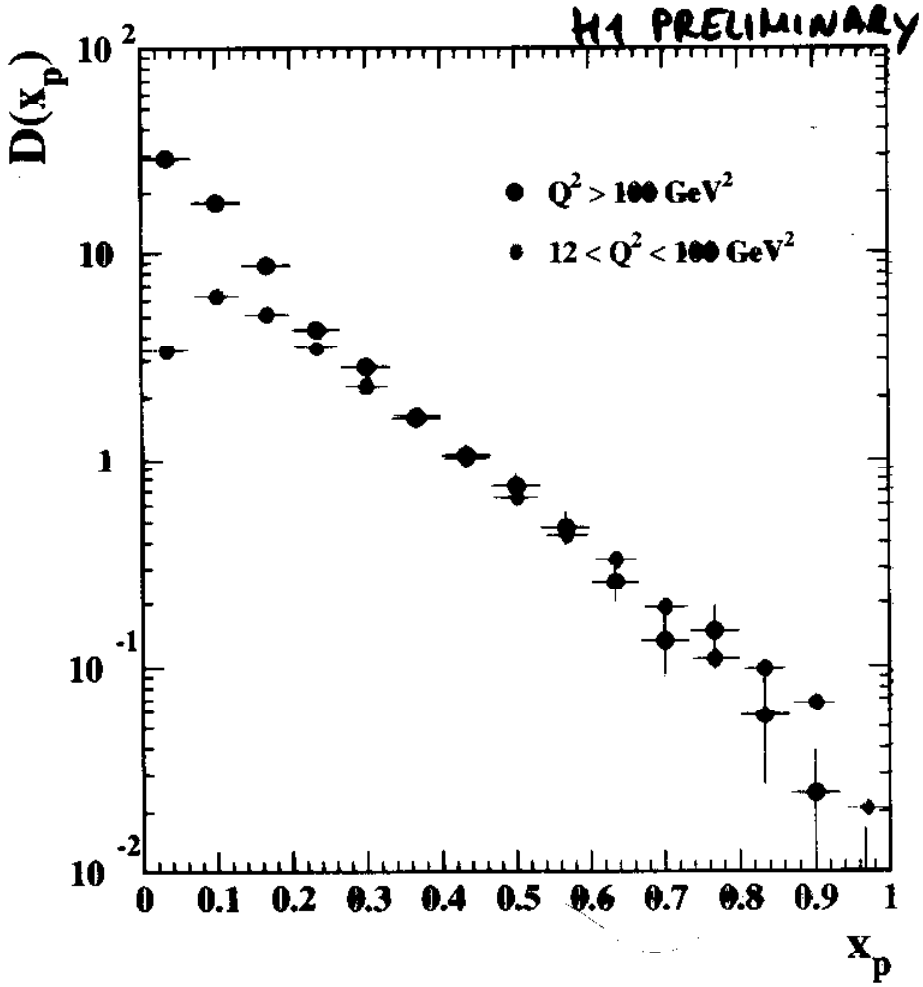
FRAGMENTATION FUNCTION

SCALED MOMENTUM VARIABLE $x_p = 2p/Q$

THE FRAGMENTATION FUNCTION $D(x_p) = \frac{1}{N_{ev}} \frac{dn}{dx_p}$

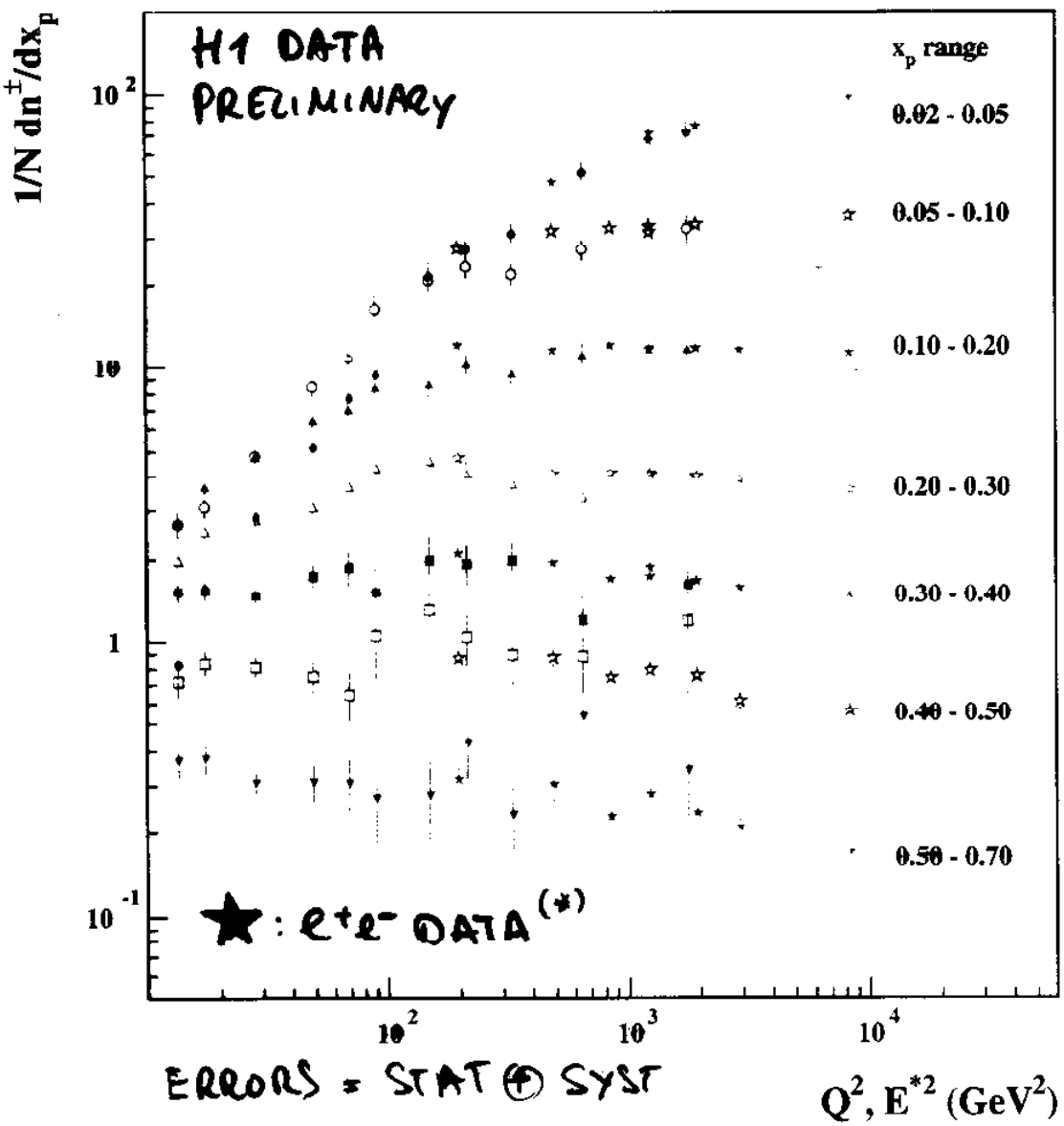
Fragmentation Functions for Data



$D(x_p)$ BECOMES SOFTER FOR $Q^2 \uparrow$

SCALING VIOLATIONS

Q2 dependence of $D(x_p)$



ERRORS = STAT ⊕ SYST

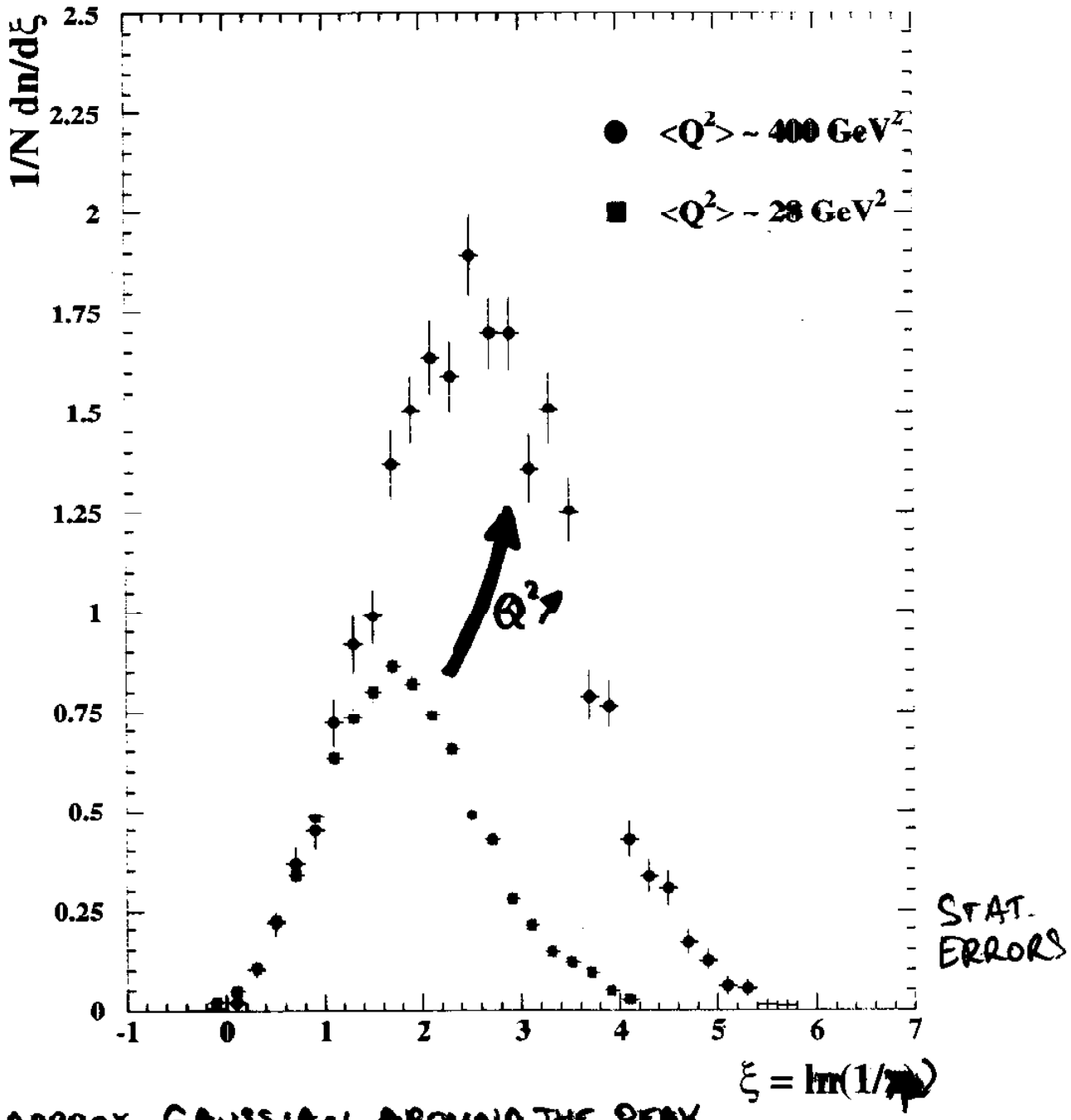
* SAME BEHAVIOUR AS IN e^+e^-
* EXTRACTION OF α_s IS BEING STUDIED

