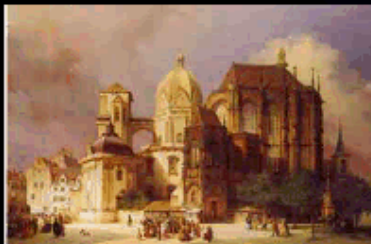

SEARCH FOR EXCITED FERMIONS



EPS-03, Aachen, July 2003

Eusebio Sánchez Álvarez (on behalf of collaborations)

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LEP (DELPHI, L3, OPAL)
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INTRODUCTION

Excited states of fermions can exist if leptons and quarks are not elementary particles but composite.

Excited fermions are considered as spin=1/2 and isospin=1/2 particles and couple to gauge bosons according to their quantum numbers.

Both left-handed and right-handed components of excited fermions are weak isodoublets.

$SU(3) \times SU(2) \times U(1)$ symmetry is still respected.

Excited fermions would decay into an ordinary fermion and a gauge boson.

phenomenological model

(hagiwara, komamiya, zeppenfeld)

Left-handed fermions couple to right-handed excited fermions.

Coupling strength and scale of compositeness are free parameters of the model

3 couplings: f for SU(2); f' for U(1); f_s for SU(3)

$$\mathcal{L}_{int} = \frac{1}{2\Lambda} \bar{F}_R^* \sigma^{\mu\nu} \left[g f \frac{\tau^a}{2} W_{\mu\nu}^a + g' f' \frac{Y}{2} B_{\mu\nu} + g_s f_s \frac{\lambda_a}{2} G_{\mu\nu}^a \right] F_L + h.c.$$

- Right and left-handed components of the excited form weak isodoublets
- Field-strength tensors associated to gauge fields SU(2), U(1) and SU(3)
- SM couplings
- Coupling strength between f^* and bosons from SU(2), U(1) and SU(3)
- Compositeness scale

Usual Assumptions

FOR l^*, ν^* SEARCHES

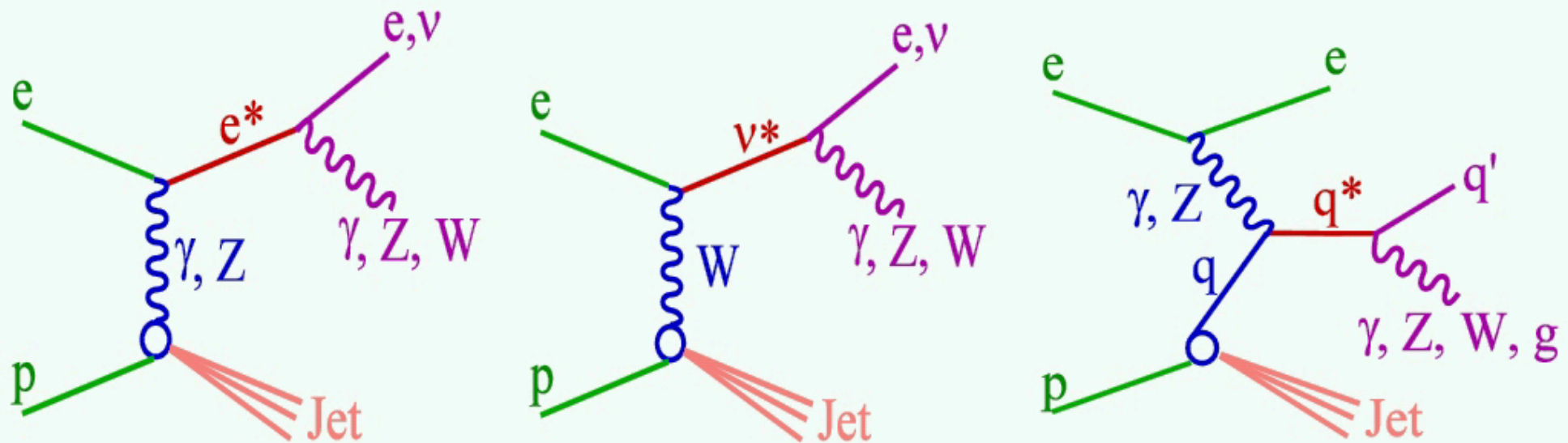
$f=f'$ \rightarrow forbids $\nu^* \rightarrow \nu \gamma$
 $f=-f'$ \rightarrow forbids $e^* \rightarrow e \gamma$
in both cases $f_s=0$

FOR q^* SEARCHES

if $f_s \sim f, f'$ $\rightarrow q^* \rightarrow q \gamma$ dominates largely.
As far as f_s is not too small,
Tevatron sets SEVERE limits on q^*

EXCITED FERMIONS PRODUCTION MECHANISM

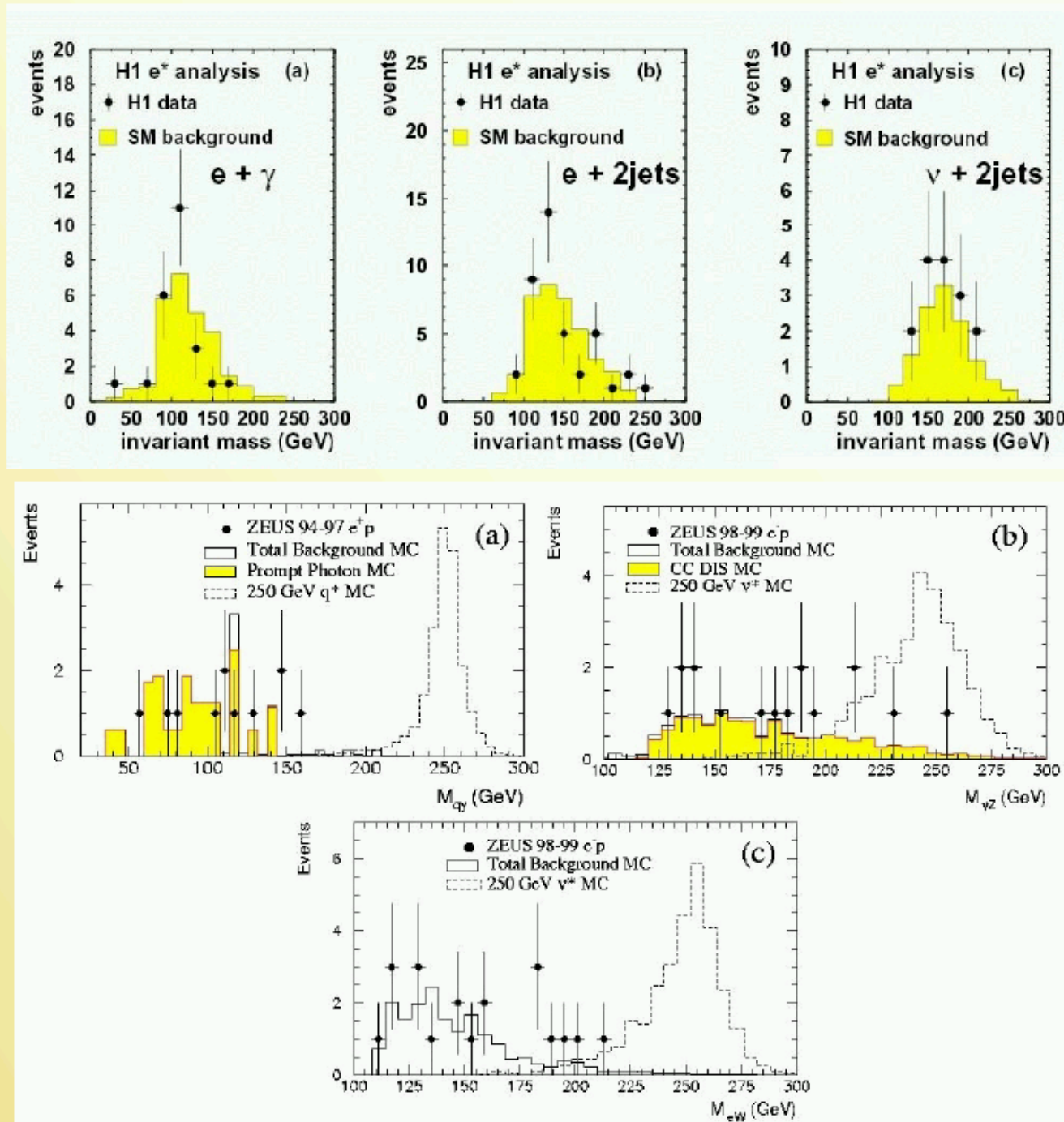
at HERA



48-120 1/pb at center of mass energy 300 GeV
~15 1/pb at center of mass energy 318 GeV

Selection based on :
photon or electron ID
missing transverse energy
hadronic jets.

