Performance of the PHENIX EMCalorimeter

QM2001 Poster

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for the PHENIX Collaboration

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Physics Goal &EM probes

- ***QGP search***
  - *Global characteristics*
  - *Thermal radiation*
  - *Chiral symmetry restortion*
  - *Debye screening*
  - *Jet quenching*
  - *Space time evolution*
  - *Fluctuation*
- ***Spin physics***
  - ÄG
  - Ä $\bar{q}$

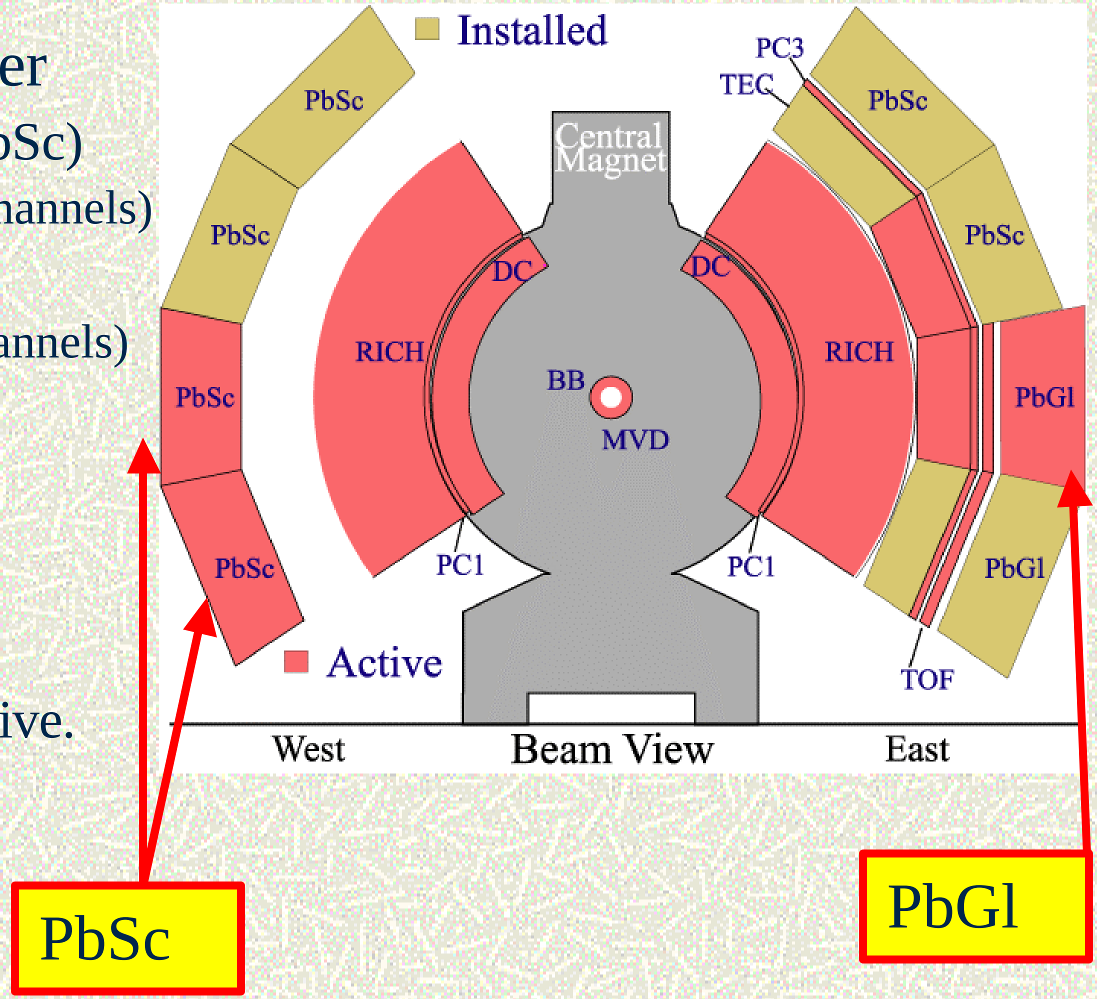
total transverse energy
direct γ, π^0
ϕ → e+e-,K+K-
J/Ψ → e+e-
high-p_T π^0
HBT, flow
DCC

direct γ
π^0
open heavy flavor,J/Ψ
$W^{\pm}$ → $e^{\pm}$

PHENIX EM Calorimeter

- PbSc (lead scintillator) and PbGl (lead glass) -

- Two type Calorimeter
  - Lead Scintillator (PbSc)
    - 6 sectors(15552 channels)
  - Lead Glass (PbGl)
    - 2sectors (9216 channels)
- Coverage
  - $|\eta|<0.38$
  - $\phi = 180°$
- In the first year run
  - $\phi = 45° + 90°$ are active.
    - 2 sectors PbSc
    - 1 sectors PbGl



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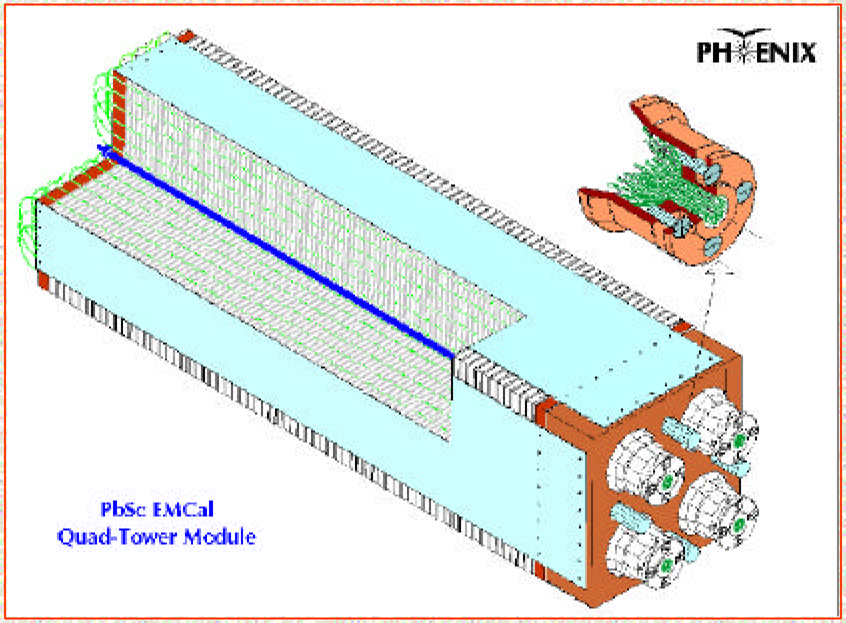
PbSc Calorimeter



