Optimizing the Reconstruction of ϕ Mesons in K^+K^- Decays with the PHENIX Experiment at RHIC

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for

PHENIX Collaboration

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Motivation

The Main goal of the Heavy Ion Program at RHIC

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- Identification of experimental signals from potential phase transitions in strongly interacting matter associated with deconfinement or chiral symmetry restoration

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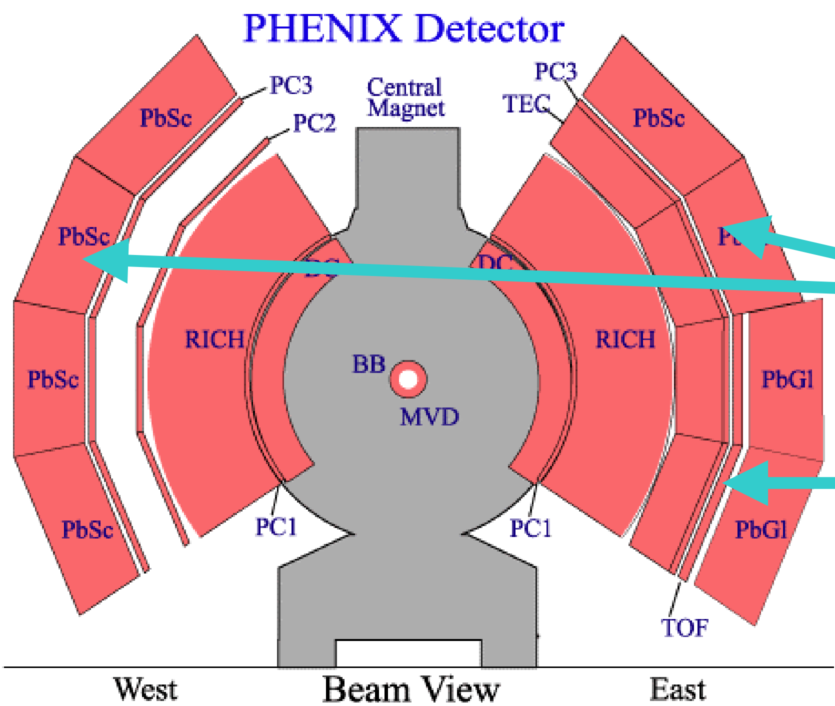
- An enhanced ϕ-meson production has been suggested as a signature for the formation of a deconfined phase
- Medium modifications of ϕ-meson properties might be related to the expected chiral phase transition
- The change in the branching ratio in leptonic and hadronic channels may point to the chiral symmetry restoration.

