Diffractive *Open Charm* Production at HERA

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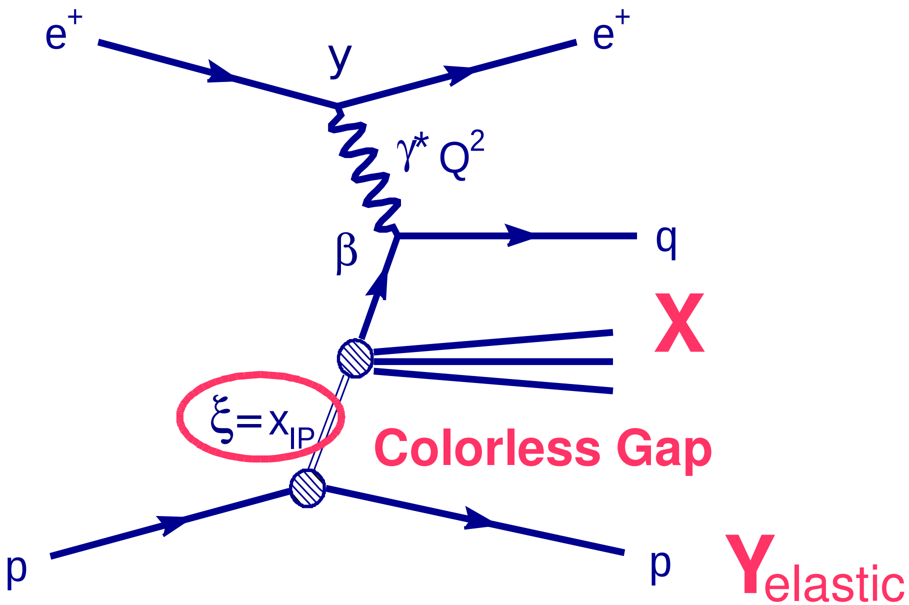
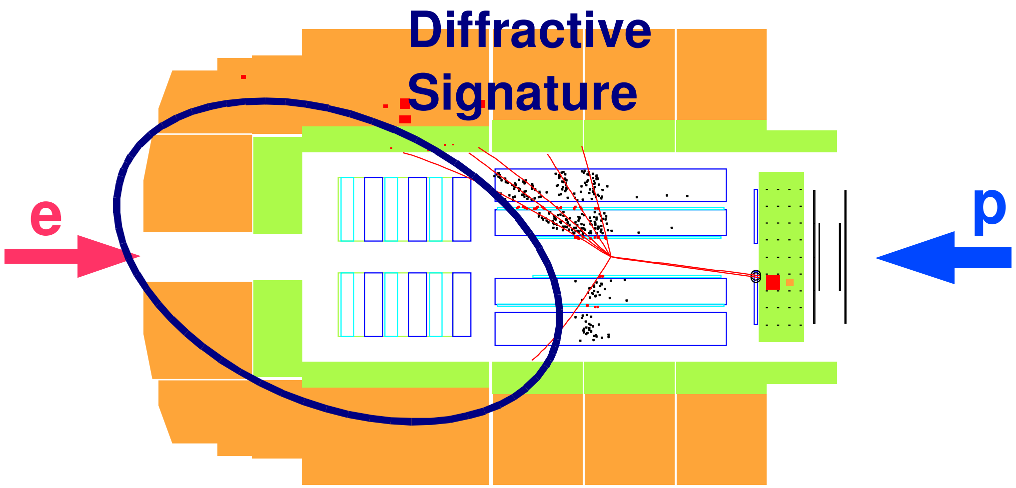
Diffractive *open charm* Production...



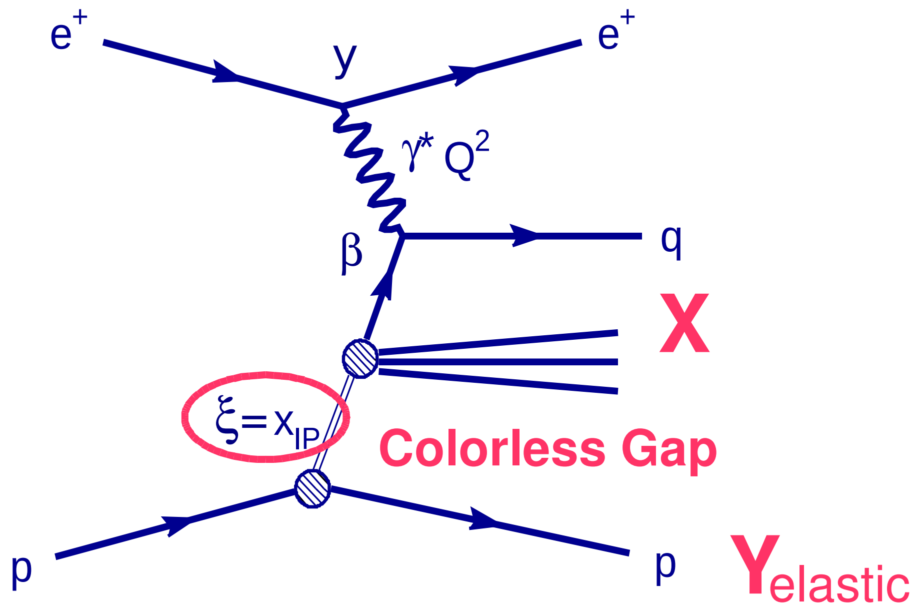
...means a 2-fold restriction to the Hadronic Final State:

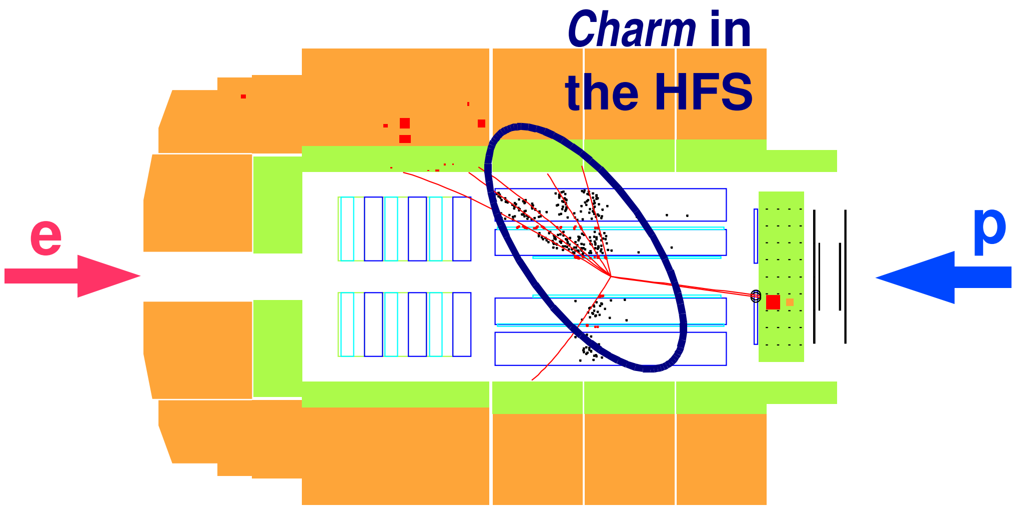
(1) Diffractive Event Signature

- **NO** forward energy flow
- **Less than 3%** of the proton momentum take part in the hard scattering process



Diffractive *open charm* Production...