	PbSc
Size(cm x cm)	5.52 x 5.52
Depth(cm)	37.5
Number of towers	15552
Sampling fraction	~ 20%
h cov.	0.7
f cov.	90+45deg
h/mod	0.011
f/mod	0.011
X_0	18
Molière Radius	~ 3cm

Sandwich type calorimeter
- Lead plates 55.2x55.2x1.5mm
- Scintillator plates 110.4x110.4x4mm

Shish-kebab geometry wave shifter fiber readout
- 6x6 fibers → 1 PMT = 1 tower
- 2 x 2 towers = 1 module
- 6 x 6 module = 1 super module
- 6 x 3 super module = 1 sector

PbSc sector 2.0m x 4.0m

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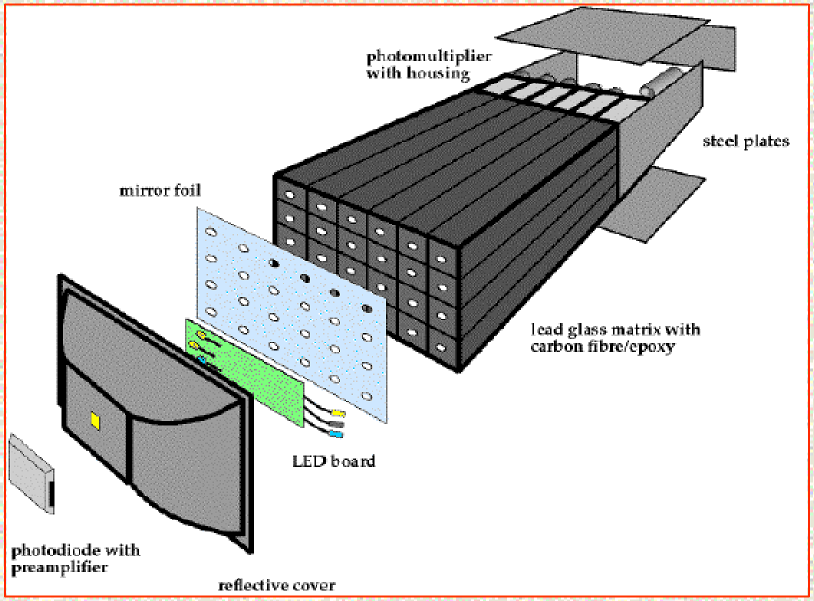
PbGl Calorimeter

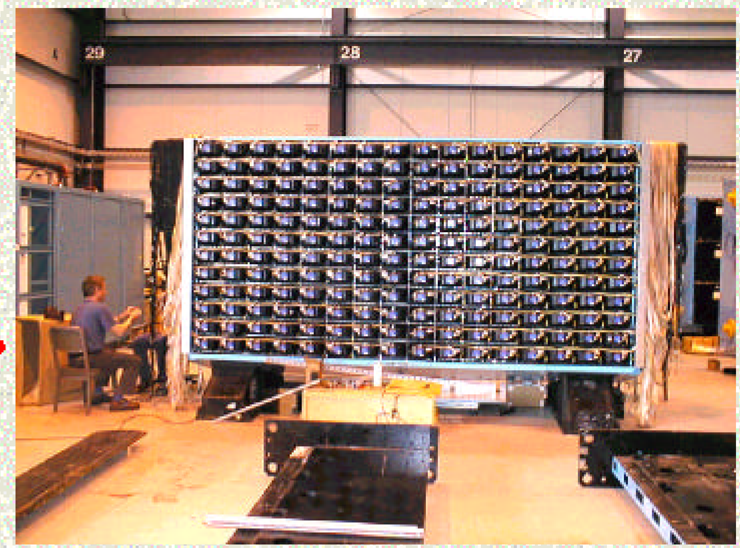


	PbGl
Size(cm x cm)	4.0 x 4.0
Depth(cm)	40
Number of towers	9216
Sampling fraction	100%
h cov.	0.7
f cov.	45deg
h/mod	0.008
f/mod	0.008
X_0	14.4
Molière Radius	3.68cm

Lead Glass calorimeter

Lead Glass 40x40x400mm
used at WA98 exp.

4x6 towers = 1 super module
15*12 super module = 1 sector



PbGl sector 2.1m x 3.9m

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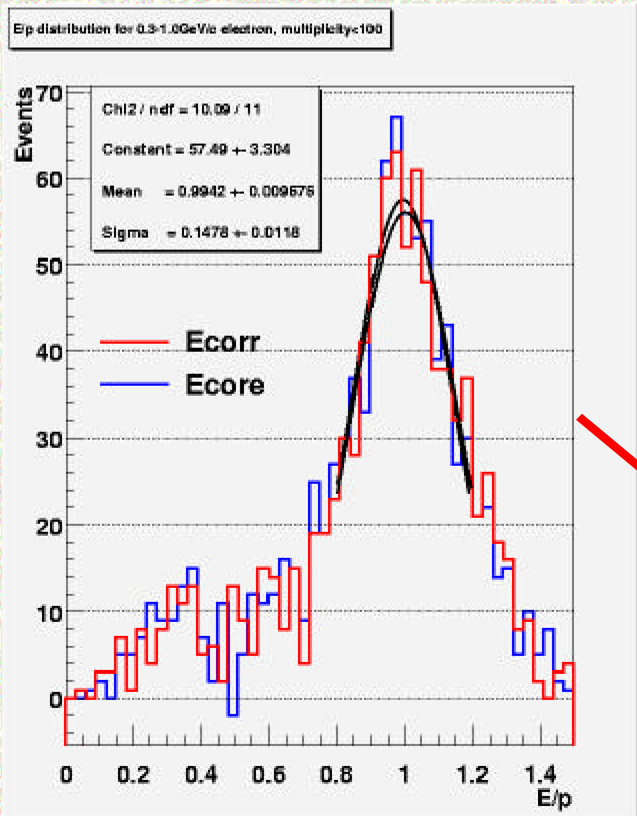
Electron Measurement



