

Writing an HZTool routine and Beauty Photoproduction at HERA

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12th June 2006

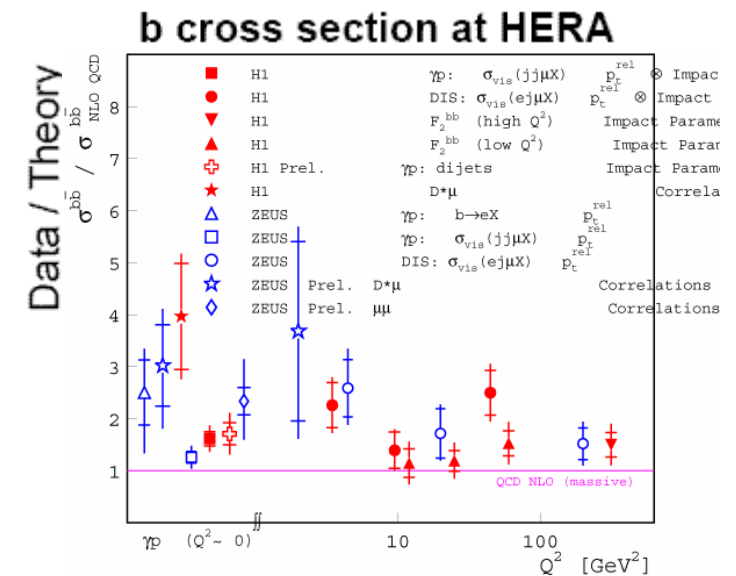


Introduction

- Heavy Flavour Physics at HERA
- D^* Photoproduction Measurement
- HZTool
- Beauty Photoproduction Measurement
- Event Selection
- The results
- Summary

Heavy Flavour Physics at HERA

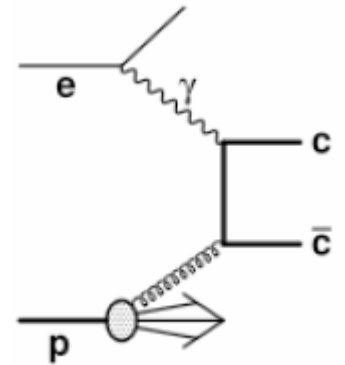
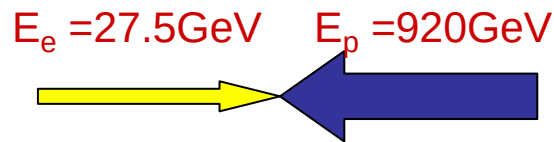
- Heavy Flavour means Charm and Beauty
- High Mass $m_q \gg \Lambda_{\text{QCD}}$ provides hard scale
- Should agree with theoretical predictions from NLO QCD
- Experimentally discrepancies with NLO QCD calculations are observed



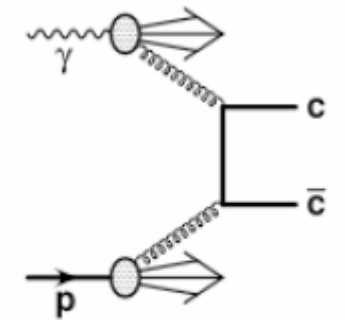
Inclusive jet cross sections and Dijet correlations in D^* photoproduction at Hera

Hep-ex/0507089 (2005)

- Hera 1998-2000
- Photoproduction ($Q^2 < 1 \text{ GeV}^2$) Direct/Resolved
- Decay Channel $D^* \rightarrow D^0 \pi_S \rightarrow (K\pi) \pi_S$
- Find jets and tag D^* mesons in events
- Precise Measurement over wide phase space
- Will not be bettered for a significant time
- Measuring jets reduces effect of hadronisation on predictions



