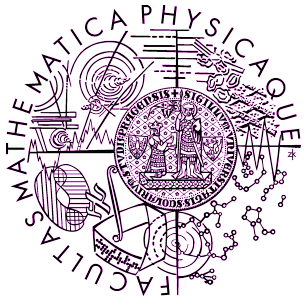
Diffractive jet production in *ep* collisions at HERA

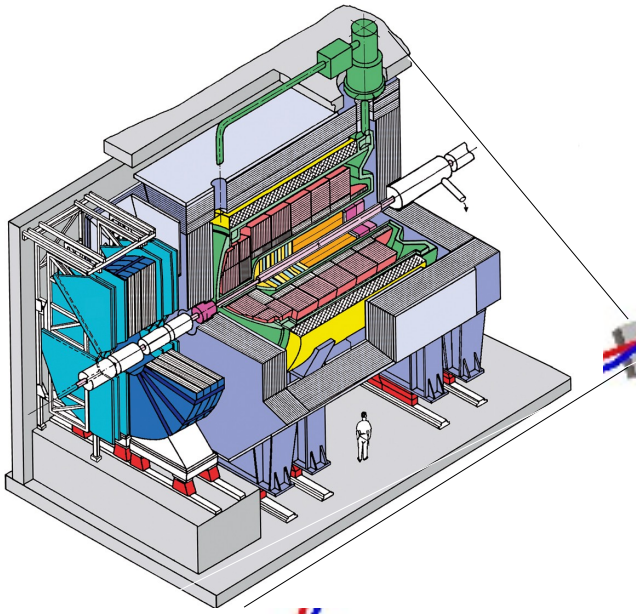


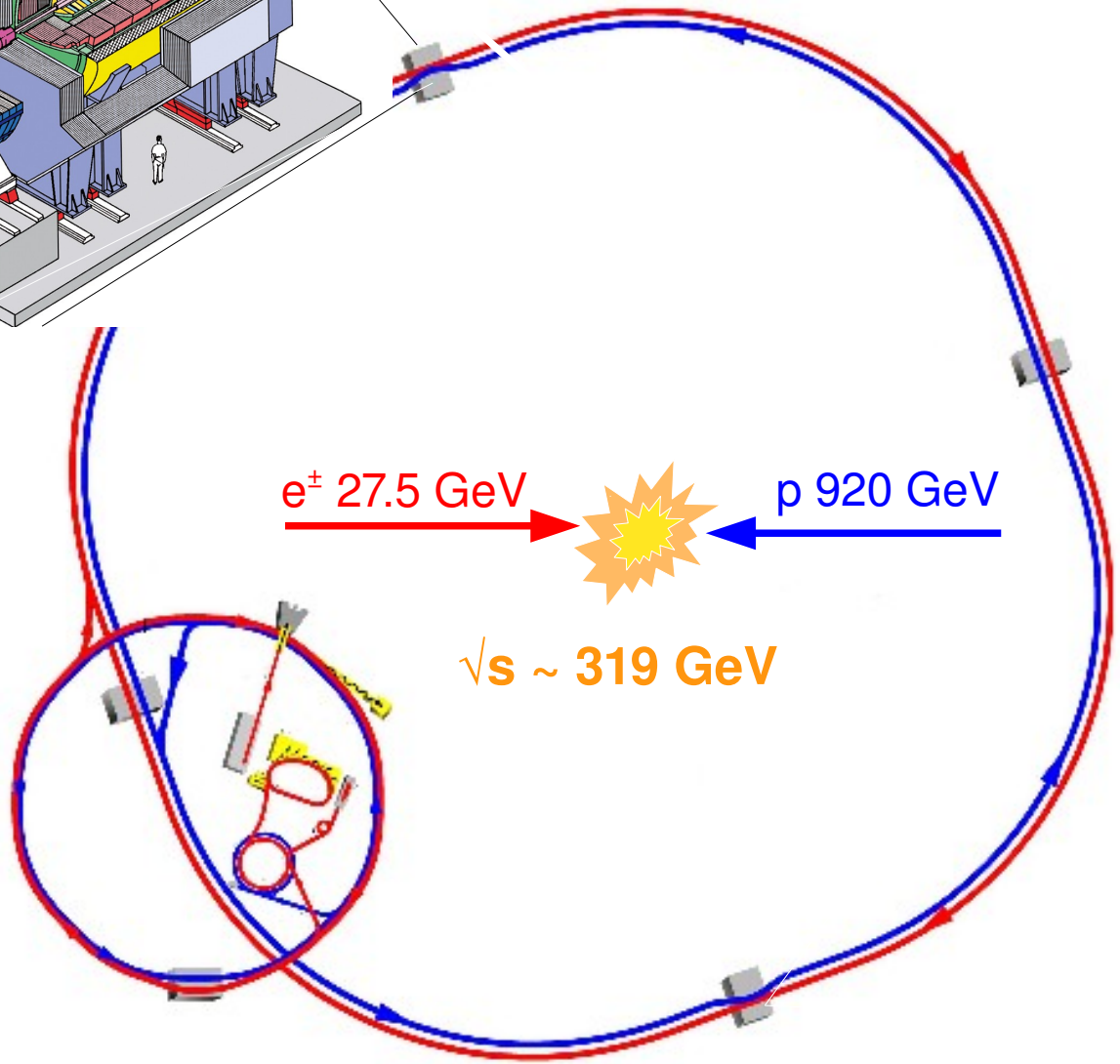
Richard Polifka
Charles University in Prague

