

CALICE UK Meeting April 2008

Analysis of pion showers in the ECAL from
CERN Oct 2006 Data
– Status report –

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University of Cambridge

Summary of data

- Reconstructed data

Run300588	6GeV	pi+
Run300669	6GeV	pi-
Run300667	10GeV	pi-
Run300666	12GeV	pi-
Run300586	20GeV	pi+
Run300696	30GeV	pi+
Run300698	50GeV	pi+
Run300694	80GeV	pi+

- GEANT4 simulations

Mokka version 6.3 p02 with physics lists...

LCPhys	QGSP
QGSC	QGSP_BIC
QGSC_LEAD	QGSP_EMV
FTFC	QGSP_BERT
LHEP	QGSP_BERT_HP
LHEP_BERT	QGSP_HP

Overview of GEANT4 simulations

- QGSP

- Quark Gluon-String with Precompound
- Precompound (P) calls nuclear de-excitation routine
- 12GeV – 50TeV (QGS)

- EMV

- V7.1 EM processing
- Revised EM multiple scattering

- BIC

- Binary Cascade
- Based on 2->2 or 2->1 interactions
- Up to ~10GeV

- BERT

- BERTini cascade
- Unique evaporation model to de-excite the remnant nucleus
- Up to ~10GeV

Overview of GEANT4 simulations

- HP

- High Precision neutron
- Allows precise transportation of neutrons

- LCPhys

- Linear Collider Physics list by Dennis Wright (SLAC)
- “best-guess selection of EM and hadronic physics processes for LC detector”

- QGSC

- QGS with CHIPS
- CHIPS provide photo-nuclear and EM-nuclear interaction processes
- CHIPS alternative to Precompound method

- LEAD

- LEADing particle biasing
-

Overview of GEANT4 simulations

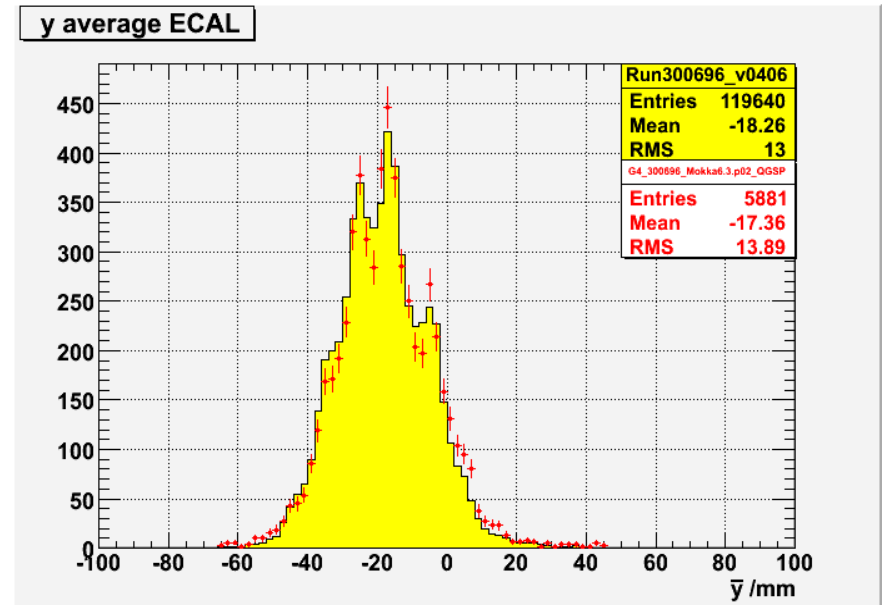
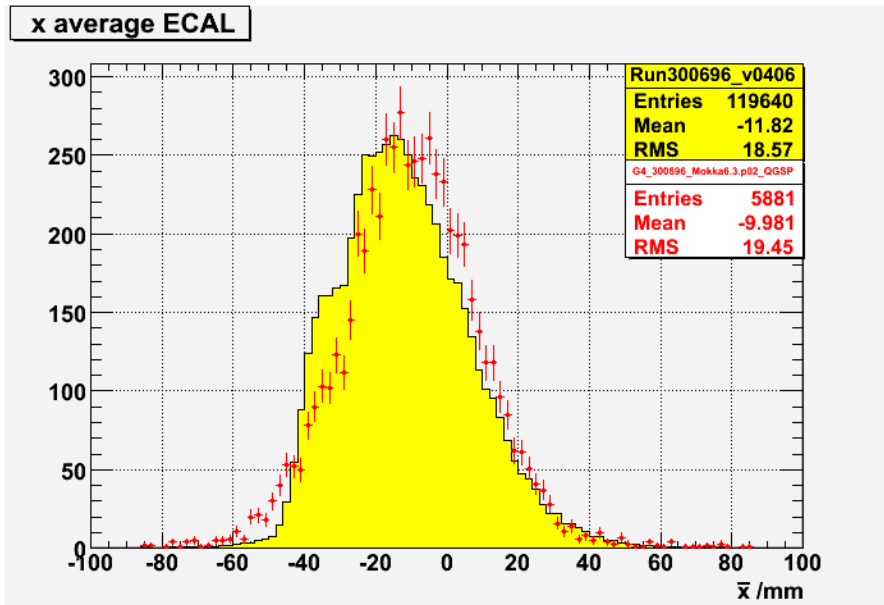
- LHEP

- Low and High Energy
Parametrized
- Fast, parametrized model
based on GHEISHA
- Average Energy and
Momentum are well
described (conserved)

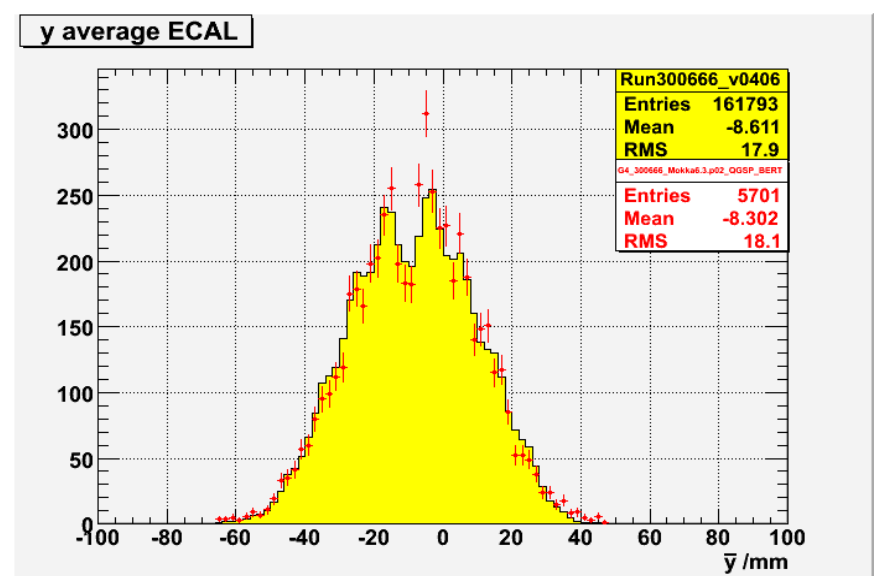
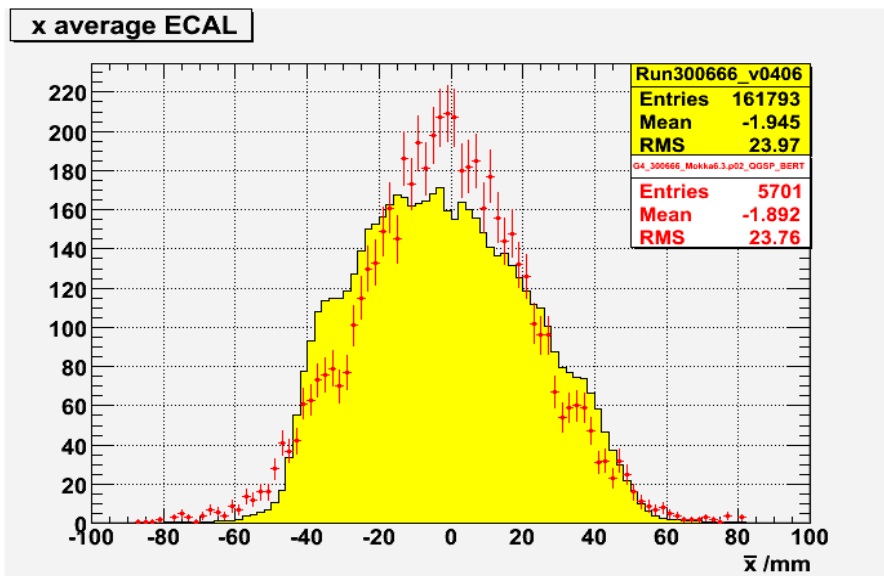
- FTFC

- FriTjoF with CHIPS
- Fritjof model is the diffractive
string excitation model,
offers an alternative to QGS

Beam Shape and Position

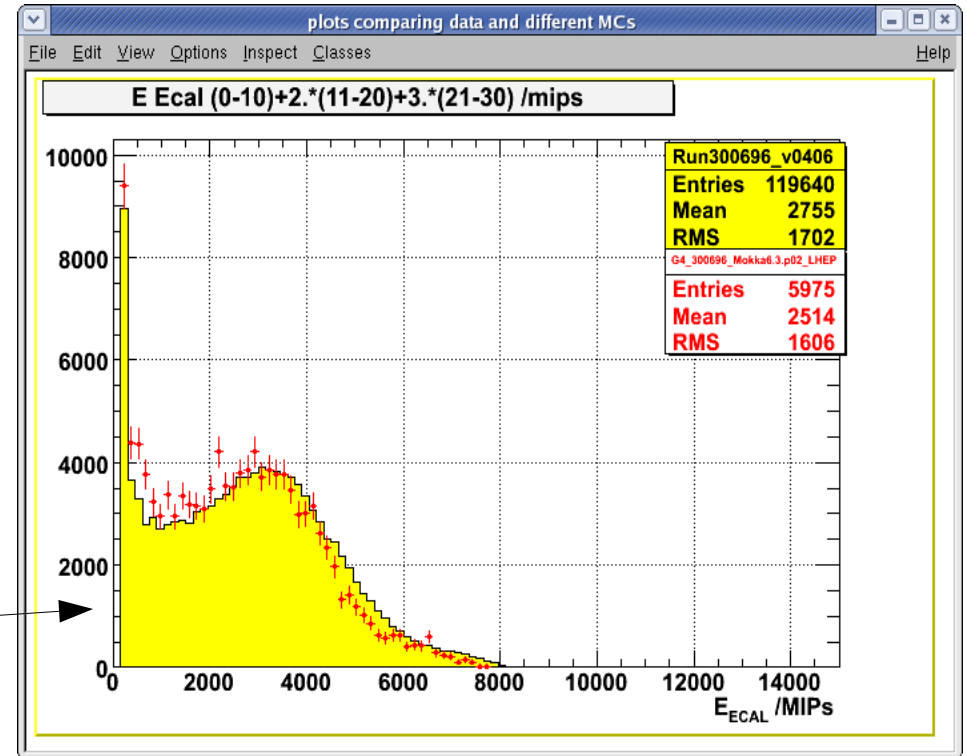
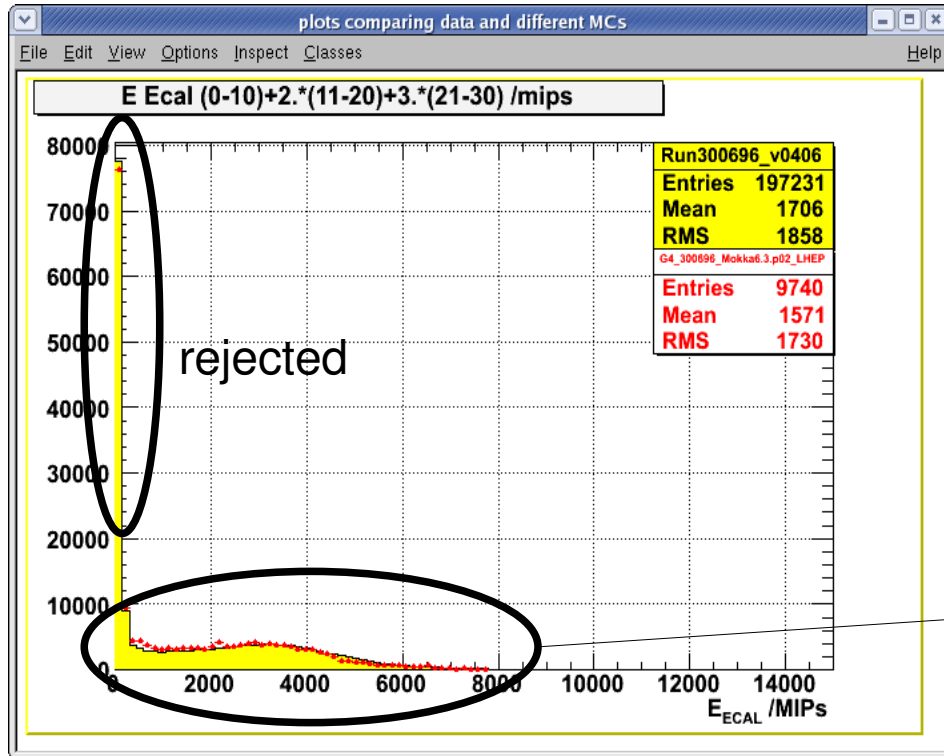


