SIMULATION STUDY OF BACKGROUND PARTICLES IN THE MUON TELESCOPE DETECTOR AT THE STAR EXPERIMENT

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Thanks to Dr. Mioduszewski and Yanfang Liu
Overview

- Background
- Simulation data
- Cuts
- Survival Probabilities (pions, kaons, protons, and muons)
- $p_T$ Distributions
- Delta Z distributions
Background

- The newly built Muon Telescope Detector probes the QGP through the detection of:
  - di-muon pairs from QGP thermal radiation, quarkonia, light vector mesons, resonances in QGP, and Drell-Yan production
  - single muons from the semi-leptonic decays of heavy flavor hadrons.

- The MTD is located on the outside of the time projection chamber (TPC)
  - The TPC is the main tracking detector for STAR

- Non-muon particles are intercepted by the barrel-electromagnetic calorimeter (BEMC) and the steel from the magnet; however not all of the background particles are filtered
Simulation Data

- Run 14: 14.5 GeV Au+Au collision

- Omega production
  - $\Omega^- \rightarrow \Lambda + K^-$
    - $\Lambda \rightarrow p + \pi^-$
    - $K^- \rightarrow \mu^- + \nu^-$
  - # $K$: 141866
  - # $\pi$: 138300
  - # $p$: 172865
  - # $\mu$: 16564

- Phi production
  - $\phi \rightarrow K^- + K^+$
    - $K^{\pm} \rightarrow \pi^{\pm} + \pi^{\pm} + \pi^{\mp}$
  - # $K$: 309034
  - # $\pi$: 11912
  - # $p$: 4790
  - # $\mu$: 15882
Cut Numbers

1. $p_T$ cut: $1.2 \text{ GeV/c} < p_T < 30 \text{ GeV/c}$
2. NHitsFit cut: NHitsFit $> 20$
3. NHitsDedx cut: NHitsDedx $> 15$
4. Pseudorapidity cut: $|\eta| \leq 0.65$
5. Tracks associated with MTD hit
6. Dedx (ionization energy loss the in TPC) cut: $-1 < \text{NSigmaPion} < 3$

Cuts on the distance between track projection and MTD hits for:

1. Y coordinate: $|\Delta Y| < 20$
2. Z coordinate: $|\Delta Z| < 20$
Analysis

- Investigate the survivability of background particles
  - what percent survive all the cuts
- The shape of Delta Z distribution to estimate the number of background particles that survive these cuts in the real data
0.28% of the pions, that have a $p_T > 1.2$ GeV, survive the cuts.
0.29% of the kaons, that have a $p_T > 1.2$ GeV, survive the cuts.
0.16% of the protons, that have a $p_T > 1.2$ GeV, survive the cuts.
20% of the muons, that have a $p_T > 1.2$ GeV, survive the cuts.
After cut 7
- 31 pions survive out of the original 150212
- 1225 kaons survive out of the original 141866
- 309 protons survive out of the original 177665
After cut 7, 1277 muons survive out of the original 32446
The background particles have a width of $18.08 \pm 0.91$
Kaons have a width of $22.02 \pm 1.49$
Muons have a width of $9.789 \pm 0.466$
The signal fit (suspected muons) has a width of $8.988 \pm 0.010$

The background fit has a width of $25.2 \pm 0.1$

Background particles make up about 38% of the data
Summary

- 0.28% of the pions, that have a $p_T > 1.2$ GeV, survive the cuts.
- 0.29% of the kaons, that have a $p_T > 1.2$ GeV, survive the cuts.
- 0.16% of the protons, that have a $p_T > 1.2$ GeV, survive the cuts.
- 20% of the muons that have a $p_T > 1.2$ GeV survive the cuts, 100 X greater survivability than the background.
- Background particles have a Delta Z width of $18.08 \pm 0.91$.
- Kaons have a Delta Z width of $22.02 \pm 1.49$.
- Muons have a Delta Z width of $9.789.08 \pm .466$.
- The Delta Z widths agree well with the double Gaussian fit.
Backup slides
Track Matching to MTD hits

Delta Z

Delta Y
What’s next?

- More Statistics
  - Simulate flat $p_T$ and weight each entry with true $p_T$
- Time of flight cut (TOF)
Pt distribution for background particles

Entries: 781015
Mean: 1.374
RMS: 0.9541