...means a 2-fold restriction to the Hadronic Final State:

(1) Diffractive Event Signature

- **NO** forward energy flow
- **Less than 3%** of the proton momentum take part in the hard scattering process

(2) Charm Quarks in Final State

- Reconstruct **exclusively** (D*-mesons)
- Reconstruct **inclusively** via character. properties of *charmed* hadrons (lifetime)

Outline

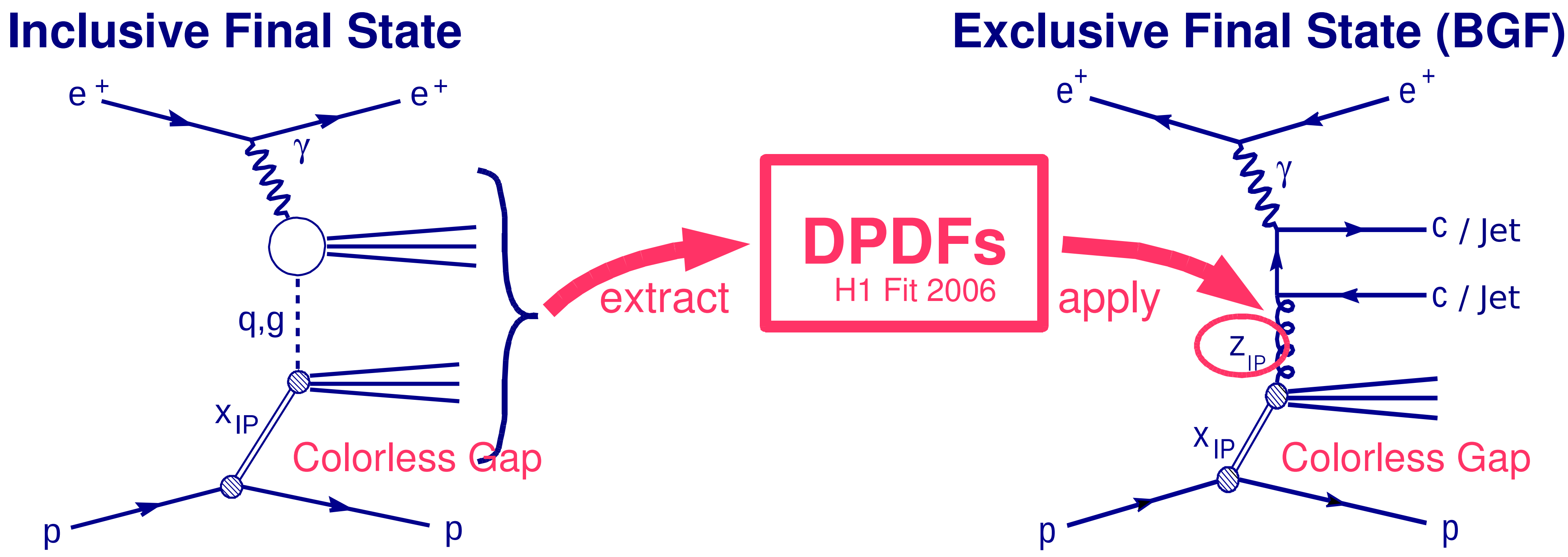
- Tests of QCD Factorization in Diffraction (in the frame of H1 diffractive parton densities from F2d)

- Test of perturbative 2g models (describe diffractive scattering with inclusive PDFs)

- Charm contribution to F2d (model independent property)

QCD Factorization in Diffraction

$$\sigma_{meas} = (\textbf{universal}\ \text{DPDFs}) \otimes (\text{Hard}\ \textbf{ME})$$



- **Solid proof** for ep at 'sufficiently' large scales μ
- **BGF** can be selected by dijets or *open charm*

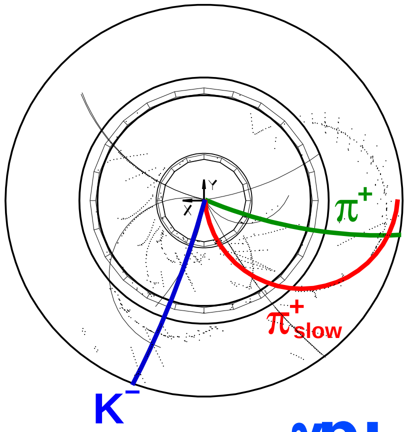
Event Selection in DIS & γp

Charm:

- **$D^* \rightarrow K \pi \pi_s$**
- $p_t(D^*)>2.0$GeV
- $|\eta(D^*)|<1.5$

Diffraction:

- $x_{IP}<0.03$
- $|t|<1.0$ GeV^2
- $M_Y<1.6$ GeV

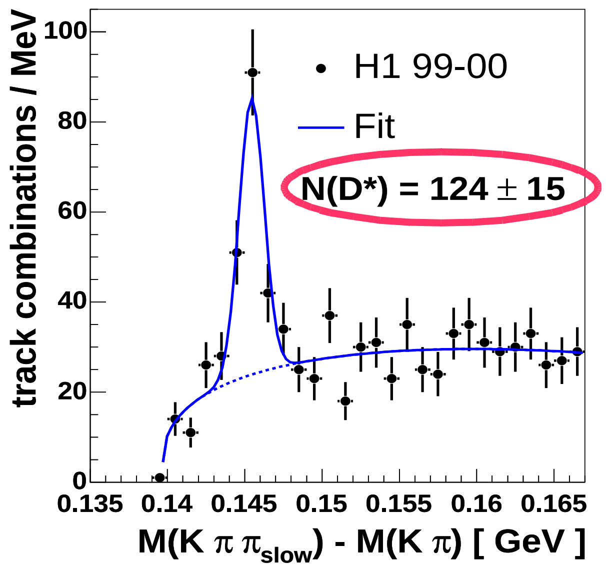


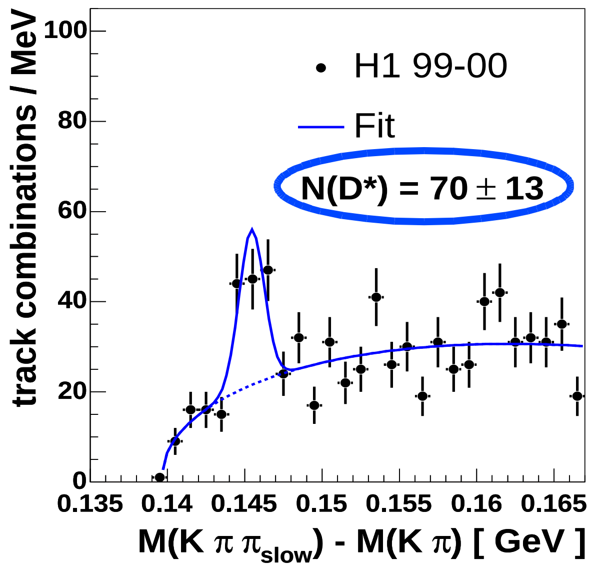
DIS:

- $2<Q^2<100$ GeV^2
- $0.05<y<0.7$

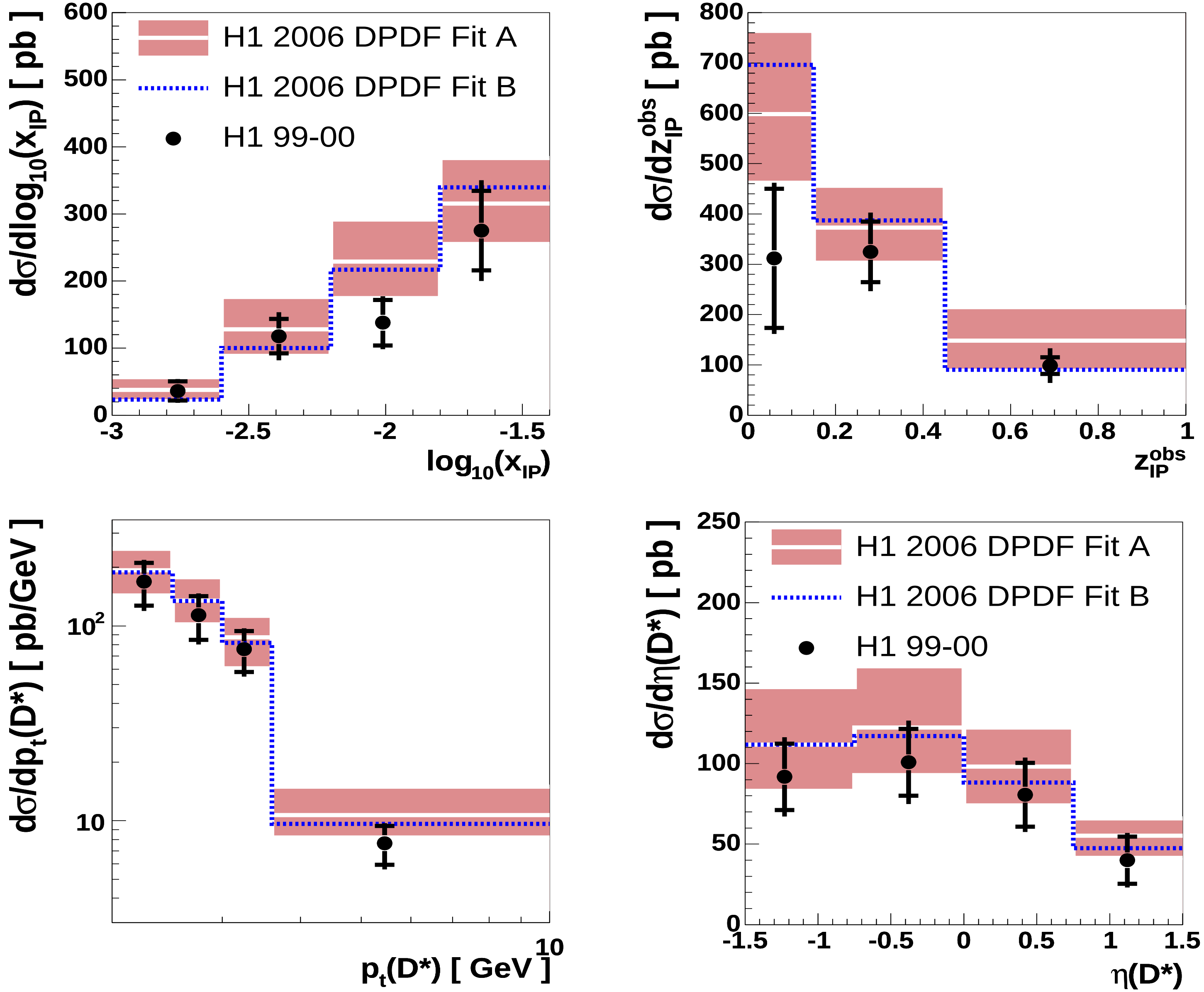
γp:

- $Q^2<0.01$ GeV^2
- $0.3<y<0.65$





*D** Cross Sections in DIS



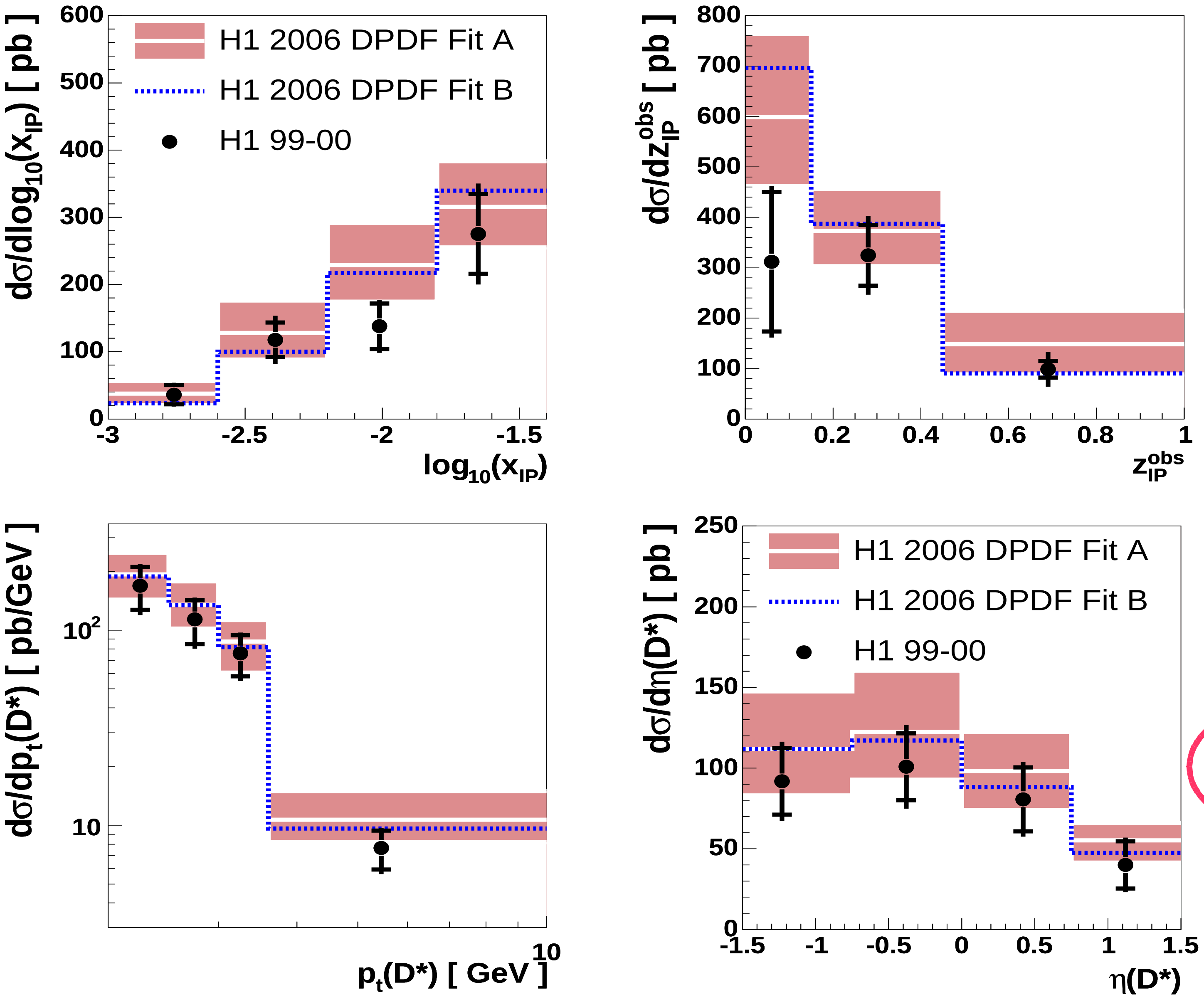
Comparison:

- NLO Calculation (hvqdis): Collins et al. (*massive scheme*)
- H1 2006 DPDF Fit A & B
- At $\mu^2=4m_c^2+Q^2$

Result:

- Overall good description
- QCD Factorization valid for *charm* production in DIS

D^* Cross Sections in DIS



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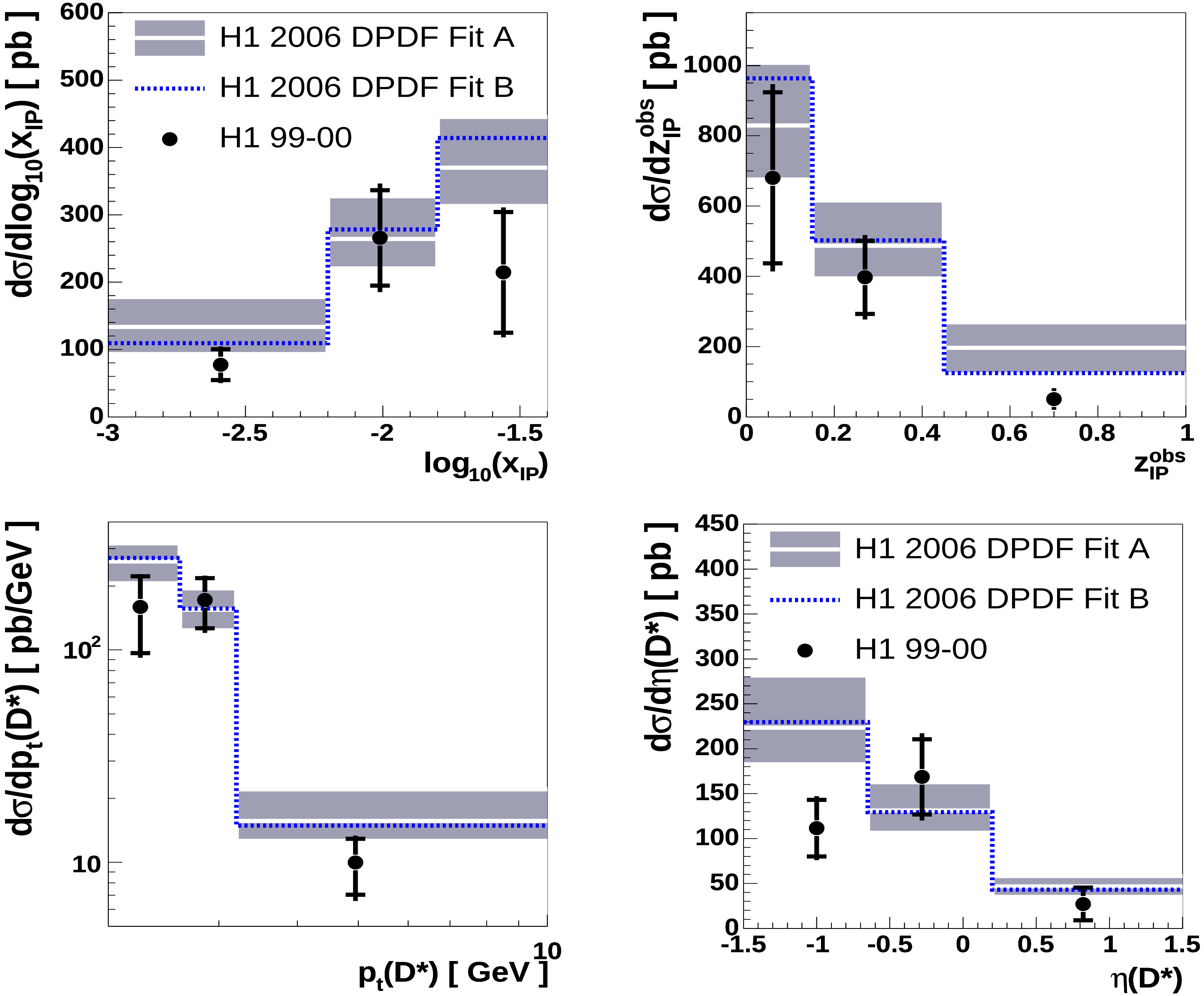
*D** Cross Sections in γp



