Phi Production in Au + Au collision at RHIC-PHENIX

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2. Experimental measurement of ϕ at PHENIX
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   - PID of Kaons
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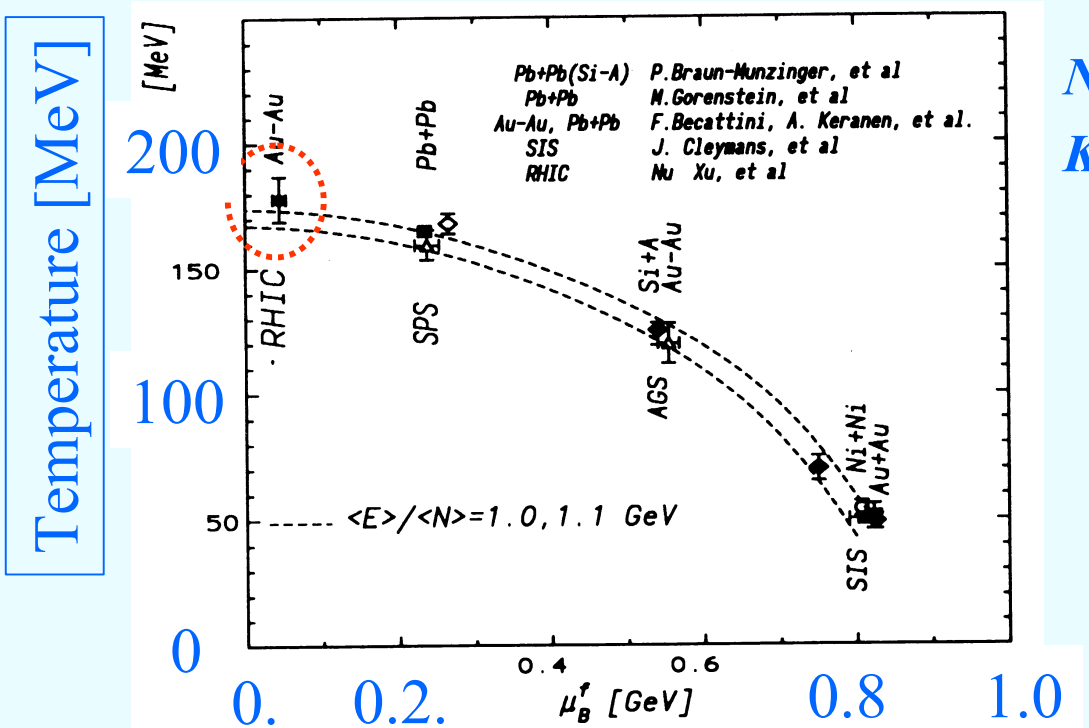
Environment of ϕ meson in the fireball

– In the heavy ion collision system at the RHIC energy, higher temperature is expected to be achieved with relatively less baryon density.