(*) e^+e^- DATA HAVE BEEN DIVIDED BY 2

EXPAND TURN-OVER REGION AT LOW x_p

$$x_p \rightarrow \xi = \ln(1/x_p)$$

Fragmentation Fuctions - H1 PRELIMINARY



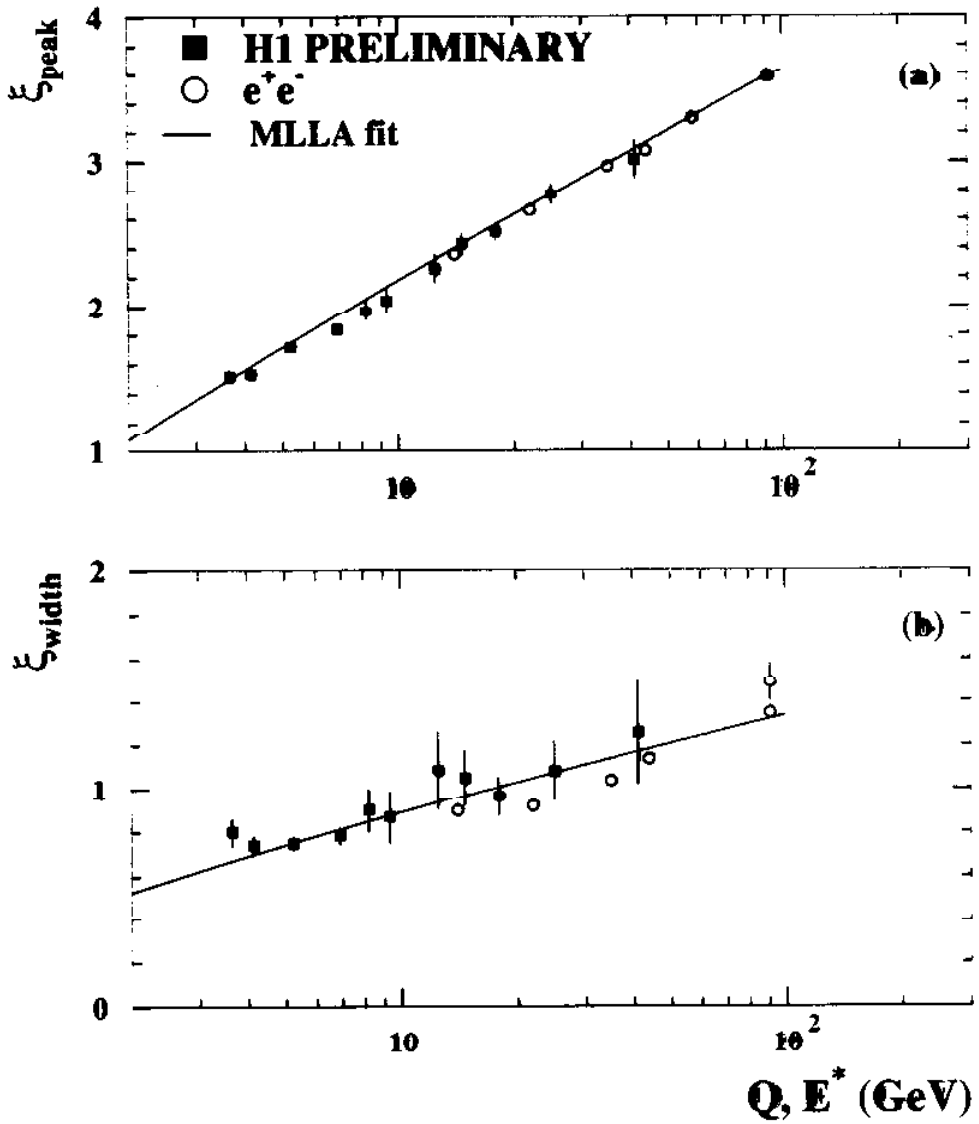
APPROX. GAUSSIAN AROUND THE PEAK
(EXPECTED IN MODIFIED LEADING LOG. APPROX. MLLA
+ LOCAL PARTON HADRON DUALITY LPHD)

Evolution of the Peak and Width of $D(\xi)$

Results of Simultaneous fit to H1 data ONLY

$\Lambda = 0.21 \pm 0.02$ GeV (*)

