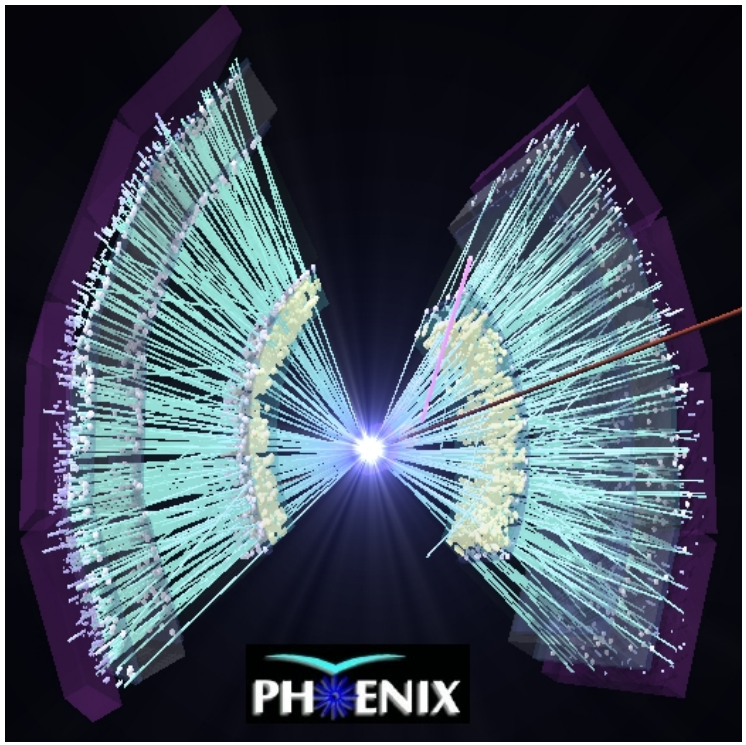
Heavy flavor production from single muons in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV



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APS/JPS Meeting
Hawaii 2005

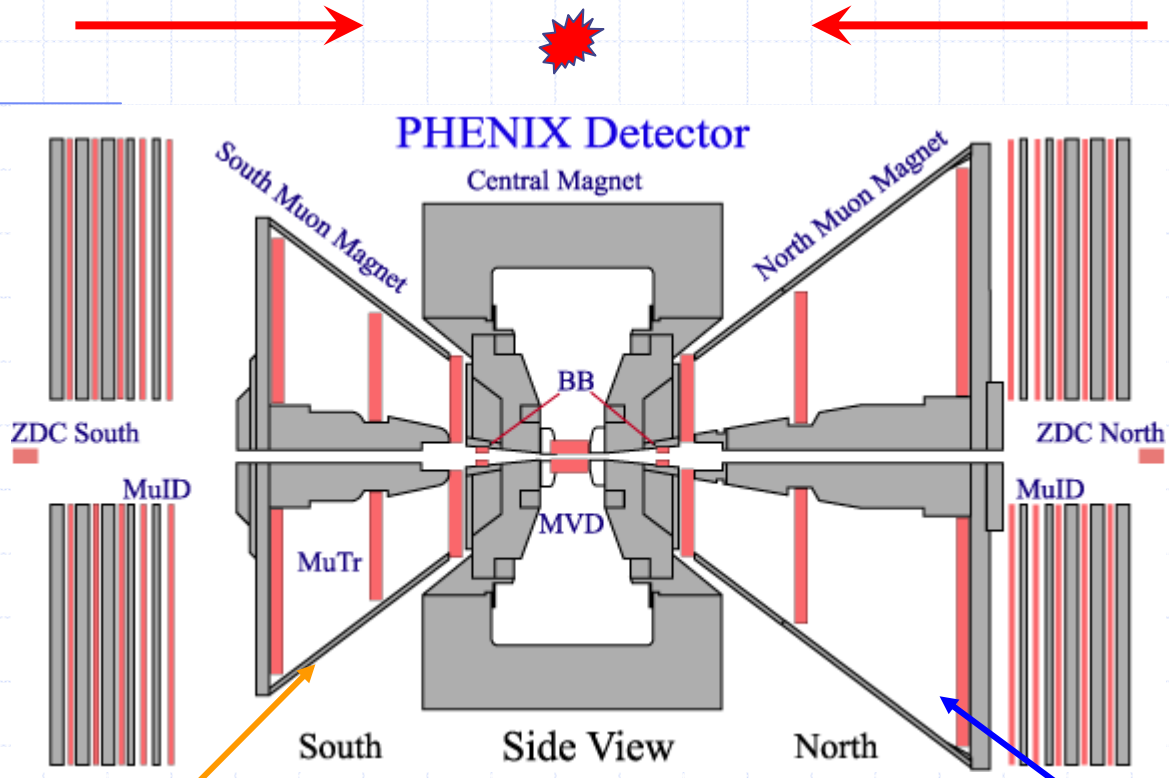
Why charm?

