



Line Shape Analysis for the $\phi \rightarrow K^+K^-$ in Au+Au at $s_{NN} = 200$ GeV

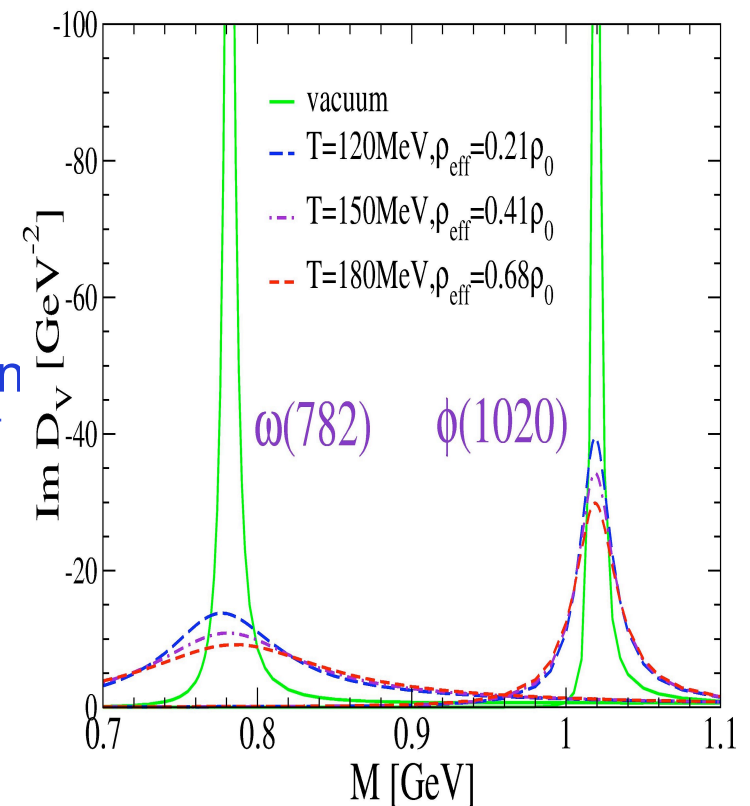
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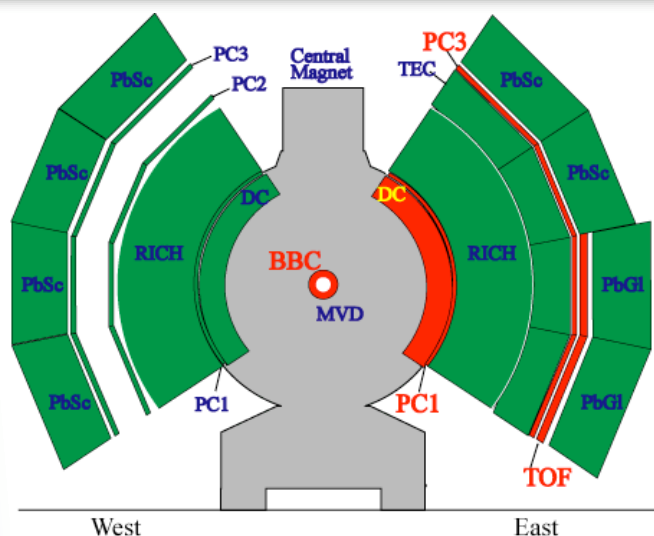
- Motivation for the study of the ϕ at RHIC
- Description of PHENIX particle identification system
- Simulations of the ϕ pair mass resolution
- Signal spectra observed in PHENIX
- Summary of preliminary results

- Restoration of approximate chiral symmetry may modify the ϕ mass and width in medium
 - Mass = 1019.456 +/- 0.020 MeV (PDG 2002)
Breit-Wigner $\Gamma = 4.26 \pm 0.05$ MeV
 - Look for variations with centrality
 - Compare to p+p and d+A results
- These modifications may result in a change in the branching fraction of $\phi \rightarrow K^+K^-$ and $\phi \rightarrow e^+e^-$ when the ϕ decays in medium ($t_\phi \sim 44$ fm/c)
 - Compare different pair p_T ranges
- Final state interactions of kaons may lower the apparent measured branching fraction of $\phi \rightarrow K^+K^-$ relative to $\phi \rightarrow e^+e^-$
 - Measure both channels in the same detector

R. Rapp nucl-th/0204003



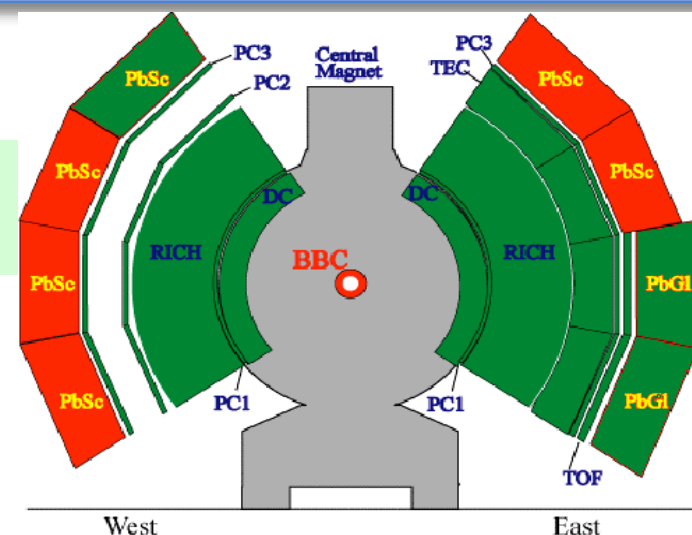
Detecting π^\pm , K^\pm , p^\pm in PHENIX



