DELPHI week, September 2001

Presented by: S. Ask

The single photon analysis

$$e^+e^- \rightarrow \not{X} + \gamma$$

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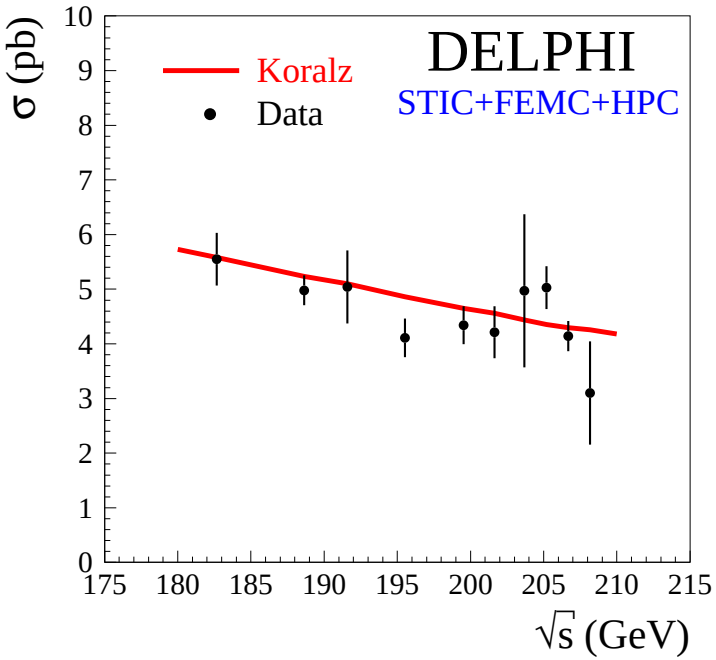
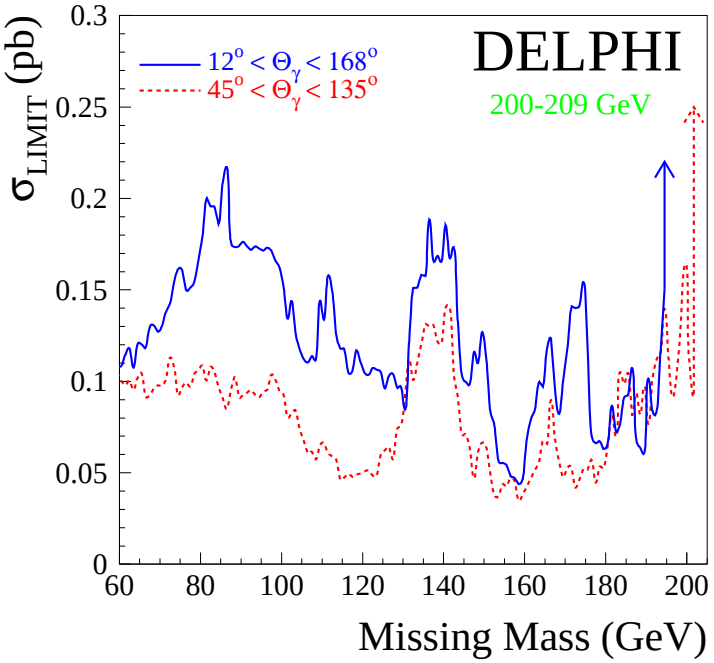
1. Single Photon Summary
2. The Gravitino-Neutralino Analysis
3. "The Susygen Problem"
4. The Results
5. Conclusion & Final Part

