5th International Workshop on
Deep Inelastic Scattering and pQCD

DIS '97

15.4.97

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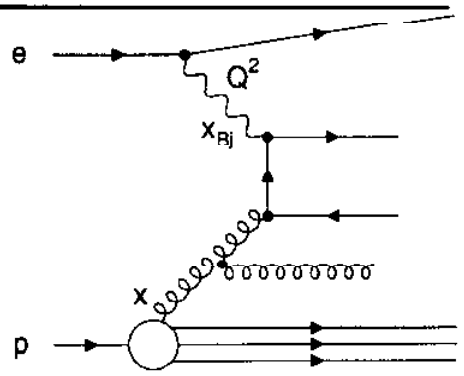
H1 collaboration

H1 results on dijet rates, forward jets and high $p_\perp^*$ particles

- physics of high $p_\perp^*$ hadronic final states
- the H1 detector – Kinematical region
- dijet rates
- forward jet production
- spectra of charged high $p_\perp^*$ particles
- summary & conclusions

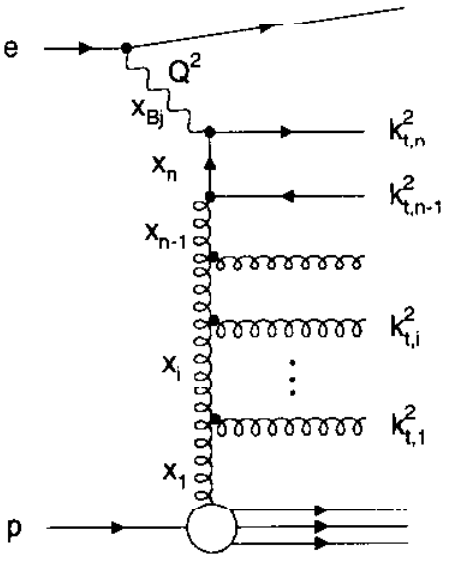
high $p_\perp^*$ hadr. final state:

fixed order α_s



NLO

resummation of leading logarithms



DGLAP $(\alpha_s \ln \frac{Q^2}{Q_0^2})^n$

$k_{t,1} \ll k_{t,2} \ll \cdots \ll k_{t,n}$

$x_1 > x_2 > \cdots > x_n$

BFKL $(\alpha_s \ln \frac{1}{x})^n$

$k_{t,i} \sim k_{t,i+1}$

$x_1 \gg x_2 \gg \cdots \gg x_n$

(should become relevant at small x)

calculations / models

NLO → parton level Monte Carlos
MEPJET , DISENT

DGLAP → full event generators

Matrixelement + Partonshower (MEPS)
+ String- or Clusterfragmentation
LEPTO & HERWIG

BFKL

→ analytical calculations
(parton level , +fragmentation functions)

??? ~→ Colour Dipole Model (CDM)
+ string fragmentation: ARIADNE

(no strong k_t ordering) ← "BFKL feature"

physics at small x

- expected to be well described by conventional theory (NLO) :

① → production of dijets with small rapidity differences

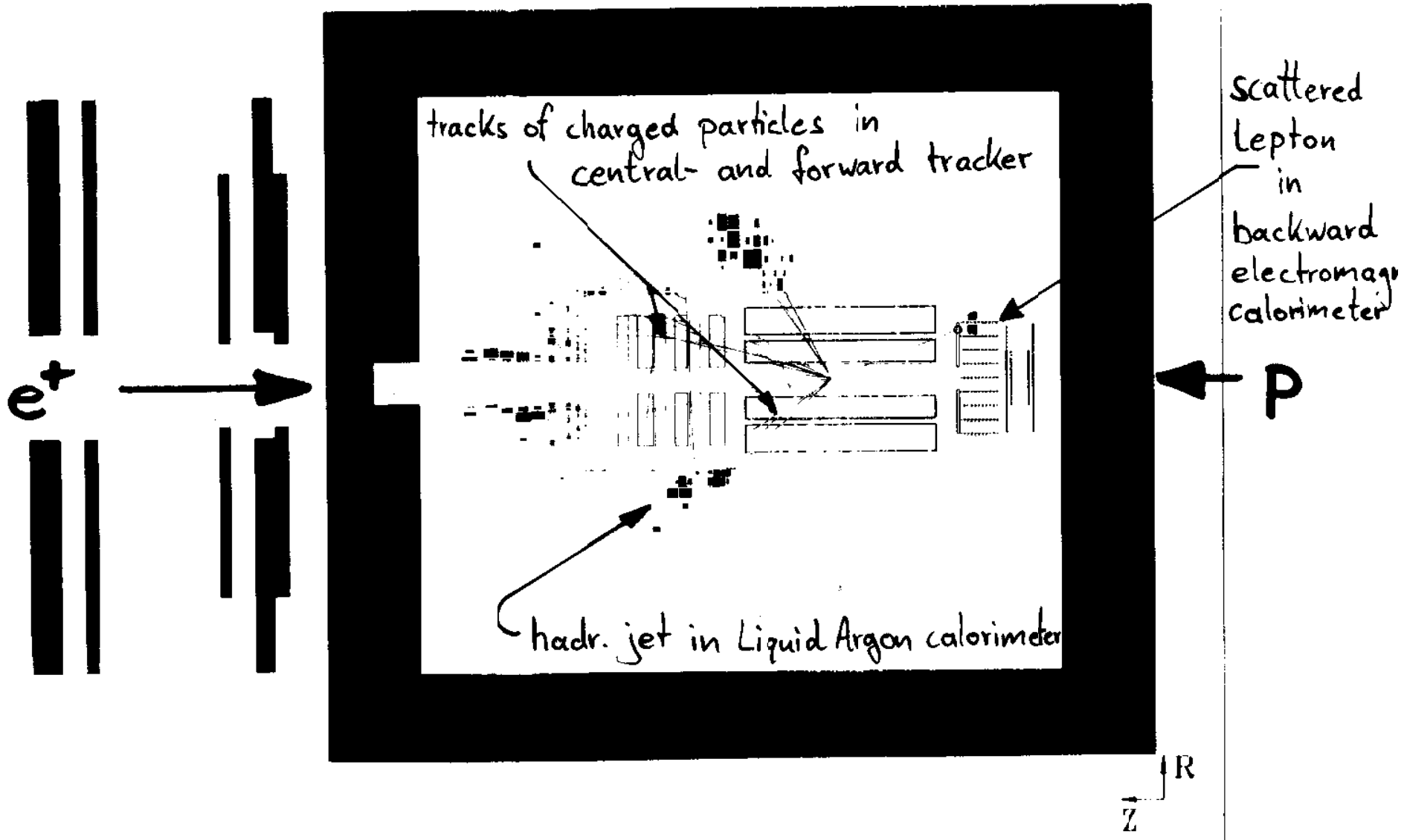
- expected to have sensitivity for discrimination between DGLAP and BFKL :

