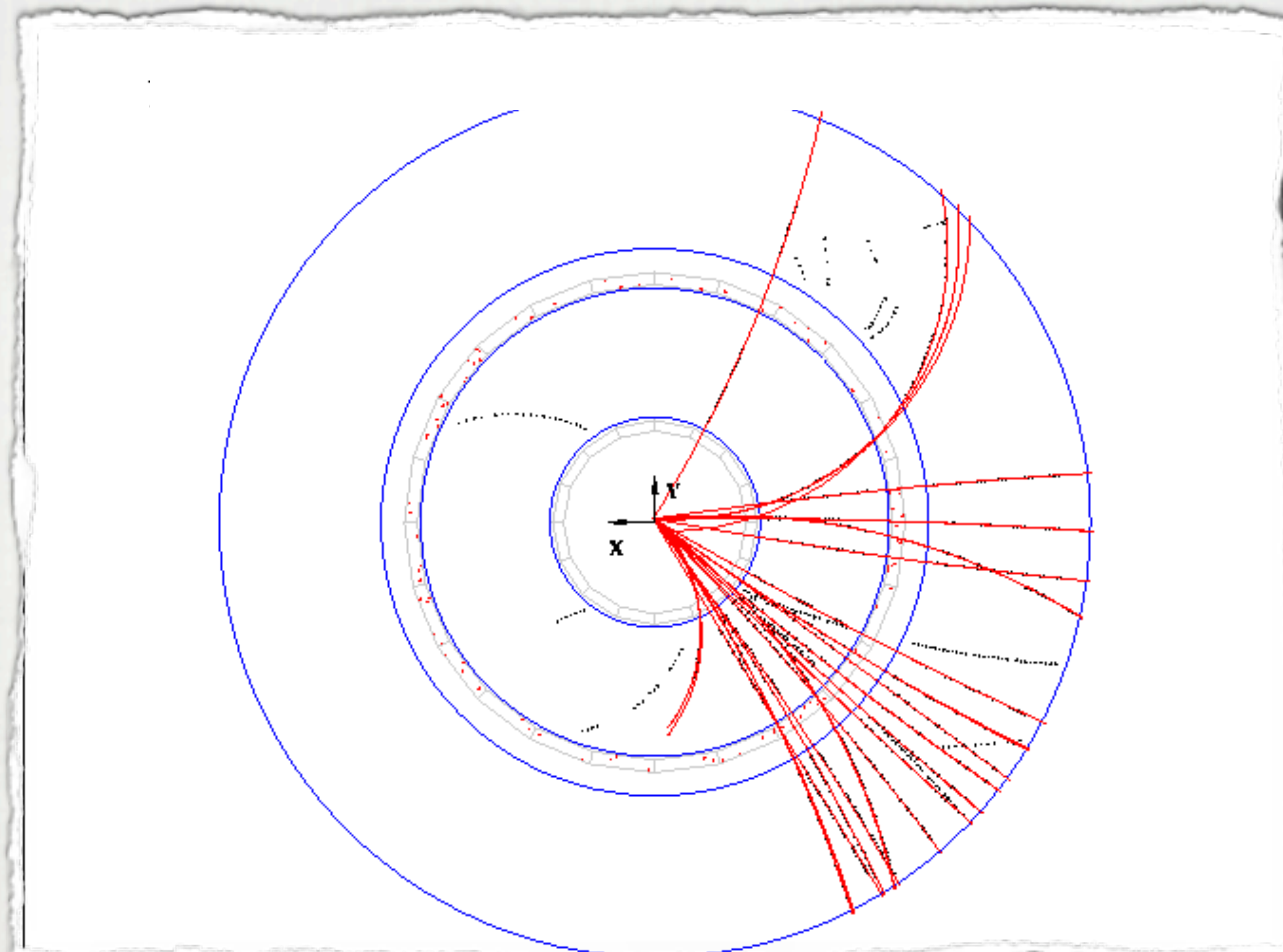
CHARGED PARTICLE PRODUCTION AT H1



DANIEL TRAYNOR, DIS 2008

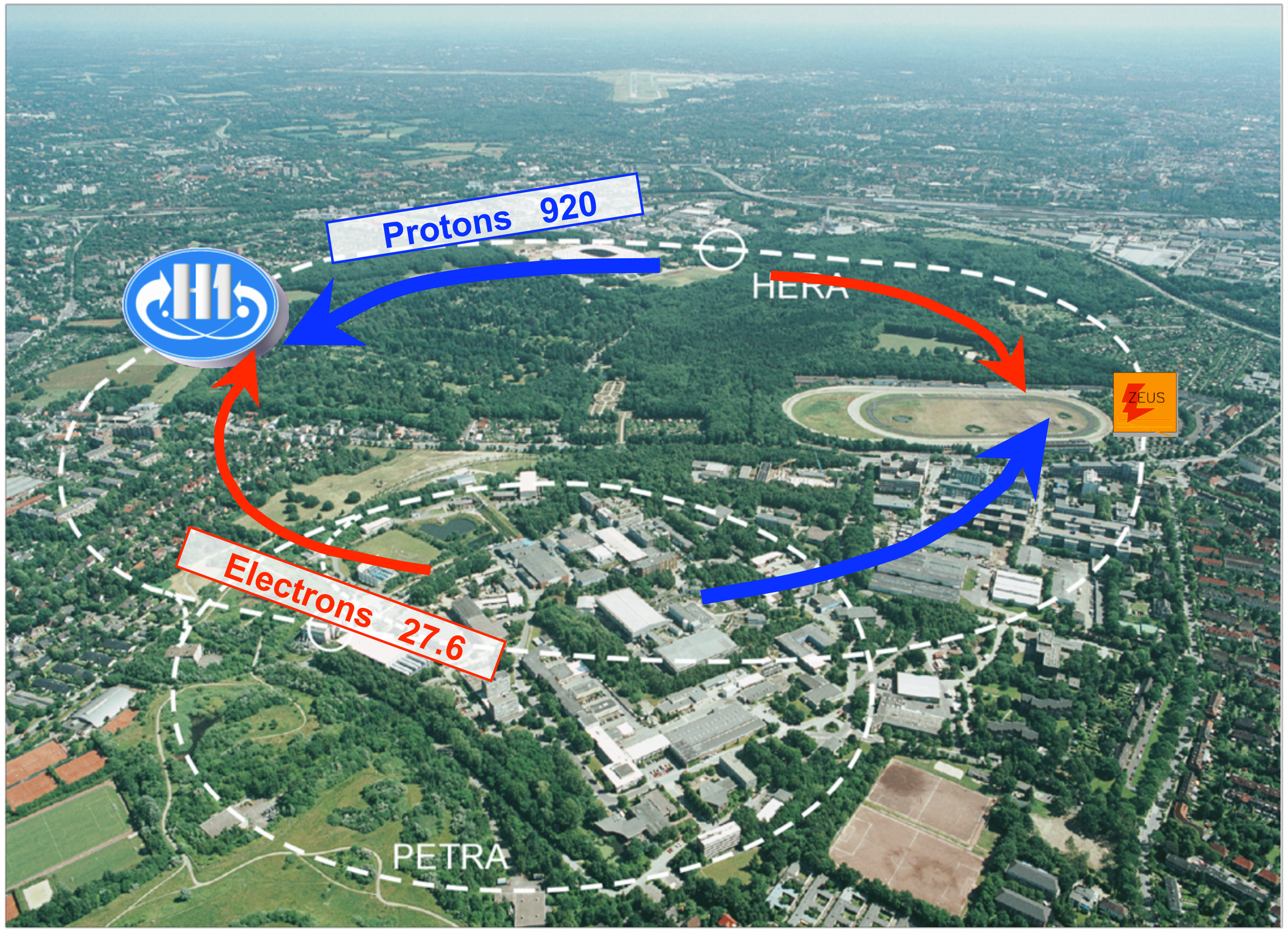
OVERVIEW

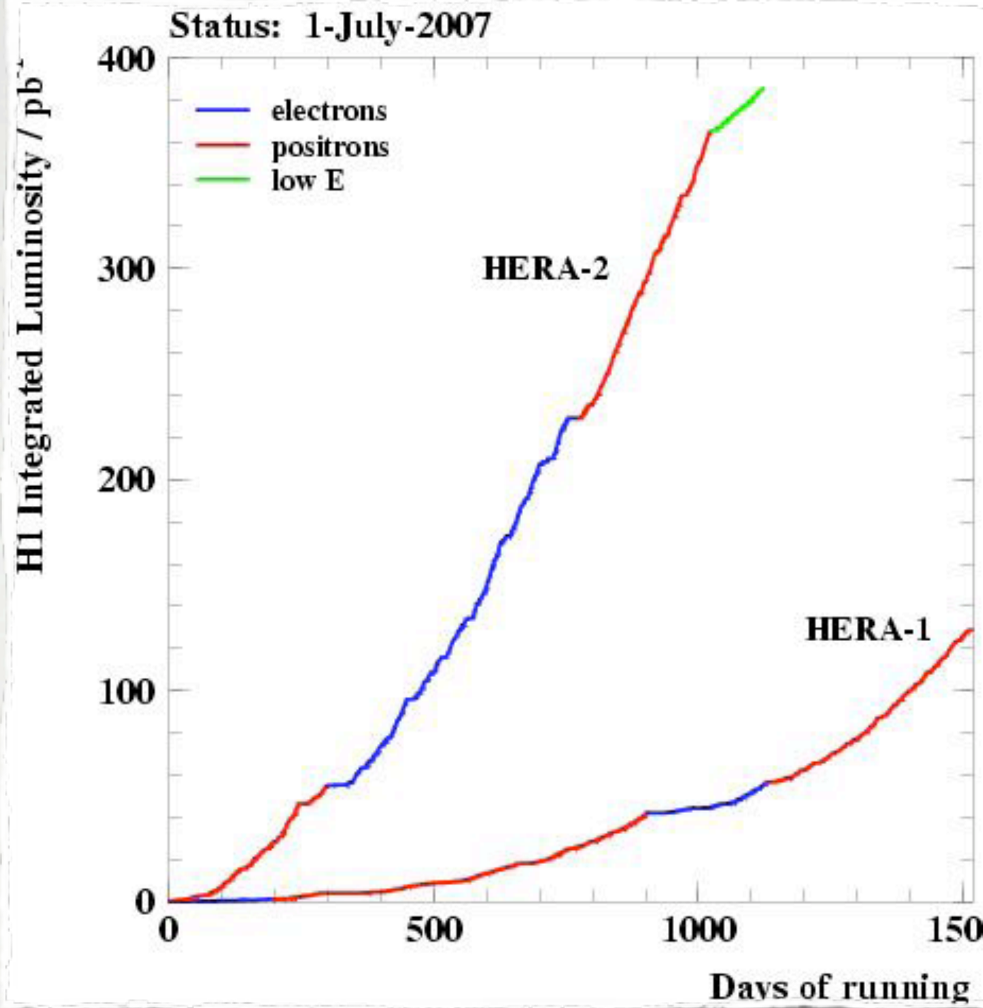
- GENERAL INTRO (HERA, H1, AND SOME THEORY).
- AVERAGE CHARGED PARTICLE MULTIPLICITY: VS e^+e^-, MONTE CARLO PREDICTIONS.
- FRAGMENTATION FUNCTION: VS e^+e^-, MONTE CARLO AND NLO QCD PREDICTIONS.
- SUMMARY.

RESULTS TAKEN FROM:

H1 COLLABORATION., F.D. AARON ET AL., PHYS.LETT.B654:148-159,2007.

ARXIV:0706.2456[HEP-EX]