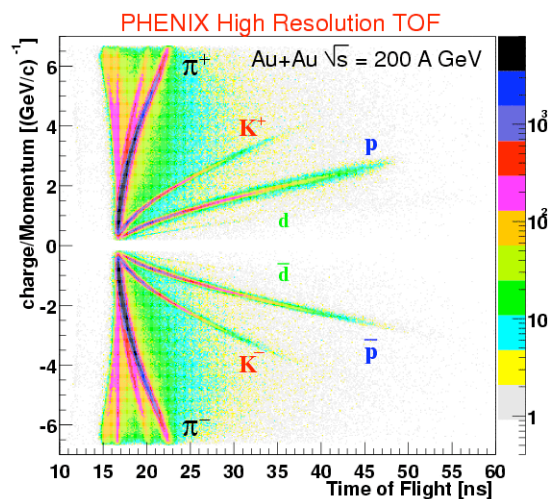
TOF resolution 120 ps

momentum resolution
 $\Delta p/p \sim 1\% \oplus 1\% p$

Inclusive identified
 hadron spectra use
 TOF in East Arm

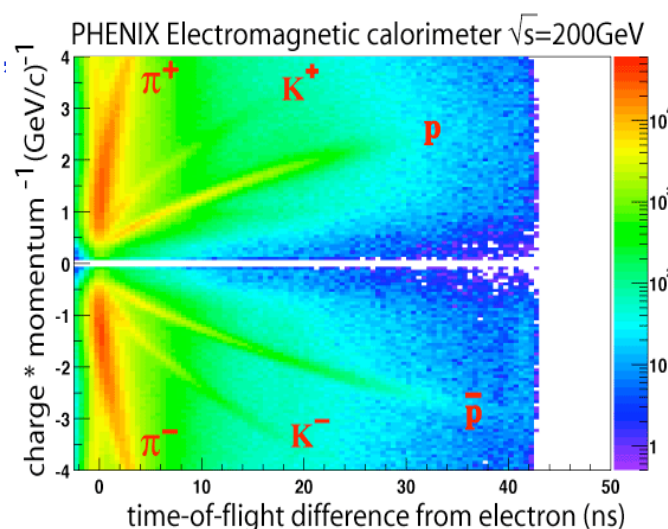


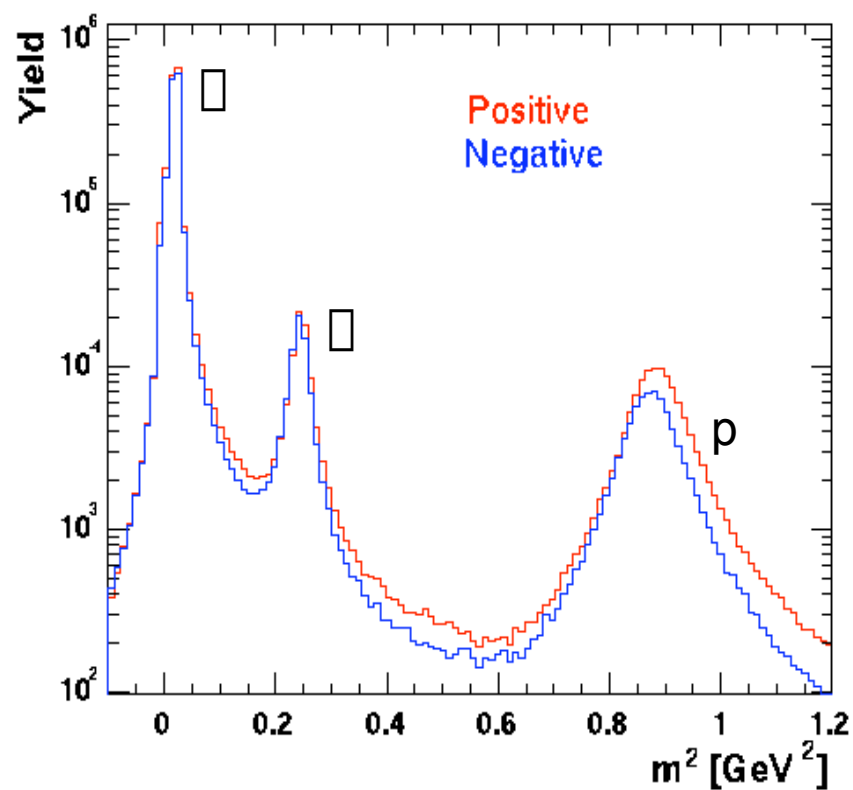
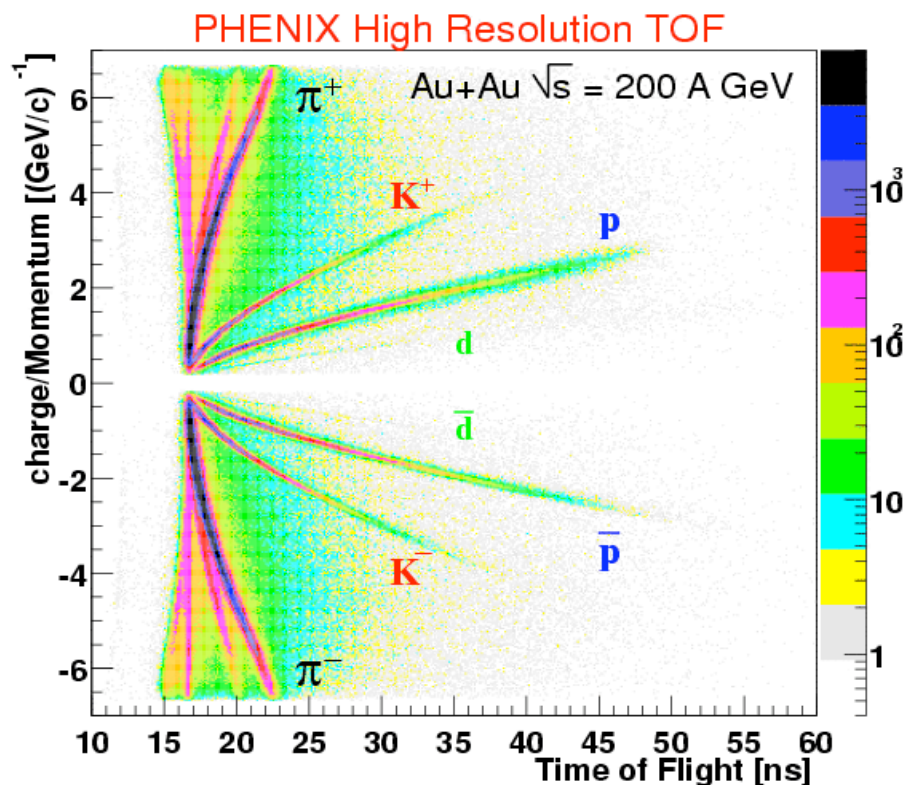
EMCal resolution 450 ps



