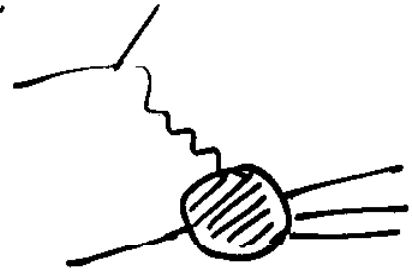
OVERVIEW OF RESULTS FROM COLLIDER + FIXED TARGET.

- INTRODUCTION
- STRUCTURE FUNCTIONS
- ELECTROWEAK QCD
- PRODUCTION CROSS-SECTIONS t, b, c
- INCLUSIVE JETS, ~~DI-JET MASS~~
- LEPTOQUARKS
- MULTI JET ~~, CORRELATIONS~~, DPS
- GAP, DIFFRACTIVE
- CONCLUSIONS

H.E. MONTGOMERY
DIS '97

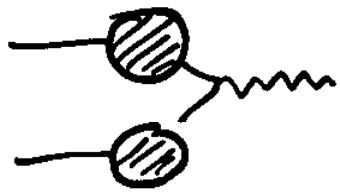
DEEP INELASTIC

$$\frac{d\sigma}{dx\,dQ^2} \sim \sum_i q_i(x, Q^2)$$



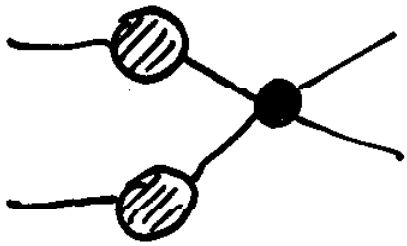
DRELL-YAN

$$\frac{d\sigma}{d\ldots} \sim \sum q_i(x, Q^2)\ \bar{q}_j(x, Q^2)$$



HADRON SCATTERING

$$\frac{d\sigma}{d\ldots} \sim f_i(x, Q^2)\,\sigma_{ij}\,f_j(x, Q^2)$$



EXPERIMENTS / PEOPLE

E665 - MUON SCATT

E683 - γN

E706 - "SINGLE PHOTON"

E740 - $D\phi$ $\bar{p}p$

E769
E791 - CHARM PROD^{N}.

E770 - CCFR - NEUTRINOS

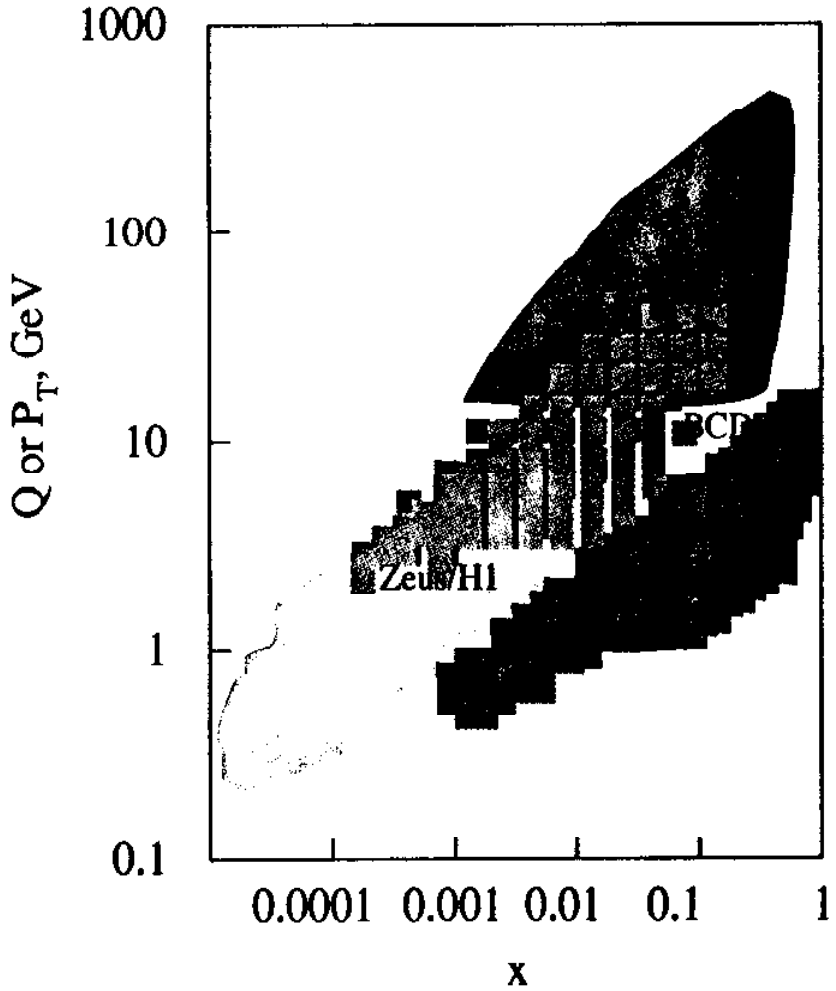
E775 - CDF $\bar{p}p$

E866 - DRELL-YAN

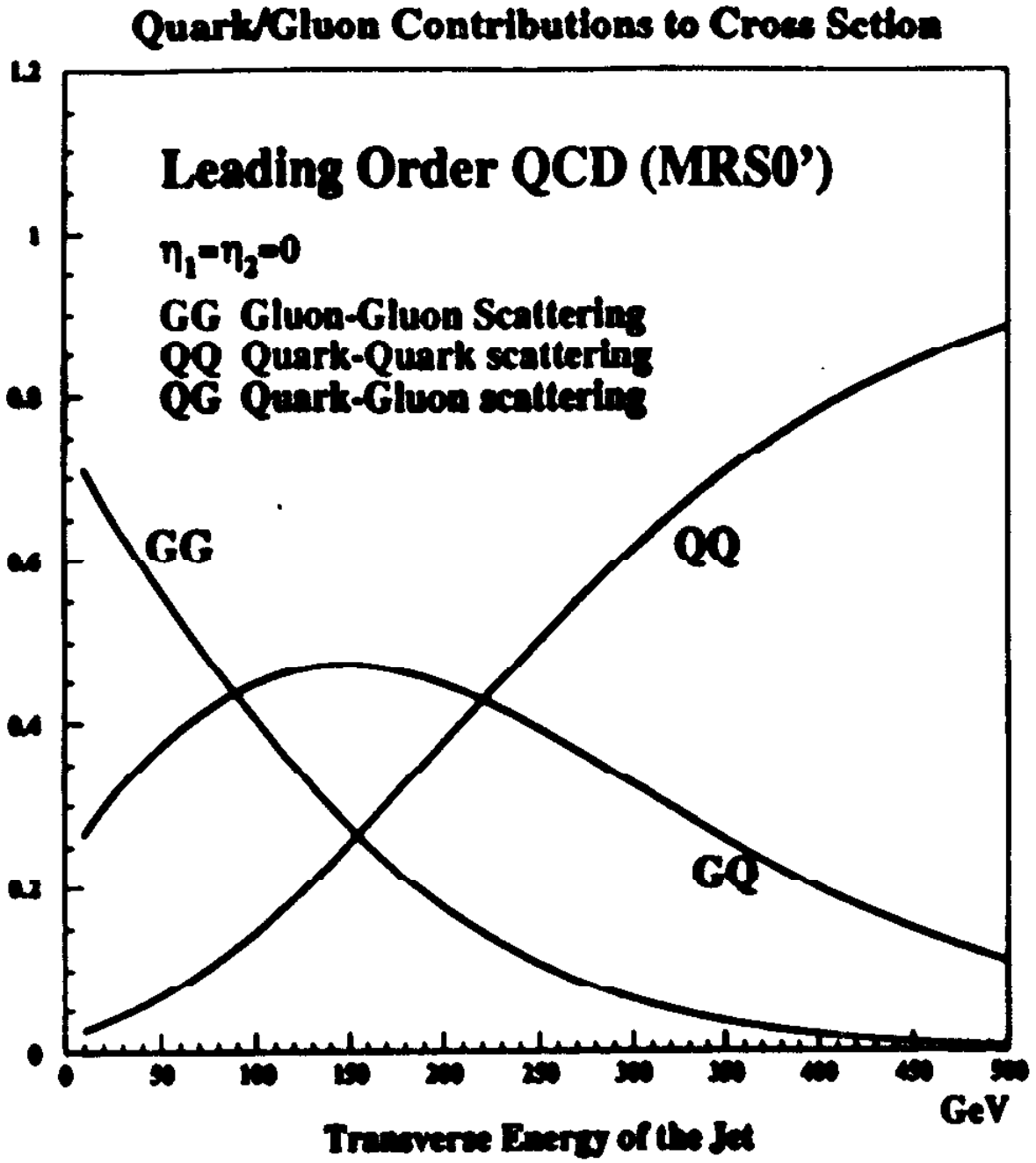
JEFF APPEL
ANDREW BRANDT
CHUCK BROWN
JANET CONRAD
MARJ CORCORAN
DAN CRONIN-HONNESSY
BOB HIROSKY
JOEY HUSTON
HARRY MELANSON
HEIDI SCHELLMAN
NIKOS VARELAS
JOHN WOMERSLEY
MAREK ZIELINSKI
⋮

KINEMATICS

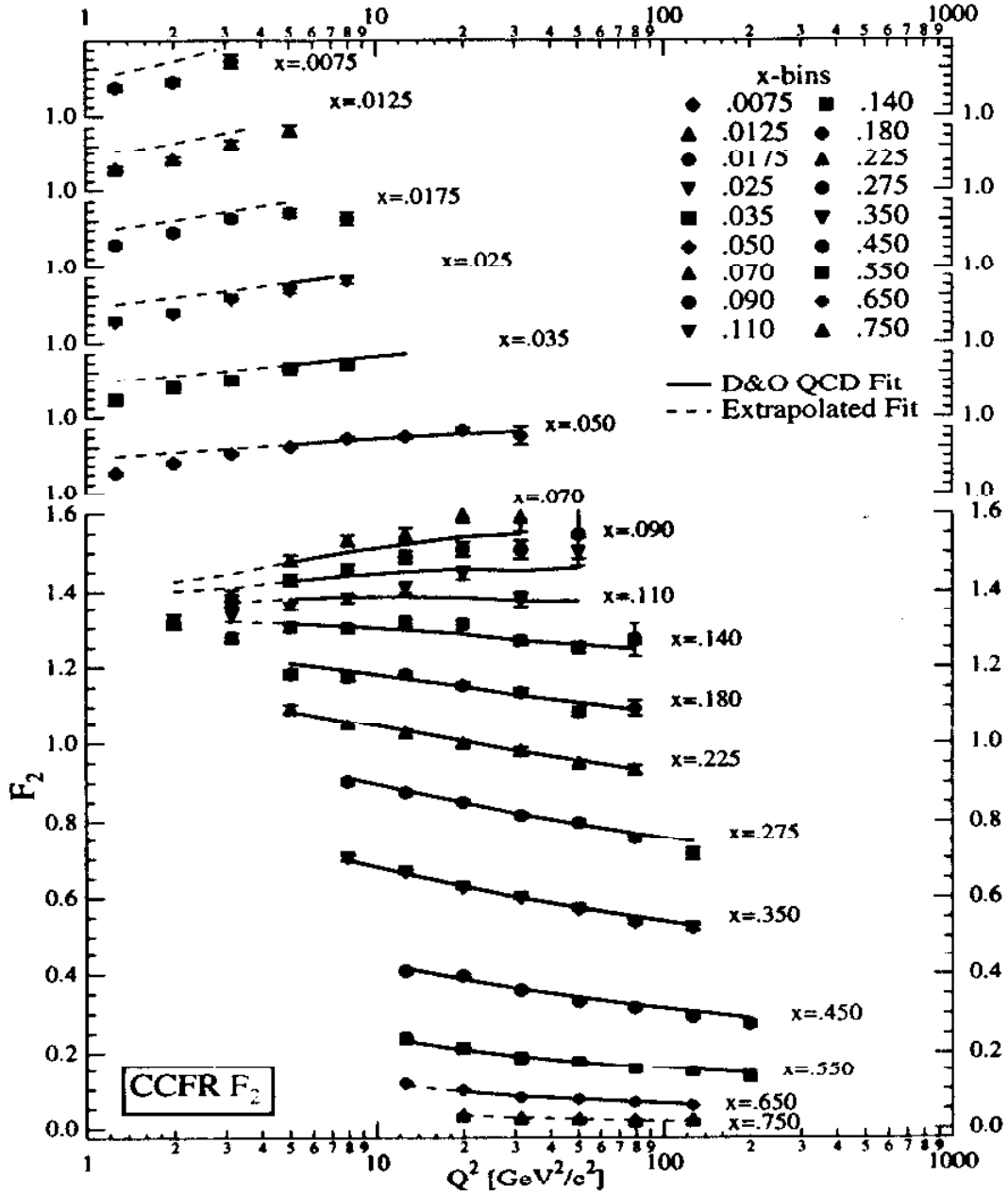
Kinematic Coverage of QCD Experiments



PARTON PARTON SCATTERING.



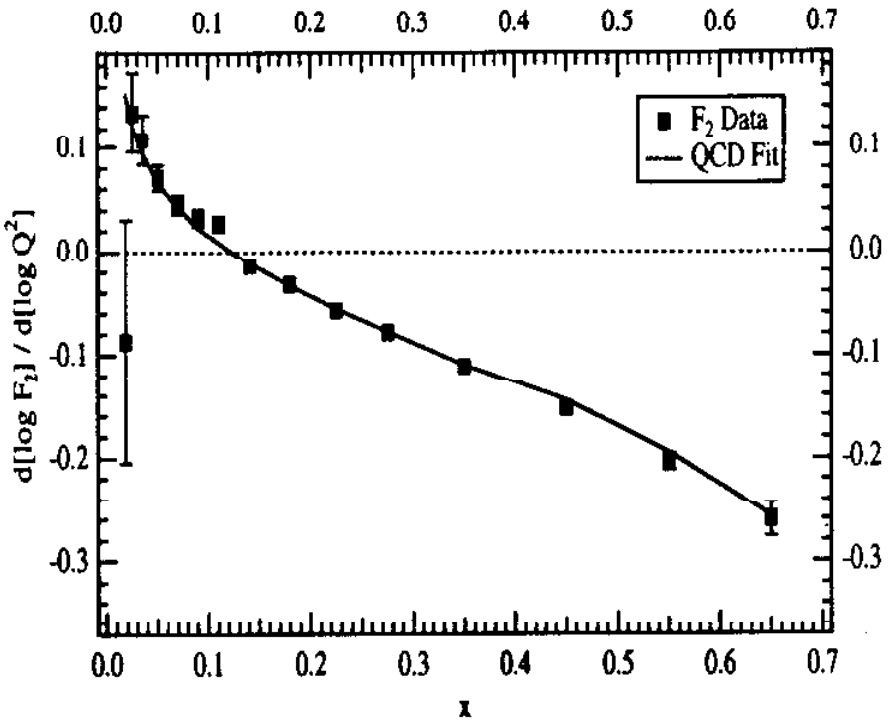
Structure Function : $F_2 = xq + x\overline{q}$

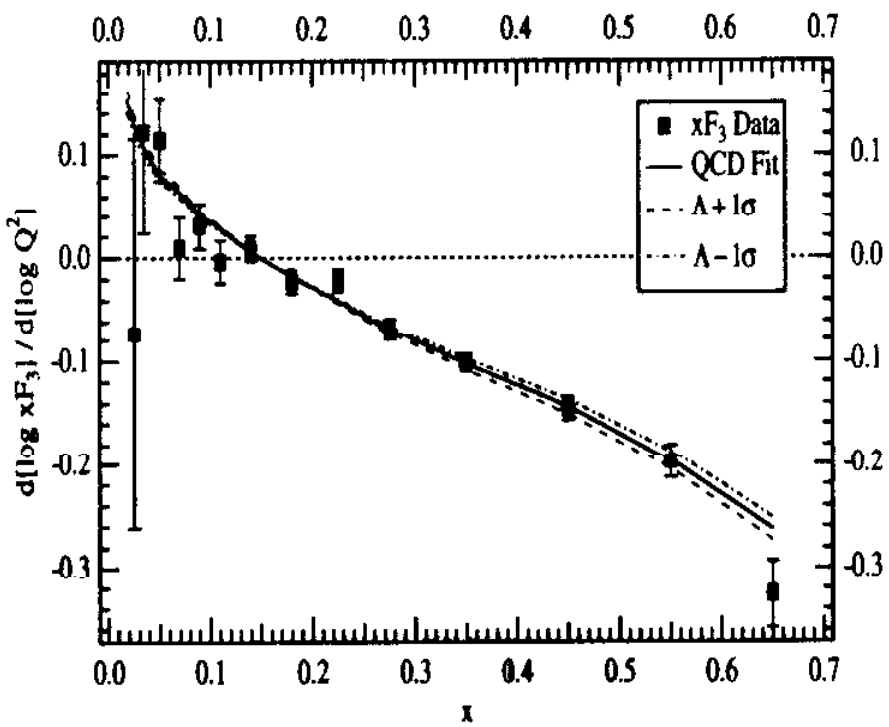


CCFR

NEUTRINO STRUCTURE FUNCTIONS

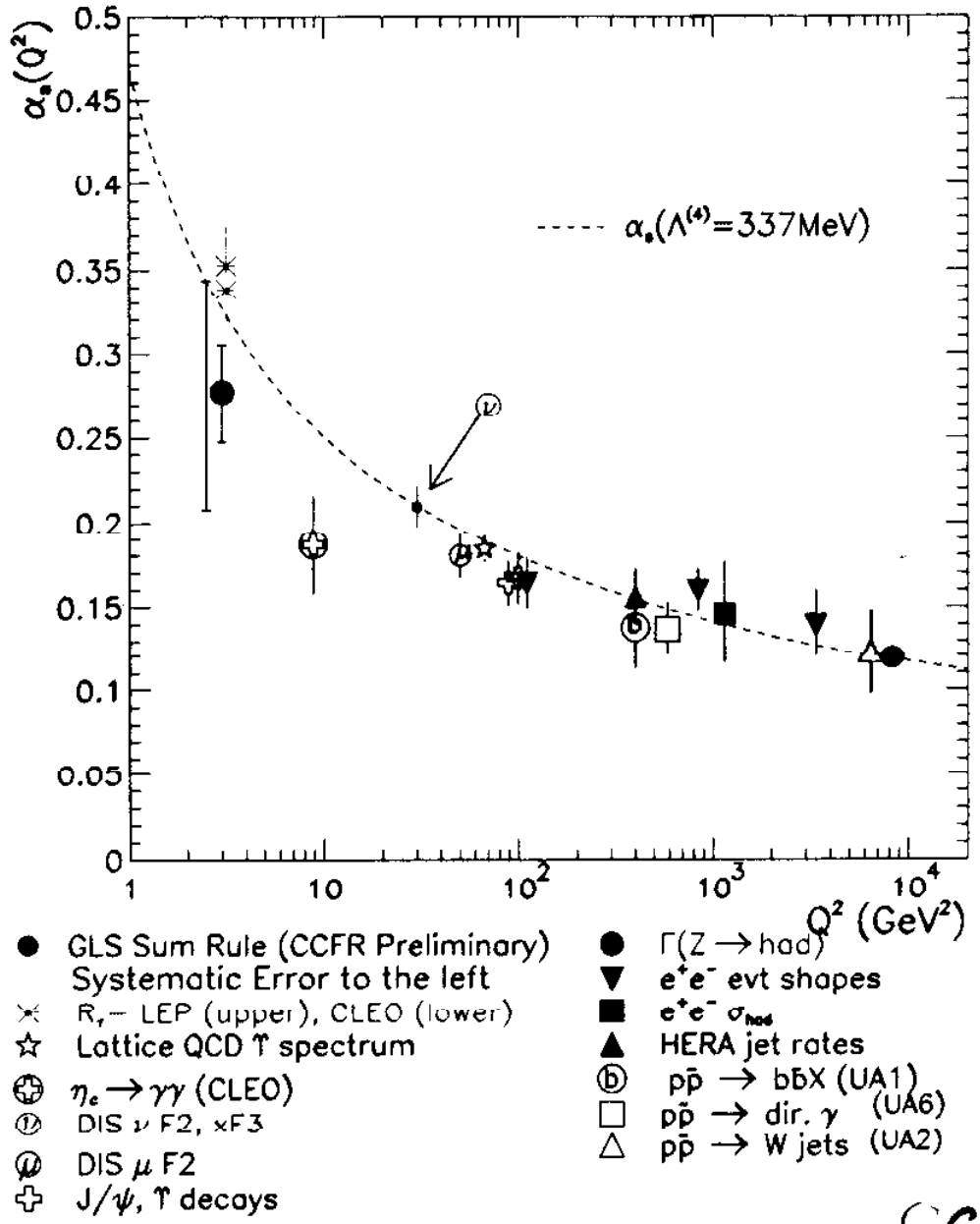
QCD fit results : $d(F_2)/d[ln(Q^2)]$ and $d(xF_3)/d[ln(Q^2)]$





