

# Searches for New Physics by the H1 Experiment at HERA



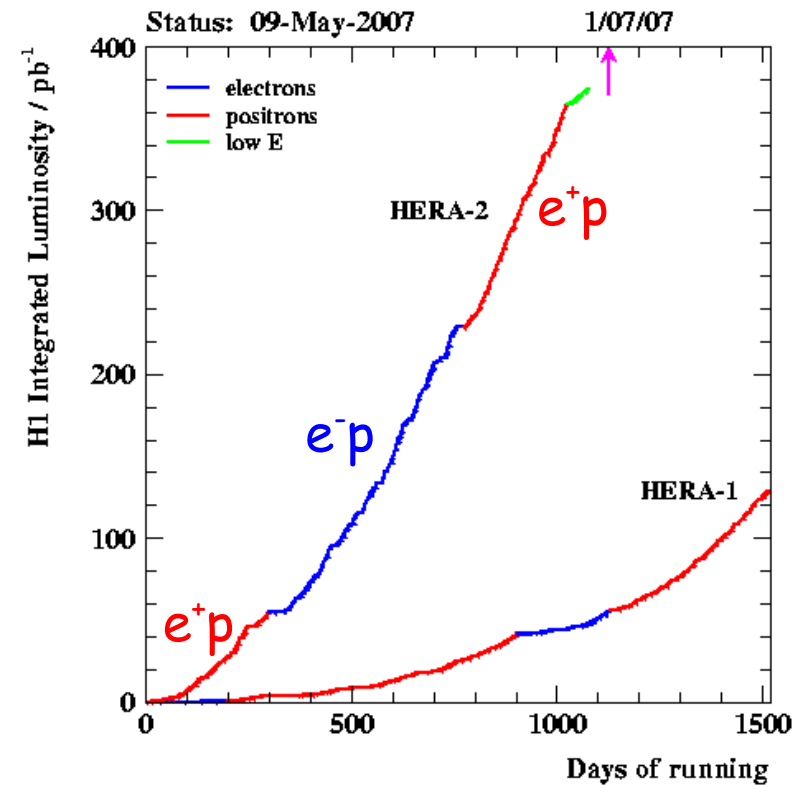
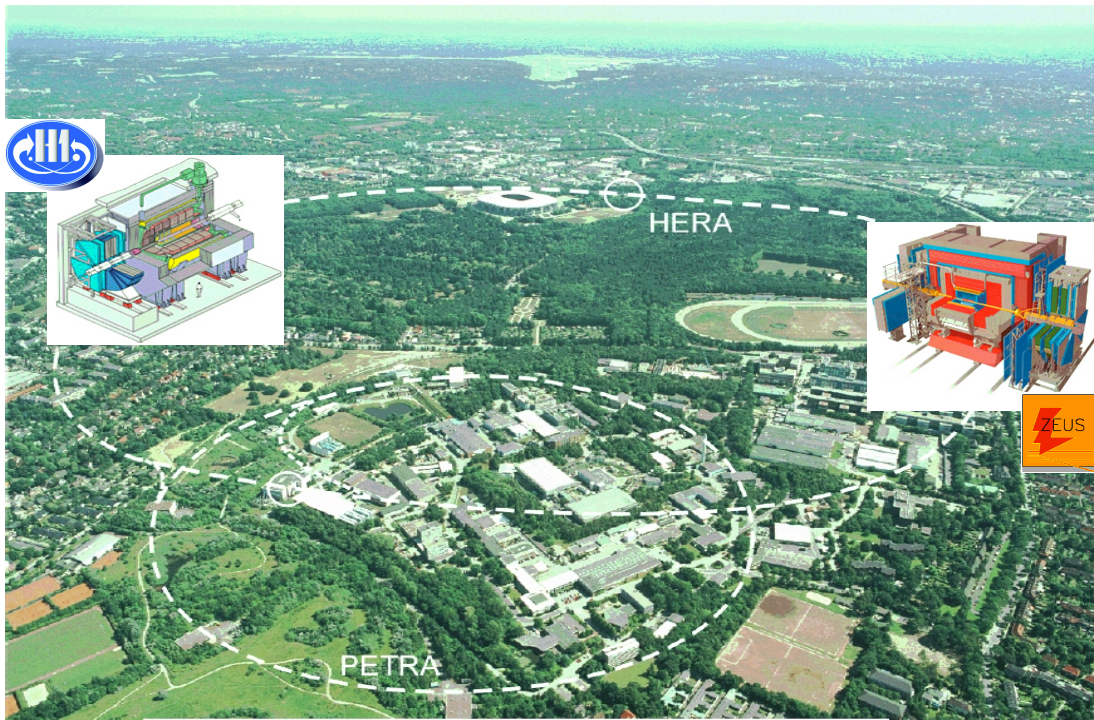
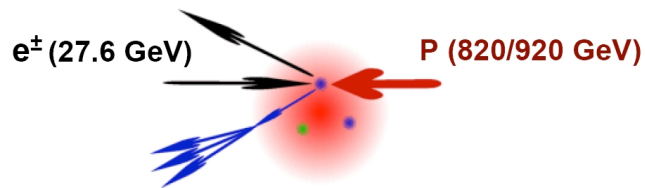
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On behalf of the H1 Collaboration



