

A piece of pQCD in Heavy Ion Collisions

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1. We describe parton model and its link to the heavy ion collision.
2. We describe our efforts in PHENIX single muon analysis along this goal.
3. We see an interesting possibility to utilize and enhance strength of Korea.

A picture of hadron

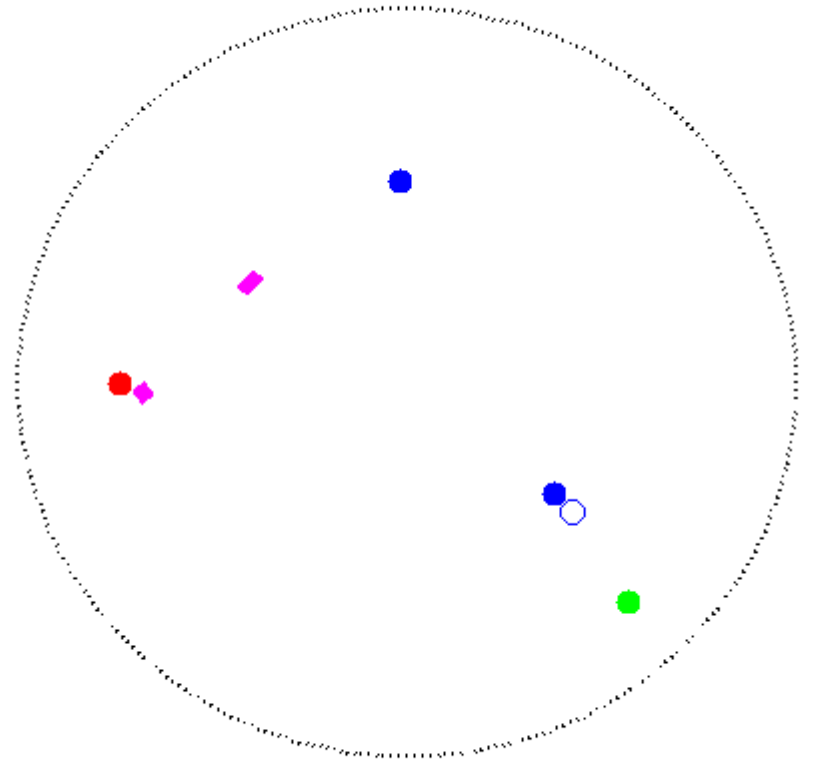
From hadron spectroscopy



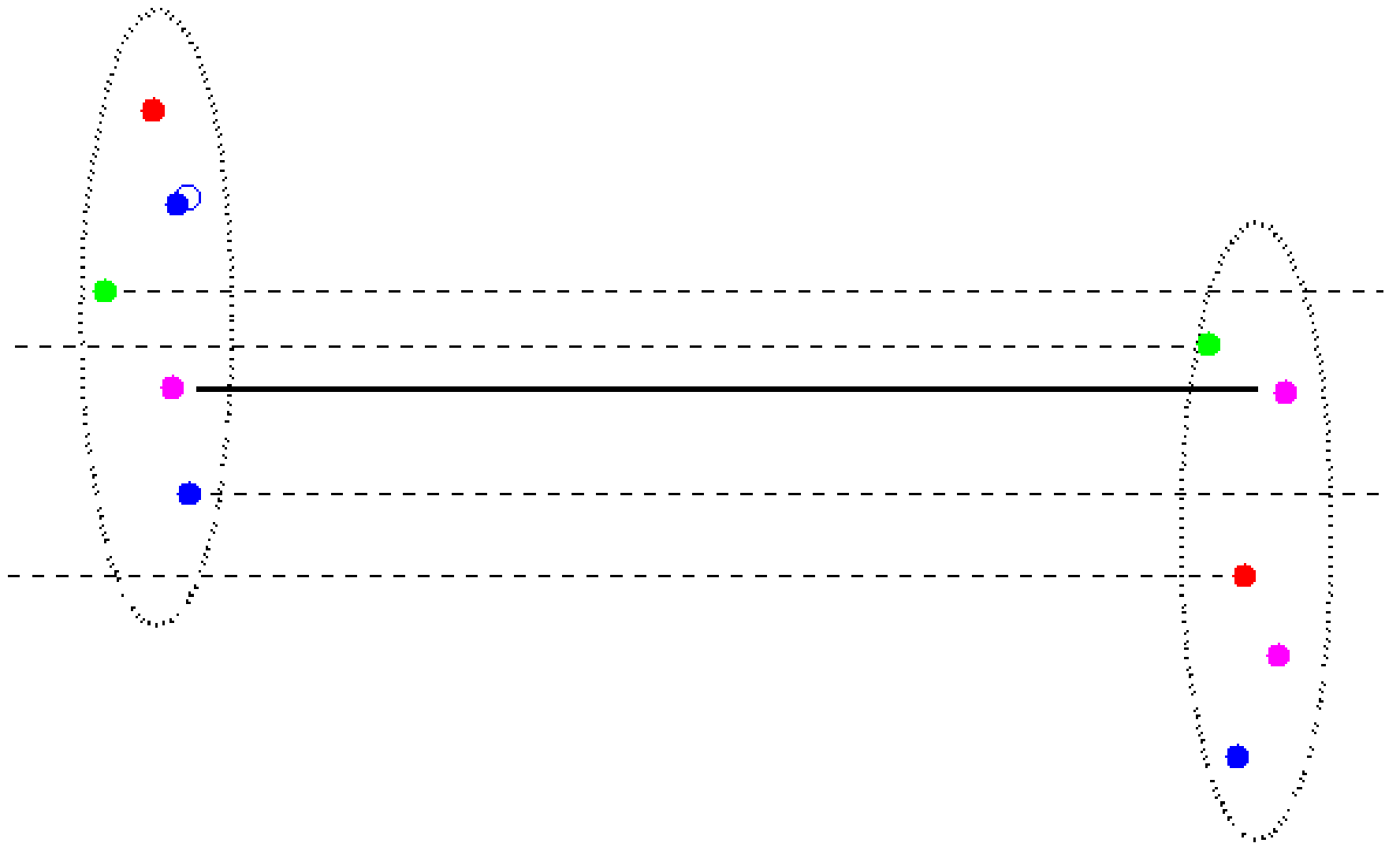
We know there are 2 or 3 quarks
Inside hadrons. Can we really see
them?

