ICHEP 2000, Osaka

Friday, July 28, 2000

W Production and Search for Top at HERA

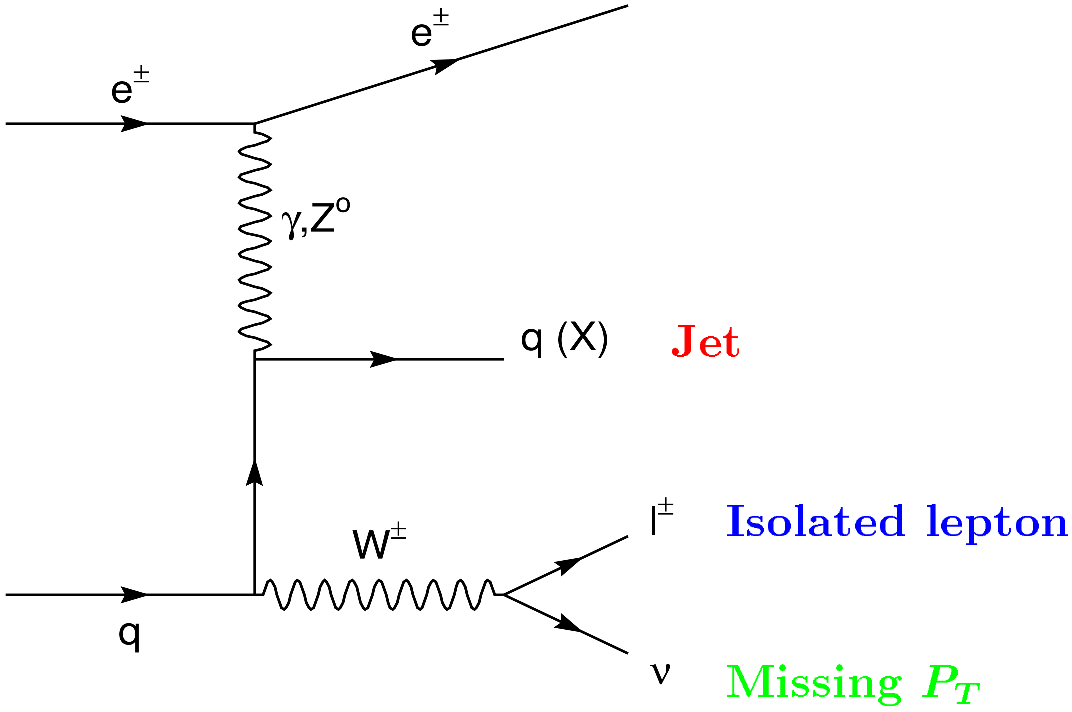
Andrew Mehta - Liverpool University

- Introduction
- W Search
- H1-ZEUS Comparison
- Top Search
- Summary

Introduction(1)

The H1 and ZEUS detectors at the HERA ep collider have now each recorded $\approx 100pb^{-1}$ of data

$\rightarrow$ Sensitivity to rare SM physics processes
e.g. W production :

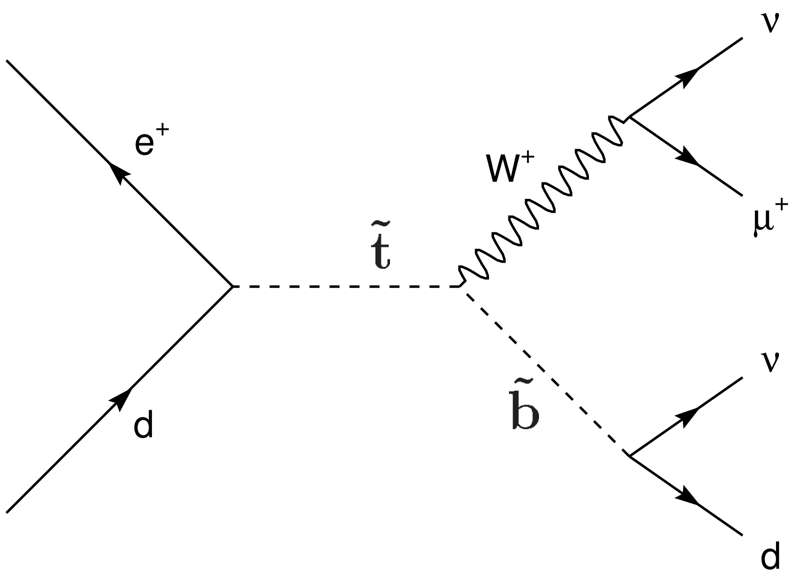


Standard Model (QCD LO) predicts
$\sigma(ep \rightarrow eW^{\pm}X) \approx$ 1pb

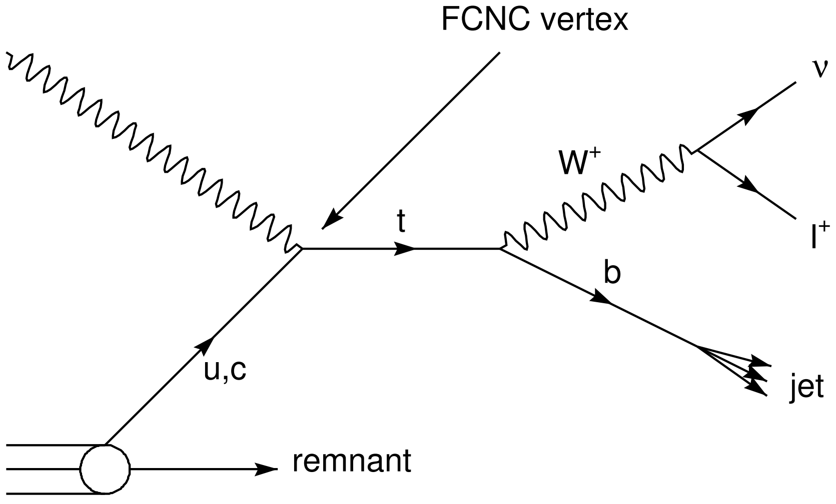
Uncertainties on proton/photon structure functions and QCD scale
give $\approx 30\%$ uncertainty on cross section

