Systematic study of fragmentation functions in inclusive jets from p+p collisions at 200 GeV by STAR

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Outline & Motivation

- Motivation for Fragmentation Function study
- □ Jet-Finding Algorithm
- □ STAR dataset and triggers
- \Box Charged particle ξ distribution
- \square Identified particle ξ distribution
- **Comparisons to PYTHIA**
- □ Summary

Motivation



- □ A recent paper predicts that the heavy ion medium will significantly modify the particle hadro-composition and their ratios in jets.
- We want to provide a baseline measurement in p+p to compare future HI measurements to

- Test energy scaling of fragmentation functions
- No previous comparisons at RHIC energies available



Jet-Finding Algorithm



Midpoint-cone algorithm

- Search over "all" possible seeds for stable groupings
- Check midpoints between jet-jet pairs for stable groupings
- •Split/merge jets based on E_{overlap}

Jet-Finder Algorithm cuts: - p_T (track/tower) > 0.2 GeV

-Seed-Cut: 0.5 GeV/c (use only highest jet in event)

-Split/Merge fraction = 0.5

 $-|\eta_{iet}| < (1 - Cone radius)$

 $-0.05 < E_{neutral}/E_{jet}$ (NEF) < 0.85

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STAR detector & Triggers



STAR Triggers

<u>1) Minbias:</u> Beam-Beam-Counter (BBC) coincidence

2) High Tower Trigger: BBC coincidence + one tower ($\eta \times \phi = 0.05 \times 0.05$) above threshold: $E_T > 5.4$ GeV

3) Jet-Patch Trigger (used <u>here</u>): BBC coincidence + Jet-Patch ($\eta \ x \ \phi = 1x1$) above threshold $E_T > 8 \ GeV$

Jet production at RHIC

STAR recently published two papers on Double-spin asymmetry

Jet cross section is well described by pQCD over 7 orders of magnitude



Energy Resolution

- Using jets PYTHIA we have studied the energy resolution using a full input spectrum and GEANT simulation
- \square We see a relative energy resolution of ~25%



Jet-Energy vs cone radius R

Measured Jet-energy spectrum not corrected for trigger / resolution Jet Energy corrected for electrons and **10**⁴ hadrons EM-energy Statistics 40-50 GeV bin: 10³ R<0.7: 252 ($|\eta_{iet}| < 0.3$) R<0.5: 475 ($|\eta_{jet}| < 0.5$) R<0.4: 557 ($|\eta_{jet}| < 0.6$) 10² 10<u></u> n 5 10 15

Total number of reconstructed jets

20

25

30

35

40

— R < 0.4

— R < 0.7

R < 0.5

STAR Preliminary

50

45

E^{reco} (GeV/c)

ξ Distribution for Charged Hadron



Nice agreement for the R=0.4 cone-size over full ξ range. PYTHIA 6.4 describes FF well at RHIC energies

Charged Hadrons ξ for different R



Mark Heinz (STAR)

Identified particles in jets

- □ STAR has very good acceptance to identify V0-particles via weak decay topology over a large kinematical range
 - Number of reconstructed K⁰s: ~100'000
 - Number of reconstructed Λ : ~45'000
- \Box 0.5 < p_T(V0) < 8-10 GeV/c
- Reconstruction & tracking efficiencies obtained from a sample of PYTHIA-jets processed with GEANT. Fits of efficiencies are applied to PID -ξ distribution



ξ for K^0_{short} & Lambda



Ratio of ξ-distribution





- The ratio of ξ distribution for K⁰/h and Λ/h are compared to PYTHIA (right) and show a significantly different behavior for Lambda.
- □ The Λ/K at $\xi \sim 2$ is larger than the ratio in inclusive p+p collisions (see right figure).
- (STAR has shown previously that factorized QCD (LO & NLO) does not describe strange baryon production well in inclusive p+p collisions (Phys Rev C 75 (2007))

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Mean of ξ distribution

\square QCD predicts particle mass ordering of mean ξ value:

- In data we observe an inverse $\langle \xi \rangle$ ordering of K_{s}^{0} and Lambda.
- Similar observation with kaons and protons shown at the Trento Fragmentation Workshop by BABAR collaboration (hep-ph/0804.2021)



Summary & Outlook

- **ω** We have shown ξ distributions for charged hadrons up to $E_{iet} \sim 40$ GeV.
- Charged hadron ξ for small cone-radii agrees well with PYTHIA 6.4.
- **□** We have shown ξ for identified K⁰_s and Lambda up to E_{iet} ~20 GeV.

Discussion

- □ Charged hadrons:
 - Good agreement with PYTHIA for R=0.4
 - Can beyond LO effects improve the description of the ξ -distribution for larger cone-radii (>0.4) ?
- □ Identified hadrons:
 - We observe that the $\langle \xi \rangle$ for K^0_s and Λ do not follow a particle mass ordering expected from PYTHIA.
 - Baryon-Meson ratio (Λ/K) in jets at $\xi \sim 2$ is greater than from inclusive p+p collisions. May help determine baryon fragmentation function.

<u>Outlook</u>

- $\square \quad \text{Compare more jet-variables } (k_T, j_T, \text{ etc}) \text{ to } pQCD$
- **Further studies ongoing to measure PID fragmentation functions in heavy ion collision**