Rapidity Gaps and Survival Probability

Experimental Introduction

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Hard Diffraction

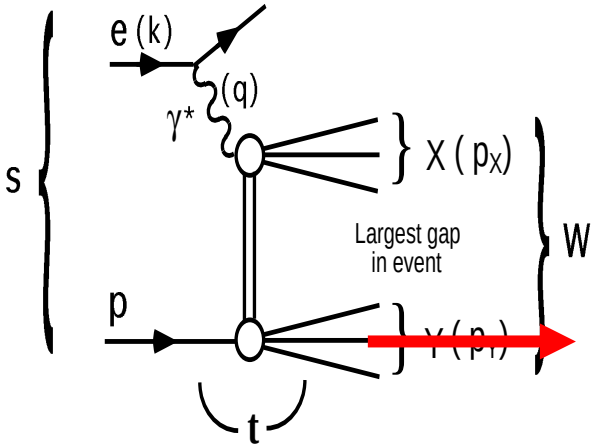
(hard scale: jets production, W etc)

Rapidity gap: $\Delta\eta = |\eta_1 - \eta_2|$

$$\eta = -\log\tan(\frac{\theta}{2})$$

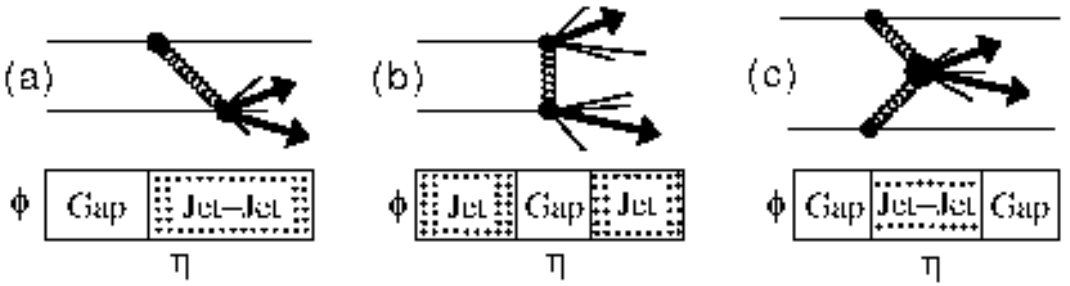
HERA

ep



TEVATRON

$p\bar{p}$



SD **DD** **DPE**

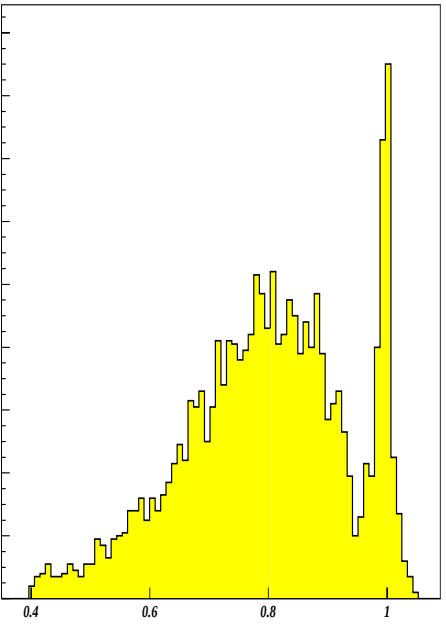
Events signature at HERA

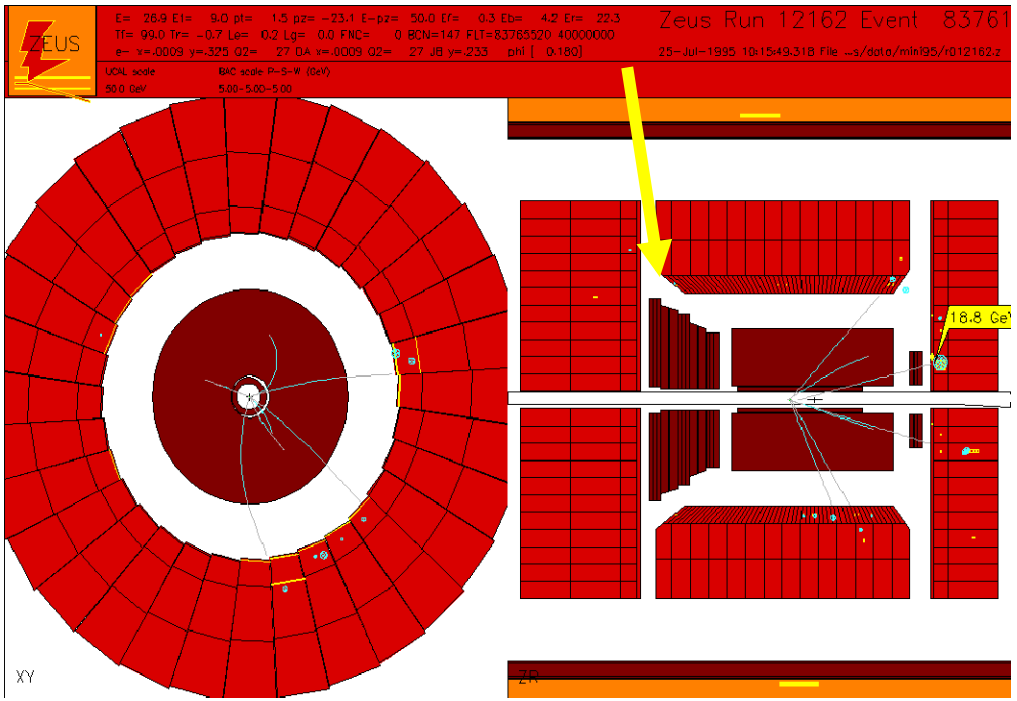
