11th International Workshop on Deep Inelastic Scattering and QCD

Inclusive D* Meson and Dijet Production with Charm in DIS

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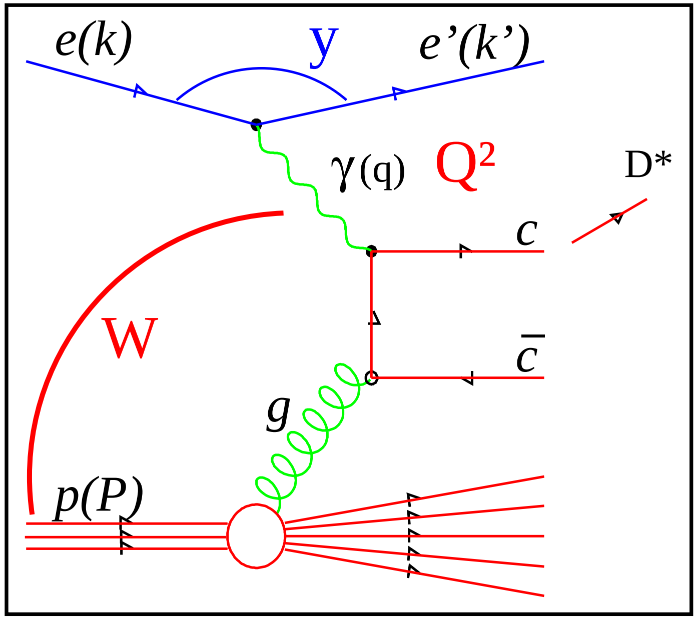
- Introduction
- $D^{*\pm}$ cross sections
- Dijets associated with $D^{*\pm}$ mesons
- Conclusions

Charm Production in LO

...dominated by BGF:



- Kinematics:

  $\sqrt{s} = 318$ GeV

  Q^2: 4-momentum transfer^2

  x: Bjorken x

  y: inelasticity

  W^2: mass^2 of hadronic final state

- $D^{*\pm}$ from fragmentation:

  $\rightarrow \eta = -\ln\tan\left(\frac{\theta_{D^*}}{2}\right)$: pseudo rapidity

  $\rightarrow p_t$: transverse momentum

  $\rightarrow z_{D^*} = \frac{P \cdot p_{D^*}}{P \cdot q}$: elasticity

Models for Charm Production

- Q^2 and m_Q^2 provide hard scale to allow pQCD calculations
- Various schemes:
  - FFNS (massive and massless approach)
  - VFNS (no Monte Carlo available for DIS)
- We are using the massive FFNS approach,
  $\rightarrow$ reliable for $Q^2 \approx m_Q^2$, breakdown for $Q^2 \gg m_Q^2$

Models for Charm Production

Various evolution schemes:

- DGLAP: evolution of parton densities by DGLAP equation

  $\rightarrow$ HVQDIS (Harris, Smith): generator for $c\bar{c}$ and $c\bar{c}g$ in NLO (using CTEQ5F3)

  $D^{*\pm}$ added using Peterson fragmentation with transverse momentum smearing

  $\rightarrow$ RAPGAP (Jung): MC for LO + parton shower

  direct and resolved contributions of γ^*

- CCFM evolution: using angular ordering and unintegrated gluon density, more appropriate for small x

  $\rightarrow$ CASCADE (Jung, Salam): MC for CCFM generating a complete hadronic final state

