Diffractive Dijet Production at HERA

Frank-Peter Schilling
(University of Heidelberg)

representing the

collaboration

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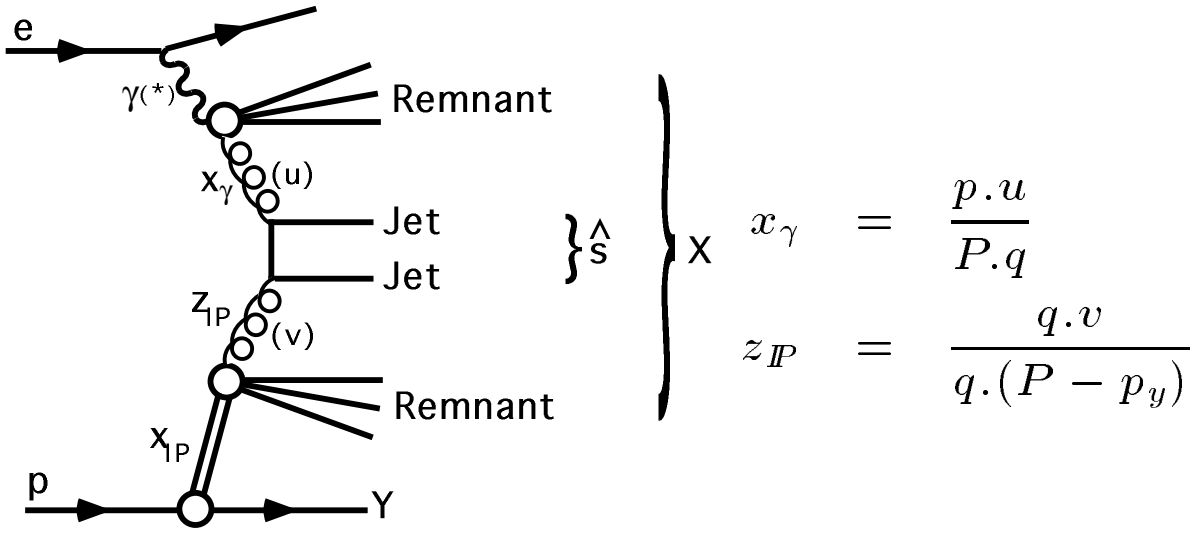
Physics Motivation

- Diffractive DIS at HERA $(F_2^{D(3)}(x_{I\!P}, Q^2, \beta))$ has been successfully interpreted in terms of resolved IP model with diffractive parton densities which are gluon dominated and evolve with DGLAP:

$$F_2^{D(4)}(x_{I\!P}, t, Q^2, \beta) = f_{I\!P}(x_{I\!P}, t) * F_2^{I\!P}(\beta, Q2) + \text{subl.exch.}$$

