DELPHI week, April 2001

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Search for charginos

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Charginos

Mass eigenstates of the supersymmetric partners to the Higgs and Gauge bosons:

$$[\tilde{W}^{\pm}, \tilde{H}^{\pm}] \Rightarrow \tilde{\chi}_i^{\pm}{}_{i=1,2}$$
$$[\tilde{\gamma}, \tilde{Z}^0, \tilde{H}^0_{1,2}] \Rightarrow \tilde{\chi}^0_i{}_{i=1,..,4}$$

- R–parity conservation

$\longrightarrow$ Stable Lightest Supersymmetric Particle.
$\longrightarrow$ Pair production of the SUSY particles.

- GUT

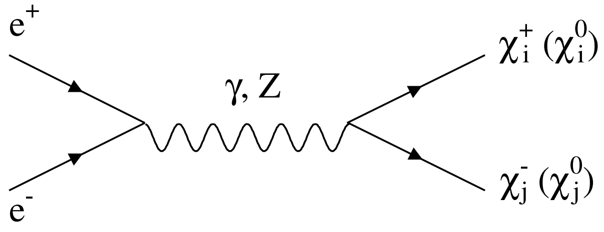
$\longrightarrow$ 8 parameters, $[m_0, m_{\frac{1}{2}}, m_A, \mu, tan(\beta), A_i]$.

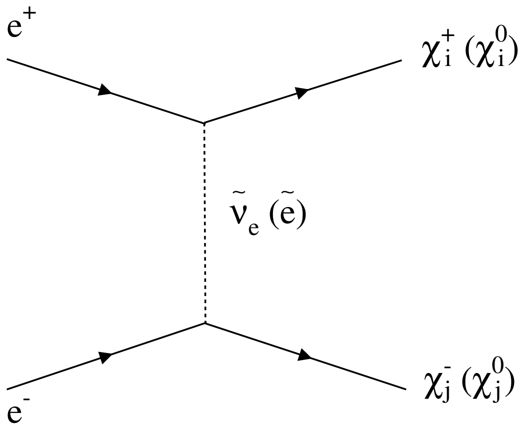
- SUGRA

$\longrightarrow$ $\tilde{\chi}^0_1$ $(\tilde{\nu})$ is the LSP.

Production

When the Chargino is not pure Higgsino the t-channel diagram contributes with negative interference for low $m_{\tilde{\nu}}$.



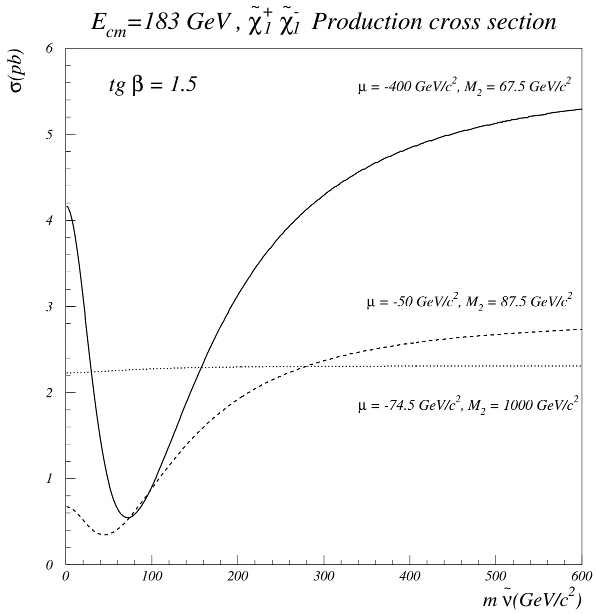


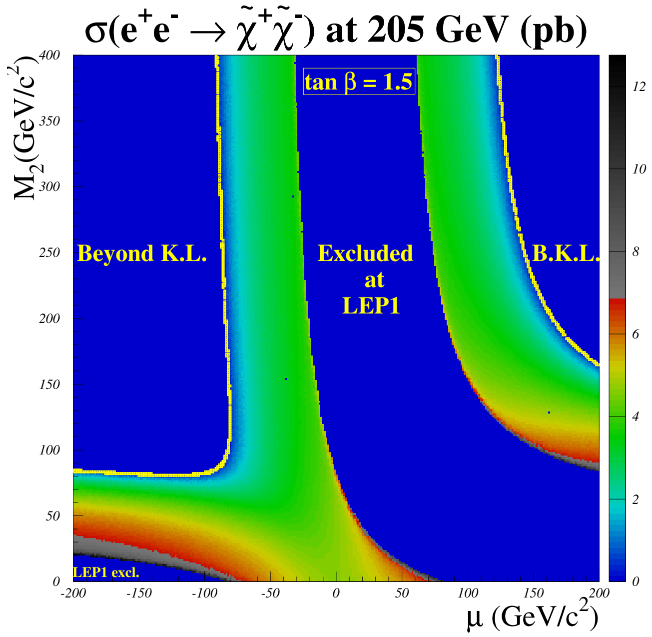
$$\boxed{\begin{array}{c}\text{High } m_{\tilde{\nu}} \\ (\text{Constrained by } \mathrm{m}_0,\ \mathrm{m}_0 = 1 \text{ TeV})\end{array}}$$

$$\Downarrow$$

$$M_{\tilde{\chi}_i^{\pm}} = f(\mu, tan(\beta), m_{\frac{1}{2}})$$

$$\sigma(e^+e^- \rightarrow \tilde{\chi}_i^+ \tilde{\chi}_j^-) = f(\mu, tan(\beta), m_{\frac{1}{2}}, E_{cm})$$

