Searches at ZEUS

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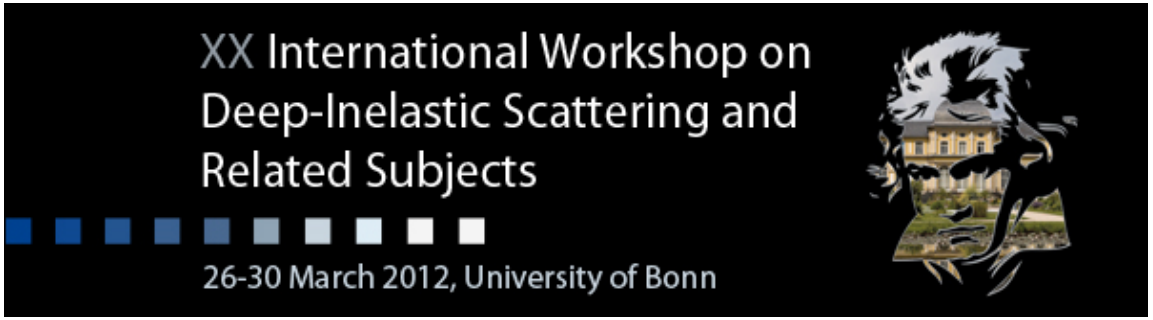
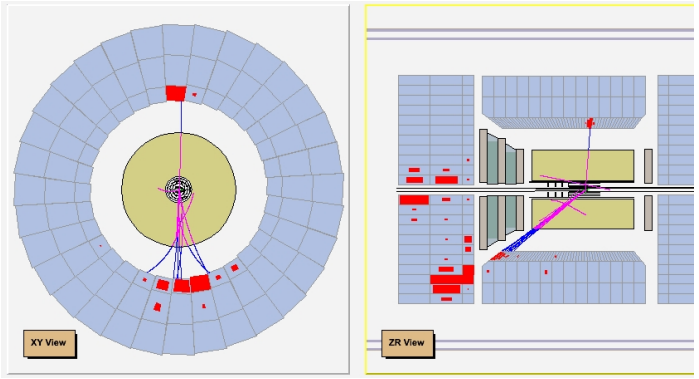
Bonn, DIS12



Outline

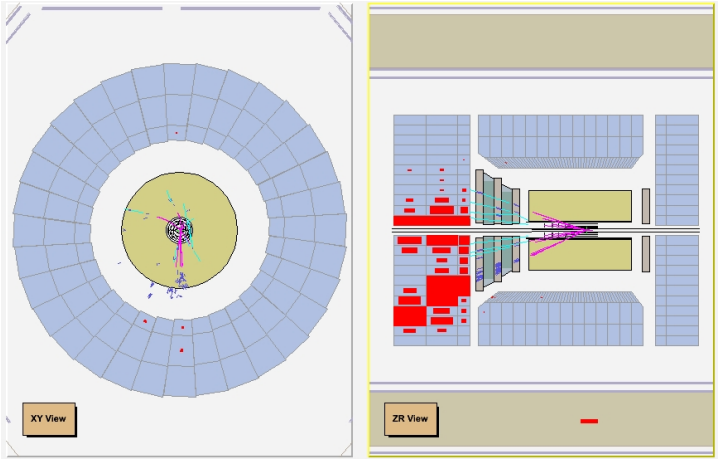
Exploiting HERA data for searches beyond SM

Tipical topology involves one or more leptons and/or missing P_T; NC evt on top, CC evt down



This talk will give an overview of recent results about:

Leptoquarks (e-jet, P_T^{miss}-jet)
single top prod. via FCNC

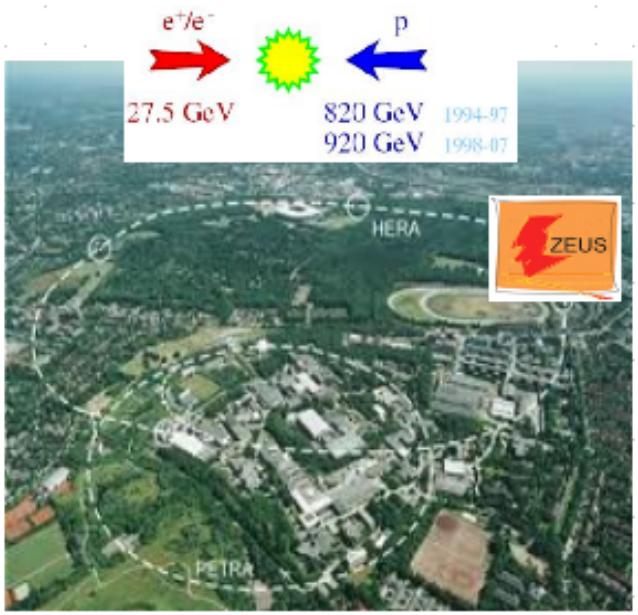


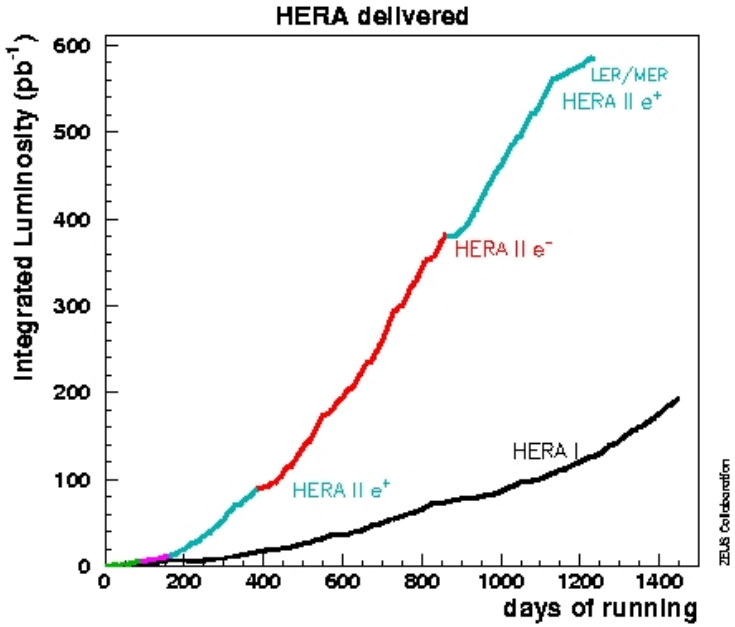
HERA data taking summary

Data taking 1992-2007

HERA I (1992-2000) $\mathcal{L} = 130 pb^{-1}$ mostly e^+p

HERA II (2002-2007) $\mathcal{L} = 370 pb^{-1}$ polarization $\sim 30\%$ e^+/e^-p balanced





ZEUS located at ep interaction point

$\sqrt{s} = 318 GeV$

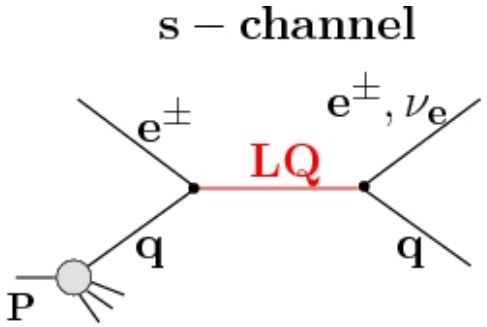
0.5 fb^{-1} data collected

Leptoquarks

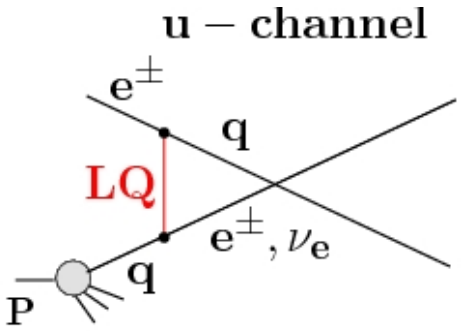
Leptoquarks, fusion of lepton and quark, are scalar or vector boson carrying both lepton (L) and baryon (B) numbers Fermion number:

$F = L + 3B$ $(F = 0, 2)$ $spin = 0, 1$

At HERA, leptoquarks can be produced in the s-channel for $M_{LQ} < \sqrt{s}$...



