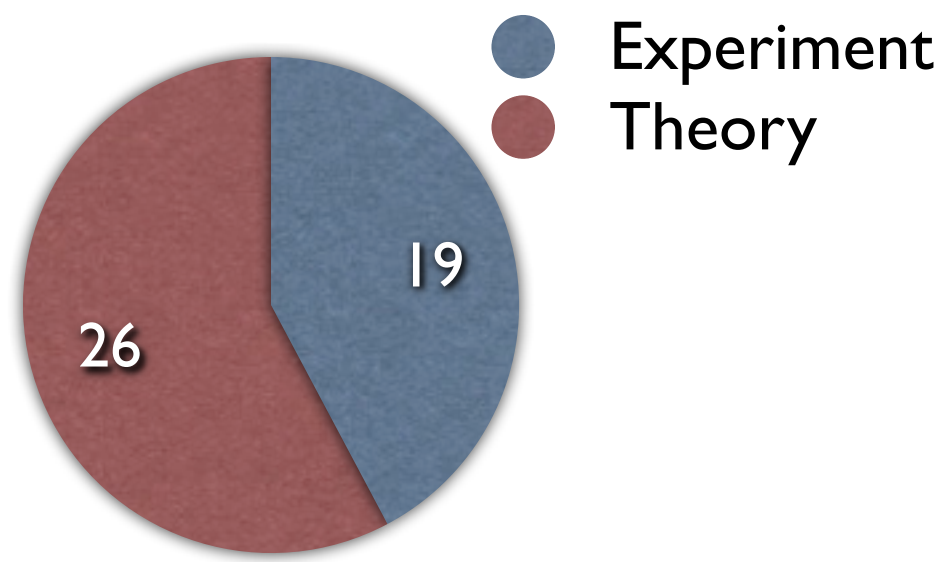
Diffraction and Vector Meson Parallel Session Summary

Marta Ruspa (Torino University)
Dimitri Colferai (University of Florence)
Richard Polifka (Charles University in Prague, University of Toronto)

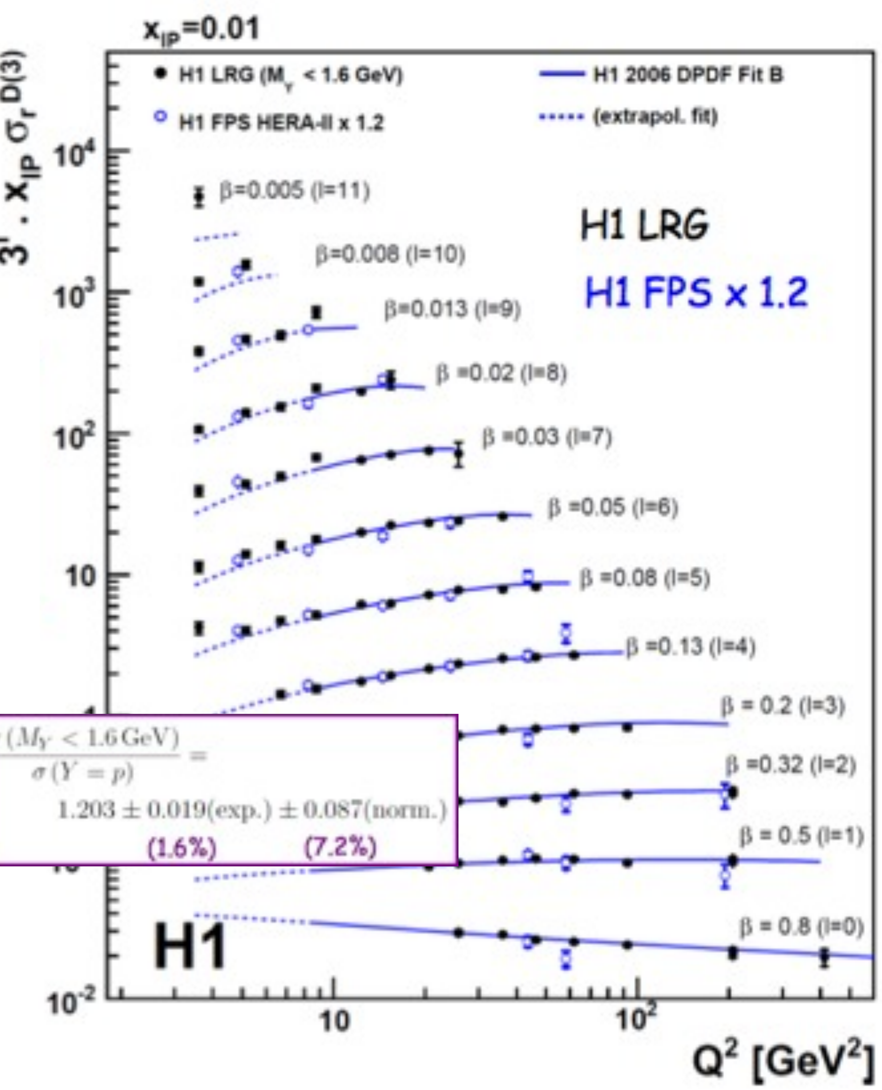


E. Sauvan

F_2^{D3} @ H1

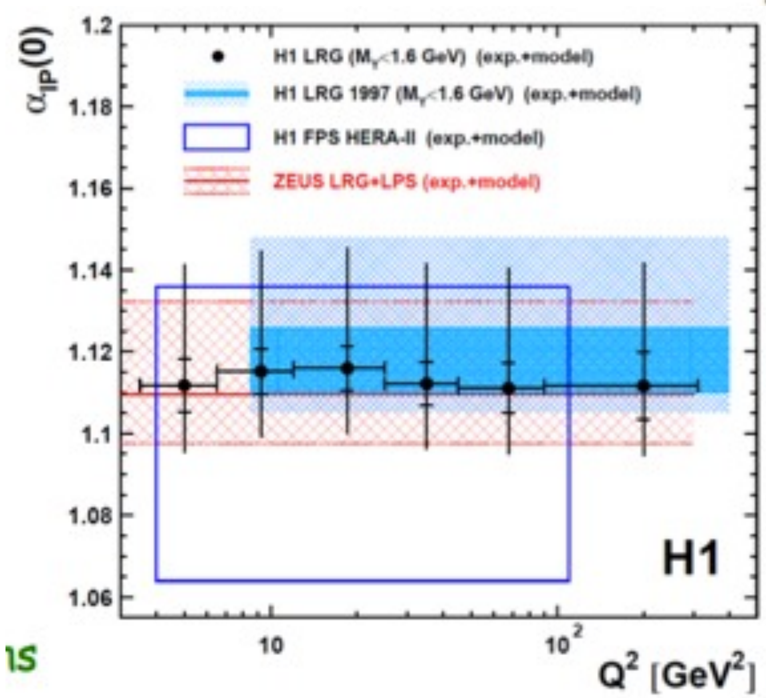
Data Set	Q^2 range (GeV^2)	Proton Energy E_p (GeV)	Luminosity (pb^{-1})
New data samples			
1999 MB	$3 < Q^2 < 25$	920	3.5
1999-2000	$10 < Q^2 < 105$	920	34.3
2004-2007	$10 < Q^2 < 105$	920	336.6
Previously published data samples			
1997 MB	$3 < Q^2 < 13.5$	820	2.0
1997	$13.5 < Q^2 < 105$	820	10.6
1999-2000	$133 < Q^2 < 1600$	920	61.6

$$\sigma_r^{D(3)}(Q^2,\beta,x_{I\!P}) = \frac{\beta Q^4}{4\pi\alpha_{em}^2}\,\frac{1}{(1-y+\frac{y^2}{2})}\,\frac{d^3\sigma^{ep\to eXY}}{dQ^2\,d\beta\,dx_{I\!P}}$$

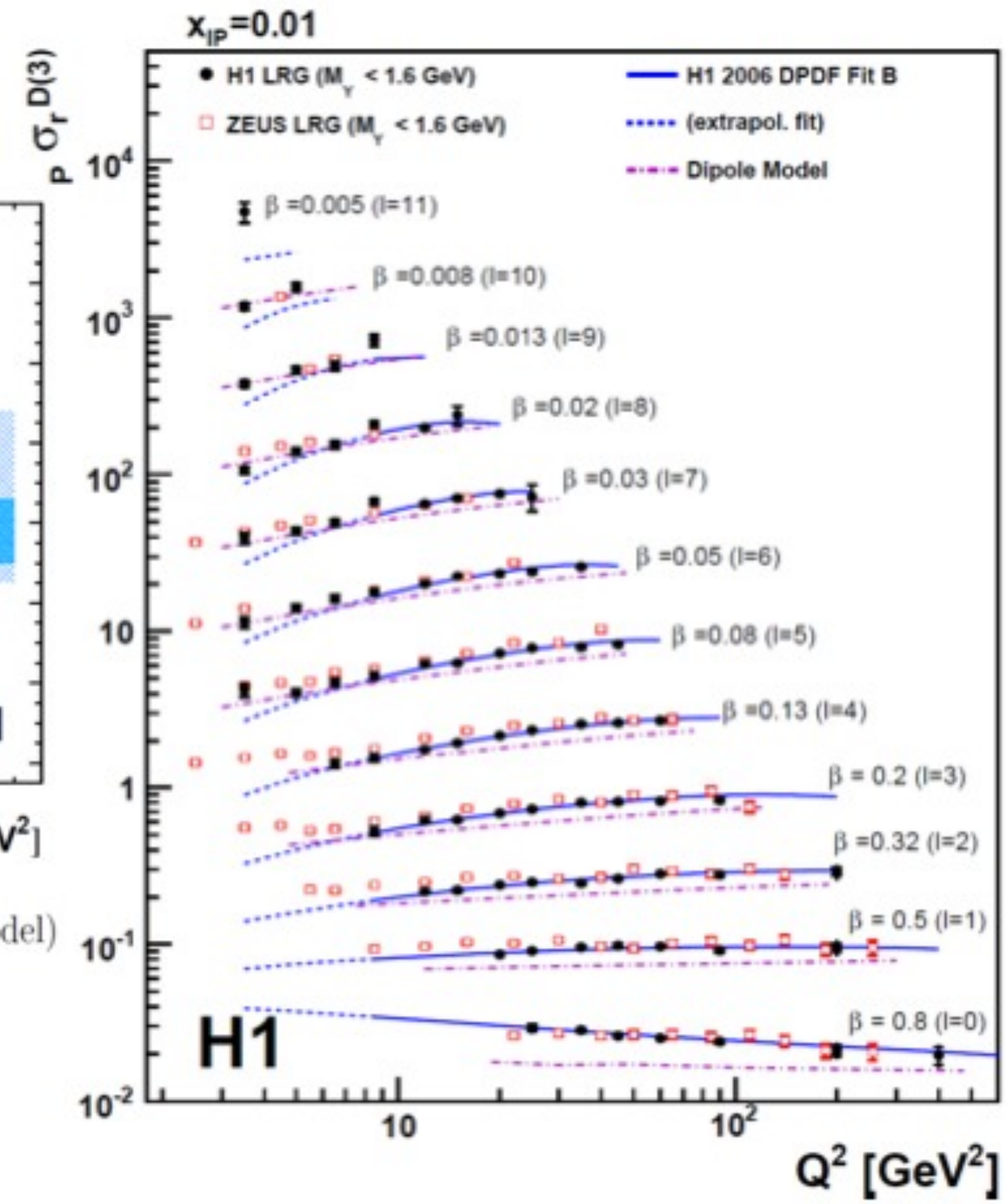


$$\frac{\sigma(M_Y < 1.6\,\mathrm{GeV})}{\sigma(Y=p)} = 1.203 \pm 0.019(\mathrm{exp.}) \pm 0.087(\mathrm{norm.})$$

(1.6%) (7.2%)



$$\alpha_{I\!P}(0) = 1.113 \pm 0.002\,(\mathrm{exp.})\,^{+0.029}_{-0.015}\,(\mathrm{model})$$



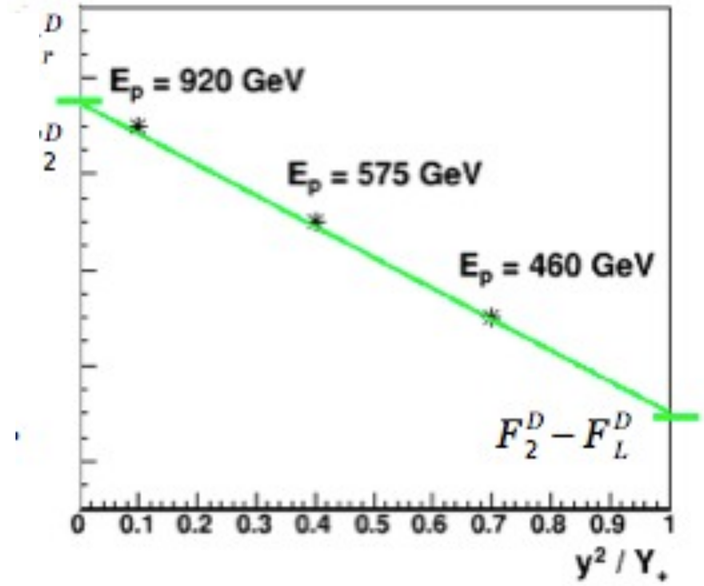
F_L^D @ H1

D. Šálek

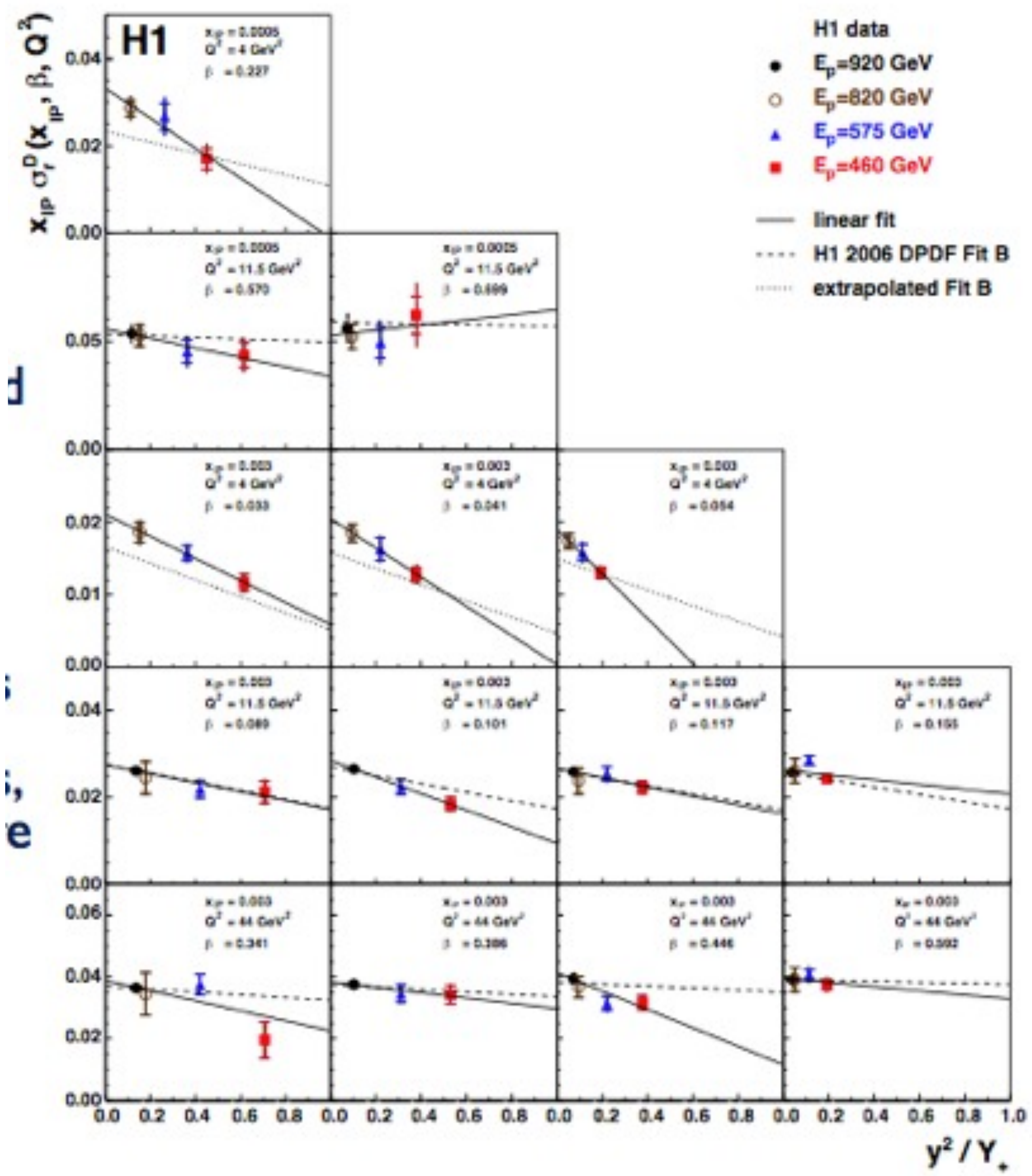
$$\sigma_r^D = F_2^D - \frac{y^2}{Y_+} F_L^D$$