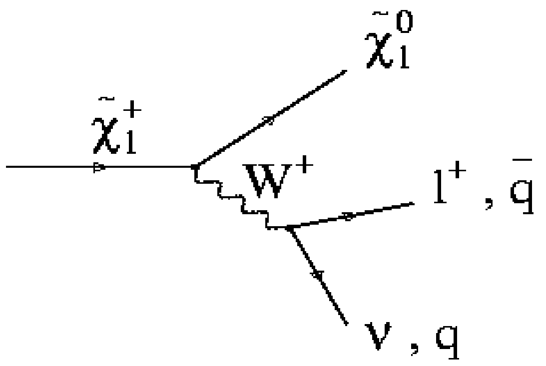


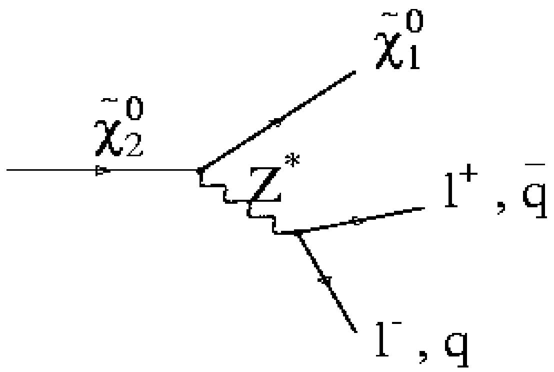


The signal shape depends on:

$$M_{\tilde{\chi}^{\pm}} - M_{\tilde{\chi}^{0}_{1}} = \Delta M$$

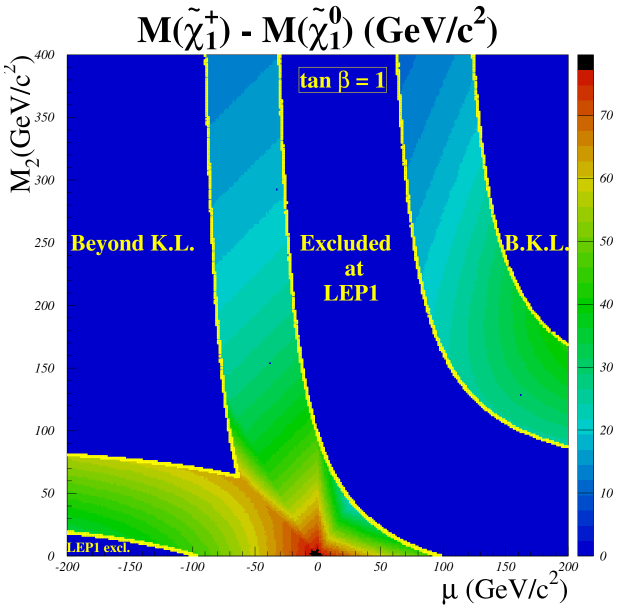
$$(\mathrm{m}_{\tilde{l},\tilde{q},H^{\pm,0},A} > M_{\tilde{\chi}^{\pm}_{1}})$$

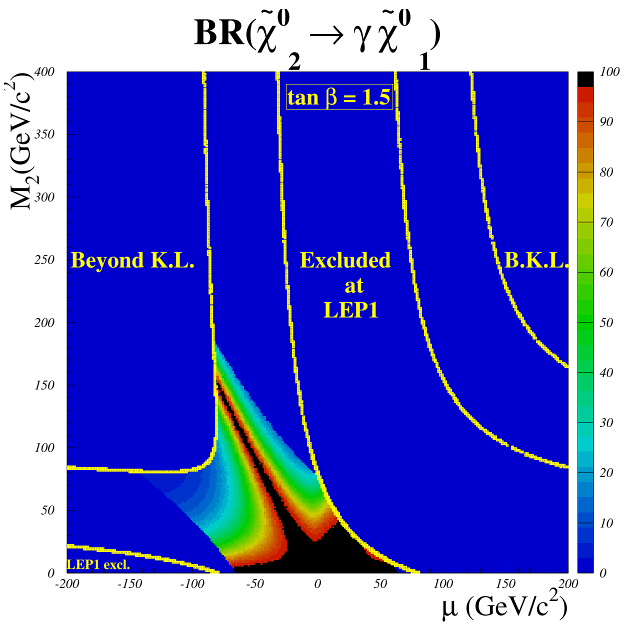




And if $\tilde{\chi}^{0}_{2}$ can be produced, causing a cascade decay:

$$\tilde{\chi}^{\pm}_{1} \rightarrow \tilde{\chi}^{0}_{2} \mathrm{f}_1 \bar{\mathrm{f}}'_1 \rightarrow \tilde{\chi}^{0}_{1}\ \mathrm{f}_1 \bar{\mathrm{f}}'_1 + \mathrm{f}_2 \bar{\mathrm{f}}_2$$
$$\tilde{\chi}^{\pm}_{1} \rightarrow \tilde{\chi}^{0}_{2} \mathrm{f}_1 \bar{\mathrm{f}}'_1 \rightarrow \tilde{\chi}^{0}_{1} \mathrm{f}_1 \bar{\mathrm{f}}'_1 + \gamma$$





