ZEUS UK Collaboration Status Report

— Part 1 —

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1st July 2002

Overview

- Introduction to HERA and ZEUS
- Detector Status
  - Central Tracking Detector
  - Microvertex Detector
  - Global Tracking Trigger
  - Transverse Polarimeter Upgrade
- Physics Results on Heavy Flavour Production

Role of UK within ZEUS

- **Spokesman**
- **Vital UK role in data taking**
  - ***Runcoordinators, Shifts, Component coordination, Background studies***
- **Joint coordinators in 3 (of 5) physics groups**
- **Monte Carlo and Tracking Coordinators**
- **Leading a wide range of analyses**

ZEUS UK plays an essential role within ZEUS

HERA — World's only ep collider

HERA Physics program:

- ▷ **Understanding p and γ structure**
- ▷ **QCD studies**
- ▷ **Electroweak tests**
- ▷ **Searches**

HERA luminosity upgrade (2000-1) — Increase in specific luminosity

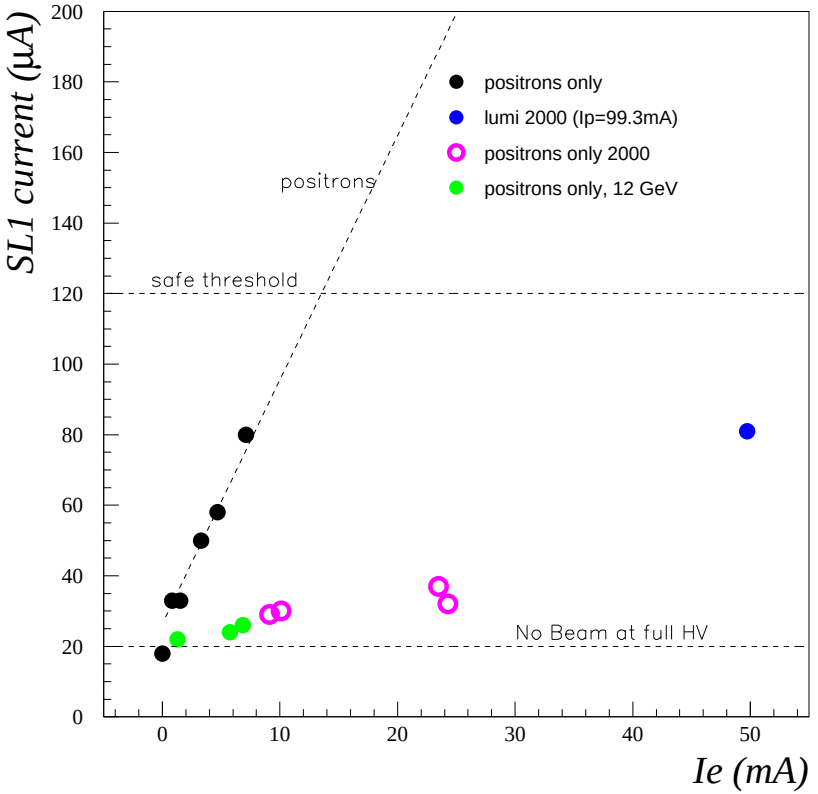
Recommissioning: L_{spec} = 1.4$\cdot 10^{30} cm^{-2} s^{-1} mA^{-2}$ (design 1.8$\cdot 10^{30}$)

- ▷ **Encouraging**

HERA Recommissioning

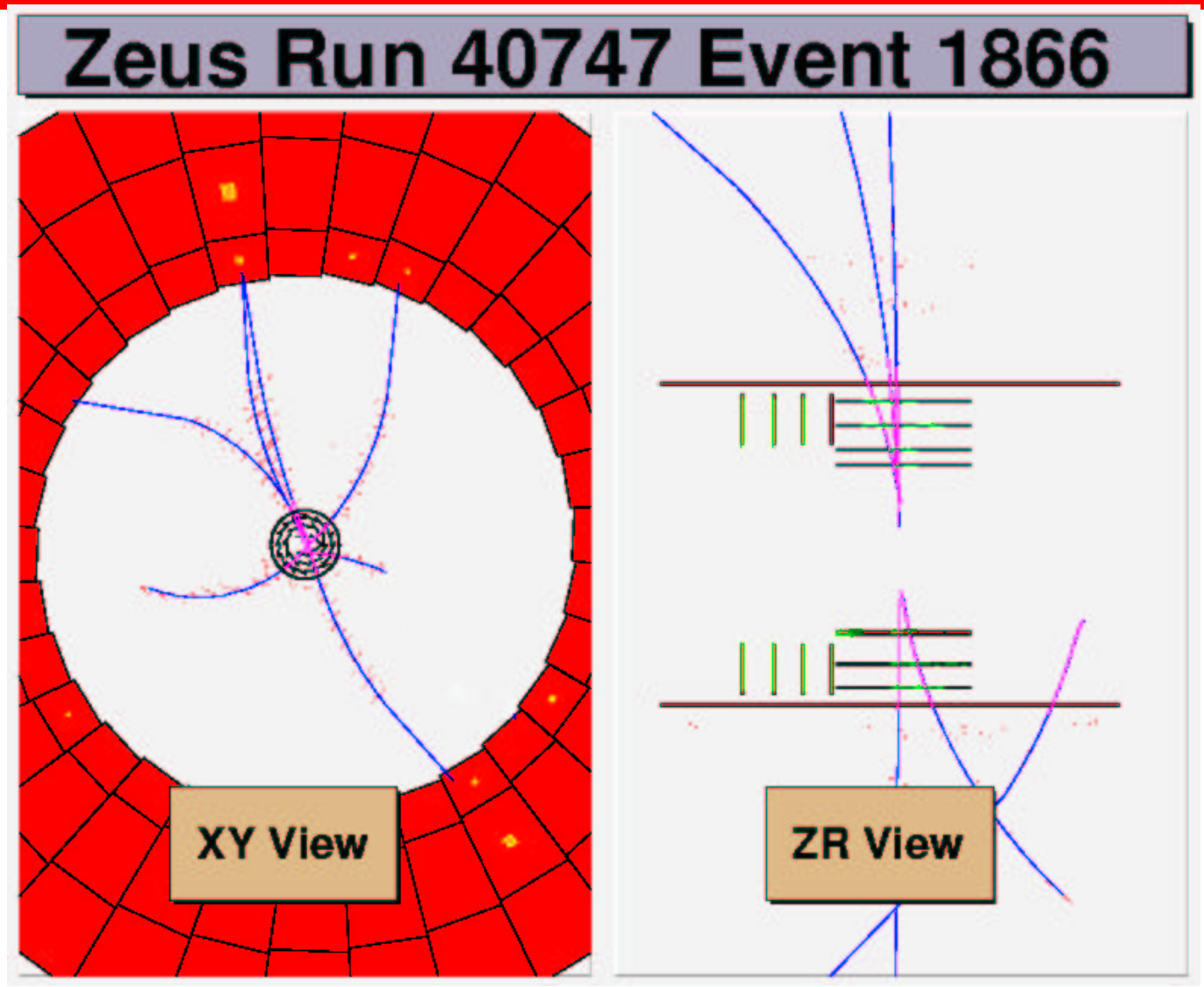
- **Initially reproducability of beam orbits was poor**
  - ▷ **Machine now better understood**
- **Background conditions in experimental areas too high**
  - ▷ **New collimators installed in March reduced backgrounds significantly**
  - ▷ **Backgrounds for ZEUS still too high to operate detector effectively**
- **CTD essential for solving problems**