HERA experimental distributions



data in agreement with SM

EXCITED FERMIONS PRODUCTION MECHANISM

at LEP

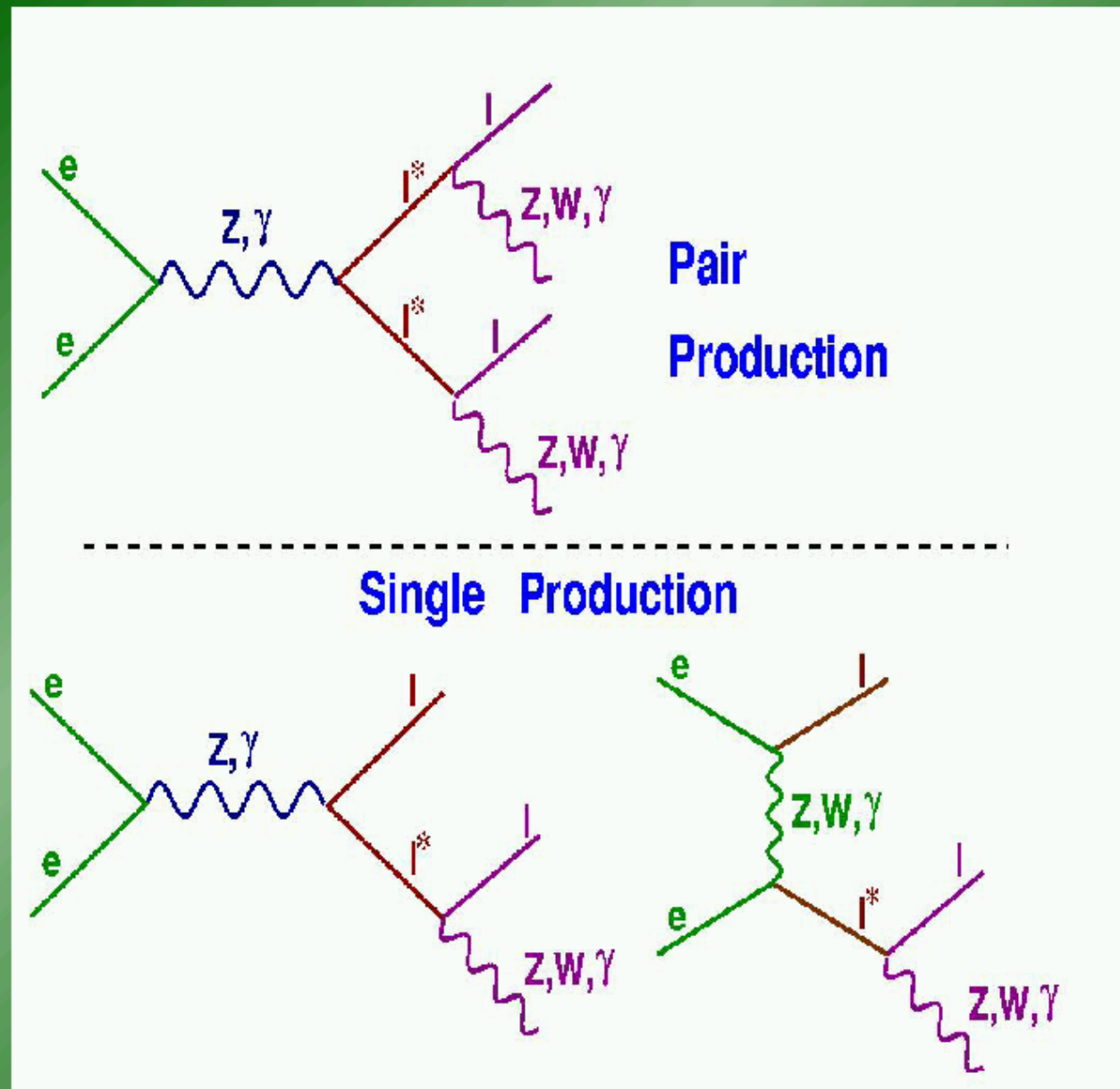
Photon, electron
and muon ID

τ reconstruction

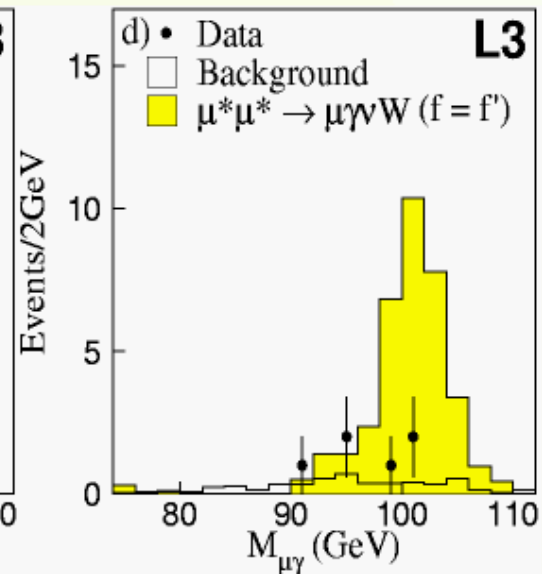
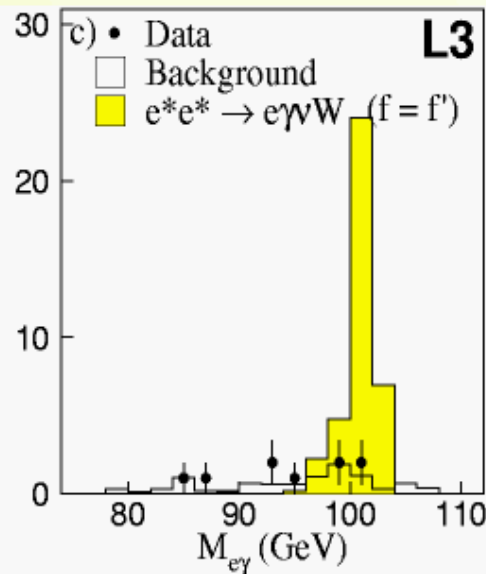
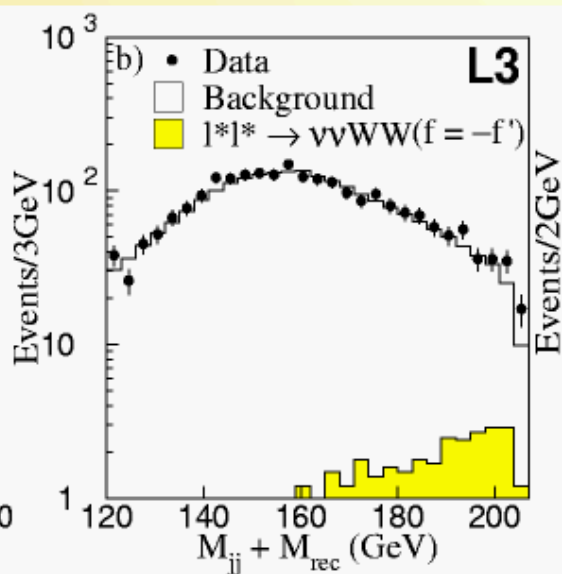