If we take a snapshot
with an exposure $\delta t \sim 2 \text{ fm}/c$,
range : $c \delta t \sim 2 \text{ fm}$,
virtuality : $\delta E \sim 0.1 \text{ (GeV)}$

For shorter exposure (harder
process), we see smaller scale



Evolution of hadron collision (slow movie)



New physics?

Factorization theorem

$$d\sigma [A+B \rightarrow H+X] = \sum_{ij} f_{i/A} \otimes f_{j/B} \otimes d\sigma [ij \rightarrow c\bar{c}+X] \otimes D_{c \rightarrow H} + \dots$$

$f_{i/A}, f_{j/B}$: distribution function for parton i, j

$D_{c \rightarrow H}$: fragmentation function for c

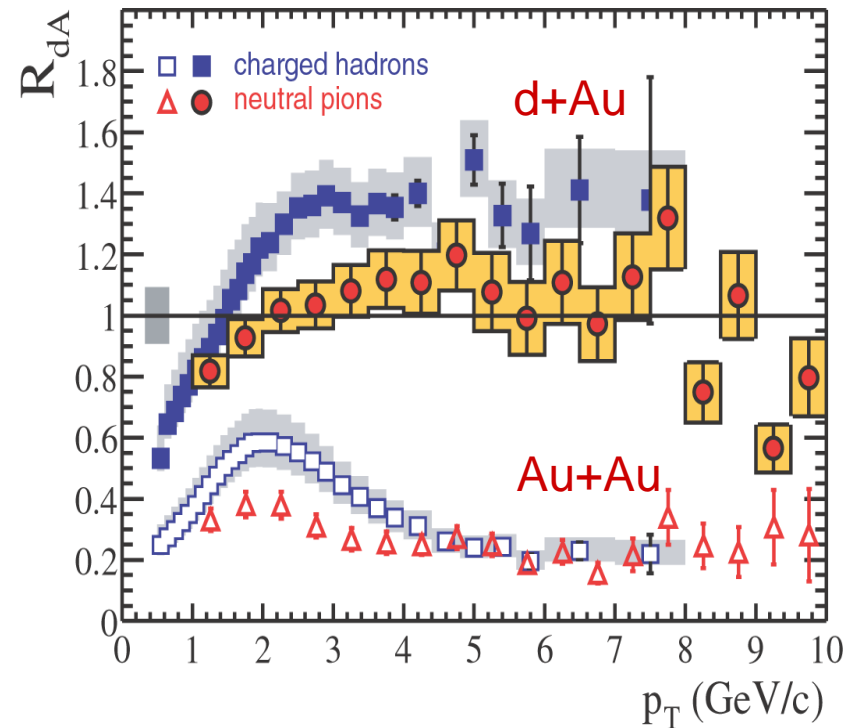
$d\sigma [ij \rightarrow c\bar{c}+X]$: parton cross section

+ ... : higher twist (power suppressed by Λ_{QCD}/m_c , or Λ_{QCD}/p_t if $p_t \gg m_c$):
e.g. "recombination" PRL, 89 122002 (2002)

Application to nuclei:

$$f_{i/\text{Au}} \approx 79 f_{i/p} + 118 f_{i/n} \approx 197 f_{i/N}$$

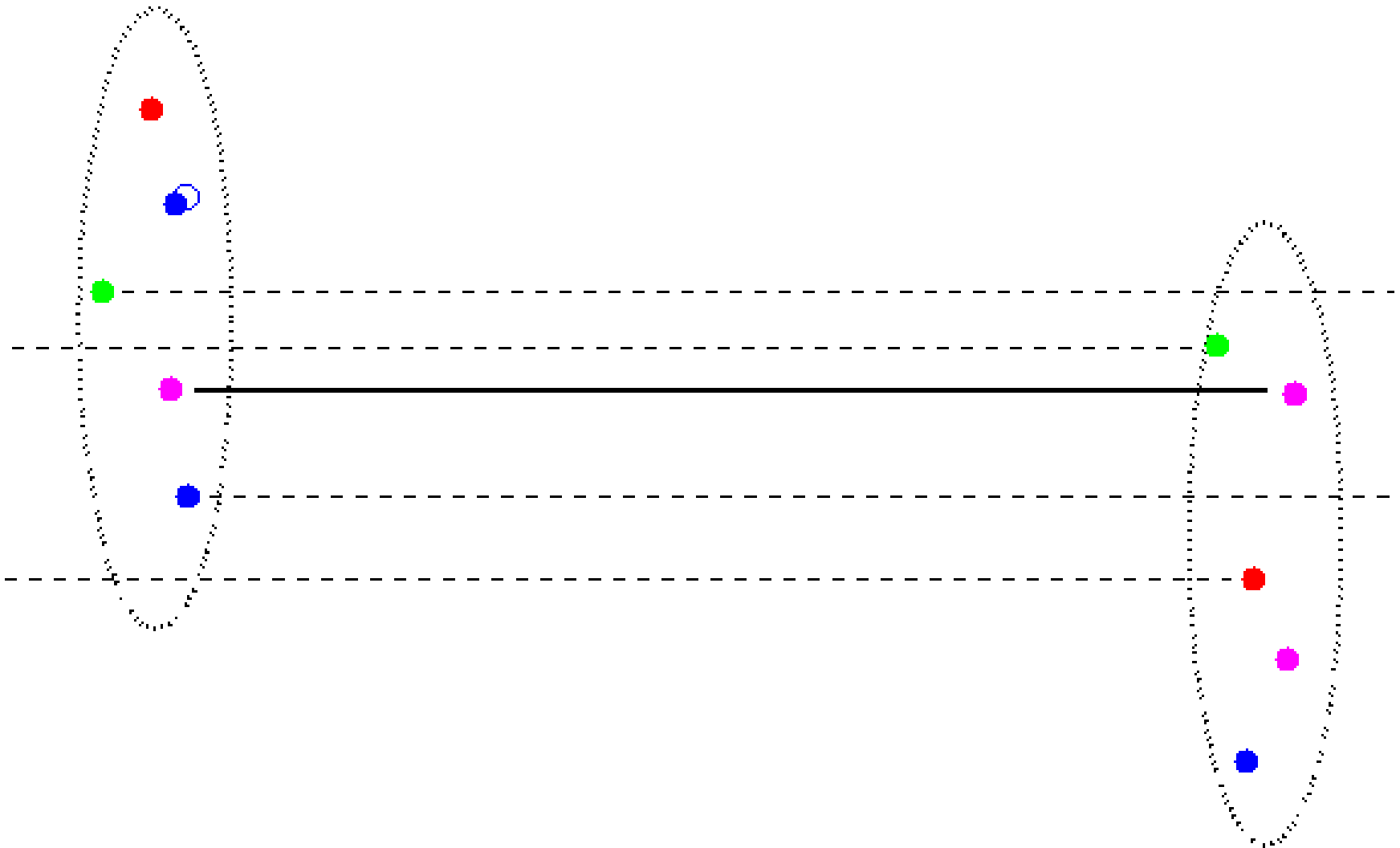
$$f_{i/d} \approx f_{i/p} + f_{i/n} \approx 2 f_{i/N}$$



