Measurement of the Differential Luminosity at 3 TeV CLIC

– Looking at Large Angle Bhabha scattering –

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FCAL Workshop, CERN
November 2012

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The Bhabha sample: BHWide

Input: see previous talk

- GUINEAPIG luminosity files: with and without cross-section weighting
- our model files, with and without cross-section effects

Output: final state particles of Bhabha scattering

- e^+
- e^-
- photons: ISR and FSR cannot be distinguished

Cuts at generation: $7^\circ < \theta_{e^\pm} < 173^\circ$

Effective cross section:

- 10 pb
- About 1 million events in 100 fb^{-1}

We use 3 000 000 data events, and 10 000 000 MC events

Observables used in the fits

3 dimensions fit:

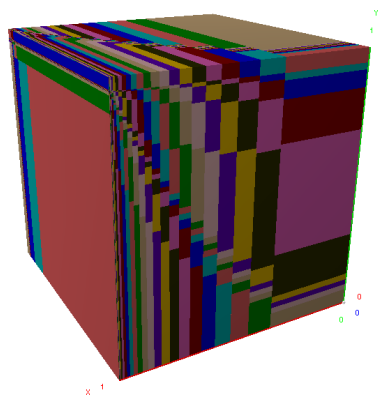
- energy of the final state electron
- energy of the final state positron
- relative center-of-mass (CME) energy defined as

$$\frac{\sqrt{s_{\text{acol}}}}{\sqrt{s_{\text{nom}}}} = \sqrt{\frac{\sin(\theta_1)+\sin(\theta_2)+\sin(\theta_1+\theta_2)}{\sin(\theta_1)+\sin(\theta_2)-\sin(\theta_1+\theta_2)}}$$

One event is defined as $E_{B1}, E_{B2}, E_{e^-}, E_{e^+}, \frac{\sqrt{s_{\text{acol}}}}{\sqrt{s_{\text{nom}}}}$

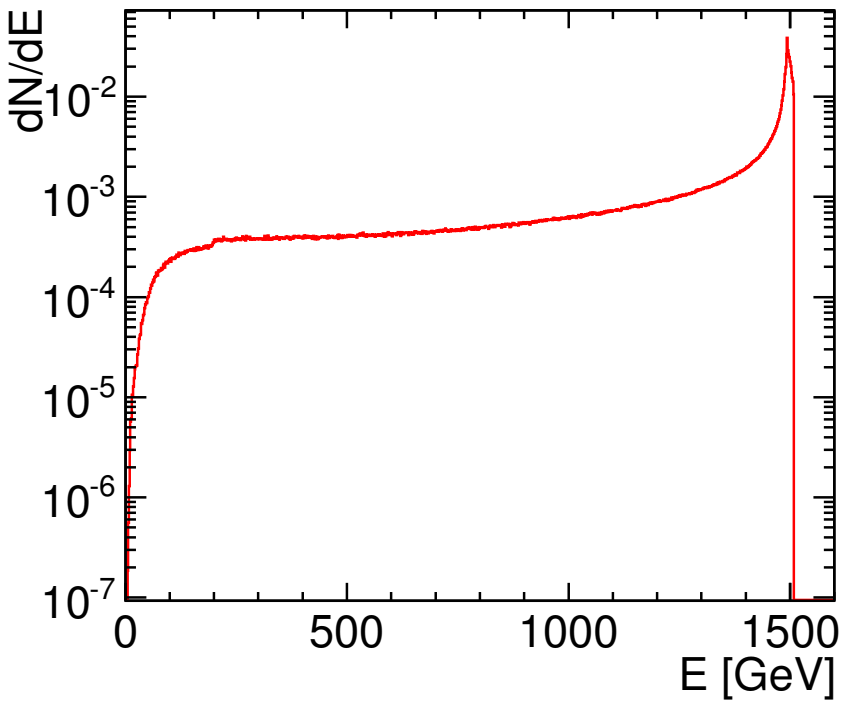
- Use the final state observables to classify the events in bins,
- Use the beam energies to compute the event weights

Equiprobability binning:

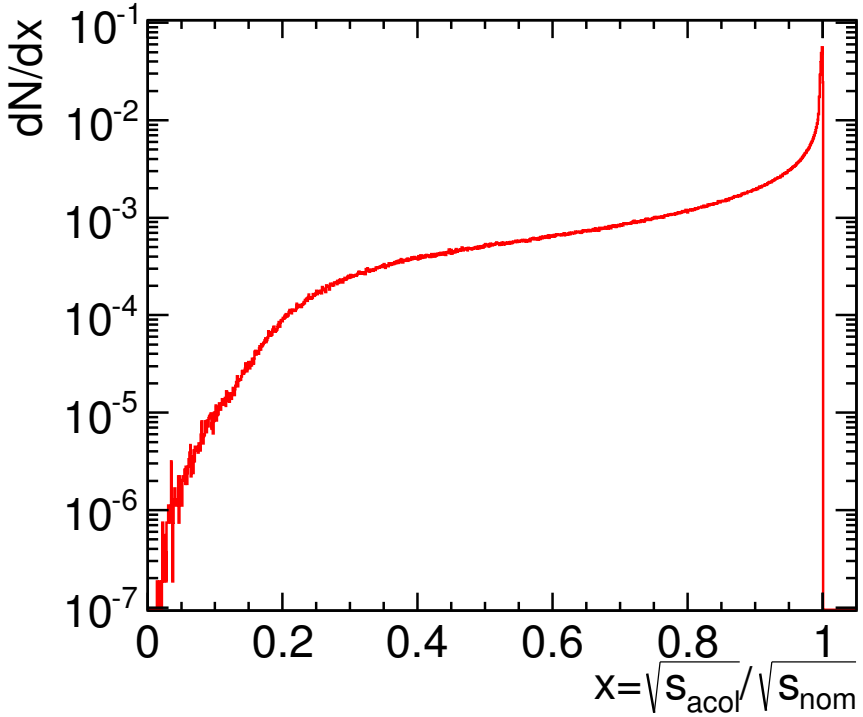


Energy and Relative CME: no detector effects

Energy of the leptons:

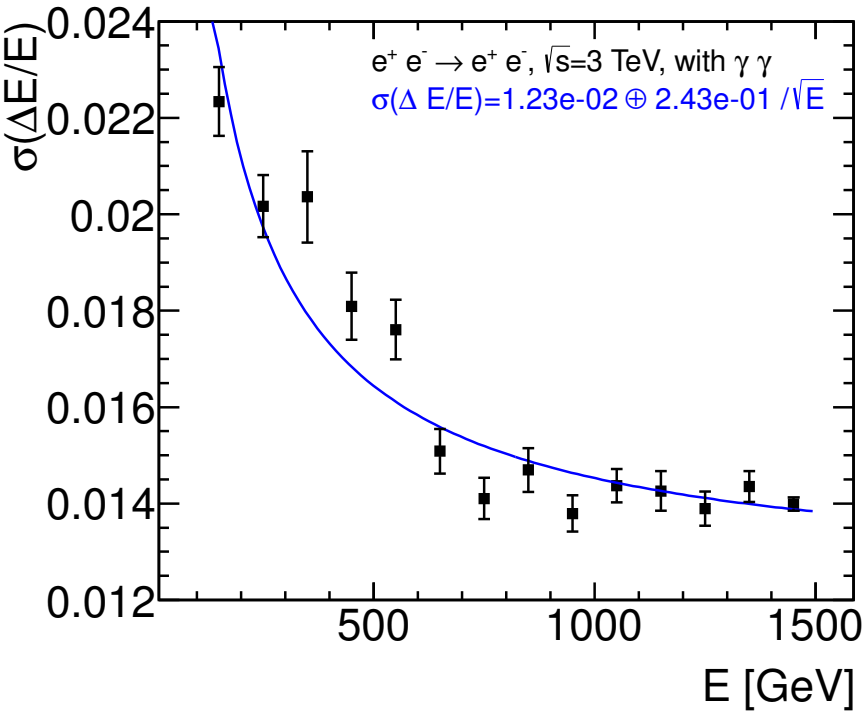


Relative CME:

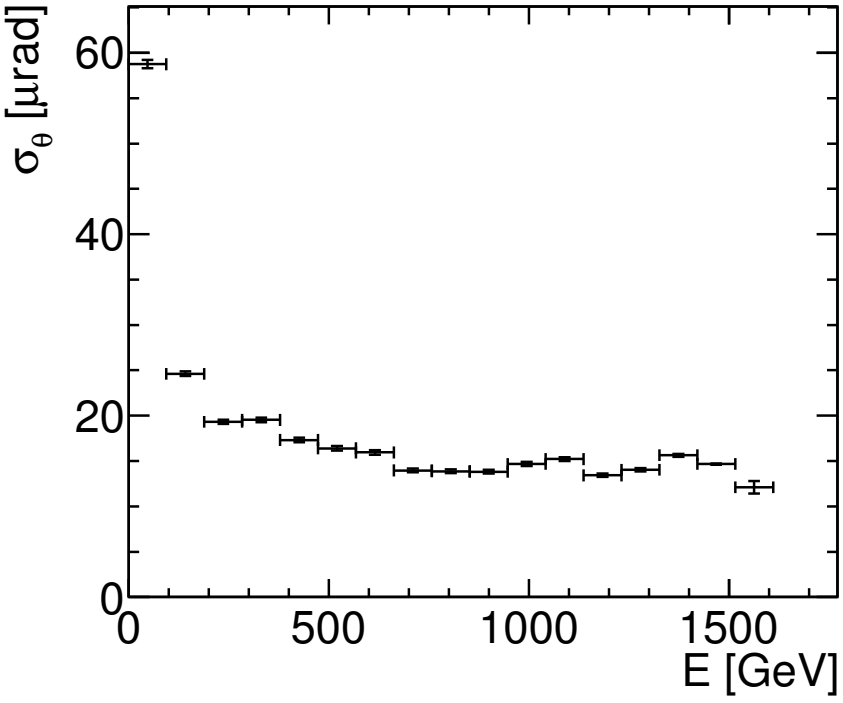


The detector effects

Particle Energy



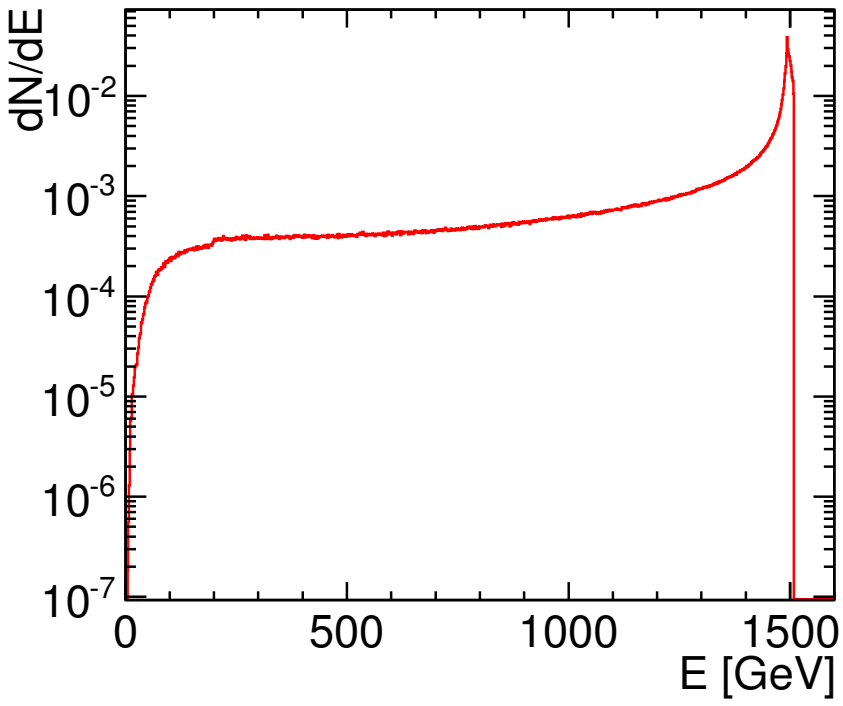
Angular Resolution ($e^{\pm}, \theta \geq 7^{\circ}$)