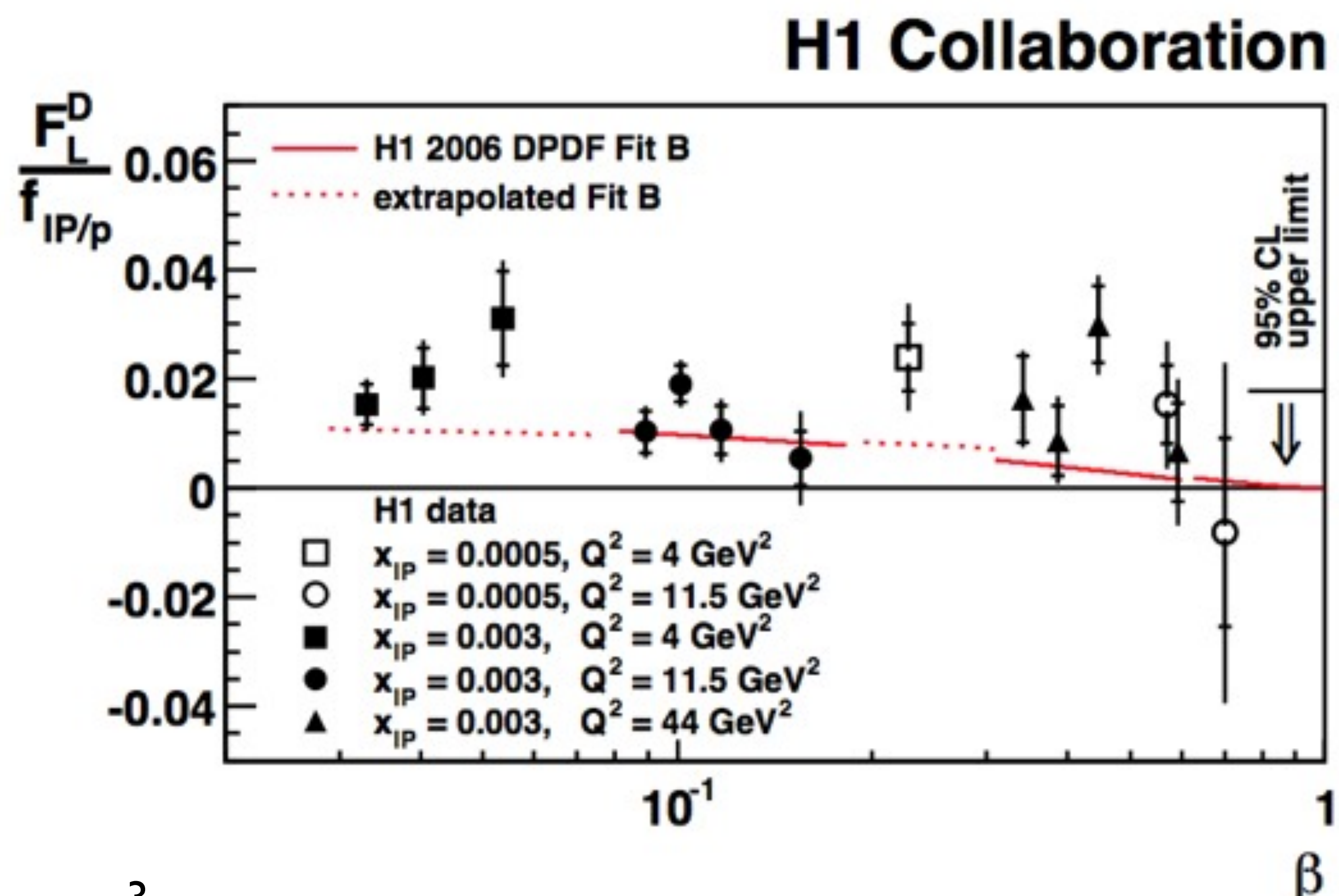
$$F_L^D \sim x\, g(x)$$

$$Q^2 = x_{IP}\, \beta\, y\, s$$



- $x_{IP} = 0.0005,\ 0.003$
- $Q^2 = 4,\ 11.5,\ 44\ \mathrm{GeV}^2$
- $0.033 < \beta < 0.7$



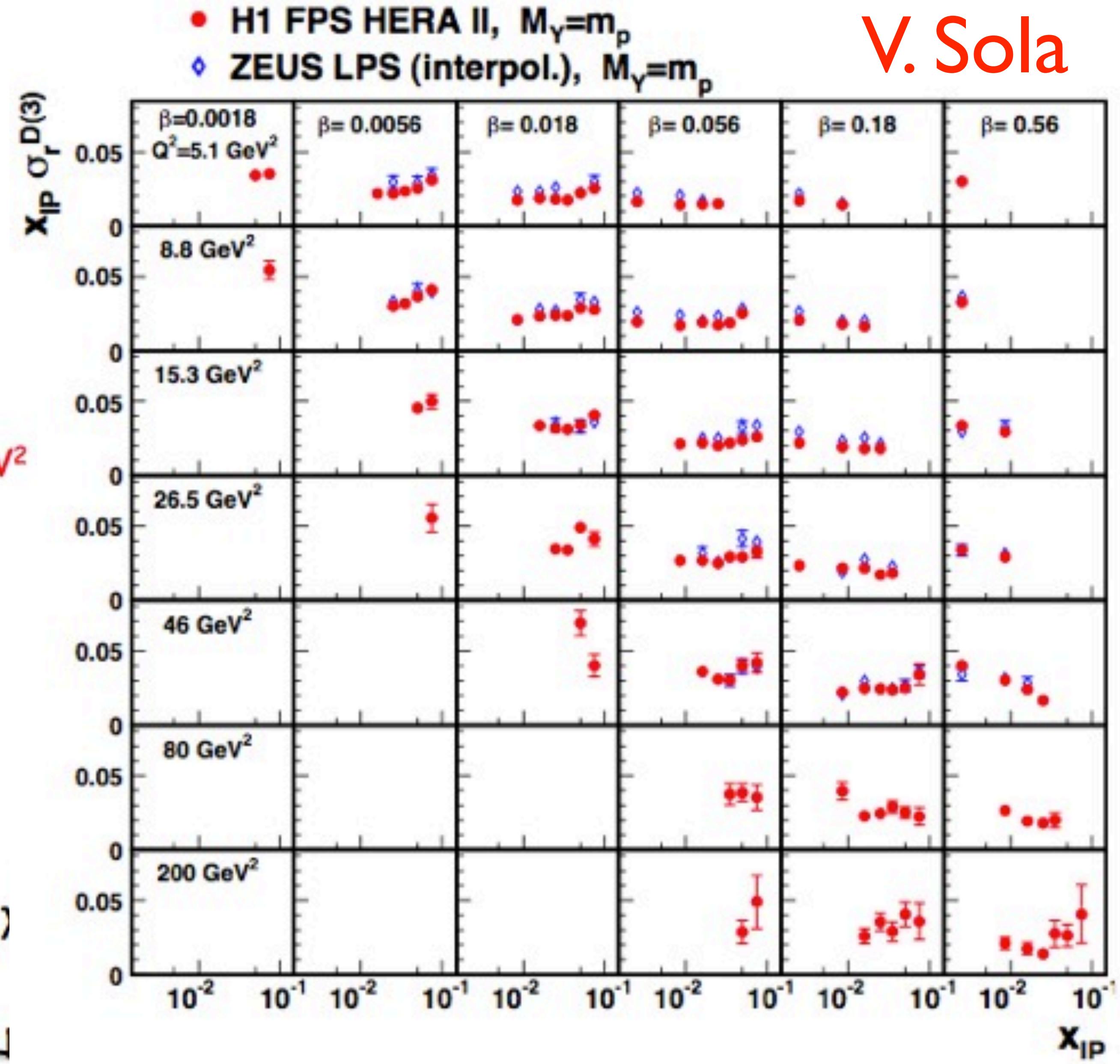


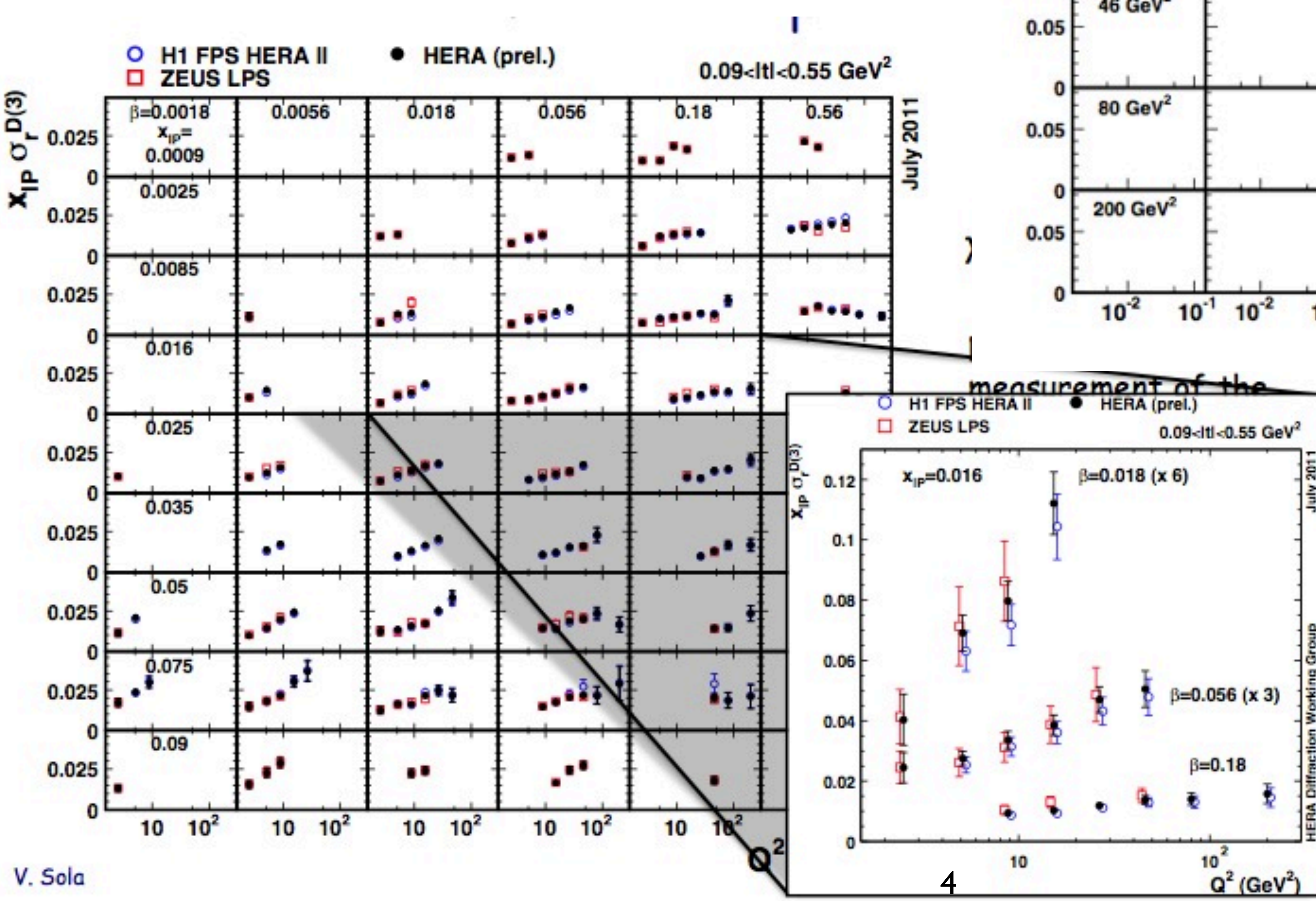
V. Sola

+ =

- H1 FPS HERA II
  [Eur.Phys.J. C71 (2011) 1578]
  Luminosity = 156.6 pb^{-1}
  Visible range $|t|$ = 0.1 - 0.7 GeV^2
  Norm unc ~ ± 4.8%

- ZEUS LPS
  [Nucl.Phys. B816 (2009) 1]
  Luminosity = 32.6 pb^{-1}
  Visible range $|t|$ = 0.09 - 0.55 GeV^2
  Norm unc ~ ± 7%





χ^2/ndf = 52/58

Kinematic region covered by H1 and ZEUS data

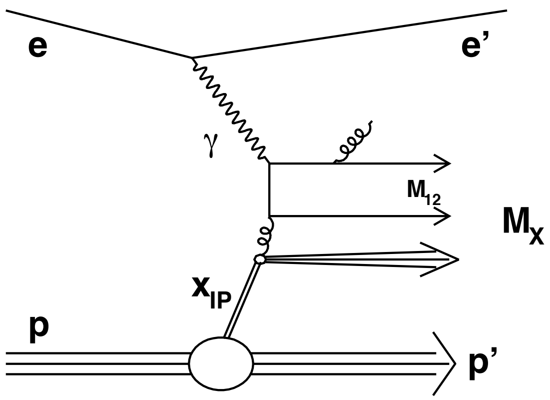
Q^2 = 2.5 - 200 GeV^2

β = 0.0018 - 0.816

x_{IP} = 0.00035 - 0.09

$|t|$ = 0.09 - 0.55

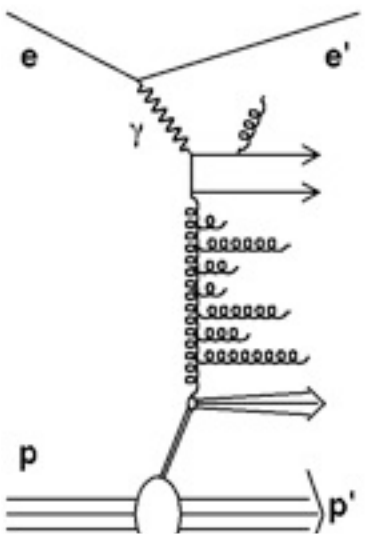
V. Sola

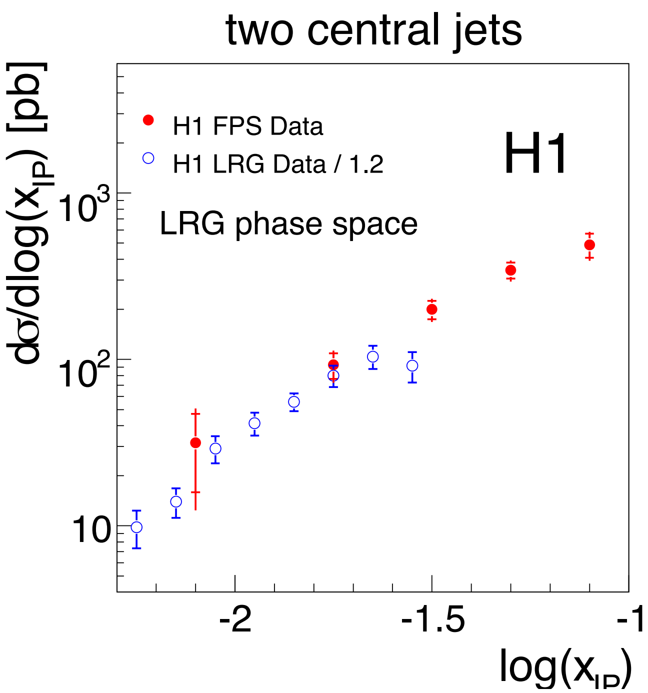


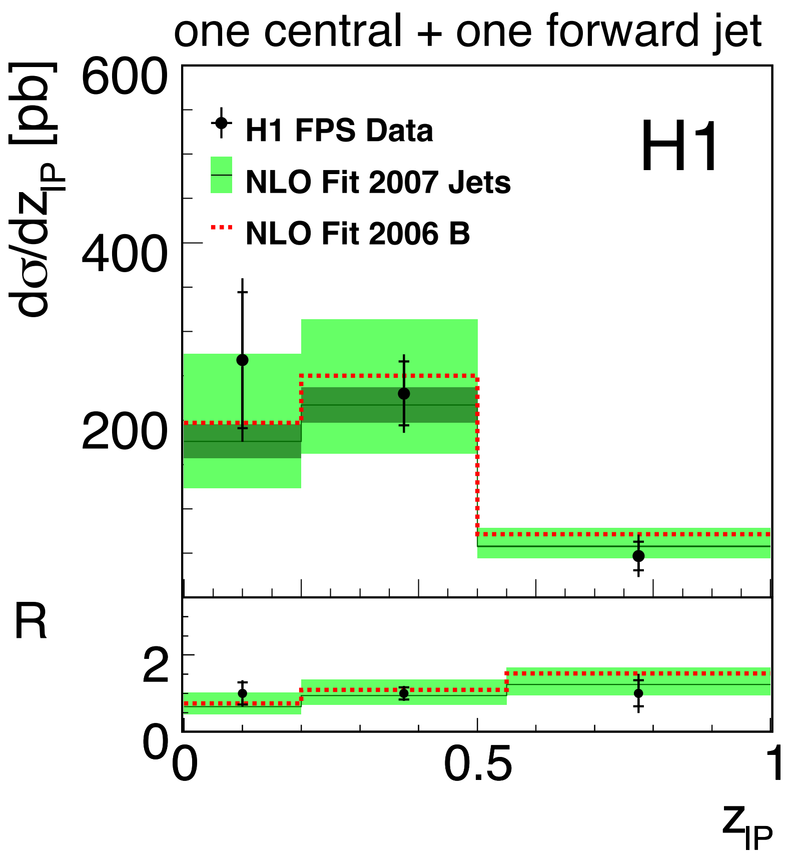
Diffractive Jets @ H1

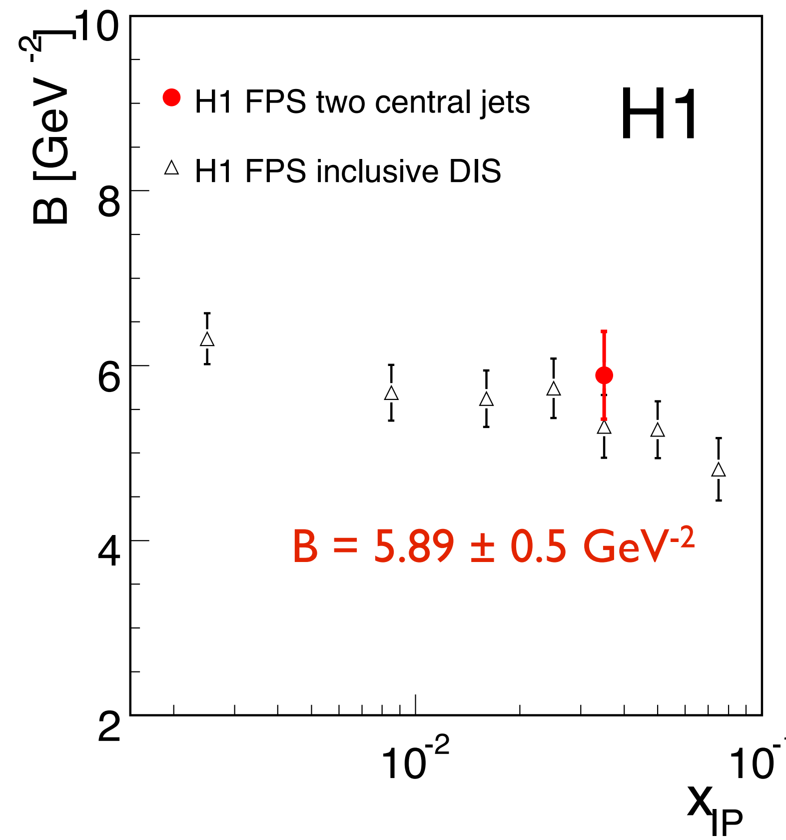
R. Polifka

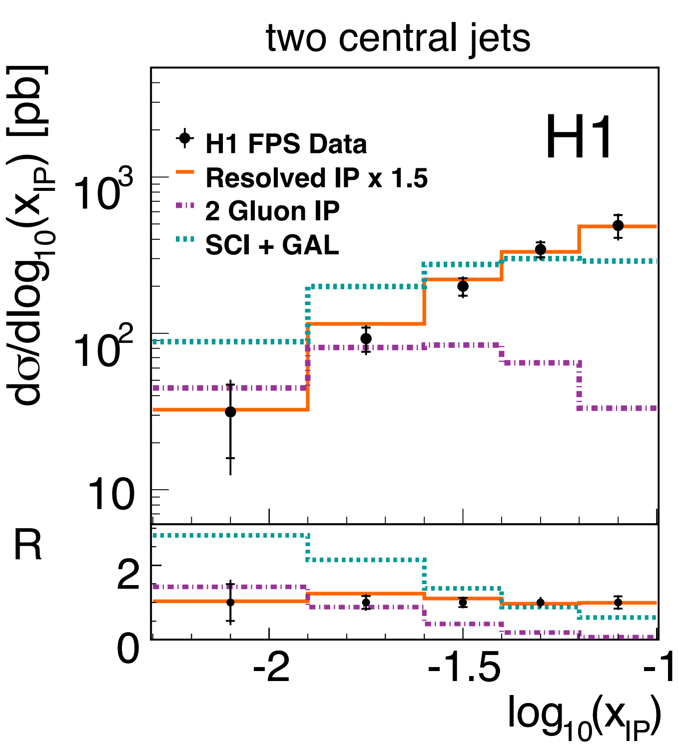
Selection	two central jets	one central + one forward jet
DIS	$4 < Q^2 < 110$ GeV^2 $0.05 < y < 0.7$	
Leading Proton	$x_{I\!P} < 0.1$ $\lvert t \rvert < 1$ GeV^2	
Jets	$P^*_{T,1} > 5$ GeV $P^*_{T,2} > 4$ GeV $-1 < \eta_{1,2} < 2.5$	$P^*_{T,c}, P^*_{T,f} > 3.5$ GeV $M_{jj} > 12$ GeV $-1 < \eta_c < 2.5$ $1 < \eta_f < 2.8, \eta_f > \eta_c$