Introduction(2)

Beyond the Standard Model, W production is background to other processes with a jet, an isolated lepton and missing P_T
e.g. anomalous $WW\gamma$ couplings, compositeness, R_p violating SUSY:



or anomalous single top production



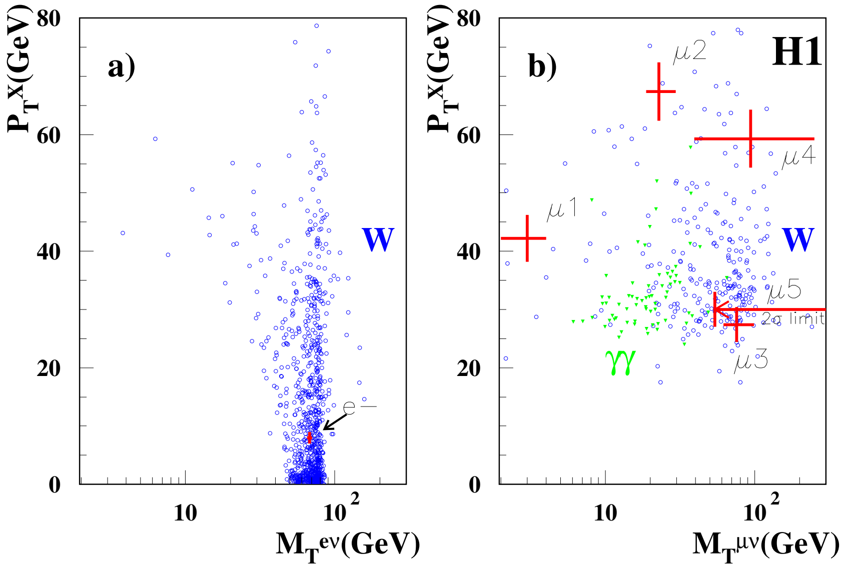
An important process for searches

H1+ZEUS published 94-97 e^+p data

Searches for Ws and Events with Isolated leptons with Missing P_T

H1

MC lumi = 500 x data



lumi= 36.5 pb^{-1}

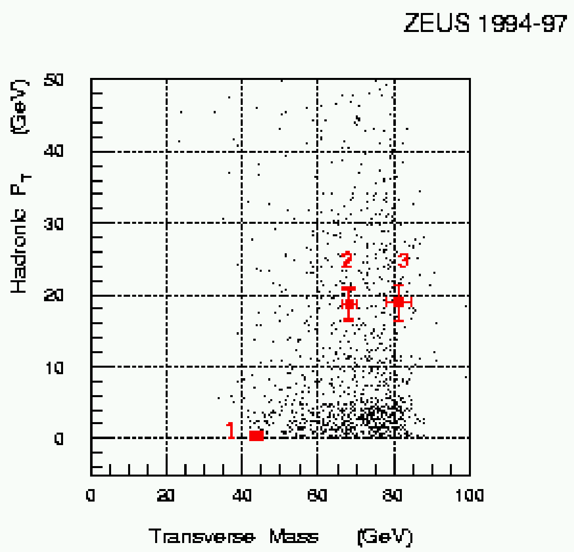
1 e^- cf 2.4 ± 0.5 SM

5 $\mu^\pm$ cf 0.8 ± 0.2 SM

3 events seen at high P_T^X where SM is low

ZEUS

MC lumi = 1000 x data



lumi= 47.7 pb^{-1}

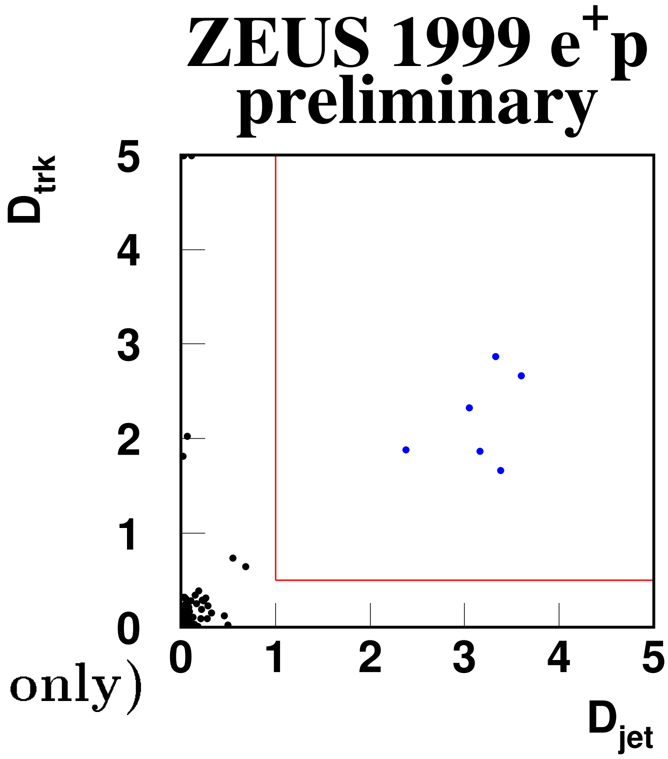
3 e^+ cf 3.2 SM

0 $\mu^\pm$ cf 1.4 SM

Good agreement with SM expectation

New Analyses

ZEUS Selection



$17^o < \theta_l < 115^o$

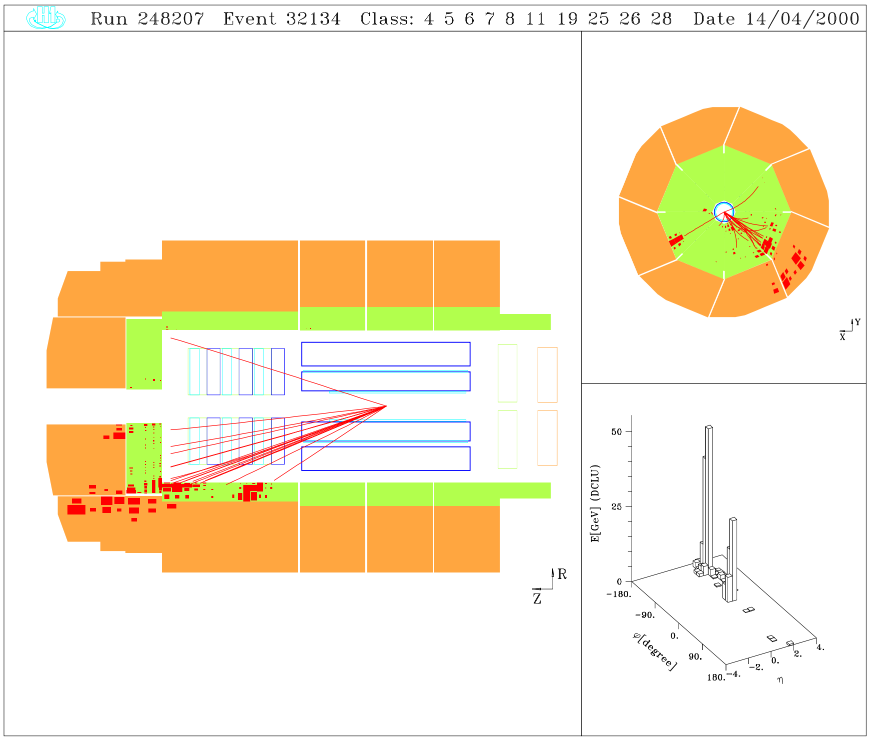
$P_T^l > 10$ GeV

$P_T^{calo} > 20$ GeV

$D_{\rm jet} > 1.0$

$D_{\rm trk} > 0.5$

$\Delta\phi_{e-X} > 11^o$ (e channel only)



H1 Selection

$5^o < \theta_l < 145^o$

$P_T^l > 10$ GeV

$P_T^{miss} > 12$ GeV

$P_T^{calo} > 12$ GeV

$D_{\rm jet} > 1.0$

$D_{\rm trk} > 0.5$ (e channel only for $\theta_e > 45^o$)

$\Delta\phi_{e-X} > 20^o$ (e channel only)