12GeV



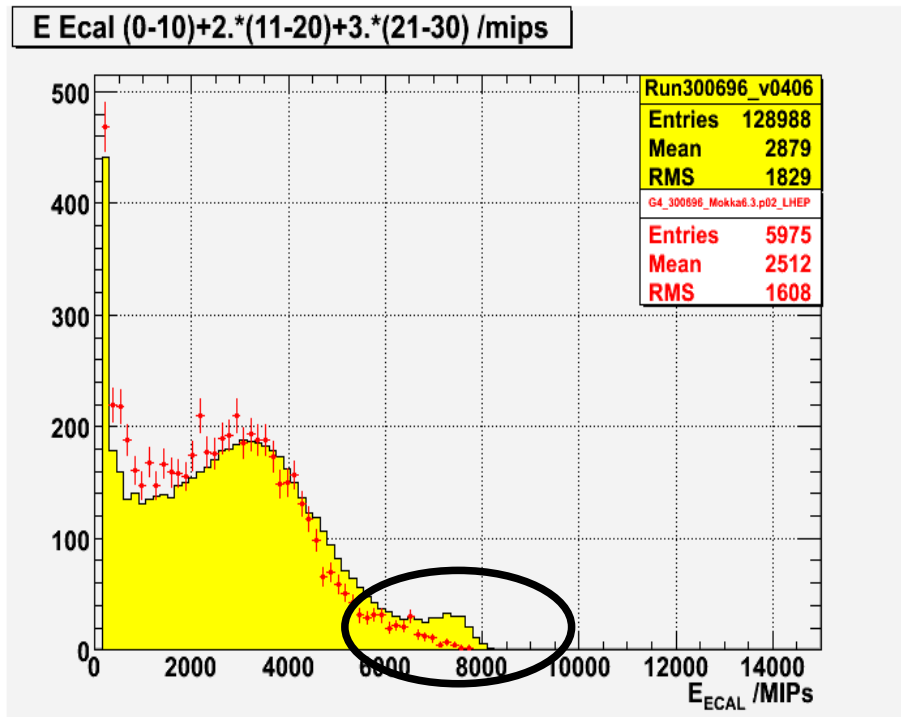
30GeV

Event Selection – Muon rejection

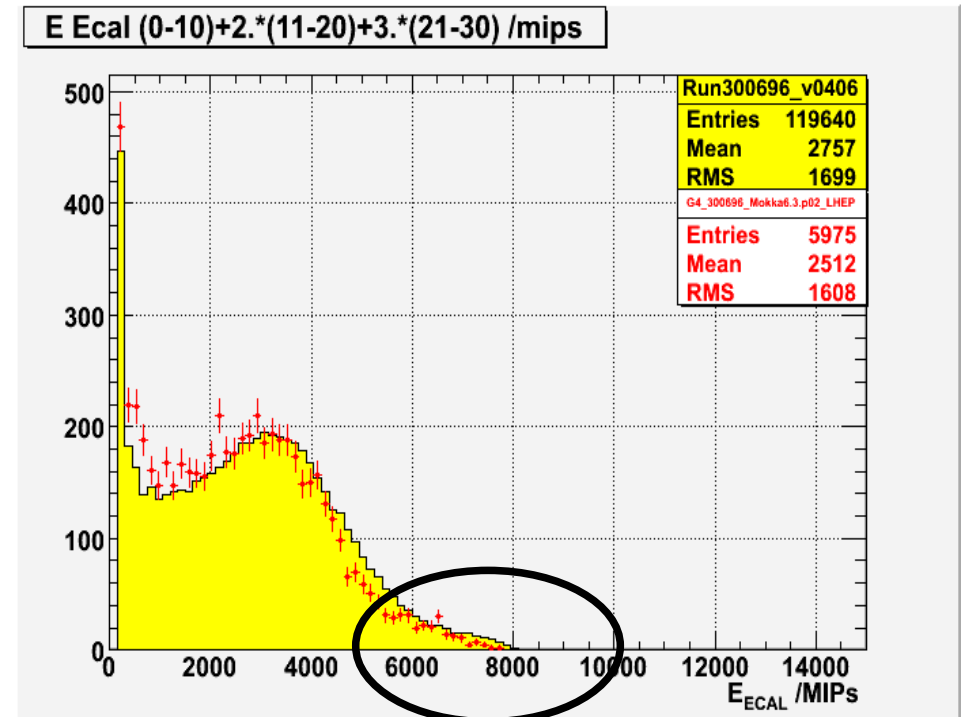


Low energy events are rejected to eliminate events which did not interact with ECAL (mainly muons).

Event Selection – Electron rejection



Before the Cut



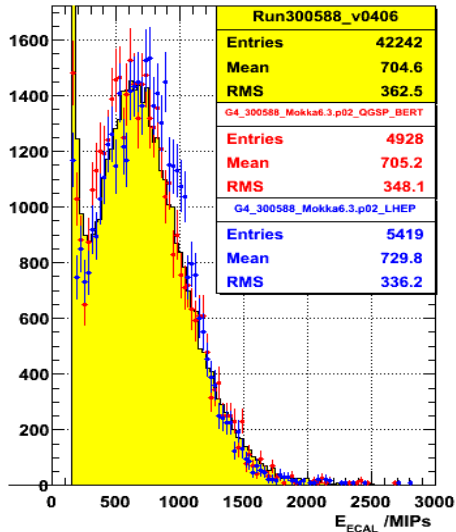
After the Cut

Events with Cherenkov radiation, which are set to distinguish electrons from rest of the beam, are eliminated.

