Measurement of Diffractive Charm in DIS at HERA

Andrew Mehta

UNIVERSITY OF LIVERPOOL

ICHEP, Seoul, South Korea

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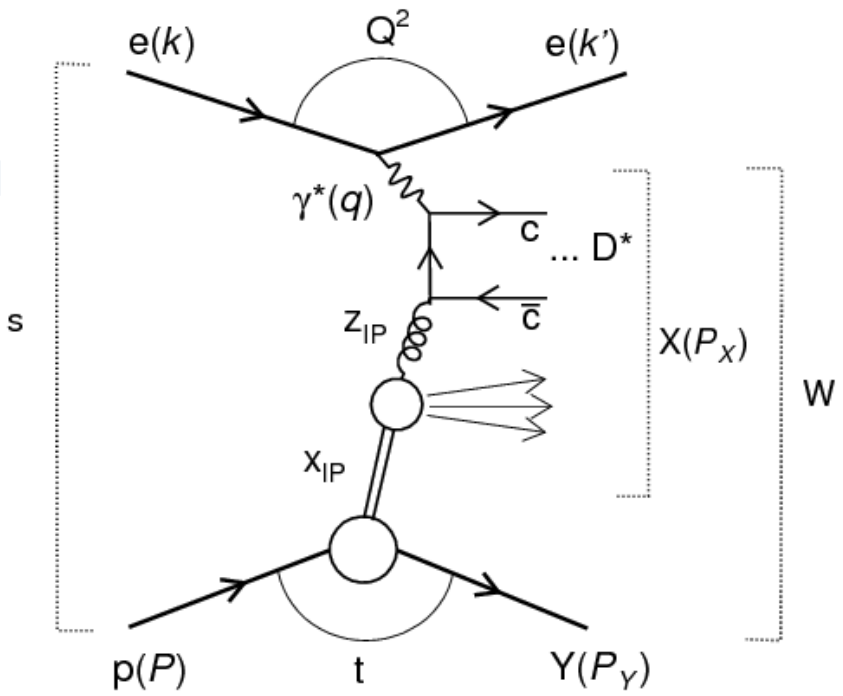
Diffractive DIS D^* Production

$$ep \rightarrow epX$$

- Diffraction characterized by larger rapidity gap or intact proton
- QCD description as an exchange of a colourless partonic state (pomeron) based on
  - colinear factorisation
  - proton vertex factorisation
- Diffractive PDFs obtained from fit to inclusive diffractive data with DGLAP evolution equations
- D^* produced via photon—gluon fusion
  - probe gluon content of pomeron and test factorisation ansatz