Hadrionization of the charm quark: Peterson fragmentation with parameter ϵ

$\Rightarrow$ compare our data with the different models

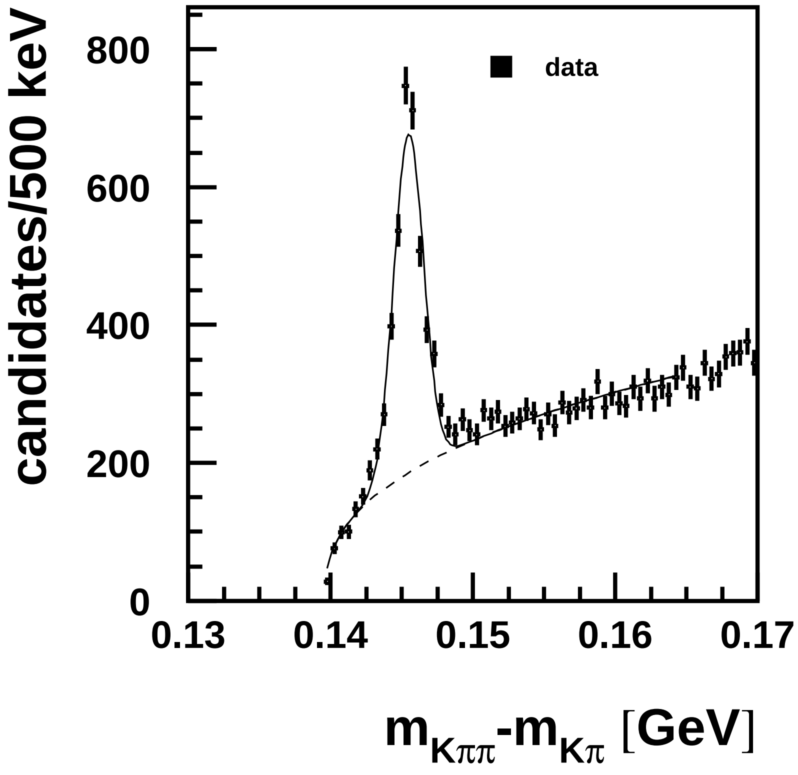
Charm Tagging

- DIS selection by demanding scattered electron in backward calorimeter

  $\rightarrow$ kinematic range: $2 < Q^2 < 100\,\text{GeV}^2,\ 0.05 < y < 0.7$
- Using decay chain $\quad D^{*\pm} \longrightarrow \overset{(-)}{D^0}\pi^{\pm}_{\text{slow}} \longrightarrow K^{\mp}\pi^{\pm}\pi^{\pm}_{\text{slow}}$
- Decay particles visible in detector

  $\rightarrow$ visible range: $p_{t,D^*} > 1.5\,\text{GeV},\ |\eta_{D^*}| < 1.5$
- Luminosity 99 and 2000 e^+p data of H1

  $\rightarrow \mathcal{L} = 47.0\,\text{pb}^{-1}$



Inclusive D* Cross Section

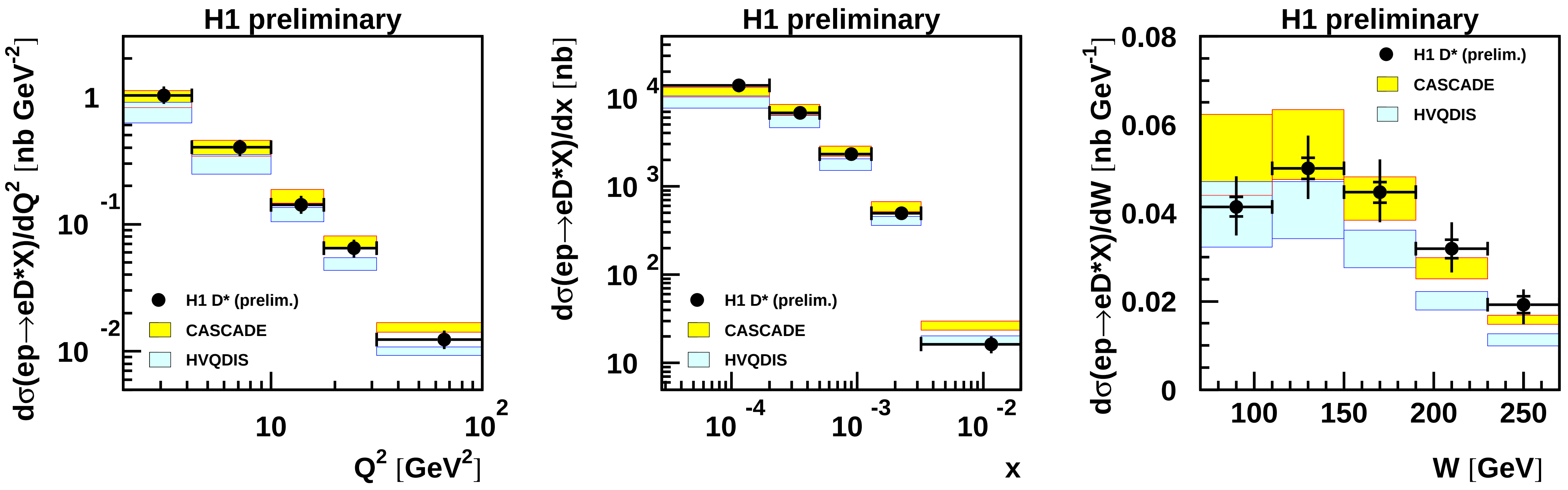
- kinematical range: $2 < Q^2 < 100\,\text{GeV}^2$, $0.05 < y < 0.7$
- visible range: $p_{t,D^*} > 1.5\,\text{GeV}$, $|\eta_{D^*}| < 1.5$

$$\sigma^{\text{vis}}(e^+p \longrightarrow e^+D^{*\pm}X) = 7.72 \pm 0.23\,(\text{stat.}) \pm 1.09\,(\text{syst.})\,\text{nb}$$

