Single Muon Production in $\sqrt{s_{NN}}$ = 200GeV Au+Au Collisions at the PHENIX Experiment

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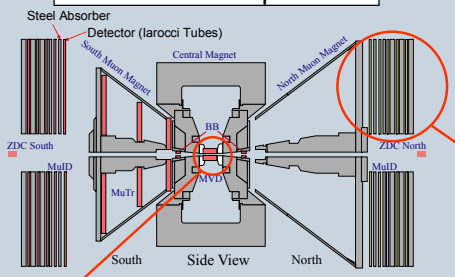
Goal and Motivation

- **To measure heavy charm production using single muons** (from semi-leptonic decays of heavy mesons). This would be an important extension of PHENIX mid-rapidity measurements using single electrons.
- **Open charm measurements will be crucial to understanding charmonium production**, which is important for studying color deconfinement and color screening associated with a QGP.

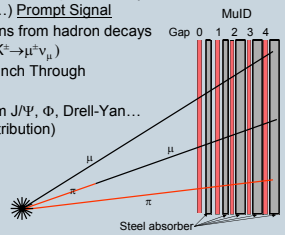
The PHENIX Experiment



Sources of Muon Candidates

Backgrounds

- D (B) meson semi-leptonic decays ($D \rightarrow \mu\nu_\mu K$ …) Prompt Signal
- Decay muons from hadron decays ($\pi^\pm \rightarrow \mu^\pm\nu_\mu$, $K^\pm \rightarrow \mu^\pm\nu_\mu$)
- 'Hadron' Punch Through ($\pi^\pm$, $K^\pm$, p)
- Decays from J/Ψ, Φ, Drell-Yan… (Small Contribution)

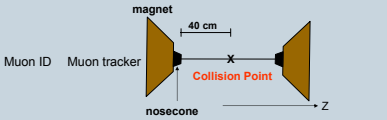


Decay Contribution

We want to separate the contribution from prompt muon production and π/K decays

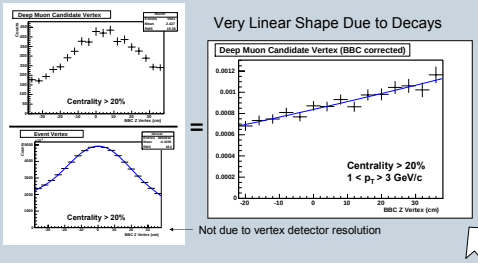
- D $c\tau$ = 0.03 cm Decays before absorber
- π $c\tau$ = 780 cm Most are absorbed, but some decay first
- K $c\tau$ = 371 cm Most are absorbed, but some decay first

$\gamma c\tau$ >> 80cm → Decay Probability nearly constant between nosecones



Collisions occurring closer to the absorber will have fewer decay contributions. **Should see a linear increase in decay background with increasing vertex.**

"Muon" Vertex Dependence

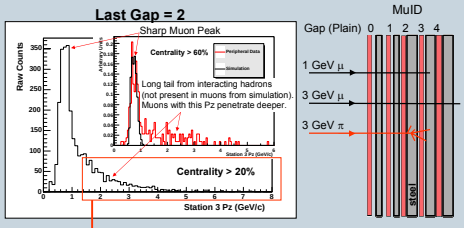


Very Linear Shape Due to Decays

Not due to vertex detector resolution

The muon candidate distribution is divided by the event vertex distribution to reveal the expected shape caused by decays.

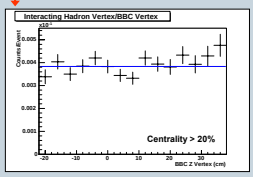
Muon / Hadron Separation



Main muon identification is from momentum/depth matching

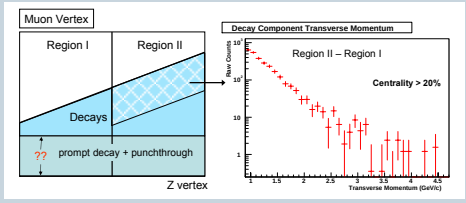
Very Different

Interacting Hadron Vertex



Last Gaps 2 and 3, Pz St3 tail.
Flat shape indicates little decay muon component. Since the longitudinal momentum cut should not discriminate between decay and prompt muons, the distribution is due primarily to the hadrons.

Decay "Muon" p_T Distribution



From simple (event vertex corrected) subtraction of near muon spectra from far muon spectra free decays can be studied.
(NOT NORMALIZED, also NOT ACCEPTANCE/EFFICIENCY CORRECTED)

Data Selection

Run II Au+Au min-bias from cleanest section of run (7.7M events).

Quality cuts on vertex, θ (η), azimuth, and track quality.

Simulations

- A first approach to estimate the fraction of decay contribution used HIJING+GEANT Au+Au simulations.
  - Large statistical error and large error due to lack of HIJING tuning (K/π Ratios, p_T distributions etc.)
- With the recent availability of BRAHMS π and K data at Muon Arm rapidities, we can examine a data driven simulation approach.
- An accurate modeling of K and π (and p) production for simulation input is needed for punchthrough estimations.

First Look At Data Driven Simulation

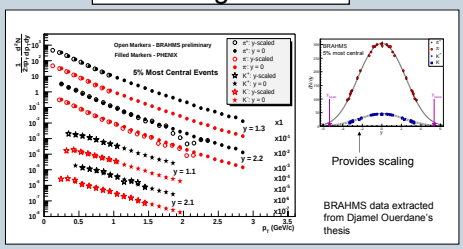
- Single K's and π's thrown with BRAHMS (preliminary, 5% most central) p_T and dN/dy shapes. p_T > 1 GeV required. Passed through full simulation/reconstruction.
- Decays: 900K Single Hadrons Gives:

Last Gap Reached	Reconstructed Decay Muons
2	161
3	297
4	712

- Punchthrough: 800K Single Hadrons Gives:

Last Gap Reached	Reconstructed Punch Through
2	222
3	150
4	66

Extending the Data



BRAHMS data extracted from Djamel Ouerdane's thesis

Use scaled PHENIX central arm data to for basis of event generator. BRAHMS preliminary data helps with scaling and justification ($P(y,p_T) \approx P(y)P(p_T)$). Only measurements for 5% most central events are available from BRAHMS. (Some information for protons is also available.)

Summary and Outlook

- A significant number of muons were measured in Run II Au+Au.
- A fraction of interacting hadrons can be clearly identified. (which helps with understand hadronic contribution)
- Muon candidate vertex dependence provides important information about decay contribution.
- A simulation procedure is being developed which will allow quantitative estimation of decay and punch through contributions.
- Differences in hadronic shower software such as FLUKA and GEISHA, and similar systematics, must be addressed.

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