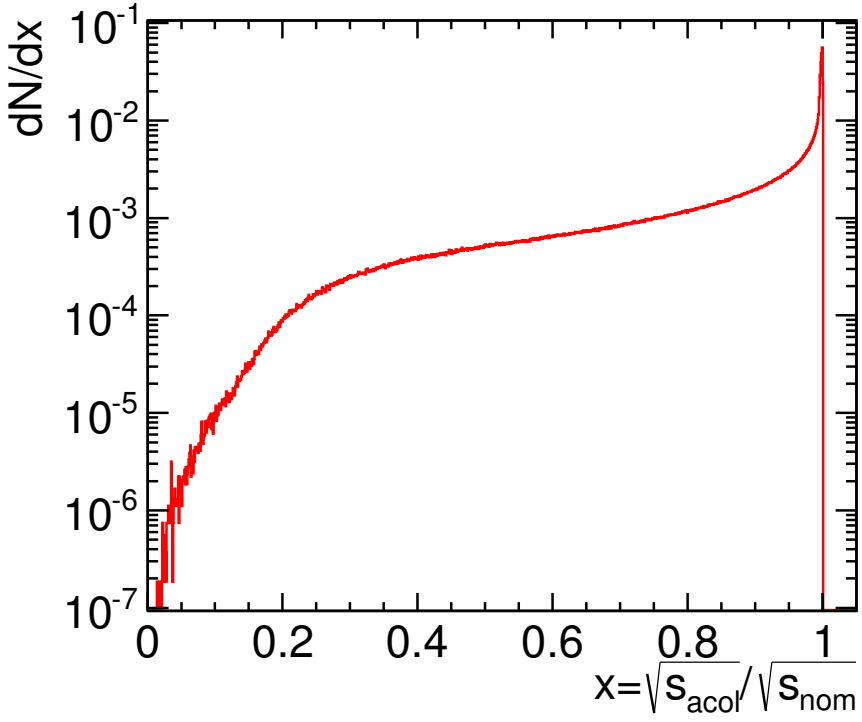
Detector resolutions obtained with full simulation/reconstruction with background overlay, only 100 000 events needed

Smeared observables

Energy of the leptons:



Relative CME:



Very large effect on energy, small on relative CME:

- lower energy precision (higher background),
- high angular precision (low magnetic field effect, straight tracks)