- Hard collisions can lead to charm production via g+g fusion.
- Open charm (as opposed to bound states) is an important baseline for J/Ψ production.
- Momentum modification R_{AA} and flow v_2 measurements can shed light on energy loss for heavy quarks.
- Work by Teaney and Moore shows correlation between suppression R_{AA} and momentum anisotropy for heavy quarks.
- Charm energy loss expected to be different compared to that of light quarks (E.g. dead cone effect [Djordjevic and Gyulassy]).

How can we measure charm?

- Primarily through semi-leptonic decays of D mesons to μ and e.
- μ measurements in muon arms:
  - R_{AA}
  - Spectra
  - Flow v_2
- WARNING: this is work in progress...

The PHENIX Detector



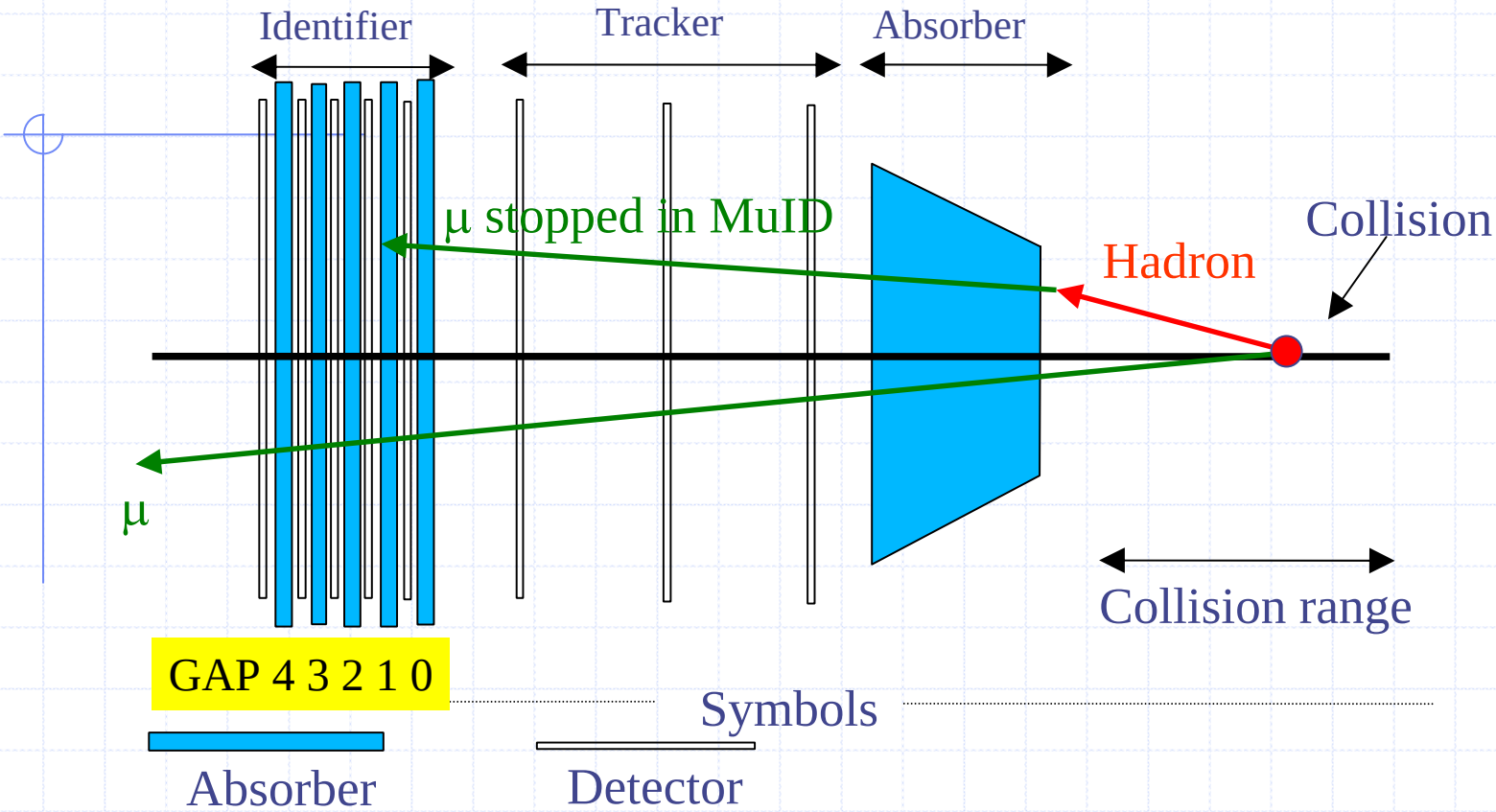
South Muon arm : $-2.2 < \eta < -1.2$

North Muon arm : $1.2 < \eta < 2.4$

Muon selection

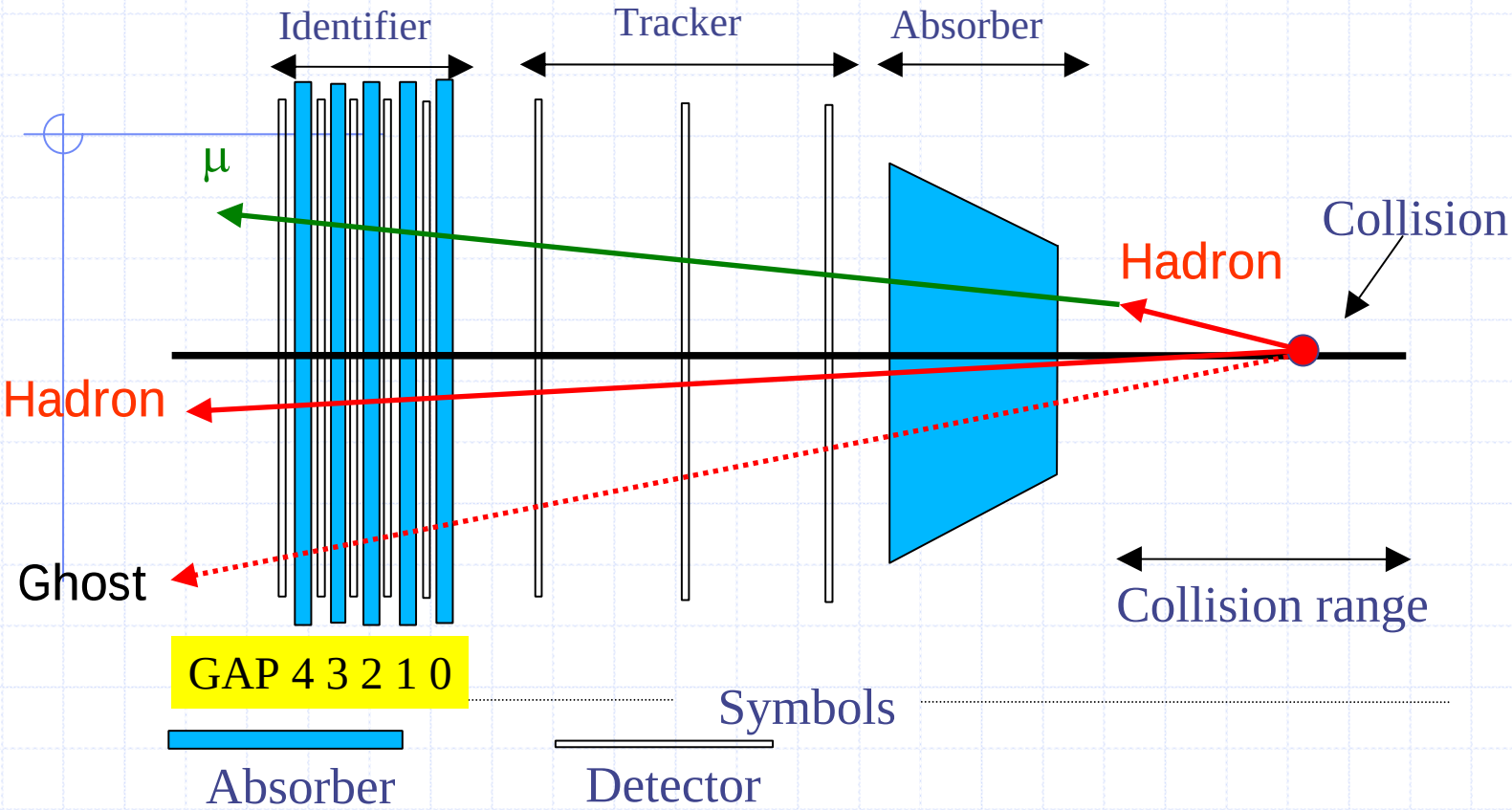
- PHENIX Muon arms can be used to detect muons by two methods:
  - Low p_T muons which penetrate partway into the MuID steel and stop.
  - High p_T muons which penetrate to the last layer of the MuID.

