SUMMARY REPORT

'HARD INTERACTIONS'

Convenors:

Michel Fontannaz
Joachim Meyer

Topics:

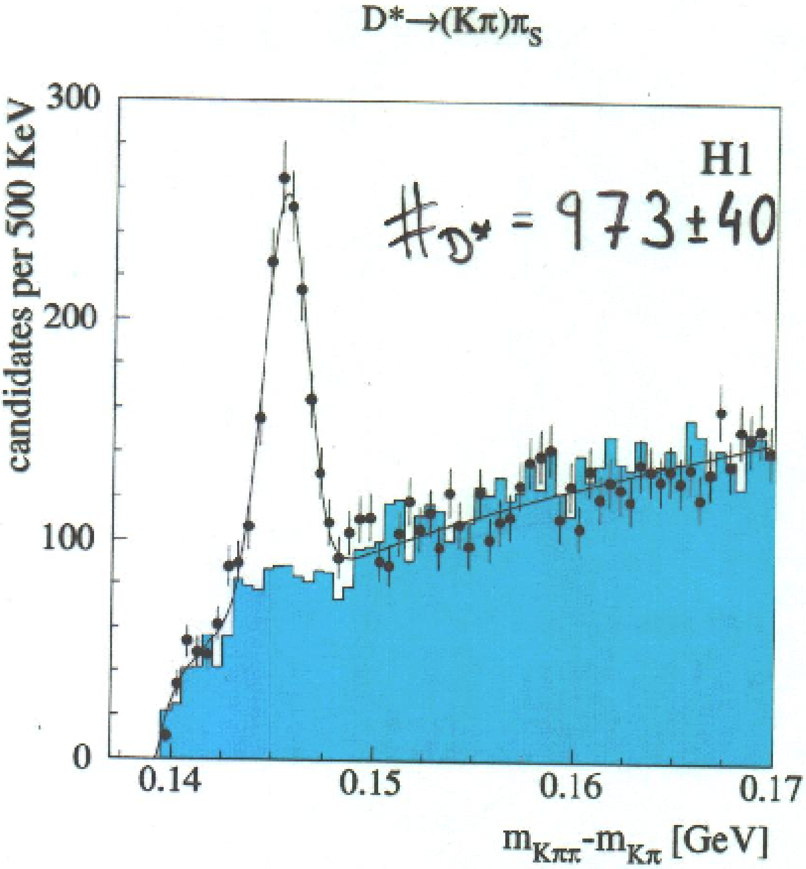
- HEAVY QUARK PRODUCTION
- HADRONIC FINAL STATES and JETS
- SEARCHES

Inclusive D^* Cross Section (H1)

DIS HERA S. Rohrdiedz

kinematic region: $ep \to e D^* X$

$1 < Q^2 < 100\ GeV^2$; $0.05 < y < 0.7$



"visible" range:

$p_t(D^*) > 1.5\ GeV$

$|\eta(D^*)| < 1.5$

visible x-section:

$\sigma(ep \to e D^* X) = (8.50 \pm 0.42\ ^{+1.02}_{-0.76} \pm 0.65)\ nb$

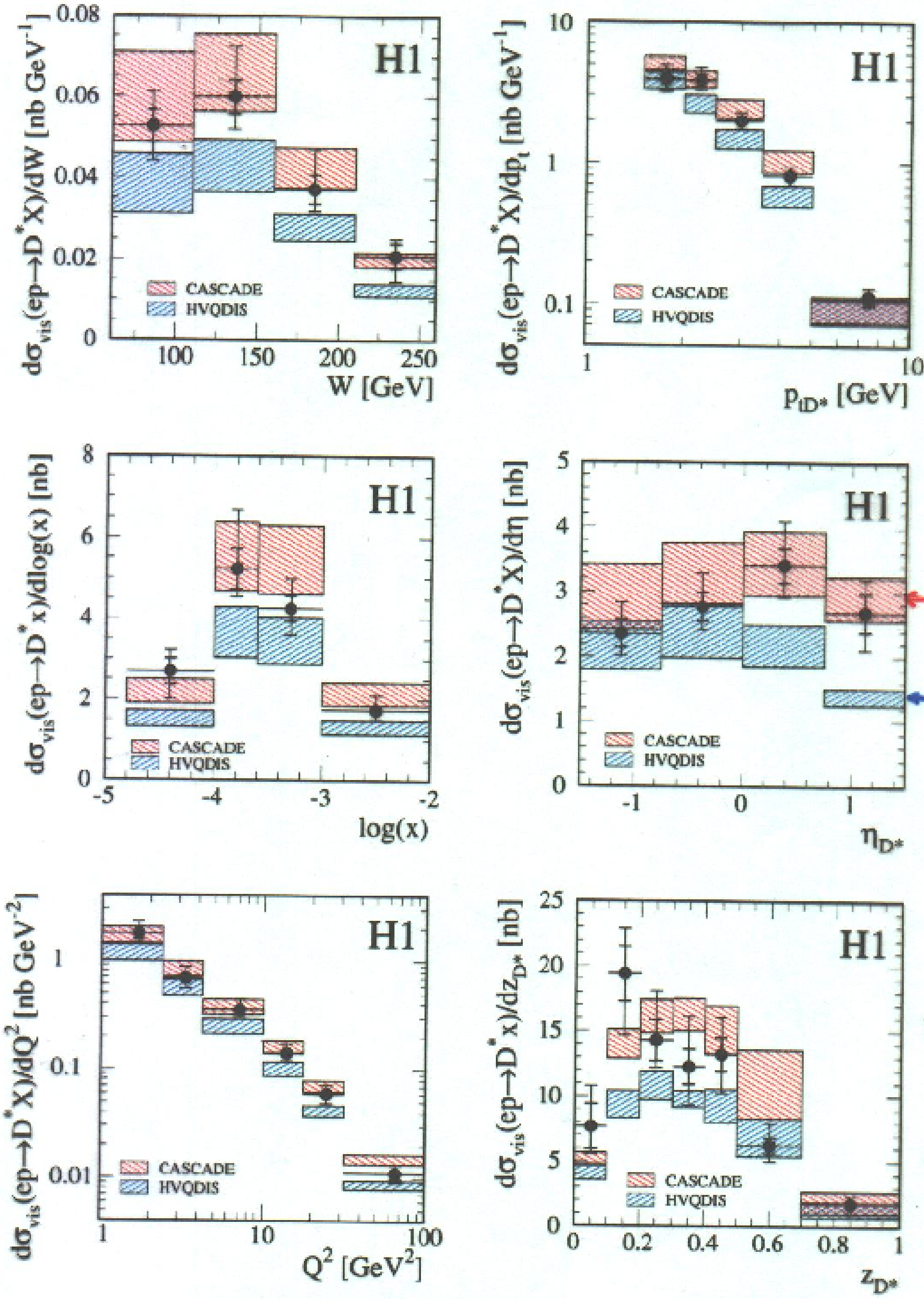
statistical error — systematic error (experimental) — model uncertainties

HVQDIS (NLO DGLAP): $5.17\ nb \left(\begin{matrix} m_c = 1.5\ GeV \\ \epsilon_c = 0.1 \end{matrix}\right) \cdots 7.02\ nb \left(\begin{matrix} m_c = 1.3\ GeV \\ \epsilon_c = 0.035 \end{matrix}\right)$

CASCADE (CCFM): $8.04\ nb \cdots 10.77\ nb$

Differential x-sections

S. Mohrdieck



← CASCADE

← HVQDIS

$z_D = \frac{P \cdot p_D}{P \cdot q}$

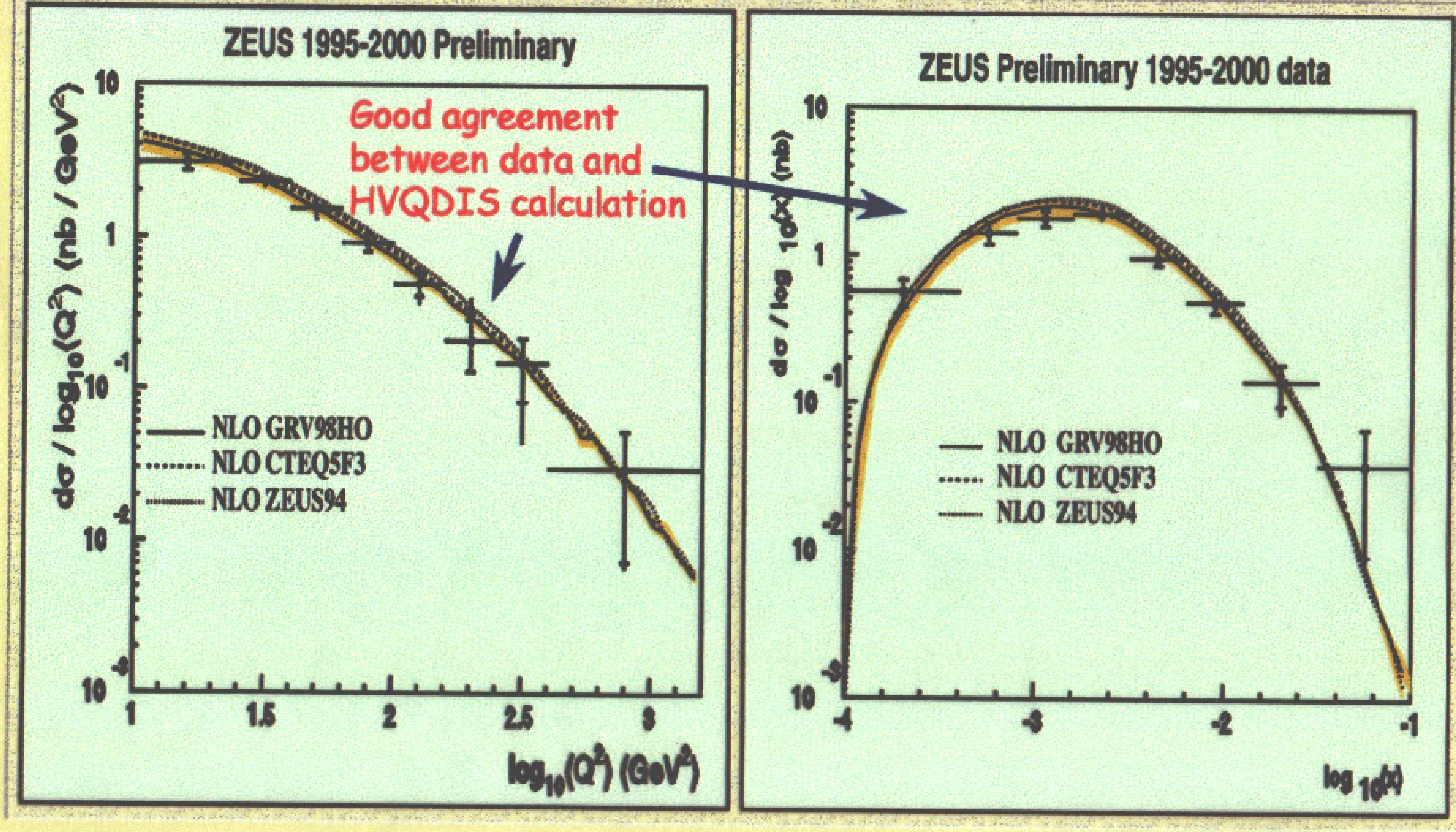
inelasticity

HVQDIS (NLO DGLAP): + shapes reasonable in agreement besides η : excess at large η
$\hat{=}$ excess at small z_D

CASCADE (CCFM): + agreement in shapes and normalization

S. Schagen

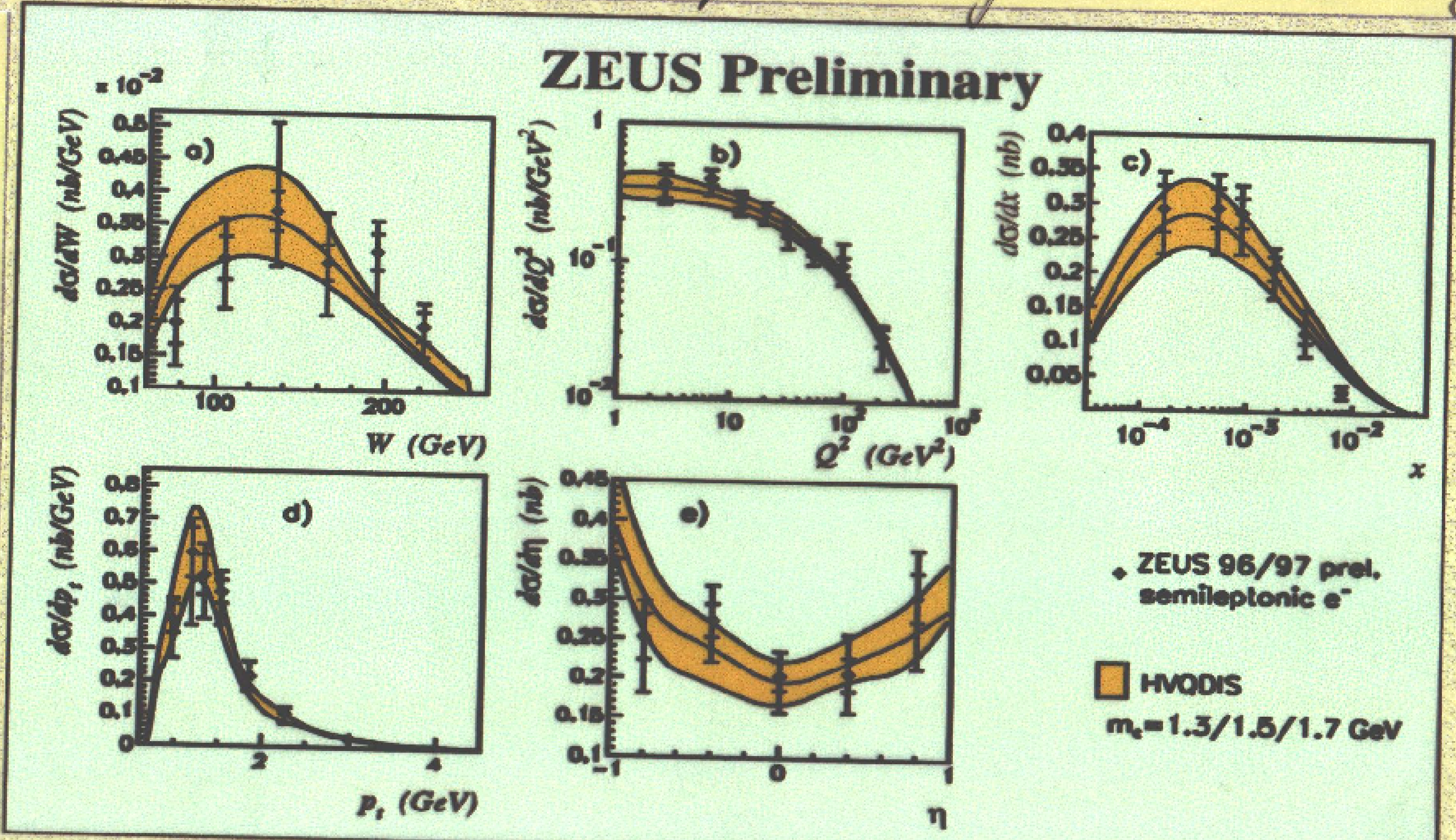
D* DIFFERENTIAL CROSS SECTIONS



S. Schagen

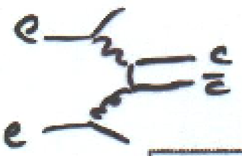
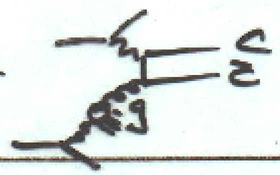
DIFFERENTIAL CROSS SECTIONS

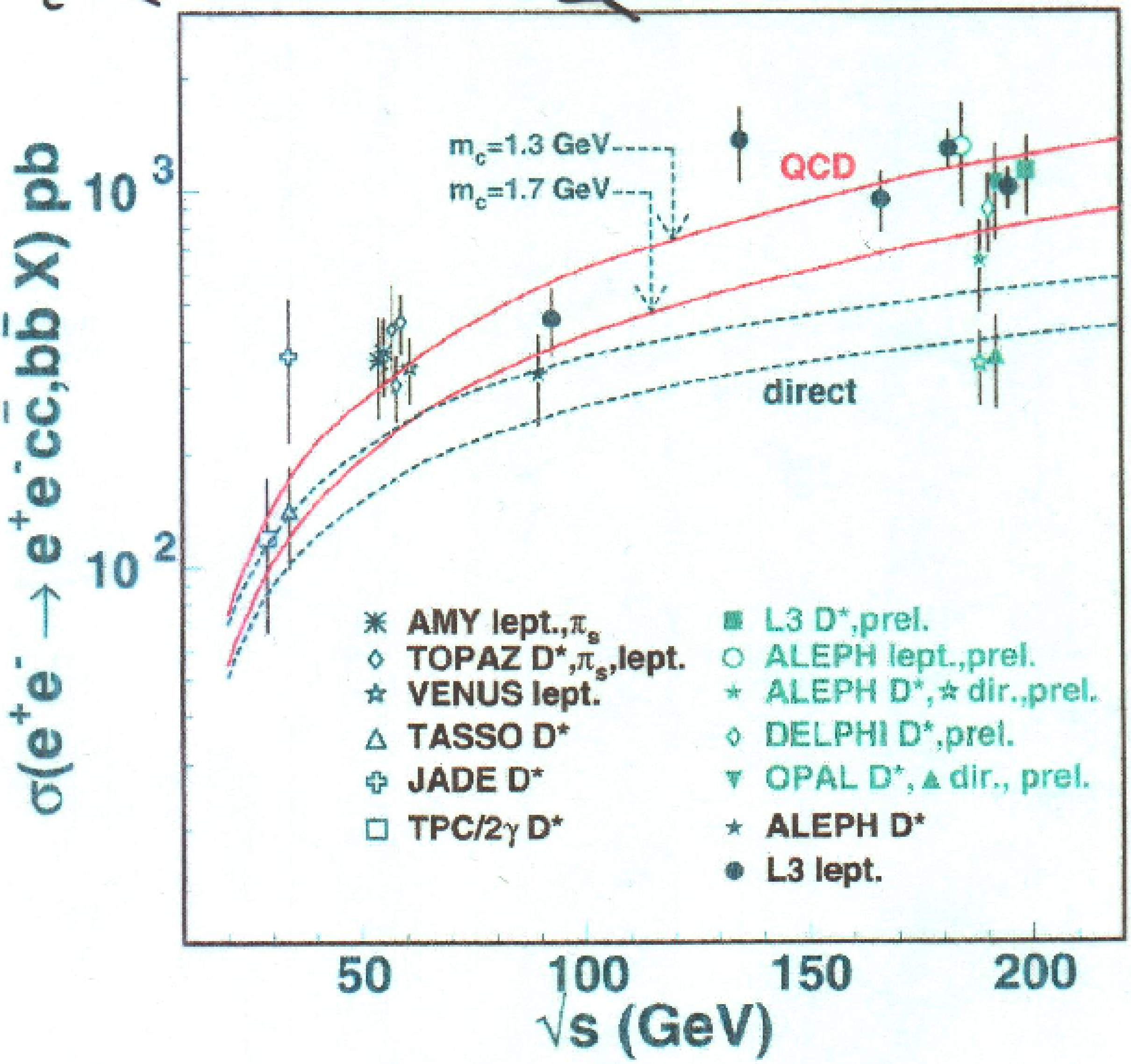
Semileptonic charm decays. Good agreement with D^* analys.



D*, leptons LEP II S. VLACHOS

$\sigma(e^+e^- \rightarrow e^+e^- c\bar{c}X)$

direct 
resolved 

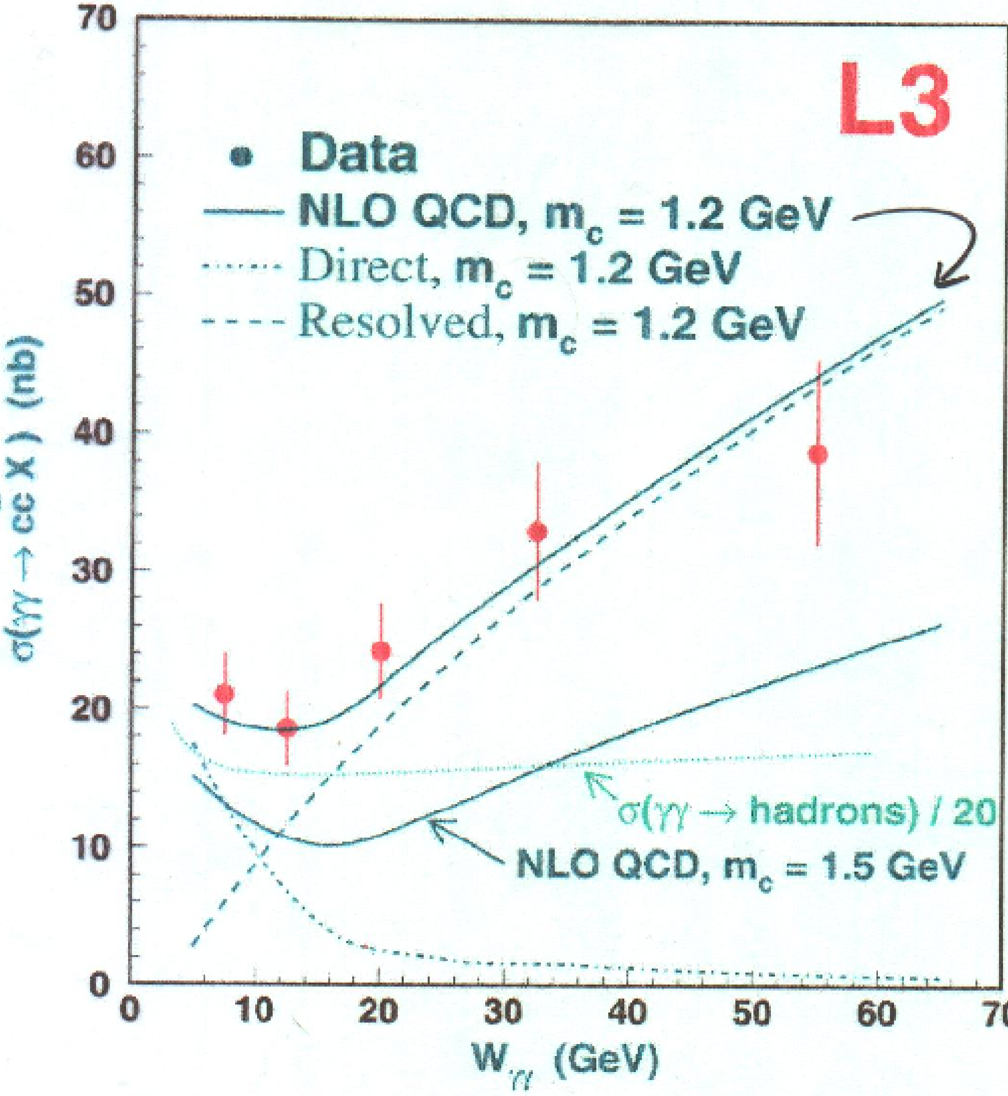


Evidence for gluon content of photon

Theory prediction from:
M. Dress et al., Phys. Lett. B 306 (1993) 371.

S. VLACHOS

$\sigma(\gamma\gamma \rightarrow c\bar{c})$ vs $W_{\gamma\gamma}$



Fit with : $\sigma = As^{\varepsilon} + Bs^{-\eta}$

$\varepsilon = 0.400 \pm 0.03$ (stat.) ± 0.07 (syst.)