27.5 GeV **820/920 GeV**

e ⟵⟶ **P**

Large Rapidity Gap

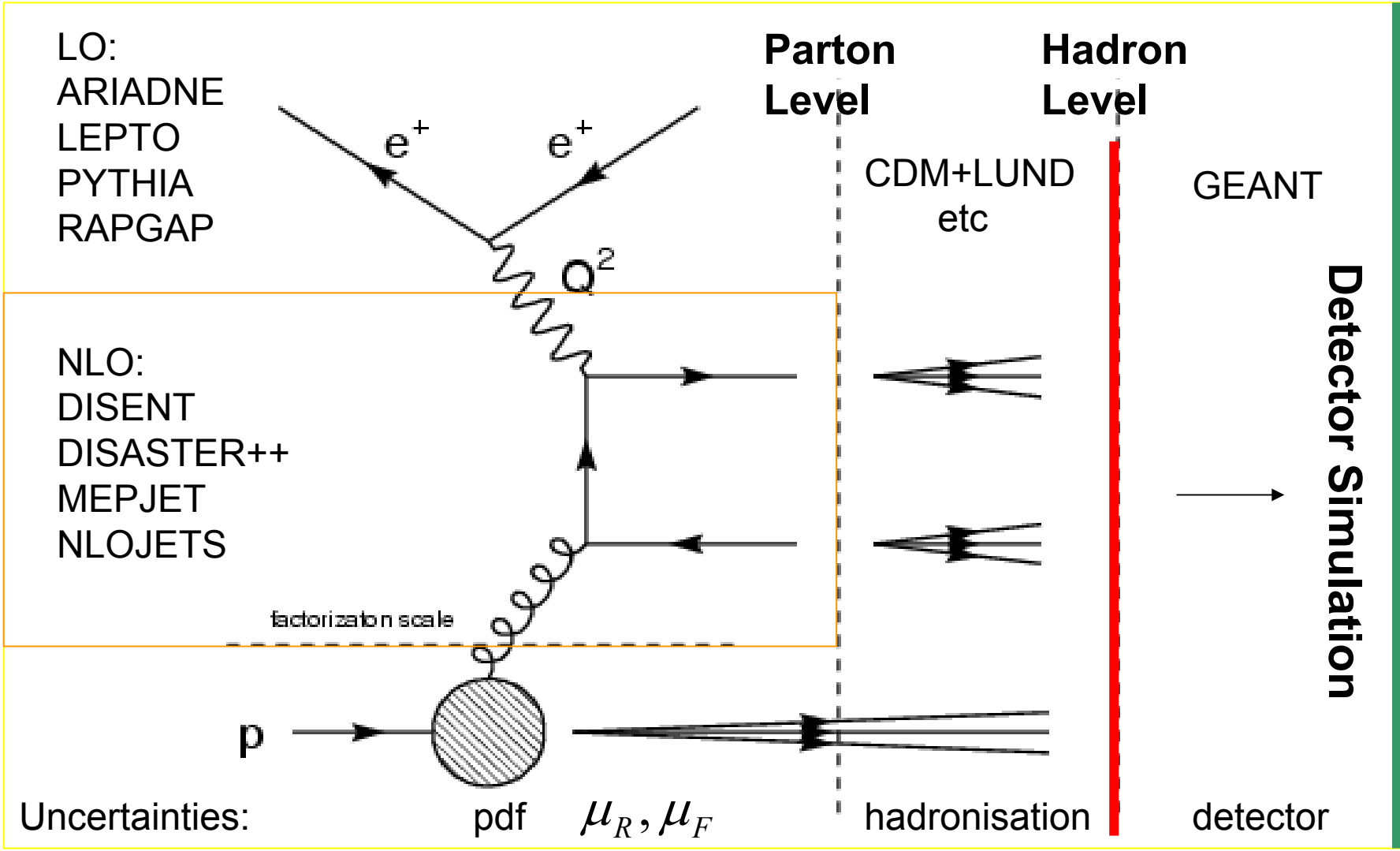
eading Proton Spectrometer (LPS, ZEUS)
Forward Proton Spectrometer (FPS, H1)





Ep'/Ep = 1

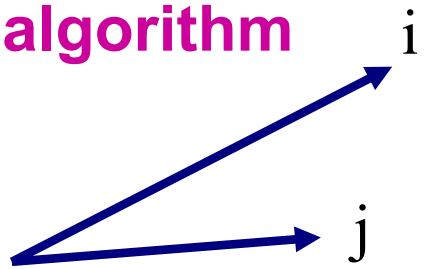
Event simulation



Jet Finding

HERA

Longitudinally invariant k_T cluster algorithm



$$d_i = E_{T,i}^2$$

$$d_{ij} = \min\{E_{T,i}^2, E_{T,j}^2\}\frac{((\Delta\eta)^2 + (\Delta\phi)^2)}{R^2}$$

Inclusive mode, combine if: $d_{ij} < d_i < d_j$

Exclusive mode:

$$y_{ij} = \frac{2}{Q^2}\min\{E_i^2, E_j^2\}(1 - \cos\Theta_{ij})$$

combine until $y_{ij} < y^{cut}$

TEVATRON

Cone algorithm

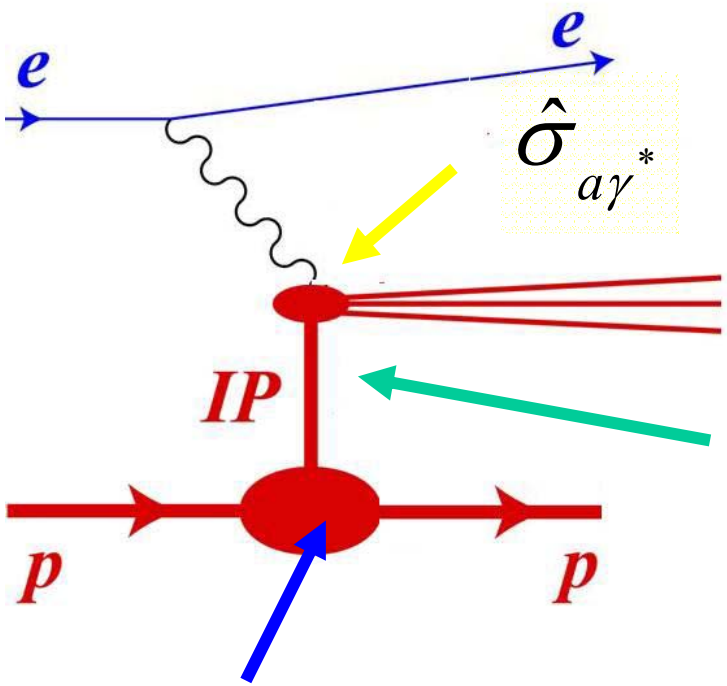
$$R = \sqrt{(\Delta\eta)^2 + (\Delta\phi)^2}$$

$\max[E_T]$ **with** ε^{cut}

Out-of-cone correction:

an addition to the jet Pt (R)

QCD fits and Pomeron parton density functions



$\hat{\sigma}_{a\gamma^*}$ universal partonic cross section

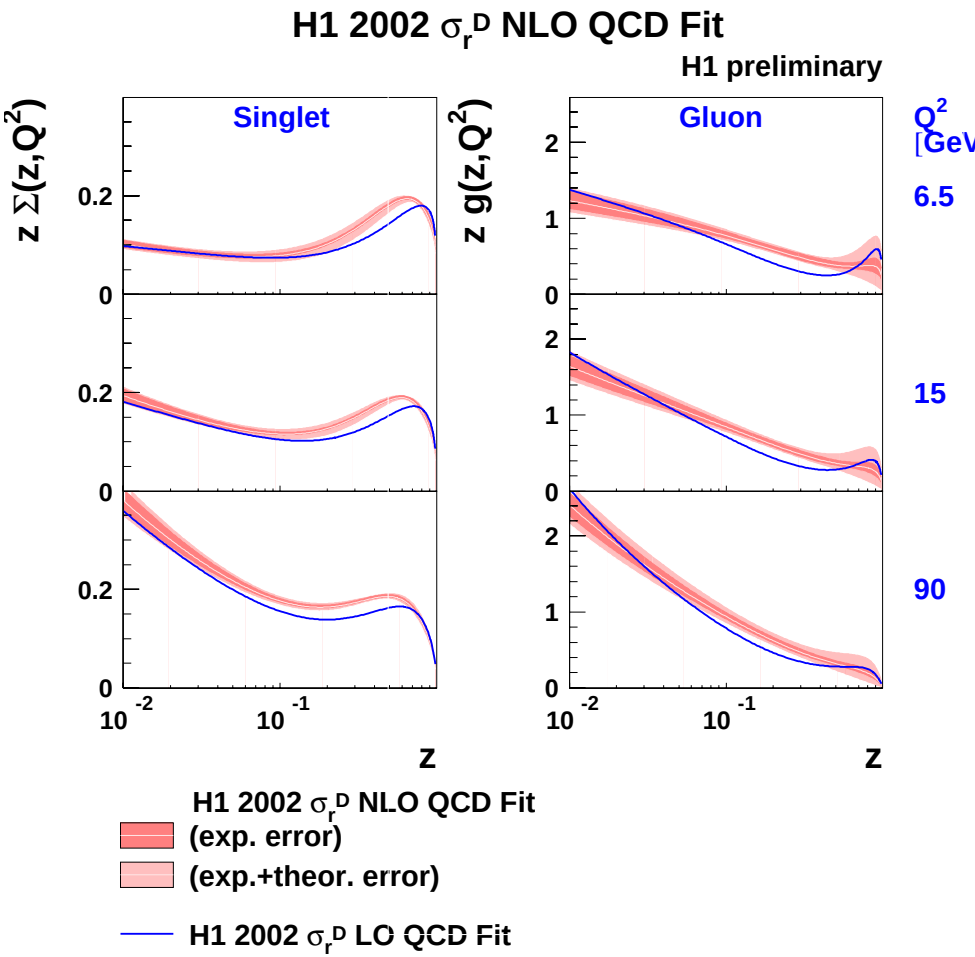
$f_{a/IP}(x_a, \mu)$ parton distributions