PHENIX in Run-2



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

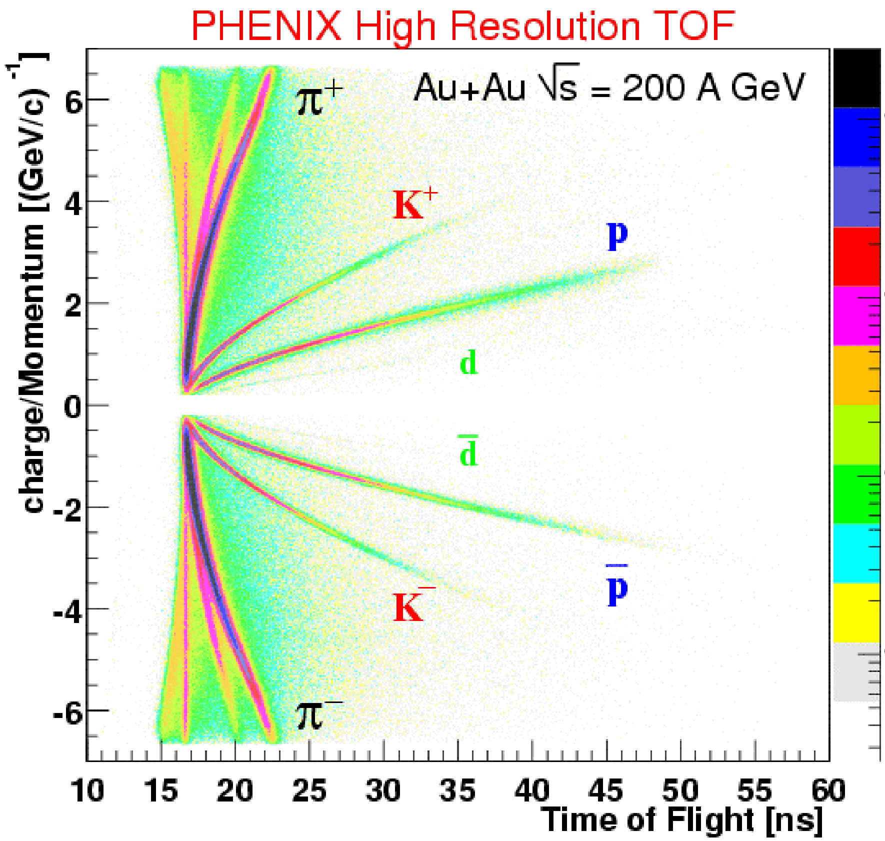
Electromagnetic Calorimeter

Time-of-Flight Detector

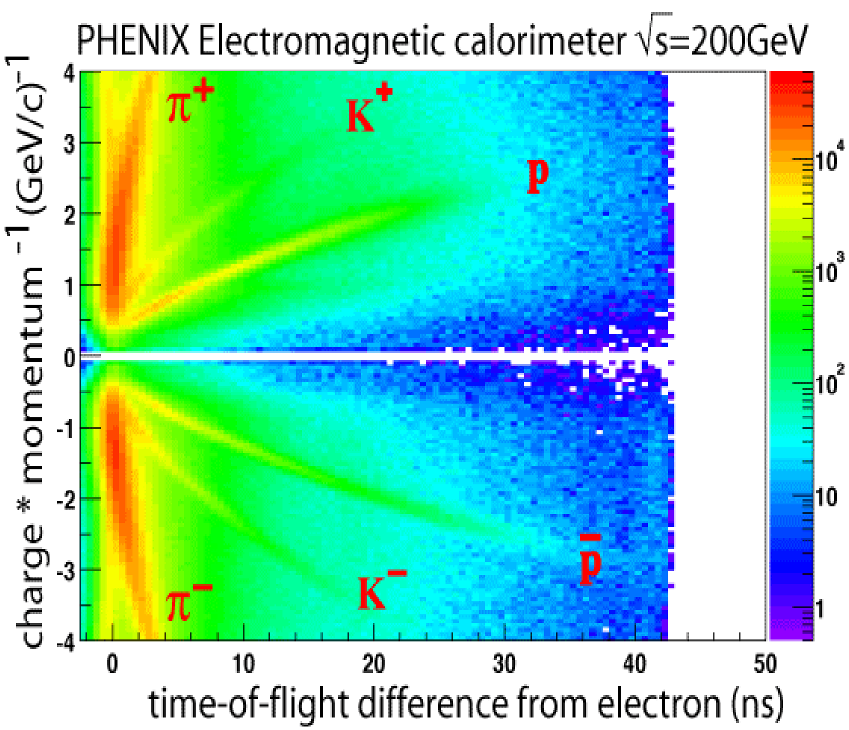
Excellent Particle Identification Capability