Single Photon Summary

Single photon cross section



Model independent search



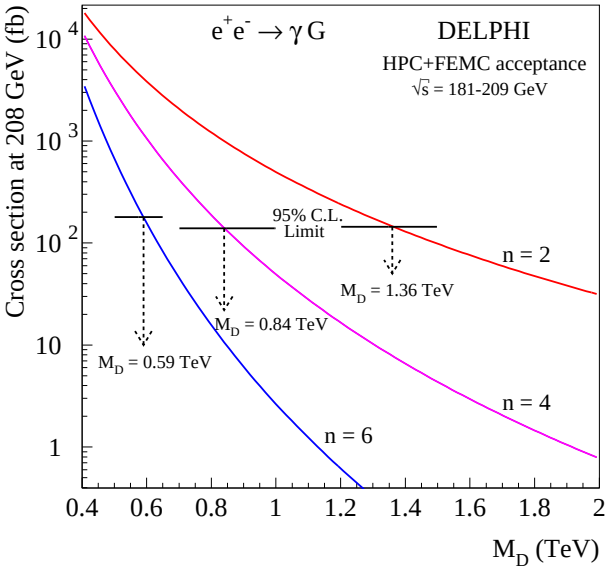
$\Downarrow$

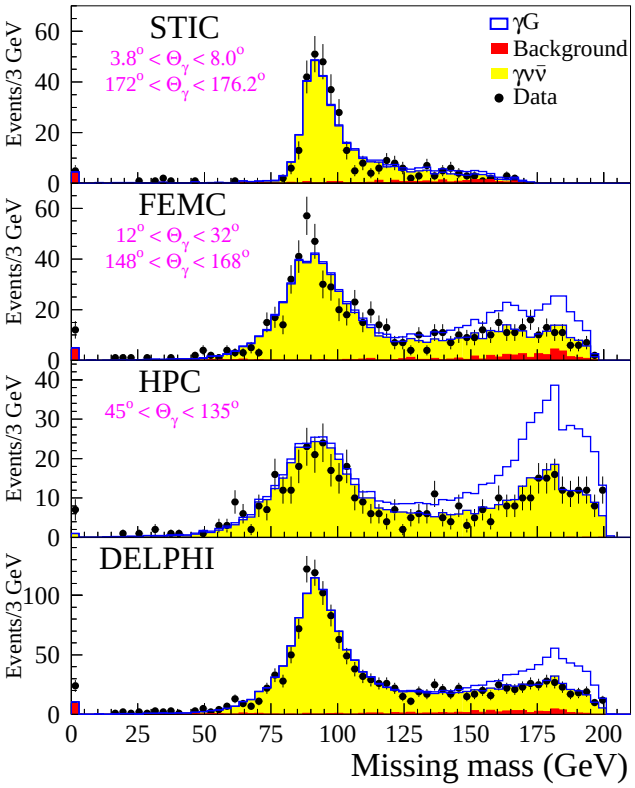
$$N_\nu = 2.80 \pm 0.10\ (stat) \pm 0.14\ (syst)$$

$$e^+e^- \to G + \gamma$$

- Gravity alone propagates in extra dimensions

$$G_N^{-1} = 8\pi R^\delta M_D^{\delta+2} \quad (\leftarrow \text{Giudice et al.})$$

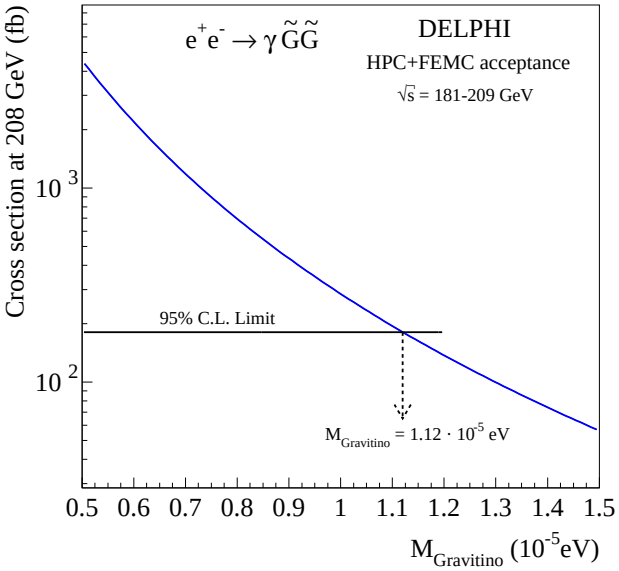


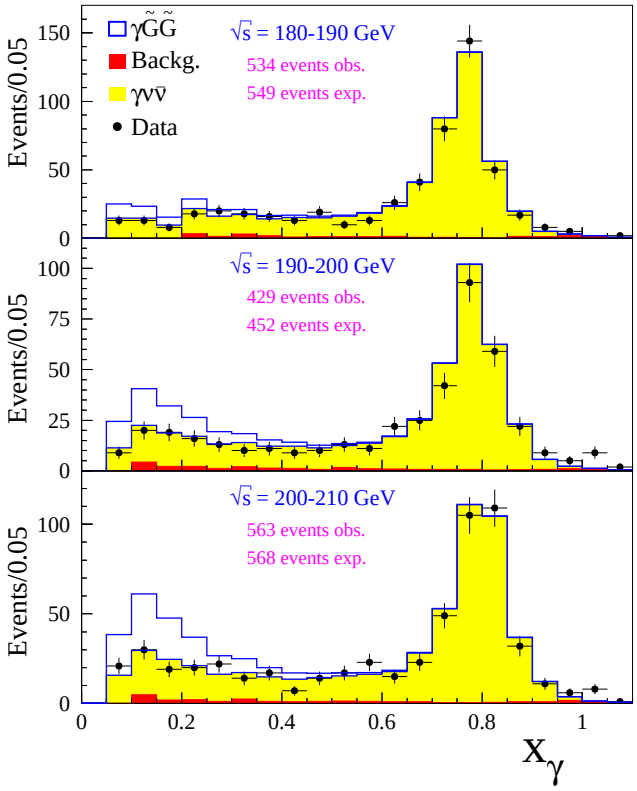


Dimensions	$M_D >$ (exp)	$M_D >$	Radius <
2	1.32	1.36 TeV	0.26 mm
3	1.01	1.05 TeV	3.3 nm
4	0.82	0.84 TeV	13 pm
5	0.69	0.69 TeV	0.48 pm
6	0.59	0.59 TeV	0.54 fm

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

- Gravitino LSP
- All other SUSY-partners to heavy
- $\mathcal{L}_r$ method used to select the candidates
- All DELPHI data $\sqrt{s} = 181$-209 GeV combined