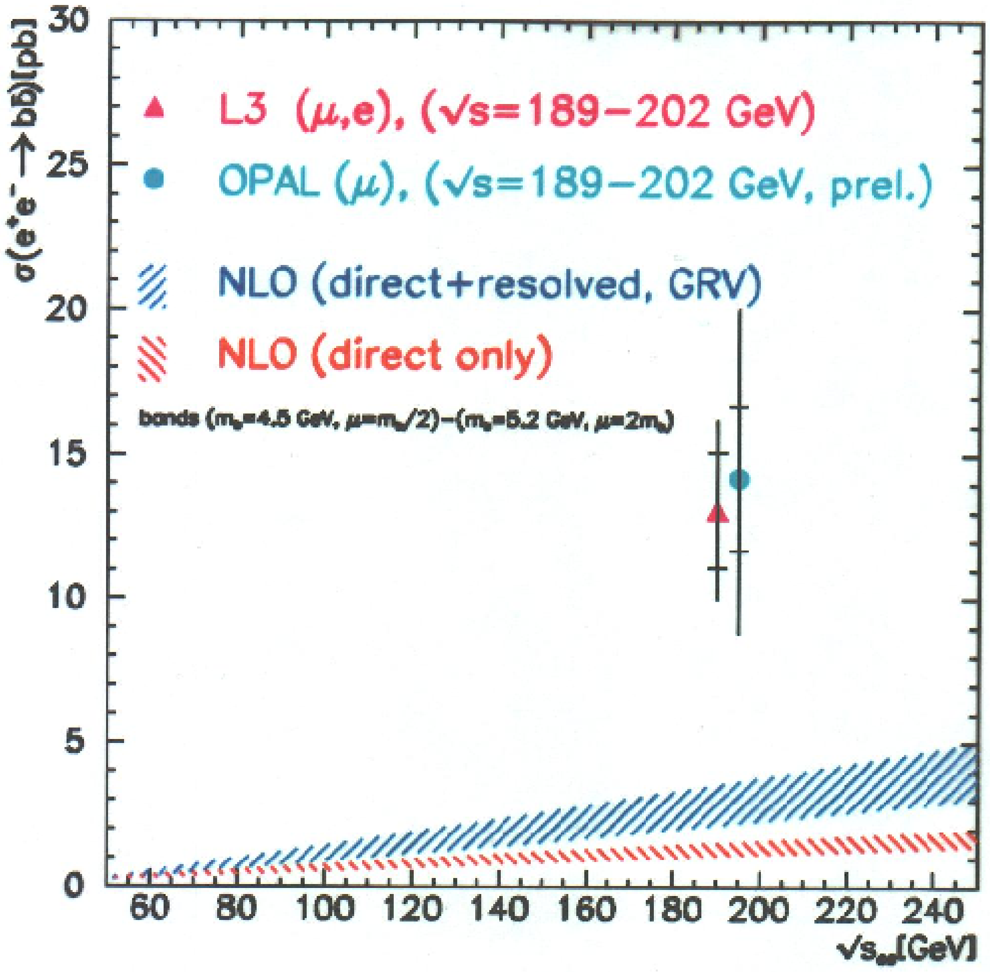
L3: CERN-EP/2000-155

$\gamma\gamma \to b X$ A. Böhrer

LEP II

L3, OPAL

Inclusive Bottom Cross Section

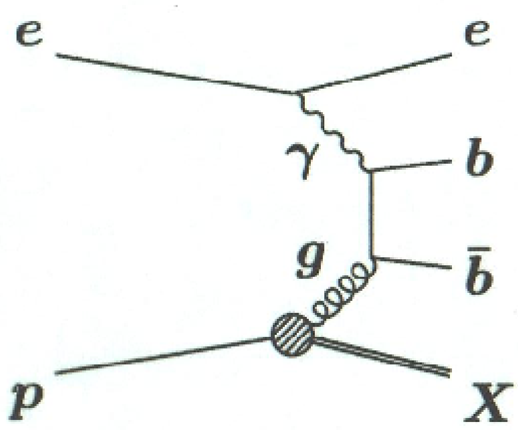


models to low: factors 3; 2 to 3.5σ!

2 independent measurement; though same methods (leptons)

Kroseberg

Production of Open Beauty at HERA (H1, ZEUS)



- necessary ingredient to **understand proton structure**
- b mass provides hard scale, i.e. good **testing ground for pQCD**

QCD calculations available in NLO
$p_t \approx m_b \rightarrow$ **'massive' approach**
(b produced dynamically in hard subprocess)

- γp: **'FMNR'** (Frixione et al.)
- **DIS: 'HVQDIS'** (Harris, Smith)

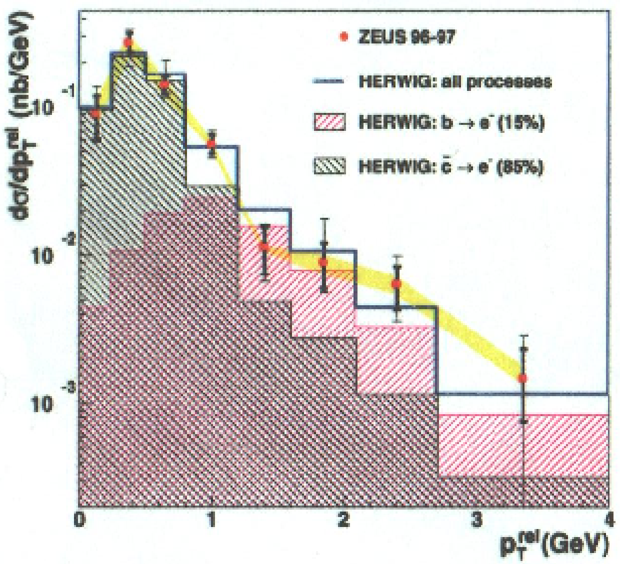
NLO corrections large in both cases

Kroseberg

Open Beauty at HERA(I) : Photoproduction Cross Sections

new data and new methods $\rightarrow$ **γp results confirmed and improved**

ZEUS: electron p_t^{rel} analysis



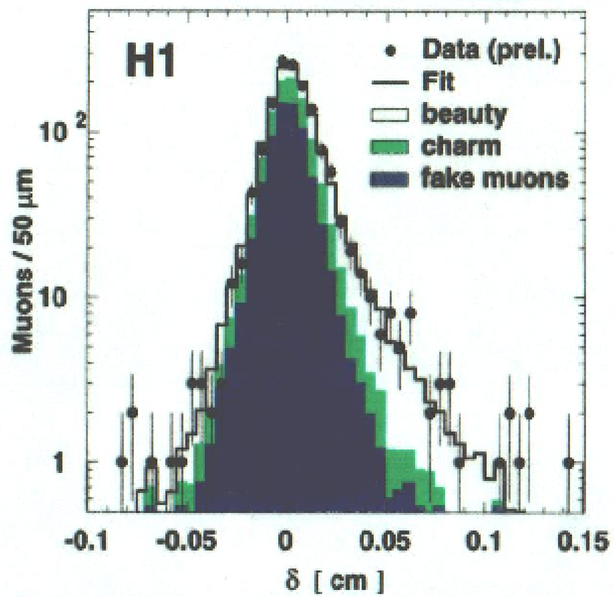
parton level cross section

$\sigma_{ep\rightarrow e^+bX} = (1.6 \pm 0.4\ ^{+0.3}_{-0.5}\ ^{+0.2}_{-0.4})$ nb

[NLO QCD: $\sigma = (0.64 \pm\ ^{+0.14}_{-0.10})$ **nb]**

$p_T^b > 5$ GeV

H1: muon lifetime + p_t^{rel} analysis



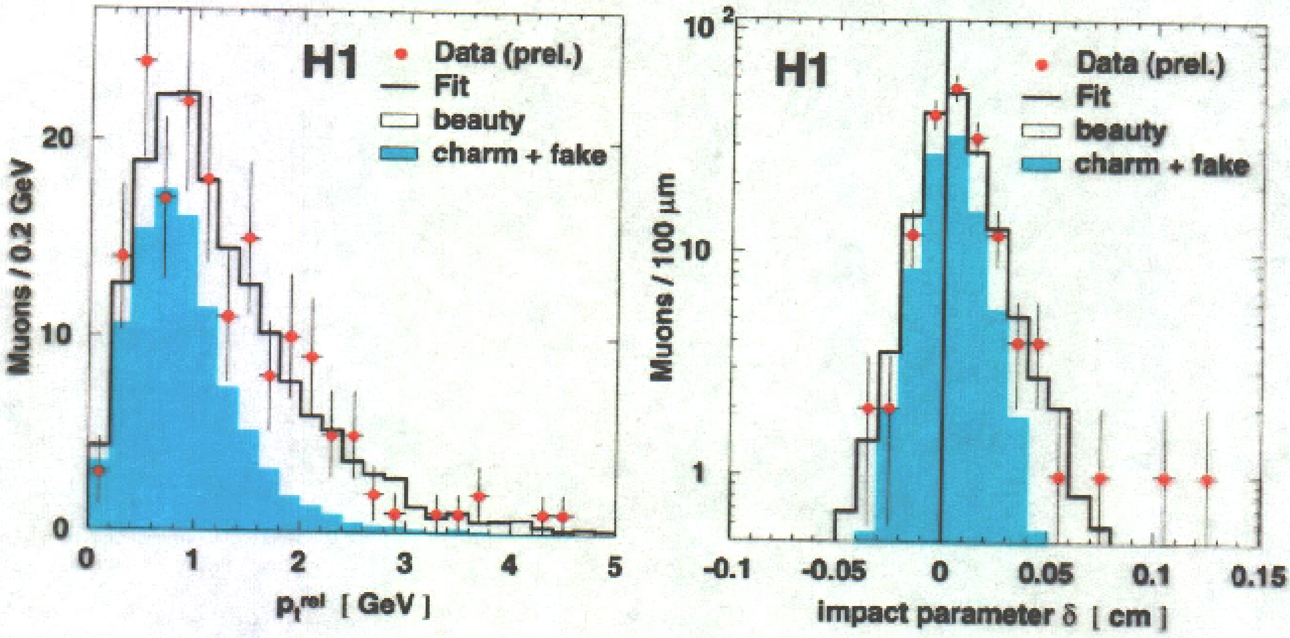
visible cross section (comb. with publ. result)

$\sigma_{vis}^{ep\rightarrow b\bar{b}X\rightarrow \mu X'} = (170 \pm 25)$ pb

[NLO QCD: $\sigma = (104 \pm 17)$ pb **]**

Open Beauty at HERA (II)

- **first measurement in DIS:**



$ep \rightarrow b\bar{b}eX \rightarrow \mu X'$ **cross section in visible range:**

$$\sigma_{vis} = [39 \pm 8\,(stat.) \pm 10\,(syst.)\,]\ \mathrm{pb}$$

NLO QCD: $\sigma = (11 \pm 2)$ pb

- **all measured cross sections above NLO QCD**

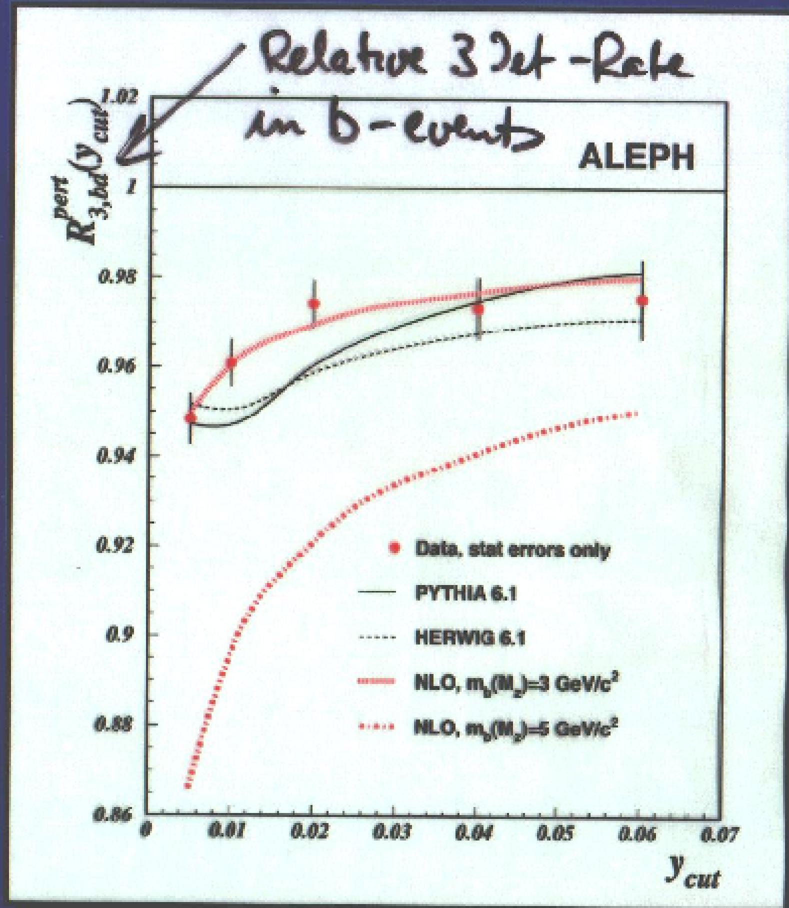
→ discrepancy theory ↔ data further established

→ now seen in ep, γp, $\gamma\gamma$ and $p\bar{p}$ interactions

ALEPH results

$$R^{b-all}(O) = O_b/O_{all} \rightarrow R^{b\ell}(O)$$

- O: R_3 (Durham), T_1, T_2, C_1, C_2, y_{3_1}, y_{3_2}, B_{T_1}, B_{T_2}, B_{W_1}, B_{W_2}.
- Requirements for O: Small NLO and hadronization corrections with respect to the mass effect and uncertainty at the 1% level ⇒ Only R_3 and y_{3_1}.
- y_{3_1} gives the smallest hadronization correction and systematic uncertainties ⇒ it is the one used.

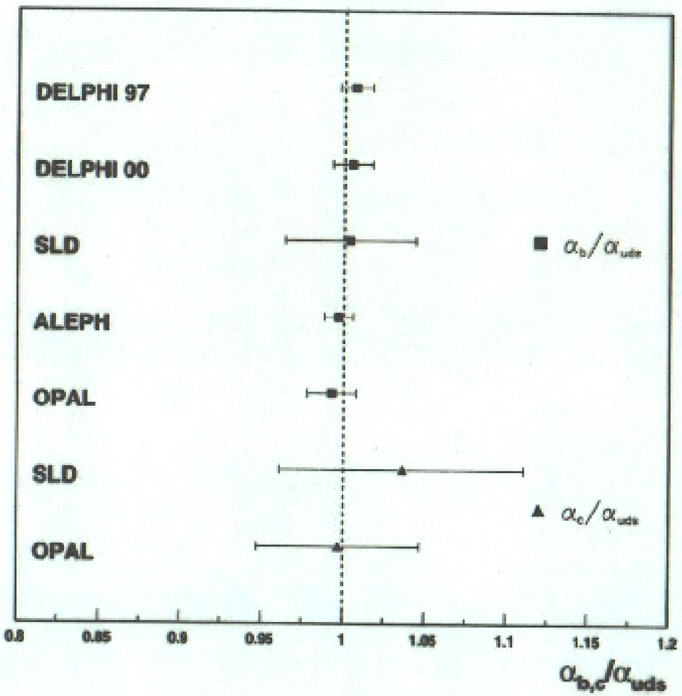


$$m_b(M_Z) = 3.27 \pm 0.22(stat) \pm 0.22(exp) \pm 0.38(had) \pm 0.16(theo)$$
$$\alpha_s^b/\alpha_s^{uds} = 0.997 \pm 0.004(stat) \pm 0.004(exp) \pm 0.007(had) \pm 0.003(theo)$$

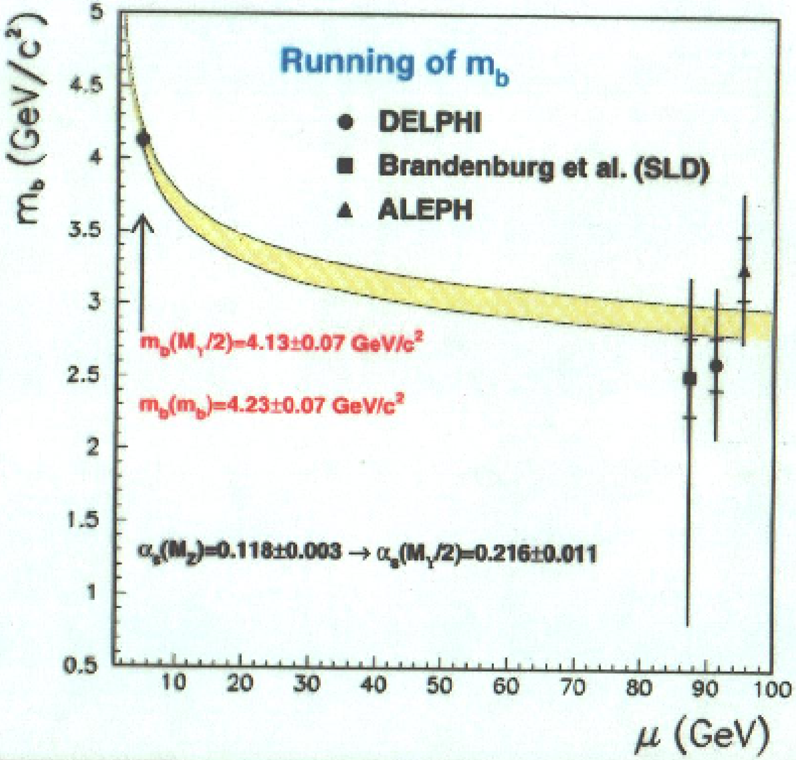
Costa

Summary

α_s universality



$m_b(M_Z)$ running

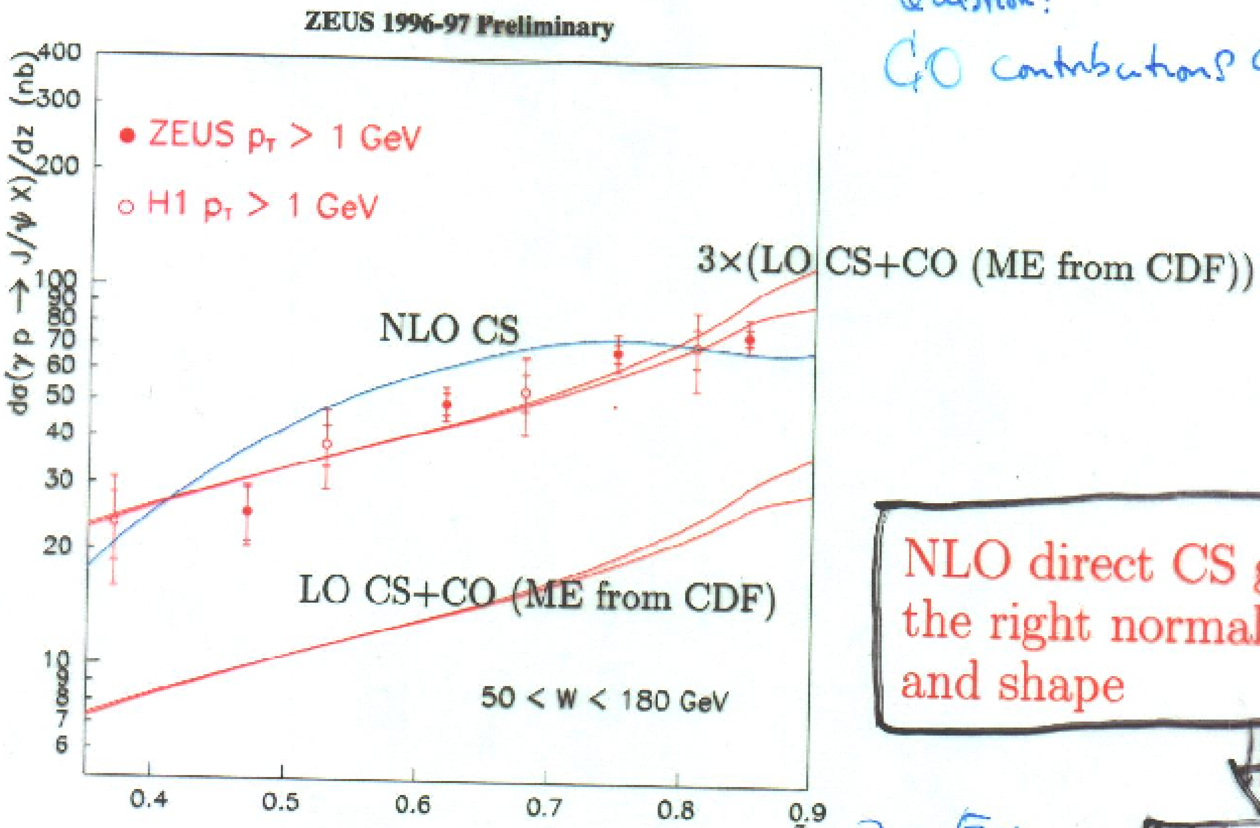


Inelastic J/ψ at HERA

R. Brugnera

▶ z distribution

Question: CO contributions?

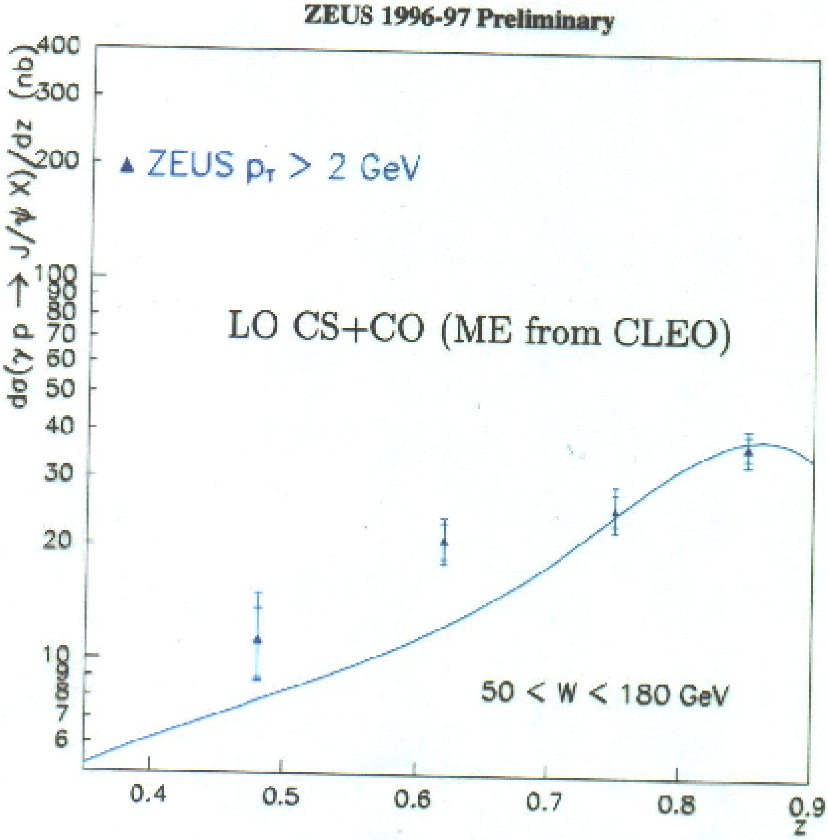


NLO direct CS gives the right normalization and shape

⇓

No need for CO

$z = \frac{E_\psi}{E_\gamma}$



theory (LO CS+CO calculation with ME from CLEO) in agreement with data doing a high pt cut

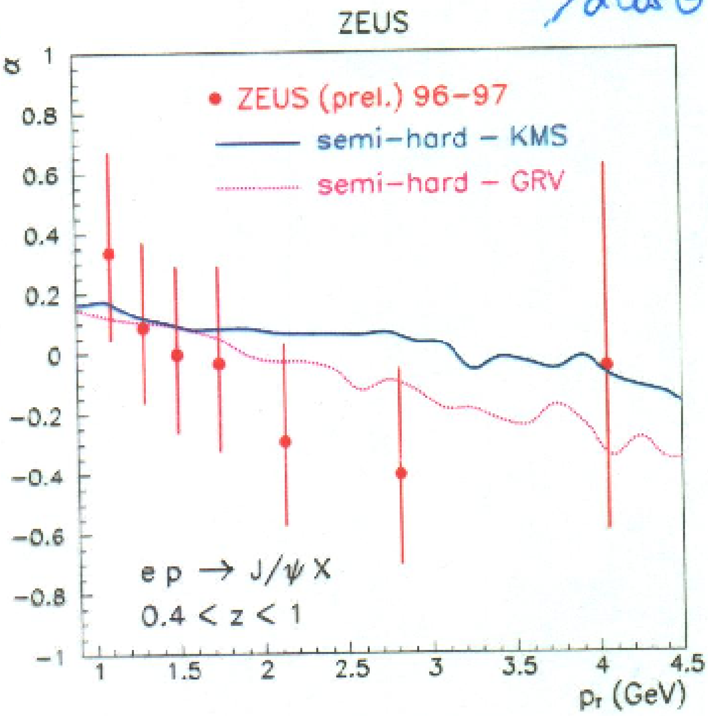
No k-factor!

