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Events with high-p_T leptons and missing momentum at ZEUS

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Motivations

H1 has observed an excess over the SM expectation of events with

- a high-p_T isolated lepton ($p_T^l > 10$ GeV),
- large missing total transverse momentum ($P_T^{\text{miss}} > 12$ GeV),
- large hadronic transverse momentum ($P_T^X > 25$ GeV)

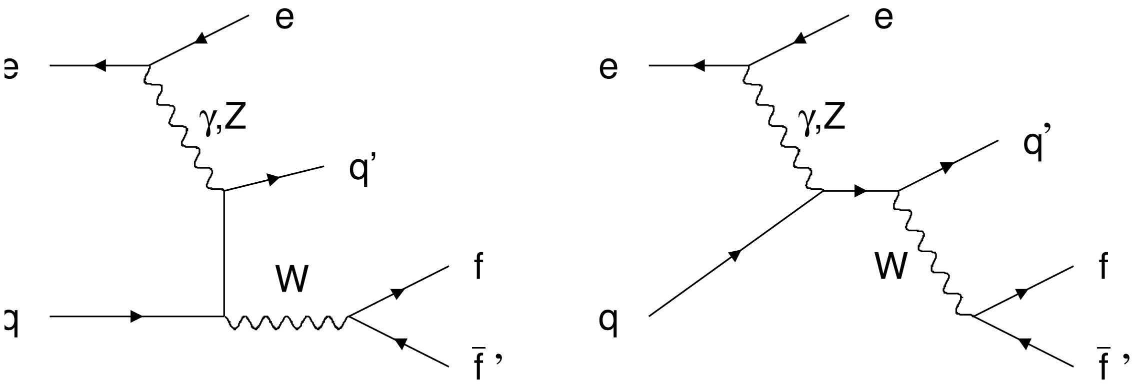
Channel	94-04 e^+p (158 pb^{-1}) N_{obs} / N_{SM} (W)	98-05 (e^-p 121pb^{-1}) N_{obs} / N_{SM} (W)	94-05 ($e^{\pm}p$ 279 pb^{-1}) N_{obs} / N_{SM} (W)
e	$9/2.3 \pm 0.4(80\%)$	$2/2.4 \pm 0.5(62\%)$	$11/4.7 \pm 0.9(69\%)$
μ	$6/2.3 \pm 0.4(84\%)$	$0/2.0 \pm 0.3(76\%)$	$6/4.3(78\%)$

No excess observed by H1 in the τ channel with HERA I data.

Does ZEUS see a similar excess ?

W production

$W \to l\nu$ main SM source of leptons and P_T^{miss}
Mainly from neutral current (W radiation from q line)

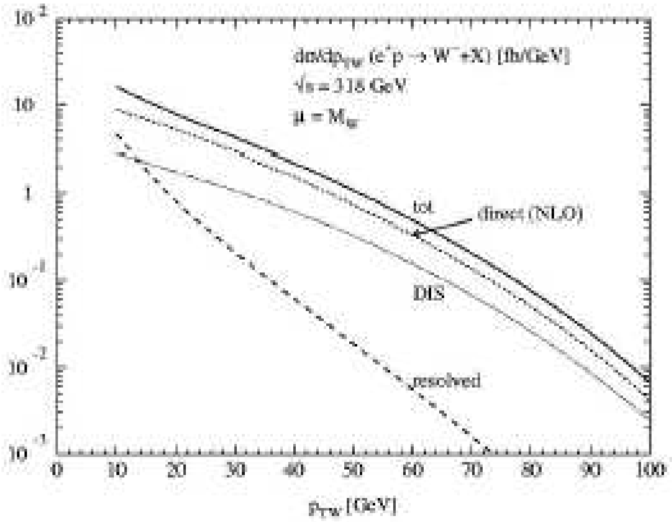


(a) (b)

$$\sigma(ep \to e'W^{\pm}X) = 1.1 \text{ pb}$$

$$BR(W^{\pm} \to l\nu) = 11\%$$

$d\sigma/dP_T^X$
(fb/GeV)