Direct Process

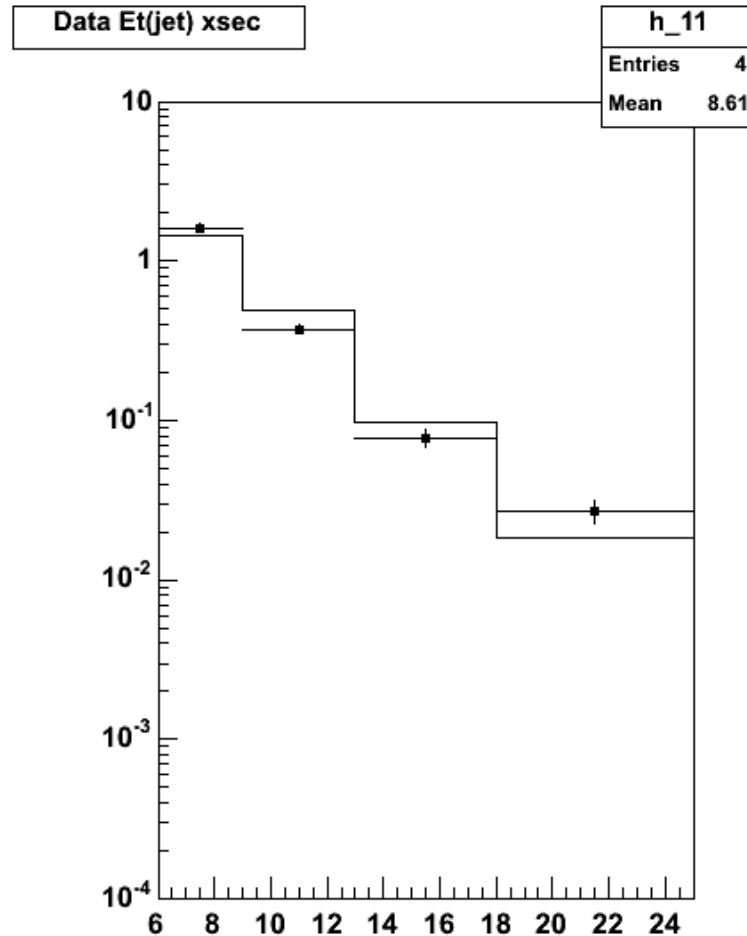


Resolved Process

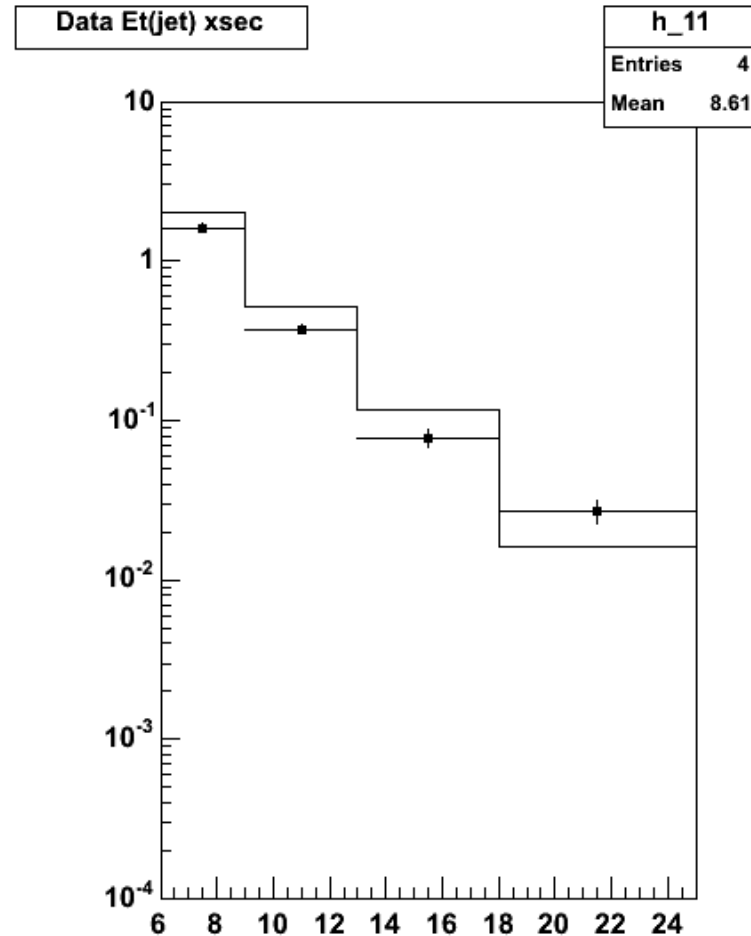
HZTool

- Currently Fortran based program
- Library of subroutines associated with papers
- Reproduces plots from measurements that can be easily compared with any others