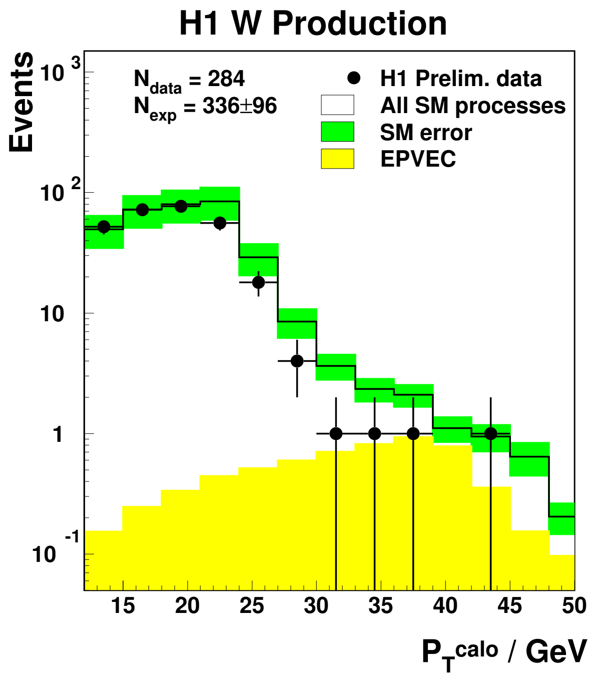
Cut dimuon events

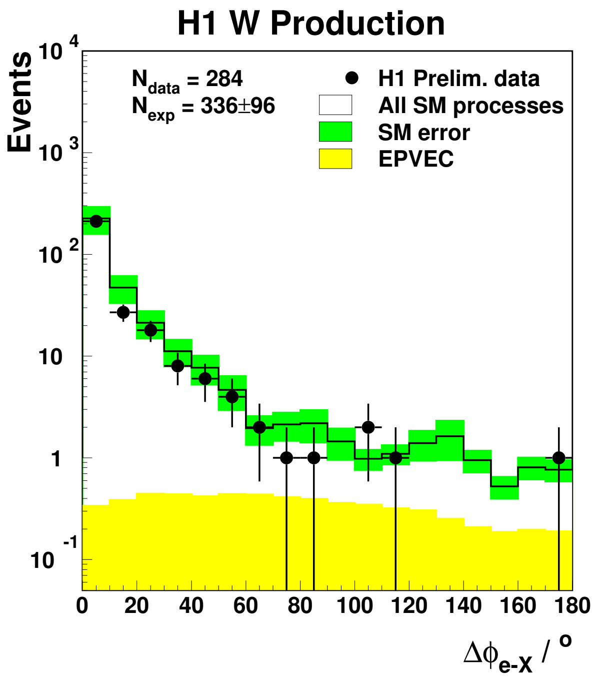
+ Extra cuts against NC background

H1 Control Distributions 99-00 e^+p Data

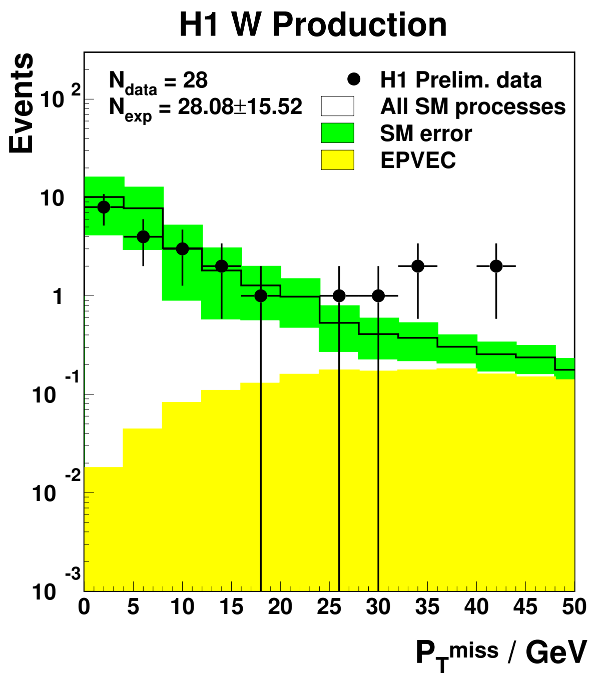
Check backgrounds with relaxed cuts

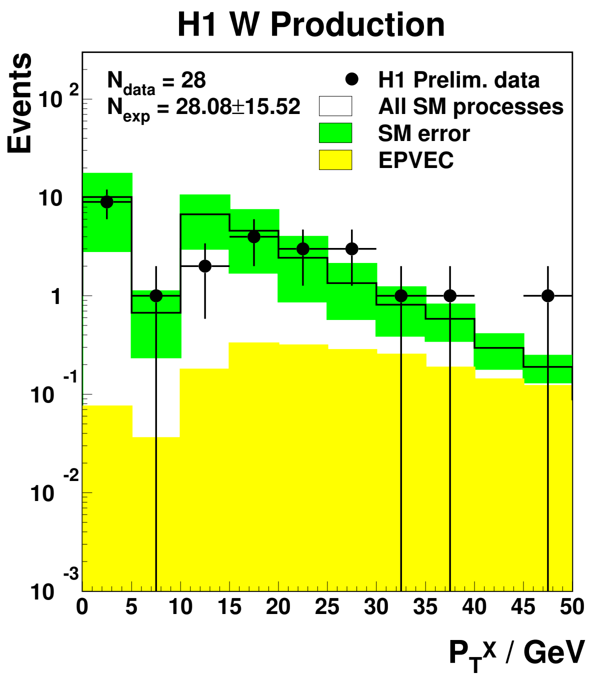
Electron channel:





Muon channel:





Distributions well described in shape and normalisation

New Results : 1994 - 2000 data

Tables show:
observed events /expectation from all SM processes

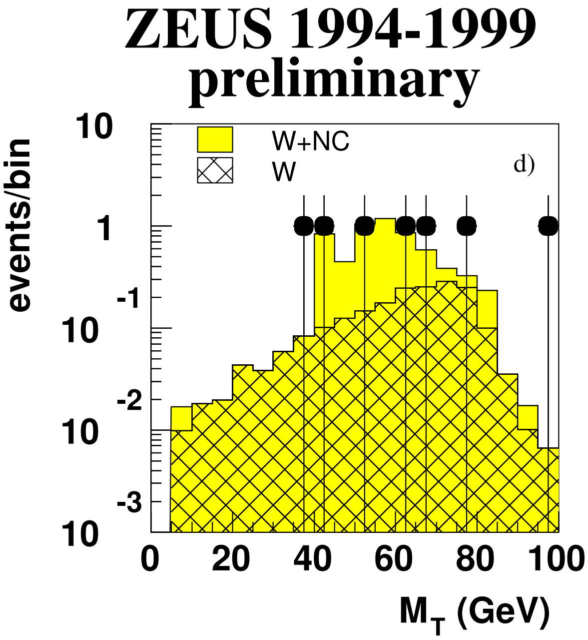
ZEUS	Electrons	Muons
94-97 e^+p 48 pb^{-1} Published	3 / 3.5±0.7	0/ 2.0±0.4
98-99 e^-p 16 pb^{-1} Preliminary	2 / 0.8±0.4	0 /0.8±0.1
99 e^+p 18 pb^{-1} Preliminary	2 /1.8±0.4	4 / 0.9±0.1
Total 82 pb^{-1}	7 / 6.1 ±0.9 (only W 1.9)	4 / 3.7 ±0.4 (only W 0.8)