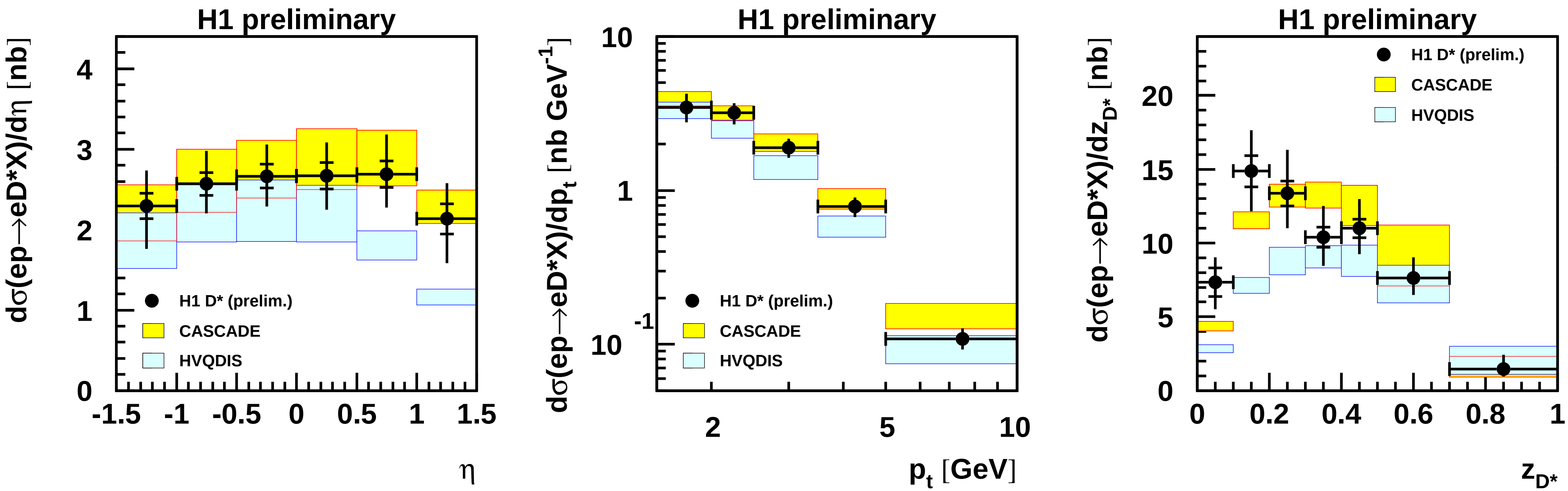
- model predictions:

	HVQDIS NLO DGLAP	CASCADE CCFM	RAPGAP DGLAP LO+PS dir+res	RAPGAP DGLAP LO+PS dir only
$m_c = 1.5\,\text{GeV}, \epsilon = 0.100$	$4.90\,\text{nb}$	$6.79\,\text{nb}$		
$m_c = 1.4\,\text{GeV}, \epsilon = 0.078$	$5.54\,\text{nb}$	$7.50\,\text{nb}$	$8.55\,\text{nb}$	$6.78\,\text{nb}$
$m_c = 1.3\,\text{GeV}, \epsilon = 0.035$	$6.62\,\text{nb}$	$8.82\,\text{nb}$		