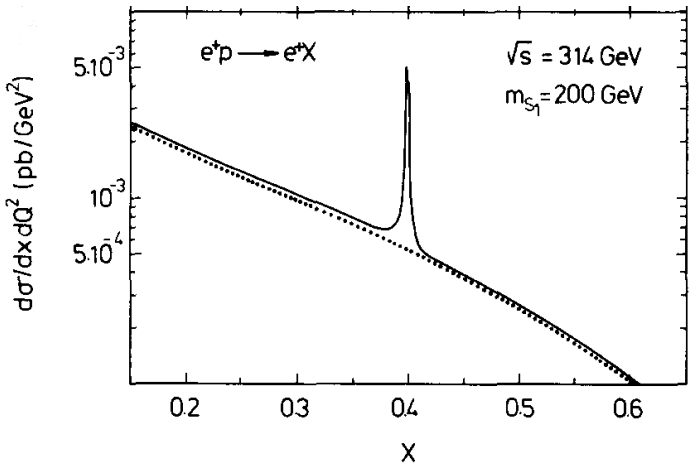
...or exchanged in u-channel



Topology is similar to NC or CC DIS events with an e-jet or ν-jet in the final state. Analysis searches for deviations from the SM in the lepton-jet invariant mass spectrum at different lepton scattering angle to reduce DIS background

Leptoquarks at HERA

Leptoquarks with $M_{LQ} < \sqrt{s}$ give rise to a narrow peak in the lepton-jet inv. mass spectrum (NWA ; small decay width compared to detector resolution) while, at higher masses, give deviations from SM predictions (Plot from W. Buchmüller, R. Rückl, D. Wyler, Leptoquarks in lepton-quark collisions, Physics Letters B, Volume 191, Issue 4, 18 June 1987, Pages 442-448)

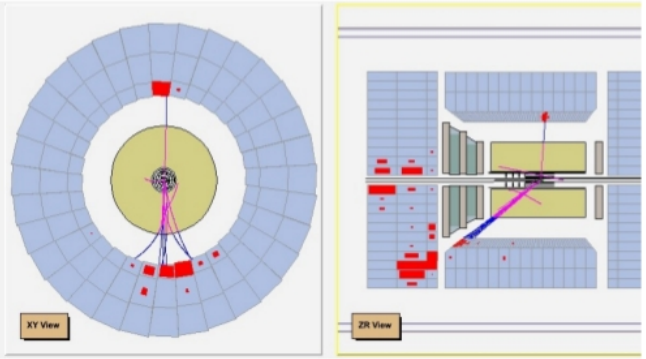


In the $e - jet$ channel, mass resolution varies from $5\% \rightarrow 3\%$ with the increasing of resonant mass from $150 \rightarrow 290 GeV$; in the $\nu - jet$ channel the resolution varies from $8\% \rightarrow 6\%$

The lepton scattering angle in the lepton-jets scattering frame, θ^*, can be used to reduce DIS background due to the fact that, e.g., a scalar resonance has a flat distribution in $cos\theta^*$ while NC DIS follows a $1/(1 - cos\theta^*)^2$ distribution

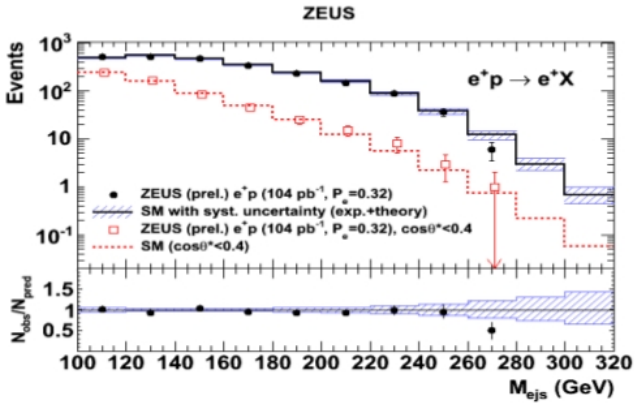
LQ and DIS backgrounds cross section have different polarisation dependence so samples with different polarisation can help by enhancing signal/bkg