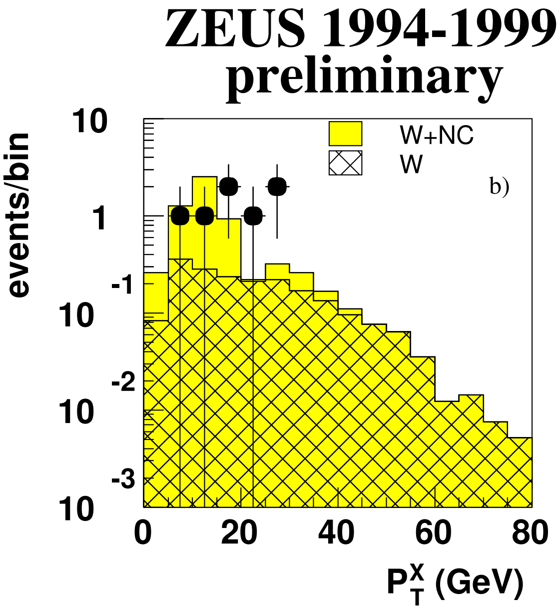
H1 94-00 e^+p 82 pb^{-1} Preliminary	Electrons	Muons	combined $e + \mu$
$P_T^X > 0$ GeV	6 / 6.1±1.5	–	14/8.2±2.0 (only W 6.4)
$P_T^X > 12$ GeV	4 / 2.1±0.5	8 /2.0±0.5	12/4.1±1.0 (only W 3.3)
$P_T^X > 25$ GeV	3 /1.1±0.3	6 / 1.2±0.3	9/2.3±0.6 (only W 1.8)
$P_T^X > 40$ GeV	2 / 0.3 ±0.1	4 / 0.5 ±0.1	6/0.8±0.2 (only W 0.7)

- ZEUS see good agreement with SM expectation
- H1 see an excess for $P_T^X > 25$ GeV
  4 new events in 99-00 data (5 events in 94-97)

