DELPHI week, April 2001

Presented by: S. Ask

Search for charginos

Thomas Alderweireld (Mons-Belgium)
Stefan Ask (Lund-Sweden)
Alberto Brambilla (Milano-Italia)
Josef Strauss (HEPHY Austria)

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.

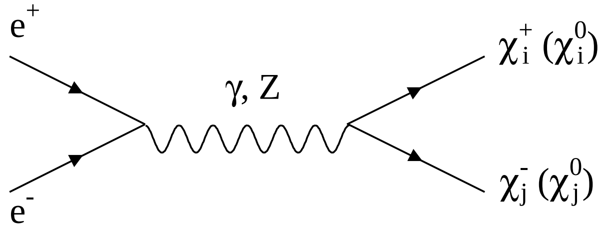
- GUT

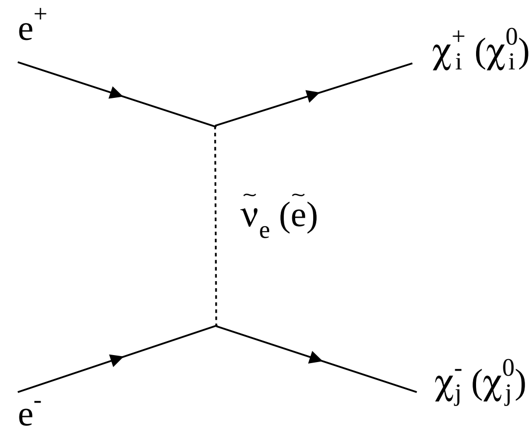
$\longrightarrow$ 8 parameters, $[m_0, m_{\frac{1}{2}}, m_A, \mu, tan(\beta), A_i]$.

- SUGRA

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

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

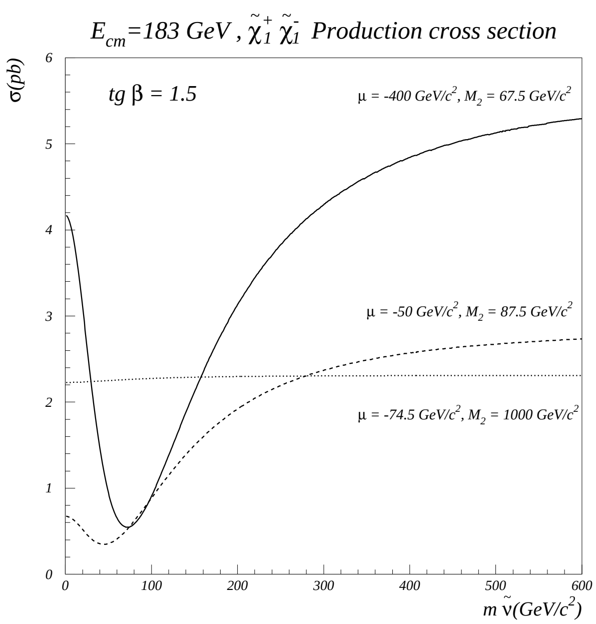


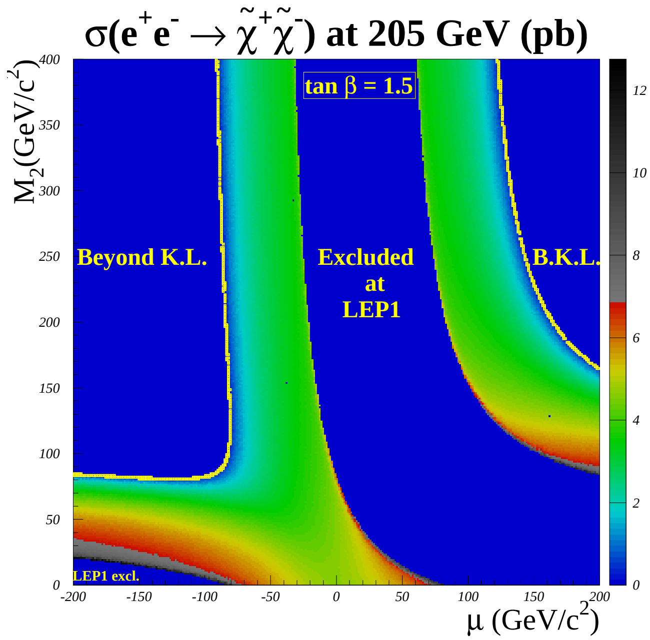


High $m_{\tilde{\nu}}$
(Constrained by m_0, $m_0 = 1$ TeV)

