SUSY Analysis with Full Simulation

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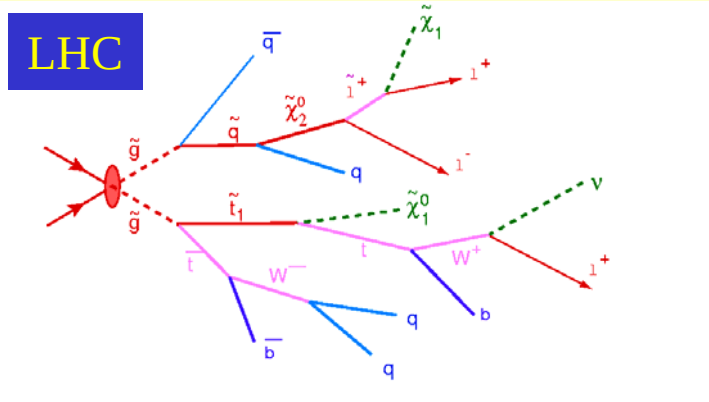
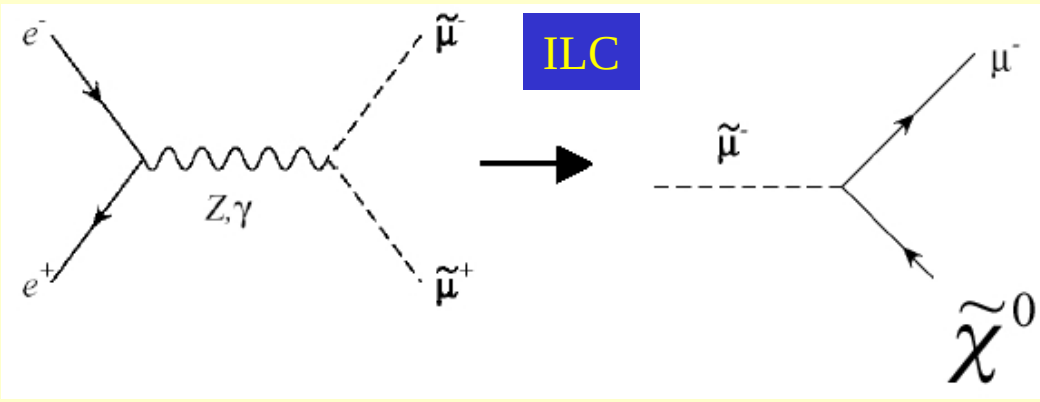
Introduction

- LHC would discover SUSY or missing-energy phenomena.
- SUSY Study @ ILC : Precise measurements of sparticle properties.
- ILC + LHC : Determine underlying SUSY model and SUSY breaking mechanism.





- Fast MC studies at JLC/GLC era exist.
- Towards LoI : Physics studies with full simulation.
- First step : Perfrom same analysis with full simulation.