$\kappa = -0.43 \pm 0.06$



e^+e^-

$\Lambda = 0.21 \pm 0.026$

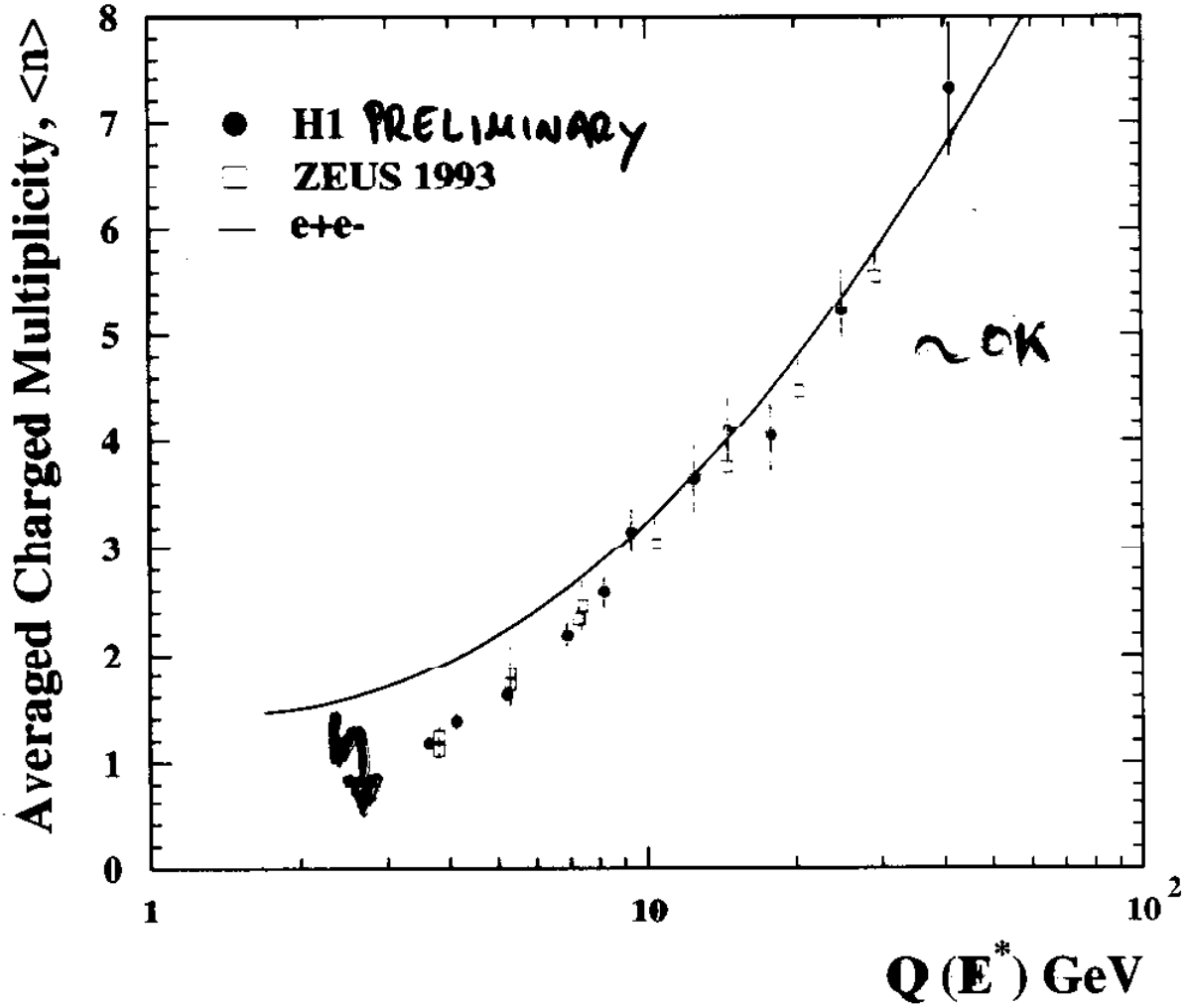
$\kappa = -0.32 \pm 0.06$

(*) MLLA/LPHD $\rightarrow$ $\xi_{PEAK} = 0.5\,Y + C_2\sqrt{Y} + \kappa$

$\xi_{WIDTH} = \sqrt{Y^{3/2}/2C_1}$

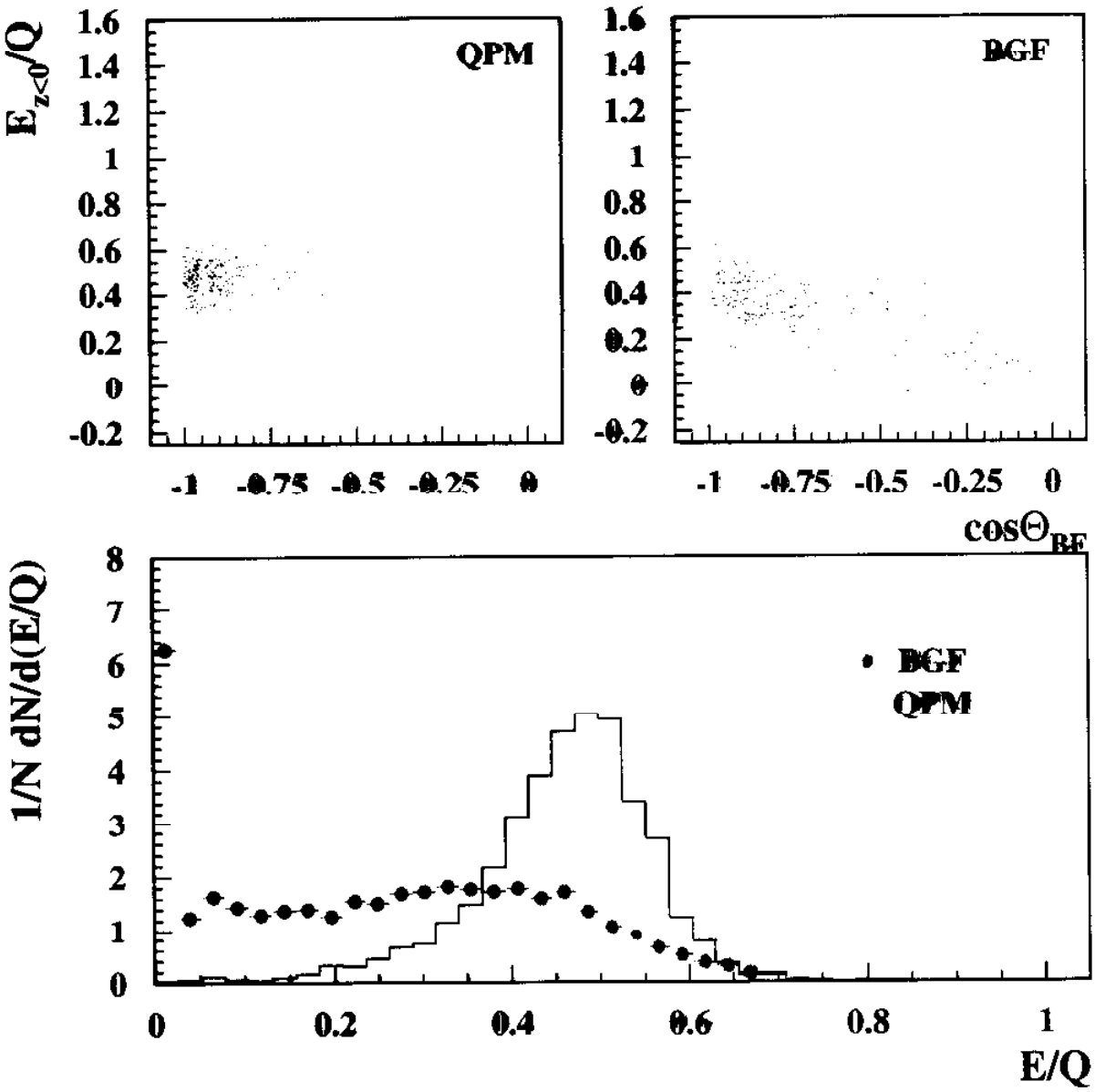
$Y = \ln(Q/\Lambda_{eff})$; C_1, C_2 CONSTANTS, DEPEND ON N_c, N_f

