LAKE LOUISE WINTER INSTITUTE FEB. 14-20, 1999

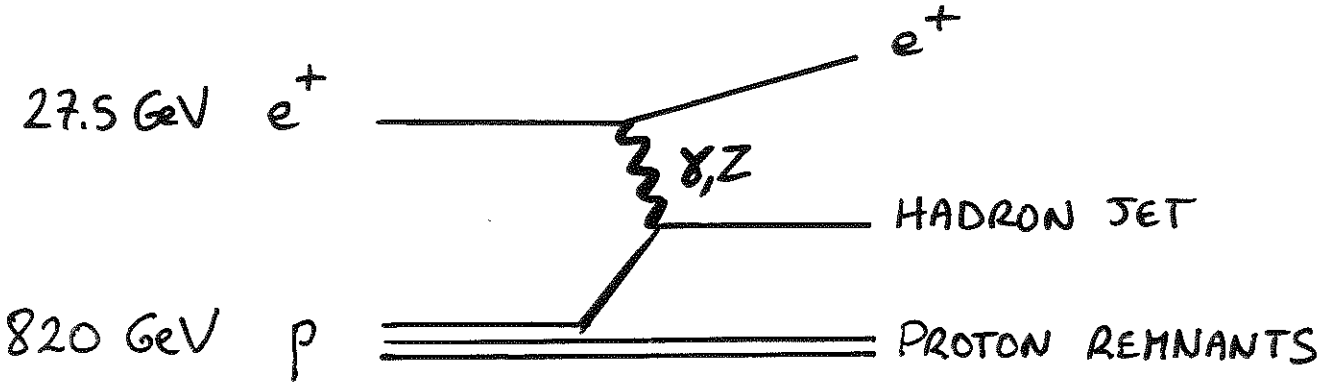
THE W CROSS SECTION AND LEPTON PRODUCTION WITH MISSING P_T AT HERA

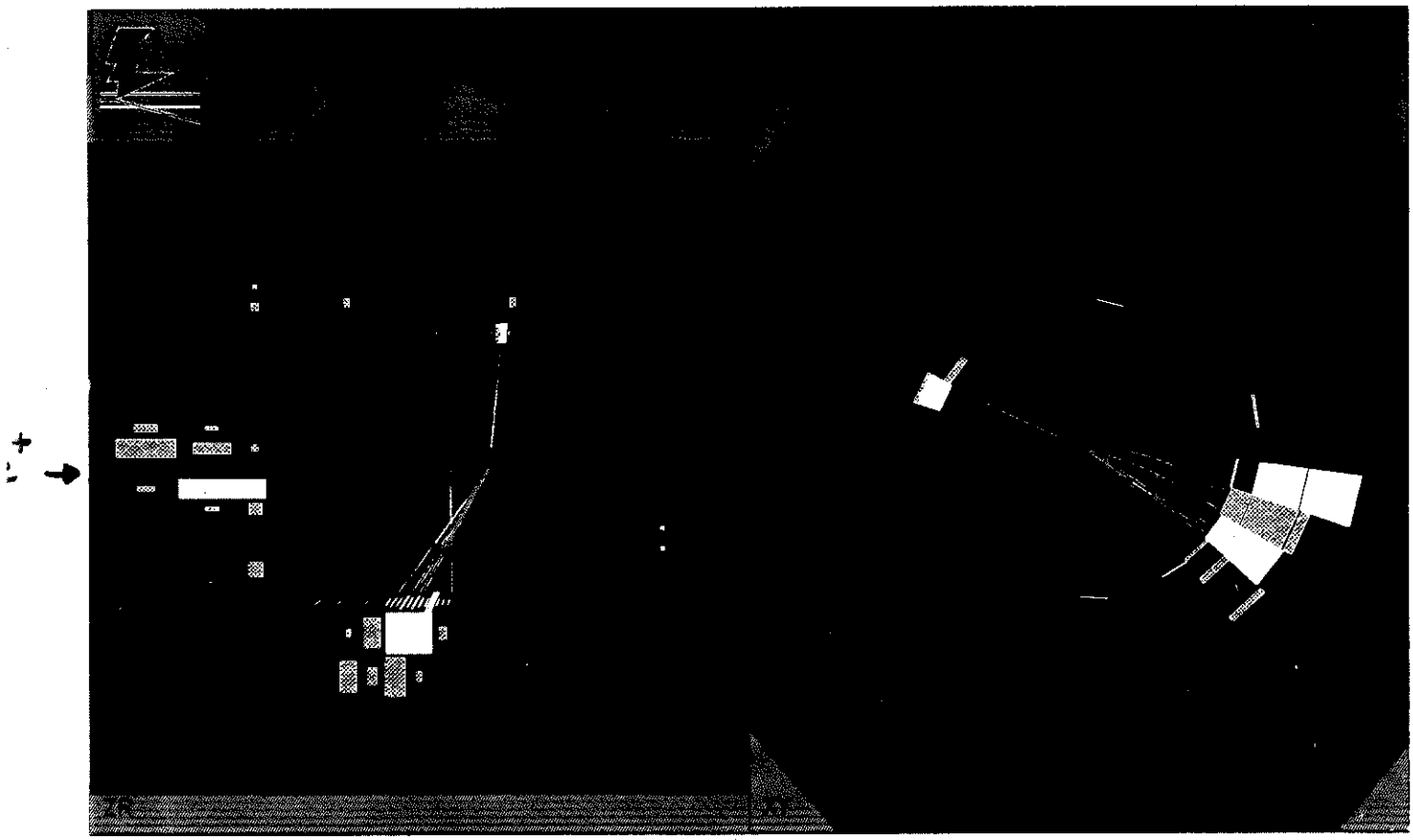
CLAUDE VALLÉE
CPPM - MARSEILLE
FOR THE ZEUS AND H1 COLLABORATIONS

See also | PAPER N° 756 TO ICHEP 98 (ZEUS)
EUR. PHYS. J. 5 (1998) 575 (H1) + H1 AND ZEUS WEB PAGES

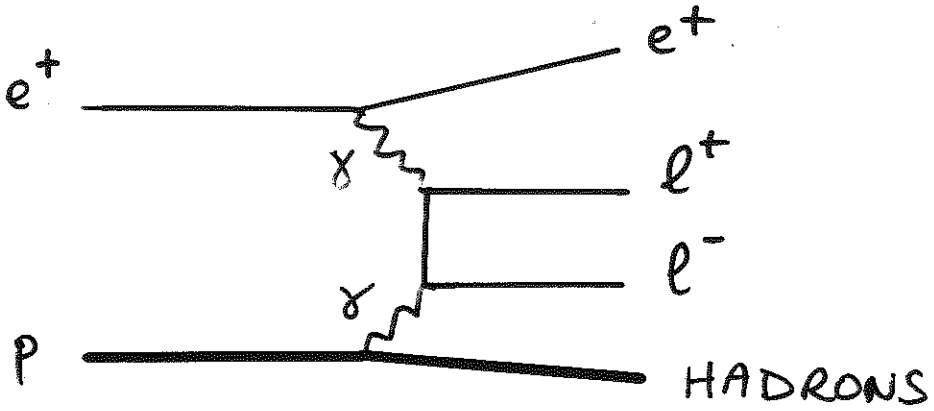
- HIGH-P_T LEPTON PRODUCTION IN THE STANDARD MODEL
- RESEARCH STRATEGIES
- RESULTS
- DISCUSSION OF H1 ATYPICAL EVENTS