- Also produces Monte Carlo simulation of events for each measurement

Inclusive Jet E_T cross section



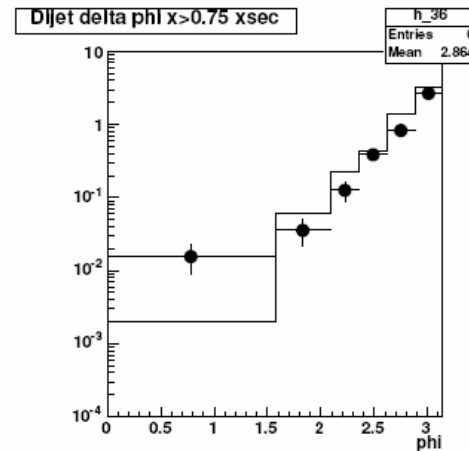
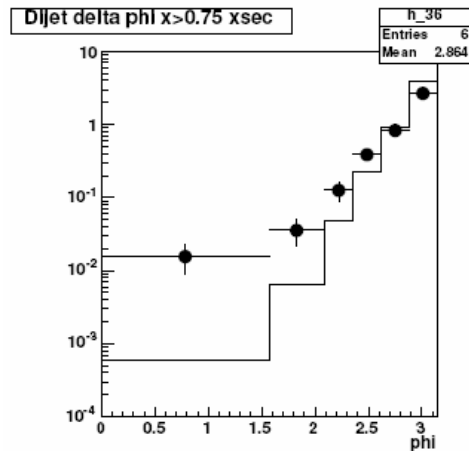
PYTHIA



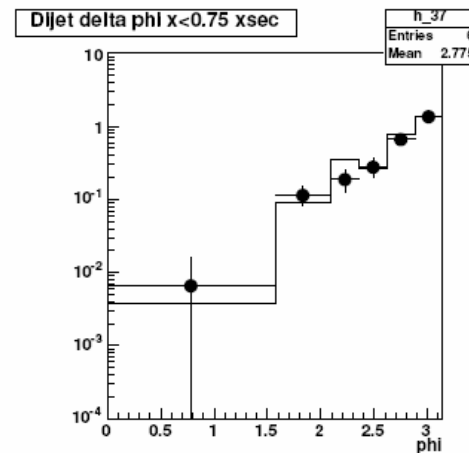
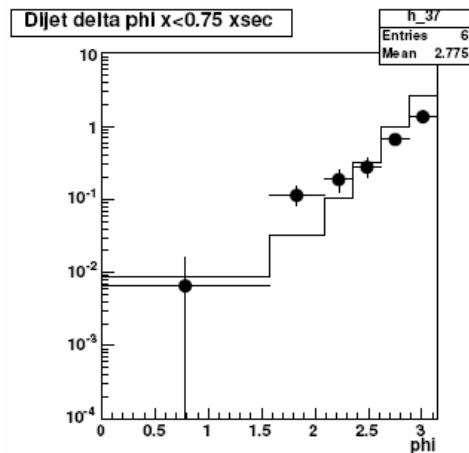
HERWIG

Dijet $\Delta\phi$ cross sections

DIRECT:



RESOLVED:

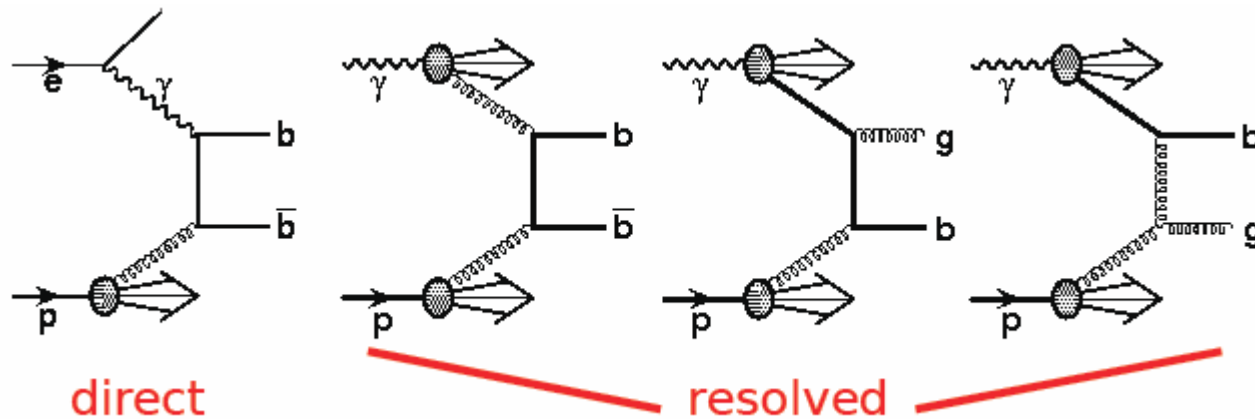


PYTHIA

HERWIG

Charm jet production at HERA and its implementation into HZTool – Sarah Boutle

Beauty Photoproduction

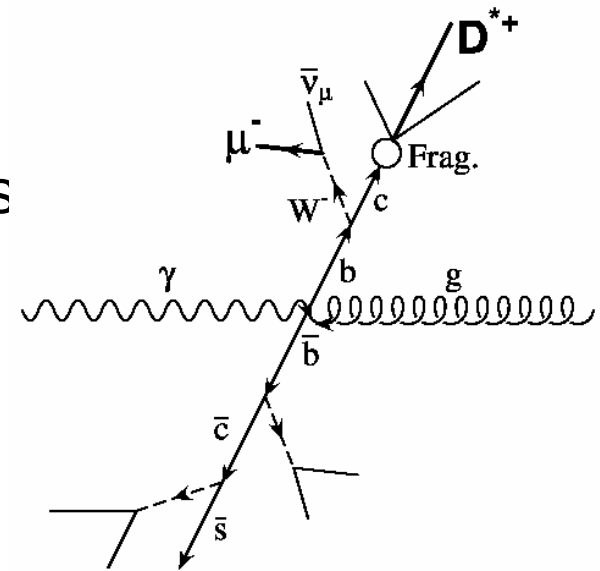


- $Q^2 \sim 0 \text{ GeV}^2$ Boson exchanged is a nearly real photon
- Direct: Photon behaves like a pointlike object
- Resolved: Photon behaves as a source of partons

Semi-Muonic Decay

- Clean experimental Signature:
muon detected in muon chambers
- Neutrino is undetected:
lose some kinematic information
- c quark fragments into jet of hadrons

➔ Look for 2 or more jets + muon



Background Processes

- Heavy Vector Mesons – $J/\psi \rightarrow \mu^+\mu^-$ contribution $< 1\%$
- Cosmic muons contribution is negligible
- Misidentified hadrons
- Semi-muonic charm decays: very similar to signal