# The HERA collider



→ HERA I: 1992-2000,  $\sim 120 \text{ pb}^{-1}$

→ HERA II: luminosity upgrade and polarised lepton beams

↘ High energy run ended on March 2007

☞ H1 at HERA I+II:  $\sim 0.5 \text{ fb}^{-1}$

# Hints for New Physics at HERA

↘ Will show the most recent results of searches for new physics from H1:

① Model dependent searches for new particles

◆ Excited Leptons

② Model independent searches for new physics

◆ Isolated Lepton Events with missing  $P_T$

◆ Multi-Lepton Final States

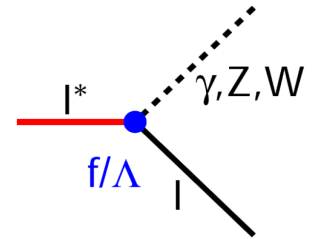
◆ A General Search

# Compositeness: Excited Leptons

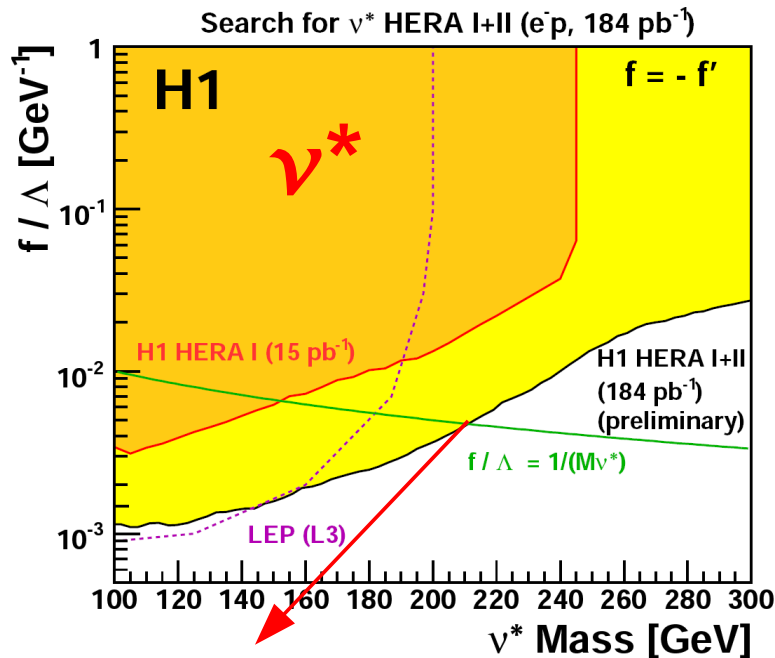
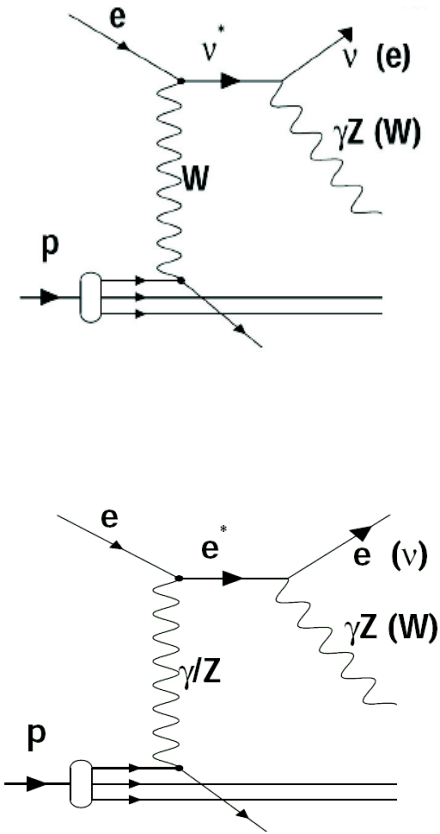
- Excited fermions: direct signature of a new scale of matter
- (De-)excitation described by the effective Lagrangian:

$$\mathcal{L}_{\ell\ell^*V} = \frac{1}{2\Lambda} \bar{\ell}^* \sigma^{\mu\nu} \left[ gf \frac{\tau}{2} \mathbf{W}_{\mu\nu} + g' f' \frac{Y}{2} B_{\mu\nu} \right] \ell_L$$

