

# NC ( $e^-p$ ) at high $x$

HERA-II + new  $x$  reconstruction method

**DIS2010**

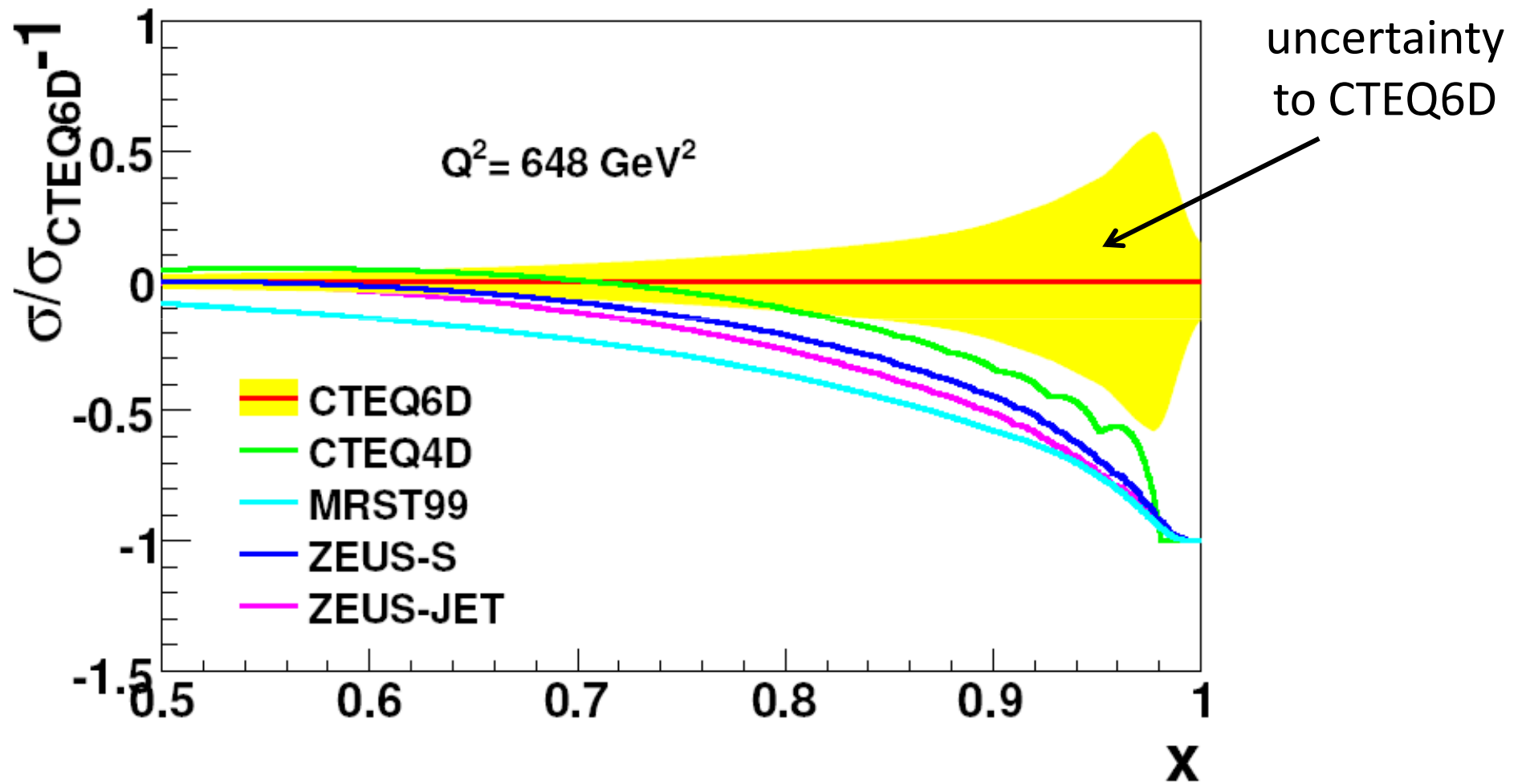
21.04.2010

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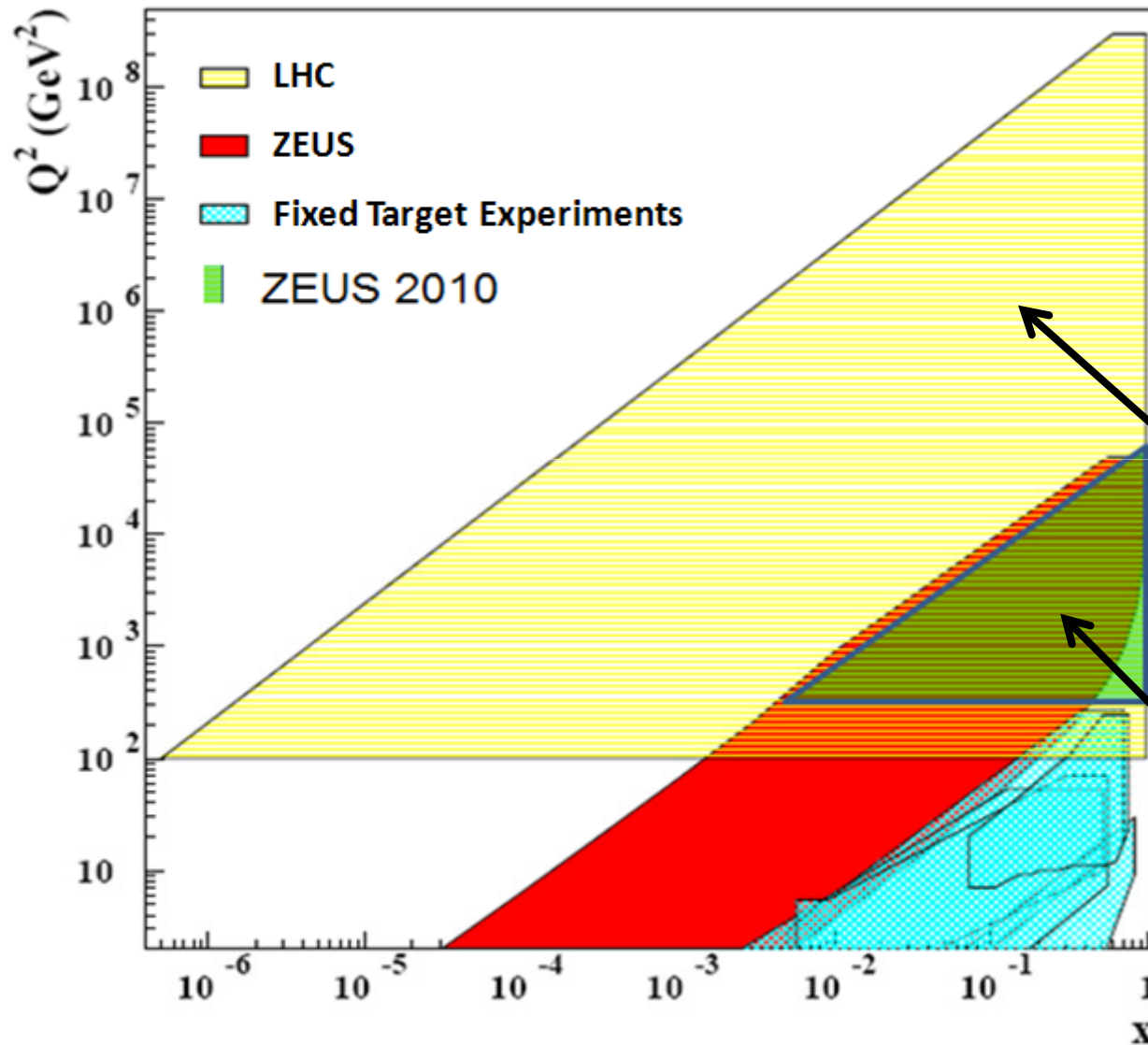
On behalf of the **ZEUS** Collaboration

