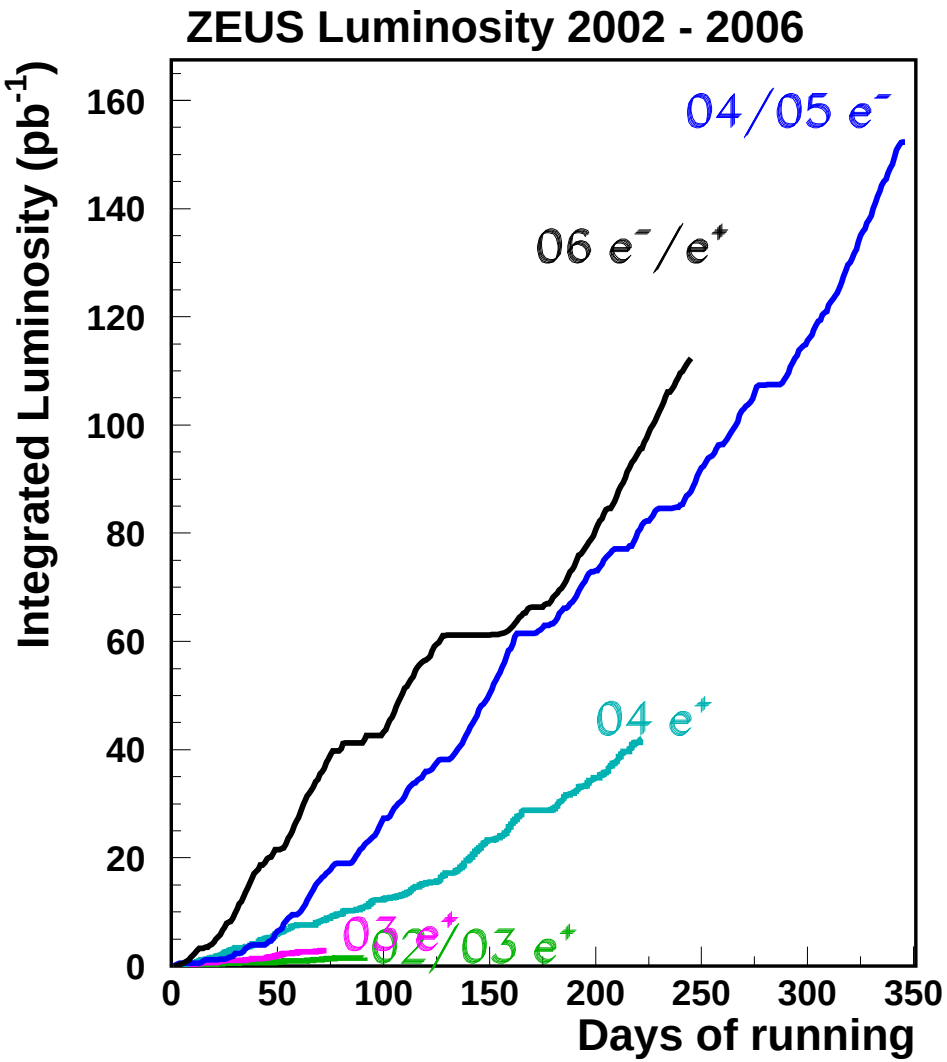
ZEUS Status Report

J. Ferrando

University of Glasgow
On behalf of the ZEUS collaboration

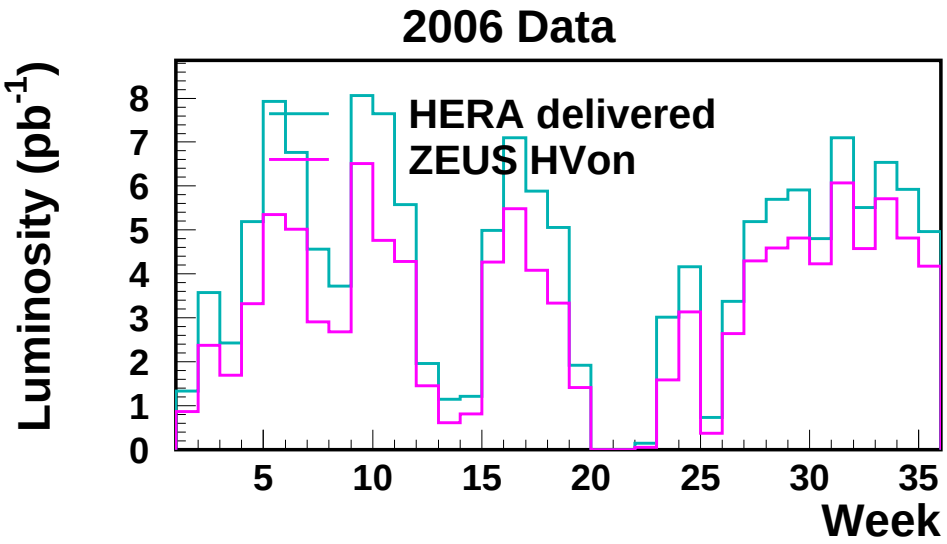
62nd Physics Research Committee Meeting
October 23rd, 2006

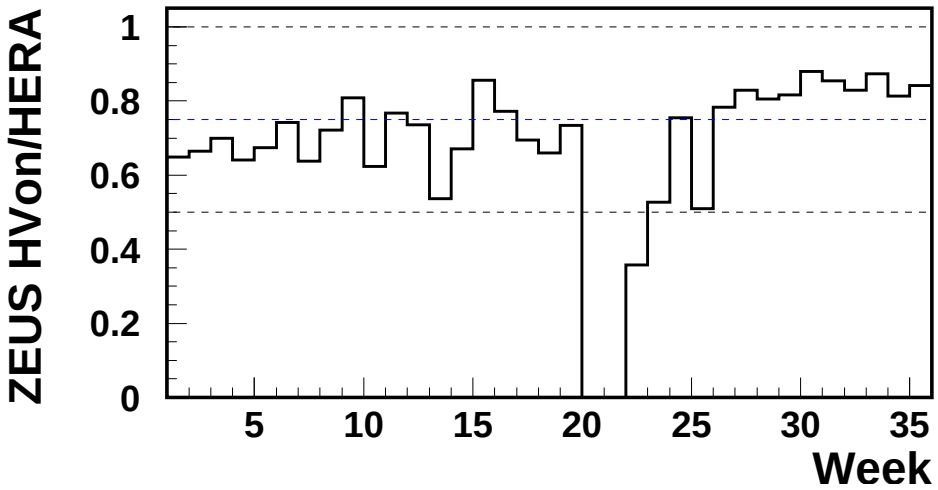
Outline



- ZEUS gated luminosity as a function of days of running.
- Thank you for the excellent performance of HERA in 2006

Recent Running II





- HERA were able to deliver more than 7 pb^{-1} per week
- Recent ZEUS efficiency with HV on $> 80\%$

ZEUS DAQ and detectors are operating well

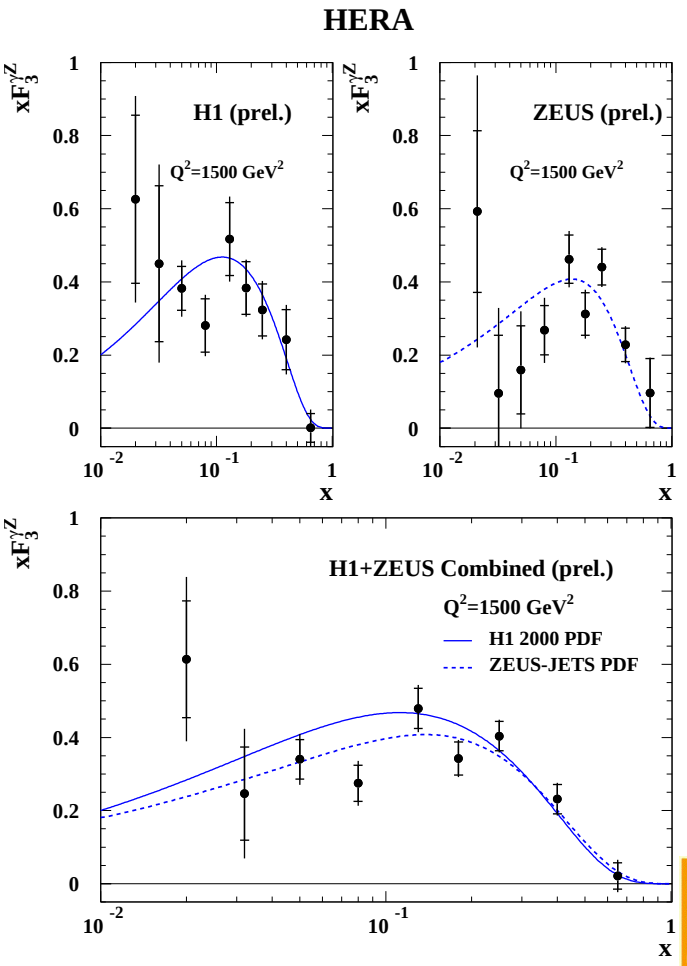
- Completing HERA I measurements
  - New results in diffraction
- Measurements making strong use of new HERA II detectors:
  - D^+ lifetime
- Searches and measurements using data samples benefitting from large HERA II luminosity
  - D^* cross sections
  - J/ψ helicity
  - CC DIS inclusive Jets
  - Isolated Leptons
  - Contact Interactions
  - Multilepton events
- Combined ZEUS + H1 work

HERA Combined NC Measurements

- NC DIS results have been combined with those of H1.
- Enables investigation of the interference of weak and electromagnetic interactions at high Q^2

$$\tilde{\sigma}^- - \tilde{\sigma}^+ = 2\frac{Y_-}{Y_+}(-a_e \cdot kxF_3^{\gamma Z} + 2v_e a_e \cdot k^2 xF_3^Z)$$

- We now have accurate combined measurements of the interference structure function $xF_3^{\gamma Z} \Rightarrow$



In HERA II we now have access to Polarisation asymmetries:

$$A^{\pm} = \frac{2}{\mathcal{P}_R - \mathcal{P}_L} \cdot \frac{\sigma^{\pm}(\mathcal{P}_R) - \sigma^{\pm}(\mathcal{P}_L)}{\sigma^{\pm}(\mathcal{P}_R) + \sigma^{\pm}(\mathcal{P}_L)}$$