$\Lambda \sim 340$ MeV

World α_s

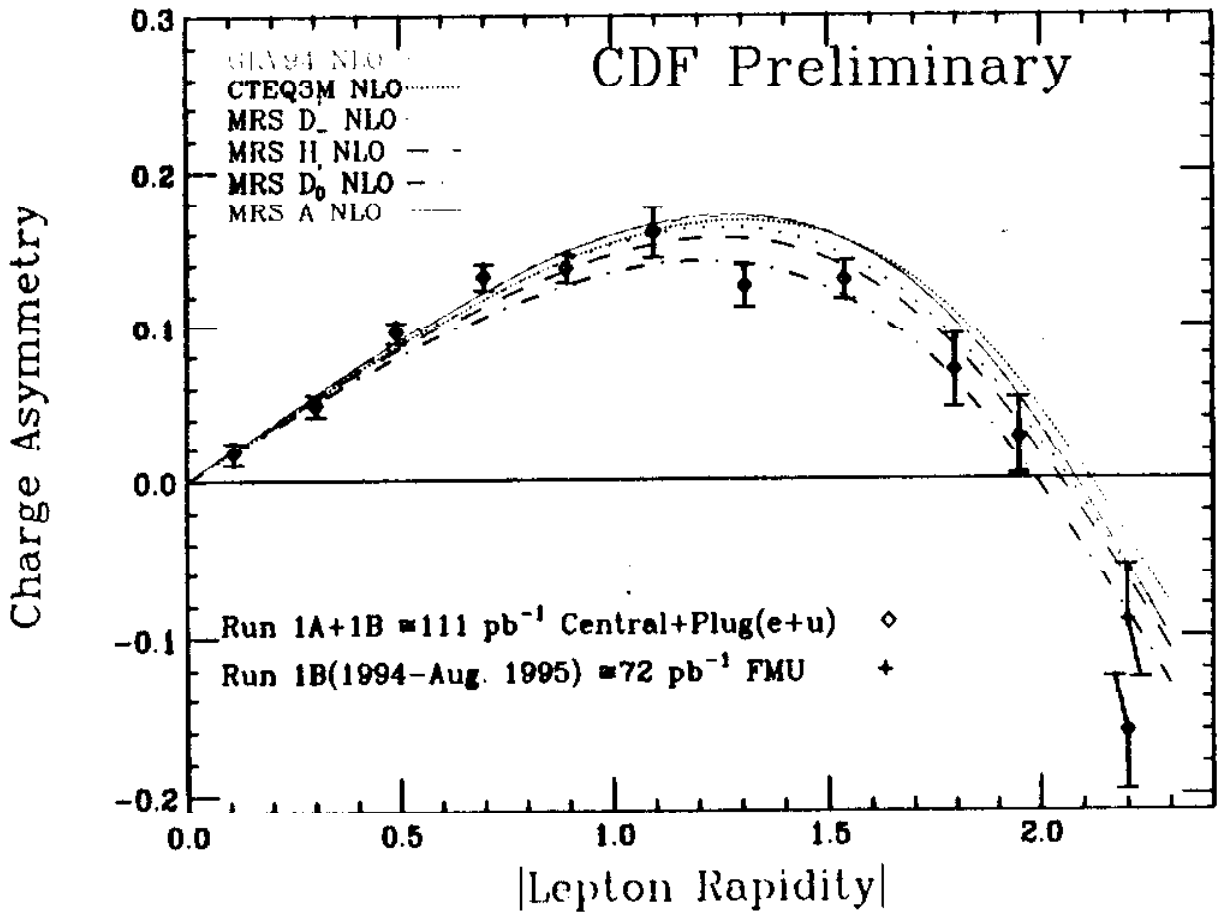


CCFR

xF_3, F_2
GLS $\longrightarrow \alpha_s$

W ASYMMETRY

CDF



CDF Preliminary

PDF Set	$0.0 < \|y\| < 2.0$ (10 dof) χ^2	$\mathcal{P}(\chi^2)$	$A(y)$ $0.0 < \|y\| < 2.3$ $\Delta\sigma$	$\mathcal{P}(\sigma^2)$
CTEQ 3M*	22.21	0.014	1.16	0.245
MRS A*,G*	21.53	0.018	1.75	0.080
MRS H	15.32	0.121	-0.51	0.611
MRS D'_	17.76	0.059	0.68	0.498
GRV94*	26.90	0.003	2.59	0.010
GRV92	39.81	< 0.001	4.13	< 0.001

Fermilab E866 - NuSea

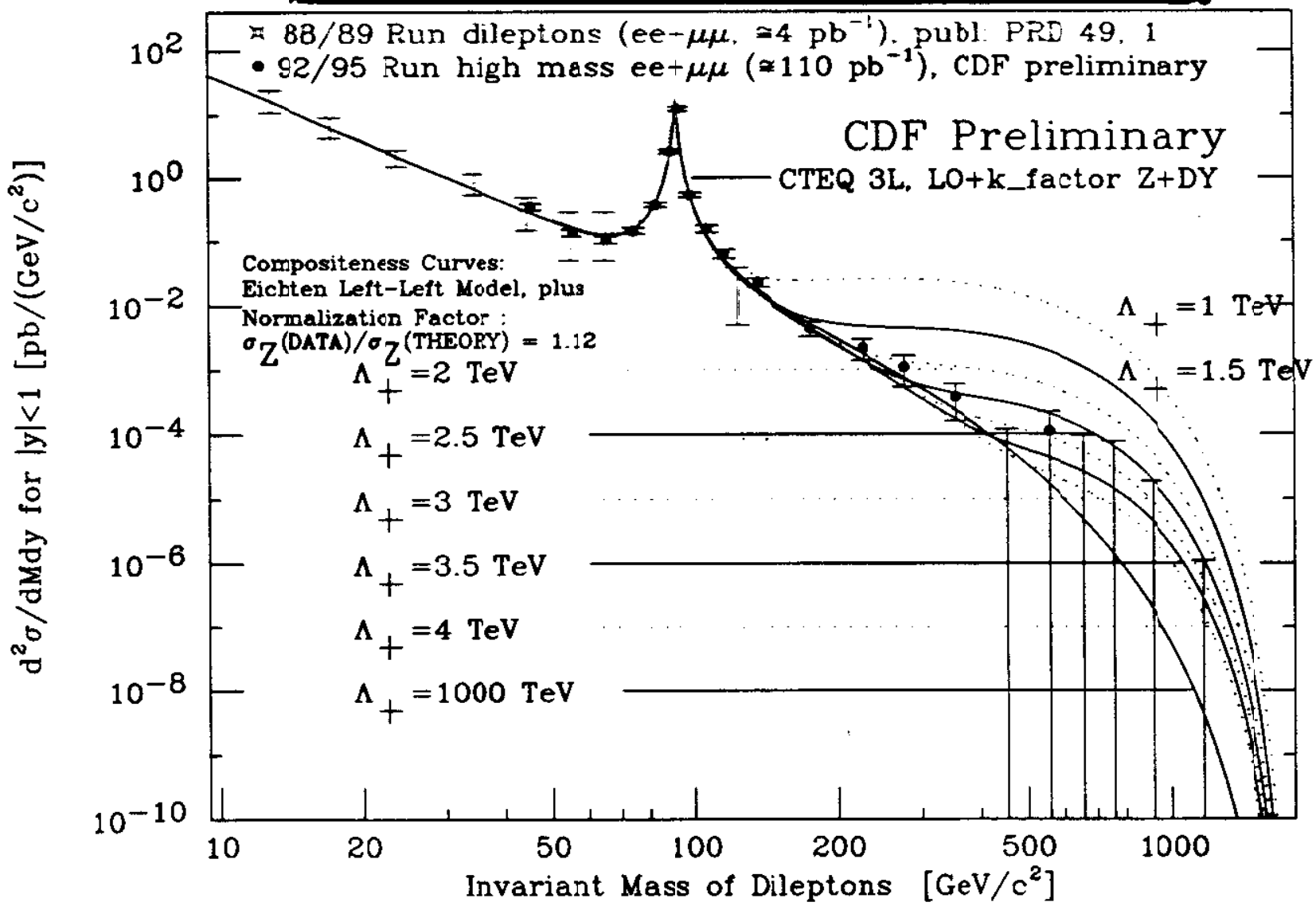
The goal of the E866 experiment is to measure $\bar{u}_p(x)/\bar{d}_p(x)$ for $0.05 \leq x \leq 0.30$.

Drell-Yan yields from liquid H_2 and D_2 targets were measured. For Drell-Yan dimuons, the ratio $\sigma^{pd}/2\sigma^{pp}$ is directly related to $\bar{u}(x)/\bar{d}(x)$.

Rusty Towell will present preliminary results from E866 in the Thursday morning session of Working Group I.

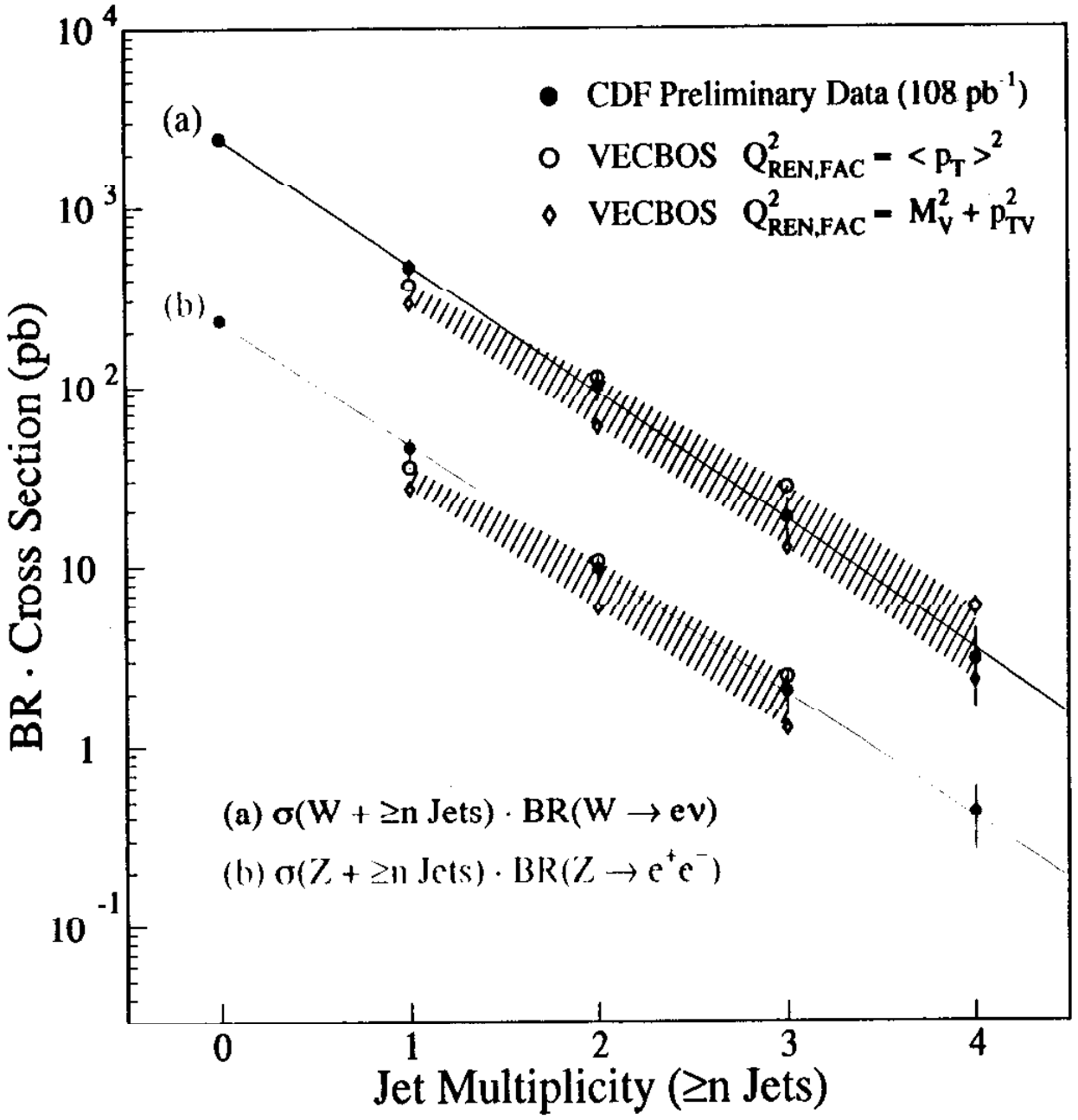
The E866 preliminary results confirm the NMC evidence that $\bar{u}_p \neq \bar{d}_p$, and the NA51 result for $\bar{u}_p/\bar{d}_p$. The data do not agree well with several parameterizations of the proton.

Drell–Yan differential cross–section



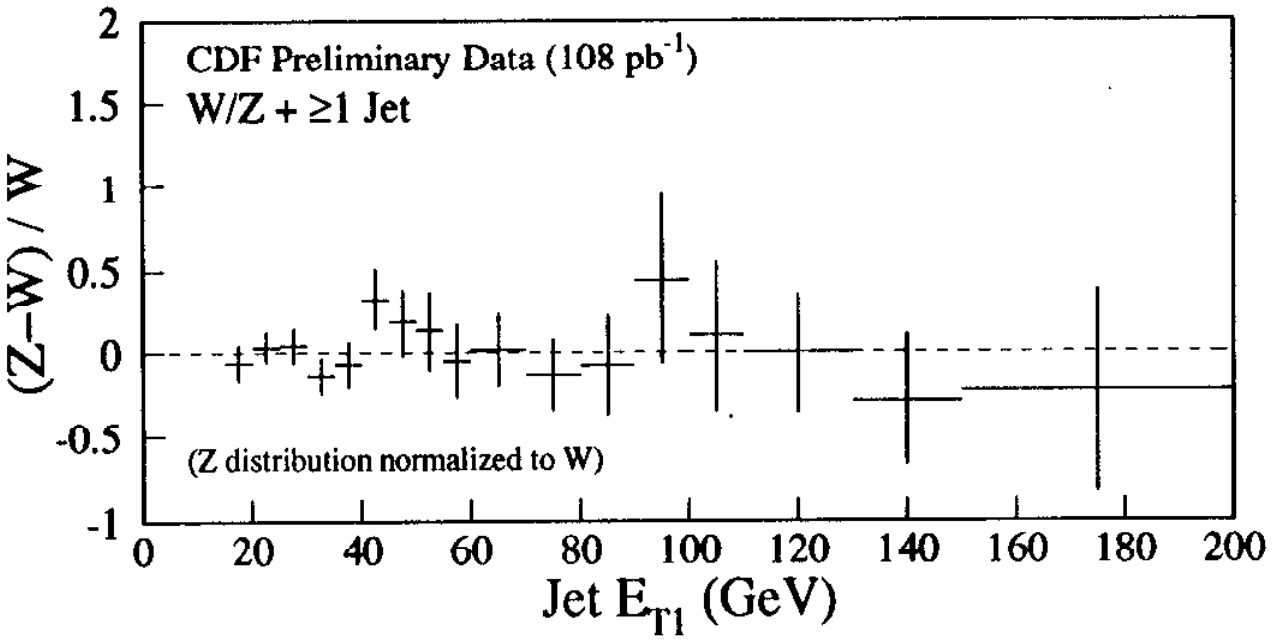
W + JETS MULTIPLICITY

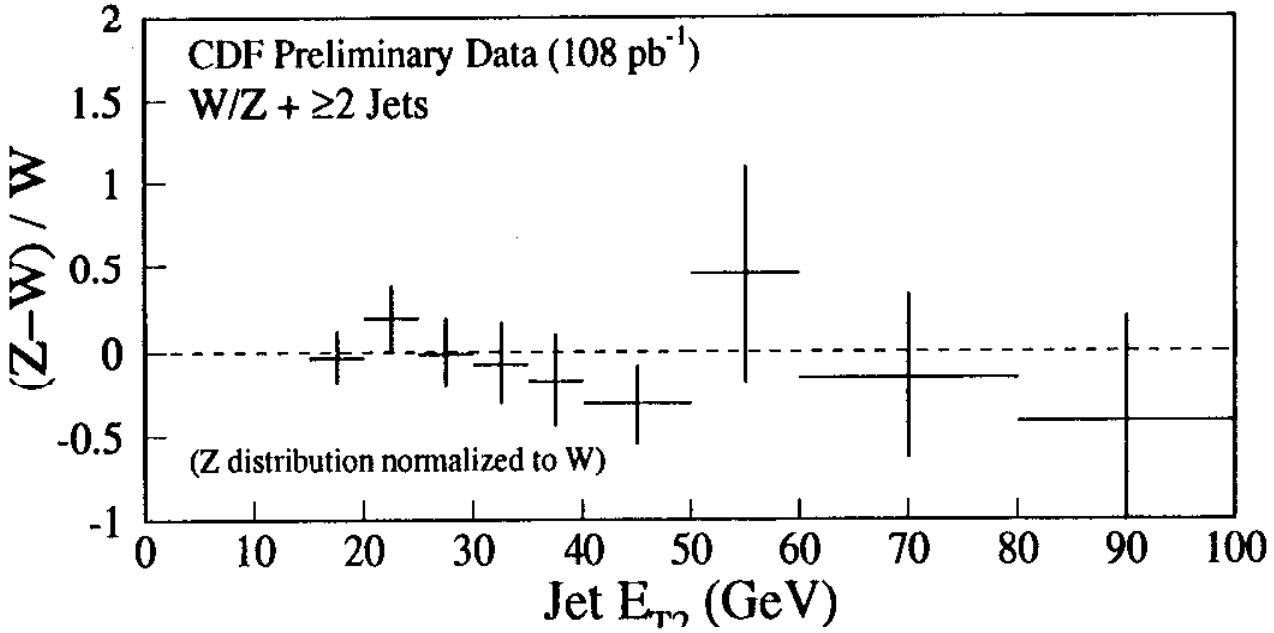
CDF



W, Z + JETS

CDF


CDF Preliminary Data (108 pb^{-1})
W/Z + ≥1 Jet
(Z distribution normalized to W)
(Z−W) / W
Jet E_{T1} (GeV)