# Motivation

## PDFs **uncertainties**



# HERA & LHC



Large- $x$  needed for precision measurements at LHC.

DGLAP evolution – sensitive to values of  $x$  up to  $x=1$

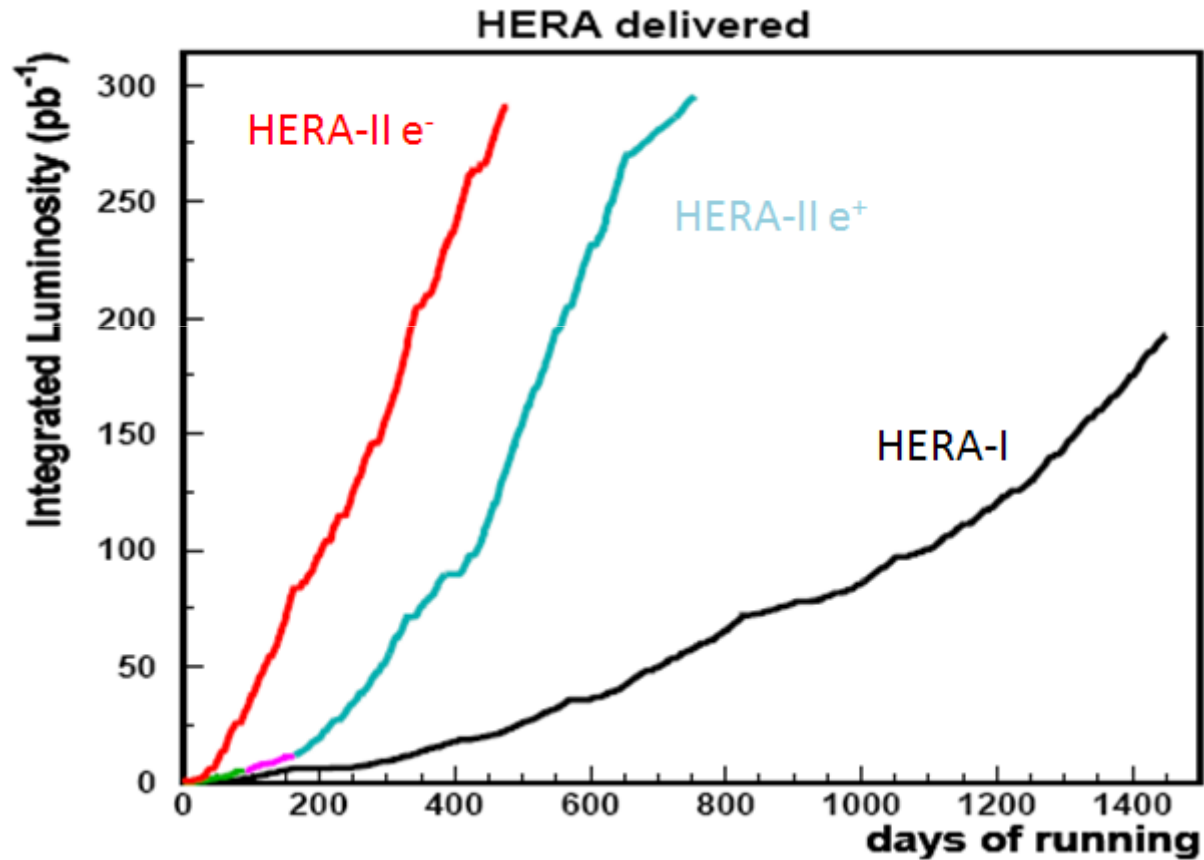
Measurements from HERA up to  $x=1$ .

