SEARCHES FOR NEW PARTICLES @ LEP2

S. ROSIER-LEES (LAPP-ANNECY)
on behalf of the LEP experiments

SSI - 13 August 98

OUTLINE

Higgs Bosons

the Standard Model Higgs boson

the Higgs bosons of the MSSM (neutral and charged)

SUPERSYMMETRY

RP conserved

R_p not conserved

GMSB

not covered here $\tilde{t}'$, ℓ^*, $L^\pm$
but searches covered at LEP

DATA SAMPLES

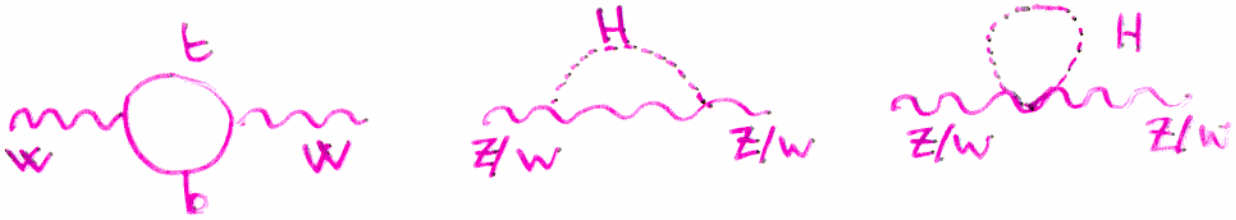
4 LEP EXPERIMENTS ADLO

	CM : $\sqrt{s}$	$\int \mathcal{L} dt$ / expt
1995	130-136 GeV	~ 6 pb^{-1}
1996	161 - 172 GeV	~ 20 pb^{-1}
1997	181 - 184 GeV.	~ 57 pb^{-1}
1998	189 GeV	$\sim$ 35-40 pb^{-1} (mid of July)

Note
- Most of the 183 GeV results are final and combined (thanks to Higgs and susy LEP WG)
- 189 GeV results are preliminary

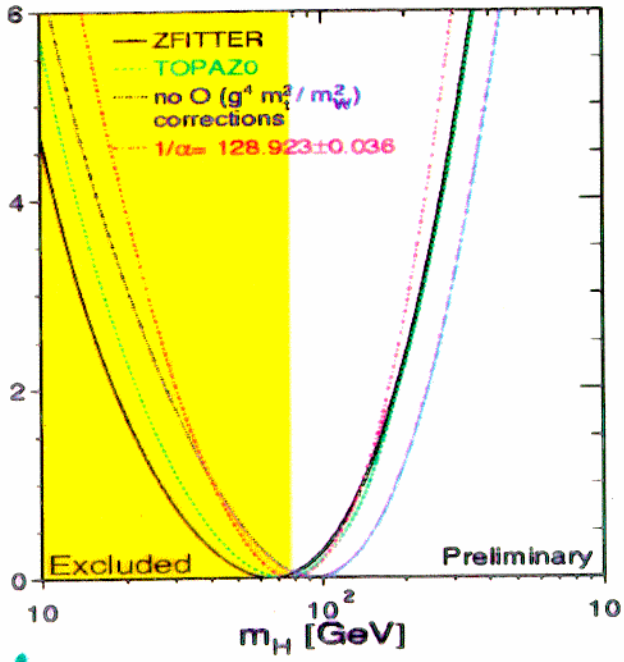
Indirect Search for H_{SM} from E.W. Measurements

Electroweak measurements sensitive to M_{Higgs} via radiative corrections



↳ accurate Electroweak measurements announce a light H_{SM}

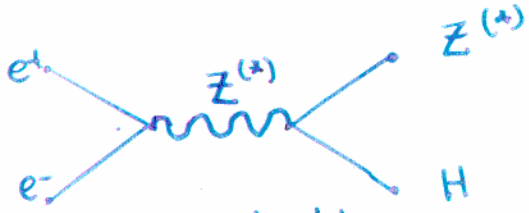
$m_H^{SM} \lesssim 280$ GeV @ 95% C.L



LEP Electroweak Working Group

Standard Model Higgs at LEP

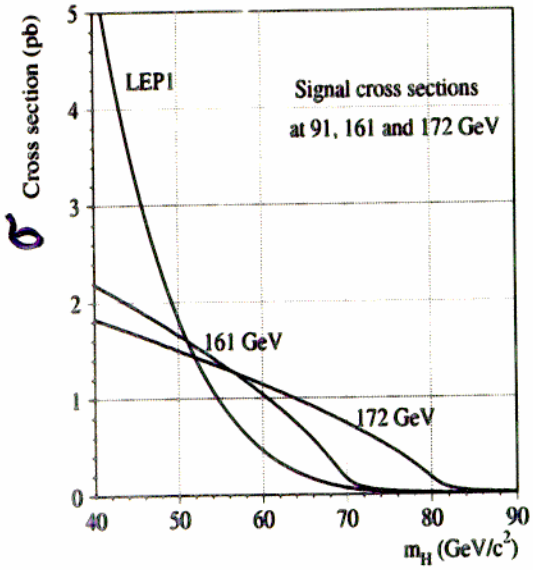
Main production mode :



Higgs strahlung

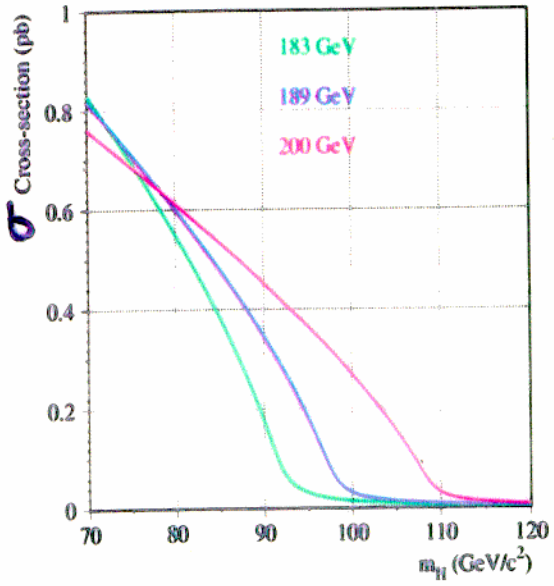
for $M_H \geq 50$ GeV

$\sigma_{LEP2} > \sigma_{LEP1}$



for $M_H = 85$ GeV

~ 20 events per exp. expected at 183 GeV



Mayor background

$e^+e^- \to q\bar{q}(\gamma)$	100pb
WW	10pb
ZZ	1 pb

b tagging is crucial

$\frac{S}{b}\Big|_{LEP1} \sim 10^{-6} \longrightarrow \frac{S}{b}\Big|_{LEP2} \sim 10^{-2} - 10^{-3}$

H_{SH} Topologies

$H \rightarrow b\bar{b}$ ~85%
$\tau\tau$ ~8%
gg, cc ~7%
|||
hadrons ~92%

$Z \rightarrow$ hadrons (70%)
$\nu\bar{\nu}$ (20%)
leptons (10%)

4 topologies

$Hq\bar{q}$

Br ~ 60%

Top: Four Jets
1 pairing $= m_Z$

Back: WW, $q\bar{q}$, (ZZ)

$\varepsilon \sim 25\%$

B_tag

$H\nu\nu$

Br ~ 17%

Top.: $\not{E}$
Acop. Jets
H_Z = Recoiling Mass

Back $We\nu$, $WW_{\rightarrow B\bar{B}}$

$\varepsilon \sim 45\%$ Hermeticity + B_tag

Hll

Br ~ 6%

Top.: 2 isolated l
$M_{ll} \sim m_Z$

Back $ZZ \rightarrow l^+l^- q\bar{q}$

Excellent Mass Resolution
$\frac{\sigma_{MH}}{M_H} \sim 2\%$

$\varepsilon \sim 60 : 75\%$

$\tau\tau q\bar{q}$, $q\bar{q}\tau\tau$

Br ~ 9%

Top: 2τ isol
+ 2 jets

Back $ZZ \rightarrow \tau\tau q\bar{q}$

$\varepsilon \sim 20\%$

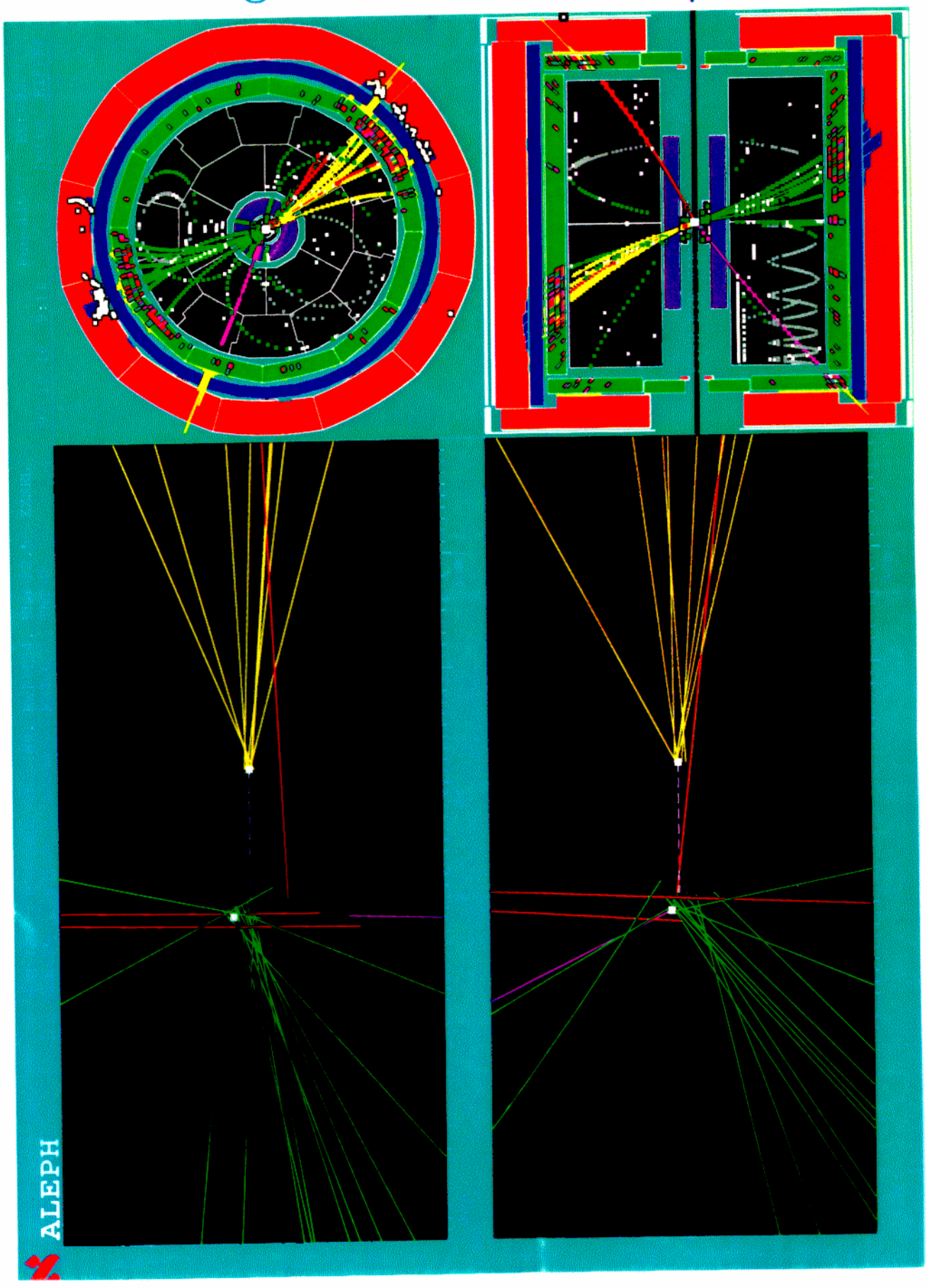
- ALL THE DECAY CHANNELS ARE USED ($\neq$ LEPI)

Made on 4-Nov-1997 17:06:25 by DREVERMANN with DALI_E1.
Filename: DC044577_009277_971104_1705.PS_ZZ_TO_B

$e^+e^- \rightarrow e^+e^- b\bar{b}$

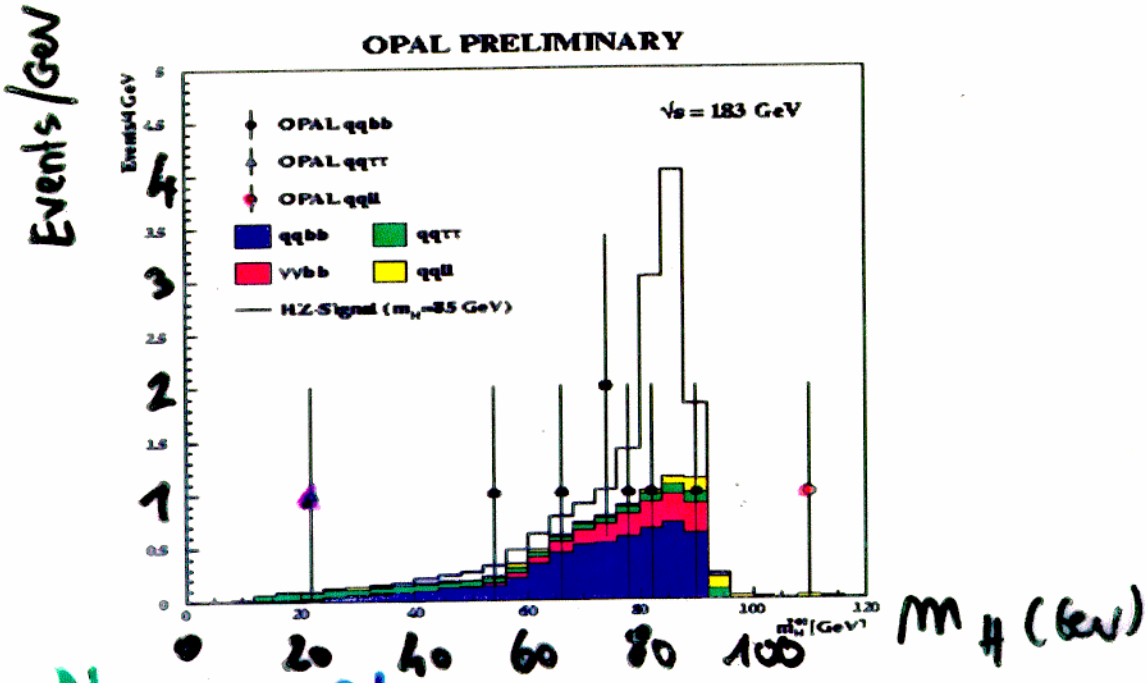
$M_{b\bar{b}} \approx 96$ GeV

$M_{e^+e^-} \approx 85$ GeV



H_{SM} - Results @ 183 GeV

- Mass distribution for the candidates from OPAL



	N_{exp}	N_{obs}
A	7.2	7
D	6	6
L	11	11
O	9	9

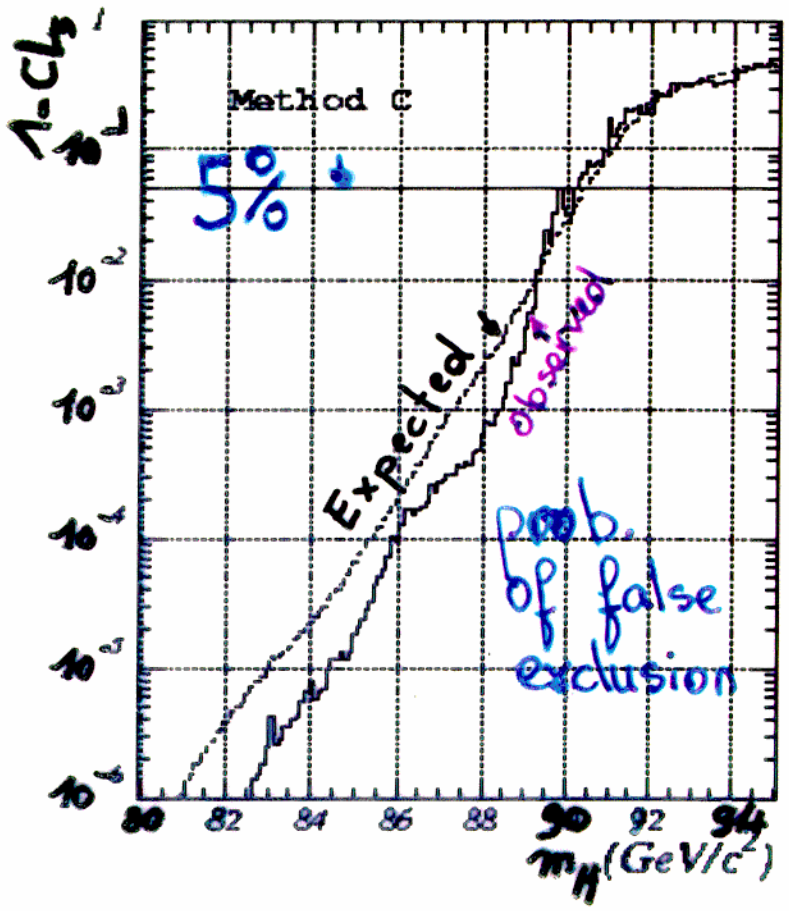
Number of events @ 183 GeV

No excess => limit on the mass

LIMIT ON $M_{H_{SM}}$ UP TO 183 GeV

	Expected $M_{H_{SM}} \geq$ (GeV)	observed $M_{H_{SM}} \geq$ G
A	85.5	87.9
D	86.5	85.7
L	85.0	87.6
O	86.2	88.3