On behalf of the H1 Collaboration

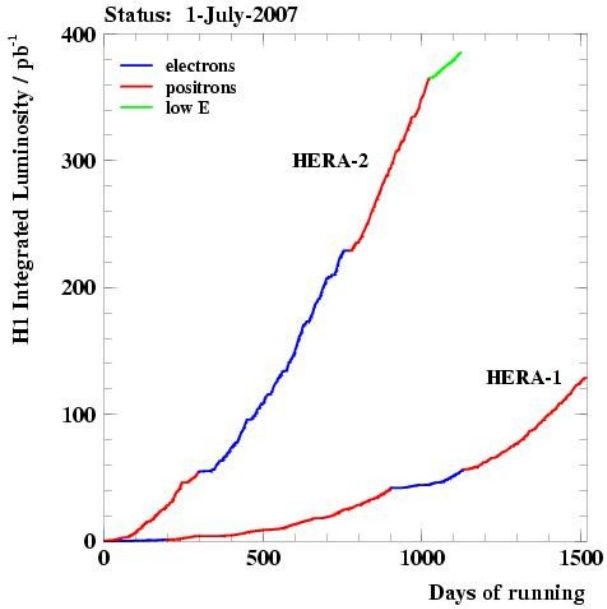
23.07.2011
International Europhysics Conference on High Energy Physics
Grenoble, France

HERA





1992 – 2007
Deutsches Elektronen Synchrotron
Hamburg, Germany
H1 and ZEUS (4π)



Experimental methods

Proton Tagging:

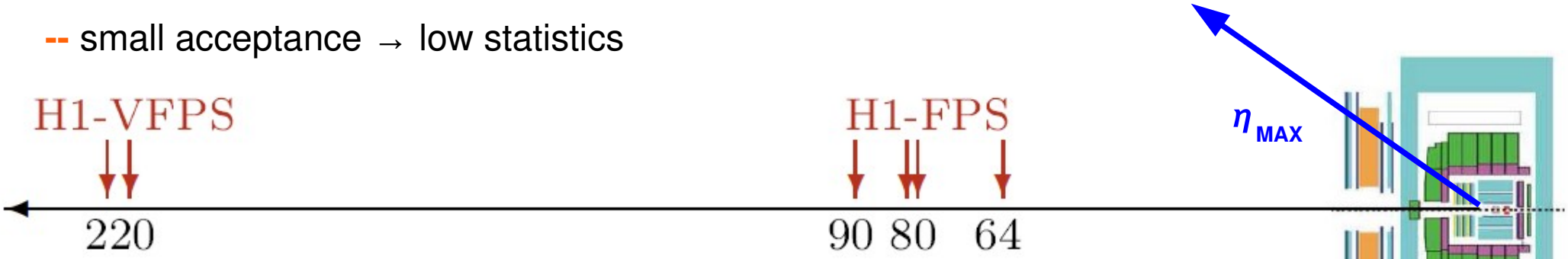
Detection of the leading proton in forward detectors - FPS and VFPS

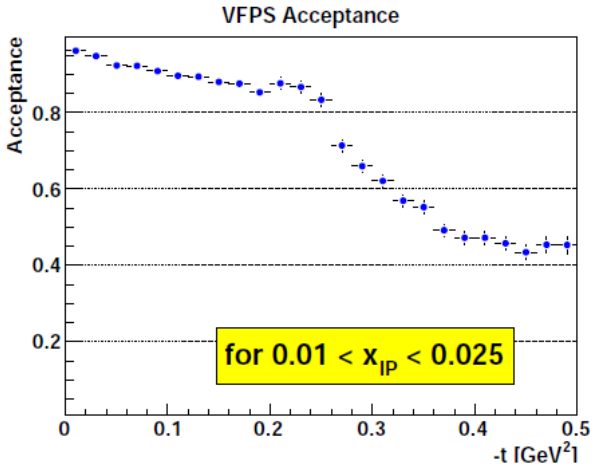
+ direct extraction of diffractive variables
+ free of proton dissociation background
-- small acceptance → low statistics

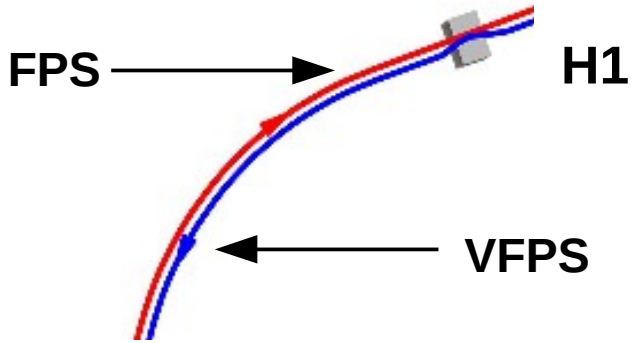
LRG method:

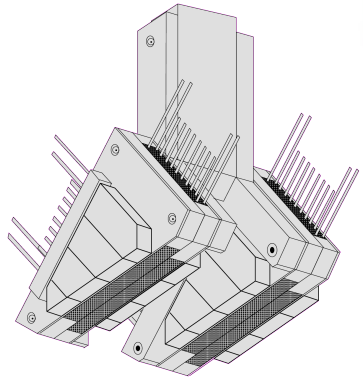
Requirement of no activity in the forward part

+ high statistics
-- proton dissociative background

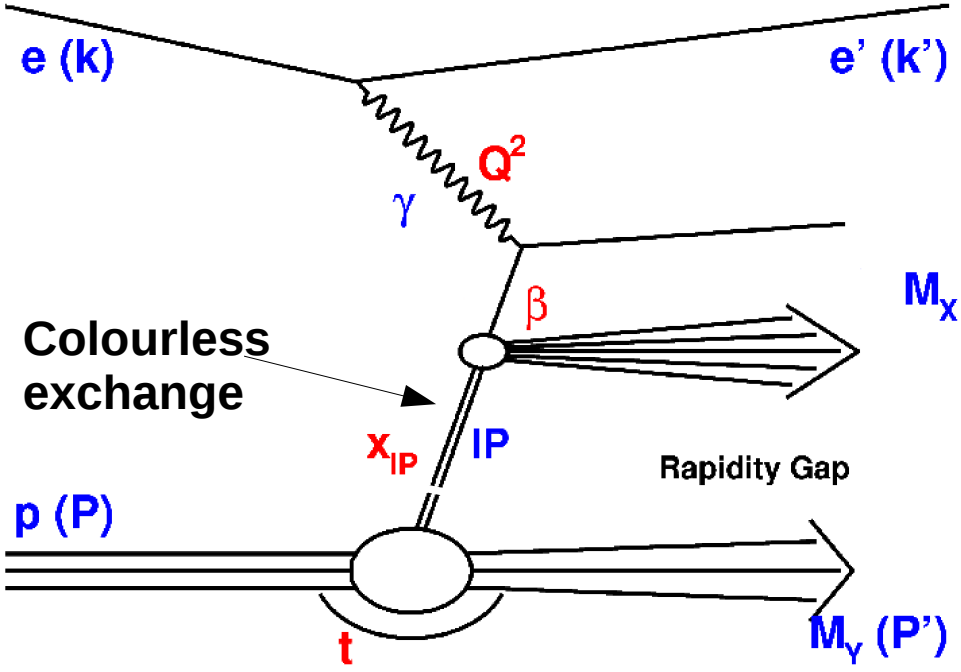








Diffractive kinematics & factorisation



$Q^2 = -q^2 = (k - k')^2$

$x = Q^2/2Pq$

$x_{IP} = q(P' - P)/qP = 1 - E_p/E'_p$

$\beta = x/x_{IP}$

$t = (P' - P)^2$

$M_Y = m_p$ intact proton

$m_p \leq M_Y \leq 1.6$ GeV intact proton or proton dissociation (incl. nucleon resonances)

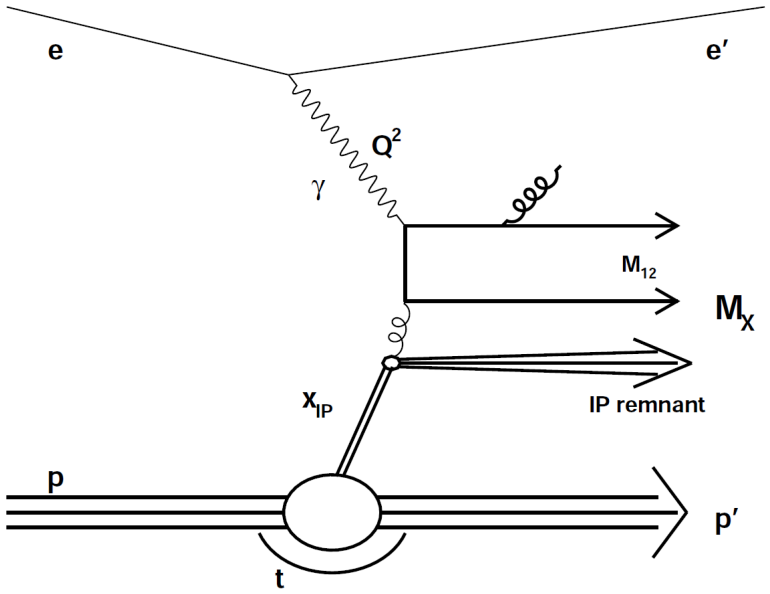
Collins factorisation, proven:

$$d\sigma^{ep\to eXp}(\beta, Q^2, x_{IP}, t) = \sum_i f_i^D(\beta, Q^2, x_{IP}, t) \cdot d\sigma^{ei}(\beta, Q^2)$$