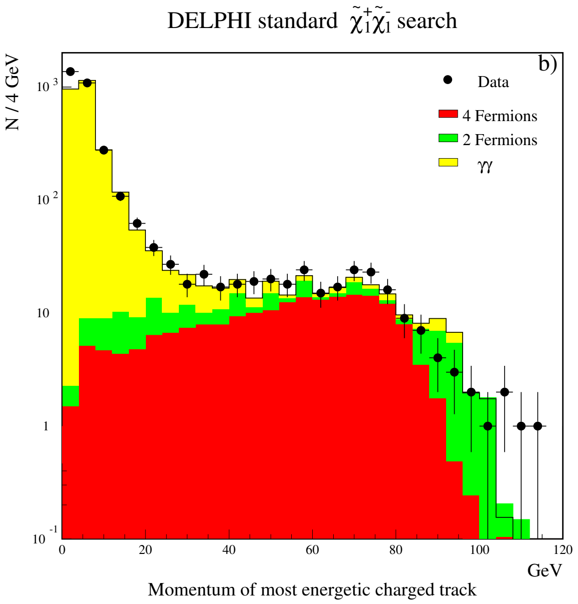
Background

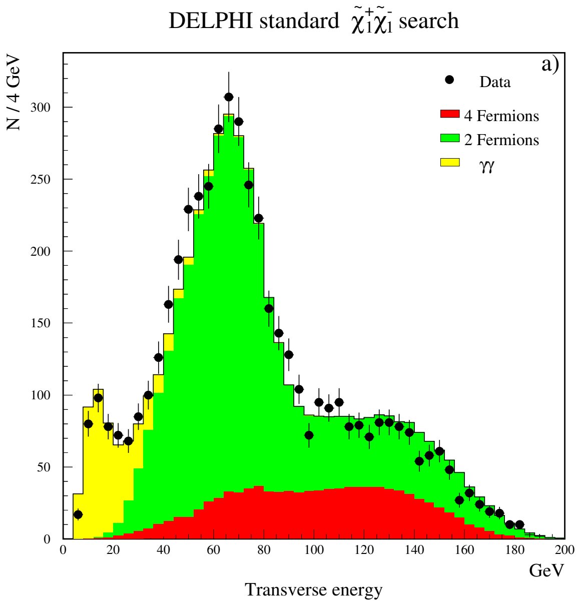
Main background

$\Downarrow$

Low ΔM $\rightarrow \gamma\gamma$
High ΔM $\rightarrow$ 4/2 fermions (WW)

$E_{cm} = 206$ GeV





No isolated Photon
Number of tracks ≤ 5

No isolated Photon or lepton
Number of tracks > 5

Windows

❍ Radiative topology:

Important for high ΔM
(WW suppression)

At least 1 isolated photon
($E_\gamma > 5$ GeV ; $15^o < \theta_\gamma < 165^o$; $\alpha_\gamma^{iso} > 15^o$)

❍ $\ell\ell$ topology:

No isolated photons
Number of tracks ≤ 5

❍ jℓ topology:

No isolated photons
Number of tracks > 5
At least 1 isolated lepton ($P_\ell > 3$ GeV/c ; $\alpha_\ell^{iso} > 2\ 0^o$)

❍ jj topology:

No isolated photons
Number of tracks > 5
No isolated leptons

ΔM REGIONS

$3 \leq$	ΔM	< 5	GeV/c^2
$5 \leq$	ΔM	< 10	GeV/c^2
$10 \leq$	ΔM	< 25	GeV/c^2
$25 \leq$	ΔM	< 35	GeV/c^2
$35 \leq$	ΔM	< 50	GeV/c^2
$50 \leq$	ΔM		GeV/c^2

Event selection

EVENTS

$\Downarrow$

for a given topology

Topological cuts

(the same for all ΔM)

$\Downarrow$

Preselection cuts

(different for each ΔM)

