D^*-Photoproduction in γp-Collisions at HERA with H1

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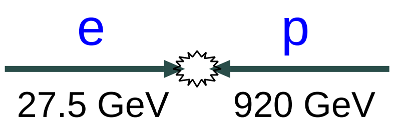
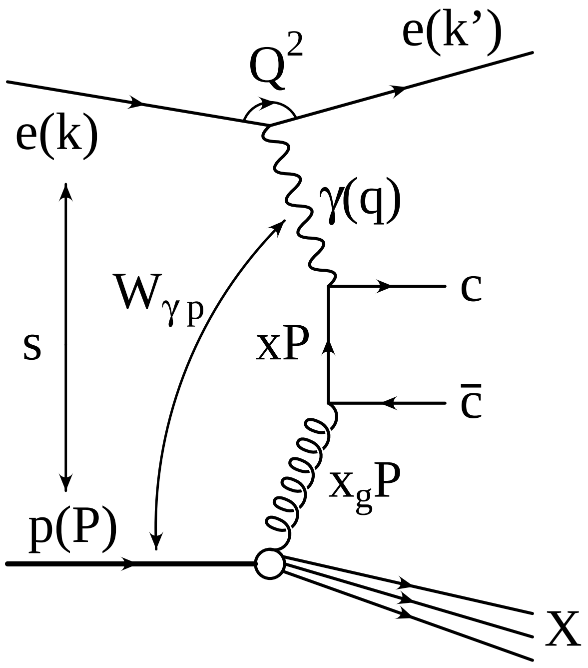
- Charm Photoproduction at HERA
- Tagged Photoproduction
- Differential Cross Section
- Summary

Charm Production in ep-Scattering



Photon-Gluon-Fusion



$$s = (k+P)^2$$

$$Q^2 = -q^2$$

$$x = \frac{Q^2}{2 \cdot q \cdot P}$$

$$y = \frac{q \cdot P}{k \cdot P}$$

$$W_{\gamma p}^2 = (q+P)^2$$

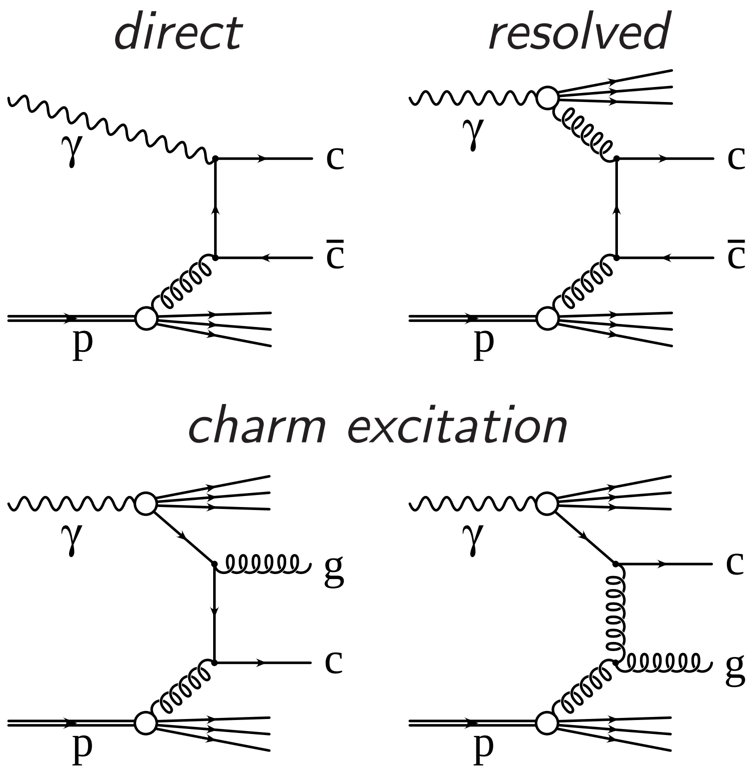
Tagged photoproduction:

$Q^2 < 0.01$ GeV^2 $\qquad$ $171 < W_{\gamma p} < 256$ GeV

Charm Photoproduction

- study quasi real photon structure:

LO picture:



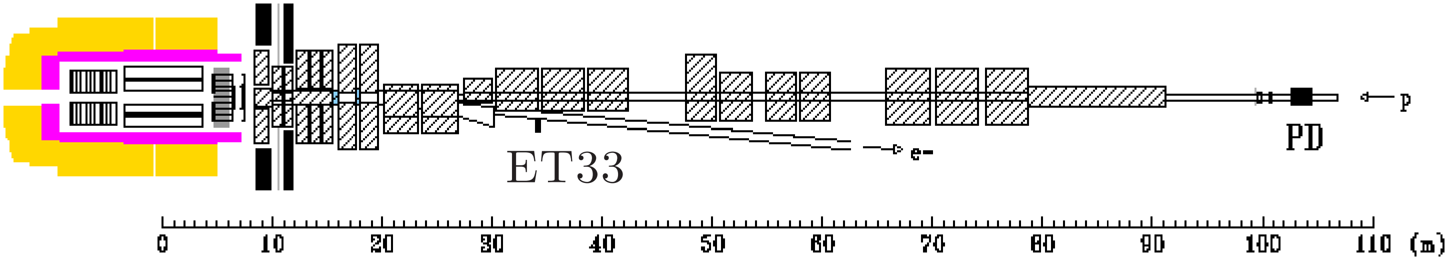
- sensitivity to the gluon density

- test perturbative QCD:

  m_c serves as hard scale

(Tagged) Photoproduction

$Q^2 < 1$ GeV^2 $\Rightarrow$ no scattered electron in main detector



detection in
electron tagger (calorimeter)
at small angle ($\theta < 5$ mrad)
outside H1

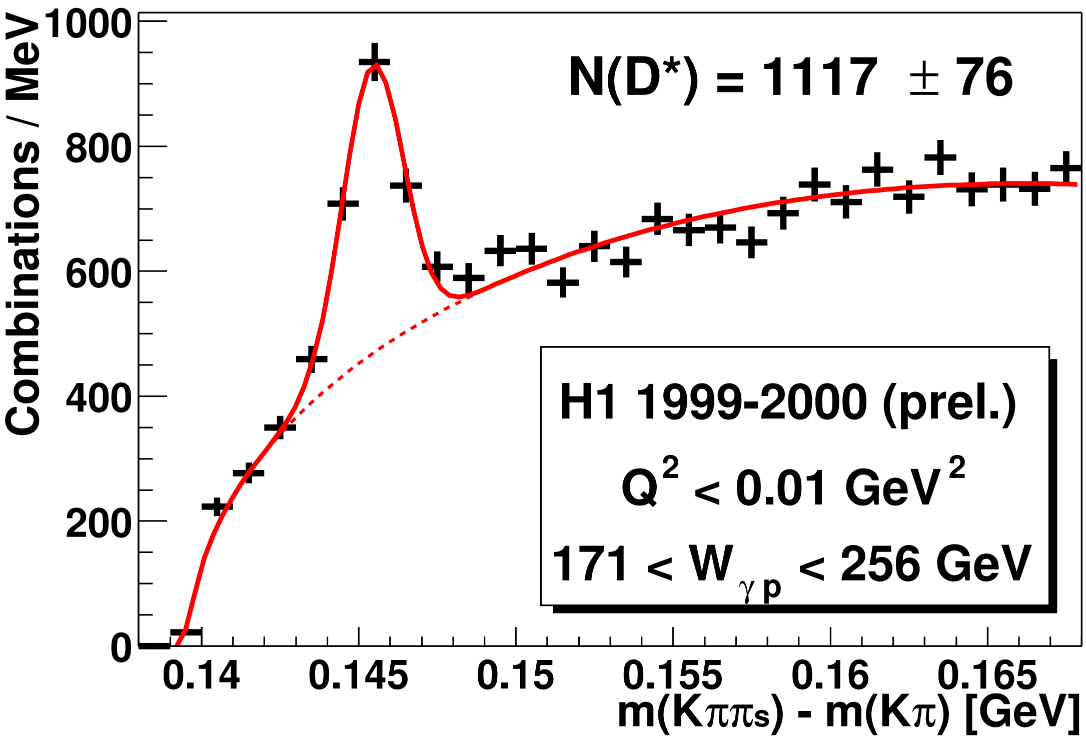
visible range	
Q^2	< 0.01 GeV^2
y	$0.29 < y < 0.65$
$W_{\gamma p}$	$171 < W_{\gamma p} < 256$ GeV