CTD SL1 currents, positrons only



ZEUS and HERA working closely together to solve this problem

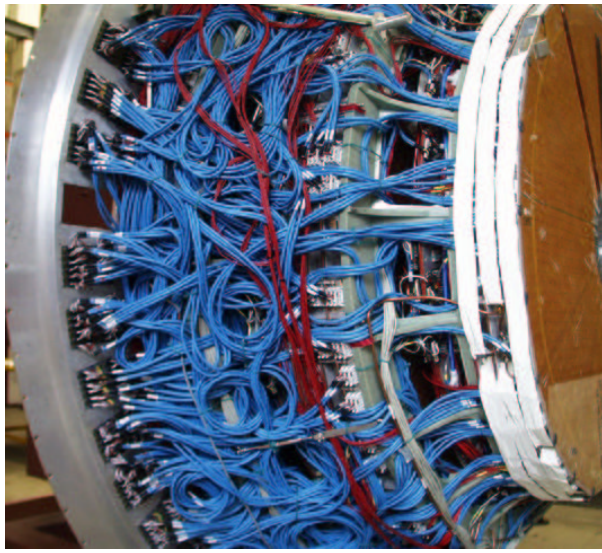
ep Collisions

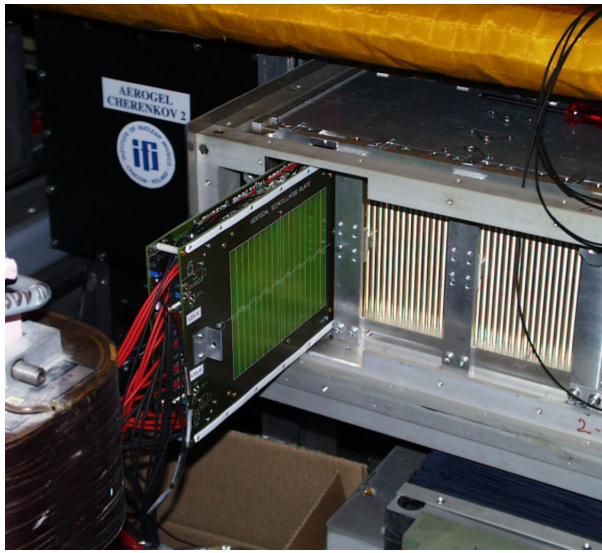


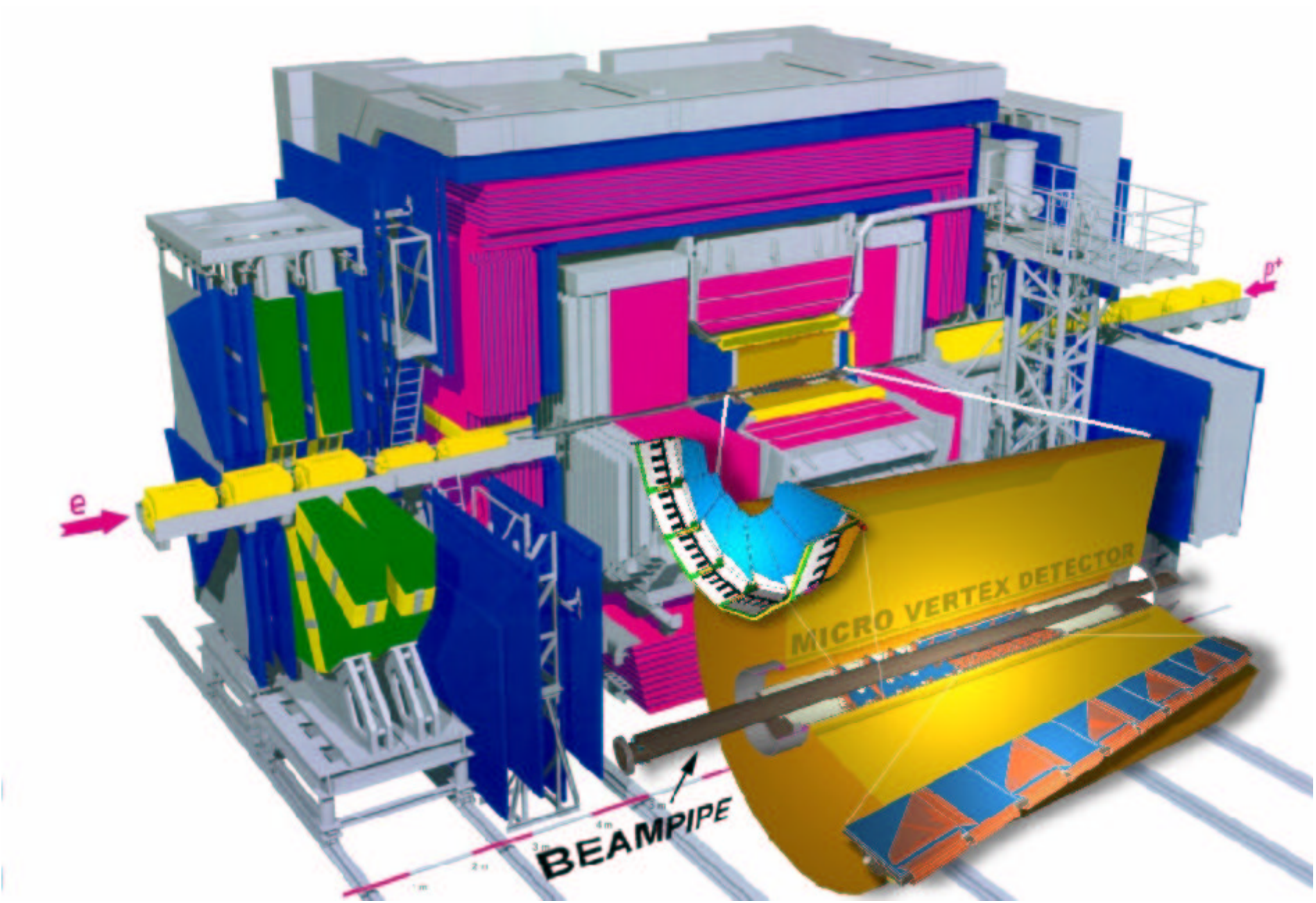
ep collisions observed at HERA II

Upgrade of the ZEUS Detector during Shutdown

- **Significant upgrades to the ZEUS detctor**
  - ▷ **Microvertex Detector → more later!**
  - ▷ **Global Tracking Trigger → more later!**
  - ▷ **Straw Tube Tracker → Tracking in forward direction**
  - ▷ **Luminosity Monitor → 3 detectors installed**
  - ▷ **Polarisation → more later!**






e
p+
MICRO VERTEX DETECTOR
BEAMPIPE

Central Tracking Detector (CTD)

- **Primary ZEUS UK contribution ▷ CTD essential for ZEUS running**
- **Very successful throughout HERA I**
- **Possibly observed *"Malter"* effect in 2000 ▷ Fixed**
  - **▷ High Voltage Breakdown problems not observed since then**
