HSQCD2005, 20- 24th September St. Petersburg

Experimental Summary

Joerg Gayler, DESY

Results presented

from all 4 HERA experiments
D0
WA89 (hyperon beam)
SVD
PHENIX(RHIC)

Conclusion

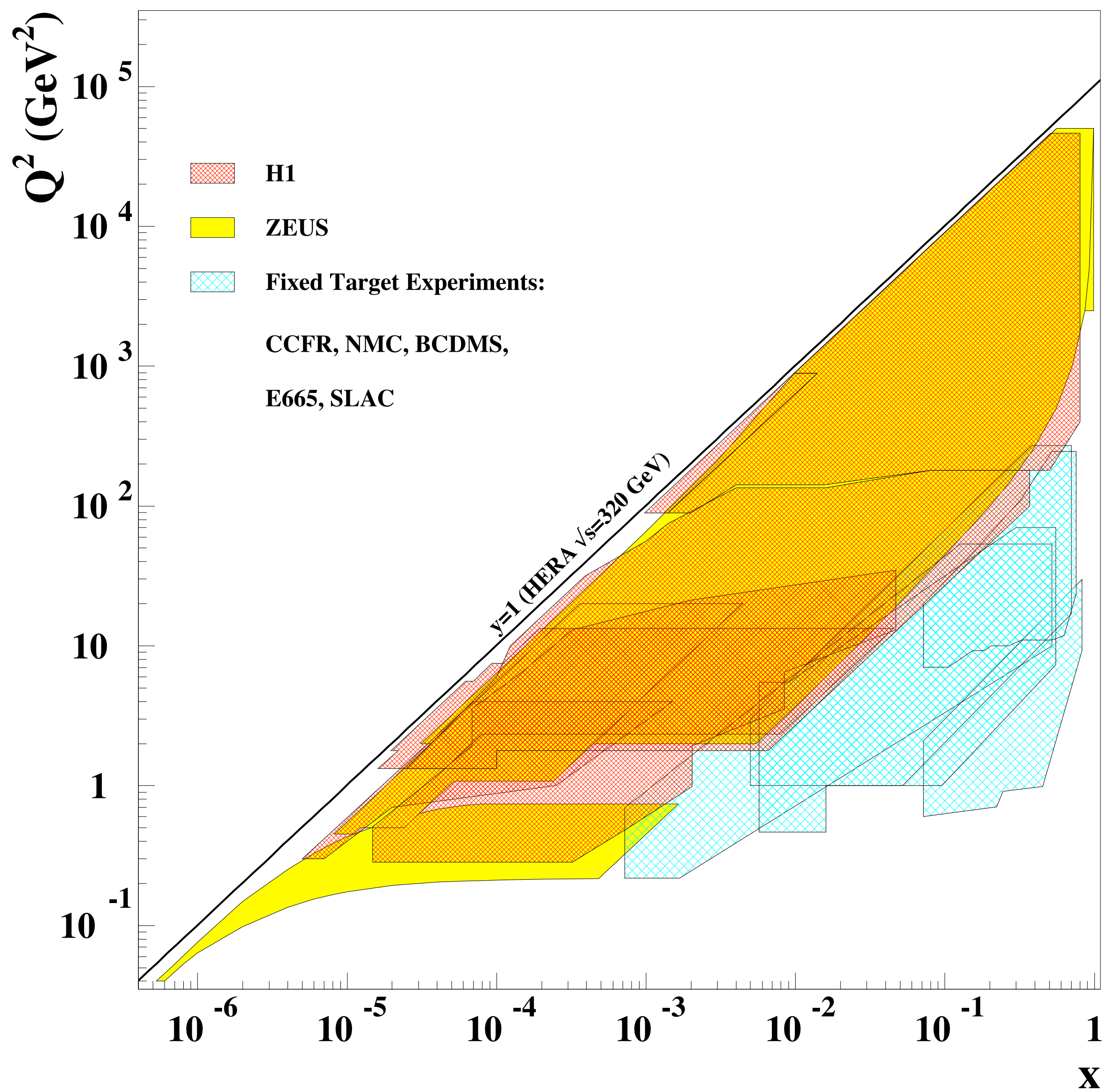
many slides have name of the speakers,
but they are not responsible
at least not for the purple stuff

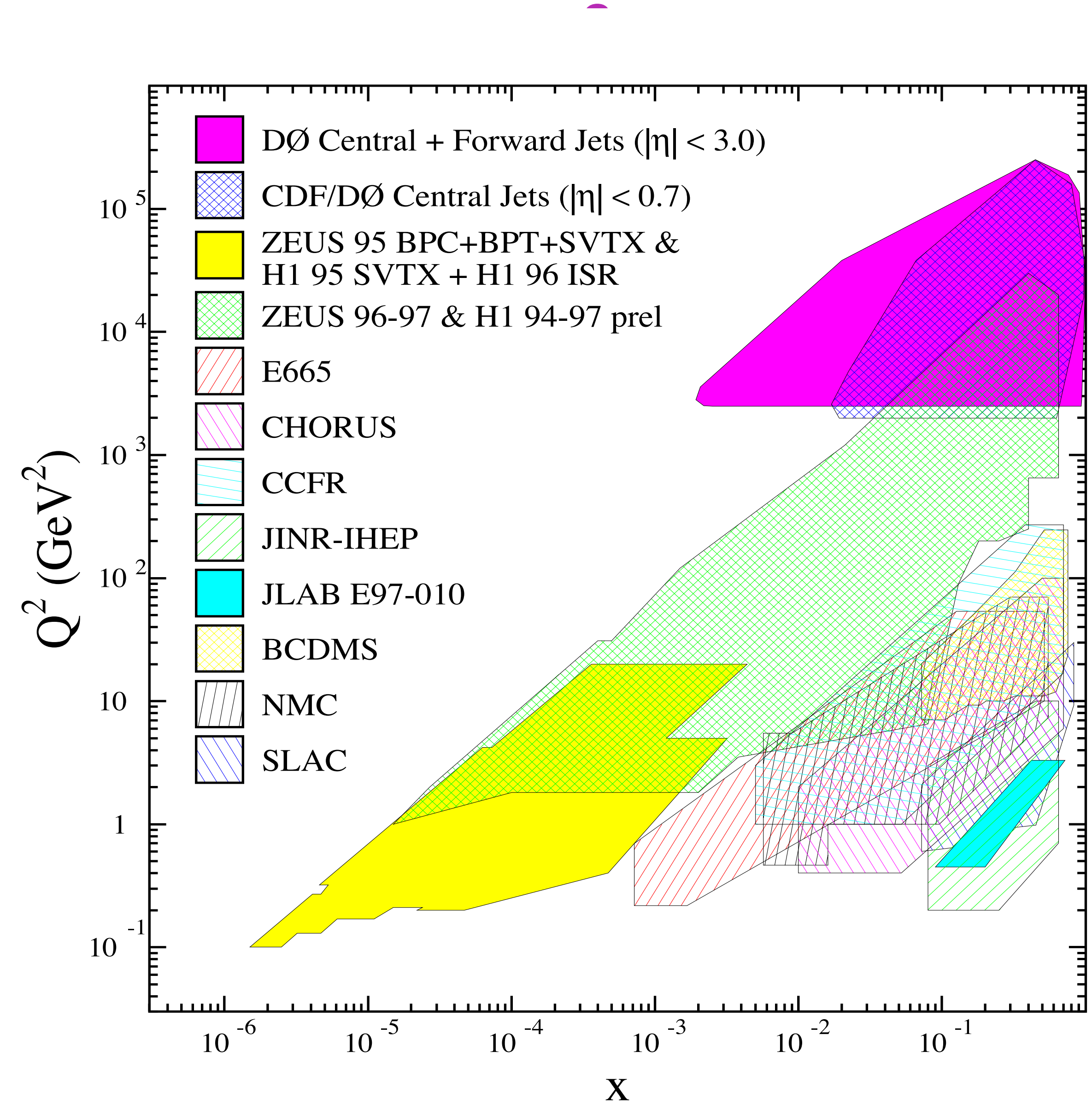
I tried to pick from all speakers the most important results

Very subjective and in a hurry

large phase space covered by HERA e^+p e^-p data

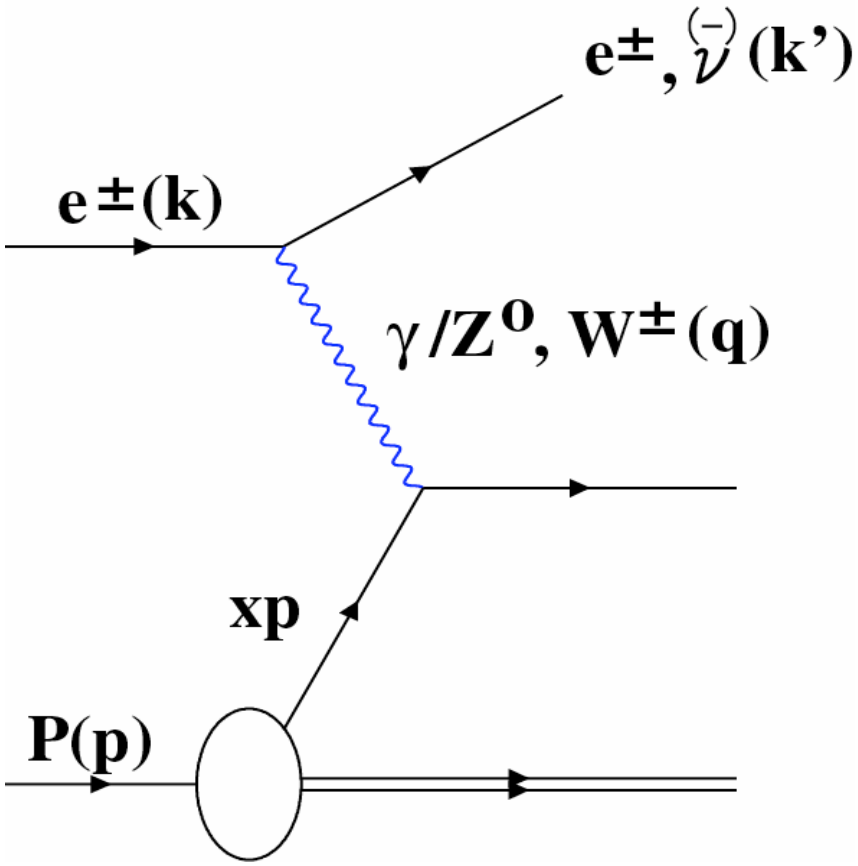
at high Q2 and x
Tevatron jet data contribute to pdf





Yongdonk Ri

Deep Inelastic Scattering at HERA



$Q^2 = -q^2 = -(k-k')^2$

Virtuality of exchanged boson

spatial resolution : $\lambda \approx \frac{1}{\sqrt{Q^2}}$

$x = \frac{Q^2}{2p \cdot q}$ **momentum fraction of the struck quark**

$y = \frac{p \cdot q}{p \cdot k}$ **inelasticity**

$s = (p+k)^2 \quad Q^2 = s \cdot x \cdot y$

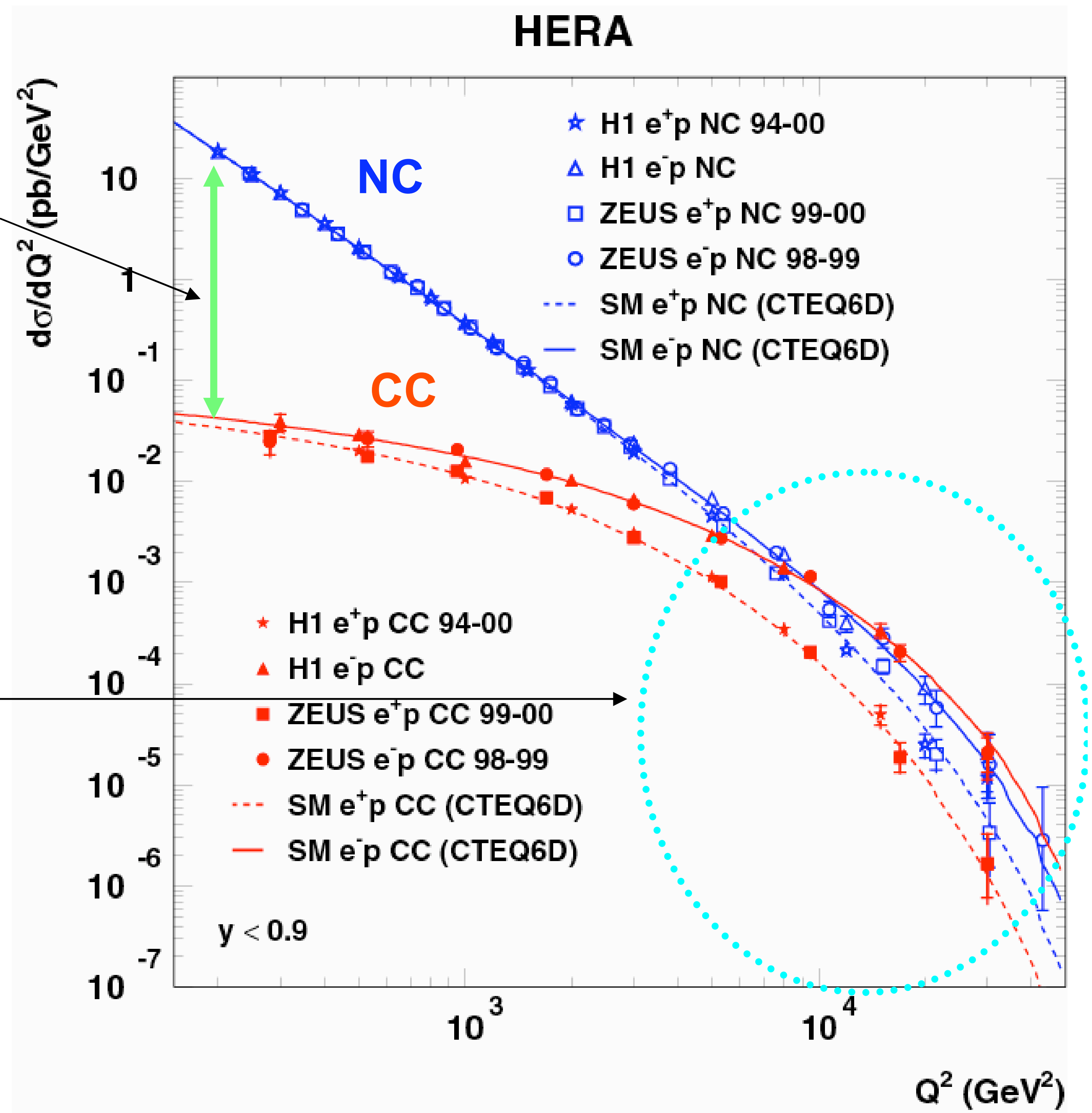
Only two independent

- Neutral Current : exchange of γ or Z^0
- Charged Current : exchange of $W^{\pm}$

Measured NC and CC cross sections

Suppressed due to large mass of W boson compared to NC DIS

Electro-Weak unification at high Q^2



20-25 Sep 2005

Yongdonk Ri

Combined EW pQCD fit

Propagator mass analysis (H1)

In fit **G-M_{prop}-PDFs**,

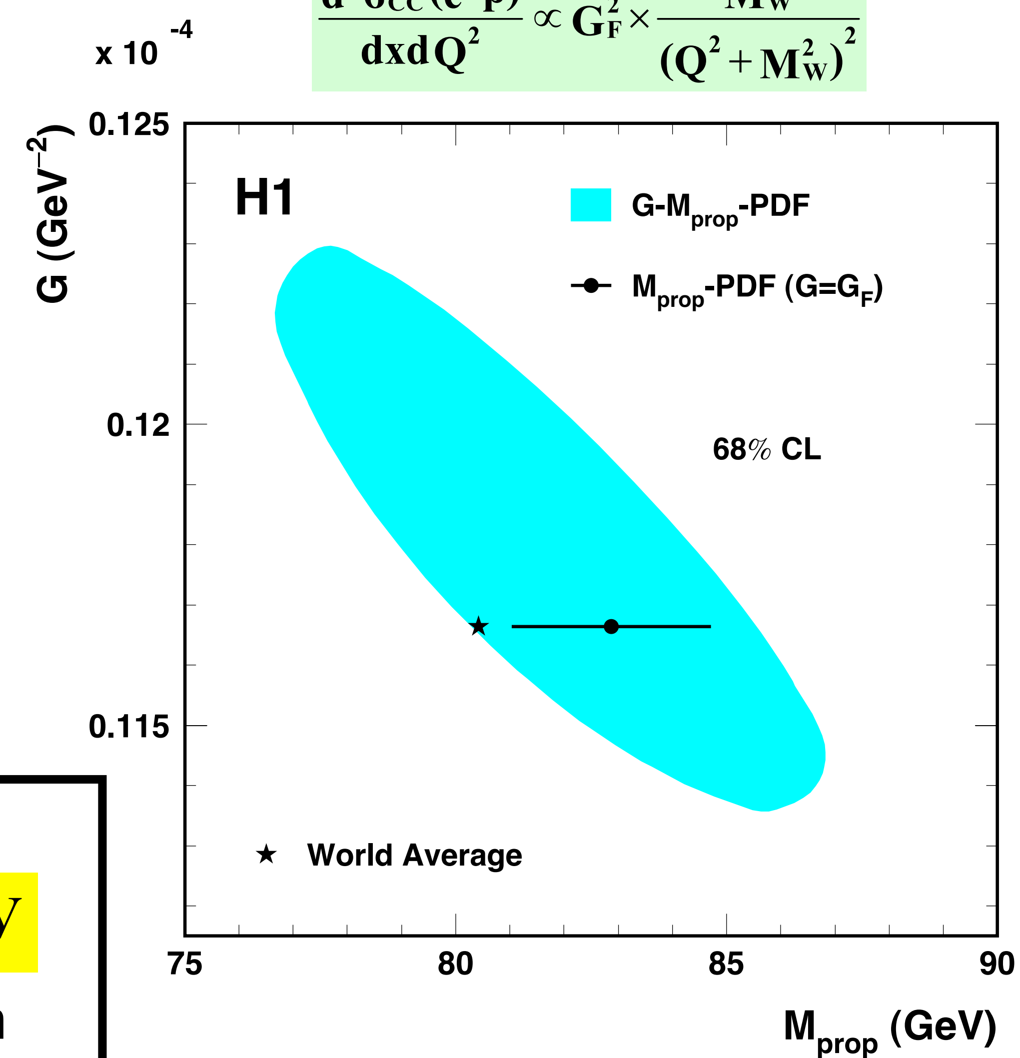
- Sensitivity to G : normalisation of the CC cross section
- Sensitivity to M_{prop} : Q^2 dependence
- G is consistent with G_F obtained from the muon lifetime measurement
- Demonstrating the universality of the CC interaction over a large range of Q^2 values

In fit **M_{prop}-PDFs**, fixing G to G_F,

$$M_{prop} = 82.87 \pm 1.82(\mathrm{exp})^{+0.30}_{-0.16}(\mathrm{mod})\,\mathrm{GeV}$$

- Measurement of propagator mass in HERA **space-like** region is complementary and consistent with Tevatron/LEP **time-like** one

$$\frac{d^2\sigma_{CC}(e^{\pm}p)}{dx\,dQ^2} \propto G_F^2 \times \frac{M_W^4}{(Q^2+M_W^2)^2}$$



11

consistent result in space like region,
this no effort to improve time like measurements

Yongdonk Ri

Combined EW pQCD fit

Determination of quark couplings to Z^0 (H1)

At high Q^2 and high x, NC cross sections are sensitive to the up- and down-type quark couplings dominated by the **light u and d quarks**

Complementary measurement of **heavy quark couplings** measured very precisely by LEP

$$a_q = I_q^3$$

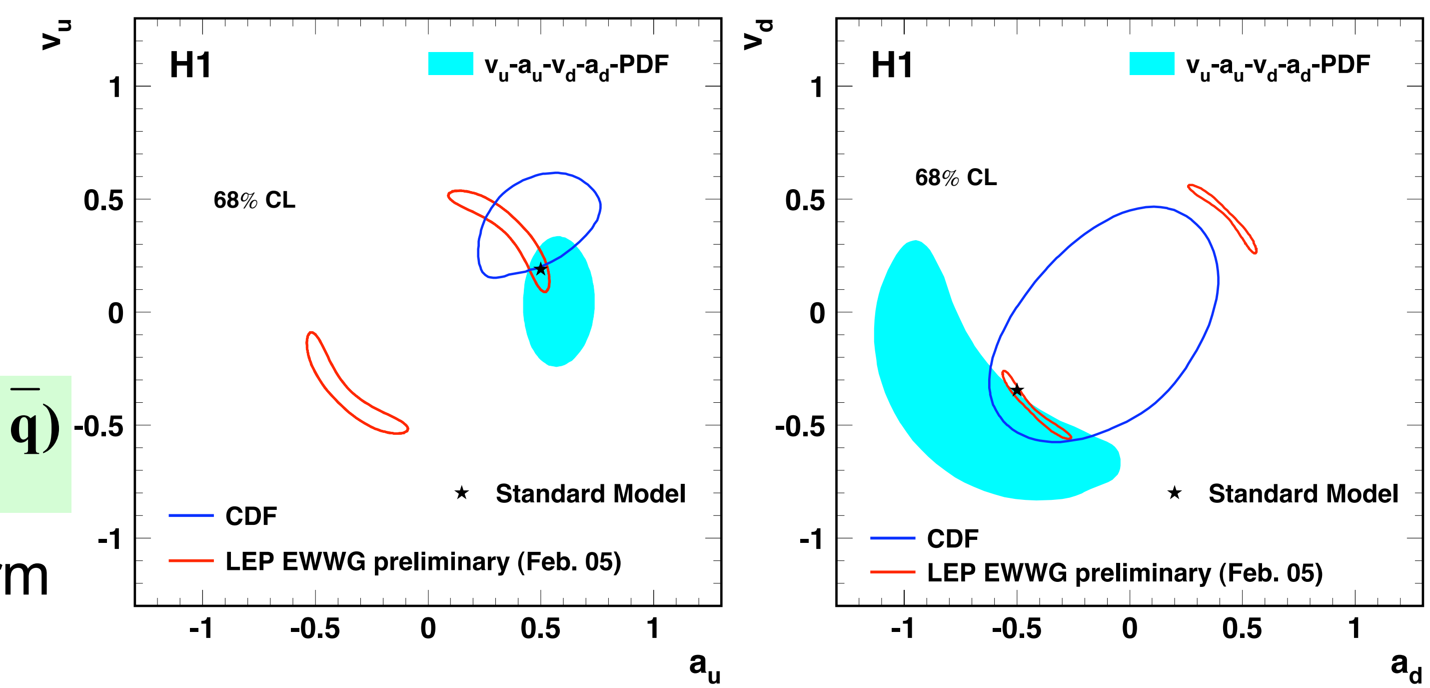
For u, a_q=+1/2

For d, a_q=-1/2

$$v_q = I_q^3 - 2e_q \sin^2\theta_w$$

$$xF_3^{NC} \approx -a_e K_z \cdot 2x \sum_q e_q a_q (q - \bar{q})$$

v_e is small, ignore K_z^2 term



More sensitivity to the U couplings than to D couplings due to PDFs and to the a_q couplings than to v_q couplings for U due to xF_3^{NC}

- **Comparable precision to that from the Tevatron**
- **Remove LEP ambiguities**

12

Yongdonk Ri

Data from HERA II with e polarisation

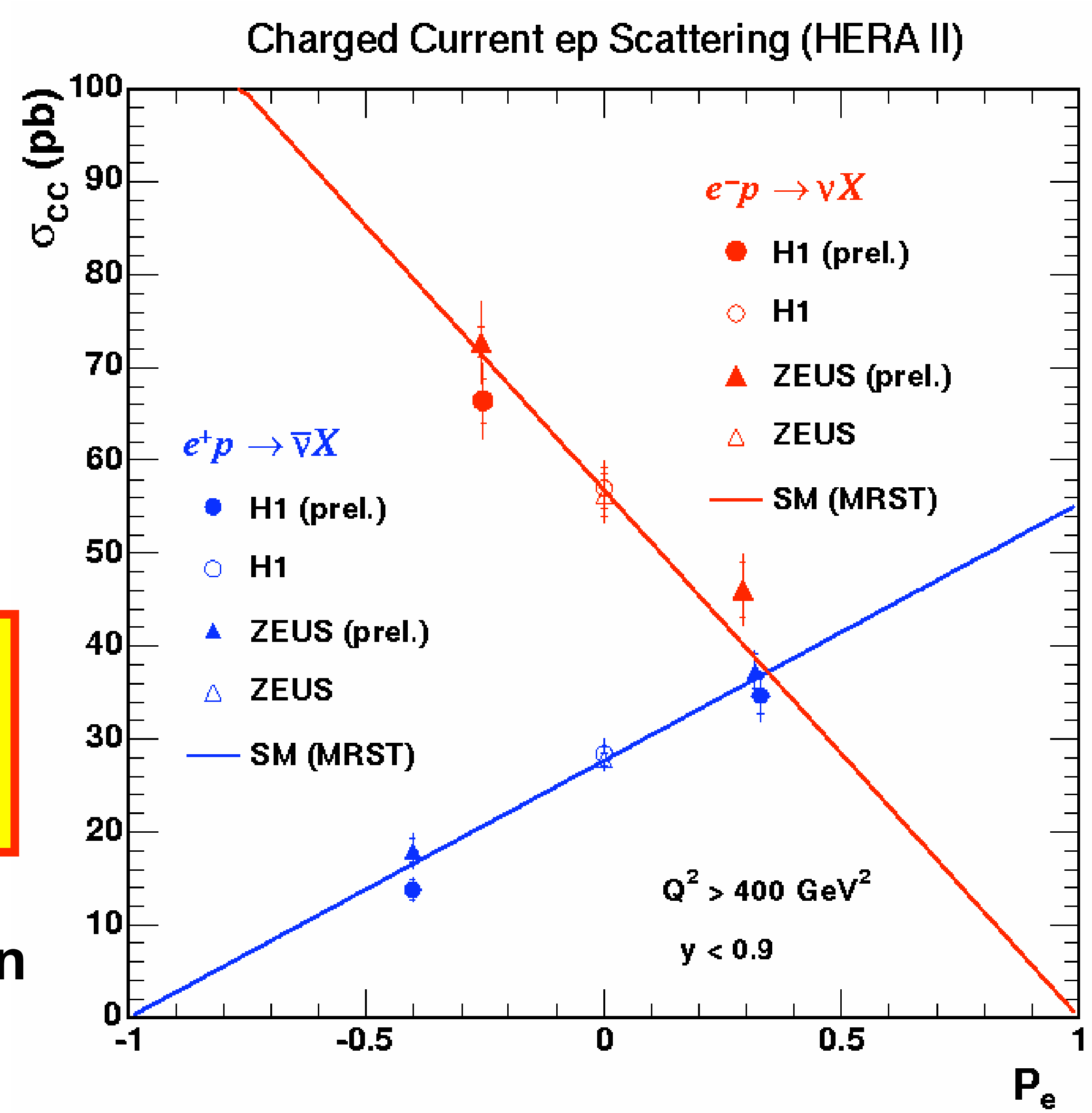
CC Total Cross-Section : H1 and ZEUS

Q^2>400GeV^2, y<0.9

Right Handed CC cross section is extrapolated by linear fit to H1+ZEUS e^+p data

$$\sigma_{e^+ p \to \bar{\nu} X}(P_{e^+} = -100\%) = 0.2 \pm 1.8(stat.) \pm 1.6(syst.)\ \mathbf{pb}$$