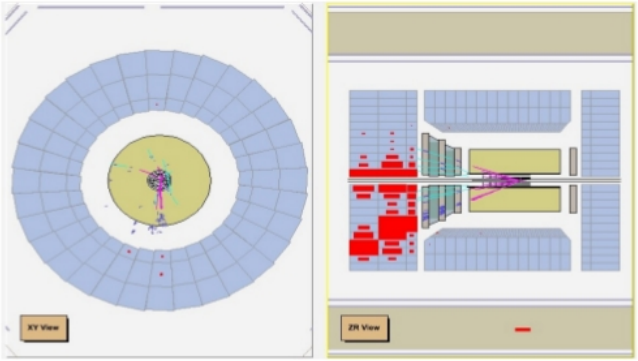
Leptoquarks: invariant mass



$M_{e\text{-jet}}$

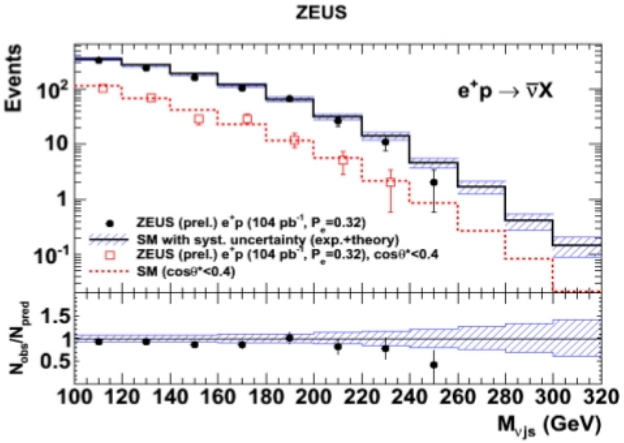
e+jet final state





$M_{\nu\text{-jet}}$

ν+jet final state



No evidence for LQs $\rightarrow$ set limits on λ (e-q-LQ coupling) as a function of M_{LQ}

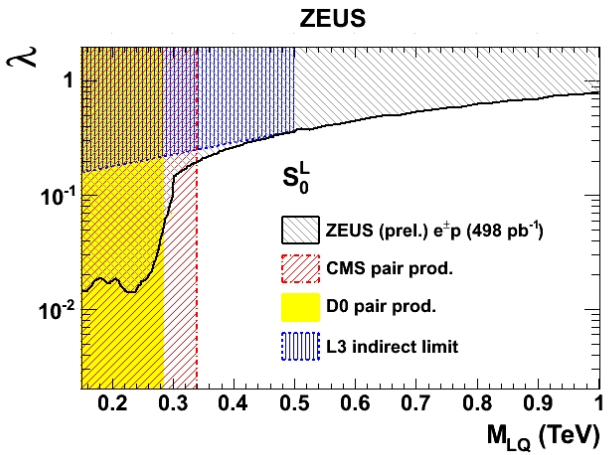
Leptoquarks: limits

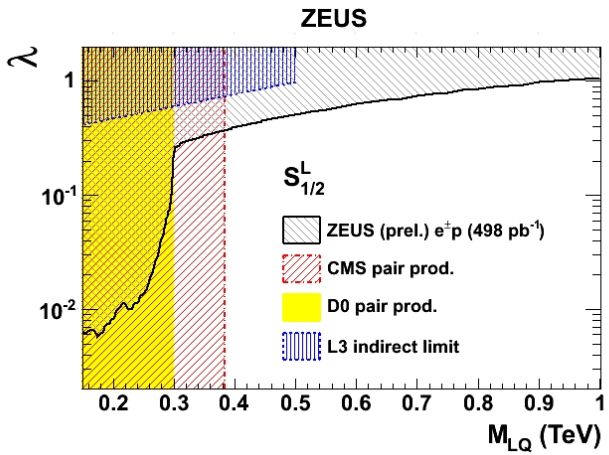
Buchmüller-Rückl-Wyler model used: SM simmetry conserved, lepton and baryon numbers conserved, couple either to left-handed or right-handed leptons but not both

Limits for 7 scalar + 7 vector states

assuming em coupling: $\lambda = \sqrt{4\pi\alpha} = 0.3$

LQ Type (F=0)	V_0^L	V_0^R	$\tilde{V}_0^R$	V_1^L	$S_{1/2}^L$	$S_{1/2}^R$	$\tilde{S}_{1/2}^L$
M_{LQ}(GeV) ZEUS (prel.)	504	293	343	629	322	300	293
LQ Type (F=2)	S_0^L	S_0^R	$\tilde{S}_0^R$	S_1^L	$V_{1/2}^L$	$V_{1/2}^R$	$\tilde{V}_{1/2}^L$
M_{LQ}(GeV) ZEUS (prel.)	435	326	291	466	292	324	409