- Gluon content of IP: $80 - 90\%$

- Diffractive dijet production: probe partonic structure of IP



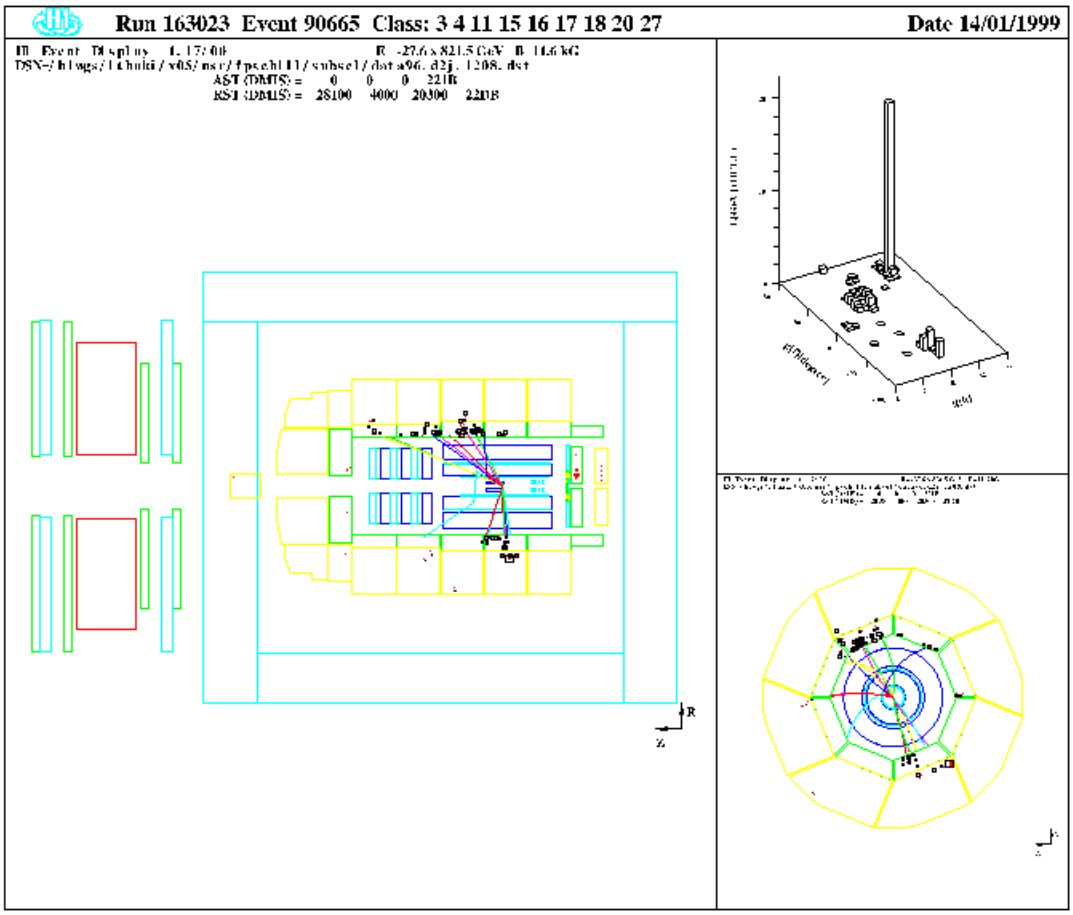
$$x_\gamma = \frac{p.u}{P.q}$$

$$z_{I\!P} = \frac{q.v}{q.(P - p_y)}$$

$\rightarrow$ Test universality of diffr. PDF's in different kin. regime

$\rightarrow$ Large sensitivity to gluons through $\mathcal{O}(\alpha_s)$ diagrams

Data Selection



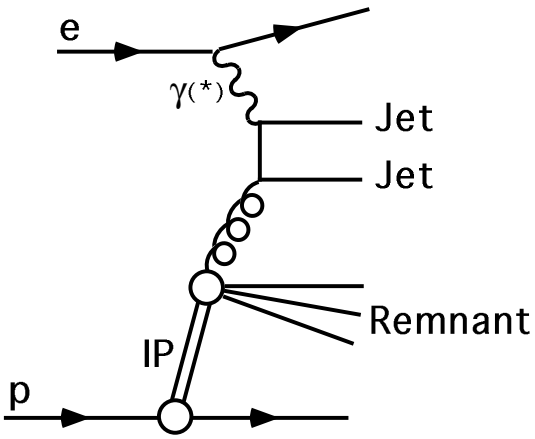
- DIS ($Q^2 \gg 0\ GeV^2$): sc. e^- in bkwd. calo of main det.
- γp ($Q^2 \approx 0\ GeV^2$): sc. e^- in low angle det.
- Diffractive events: Requirement of no hadronic activity in region $3.2 < \eta < 7.5$ in forward (proton) direction
  $\rightarrow$ low M_Y, $|t|$ and $x_{I\!P}$
- Dijet events: standard cone algorithm applied on X system, in lab (γp) or $\gamma^* I\!P$-CMS (DIS)

$$\mathcal{L}_{int} \approx 2\ pb^{-1} \qquad N_{\gamma p} \approx 400 \qquad N_{DIS} \approx 55$$

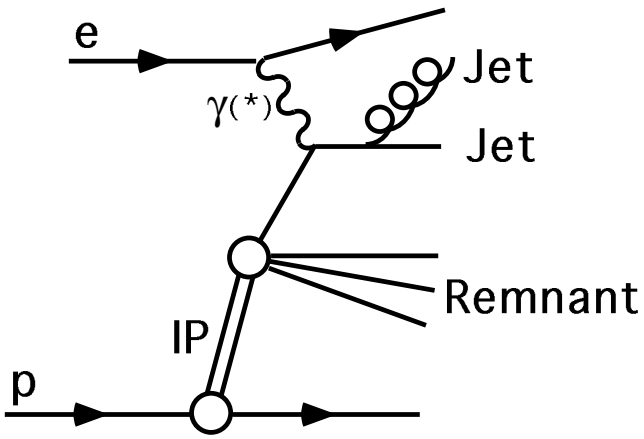
QCD Models

- Hard diffr. scattering in γp: POMPYT 2.6 (direct and resolved γ, diffr. extension to PYTHIA)
- DIS diffr. hard scattering: RAPGAP 2.02