Binary scaling not working
for high p_t particles in central AuAu collisions!

PHENIX: PRL, 91, 072303 (2003)

Lepton from the heavy flavor decay



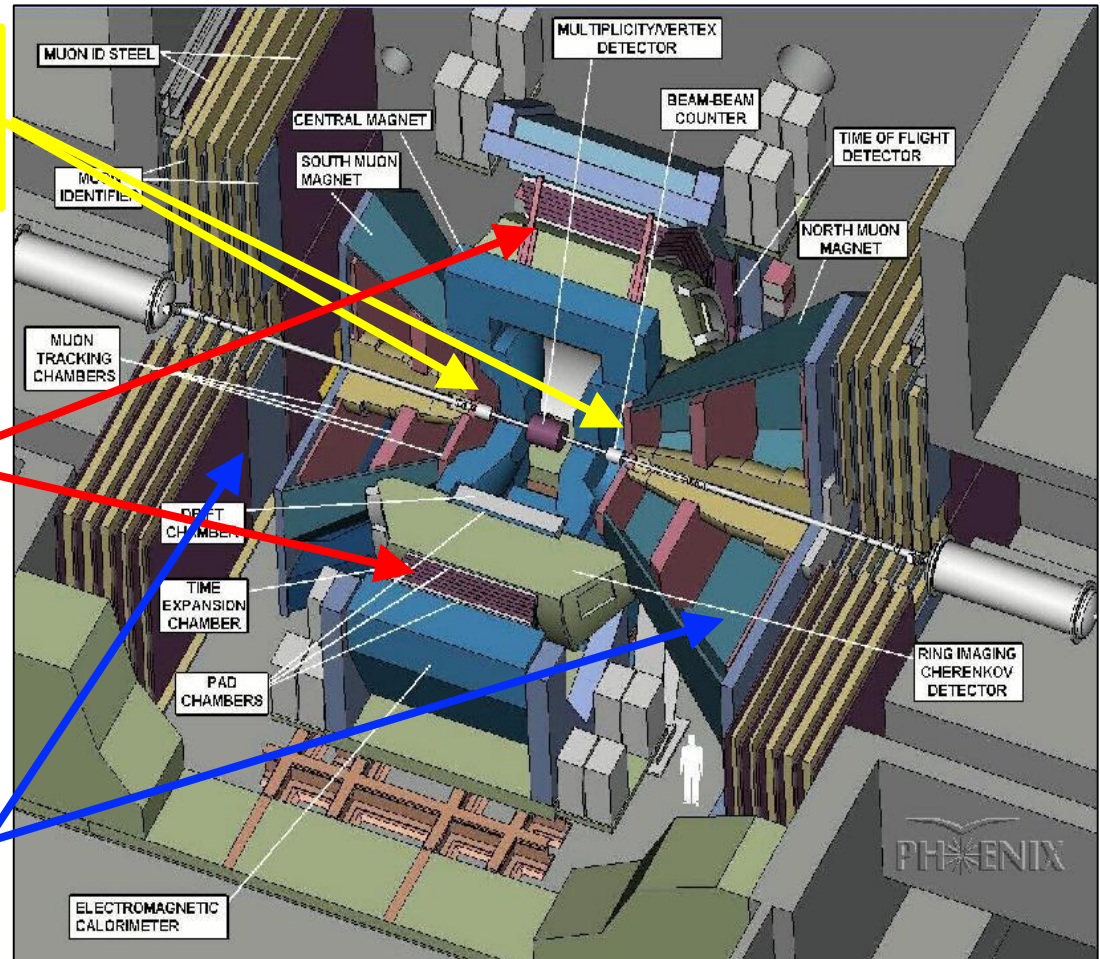
The PHENIX Experiment

(12 Countries; 58 Institutions; 480 Participants as of January 2004)

