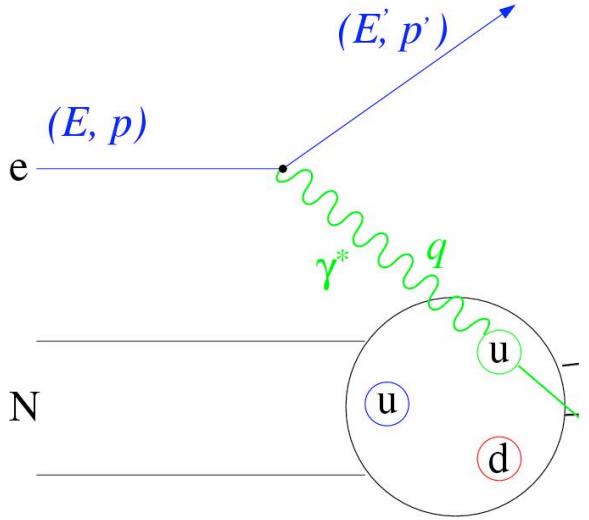
Polarized PDFs from Semi-inclusive DIS with an EIC

- Little progress since about a year
- Here, I present the talk of Joe Seele, who has performed the simulations and presented the results at the 2007 Spring APS meeting
- Plans for the future

Semi-inclusive DIS

In inclusive Deep Inelastic Scattering (DIS), a virtual photon, emitted from a lepton, strikes a quark inside a hadron.



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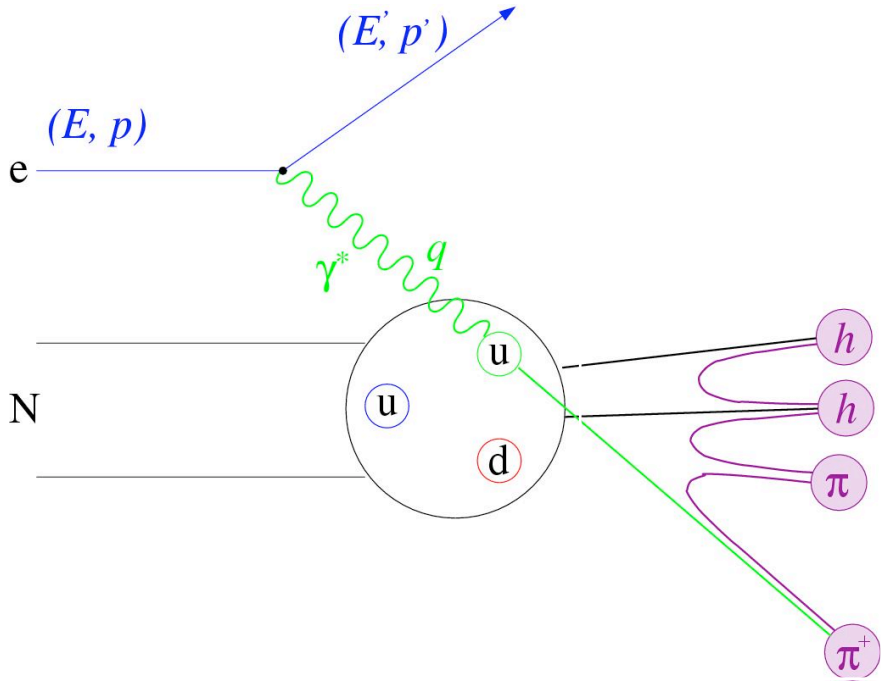

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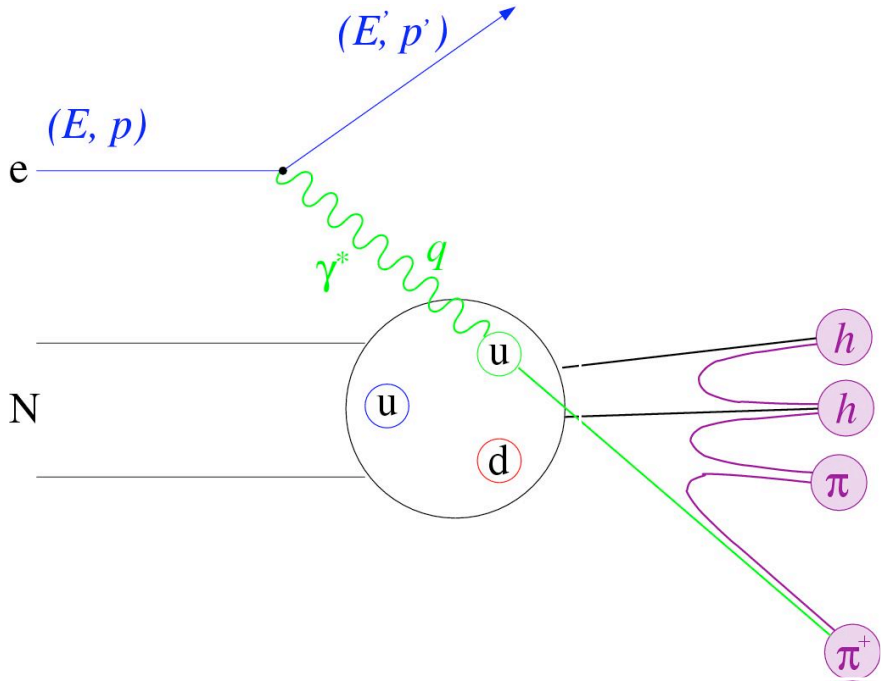