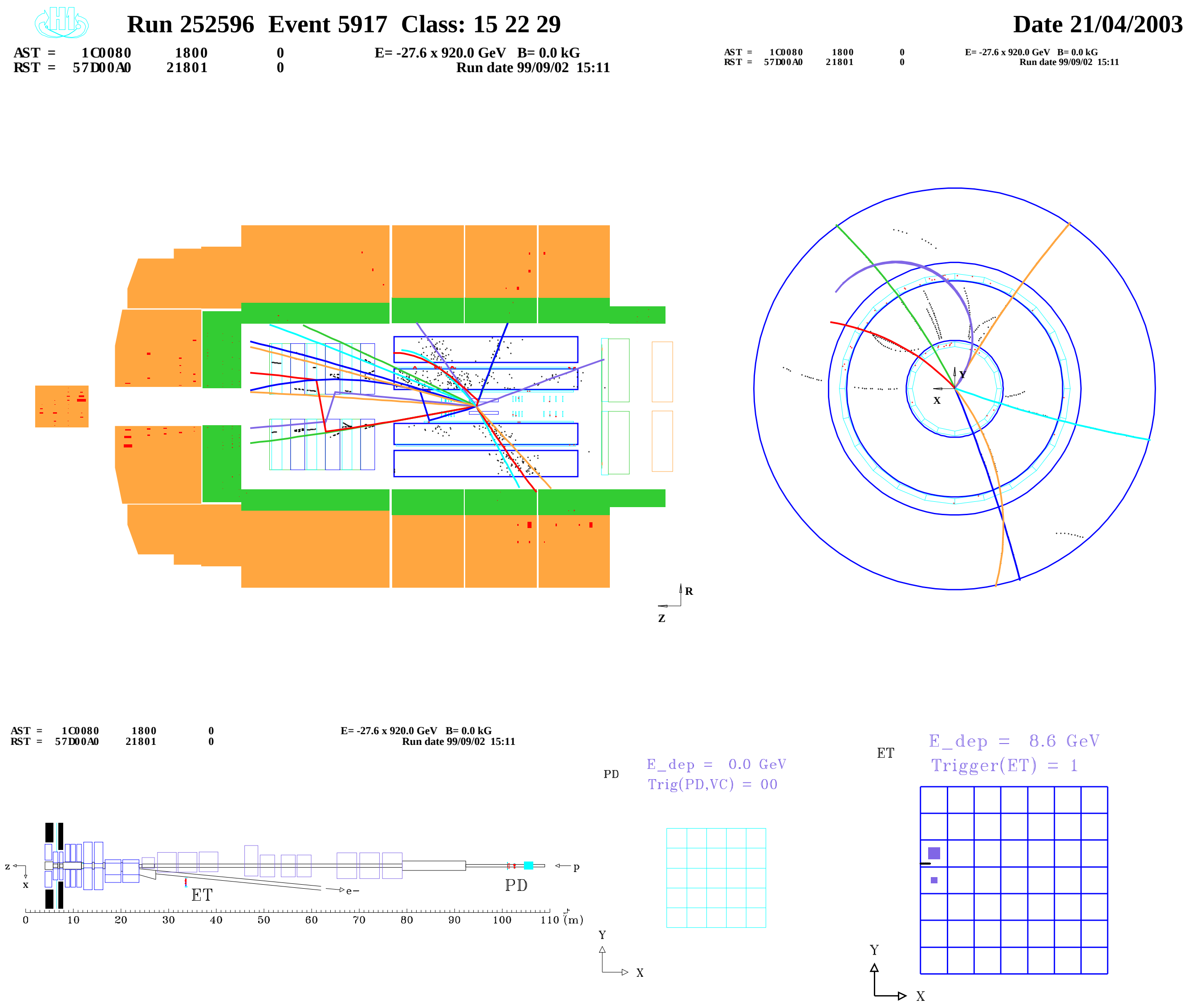
$W_{\gamma p} = \sqrt{y \cdot s}$

Charm Tagging

$D^{*+} \to D^0 \pi_s^+ \to (K^- \pi^+) \pi_s^+$ (+c.c.)