② → forward jet production

③ → charged particle p_T^* spectra

Run 87456 Event 13017 Class: 2 3 4 8 9 11 20 22 24 Date 5/03/1997

AST (DM1S) = 0 399D 61040000 101B E= -27.6 x 819.9 GeV B=11.6 kG
RST (DM1S) = 57BF00 B9FD 63060395 1DFF



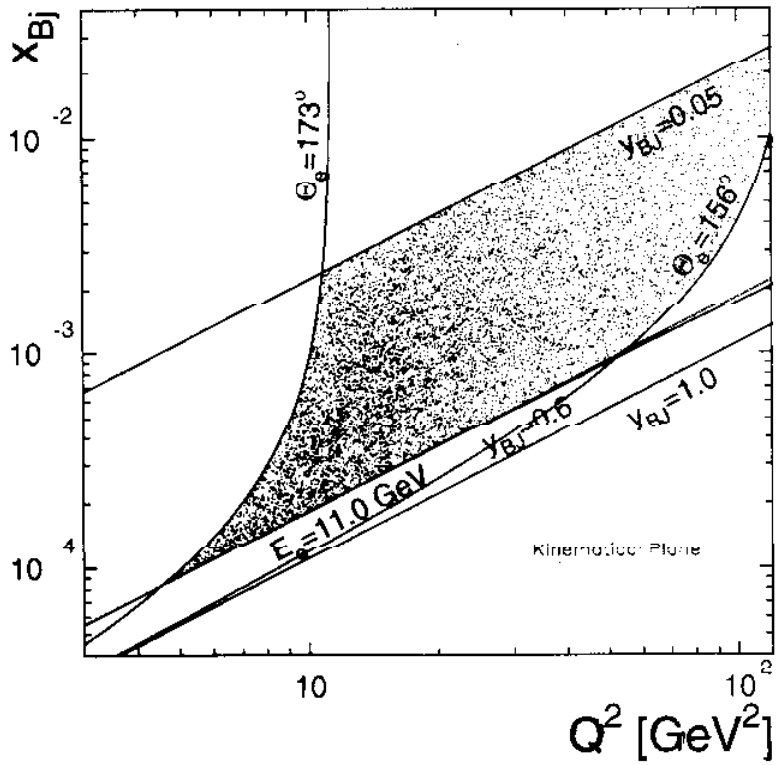
Kinematical region

scattered electron: $E'_e > 11\,GeV$ $(12\,GeV)$ ← ①

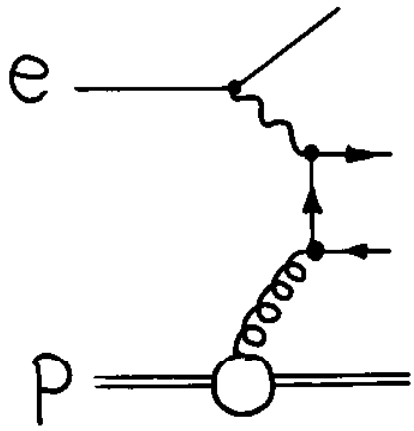
② → $(160°)$ $157° < \vartheta_e < 173°$

Kin. variables: $y > 0.05$ (0.1) ← ②

$5\,GeV^2 \lesssim Q^2 \lesssim 100\,GeV^2$ $(50\,GeV^2)$ ← ③

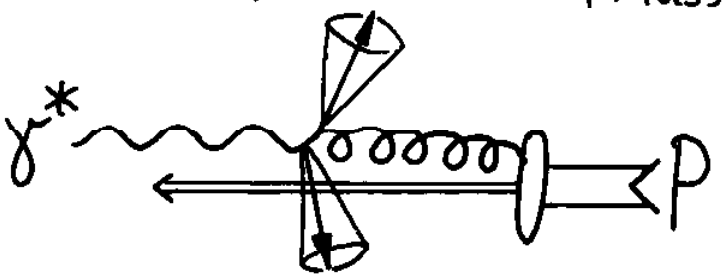


Dijet rates



BGF

in hadronic centre of mass:



two jets with balanced transverse momenta

dijet rate: $R_2 \equiv \frac{\sigma_{2\text{-jet}}}{\sigma_{tot}} = \frac{N_{2\text{-jet}}}{N_{all\text{-}DIS}}$

→ **expect:**

good description by conventional pQCD (NLO)!