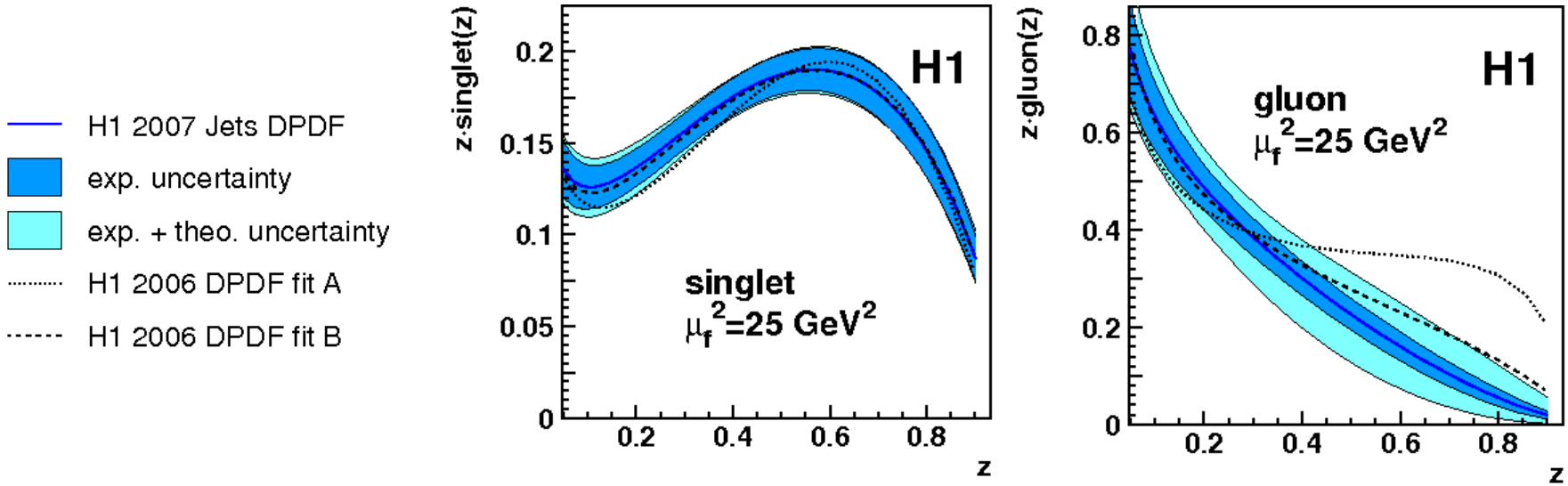
Proton Vertex Factorisation, consistent with data:

$$f_i^D(\beta, Q^2, x_{IP}, t) = f_{IP/p}(x_{IP}, t) \cdot f_i(\beta, Q^2)$$

Diffractive PDFs



- DPDF extraction from inclusive measurements gives 2 solutions → jets
- Diffractive Jets constrain gluon part of DPDFs – sensitivity to high $\beta(z_{IP})$
- Jets - Presence of an additional hard scale – p_T, possible to compare with NLO QCD calculations
- Search for physics beyond DGLAP parton evolution



Comparison of FPS and LRG

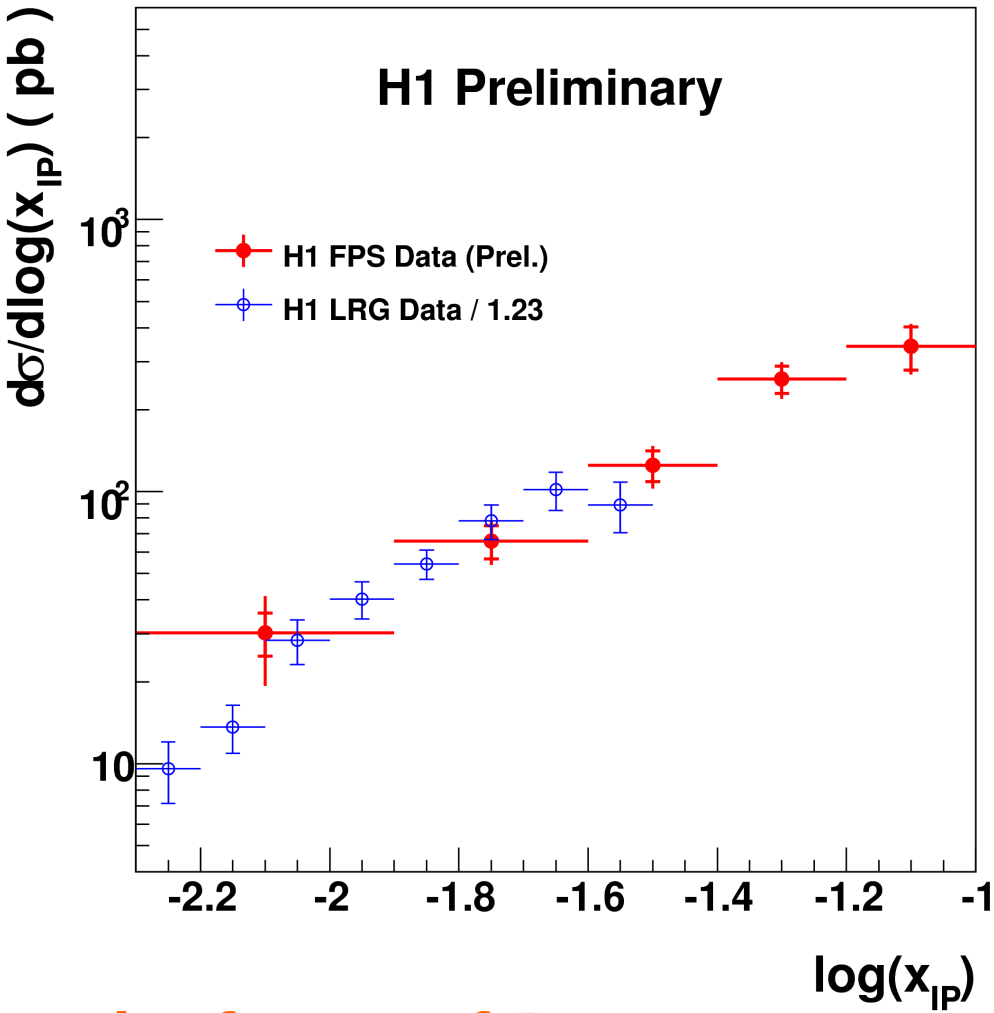
- Diffractive DIS dijet analysis with LRG (JHEP 0710:042)
- Published data corrected for proton dissociation

