Model Independent WIMP Search: From LDC to ILD

In Full Simulation of the ILD

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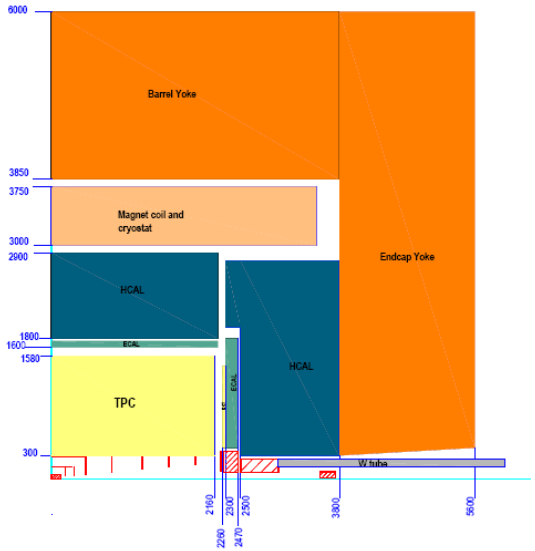
Outline

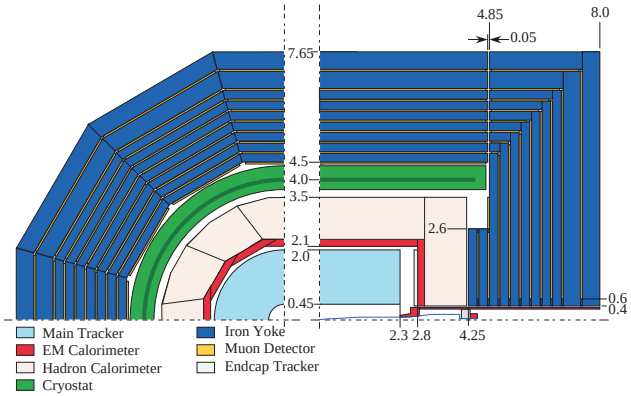
Current Efforts

Merging LDC and GLD to ILD

The ILD Detector Concept

- Design of a new Detector "between" LDC and GLD
- Latest models: LDC01_06Sc and LDCPrime02 in Mokka
- Agreement between LDC and GLD to base optimisation on common MC sample
- $\Rightarrow$ Whizard SM sample by T. Barklow et al.
- Mass production of SM events has started
- Physics analyses





Current Physics and Optimisation Analyses

- W^+W^- cross section measurement (Ivan Marchesini)
- $\tilde{\chi}_2^0$ pair production (Nicola D'Ascenzo,see talk)
- $\tilde{\tau}$ polarisation (Peter Schade)
- $\tilde{\chi}_1^0 \rightarrow \tilde{G}\gamma$ (Nanda Wattimena)
- $\tilde{\tau}$ mass measurement (Olga Stempel)
- Single photon events in DM and SUSY models (CB)

Outline

Why Single Photon Events?

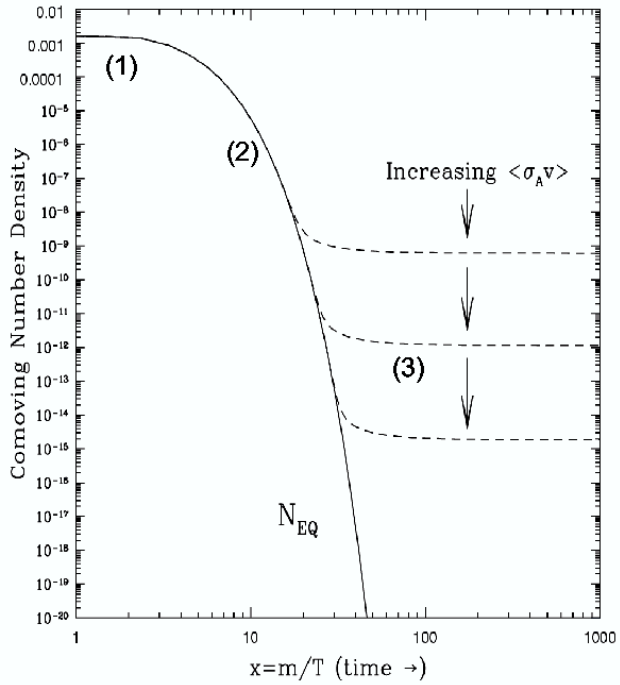
BSM physics with ISR

Some Good Reasons

- Might be only BSM signal at ILC if masses are close to/above $\frac{\sqrt{s}}{2}$
- DM searches
- Simple and clean signature
- Good for optimization