$\pi \rightarrow K^+ K^-$ uses TOF-TOF,
 EMCal-EMCal, and
 TOF-EMCal in East

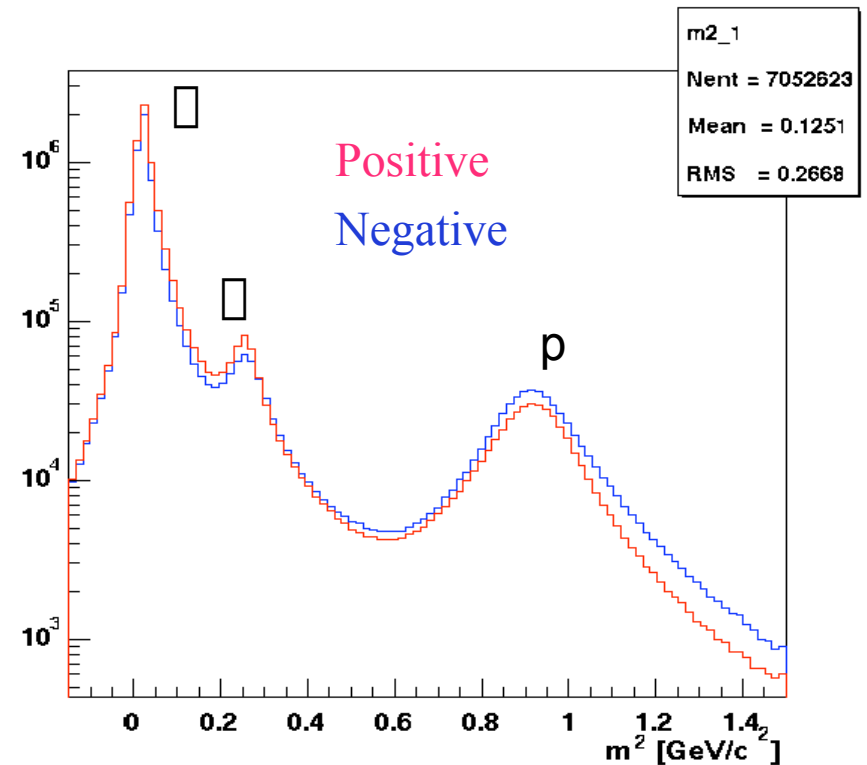
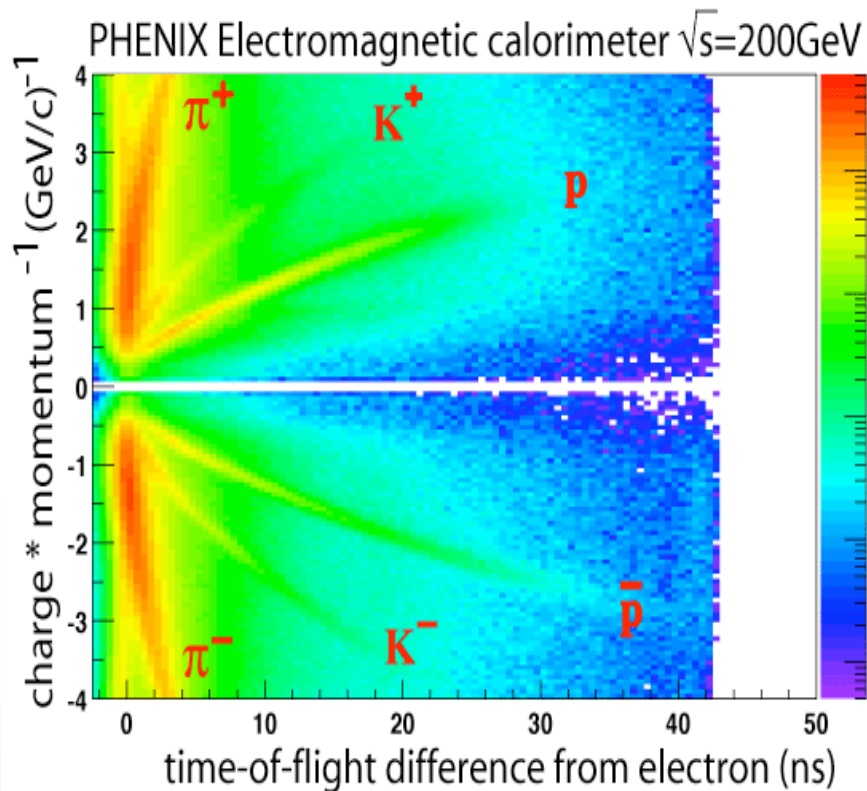
$\pi \rightarrow e^+ e^-$ uses RICH,
 EMCal-EMCal in
 East-West, East-East,
 and West-West