- no hints for physics beyond DGLAP
- consistency with LRG
- amount of proton dissociation same as in iDDIS
- consistent with proton vertex factorisation

F. A. Ceccopieri

QCD analyses of HERA data

S.T. Monfared

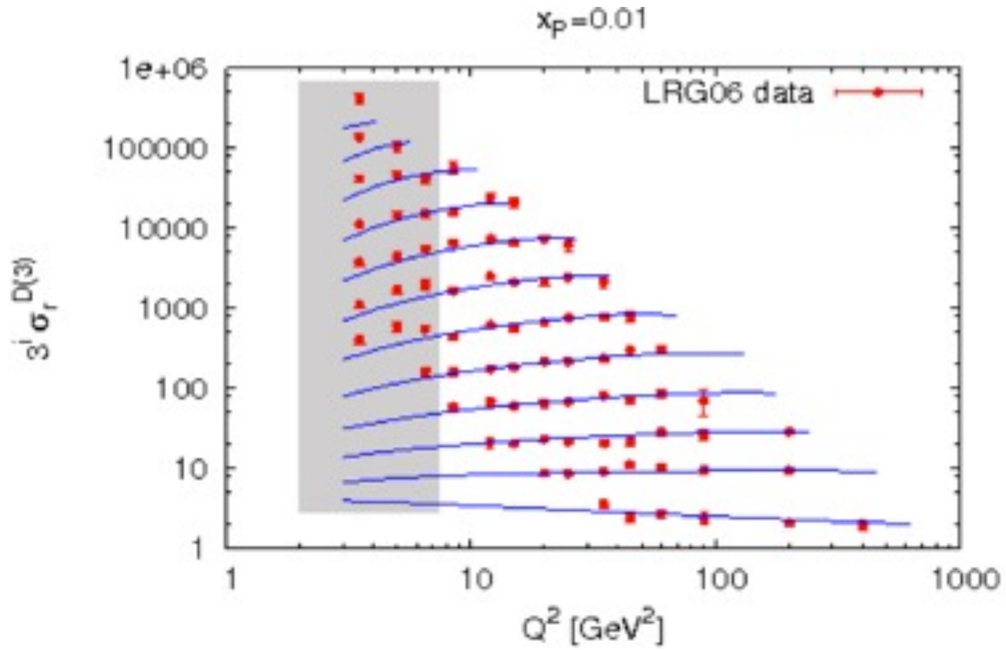
$$\Sigma(\beta, x_{I\!P}, Q_0^2) = A_q(x_{I\!P})\, \beta^{B_q(x_{I\!P})}\, (1-\beta)^{C_q(x_{I\!P})}\, e^{\frac{-0.01}{1-\beta}}$$

$$g(\beta, x_{I\!P}, Q_0^2) = A_g(x_{I\!P})\, e^{\frac{-0.01}{1-\beta}}$$

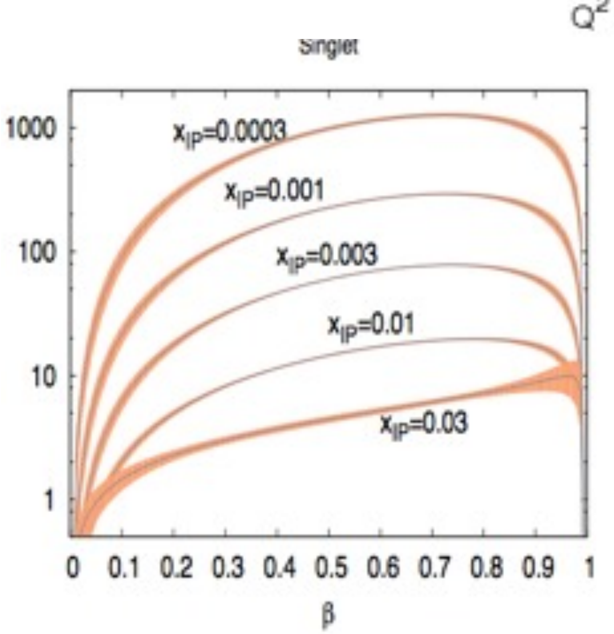
$$z\sum(z,Q_0^2) = A_\Sigma z^{B_\Sigma}(1-z)^{C_\Sigma}(1 + D_\Sigma z + E_\Sigma z^{F_\Sigma})$$

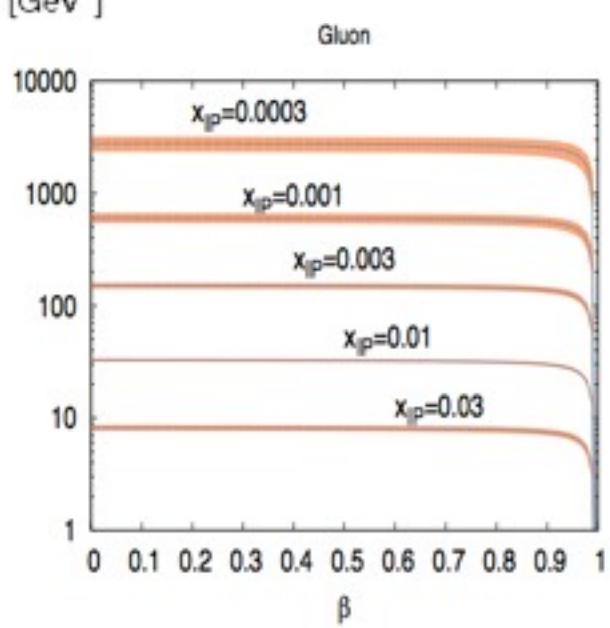
$$zg(z,Q_0^2) = A_g e^{\frac{a=-0.01}{1-z}}$$

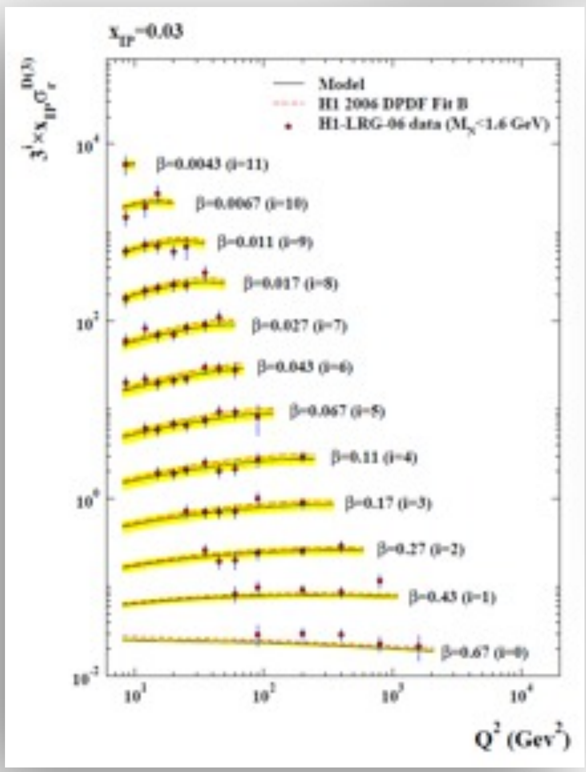
$M_X^2 > 4\ \mathrm{GeV}^2$, $Q^2_{\mathrm{min}} \geq 8.5\ \mathrm{GeV}^2$, 190 points

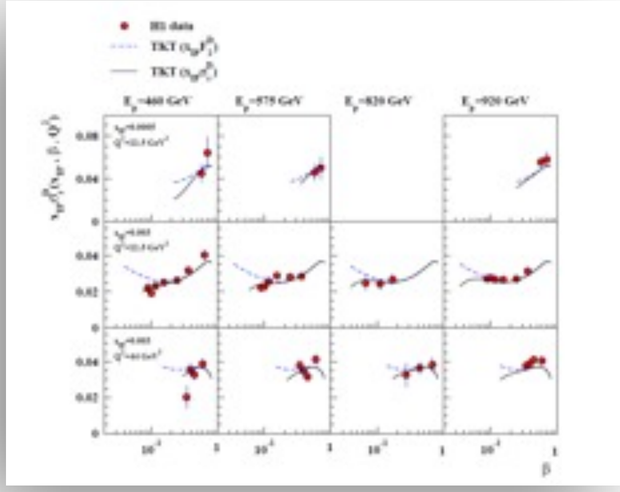


Lable	χ^2/dof	Data points
H1-LRG-06	0.79	190
H1-FPS-06	0.53	40
H1-FPS-10	0.91	100
ZEUS-LPS-04	0.23	27
ZEUS-LPS-09	0.78	42
ZEUS-LRG-09	1.08	155
H1-LRG-11	0.89	67







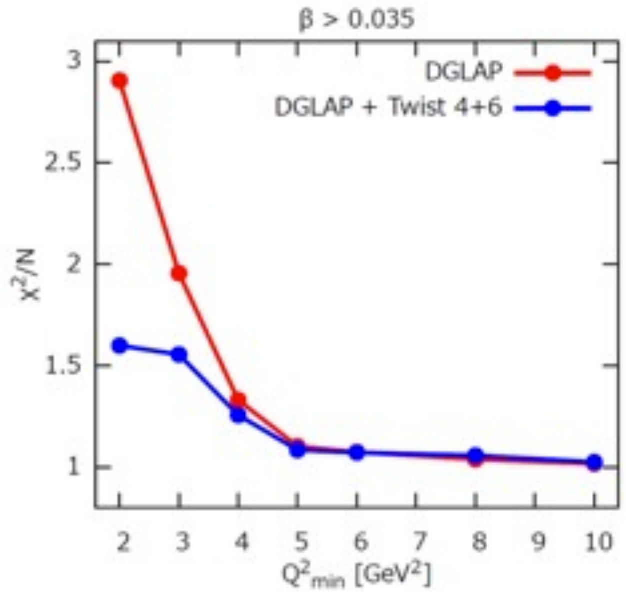


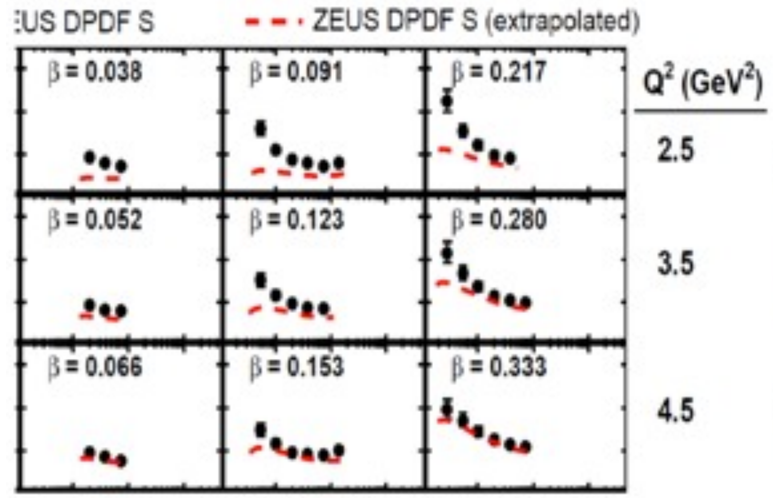
Eager to test both approaches on the latest data

M. Sadzikowski

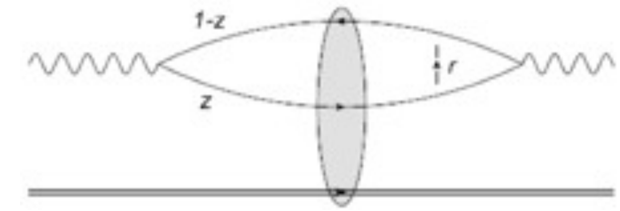
Low Q2 region and higher twists

L. Motyka





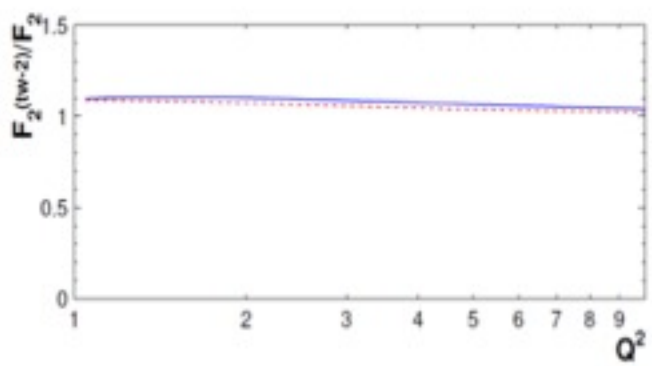
- Rapid deviation of the fit from data with decreasing Q^2
- Indication of higher twists?



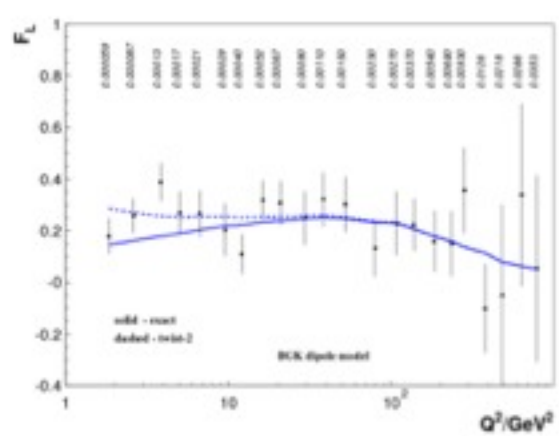
$$\sigma_d(x,r^2) = \sigma_0 \left[1 - \exp\left(-\frac{r^2}{4R^2(x)} \right) \right]$$

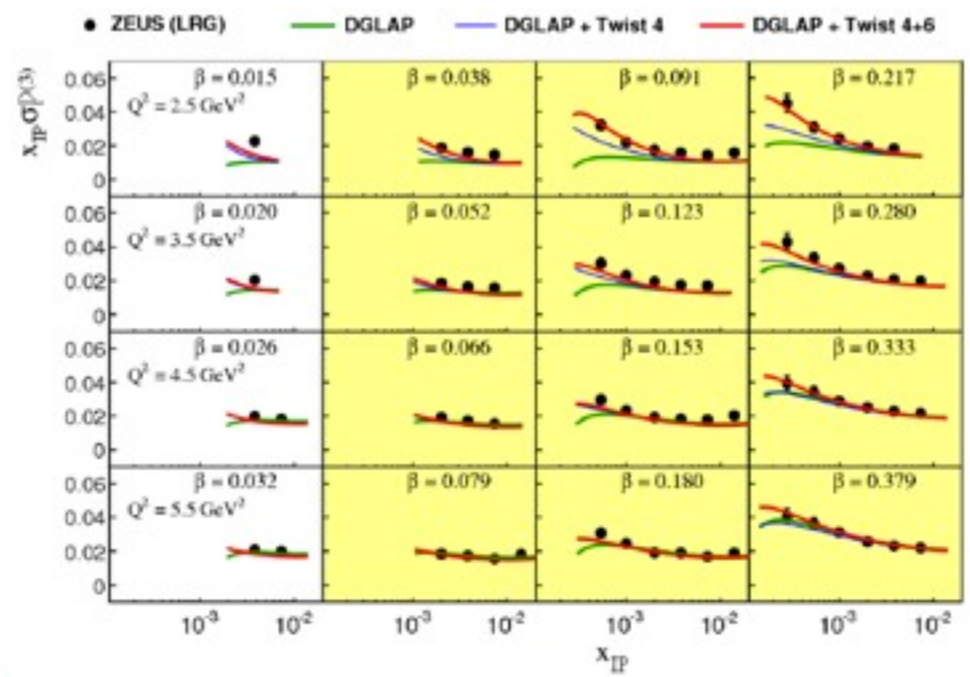
attempt to describe DIS, DDIS, VMs,...