Particle Identification

Particle Identified through High Resolution Time-of-Flight Detector



Particle Identified through Electromagnetic Calorimeter

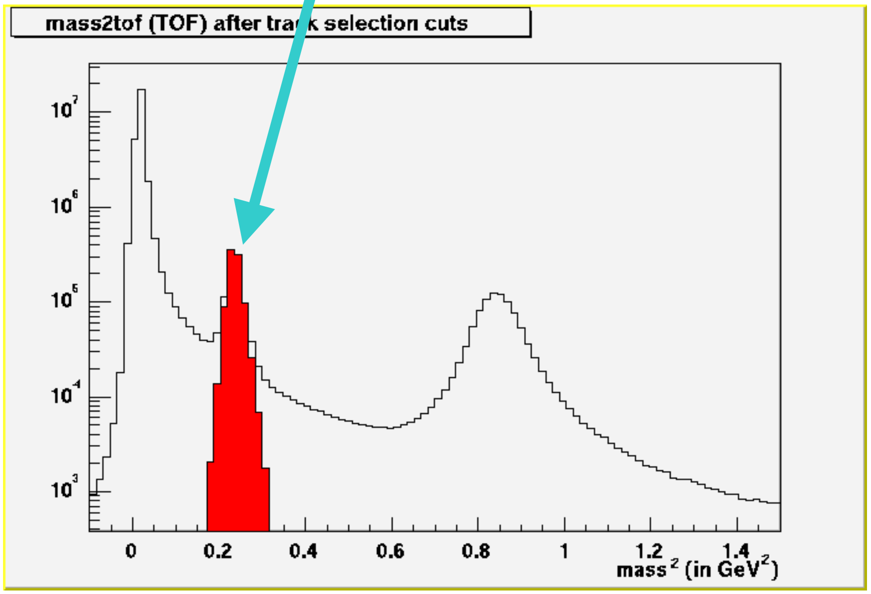


Data Sample Selection

- 25 Million Minimum Bias Au+Au events
- Track Selection
  - 3 σ track projection matching at PC3
  - 3 σ matching on PC3
  - Best quality DC tracks
- Energy Loss in TOF > 2 MeV
- Momentum between 200MeV/c and 1.2 GeV/c in Time of Flight
- Momentum upto 900 MeV/c in EMCal
- 3σ cut on the calibrated mass^2 of kaon
- 5σ above the Pion mass^2 band

Mass squared of Particles are Calculated. Sample is selected on its mass^2 Distribution

