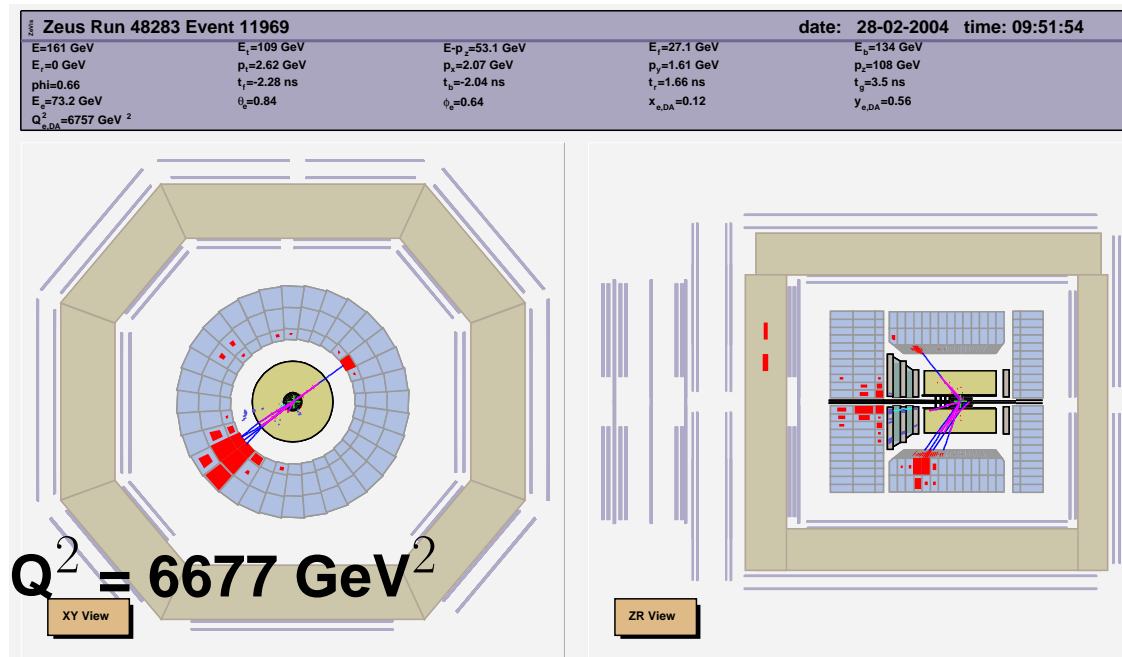


# ZEUS Status Report — Recent Results and Progress

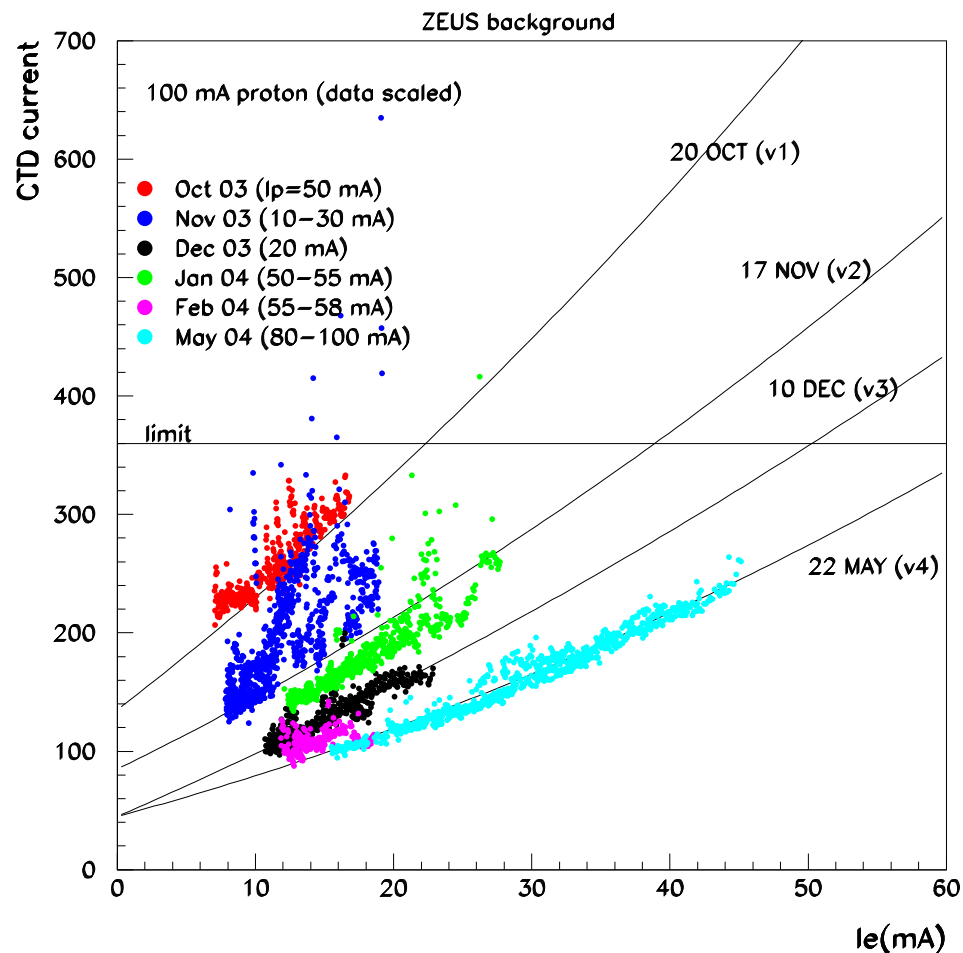
## PRC, DESY

Richard Hall-Wilton (University College London)



- Running Conditions
- Detector Status
- Results from Recent Data
- Physics Highlights
- Summary

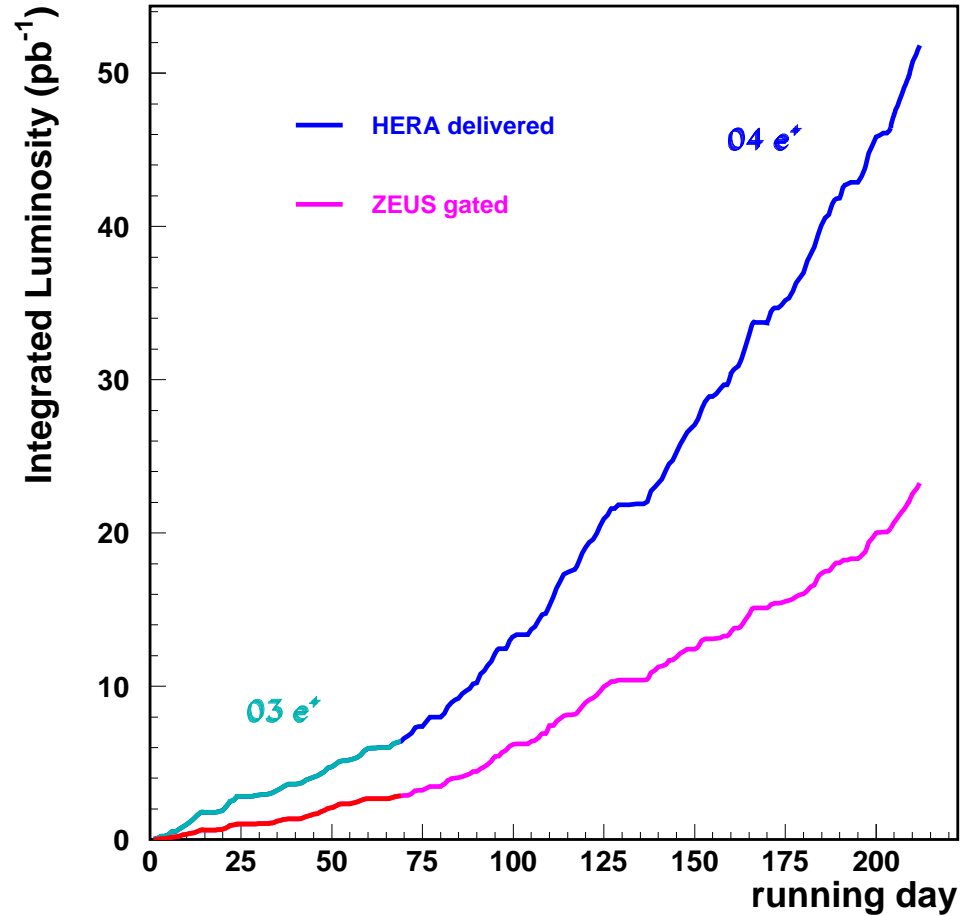
## ZEUS Background levels



- At the last PRC the extrapolated backgrounds at high beam currents above the safe operating level for the CTD
  - ▷ Pumping procedure and cleaning with beam has cleared up the proton background problems
  - ▷ Even at maximum anticipated beam currents, below the CTD safe operating level
- ▷ Proton Background problems solved!

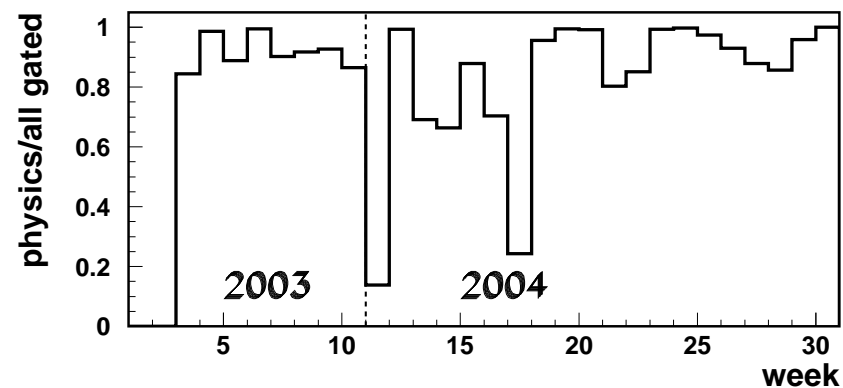
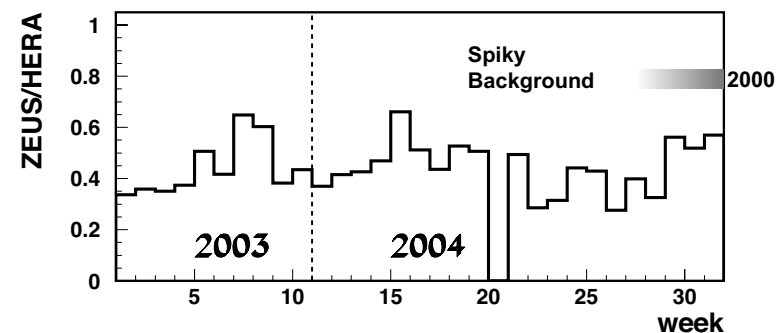
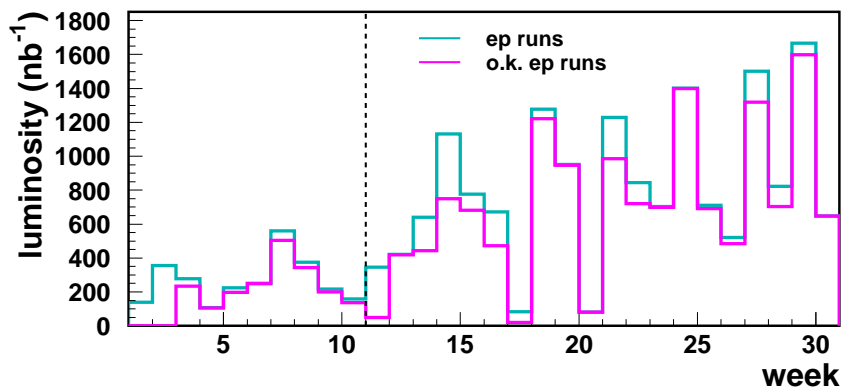
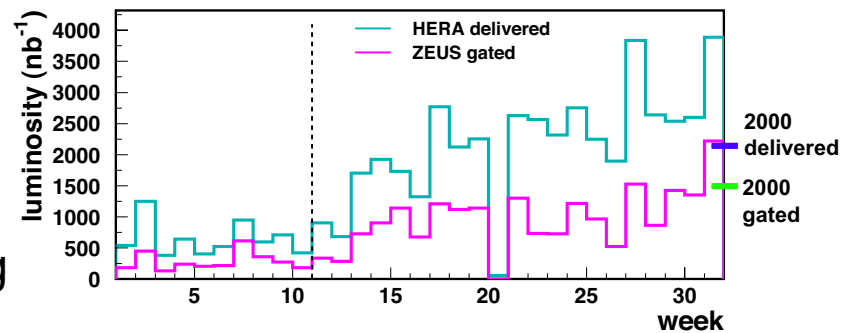
## Luminosity since the last PRC