Limits are below the K.L more Luminosity helps



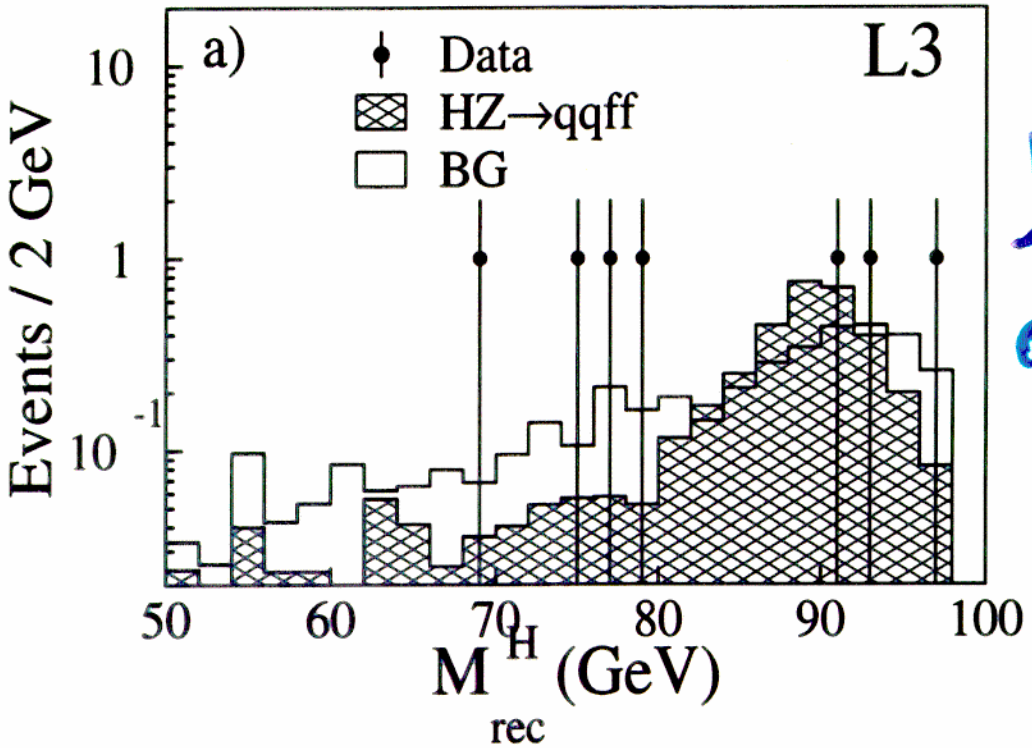
When Combining

P. Igokemenes et al. LEP Higgs WG

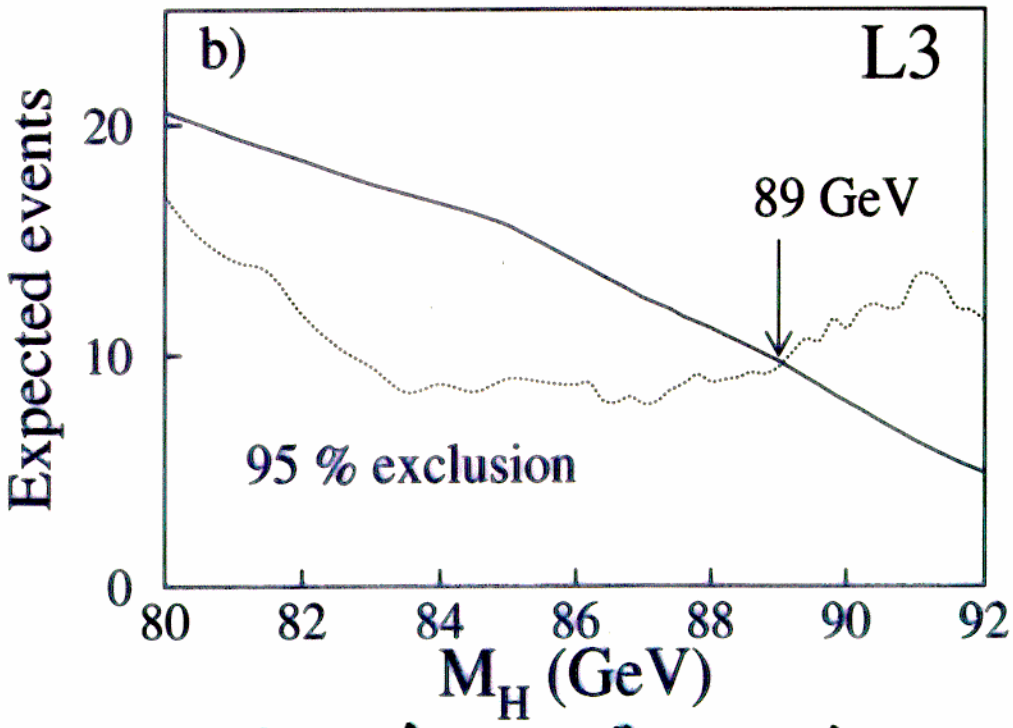
$M_{H_{SM}} \geq 89.8$ GeV (90.4 exp)

Note: four methods are used; spread of the limit is 0.15 GeV the most conservative result is choosen.

H_{SM}. Preliminary 183 and 189 Results



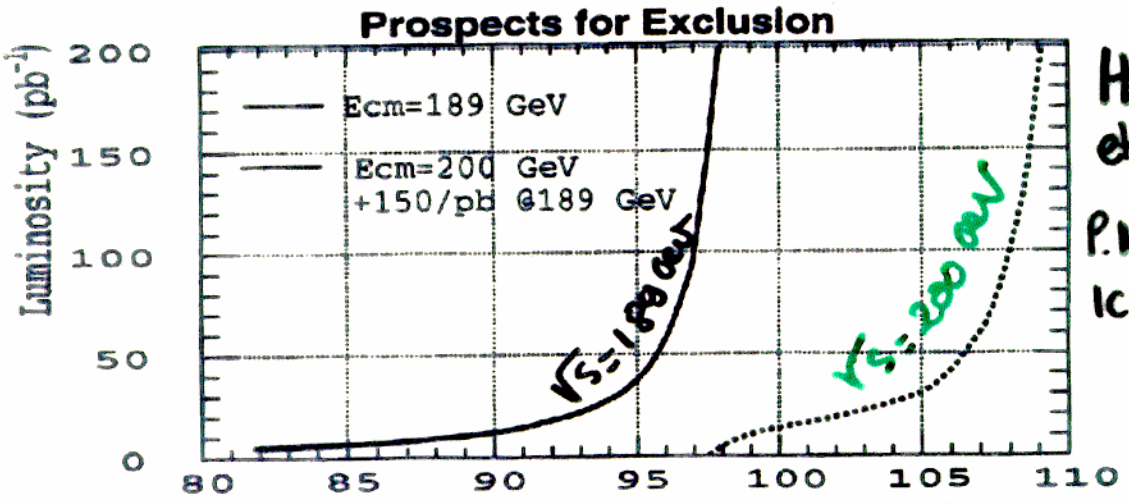
$\sqrt{s}$ = 189 GeV only



$M_{H_{SM}} > ?$ (GeV)	A	D	L	O
exp	87.5	89.5	88.6	89.3
obs	88	89.6	89	93.6

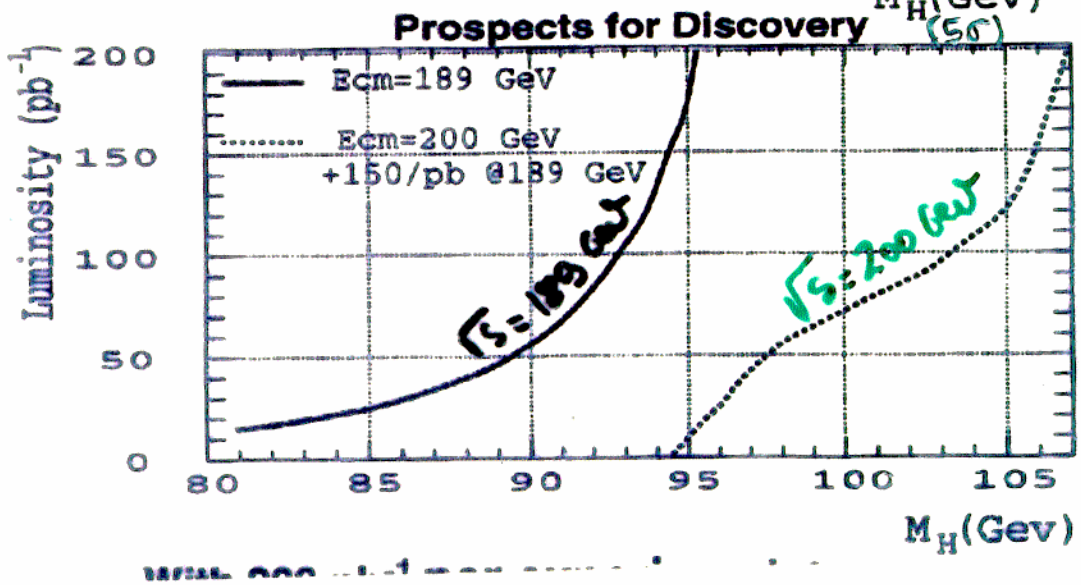
H_{SM} - Prospects

Note: LEP COMBINED



H. Gross et. Al

P. McNamara ICHEP 98



$\sqrt{s}$ = 189 GeV sensitive to ~ 94 GeV

$\sqrt{s}$ = 200 GeV sensitive to ~ 107 GeV

The Higgs bosons of the MSSM

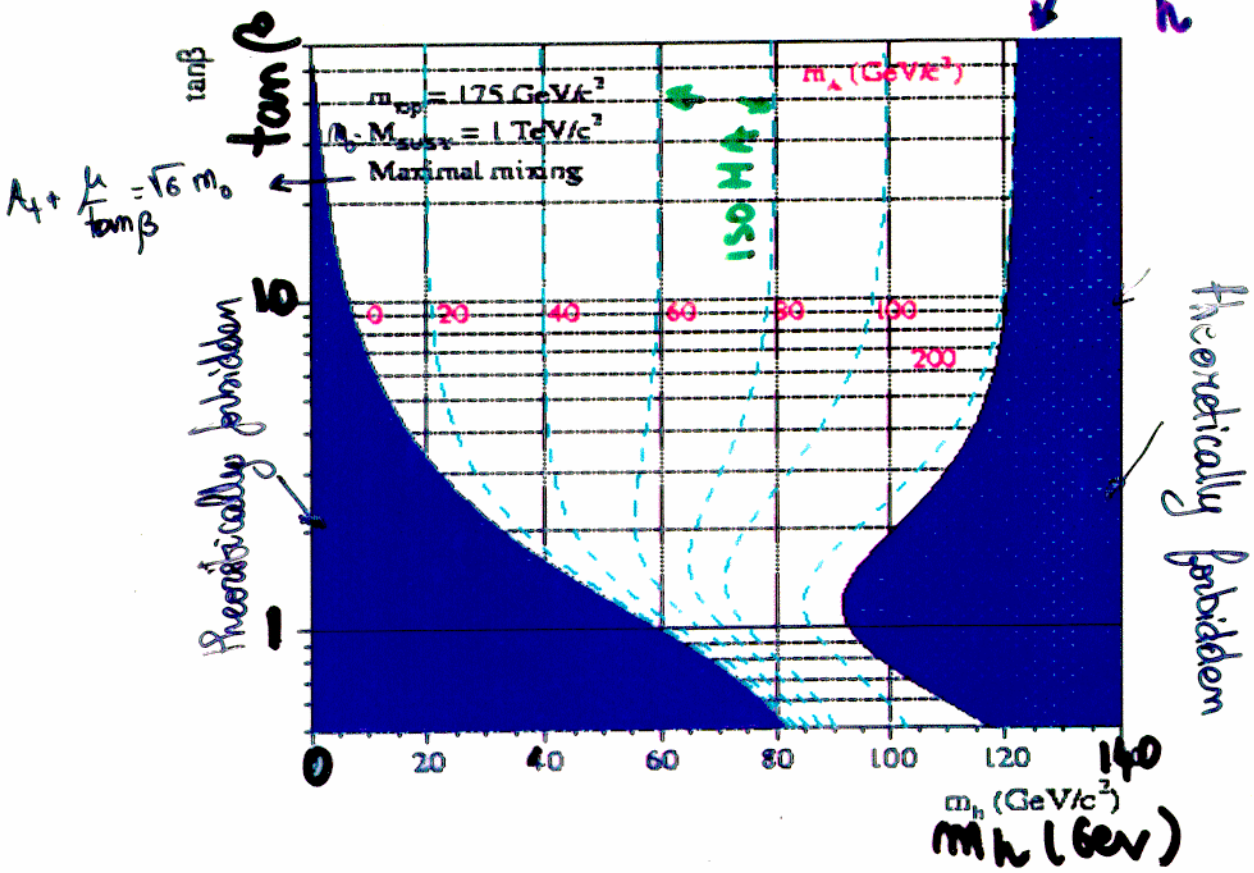
(reminder SM)

- Two Higgs doublets v_1, v_2 [one doublet : v]

$H_1 \begin{pmatrix} \phi_1^0 \\ \phi_1^- \end{pmatrix}$ → up quark mass $v_1 = \langle H_1^0 \rangle$ v.e. v