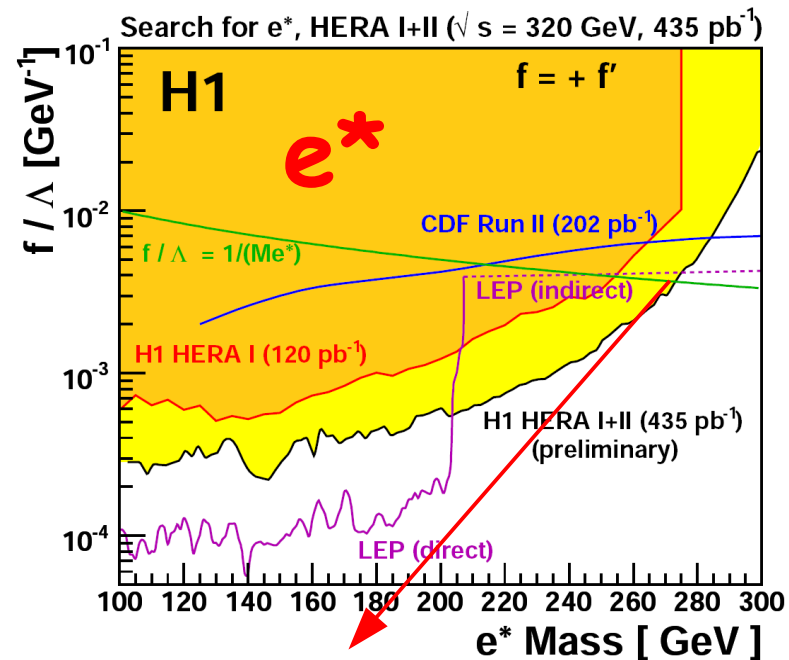
compositeness scale
weight factors



- Analysis of all HERA I+II data at  $\sqrt{s} = 320 \text{ GeV}$  (**435 pb<sup>-1</sup>**)



If  $f = -f'$  and  $f/\Lambda = 1/M_{\nu^*}$  :  
 $M_{\nu^*} < 211 \text{ GeV}$  are excluded

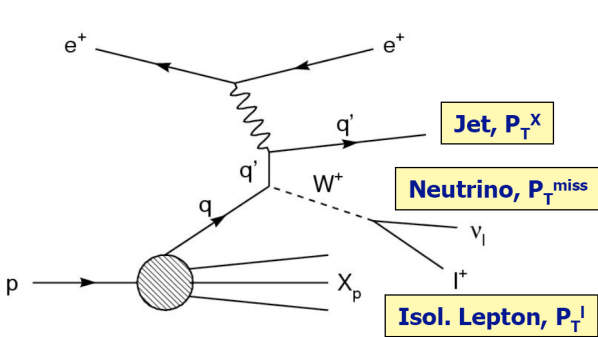


If  $f=+f'$  and  $f/\Lambda = 1/M_{e^*}$  :  
 $M_{e^*} < 273 \text{ GeV}$  are excluded