→ therefore used for determination of

α_s, gluon density (→ talks of H1, ZEUS)

jet definition

- cone algorithm (a la Snowmass conv.)
  in hadronic centre of mass : $R_{cone} = 1$

- require exactly 2 jets with :

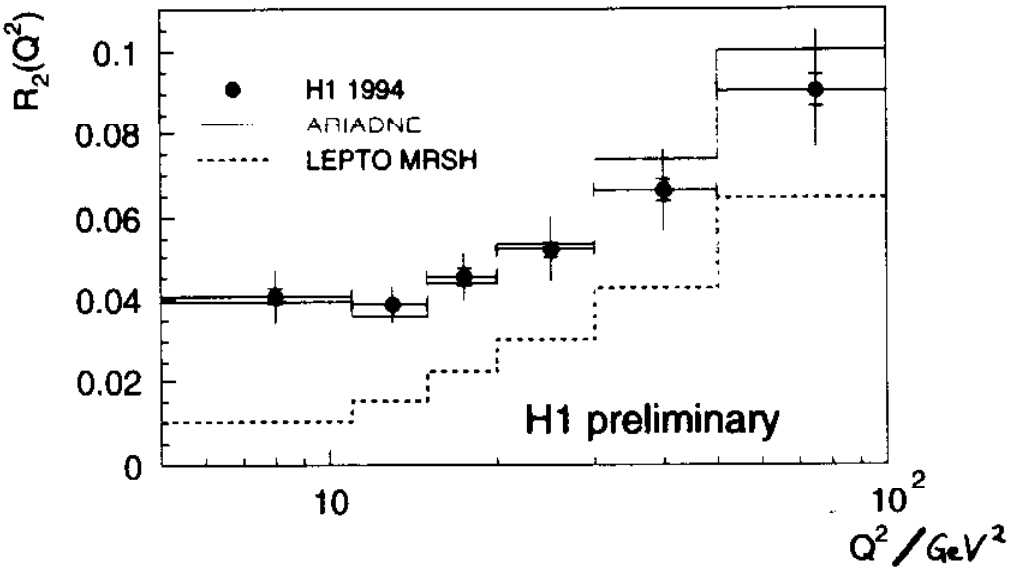
  $P_\perp^* > 5$ GeV (→ hard process)

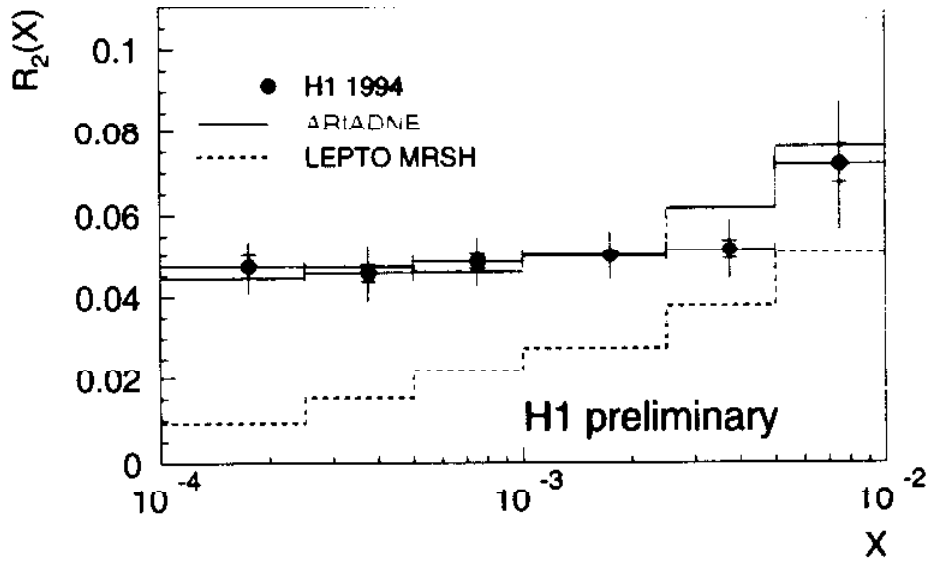
  $\Delta\eta^* < 2$ ($\hat{=}$ $z_p \gtrsim 0{,}12$)

- correct for detector effects (↝ hadron level)