# HERA-II Luminosity

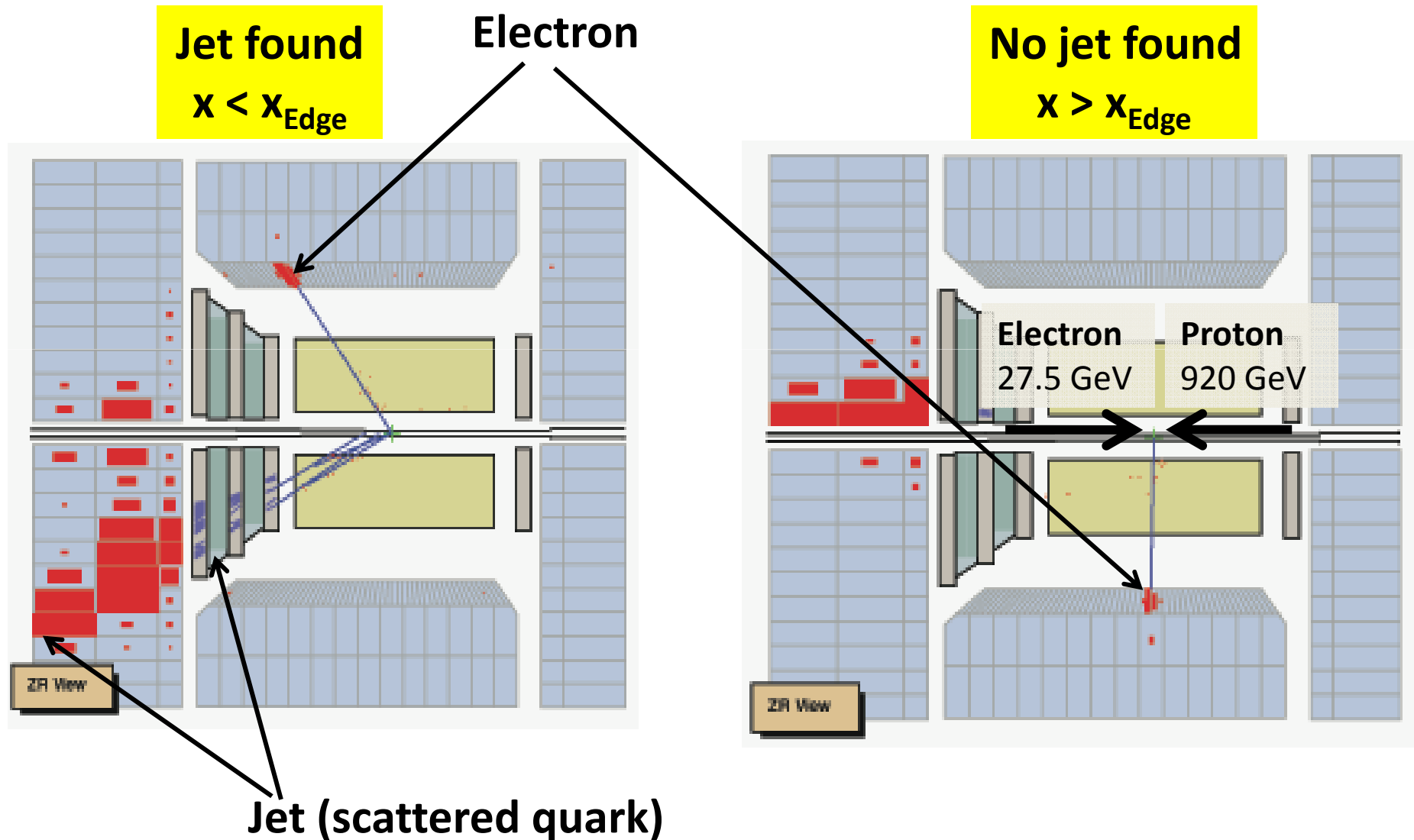
HERA-II luminosity is 3 times bigger than HERA-I

In HERA-II the electron beams are polarized.

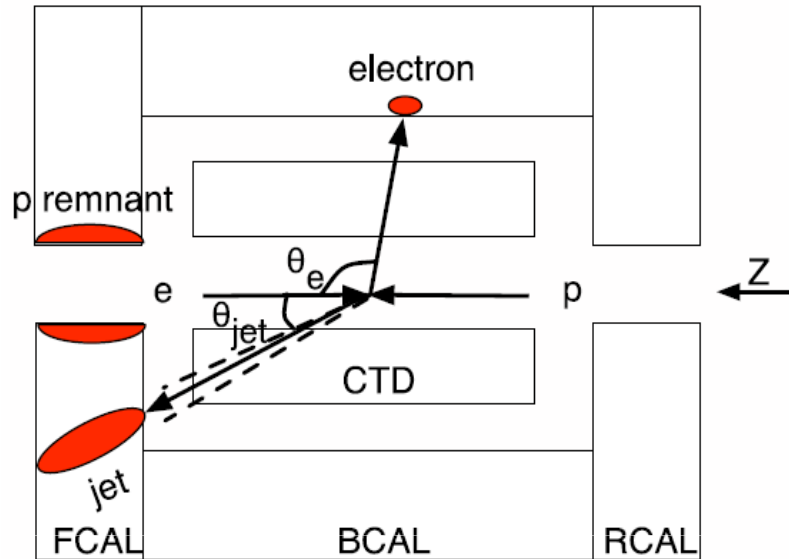
Our sample as both polarization which adds to a non polarized sample



# Event topology at HERA at large-x



# $Q^2$ and $x$ reconstruction



$$Q^2 = 2E_e E'_e (1 + \cos\theta_e)$$

$$x = \frac{Q^2}{sy}$$

$$Q^2 = \frac{p_{T\text{jet}}^2}{1 - y}$$

$$y = \frac{(E - P_z)_{\text{jet}}}{2E_0}$$



$$x = \frac{E_{\text{jet}} (1 + \cos\theta_{\text{jet}})}{2E_p \left( 1 - \frac{E_{\text{jet}} (1 - \cos\theta_{\text{jet}})}{2E_e} \right)}$$

$$p_{Te} = p_{T\text{jet}}$$



$$x = \frac{(p_{t_e}/\sin\theta_{\text{jet}})(1 + \cos\theta_{\text{jet}})}{2E_p \left( 1 - \frac{(p_{t_e}/\sin\theta_{\text{jet}})(1 - \cos\theta_{\text{jet}})}{2E_e} \right)}$$

# Reconstruction of $x$

Best resolution achieved

## One jet events

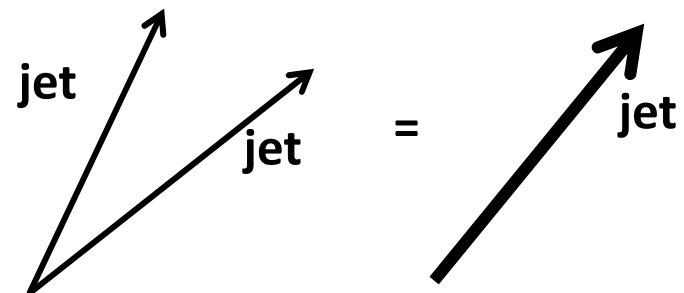
$$x = \frac{(p_{t_e}/\sin\theta_{jet})(1 + \cos\theta_{jet})}{2E_p(1 - \frac{(p_{t_e}/\sin\theta_{jet})(1 - \cos\theta_{jet})}{2E_e})}$$