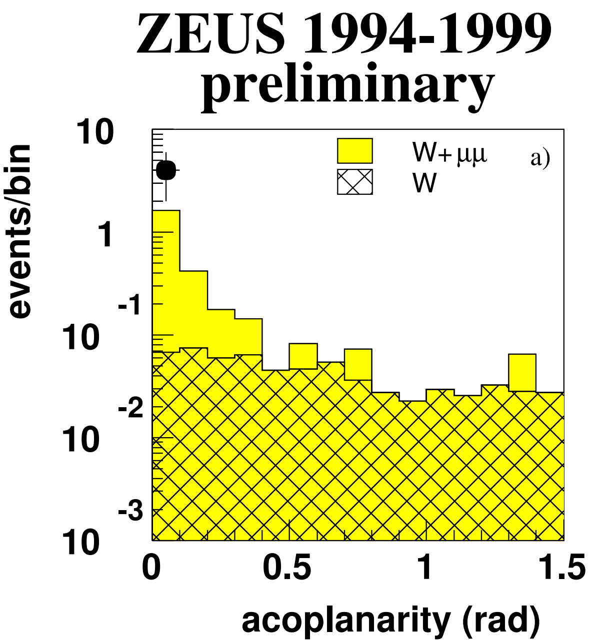
ZEUS Final Distributions

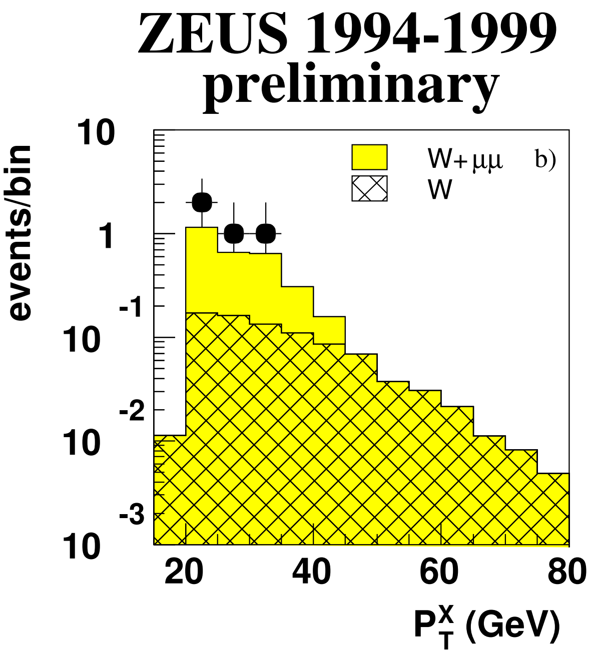
Electron channel





Muon channel

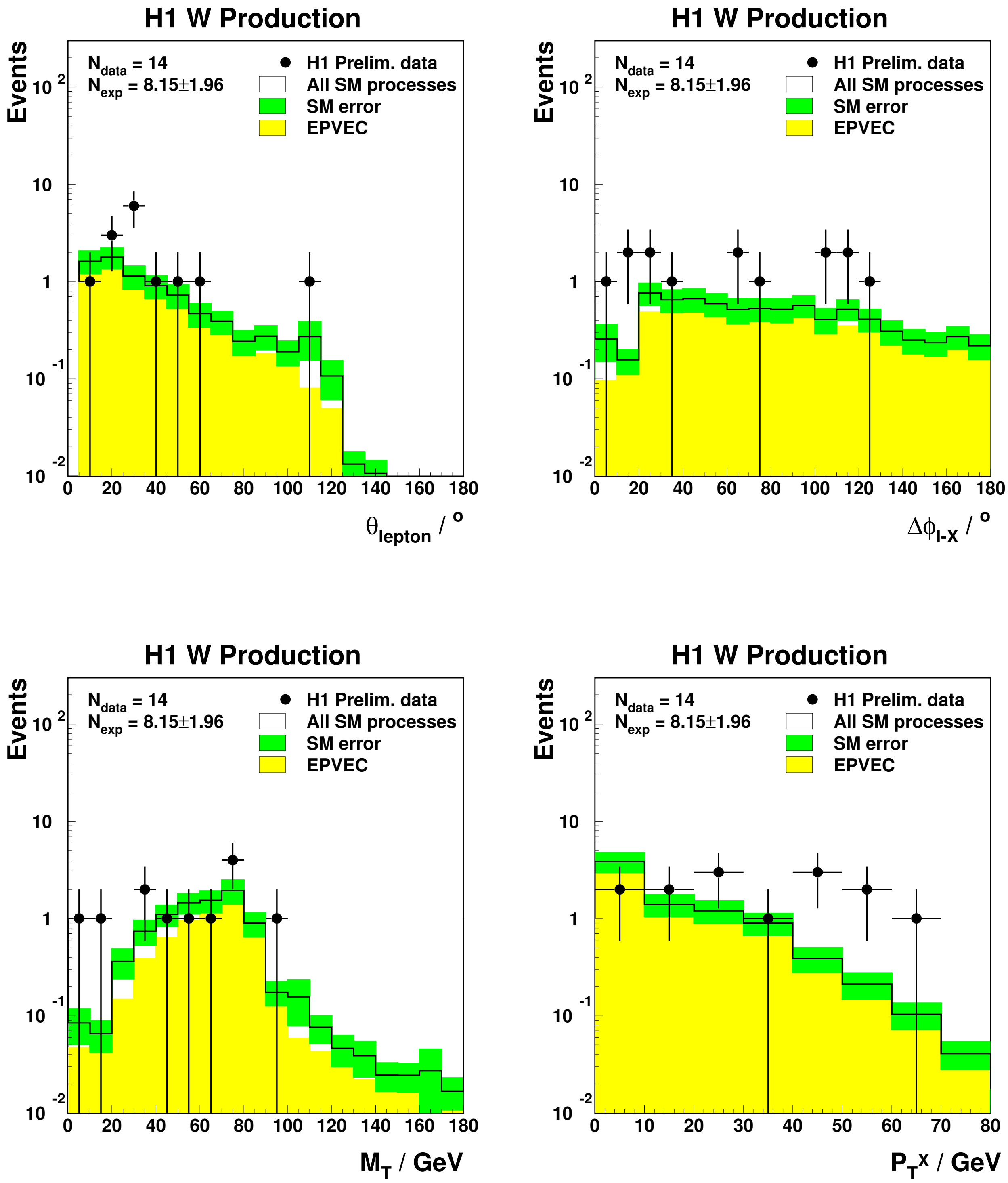




Data agree well with SM shape + normalisation

H1 Final Distributions

Electrons and muons combined



Excess over expectation at large P_T^X

Shapes of other distributions compatible with expectation

H1 ZEUS Comparison

- Standard cuts are different for H1 and ZEUS

$\Rightarrow$ different SM expectations

Make a comparison with similar cuts:

- Zeus apply extra cuts:

For μ: $P_T^{miss} > 12$ GeV, Cut dimuon events
For e: $E - Pz < 45$ GeV

ZEUS 94-99 82 pb^{-1}

	Electrons	Muons
$P_T^X > 25$ GeV	1 /0.78	0 /0.82
$P_T^X > 40$ GeV	0 / 0.27	0 / 0.32

- H1 restrict measurement to ZEUS θ_l range