→ $R_2(Q^2)$, $R_2(x_{Bj})$

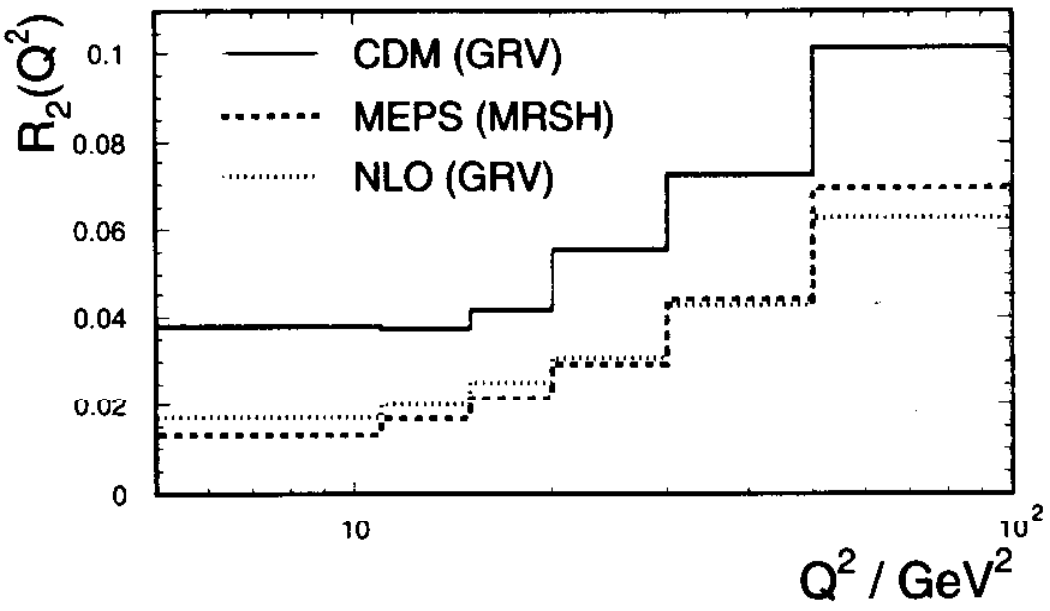
dijet rates (hadron-level)

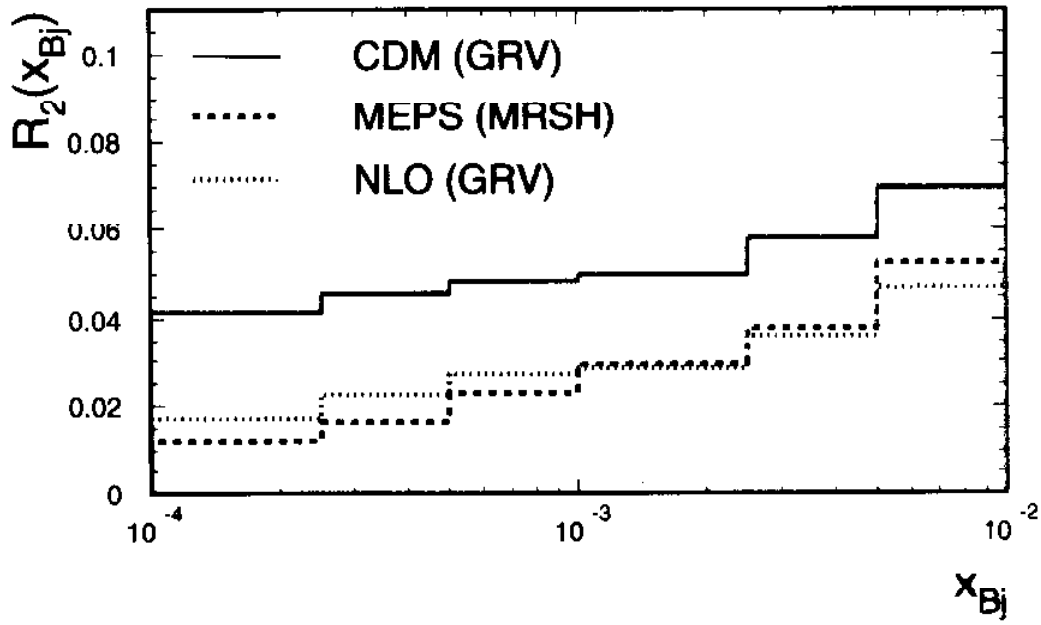




$E'_{el} > 11$ GeV $153^\circ < \vartheta_{el} < 173^\circ$ $y > 0.05$	cone algorithm in hcm $R_{cone} = 1.$ $p^*_{\perp jet} > 5.$ GeV 2 jets with: $\Delta\eta^* < 2.$

dijet rate (cone) - parton level





dijet rates

- a large deviation compared to MEPS and NLO is observed in whole region: $5 < Q^2 < 100\ \mathrm{GeV}^2$
- good description by CDM

- cut: $\Delta\eta^* < 2$

  leads to suppression of BFKL phase space

- J. Rathsmann: (concerning dijet rates)

  Difference between CDM and MEPS is due to "unorthodox suppression factor" in ARIADNE

  NOT due to non-$k_\perp$ ordering!
- problem maybe: 2 scales involved $(Q^2, P_\perp^2)$?