$$\frac{d\sigma}{dxdQ^2} \propto \sum_a e_q^2 f_q(x,Q^2)$$

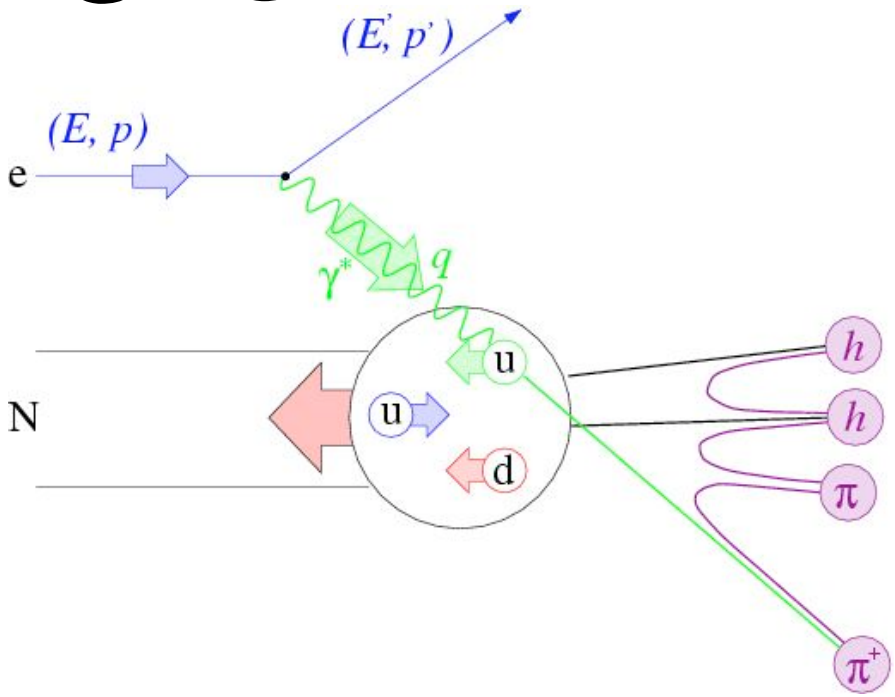
In semi-inclusive DIS, a hadron is measured in coincidence with the scattered lepton

$$\frac{d\sigma^h}{dzdxdQ^2} \propto \sum_a e_q^2 f_q(x,Q^2) D_q^h(z,Q^2)$$

If the fragmentation functions are known, the flavor separated parton distributions functions (pdf) can be obtained.

Asymmetries and SIDIS

By measuring counting asymmetries in hadron production between different helicity configurations, the polarized pdfs can be accessed



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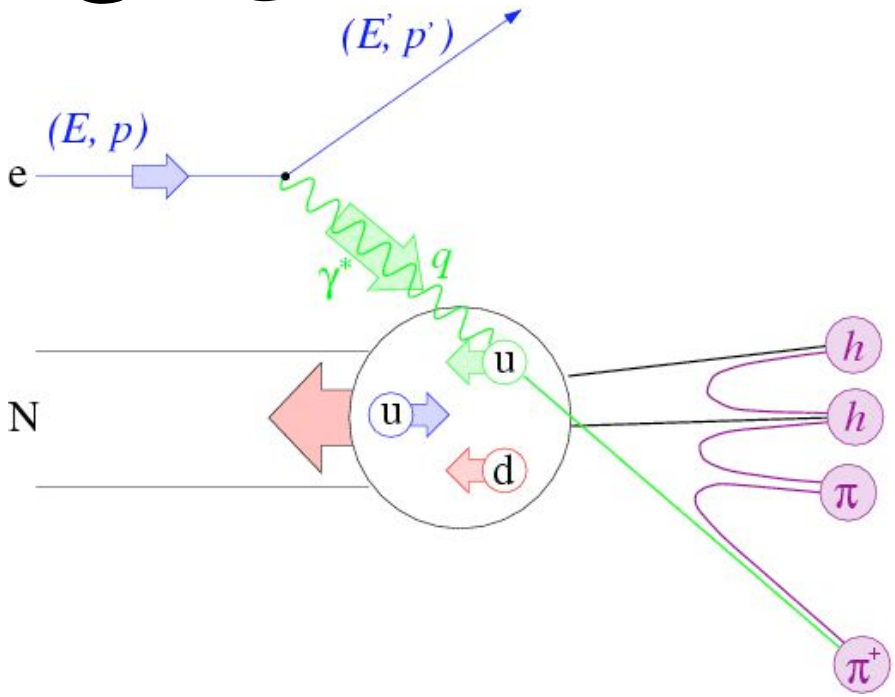

$$A^h = \frac{N^{++} - N^{+-}}{N^{++} + N^{+-}} \propto \frac{\Delta\sigma}{\sigma} = \frac{\sum_q e_q^2 \Delta q(x,Q^2) D_q^h(x,Q^2)}{\sum_{q'} e_{q'}^2 q'(x,Q^2) D_{q'}^h(x,Q^2)}$$

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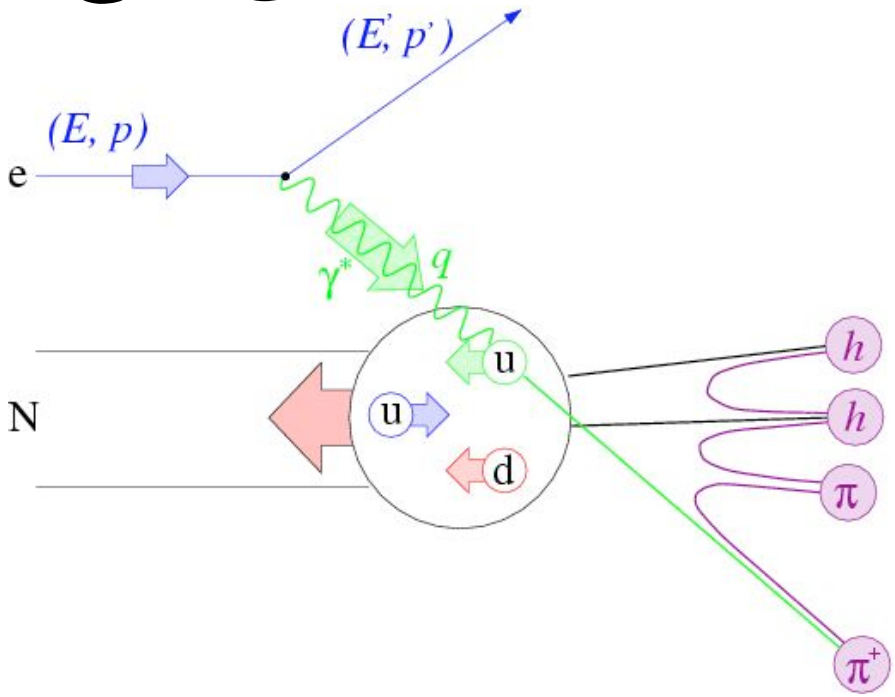

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$$A^h \propto \frac{\sum_q e_q^2 \Delta q(x,Q^2) D_q^h(x,Q^2)}{\sum_{q'} e_{q'}^2 q'(x,Q^2) D_{q'}^h(x,Q^2)} \equiv \sum_q P_q^h(z,x,Q^2) \frac{\Delta q(x,Q^2)}{q(x,Q^2)}$$