NEUTRAL CURRENTS





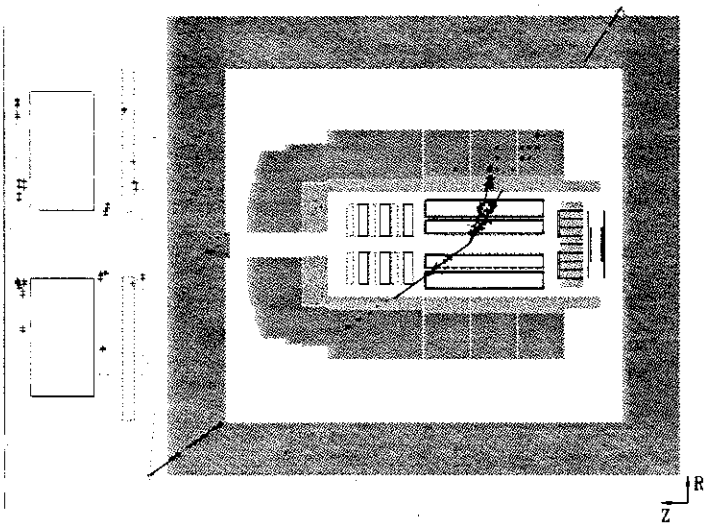
PHOTON - PHOTON

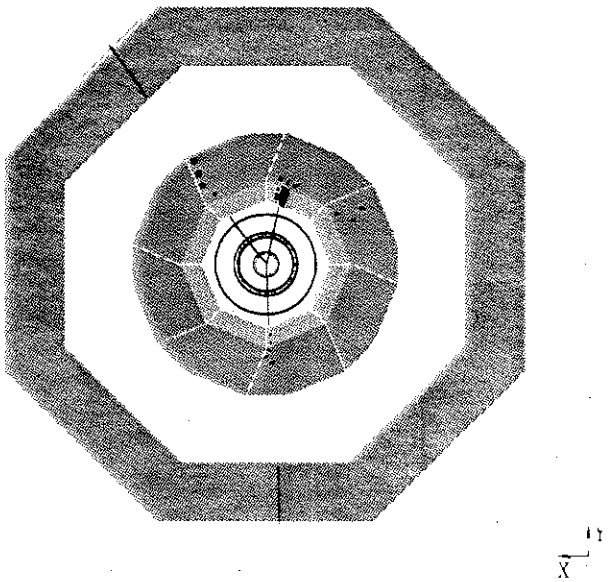


Run 88855 Event 24022 Class: 2 4 6 8 15 17 22 24 28 Run Date 9/10/94

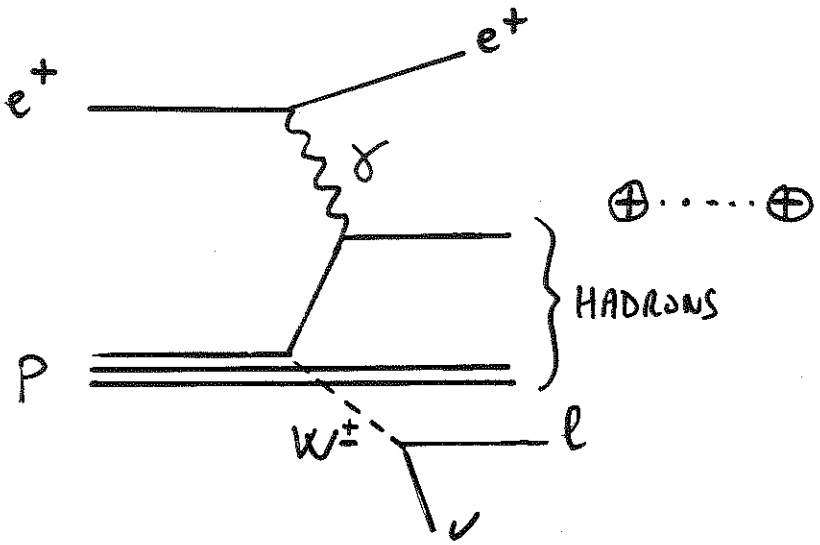
H1

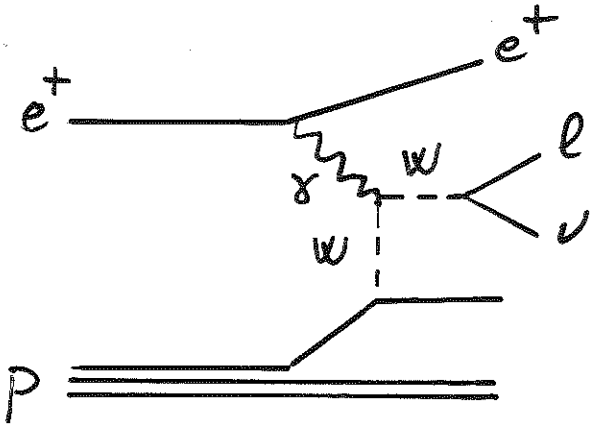
e+ mu+ mu-



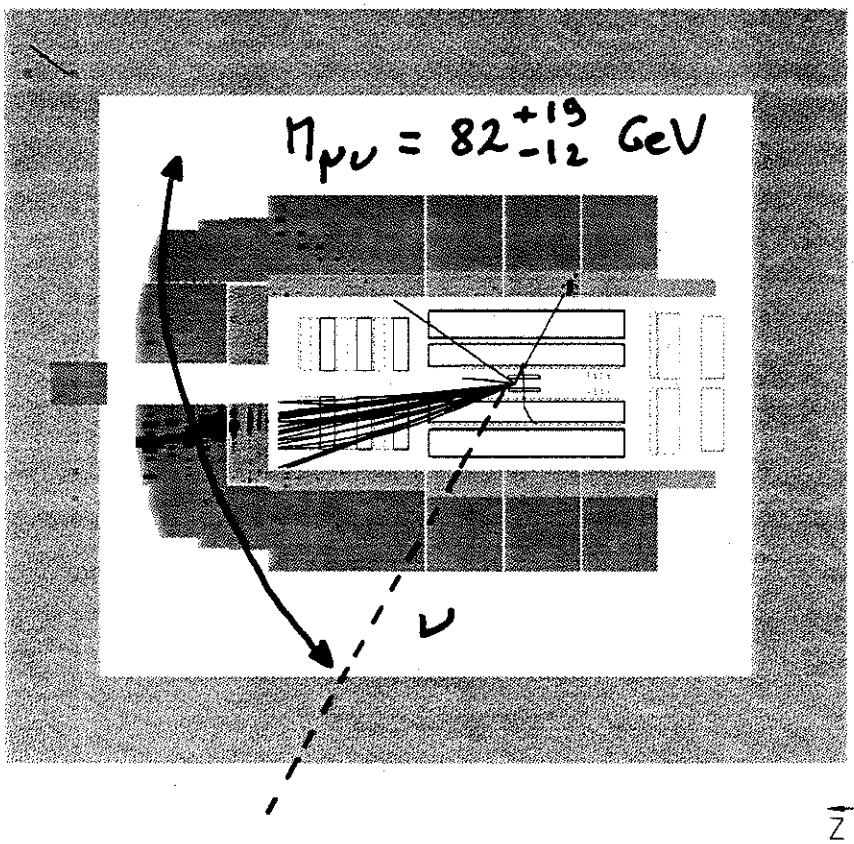


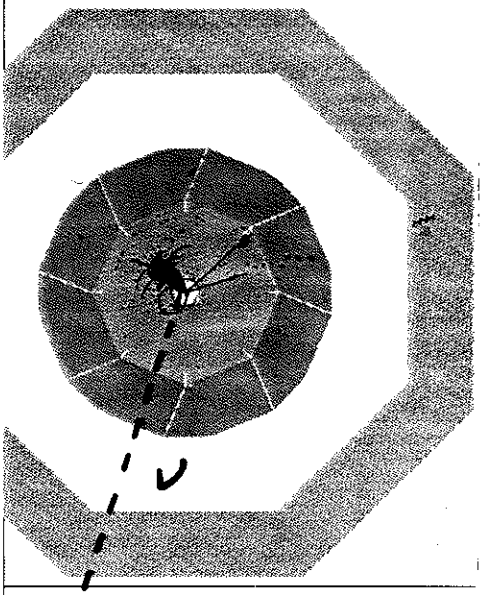
W PRODUCTION

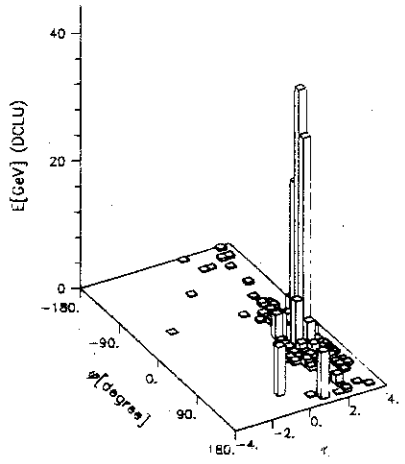




H1



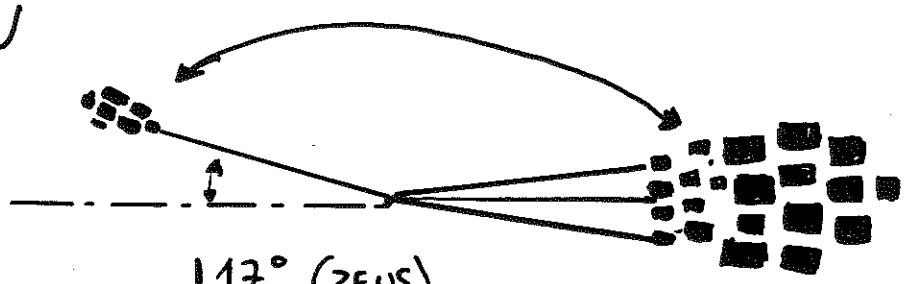




KINEMATICAL CUTS
(anti-NC and $\gamma\gamma$)

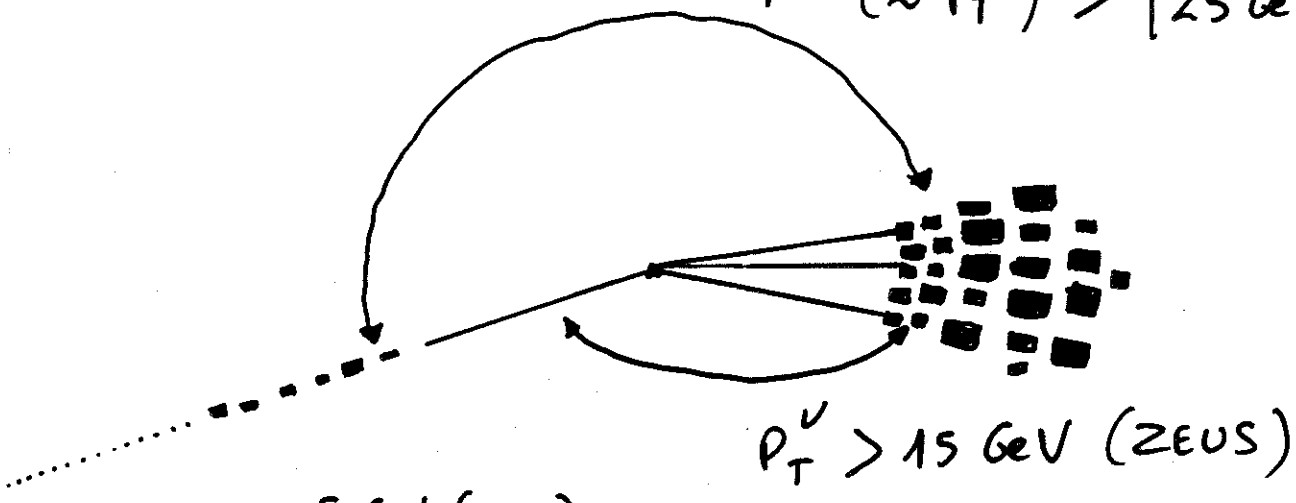
$\not{P}_T^{CALO} (\approx P_T^{\nu}) > \begin{cases} 20\ GeV\ (ZEUS) \\ 25\ GeV\ (H1) \end{cases}$

