Selectron Pair Production in $e^- e^-$ Scattering

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Contents

I. Introduction and Motivation

We investigate the process

$$e^- + e^- \xrightarrow[\tilde{\chi}_i^0]{} \tilde{e}^-_{L/R} + \tilde{e}^-_{L/R}$$

$$\tilde{e}^-_{L/R} \to \tilde{\chi}_1^0 + e^-$$

$$\tilde{e}^-_{L/R} \to \tilde{\chi}_1^0 + e^-$$

- Higher cross sections in e^-e^- scattering

- Better polarization in e^-e^- scattering

- All 4 neutralinos as exchange particles
  $\to M_1$ dependence over a large range of M_1

MSSM - Parametrs

MSSM-Parameter:

M_1, M_2, μ, $\tan\beta$, $m_{\tilde{e}_L}$, $m_{\tilde{e}_R}$

$M_1 \uparrow U(1)$, $M_2 \uparrow SU(2)$, $m_{\tilde{e}_L}, m_{\tilde{e}_R} \leftarrow m_0$

GUT-Relation: $M_1 = M_2 \cdot \frac{5}{3} \tan^2\theta_W$

CP-Conservation: M_1, M_2, μ real

Parameters for all plots:

$$M_2 = 152 \text{ GeV}$$

$$\mu = 316 \text{ GeV}$$

$$\tan\beta = 3$$

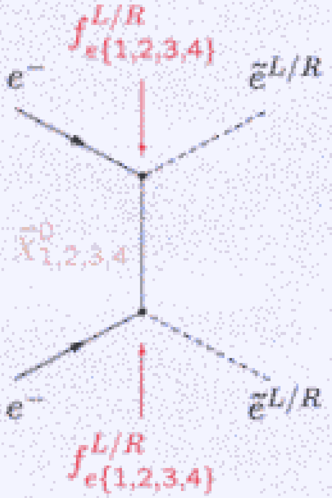
Different choices for:

$\sqrt{s_{ee}}$, $m_{\tilde{e}_L}$, $m_{\tilde{e}_R}$, beam polarisation P_{e_1}, P_{e_2}

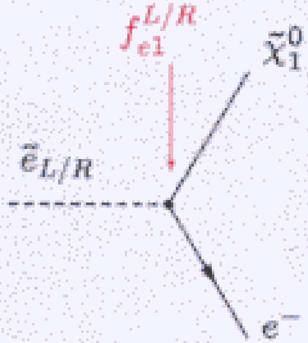
II. Total Cross Section

Production :

$$\sum_{i=1}^{4}$$



Decay :



$\rightarrow$ signature: $e^- + e^- + \not{E}$

Neutralino-basis: $\{ \tilde{\gamma}, \tilde{Z}, \tilde{H}_1, \tilde{H}_2 \}$

$$f^L_{ej} = -\sqrt{2}\left[\frac{1}{\cos\theta_W}\left(-\frac{1}{2} + \sin^2\theta_W\right) N_{j2} - \sin\theta_W N_{j1}\right]$$

$$f^R_{ej} = \sqrt{2}\sin\theta_W\left[\tan\theta_W N^*_{j2} - N^*_{j1}\right]$$

Total Cross Section:

$$\begin{aligned}\sigma_{ee}\left(P_{e_1},P_{e_2}\right) &= \sigma_{RR}+\sigma_{LL}+\sigma_{LR}+\sigma_{RL}\\ &= \left(1+P_{e_1}\right)\left(1+P_{e_2}\right)\tilde{\sigma}_{RR}\\ &\quad +\left(1-P_{e_1}\right)\left(1-P_{e_2}\right)\tilde{\sigma}_{LL}\\ &\quad +\left(1-P_{e_1}\right)\left(1+P_{e_2}\right)\tilde{\sigma}_{LR}\\ &\quad +\left(1+P_{e_1}\right)\left(1-P_{e_2}\right)\tilde{\sigma}_{RL}\end{aligned}$$

III. Numerical Results

III.1 Energy Dependence

Two scenarios:

(A) $m_{\tilde{e}_R} = 137.7$ GeV, $m_{\tilde{e}_L} = 179.3$ GeV
($m_0 = 110$ GeV)

(B) $m_{\tilde{e}_R} = 330$ GeV, $m_{\tilde{e}_L} = 350$ GeV
($m_0 = 320$ GeV)