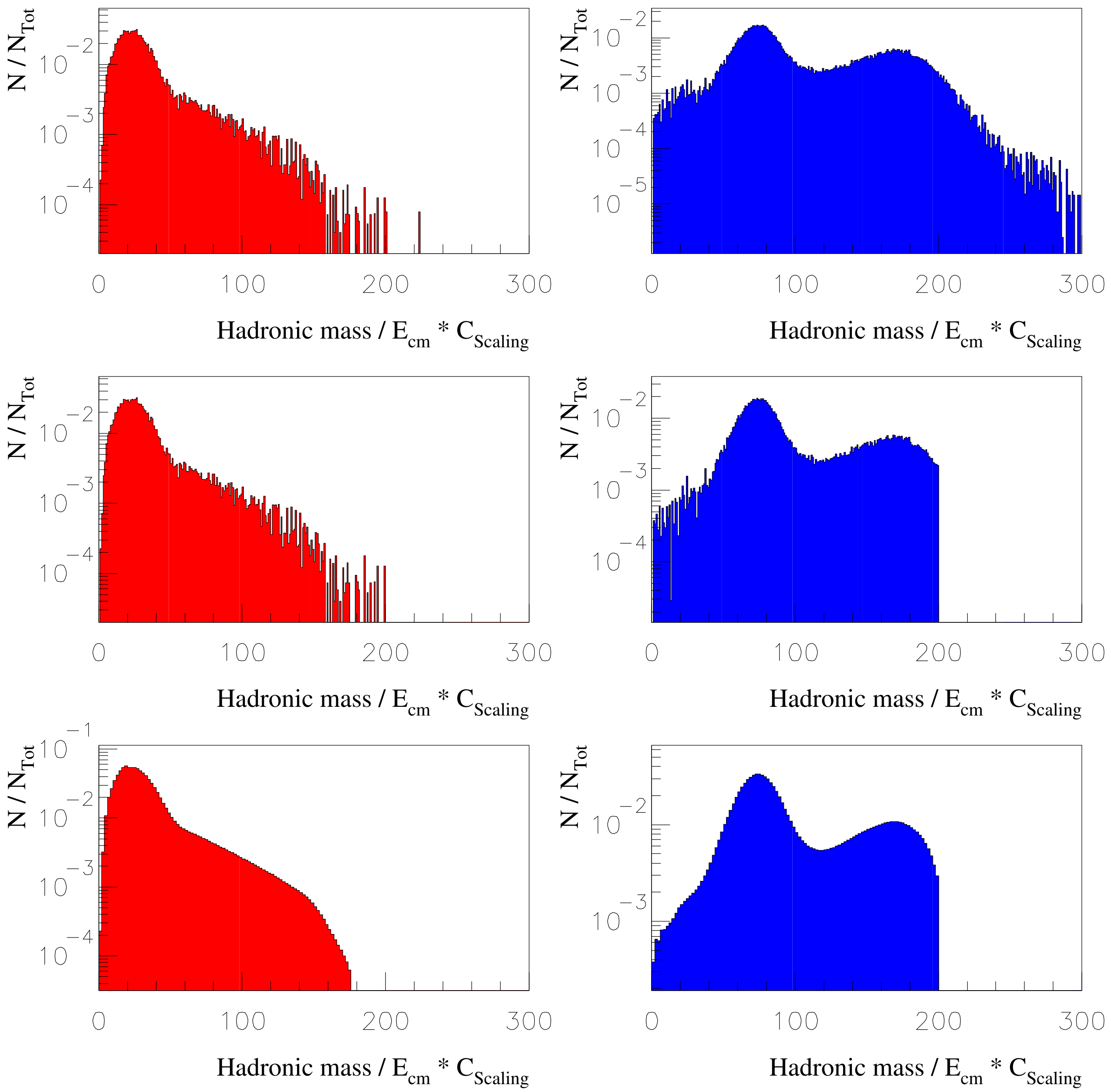
$\Downarrow$

Likelihood cut

$$\left(\mathcal{L}_{\mathcal{R}}(x_1, ..., x_n) = \frac{\Pi_{i=1}^{n} P_S^i(x_i)}{\Pi_{i=1}^{n} P_B^i(x_i)}\ \right)$$