Averaged Charged Particle Multiplicity

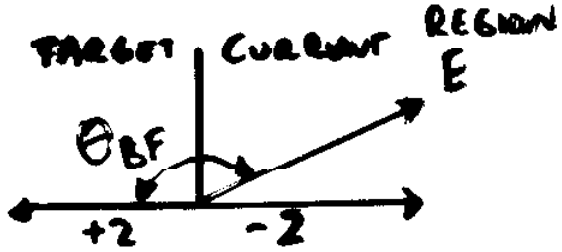


e^+e^- "CORRECTED" FOR K^0, Λ, b-quarks in e^+e^-

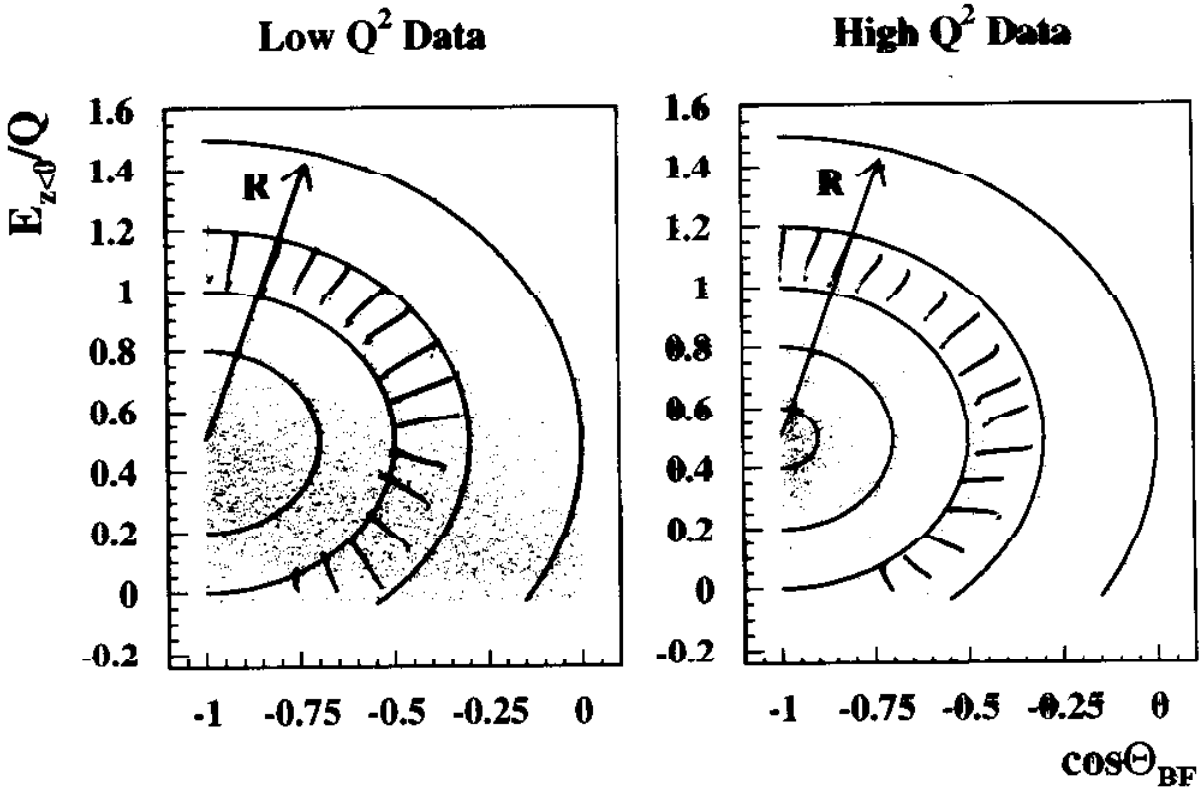
Tagged Events in Lepto 6.4 Generator



REDUCING THE EFFECT OF BOSON GLUON FUSION AND INITIAL STATE RADIATION



FOR ENERGY CLUSTERS IN THE CURRENT REGION: STUDY COSINE OF THE RESULTANT POLAR ANGLE VERSUS TOTAL ENERGY OF THE CLUSTERS

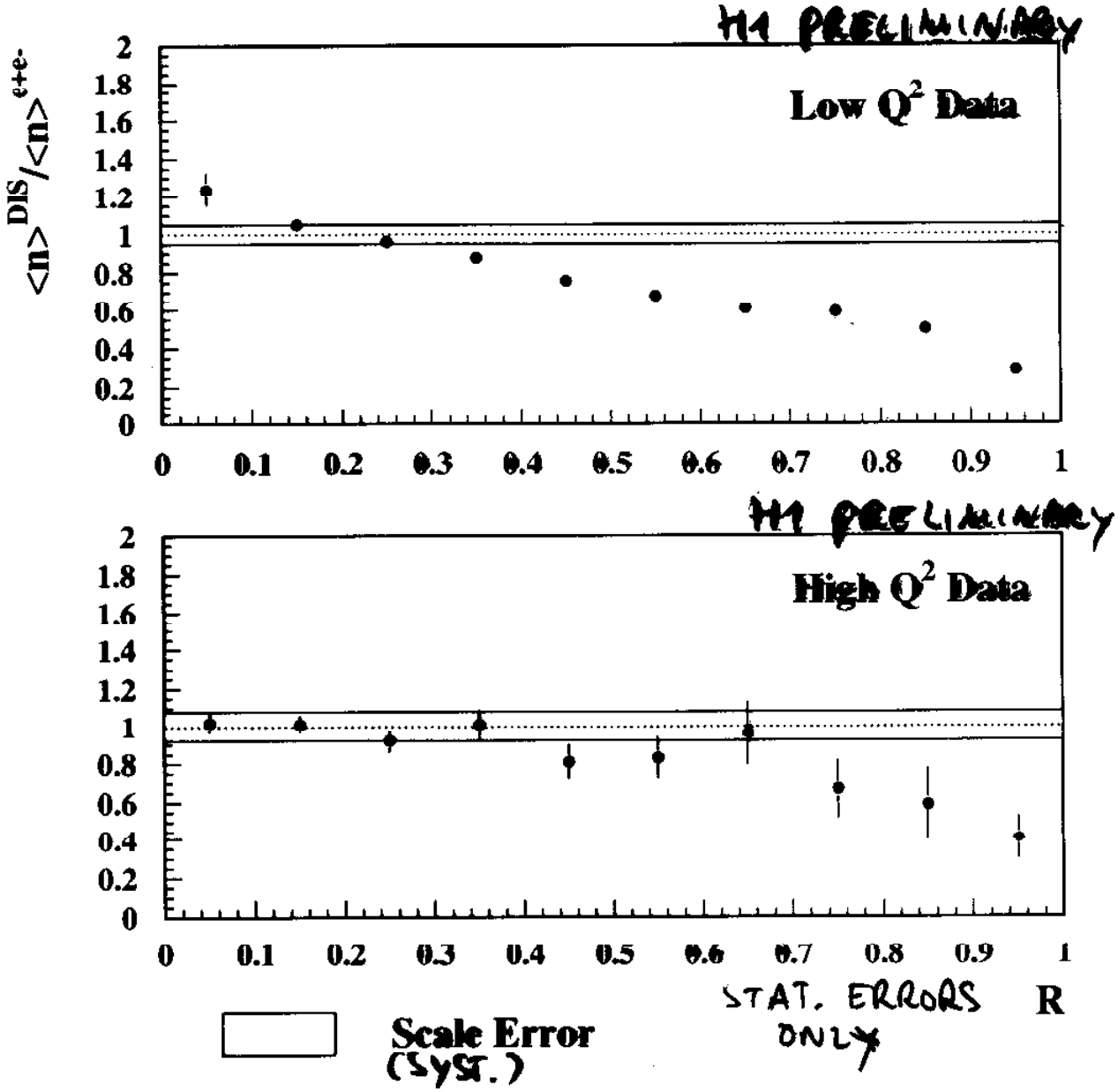


EXPECTATION OF QPM $E_{z<0} = Q/2$

$\cos\theta_{BF} = -1$

COMPARE $\langle m \rangle^{DIS} / \langle m \rangle^{e^+e^-}$ VS R

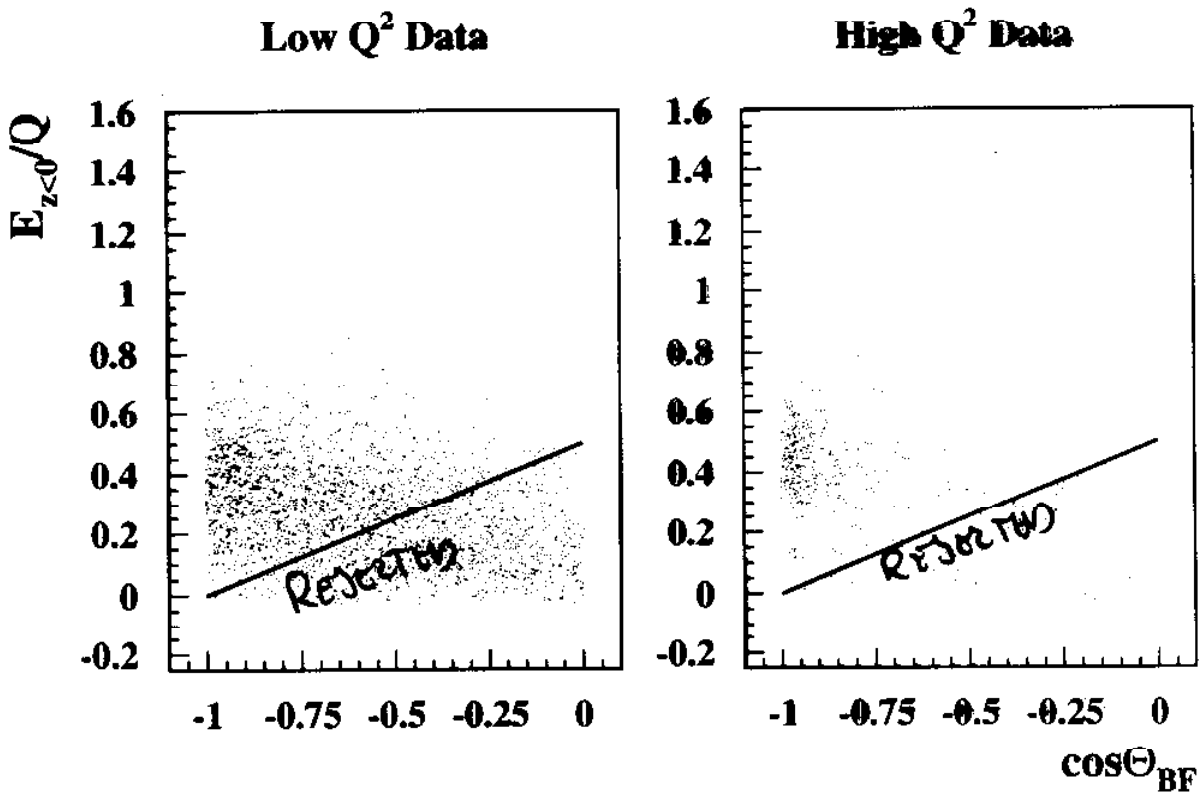
The Ratio of H1 Average Charged Multiplicity to that of a Single e+e- Hemisphere as a Function of the Radius R



