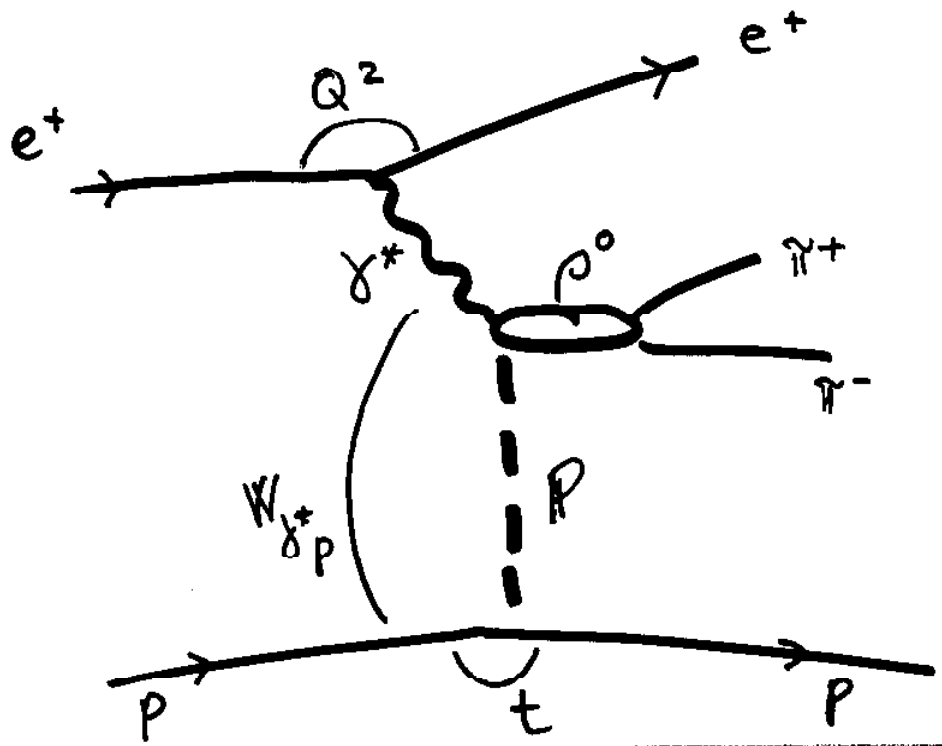
DIS 97
CHICAGO, APRIL 97

ZEUS ELASTIC ρ^0 PRODUCTION AT INTERMEDIATE AND HIGH Q^2

TERESA MONTEIRO (DESY)
FOR THE ZEUS COLLABORATION

- THE PROCESS :



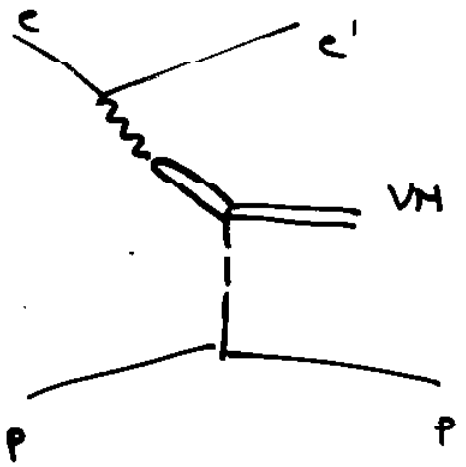
MOTIVATION

- CAN PROVIDE INFORMATION ON THE NATURE OF THE (SOFT / HARD?) $\mathbb{P}$

- ONE OF FEW CALCULABLE EXCLUSIVE PROCESSES IN pQCD :

  ALLOW STUDY OF TRANSITION BETWEEN

  NON PERTURBATIVE AND pQCD MODELS



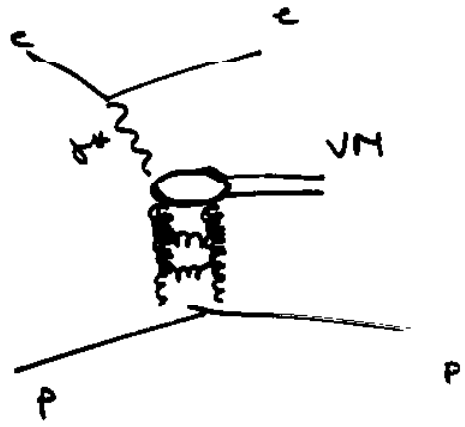
VDM + REGGE

DONNACHIE LANDSHOFF

SOFT POMERON

$\sigma \propto 1/Q^{4-6}$

$\sigma \propto W^{0.2}$



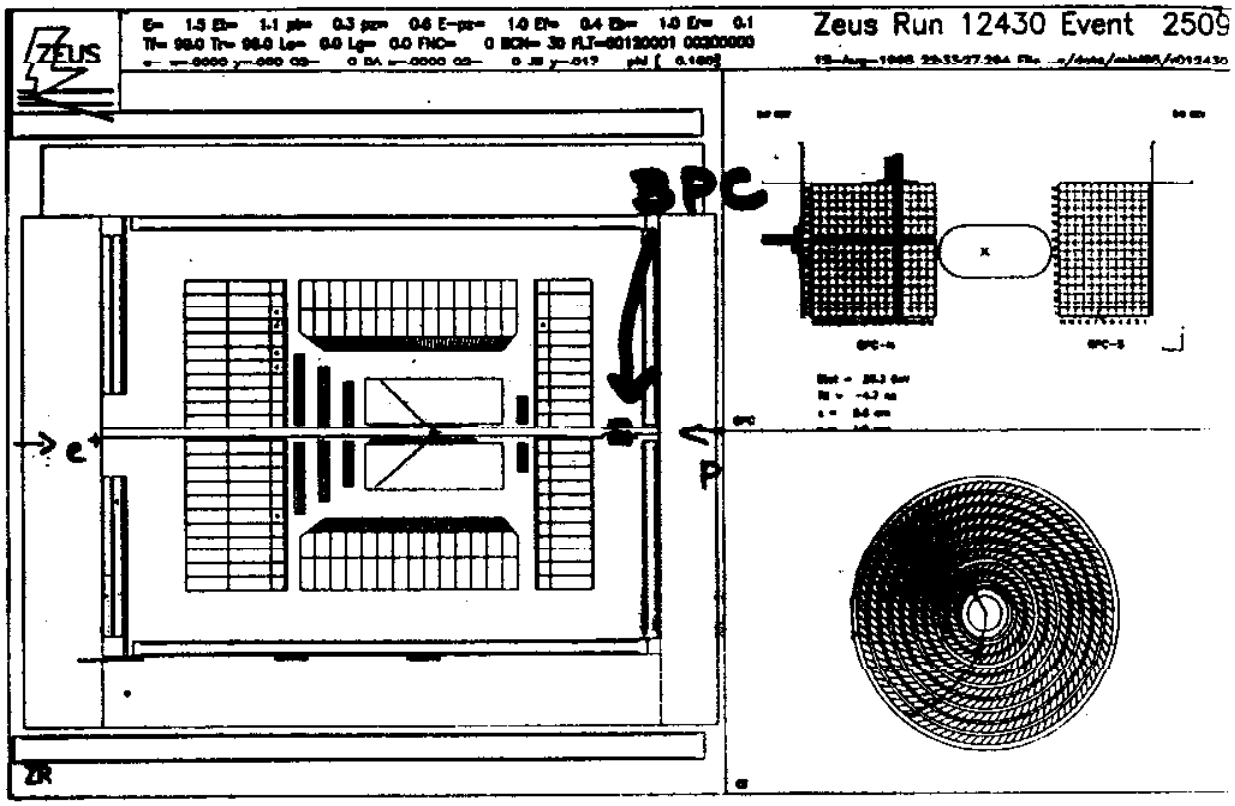
$\sigma \propto 1/Q^{6}$

MODIFIED BY

$\alpha_s(Q^2) \cdot xg(x,Q^2)$

$\sigma \propto [\alpha_s(Q^2) \cdot xg(x,Q)]^2$

$\sim W^{1}$



• EVENT SELECTION

- 2 OPPOSITE CHARGE TRACKS FROM VERTEX
- ELECTRON FOUND IN MAIN DETECTOR OR IN BE

PIPE CALORIMETER

BPC :