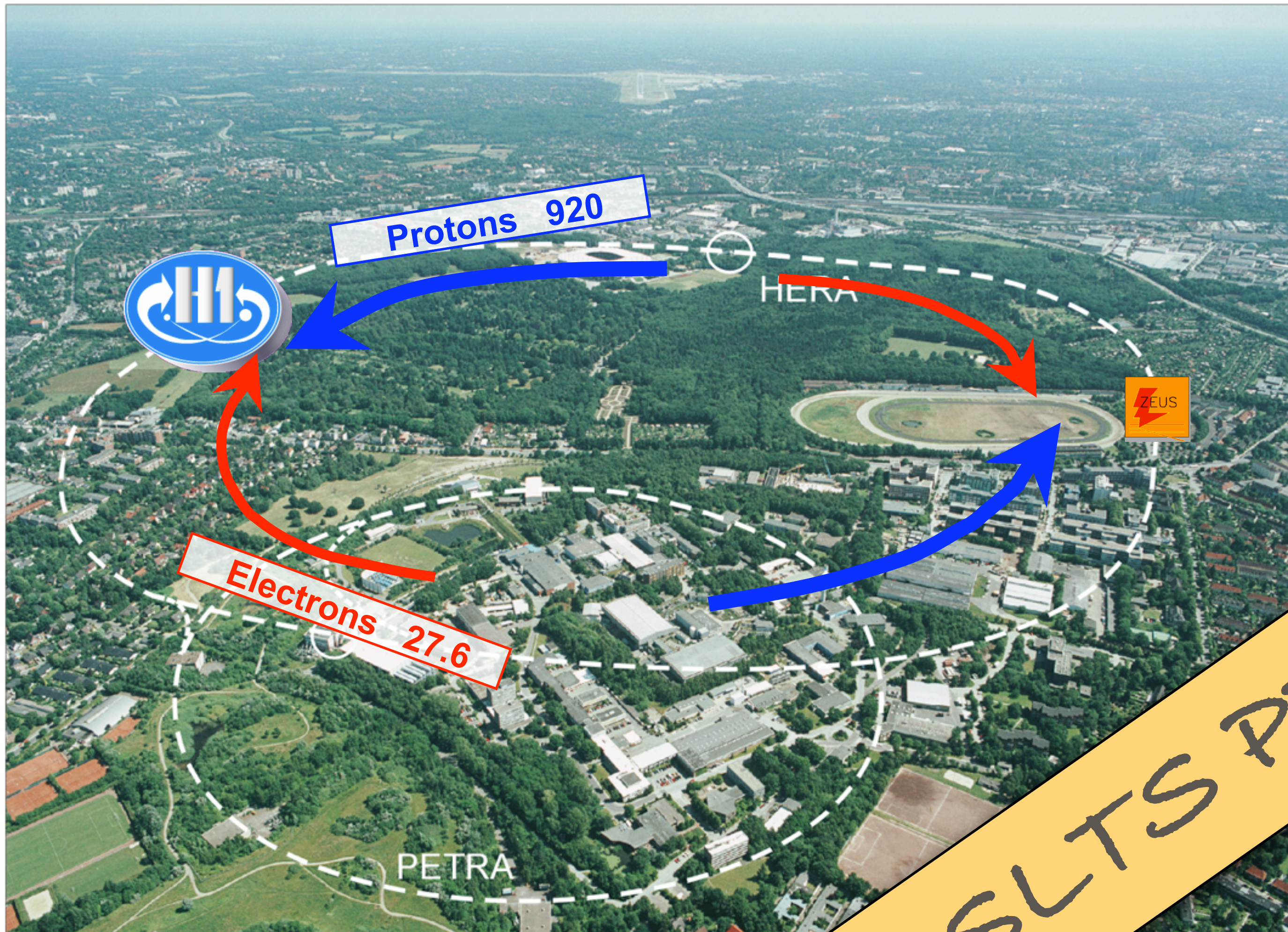


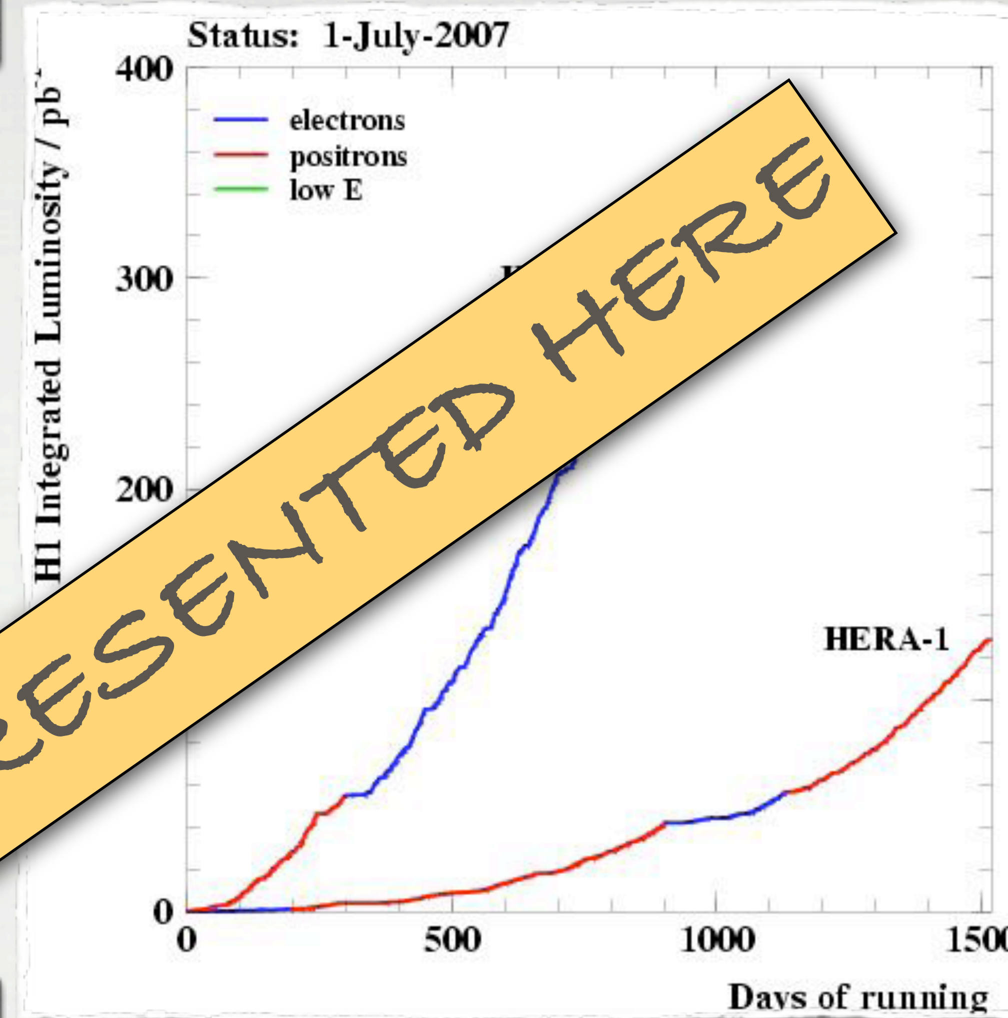
H1 PHYSICS USABLE SAMPLE ~500 pb^{-1}

ELECTRONS OR POSITRONS

4 DIFFERENT PROTON ENERGIES

POLARISED LEPTON BEAMS





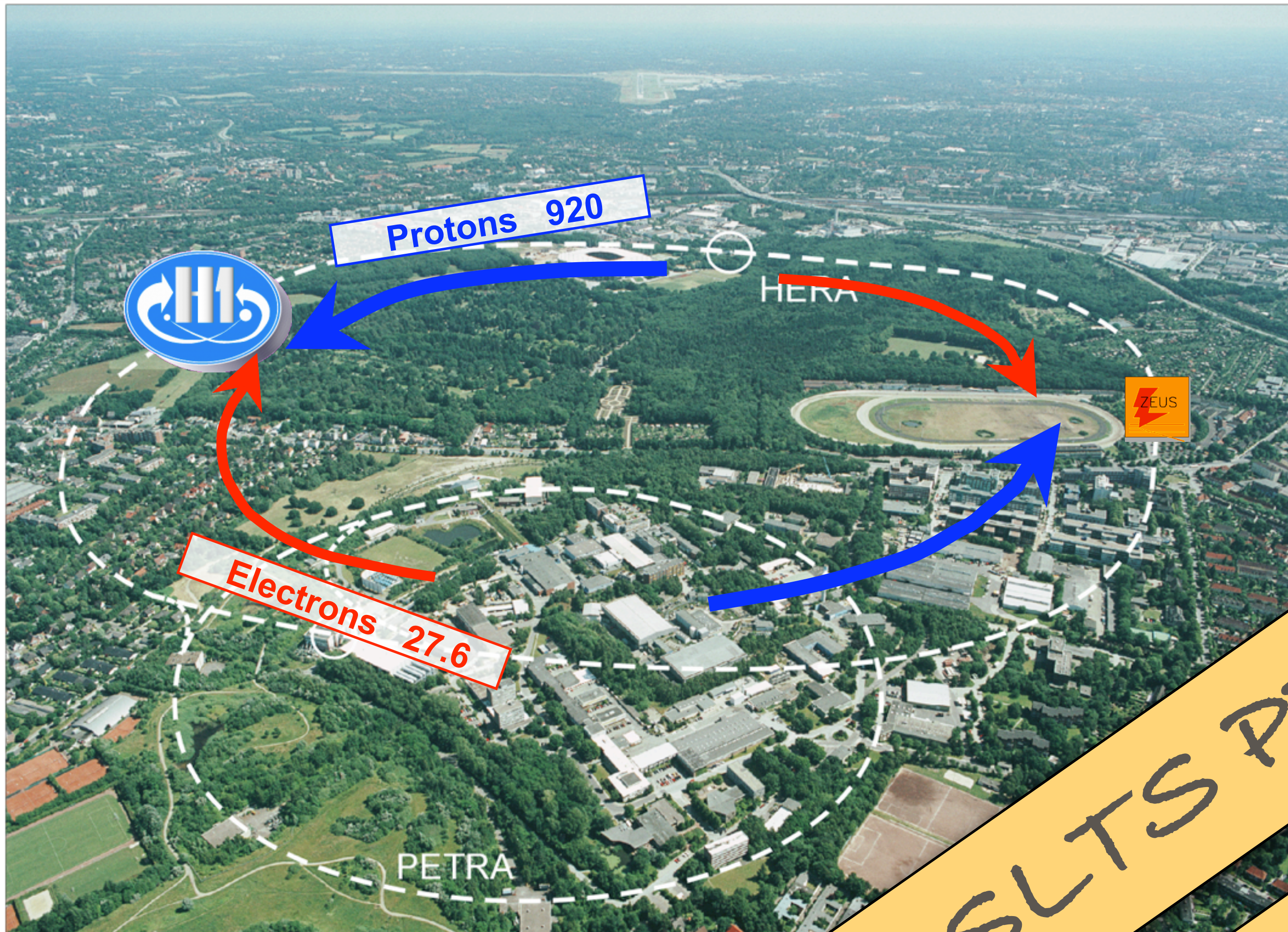
ONLY HERA I RESLTS PRESENTED HERE

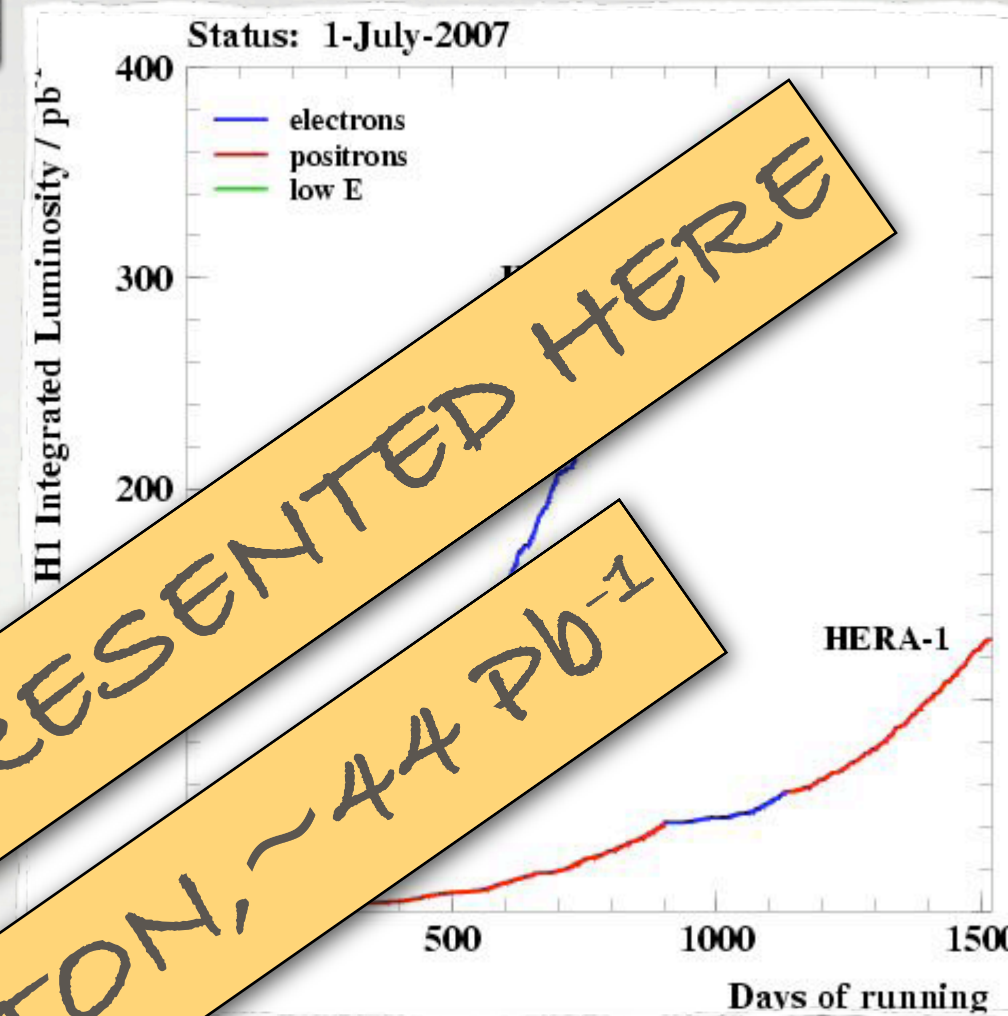
H1 P… S USABLE SAMPLE ~500 pb^{-1}

ELECTRONS OR POSITRONS

4 DIFFERENT PROTON ENERGIES

POLARISED LEPTON BEAMS





ONLY HERA I RESLTS PRESENTED HERE

POSITRON - PROTON, ~44 pb^{-1}

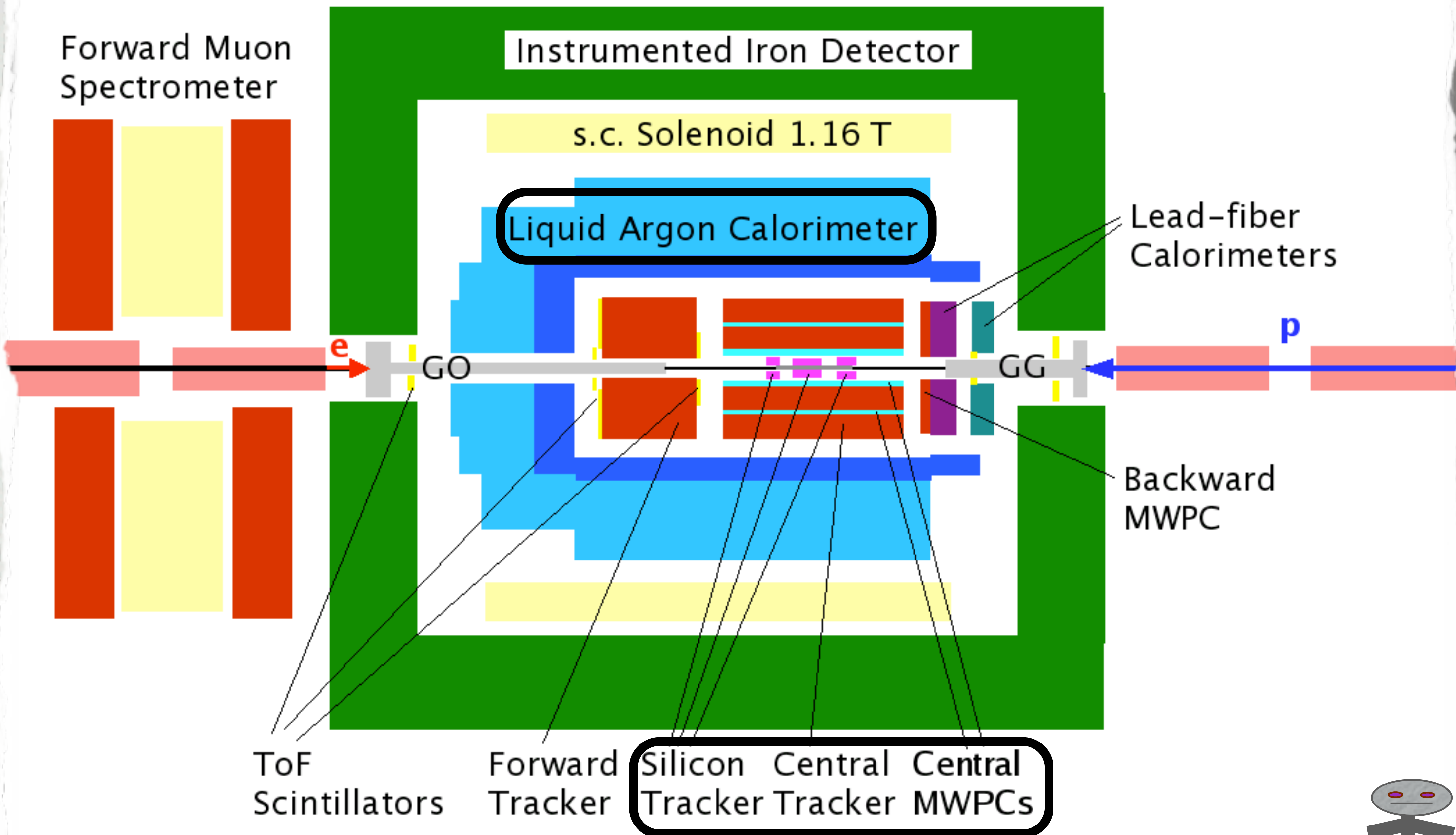
H1 P... SAMPLE ~500 pb^{-1}

...CTRONS OR POSITRONS

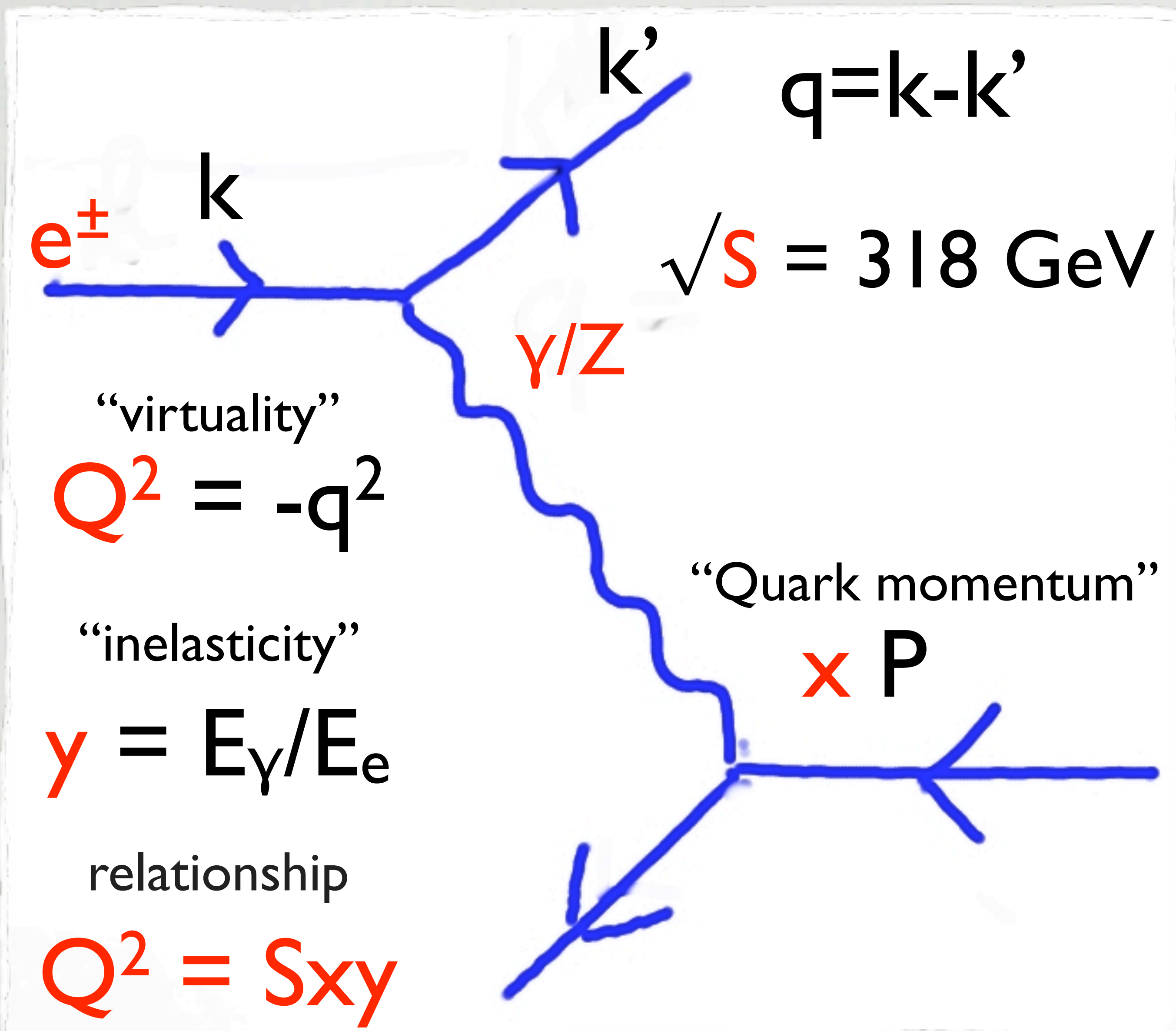
...ERENT PROTON ENERGIES

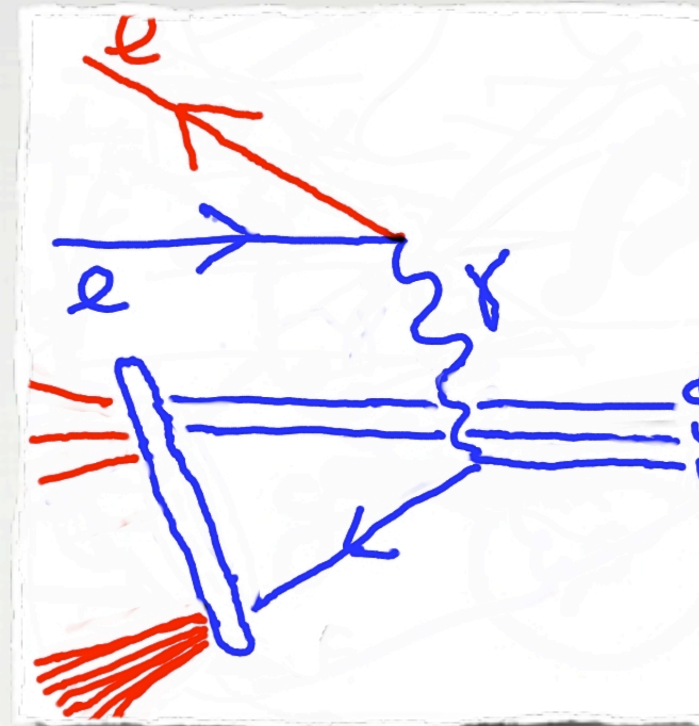
POLARISED LEPTON BEAMS

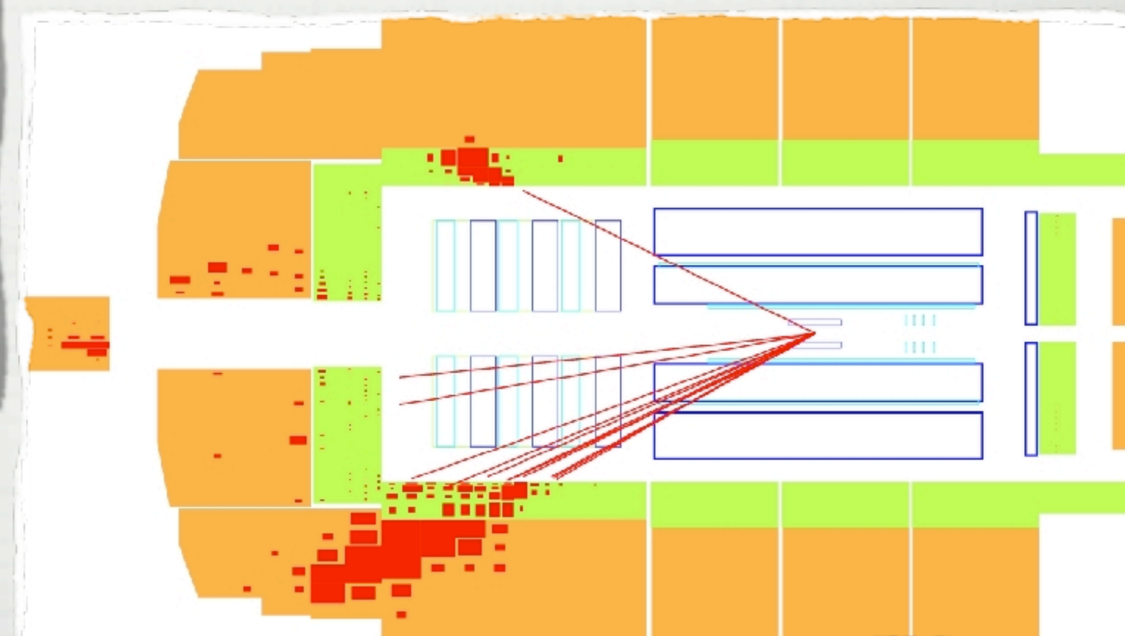
H1 AND HERA


Forward Muon Spectrometer
Instrumented Iron Detector
s.c. Solenoid 1.16 T
Liquid Argon Calorimeter