DM WIMPs

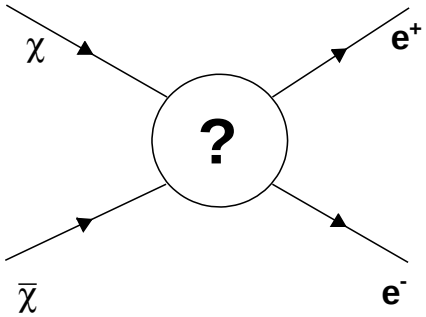
- Up to 250 GeV detectable via ISR photon
- Needed: Production cross section
- Can be derived from cosmological observation



Single Photon Processes

WIMPs @ ILC

- Cosmological DM-density Ω_{DM} observed ($\sim 20\%$)
- Annihilation X-Section σ_{an} estimated through Ω_{DM}



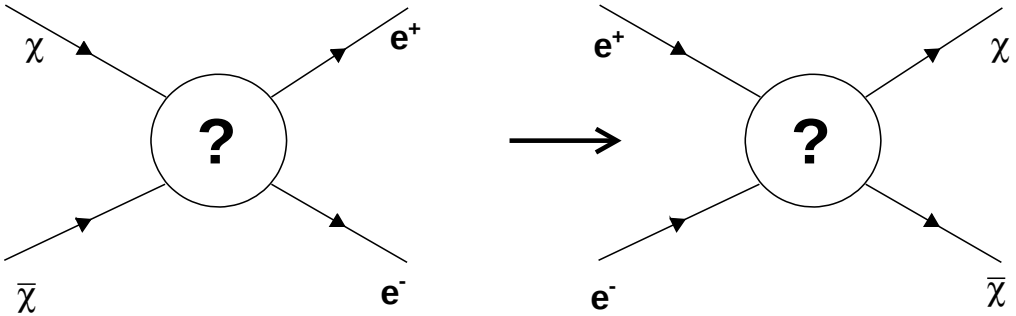
Cross section of $e^+e^- \rightarrow \chi\chi\gamma$

- Model independent
- Parameter: Annihilation fraction into electrons κ_e
- Masses accessible up to $m_\chi \simeq \frac{\sqrt{s}}{2}$

Single Photon Processes

WIMPs @ ILC

- Crossing Symmetry: $\sigma_{an} \rightarrow \sigma(e^+e^- \rightarrow \chi\overline{\chi})$
- Inclusion of ISR: $\sigma(e^+e^- \rightarrow \chi\overline{\chi}\gamma)$



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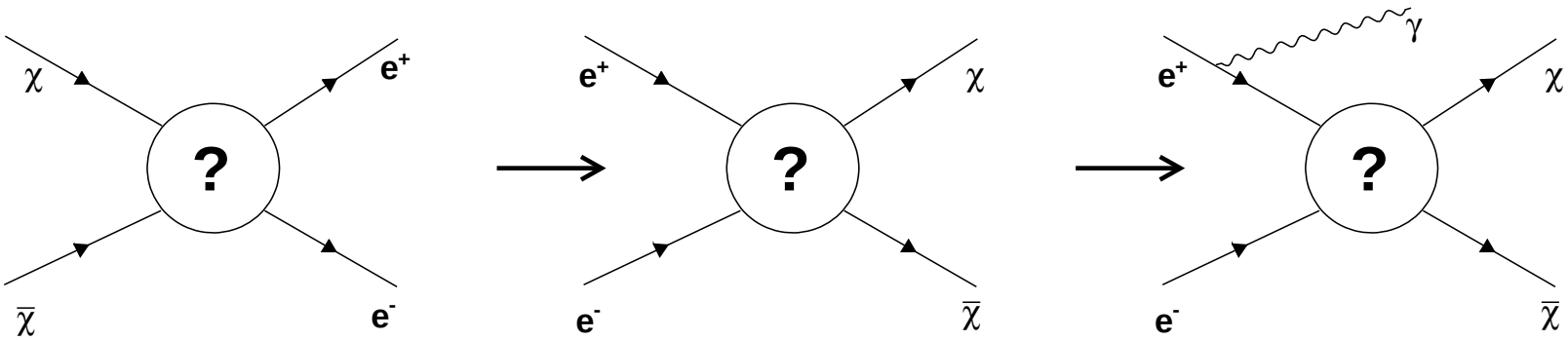