$H_2 \begin{pmatrix} \phi_2^+ \\ \phi_1^0 \end{pmatrix}$ → down quark mass $v_2 = \langle H_2^0 \rangle$ v.e v

$m_h \leq 130$ GeV



- Five physical states [one physical state H]

h^0, H	A	H^+H^-
cp even (a)	cp odd	charged

- Two parameter at tree level [one parameter m_H]

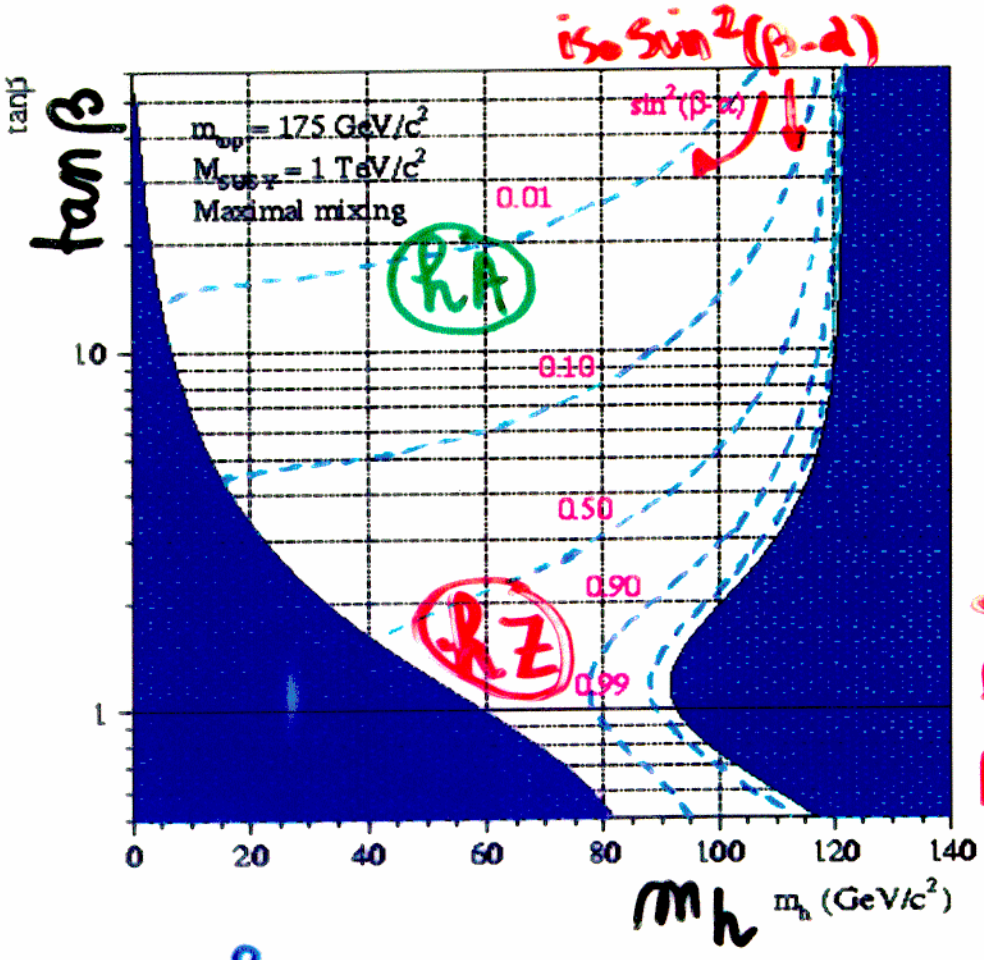
$tg\beta = v_2/v_1$, m_h

- Radiative Corrections [quadratically divergent]

Finite but depend on m_{top}, $m_{\tilde{t}}(m_{susy})$, A_t, A_b, μ $(m_{\tilde{f}})$

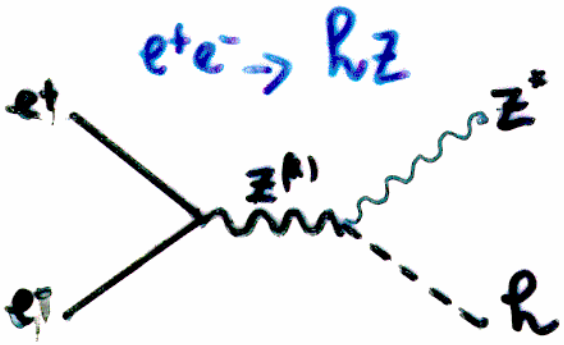
Production Processes

Look for h and A since H is to heavy to be produced at LEP

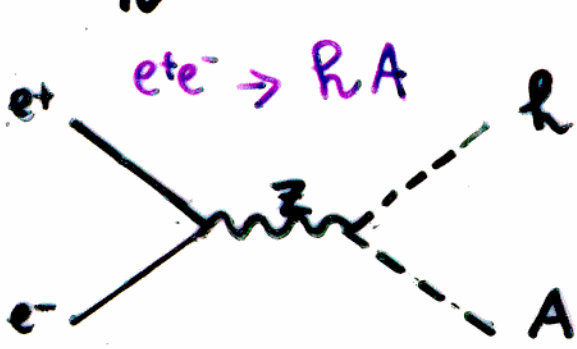


Large tanβ hA dominates

small tanβ hZ dominates



$\sigma\alpha \sin^2(\beta-\alpha)$



$\sigma\alpha \cos^2(\beta-\alpha)$

↑ COMPLEMENTARY ↑

Searches for $e^+e^- \to hZ$

- Standard Model like decays

  same topdogies as for S.M

- Invisible decays

  $h \to \chi_1^0 \chi_1^0$, $Z \to e^+e^-, q\bar{q}$

	M_{hZ} (GeV)	
A	80	
D	84.3	(189 GeV included)
L	83.6	
O	81	

- $m_A < m_h/2 \to h \to AA$

  → if $m_A > 2m_b$ cf S.M

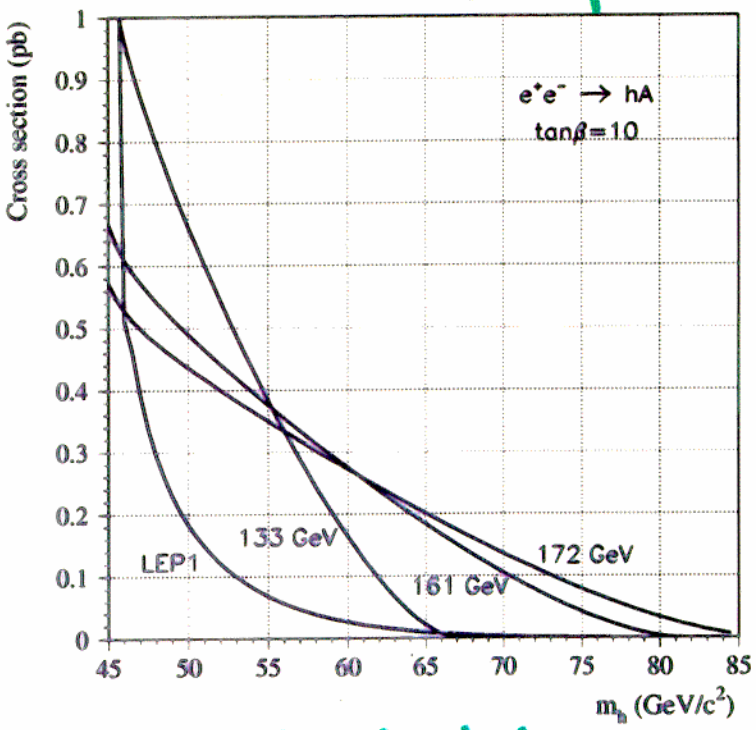
  → if $m_A < 2m_b$ not yet excluded tampons

Searches for hA

- Production cross section $\sin^2(\beta-\alpha) \sim 1$

$m_A \sim 70$ GeV , $\sigma_{161} \sim \sigma_{172} \sim 0.15$ pb
$\sigma_{183} \sim 0.18$ pb

↳ $\sim$ 11 hA events in each experiment



- Topologies : Two final states

$hA \rightarrow b\bar{b}\,b\bar{b}$ (85%)

4 Jets, all b-tagged.
(also $hA \rightarrow AA \rightarrow b\bar{b}b\bar{b}b\bar{b}$ by opal)

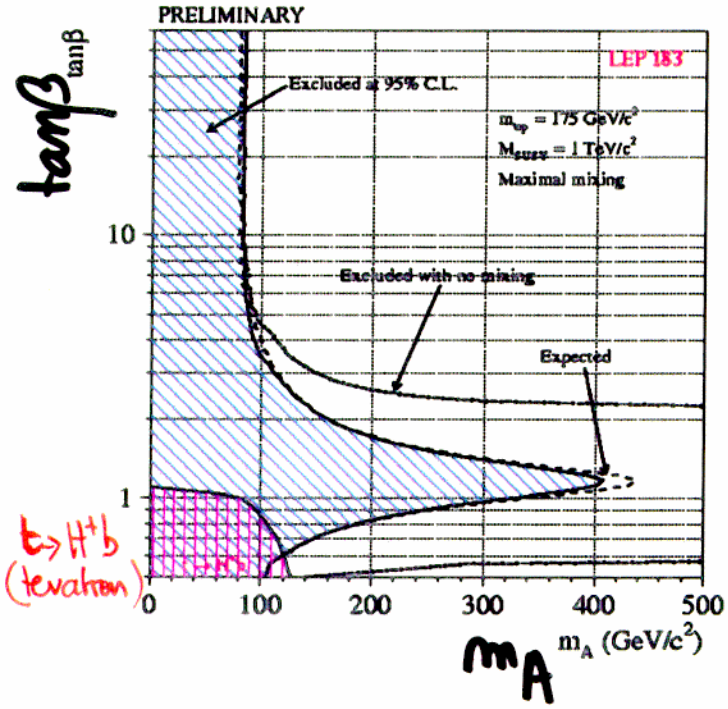
$hA \rightarrow c\bar{c}b\bar{b}$, $b\bar{b}c\bar{c}$ (15%)

two b-tagged jets
two thin jets

	N_{back}	N_{obs}	ε(%)	N_{back}	N_{obs}	ε(%)
ADLO	11.2	11	50-60	2.5	3	25-45

$e^+e^- \to hA$ Results

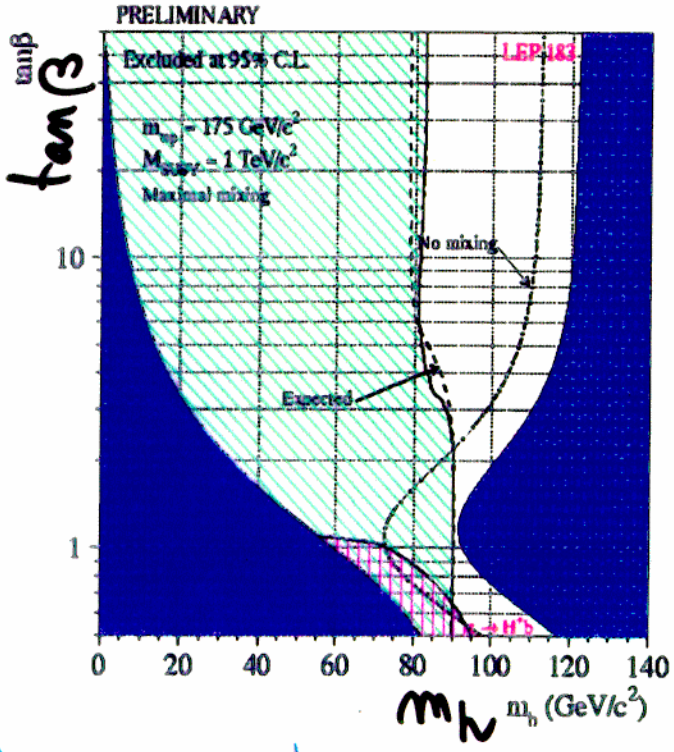
"benchmark" Scan : $m_0 = 1$ TeV ; minimal or maximal mixing ; $m_{top} = 175$ GeV



	$m_h \geq$ (GeV)	$m_A \geq$ (GeV)
A	72.2	76.1
D	74.4	75.2
L	70.7	71.0
O	70	70.5

$\sqrt{s} = 183$ GeV

ADLO combined (183 GeV)



$m_h \geq 77$ GeV

$m_A \geq 78$ GeV

$\forall\, tg\beta \geq 0.8$

Note : for minimal mixing $tg\beta \leq 2.1$ excluded.

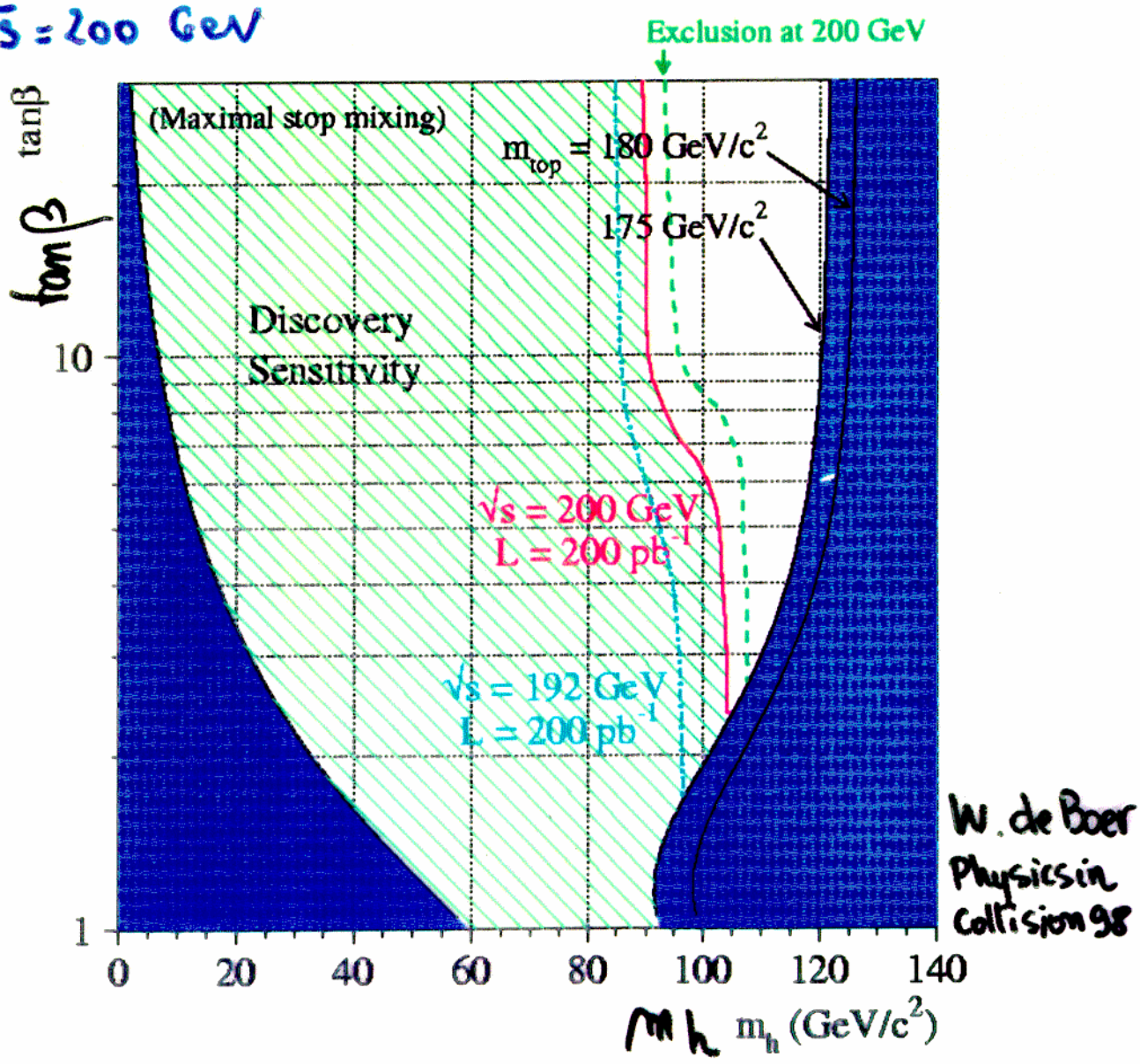
e^+e^- → hA FUTURE

- $\sqrt{s}$ = 189 GeV

  for all experiment limits improved already by 4 ÷ 5 GeV

  $m_h, m_A \geq 79.7$ GeV ALEPH

- $\sqrt{s}$ = 200 GeV



discovery (5σ)

