

Recent HERA Results on Leptoquarks and other SUSY related Signatures

Stefan Schmitt (DESY) on behalf of the H1 and ZEUS collaborations

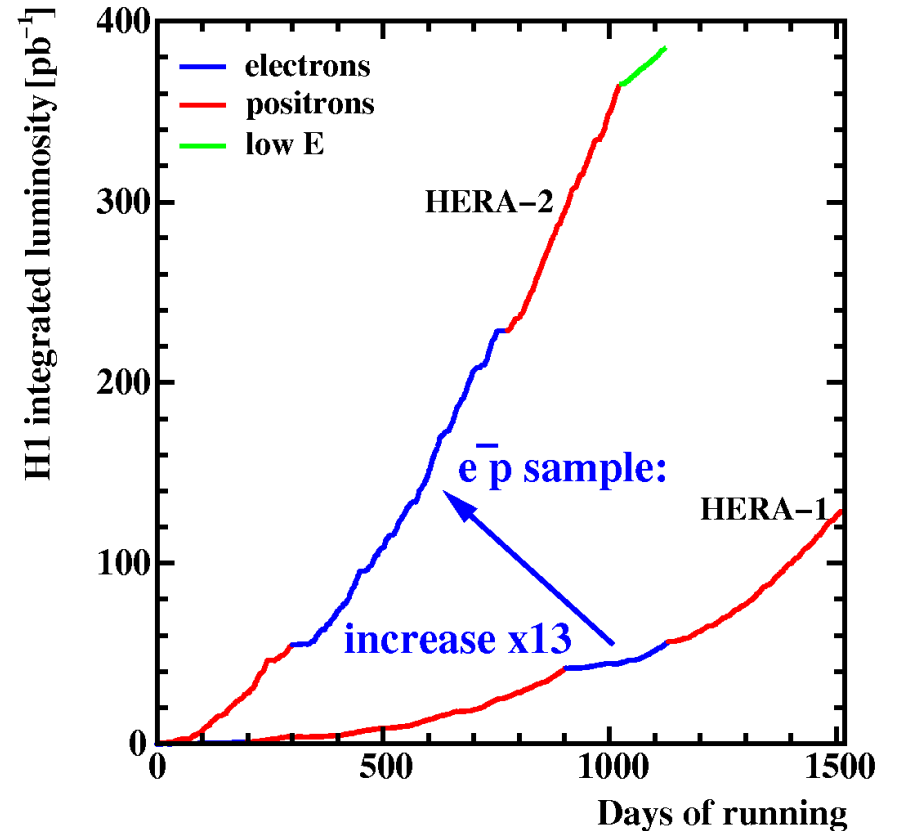
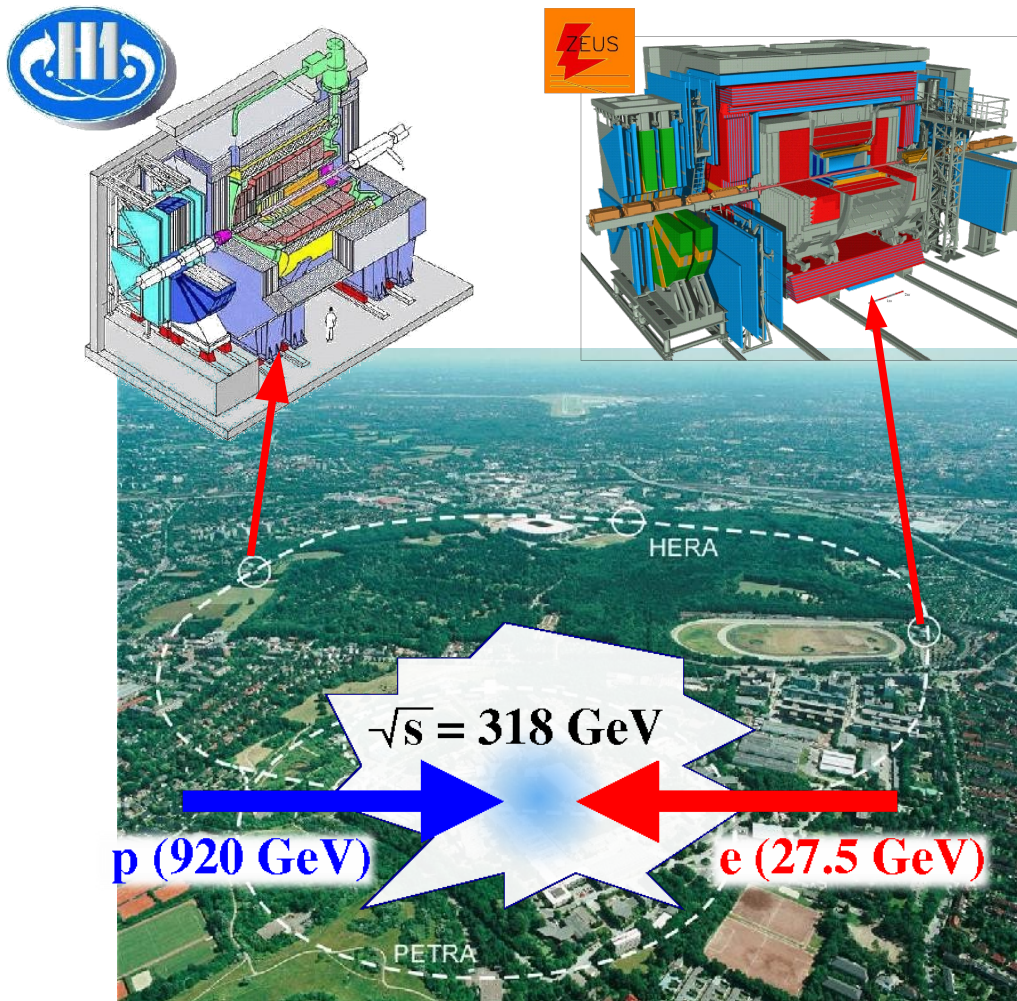
SUSY08 conference, Seoul



- Leptoquarks
- Isolated Lepton and Multilepton Signatures
- General Search

The HERA ep Collider at DESY

4 π coverage, excellent lepton ID+calorimeters

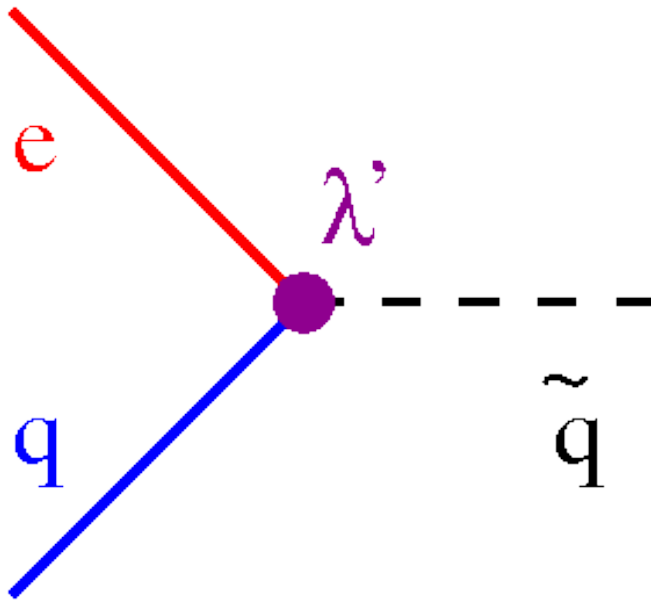


Two experiments H1, ZEUS

HERA-1: 1994-2000: 2x120 inv.pb
 HERA-2: 2003-2007: 2x350 inv.pb
 + longitudinally polarized e-beam