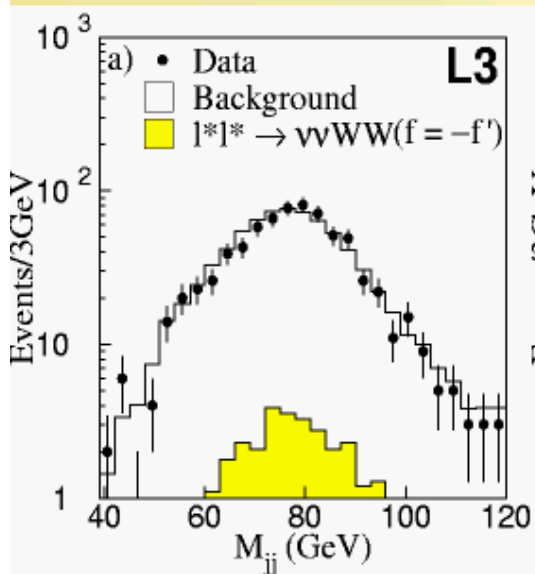
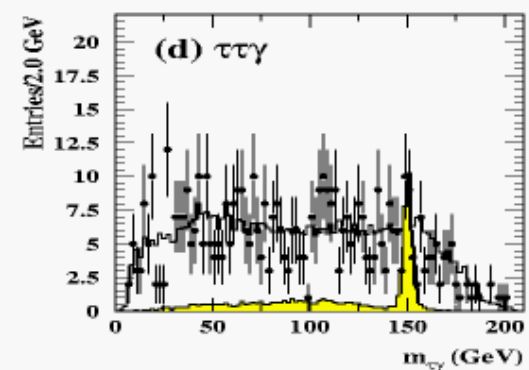
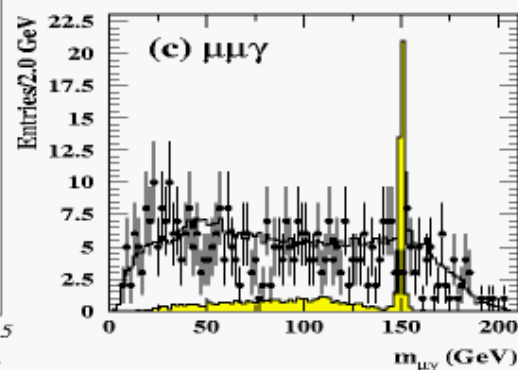
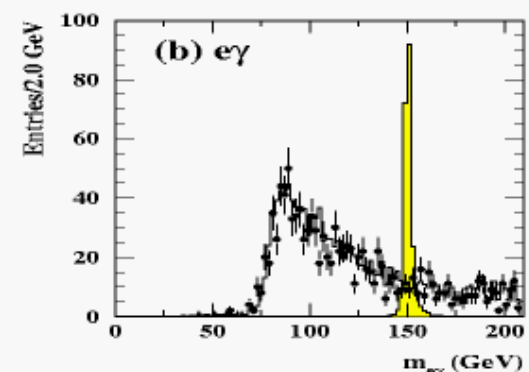
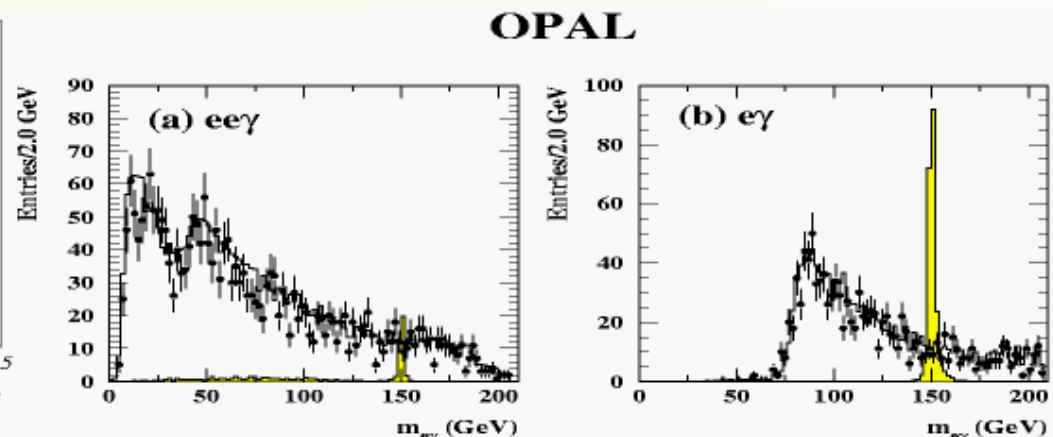
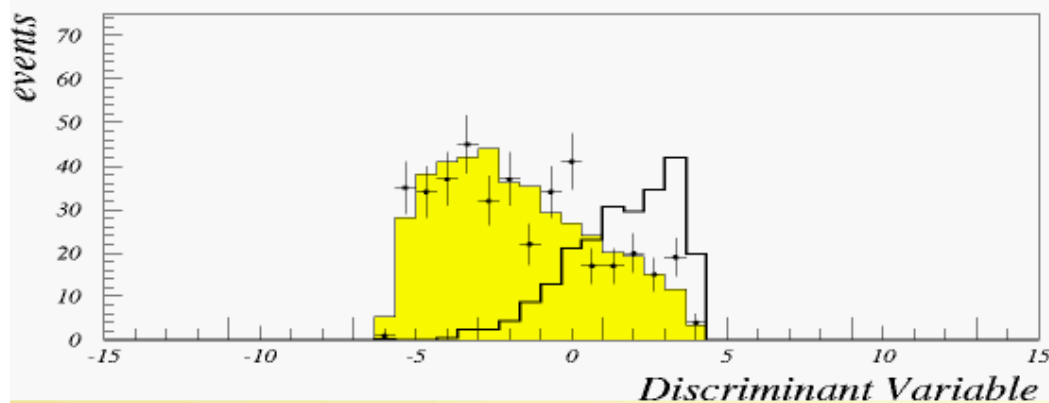
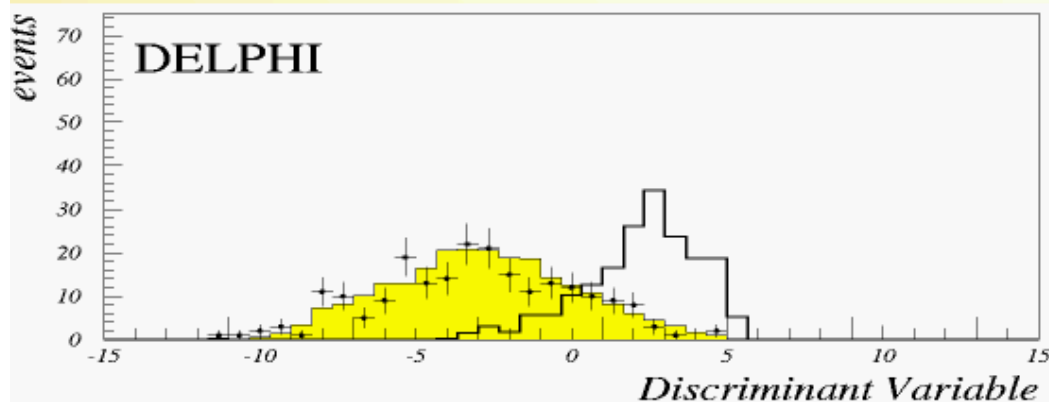
Missing mass and
momentum

hadronic jets
(mass and momentum)