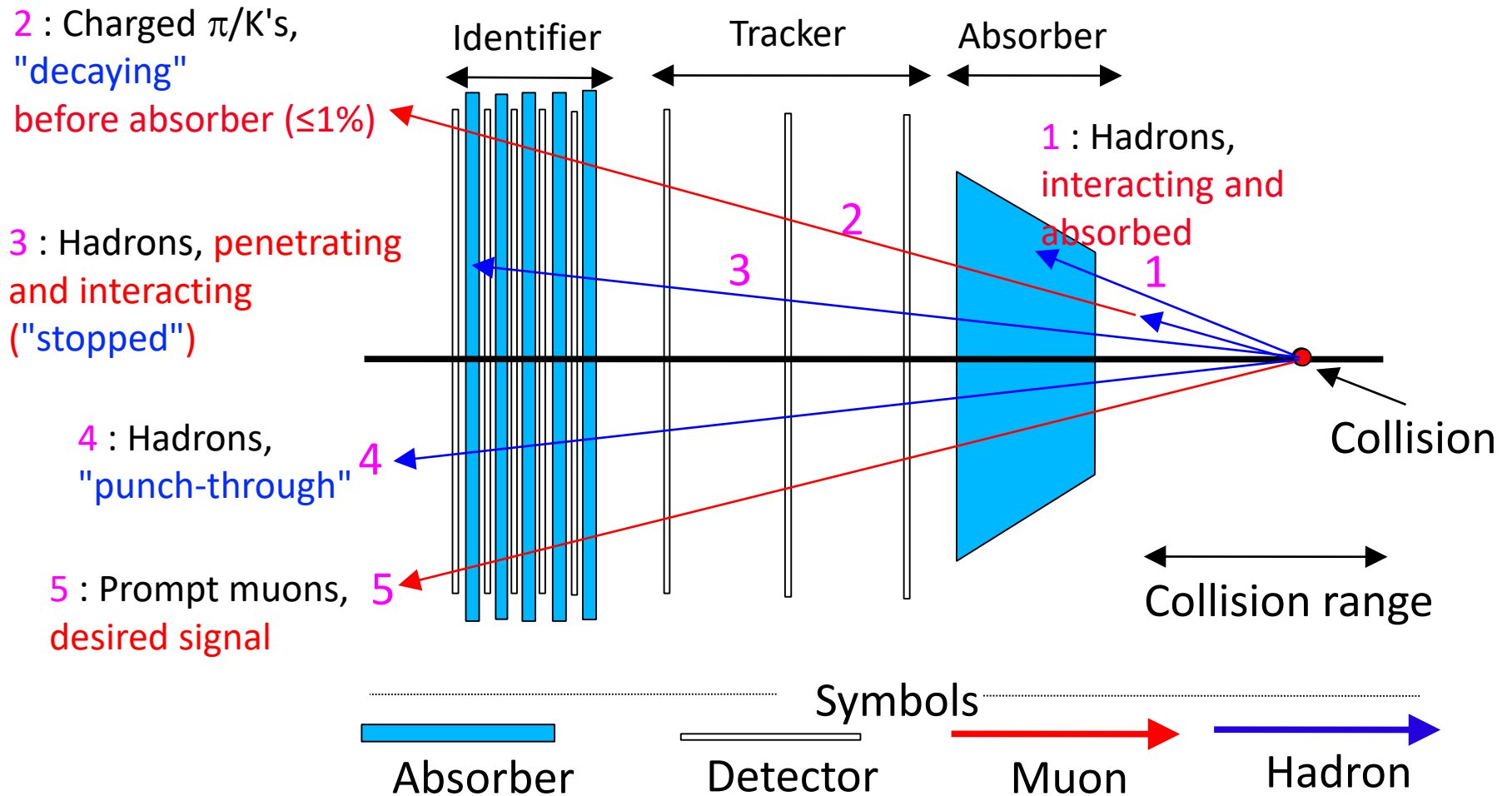
Event characterization
detectors

Two **central** arms for
measuring hadrons,
photons and electrons

Two **forward** arms for
measuring muons

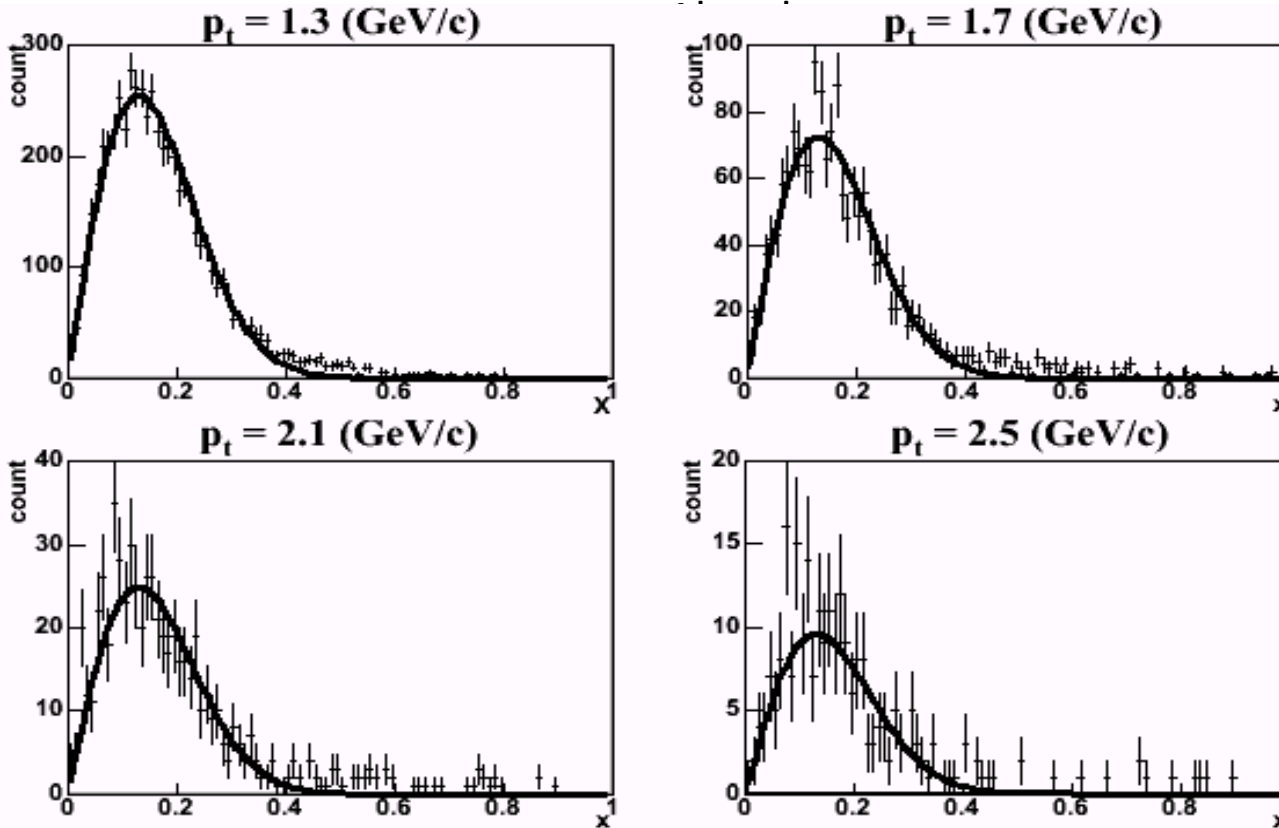