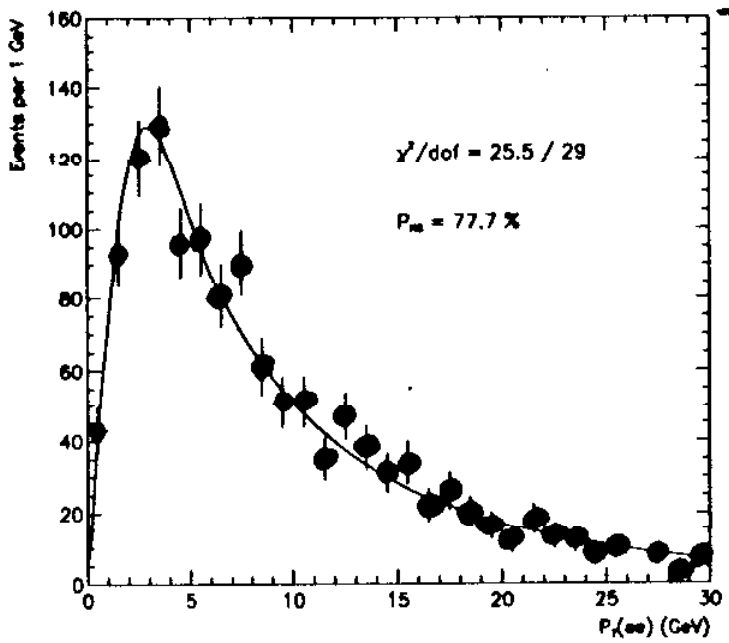

CDF Preliminary Data (108 pb^{-1})
W/Z + ≥2 Jets
(Z distribution normalized to W)
(Z−W) / W
Jet E_{T2} (GeV)

W Production Model

LADINSKY - YUAN

- fit g_2 using DØ $Z \to ee$ data g_1, g_2, g_3

MRSA′	0.59	$\pm 0.10(stat)$
MRSD−′	0.61	$\pm 0.05(syst)$ GeV^2
CTEQ3M	0.54	
CTEQ2M	0.61	



DØ

Z

P_T

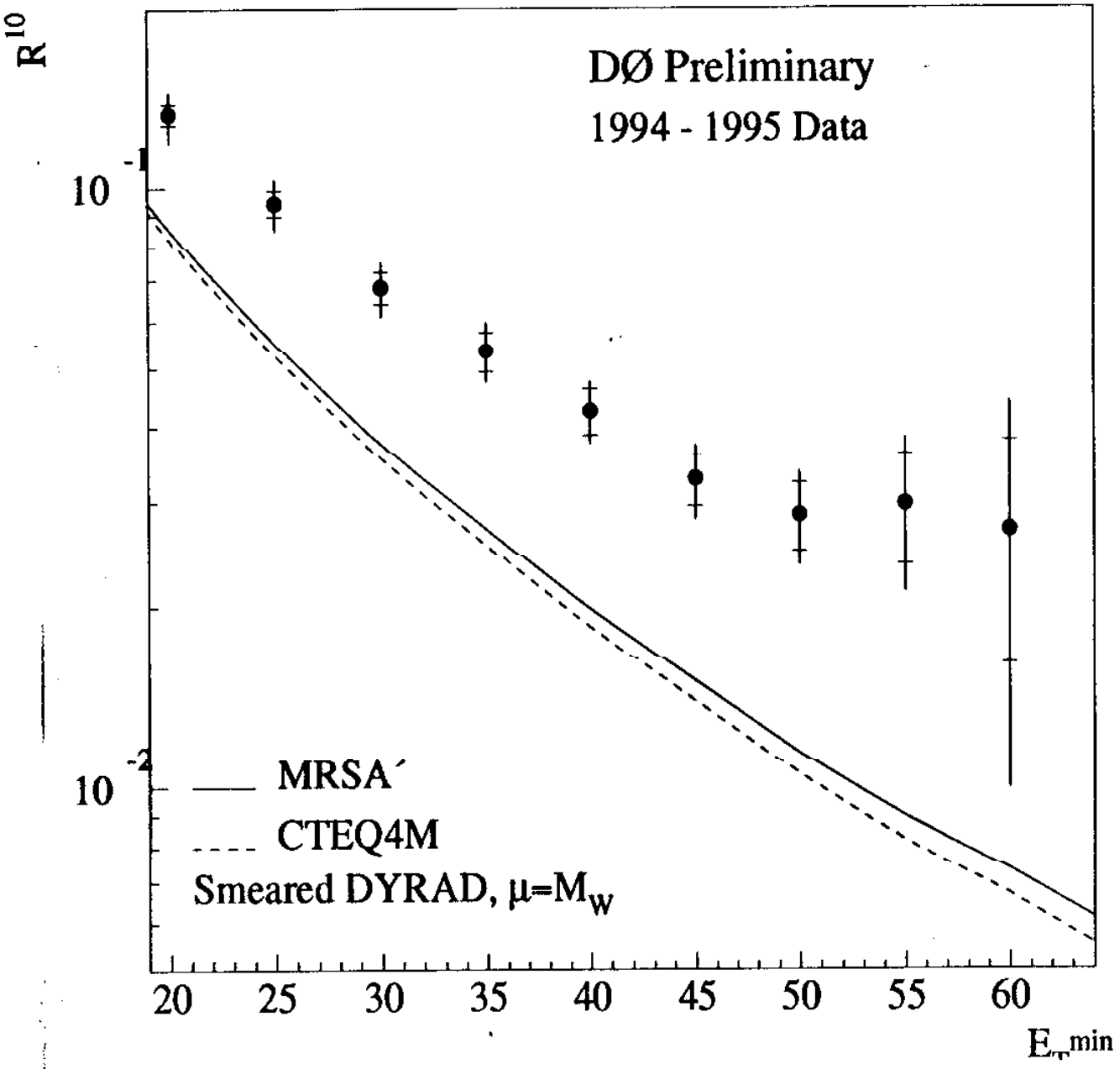
- deviations of fitted W mass for different pdf's

	g_2	m_T fit	$p_T(e)$ fit
MRSA′	0.59	$\equiv 0$	$\equiv 0$
MRSD−′	0.61	+20 MeV	+19 MeV
CTEQ3M	0.54	+5 MeV	+48 MeV
CTEQ2M	0.61	−21 MeV	−17 MeV

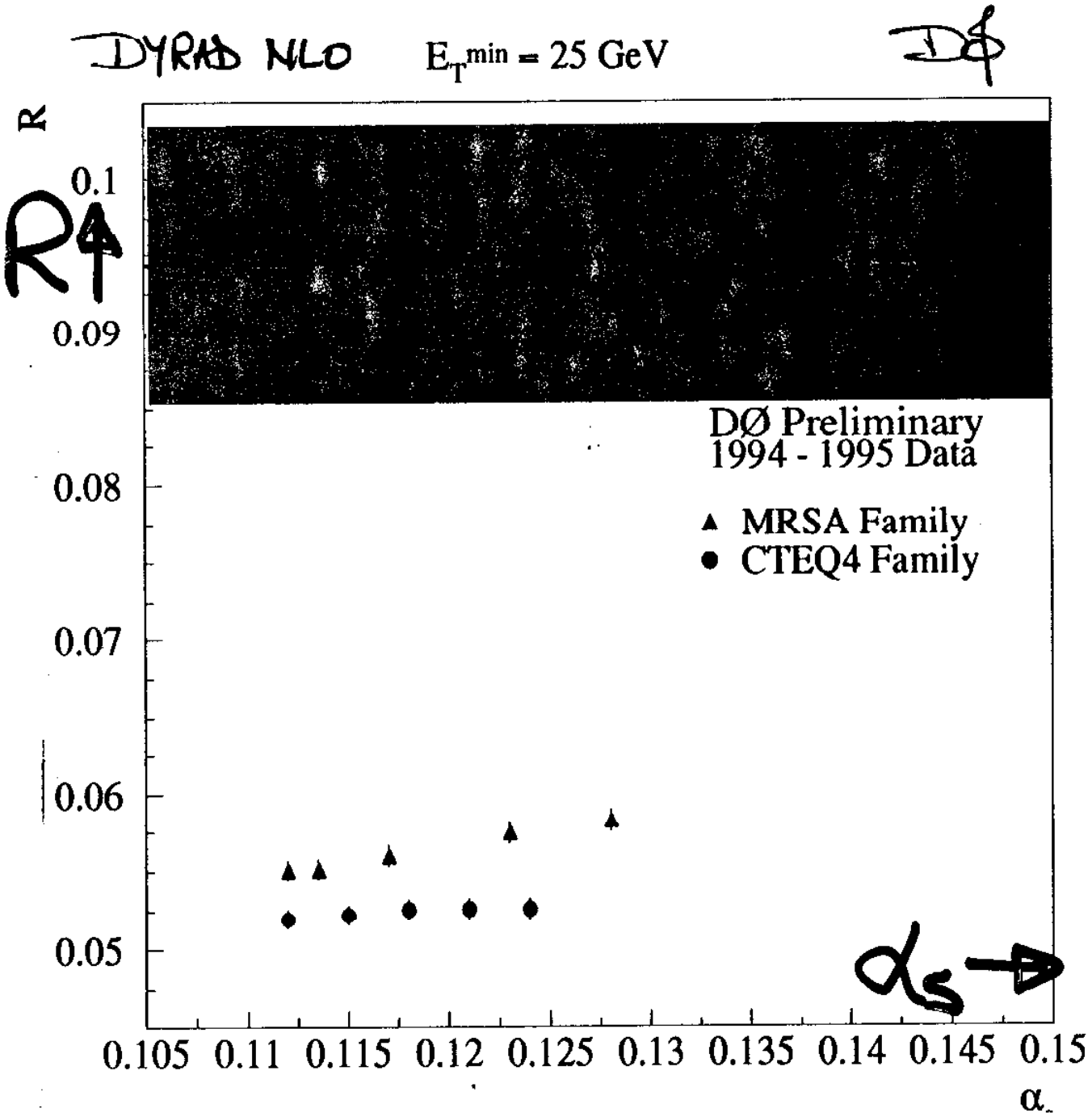
$$\frac{W + 1 \text{ jet}}{W + 0 \text{ jet}}$$

DYRAD NLO

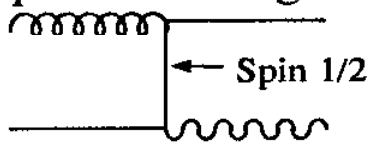
DØ



$$\frac{W + 1\ \text{jet}}{W + \phi\ \text{jet}}$$

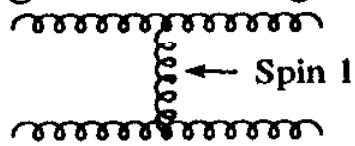


γ+ Jet and W+Jet:
quark exchange

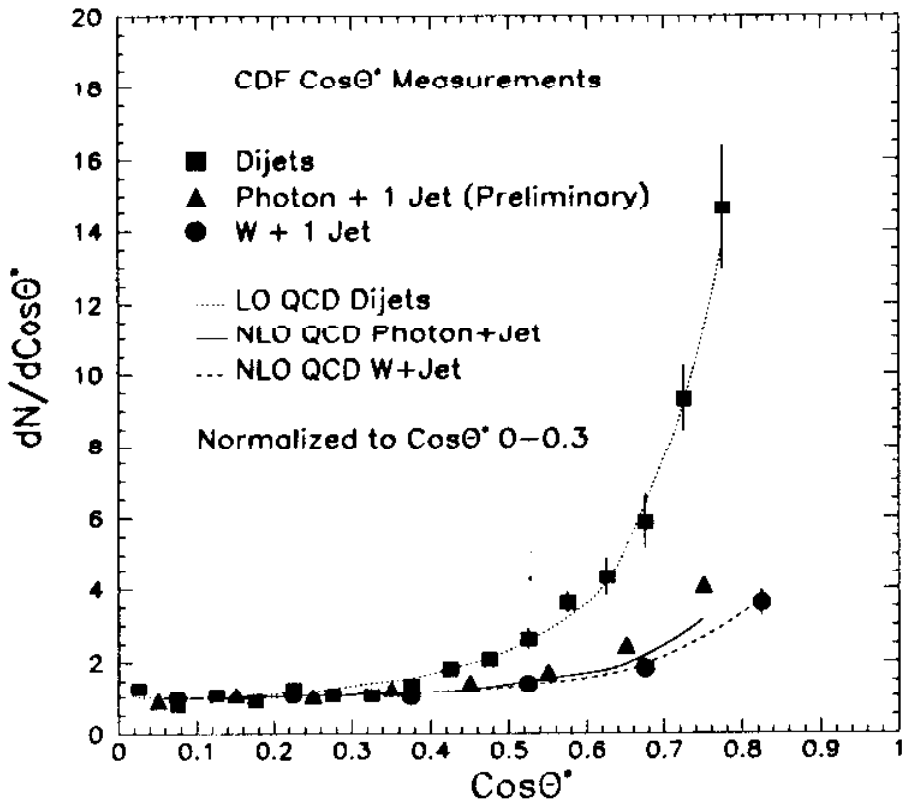


$$\frac{dN}{d\cos\theta^*} \sim \frac{1}{(1-\cos\theta^*)}$$

Jet + Jet:
gluon exchange



$$\frac{dN}{d\cos\theta^*} \sim \frac{1}{(1-\cos\theta^*)^2}$$



ANG. DISTS FOR SINGLE γ – OK

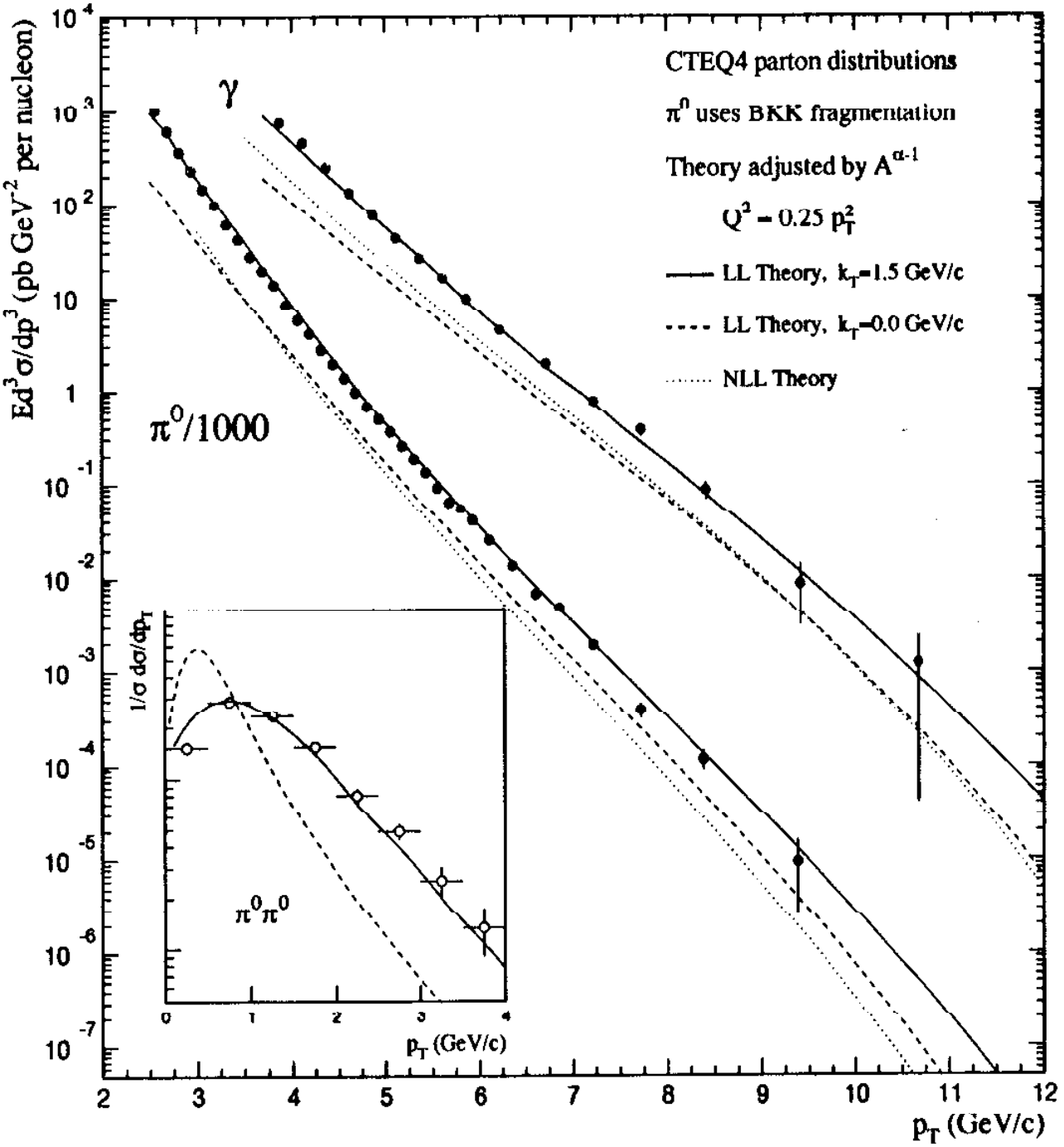
HIGH p_T SPECTRA – OK

HINT OF PROBLEM AT LOW p_T

k_T?