IMPROVED AGREEMENT WITH e^+e^- FOR $R \to 0$

FOR FURTHER ANALYSES

BREIT FRAME ENERGY CUT

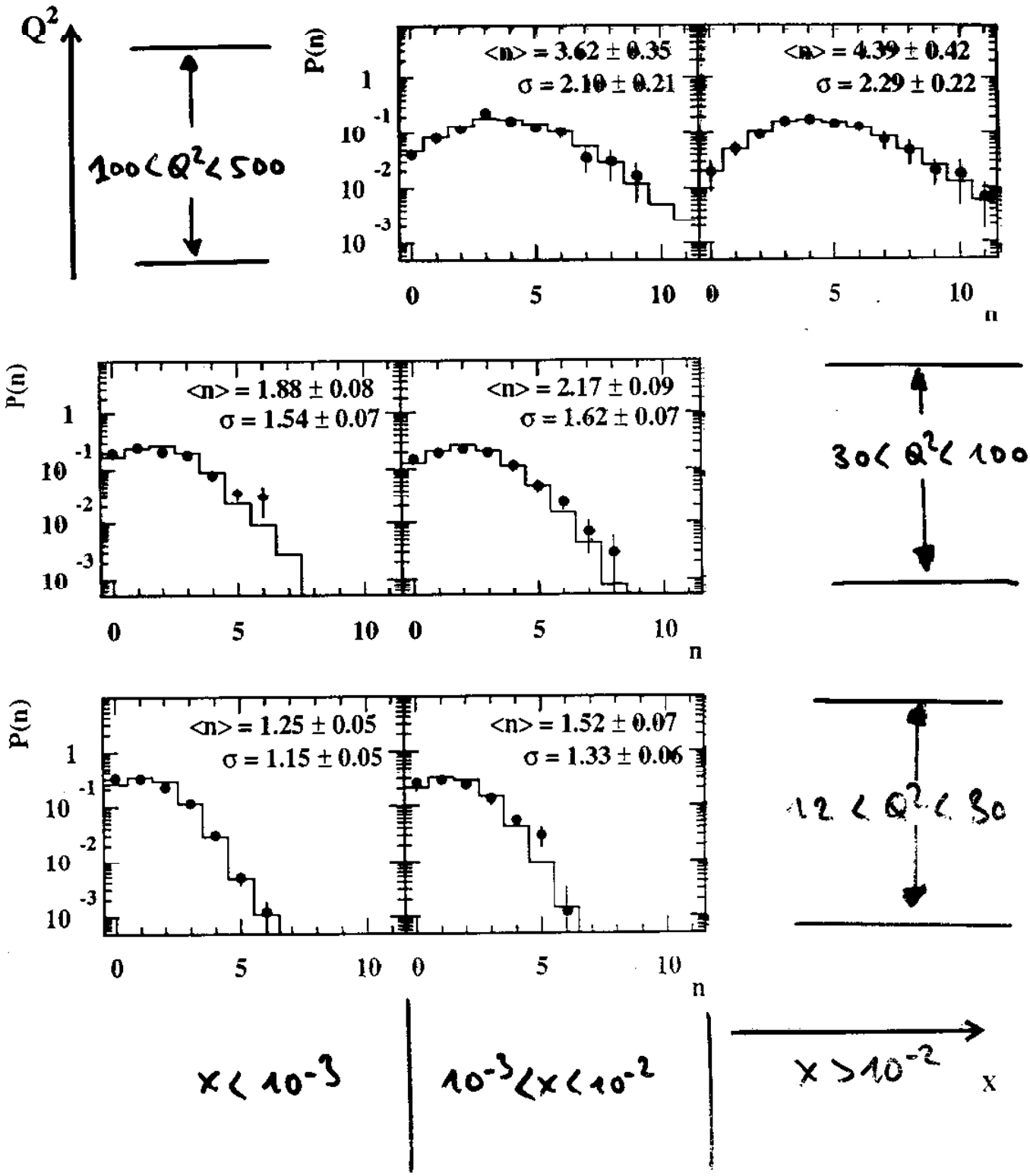


* PEAK AND WIDTH OF THE FRAGMENTATION FUNCTION ARE NOT SIGNIFICANTLY AFFECTED BY THIS CUT

MULTIPLICITY DISTRIBUTIONS

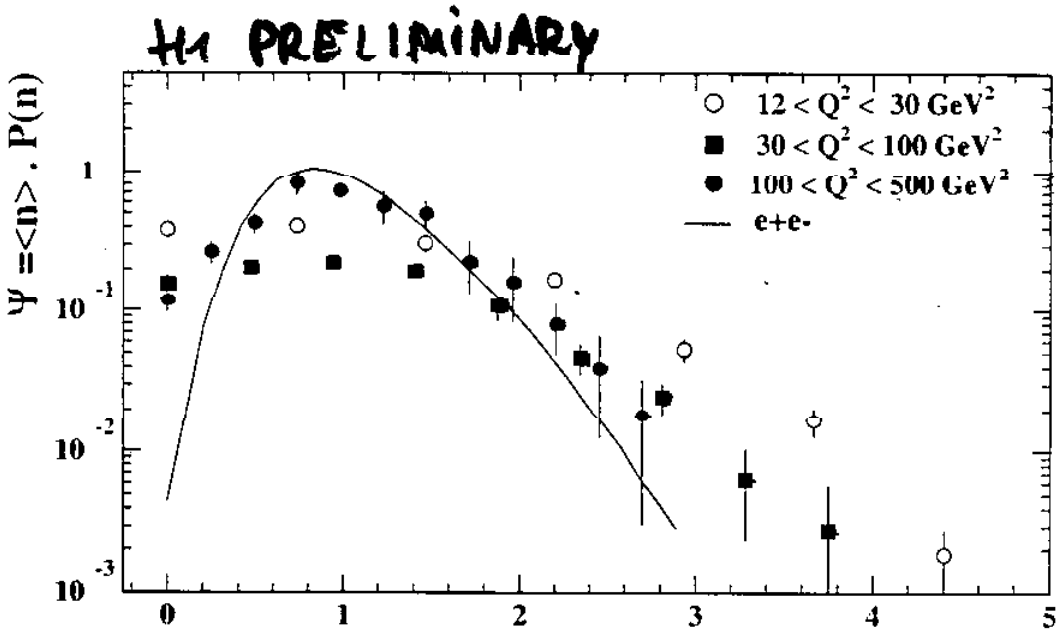
H1 PRELIMINARY

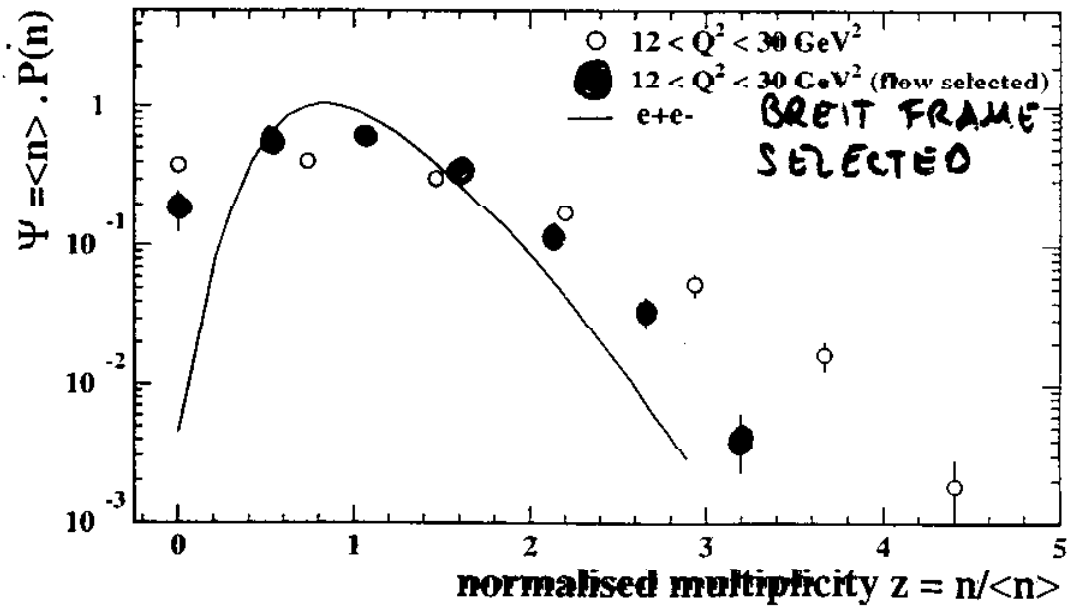