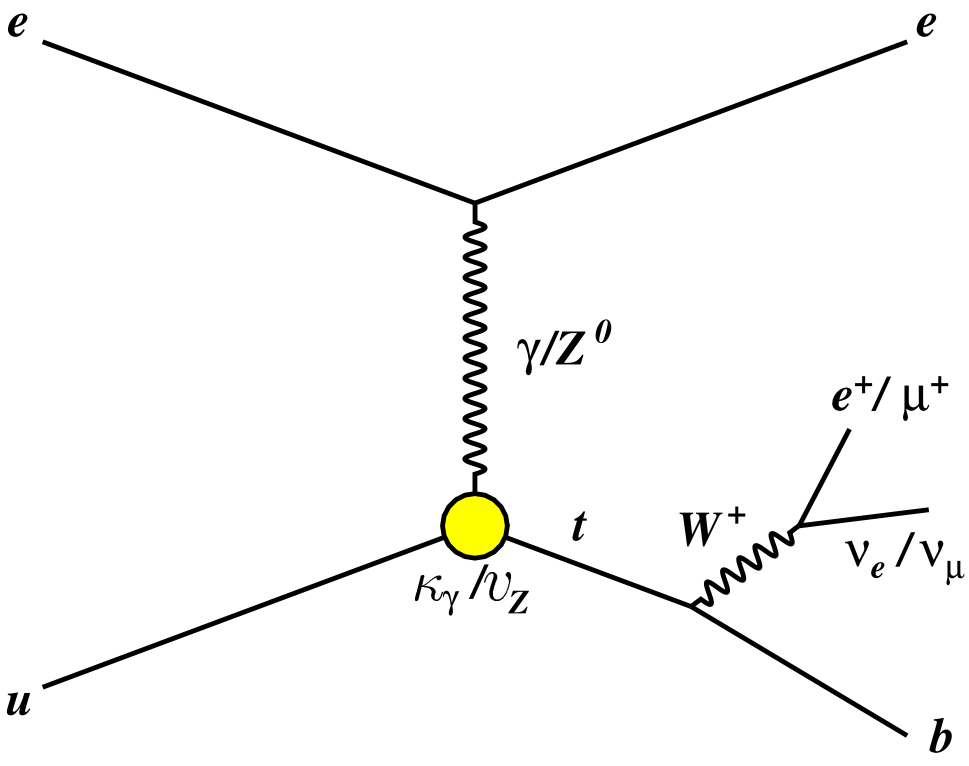




ZEUS limits compatible with other experiments

Search for single top: signal topology

- SM single top cross section $\sim 1fb$ (CC process)
- BSM extra prod. possible via FCNC process
- Topology: high-p_T isolated leptons, missing P_T and high $p_{T,had}$
- At HERA, most sensitive to $\kappa_{tu\gamma}$ coupling

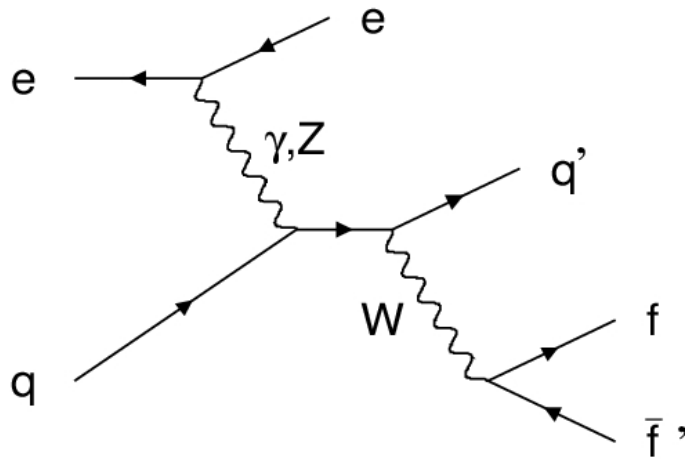


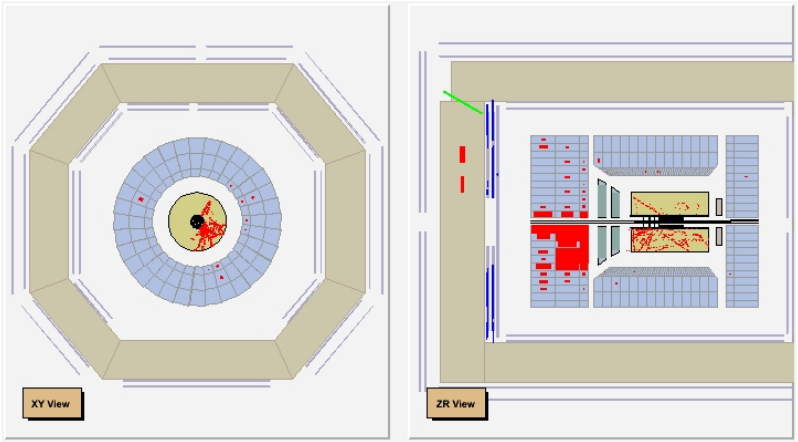
All HERA data ($0.5fb^{-1}$), published in Physics Letters B 708 (2012) 27-36