Major sources of inclusive tracks



Purity of track?

DATA



Dominant
Multiple Scattering

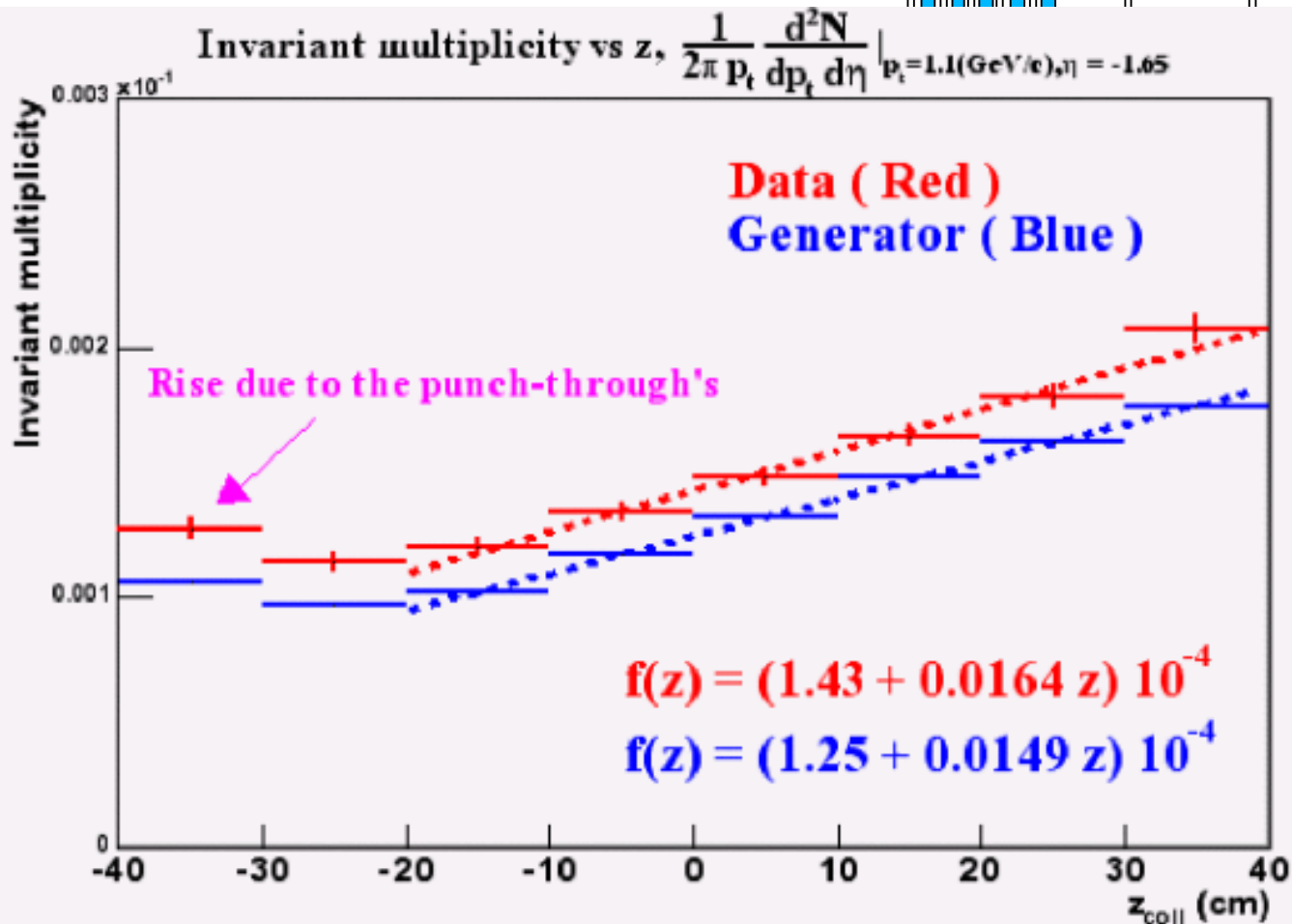
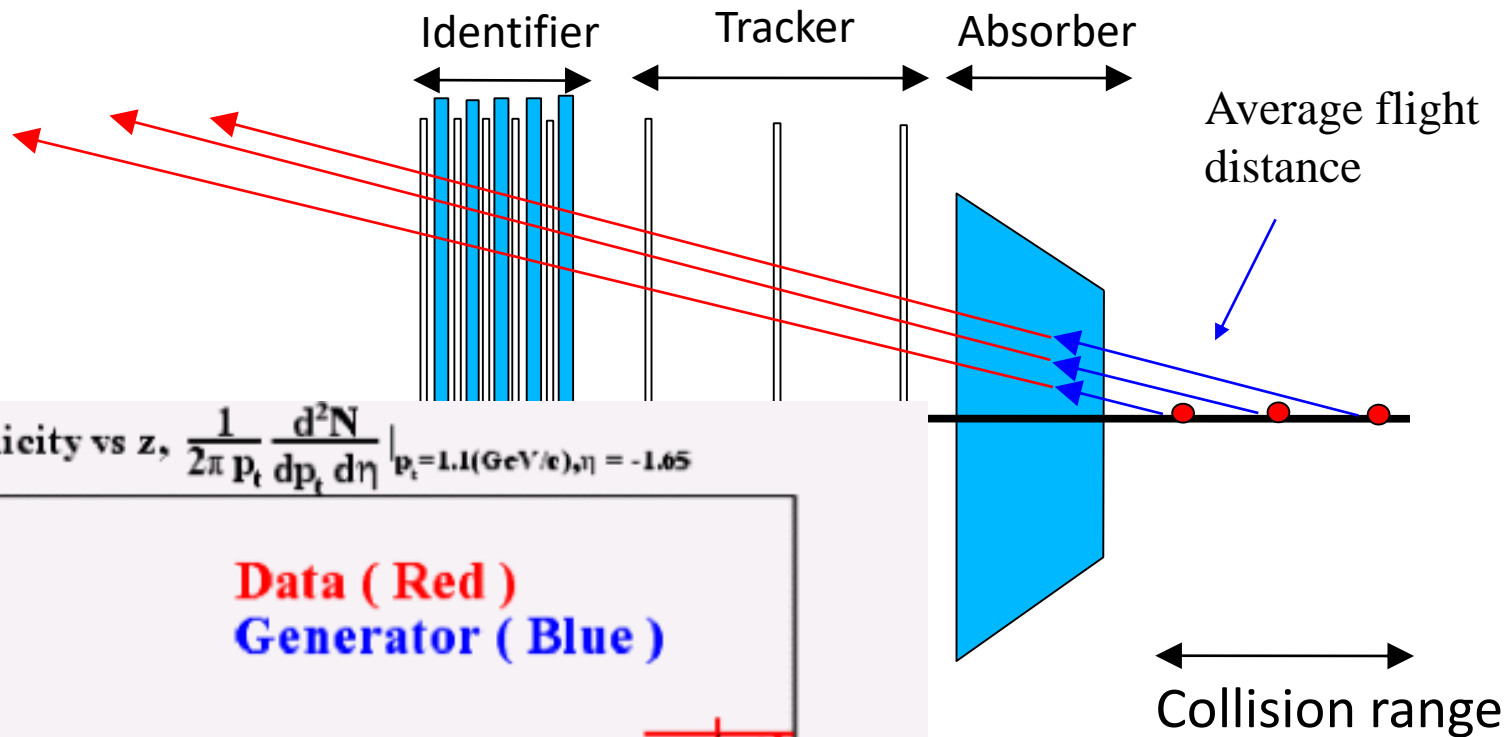
$$X \equiv p_{\text{mean}} \delta\theta$$