$4 < Q^2 < 80\ \mathrm{GeV}^2$

$0.1 < y < 0.7$

$p_{T1}^* > 5.5\ \mathrm{GeV}$

$p_{T2}^* > 4\ \mathrm{GeV}$



- **Very good agreement**
- **Phase space extension in x_{IP} by factor of 3**
- **Same fraction of proton dissociation as for incl. diff.**

$d\sigma/dx_{IP}$

VFPS

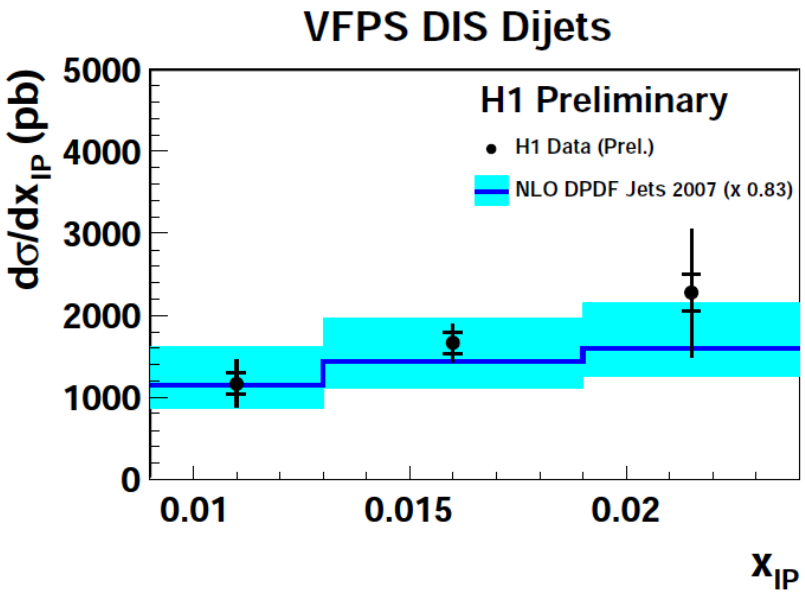
$5 < Q^2 < 80\ GeV^2$
$0.1 < y < 0.65$
$0.009 < x_{IP} < 0.024$

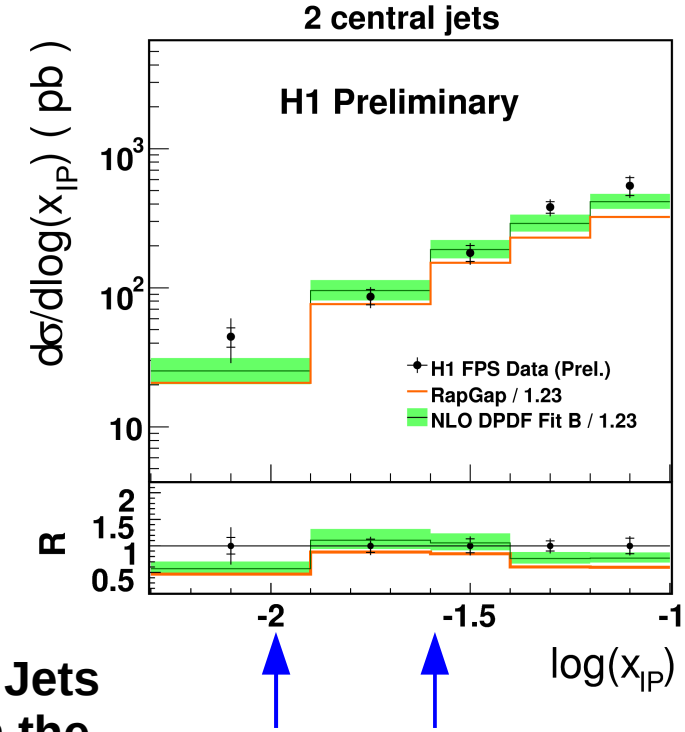
$p_{T1}^* > 5.5\ GeV$
$p_{T2}^* > 4\ GeV$
$-3 < \eta^* < 0$