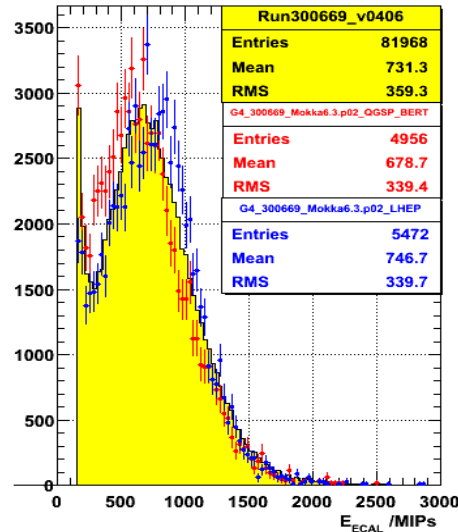
LHEP, QGSP_BERT vs Energy

Total Energy Dissipated on ECAL

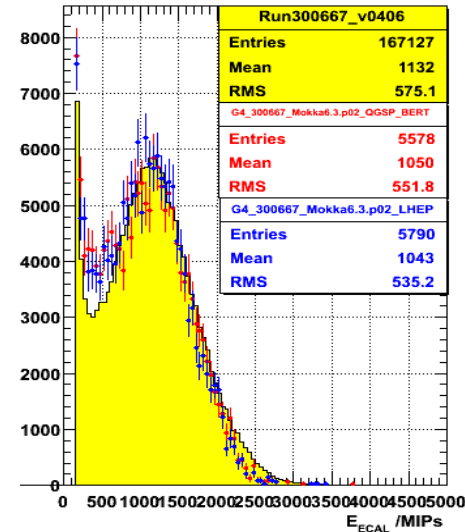
Run300588, 6GeV pi+



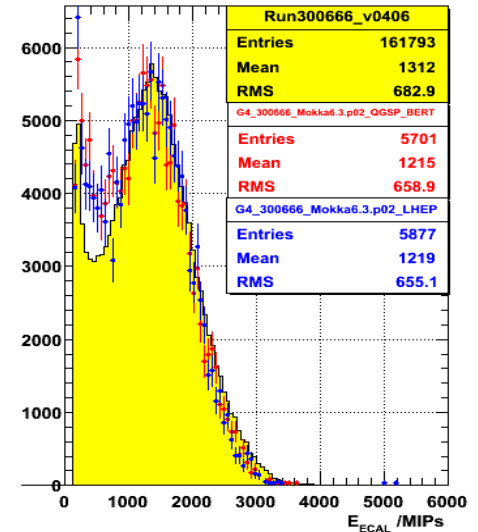
Run300669, 6GeV pi-



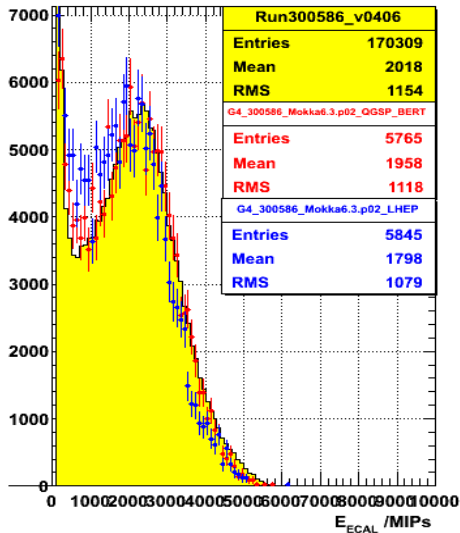
Run300667, 10GeV pi-



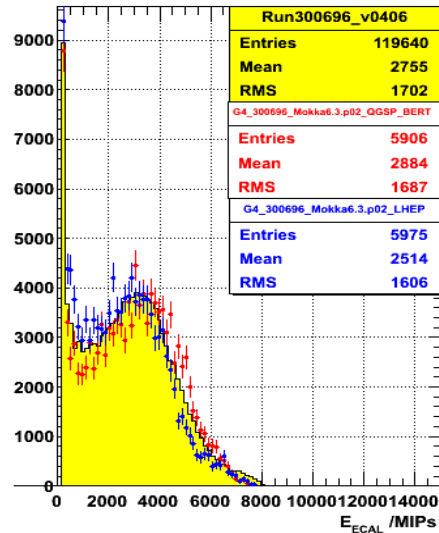
Run300666, 12GeV pi-



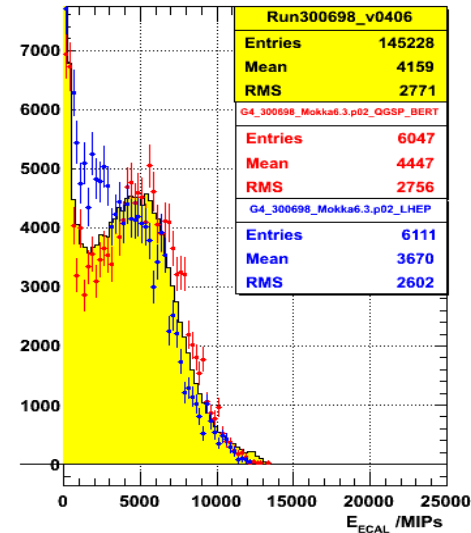
Run300586, 20GeV pi+



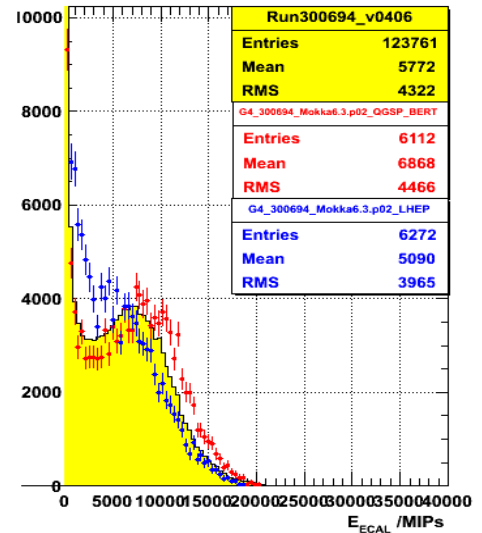
Run300696, 30GeV pi+



Run300698, 50GeV pi+



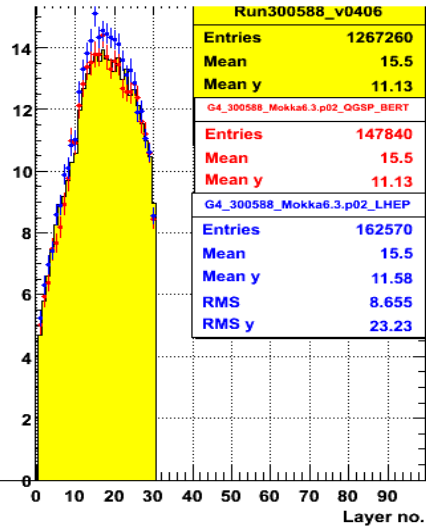
Run300694, 80GeV pi+



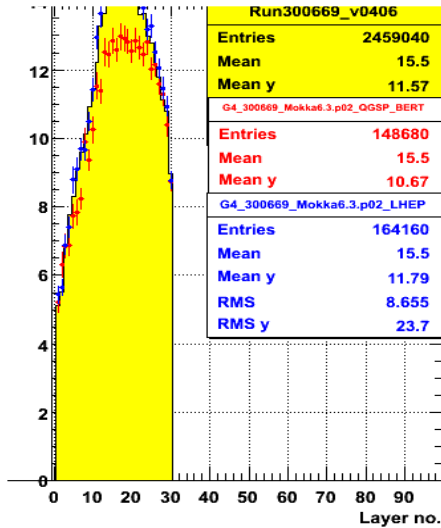
LHEP, QGSP_BERT vs Energy

Longitudinal Energy Distribution

Run300588, 6GeV pi+



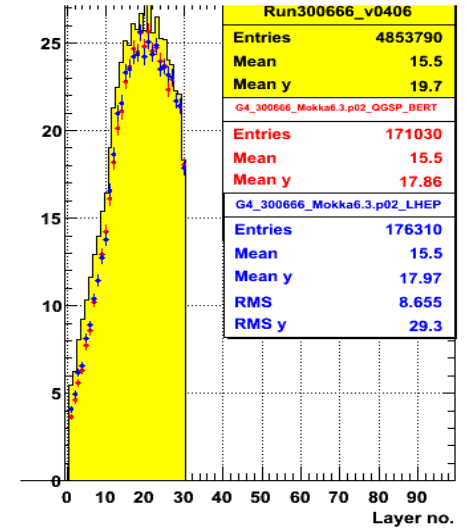
Run300669, 6GeV pi-



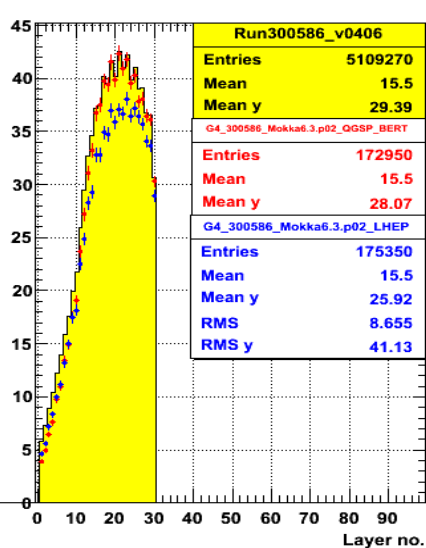
Run300667, 10GeV pi-



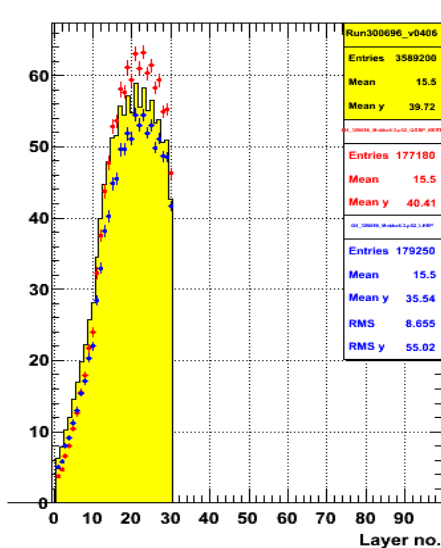
Run300666, 12GeV pi-



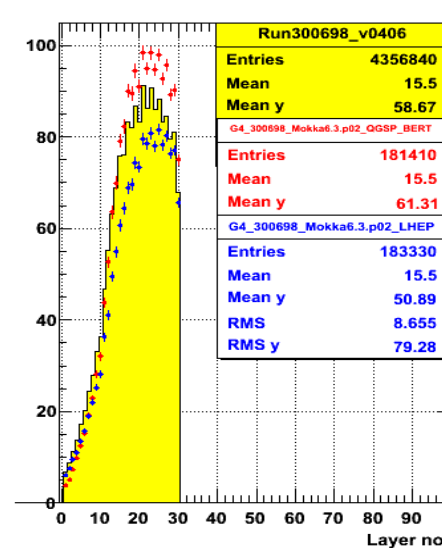
Run300586, 20GeV pi+



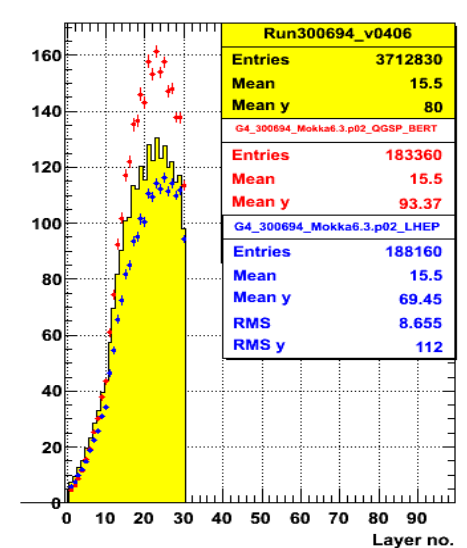
Run300696, 30GeV pi+



Run300698, 50GeV pi+



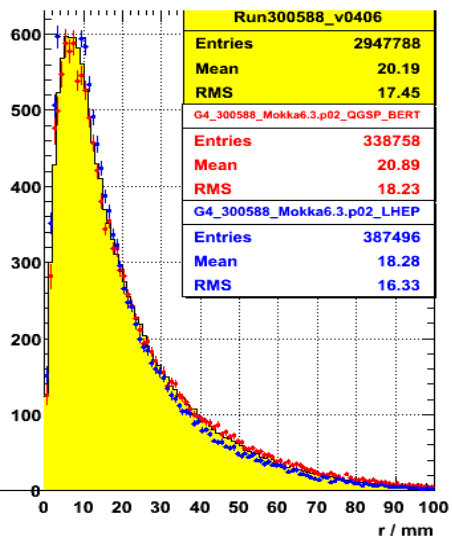
Run300694, 80GeV pi+



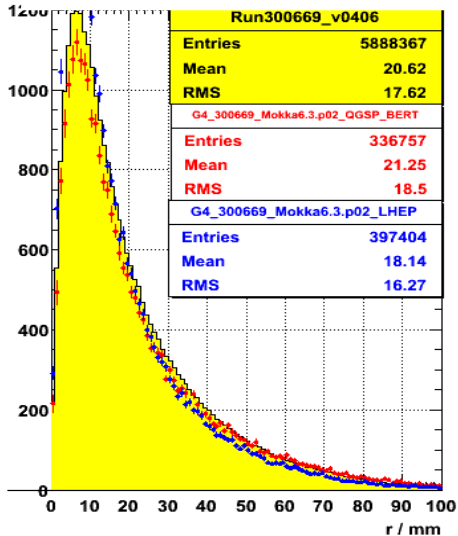
LHEP, QGSP_BERT vs Energy

Transverse Energy Distribution

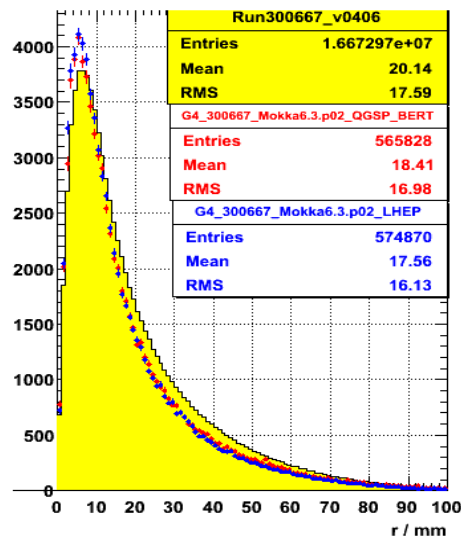
Run300588, 6GeV pi+



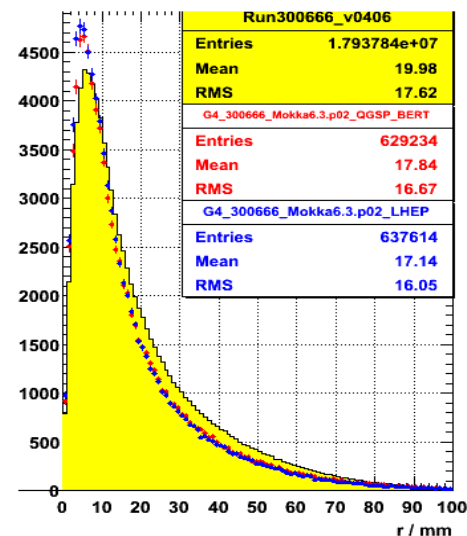
Run300669, 6GeV pi-



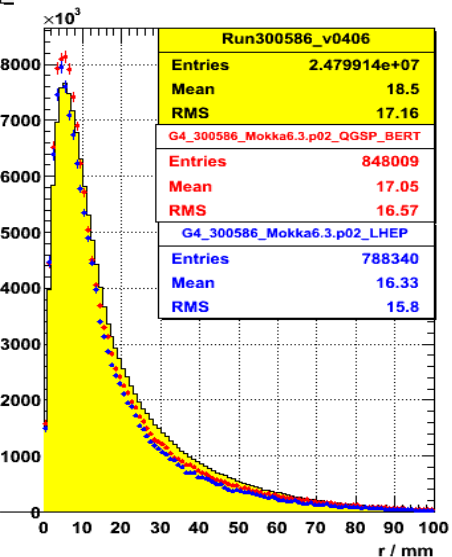
Run300667, 10GeV pi-



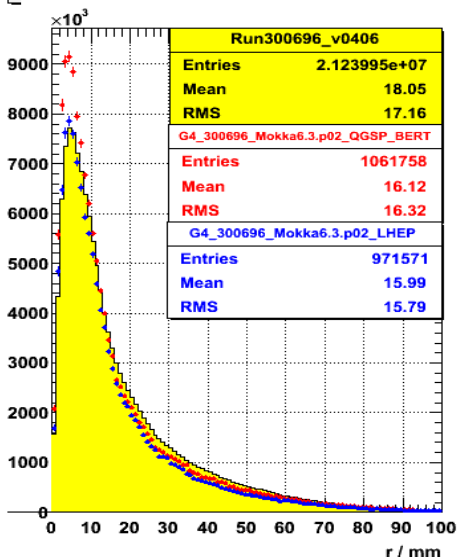
Run300666, 12GeV pi-



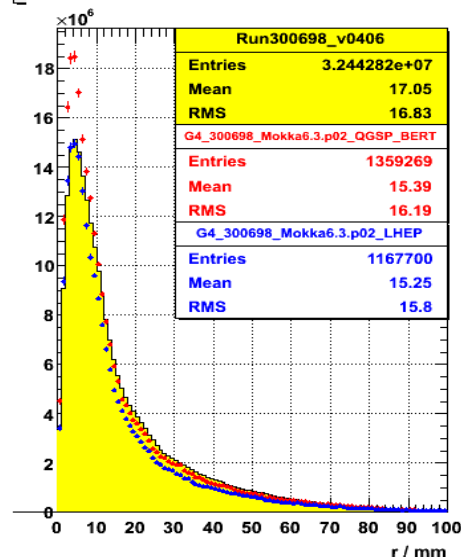
Run300586, 20GeV pi+



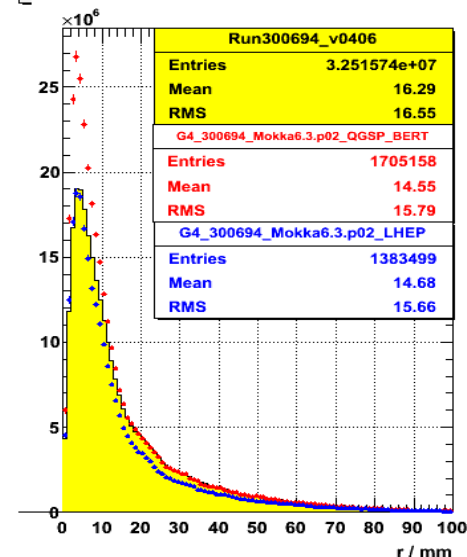
Run300696, 30GeV pi+



Run300698, 50GeV pi+

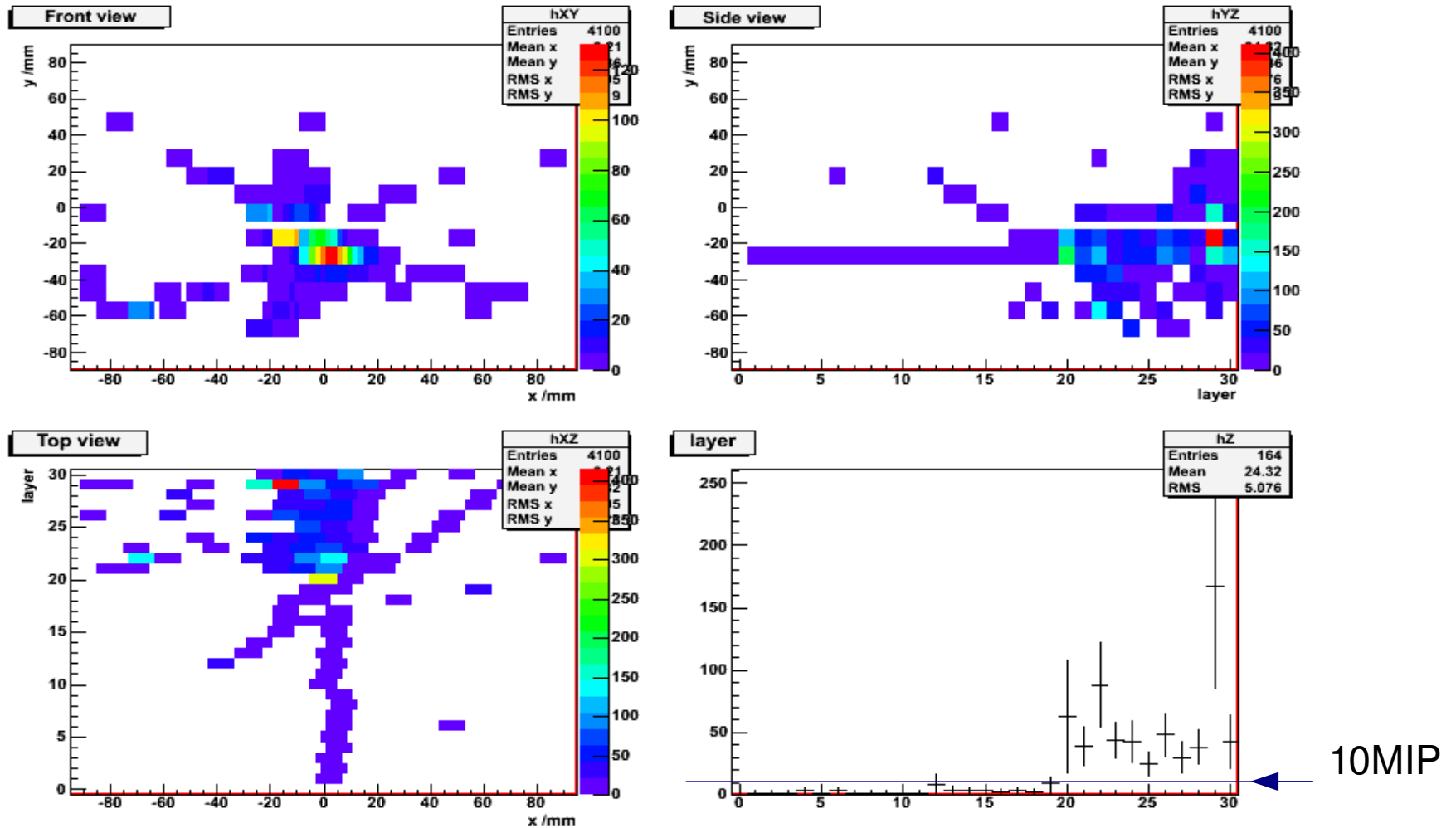


