KEK-PS E325 Results

Outline

- Physics motivation
- KEK-PS E325 detector
- Production of vector mesons
- Modification of mass spectra
- Summary

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(KEK-PS ***E325*** Collaboration)

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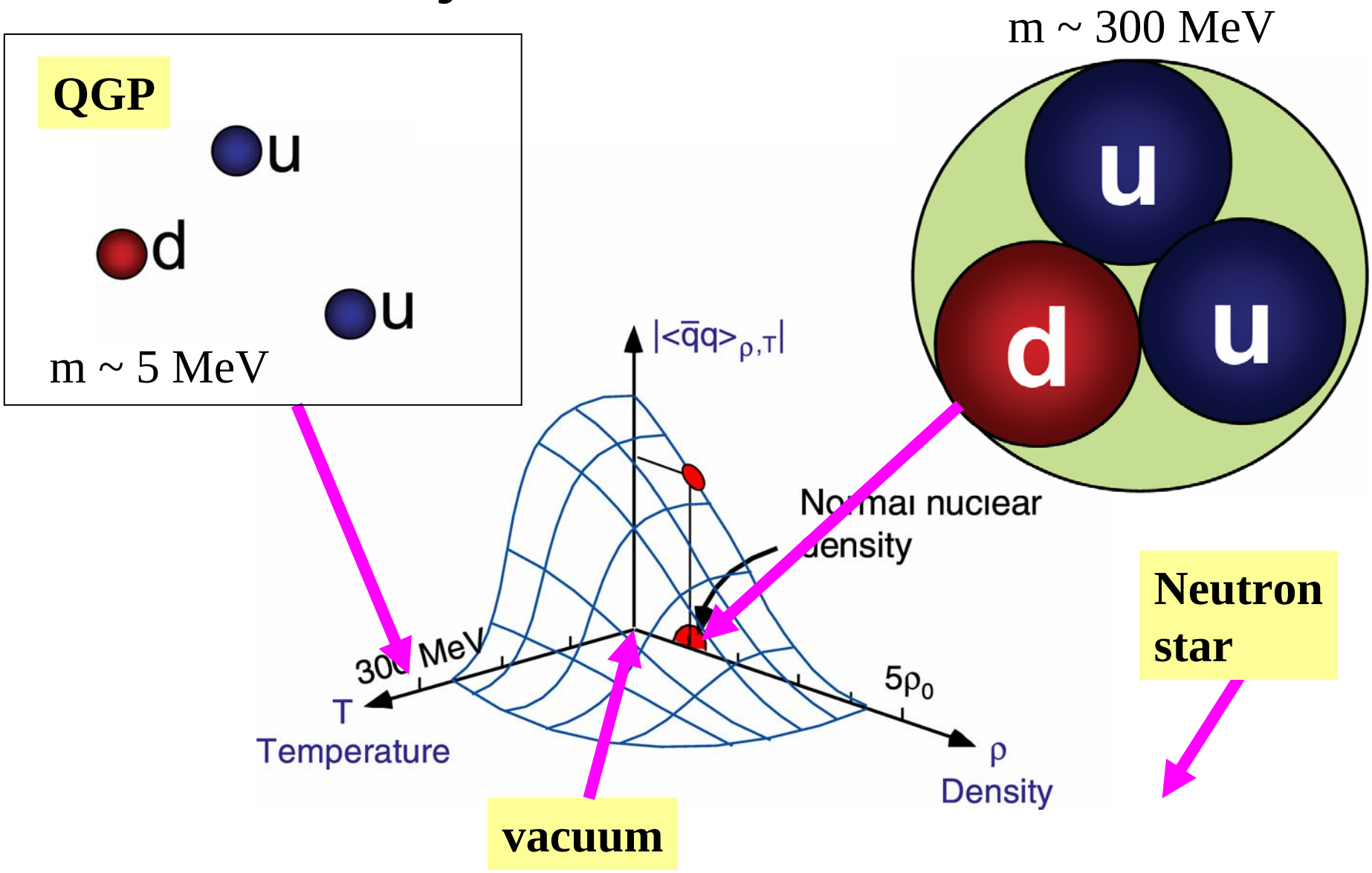
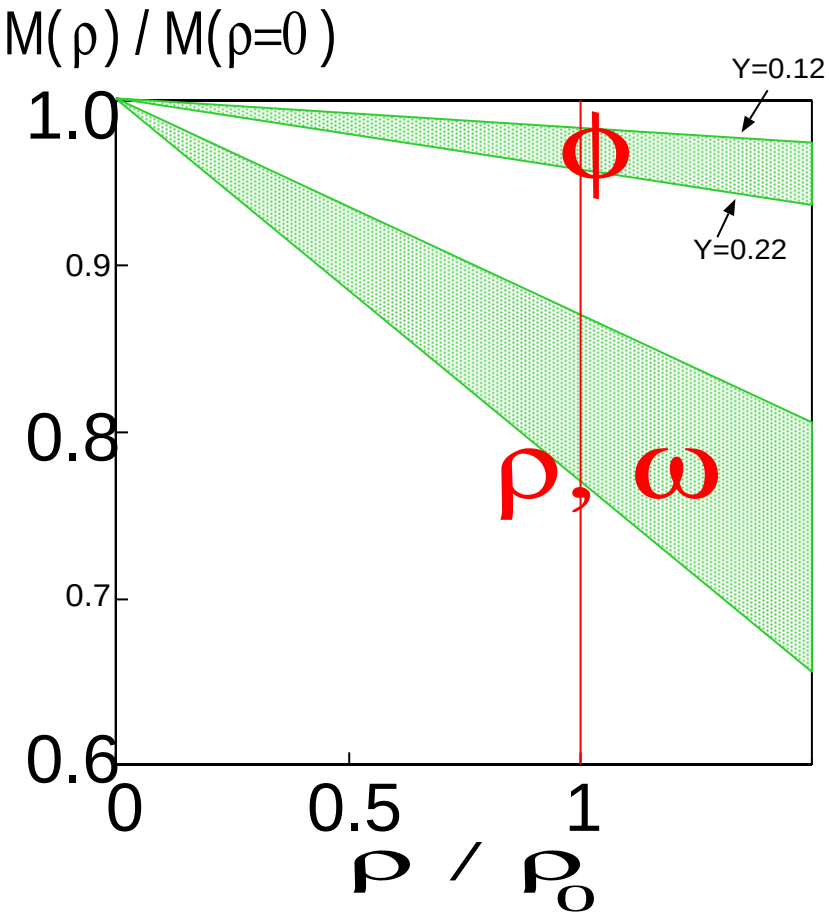
Physics motivation



Vector meson

Hatsuda & Lee PRC 46, R34(1992)



φ

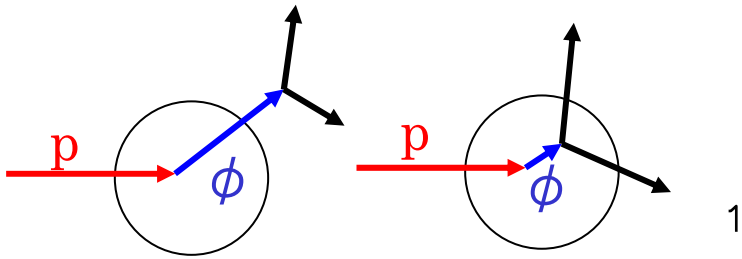
Mass modification **20 ~ 40 MeV/c²**
: relatively small
Small decay width (**4.4 MeV/c²**),
no other resonance nearby
: sensitive to small mass modification

ρ, ω

Large mass modification
~120 MeV/c² at $\rho = \rho_0$
Large cross section
Difficult to separate ρ and ω
on e^+e^- mass spectrum

predictions of vector meson modification in medium
Brown, Rho(1991), Hatsuda, Lee(1992), Klingl, Kaiser, Weise(1997), etc.