$P_T^e > 10\ GeV$



$\Delta\varphi > \begin{cases} 17^\circ\ (ZEUS) \\ 5^\circ\ (H1) \end{cases}$

$\not{P}_T^{CALO} (\approx P_T^{H}) > \begin{cases} 15\ GeV\ (ZEUS) \\ 25\ GeV\ (H1) \end{cases}$

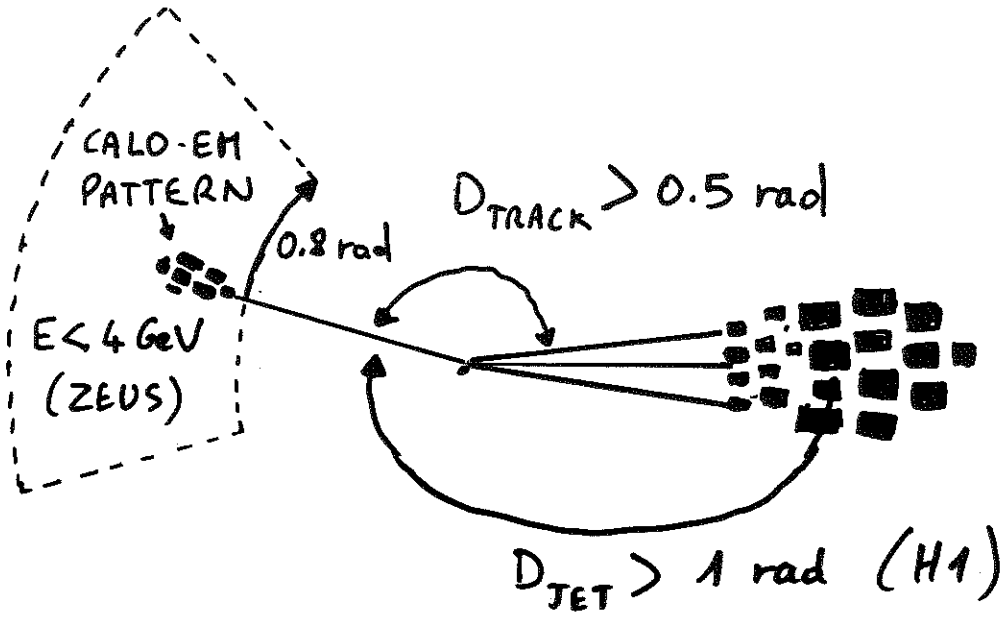


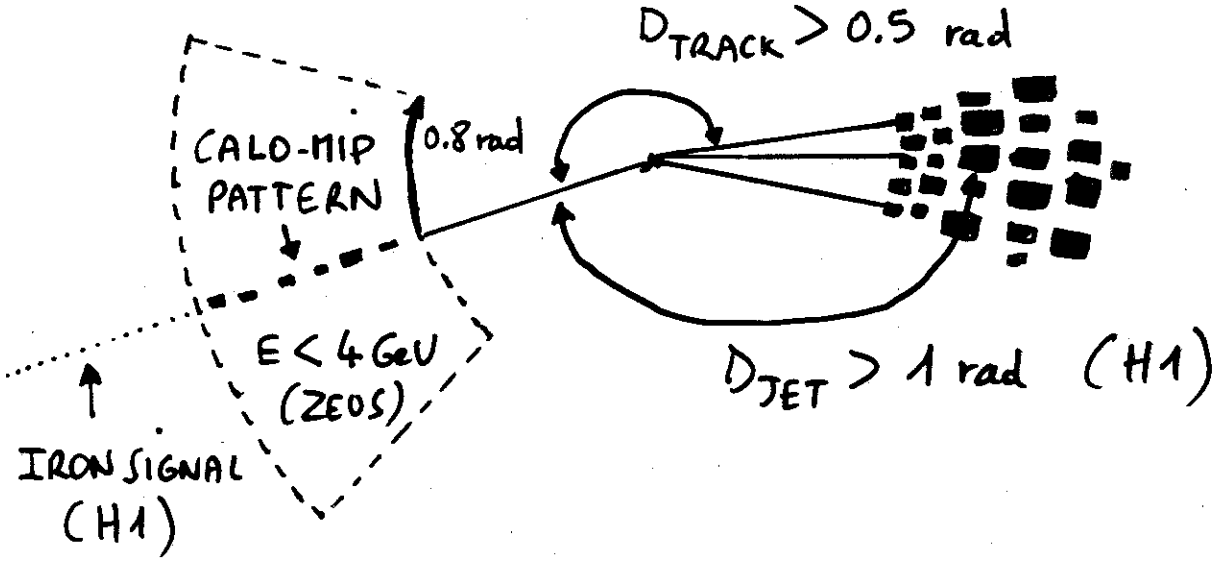
$P_T^{\nu} > 15\ GeV\ (ZEUS)$

$P_T^{\mu} > \begin{cases} 5\ GeV\ (ZEUS) \\ 10\ GeV\ (H1) \end{cases}$

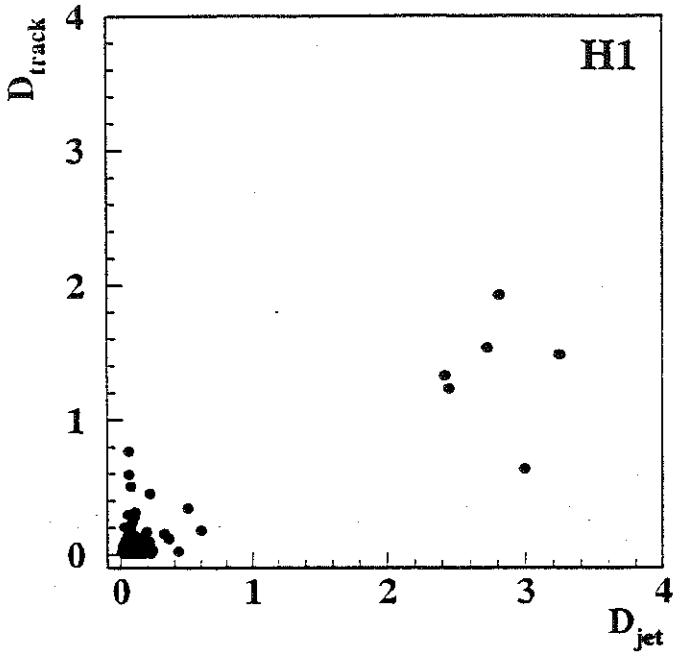
LEPTON IDENTIFICATION AND ISOLATION

DISTANCES IN (η, φ) PLANE





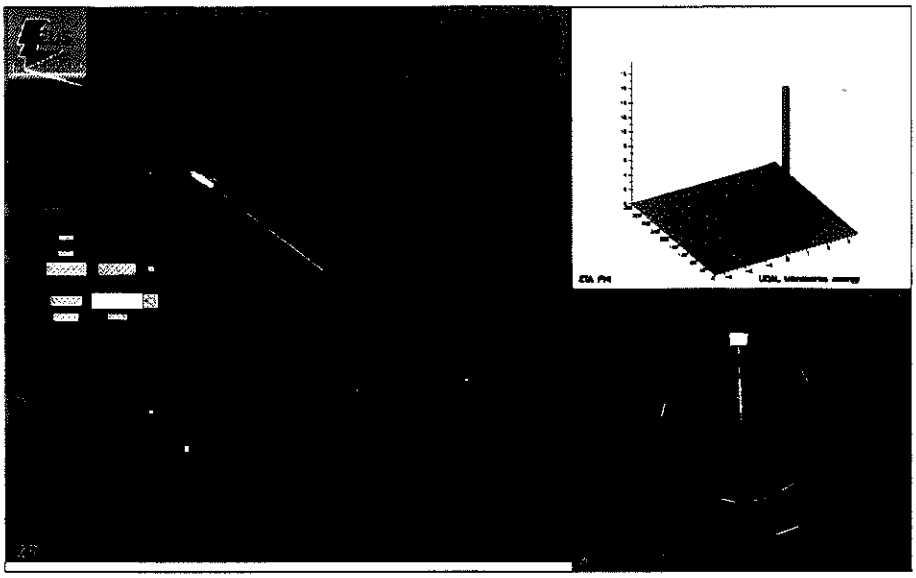
RESULTS



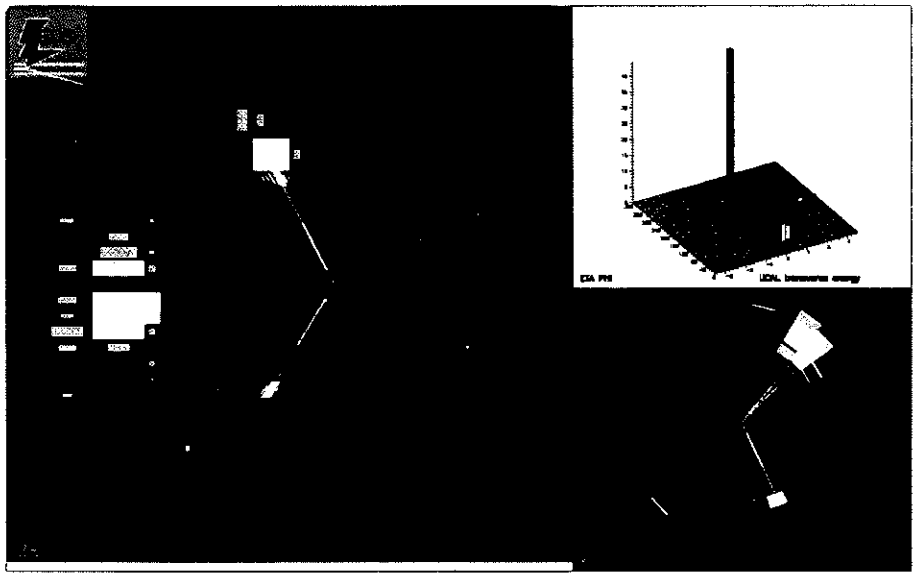
BEFORE LEPTON IDENTIFICATION AND ISOLATION

ZEUS : $3\ e^+$

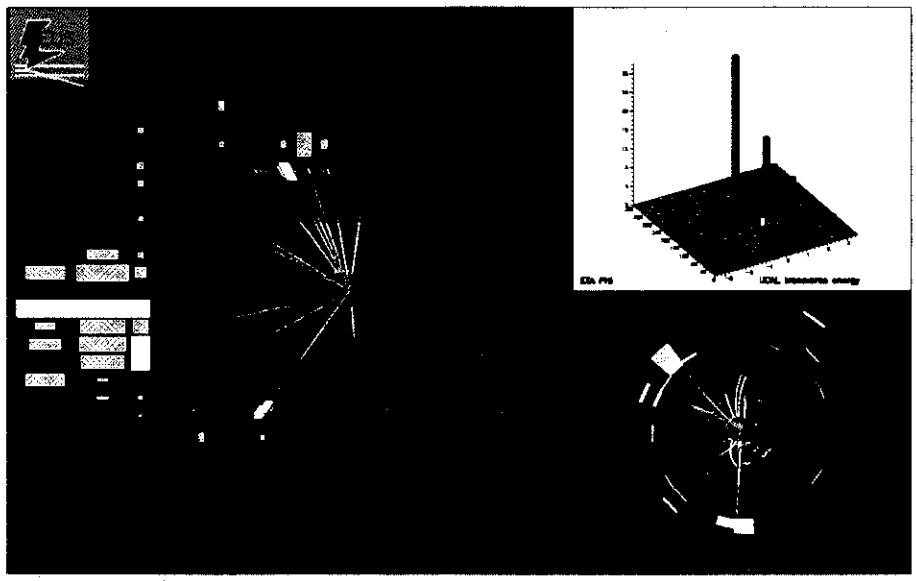
H1 : $1\ e^-, 2\ \mu^+, 2\ \mu^-, 1\ \mu^\pm$