Lead-fiber Calorimeters
e
GO
GG
p
Backward MWPC
ToF Scintillators
Forward Tracker
Silicon Tracker
Central Tracker
Central MWPCs

H1





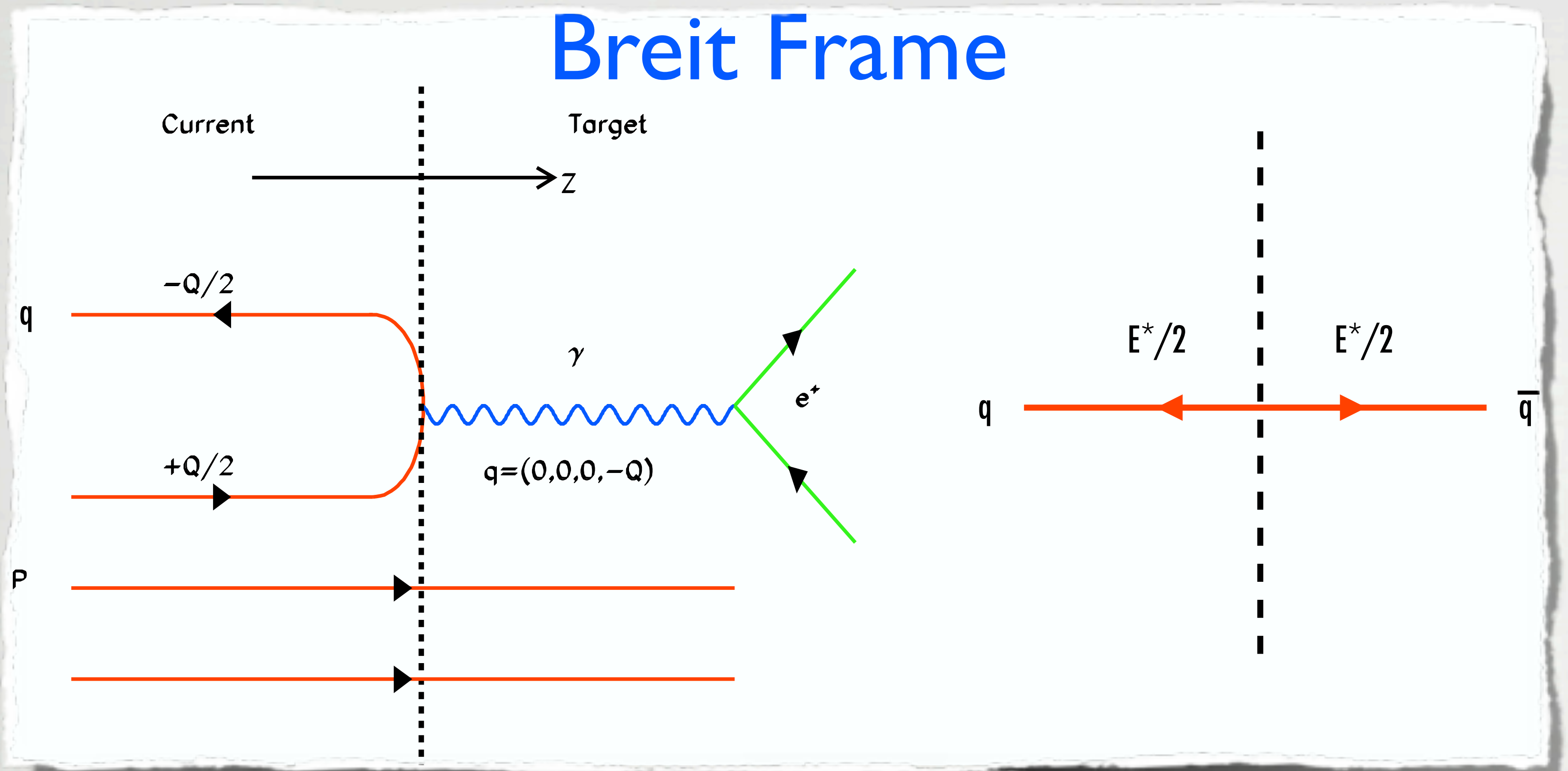


DIS, BORN LEVEL

DEEP INELASTIC SCATTERING

THE BREIT FRAME

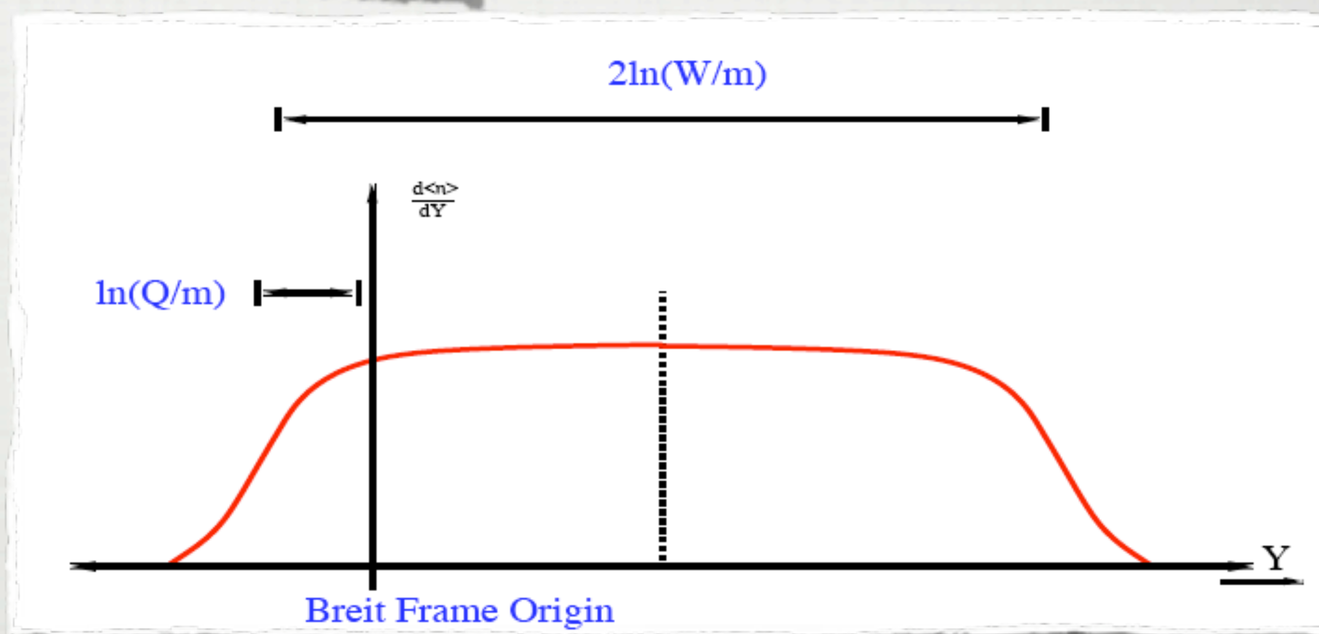
$ep \to eX$ $\qquad$ $e^+e^- \to q\bar{q}$



PROVIDES CLEAREST SEPARATION BETWEEN PARTICLES FROM HARD SCATTERING AND PROTON REMNANT. ALLOWS FOR EASY COMPARISON WITH e^+e^- DATA

CURRENT REGION ENERGY SCALE IS Q/2

BOOST TO BREIT FRAME MEANS WE MEASURE DOWN TO $P_{BREIT} = 0$!



KINEMATIC PHASE SPACE

$100 < Q^2 < 20{,}000$ GEV^2

$0.05 < Y < 0.6$

$\theta_{electron} > 150°$

$30° < \theta_{q,lab} < 150°$

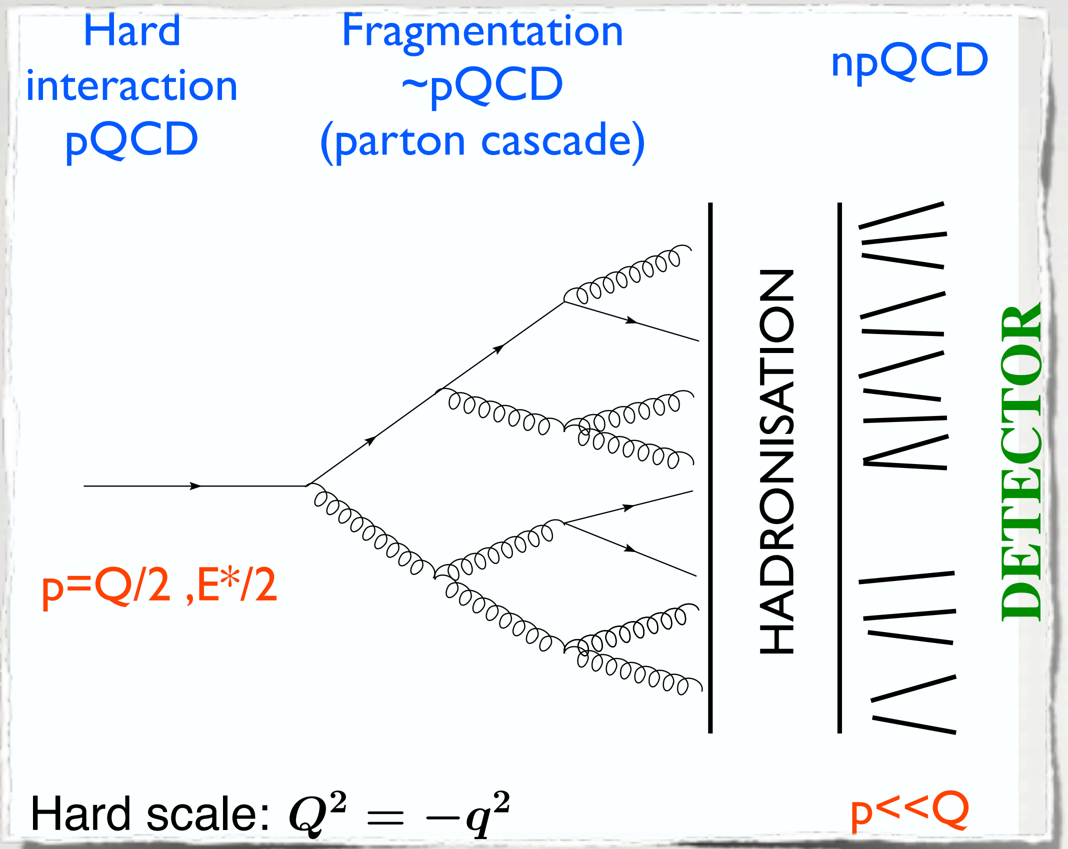
QUARK SCATTERING ANGLE, $\Theta_{Q,LAB}$, CALCULATED FROM KINEMATICS.
ENSURES CURRENT REGION OF BREIT FRAME REMAINS WITHIN TRACKING ACCEPTANCE.
EASY TO CALCULATE IN THEORY!