Single Differential Cross Sections



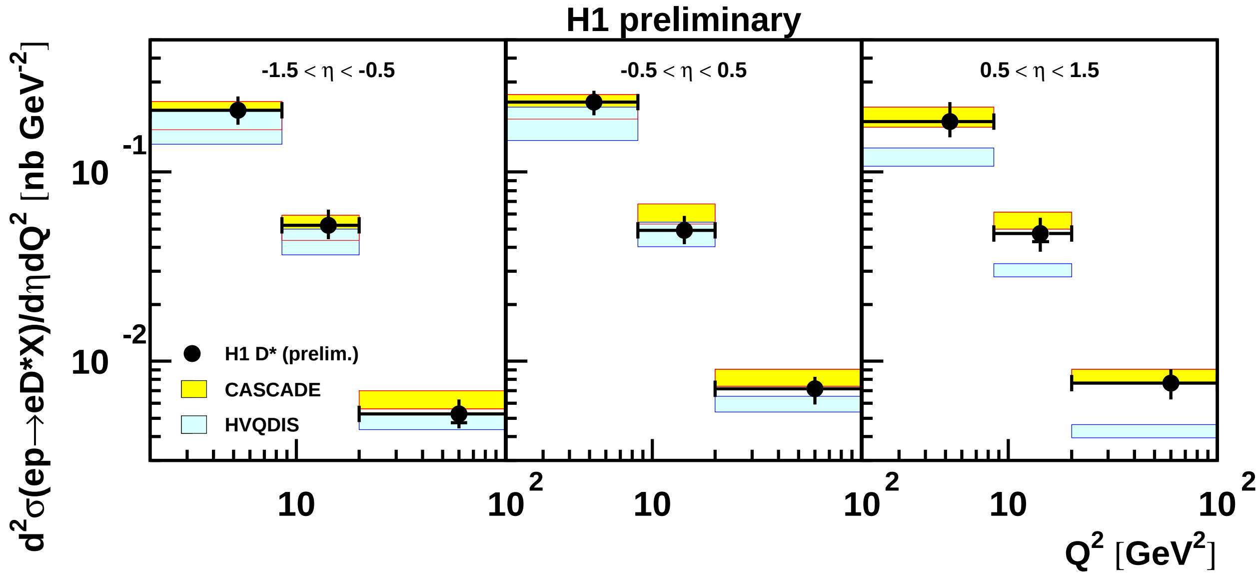
Single Differential Cross Sections

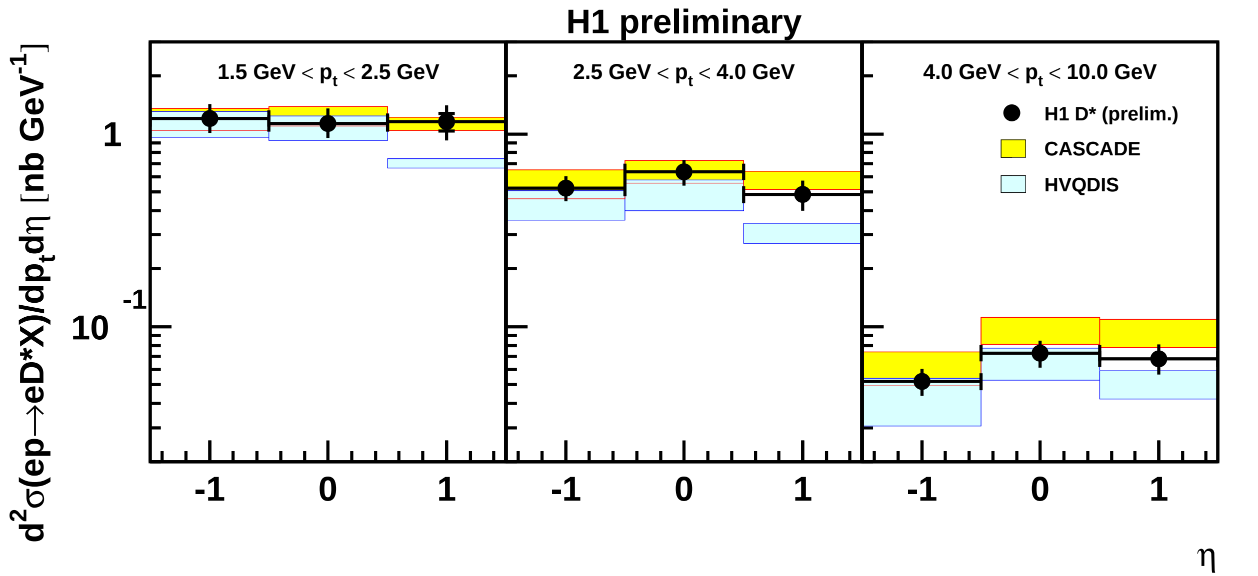


→ HVQDIS: shapes in reasonable agreement (below data at large η, small z_{D*})

→ CASCADE: agreement in shapes and normalization

Double Differential Cross Sections





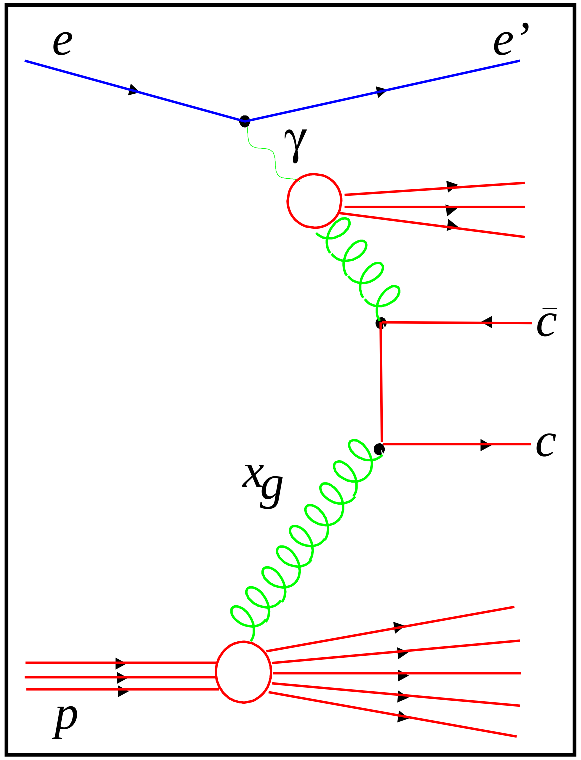
$\rightarrow$ HVQDIS: deficit for large η for all Q^2 bins and low p_t bins