↘ Large new parameter space explored at high mass

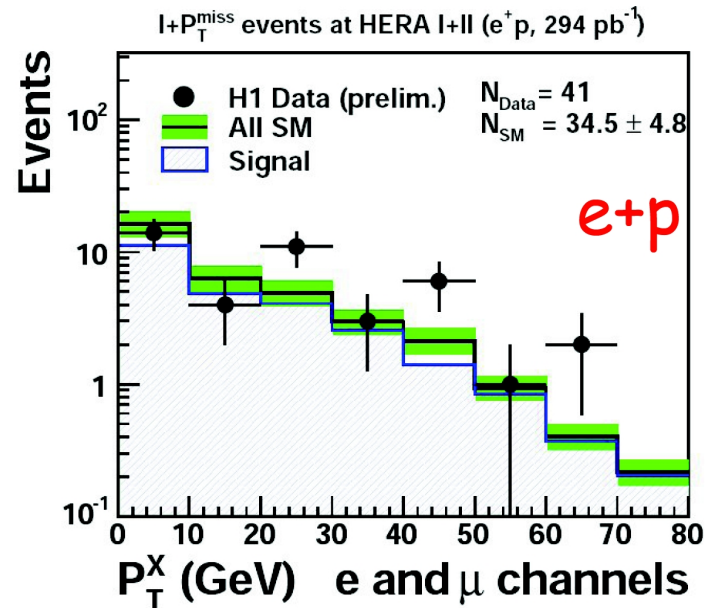
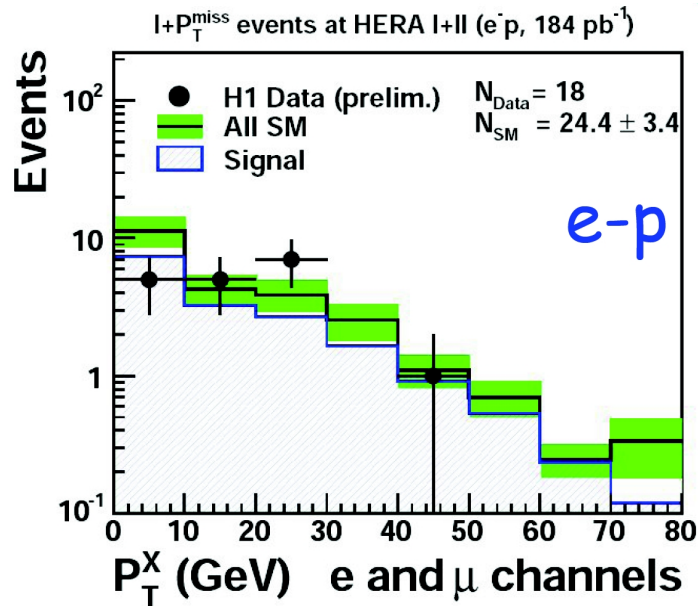
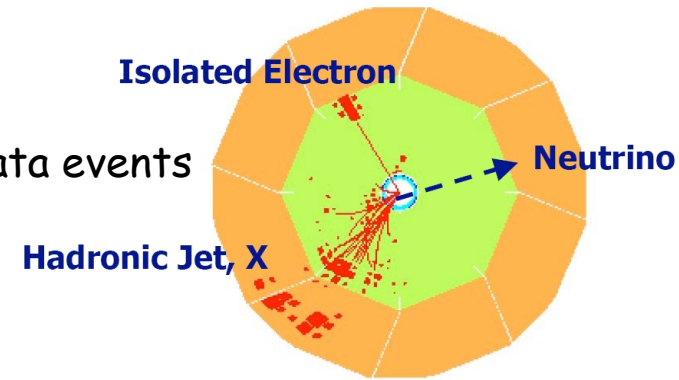
# Isolated Leptons Events

Look for events "signals": which contain an high- $P_T$   $e$  or  $\mu$ , missing  $P_T$  and hadronic system  $X$  ( $P_T^X$ )



$\sigma \sim 1.3 \text{ pb}$

- Full HERA I+II data ( $478 \text{ pb}^{-1}$ )
- HERA I,  $P_T^X > 25 \text{ GeV}$ : an excess of data events
- SM signal: real  $W$  production



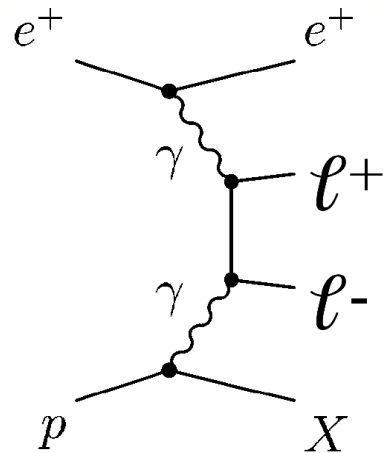
Different observation in  $e+p$  and  $e-p$  data

Excess not clarified with HERA II data:  $3\sigma$  in  $e+p$



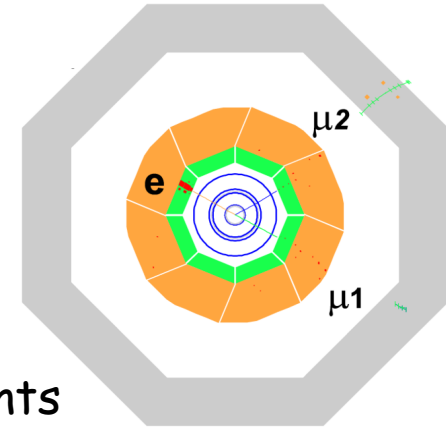
# Multi-Leptons Events

↘ Motivation: if anomalous  $l-\nu$  production, what's about  $l-l$  final states?



