Supersymmetry at ZEUS

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On Behalf of the ZEUS Collaboration

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RPV Supersymmetry
Search for Stop production
Search for Gaugino production
Summary

RPV Supersymmetry

Multiplicative, discreet Symmetry: $R_p=(-1)^{3B+L+2S}$ +1 for SM particles, -1 for SUSY particles

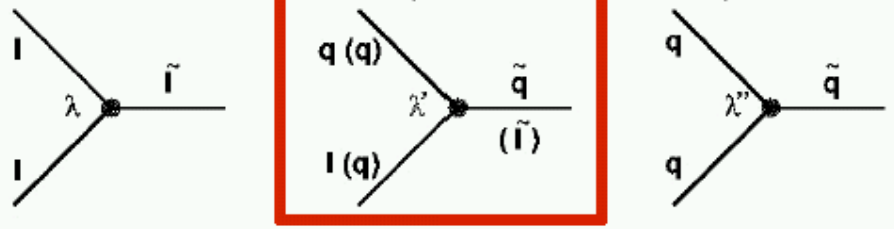
Framework: MSSM, R_p not conserved

Allows single SUSY particle production; LSP can decay to SM particles

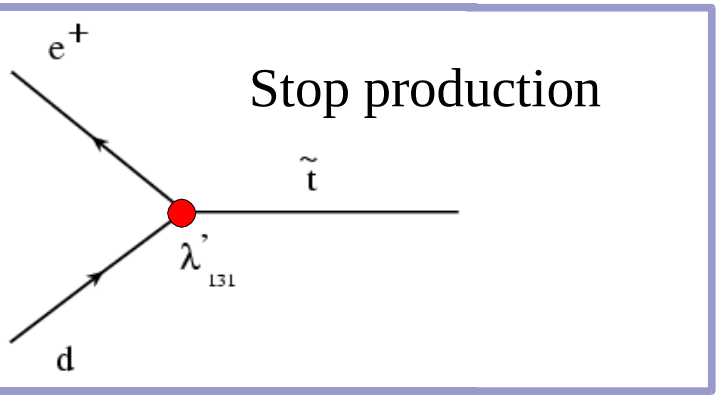
Additional trilinear terms in superpotential:

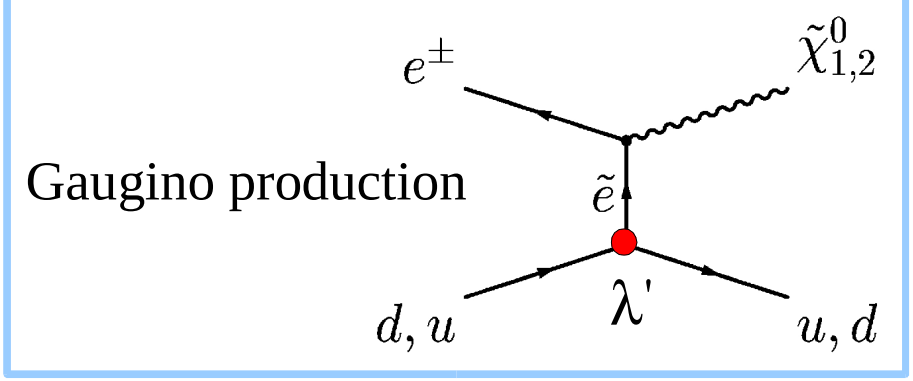
$$W_{\not R_p} = \underbrace{\lambda_{ijk} L_i L_j \bar{e}_k}_{\not L} + \underbrace{\lambda'_{ijk} L_i Q_j \bar{d}_k}_{\not L} + \underbrace{\lambda''_{ijk} \bar{u}_i \bar{d}_j \bar{d}_k}_{\not B} \ldots$$

Leading order diagrams at HERA from λ'_{ijk} term.



Squark masses up to 320GeV.





Search for Stop production

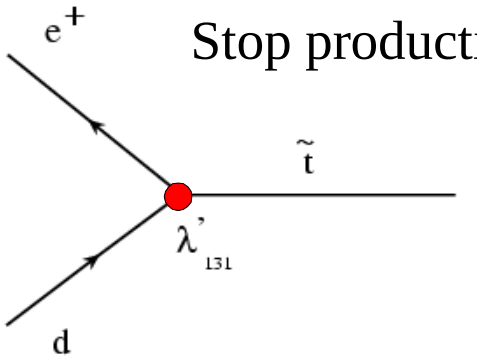
MSSM parameter space:

$100\ \text{GeV} < M_2 < 300\ \text{GeV}$

$-300\ \text{GeV} < \mu < 300\ \text{GeV}$

$\tan(\beta) = 6$

Stop production

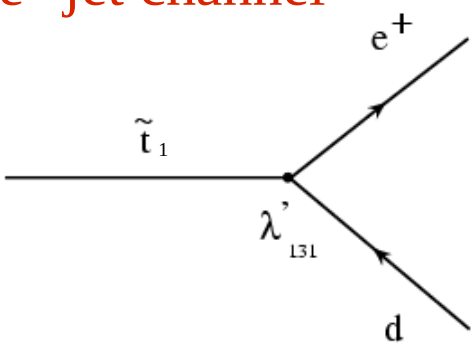


Stop is lightest squark in most of parameter space.