TOF timing resolution: $\Delta t \sim 120$ ps

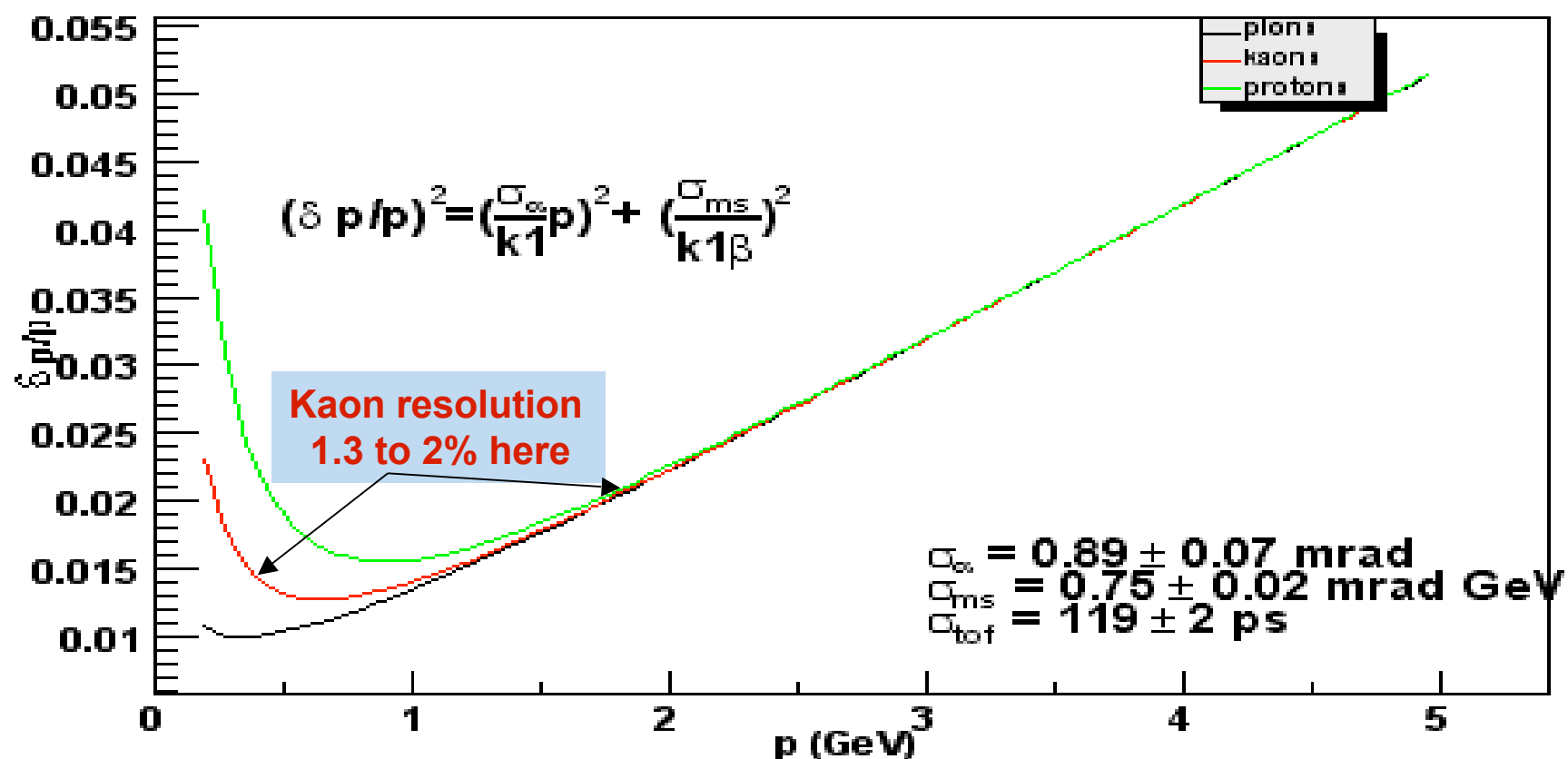
K/ π separation up to 2.0 GeV/c



EMCAL resolution: $\Delta_t \sim 450$ ps

K/ π well separated for $0.3 < p$ [GeV/c] < 1.0

Momentum resolution



- **Fast Monte Carlo Software**

- ♦ Generate single ϕ meson events thrown into the complete PHENIX East Arm acceptance
- ♦ Decay Kaon momenta are randomized in momentum magnitude
- ♦ Randomization ϕ taken from studies of single particle mass resolution studies of identified hadrons
- ♦ Pairs are reconstructed with altered Kaon momenta

- **Algorithm**

$$M^2 = (E_1 + E_2)^2 - p_1^2 - p_2^2 - 2p_1 * p_2 * \cos(\phi_{12})$$

$$E^2 = m_K^2 + p^2$$

Randomize each momentum magnitude p according to:

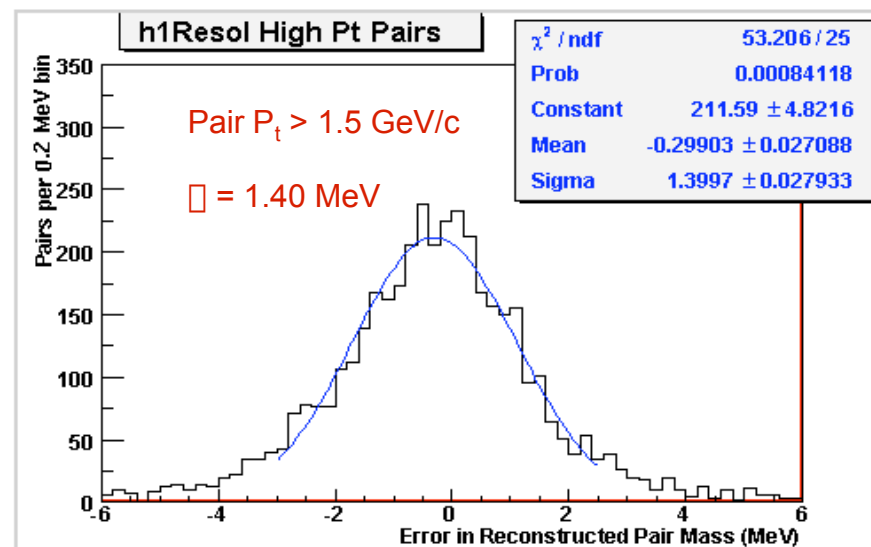
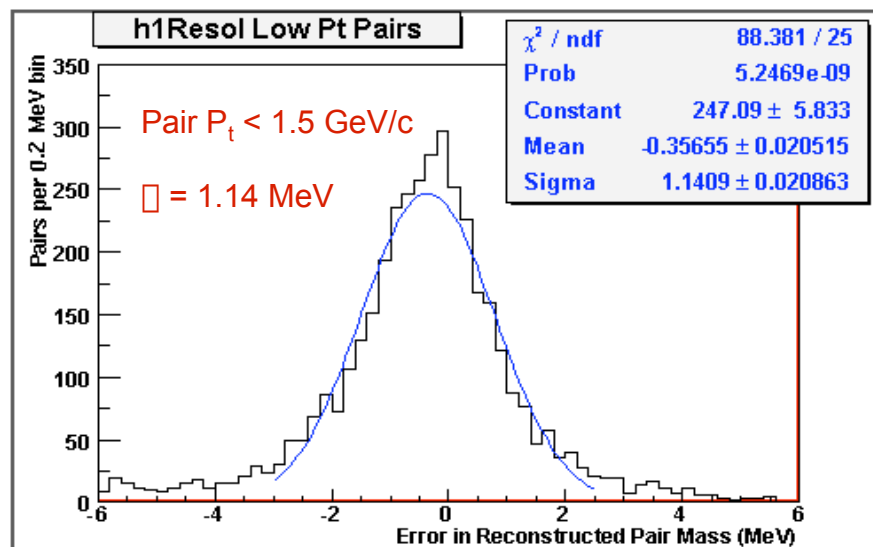
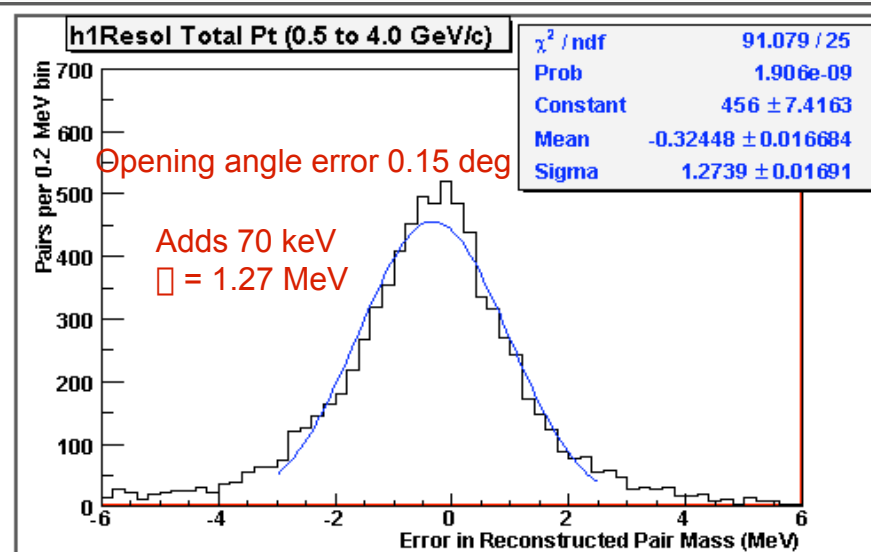
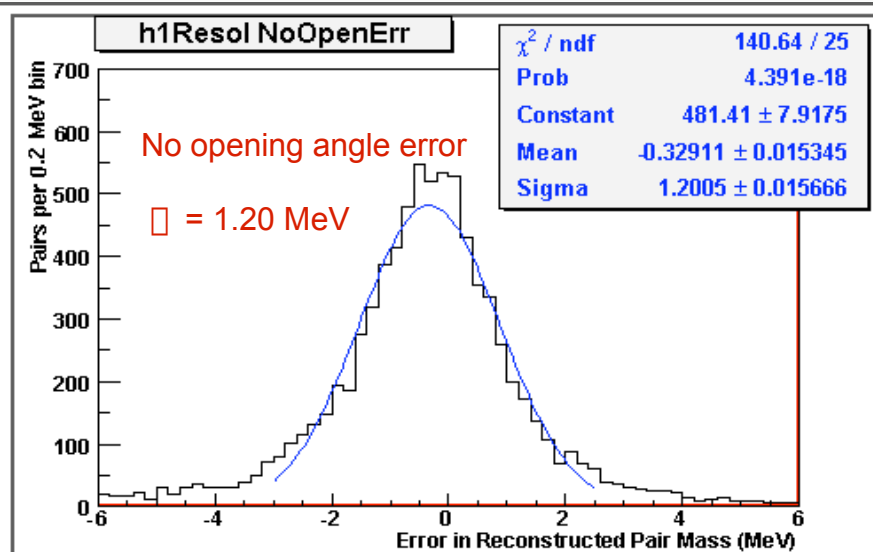
Drift Chamber resolution parameter ϕ_ϕ from identified mass study

