



# Dijet production in diffractive deep inelastic scattering using VFPS at HERA

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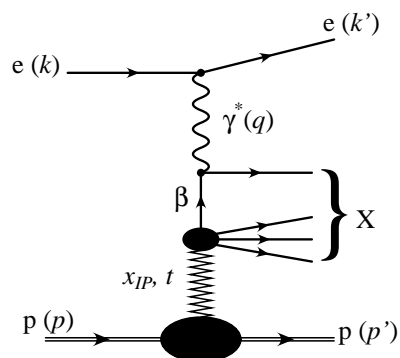
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On behalf of the H1 collaboration



XIX International Workshop on Deep-Inelastic Scattering and Related  
Subjects

# Inclusive Diffraction in H1



$Q^2$  = virtuality of the  $\gamma$

$x_{\mathbb{P}}$  = momentum fraction of the  $p$  carried by the  $\mathbb{P}$

$\beta$  = momentum fraction of the  $\mathbb{P}$  interacting with the  $\gamma$

$t$  = momentum squared of the  $\mathbb{P}$

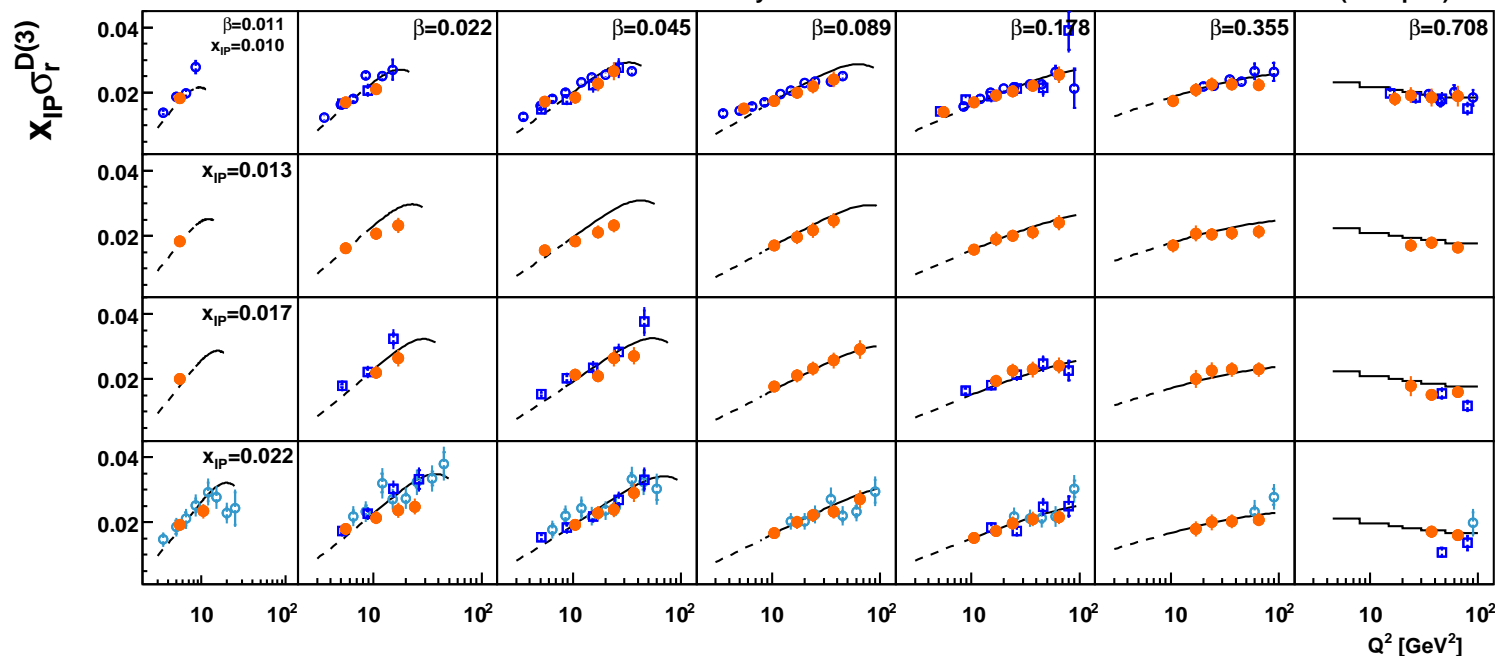
$y$  = inelasticity

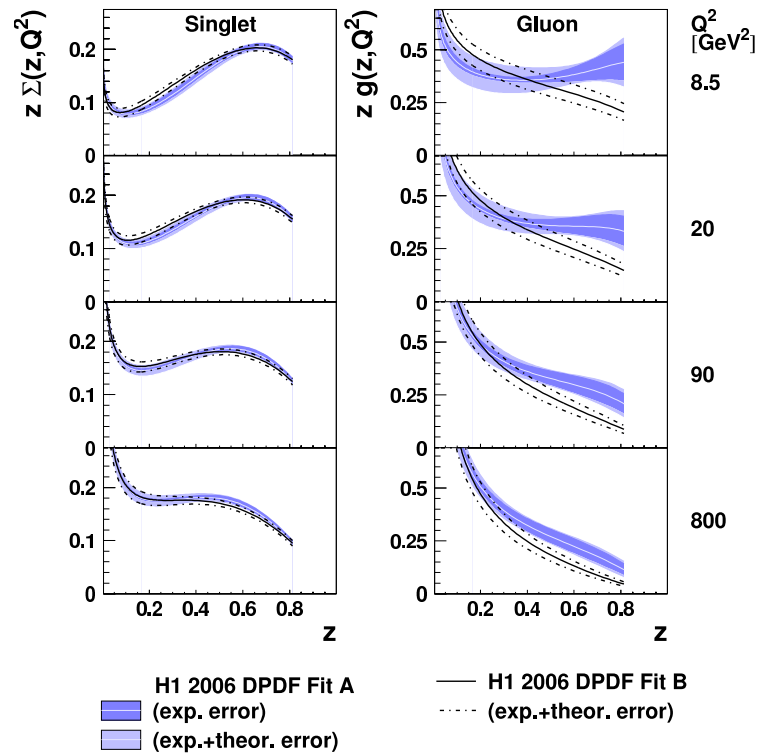
$$\frac{d^3\sigma(x_{\mathbb{P}}, Q^2, \beta)}{dx_{\mathbb{P}} dQ^2 d\beta} = \frac{4\pi\alpha^2}{\beta Q^4} \left(1 - y + \frac{y^2}{2}\right) F_2^{D(3)}(x_{\mathbb{P}}, Q^2, \beta)$$

**H1 PRELIMINARY**

- H1 VFPS Preliminary
- H1 FPS
- H1 LRG Preliminary x 0.81

- H1 LRG Published x 0.81
- H1 2006 DPDF Fit B x 0.81
- - - H1 2006 DPDF Fit B x 0.81 (extrapol.)