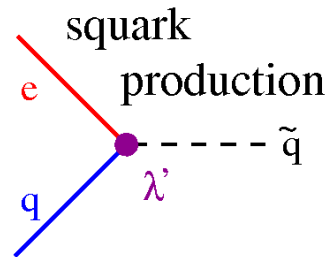
Squark Production at HERA

- ep initial state -> pair-production searches disfavoured
- HERA analyses focussed on R-parity violating models

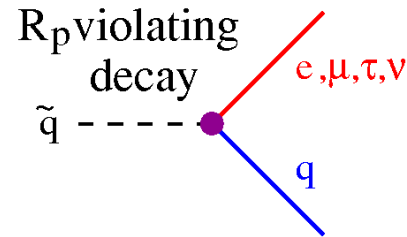


- Resonant production of Squarks with R-parity violating coupling λ'
- Search strategy depends on the decay modes allowed for a specific SUSY model

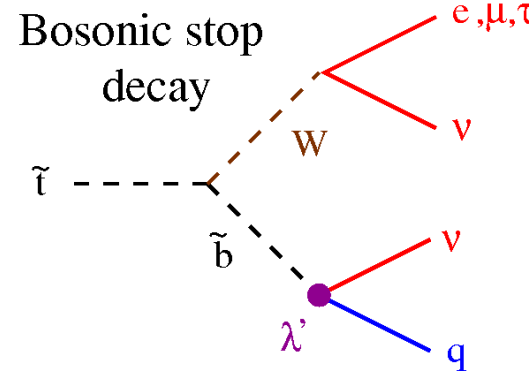
Squark Searches at HERA



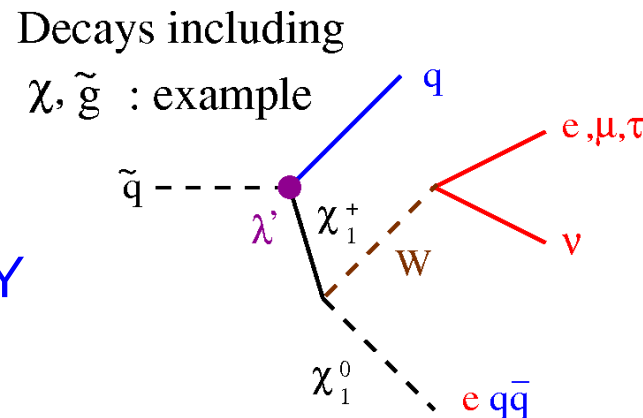
- HERA-1 data: dedicated scan of SUSY parameter space
- This conference: new results on Leptoquark searches and final states with isolated leptons
- No new results from SUSY model parameter scans



Lepton+jet:
Leptoquark searches



Lepton+missing
transverse momentum

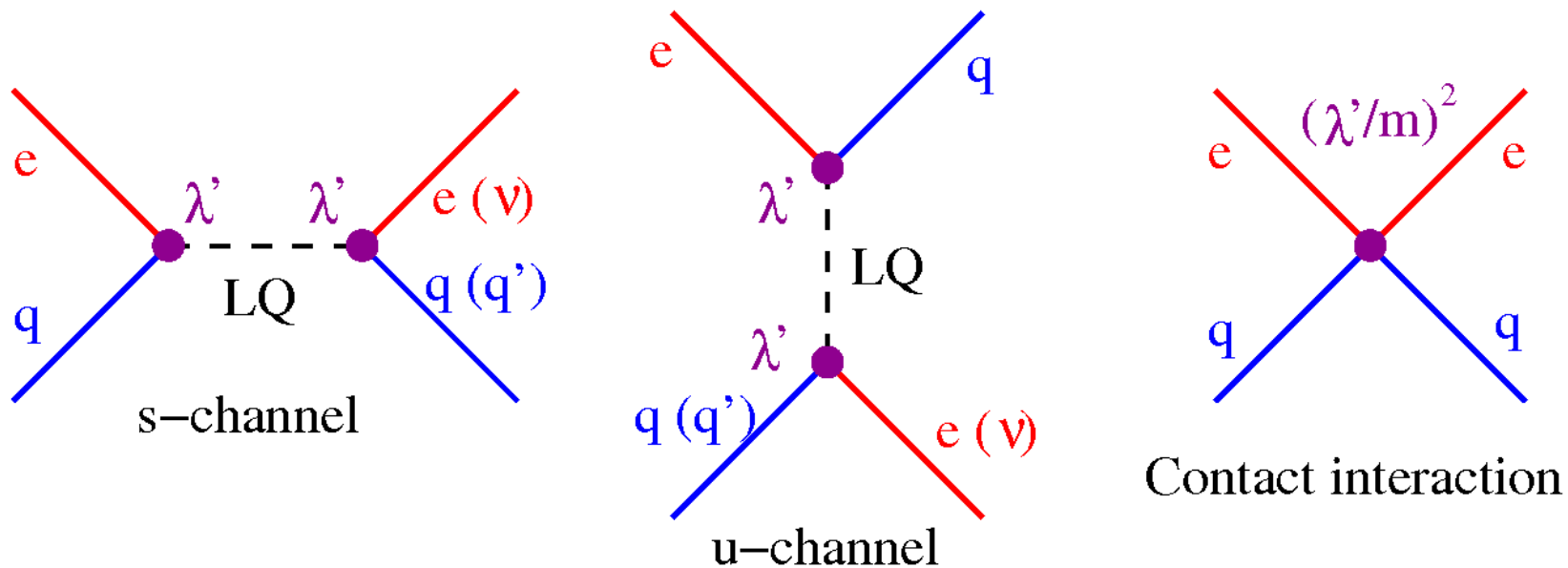


Final states with
leptons and jets

HERA Leptoquark Searches

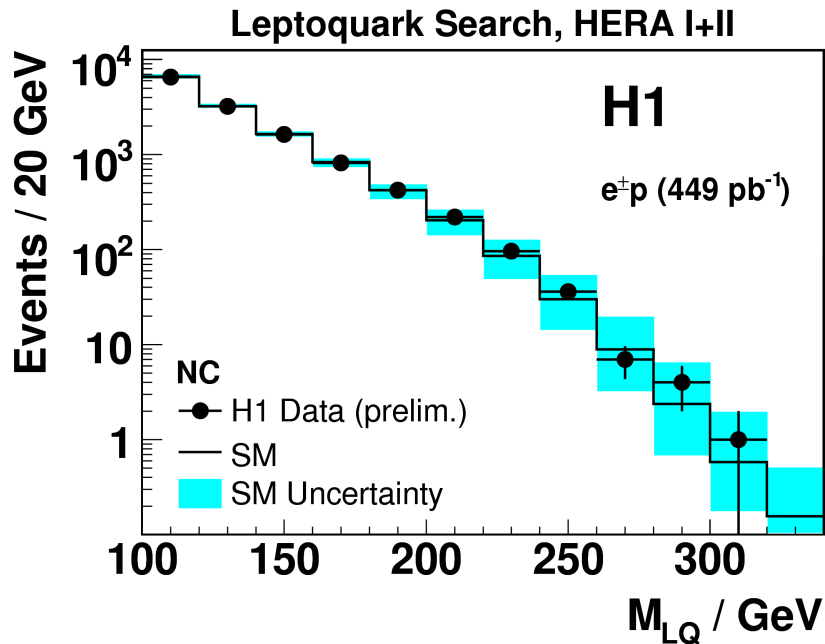
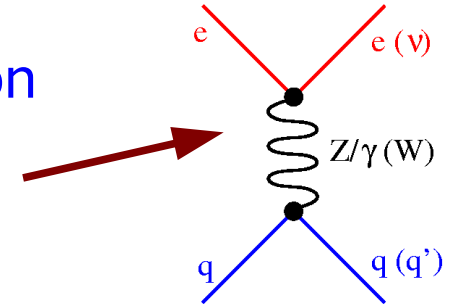
- Leptoquarks at HERA: **s-channel resonant production** possible
- At high masses: **contact-interaction**, independent of branching ratio
- Interference term with γ/Z exchange included in analysis
- **SUSY application: Rp-violating Squarks**