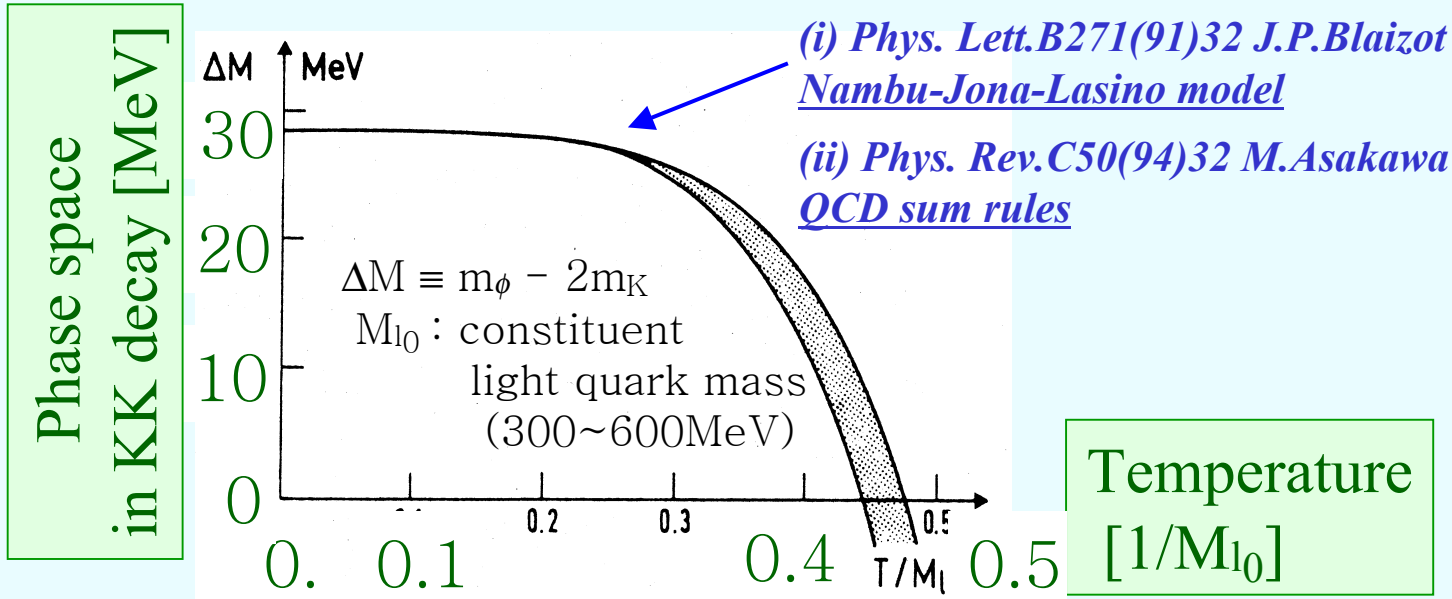


NPA698(2002)94c

K. Redlich

Expectation of $\phi(1020)$ mass at the high temperature environment

(1) Mass shift in hot matter → Less yield in KK decay mode is expected.



(i) Phys. Lett.B271(91)32 J.P.Blaizot et al.
Nambu-Jona-Lasino model

(ii) Phys. Rev.C50(94)32 M.Asakawa et al.
QCD sum rules

(2) Increase of mass width

→ Change in Branching ratio, and/or

→ Broadening of invariant mass distribution.

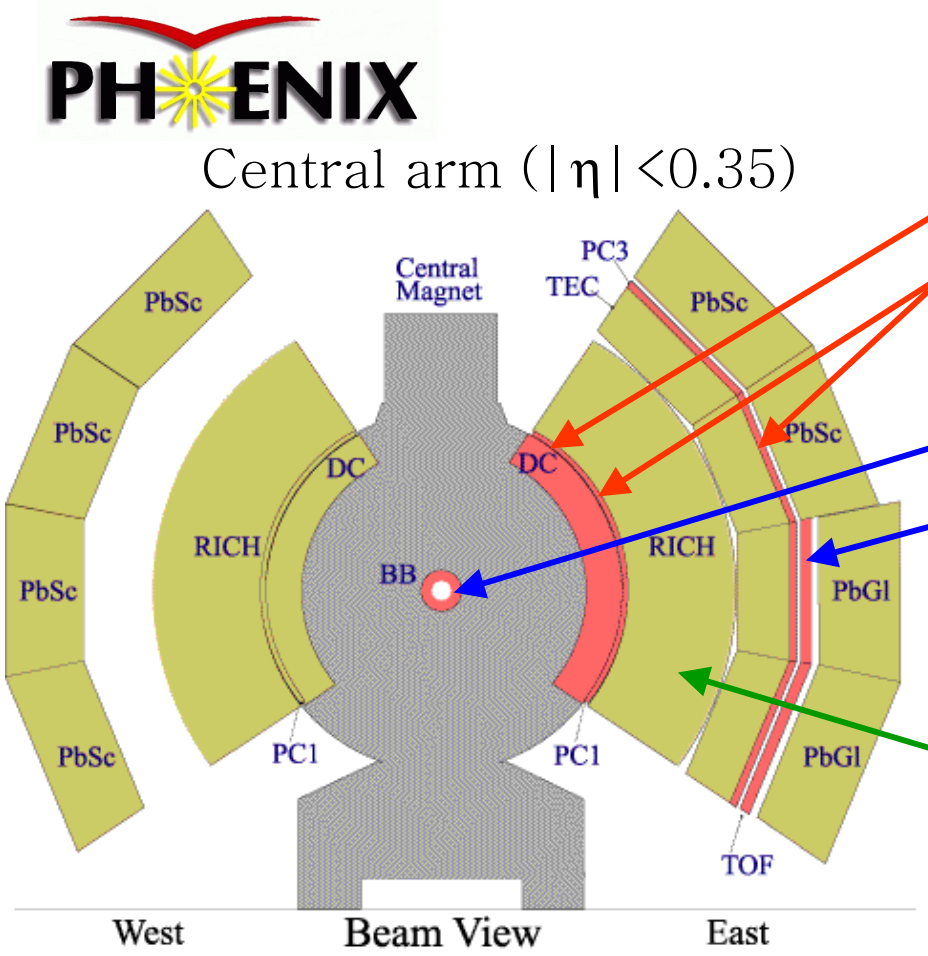
(i)Phys. Lett.B262(91)485, J.Rafelski et al. (assuming a model on QCD vacuum structure)