NLO QCD Calculation

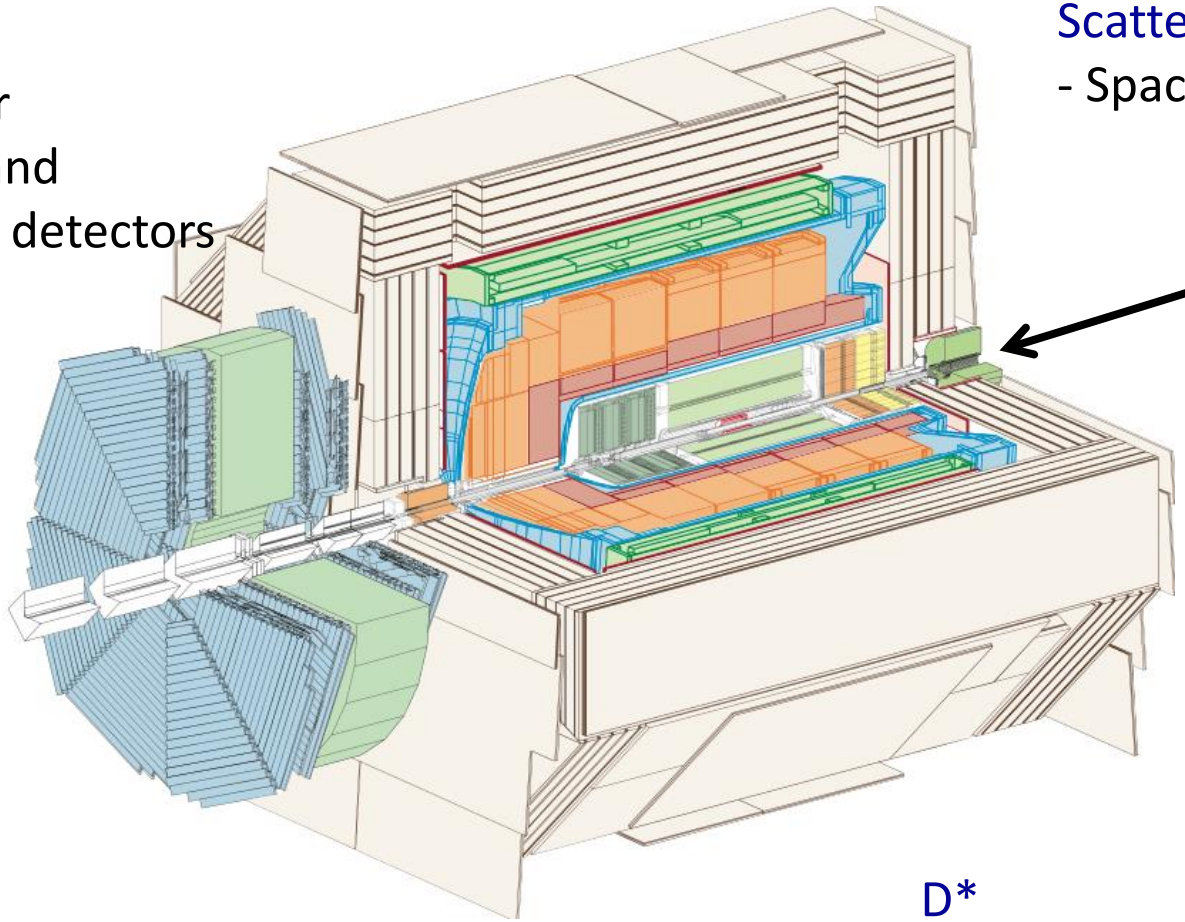
- HVQDIS program to produce inclusive inclusive charm adapted to produce diffractive events
- Use collinear factorisation model with diffractive PDFs taken from H1 2006 FIT B
- Charm fragmentation assuming $f\ (c \to D^*) = 0.235 \pm 0.007$ and the Kartvelishvili parameterisation
- Factorisation and normalisation scales set to $\mu_f = \mu_r = \sqrt{(Q^2 + 4m_c^2}$ with $m_c = 1.5$ GeV
- Uncertainties:
  - Factorisation and normalisation scales varied from 0.5 to 2
  - m_c varied between 1.3 and 1.7 GeV
  - Uncertainties on Kartvelishvili parameters
  - DPDF uncertainties
- Contributions from b hadron decays (3% in non-diffractive) not subtracted from measurements