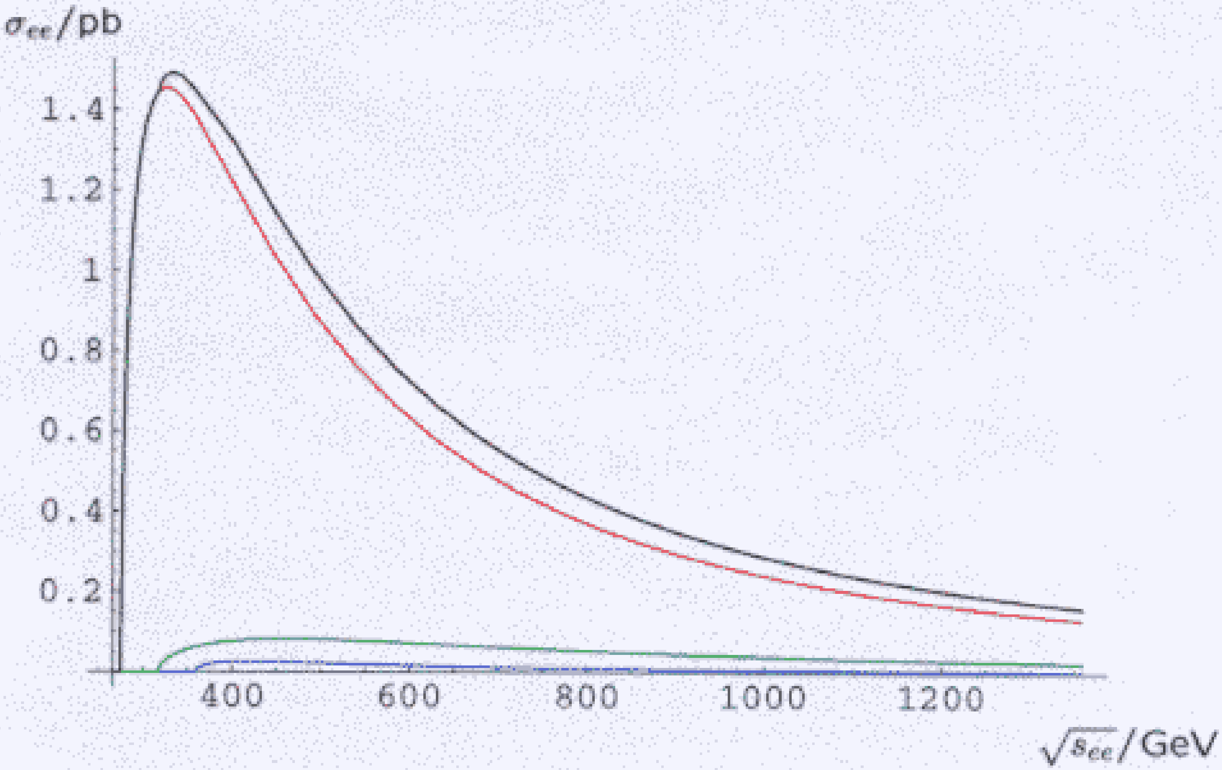
$M_2 = 152$ GeV, $M_1 = 79$ GeV, $\mu = 316$ GeV, $\tan\beta = 3$:

$\rightarrow m_{\tilde{\chi}_1^0} = 69$ GeV $m_{\tilde{\chi}_1^\pm} = 128$ GeV
$m_{\tilde{\chi}_2^0} = 130$ GeV $m_{\tilde{\chi}_2^\pm} = 345$ GeV
$m_{\tilde{\chi}_3^0} = 320$ GeV
$m_{\tilde{\chi}_4^0} = 348$ GeV

For all plots: black : $\sigma_{ee} = \sigma_{RR} + \sigma_{LL} + \sigma_{LR} + \sigma_{RL}$

Total Cross Section σ_{ee}

$$\sigma_{ee} = \sigma\left(e^- e^- \to \tilde{e}_{L/R}\tilde{e}_{L/R} \to e^- e^- \tilde{\chi}_1^0 \tilde{\chi}_1^0\right)$$