$f_{IP/p}(x_{IP}, t)$ flux

QCD-fit to $F_2^{D(3)}$

PDF was assigned to the Pomeron and evolved using DGLAP equation

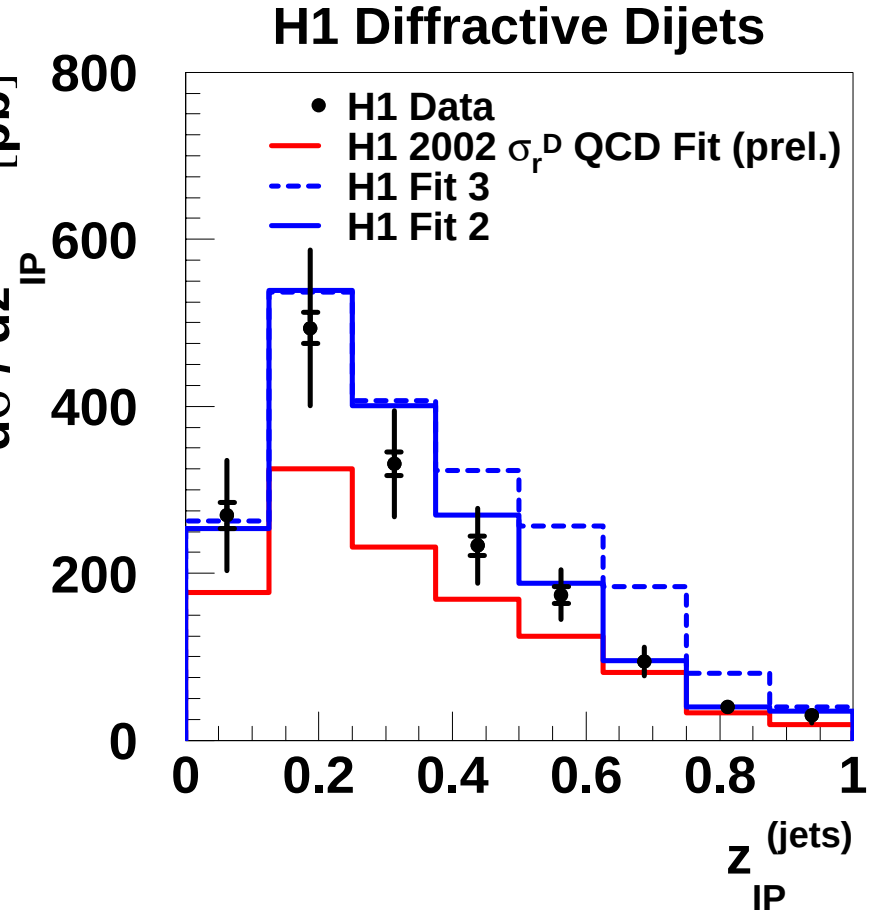
Z is the fractional momentum of Pomeron carried by the struck parton



Diffractive DIS Dijets Data

Using PDF's from LO fits to F2D and RAPGAP

Shape is o.k. Normalization?



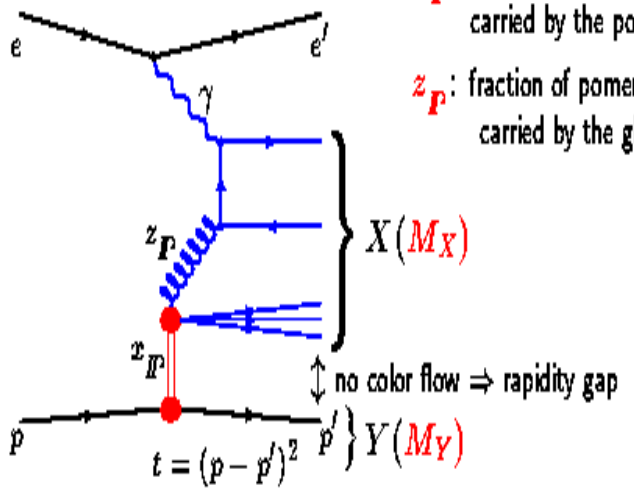
$18\,pb^{-1}$

$2 < Q^2 < 80 GeV^2$

$x_P < 0.05$

$p_T^{jet} > 4GeV$

1996-97



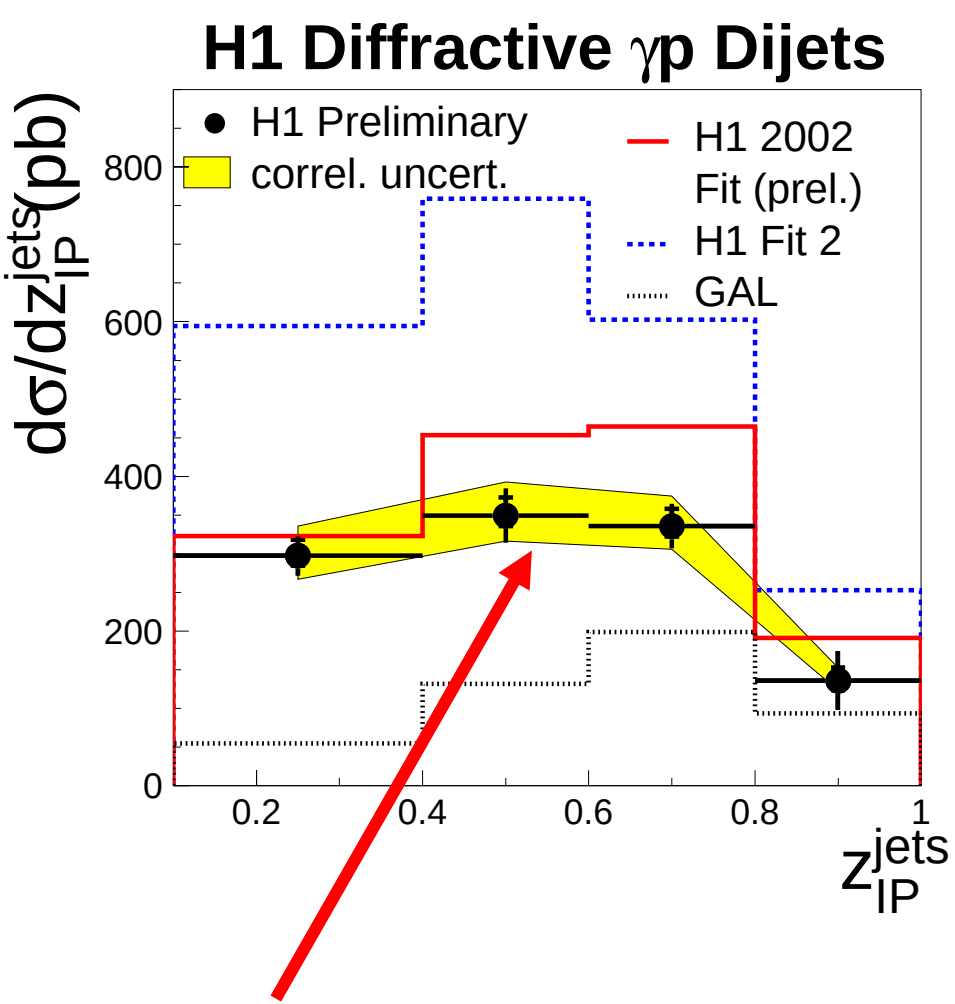
$x_{I\!P}$: fraction of proton momentum carried by the pomeron