## multi jets events

$$x = \frac{p_{tjets}^2}{s y_{jb}(1 - y_{jb})}$$

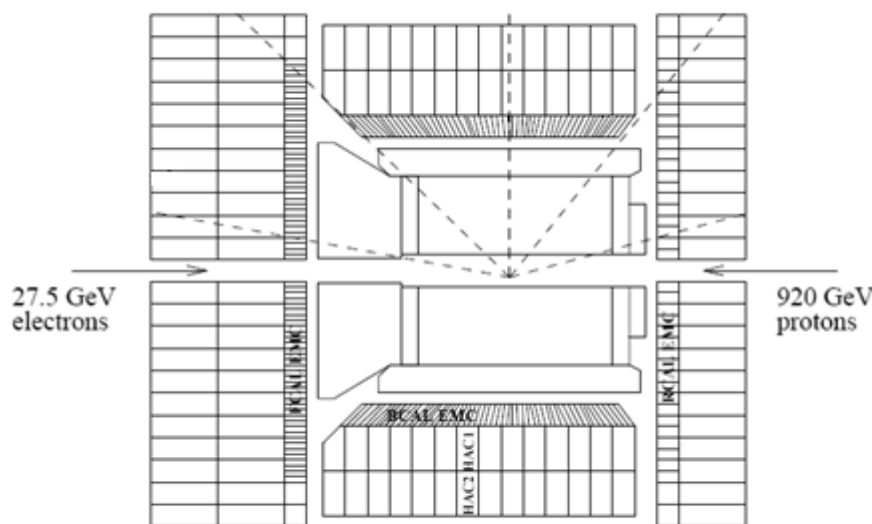
$$p_{tjets}^2 = \left(\sum_i p_{xjet}\right)^2 + \left(\sum_i p_{yjet}\right)^2$$

$$y_{jb} = \frac{\sum_i [E_{jet_i}(1 - \cos\theta_{jet_i})]}{2E_e}$$



# ZEUS detector projected onto $x$ and $Q^2$ plane

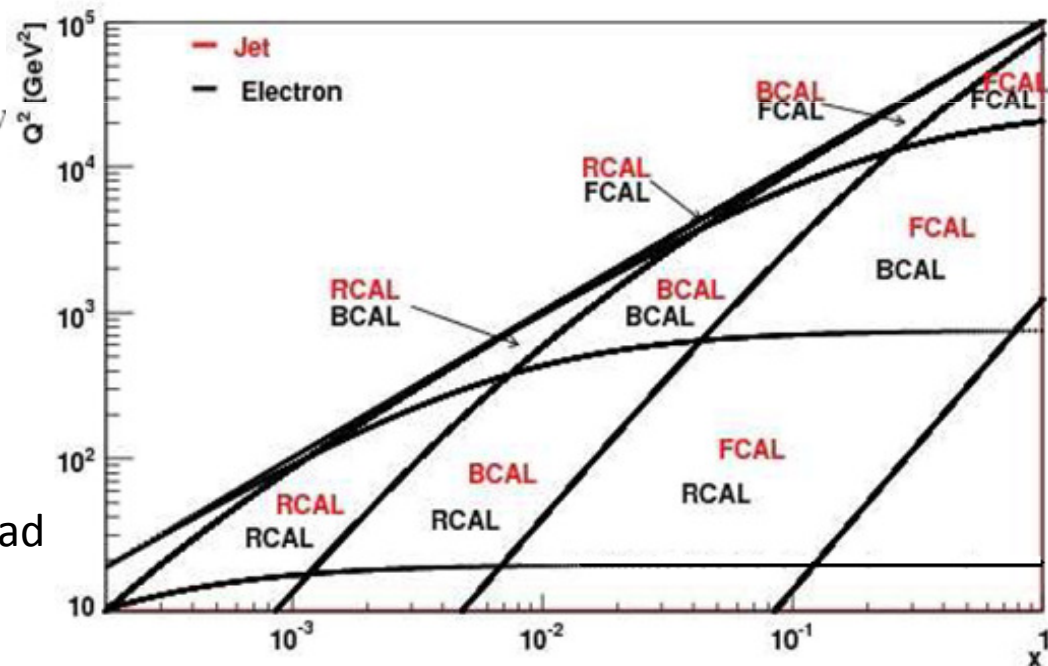
ZEUS Detector



**FCAL BCAL RCAL**

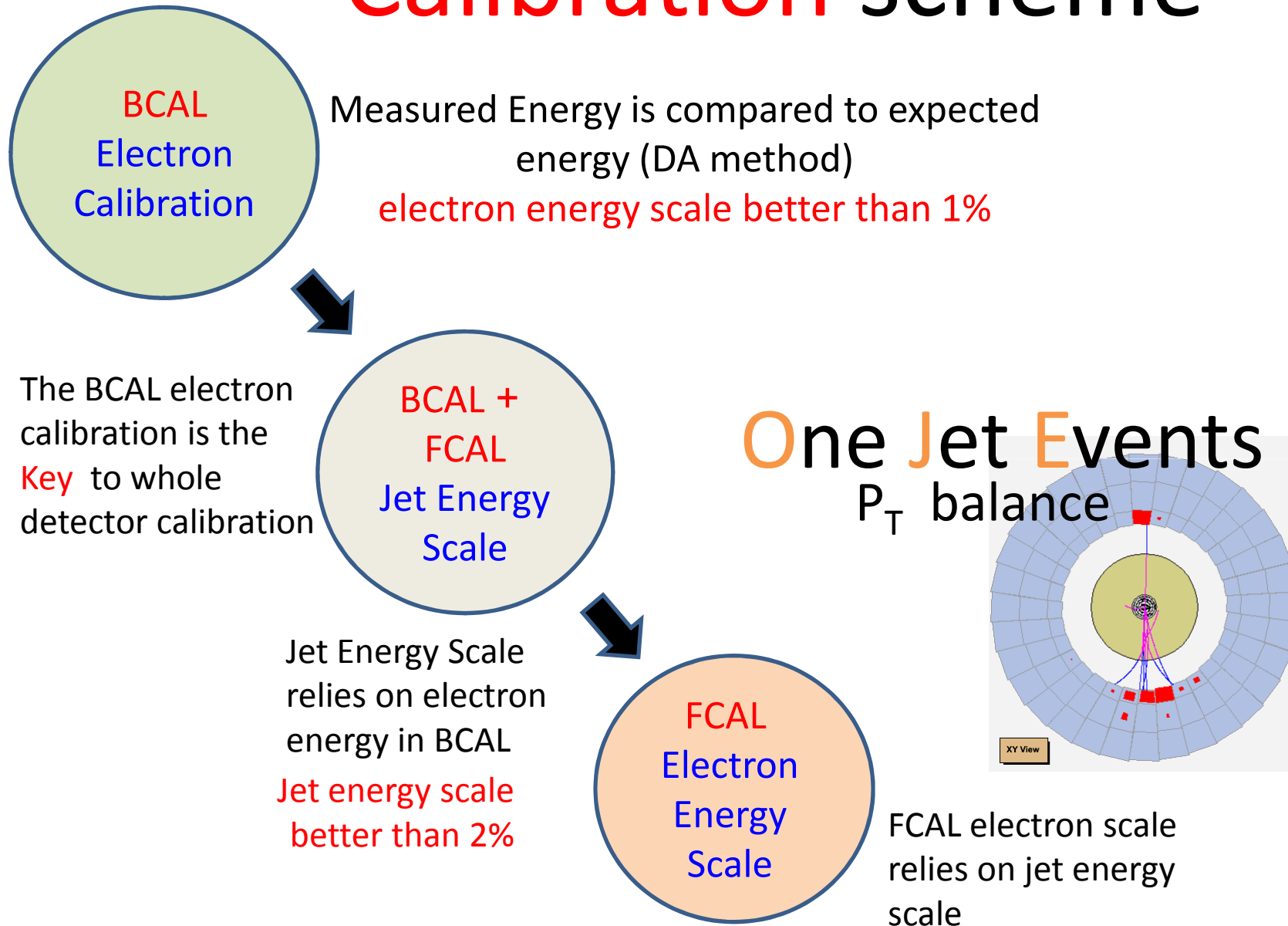
Important to understand **FCAL** and **BCAL** Had and EM energy scales