Purity

Polarization

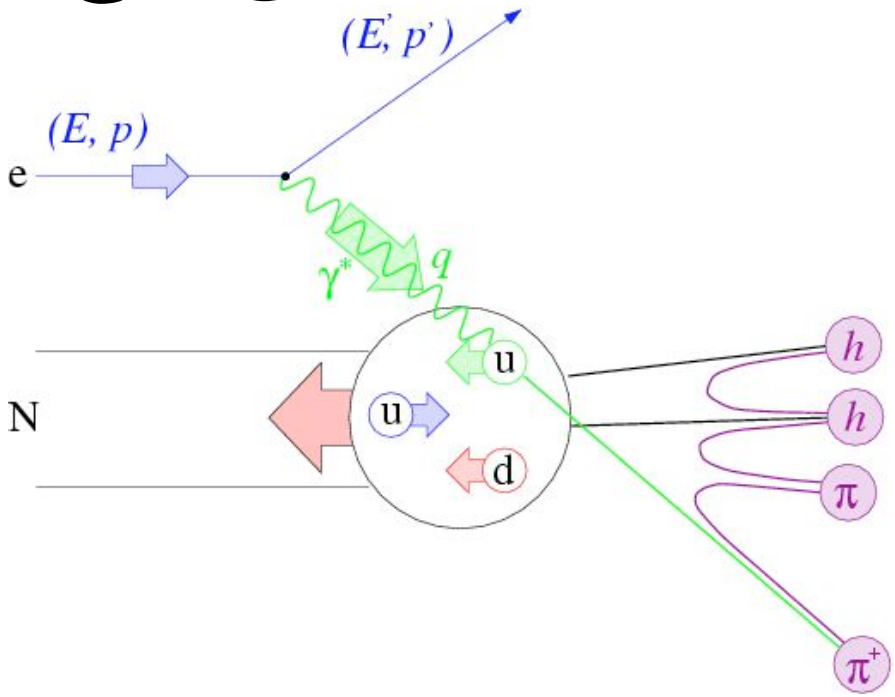
$$P_q^h(x,Q^2,z) = \frac{e_q^2 q(x,Q^2) D_q^h(z,Q^2)}{\sum_{q'} e_{q'}^2 q'(x,Q^2) D_{q'}^h(z,Q^2)} \rightarrow \frac{N_q^h}{\sum_{q'} N_{q'}^h}$$

Typically calculated in a Monte Carlo

Asymmetries and SIDIS II

Measuring the asymmetries of multiple species allows a better determination of the polarizations

$$\begin{pmatrix} A^{h_1} \\ A^{h_2} \\ \vdots \end{pmatrix} = \begin{pmatrix} P_{q_1}^{h_1} & P_{q_2}^{h_1} & \cdots \\ P_{q_2}^{h_2} & P_{q_2}^{h_2} & \cdots \\ \vdots & \vdots & \ddots \end{pmatrix} \begin{pmatrix} \Delta q_1 / q_1 \\ \Delta q_2 / q_2 \\ \vdots \end{pmatrix}$$



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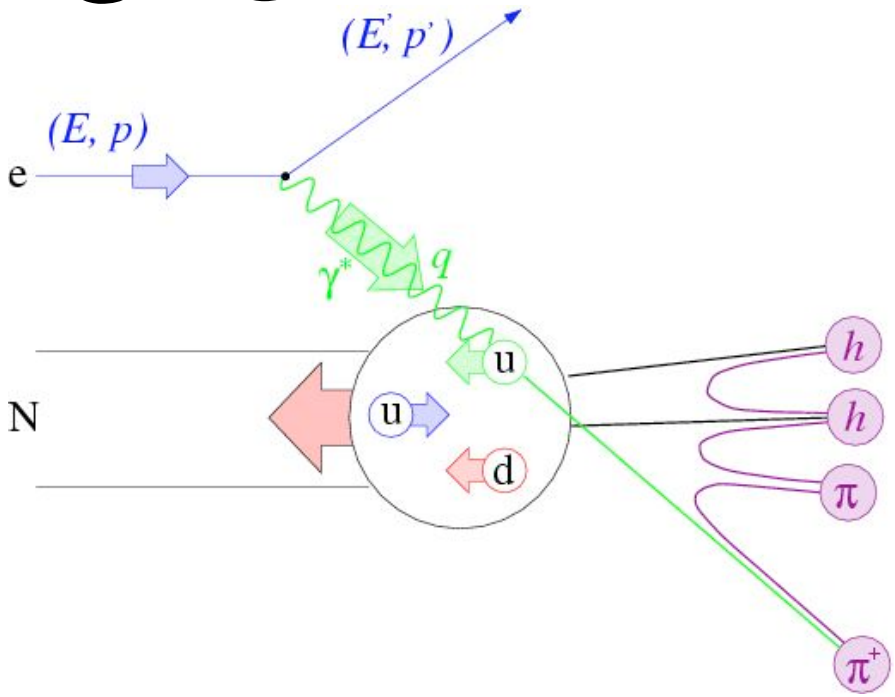


This method gives the polarizations as well as their errors and correlations

Simulations

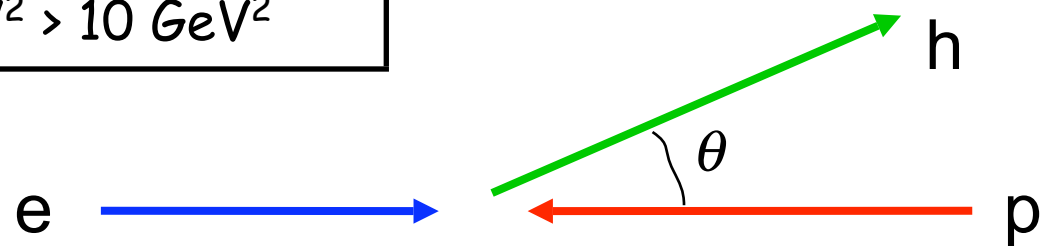
- The cross sections, correlations, yields, and purities were simulated using LEPTO with an integrated luminosity of 100 days at $10^{\wedge 33} cm^{-2} s^{-1}$ ($8.6\ fb^{-1}$)
  - 3 proposed energies were simulated (E_{e^-} on E_p):
    - ➡ 5 on 50, 7 on 150, and 10 on 250
  - 6 species were used in this $\pi^+, \pi^-, K^+, K^-, p, \bar{p}$