W produced mostly at small P_T^X

Leading order MC (EPVEC, Baur, Vermaseren, Zeppenfeld)

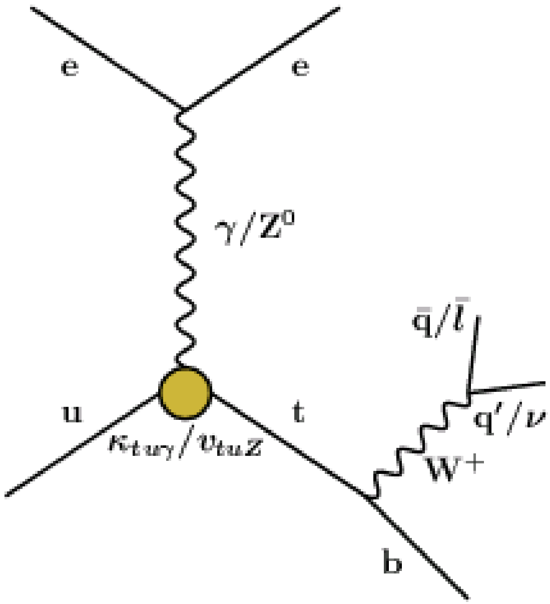
Main QCD (NLO) correction available (Sprira et al.) $O(10\%)$ uncertainty from 30% (LO) to 15% (NLO)

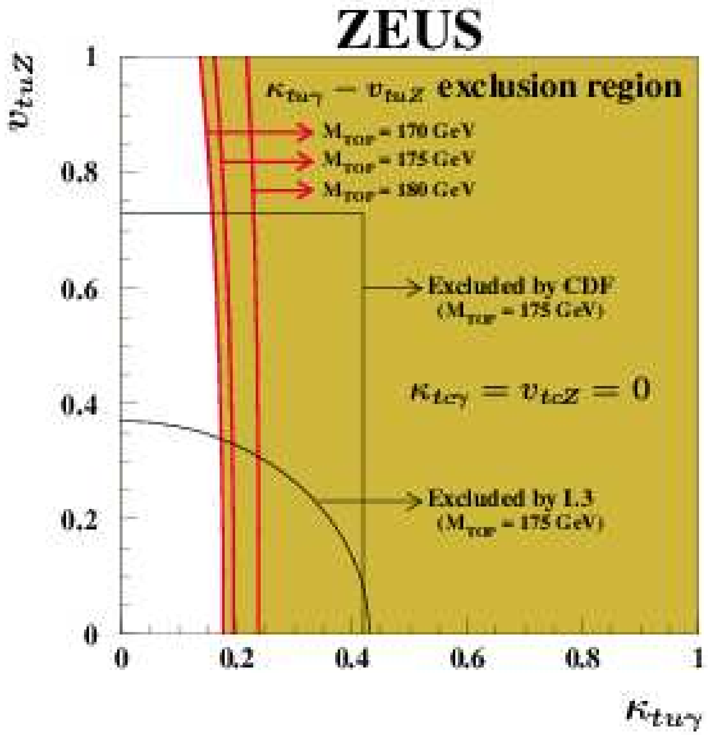
Single top production

Anomalous W production with a high-p_T jet can be due to top decay $t \to Wb$

SM top production $eb \to \nu t$ negligible

Single top from anomalous FCNC coupling $k_{tu\gamma}$?





Limit on $k_{tu\gamma}$
from HERA-I

HERA-I results from ZEUS

- W production ... (PL B 471 (2000) 411),
  '94-'97 data (47.7 pb^{-1} e^+p $\sqrt{s} =$ 300GeV)
  consistent with SM, no e, μ event with $P_T^X >$ 25GeV seen (1.4 expected.)