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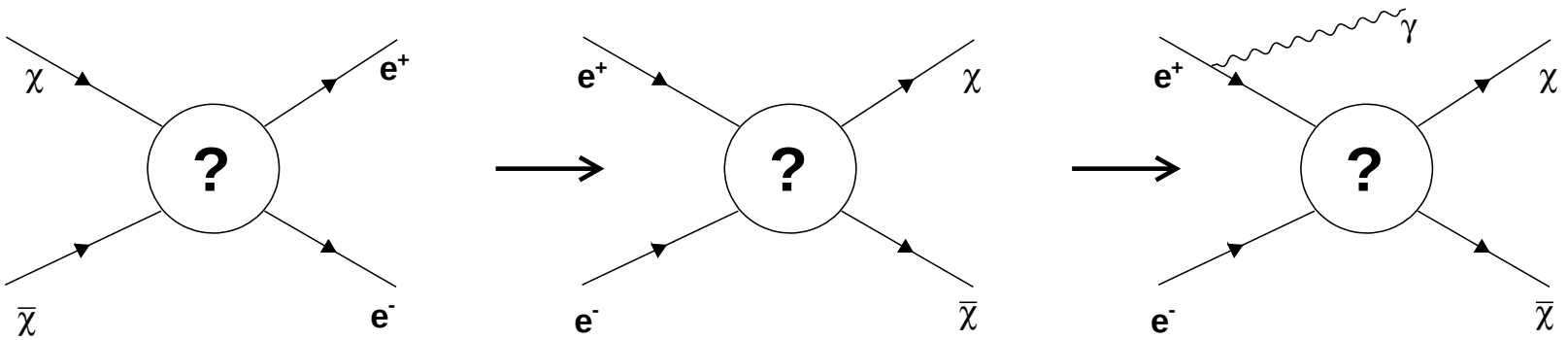

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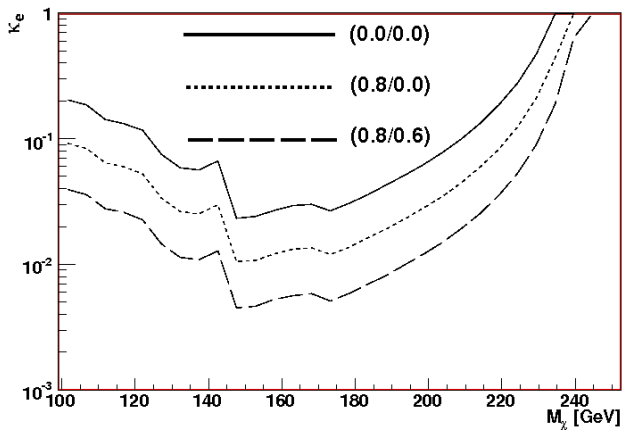
The Benefit of Beam Polarisation

- ILC provides up to 80% electron polarisation
- And maybe 30%(60%) positron polarisation
- Main $e^+e^- \rightarrow \nu\nu\gamma$ background strongly surpressed for $e^+_L e^-_R$
- WIMP couplings to electrons might have different behaviour
- $\rightarrow$ increase in signal to background ratio

