ILC performance in scenarios with light sleptons

Mikael Berggren[1]

[1]DESY, Hamburg

LCWS12, Arlington, TX, Oct 2012

Outline

Introduction

- LHC did not see SUSY, yet.
- But something higgs-ish was seen...
- ... with a mass in the MSSM prediction window.
- Given this: Is SUSY scenarios with a rich spectrum of sparticles in ILC-500 reach still possible ?
- If so, how should it be studied ?

This talk:

A very, very preliminary look at these questions.
Don't expect any numbers or firm answers !

Introduction

- LHC did not see SUSY, yet.
- But something higgs-ish was seen...
- ... with a mass in the MSSM prediction window.
- Given this: Is SUSY scenarios with a rich spectrum of sparticles in ILC-500 reach still possible ?
- If so, how should it be studied ?

This talk:

A very, very preliminary look at these questions.
Don't expect any numbers or firm answers !

Introduction

- LHC did not see SUSY, yet.
- But something higgs-ish was seen...
- ... with a mass in the MSSM prediction window.
- Given this: Is SUSY scenarios with a rich spectrum of sparticles in ILC-500 reach still possible ?
- If so, how should it be studied ?

This talk:

A very, very preliminary look at these questions.
Don't expect any numbers or firm answers !

Introduction

- LHC did not see SUSY, yet.
- But something higgs-ish was seen...
- ... with a mass in the MSSM prediction window.
- Given this: Is SUSY scenarios with a rich spectrum of sparticles in ILC-500 reach still possible ?
- If so, how should it be studied ?

This talk:

A very, very preliminary look at these questions.
Don't expect any numbers or firm answers !

Introduction

- LHC did not see SUSY, yet.
- But something higgs-ish was seen...
- ... with a mass in the MSSM prediction window.
- Given this: Is SUSY scenarios with a rich spectrum of sparticles in ILC-500 reach still possible ?
- If so, how should it be studied ?

This talk:

A very, very preliminary look at these questions.
Don't expect any numbers or firm answers !

Introduction

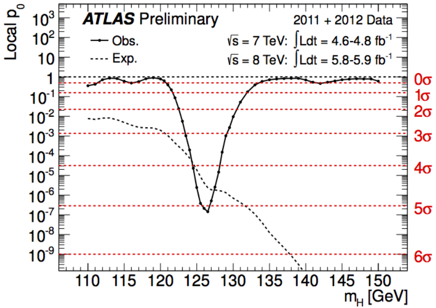
- LHC did not see SUSY, yet.
- But something higgs-ish was seen...
- ... with a mass in the MSSM prediction window.
- Given this: Is SUSY scenarios with a rich spectrum of sparticles in ILC-500 reach still possible ?
- If so, how should it be studied ?

This talk:

A very, very preliminary look at these questions.
Don't expect any numbers or firm answers !

LHC results and SUSY

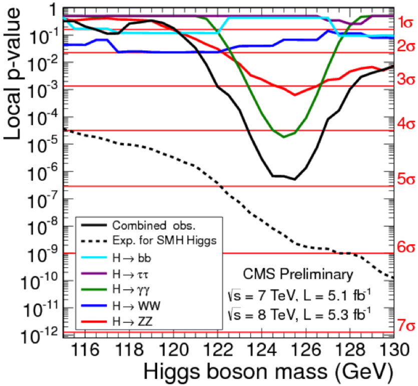
- The Higgs as seen by ATLAS and CMS:
- ... and it's implication for SUSY models (from A. Djouadi).
- Limits in the Constrained Minimal Susy Model (CMSSM) from ATLAS
- Limits in the "simplified SUSY model"



So: Is SUSY under pressure ??

LHC results and SUSY

- The Higgs as seen by ATLAS and CMS:
- ... and it's implication for SUSY models (from A. Djouadi).
- Limits in the Constrained Minimal Susy Model (CMSSM) from ATLAS
- Limits in the "simplified SUSY model"

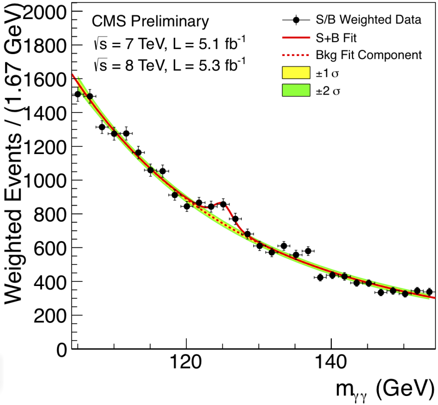


So: Is SUSY under pressure ??

LHC results and SUSY

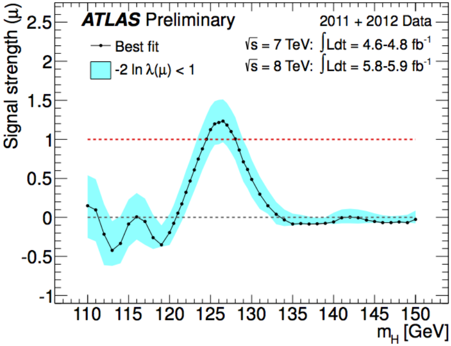
- The Higgs as seen by ATLAS and CMS:
- ... and it's implication for SUSY models (from A. Djouadi).
- Limits in the Constrained Minimal Susy Model (CMSSM) from ATLAS
- Limits in the "simplified SUSY model"

So: Is SUSY under pressure ??



LHC results and SUSY

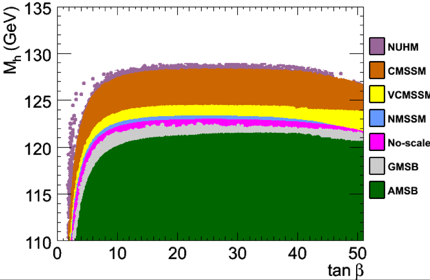
- The Higgs as seen by ATLAS and CMS:
- ... and it's implication for SUSY models (from A. Djouadi).
- Limits in the Constrained Minimal Susy Model (CMSSM) from ATLAS
- Limits in the "simplified SUSY model"



So: Is SUSY under pressure ??

LHC results and SUSY

- The Higgs as seen by ATLAS and CMS:
- ... and it's implication for SUSY models (from A. Djouadi).
- Limits in the Constrained Minimal Susy Model (CMSSM) from ATLAS
- Limits in the "simplified SUSY model"



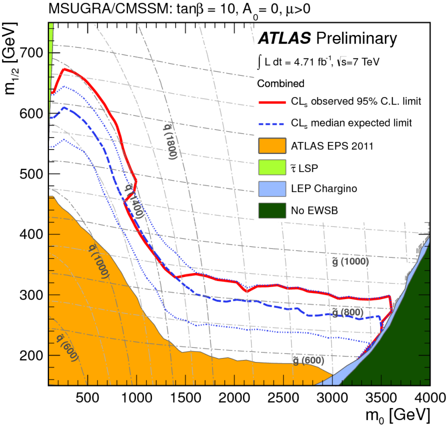
model	amsb	gmsb	sugra	noscale	cnmssm	vcmssm
M_h^{max}	120	121	128	123	123	126

So: Is SUSY under pressure ??

LHC results and SUSY

- The Higgs as seen by ATLAS and CMS:
- ... and it's implication for SUSY models (from A. Djouadi).
- Limits in the Constrained Minimal Susy Model (CMSSM) from ATLAS
- Limits in the "simplified SUSY model"

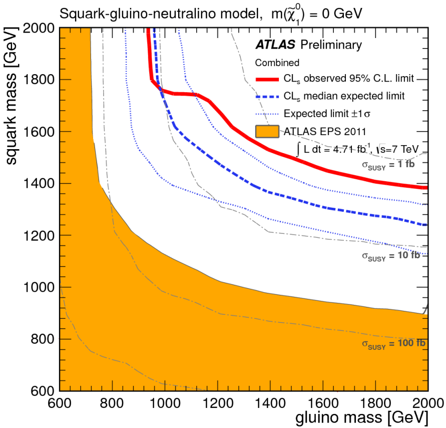
So: Is SUSY under pressure ??



LHC results and SUSY

- The Higgs as seen by ATLAS and CMS:
- ... and it's implication for SUSY models (from A. Djouadi).
- Limits in the Constrained Minimal Susy Model (CMSSM) from ATLAS
- Limits in the "simplified SUSY model"

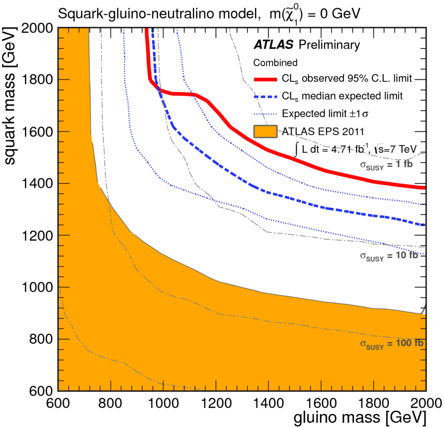
So: Is SUSY under pressure ??



LHC results and SUSY

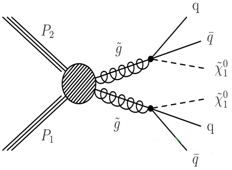
- The Higgs as seen by ATLAS and CMS:
- ... and it's implication for SUSY models (from A. Djouadi).
- Limits in the Constrained Minimal Susy Model (CMSSM) from ATLAS
- Limits in the "simplified SUSY model"

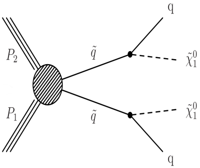
So: Is SUSY under pressure ??