$$\sigma_{ee} = \sigma_{RR} + \sigma_{LL} + \sigma_{LR} + \sigma_{RL}$$

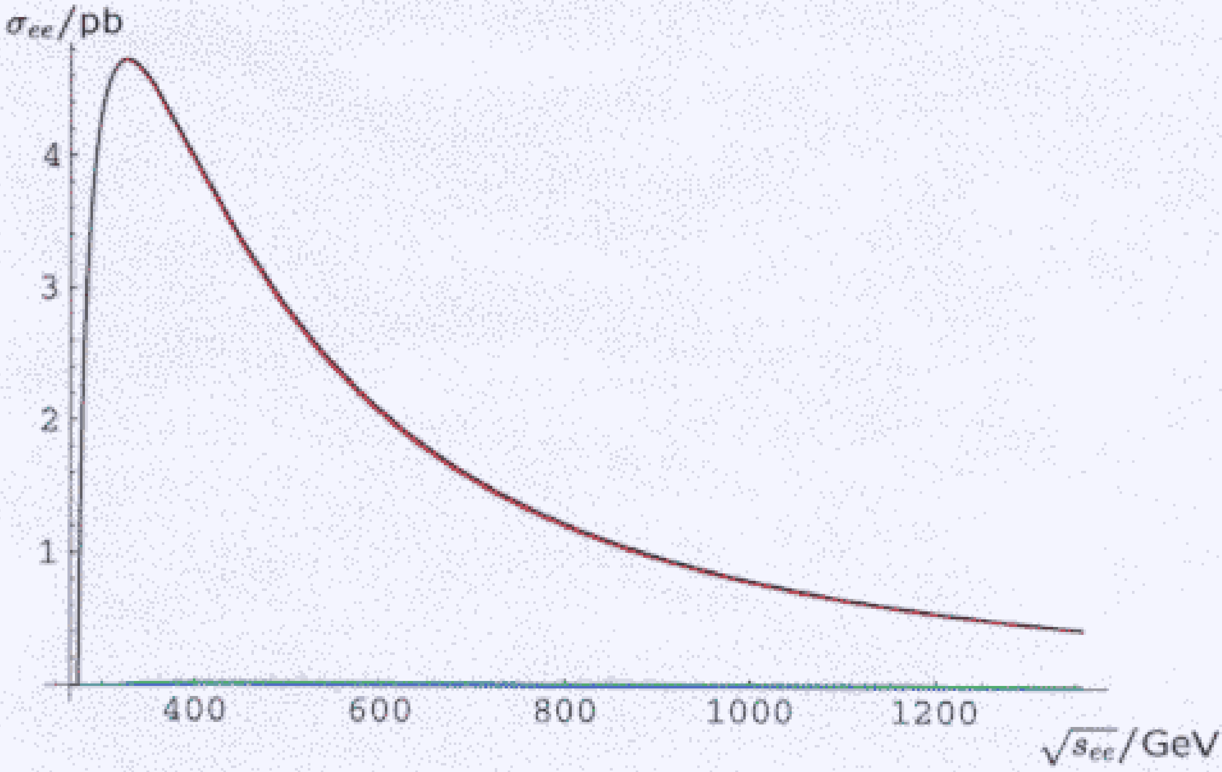
$m_{\tilde{e}_R} = 137.7$ GeV

$m_{\tilde{e}_L} = 179.3$ GeV

$P_{e_1} = P_{e_2} = 0\%$

Total Cross Section σ_{ee}

$$\sigma_{ee} = \sigma\left(e^- e^- \to \tilde{e}_{L/R}\tilde{e}_{L/R} \to e^- e^- \tilde{\chi}_1^0\tilde{\chi}_1^0\right)$$