Electron E/p ratio is 1.0

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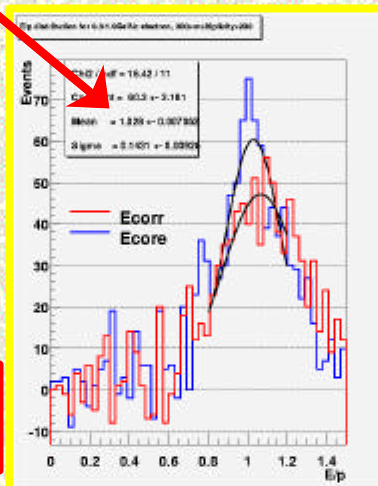
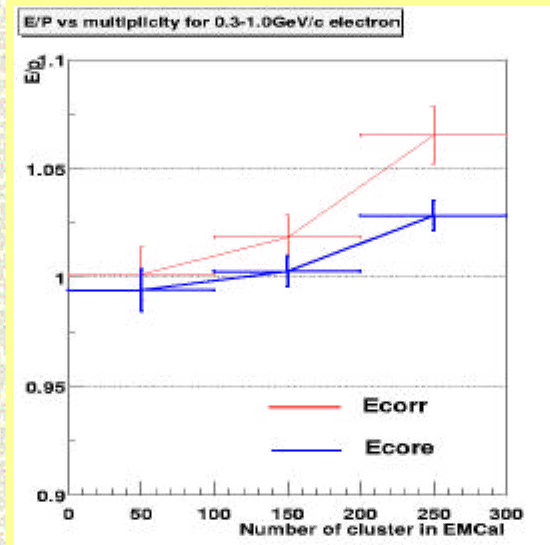
High multiplicity condition



E/p distribution shift up.

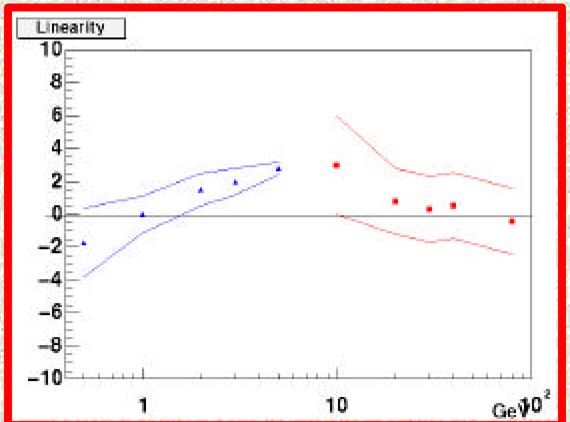
E/p multiplicity dependence



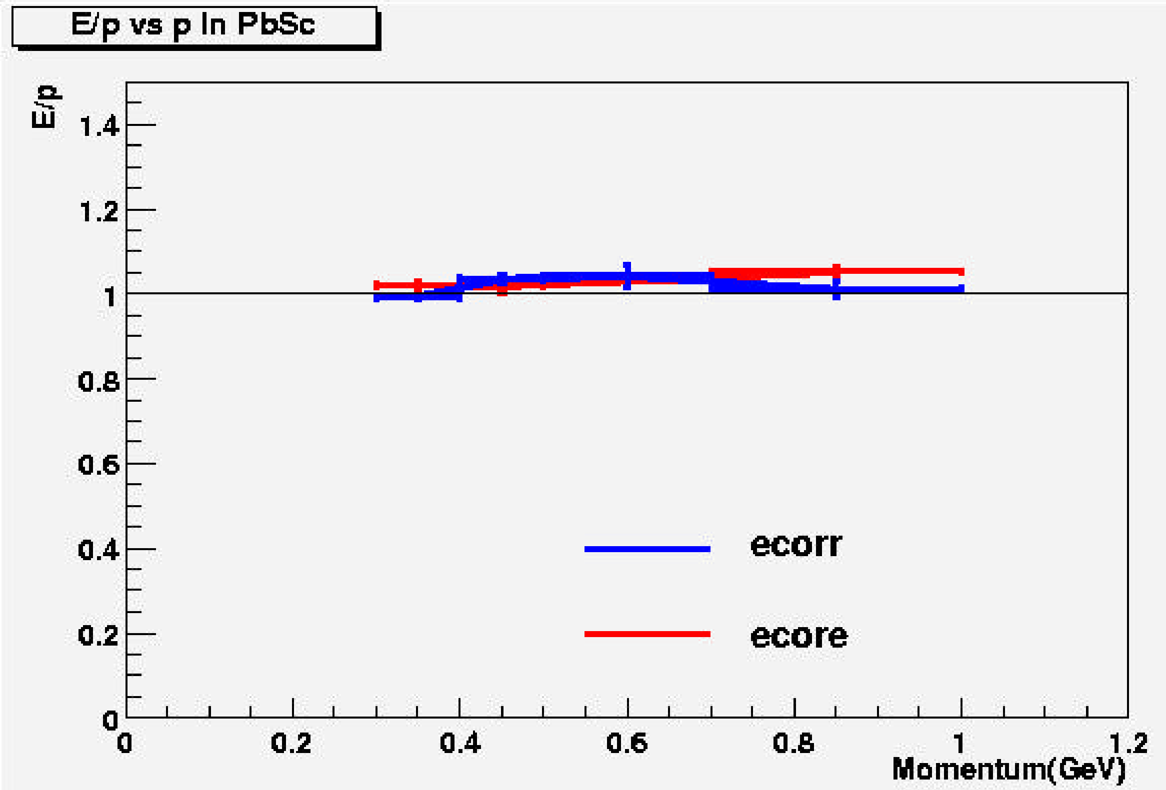
The 'Ecorr' and 'Ecore' are the PHENIX EMCal clustering algorithm. 'Ecorr' is energy sum of all towers in a shower with linearity correction. 'Ecore' is energy sum of a few core towers to eliminate effect from adjacent shower overlapping. In high multiplicity condition, 'Ecore' shifts up by 3%, otherwise 'Ecorr' shifts by 7%.

Electron Energy measurement

~ Linearity ~



Test beam @AGS & CERN



Observed energy was corrected by the test beam result which is described by two different effects.