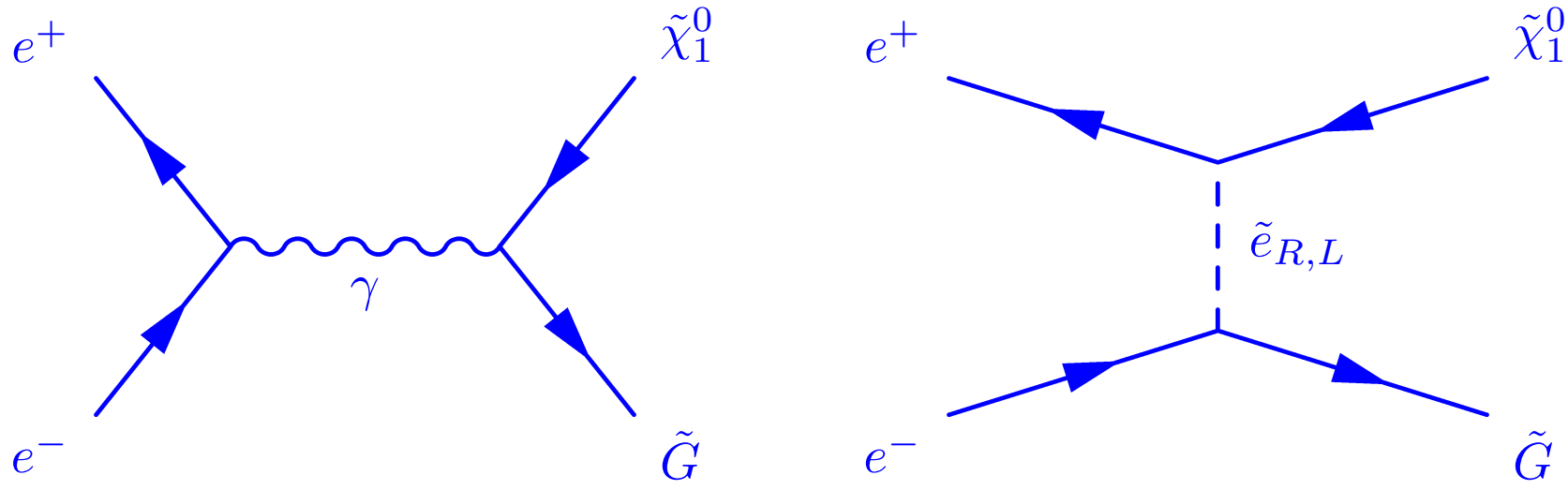
Expected limit: $m_{\tilde{G}} > 1.14 \times 10^{-5}$ eV

Obtained limit: $m_{\tilde{G}} > 1.12 \times 10^{-5}$ eV

$\Downarrow$

$\sqrt{F} > 217$ GeV

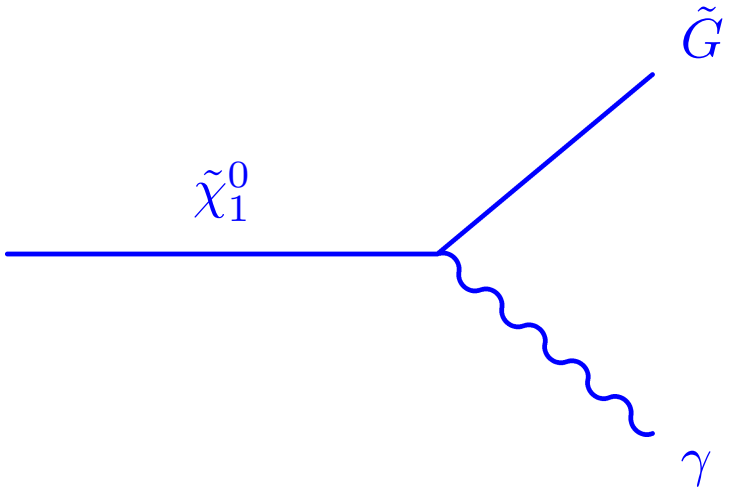
The Gravitino-Neutralino Analysis

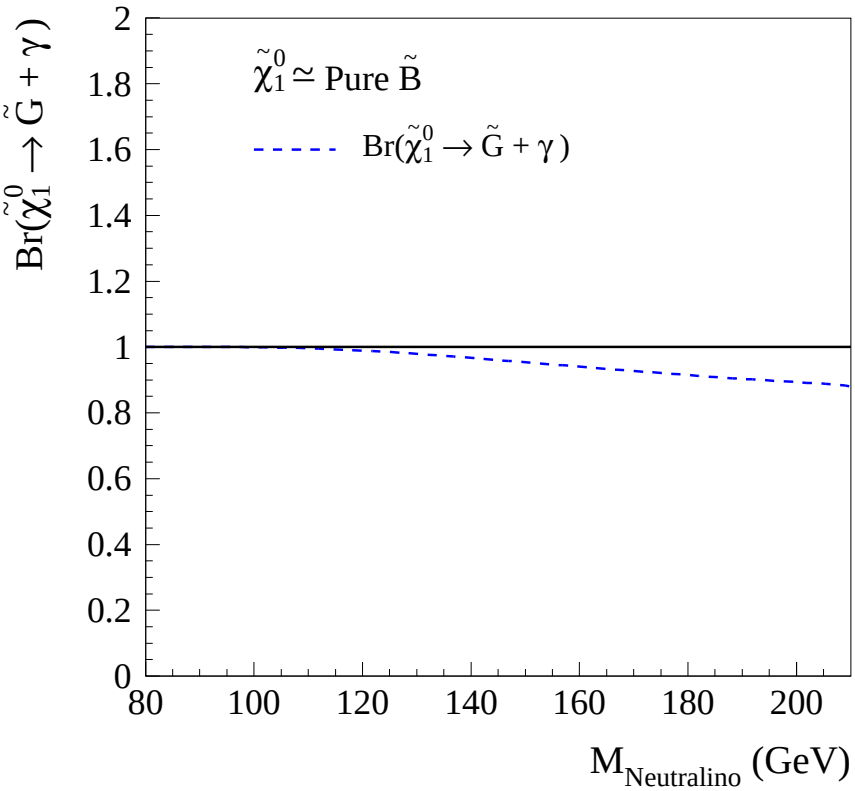


$$\sigma(e^+e^- \to \tilde{\chi}_1^0\tilde{G}) = \mathsf{f}(\mathsf{m}_{\tilde{G}}, \mathsf{m}_{\tilde{\chi}_1^0}, \mathsf{m}_{\tilde{e}_{R,L}}, \mathsf{N}_{11}, \mathsf{N}_{12}, \sqrt{s})$$