CORRECTION FACTOR < 1.2. DOMINATED BY BOOST TO BREIT FRAME. CORRECTION FOR TRACKING EFFICIENCIES FEW %

SYSTEMATIC ERROR ~5%

K^0, Λ, ETC.. CONSIDERED AS STABLE

EXPERIMENTAL POINTS



$\pi^{+/-}$

$K^{+/-}$

$p^{+/-}$

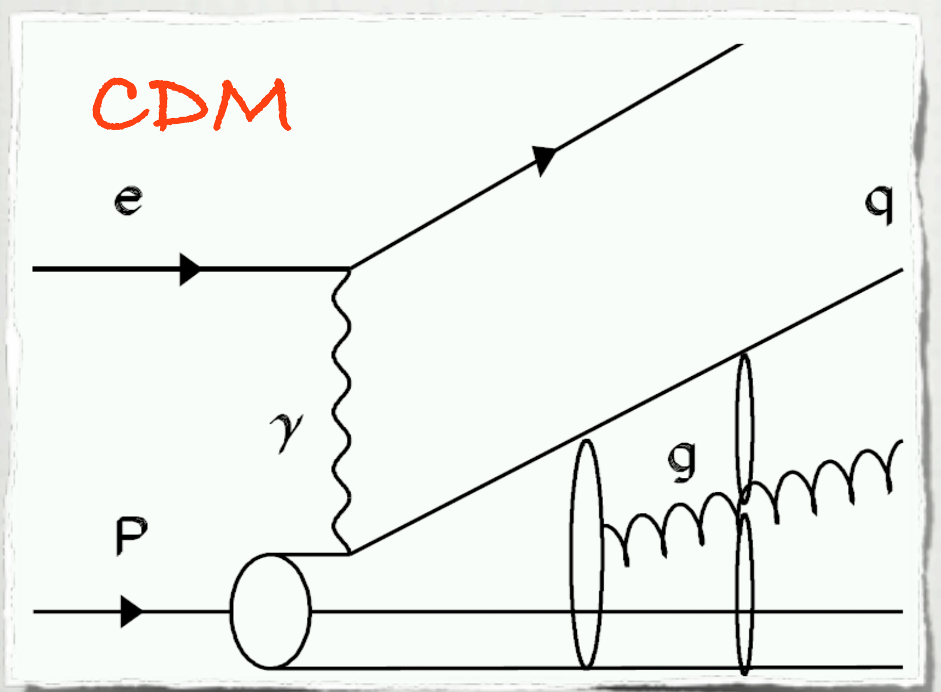
~~K^0...~~

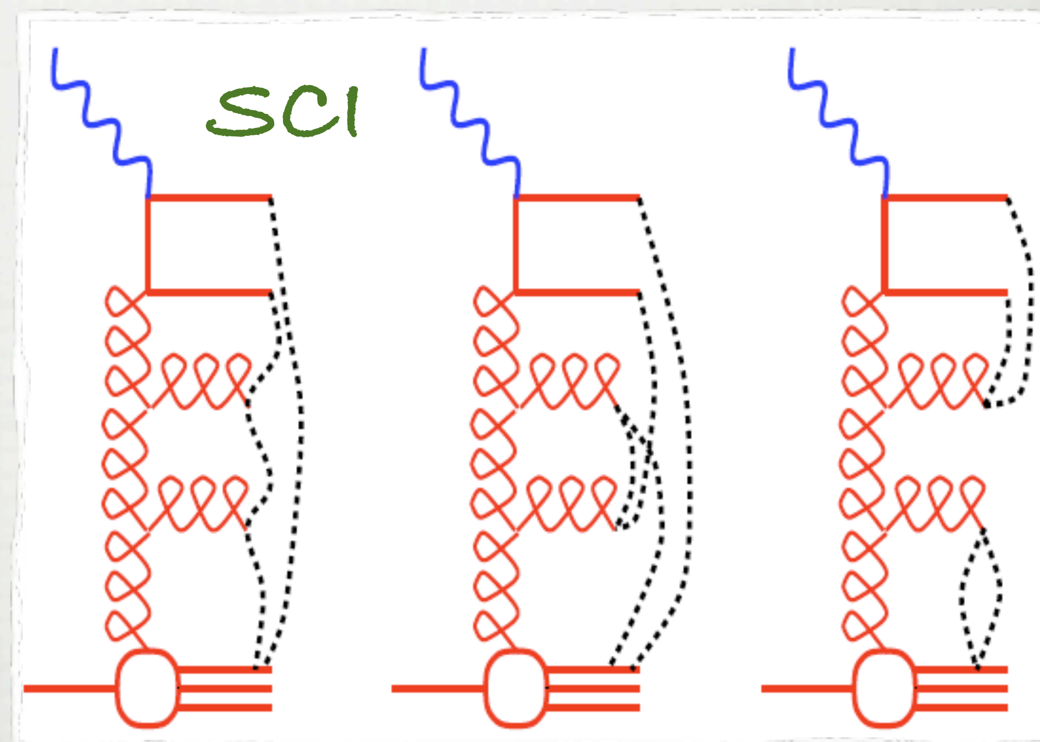
LEPTO (PARTON SHOWERS + STRING)

SCI (LEPTO + SOFT COLOUR INTERACTIONS)

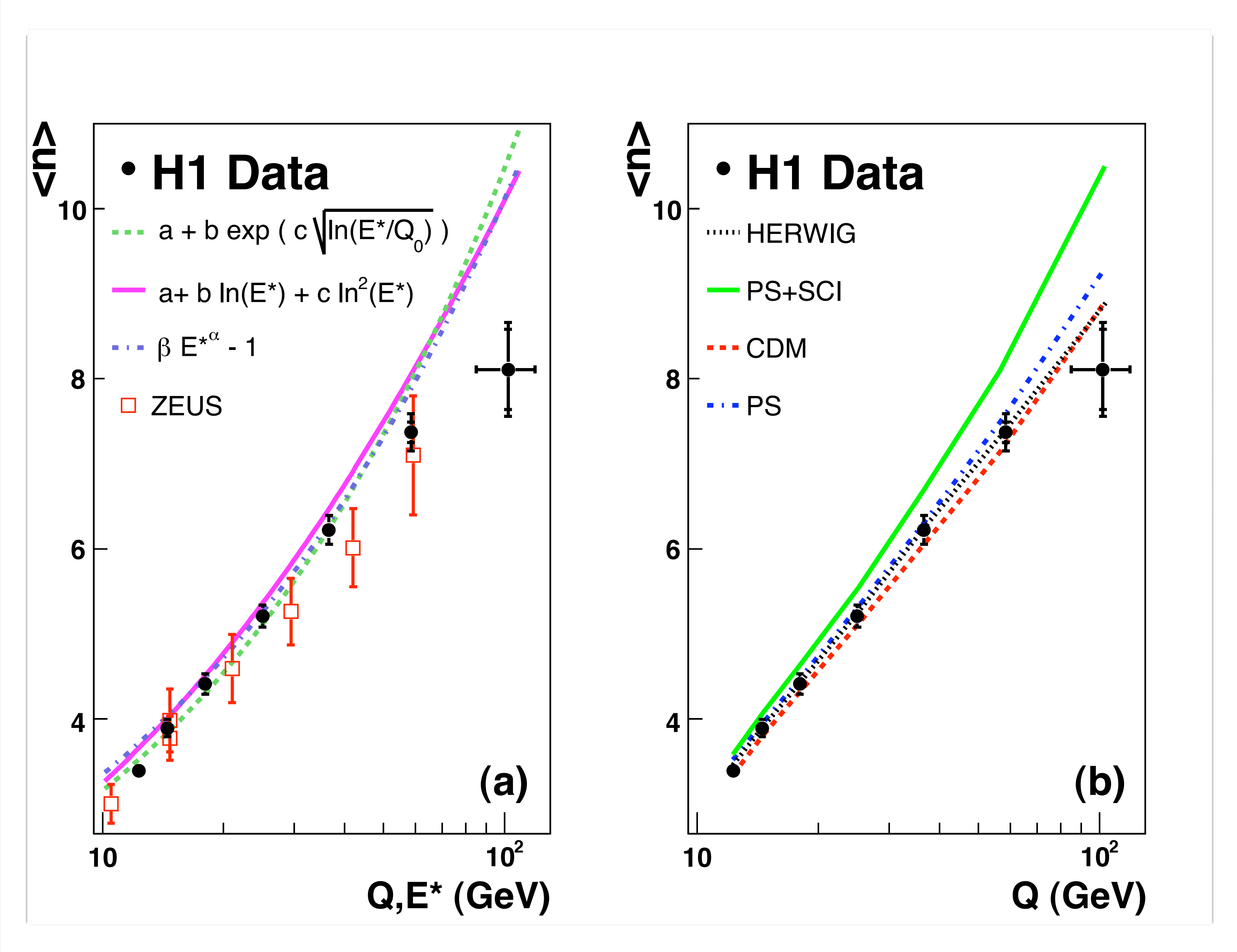
ARIADNE (COLOUR DIPOLE MODEL + STRING)

HERWIG (PS + CLUSTER)





MONTE CARLO (LO ME + ?)



GOOD AGREEMENT WITH e^+e^- EXCEPT AT HIGHEST Q^2

GOOD AGREMENT WITH MODELS EXCEPT FOR SCI

e^+e^- PARAMETERISATIONS
OPEL Z. PHYS C534 539 (1992)

→ CORRECTED FOR K^0/Λ DECAYS

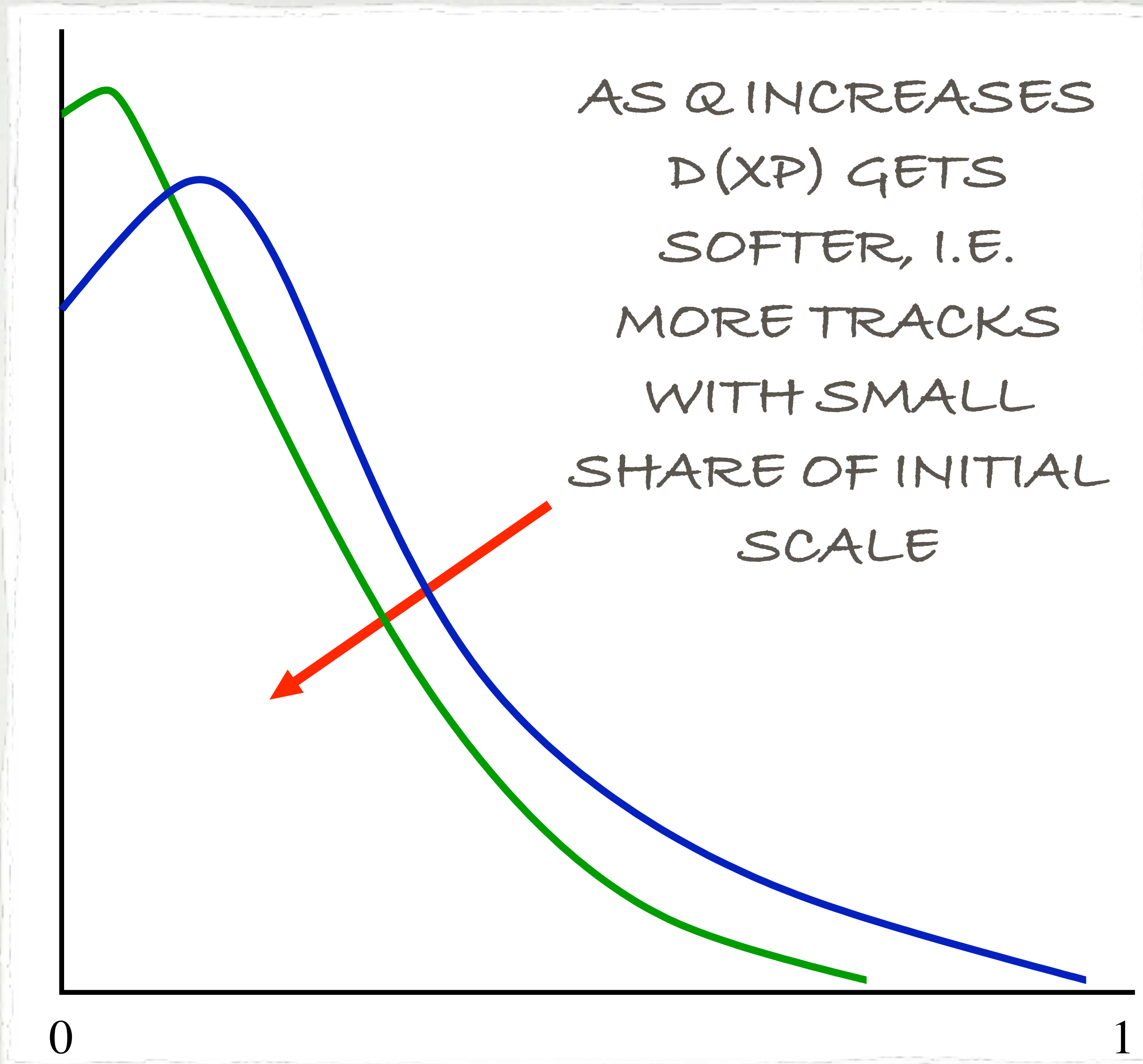
ZEUS RESULTS 94-97 DATA
EUR. PHYS. J. C 11, 251-270 (1999)