$$\sigma_{ee} = \sigma_{RR} + \sigma_{LL} + \sigma_{LR} + \sigma_{RL}$$

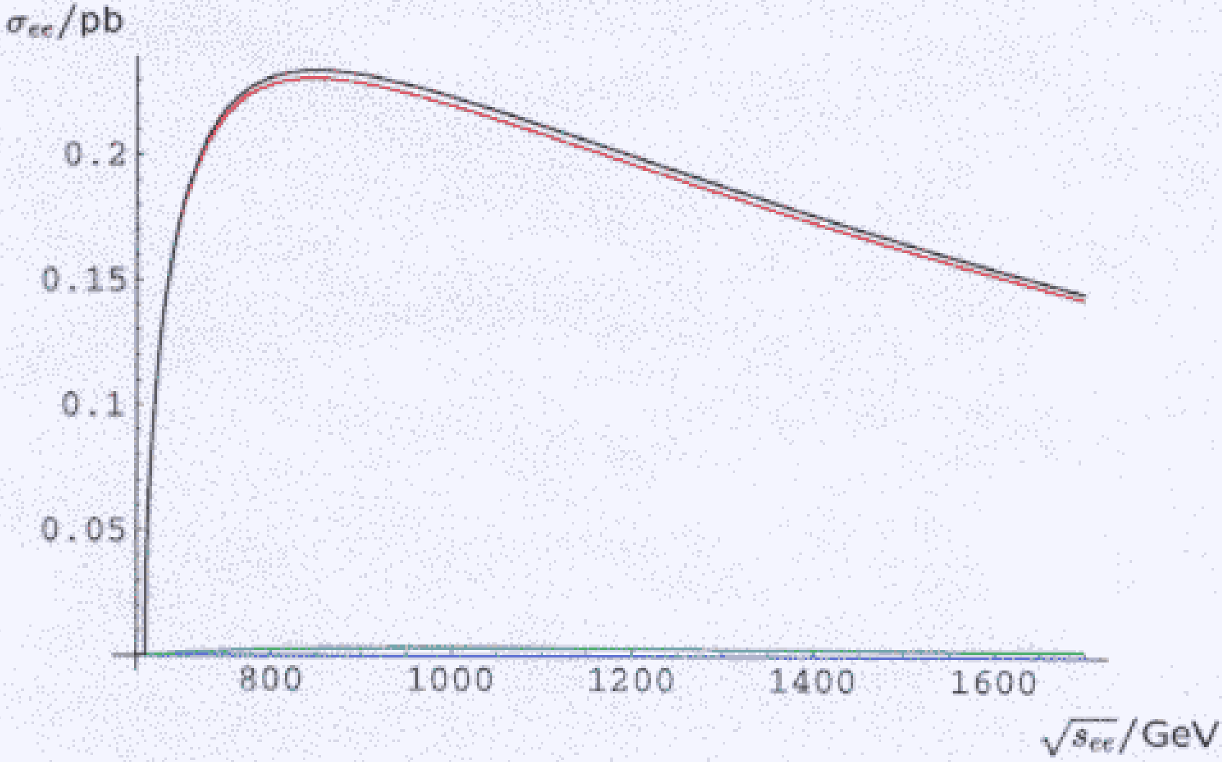
$m_{\tilde{e}_R} = 137.7$ GeV

$m_{\tilde{e}_L} = 179.3$ GeV

$P_{e_1} = P_{e_2} = 80\%$

Total Cross Section σ_{ee}

$$\sigma_{ee} = \sigma\left(e^-e^- \to \tilde{e}_{L/R}\tilde{e}_{L/R} \to e^-e^-\tilde{\chi}_1^0\tilde{\chi}_1^0\right)$$



$$\sigma_{ee} = \sigma_{RR} + \sigma_{LL} + \sigma_{LR} + \sigma_{RL}$$

$m_{\tilde{e}_R} = 330$ GeV

$m_{\tilde{e}_L} = 350$ GeV

$P_{e_1} = P_{e_2} = 80\%$

III.2 M_1 Dependence

Two scenarios:

(A) $\sqrt{s_{ee}} = 500$ GeV
$m_{\tilde{e}_R} = 137$ GeV, $m_{\tilde{e}_L} = 179$ GeV
(corr. to $m_0 = 110$ GeV)

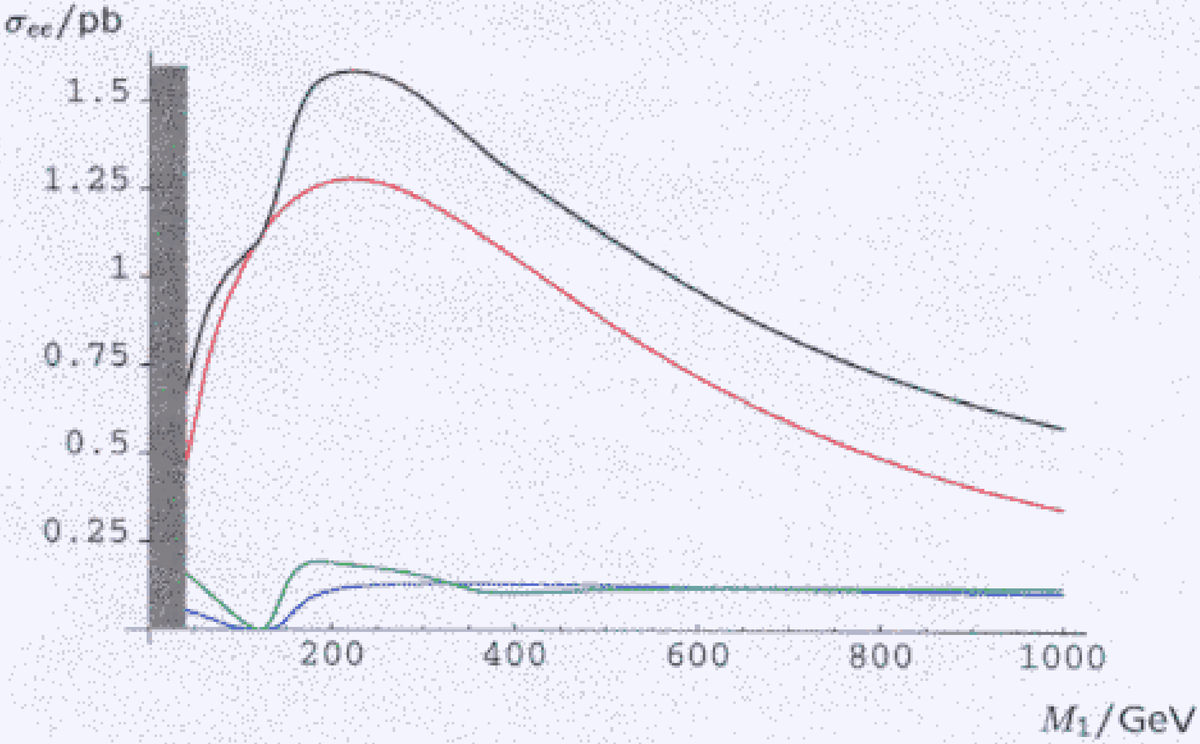
(B) $\sqrt{s_{ee}} = 1000$ GeV
$m_{\tilde{e}_R} = 330$ GeV, $m_{\tilde{e}_L} = 350$ GeV
($m_0 = 320$ GeV)

