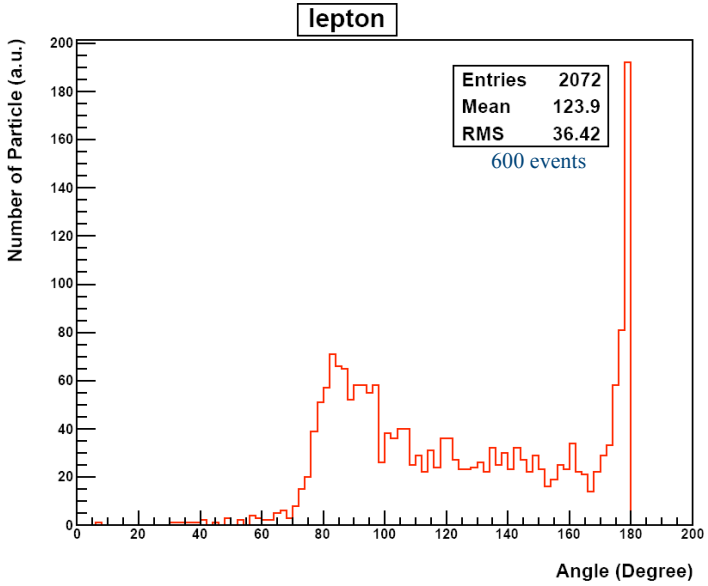
Magnetic Field value in Solenoid Coil is 2 Tesla