SP

R. Brugnera

helicity distribution

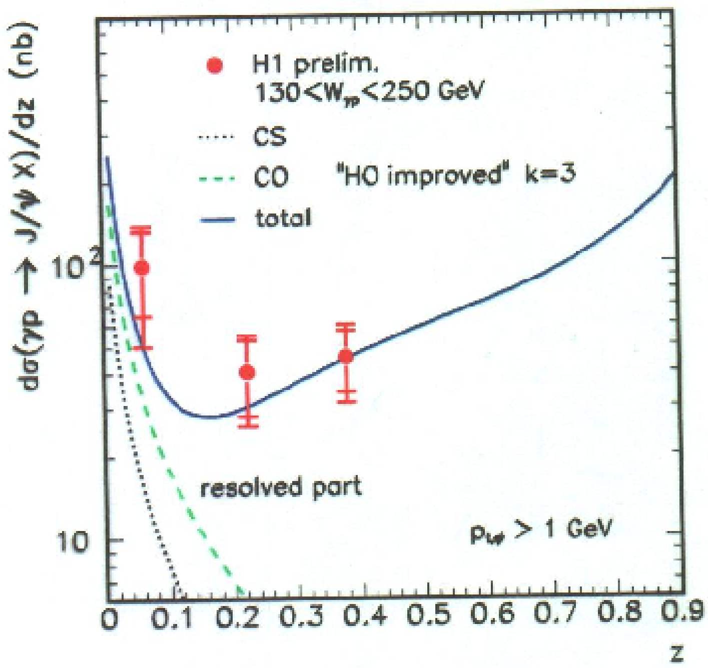
$dN/d\cos\theta^* \propto 1 + \alpha^2 \cos\theta^*$



The helicity distributions may be sensitive to the underlying production mechanism (singlet vs. octet)

Only CS calc. available
Waiting for CS+CO calc.

low z region



colour singlet + octet with CDF octet matrix elements undershoots data but shape is fine

sensitive to the resolved singlet + octet component

and $\frac{\sigma_{\psi'}}{\sigma_{\psi}} \approx 20\%$ as expected

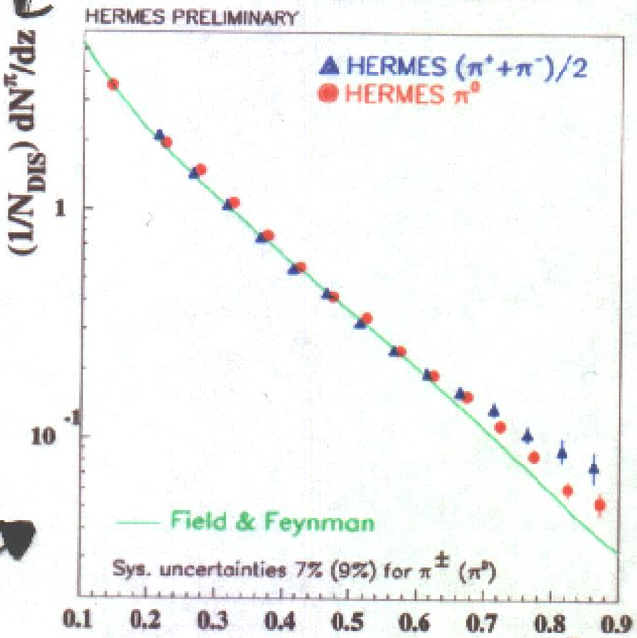
JF

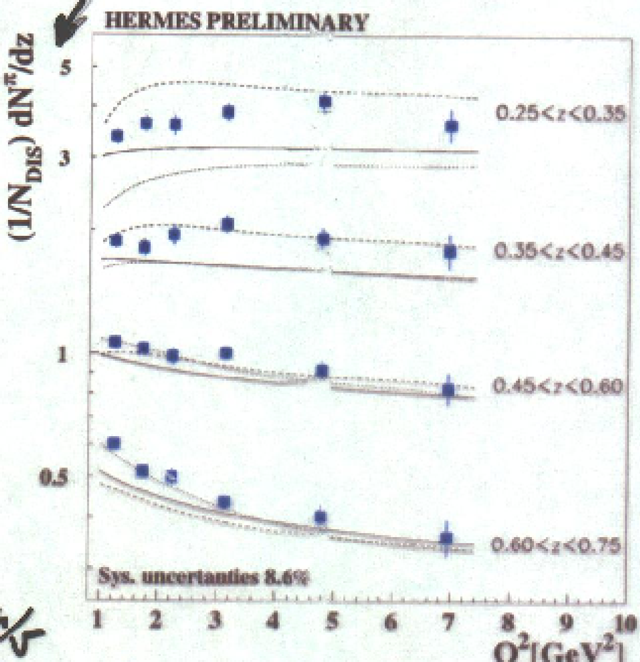
Hadronic Final States and Jets

$ep \to eX$ (Di Nezza

Pion multiplicities and $< P_\perp >$

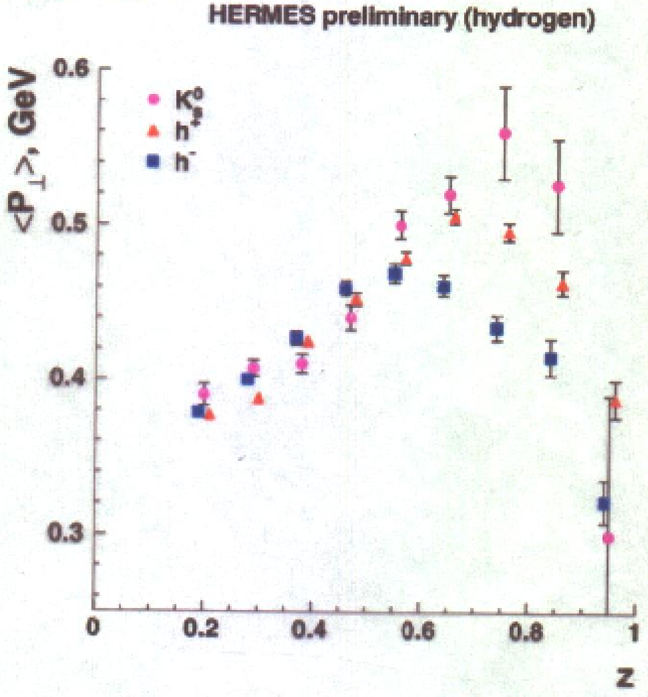
Pasquale Di Nezza for the HERMES collaboration





Charged and neutral pion multiplicities have been measured with high statistical and systematical accuracy:

- isospin violation at high z due to a possible contribution of Higher-Twist terms and exclusive channels;
- clear scaling violation of the Fragmentation Functions, good agreement with theoretical models (BKK, KKP) tuned at very high Q^2.



The difference of $< P_\perp >$ in the fragmentation process suggests the hypothesis that the internal transverse momenta is flavour dependent. (u, d)

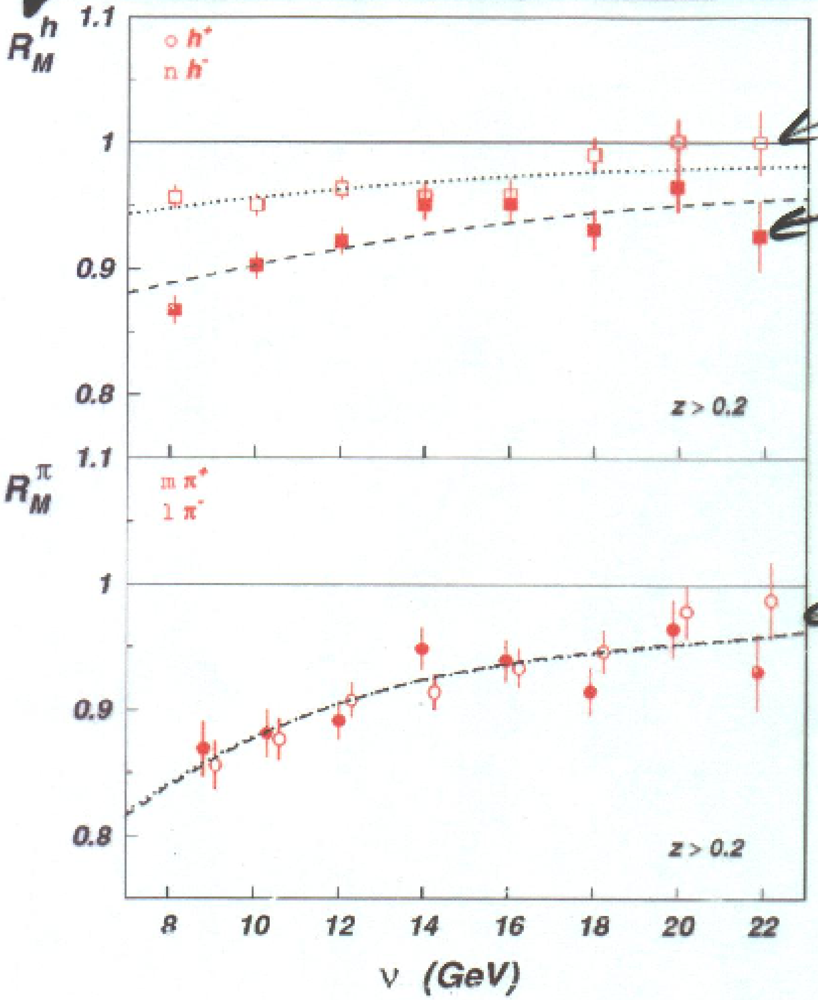
h^+, h^-

V. Muccifore

Attenuation Ratio *vs* ν for + and − charge

$\frac{^{14}N}{D}$

$ep \to ehX$



- $h^+(\pi^+, K^+, p) \Leftrightarrow h^-(\pi^-, K^-, \bar{p})$: for the first time a possible dependence on the m_h. Protons seem to be less attenuated $\Rightarrow$ longer τ_f.
- No significant difference between π^+ and π^- $\Rightarrow$ formation time is charge-independent.

	τ_f [fm/(GeV·c)]
h^+	3.49 ± 0.51
h^-	1.32 ± 0.16
π^+	1.37 ± 0.18
π^-	1.38 ± 0.21

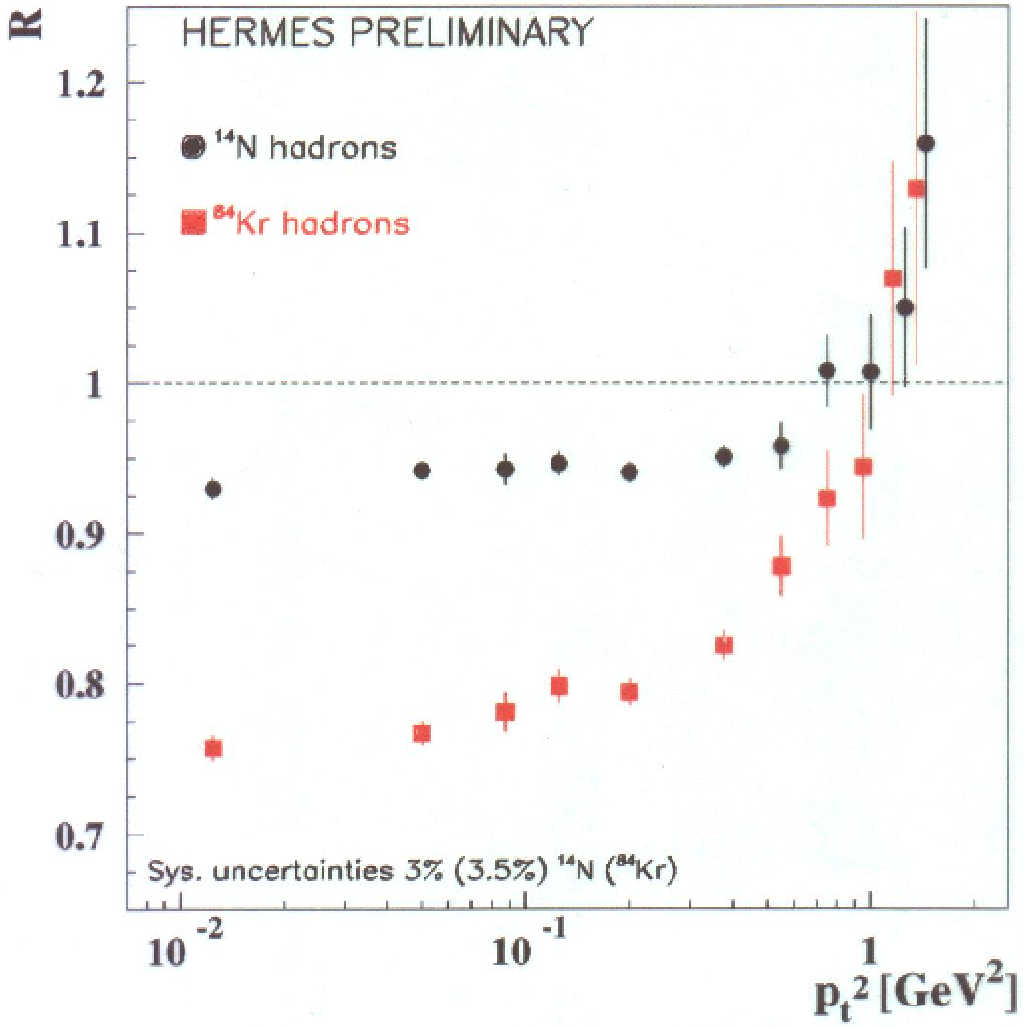
Submitted to Eur. Phys. Jour. C; hep-ex/0012049

V. Muccifora

INFN Frascati

Attenuation Ratio vs p_t^2

In the lepton nucleon scattering neither multiple scattering of the incident particle nor interaction of its constituents complicate the interpretation.



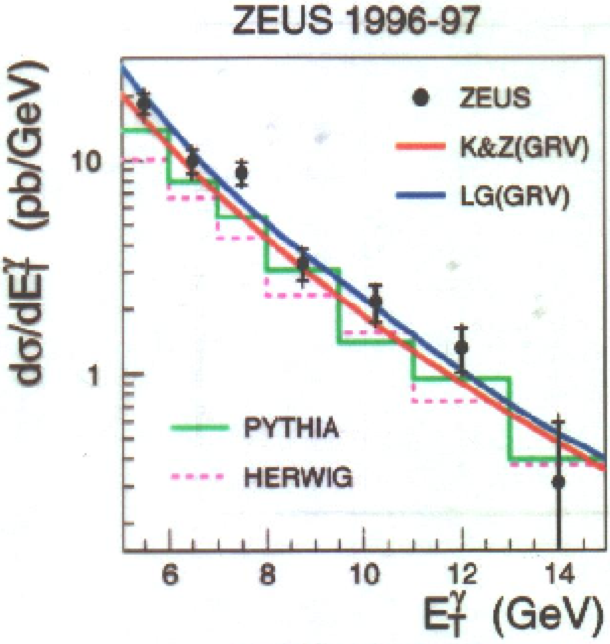
The p_t enhancement is similar to that observed in hadron nucleus scattering but is smaller in magnitude

The ${p_t}^2$ enhancement supports the hypothesis of the rescattering of either hadrons and quarks in the final state (Cronin effect).

P. Bussey

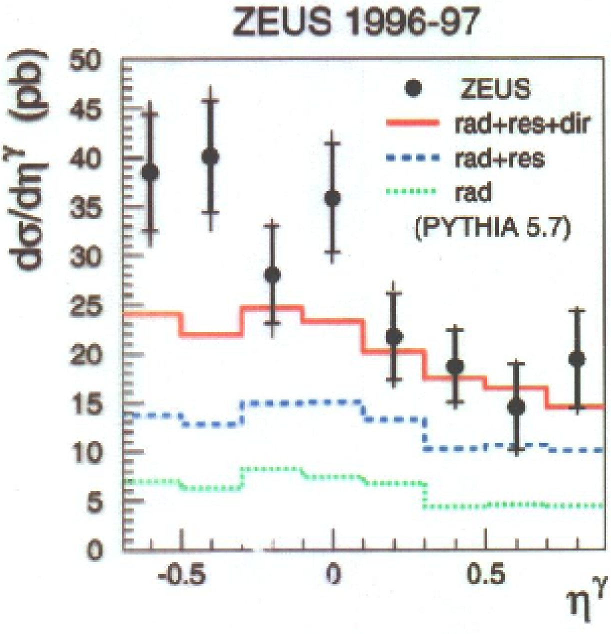
INCLUSIVE PROMPT PHOTONS

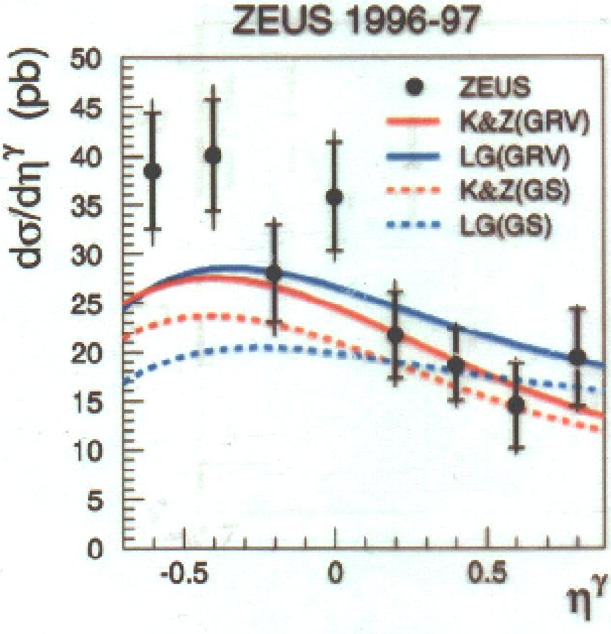
$E_T > 5$ **GeV**, $134 < W < 285$ **GeV** **PLB 472 (2000) 175**



Photoproduction at HERA

ZEUS





PYTHIA does only fairly well (HERWIG is lower).
NLO calculations an improvement.
GRV photon structure apparently favoured.
Signs of a discrepancy?

P. Bussey

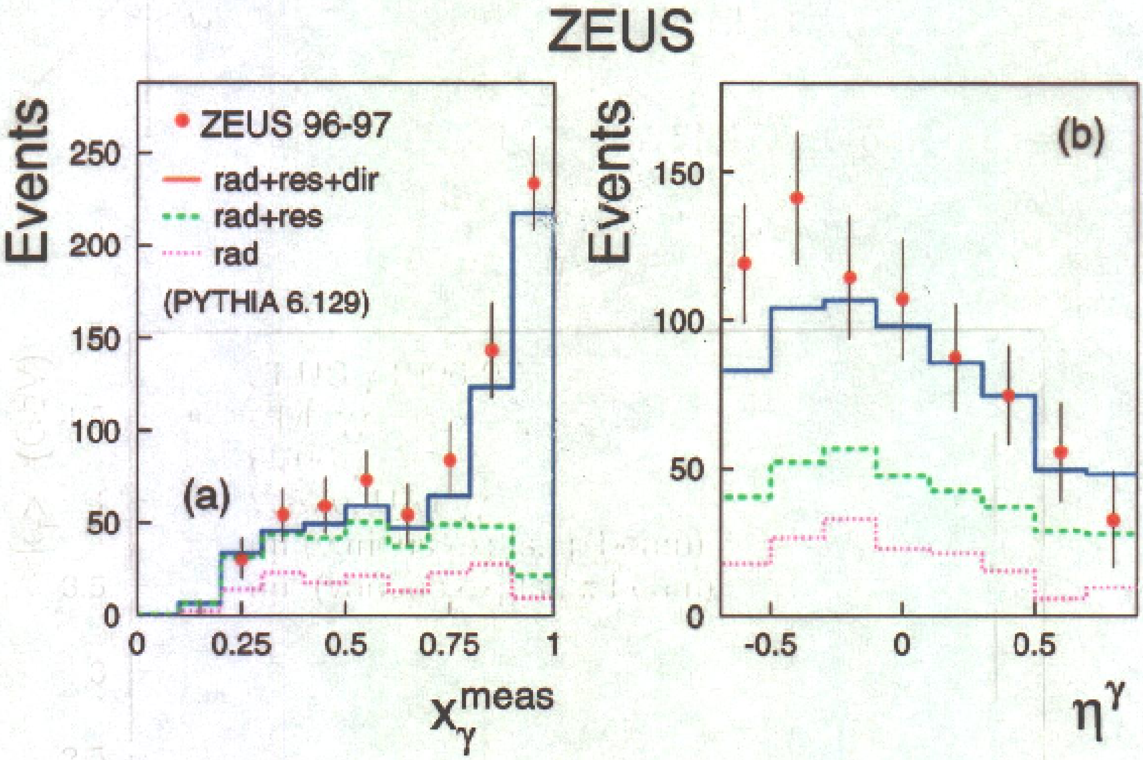
ZEUS: PROMPT PHOTON + JET in γp

Select: photon: $E_T > 5$ **GeV,** $-0.7 < \eta < 0.9$

jet: $E_T > 5$ **GeV,** $-1.5 < \eta < 1.8$

$0.2 < y_{JB} < 0.7$

Jet finder: KTCLUS



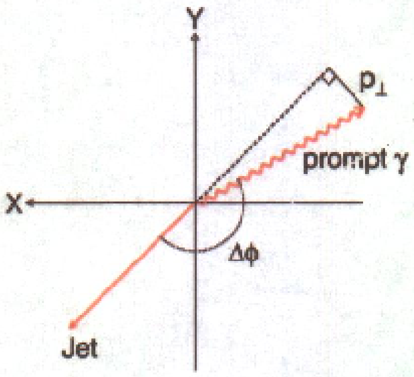
Prominent peak near $x_\gamma = 1$ corresponding to Direct Compton process $\gamma q \to \gamma q$.

PYTHIA OK! – differences are compatible with LO→NLO.

Select a highly direct-enhanced sample by requiring $x_\gamma^{meas} > 0.9$ to minimise effects of photon structure.