Center of mass energies
up to 209 GeV and
luminosity around
500 1/pb



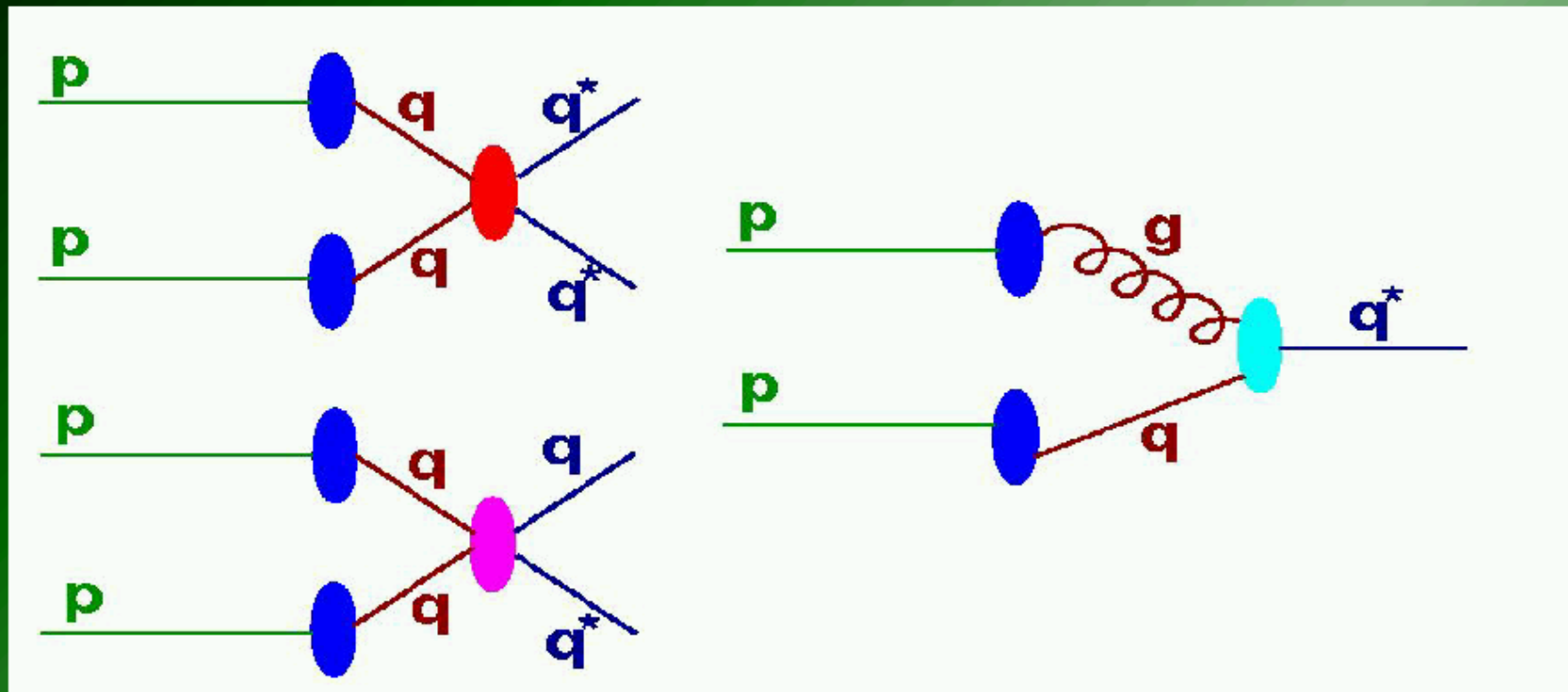
LEP experimental distributions



data in good agreement with SM expectations

EXCITED FERMIONS PRODUCTION MECHANISM

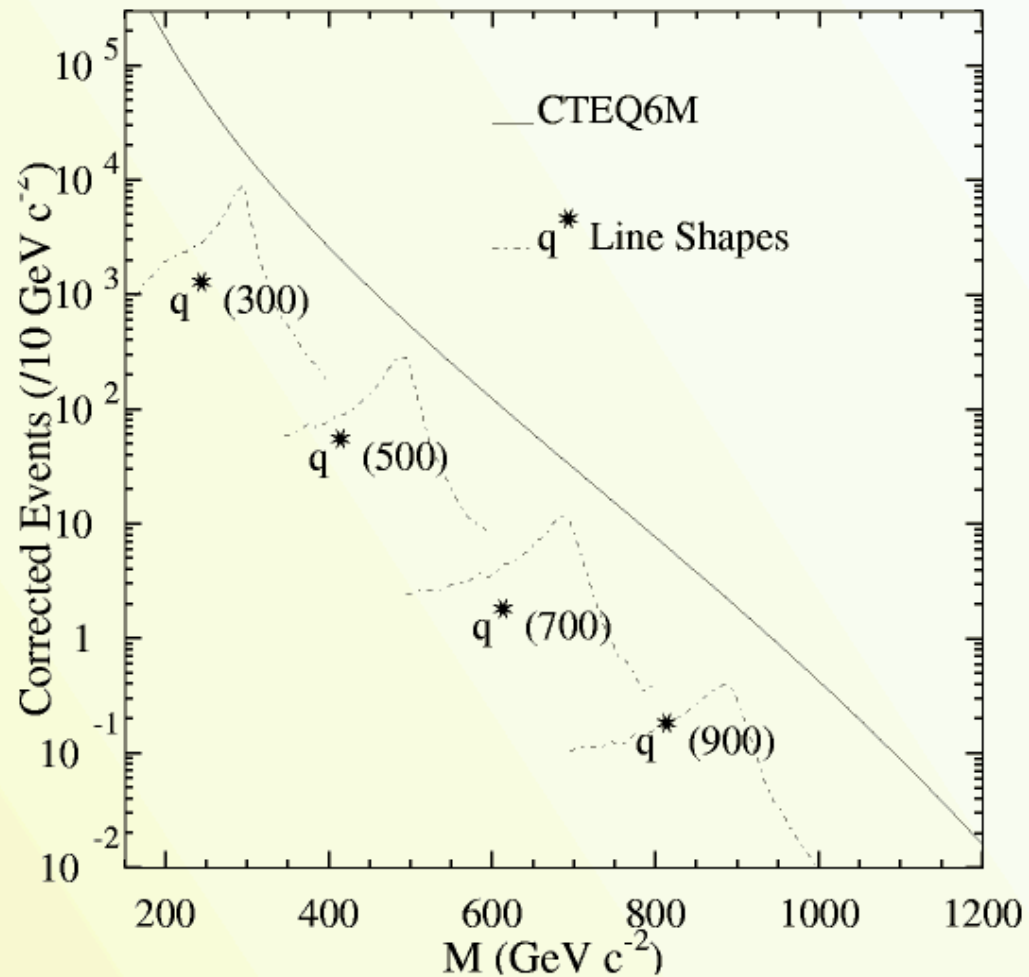
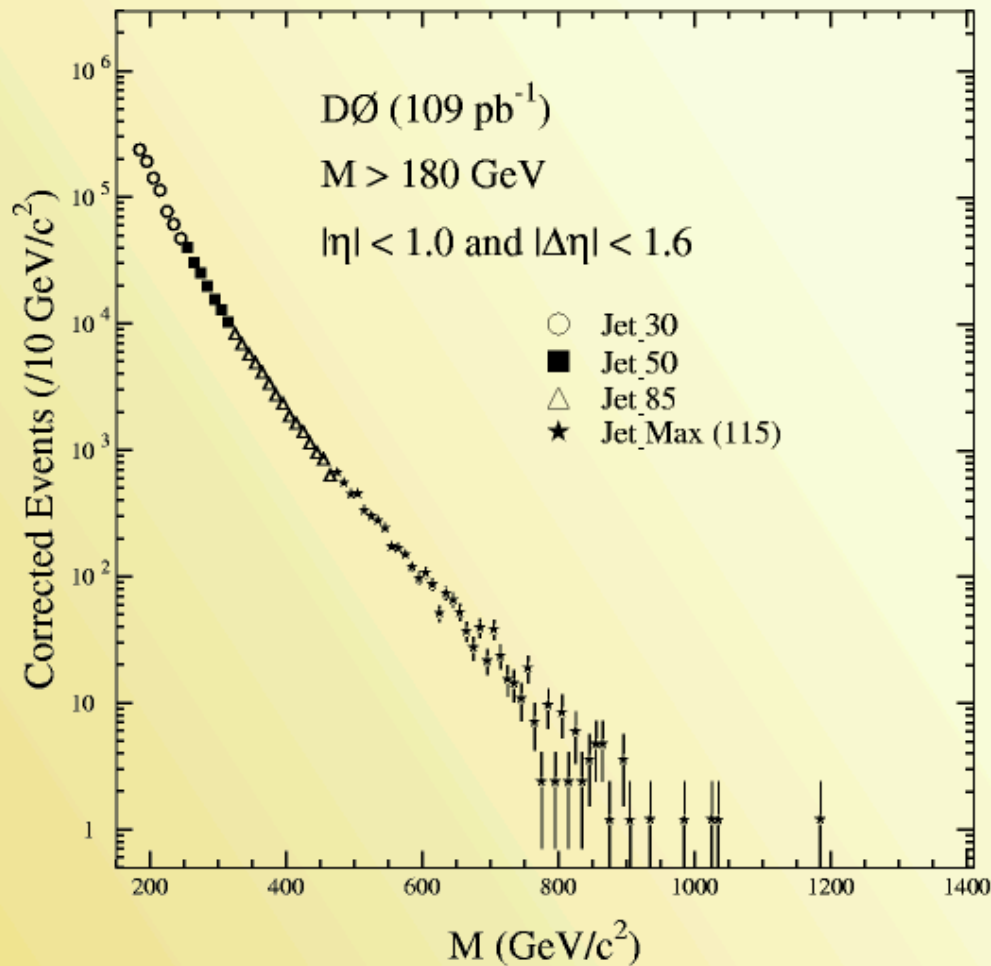
at TEVATRON