Multiple scattering parameter ϕ_{MS} from identified mass study

Pair opening angle ϕ_{12} error taken from simulation of single kaon momentum direction errors

Results of $\pi^+\pi^-$ Pair Mass Resolution Simulation:

PHENIX obtains excellent pair mass resolution (~ 1.25 MeV) for the $\pi^+\pi^-$



\square $K^+ K^-$ from TOF-TOF Pairs

Au + Au minimum bias (0-92% central) at $E_{cm}=200$ GeV

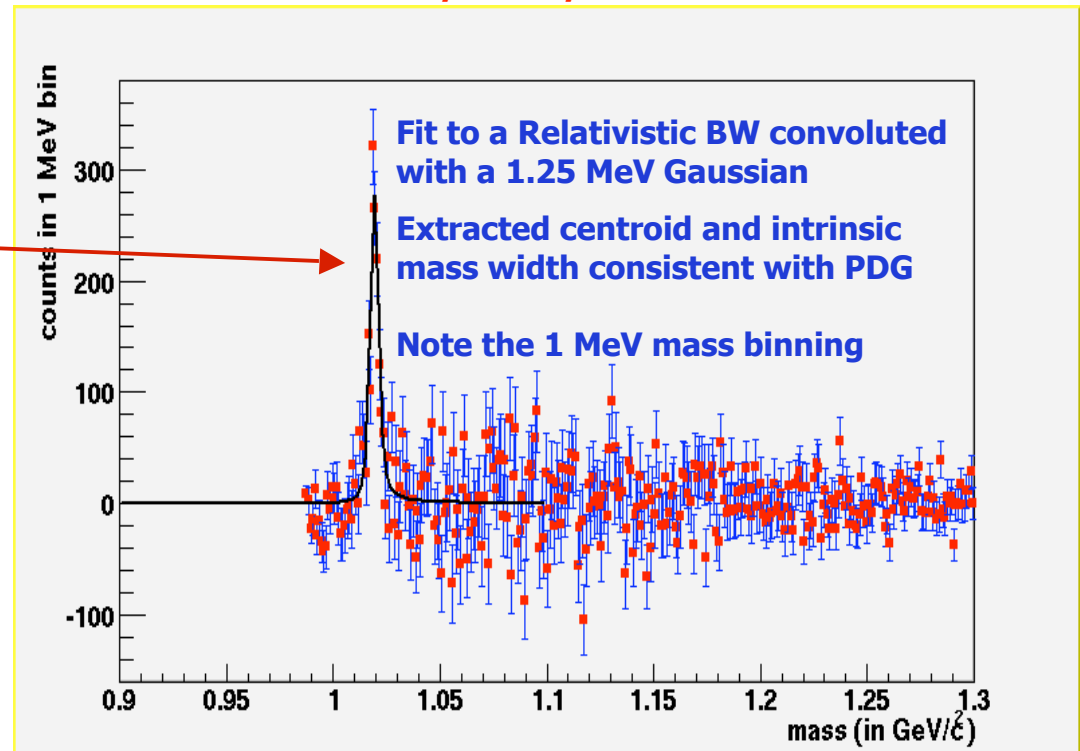
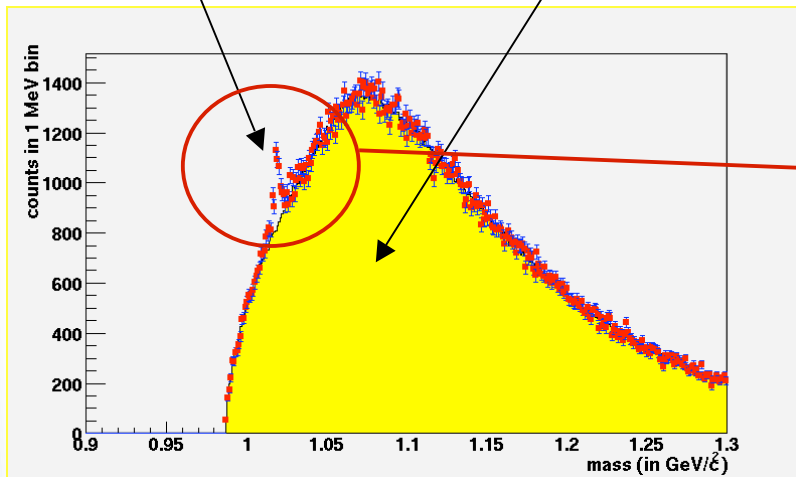
\square signal : 1410 ± 131