Expected signal



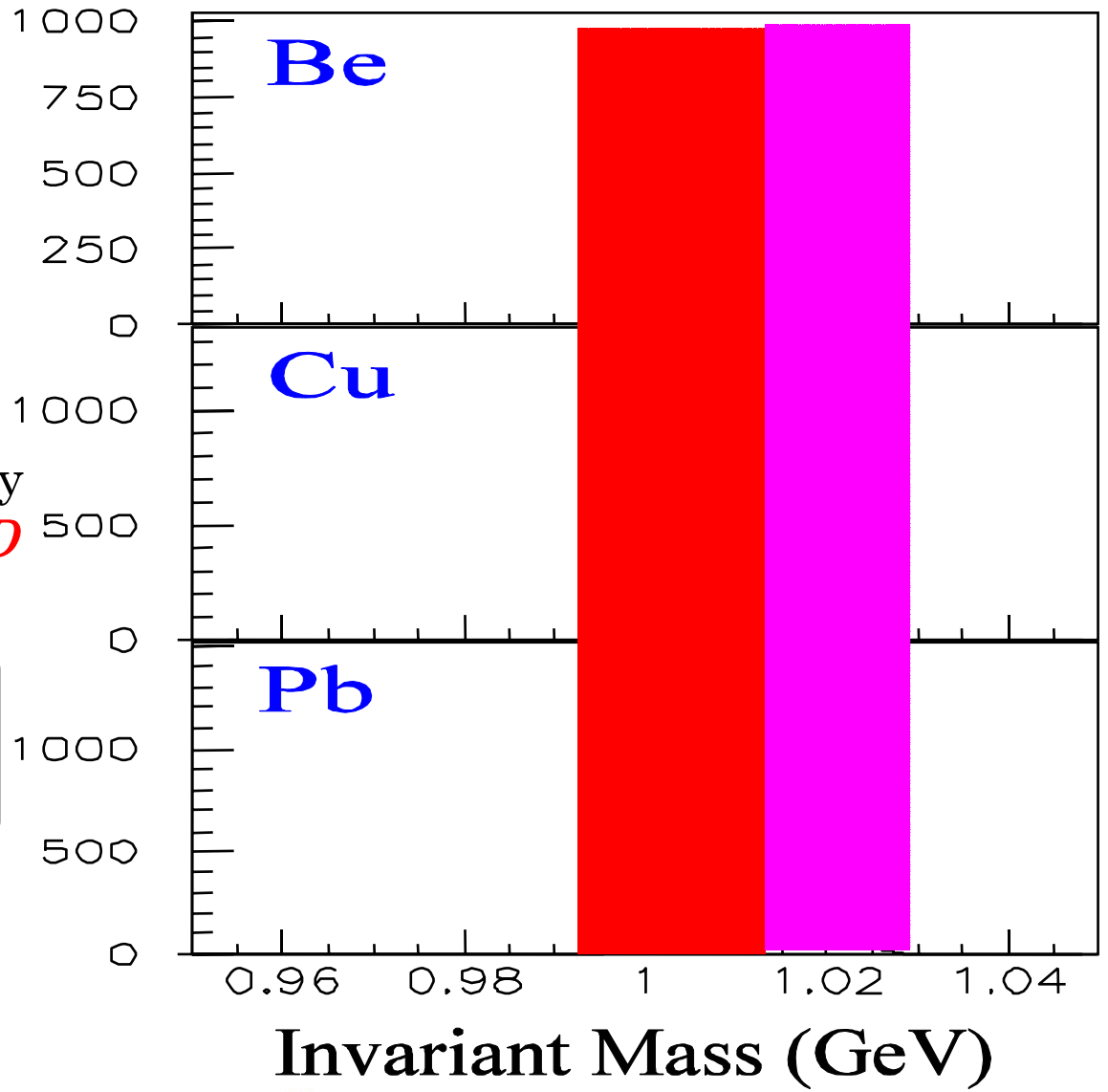
outside decay, inside decay

UNMODIFIED MODIFIED

$$m^*/m = 1 - 0.15 y \rho / \rho_0$$

$$y \equiv 2\langle \bar{s}s \rangle_N \Big/ \left(\langle \bar{u}u \rangle_N + \langle \bar{d}d \rangle_N \right)$$

Simulation result



Key features

Slowly moving ρ ω ϕ (p_{lab} ~ 2 GeV/c) in target nuclei

→**Reaction of 12 GeV p +A**

→**Spectrometer with large acceptance**

Free from final state interaction

→ ρ, ω, ϕ → $e^+ e^-$ decay channels

Small effect (Δm ~ 20 MeV)