For all plots:

black : $\sigma_{ee} = \sigma_{RR} + \sigma_{LL} + \sigma_{LR} + \sigma_{RL}$
red : σ_{RR}
blue : σ_{LL}
green : $\sigma_{LR} + \sigma_{RL}$

Total Cross Section σ_{ee}

$$\sigma_{ee} = \sigma\left(e^- e^- \rightarrow \tilde{e}_{L/R}\tilde{e}_{L/R} \rightarrow e^- e^- \tilde{\chi}_1^0 \tilde{\chi}_1^0\right)$$



$$\sigma_{ee} = \sigma_{RR} + \sigma_{LL} + \sigma_{LR} + \sigma_{RL}$$

$\sqrt{s_{ee}} = 500$ GeV

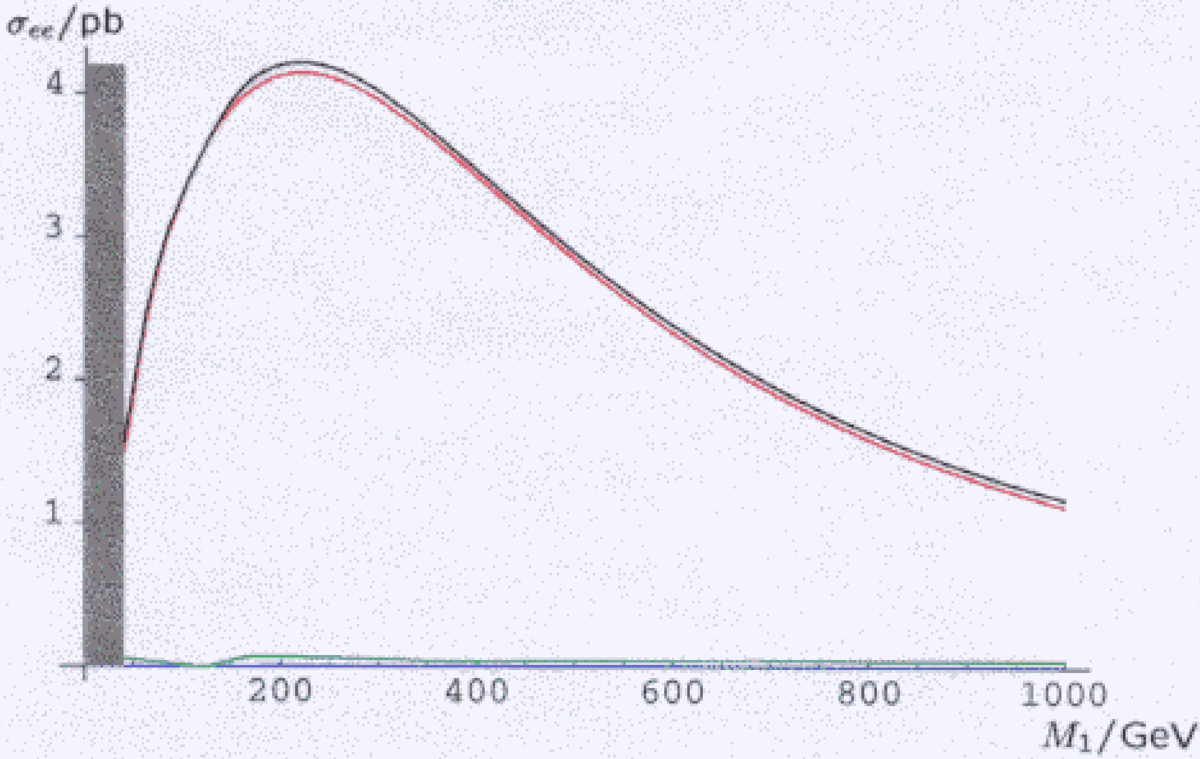
$m_{\tilde{e}_R} = 137.7$ GeV

$m_{\tilde{e}_L} = 179.3$ GeV

$P_{e_1} = P_{e_2} = 0\%$

Total Cross Section σ_{ee}

$$\sigma_{ee} = \sigma\left(e^- e^- \to \tilde{e}_{L/R}\tilde{e}_{L/R} \to e^- e^- \tilde{\chi}_1^0 \tilde{\chi}_1^0\right)$$