ALL EVENTS



MULTIPLICITY DISTRIBUTION / KNO FORM

KNO-SCALING VIOLATIONS AT LOW Q^2





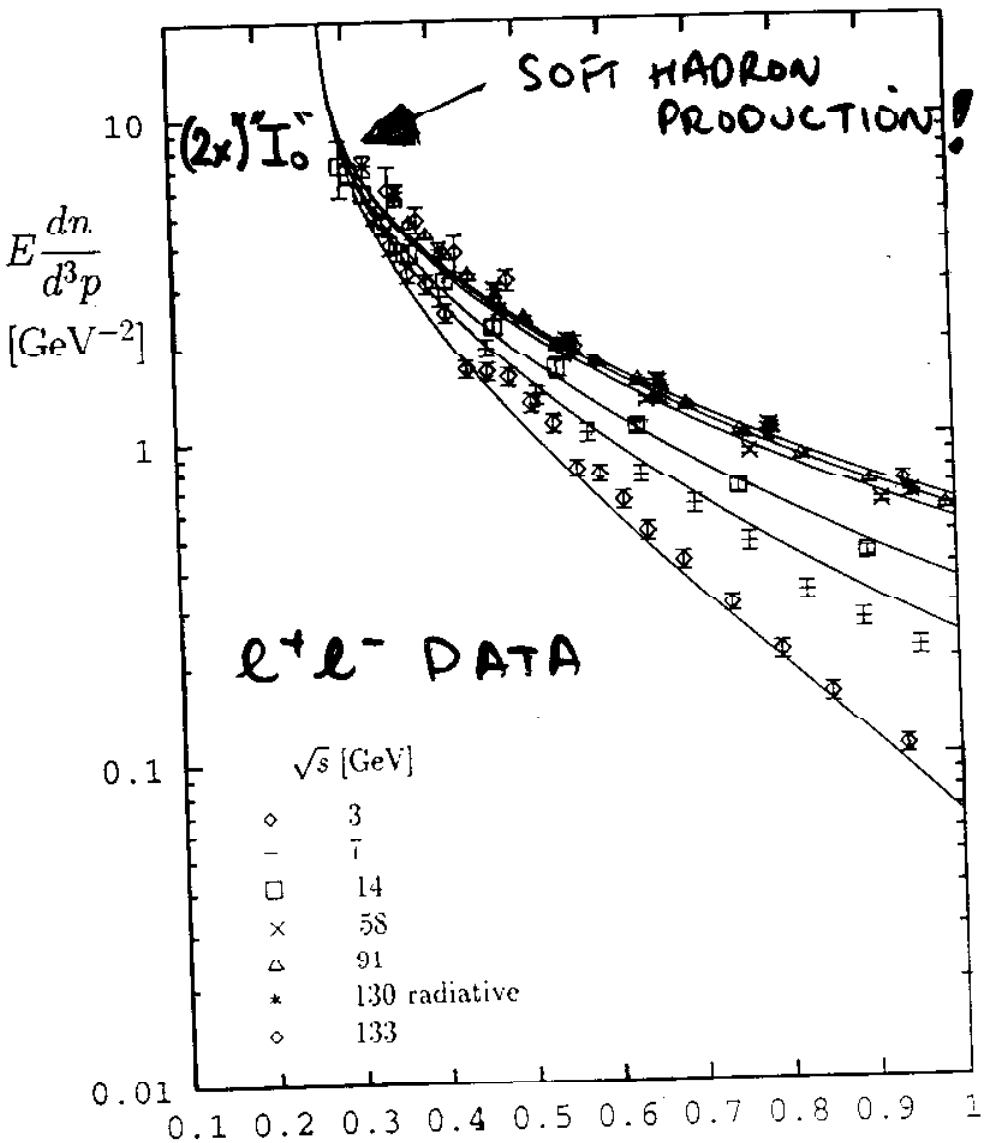
➡ SCALING VIOLATIONS REDUCED WHEN MORE "D+D-_LIKE" EVENTS ARE SELECTED

INVARIANT ENERGY SPECTRA

MEASURE $\frac{1}{N_{ev}} E \frac{dn}{d^3p}$ $\qquad I_0^{e^+e^-} = \frac{1}{2} \lim_{p \to 0} E \frac{dn}{d^3p}$