At high  $x$  and high  $Q^2$  events the jets and electron can be found in the **BCAL** and **FCAL**



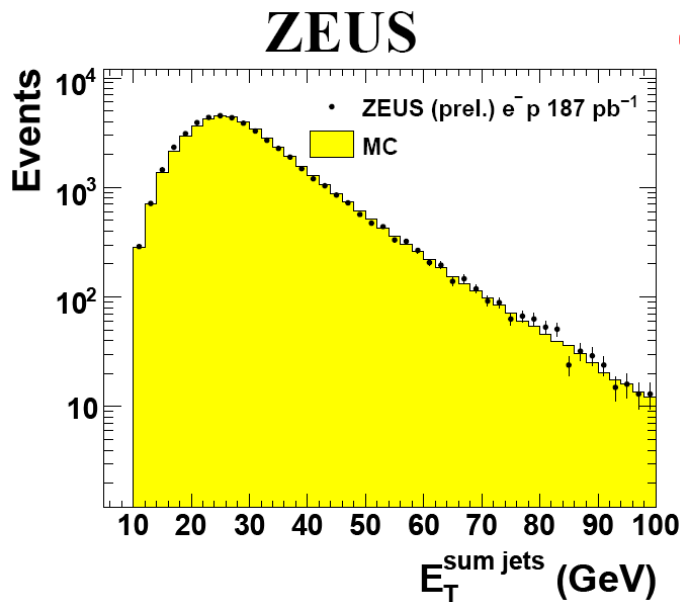
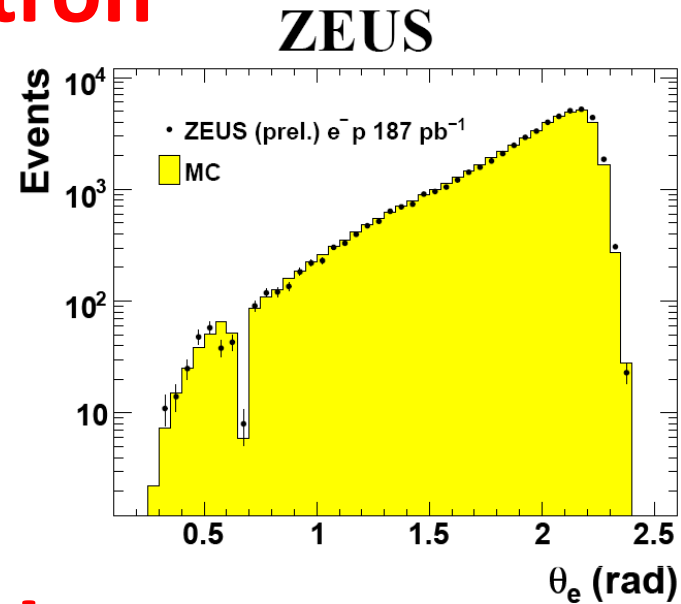
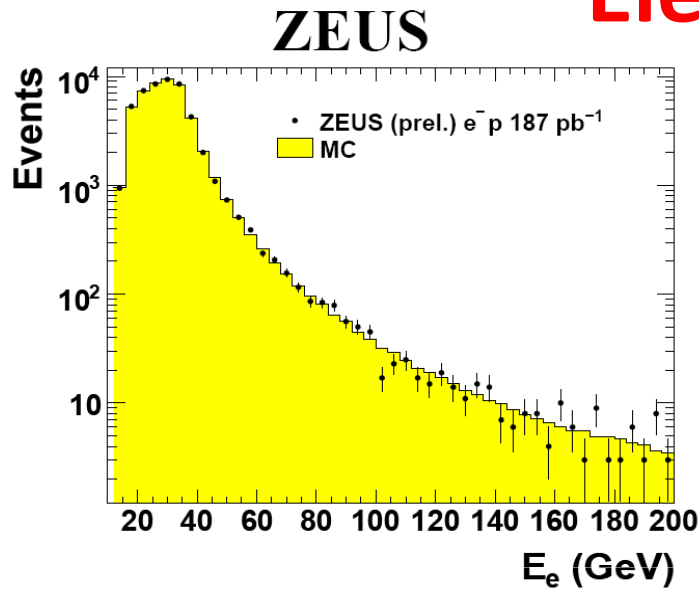