Consistent with the SM prediction of : $\sigma_{CC}(RH) = 0$



20-25 Sep 2005 HSQCD05@St.Petersburg 23

NC input

to pQCD pdf analyses

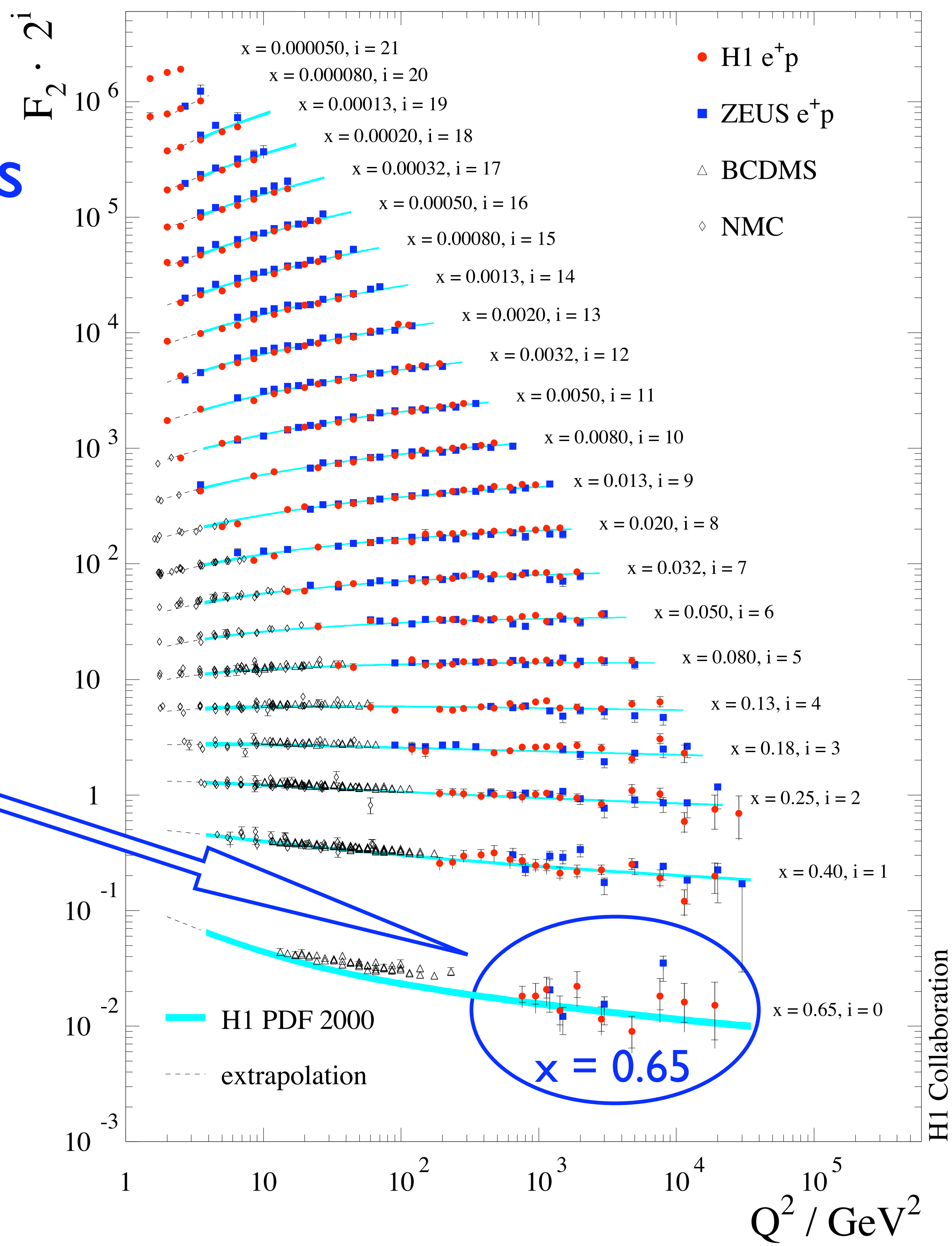
HERA provides data over

4 orders of magnitude

in x and Q^2

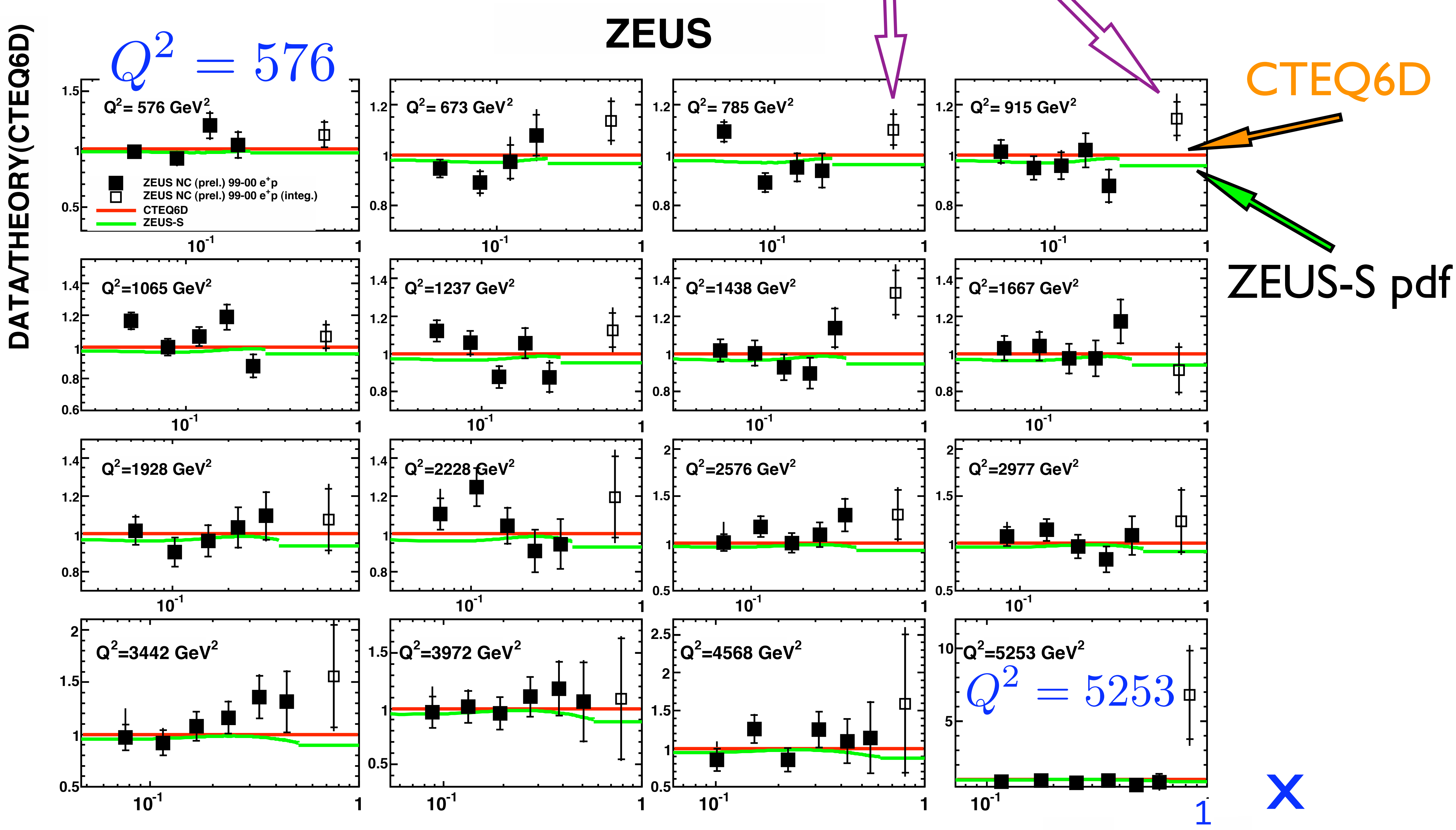
cross sections at largest x

here large uncertainties



New technique at high x, jet in beam pipe

NC e+p, ratio to NLO expectation



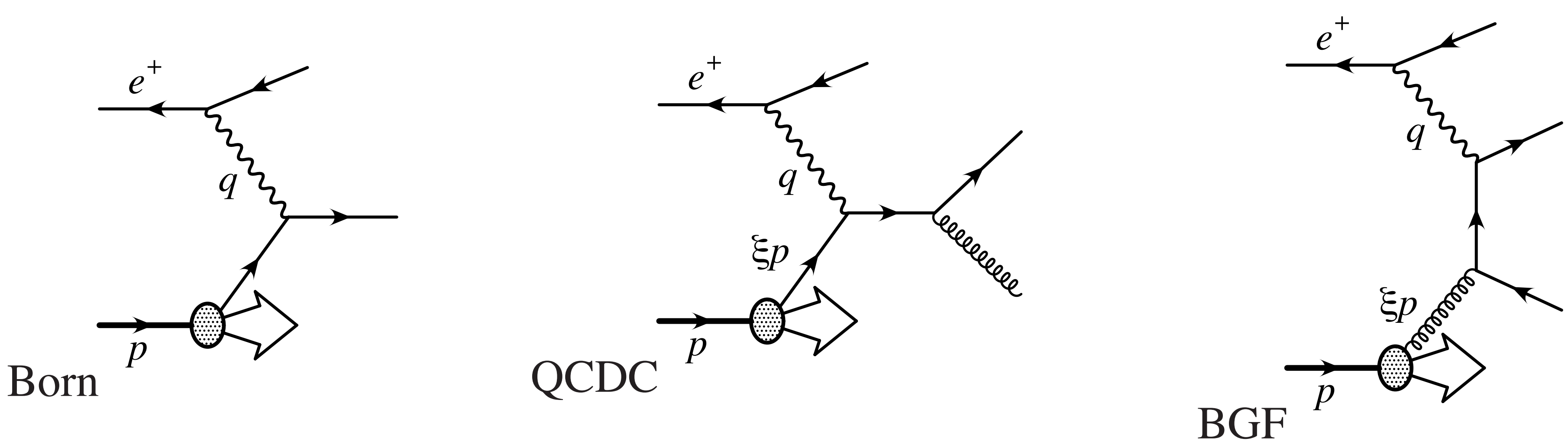
data close to expectation, but tend to be above at highest x

→ to include in pdf fits

Jets in deep inelastic scattering

- Factorise jet cross-section into a convolution of PDF's in the proton, f_a, with short distance subprocess, $d\hat{\sigma}_a$....

$$d\sigma_{\rm jet} = \sum_{a=q,\bar{q},g} \int dx\, f_a(x,\mu_F^2) \times d\hat{\sigma}_a(x,\alpha_s(\mu_R^2),\mu_R^2,\mu_F^2) \times (1+\delta_{\rm had})$$



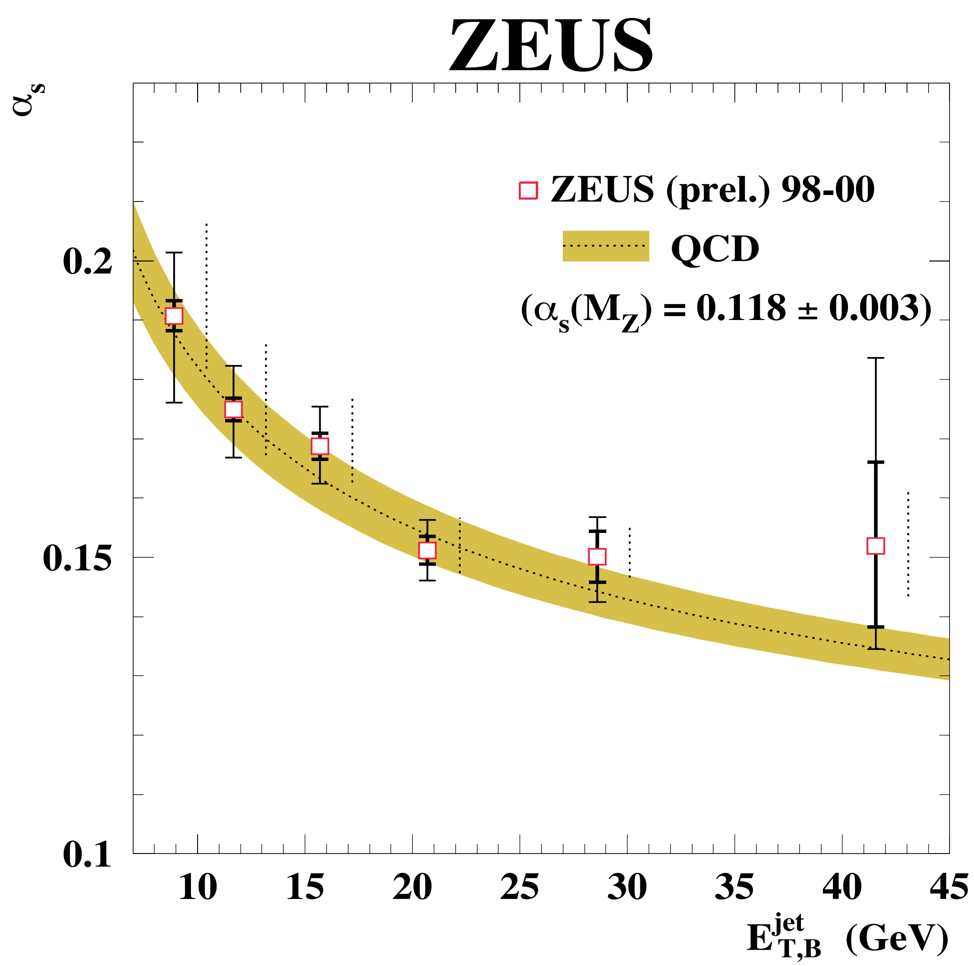
- Longitudinally invariant k_T algorithm (Catani et al).
  ➡ At high E_T hadronisation effects are small ➡ more reliable QCD predictions.
- Large scale variation possible in both Q^2 and E_T.

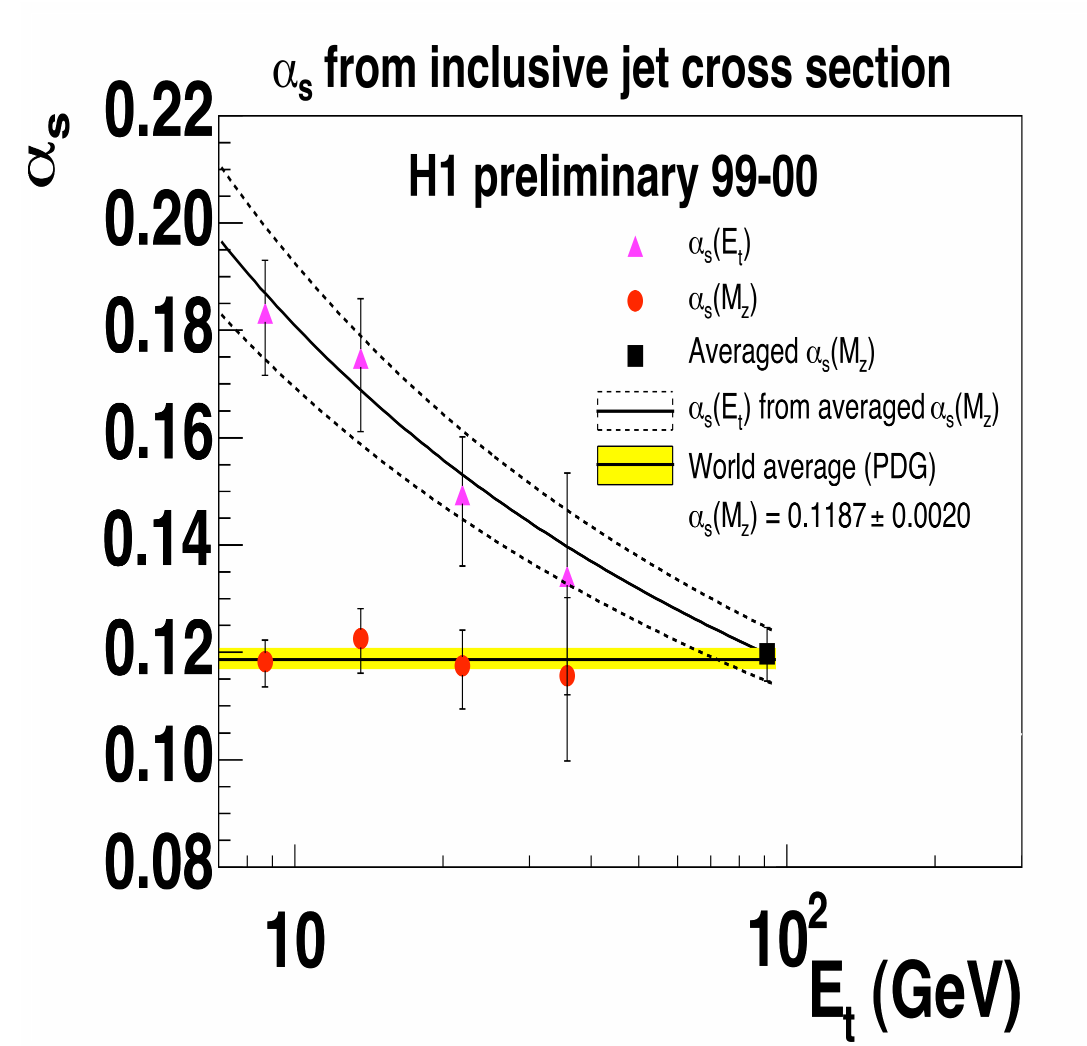
DIS high Q2 jet data are consistent with pQCD calculations allowing extraction of α_s

Mark Sutton

HSQCD 2005 – September 19th, St Petersburg

Extraction of the strong coupling constant



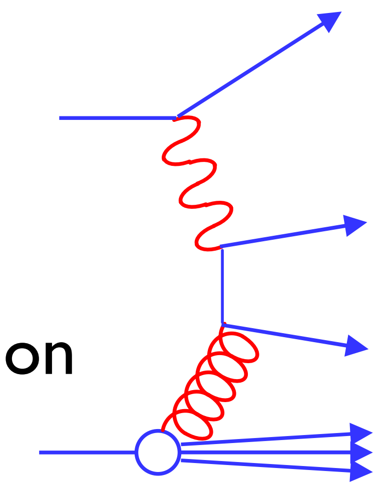


- H1 value $\alpha_s(M_Z) = 0.1197 \pm 0.0016(exp)^{+0.0046}_{-0.0048}(th)$
- ZEUS value $\alpha_s(M_Z) = 0.1196 \pm 0.0011(stat)^{+0.0019}_{-0.0025}(exp)^{+0.0029}_{-0.0017}(th.)$

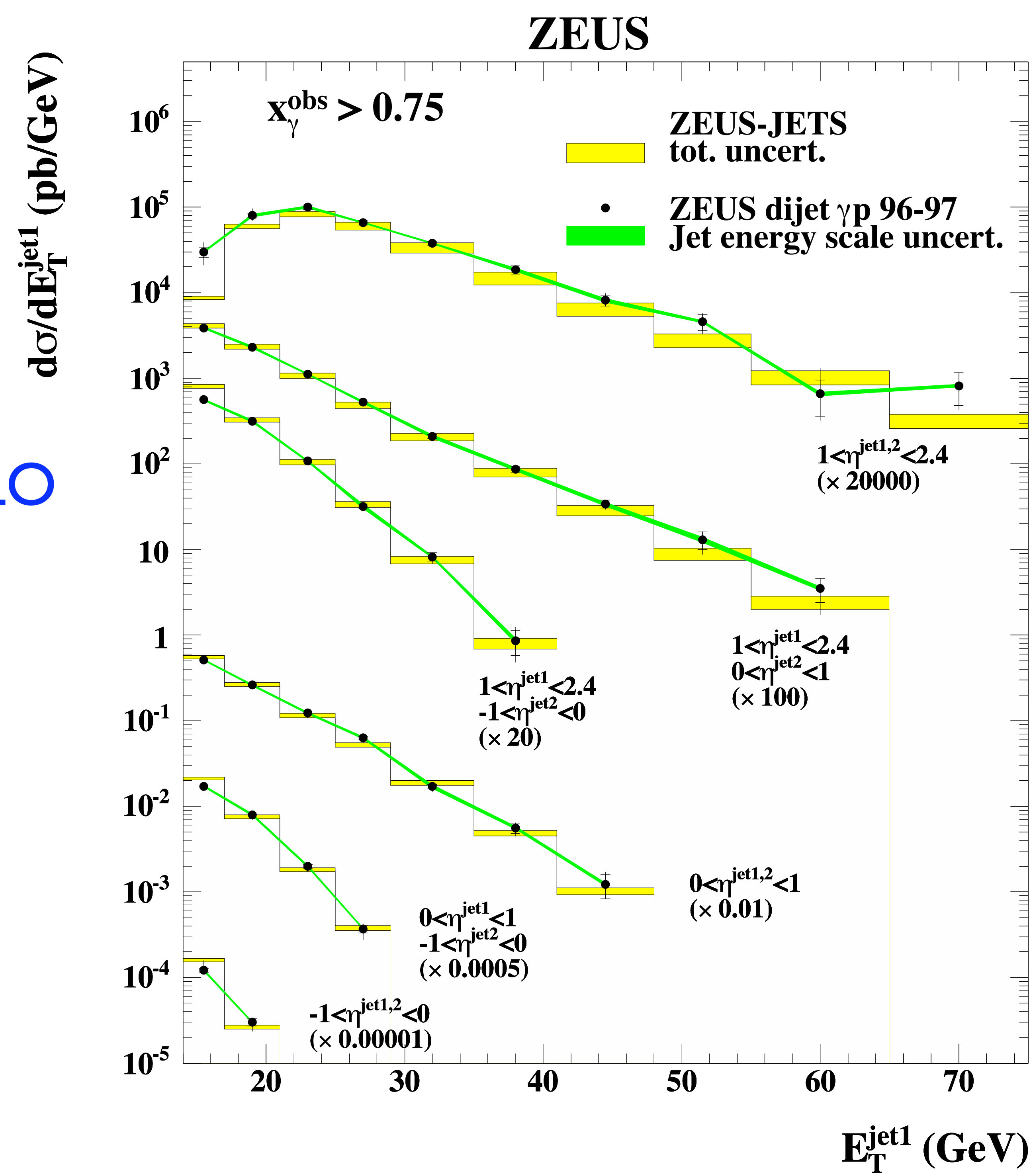
increased sensitivity to gluons using inclusive ep and jets in QCD analysis