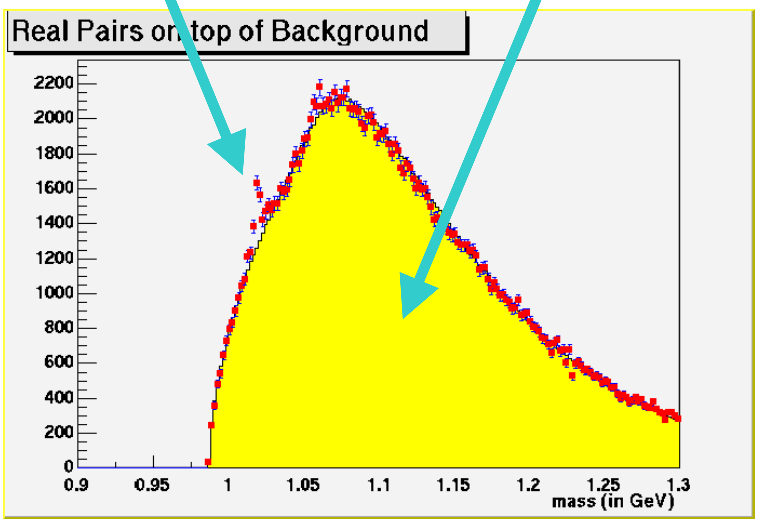
3σ around the peak of mass^2



ϕ Invariant Mass

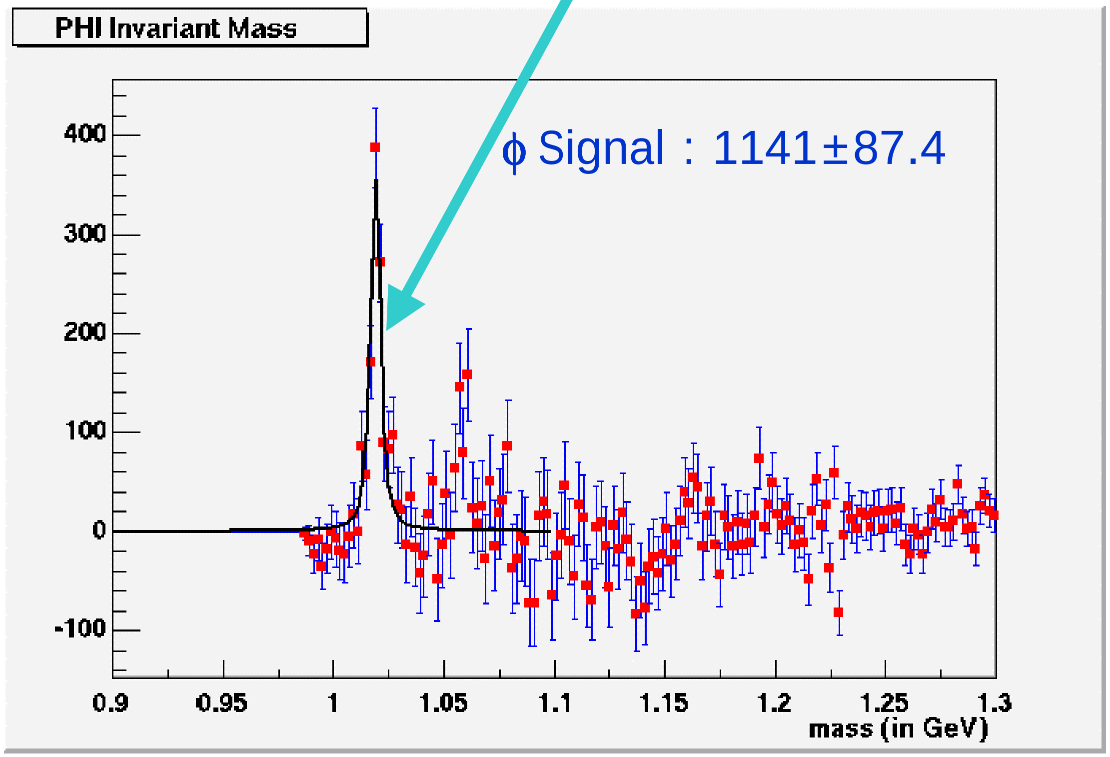
Actual pairs

Mixed background



Mixed N_{+-} Normalized by Actual Pair N_{++} and N_{--} as $2\sqrt{(N_{++}.N_{--})}$

Fit with a Breit-Wigner Convoluted with a Gaussian

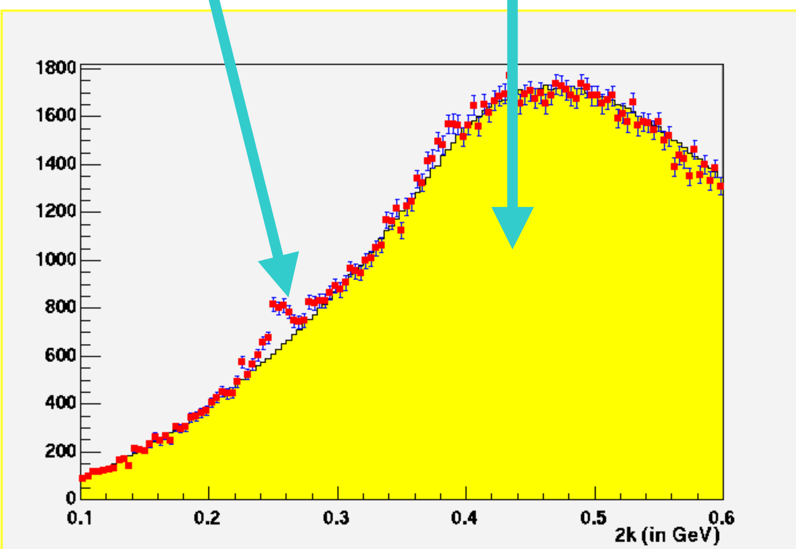


ϕ Invariant 2k

Another approach to extract ϕ signal by looking at the difference of 4-momenta of kaons: $k = \sqrt{(p_{1\mu}-p_{2\mu})^2}$

