### **DESY PRC Meeting: Report from**

## THE ZEUS EXPERIMENT

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65<sup>th</sup> Physics Research Committee Meeting DESY, 1/2 April 2008

#### Outline

- ZEUS 2008 2012
  - Plans and Resources
- Dismantling
- Physics Highlights



### ZEUS FROM 2008 TO 2012 (1)

#### Focus on physics questions:

- Precise determination of parton content of the proton and effect on future experiments (LHC, astro-particle physics, cosmic showers, ...).
- Effects beyond the Standard Model in HERA data?
- Exotic hadrons (tetraquarks, pentaquarks, glueballs)?
- Effects like instantons or sphalerons?
- Progress in perturbative QCD dynamics and color-charge confinement?
- Understand diffractive phenomena in ep and extrapolation to pp?

### Current emphasis: "Grand Reprocessing" of all HERA-II data

- Finalise calibrations and alignments (MVD+STT  $\rightarrow$  heavy-flavour physics!), unify tracking, polish analysis and reprocessing software (middle 2008).
- "Grand Reprocessing" of all HERA-II data until latest middle 2009.



### **ZEUS FROM 2008 TO 2012 (2)**

### Analysis focus on

- $\rightarrow$  Searches,
- $\rightarrow$  PDF + EW parameters,
- $\rightarrow$  QCD measurements.

### Interpretation of the data:

- → PDF fits with non-inclusive observables (→ gluon at high x, etc.): HFS, jets, heavy flavours, prompt photons.
- $\rightarrow$  Final limits on BSM phenomena.
- $\rightarrow$  Also in collaboration with H1.

### Plan for 10-15 papers / year

... Since March 07, published 14 papers (for details see later).

### RESOURCES

### Manpower and analysis situation:

- Currently 325 authors on publications.
- About 80 ongoing analyses, 14 in editorial process.
- About 20 analyses heavily affected by manpower problems.
  - → only sufficient personnel for high-priority analyses!
- Many analyses will profit from "Grand Reprocessing";
  - concerned about manpower after middle 2009!

### Requirements on resources:

- Sufficient computing power for simulation, reconstruction and analysis.
- Sufficient access to Post-Docs + students at ~today's level from all collaboration institutes.
- Funding travel to and from DESY.
- Funding for inviting Eastern European colleagues.
- Support from DESY directorate for reasonable representation at major conferences.

### **STATUS OF ZEUS DISMANTLING**

#### Removal of most parts so far on schedule:

- infrastructure, shielding, forward muon system, luminosity system, toroid ...
- Removal of CAL electronics, infrastructure.

#### Next major step: UCAL

- first F/RCAL, then BCAL, 520 t of Uranium.
- Export permission from authorities: February 11<sup>th</sup>.
- Nevada Test Site permission (DOE) March 11<sup>th</sup>.
- First shipments to US: April 11<sup>th</sup>.
- Finish with F/RCAL until June, BCAL until September.
- Inner detector start only after F/RCAL removal!

#### Further steps:

- Removal of inner detector, beam pipe, solenoid, barrel muon chambers .
- Disassembly of yoke (2000 t of steel).

Cables:	45 t
Electronics	s: 10 t
Copper:	~7 t
Steel:	>100 t
Toroid:	> 200 t



### **STATUS OF ZEUS DISMANTLING**



### **PHYSICS NEWS**

New papers since last PRC session (8 November 2007):

- Energy dependence of the charged multiplicities in NC DIS at HERA (DESY-08-036, March 2008, submitted to JHEP)
- Deep inelastic inclusive and diffractive scattering at Q<sup>2</sup> values from 25 to 320 GeV<sup>2</sup> with the ZEUS forward plug calorimeter. (DESY-08-011, February 2008, accepted to NPB)
- Multi-jet cross sections in charged current ep scattering at HERA.
  (DESY-08-024, February 2008, accepted to PRD)

#### New final and preliminary results:

- Isolated leptons and W production (HERA-I+II).
- K0sK0s resonances (HERA-I+II).
- Beauty cross sections with dimuon and electron final states (HERA-I).
- Total cross section measurement (HERA-II).

### H1+ZEUS combined results and working groups:

- Combined isolated, high- $p_T$  and multi-leptons.
- Towards combined contact interaction analyses.
- $\alpha_s$  from combined HERA-I H1+ZEUS jet measurements.
- Combined NC cross sections + PDF, HFL measurements (D\*)  $\rightarrow$  K. Lipka.
- Diffraction (not covered).

