Rough Idea of $K^+ + A \rightarrow K^* + X$ Experiments
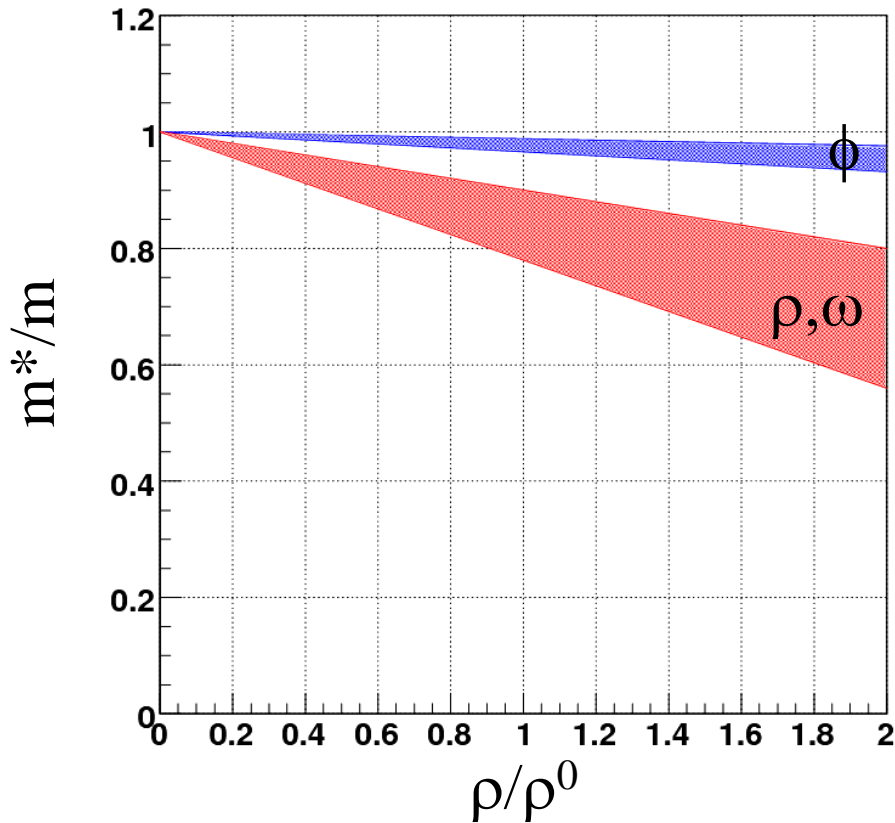
Masashi Kaneta

Department of Physics
Tohoku University

Motivation

$$\frac{m_\phi^*}{m_\phi} = 1 - (0.023 \pm 0.011) \frac{\rho}{\rho_0}$$

$$\frac{m_{\rho,\omega}^*}{m_{\rho,\omega}} = 1 - (0.16 \pm 0.06) \frac{\rho}{\rho_0}$$

predictions from
Hatsuda and Lee

- Medium effect for vector meson is at KEK-PS
  - via ϕ, ρ, ω channels

- How about the other vector meson?
  - K^*
    - effect might be between ϕ and ρ, ω
      - T.Hatsuda said, result from Walecka model are different from one of QCD sum rule
  - K^* seems to be fine with Kaon beam at J-PARC

Masashi Kaneta, Tohoku Univ.

K*(892)