MLLA/LPHD SCALING EXPECTED AT SMALL p
COLOUR COHERENCE

V. KHOZE ET AL
HEP/PH 9610204



$E[GeV] = \sqrt{Q_0^2 + p^2}$

$e^+e^- \to 2\mu$ MeV

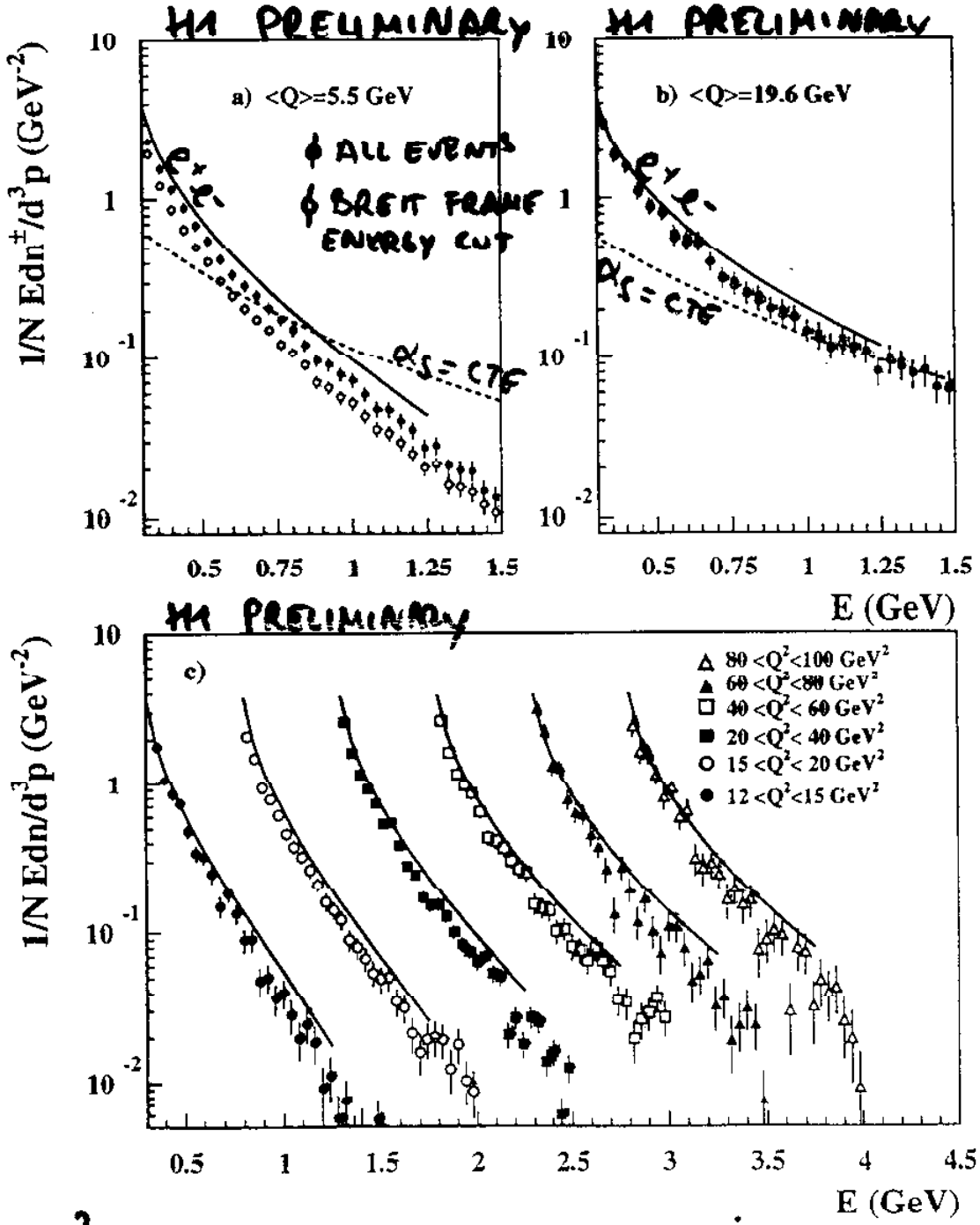
- "EFFECTIVE MASS SCALE"
- p_T^2 CUTOFF IN CASCADE

$I_0^{e^+e^-} \leftrightarrow I_0^{DIS}$?

INVARIANT ENERGY SPECTRA

→ MEASURED FOR THE FIRST TIME

$$I_0^{e^+e^-} \sim I_0^{DIS}$$



* ALL Q^2 ~ COMMON LOW ENERGY LIMIT
* VERY SENSITIVE TO α_S

SUMMARY

A NEW STUDY ON PARTICLE PRODUCTION IN THE CURRENT REGION OF THE BREIT FRAME

* FRAGMENTATION FUNCTIONS

- SCALING VIOLATIONS (Q^2)
- WIDTH AND PEAK OF $D(\xi)$ WITH Q^2 SIMILAR AS FOR e^+e^- ($\sqrt{s}$)

* AVERAGE MULTIPLICITIES

- DISCREPANCIES WITH e^+e^- AT LOW Q^2 (*) (<100 GeV^2)

* MULTIPLICITY DISTRIBUTIONS

- KNO SCALING VIOLATIONS AT LOW Q^2 (*) (<100 GeV^2)

(*) BOTH EFFECTS ARE REDUCED WITH CUTS WHICH REDUCE $O(\alpha_s)$ PROCESSES ABSCENT IN e^+e^- (BGF, IN. ST. QCD-C)

* INVARIANT ENERGY SPECTRA

- MEASURED FOR THE FIRST TIME IN DIS
- LOW ENERGY PART OF THE SPECTRA IS CONSISTENT WITH A COMMON LIMIT $\sim e^+e^-$

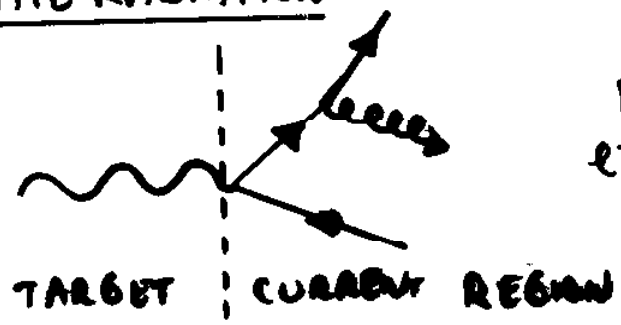
→ DATA SUPPORT THE CONCEPT OF QUARK FRAGMENTATION UNIVERSALITY

EXPECTED DIFFERENCES

e^+e^- ↔ LEPTON-HADRON

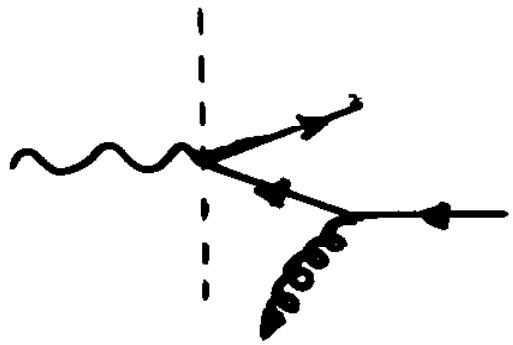
$O(\alpha_s)$ DIAGRAMS

1) FINAL STATE RADIATION



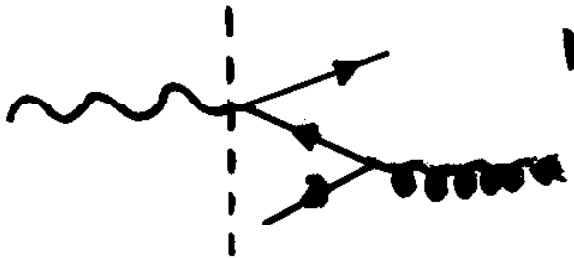
BOTH IN e^+e^- AND DIS

2) INITIAL STATE RADIATION



NOT IN e^+e

3) BOSON GLUON FUSION

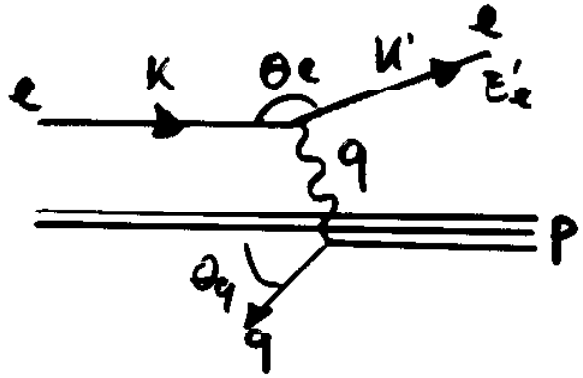


NOT IN e^+e^-

CUTS WILL BE MADE TO REDUCE THE CONTRIBUT FROM 2) AND 3) (MONTE CARLO INSPIRED)