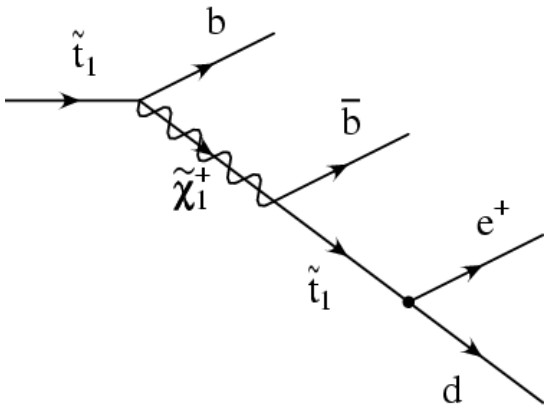
Dominant decay channels:

NC like channels

e^+-jet channel

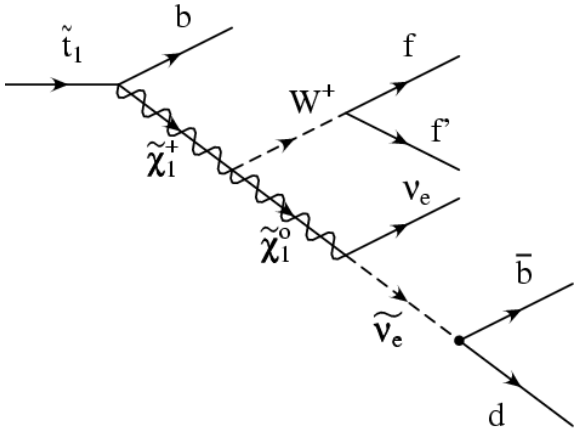


e^+-multi jet channel



CC like channel

ν-multi jet channel



Preselection for e^+-jet and e^+-multijet channel

ZEUS data 99-00: 65.1 pb^{-1}

Standard NC selection

$|Z_{vtx}| < 50$ cm

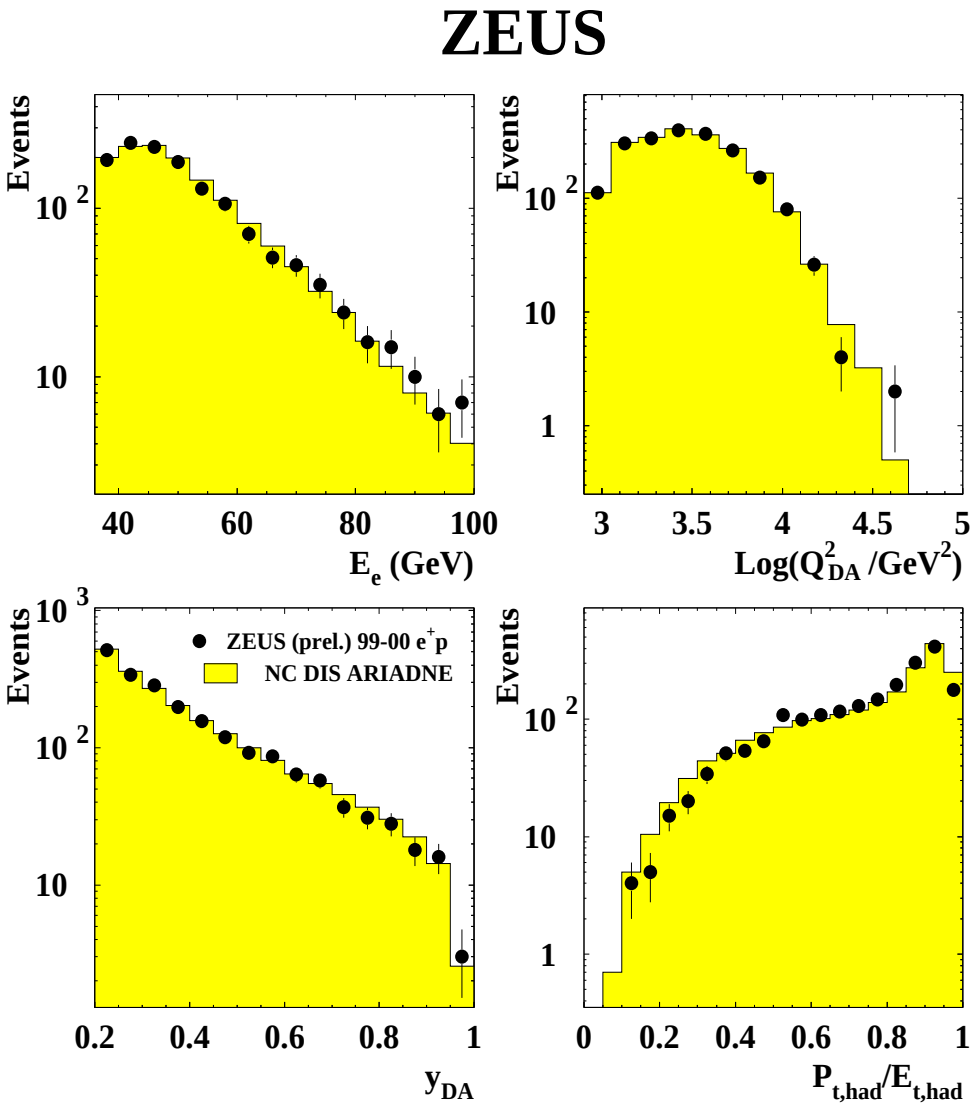
$50\ \text{GeV} < E - P_z < 65\ \text{GeV}$