H1 Detector

Rapidity gap
- LAr calorimeter
Forward muon and
Forward tagging detectors

Hadronic final state
- Calorimeters and central tracker

e
27.6 GeV



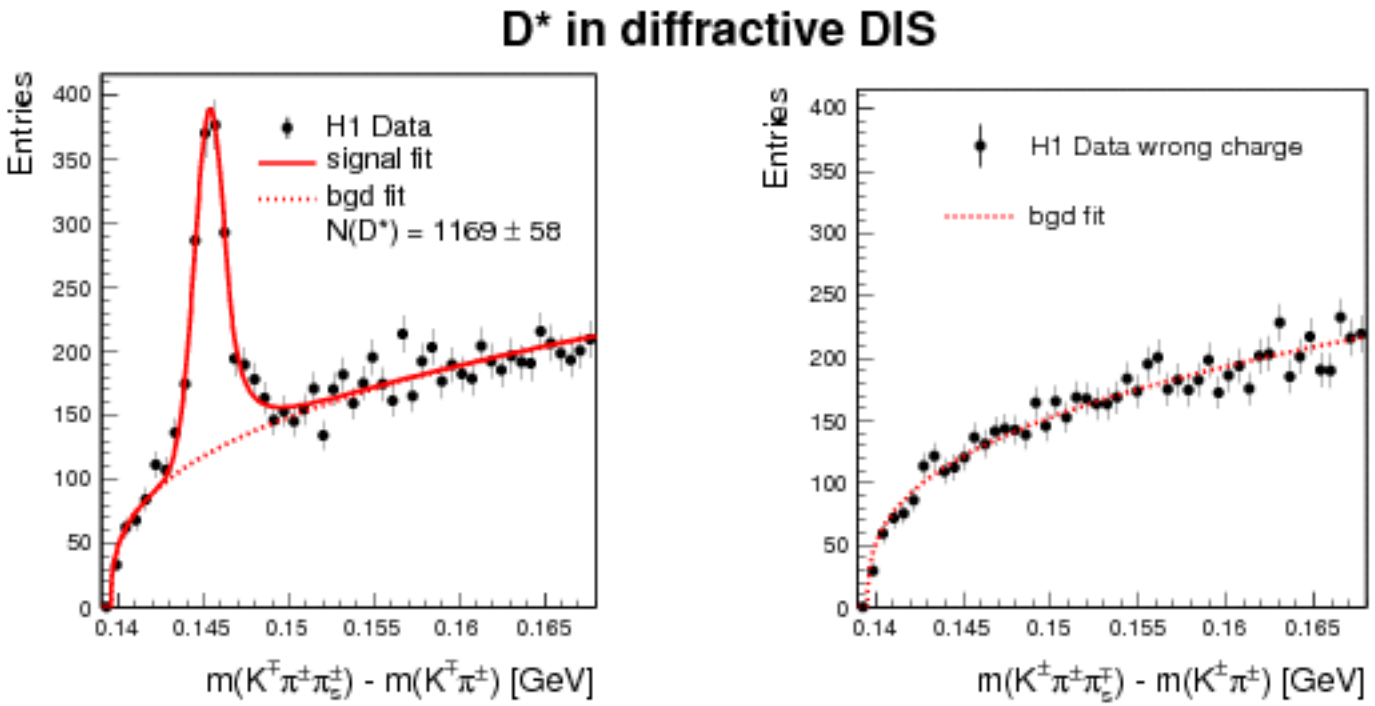
Scattered electron
- Spacal

p
920 GeV

D*
-central tracker

Reconstruction of D^*s

- Use the 'golden' decay $D^{*\pm} \rightarrow D^0\pi^\pm \rightarrow (K^\mp\pi^\pm)\pi^\pm$
- Branching ratio of 2.66 ± 0.03%
- Use $D^{*\pm} - D^0$ mass difference (better resolution)
- Simultaneous fit to right and wrong charge combinations to obtain signal and background

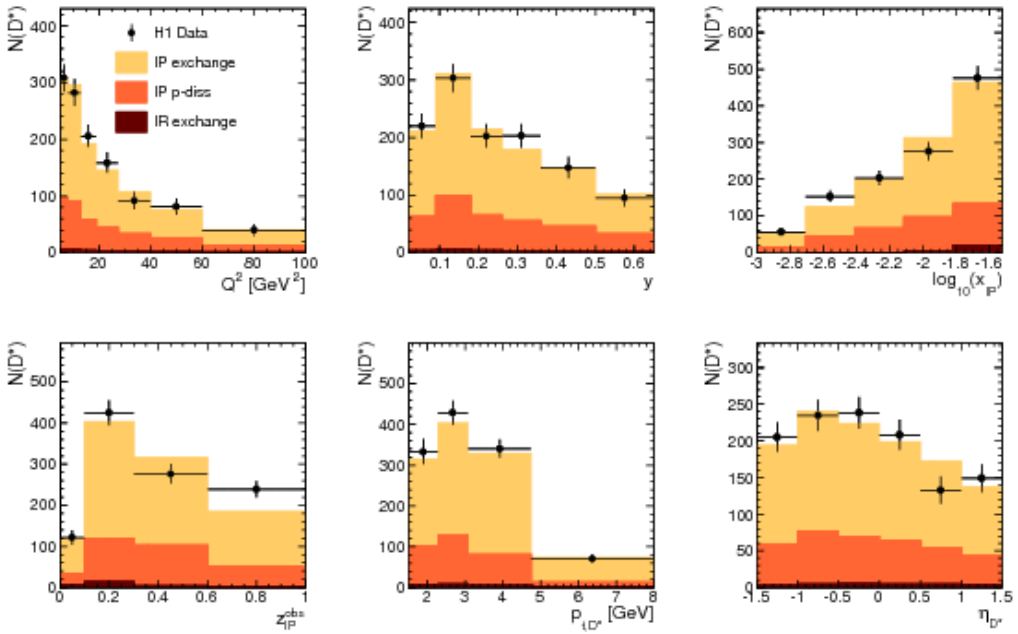


Diffractive DIS Charm Production

- Data collected 2005 and 2006
- Integrated luminosity 287 pb^{-1}
- Diffractive data selected by rapidity gap method
  - no activity in calorimeter for η>3.2
  - no activity in forward detectors
- Data corrected for
  - background
  - acceptance
  - trigger efficiency
  - QED randiation