Generated Events

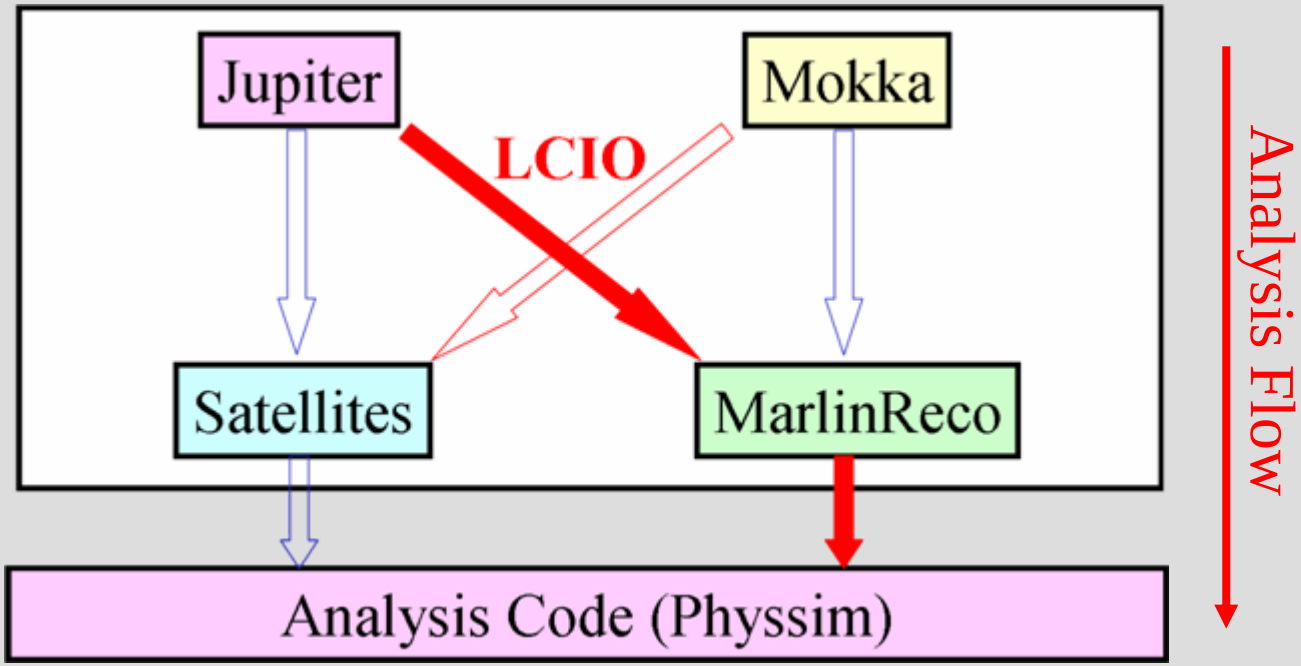
- Helas based generator
- BSGEN : A generator of beamstrahlung spectrum
- Beam ploarization : P(e-) = 90%

- $e^+e^- \rightarrow \tilde{\mu}_R^+ \tilde{\mu}_R^-$ @ 500GeV
  - (M0, μ, M1/2, tanβ) = (70, 389, 250, 10)
  - smuon mass : 144.37GeV
  - neutralino mass : 121.59GeV
  - Luminosity : 55fb-1

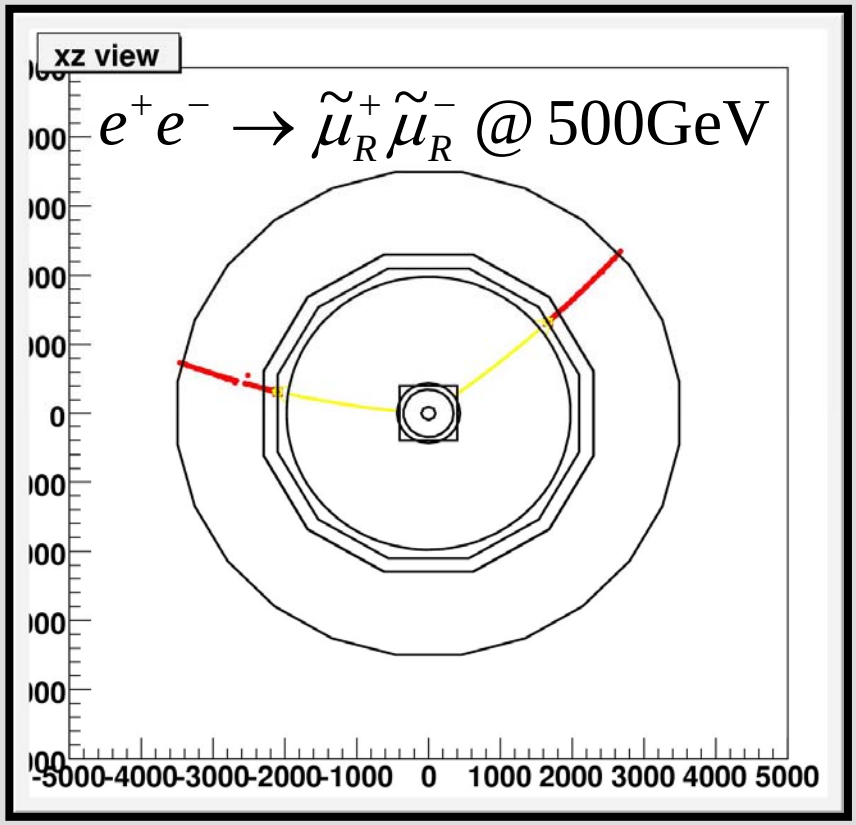
- $e^+e^- \rightarrow \tilde{\chi}_1^+ \tilde{\chi}_1^-$ @ 500 GeV
  - (M0, μ, M1/2, tanβ) = (206, 375, 243, 10)
  - chargino mass : 222.63 GeV
  - neutralino mass : 117.96 GeV
  - Luminosity : 100 fb-1