LQ Limits are valid for Squarks if the Rp-violating decay dominates or in case of Contact interactions ($m > \sqrt{s}$)

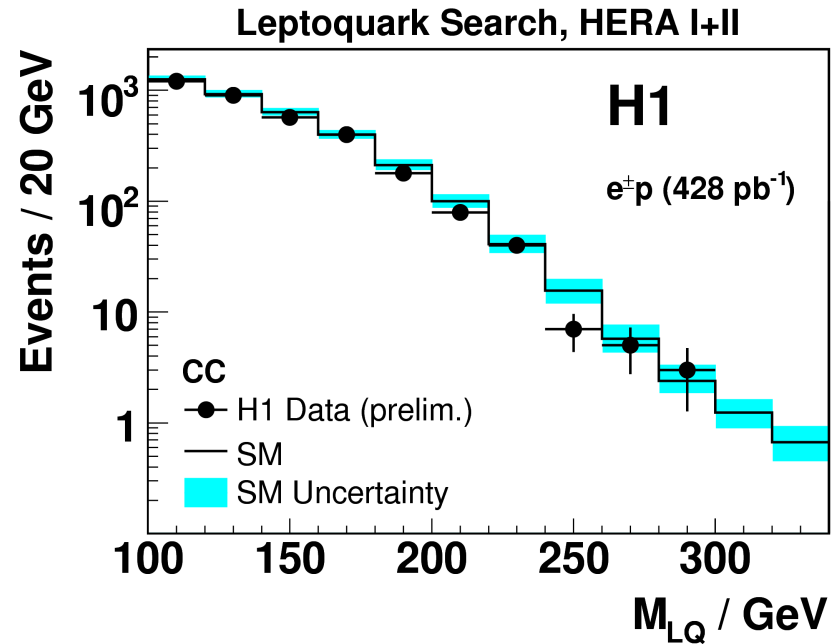


H1 leptoquark search

- Search for resonant structure in LQ mass distribution
- Spectra are dominated by Deep-inelastic scattering
- No leptoquarks observed, set limits



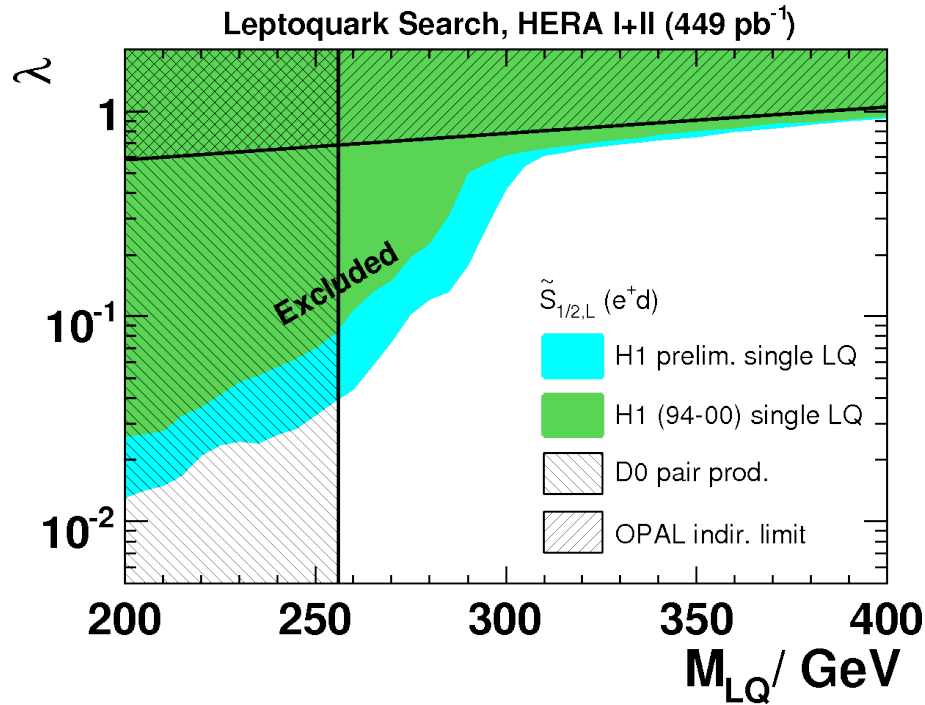
$ep \rightarrow eX$



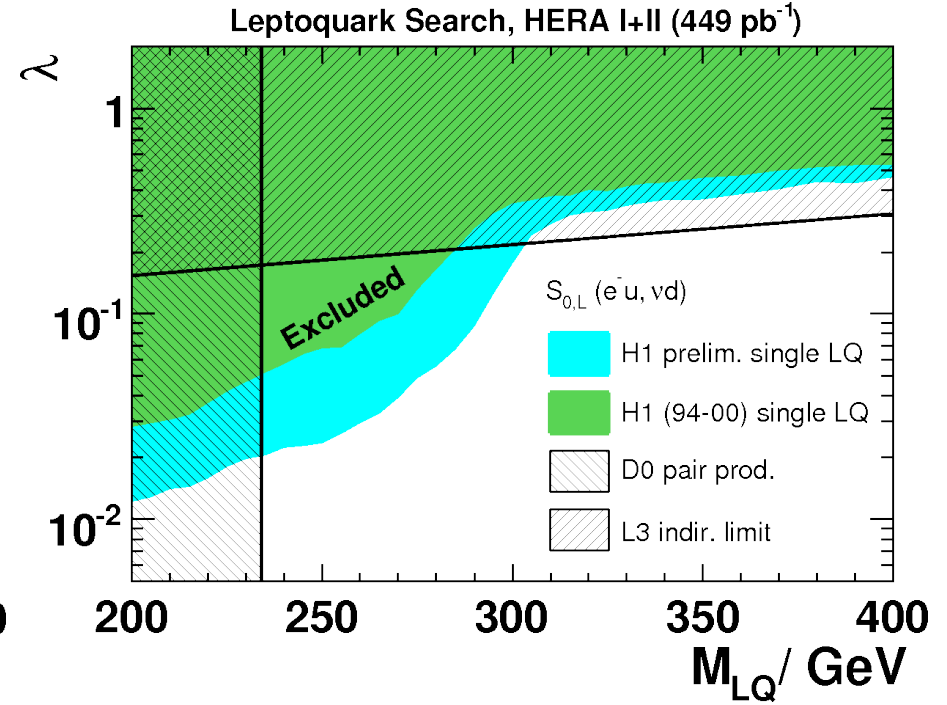
$ep \rightarrow \nu X$

H1 Leptoquark Limits

- 14 types of Leptoquark models investigated
- Shown: the two models which are relevant for Rp violating SUSY