DIS phase space
$5 < Q^2 < 100\ \mathrm{GeV}^2$
$0.02 < y < 0.65$
D^* kinematics
$p_{t,D^*} > 1.5\ \mathrm{GeV}$
$-1.5 < \eta_{D^*} < 1.5$
Diffractive phase space
$x_{I\!P} < 0.03$
$M_Y < 1.6\ \mathrm{GeV}$
$\lvert t \rvert < 1\ \mathrm{GeV}^2$

Uncorrected distributions compared with RAPGAP Monte Carlo



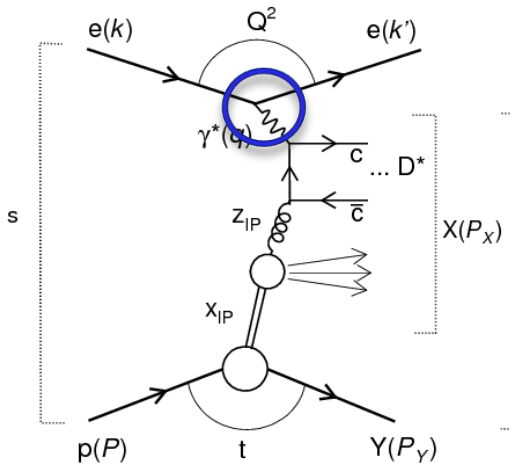
Total Cross Section

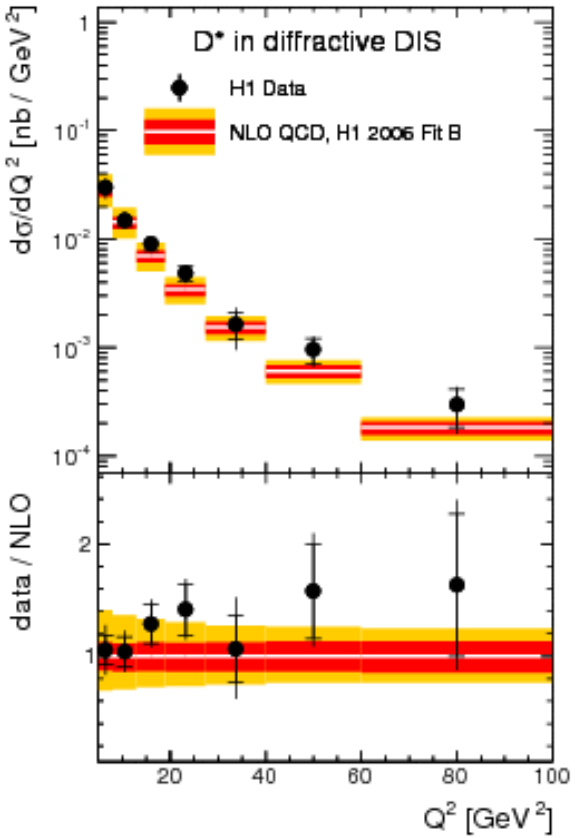
$$\sigma_{ep\to eYX(D^*)} = 314 \pm 23\ (\text{stat.}) \ \pm 35\ (\text{syst.}) \ \text{pb}.$$