- HERA delivered  $51 \text{ pb}^{-1}$
- ZEUS taken  $22 \text{ pb}^{-1}$ 
  - ▷ A closer look at the efficiency



# Luminosity Delivered per Week

- ZEUS efficiency started at  $\sim 40\%$
- Presently 50 - 60%
- CTD HV required to be on for data taking



- Nearly all data taken can be used for physics

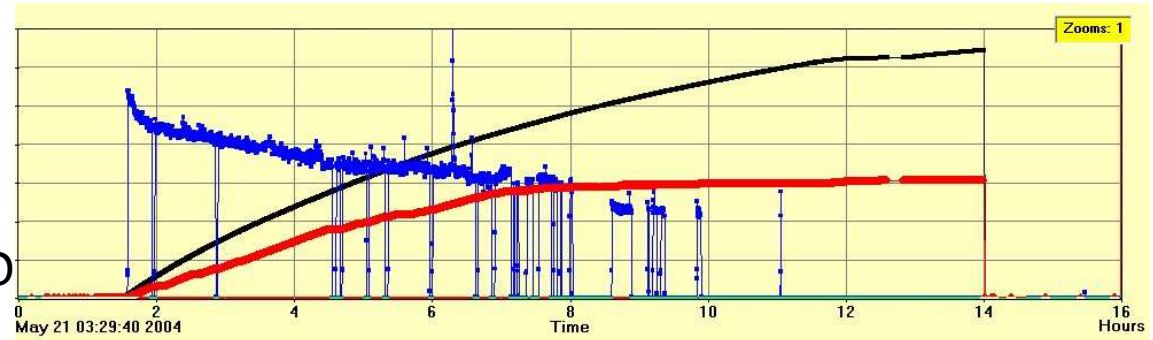
# ZEUS Efficiency — Examples of good and bad fills

- Fills from Last Week

- Bad Fill

- ▷ ZEUS Efficiency - 47%
- ▷ Regular trips
- ▷ Half way through the fill CTD

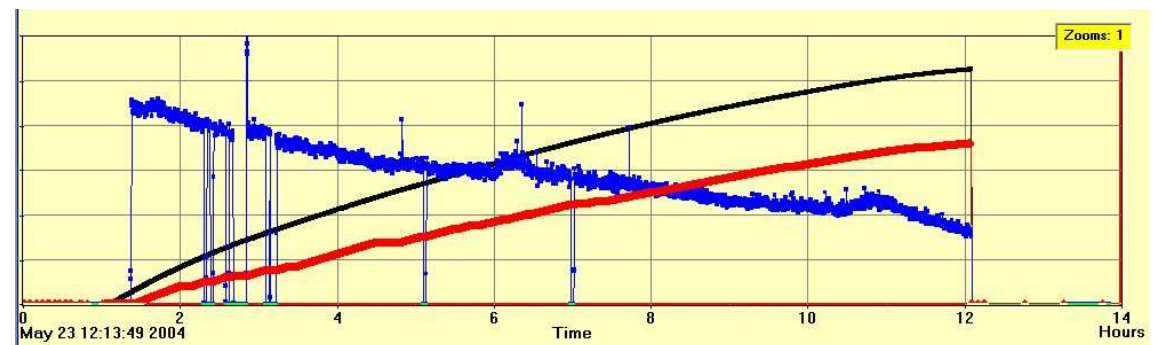
became inoperable



● CTD CURRENT  
● HERA DELIVERED LUMINOSITY  
● ZEUS GATED LUMINOSITY

- Good Fill

- ▷ ZEUS Efficiency - 68%
- ▷ Occasional Trips
- ▷ DAQ Deadtime (15% beginning of fill, 5% later)
- ▷ Occasional DAQ glitches
- ▷ Loss before detector is on

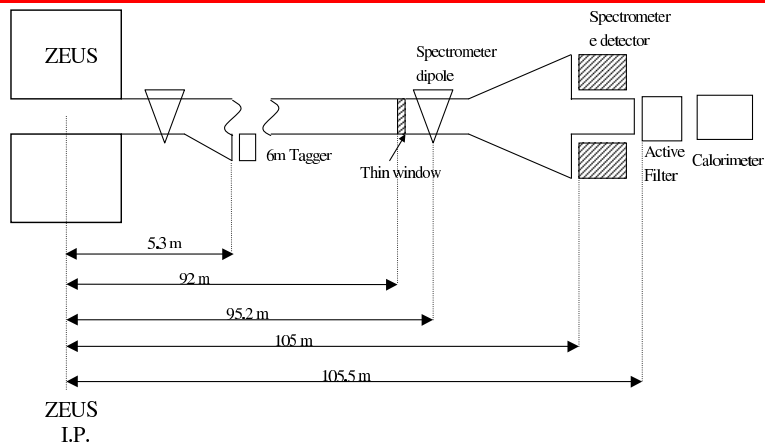


More typical since last weekend

## ZEUS Efficiency — Improvements

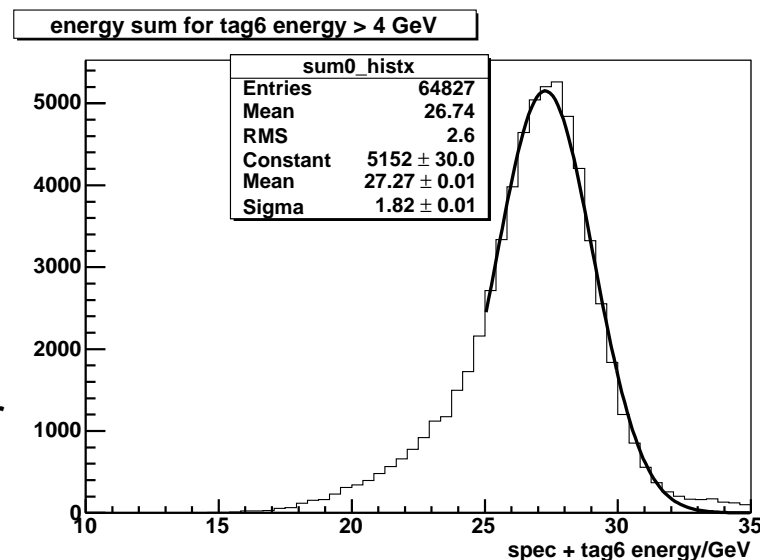
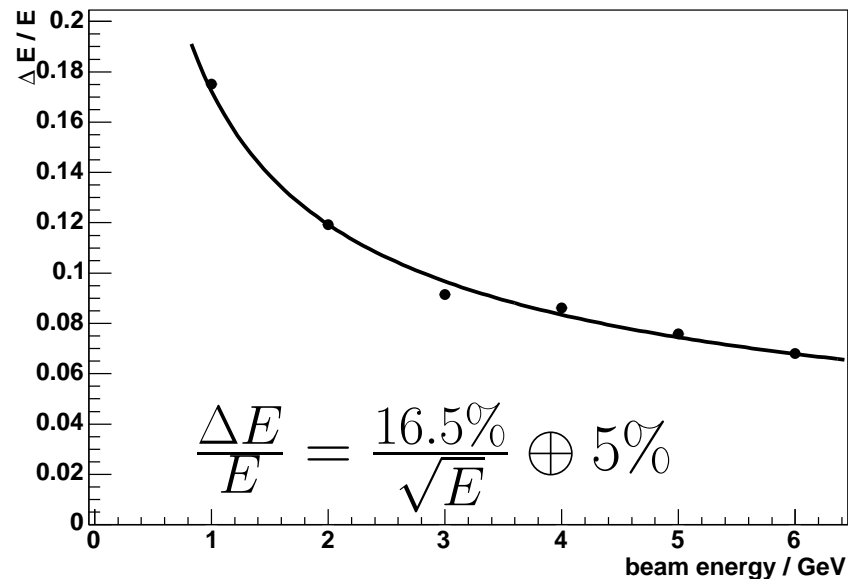
- Beam conditions become very spiky as the fill ages
  - ▷ Working closely with HERA to solve this
  - ▷ CTD trip thresholds have been increased to reduce sensitivity
  - ▷ Provided information on the spikes to HERA
  - ▷ Large effort from HERA → **Conditions are improving**
- DAQ Deadtime
  - ▷ Caused by huge size of events in DAQ system due to background
  - ▷ Solution: Use new Global Tracking Trigger at SLT to reject these events
  - ▷ Fully implemented by the end of this week
- DAQ Glitches
  - ▷ Problems identified
  - ▷ Efficiency is improving
- Improving luminosity procedure

# Luminosity Monitor Upgrade — 6m Tagger Status



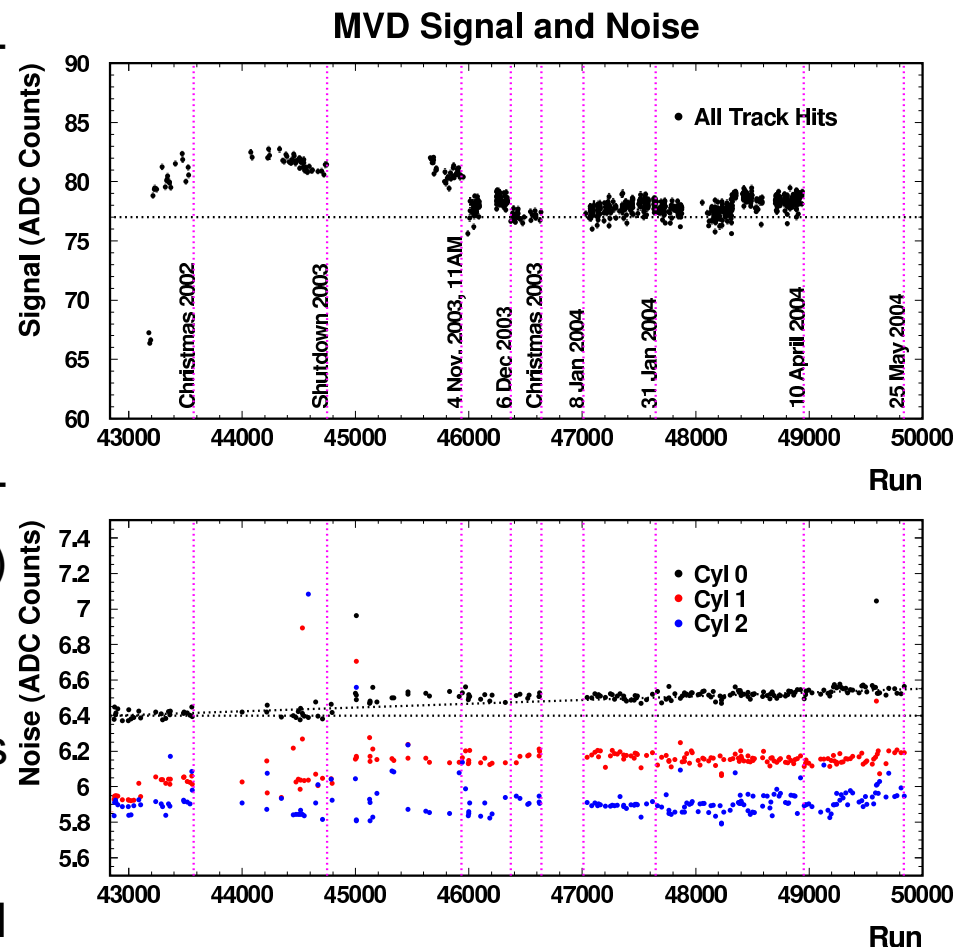
- Necessary to achieve 1% precision
  - ▷  $\gamma$ -Cal energy calibration
  - ▷ Spectrometer acceptance calibration

- Rebuilt and installed in November
- Data in coincidence with Spectrometer:
  - ▷ Energy sum within 1%
- Final integration with  $\gamma$  calorimeter trigger ongoing