- 95 DATA : 3.8 pb^{-1}
- $0.55 < M_{\pi\pi} < 1.2$ GeV
- $0.25 < Q^2 < 0.85$ GeV^2
- $|t| < 0.6$ GeV^2
- $20 < W_{\gamma^* p} < 90$ GeV

$(0.0044 < y < 0.09)$

~ 6000 EVENTS

DIS :

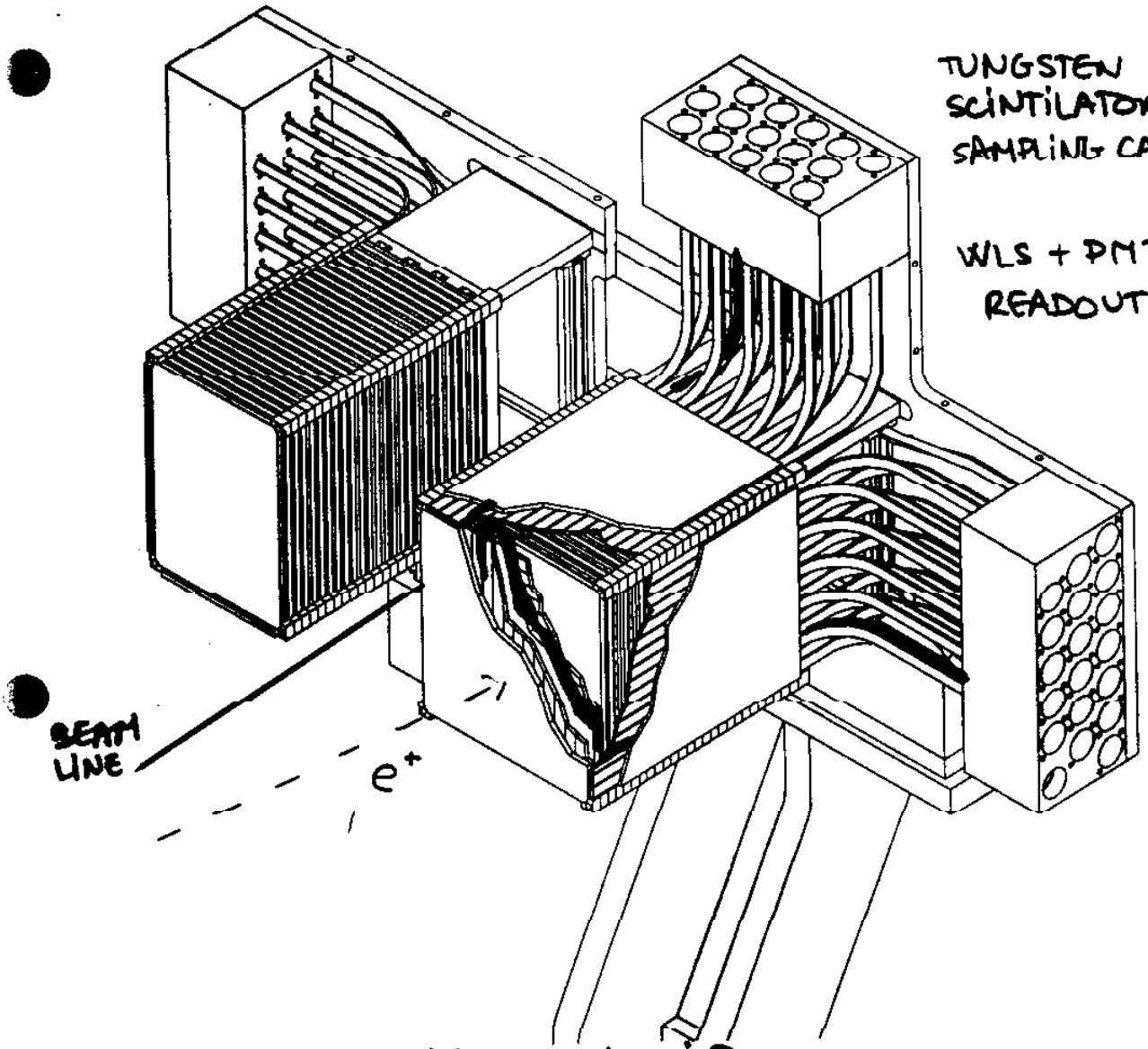
- 94 DATA : 2.6 pb
- $0.6 < M_{\pi\bar{\pi}} < 1.2$ G
- $5 < Q^2 < 30$ G
- $|t| < 0.6$ GeV^2
- $42 < W_{\gamma^* p} < 134$

$(0.02 < y < 0.2$

~ 750 EVENT

(~ 2.0 % PROTON DISSOCIATING BKGD. SUBTRACTED)