Event level and scattered lepton cuts

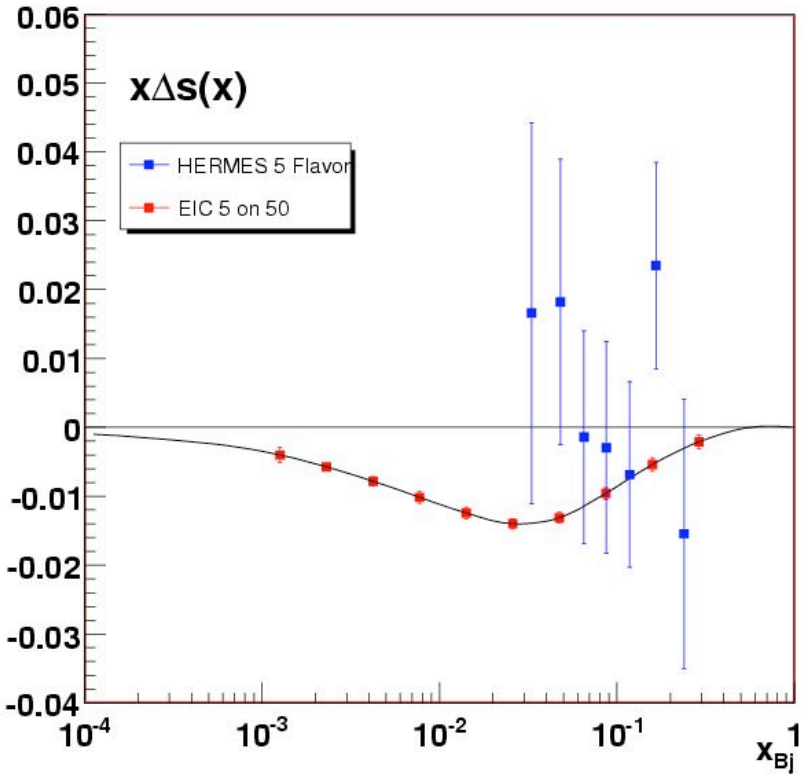
$E'_{lepton} > 1 GeV$
$Q^2 > 1\ GeV^2$
$0.05 < y < 0.85$
$5^o < theta < 175^o$
$W^2 > 10\ GeV^2$

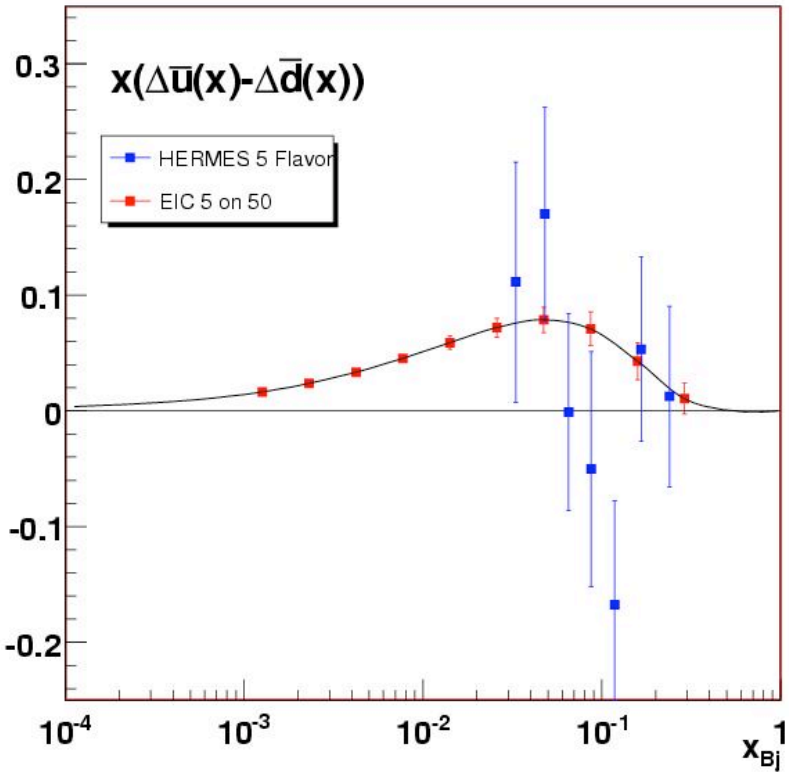
$E_{had} > 1\ GeV$
$5^o < theta < 175^o$
$0.2 < z < 0.8$
$x_F > 0.15$