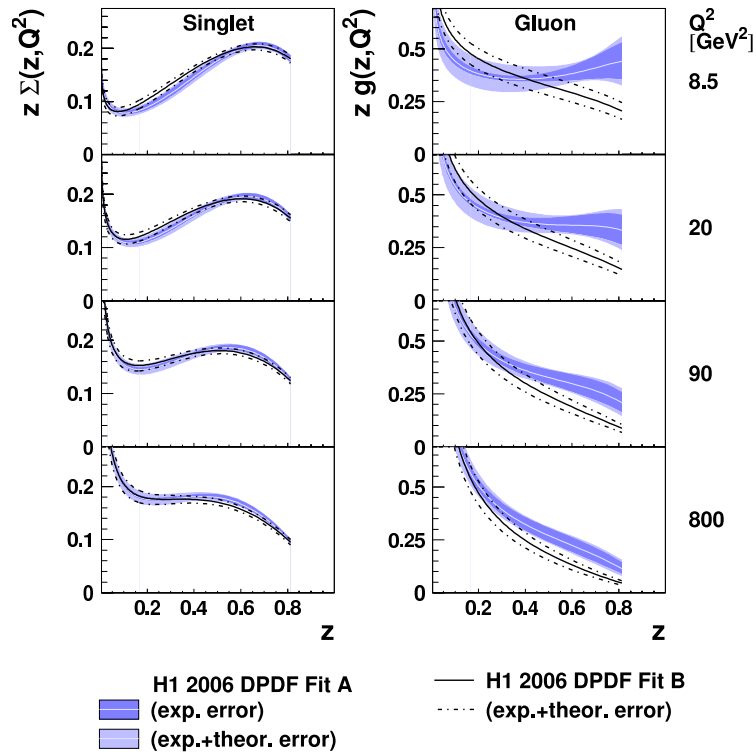


No direct access to gluon  
component



Large uncertainty on gluon  
distribution

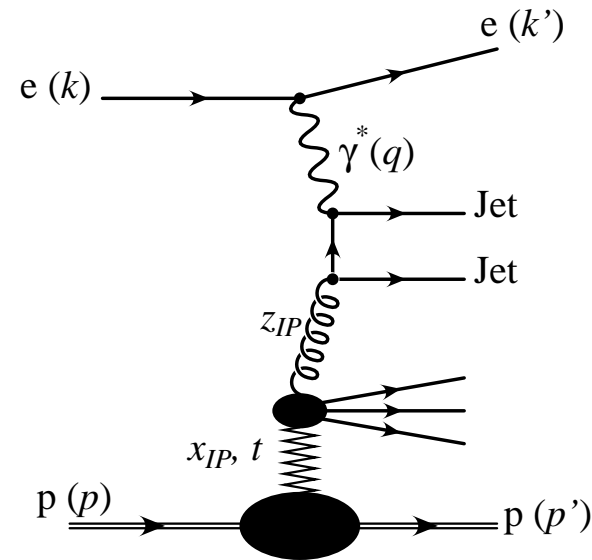
# Jets in diffraction



No direct access to gluon component



Large uncertainty on gluon distribution



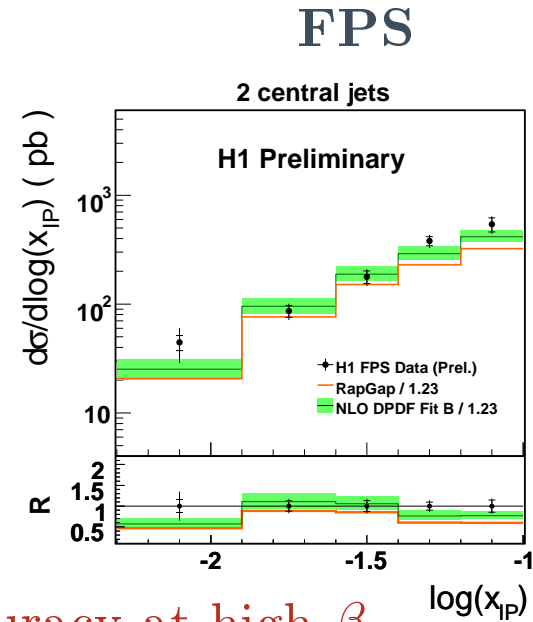