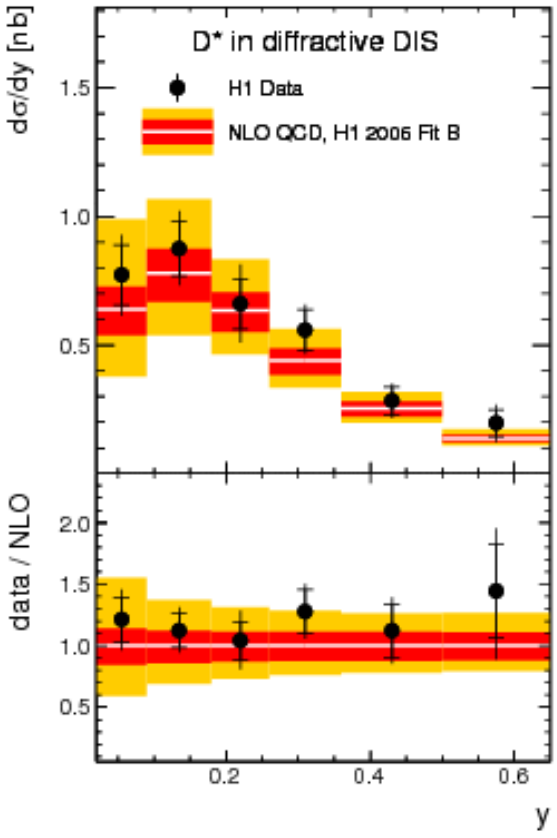
$$\sigma^{\text{theory}}_{ep\to eYX(D^*)} = 265\ ^{+54}_{-40}\ (\text{scale})\ ^{+68}_{-54}\ (m_c)\ ^{+7.0}_{-8.2}\ (\text{frag.})\ ^{+31}_{-35}\ (\text{DPDF})\ \text{pb}.$$

- Agrees with theory within errors
- Theory depends strongly on charm mass and factorisation and renormalisation scales

Differential Cross Sections







- Good agreement with NLO inclusive diffractive fit

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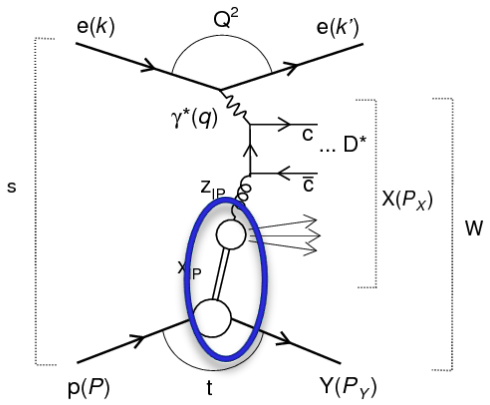