BGF

Boson Gluon Fusion

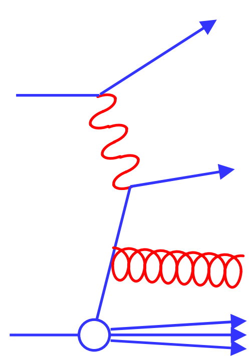


di-jets in photoproduction

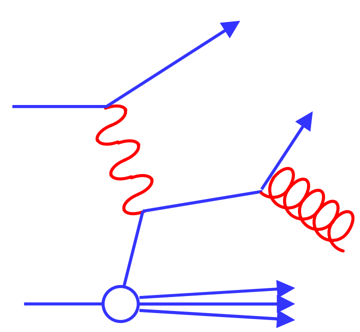


jets sensitive to gluon distribution in LO

in BGF full correlation with α_s ,
different in QCD-Compton graphs

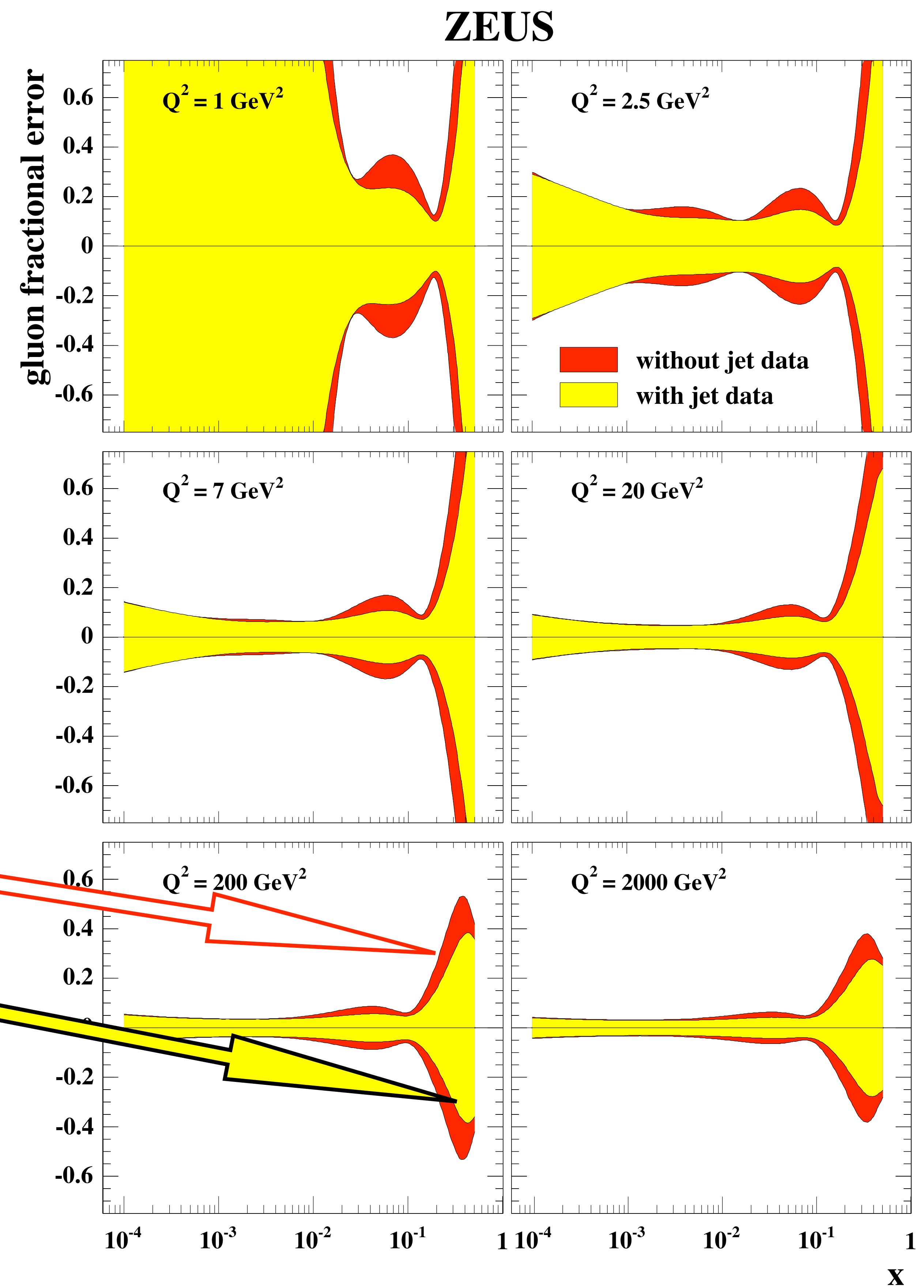


QCDC



Impact of jet data on gluon determination in ZEUS-JETS fit

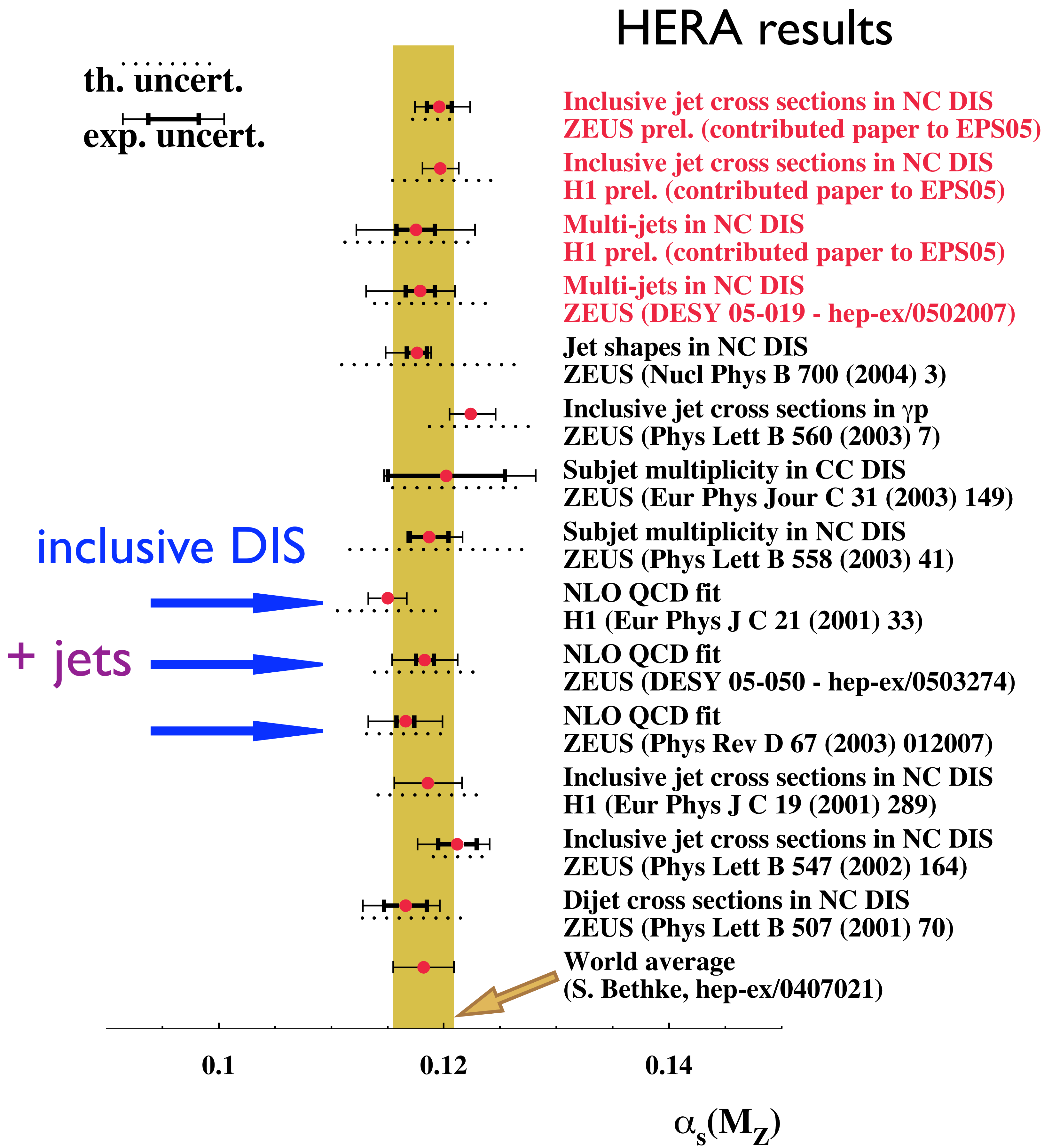
fractional error of g(x)



NC , CC only

jets included

jet data constrain g(x) at medium and high x (0.01 to 0.4)



α_s

DIS inclusive jets

results of

inclusive DIS pdf fits

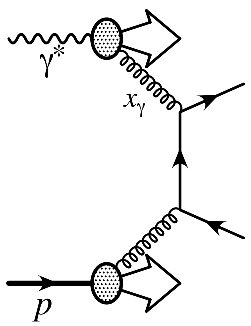
(with $\alpha_s(\mathrm{M_Z})$ as free parameter)

consistent with

final state analyses

and world average

- exp. precision calls for NNLO analysis
- calculations exist for inclusive DIS (Moch, Vermaseren, Vogt)



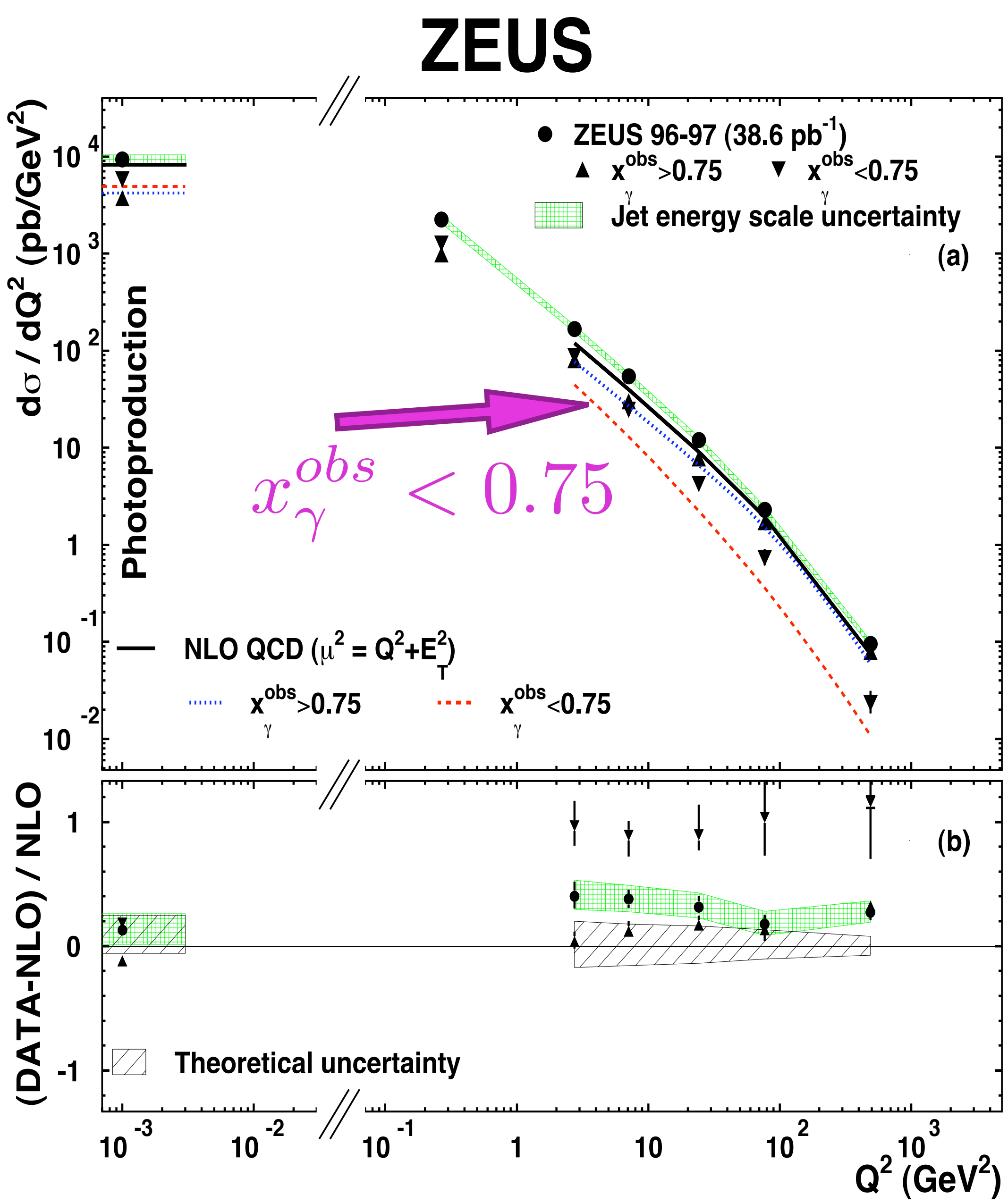
- In dijet production, at very low Q^2, we have $Q^2 < E_T^2$ ➡ large logarithms of $\ln E_T/Q^2$, ➡ formally resum into "resolved" photon structure.

➡ Photon can interact directly or via a parton with some momentum fraction $x_\gamma < 1$.

Mark Sutton

HSQCD 2005 – September 19th, St Petersburg

Virtual photon structure – comparison with NLO theory



$x_\gamma^{obs} < 0.75$ resolved enhanced not described

- $E_T^{\text{jet1,2}} > 7.5, 6.5$ GeV.
- $-3 < \eta_{\gamma^* p}^{\text{jet}} < 0$
- NLO DIS calculation ➡ no resolved photon.
- Ratio of direct enhanced to resolved enhanced too low at lower Q^2.
- Expect larger resolved fraction when including resolved virtual photon.
- Need additional NLO calculations at lower Q^2.

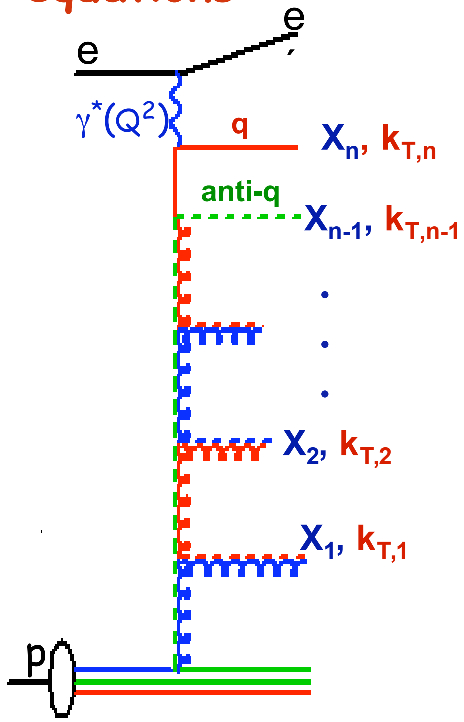
difficulties at low Q2

QCD Dynamics at low x

Didar Dobur

$\sim \Sigma_{mn} A_{mn} \ln(Q^2)^m \ln(1/x)^n$

Perturbative expansion of parton evolution equations ➡ Cannot be explicitly calculated to all orders



- **DGLAP:** $\sum (\alpha_s \ln Q^2)^n$

  $k_{T,1}^2 << k_{T,2}^2 << \ldots k_{T,n-1}^2 << k_{T,n}^2 \approx Q^2$

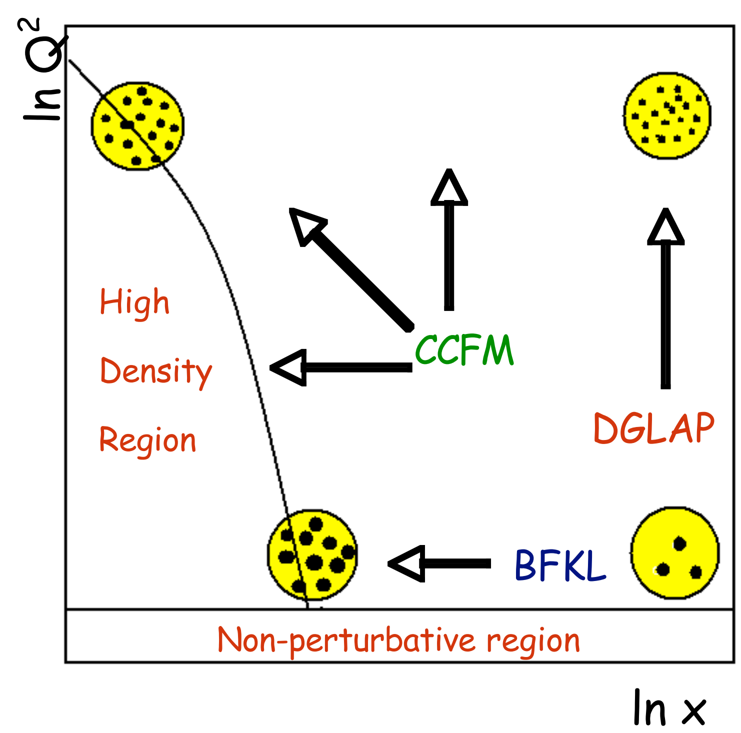
  $x_1 > x_2 > \ldots > x_{n-1} > x_n = x_{Bj}$

- **BFKL** : $\sum (\alpha_s \ln (1/x))^n$

  $x_1 >> x_2 >> \ldots >> x_{n-1} >> x_n = x_{Bj}$

- **CCFM** : $\ln(Q^2)$ and $\ln(1/x)$

  $\theta_n >> \theta_{n-1} >> \ldots >> \theta_2 >> \theta_1$

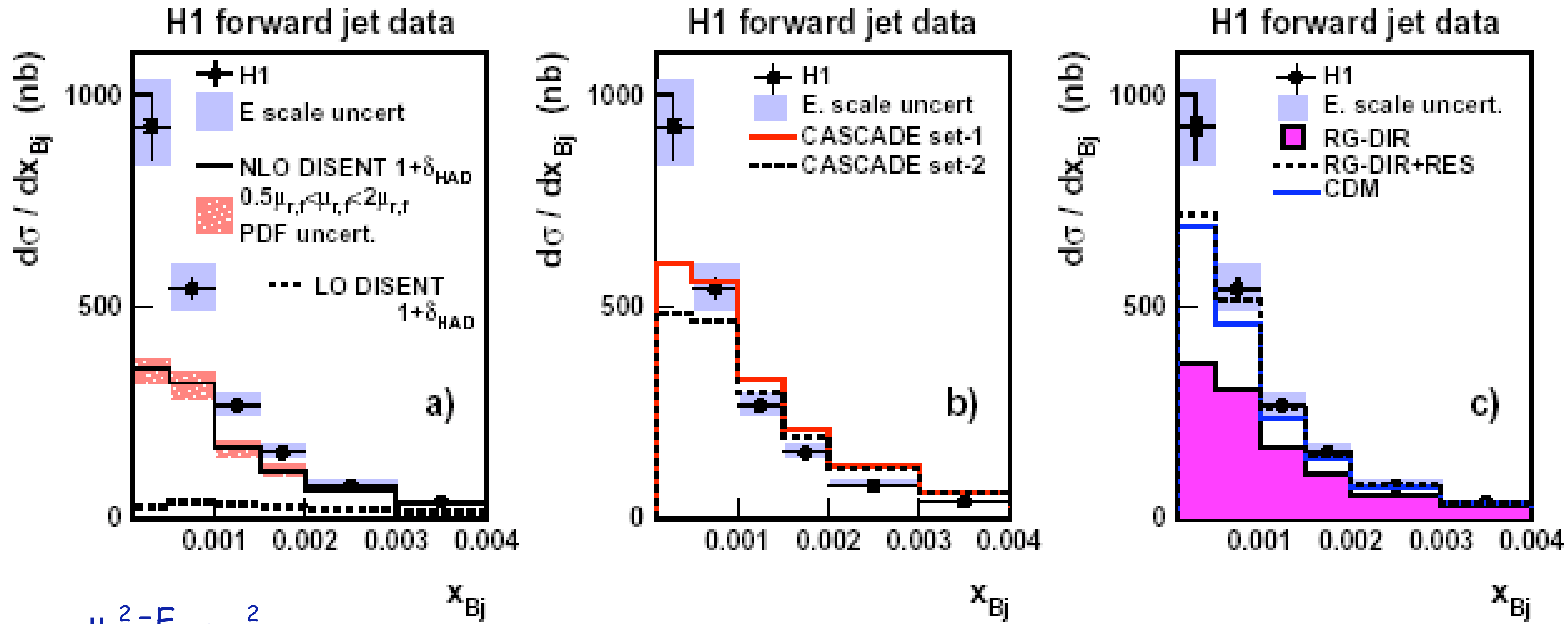


- DGLAP successful at high scale (Q^2) but expected to fail at low scales and low x
- BFKL should be applicable at very low-x
- CCFM expected to be valid in whole x, Q^2 range

Goal: identify the phase space regions where these different parton evolution models are applicable by studying forward jets at HERA

Didar Dobur

Forward Jet Measurement with H1 data



$\mu_r^2 = E_{T\text{-dijet}}^2$

$\mu_f^2 = E_{T\text{-jet}}^2$

CTEQ6M

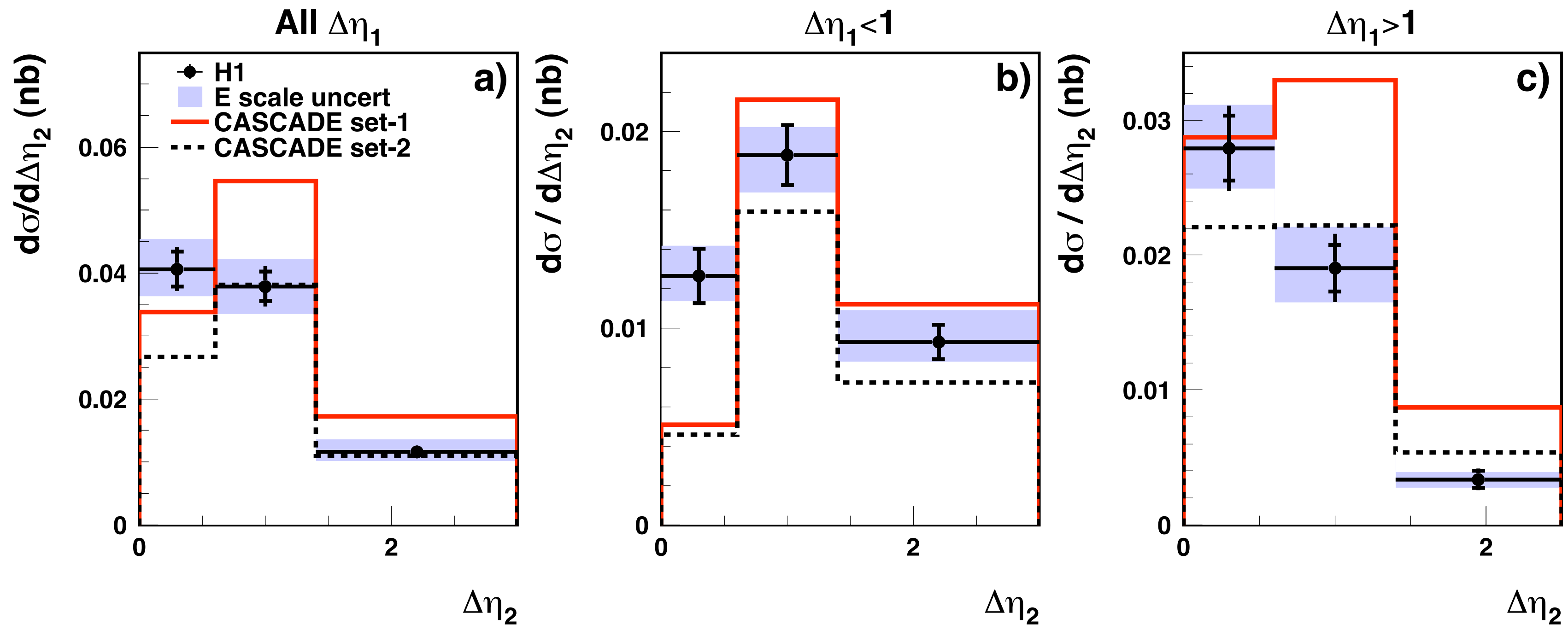
CDM and RG-DIR+RES are very similar and reasonable

- Improved description with NLO $O(\alpha_s^2)$ calculations but still fail at low-x_{Bj} region (as ZEUS)

- CCFM does not describe the shape of x dependence
- DGLAP is similar to NLO
- DGLAP with res-γ improves significantly the description, low-x_{Bj} → possible BFKL signal
- CDM (non-ordered E_T emotions) gives a reasonable description for higher x