- Search for single top production (PL B 559 (2003) 153),
  full HERA-I sample (130.1 pb^{-1})
  Analysis optimized for single-top search, no excess over SM seen,
  for $P_T^X >$ 25GeV 7 events (e, μ) observed, 5.6 expected,

- Search for isolated τ (PL B 583 (2004) 41)
  full HERA-I sample (130.1 pb^{-1})
  for $P_T^X >$ 25GeV 2 events observed, 0.2 expected,

- Preliminary results on search for $W \to jj$ (shown at EPS03),
  no excess over SM

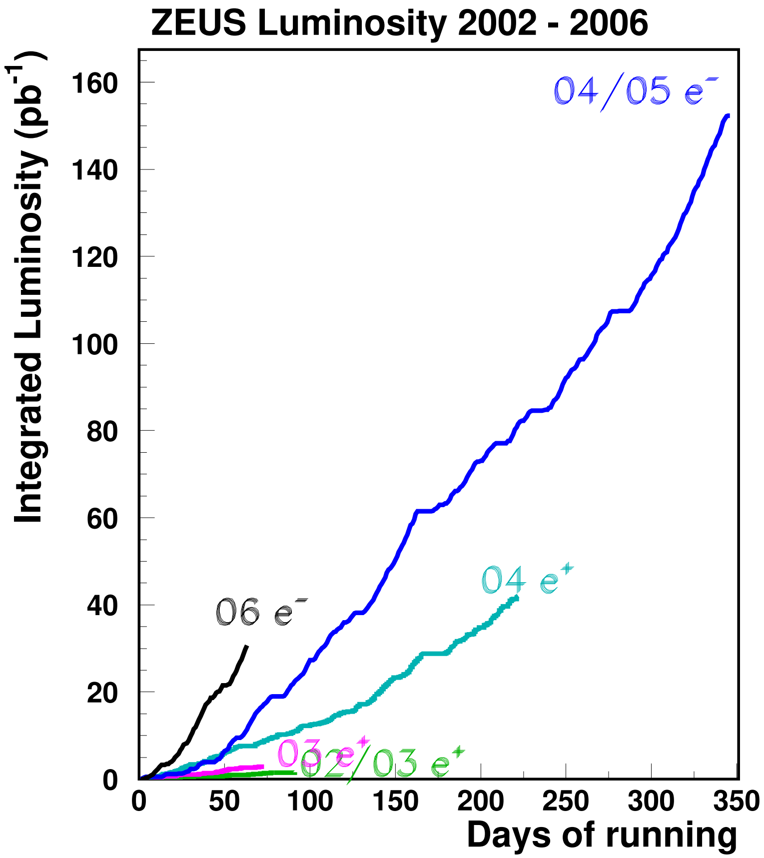
New analysis of HERA-I+HERA-II

Analysis of HERA-I + HERA-II data, selection closer to H1

e channel analysed up to now:

- e^+p prel., presented last summer:
  99-00 (66 pb^{-1}) + 03-04 (40 pb^{-1})

- e^-p prel., new:
  98-99 (17 pb^{-1}) + 04-05 (126 pb^{-1})
  Net 04-05 e^- polarisation $\mathcal{P} = -0.06$



SM prediction

Backgrounds:

- Neutral Current DIS (true e, fake P_T^{miss})
  MC: DjangoH+ Ariadne or MEPS

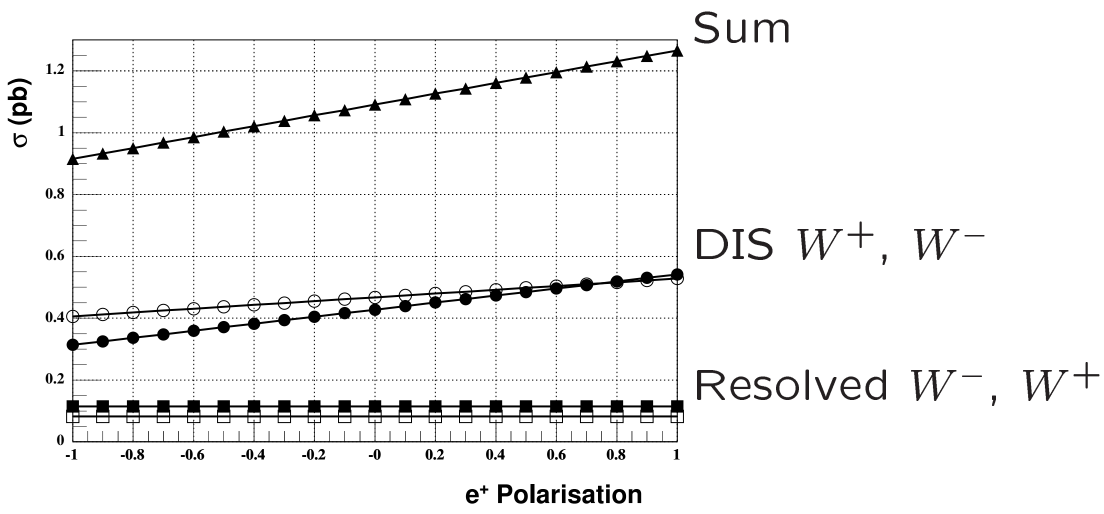
- Charged Current DIS (true P_T^{miss}, fake lepton)
  MC: DJangoH + Ariadne or MEPS