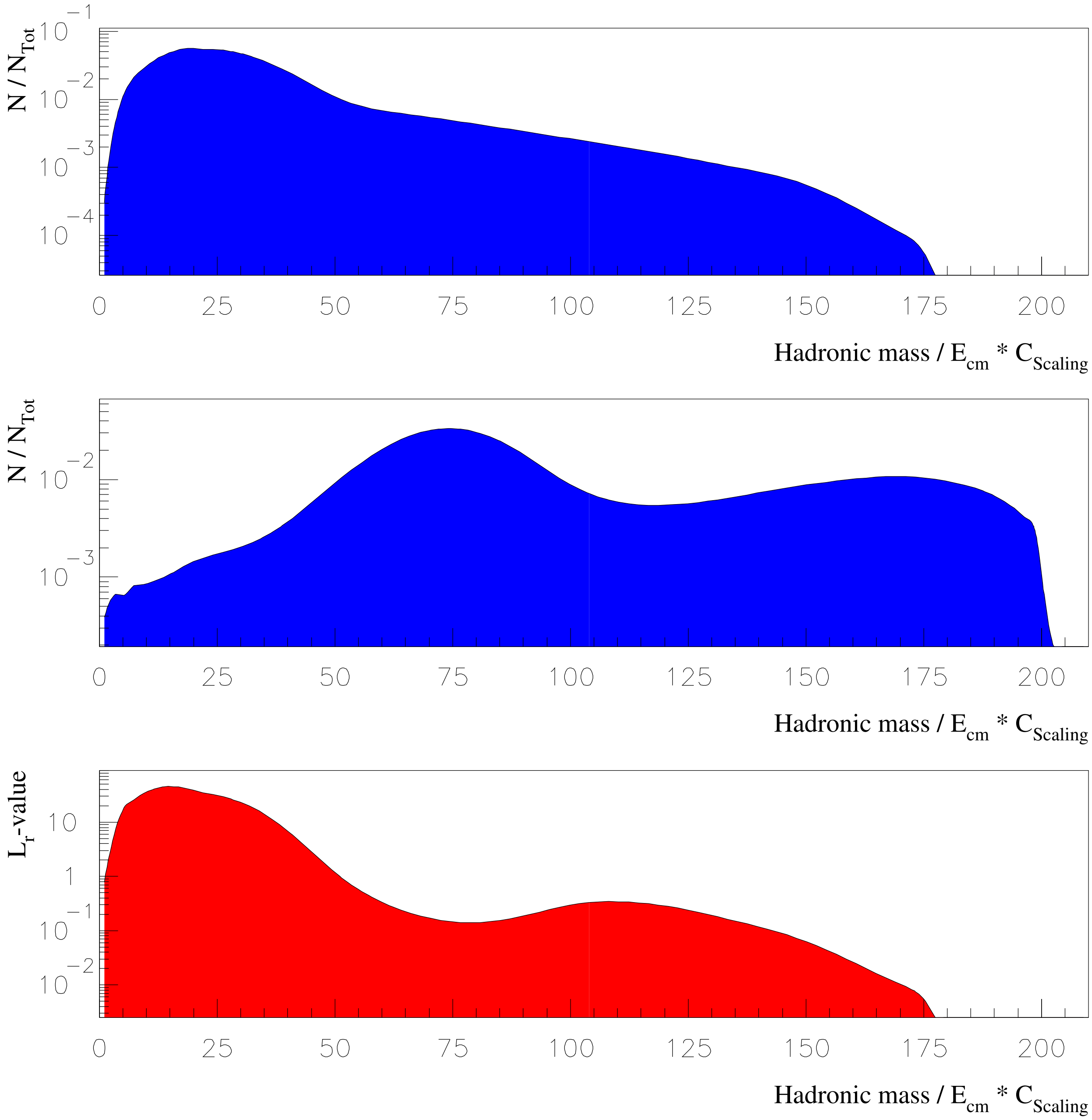
PDF's

- Cut away events with $P_S() = 0$
- Triangular filter



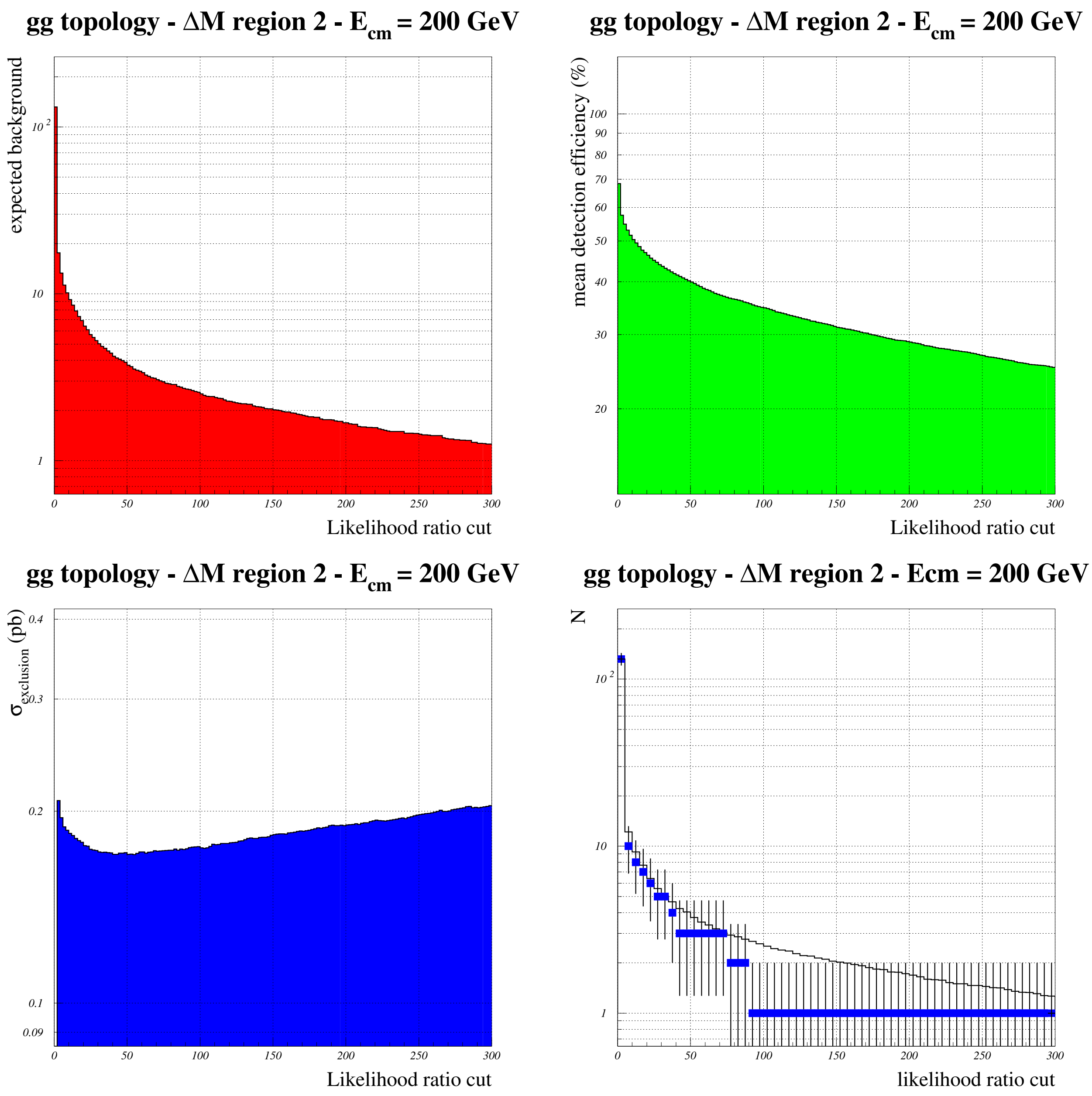
L_r functions

$$\mathcal{L}_{\mathcal{R}}(M_{Hadronic}) = \frac{P_S(M_{Hadronic})}{P_B(M_{Hadronic})}.$$



L_r optimisation

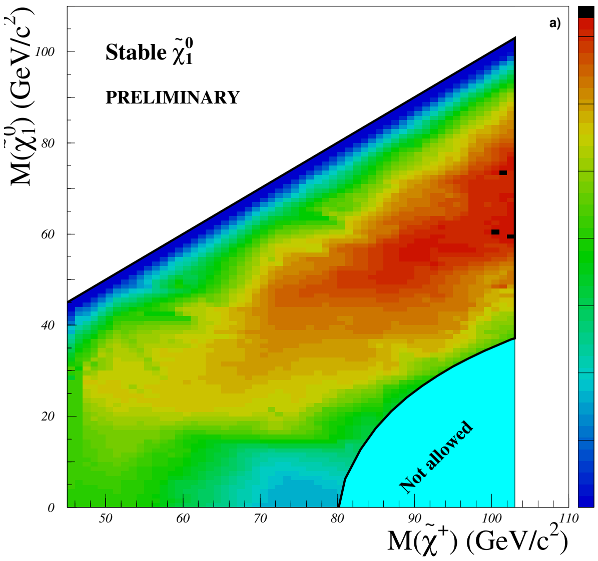
$$\sigma_{exclusion} = \frac{N_{95}(N_B(\mathcal{L}_{\mathcal{R}cut}))}{\epsilon_S(\mathcal{L}_{\mathcal{R}cut}) \times L}.$$