LHC: the fine-print

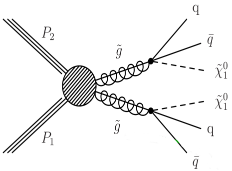
- Simplified models are (very) special cases: the produced SUSY particle goes directly to it's SM partner+MET.
- CMSSM is also a (very) special case: coloured sector ↔ non-coloured sector.
- Production needs a gluino in reach.
- Only gen. 1&2 squarks (≈ no t, b in protons!)
- But what matters for naturalness is the third generation:
  - M_H is destabilised by fermion-loops
  - but boson-loops have the same size but opposite sign
  - ⇒ Divergences cancel !
  - For this to work: $M_{particle} \approx M_{sparticle}$
  - Higgs coupling ∝ Mass ⇒ what matters is the top !

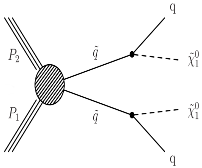




LHC: the fine-print

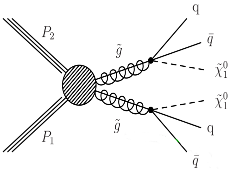
- Simplified models are (very) special cases: the produced SUSY particle goes directly to it's SM partner+MET.
- CMSSM is also a (very) special case: coloured sector $\leftrightarrow$ non-coloured sector.
- Production needs a gluino in reach.
- Only gen. 1&2 squarks ($\approx$ no t, b in protons!)
- But what matters for naturalness is the third generation:
  - M_H is destabilised by fermion-loops
  - but boson-loops have the same size but opposite sign
  - $\Rightarrow$ Divergences cancel !
  - For this to work: $M_{particle} \approx M_{sparticle}$
  - Higgs coupling $\propto$ Mass $\Rightarrow$ what matters is the top !

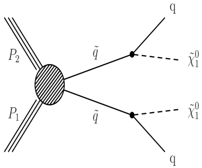




LHC: the fine-print

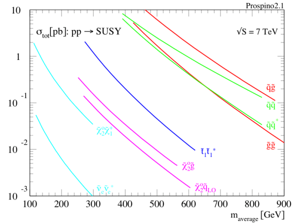
- Simplified models are (very) special cases: the produced SUSY particle goes directly to it's SM partner+MET.
- CMSSM is also a (very) special case: coloured sector ↔ non-coloured sector.
- Production needs a gluino in reach.
- Only gen. 1&2 squarks (≈ no t, b in protons!)
- But what matters for naturalness is the third generation:
  - M_H is destabilised by fermion-loops
  - but boson-loops have the same size but opposite sign
  - ⇒ Divergences cancel !
  - For this to work: $M_{particle} \approx M_{sparticle}$
  - Higgs coupling ∝ Mass ⇒ what matters is the top !





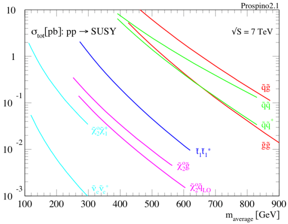
LHC: the fine-print

- Simplified models are (very) special cases: the produced SUSY particle goes directly to it's SM partner+MET.
- CMSSM is also a (very) special case: coloured sector ↔ non-coloured sector.
- Production needs a gluino in reach.
- Only gen. 1&2 squarks (≈ no t, b in protons!)
- But what matters for naturalness is the third generation:
  - M_H is destabilised by fermion-loops
  - but boson-loops have the same size but opposite sign
  - ⇒ Divergences cancel !
  - For this to work: $M_{particle} \approx M_{sparticle}$
  - Higgs coupling ∝ Mass ⇒ what matters is the top !



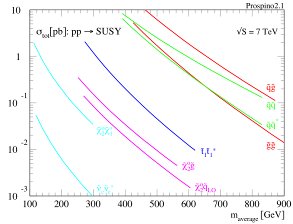
LHC: the fine-print

- Simplified models are (very) special cases: the produced SUSY particle goes directly to it's SM partner+MET.
- CMSSM is also a (very) special case: coloured sector $\leftrightarrow$ non-coloured sector.
- Production needs a gluino in reach.
- Only gen. 1&2 squarks ($\approx$ no t, b in protons!)
- But what matters for naturalness is the third generation:
  - M_H is destabilised by fermion-loops
  - but boson-loops have the same size but opposite sign
  - $\Rightarrow$ Divergences cancel !
  - For this to work: $M_{particle} \approx M_{sparticle}$
  - Higgs coupling $\propto$ Mass $\Rightarrow$ what matters is the top !



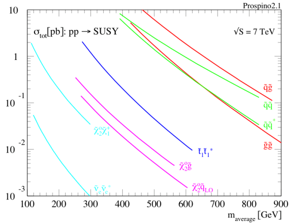
LHC: the fine-print

- Simplified models are (very) special cases: the produced SUSY particle goes directly to it's SM partner+MET.
- CMSSM is also a (very) special case: coloured sector $\leftrightarrow$ non-coloured sector.
- Production needs a gluino in reach.
- Only gen. 1&2 squarks ($\approx$ no t, b in protons!)
- But what matters for naturalness is the third generation:
  - M_H is destabilised by fermion-loops
  - but boson-loops have the same size but opposite sign
  - $\Rightarrow$ Divergences cancel !
  - For this to work: $M_{particle} \approx M_{sparticle}$
  - Higgs coupling $\propto$ Mass $\Rightarrow$ what matters is the top !



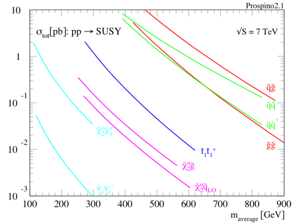
LHC: the fine-print

- Simplified models are (very) special cases: the produced SUSY particle goes directly to it's SM partner+MET.
- CMSSM is also a (very) special case: coloured sector $\leftrightarrow$ non-coloured sector.
- Production needs a gluino in reach.
- Only gen. 1&2 squarks ($\approx$ no t, b in protons!)
- But what matters for naturalness is the third generation:
  - M_H is destabilised by fermion-loops
  - but boson-loops have the same size but opposite sign
  - $\Rightarrow$ Divergences cancel !
  - For this to work: $M_{particle} \approx M_{sparticle}$
  - Higgs coupling $\propto$ Mass $\Rightarrow$ what matters is the top !



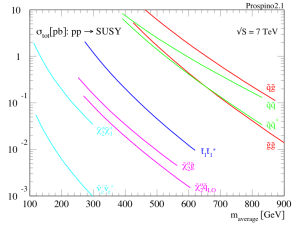
LHC: the fine-print

- Simplified models are (very) special cases: the produced SUSY particle goes directly to it's SM partner+MET.
- CMSSM is also a (very) special case: coloured sector $\leftrightarrow$ non-coloured sector.
- Production needs a gluino in reach.
- Only gen. 1&2 squarks ($\approx$ no t, b in protons!)
- But what matters for naturalness is the third generation:
  - M_H is destabilised by fermion-loops
  - but boson-loops have the same size but opposite sign
  - $\Rightarrow$ Divergences cancel !
  - For this to work: $M_{particle} \approx M_{sparticle}$
  - Higgs coupling $\propto$ Mass $\Rightarrow$ what matters is the top !



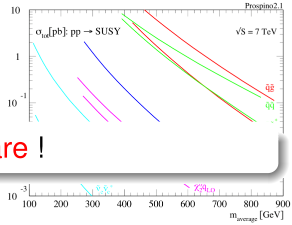
LHC: the fine-print

- Simplified models are (very) special cases: the produced SUSY particle goes directly to it's SM partner+MET.
- CMSSM is also a (very) special case: coloured sector $\leftrightarrow$ non-coloured sector.
- Production needs a gluino in reach.
- Only gen. 1&2 squarks ($\approx$ no t, b in protons!)
- But what matters for naturalness is the third generation:
  - M_H is destabilised by fermion-loops
  - but boson-loops have the same size but opposite sign
  - $\Rightarrow$ Divergences cancel !
  - For this to work: $M_{particle} \approx M_{sparticle}$
  - Higgs coupling $\propto$ Mass $\Rightarrow$ what matters is the top !



LHC: the fine-print

- Simplified models are (very) special cases: the produced SUSY particle goes directly to it's SM partner+MET.
- CMSSM is also a (very) special case: coloured sector $\leftrightarrow$ non-coloured sector.
- Production needs a gluino in reach



SUSY under pressure ?? No, but simple models are !

- But what matters for naturalness is the third generation:
  - M_H is destabilised by fermion-loops
  - but boson-loops have the same size but opposite sign
  - $\Rightarrow$ Divergences cancel !
  - For this to work: $M_{particle} \approx M_{sparticle}$
  - Higgs coupling $\propto$ Mass $\Rightarrow$ what matters is the top !

A New bench-mark point

Remember, apart from naturalness:

- Anomaly in $g-2$ of the μ: Would prefer a not-too-heavy smuon.
- Dark matter : A WIMP of $\sim 100\ \mathrm{GeV}$ would be required.
- EW symmetry breaking, coupling constant unification: points to NP at or below 1 TeV
- Suppress the SUSY flavour problem (FCNC:s etc): Heavy 1:st & 2:nd generation squarks would be nice ...
- Other low-energy constrains : $b \rightarrow s\gamma$, $b \rightarrow \mu\mu$, ρ-parameter, $\Gamma(Z)$ ...