## Micro Vertex Detector

- No evidence of significant radiation damage during routine HERA operation
  - ▷ Mean signal size stable (S/N 12)
  - ▷ Uncontrolled Proton beam loss (4 Nov) caused 10% drop in signal
  - ▷ Enormous effort from HERA to reduce this risk (exp.  $< 1$  to end of HERA)
  - ▷ Noise shows shallow slope
  - ▷ Corresponds to 6 kRad in 500 days on innermost cylinder
  - ▷ 25 kRad expected by end of HERA II
  - ▷ Front End Chips tested to 300 kRad
  - ▷ Do not expect major damage from radiation

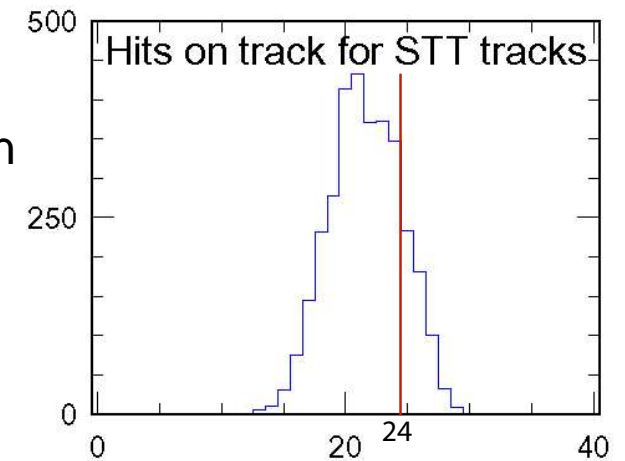
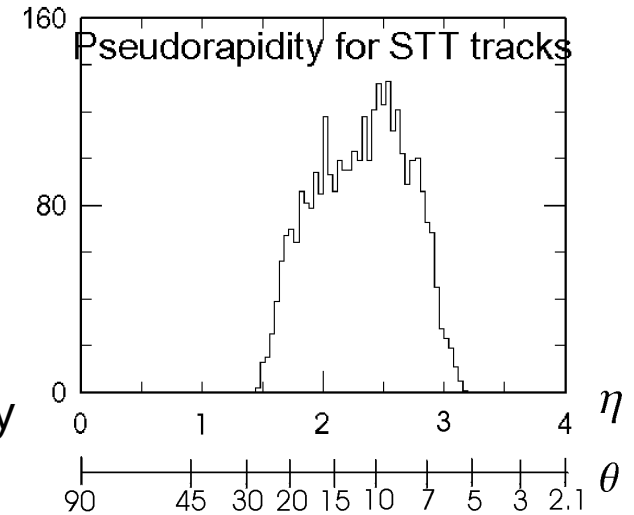


- Detector in good shape
  - ▷ Bad channels stable  $< 2\%$
  - ▷ First physics results using MVD ...

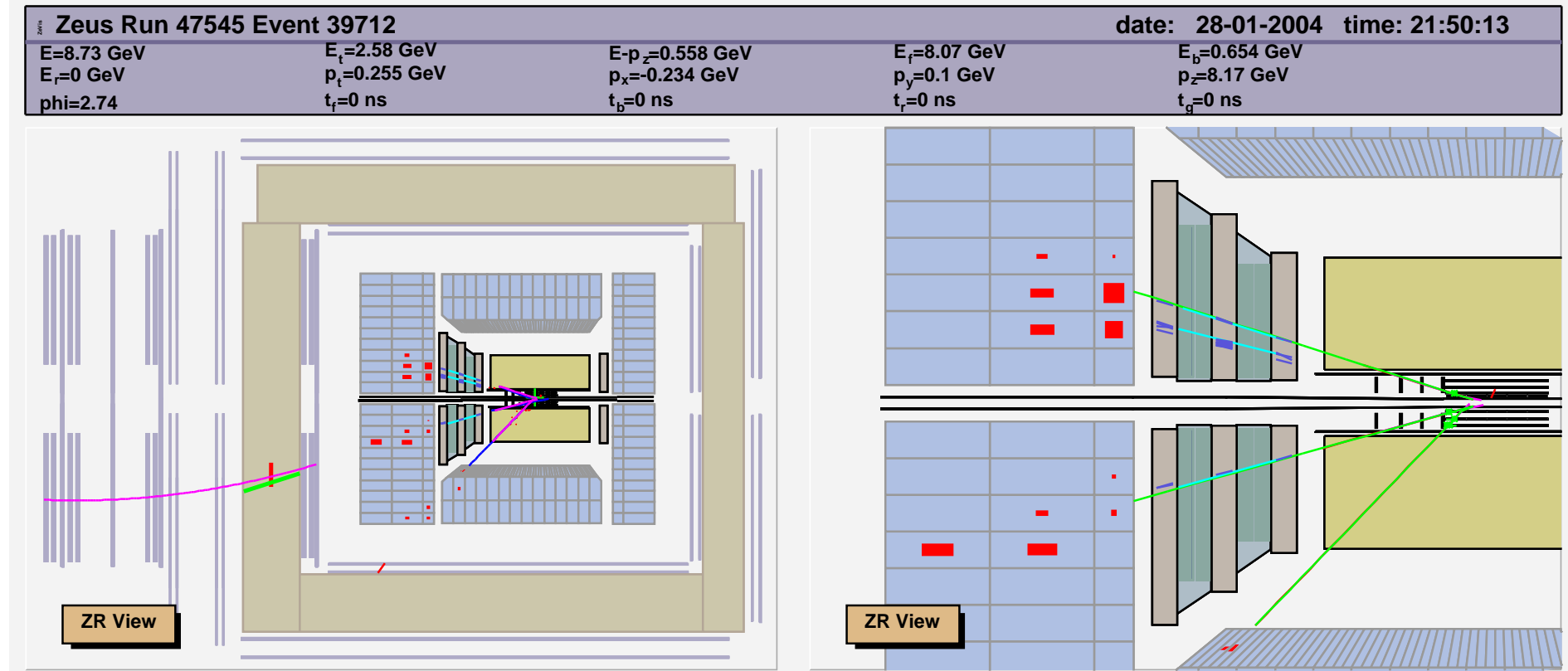


## Straw Tube Tracker

- After major work on STT during last summers shutdown:
- STT stable and included in luminosity running
  - ▷ STT running at full voltage since December
  - ▷ 3/48 sectors have low efficiency (though stable)
  - ▷ Not a problem for track finding as there is redundancy
  - ▷ Being implemented into SLT (GTT)
- Work ongoing to tune the tracking
  - ▷ Number of hits indicate high efficiency of pattern recognition



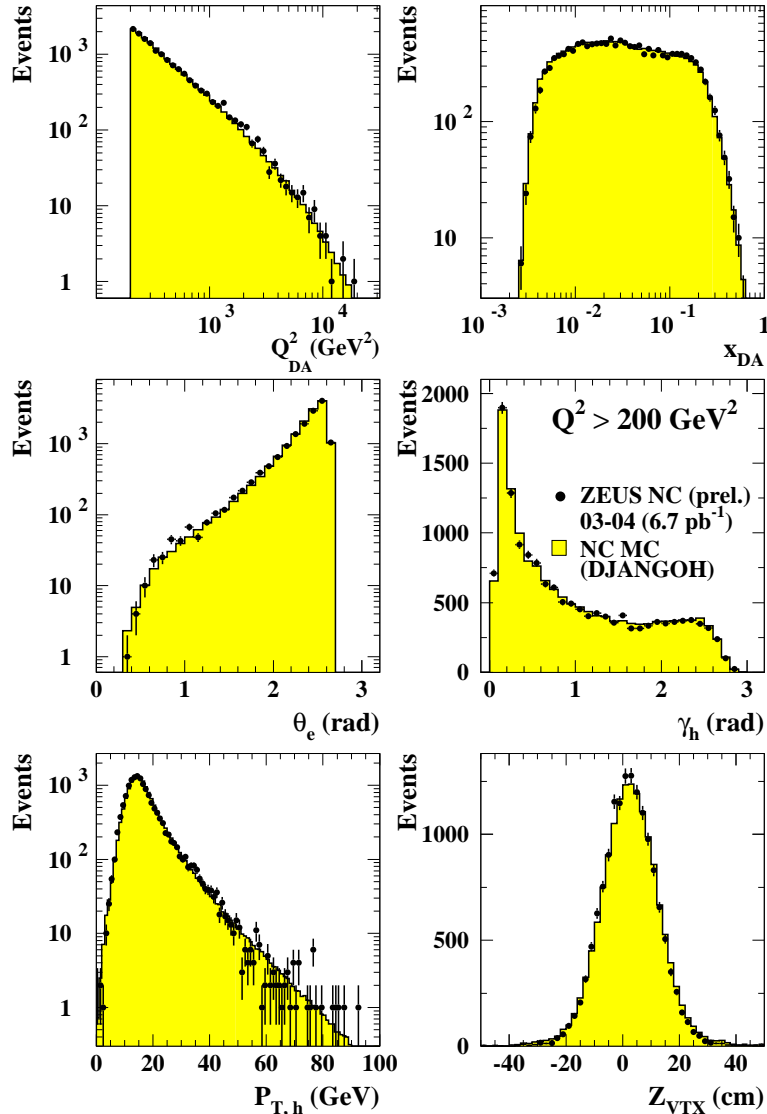
## Recent Data — STT Tracking



- Selecting low multiplicity events from Data to tune the Monte Carlo
- STT matching with CTD and MVD found tracks ongoing