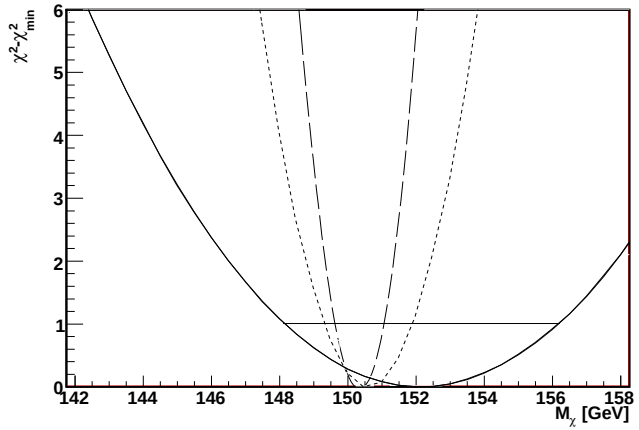
Reach on Couplings and Massresolution

LCWS '07

Reach on annihilation fraction κ_e as function of WIMP mass



Mass resolution on 150 GeV WIMP



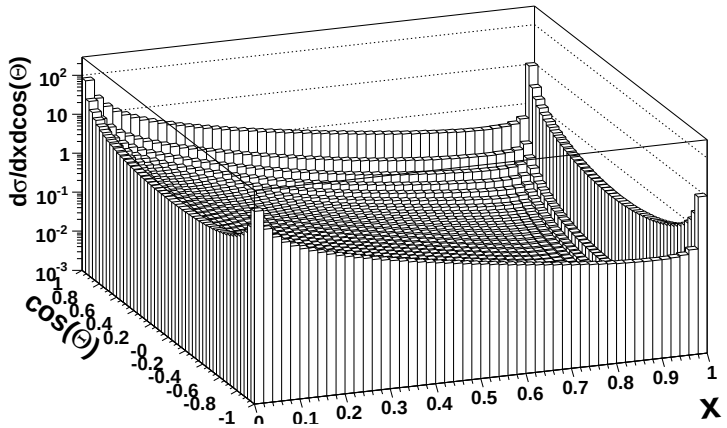
- Both for several beam polarisation configurations
- WIMP couplings to electrons conserve parity and helicity: $\kappa(e_L^+ e_R^-) = \kappa(e_R^+ e_L^-)$

Analysis

And SM Background

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

- dominant background
- strongly polarisation sensitive due to $(1 - \gamma_5)$ contribution



Analysis Walkthrough

- Signal and background indistinguishable
- Generation of SM $\nu\nu\gamma$-sample
- Full Detector simulation
- Weights: $\frac{\sigma_{sig}}{\sigma_{bg}}(E_\gamma, \Theta_\gamma)$
- $\Rightarrow$ Each event obtains signal contribution

Advantage: one sample covers the full parameter space

Outline

New Detector Models and Other Changes

On the way from LDC to ILD

- New models LDC01_06Sc and LDCPrime
- Differing in e.g. Radius
- All major bugs seem to be eliminated
- Central MC production based on Whizard has started

Changes in the Analysis

- Cross section now evaluated with matrix element (in contrast to normalised event histograms)
- Particle Flow: Switch algorithms from Wolf to PandoraPFA
- Review of different calibration methods
- Definition of standard reconstruction

Do the Changes Make Sense?

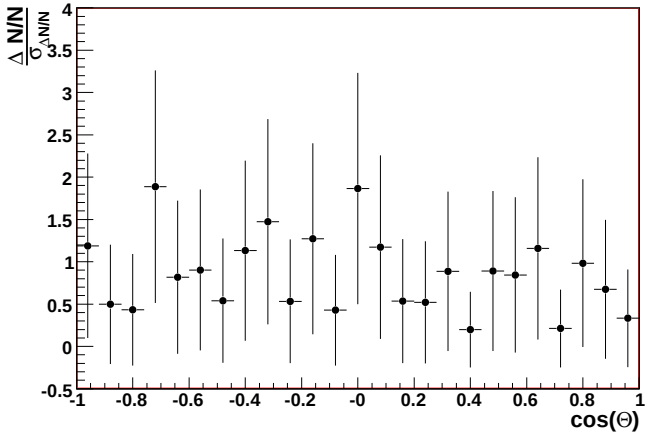
Background and Signal Generation

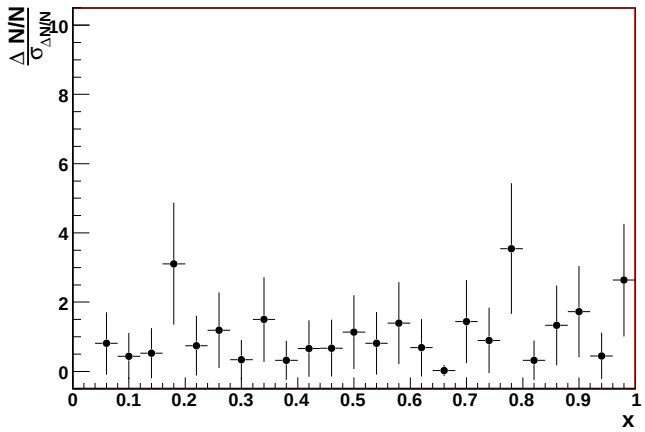
Background

- Generator: Whizard

Signal

- Reweight background according to $\frac{\sigma_{sig}}{\sigma_{bg}}(E_\gamma, \Theta_\gamma)$
- Is σ_{bg} in agreement with Whizards bg prediction?