FPS

$4 < Q^2 < 110\ GeV^2$
$0.05 < y < 0.7$
$0.005 < x_{IP} < 0.1$

$p_{T1}^* > 5\ GeV$
$p_{T2}^* > 4\ GeV$
$-1 < \eta < 2.5$





NLO QCD predictions based on DPDFs H1 2007 Jets and H1 2006 B provide a good description within the errors

VFPS

$d\sigma/dz_{IP}$

VFPS

$5 < Q^2 < 80\ GeV^2$
$0.1 < y < 0.65$
$0.009 < x_{IP} < 0.024$

$p_{T1}^* > 5.5\ GeV$
$p_{T2}^* > 4\ GeV$
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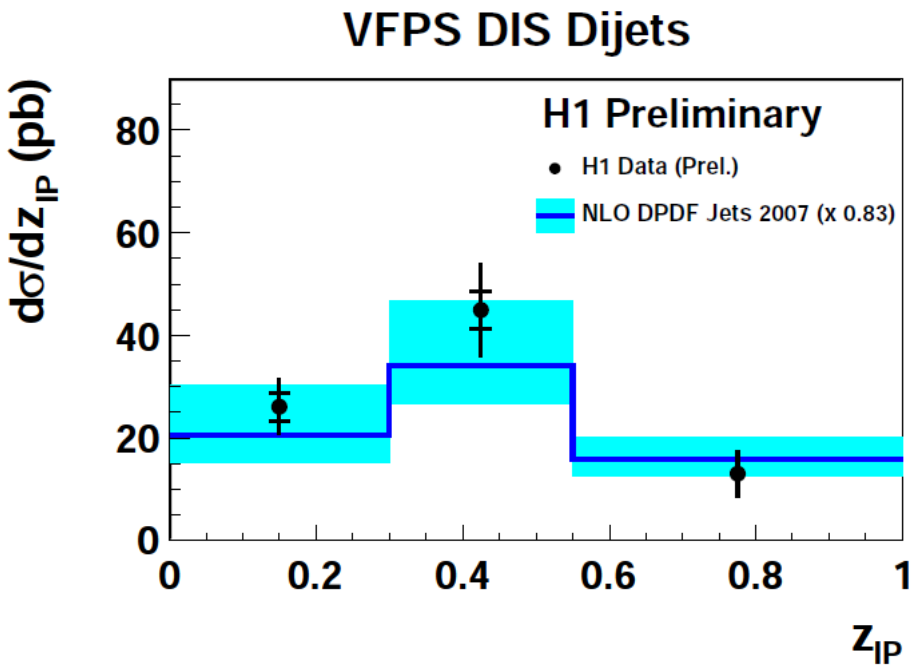

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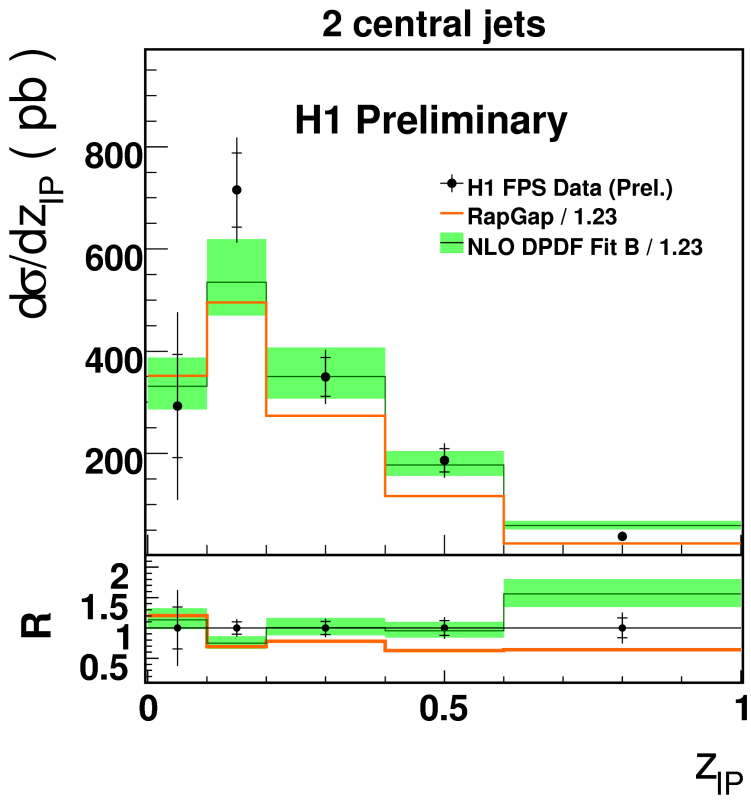
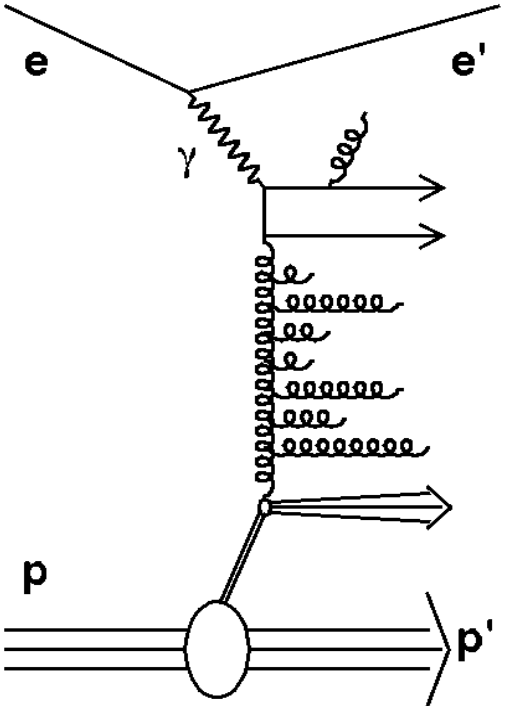