Electron:

$\theta_e > 0.3$: $E_e > 8$ GeV

$\theta_e < 0.3$: $E_e > 20$ GeV

Stop Mass > 100 GeV



Preselection for ν-multijet channel

Standard CC selection

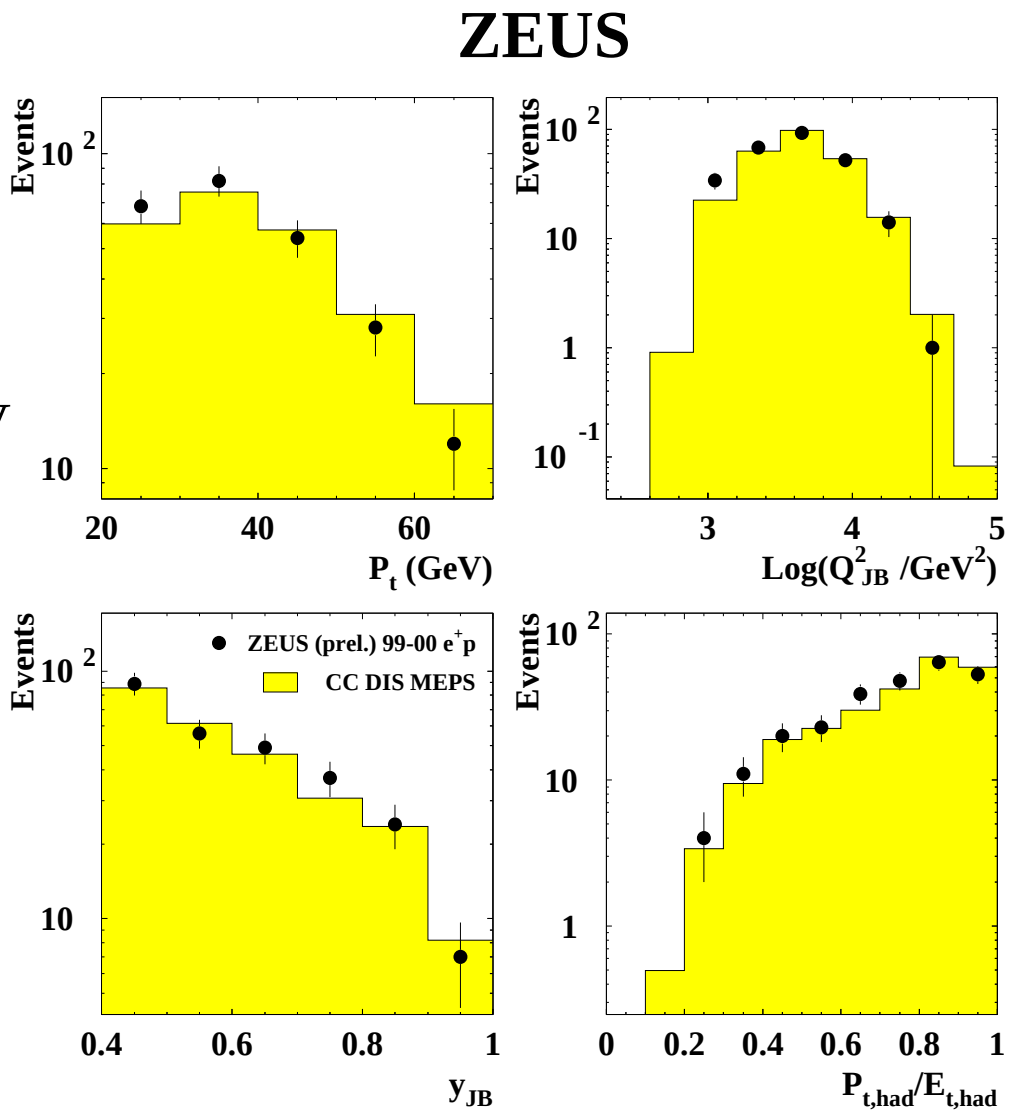
$|Z_{vtx}| < 50$ cm

$P_t > 20$ GeV

$22 \text{ GeV} < E - P_z < 65 \text{ GeV}$

No electron

Stop Mass > 80 GeV



Final selection

$Q^2_{DA} > 3000\ GeV^2$

$y_{DA} > 0.2 – 0.6$

e^+jet channel:

$P_{t,had}/E_{t,had} > 0.8$

(select signle jet events)

e^+multi jet channel:

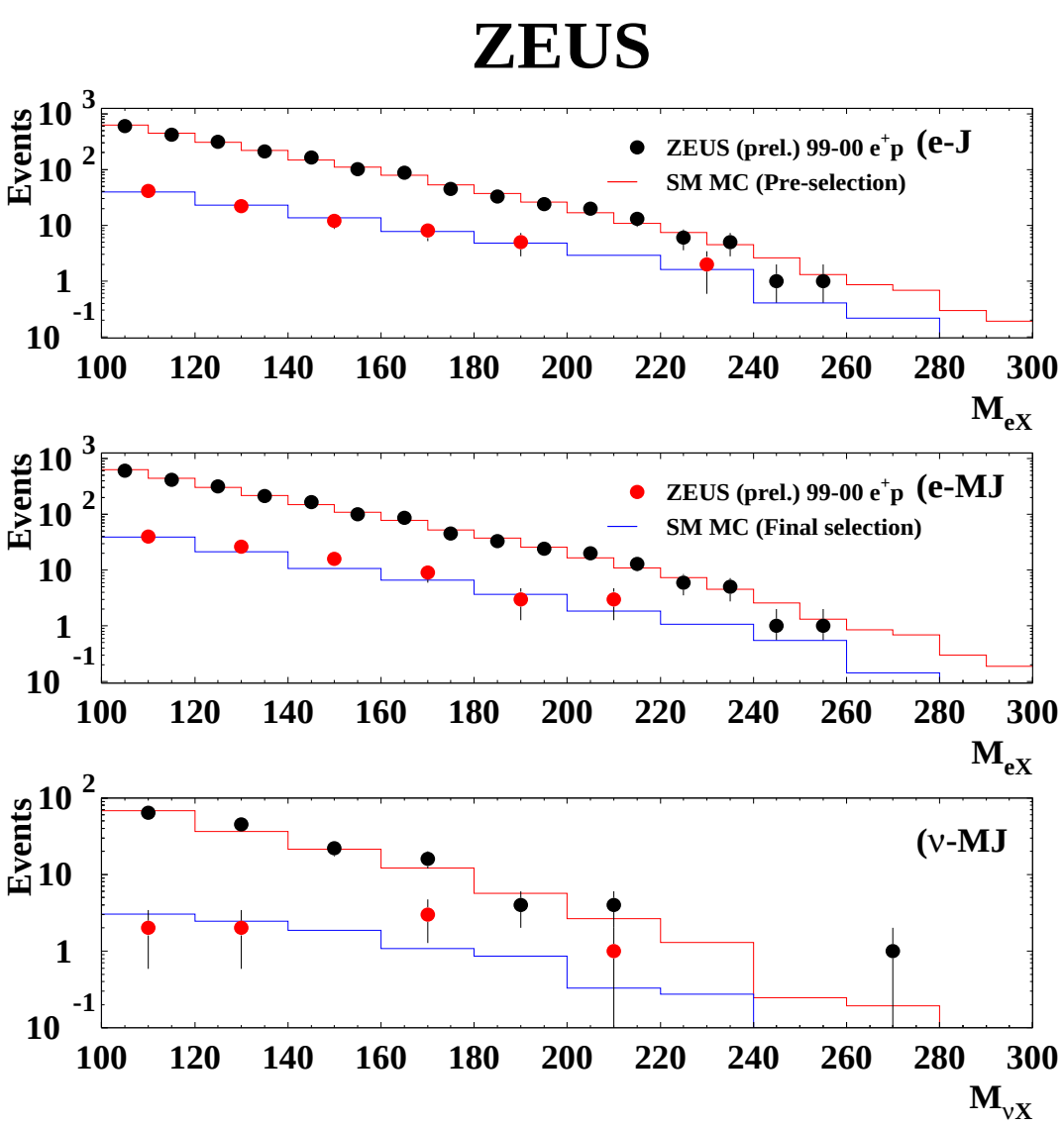
$P_{t,had}/E_{t,had} < 0.8$

(select multi-jets events)

ν-multi jet channel:

E-Pz > 25 GeV

$P_{t,had}/E_{t,had} < 0.4$



Results

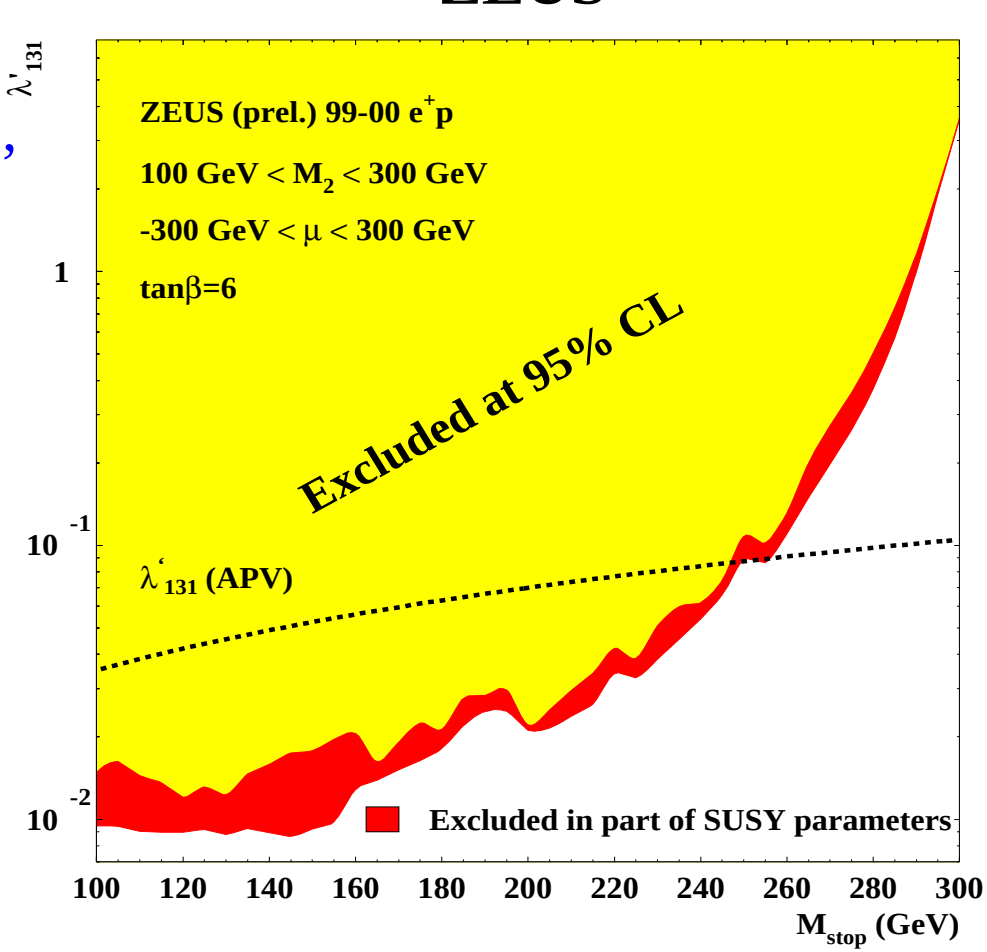
No deviation from Standard Model was found.