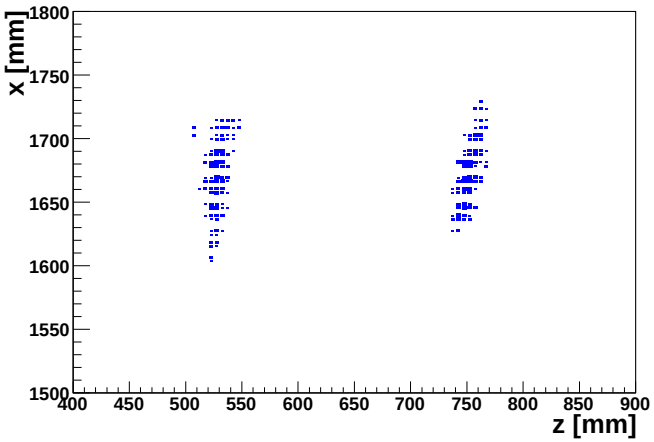
The Calibration Problem

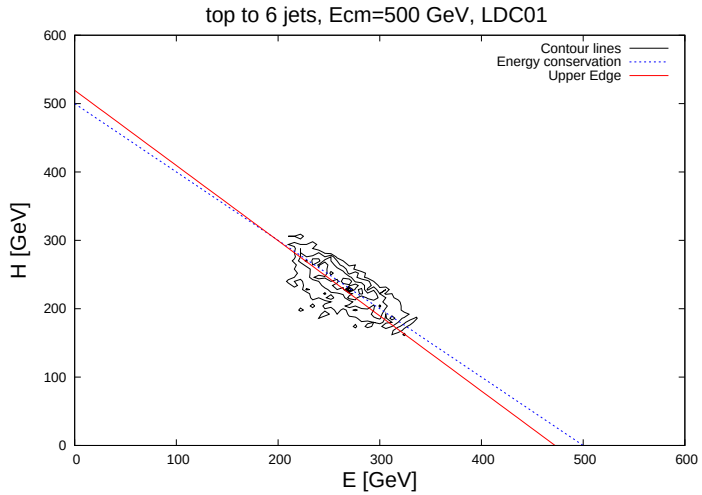
Concerning the electromagnetic and hadronic calorimeters

- Currently we don't have standardized calibration method
- Resulting calibration depends on method and physics used

2 Approaches

- Shoot single particles into calorimeter subsystems (ECAL/HCAL)
- Use full detector and full events of certain types, e.g. $t\bar{t}$