Run of 10 events Geant4 Simulation

Simulation Results

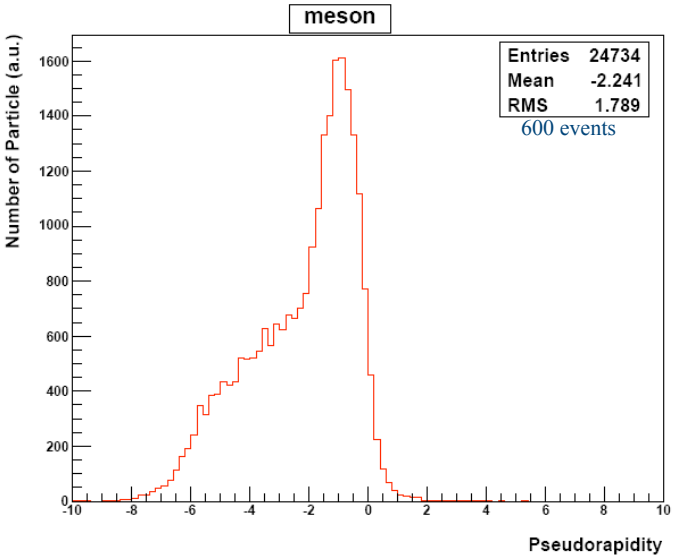


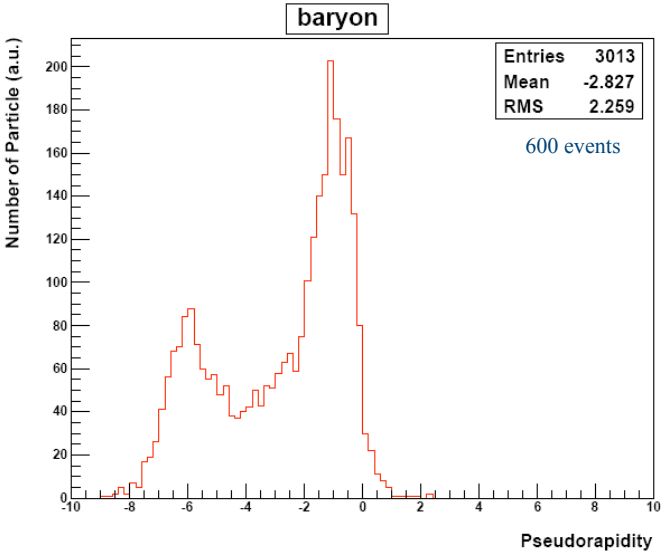


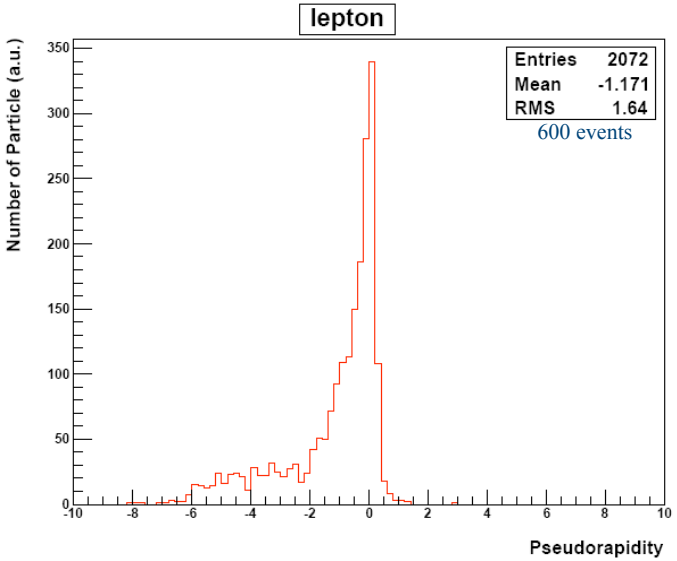


Angle distributions for mesons, baryons and leptons

Simulation Results





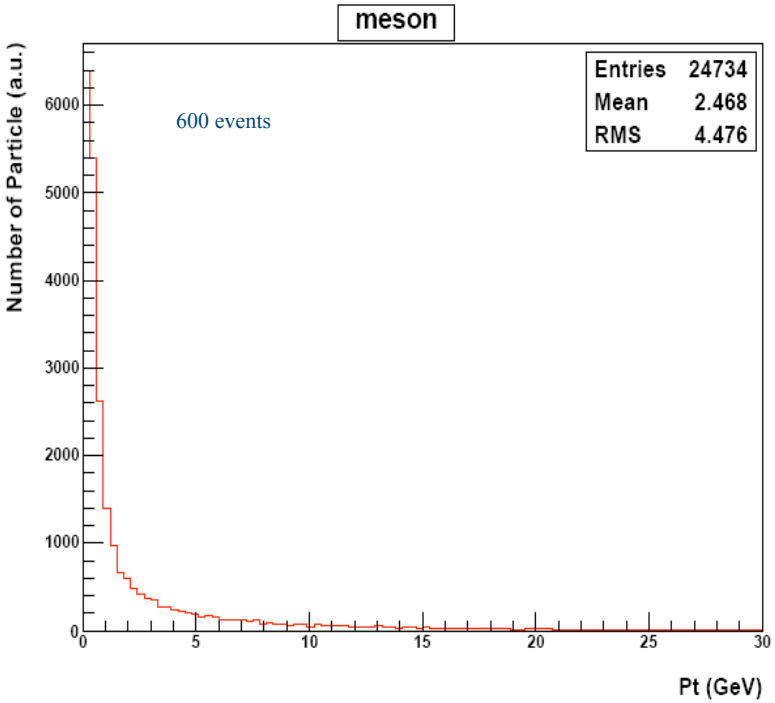


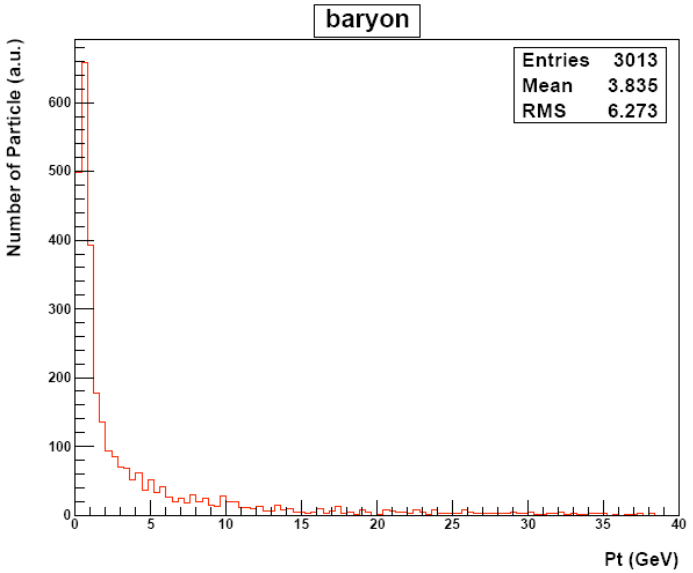
Pseudorapidity;