- **dE/dx now understood for physics analysis**
  - **▷ dE/dx used in several results in past 2 years**
- **Essential for all 3 levels of the trigger at HERA I and II**

- **CTD used in virtually every ZEUS result published from HERA I**
  - **▷ Will be needed for every result from HERA II**

Micro Vertex Detector (MVD) Installation

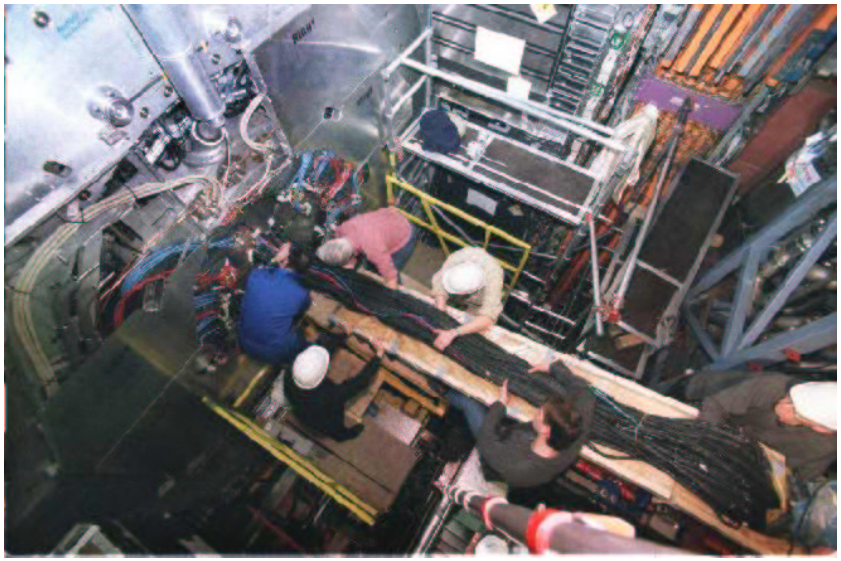
UK MVD Responsibilities:

- Clock + Control Electronics
- Laser Alignment System
- Patch box
- Installation

- MVD installed March - April 2001

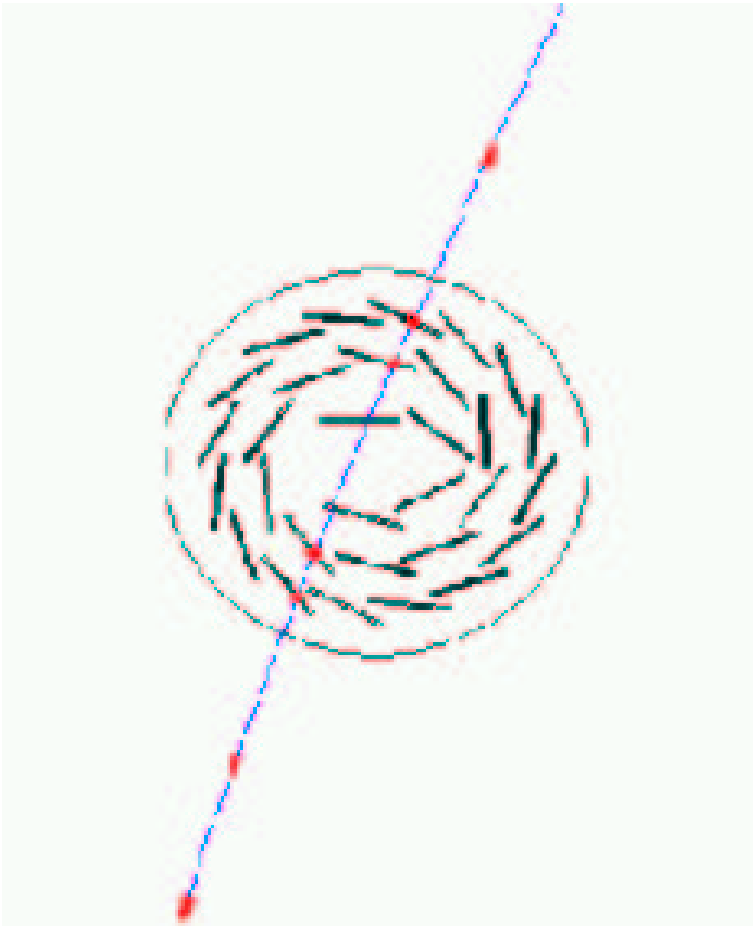
MVD motivated by strong UK physics program:

Understand charm and beauty production in QCD



Micro Vertex Detector (MVD) Commissioning

- UK people heavily involved in pre-installation system test
  - Provided shift people and visualisation software
- Involved in post-installation commissioning
- MVD commissioned in ZEUS DAQ chain for July 2001 cosmic test
- Offline alignment ongoing