NLO QCD predictions based on DPDFs H1 2007 Jets and H1 2006 B provide a good description within the errors

Diffractive Forward Jets

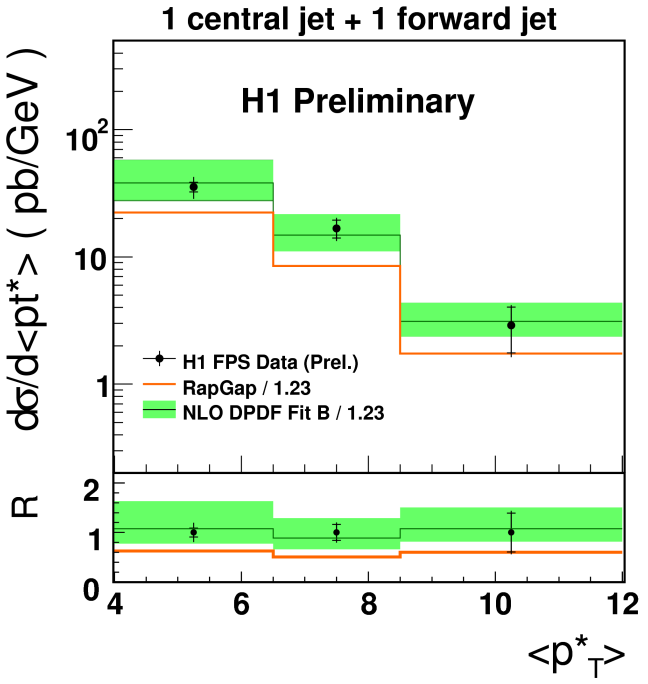


- Forward jets with leading proton in DDIS – search for physics beyond DGLAP
  - Possibility to investigate jets close to the proton direction, low x region