Scenario:

General	LNZ
$\tilde{\chi}_1^0 \simeq \tilde{B}$	$\mathsf{m}_{\tilde{G}}$ & $\mathsf{m}_{\tilde{\chi}_1^0}$
GMSB: $\lvert\mu\rvert \gg M_2$	are the only free parameters
Independent of $\tan(\beta)$	





$$m_{\tilde{\chi}_1^0} > 100 \text{ GeV} \Rightarrow Br(\tilde{\chi}_1^0 \to \tilde{G}\gamma) < 1$$

$$1 - Br(\tilde{\chi}_1^0 \to \tilde{G}\gamma) = Br(\tilde{\chi}_1^0 \to \tilde{G}Z^0)$$

The General scenario

Assume the $\tilde{\chi}_1^0$ is gaugino like

$+$

Signal shape and $\sigma(e^+e^- \rightarrow \tilde{\chi}_1^0\tilde{G})$
unsensitive to gaugino composition of $\tilde{\chi}_1^0$

$\Downarrow$

We set $\tilde{\chi}_1^0$ to pure $\tilde{B}$

$\Updownarrow$

GMSB: $|\mu| \gg M_2$
Independent of $\tan(\beta)$

$\Downarrow$

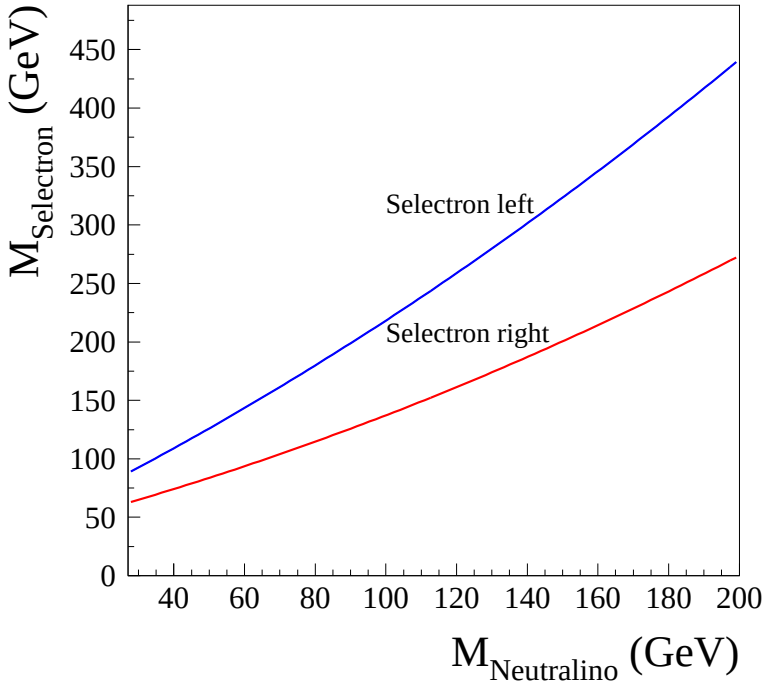
Calculate exclusion limits for
$m_{\tilde{e}_R} = m_{\tilde{e}_L} = 75$ GeV
$m_{\tilde{e}_R} = m_{\tilde{e}_L} = 150$ GeV