F2 - strong cancellations: a striking result! 1% effect of higher twists



FL – up to O(40%) effects of higher twists – still not sufficient to provide good constraints





Inclusive data leave a lot of freedom for higher twists

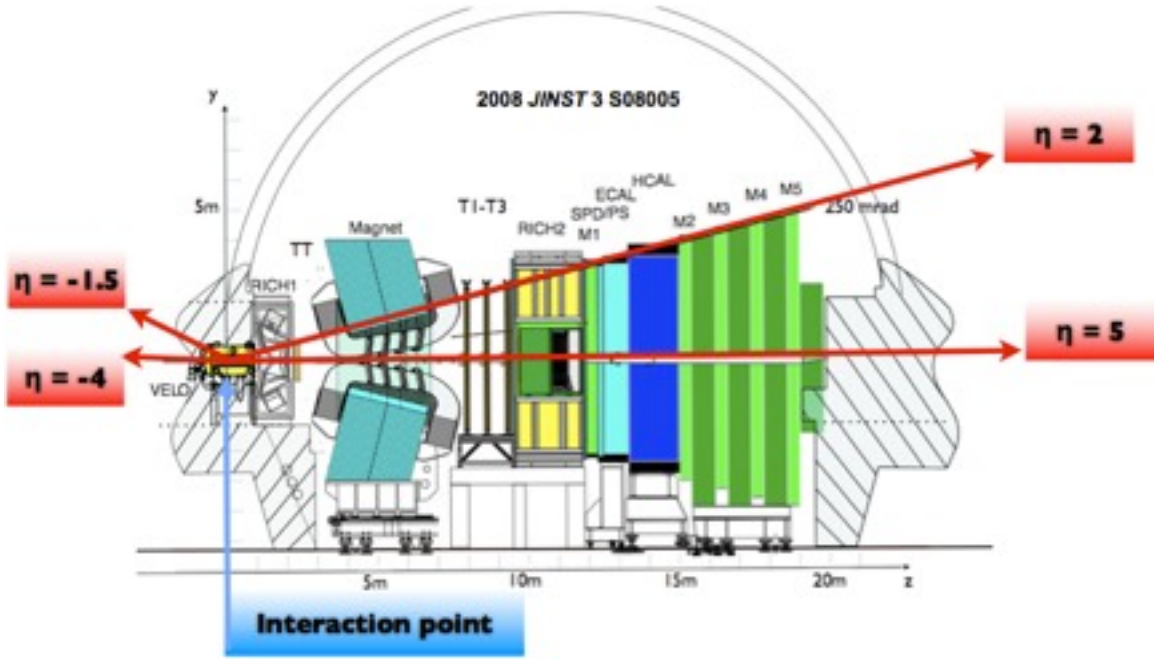
- HERA data are consistent with discovery of the strong (up to 100%) positive higher twists effect in DDIS at, and below Q^2 of order 5 GeV^2

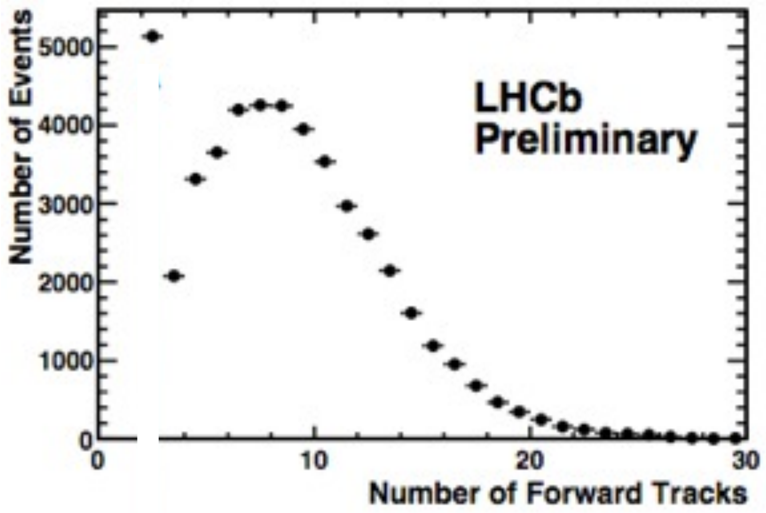
- Eikonal saturation model – not supported by theory, that suggest coupling of one t-channel gluon per one s-channel quark line
- Eikonal saturation model may and should be modified to represent better higher twist coefficient functions

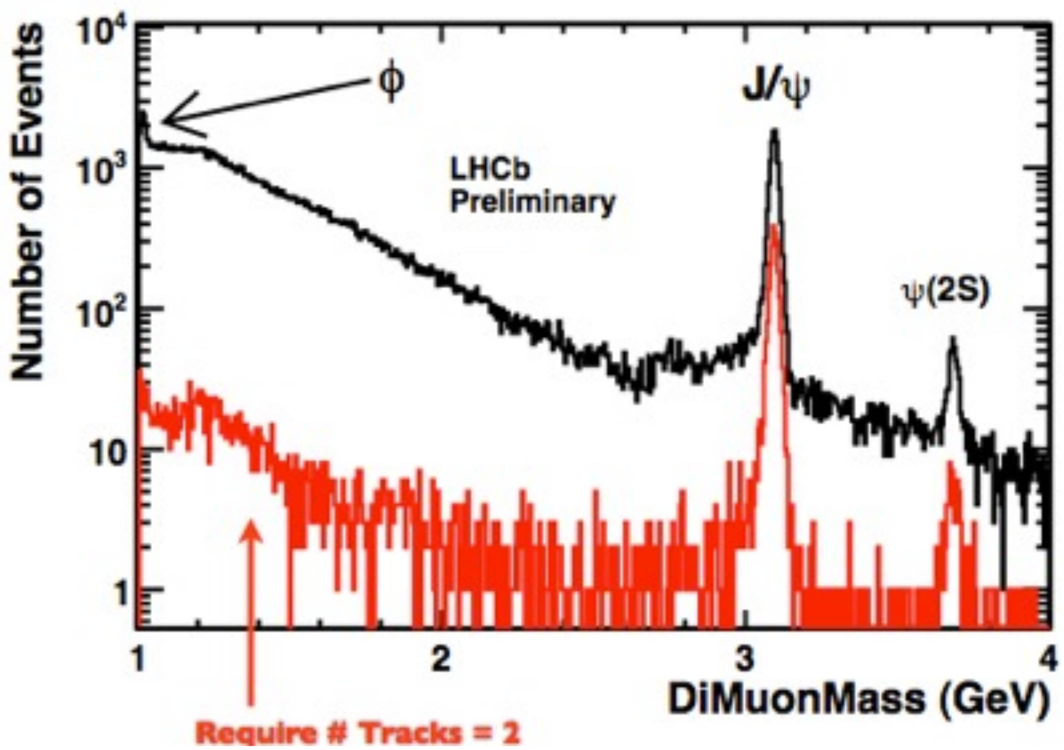
Exclusive production @ LHCb

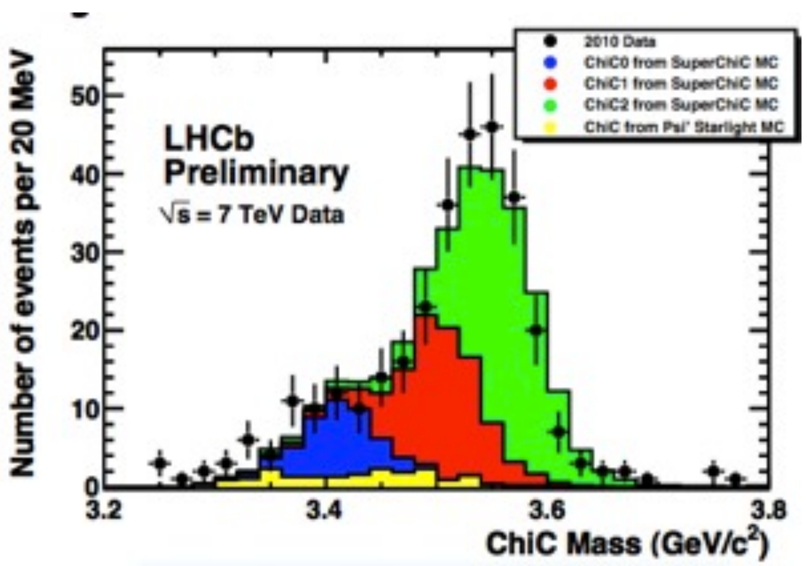
D. Moran

- 2010 data analyses
- gg -> μμ ideal for lumi measurement
- exclusive J/Psi, Xc production



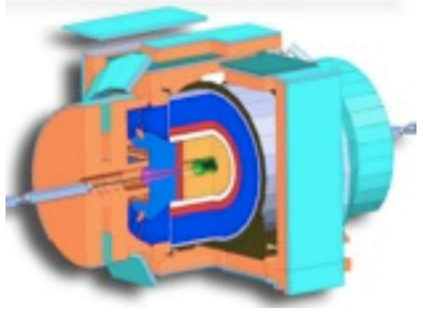




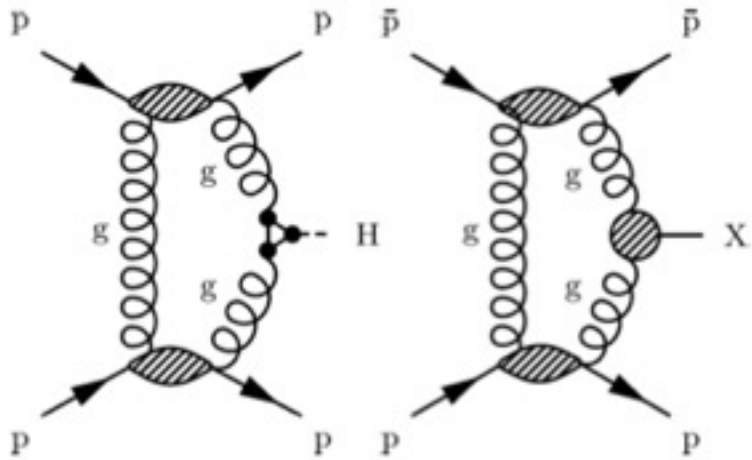


- cross sections are consistent with theoretical predictions
  - 2011 data on the way

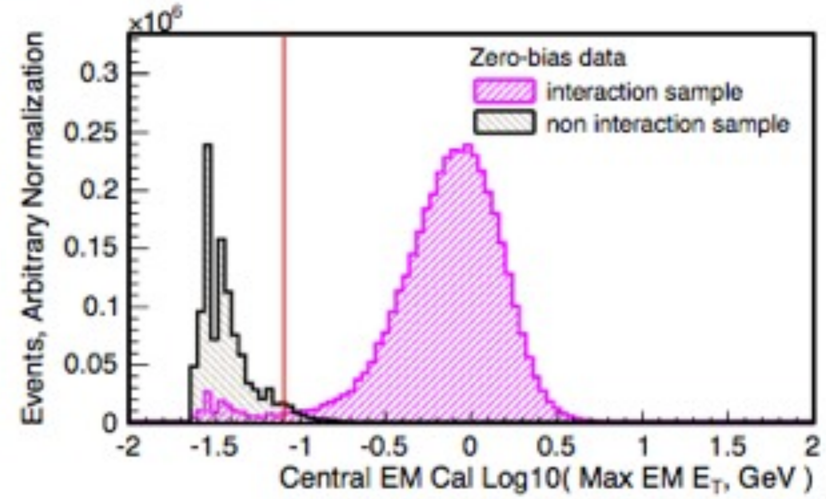
E. Brücken

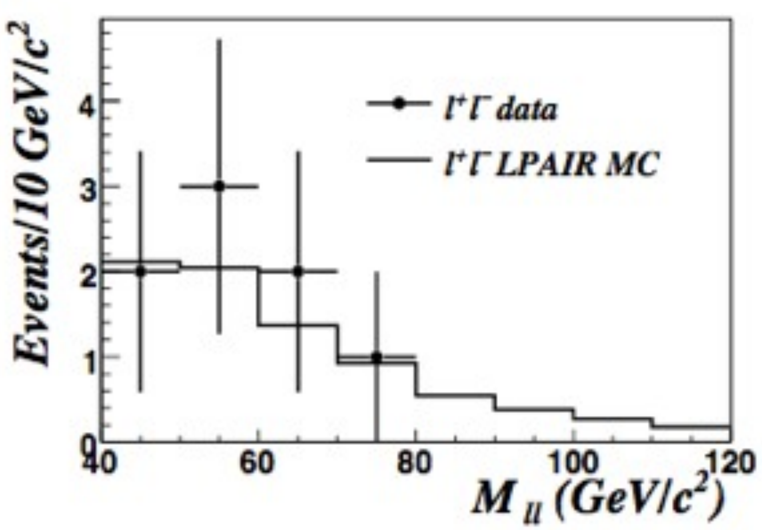


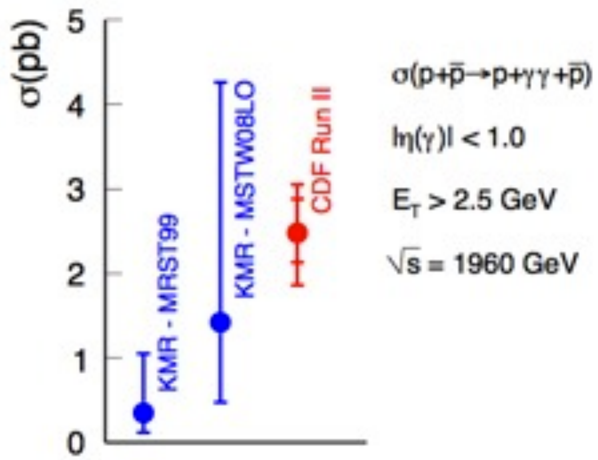
Central Exclusive Production at CDF II

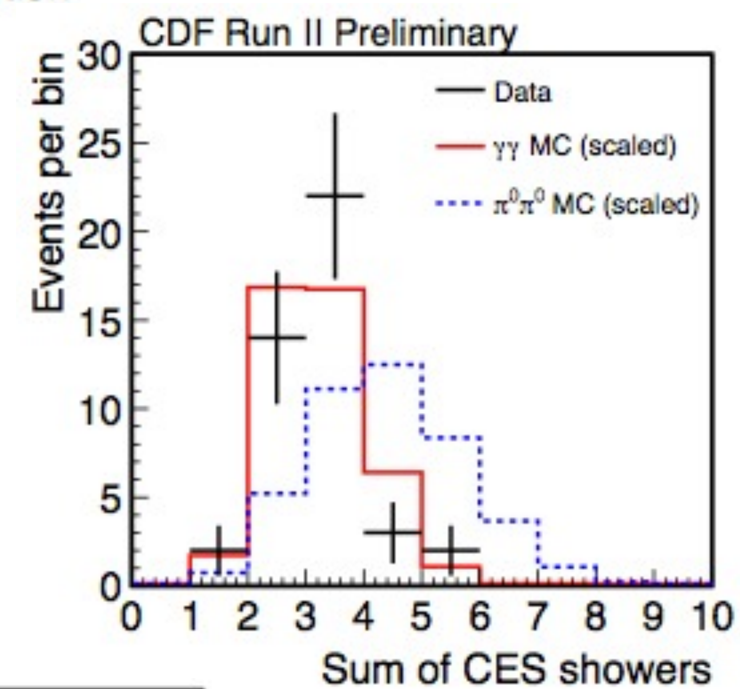


- **QED Production**
  - ★ Exclusive e^+e^- Production
  - ★ Exclusive $\mu^+\mu^-$ Production
- **Photoproduction**
  - ★ Exclusive J/Ψ Production
  - ★ Search for Exclusive Z Production
- **Double Pomeron Exchange**
  - ★ Exclusive Dijet Production
  - ★ Exclusive Charmonium and χ_c Production
  - ★ Exclusive $\gamma\gamma$ Production



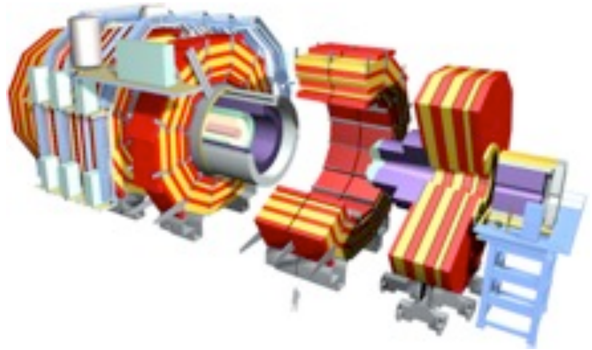






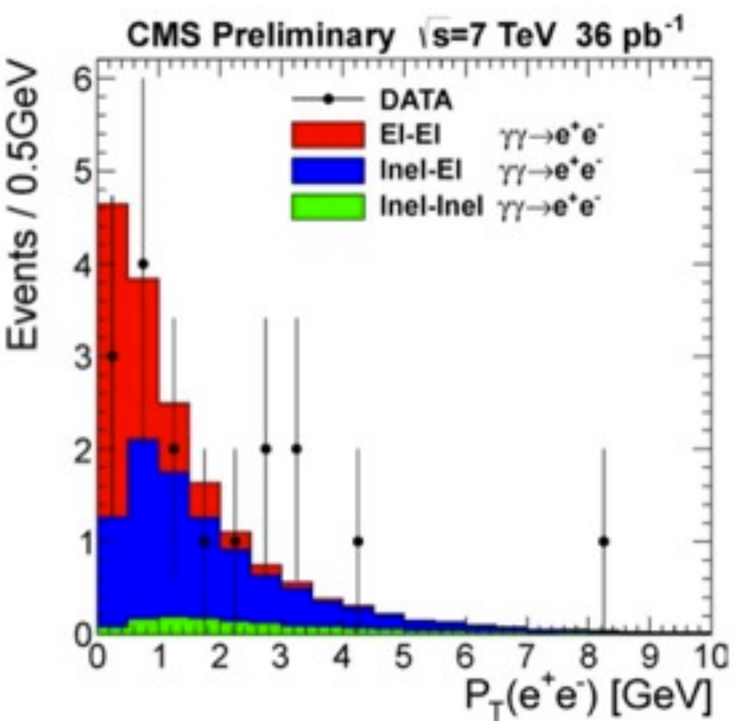
Exclusive Photon-Pair Production	
Theoretical	$\sigma^{\lvert\eta\rvert<1,E_T>2.5\mathrm{GeV}}_{\mathrm{SuperCHIC}} = 0.35^{\times 3}_{\div 3}\mathrm{pb}$ (MRST99)
	$\sigma^{\lvert\eta\rvert<1,E_T>2.5\mathrm{GeV}}_{\mathrm{SuperCHIC}} = 1.42^{\times 3}_{\div 3}\mathrm{pb}$ (MSTW08LO)
Measured	$\sigma^{\lvert\eta\rvert<1,E_T>2.5\mathrm{GeV}}_{\gamma\gamma\mathrm{excl.}} = 2.48\,^{+0.40}_{-0.35}(\mathrm{stat})\,^{+0.40}_{-0.51}(\mathrm{syst})\,\mathrm{pb}$