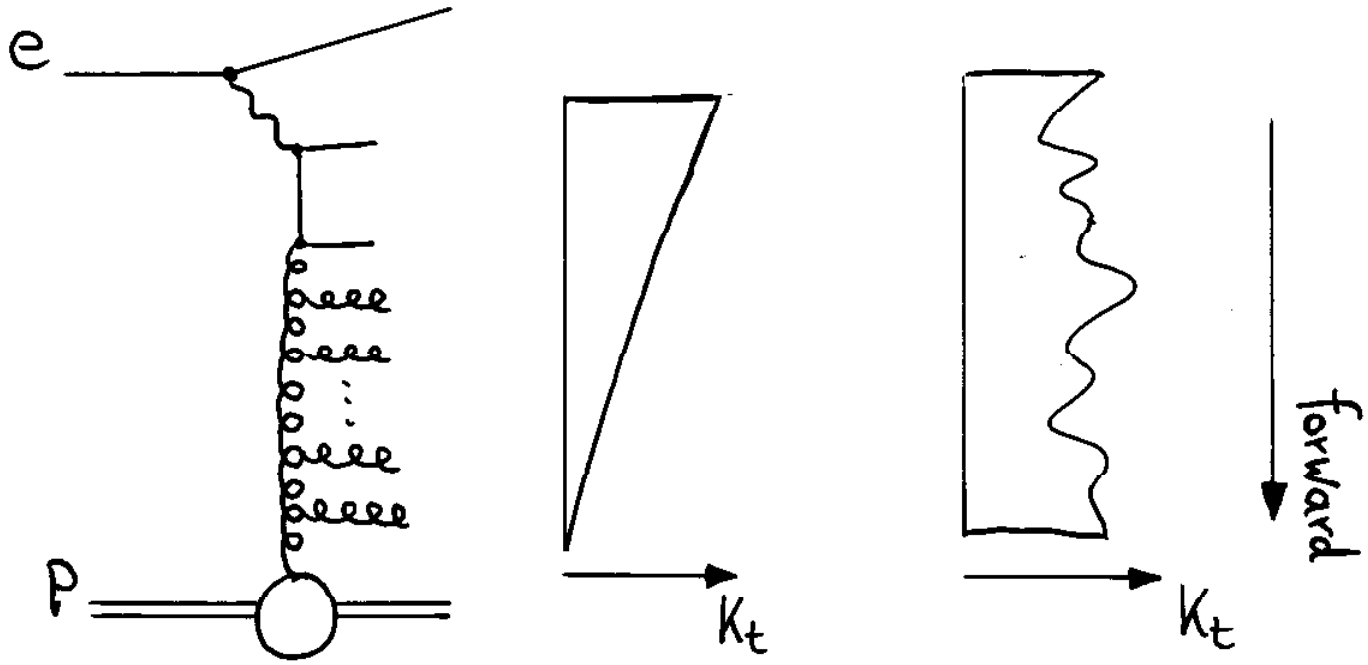
Sensitivity for BFKL ?

DGLAP

k_t ordering

BFKL

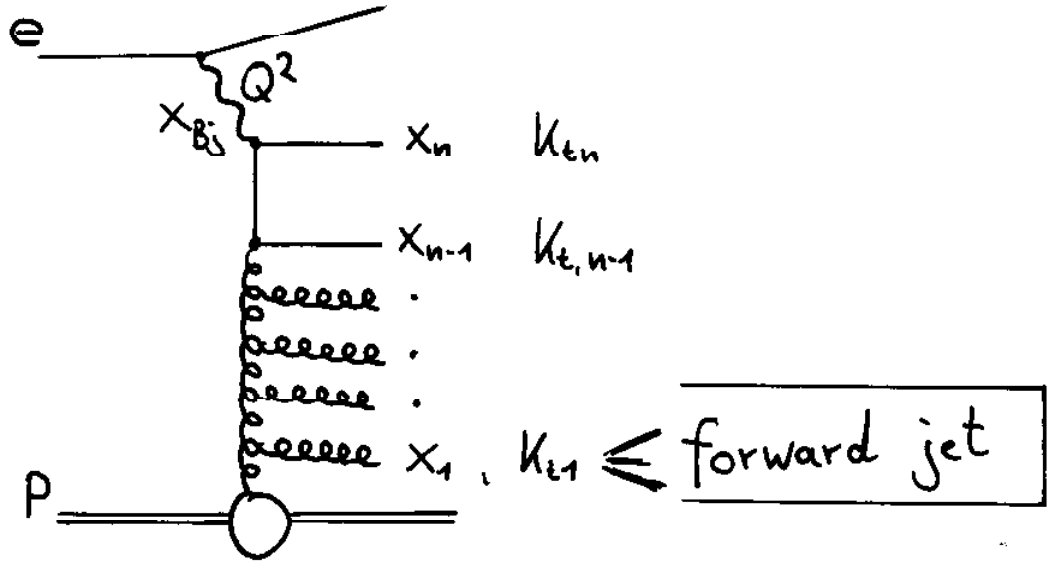
non-k_t ordering
(random walk)



→ expect more forward activity for BFKL evolution

(e.g. forward jets, high p_T^* particles)

forward jet production



DGLAP: $k_{t,n}^2 \gg k_{t,n-1}^2 \gg \cdots \gg k_{t,1}^2$ $\qquad x_n < x_{n-1} < \cdots < x_1$