ZEUS BEAM PIPE CALORIMETER



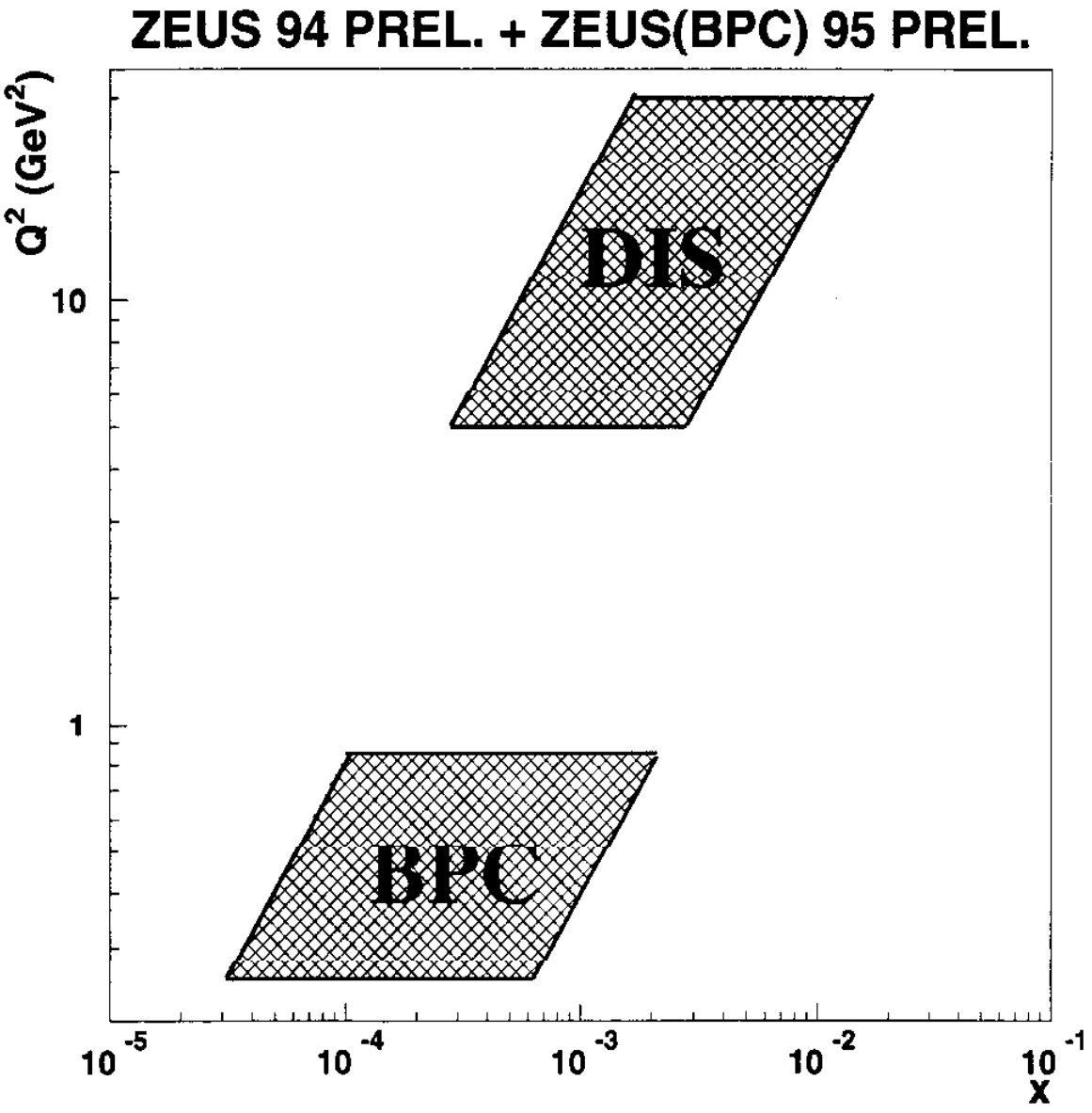
3 m AWAY FROM IP

ANGULAR COVERAGE : 17 - 35 mrad

POSITION RESOLUTION : BETTER THAN 1 mm

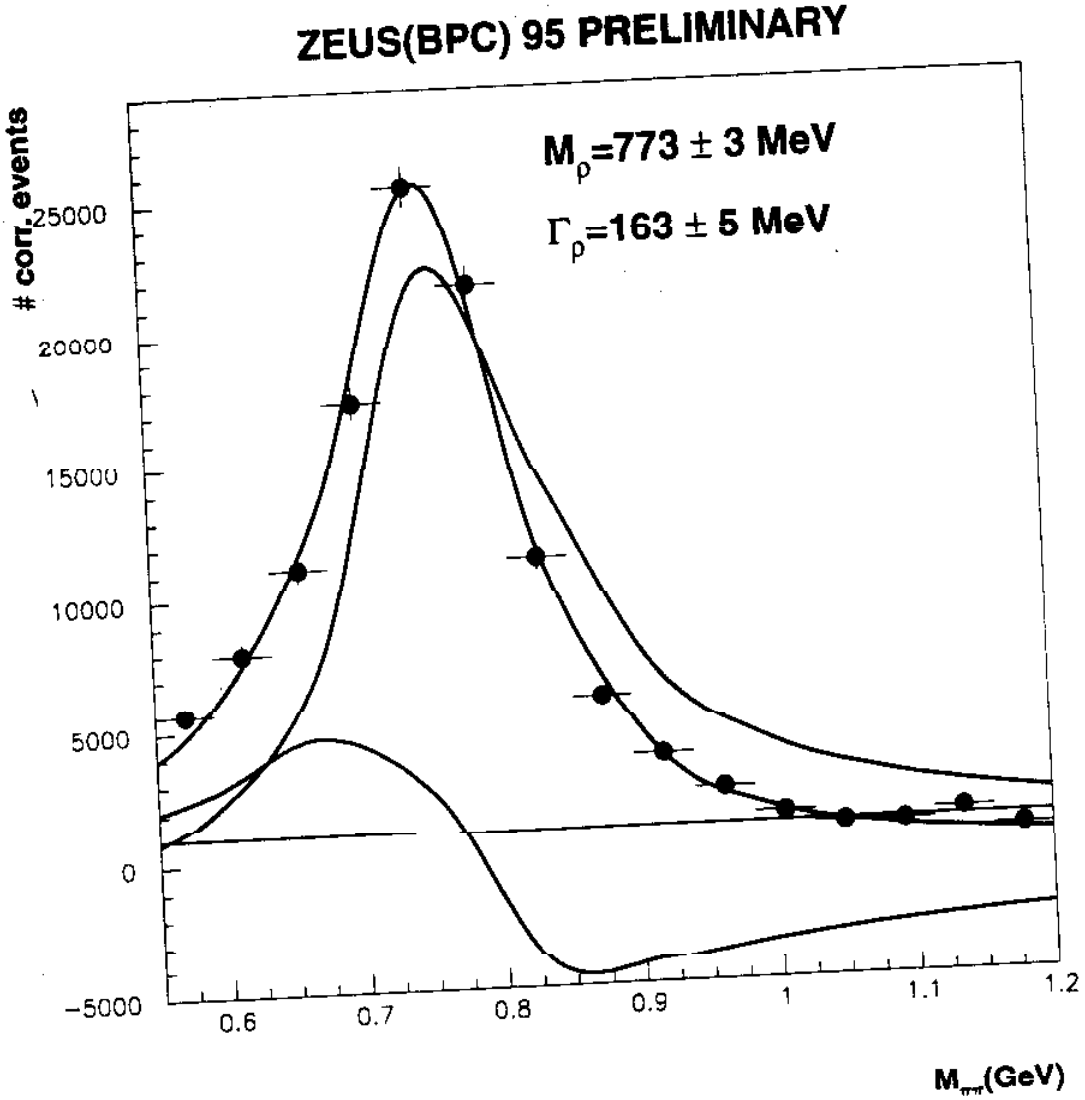
ENERGY RESOLUTION : $\sim 17\% / \sqrt{E}$

ENERGY CALIBRATION TO $\lesssim 1\%$


ZEUS 94 PREL. + ZEUS(BPC) 95 PREL.
Q^2 (GeV^2)
10
1
DIS
BPC
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
X