W. Li

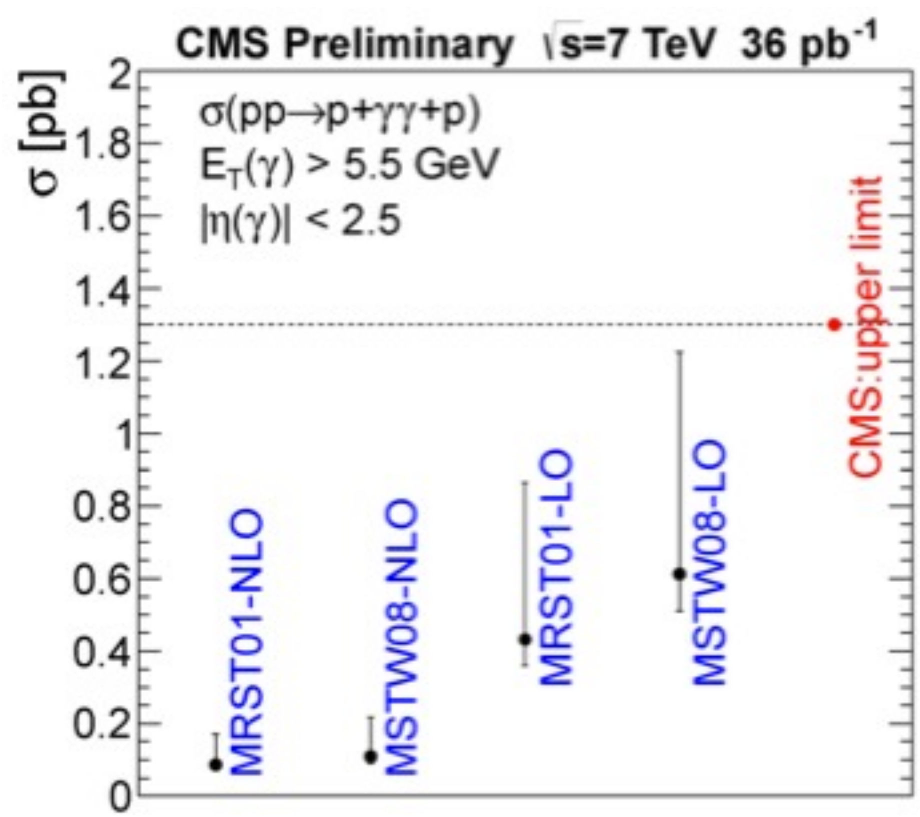


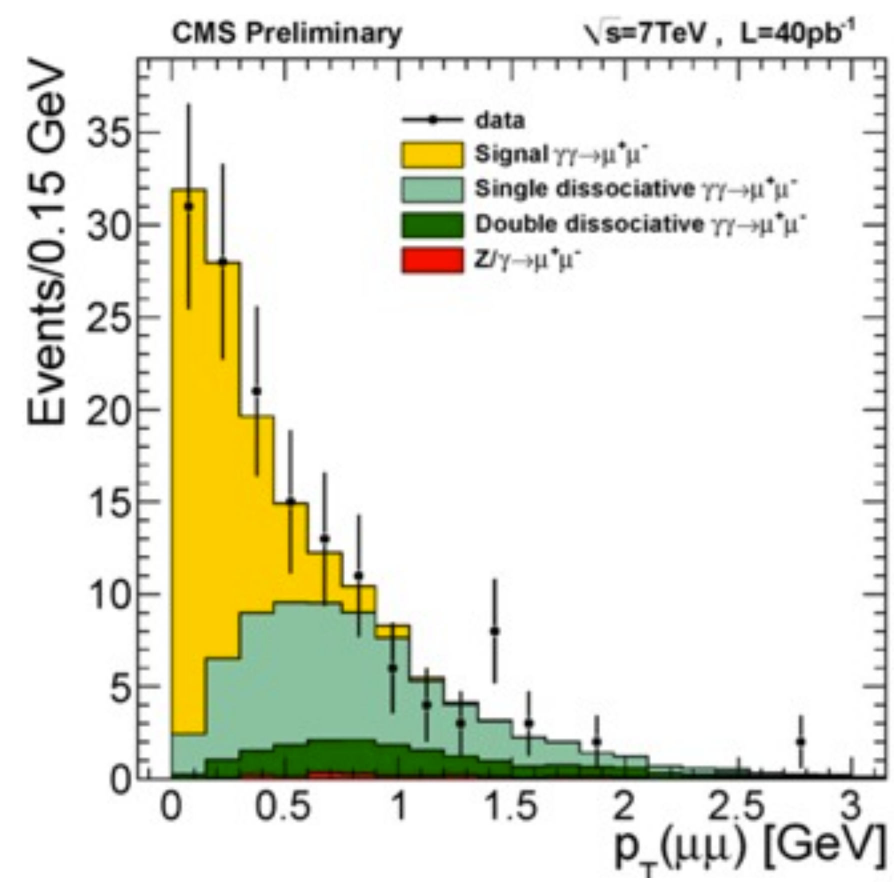
Central Exclusive Production @ CMS

exclusive diphoton analysis		exclusive dielectron analysis	
selection criterion	events remaining	selection criterion	events remaining
Trigger	3 023 496	Trigger	3 023 496
Photon reconstruction	1 683 526	Electron reconstruction	132 271
Photon identification	40 692	Electron identification	2 648
Cosmic ray rejection	32 775	Cosmic ray rejection	2 023
Exclusivity requirement	0	Exclusivity requirement	17



not a cross section measurement





$$\sigma = 3.38^{+0.58}_{-0.55}\,(\text{stat.}) \pm 0.16\,(\text{syst.}) \pm 0.14\,(\text{lumi.})\ \text{pb}$$

Central Exclusive Production in Theory

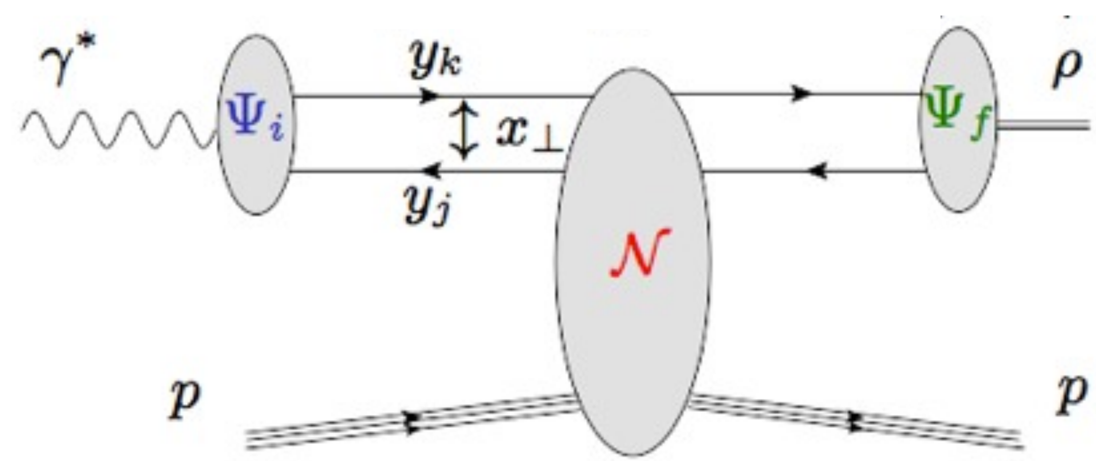
M. Taševský

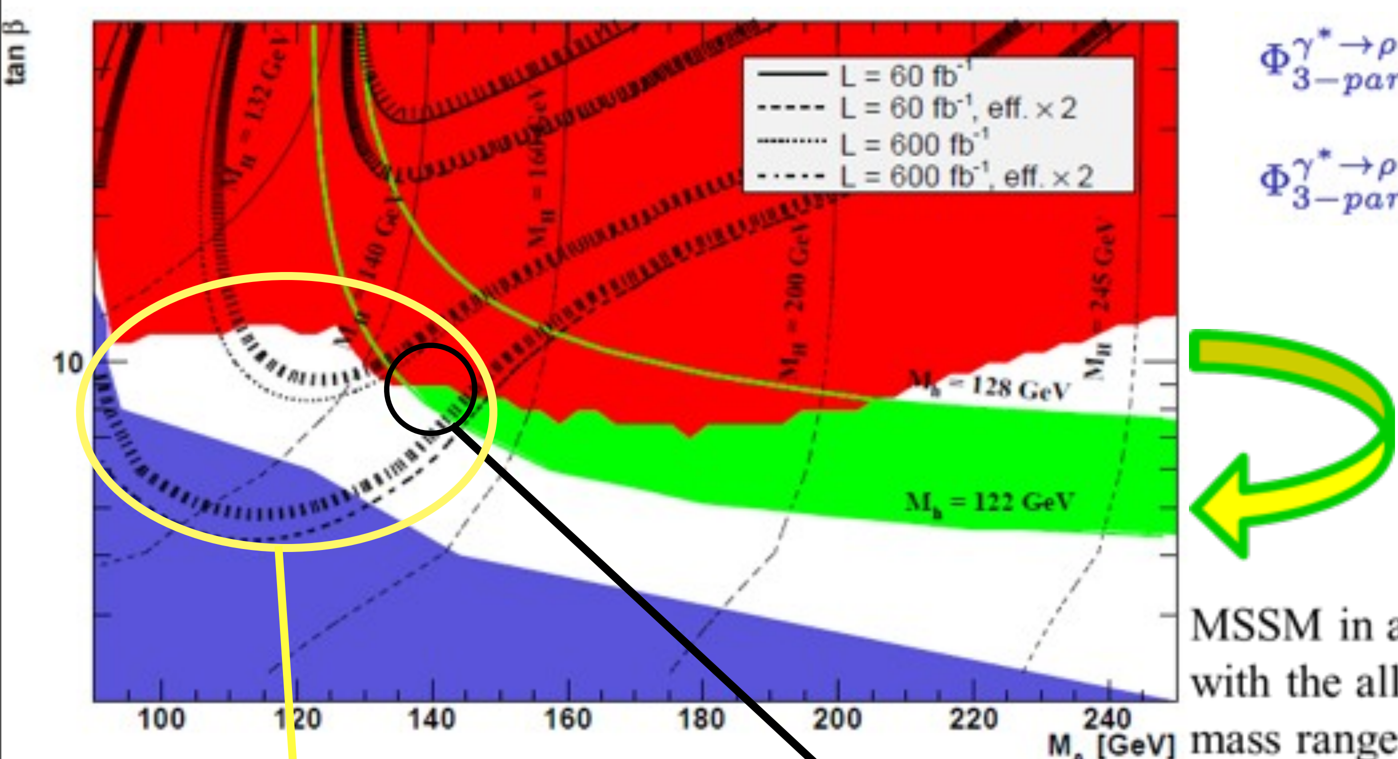
A. Besse

Higgs in Central Exclusive Diffraction!

J_Z = 0, C-even, P-even selection rule leads to a clear determination of quantum numbers of the
centrally produced resonance. A few events are enough.

MSSM: large enhancement for H/h→bb enables to measure Hbb Yukawa coupling!





MSSM in agreement with the allowed mass range

SM

MSSM enhancement

$$\Phi^{\gamma^*\to\rho,nf}_{3-parton} \propto \int d^2\underline{x}\, S(y_1,y_2)\mu^2 K_0(\mu\,|\underline{x}|)\times\mathcal{N}(\underline{x},\underline{k}) + \int dy_1\, dy_2\, \frac{2S(y_1,y_2)}{\bar{y}_1}$$

$$\Phi^{\gamma^*\to\rho,f}_{3-parton} \propto \int d^2\underline{x}\, S(y_1,y_2)\mu^2 K_2(\mu\,|\underline{x}|)\times\mathcal{N}(\underline{x},\underline{k})$$

- gluon amplitude calculated up to twist 3
- photon wave function factorizes in the WW approximation
- Saturation effects to be included

E. Chapon

A. Szczurek

Vector Boson Couplings

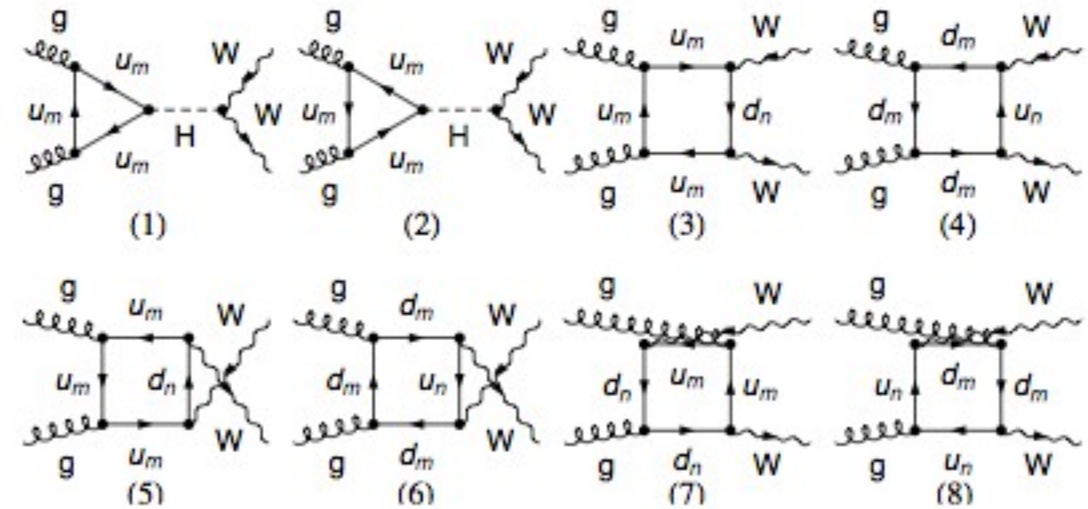
Lagrangian for anomalous quartic gauge couplings:

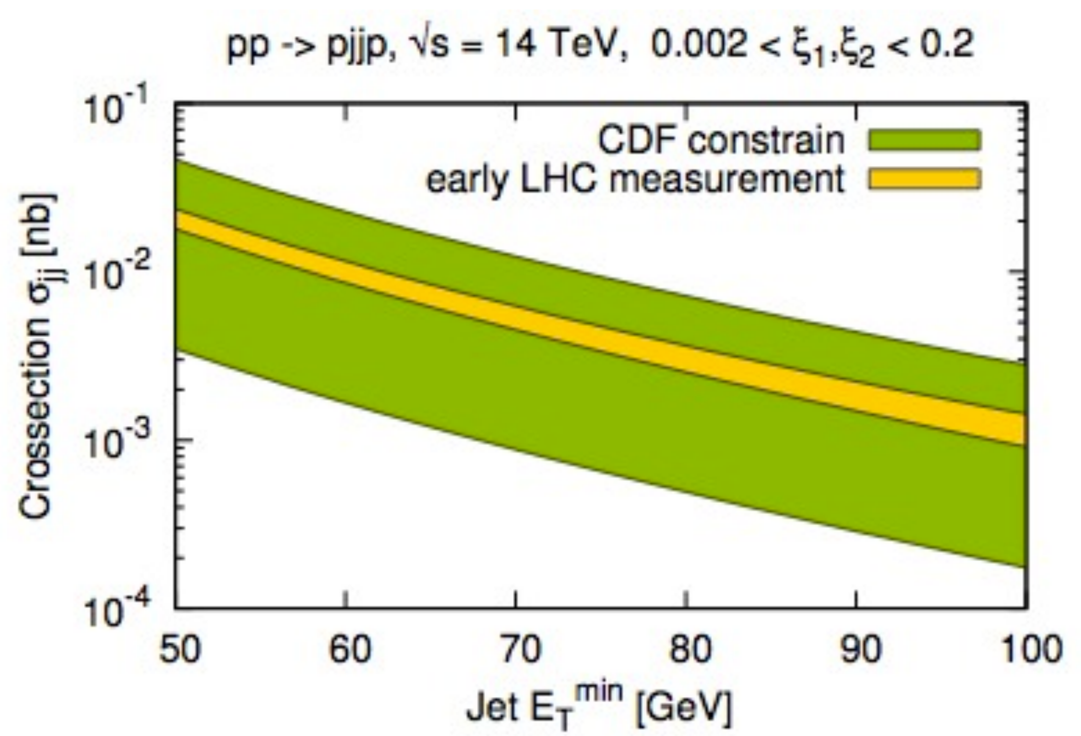
$$\mathcal{L}_6^0 = \frac{-e^2}{8}\frac{a_0^W}{\Lambda^2} F_{\mu\nu}F^{\mu\nu}W^{+\alpha}W^-_\alpha - \frac{e^2}{16\cos^2\Theta_W}\frac{a_0^Z}{\Lambda^2}F_{\mu\nu}F^{\mu\nu}Z^\alpha Z_\alpha$$

$$\mathcal{L}_6^C = \frac{-e^2}{16}\frac{a_C^W}{\Lambda^2} F_{\mu\alpha}F^{\mu\beta}(W^{+\alpha}W^-_\beta + W^{-\alpha}W^+_\beta) - \frac{e^2}{16\cos^2\Theta_W}\frac{a_C^Z}{\Lambda^2}F_{\mu\alpha}F^{\mu\beta}Z^\alpha Z_\beta$$

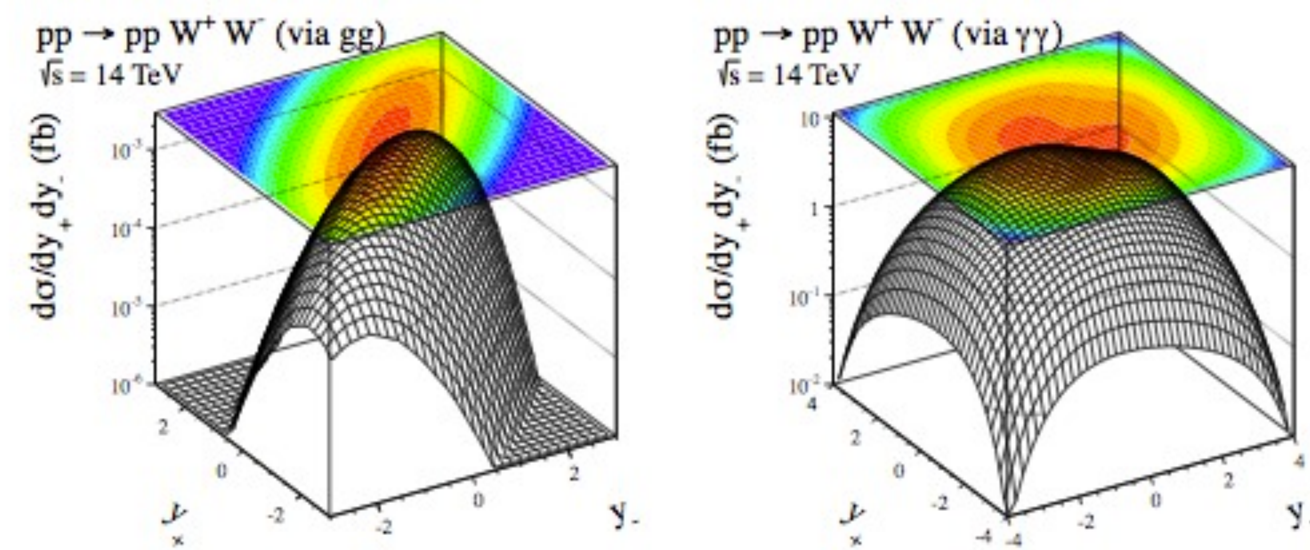
where $F_{\mu\nu}$ is the electromagnetic field tensor $F_{\mu\nu} = \partial_\mu A_\nu - \partial_\nu A_\mu$