Comparison:

- NLO Calculation (fmnr): Frixione et al. (*massive scheme*)
- H1 2006 DPDF Fit A & B
- At $\mu^2 = 4m_c^2 + p_t^2$

Result:

- Overall good description!
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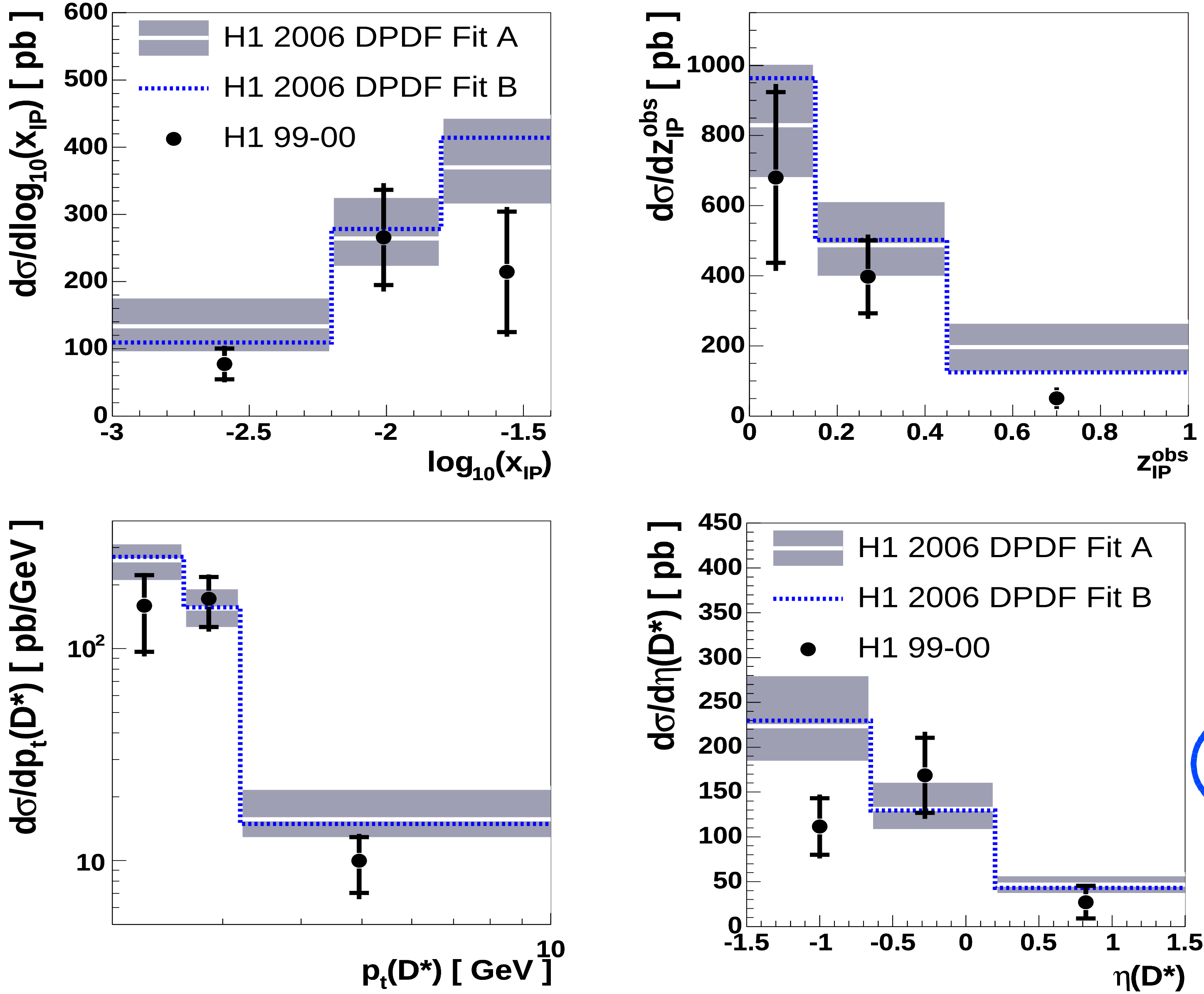
*D** Cross Sections in γp



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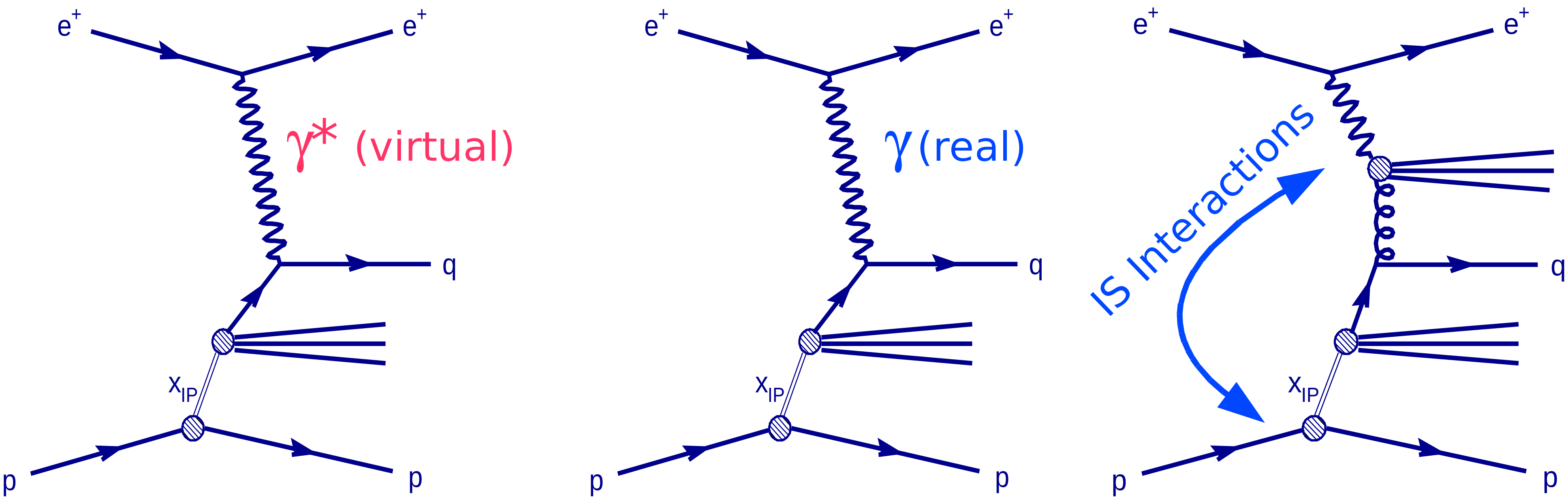
Relevance of the γp Masurement

DIS | **Photoproduction (γp)**



Lepton-Hadron | Photon-Hadron | Hadron-Hadron

	Photon (direct)	Hadron (resolved)
Open charm	**~90%**	~10%
Dijet	~60%	~40%

QCD Factorization: Summary

Observation:

- Good description of all differential distributions
- No indication for Factorization Breaking in γp
- Still compatible with a gap survival of 0.6 (esp. for a suppression preferencially of the hadronic part of the γ)