proton antiproton collisions
Luminosity of 10^9 1/pb at center of
mass energy of 1.8 TeV

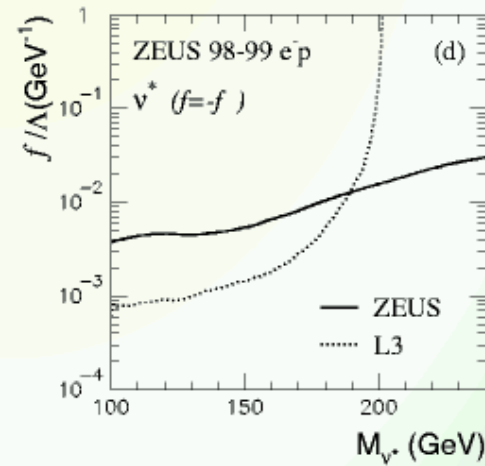
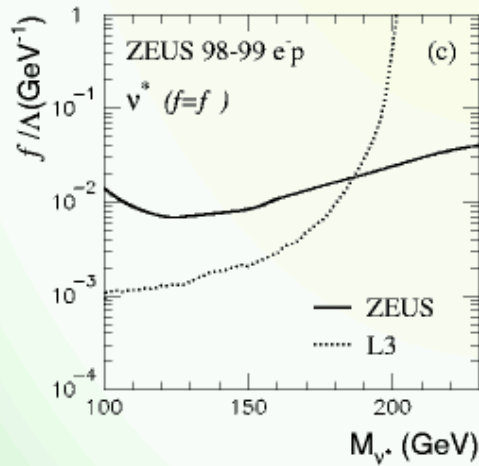
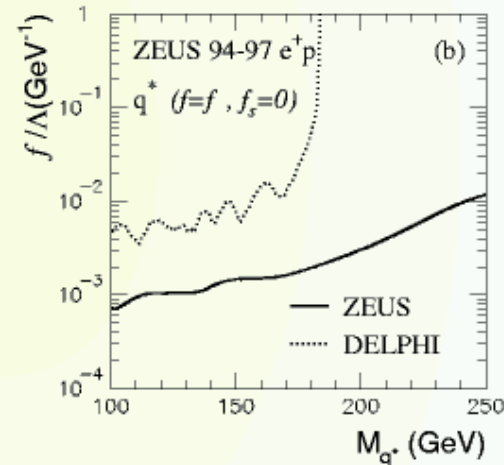
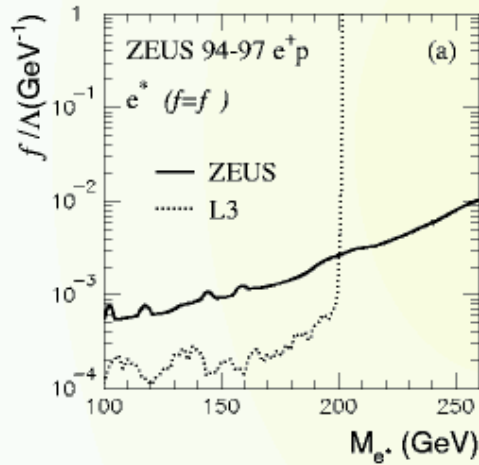
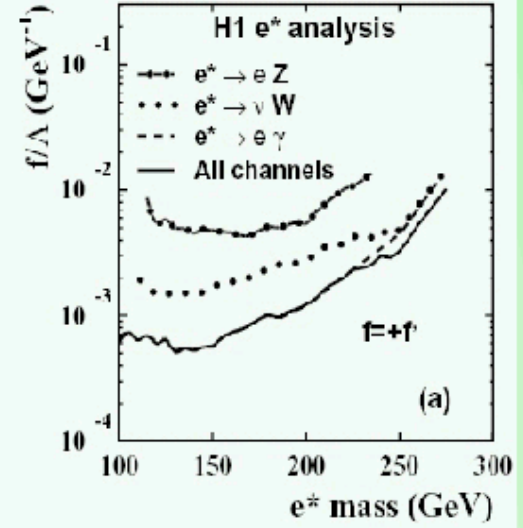
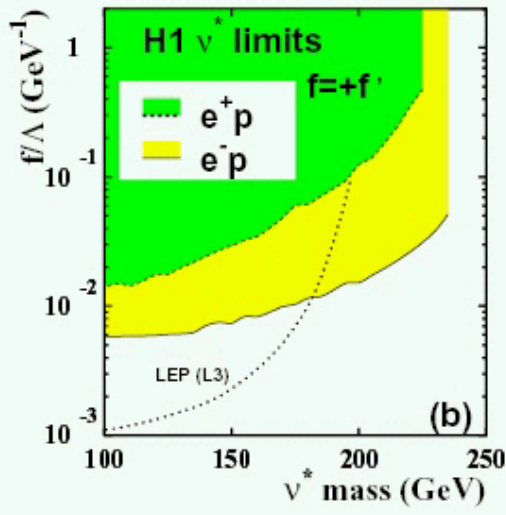
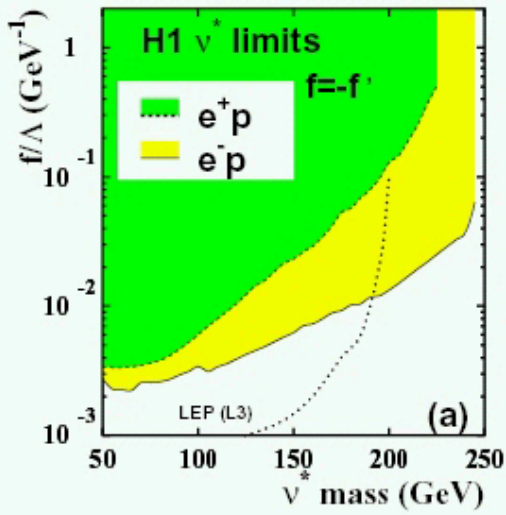
Results coming from the analysis of events
with two high pt jets in the final state