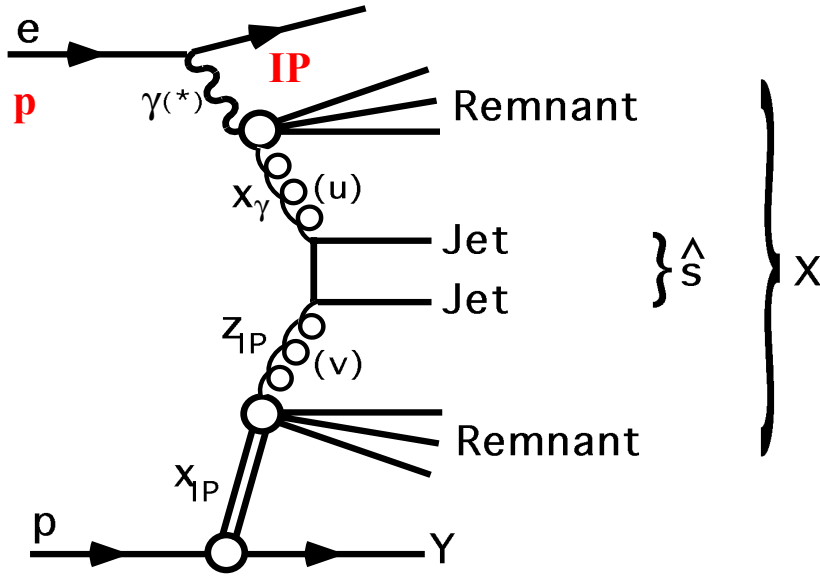
$z_{I\!P}$: fraction of pomeron momentum carried by the gluon

$$Z_{IP}^{(jets)} = \frac{Q^2 + M_{12}^2}{Q^2 + M_X^2}$$

$$\beta = \frac{x}{x_{IP}}$$

Diffractive PHP Dijet Data





$18\,pb^{-1}$

$Q^2 < 0.01 GeV^2$

$165 < W < 240 GeV$

$x_P < 0.03$

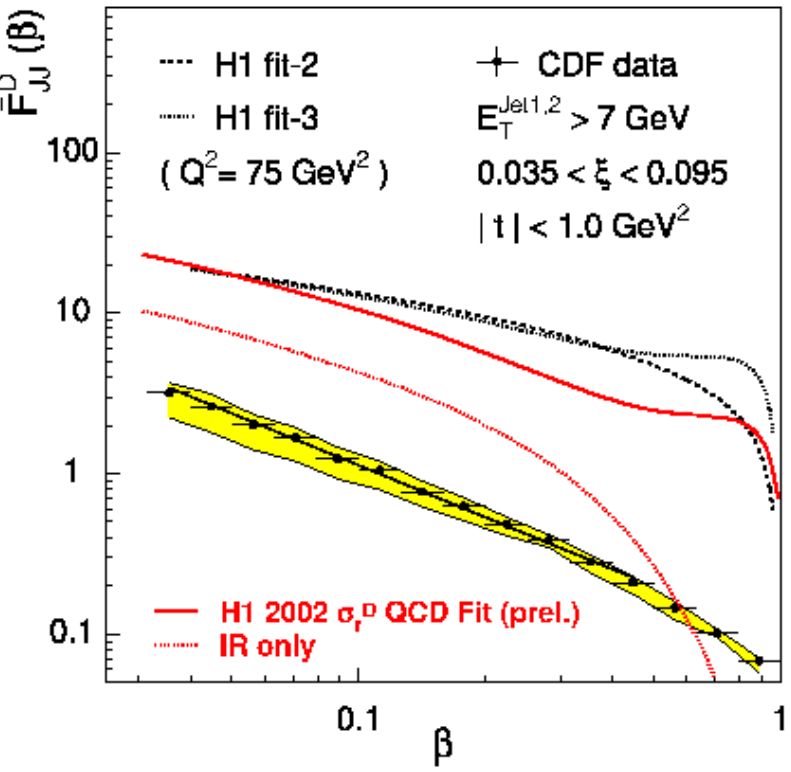
$E_T^{jet1} > 5, E_T^{jet2} > 4 GeV$

1996-97

Gap survival factor?

GAL
Generalised Area Low
model for pp diff.scattering
(fits to inclusive DIS ee data).

Tevatron vs HERA



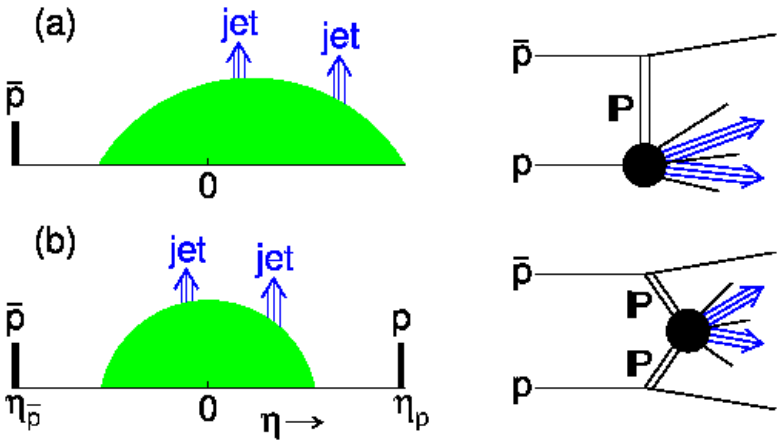
LO fits: HERA predictions for the rate of dijet production in $p\bar{p}$ exceed the observed rate by a factor 10!