Major Sources of Muon Tracks



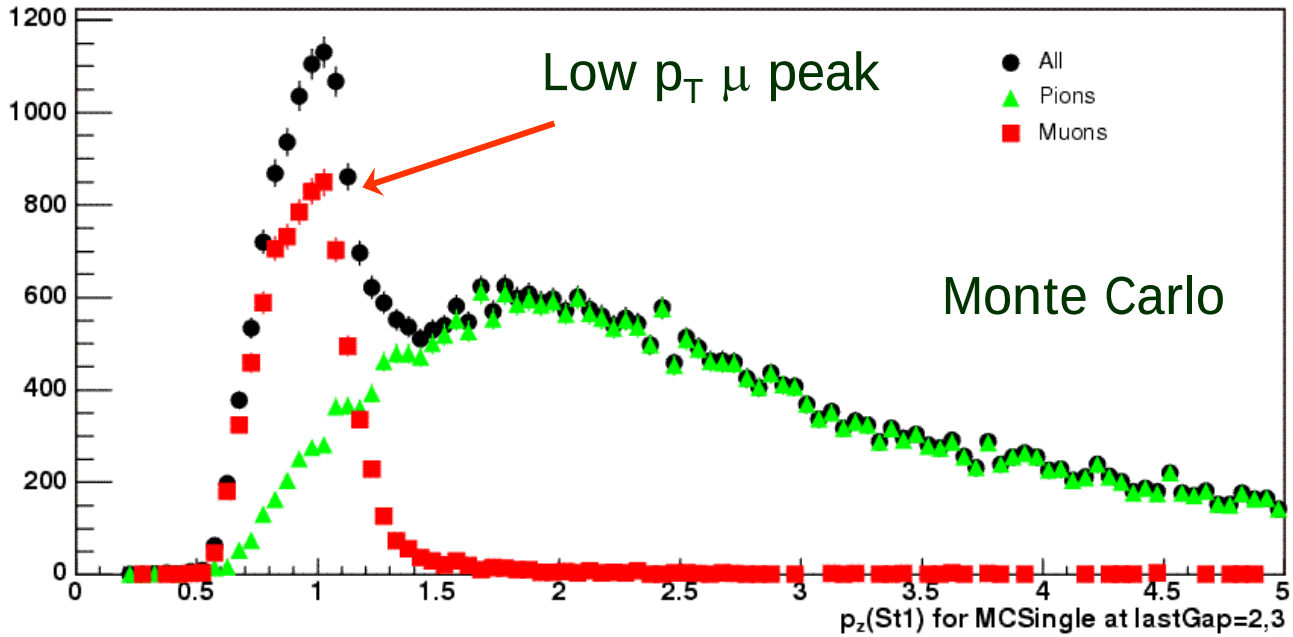
1. Low pT muons stopped in shallow gaps.
2. High p_T muons which go the last Gap of MuID

Major Sources of Background Tracks



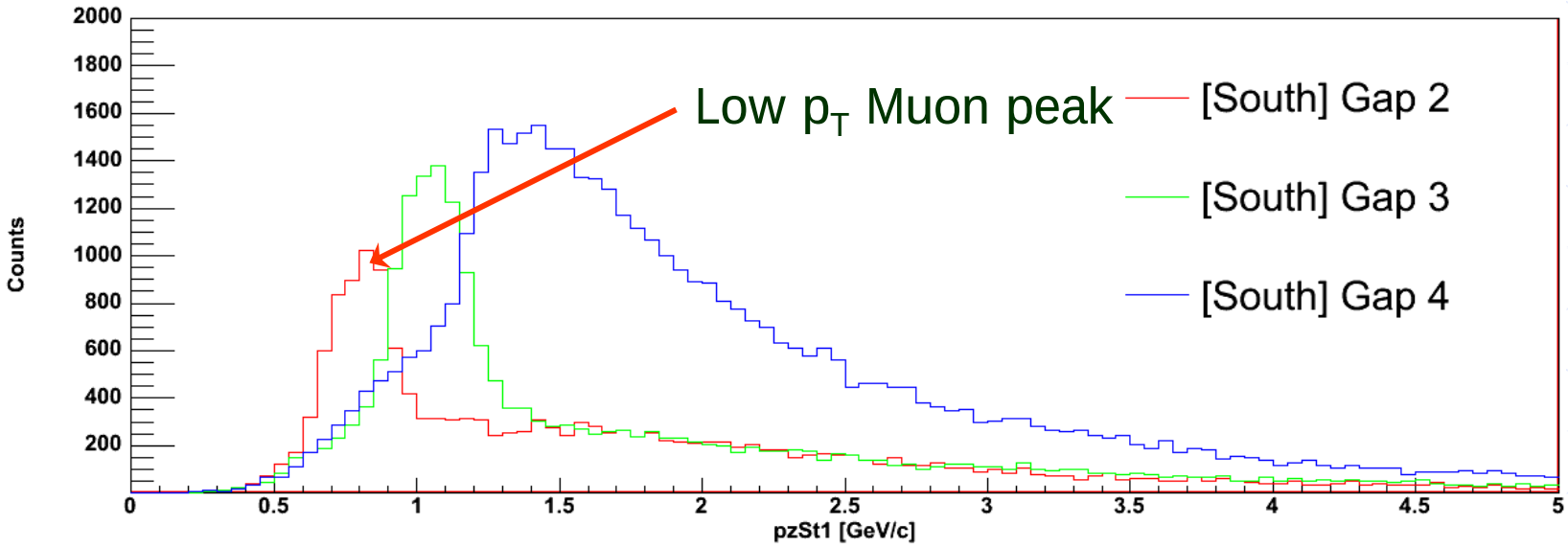
1. π, K decays into muons.
2. High p_T hadronic punch-throughs which go the last Gap.
3. Ghost tracks (tracks due to misidentification of hits) in high multiplicity events.