Tevatron experimental distributions

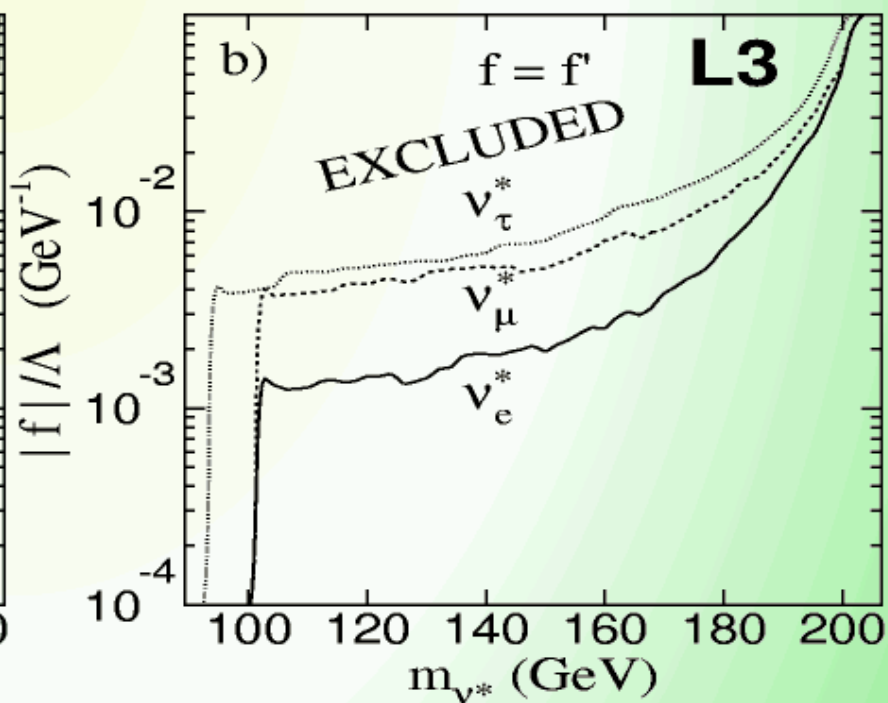
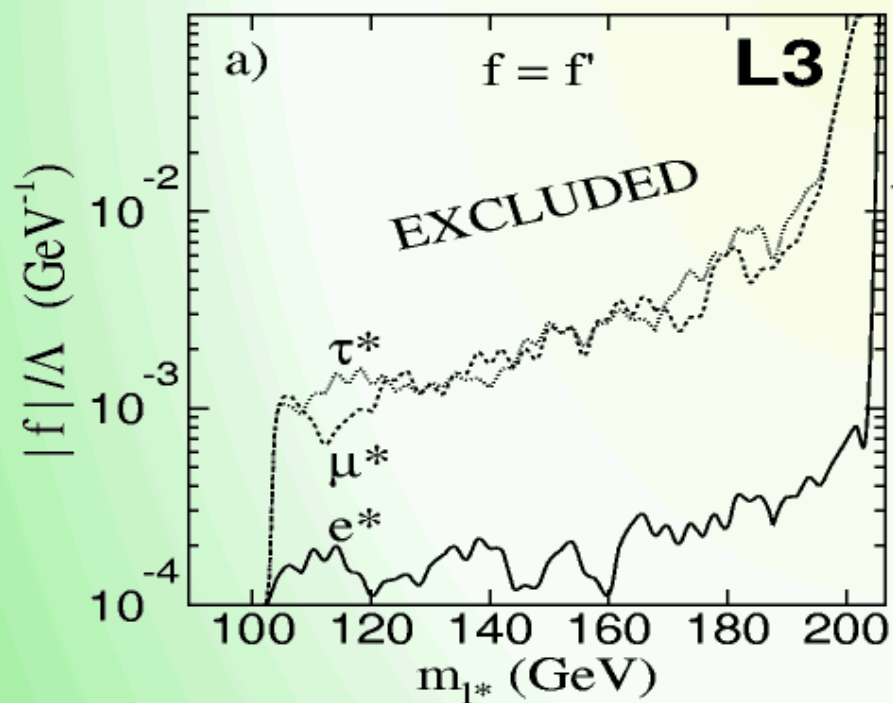
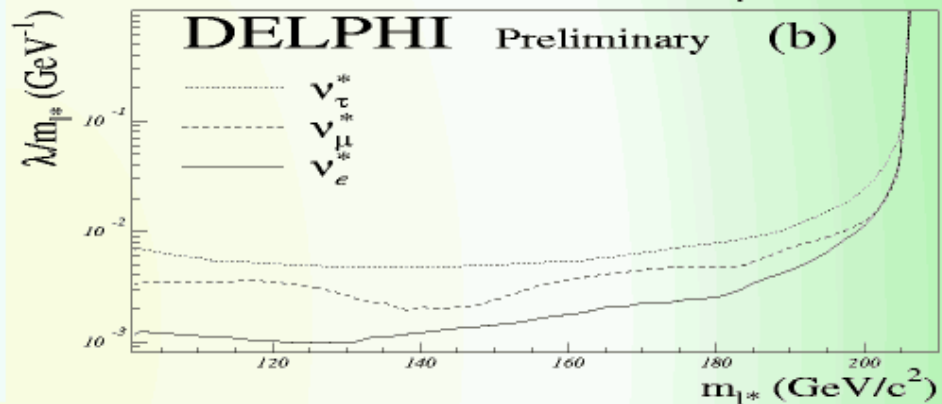
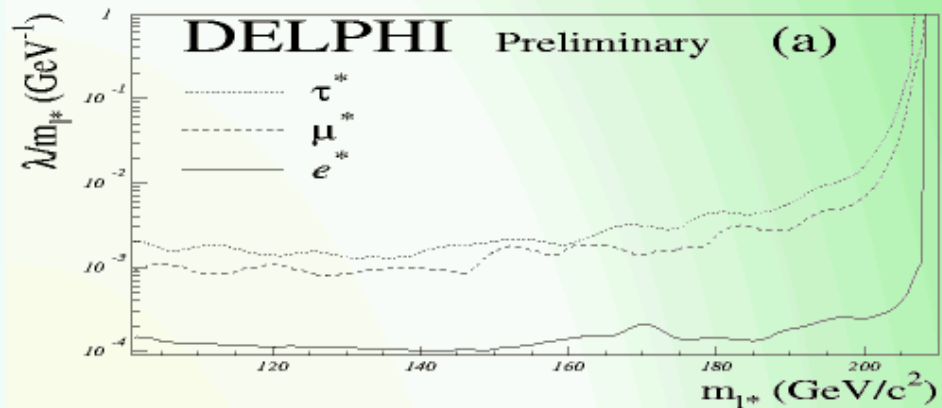
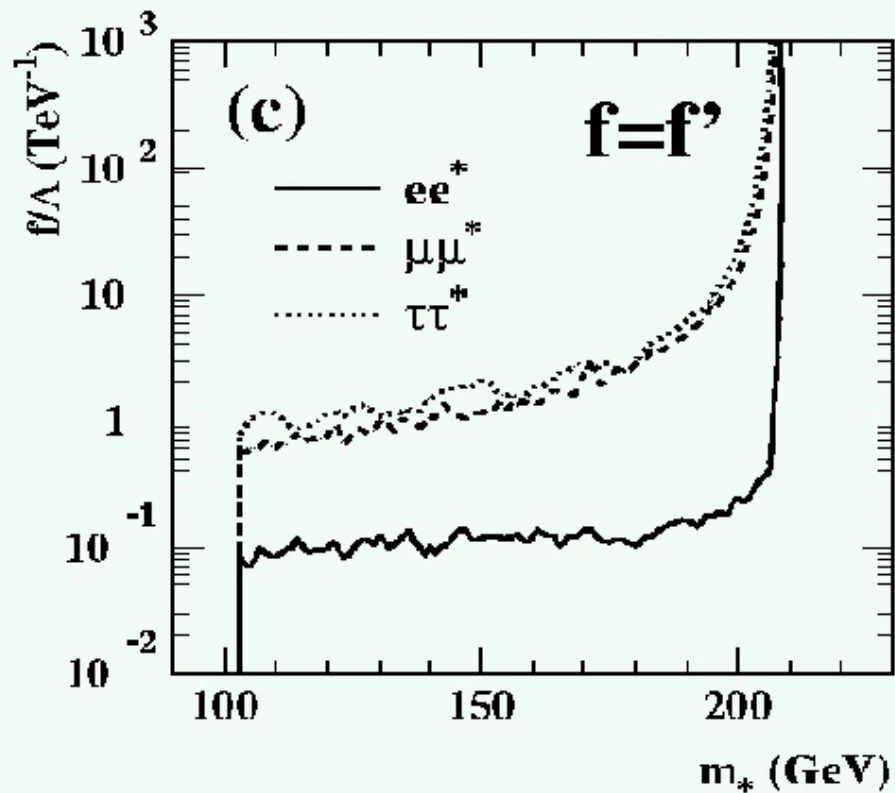