$$\sigma_{ee} = \sigma_{RR} + \sigma_{LL} + \sigma_{LR} + \sigma_{RL}$$

$\sqrt{s_{ee}} = 500$ GeV

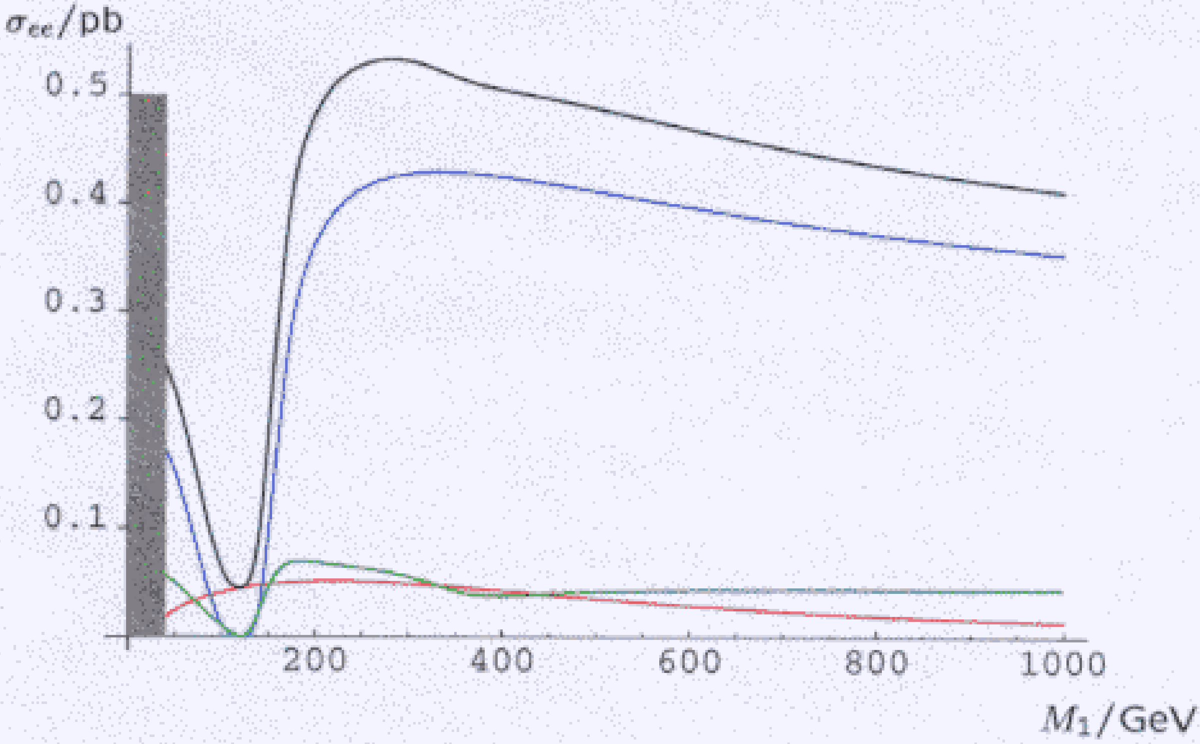
$m_{\tilde{e}_R} = 137.7$ GeV

$m_{\tilde{e}_L} = 179.3$ GeV

$P_{e_1} = P_{e_2} = 80\%$

Total Cross Section σ_{ee}

$$\sigma_{ee} = \sigma\left(e^- e^- \to \tilde{e}_{L/R}\tilde{e}_{L/R} \to e^- e^- \tilde{\chi}_1^0\tilde{\chi}_1^0\right)$$