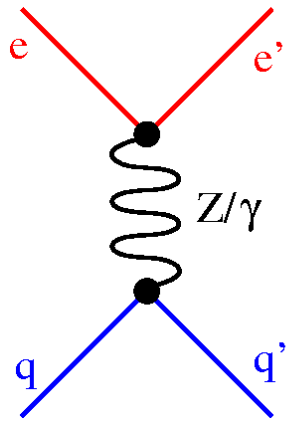
U-type squark, decay to ed
Rp-violating coupling λ'_{1j1}



D-type squark, decay to $eu, \nu d$
Rp-violating coupling λ'_{11k}

LQ limits are valid for squark searches if $\text{Br}(\text{RpV}) \approx 100\%$ or if $M > 300 \text{ GeV}$

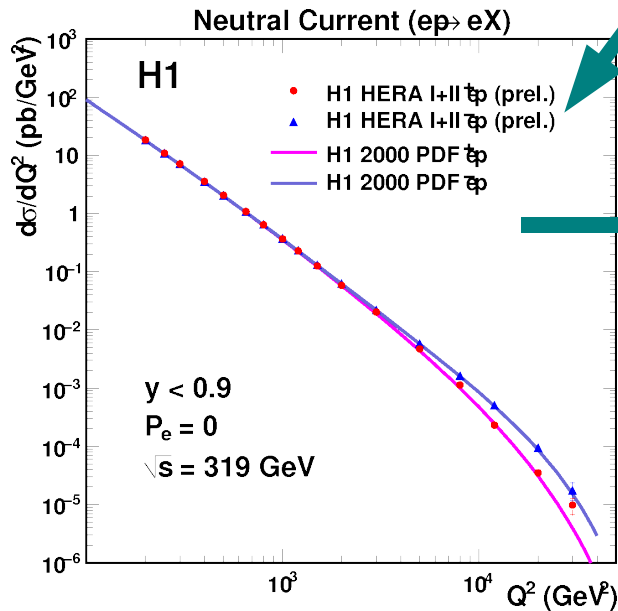
LQ Limits from Contact-Interactions



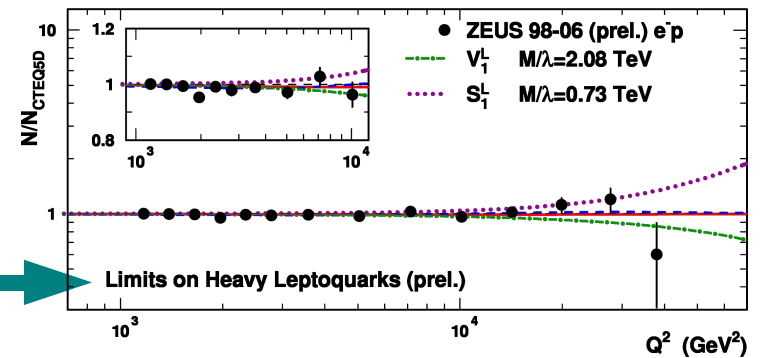
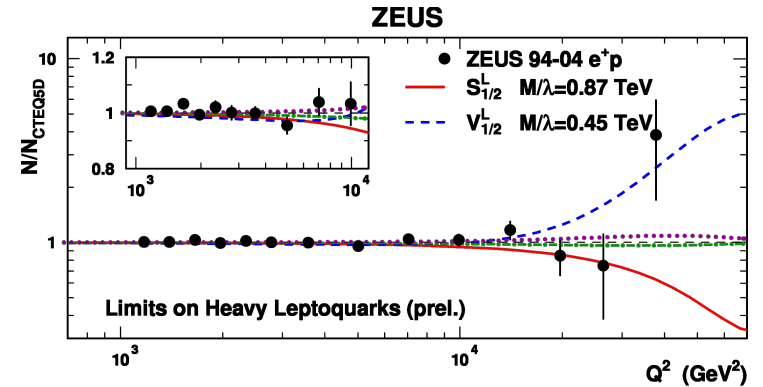
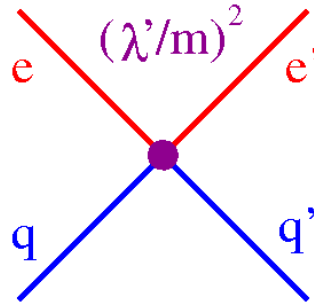
Deep-inelastic scattering
Momentum transfer

$$Q^2 = -(e-e')^2$$

Measure single-differential
cross-section $\frac{d\sigma}{dQ^2}$



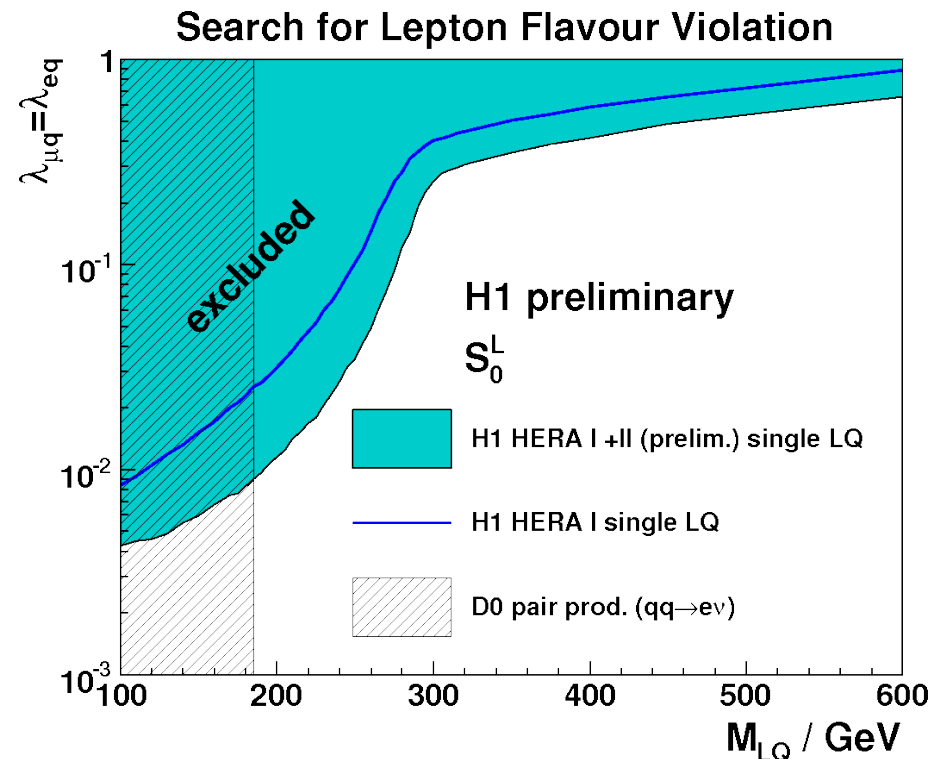
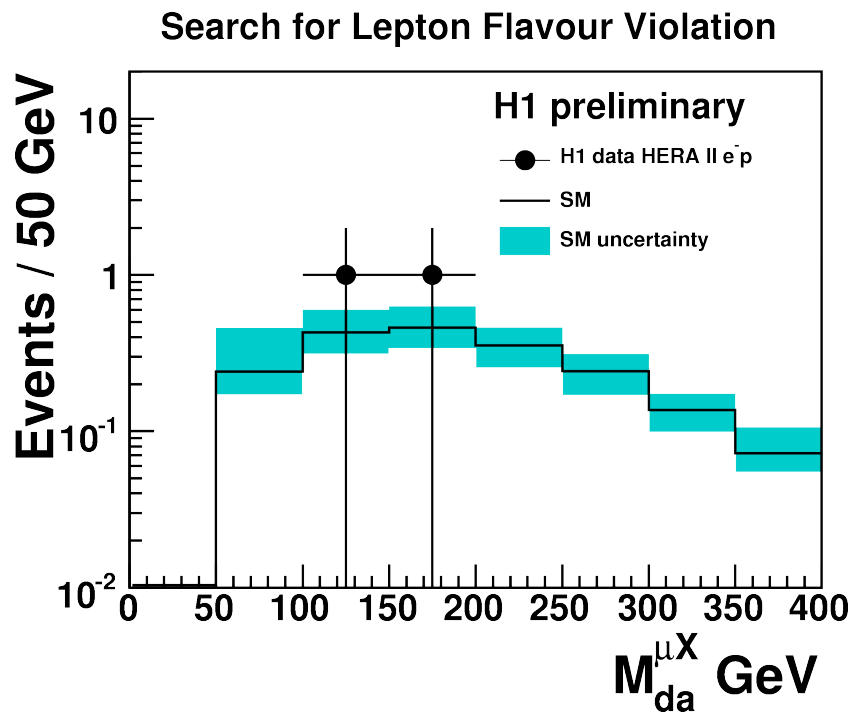
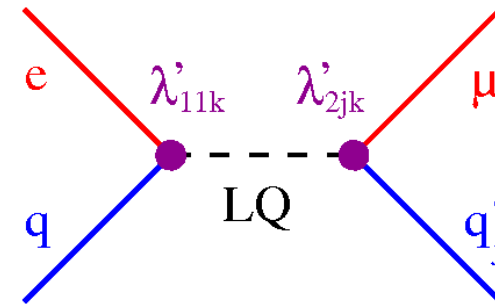
cross-section is altered by contact interactions