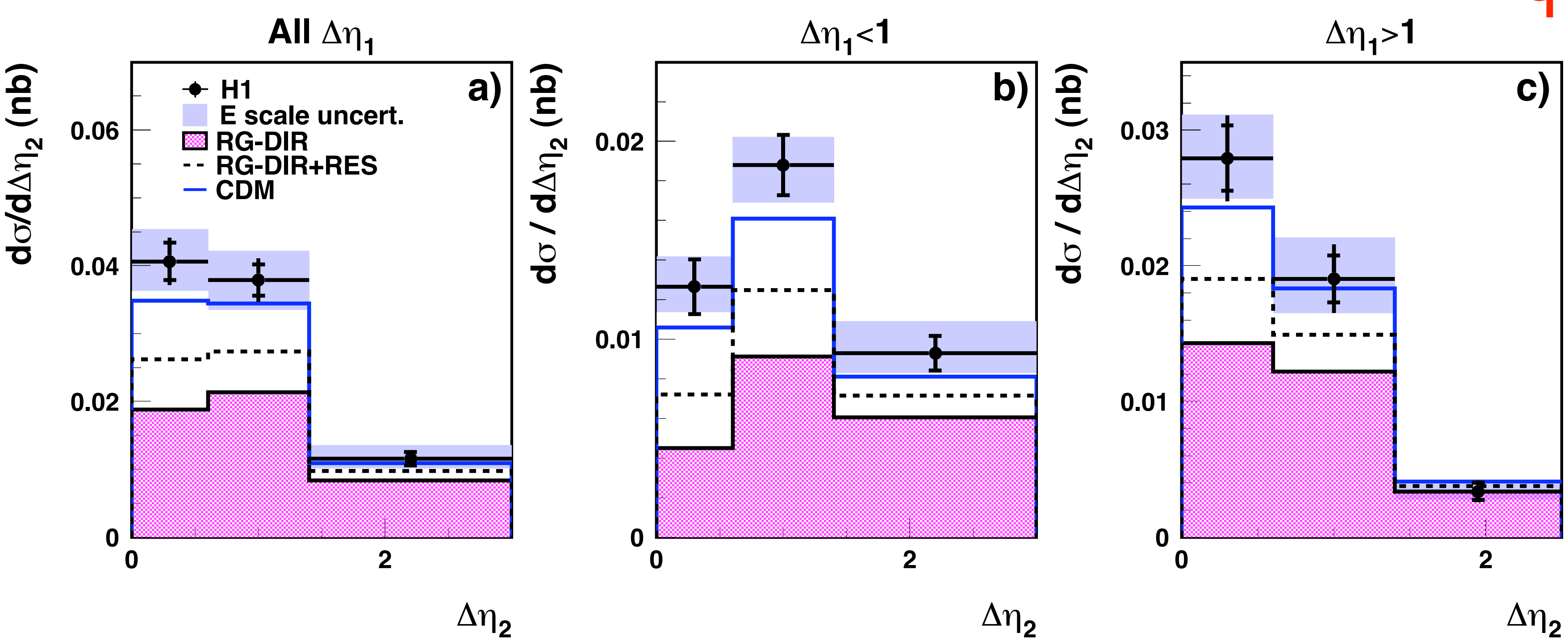
two central jets (PT > 6 GeV)
in addition to forward jet
to enhance unordered emission

not shown yet here



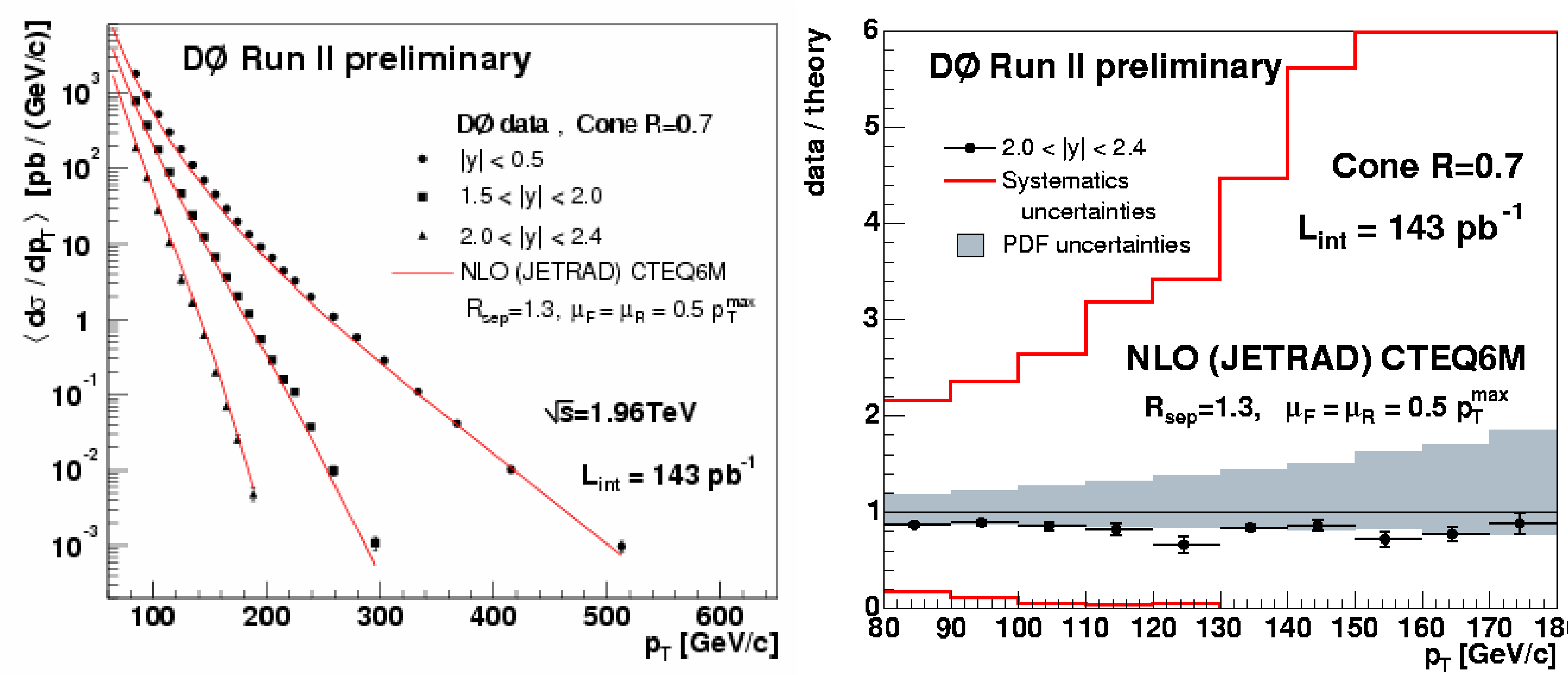
now besides CASCADE
also RG-DIR+RES fails

CDM with unordered emissions
quite good description



most BFKL like?

Inclusive DØ Single Jet Cross Section vs. y

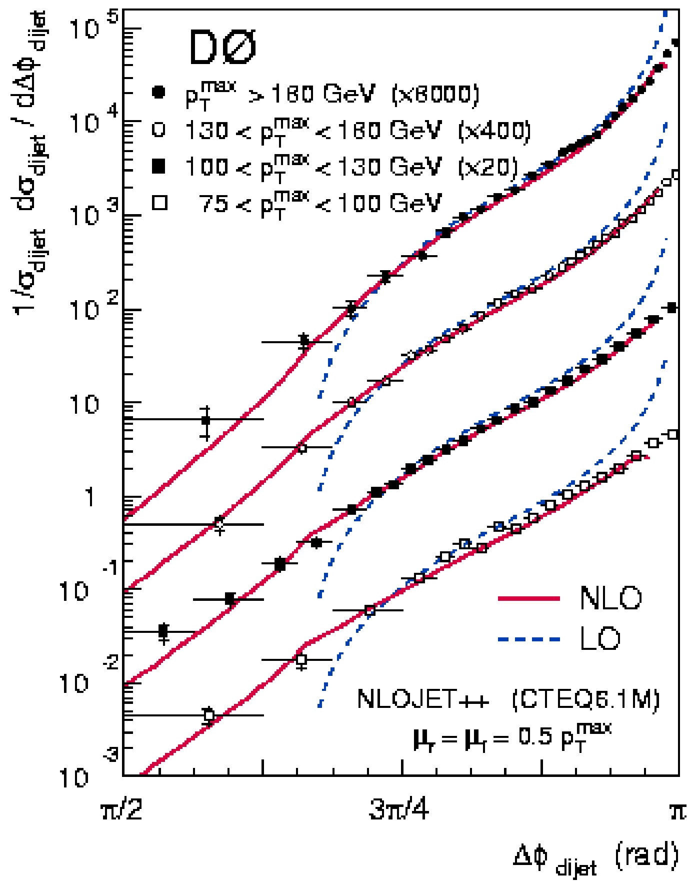


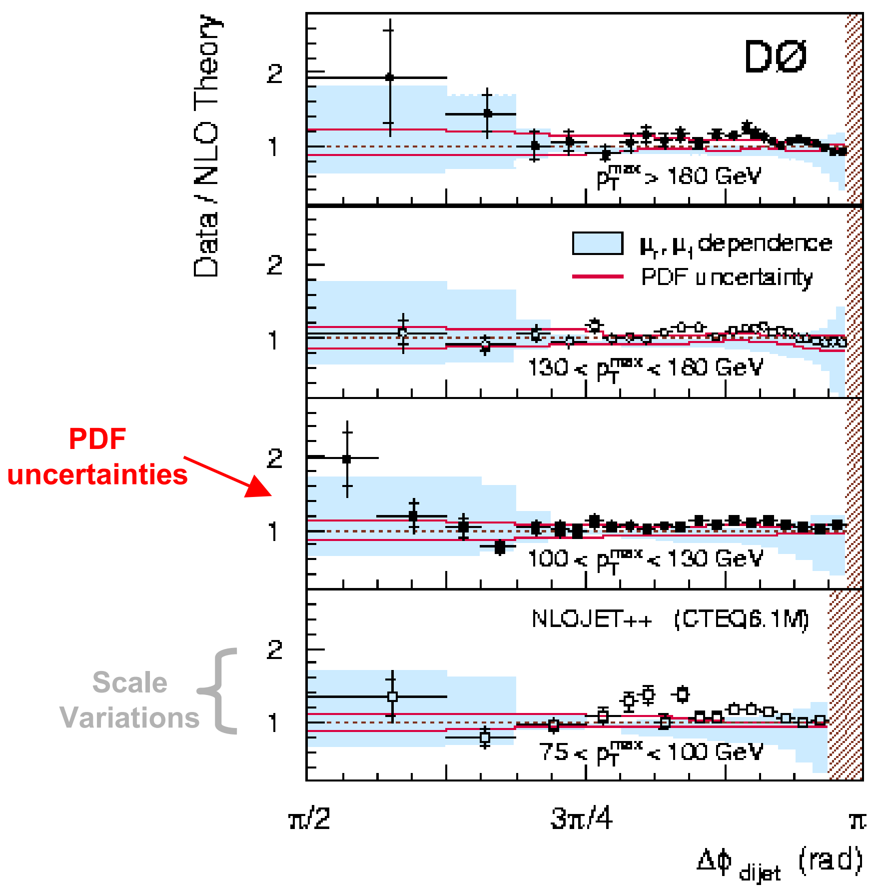
- First corrected Run II cross section for forward jets
- Important PDF information in cross section vs. rapidity
- Jet Energy Scale uncertainties dominate – need to beat these down!

Beautiful agreement with pQCD
but huge systematics due to calorimetric energy uncertainty
How to improve?

Gennady Obrant

Δϕ between jets – Comparison with pQCD





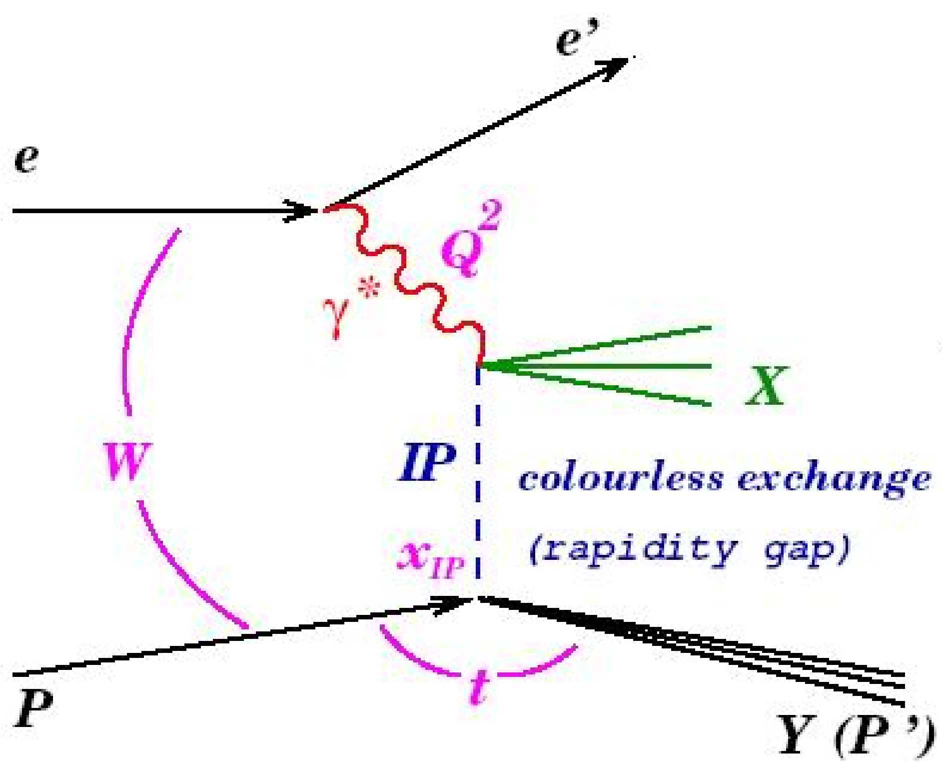
ΔΦ as function of Jet$_1$ P$_T$ (Jet$_2$ P$_T$ > 40 GeV/c)
Compared to LO and NLO pQCD in 3rd jet

- **NLO better than LO**
- **Both fail at soft jet limit**

NLO pQCD describes angular correlation well at high pt
no call for higher orders

Diffraction kinematics

Kinematic variables definition



Colorless exchange, vacuum quantum numbers

- proton survives the collision intact or dissociates to low mass state
- large region in pseudorapidity is left empty
- small momentum transfer t

$Q^2 = -q^2$	photon virtuality
$x = \frac{Q^2}{2q\cdot p}$	Bjorken scaling variable
$W^2 = (p+q)^2$	$\gamma^* p$ CM energy squared
$t = (p - p_Y)^2$	4-momentum transfer squared
$x_{I\!P} = \frac{q\cdot(p-Y)}{q\cdot p}$	fraction of p momentum transferred to $I\!P$ ($x_{I\!P} \simeq 1 - E_Y/E_p$)
$\beta = \frac{Q^2}{2q\cdot(p-Y)}$	fraction of $I\!P$ momentum carried by struck quark ($x_{I\!P}\beta = x$)
M_X	Inv. mass of system X

~10% of DIS events at HERA are diffractive

QCD Fit to $F_2^{D(3)}$

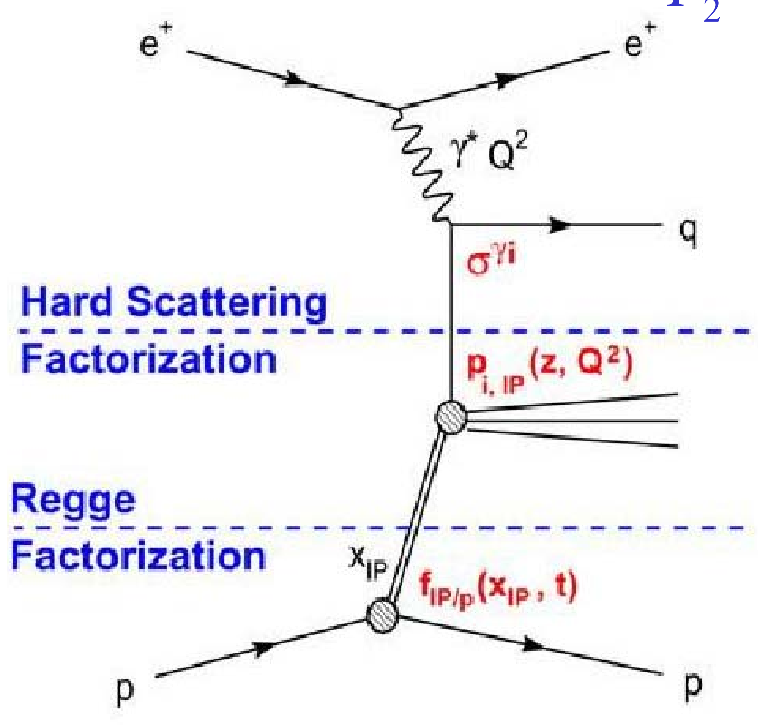
Vitaliy Dodonov

Apply same NLO QCD DGLAP technique to Q^2 and β dependencies as for inclusive DIS

- quark density directly from F_2^D
- gluon density from scaling violation

Assume Regge factorization: PDF = Pomeron-flux x Pomeron-parton-density

$$F_2^{D(4)}\left(x_{IP}, t, Q^2, \beta\right) = f_{IP/p}(x_{IP}, t) F_2^{IP}(Q^2, \beta)$$



pdfs from inclusive diffractive work also for jets in and diffractive charm in DIS

$$F_2^{D(4)}\left(x_{IP}, t, Q^2, \beta\right) = f_{IP/p}(x_{IP}, t) F_2^{IP}(Q^2, \beta)$$

this supports factorisation, but Tevatron $p\bar{p}$ diffractive is overestimated

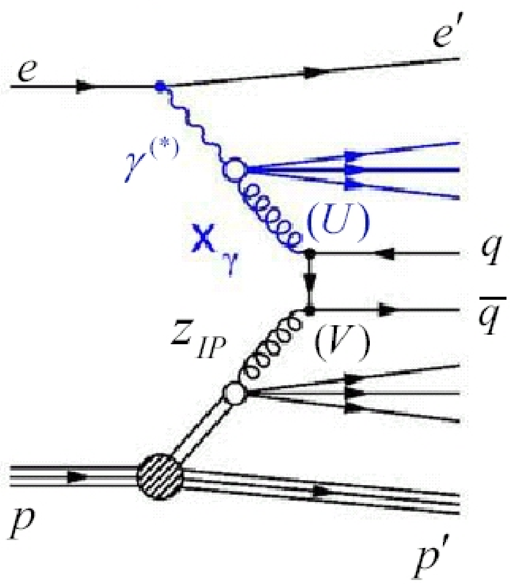
photoproduction may be closer to $p\bar{p}$?

Vitaliy Dodonov

Jets in photoproduction

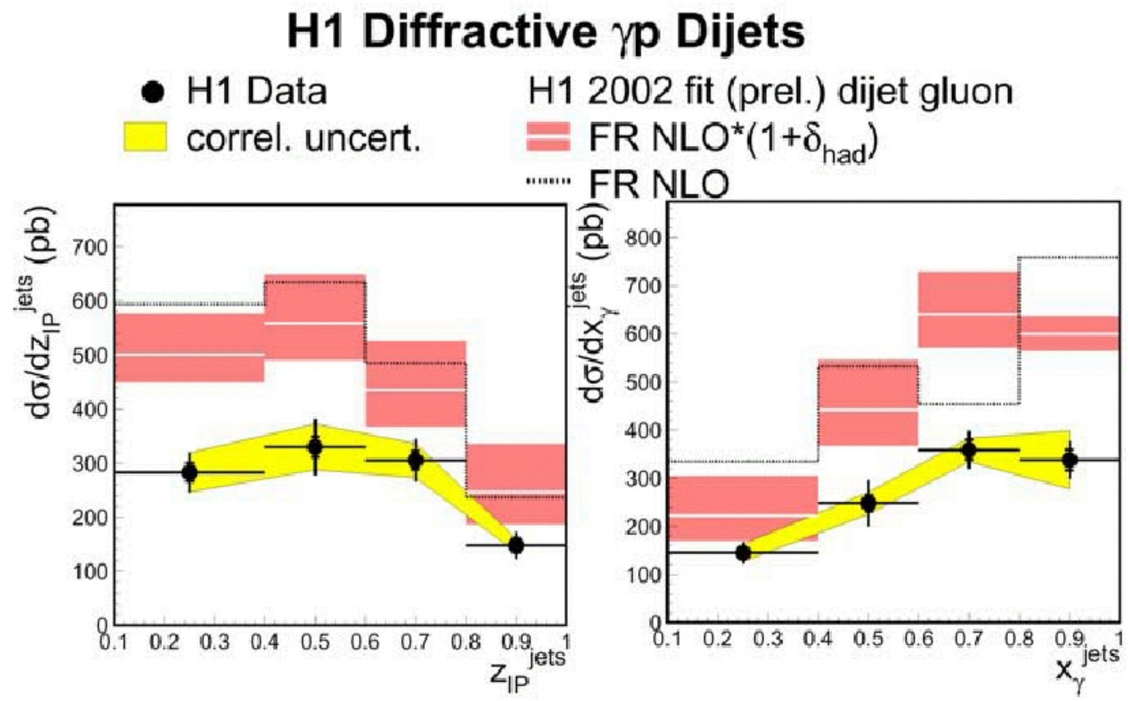
Direct and resolved γ interaction:

- *γ involved point-like into γp:* $x_\gamma \sim 1$
- *γ fluctuate into hadronic system:* $x_\gamma < 1$



$$x_\gamma = \sum_{jets} (E - p_z) / (2yE_e)$$

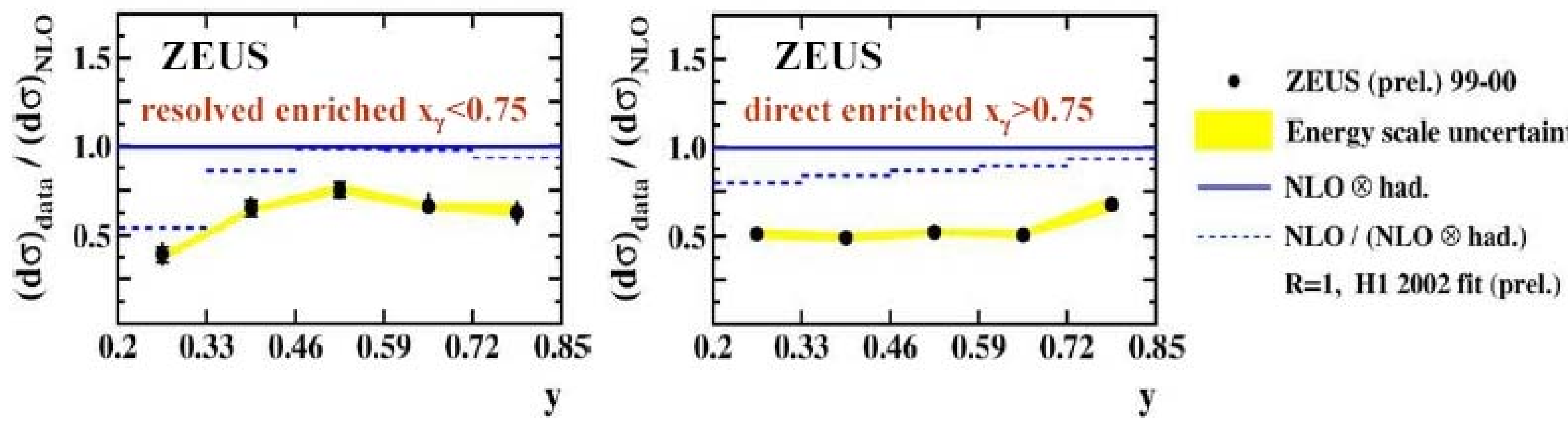
Momentum fraction of γ carried by γ-parton



$y = Q^2/sx$

inelasticity

Ratio data/NLO for dijets in photoproduction



NLO overestimates dijet in photoproduction data by factor 2 for both direct and resolved photon

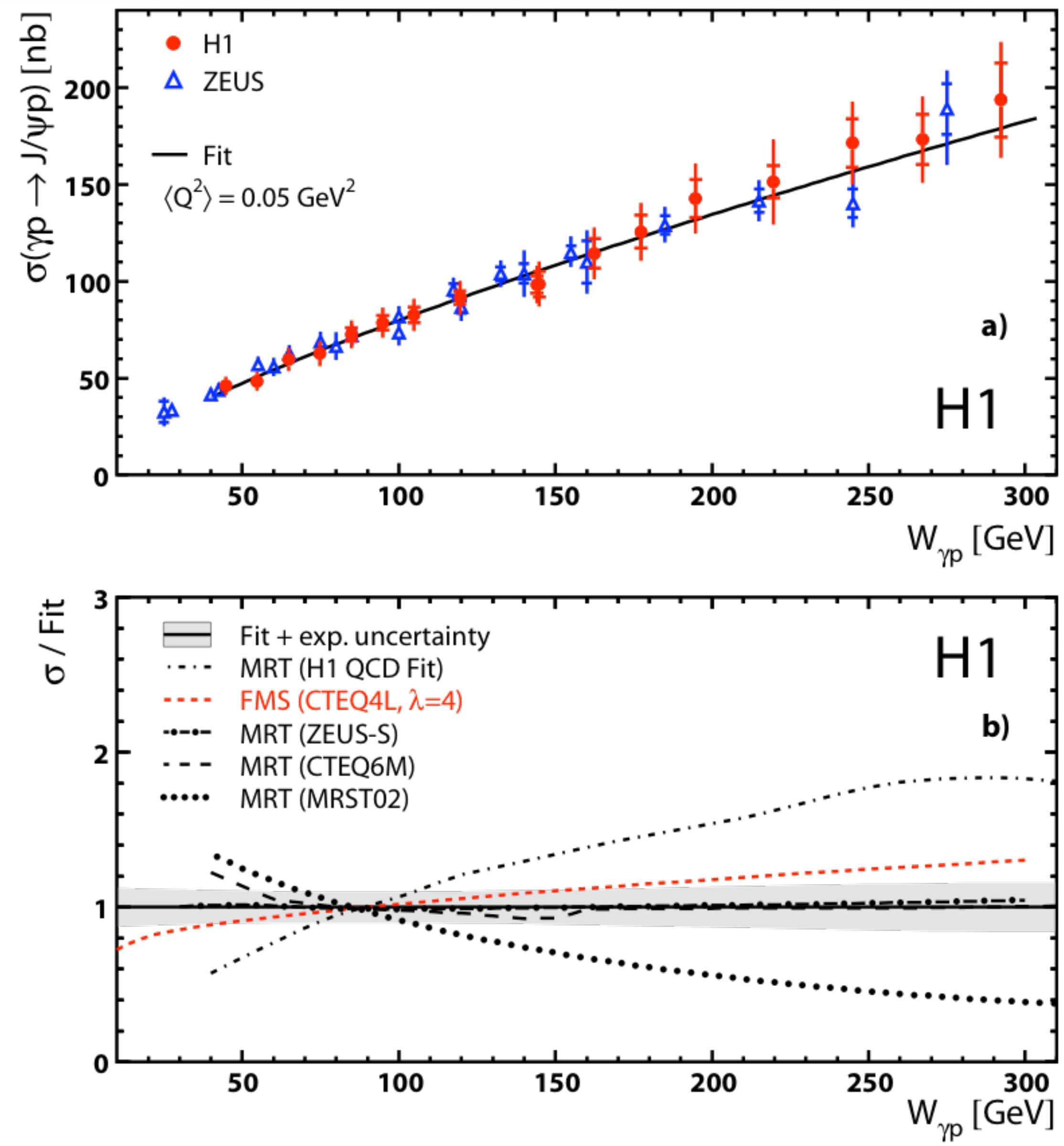
Factorization fails

J/Ψ - testing gluon densities!