$$\theta^e = 37^\circ$$
$$E_T^e = 22.1 \pm 1.1$$
$$p_t^{track} = 22.3^{+6.8}_{-4.2}$$
$$\text{charge} = +1(4.3\sigma)$$
$$P_T^h = 0.4 \pm 0.1$$
$$P_T^{CAL} = 21.7 \pm 1.1$$
$$M_T = 43.7 \pm 1.6$$

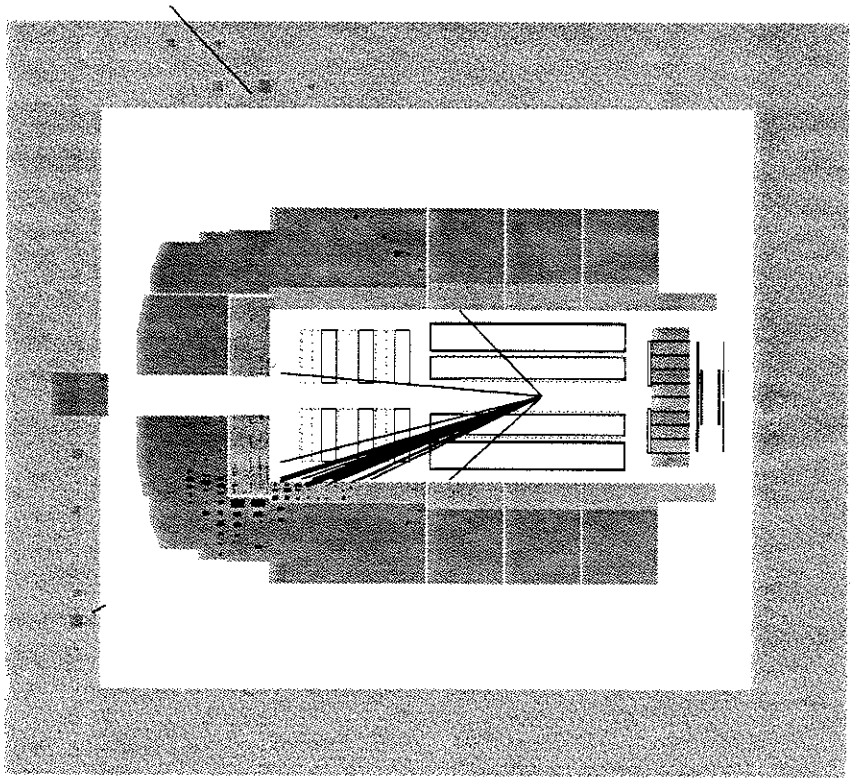


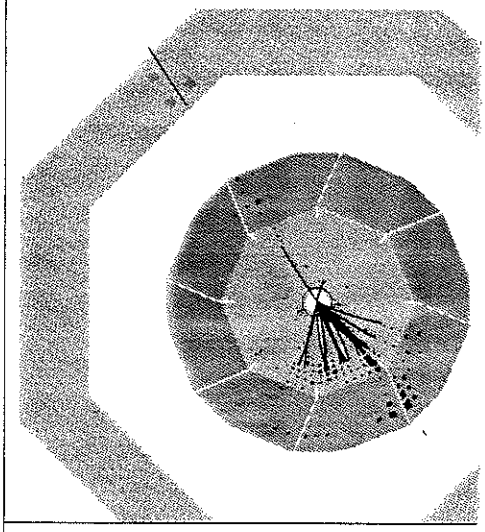
$$\theta^e = 58^\circ$$
$$E_T^e = 48.8 \pm 2.0$$
$$p_t^{track} = 44.1^{+33.0}_{-13.2}$$
$$\text{charge} = +1(2.3\sigma)$$
$$P_T^h = 19.0 \pm 2.5$$
$$P_T^{CAL} = 34.9 \pm 2.4$$
$$M_T = 81.4 \pm 3.2$$

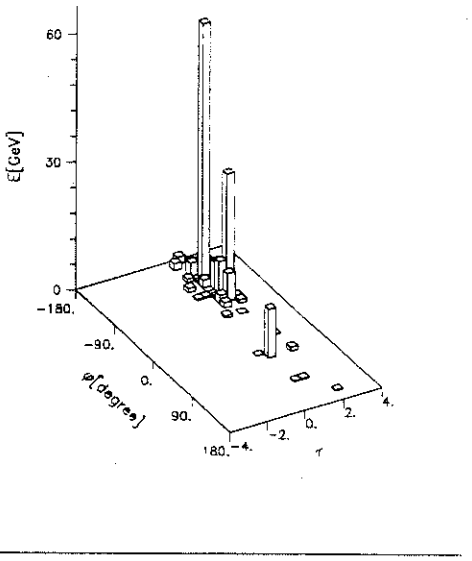


$$\theta^e = 54^\circ$$
$$E_T^e = 37.1 \pm 1.6$$
$$p_t^{track} = 35.9^{+13.8}_{-7.8}$$
$$\text{charge} = +1(3.6\sigma)$$
$$P_T^h = 18.7 \pm 2.2$$
$$P_T^{CAL} = 32.9 \pm 1.4$$
$$M_T = 68.2 \pm 2.2$$