Recent Data — Neutral Current

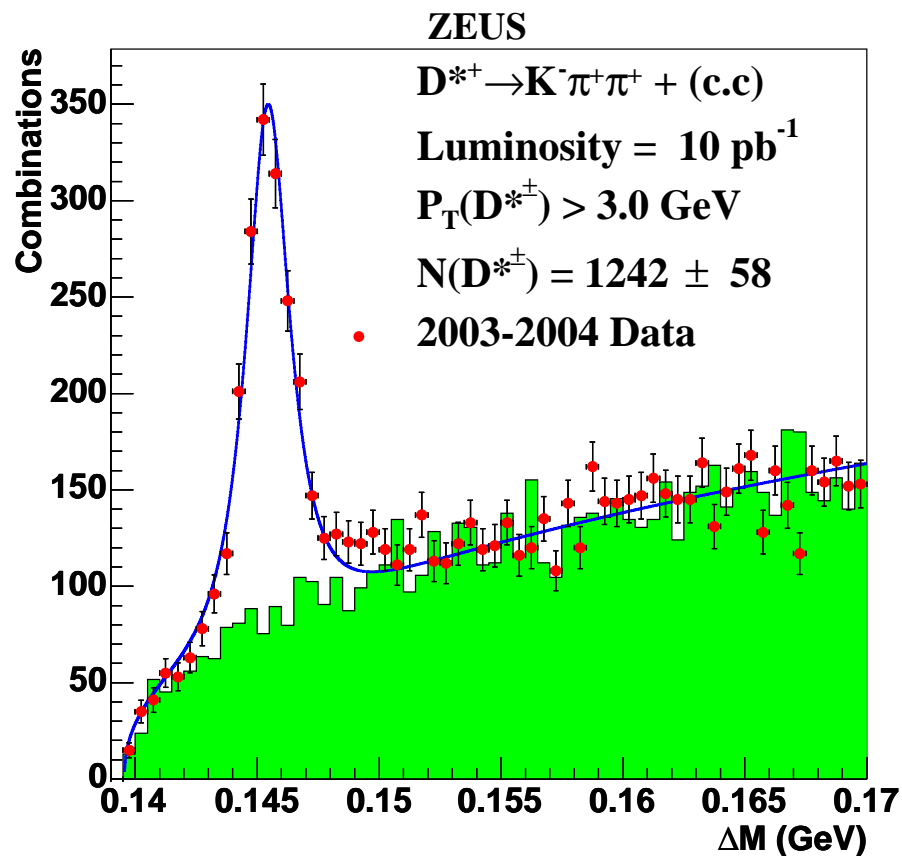
ZEUS



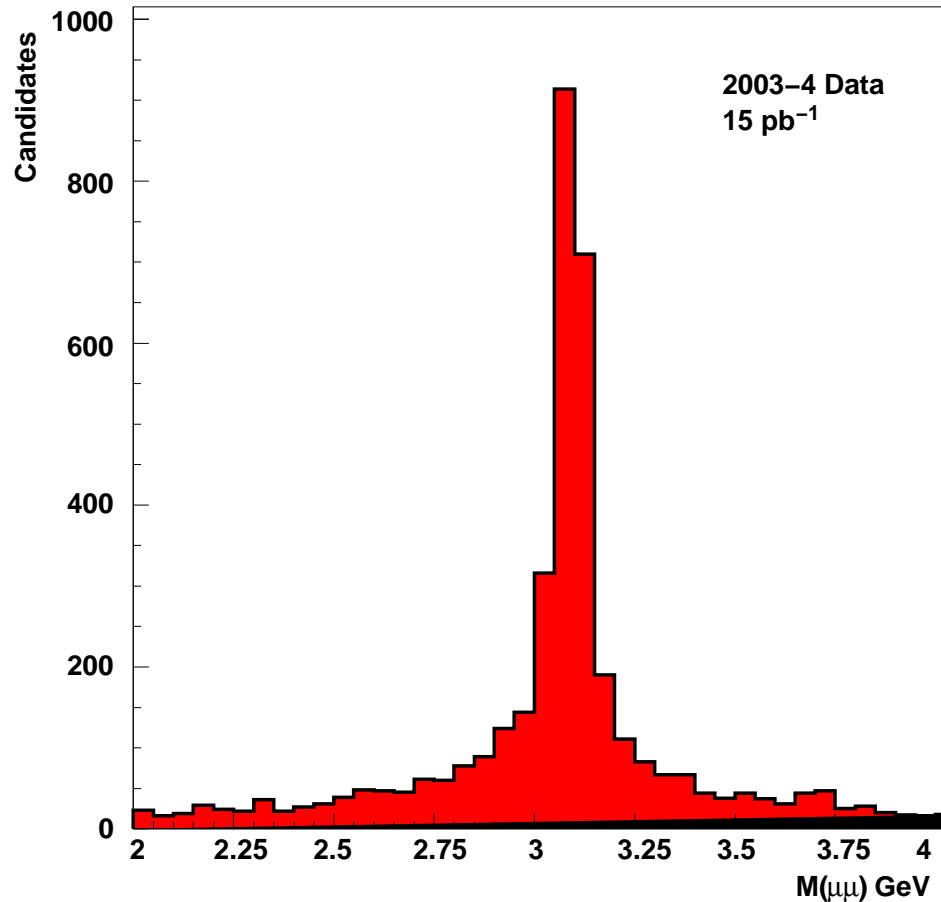
- Neutral Current,  $Q^2 > 200 \text{ GeV}^2$ 
  - ▷  $\sim 15000$  events for  $6.7 \text{ pb}^{-1}$
  - ▷ Preliminary result for Moriond EW
- Monte Carlo describes Data well
  - ▷ Understand and model the observed hadronic and electron final states
  - ▷ Also confirms the luminosity measurement

## Recent Data — $J/\psi$ and $D^*$ Production

- $\sim 2000$   $J/\psi$  Candidates  $\rightarrow$



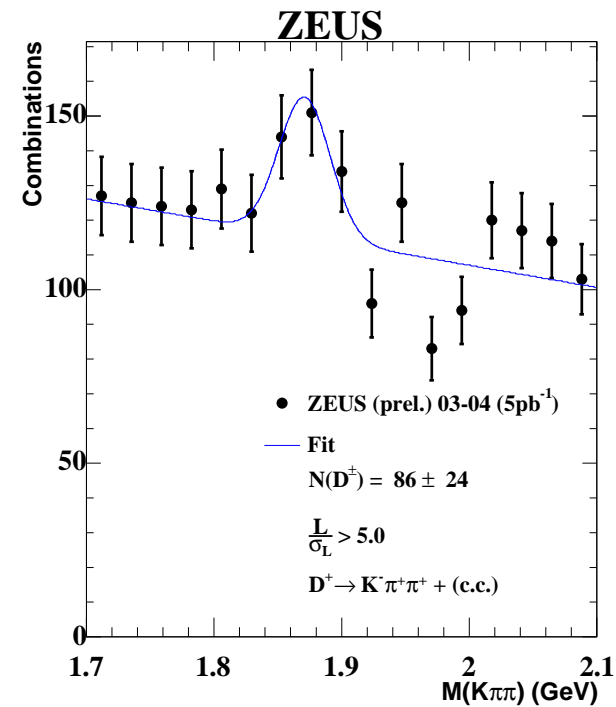
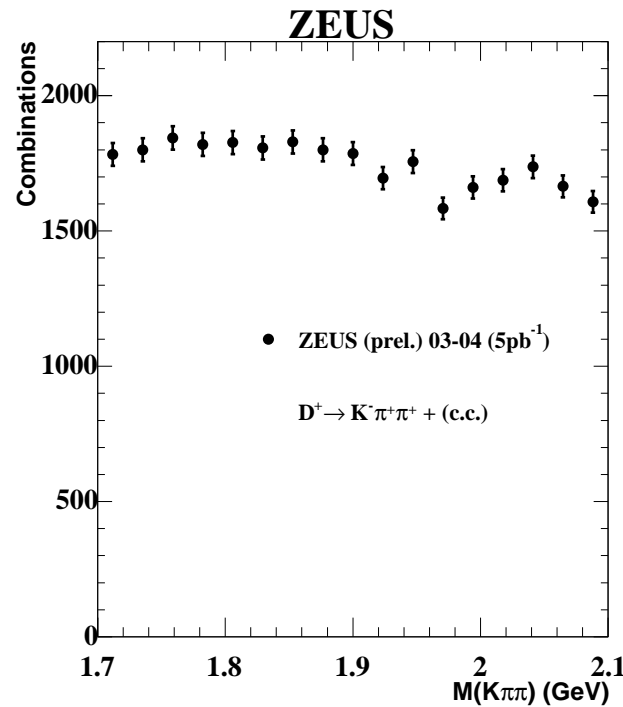
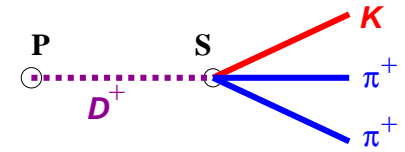
- $\sim 1240$   $D^*$  Candidates



- CTD performance is good
- Tracking using MVD + CTD
- Tracking working well

# Recent Data — $D^+$ Signal

- Use the MVD to tag secondary vertices from charm:



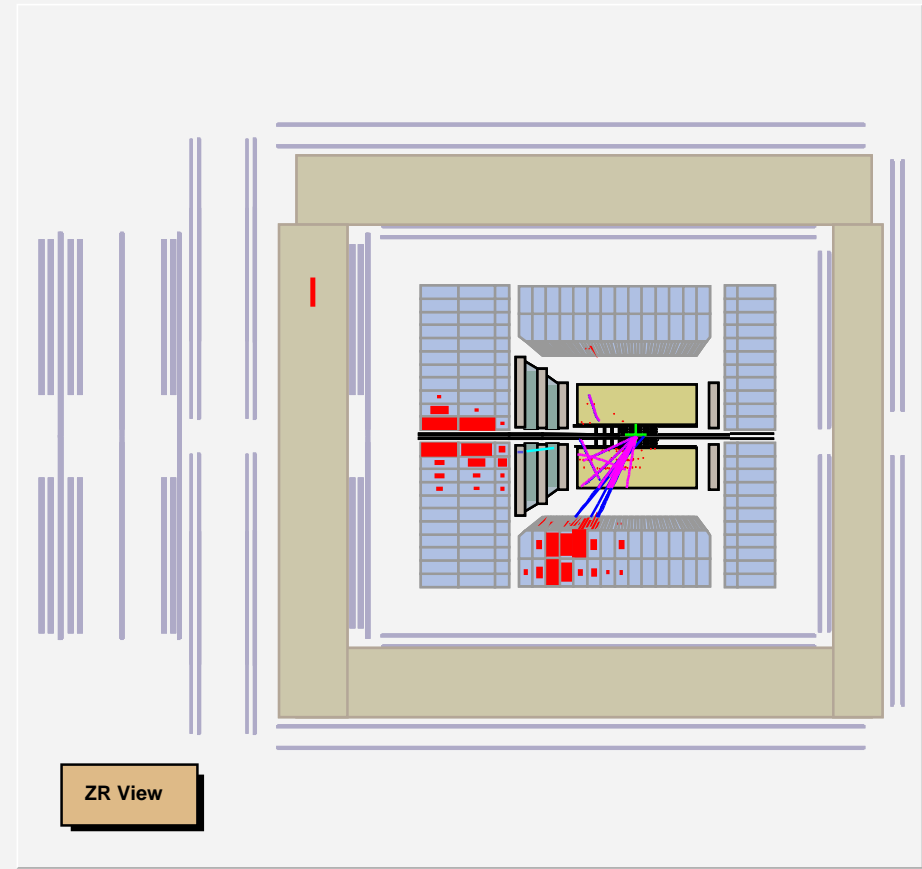
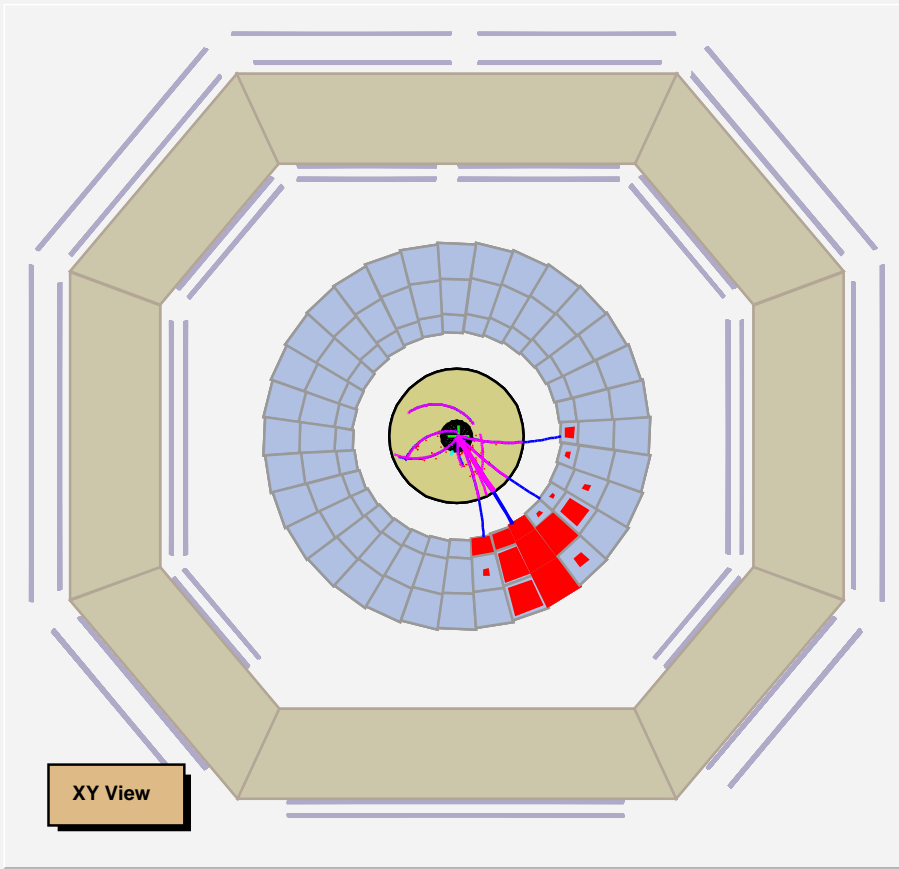
- Can define a significance of separation of secondary and primary vertices:

$$\vec{L} = \vec{S} - \vec{P}$$

- No signal visible before
- Signal enhanced by cutting on significance parameter → Encouraging!