LHC up to 4 orders of magnitude more sensitive than LEP





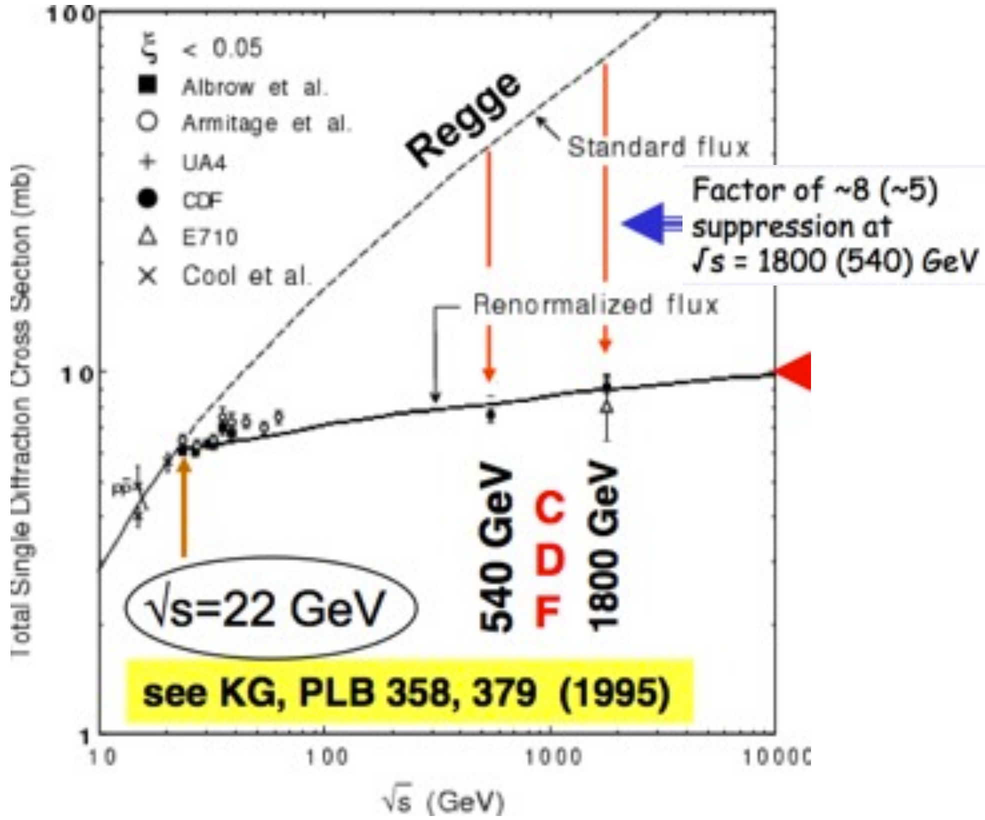
effect of LHC on the Sudakov FF uncertainties in CEP



- σ(diffractive WW) << σ(γγ->WW)
- very promising laboratory for testing of VB triple and quartic couplings

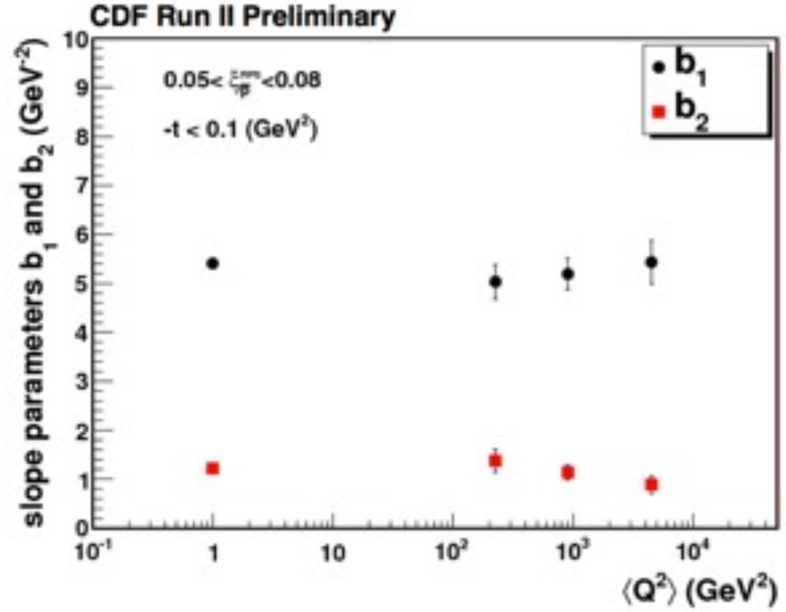
t measurement @ CDF

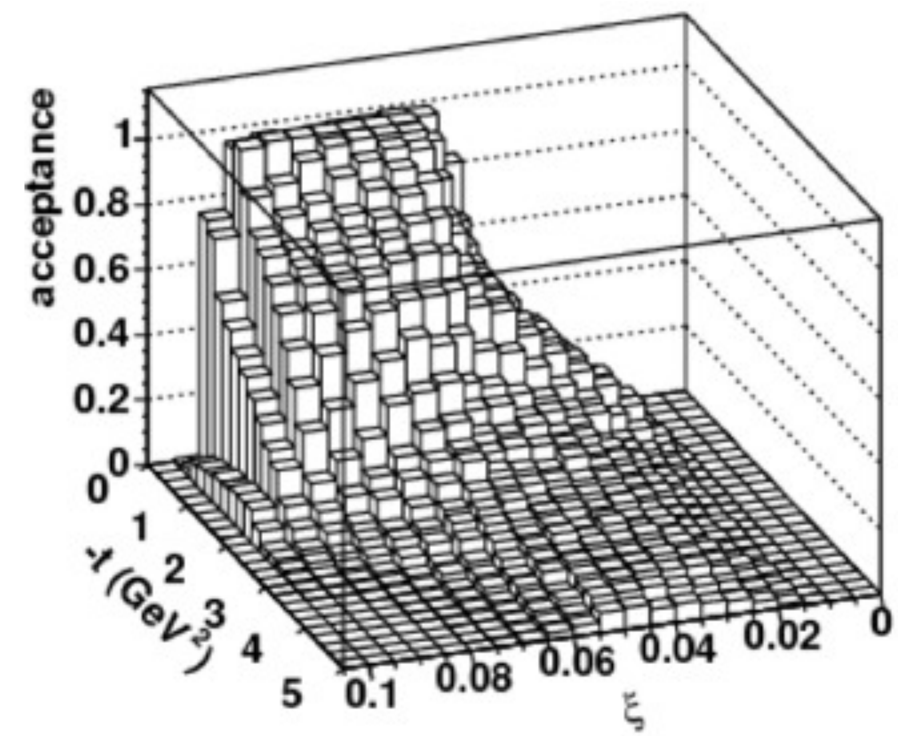
K. Goulianos

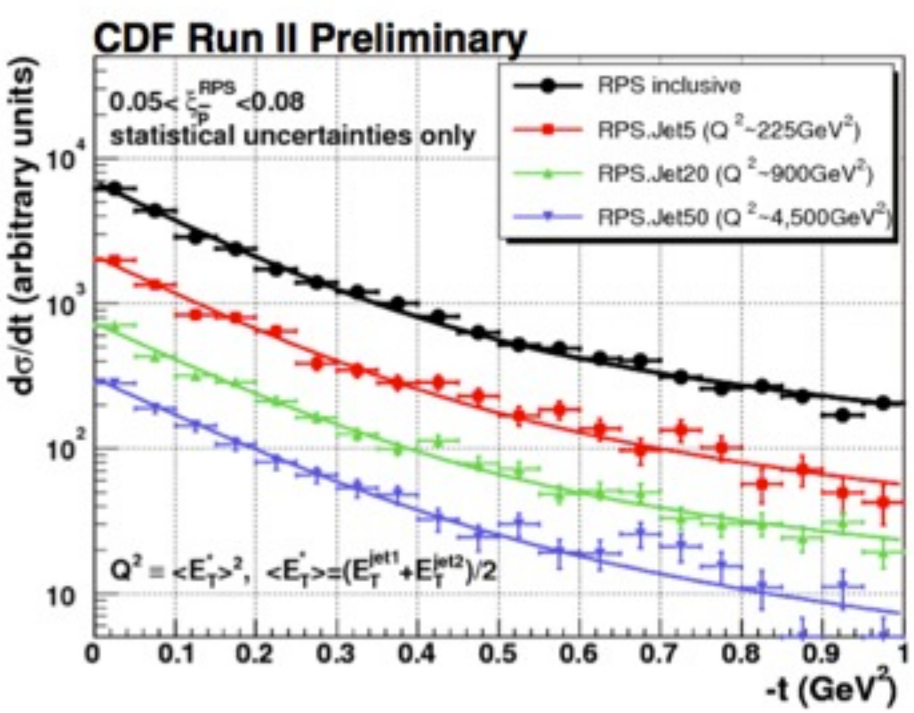


Q: Does factorisation breaking affect t-distributions?

$$F = 0.9 \cdot e^{b_1 \cdot t} + 0.1 \cdot e^{b_2 \cdot t}$$





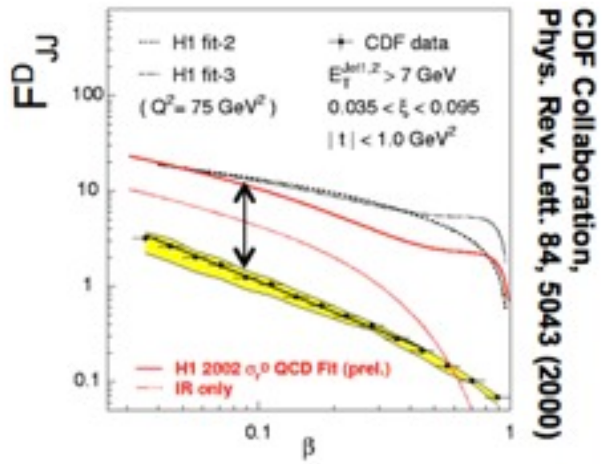


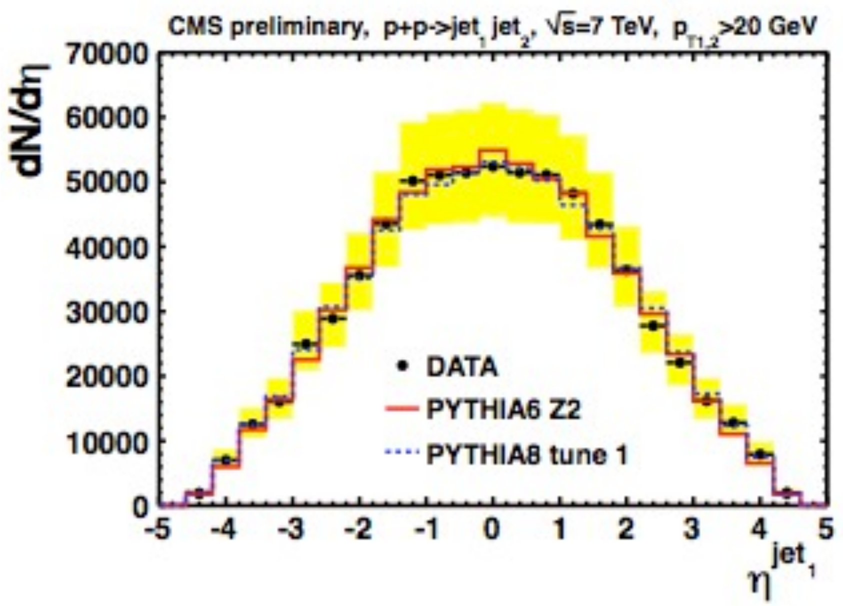
A: No

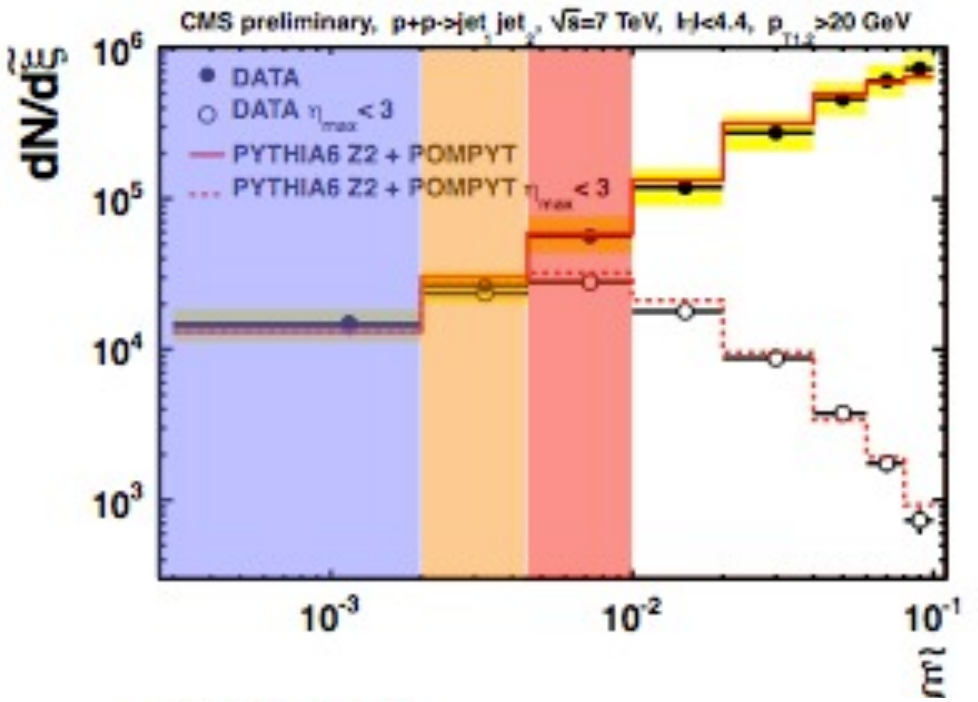
- t slope Q2 independent
- data agree with DL for $t \leq$ ~0.5 GeV2
- flattening larger by ~10 than DL