$p^*_{T,forward} > 4.5$ GeV, $p^*_{T,central} > 3.5$ GeV

$1 < \eta_{forward} < 2.8$, $-1 < \eta_{central} < 2.5$

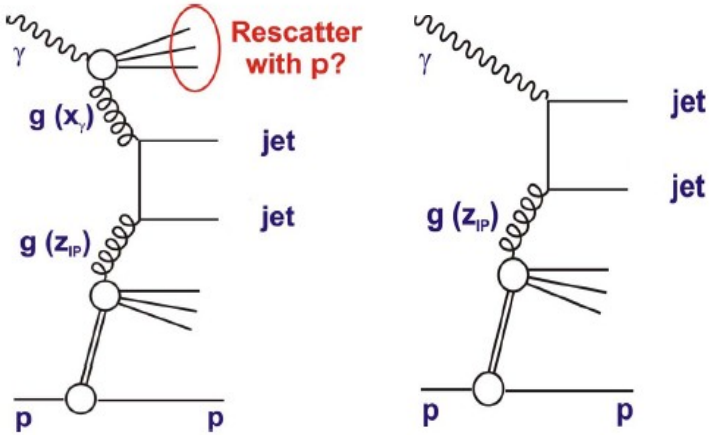
$\eta_{central} < \eta_{forward}$



Good description by NLO QCD DGLAP predicions

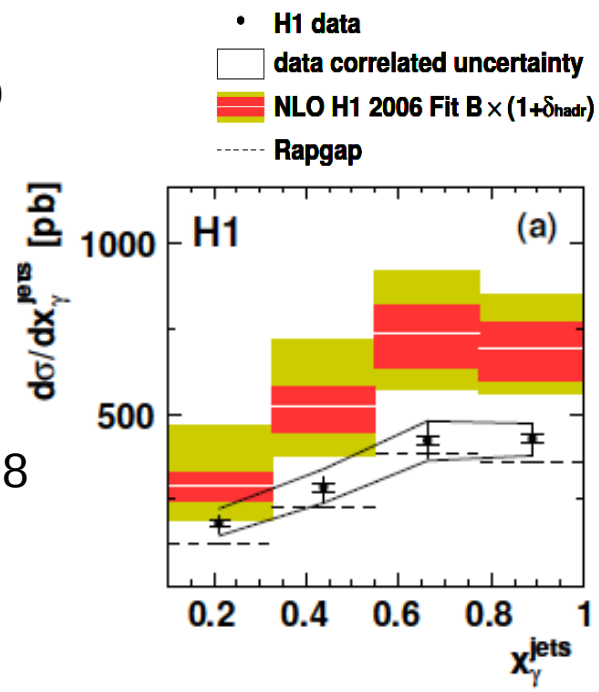
Factorisation in photoproduction

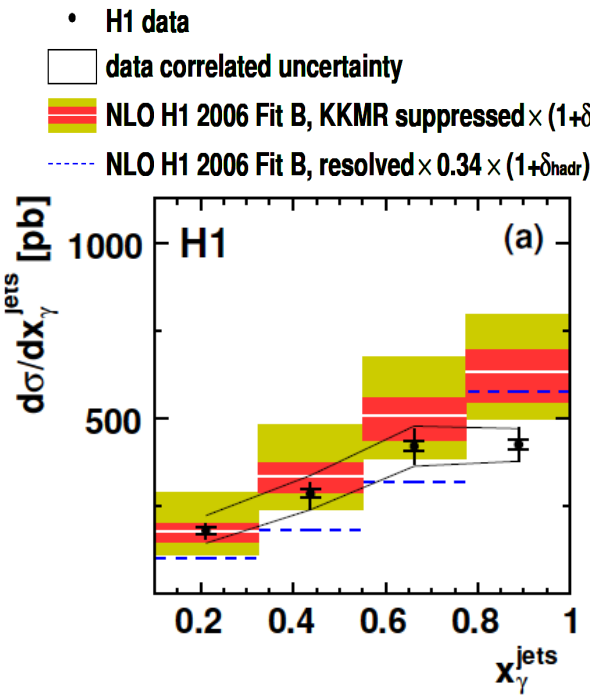
- Soft interactions between proton remnants destroys the rapidity gap → **Survival Probability** (S^2 ~ 0.1 for CDF)
- Factorisation test at HERA → measurement of PHP dijets
- For HERA kinematics KKMR prediction S^2 ~ 0.34 for resolved component, KKMR revised ~0.7-0.8

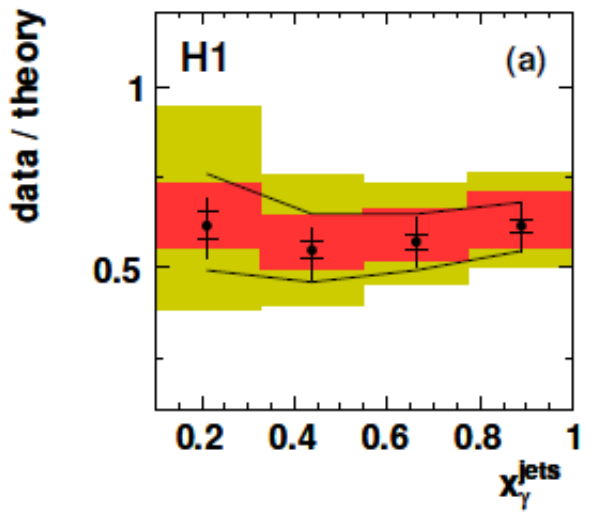


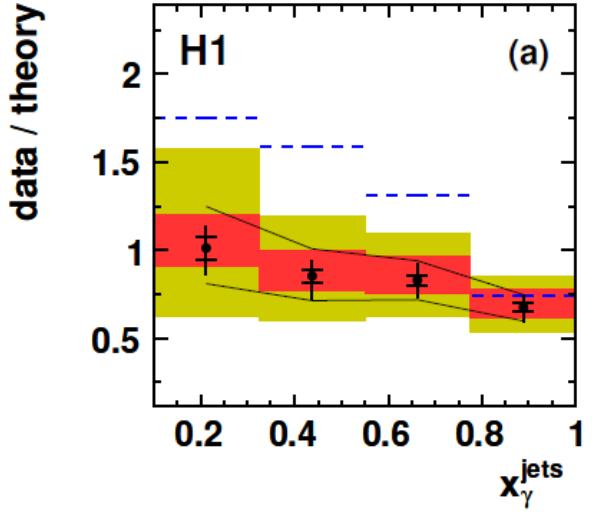
resolved, x_γ < 1 **direct, x_γ ~ 1**

$$x_\gamma \approx x_\gamma^{jets} = \frac{\sum (E - p_z)_{jets}}{(E - p_z)_{hadrons}}$$









Suppression ~0.58+-0.21 observed for both components, factorisation breaking?

Summary

- Measurements of diffractive dijets with different experimental techniques presented, VFPS dijets measured for the first time
- Very good agreement of FPS and LRG measurement within errors, fraction of proton dissociation is consistent for inclusive and jet final states
- Diffractive forward jets with tagged proton measured for the first time

- Good agreement of diffractive DIS with NLO QCD predictions based on DPDFs
- NLO QCD DGLAP calculations describe the diffractive forward jets successfully

- Possible factorisation breaking observed in photoproduction

backup

Beam Halo Background

- Coincidence of beam halo protons in (V)FPS and DIS event in H1
- Data driven Background estimation