-Attenuation in fiber

-Shower Leakage

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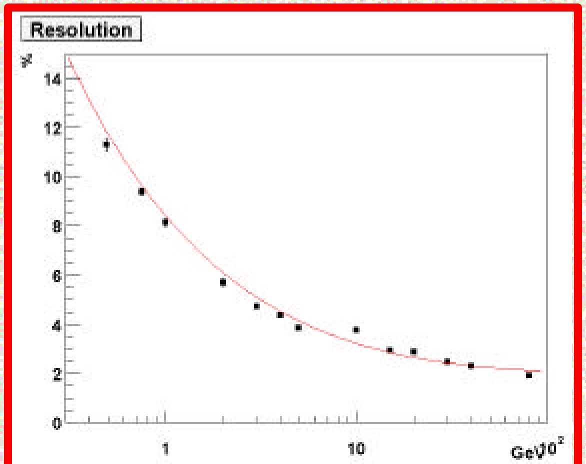
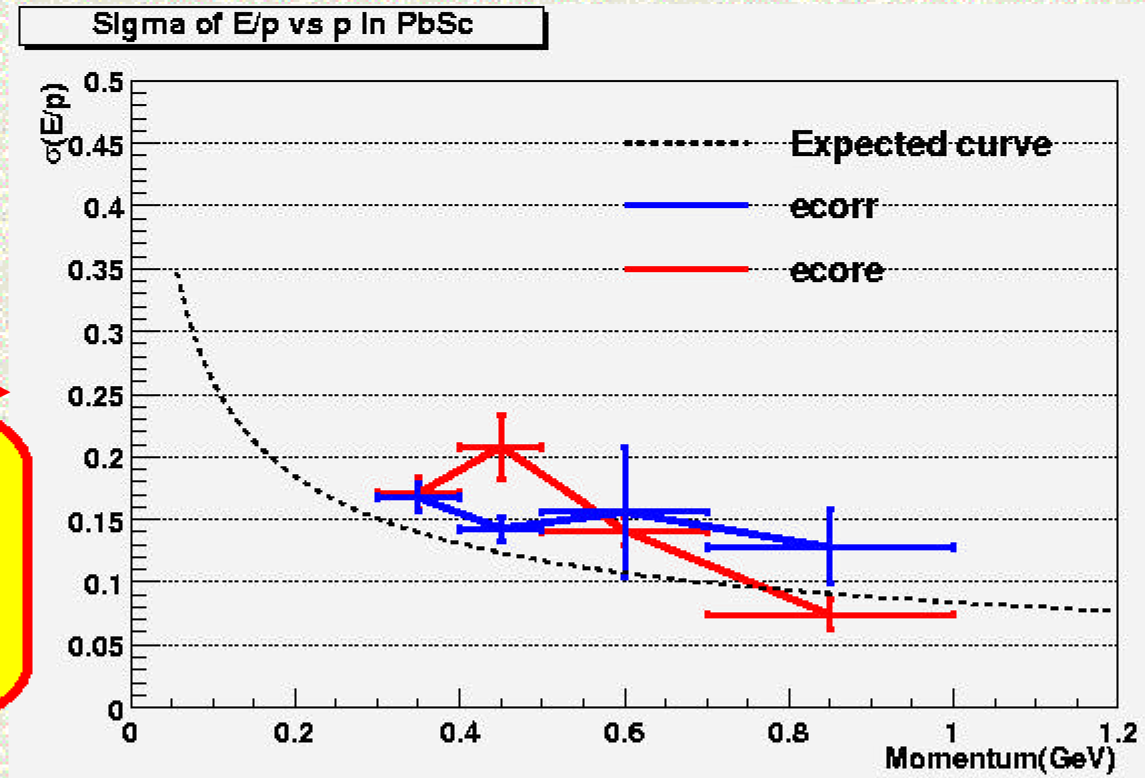
Electron Energy Measurement

~ Resolution ~



Test beam @AGS & CERN



Intrinsic energy resolution was obtained by test beam

$1.9\% \oplus 8.2\%/\sqrt{E}$

Current resolution is higher. It is under improvement.