$$\sigma_{ee} = \sigma_{RR} + \sigma_{LL} + \sigma_{LR} + \sigma_{RL}$$

$\sqrt{s_{ee}} = 500$ GeV

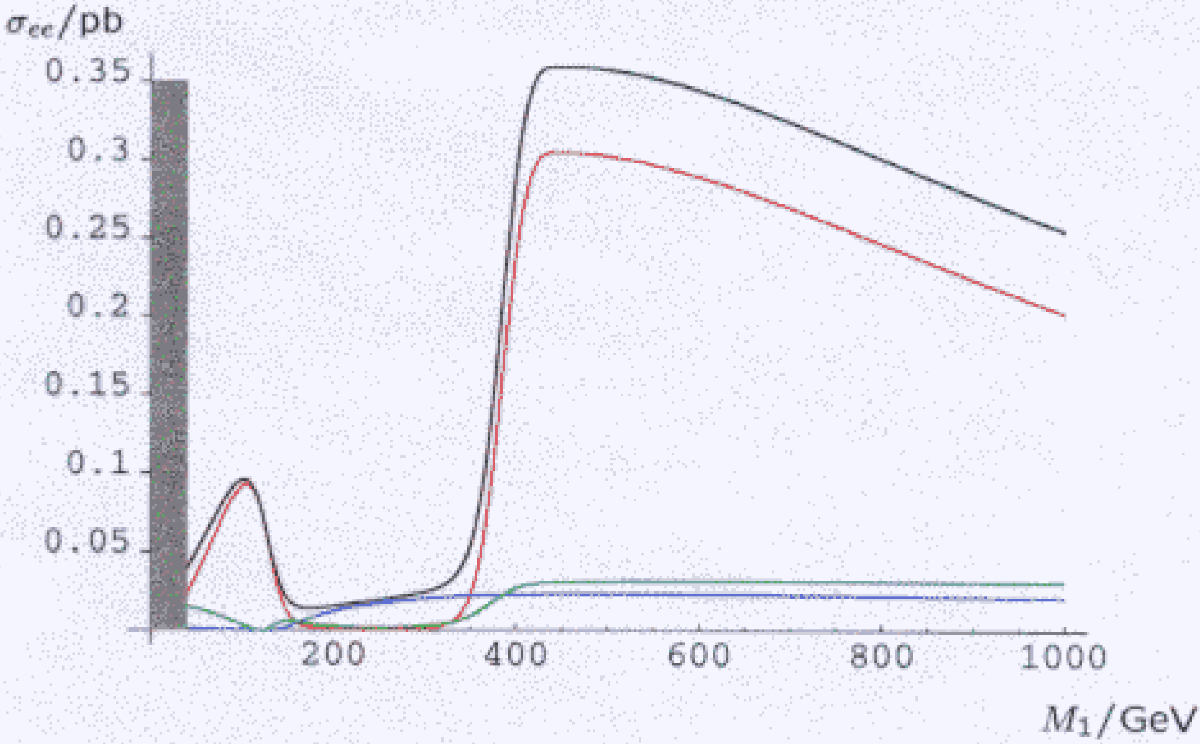
$m_{\tilde{e}_R} = 137.7$ GeV

$m_{\tilde{e}_L} = 179.3$ GeV

$P_{e_1} = P_{e_2} = -80\%$

Total Cross Section σ_{ee}

$$\sigma_{ee} = \sigma\left(e^- e^- \to \tilde{e}_{L/R}\tilde{e}_{L/R} \to e^- e^- \tilde{\chi}_1^0 \tilde{\chi}_1^0\right)$$



$$\sigma_{ee} = \sigma_{RR} + \sigma_{LL} + \sigma_{LR} + \sigma_{RL}$$

$\sqrt{s_{ee}} = 1000$ GeV

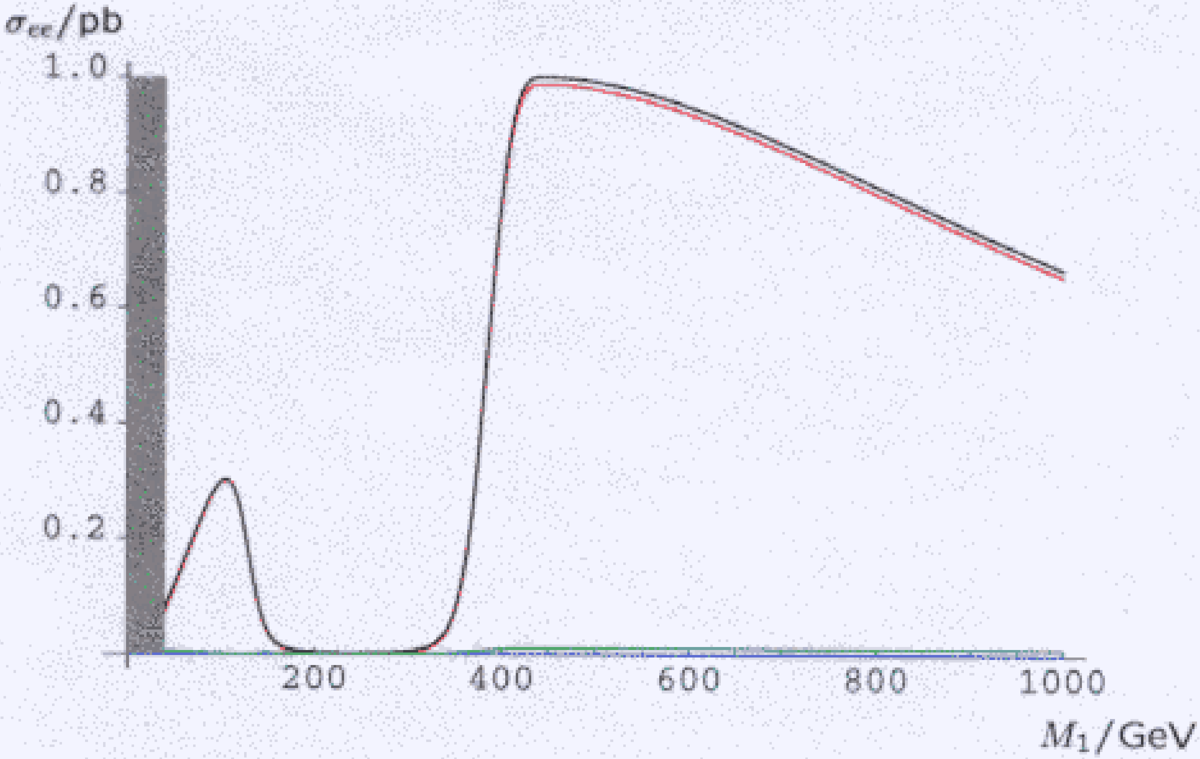
$m_{\tilde{e}_R} = 330$ GeV

$m_{\tilde{e}_L} = 350$ GeV

$P_{e_1} = P_{e_2} = 0\%$

Total Cross Section σ_{ee}

$$\sigma_{ee} = \sigma\left(e^-e^- \to \tilde{e}_{L/R}\tilde{e}_{L/R} \to e^-e^-\tilde{\chi}_1^0\tilde{\chi}_1^0\right)$$