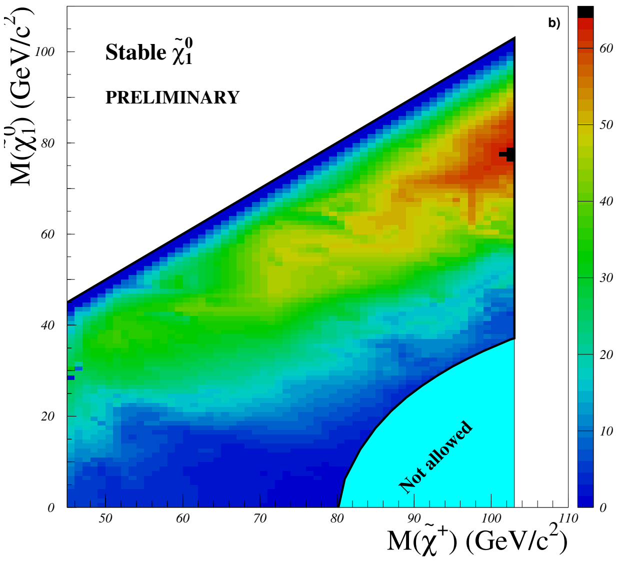
Topology:	j ℓ	$\ell\ell$	jj	rad	TOTAL
	3 $\leq$ **ΔM** $<$ **5** GeV$/c^2$				
N data:	1	54	1	6	62
N backg:	$3.3\,^{+1.90}_{-0.64}$	$54.8\,^{+4.67}_{-3.35}$	$2.5\,^{+1.87}_{-0.56}$	$4.2\,^{+1.84}_{-0.43}$	$64.9\,^{+5.63}_{-3.47}$
	5 $\leq$ **ΔM** $<$ **10** GeV$/c^2$				
N data:	1	16	4	6	27
N backg:	$3.3\,^{+1.90}_{-0.64}$	$10.5\,^{+2.43}_{-1.12}$	$6.2\,^{+2.13}_{-0.91}$	$4.2\,^{+1.84}_{-0.43}$	$24.3\,^{+4.11}_{-1.69}$
	10 $\leq$ **ΔM** $<$ **25** GeV$/c^2$				
N data:	1	12	8	6	27
N backg:	$3.3\,^{+1.90}_{-0.64}$	$11.3\,^{+2.18}_{-0.81}$	$10.7\,^{+2.10}_{-1.05}$	$4.2\,^{+1.84}_{-0.43}$	$29.6\,^{+4.05}_{-1.58}$
	25 $\leq$ **ΔM** $<$ **35** GeV$/c^2$				
N data:	2	26	7	6	41
N backg:	$2.7\,^{+1.77}_{-0.39}$	$21.2\,^{+2.39}_{-1.08}$	$5.7\,^{+1.71}_{-0.38}$	$4.2\,^{+1.84}_{-0.43}$	$33.9\,^{+3.82}_{-1.23}$
	35 $\leq$ **ΔM** $<$ **50** GeV$/c^2$				
N data:	2	30	16	14	62
N backg:	$2.1\,^{+1.56}_{-0.12}$	$36.4\,^{+2.52}_{-1.23}$	$14.6\,^{+1.69}_{-0.43}$	$13.5\,^{+1.84}_{-0.56}$	$66.7\,^{+3.87}_{-1.46}$
	50 GeV$/c^2$ $\leq$ **ΔM**				
N data:	5	44	26	14	89
N backg:	$7.9\,^{+1.74}_{-0.45}$	$47.7\,^{+2.47}_{-1.21}$	$25.0\,^{+1.73}_{-0.50}$	$13.5\,^{+1.84}_{-0.56}$	$94.2\,^{+3.97}_{-1.51}$
	TOTAL (logical .OR. between different ΔM windows)				
N data:	7	101	37	15	160
N backg:	$11.6\,^{+2.10}_{-0.82}$	$105.6\,^{+4.91}_{-3.62}$	$36.8\,^{+2.55}_{-1.59}$	$15.1\,^{+1.98}_{-0.78}$	$169.3\,^{+6.24}_{-4.19}$

Signal efficiencies at $E_{cm} = 206$ GeV

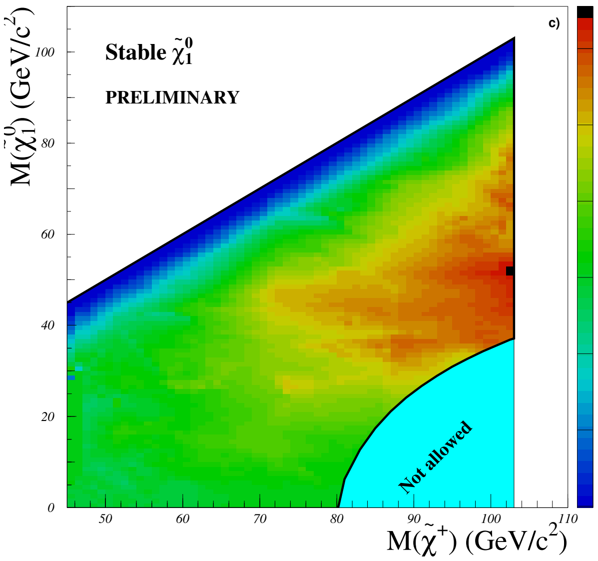
$e^+e^- \rightarrow \tilde{\chi}^+\tilde{\chi}^- \rightarrow$ jjl detection efficiency



