ϕ Meson Production in Au-Au Collisions at $\sqrt{s_{NN}}$=200 GeV

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For

PHENIX Collaboration

Outline

PHENIX

- Motivation
- Detector Setup
- Data Sample Selection
- Particle Identification
- Analysis Procedure
- ϕ Invariant Mass Reconstruction
- Summary

Motivation

- An enhanced ϕ-meson production has been suggested as a signature for the formation of a deconfined phase.

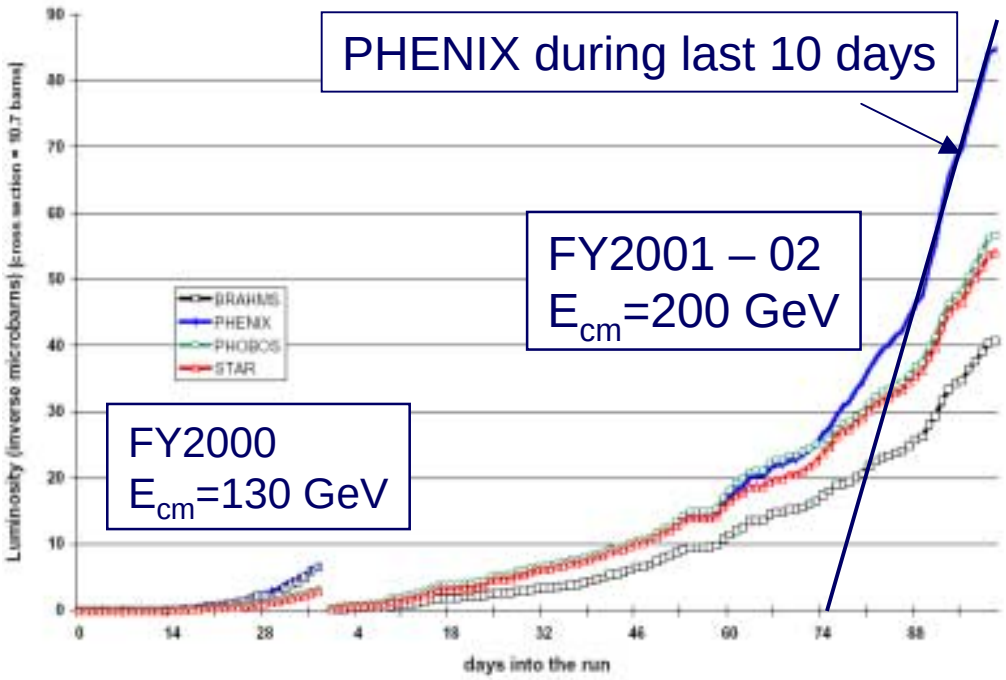
- Chiral symmetry restoration expected in heavy ion collisions may lead to medium modifications of ϕ-meson properties.

R. Rapp nucl-th/0204003

- The change in the branching ratio in leptonic and hadronic channels may point to the chiral symmetry restoration.

- The measurement of ϕ in K^+K^- channel combined with the measurement in the e^+e^- channel may be a good diagnostic tool of the new phase created in the heavy ion collisions.

Run Condition



RHIC Beam Delivered at PHENIX

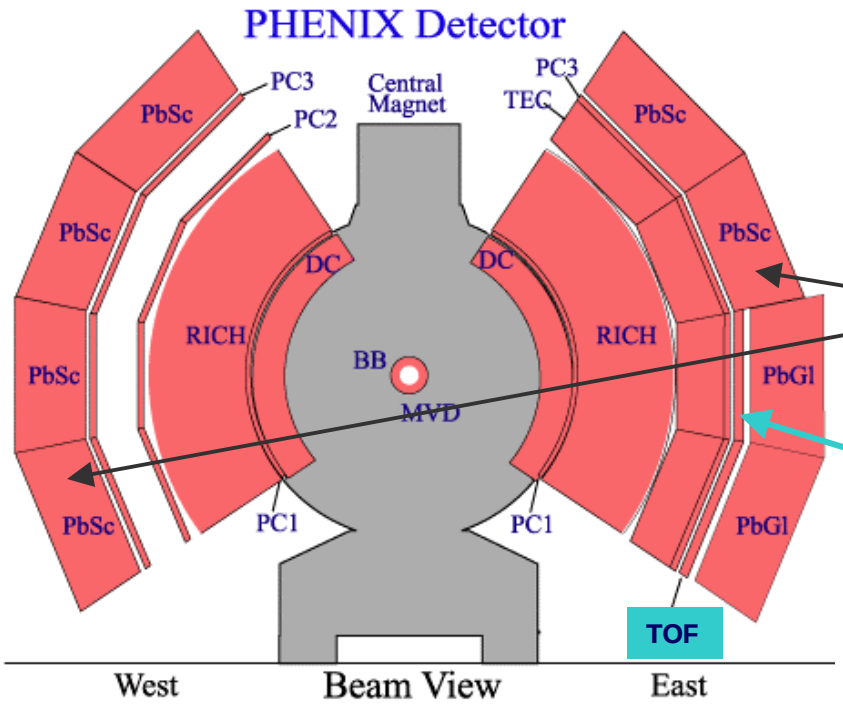
- At 42 μb^{-1}
- Over 50% of Data accumulated in the last two weeks of Au-Au Run

92 million min-bias data recorded for Au-Au Run

After imposing a ±30 cm vertex cut and strict data quality control, 20 millions minimum bias data were selected for this analysis

PHENIX in Run-II

- PHENIX Central Arm
  - Capable of Measuring hadrons, electrons and photons



Tracking:

Drift Chamber
Pad Chamber1
Pad Chamber3

Kaon Identification

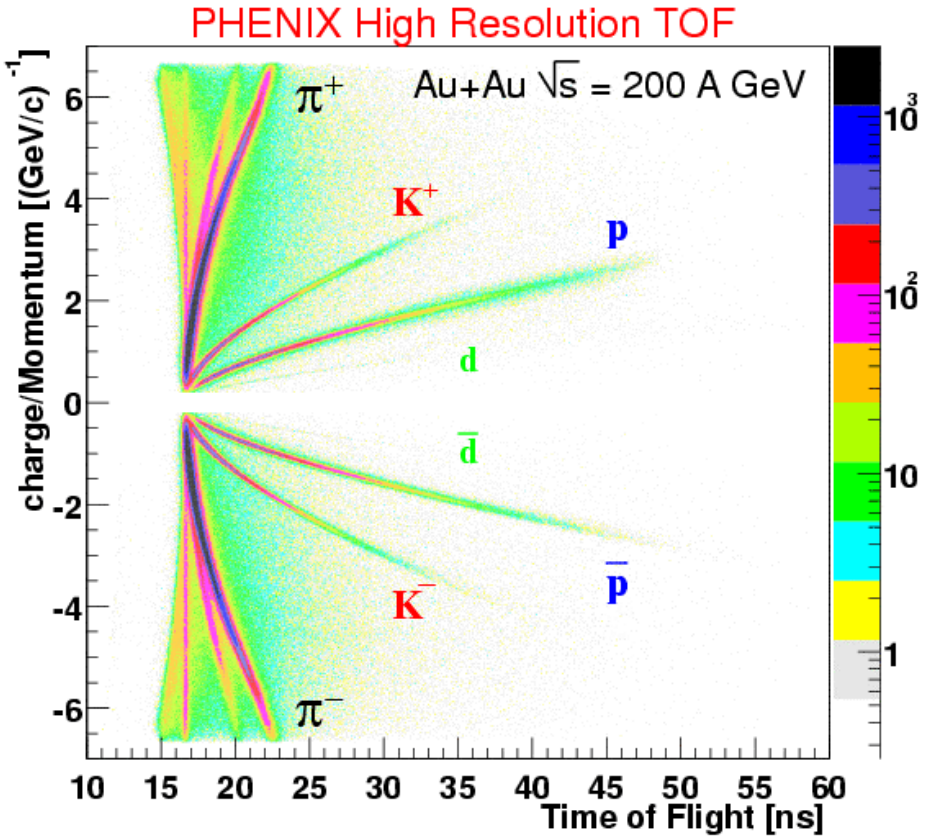
Electromagnetic Calorimeter

Time-of-Flight Detector

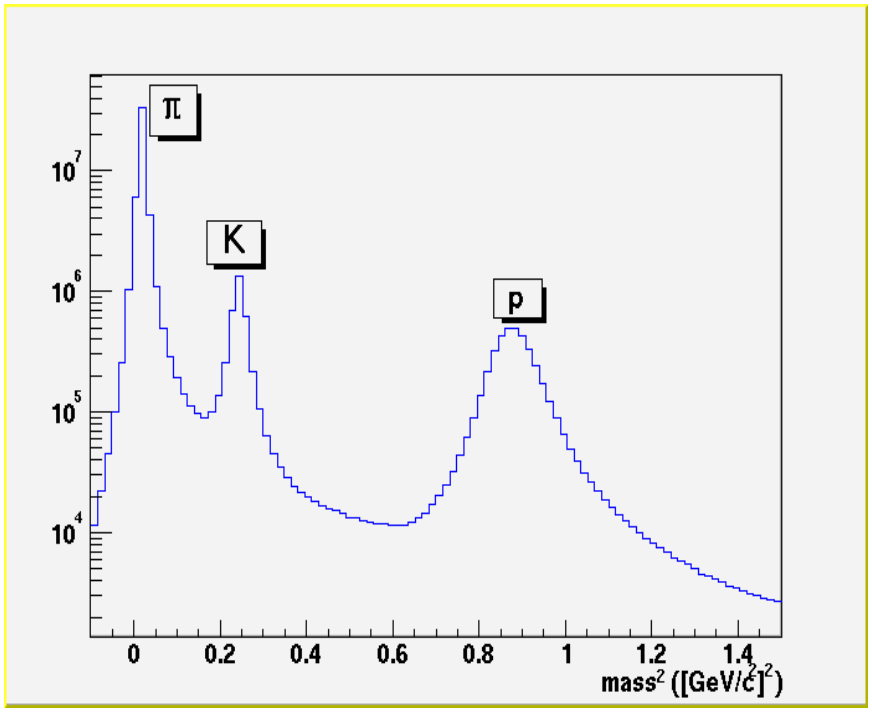
Excellent Particle Identification Capability