- Even more prominent in W dependence
- Normalise predictions at $W = 90$ GeV, compare shapes
- Access to gluon densities in regions poorly constrained by inclusive DIS data (very low x)
- Uncertainties on Gluon distri-butions not taken ito account

Theoretical alternative: Dipole model by Frankfurt, McDermott and Strikman (FMS)
(JHEP 0103 (2001) 045)

H1: To be published in Eur.Phys.J. C
ZEUS: Nucl. Phys. B 695 (2004) 3 (DIS)



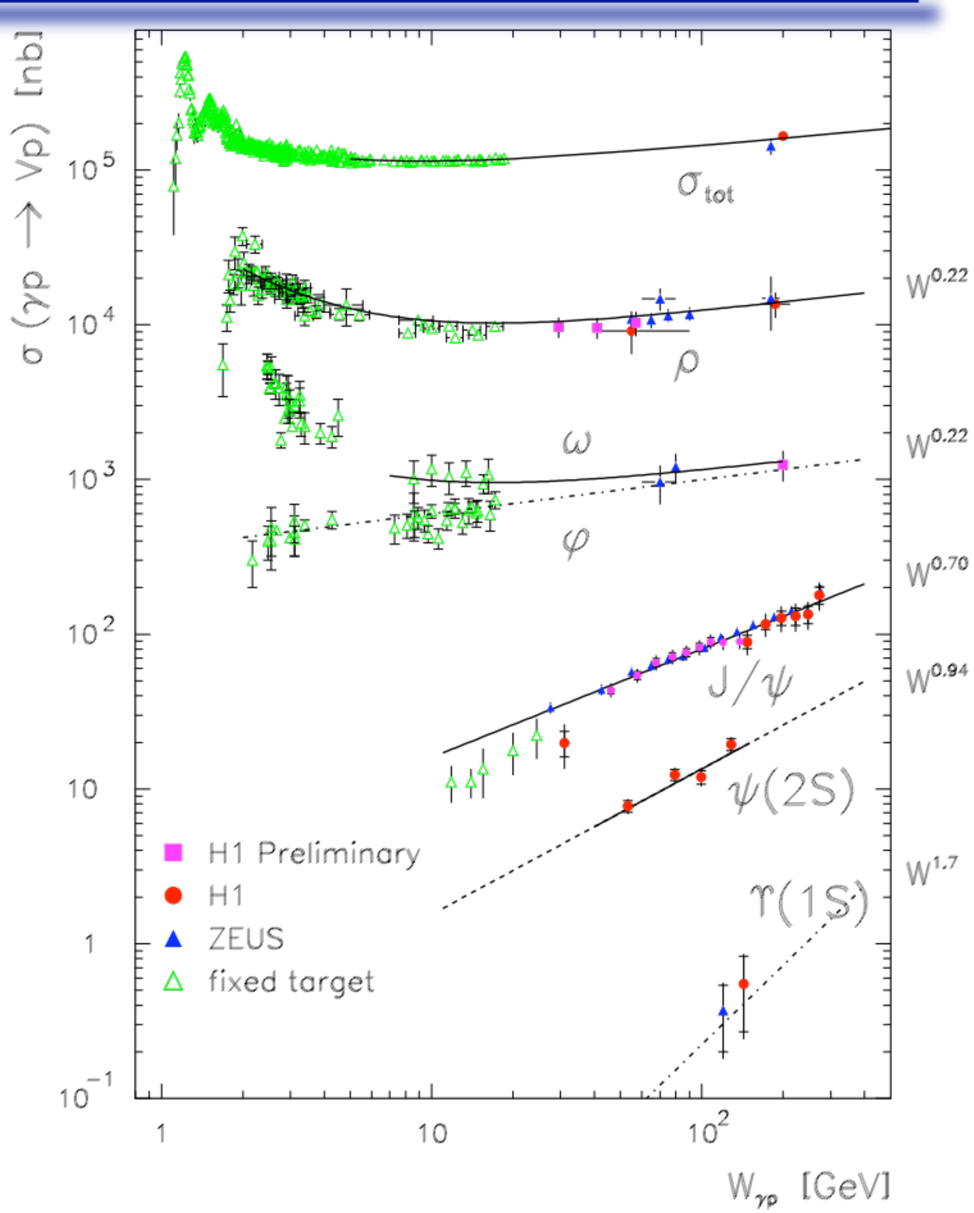
Niklaus Berger

new data discussed : J/ψ γp , DIS high t, ϕ DIS, ρ^0 γp high t

14

Vector Mesons: Summary

- As soon as a hard scale is involved, measurements disagree with soft pomeron
- J/Ψ Measurements and theory together come close to constraining gluon densities
- Light vector mesons at high *t* or in electroproduction can shed light on soft-hard transition and test QCD models



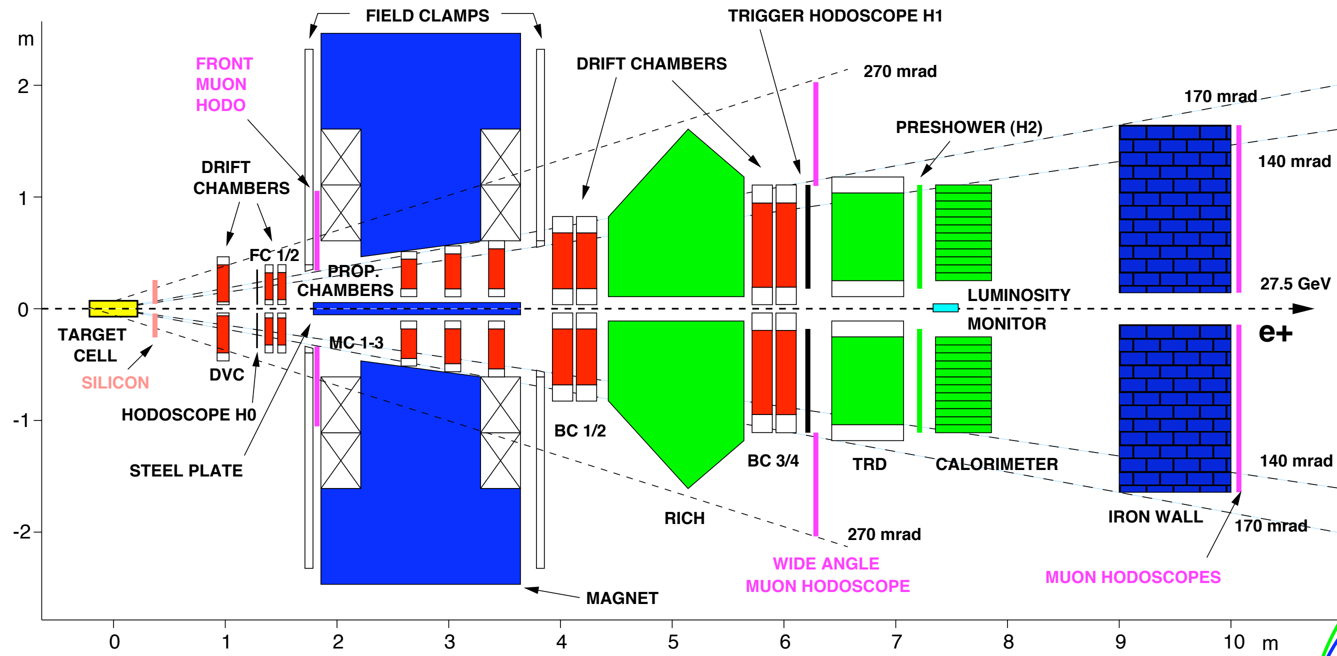
rich field for QCD models

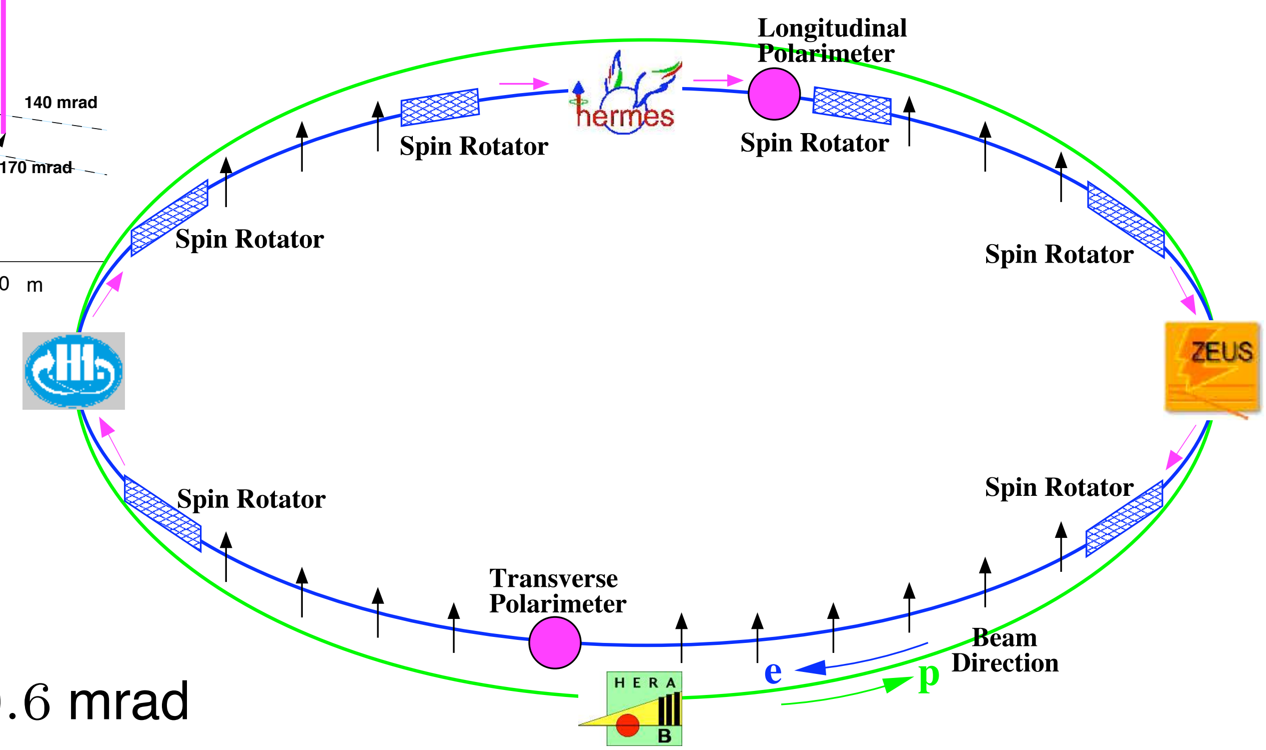
Comparisons of DGLAP and BFKL calculations

Michael Tytgat

The HERMES Experiment @ DESY

HERA pol e beam
on pol and unpol gas targets





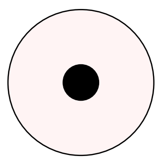
- 27.6 GeV HERA $\vec{e}$-beam
- Internal, pure gas target : $\vec{\mathrm{H}}$e, $\vec{\mathrm{H}}$, $\vec{\mathrm{D}}$, H↑;
  unpol : H_2, D_2, He, N, Ne, Kr, Xe
- Resolution : $\Delta p/p = 1.4 - 2.5$ %, $\Delta\theta < 0.6$ mrad
- Lepton/hadron separation : TRD, Preshower, Calorimeter, Cherenkov (1995-97)
- Hadron ID : Cherenkov (1995-97) - RICH (1998- ...)
- Target polarization : longitudinal (1996-2000) $\langle P_t \rangle \sim 85$ %
  & transverse (2002-2005) $\langle P_t \rangle \sim 75$ % ; flipping every 90s
- HERA beam polarization $\langle P_b \rangle = 53$ % longitudinal

Michael Tytgat

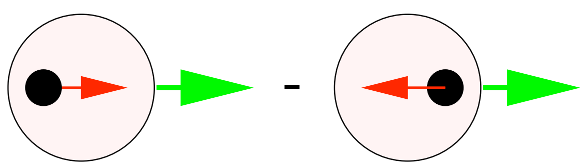
measure quark helicity in polarised nucleon

Distribution Functions

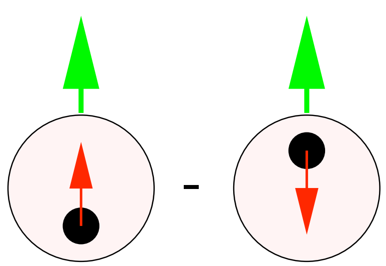
In leading twist, integrating over quark transverse momenta, 3 DFs :

f_1 =  : unpolarized quarks in unpolarized nucleons

$\Rightarrow$ Unpolarized DF $q(x)$: spin averaged, very well known

g_1 =  : longitudinally polarized quarks in longitudinal nucleons

$\Rightarrow$ Helicity DF $\Delta q(x) \equiv q^{\rightrightarrows}(x) - q^{\rightleftarrows}(x)$: helicity difference, well known (HERMES-I)

h_1 =  : transversely polarized quarks in transverse nucleons

$\Rightarrow$ Tranversity $\delta q = q^{\uparrow\Uparrow} - q^{\uparrow\Downarrow}$: helicity flip, unkwnown (HERMES-II)

Michael Tytgat

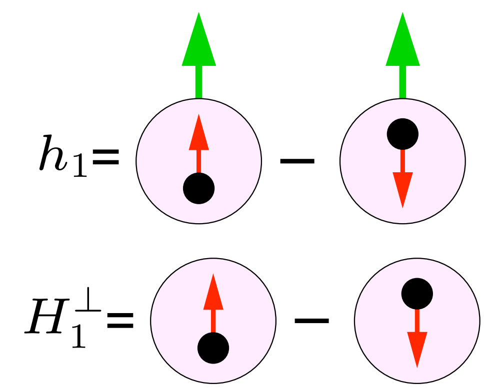
(but I tried to simplify)

in Transversity studies, consider quark pt in nucleon and fragmentation

measure :

single-spin azimuthal asymmetries in $e + p \rightarrow e + h + X$ on a polarized target

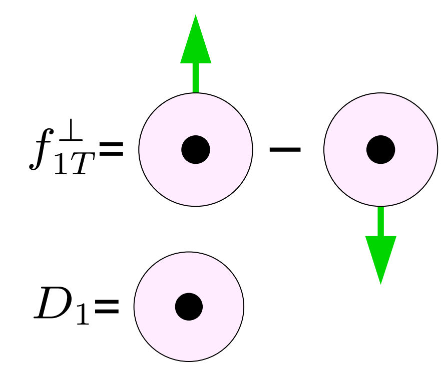
Collins effect : $A \sim h_1(x)\, H_1^{\perp}(z)$



effect of quarks polarisation on pt in fragmentation

Sivers effect : $A \sim f_{1T}^{\perp}(x)\, D_1(z)$

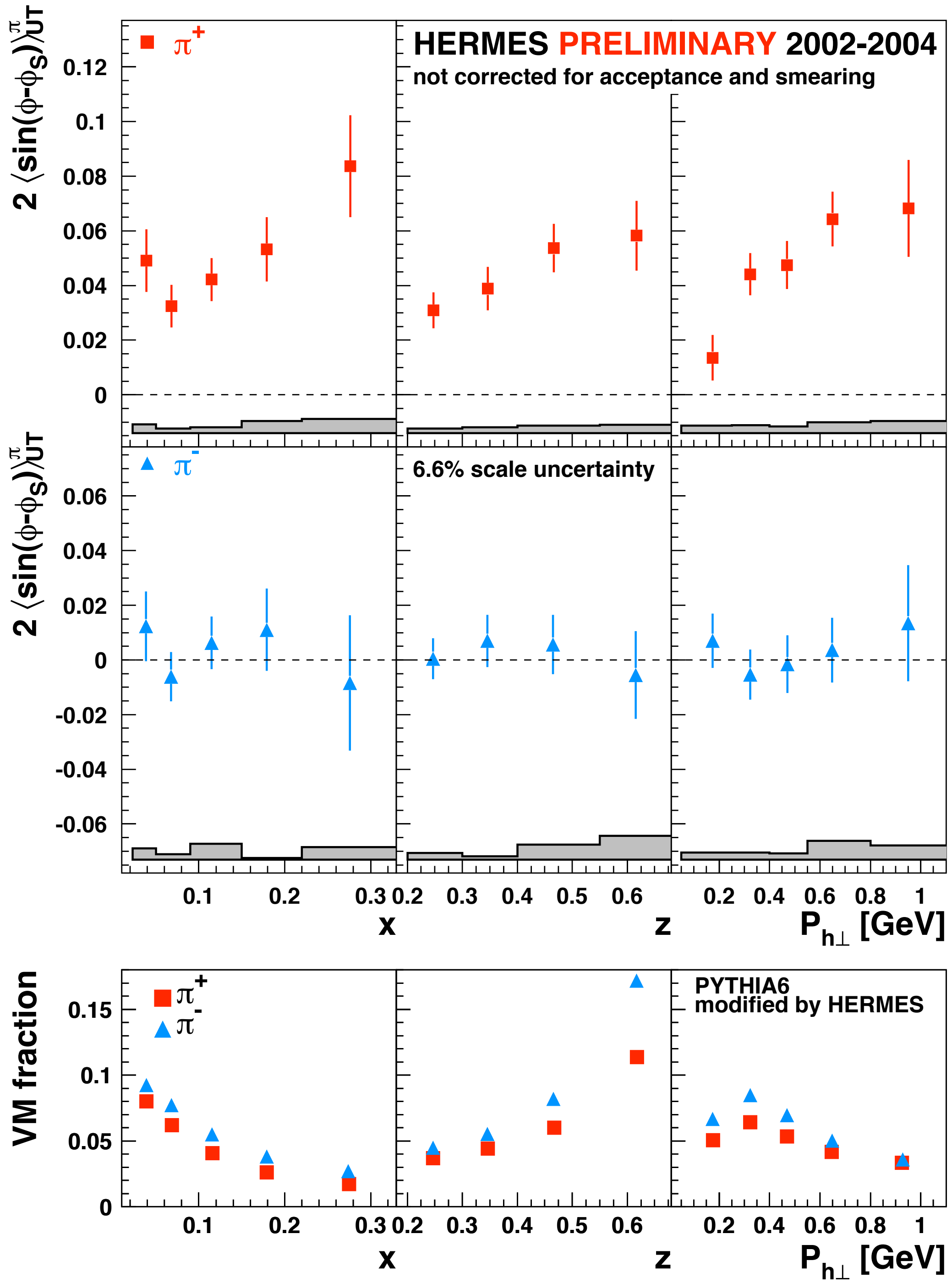
Sivers function $f_{1T}^{\perp}$



effect of quarks pt in polarised nucleon on fragmentation.

Asymmetry implies effect of quark angular momentum

Extracted Sivers Moments



striking difference of

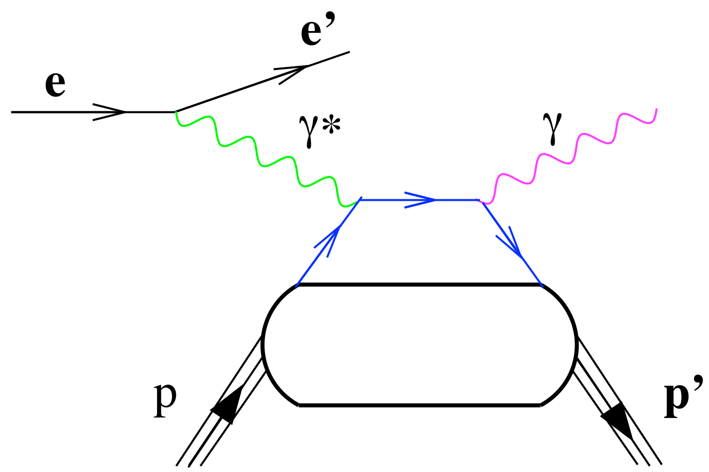
$\pi^+ \quad \pi^-$

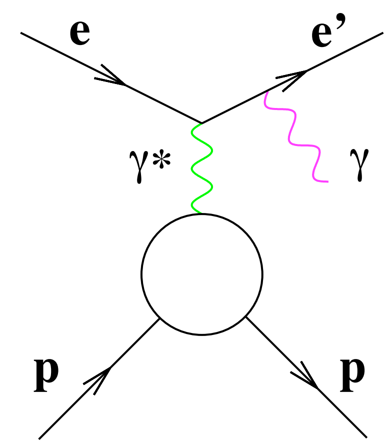
should have a clear explanation

- Sivers moment significantly positive for π^+; requires a non-vanishing quark orbital angular momentum
- Sivers moment consistent with zero for π^-
- Extraction of Sivers function in principle possible (known unpolarized fragmentation function)

is it a consequence of different polarisation u and d valence ?

Deeply Virtual Compton Scattering



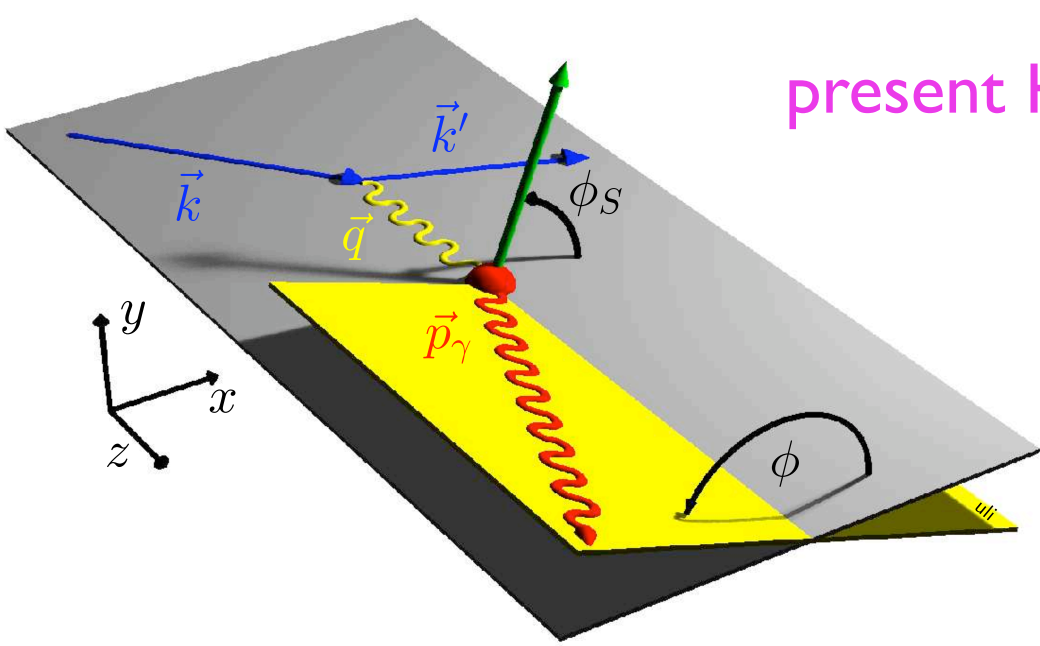


BH ≫ DVCS for HERMES kinematics

$$\mathrm{d}\sigma(eN \to eN\gamma) \propto |T_{BH}|^2 + |T_{DVCS}|^2 + T_{BH}T^*_{DVCS} + T^*_{BH}T_{DVCS}$$

☞ Interference term gives rise to azimuthal asymmetries

present H1 and ZEUS data (no interference yet)



$$A(\phi) = \frac{N^+(\phi) - N^-(\phi)}{N^+(\phi) + N^-(\phi)}$$

Accessing Generalized Parton Distributions

Michael Tytgat

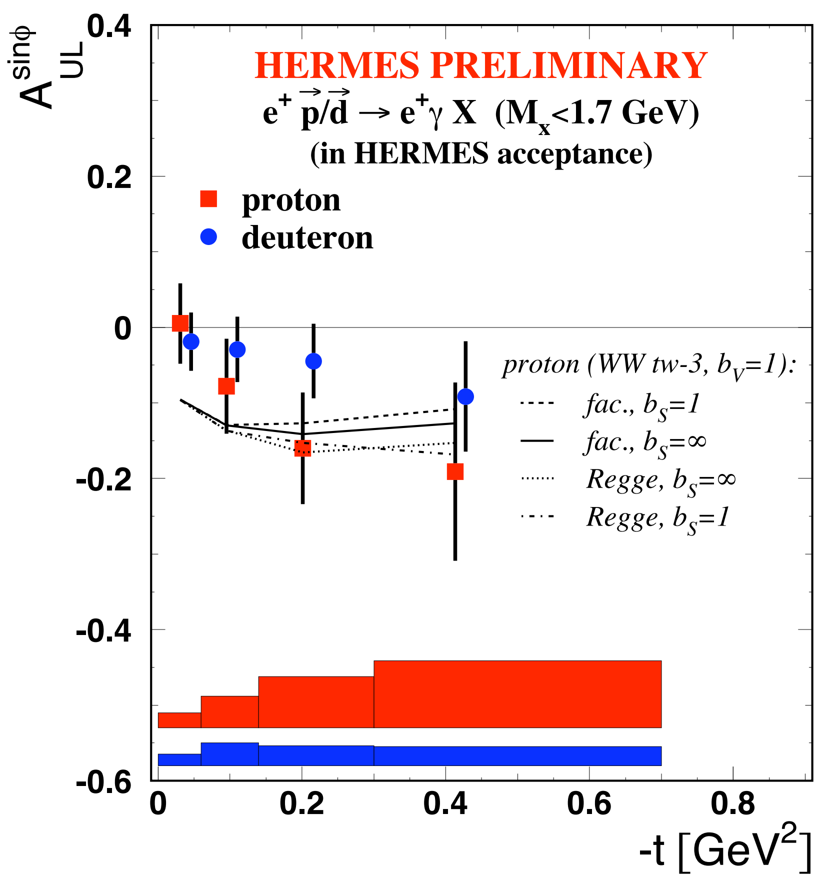
Final state quantum numbers select different GPDs :