- D-type Squark ($\tilde{S}_{1/2}$):
 $M / \lambda'_{11k} > 0.96 \text{ TeV}$
- U-type Squark (S_{0L}):
 $M / \lambda'_{1j1} > 0.44 \text{ TeV}$

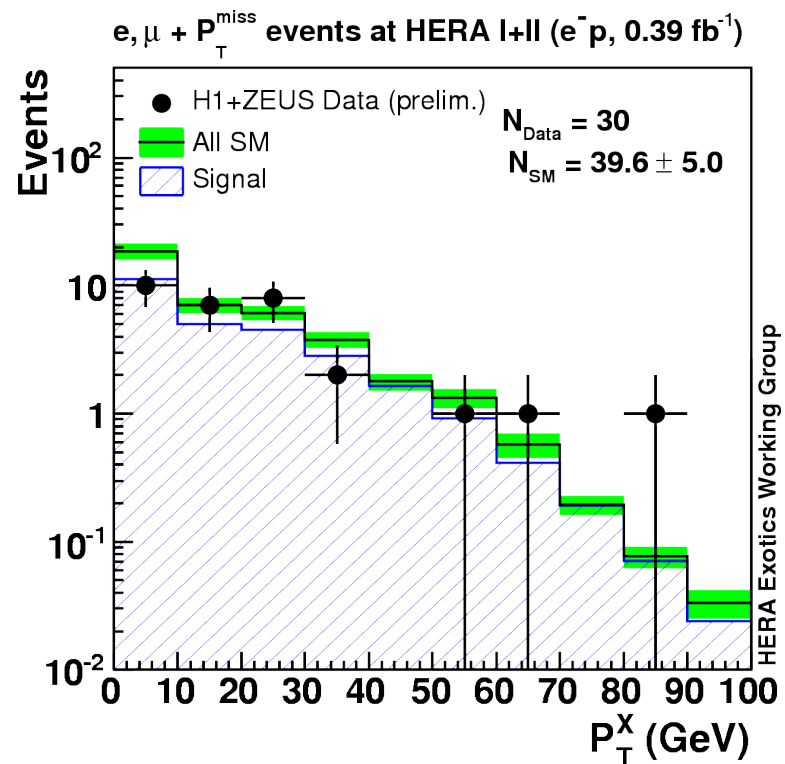
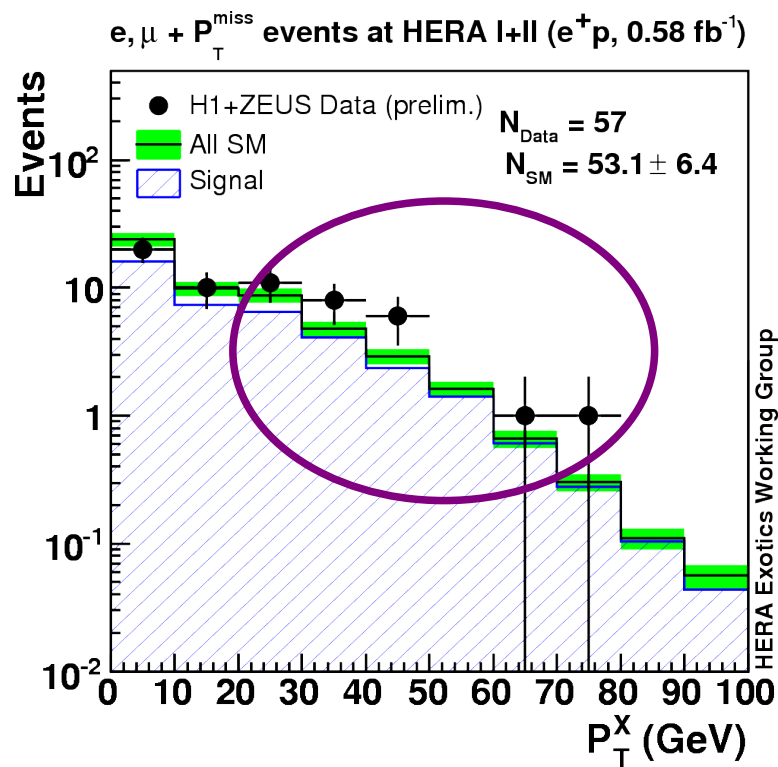
Lepton flavour violating Leptoquarks

- Study LQ decay to μ +jet
- New HERA-2 results
- Limit on $\lambda'_{11k}, \lambda'_{2jk}$
- Rp-violation: probe off-diagonal couplings