$M_{\pi\pi}$ DISTRIBUTION

BPC SAMPLE



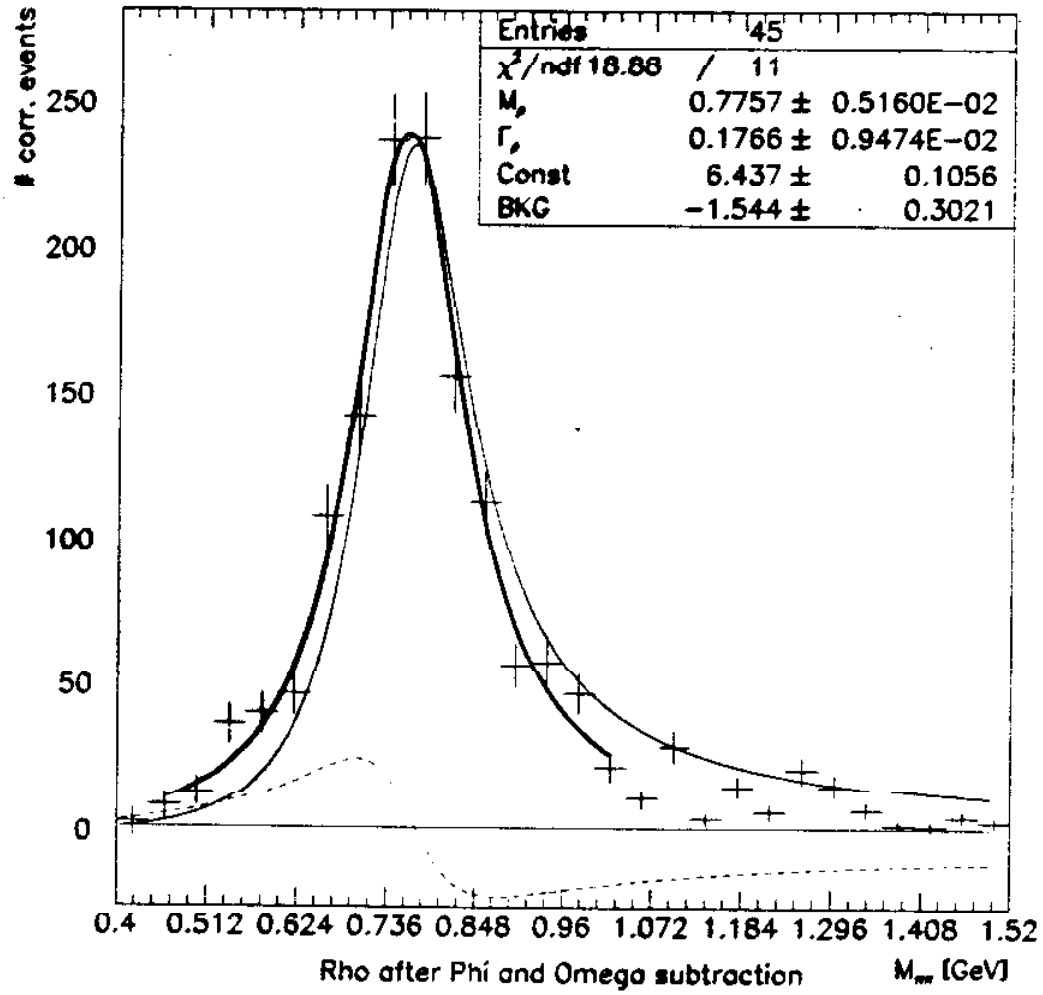
FITS TO SÖDING MODEL

$$\frac{dN}{dM_{\pi\pi}} = \left| A \cdot \sqrt{BW} + C \right|^2$$

$M_{\pi\pi}$ DISTRIBUTION

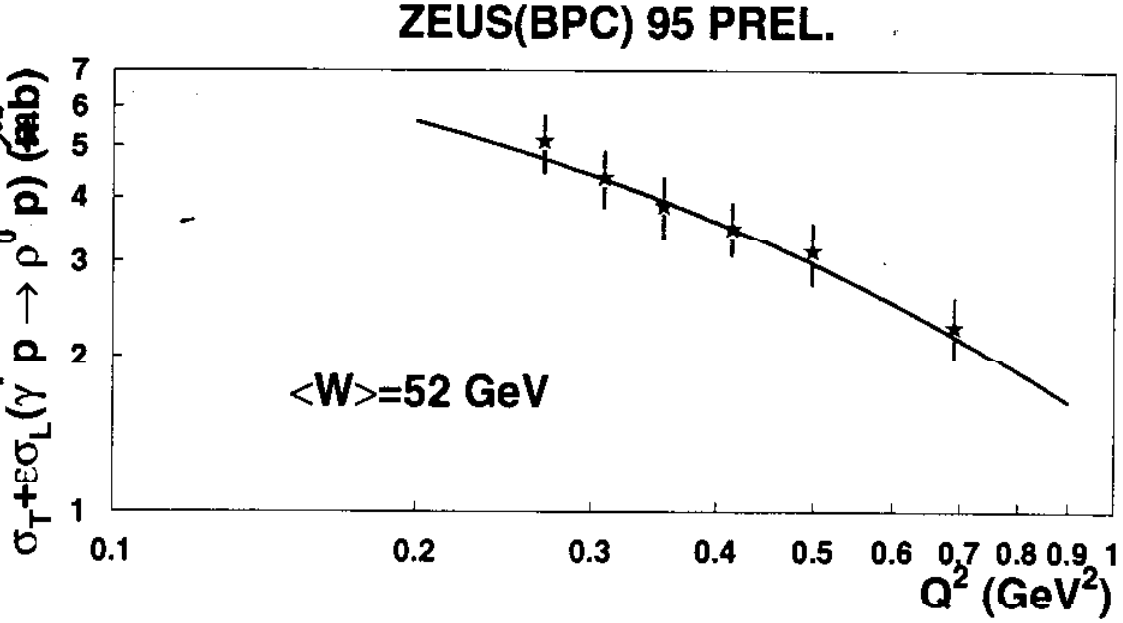
DIS SAMPLE

97/03/15 16.22



$\sigma_{\gamma^* p \to \rho^0 p}$ vs Q^2

BPC SAMPLE



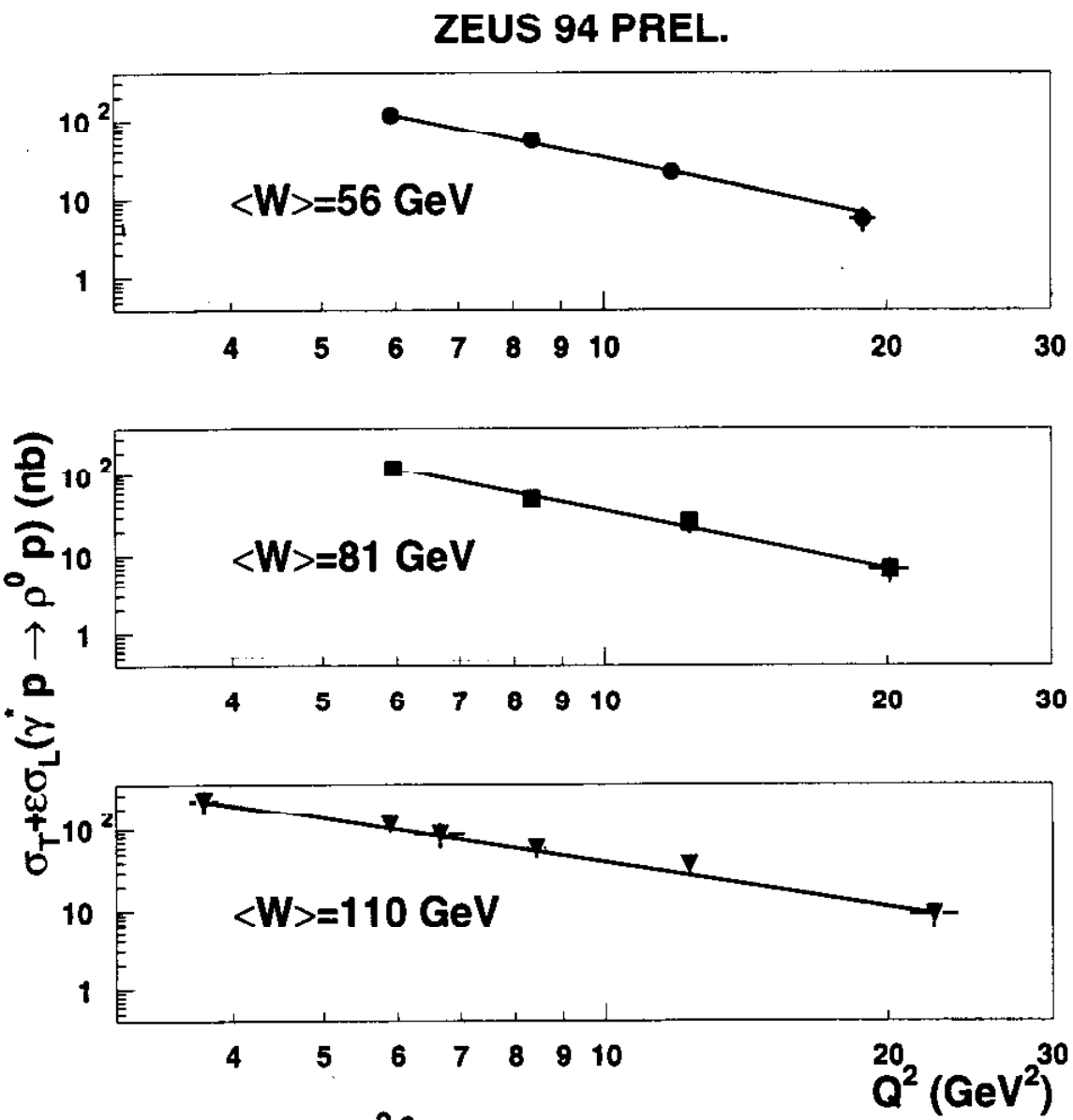
Fit to $\sigma \propto (1+Q^2/M_\rho^2)^{-n}$:

n=1.94 ±0.12(stat) ±0.18(sys)

HERE AND IN THE FOLLOWING :