(within the window of $1.014 < m_{\square} < 1.024$ GeV)

$S/B = 1/6$

Actual Pairs

Background



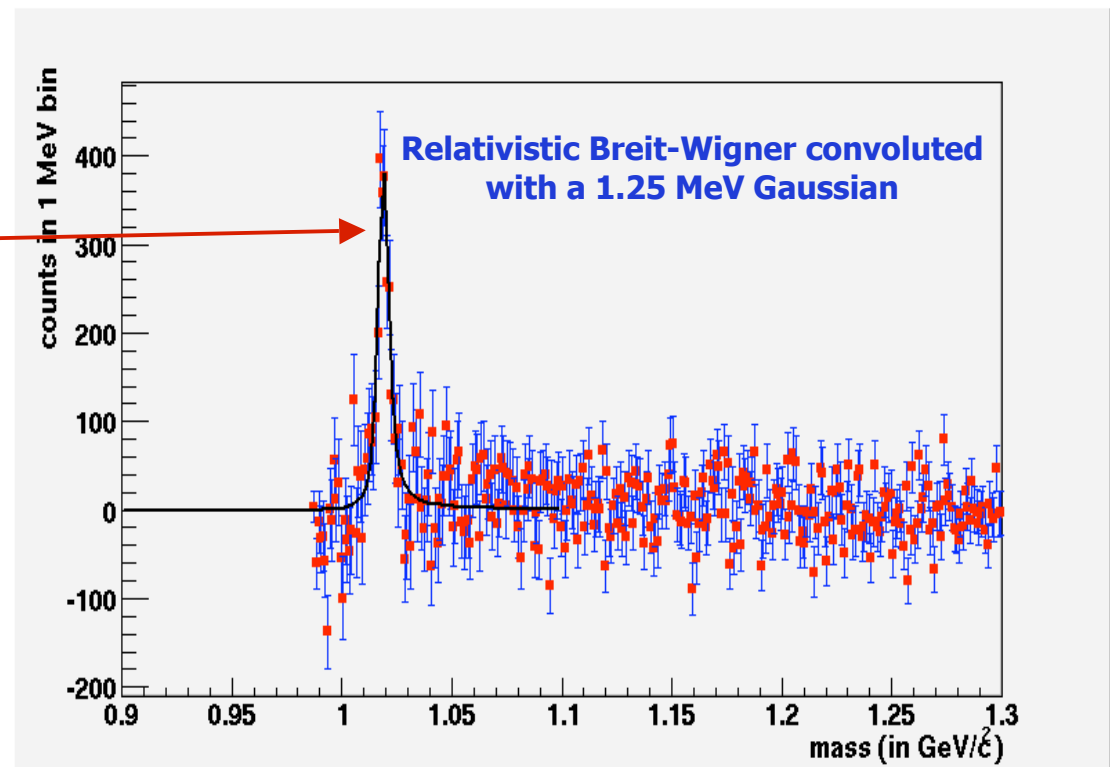
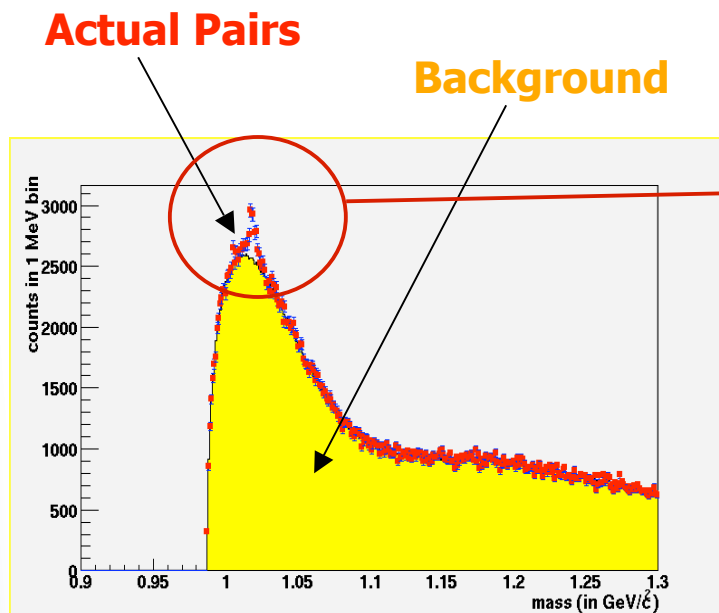
□ $K^+ K^-$ from TOF-EMCal Pairs

Au + Au minimum bias (0-92% central) at $E_{cm}=200$ GeV

□ signal : 2276 ± 217

(within the window of $1.014 < m_{\square} < 1.024$)