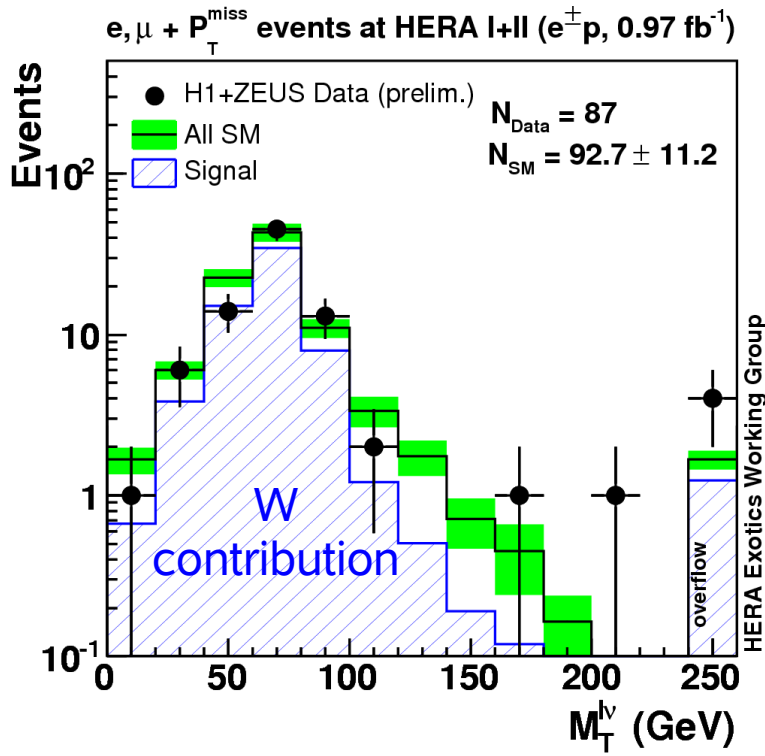
Isolated leptons with missing P_T

- Select events with isolated lepton (e, μ, τ) and missing P_T
- Hadronic activity: X , transverse momentum from hadrons: P_T^X
- New: combined H1/ZEUS results for (e, μ) using all HERA data
- Excess of events in e^+p at $P_T^X > 25$ GeV: **23 observed** / 14.6 ± 1.9 expected



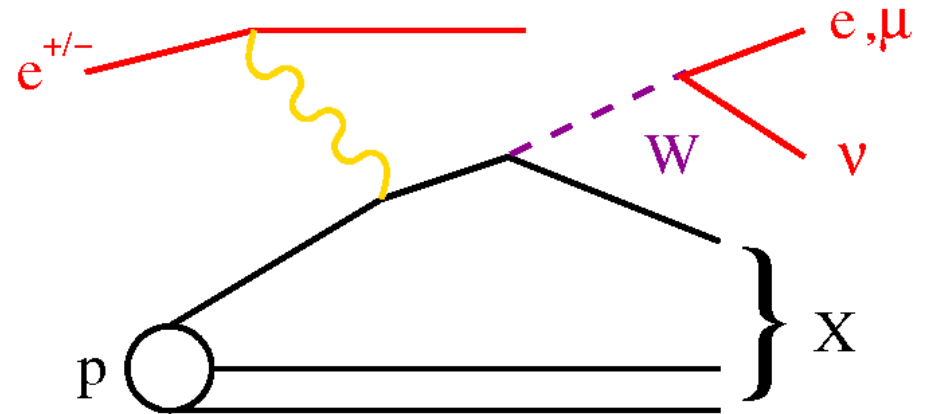
Isolated leptons and missing P_T (2)

Peak in transverse mass
 → events are from W decay

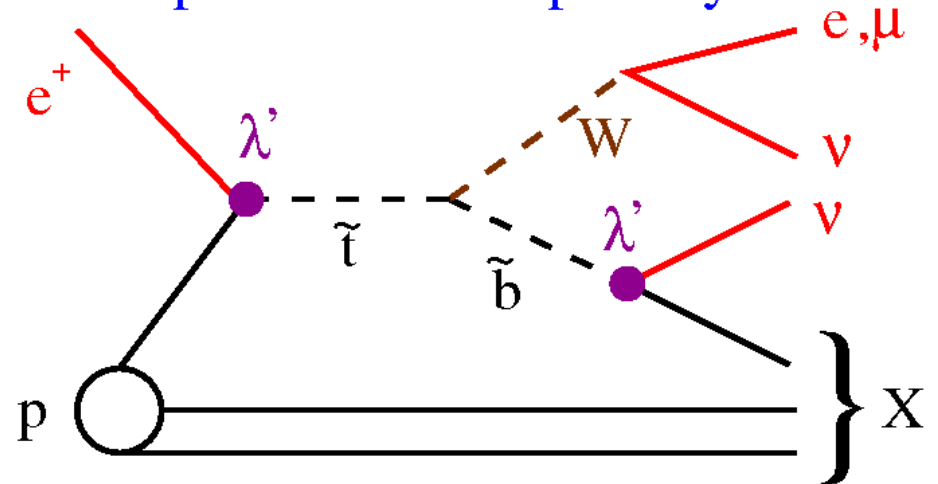


Excess at high P_T^X : not enough data to judge whether it is just a fluctuation.

Standard-model W production

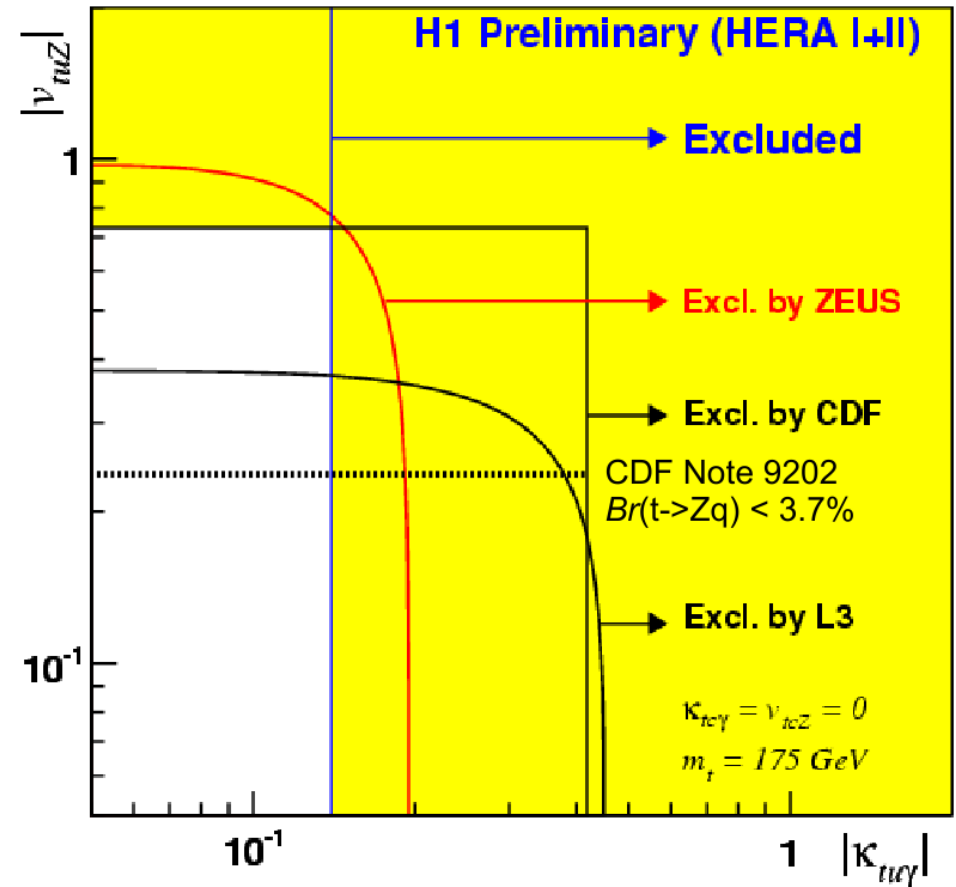
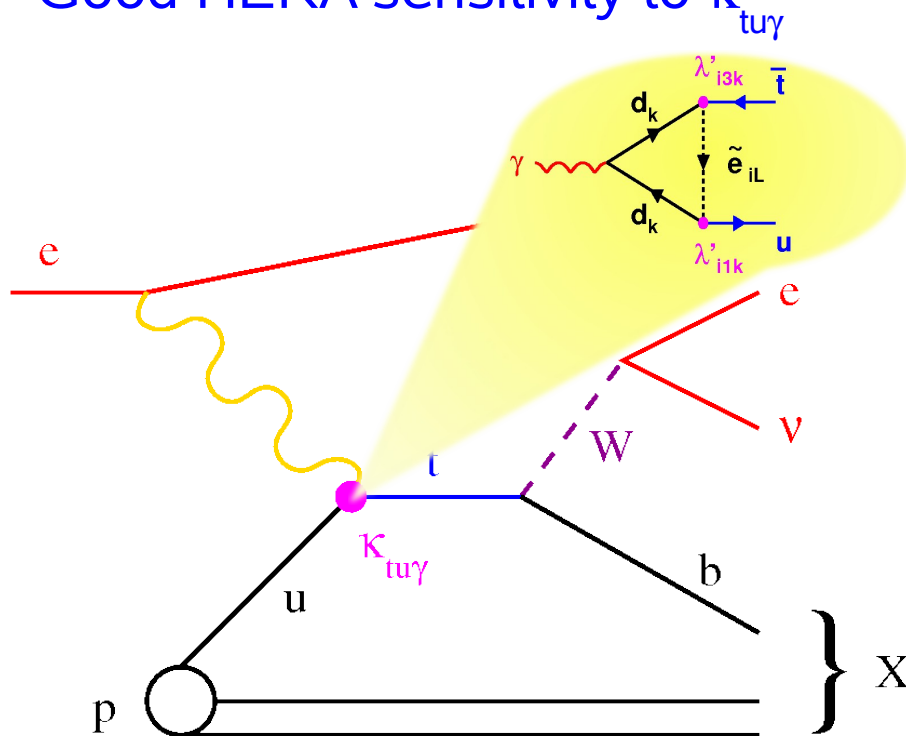