EVENT AND CHARGED PARTICLE SELECTION

'94 H1 DATA $\int \mathcal{L} dt \sim 1.3\ pb^{-1}$



* x, Q^2 CALCULATED FROM SCATTERED ELECTRON (θ_e,

* $E'_e > 14$ GeV
  $0.05 < y < 0.6$
  W^2 (ELECTR./HADRONS) > 4400 GeV
  } SMALL γp BACKGROUND AND RADIATIVE CORRECTIONS

* $10° < \theta_q < 150°$ — ACCEPTANCE IN DETECTOR

* $\sum_{\theta=4.4°}^{\theta=15°} E > 0.5$ GeV — EXCLUDE RAPIDITY GAP EVENTS (NO CORRESP. IN e^+e^-)

* VERTEX ...

→ LOW Q^2 SAMPLE $157° < \theta_e < 172.5°$, $12 < Q^2 < 100$ GeV^2 — 20810 EVT

HIGH Q^2 SAMPLE $10° < \theta_e < 150°$, $Q^2 > 100$ GeV^2 — 1250 EVT

* CHARGED PARTICLES: "CENTRAL" ~ ($20° < \theta < 160°$) : $p_T > 150$ M
  "FORWARD" ~ ($\theta < 20°$) : $p > 500$ Me
  + TRACK QUALITY CUTS

CHARGED PARTICLE PRODUCTION IN THE CURRENT FRAGMENTATION REGION OF THE BREIT FRAME AT HERA

FRAGMENTATION AND SCALING VIOLATIONS

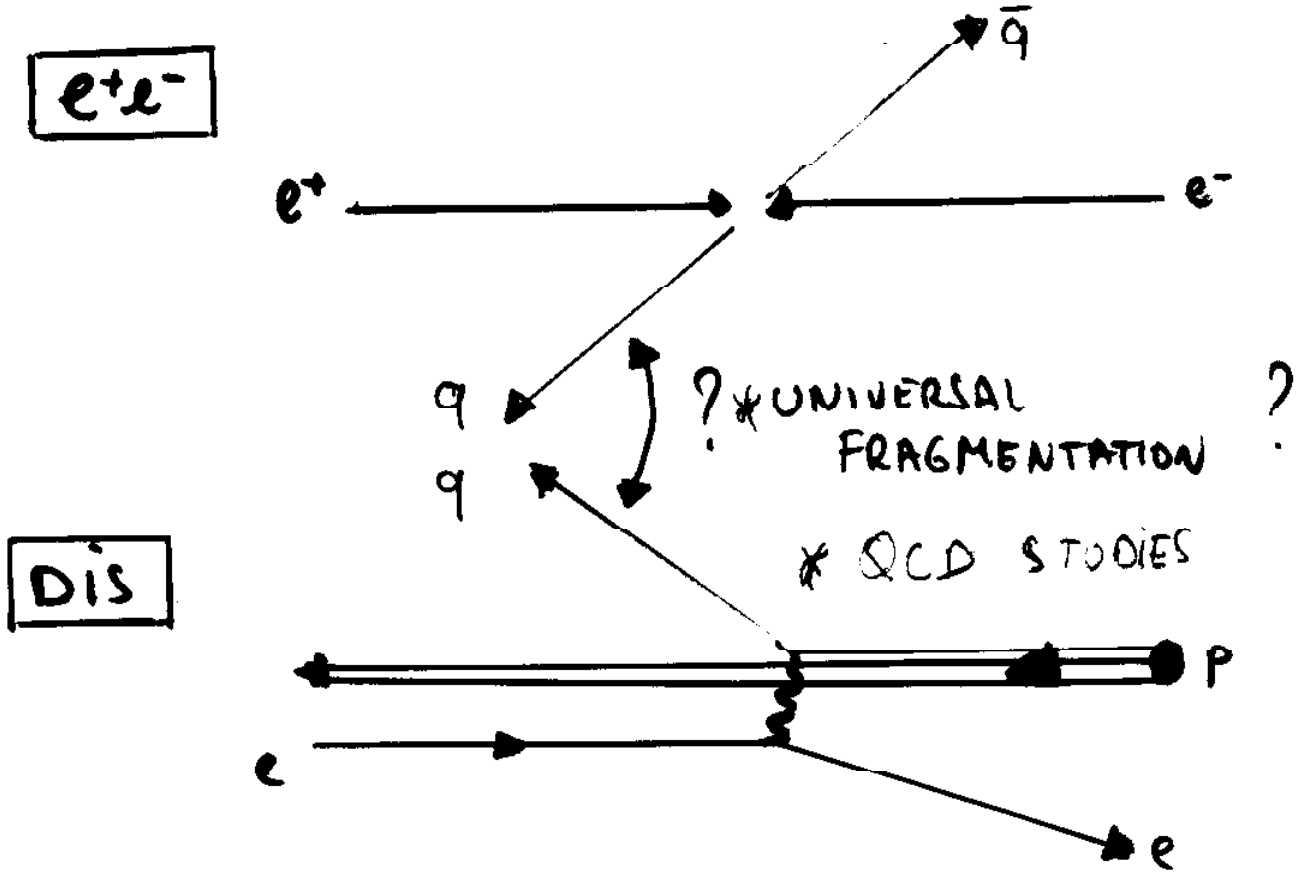
H1-COLLABORATION

A. DE ROECK/DESY

CONTENTS

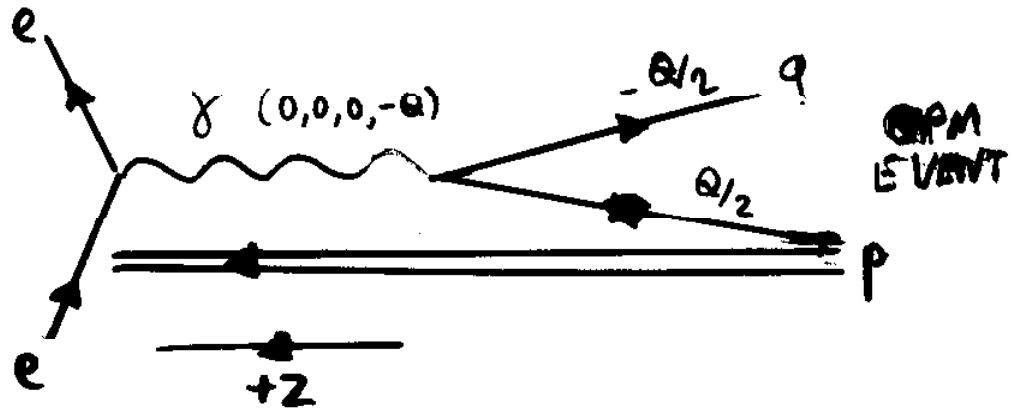
* INTRODUCTION
* FRAGMENTATION FUNCTION
* AVERAGE MULTIPLICITIES
* MULTIPLICITY DISTRIBUTIONS
* INVARIANT DENSITIES $E\frac{dn}{d^3p}$
* SUMMARY

QUARK FRAGMENTATION



CURRENT QUARK FRAGMENTATION REGION
→ CURRENT (-Z) REGION IN THE BREIT FRAME

(?) $Q_{DIS} = \sqrt{S_{e^+e^-}}$



COLLINEAR WITH $\gamma^* p$ CMS SYSTEM