ERROR = $(\text{STAT}^2 + \text{SYS}^2)^{1/2}$

$\sigma_{\gamma^* p \to \rho^0 p}$ vs Q^2
DIS SAMPLE

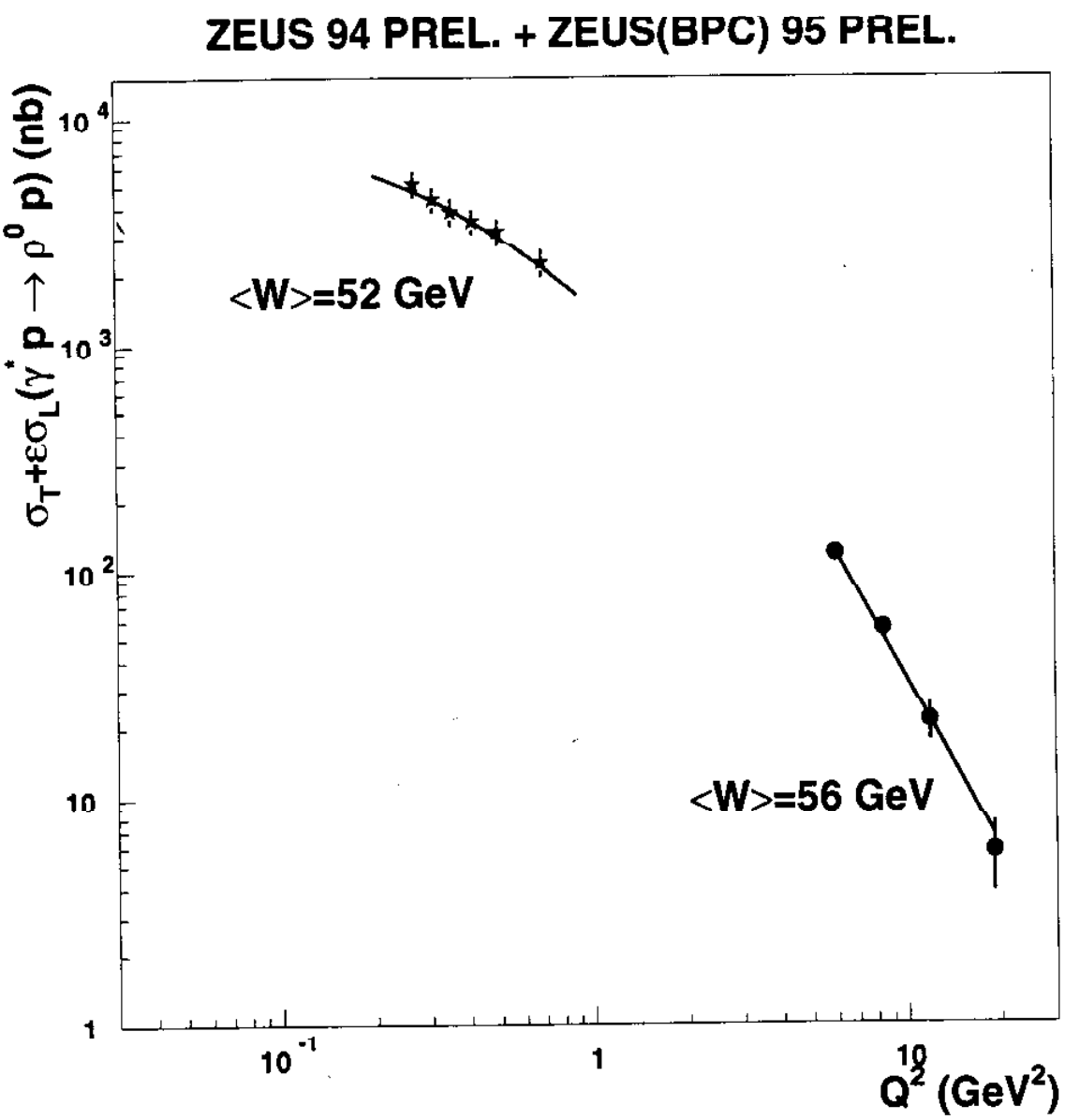


Fits to $\sigma \propto Q^{-2a}$:

a= 2.52 ±0.28(stat) ±0.24(sys)

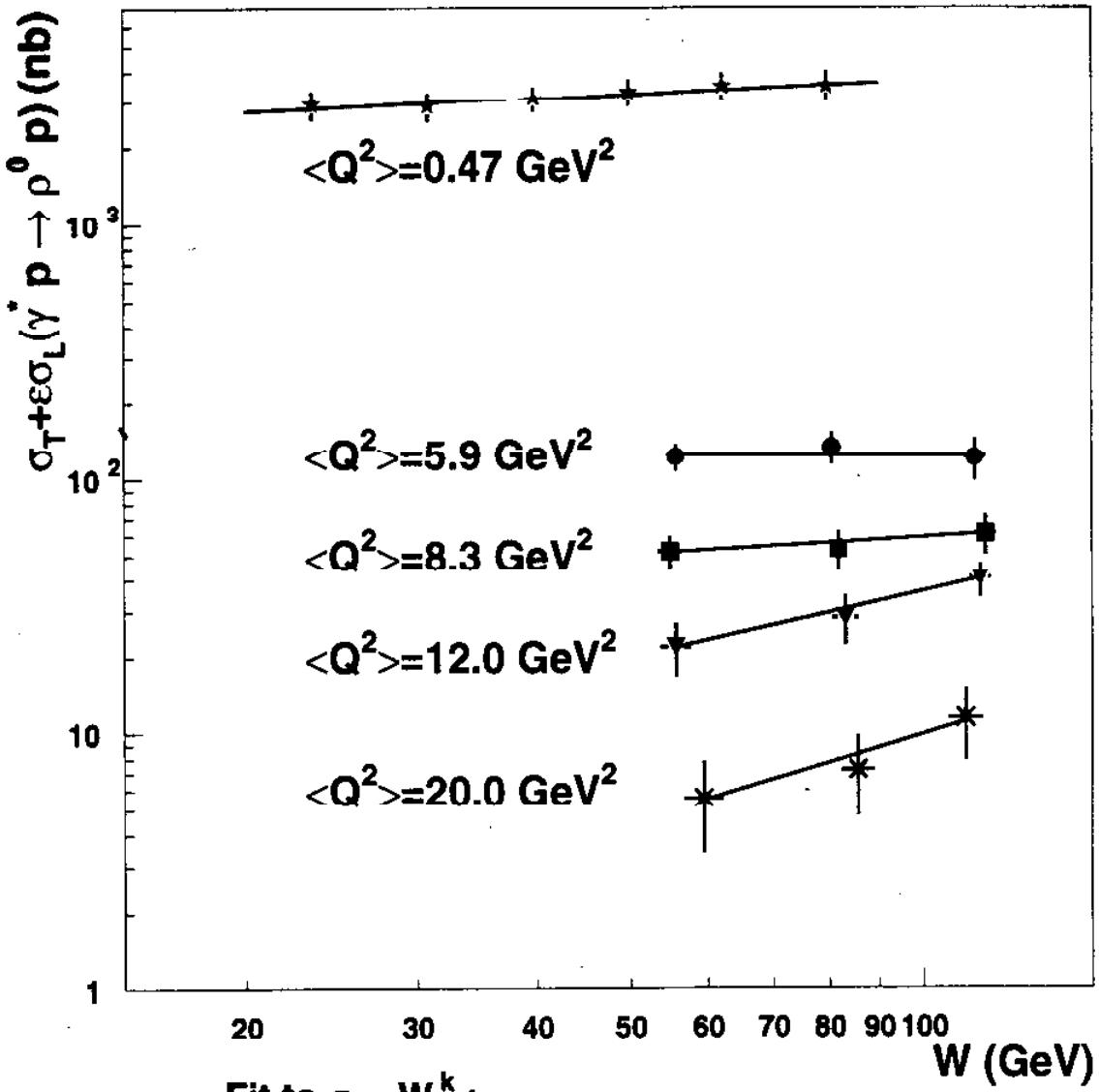
a= 2.37 ±0.28(stat) ±0.25(sys)

$\sigma\, \gamma^* p \to \rho^0 p$ vs Q^2



$\sigma_{\gamma^* p \to \rho^0 p}$ vs W

ZEUS 94 PREL. + ZEUS(BPC) 95 PREL.



Fit to $\sigma \propto W^k$:

$k=0.18 \pm 0.05(stat) \pm 0.13(sys)$

$k=0.00 \pm 0.33(stat) \pm 0.27(sys)$

$k=0.22 \pm 0.38(stat) \pm 0.26(sys)$

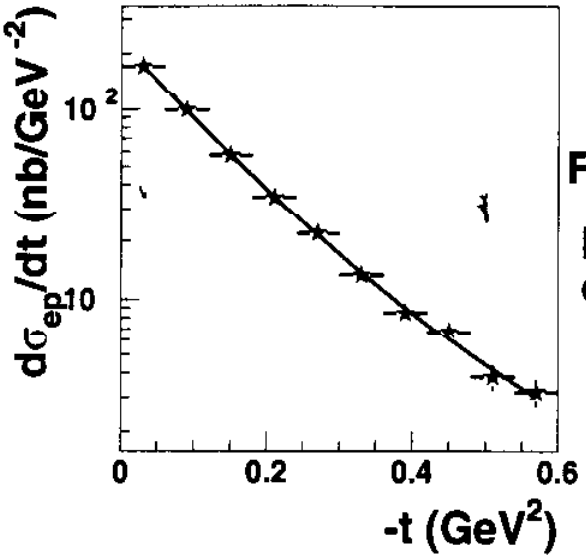
$k=0.86 \pm 0.46(stat) \pm 0.40(sys)$

$k=1.15 \pm 0.92(stat) \pm 0.56(sys)$

$d\sigma_{ep}/dt$

(INCLUDES NON-RES QUANT AND INTERFERENCE CONTRIBUTION)

ZEUS 94 PREL. + ZEUS(BPC) 95 PREL.