$\Downarrow$

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

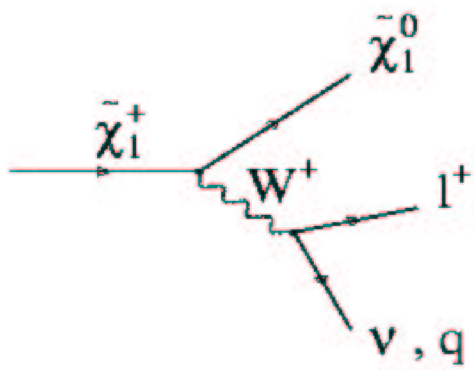


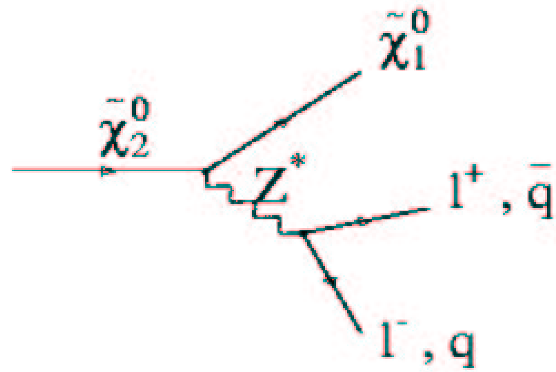


The signal shape depends on:

$$M_{\tilde{\chi}^\pm} - M_{\tilde{\chi}^0_1} = \Delta M$$

$$(m_{\tilde{l},\tilde{q},H^{\pm,0},A} > M_{\tilde{\chi}^\pm_1})$$

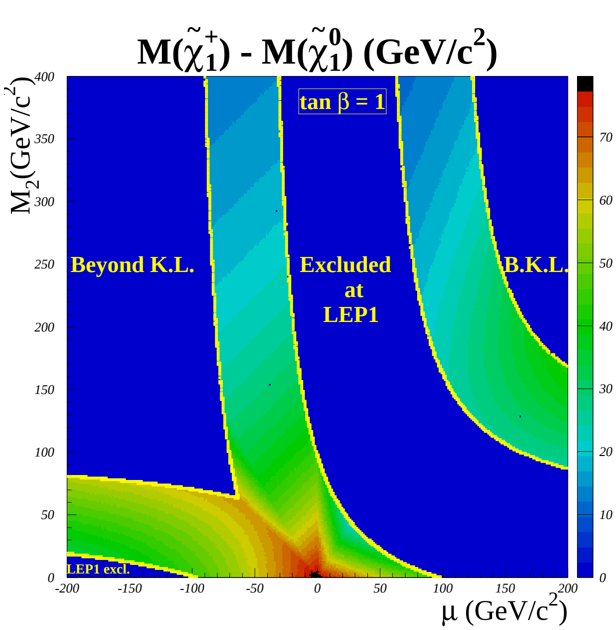


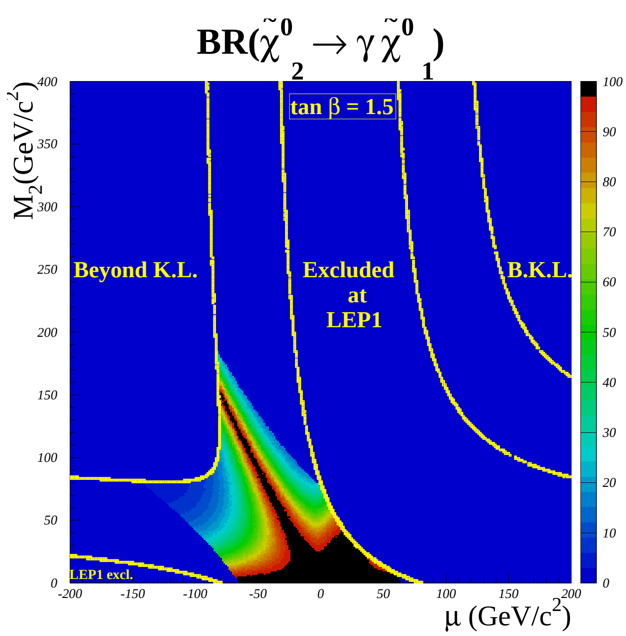


And if $\tilde{\chi}^0_2$ can be produced, causing a cascade decay:

$$\tilde{\chi}^\pm_1 \to \tilde{\chi}^0_2 f_1 \bar{f}_1' \to \tilde{\chi}^0_1\ f_1 \bar{f}_1' + f_2 \bar{f}_2$$

$$\tilde{\chi}^\pm_1 \to \tilde{\chi}^0_2 f_1 \bar{f}_1' \to \tilde{\chi}^0_1 f_1 \bar{f}_1' + \gamma$$