$$f(X) = C_0 X \exp\left(-\frac{X^2}{2\sigma^2}\right)$$

$$\sigma \sim 0.13 \text{ (GeV/c)}$$

Determined by
absorber thickness

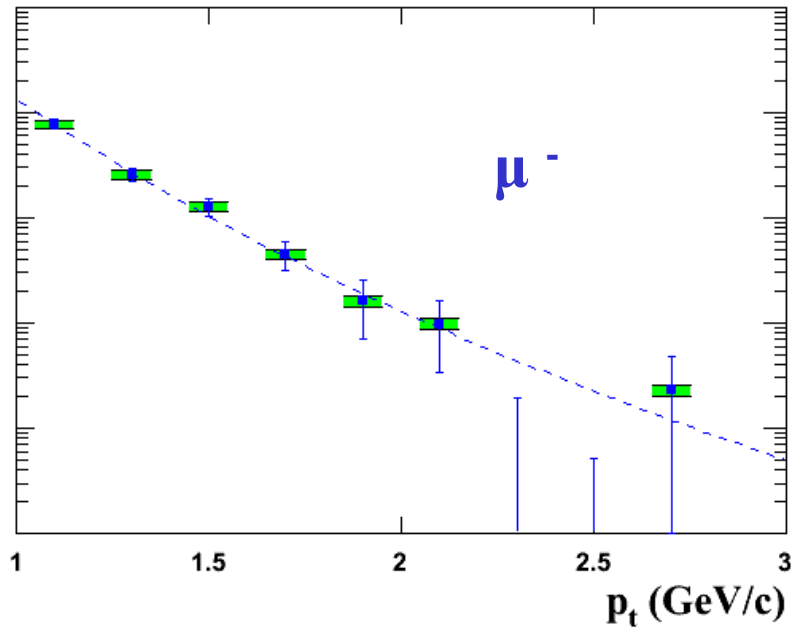
Charged π/K 's, "decaying" before absorber



Decay muons as Signals !