MONTE CARLO FRAGMENTATION MODELS TUNED USING e^+e^-

AVERAGE CHARGED PARTICLE MULTIPLICITY

$$x_p = \frac{(2P_h)}{Q}$$

$$D(x_p) = \frac{1}{N_{event}} dn/dx_p$$



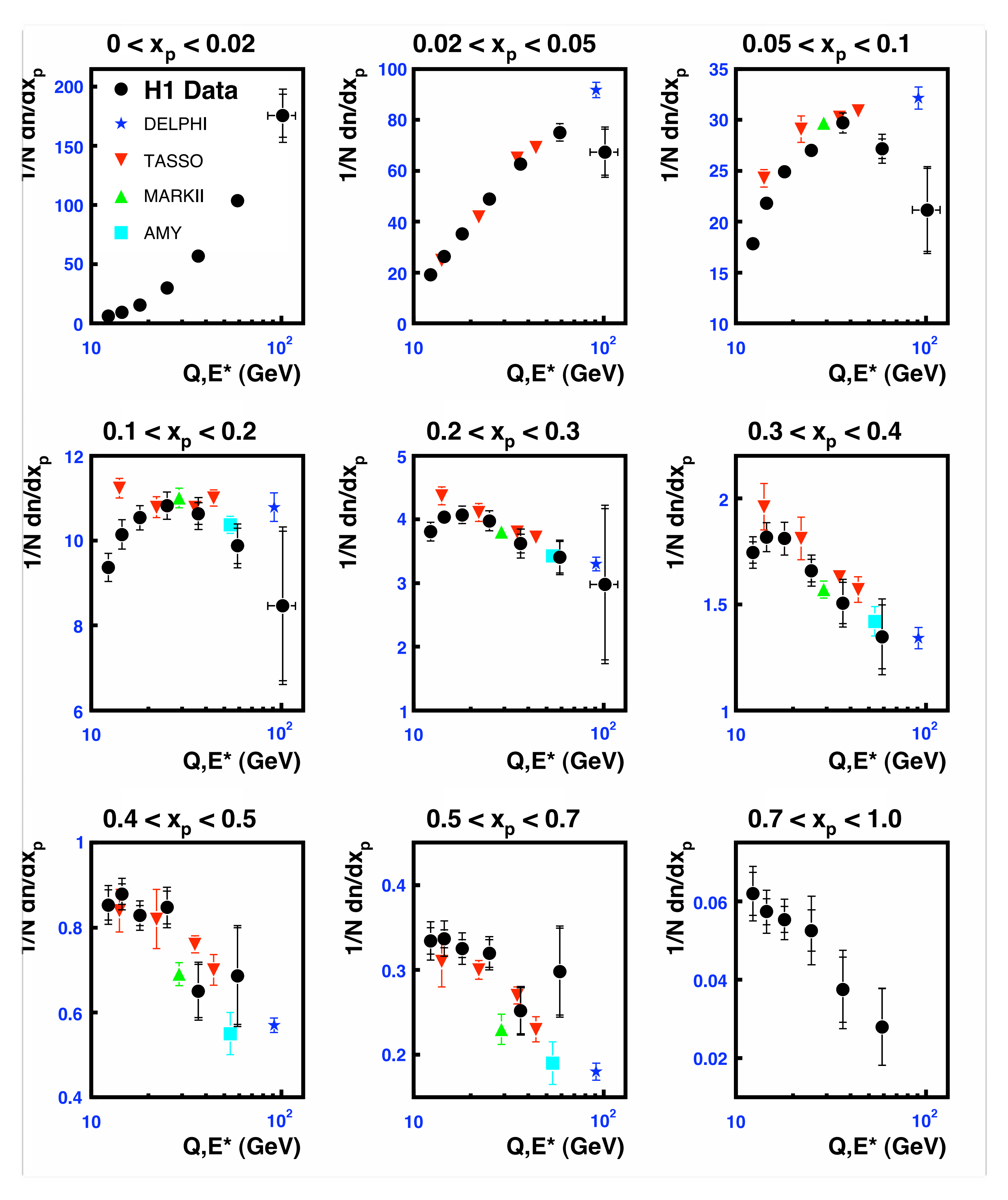
X_P = SCALED MOMENTUM VARIABLE

$Q/2$ = SCALE IN CURRENT REGION OF BREIT FRAME

P_h = MOMENTUM OF CHARGED PARTICLE IN CURRENT REGION OF BREIT FRAME

$D(X_P)$ = EVENT NORMALISED, CHARGED PARTICLE, SCALED MOMENTUM DISTRIBUTION

SCALED MOMENTUM DISTRIBUTION



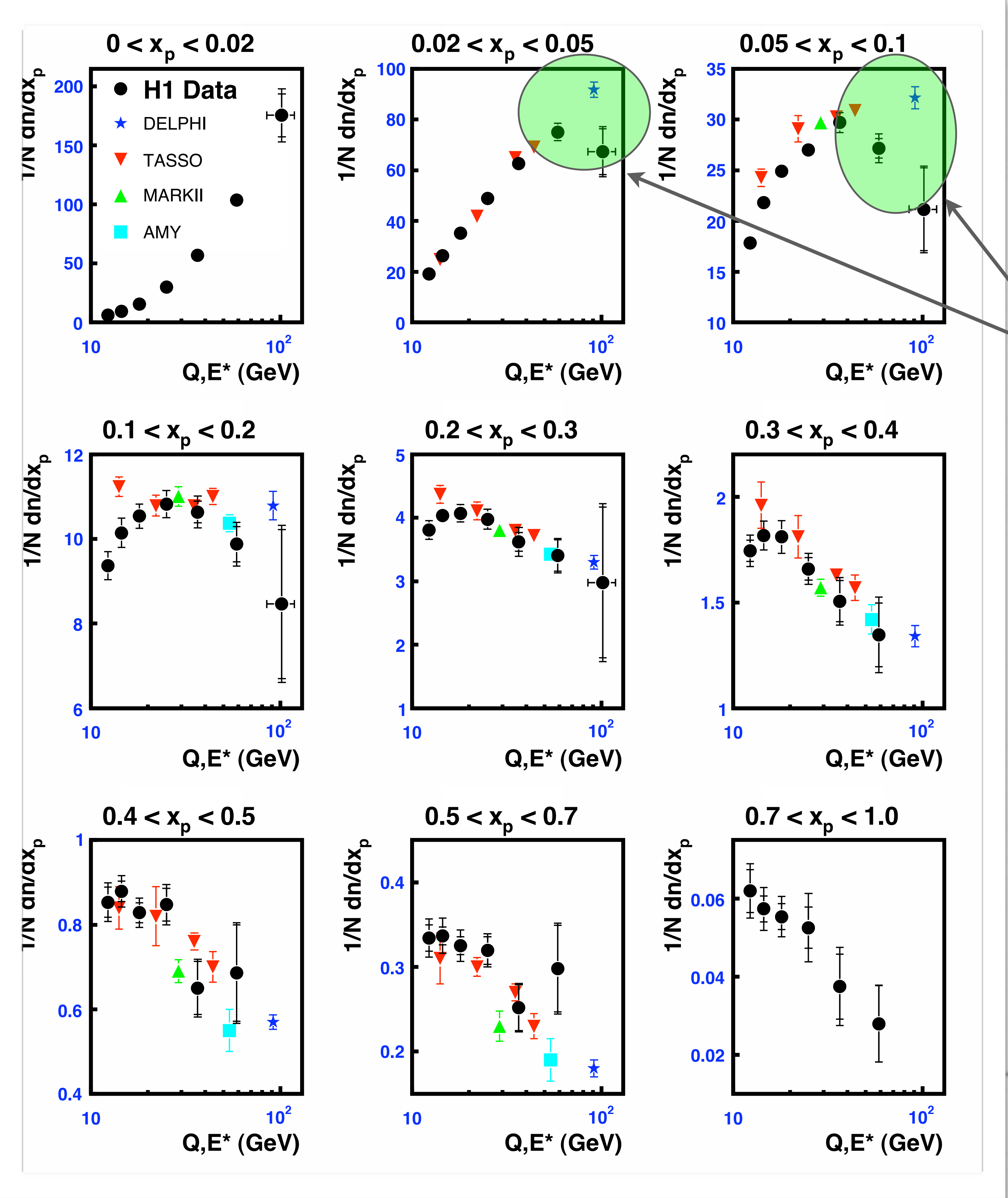
PRETTY GOOD AGREEMENT BETWEEN ep AND e^+e^- !

HIGH Q^2 AND SMALL X_P REASON UNCLEAR

LOW Q^2, MID X_P. EXPECTED TO BE DUE TO BGF KINEMATICS PRODUCING EMPTY CURRENT REGION

NB: SUPPRESSED ZEROS

SCALED MOMENTUM



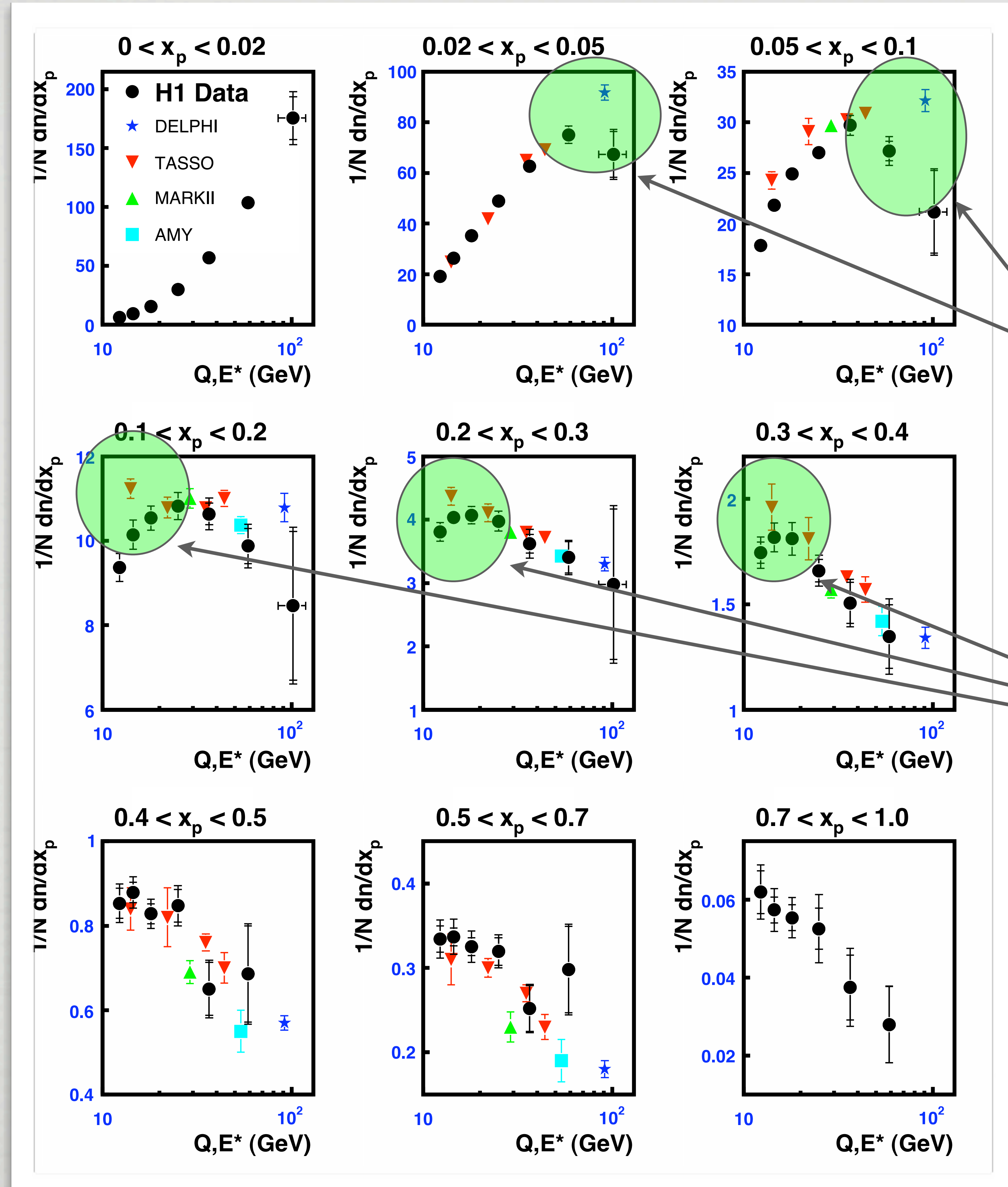
PRETTY GOOD AGREEMENT BETWEEN ep AND e^+e^- !

HIGH Q^2 AND SMALL X_P
REASON UNCLEAR

LOW Q^2, MID X_P.
EXPECTED TO BE DUE TO BGF KINEMATICS PRODUCING EMPTY CURRENT REGION

NB: SUPPRESSED ZEROS

SCALED MOMENTUM



PRETTY GOOD AGREEMENT BETWEEN ep AND e^+e^- !

HIGH Q^2 AND SMALL X_P
REASON UNCLEAR

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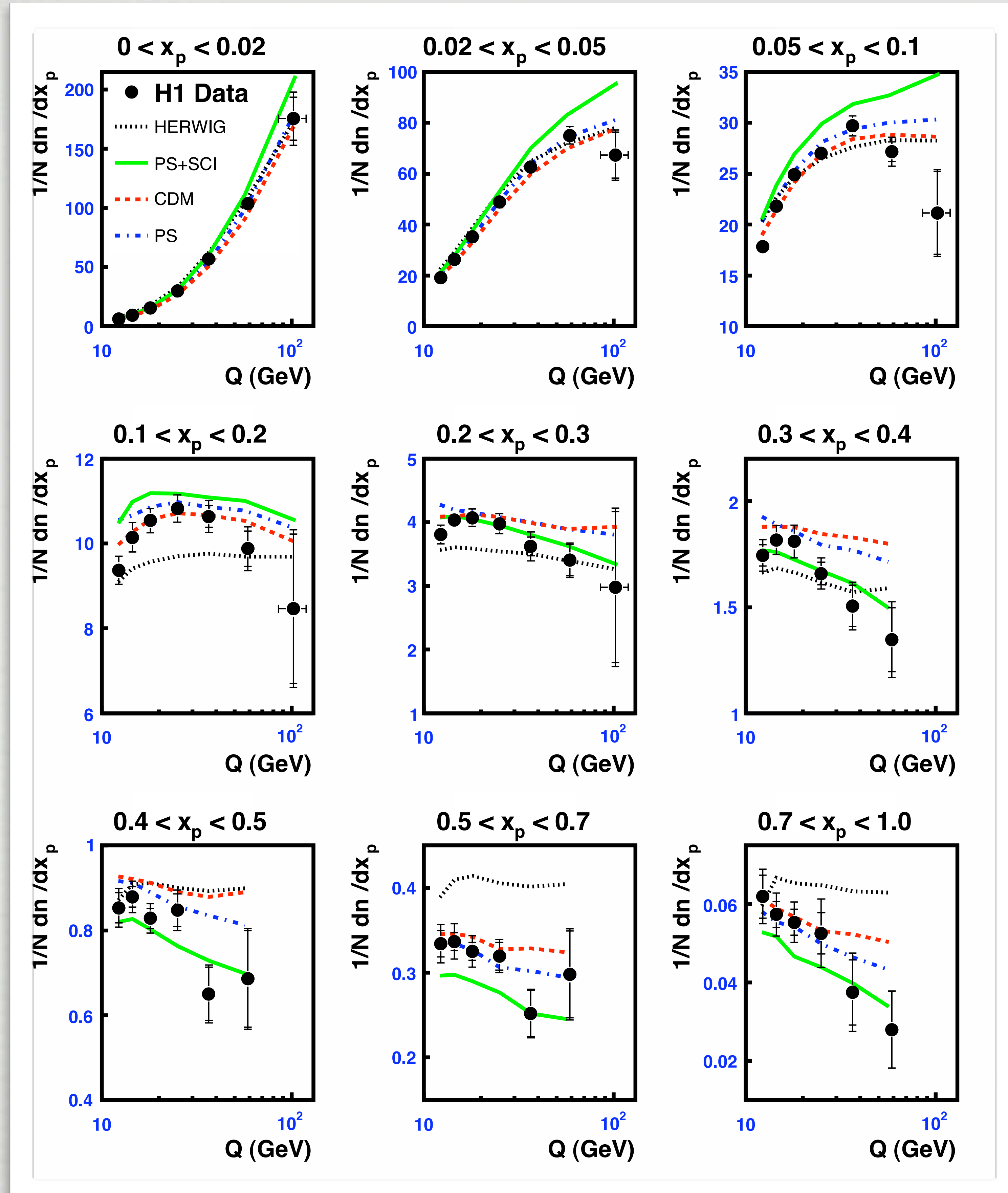
NB: SUPPRESSED ZEROS