Low p_T μ: MC



- Low p_T μ stop in the shallow MuID steel.
- Simple Monte Carlo to illustrates stopped μ peak from π decays.

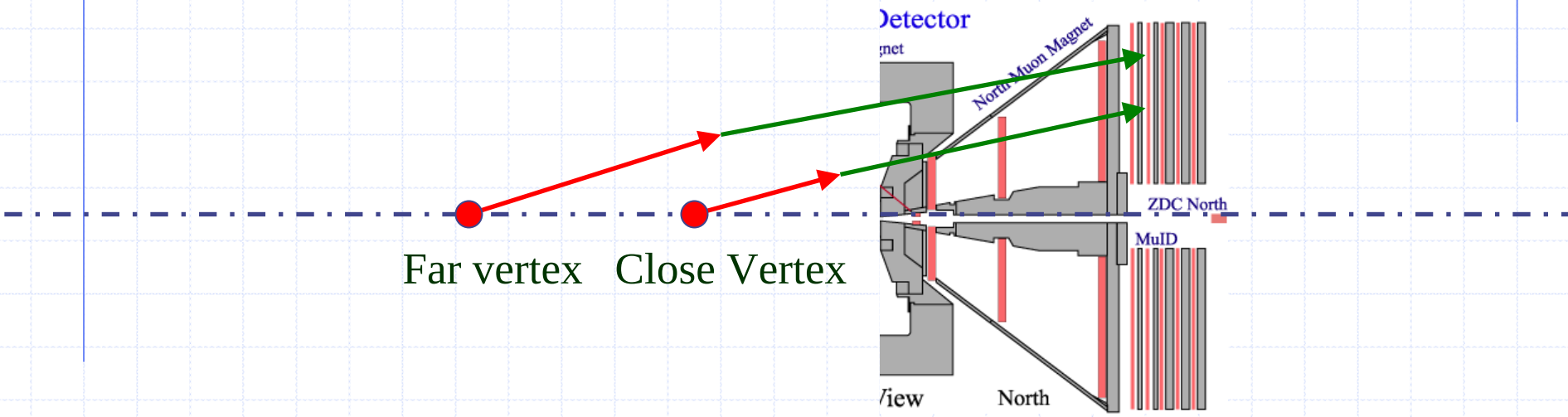
Low p_T μ: Au+Au data



- See the same stopped μ peak.
- But at this p_T mostly from π, K decays.

Decay Muons

- Light hadrons like pions and kaons can decay into muons before reaching the MuID.