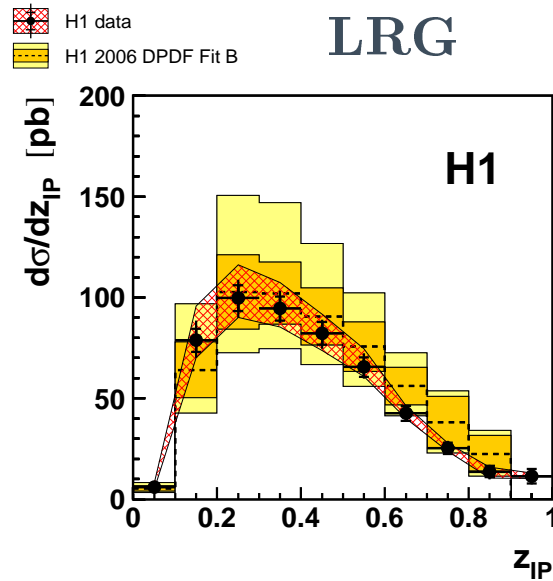
$z_{\mathbb{P}}$  = fraction of momentum of  $\mathbb{P}$  entering in the hard interaction.

Jets via BOSON-GLUON FUSION



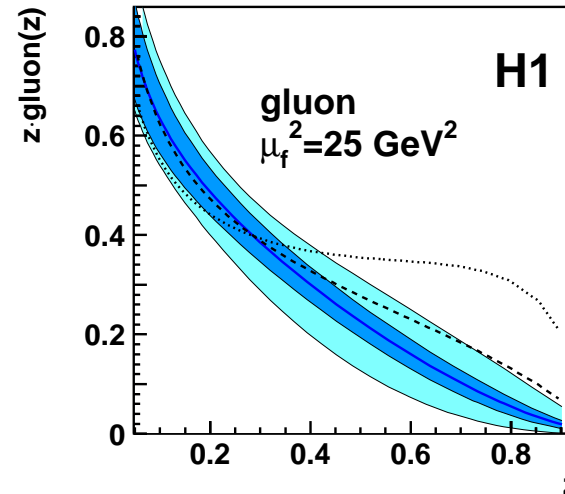
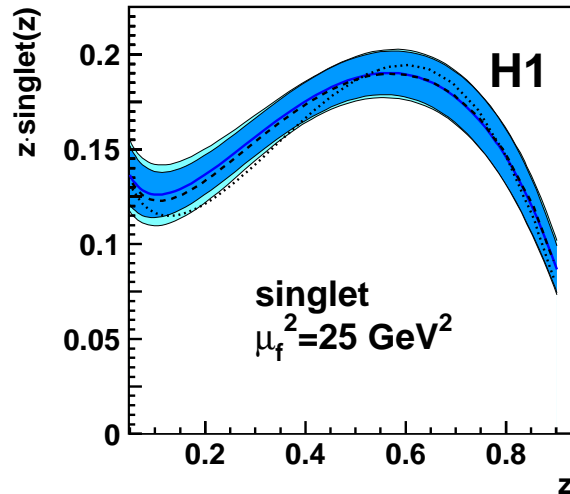
Directly sensitive to gluon densities in  $\mathbb{P}$