A New bench-mark point

Remember, apart from naturalness:

- Anomaly in $g-2$ of the μ: Would prefer a not-too-heavy smuon.
- Dark matter : A WIMP of $\sim 100\ \mathrm{GeV}$ would be required.
- EW symmetry breaking, coupling constant unification: points to NP at or below 1 TeV
- Suppress the SUSY flavour problem (FCNC:s etc): Heavy 1:st & 2:nd generation squarks would be nice ...
- Other low-energy constrains : $b \to s\gamma$, $b \to \mu\mu$, ρ-parameter, $\Gamma(Z)$ ...

A New bench-mark point

Remember, apart from naturalness:

- Anomaly in $g-2$ of the μ: Would prefer a not-too-heavy smuon.
- Dark matter : A WIMP of $\sim 100\ \mathrm{GeV}$ would be required.
- EW symmetry breaking, coupling constant unification: points to NP at or below 1 TeV
- Suppress the SUSY flavour problem (FCNC:s etc): Heavy 1:st & 2:nd generation squarks would be nice ...
- Other low-energy constrains : $b \to s\gamma$, $b \to \mu\mu$, ρ-parameter, $\Gamma(Z)$ ...

A New bench-mark point

Remember, apart from naturalness:

- Anomaly in $g-2$ of the μ: Would prefer a not-too-heavy smuon.
- Dark matter : A WIMP of $\sim 100\ \mathrm{GeV}$ would be required.
- EW symmetry breaking, coupling constant unification: points to NP at or below 1 TeV
- Suppress the SUSY flavour problem (FCNC:s etc): Heavy 1:st & 2:nd generation squarks would be nice ...
- Other low-energy constrains : $b \to s\gamma$, $b \to \mu\mu$, ρ-parameter, $\Gamma(Z)$ ...

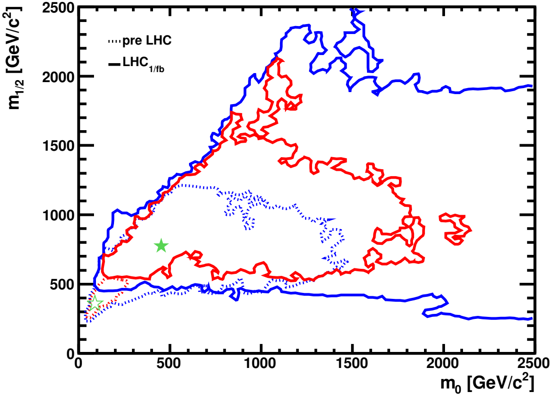
A New bench-mark point

Remember, apart from naturalness:

- Anomaly in $g-2$ of the μ: Would prefer a not-too-heavy smuon.
- Dark matter : A WIMP of $\sim 100\ \mathrm{GeV}$ would be required.
- EW symmetry breaking, coupling constant unification: points to NP at or below 1 TeV
- Suppress the SUSY flavour problem (FCNC:s etc): Heavy 1:st & 2:nd generation squarks would be nice ...
- Other low-energy constrains : $b \to s\gamma$, $b \to \mu\mu$, ρ-parameter, $\Gamma(Z)$ ...

A New bench-mark point

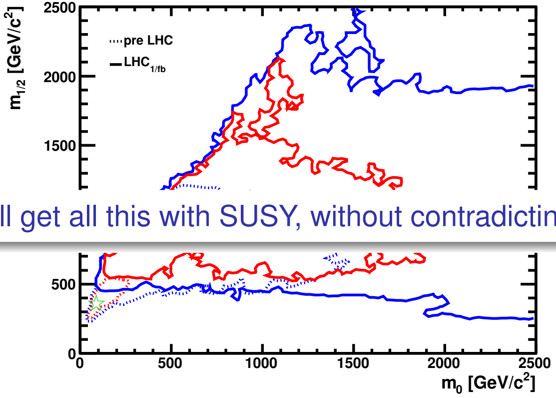
Remember: Without LHC Sps1a' is the best fit!



(From Mastercode).

A New bench-mark point

Remember: Without LHC Sps1a' is the best fit!



Can we still get all this with SUSY, without contradicting LHC limits ?!

(From Mastercode).

New points

Can all this be provided by SUSY ? Yes, sure !

Take old ILC favourite benchmark SPS1a, and make the TDR4 point (see Baer&List arXiv:1205.6929v1

New points

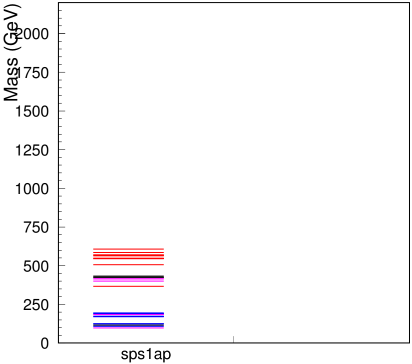
Can all this be provided by SUSY ?Yes, sure !

Take old ILC favourite benchmark SPS1a, and make the TDR4 point (see Baer&List arXiv:1205.6929v1

New points

Can all this be provided by SUSY ?Yes, sure !

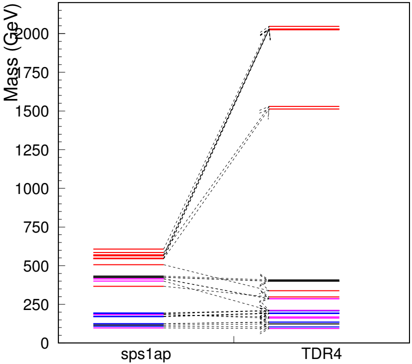
Take old ILC favourite benchmark SPS1a, and make the TDR4 point (see Baer&List arXiv:1205.6929v1



New points

Can all this be provided by SUSY ?Yes, sure !

Take old ILC favourite benchmark SPS1a, and make the TDR4 point (see Baer&List arXiv:1205.6929v1



New points

Can all this be provided by SUSY ?Yes, sure !

Take old ILC favourite benchmark SPS1a, and make the TDR4 point (see Baer&List arXiv:1205.6929v1

SPS1a: mSUGRA

- 5 parameters.
- One gaugino parameter
- One scalar parameter

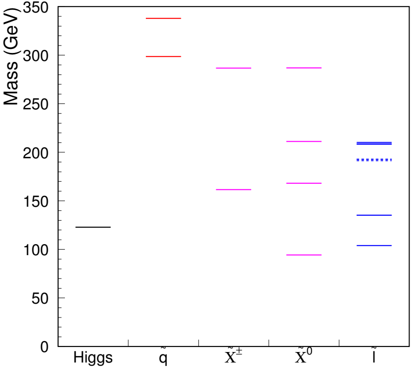
TDR4: Phenomenological SUSY

- 11 parameters.
- Separate gluino
- Higgs, un-coloured, and coloured scalar parameters separate

Parameters chosen to deliver all constraints,≈ same ILC accessible spectrum ⇒ old analyses still valid !

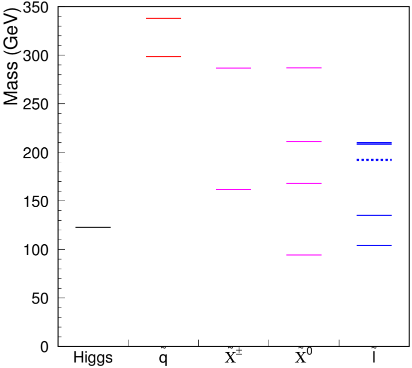
Features of TDR 4

- The $\tilde{\tau}_1$ is the NLSP.
- For $\tilde{\tau}_1$: Small Δ_M, $\gamma\gamma$ - background
- For $\tilde{\tau}_2$: $WW \rightarrow l\nu l\nu$ - background $\Leftrightarrow$ Polarisation.
- $\tilde{\tau}$ NLSP $\rightarrow$ τ:s in most SUSY decays $\rightarrow$ SUSY is background to SUSY.
- For pol=(-1,1): $\sigma(\tilde{\chi}^0_2\tilde{\chi}^0_2)$ and $\sigma(\tilde{\chi}^+_1\tilde{\chi}^-_1)$ = several hundred fb and BR(X$\rightarrow$ $\tilde{\tau}$) $>$ 50 %. For pol=(1,-1): $\sigma(\tilde{\chi}^0_2\tilde{\chi}^0_2)$ and $\sigma(\tilde{\chi}^+_1\tilde{\chi}^-_1) \approx 0$.

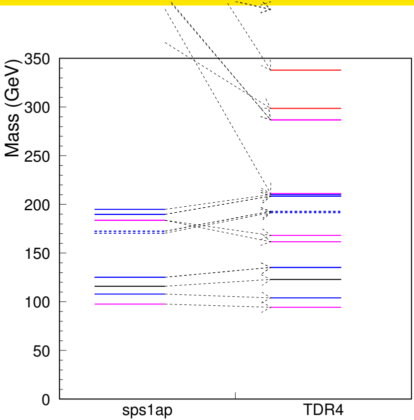


Features of TDR 4

- The $\tilde{\tau}_1$ is the NLSP.
- For $\tilde{\tau}_1$: Small Δ_M, $\gamma\gamma$ - background
- For $\tilde{\tau}_2$: $WW \rightarrow l\nu l\nu$ - background $\Leftrightarrow$ Polarisation.
- $\tilde{\tau}$ NLSP $\rightarrow \tau$:s in most SUSY decays $\rightarrow$ SUSY is background to SUSY.
- For pol=(-1,1): $\sigma(\tilde{\chi}^0_2\tilde{\chi}^0_2)$ and $\sigma(\tilde{\chi}^+_1\tilde{\chi}^-_1)$ = several hundred fb and BR(X$\rightarrow \tilde{\tau}$) $>$ 50 %. For pol=(1,-1): $\sigma(\tilde{\chi}^0_2\tilde{\chi}^0_2)$ and $\sigma(\tilde{\chi}^+_1\tilde{\chi}^-_1) \approx 0$.