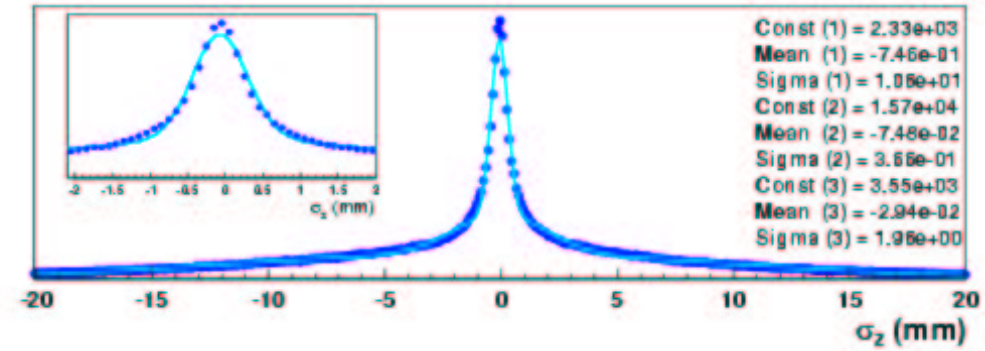


MVD now installed + works in situ!

Global Tracking Trigger (GTT) Algorithm

- Integrate tracking from CTD, MVD and STT at Second Level Trigger
  - ▷ Harsh environment ▷ high contribution from beam gas
- Operate within existing CTD SLT latency (Mean $\sim$ 10 ms)
- CTD+MVD algorithm written and tested ▷ compared to current offline

▷ Track Resolutions comparable or better than current offline



Event vertex

- ▷ $\sigma(z) \sim 355\mu m$
- ▷ cf 1mm current offline
- ▷ cf 8cm present CTD-SLT

Combined CTD + MVD tracks are available at the SLT

Physics Motivation for Polarisation

- Spin rotators installed around HERA experiments during shutdown
  - ▷ Polarisation possible after upgrade

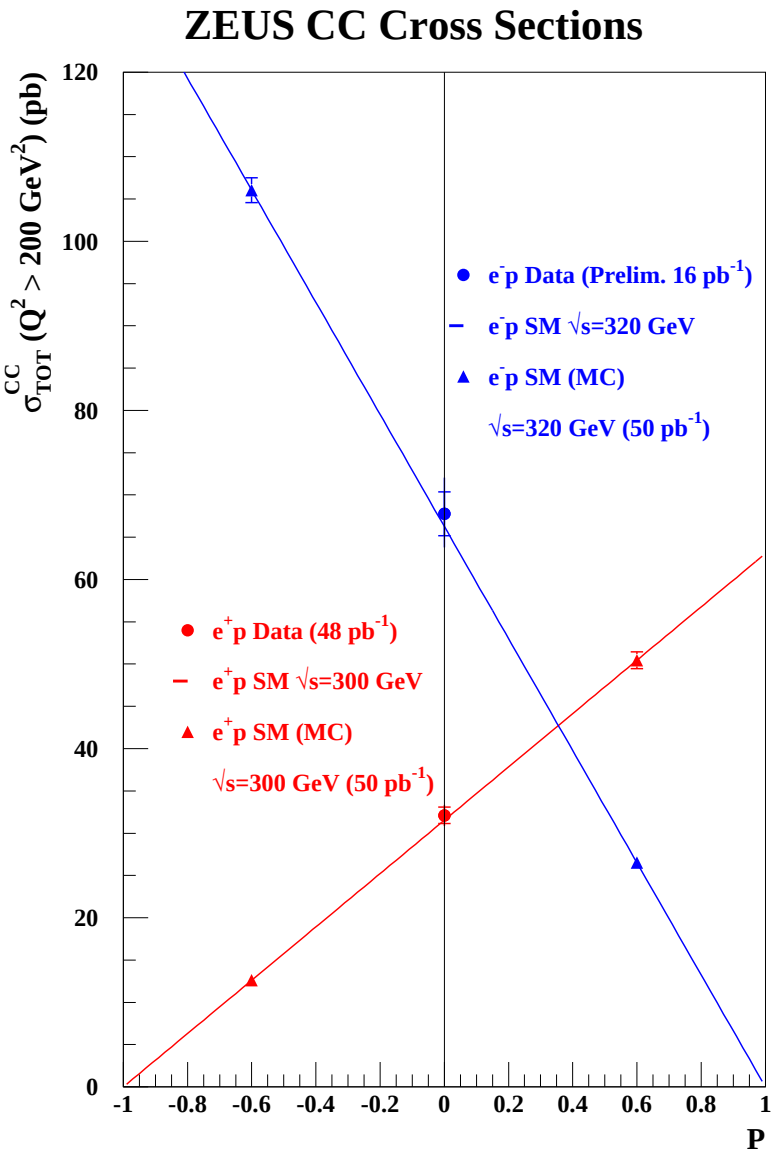
AIM: 4 data sets from HERA II:

e^+, e^- ; P > 0, P < 0

▷Fully investigate structure functions and electroweak physics

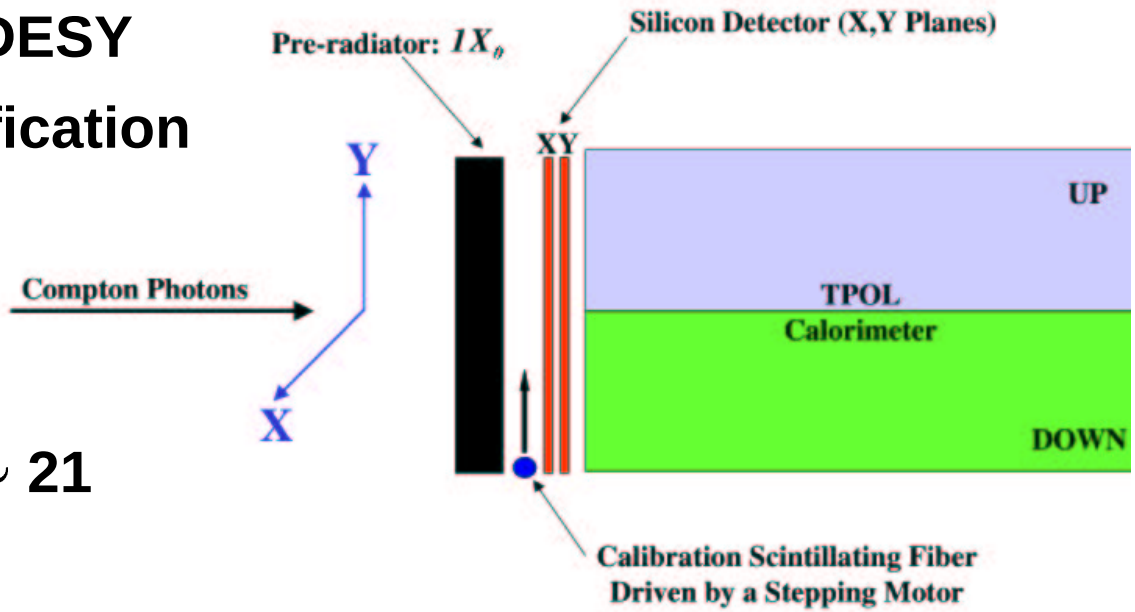
▷ $\frac{\Delta P}{P} < 1\%$ required →

Transverse Polarimeter upgrade - A ZEUS UK Contribution



Transverse Polarimeter Upgrade

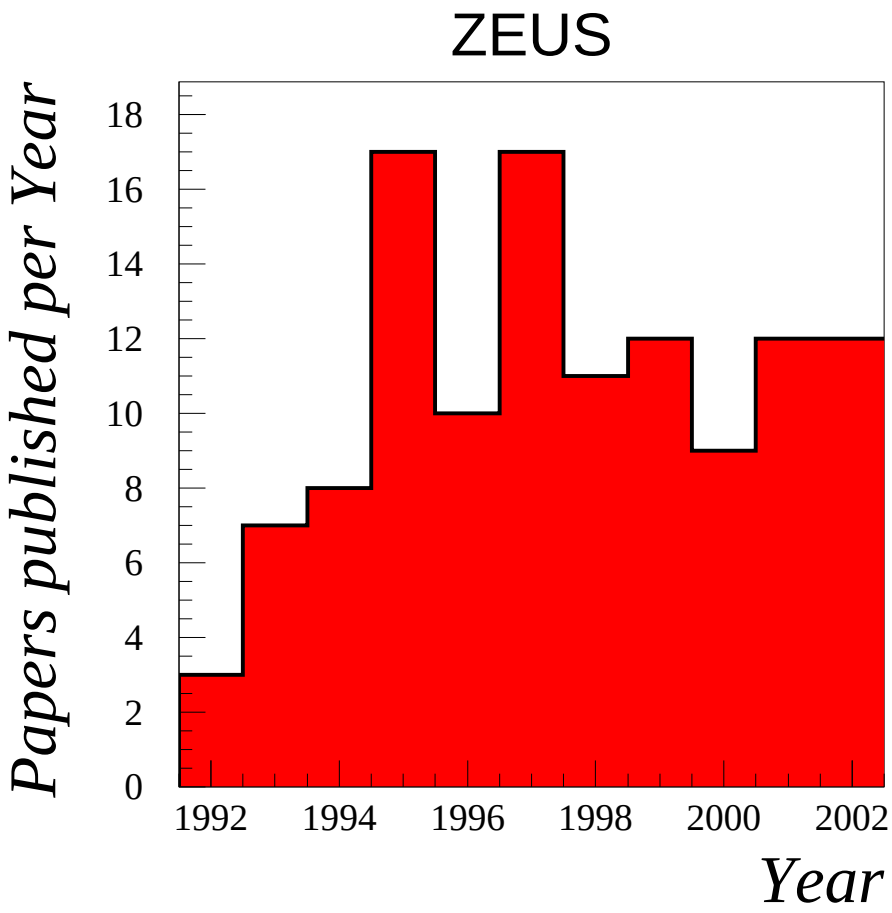
- Built, calibrated and installed
- Testbeam in CERN and DESY
  - Results meets specification



- Silicon detector
  - $\sigma(y) < 50\ \mu$m, S/N ~ 21
- TPOL Calorimeter
  - $\sigma(E)/E \sim \frac{25}{\sqrt{E}} \oplus 4\,\%$
- Installed November 2001
- Post-installation
  - Operated successfully with unpolarised beams
  - Measuring bunch-by-bunch polarisation

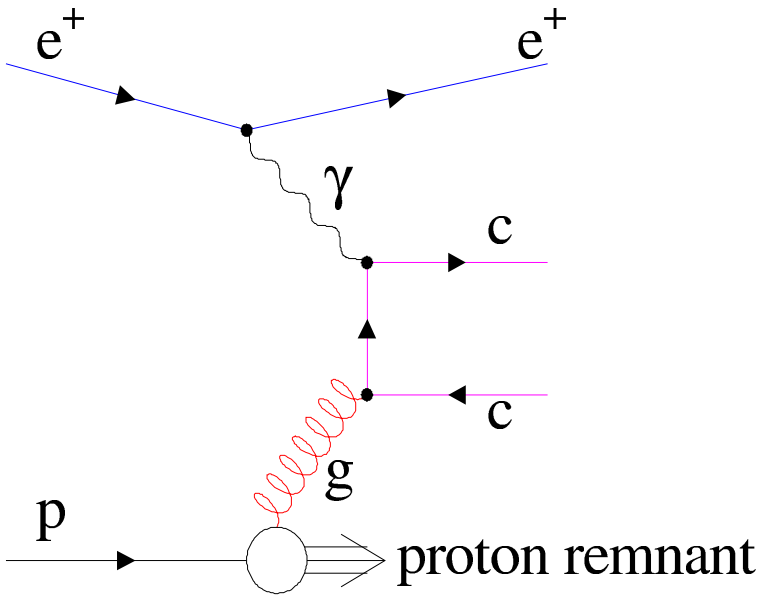
HERA I

- Already a very successful physics program from HERA I
- 113 Papers from ZEUS
- 131 pb^{-1} data taken
  - ▷ Many more results to come ...
- Talk about results in heavy flavour physics here
- Results on Structure Functions, Electro-Weak, Jets, Searches . . .
  - ▷ See next talk . . .