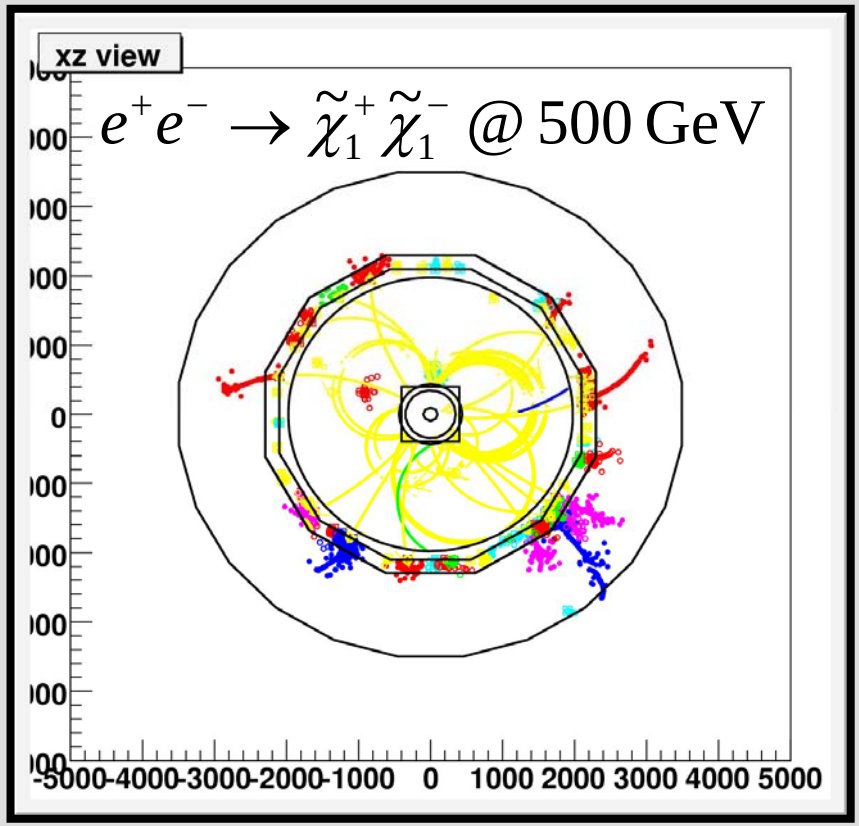
Simulation/Reconstruction

- Simulation : Jupiter
  - Geant4.9.0p1 and LCPhysicsList w/ GLD geometry
- Reconstruction : ilcsoft v01-03
  - FullLDCTracking + PandoraPFA v02-01
- Analysis : Physsim
  - Developed for fast MC data. PFO based analysis.



Event Displays





- Typical event display for both smuon-pair and chargino-pair production processes.