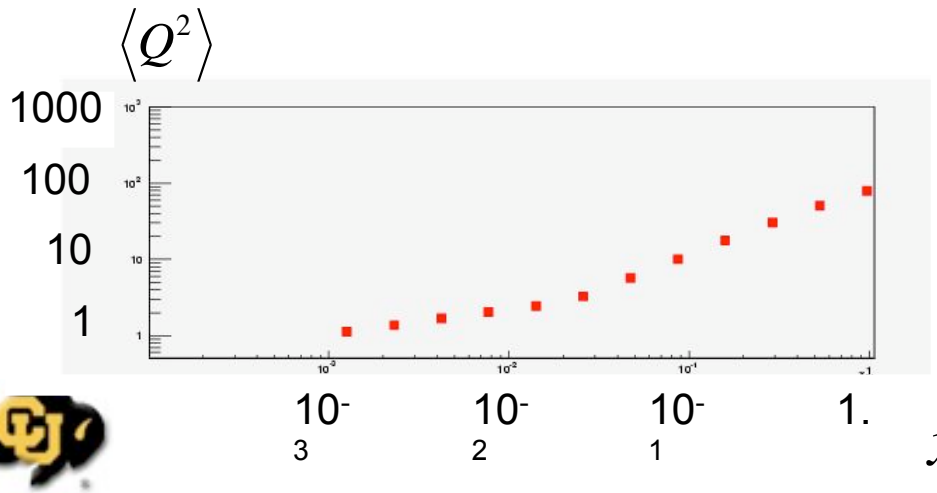
Hadronic cuts



5 on 50 Expectations







Curves are GRSV

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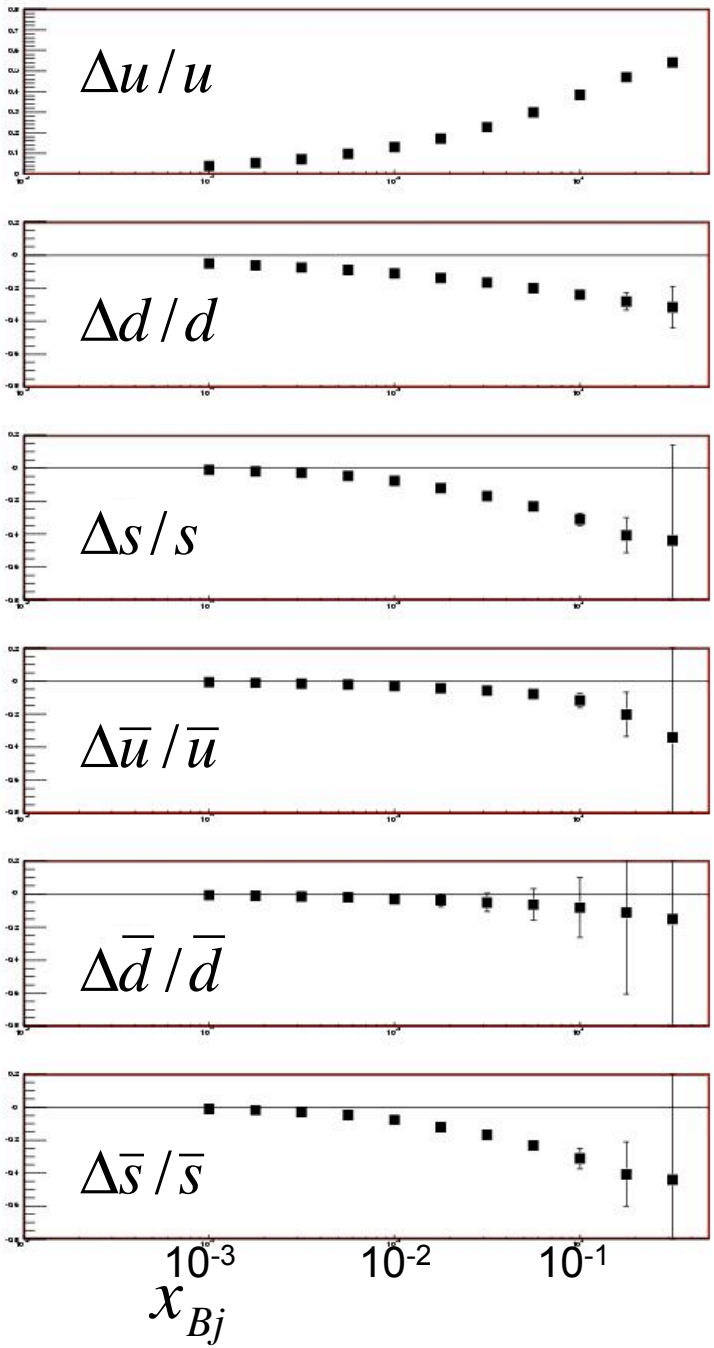
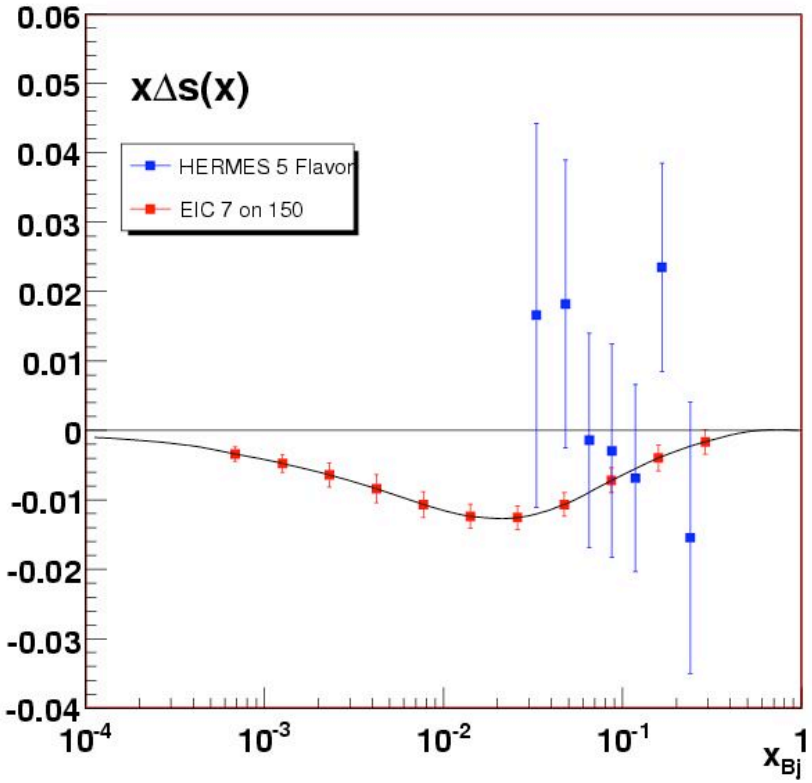
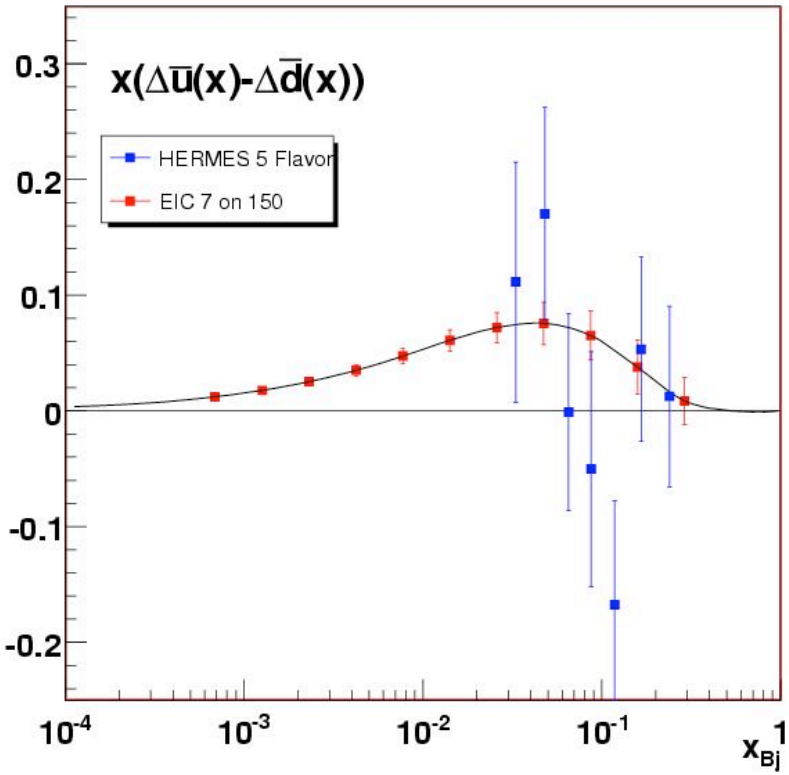
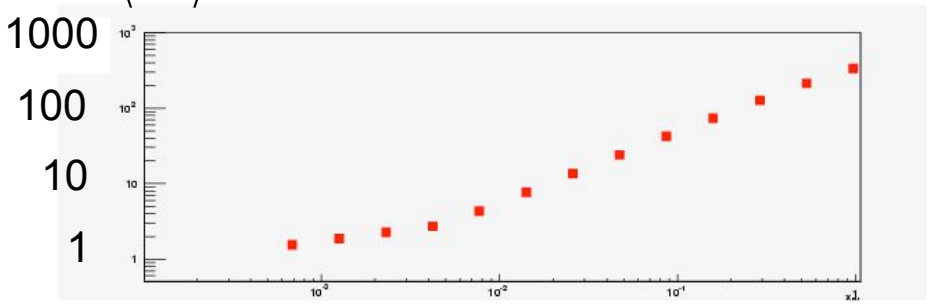