- no particle identification:
  assigning $m(K)$ and $m(\pi)$ to charged tracks
- N(D^*) from fit:
  gaussian signal + background
  in $\Delta m = m(K\pi\pi_s) - m(K\pi)$
- 1999/2000 e^+p-scattering: $\mathcal{L} = 49.2$ pb^{-1}
- $p_t(D^*) > 2.5$ GeV, $|\eta(D^*)| < 1.5$




Run 252596 Event 5917 Class: 15 22 29
Date 21/04/2003
AST = 1C0080 1800 0
RST = 57D00A0 21801 0
E= -27.6 x 920.0 GeV B= 0.0 kG
Run date 99/09/02 15:11
R
Z
Y
X
PD
E_dep = 0.0 GeV
Trig(PD,VC) = 00
ET
E_dep = 8.6 GeV
Trigger(ET) = 1
ET
PD
e−
p
0 10 20 30 40 50 60 70 80 90 100 110 (m)

Perturbative QCD Calculations

- LO matrix elements and parton showers:

  ◇ PYTHIA: DGLAP evolution
  - adding up massive matrix element
    u,d,s as active flavour in γ, p:
    direct + "normal" resolved
  - and massless matrix element
    u,d,s,c in γ, p: charm excitation
  - p- (γ-) structure: CTEQ 5L (GRV-G LO)

  ◇ CASCADE: CCFM evolution
  - direct γ only
  - off shell matrix element
  - unintegrated gluon density
    (fit to H1-F_2-data)

  ○ common parameters:

$$\begin{aligned} m_c &= 1.5 \text{ GeV} \\ \epsilon_{pet} &= 0.078 \end{aligned}$$

Perturbative QCD Calculations (cont.)

- Next-to-Leading Order
  - ◇ fixed order – massive

    only u,d,s as active flavour in γ, p

    valid for $p_t \approx m_c$
  - ◇ resummed – massless

    charm included in structure functions

    valid for $p_t \gg m_c$
  - ◇ matched calculations – FONLL

- using fixed order:

$$\mu_f = \sqrt{m_c^2 + p_t(c)^2}$$

$$\epsilon_{pet} = 0.035$$

γ structure	GRV-G HO
p structure	CTEQ 5D

uncertainty: vary m_c and renormalisation scale μ_r

	central	upper	lower
m_c [GeV]	1.5	1.3	1.7
μ_r	$\sqrt{m_c^2 + p_t(c)^2}$	$\times 0.5$	$\times 2$

Visible Cross Section

visible range	
Q^2	< 0.01 GeV^2
$W_{\gamma p}$	$171 < W_{\gamma p} < 256$ GeV
$p_t(D^*)$	> 2.5 GeV
$\eta(D^*)$	$-1.5 < \eta < 1.5$

H1 99-00 (preliminary):

$$\sigma_{vis}(ep \rightarrow e'D^*X) = (4.74 \pm 0.32 \pm 0.64) \text{ nb}$$

NLO QCD (fixed order/massive):

$$\sigma_{vis}(ep \rightarrow e'D^*X) = (2.46^{+1.09}_{-0.60}) \text{ nb}$$

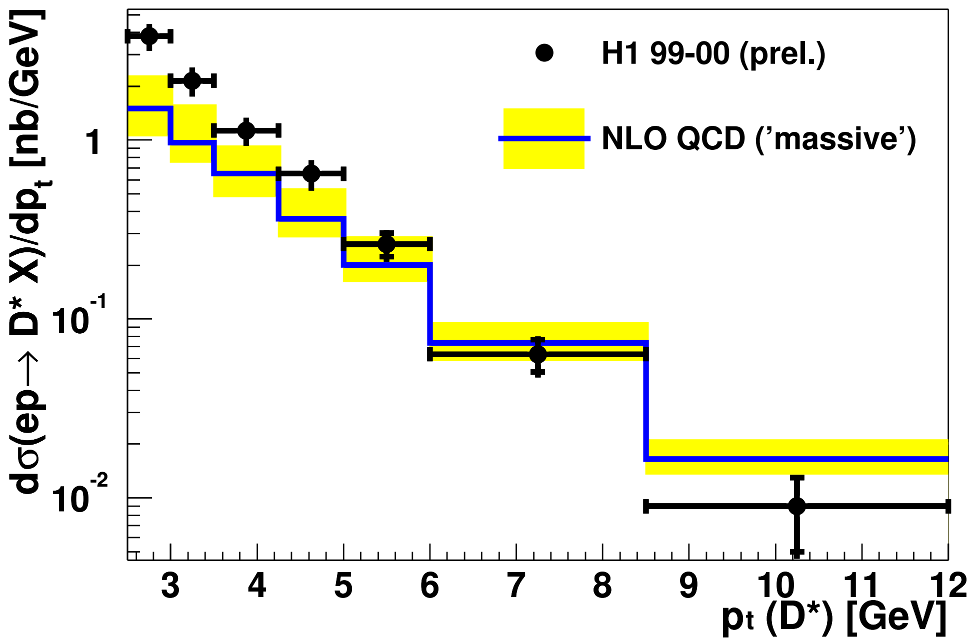
LO + DGLAP parton shower (Pythia):