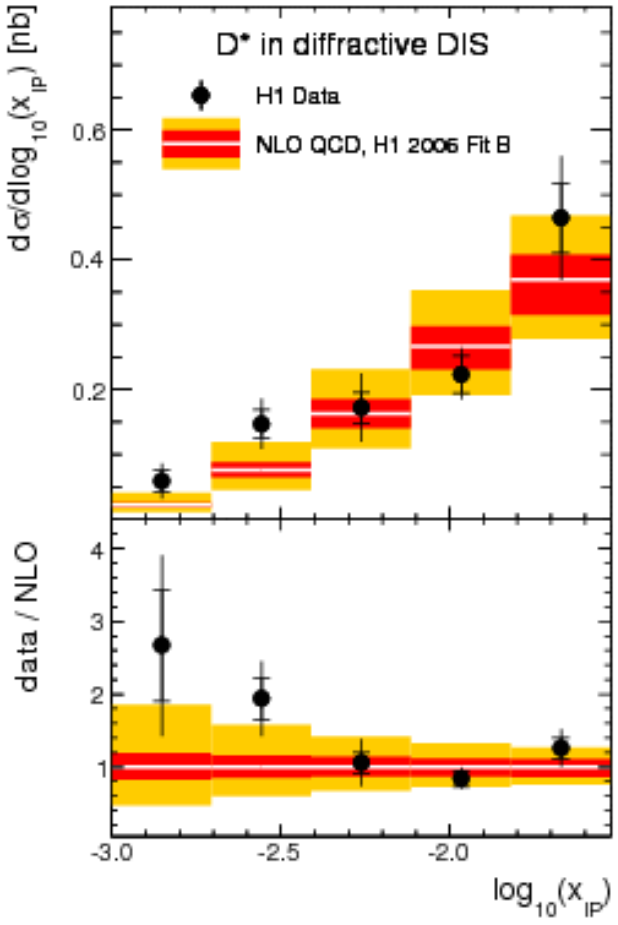

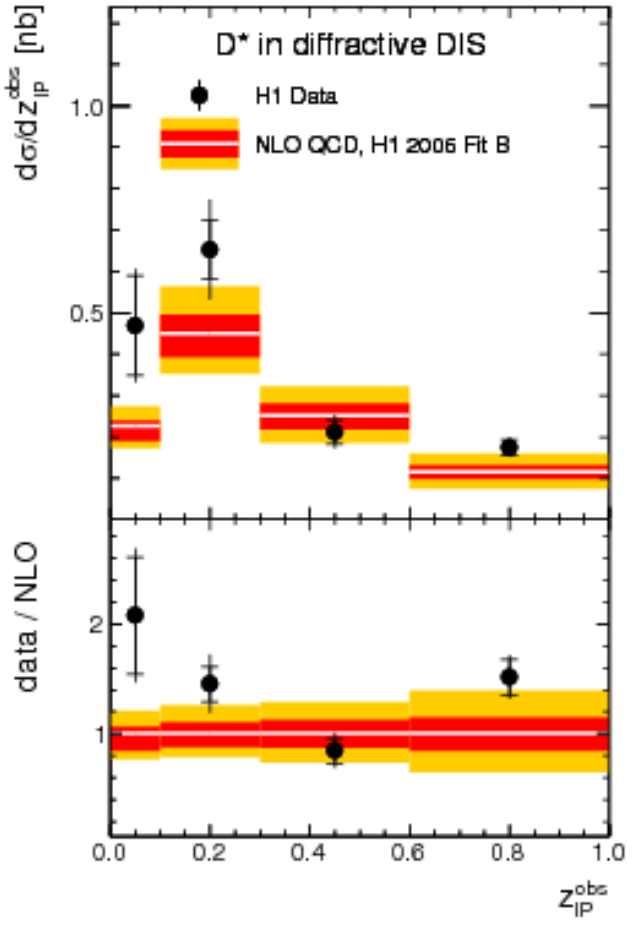

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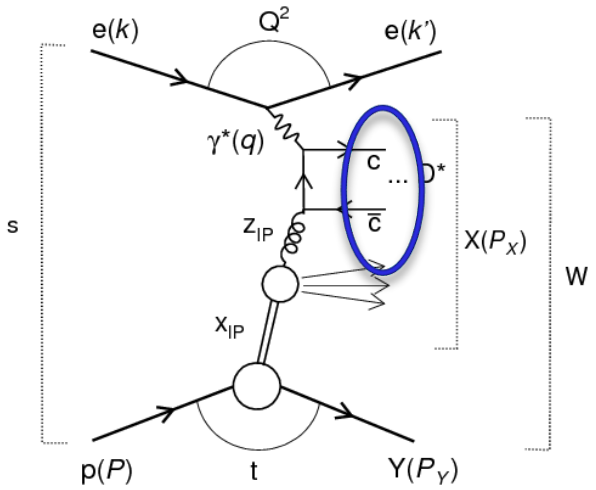
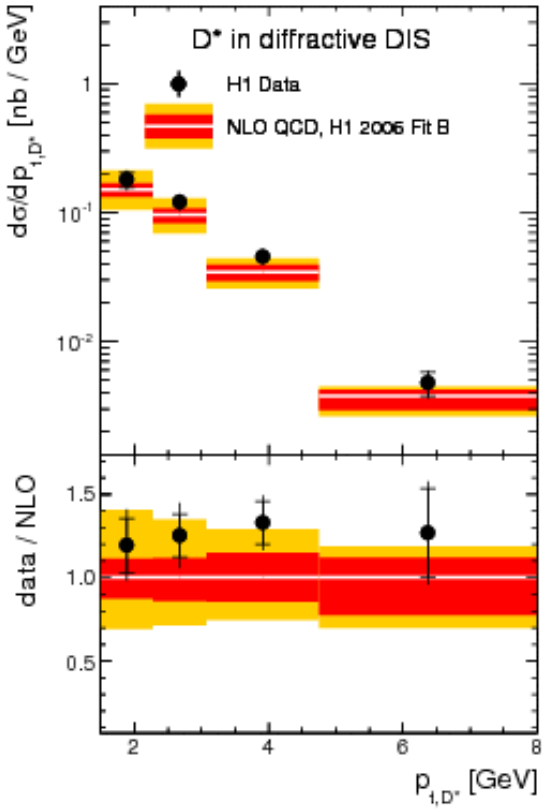
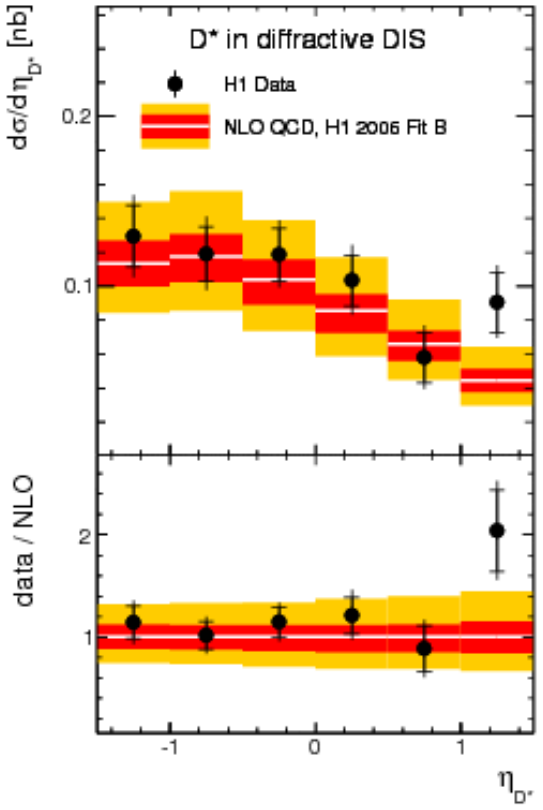