$$K^*(892) \qquad I(J^P) = \tfrac{1}{2}(1^-)$$
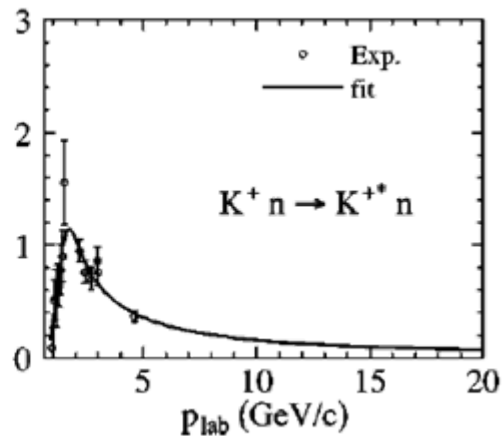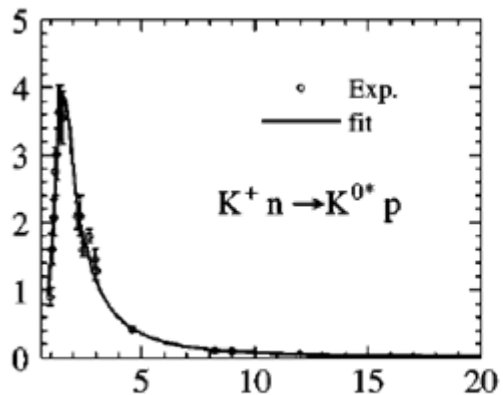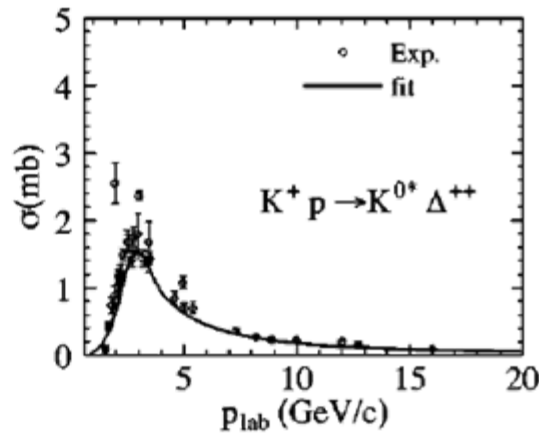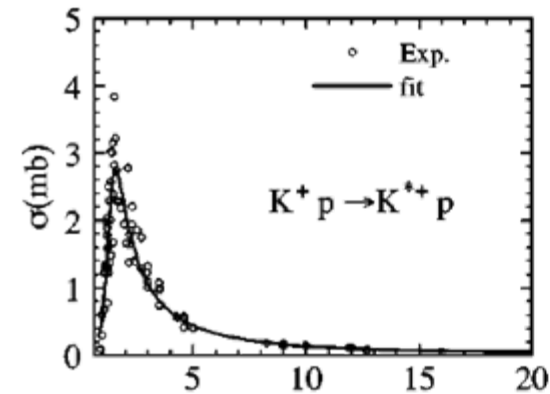
$K^*(892)^\pm$ mass $m = 891.66 \pm 0.26$ MeV

$K^*(892)^0$ mass $m = 896.00 \pm 0.25$ MeV (S = 1.4)

$K^*(892)^\pm$ full width $\Gamma = 50.8 \pm 0.9$ MeV

$K^*(892)^0$ full width $\Gamma = 50.3 \pm 0.6$ MeV (S = 1.1)

$K^*(892)$ DECAY MODES	Fraction (Γ_i/Γ)	Confidence level	p (MeV/c)
$K\pi$	~ 100 %		289
$K^0\gamma$	(2.31 ± 0.20) $\times 10^{-3}$		307
$K^\pm\gamma$	(9.9 ± 0.9) $\times 10^{-4}$		309
$K\pi\pi$	$< 7 \times 10^{-4}$	95%	223

Masashi Kaneta, Tohoku Univ.

$K^+ + p(n) \rightarrow K^* + X$ cross-section

reaction		K^+ 1.1 GeV/c	K^+ 1.5 GeV/c	K^+ 1.8 GeV/c
K^+ + p	total	~17.5 [mb]	~18 [mb]	~17.8 [mb]
	K^{*+} + p	~1.3 [mb]	~4 [mb]	~2.6 [mb]
	K^{*0} + Δ^{++}	~0.2 [mb]	~0.3 [mb]	~0.4 [mb]
K^+ + n	total	18-22 [mb]	~18 [mb]	~18 [mb]
	K^{*0} + p	~1.8 [mb]	~4 [mb]	~3.5 [mb]
	K^{*+} + n	~0.5 [mb]	~1.5 [mb]	~1.1 [mb]

PRC61 (1999) 024901
(Note: original data points from
Total Cross-Sections for Reactions of High Energy Particles,
edited by A. Baldni, V. Flaminio, W. G. Moorhead, and D. R.
O. Morrison ~Springer-Verlag, Berlin, 1988!, Vols. 12a, 12b.)

Masashi Kaneta, Tohoku Univ.