Even more for DPE:

CDF measured: $44.6 \pm 4.4 \pm 21.6 nb$

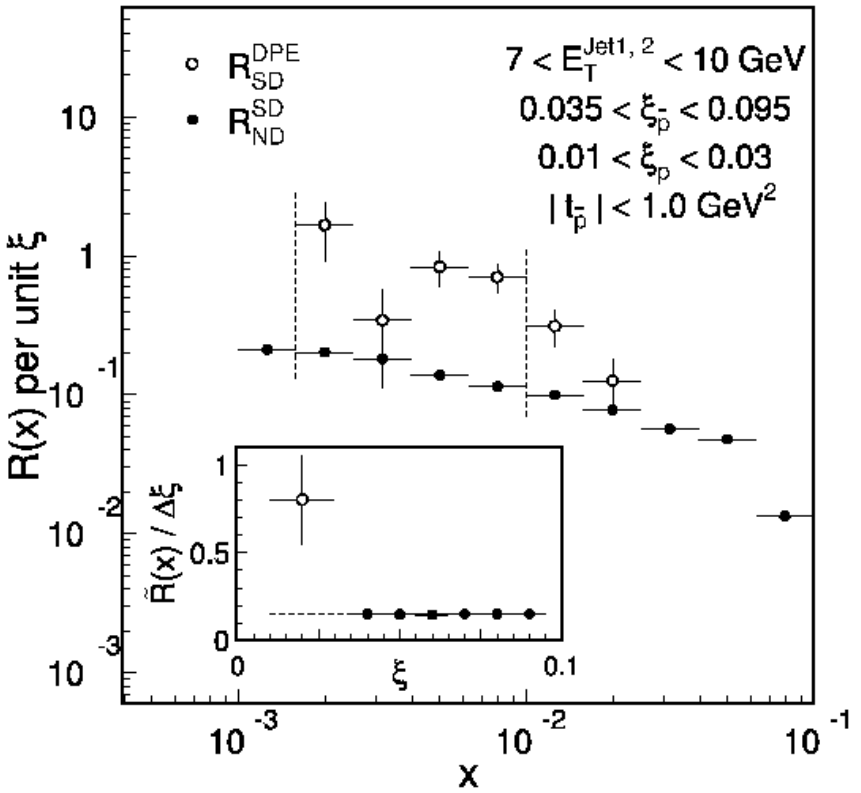
Predicted using H1 fit 6: $946.2 nb$

Tevatron vs Tevatron: Double Pomeron Exchange vs SD

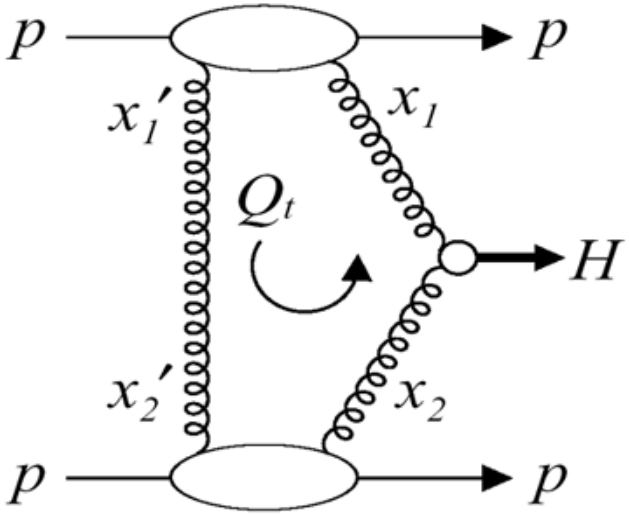


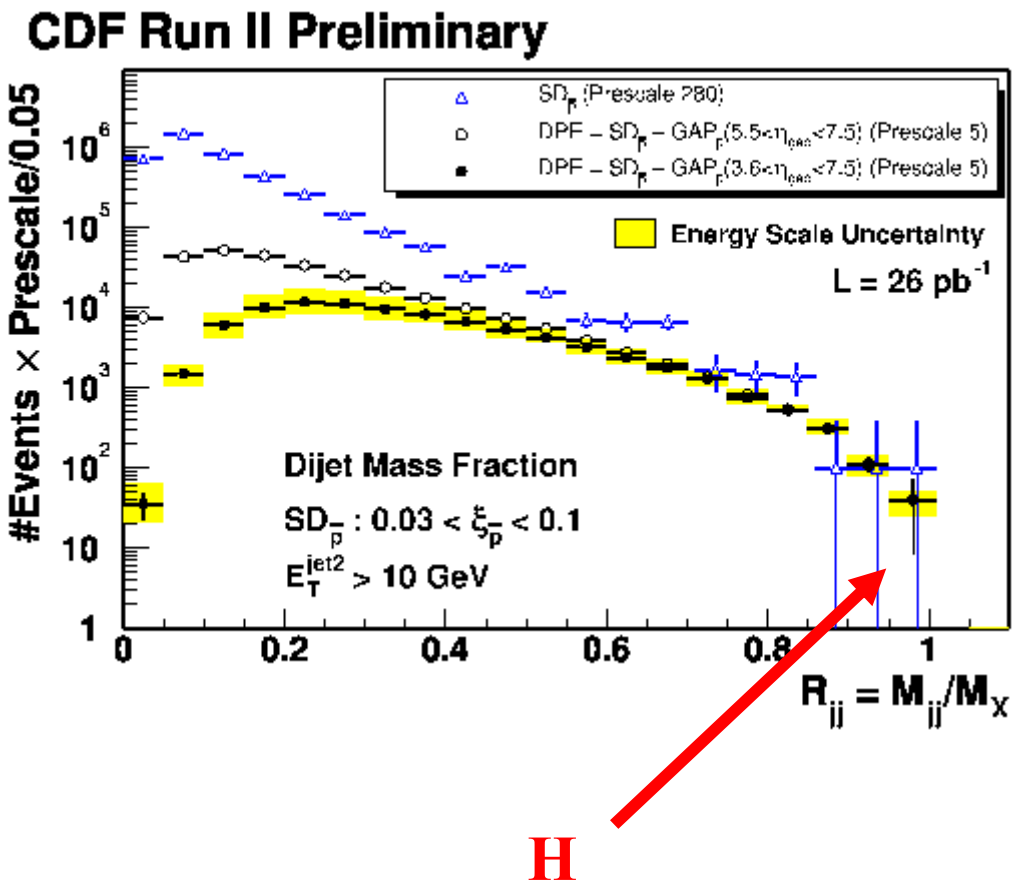
$$D = R_{ND}^{SD}(x_{\bar{p}}) / R_{SD}^{DPE}(x_p)$$