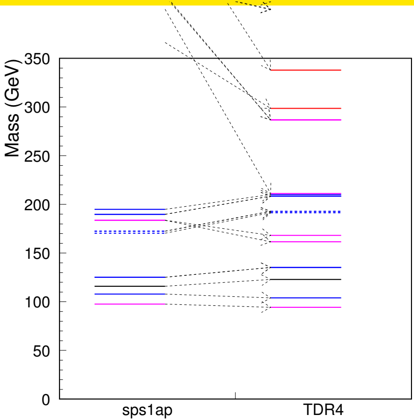
Differences TDR4 - SPS1a'



- All bosinos
- M_h OK
- $\tilde{\ell}_L \to \tilde{\chi}^0_0 \ell$ at 30-40 % BR.

- $\tilde{\chi}^0_4$ and $\tilde{\chi}^\pm_2$ too heavy
- M_h too small
- $\tilde{\ell}_L \to \tilde{\chi}^0_0 \ell$ at $\sim$ 95 % BR.

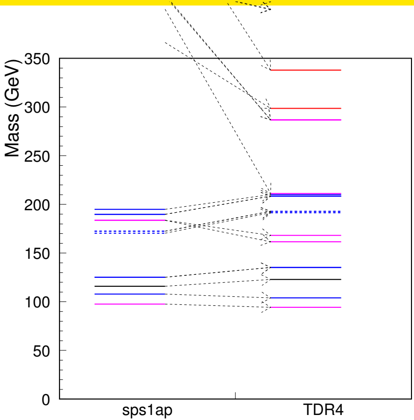
Differences TDR4 - SPS1a'



- All bosinos
- M_h OK
- $\tilde{\ell}_L \rightarrow \tilde{\chi}_0^0 \ell$ at 30-40 % BR.

- $\tilde{\chi}_4^0$ and $\tilde{\chi}_2^\pm$ too heavy
- M_h too small
- $\tilde{\ell}_L \rightarrow \tilde{\chi}_0^0 \ell$ at $\sim$ 95 % BR.

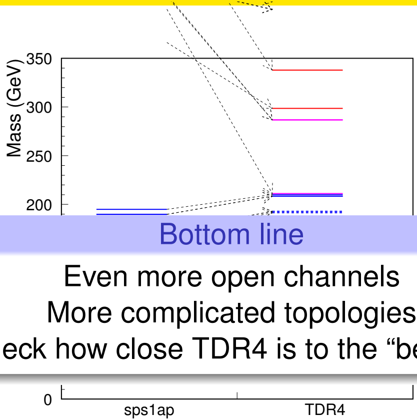
Differences TDR4 - SPS1a’



- All bosinos
- M_h OK
- $\tilde{\ell}_L \rightarrow \tilde{\chi}^0_0 \ell$ at 30-40 % BR.

- $\tilde{\chi}^0_4$ and $\tilde{\chi}^{\pm}_2$ too heavy
- M_h too small
- $\tilde{\ell}_L \rightarrow \tilde{\chi}^0_0 \ell$ at $\sim$ 95 % BR.

Differences TDR4 - SPS1a'



Bottom line

Even more open channels
More complicated topologies
We plan to check how close TDR4 is to the "best fit" (with fittino

- All bosinos
- M_h OK
- $\tilde{\ell}_L \rightarrow \tilde{\chi}^0_0 \ell$ at 30-40 % BR.

- $\tilde{\chi}^0_4$ and $\tilde{\chi}^\pm_2$ too heavy
- M_h too small
- $\tilde{\ell}_L \rightarrow \tilde{\chi}^0_0 \ell$ at $\sim$ 95 % BR.

Analysis: Final Aim

- When data starts coming in, what is is first light ?
- How do we quickly determine a set of approximative model parameters ?
- What is then the optimal use of beam-time in such a scenario ?
- And in a staged approach ?
- Spectrum in continuum vs. threshold-scans?
- Special points, eg. between $\tilde{\tau}_1\tilde{\tau}_2$ and $\tilde{\tau}_2\tilde{\tau}_2$ thresholds.
- Clean vs. high cross-section.
- ...

But...

Not much will be covered here...

Analysis: Final Aim

- When data starts coming in, what is is first light ?
- How do we quickly determine a set of approximative model parameters ?
- What is then the optimal use of beam-time in such a scenario ?
- And in a staged approach ?
- Spectrum in continuum vs. threshold-scans?
- Special points, eg. between $\tilde{\tau}_1\tilde{\tau}_2$ and $\tilde{\tau}_2\tilde{\tau}_2$ thresholds.
- Clean vs. high cross-section.
- ...

But...

Not much will be covered here...

Analysis: Final Aim

- When data starts coming in, what is is first light ?
- How do we quickly determine a set of approximative model parameters ?
- What is then the optimal use of beam-time in such a scenario ?
- And in a staged approach ?
- Spectrum in continuum vs. threshold-scans?
- Special points, eg. between $\tilde{\tau}_1\tilde{\tau}_2$ and $\tilde{\tau}_2\tilde{\tau}_2$ thresholds.
- Clean vs. high cross-section.
- ...

But...

Not much will be covered here...

Analysis: Final Aim

- When data starts coming in, what is is first light ?
- How do we quickly determine a set of approximative model parameters ?
- What is then the optimal use of beam-time in such a scenario ?
- And in a staged approach ?
- Spectrum in continuum vs. threshold-scans?
- Special points, eg. between $\tilde{\tau}_1\tilde{\tau}_2$ and $\tilde{\tau}_2\tilde{\tau}_2$ thresholds.
- Clean vs. high cross-section.
- ...

But...

Not much will be covered here...

Analysis: Final Aim

- When data starts coming in, what is is first light ?
- How do we quickly determine a set of approximative model parameters ?
- What is then the optimal use of beam-time in such a scenario ?
- And in a staged approach ?
- Spectrum in continuum vs. threshold-scans?
- Special points, eg. between $\tilde{\tau}_1\tilde{\tau}_2$ and $\tilde{\tau}_2\tilde{\tau}_2$ thresholds.
- Clean vs. high cross-section.
- ...

But...

Not much will be covered here...

Analysis

Disclaimer

- Very preliminary
- Mostly taken over SPS1a' analyses: Guaranteed to have bad efficiency for heavier states, due to the increase of cascade decays (mostly ignored in Sps1a')

Take over SPS1a' (Phys.Rev.D82:055016,2010, Nicola's thesis,...)

Lighter sleptons

Use the polarisation (0.8,-0.3) of the data to reduce bosino background. Assumed to be 50 % of all data.

From decay kinematics:

- $m_{\tilde{\ell}}$ and $M_{\tilde{\chi}^0_1}$ and end-points of spectrum = $E_{\ell,min(max)}$.
- For $\tilde{\tau}_1$: other end-point hidden in $\gamma\gamma$ background:Must get $M_{\tilde{\chi}^0_1}$ from other sources. ($\tilde{\mu}$, ẽ, ...)

$m_{\tilde{\ell}}$ also from cross-section:

- $\sigma_{\tilde{\ell}} = A(\theta_{\tilde{\ell}}, \mathcal{P}_{beam}) \times \beta^3/s$, so
- $m_{\tilde{\ell}} = E_{beam}\sqrt{1-(\sigma s/A)^{2/3}}$: no $M_{\tilde{\chi}^0_1}$!

From decay spectra:

- $\mathcal{P}_{\tau}$ from exclusive decay-mode(s): handle on mixing angles $\theta_{\tilde{\tau}}$ and $\theta_{\tilde{\chi}^0_1}$

Topology selection

Take over SPS1a' $\tilde{\tau}$ analysis principle

$\tilde{\ell}$ properties:

- Only two particles (possibly τ:s:s) in the final state.
- Large missing energy and momentum.
- High Acolinearity, with little correlation to the energy of the τ decay-products.
- Central production.
- No forward-backward asymmetry.

+ anti $\gamma\gamma$ cuts (see backup)

Select this by:

- Exactly two jets.
- $N_{ch} < 10$
- Vanishing total charge.
- Charge of each jet = $\pm$ 1,
- $M_{jet} < 2{:}5\ \mathrm{GeV}/c^2$,
- E_{vis} significantly less than E_{CMS}.
- M_{miss} significantly less than M_{CMS}.
- No particle with momentum close to E_{beam}.

Topology selection

Take over SPS1a' $\tilde{\tau}$ analysis principle

$\tilde{\ell}$ properties:

- Only two particles (possibly τ:s:s) in the final state.
- Large missing energy and momentum.
- High Acolinearity, with little correlation to the energy of the τ decay-products.
- Central production.
- No forward-backward asymmetry.