Double Ratio:

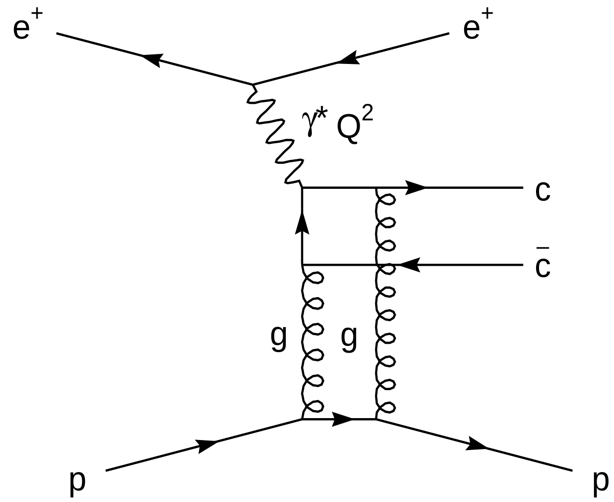
DIS restricted to the same range in y as in γp

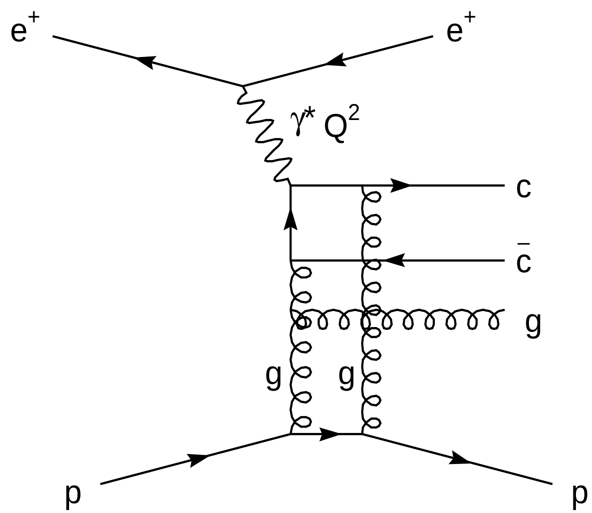
$$R_{DIS}^{\gamma p} = \frac{(\sigma_{vis}/NLO)_{\gamma p}}{(\sigma_{vis}/NLO)_{DIS}} = 1.15 \pm 0.40(\text{stat}) \pm 0.09(\text{syst})$$

- Low Statistics (in γp & in restricted DIS)
- $\sim 1.4\sigma$ deviation from 0.6

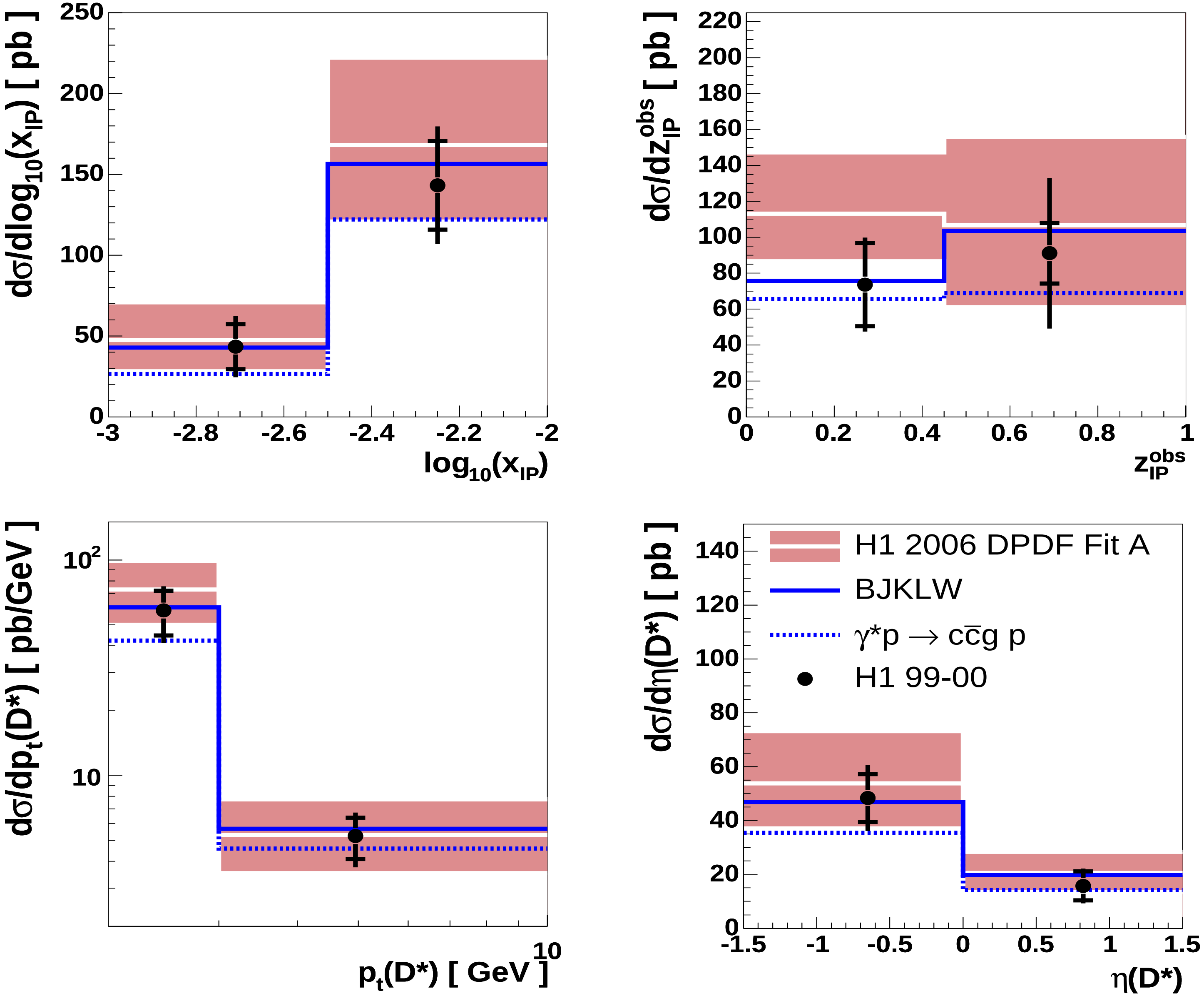
The Perturbative 2g Model

- Describes diffractive processes via simplest possible colorless exchange (2g)
- Input: inclusive PDFs (J2003 set 2)
- Factorization scheme: CCFM, k_t
- One free parameter ($p_t(g)_{ccg}$ tuned to forward jet measurements)
- Valid only where secondary Reggeon exchanges are suppressed (x_{IP}<0.01)





D^* Cross Sections in DIS (x_{IP}<0.01)



Comparison:

- LO MC Rapgap (CCFM, k_t)
- J2003 set 2
- With $p_t(g)$>2 GeV
- cc & ccg contrib'n

Result:

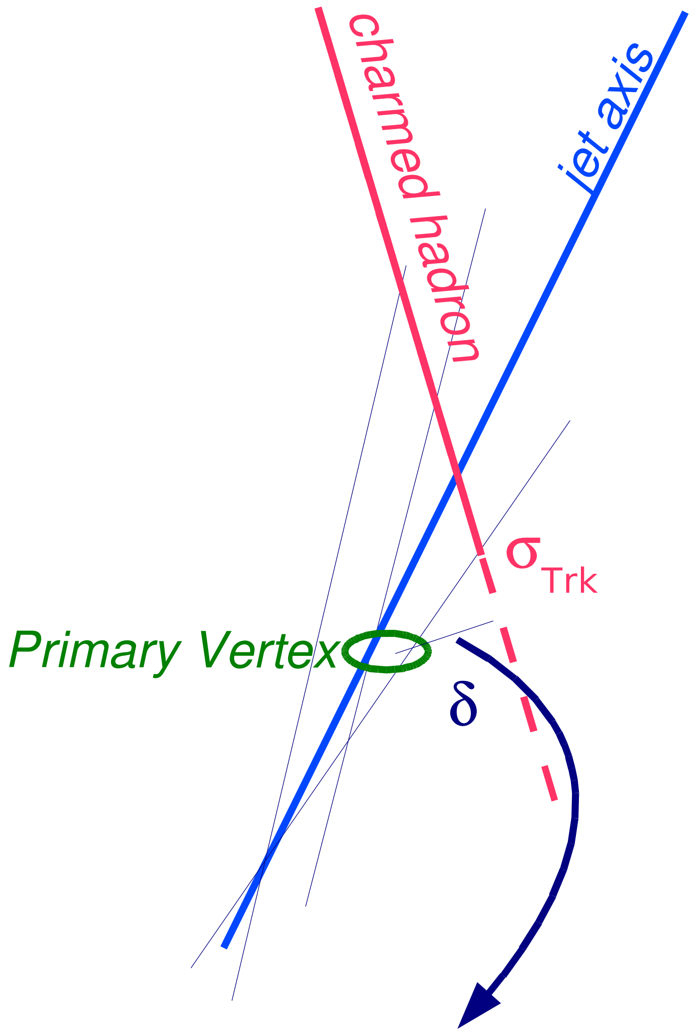
- Overall good description
- 2g works well
- Need ccg contrib'n