→ **Fine mass resolution (~ 10 MeV/c^2 for e^+e^-)**

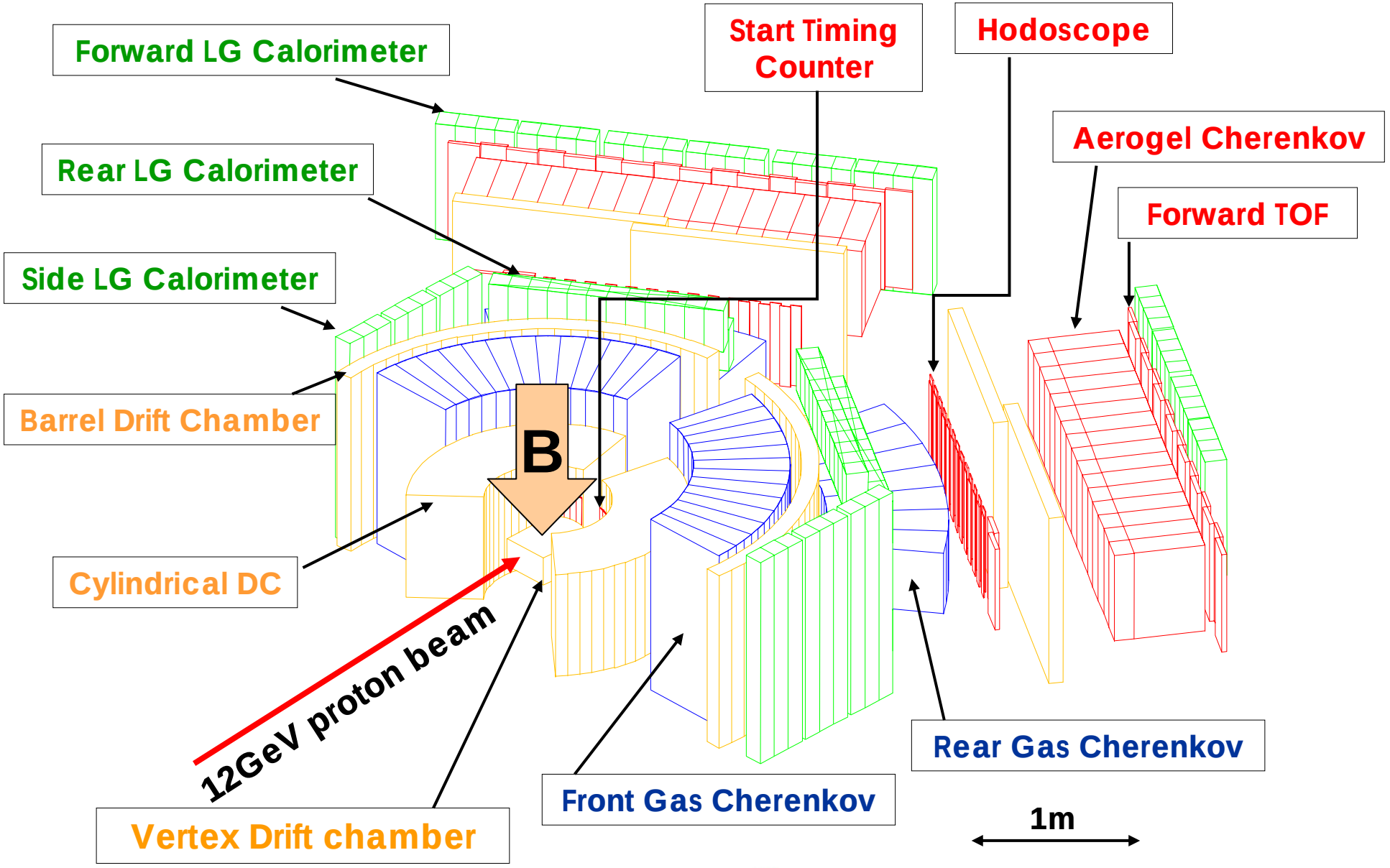
Reduce conversion background

→ **Thin target & strong beam**

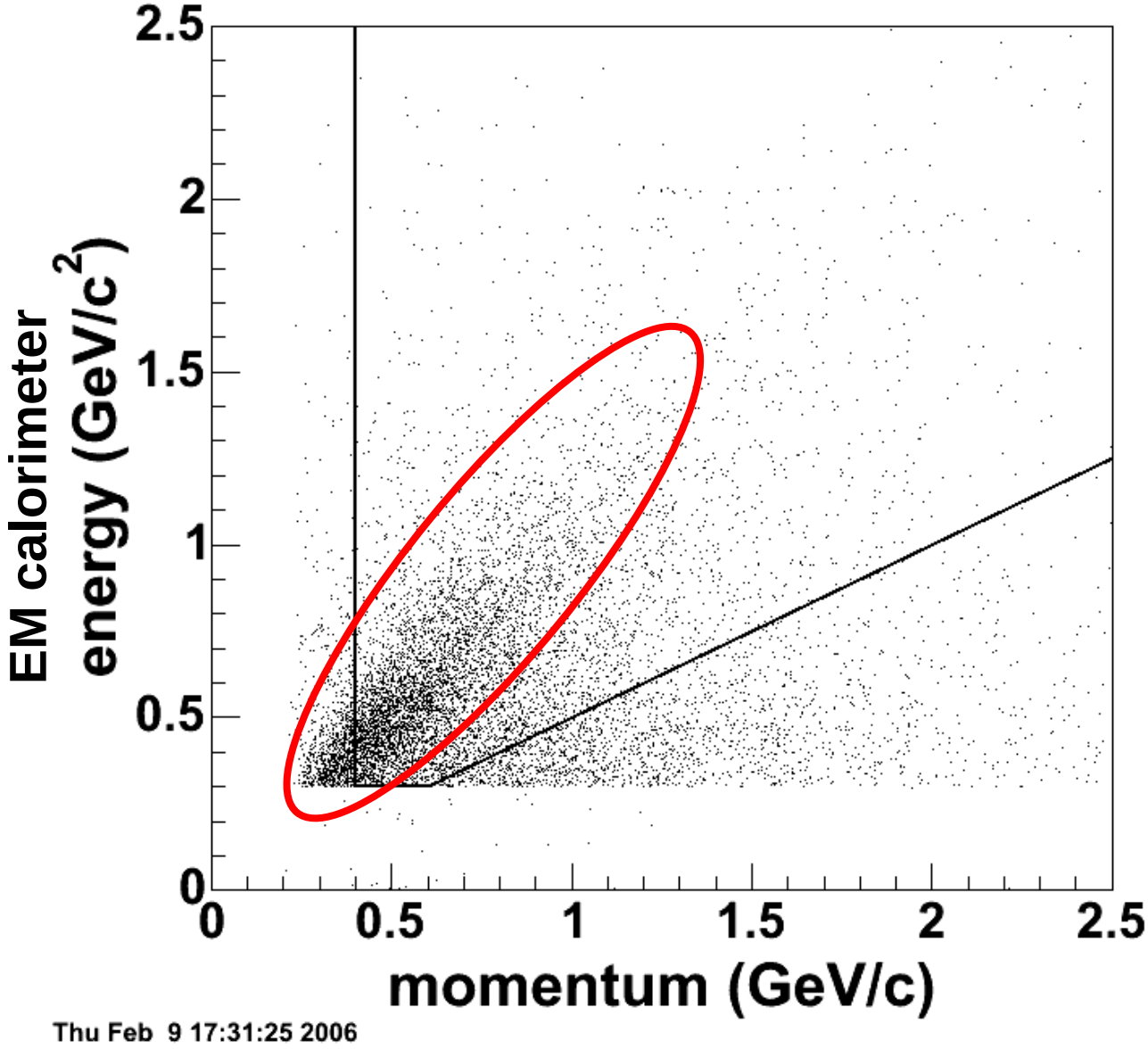
Targets	C	Cu
Interaction length	0.2%	$4 \times 0.05\%$
radiation length	0.4%	$4 \times 0.5\%$

Primary proton @ ~10^9 / spill (1.8 s)