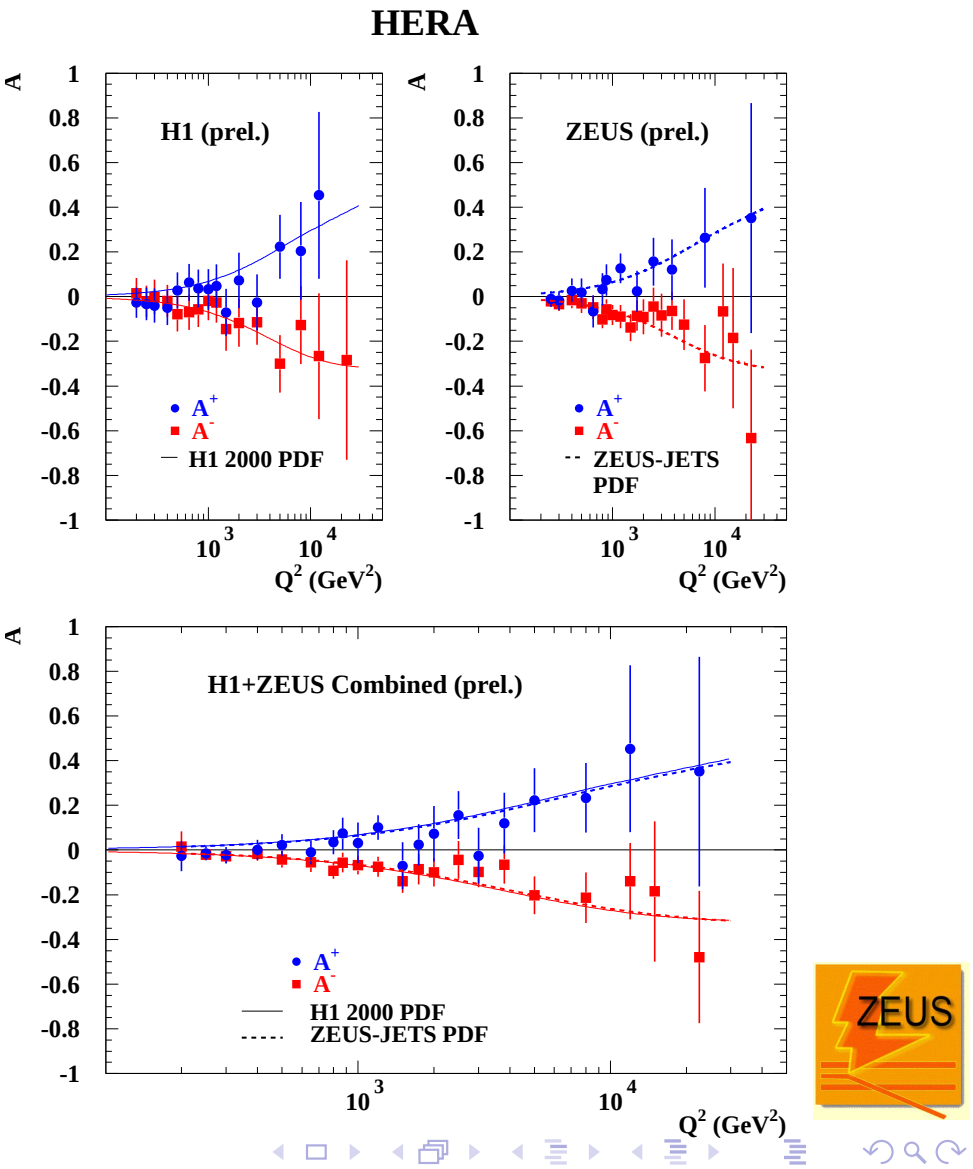
to a good approximation:

$$A^{\pm} \simeq \mp k a_e \frac{F_2^{\gamma Z}}{F_2}$$

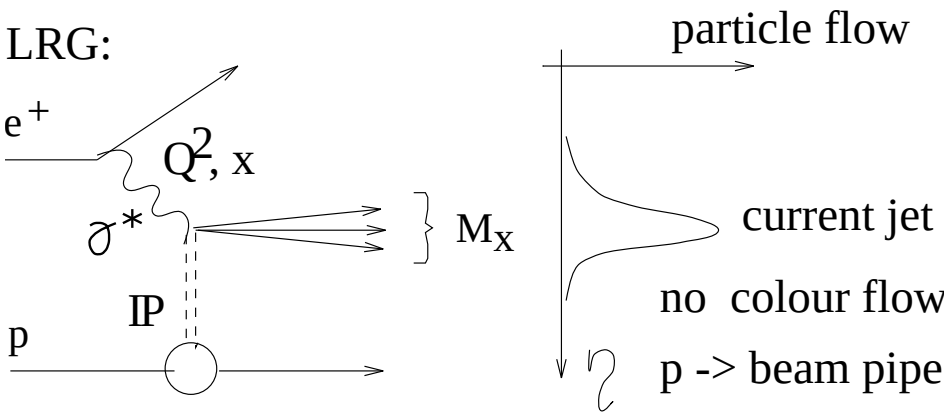
at large Bjorken-x

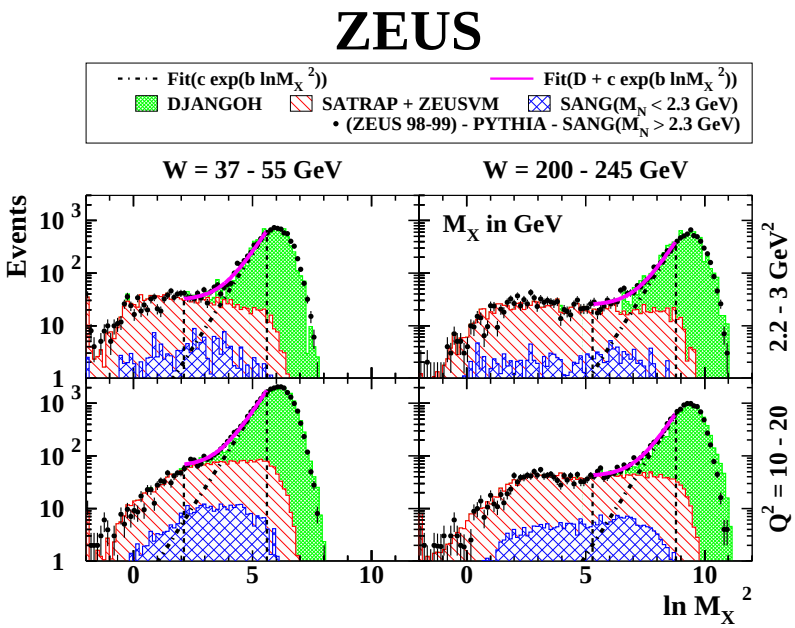
$$A^{\pm} \simeq \mp - k \frac{1 + d_v/u_v}{4 + d_v/u_v}$$

At $Q^2 \approx 5000\ \mathrm{GeV}^2$ δA has a probability of 3.1×10^{-3} of being zero.

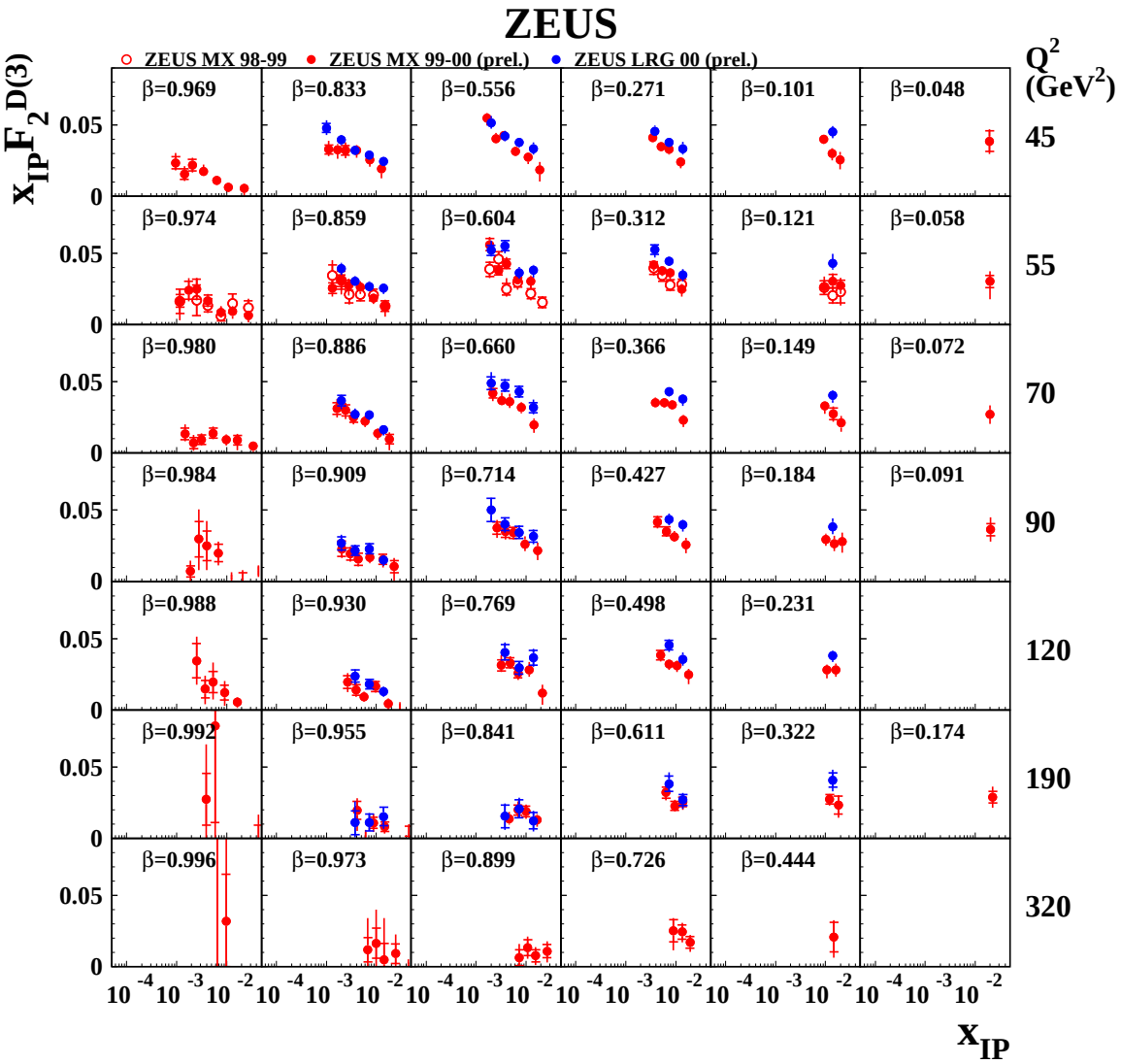


Diffraction



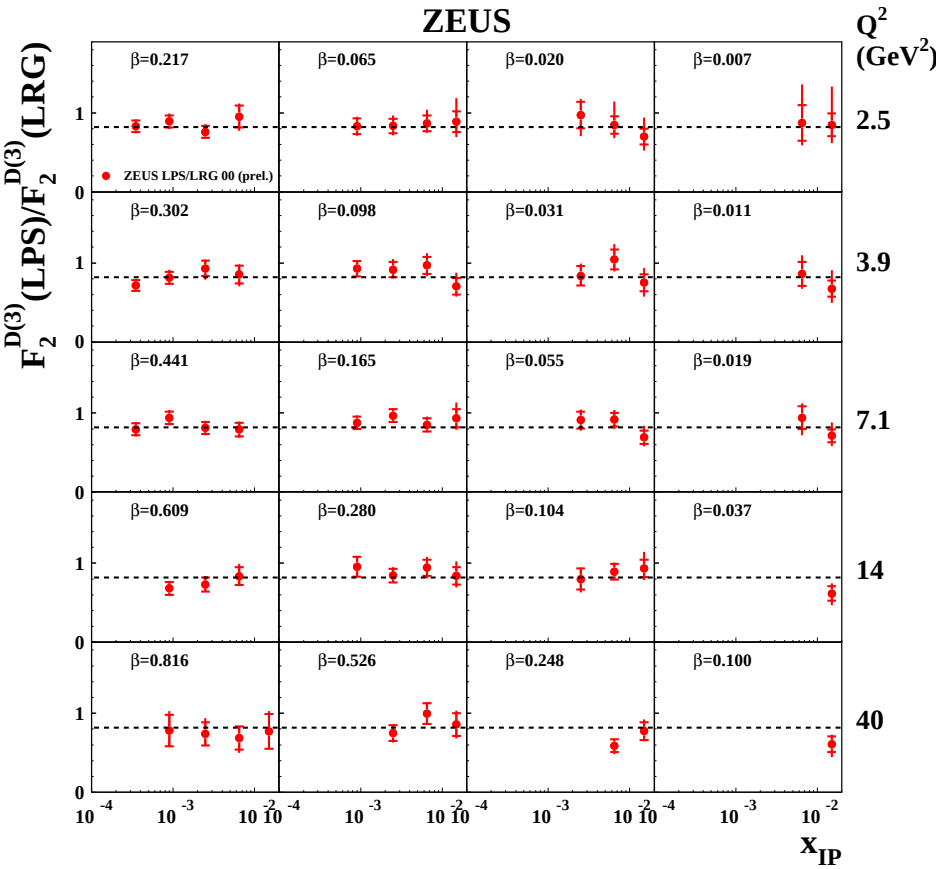


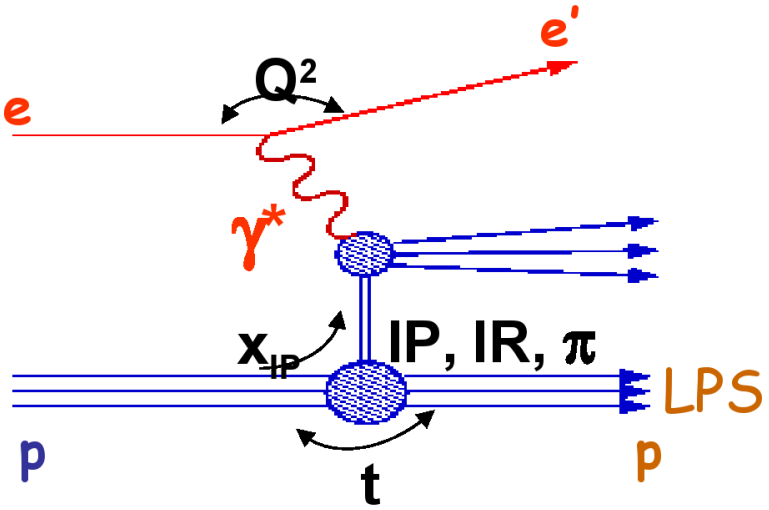
- 3 different methods used to tag diffraction: LRG, LPS, M_X
- Different methods measure slightly different processes