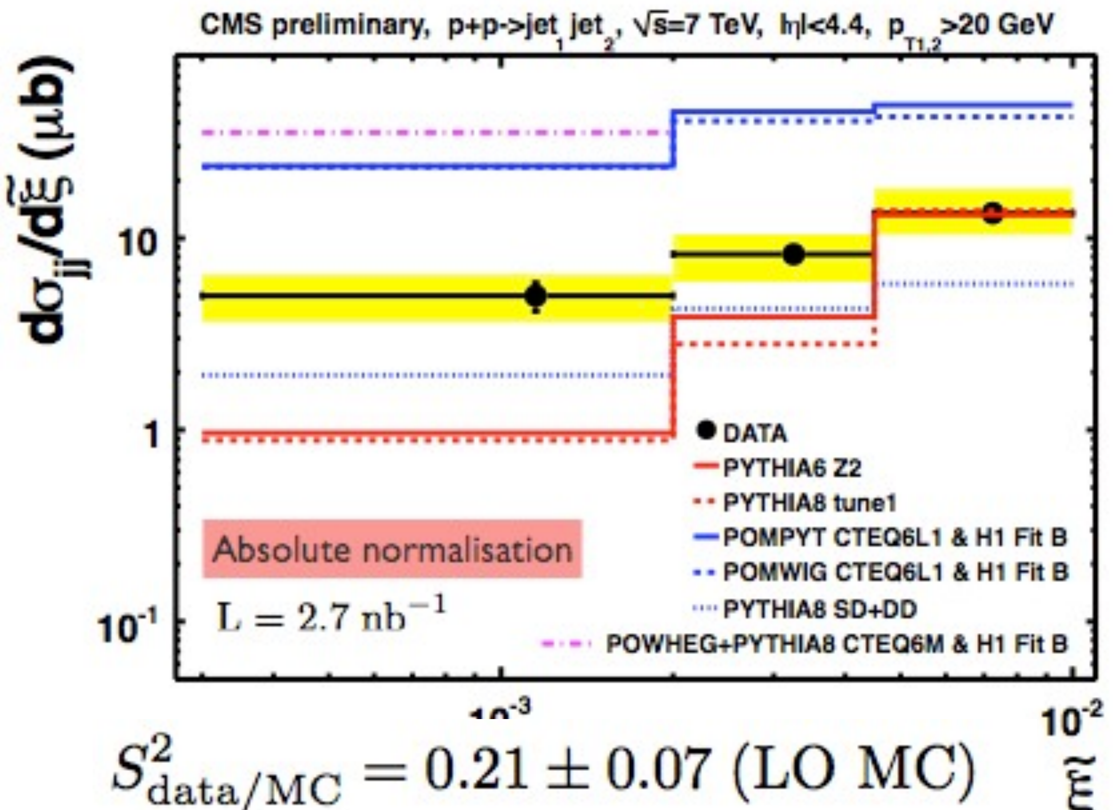
Hard diffraction @ CMS

A.V. Pereira





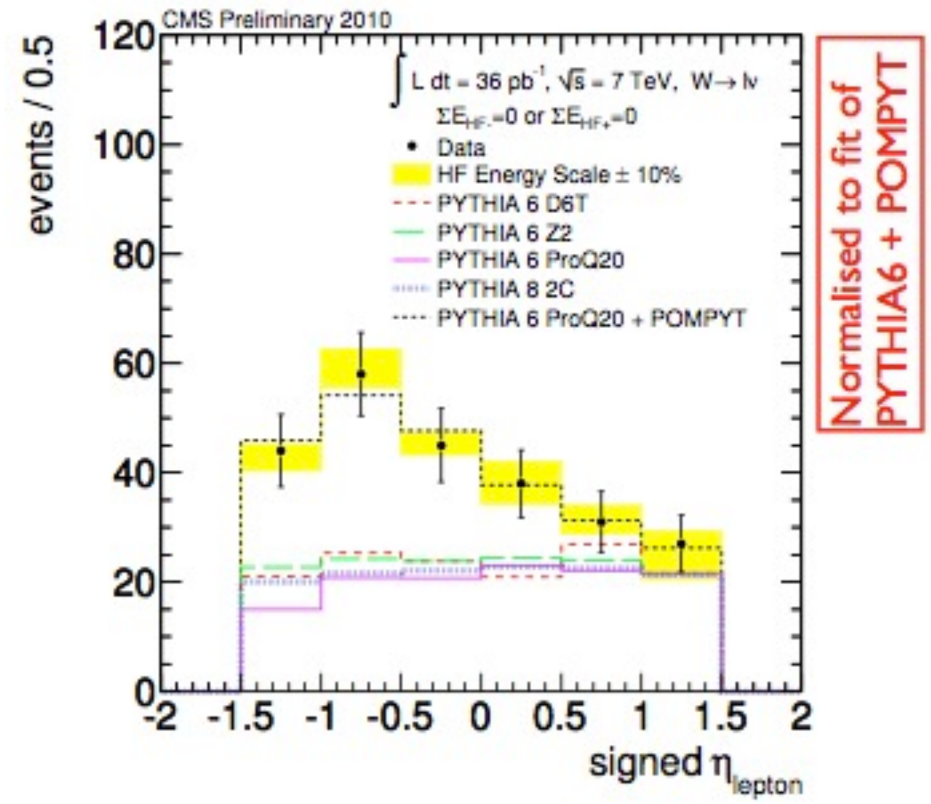




$$S^2_{\mathrm{data/MC}} = 0.21 \pm 0.07 \text{ (LO MC)}$$

$$S^2_{\mathrm{data/MC}} = 0.14 \pm 0.05 \text{ (NLO MC)}$$

based on HERA DPDFs

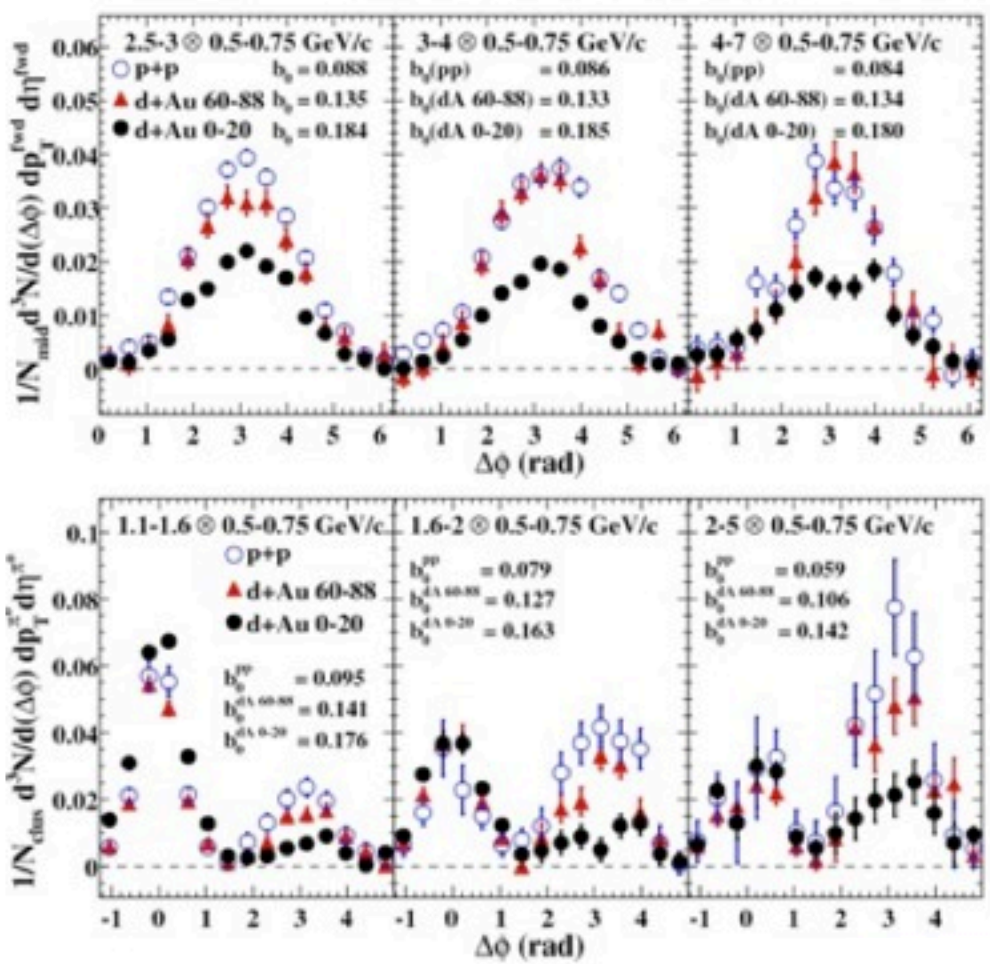


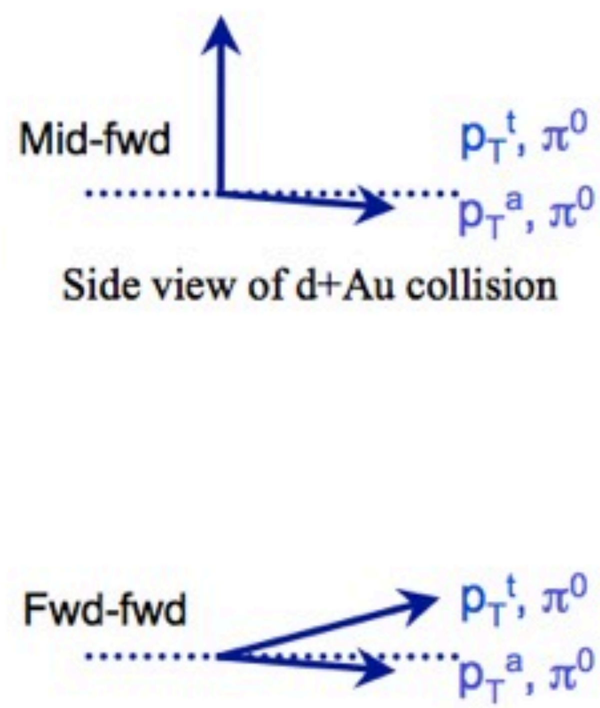
measurements give constraint to the hard diffractive processes @ LHC

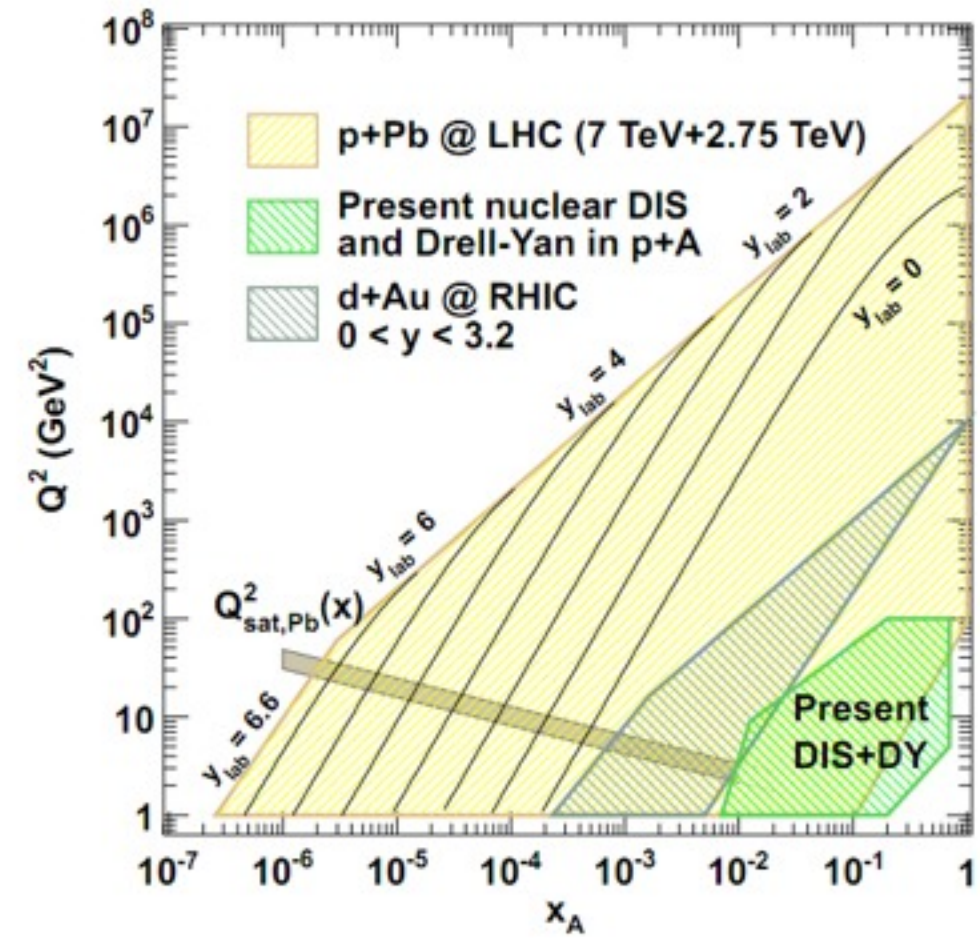
Low x structure of the Nucleus

M. Chiu

PHOENIX @ RHIC





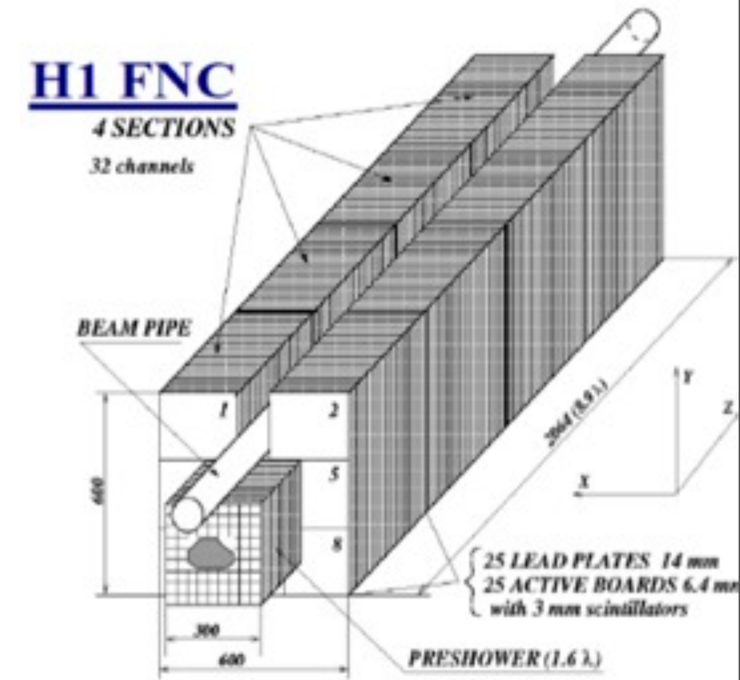


Peripheral d+Au collisions are similar to p+p collisions

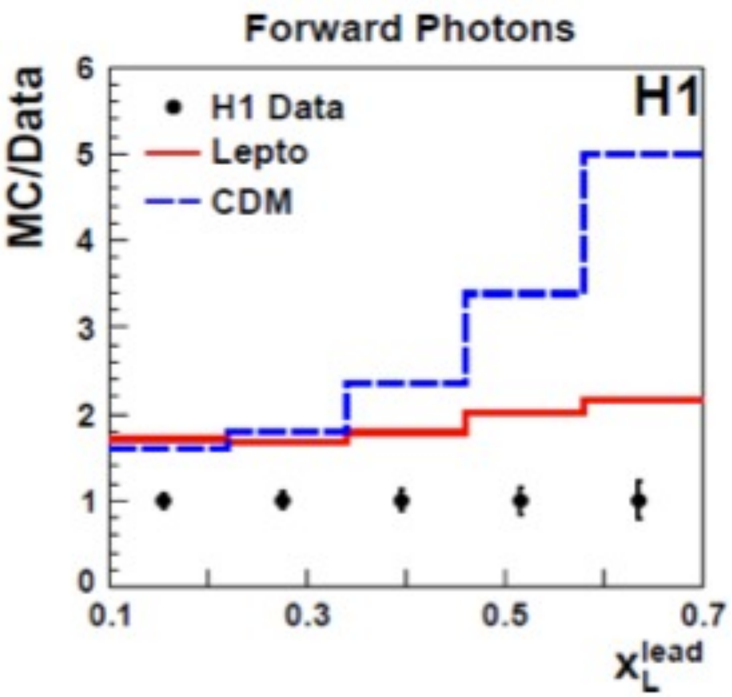
- suppression depends strongly on centrality
- get stronger towards forward rapidities
- do we see nuclear shadowing?
- more results with new data and pPb @ LHC

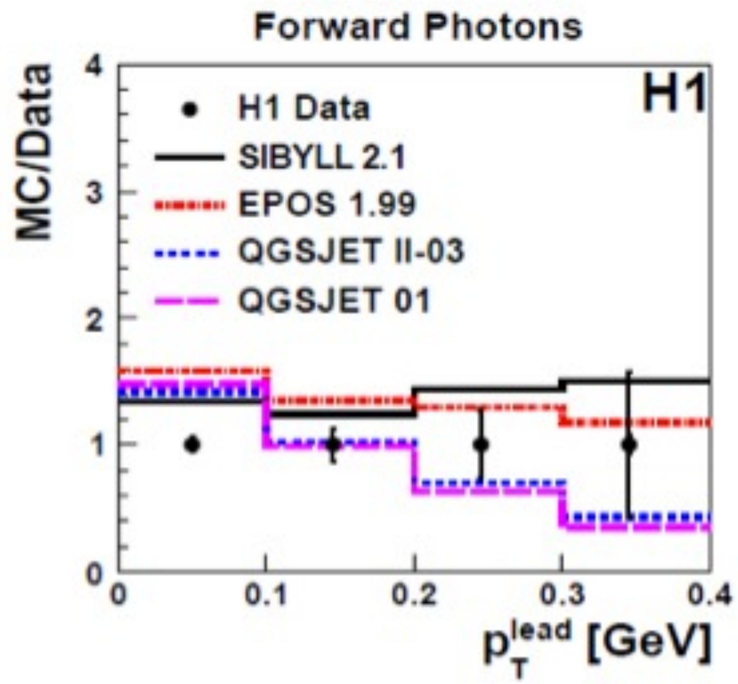
H. Zohrabyan

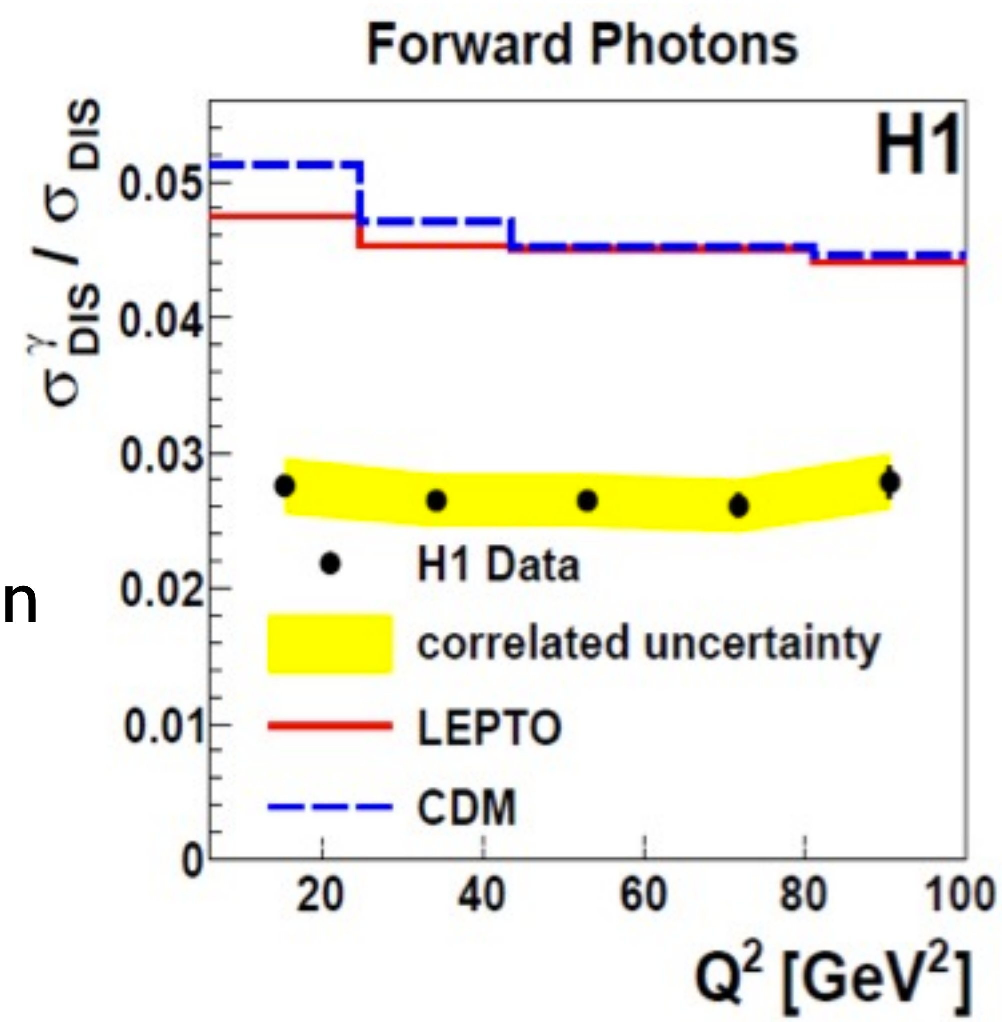
Forward Photons at HERA



- measurement of forward photons in DIS and comparison to inclusive DIS MC models and Cosmic Rays MCs







- measurements show sensitivity to fragmentation models => input for MC tuning
- $\text{yield}_{MC} > \text{yield}_{Data}$
- Lepto - shape ok, CDM - harder spectra
- CRs - over by 30 - 50%, different spectra
- limited fragmentation hypothesis (independence of Q^2 and x_{Bj}) supported by the data