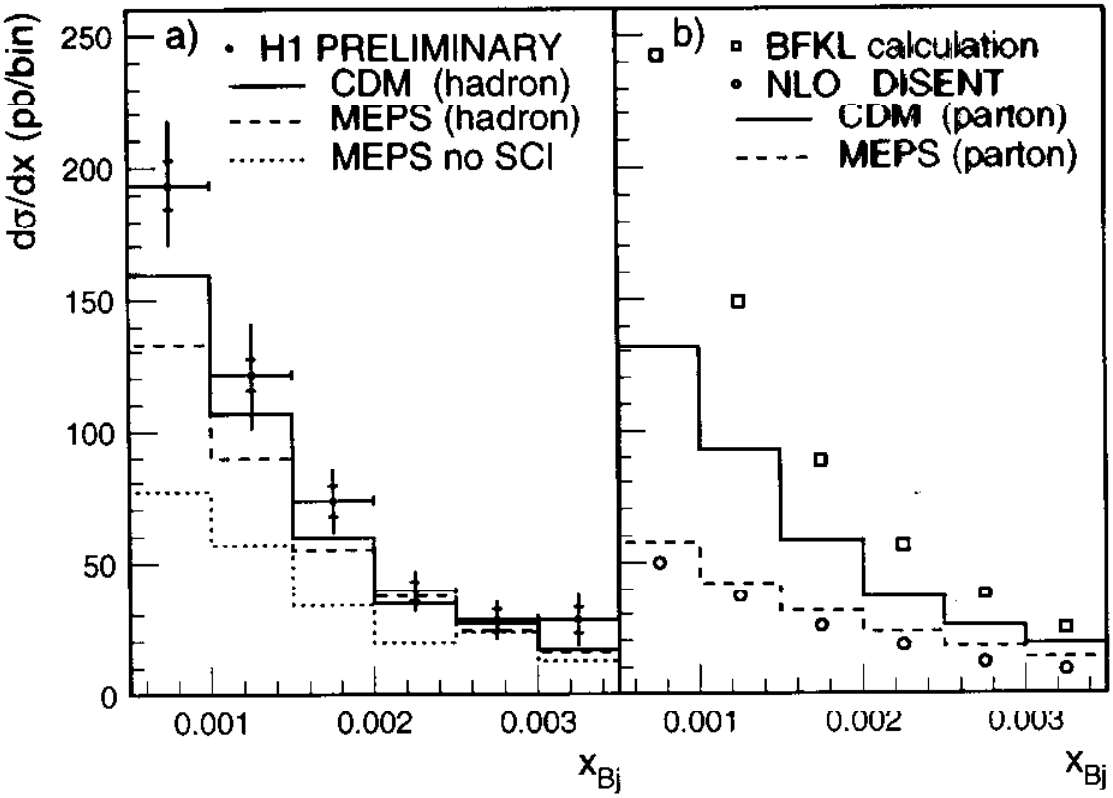
BFKL: no k_t-ordering $\qquad x_n \ll x_{n-1} \ll \cdots \ll x_1$

- $k_t^2 \simeq Q^2 \Rightarrow$ suppress phase space for DGLAP
- $x_{jet} = \frac{E_{jet}}{E_p}$ large $\qquad x_{Bj}$ small

  $\Rightarrow$ maximize phase space for BFKL evolution

  $$\sim \left(\frac{x_{jet}}{x_{Bj}} \right)$$

forward jets



	cone in lab R=1.
$E'_{el} > 11$ GeV	$E_{jet} > 28.7$ GeV
$160^\circ < \vartheta_{el} < 173^\circ$	$p_{\perp jet} > 3.5$ GeV
$y > 0.1$	$7^\circ < \vartheta_{jet} < 20^\circ$
	$0.5 < p^2_{\perp jet}/Q^2 < 2$

NLO, CDM, MEPS: MRS H parton densities

BFKL calculation: (normalization unknown)

Bartels, Del Duca, De Roeck, Graudenz, Wüsthoff

forward jets

- data is above all models
- closest model: CDM / MEPS fails
- BFKL (parton-level) calculation is above data
  → large uncertainty for hadronization corrections
  (very large model dependence)
- NLO calculation not very predictive:

$$\frac{\sigma_{NLO}}{\sigma_{LO}} \simeq 6$$

→ future prospects:

require higher transverse momentum
to decrease hadronization effects!

measurement of charged particle transverse momentum spectra

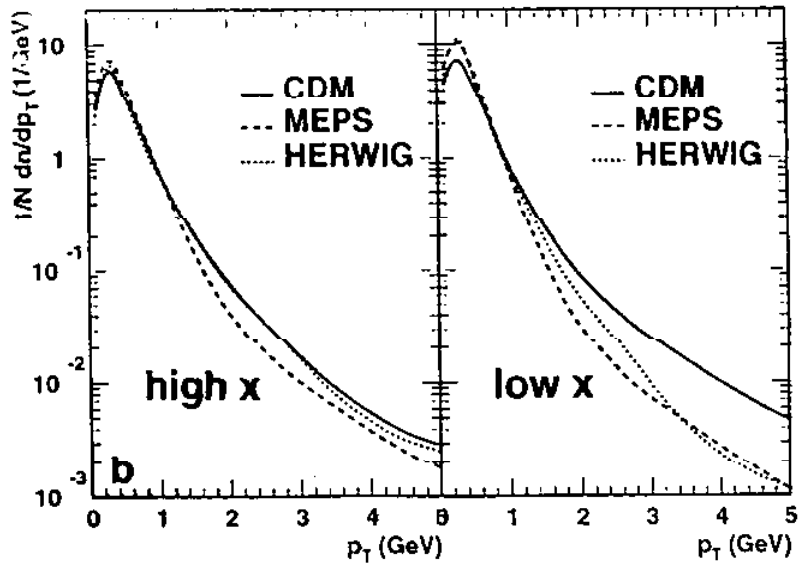
CDM: unordered emission

→ more $E_\perp$ in central region than ordered cascade (LEPTO . HERWIG)