Particle Identification in TOF

Particle Identified through High Resolution Time-of-Flight Detector



Mass^2 of particles identified in TOF

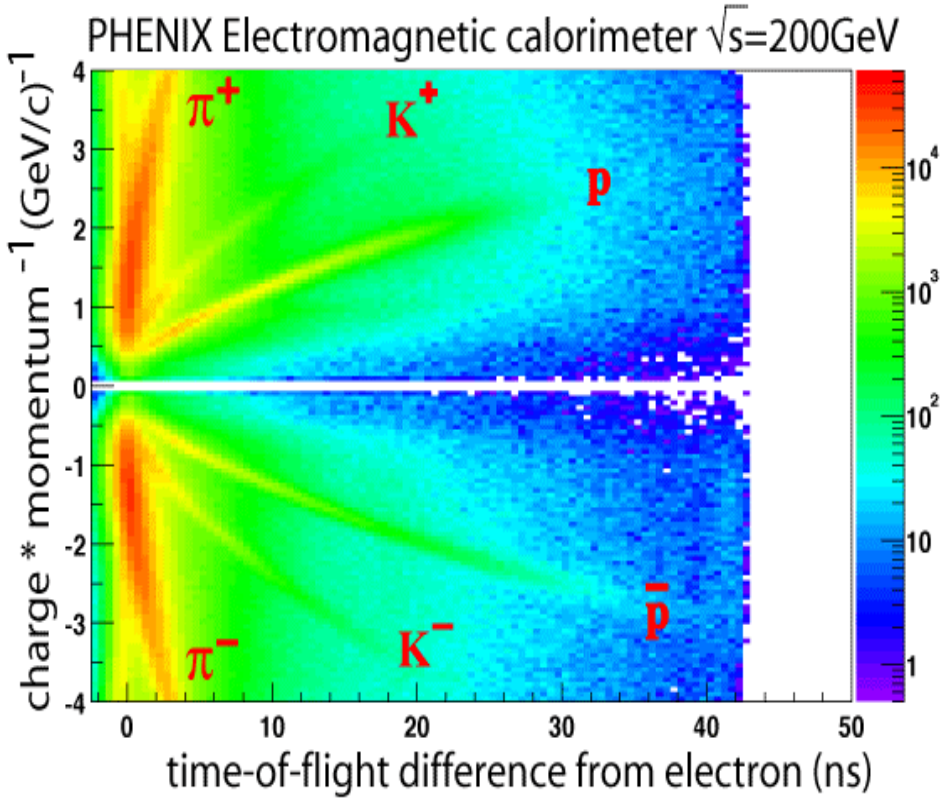


Timing resolution ~ 120ps

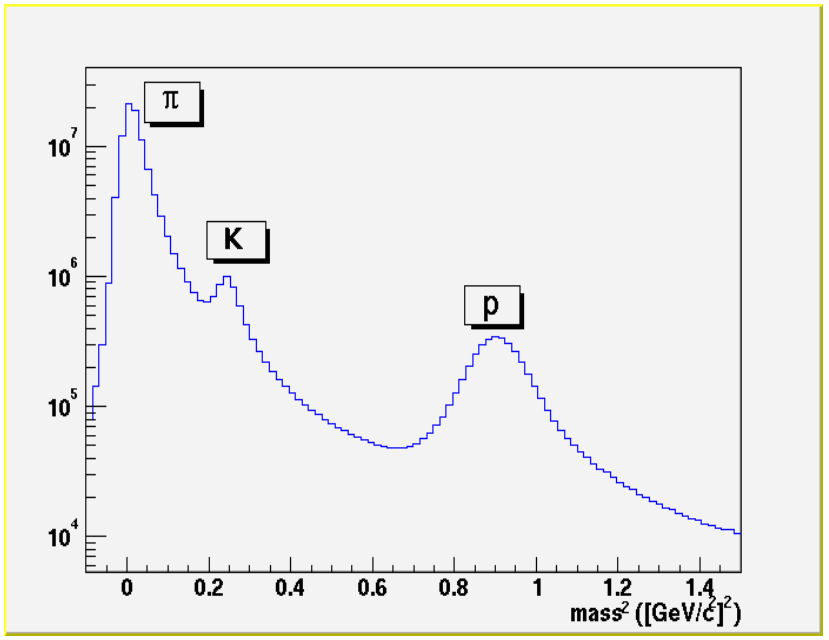
Kaon are well separated between 0.2<p<2.2 GeV/c

Particle Identification

Particle Identified through Electromagnetic Calorimeter



Mass^2 of particles identified in EMCal



Timing resolution ~ 480ps

Kaons are separated between 0.2<p<1.2 GeV/c

Data Sample

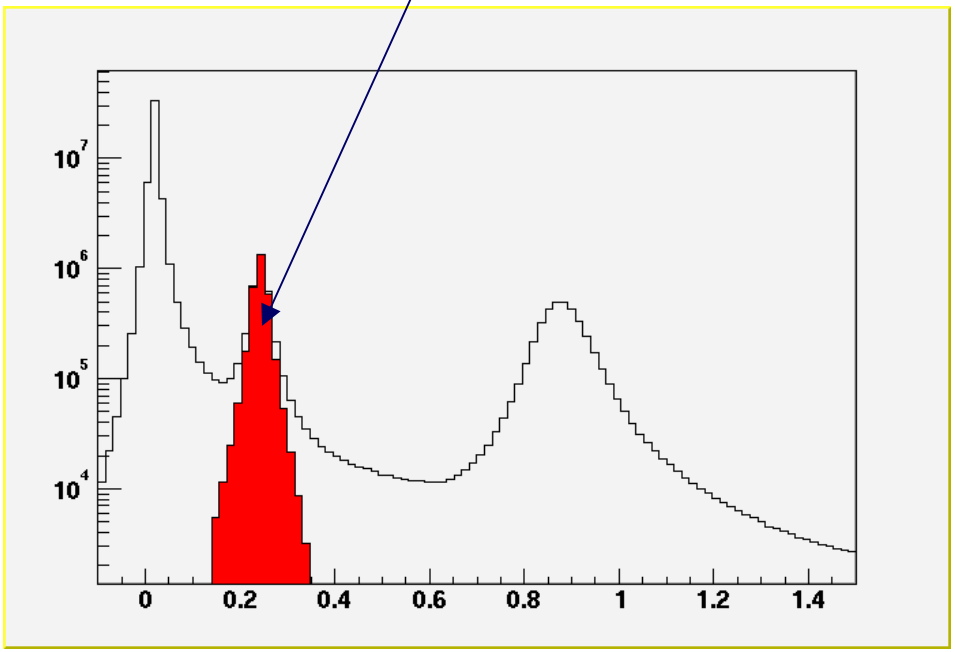
Particles identified in TOF and

East arm EMCal are used for this analysis

- **20 Million Minimum Bias Au+Au events.**
- **Track Selection**
  - **3σ matching between detectors.**
- **Momentum between 300MeV/c and 2.0 GeV/c for particles identified in TOF.**
- **Momentum between 300MeV/c and 1.0 GeV/c for identified in EMCal.**
- **2σ cut on the calibrated mass² of kaons.**