DPDFs to predict jet production via Factorization theorem



Dijet included in the fit  $\Rightarrow$  improve accuracy at high  $\beta$

- H1 2007 Jets DPDF
- exp. uncertainty
- exp. + theo. uncertainty
- ..... H1 2006 DPDF fit A
- ..... H1 2006 DPDF fit B



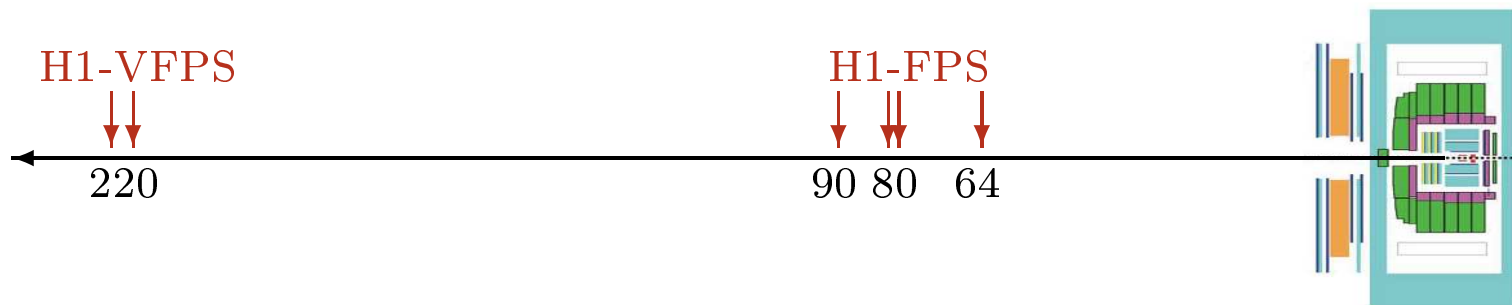


# The Very Forward Proton Spectrometer

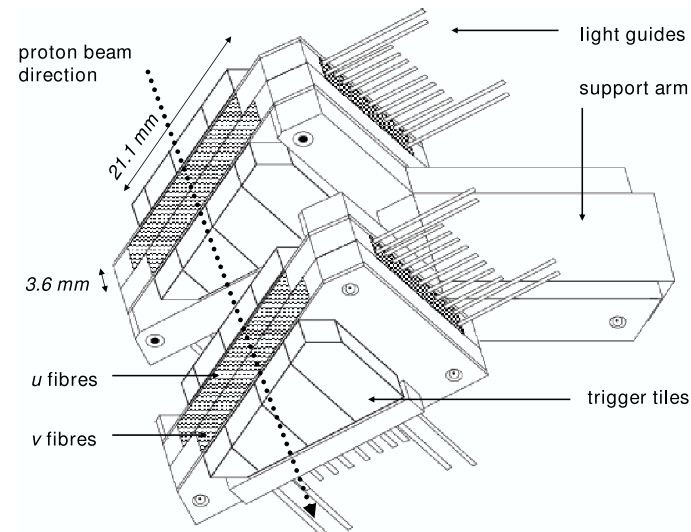
Purpose : direct measurement of the scattered proton with high acceptance and low background

Since 2004, stable data since 2006

Located at 220 meters from the interaction point



- 2 stations each with 2 scintillating fibers detector
- 4 planes of 4 trigger tiles