$<k_T>$ OF PARTONS IN PROTON

Use direct γ + jet kinematics to determine $<k_T>$



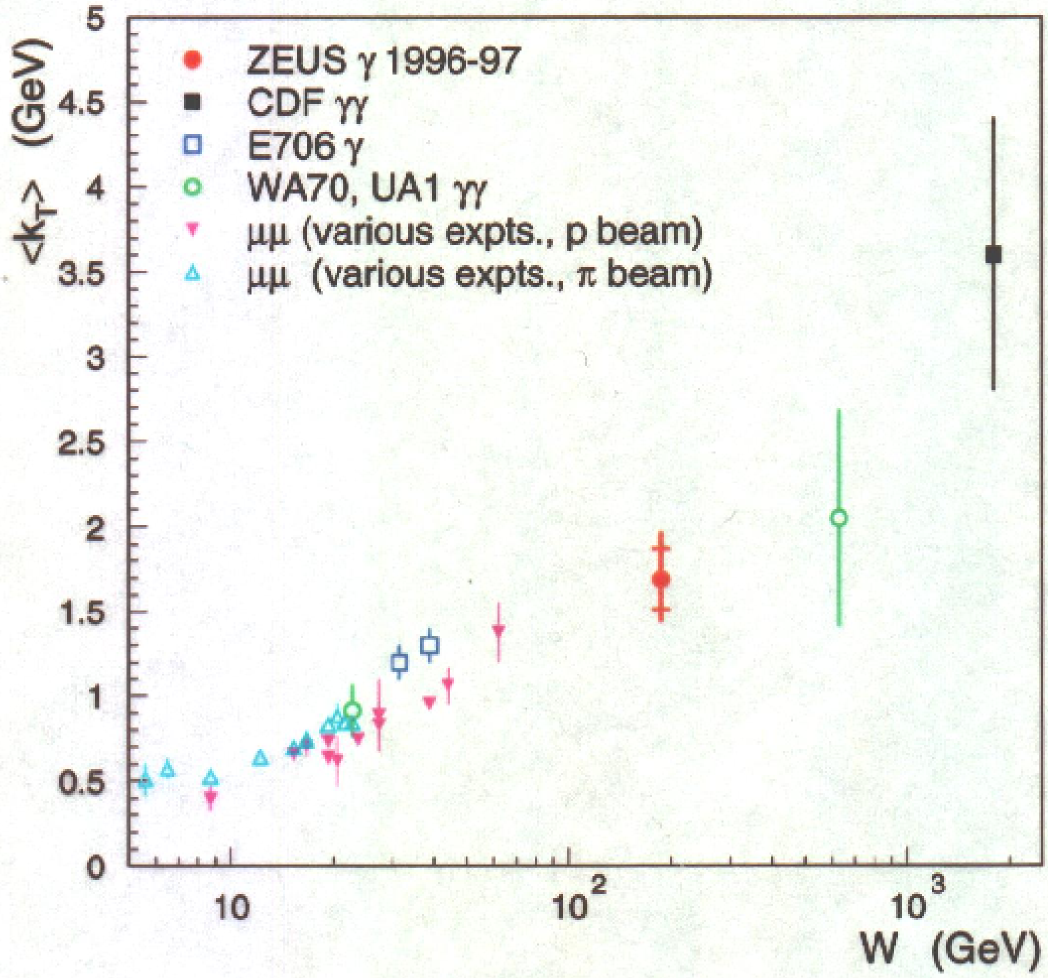
– Use direct-enhanced sample to minimise sensitivity to resolved photon

– Vary 'intrinsic' contribution k_0 in PYTHIA.

– Fit $p_\perp$ distribution using series of k_0 values

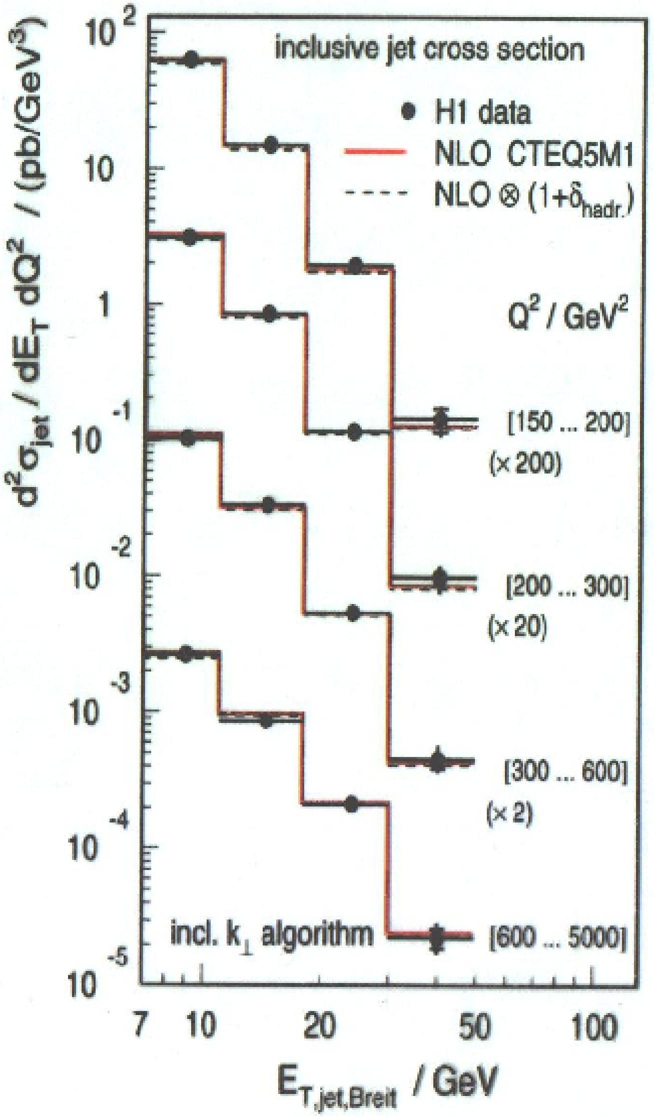
– Use PYTHIA at parton level to incorporate parton shower effects

$$< k_T >= 1.69 \pm 0.18\ ^{+0.18}_{-0.20}\ \text{GeV}$$



Inclusive Double Differential Jet Cross Sections

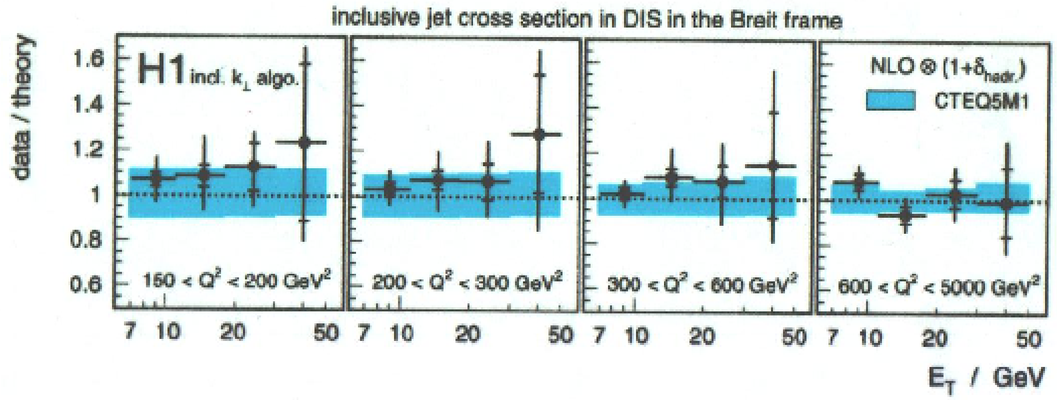
$\sigma_{\text{jet}}(Q^2, E_T)$



H1

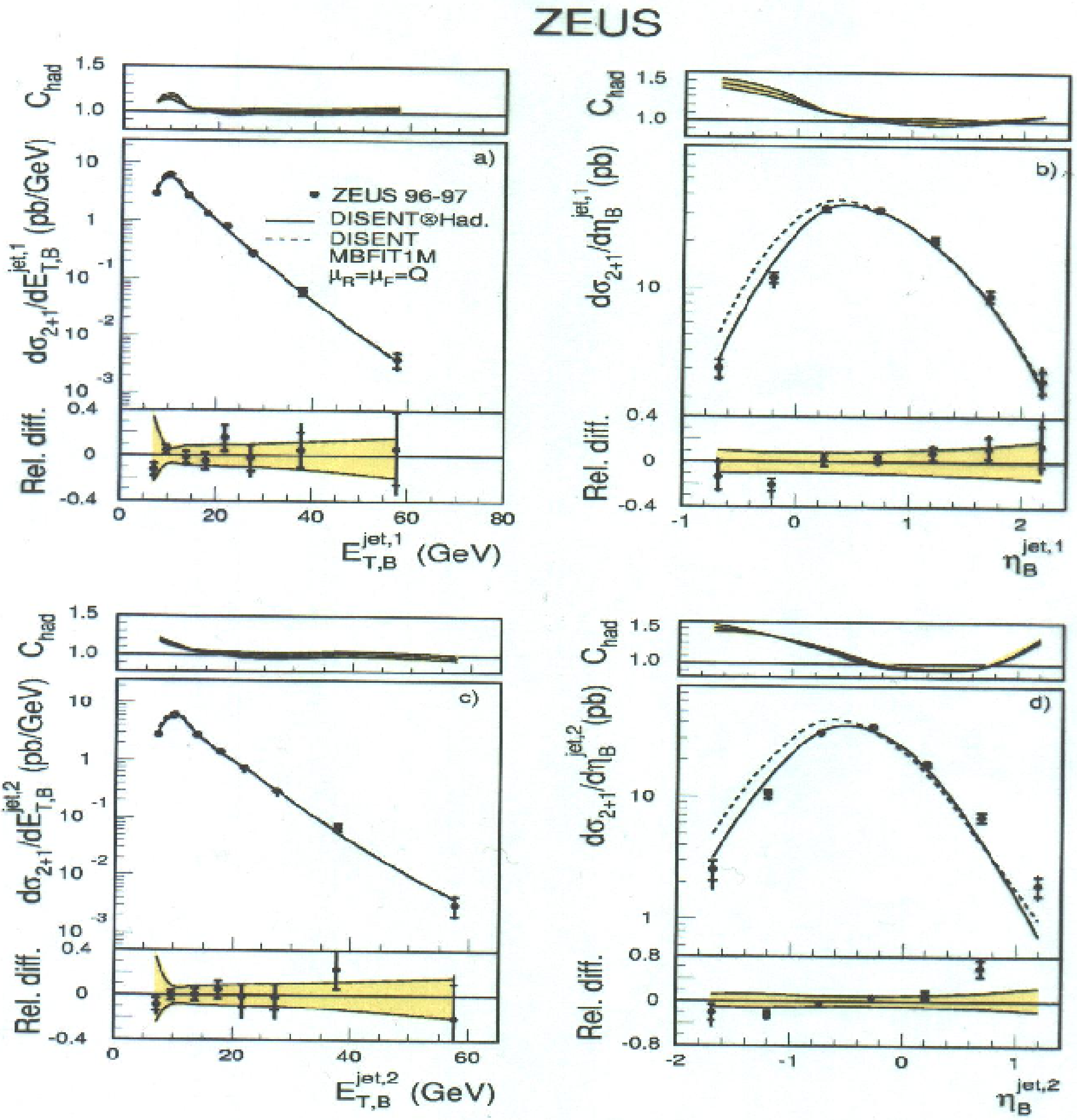
Jets in DIS at HERA

- $150 < Q^2 < 5000$ GeV^2
- $7 < E_{T,\text{jet, Breit}} < 50$ GeV
- $\mu_r = E_{T;\text{jet, Breit}}$



⇒ Data well described by NLO QCD over whole range in Q^2 and $E_{T,\text{jet, Breit}}$

Dijet cross sections

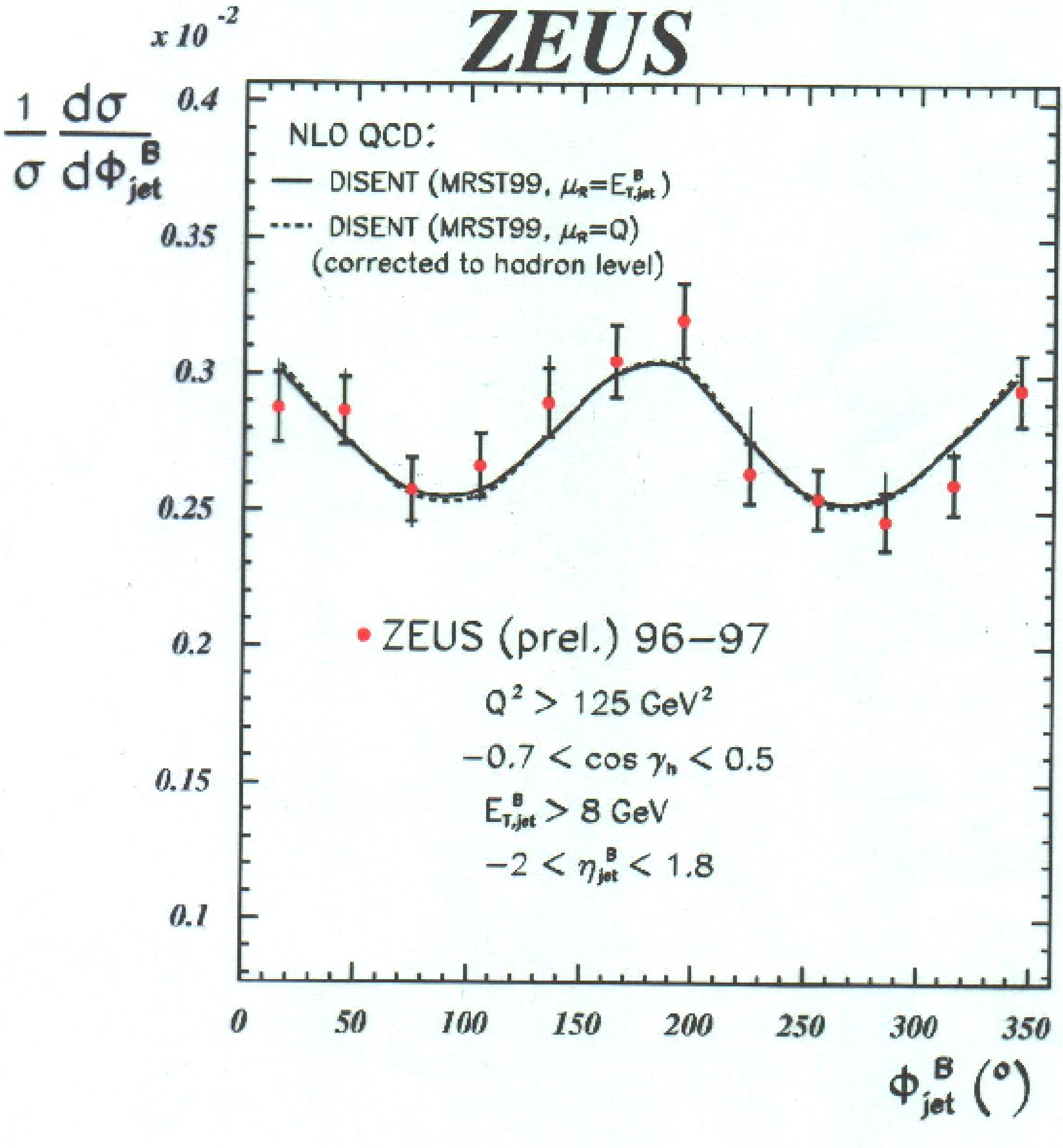


- $E_{T,B}^{\text{jet}}$ ⇒ Well described by NLO pQCD calculations
- η_B^{jet} ⇒ Large hadronisation corrections

Azimuthal asymmetry (incl. jets)

Without an identification of quark/gluon initiated jets QCD predicts:

$$d\sigma/d\phi_B^{\rm jet} \sim A + C cos2\phi$$

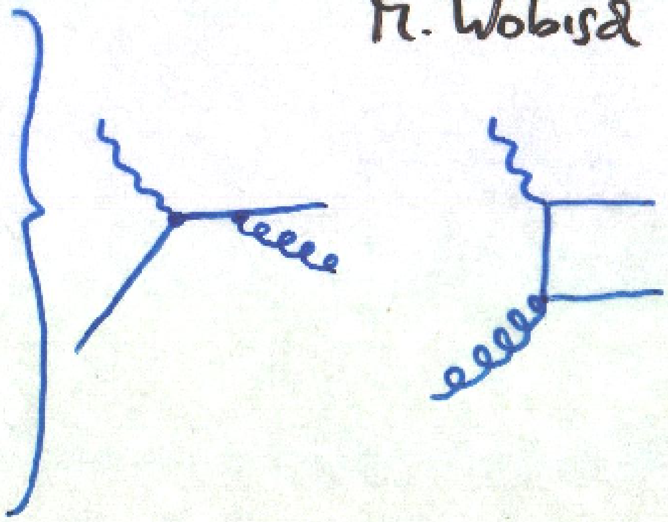


- NLO shape well reproduced by the data
- First observation from a NC DIS jet cross section

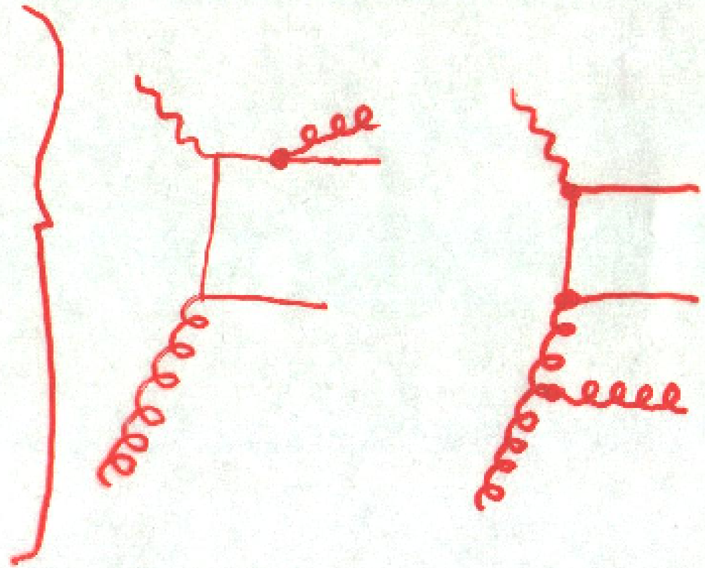
QCD Processes in the Hadronic Final State in DIS

M. Wobisch

- **event shape variables:**
  soft processes $\mathcal{O}(\alpha_s)$
- **inclusive jet and dijet production:**
  hard processes $\mathcal{O}(\alpha_s)$
  $\rightarrow$ determination of α_s and the gluon density



- **internal structure of jets in dijet production:**
  (hard +) soft processes $\mathcal{O}(\alpha_s^2)$
- **three-jet production:**
  hard processes $\mathcal{O}(\alpha_s^2)$
  more degrees of freedom
  QCD tests in greater detail