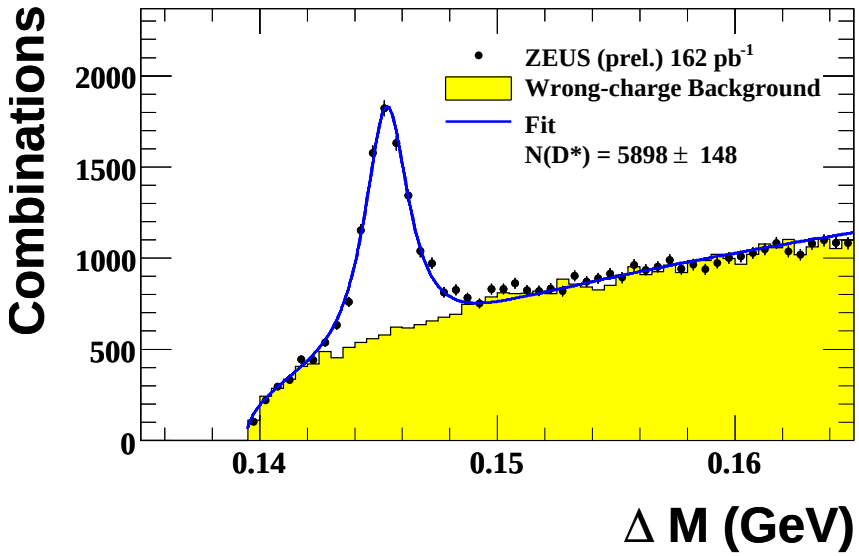
- Comparison of the same dataset with different methods
- 2 methods give slightly different values for some of the phase space
- Progress being made in achieving consistency and understanding remaining differences

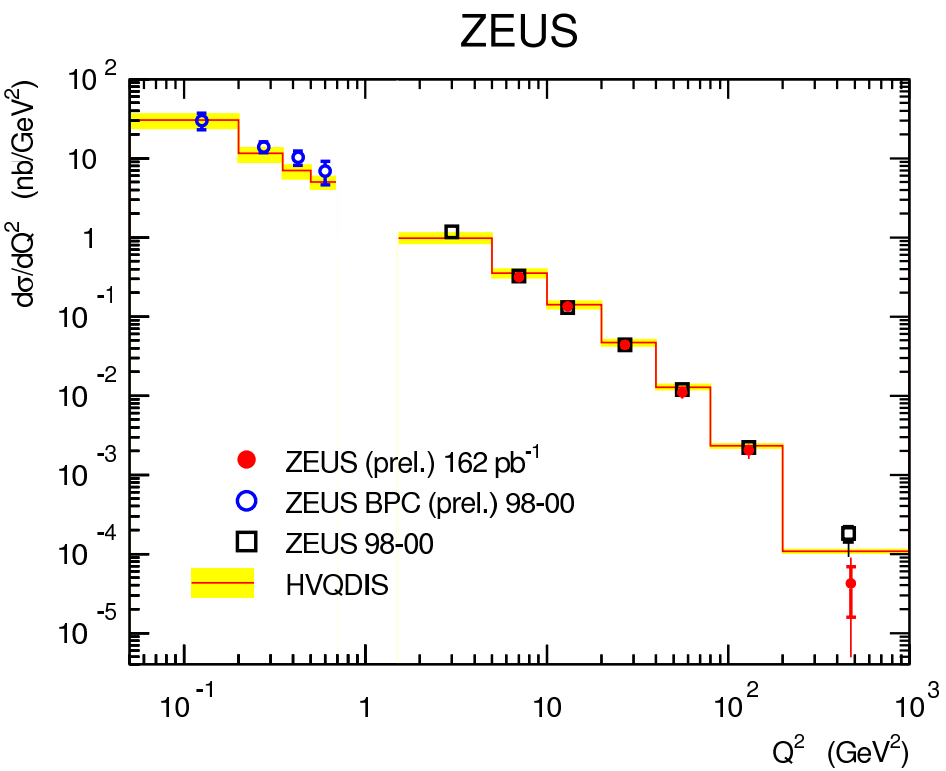
Diffraction
LPS & LRG



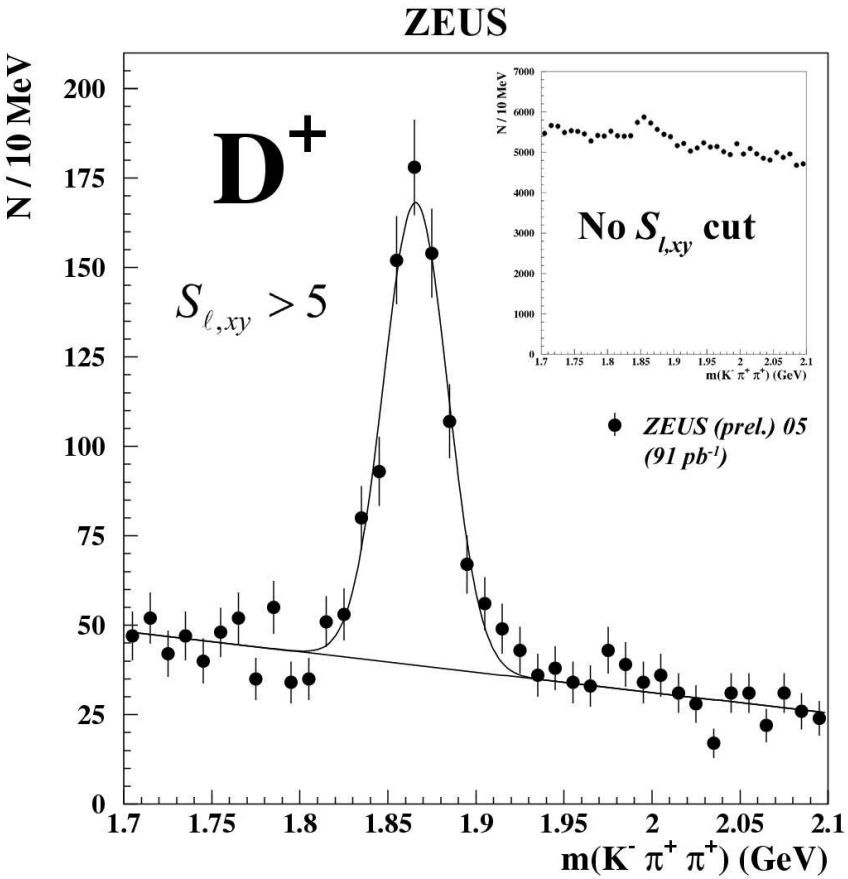


- LPS sample a low statistics analysis uncontaminated by proton dissociation
- Can be used to assess contamination of other samples (ratio 0.82 ± 0.01)





- Our first charm cross sections for HERA II, from D^* mesons
- HERA II and HERA I cross sections consistent with each other and NLO

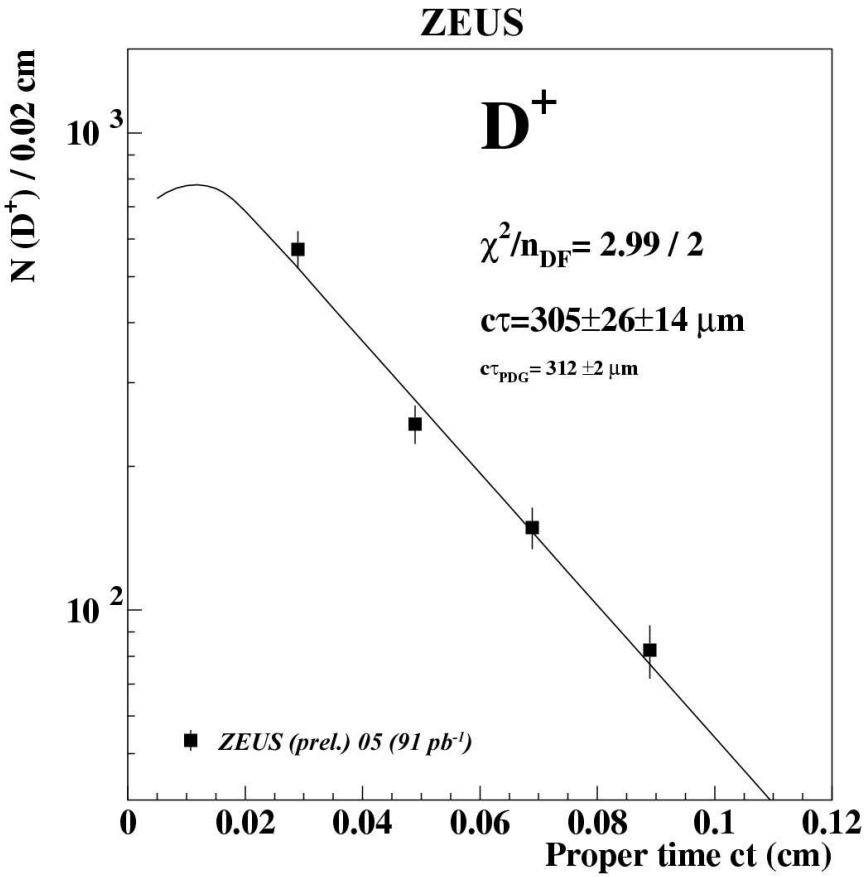


Our first charm measurement based on MVD data.