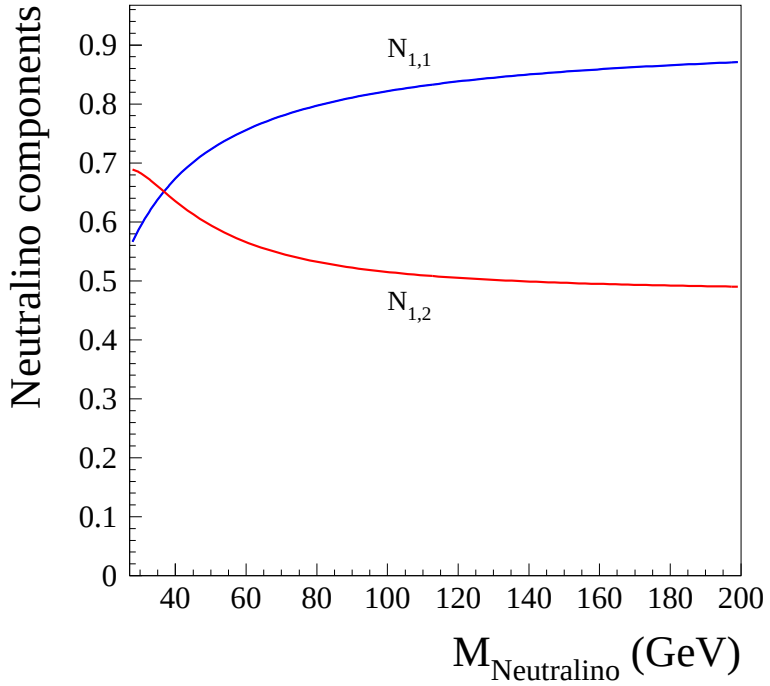
The LNZ model

Only free parameters are $m_{\tilde{G}}$ & $m_{\tilde{\chi}_1^0}$

Gravitino LSP

Gaugino dominated neutralino





The Analysis

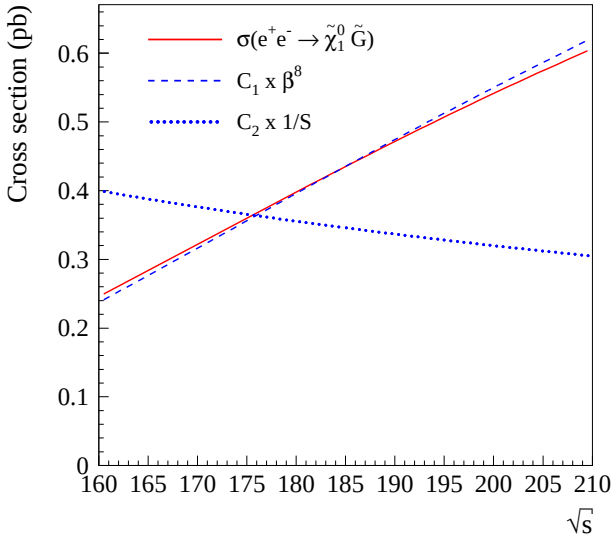
$\mathcal{L}_r$-method from the $\tilde{\chi}_1^+\tilde{\chi}_1^-$-analysis
was used to select the events

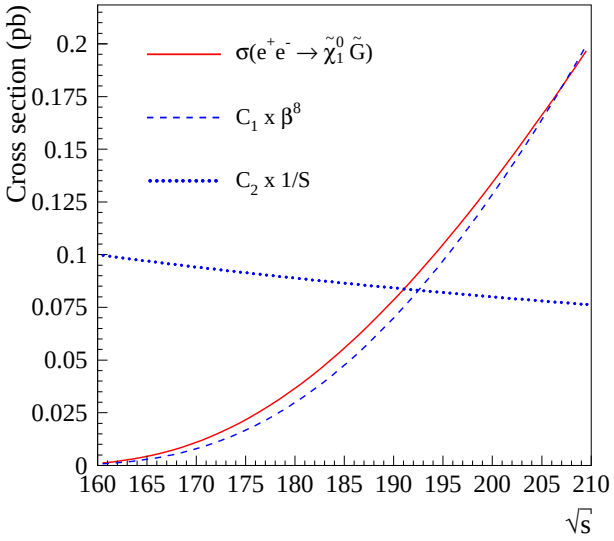
Data with $\sqrt{s}$ = 181-209 GeV was combined
with the multichannel Bayesian formula

$\Downarrow$

$$\sigma(e^+e^- \to \tilde{\chi}_1^0\tilde{G}) = \frac{1}{s} \text{ ???}$$

(Th. Paper = J.L. Lopez et al. Phys. Rev. D55 (1997) 5813)



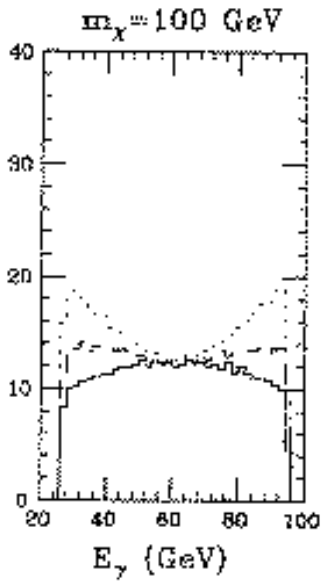


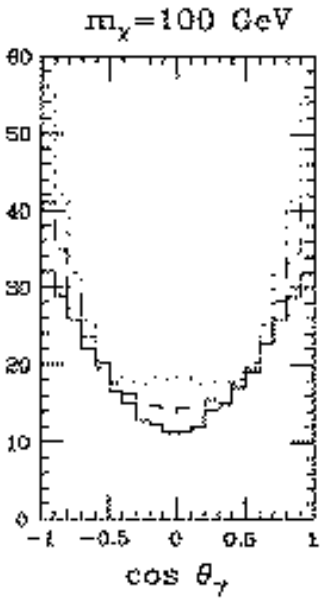
$m_{\tilde{\chi}_1^0}$ = 100 GeV
$m_{\tilde{e}_R} = m_{\tilde{e}_L}$ = 150 GeV