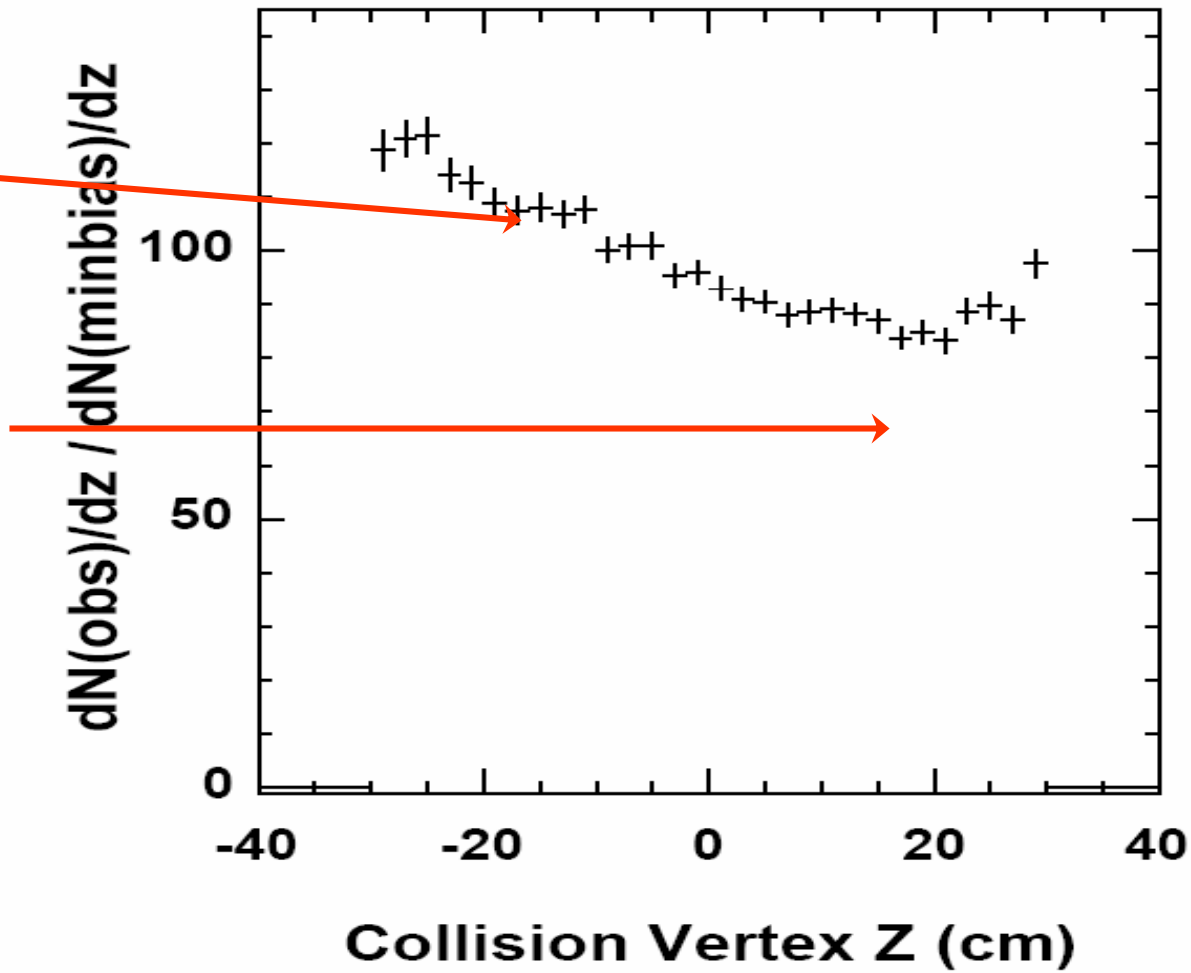
- The decay probability of a meson with momentum p is proportional to the distance (L) between collision vertex and absorber:

$$P_{decay}(p, L) = 1 - e^{-\frac{L \cdot m}{\tau \cdot p}}$$

Decay muons and z dependence

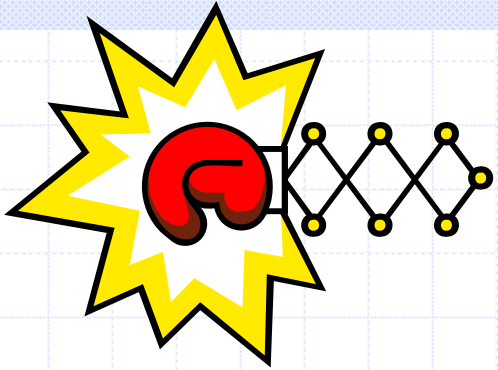
Hadron d+Au data : *PRL 94, 082302 (2005)*

- Z dependence: due to π, K decays.
- Flat part: due to D meson decays, and hadronic punch-throughs.