Mass squared of Particles are Calculated. Sample is selected on its mass² Distribution

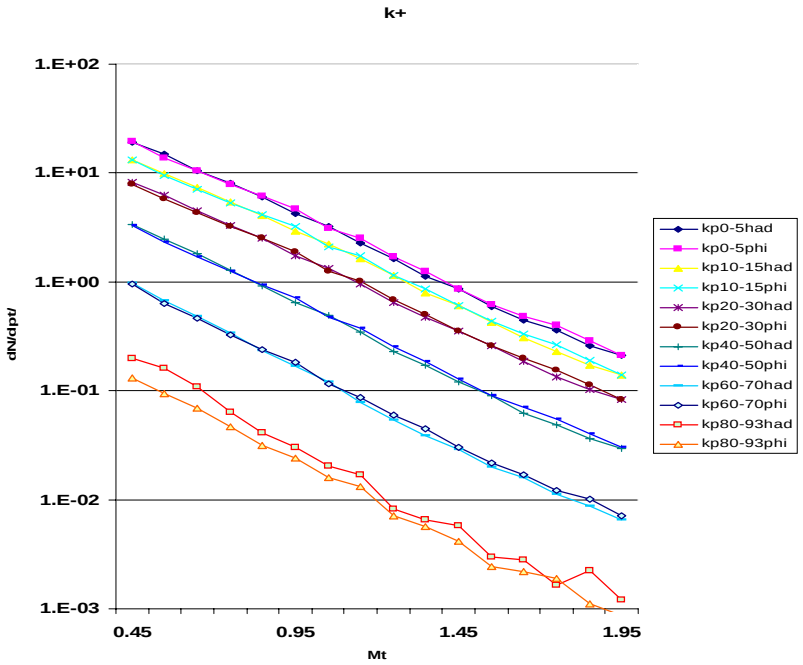
2σ around the peak of mass²

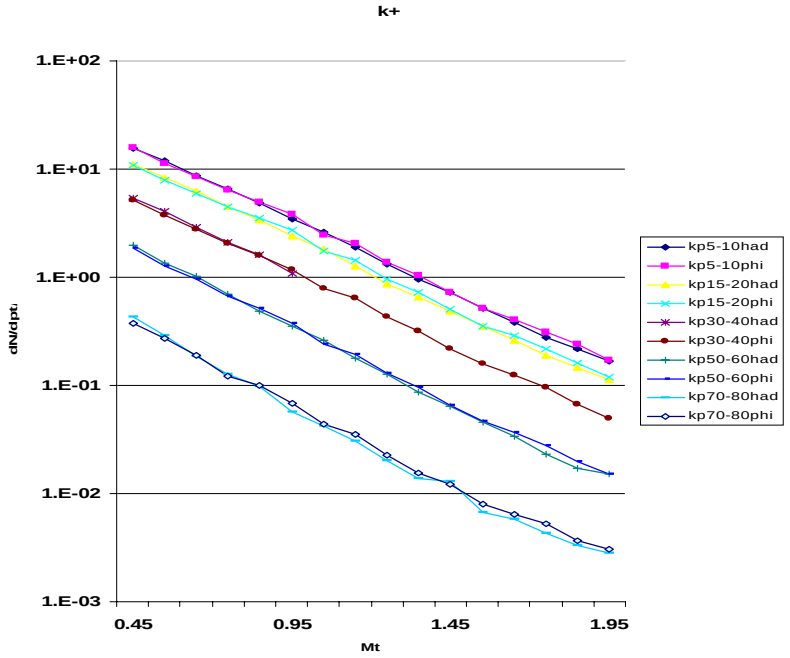


Analysis Procedure : Single Kaon Analysis

Inclusive Kaon analysis to compare with other kaon measurements in PHENIX

- **Kaons selected for ϕ analysis have different cut conditions than PHENIX preliminary results on kaon spectra**
- **Before starting ϕ analysis, we need to make sure that the kaon sample we selected agrees with other independent measurement of single kaon spectra**