H1 94-00 e^+p 82 pb^{-1} Preliminary
Results for $17^o < \theta_l < 115^o$

	Electrons	Muons
$P_T^X > 25$ GeV	3 /0.84$\pm$0.22	6 / 0.94$\pm$0.26
$P_T^X > 40$ GeV	2 / 0.27 $\pm$0.08	4 / 0.35 $\pm$0.10

Tables show:
observed events /expectation from all SM processes

- SM expectations similar for H1+ZEUS
- H1 sees excess for $P_T^X > 25$ GeV
- ZEUS data in agreement with SM expectation

Search for Single Top $t \to Wb$

Lepton Channel

H1 apply W selection +
$P_T^{\rm jet} > 25$ GeV for $\theta^{\rm jet} > 35^o$
$P_T^{\rm jet} > 35$ GeV for $\theta^{\rm jet} < 35^o$
$M_T^{l\nu} > 10$ GeV
Reject events with $-$ve charged leptons

ZEUS apply W selection $P_T^X > 40$ GeV

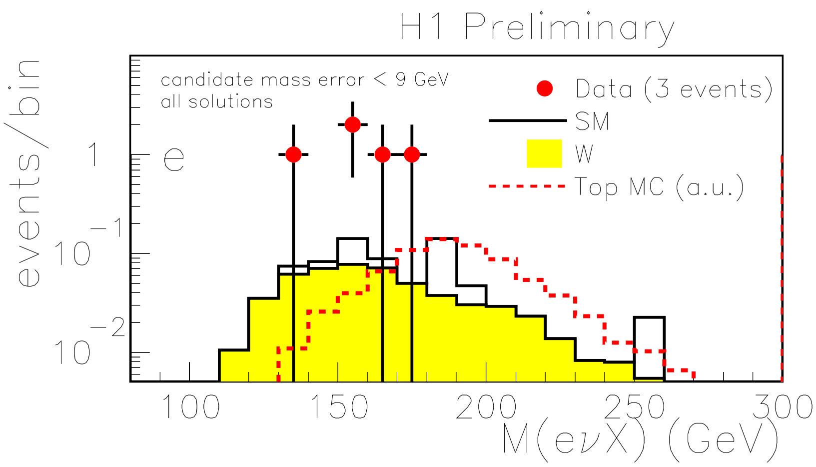
H1 see 5 events (1.44 ± 0.48 SM expectation)
ZEUS see 0 events (0.65 SM expectation)
(Preliminary results)