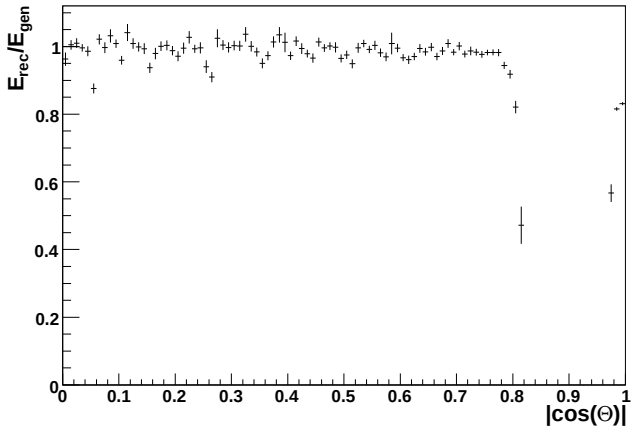




Calibration

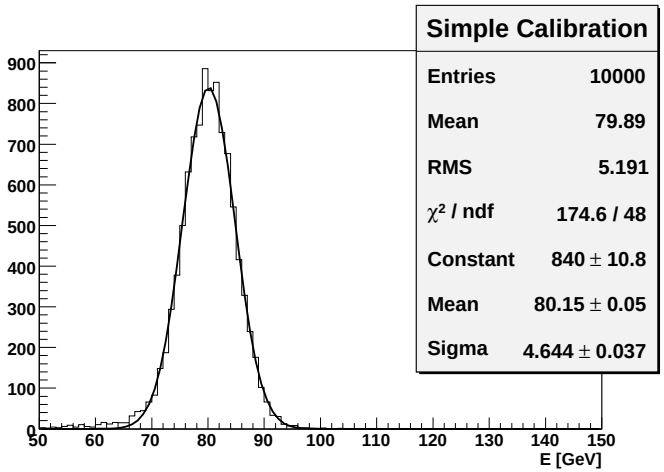
Calibration

- LDC01_06Sc calibrated on em particles
- Single photons for ECAL
- K_L^0 for HCAL
- Seems ok on photons but fails miserably on e.g. the Z :)



What Method to Use?

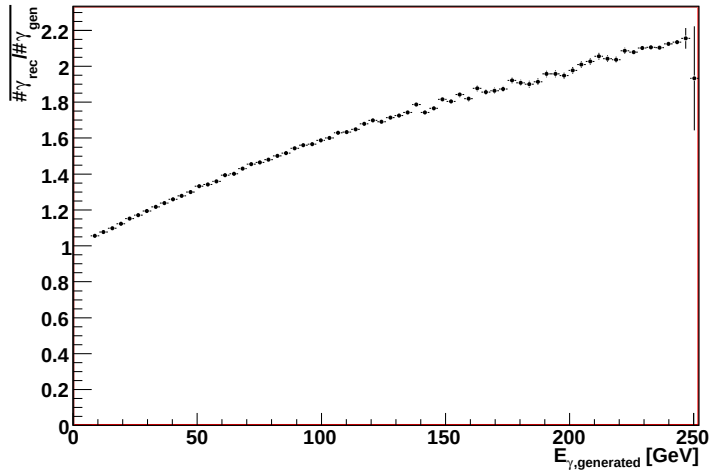
- Single particle calibration is not applicable for complex hadronic events
- Second method overestimates coefficients for ECAL by 20%



Clustering

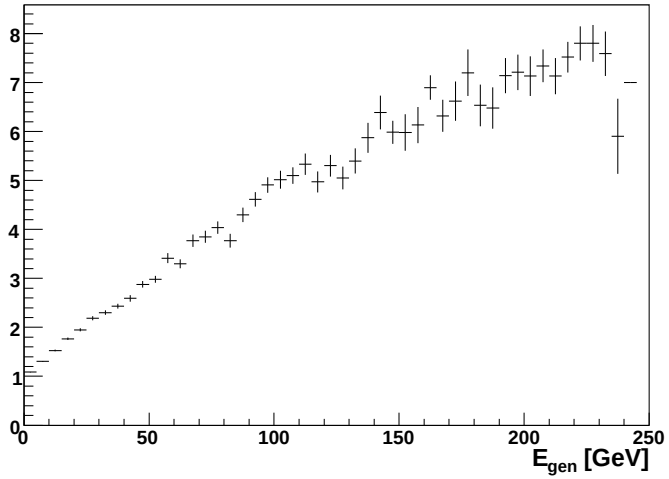
Clustering

- Wolf has tendency to split larger em Clusters in smaller ones
- Pandora shows same behaviour above 50 Gev?



Important note:

The tests on Pandora have been performed just before ECFA
$\longrightarrow$ Has to be investigated