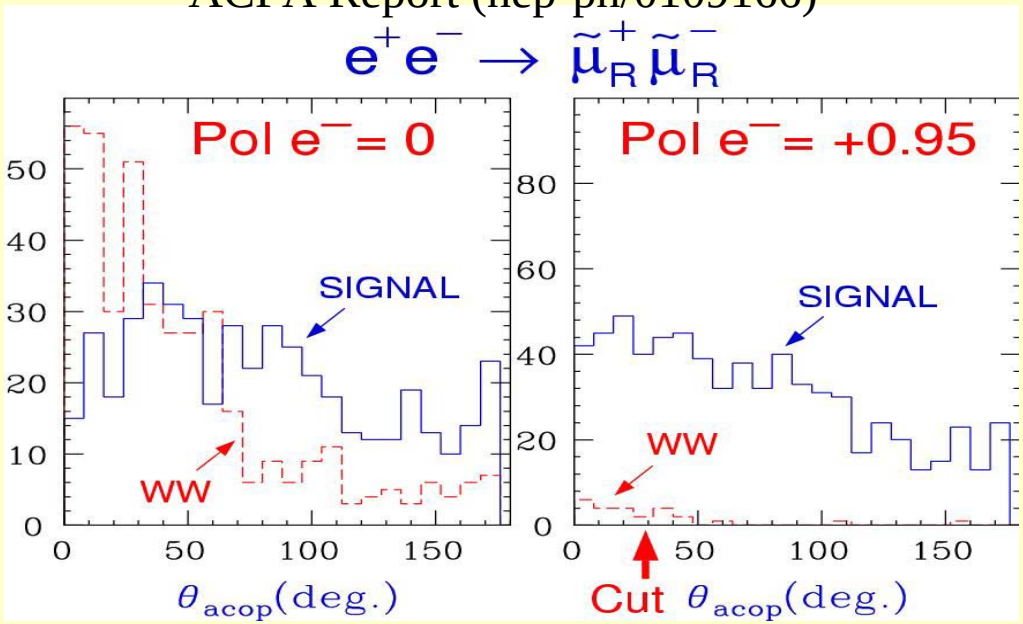
Smuon Pair-Production Process

- Smuon pair-production process : $e^+e^- \rightarrow \tilde{\mu}_R^+\tilde{\mu}_R^- \rightarrow (\mu^+\tilde{\chi}_1^0)(\mu^-\tilde{\chi}_1^0)$
- Signal signature : 2 lepton + Pt missing.

- Polarized electron beam is effective.

  - Signal x 2
  - Background (WW) ~ 0 after θ_{acp} cut

ACFA Report (hep-ph/0109166)