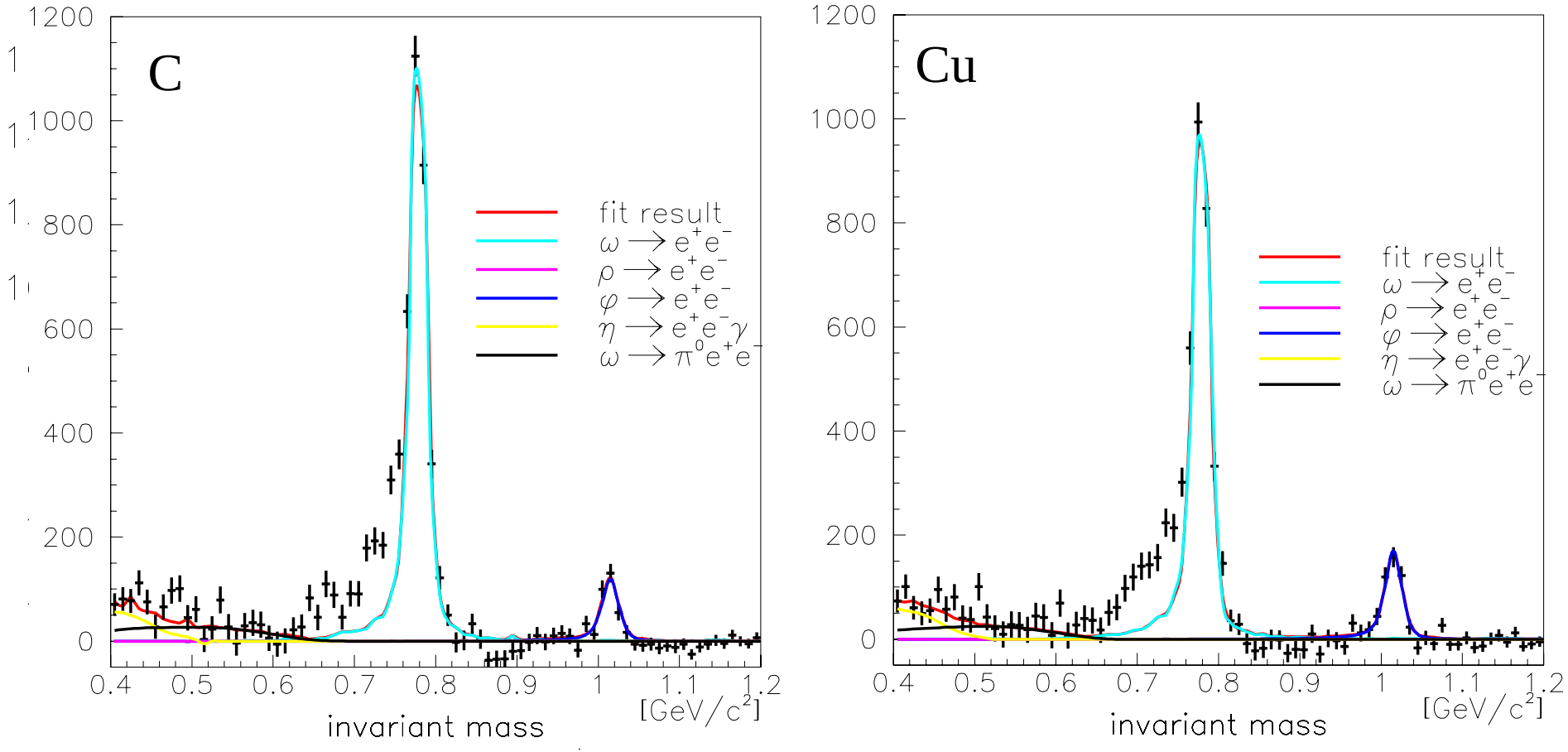
Spectrometer



Particle identification

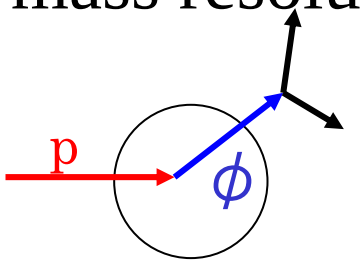


Invariant mass spectrum



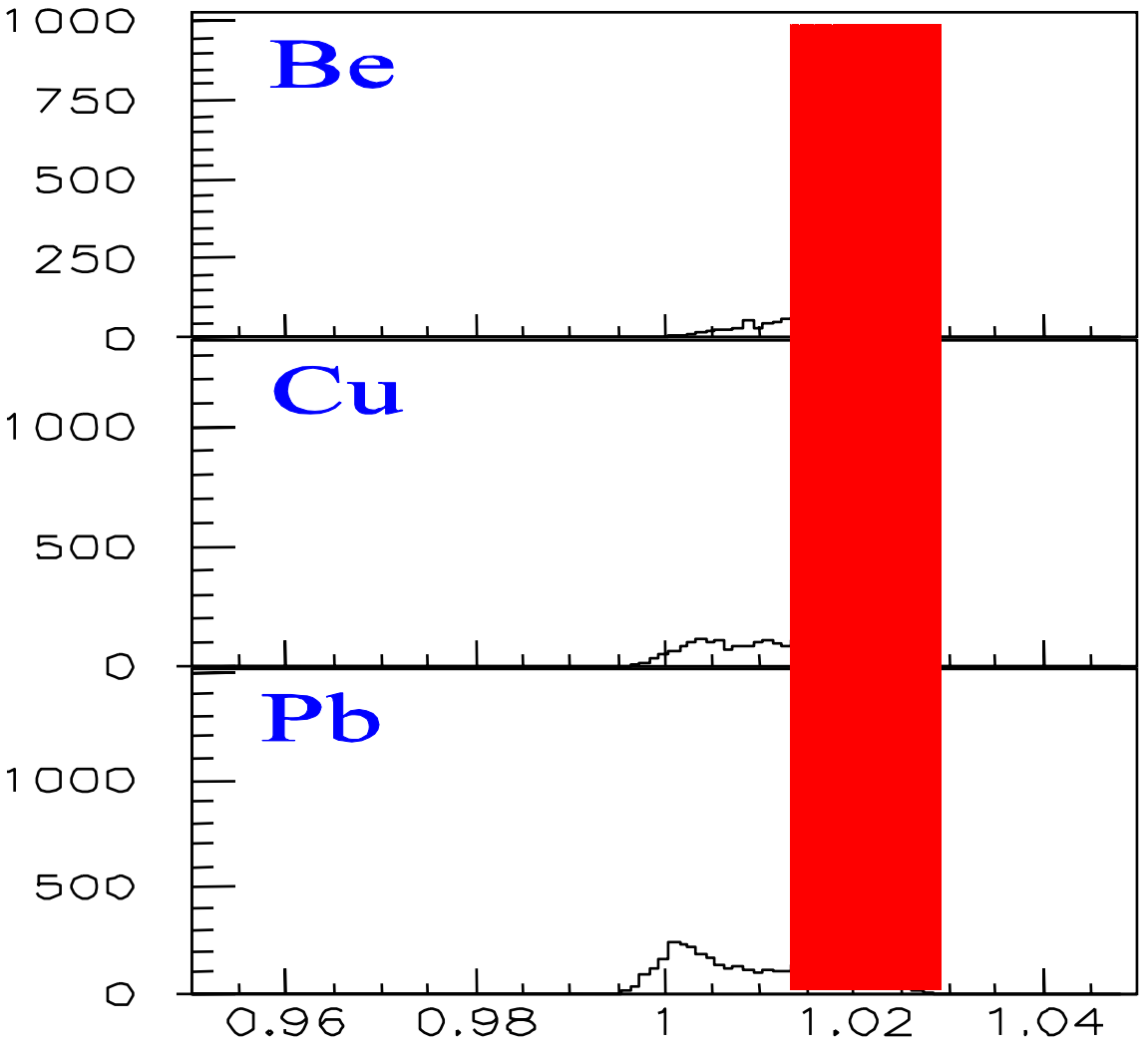
Meson production – unmodified part

- Unmodified part
  - Described by Breit-Wigner function folded with Gaussian corresponding with the mass resolution.