$$\sigma_{vis}(ep \rightarrow e'D^*X) = 5.9 \text{ nb}$$

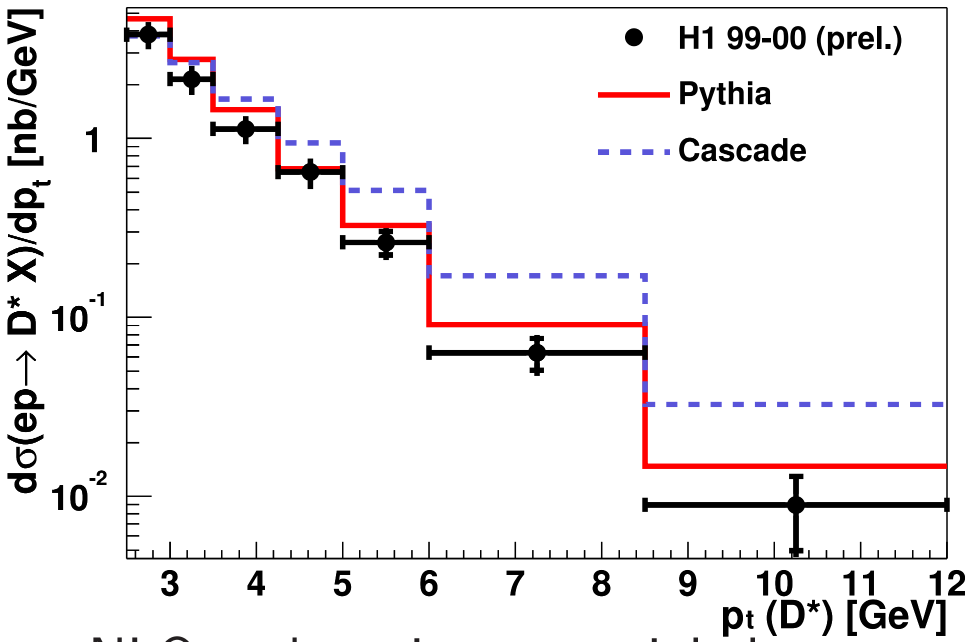
LO + CCFM parton shower (Cascade):