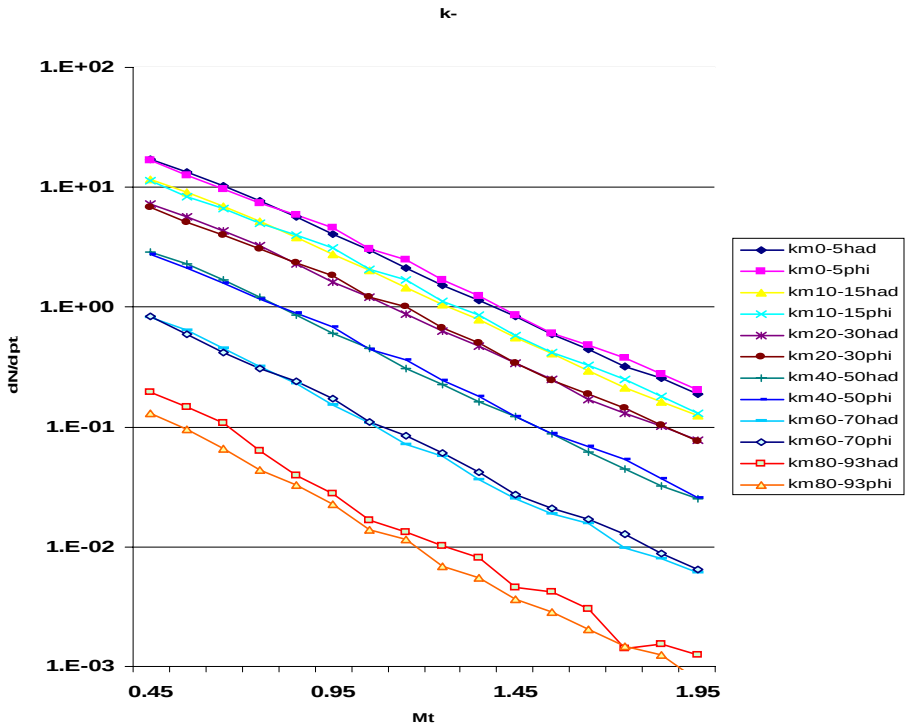


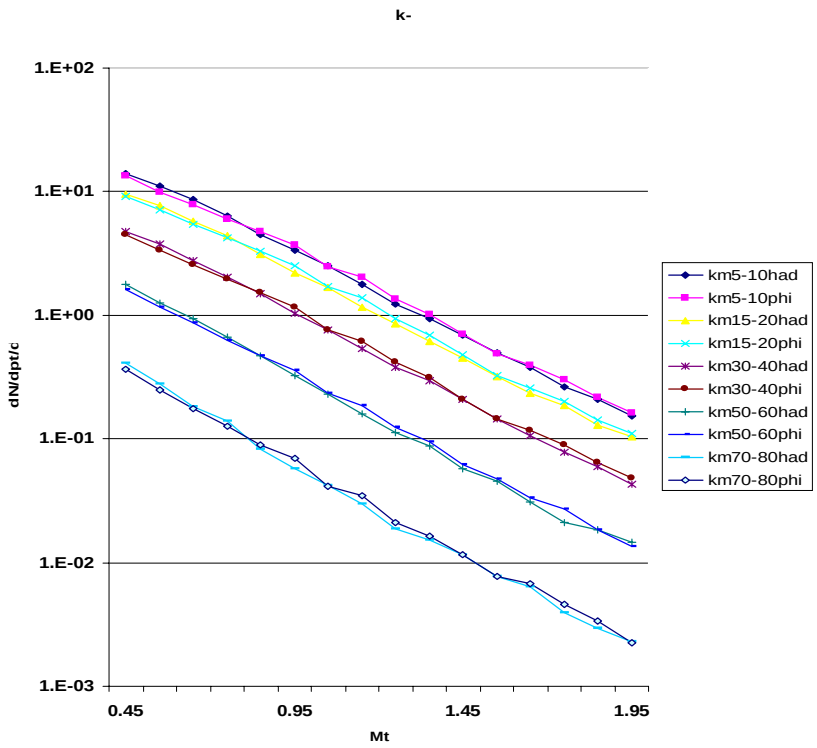


Points labeled as “had” represents the PHENIX Preliminary on single kaon spectra

Points labeled as “phi” are from this analysis

Single kaon Analysis continued





The yield and inverse slope parameters extracted in the two independent measurements agree well with each other.

This confirms the

- **Acceptance of kaons : PID, tracking**
- **Correction of efficiency loss due to high occupancy**
- **Run by run detector efficiency corrections**

Analysis Procedure

Momentum range of tracks are different in TOF and EMCal

We do three types of combinations

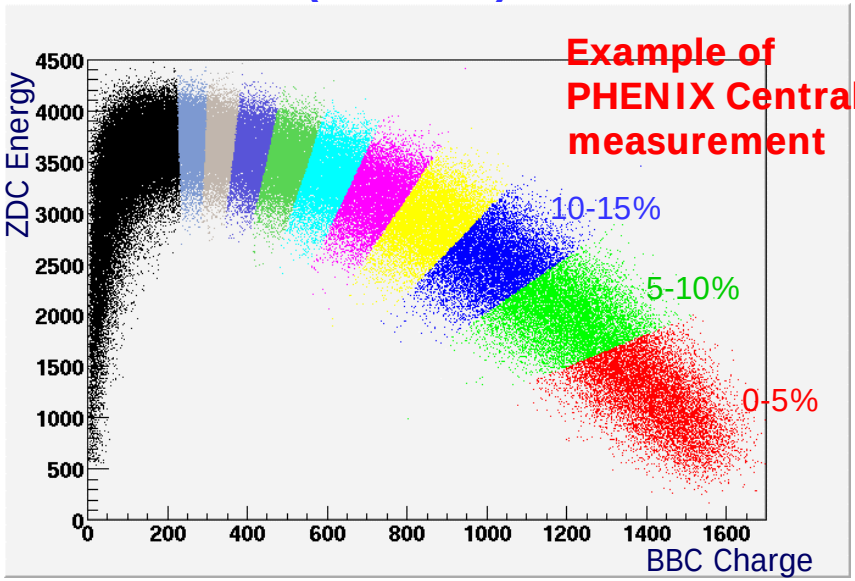
- **Both K^+ and K^- are identified in TOF (TOF-TOF)**
- **Both K^+ and K^- are identified in EMCal (EMC-EMC)**
- **One of the tracks identified in TOF and the other in EMCal (TOF-EMC)**

Vertex and centrality conditions on tracks:

-30cm < bbcz < 30cm , 0<centrality<93

For Mixing we divide data into

- **18 centrality bins from 0% in an increment of 5%, the last bin is 85%-92%**
- **15 vertex bins from –30 cm in an increment of 4 cm**