$m_h \sim 105$ GeV $tg\beta \leq 5$

$m_h \sim 84$ GeV $tg\beta \geq 5$.

low tanβ excluded if no discovery

Charged Higgs Bosons

. Production cross sections @ LEP

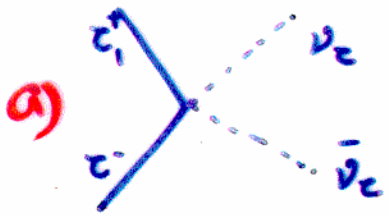
$M_{H^\pm} = 55$ GeV

$\sigma_{161} = \sigma_{172} \simeq \sigma_{183} = 0.5$ pb

$\mathcal{L} \rightarrow$ 35 evts / expt

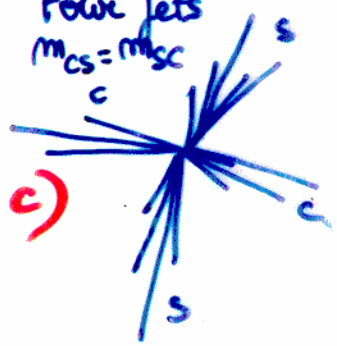
. Topologies $H^\pm \rightarrow \tau \nu_\tau$, $c\bar{s}$

acoplanar taus



2 Jets, 1 Tau, $\not{E}$

Four jets $m_{cs} = m_{sc}$



Experimentally challenging

W-pair production difficult to suppress

Note in the MSSM $m^2_{H^\pm} = m_A^2 + m_W^2 + \delta_{rad.corr}$ (very small, < 0)

$\Rightarrow m_{H^\pm} > m_{W^\pm}$

but LEP2 range may be relevant for NMSSM (M. Drees et al)

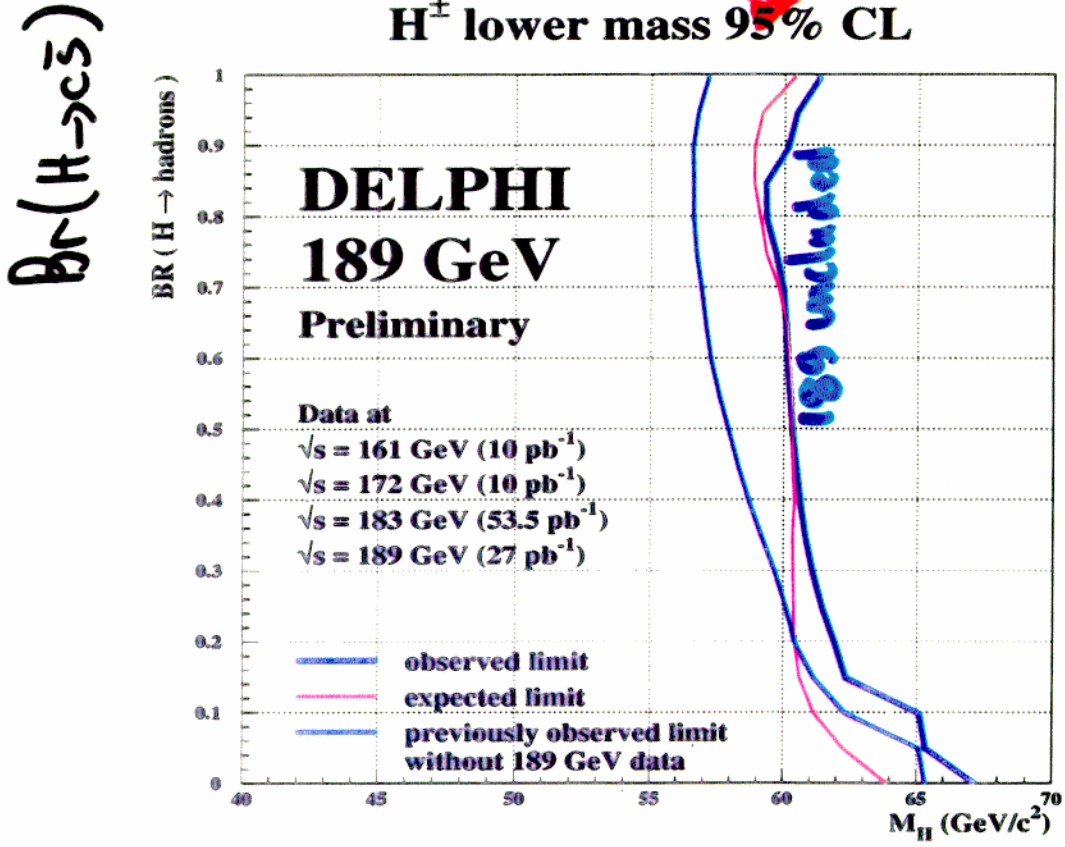
Charged Higgs - Results

- $\sqrt{s}$ = 183 GeV no excess observed ADLO

	N_{exp}	N_{seen}	ε (%)
topo b)	1.9	2	31
topo c)	4	3	17

Delphi @ 189 GeV

$Br(H \to c\bar{s})$



- Limits independent of $Br(H^+ \to \tau\nu)$

	$M_{H^+} \geq$ (GeV)	
A	59	
D	59.2	(189 included)
L	57	
O	56	

assuming $Br(H^+ \to \tau\nu) + Br(H^+ \to c\bar{s}) = 1$

Super Symmetry

Motivations

- boson $\overset{SUSY}{\leftrightarrow}$ fermions
- quadratic divergence solved in Higgs Sector
- may provide one candidate for the dark matter
- ...

Minimal Particle Contents

- Standard Particule / Superpartner sector

leptons $l^\pm$	sleptons $\tilde{l}_R, \tilde{l}_L$
neutrinos ν_l	sneutrinos $\tilde{\nu}$
quarks q_i	squarks $\tilde{q}_{R,L}$ $\tilde{t}, \tilde{b}$

[ALL SCALARS]

- Gauge / Gauginos Sector

Standard Bosons	Superpartner	
$W^\pm$, $H^\pm$	$\tilde{\chi}_i^\pm$ $i=1,2$	charginos
γ, Z, h, H, A	$\tilde{\chi}_i^0$ $i=1,4$	neutralinos
g_i	$\tilde{g}$	gluinos
G graviton	$\tilde{G}$ ou $\tilde{g}_{3/2}$	

[ALL FERMIONS]

○ produced/detectable at LEP

Phenomenology

SM particules and Susy partners should have the same mass, coupling

↳ **Susy has to be broken**

breaking susy mediated by gravity ↳ **Sugra**

or by gauge bosons ↳ **GMSB models**

MSugra + R_p conserved

$R_{parity} = R_p = (-1)^{2S+3B+L} = -1$ (Susy) 1 (SM)

- **LSP is Stable** dark Matter cand
- **Susy partides** produced by pairs $\not{E}$ $\not{M}$ acop. obj
- **NLSP** → **LSP** + $(X)_{SM}$

MSugra + R_p violated

- Vertex with on Susy particle allowed
- **LSP is now visible** no more $\not{E}$ ...

GMSB Models

- $\tilde{G}$ **gravtino is the LSP** $M_{\tilde{G}} \leq 1$ keV
- **NLSP?** $\chi_1^0 \to \tilde{G}\gamma$ or $\tilde{\tau} \to \tilde{G}\gamma$

The MSSM parameters

MSSM

m_A or m_R, $\tan\beta$

μ, A_t, A_b — Higgs / stop / sbottom mixing para

M_1, M_2, M_3 — gaugino mass parameters

$m_{\tilde{\ell}_R}$, $m_{\tilde{\ell}_L}$, $m_{\tilde{\nu}}$ — sfermions mass parameter

etc

124 parameters

Constrained MSSM

1) Unifies M_1, M_2, M_3 at the GUT scale $\rightarrow m_{1/2}$

$M_1 \sim 0.5\, M_2$ ($\hookrightarrow \chi_1^0$) $\quad M_2 \sim 0.8\, m_{1/2}$ ($\hookrightarrow \chi^+$) $\quad M_3 = 3.5\, M_2$ ($\hookrightarrow \tilde{g}$)

2) Unifies also scalare particules masses ($\tilde{f}$, higgs) $\rightarrow m_0$

$$m_{\tilde{\ell}_R}^2 \simeq m_0^2 + 0.15\, m_{1/2}^2 + \dots$$
$$m_{\tilde{\ell}_L}^2 \simeq m_0^2 + 0.5\, m_{1/2}^2 + \dots$$
$$m_{\tilde{q}}^2 \simeq m_0^2 + 6\, m_{1/2}^2 + \dots$$

Only Five parameters Left

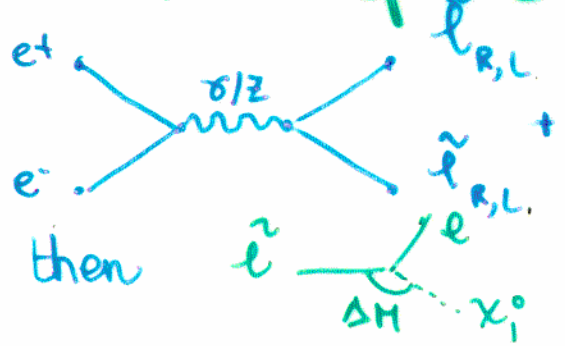
$\tan\beta$, μ, m_0, $m_{1/2}$, A_0

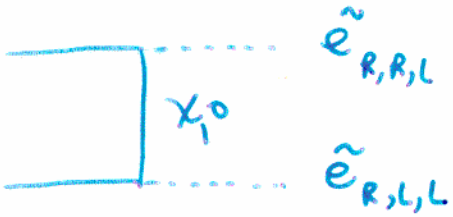
$m_{1/2}$ = M_1 = M_2

A_0 = common trilinear coupling (squark mixing)

What do we look for ?

• Scalar Leptons



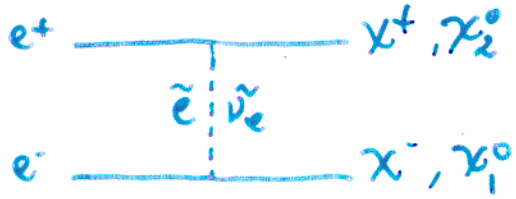


$m_{\tilde{e}_R} \sim 85$ GeV — 11 evts/expt 183 GeV

$m_{\tilde{\mu}_R} \sim 85$ GeV — 2 evts/expt

topology : 2 acop. leptons + $\not{E}$

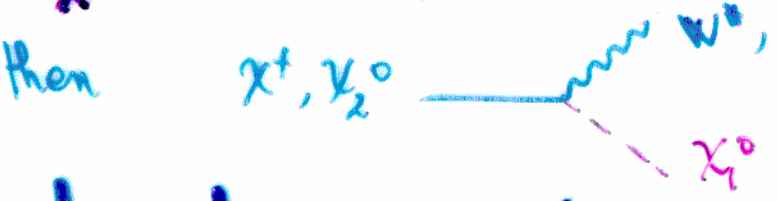
• Charginos - Neutralinos



destructive for $\chi^+\chi^-$ for $m_{\chi} \sim 80$ & 100 GeV

pure Jaugines, high m_{χ}, $\sigma_{ee \to \chi^+\chi^-} \sim 5$ pb

$m_{\chi^\pm} = 94.5$ GeV, ~ 50 evts/exp for $\int \mathcal{L} dt = 10$ pb^{-1}

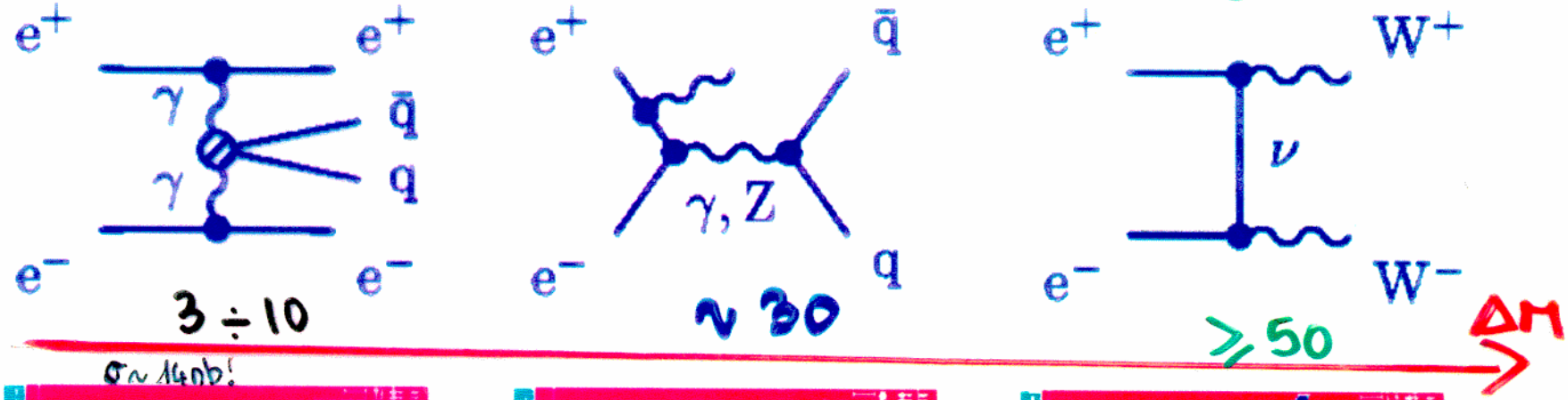


4 topologies : hadrons + $\not{E}$; ℓ, hadrons + $\not{E}$, acop jets + $\not{E}$, acop lept + $\not{E}$

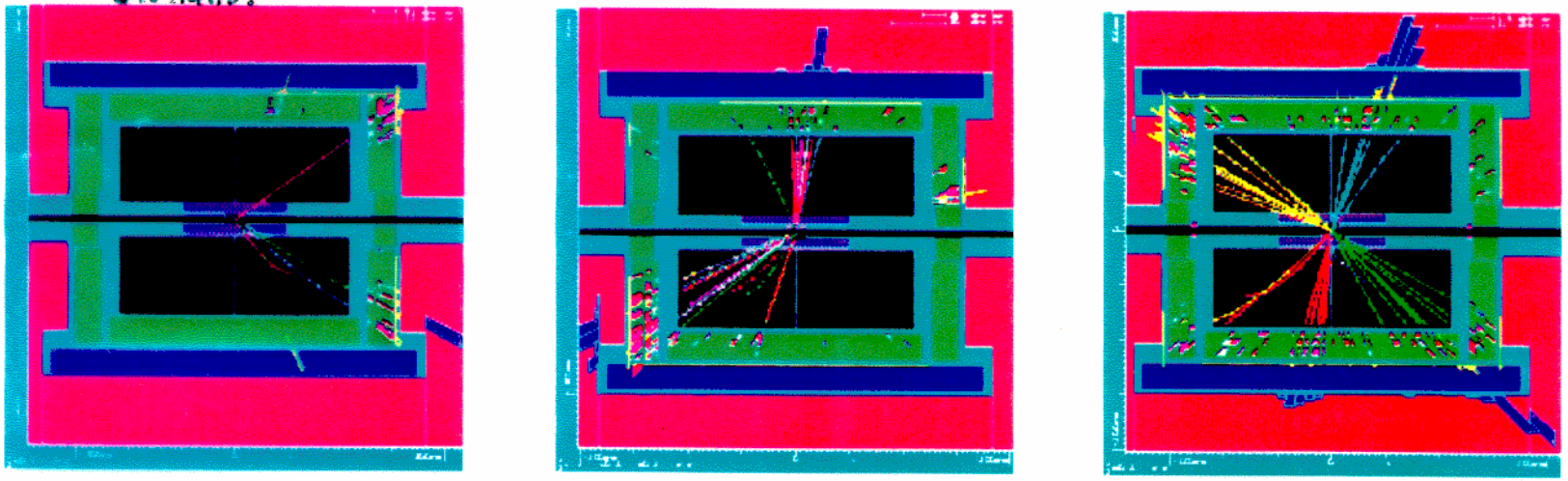
Experimental Challenge

$e\chi_1^0$ produced escaping detection $\Rightarrow$ Large $\not{E}$

$\Delta M = M_{sparticule} - M_{\chi_1^0} \simeq$ visible energy



$\sigma \sim 14pb$!