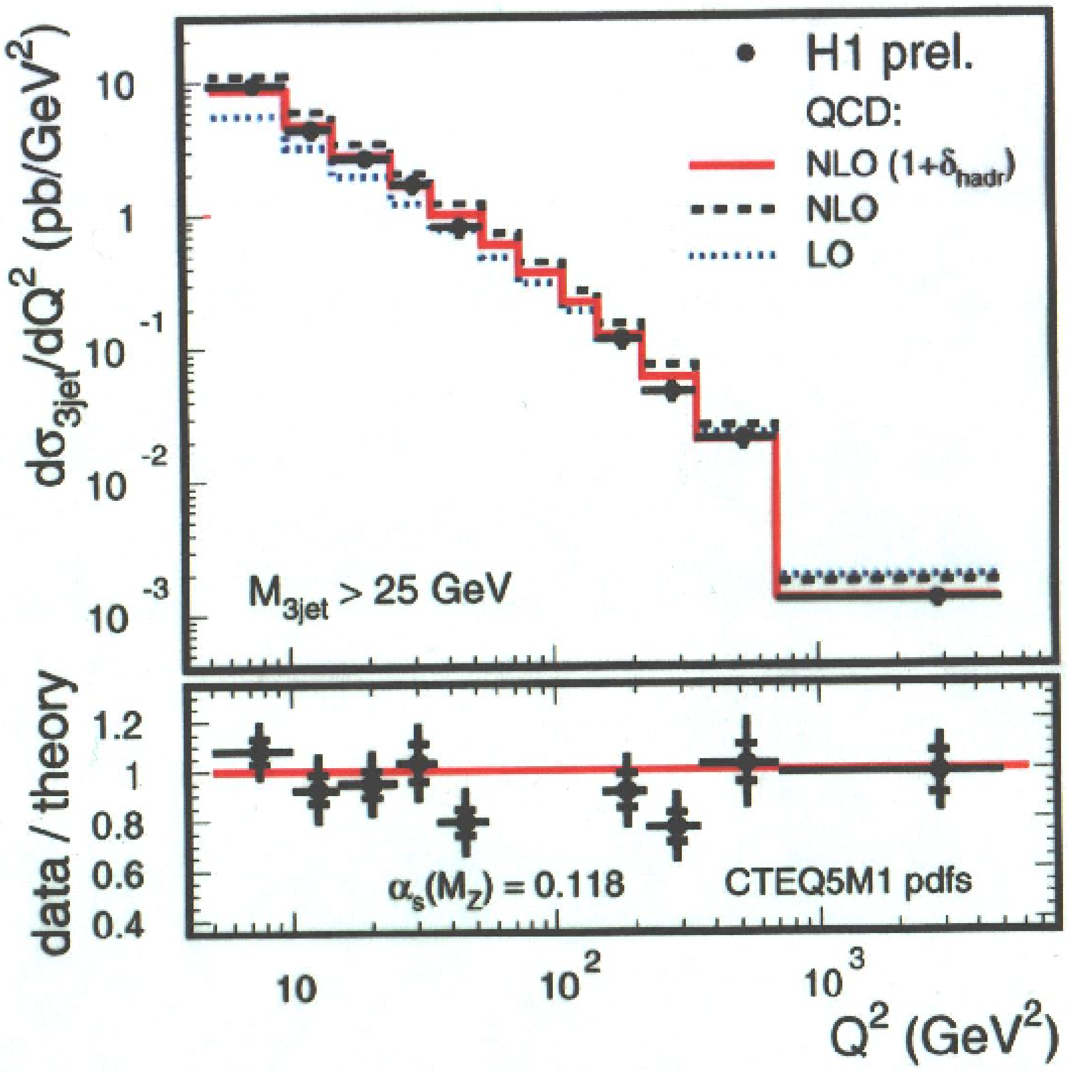
H1: Three-Jet Production in DIS

$\sigma_{3jet} \propto \alpha_s^2$

$\rightarrow$ direct test of $\mathcal{O}(\alpha_s^2)$ matrixelements

$5 < Q^2 < 5000$ GeV^2

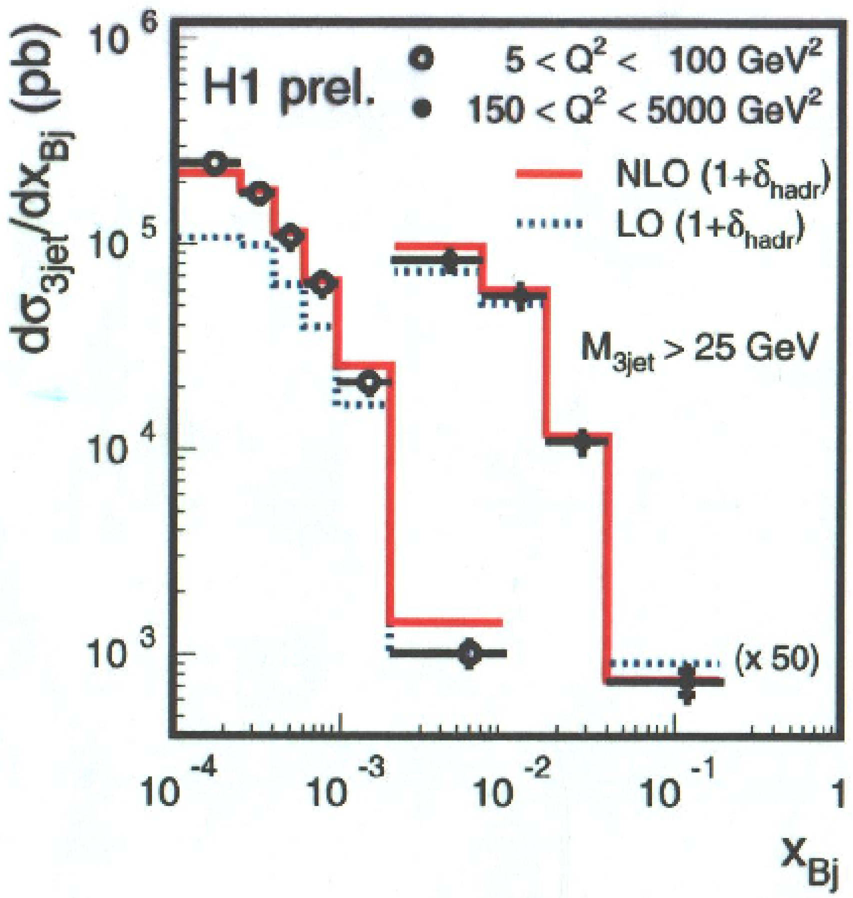
$M_{3jet} > 25$ GeV

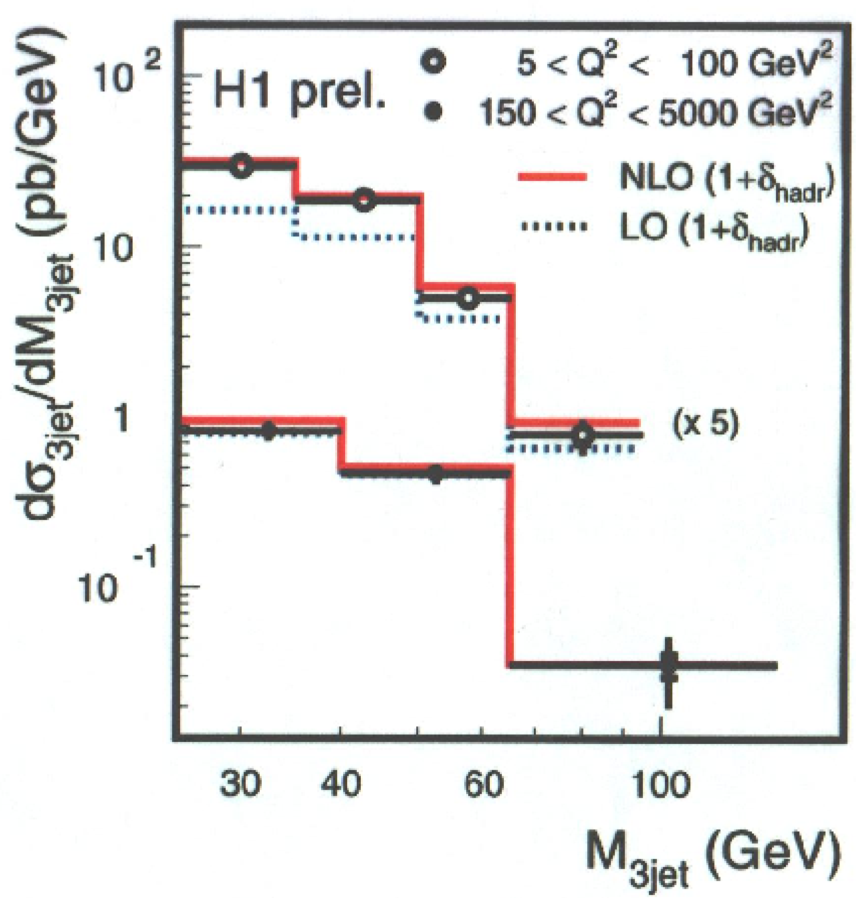


$\Longrightarrow$ **good desription by NLO pQCD over whole Q^2 range**

SF

3-jet cross section: Bjorken-x and invariant 3-jet mass



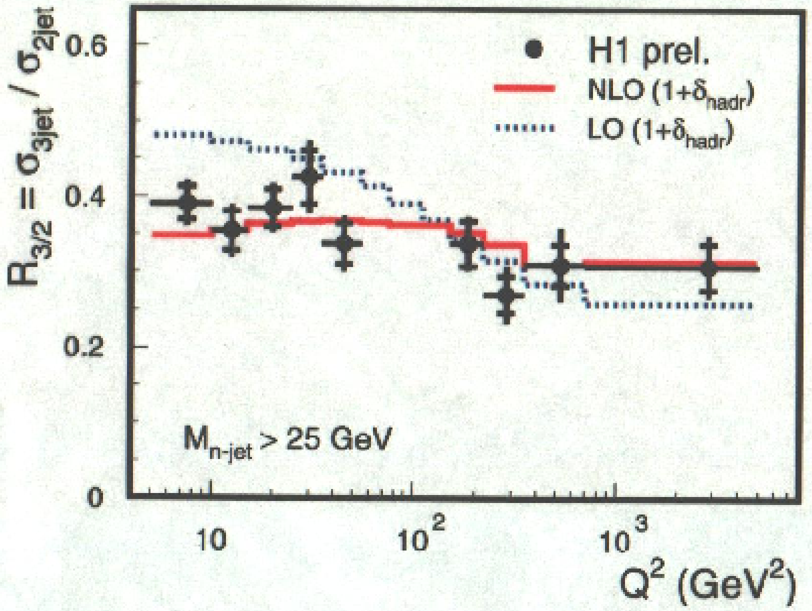


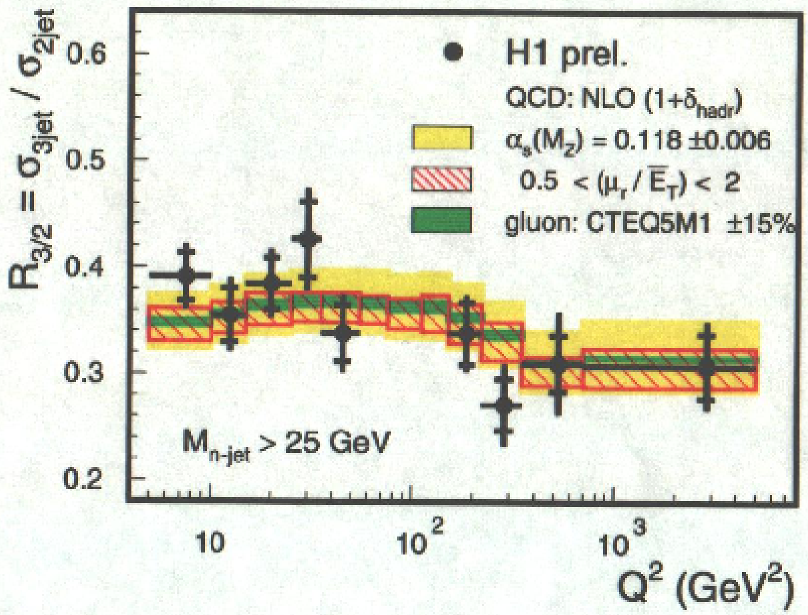
⇒ agreement over $10^{-4} < x_{\rm Bj} < 0.15$ and $25 < M_{\rm 3jet} < 140\,{\rm GeV}$

Ratio of 3-Jet and 2-Jet Cross Section: $R_{3/2} \propto \alpha_s$

measurement with same cut: $M_{\text{n-jet}} > 25$ GeV
probe PDFs at same x ⇒ cancellation of PDF uncertainties

comparing data with leading order and with next-to-leading order pQCD



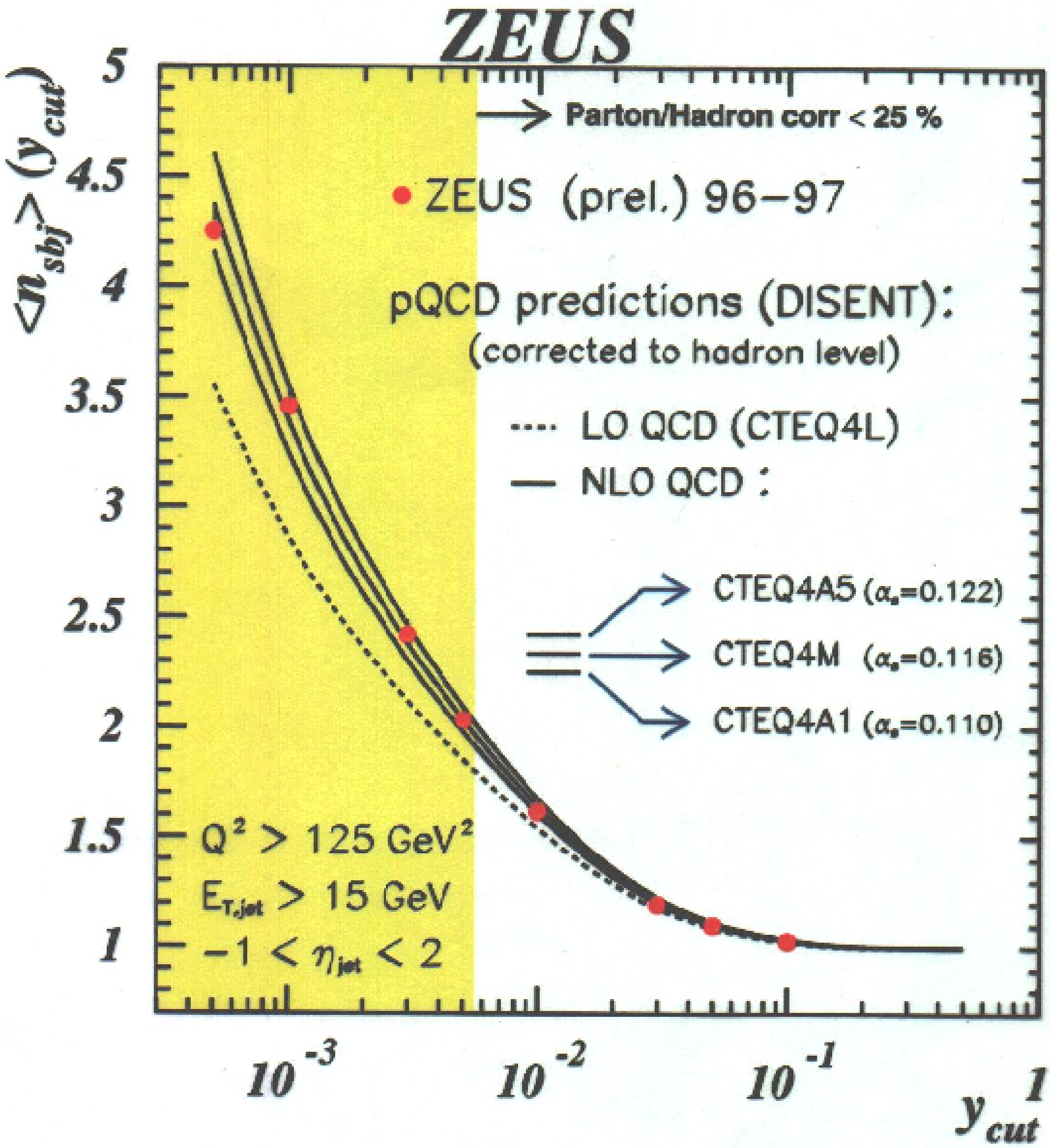


⇒ NLO: significant change of shape + good agreement with data

⇒ small renormalization scale dependence over whole Q^2 range ⇒ α_s Sensitivity

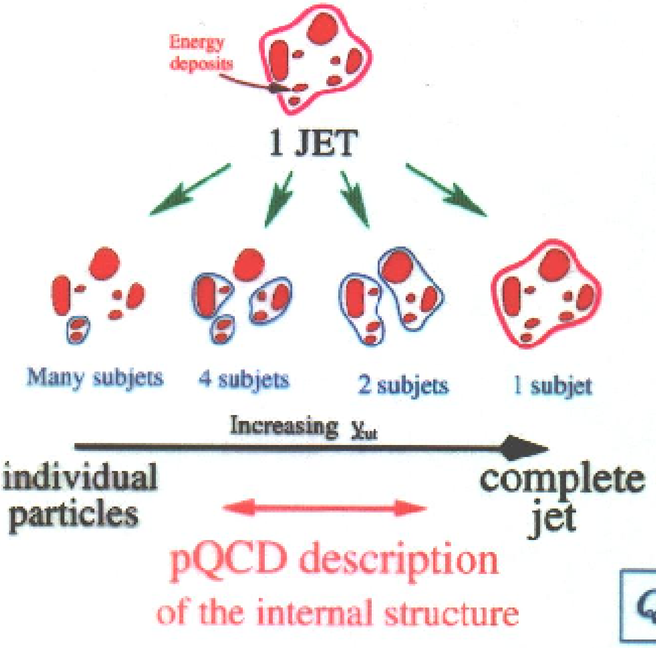
Comparison of the DATA with NLO QCD predictions

→ Comparison at hadron level



- NLO QCD describes the data.

Determination of α_s using subjet multiplicities in NC DIS

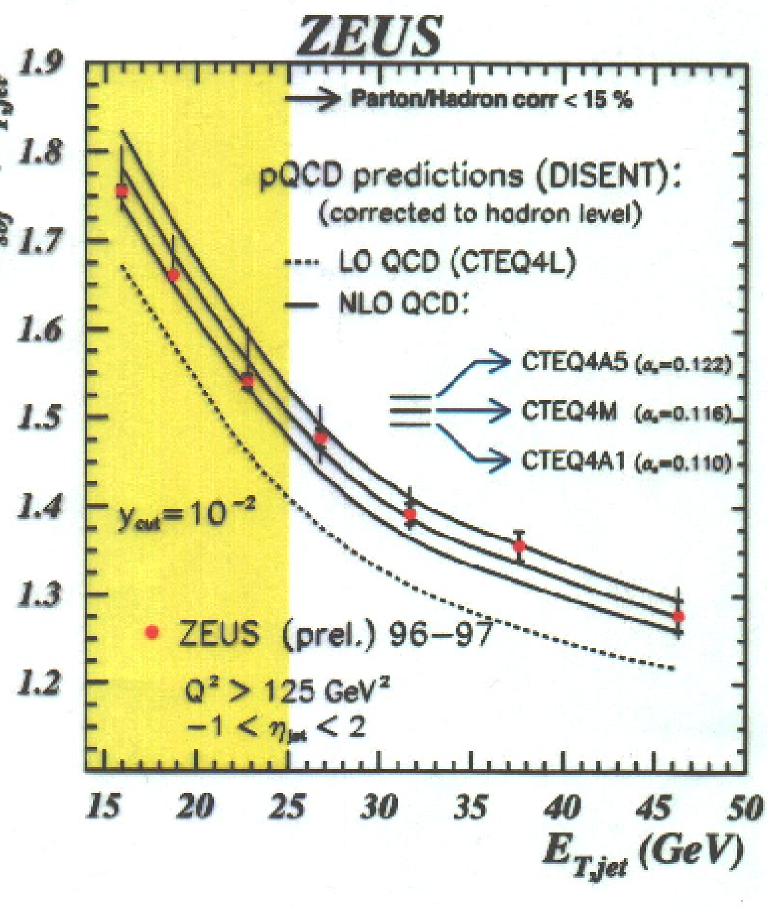


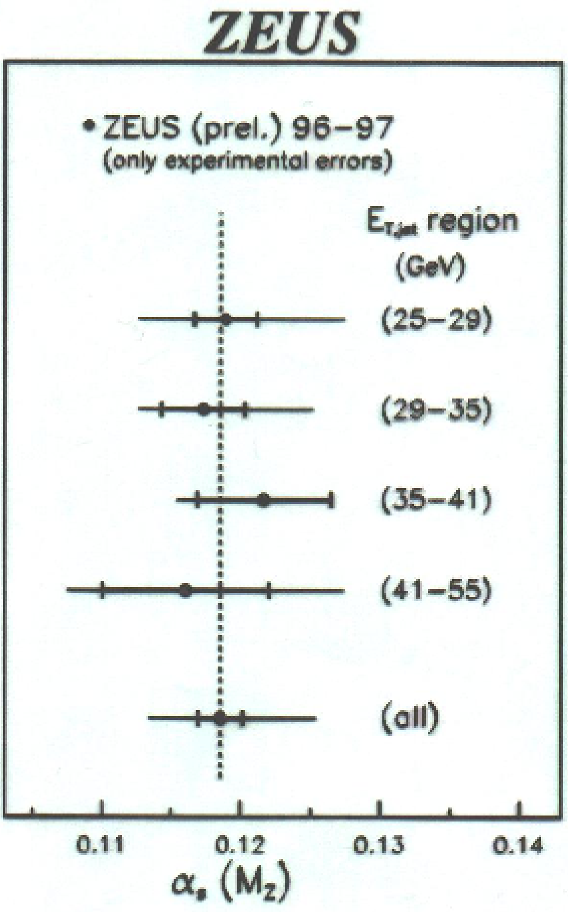
ZEUS

- k_T-cluster algorithm in the Laboratory Frame
- mean subjet multiplicity:

$$< n_{sbj} >= \frac{1}{N_{jet}} \sum_{k=1}^{N_{jet}} (n_{sbj})_k$$

$Q^2 > 125$ GeV $E_{T,jet} > 15$ GeV $-1 < \eta_{jet} < 2$

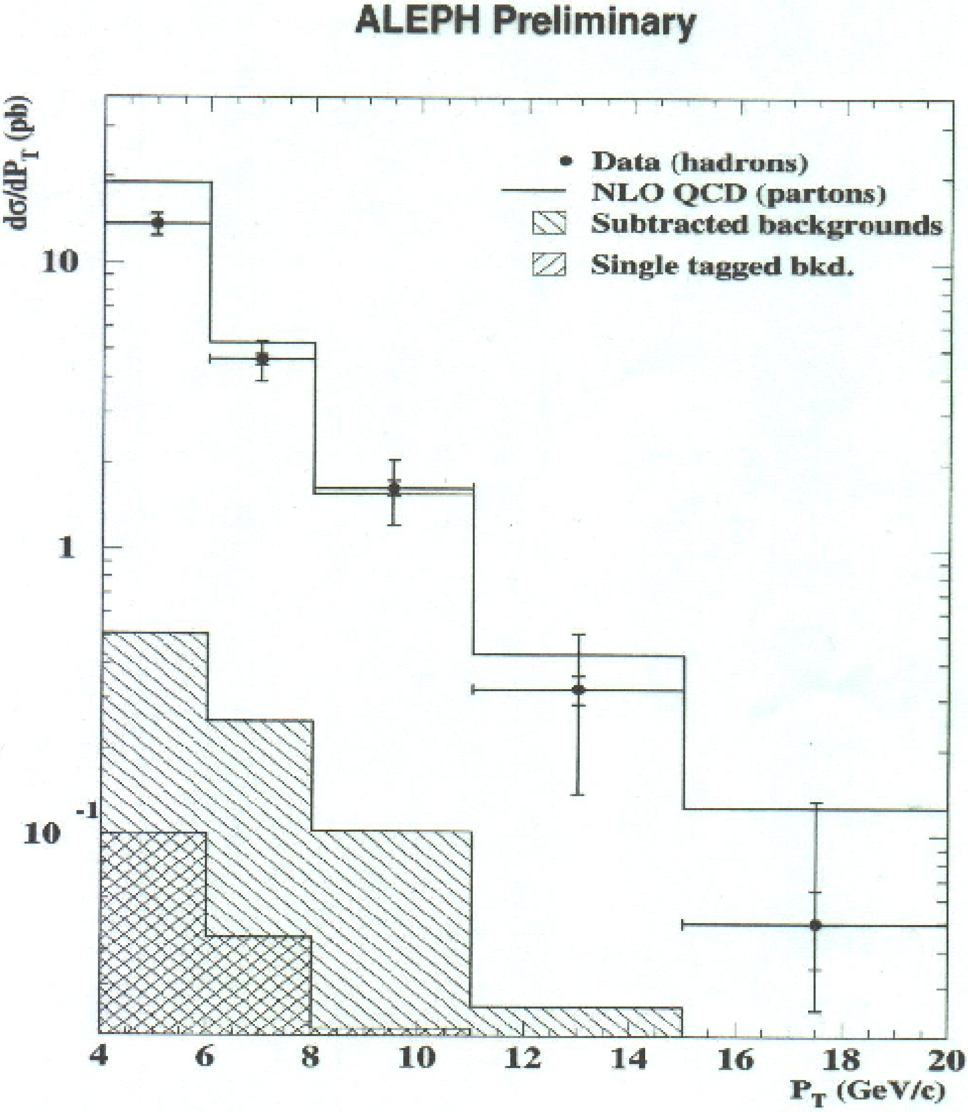




$$\alpha_s(M_Z) = 0.1185 \pm 0.0016 \text{ (stat.)}^{+0.0067}_{-0.0048} \text{ (syst.)}^{+0.0089}_{-0.0071} \text{ (th.)}$$

LEP γγ → hadrons untagged P. Hodgson

The Di-Jet cross section and NLO calculations



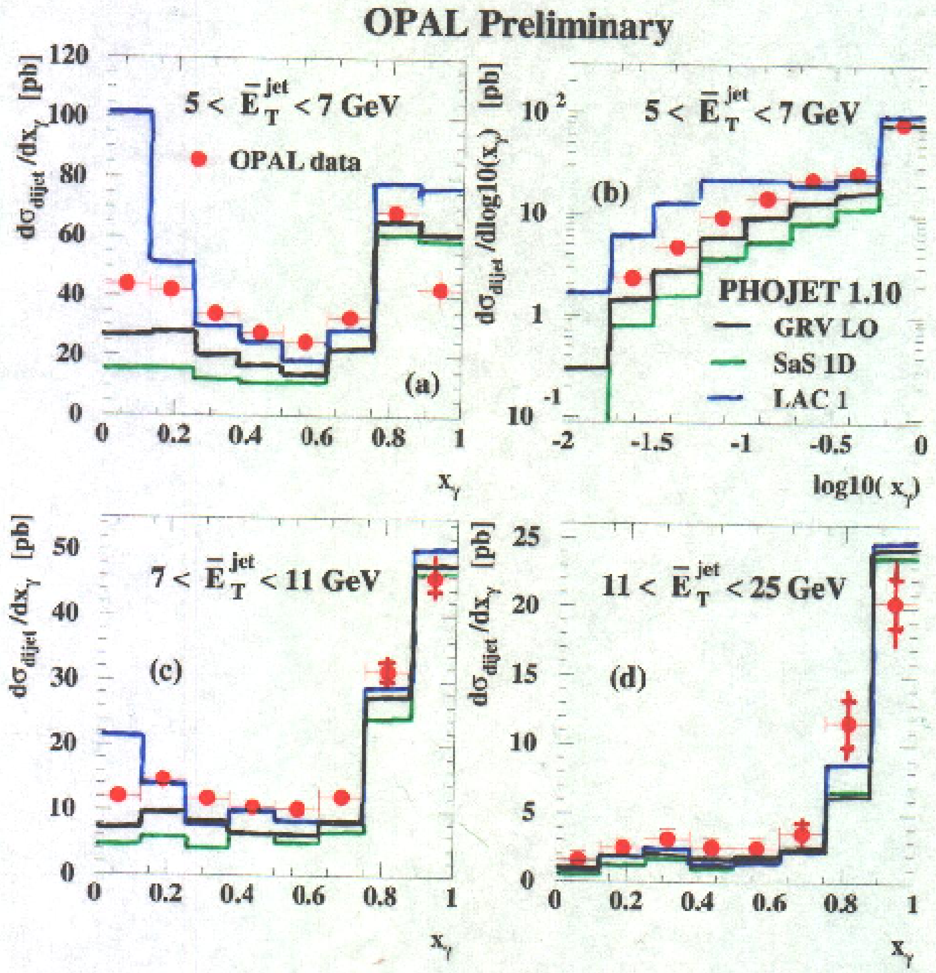
- NLO QCD calculations provided by M. Klasen and B. Pötter
- Theory in good agreement with data except in first bin where calculation predicts a much higher cross section

Sensitivity to γ - PDF

γγ → dijets

Di-Jet cross sections

- Measured di-jet cross sections as a function of x_γ



- Compare data with different PDF's in PHOJET
- Data falls between LAC1 and GRV LO/SaS 1D predictions at low E_T

QCD at LEP II

[Eventshapes]