+ anti $\gamma\gamma$ cuts (see backup)

Select this by:

- Exactly two jets.
- $N_{ch} < 10$
- Vanishing total charge.
- Charge of each jet = $\pm$ 1,
- $M_{jet} < 2{:}5\ \mathrm{GeV}/c^2$,
- E_{vis} significantly less than E_{CMS}.
- M_{miss} significantly less than M_{CMS}.
- No particle with momentum close to E_{beam}.

Topology selection

Take over SPS1a' $\tilde{\tau}$ analysis principle

$\tilde{\ell}$ properties:

- Only two particles (possibly τ:s:s) in the final state.
- Large missing energy and momentum.
- High Acolinearity, with little correlation to the energy of the τ decay-products.
- Central production.
- No forward-backward asymmetry.

+ anti $\gamma\gamma$ cuts (see backup)

Select this by:

- Exactly two jets.
- $N_{ch} < 10$
- Vanishing total charge.
- Charge of each jet = $\pm$ 1,
- $M_{jet} < 2{:}5 \ \mathrm{GeV}/c^2$,
- E_{vis} significantly less than E_{CMS}.
- M_{miss} significantly less than M_{CMS}.
- No particle with momentum close to E_{beam}.

$\tilde{e}_R$

Early discovery channel:
crossection in the pb-range.

- Few simple cuts.
  - $E_{vis} < 400$ GeV ($=E_{CMS} - 2M_{\tilde{\chi}^0_1\, min,LEP}$).
  - 2 charged particles
  - $< 40\%$ of $E_{vis} <$ below 30 degrees.
- Simple observable: E_{vis}: Peak and width gives $M_{\tilde{e}_R}$ and $M_{\tilde{\chi}^0_1}$.
- See the signal appearing after
  - 1 fb^{-1}
  - 5 fb^{-1}
  - 25 fb^{-1}
  - 100 fb^{-1}
  - 250 fb^{-1}

$\tilde{\mathrm{e}}_\mathrm{R}$

Early discovery channel:
crossection in the pb-range.

- Few simple cuts.
  - $E_{vis} < 400$ GeV (=$E_{CMS} - 2M_{\tilde{\chi}^0_1\,min,LEP}$).
  - 2 charged particles
  - $< 40\%$ of $E_{vis} <$ below 30 degrees.
- Simple observable: E_{vis}: Peak and width gives $M_{\tilde{e}_R}$ and $M_{\tilde{\chi}^0_1}$.
- See the signal appearing after
  - 1 fb^{-1}
  - 5 fb^{-1}
  - 25 fb^{-1}
  - 100 fb^{-1}
  - 250 fb^{-1}

$\tilde{e}_R$

Early discovery channel:
crossection in the pb-range.

- Few simple cuts.
  - $E_{vis} < 400$ GeV (=$E_{CMS} - 2M_{\tilde{\chi}^0_1\,min,LEP}$).
  - 2 charged particles
  - $< 40\%$ of $E_{vis} <$ below 30 degrees.
- Simple observable: E_{vis}: Peak and width gives $M_{\tilde{e}_R}$ and $M_{\tilde{\chi}^0_1}$.
- See the signal appearing after
  - 1 fb^{-1}
  - 5 fb^{-1}
  - 25 fb^{-1}
  - 100 fb^{-1}
  - 250 fb^{-1}

$\tilde{e}_R$

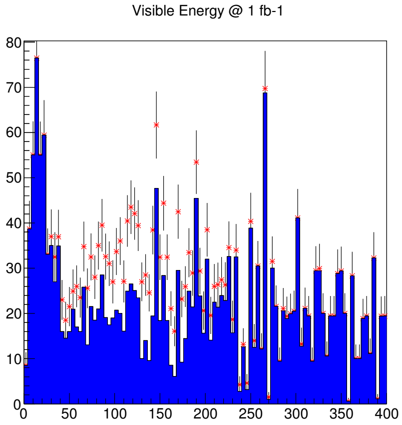
Early discovery channel:
crossection in the pb-range.

- Few simple cuts.
  - $E_{vis} < 400$ GeV ($=E_{CMS} - 2M_{\tilde{\chi}^0_1\,min,LEP}$).
  - 2 charged particles
  - $< 40\%$ of $E_{vis} <$ below 30 degrees.
- Simple observable: E_{vis}: Peak and width gives $M_{\tilde{e}_R}$ and $M_{\tilde{\chi}^0_1}$.
- See the signal appearing after
  - 1 fb^{-1}
  - 5 fb^{-1}
  - 25 fb^{-1}
  - 100 fb^{-1}
  - 250 fb^{-1}

$\tilde{e}_R$

Early discovery channel: crossection in the pb-range.

- Few simple cuts.
  - $E_{vis} < 400$ GeV ($= E_{CMS} - 2M_{\tilde{\chi}^0_1\, min,LEP}$).
  - 2 charged particles
  - $< 40\%$ of $E_{vis} <$ below 30 degrees.
- Simple observable: E_{vis}: Peak and width gives $M_{\tilde{e}_R}$ and $M_{\tilde{\chi}^0_1}$.
- See the signal appearing after
  - 1 fb^{-1}
  - 5 fb^{-1}
  - 25 fb^{-1}
  - 100 fb^{-1}
  - 250 fb^{-1}

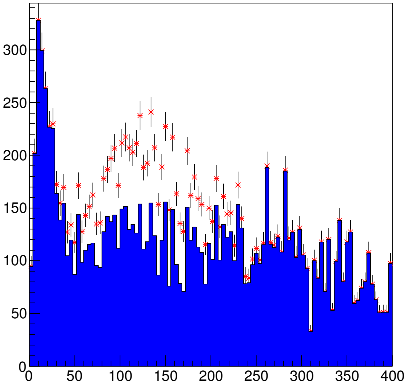


$\tilde{e}_R$

Early discovery channel: crossection in the pb-range.

- Few simple cuts.
  - $E_{vis} < 400$ GeV ($= E_{CMS} - 2M_{\tilde{\chi}^0_1\,min,LEP}$).
  - 2 charged particles
  - $<$ 40% of E_{vis} $<$ below 30 degrees.
- Simple observable: E_{vis}: Peak and width gives $M_{\tilde{e}_R}$ and $M_{\tilde{\chi}^0_1}$.
- See the signal appearing after
  - 1 fb^{-1}
  - 5 fb^{-1}
  - 25 fb^{-1}
  - 100 fb^{-1}
  - 250 fb^{-1}

Visible Energy @ 5 fb-1

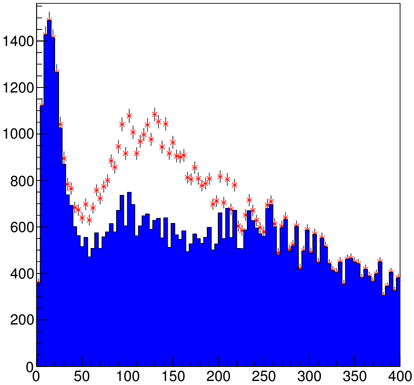


$\tilde{e}_R$

Early discovery channel: crossection in the pb-range.

- Few simple cuts.
  - $E_{vis} < 400$ GeV $(= E_{CMS} - 2M_{\tilde{\chi}^0_1\, min,LEP})$.
  - 2 charged particles
  - $<$ 40% of E_{vis} $<$ below 30 degrees.
- Simple observable: E_{vis}: Peak and width gives $M_{\tilde{e}_R}$ and $M_{\tilde{\chi}^0_1}$.
- See the signal appearing after
  - 1 fb^{-1}
  - 5 fb^{-1}
  - 25 fb^{-1}
  - 100 fb^{-1}
  - 250 fb^{-1}

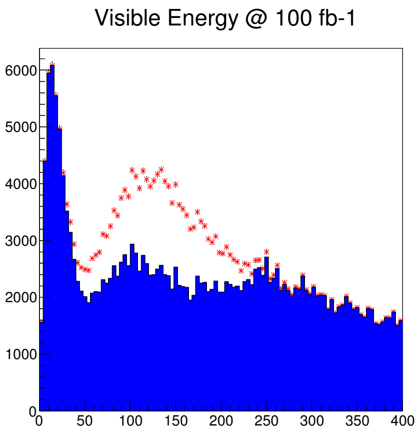
Visible Energy @ 25 fb-1



$\tilde{e}_R$

Early discovery channel: crossection in the pb-range.

- Few simple cuts.
  - $E_{vis} < 400$ GeV ($= E_{CMS} - 2M_{\tilde{\chi}^0_1\,min,LEP}$).
  - 2 charged particles
  - $<$ 40% of $E_{vis} <$ below 30 degrees.
- Simple observable: E_{vis}: Peak and width gives $M_{\tilde{e}_R}$ and $M_{\tilde{\chi}^0_1}$.
- See the signal appearing after
  - 1 fb^{-1}
  - 5 fb^{-1}
  - 25 fb^{-1}
  - 100 fb^{-1}
  - 250 fb^{-1}

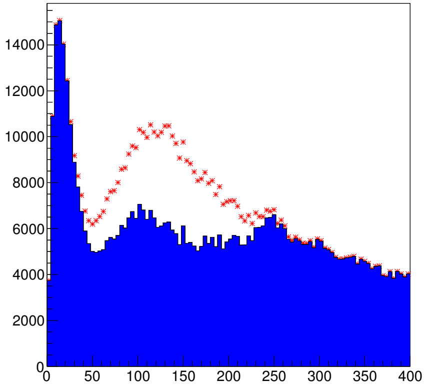


$\tilde{e}_R$

Early discovery channel: crossection in the pb-range.