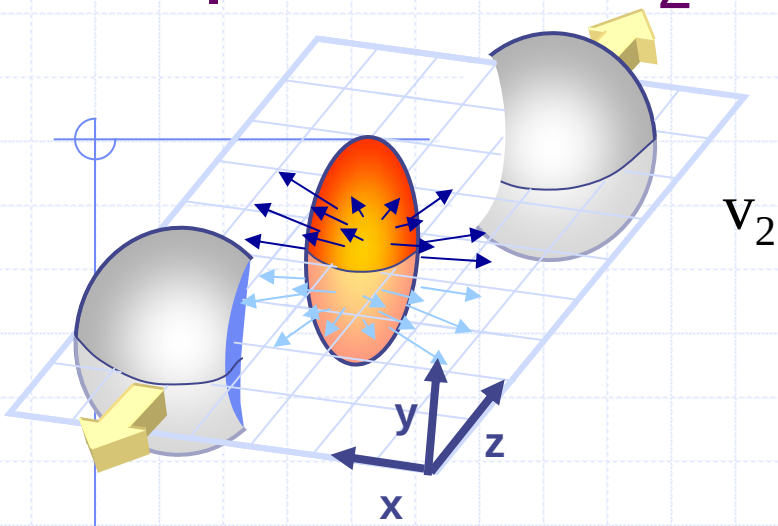
What about ?

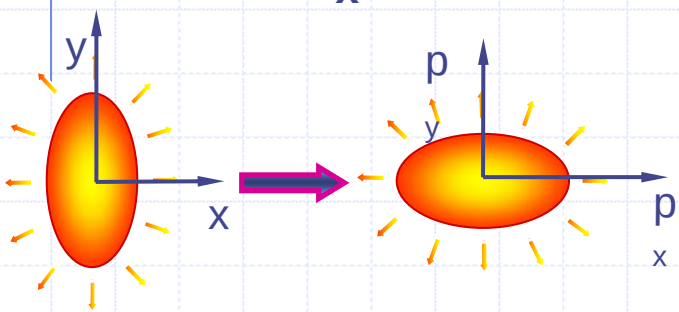
- In large multiplicity Au+Au events we can have ghost tracks due to sharing of hits between different tracks or mismatch between MuTr and MuID and so on.
- Angular and matching cuts can reduce these. E.g. distance from the road on MuID to the track as measured in the MuTr.
- Ongoing systematic studies to understand effect of these type of cuts.

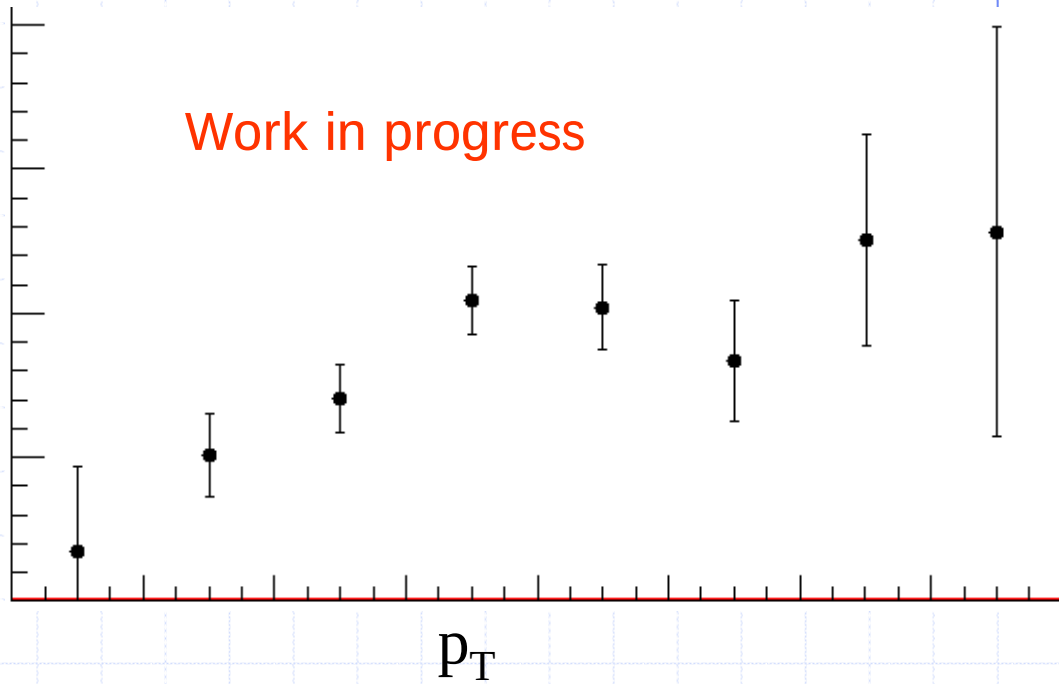
What about hadronic  ?

- Hadronic punch-throughs can be estimated in two ways:
  1. Variation in stopped hadrons from one MuID gap to another can allow us to estimate what fraction of tracks in the last gap of MuID is due to hadrons.
  2. Look at charge asymmetry that can occur due to difference in cross sections between K^+ and K^- as a function of MuID gaps.