$\Rightarrow$ Analyses optimized for different values of ΔM

$\Rightarrow$ a very accurate measurement of $\not{E}$ is required $\Leftrightarrow$ good hermiticity required

Susy Rp conserved Results

exemple: Inclusive searches in L3

N_{obs} : 27 evts

N_{exp} : 32.4±9 evts

$\int \mathcal{L} dt = 52\ pb^{-1}$
$\sqrt{s} = 183$ GeV

No excess

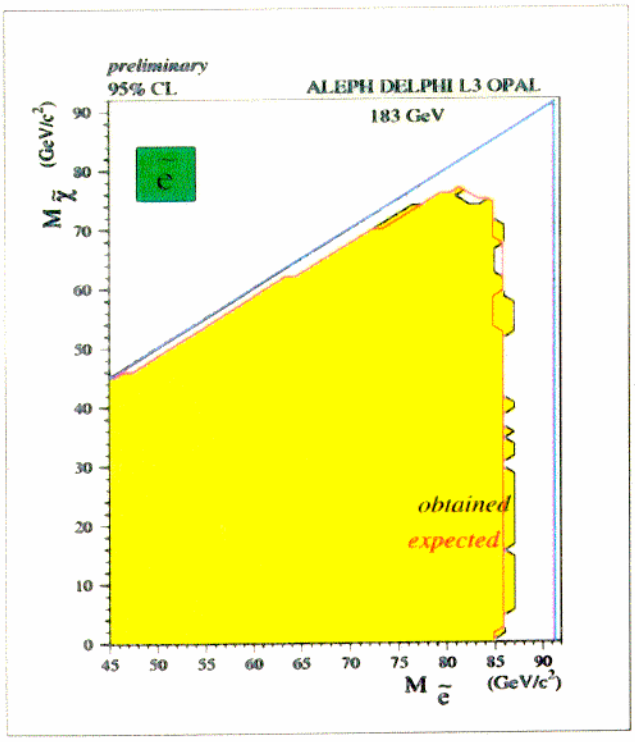
ADLO up to 189 GeV

↳ limits on cross section production

↳ limits on masses in the MSSM framework

SCALAR LEPTONS

LEP Combined Results



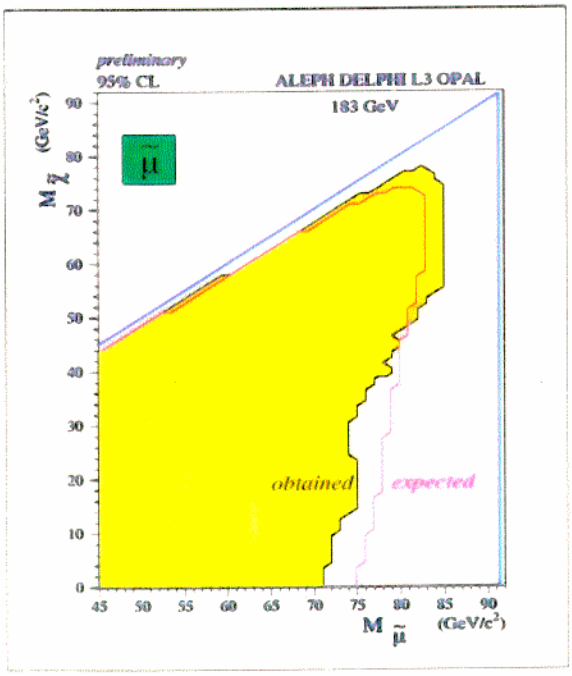
- ADLO (183 GeV)

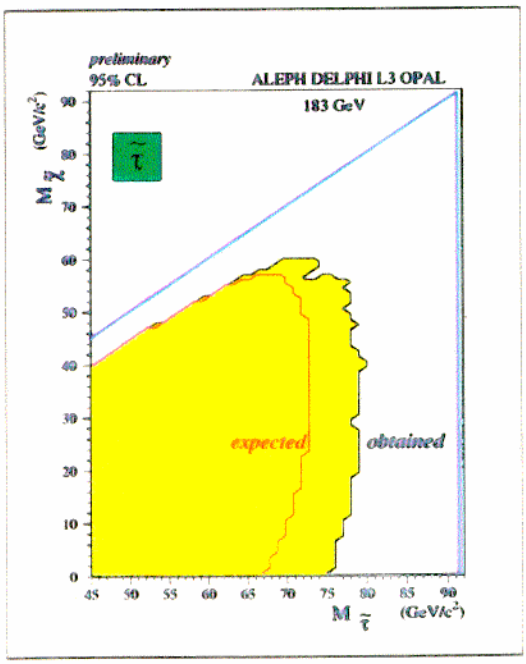
$m_{\tilde{e}_R} \geq 85$ GeV

$m_{\tilde{\mu}_R} \geq 71$ GeV

$m_{\tilde{\tau}_R} \geq 72$ GeV

$\Delta M \geq 15$ GeV





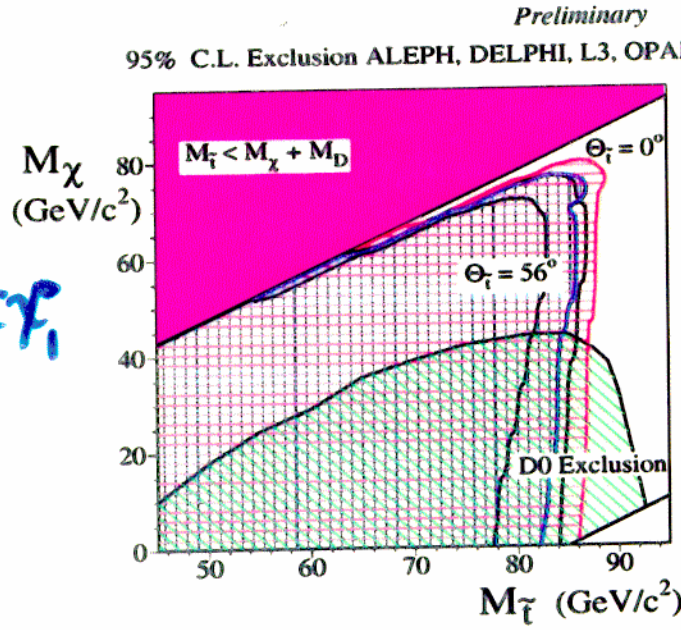
(Very preliminary)
$\sqrt{s} = 189$ GeV

$m_{\tilde{e}_R} \geq 90$ GeV $m_{\tilde{\mu}} \geq 80$ GeV
(ALEPH)

$\tilde{t}$, $\tilde{b}$

LEP combined results ($\Delta M \geq 15$ GeV)

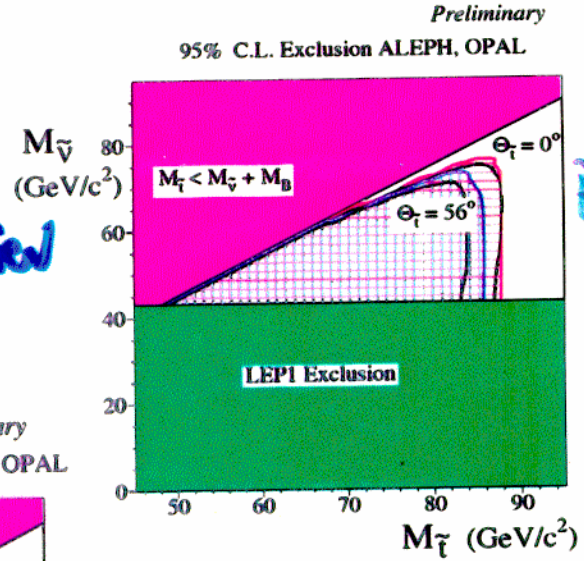
$\theta_{mix} = 0$



$\tilde{t} \to c\chi_1^0$

$m_{\tilde{t}} \geq 86.5$ GeV

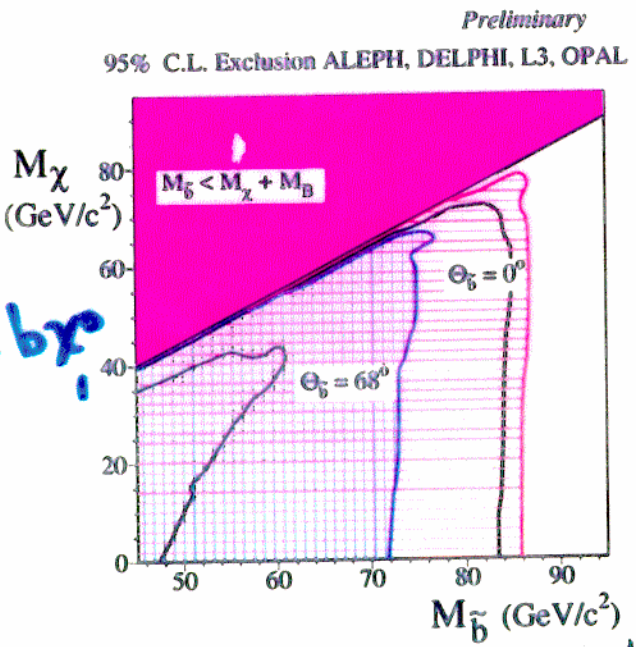
$\theta_{mix} = 0$, $\Delta M \geq 15$ GeV



$\tilde{t} \to b\ell\tilde{\nu}$

$m_{\tilde{t}} \geq 87.5$ GeV

$\theta_{mix} = 0$, $\Delta M \geq 15$ GeV



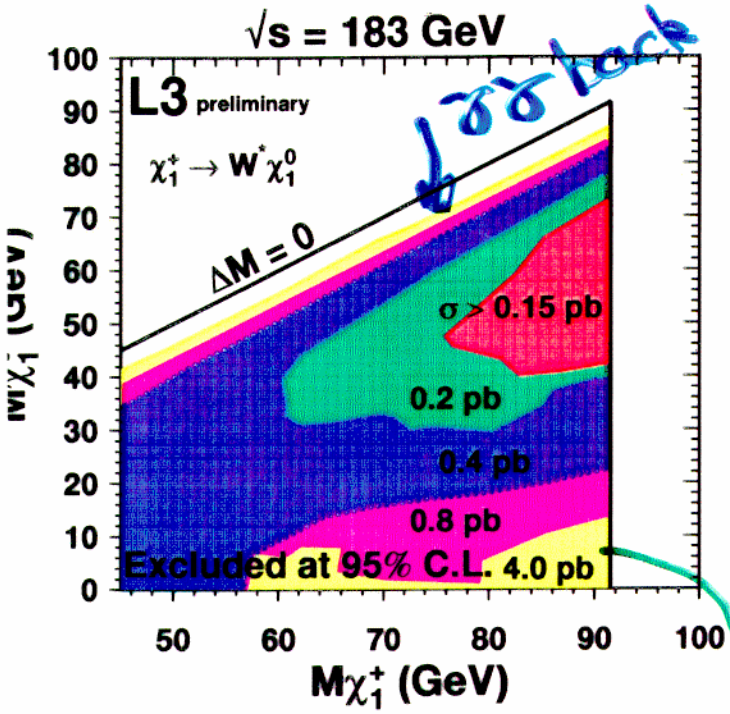
$\tilde{b} \to b\chi_1^0$

$m_{\tilde{b}} > 86.5$ GeV

$\theta_{mix} = 0$ $\Delta M \geq 15$ GeV.

Note: (very preliminary update at 189 GeV)
$m_{\tilde{t}} \geq 85$ GeV OPAL [$\theta_{mix} = 0$, $\tilde{t} \to c\chi_1^0$]

Chargino - Neutralino Searches



$\gamma\gamma$ back

WW back.

chargino

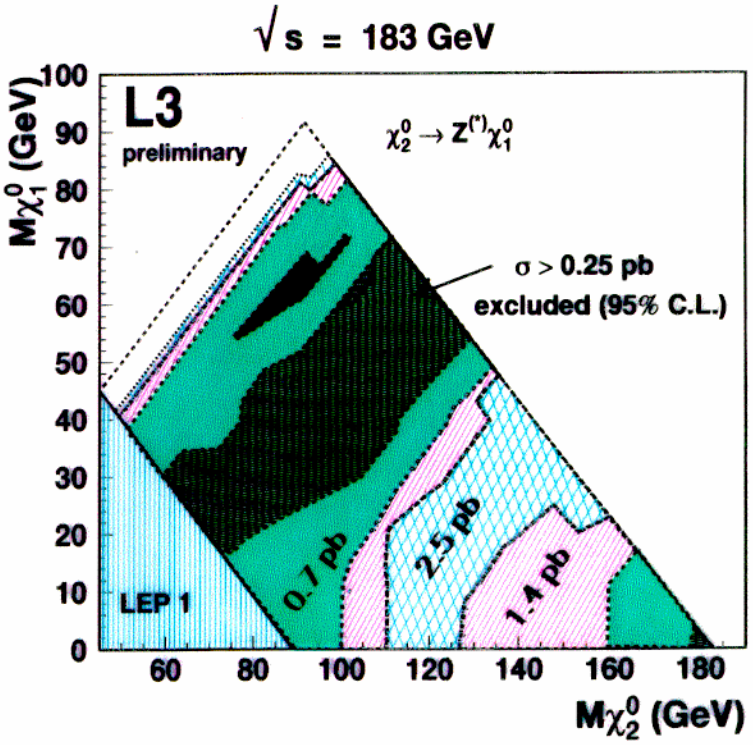
Upper limit on production cross section

$Br(\chi^+ \to W^* \chi_1^0) = 100\%$ assumed

Neutralino

assuming

$Br(\chi_2^0 \to Z\chi_1^0) = 1$

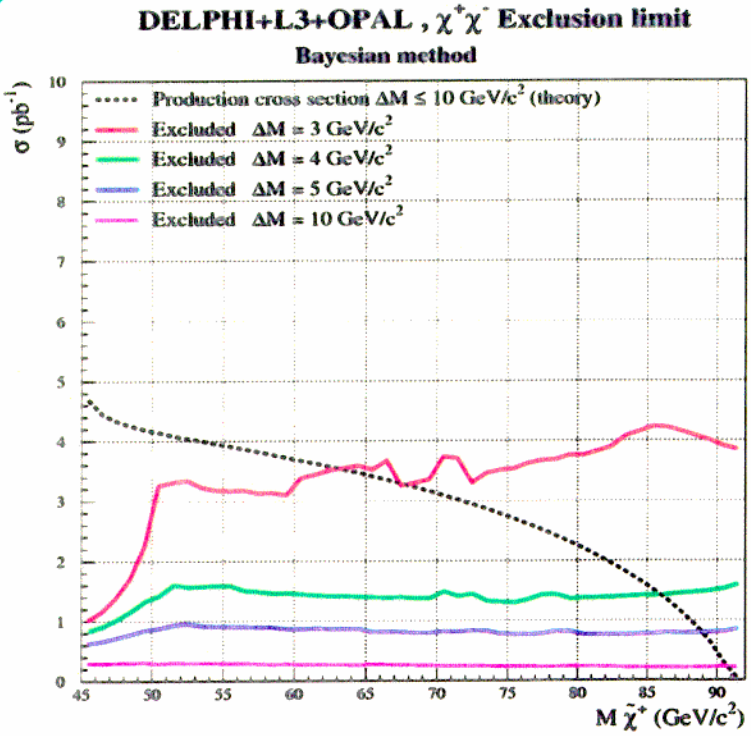


$M_{\chi_1^+}$ Limit

- Higgsino - like : Low ΔM

$\Delta M \leq 10$ GeV

($\sim M_2 > 400$ GeV)