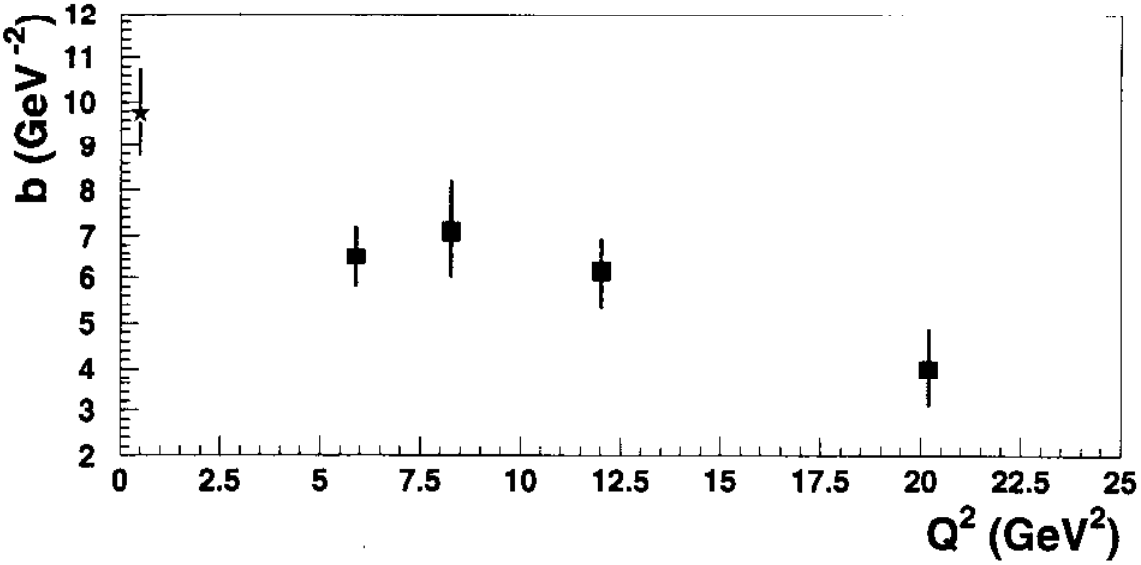


Fit to $\sigma \propto e^{(bt + ct^{**2})}$:

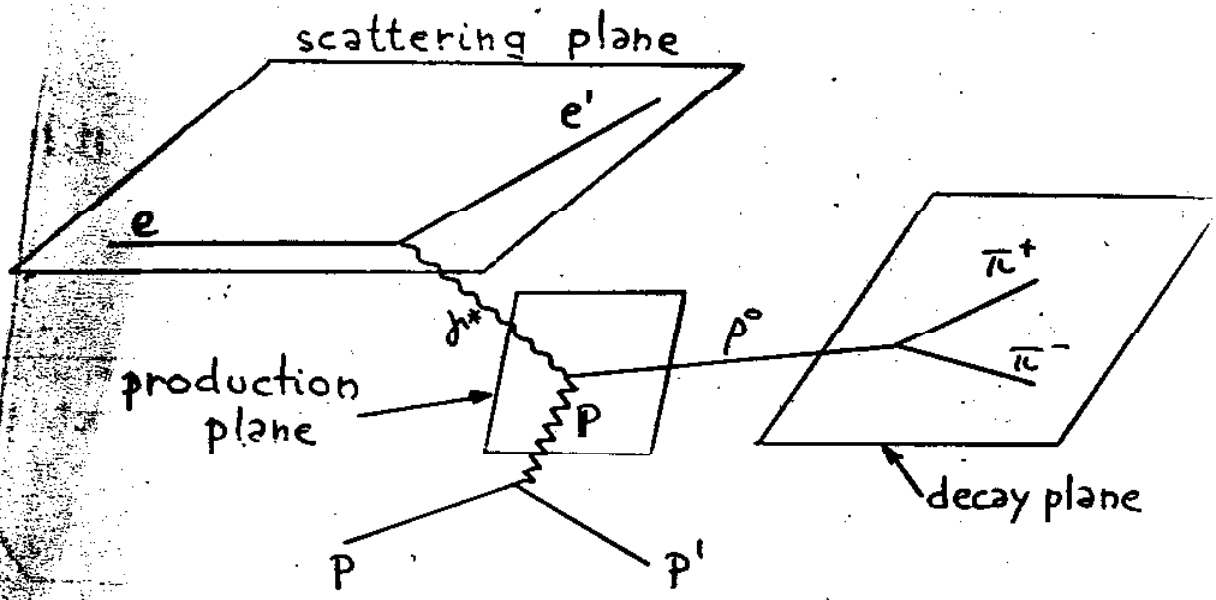
$b = 9.8 \pm 0.5(stat) \pm 0.9(sys)$ GeV^{-2}
$c = 3.8 \pm 0.9(stat) \pm 1.0(sys)$ GeV^{-4}

$0.25 < Q^2 < 0.85$ GeV^2

$20 < W < 90$ GeV



Decay angular distributions



θ^* = polar angle of π^+ in the ρ^0 rest frame (with quantisation axis opposite to proton direction)

φ = azimuthal angle of π^+
$\varphi = 0$ when decay plane ≡ production plane

Φ = angle between scattering plane and production plane

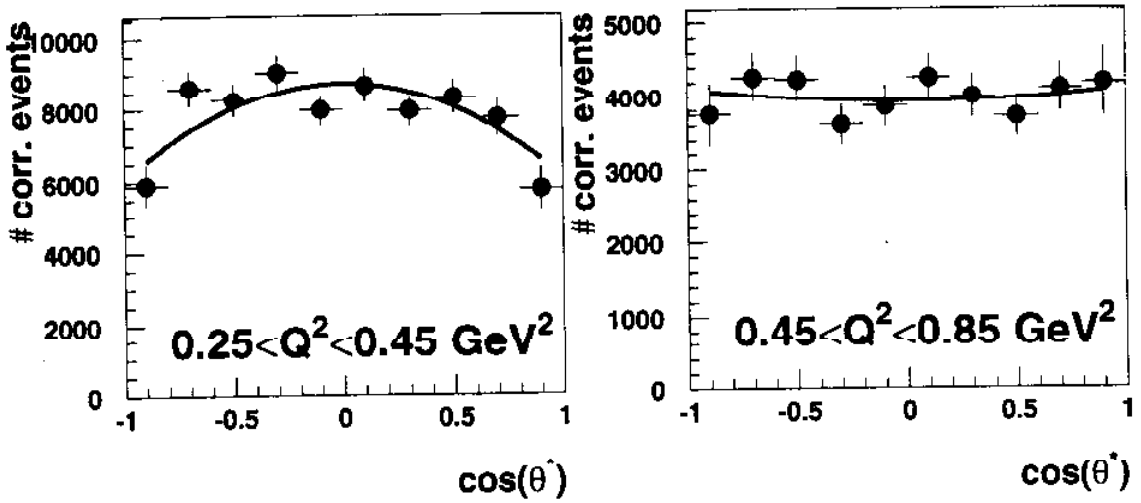
Ψ = $\varphi - \Phi$

IN ANG. DIST. ANALYSES ALL $\pi^+\pi^-$ EVENTS IN $0.6 < M_{\pi\pi} < 1$ GeV WERE USED (RESONANT + NON-RESS + INTERF.)

r_{00}^{04} : PROB. THAT ρ^0 IS PRODUCED WITH HELICITY 0

$$dN/d\cos\theta^* \propto \left\{ 1 - r_{00}^{04} + (3 \cdot r_{00}^{04} - 1) \cdot \cos^2\theta^* \right\}$$