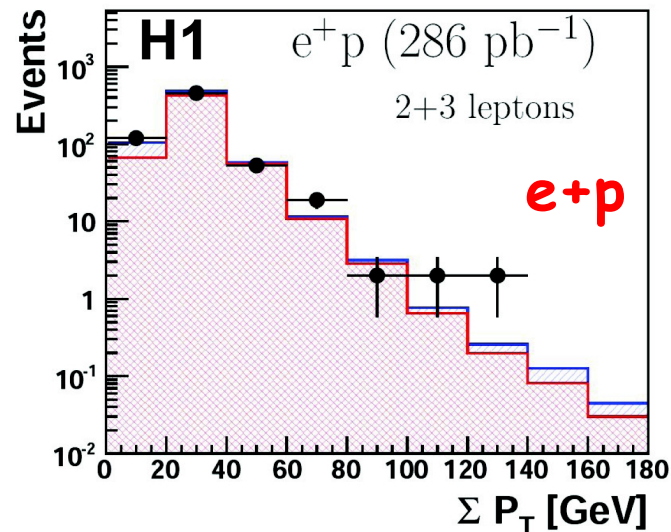
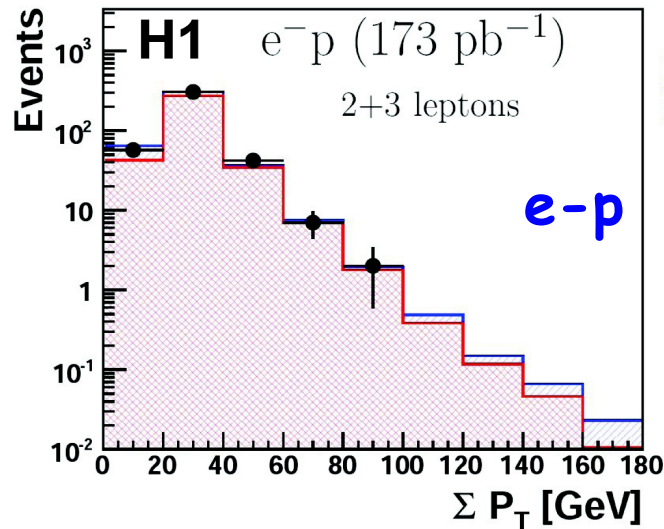
↘ Multi-lepton ( $e$  or  $\mu$ ) production is studied at high- $P_T$

- Covered topologies:  $ee, eee, e\mu, \mu\mu, e\mu\mu$
- SM signal: dominated by  $\gamma-\gamma$  processes
- Full HERA I+II data ( $459 \text{ pb}^{-1}$ )



$\sigma \sim 1 \text{ pb}$

→ Look at  $\Sigma P_T$  distribution: "hardness scale" of the events



● H1 Data (prelim.)  
▨ DIS+Compton  
▨ Pair Production

↘ Good agreement with SM

↘ All 4 / 1.2 events at  $\Sigma P_T > 100 \text{ GeV}$  in  $e^+p$  data

# A General Search

Model independent search for deviation from SM examines all possible different high transverse momentum final states