SCALED MOMENTUM

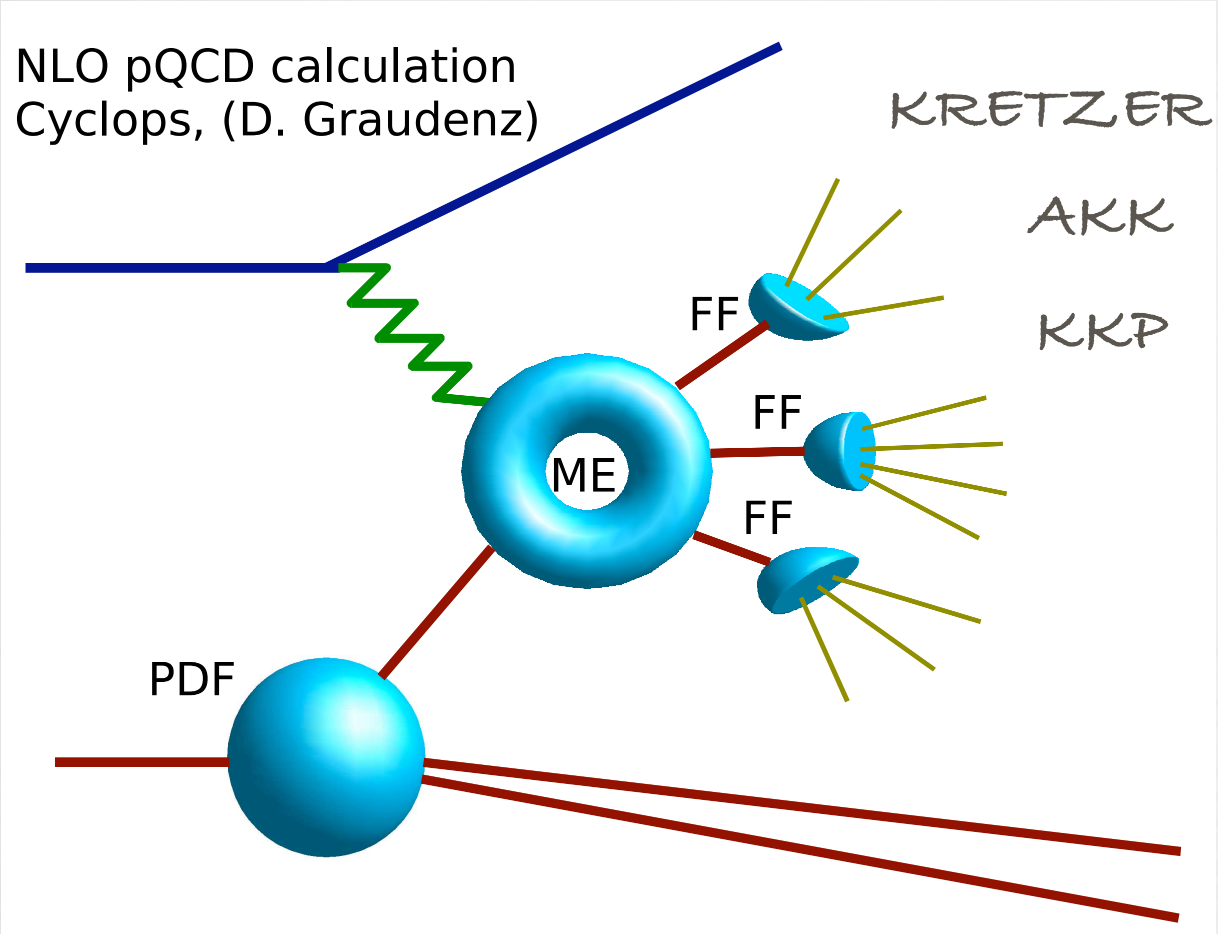


CDM AND PS ACCEPTABLE DESCRIPTION OF DATA. BOTH TEND TO OVERESTIMATE THE MULTIPLICITY AT HIGH Q^2

SCI MODEL PREDICTS TOO SOFT A SPECTRUM

HERWIG IS TOO HARD AND FAILS TO REPRODUCE SCALING VIOLATIONS SEEN IN THE DATA

SCALED MOMENTUM



KRETZER

AKK

KKP

σ_h = PDF ⊗ M.E. ⊗ FF

<u>NLO PQCD</u> CYCLOPS

FRAGMENTATION FUNCTIONS - e^+e^- FITS

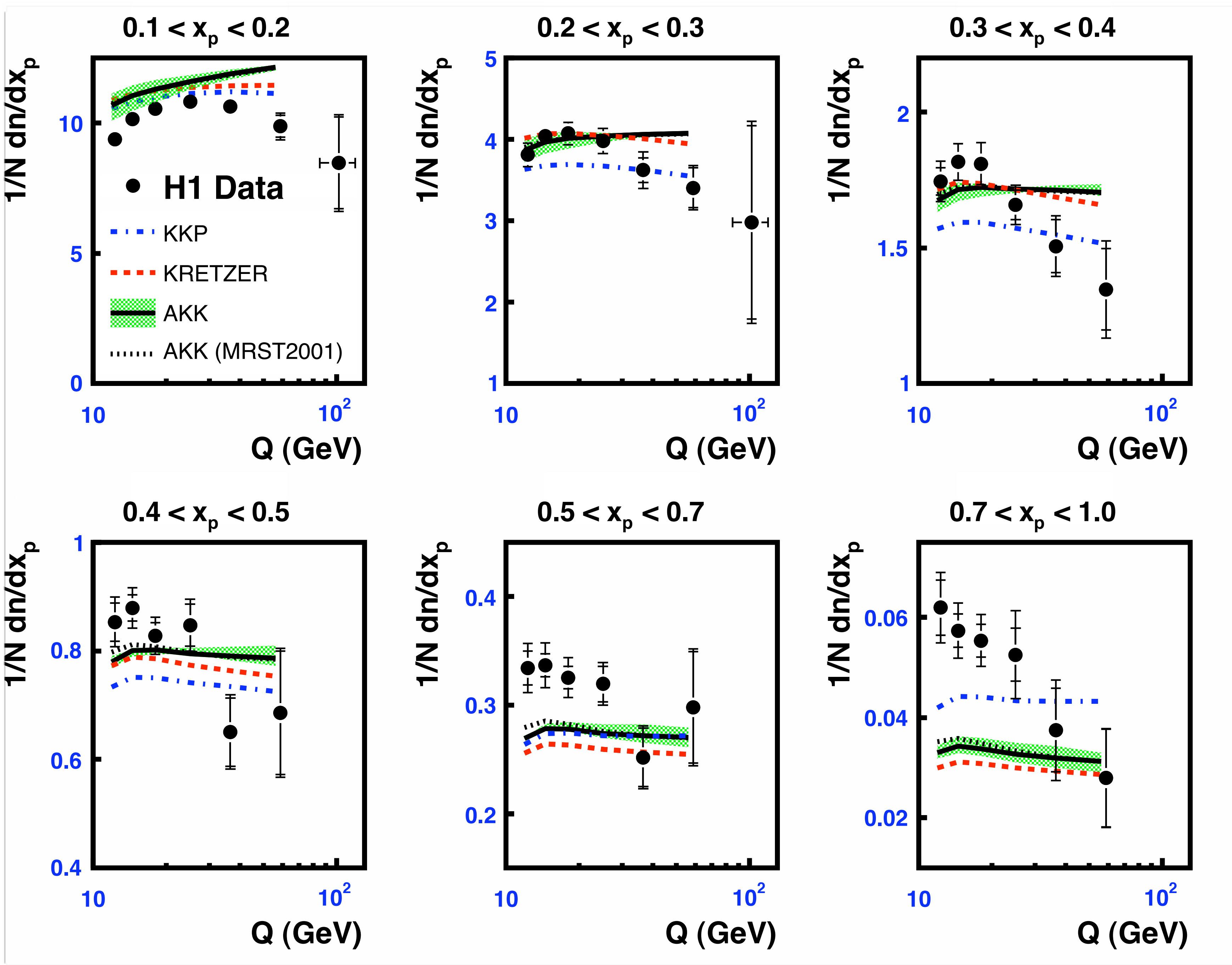
INFRA RED SAFE REGION
(Q2>100), XP > 0.1

FF PARAMETERISED FROM
XP>0.1

HIGHEST Q2 BIN (8,000 - 20,000)
LOW IN STATISTICS.

CTEQ6M, Λ(5)QCD = 226 MEV
(ALSO ME + FF)

PHYSICS MODELS



FRAGMENTATION FUNCTIONS (KKP, KRETZER, AKK) TAKEN FROM FITS TO e^+e^- DATA

SCALE AND PDF ERRORS SMALL

SENSITIVITY TO DIFFERENT FF

NLO THEORY DOES NOT DESCRIBE THE DATA!

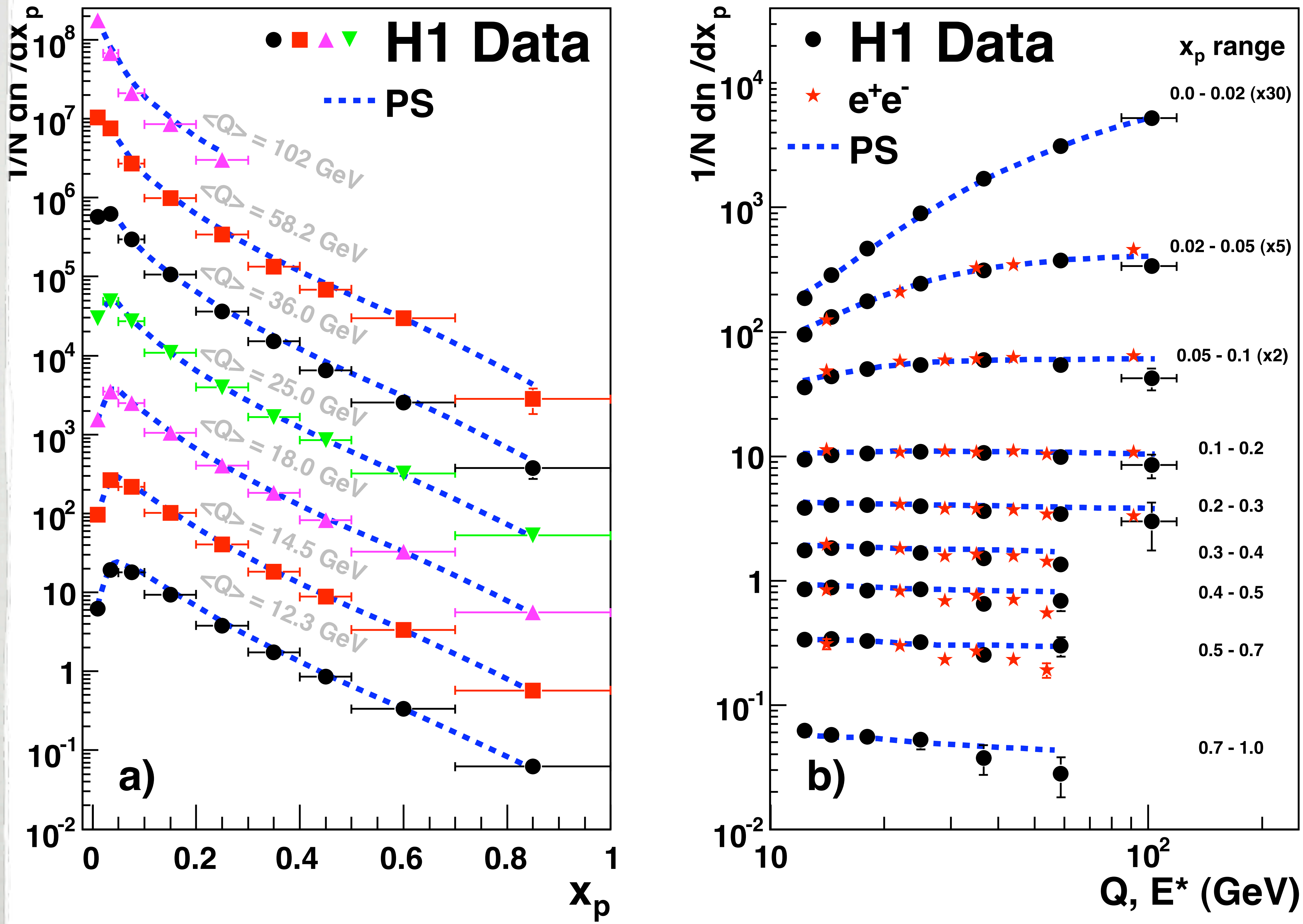
SCALED MOMENTUM

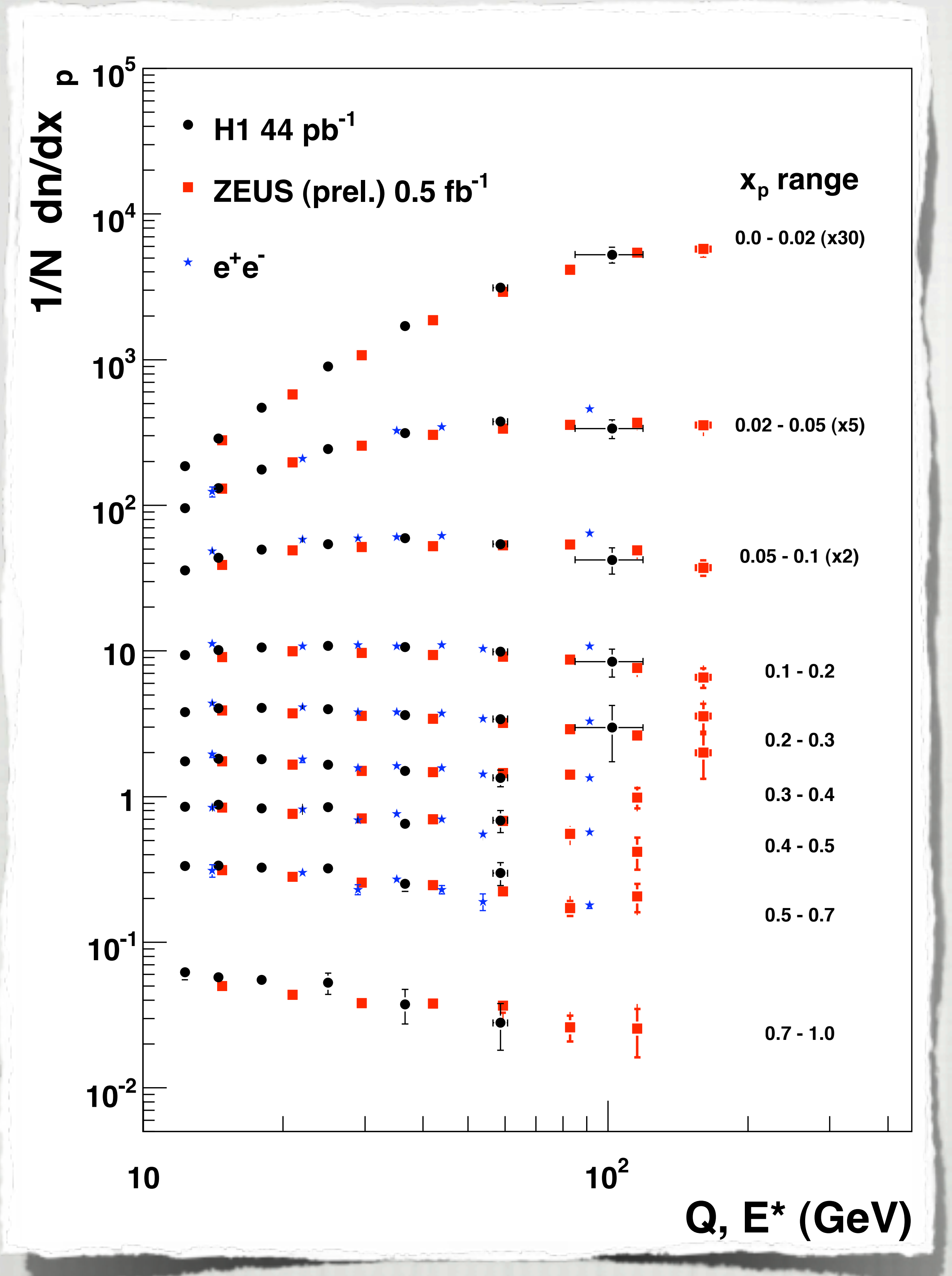
SUMMARY

- THE RESULTS BROADLY SUPPORT THE CONCEPT OF QUARK FRAGMENTATION UNIVERSALITY IN ep COLLISIONS AND e^+e^- ANNIHILATION.