Run300694, 80GeV pi+



First interaction layer – Algorithm

Aim : To test the cross-section for primary interaction

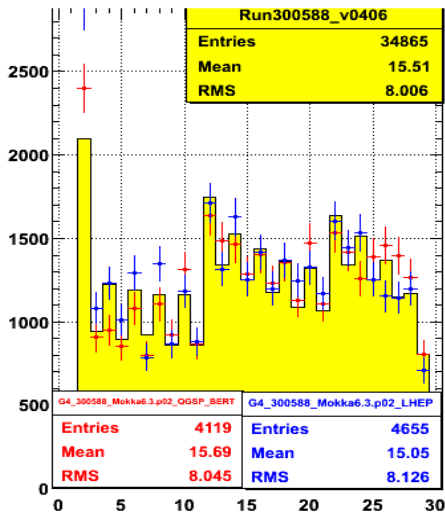


Identify the first layer which 3 layers out of 4 consecutive layers >10MIPs

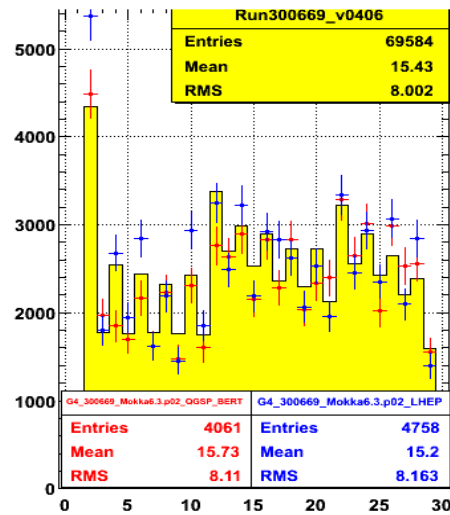
LHEP, QGSP_BERT vs Energy

First interaction layer

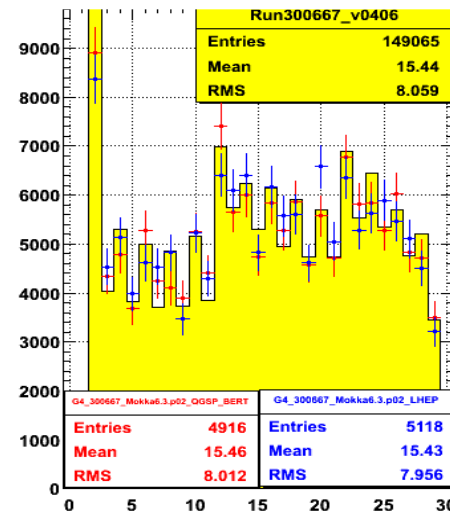
Run300588, 6GeV pi+



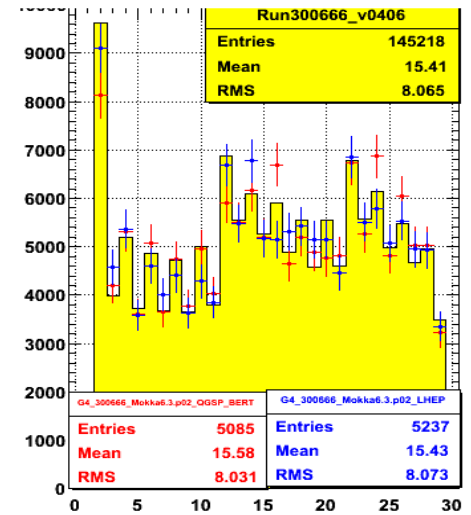
Run3005669 6GeV pi-



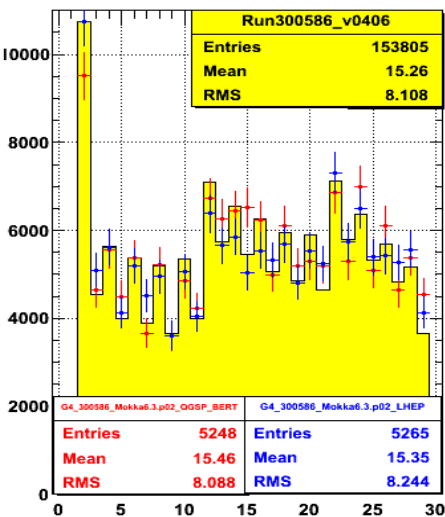
Run300667, 10GeV pi-



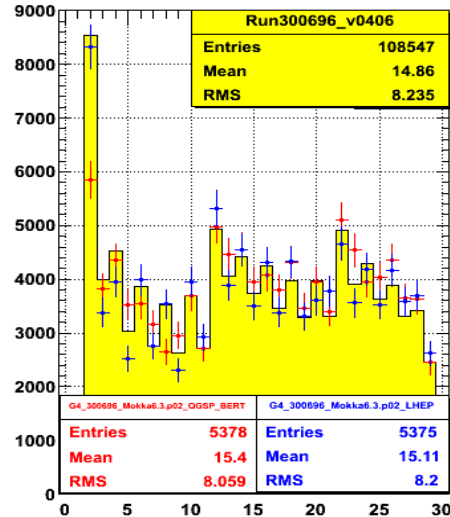
Run300666, 12GeV pi-



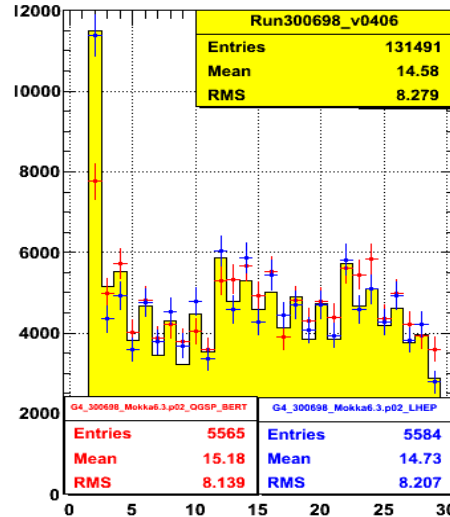
Run300586, 20GeV pi+



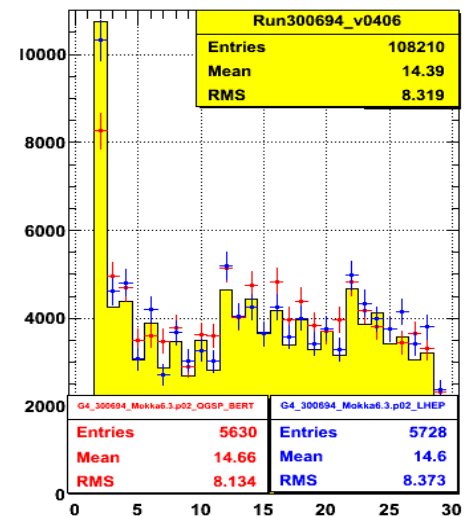
Run300696, 30GeV pi+



Run300698, 50GeV pi+



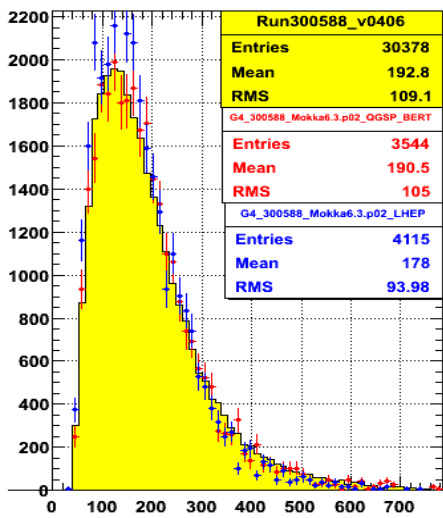
Run300694, 80GeV pi+



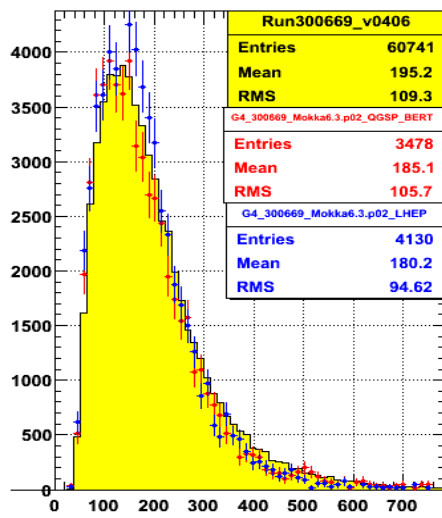
LHEP, QGSP_BERT vs Energy

Shower Energy – First 5 layers after 1st interaction

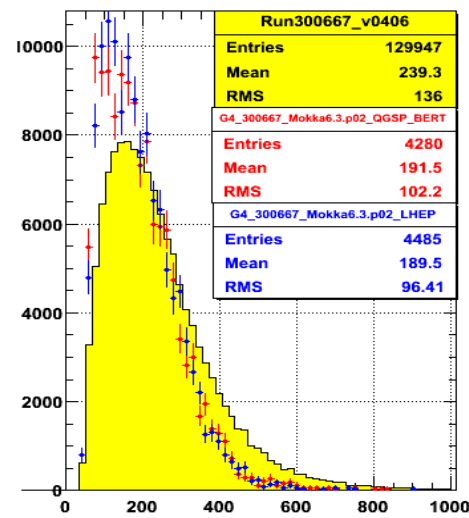
Run300588, 6GeV pi+



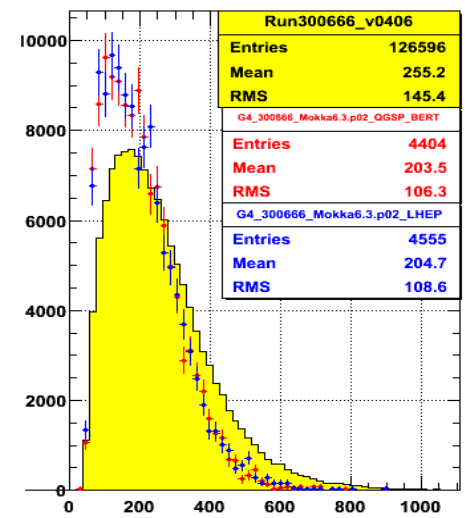
Run300669, 6GeV pi+



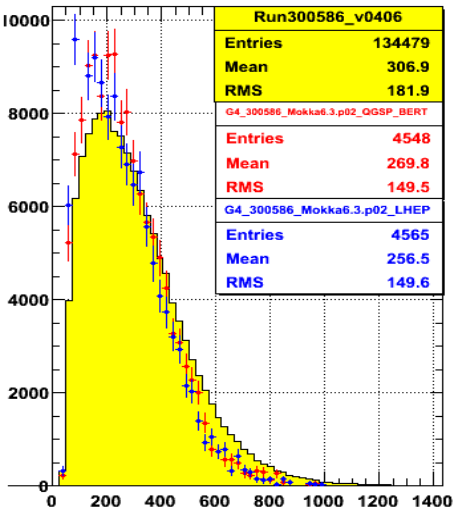
Run300667, 10GeV pi+



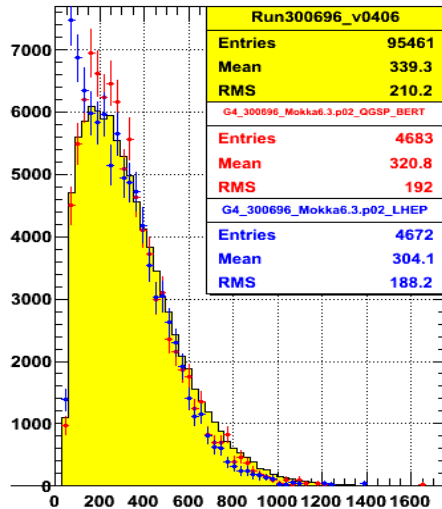
Run300666, 12GeV pi+



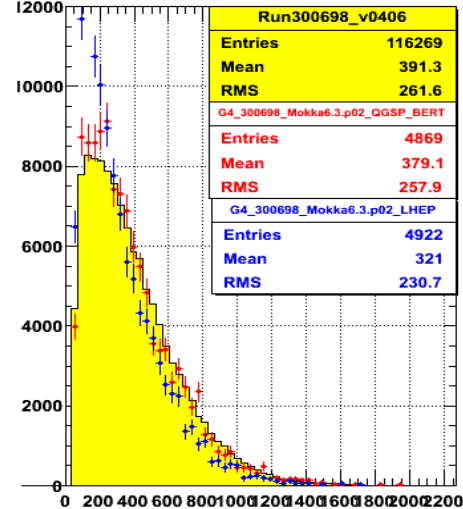
Run300586, 20GeV pi+



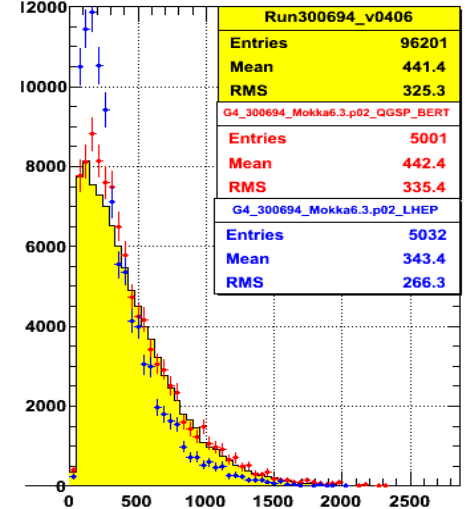
Run300696, 30GeV pi+



Run300698, 50GeV pi+



Run300694, 80GeV pi+

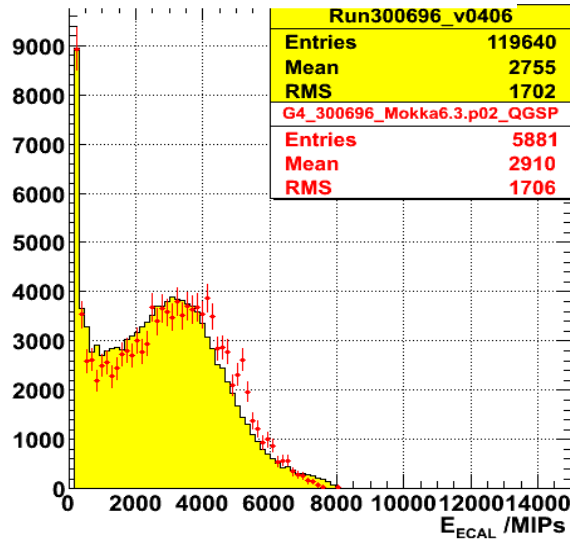


Run300696 (30GeV) vs Simulations

Total Energy Dissipated on ECAL

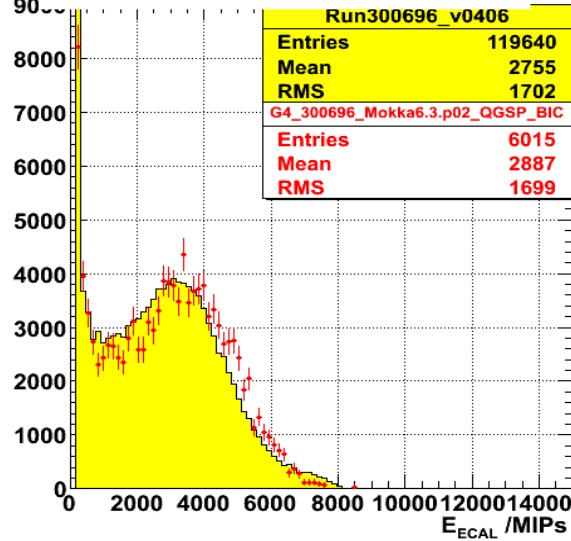
Q

QGSP



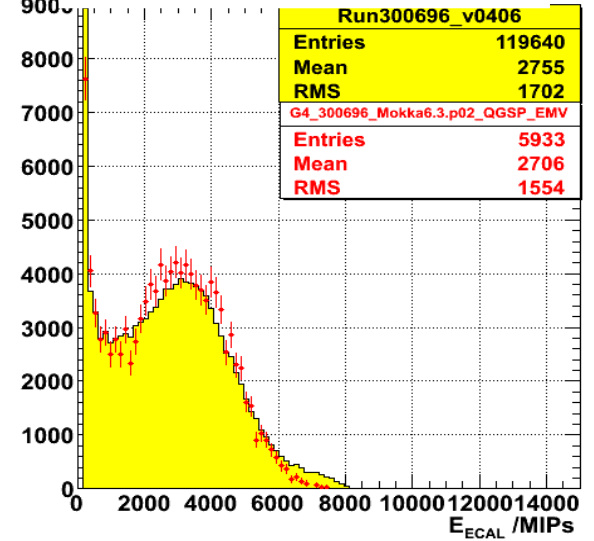
E

QGSP_BIC



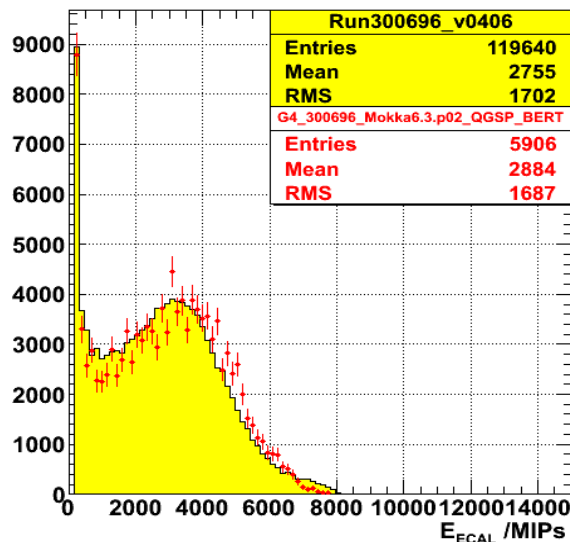
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QGSP_EMV