The Structure Function F2d(*charm*)

- Determine Diffractive Structure Function with the condition of *charm* in the event

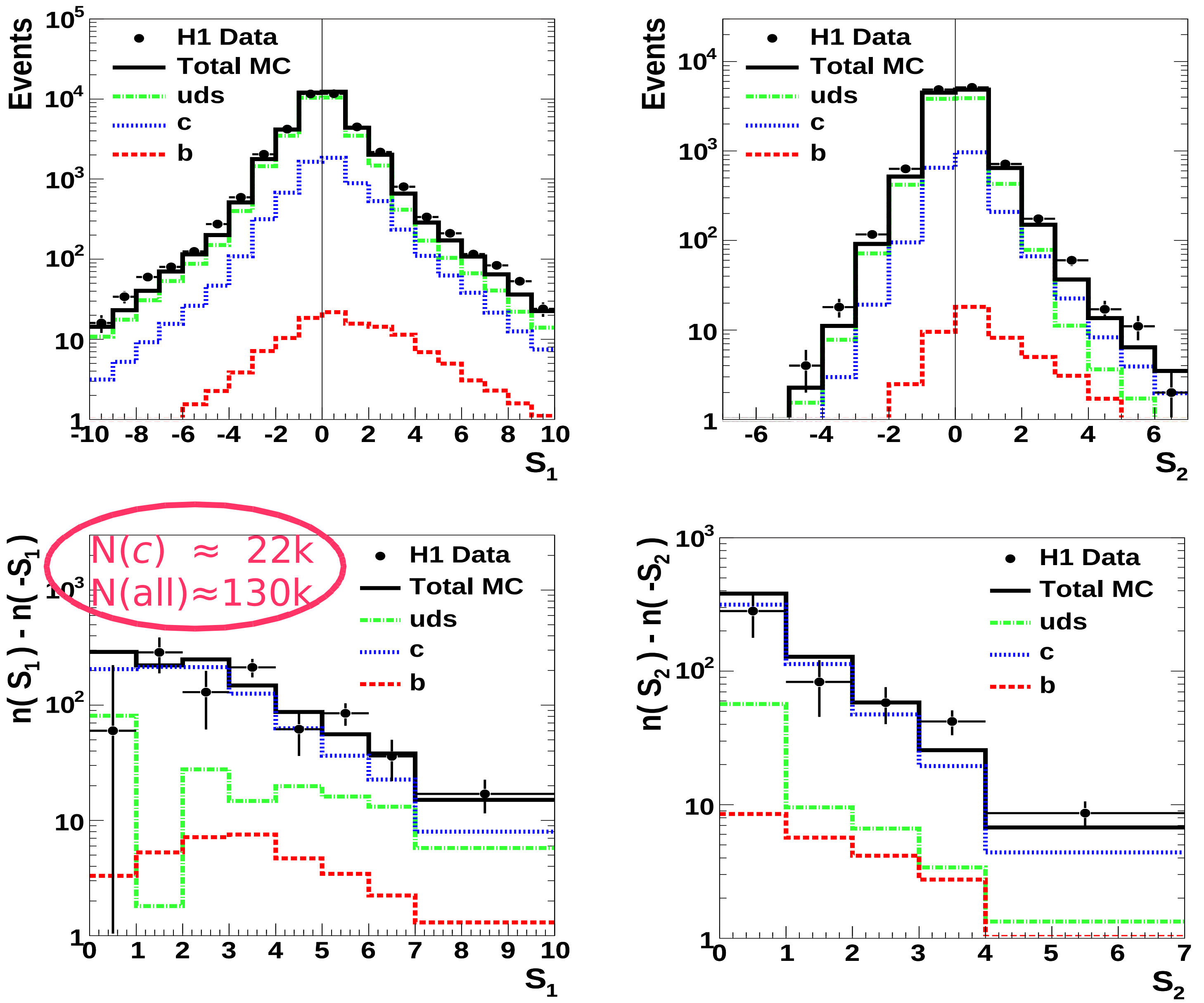
- Large extrapolation factors if determined by *D** due to visible range restriction (~3 for p_t>2GeV, $|\eta|$<1.5)

- Introduce new method (from hep-ex/0411046, hep-ex/0507081) to determine *charm* inclusively from displaced tracks (lifetime measurement)



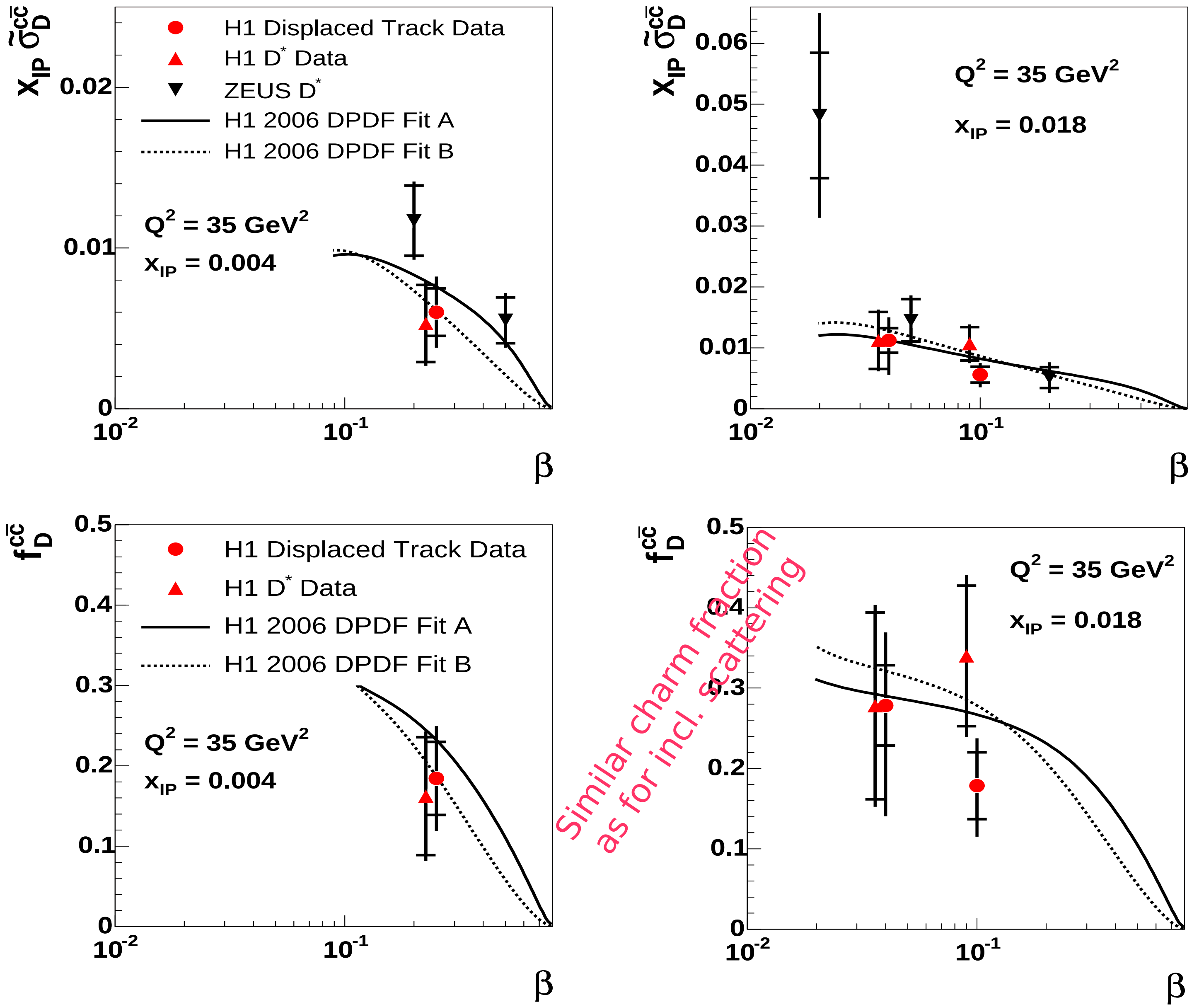
- Impact Parameter δ
- Significance $S=\delta/\sigma_{Trk}$