Hadron Channel (H1)

3 jets
$P_T^{\rm jet1} > 25$ GeV $P_T^{\rm jet2} > 15$ GeV $P_T^{\rm jet3} > 10$ GeV
$E_T^{\rm tot} > 120$ GeV
$70 < M_{ij} < 90$ GeV (any combination)
$150 < M_{tot} < 190$ GeV (all jets)

H1 see 10 events ($8.3^{+5.9}_{-4.6}$ expected from SM)
(Preliminary results)

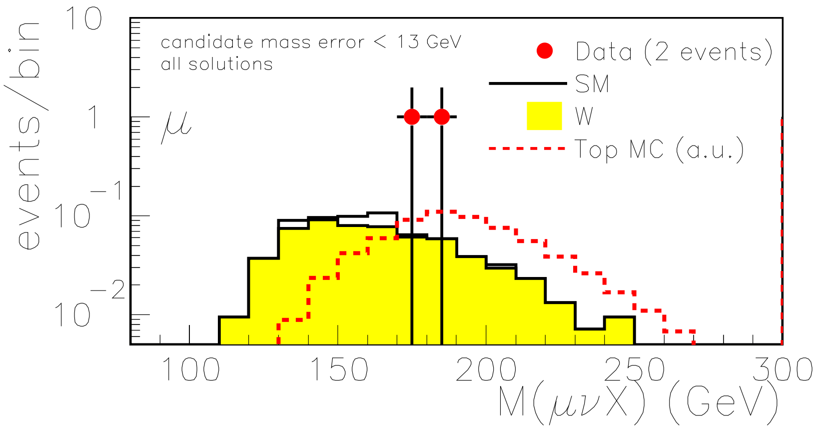
H1 Search for Single Top $t \to Wb$



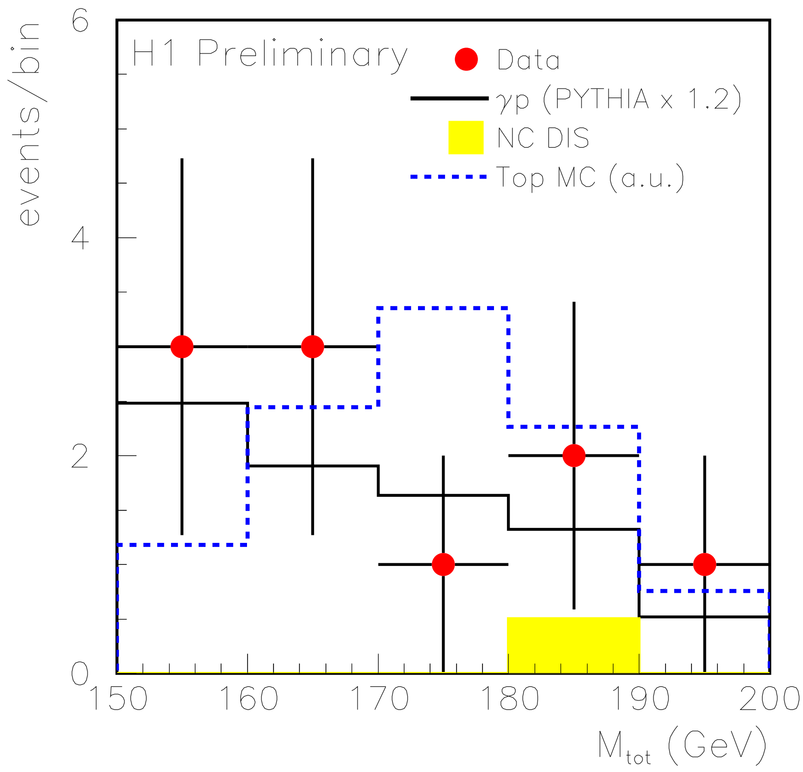
$W \to e\nu$

Impose W mass constraint $\Rightarrow$

2 possible solutions per event

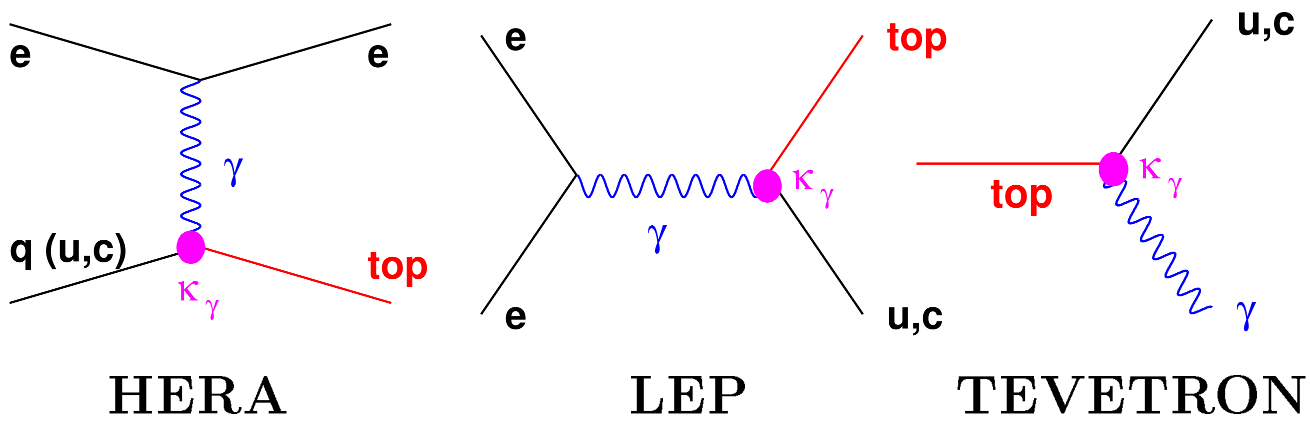


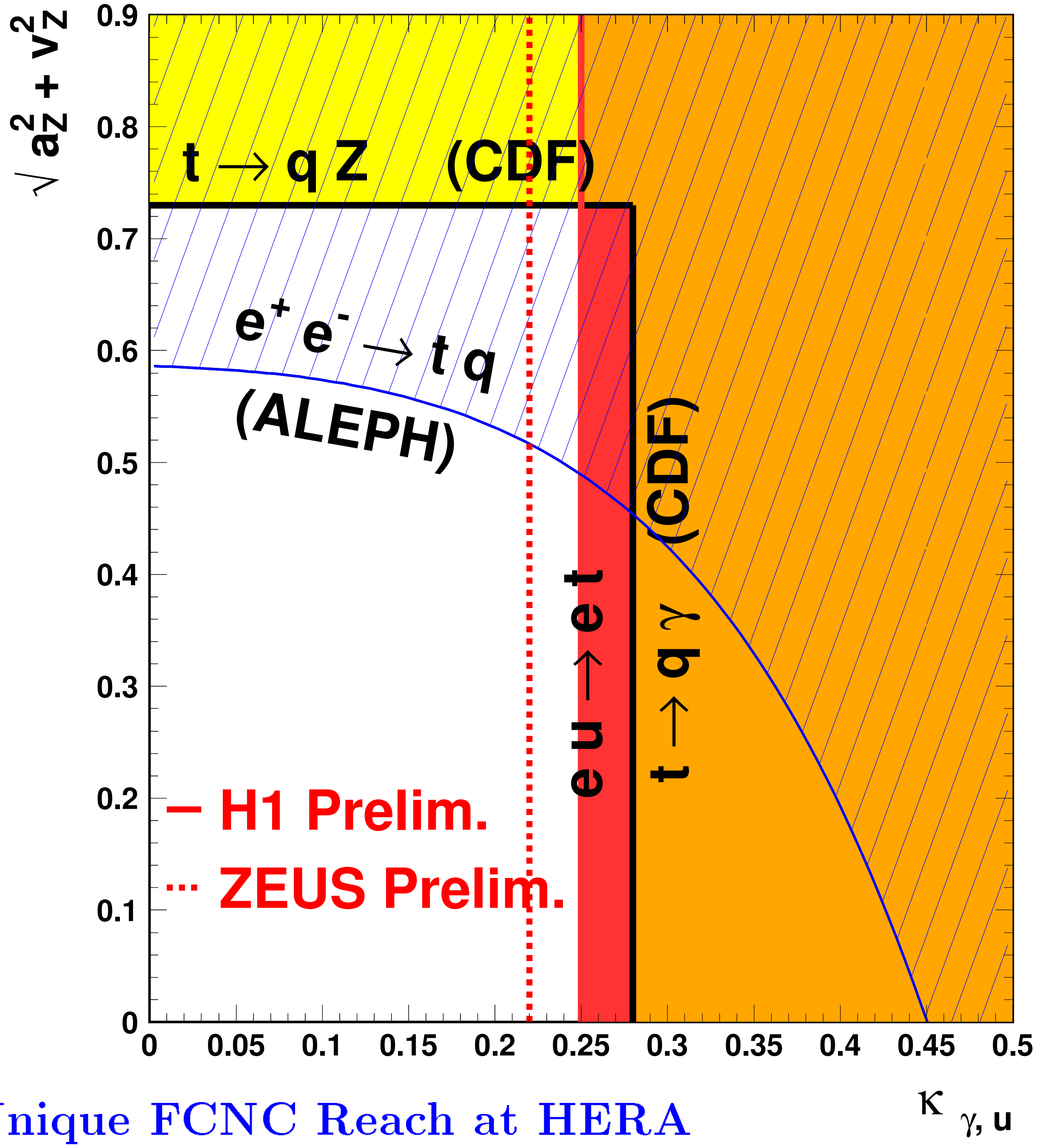
$W \to \mu\nu$



$W \to q\bar{q}'$

Limits for FCNC couplings





Unique FCNC Reach at HERA

Summary: W and top at HERA

Events with isolated lepton and missing transverse momentum observed at HERA

Such events interpreted in SM as W production with leptonic decay

In 1994-1999 e^+p and e^-p data, ZEUS see 7 e events and 4 μ events, in agreement with SM prediction 6.1$\pm$0.9 and 3.7$\pm$0.4

In 1994-2000 e^+p collisions, H1 see 9 events with e or μ, and large hadronic recoil (P_T^X >25 GeV), compared to SM prediction 2.3$\pm$0.60

Search for top production sets limits for the FCNC $tu\gamma$ coupling

Data after HERA upgrade will prove whether the events are new physics or a statistical fluctuation