Photon TOF measurement

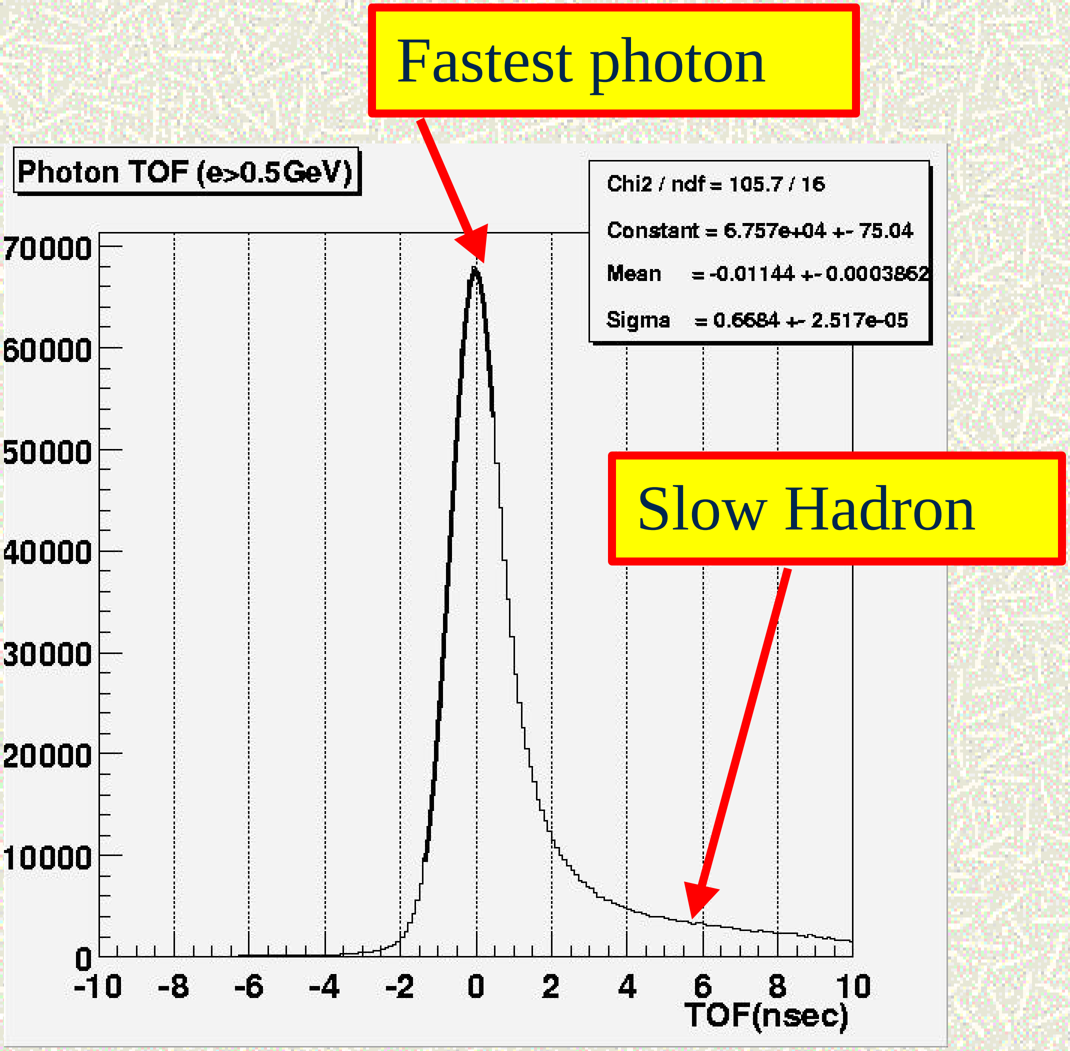
Current status is

0.78nsec at >0.3GeV

0.67nsec at >0.5GeV

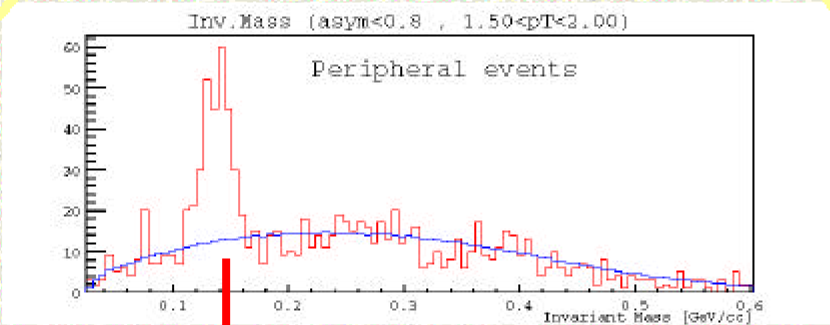
It is under improvement.

The intrinsic TOF resolution is measured at AGS beam test as 0.1nsec at 1GeV/c.

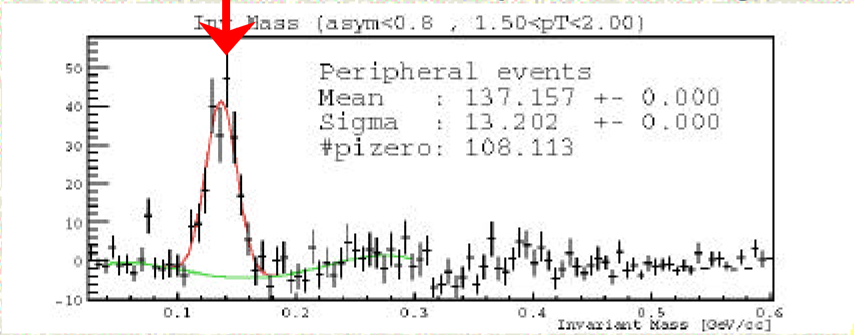


π^0 measurement

Peripheral events

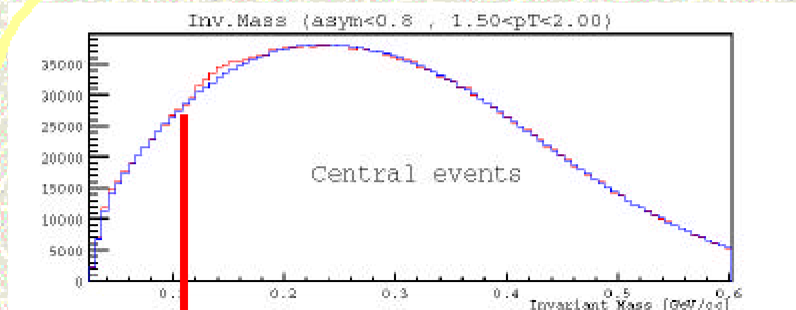


Subtraction by event mixing

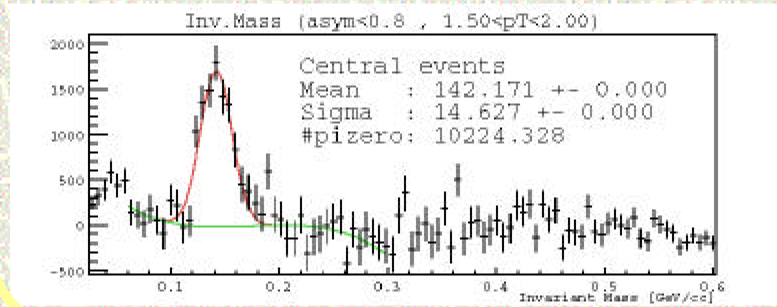


75-92% centrality

Central events



Subtraction by event mixing



10% centrality

pT = 1.5 – 2.0Gev/c Energy Asymmetry < 0.8

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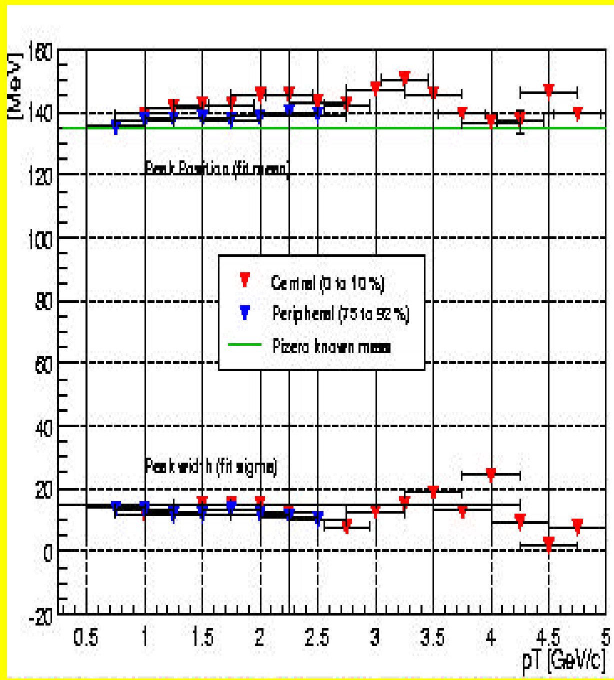
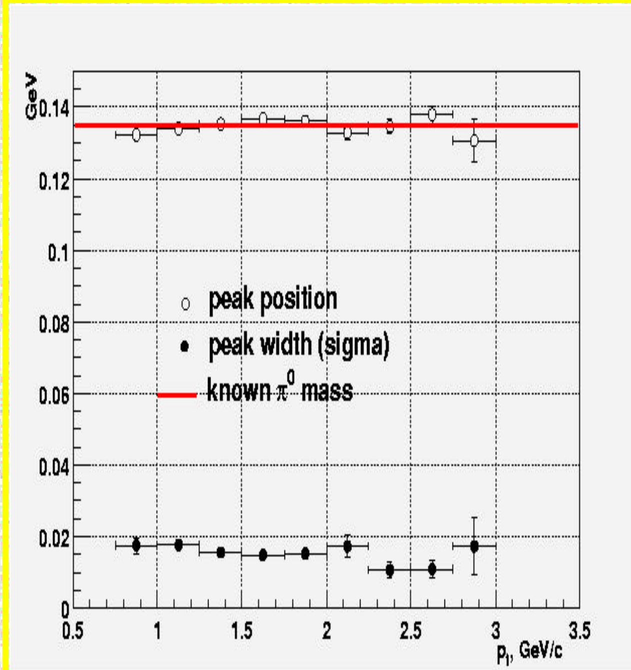
π^0 invariant mass