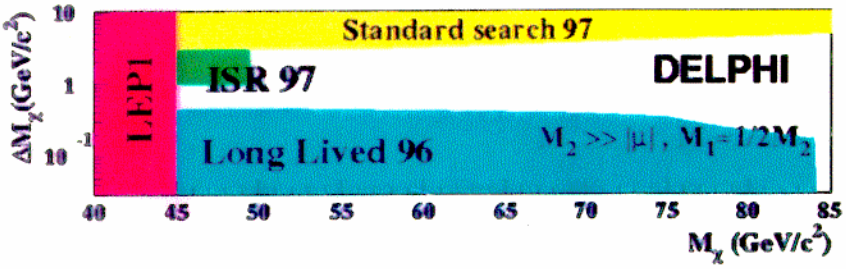


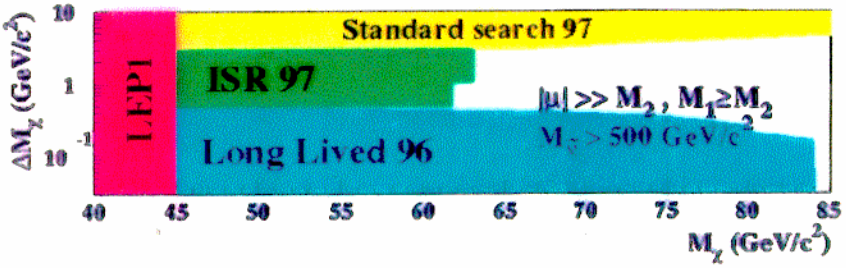
$\Delta M \geq 3$ GeV

$M_{\chi^+} \geq 63$ GeV

Extension for very Low ΔM

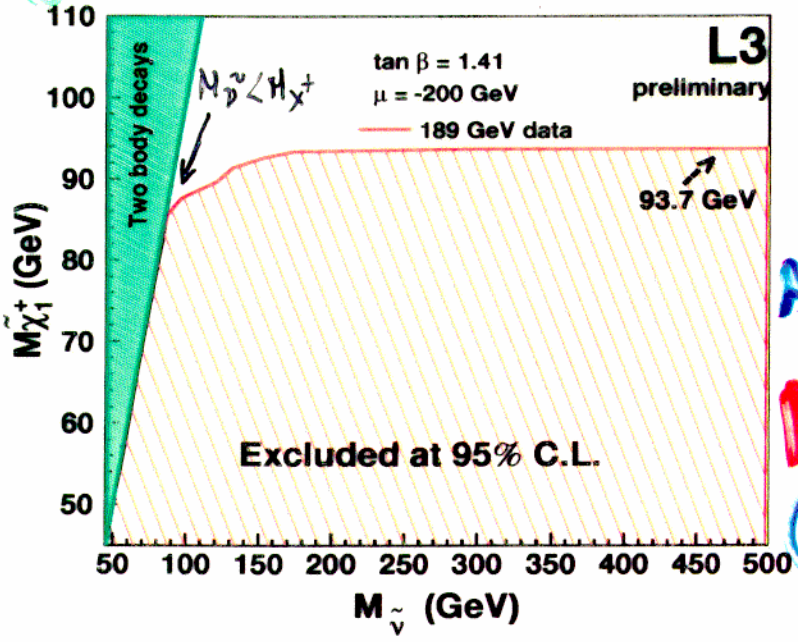
$\Delta M < 1$ GeV





Chargino Mass Limit

- Gaugino like



Kinematic limit

ADLO $\sqrt{s} = 189$ GeV

$m_{\chi_1^+} \geq 93.7$ GeV

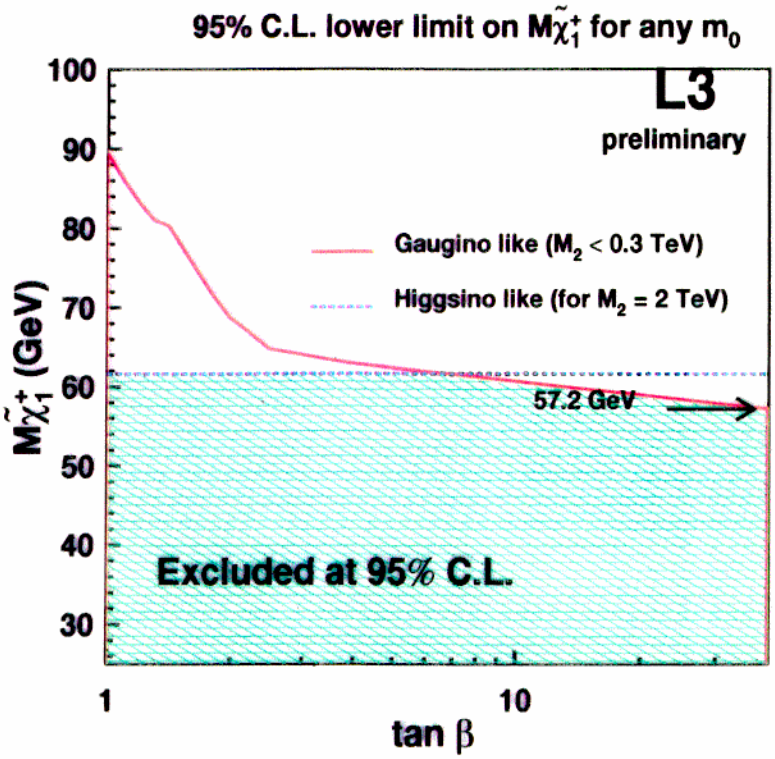
($m_{\tilde{\nu}} > 300$ GeV)

Extend the limit + $\not{p}$ searches included

$|M_{\chi_1^+} - M_{\tilde{\nu}}| \leq 3$ GeV and $M_{\chi^+} > M_{\tilde{e}}$

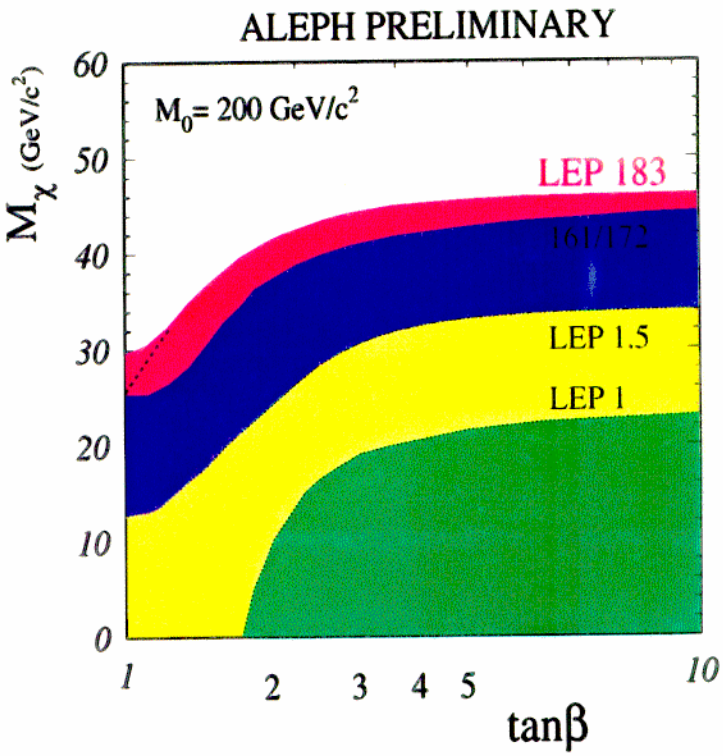
$M_{\chi_1^+} \geq 57.2$ GeV

$\forall\, m_0, A, \tan\beta$



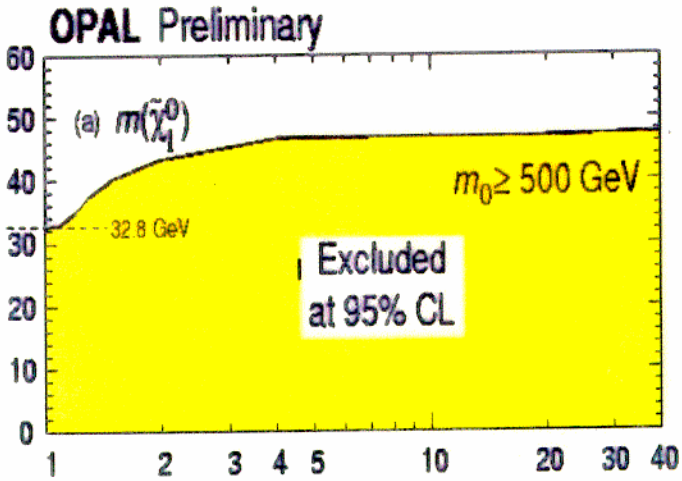
Mass limits on the lightest Neutralino high m_0

Use the MSSM mass relations to obtain LSP Limits from chargino and neutralino searches including all $\chi^0_j \chi^0_k$ processes