Significance and Impact Parameter



- Consider track with highest and second highest S_i
- Subtract neg. from pos. values (resolution from data)
- Fit template distrib's for b/c/uds taken from MC to obtain the signal composition

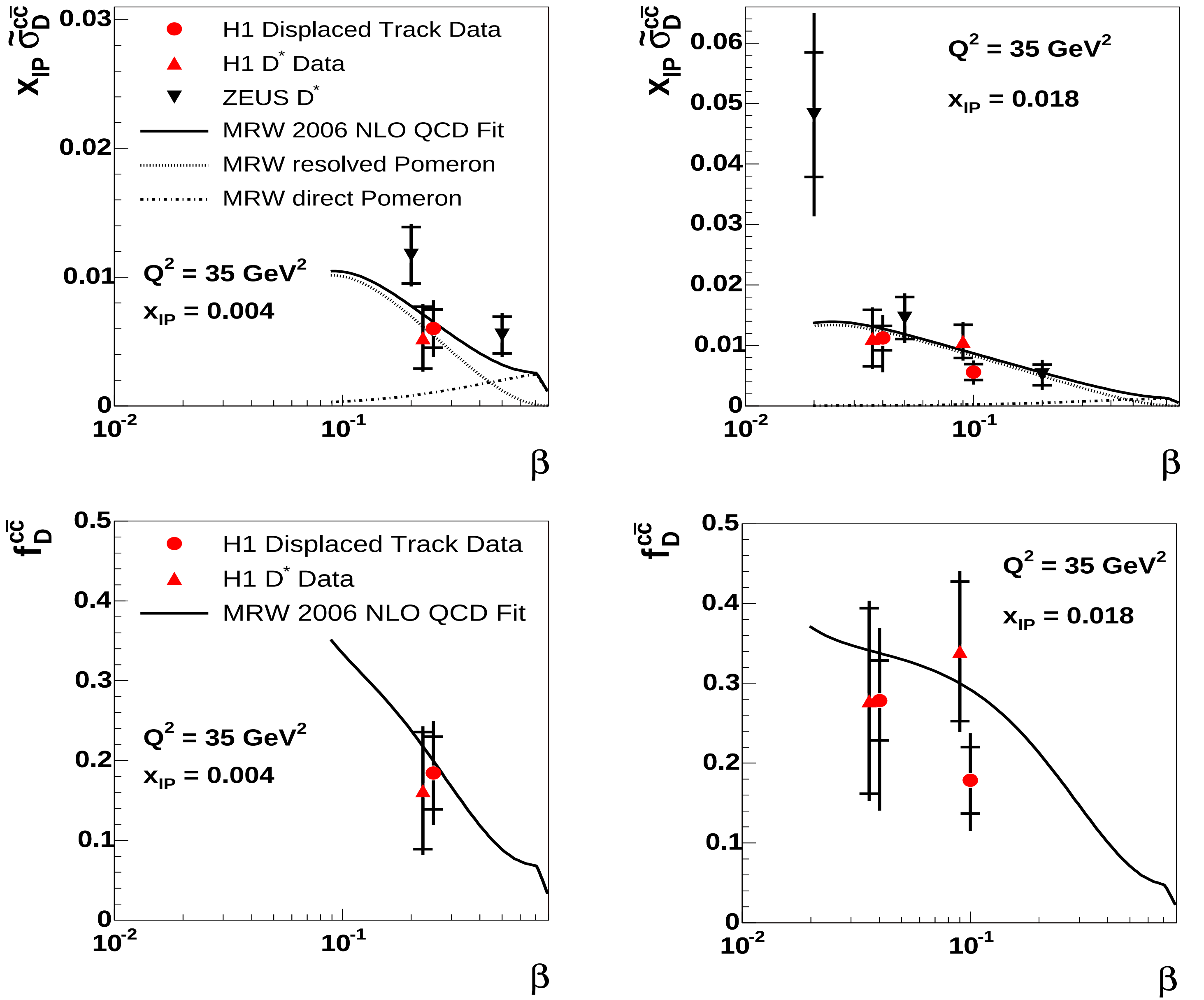
F2d(*charm*) measurement



- NLO: direct comp. (*massive scheme*)
- H1 2006 DPDF Fit A & B
- $\mu^2 = 4m_c^2$

- Overall good agreement between all methods and experiments
- Overall good description

Comparison with 2g Model of MRW



- MRW2006 NLO QCD Fit: direct comp. (*massive scheme*)
- $\mu^2=4m_c^2$

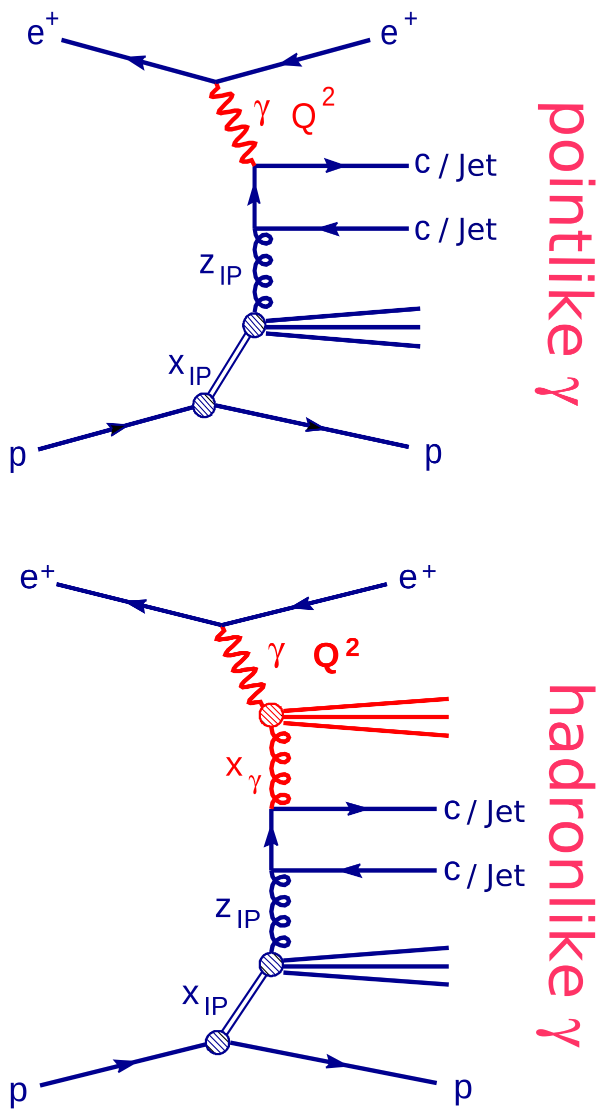
- Overall good description of the data by the model

Conclusions

- New Measurements of Diffractive *open charm* Production at H1 (hep-ex/0610076):
  - Compile a wide kinematic Range ($0.01<Q^2<100$ GeV^2) and different measuring techniques
  - Including a few 'Premiers' at HERA (Diffractive D* in γp, lifetime method)
  - Give a consistent picture between meth's/exp's (experimentally solid data)
  - Are in good agreement with QCD Factorization (in DIS & γp) and with perturbative 2g models in different approaches.