$\rightarrow$ CASCADE: agrees better with data

Jets Associated with $D^{*\pm}$ mesons

Motivation:

- differences between NLO DGLAP and data for large η:
  beauty ($\rightarrow$ only small contribution), resolved contributions?
- check our understanding of charm production mechanism
  by tagging both charm quarks!
- but asking for 2 $D^{*\pm}$ mesons reduces statistics
  significantly
- alternative: JETS



Apply jet algorithm to events with one tagged $D^{*\pm}$ meson:

- inclusive k_t cluster algorithm in the Breit frame
- at least 2 jets with $E_t^{\text{jet 1}} > 4$ GeV, $E_t^{\text{jet 2}} > 3$ GeV
- $-1 < \eta_{\text{lab}}^{\text{jet 1,2}} < 2$

$D*\pm +$ Dijet Cross Section

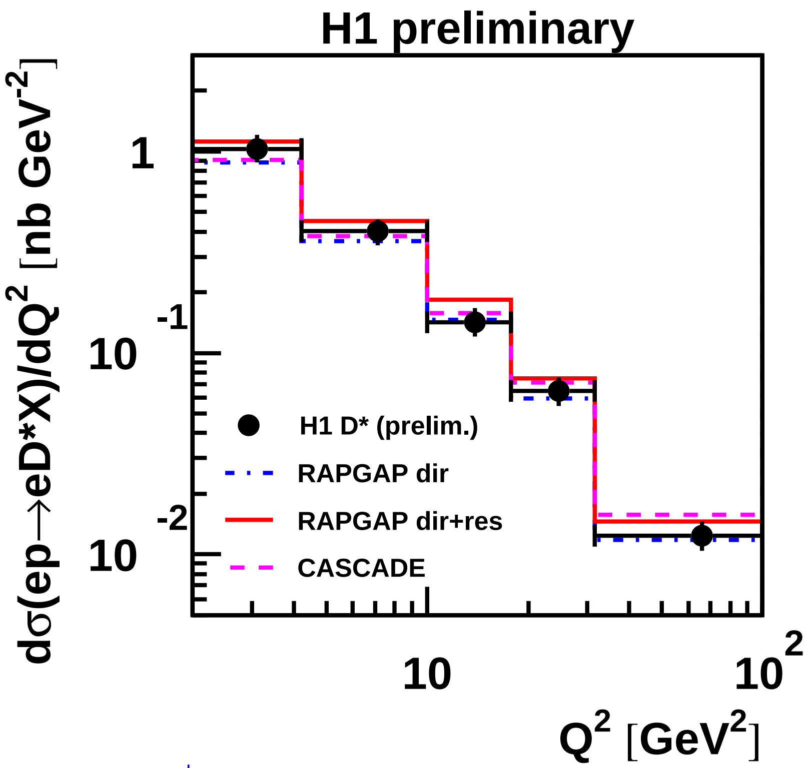
- kinematical range: $2 < Q^2 < 100$ GeV^2, $0.05 < y < 0.7$
- visible range for $D^{*\pm}$: $p_{t,D^*} > 1.5$ GeV, $|\eta_{D^*}| < 1.5$
- inclusive k_t cluster algorithm in the Breit frame
- at least 2 jets with $E_t^{\text{jet 1}} > 4$ GeV, $E_t^{\text{jet 2}} > 3$ GeV
- $-1 < \eta_{\text{lab}}^{\text{jet 1,2}} < 2$

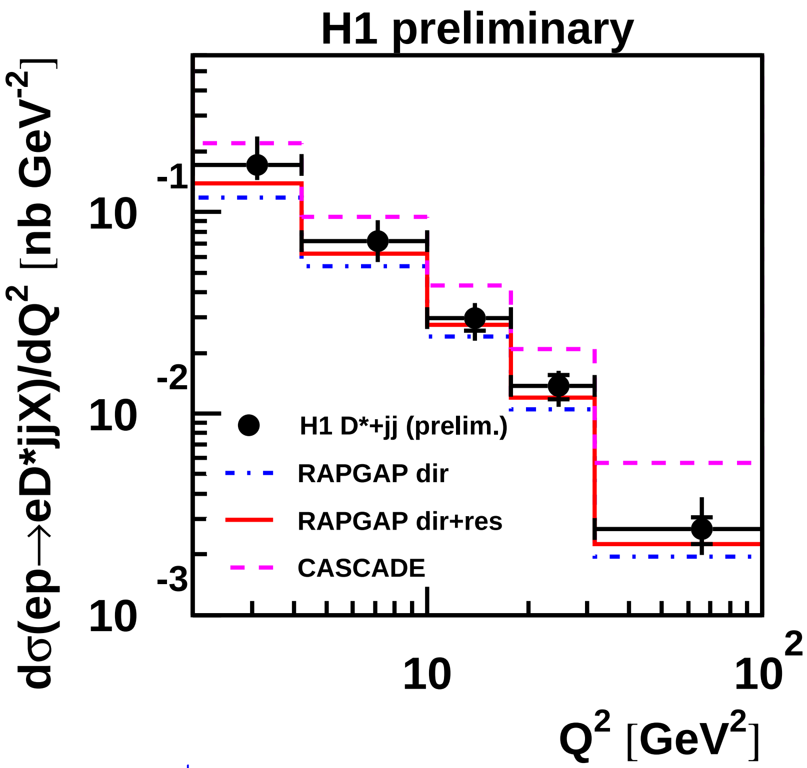
$$\sigma^{\text{vis}}(e^+p \longrightarrow e^+D^{*\pm} + jj + X) = 1.63 \pm 0.10\,(\text{stat.}) \pm 0.25\,(\text{syst.})\ \text{nb}$$