- e^+e^- TUNED MONTE CARLO MODELS GENERALLY DESCRIBE THE DATA BUT THERE ARE DIFFERENCE IN THE DETAIL.

- ALL THREE PARAMETERISATIONS OF THE FRAGMENTATION FUNCTIONS USED IN THE NLO PREDICTIONS FAIL TO DESCRIBE THE SCALING VIOLATIONS SEEN IN THE DATA.


H1 Data
PS
1/N dn /dx_p
<Q> = 102 GeV
<Q> = 58.2 GeV
<Q> = 36.0 GeV
<Q> = 25.0 GeV
<Q> = 18.0 GeV
<Q> = 14.5 GeV
<Q> = 12.3 GeV
a)
x_p
H1 Data
e+e-
PS
x_p range
0.0 - 0.02 (x30)
0.02 - 0.05 (x5)
0.05 - 0.1 (x2)
0.1 - 0.2
0.2 - 0.3
0.3 - 0.4
0.4 - 0.5
0.5 - 0.7
0.7 - 1.0
b)
Q, E* (GeV)



SCALED MOMENTUM

SUMMARY:

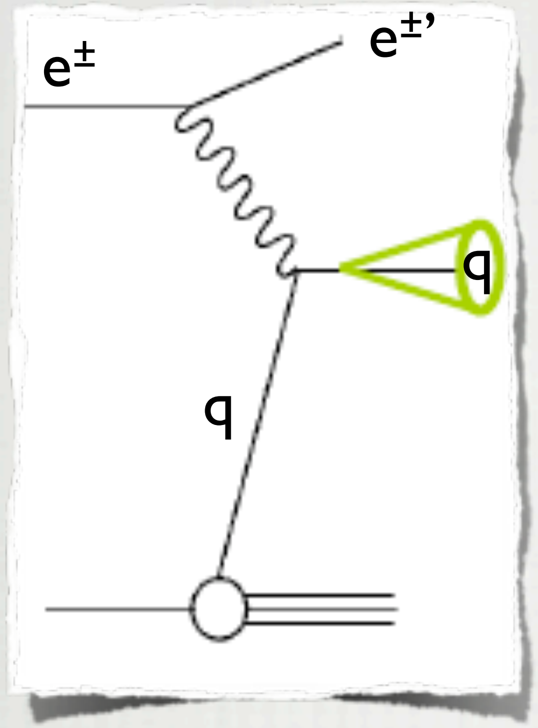
PUBLISHED H1 RESULTS

PRELIMINARY ZEUS DATA

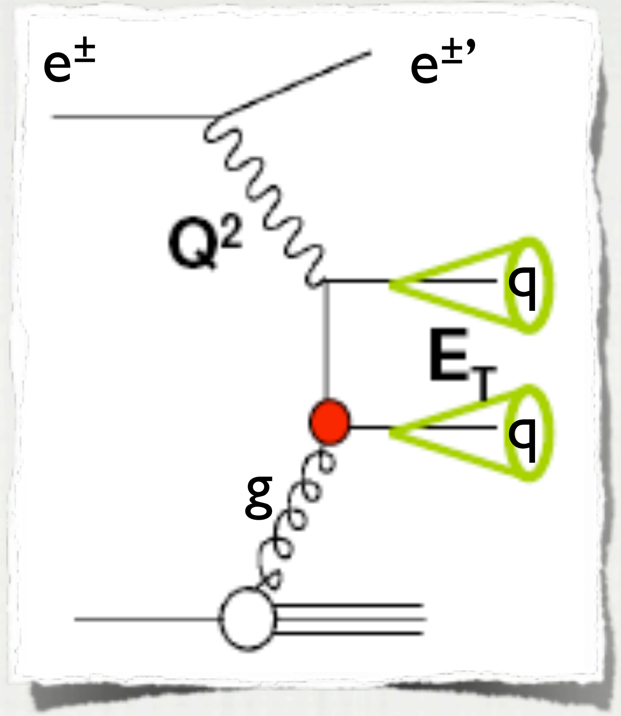
SELECTED e^+e^- RESULTS

BACKUP

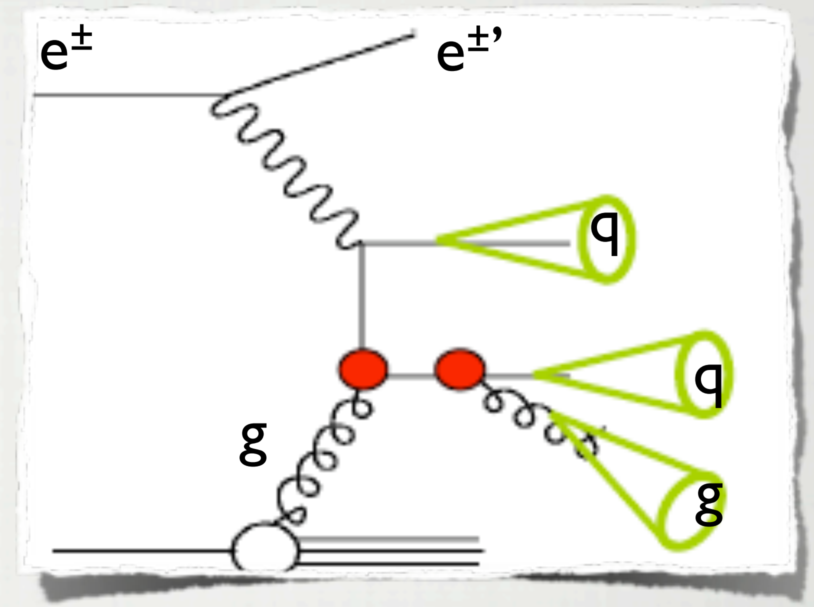
BORN



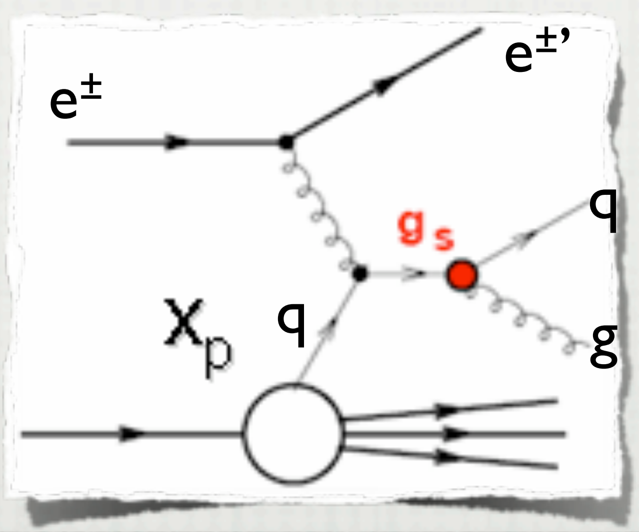
LO BGF



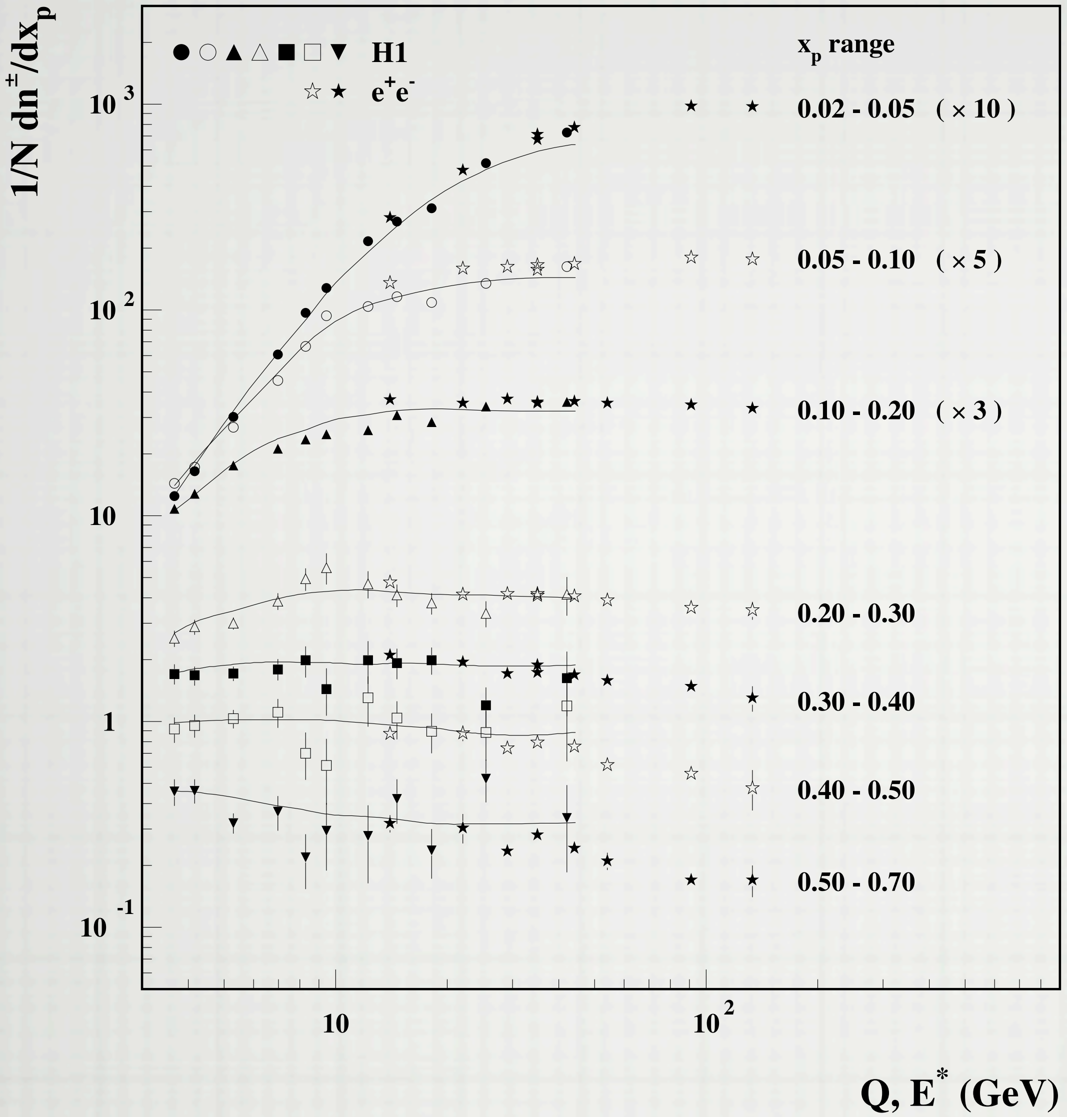
NLO

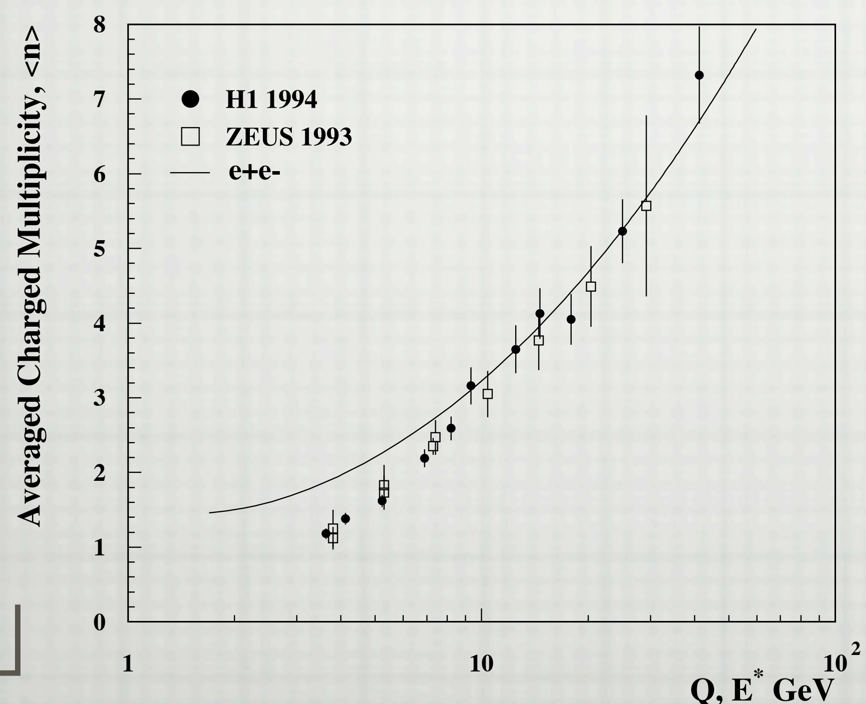


LO QCD COMPTON



H1 DISMANTLING





PREVIOUS RESULTS

LAST PUBLISHED DATA FROM H1 FROM 1994 DATA.