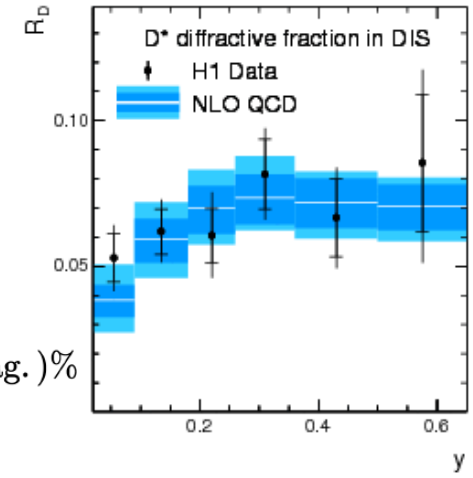


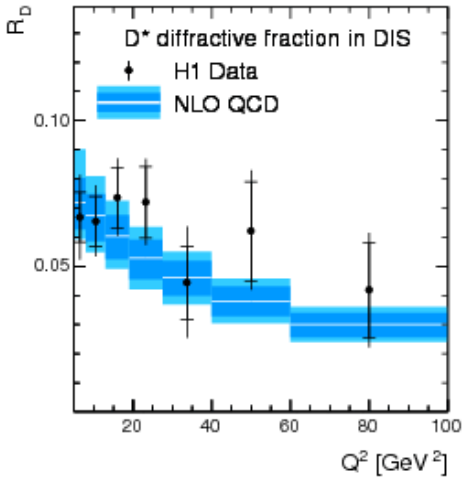
Diffractive to Non-diffractive ratio

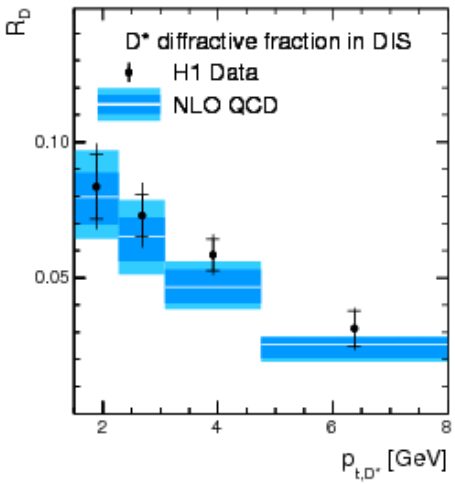
$$R_{\mathrm{D}} = 6.6 \pm 0.5\,(\mathrm{stat.})\,^{+0.9}_{-0.8}\,(\mathrm{syst.})\%$$