→ single particle $p_\perp$ spectra are directly sensitive to underlying parton dynamics (production from hadronization is suppressed)

charged particle $p_\perp^*$ spectra in

$0 < \eta^* < 2$



CDM:
more high $p_\perp^*$ partons

transverse momentum spectra of charged particles

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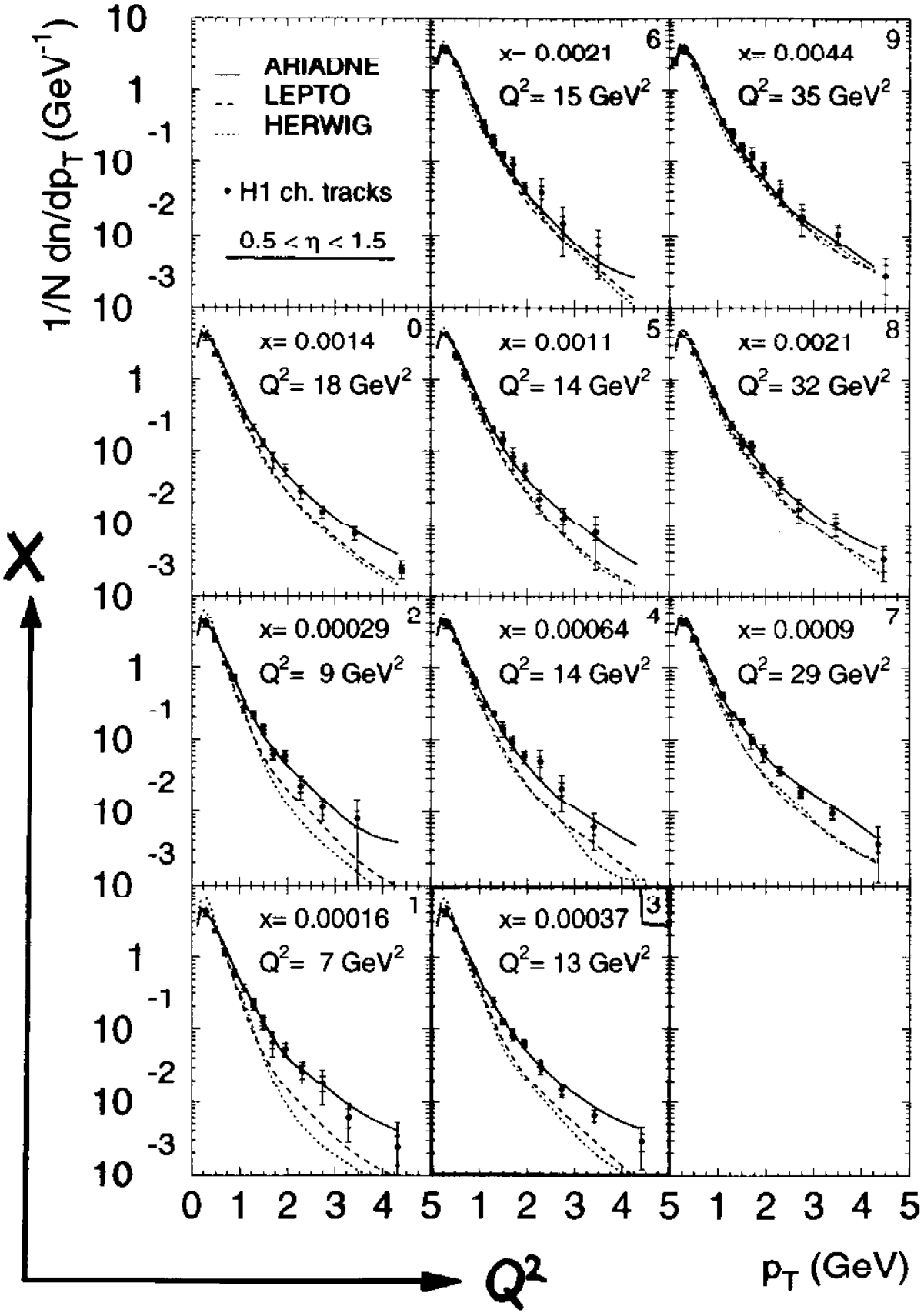
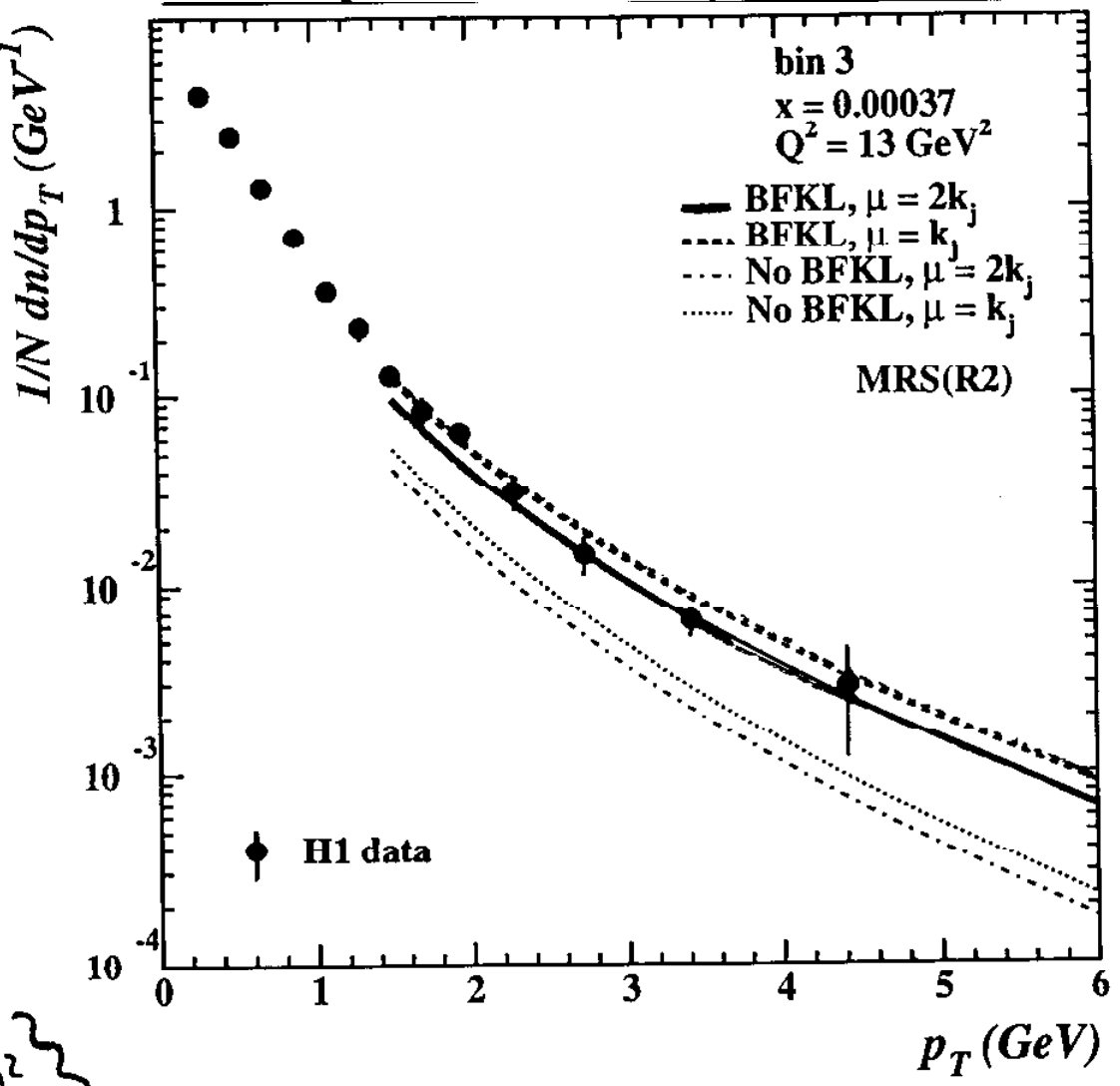
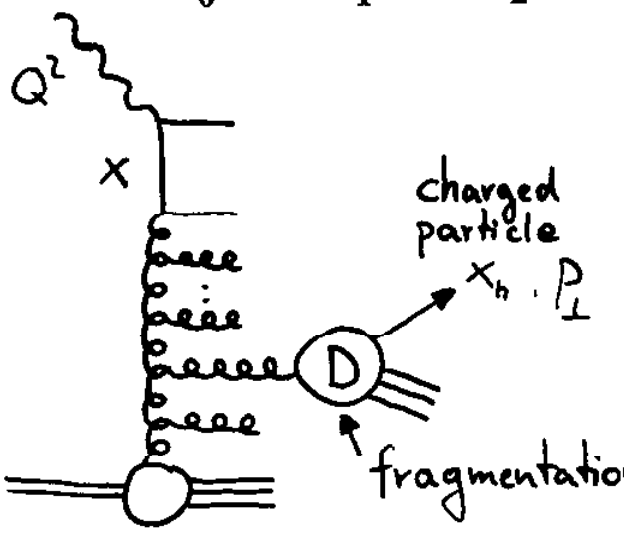