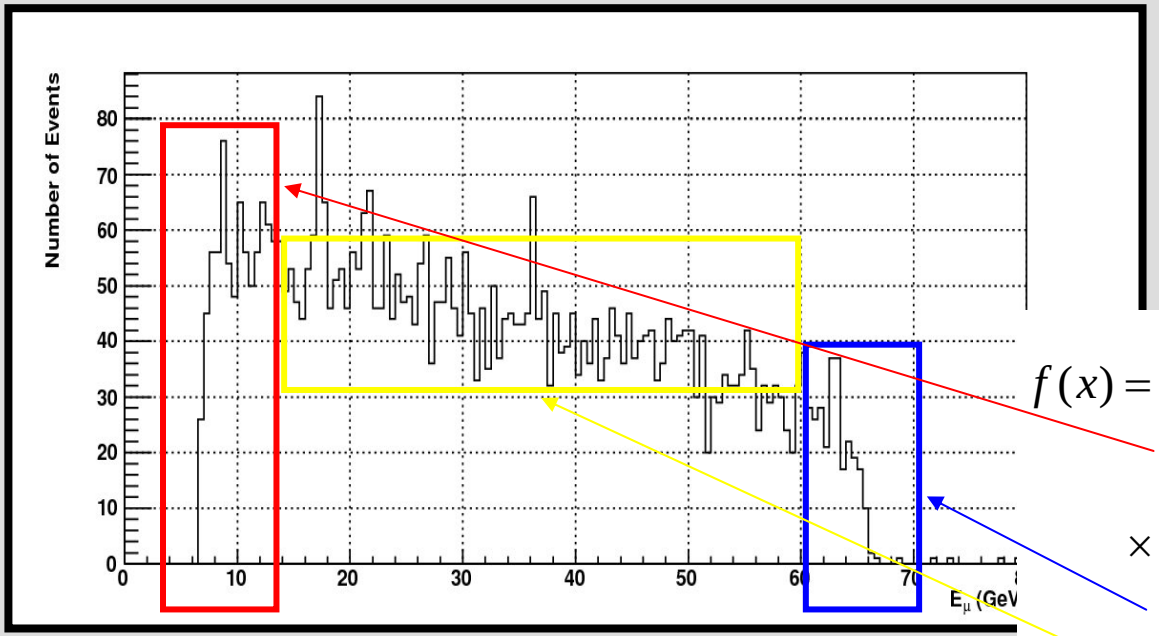


- $\tilde{\mu}_R^{\pm}$ / $\tilde{\chi}_1^0$ mass can be determined from muon energy distribution after all selection criteria.

→ Test of tracker momentum resolution

Fitted Function

- Muon energy distribution is fitted by an empirical function.



$$f(x) = \left(1 + Erf\left(\frac{x - E_{\min}}{\sigma_{\min}}\right)\right) : \text{Lower Edge}$$

$$\times \left(1 - Erf\left(\frac{x - E_{\max}}{\sigma_{\max}}\right)\right) : \text{Upper Edge}$$