# Recent Data — Charged Current

<b>Zeus Run 48214 Event 42200</b>				<b>date: 26-02-2004 time: 12:58:18</b>	
$E=88.5$ GeV	$E_i=48.2$ GeV	$E-p_z=25.1$ GeV	$E_f=35.4$ GeV	$E_p=53.2$ GeV	
$E_f=0$ GeV	$p_i=44.7$ GeV	$p_x=24.6$ GeV	$p_y=-37.3$ GeV	$p_z=63.4$ GeV	
$\phi_i=-0.99$	$t_f=5.29$ ns	$t_b=-8.51$ ns	$t_r=6.24$ ns	$t_g=11.9$ ns	
$E_e=2.14$ GeV	$\theta_e=1.12$	$\phi_e=-1.31$	$x_{e,DA}=0.09$	$y_{e,DA}=0.47$	
$Q_{e,DA}^2=4155$ GeV <sup>2</sup>					



$$Q^2 = 3433 \text{ GeV}^2, \not{p}_T = 45 \text{ GeV}$$

## Polarised Charged Current Cross Section

### ZEUS

- Charged Current cross section from October 03 - March 04 Data

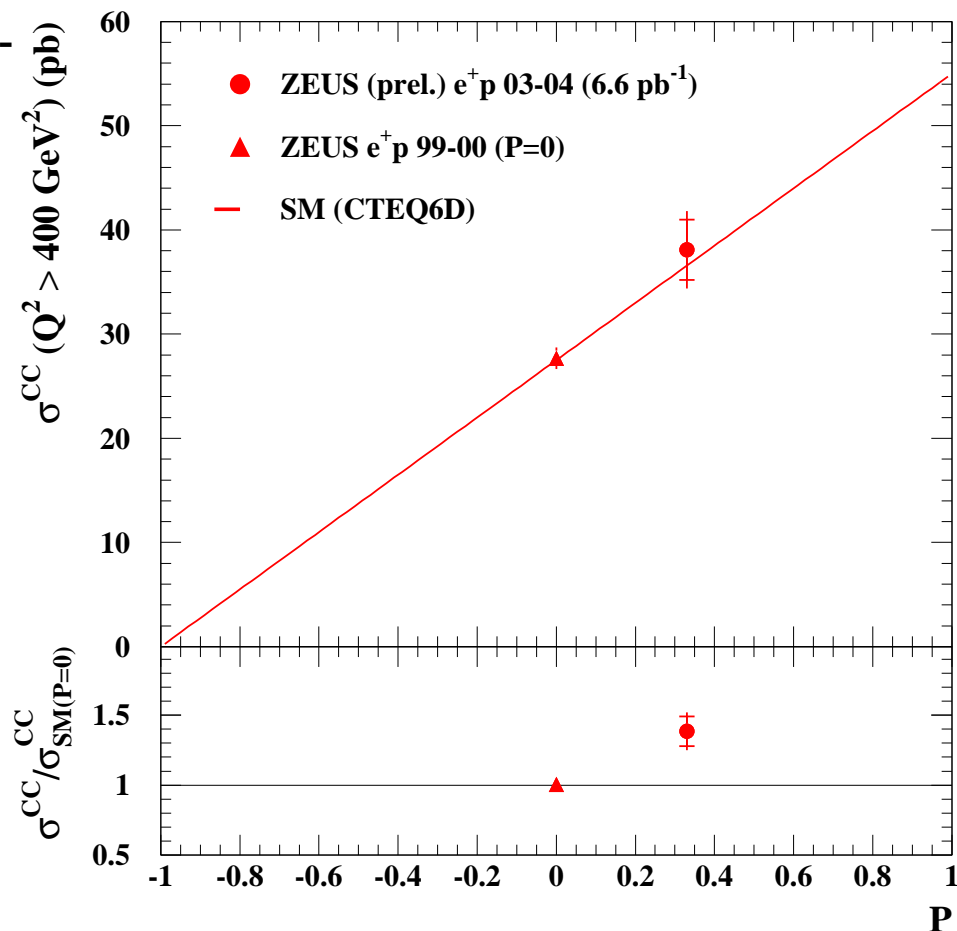
- ▷ Right-handed  $e^+$  polarisation
- ▷ Average +33% polarisation
- ▷ Preliminary result for Moriond EW

- Cross Section for  $Q^2 > 400 \text{ GeV}^2$ :

$$\sigma_{cc} = 38.1 \pm 2.1 \text{ (stat.)} \pm 0.8 \text{ (sys.)} \\ \pm 2.0 \text{ (lumi.)} \pm 0.8 \text{ (pol.) pb}$$

- ▷ Cross section above unpolarised value
- ▷ In agreement with standard model

Spin direction was changed 1 April



## Recent ZEUS Physics Output

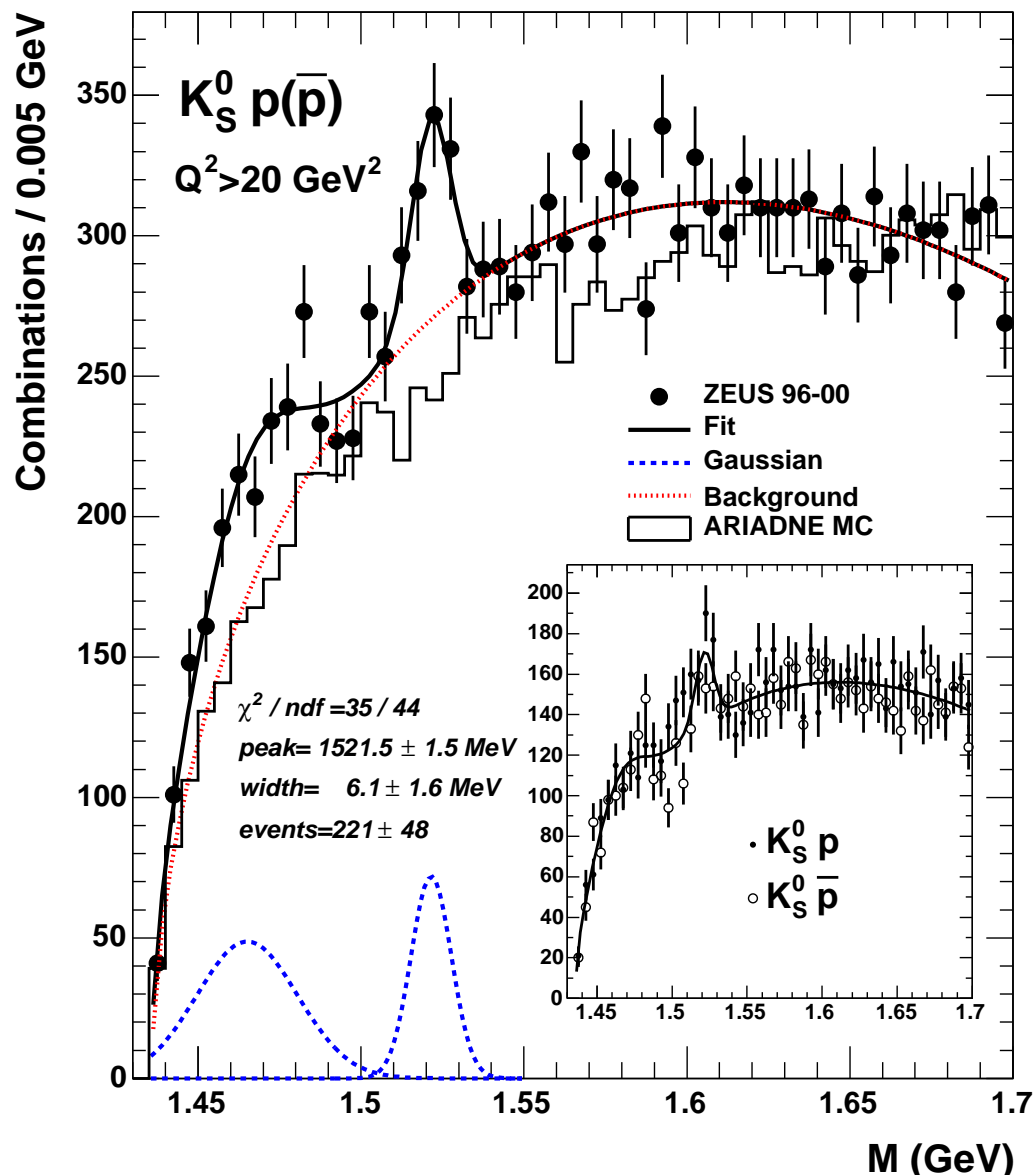
- 12 new papers since last PRC →
- DIS04: 15 new preliminary results
- 55 abstracts submitted to ICHEP
  - ▷ 4 abstracts on HERA II data
- Have a look at some of the highlights from recent results now ...

1. Instantons
2. Beauty photoproduction at HERA
3. High Q<sup>2</sup> Neutral Current Cross Sections in e+p DIS at  $\sqrt{s}=318$  GeV
4. Search for Contact Interactions, large extra dimensions, finite quark radius
5. Photoproduction of D\* Mesons associated with a Leading Neutron
6. Observation of Isolated High ET Photons in DIS
7. Pion Trajectory
8. Exclusive Electroproduction of J/Psi Mesons at HERA
9. The dependence of dijet production on photon virtuality at HERA
10. Evidence for a narrow baryonic state decaying to Ks (anti)proton
11. Beauty in DIS
12. Substructure dependence of jet cross sections and determination of alphas



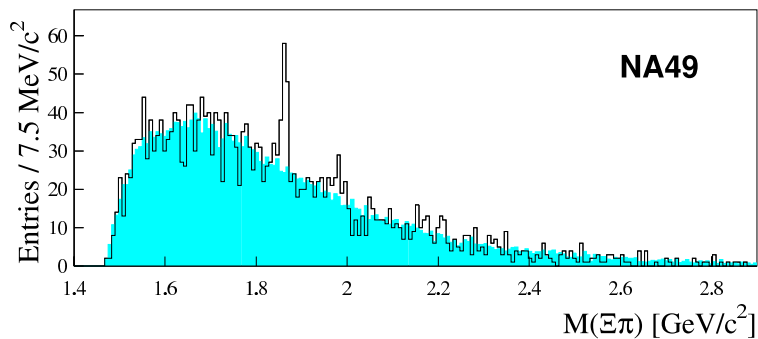
# Strange Pentaquarks

## ZEUS

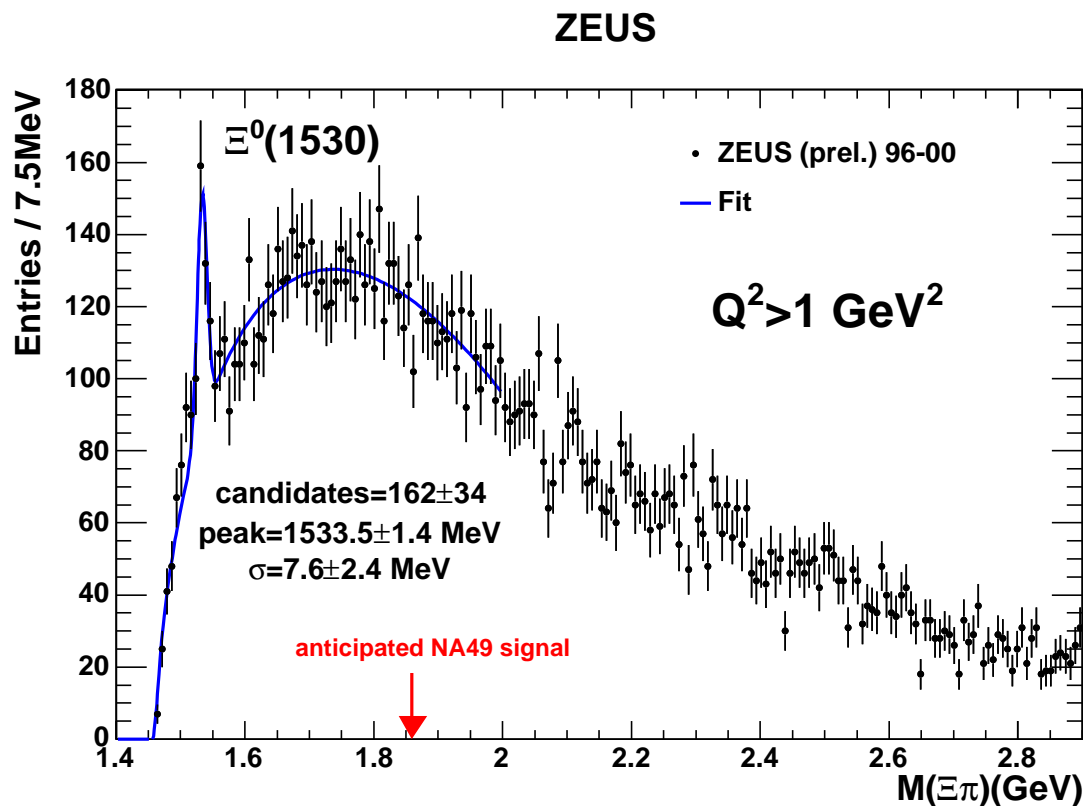


- Accepted by *Phys. Lett. B*
- Select  $p K_S^0$  combinations
- Peak at  $1521.5 \pm 1.5 \begin{smallmatrix} +2.8 \\ -1.7 \end{smallmatrix}$  MeV
  - ▷ Width above but compatible with experimental resolution
  - ▷ Signal present in both charge combinations
- Interpreted as  $\Theta^\pm$  pentaquark
  - ▷ Significance  $\sim 4.6\sigma$
- Pentaquark spectroscopy and searches become an active area of physics at HERA