$m_{\tilde{\chi}_1^0}$ = 150 GeV
$m_{\tilde{e}_R} = m_{\tilde{e}_L}$ = 100 GeV

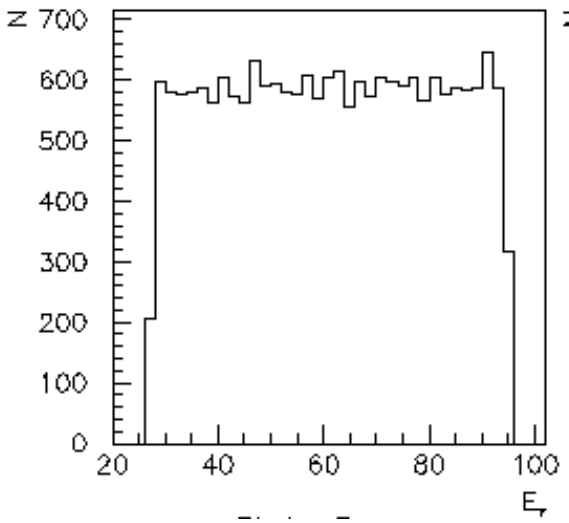
Susygen - Th. paper difference

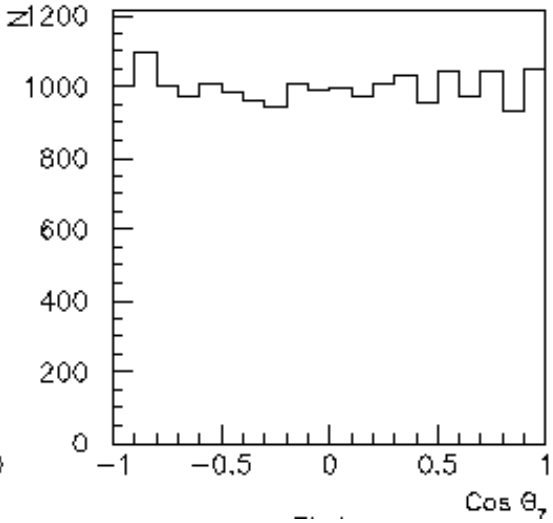
$m_{\tilde{\chi}_1^0} = 100$ GeV



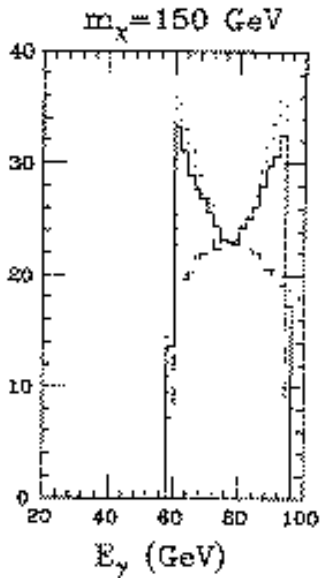


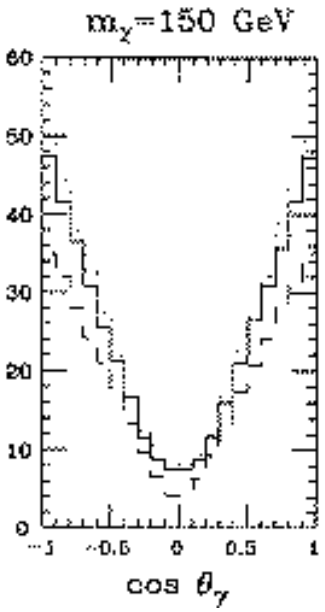
$M_{Neutralino} = 100$, $M_{Selectron} = 300$



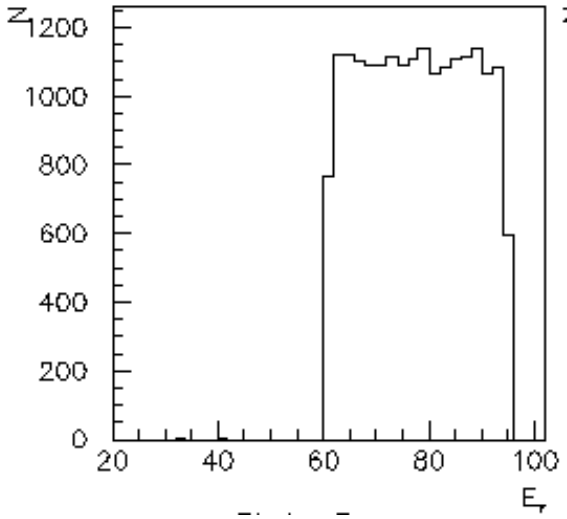


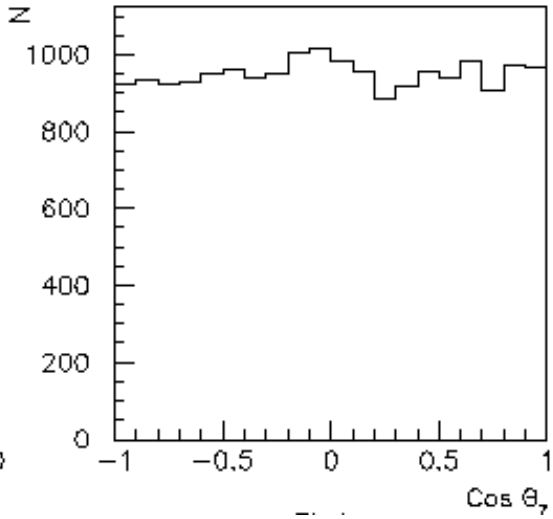
$m_{\tilde{\chi}_1^0} = 150$ GeV





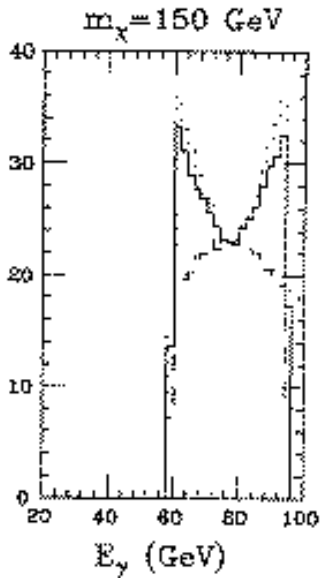
$M_{Neutralino} = 150$, $M_{Selectron} = 150$