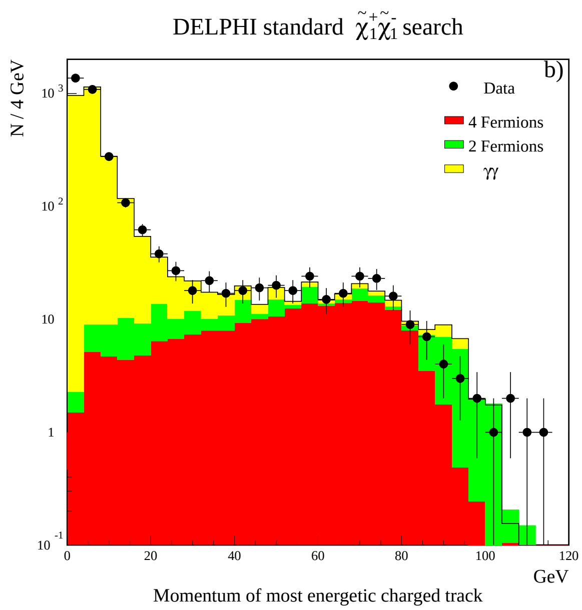


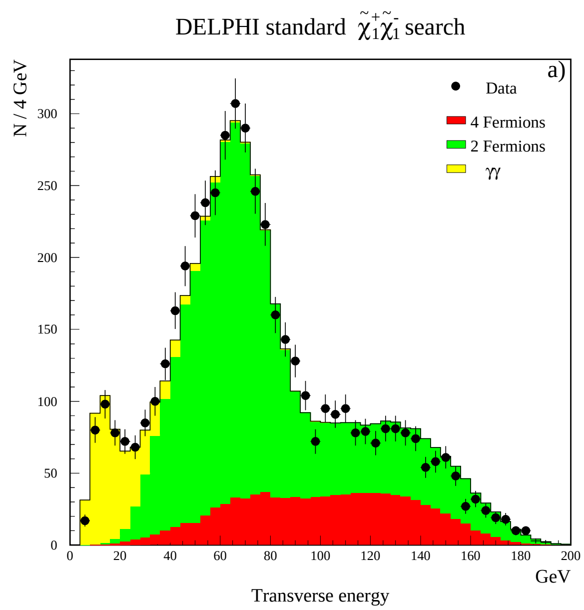
Main background

$\Downarrow$

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

$E_{cm} = 206$ GeV





No isolated Photon
Number of tracks ≤ 5

No isolated Photon or lepton
Number of tracks > 5

❍ 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

EVENTS

$\Downarrow$

for a given topology

Topological cuts

(the same for all ΔM)

$\Downarrow$

Preselection cuts

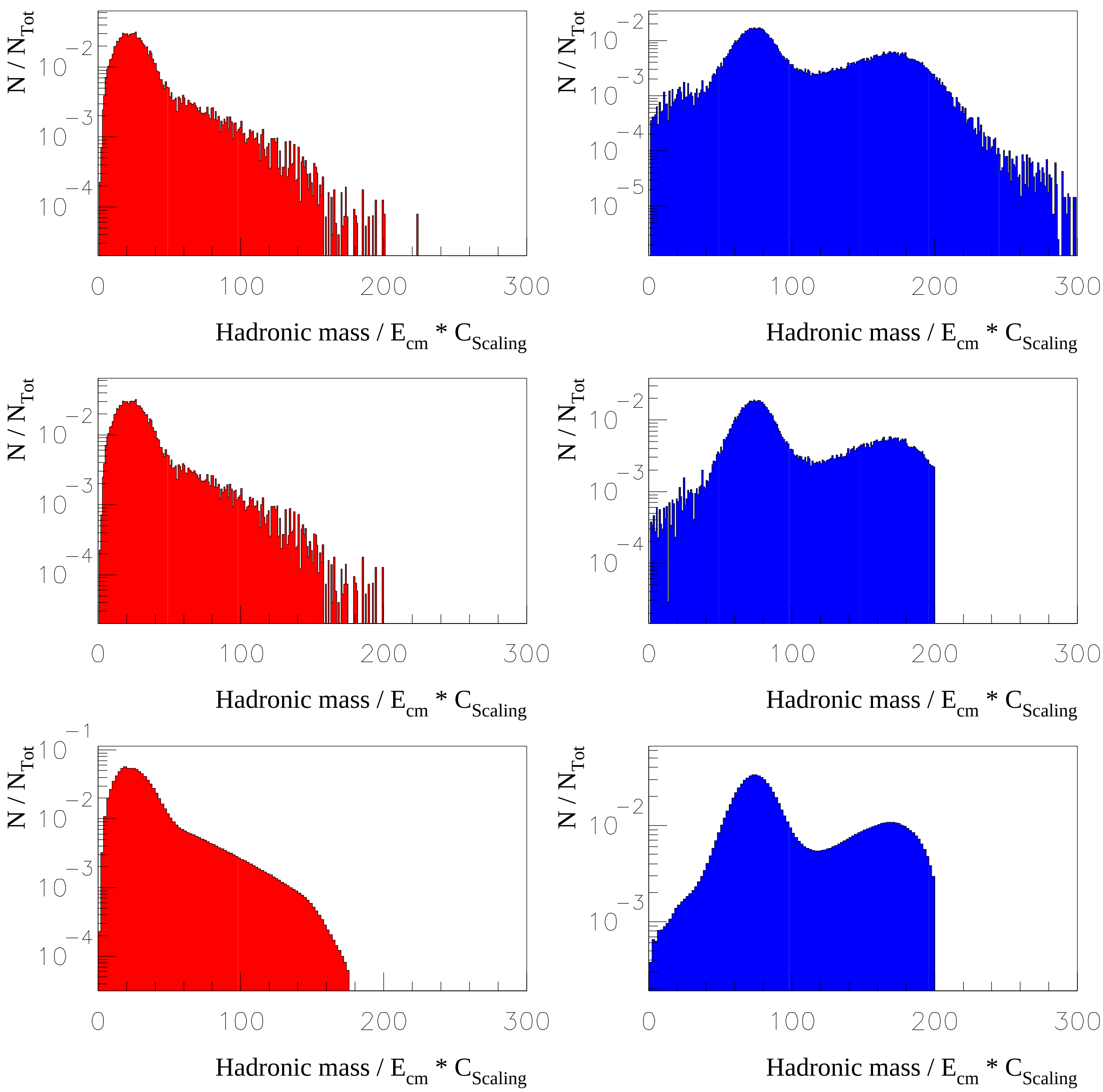
(different for each ΔM)