Search for single top: high p_T leptons

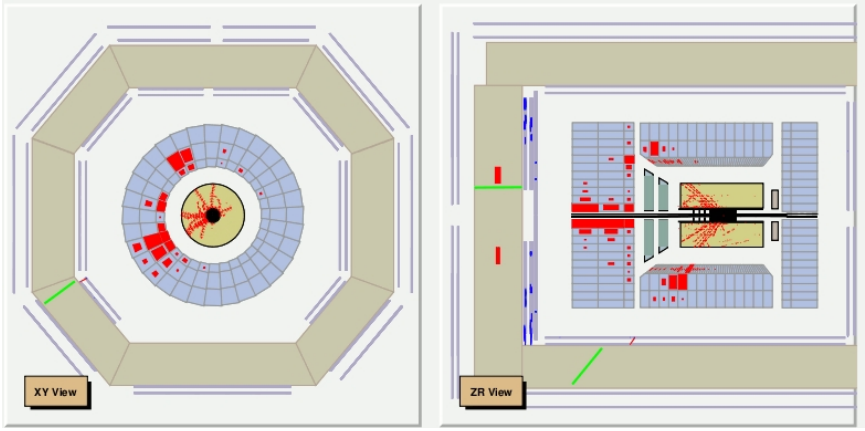
Study of high p_T isolated leptons suited for searches of physics BSM

- Clear and striking signature
- In SM: low cross section, mainly due to W production ($\sim 1pb$)
- Low $p_{T,had}$ differently from single top