- Partonic structure of the IP:
  $d\sigma^D(ep \to epX) = f_{I\!P/p}\; d\sigma^{eI\!P \to eX}(\mu, x_\gamma, z_{I\!P})$
- Photoproduction: photon flux using EPA:
  $d\sigma^{eI\!P \to eX}(\mu, x_\gamma, z_{I\!P}) = f_{\gamma/e}(y, Q^2)\; d\sigma^{\gamma I\!P \to X}(\mu, x_\gamma, z_{I\!P})$
  Photon PDF: GRV LO
- Pomeron flux factor:
  $f_{I\!P/p}(x_{I\!P}, t) = \left(\frac{1}{x_{I\!P}}\right)^{2\alpha_{I\!P}-1} e^{b_{I\!P} t}$
  with
  $\alpha_{I\!P}(t) = 1.20 + 0.26t$ and $b_{I\!P} = 4.6\ GeV^{-2}$



BGF

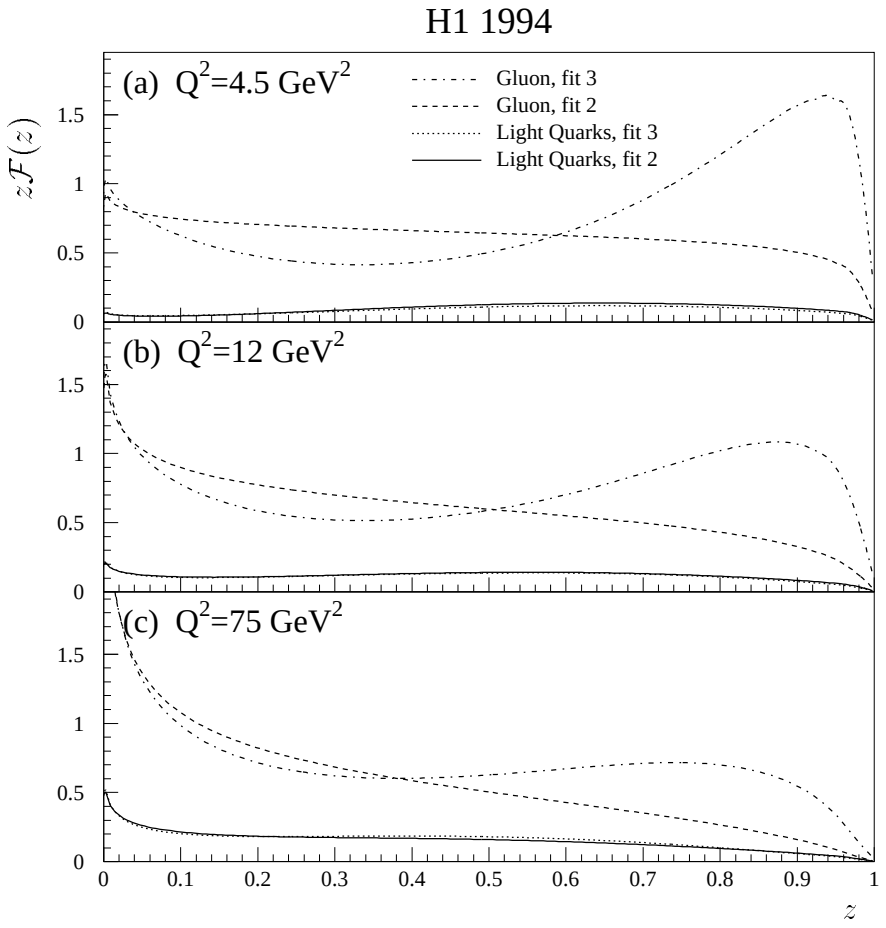


QCDC

- hard scattering via LO QCD matrix elements;
  dominant high P_T direct γ processes: BGF and QCDC