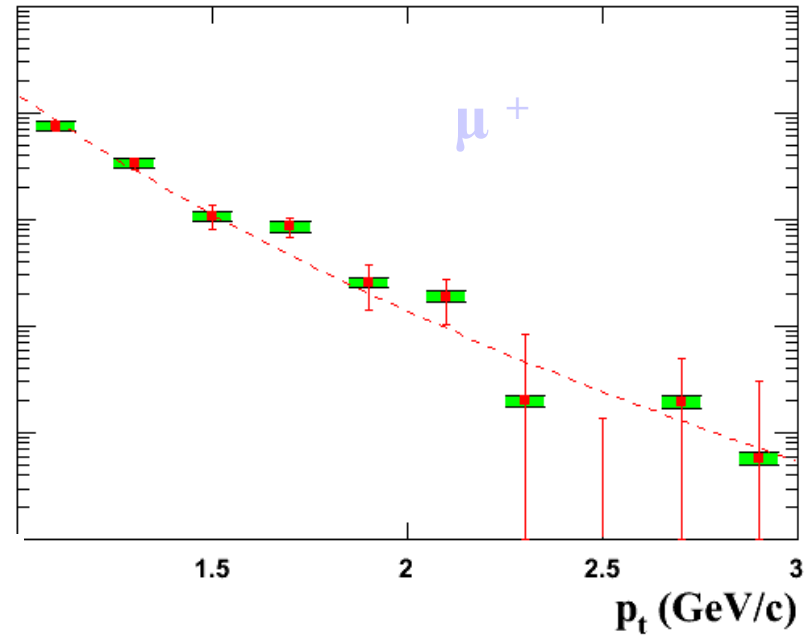
$1/2\pi p_t d^2N/dp_t d\eta dl$

μ^- 's, minimum bias pp at $\sqrt{s} = 200\text{GeV}$



$1/2\pi p_t d^2N/dp_t d\eta dl$

μ^+ 's, minimum bias pp at $\sqrt{s} = 200\text{GeV}$



Red and blue lines show
statistical uncertainty.

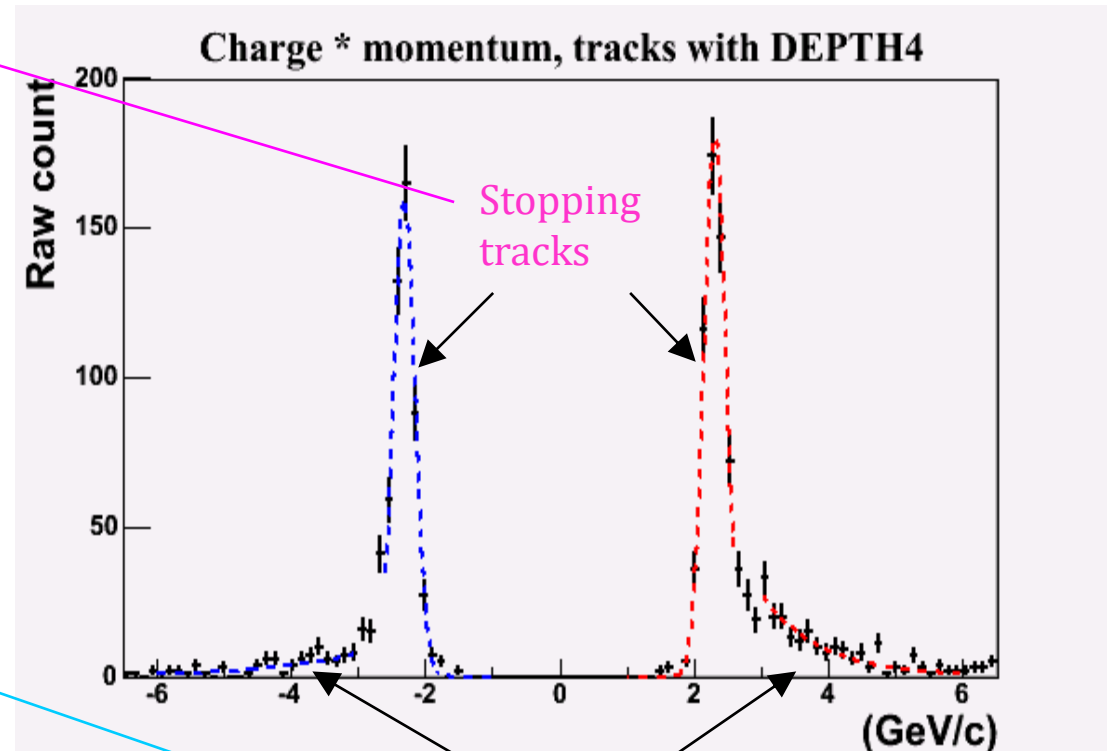
Green band represents
systematic uncertainty.

Red and blue dotted lines
correspond to expectation.

Hadrons, penetrating and interacting ("stopped")