# Pentaquark searches

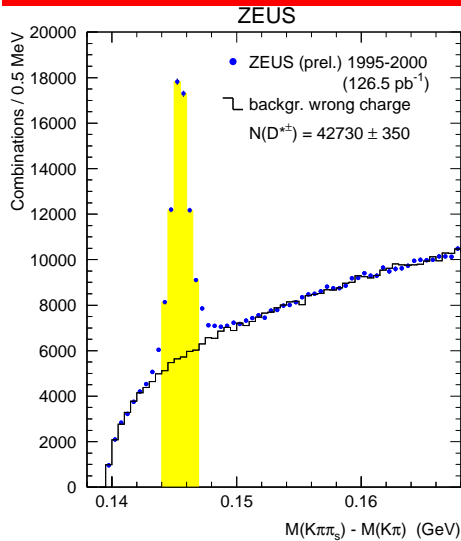


- NA49 report resonance in  $\Xi^0 \pi$  at 1.862 GeV
- ▷ Signal /  $\Xi^0(1530) \sim 6 - 8$

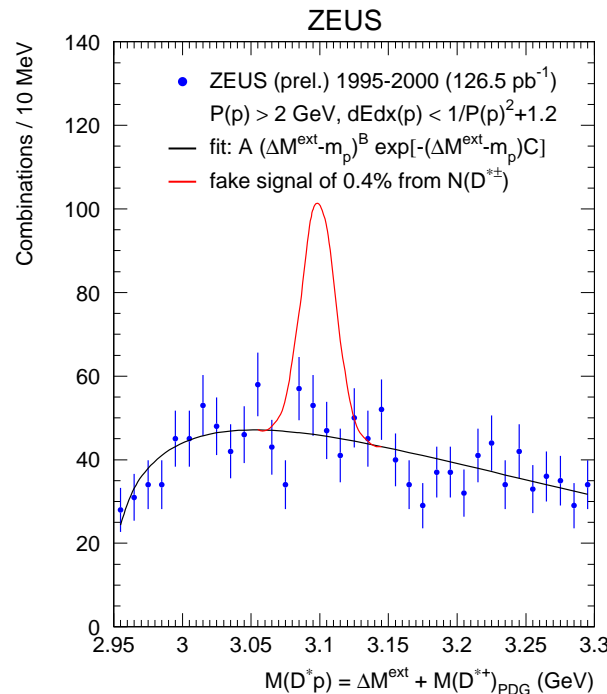
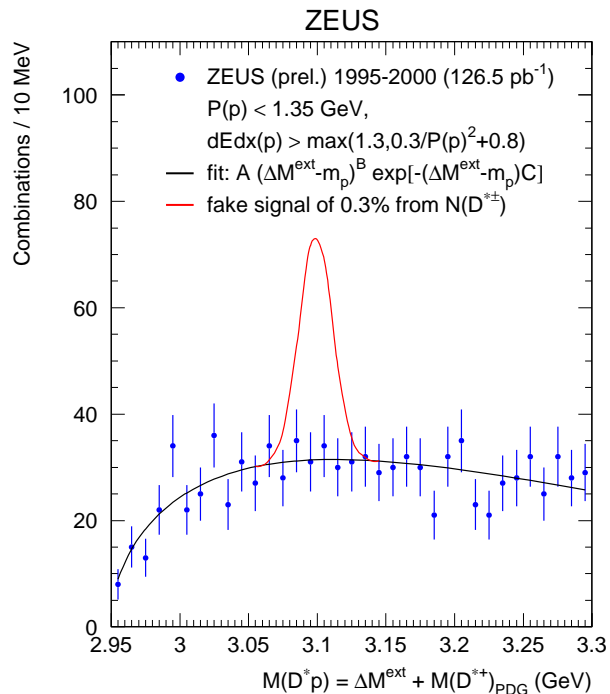


- ZEUS sees **no evidence of a signal**
  - ▷ Clearer  $\Xi^0(1530)$  signal
  - ▷ Larger statistics and smaller background

# Charm Pentaquark Search



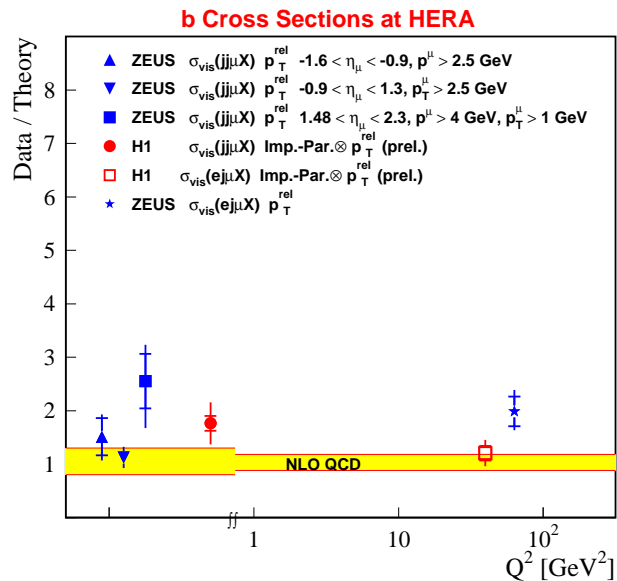
- H1 has reported resonance at 3.1 GeV in  $M(D^*p)$ 
  - ▷ Interpreted as charmed pentaquark
- Search by ZEUS shows **no evidence for signal at 3.1 GeV**
  - ▷ Inclusive  $D^*$  sample  $\sim 43000$
  - ▷ DIS  $D^*$  sample  $\sim 9700$



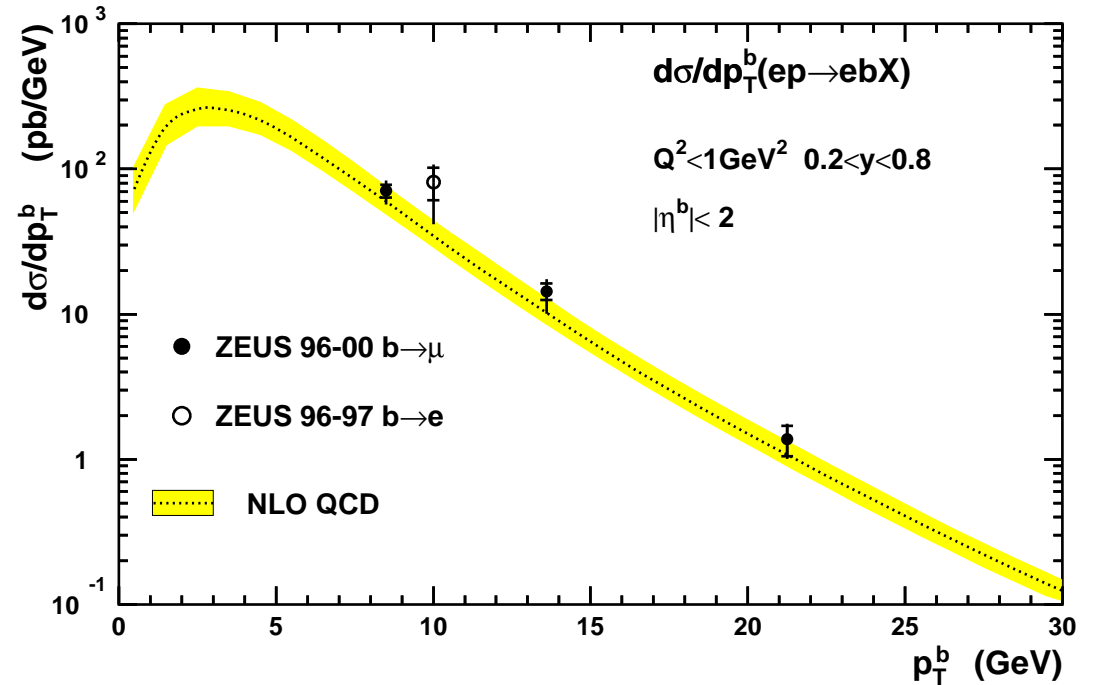
- Gaussian shows expected signal for  $N(\Theta_C^0)/N(D^*) = 1\%$

# Beauty Production at HERA

- Papers published on beauty production in DIS and PhP
  - ▷ PhP: subm to Phys. Rev. D
  - ▷ DIS: subm to Phys. Lett. B
- PhP result:
  - ▷ Good agreement with NLO



## ZEUS

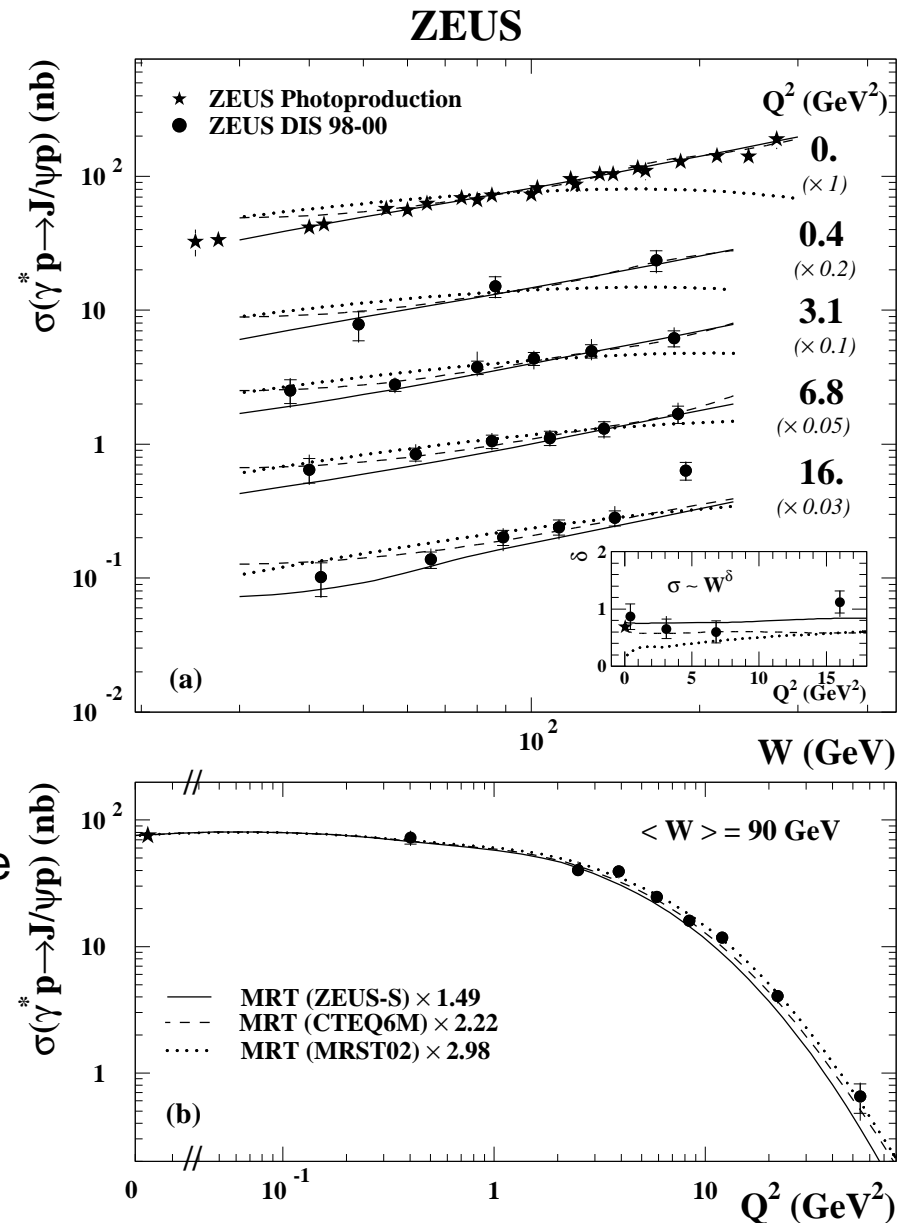


- DIS result - 1st publication on this topic
- HERA I message on beauty production:

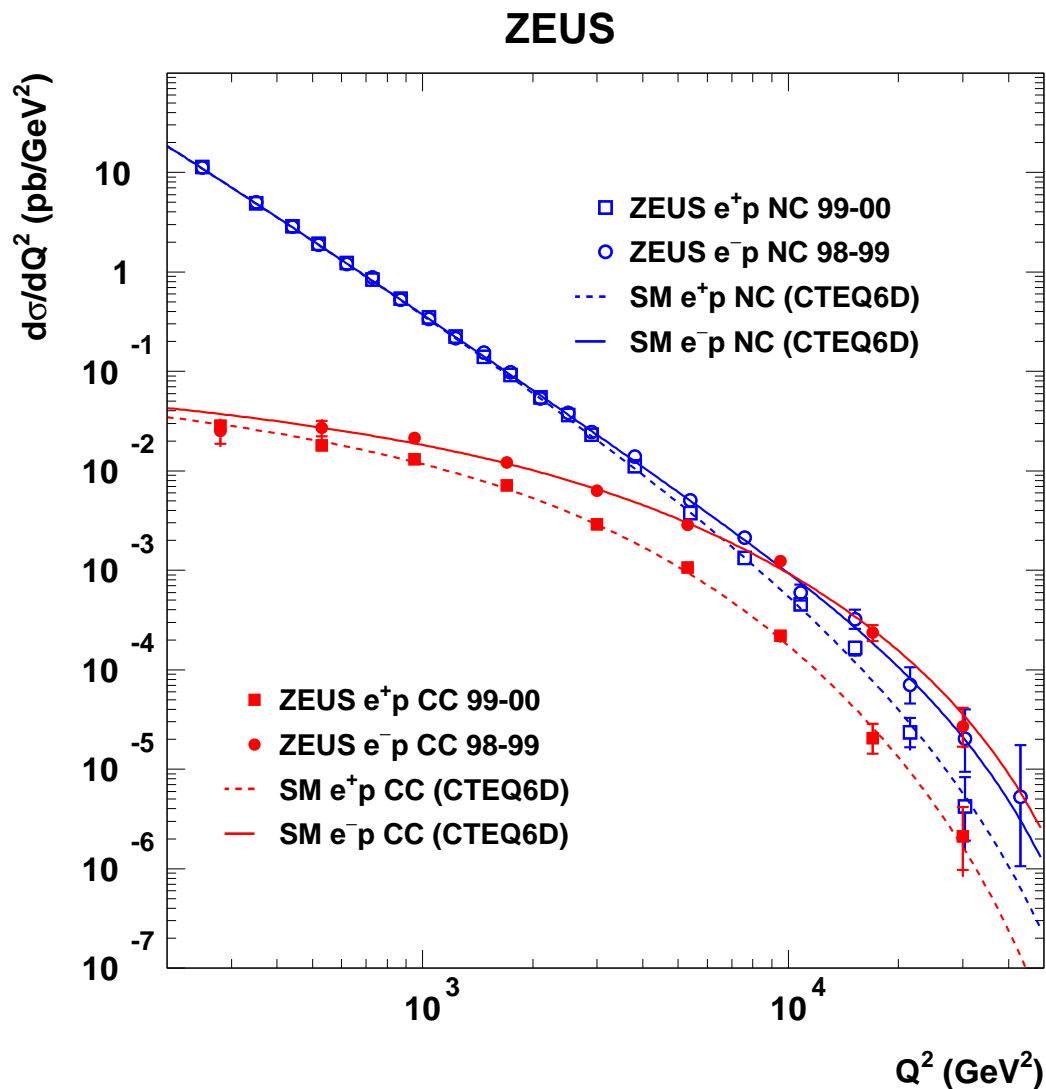
Good agreement between data and NLO pQCD

# Exclusive $J/\psi$ Production in DIS

- All of HERA I Data published  
(paper subm. to Nucl. Phys. B)
- Precision of the data impressive
- $J/\psi \rightarrow$  pQCD should be applicable
- Cross Section sensitive to gluons
  - ▷  $\sigma \propto (\text{gluon})^2$
  - ▷ Data distinguishes between PDF fits
  - ▷ **Clear sensitivity to the gluon**
  - ▷ Need NLO to be able to constrain the gluon with the data



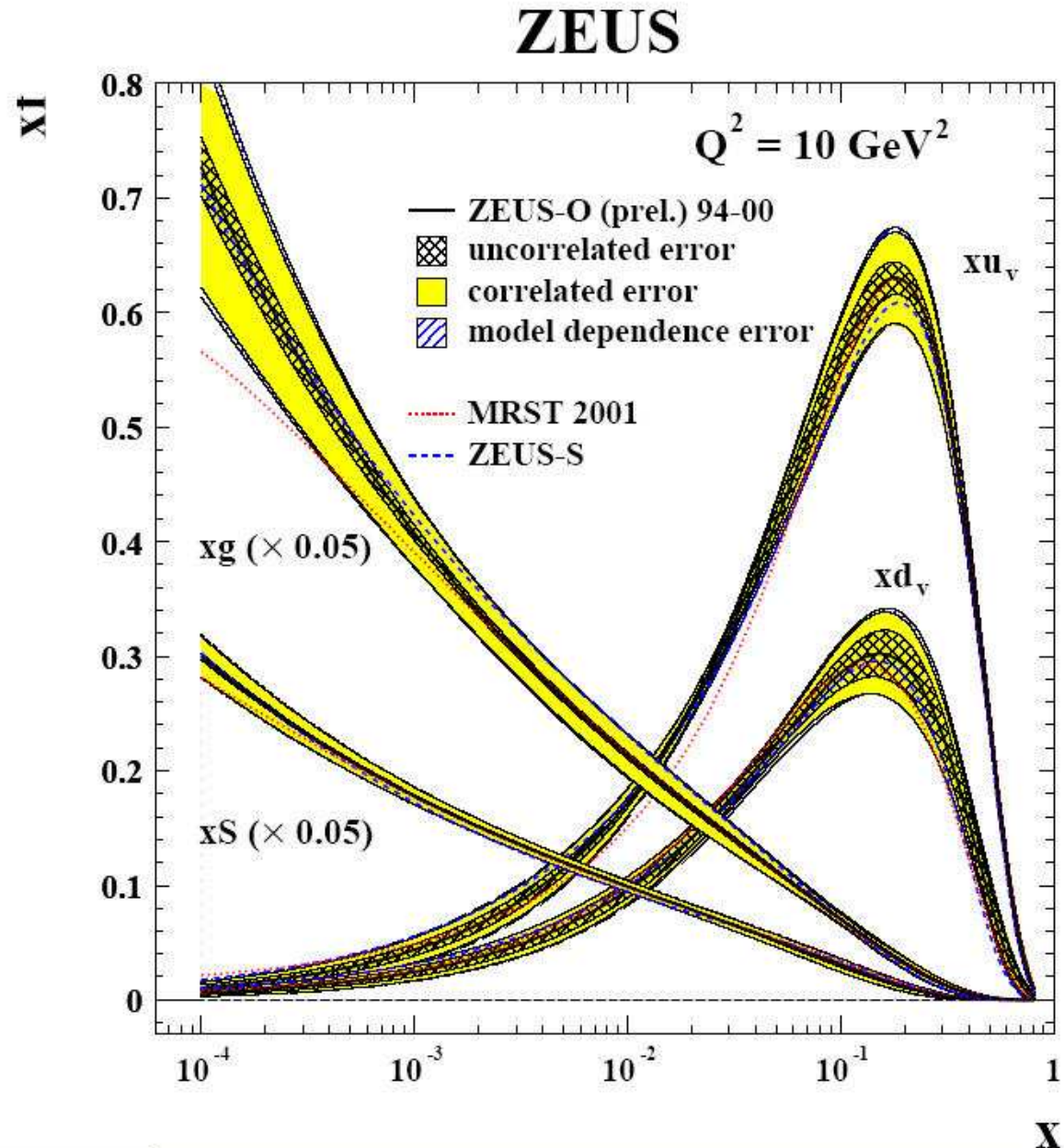
# Charged and Neutral Current DIS Cross Section Measurements



- Charged and Neutral Current Cross sections for  $e^+p$  and  $e^-p$  published
- Above  $Q^2 \sim 10000 \text{ GeV}^2$ 
  - ▷ Electroweak Unification
- Standard model - excellent description of the data
- Complete picture from HERA I
  - ▷ Use this data in QCD fits

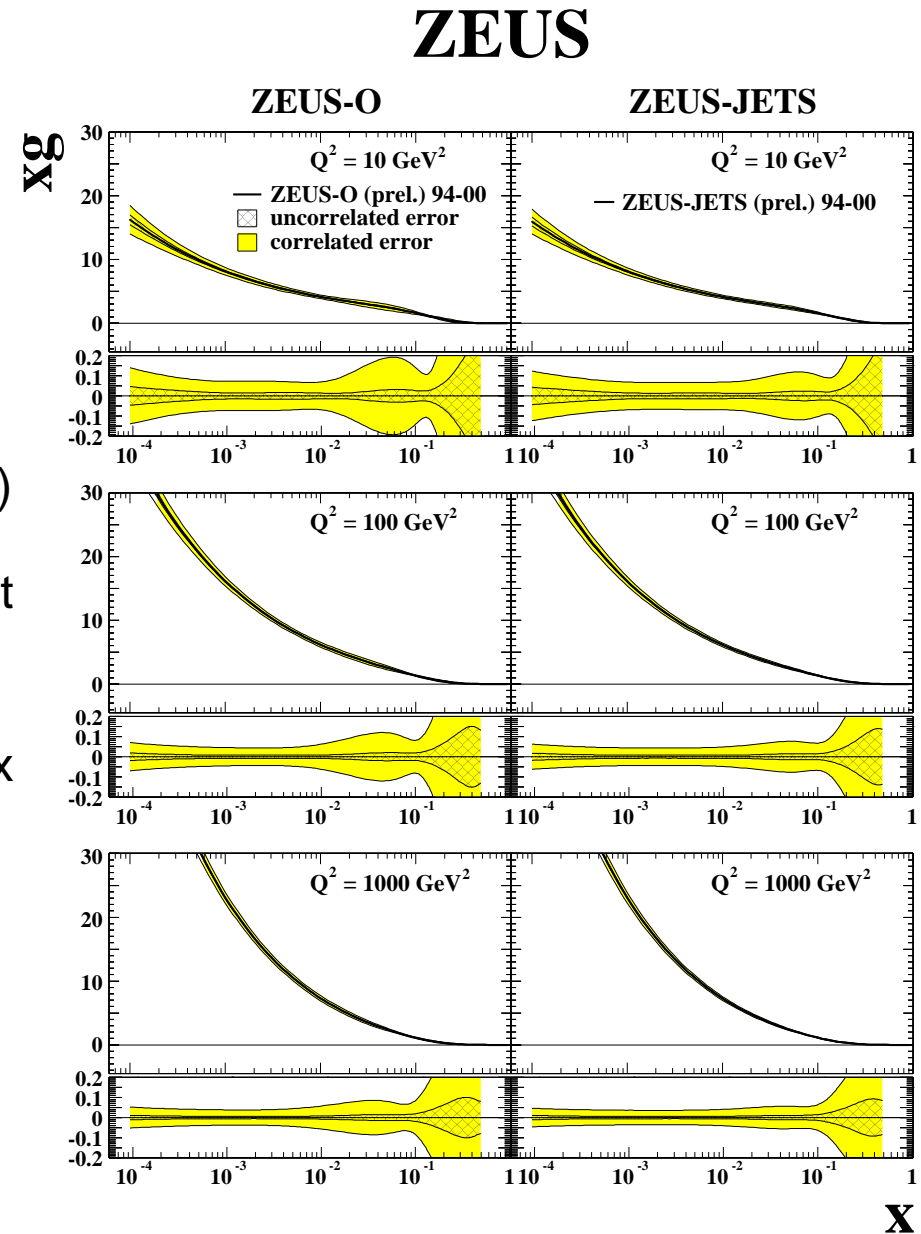
New QCD Fits

- Add high  $Q^2$  data into ZEUS-  
Only structure function fit
  - ▷ Full ZEUS HERA I data set
  - ▷ All 94-00  $e^\pm p$  Data
- Compare to published ZEUS-S
  - ▷ Include Fixed target data
  - ▷ 94-98 ZEUS Data
- Good agreement
  - ▷ ZEUS-Only Fit still needs additional constraint for  $x > 0.1$
  - ▷ HERA II Data at high  $x$
  - ▷ Use jets data in the fit