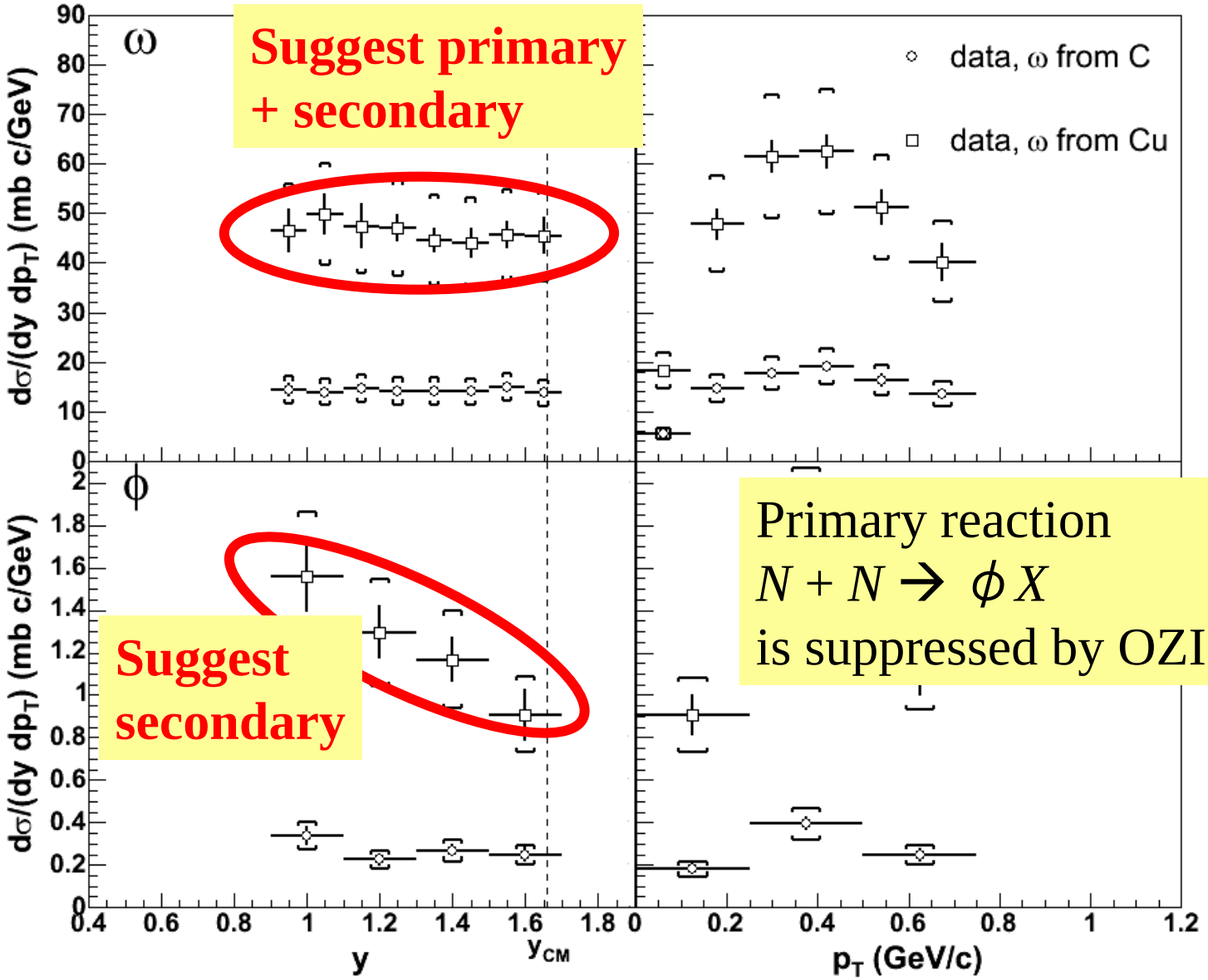


outside decay,
UNMODIFIED

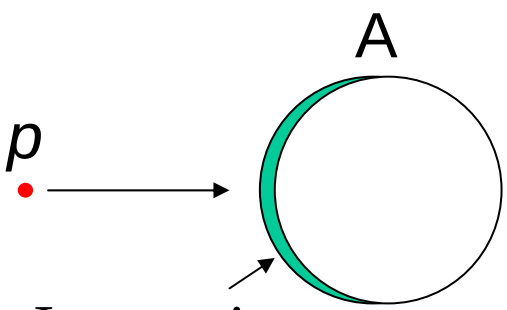
Simulation result

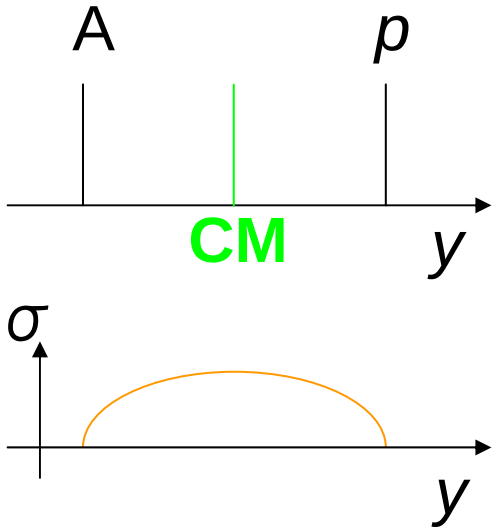


Differential cross sections



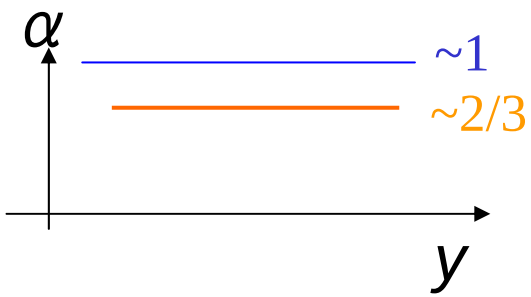
Primary / secondary reactions

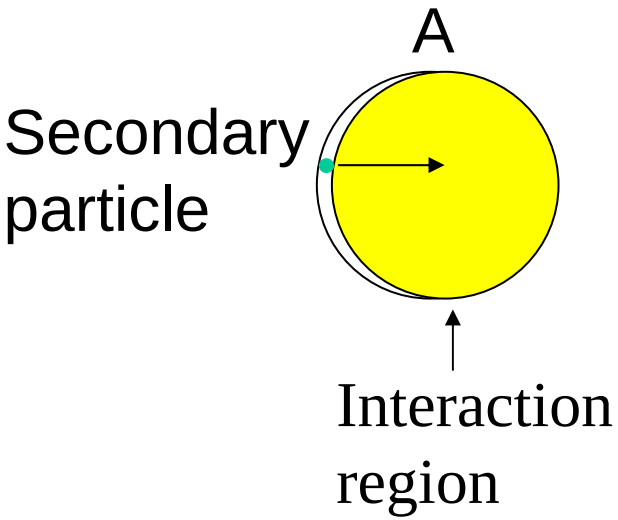


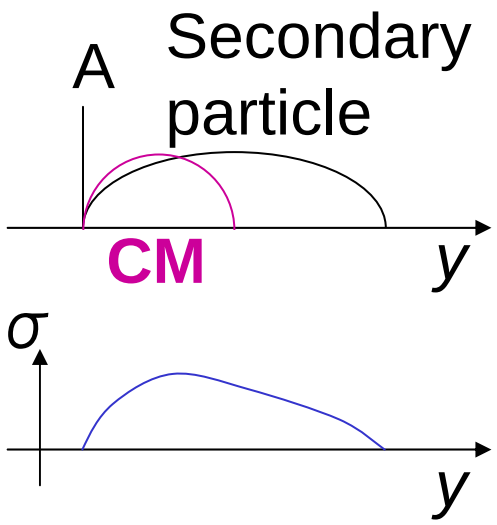


Mass number dependence α :

$$\sigma(A) = \sigma_0 A^{\alpha}$$

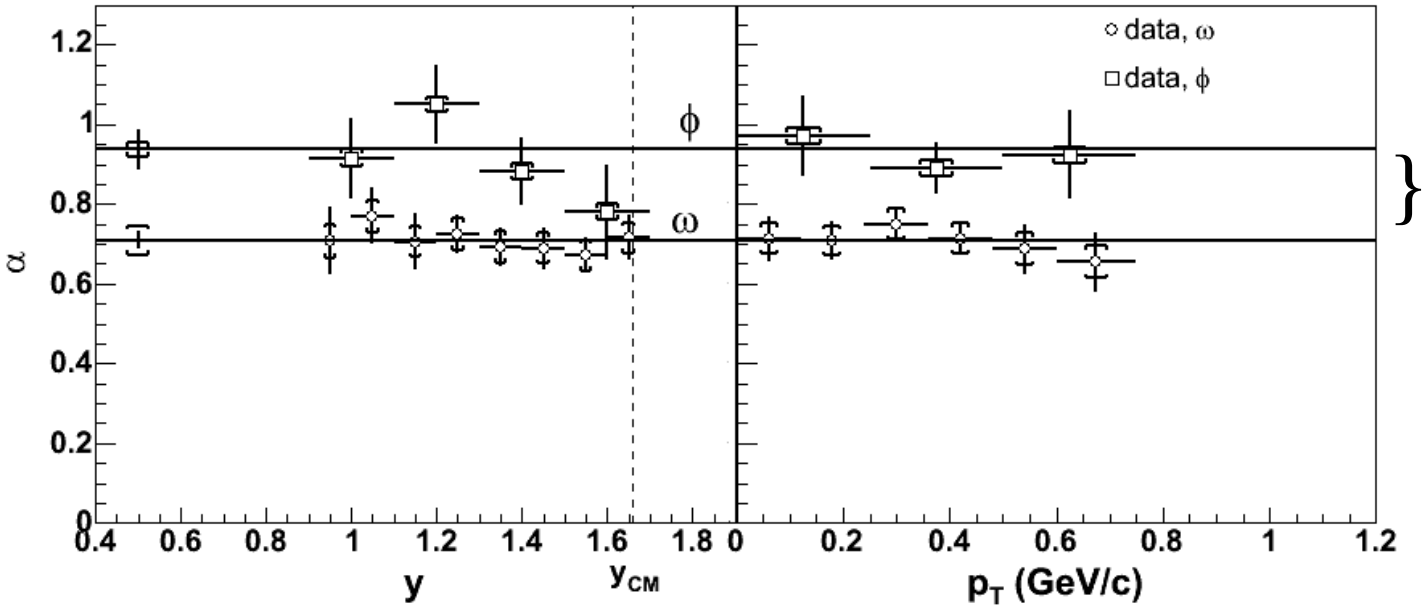






Nuclear mass number dependence

- Mass number dependence α : $\sigma(A) = \sigma_0 A^{\alpha}$

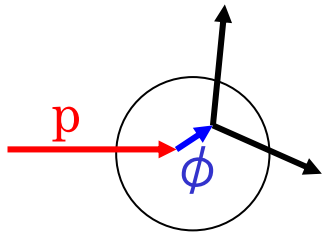


Suggest different production mechanism

- Possibly
  - **ϕ mesons in secondary reactions. (α =0.94)**
  - **ω mesons in primary + secondary reactions. (α =0.71)**

Mass modification

- Modified part
  - Mesons decayed in target nuclei.
  - Smaller mass.