MUON - 1





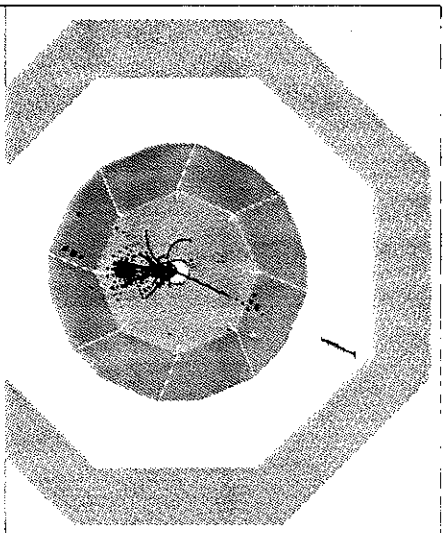


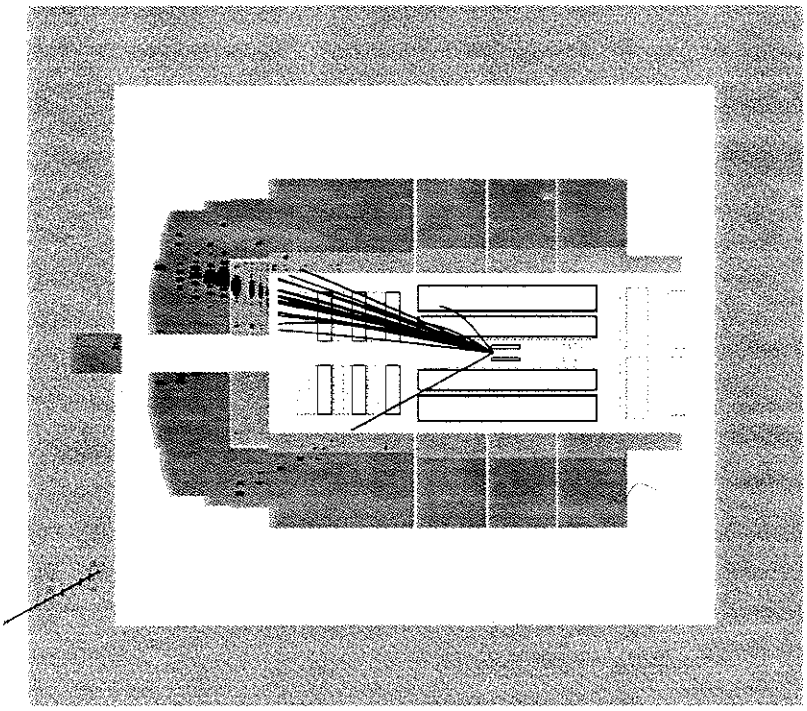
H1

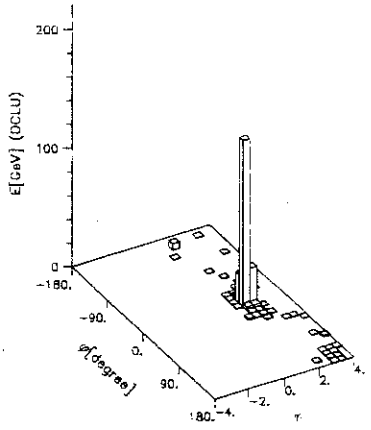
$$e^+p \to \mu^+X$$

Event MUON-2

$P_T^\mu = 28\,\text{GeV}, P_T^X = 67\,\text{GeV}, P_T^{miss} = 43\,\text{GeV}$







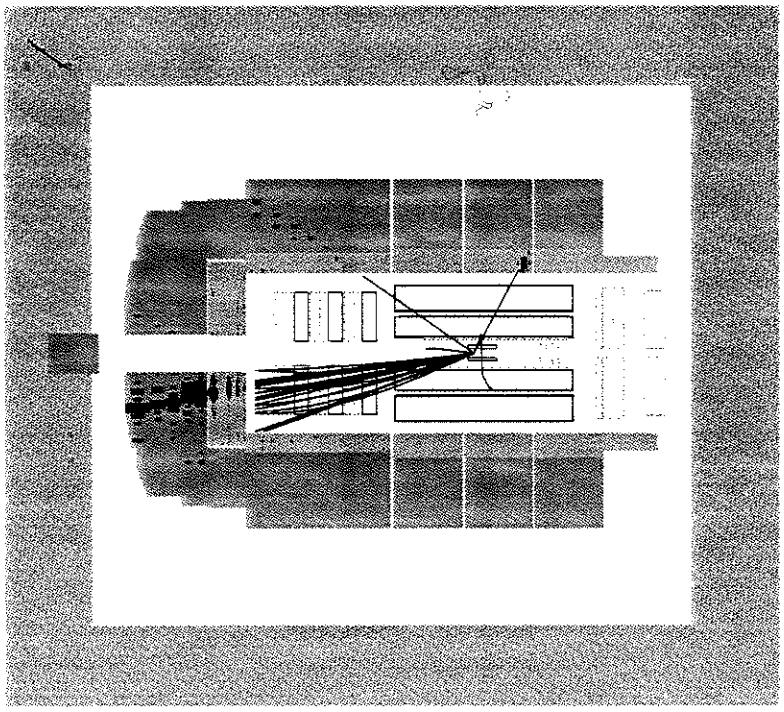
H1

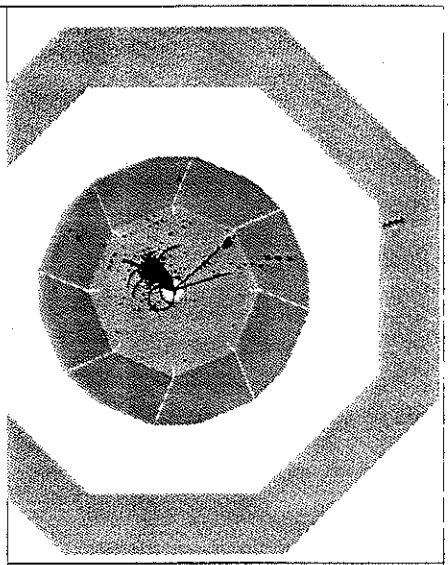
$e^+p \to e^+\mu^- X$

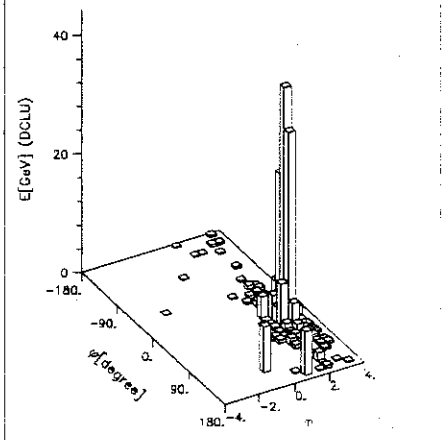
Event MUON-3

$P_T^\mu = 39\,\text{GeV}, P_T^X = 27\,\text{GeV}, P_T^{miss} = 42\,\text{GeV}$

$M_{\mu\nu} = 82\,\text{GeV} \qquad W^- \to \mu^-\nu \quad Candidate$

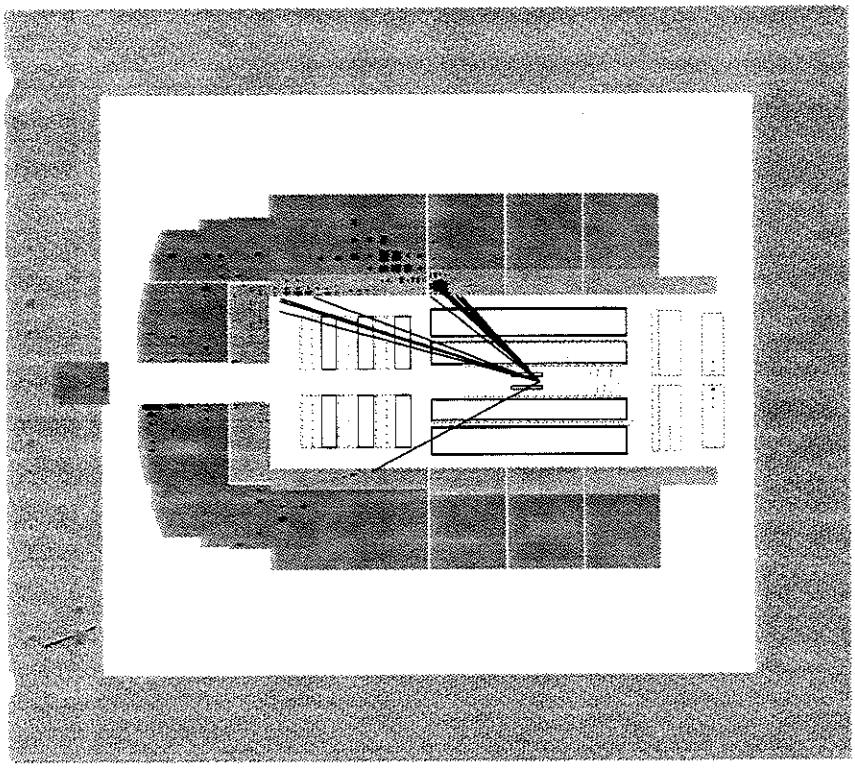


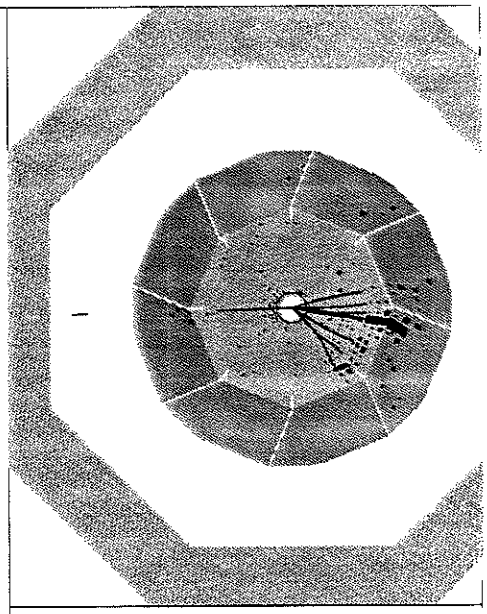