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### **PHYSICS IN THE PIPELINE**

At "editorial board" stage etc.:

- Measurement of F<sub>L</sub> (DIS08 preliminary)
- High-Q<sup>2</sup> CC incl. cross sections with polarized e± beams
- High-Q<sup>2</sup> NC incl. cross sections
- Subjet distributions
- Three-jet angular correlations (QCD color factors)
- Scaled momentum spectra in the Breit frame
- Dijets with a leading neutron
- DVCS with the LPS
- Leading protons in DIS
- Diffractive DIS with LRG and LPS.
- Excited charm and strange mesons









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### **ISOLATED LEPTONS, W PRODUCTION**

## Study of isolated leptons with large missing $p_T$ :

- H1: Excess in e and  $\mu$  channels.
- Never confirmed by ZEUS so far.
- Now at ZEUS: use full 504 pb-1!

### Search results:

- Electron and muon results in good agreement with SM expectations!
   Final ZEUS result on high-p<sub>T</sub> leptons.
- No confirmation of H1 excess!

	12-25 GeV	> 25 GeV
e <sup>±</sup> p	13	11
(504 pb <sup>-1</sup> )	(11.5±1.5)	(13.4±1.8)

### Single W cross section:

- 20-30% low, but consistent with SM.
- Exp and theo precision ~15%.

 $\sigma_{ep \to eWX} = 0.9^{+0.2}_{-0.2} (\text{stat}) \pm 0.1 (\text{syst}) \text{pb}$ 



### **ISOLATED + MULTI-LEPTONS**



## F<sub>2</sub> AND F<sub>2</sub><sup>D</sup> AT LOW Q<sup>2</sup>

## New measurement of $F_2$ and its diffractive component in 99/00 data:

- 25-320 GeV<sup>2</sup>.
- FPC for measurement of particles with  $4 < \eta < 5$  (rapidity gap!).
- "M<sub>X</sub> method" for diffr. component.



#### Diffractive structure function $F_2(3D)$ :



Diffractive contribution up to 100 GeV<sup>2</sup>! Logarithmic decrease of diffraction with Q<sup>2</sup>!

### **JETS IN CC DIS**



• ZEUS CC e p 180 pb

### **JETS IN CC DIS**

### CC jets in polarized e<sup>±</sup>p scattering:

- Detailed tests of QCD+EW physics.
- Potential to constrain proton flavour content!

#### Measured 1/2/3 jet events:

- Inclusive jets well described by NLO.
- Dijets only poorly decribed!
- Three-jets well described at LO!

## And: First observation of four-jet production in CC DIS (11 events)!





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### **BEAUTY:** $b \rightarrow \mu\mu$ , $b \rightarrow e$ , ...

#### Beauty production in photoproduction:

- Stringent test of QCD - high scale in all regions of phase space.

 $-b \rightarrow \mu\mu$ : b signal with  $p_T(\mu) > 0.75$  GeV.

![](_page_13_Figure_4.jpeg)

#### Beauty @ HERA reasonably well described

- New measurements compatible with old ones and with theory.
- New measurements extend kinematic range.

### **KOsKOs RESONANCE PRODUCTION**

### Hunting for glueballs.

- Several candidates reported.
- Especially f<sub>0</sub>(1710)!
- Use all data (about 0.5 fb<sup>-1</sup> ...)

### Results in comparison:

![](_page_14_Figure_6.jpeg)

![](_page_14_Figure_7.jpeg)

### **APPETIZER:** $\sigma_{TOT}$

Measure  $\sigma_{\gamma p}$  at different CMS energies W:  $\rightarrow$  cancel uncertainties, acceptances, etc.

# $\sigma_{\gamma} = \frac{N_{evt}}{L \cdot f_{\gamma/e} \cdot A_{tagger} \cdot A_{CAL}}$

→ Extract Regge exponent ε: (ZEUS published: ε=0.09-0.10)

$$\sigma_{\gamma} \propto W^{2\varepsilon}$$

### Progress:

- Luminosities,  $N_{\text{evt}}$  and  $A_{\text{CAL}}$  determined.
- Preliminary shot at fluxes f
- → Veeery preliminary ratio HER/LER:

$$\sigma_{\gamma}^{HER} / \sigma_{\gamma}^{LER} = 1.050 \pm ???$$

... resulting in  $\epsilon = 0.070 \pm ???$ 

#### Preliminary result at DIS08!

![](_page_15_Figure_12.jpeg)

### **CONCLUSIONS AND OUTLOOK**

### ZEUS still going strong!

- Many ongoing analyses on full data set of about 0.5 fb<sup>-1</sup>.
- Focusing on PDFs+EW, QCD, Searches.

#### Manpower and Resources

- Currently 325 authors and 80 ongoing analyses
- Manpower only sufficient for high priority analyses.
- Depend on strong support from all collaborating institutes (people, computing, travel, conferences, ...)

#### Recent physics highlights:

- More and more combined efforts with H1.
- Final words on high- $p_T$  isolated leptons.
- Jets in CC DIS.
- New results from heavy-flavour physics.
- Total cross section measurements.
- Working on structure function measurements ( $F_2$ ,  $F_L$ ,  $F_2(D)$ ,  $F_2(b)$ , ...).