$\Downarrow$

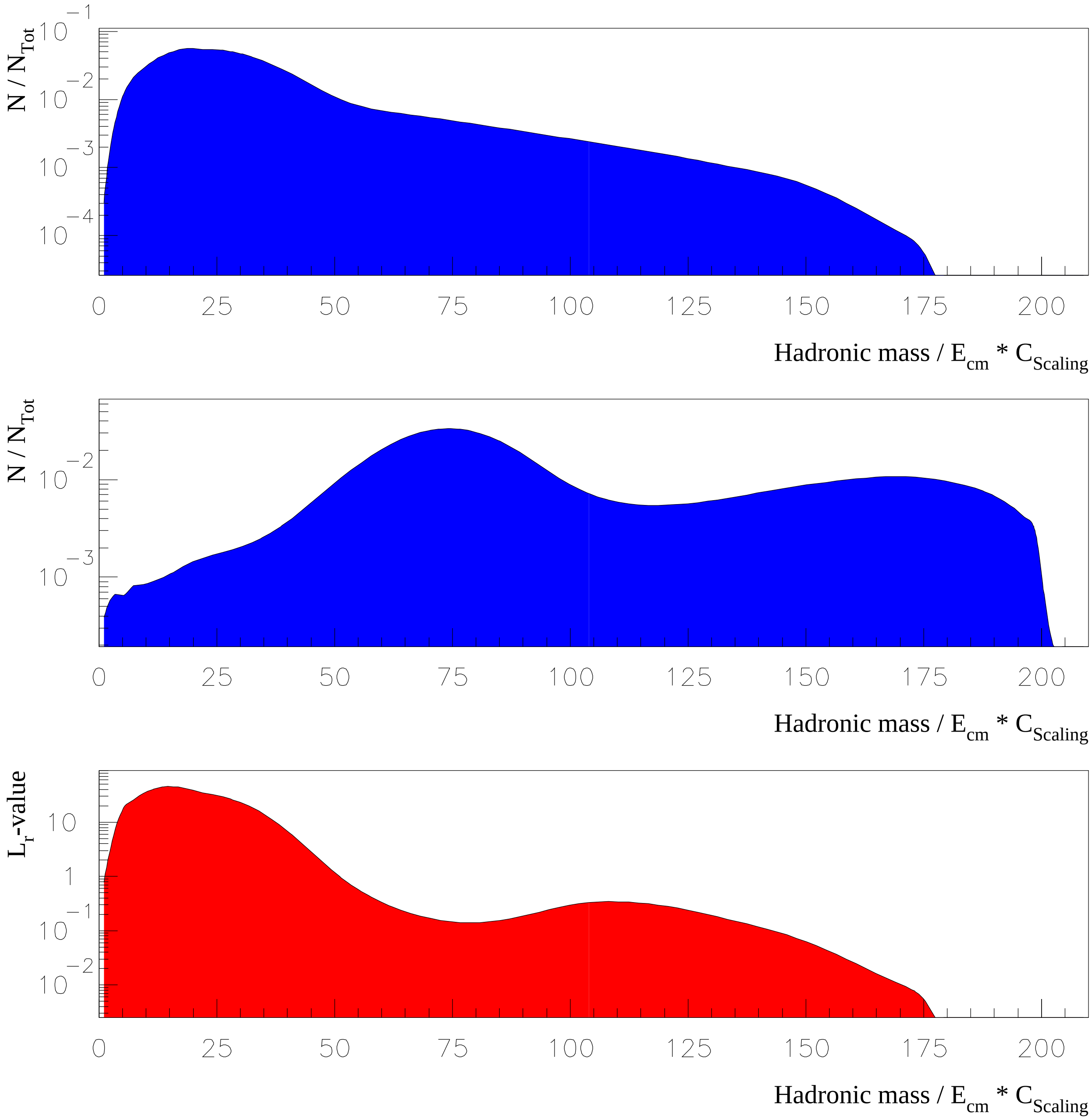
Likelihood cut

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

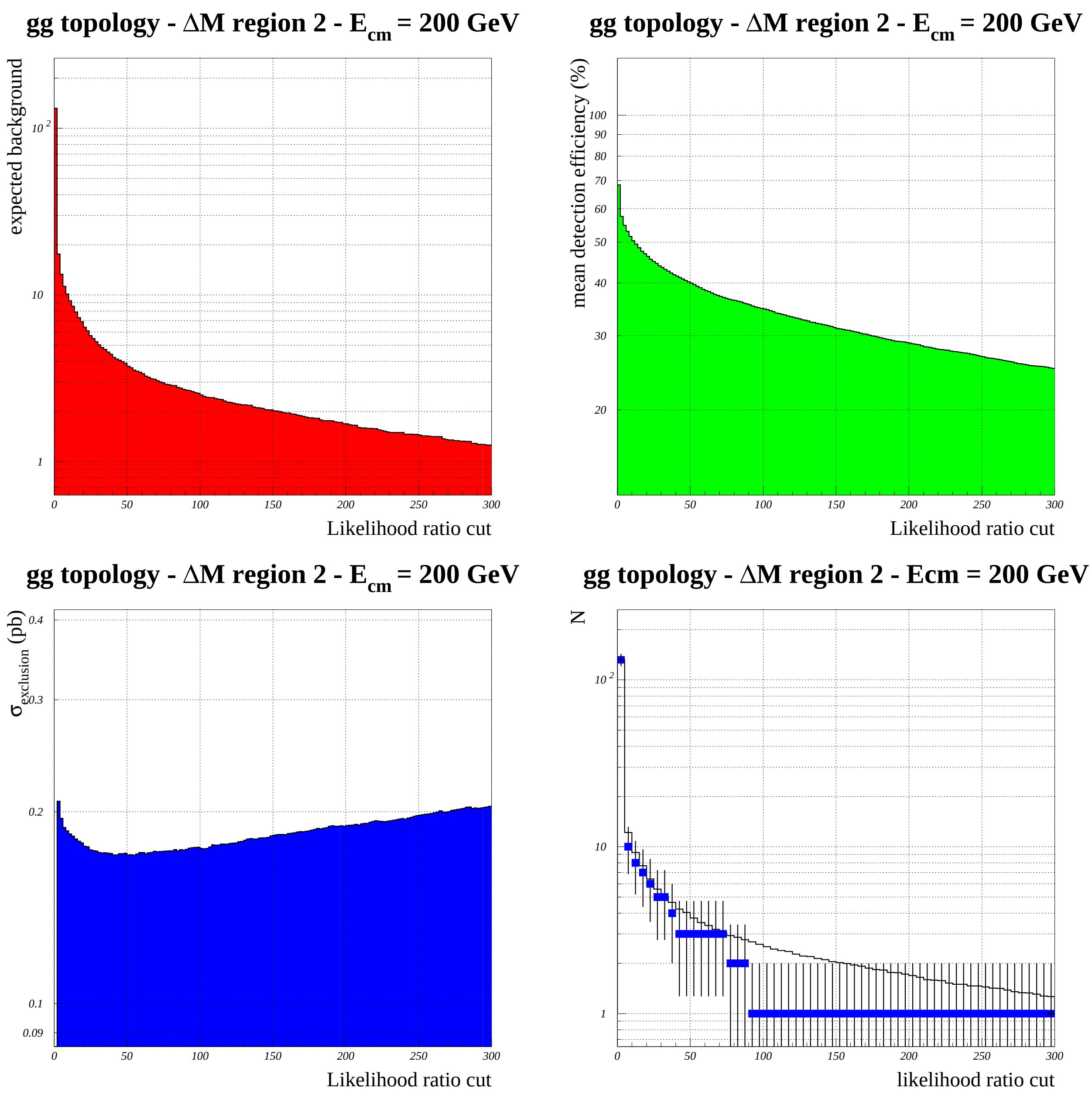
- Cut away events with $P_S() = 0$
- Triangular filter