Actual pairs

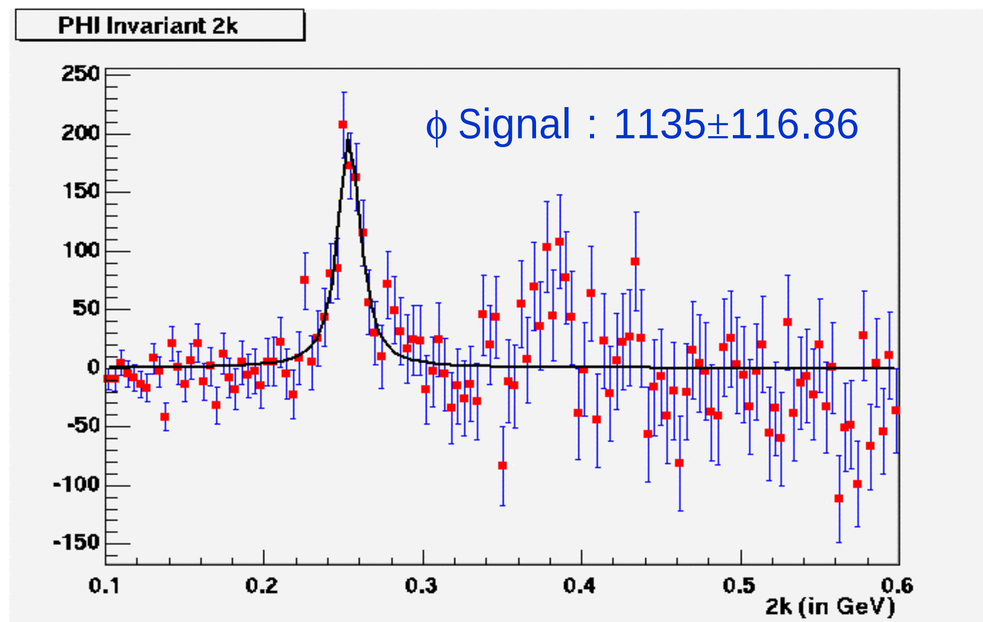
Mixed background



Mixed N_{+-} Normalized by Actual Pair N_{++} and N_{--} as $2\sqrt{(N_{++}.N_{--})}$

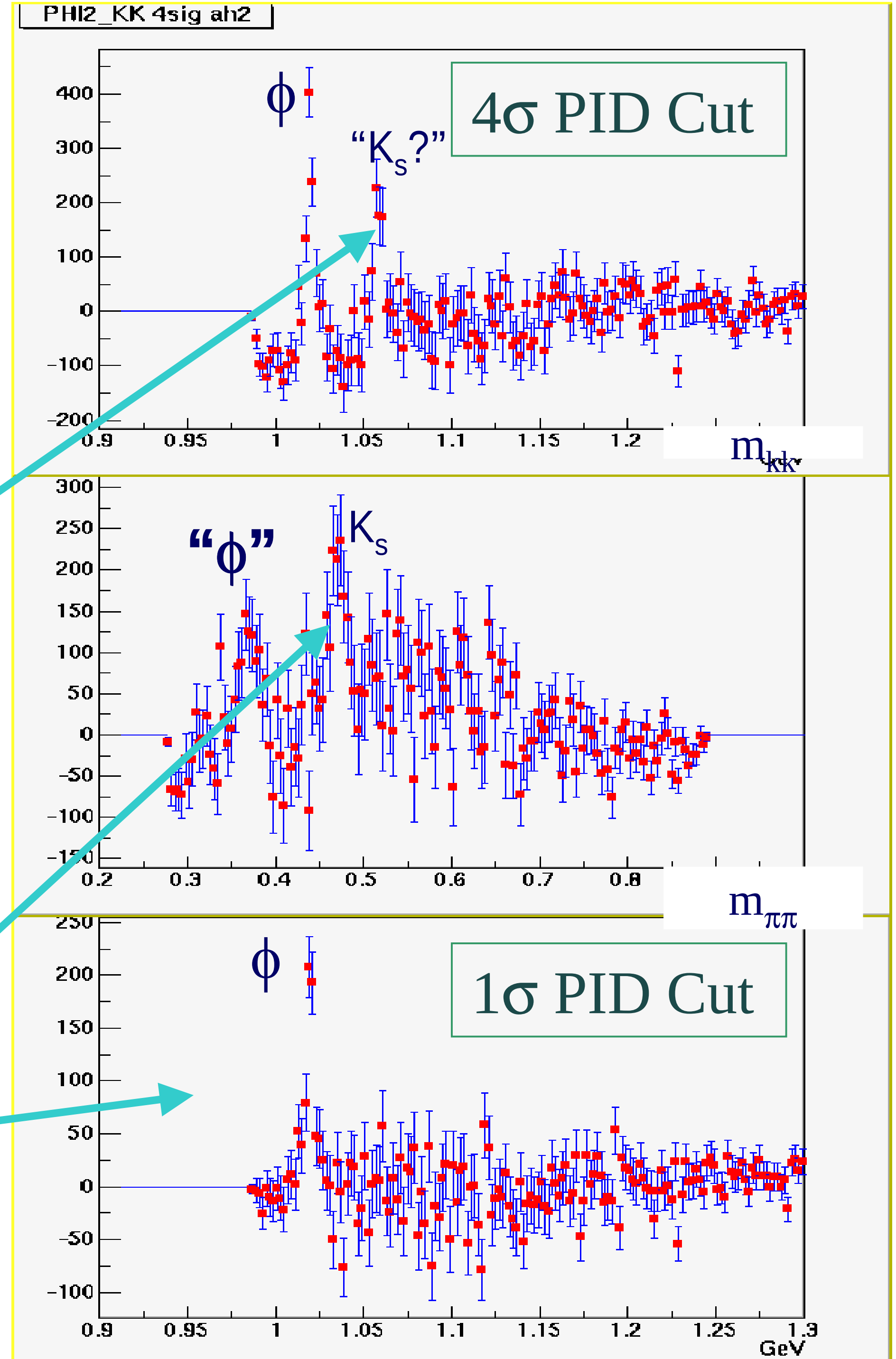
Advantages:

- **Pushes the ϕ peak away from the kinematic edge**
- **Puts any correlated pairs into a different region of phase space**



Background above ϕ

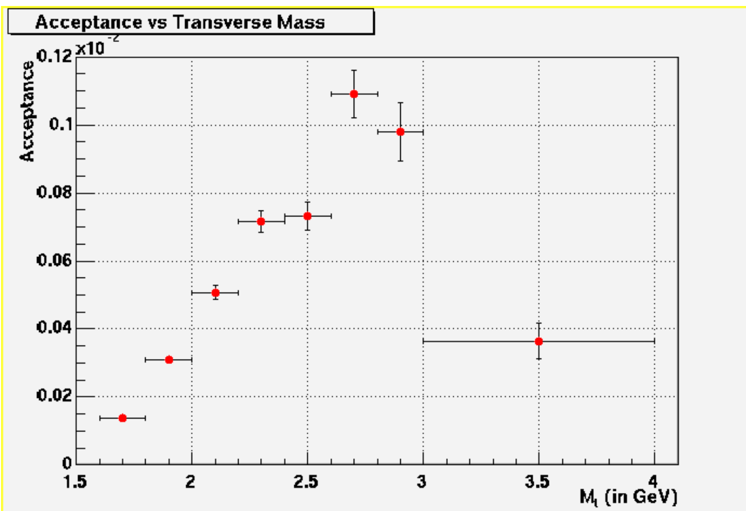
- Investigate background above ϕ, m~1.07 GeV
  - Make looser PID cut (4σ)
  - Subtraction done by normalizing to region above peak
  - Larger contamination from secondary peak
- K_s from misidentified momentum in the TOF array?
  - Reconstruct mass assuming particles are pions
  - Peak shows up at ~494 MeV ~M_K
- Make a tighter PID cut 1σ
  - Extra mass peak largely disappears