need to distinguish between them using

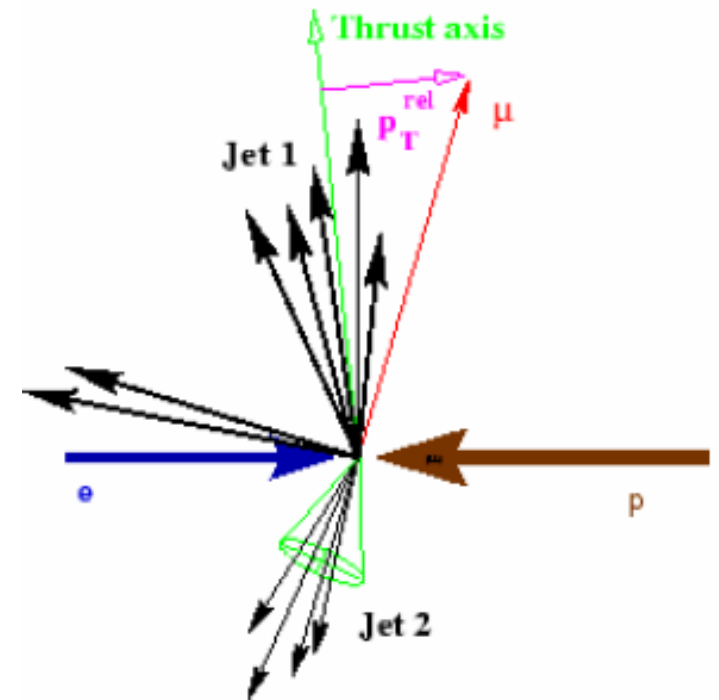


mass or lifetime.... need analysis observables

P_T^{rel} : the Mass Signature

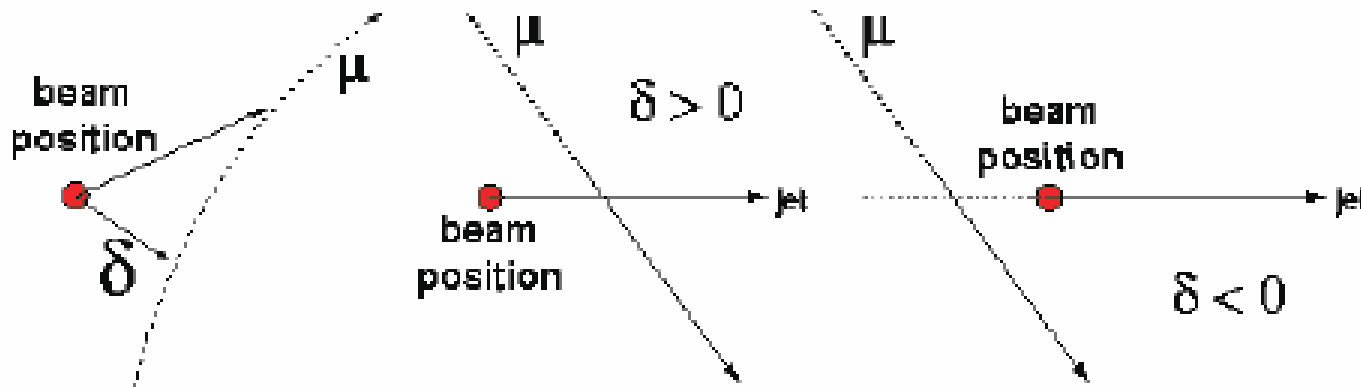
- Muon has higher p_T than in charm decay
- A more efficient quantity: p_T relative to the mother hadron
- Experimentally: use jet axis

$$P_T^{\text{rel}, \text{jet}-\mu} = |P_T^\mu| \cdot \sin \left(\arccos \left(\frac{\vec{P}_T^\mu \cdot (\vec{P}_T^{\text{jet}} - \vec{P}_T^\mu)}{|\vec{P}_T^\mu| \cdot |\vec{P}_T^{\text{jet}} - \vec{P}_T^\mu|} \right) \right)$$



The Impact Parameter: Lifetime Signature

- The transverse distance of closest approach of the reconstructed muon from the primary vertex.
- Use the signed impact parameter to remove detector resolution effects.