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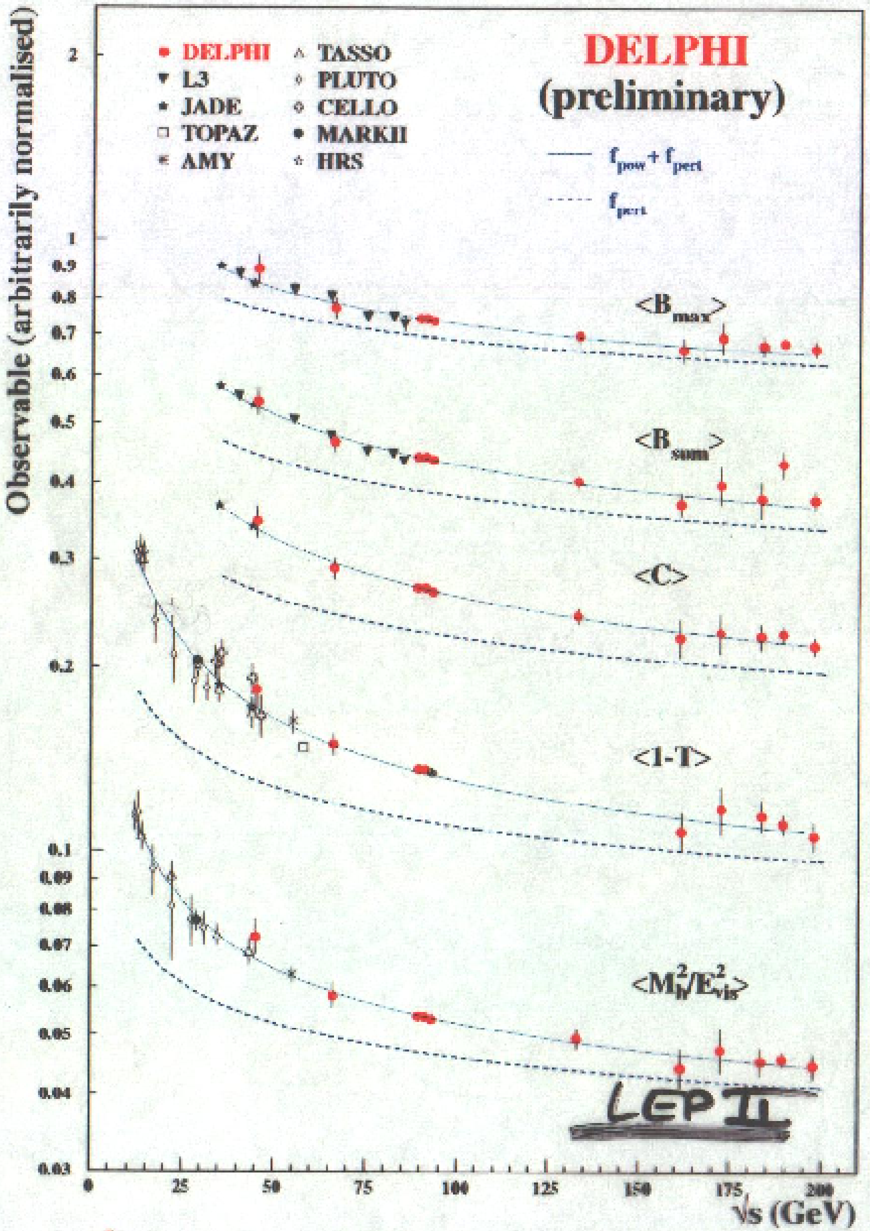

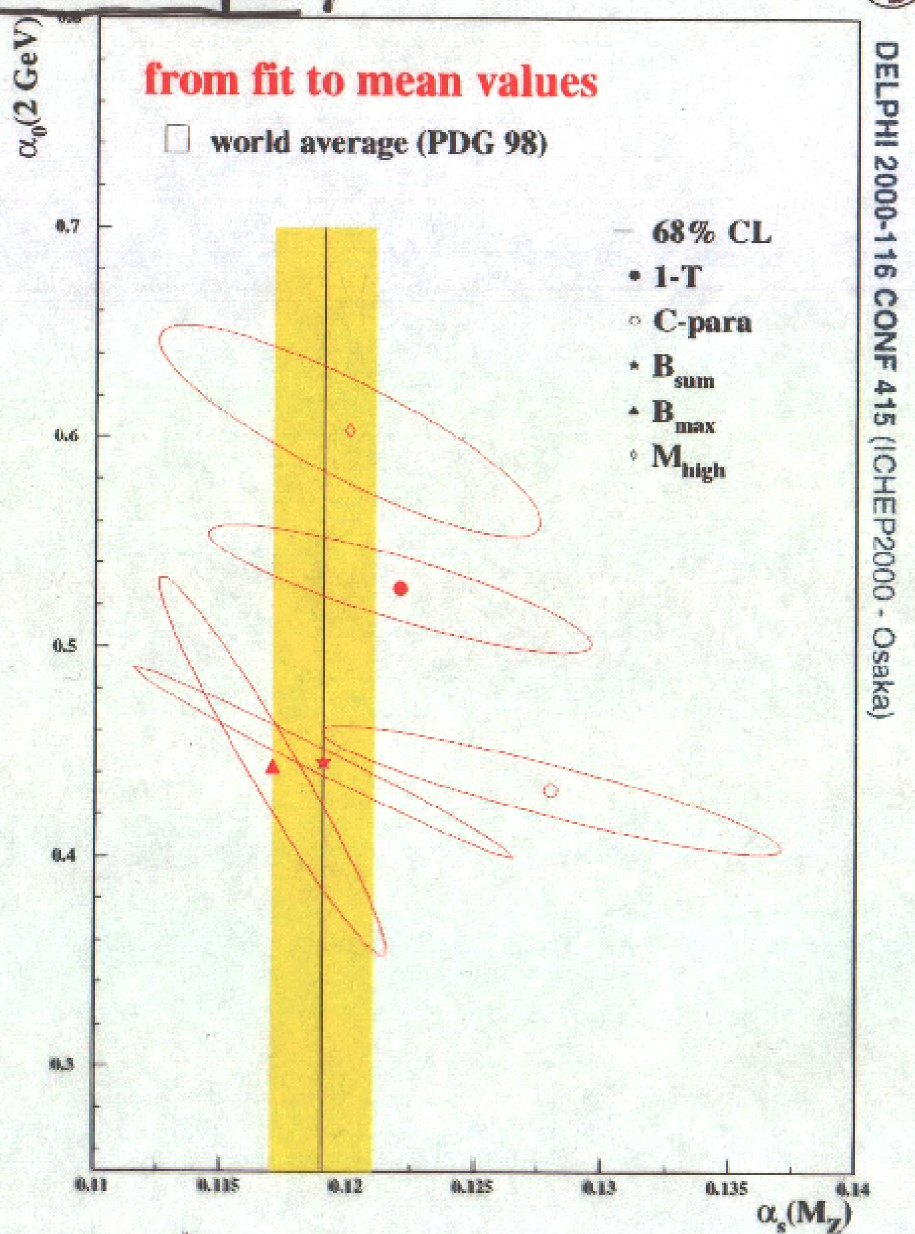

- ✓ perturbative component *alone* <u>not</u> able to describe √s evolution of <y>
- ✓ power correction term less and less significant moving towards higher energies

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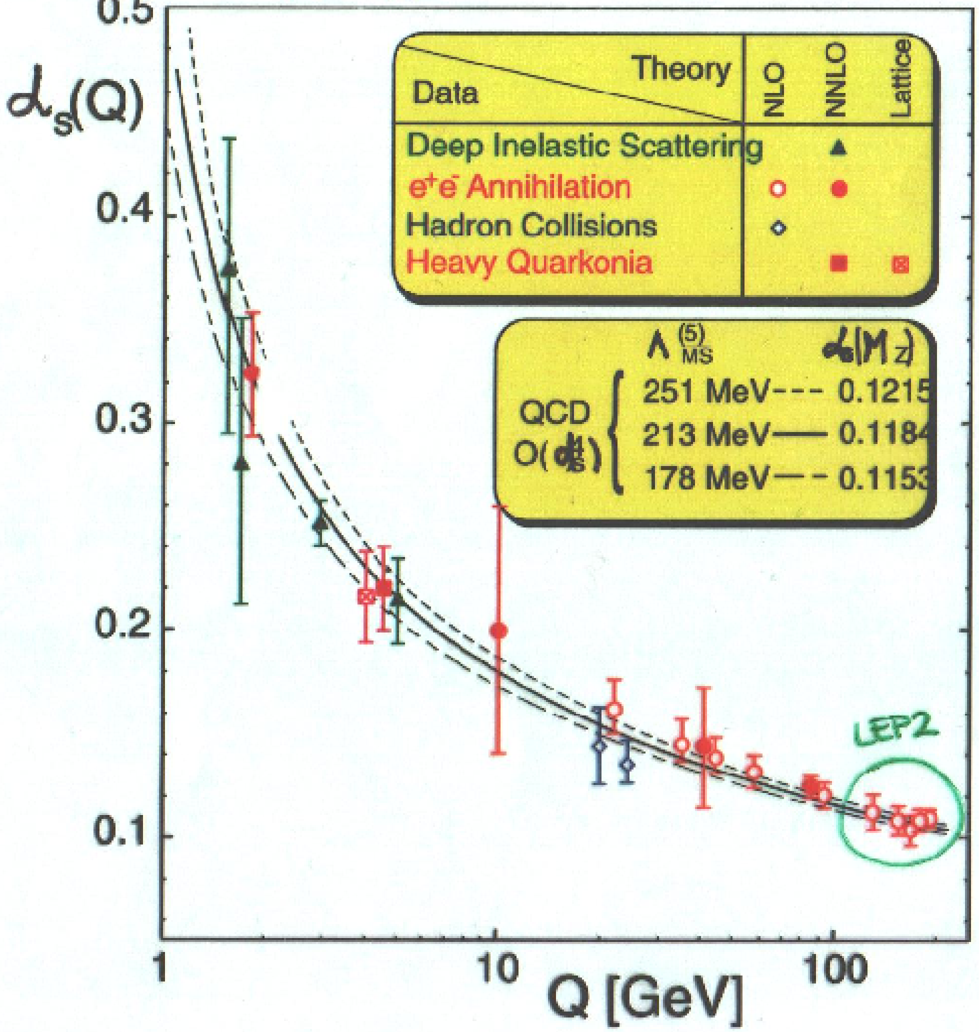
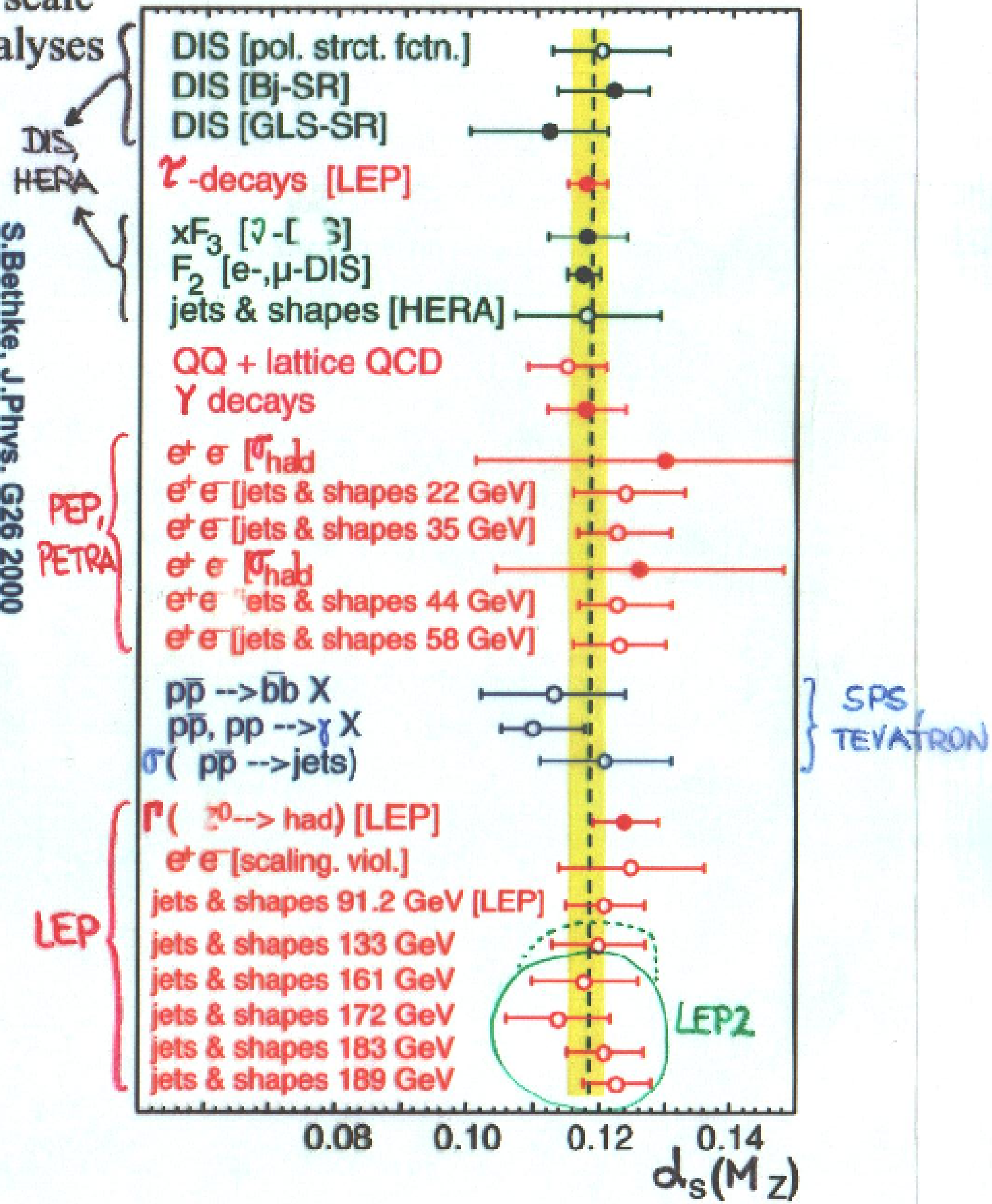
α_s : results and running

- ✓ World average of α_s, expressed at the energy scale of the rest mass of the Z, determined from analyses based on complete NNLO pt-QCD, yields:

$$\alpha_s(M_Z) = 0.1184 \pm 0.0031$$



S.Bethke, J.Phys. G26 2000



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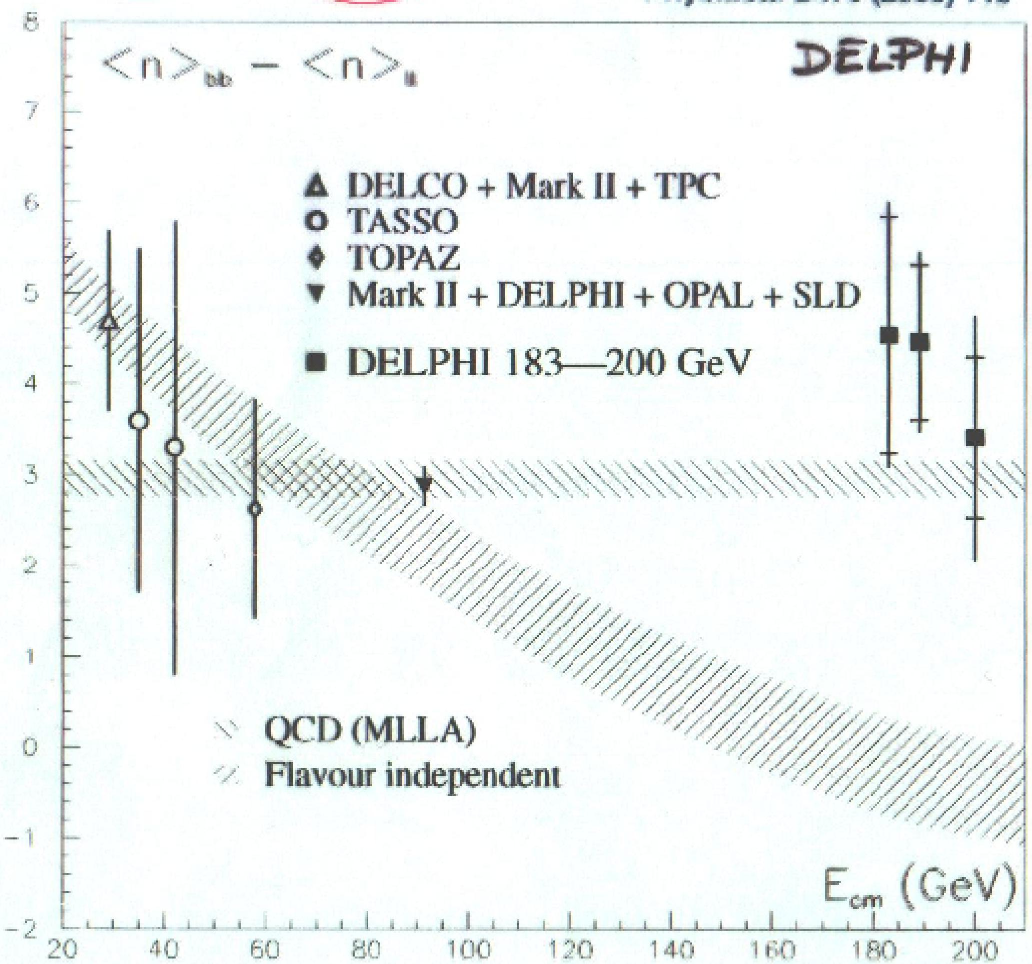
$\delta_{bl} \equiv \langle n \rangle_{b\bar{b}} - \langle n \rangle_{l\bar{l}}$

Phys.Lett. B479 (2000) 118



Charged particle multiplicities in b- events

} **QCD prediction**

} **Prediction from flavour-indep. fragmentation**

- experimental tests @ LEP1 were not conclusive...
- ✓ LEP2 data allow to distinguish between the 2 models

⇨ results (so far) consistent with the hypothesis of energy-independence, as predicted by **QCD MLLA**

√s dependence of mean charged particle multiplicity

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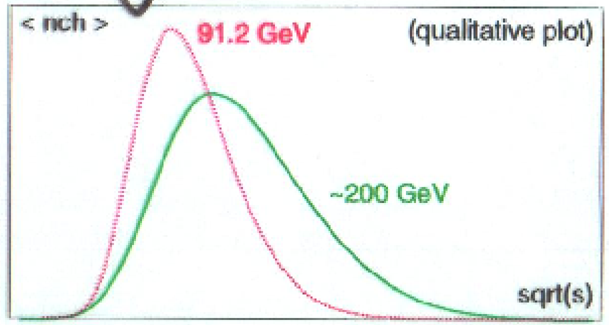
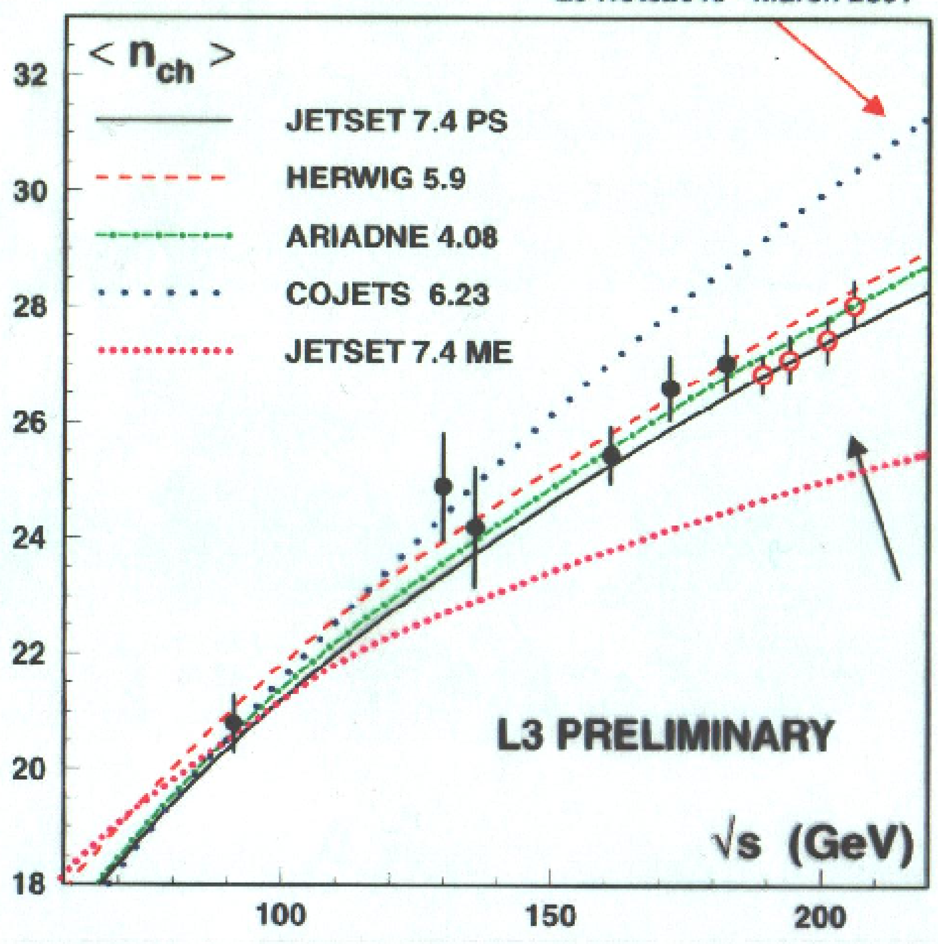
- ✓ good agreement data-MC even at highest energies
- ✓ n_{ch} spectra "shift" & "broaden" with increasing $\sqrt{s}$ →



- ✓ consistency between direct and indirect n_{ch} measurements (e.g.: by integrating rapidity distribution)

L3 Note2645 - march 2001



- ✓ COJETS (incoherent PS & independent fragm.) overestimates multiplicity at high energies
- ✓ coherent PS models (⇒ soft gluon suppression) explains energy evolution of $<n_{ch}>$
- ✓ second-order ME models (with fixed nb of partons) not able to describe evolution

  (→ would require a re-tuning at each energy…)

SEARCHES

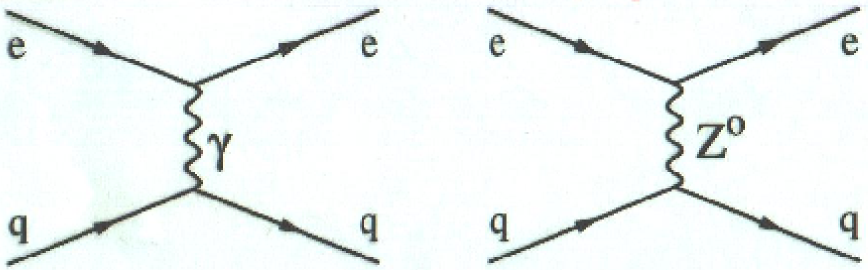
Contact Interactions

Żarnecki

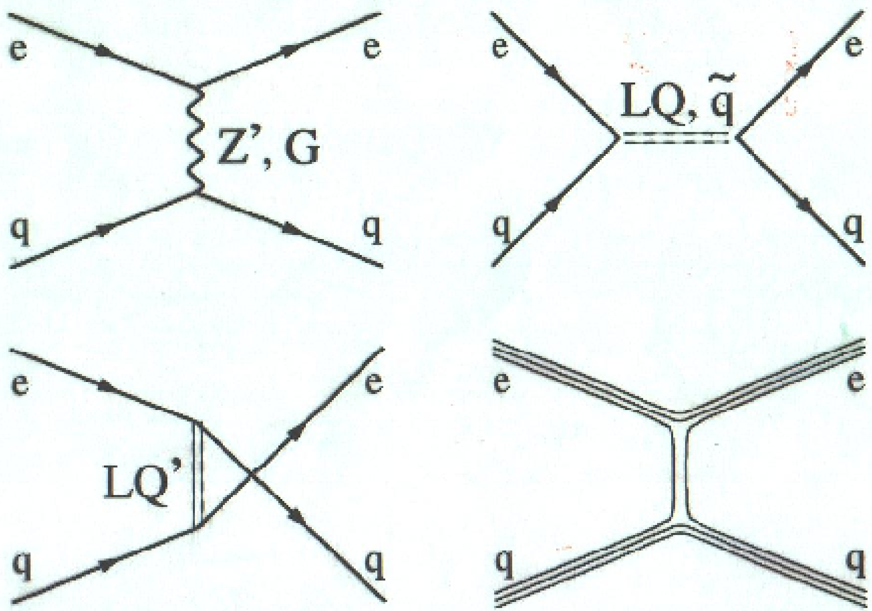
$\frac{d\sigma}{dQ^2}$ NC HERA

Neutral Current eq Scattering

Two processes contribute in SM:

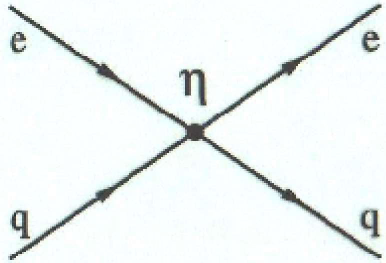


Possible "new physics" processes:



For $\sqrt{s}$ much smaller than process scale Λ

⇒ effective parameterization:



$eeqq$ contact interactions (CI)

Effective Lagrangian for vector $eeqq$ contact interactions:

$$\mathcal{L}_{CI} = \sum_{\substack{\alpha,\beta=L,R \\ q}} \eta^{eq}_{\alpha\beta} \cdot (\bar{e}_\alpha \gamma^\mu e_\alpha)(\bar{q}_\beta \gamma_\mu q_\beta)$$

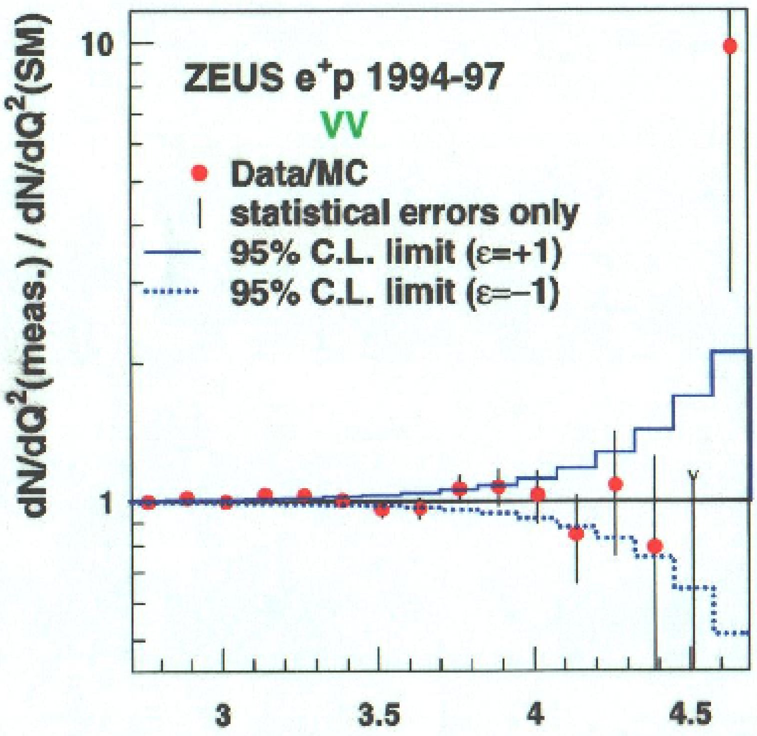
Scalar and tensor CI constrained beyond HERA sensitivity.