$S/B = 1/11$



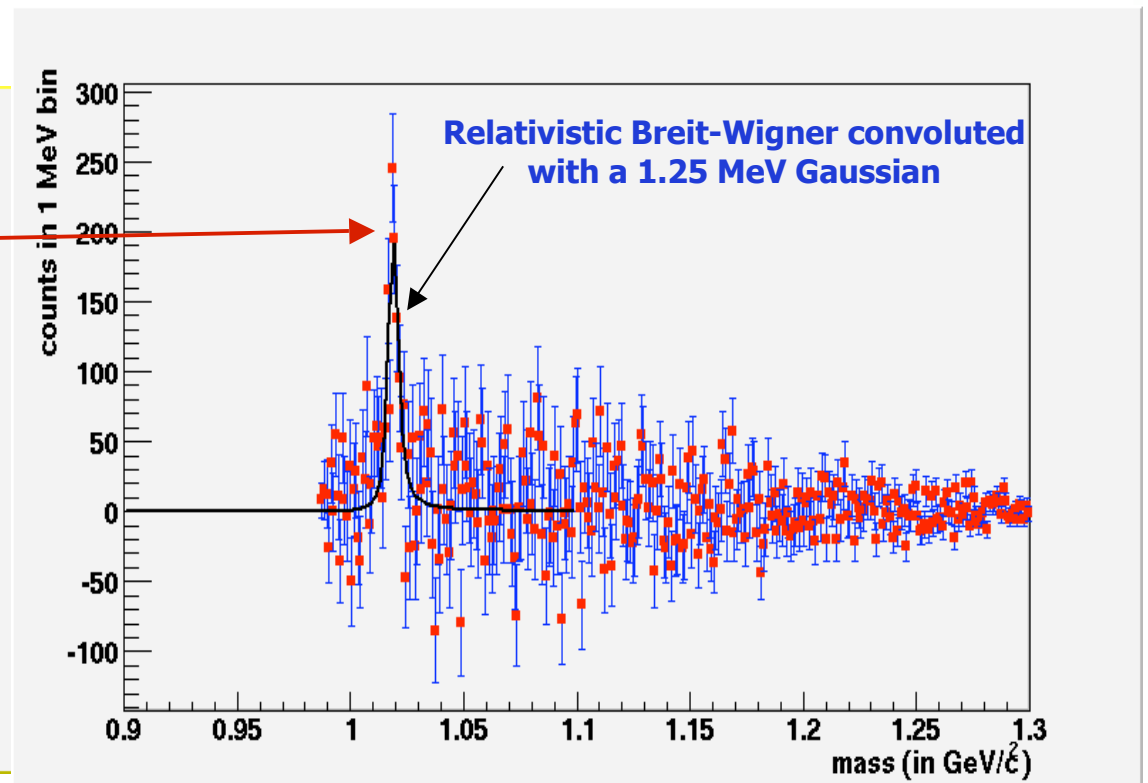
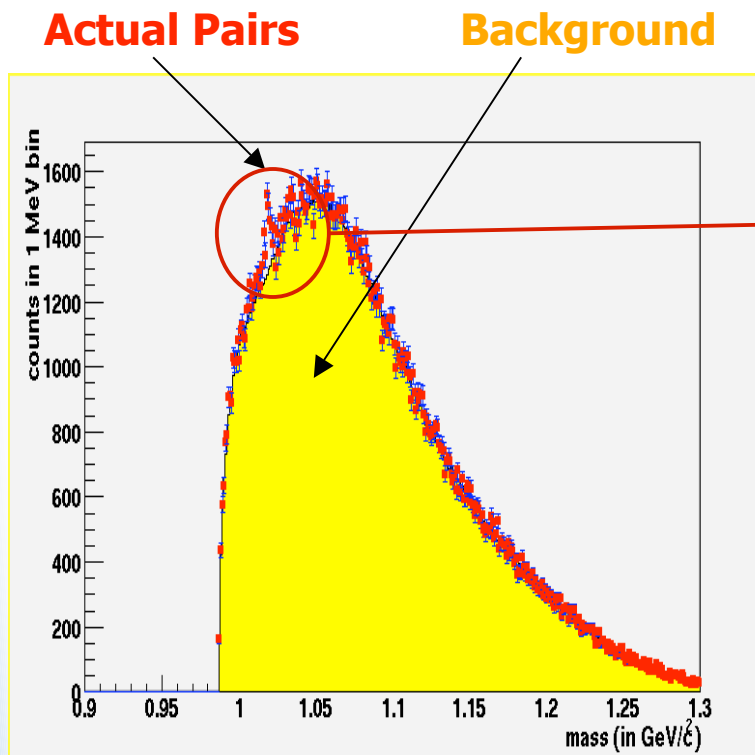
$K^+ K^-$ from EMCal-EMCal Pairs

Au + Au minimum bias (0-92% central) at $E_{\text{cm}} = 200$ GeV

\square signal : 1095 ± 118

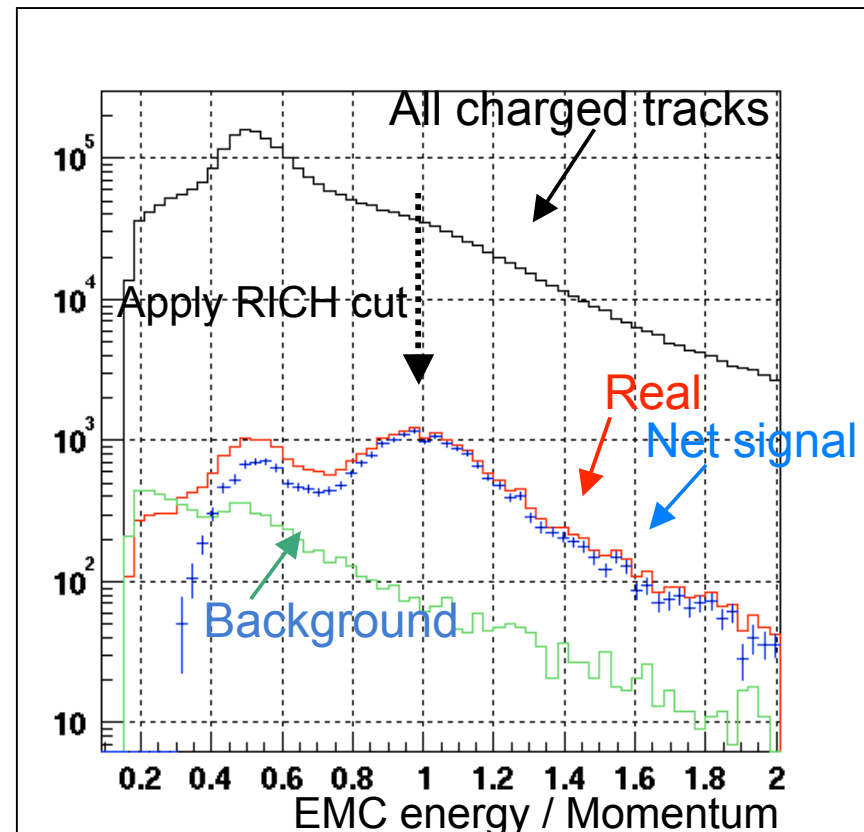
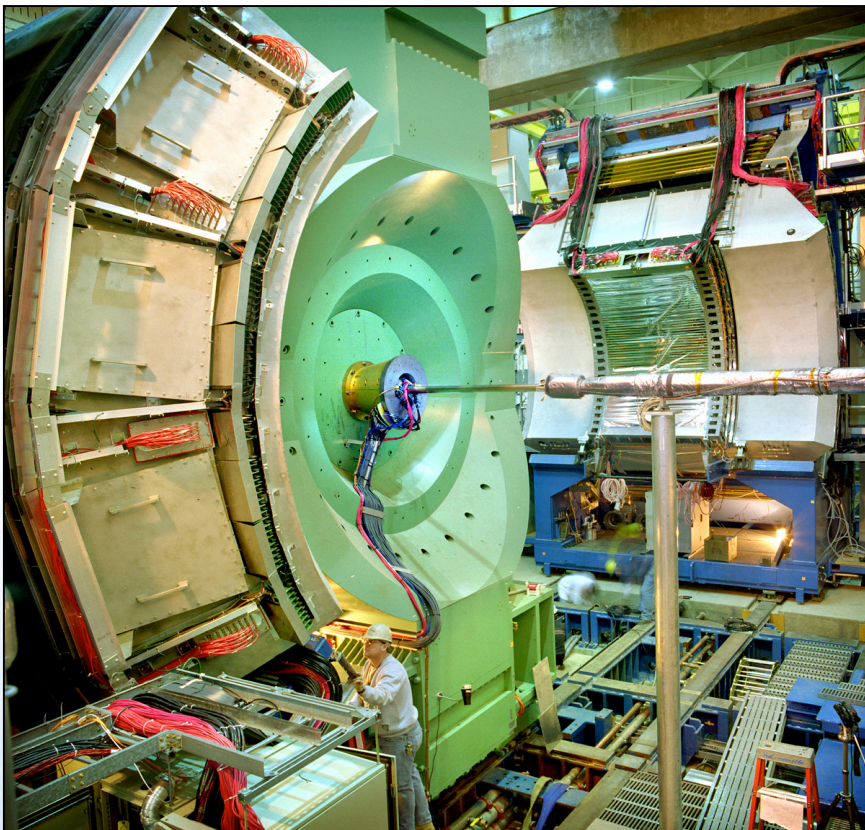
(within the window of $1.014 < m_{\square} < 1.024$)