Example: bosonic stop decay



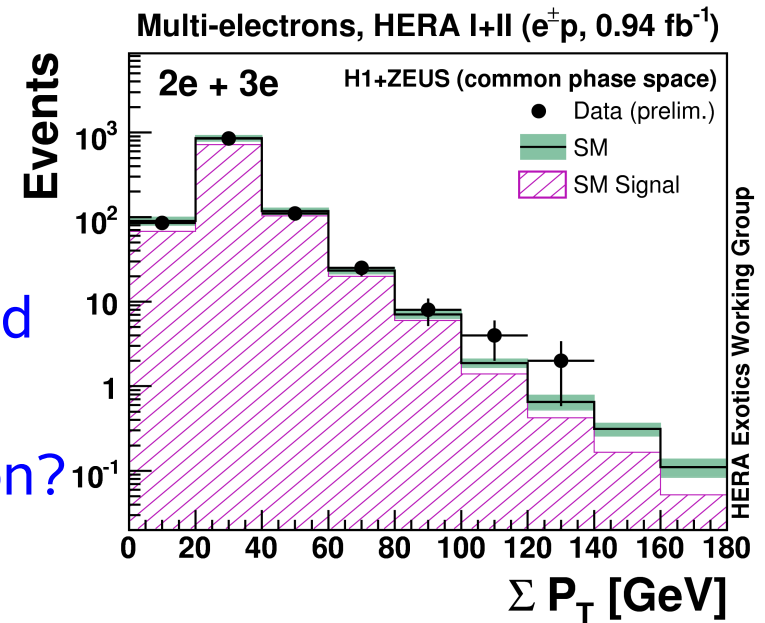
Anomalous Top Production

- Hypothesis: W events originating from top production
- Probe anomalous top couplings
- Good HERA sensitivity to $\kappa_{t\gamma}$



Multiepton Events

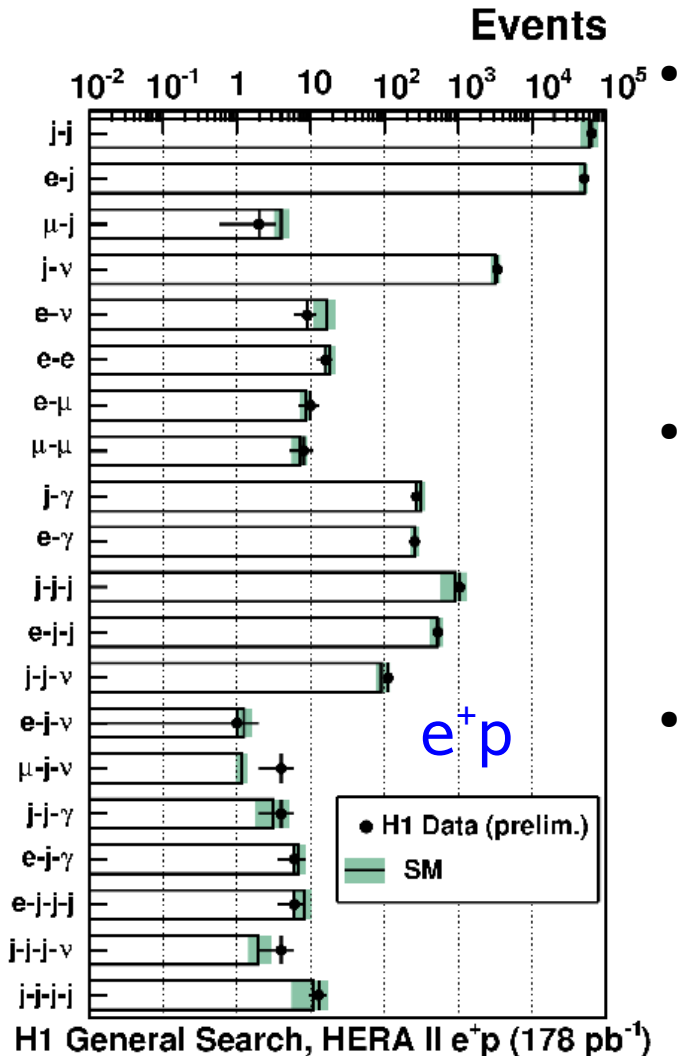
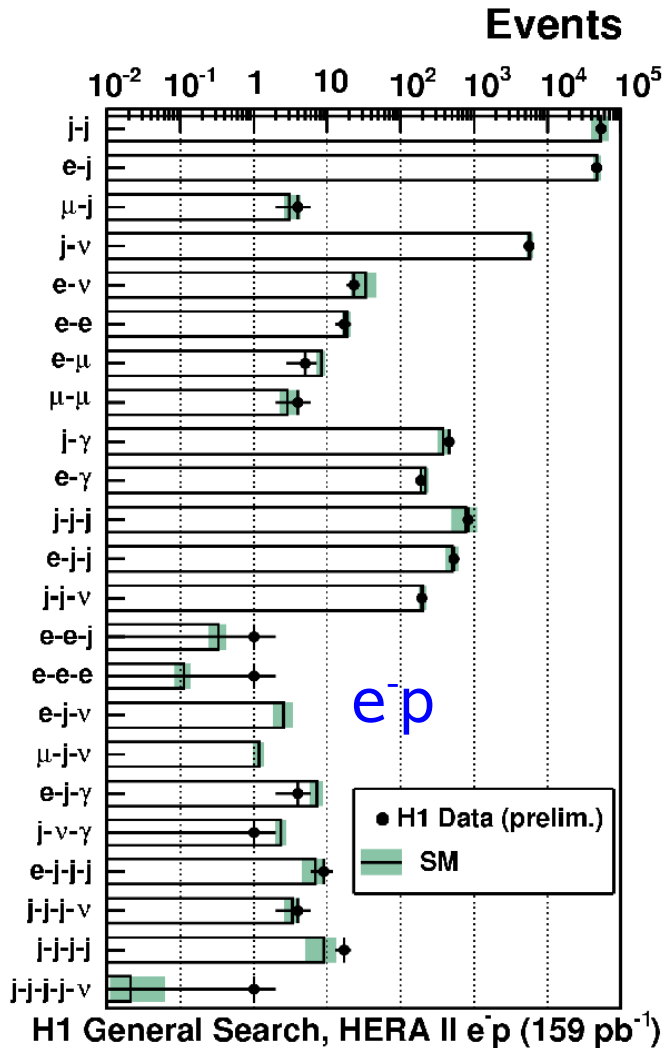
- Events with 2 or 3 electrons
- Study exotic resonances, e.g. doubly-charged Higgs
- **New:** combined results from ZEUS and H1 for electrons
- Excess at high P_T : statistical fluctuation?