- Measurement made possible by alignment work shown last PRC
- D^+ signal significantly enhanced with significance cuts
- Production analysed in ct bins:

$$ct = \frac{m}{p_T} l_{xy}$$

$$\frac{dN}{d(ct)} \propto \int d(ct)_{true} \exp\left(-\frac{(ct)_{true}}{c\tau}\right) \int d\left(\frac{p_T}{m}\right) g\left(\frac{p_T}{m}\right) h\left(\frac{p_T}{m}\ (ct - (ct)_{true})\right)$$



Resolution function h assumed to be a Gaussian with resolution of $160\mu m$ + beam spot spread

	$\tau(D^+)$ (fs)
ZEUS (prel.) 05	$1017 \pm 86 \pm 47$
World average	1040 ± 7

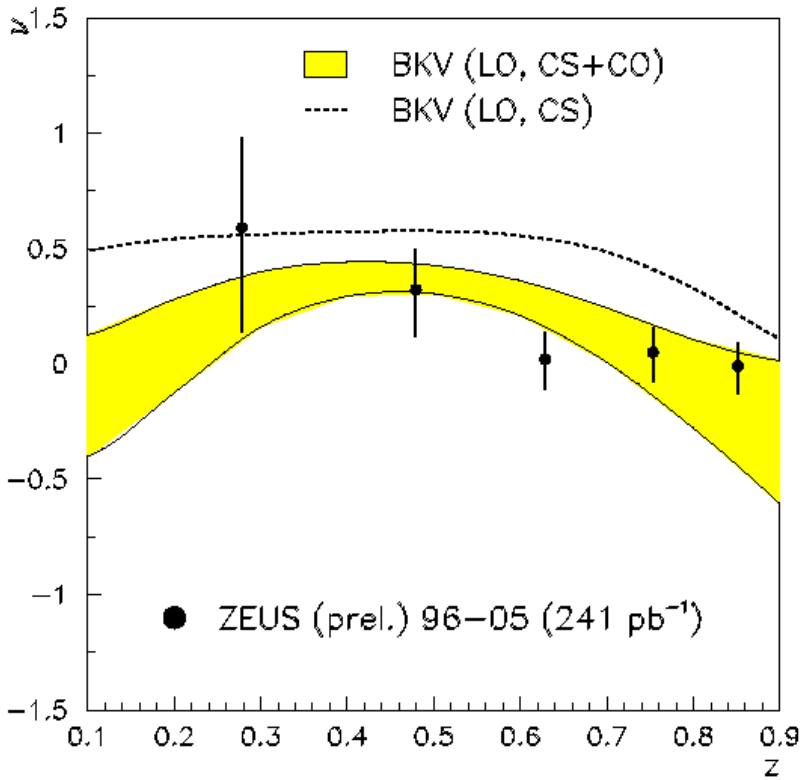
Similar accuracy to CERN SPS experiments
Demonstrates our understanding of the MVD resolution

J/ψ Helicity

$$\frac{1}{\sigma}\frac{\mathrm{d}^2\sigma}{d\Omega \mathrm{d}z} = 1 + \lambda(z)\cos^2\theta^* + \mu(z)\sin 2\theta^* \cos\phi^* + \frac{\nu(z)}{2}\sin^2\theta^* \cos 2\phi^*$$

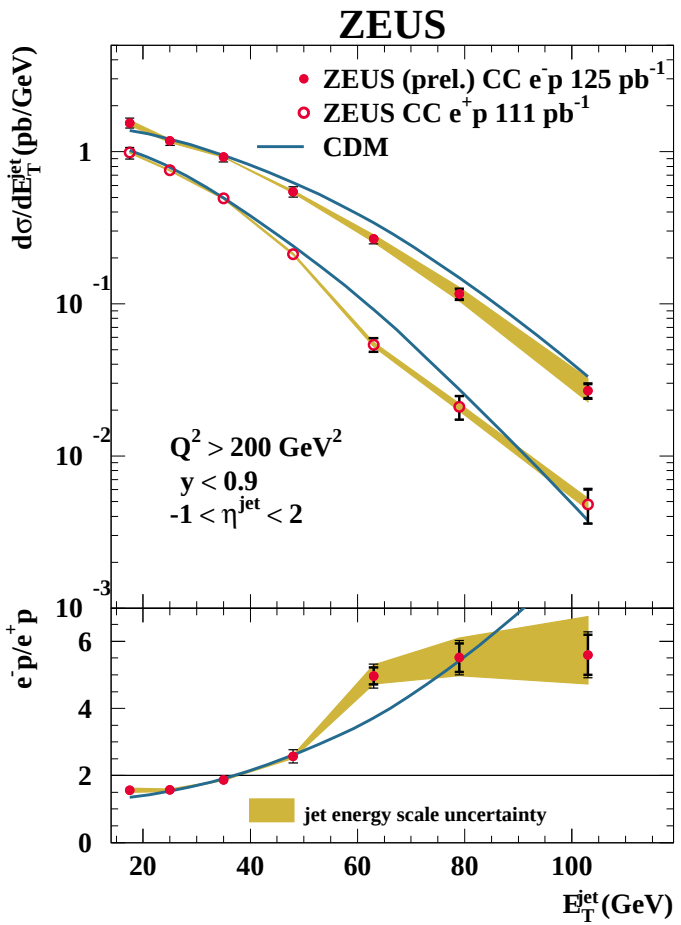
- Measurement of ν may allow distinction between colour-singlet and colour-octet models for J/ψ production
- Analysis of ν as a function of z shows that ZEUS data seems to disfavour CS only picture

$$z = \frac{\mathbf{P}\cdot\mathbf{p}_{J/\psi}}{\mathbf{p}\cdot\mathbf{q}}$$



Our first HERA II Jet measurements:

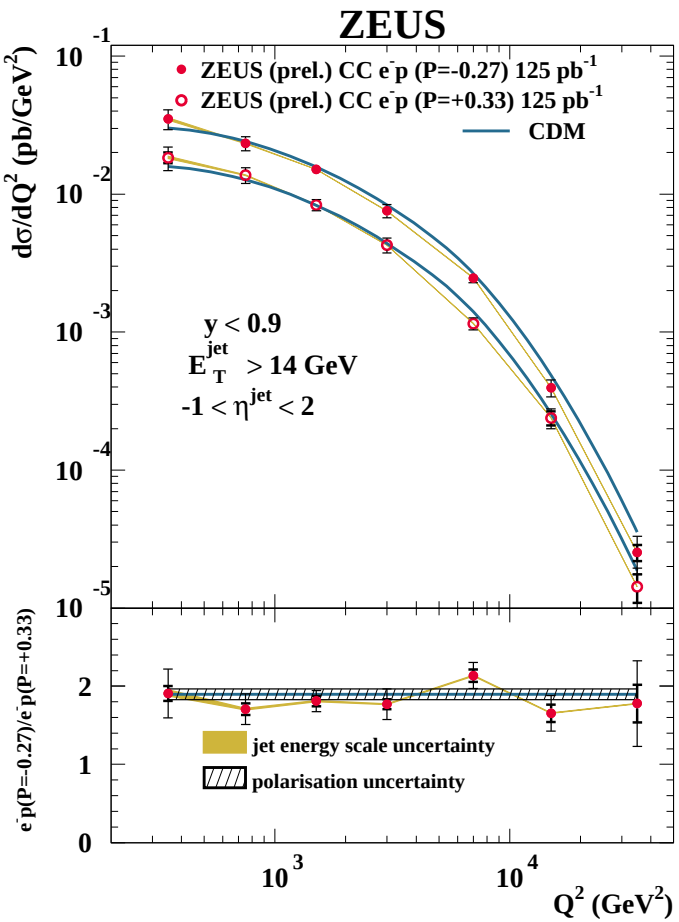
- Test of SM
- Factor $\times 7$ more $e^- p$ lumi than in HERA I
- Measurements were compared to $e^+ p$ data
- Cross section in good agreement with SM expectations



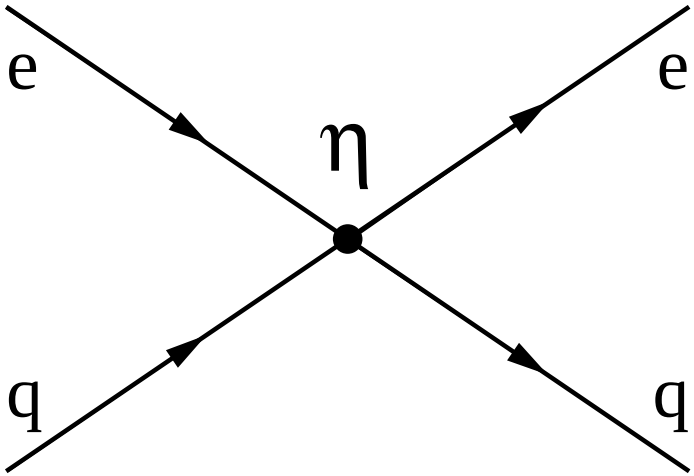
Our first HERA II Jet measurements:

- Samples with different polarisation were compared
- Good agreement with expectations

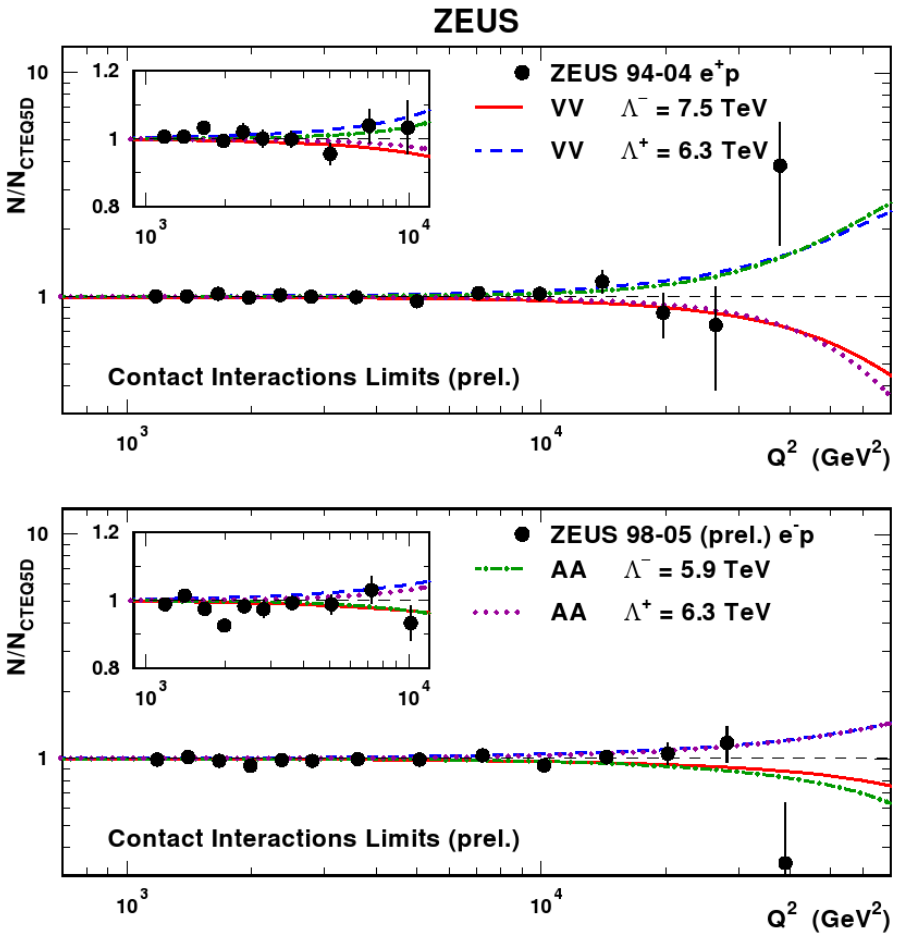
- Inclusive jet sample is under control
- Now we can look at multijets and jet substructure in CC $e^- p$ data