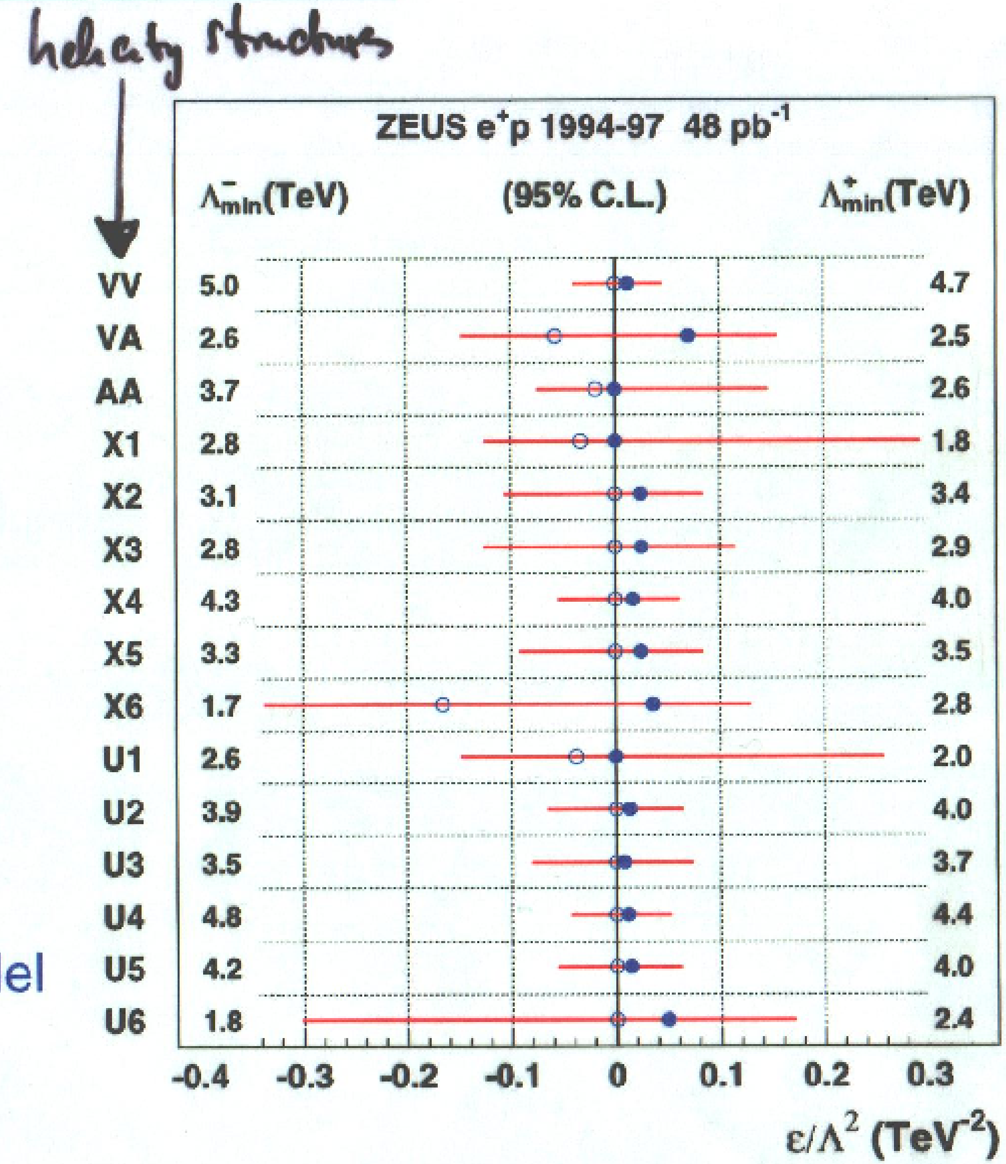
$\eta^{eq}_{\alpha\beta}$ - 4 possible couplings for every flavor q

General models

Results

ZEUS 1994-97 analysis





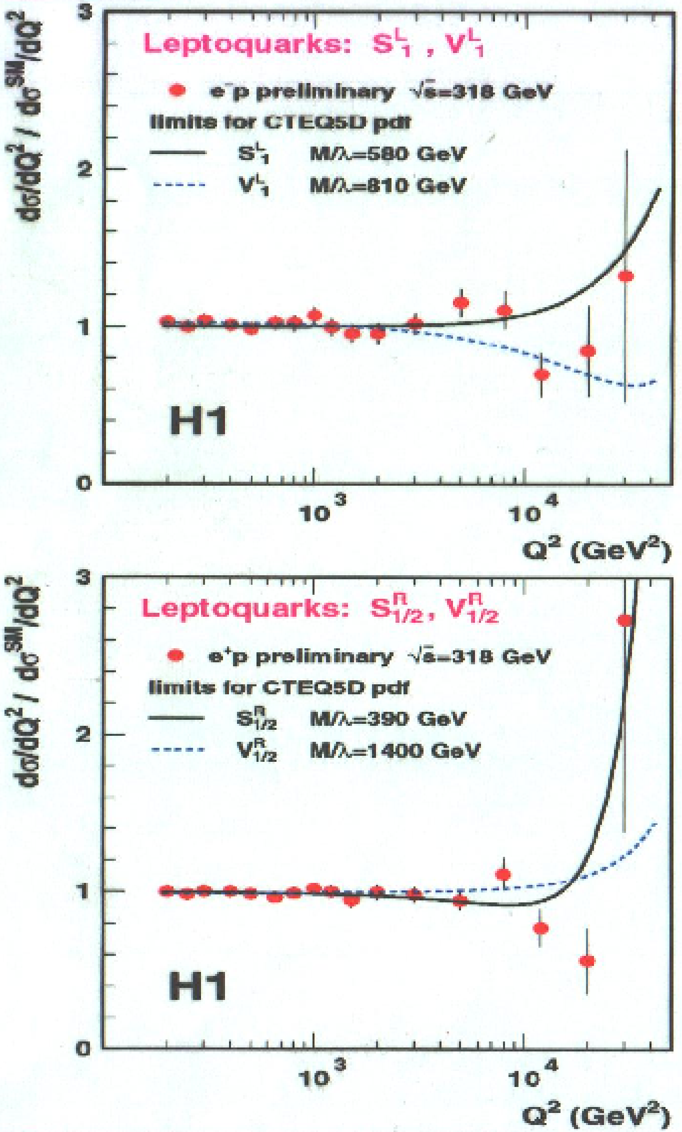
Good agreement with the Standard Model

95% CL limits:

$\Lambda > 1.7 - 5.0$ TeV

High mass leptoquarks

Results

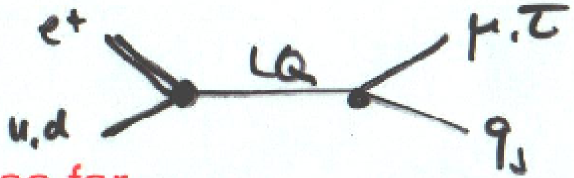


H1 1994-00 preliminary, 95% CL limits

LQ	η^u $(\lambda/M_{LQ})^2$	η^d $(\lambda/M_{LQ})^2$	F	M_{LQ}/λ [GeV]
S_0^L	$+\frac{1}{2}$		2	1070
S_0^R	$+\frac{1}{2}$		2	960
$\tilde{S}_0^R$		$+\frac{1}{2}$	2	290
$S_{1/2}^L$	$-\frac{1}{2}$		0	380
$S_{1/2}^R$	$-\frac{1}{2}$	$-\frac{1}{2}$	0	380
$\tilde{S}_{1/2}^L$		$-\frac{1}{2}$	0	650
S_1^L	$+\frac{1}{2}$	$+1$	2	690
V_0^L		-1	0	1030
V_0^R		-1	0	810
$\tilde{V}_0^R$	-1		0	530
$V_{1/2}^L$		$+1$	2	480
$V_{1/2}^R$	$+1$	$+1$	2	1510
$\tilde{V}_{1/2}^L$	$+1$		2	1690
V_1^L	-2	-1	0	680

Summary

- Over 200 pb^{-1} of $e^{\pm}p$ data collected by H1 and ZEUS
- Contact Interaction approximation used to search for:
  - ⇒ Compositeness — Compositeness scale $\Lambda > 1.6 - 9.2$ TeV (H1)
  - ⇒ Large Extra Dimensions — effective mass $M_S > 0.8$ TeV (ZEUS)
  - ⇒ Quark radius — $R_{quark} < 0.73 \cdot 10^{-18}$ m (ZEUS)
  - ⇒ High mass leptoquarks — $\frac{M_{LQ}}{\lambda} > 0.3 - 1.7$ TeV depend. on LQ type
  - ⇒ Lepton Flavor Violation



- No evidence for new physics so far...
- Limits comparable/complementary to LEP/Tevatron
- Exciting future after HERA upgrade...

Sleuth

A quasi-model-independent search strategy for new physics

Motivation

Sleuth

Results

B. Paul Padley
Rice University

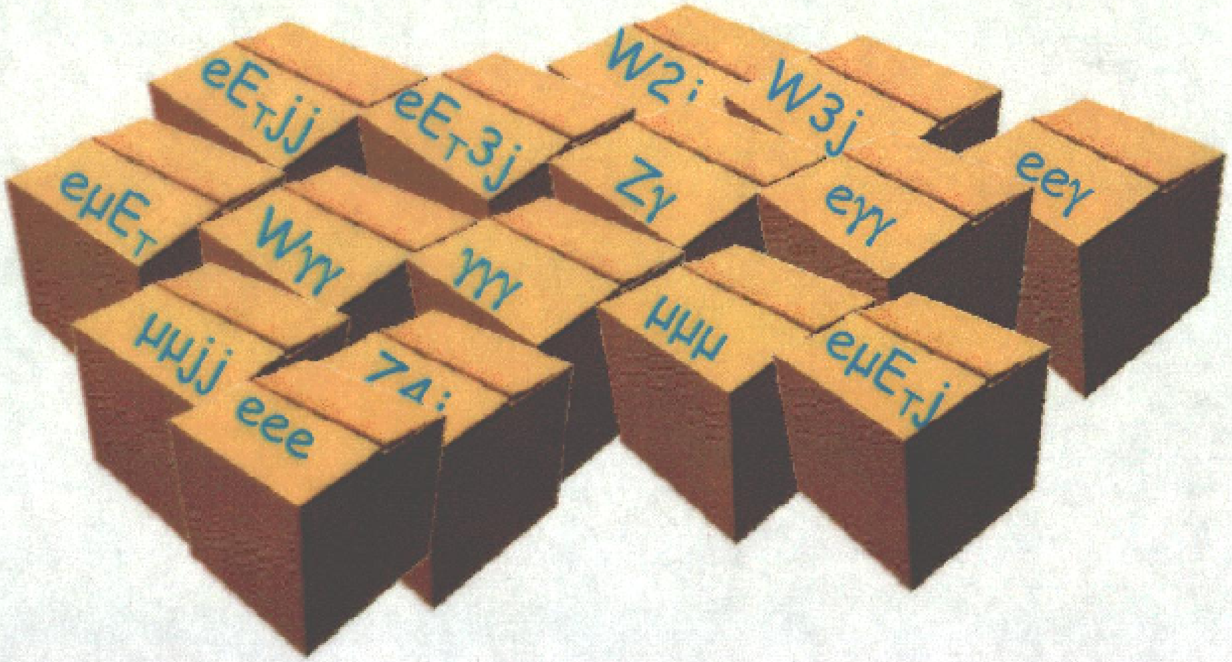
Steps:

1) We consider exclusive final states

We assume the existence of standard object definitions

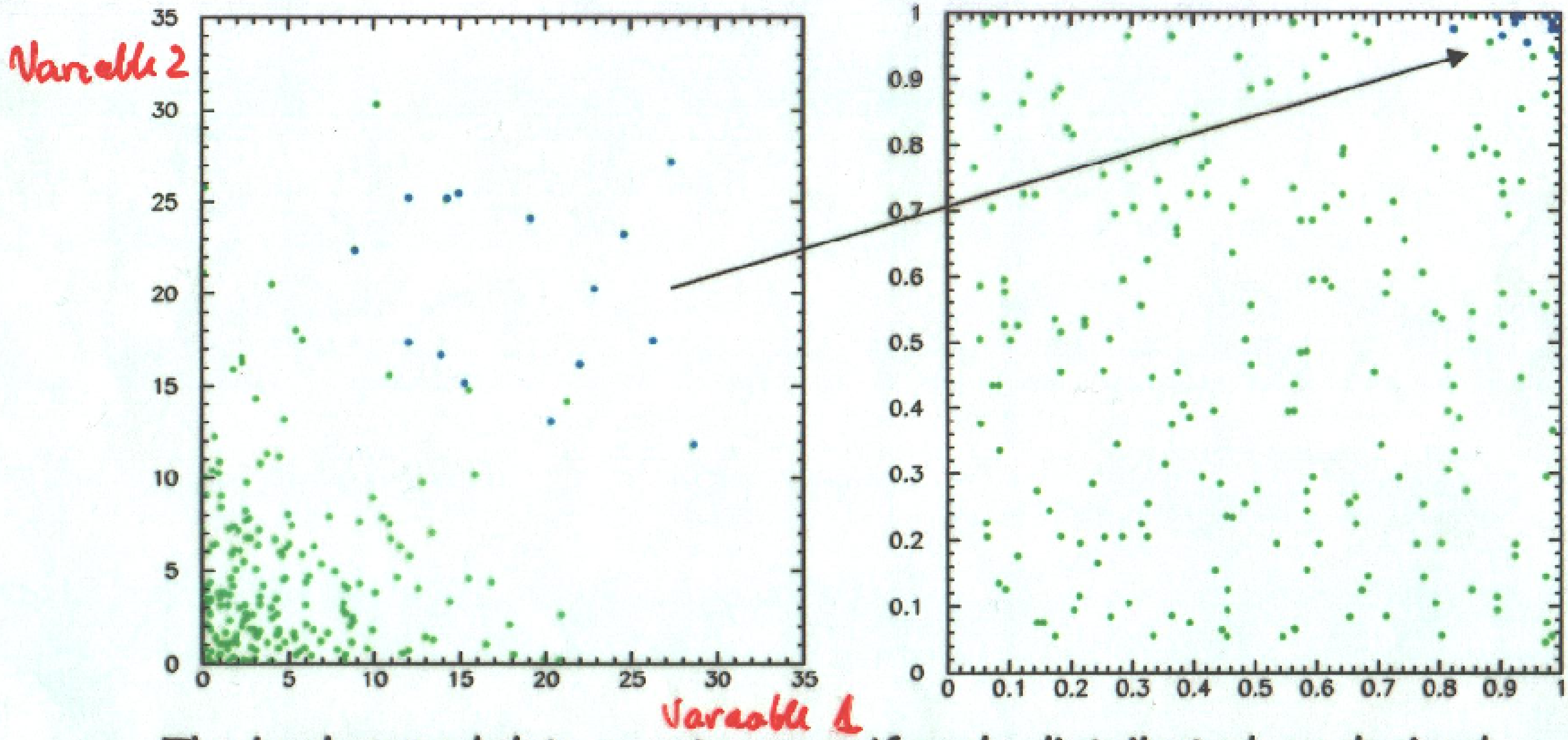
These define e, μ, τ, γ, j, b, $\not{E}_T$, W, and Z

All events that contain the same numbers of each of these objects belong to the same final state



Variable transformation

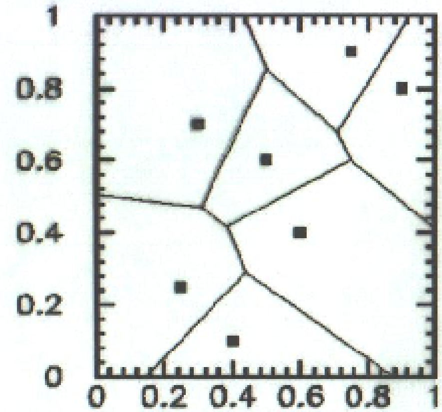
The transformation maps the signal region into the upper right-hand corner of the unit box



The background data events are uniformly distributed, as desired, and the signal cluster is "obvious"

SM events

3) Search for regions of excess (more data events than expected from background) within that variable space



For each final state . . .

Input: 1 data file, estimated backgrounds

- transform variables into the unit box
- define regions about sets of data points
  - Voronoi diagrams
- define the "interestingness" of an arbitrary region
  - the probability that the background within that region fluctuates up to or beyond the observed number of events
- search the data to find the most interesting region, **R**
- determine **P**, the fraction of *hypothetical similar experiments* (hse's) in which you would see something more interesting than **R**
  - Take account of the fact that we have looked in many different places

Output: **R**, **P**

Conclusions

- **Sleuth** is a quasi-model-independent search strategy for new high p_T physics
  - Defines final states and variables
  - Systematically searches for and quantifies regions of excess
- **Sleuth** allows an *a posteriori* analysis of interesting events
- **Sleuth** appears sensitive to new physics
- **Sleuth** finds no evidence of new physics in DØ data
- **Sleuth** has the potential for being a very useful tool
  - **Looking forward to Run II**

hep-ex/0006011 PRD
hep-ex/0011067 PRD
hep-ex/0011071 PRL

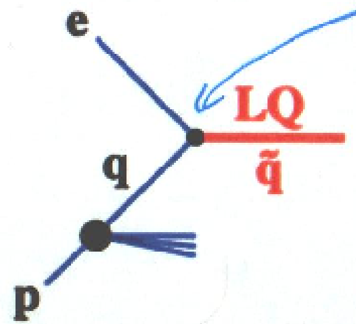
High Lumi !
High $\sqrt{s}$!

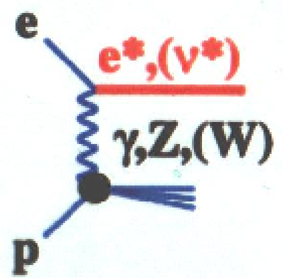
Zhang

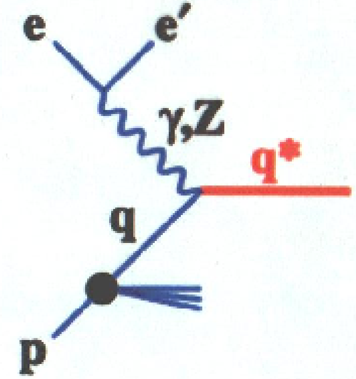
Search for New Physics at HERA

Direct production of resonances for mass $< \sqrt{s}$ (this talk)

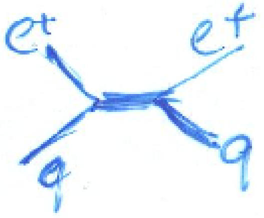
- Leptoquarks (LQs)
  (eq) bound states in various
  theories beyonds SM
- Squarks ($\tilde{q}$) in $\not R_P$ SUSY
  Supersymmetric (SUSY)
  partners of quarks
- Excited fermions (e^*, ν^*, q^*)
  Substructure of SM fermions





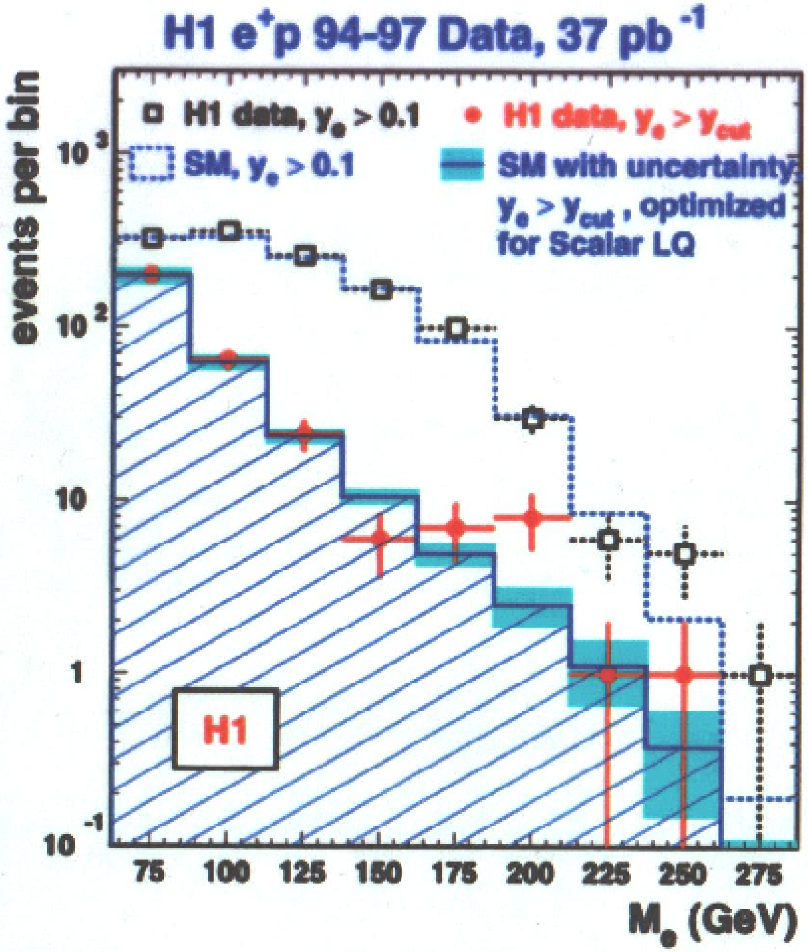


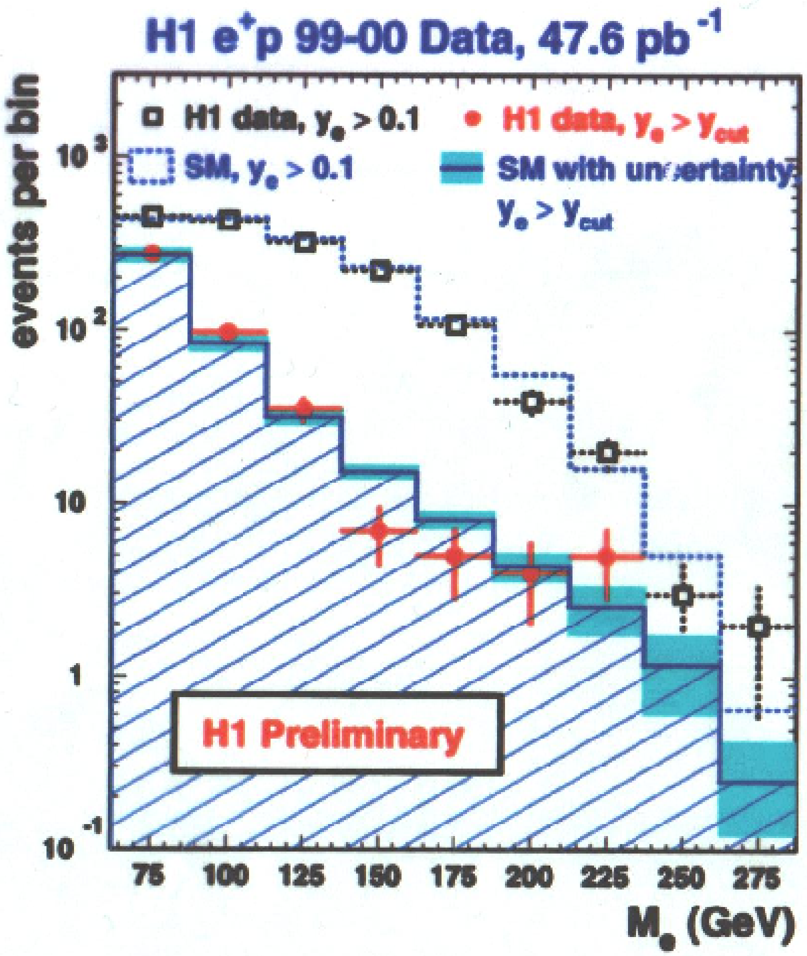
Indirect search (contact interactions) for mass $> \sqrt{s}$ (→ Zarnecki)



Mass distribution: Excess or Fluctuation?