QCD Models II

- parton distributions for IP from QCD fits to $F_2^{D(3)}(H1)$ factorisation scale $\mu^2 = P_T^2$



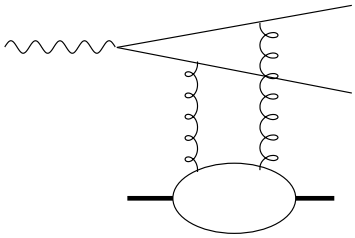
fit 1: only $q\overline{q}$ at μ_0^2

fit 2: flat g

fit 3: peaked g

- sub-leading exchange (IR), Pion PDF and $\alpha_{I\!R}(t) = 0.50 + 0.90t$ and $b_{I\!R} = 2.0\ GeV^{-2}$

- Also tested in DIS: Model of Bartels et al. for $q\overline{q}$ production through two-gluon exchange $\gamma^* p \to q\overline{q} + p$



Cross section Measurement

Cross section definition:

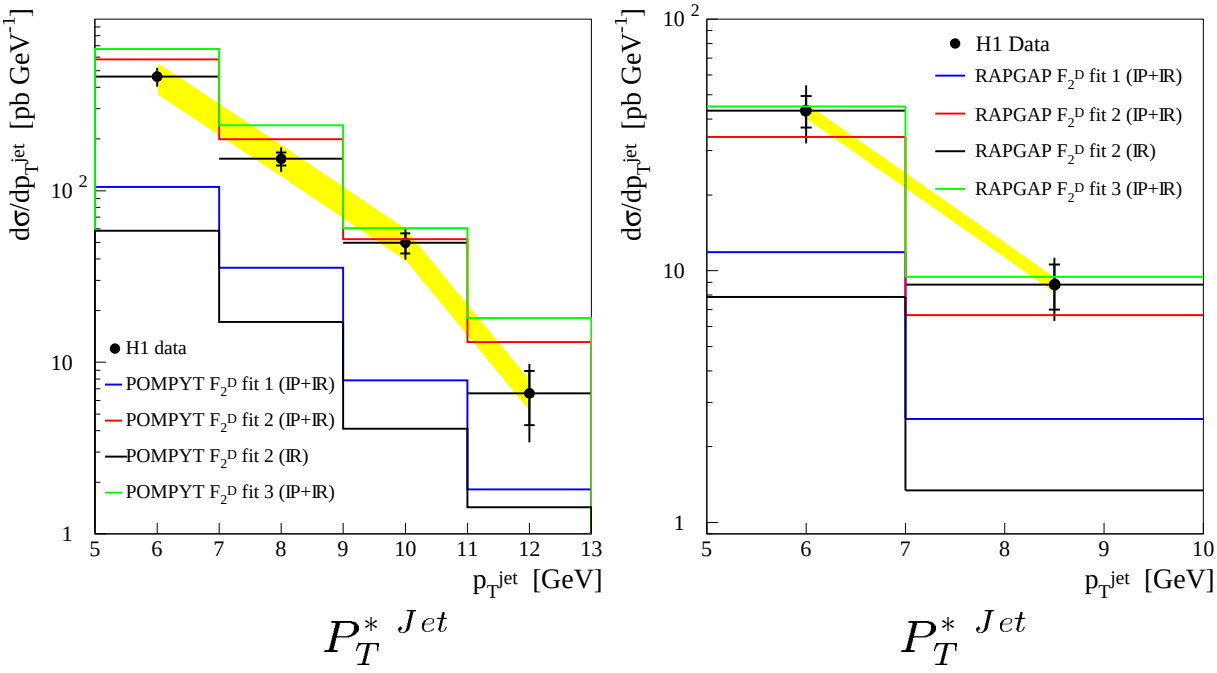
Photoproduction	DIS
$Q^2 < 0.01\ GeV^2$ $0.25 < y < 0.7$	$Q^2 = 7.5 \ldots 80\ GeV^2$ $0.1 < y < 0.7$
$x_{I\!P} < 0.05$ $M_Y < 1.6\ GeV^2$ $\|t\| < 1\ GeV^2$	$x_{I\!P} = 0.005 \ldots 0.05$ $M_Y < 1.6\ GeV^2$ $\|t\| < 1\ GeV^2$
$N_{Jets} = 2$ $P_T^* > 5\ GeV$	$N_{Jets} = 2$ $P_T^* > 5\ GeV$

Main systematic errors:

Error source	Syst. error
Hadronic calibration of detector components (γp and DIS)	$15 - 20\%$
low angle e tagger acceptance and trigger efficiency (γp)	each 5%
E and θ of scattered e (DIS)	6% and 2%
Model dependence: shape of P_T, $z_{I\!P}$, $x_{I\!P}$ and t distributions	6%, 3%, 1% and 3%
migrations across $M_Y < 1.6\ GeV$	6%
migrations across $x_{I\!P} < 0.05$	7%
modelling of hadronisation	3%

Jet rates and P_T spectra

γp DIS

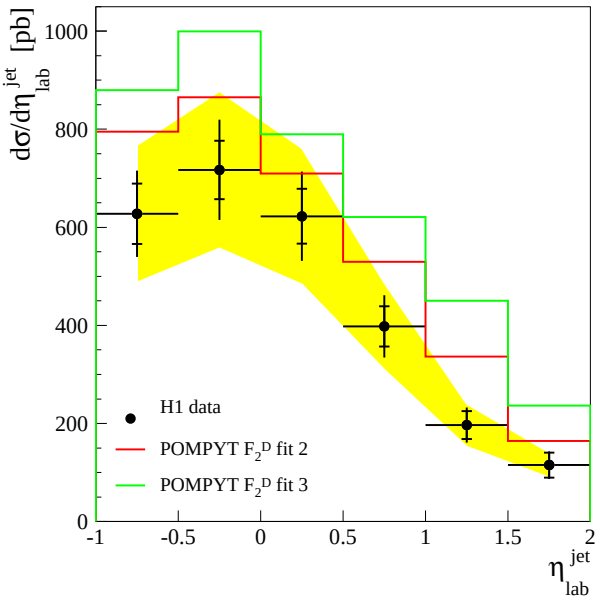


P_T^{Jet} relative to $\gamma^{(*)}$ axis in rest frame of X

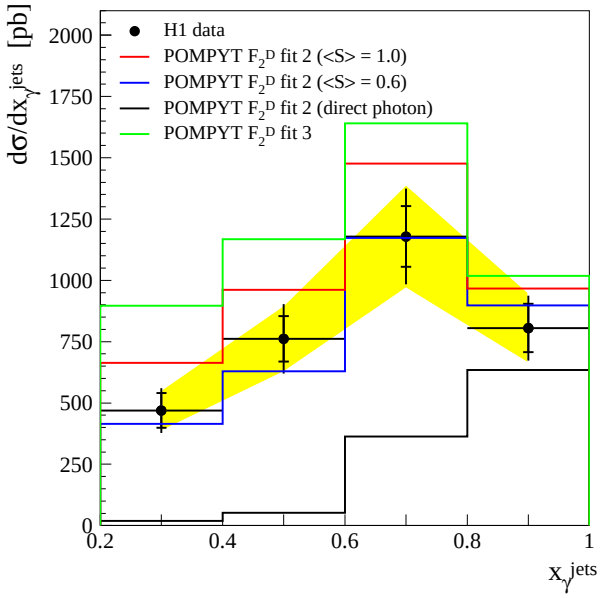
- Sub-leading exchange contribution $\approx 15\%$
- Models in which IP consists only of quarks at starting scale undershoot data by factor of ≈ 5!
- Models where IP is dominated by hard gluons give
- resonable description of data

$\rightarrow$ Jet rates sensitive to gluon content of IP !