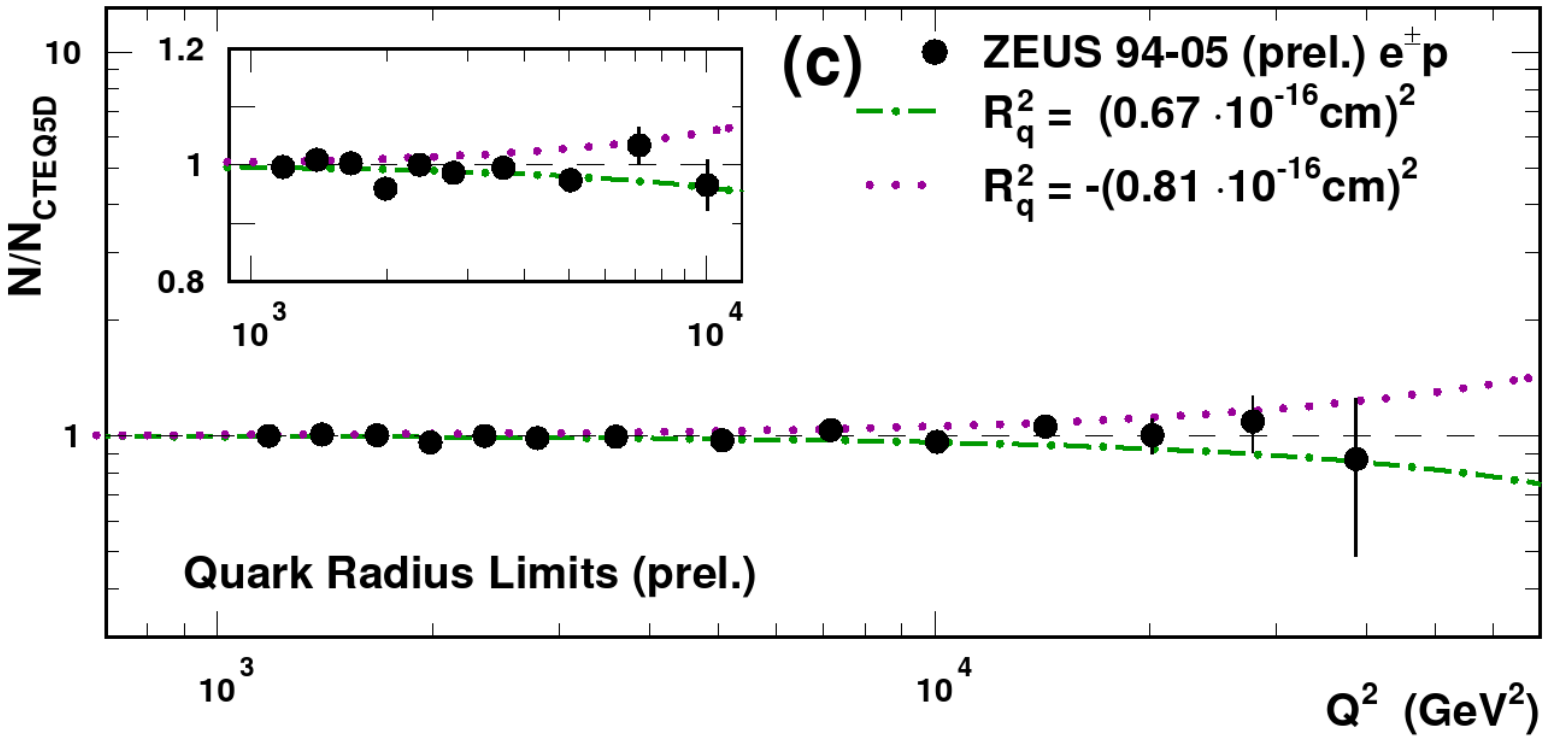


Contact Interactions



- CI models describe the effects of:
  - Heavy leptoquarks
  - Additional heavy weak bosons
  - Large extra dimensions
  - Electron or quark compositeness

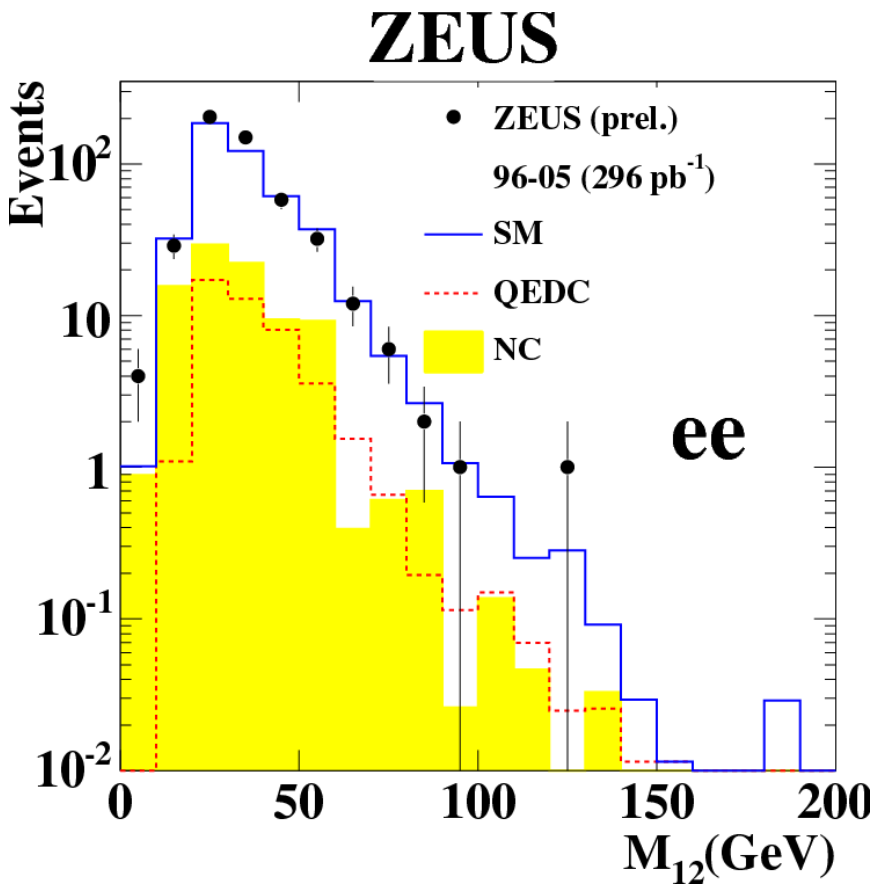




$$\frac{d\sigma}{dQ^2} = \frac{d\sigma^{SM}}{dQ^2}\left(1 - \frac{R_e^2}{6}\right)^2\left(1 - \frac{R_q^2}{6}\right)^2$$

$$R_q < 0.67 \times 10^{-3} \text{ fm}$$

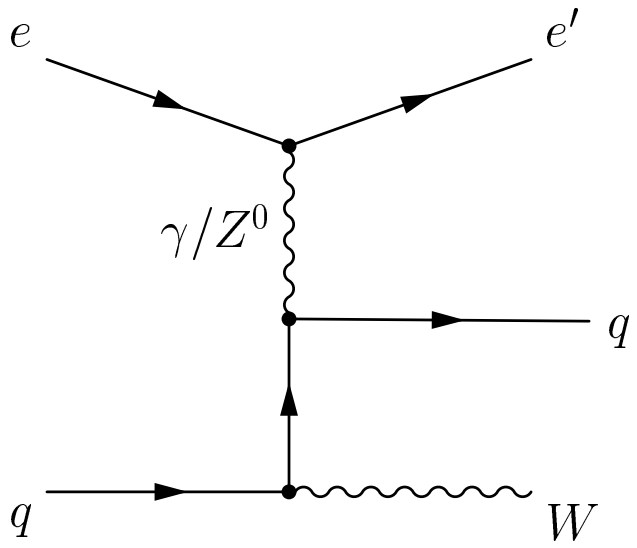
- Production of di-lepton and 3-lepton events is sensitive to new physics, especially at high masses
- H1 have observed an excess at high invariant masses ($3/0.44 \pm 0.1 > 100\mathrm{GeV}$ in *ee* channel)
- No excess observed in *ee* or *eee* channel by ZEUS



Reminder

- At the last PRC ZEUS presented first isolated muon results for a W production optimised search (similar to H1 search)
- Search on 1998-2005 data (249 pb^{-1}, 143 pb^{-1} $e^- p$, 106 pb^{-1} $e^+ p$) made preliminary for ICHEP06

- New for this PRC: Analysis has been extended to cover full HERA data taking period up to October 2006:
  - 175 pb^{-1} $e^+ p$
  - 204 pb^{-1} $e^- p$



New Results

Isolated e	$12 < p_T^X < 25$ **GeV**	$p_T^X > 25$ **GeV**
ZEUS (prel.) 96-97 e^+p (39 pb^{-1})	**2**/0.3 ± 0.2 (85%)	**0**/0.5 ± 0.2 (62%)
ZEUS (prel.) 05-06 e^-p (61 pb^{-1})	**2**/0.9 ± 0.3 (52%)	**2**/0.9 ± 0.3 (62%)
ZEUS (prel.) 03-06 e^+p (70 pb^{-1})	**1**/0.8 ± 0.2 (64%)	**0**/1.0 ± 0.2 (76%)

Isolated μ	$12 < p_T^X < 25$ **GeV**	$p_T^X > 25$ **GeV**
ZEUS (prel.) 96-97 e^+p (39 pb^{-1})	**1**/0.3 ± 0.2 (84%)	**0**/0.4 ± 0.2 (68%)
ZEUS (prel.) 04-06 e^-p (187 pb^{-1})	**2**/2.0 ± 0.3 (68%)	**2**/2.0 ± 0.3 (86%)
ZEUS (prel.) 03-06 e^+p (70 pb^{-1})	**2**/0.9 ± 0.2 (64%)	**0**/1.0 ± 0.2 (82%)

In 30 pb^{-1} 2006 e^+p data: 1 new e event and 1 new μ event, both with $12 < P_T^X < 25$ GeV.

Total Numbers

Isolated e	$12 < p_T^X < 25$ **GeV**	$p_T^X > 25$ **GeV**
ZEUS (prel.) 96-06 e^+p (175 pb^{-1})	**4**/2.1 ± 0.3 (63%)	**1**/2.2 ± 0.3 (75%)
ZEUS (prel.) 98-06 e^-p (204 pb^{-1})	**6**/2.9 ± 0.5 (56%)	**5**/3.8 ± 0.6 (55%)
ZEUS (prel.) 96-06 $e^\pm p$ (379 pb^{-1})	**10**/5.0 ± 0.6 (59%)	**6**/6.0 ± 0.7 (63%)

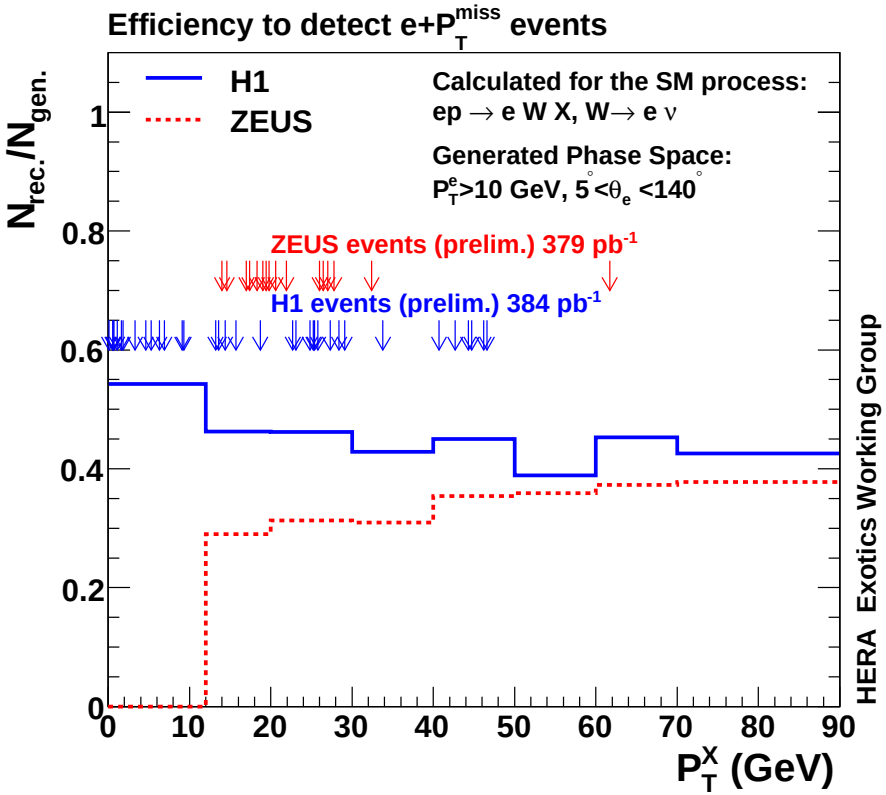
Isolated μ	$12 < p_T^X < 25$ **GeV**	$p_T^X > 25$ **GeV**
ZEUS (prel.) 96-06 e^+p (175 pb^{-1})	**3**/1.9 ± 0.4 (71%)	**1**/2.3 ± 0.4 (78%)
ZEUS (prel.) 98-06 e^-p (204 pb^{-1})	**2**/2.2 ± 0.3 (68%)	**2**/2.2 ± 0.3 (86%)
ZEUS (prel.) 96-06 $e^\pm p$ (379 pb^{-1})	**5**/4.1 ± 0.5 (75%)	**3**/4.5 ± 0.5 (82%)