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

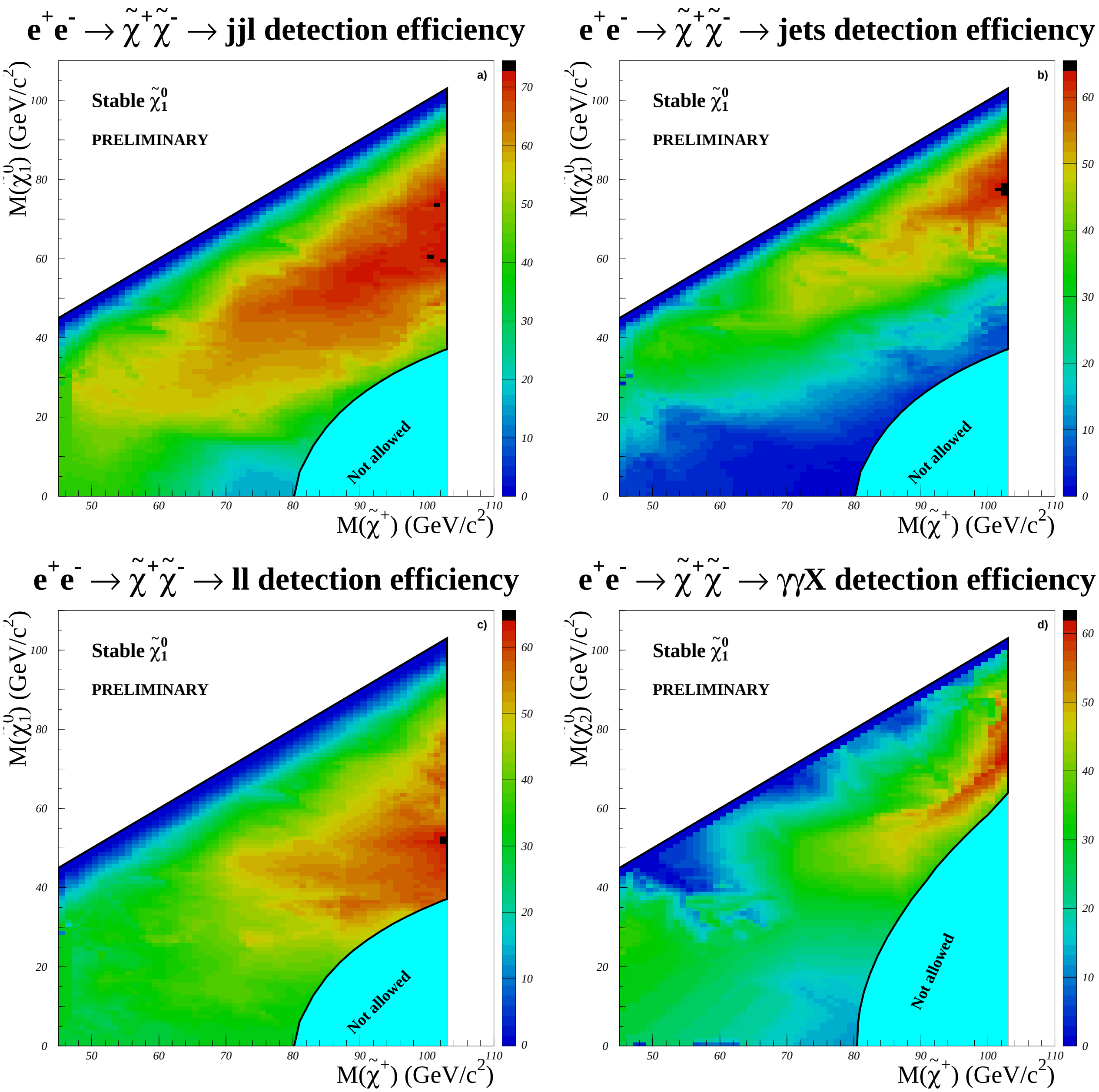


$$\sigma_{exclusion} = \frac{N_{95}(N_B(\mathcal{L}_{\mathcal{R}cut}))}{\epsilon_S(\mathcal{L}_{\mathcal{R}cut}) \times L}.$$