K* Experiments

- ## $K^+ + A$ reaction
  - Measure $K^{*+} \rightarrow K^+ + \gamma$
    - $> 1 \ \mu b$
      - $\sim$ 2.6 (1.1) mb for 1.8GeV/c $K^+ + p$ (n)
      - $\sim$ 4 (4) mb for 1.5GeV/c $K^+ + p$ (n)
      - $\sim$ 1.3 (0.5) mb for 1.1GeV/c $K^+ + p$ (n)
      - Branching ratio is 0.001 for $K^{*+} \rightarrow K^+ + \gamma$
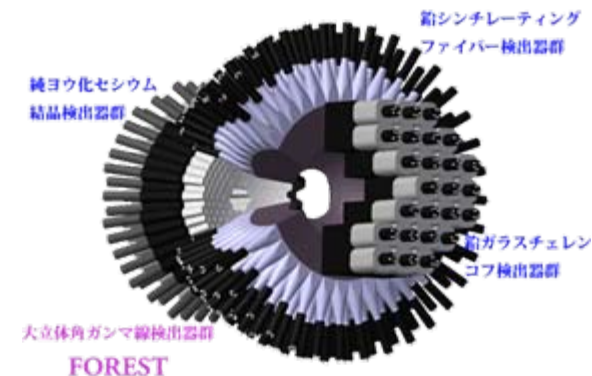   - Mean free path of K = 5-6 fm/c
    - Detector
      - K^+: high resolution spectrometer
      - γ: EMCal (should be sensitive <1GeV)
        » like SKS + FOREST at K1.8
        » like SSKS (or HKS) + FOREST at K1.1

純ヨウ化セシウム
結晶検出器群

鉛シンチレーティング
ファイバー検出器群

鉛ガラスチェレン
コフ検出器群

大立体角ガンマ線検出器群
FOREST

K^* Experiments

- ## $K^{*+} \rightarrow K^+ + \gamma$

  - Need to be estimate quantitatively
    - beam momentum
    - yield
    - efficiency: K^+ and γ momentum and angle distribution
    - trigger
    - background
      - $K^{*+} \rightarrow K^+ + \pi^0$ itself makes a background

- ## Via $K + \pi$ decay channel?

  - $K^+ + \pi^-$ or $K^+ + \pi^0$, or $K^0 + \pi^+$
  - Large solid angle spectrometer with enough resolution
    - J-PARC E16 + TOF (MRPC?)
  - $K^+ + A$: K1.8
  - p+A: 30GeV or 50GeV primary proton beam