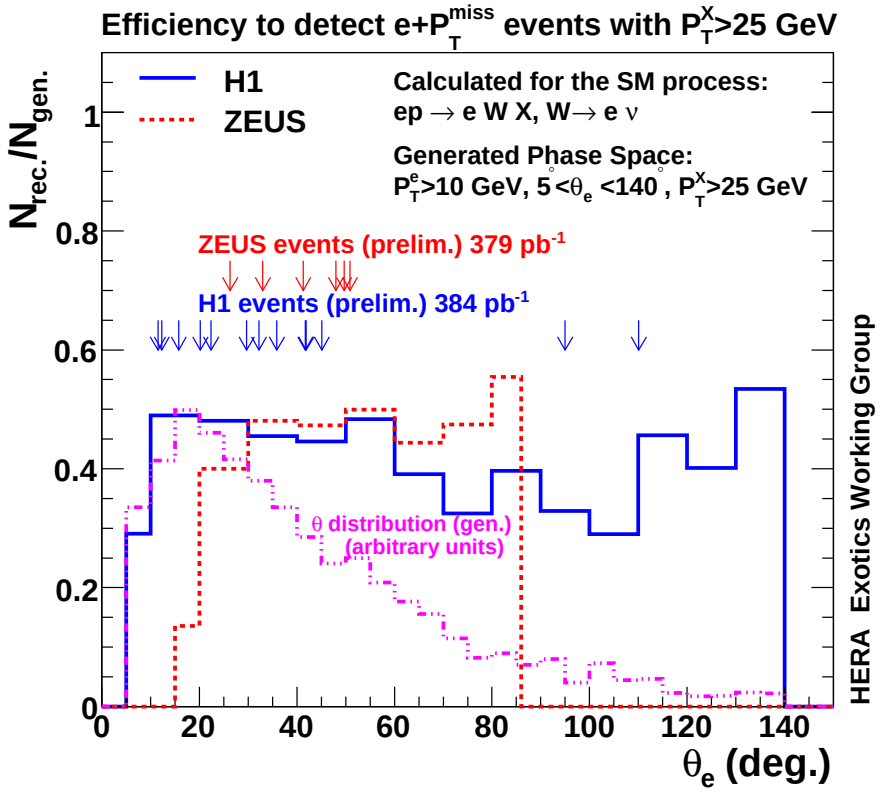
HERA Exotics Working Group

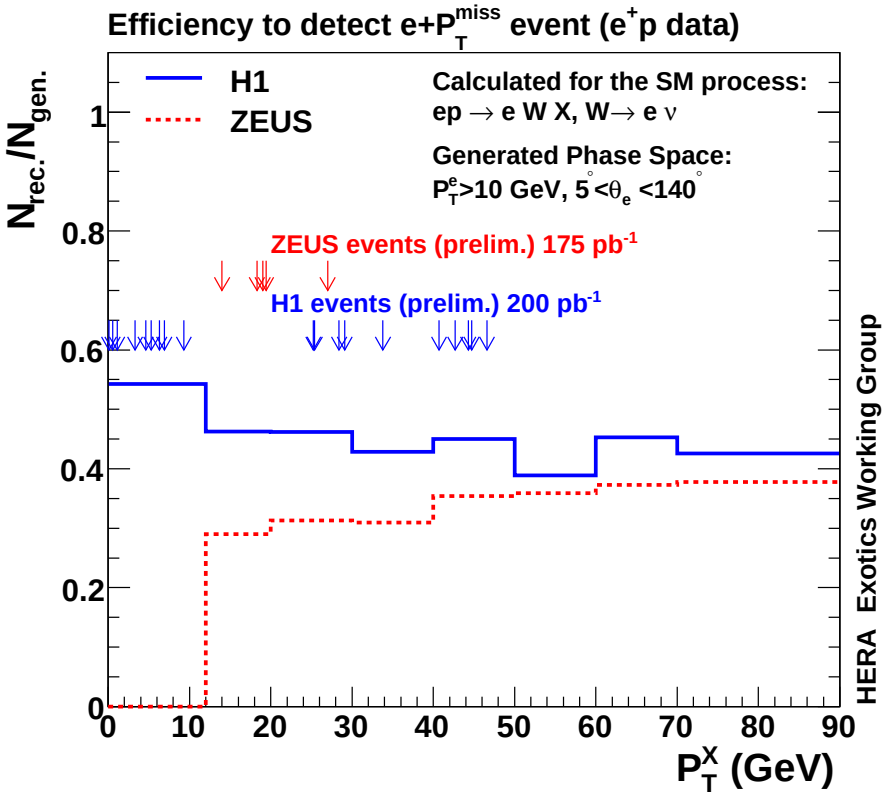
Members of the Working group focused on isolated leptons:

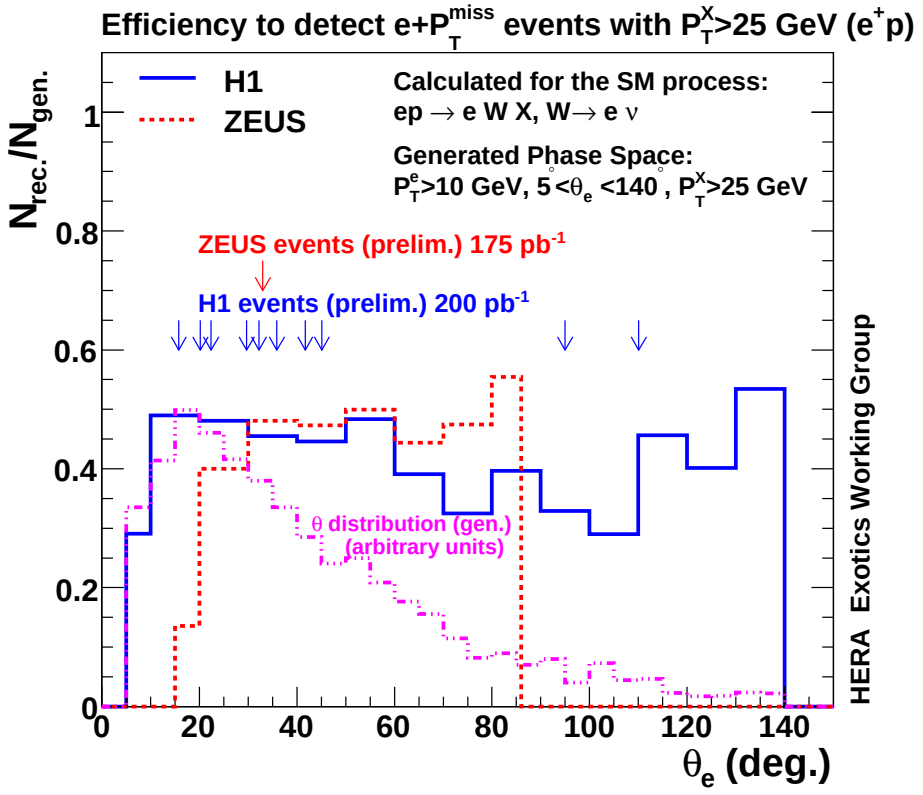
- H1: G. Brandt, C. Diaconu, D. South
- ZEUS: J. Ferrando, K. Korcsak-Gorzo

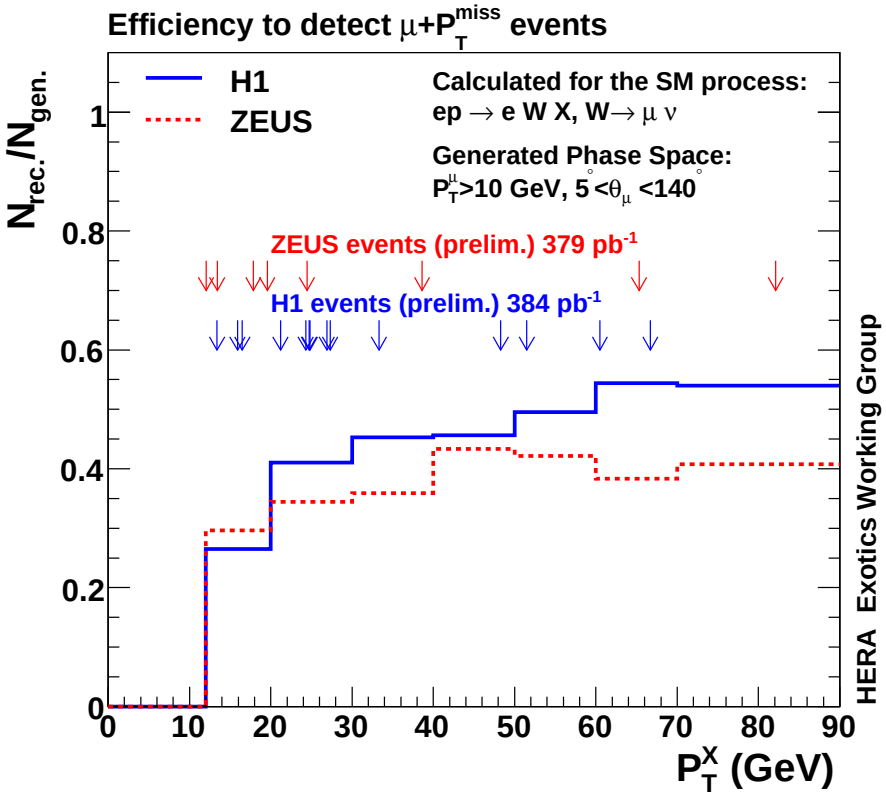
- Work has focused on trying to understand possible differences between H1 and ZEUS searches
- Common analysis region for future comparison has been agreed
- Managed to send first results (efficiency comparisons of existing searches) to ICHEP06

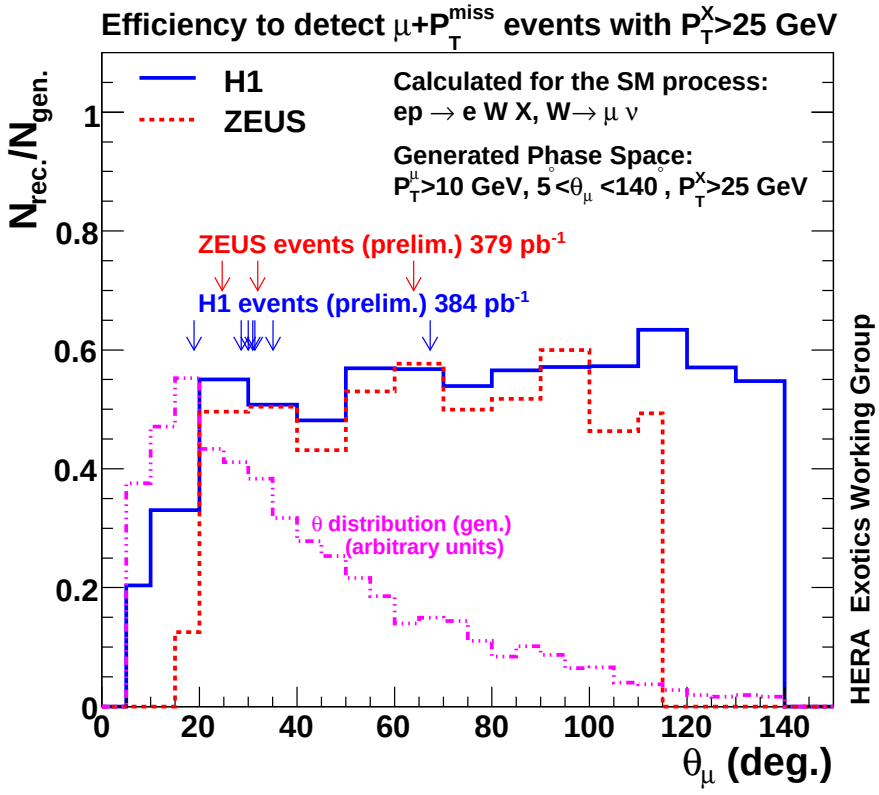

Efficiency to detect e+P$_T^{miss}$ events
H1
ZEUS
Calculated for the SM process:
ep → e W X, W→ e ν
Generated Phase Space:
P$_T^e$>10 GeV, 5°<θ$_e$ <140°
ZEUS events (prelim.) 379 pb^{-1}
H1 events (prelim.) 384 pb^{-1}
N$_{rec.}$/N$_{gen.}$
P$_T^X$ (GeV)
HERA Exotics Working Group