$$0.19 \pm 0.07$$



DPE Higgs production

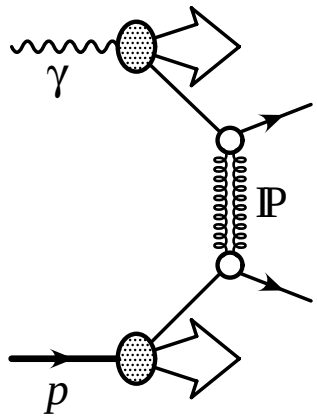




Jets with rapidity gap - interjet energy flow

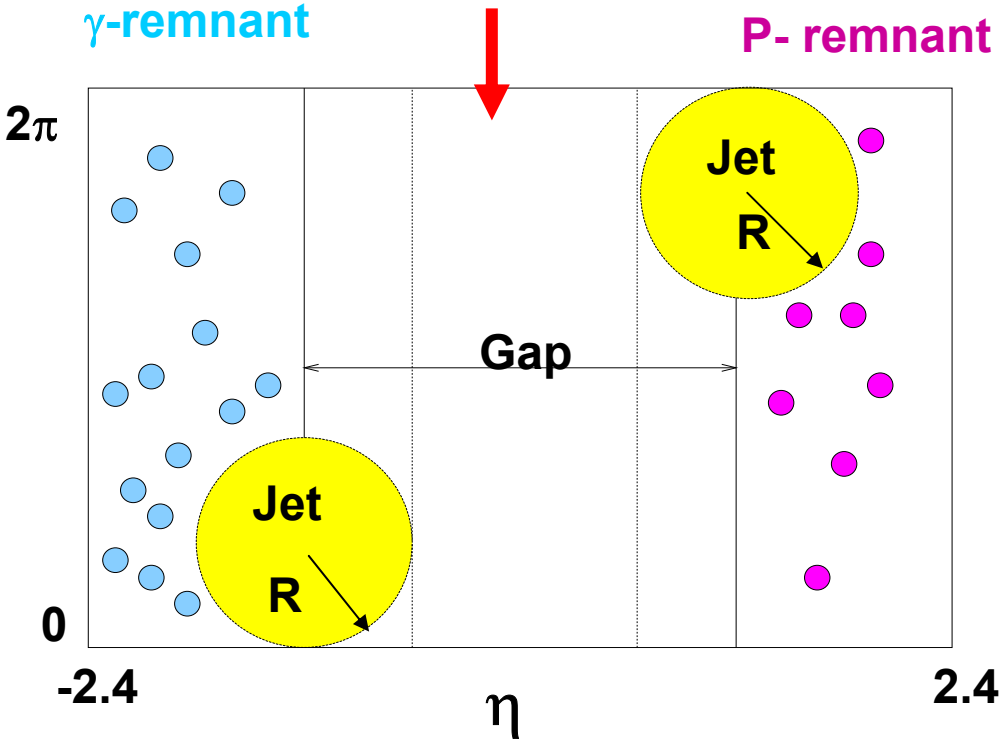
- Infrared safe way to study gaps-between-jets ;
- pQCD/npQCD at 1 GeV ;

PHP



2 high-Et jets

Total minijet energy in the gap



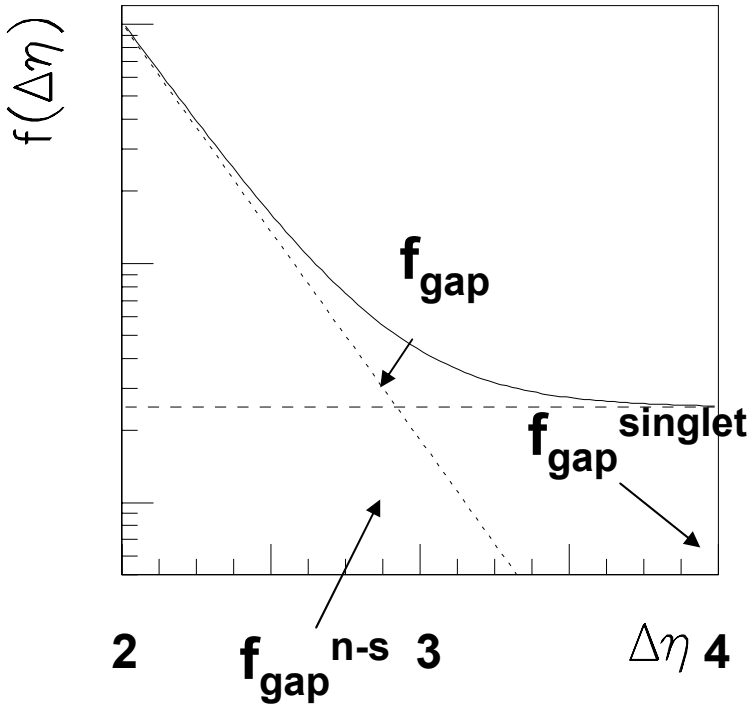
Gap Fraction

Dijet events with Rapidity Gap (Egap-dep.)