- Deeply Virtual Compton Scattering : $H,\ E,\ \tilde{H},\ \tilde{E}$
  - $\Rightarrow$ Beam charge asymmetry ($e^+ \leftrightarrow e^-$) : H
  - $\Rightarrow$ Beam-spin Azimuthal Asymmetry : H
  - $\Rightarrow$ Longitudinal Target Spin Asymmetry : $\tilde{H}$
  - $\Rightarrow$ Transverse Target Spin Asymmetry : $E,\ J_q$

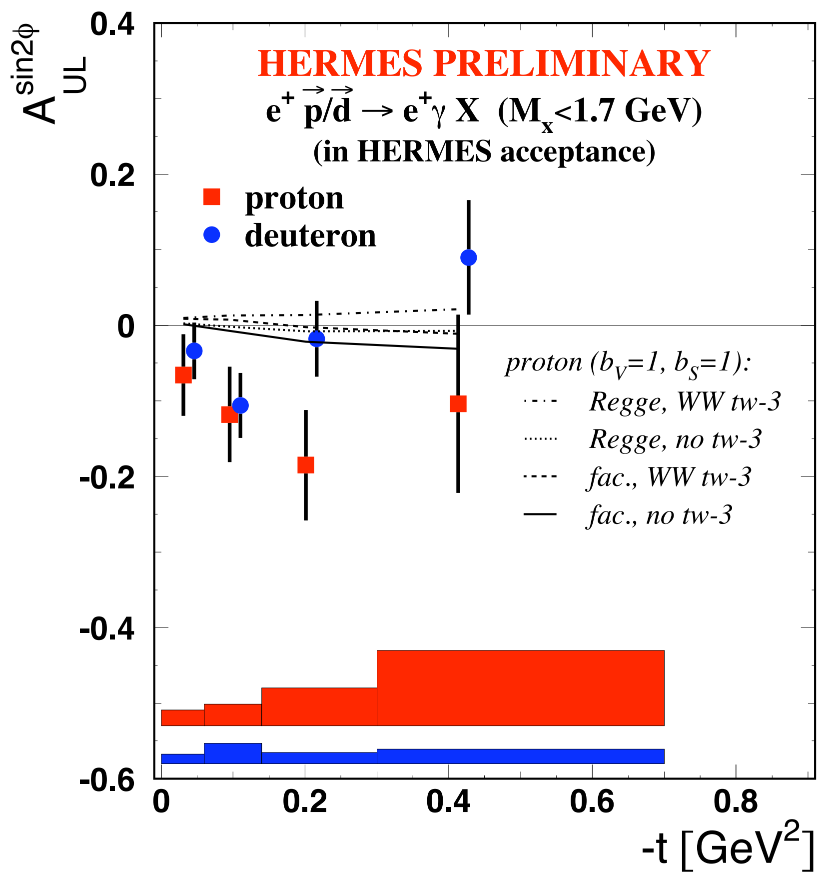
HERMES measures all asymmetries for p and d targets

for example **Longitudinal Target Spin Asymmetry**

$$A_{UL} : \mathrm{d}\sigma(\overrightarrow{p}, \phi) - \mathrm{d}\sigma(\overleftarrow{p}, \phi) \propto A_{UL}^{\sin\phi} \sin\phi + A_{UL}^{\sin 2\phi} \sin 2\phi$$



$A_{UL}^{\sin\phi} \propto \mathrm{Im}(F_1\tilde{H})$;
compatible with theory model



$A_{UL}^{\sin 2\phi}$ larger than theory expectation
$\rightarrow$ twist-3 GPD ?

theoretically not yet understood

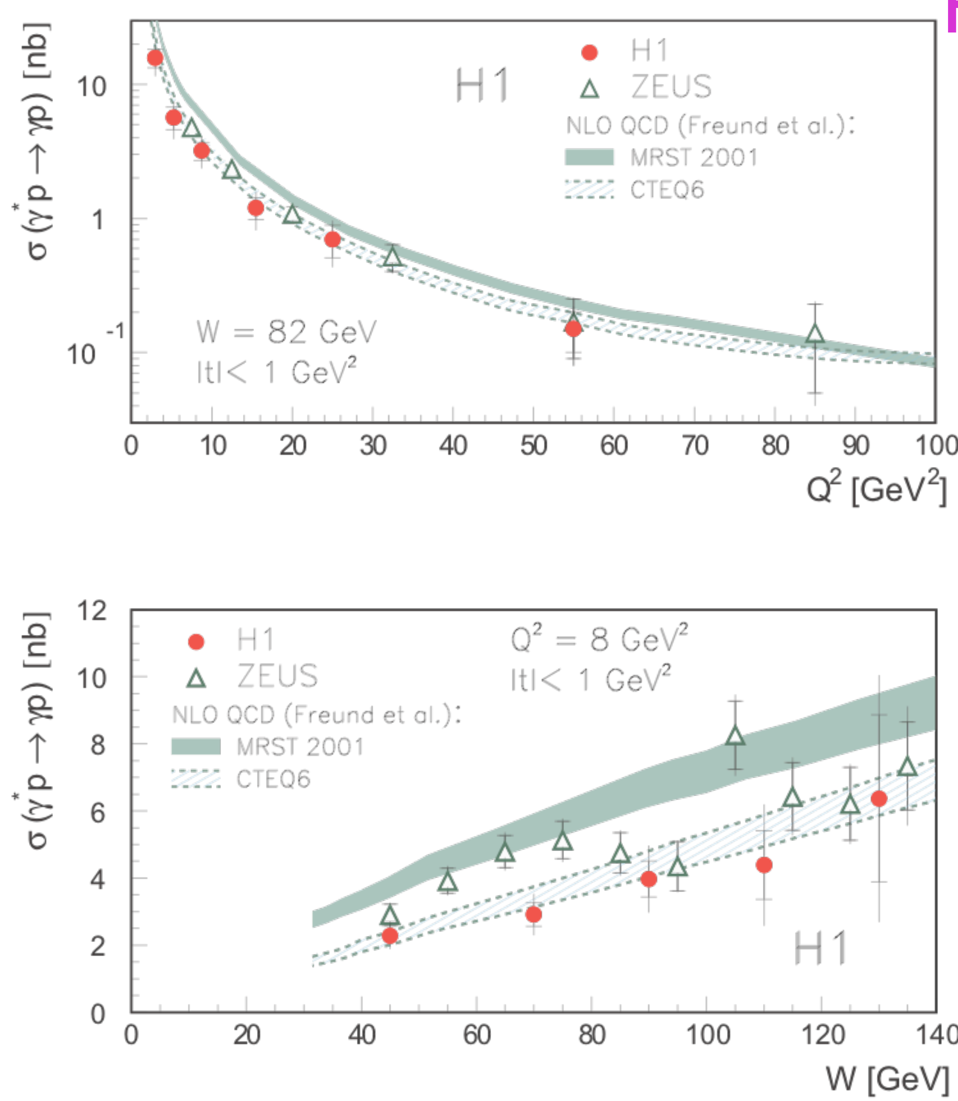
expect better selection of elasticDVCS with HERMES recoil detector (end of 2005)

DVCS: Comparison with QCD Predictions

H1, ZEUS

Comparison to NLO QCD:

- Band width reduced by *t* slope measurement
- Good description of the data
- Sensitive to GPD parametri-sations?

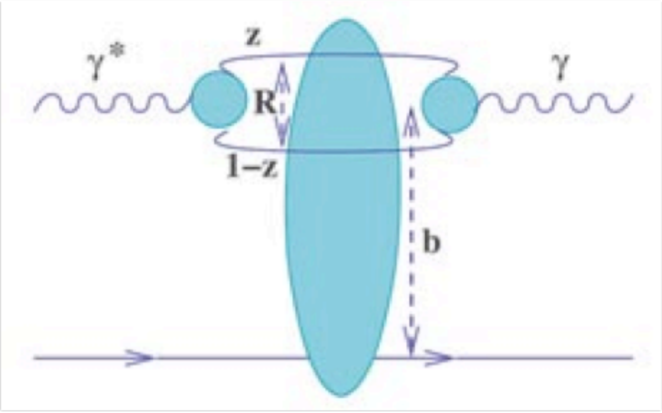


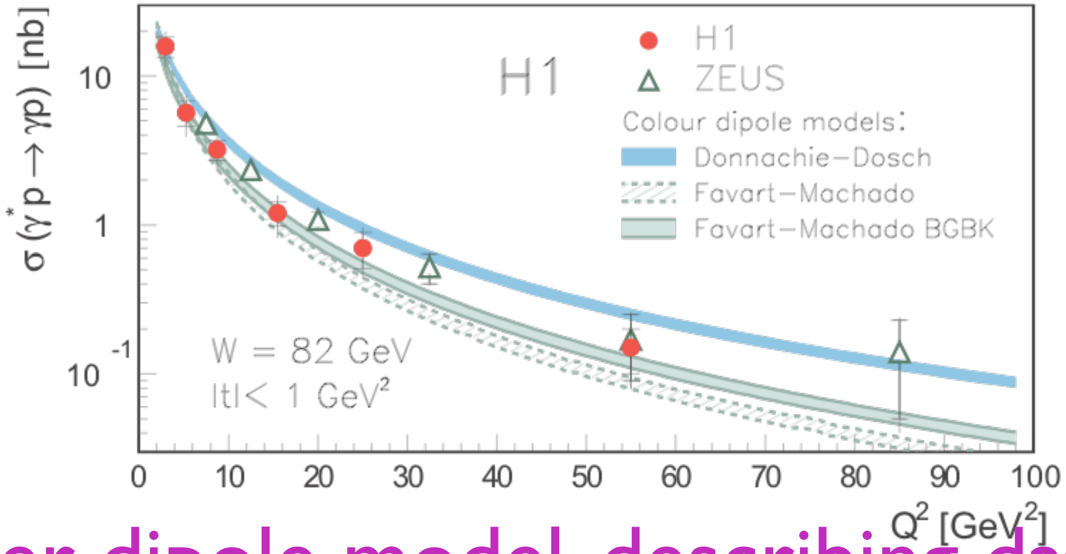
beam and charge and pol asymmetries now accessible at HERA

will measure amplitudes by interference with BH at high energies

DVCS: Comparison with Colour Dipoles

In proton rest frame:

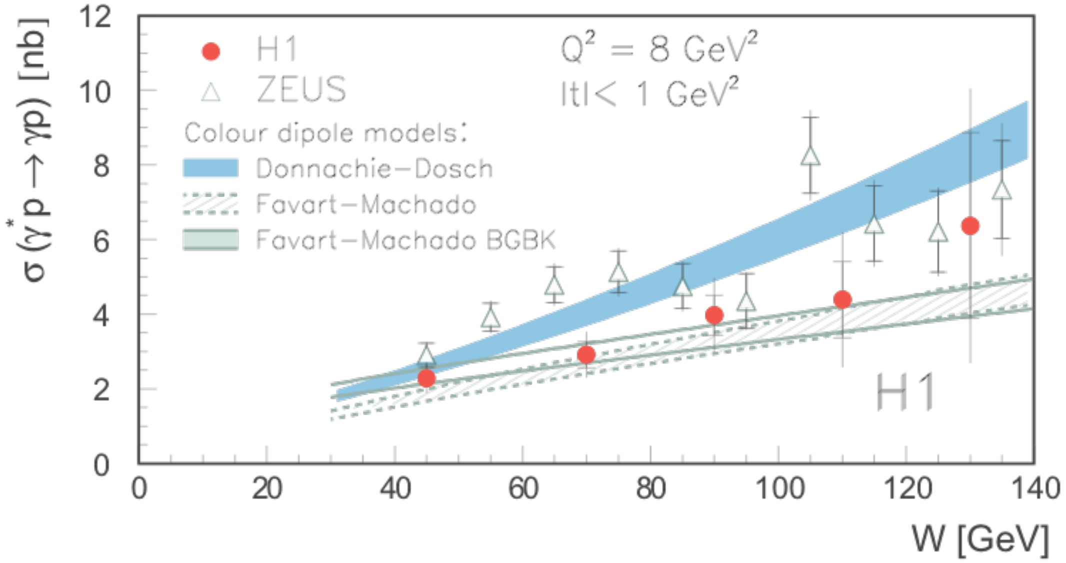




Photon fluctuates to $q\bar{q}$

G. Shaw showed other dipole model, describing data well

- Donnachie-Dosch: Hard and soft $I\!\!P$ (Phys.Lett. B502 (2001) 74)
- Favart-Machado: saturation model (Eur.Phys.J. C29 (2003) 365)
- Good description of shape and normalisation



H.-W. Siebert

A measurement of Λ and Ξ^- polarization in inclusive production by Σ^- of 340 GeV/c in C and Cu targets

polarisation normal to production plane (parity conservation)

polarisation observed in many eperiments

hyperon polarizations in inclusive production by protons:
Λ: negative, reaches ~-40% at large x_f and p_t.
$\Sigma^\pm$: positive
Ξ^-, Ξ^0: negative
Ω: zero

Λ polarization in production by
neutrons: $\approx$ same as by protons
π^-: small, negative
K^-: twice as large as by protons, positive

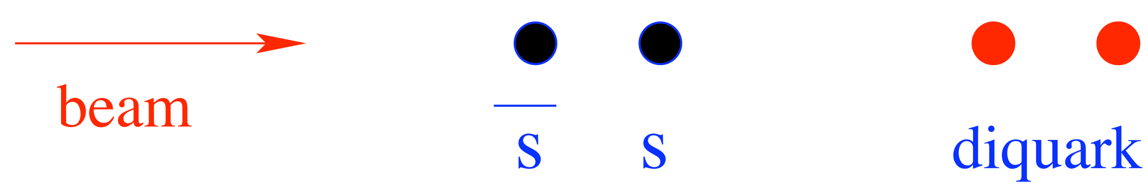
$\Longrightarrow$ an interesting and complex set of data !!

H.-W. Siebert

no pQCD predictions exist

Qualitative explanation in **Lund model**

B. Andersson et al., Physics Reports **97** (1983) 31



if $\bar{s}$ s pair has spin 1,

local conservation of angular momentum will
cause s polarization ↑↓ prod. normal

Signs explained, no predictions of magnitude or dependence on x_f or p_t.

another approach: the **recombination model**

T.A. DeGrand and H.I. Miettinen, Phys. Rev. D23 (1981) 1227, D24 (1981) 2419

recombination of a maximum number of valence q from the beam particle with a minimum number of sea q/$\bar{\text{q}}$

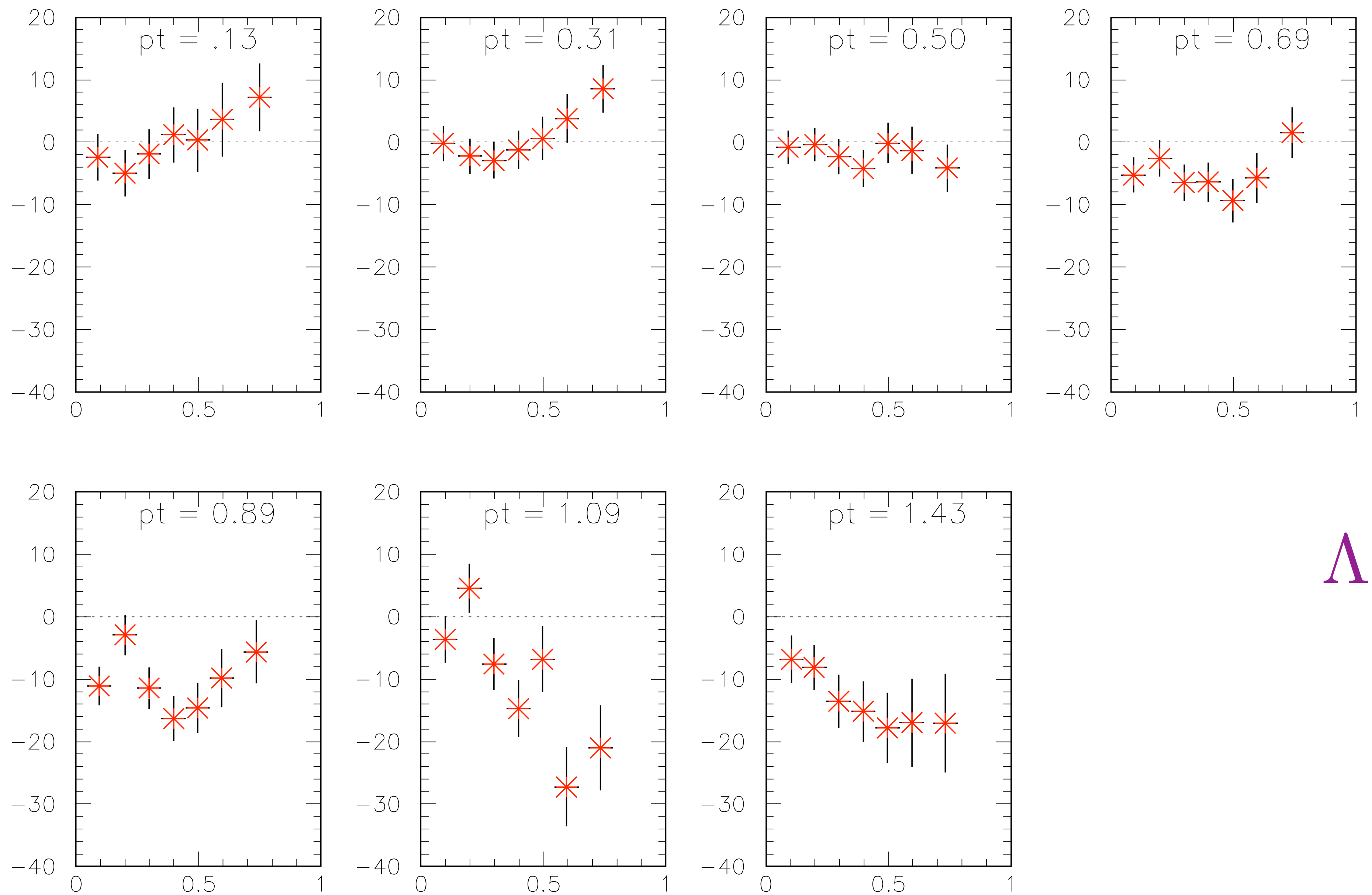
the force between the beam fragment and the q or diquark created from the sea will not be parallel to the velocities $\Longrightarrow$ **Thomas precession**

H.-W. Siebert

Experiment WA89 at CERN ran from 1990 to 1994 in the CERN West Hall.

Σ^- beam, mean momentum 340 GeV/c

Ξ^- polarizations



Ξ^- polarizations as a function of x_F for fixed bins in p_t, in units of %.

Λ pol positive !

negative sign is no surprise

but: positive sign at high x_F, low p_t ??

H.-W. Siebert

Conclusion:

Ξ^- polarization agrees with qualitative expectations

the positive sign of the Λ polarization and the breakdown above $\approx$1.2 GeV/c were unexpected at the time of the experiment,
now an explanation is offered in an extension of the recombination model

No comprehensive explanation of all polarization data exists, not even a coherent phenomenological description !!

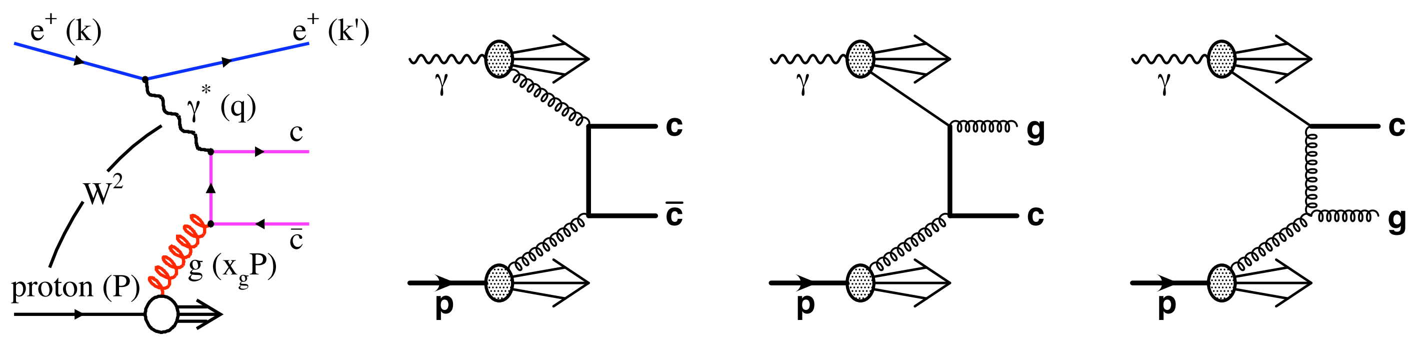
→ Food for theorists ....

LHC: polarization studies may (will) need an estimate of polarizations in hadronic interaction backgrounds

Beauty and

Charm production is expected to be described by pQCD:

LO
with "resolved photon"



heavy quarks provide a hard scale

NNLO and partially NNLO calculations available

$F_2^{c\bar{c}}$ & $F_2^{b\bar{b}}$ from Impact Parameters

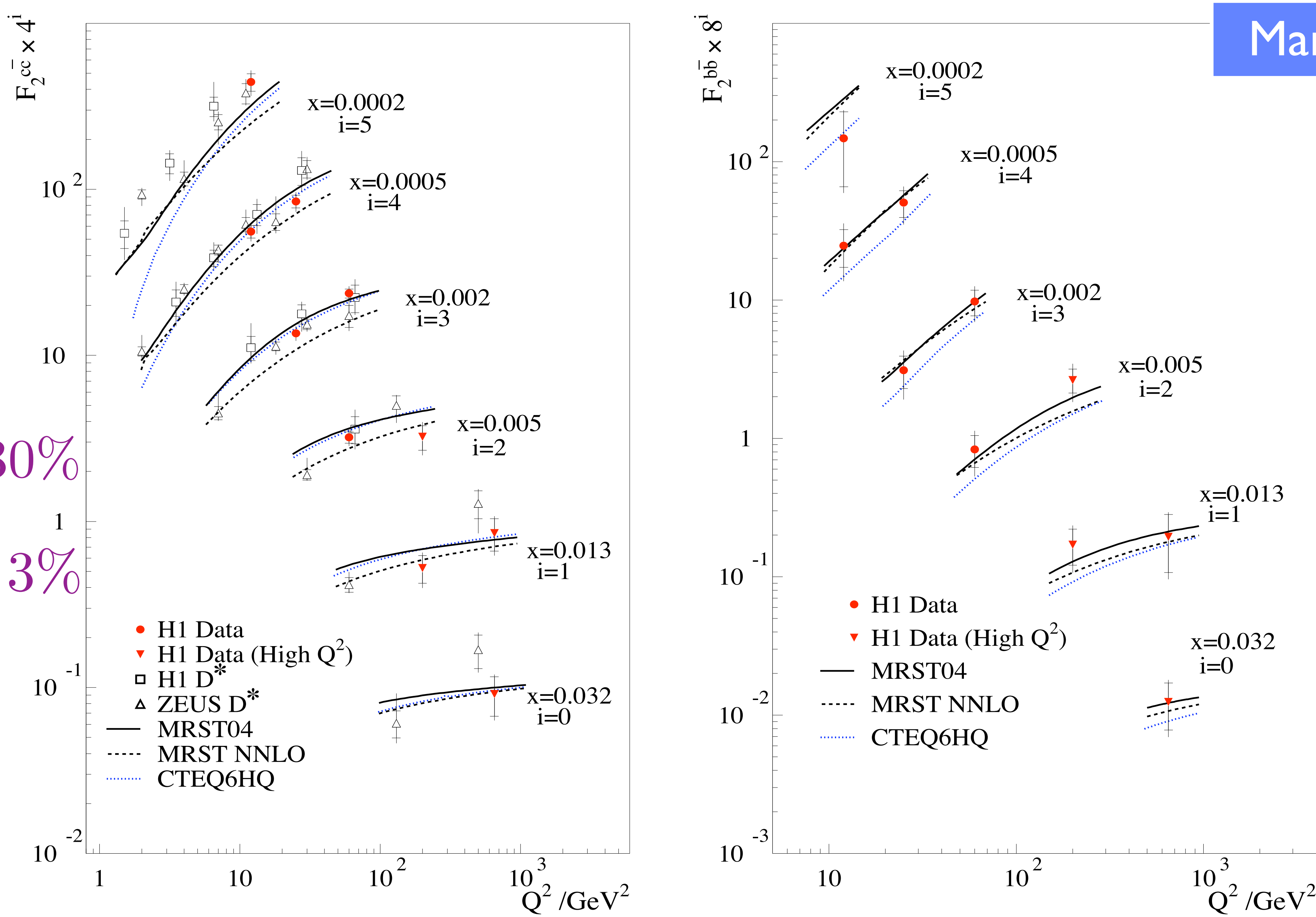
Mark Bell

fraction of

$F_2^{inclusive}$

$f^{c\bar{c}} \sim 20\%$ to 30%

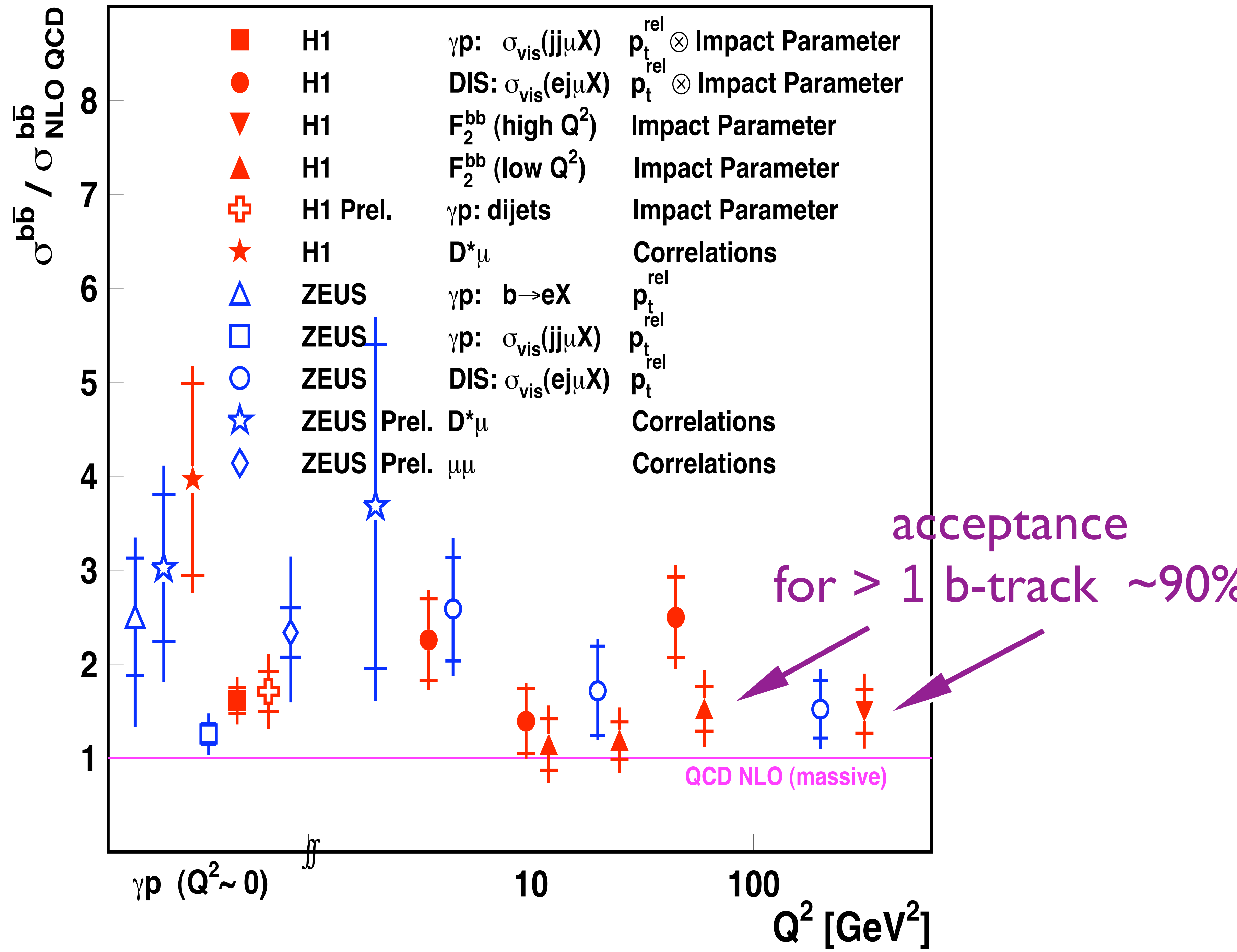
$f^{b\bar{b}} \sim 0.3\%$ to 3%



- QCD calculations fit the data reasonably well; NNLO calculations now available.
- Scaling violations apparent at low x.