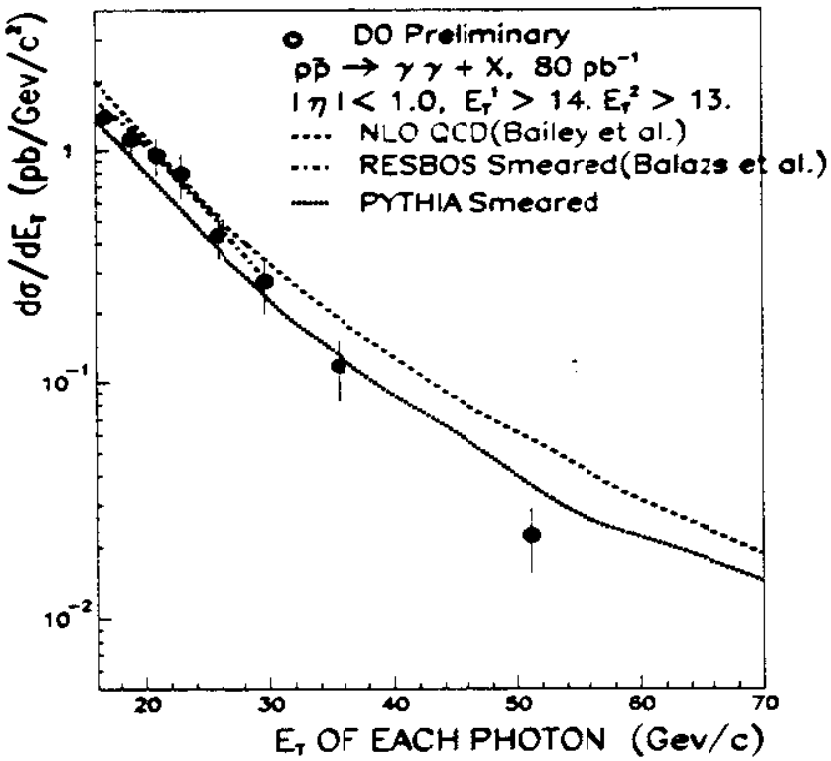
γ, π⁰ PRODUCTION

E706 pBe at √s=31.6 GeV/c



WANT k_T !

Diphoton Results



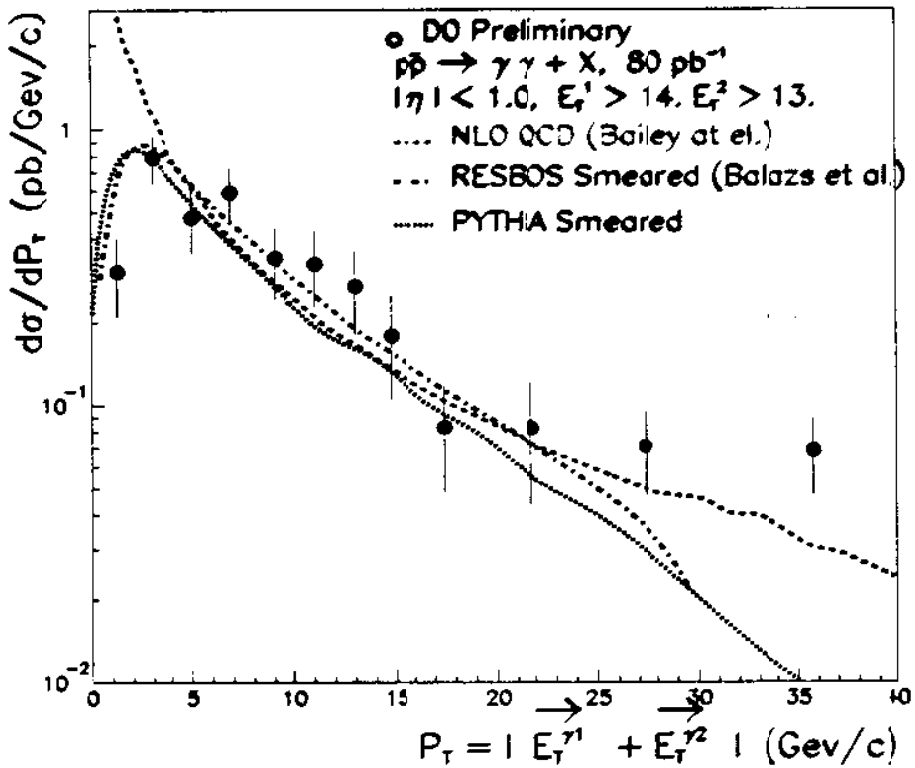
E_T spectrum

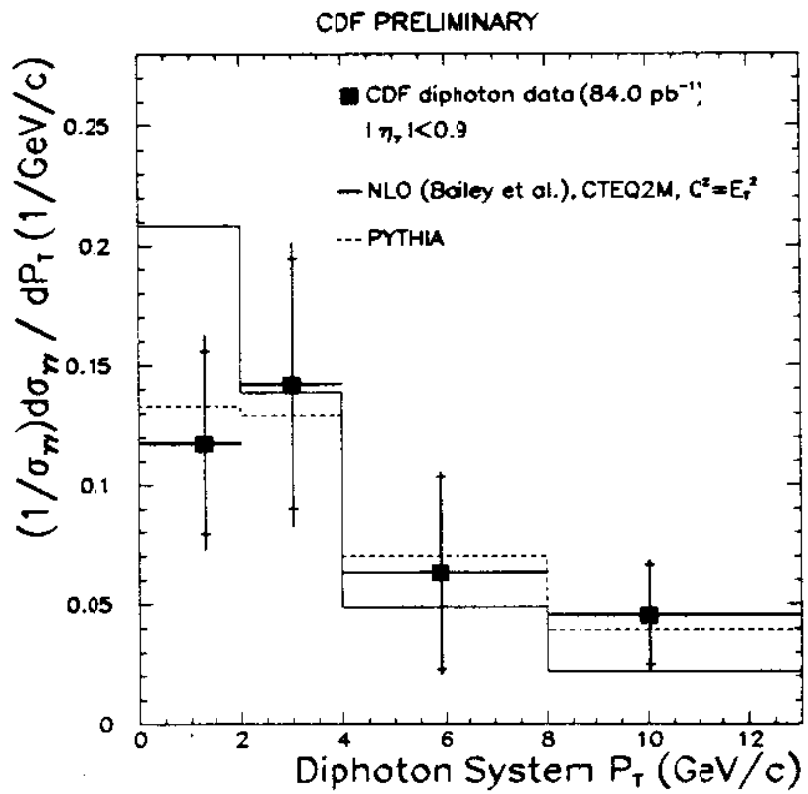
- stat. and syst. (purity)
  [redacted]ty

- resummed NLO model available: RESBOS
  Phys.Lett.B355:548-554, 1995, hep-ph/9505203.
  resums multiple soft gluon emission in the initial state; originally for production of massive vectorbosons

Diphoton k_T

RESBOS (and Pythia) describe lower part of k_T spectrum very well

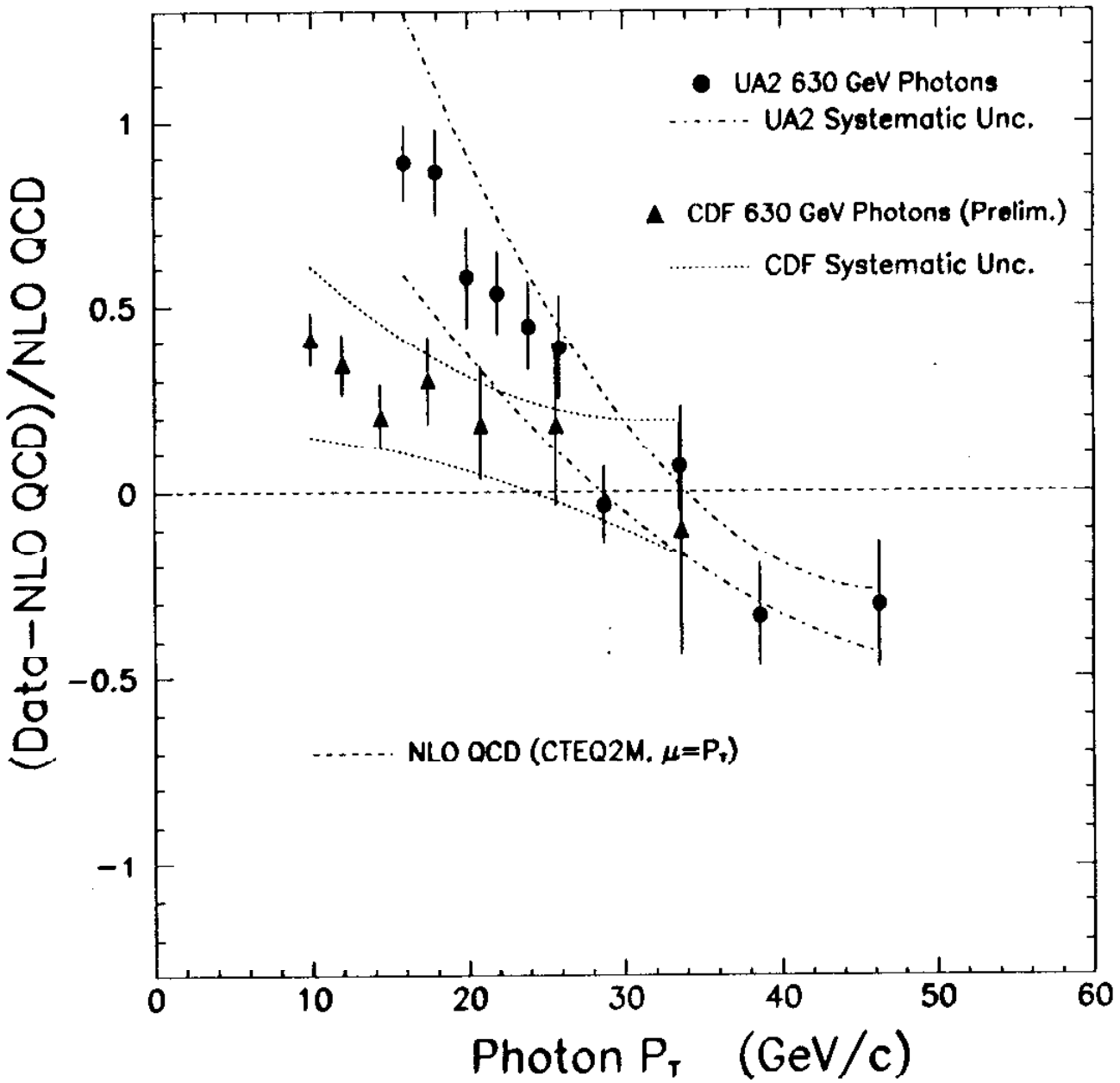




Stefan Grünendahl March '97

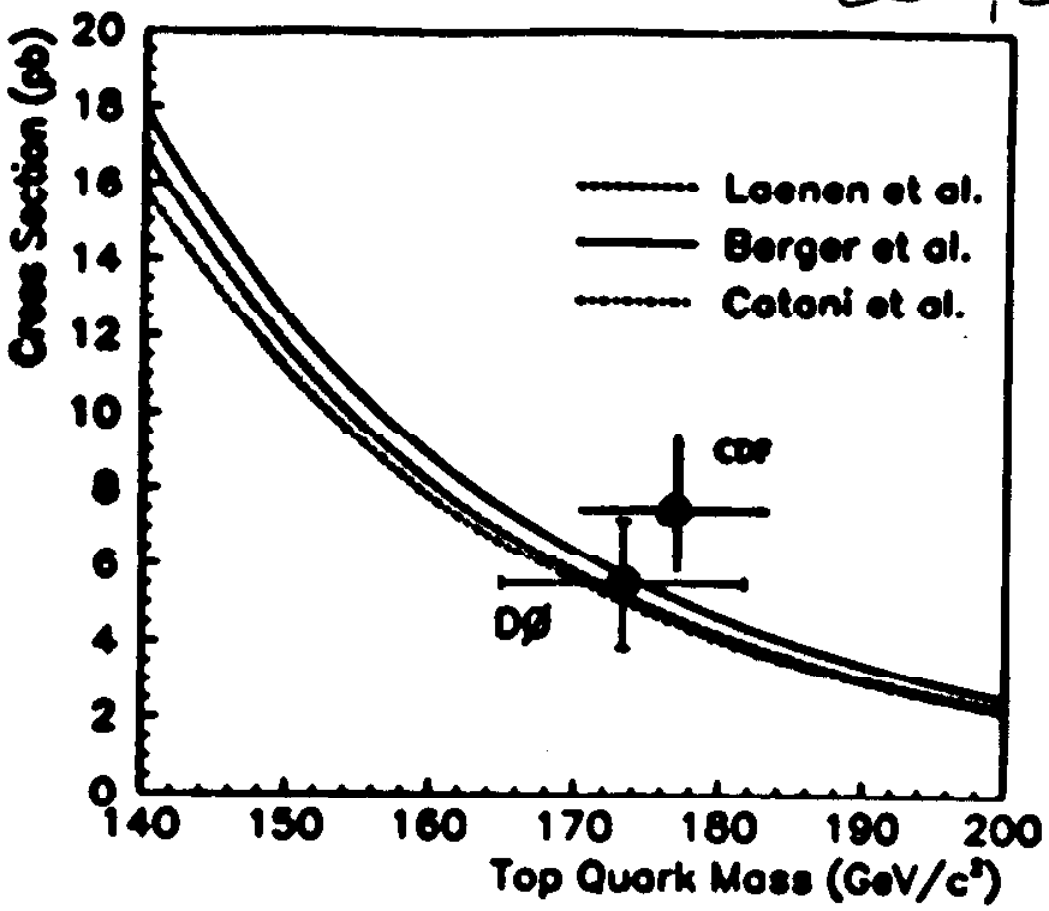
630 GeV γ DATA

CDF



TOP PRODUCTION

CDF, DØ



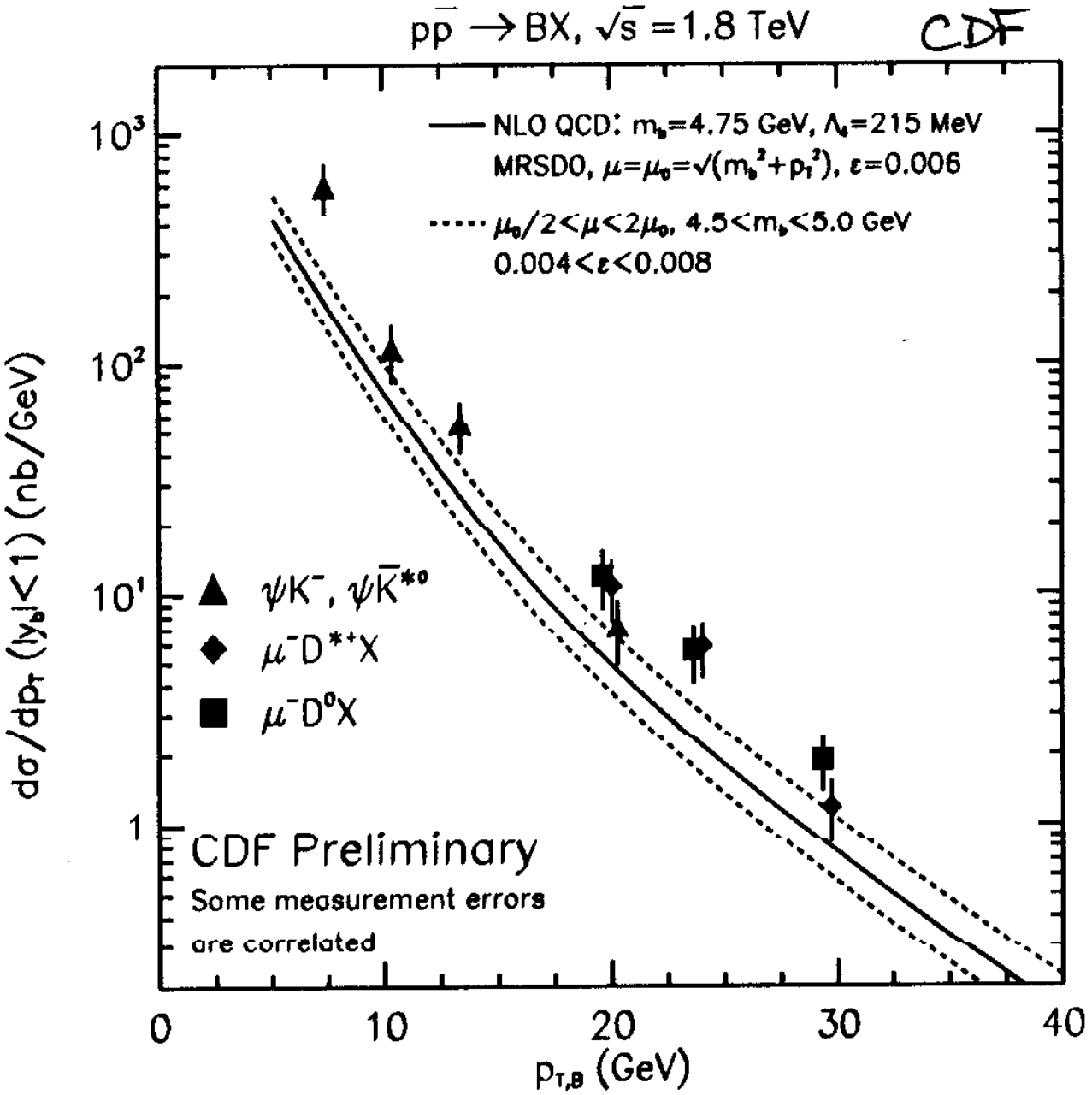
CDF (176.8): $7.5^{+1.8}_{-1.7}$ pb

DØ (173.3): 5.5 ± 1.7 pb

6.5 ± 1.3 pb

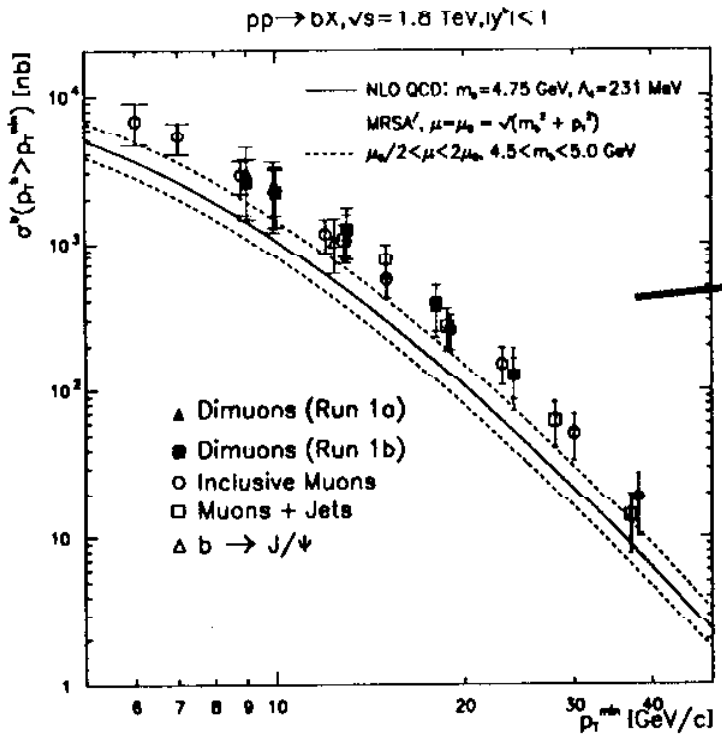
ELLIS '91		$4.20^{+0.28}_{-0.54}$ pb
LAENEN, SMITH, VAN NEERVEN	'94	$4.94^{+0.71}_{-0.45}$ pb
BERGER, CONTOPANAGOS	'95	$5.52^{+0.07}_{-0.45}$ pb
CATANI et al	'96	$4.75^{+0.63}_{-0.68}$ pb