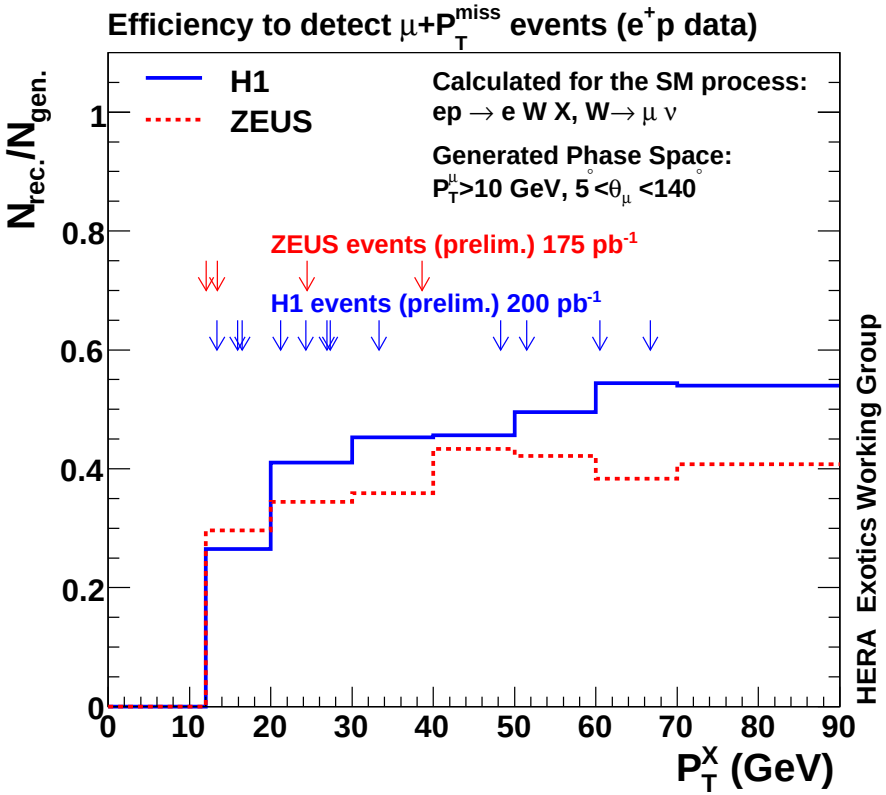

Efficiency to detect e+P$_T^{miss}$ events with P$_T^X$>25 GeV
H1
ZEUS
Calculated for the SM process:
ep → e W X, W→ e ν
Generated Phase Space:
P$_T^e$>10 GeV, 5°<θ$_e$ <140°, P$_T^X$>25 GeV
ZEUS events (prelim.) 379 pb^{-1}
H1 events (prelim.) 384 pb^{-1}
θ distribution (gen.)
(arbitrary units)
N$_{rec.}$/N$_{gen.}$
θ$_e$ (deg.)
HERA Exotics Working Group

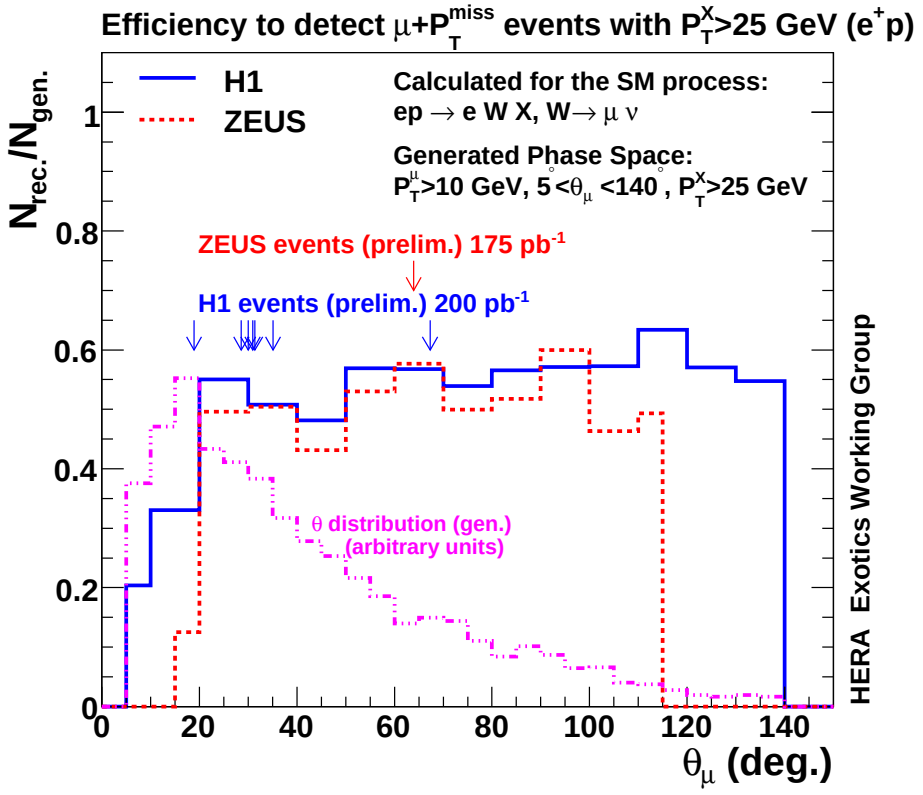

Efficiency to detect e+P$_T^{miss}$ event (e$^+$p data)
N$_{rec.}$/N$_{gen.}$
H1
ZEUS
Calculated for the SM process:
ep → e W X, W→ e ν
Generated Phase Space:
P$_T^e$>10 GeV, 5°<θ$_e$ <140°
ZEUS events (prelim.) 175 pb^{-1}
H1 events (prelim.) 200 pb^{-1}
HERA Exotics Working Group
P$_T^X$ (GeV)


Efficiency to detect e+P$_T^{miss}$ events with P$_T^X$>25 GeV (e$^+$p)
N$_{rec.}$/N$_{gen.}$
H1
ZEUS
Calculated for the SM process:
ep → e W X, W→ e ν
Generated Phase Space:
P$_T^e$>10 GeV, 5°<θ$_e$ <140°, P$_T^X$>25 GeV
ZEUS events (prelim.) 175 pb^{-1}
H1 events (prelim.) 200 pb^{-1}
θ distribution (gen.)
(arbitrary units)
HERA Exotics Working Group
θ$_e$ (deg.)


Efficiency to detect μ+P_T^miss events
H1
ZEUS
Calculated for the SM process:
ep → e W X, W→ μ ν
Generated Phase Space:
P_T^μ>10 GeV, 5°<θ_μ <140°
ZEUS events (prelim.) 379 pb-1
H1 events (prelim.) 384 pb-1
N_rec./N_gen.
P_T^X (GeV)
HERA Exotics Working Group


Efficiency to detect μ+P_T^miss events with P_T^X>25 GeV
H1
ZEUS
Calculated for the SM process:
ep → e W X, W→ μ ν
Generated Phase Space:
P_T^μ>10 GeV, 5°<θ_μ <140°, P_T^X>25 GeV
ZEUS events (prelim.) 379 pb-1
H1 events (prelim.) 384 pb-1
θ distribution (gen.)
(arbitrary units)
N_rec./N_gen.
θ_μ (deg.)
HERA Exotics Working Group

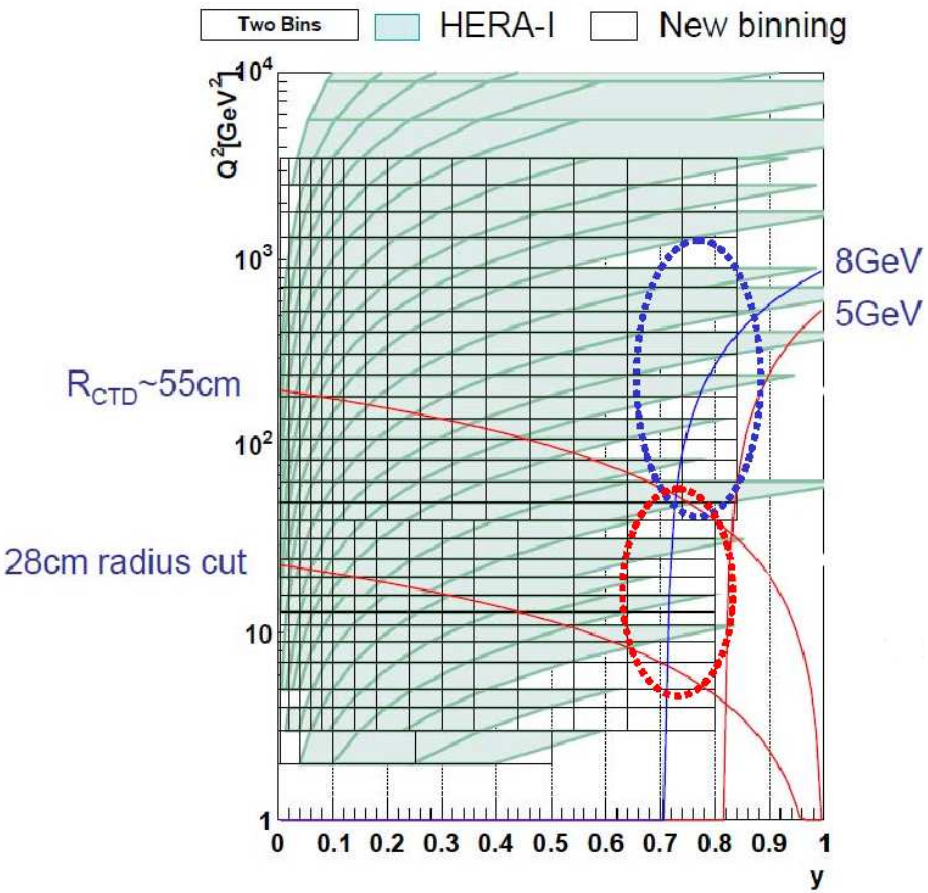

Efficiency to detect μ+P_T^miss events (e+p data)
N_rec./N_gen.
H1
ZEUS
Calculated for the SM process:
ep → e W X, W→ μ ν
Generated Phase Space:
P_T^μ>10 GeV, 5°<θ_μ <140°
ZEUS events (prelim.) 175 pb-1
H1 events (prelim.) 200 pb-1
HERA Exotics Working Group
P_T^X (GeV)


Efficiency to detect μ+P_T^miss events with P_T^X>25 GeV (e+p)
N_rec./N_gen.
H1
ZEUS
Calculated for the SM process:
ep → e W X, W→ μ ν
Generated Phase Space:
P_T^μ>10 GeV, 5°<θ_μ <140°, P_T^X>25 GeV
ZEUS events (prelim.) 175 pb-1
H1 events (prelim.) 200 pb-1
θ distribution (gen.)
(arbitrary units)
HERA Exotics Working Group
θ_μ (deg.)