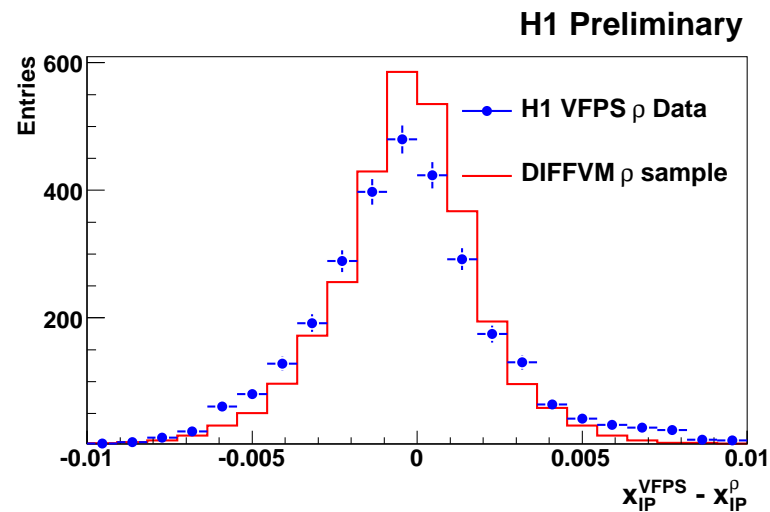


In a simple approximation ( $t = 0 \text{ GeV}^2$ ) position in  $x$  of  $p$ -impact is proportional to  $x_{\mathbb{P}}$

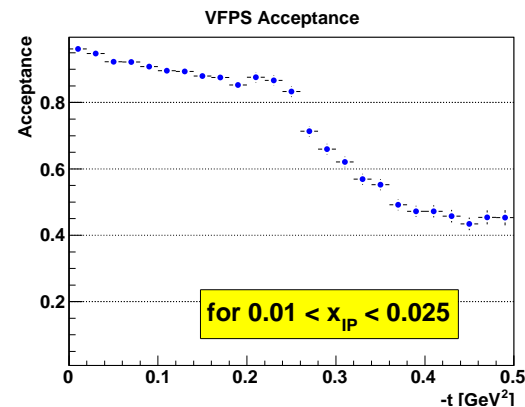
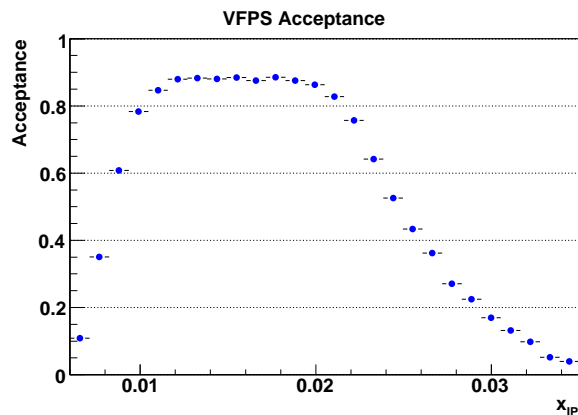
$x_{\mathbb{P}}$  is reconstructed directly from VFPS

Check calibration with exclusive events ( $\rho$ ) :  $ep \rightarrow e \text{ p } \rho$

Compare  $x_{\mathbb{P}}^{\rho}$  reconstructed from  $\rho$  decay tracks and scattered electron to  $x_{\mathbb{P}}^{VFPS}$  reconstructed using VFPS

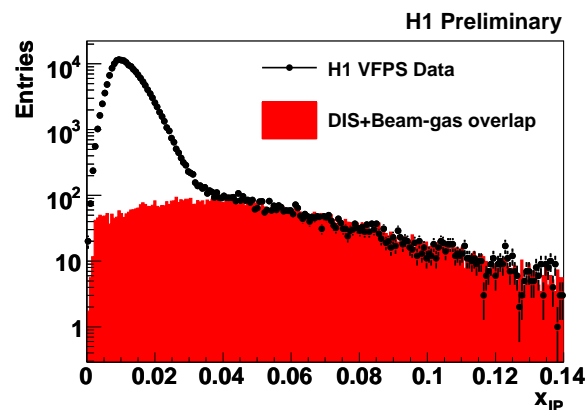


- High Acceptance  $\approx 90\%$  for  $0.01 < x_{\text{IP}} < 0.025$



- High track reconstruction efficiency  $\approx 96\%$
- Low background (Beam Gas + DIS)  $< 2\%$

$$\begin{cases} pA \rightarrow p(A') \\ ep \rightarrow eX \end{cases}$$



# Selection of events

## DIS Cuts

- Electron in SpaCal Calorimeter
- At least one track in VFPS1 OR in VFPS2

## Jet cuts

- At least 2 central jets
- Jets selected in  $\gamma^* - p$  frame
- $P_{t,jet1}^* > 5.5 GeV$
- $P_{t,jet2}^* > 4 GeV$