BOTTOM PRODUCTION

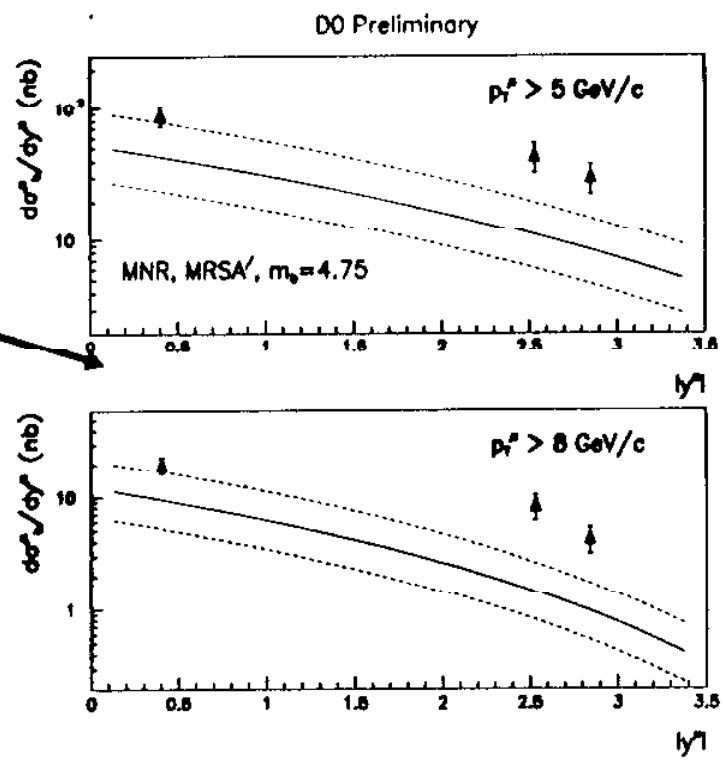


BOTTOM PRODUCTION

DØ



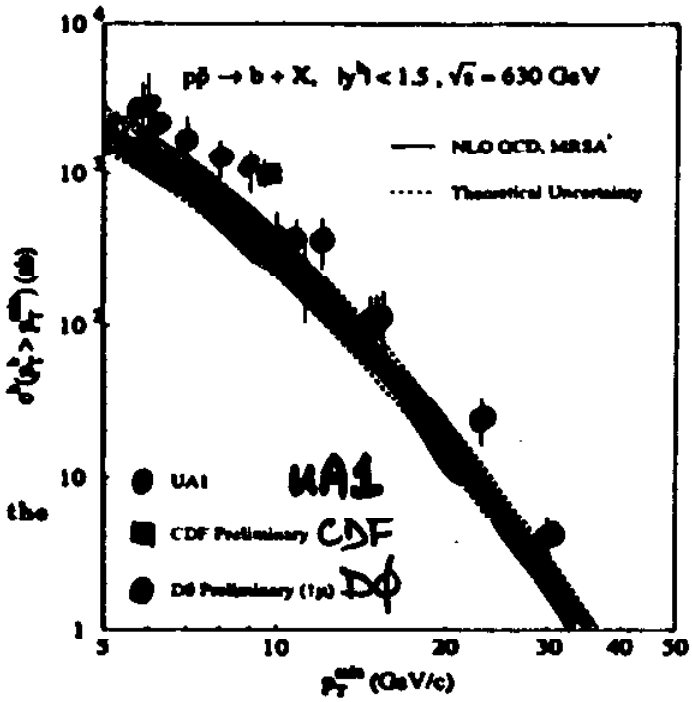
Inclusive B cross section for $P_t^b > P_t^{min}$ for several final states



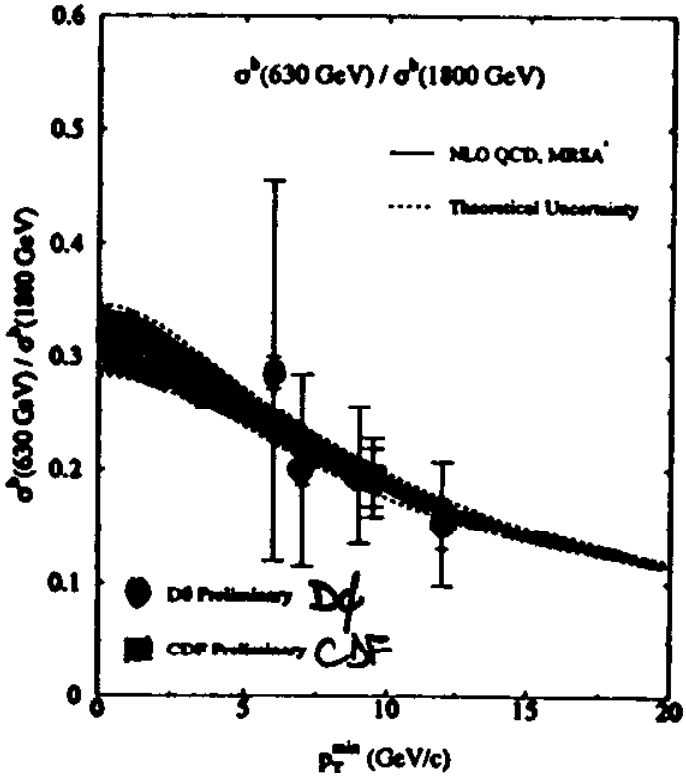
Rapidity dependence of inclusive B cross.

630 GeV BOTTOM PRODUCTION

CDF ■
DØ ●
UA1 ●

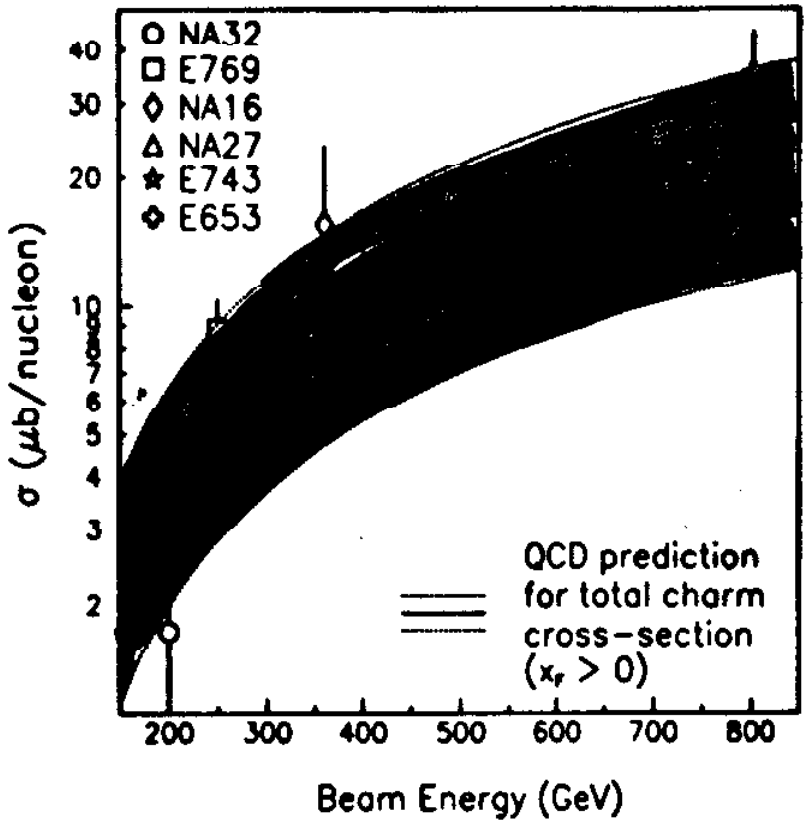


- NLO QCD prediction obtained with MNR using the MRSA' pdf.
  - $\Lambda^5_{\overline{MS}} = 152$ MeV (fixed)
  - $m_b = 4.75$ GeV/c^2 (4.5 and 5 GeV/c^2)
  - $\mu = \mu_0 \equiv \sqrt{m_b^2 + (p_T^b)^2}$ ($\mu_0/2$ and $2\mu_0$)