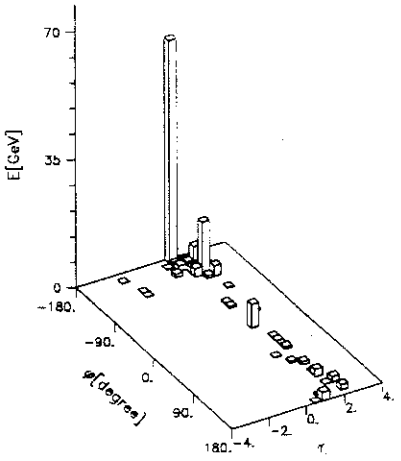


H1

MUON - 4



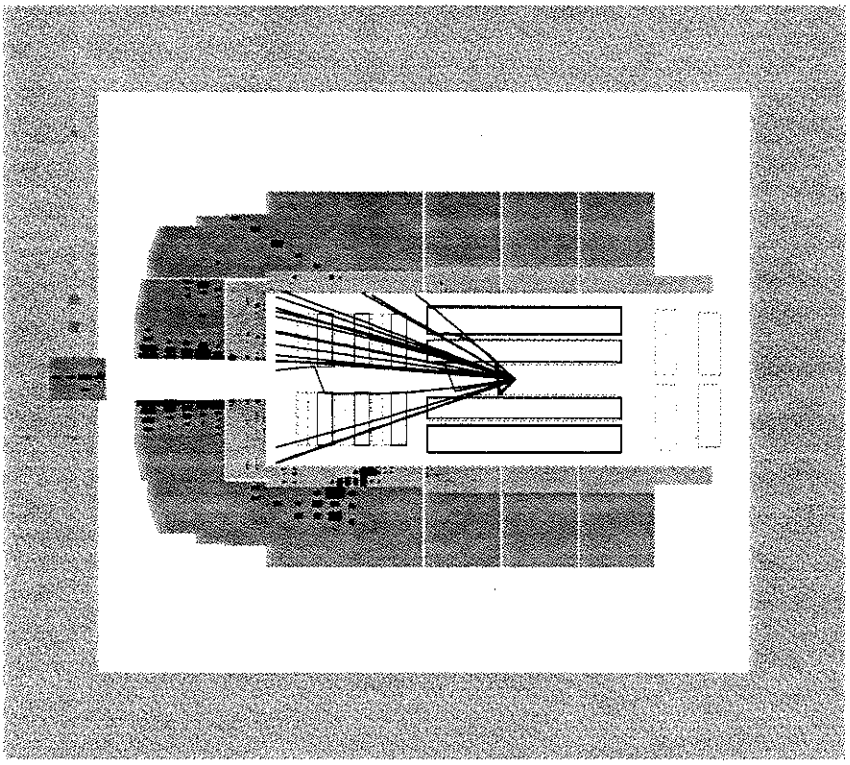


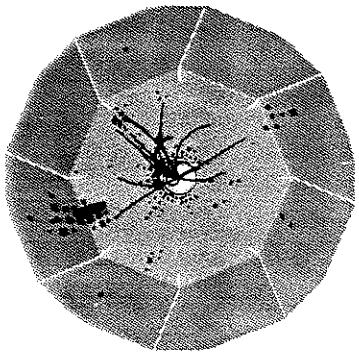


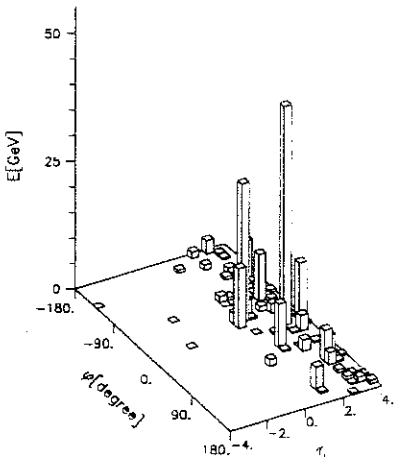
R
Z

H1

NUON - 5





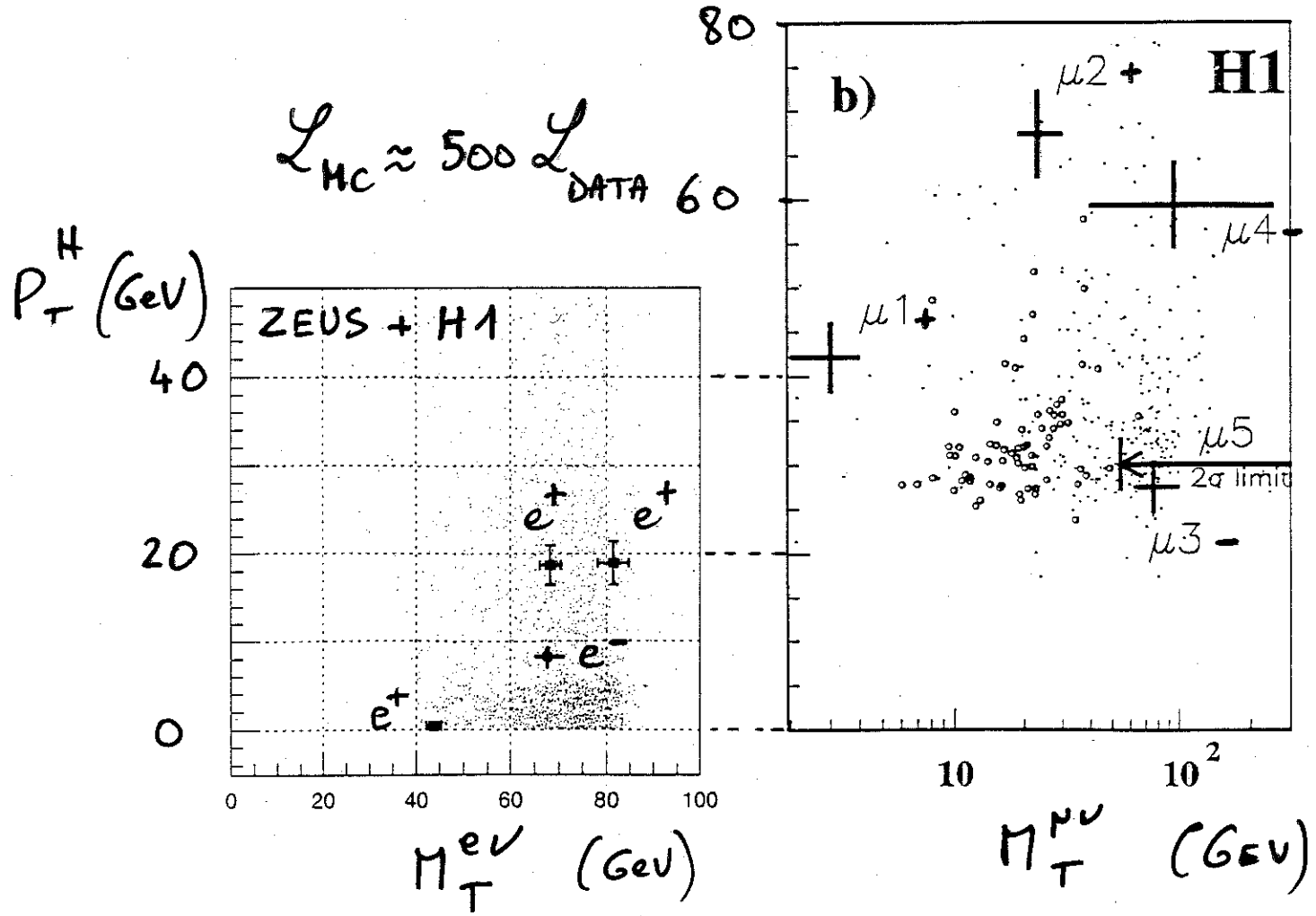


H1

COMPARISON TO THE STANDARD MODEL

	e - CHANNEL		ν - CHANNEL	
	ZEUS	H1	ZEUS	H1
DATA	3	1	0	5
W	2.0	1.7 ± 0.5	0.6	0.5 ± 0.1
OTHERS (NC+γγ+...)	1.0 ± 0.5	0.7 ± 0.1	0.6 ± 0.2	0.3 ± 0.2

$\mathcal{L}_{MC} \approx 500\, \mathcal{L}_{DATA}$



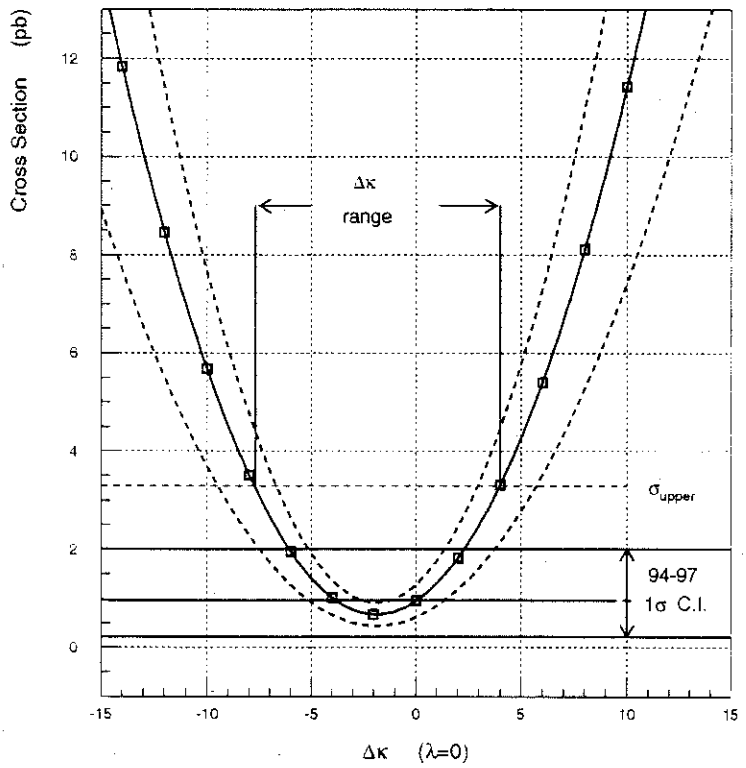
THE W CROSS SECTION

ZEUS e^+ CANDIDATES

$$\Downarrow$$

$$\sigma(e^+p \to e^+ W^\pm X) = 1.0\ {}^{+1.0}_{-0.7}\ (\text{STAT})\ \pm 0.3\ (\text{SYST})\ \text{pb}$$