Smeared observables

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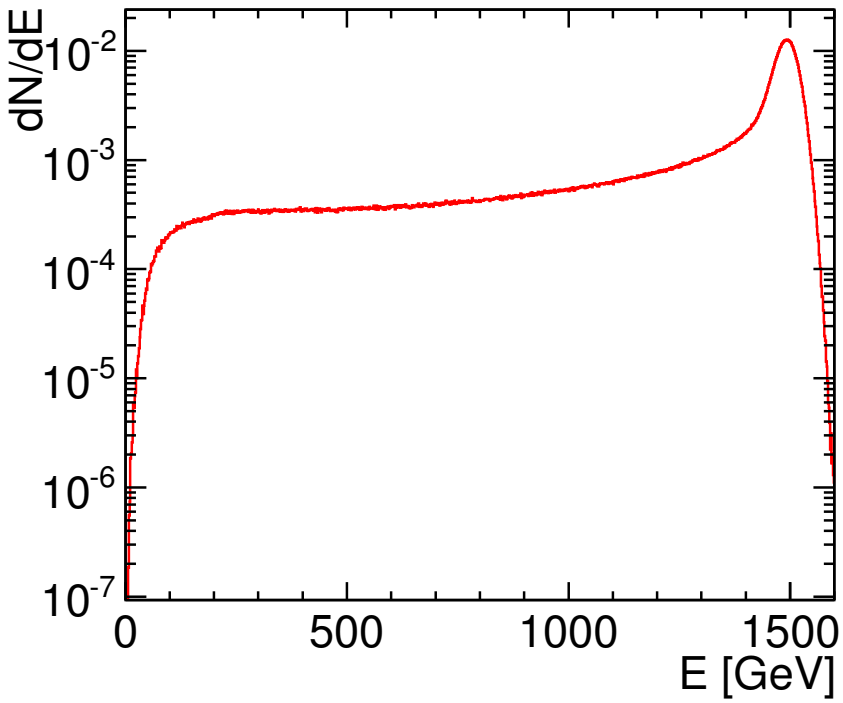
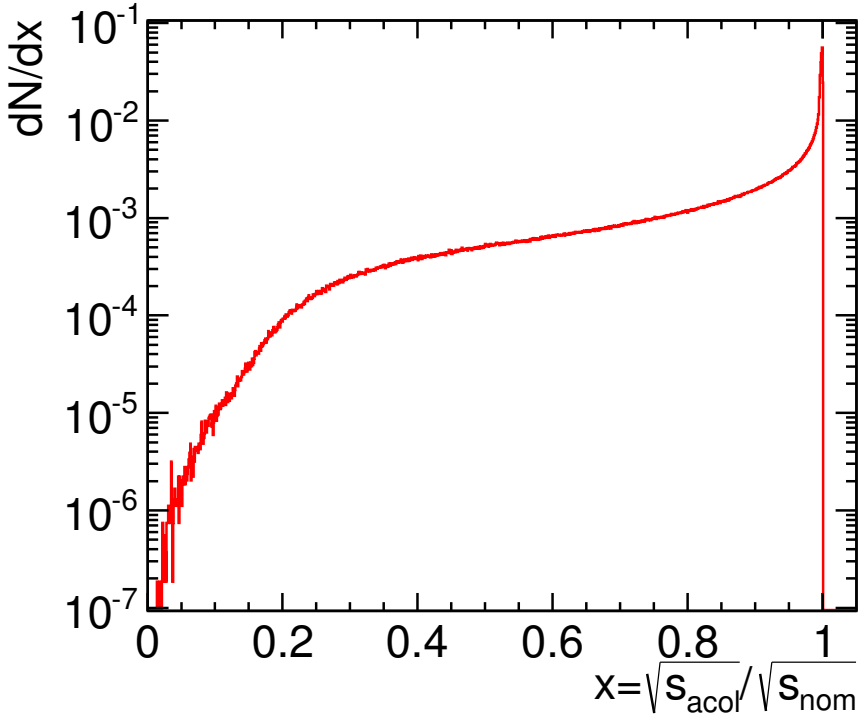


Relative CME:



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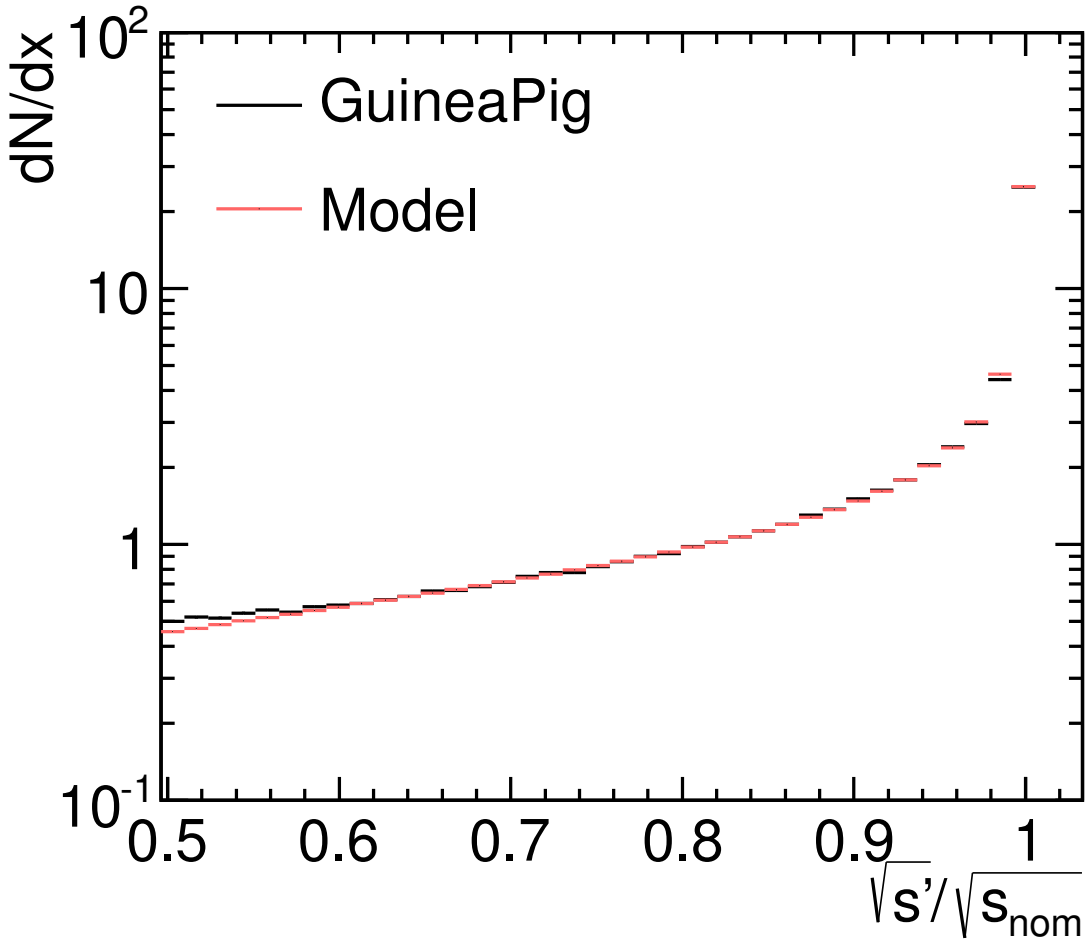
Final fit: all effects