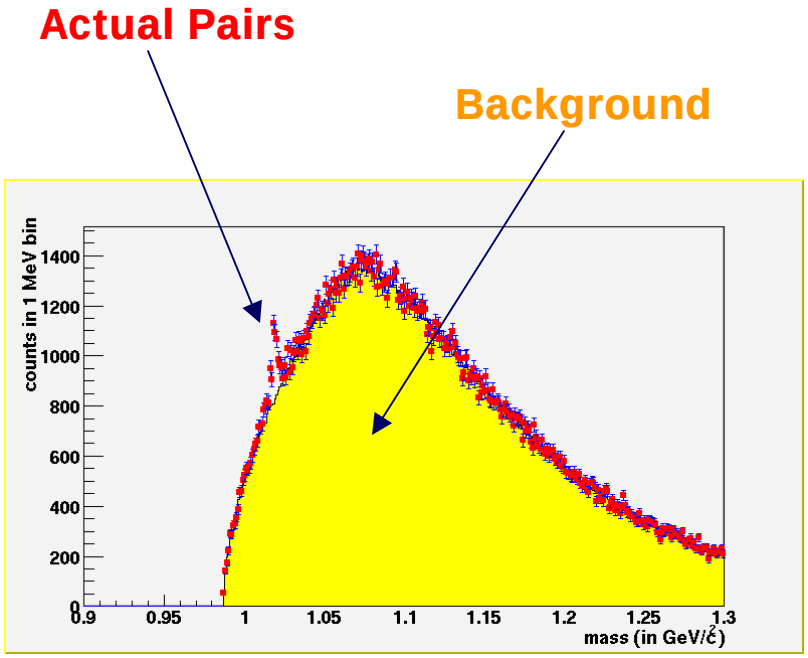
- **K^+ and K^- from same event are paired together to give Actual N_{+-}**
- **K^+ and K^- from different events, but from same centrality and vertex bins, are paired together to give Mixed N_{+-}**
- **Mixed N_{+-} Normalized by Actual Pair N_{++} and N_{--}as $CB=2\sqrt{(N_{++}.N_{--})}$, where CB stands for the combinatorial background**
- **Signal = Actual N_{+-} - CB**

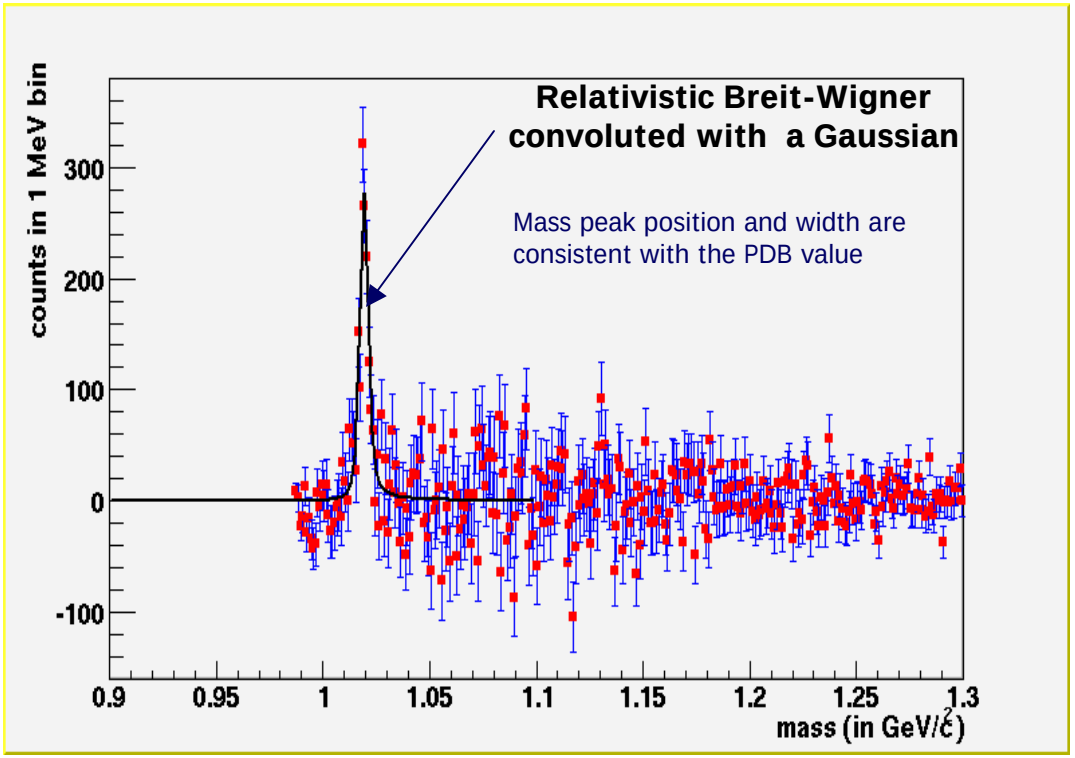
$\phi \longrightarrow K^+K^-$ Signal from the TOF-TOF Pairs

ϕ signal : 1410±131

(within the window of $1.014 < m_\phi < 1.024$)