Elliptic Flow v_2





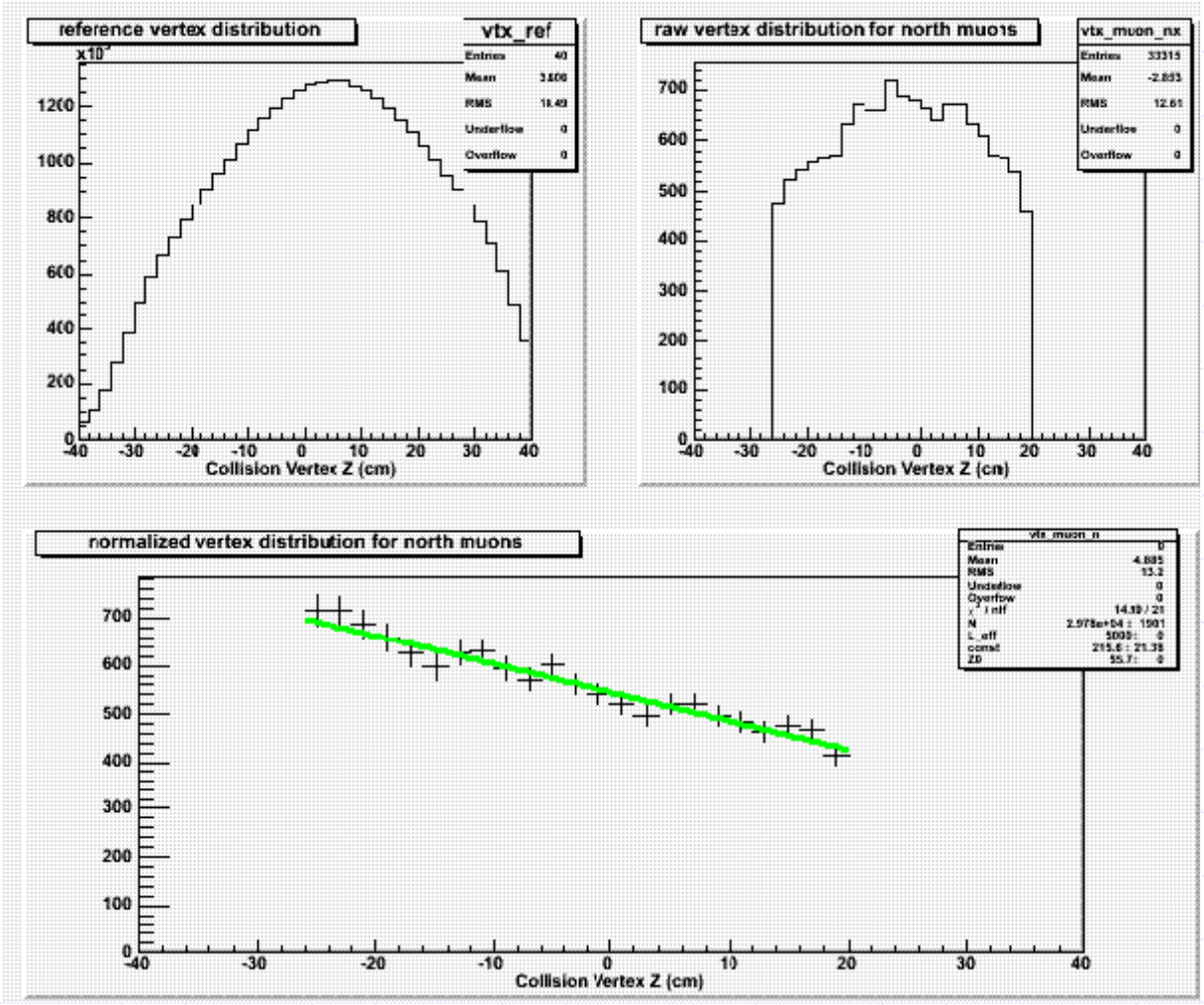


$$\frac{dN}{d\phi} \sim \left[1 + 2v_1\cos(\phi) + 2v_2\cos(2\phi)\right]$$

$$v_2 = <\cos(2\phi)>$$

- Measure inclusive μ yields w.r.t reaction plane.
- Work underway to initially extract inclusive muon v_2.

Summary

- Measurement of open charm is important to understand the behavior of the J/Ψ.
- Momentum modification **R_{AA}** and anisotropy **v_2** measurements are an essential ingredient to understand the thermalisation and energy loss for heavy quarks.
- Work underway to understand background tracks from decay muons, punch-throughs and ghost tracks in Au+Au collisions.
- Try to extract prompt μ v_2 from other background sources.

Backup Slides: Slope dependence