7 on 150 Expectations





$\langle Q^2 \rangle$



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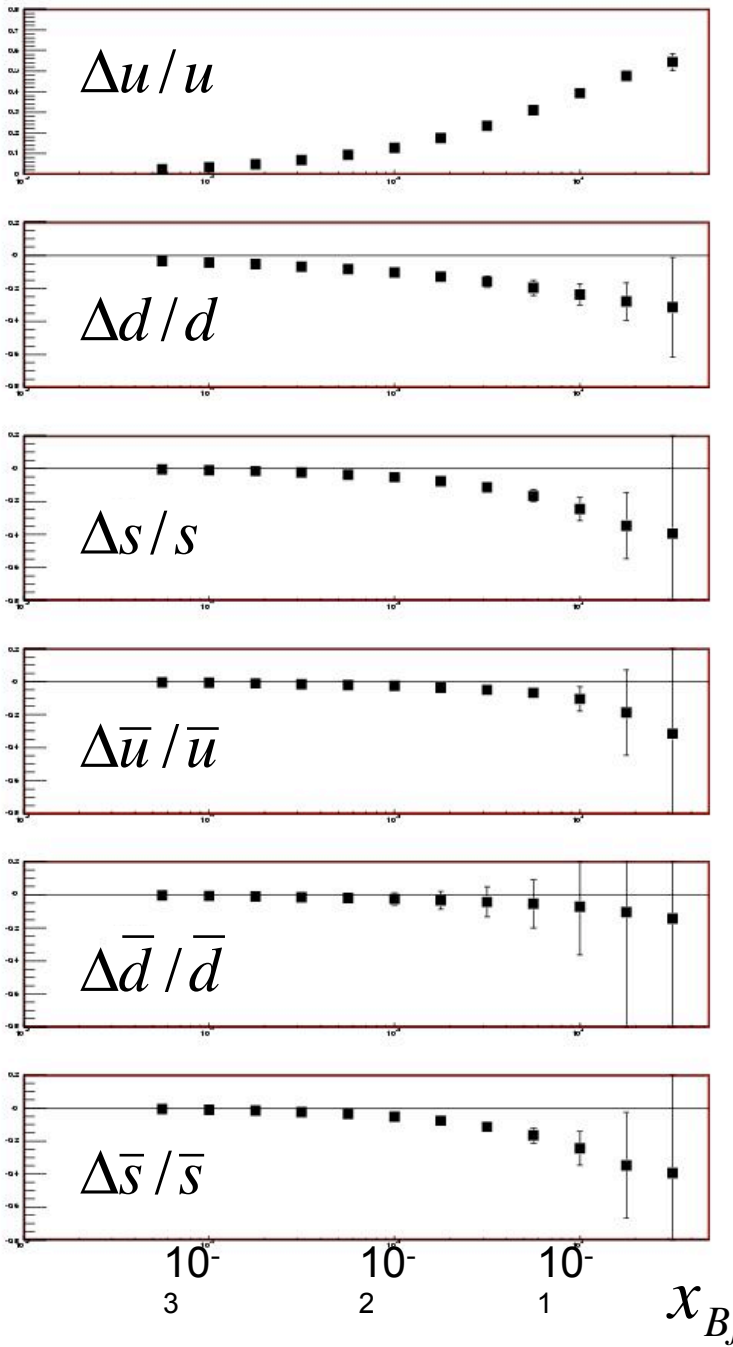
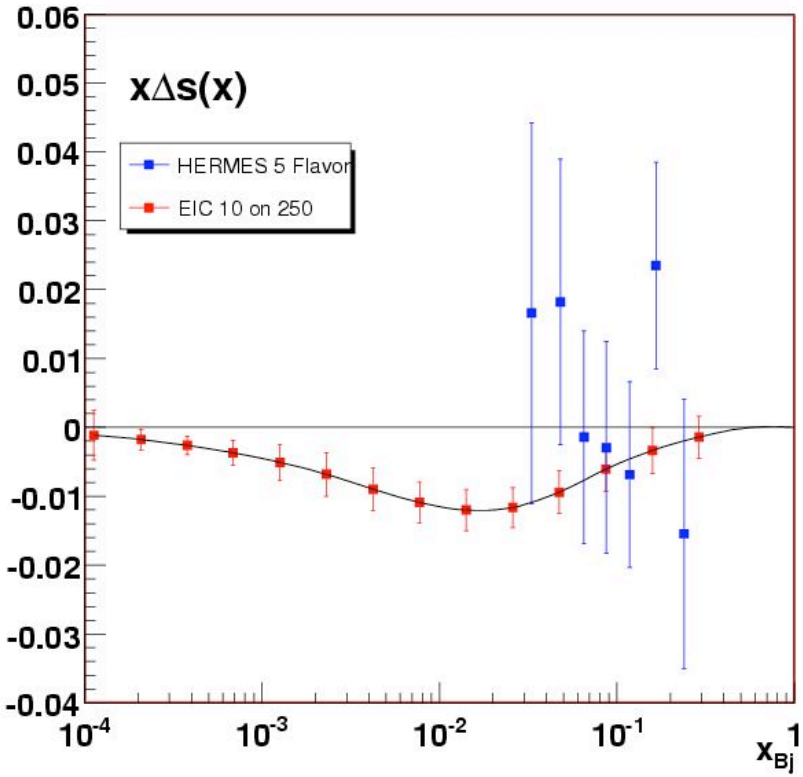
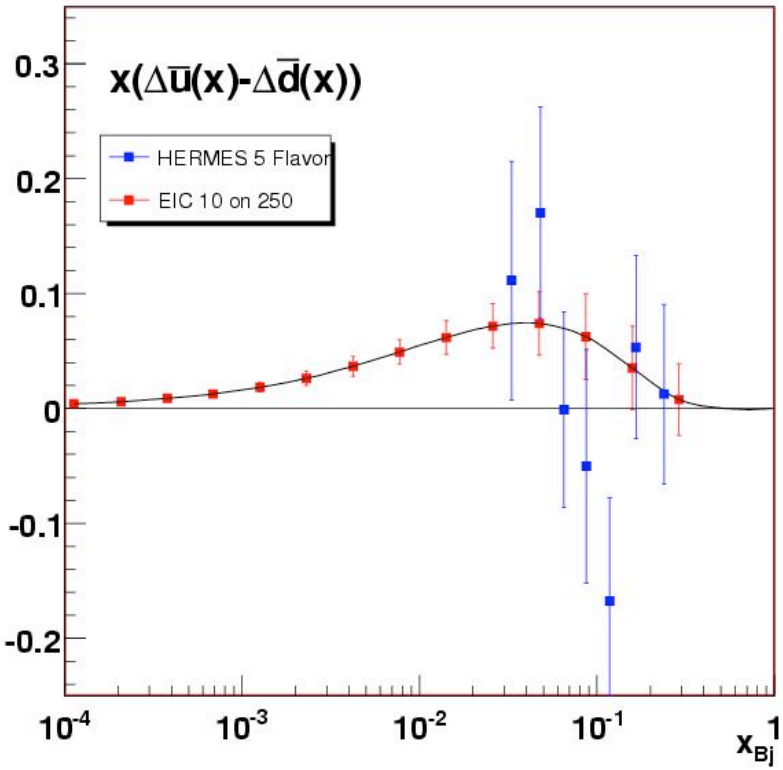
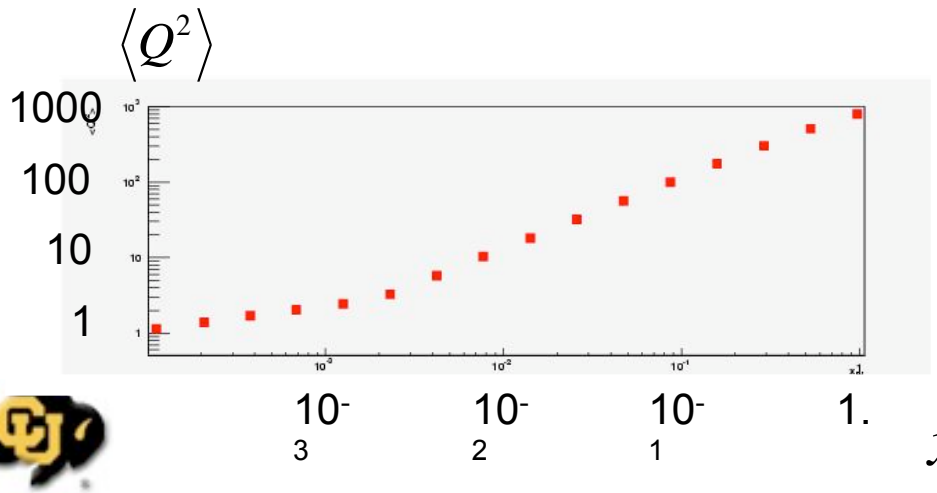