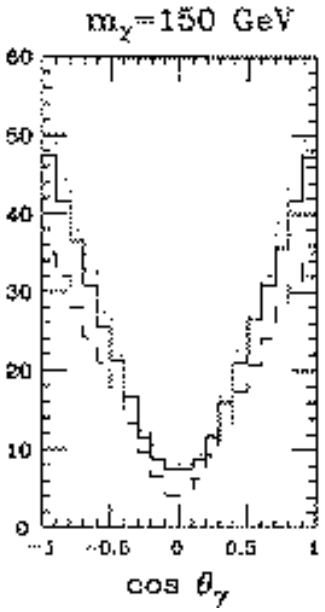


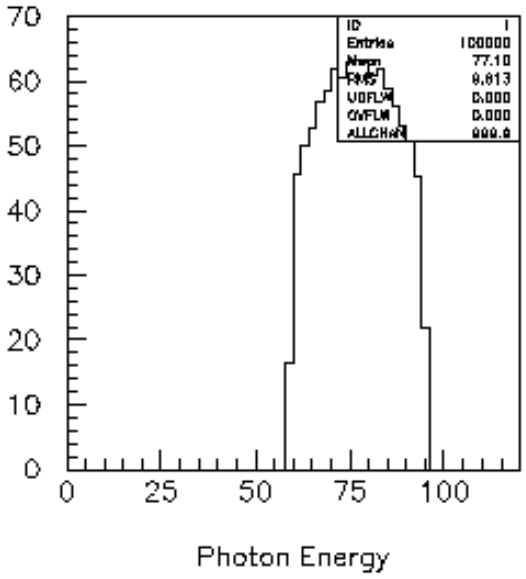


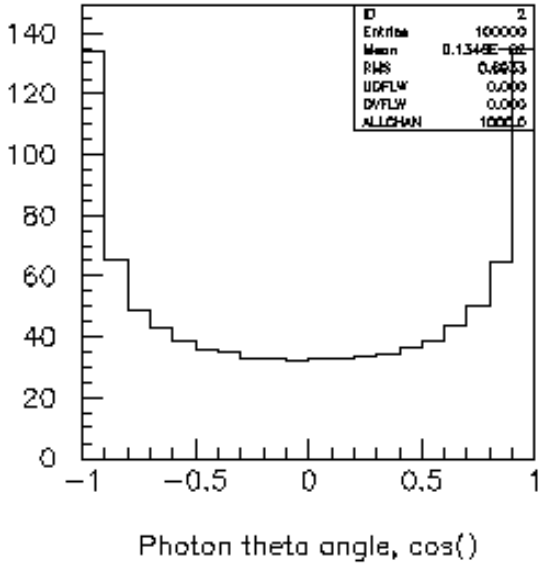
Isotropic θ-distribution
(instead of $Cos(\theta)$)

$m_{\tilde{\chi}_1^0} = 150$ GeV









Susygen - Th. paper difference

Mail to Nabil Ghodbane → No bugs found

$\sigma(e^+e^- \to \tilde{\chi}_1^0\tilde{G})$ from Th. paper → Toy Monte Carlo

!!! SAME RESULTS !!!

Mail to Dimitri Nanopoulos

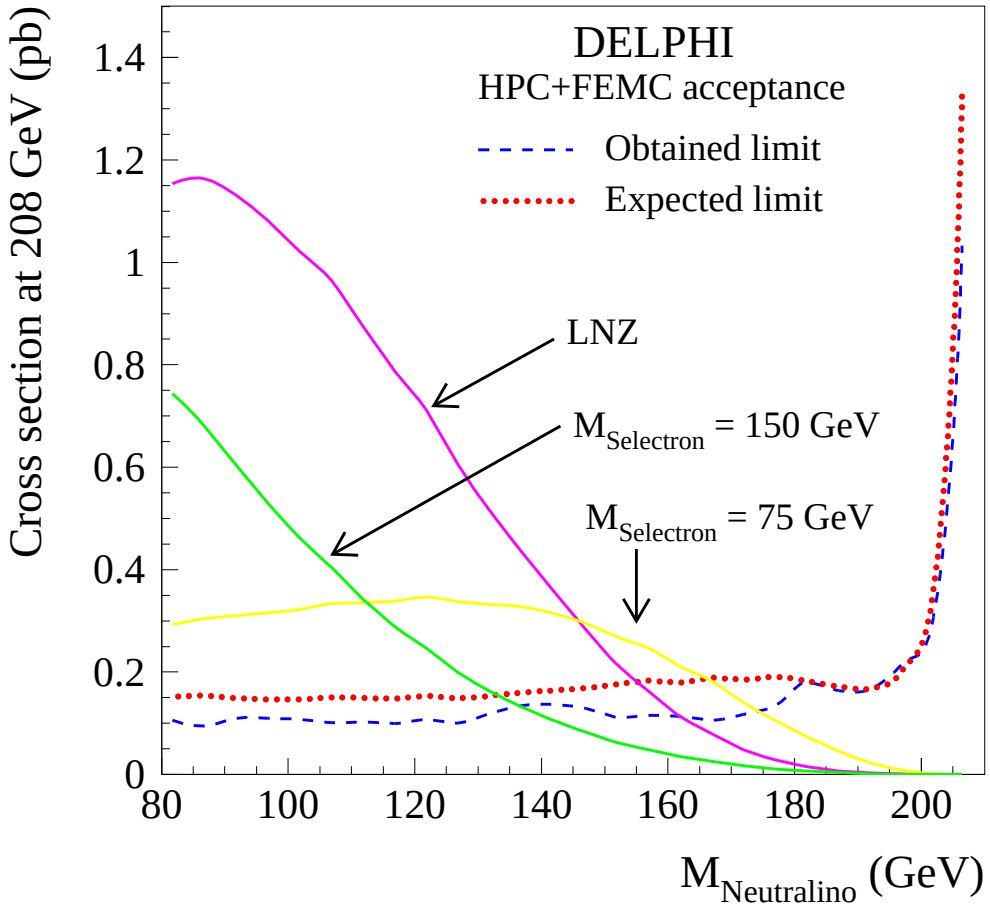
Continue Analysis

Limit on excluded cross section

Since the shape of the signal distributions used by the $\mathcal{L}_r$-selection is unsensitive to different $m_{\tilde{e}_{R,L}}$, N_{11} & N_{12}