Topology:	j ℓ	$\ell\ell$	jj	rad	TOTAL
	$3 \leq \Delta M < 5$ GeV$/c^2$				
N data:	1	54	1	6	62
N backg:	$3.3\ ^{+1.90}_{-0.64}$	$54.8\ ^{+4.67}_{-3.35}$	$2.5\ ^{+1.87}_{-0.56}$	$4.2\ ^{+1.84}_{-0.43}$	$64.9\ ^{+5.63}_{-3.47}$
	$5 \leq \Delta M < 10$ GeV$/c^2$				
N data:	1	16	4	6	27
N backg:	$3.3\ ^{+1.90}_{-0.64}$	$10.5\ ^{+2.43}_{-1.12}$	$6.2\ ^{+2.13}_{-0.91}$	$4.2\ ^{+1.84}_{-0.43}$	$24.3\ ^{+4.11}_{-1.69}$
	$10 \leq \Delta M < 25$ GeV$/c^2$				
N data:	1	12	8	6	27
N backg:	$3.3\ ^{+1.90}_{-0.64}$	$11.3\ ^{+2.18}_{-0.81}$	$10.7\ ^{+2.10}_{-1.05}$	$4.2\ ^{+1.84}_{-0.43}$	$29.6\ ^{+4.05}_{-1.58}$
	$25 \leq \Delta M < 35$ GeV$/c^2$				
N data:	2	26	7	6	41
N backg:	$2.7\ ^{+1.77}_{-0.39}$	$21.2\ ^{+2.39}_{-1.08}$	$5.7\ ^{+1.71}_{-0.38}$	$4.2\ ^{+1.84}_{-0.43}$	$33.9\ ^{+3.82}_{-1.23}$
	$35 \leq \Delta M < 50$ 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$/c^2 \leq \Delta M$				
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