inside decay

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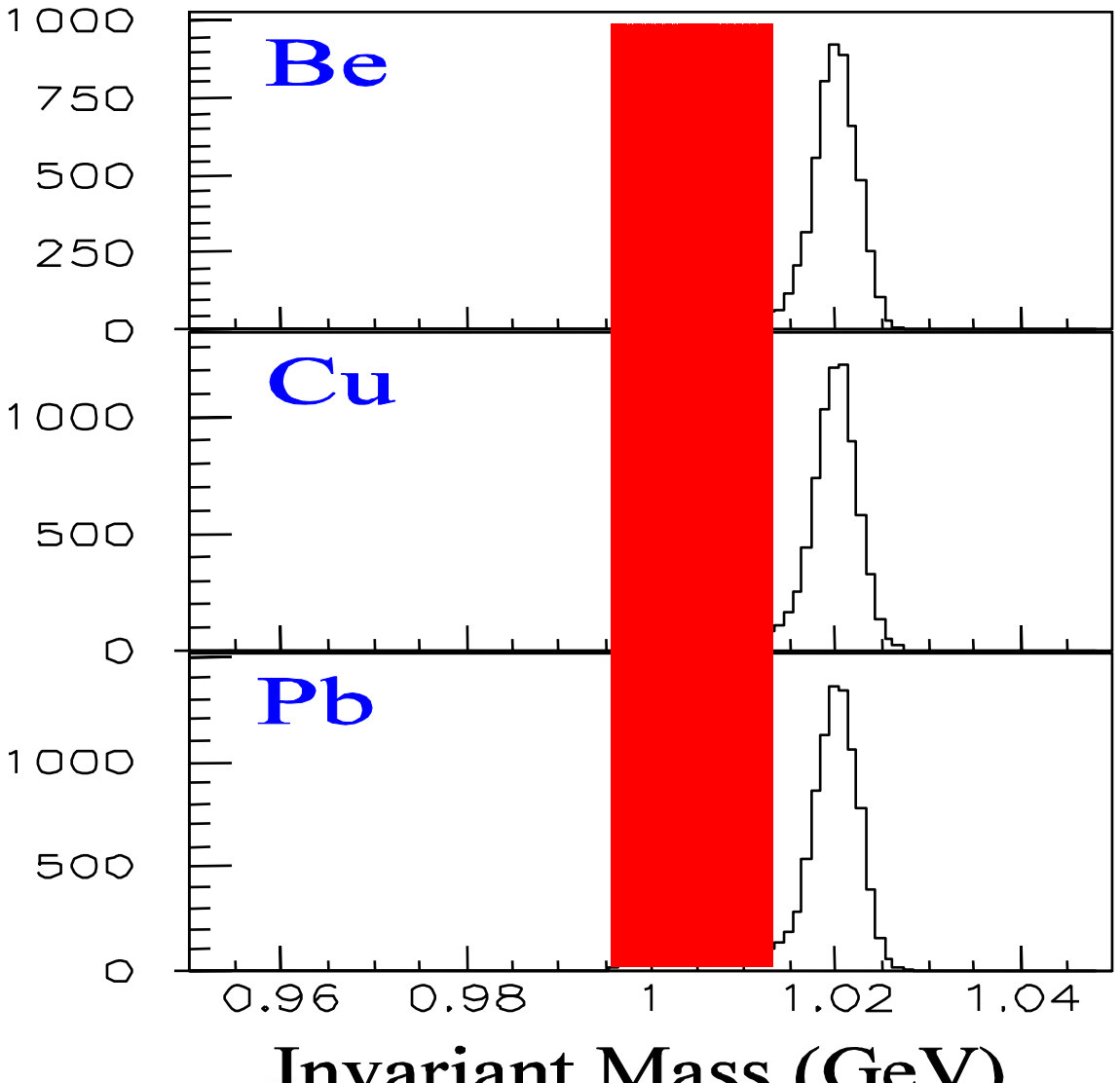
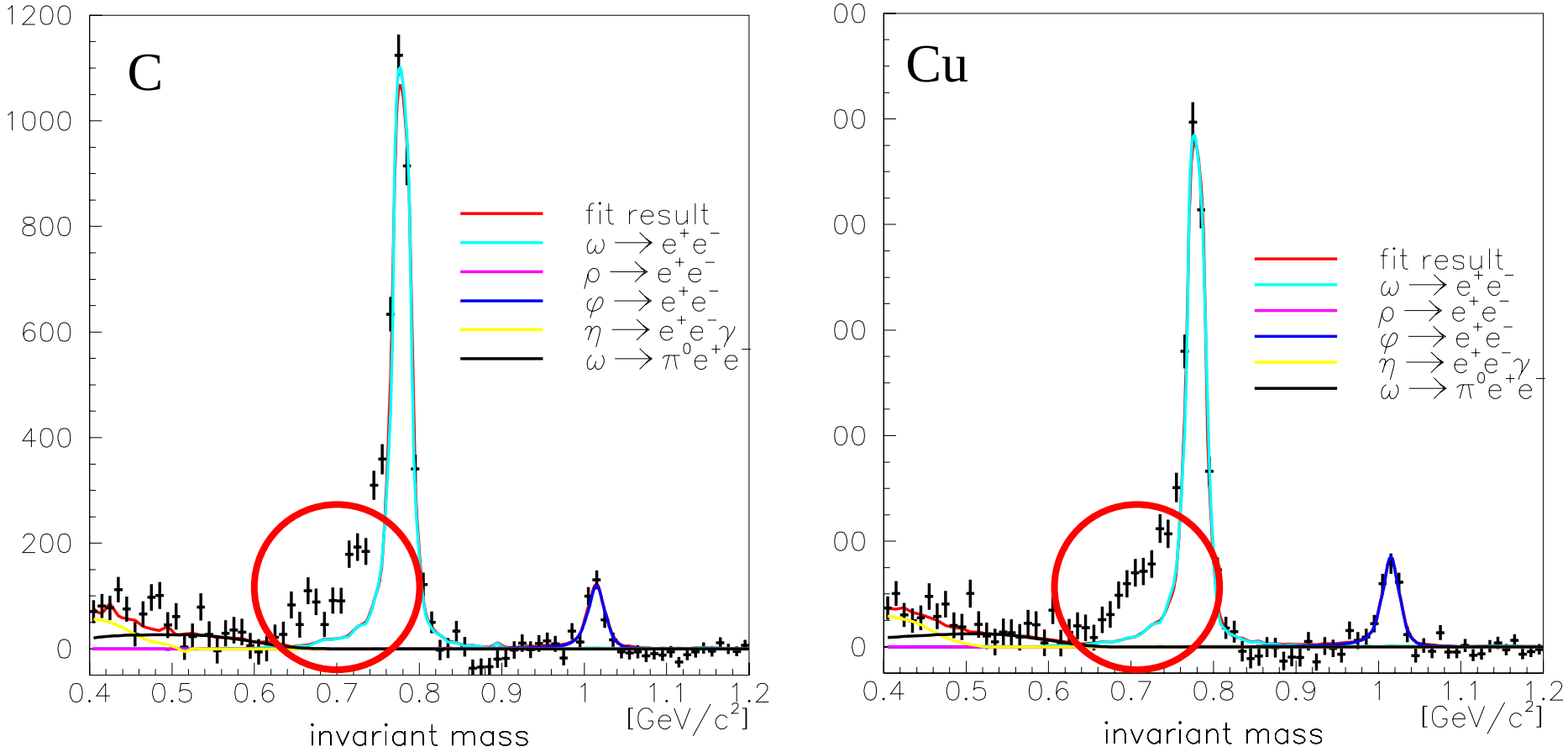
Simulation result