# Adding ZEUS Jet Data to QCD Fits

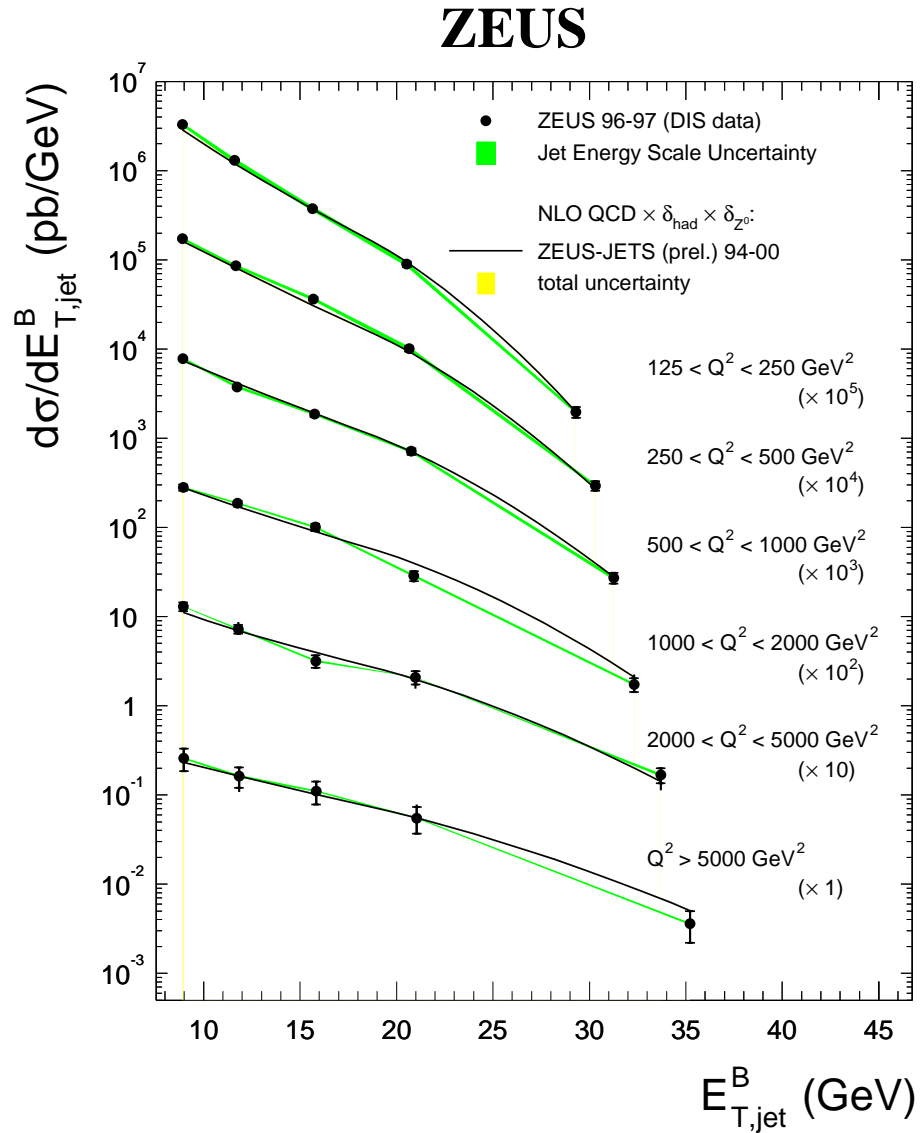
- Very precise jet data from ZEUS
- Include ZEUS jet data in QCD fits
  - ▷ Rigorous
  - ▷ Inclusive DIS jet data
  - ▷ High  $E_T$  dijet PhP Data ( $x_\gamma > 0.75$ )
- Compare ZEUS-Only fit with + without jet data
  - ▷ Jet data constrain gluon at medium x
  - ▷ Improved precision at high x





# Adding ZEUS Jet Data to QCD Fits

- DIS Jet data used in the QCD fit
  - ▷ Fit describes the data well
- Note precision of cross sections
  - ▷ Jet energy scale uncertainty 1%

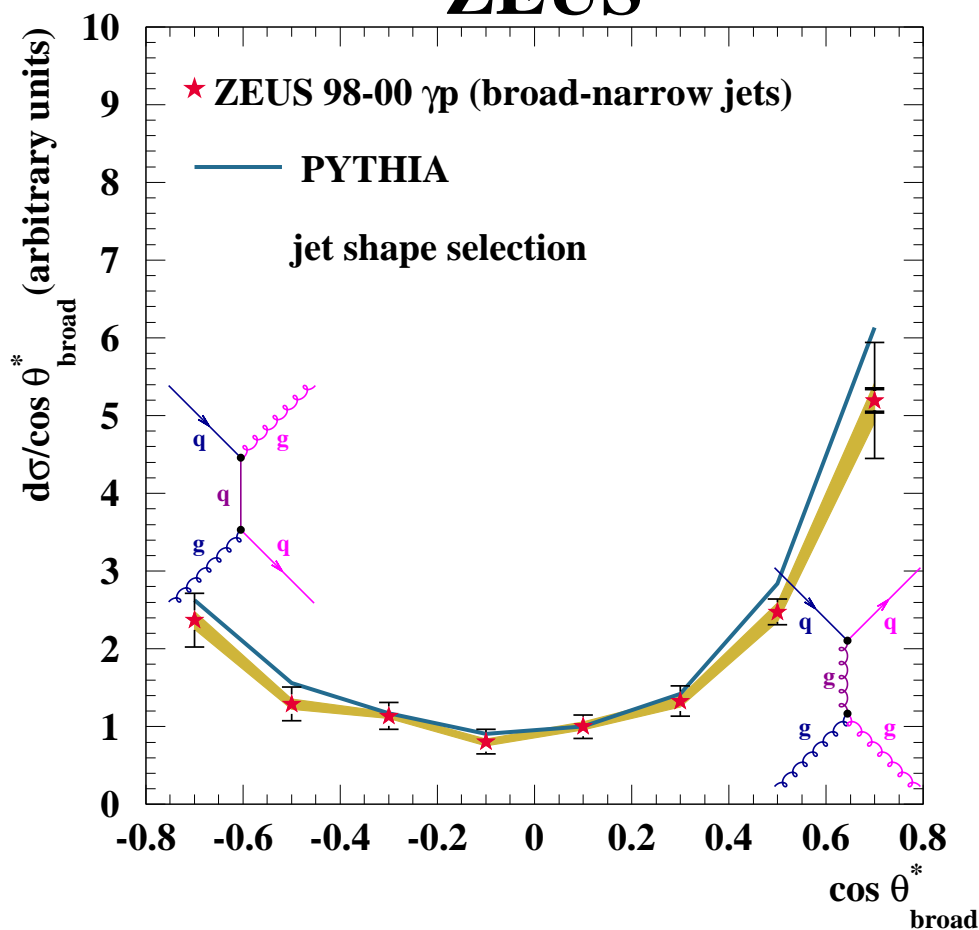


# Jet Substructure

- QCD predicts: gluon initiated jets **broader** than quark initiated jets (**narrow**)
- The scattering angle  $\theta^*$  sensitive to spin of exchanged particle
  - ▷ Use dijet events to investigate the underlying parton dynamics

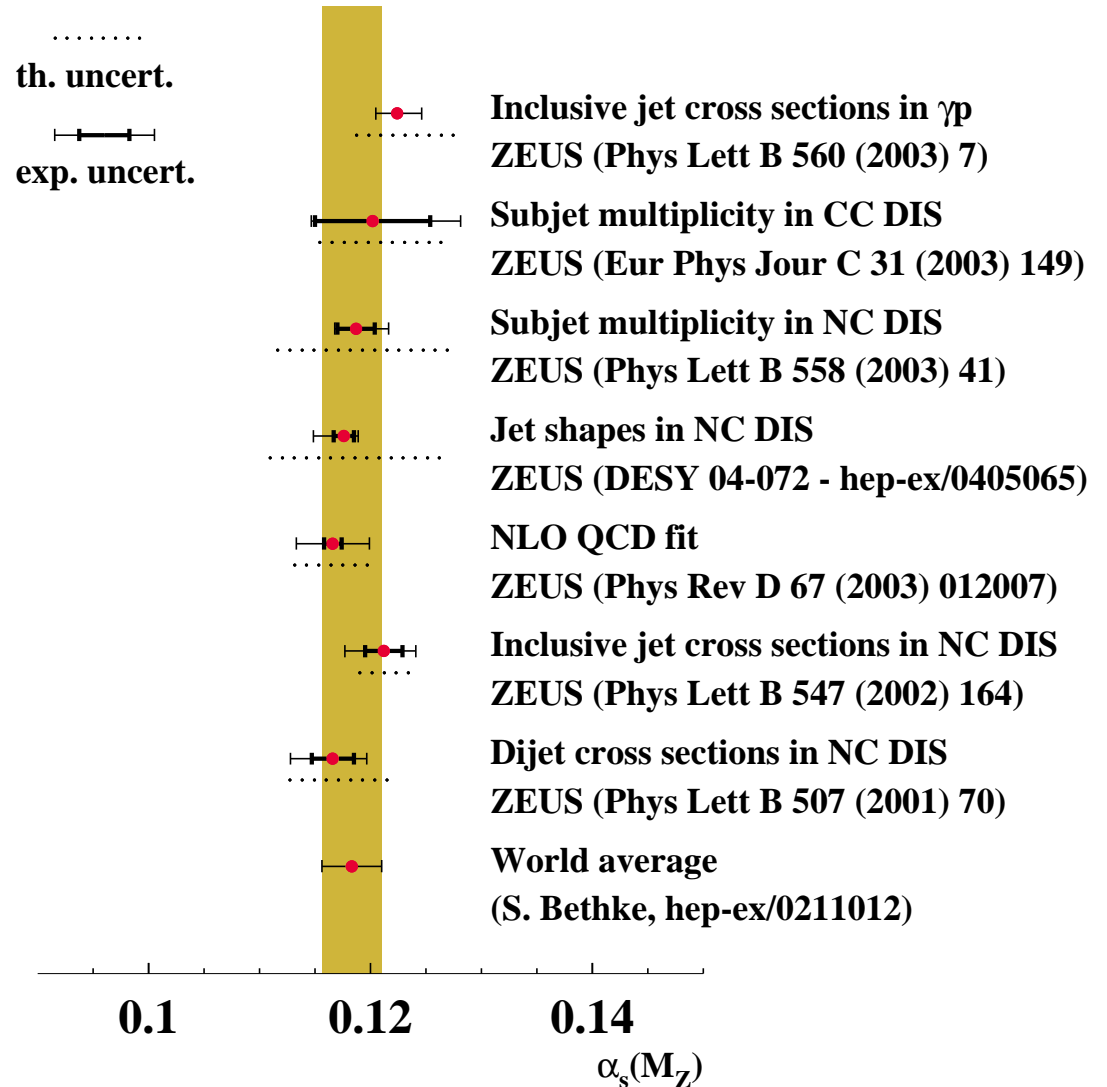
ZEUS

- $d\sigma/d\cos\theta_{broad}^*$  for events with 1 broad jet, 1 narrow jet
- Dominant diagrams  $\cos\theta^* \pm 1$  different
  - ▷ Positive-negative assymetry
  - ▷ +1 — t-channel gluon exchange
  - ▷ -1 — u-channel quark exchange
- QCD subprocesses separated for first time
- subm. to Nucl. Phys. B



# $\alpha_s$ Measurements from ZEUS

- Large number of  $\alpha_s$  measurements from ZEUS
  - ▷ Compatible with world average
  - ▷ World average does not include ZEUS measurements
  - ▷ Individual measurements competitive with world average



## Outlook

- Vast improvement in beam conditions and luminosity
  - ▷ Enormous efforts by HERA
  - ▷ Very good cooperation between HERA and all experiments
  - ▷ Thanks to HERA as well as H1 and HERMES
- Detector in good shape, efficiency improving
- Wealth of results from HERA I data and ...
- First results from HERA II coming in.
- Looking forward to running with electrons later this year!!