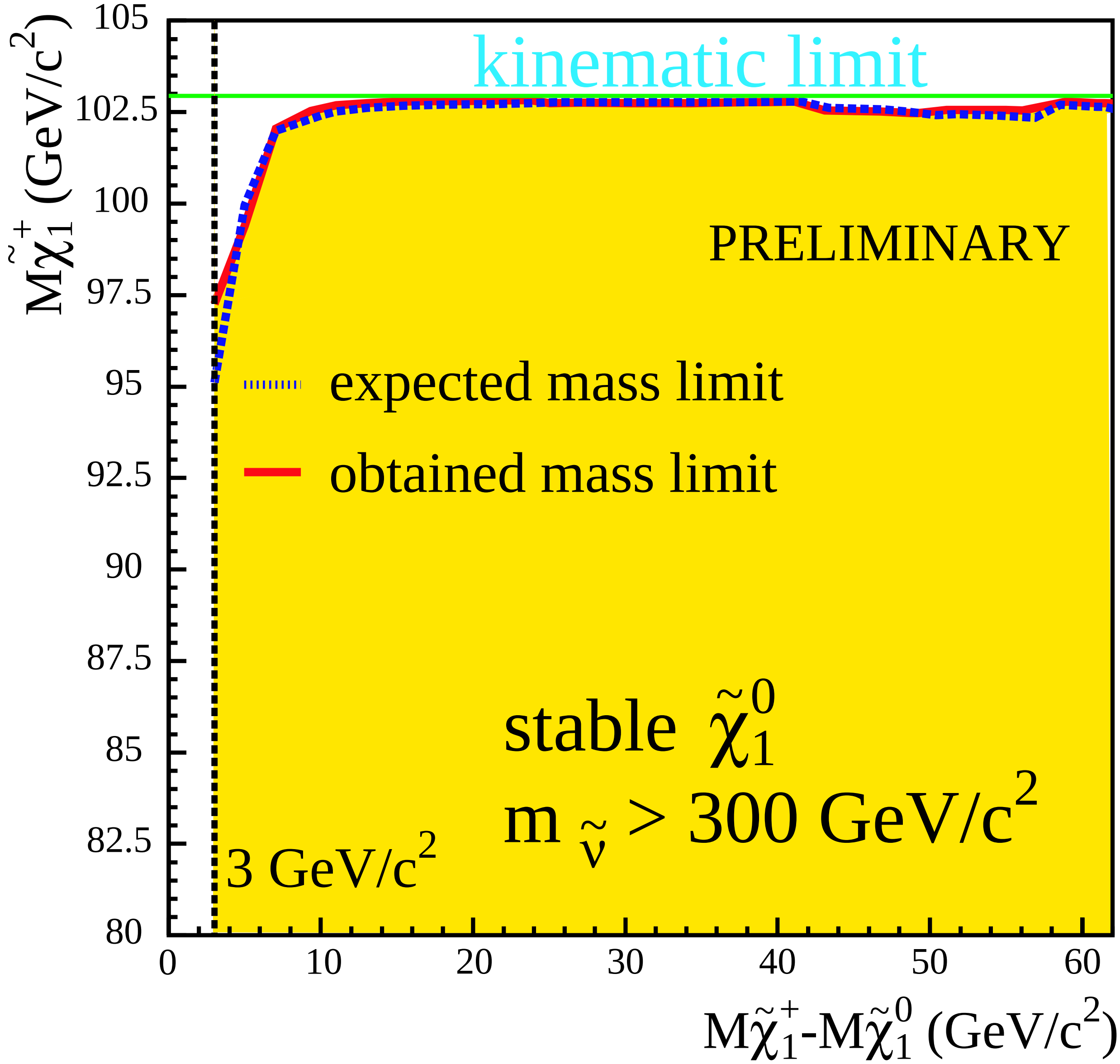
$\tilde{\chi}_1^+$ limits

No Excess

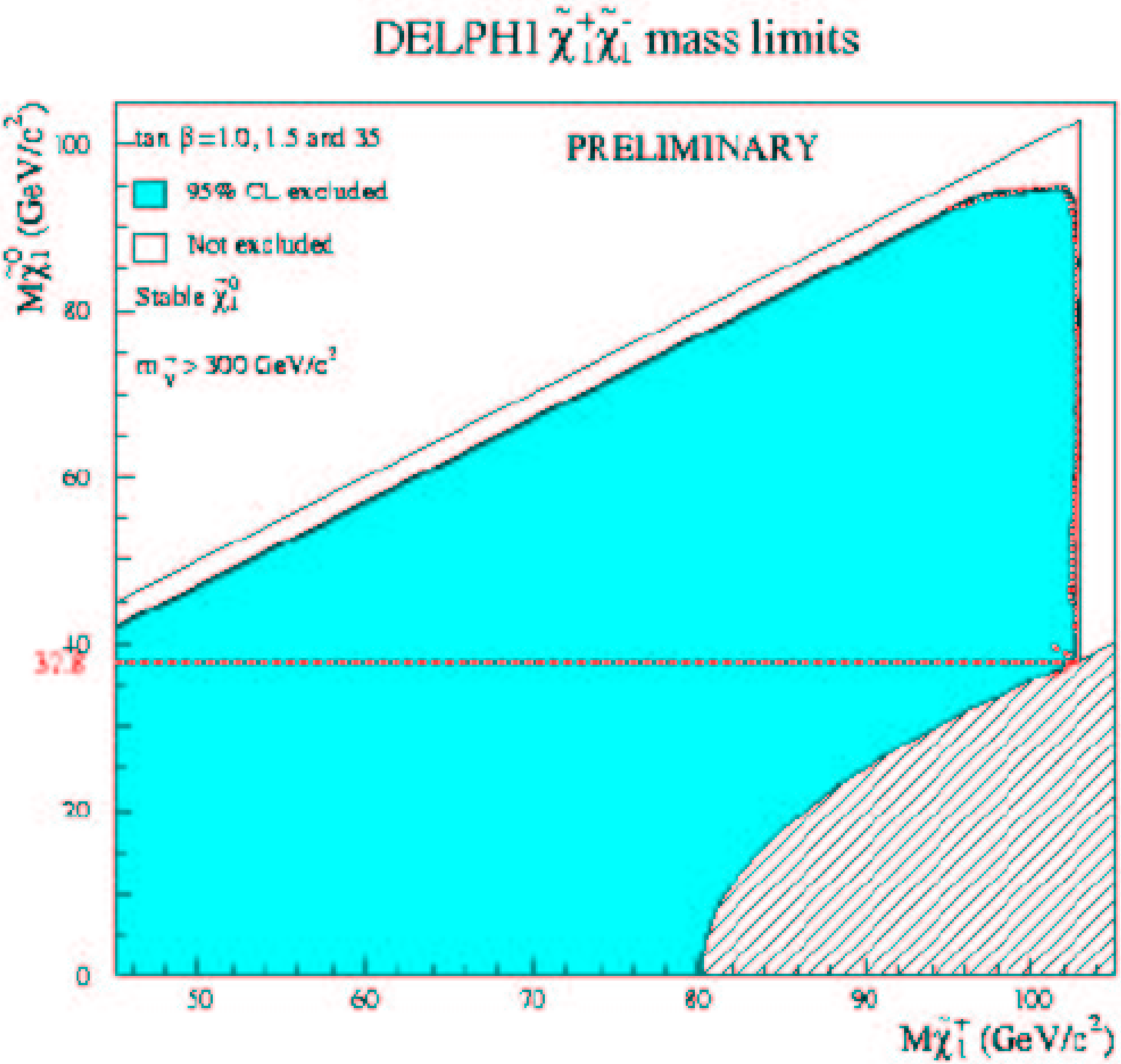
$\Downarrow$

Limits were set at 95 C.L.

$\Downarrow$



$\tilde{\chi}_1^0$ 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

χ_1 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} = 191.6-205.9 GeV			
$\Delta \mathrm{M}_+ > 10\ \mathrm{GeV}/c^2$	$>$ 300	102.5	0.21
$\Delta \mathrm{M}_+ = 5\ \mathrm{GeV}/c^2$	$>$ 300	99.4	0.81
$\Delta \mathrm{M}_+ = 3\ \mathrm{GeV}/c^2$	$> M_{\chi^\pm}$	97.3	1.09

- **Until June** (Summer conferences)

$\longrightarrow$ 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

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

$\longrightarrow$ The effect of the interpolation of the signal efficiency on the systematics

- **After June**

$\longrightarrow$ Systematical errors

$\longrightarrow$ DELPHI note