$$\times \text{Polynomial Function} : \text{Central Part}$$

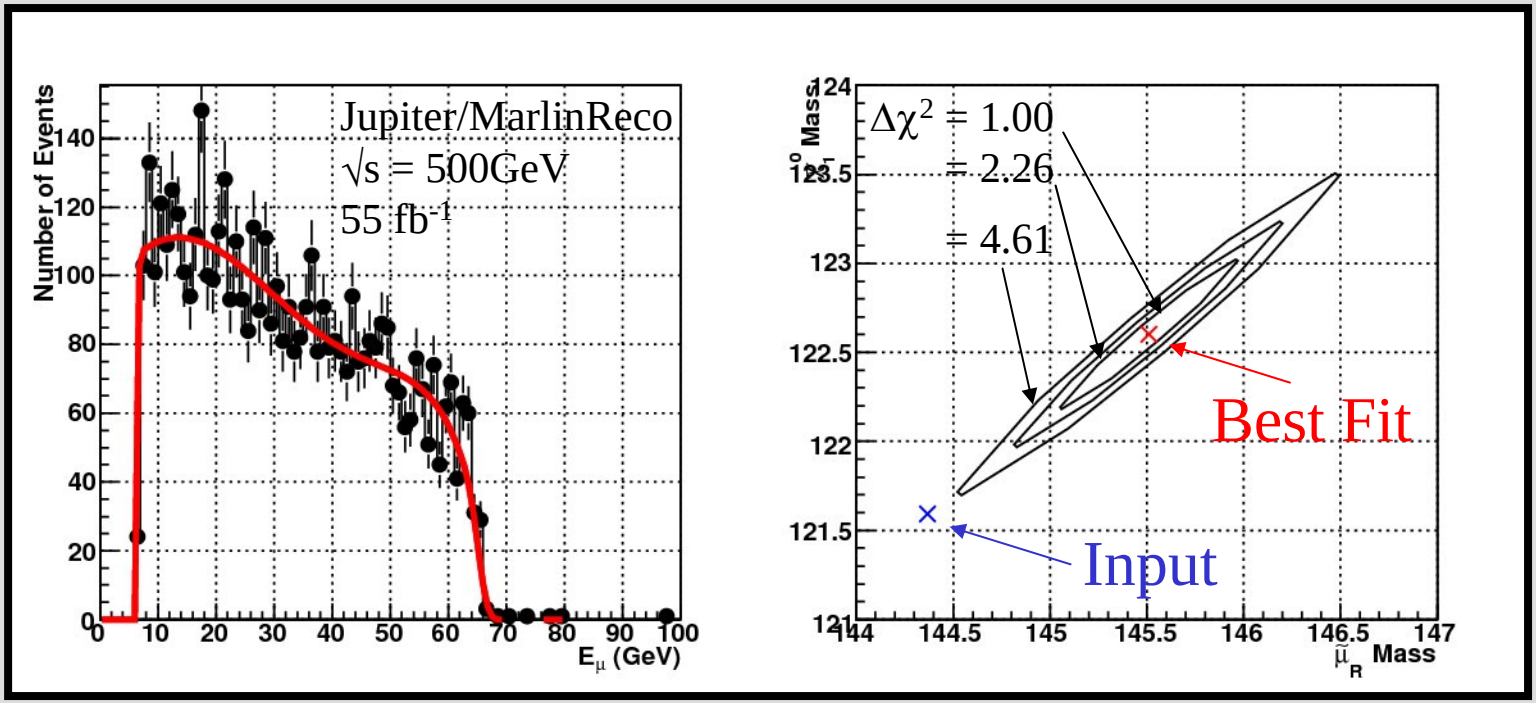
where

$$Erf(x) = \frac{2}{\sqrt{\pi}} \int_0^x e^{-t^2} dt$$

Fit by letting the smuon and Neutralino masses move freely.

Smuon Pair (FullLDCTracking)

- Muon energy distribution is fitted by an empirical function.