# Calibration scheme

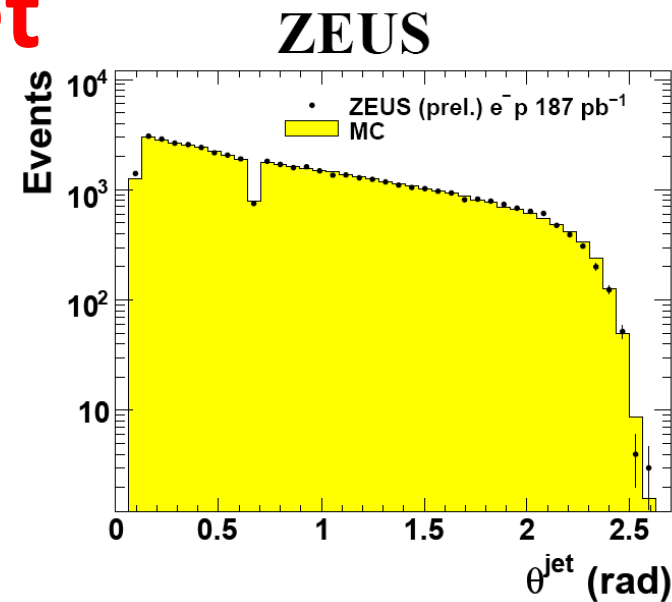


# DATA and MC comparison

## Electron

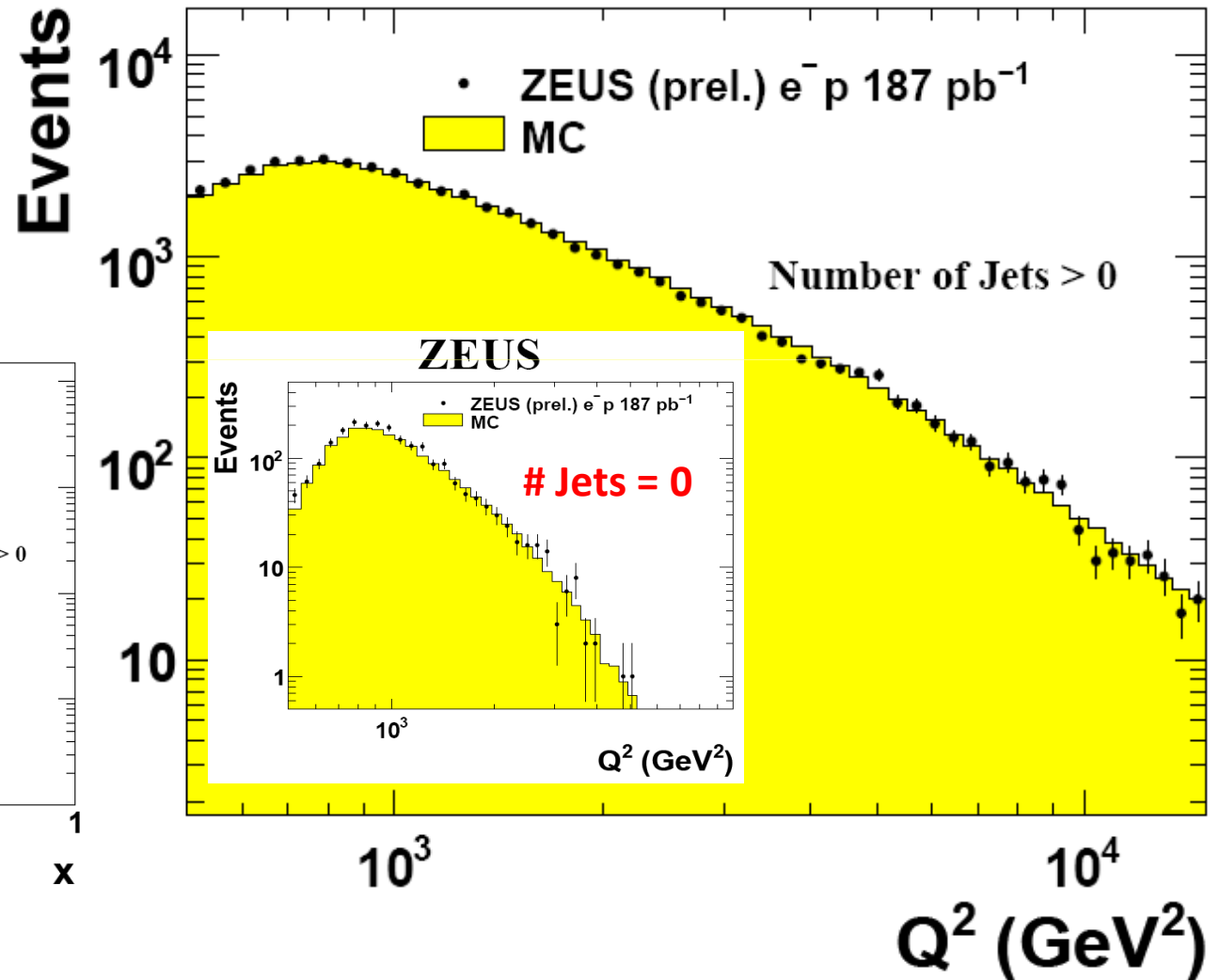
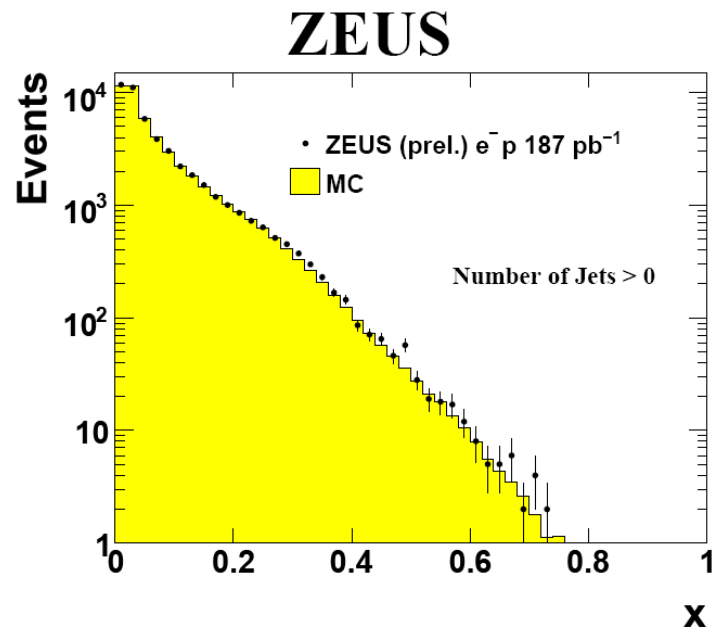