Photoproduction and possible breaking of factorisation



η_{lab}^{Jet}



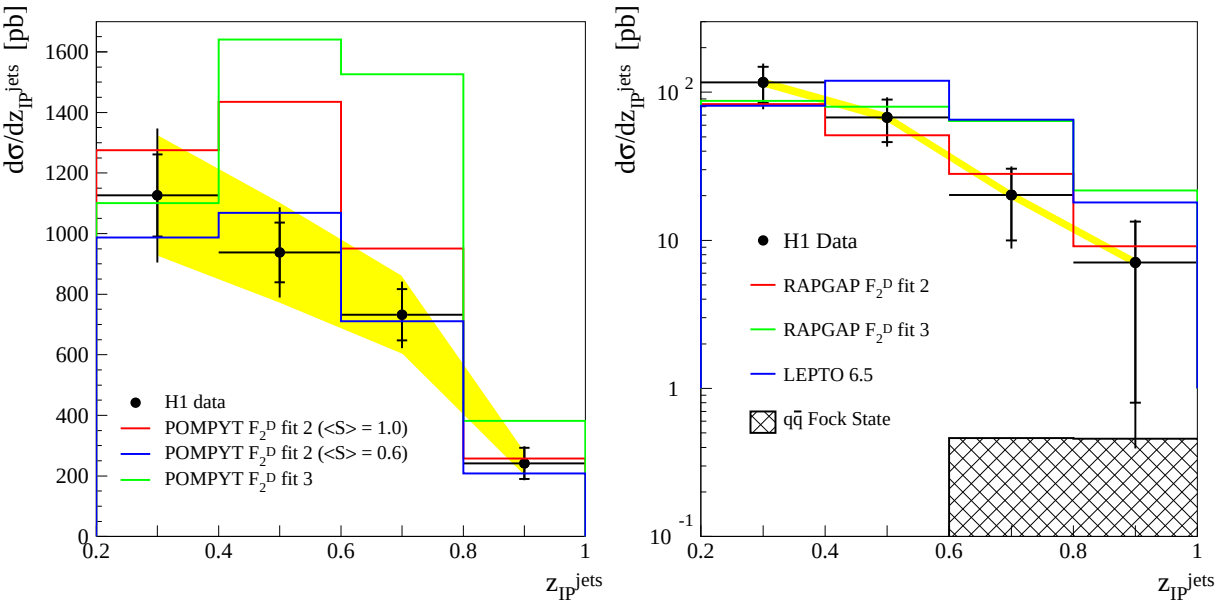
$x_\gamma^{Jets} = \frac{\Sigma_{Jets}(E-Pz)}{\Sigma_X(E-Pz)}$

- η_{lab}^{Jet}: decomposition in x_γ, $z_{I\!P}$
- x_γ^{Jets}: direct and resolved components
- Gluon dominated IP models describe shape
- resolved γ: soft interactions between remnant particles can destroy rapidity gaps
  $\rightarrow$ breaking of factorisation ('survival probability')?
- Toy model $< S > |_{x\gamma<0.8} = 0.6 \rightarrow$ improved descr.
- Comparision with results from diffractive dijet production at TEVATRON: $< S >= 0.1$ at $\sqrt{s} = 1800\ GeV$

$\rightarrow$ Energy dependence of factorisation breaking effects?

Dependence on fractional momentum from IP

γp DIS



$$z_{I\!P}^{jets} = \frac{\Sigma_{Jets}(E+P_z)}{\Sigma_X(E+P_z)} \qquad z_{I\!P}^{jets} = \beta\left(1+\frac{s^{jets}}{Q^2}\right)$$

- fractional momentum of IP which enters hard scattering
- reasonable description by gluon dominated IP

- In DIS: Bartels et al. calculation ($q\overline{q}$ prod. by $2g$ exchange) contributes only at large $z_{I\!P}$;
  in kinematic regime of large M_X (low $z_{I\!P}$) other contributions important as well (eg. $q\overline{q}g$)

- SCI model in DIS (LEPTO 6.5 with $R_{SCI} \approx 0.5$) gives similar description than peaked gluon model in RAPGAP

→ Momentum distribution neither soft nor 'super-hard'
→ data favour $fit\ 2$ more than $fit\ 3$!

Conclusions

- First measurement of diffractive dijet production cross sections in γp and DIS from H1
- Comparision with resolved IP model with parton densities obtained from QCD fits to $F_2^{D(3)}(H1)$, evolving with a scale $\mu^2 = P_T^2$
- Models where IP is dominated by hard gluons describe data; '$flat\ g$' (fit 2) better than '$peaked\ g$' (fit 3)
- γp data show direct and resolved components and possible presence of factorisation breaking effects for resolved γ
- Indication of energy dependence of factorisation breaking effects (compared with $p\overline{p}$ interactions at larger energies)
- Bartels et al. $2g$ model of $q\overline{q}$ production not expected to describe DIS dijet production in high M_X , high P_T region; other contributions like $q\overline{q}g$ important as well

$\rightarrow$ consistent picture from F_2^D, charged particles, event shapes and -flow and dijet production from H1:
$\rightarrow$ resolved IP model with gluon dominated parton densities evolving with scale of hard interaction

... but wait for talk about diffr. D^* production from H1!