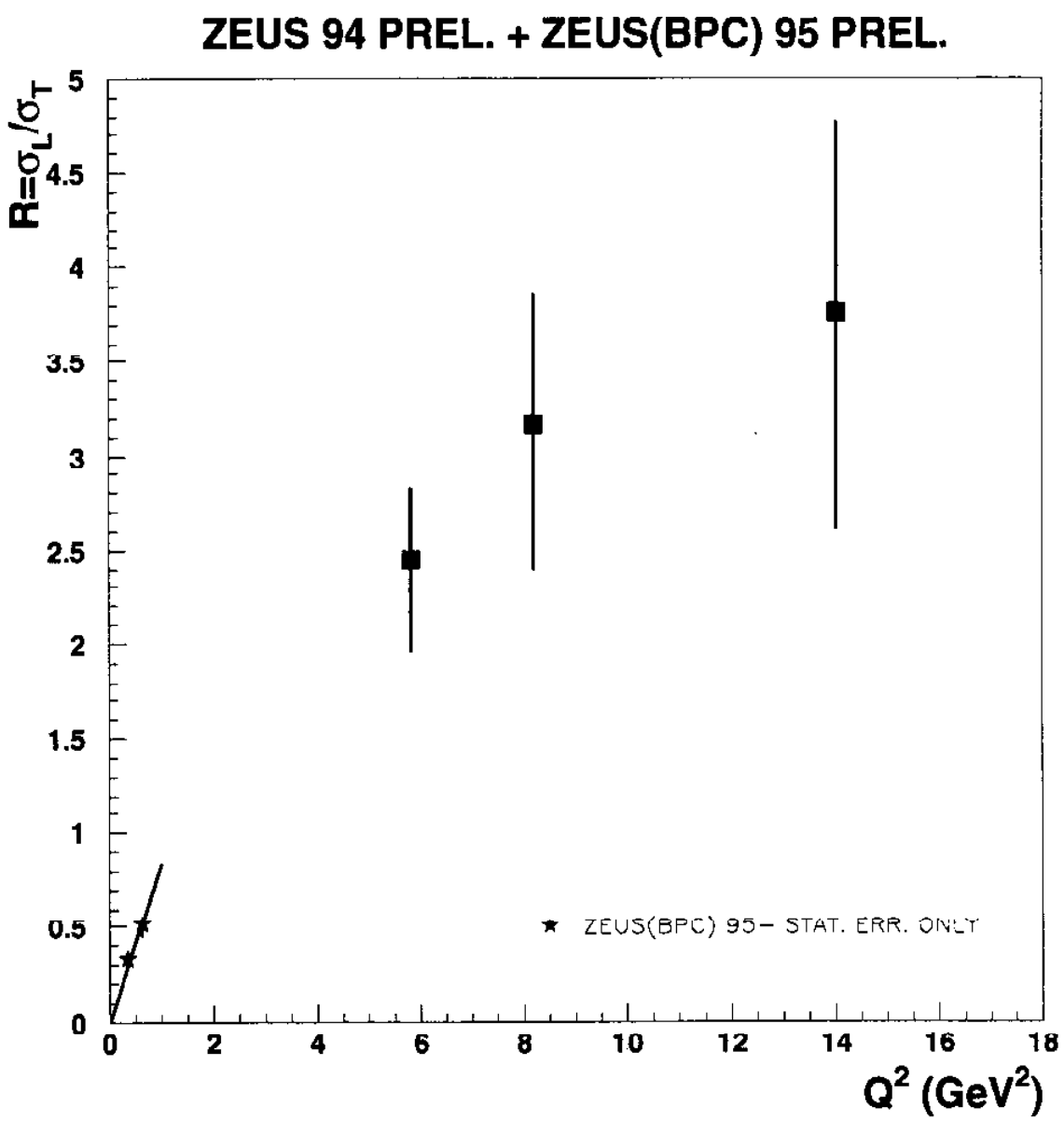
ZEUS 94 PREL. + ZEUS(BPC) 95 PREL.



Q^2 (GeV^2)	r_{00}^{04}
0.34	$0.24 \pm 0.02(\text{stat})$
0.62	$0.33 \pm 0.03(\text{stat})$
5.8	$0.71^{+0.03}_{-0.04}(\text{stat})^{+0.01}_{-0.01}(\text{sys})$
8.2	$0.76^{+0.04}_{-0.04}(\text{stat})^{+0.00}_{-0.02}(\text{sys})$
14	$0.79^{+0.04}_{-0.05}(\text{stat})^{+0.02}_{-0.01}(\text{sys})$

R vs Q^2

if SCHC : $R = \sigma_L/\sigma_T = \frac{1}{\varepsilon} \cdot \frac{r_{00}^{04}}{1 - r_{00}^{04}}$

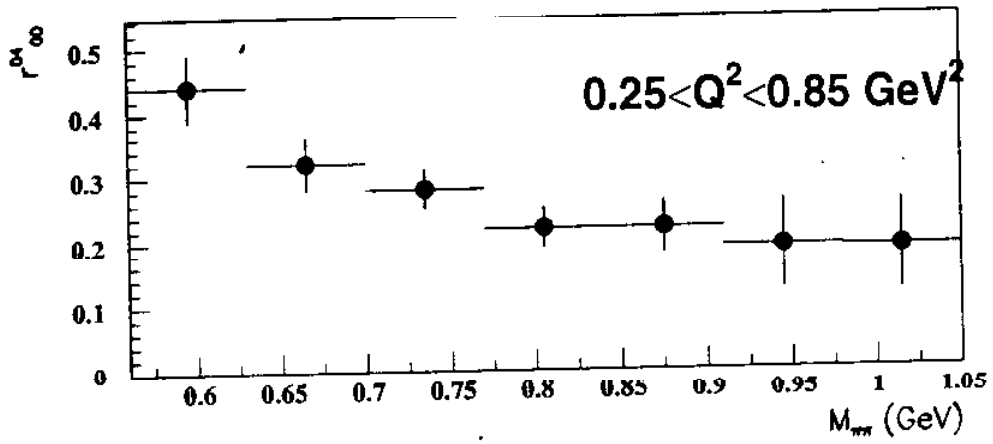


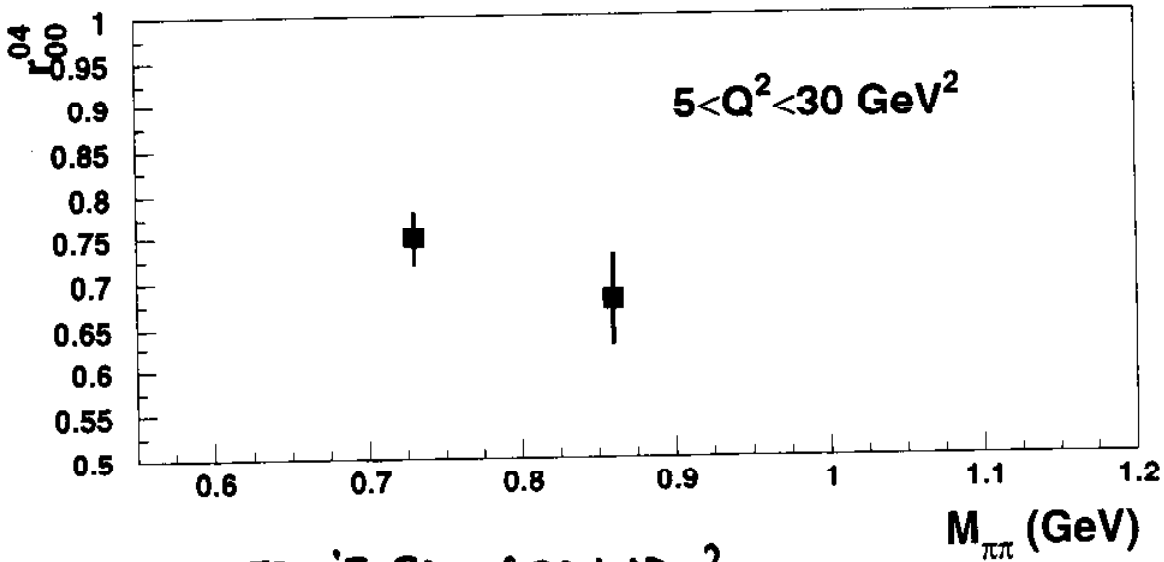
ε : RATIO OF LONGITUDINAL TO TRANSVERSE γ^* FLUX

BUT ...

r_{00}^{04} VS $M_{\pi\pi}$

ZEUS 94 PREL. + ZEUS(BPC) 95 PREL.





IS IT BACKGROUND ?