LQ





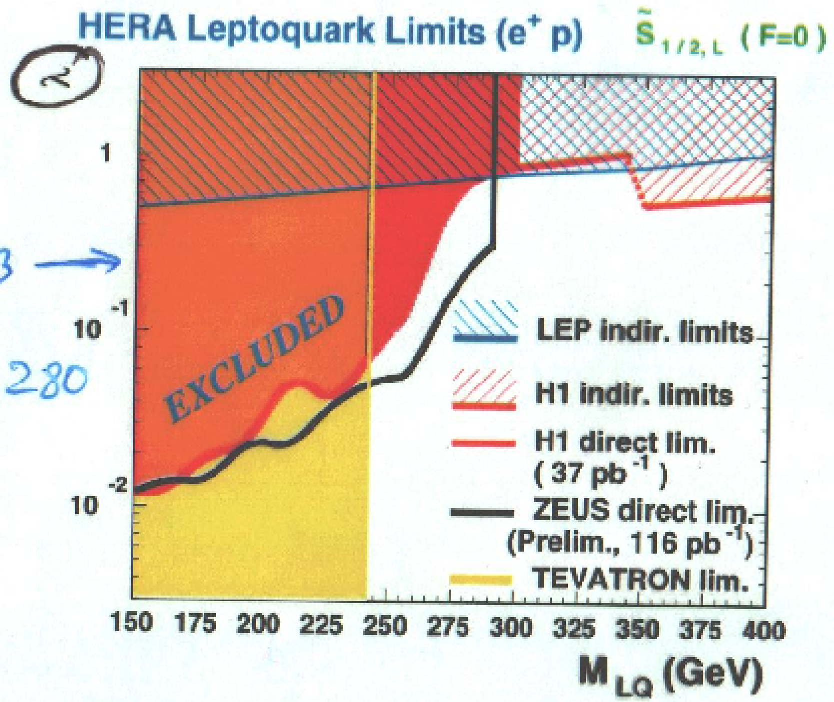
⇒ Excess in old data not confirmed by new data (also for ZEUS)

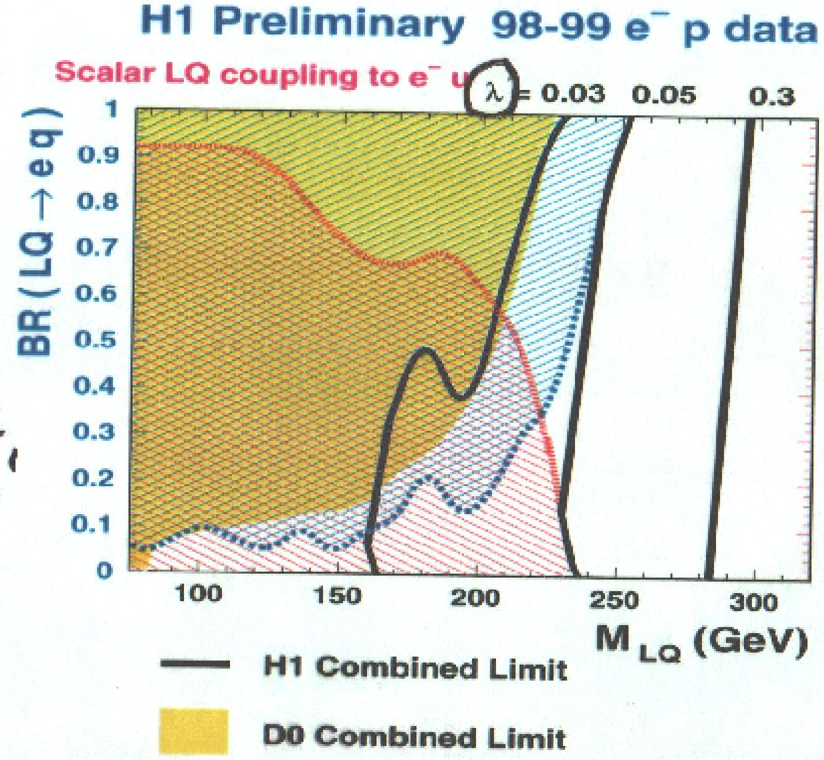
⇒ Proceed to derive limits on the LQ couplings λ and masses

Search for leptoquarks at HERA

In Buchmüller-Rückl-Wyler model:
$BR_{eq} = 1, 1/2,\ BR_{\nu q} = 0, 1/2$

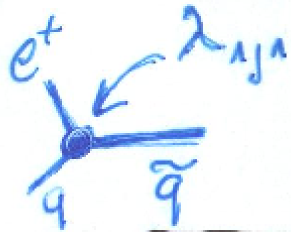
In generic models:
BR_{eq} and $BR_{\nu q}$ not fixed





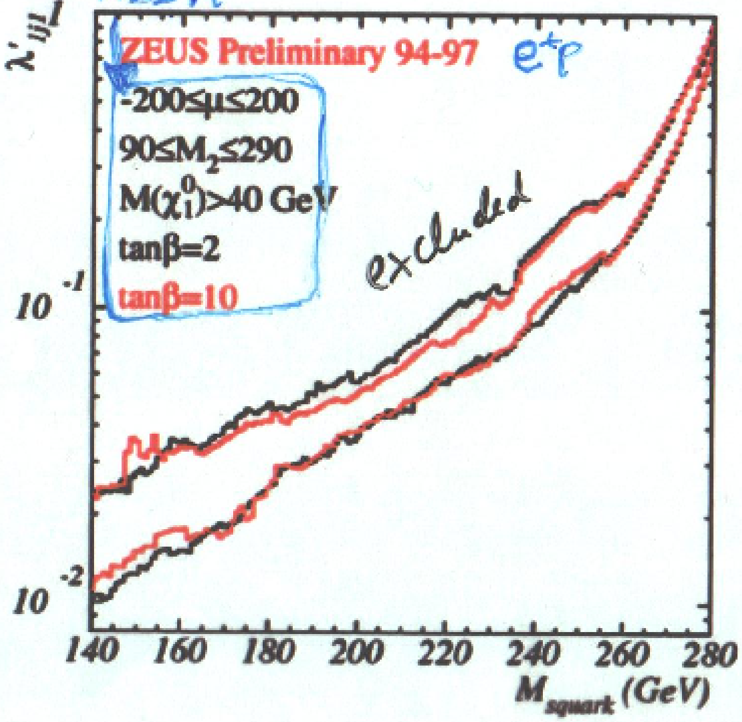
HERA complements LEP, Tevatron
HERA sensitivity larger with $\sqrt{s} \nearrow$

Combined $BR_{eq} + BR_{\nu q} = 1$ mass limits
largely independent of individual BR



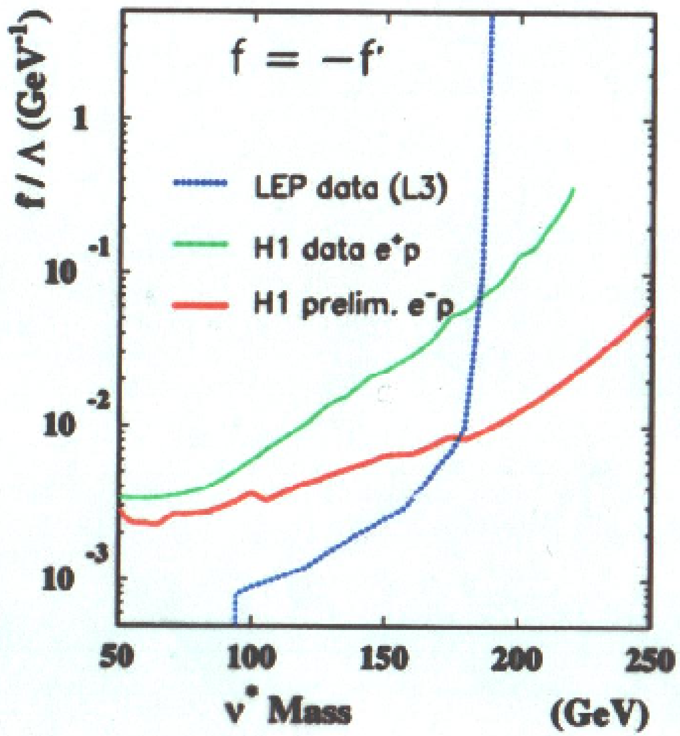
Search for $\tilde{q}$ in $\not{R}_P$ SUSY and f^* at HERA

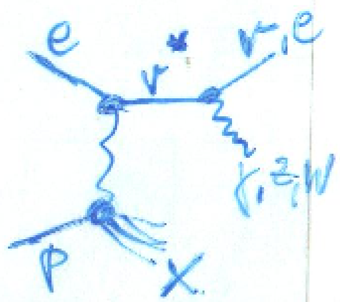
Squarks in $\not{R}_P$ SUSY:
scan in parameter space performed



For $\lambda' = 0.3$, $M_{\tilde{q}} < 270\,\text{GeV}$ excluded,
Improvement expected with e^-p, e^+p
data at $\sqrt{s} = 320\,\text{GeV}$

Excited neutrinos:
$e^+p(\sqrt{s} = 300)$ versus $e^-p(\sqrt{s} = 320)$



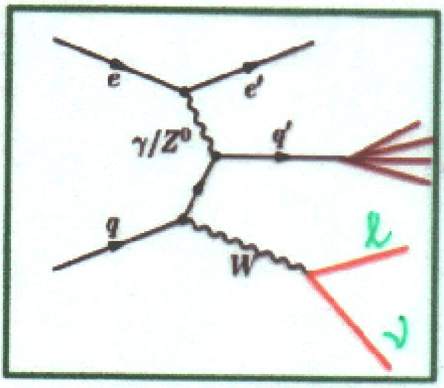


For $f/\Lambda = 1/M_{\nu^*}$, $e^-p(e^+p)$ data:
$M_{\nu^*} < 150(114)\,\text{GeV}$ excluded,
HERA extends LEP at high M_{ν^*}

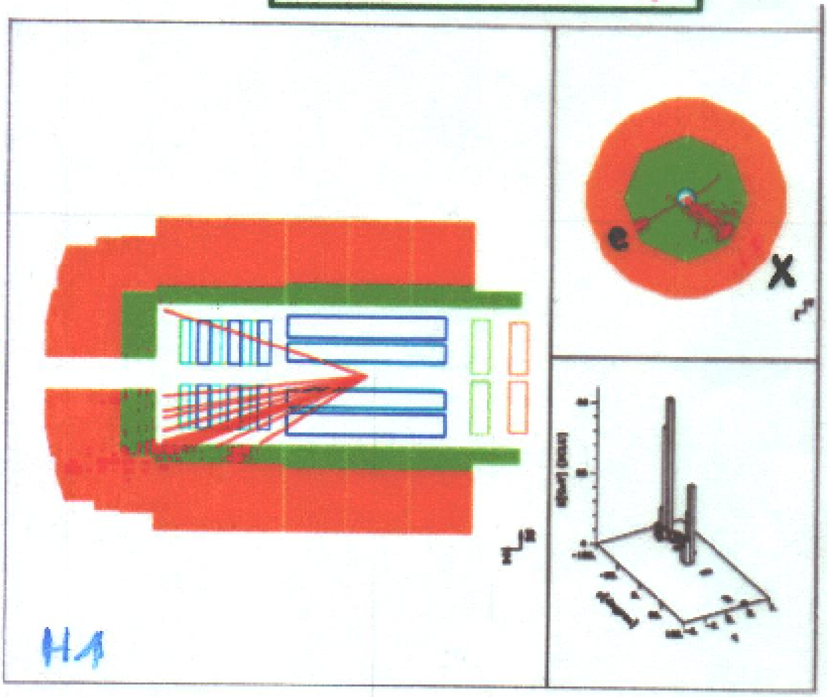
Diaconu / Matsushita

Standard Model $\ell + P_T^{miss}$ events

Expectation:



Observation:



$e^{\pm}p \rightarrow (e^{\pm})\ \ell\ \nu\ X$

lepton (e,μ) ↑ ↑ P_T^{miss}

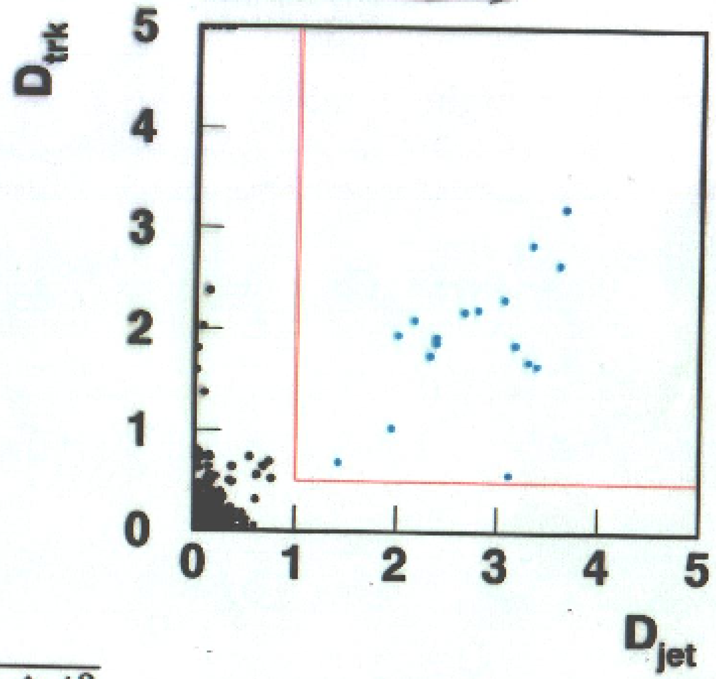
- W mostly photo-produced → low(ish) P_T
  P_T^W is measured from hadrons $= P_T^X$
- Standard Model (QCD LO) $\sigma(ep \rightarrow eW^{\pm}X) \simeq 1.2pb^{-1}$ (EPVEC) Baur, Vermaseren, Zeppenfeld
- HERA experiments accumulated 120 pb^{-1}/exp.
  ~ 30 events already produced in each detector

1994–2000 Inclusive analysis

So far no excess; with 82pb^{-1} of 1994–1999 data
Update with 48pb^{-1} of 2000 data

Search for high-p_t tracks in large P_T^{CAL} sample

- $P_T^{CAL} > 25$ GeV
- $p_t^{track} > 10$ GeV



Check isolation of high-p_t tracks with respect to other tracks (D_{track}) and jets (D_{jet}) $D_{track/jet} = \sqrt{\Delta\eta^2 + \Delta\phi^2}$

10 e and 7 μ 17 events
(2 e and 3 μ from 2000 data)

Event rate consistent with SM prediction

ZEUS preliminary 1994–2000	Electrons Observed/expected (W)	Muons Observed/Expected (W)
e^+p 114 pb^{-1}	7 / 9.9±1.6 (2.4)	7 / 4.6±0.6 (1.1)
e^-p 16 pb^{-1}	3 / 1.1±0.4 (0.3)	0 / 0.8±0.1 (0.2)
Total 130 pb^{-1}	10 / 11.0±1.6 (2.7)	7 / 5.4±0.7 (1.3)

W not dominating

C. Diaconu

$P_T^{\ell} > 10$ GeV
$P_T^{X} > 12$ GeV

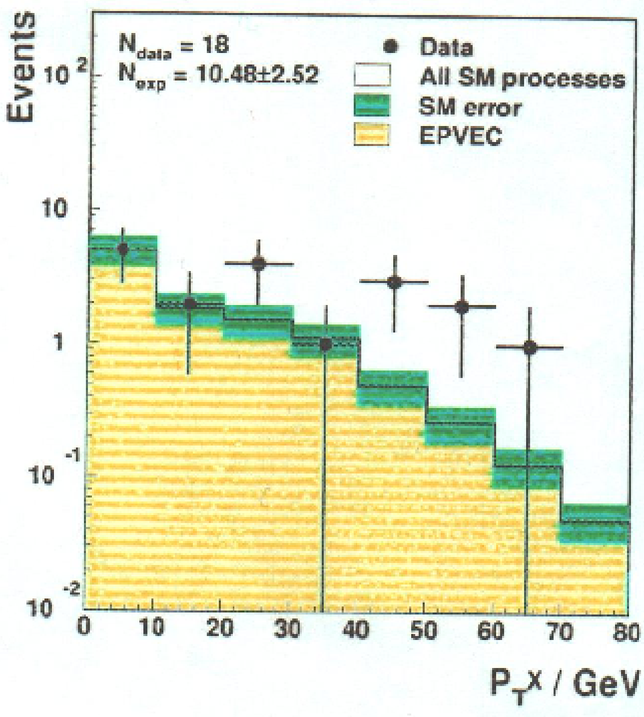
H1 dedicated W search

$\ell + P_T^{miss}$ (H1)

New Data since Osaka: extra 20 pb^{-1} e^+p @ $\sqrt{s} = 320$ GeV
4 new W candidates in e-channel (1e$^+$ @ $P_T^X > 25$ GeV)

H1 94-00 e+p 101.6 pb^{-1}	Electrons	Muons	e+μ combined
$P_T^X > 0$ GeV	10 / 7.9 ± 1.9 6_{Osaka}	8 / 2.6 ± 0.7	18 / 10.5 ± 2.5 (only W 8.2)
$P_T^X > 25$ GeV	4 / 1.3 ± 0.3 3_{Osaka}	6 / 1.5 ± 0.4	10 / 2.8 ± 0.7 (only W 2.3)

W as dominating SM Expectation



Hadronic P_T

Comparison ZEUS-H1

H1	(101.6 pb^{-1}) e^+p data only	18/10.5 (8.2 from W only)	High Purity/Efficiency for $\ell + P_T^{miss}$ events
H1	(115.2 pb^{-1}) $e^{\pm}p$ data	18/12.3 (9.4 from W only)	
ZEUS	(130 pb^{-1}) $e^{\pm}p$ data	17/16.4 (4.0 from W only)	Inclusive sample of lepton events

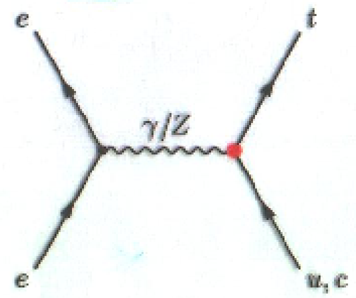
When the same phase space is selected @ $P_T^X > 25$ GeV, same angular range (H1) and Inforced non-W rejection (ZEUS)

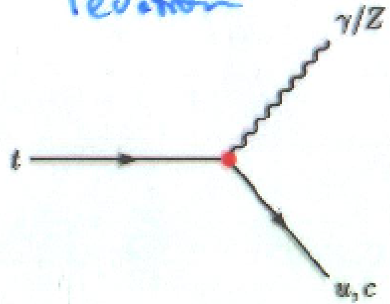
'same analysis' ⇒

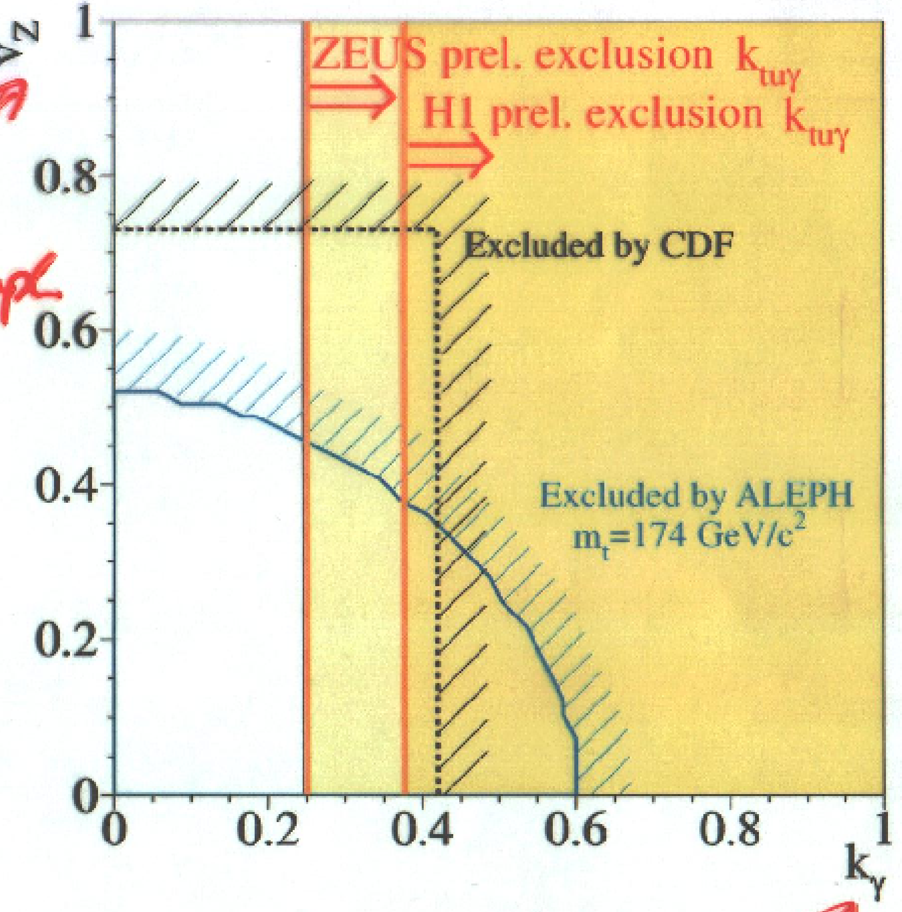
H1	(82 pb−1 Osaka)	9/1.8 (1.5 from W)
ZEUS	(130 pb^{-1})	2/2.4 (2.1 from W)

- SM expectations are in agreement
  we do expect same rate of $\ell + P_T^{miss}$ SM events
- H1 sees more events at high P_T^X
  ZEUS has the acceptance to detect such events
- Statistical fluctuation.?

Limits for anomalous FCNC couplings







- LEP: $e^+e^- \to tc, tu$ limits represented in γ- and Z-couplings plane
- TeVatron: rare top decay $t \to q\gamma, qZ$ separate limits on γ- and Z-couplings from different rare decays
- HERA: limits obtained only for γ coupling, valid only for t-u FCNC (not t-c)

Very competitive results.

University of Oxford
Takashi Matsushita