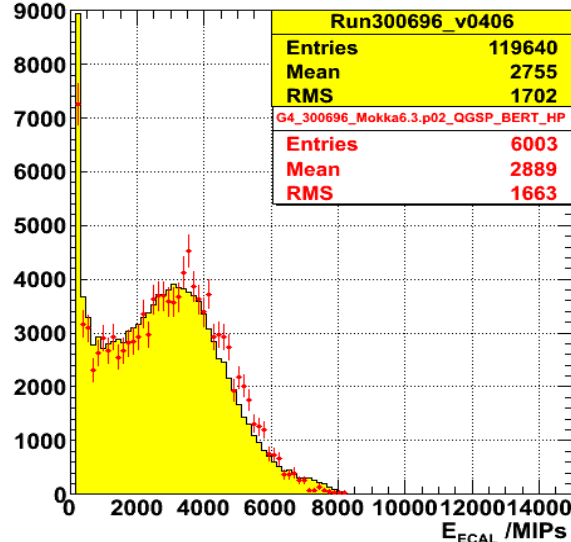
Q

QGSP_BERT



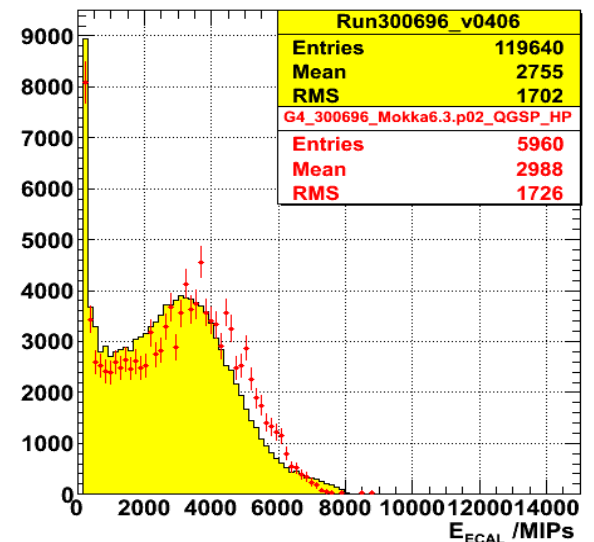
E

QGSP_BERT_HP



E

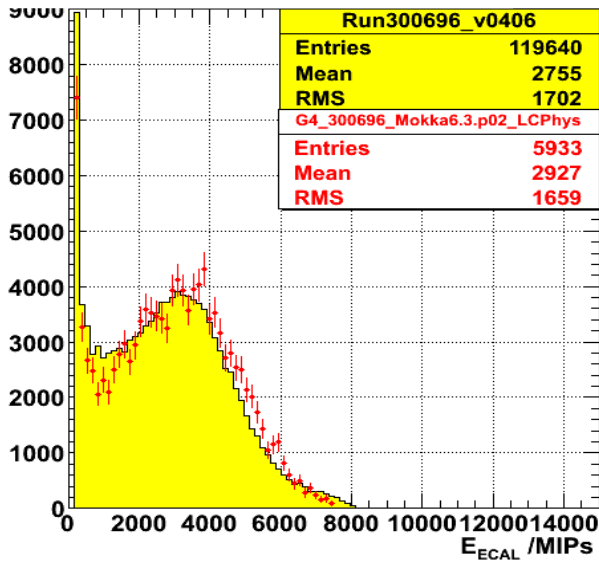
QGSP_HP



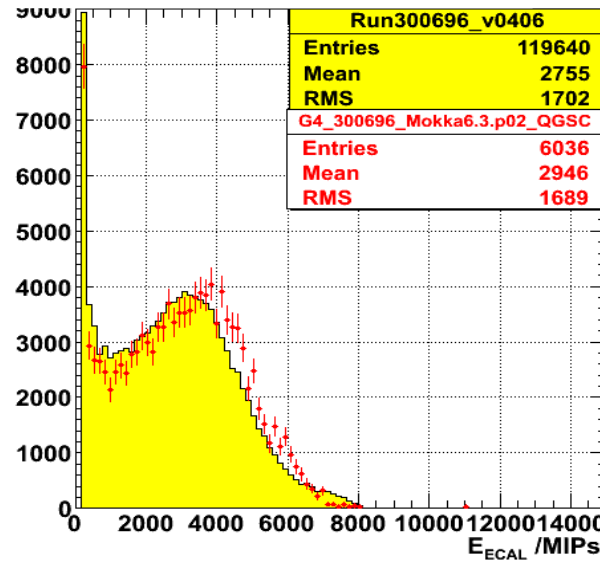
Run300696 (30GeV) vs Simulations

Total Energy Dissipated on ECAL

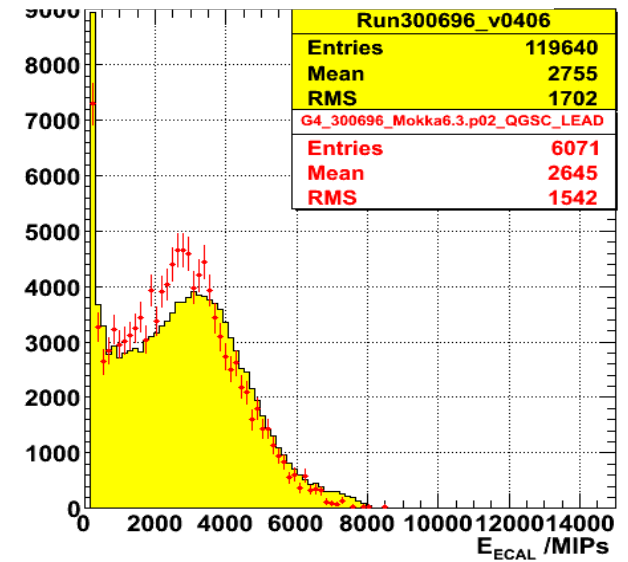
LCPhys



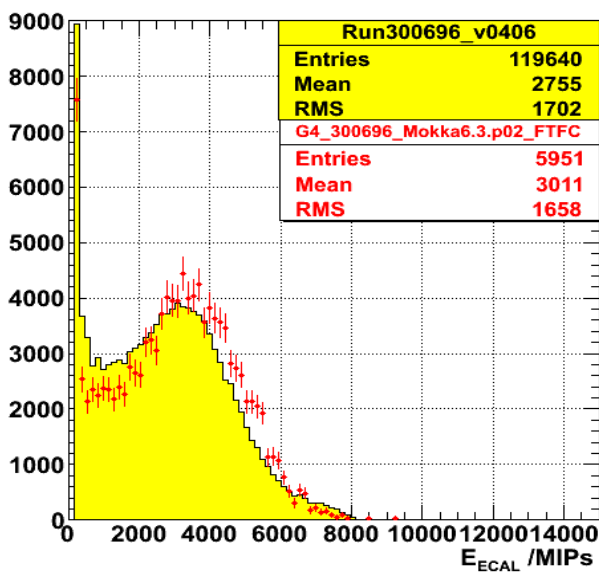
QGSC



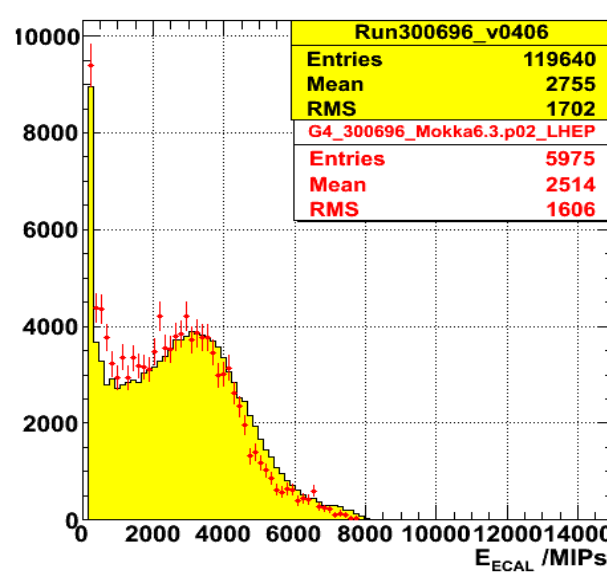
QGSC_LEAD



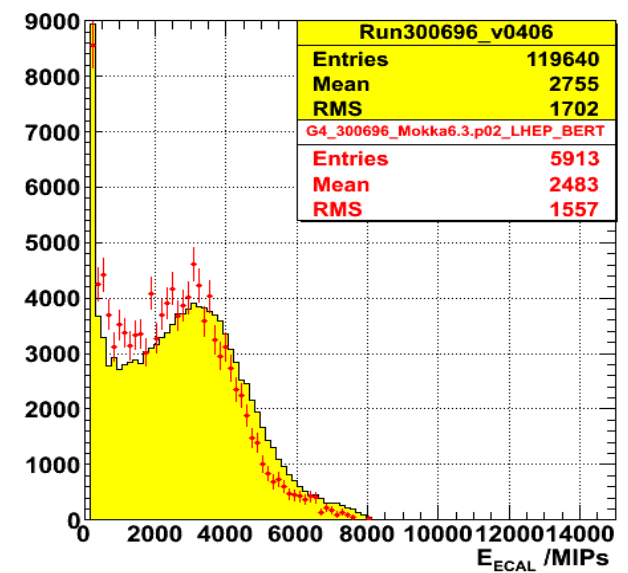
FTFC



LHEP



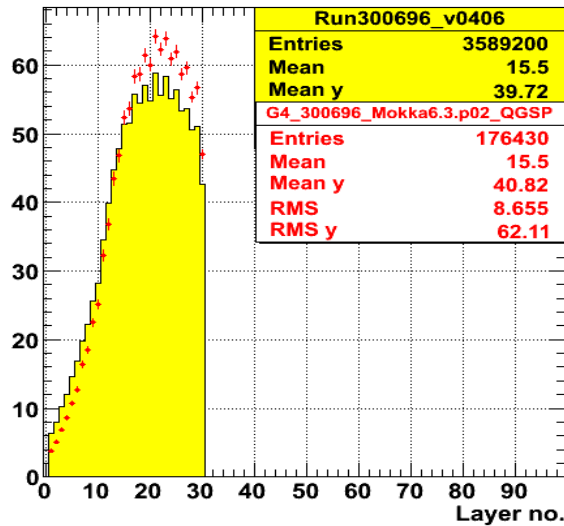
LHEP_BERT



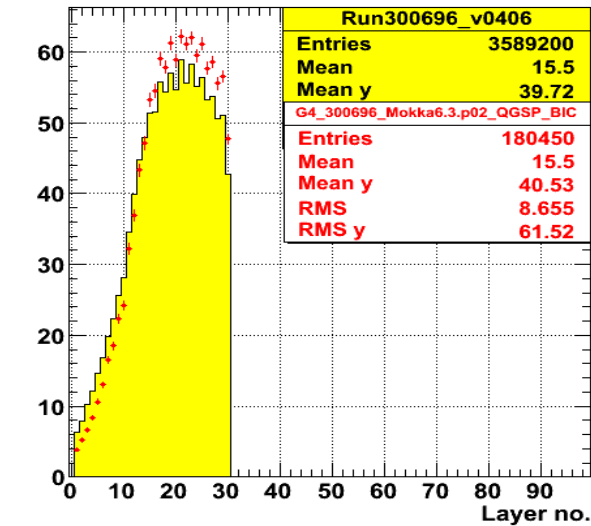
Run300696 vs Simulations

Longitudinal Energy Distribution

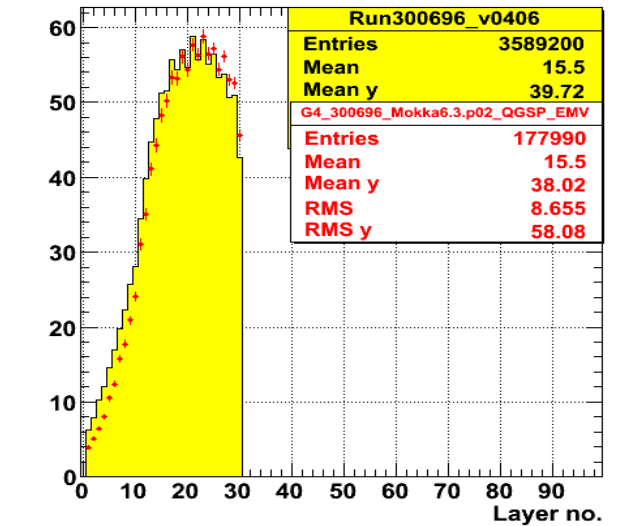
QGSP



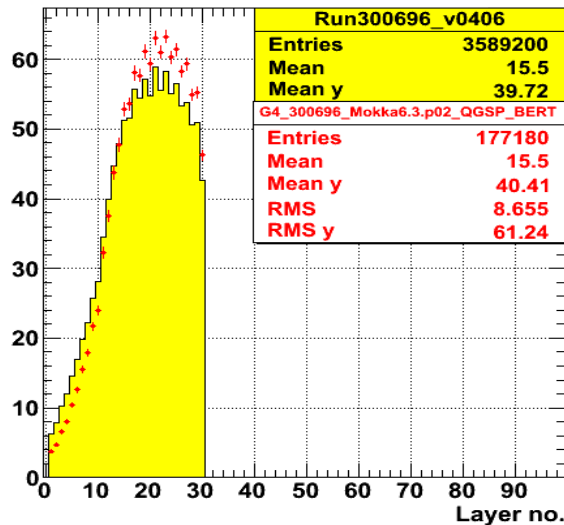
QGSP_BIC



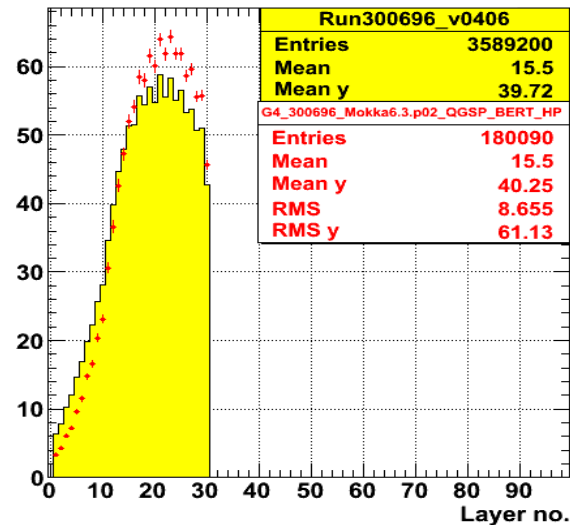
QGSP_EMV



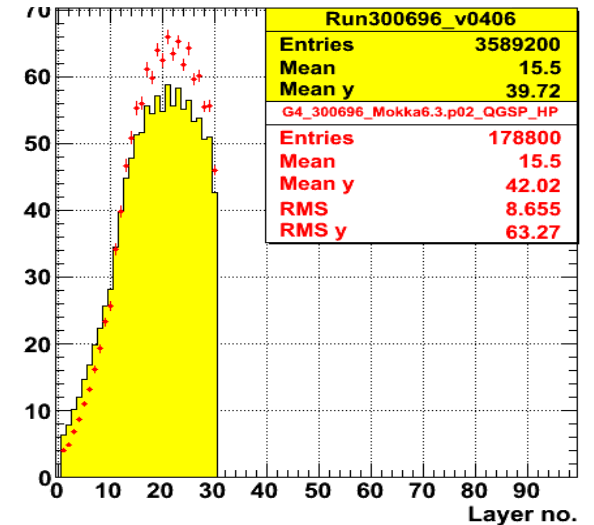