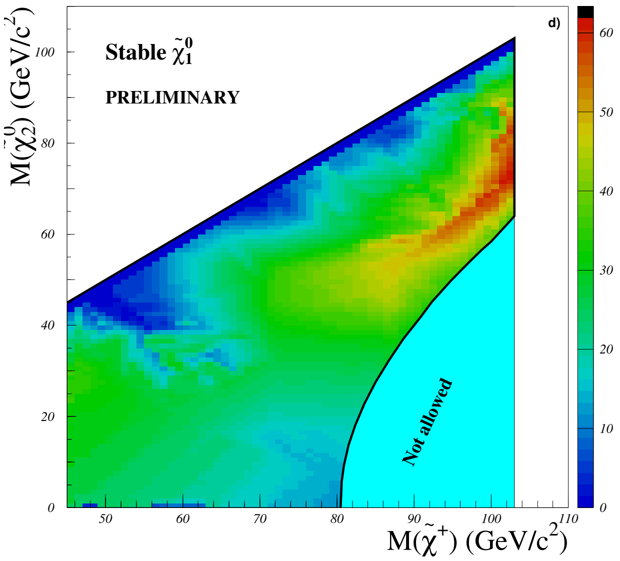
$e^+e^- \rightarrow \tilde{\chi}^+\tilde{\chi}^- \rightarrow$ jets detection efficiency



$e^+e^- \rightarrow \tilde{\chi}^+\tilde{\chi}^- \rightarrow$ ll detection efficiency



$e^+e^- \rightarrow \tilde{\chi}^+\tilde{\chi}^- \rightarrow \gamma\gamma X$ detection efficiency



$\tilde{\chi}_1^{\pm}$ limits

No Excess

$\Downarrow$

Limits were set at 95 C.L.

