On reconstruction of χ_{c1} and χ_{c2} at SPD

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Introduction and motivation

1. The inclusive χc states production properties are known much worse the ones of J/ψ.
2. These properties are important for
   a. testing and validation of charmonia production model,
   b. probing spin-dependent proton structure (TMD factorization for J/ψ may be broken).
3. The SPD open spectrometer might provide unique measurements of these states.

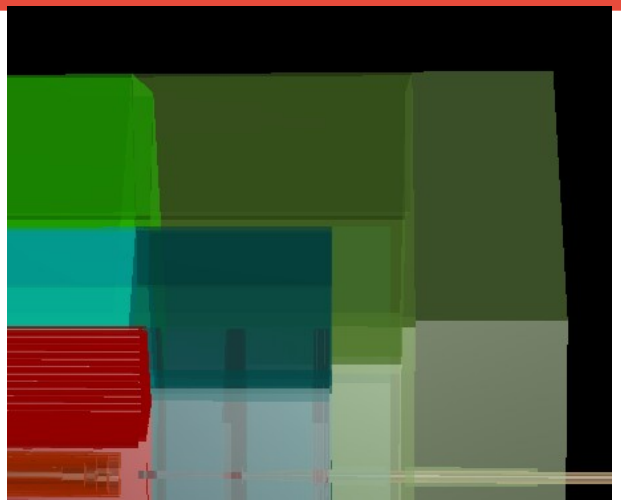
On measurements are experimental challenges:

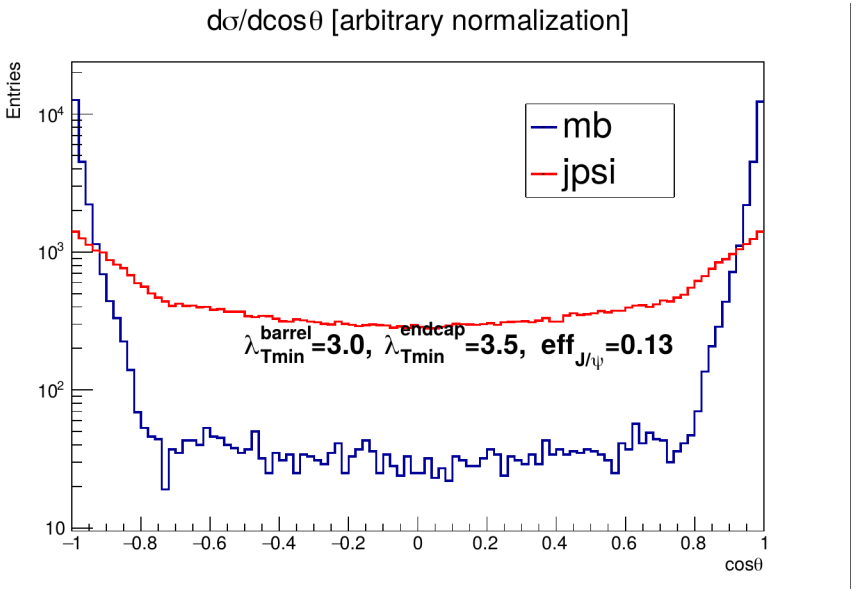
1. X_{c1} and X_{c2} have a large Br(Xc → γJ/ψ) and will be reconstructed from Xc → γJ/ψ, J/ψ → $\mu^+\mu^-$.
2. The mass difference between χc1 and χc1 is ~50 MeV making their separation or event measurement of relative fractions experimentally challenging.
3. Based on previous studies, a huge background level can be expected.

On inclusive J/ψ selection (from the prev. talk)