## Jet

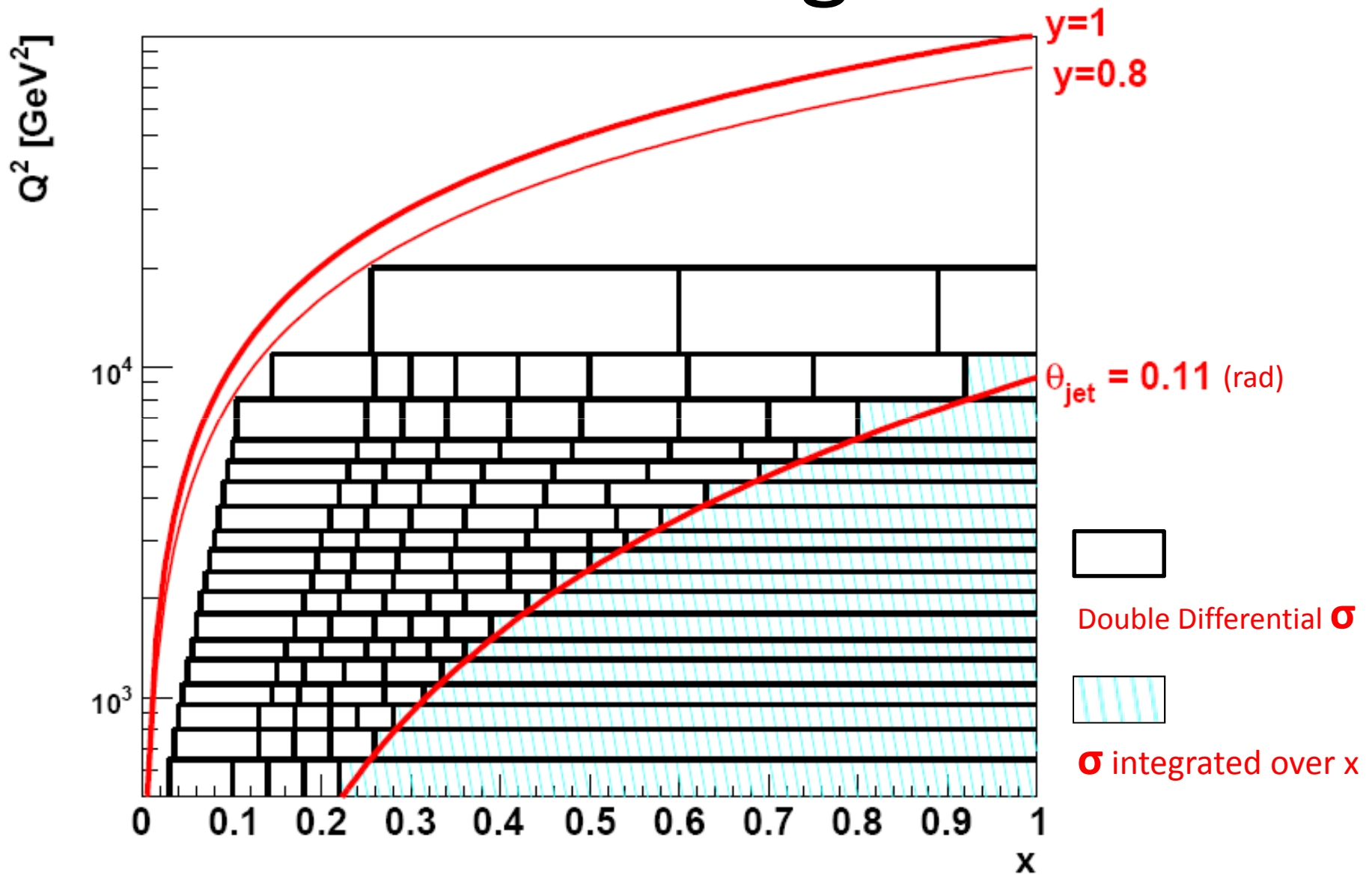


# DATA and MC comparison

## ZEUS

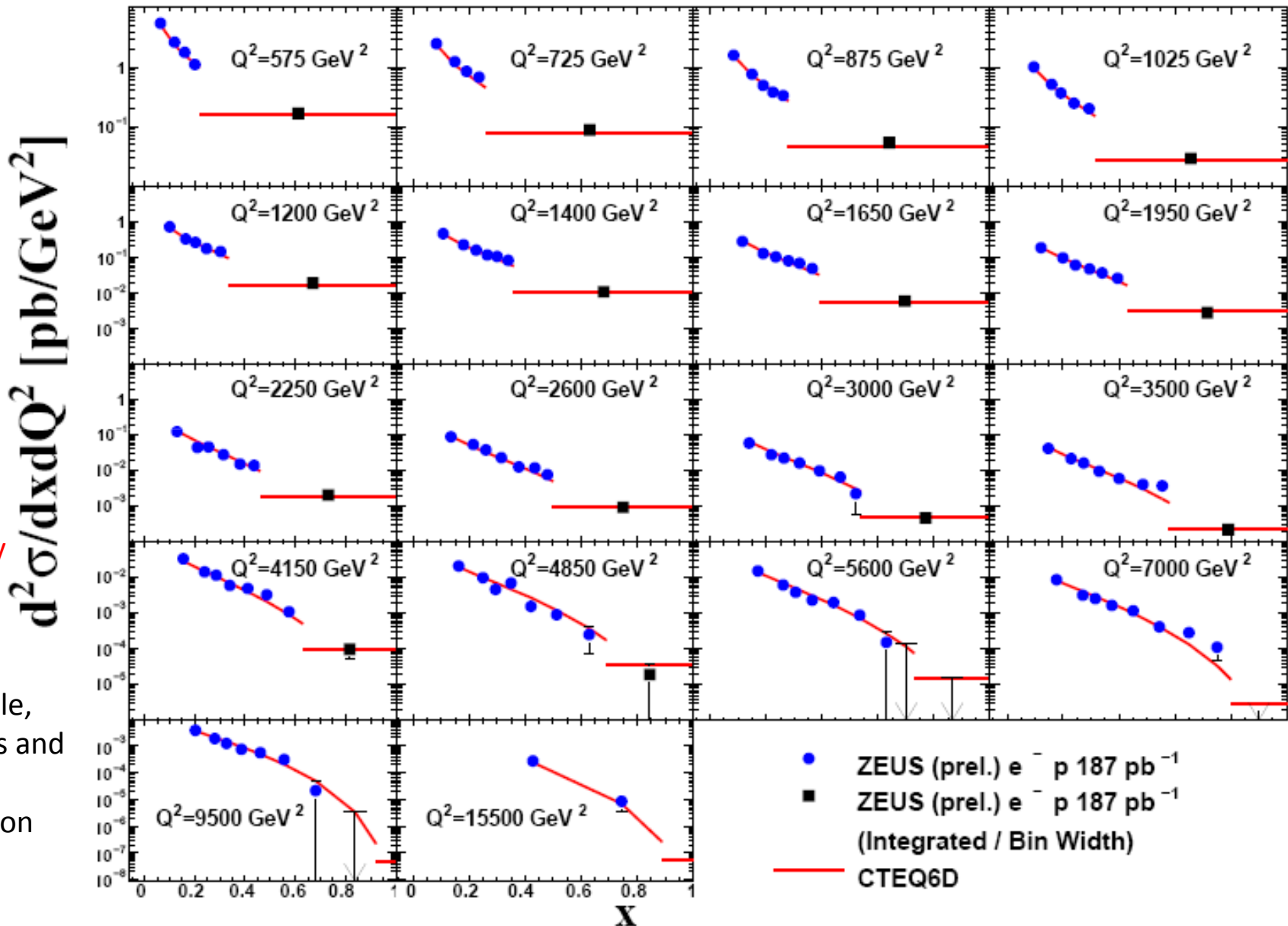


# Binning



# Results:

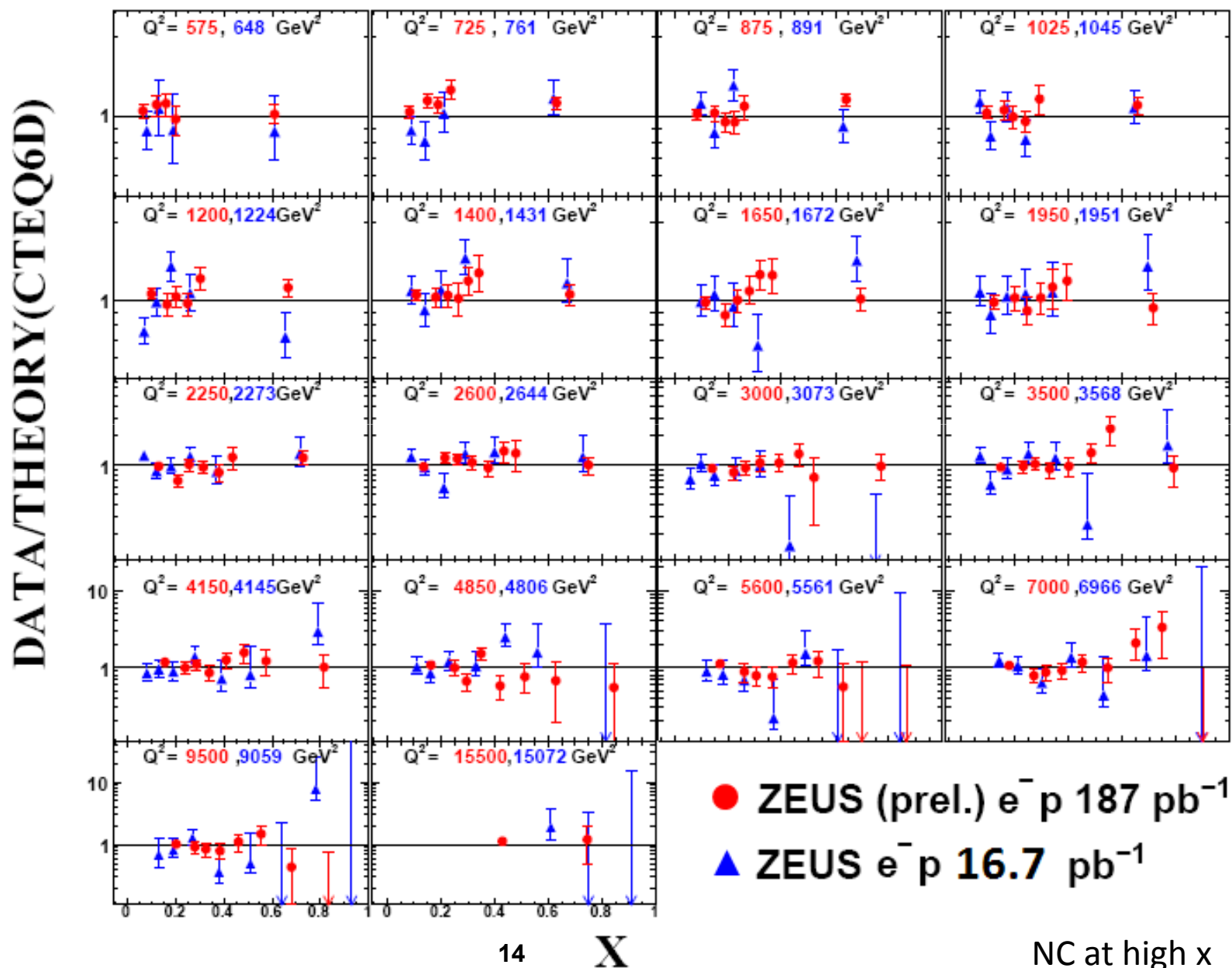
# ZEUS



Uncertainty  
 includes  
 systematic  
 effects  
 (energy scale,  
 fiducial cuts and  
 overall 4%  
 normalization  
 error)

# Comparison:

# ZEUS



# Summary



## New in this analysis:

1. HERA-II statistics ( $187 \text{ pb}^{-1}$ ), previous study ( $16.7 \text{ pb}^{-1}$ )
2. Multi jet events (previous 0 + 1 jets)
3. New x-reconstruction method – leading to better resolution
4. Better understanding of the detector calibration

## Results:

1. Higher x.
2. More x bins.
3. Smaller error.

## Expected outcome:

Reduce PDFs uncertainty at high x.