Most realistic sample possible: lumi spectrum, cross-section weighting, ISR, FSR, smearing



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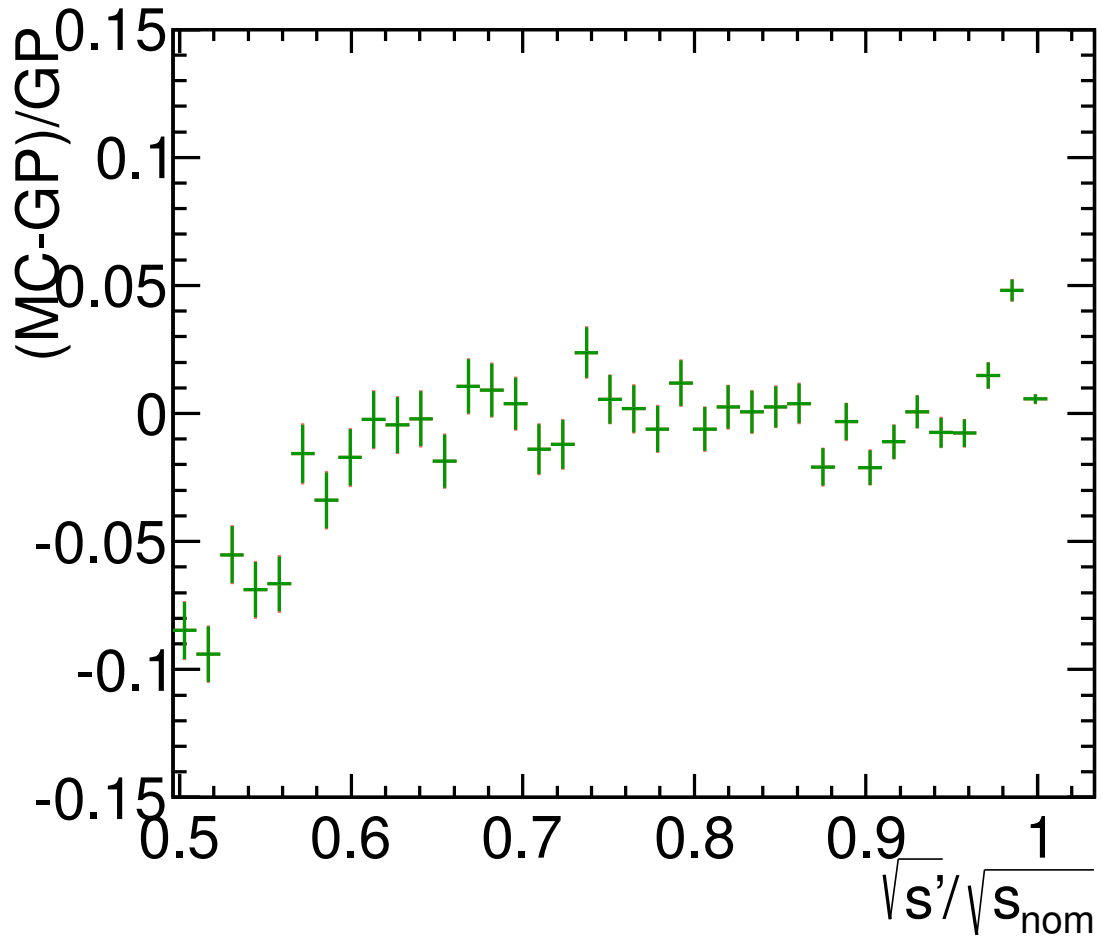