Momentum distribution of the tracks with DEPTH 4

Lose all of its energy by ionization

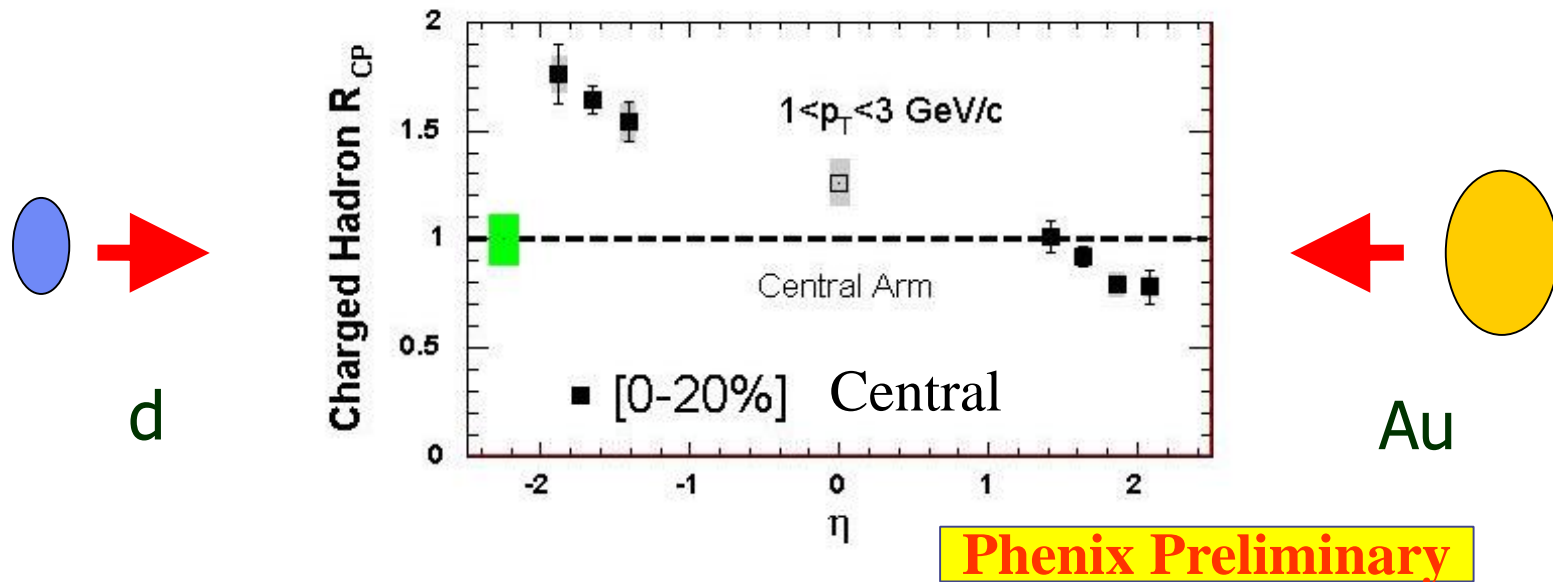


Large momenta to reach the last MuId layer, but hadron interaction in the last absorber layer to stop before last MuId layer.

Interacting hadrons

Hadrons as Signals !

As a by-product, measured backgrounds (abundant hadrons, especially stopped hadrons in MuId) also lead to an interesting physics (study of shadowing/saturation).



R_{cp} : nuclear modification factor

Depletion on the d-going side (low x partons in Au) :

Shadowing/suppression region (depletion of low x in Au compared to nucleon)

Prompt muon production: In Progress

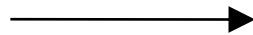
Remaining to the measurement of the prompt μ yields,

$$N_{\text{inclusive}} - N_{\text{decay}} - N_{\text{punch through}} = N_{\text{prompt}} + N_{\text{background}}$$

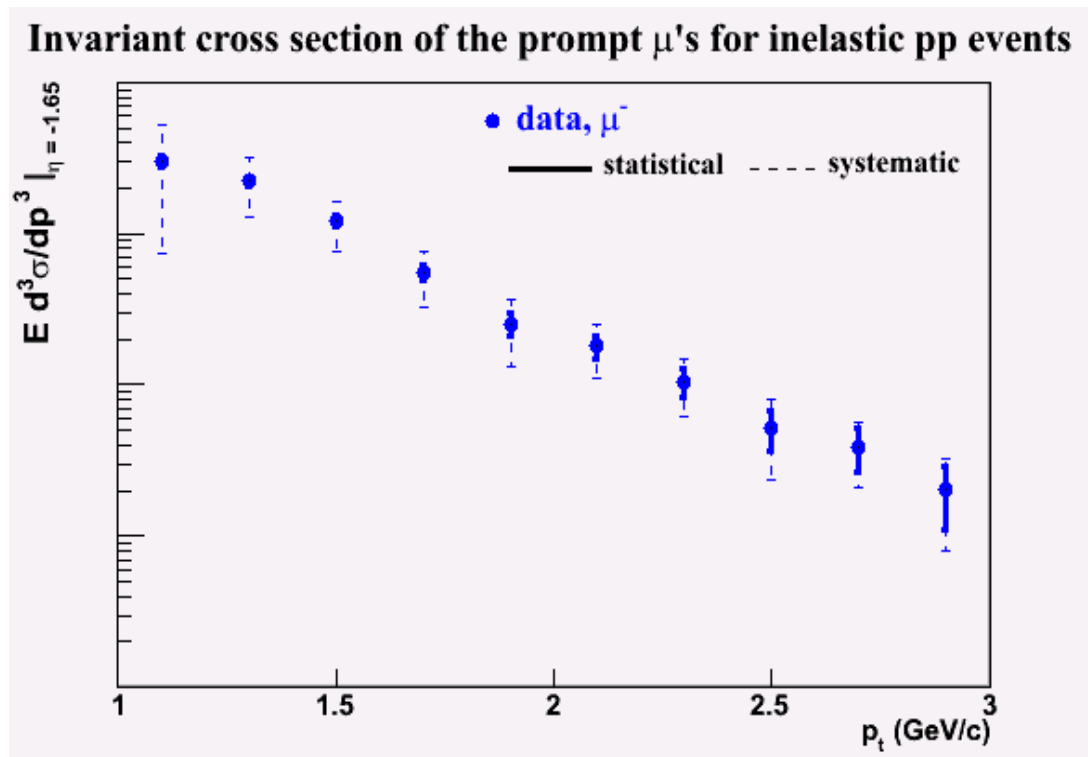
In Control

(about 10-20%)

Expected plot



No absolute value yet;
It's a big collaboration...



A rising problems in current/future experiment

Quickly developing data collection capability (~ a few Tbyte/day as of today) produces a big challenge and many limitations to the data processing and subsequent analysis.

This is especially so in the heavy ion experiment where data serve various possibilities and **experimental trigger is limited**.

→ **Currently occurring to PHENIX.**

Possibilities in Korea

Domestic production of key computer parts :

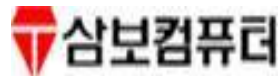
Memory ~ **big program & multiple processes**

hard disk ~ effective low cost storage

(**instantly, simultaneously & randomly accessible**)



Popular uses of PC's ~ **omnipresent in low duty factor**



Exploration & utilization?

Current group **experienced substantial** for the analysis from this advantage. Even **help** creator possibility is seen if we gain additional experiences. **Competative data processing and analysis will be possible with this.**