- Dileptons (true l, fake P_T^{miss})
  MC: Grape Dilepton

Signal:

- $ep \to W^{\pm}X$
  MC: EPVEC
  $\mathcal{P}$ effect negligible: $\Rightarrow$

$\sigma(e^+p \to W^+X)$ vs $\mathcal{P}$

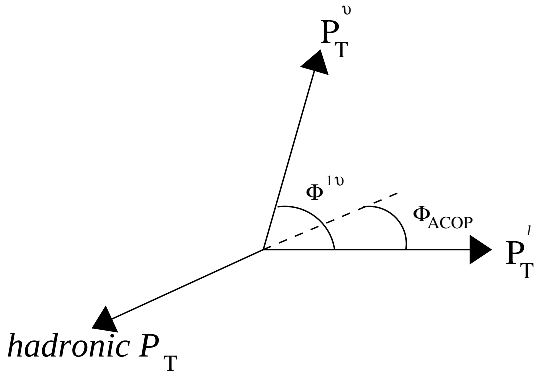


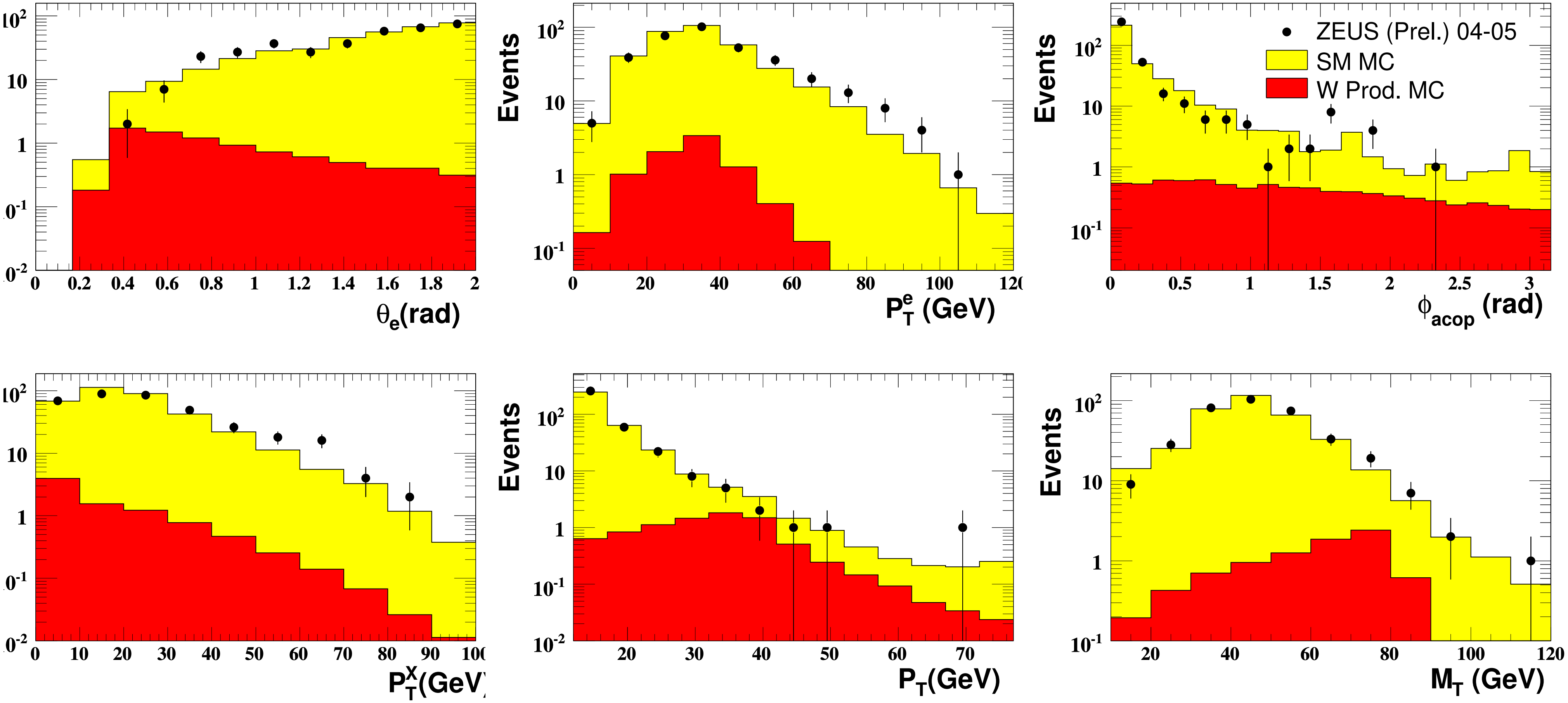
Preselection: electron + $P_T^{\rm miss}$