$$f(\Delta\eta) = \frac{d\sigma_{gap}/d\Delta\eta}{d\sigma/d\Delta\eta}$$

All Dijet events

Expectation for behavior of Gap Fraction (J. D. Bjorken, V. Del Duca, W.-K. Tang)



The Gap Fraction

H1

$6.6\,pb^{-1}$

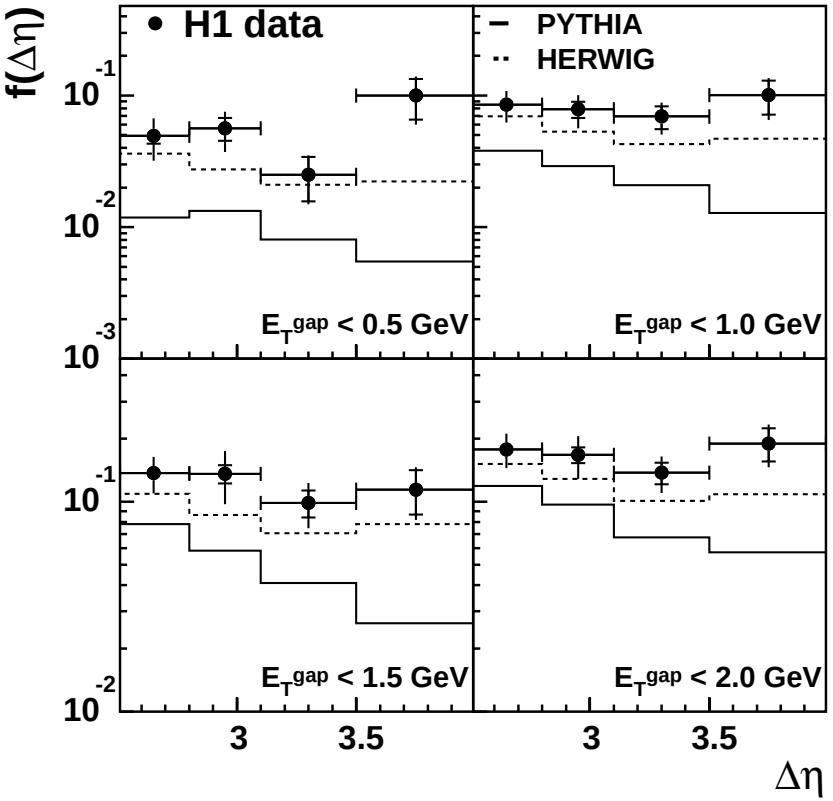
$Q^2 < 0.01 GeV^2$

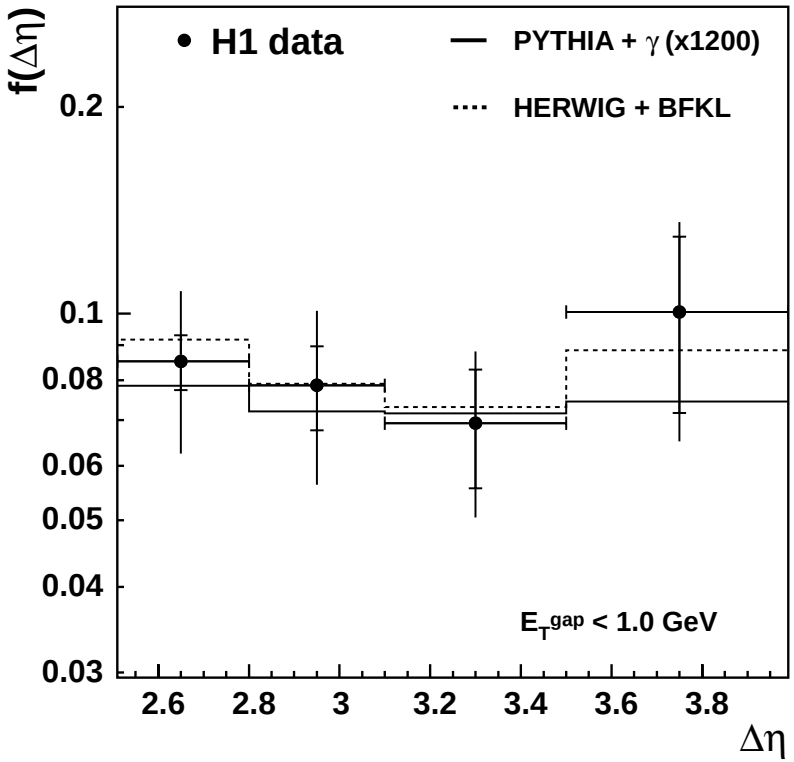
$165 < W < 233 GeV$

$E_T^{jet,1} > 6.0; E_T^{jet,2} > 5.0 GeV$

$\eta^{jet,1}, \eta^{jet,2} < 2.65$

$2.5 < \Delta\eta < 4.0$





Color singlet added

The Gap Fraction

ZEUS

$36.8\,pb^{-1}$

$Q^2 < 1.0 GeV^2$

$0.2 < y < 0.85$

New ressumation