(ii)Phys. Lett.B253(91)15, E.Shuryak et al. (assuming K meson modification by collective interaction)

(3) Two mass peaks *Phys. Rev.C50(94)50 M.Asakawa et al. (QCD sum rules)*

(1-*cf.*) Mass shift in dense matter *Phys. Rev.C46 (92)R34 T.Hatsuda et al. (QCD sum rules)*

Unique experimental capability of ϕ measurement at RHIC-PHENIX

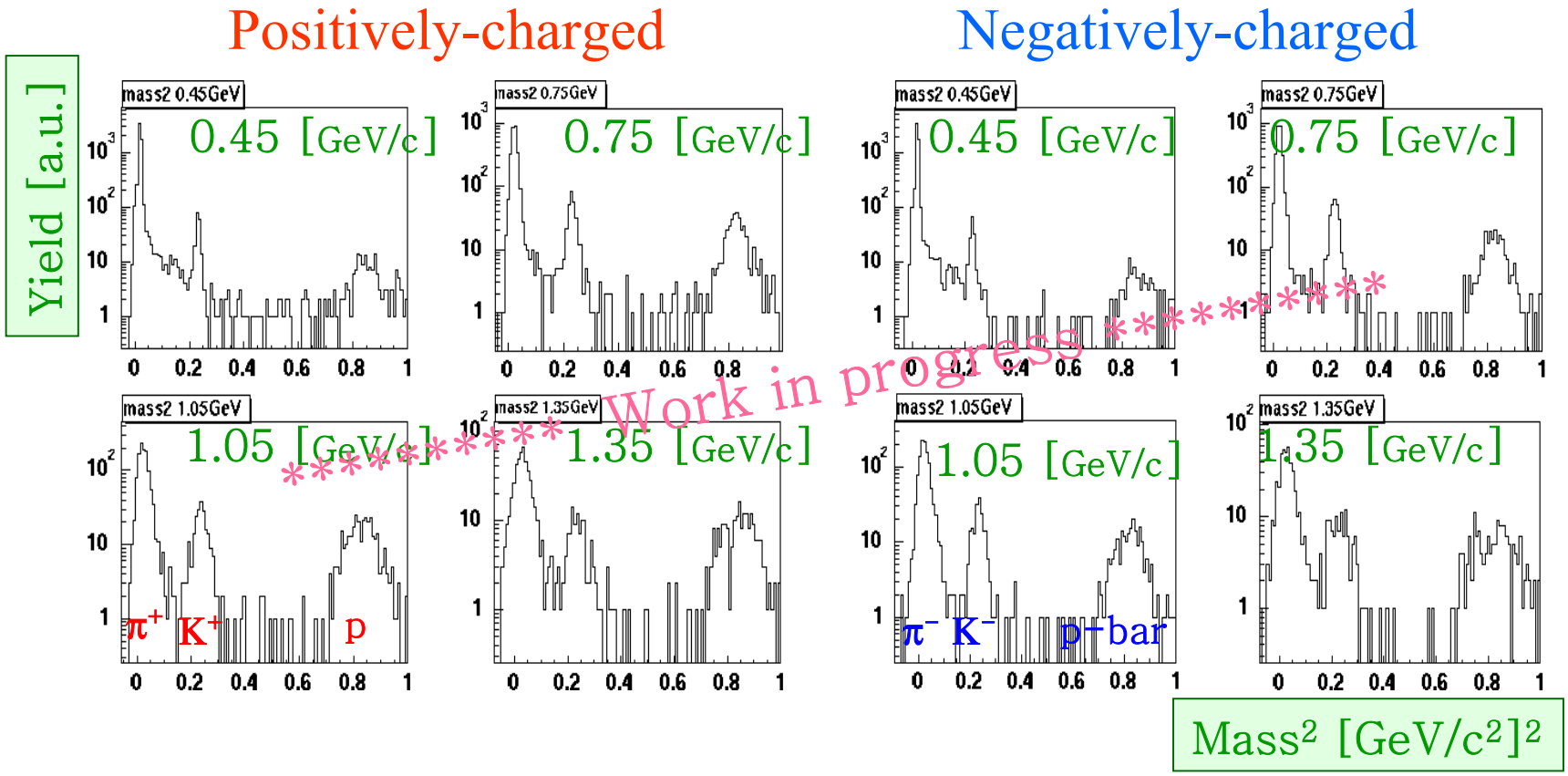