- $P_T^{\rm miss} > 12$ GeV, $P_T^{\rm miss}$(-1st CAL ring)> 9 GeV
- Electron (track + CAL):
  - $E^e > 8$ GeV, $p_T^e > 5$ GeV
  - $\theta_e < 2$ rad
  - CAL isolation ($E < 4$ GeV in a cone $D_{CAL} = 0.8$)
  - track isolation (no other track for $D_{trk} > 0.5$)

Main background at this stage: NC DIS with misrmeasured $P_T^{\rm miss}$

04-05 e^-, preselection





Final selection

- $p_T^e > 10$ GeV
- $\theta_e < 1.5$ rad
- $\Phi_{\rm acop} > 0.3$ rad
- $Q_e^2 > 5000$ GeV^2 (or $P_T^{\rm miss} > 25$ GeV)
- $E - P_z < 50$ GeV

Efficiency for $W \to e\nu \sim 42\%$

Results

Data set	$12 < P_T^X < 25$ GeV N_{obs} / N_{SM} (W)	$P_T^X > 25$ GeV N_{obs} / N_{SM} (W)
ZEUS (prel.)		
98-99 e^-p (17 pb^{-1})	$1/0.23 \pm 0.06(67\%)$	$0/0.32 \pm 0.09(65\%)$
04-05 e^-p (126 pb^{-1})	$3/1.75 \pm 0.36(57\%)$	$3/2.54 \pm 0.46(51\%)$
99-00 e^+p (66 pb^{-1})	$1/1.04 \pm 0.11(57\%)$	$1/0.92 \pm 0.09(79\%)$
03-04 e^+p (40 pb^{-1})	$0/0.46 \pm 0.10(64\%)$	$0/0.58^{+0.08}_{-0.09}(76\%)$
98-05 e^-p (143 pb^{-1})	$4/1.98 \pm 0.36(58\%)$	$3/2.86 \pm 0.46(53\%)$
99-04 e^+p (106 pb^{-1})	$1/1.50 \pm 0.15(59\%)$	$1/1.50^{+0.12}_{-0.13}(78\%)$
98-05 $e^{\pm}p$ (249 pb^{-1})	$5/3.5 \pm 0.4(58\%)$	$4/4.4 \pm 0.5(61\%)$
H1 (prel.)		
94-05 $e^{\pm}p$ (279 pb^{-1})	-	$11/4.7 \pm 0.9(69\%)$