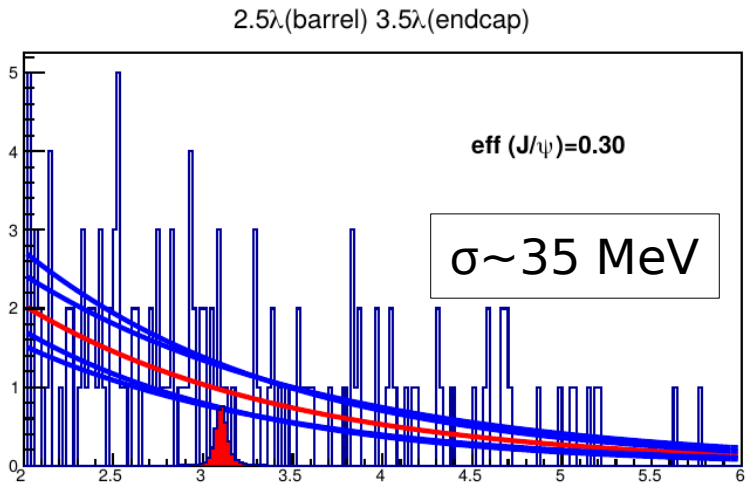
- Track is charged
- Transverse distance in RS (in λ)
  - $n_{\lambda T,barrel} > n_{\lambda T,barrel_min}$ or
  - $n_{\lambda T,endcap} > n_{\lambda T,endcap_min}$ or
  - $(n_{\lambda T,barrel} + n_{\lambda T,endcap}) > (n_{\lambda T,barrel_min} + n_{\lambda T,endcap_min})/2.$
- Track originates from the primary interaction vertex or the same holds for its mother particle (here only pion).
- $|\cos\theta| < 0.9$

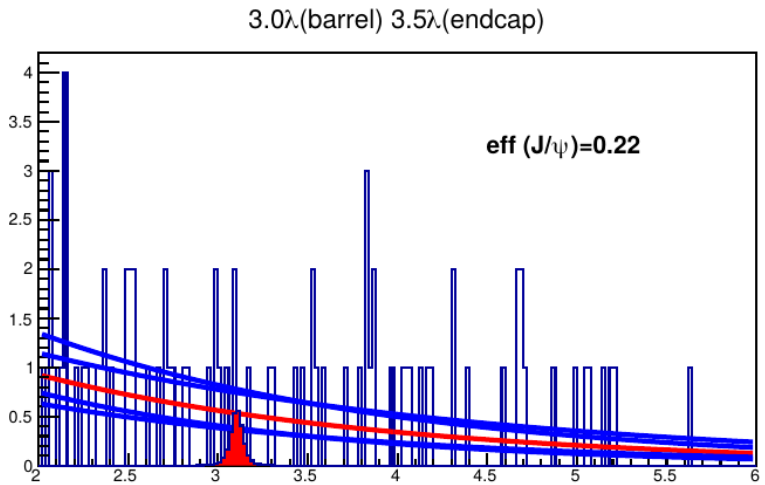
The realistic performance of RS in simulation is crucial to proceed!