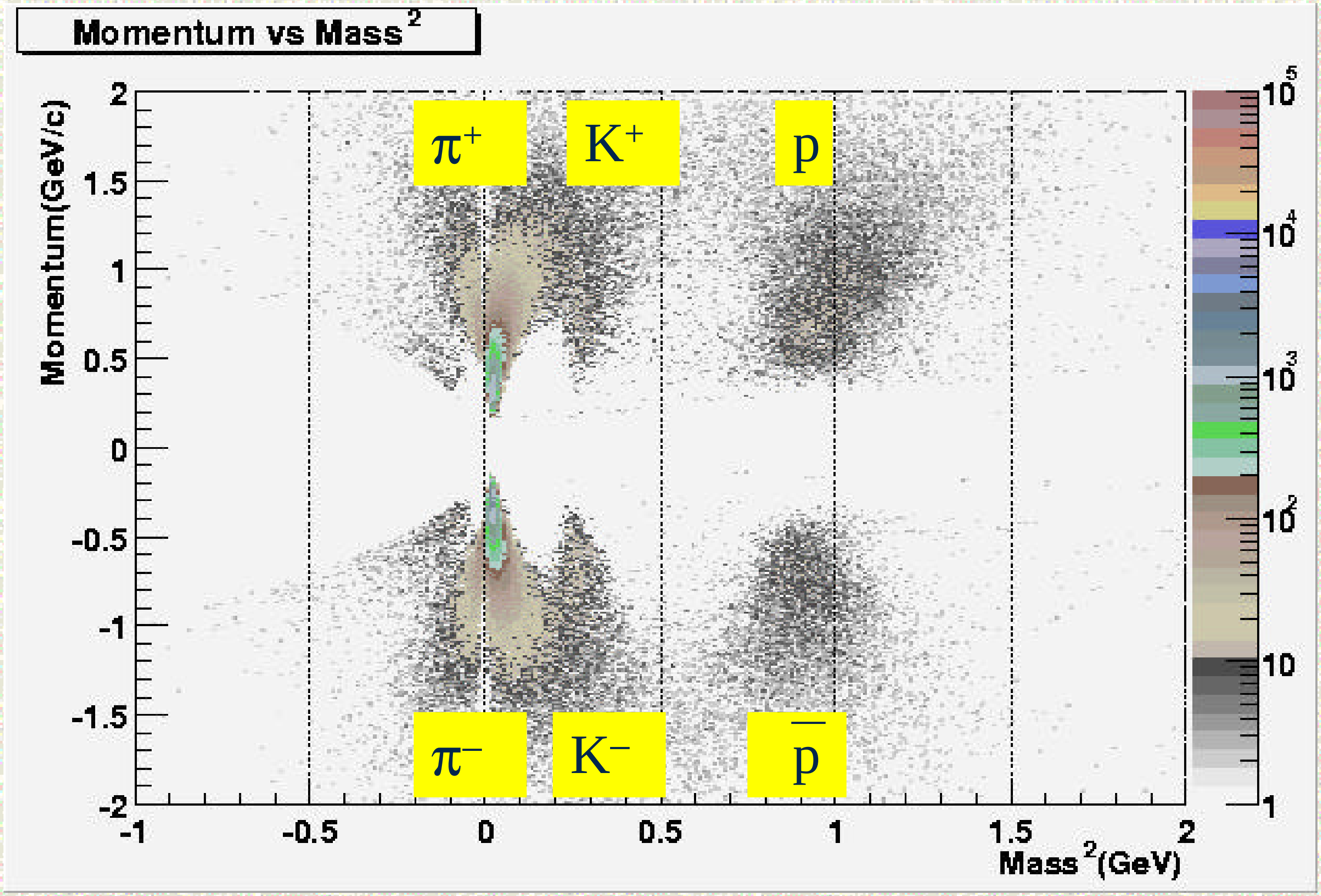
π^0 mass in PbSc



π^0 mass in PbGl

In higher multiplicity condition, the mass shows 1% higher than that in lower multiplicity condition. It is known to the overlapping effect of the two photon clusters. π^0 mass shows the energy calibration with accuracy of 2%.

Hadron PID



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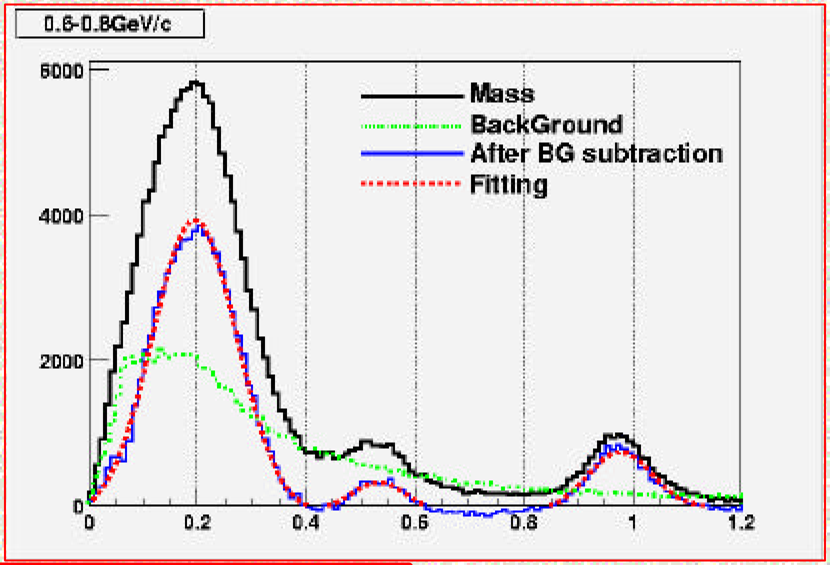
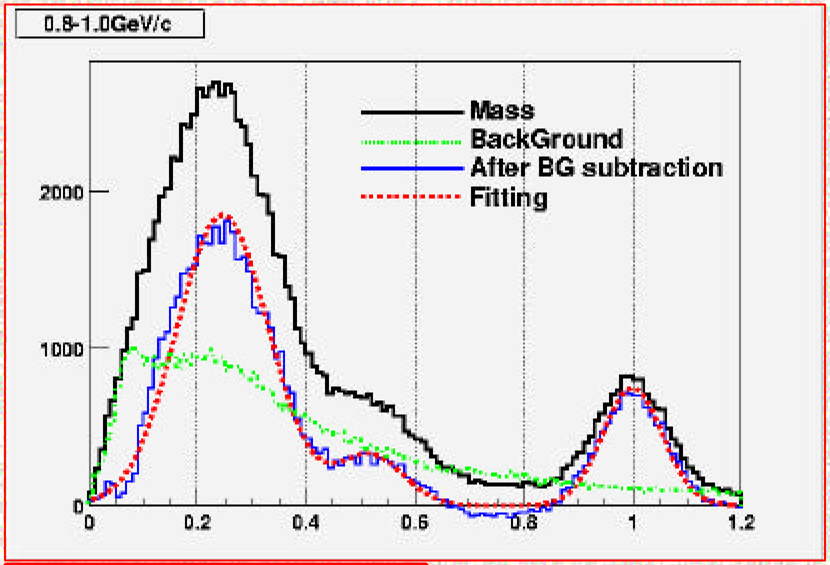
Hadron PID



0.6-0.8GeV/c



0.8-1.0GeV/c

π/K are separated up to 0.8GeV/c
Hadron physics will be obtained in large acceptance by using low energy hadron.