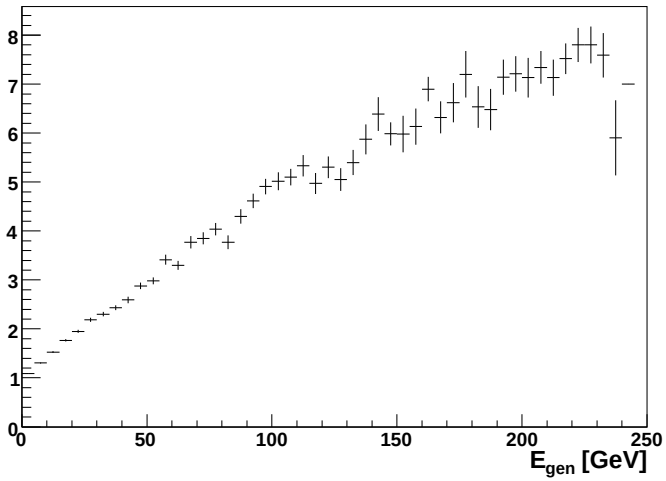


Workaround

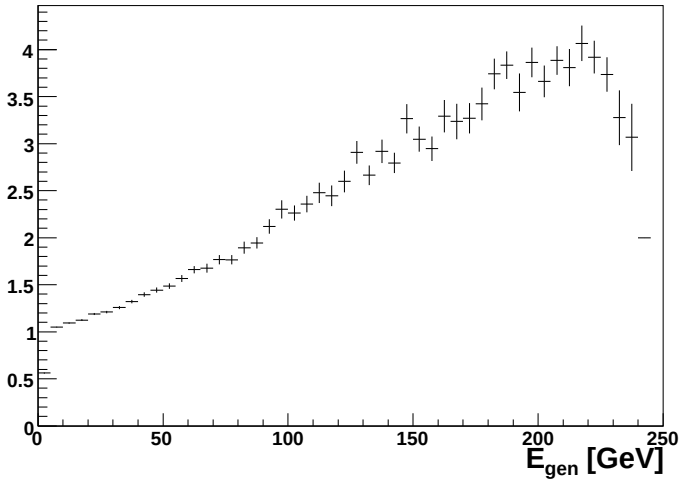
Sum up photon energies

Comparison between LDC01_06Sc and LDCPrime

LDC01_06Sc, no cut in E_γ



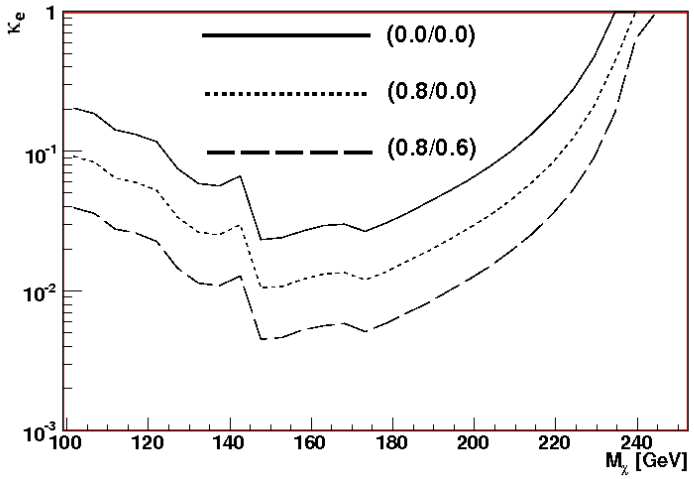
LDCPrime02Sc, 1 GeV cut



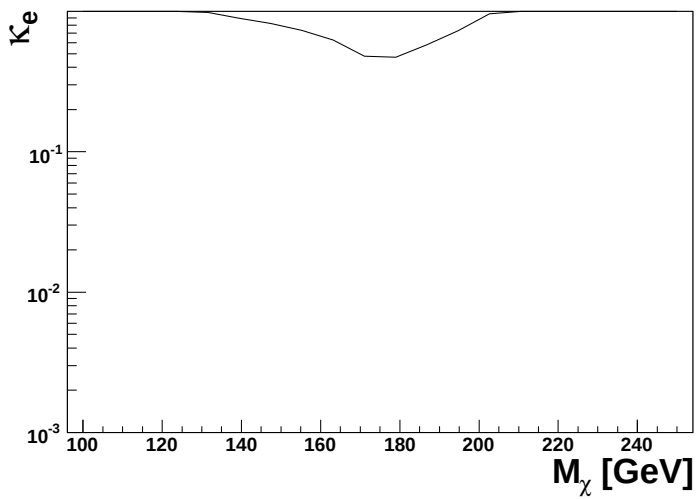
- Cluster splitting seems to be a problem with both new detector models and Pandora
- Again: a little playing around with steering parameters might solve the problem

A Very Preliminary Plot

LCWS '07



ECFA '08



- Much less statistics
- Very preliminary
- Analysis ongoing

Outline

Conclusions and Outlook

Conclusions

- Analysis improved since LCWS 2007
- First results with new software chain
- First results with new detectors
- A lot of changes: Hard/Impossible to disentagle these effects

Outlook

- Investigate SUSY scenarios
- Have a look at other detector models
- Better photon ID needed