$$\sigma_{ee} = \sigma_{RR} + \sigma_{LL} + \sigma_{LR} + \sigma_{RL}$$

$\sqrt{s_{ee}} = 1000$ GeV

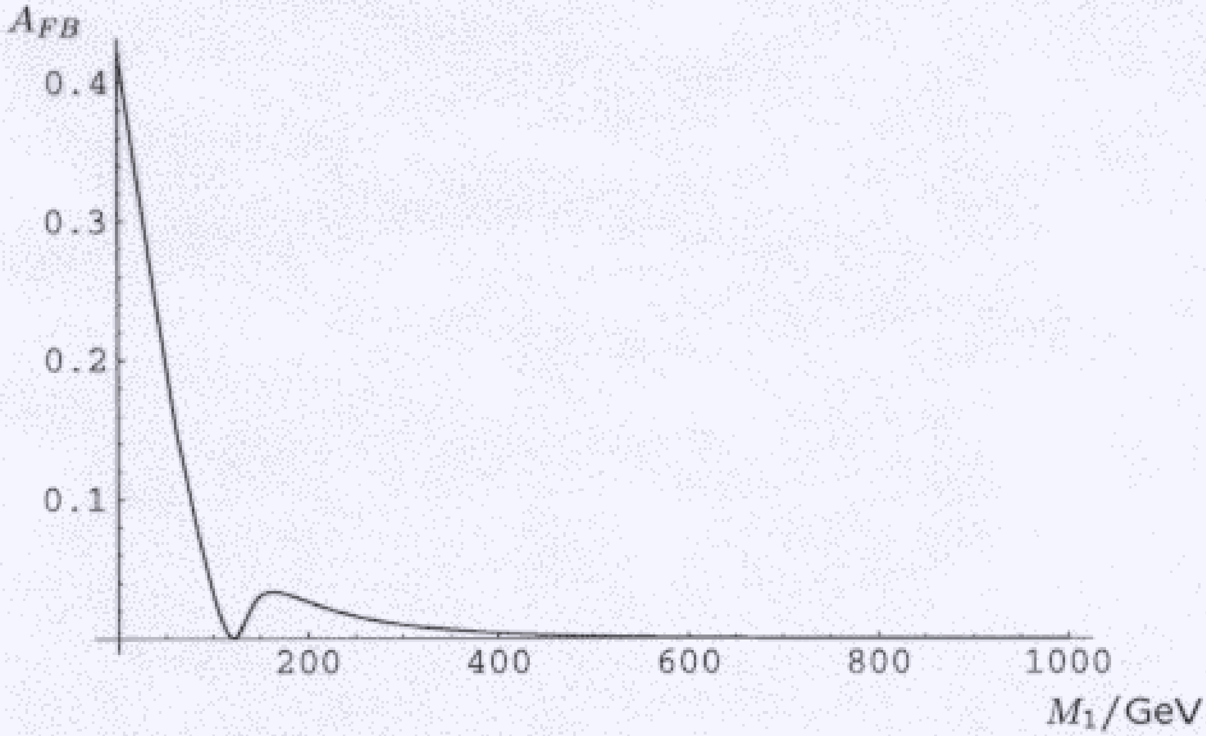
$m_{\tilde{e}_R} = 330$ GeV

$m_{\tilde{e}_L} = 350$ GeV

$P_{e_1} = P_{e_2} = 80\%$

Asymmetry A_{FB}

$$A_{FB} = \frac{\sigma^{prod}\left(\vartheta > \frac{\pi}{2}\right) - \sigma^{prod}\left(\vartheta < \frac{\pi}{2}\right)}{\sigma^{prod}\left(\vartheta > \frac{\pi}{2}\right) + \sigma^{prod}\left(\vartheta < \frac{\pi}{2}\right)}$$



$\sqrt{s_{ee}} = 500$ GeV

$m_{\tilde{e}_R} = 137.7$ GeV

$m_{\tilde{e}_L} = 179.3$ GeV

$P_{e_1} = -P_{e_2} = 80\%$

III. Conclusions and Outlook

- suitable beam polarisation → high production cross sections

- sum of RR, LL, RL, LR

- but: $\mathcal{L}_{e^-e^-} = 0.1 \cdot \mathcal{L}_{e^+e^-}$!!

- all 4 neutralinos in the exchange channel
  → M_1 dependence in a large region
  → good process for high M_1

- Outlook: final state asymmetries
  angular distributions
  polarisation asymmetries
  comparison with $e^+e^- \to \tilde{e}_{L/R}\tilde{e}_{L/R}$
  $\gamma\gamma \to \tilde{e}_{L/R}\tilde{e}_{L/R}$