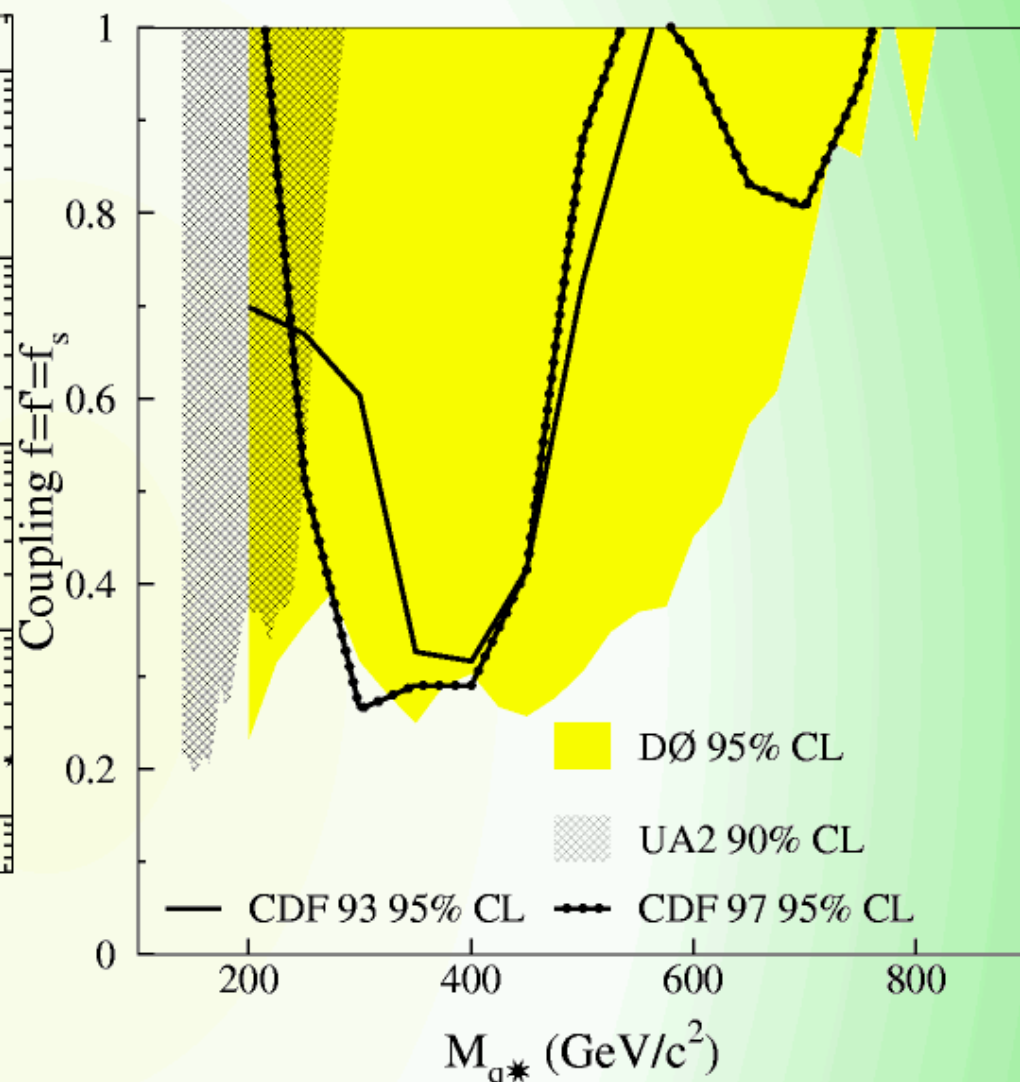
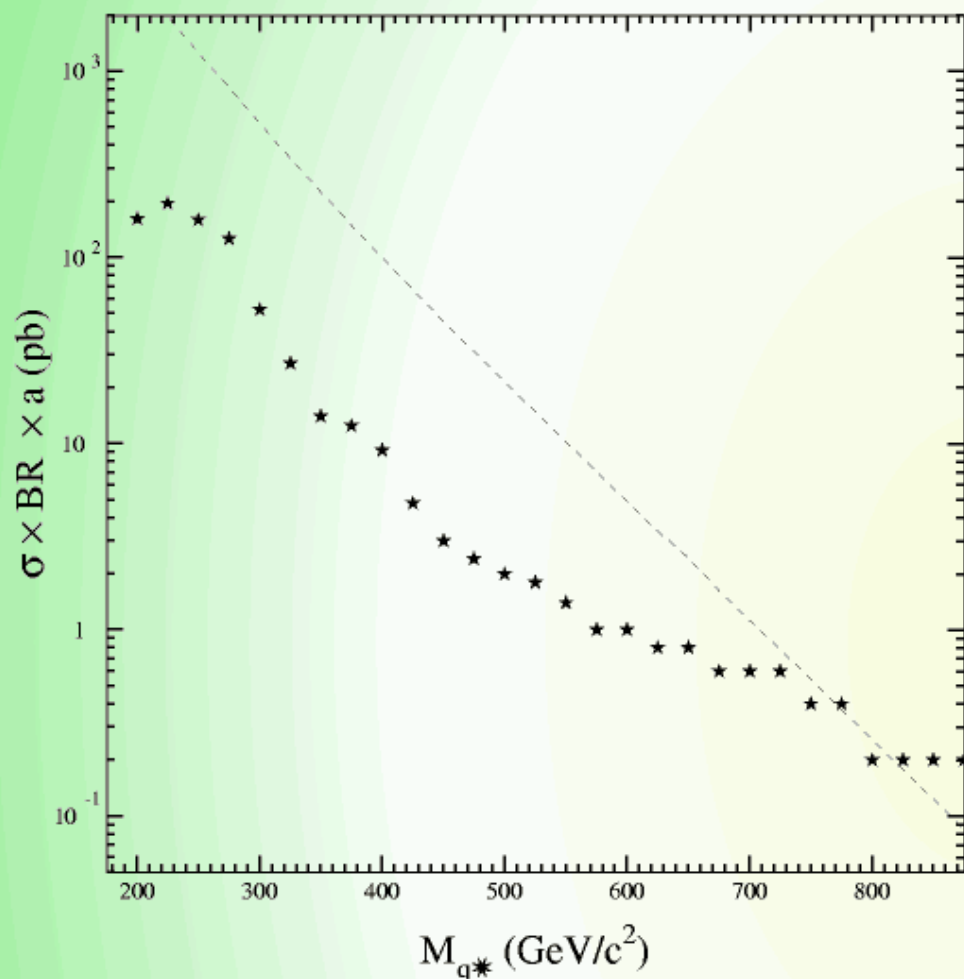
data in good agreement with SM expectations