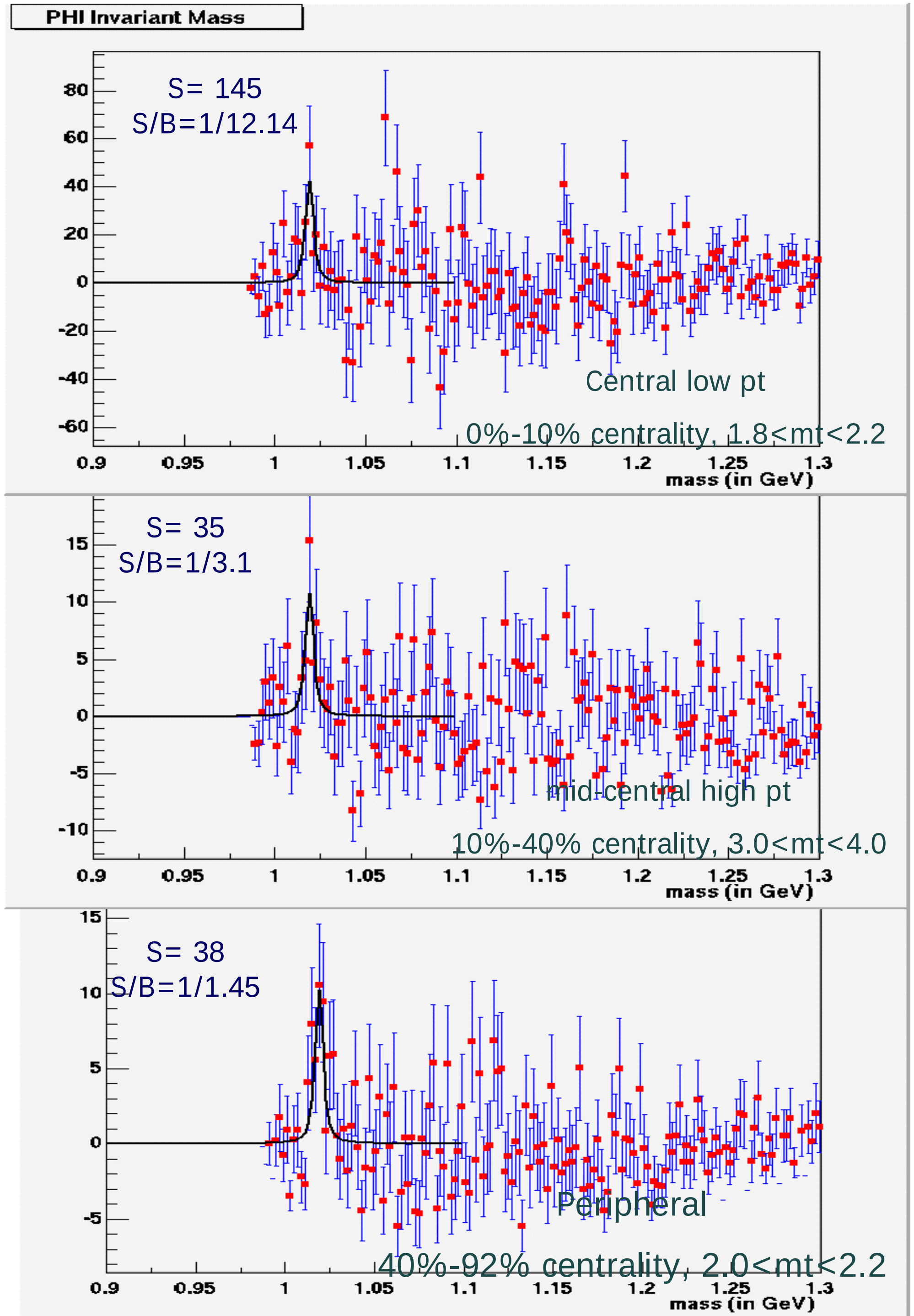
Acceptance vs m_t

- 3 Centrality Classes

  0%-10%, 10%-40%, 40%-92%
- 8 M_t Bins 1.6-1.8,1.8-2.0,2.0-2.2,2.2-2.4,2.4-2.6,2.6-2.8,2.8-3.0,3.0-4.0
- Fitting for each centrality and M_t bins are done by fixing the values of mass and Γ from the fit of min bias, and letting the constant free.