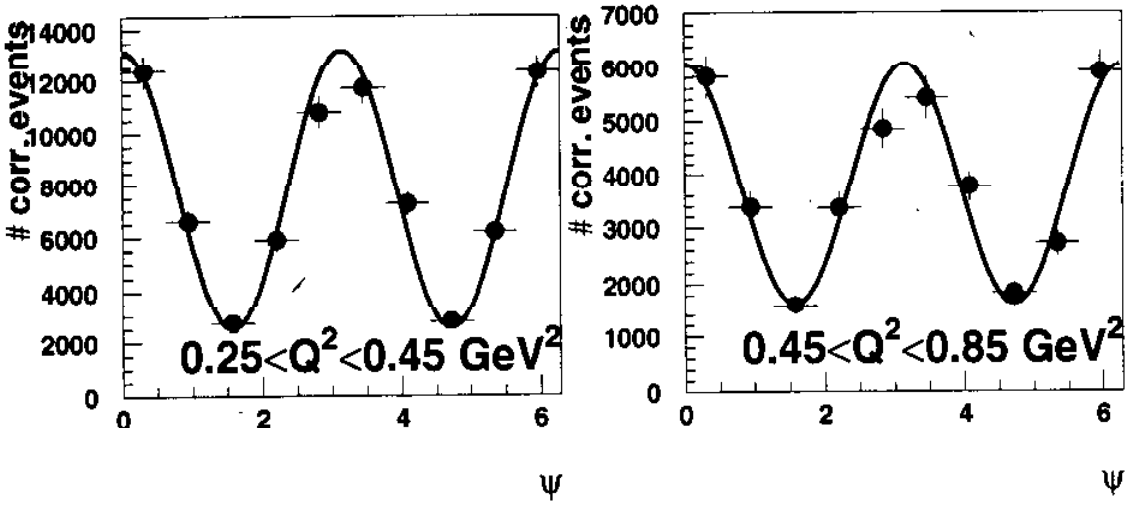
IS IT ρ^0 ?

WHAT MASS RANGE TO USE ?

r^1_{1-1}

IF SCHC : $dN/d\Psi \propto \{1 + 2\varepsilon\, r^1_{1-1} \cos(2\Psi)\}$

ZEUS 94 PREL. + ZEUS(BPC) 95 PREL.



IF SCHC + NAT. PARITY EXCHANGE :

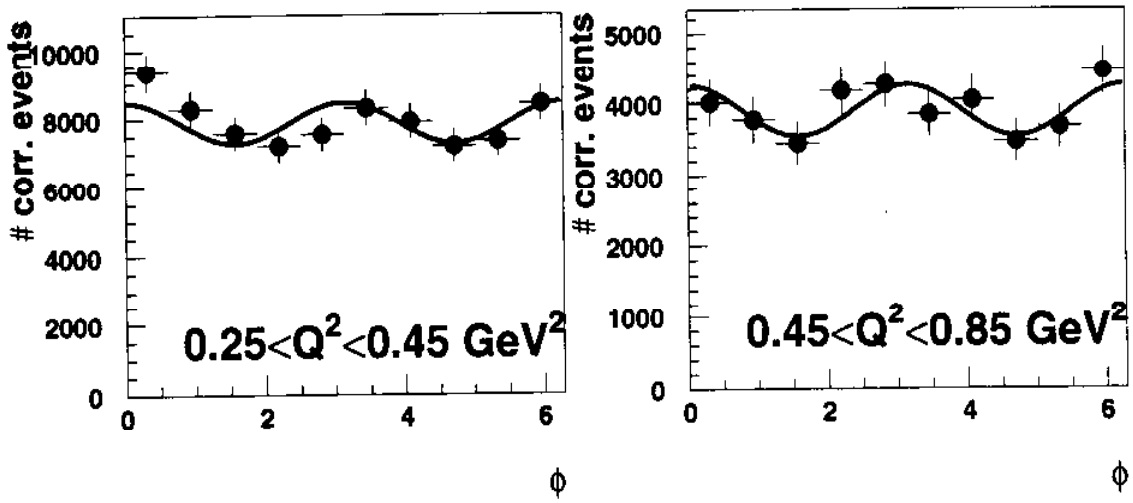
$$r^1_{1-1} = \frac{1}{2} \cdot \left(1 - r^{04}_{00}\right)$$

Q^2 (GeV^2)	measured r^1_{1-1}	r^1_{1-1} from r^{04}_{00}
0.34	0.36 ±0.02(stat)	0.38 ±0.01(stat)
0.62	0.32 ±0.02(stat)	0.34 ±0.01(stat)
5.8	0.13 ±0.04(stat)	0.14 ±0.02(stat)
8.2	0.11 ±0.04(stat)	0.12 ±0.02(stat)
14	0.11 ±0.04(stat)	0.10 ±0.02(stat)

r^{04}_{1-1} BPC SAMPLE

$$dN/d\phi \propto (1 - 2\, r^{04}_{1-1} \cdot \cos 2\phi)$$

ZEUS 94 PREL. + ZEUS(BPC) 95 PREL.



IF SCHC : $r^{04}_{1-1} = 0$

Q^2 (GeV^2)	r^{04}_{1-1}
0.34	-0.04 ±0.03(stat)
0.62	-0.04 ±0.03(stat)

$Re(r^5_{10})$ & $\cos\delta$

DIS SAMPLE

IF SCHC :

$$W(\cos\theta^*, \Psi) = \frac{3}{4} \cdot \left\{ \frac{1}{2}(1 - r^{04}_{00}) + \frac{1}{2}(3 \cdot r^{04}_{00} - 1) \cdot \cos^2\theta^* + \varepsilon\, r^1_{1-1} \sin^2\theta^* \cos 2\Psi - 2\sqrt{\varepsilon(1+\varepsilon)}\, Re(r^5_{10}) \sin 2\theta^* \cos\Psi \right\}$$

IF SCHC + NAT. PARITY EXCHANGE :

$$W(\cos\theta^*, \Psi) = \frac{1}{1+\varepsilon R} \cdot \frac{3}{8\pi} \left\{ \sin^2\theta^* \cdot (1 + \varepsilon\cos 2\Psi) + 2\varepsilon R \cos^2\theta^* - \sqrt{2\varepsilon(1+\varepsilon)R} \cdot \cos\delta \sin 2\theta^* \cos\Psi \right\}$$

Q^2 (GeV^2)	$Re(r^5_{10})$	$\cos\delta$
5.8	0.10 ± 0.04(stat)	$0.92^{+0.06}_{-0.07}$(stat)$^{+0.02}_{-0.06}$(sys)
8.2	0.11 ± 0.04(stat)	$0.99^{+0.05}_{-0.07}$(stat)$^{+0.00}_{-0.01}$(sys)
14	0.08 ± 0.05(stat)	$0.81^{+0.10}_{-0.12}$(stat)$^{+0.02}_{-0.08}$(sys)

r^5_{10} : INTERFERENCE BETWEEN LONGITUDINAL AND TRANSVERSE AMPLITUDES

$\cos\delta$: PHASE BETWEEN LONGITUDINAL AND TRANSVERSE AMPLITUDES

CONCLUSION

- STUDY OF ELASTIC ρ^0 PRODUCTION IN EXTENDED Q^2, W RANGE :
  $0.25 < Q^2 < 0.85 GeV^2$, $5 < Q^2 < 30\ GeV^2$
- Q^2 DEPENDENCE OF CROSS SECTION :

  $\sim 1/Q^{4-5}$

  STEEPER WITH INCREASING Q^2 ?

  SOFTER WITH INCREASING W ?
- W DEPENDENCE OF CROSS SECTION :

  AT $Q^2 = 0.42 GeV^2$, COMPATIBLE WITH DL SOFT ~~P~~

  STEEPER WITH INCREASING Q^2 ?
- b SLOPE :

  b DECREASES WITH Q^2
- $R = \sigma_L/\sigma_T$ VERSUS Q^2 :

  $R \propto Q^2$ AT LOWER Q^2, BUT BEGINS TO SATURATE. FOR $Q^2 \gtrsim 5\ GeV^2$
- DATA COMPATIBLE WITH SCHC AND DOMINANCE OF NATURAL PARITY EXCHANGE ,,

OUTLOOK :

DIS 95 SAMPLE