(SM: 0.94 pb)



$$\mathcal{L}_{WW\gamma} \approx K\, W^+_\mu W_\nu V^{\mu\nu} + \frac{\lambda}{M_W^2} W^+_{\rho\mu} W^\mu_\nu V^{\nu\rho}$$

SM $\Rightarrow$ $K = 1$, $\lambda = 0$

$$\Downarrow$$

$$-7.6 < \Delta K < 3.9 \quad \text{AT 95\% CL } (\lambda = 0)$$

ZEUS - H1 COMPATIBILITY

ZEUS ANALYSIS "à la H1"

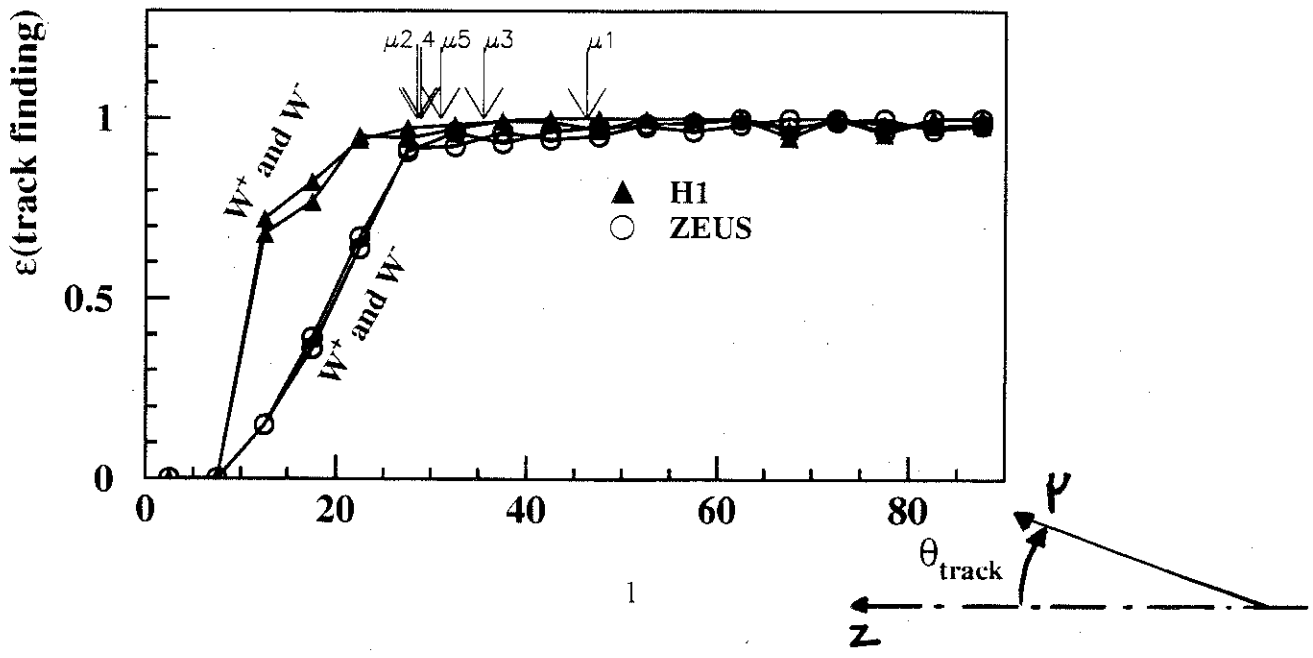
$\Rightarrow$ STILL NO ν CANDIDATE AT HIGH p_T^H

$\Rightarrow$ σ(HIGH-p_T ν, $p_T^H > 30$ GeV) < 0.17 pb (95% CL)

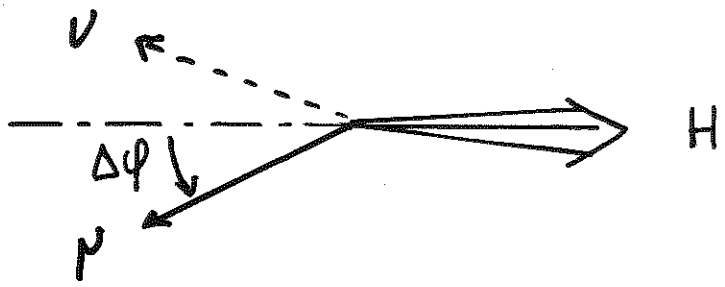
$\Rightarrow$ $N^{\text{EXPECTED}}_{\text{MAX}}(\text{H1}) \approx \underbrace{0.17}_{\sigma_{\text{MAX}}(\text{ZEUS})} \times \underbrace{37}_{\mathcal{L}(\text{H1})} \times \underbrace{0.5}_{\varepsilon_{\text{SEL}}(\text{H1})} \approx 3.2$ EVENTS (95% CL)

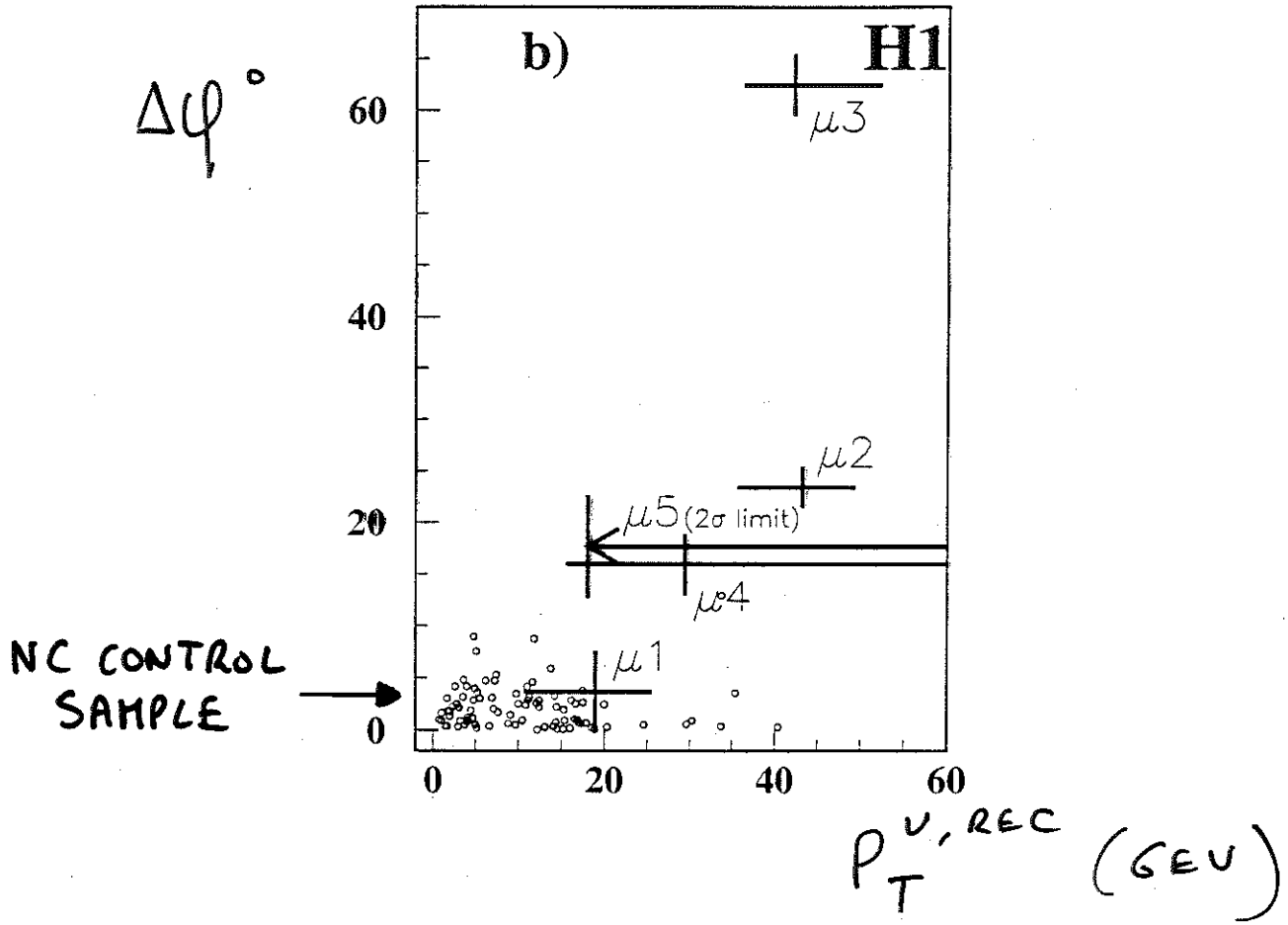
TO BE COMPARED TO 4 EVENTS $p_T^H > 30$ GeV