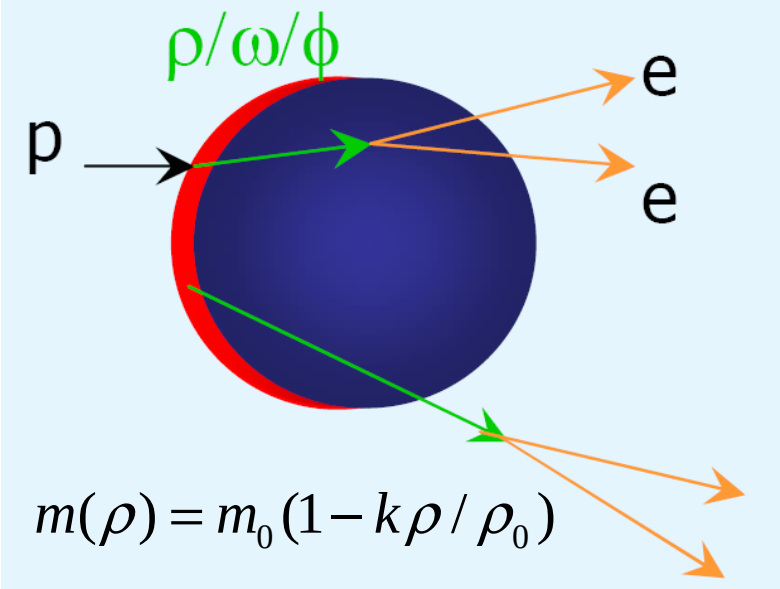


Excess at low mass side of ω



Clear excess from unknown source

Assumption by toy model

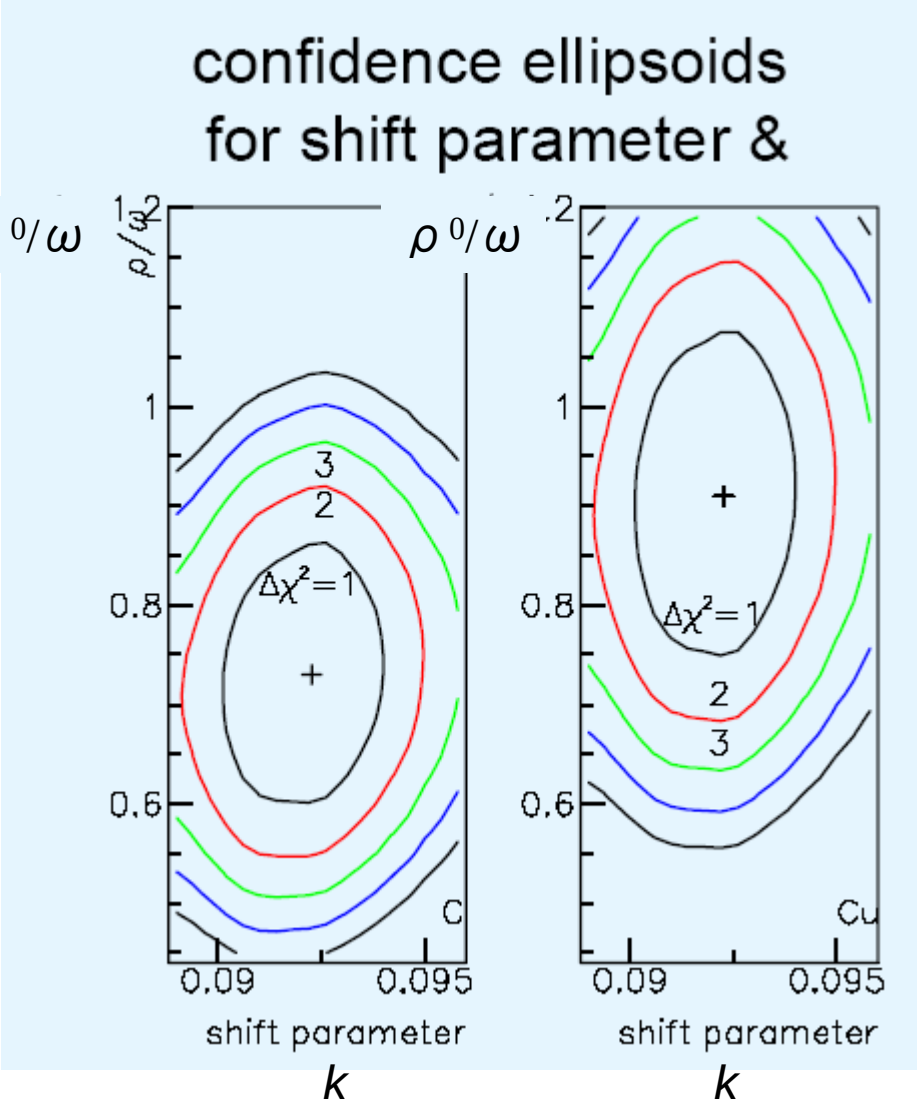


- production ratio ρ/ω VS shift parameter k
- Best-Fit value is

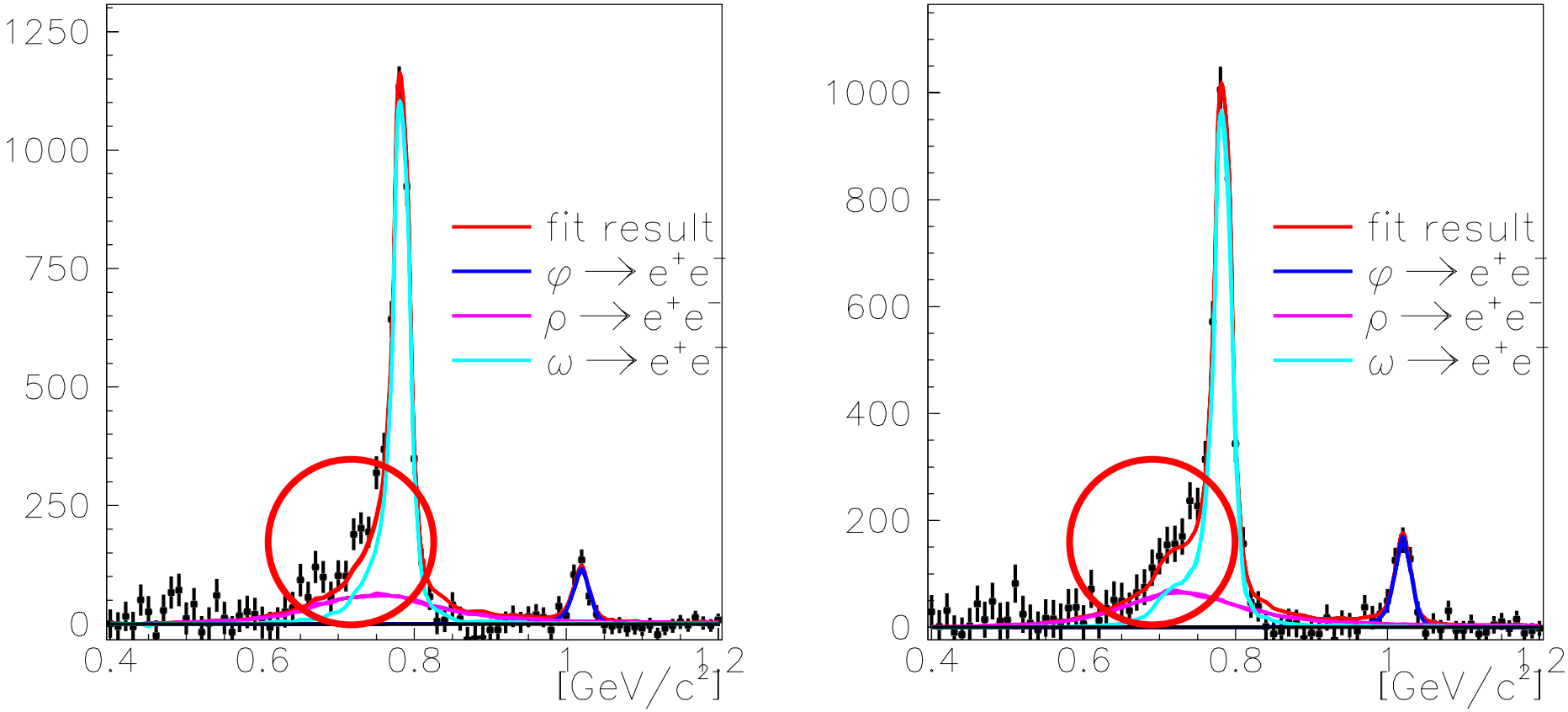
k= 0.092±0.002

ρ/ω = 0.7±0.1 (C)

0.9±0.2 (Cu)