- Few simple cuts.
  - $E_{vis} < 400$ GeV $(= E_{CMS} - 2M_{\tilde{\chi}^0_1\,min,LEP})$.
  - 2 charged particles
  - $<$ 40% of E_{vis} $<$ below 30 degrees.
- Simple observable: E_{vis}: Peak and width gives $M_{\tilde{e}_R}$ and $M_{\tilde{\chi}^0_1}$.
- See the signal appearing after
  - 1 fb^{-1}
  - 5 fb^{-1}
  - 25 fb^{-1}
  - 100 fb^{-1}
  - 250 fb^{-1}

Visible Energy @ 250 fb-1



$\tilde{e}_R$ spectrum

- So, within months after start-up, we can estimate $M_{\tilde{e}_R}$ and $M_{\tilde{\chi}_1^0}$ to within a few GeV.
- Use this knowledge for better selection cuts.
- Probably, we have also seen the $\tilde{\mu}_R$.
- ... and that it has $\approx$ the same mass. ass the $\tilde{e}_R$

Nets step:

Refine cuts for $\tilde{e}_R$ and $\tilde{\mu}_R$

$\tilde{e}_R$ spectrum

- So, within months after start-up, we can estimate $M_{\tilde{e}_R}$ and $M_{\tilde{\chi}_1^0}$ to within a few GeV.
- Use this knowledge for better selection cuts.
- Probably, we have also seen the $\tilde{\mu}_R$.
- ... and that it has $\approx$ the same mass. ass the $\tilde{e}_R$

Nets step:

Refine cuts for $\tilde{e}_R$ and $\tilde{\mu}_R$

$\tilde{e}_R$ spectrum

- So, within months after start-up, we can estimate $M_{\tilde{e}_R}$ and $M_{\tilde{\chi}^0_1}$ to within a few GeV.
- Use this knowledge for better selection cuts.
- Probably, we have also seen the $\tilde{\mu}_R$.
- ... and that it has ≈ the same mass. ass the $\tilde{e}_R$

Nets step:

Refine cuts for $\tilde{e}_R$ and $\tilde{\mu}_R$

$\tilde{e}_R$ spectrum

- So, within months after start-up, we can estimate $M_{\tilde{e}_R}$ and $M_{\tilde{\chi}_1^0}$ to within a few GeV.
- Use this knowledge for better selection cuts.
- Probably, we have also seen the $\tilde{\mu}_R$.
- ... and that it has $\approx$ the same mass. ass the $\tilde{e}_R$

Nets step:

Refine cuts for $\tilde{e}_R$ and $\tilde{\mu}_R$

$\tilde{e}_R$ spectrum

- So, within months after start-up, we can estimate $M_{\tilde{e}_R}$ and $M_{\tilde{\chi}_1^0}$ to within a few GeV.
- Use this knowledge for better selection cuts.
- Probably, we have also seen the $\tilde{\mu}_R$.
- ... and that it has $\approx$ the same mass. ass the $\tilde{e}_R$

Nets step:

Refine cuts for $\tilde{e}_R$ and $\tilde{\mu}_R$

$\tilde{e}_R$ spectrum

Refine cuts:

- $E_{vis} < 300$ GeV.
- $M_{miss} > 250$ GeV.
- E below 30 degrees < 10 GeV.
- $\cos\theta_{miss} < 0.95$.
- Exactly two opposite charged identified e:s.
- $(E_{jet1} + E_{jet2}) \sin\theta_{acop} > 21$, < 135 GeV.

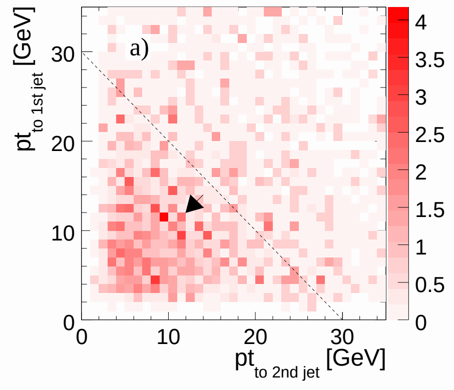
Efficiency 52 %

$\tilde{e}_R$ spectrum

Refine cuts:

- $E_{vis} < 300$ GeV.
- $M_{miss} > 250$ GeV.
- E below 30 degrees < 10 GeV.
- $\cos\theta_{miss} < 0.95$.
- Exactly two opposite charged identified e:s.
- $(E_{jet1} + E_{jet2}) \sin\theta_{acop} > 21$, < 135 GeV.

Efficiency 52 %

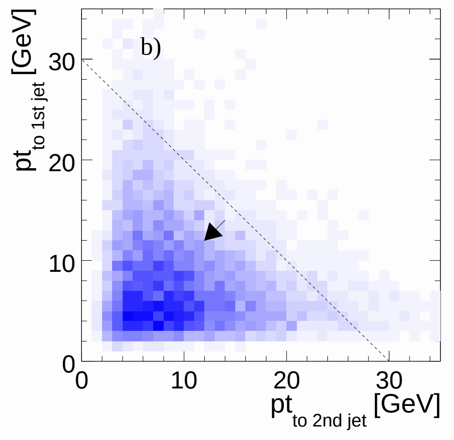


$\tilde{e}_R$ spectrum

Refine cuts:

- $E_{vis} < 300$ GeV.
- $M_{miss} > 250$ GeV.
- E below 30 degrees < 10 GeV.
- $\cos\theta_{miss} < 0.95$.
- Exactly two opposite charged identified e:s.
- $(E_{jet1} + E_{jet2}) \sin\theta_{acop} > 21$, < 135 GeV.

Efficiency 52 %

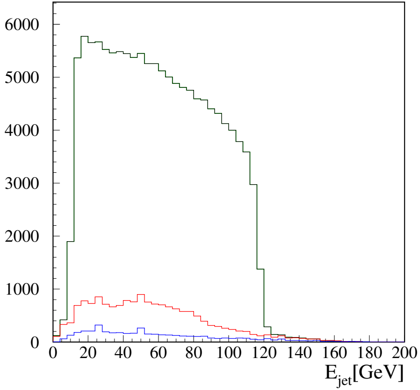


$\tilde{e}_R$ spectrum

Refine cuts:

- $E_{vis} < 300$ GeV.
- $M_{miss} > 250$ GeV.
- E below 30 degrees < 10 GeV.
- $\cos\theta_{miss} < 0.95$.
- Exactly two opposite charged identified e:s.
- $(E_{jet1} + E_{jet2})\sin\theta_{acop} > 21$, $<$ 135 GeV.

Efficiency 52 %



$\tilde{\mu}_R$ spectrum

Same cuts, but ask for two μ:s instead, ie.:

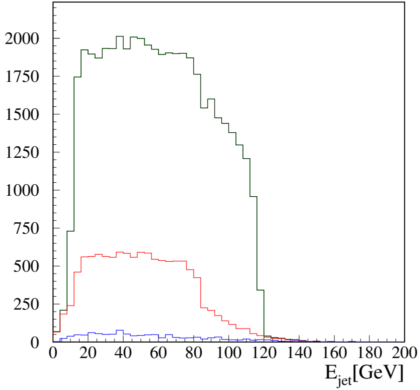
- $E_{vis} < 300$ GeV.
- $M_{miss} > 250$ GeV.
- E below 30 degrees < 10 GeV.
- $\cos\theta_{miss} < 0.95$.
- Exactly two opposite charged identified μ:s.
- $(E_{jet1} + E_{jet2}) \sin\theta_{acop} > 21$, < 135 GeV.
- Note lower cross-section.
- SUSY bck is $\tilde{\chi}^0_1\tilde{\chi}^0_2 \rightarrow \tilde{\chi}^0_1\tilde{\chi}^0_1\mu\mu$.

Efficiency 88 %

$\tilde{\mu}_R$ spectrum

Same cuts, but ask for two μ:s instead, ie.:

- $E_{vis} < 300$ GeV.
- $M_{miss} > 250$ GeV.
- E below 30 degrees < 10 GeV.
- $\cos\theta_{miss} < 0.95$.
- Exactly two opposite charged identified μ:s.
- $(E_{jet1} + E_{jet2}) \sin\theta_{acop} > 21$, < 135 GeV.
- Note lower cross-section.
- SUSY bck is $\tilde{\chi}^0_1\tilde{\chi}^0_2 \to \tilde{\chi}^0_1\tilde{\chi}^0_1\mu\mu$.

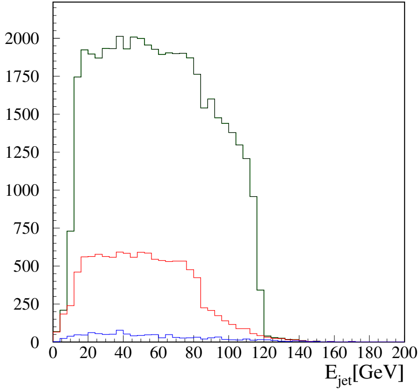


Efficiency 88 %

$\tilde{\mu}_R$ spectrum

Same cuts, but ask for two μ:s instead, ie.:

- $E_{vis} < 300$ GeV.
- $M_{miss} > 250$ GeV.
- E below 30 degrees < 10 GeV.
- $\cos\theta_{miss} < 0.95$.
- Exactly two opposite charged identified μ:s.
- $(E_{jet1} + E_{jet2}) \sin\theta_{acop} > 21$, < 135 GeV.
- Note lower cross-section.
- SUSY bck is $\tilde{\chi}^0_1\tilde{\chi}^0_2 \rightarrow \tilde{\chi}^0_1\tilde{\chi}^0_1\mu\mu$.