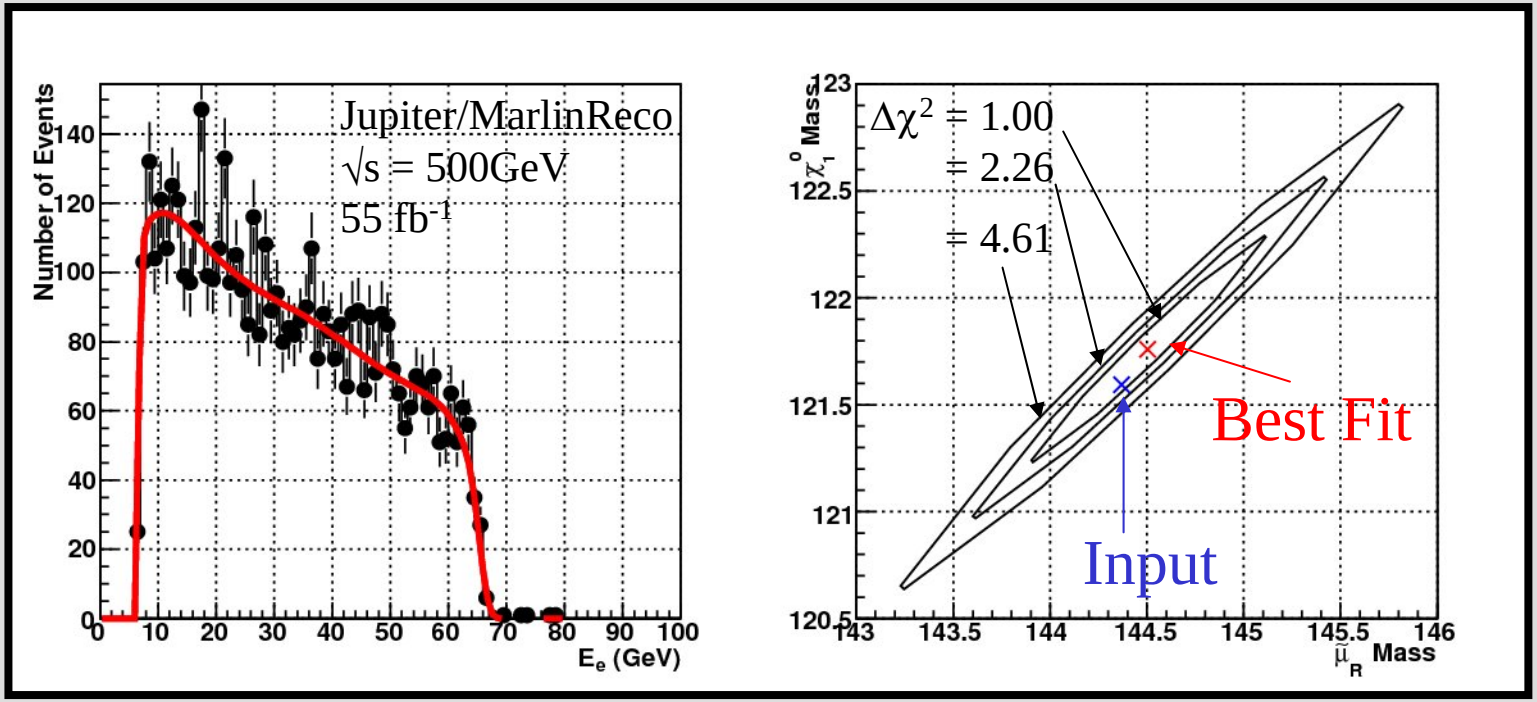


	Input	FullTracking
Smuon	144.37	145.51 ± 0.46
Neutralino	121.59	122.60 ± 0.42

←~ 1GeV shift compared to inputs

Smuon Pair (TrackCheater)

- For comparison, same analysis was done by TrackCheater.



	Input	FullTracking	TrackCheater
Smuon	144.37	145.51 ± 0.46	144.50 ± 0.61
Neutralino	121.59	122.60 ± 0.42	121.76 ± 0.53

Chargino Pair-Production Process

- Chargino pari-production process

$$: e^+e^- \rightarrow \tilde{\chi}_1^+ \tilde{\chi}_1^- \rightarrow (W^+ \tilde{\chi}_1^0)(W^- \tilde{\chi}_1^0)$$

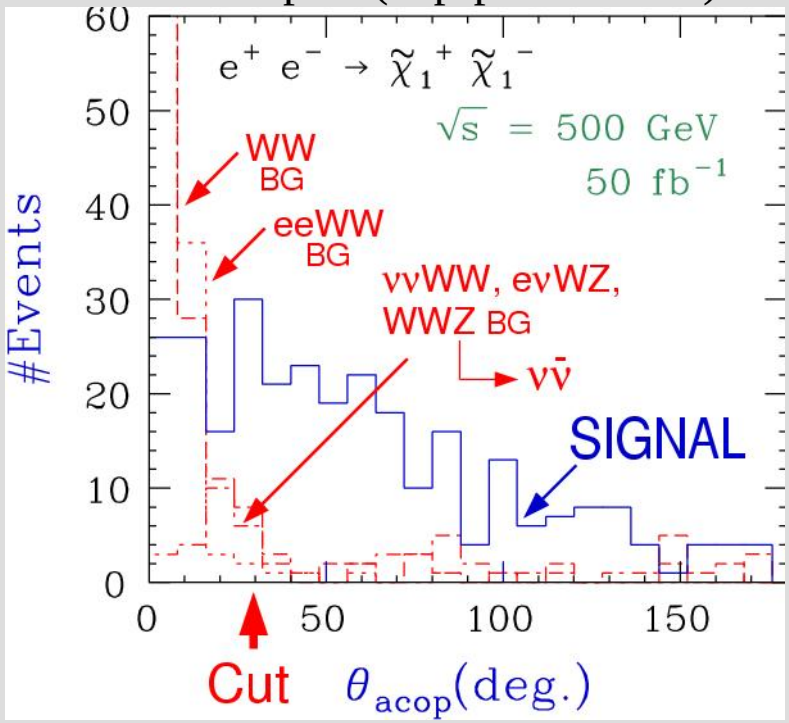
- Signal signature : 4-jet + Pt missing.

- Acoplanarity cut is also effective to reduce backgrounds.

- $\tilde{\chi}_1^{\pm}$ / $\tilde{\chi}_1^0$ mass can be determined from W energy distribution after all selection criteria.