10 on 250 Expectations







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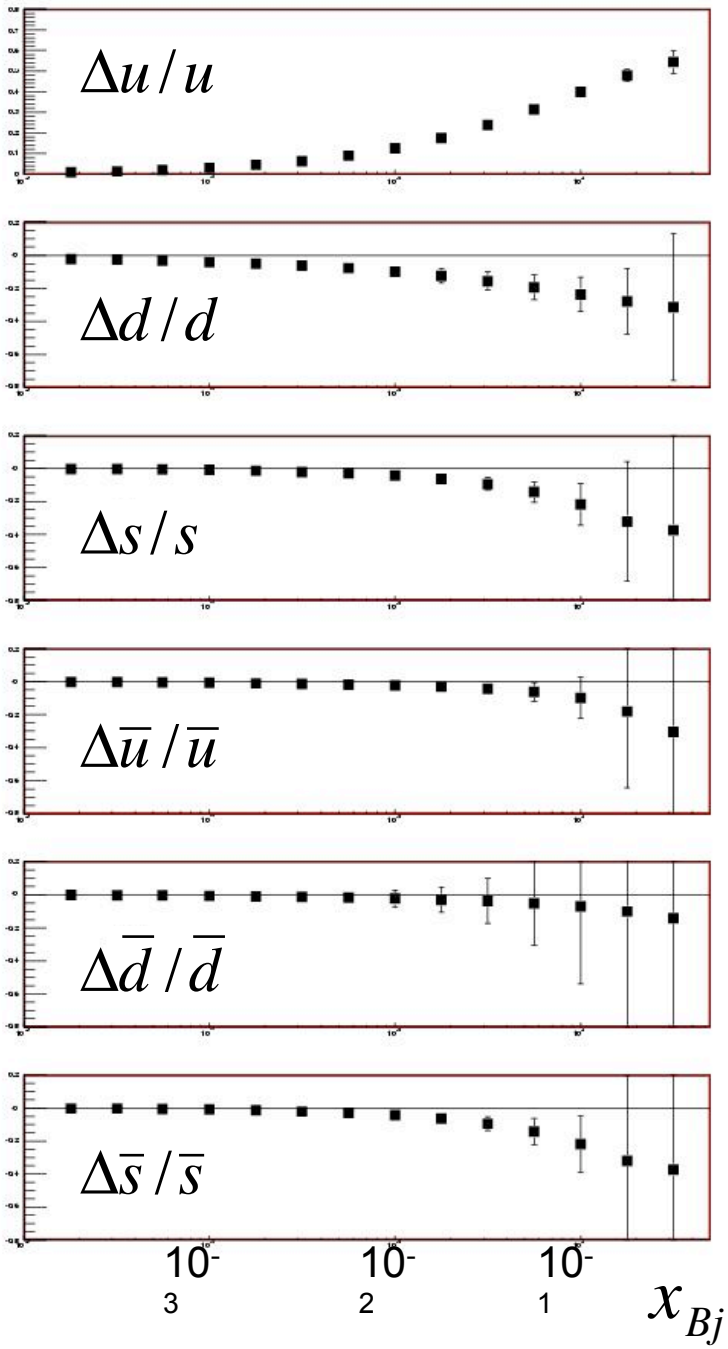