RESULTS



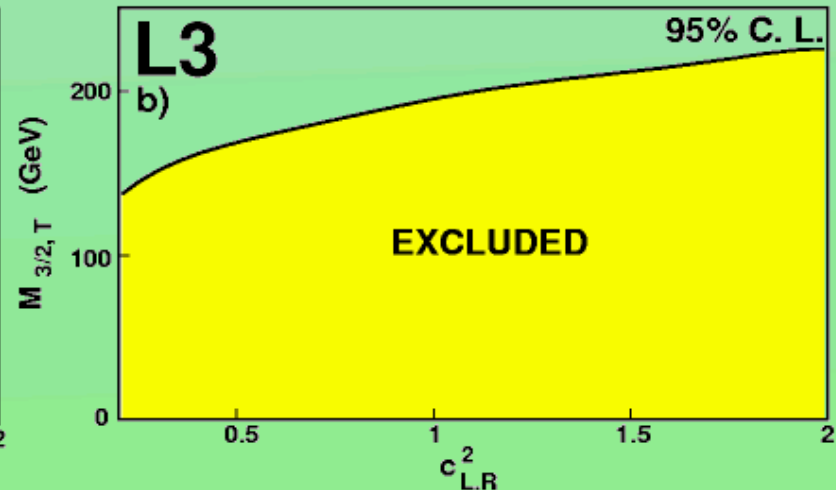
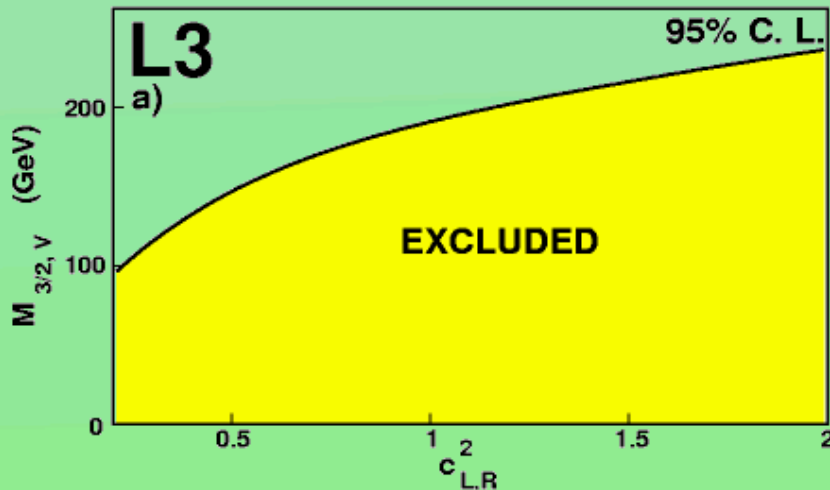
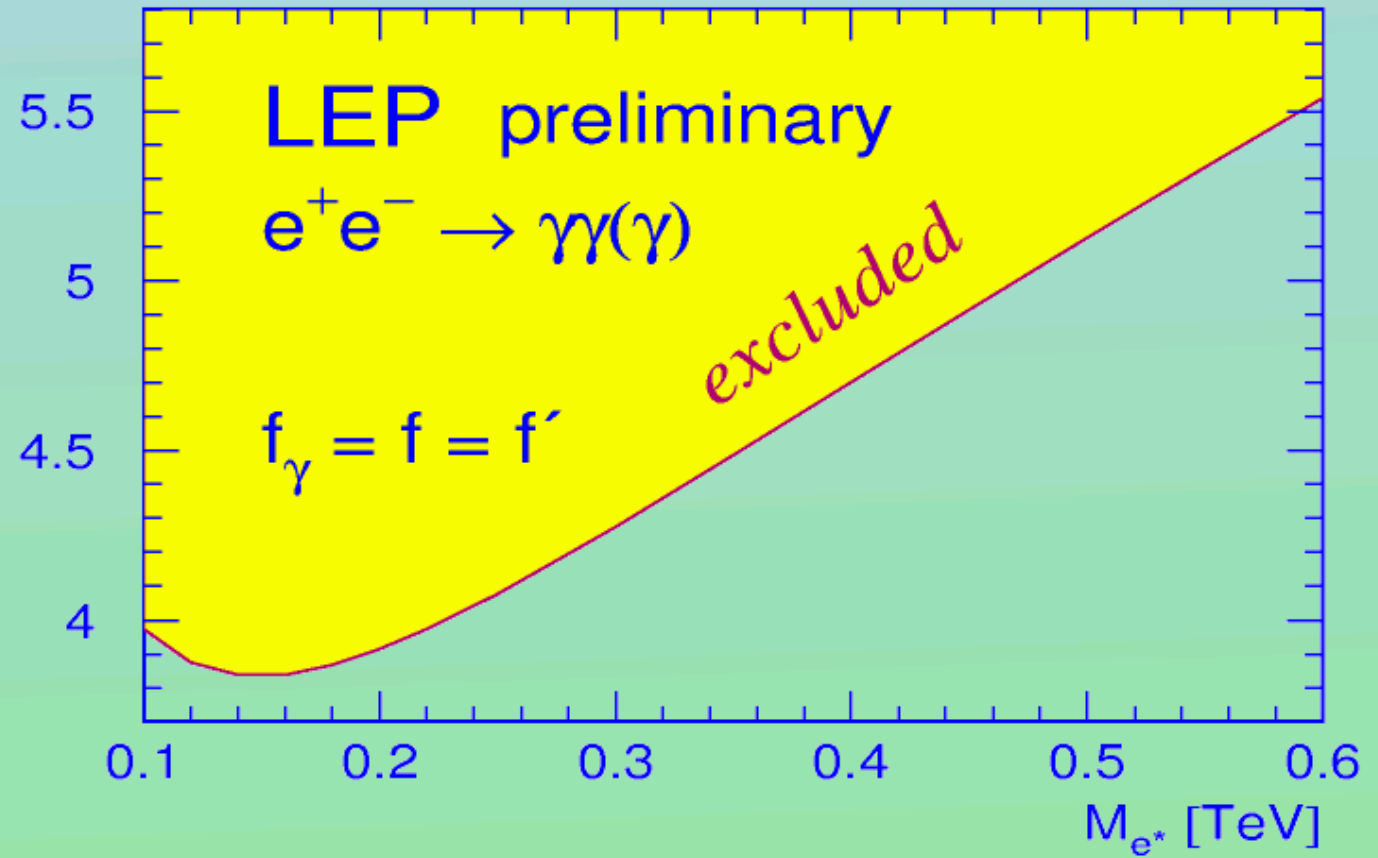
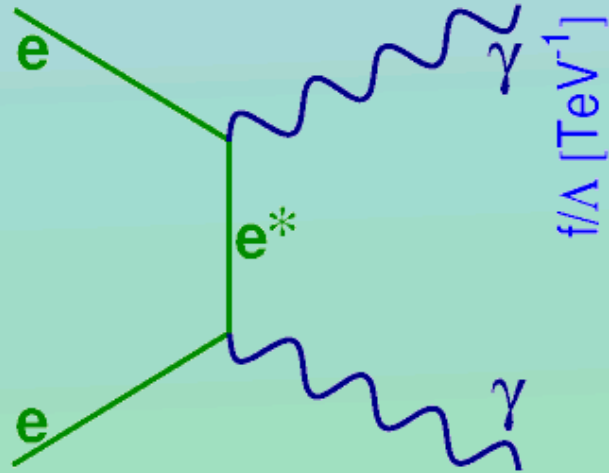
RESULTS





Mass of excited quark smaller than 770 GeV excluded
at 95% C. L. for $f_s=1$

INDIRECT SEARCH: Spin 3/2 excited fermions (L3) and limit from final state with photons



CONCLUSIONS

NO EVIDENCE of excited fermions

Masses excluded up to ~ 100 GeV for charged excited leptons or excited neutrinos and up to 770 GeV for excited quarks ($f_s=1$).

Compositeness models start to be in a difficult position