$M_{\chi_1^0} \geq 30$ GeV

ADLO $\sqrt{s}$: 183 GeV



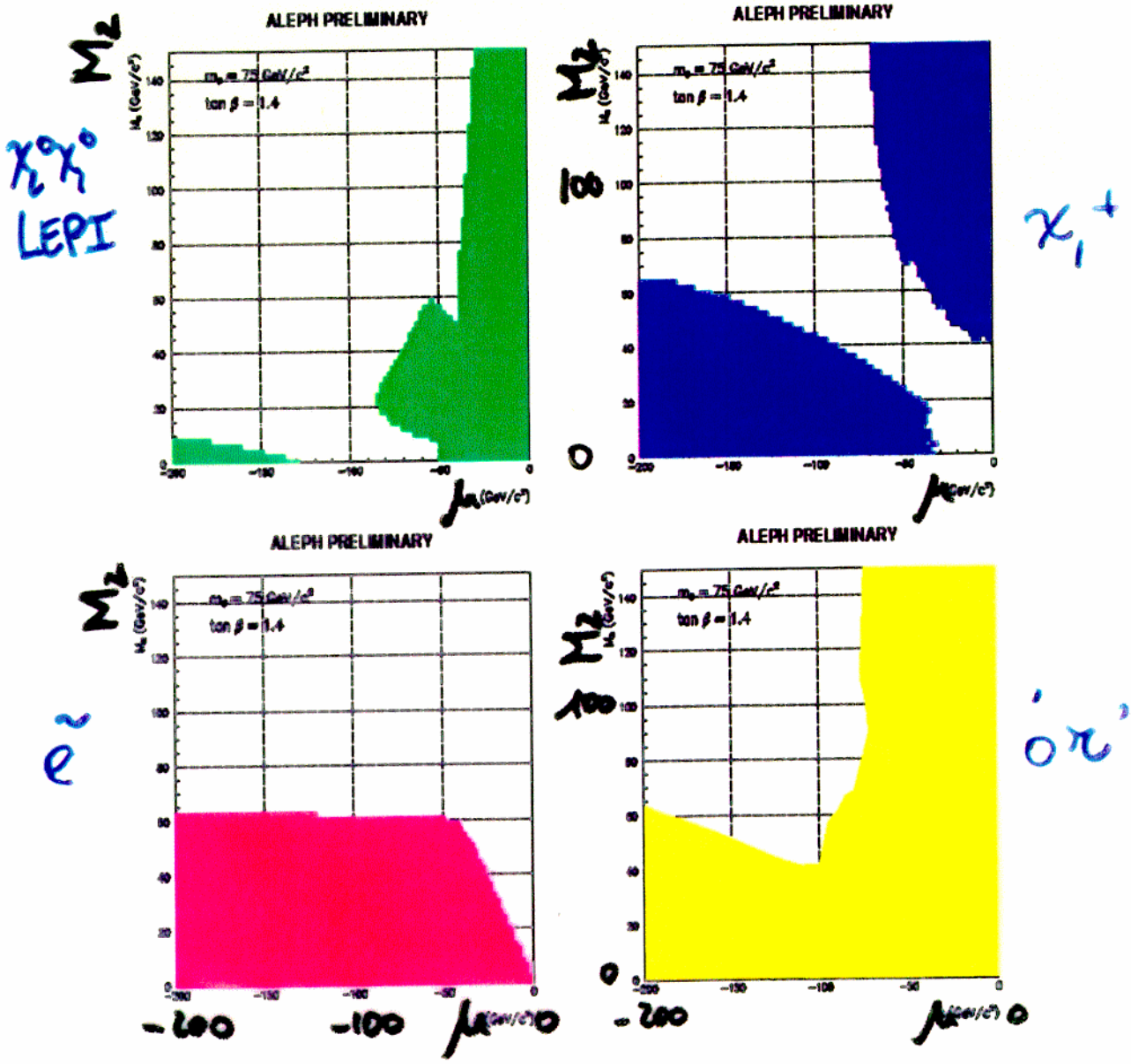
$M_{\chi_1^0} \geq 32.8$ GeV

$\sqrt{s}$ = 189 GeV

Limit on $M_{\chi_1^0}$

. Combination of all searches

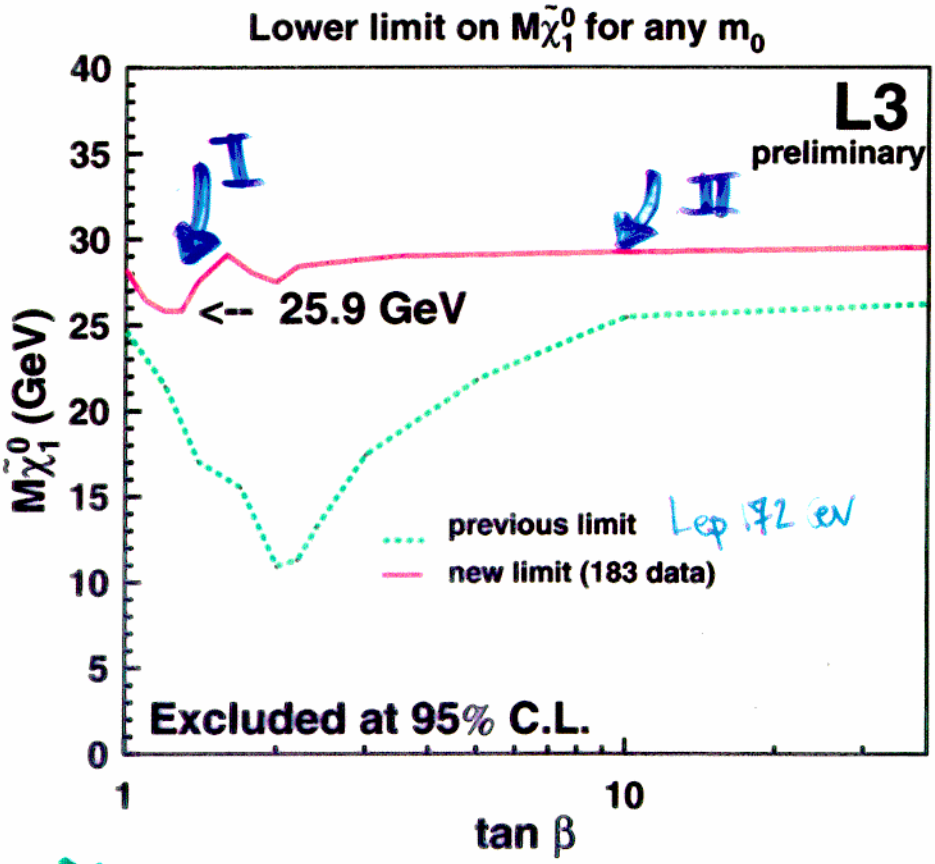
$m_0 = 75$ GeV $\tan\beta = 1.4$



Scan over $\mu, M_2, m_0, \tan\beta$

$M_{\chi_1^0}$ Limits - any m_0

- $\tilde{\ell}, \chi^+, \chi_j^0$ searches combined
- I minimal $\sigma(e^+e^- \to \chi_1^+\chi_1^-) \sim 0.1$ pb $m_{\tilde{\nu}} \sim 85$-90 GeV
- II $0 < M_{\chi_1^+} - M_{\tilde{\nu}} < 3$ GeV $\Rightarrow$ Limit come from $\tilde{\ell}$ searches



	$M_{\chi_1^0} \geq$ (GeV)	
A	26.0*	28.0 any m_0
L	25.9	$\sqrt{s} = 189$ GeV
D	23.4	using $m_{\tilde{e}_R} \geq 90$ GeV
O	25.4	

* deep gaugino region ($\tan\beta > 8$)

Susy with R_p violated

$W_{\text{superpotential}} = W_{MSSM} + W_{R\not p}$

$$W_{R\not p} = \frac{1}{2}\lambda_{LLE} L_i L_j \bar{E}_k + \frac{1}{2}\lambda_{LQD} L_i Q_j \bar{D}_k + \frac{1}{2}\lambda_{UDD} \bar{U}_i \bar{U}_j \bar{D}_k$$

9 + 27 terms: $\Delta L \neq 0$; 9 terms: $\Delta B \neq 0$

i,j,k generation indices

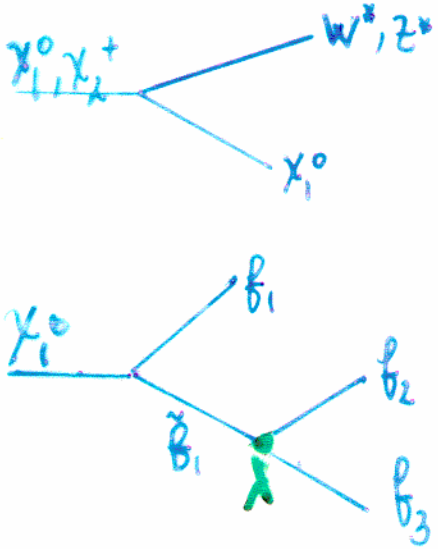
a) proton decay lifetime imposes $\lambda_{LQD} \times \lambda_{UDD} \leq 10^{-24}$

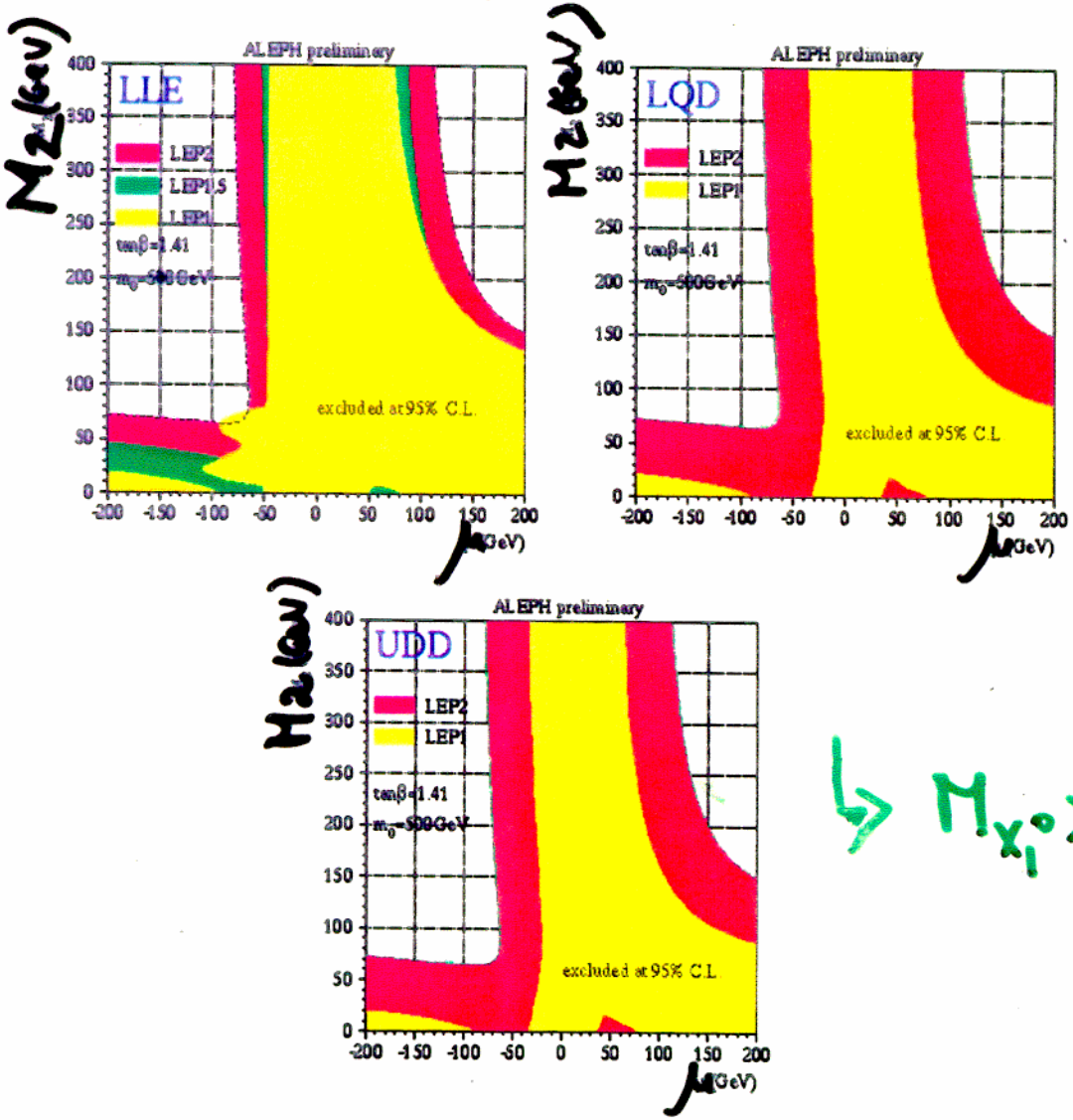
b) strong constraints from low E data

- Susy particle can be produced singly
- LSP is visible
  - L> Large multiplicity leptons or/and jets
  - L> no more $\not{E}$
  - L> in general higher sensitivity compared to susy w/ R_p cons.
- assume in general a single term is dominant
- $R_{\not p}$ in gaugino, slepton, squark sectors

SUSY with R_p violation

Gauginos
$\chi_1^0\chi_1^0, \chi_1^+\chi_1^-, \chi_1^0\chi_2^0$





Kinematic limit reached everywhere DJ even in the Higgsino region for χ_1^+

↳ $M_{\chi_1^0} \geq 26.8$ GeV L3 (λ_{LLE}) ~ ADLO

Figure 1: *Regions in the (μ, M_2) plane excluded at 95% C.L. at $\tan\beta = 1.41$ and $m_0 = 500\,\mathrm{GeV}/c^2$ for the three operators. The dotted line in the kinematic limit.*

GMSB at LEP

gravitino $\tilde{G}$ is the LSP

$M_{\tilde{G}} \sim 10^{-5}$ eV $\longrightarrow$ $\sim$ keV

- χ_1^0 NLSP : $\chi_1^0 \to \gamma \tilde{G}$

  SP $\to \chi_1^0 \; X_{SM}$

  $\hookrightarrow \gamma \tilde{G}$

  Standard topologies (susy R_p conserved) + $n\gamma$

  $\hookrightarrow$ improved sensitivity

- $\tilde{\tau}_1$ NLSP $\quad \tilde{\tau}_1 \to \tau \tilde{G}$

  SP $\to \tilde{\tau}_1$ ($\chi_1 \neq \tau$)

  $\hookrightarrow \tau \tilde{G}$

final State with high τ multiplicity plus $\not{E}$

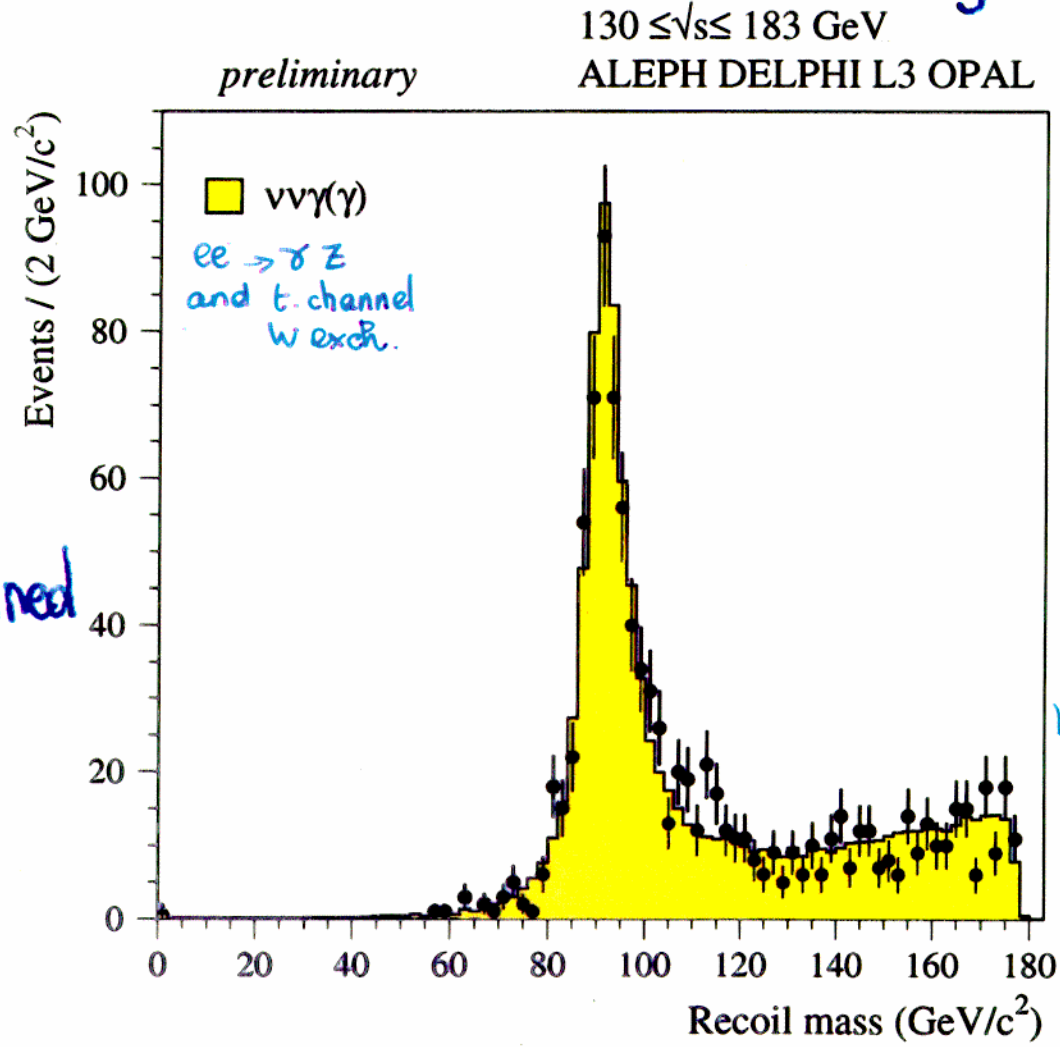
GMSB - Single γ + $\not{E}$

Look for : $e^+e^- \to \tilde{G}\chi_1^0$

$\chi_1^0 \to \tilde{G}\gamma$

$e^+e^- \to \tilde{G}\tilde{G}(\gamma)$ superlight $\tilde{G}$ only

LEP combined



L. Pape et al Lep Susy WG

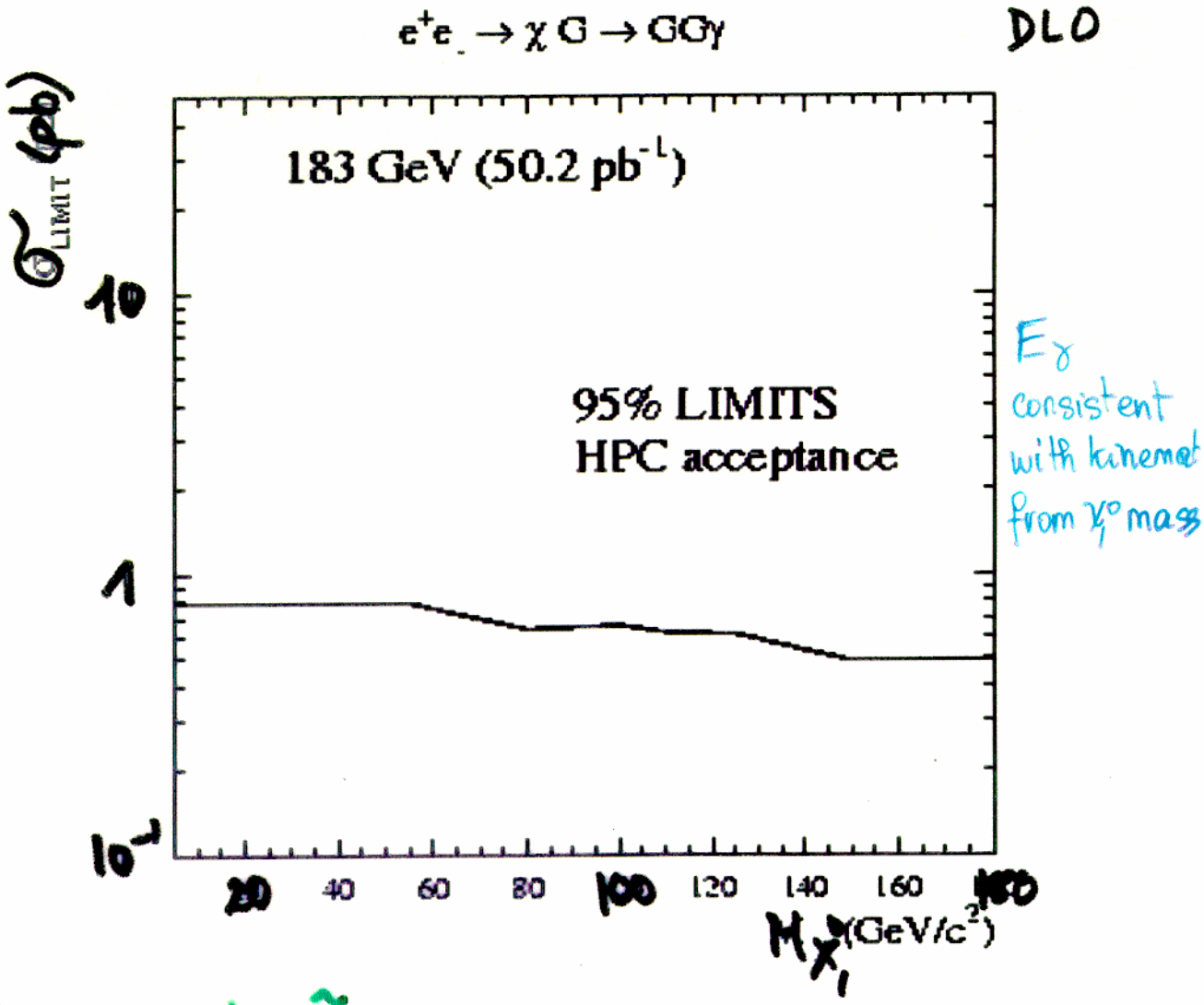
perfect agreement with Standard Model expectation