QGSP_BERT



QGSP_BERT_HP



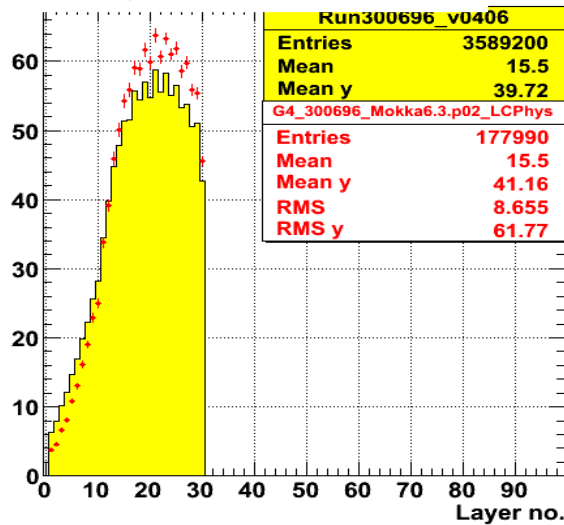
QGSP_HP



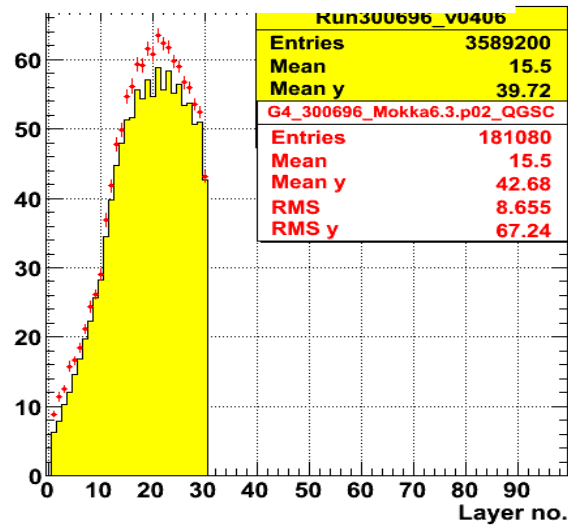
Run300696 vs Simulations

Longitudinal Energy Distribution

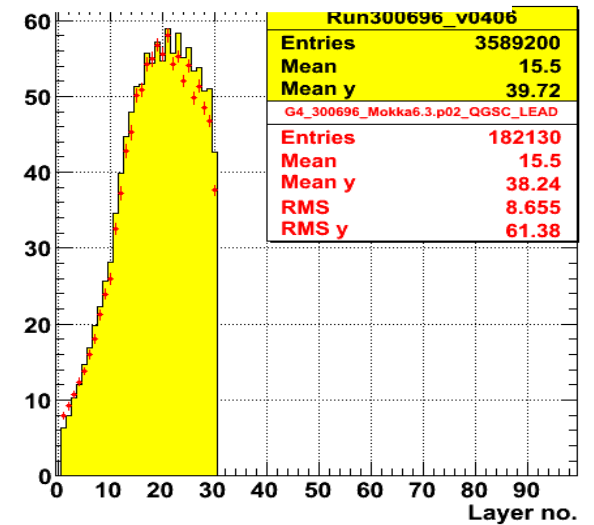
LCPhys



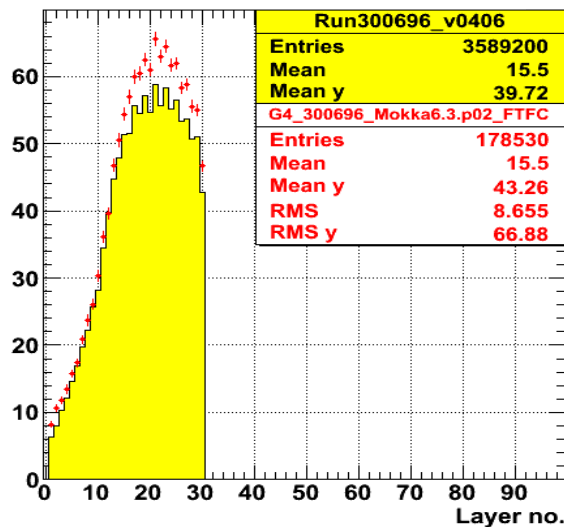
QGSC



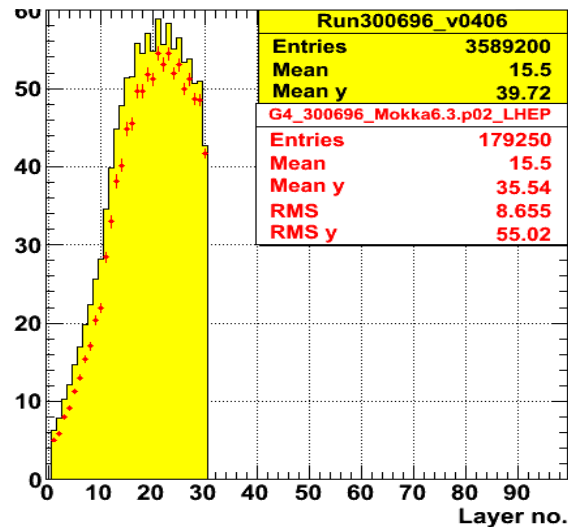
QGSC_LEAD



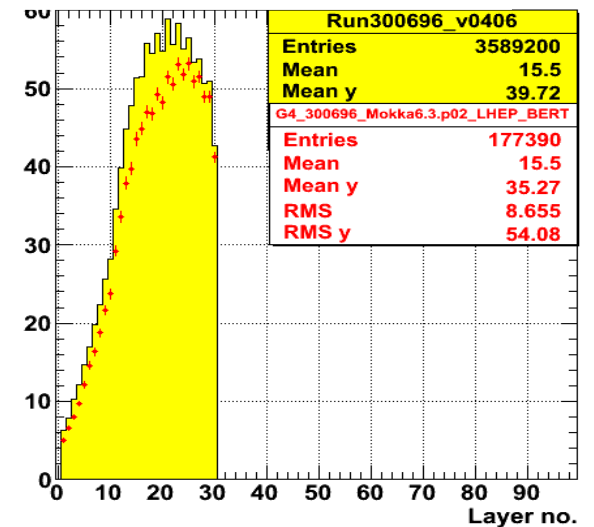
FTFC



LHEP



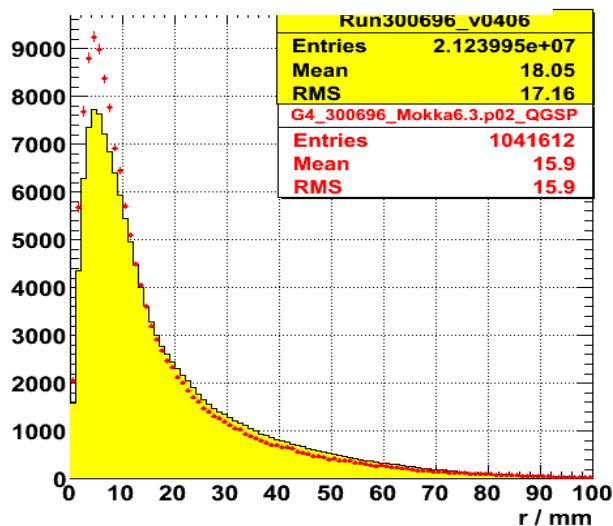
LHEP_BERT



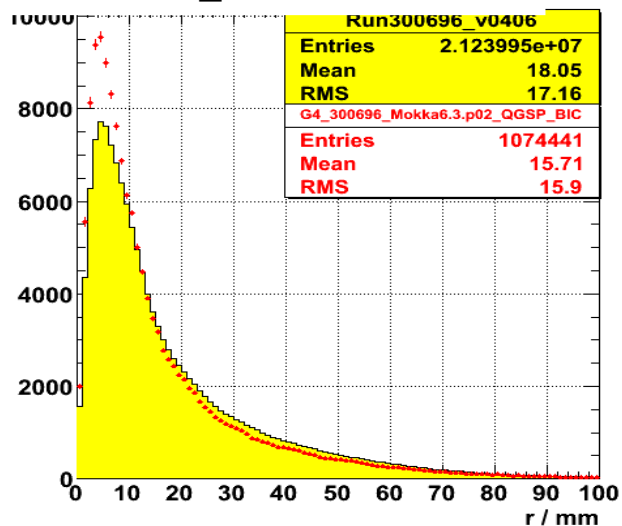
Run300696 vs Simulations

Transverse Energy Distribution

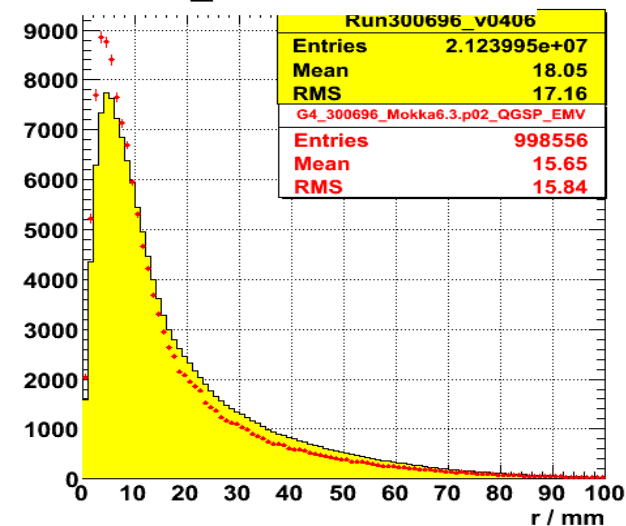
QGSP



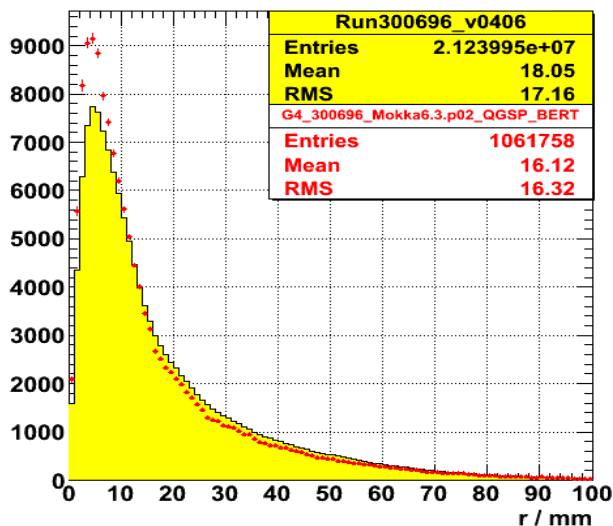
QGSP_BIC



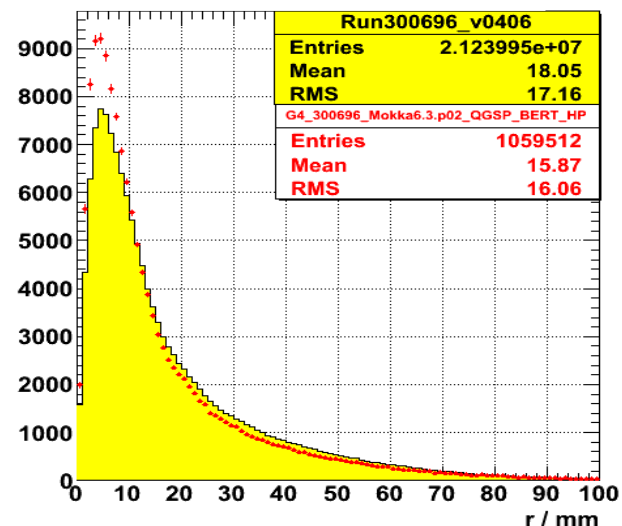
QGSP_EMV



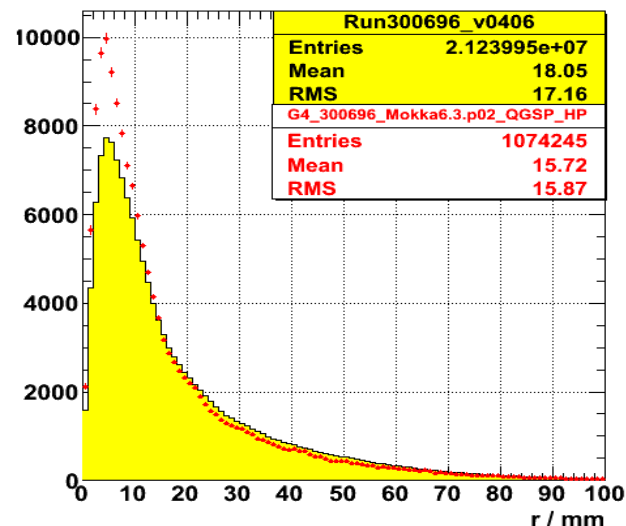
QGSP_BERT



QGSP_BERT_HP

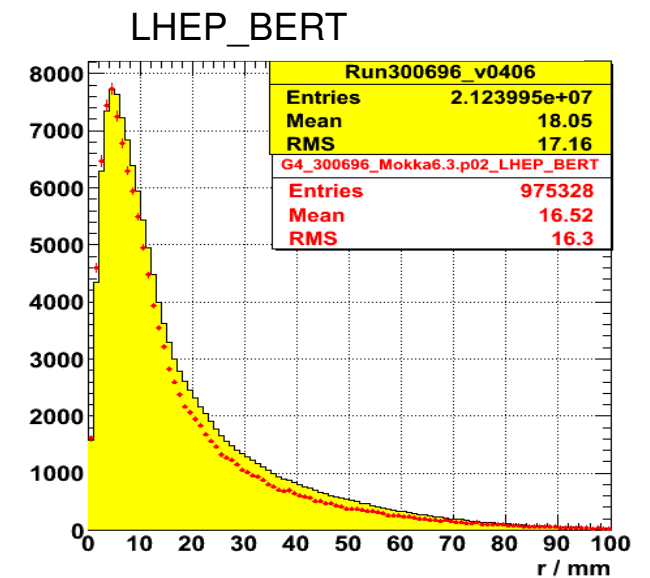