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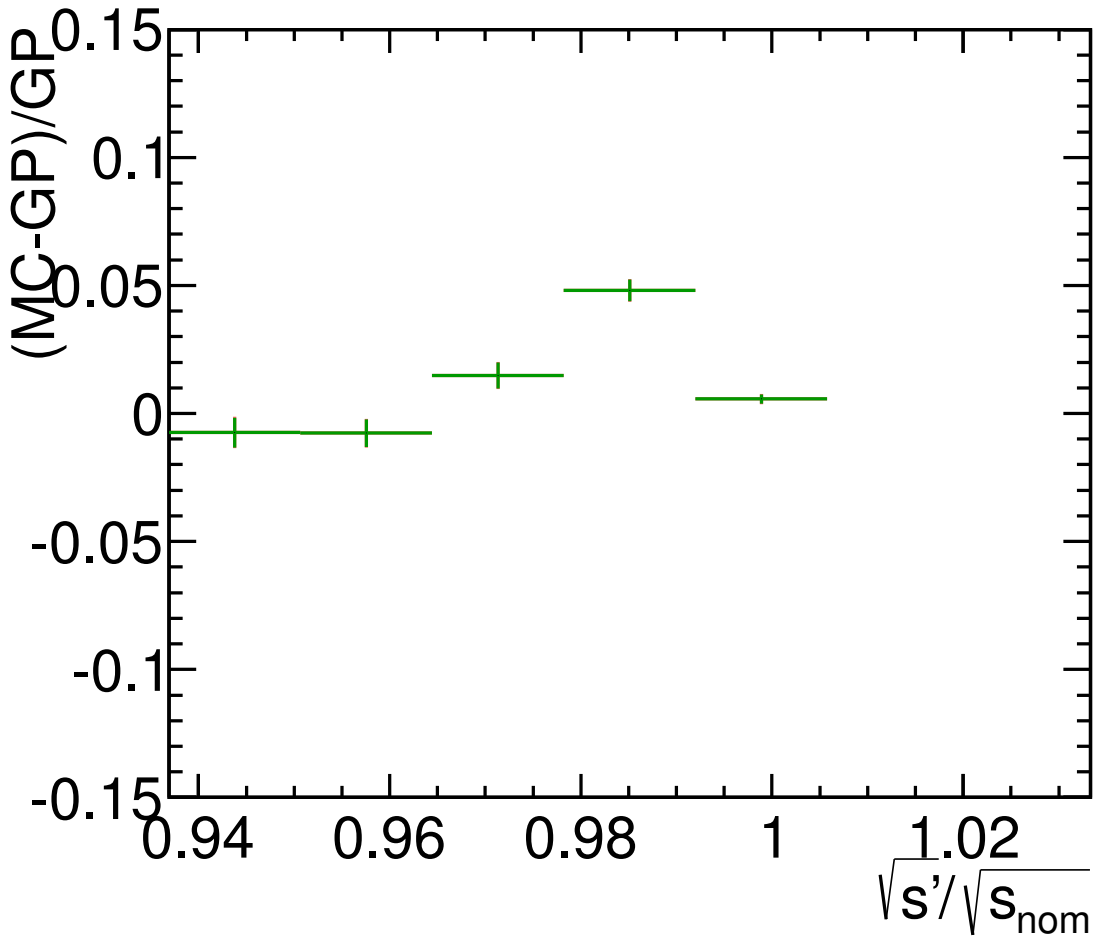