Absolute prediction for the charged particle spectrum





Kwiecinski, Lang, Martin

(normalization taken from calc. for H1 - forward jets)

charged high $p_\perp^*$ particles

measurement in current and central fragmentation regions:

- large x ($x > 10^{-3}$)
  - all models provide satisfactory description
- small x & central rapidity
  - CDM gives a good description
  - DGLAP models fail
    (observed $p_\perp^*$ distribution is significantly harder)

- new BFKL calculation (parton level + frag. funct.)
  (Kwiecinski, Lang, Martin)
  normalization from forward-jet-BFKL calculation
  ↳ good agreement with data

Summary

- recent H1 results on:
  - → dijet rates
  - → forward jets
  - → charged high p_T^* particles

- 3 observables are directly related to partonic activity (& less influenced by hadronization)

- 3× not described by MEPS models
  (dijet rates, forward jets : MEPS ≃ NLO)

- BFKL calculations can describe shapes for forward jets & high p_T^* particle spectra
  (uncertainties with normalization)

conclusions

- we observe more partonic activity than expected from NLO / DGLAP models

Sign for BFKL ??

⇝ cannot be stated from existing data!

→ need BFKL Monte Carlos

- observation of large dijet rates ($\Delta\eta^* < 2$) !
  (suppressed phase space for BFKL)

→ A possible explanation has to include these too !!!