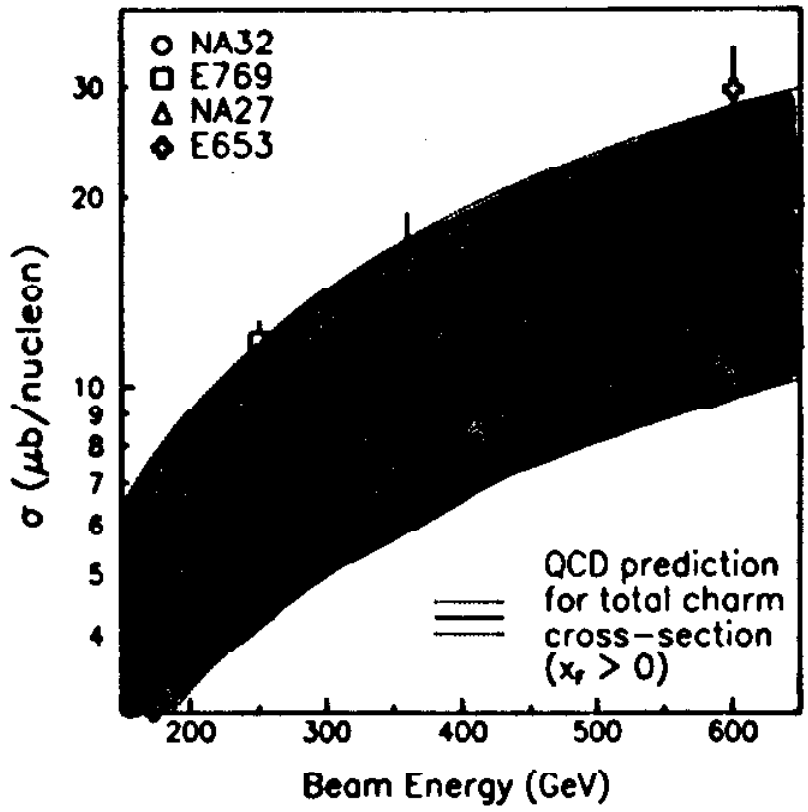
CHARM PRODUCTION

E769



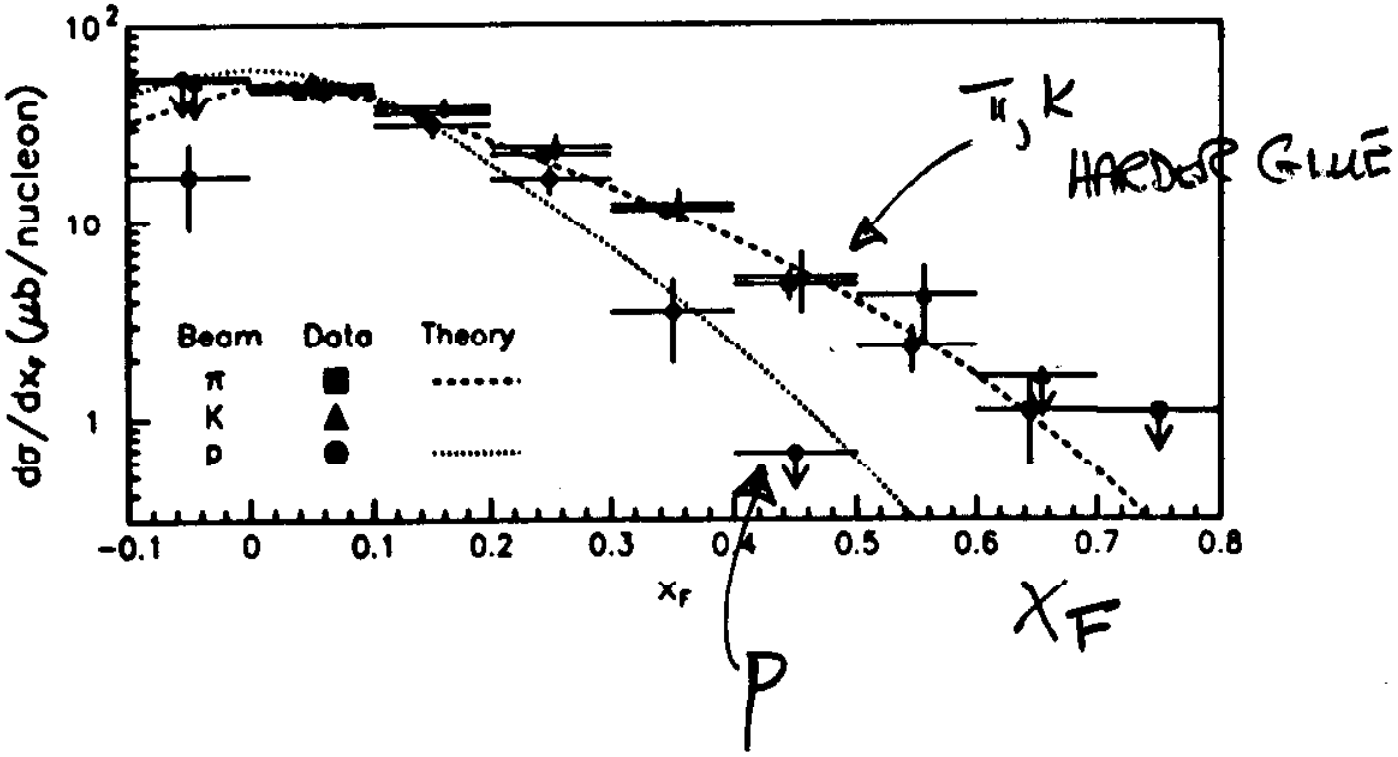
PROTONS

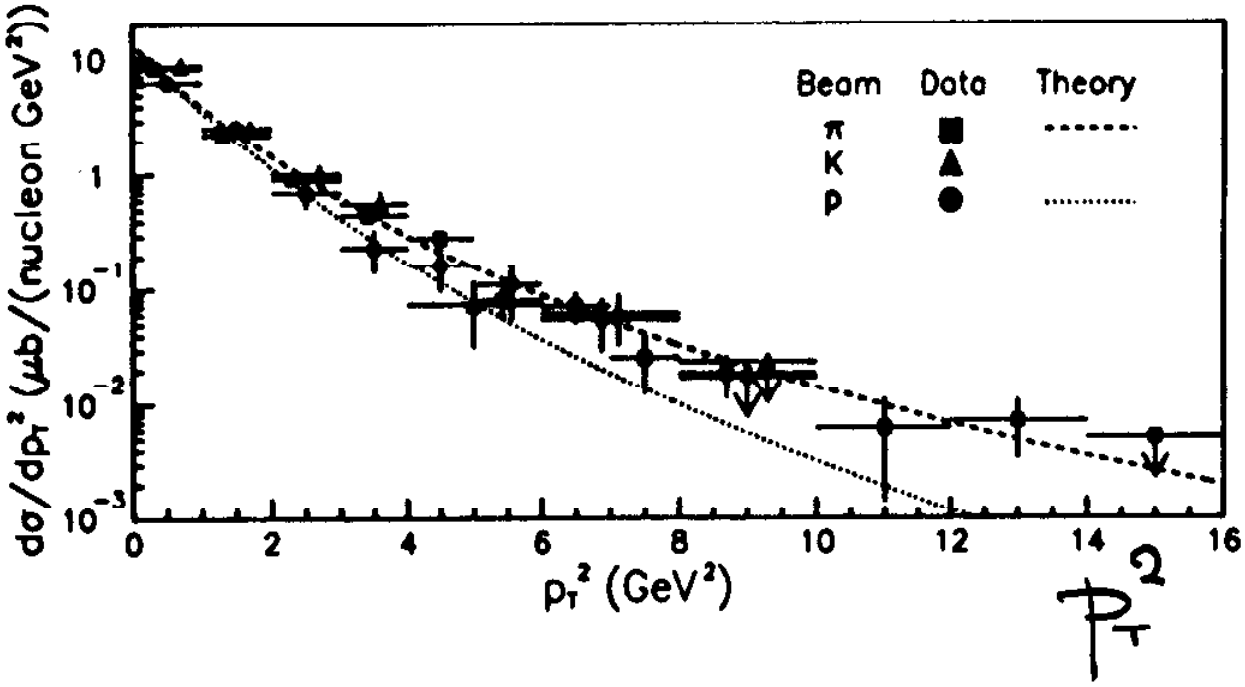
$X_F > 0$



PIONS

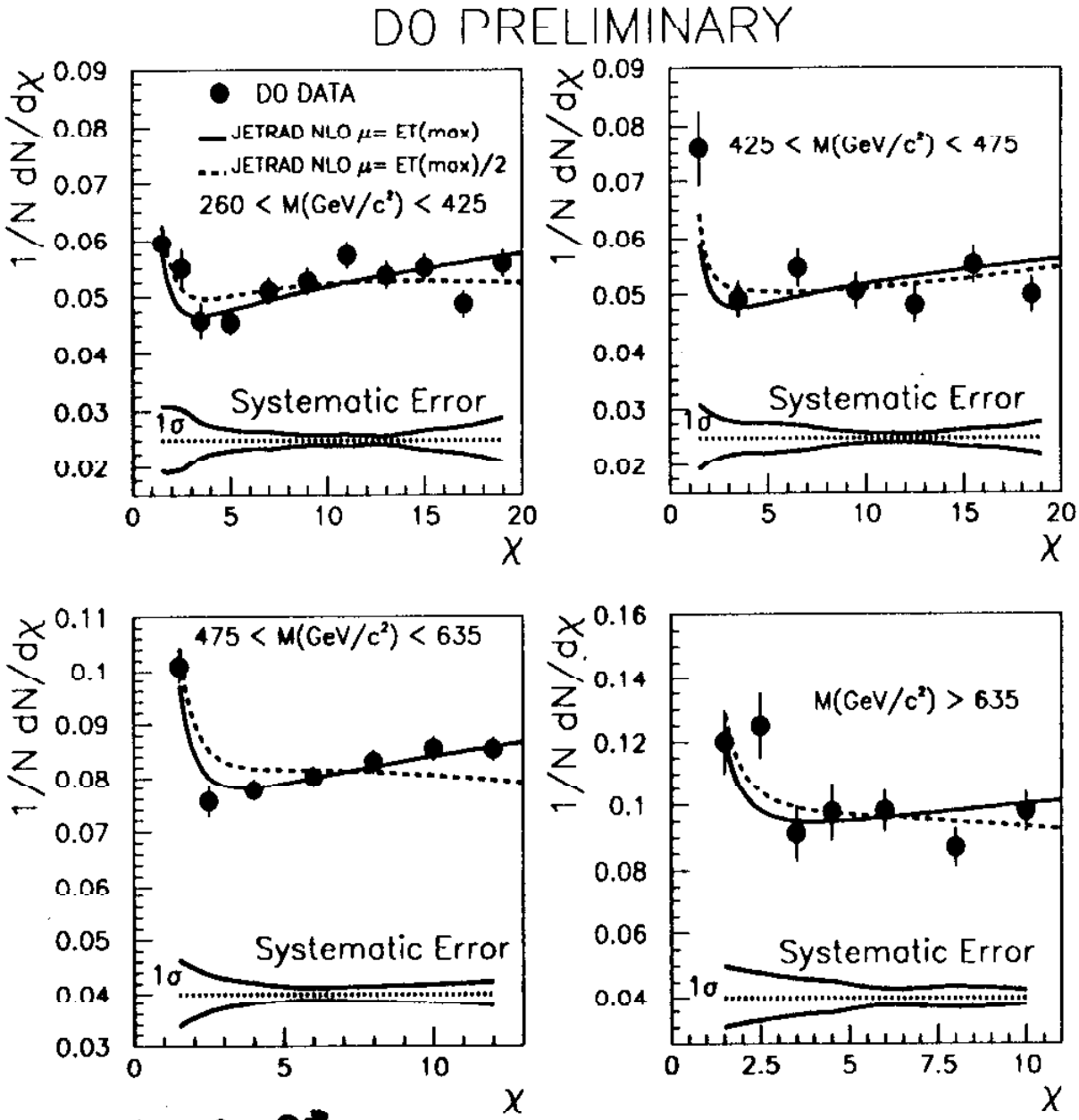
CHARM PRODUCTION





Jet Production at the Tevatron

ANGULAR DISTRIBUTIONS

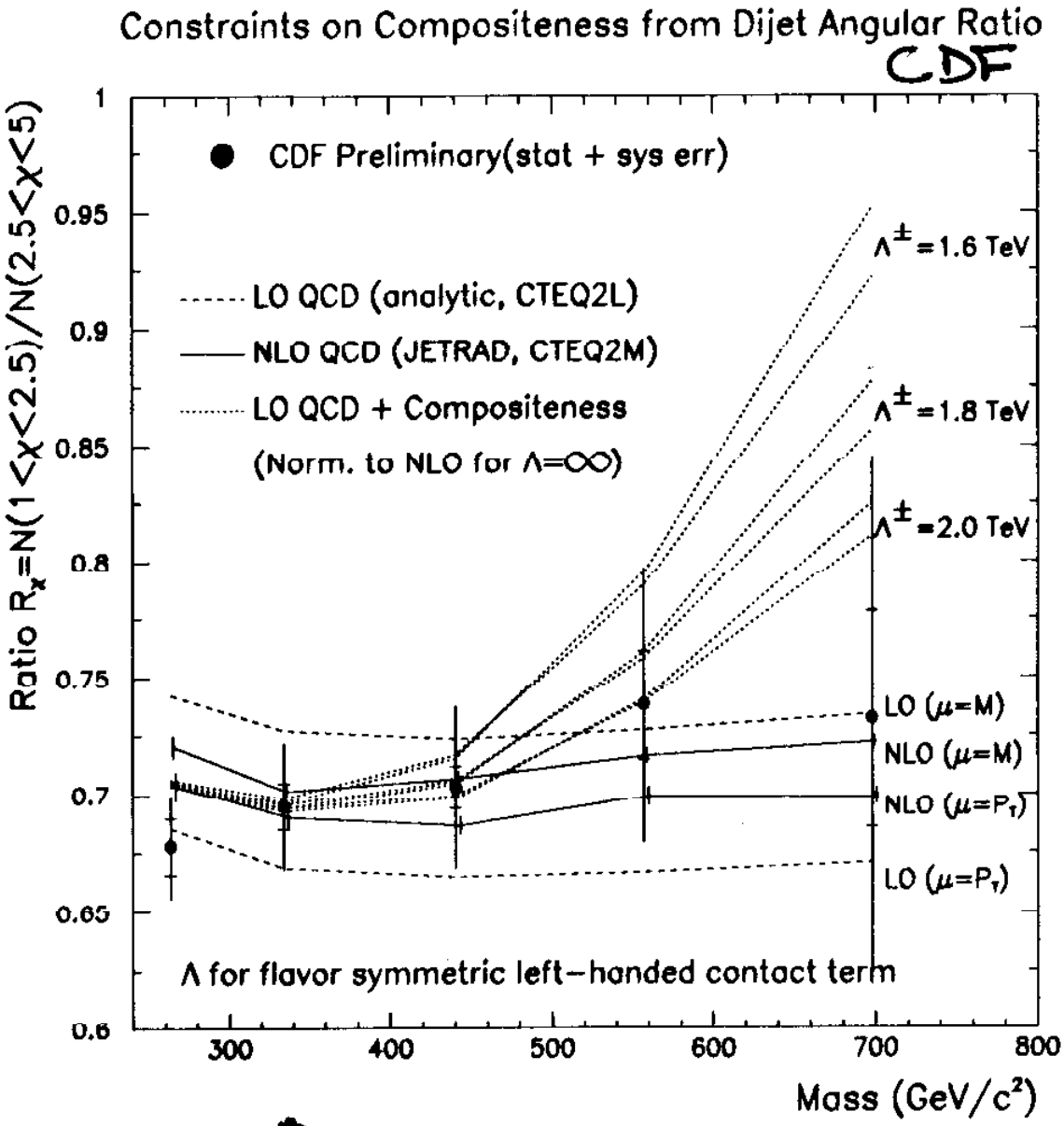


$$\chi = \frac{1+\cos\theta^*}{1-\cos\theta^*}$$

$\Lambda^+ > 2.0$ TeV

Jet Production at the Tevatron

ANGULAR DISTRIBUTIONS.



R_χ

$$\chi = \frac{1+\cos\theta^*}{1-\cos\theta^*}$$

$\Lambda^+ > 1.8$ TeV

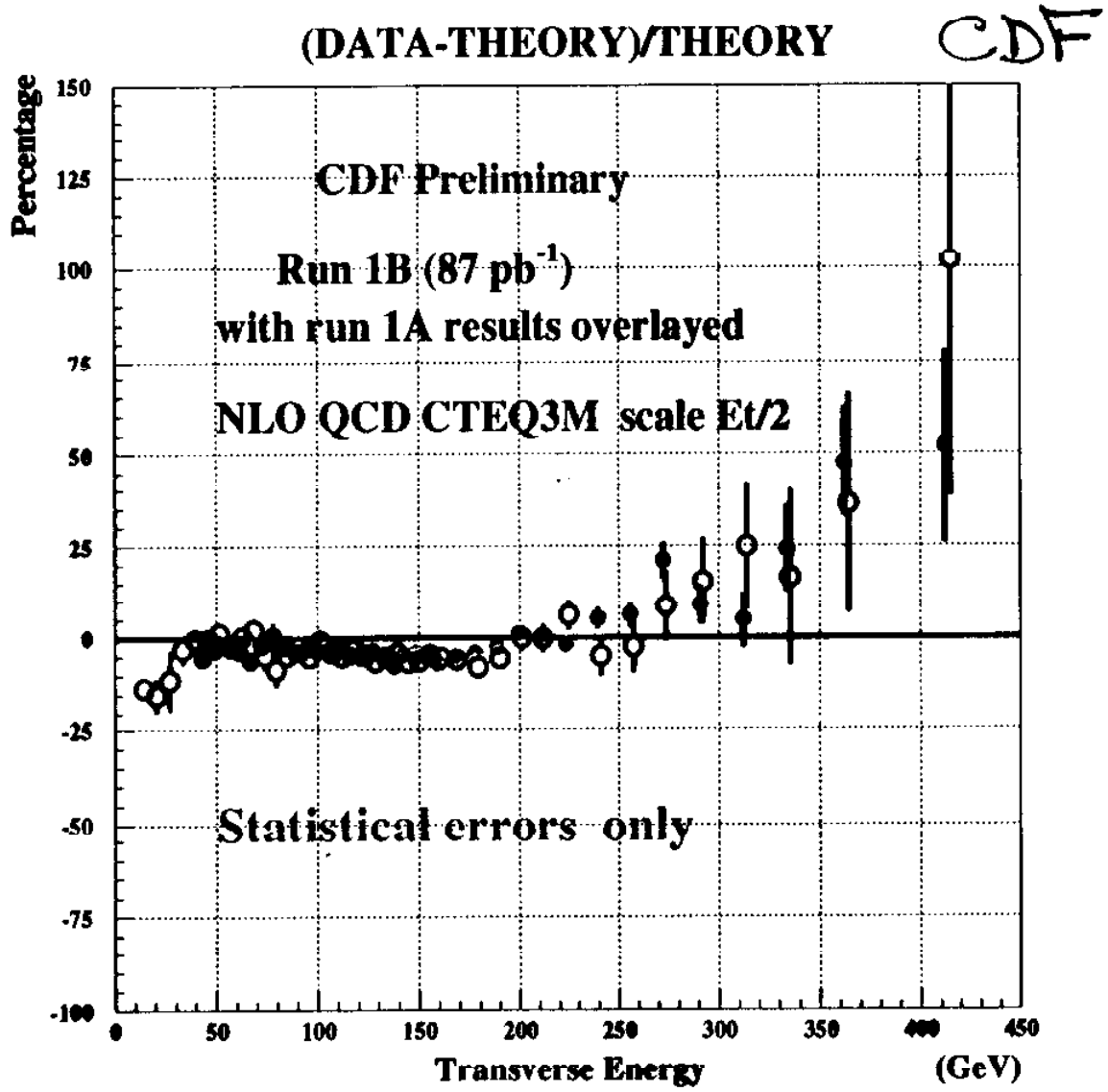
95% CL

$\Lambda^- > 1.6$ TeV

Jet Production at the Tevatron

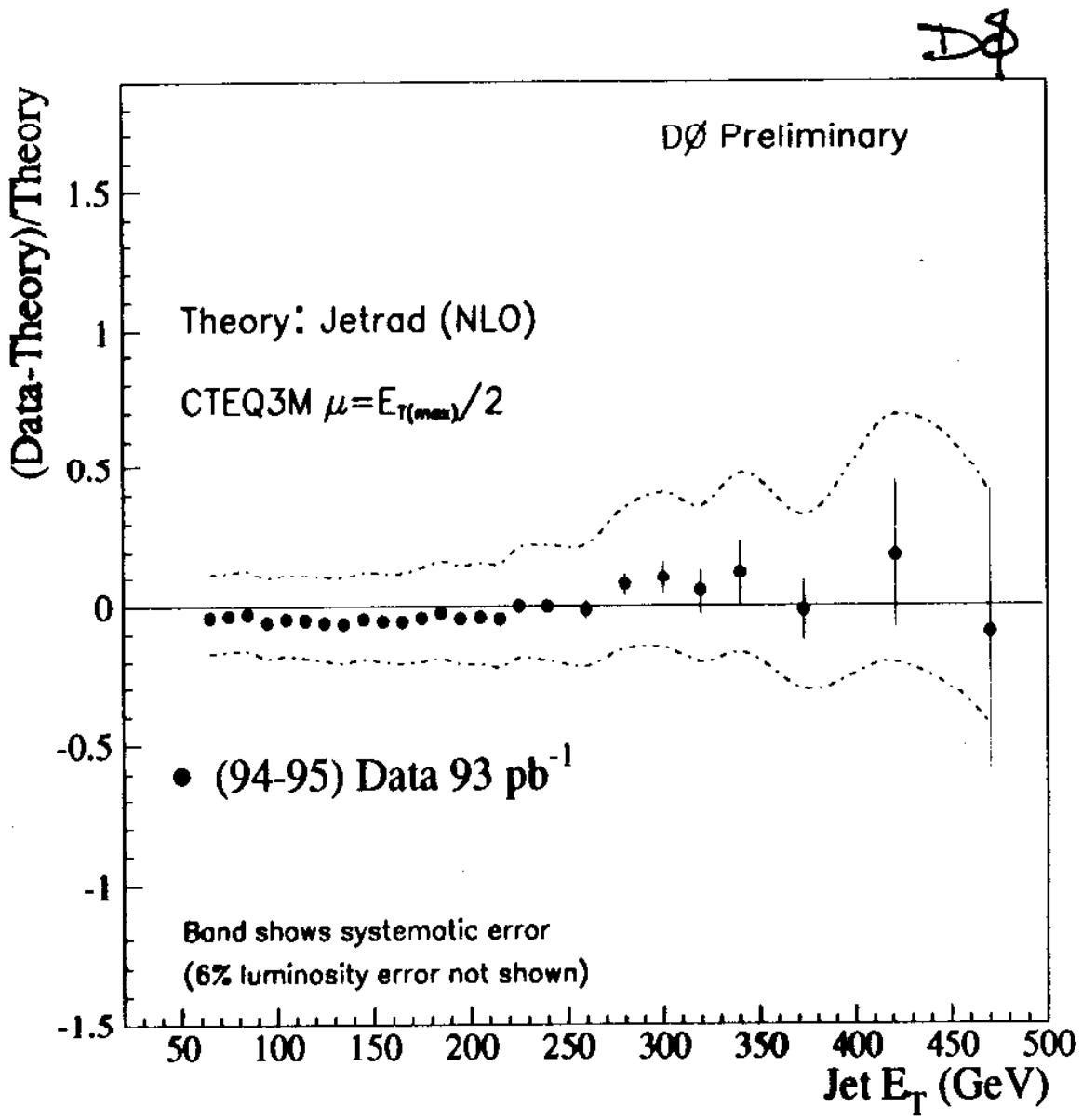
$0.1 \leq |\eta| \leq 0.7$

IB luminosity uncertainty $\approx 10\%$



Jet Production at the Tevatron

$$0.0 \leq |\eta| \leq 0.5$$



INCLUSIVE JETS

BEWARE:

JET ENERGY SCALE

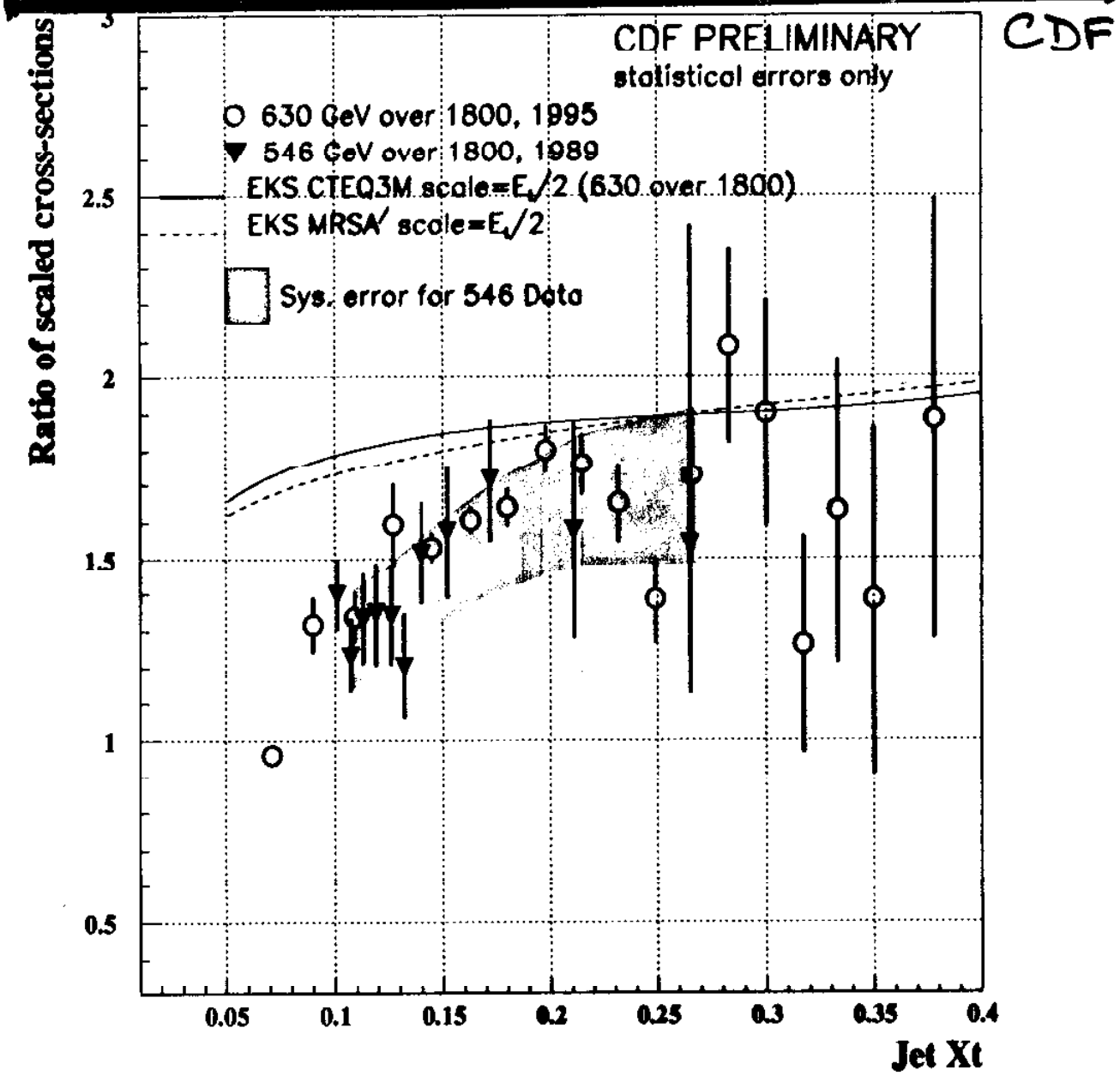
PROGRAM	JETRAD / EKS
SCALE	$E_T^{JET}/2$: $E_T^{MAX}/2$
RSEP (JET SEPARATION ALGORITHM)	1.3 : 2.0

BIN CENTER CONVENTION

pdf +

?