Heavy Flavour Physics — Motivation

- **Boson-Gluon-Fusion dominant contribution**
  - ▷ **Sensitive to gluon content of proton**
- **m_c and m_b give a hard scale to process**
  - ▷ **Good testing ground for QCD**
- **Q^2 and E_T^{jet} can also provide a hard scale**
  - ▷ **Multi-scale problem**



- **Beauty production in $p\overline{p}$ and e^+e^- above expectations**
  - ▷ **What about ep collisions?**

Heavy Flavour Physics is a major unresolved topic in QCD

Heavy Flavour Physics

Topics Covered Here:

- Charm production in Deep Inelastic Scattering
- Diffractive Charm
- Charm + Jets
  - Charm in the photon?
  - Fragmentation
- Beauty production

All results shown here led by UK people

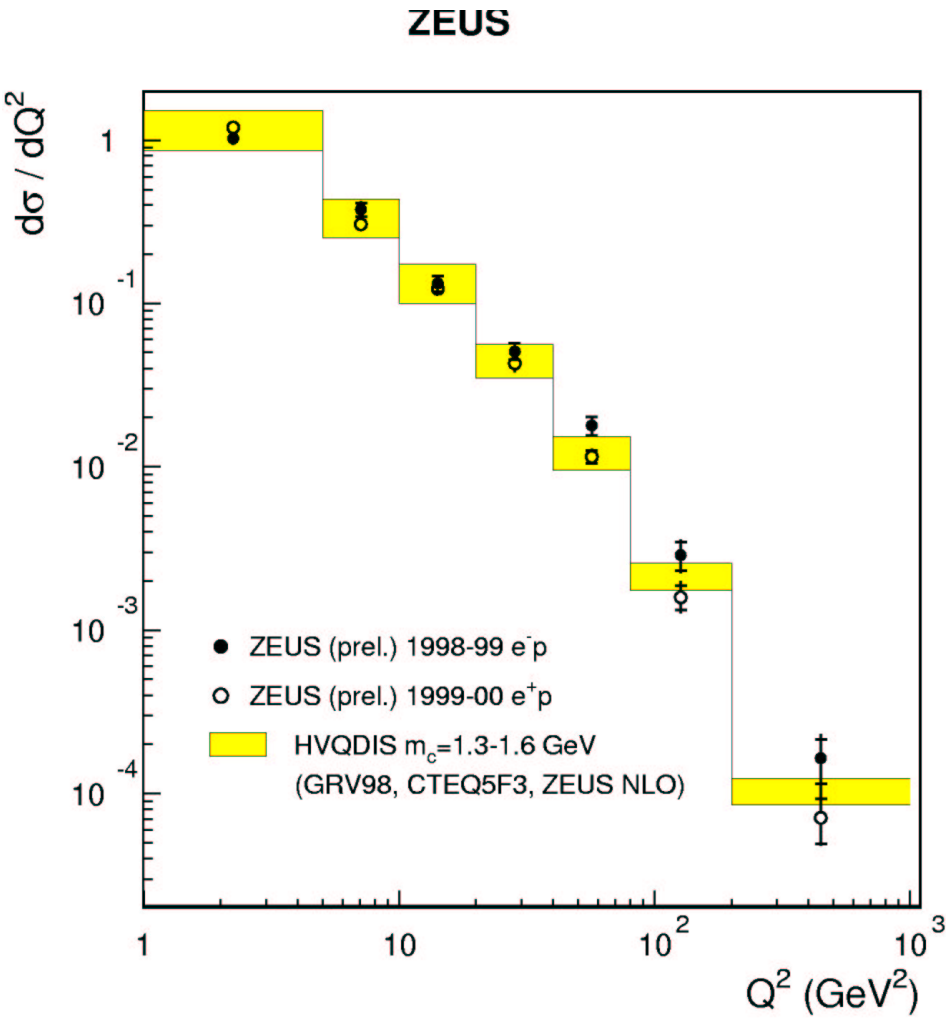
Topics not covered here:

$D^{\star}$ meson branching ratios

Alternative $D^{\star}$ meson decay channels

Charm in Deep Inelastic Scattering

- Important for understanding charm in the proton
- Tag charm by $D^{\star}$ mesons
- Vast improvement in errors from previous results
- First time $\sigma(e^{-})$ measured at HERA
- $\sigma(e^{+})$ and $\sigma(e^{-})$ in agreement with pQCD



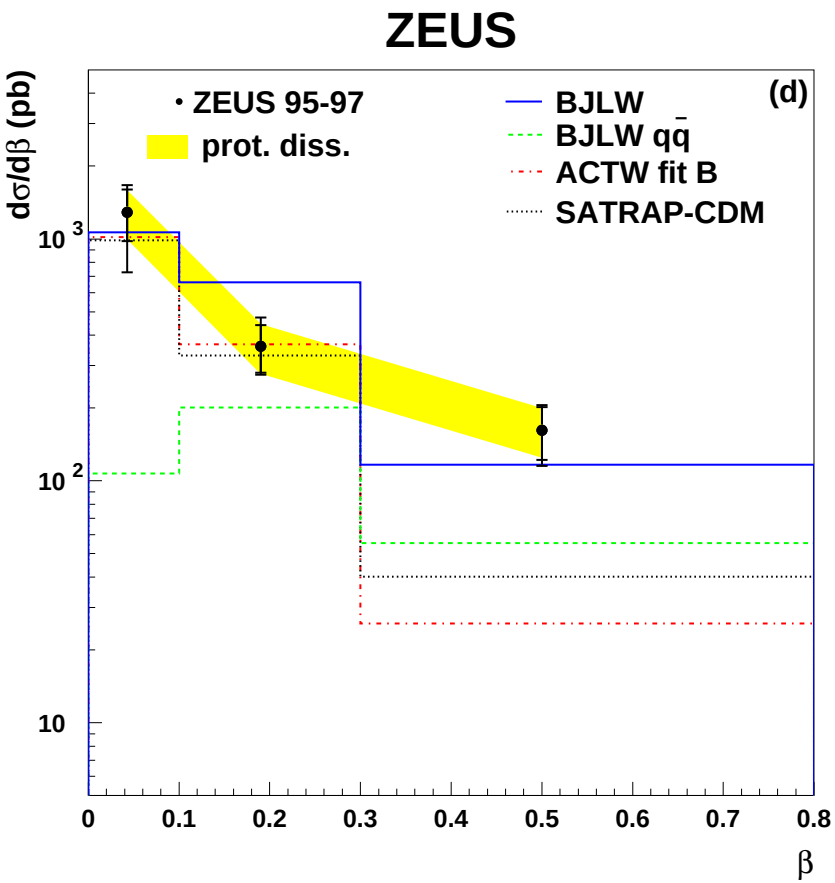
Diffractive Charm

- Diffraction at HERA is important topic
  - ▷ Characterised by a large rapidity gap in the final state
  - ▷ Exchange of colour singlet ▷ Often termed pomeron
  - ▷ What is the diffractive exchange?