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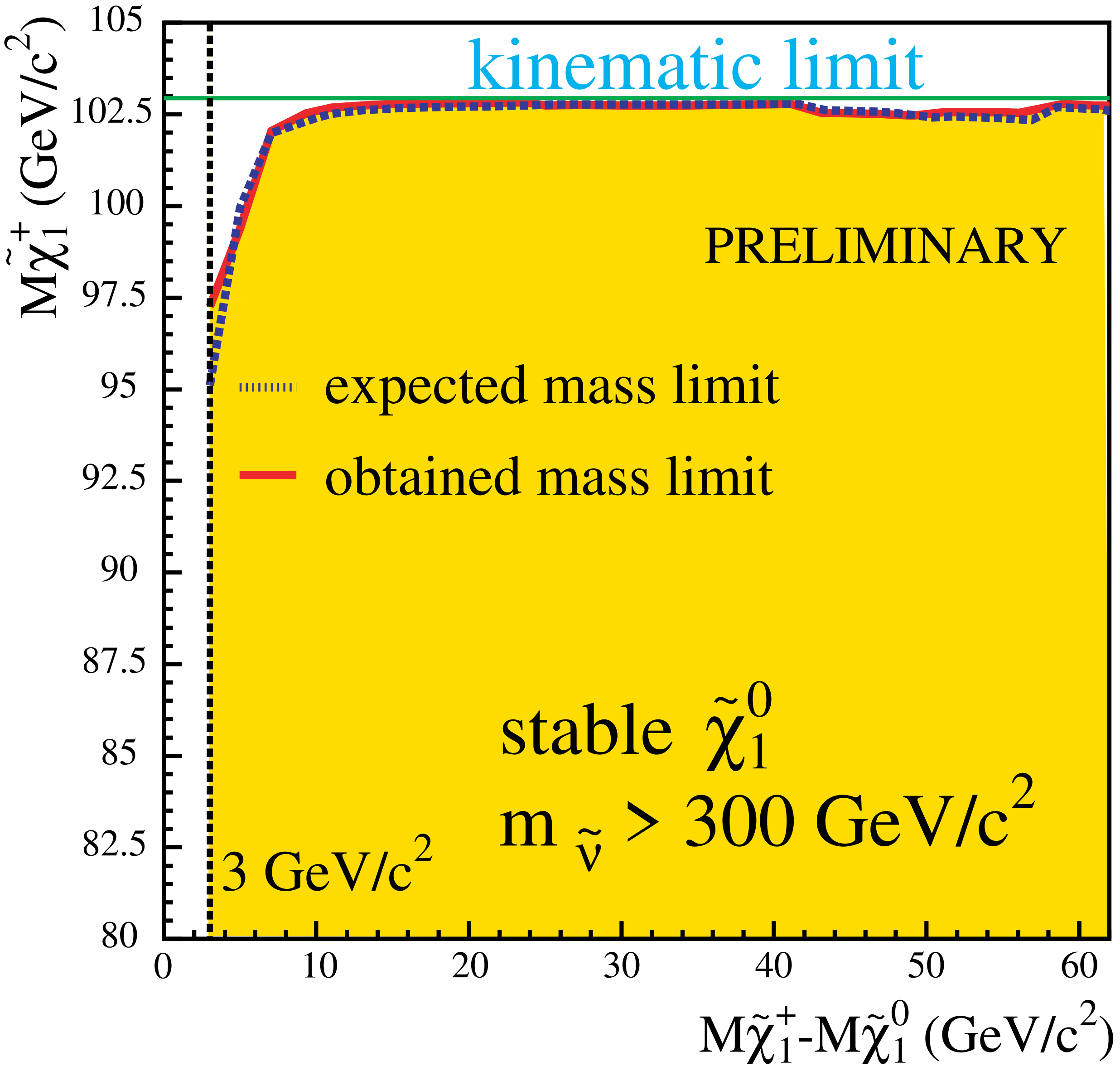
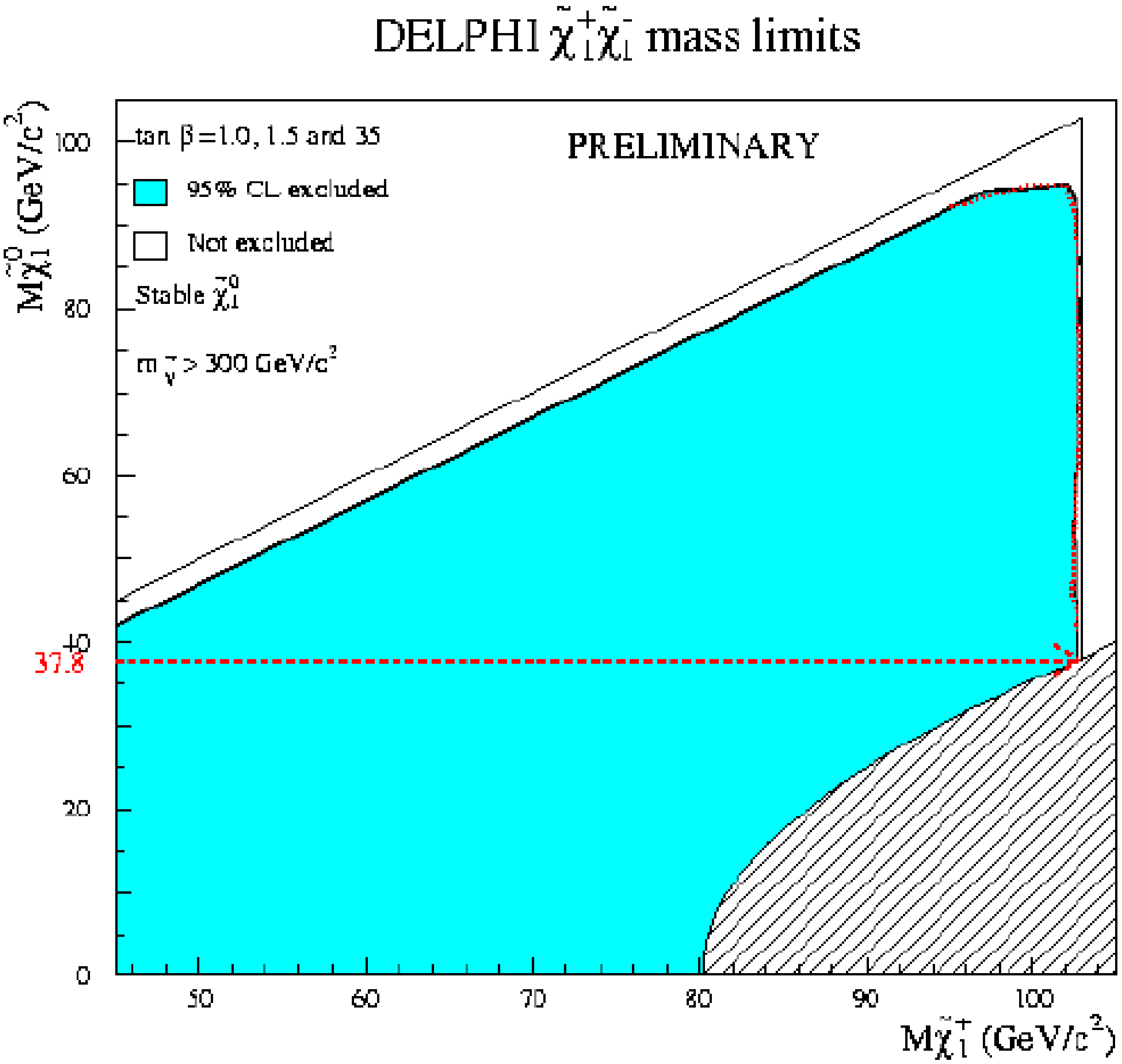


$\tilde{\chi}_1^{\pm}$ limits



Implied limit on lightest neutralino mass

$M_{\tilde{\chi}_1^0} = 37.8$ GeV/c^2 for $m_{\tilde{\nu}} > 300$ GeV/c^2

$\tilde{\chi}_1^\pm$ limits

Present limits (sent to Moriond)

Case	$m_{\tilde{\nu}}$ (GeV/c^2)	$\mathbf{M}_{\chi^\pm}^{min}$ (GeV/c^2)	σ^{max} (pb)
Stable neutralino $E_{cm} = 191.6\text{-}205.9$ GeV			
$\Delta M_+ > 10\ \mathrm{GeV}/c^2$	> 300	102.5	0.21
$\Delta M_+ = 5\ \mathrm{GeV}/c^2$	> 300	99.4	0.81
$\Delta M_+ = 3\ \mathrm{GeV}/c^2$	$> M_{\chi^\pm}$	97.3	1.09

Schedule

- Until June (Summer conferences)

→ Redo the analysis while waiting for the final reprocessing.

New PDF construction

Lr-optimisation at 206 GeV

Including S1 data

Split of the 2000 data into four windows for the limit computation

Expected final limits

$$\Delta M > 10\ \mathrm{GeV}/c^2 \Rightarrow 103$$
$$\Delta M = 5\ \mathrm{GeV}/c^2 \Rightarrow 101$$
$$\Delta M = 3\ \mathrm{GeV}/c^2 \Rightarrow 95$$

→ The effect of the interpolation of the signal efficiency on the systematics

- After June

→ Systematical errors

→ DELPHI note