Ratio of Scaled Cross-Sections: 630 and 546 over 1800

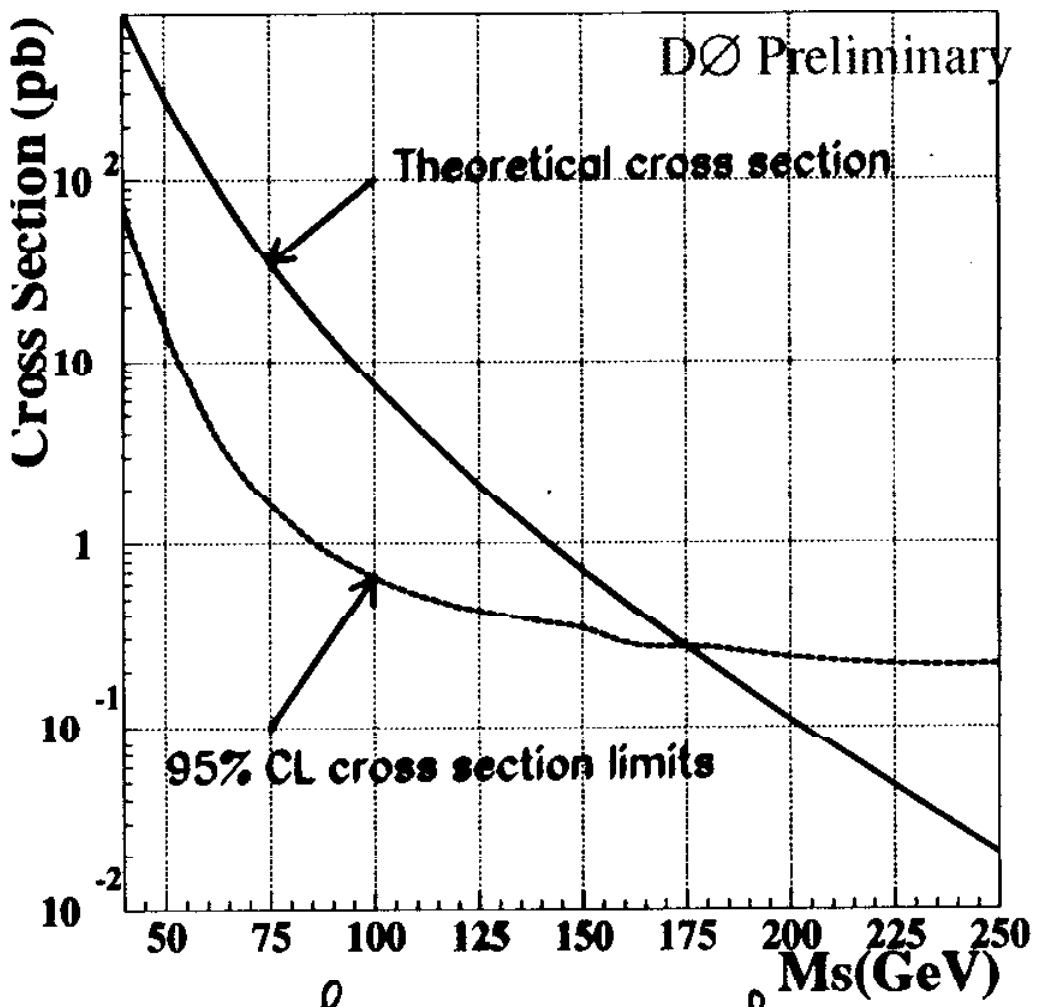


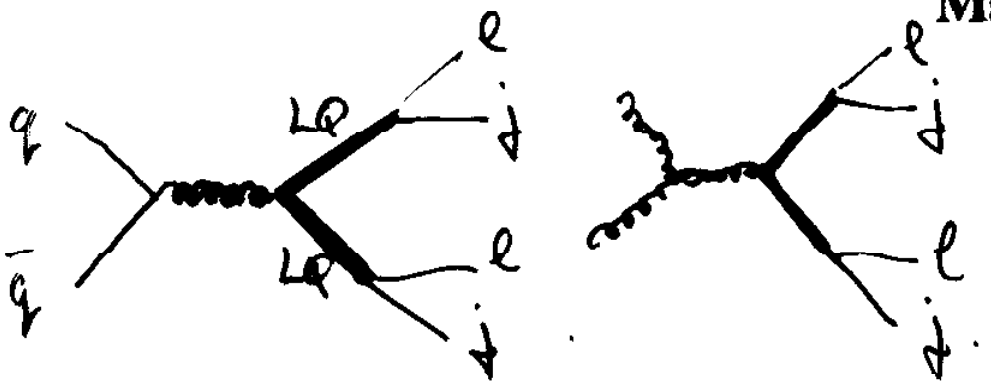
First generation: eejj

e e j j

Data:	3 events
Background:	2.9 ± 1.1

DØ

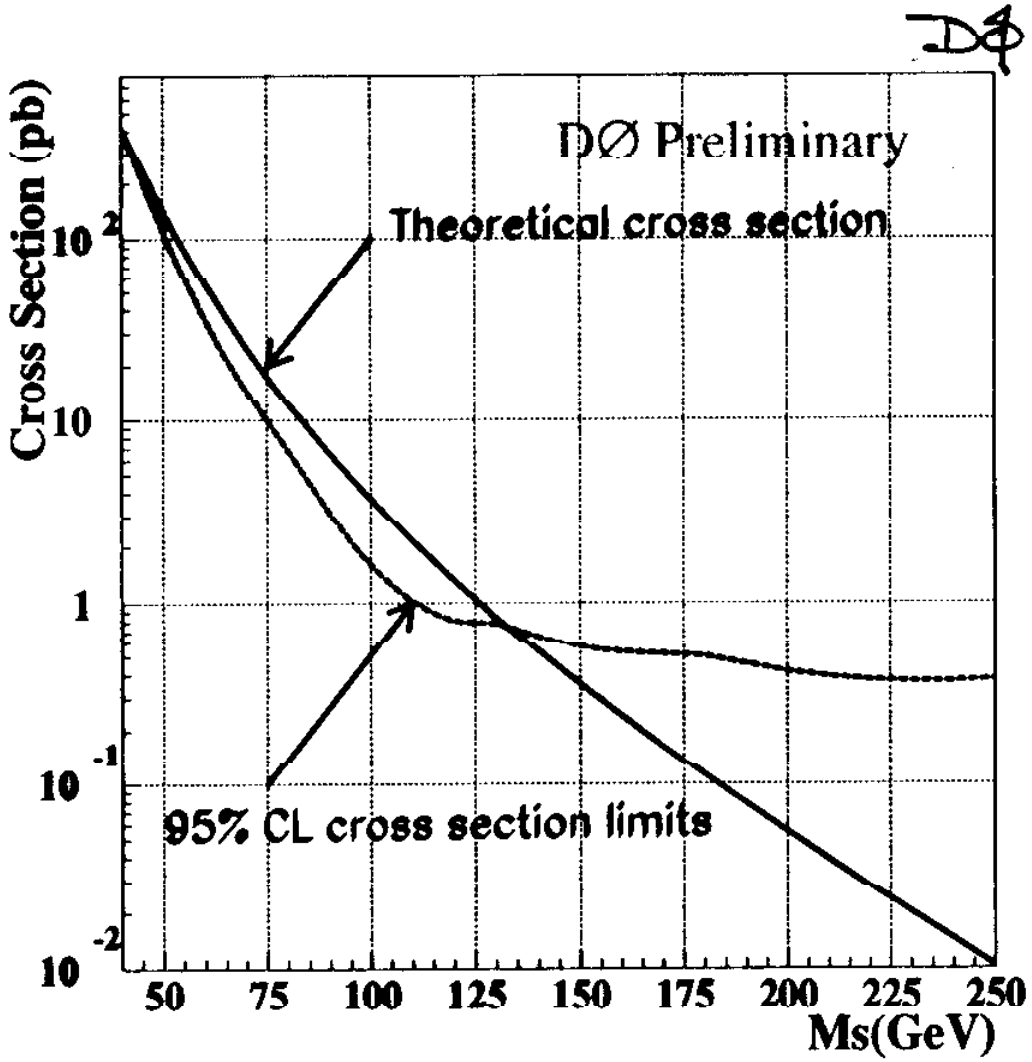




$\beta = 1$

First Generation: evjj

Data:	3
Backgrounds:	4.0 ± 1.3

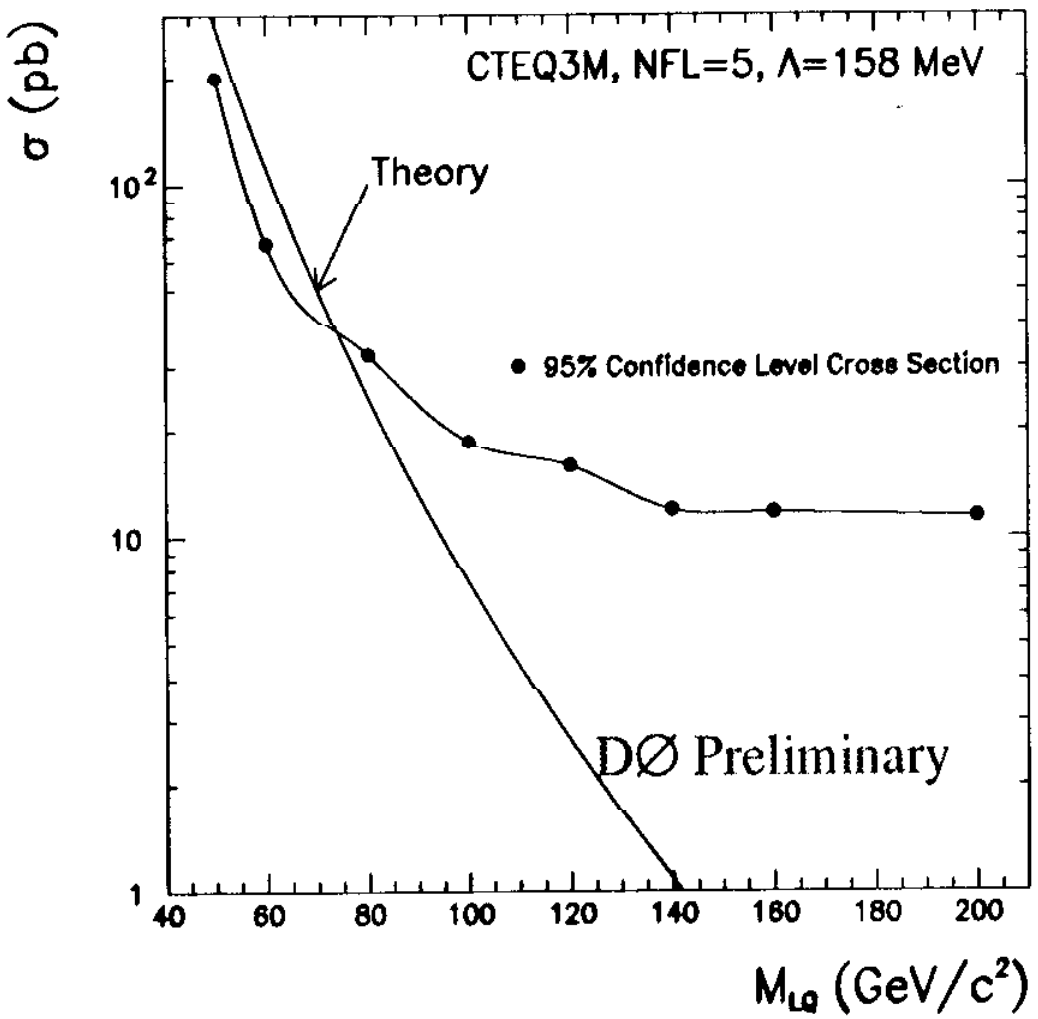


$\beta = 0.5$

First Generation: $\nu\nu jj$

2 jets
$\not{E}_T$

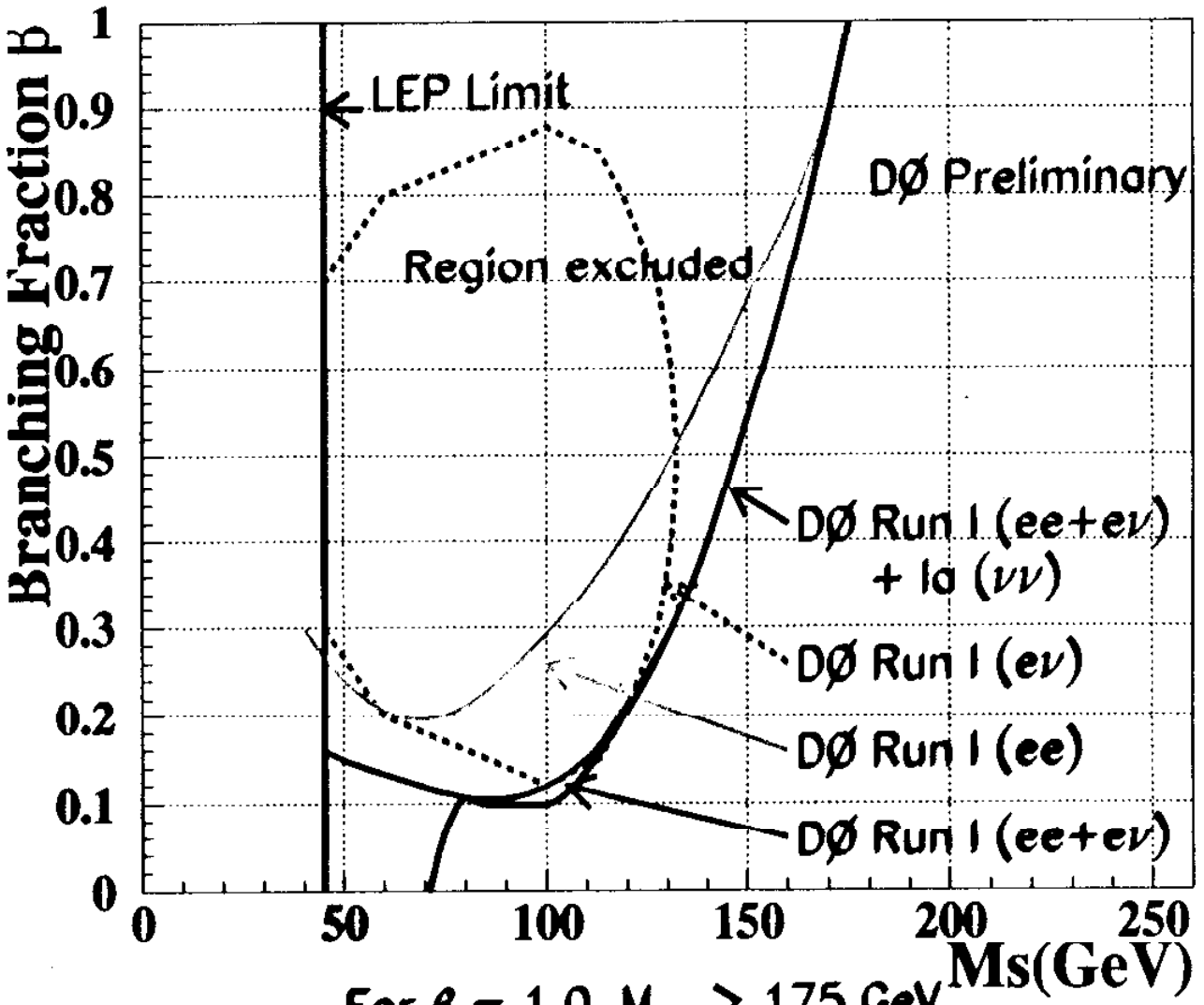
Data:	3
Background:	3.5 ± 1.2



$\beta = 0$

SCALAR LEPTOQUARKS

Combined First Generation



For $\beta = 1.0$, $M_{SLQ} > 175$ GeV

For $\beta = 0.5$, $M_{SLQ} > 147$ GeV

For $\beta = 0.0$, $M_{SLQ} > 71$ GeV

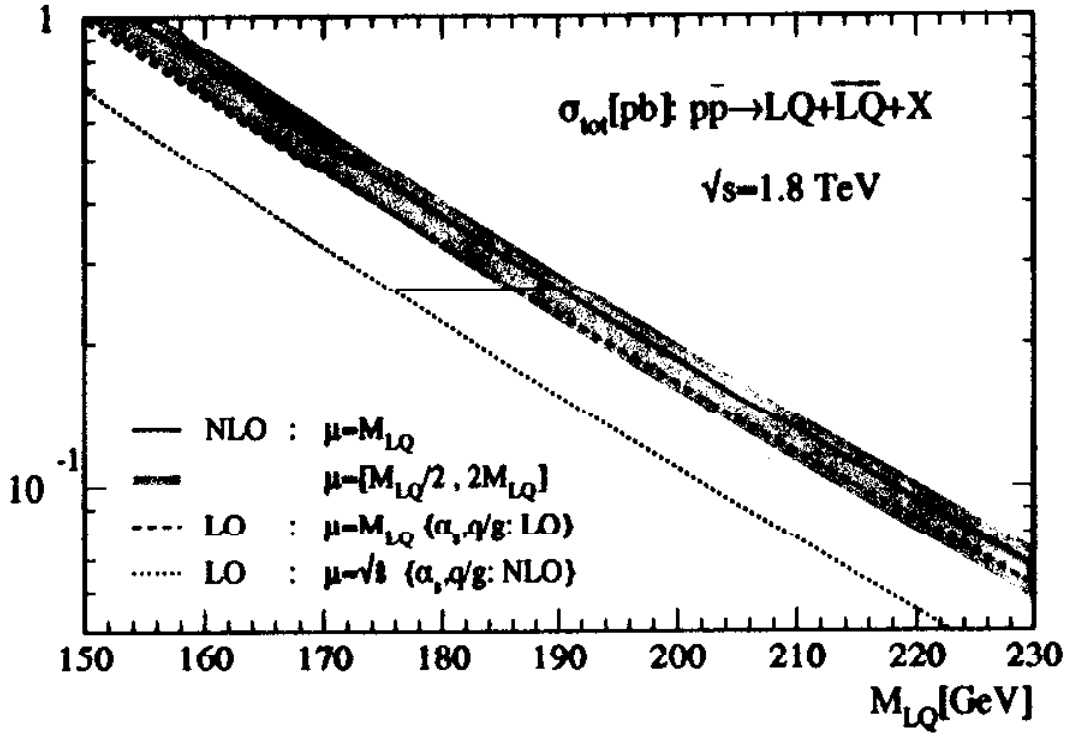
Cross section:

Blümlein, Boos, Kryukov, DESY 96-174

LEPTOQUARK PRODUCTION

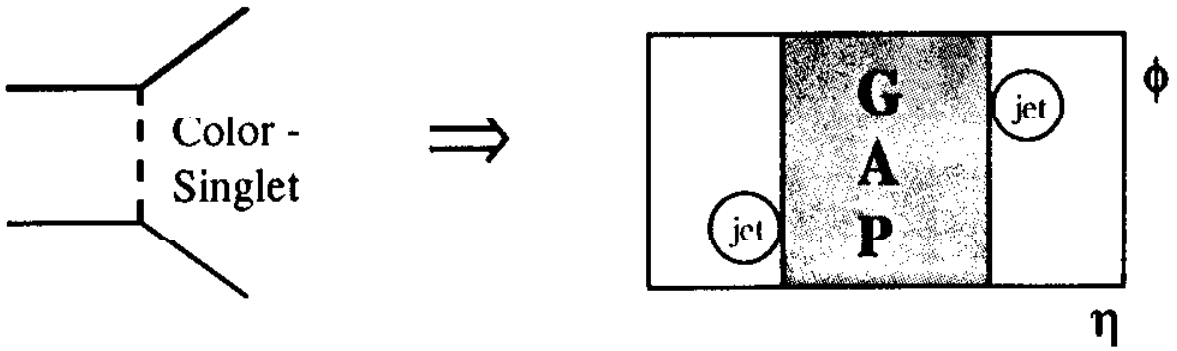
NEXT TO LEADING ORDER
KRAMER, PLEHN, SPIRA, ZERWAS

RAL 97-017
DESY 97-063
CORNELL TH/97-67



SCALAR LQ MASS LIMITS $\Delta \sim 15$ GeV

Hard Color-Singlet Exchange

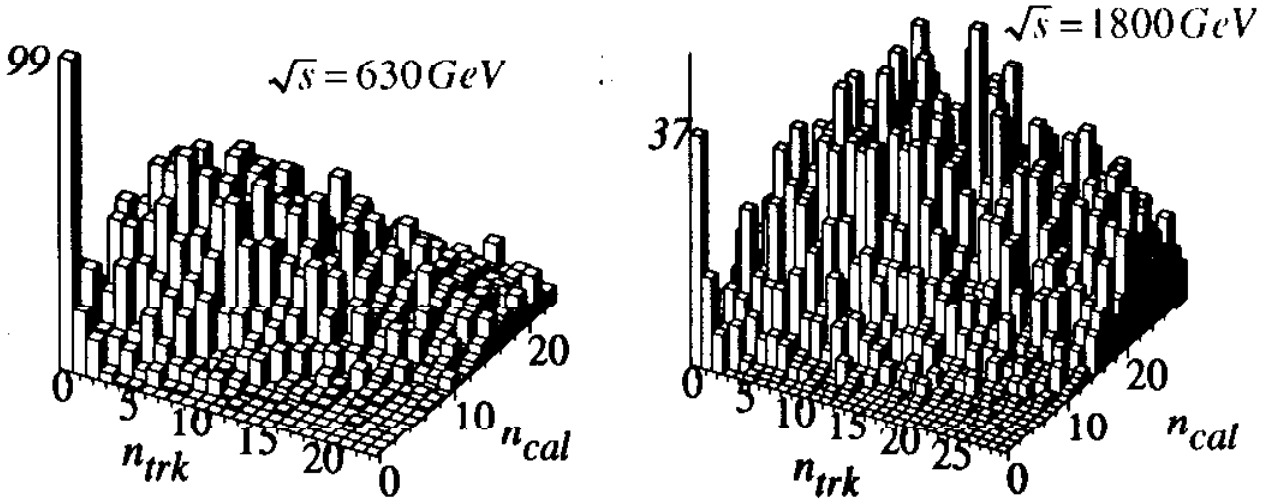


- Changing $\sqrt{s}$ probes different parton x values

Predictions:

2 Gluon Model: R = f_{630} / f_{1800} ~ 0.8

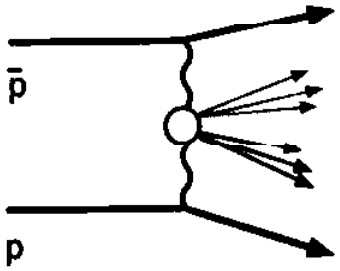
Soft Color-Rearrangement Model: R ~ 1 - 2.5



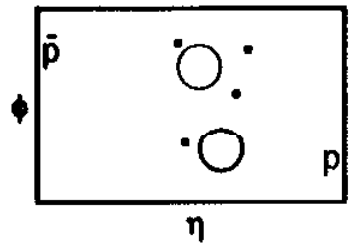
$R^{data} \cong$ 2.6 D0 Preliminary

- Fraction as function of E_T , $\Delta\eta$ at $\sqrt{s}$ = 1800 GeV also probes different parton x values
  - ★ Results are consistent with $R_{630/1800}$

Hard Double Pomeron Exchange



$p\bar{p} \rightarrow p\bar{p} + jj$

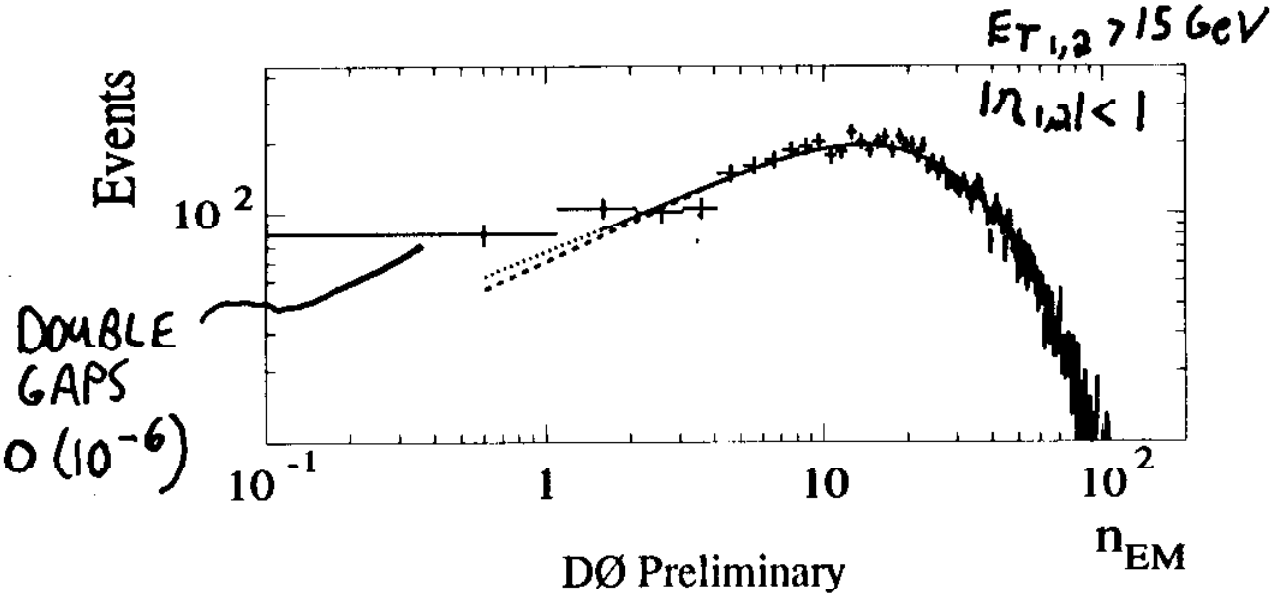


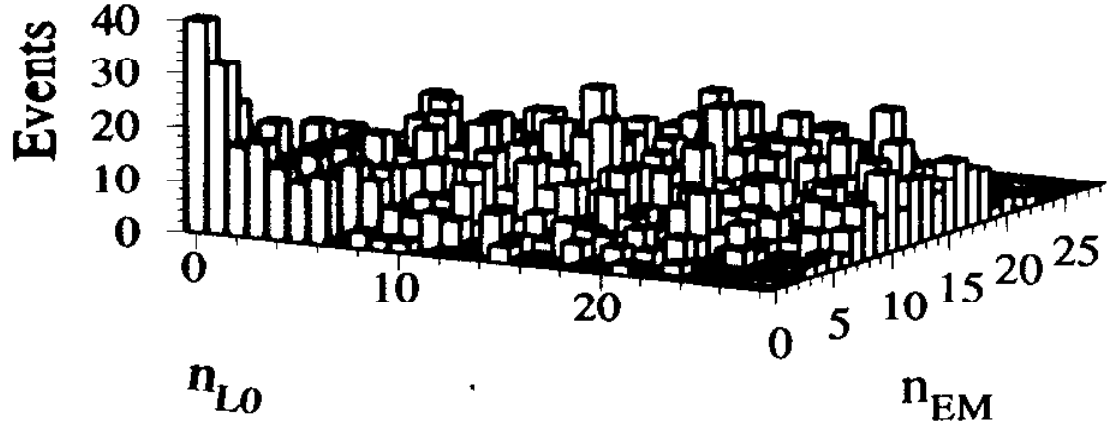
★ Single Gap Trigger: Inc Jet Trigger + one-side $n_{L0}=0$

→ Enhance SD statistics: 40k events

→ Search for Double Pomeron Exchange

• Demand $n_{EM}=n_{L0}=0$ one side, plot opposite-side:

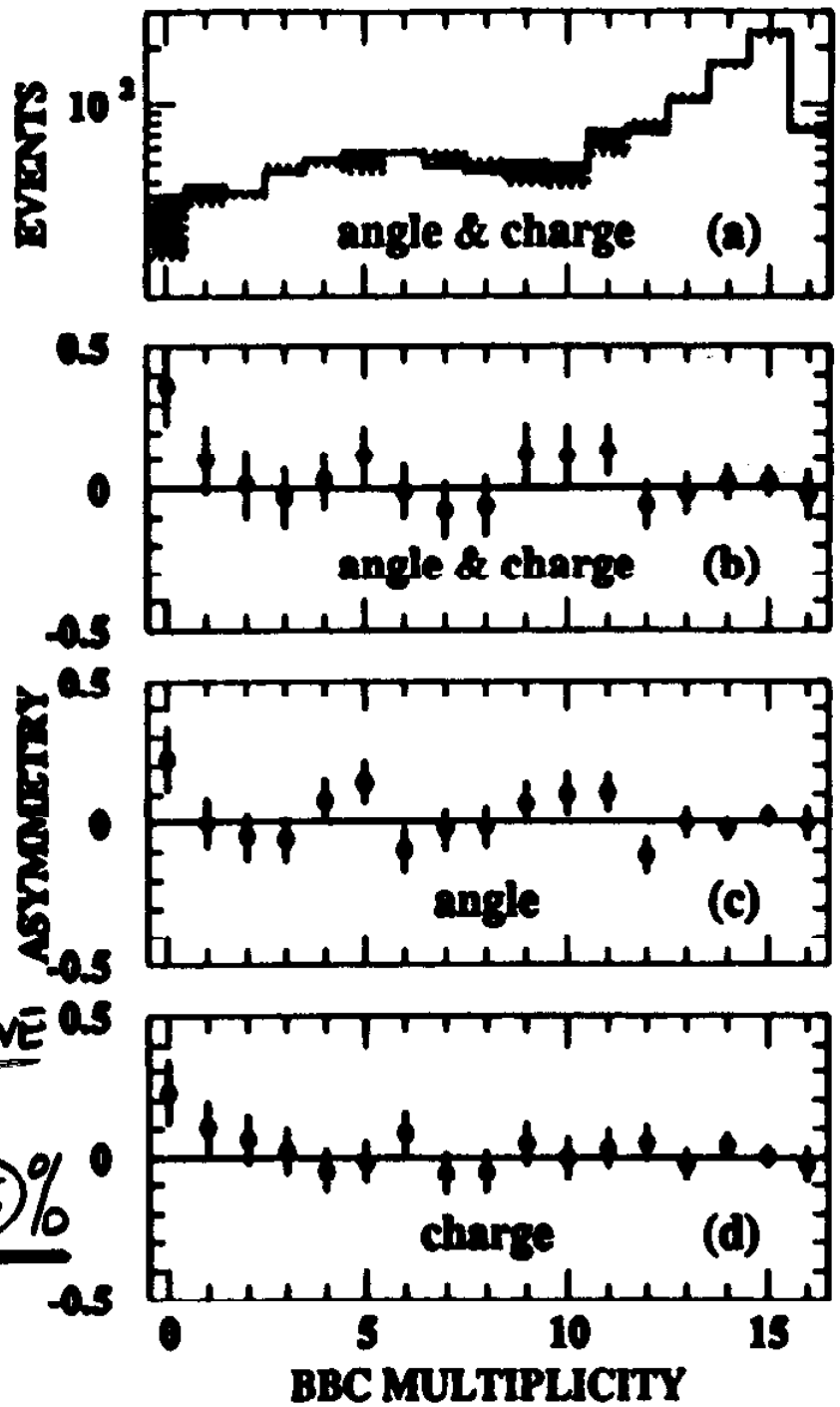




DIFFRACTIVE W PRODUCTION

SIGNAL

CDF



FORWARD COUNTER MULTIPLICITY.

$$R_W \equiv \frac{\text{DIFFRACTIVE}}{\text{ALL}}$$

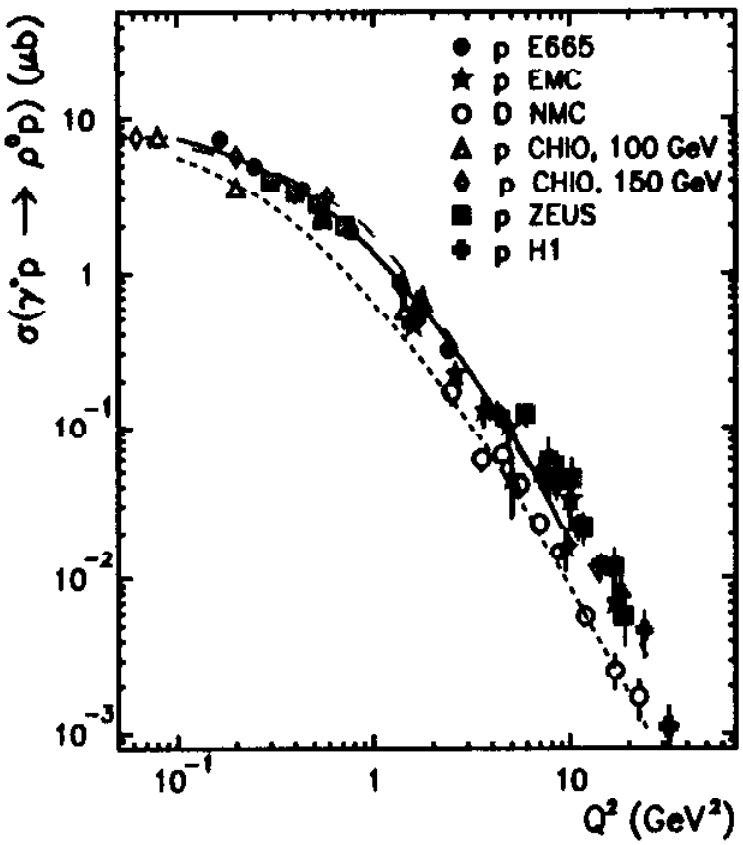
$$R_W = (1.15 \pm 0.55)\%$$

CHARACTER OF POMERON $\begin{matrix} q \\ q \end{matrix}$

ρ^0 LEPTOPRODUCTION

$$\sigma(\gamma^* p \rightarrow \rho^0 p) = \frac{1}{\Gamma_T} \cdot \frac{d\sigma(\mu p \rightarrow \mu p \rho^0)}{d\nu dQ^2}$$
$$= \sigma_T + \epsilon \cdot \sigma_L \quad \text{versus} \quad Q^2$$

E665



Solid curve : fit of $\sigma = \sigma_0 \cdot \left(\frac{M_\rho^2}{Q^2+M_\rho^2}\right)^m \cdot [1 + \epsilon R(Q^2)]$

$\Rightarrow \sigma_0 = (10.23 \pm 0.56)\ \mu b \qquad m = 2.51 \pm 0.07$

Dashed curve : Pichowsky et al., nucl-th/9612049

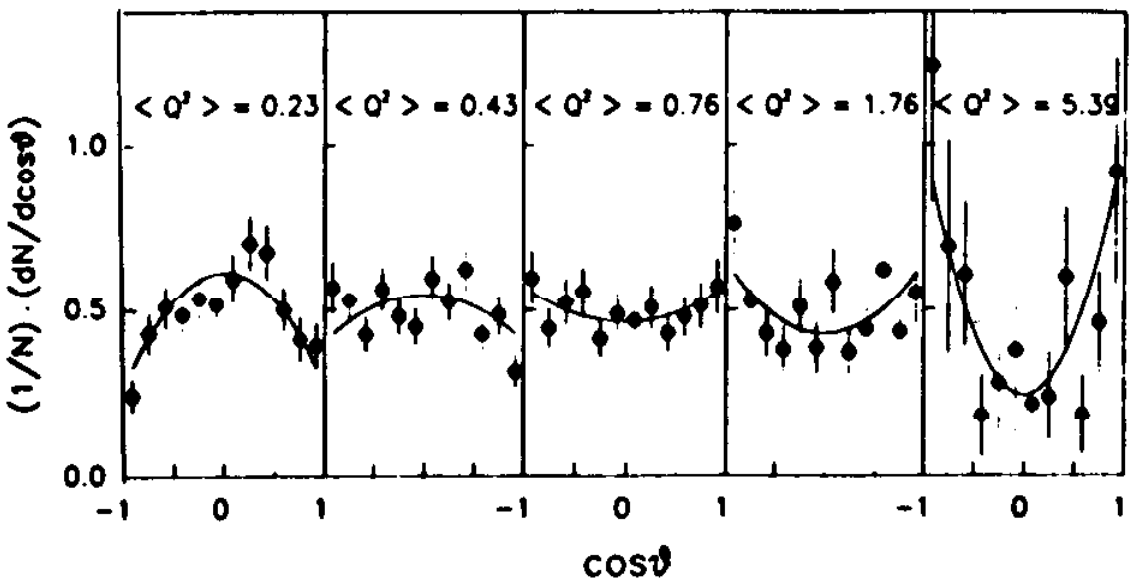
Dotted curve : Nemchik et al., hep-ph/9605231

ρ_0 LEPTOPRODUCTION

ρ^0 decay in the helicity frame :

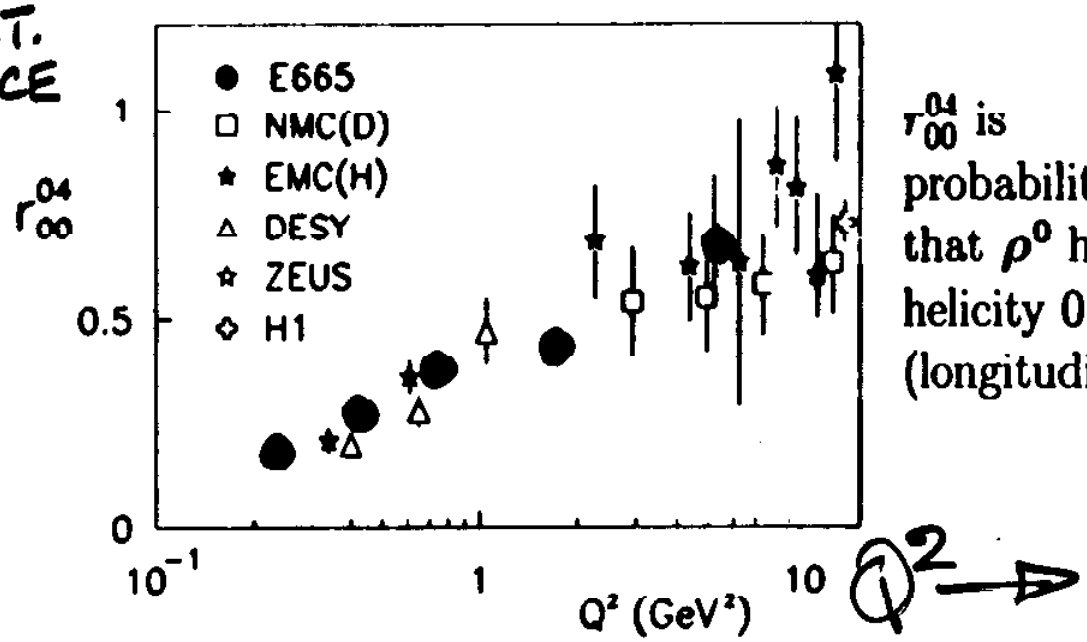
quantization axis = direction of ρ^0 in $\gamma^* p$ cms

ϑ = angle between decay π^+ and quantization axis



$$\frac{1}{N} \cdot \frac{dN}{dcos\vartheta} = \frac{3}{4} \cdot \left[1 - r^{04}_{00} + (3r^{04}_{00} - 1)\, cos^2\vartheta\right]$$

LONGT. PIECE



r^{04}_{00} is probability that ρ^0 has helicity 0 (longitudinal)

CONCLUSIONS

- BEAUTIFUL DATA

- SOME UNDERSTOOD

- NEED TO TAKE SOME MORE SERIOUSLY

- PUSHING QCD TO THE LIMITS