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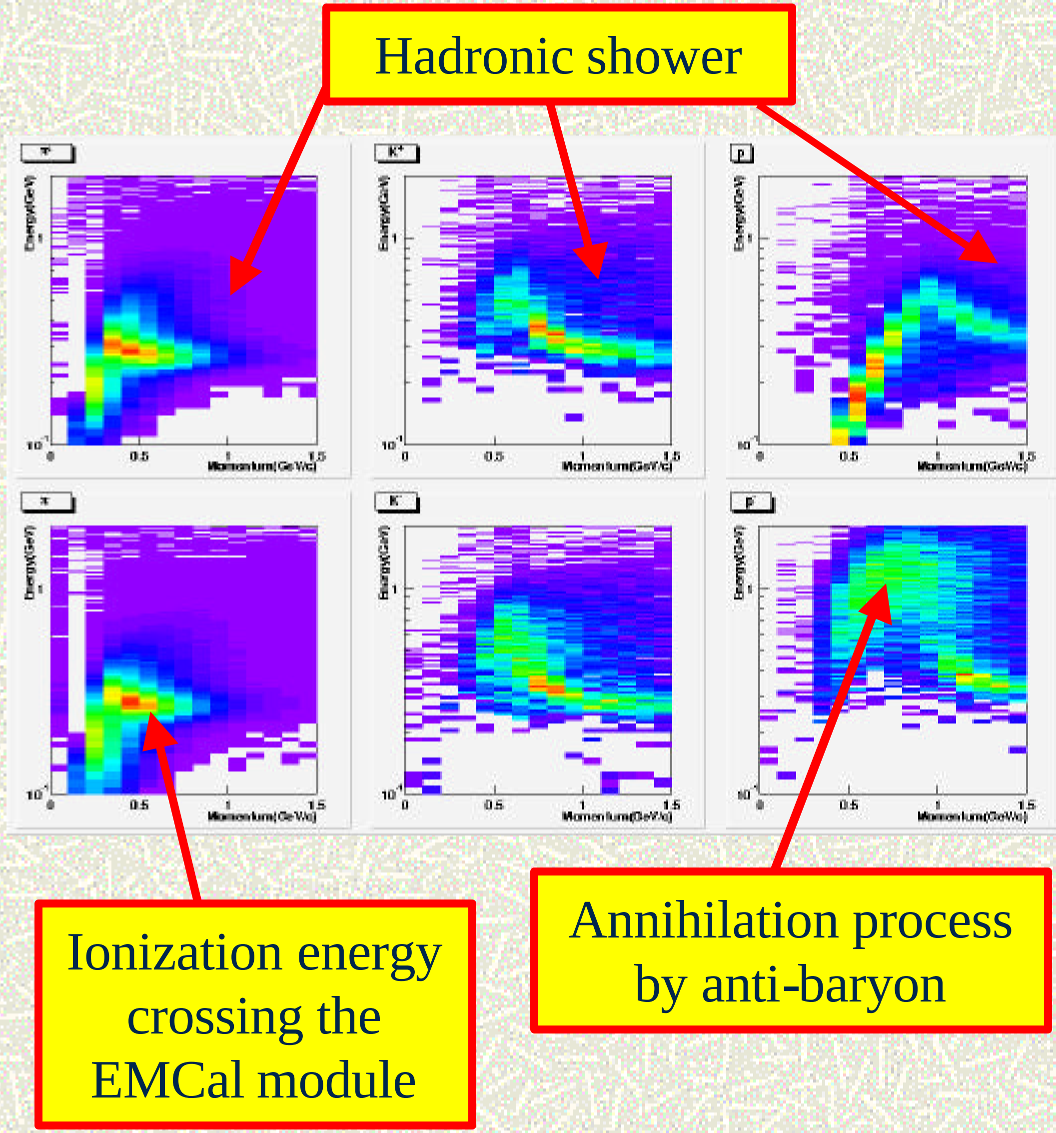
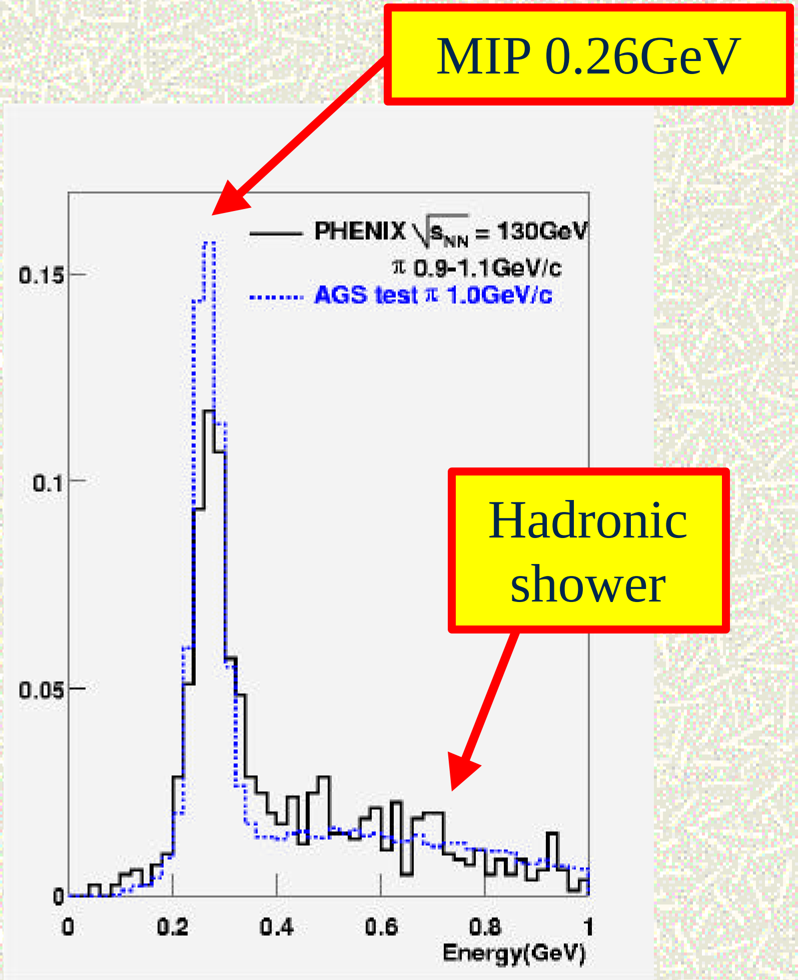
Hadron response