Calculate combined limits for λ'_{131} using three channels, 95 % confidence level.

Scenarios where χ^0 is not the LSP or $m_{\chi 0} < 30$ GeV were discrarded.

Small influence of M_2 and μ (red region).

For λ=0.3 values up to M_{stop}=270 GeV can be excluded.



Compared to APV: Better limits for Stop masses up to 250 GeV.

Search for Gaugino production

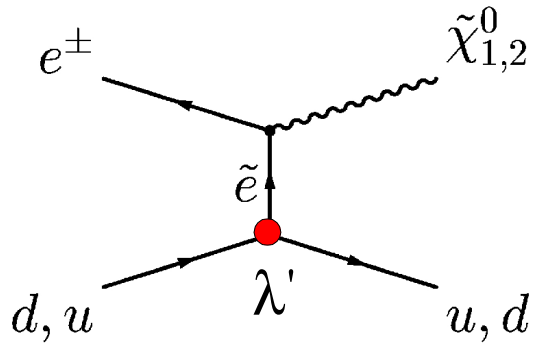
If $M_{squark} \gg M_{slepton}$:

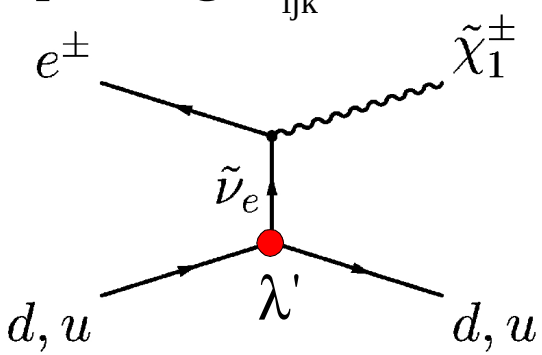
s-channel suppressed $\Rightarrow$ t-channel dominant, probing λ'_{ijk}

Gaugino production:

$\sigma \sim (\lambda')^2$

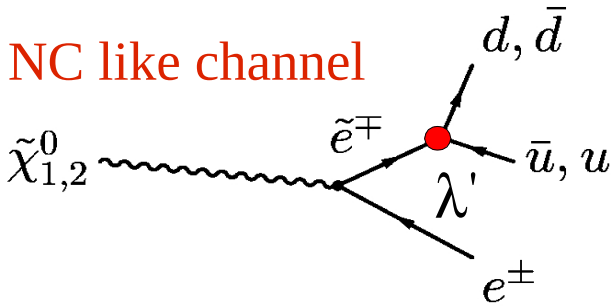
Independent of squark masses!





Gaugino Decay:

NC like channel

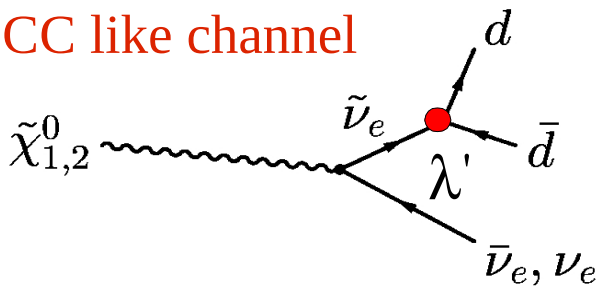


$\chi^{\pm}_1$ decays to same final state

BRs add up to almost 100%.