H1+ZEUS Multi-electron analysis HERA I+II (0.94 fb^{-1} , preliminary)

$\Sigma P_T > 100 \text{ GeV}$				
Data sample	Data	SM	Pair Production	NC-DIS + Compton
e^+p (0.56 fb^{-1})	5	1.82 ± 0.21	1.28 ± 0.16	0.54 ± 0.10
e^-p (0.38 fb^{-1})	1	1.19 ± 0.14	0.79 ± 0.09	0.40 ± 0.08
$e^\pm p$ (0.94 fb^{-1})	6	3.00 ± 0.34	2.07 ± 0.24	0.94 ± 0.16

H1 general Search



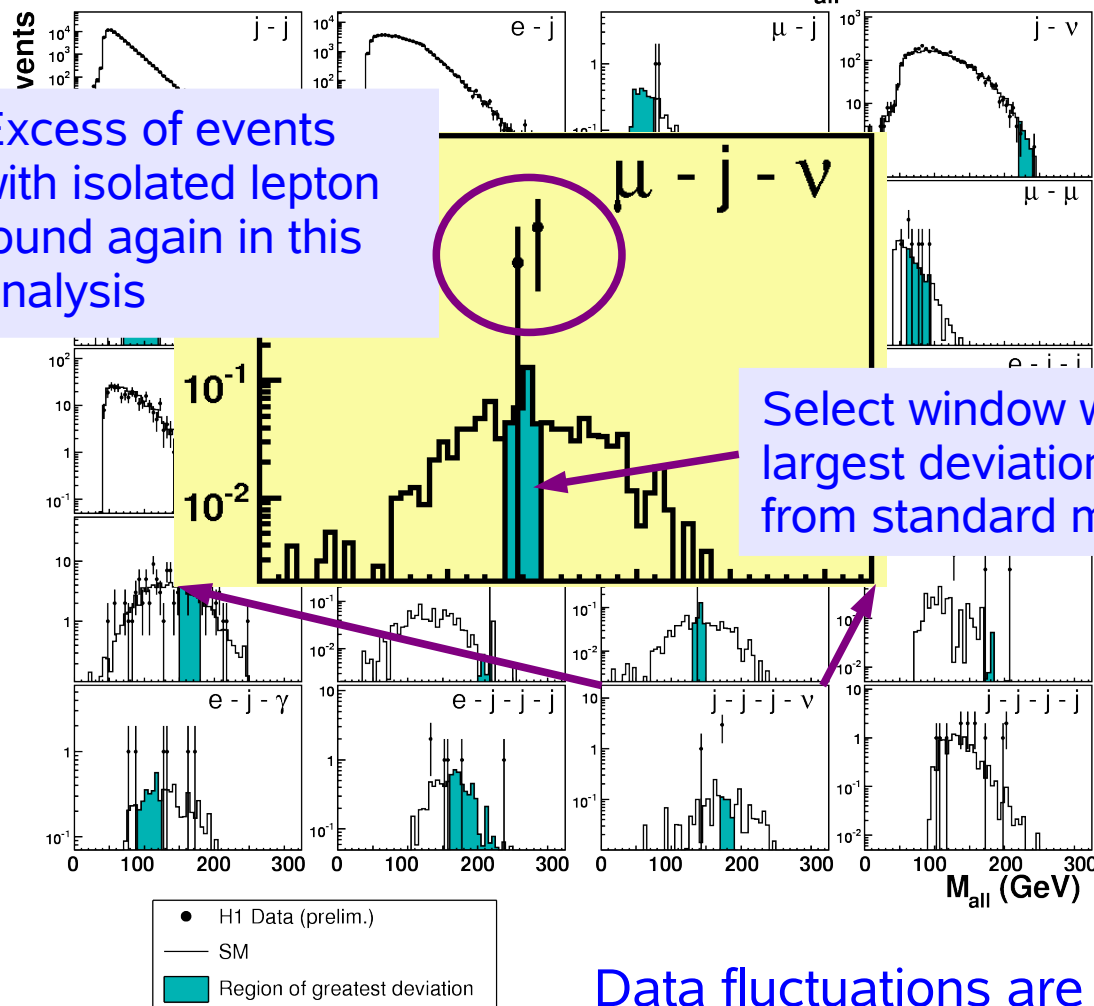
look into many final states with high P_T objects

$P_T > 20$ GeV

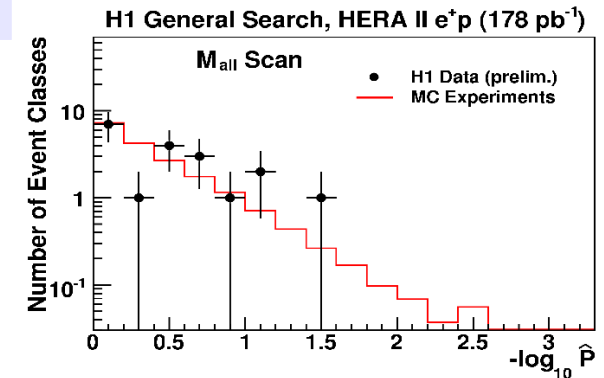
- Overall good agreement with Standard Model in all search channels
- For each channel: look into invariant mass and ΣP_T spectra

H1 general Search (2)

H1 General Search, HERA II e^+p (178 pb^{-1}) - M_{all} Distributions



- Statistical analysis of all search channels
- Select window with largest deviation from Standard model
- Determine fluctuation probability of each channel



Data fluctuations are compatible with expectations

Summary

- HERA has finished data-taking last Summer
- **New results from analyzing the full HERA data**
- Leptoquark searches and contact interactions
 - Limits on **squark production** in **Rp-violating SUSY**
- **Combined H1+ZEUS results** on isolated leptons + missing P_t
- **Combined H1+ZEUS results** multi-leptons
- H1 general search: global survey of all high P_T search channels

Final HERA analyses ongoing, still more to come for the next years