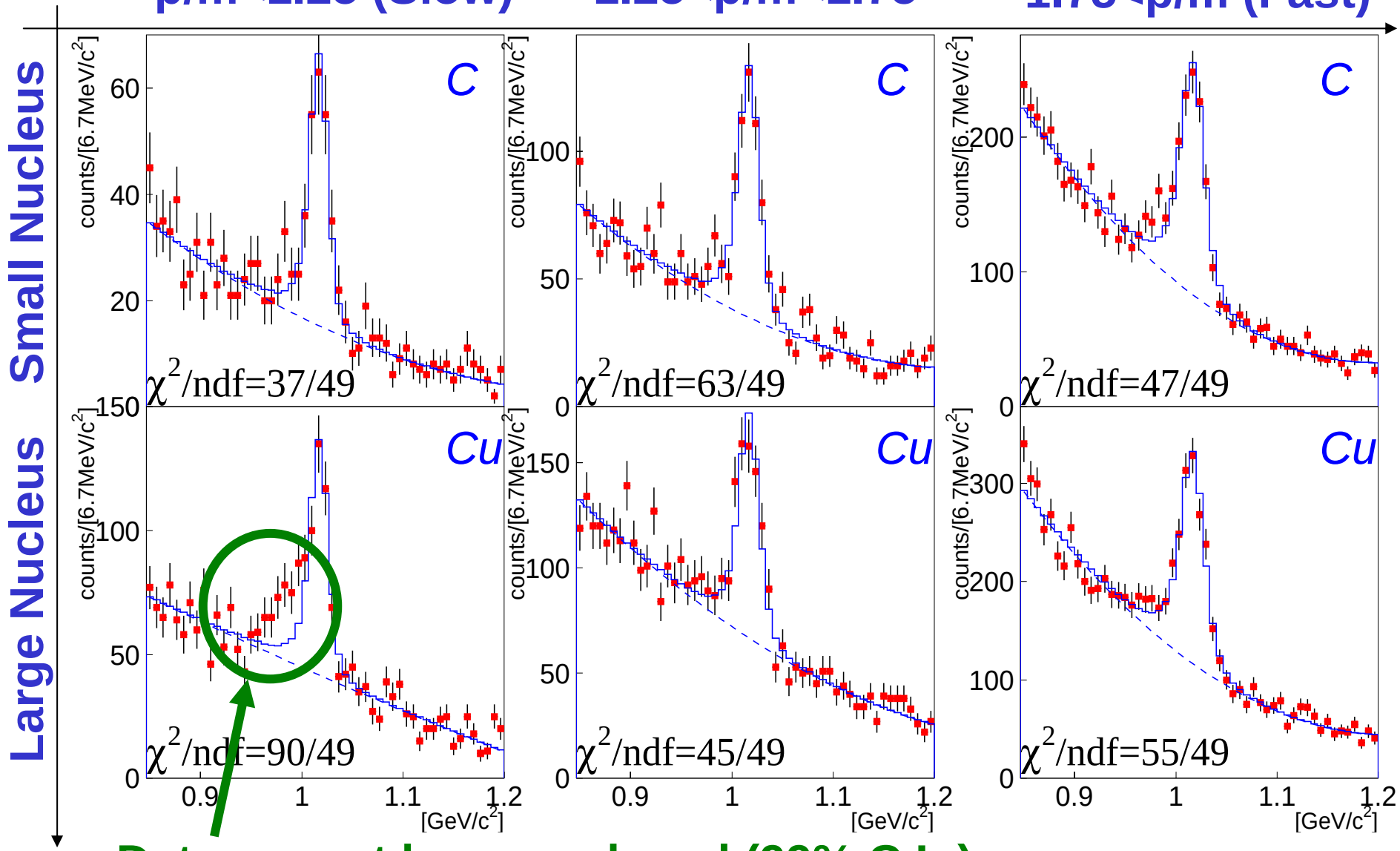
Fit using toy model spectra



- The excess is well reproduced.

→ **The excess component can be explained by modified ρ^0/ω.**

Excess at low mass side of ϕ



Data cannot be reproduced (99% C.L.)

Assumption by toy model

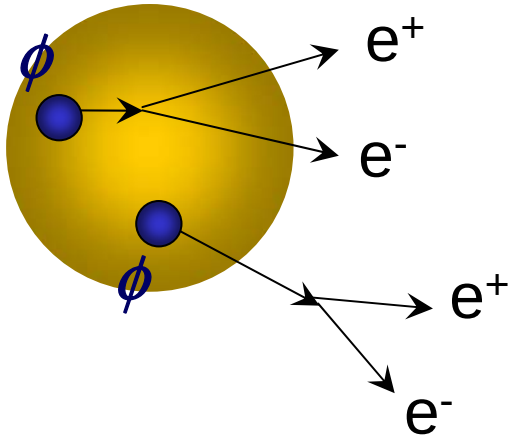
- ϕ mesons are generated uniformly in target nucleus
- momentum distribution: measured
- pole mass: $\mathbf{m^*/m = 1 - k_1\,\rho/\rho_0}$

  (from Hatsuda, Lee)

  → We set $k_1 = 0.04$
- decay width: $\mathbf{\Gamma^*/\Gamma = 1 + k_2\,\rho/\rho_0}$

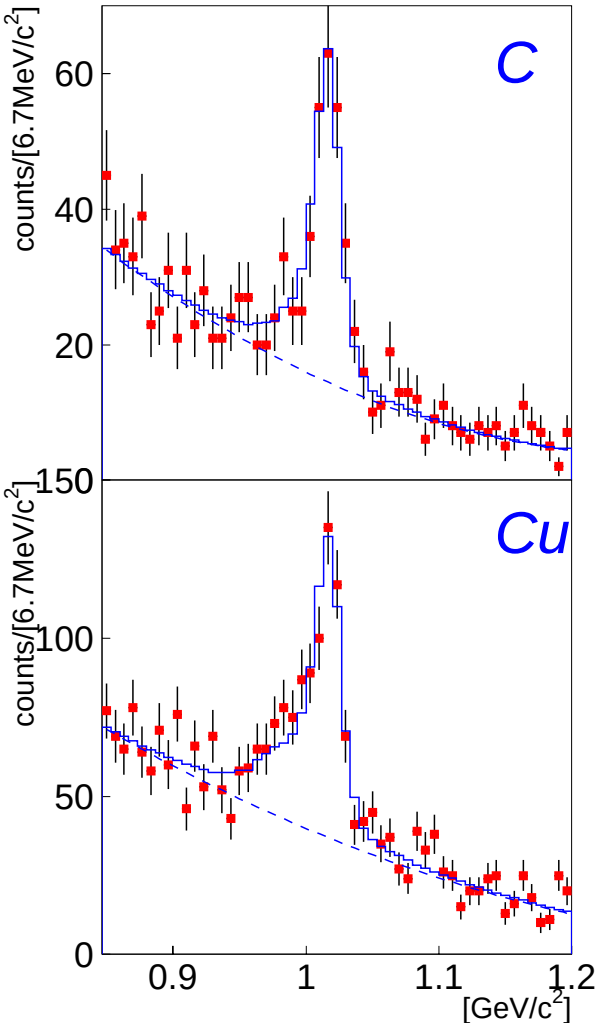
  → We set $k_2 = 10$

  (at $\rho=\rho_0$, Γ^*~48 MeV (from Klingl *et.al*))
- density distribution
  - Woods-Saxon
  - radius: C:2.3 fm/Cu:4.1 fm

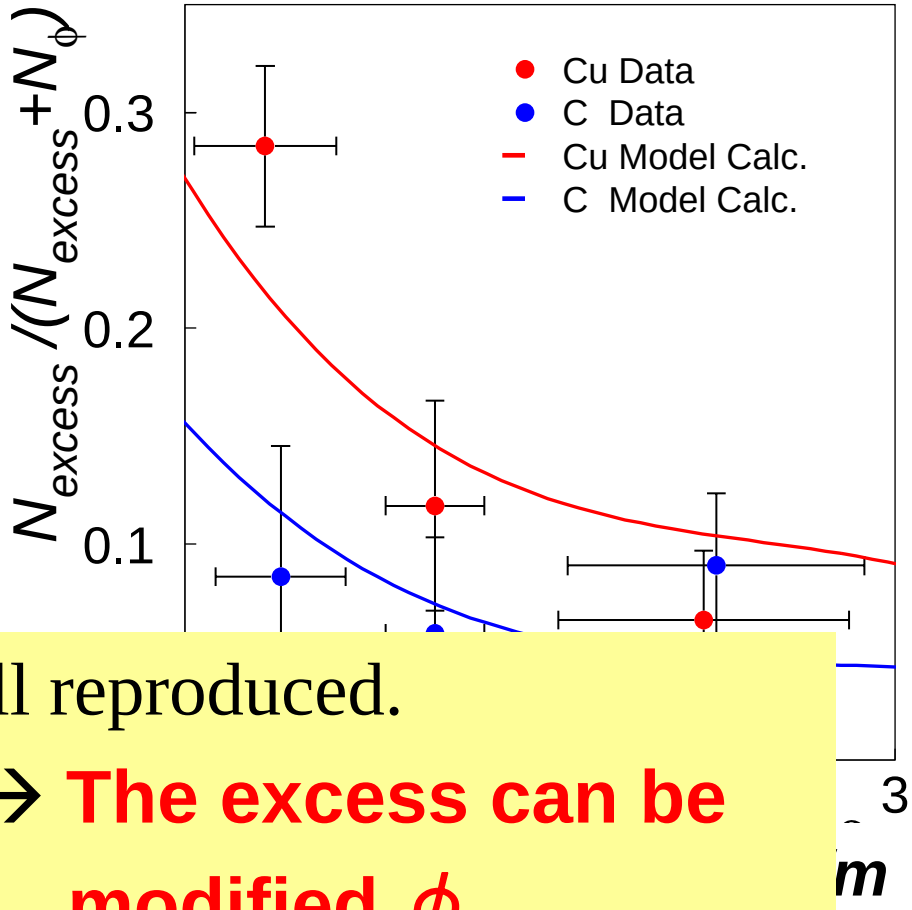


Fit using toy model spectra

p/m<1.25 (Slow)



Amount of Excess by Model Calc.



well reproduced.

→ **The excess can be modified ϕ.**

Summary

- KEK-PS E325
  - → slowly moving $\rho / \omega / \phi$ mesons
    e^+e^- decay channels
    12 GeV p + A reactions
- Cross sections & mass number dependences
  - → difference in productions mechanism of ω & ϕ mesons.
- Significant excesses at low mass sides of ω & ϕ mesons.
  - → modified mesons. (nucl-ex/0504016 & 0511019)
- The result of ϕ → K^+K^- coming soon...