Event Selection

- **DIS:** $E_{el} > 5\text{GeV}$, $\text{prob}_e > 0.9$, $y_{el} < 0.9$, $0.2 < y_{JB} < 0.8$
- **Beam Gas:** $P_T / E_T < 0.5$, $E_T - 2IR \geq 10\text{GeV}$, $P_T \leq 10\text{GeV}$
- **Beam Gas:** Vertex fitted tracks > 2 , $\text{Tot}(\text{tracks}) / \text{Tot}(\text{fitted}) \geq 10$
- **Z Vertex:** $|Z_{\text{vertex}}| < 40\text{cm}$

A Muon with:

$$P_T^\mu > 2.5 \text{ GeV}$$

$$-1.6 < \eta^\mu < 2.3$$

At least 2 jets with:

$$-2.5 < \eta^{\text{jet}} < 2.5$$

$$P_T^{\text{jet1}} > 7\text{GeV}$$

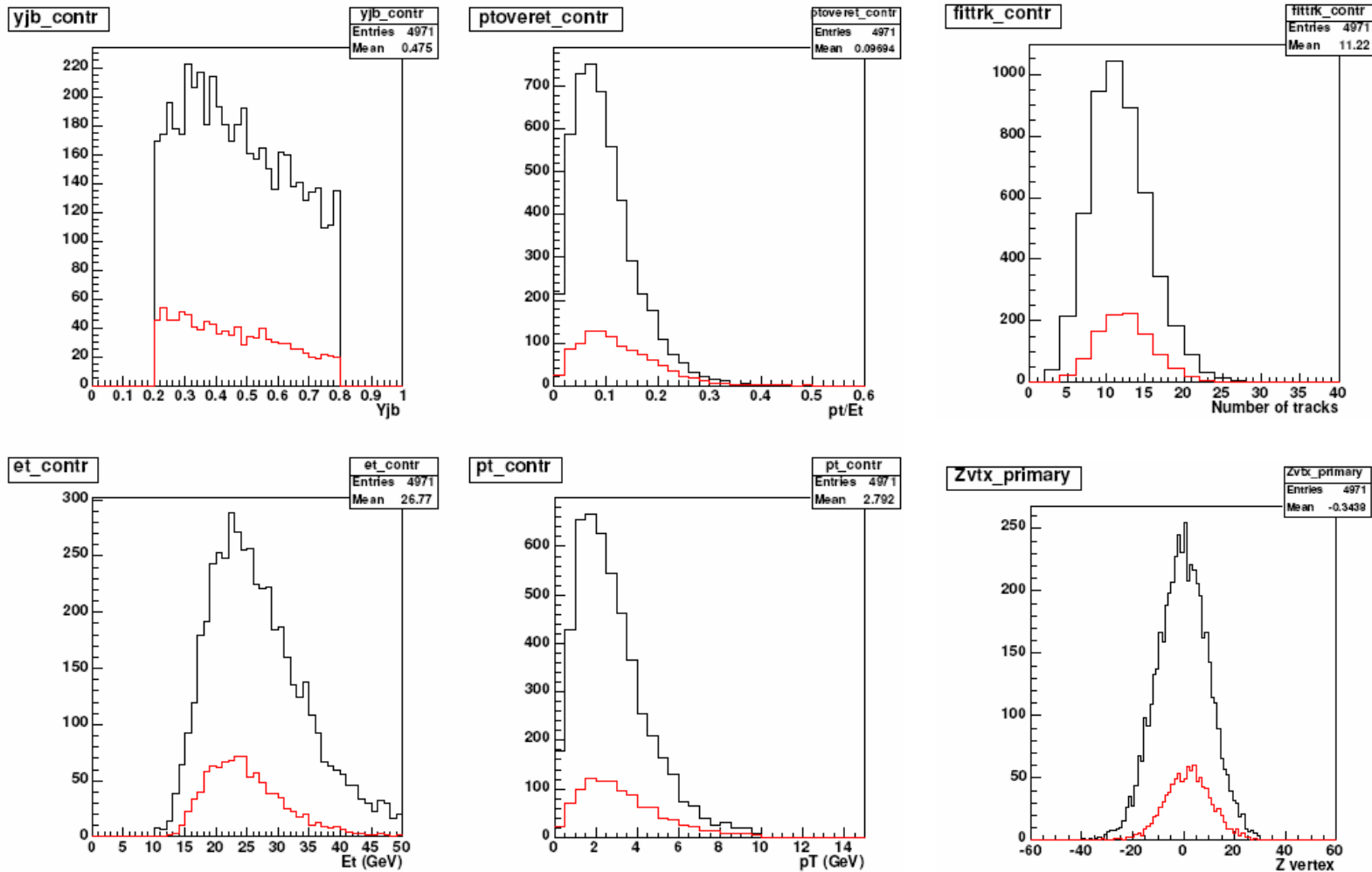
$$P_T^{\text{jet2}} > 6\text{GeV}$$

At least 1 jet with

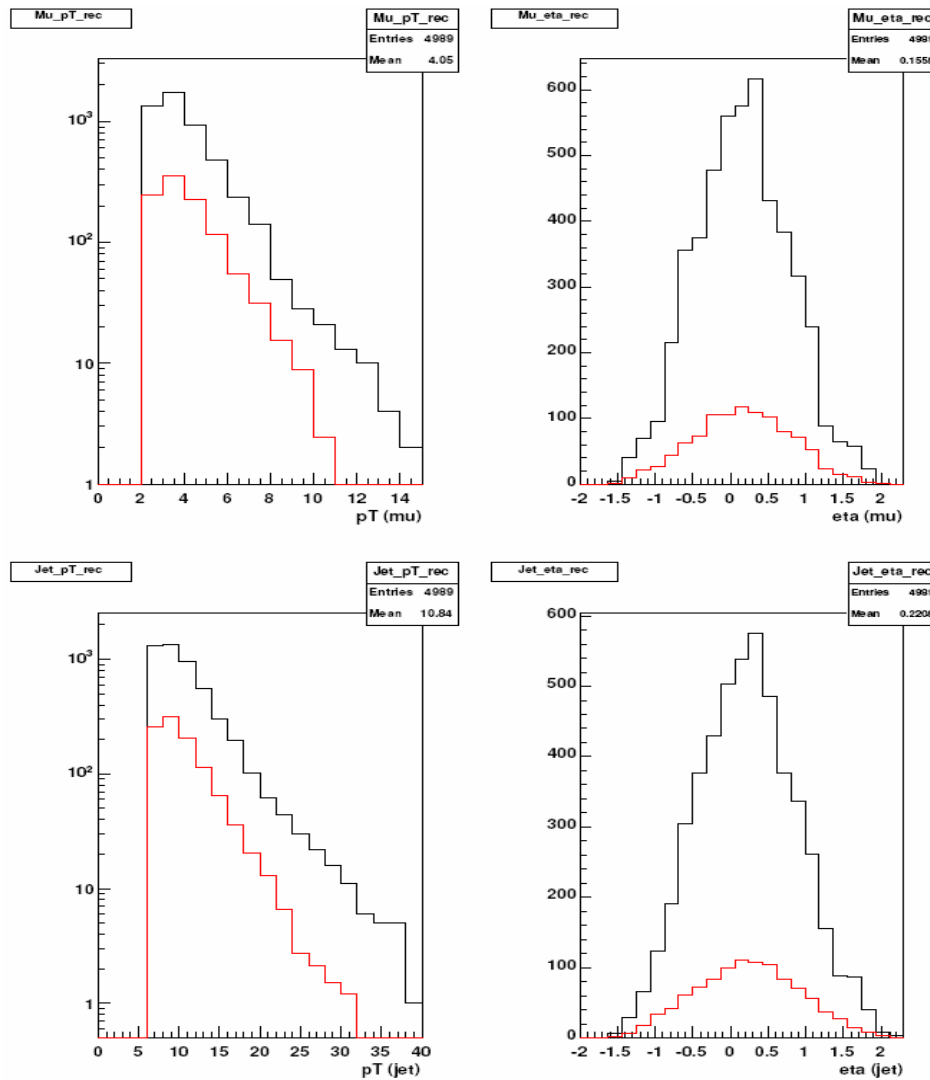
An associated muon

$$(P_T^{\text{jet}} - P_T^\mu) \geq 2\text{GeV}$$

Control Plots

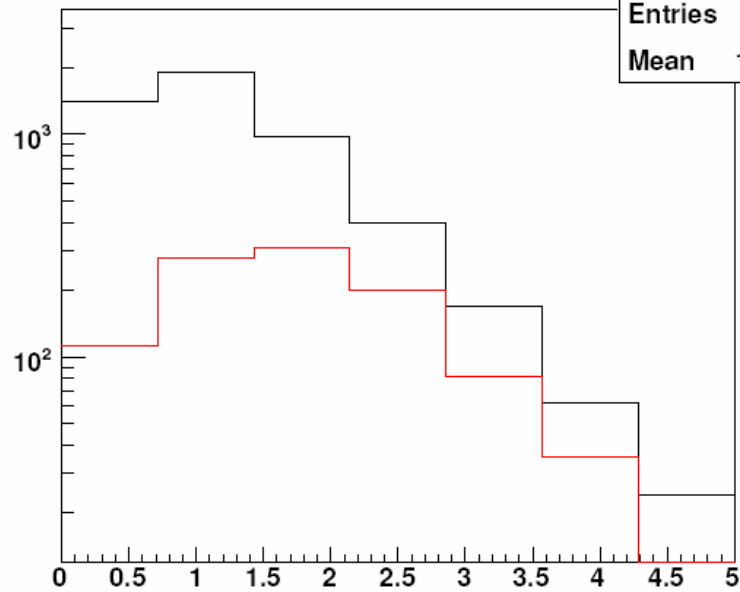


Control Plots



Results

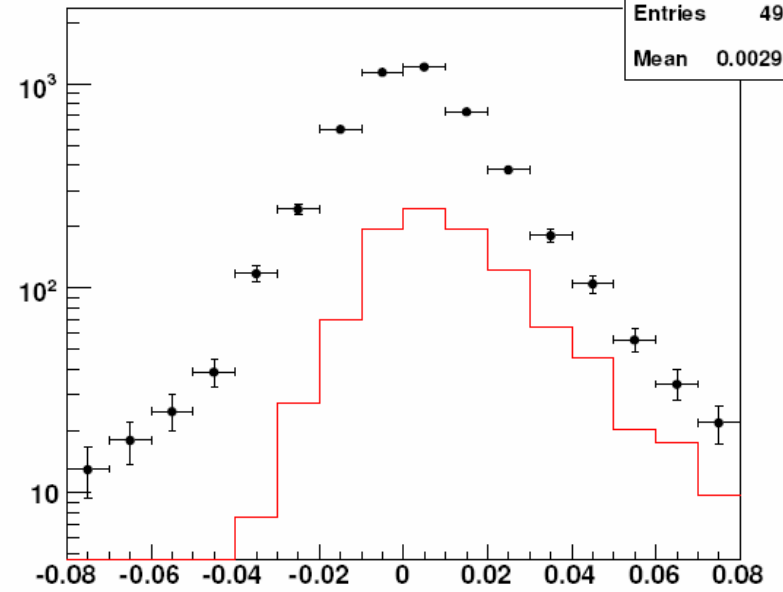
pT_rel



pT_rel

Entries 4989
Mean 1.249

Impact_Parameter



Impact_Parameter

Entries 4989
Mean 0.002912

Summary

- Developed an HZTool subroutine that corresponds to ZEUS charm paper
- Plots look as expected
- Beauty analysis event selection carried out
- Event Selection agrees with Silvia
- Control Plots look OK

Outlook

- Finalize comparison with Silvia and compare with beauty + charm + light flavour MC.
- Improve MVD reconstruction by simulating dead material.
- Extend beauty analysis to include 2005 data
- Produce physics result for beauty: significantly better than HERA I and over wider phase space