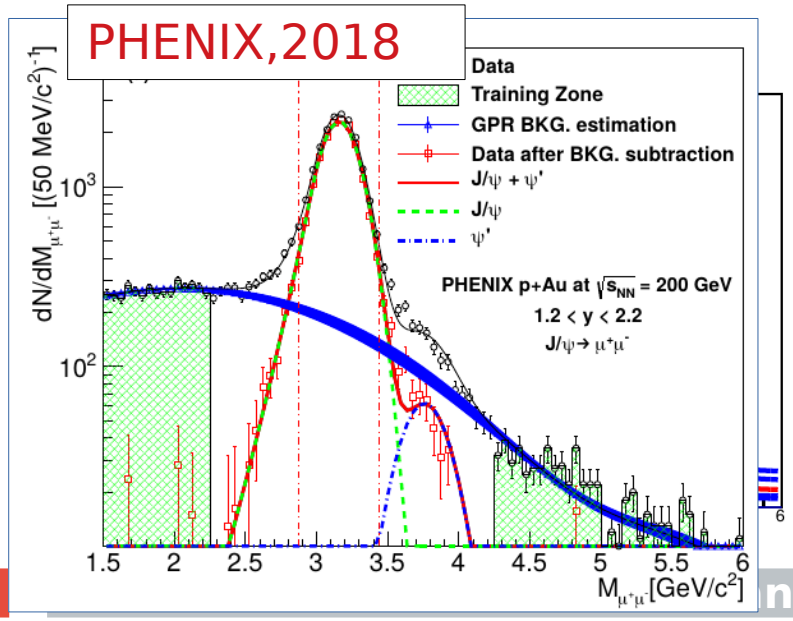


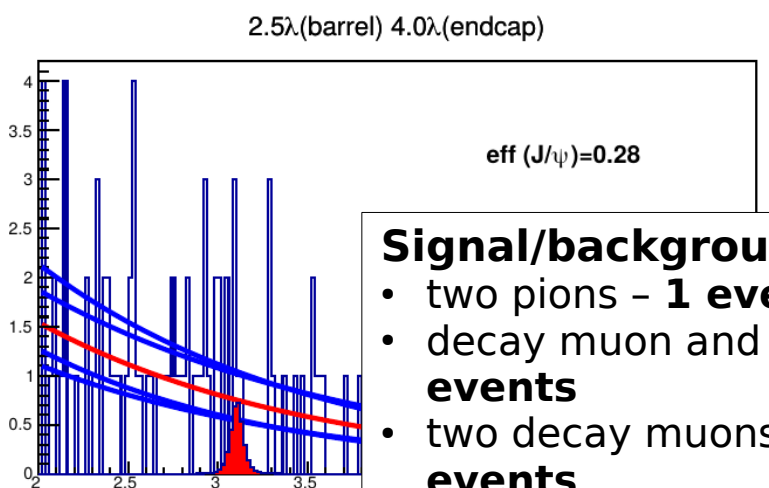


Dimuon spectrum (from the prev. talk)







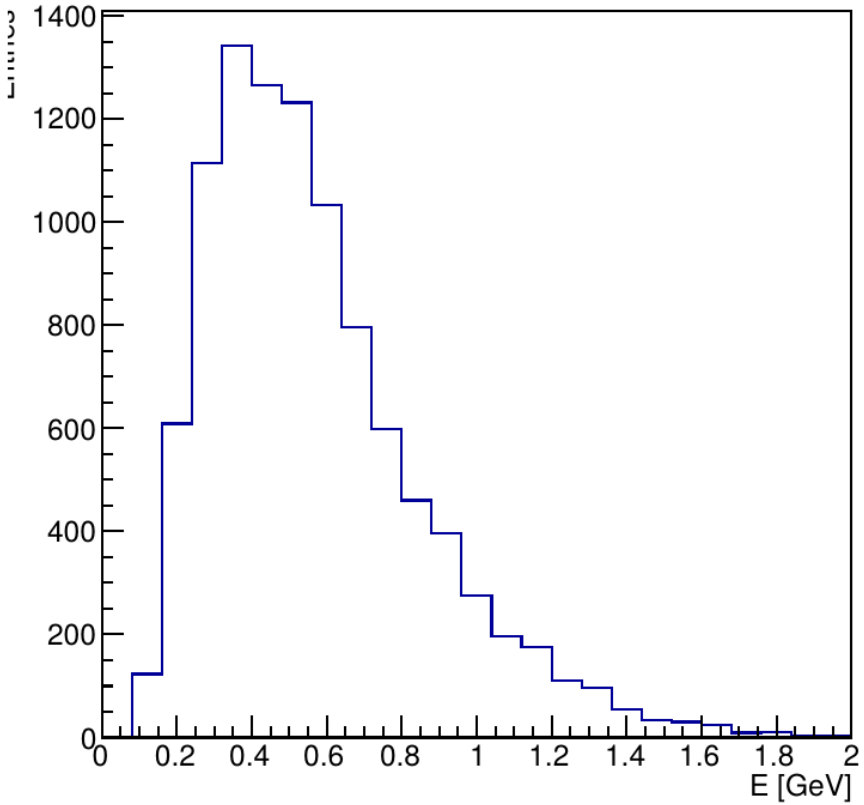


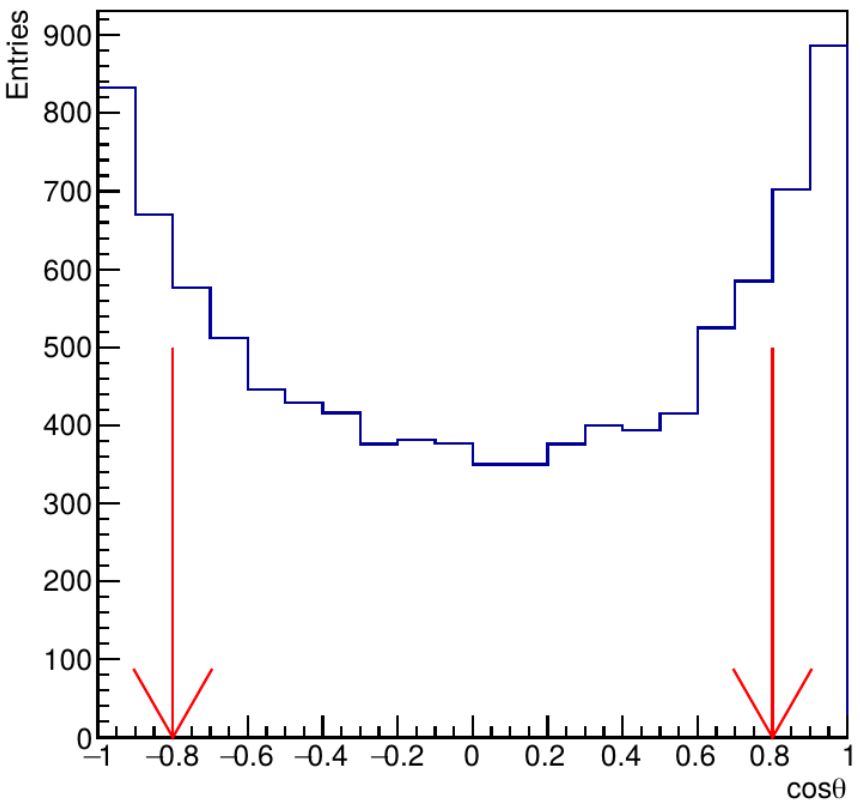
Signal/background ~1:

- two pions – **1 event**
- decay muon and pion – **33 events**
- two decay muons – **76 events**

X_{c1}: photon kinematics

Pythia8, default configuration





Arrows mark the endcap region.

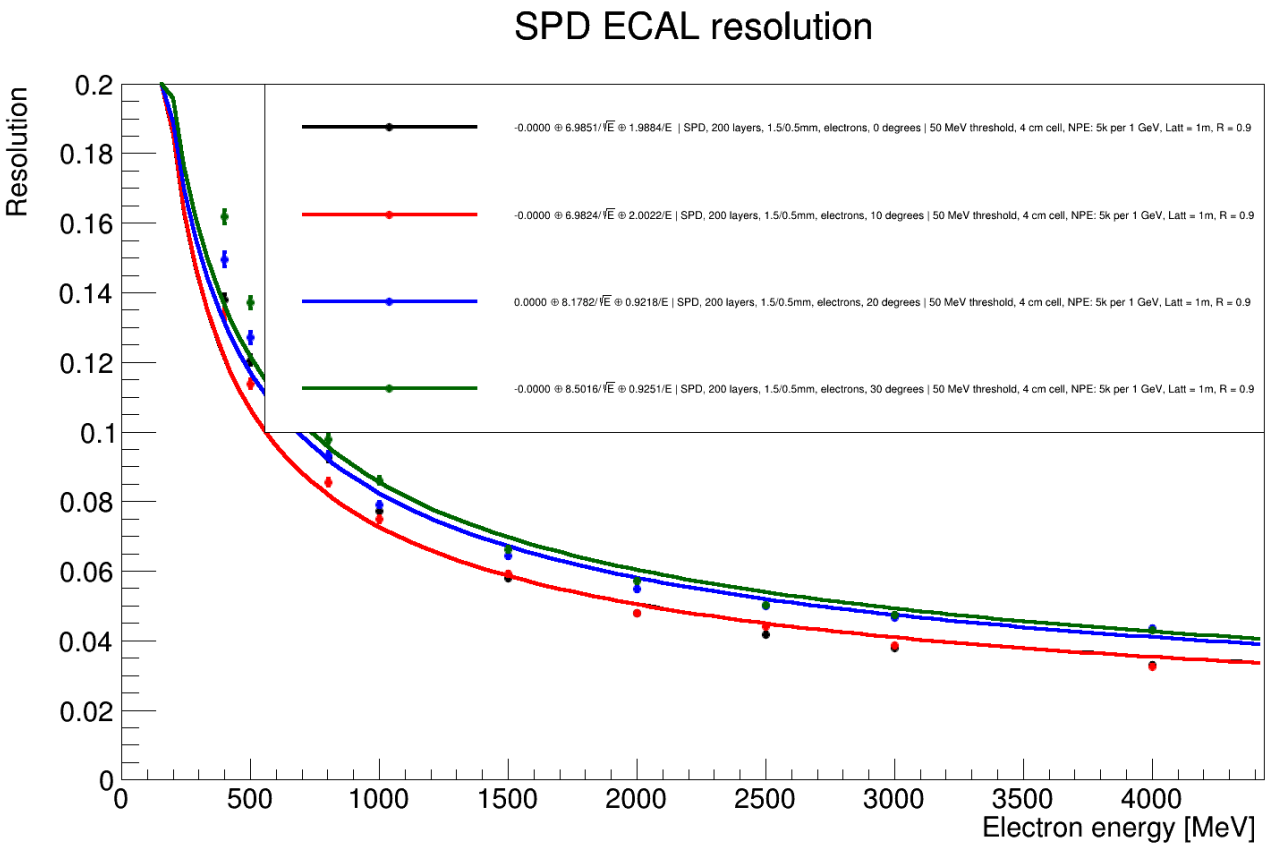
Ecal resolution simulation

Only energy resolution is considered.