$\Downarrow$

The same cross section limit can be used to exclude parameter regions for all the model scenarios



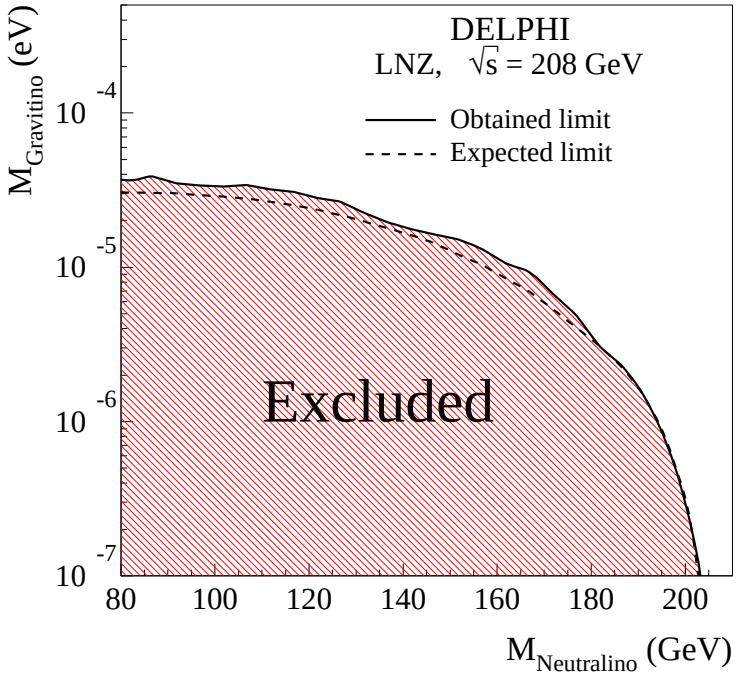
HPC deficit $\Rightarrow |\sigma_{95}^{Obtained} - \sigma_{95}^{Expected}| < 0$

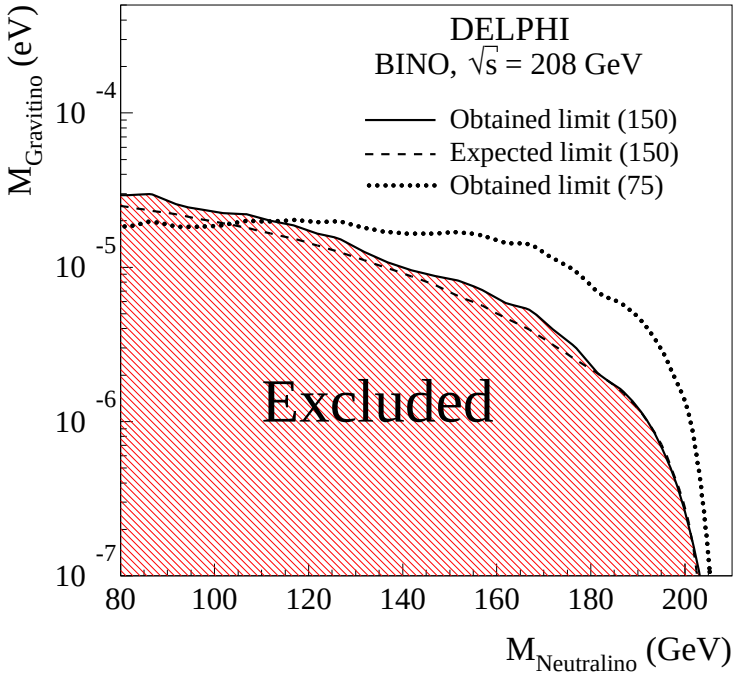
$m_{\tilde{\chi}_1^0}$-$m_{\tilde{G}}$ exclusion limits

Complement to $m_{\tilde{\chi}_1^0}$ excluded from

$$e^+e^- \to \tilde{\chi}_1^0\tilde{\chi}_1^0 \to \tilde{G}\gamma + \tilde{G}\gamma$$

since there the K.L. implies $m_{\tilde{\chi}_1^0} < \frac{\sqrt{s}}{2}$





Conclusion

- $\sigma(e^+e^- \rightarrow \tilde{\chi}_1^0\tilde{G}) \propto \beta^8(\sqrt{s})$
- Regarding the $e^+e^- \rightarrow \tilde{\chi}_1^0\tilde{G}$ event generation Susygen seems to work correctly
- Exclusion limits for the cross section and in the $m_{\tilde{\chi}_1^0}$-$m_{\tilde{G}}$ plane has been made

Remaining Part

$e^+e^- \to \tilde{\chi}_1^0\tilde{\chi}_1^0 + \gamma$:

Unsensitive !

$\sigma_{max} \sim$ 30-50 fb

$e^+e^- \to \tilde{\chi}_1^0\tilde{\chi}_2^0 \to \tilde{\chi}_1^0\tilde{\chi}_1^0 + \gamma$:

Might be sensitive in
some parts of parameter space

$\Downarrow$

At least σ_{95}-limit by modifying the
Gravitino-Neutralino code