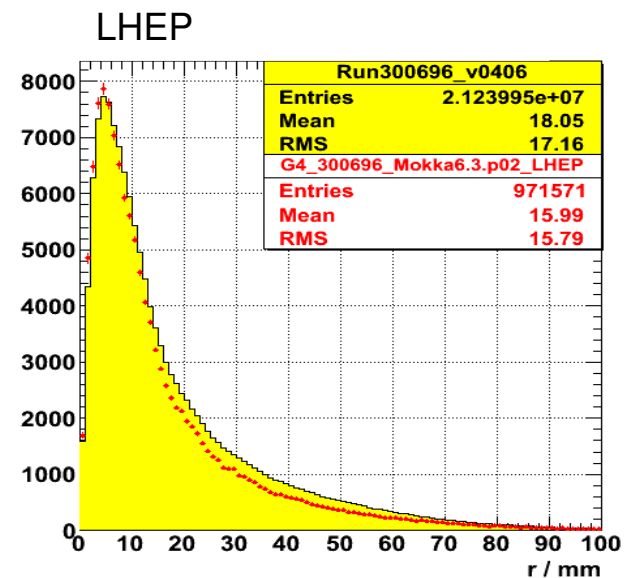
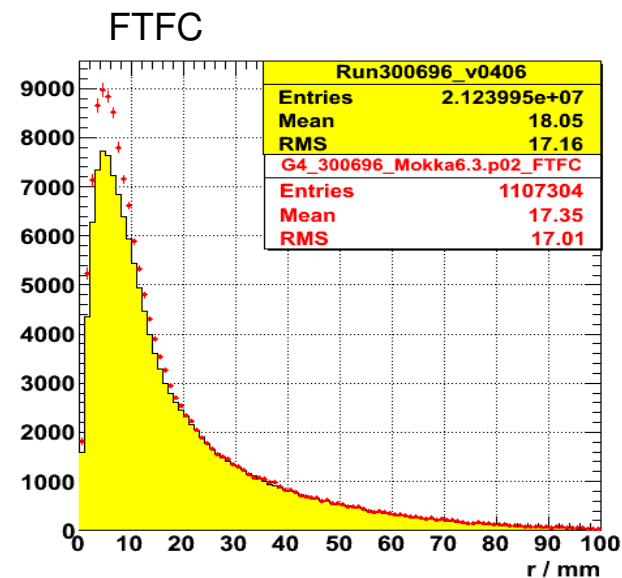
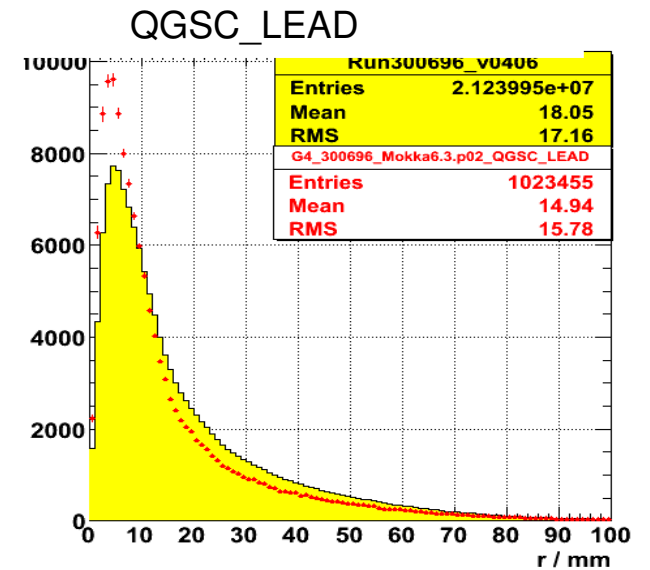
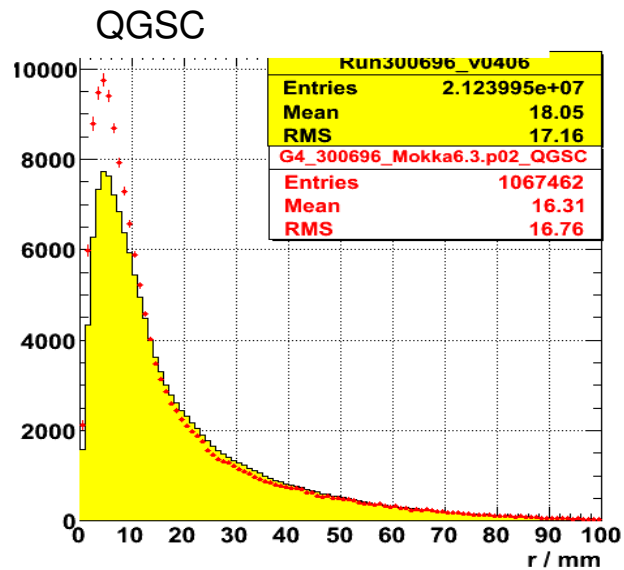
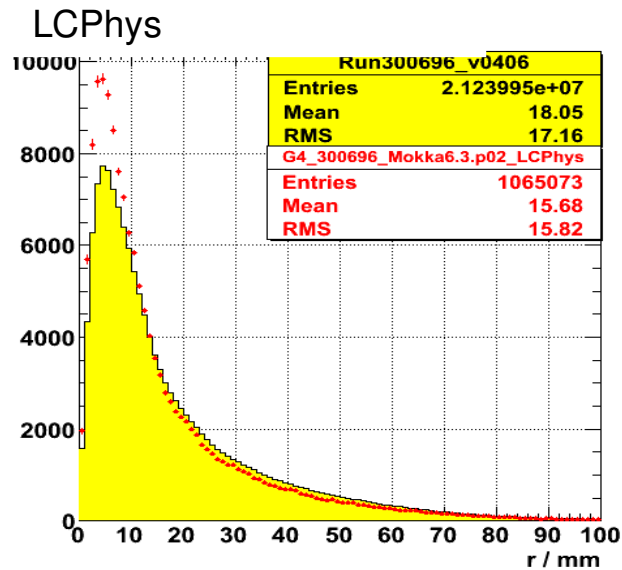


QGSP_HP



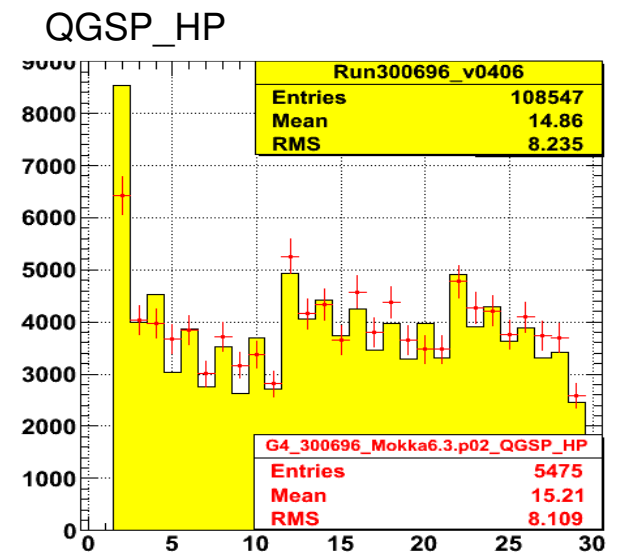
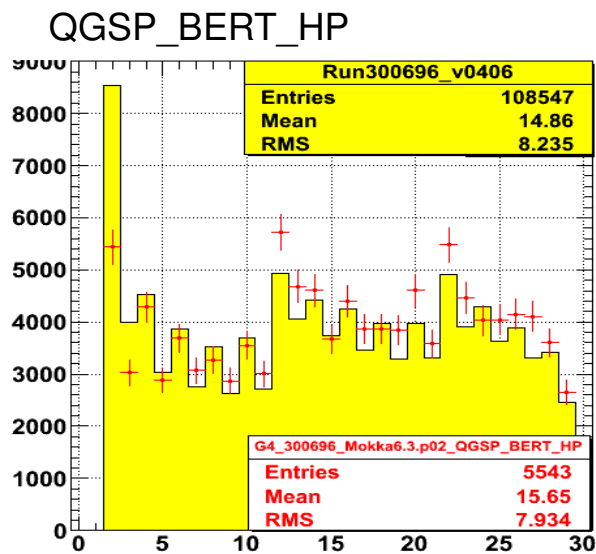
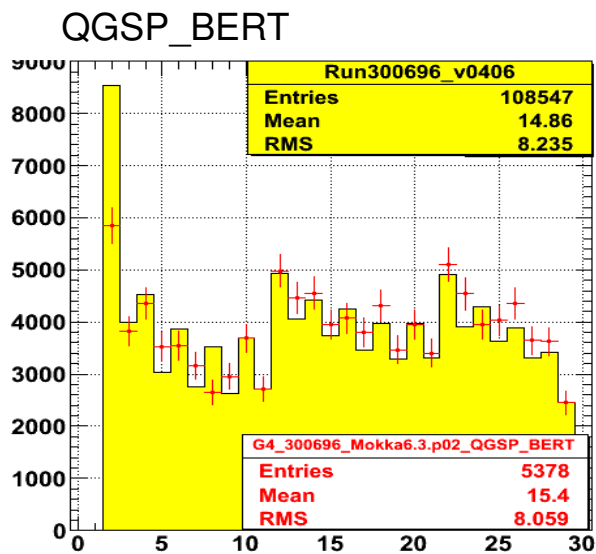
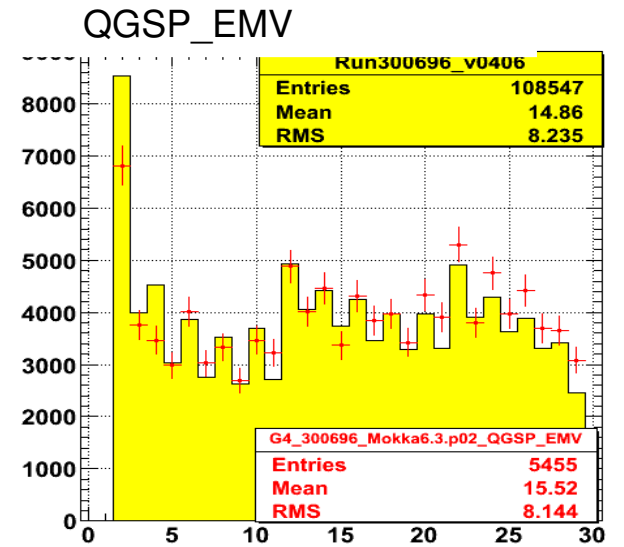
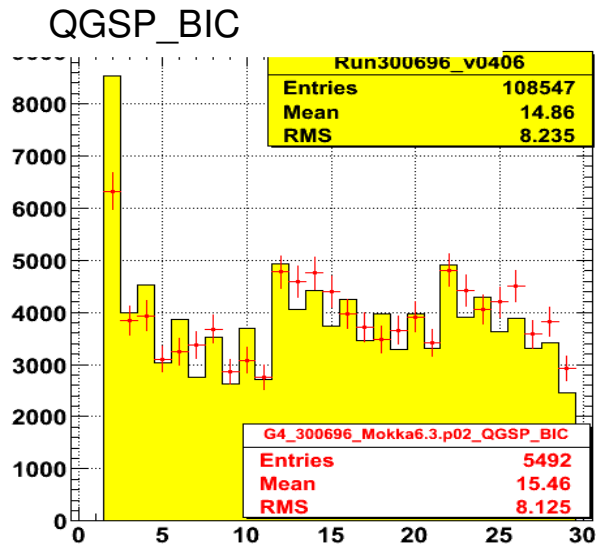
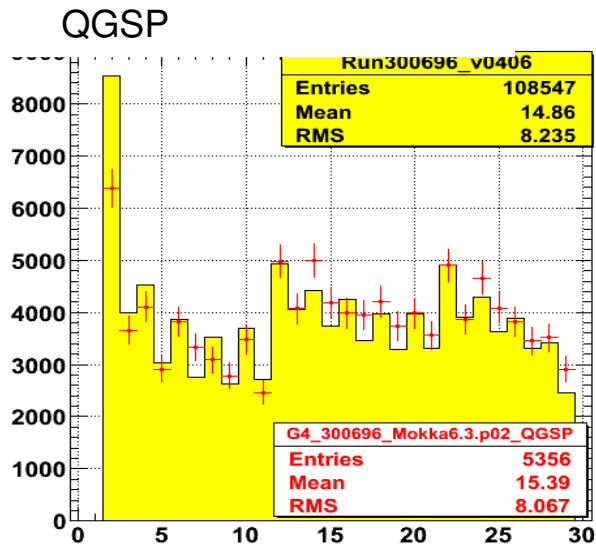
Run300696 vs Simulations

Transverse Energy Distribution



Run300696 vs Simulations

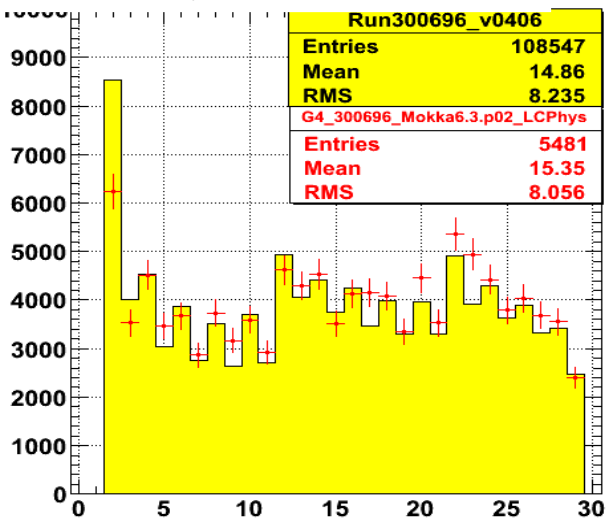
First interaction layer



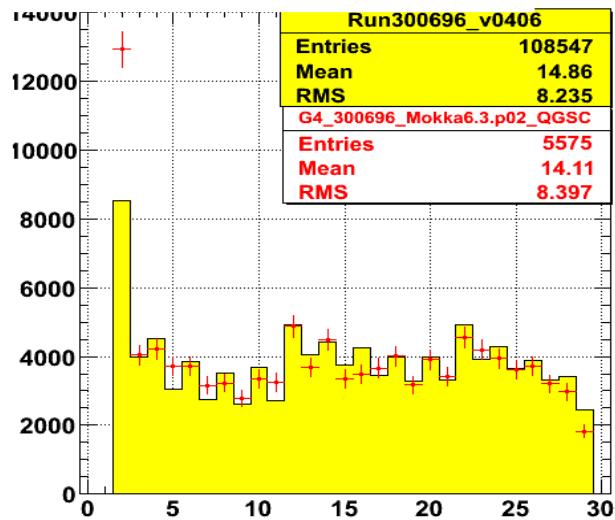
Run300696 vs Simulations

First interaction layer

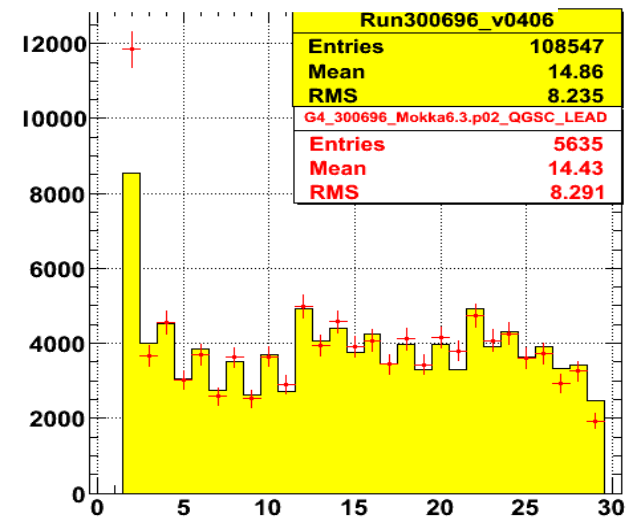
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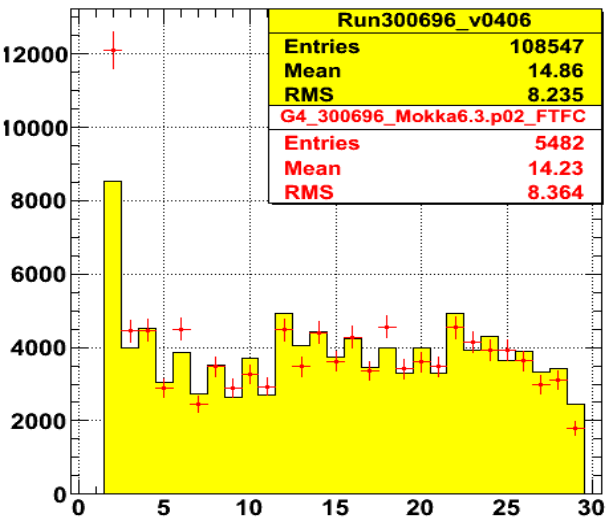
QGSC