## Kinematic Range

$$0.009 < x_{\mathbb{P}} < 0.024$$

$$5 < Q^2 < 80 \text{ GeV}^2$$

$$0.1 < y < 0.65$$

$$-3 < \eta_{j1,j2}^* < 0$$

## Kinematic Reconstruction

$$Q^2 = 4E_{e'} E_e \cos^2\left(\frac{\theta_{e'}}{2}\right)$$

$$y = 1 - \frac{E_{e'}}{E_e} \sin^2\left(\frac{\theta_{e'}}{2}\right)$$

$$x_{\mathbb{P}} = x_{\mathbb{P}}^{VFPS}$$

$$z_{\mathbb{P}} = \frac{x}{x_{\mathbb{P}}} \frac{Q^2 + M_{12}^2}{Q^2}$$

$$M_{12}^2 = (p_{j1} + p_{j2})^2$$



# Jets in DIS with VFPS

## Data Sample

2006-2007  $e^+ - e^-$  : Lumi=  $127.1 \text{ pb}^{-1} \Rightarrow 1400$  events selected

## MC Sample

Rapgap 31 H1 DPDF 2006 Fit B

## NLO Predictions

NLO Jets ++ using DPDF 2007 Jets ( $\times 0.83$  to account for  $p$ -dissociation)

$$\mu_{r,f}^2 : 0.5 * (P_{t,jet1}^2 + P_{t,jet2}^2) + Q^2$$

Scale ( $\mu_{r,f}^2 \times 0.25$  and  $\times 4$ )  $\oplus$  Hadronization uncertainties

## Cross Section Measurement

Cross Section corrected to the Born Level

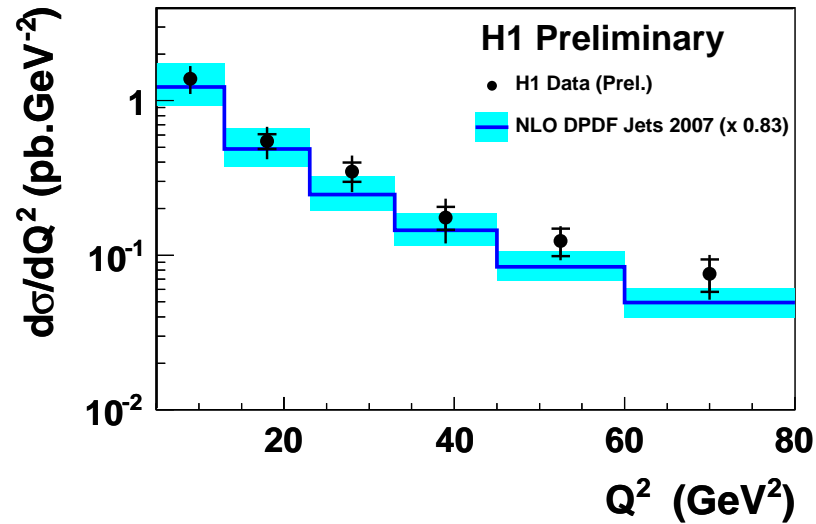
Data shown with uncorrelated systematic  $\oplus$  statistic uncertainties