$\Rightarrow$ **H1 AND ZEUS COMPATIBLE WITHIN LIMITED STATISTICS**



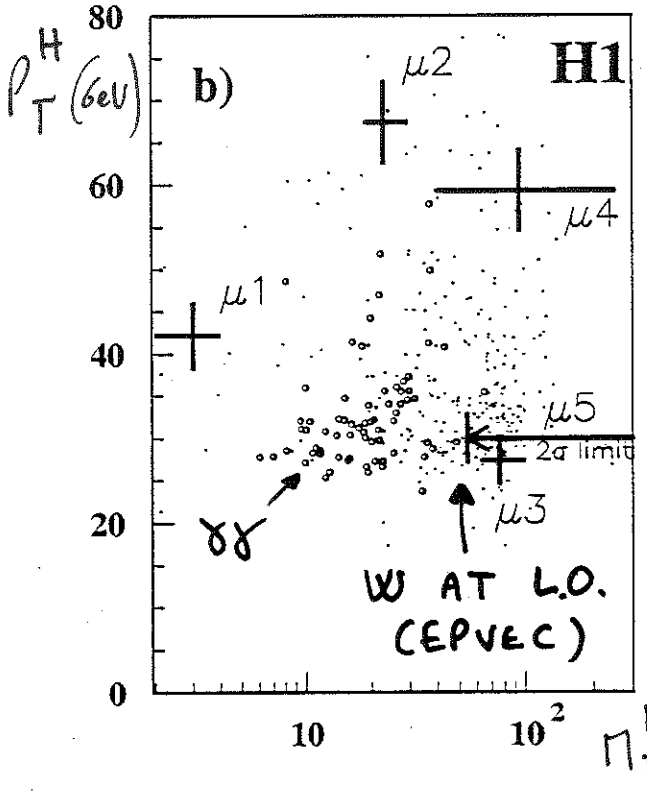
INTERPRETATION OF H1 ATYPICAL EVENTS





⇒ MISSING TRANSVERSE ENERGY VERY UNLIKELY TO BE DUE TO EXPERIMENTAL EFFECTS

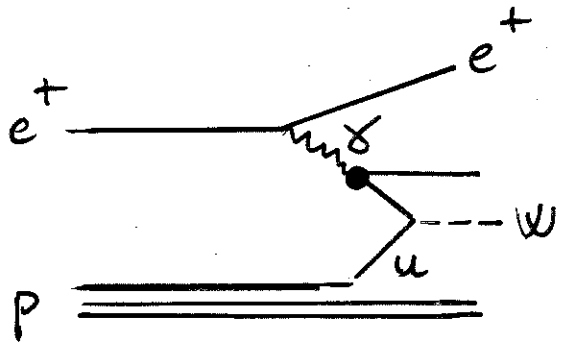
STATISTICAL FLUCTUATION OF W PRODUCTION ?



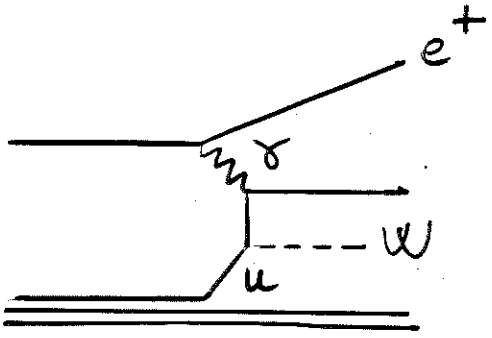
PROBA $\left(\frac{\text{5 OBSERVED}}{0.8 \pm 0.2 \text{ PREDICTED}}\right)$

$\approx$ 0.5 %

$\sigma(W) \approx$



$\oplus$



RESOLVED γ

$|u| \approx 0$

DIRECT γ

$|u| \gg 0$

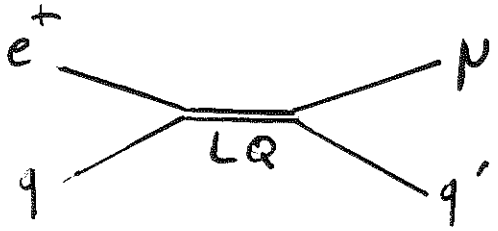
RECENTLY AVAILABLE AT NLO

P. NASON et al, DURHAM-98

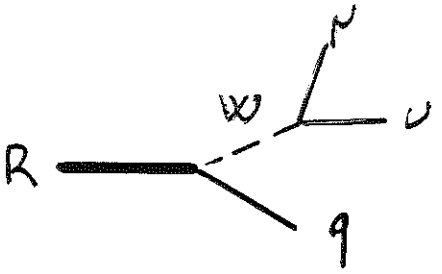
$\Rightarrow$ ~20% INCREASE OF $\sigma(W)$

NOT YET AVAILABLE AT NLO

(NEW) HEAVY PARTICLE ?



LEPTOQUARK EXCLUDED
(RECONSTRUCTED ν INCOMPATIBLE WITH 2-BODY KINEMATICS)

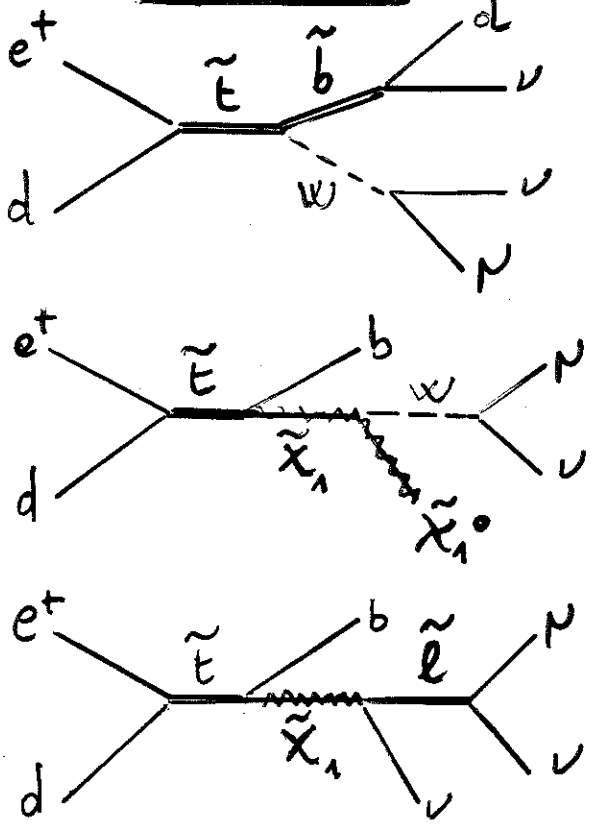


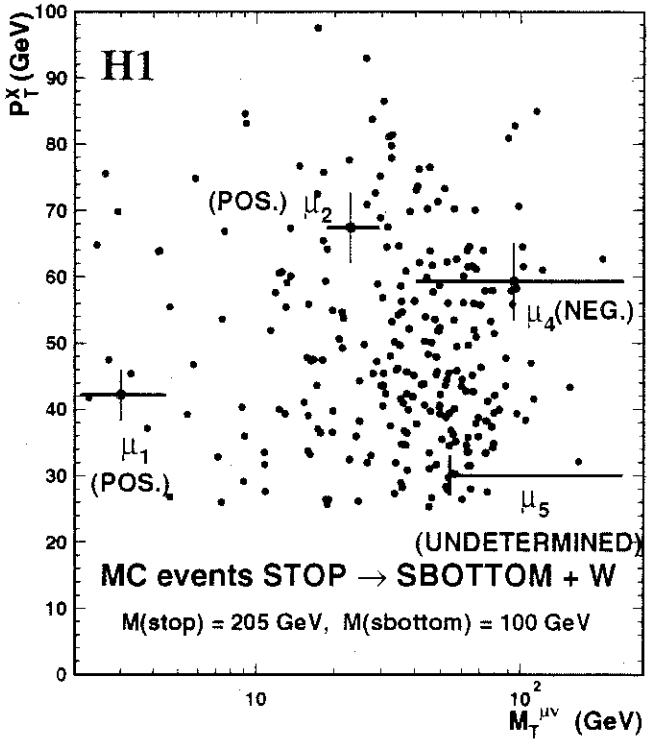
RECONSTRUCTED FROM P_T BALANCE AND M_W CONSTRAINT $\Rightarrow$ ν_2, ν_4, ν_5 COMPATIBLE WITH $M_R = 175$ GeV

$\Rightarrow$ TOP ?

cf. H. FRITZSCH et al
hep-ph/9901411

$\not{R}_p$-SUSY





cf. T. KON et al. | PHYS. LETT. B 376 (1996) 227
hep-ph/9707355

SUMMARY

- FIRST OBSERVATION BY ZEUS AND H1 OF CANDIDATES FOR EXCLUSIVE W PRODUCTION IN DEEP INELASTIC SCATTERING
- $4\ e^{\pm}$ AND $2\ \mu^{\pm}$ EVENTS AS EXPECTED FROM W PRODUCTION
  $\Rightarrow \quad \sigma_W = 1.0\ ^{+1.0}_{-0.7} \pm 0.3$ pb (ZEUS)
- 3 μ EVENTS (H1) ATYPICAL OF ALL EXPECTED SM PROCESSES

$\Rightarrow$ e^-p DATA (IN PROGRESS)
HIGH LUMI HERA UPGRADE (≥ 2000)
EAGERLY AWAITED