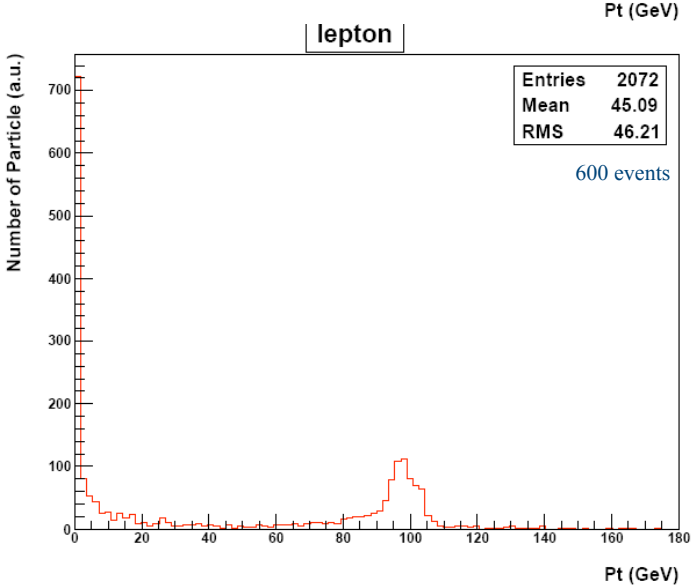
$\eta = -\ln[\tan(\theta_{cm}/2)]$

Pseudorapidity distributions for mesons, baryons and leptons

Simulation Results

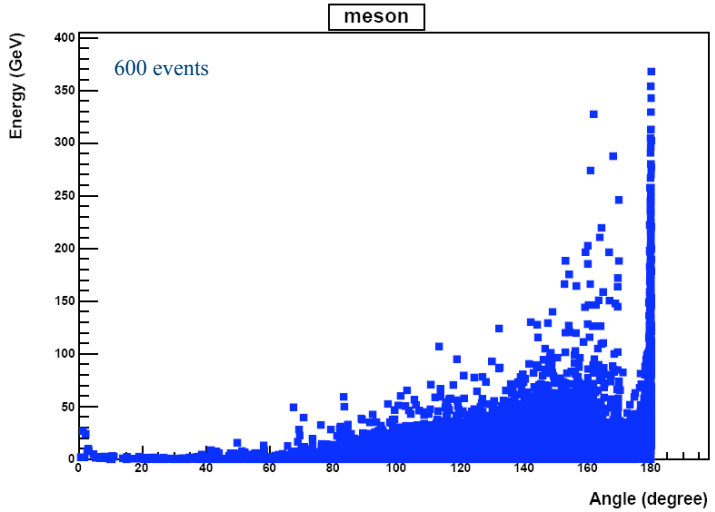


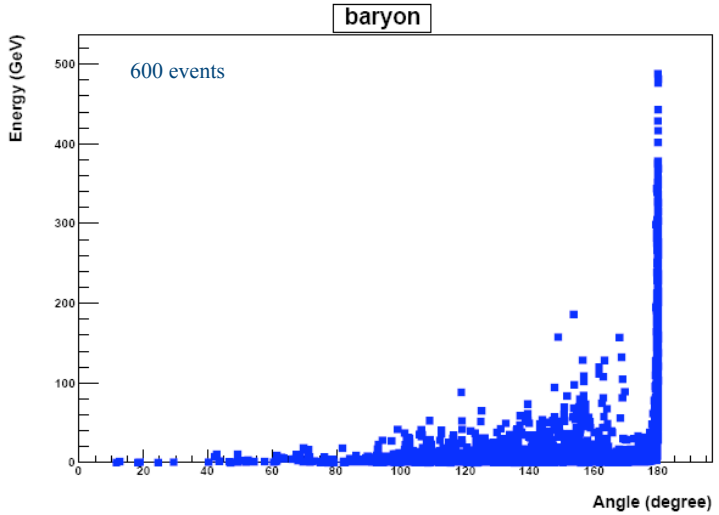


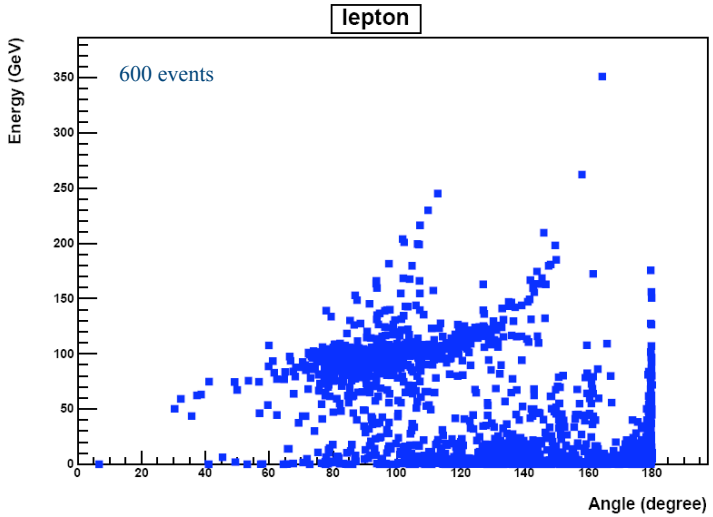


Transverse momentum (Pt) distributions for mesons, baryons and leptons

Simulation Results

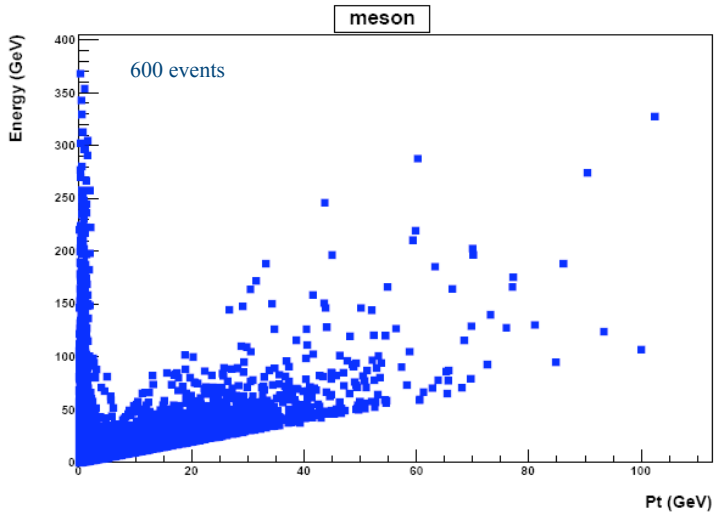


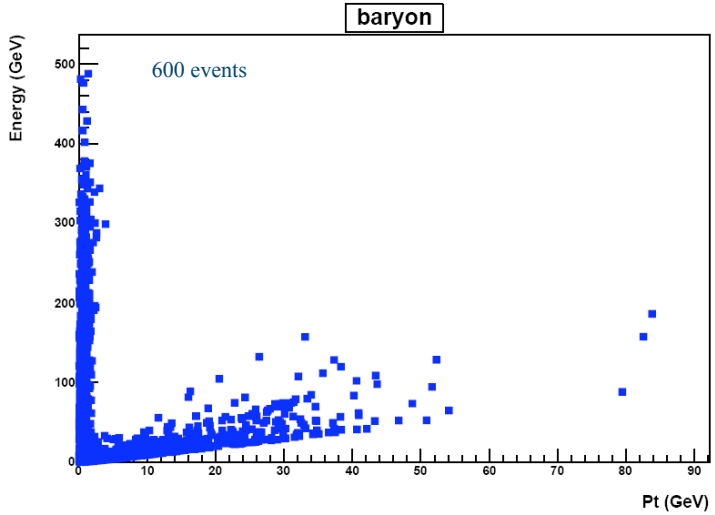