Until now: Only NC channel analysed! BR ≈ 30 – 60 %

CC like channel



Preselection for NC like channel

ZEUS data 96-00: 121 pb^{-1}

$E_T > 75$ GeV

45 GeV< E-P_z< 62 GeV

$y_{JB} > 0.4$

$Q^2_{JB} > 100$ GeV^2

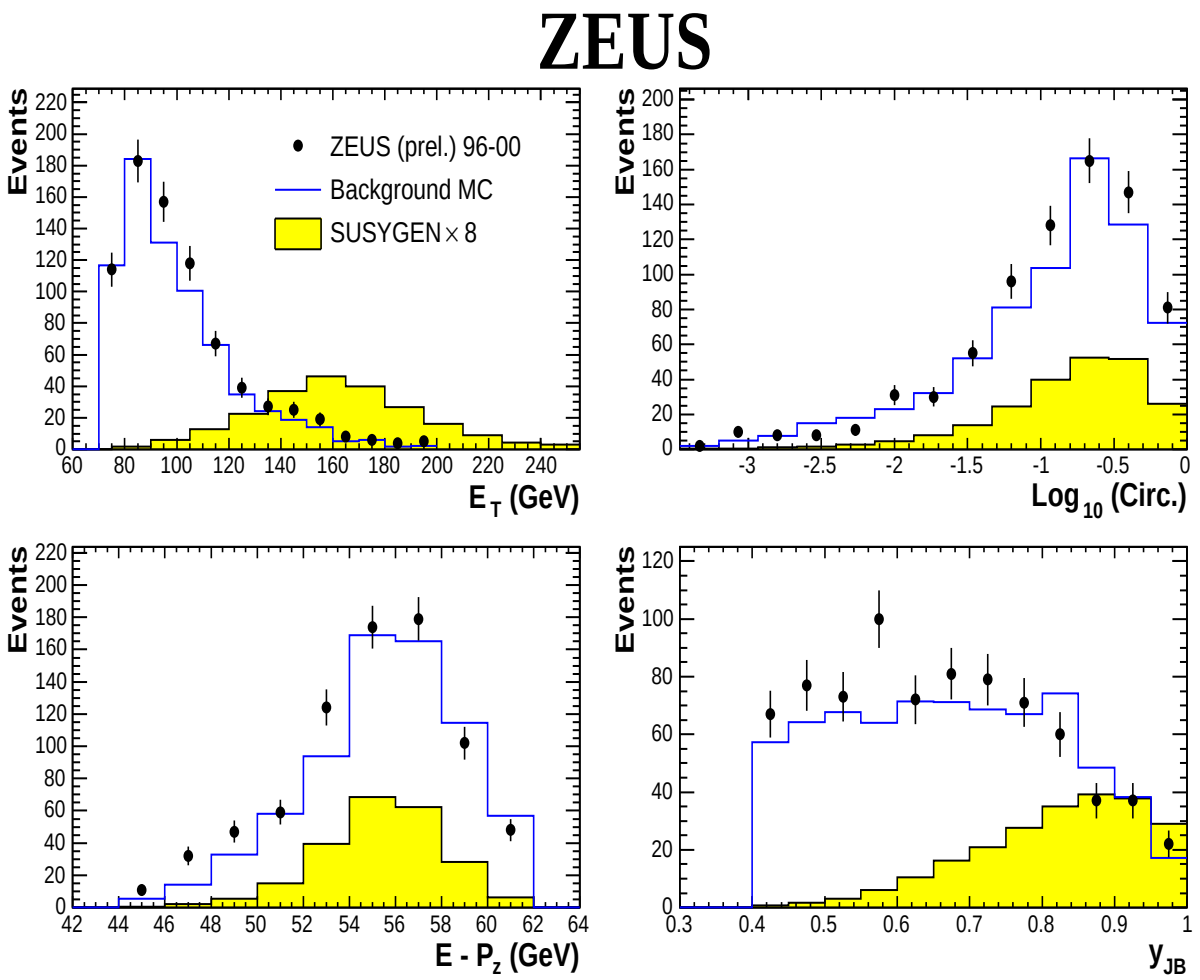
2 Jets:

$E_T > 10$ GeV

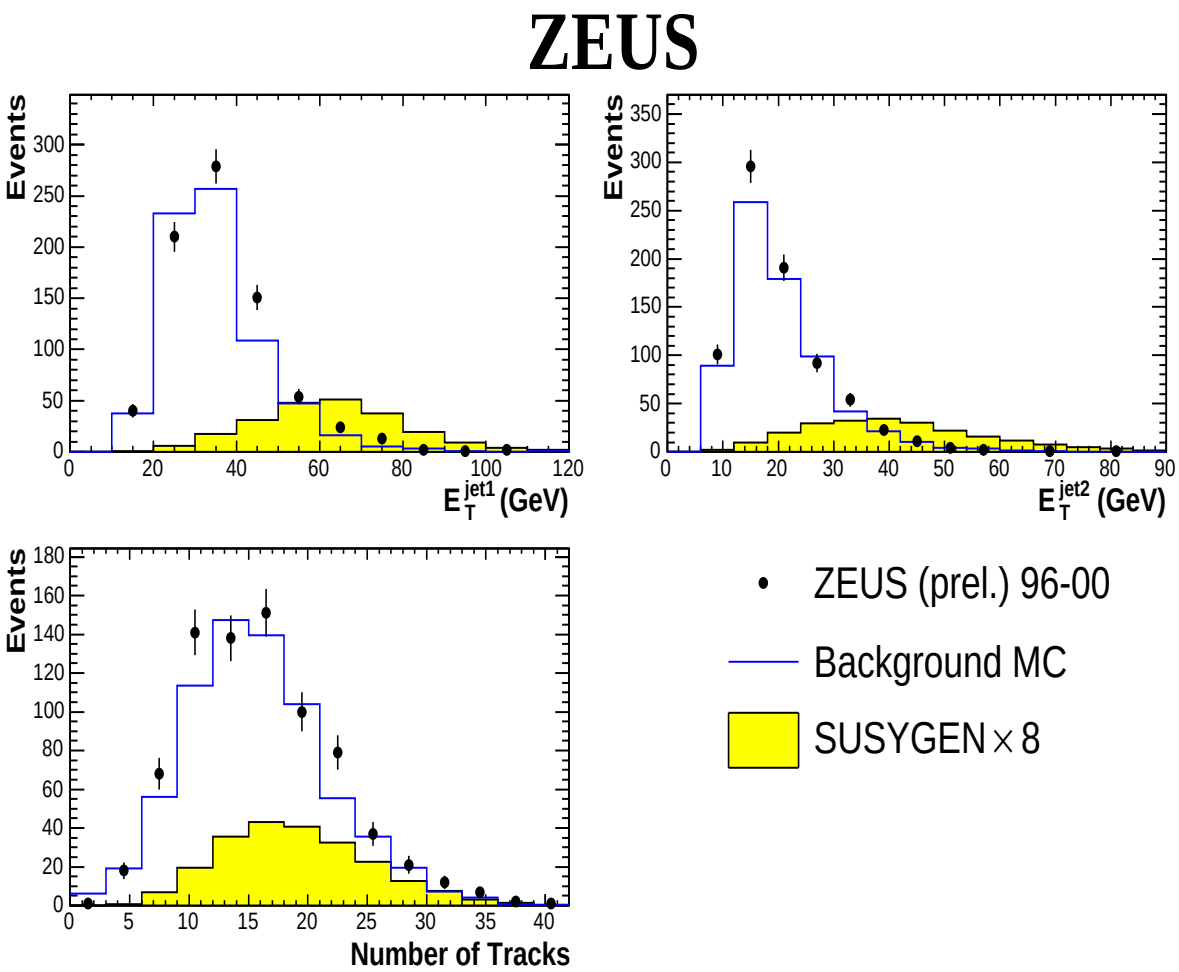
$-0.5 < \eta < 2.7$

$P_T < 18$ GeV

Electron required



Preselection 2



MSSM parameters:

$\lambda'_{111}=1$; $\tan(\beta)=30$

$M_{sqark}=$ 1 TeV

$M_{selectron}=$ 100 GeV

For scan

100 GeV < M_2 < 250 GeV

-800 GeV < μ < 800 GeV

→ σ = 0.1 – 4 pb

Efficiency × BR:
25-30%

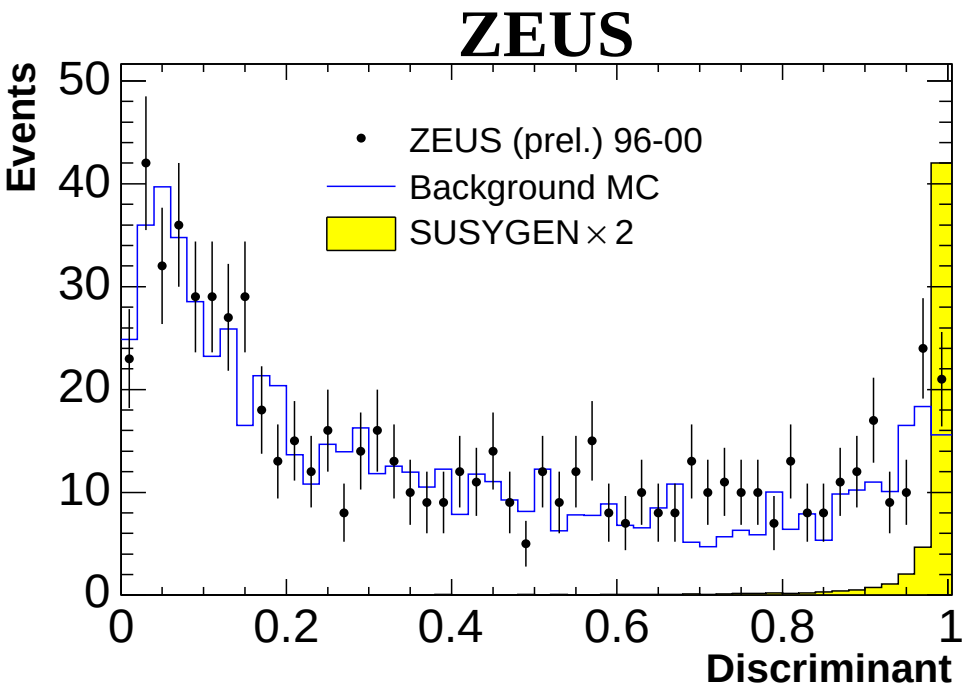
Good signal/background seperation needed!

Final selection

Used variables for discriminant calculation:

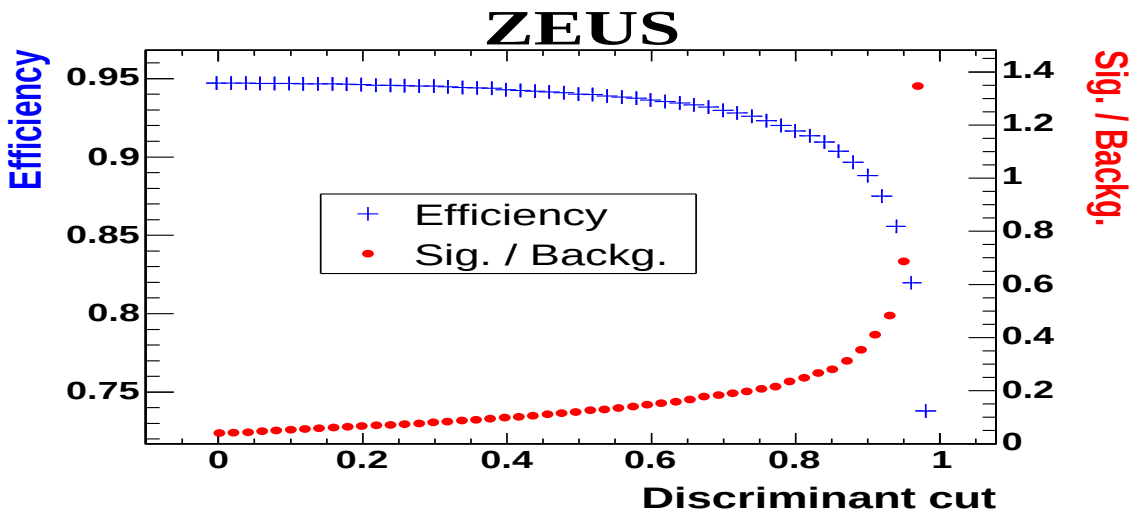
E_T, circularity, E-p_z, y_{jb}, E_T^{jet1}, E_T^{jet2} number of tracks