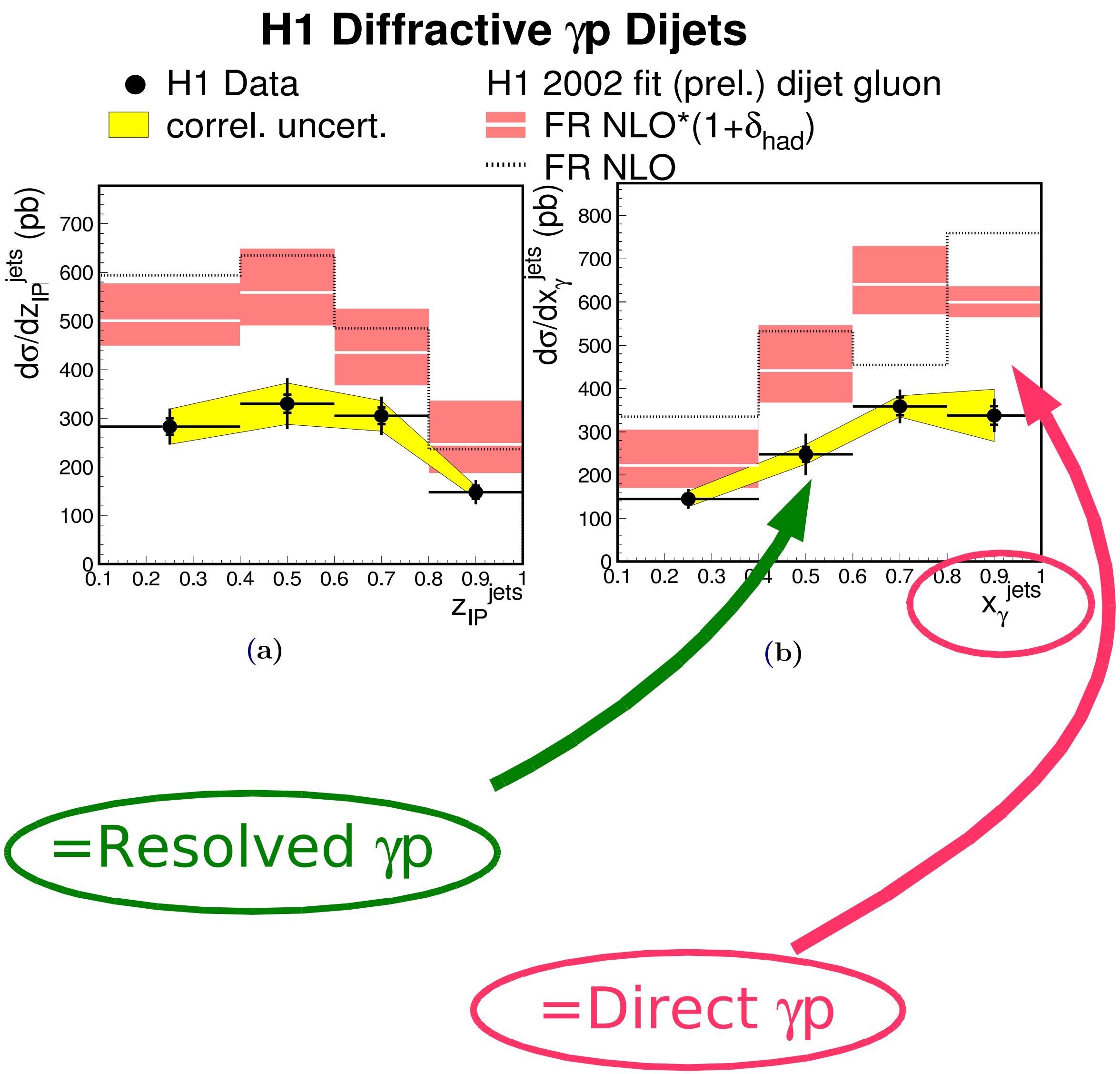
Backup

So far existing Tests in *charm* and dijets



	DIS	γp
Dijets o(1000 evts)	valid in NLO	▶ suppr. of hadron like component ▶ pointlike comp. also suppressed!
open charm	**valid**	**valid**

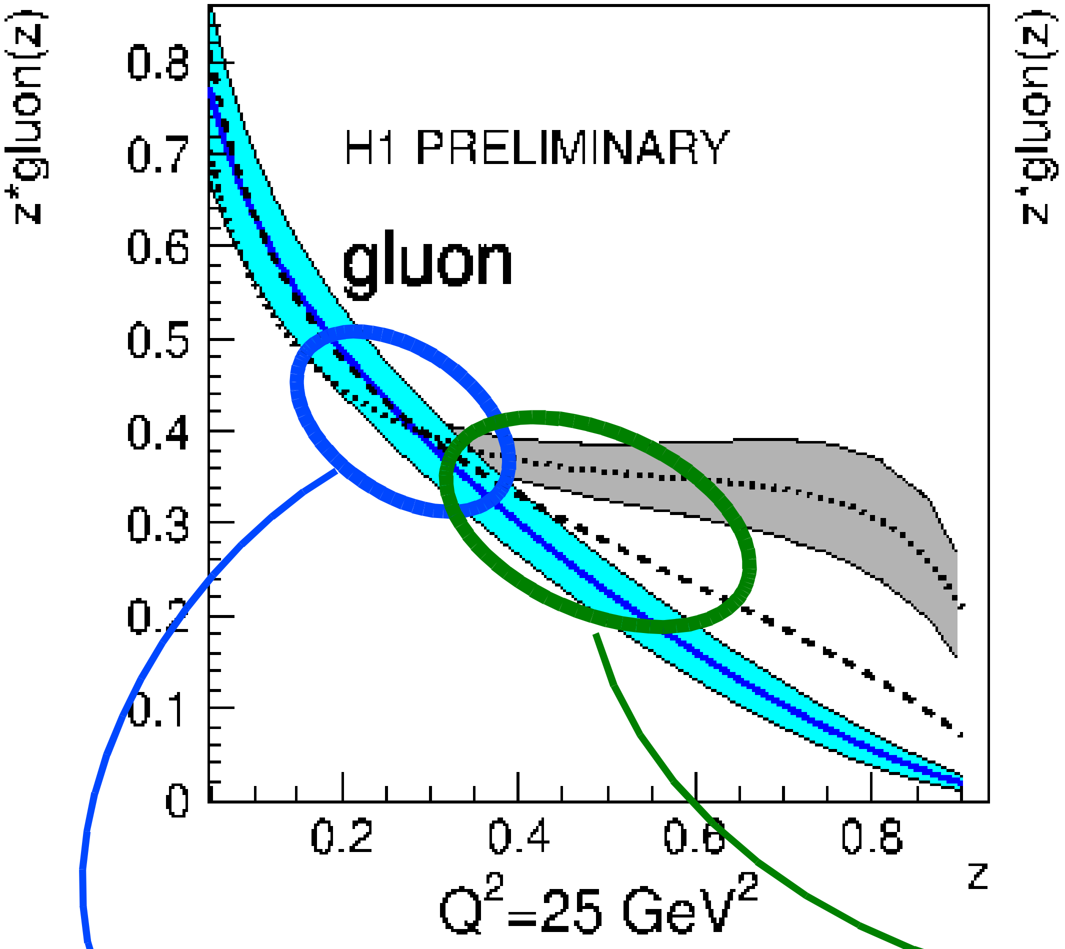
Comp with NLO: Dijets (γp)

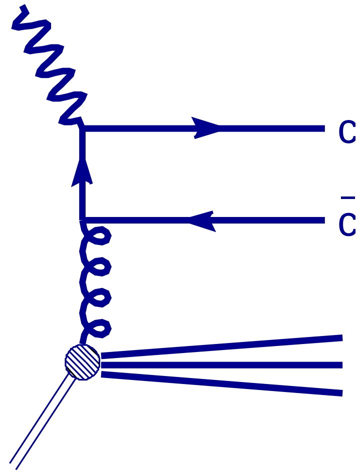


- NLO: Frixione et al.
- DPDFs: H1 2002 Fit (prel.)
- $\mu^2 = E_{t\ Jet1}^{*\ 2}$
- NLO **overestimates** data by ~**2** !!!

Factorization breaking for Dijets in γp

Complementarity of *charm* & Dijets





Probed by **Dijet** measurement
$\langle\mu^2\rangle$ = 30-40 GeV^2

Probed by ***charm*** measurement
$\langle\mu^2\rangle$ = 11-16 GeV^2

Summary

New DPDFs from Semi-Inclusive Diffractive Scattering

Apply to More Exclusive Final States @ HERA

QCD Factorization:

	DIS	**γp**
charm	+	+
Dijets	+	-

Low statistics + large NLO uncert.'s at low scales

Dijets provide **BIG improvement** of DPDFs for gluon at high z

Breakdown of factorization both in **direct** & **resolved** γp