↳ limits

↳ $\sigma(e^+e^- \to \bar{\nu}\nu(\gamma))$ measurement

GMSB. One photon final states

- Upper limit on $e^+e^- \to \chi_1^0 \tilde{G} \to \gamma \tilde{G} \tilde{G}$ cross section



E_γ consistent with kinemat from χ_1^0 mass

- Superlight $\tilde{G}$: $e^+e^- \to G\tilde{G}\gamma$

Cross section dominated by ISR

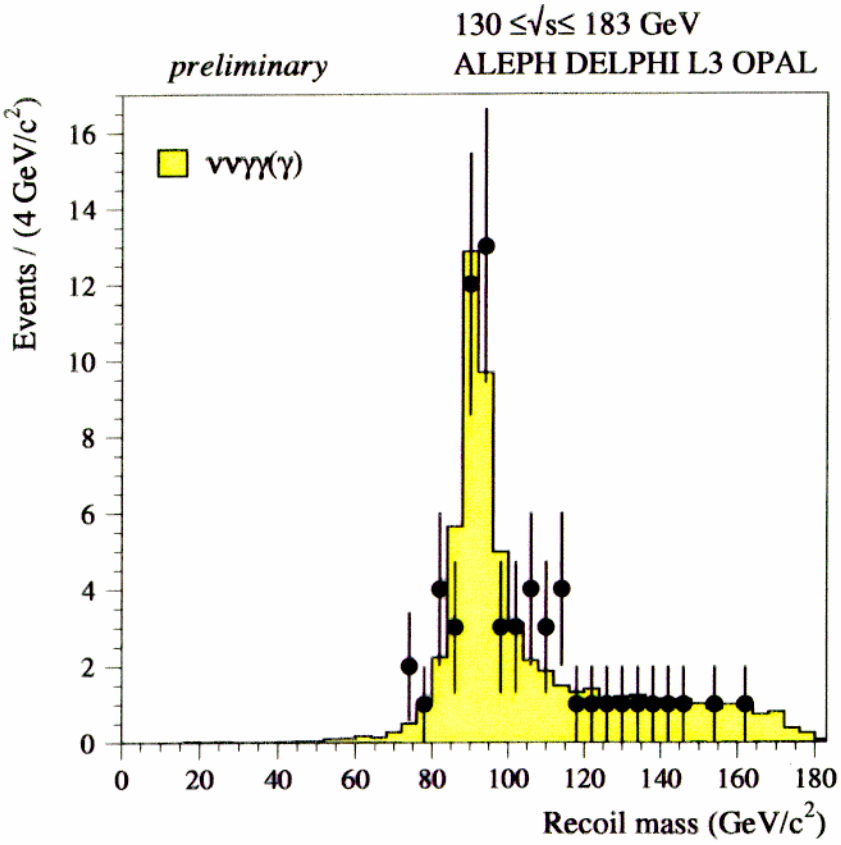
	$m_{\tilde{G}}$ (ev)
A	$8.3\ 10^{-6}$
D	$6.6\ 10^{-6}$
L	$8.0\ 10^{-6}$

EFZ Model

GMSB . two photons + $\not{E}$

Look for $e^+e^- \to \chi_1^0\chi_1^0$ with $\chi_1^0 \to \gamma\tilde{G}$ and $\chi_1^0 \to \gamma\tilde{G}$

LEP COMBINED



No excess

→ limits

GMSB. two photons + $\not{E}$ final states

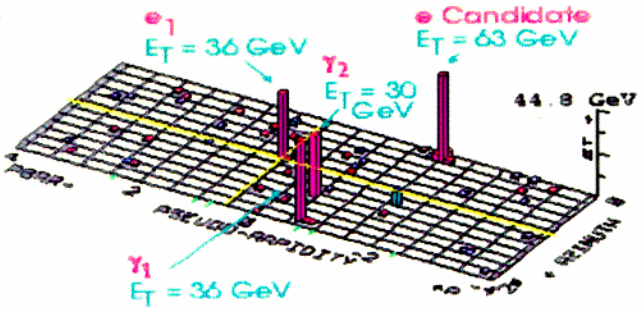
- CDF observed :

no explanation from SM

could be

$q\bar{q} \to \tilde{e}_R \tilde{e}_R \to ee\chi_1^0\chi_1^0$, $\chi_1^0 \to \gamma\tilde{G}$

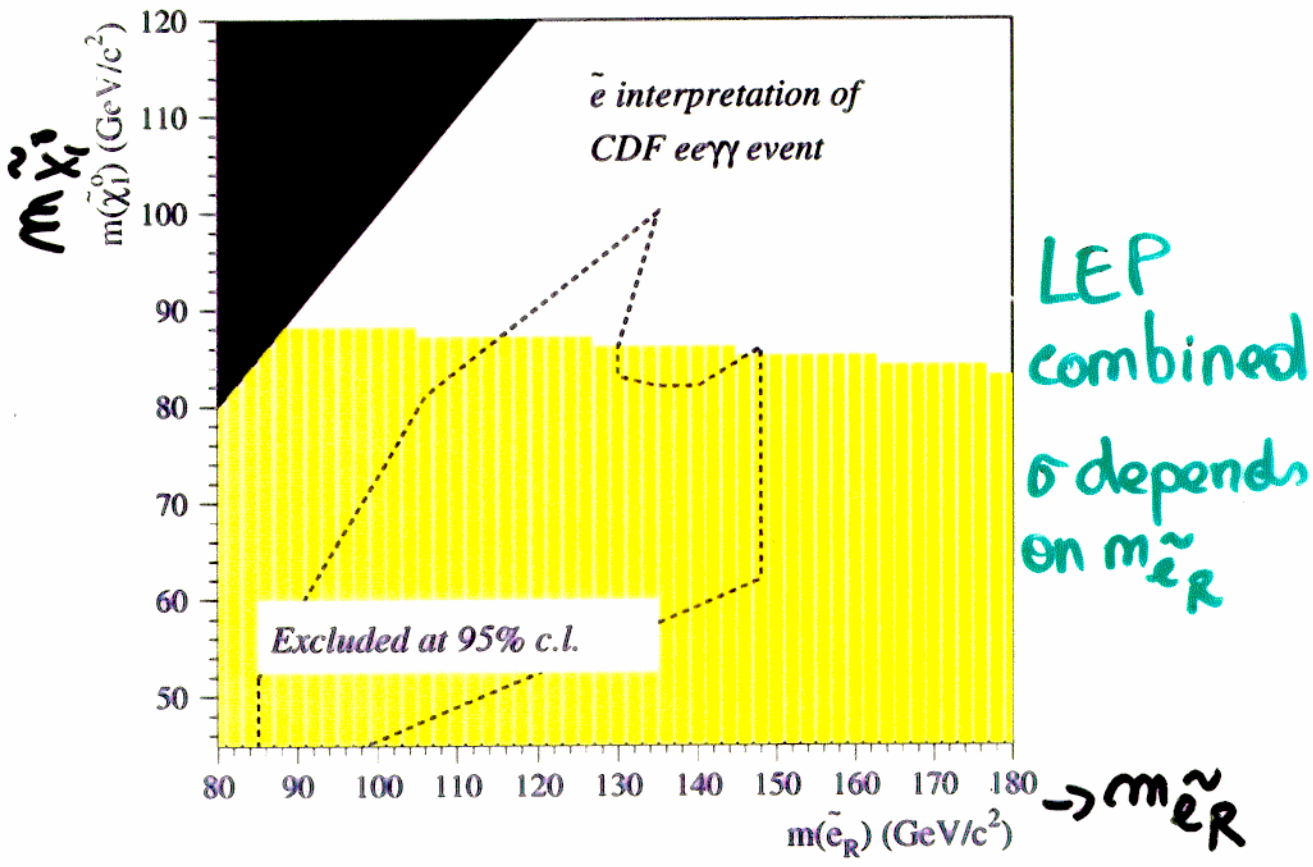
$ee\gamma\gamma \not{E}_T$ Candidate Event



note:
No excess seen by DØ

- LEP2 should be sensitive

$e^+e^- \to \chi_1^0\chi_1^0 \to \tilde{G}\tilde{G}\gamma\gamma$



$m_{\tilde{\chi}_1^0}$

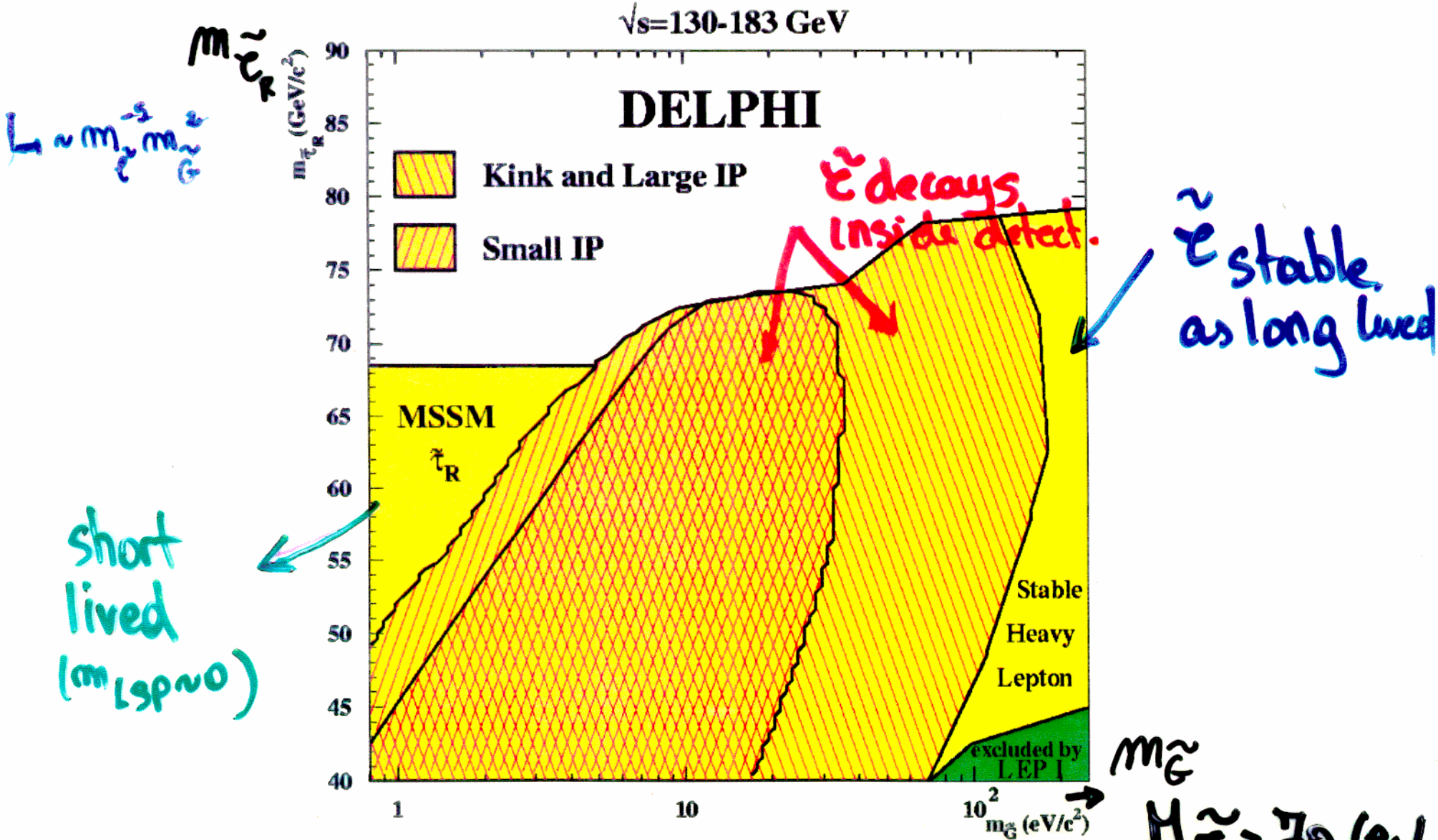
$\to m_{\tilde{e}_R}$

LEP combined

σ depends on $m_{\tilde{e}_R}$

Limits derived from the LEP data are compared to the regions favoured by the CDF event within GMSB Model

GMSB - $\tilde{\tau}$ NLSP $\tilde{\tau} \to \tilde{G}\tau$, $\chi^0 \to \tilde{\tau}\tau$



$m_{\tilde{\tau}_R}$

$L \sim m_{\tilde{\tau}}^{-5} m_{\tilde{G}}^{2}$

$\tilde{\tau}$ decays inside detect.

$\tilde{\tau}$ stable as long lived

short lived ($m_{LSP} \neq 0$)

$m_{\tilde{G}}$

$M_{\tilde{\tau}} \geq 70$ GeV

CONCLUSION

- No Indication for new physics yet
  all observed phenoma up to 183 GeV are well described by the Standard Model

- Large domain is covered, and all channels exploited (good detector performance and relatively good knowdledge of the background) →
  LEP2 can set significant limits
  ADLO 183 GeV : $M_{H_{SM}} \geq 89.8$ GeV
  $M_h \geq 77$ GeV
  $M_A \geq 78$ GeV
  $M_{\chi_1^0} \geq 28$ GeV
  K.L for χ_1^+ (large m_0, $\Delta M > 5$ GeV)
  Aleph 189 GeV
  ADLO 189 GeV
  Lep Combined beginning to be superseded by 189 GeV data

- Much more data to come : Searches are not over
  ~ 150 pb^{-1}/expt this year towards $\sqrt{s} = 200$ GeV till 2000