Data shows no signal



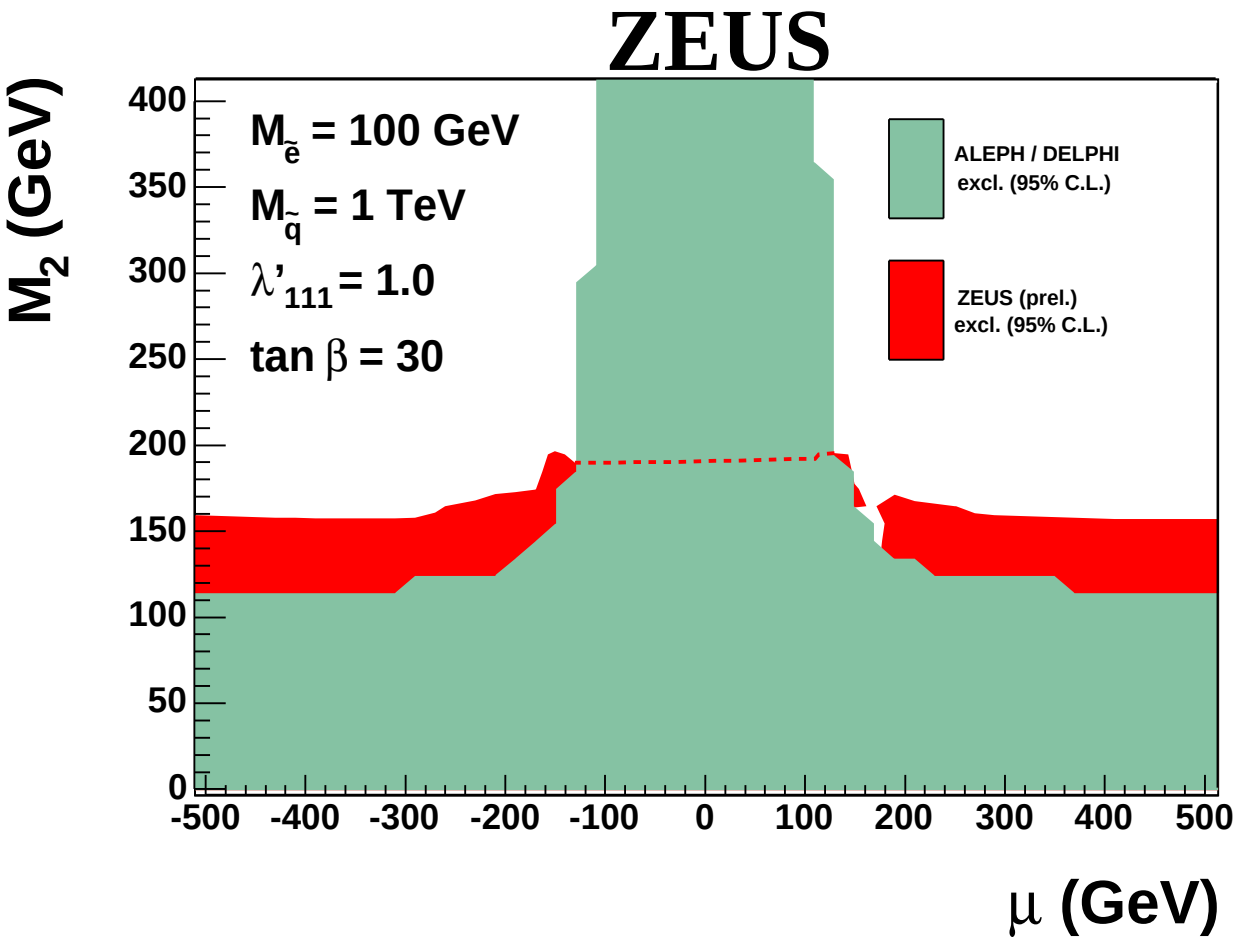
Limit calculation

Taking all bins right of D=0.7.



Modified frequentist method (***Thomas Junk, NIM A434, p. 435; hep-ex/9902006***)

Results



ALEPH / DELPHI limits from search for chargino pair production
(J. Abdallah et al., Eur.Phys.J. C37 (2004) 129-131; hep-ex/0406009)

Excluded region from scan with given parameters and $M_{\chi^{\pm}} \leq 103$ GeV.

Summary

New results in the framework of RPV supersymmetry.
No deviation from SM was observed.

Stop search:

Set limits on λ'_{131} for varying Stop mass.

Gaugino search:

Extended ALEPH and DELPHI limits in M_2–μ plane.