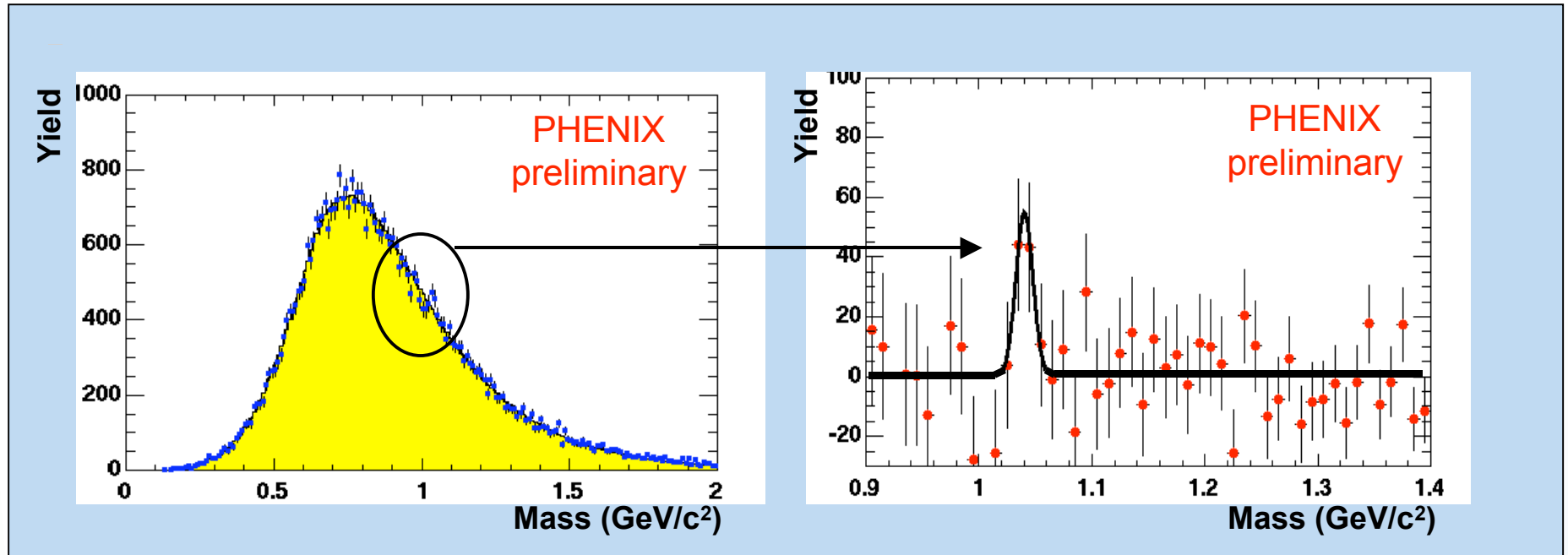
$S/B = 1/12$



PHENIX has excellent electron identification capabilities.

- Ring Imaging Cerenkov Counter - threshold selection
- Time Expansion Chamber - dE/dx measurement
- Electromagnetic Calorimeter - Energy-Momentum match





$$\text{Signal} = 101 \pm 47 \text{ (stat)}^{+56}_{-20} \text{ (sys)}$$

Signal / Background = 1 / 20

Mass peak and width agree within errors of PDG values.

dN/dy corrected for vacuum PDG branching fraction values.

B.F. $\pi\pi$ $e^+e^- = 2.9 \times 10^{-4}$, B.F. $\pi\pi$ $K^+K^- = 0.49$

PHENIX Preliminary

$$\pi\pi \quad e^+e^- : \quad \frac{dN}{dy} = 5.4 \pm 2.5(stat)_{-2.8}^{+3.4}(sys)$$

PHENIX Preliminary

$$\pi\pi \quad K^+K^- : \quad \frac{dN}{dy} = 2.01 \pm 0.22(stat)_{-0.52}^{+1.01}(sys)$$

Data are consistent with the free vacuum PDG branching fraction values to within 1 σ statistical errors.

New $\pi \rightarrow K^+K^-$ data being analyzed with the use of the EMCal will enable us to set better limits on the dN/dy , the mass centroid, and the width.

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***as of July 2002**