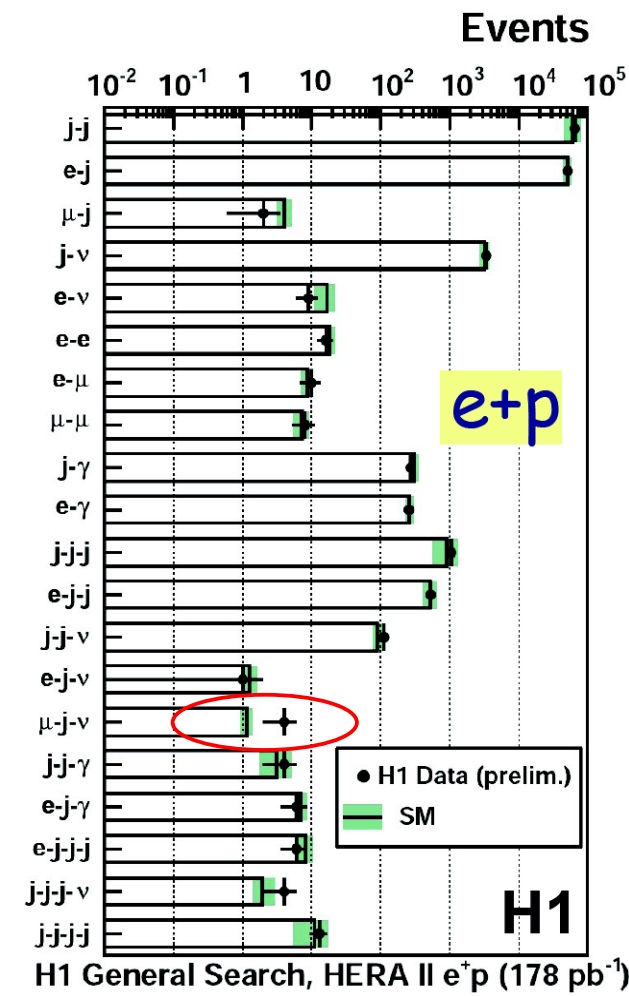
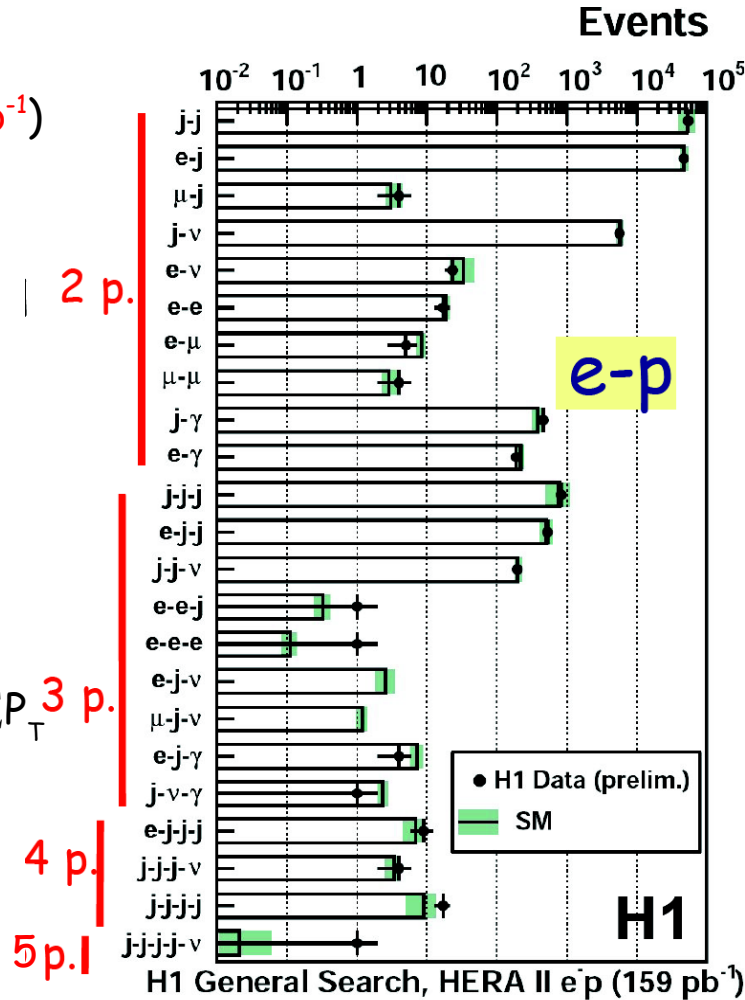
- H1: full HERA II data (337 pb<sup>-1</sup>)

- Signature: isolated particles at high P<sub>T</sub>  
(e, γ, μ, jet, ν)

- Unique phase space: P<sub>T</sub> > 20 GeV & 10° < θ < 140°

Look for possible deviation in ΣP<sub>T</sub> and M<sub>all</sub> distributions

- Statistical analysis to quantify the significance of deviation



in general: good agreement with SM

→ Most significant deviation: μ-j-ν in e<sup>+</sup>p

correspond to the topology of isolated lepton events + P<sub>T</sub><sup>miss</sup>

# Summary

- High energy running of HERA ended on March 2007
  - ↳  $\sim 0.5 \text{ fb}^{-1}$  collected by H1
- Most recent results from H1 about searches for new physics have been presented
  - A general search: good understanding of the detector and of SM processes
  - No evidence for new physics is found
  - Excited leptons: the limits derived are presently the most stringent for high mass  $e^*$ ,  $\nu^*$  and complementary to LEP & Tevatron
  - A  $3\sigma$  excess remains in H1  $e+p$  isolated lepton events