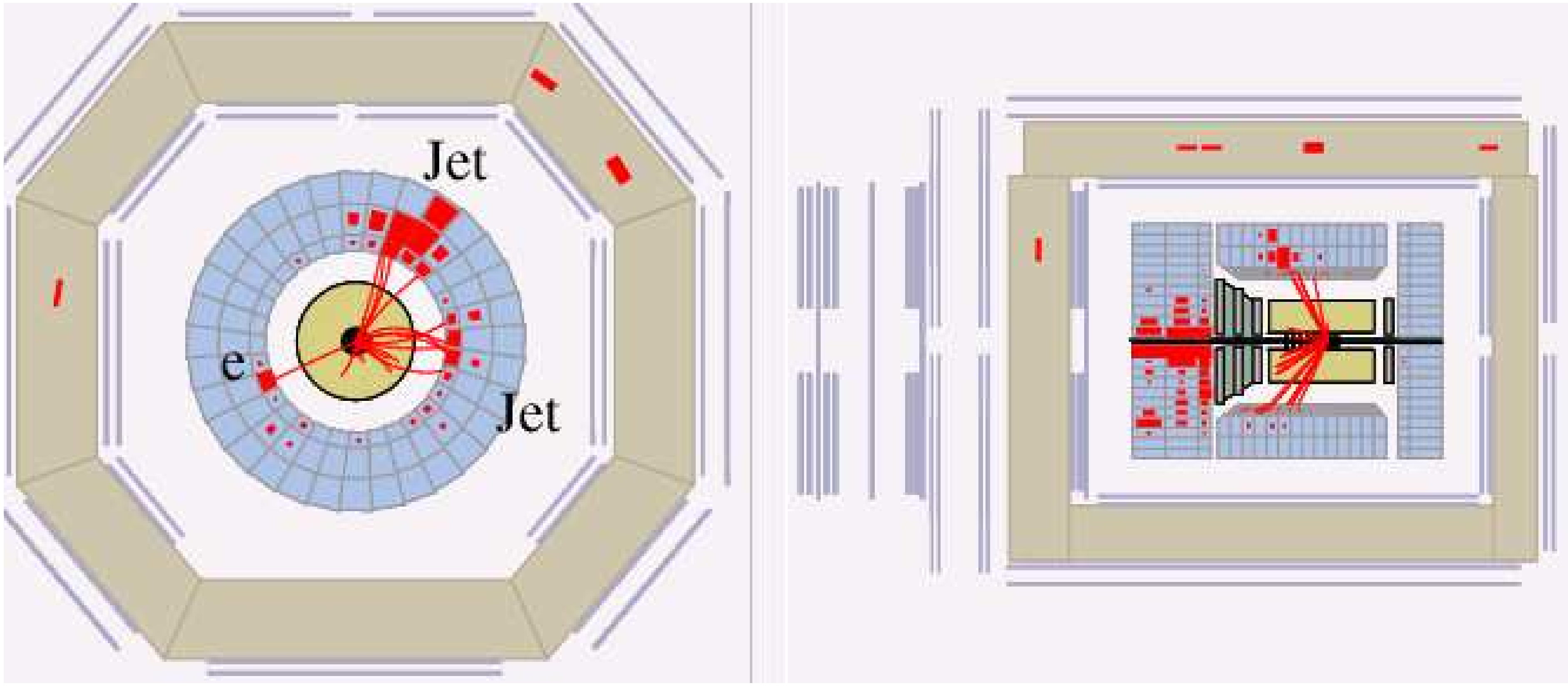
Uncertainty on SM from systematics (Ariadne/MEPS, E scale, $\mathcal{L}$, Pol.)
SM cross sections from MC (no NLO, no theor. uncertainty)