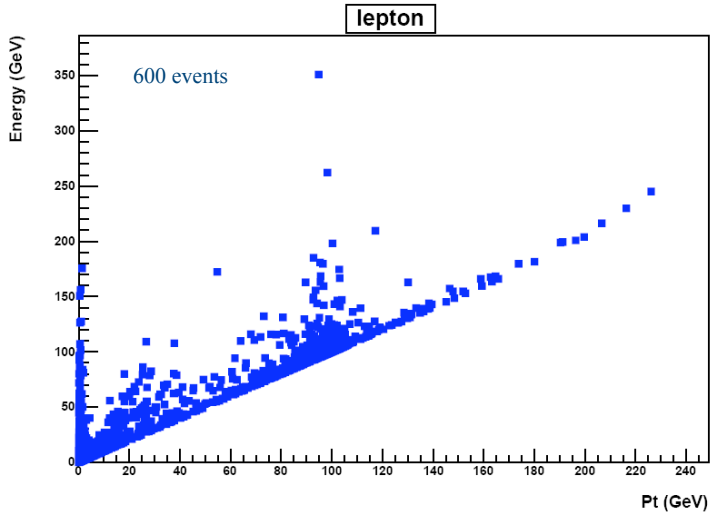


Energy distributions versus angle for mesons, baryons and leptons

Simulation Results

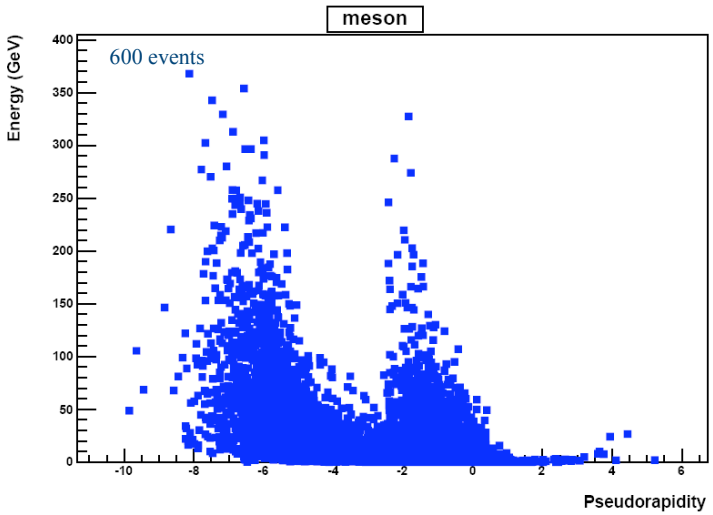


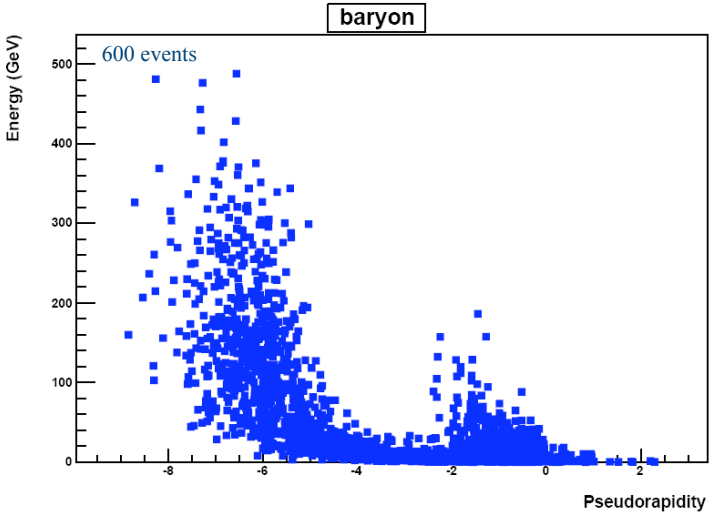


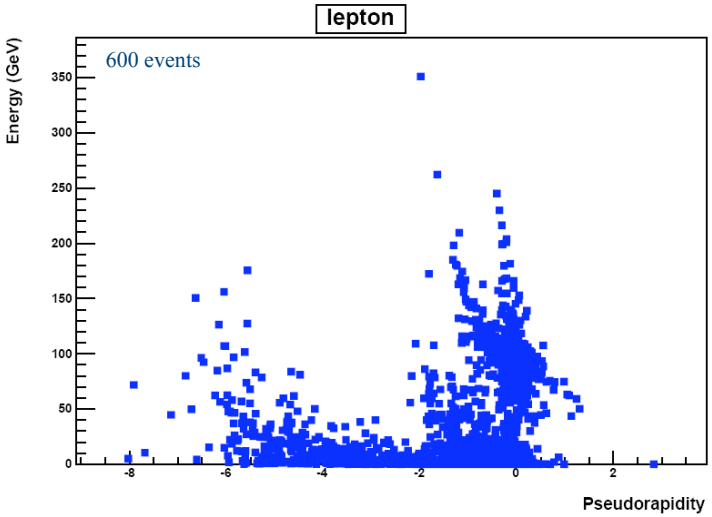


Energy distributions versus Pt for mesons, baryons and leptons

Simulation Results







Energy distributions versus pseudorapidity for mesons, baryons and leptons

Conclusion

- detector geometry is implemented in GEANT4 for the first time
- we need to investigate further a better optimised detector geometry and material description
- very very first results of generated event processing through the detector; many crosschecks and corrections needed to understand how we work with GEANT4
- more event signatures will be analysed for other benchmark processes...
- we need to move the simulation studies to the established (Root +VGM+Geant4+VMC) LHeC framework