Efficiency 88 %

$\tilde{\mu}_R$ threshold scan

From these spectra, we can estimate $M_{\tilde{e}_R}$, $M_{\tilde{\mu}_R}$ and $M_{\tilde{\chi}_1^0}$ to < 1 GeV.

$\tilde{\mu}_R$ threshold scan

From these spectra, we can estimate $M_{\tilde{e}_R}$, $M_{\tilde{\mu}_R}$ and $M_{\tilde{\chi}^0_1}$ to < 1 GeV.

So: Next step is $M_{\tilde{\mu}_R}$ from threshold:

- 10 points, 10 fb^{-1}/point.
- Luminousity $\propto E_{CMS}$, so this is $\Leftrightarrow$ 170 fb^{-1} @ E_{CMS}=500 GeV.

Error on $M_{\tilde{\mu}_R}$ = 197 Mev

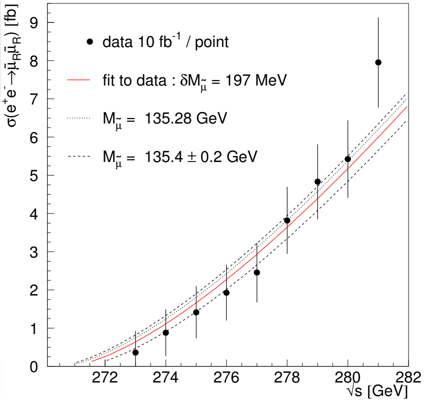
$\tilde{\mu}_R$ threshold scan

From these spectra, we can estimate $M_{\tilde{e}_R}$, $M_{\tilde{\mu}_R}$ and $M_{\tilde{\chi}_1^0}$ to < 1 GeV.

So: Next step is $M_{\tilde{\mu}_R}$ from threshold:

- 10 points, 10 fb^{-1}/point.
- Luminousity $\propto E_{CMS}$, so this is $\Leftrightarrow$ 170 fb^{-1} @ E_{CMS}=500 GeV.

Error on $M_{\tilde{\mu}_R}$ = 197 Mev



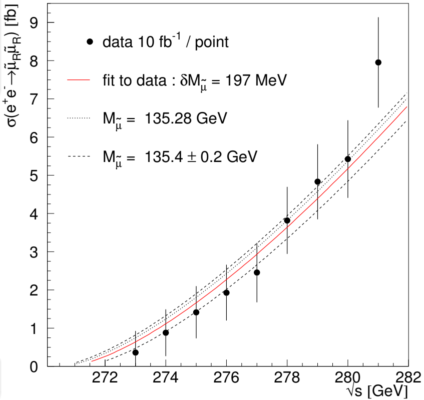
$\tilde{\mu}_R$ threshold scan

From these spectra, we can estimate $M_{\tilde{e}_R}$, $M_{\tilde{\mu}_R}$ and $M_{\tilde{\chi}^0_1}$ to < 1 GeV.

So: Next step is $M_{\tilde{\mu}_R}$ from threshold:

- 10 points, 10 fb^{-1}/point.
- Luminousity $\propto E_{CMS}$, so this is $\Leftrightarrow$ 170 fb^{-1} @ E_{CMS}=500 GeV.

Error on $M_{\tilde{\mu}_R}$ = 197 Mev



$\tilde{\tau}_1$ (SPS1a')

- $E_{vis} < 300$ GeV.
- M_{miss} > 250 GeV.
- Exactly two opposite charged jets identified w. mass < 2.5 GeV.
- No particle with P > 180 GeV.
- $(E_{jet1} + E_{jet2}) \sin\theta_{acop} < 30$ GeV.

Efficiency 15 %

$\tilde{\tau}_1$ (SPS1a')

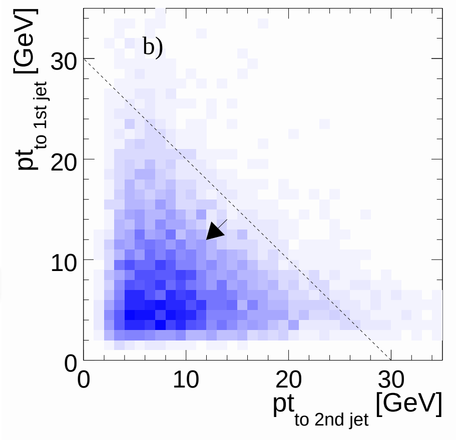
- $E_{vis} < 300$ GeV.
- $M_{miss} > 250$ GeV.
- Exactly two opposite charged jets identified w. mass < 2.5 GeV.
- No particle with P > 180 GeV.
- $(E_{jet1} + E_{jet2}) \sin\theta_{acop} < 30$ GeV.

Efficiency 15 %

$\tilde{\tau}_1$ (SPS1a')

- $E_{vis} < 300$ GeV.
- $M_{miss} > 250$ GeV.
- Exactly two opposite charged jets identified w. mass < 2.5 GeV.
- No particle with P > 180 GeV.
- $(E_{jet1} + E_{jet2}) \sin\theta_{acop} < 30$ GeV.

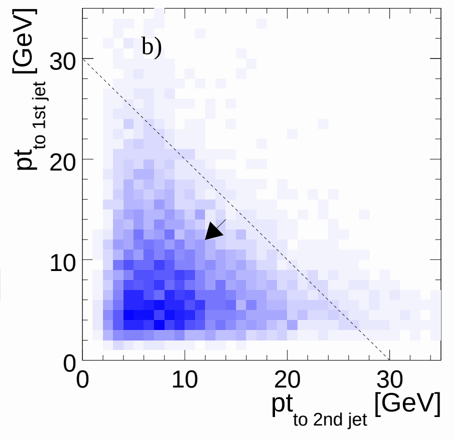
Efficiency 15 %



$\tilde{\tau}_1$ (SPS1a')

- $E_{vis} < 300$ GeV.
- $M_{miss} > 250$ GeV.
- Exactly two opposite charged jets identified w. mass < 2.5 GeV.
- No particle with P > 180 GeV.
- $(E_{jet1} + E_{jet2}) \sin \theta_{acop} < 30$ GeV.

Efficiency 15 %

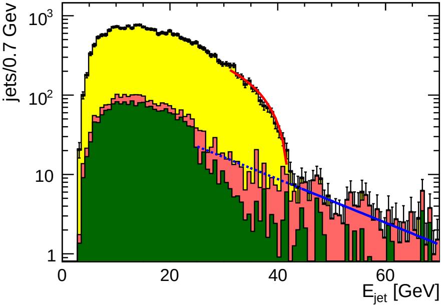


Fitting the $\tilde{\tau}_1$ mass (SPS1a')

- Only the upper end-point is relevant.
- Background subtraction:
  - Important SUSY background,but region above 45 GeV is signal free. Fit exponential and extrapolate.
- Fit line to (data-background fit).

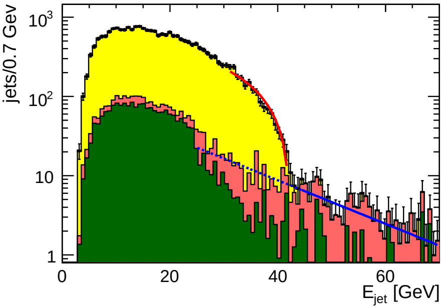
Fitting the $\tilde{\tau}_1$ mass (SPS1a')

- Only the upper end-point is relevant.
- Background subtraction:
  - Important SUSY background,but region above 45 GeV is signal free. Fit exponential and extrapolate.
- Fit line to (data-background fit).



Fitting the $\tilde{\tau}_1$ mass (SPS1a')

- Only the upper end-point is relevant.
- Background subtraction:
  - Important SUSY background,but region above 45 GeV is signal free. Fit exponential and extrapolate.
- Fit line to (data-background fit).



Fitting the $\tilde{\tau}_1$ mass (SPS1a')

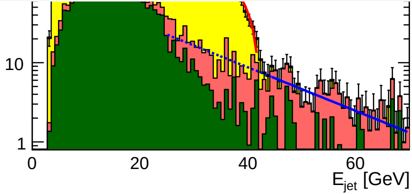
- Only the upper end-point is relevant.

Results for $\tilde{\tau}_1$

$M_{\tilde{\tau}_1} = 107.73^{+0.03}_{-0.05}\mathrm{GeV}/c^2 \otimes 1.3\Delta(M_{\tilde{\chi}^0_1})$ The error from $M_{\tilde{\chi}^0_1}$ largely dominates

Fit exponential and extrapolate.

- Fit line to (data-background fit).



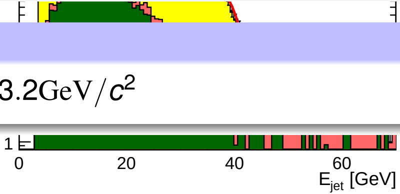
Fitting the $\tilde{\tau}_1$ mass (SPS1a')

- Only the upper end-point is relevant.