Correlated uncertainty of 5% not shown

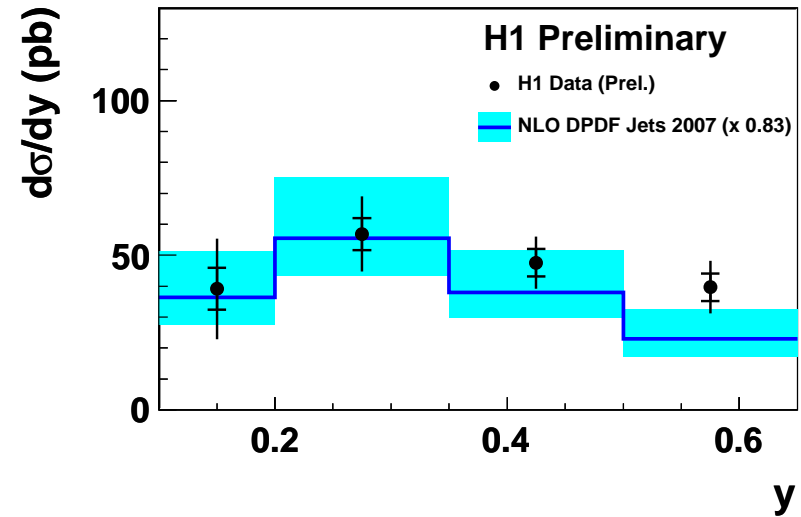


# Jet cross section in DIS with VFPS

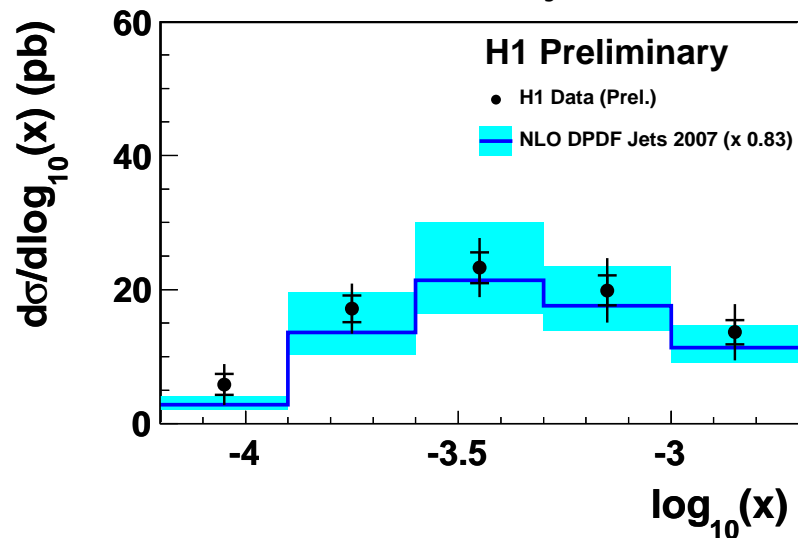
VFPS DIS Dijets



VFPS DIS Dijets



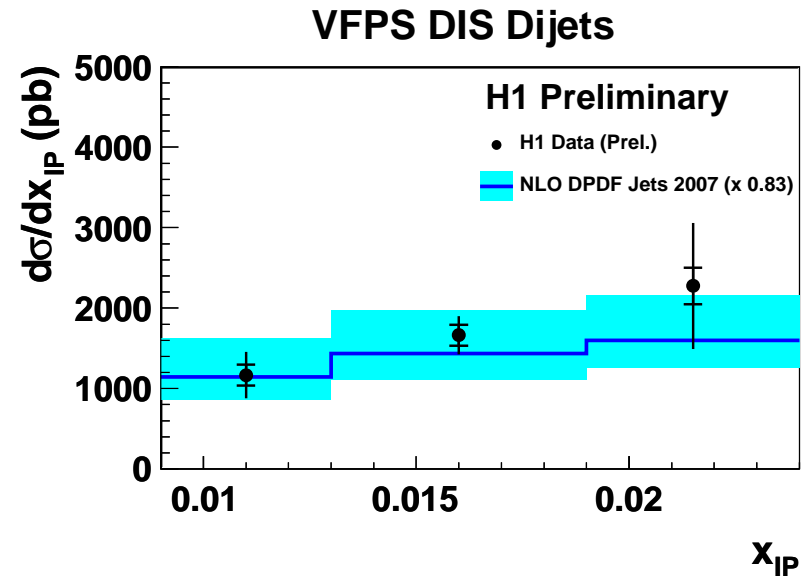
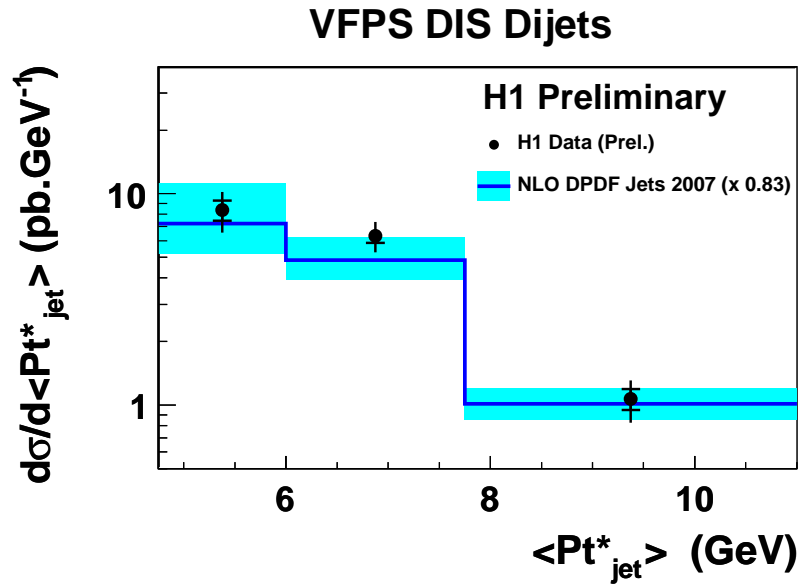
VFPS DIS Dijets