<1> Magnetic spectrometer
(Drift chamber
+ 2 Pad chambers)

<2> with hadron PID device
(Beam-Beam Start counter
+ Time of Flight detector)
for $\phi \rightarrow K^+K^-$ (B.R. 49.2%)

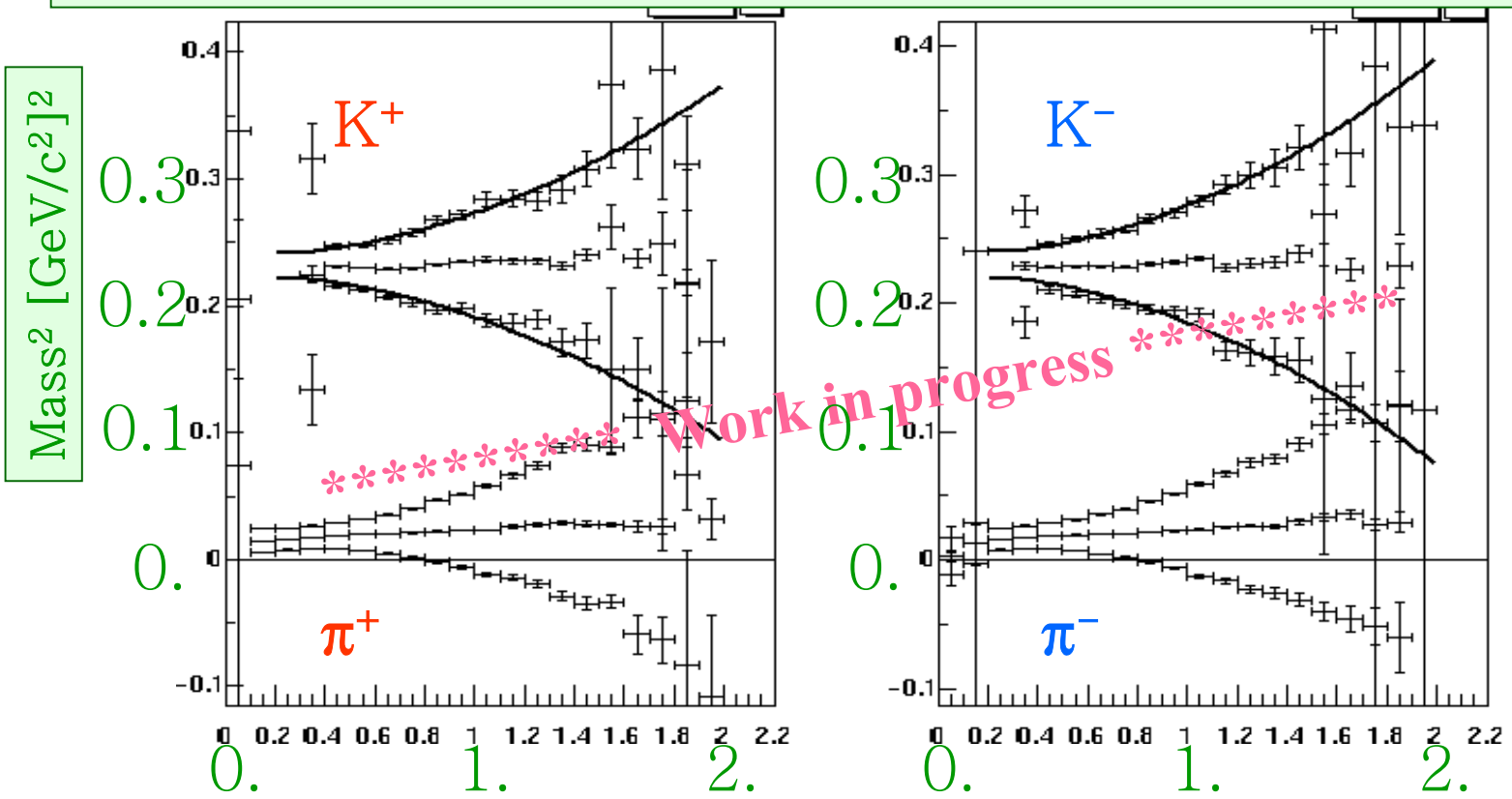
<3> as well as electron PID device
(Ring imaging Cherenkov Counter)
for $\phi \rightarrow e^+e^-$ (B.R. 0.0291%)