- Charm is sensitive to gluons
  - ▷ Gluonic content of pomeron

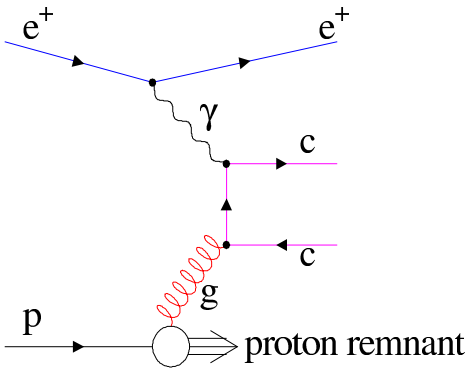
- Models with 2 gluon exchange seem to be able to describe results better

- Significant fraction of DIS charm production is diffractive (7%)



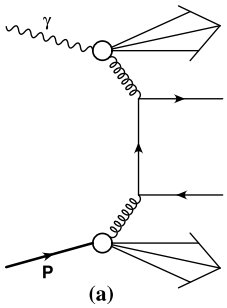
Charm and Jets

Now high enough statistics to look at charm + dijet production



Direct

High x_γ^{OBS}



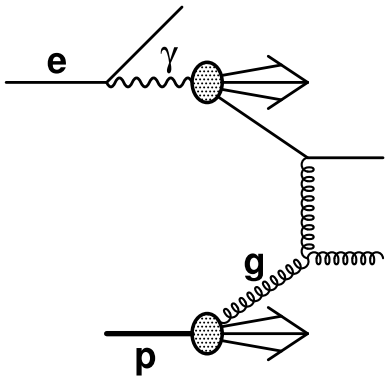
Resolved

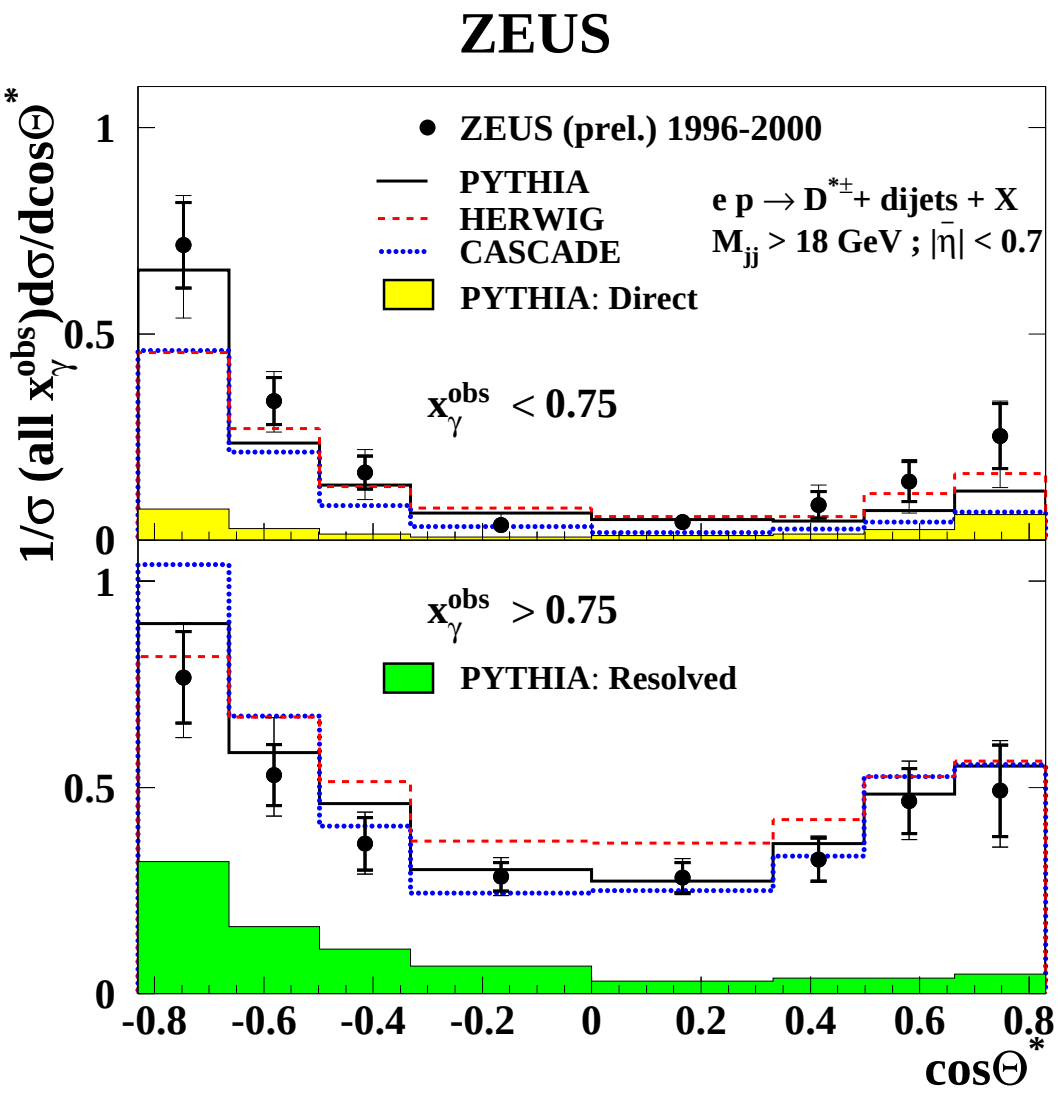
Low x_γ^{OBS}

- **In resolved events, photon acts as a source of partons**
- **Resolved charm production $\rightarrow$ sensitive to γ structure**
- **Charm with dijets give access to the production dynamics**
- **Charm Fragmentation can be studied**

Charm and Jets

- Idea: Probe production mechanism
- Direct: Approx. Symmetric
  - ▷ Boson Gluon Fusion
- Resolved: Strong assymetry in photon direction