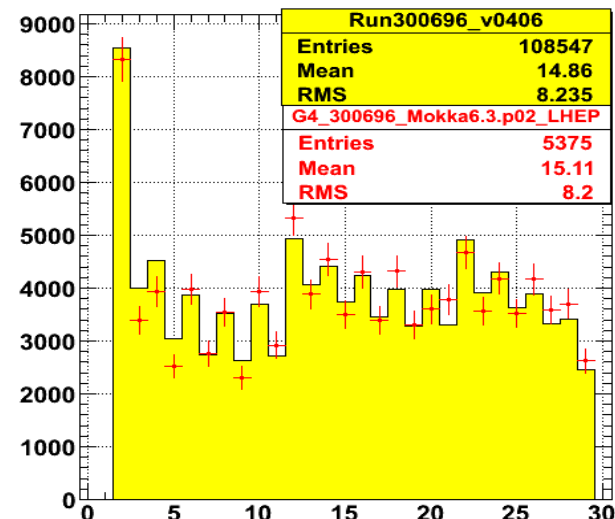
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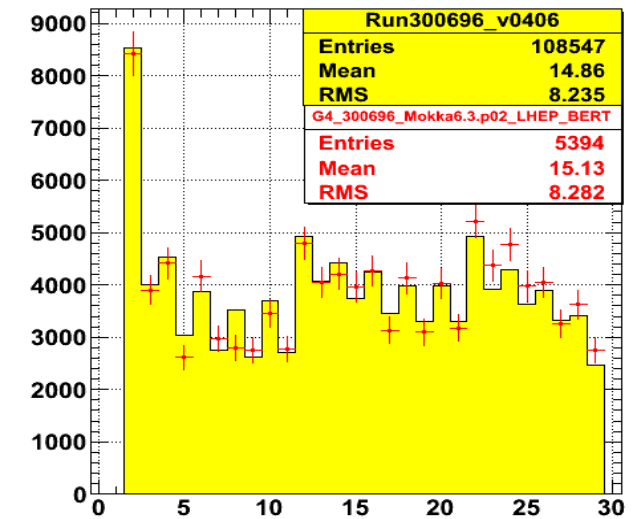
FTFC



LHEP



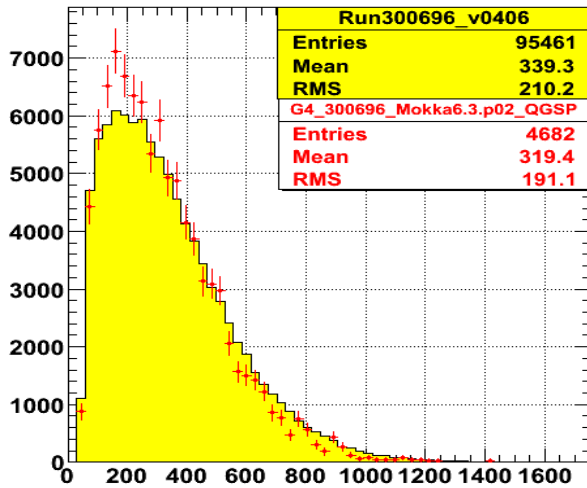
LHEP_BERT



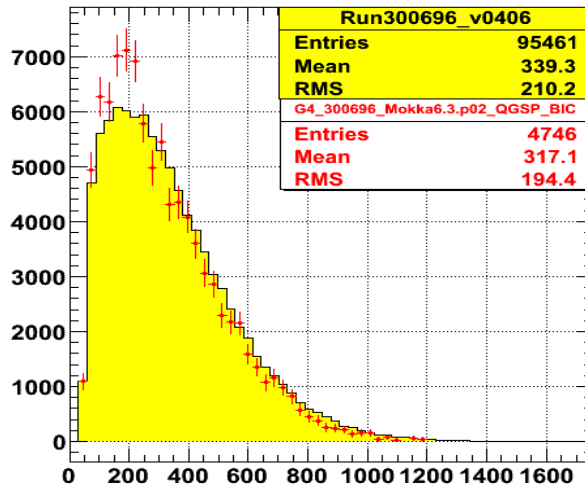
Run300696 vs Simulations

Shower Energy – first 5 layers

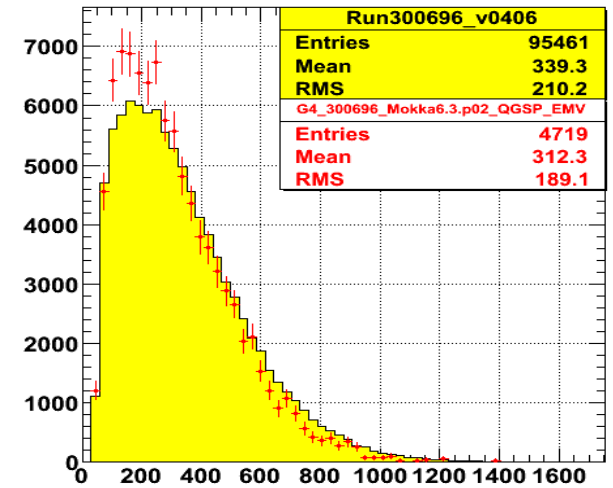
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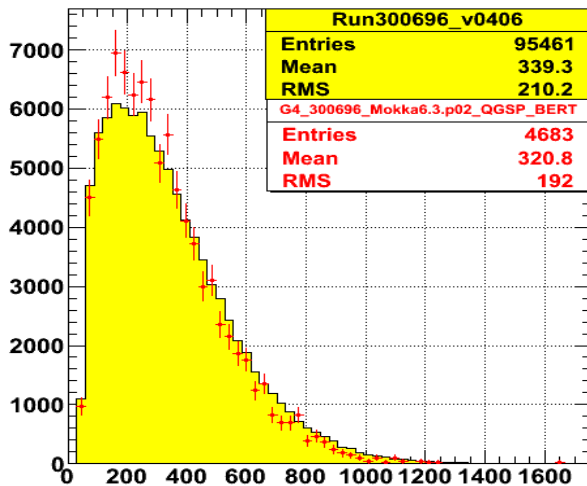
QGSP_BIC



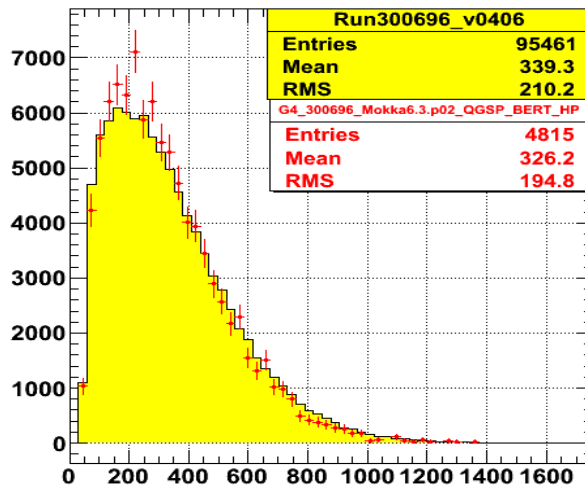
QGSP_EMV



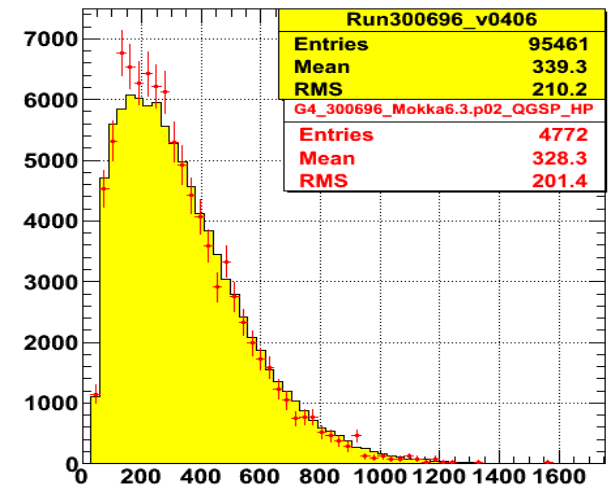
QGSP_BERT



QGSP_BERT_HP



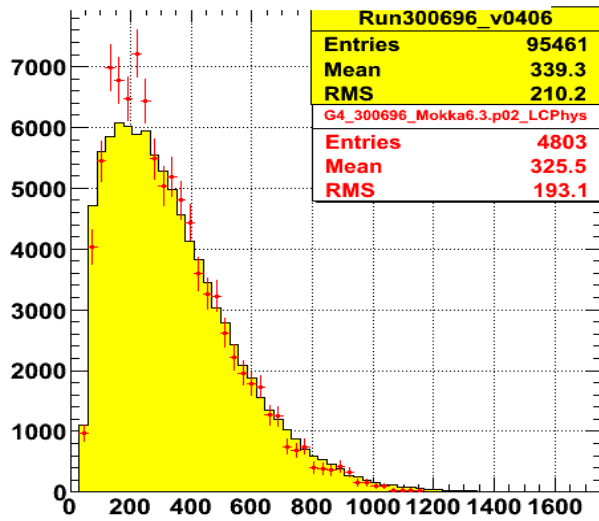
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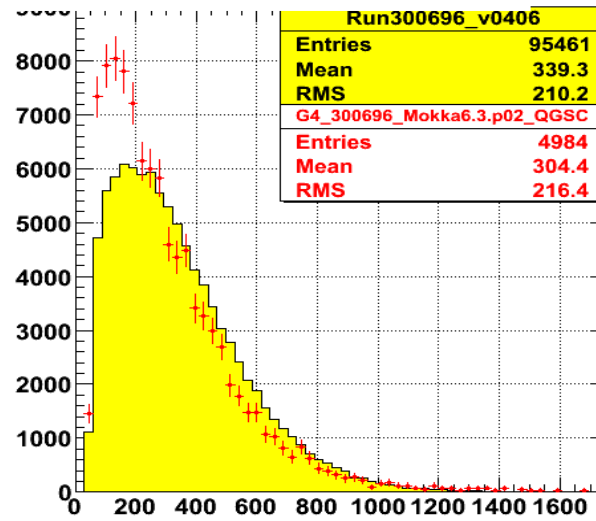
Run300696 vs Simulations

Shower Energy – first 5 layers

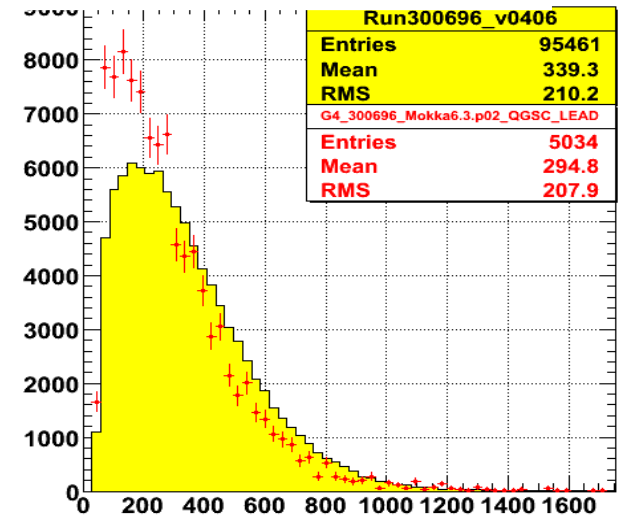
LCPhys



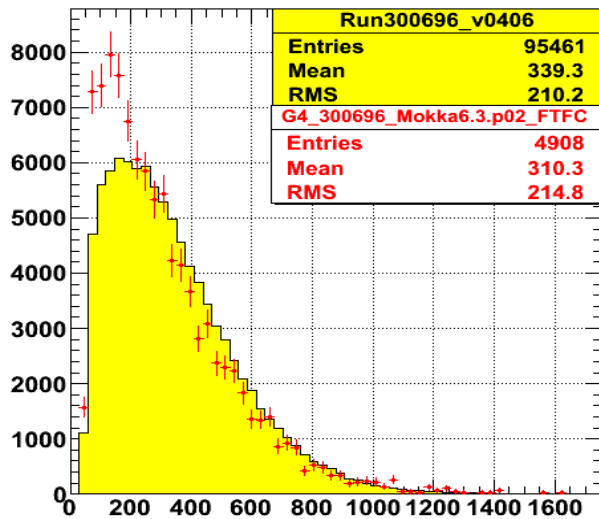
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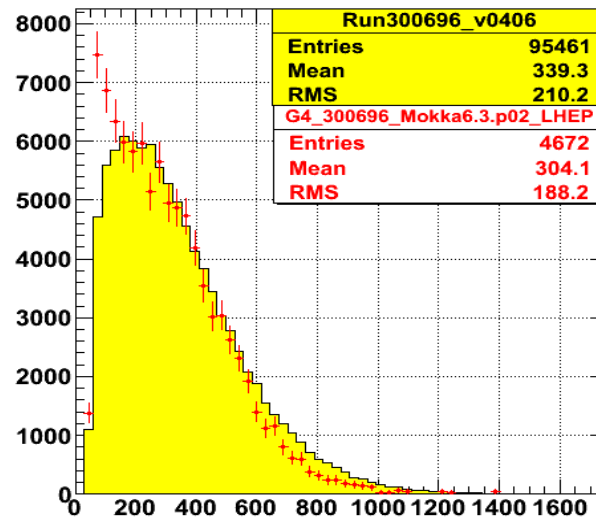
QGSC_LEAD



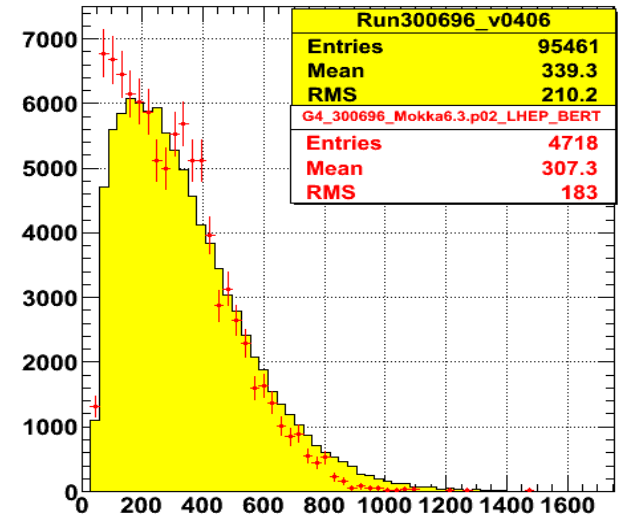
FTFC



LHEP



LHEP_BERT



Summary

- Studied energy dependence of LHEP and QGSP_BERT from 6GeV to 80GeV
- Studied 12 different physics lists at Energy 30GeV
- ECAL certainly proved some discrimination between hadronic models.
- A lot more work needs to be done to understand the results.

THE END