Current status (PID selection of K^+ and K^-)



* Clear Separation of K^+ and K^- is achieved.
* For Kaon selection, use momentum dependent $2\sigma_{m^2}$ cut (see next).

Current status (Selection of K^+ and K^-) [cont'd]



$$\sigma_{m^2}{}^2 = \left(\frac{\sigma_{muls.}}{K}\right)^2 \cdot m^4 \left(1+\frac{m^2}{p^2}\right) + \left(\frac{\sigma_{res.}\, p}{K}\right)^2 \cdot m^4 + \left(\frac{\sigma_{tof}\cdot c}{L}\right)^2 p^4 \left(1+\frac{m^2}{p^2}\right)$$

Multiple scattering Momentum resolution Time of Flight Resolution

momentum dependent fitting is used.

Outlook of kinematical cut in invariant mass. And concerns.

> Initial angle correlation cut between daughter K's

Especially for the low momentum ϕ.

> Energy asymmetry cut

$$\begin{pmatrix} E \\ p\cos\vartheta \end{pmatrix} = \begin{pmatrix} \gamma & \gamma\beta \\ \gamma\beta & \gamma \end{pmatrix} \cdot \begin{pmatrix} E^* \\ p^*\cos\vartheta^* \end{pmatrix}$$

"*" denotes c.m. system,

$$Asym. \equiv \frac{p_1\cos\vartheta_1 - p_2\cos\vartheta_2}{p_1\cos\vartheta_1 + p_2\cos\vartheta_2} = \frac{{p_1}^*\cos\vartheta_1^*}{\beta E^*}$$

"1" and "2" denote daughter K particles

$E^* \sim 510$ [MeV/c^2], and ${p_1}^* \sim 127$[MeV/c], and $cos\theta_1^*$ should be uniformly distributed (0~1), Therefore signal is to be with "Asym. $< ({p_1}^*/ E^*) \sim 1/4$", assuming $\beta \sim 1$.

- Multiplicity/Centrality dependence
- Systematics of K^+ K^- for background evaluation (i) K^+ and K^- from different event each other (ii)from same event, but K^+K^+ pair or K^-K^- pair

Summary

(1) In $(s_{NN})^{1/2}$ = 200 GeV Au + Au, ϕ measurement is of large interest.

Change in (i) mass shift, two peaks,
(ii) mass width, (iii) branching ratio

(2) At RHIC PHENIX, in $(s_{NN})^{1/2}$ = 200 GeV Au + Au data;

- Using TOF, K^+ and K^- is identified well.
- Kinematical cut, like asymmetry cut, is being studied