Effect on the $\tilde{\mu}$ and χ mass measurement (I)

(LCD-Note-2011-018)

- $e^+e^- \to \tilde{\mu}^+\tilde{\mu}^- \to \mu^+\mu^-\tilde{\chi}_1^0\tilde{\chi}_1^0$
- Every luminosity spectrum parameter p is measured as $p_i \pm \sigma_{p_i}$
- Error on smuon mass from luminosity:

$$\sigma^2_{m_{\tilde{\mu}}} = \sum_{i,j} \delta_i C_{ij} \delta_j$$

$$\delta_i = m_{+_i} - m_{-_i}$$

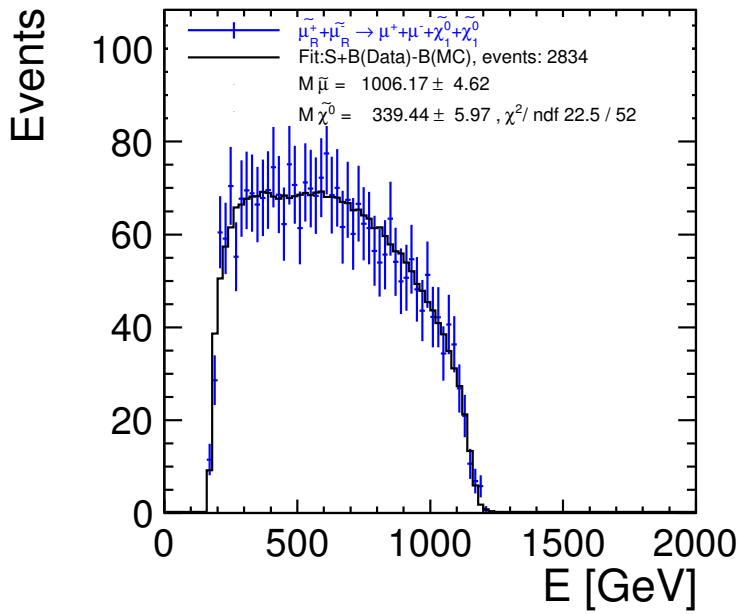
$$m_{+_i} = f\left(\vec{p} + \vec{e}_i \frac{\sigma_{p_i}}{2}\right)$$

$$m_{-_i} = f\left(\vec{p} - \vec{e}_i \frac{\sigma_{p_i}}{2}\right)$$

with the correlation matrix

$$C = \begin{pmatrix} 1 & -0.6 & \dots & -0.02 \\ -0.6 & 1 & \dots & 0.04 \\ \dots & \dots & \dots & \dots \\ -0.02 & 0.04 & \dots & 1 \end{pmatrix}$$

and f is determined by J.J. Blaising.



Effect on the $\widetilde{\mu}$ and χ mass measurement (II)

(LCD-Note-2011-018)

Results:

- Using the GUINEAPIG spectrum:

  $m_{\widetilde{\mu}} = (1006.2 \pm 4.6)$ GeV, $m_{\chi} = (339.4 \pm 6.0)$ GeV

  Errors are statistical only

- Using our measured spectrum:

  $m_{\widetilde{\mu}} = (1005.0 \pm 2.0)$ GeV, $m_{\chi} = (339.1 \pm 1.8)$ GeV

  Errors are the systematic errors due to the statistical errors on the measured spectrum

Conclusion:

- luminosity spectrum measurement has no sensible effect on $\widetilde{\mu}/\chi$ mass measurements,
- need (?) dedicated analysis

Conclusion and Prospects

Conclusions:

- The reconstruction of spectrum is possible from measured observables
- The error from the reconstruction of the spectrum for CLIC-3 TeV-benchmark smuon mass measurement is significantly smaller than the statistical error
- Depending on the analysis a more detailed model for the spectrum is needed, our MODEL can be extended there is room for improvement

Prospects:

- Apply for other benchmark analysis: $t\bar{t}$ at 350GeV?
- Study systematic uncertainty: beam offsets, range of beam energy spread, etc.
- Write/publish note

Backup Slides

Backup slides