S/B = 1/6



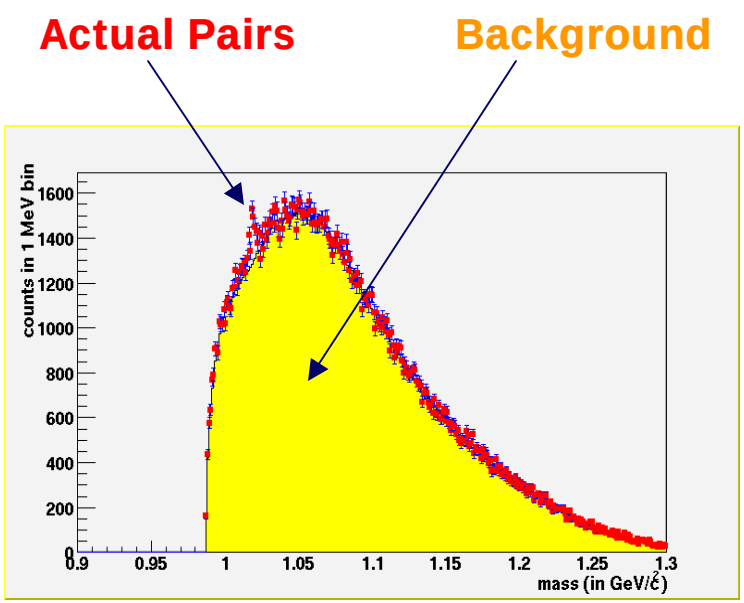


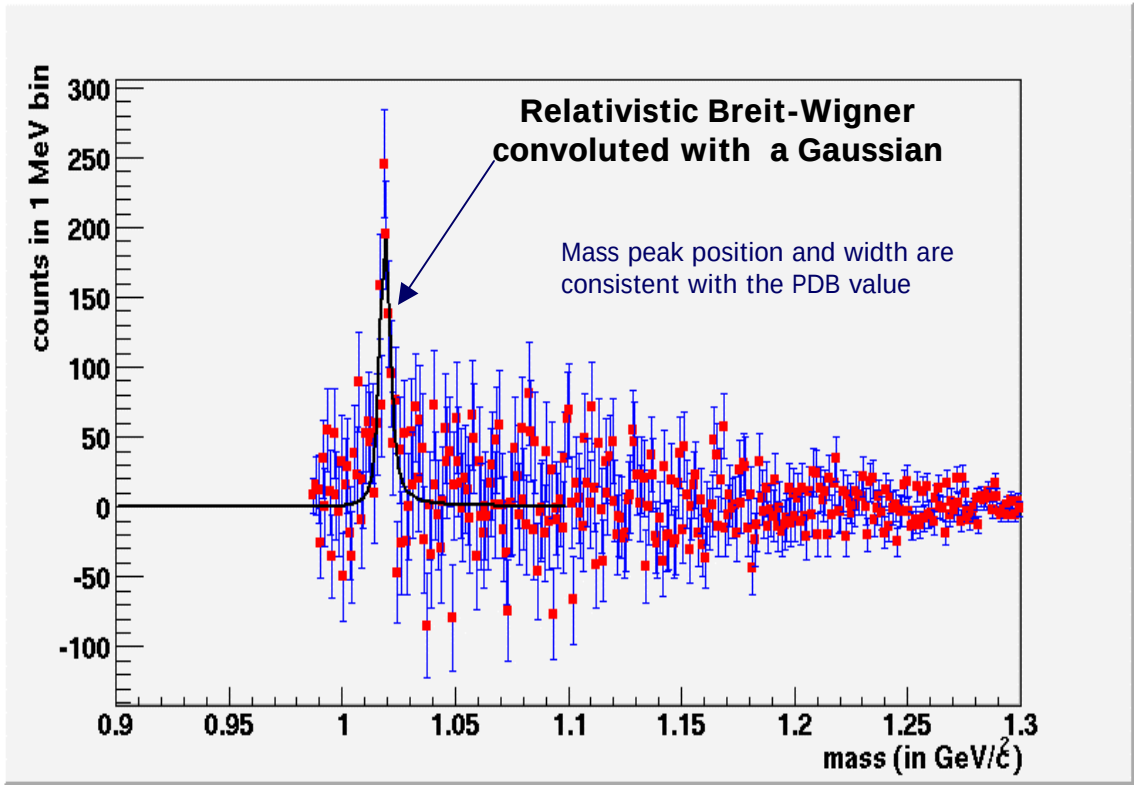
$\phi \longrightarrow K^+K^-$ Signal from the EMC-EMC Pairs

ϕ signal : 1095±118

(within the window of $1.014 < m_\phi < 1.024$)