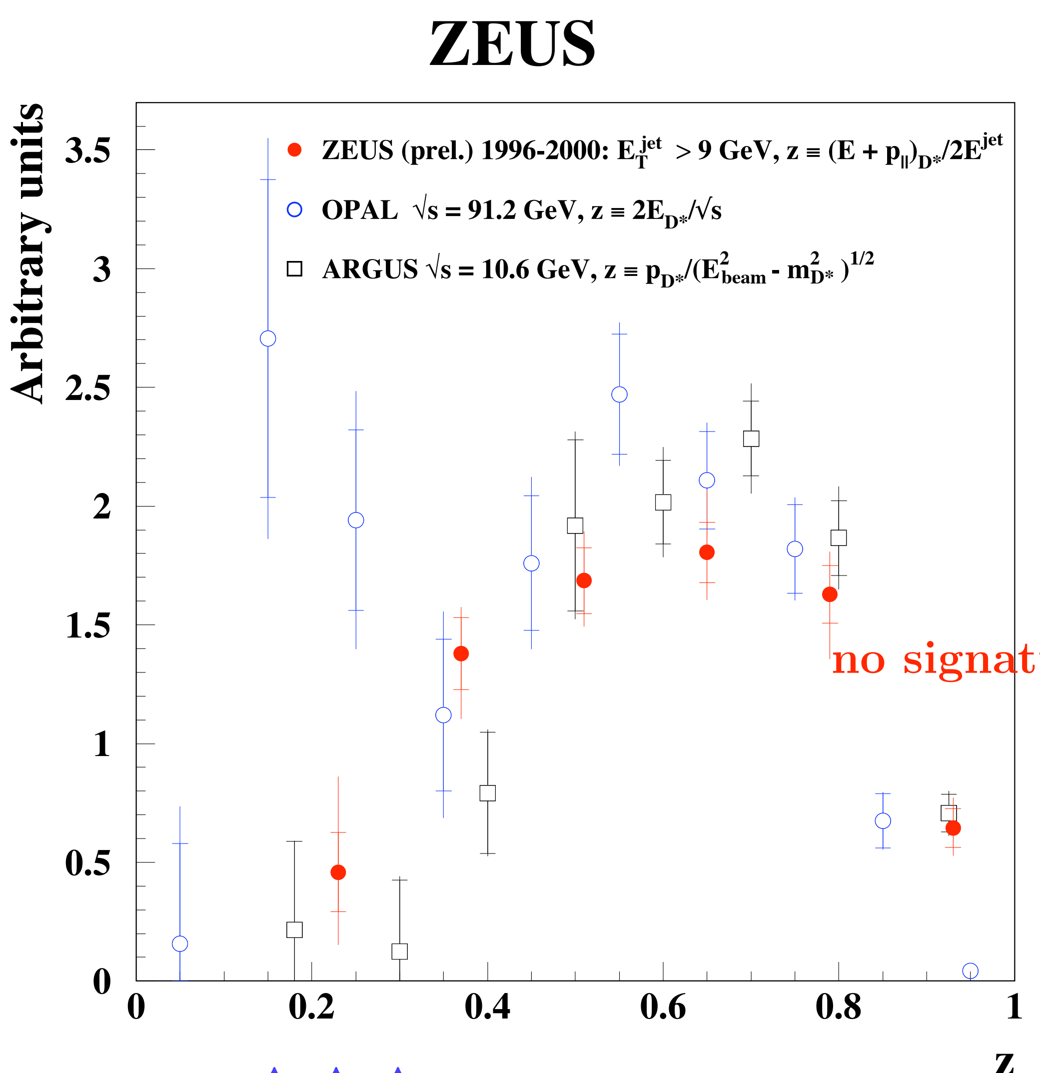
Summary of Beauty Results

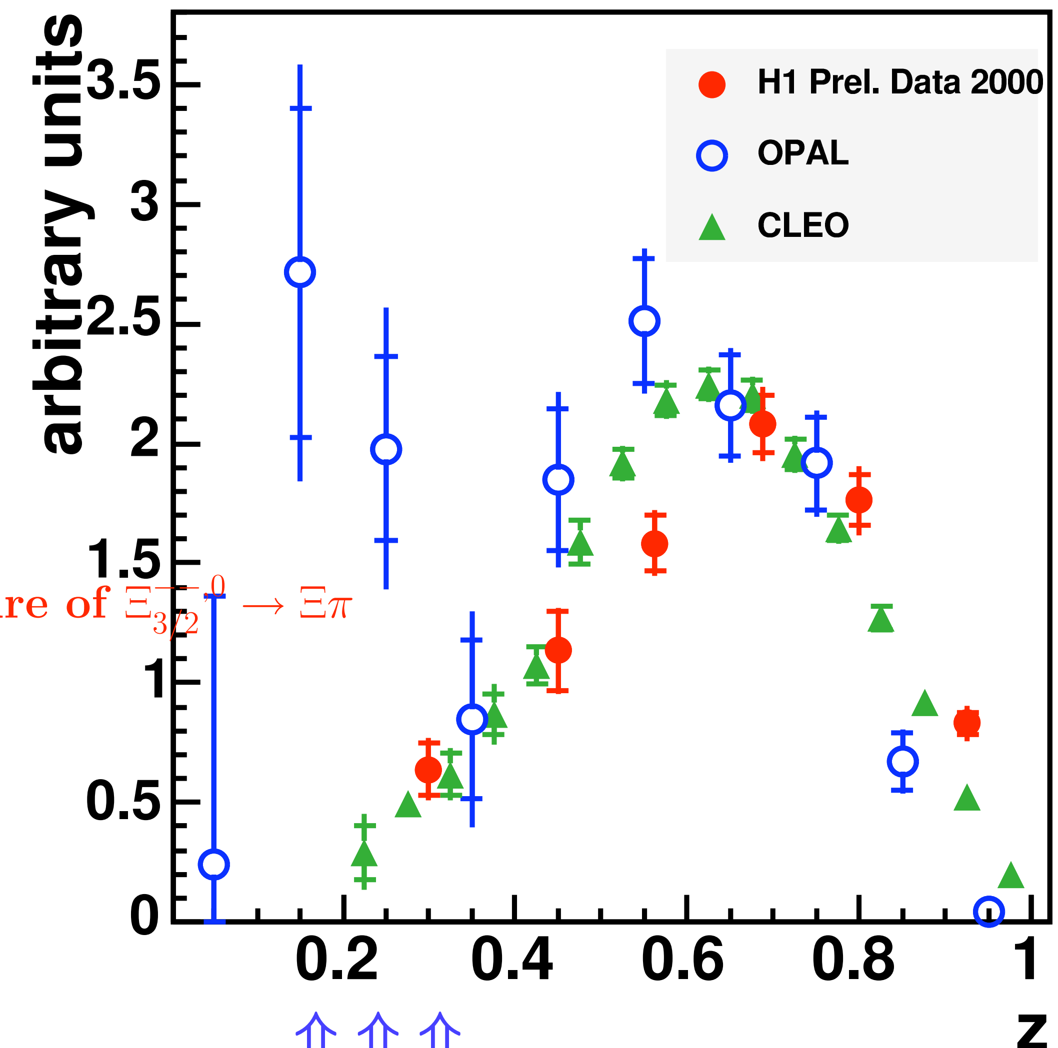
- Good coverage of measurements.
- Tendency of data to lie above NLO prediction.
- Measurements with smaller errors closer to theory.
- Improved theoretical understanding needed to include higher orders.



Leonid Gladilin

Charm fragmentation function in ep and e^+e^- collisions





no signature of $\Xi^{--0}_{3/2} \to \Xi\pi$

⇑ ⇑ ⇑ ⇑ ⇑ ⇑

no gluon-splitting component in low-energy data

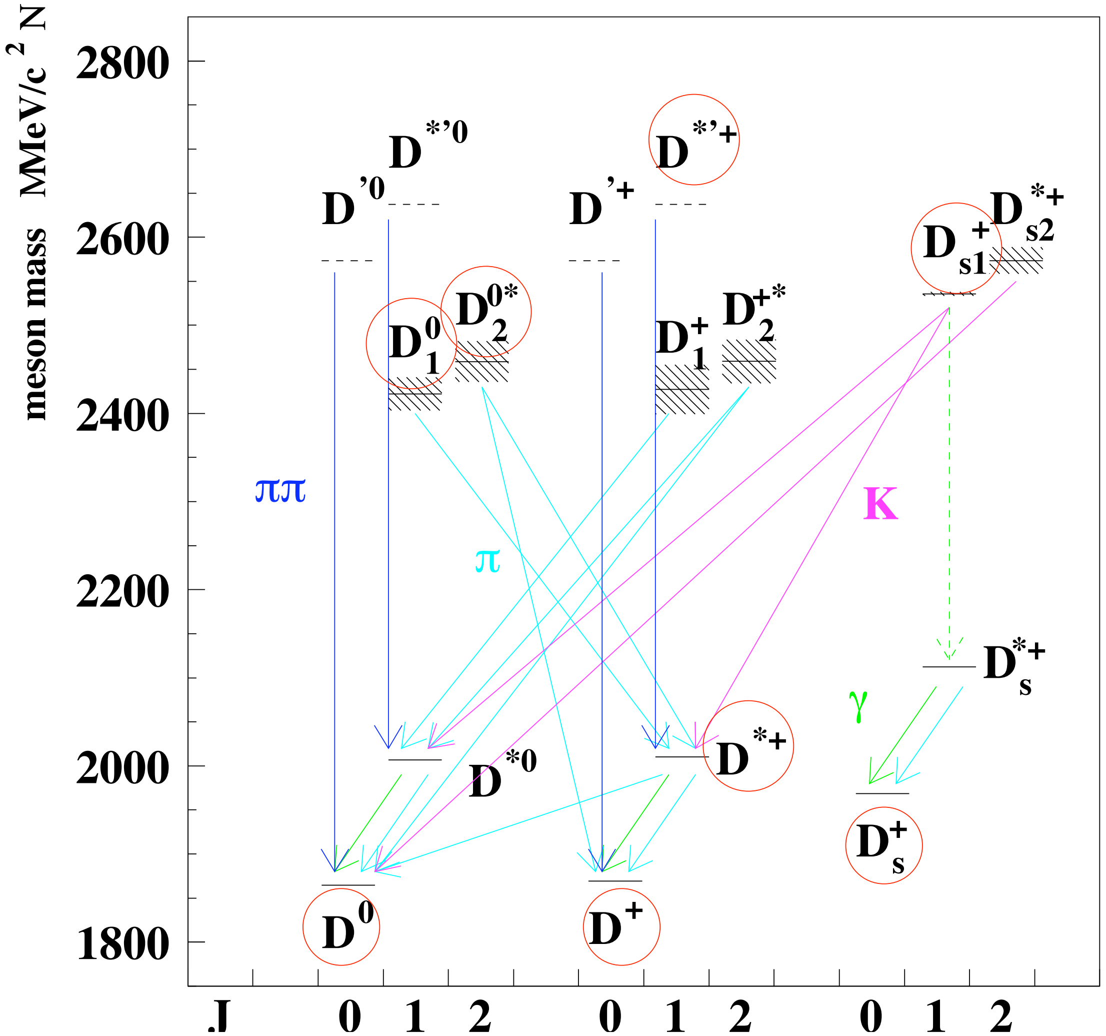
different z definitions

qualitative agreement

H1 and ZEUS :
many fragmentation results
u/d, V/(P+S), γ_s
consistent with e+e-
("universality")

Leonid Gladilin

Study of excited D mesons at HERA



Orbitally excited:

1) $D_1^0, D_2^{*0} \to D^{*+}\pi^-$ (+ c.c.)

2) $D_{s1}^+ \to D^{*+}K^0$ (+ c.c.) $\Longrightarrow$ discu

Search for radially excited:

3) $D^{*\prime+} \to D^{*+}\pi^+\pi^-$ (+ c.c.)

Leonid Gladilin

Fragmentation fractions for excited D mesons

Using world average for $f(c \to D^{*+})$:

	$f(c \to D_1^0)$ [%]	$f(c \to D_2^{*0})$ [%]	$f(c \to D_{s1}^+)$ [%]
ZEUS (prel.)	$1.46 \pm 0.18^{+0.33}_{-0.27} \pm 0.06$	$2.00 \pm 0.58^{+1.40}_{-0.48} \pm 0.41$	$1.24 \pm 0.18^{+0.08}_{-0.06} \pm 0.14$
CLEO	1.8 ± 0.3	1.9 ± 0.3	
OPAL	2.1 ± 0.8	5.2 ± 2.6	$1.6 \pm 0.4 \pm 0.3$
ALEPH	1.6 ± 0.5	4.7 ± 1.0	$0.94 \pm 0.22 \pm 0.07$
DELPHI	1.9 ± 0.4	4.7 ± 1.3	

1) the same amounts of excited D mesons in e^+e^- and ep data

2) situation with $f(c \to D_2^{*0})$ is not clear

3) $f(c \to D_{s1}^+)$ is twice as large as the expectation :

$\gamma_s \times f(c \to D_1^0) \approx 0.3 \times 2\% = 0.6\%$

Why $f(c \to D_{s1}^+)$ is so large ?

Is it connected wih its strange helicity ?

920 GeV p, fixed target

stopped data taking, analysis ongoing

V. Egorytchev

Physics topics

V. Egorytchev presented all blue topics

I show 2 examples

Di-lepton trigger

- J/ψ: A-dependence, Pt distribution, Xf distribution
- $\Psi(2S)/\ J/\psi$ production ratio
- $\chi_c\ /\ J/\psi$ production ratio
- FCNC D0 -> $\mu\mu$ Br limit
- $b\bar{b}$ cross section
- Υ production

MB data

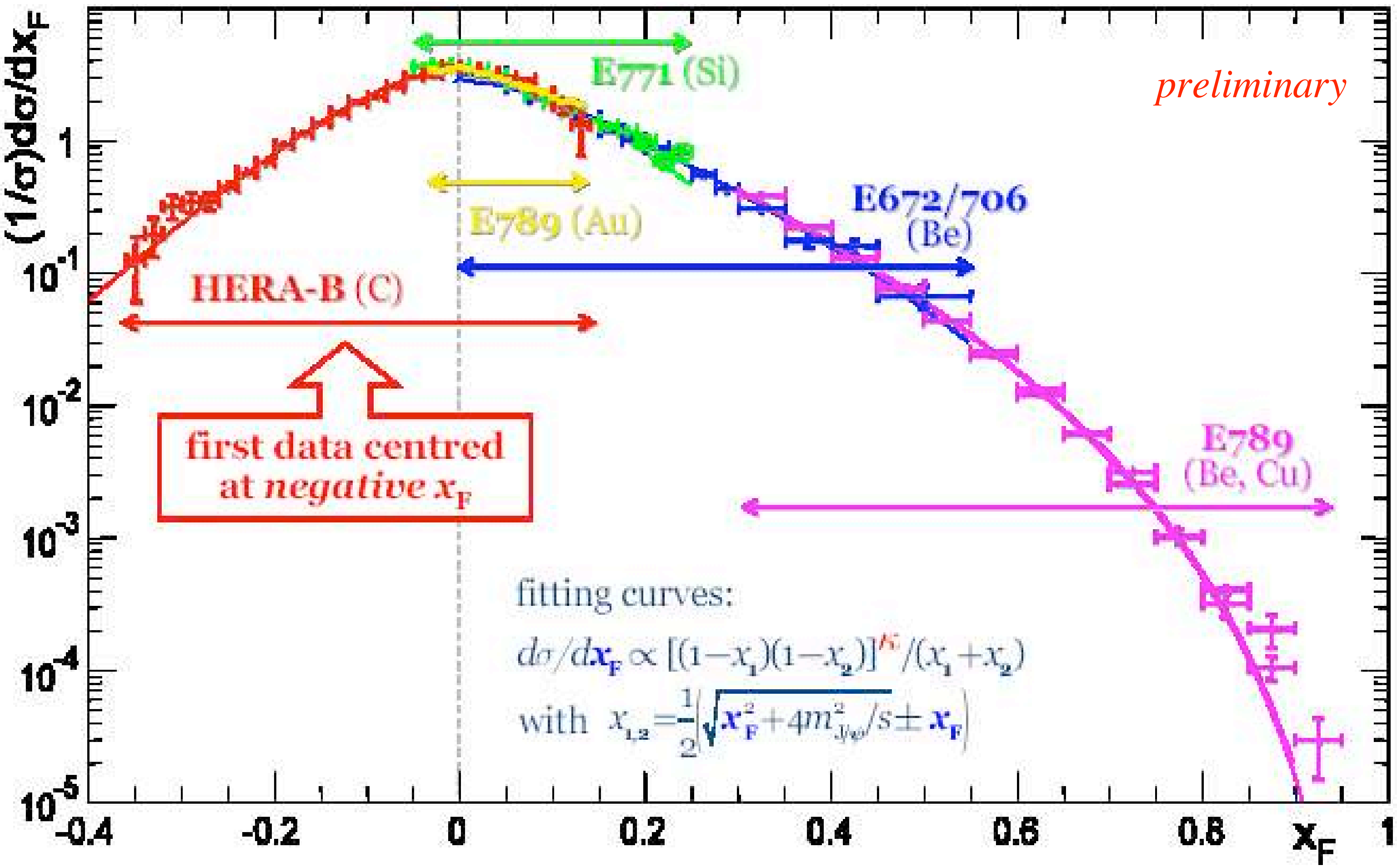
- J/ψ production cross section
- Strangeness and hyperon production
- Pentaquark search
- Λ polarization
- Deuteron/anti-deuteron production
- Open charm production

Disclaimer: all results presented in this talk are preliminary !!!

V. Egorytchev

J/ψ differential distribution: X_F

e+ e- sample, C wire



different targets

consistent picture

looks forward/backward symmetric

Large acceptance for negative X_F region

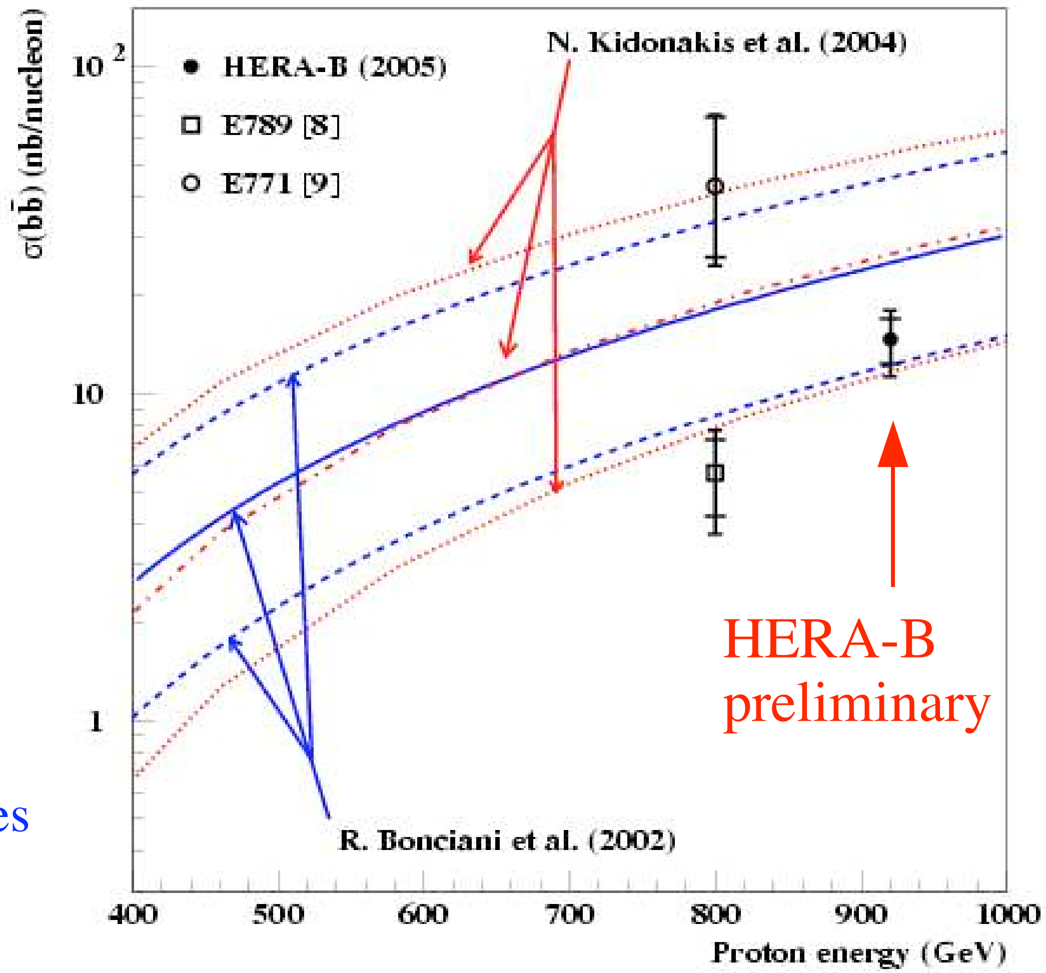
Acceptable agreement in the overlap ranges with existing experimental data

see also talk of Mikhail Ryzhinsky

V. Egorytchev

Open beauty production

- Previous measurements (E789, E771) do not agree with each other
- The present value is within 1.5 σ of the E789 experiment (after rescaling to the same √s)
- 1.8 σ below the rescaled E771 measurement
- theoretical uncertainty:
  - renormalization and factorization scales
  - *b*-quark mass



large theoretical uncertainties

HERA-B resonably consistent with E789 and E771 and theory

$$\sigma (b\,\bar{b}) \;=\; 14.6 \pm 2.3\ (\text{stat}) \pm 2.4\ (\text{sys})\ \text{nb/nucleon}$$