Future/Plans

- Model detector acceptance/efficiencies/imperfect PID
- Optimize detector vs. cost for this measurement
  - Raw acceptance cuts first
  - Characterize momentum range where PID is needed
- Study accuracy needs of fragmentation functions and pdfs
- Radiative corrections

K- from 7 on 150 GeV

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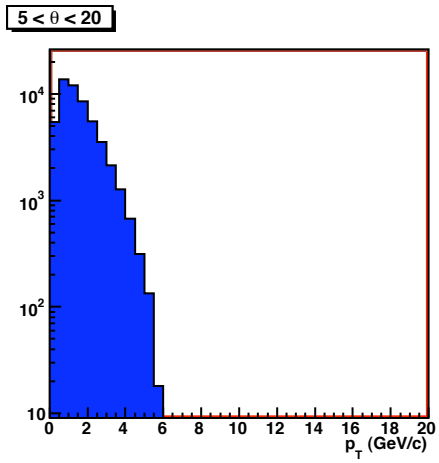

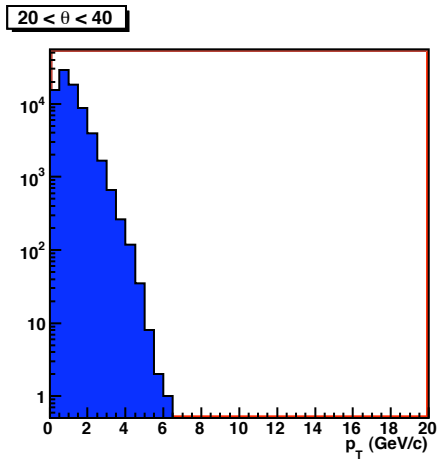

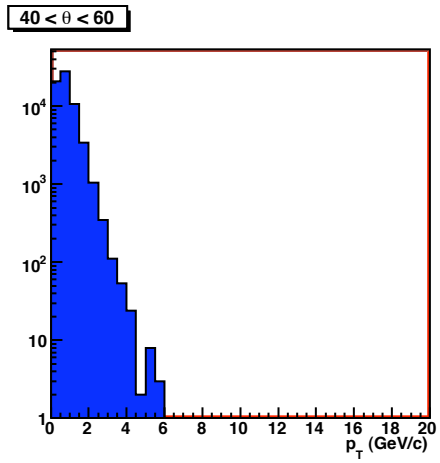

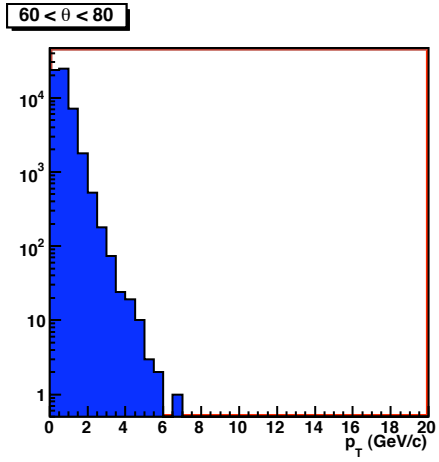

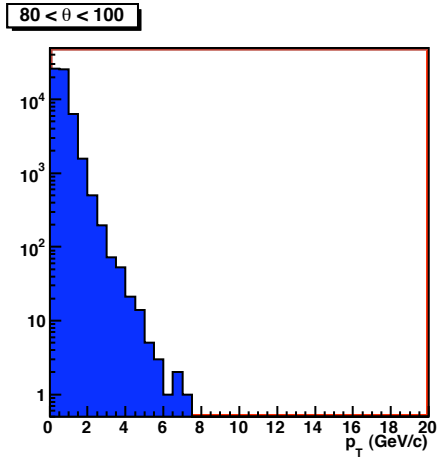

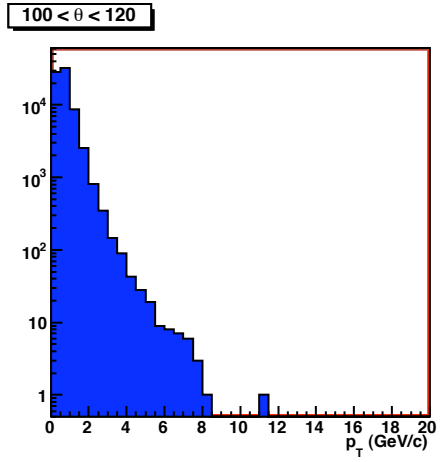

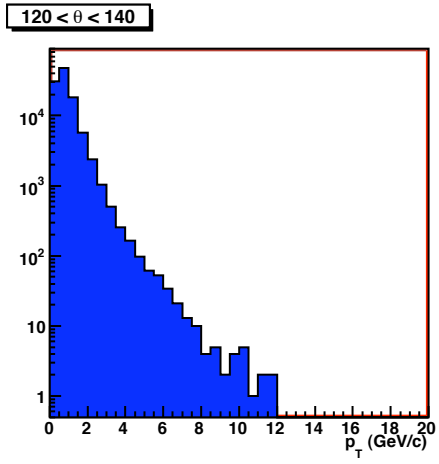

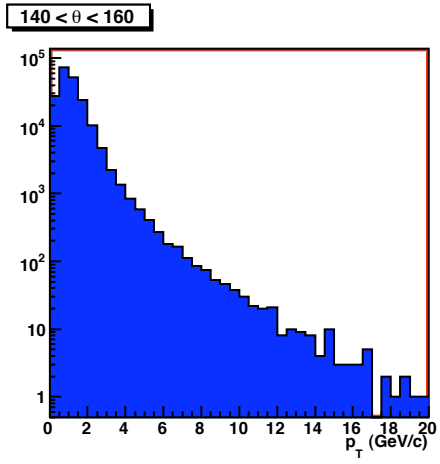

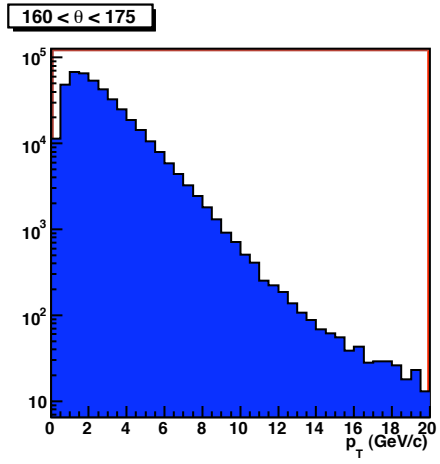

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