	$e^{\pm}p$ **Data Preliminary** $P_T^X > 25$ **GeV**		Electron obs./exp.	Muon obs./exp.	Combined obs./exp.
e^+p	H1	200 pb^{-1}	10 / 3.1 $\pm$ 0.6	7 / 2.9 $\pm$ 0.5	17 / 6.0 $\pm$ 1.0
	ZEUS	175 pb^{-1}	1 / 2.2 $\pm$ 0.3	1 / 2.3 $\pm$ 0.4	2 / 4.5 $\pm$ 0.7
	H1+ZEUS	375 pb^{-1}	11 / 5.3 $\pm$ 0.9	8 / 5.2 $\pm$ 0.9	**19 / 10.5 $\pm$ 1.7**
e^-p	H1	184 pb^{-1}	3 / 3.8 $\pm$ 0.6	0 / 3.1 $\pm$ 0.5	3 / 6.9 $\pm$ 1.1
	ZEUS	204 pb^{-1}	5 / 3.8 $\pm$ 0.6	2 / 2.2 $\pm$ 0.3	7 / 6.0 $\pm$ 0.9
	H1+ZEUS	388 pb^{-1}	8 / 7.6 $\pm$ 1.2	2 / 5.3 $\pm$ 0.8	**10 / 12.9 $\pm$ 2.0**

F_2 at High y

Preparing for F_L by measuring F_2 at high y:

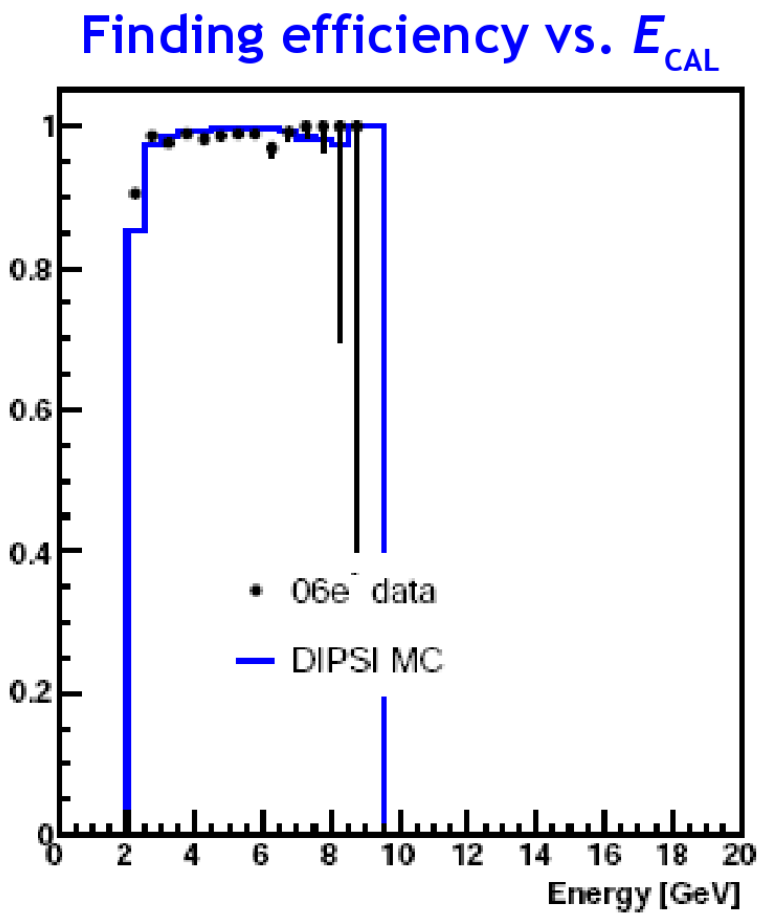


- Low x region: measurement can be performed only at HERA
- important for extracting the gluon density
- F_L contribution may be observed

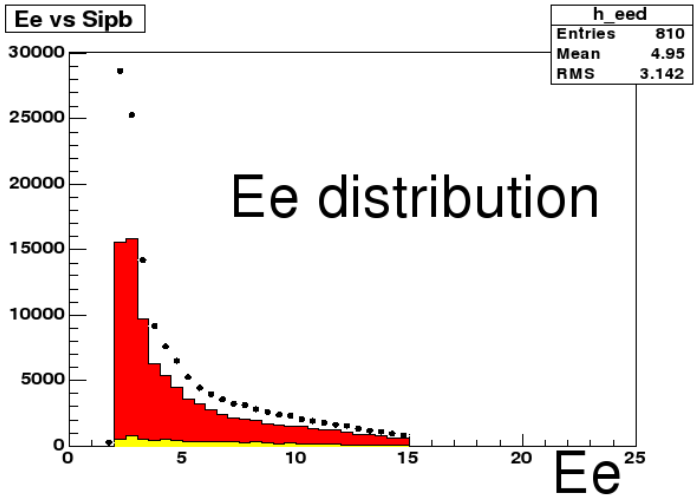
Studies also valuable because they develop technology for measuring F_L:

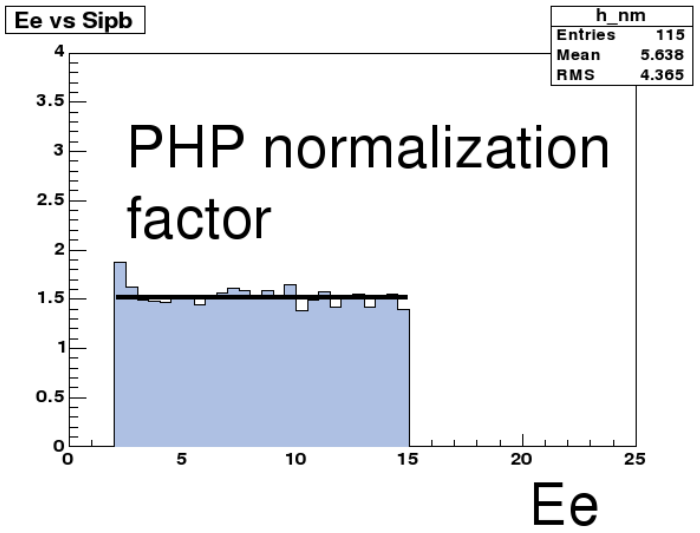
- Studies of expanding measurement to lower E_e
- New Low E_e trigger (running since August 2006)

- Electron finding at low entries is crucial for the F_L measurement and F_2 at high y
- ZEUS F_L study $\rightarrow$ large systematic contribution from electron finding efficiency at low energies
- Efficiency of electron finder at low E_e has been evaluated using $J/\psi \rightarrow ee$ events.

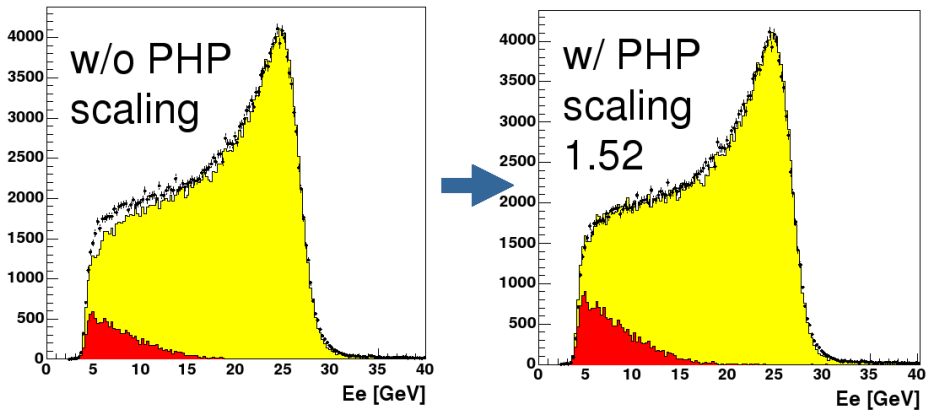


γp Background

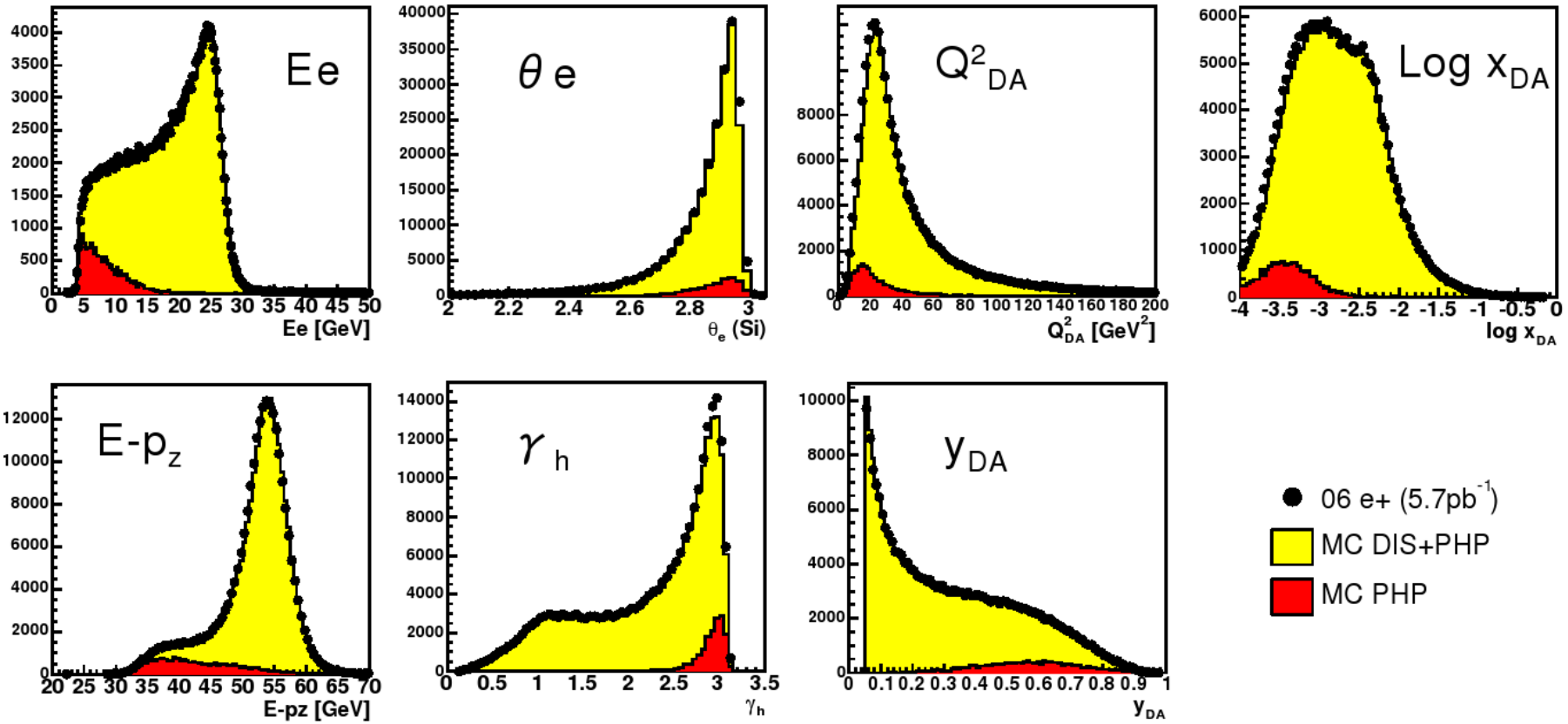




- γp is the main background for F_2 at high y / F_L
- A low $E - p_Z$ trigger was used to select a γp enriched sample



Control Plots



Summary

- In 2006 ZEUS DAQ has been operating well
- In the last few months ZEUS has achieved efficiency consistently $> 80\%$.
- HERA-II detector configuration undesrtanding progressing well, first fully MVD-based results arriving
- HERA-II physics analysis progressing well providing timely results
- Work on combined results progressing well, first results were already sent to ICHEP06 $\rightarrow$ Thanks to our H1 colleagues for a positive and effective collaborative effort
- ZEUS are addressing the challenges of Low-Energy F_L running with a strong and dedicated team. Benefits of studies also apparent for high-energy running results