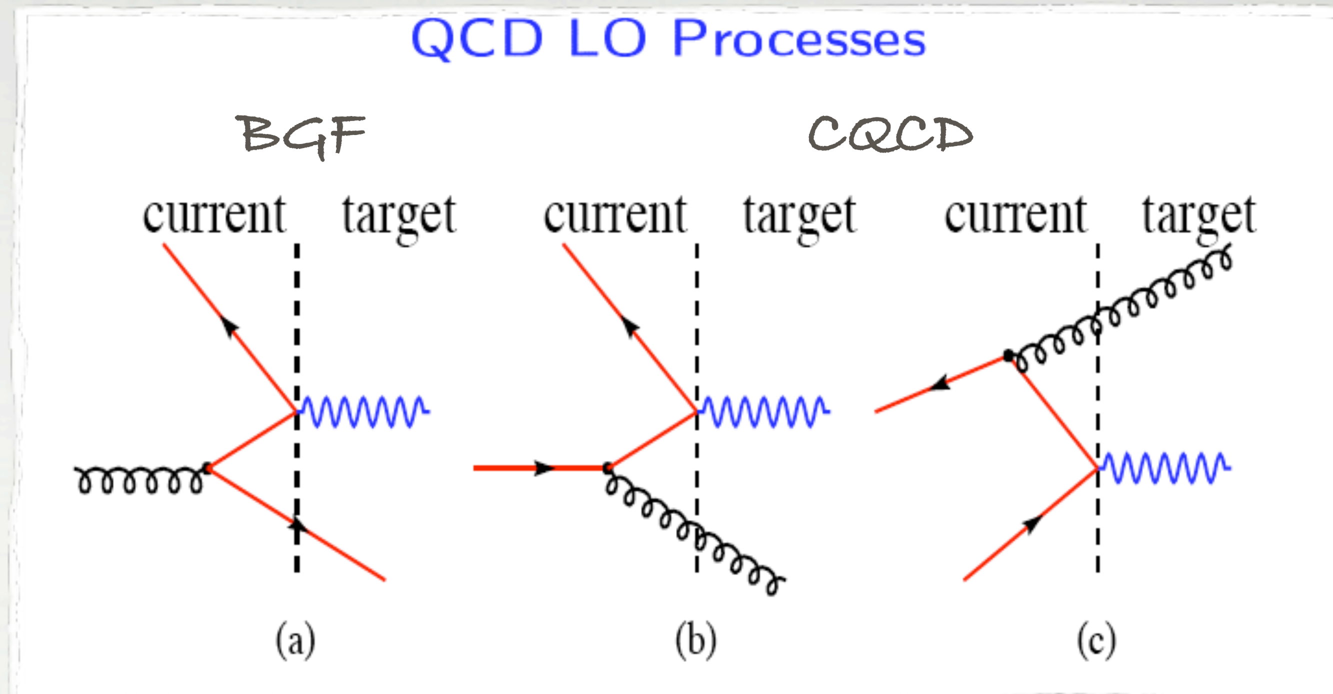
HIGH Q EP RESULTS CAN BE DIRECTLY COMPARED WITH E+E- (MOST E+E- DATA FOR E*>10GEV)

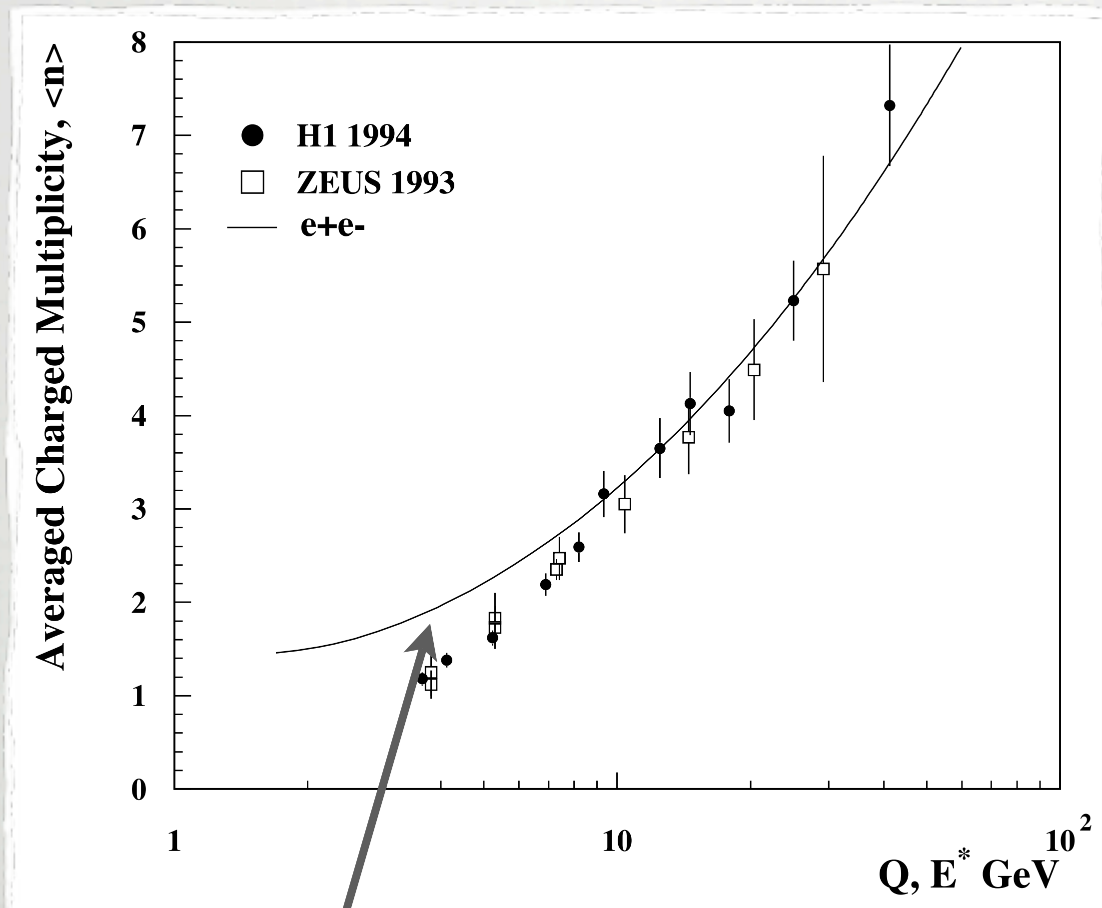
MORE DATA POINTS ARE INFRARED SAFE FOR NLO QCD CALCULATIONS AT HIGH Q

HIGH Q DATA STATISTICALLY LIMITED

COMPLICATIONS OF BGF/ISCQCD ARE SEEN TO BE LESS IMPORTANT AT HIGH Q

$\langle n^{+/-} \rangle$

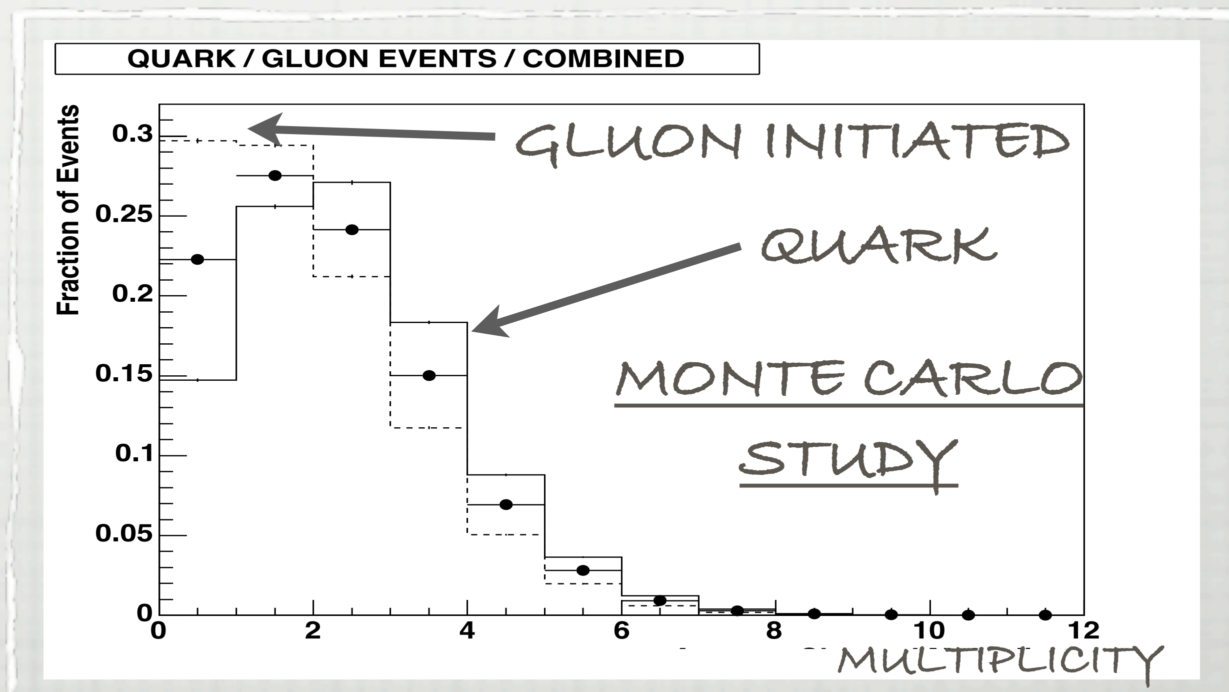


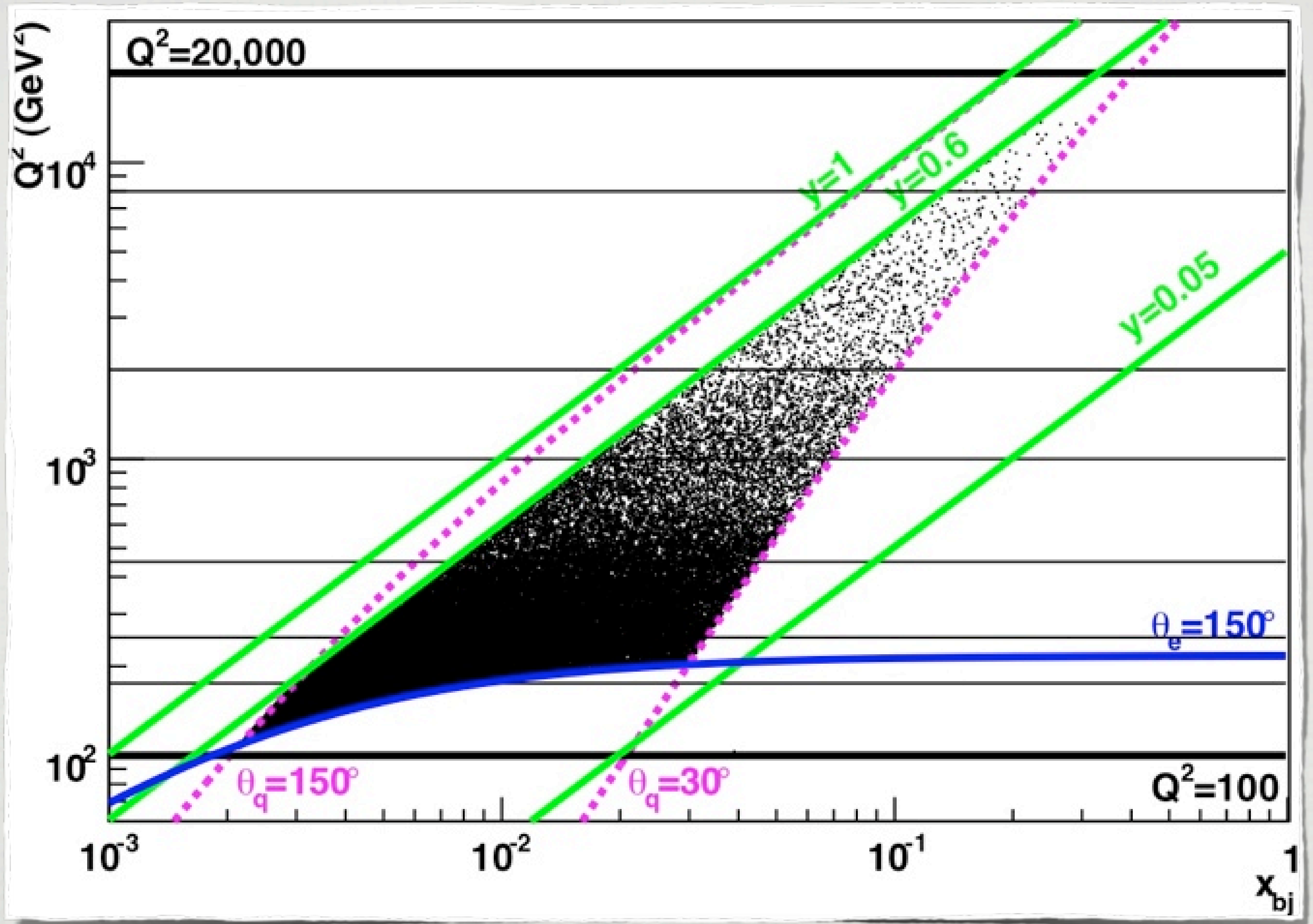


INITIAL STATE QCD NOT PRESENT IN e^+e^-

ONLY SEE 1/2 THE EVENT C.F. TO e^+e^-

DEPOPULATION OF CURRENT REGION



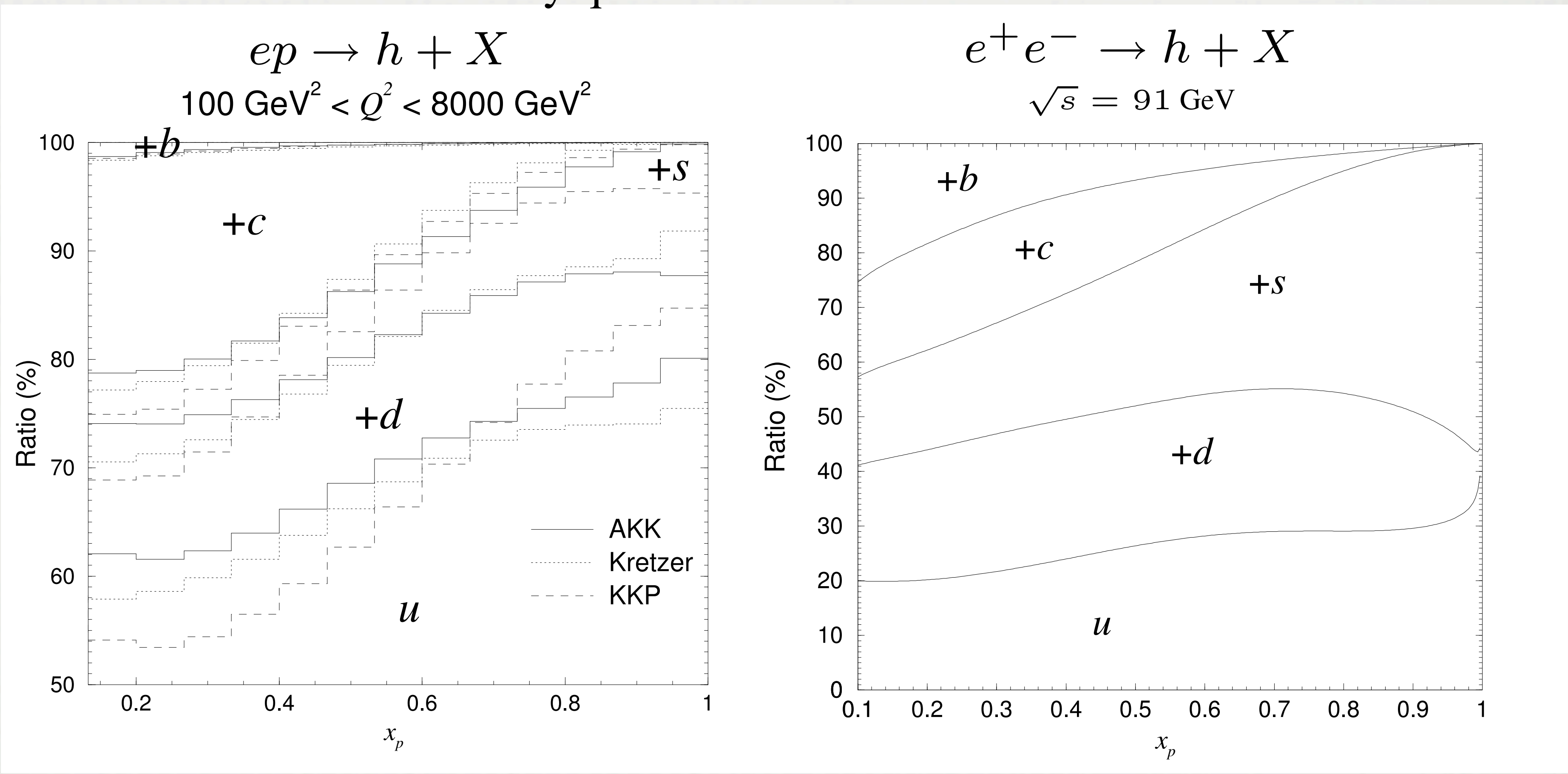


Q^2=20,000
Q^2 (GeV^2)
10^4
10^3
10^2
y=1
y=0.6
y=0.05
θ_e=150°
θ_q=150°
θ_q=30°
Q^2=100
10^{-3}
10^{-2}
10^{-1}
1
x_{bj}

PHASE SPACE

Quark tagging (H1)

Identify quark flavour at e.w. vertex



Proton is good source of u

s relatively large

In principle, ep and e^+e^- together can separate uds FFs