Results for $\tilde{\tau}_1$

$M_{\tilde{\tau}_1} = 107.73^{+0.03}_{-0.05}\mathrm{GeV}/c^2 \otimes 1.3\Delta(M_{\tilde{\chi}^0_1})$ The error from $M_{\tilde{\chi}^0_1}$ largely dominates

Fit exponential and



Results from cross-section for $\tilde{\tau}_1$

$\Delta(N_{signal})/N_{signal} = 3.1\% \rightarrow \Delta(M_{\tilde{\tau}_1}) = 3.2\mathrm{GeV}/c^2$

First look at Heavier sleptons ($\tilde{\mu}_{\rm L}$)

Remember

demanding exactly 2 objects kills 90 % of the signal in TDR4, due to cascaded decays !

- Same cuts as for $\tilde{\mu}_{\rm R}$, and
- anti-WW likelihood, take over from SPS1a'
- select using other particle: p(other μ) > 120 GeV.

Efficiency 1.5 % (!), $S/B = 0.2$.

- $S/\sqrt{B}$=5.0 for LR,
- $S/\sqrt{B}$=2.8 for RL.

First look at Heavier sleptons ($\tilde{\mu}_{\mathrm{L}}$)

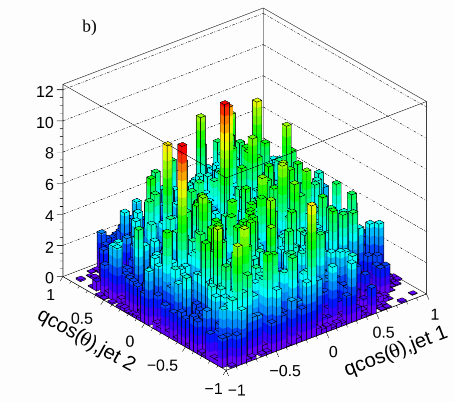
Remember

demanding exactly 2 objects kills 90 % of the signal in TDR4, due to cascaded decays !

- Same cuts as for $\tilde{\mu}_{\mathrm{R}}$, and
- anti-WW likelihood, take over from SPS1a'
- select using other particle: p(other μ) > 120 GeV.

Efficiency 1.5 % (!), $S/B = 0.2$.

- $S/\sqrt{B}$=5.0 for LR,
- $S/\sqrt{B}$=2.8 for RL.

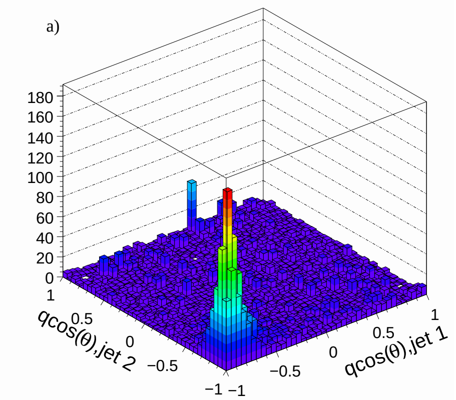


First look at Heavier sleptons ($\tilde{\mu}_{\mathrm{L}}$)

Remember

demanding exactly 2 objects kills 90 % of the signal in TDR4, due to cascaded decays !

- Same cuts as for $\tilde{\mu}_{\mathrm{R}}$, and
- anti-WW likelihood, take over from SPS1a'
- select using other particle: p(other μ) > 120 GeV.



Efficiency 1.5 % (!), $S/B = 0.2$.

- $S/\sqrt{B}$=5.0 for LR,
- $S/\sqrt{B}$=2.8 for RL.

First look at Heavier sleptons ($\tilde{\mu}_{\mathrm{L}}$)

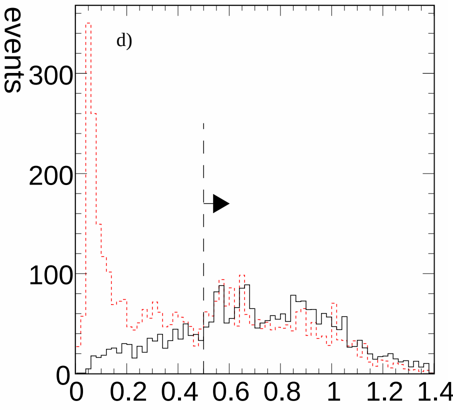
Remember

demanding exactly 2 objects kills 90 % of the signal in TDR4, due to cascaded decays !

- Same cuts as for $\tilde{\mu}_{\mathrm{R}}$, and
- anti-WW likelihood, take over from SPS1a'
- select using other particle: p(other μ) > 120 GeV.

Efficiency 1.5 % (!), $S/B = 0.2$.

- $S/\sqrt{B}$=5.0 for LR,
- $S/\sqrt{B}$=2.8 for RL.



First look at Heavier sleptons ($\tilde{\mu}_L$)

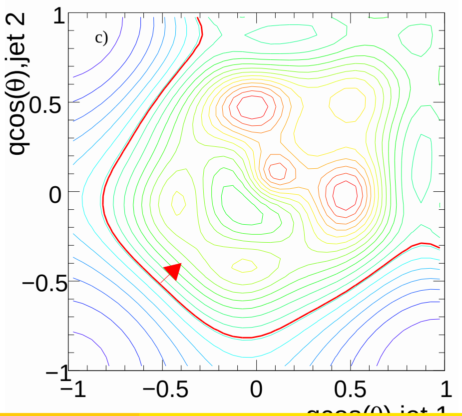
Remember

demanding exactly 2 objects kills 90 % of the signal in TDR4, due to cascaded decays !

- Same cuts as for $\tilde{\mu}_R$, and
- anti-WW likelihood, take over from SPS1a'
- select using other particle: p(other μ) > 120 GeV.

Efficiency 1.5 % (!), $S/B = 0.2$.

- $S/\sqrt{B}$=5.0 for LR,
- $S/\sqrt{B}$=2.8 for RL.



First look at Heavier sleptons ($\tilde{\mu}_{\mathrm{L}}$)

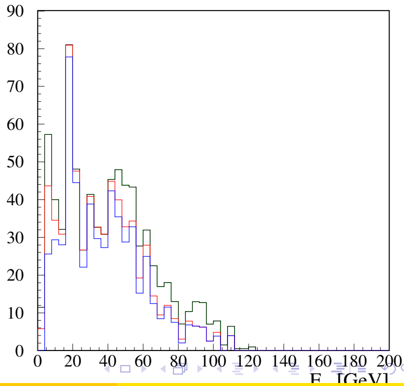
Remember

demanding exactly 2 objects kills 90 % of the signal in TDR4, due to cascaded decays !

- Same cuts as for $\tilde{\mu}_{\mathrm{R}}$, and
- anti-WW likelihood, take over from SPS1a'
- select using other particle: p(other μ) > 120 GeV.

Efficiency 1.5 % (!), S/B = 0.2.

- $S/\sqrt{B}$=5.0 for LR,
- $S/\sqrt{B}$=2.8 for RL.



First look at Heavier sleptons ($\tilde{\mu}_L$)

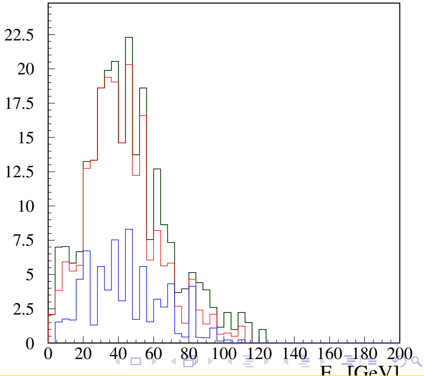
Remember

demanding exactly 2 objects kills 90 % of the signal in TDR4, due to cascaded decays !

- Same cuts as for $\tilde{\mu}_R$, and
- anti-WW likelihood, take over from SPS1a'
- select using other particle: p(other μ) > 120 GeV.

Efficiency 1.5 % (!), S/B = 0.2.

- $S/\sqrt{B}$=5.0 for LR,
- $S/\sqrt{B}$=2.8 for RL.



Conclusions

- Rich SUSY spectra at an 500 GeV ILC is by no means excluded.
- Such scenarios would be likely to be the best fit to all data - fittino analysis in the pipe.
- The way of sharing beam-time was discussed (without any recomendation, yet)
- A very preliminary analysis of some aspects of such a scenario - TDR4 - was presented.

Conclusions

- Rich SUSY spectra at an 500 GeV ILC is by no means excluded.
- Such scenarios would be likely to be the best fit to all data - fittino analysis in the pipe.
- The way of sharing beam-time was discussed (without any recomendation, yet)
- A very preliminary analysis of some aspects of such a scenario - TDR4 - was presented.

Conclusions

- Rich SUSY spectra at an 500 GeV ILC is by no means excluded.
- Such scenarios would be likely to be the best fit to all data - fittino analysis in the pipe.
- The way of sharing beam-time was discussed (without any recomendation, yet)
- A very preliminary analysis of some aspects of such a scenario - TDR4 - was presented.

Work in progress.
Stay tuned.

Conclusions

- Rich SUSY spectra at an 500 GeV ILC is by no means excluded.
- Such scenarios would be likely to be the best fit to all data - fittino analysis in the pipe.
- The way of sharing beam-time was discussed (without any recomendation, yet)
- A very preliminary analysis of some aspects of such a scenario - TDR4 - was presented.

Work in progress.
Stay tuned.

Thank You !

Backup

BACKUP SLIDES

BACKUP

Note that this wasnt counted !