Masashi Kaneta, Tohoku Univ.
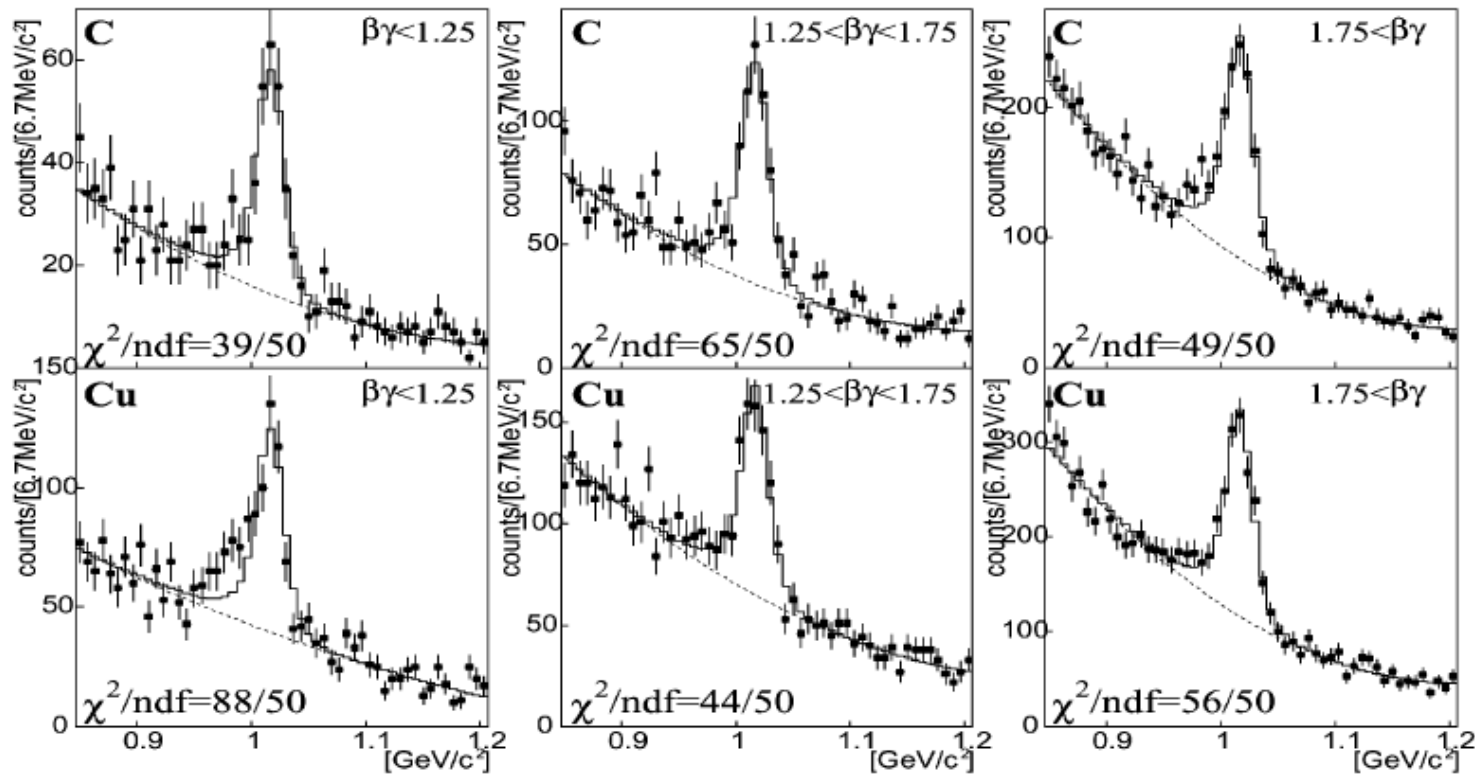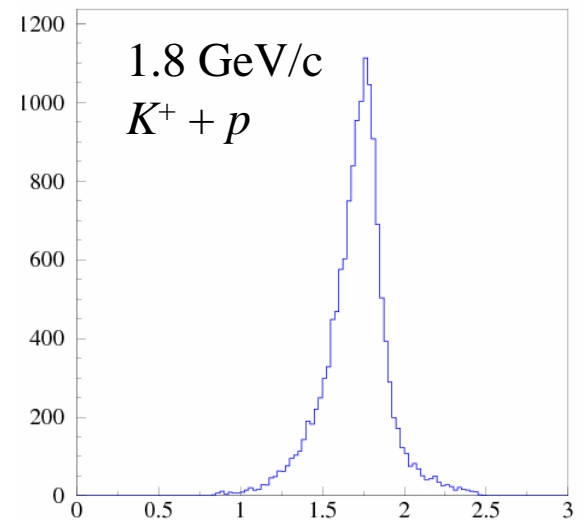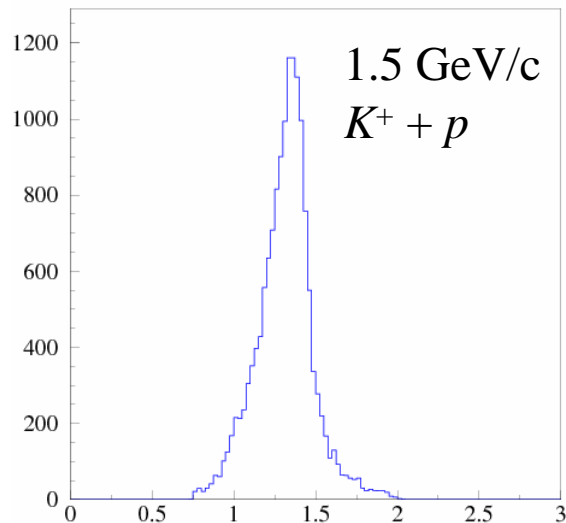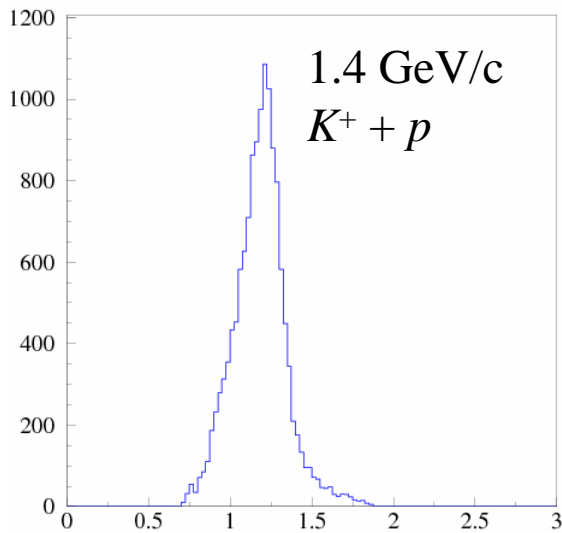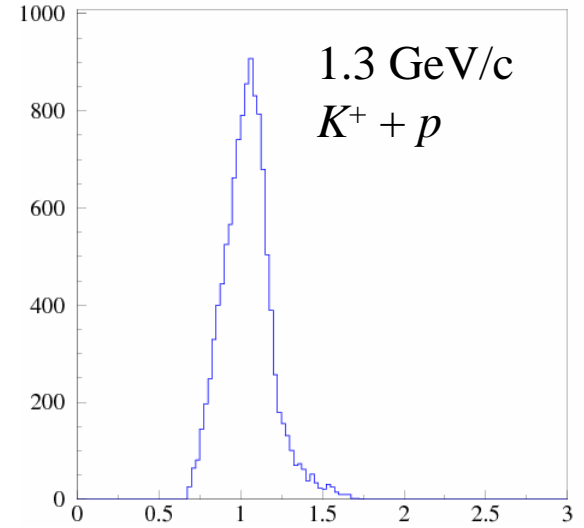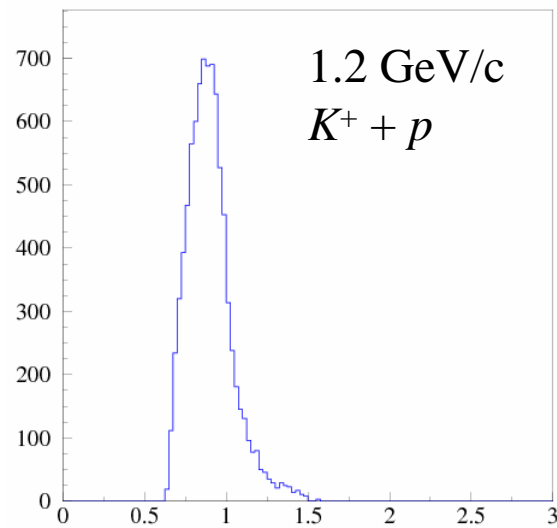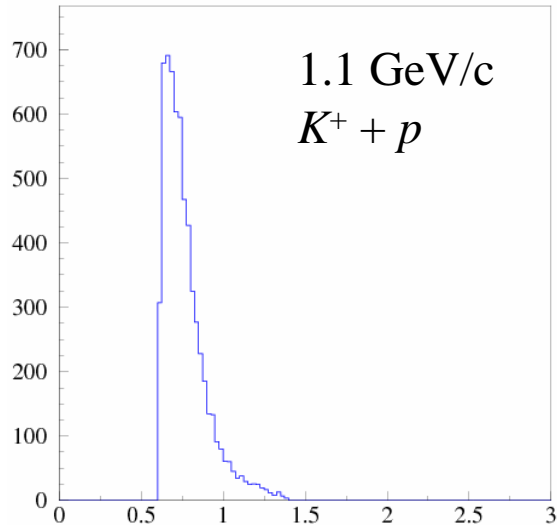
βγ dependence

Figure 1. The e^+e^- invariant mass spectra for carbon (upper) and copper (lower) targets (preliminary results). The data are divided into three $\beta\gamma_\phi$ regions as shown in the figure. Target and $\beta\gamma$-region are shown in the each panel. The solid histograms are the fit results with expected $\phi \to e^+e^-$ shape and a quadratic background. The dotted lines represent the background.

NPA774 (2006) 723

Masashi Kaneta, Tohoku Univ.

βγ

1.1 GeV/c
$K^+ + p$

1.2 GeV/c
$K^+ + p$

1.3 GeV/c
$K^+ + p$

1.4 GeV/c
$K^+ + p$

1.5 GeV/c
$K^+ + p$

1.8 GeV/c
$K^+ + p$

K^{*+} βγ

Masashi Kaneta, Tohoku Univ.

K^{*+} mass

1.1 GeV/c
$K^+ + p$

1.2 GeV/c
$K^+ + p$

1.3 GeV/c
$K^+ + p$

1.4 GeV/c
$K^+ + p$

1.5 GeV/c
$K^+ + p$

1.8 GeV/c
$K^+ + p$

Masashi Kaneta, Tohoku Univ.