Larger backgrgound with e^- because of larger CC cross section

Agreement with SM in e^-p and e^+p collisions

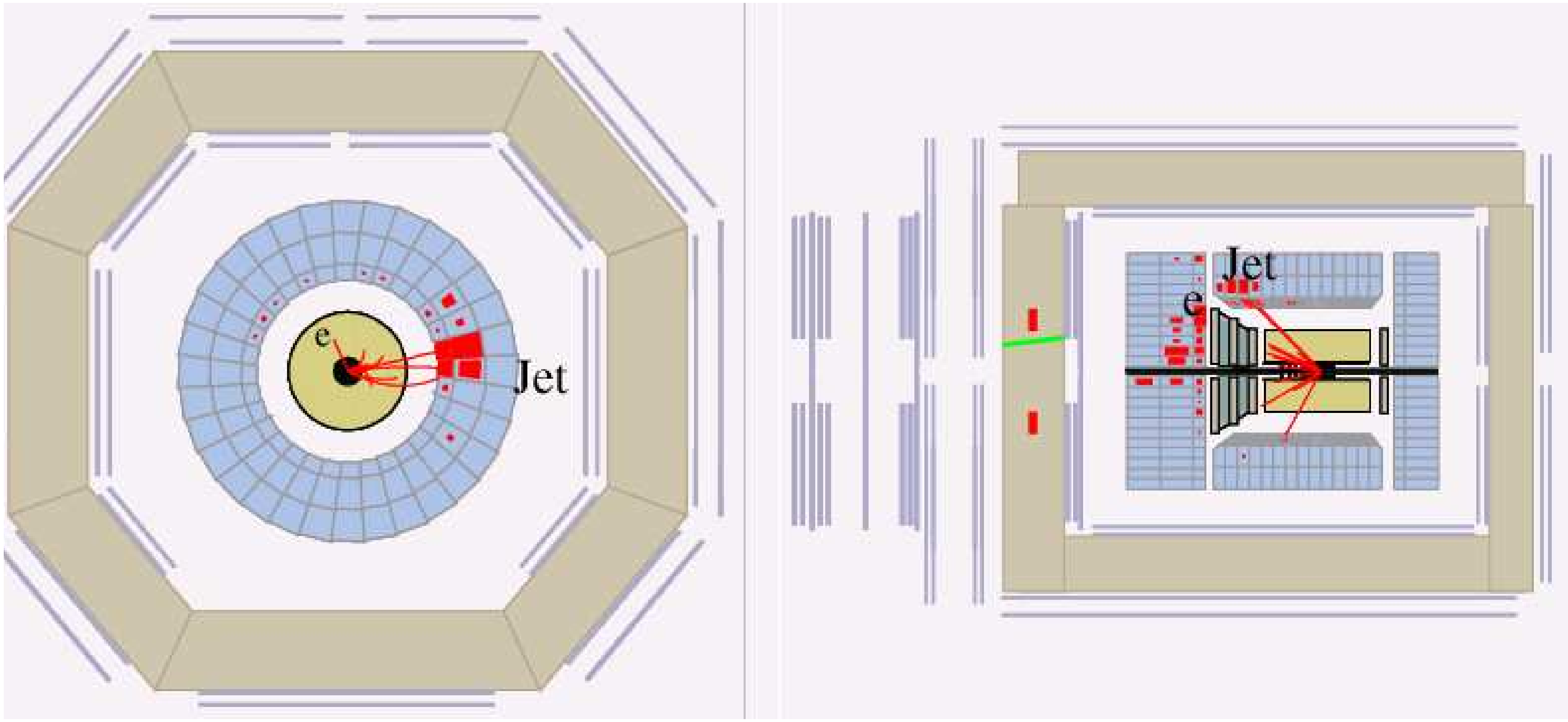
New candidate I

$p_T^e = 41.6\text{GeV}$ $P_T^X = 27.8\text{GeV}$ $P_T^{\text{miss}} = 18.1\text{GeV}$ $\theta^e = 0.84$ $\Phi_{acop} = 0.344$