L. Goerlich

Azimuthal correlations at HERA

$0.1 < y < 0.7$

$5 < Q^2 < 85\ \mathrm{GeV}^2$

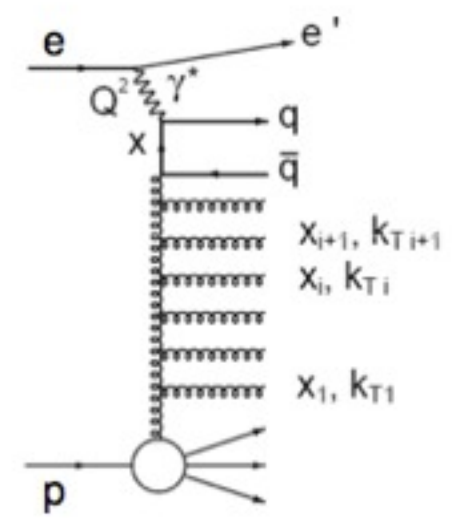
$0.0001 < x < 0.004$

$p_{T,\,\mathrm{fwdjet}} > 6$ GeV

$1.73 < \eta_{\mathrm{fwdjet}} < 2.79$

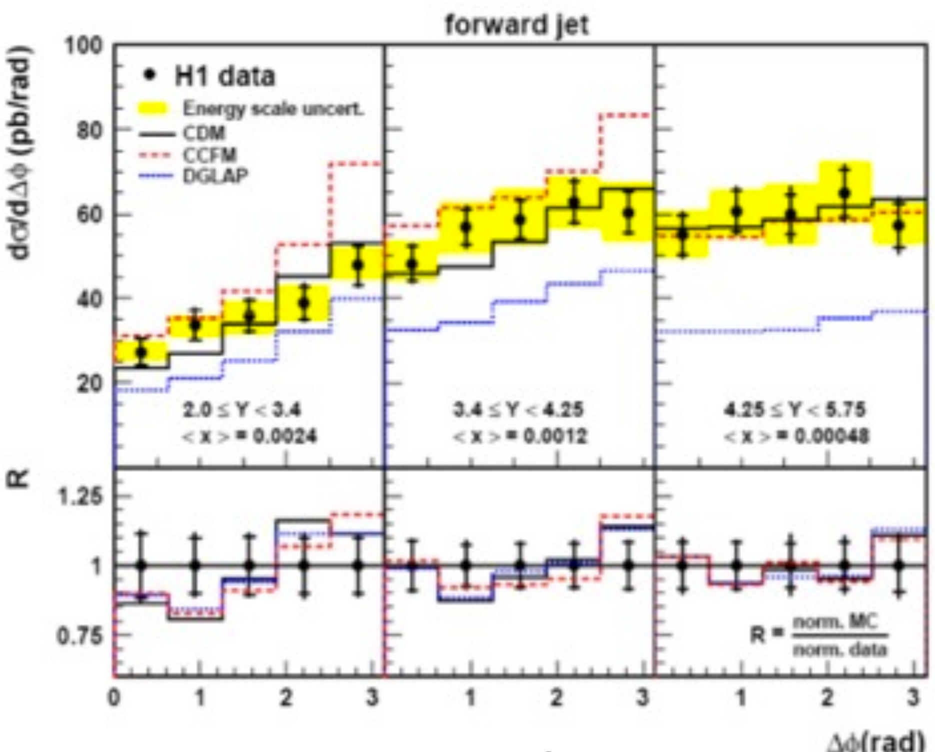
$x_{\mathrm{fwdjet}} = E_{\mathrm{fwdjet}} / E_p > 0.035$

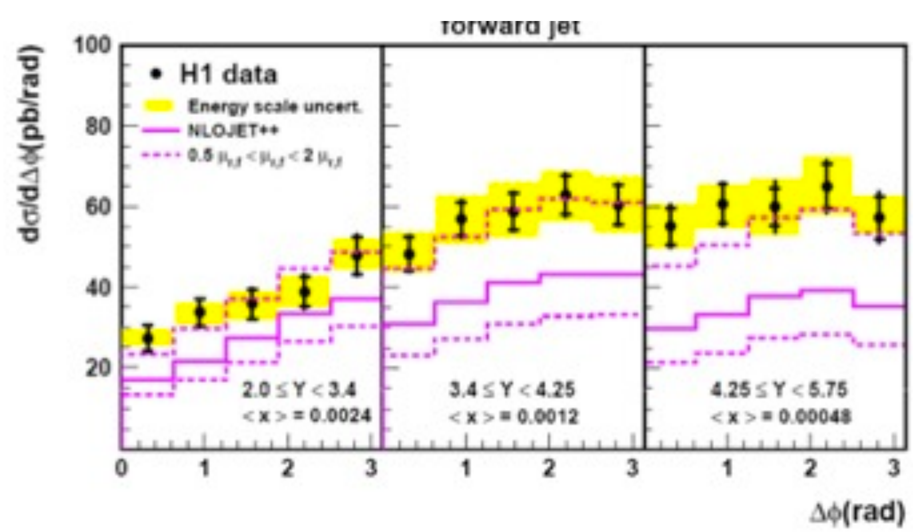
$0.5 < p_{T,\mathrm{fwdjet}}^2 / Q^2 < 6.0$

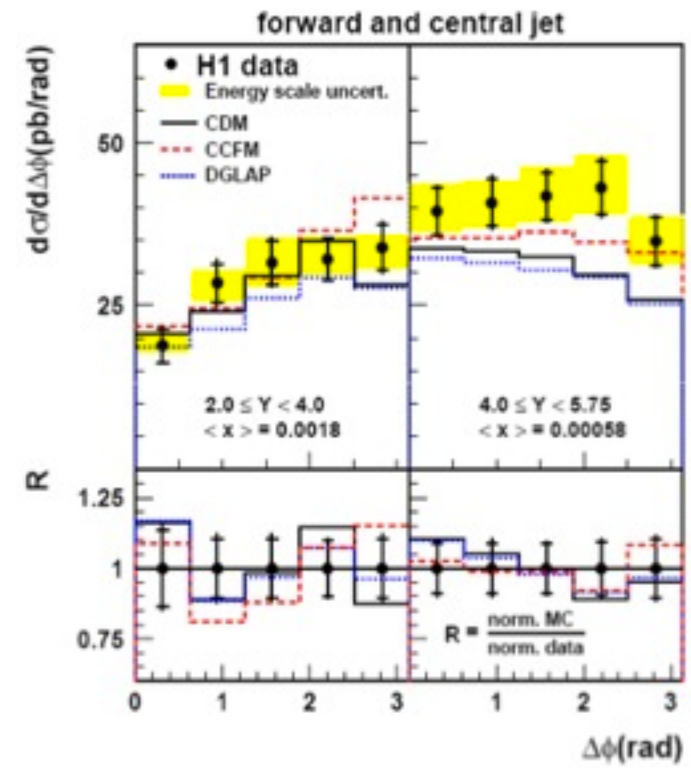


DGLAP - strong k_T ordering (RapGap)
BFKL - strong ordering in x_i (CDM)
CCFM - angular ordering (CASCADE)

$Y = \ln(x_{\mathrm{fwdjet}} / x)$







- well described by CDM
- DGLAP undershoots
- CCFM (A0) good at high Y, but very PDF dependent

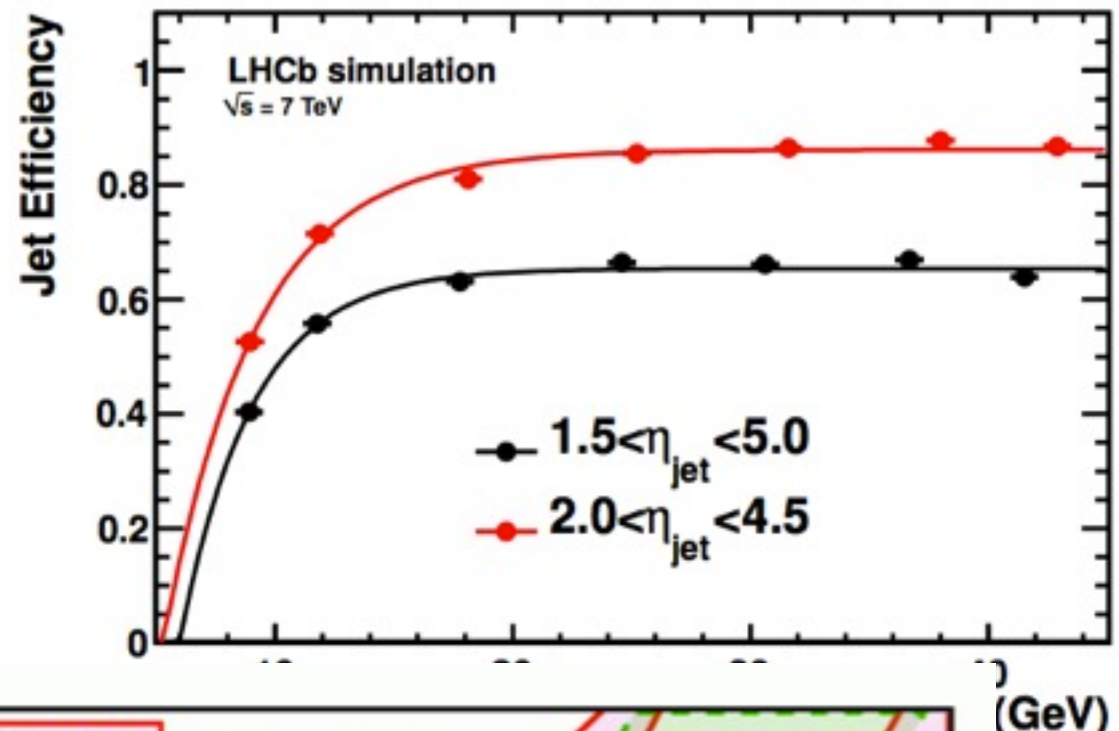
forwardjets originate from parton showers and not ME (NLO ~ LO)

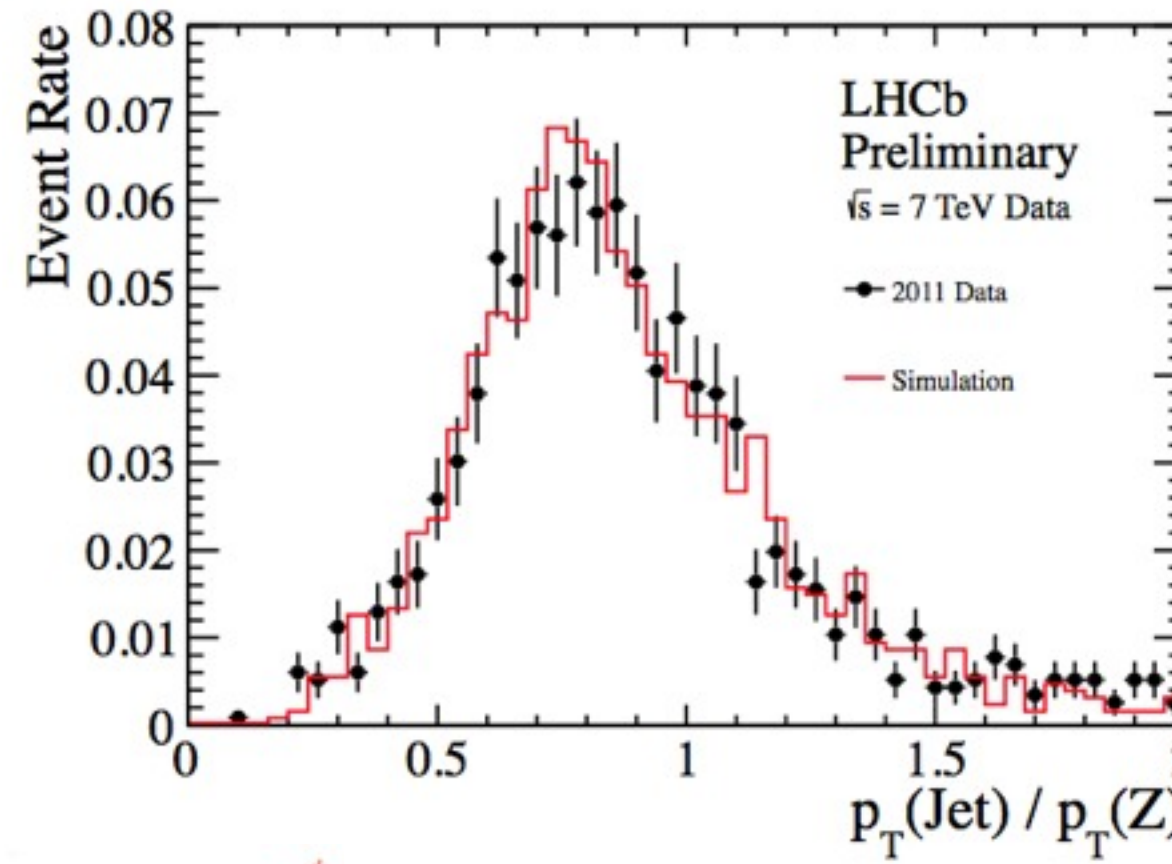
enhaces radiation, delta eta > 2
all models fine for low Y

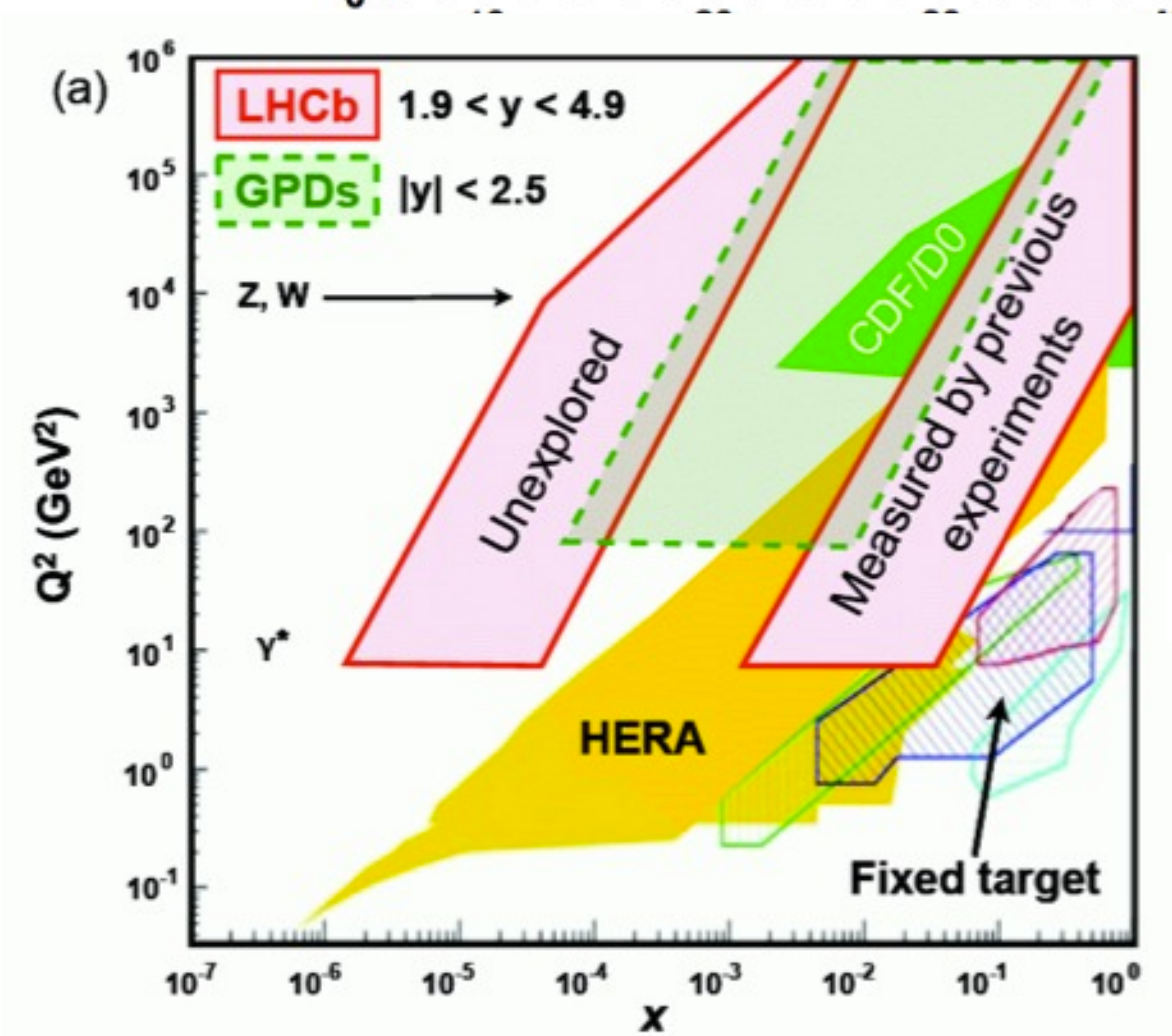
- best description by BFKL-like CDM
- NLO DGLAP within uncertainties

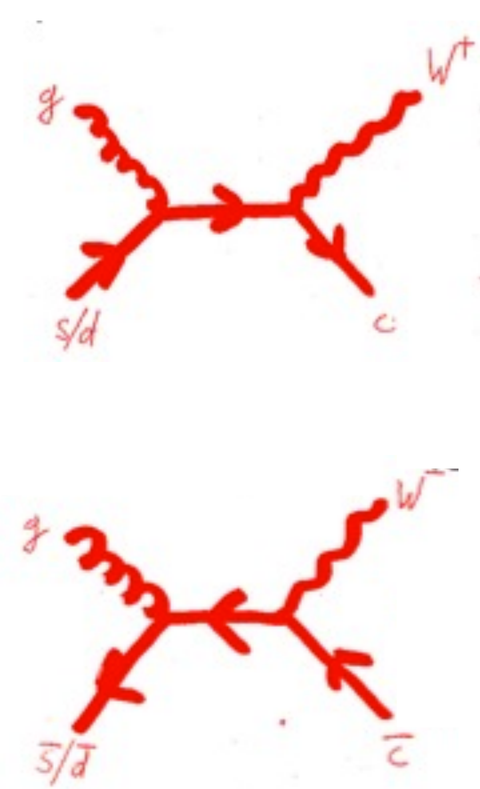
Jet reconstruction in LHCb

A. Bursche









- Z+jet production
- Data agree well with simulation
- constraining power on PDFs