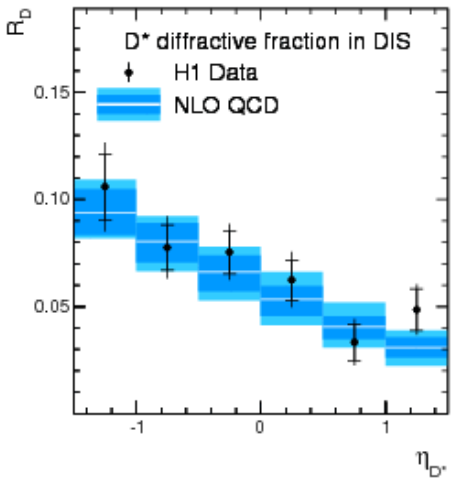
$$R_{\mathrm{D}}^{\mathrm{theory}} = 6.0\,^{+1.0}_{-0.7}\,(\mathrm{scale})\,^{+0.5}_{-0.4}\,(m_{\mathrm{c}})\,^{+0.7}_{-0.8}\,(\mathrm{DPDF})\,^{+0.02}_{-0.04}\,(\mathrm{frag.})\%$$

- Good agreement with theory based on NLO HVQDIS calculation using H1 2006 DPDF Fit B
- Fraction changes a lot with kinematics



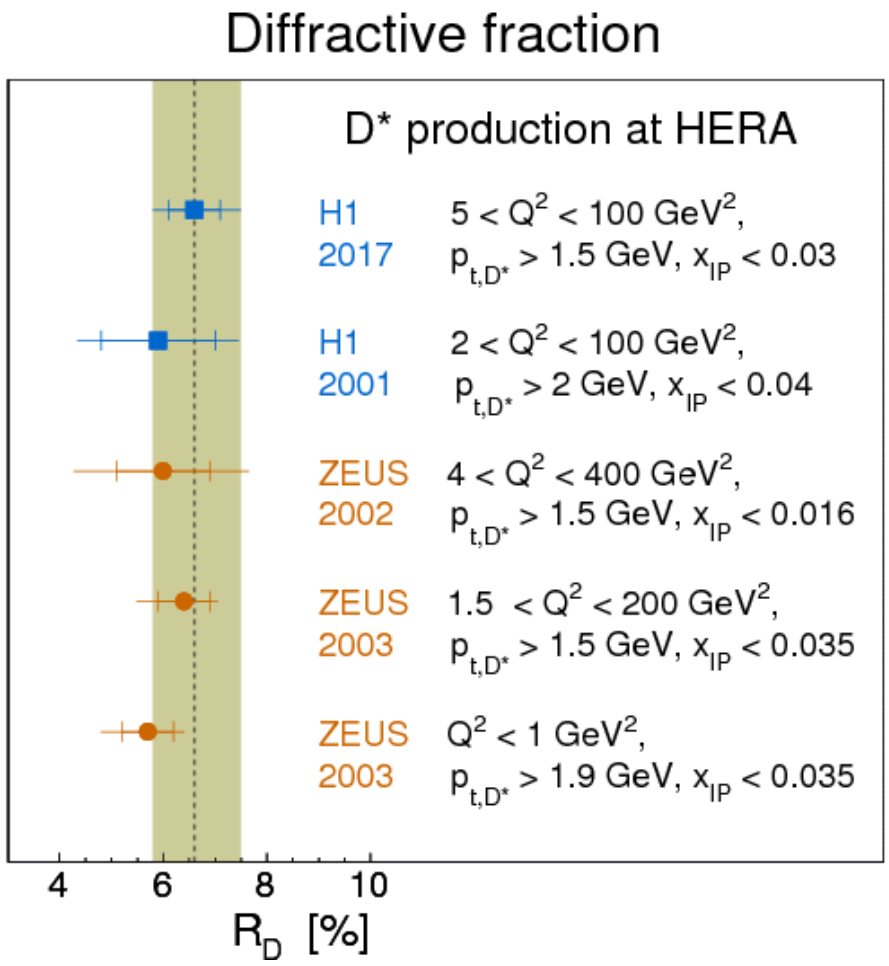






Diffractive Fraction Summary

- Compatible with previous measurements even with slightly different kinematic regions



Summary

- New measurement with 6 time statistics
- Good agreement with NLO QCD
- Validates colinear factorisation in diffractive DIS

More details:

H1 Collab., V. Andreev et al., Eur.Phys.J.C77 (2017), 340