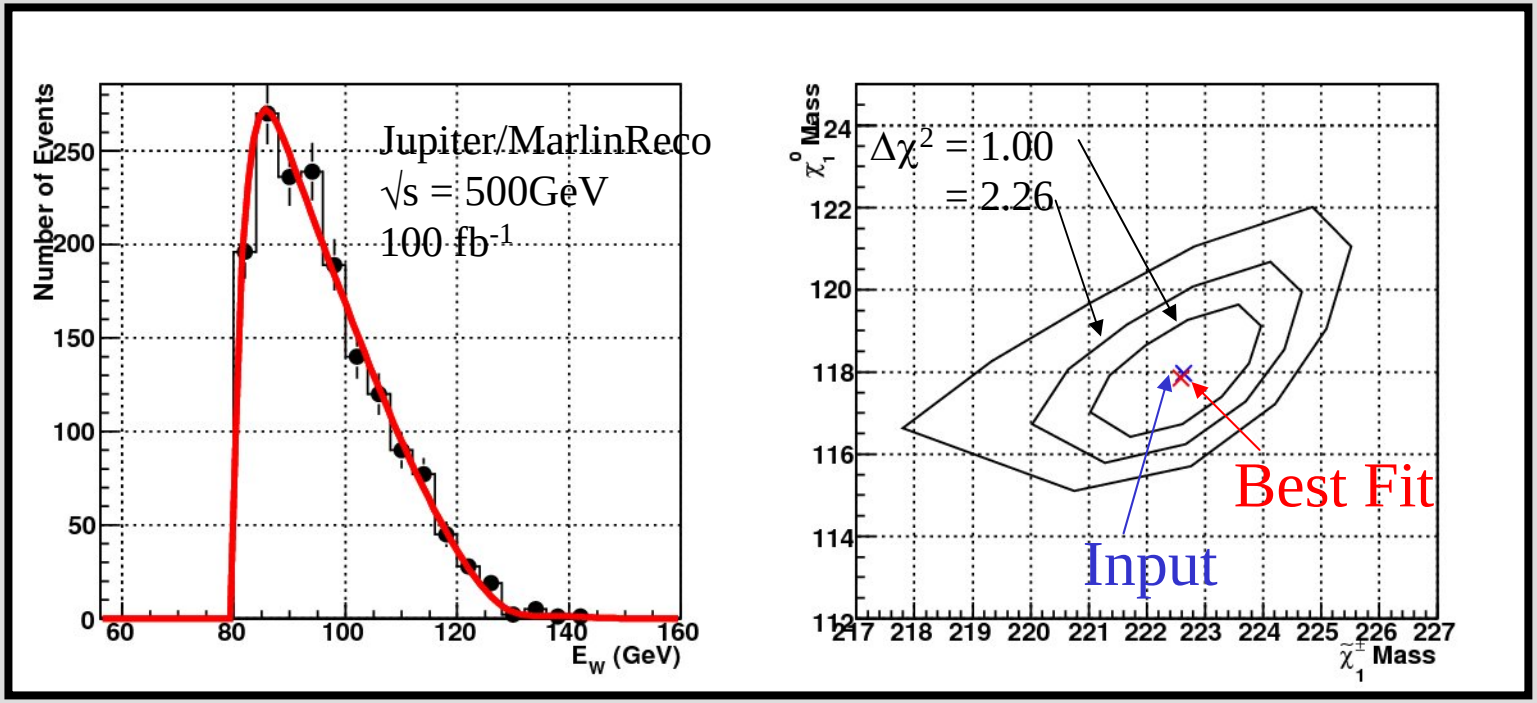
→ Test of PFA

ACFA Report (hep-ph/0109166)



Chargino Pair-Production Process

- W energy distribution is fitted by an empirical function.



	Input	Measured
Chargino	222.63	222.59 ± 1.10
Neutralino	117.96	117.97 ± 1.23

Summary

- Study of SUSY channels (smuon and chargino pair-production) **with full simulation** has been started.

  - Analysis path : Jupiter → MarlinReco/PandoraPFA → Physsim

  - Results are almost comparable to the fast MC study although background is not included in this study.
    → can be used for detector optimization study.

- Next step :
  - Include background.
  - Try other detector model (GLD prime, LDC like etc.)