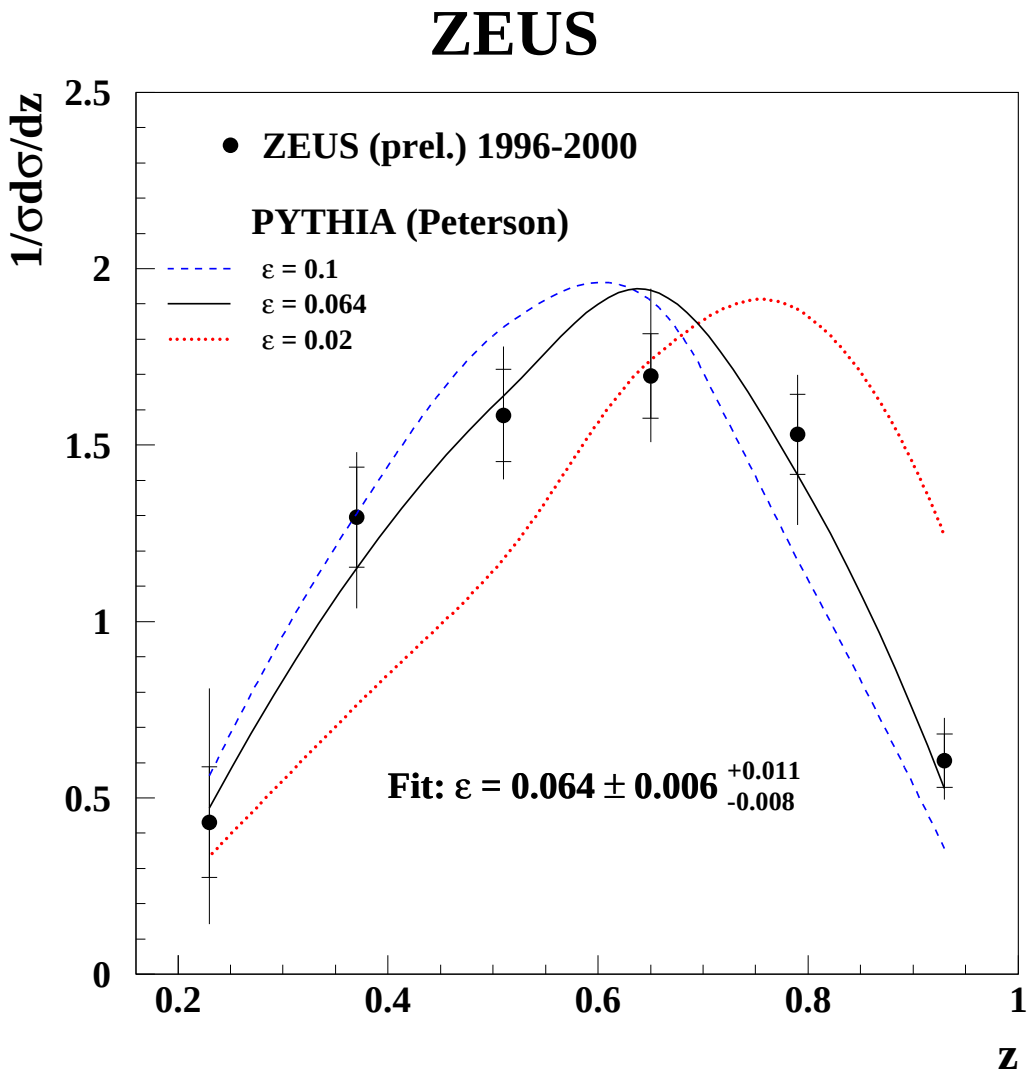




- ▷ Strong evidence for charm in the photon

Charm Fragmentation

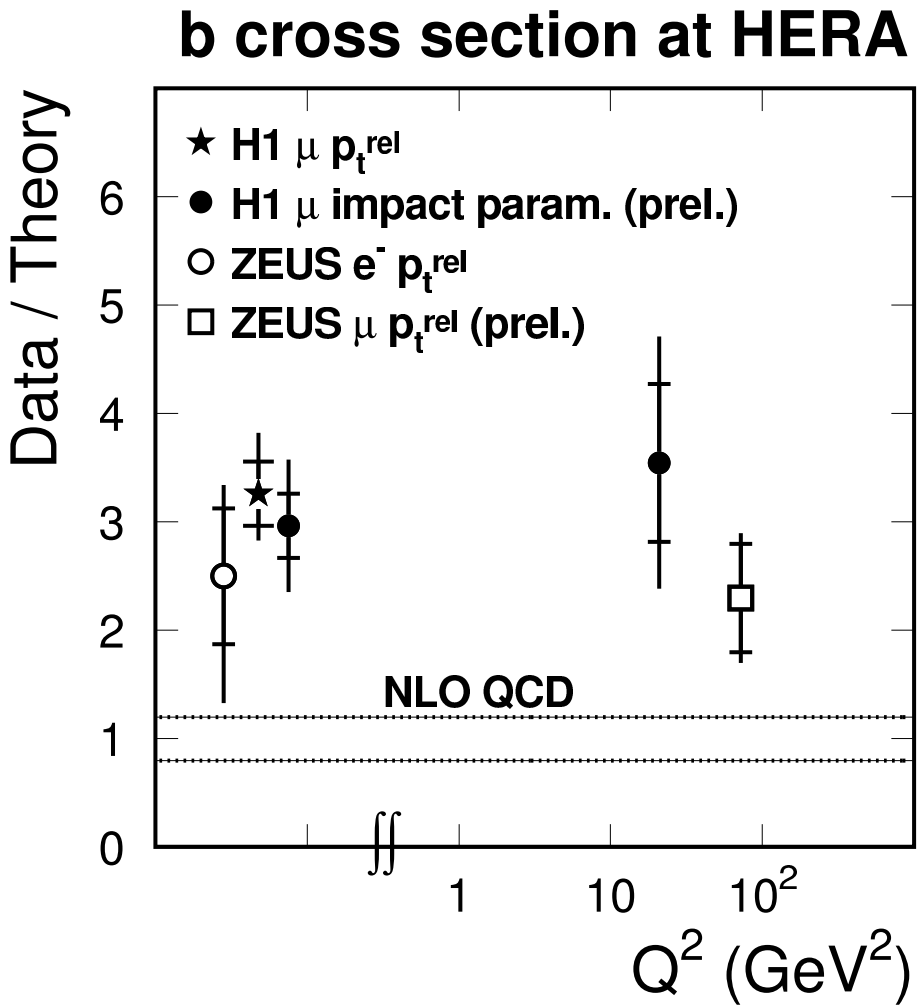
- Is charm fragmentation universal?
- Measure fragmentation: charm $\rightarrow$ $D^{\star}$ meson
  - ▷ Energy fraction, z, carried by $D^{\star}$
- Strong sensitivity to ϵ
- Data similar to that from $e^{+}e^{-}$



Precision competitive with LEP - very different production process for charm

Beauty Production

- Electrons from semi-leptonic heavy quark decays
  - ▷ Tag using dE/dx in CTD
  - ▷ Technically difficult
  - ▷ Sensitive to b quark production
  - ▷ 15% contribution from beauty
- HERA results on beauty above NLO pQCD predictions
  - ▷ In both Deep Inelastic Scattering and photoproduction
  - ▷ Statistical uncertainty still large



HERA II data will be very interesting