Cross section obtained by using the value of σ (J/ψ) = 493 ± 20 ± 43 nb/nucleon

HERA-B has still provide much information on heavy quark physics with nuclei

Searches for new physics at HERA

David South

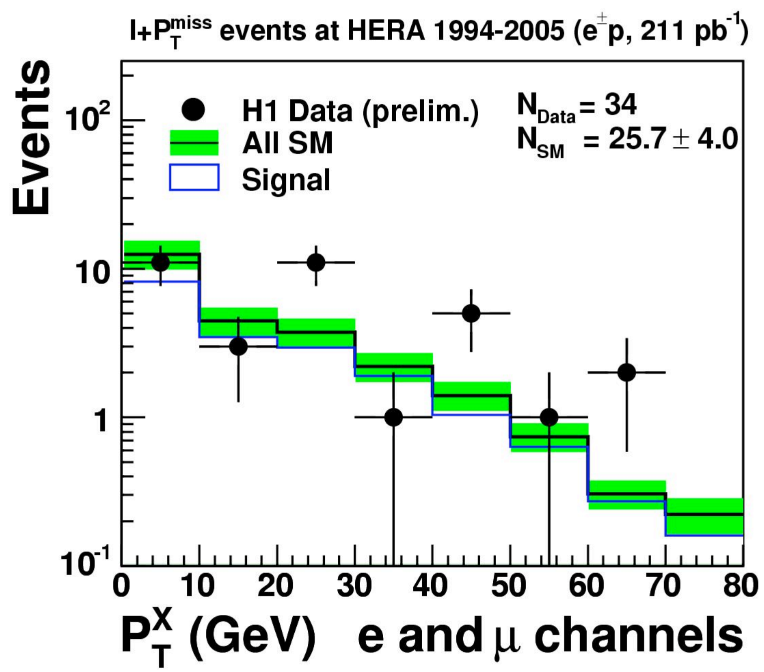
Outline

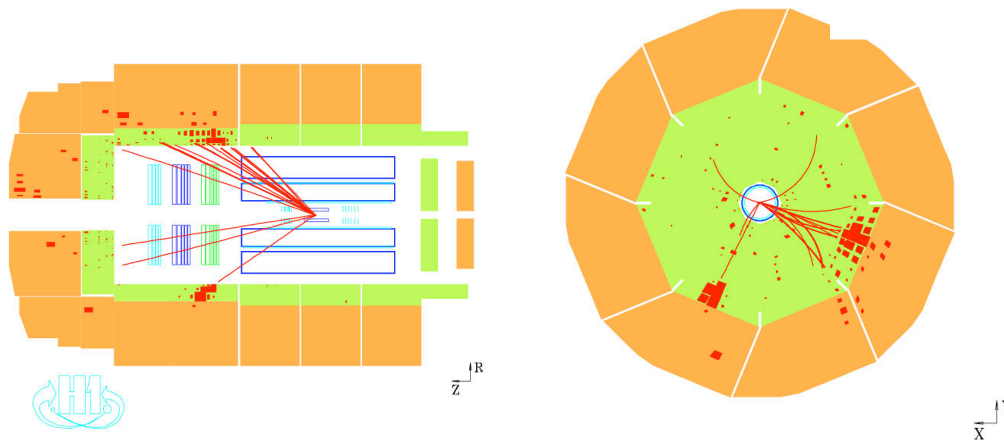
- Introduction to HERA
- Rare SM Processes
  - Isolated Leptons and Missing Transverse Momentum
  - Multi Lepton Events
  - General Search for New Phenomena
- Searches for BSM Physics
  - Leptoquark Production and Lepton Flavour Violation
  - SUSY and R-parity Violating Squark production
  - Bosonic Stop Decays in R-parity Violating SUSY
  - Search for Gaugino Production
  - Light Gravitinos in Events with Photons and Missing Transverse Momentum
- Summary of Results

} signals above expectation

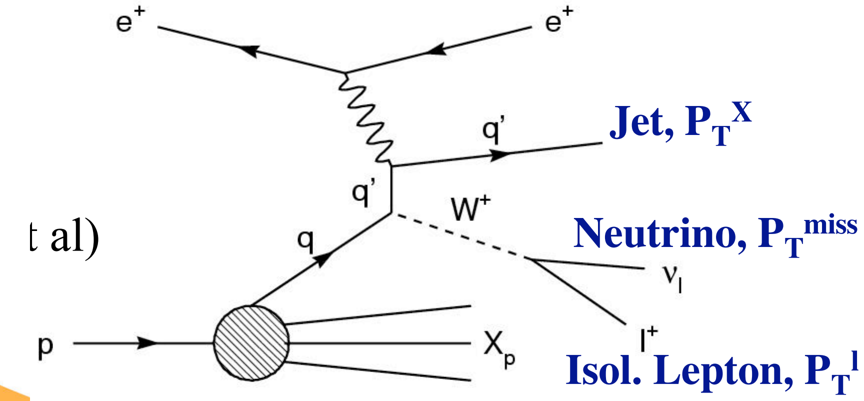
} many limits
see his talk

Isolated Leptons and Missing P_T





H1 HERA II isolated lepton event at large P_T^X



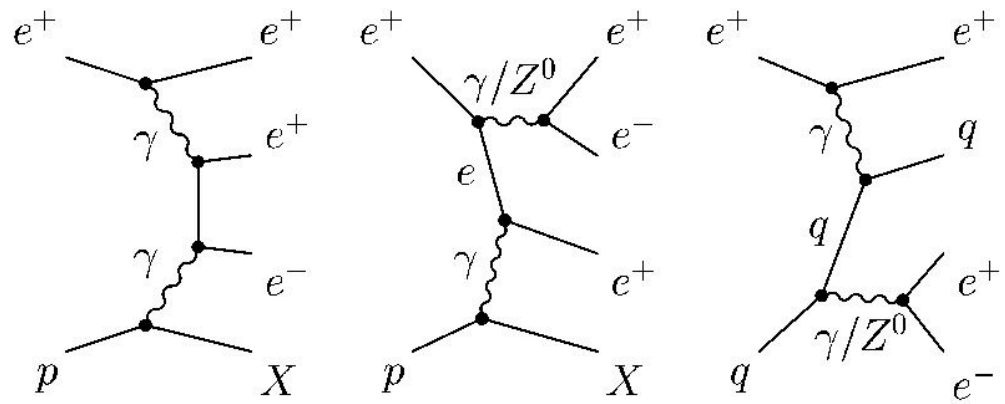
main SM contribution

H1 Prel

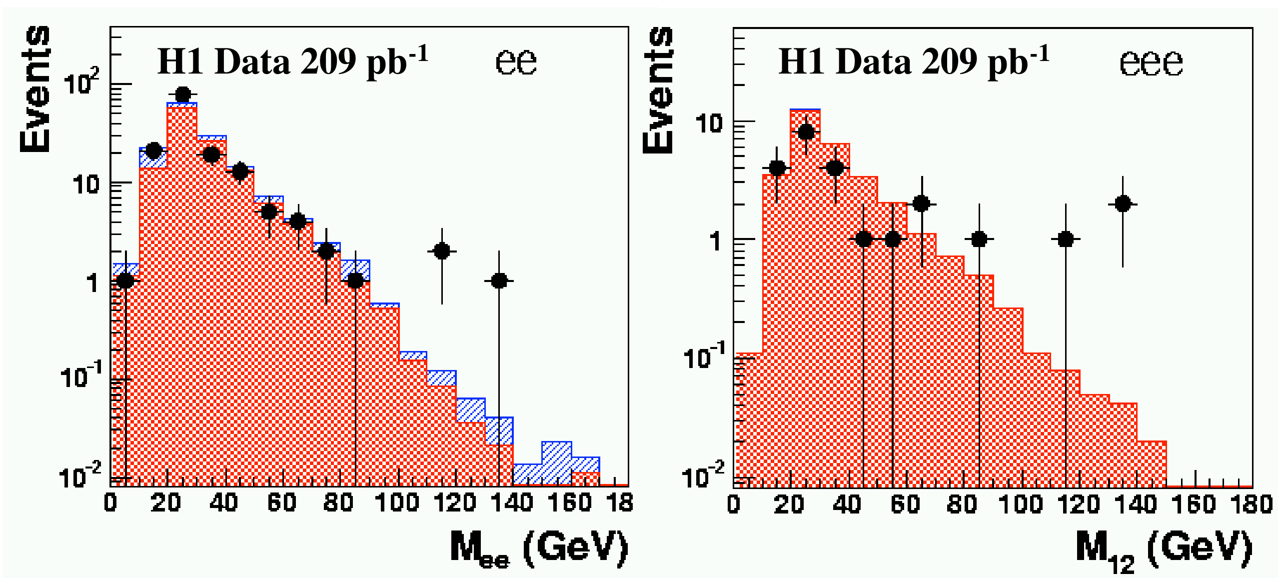
		electron	muon	combined
1994-2005 $e^{\pm}p$ 211 pb^{-1}	Full Sample	25 / 20.38 ± 2.92 (68%)	9 / 5.35 ± 1.10 (82%)	34 / 25.73 ± 4.02 (71%)
	$P_T^X > 25$ GeV	11 / 3.22 ± 0.59 (77%)	6 / 3.20 ± 0.54 (81%)	17 / 6.42 ± 1.13 (79%)

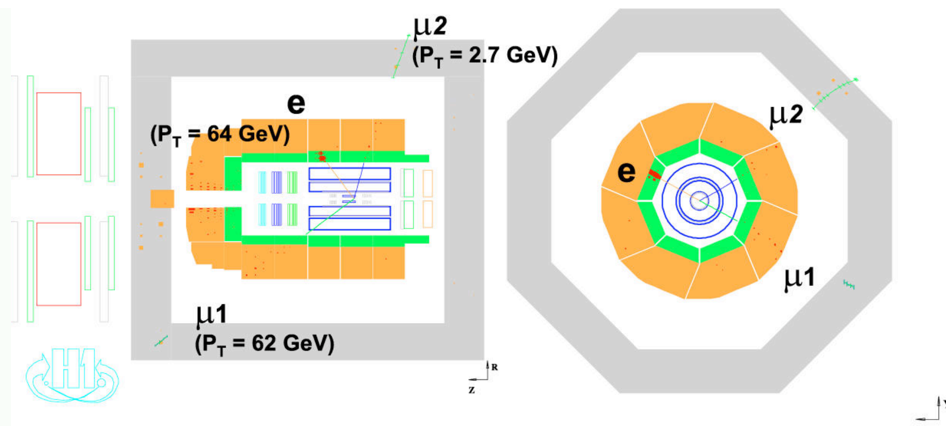
Isolated e candidates	$12 < P_T^X < 25$ GeV	$P_T^X > 25$ GeV
ZEUS (prel.) HERA I 99-00 (66 pb^{-1})	1 / 1.04 ± 0.11 (57%)	1 / 0.92 ± 0.09 (79%)
ZEUS (prel.) HERA II 03-04 (40 pb^{-1})	0 / 0.46 ± 0.10 (64%)	0 / 0.58 ± 0.09 (76%)

Excess not confirmed by ZEUS, need more data



Multi Lepton Events at H1





Event display of high mass eμμ event observed in HERA II data

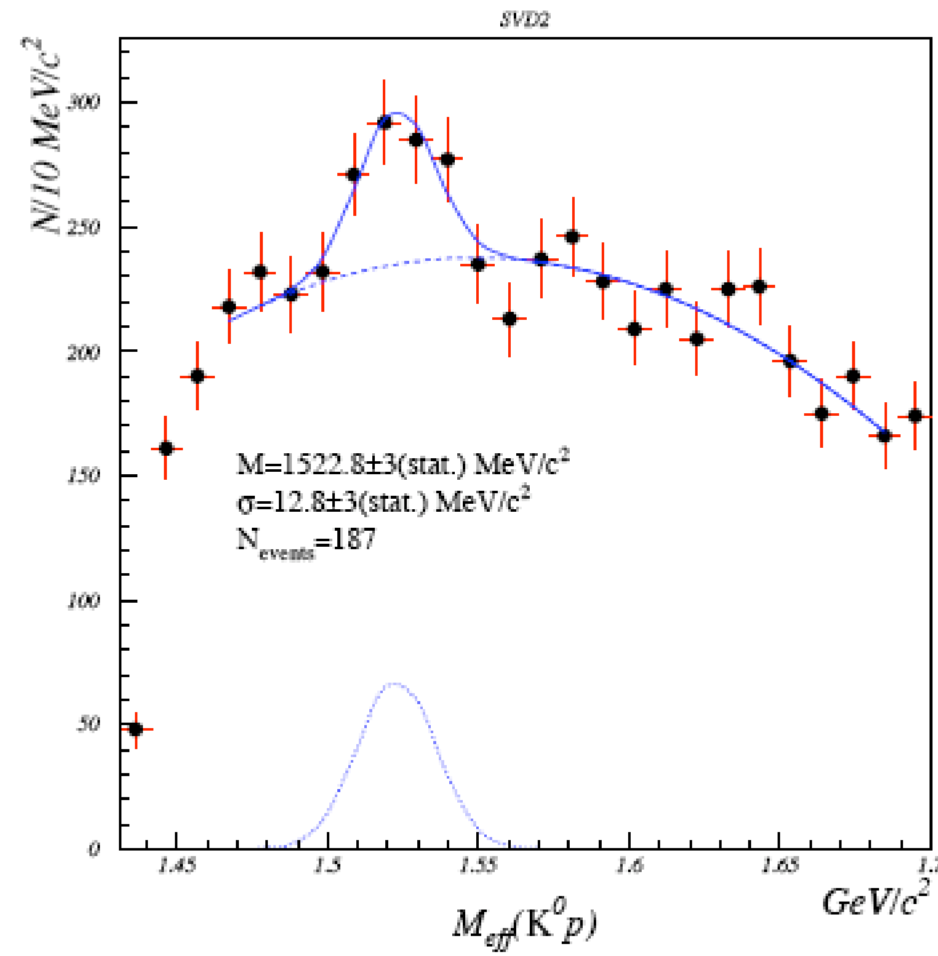
- At low mass combinations, good agreement with the SM
- Interesting events seen a large mass combinations (M > 100 GeV)
- 3 ee events (SM: 0.44 ± 0.10) and 3 eee events (SM: 0.29 ± 0.06) observed in HERA I data
- 2 eμμ events observed in HERA II data at high mass

again, more data needed

Pentaquarks

V. Popov : signal of SVD-2

important to give kinematic details !



negative and poisitive evidences discussed in

V. Popov : Review on PQs

Leonid Gladilin : only H1 sees $\Theta_c(3100)$ in direct contradiction to ZEUS
ZEUS sees $\Theta^+(1522)$, H1 not (statistically still compatible)
ZEUS sees no signal $\Xi_{3/2}^{--,0}$

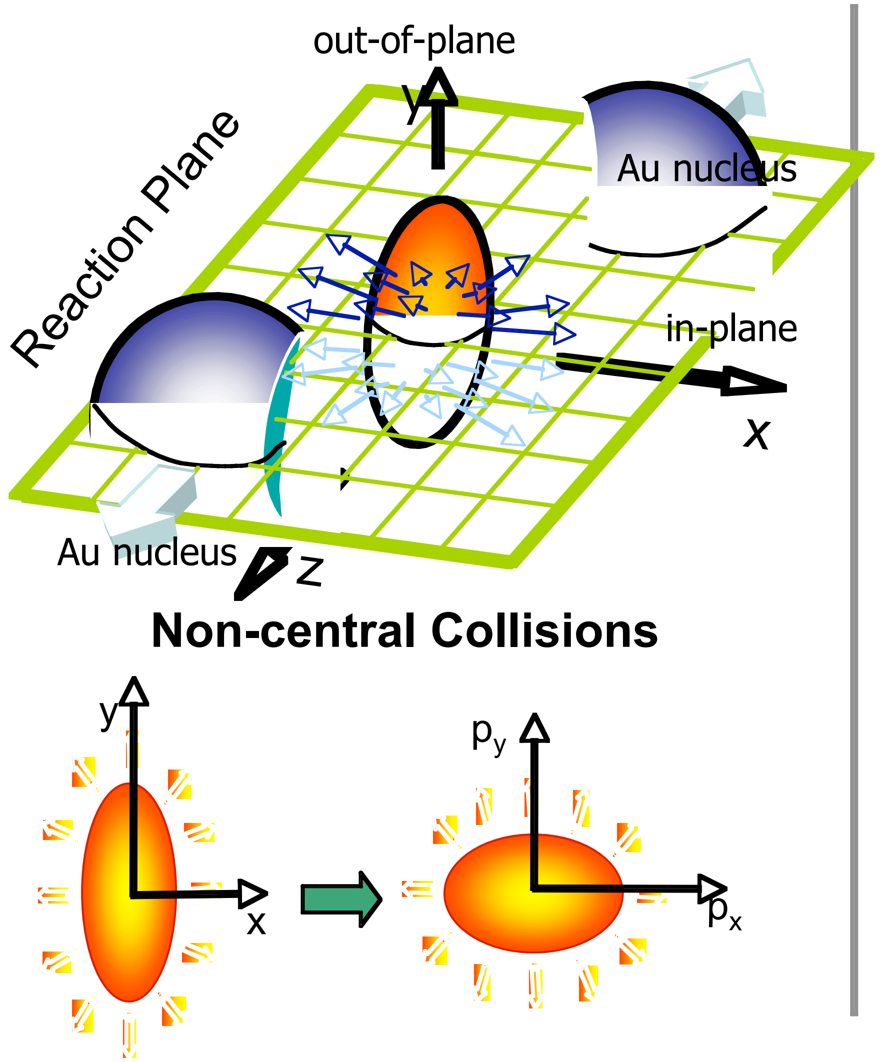
H. -W. Siebert : negative evidence for $\Xi_{3/2}^{--}$ (WA89)
and for $\Theta^+(1540)$ (Compass)

bump in $\Sigma(1760)^+ \to pK_S$ (known from phase shifts)

Tensor glue balls

M. Mateev : discussion of 3 states, around 2000 MeV, width ~500 MeV

Elliptic energy flow in Au Au colissions (PHENIX, RHIC)



Elliptic flow comes from the azimuthal dependence of pressure gradients and generated mainly during the highest density phase of the collision before the spatial asymmetry of the plasma disappears.

Calculations (hydro and parton transport) – v2 is generated before 3 fm/c. -> It is very difficult to convert the spatial anisotropy of the matter into a momentum space anisotropy once the system cools into the mixed phase.

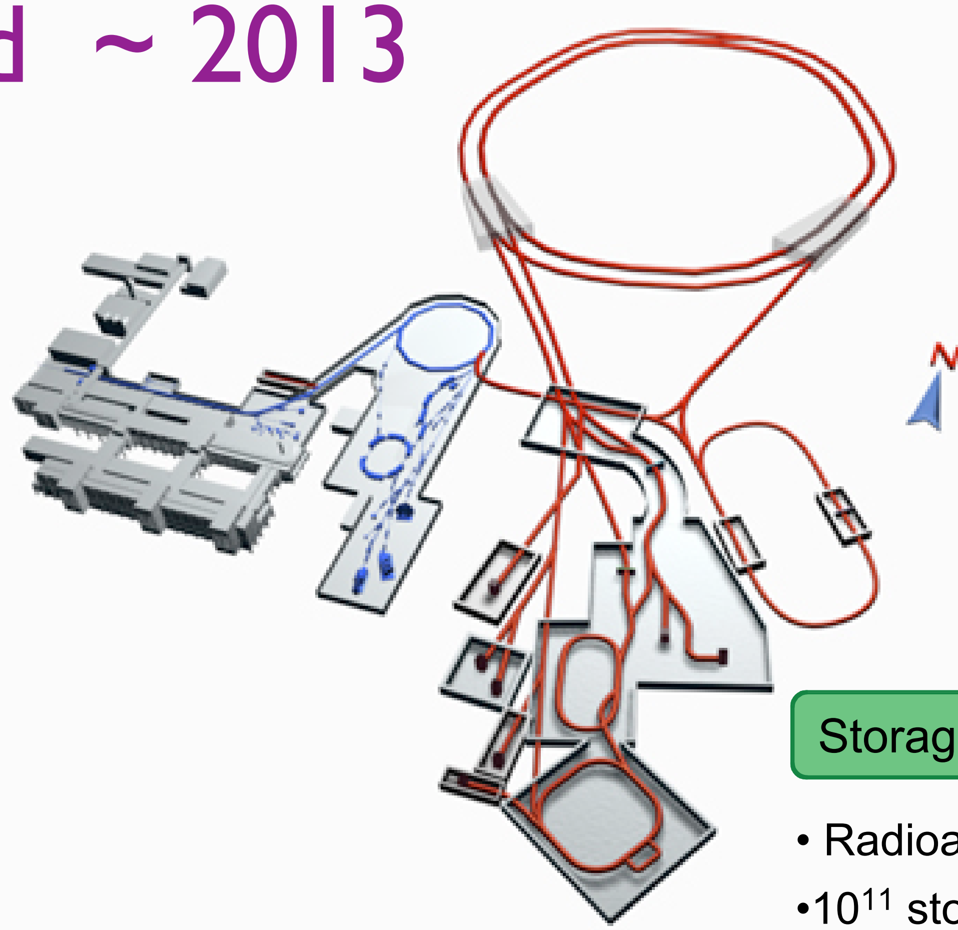
concludes, that seen for all hadrons (on question also for photons) seems to develop early (quark/gluon phase)

Jim Ritman

Facility for Antiproton and Ion Research at Darmstadt, Germany

FAIR Will Probe the Intensity Frontier With Secondary Beams

approved facility
expected ~ 2013



- 10^{12}/s; 1.5 GeV/u; $^{238}U^{28+}$
- 10^{10}/s $^{238}U^{73+}$ up to 35 GeV/u
- $3x10^{13}$/s 30 GeV protons

- Broad range of radioactive beams up to 1.5 - 2 GeV/u; up to factor 10 000 in intensity over present
- Antiprotons 3 (0) - 30 GeV

Storage and Cooler Rings

- Radioactive beams
- 10^{11} stored and cooled 1 - 15 GeV/c antiprotons

Technical Challenges include: Storage rings and high energy electron cooling

PANDA – Pbar Annihilations at Darmstadt

Hadron Spectroscopy with panda

Spectroscopy of Charmed Hadrons:

- Charmonium
- New D states

Search for Exotic Hadrons

Glueballs

Hybrids

Charm Production in pbar A

- Properties of Charmonium and open charm

Jim Ritman

Why Antiprotons?

- e+e- annihilation via virtual photon: only states with $J^{pc} = 1^{--}$

- In $p\bar{p}$ annihilation all mesons can be formed

- Resolution of the mass and width is only limited by the beam momentum resolution

Production:

$e^+e^- \to \psi'$

$\quad \hookrightarrow \gamma\, \chi_{1,2}$

$\quad\quad \hookrightarrow \gamma\, \gamma\, J/\psi$

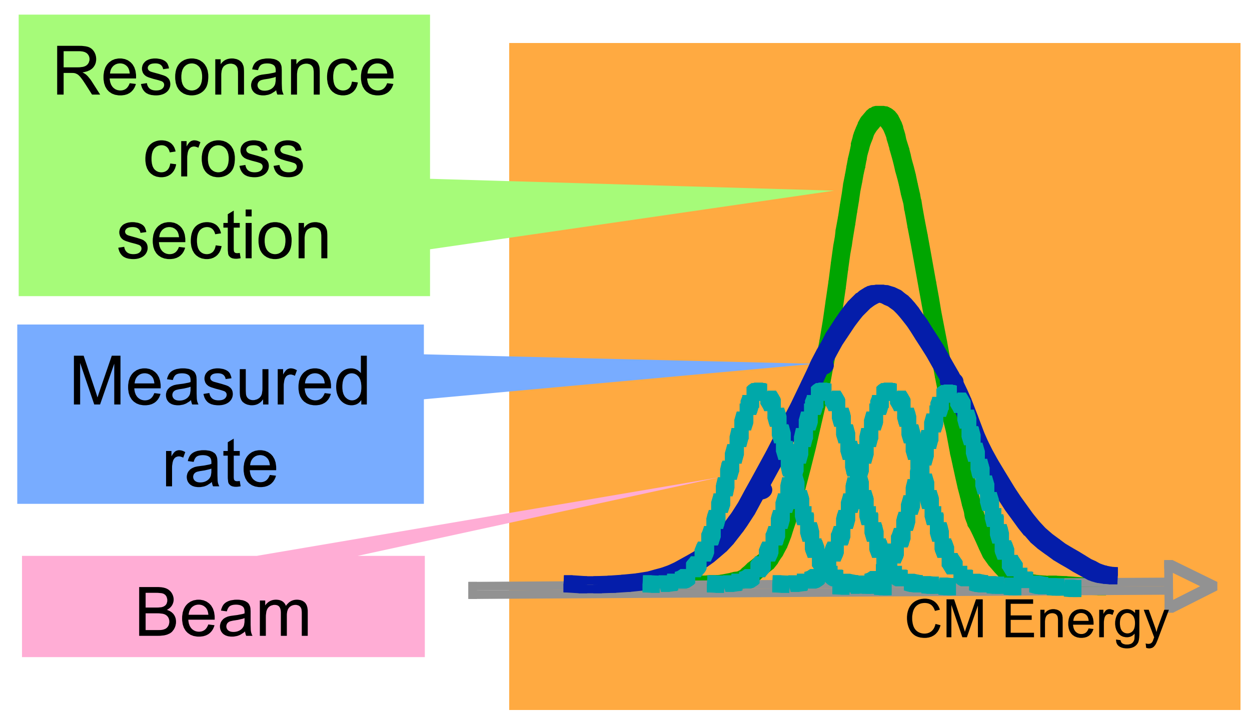
$\quad\quad\quad \hookrightarrow \gamma\, \gamma\, e^+e^-$

Formation:

$\bar{p}p \to \chi_{1,2}$

$\quad \hookrightarrow \gamma\, J/\psi$

$\quad\quad \hookrightarrow \gamma\, e^+e^-$



Conclusion

- still intensive experimental activity addressing QCD
- HERA, TEVATRON, RHIC will provide important information before LHC will have results
- We experimenters have not yet provided the data which need BFKL beyond any doubt
- Looking forward to next HSQCD