$$\sigma_{vis}(ep \rightarrow e'D^*X) = 6.2 \text{ nb}$$

$d\sigma/dp_t(D^*)$



NLO uncertainty from m_c- and μ_r-variation

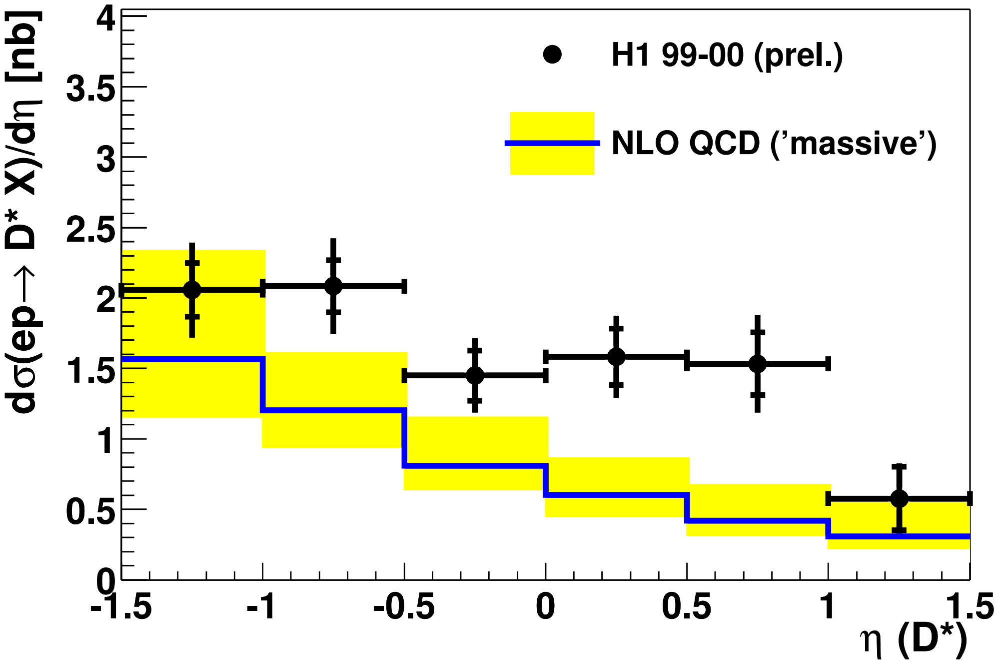


⇒ NLO underestimates mainly low p_t

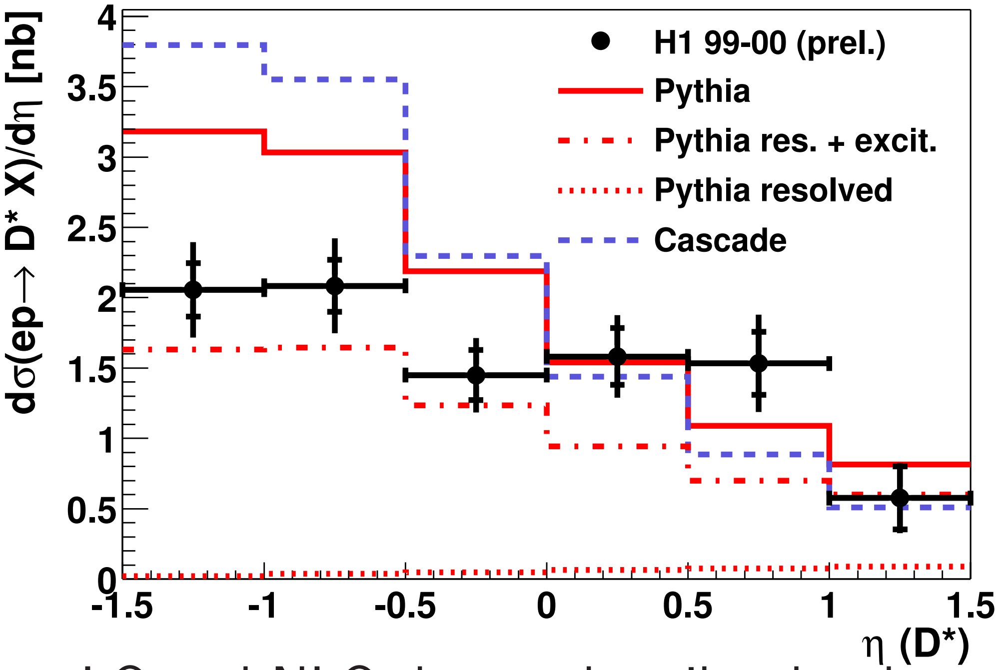
⇒ PYTHIA quite well in shape

⇒ CASCADE too hard

$d\sigma/d\eta(D^*)$



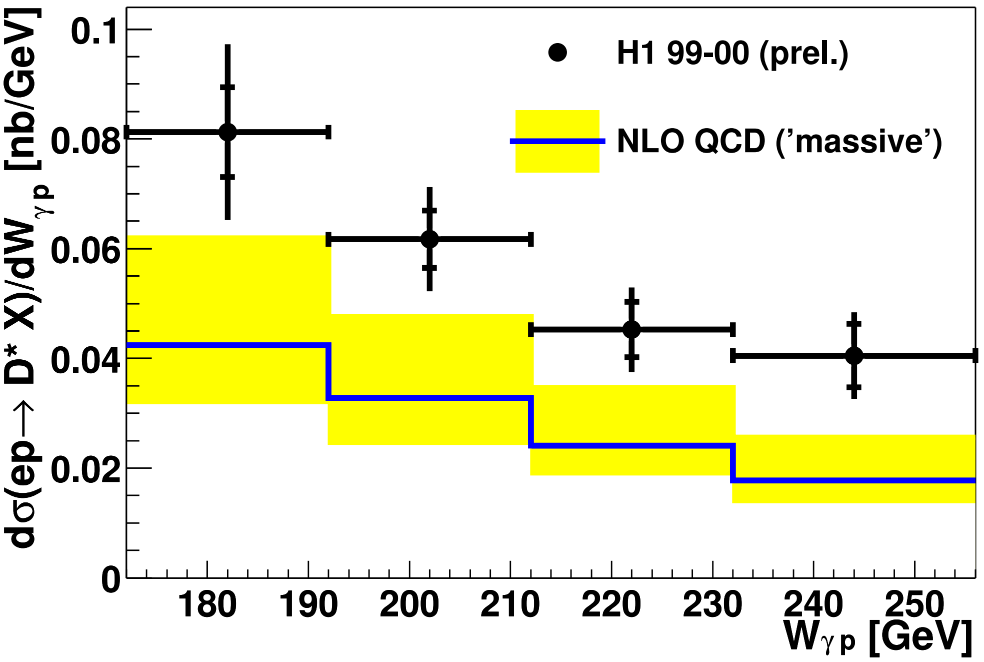
NLO uncertainty from m_c- and μ_r-variation



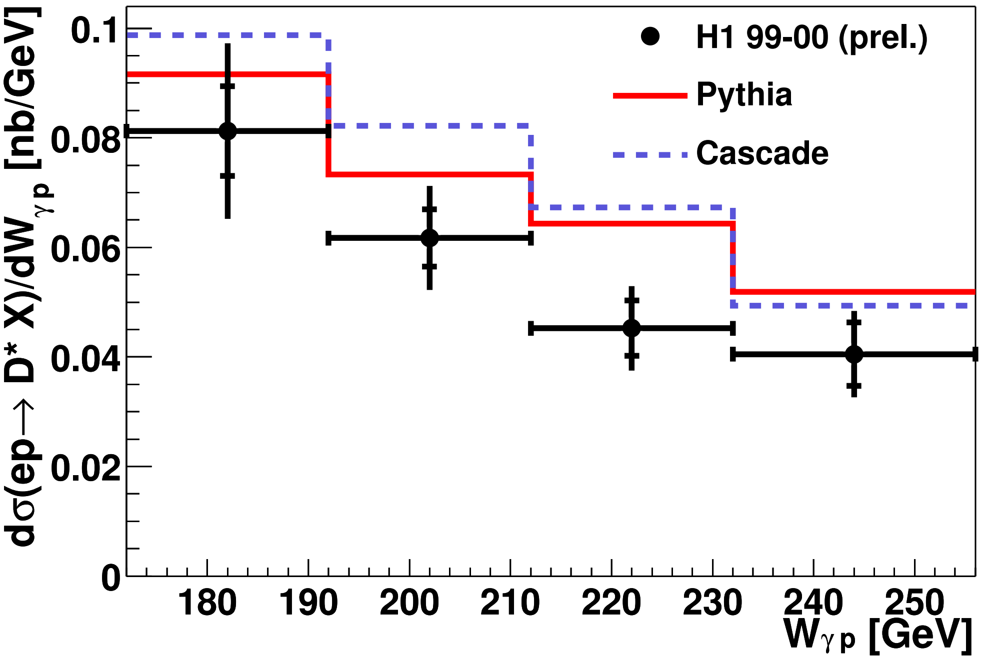
⇒ LO and NLO do not describe the shapes

⇒ NLO underestimates mainly forward direction

$d\sigma/dW_{\gamma p}$



NLO uncertainty from m_c- and μ_r-variation



$\Rightarrow$ slopes in good agreement

Summary

- tagged photoproduction:
  new (preliminary) results from H1

- LO + PS above cross section
  - CASCADE too in hard $d\sigma/dp_t$
  - PYTHIA and CASCADE cannot reproduce $d\sigma/d\eta$

- fixed order ("massive") NLO below cross section
  - mainly at small $p_t(D^*)$ and $\eta(D^*) > 0$
  - $d\sigma/dW_{\gamma p}$ described in shape

Charm photoproduction

a challenge for theory