- model predictions:

	RAPGAP DGLAP LO+PS		CASCADE
	dir+res	dir only	CCFM
$m_c = 1.4$ GeV, $\epsilon = 0.078$	1.23 nb	1.07 nb	2.05 nb

Comparison $D^{*\pm}$ vs. $D^{*\pm} + $ dijets





$D^{*\pm}$ cross section:

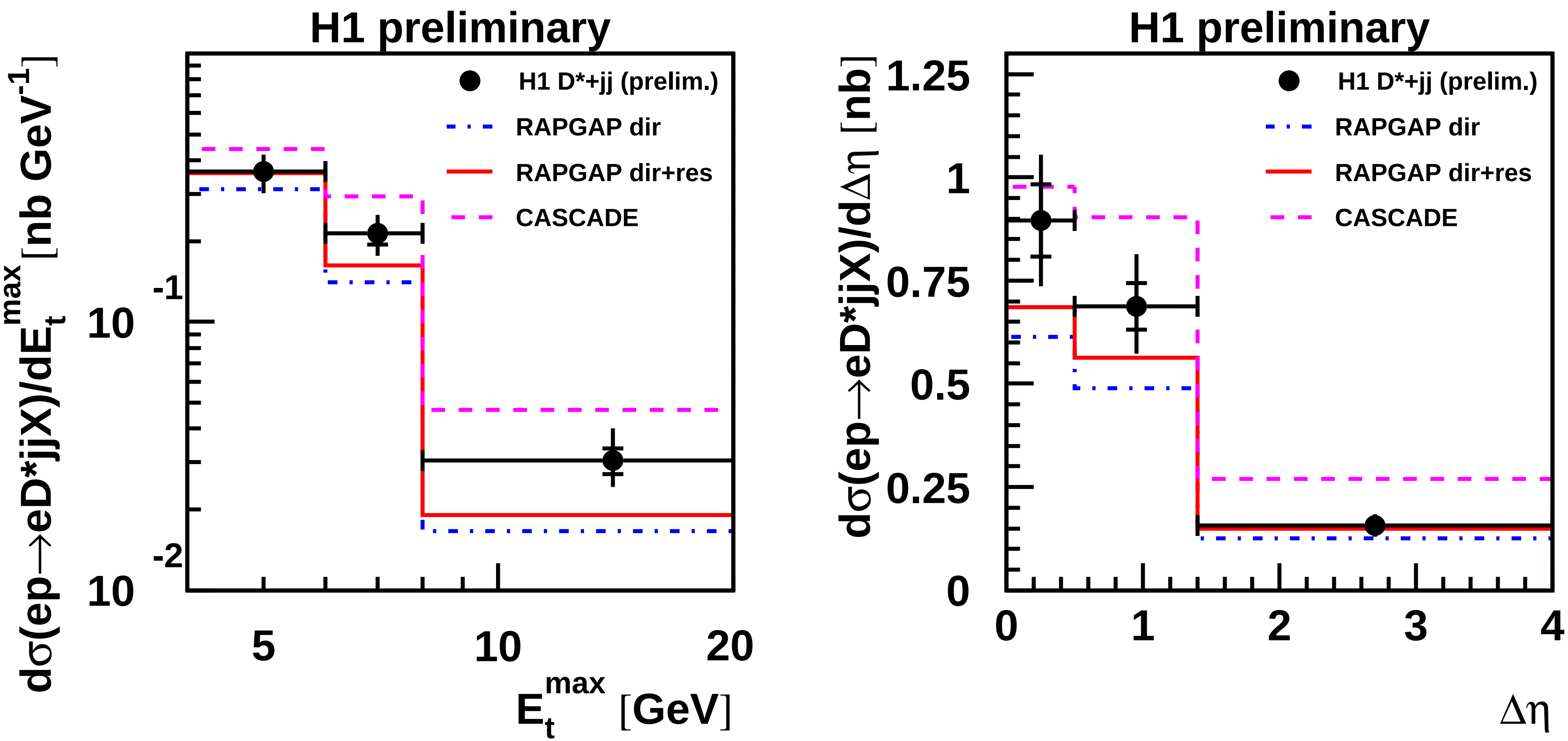
$\rightarrow$ RAPGAP dir and dir+res as well as CASCADE consistent with data