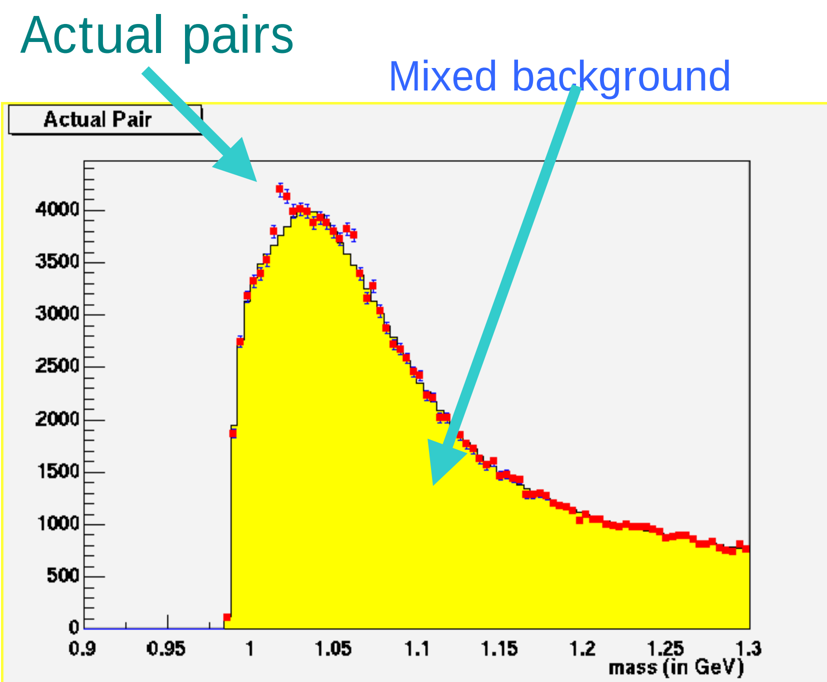
Work in progress toward m_t distribution

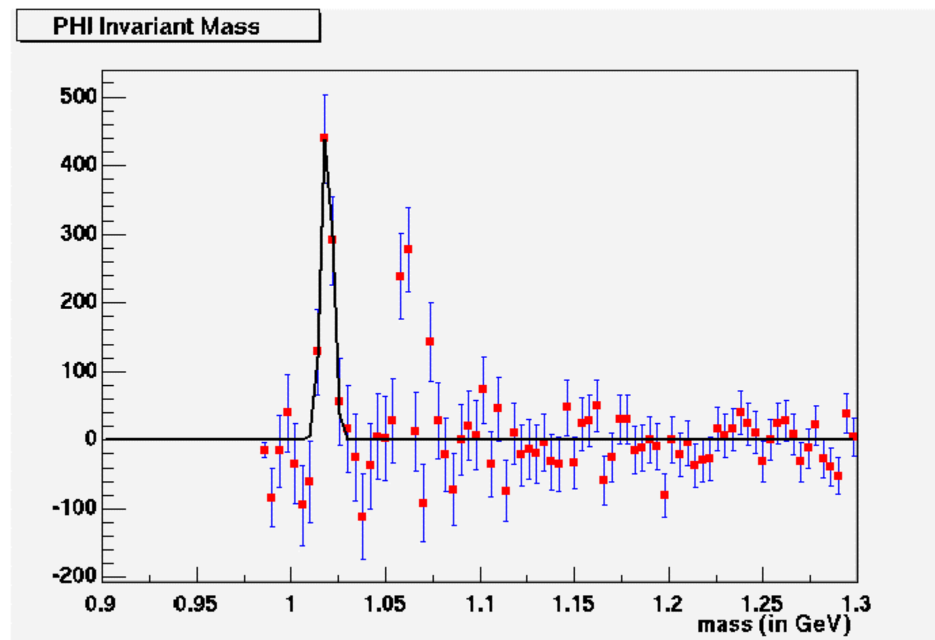


ϕ Invariant Mass in EMCal

Advantages:

- **Large Acceptance**
- **Kaons accepted upto p<900 Mev**
- **Complements the TOF measurements in the low m_t region**





Summary

- Using the excellent PID capability of PHENIX Time of Flight Detector ϕ is reconstructed via K^+K^- channel for the Au-Au Collisions at $\sqrt{S_{NN}}$=200GeV.
- The mass is fitted with a Breit-Wigner Convoluted with a Gaussian with a resolution of 1.2 MeV determined from simulation. The preliminary fit values for the mass and Γ agrees well the PDB values. The systematic errors on these numbers are still under investigation.
- With the available statistics 3 bins of centrality and 8 bins in m_t could be made which enabled us to study the yield of ϕ. This analysis is still in progress.
- It has been demonstrated that ϕ can be reconstructed through Electromagnetic Calorimeter. This will enable us to accumulate more statistics and probe into the low m_t region.