μ decay channel of W



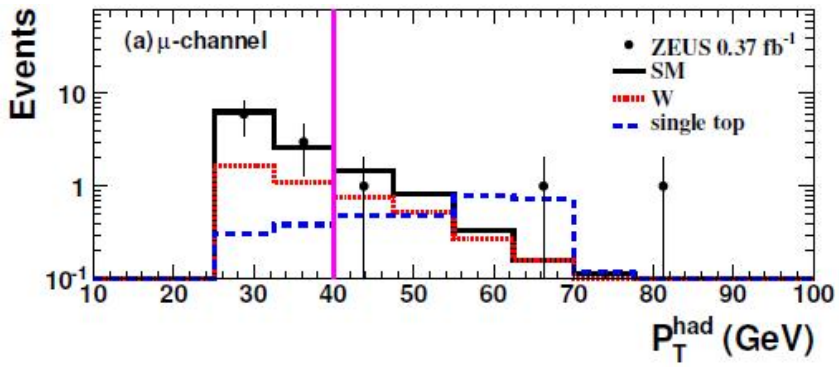
e decay channel of W

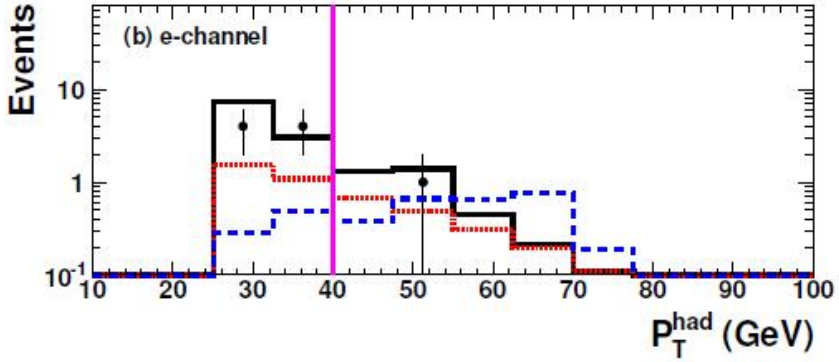
Single top: analysis

Analysis performed in the leptonic decay channels of the $W(\mu, e)$

Hadronic p_T distribution; good agreement data/MC

Final cut at $40\,GeV$ to set limits on top production

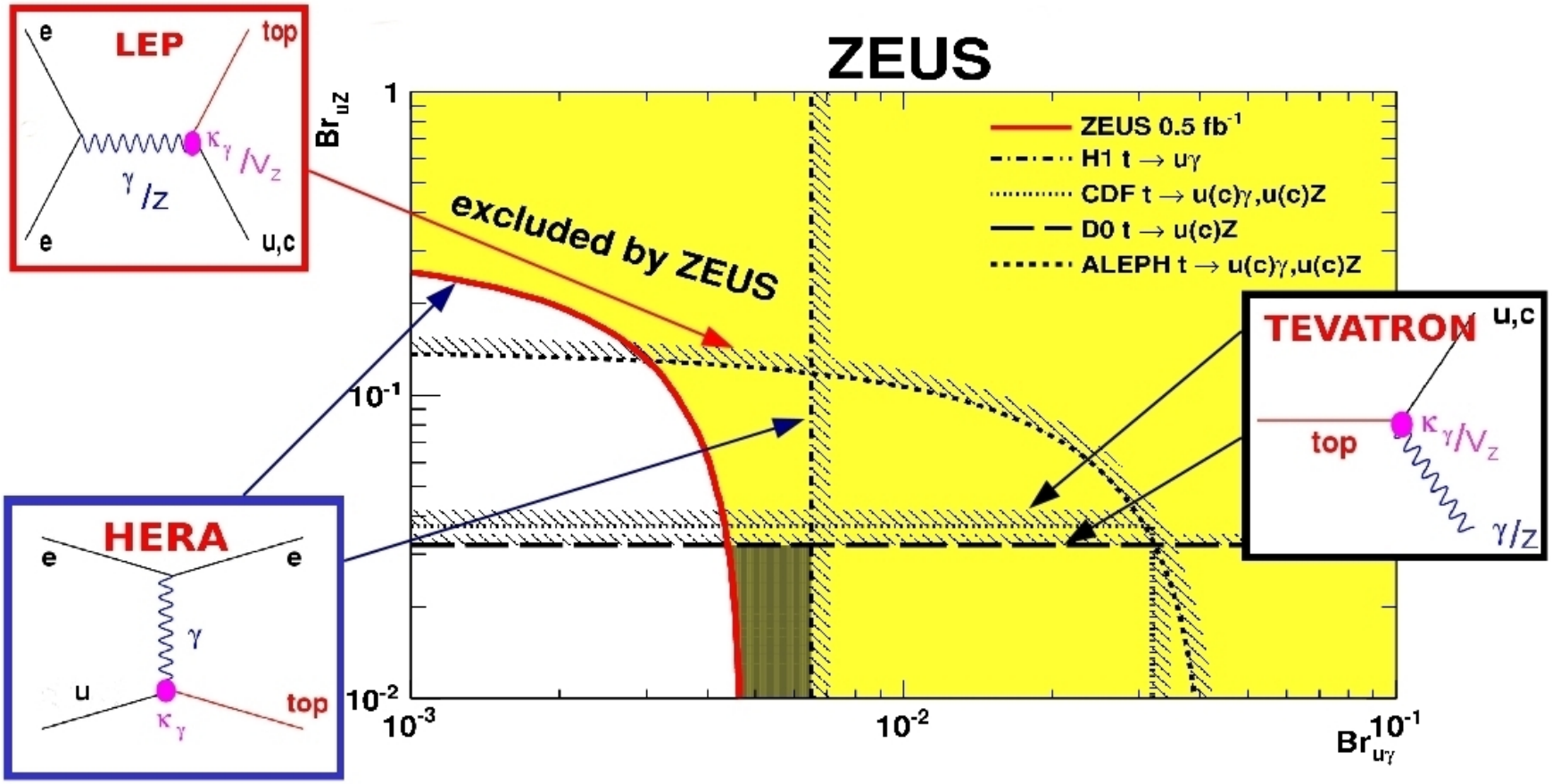




No evidence of single top found

Limits are set on anomalous single top production

Single top: limits



ZEUS boundary in the $(\mathbf{Br_{u\gamma}}, \mathbf{Br_{uZ}})$ plane. Dark shaded area is uniquely excluded by ZEUS. Same couplings probed in different processes: e^-e^+ (LEP), $p\bar{p}$ (Tevatron), $e^\pm p$ (HERA). Limits in the region where $\mathbf{Br_{uZ}}$ are $< \mathbf{4\%}$ are the best to date.

Conclusions

Overview of some recent ZEUS results on leptoquarks and single top have been presented

No evidence of new physics found

ZEUS constraints are still competitive with other collaborations and experiments

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