$D^{*\pm} + jj$ cross section:

$\rightarrow$ consistent with RAPGAP dir+res, direct only underestimates the data

$\rightarrow$ CASCADE overestimates the data

Differential Jet Cross Sections

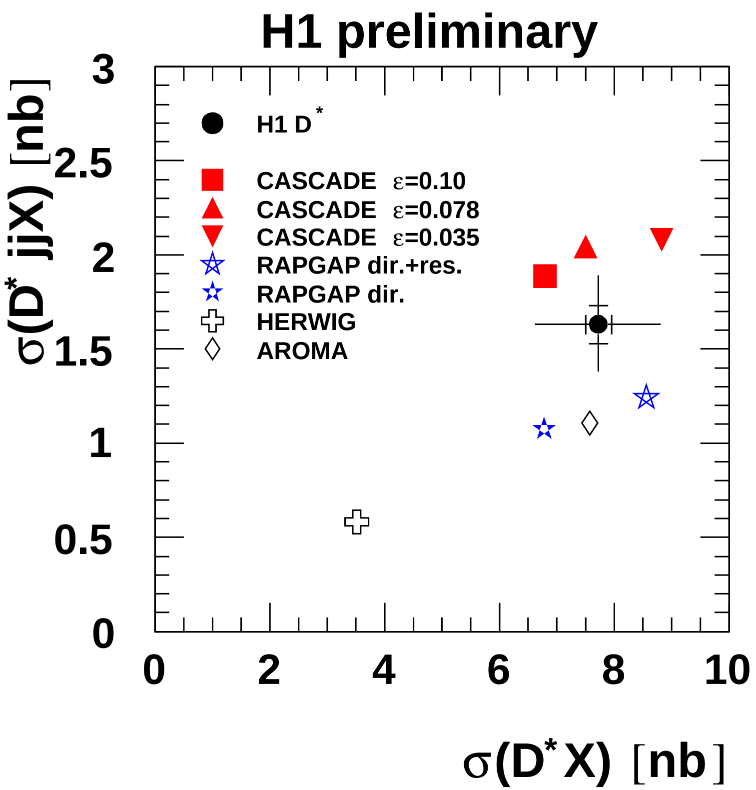


→ RAPGAP direct and direct+resolved below the data for large E_t^{max} and small $\Delta\eta$

→ CASCADE above the data

Conclusions

Measurement of $D^{*\pm}$ meson production and $D^{*\pm}$ meson + dijet production in DIS:



- published H1 results on $D^{*\pm}$ mesons are confirmed with higher statistics:

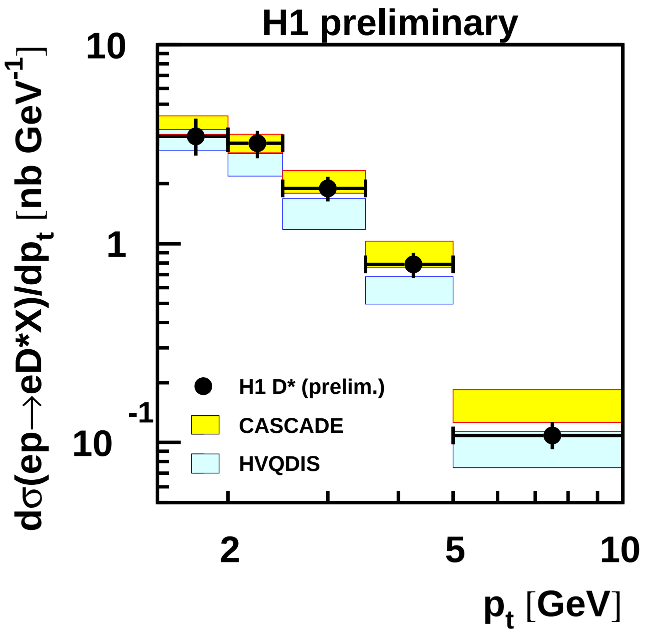
  $\rightarrow$ NLO DGLAP: differences at small p_t and large η