S/B = 1/12



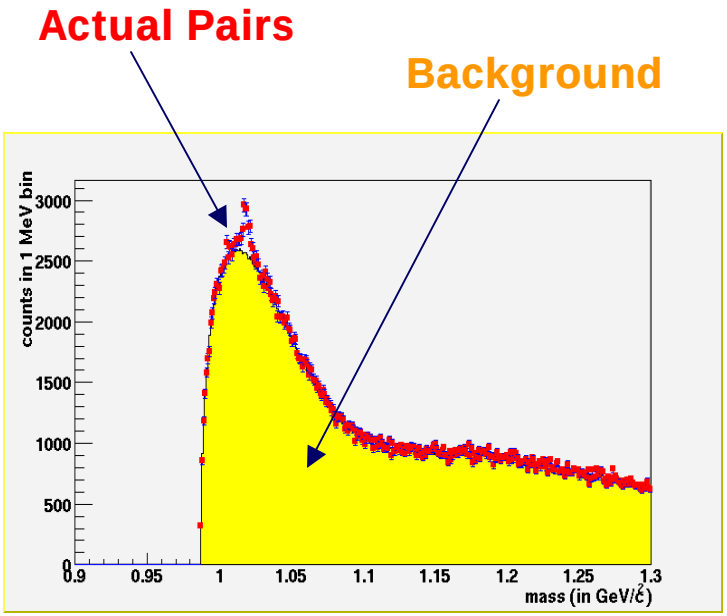


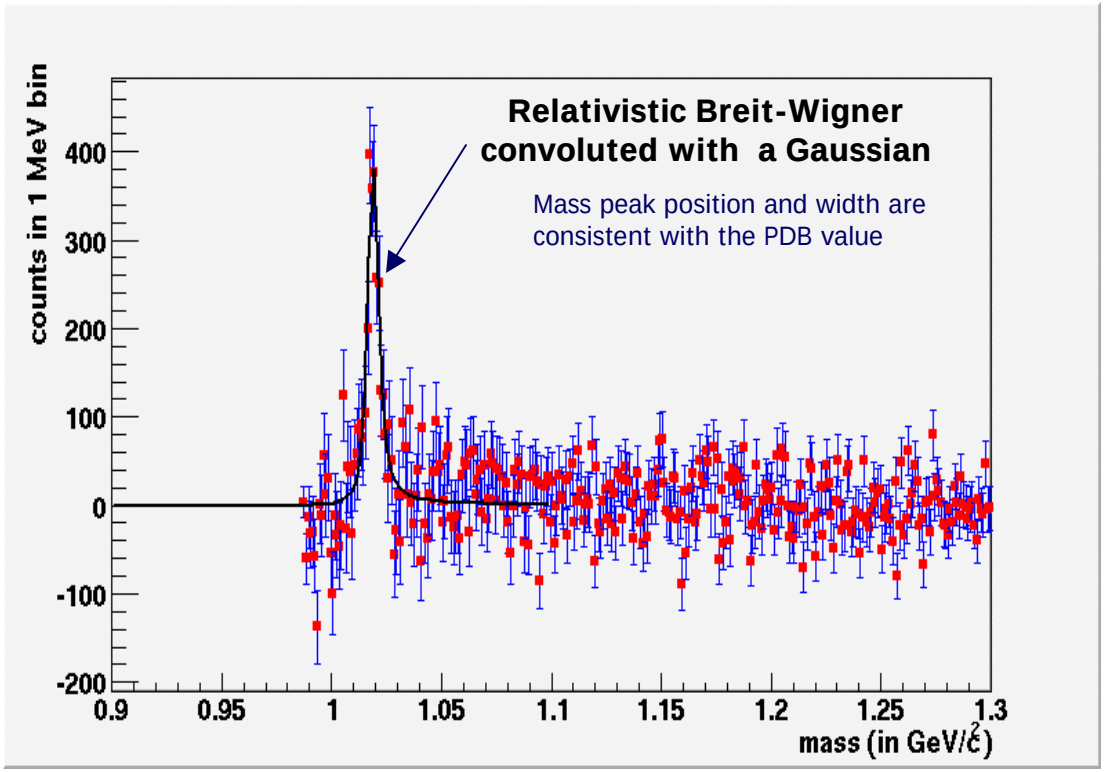
$\phi \longrightarrow K^+K^-$ Signal from the TOF-EMC Pairs

ϕ signal : 2276±217

(within the window of $1.014 < m_\phi < 1.024$)

S/B = 1/11





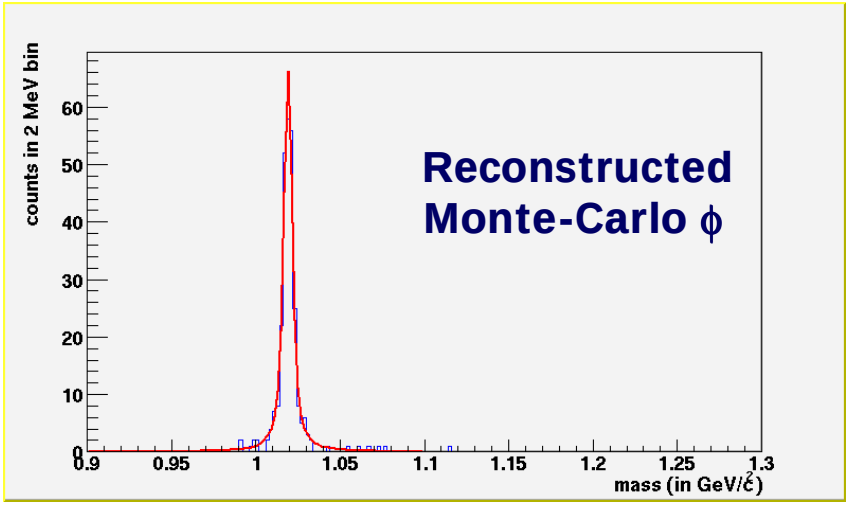
Acceptance Correction

PHENIX

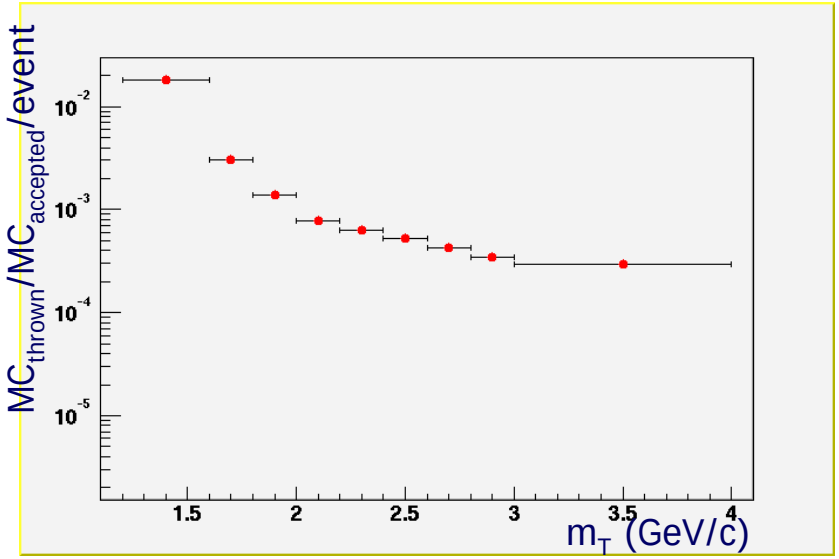
ϕ Generator

$$\frac{dN}{dp_T} = p_T \exp\left(-\frac{m_T}{T}\right)$$

-0.6<y<0.6, 0<ϕ<2π, T=320MeV



Acceptance Correction vs m_T



Other Corrections

- Correction for efficiency loss due to high occupancy
- Run by run detector efficiency correction

What is Coming up?

- PHENIX Preliminary dN/dy is 2.01±0.22(*stat*) $^{+1.01}_{-0.52}$ (*systematic*). Since then
  - Included higher statistics EMCal
  - More strict quality control on data
- These enables us to extract dN/dy and inverse slope parameter of ϕ with better precision.
- The final result will be published soon.

Summary

- ϕ mesons are reconstructed via K^+K^- channel for the Au-Au Collisions at $\sqrt{S_{NN}}$=200GeV.
- Higher statistics Electromagnetic Calorimeter is included.
- An excellent detector mass resolution allows us to measure the mass centroid and width of ϕ.
- m_T spectra of ϕ are being studied as function of centrality.
  - Higher statistics enables us to extract the ϕ yield and inverse slope parameters with better precision.
- Results will be published soon.