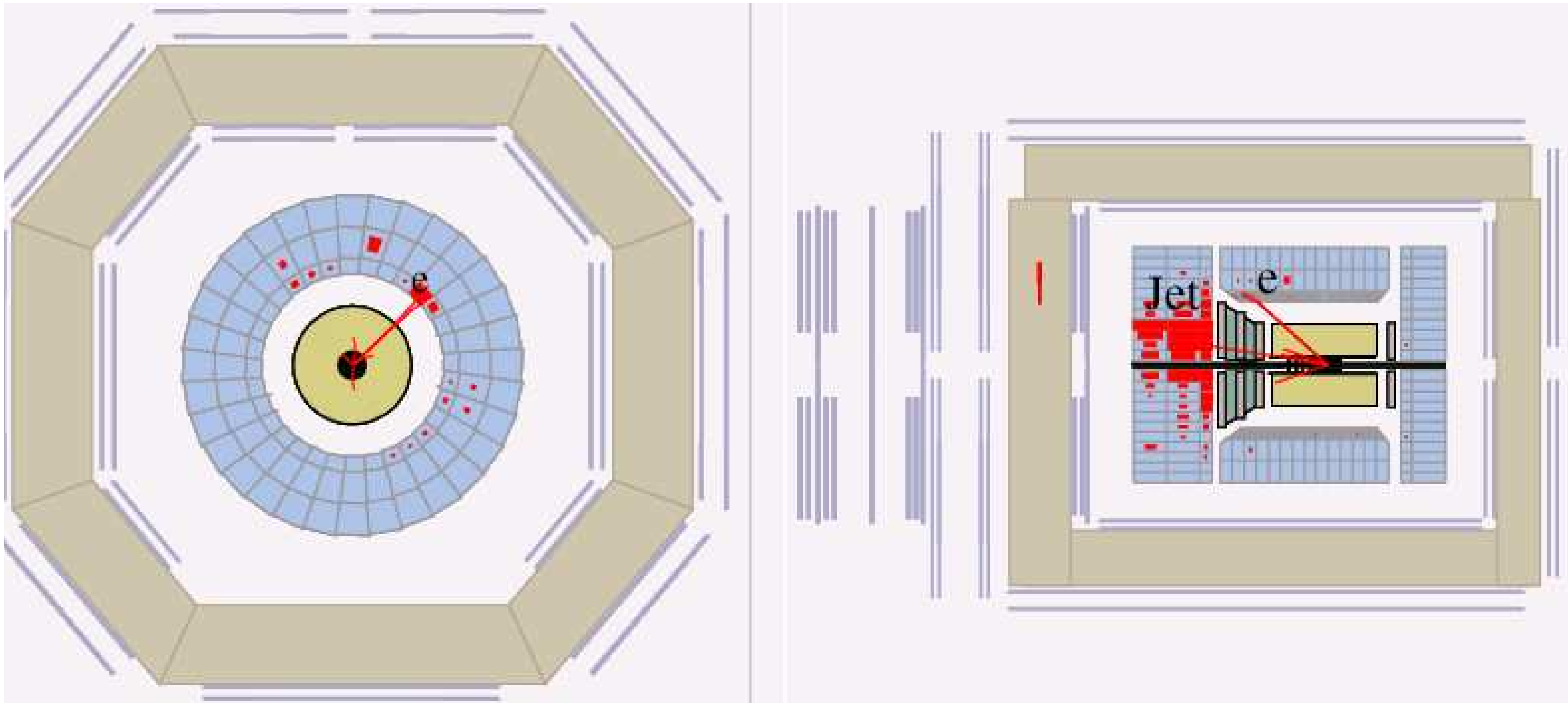
New candidate II

$p_T^e = 16.5\text{GeV}\ P_T^X = 32.4\text{GeV}\ P_T^{\text{miss}} = 33.5\text{GeV}\ \theta^e = 0.46\ \Phi_{acop} = 1.38$



New candidate III

$p_T^e = 16.5\text{GeV}$ $P_T^X = 61.7\text{GeV}$ $P_T^{\text{miss}} = 68.3\text{GeV}$ $\theta^e = 0.72$ $\Phi_{acop} = 1.86$



Summary and Outlook

- Analisys of HERA-I and HERA-II data with cuts similar to H1

- Consistent with SM

- To be extended to muon (and tau !) channels,

- to 96-97 $\sqrt{s} = 300$ GeV data,

- and to 2006 data !