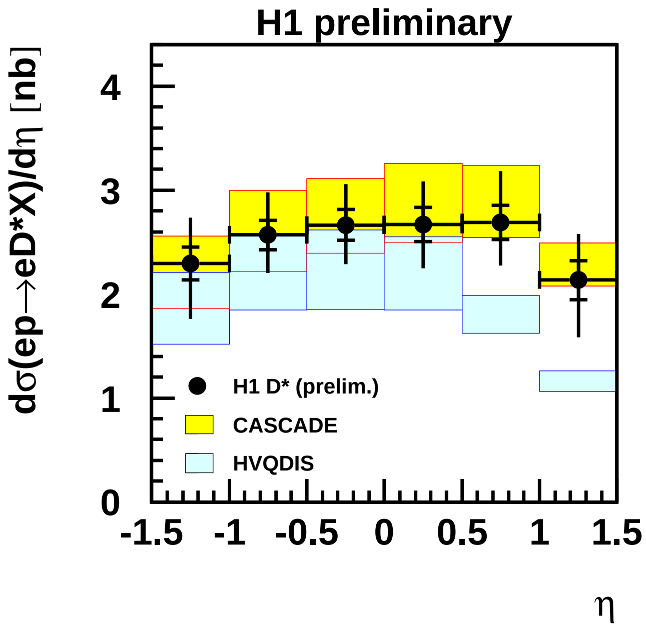
  $\rightarrow$ CCFM: in general in better agreement with data

- first H1 measurement of $D^{*\pm}$ meson + dijet production

Measurement of $D^{*\pm}$ meson production in DIS

- kinematical range: $2 < Q^2 < 100\,\text{GeV}^2$, $0.05 < y < 0.7$
- visible range: $p_{t,D^*} > 1.5\,\text{GeV}$, $|\eta_{D^*}| < 1.5$

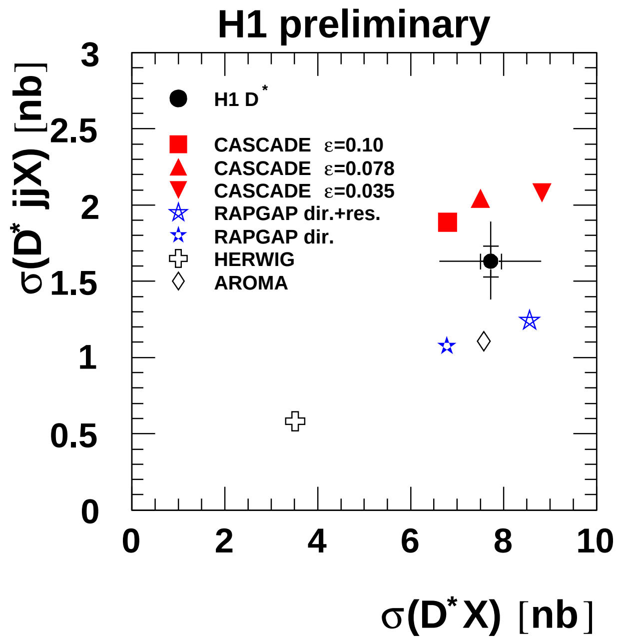


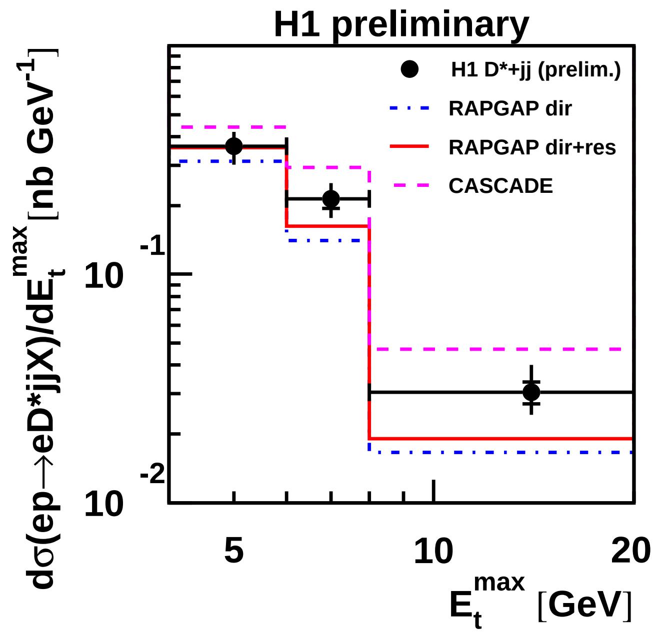


- confirms published H1 results with higher statistics
- NLO DGLAP (HVQDIS): shapes in reasonable agreement (deviations in η_{D^*})
- CASCADE (CCFM): better description of shape and normalisation

Measurement of Dijets Associated with $D^{*\pm}$ mesons in DIS

- inclusive k_t cluster algorithm in the Breit frame
- at least two jets with $E_t^{\text{jet 1}} > 4$ GeV, $E_t^{\text{jet 2}} > 3$ GeV





- comparison with LO DGLAP (RAPGAP direct and direct+resolved contribution) and CASCADE (CCFM)