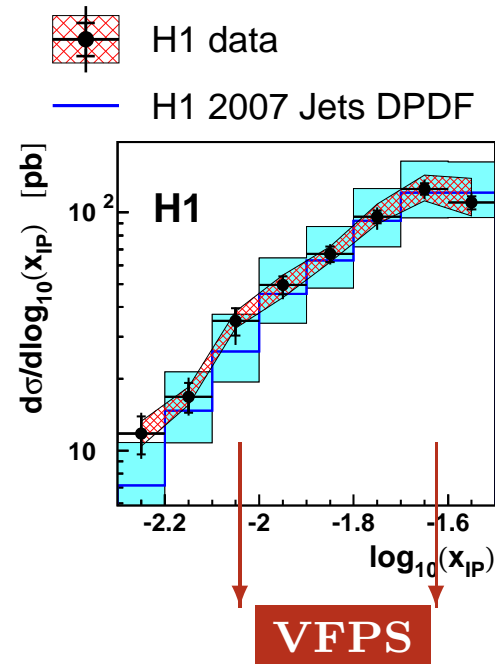
Within uncertainties  
agreement between  
NLO predictions using Fit Jets  
2007 and Data  
in shape and normalisation



# Jet cross section in DIS with VFPS

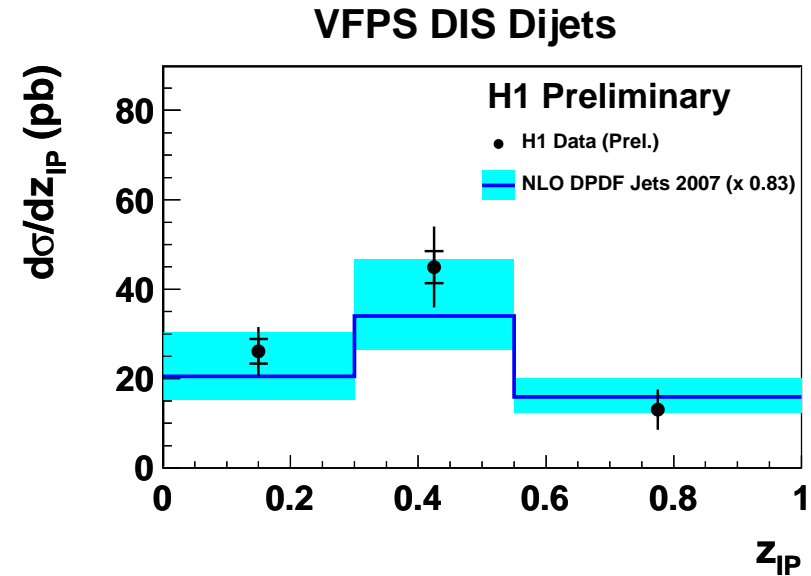
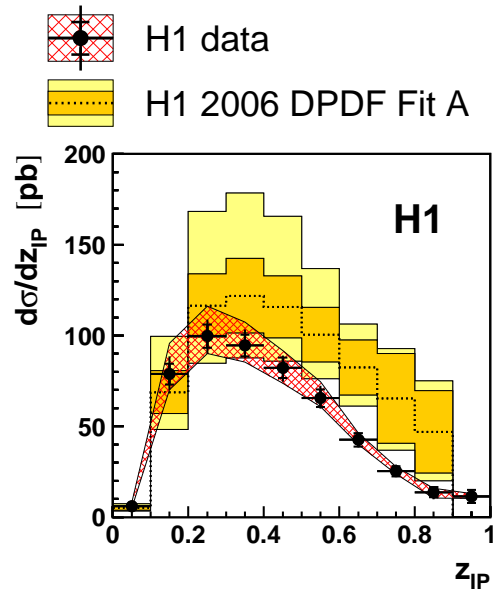


Good description of the transverse momentum of jets  $\Rightarrow$   
Good description of the hard interaction





# Jet cross section in DIS with VFPS



Extrapolated DPDF for  $z_{\mathbb{P}} > 0.9$

Higher  $z_{\mathbb{P}}$  bin in agreement with Fit Jets 2007

## Total Cross Section

H1 VFPS Preliminary :  $25.3 \pm 1.4$  (stat.)  $\pm 6.5$  (syst) pb

NLO DPDF Fit Jet 2007 :  $19.9^{+7.4}_{-4.4} \pm 0.5$  (had.) pb



# Conclusions

For the first time measurement of Dijets cross section is made with the VFPS

- HERA II data
- Based on direct detection of the scattered proton
- High acceptance detector  $\Rightarrow$  High statistic

Results are in agreement with NLO predictions using DPDF 2007 Fit Jets and confirm validity of factorization theorem in DIS

Possibility of extracting new DPDF in the future