- Energy deposit by charged hadron is characterized by.
  - Range
    - π ~ 0.3GeV/c
    - K ~ 0.5GeV/c
    - p ~ 0.9GeV/c
  - At larger momentum than range
    - Ionization energy
      - Caused by particles crossing the EMCal.
      - Minimum Ionization energy
    - Hadron shower.
  - At less momentum than range
    - Annihilation process by anti-proton produce large energy observation.

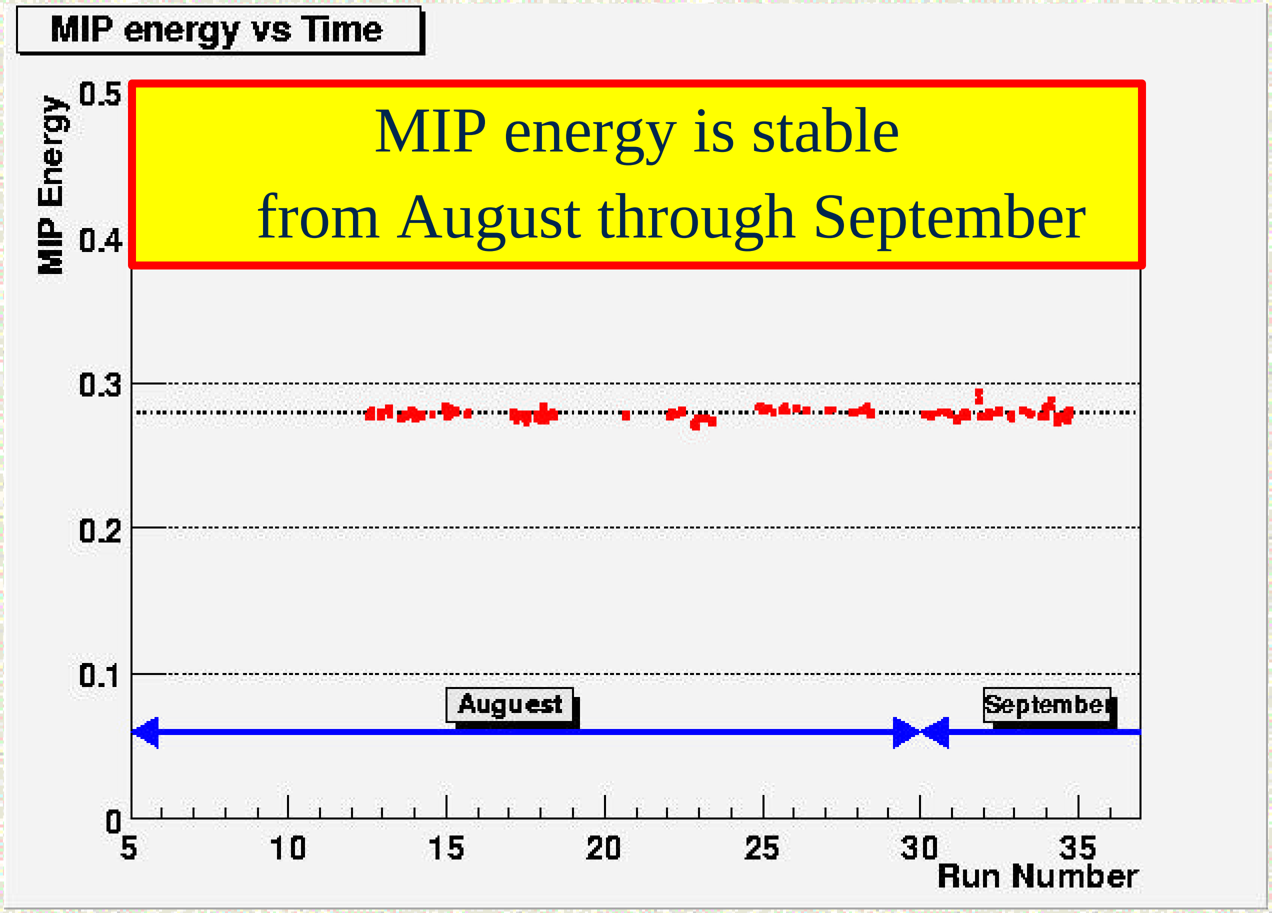


MIP Energy

- Comparison with
  AGS test results: π 1.0GeV/c.
  PHENIX $\sqrt{s_{NN}}$ = 130GeV:
    0.9-1.1GeV/c π± at lower multiplicity.
  - minimum Ionization Particle at 0.26GeV.
  - The spectrums of hadronic shower between 0.26 – 1.0GeV are very similar.
- Relative energy of every towers are calibrated by using ionization energy of 0.6-1.0GeV/c $\pi^{\pm}$ at lower multiplicity. The accuracy of this calibration is 3% accuracy which is dominated by statistical error.



MIP Run dependence



Run dependence of minimum ionization energy is obtained from August through September. The stability is < 2%

Summary

- Electron measurement
  - E/p distribution shows the peak at 1.0 from 0.3 to 1.0GeV/c electron
  - At higher multiplicity, E/p shifts by a few percent. It depends on the clustering algorithm.
  - The width of E/p is wider than our expectation. It's under improvement.
- γ/π^0 measurement
  - The resolution of γ's TOF is 780psec at > 0.3GeV. There is a room to be improved.
  - 2-photon invariant mass spectrum shows π^0 peak clearly even at high multiplicity and high background condition.
  - The measured π^0 mass is 137MeV at peripheral events. Absolute energy calibration is consistent with 2% error.
- Hadron measurement
  - Hadron PID shows π/K separation up to 0.8GeV/c.
  - Observed energy is characterized for different particle and in different way over/under range.
  - Relative energy was calibrated by using energy of minimum ionization particle at 0.26GeV. The error is 3% dominated by statistical error.
  - The comparison with the AGS beam test are very similar.
  - The energy of minimum ionization particle is stable during the runs.