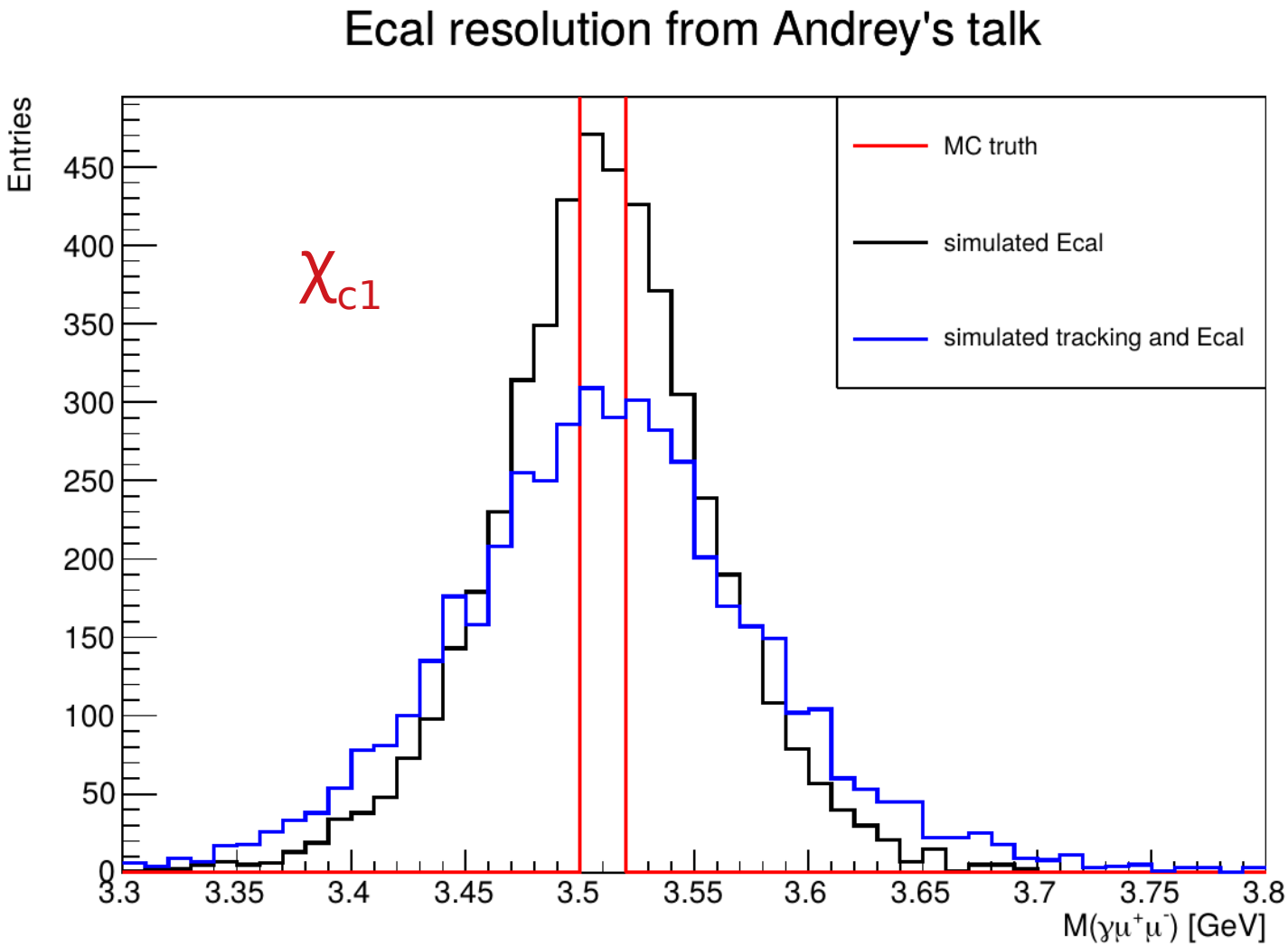
1. From Andrey Maltsev estimates (right)

2. From CDR: 5%/√E

3. CsI: 2.5%/√E



$\mu^+\mu^-\gamma$ invariant mass spectrum from χ_c decays



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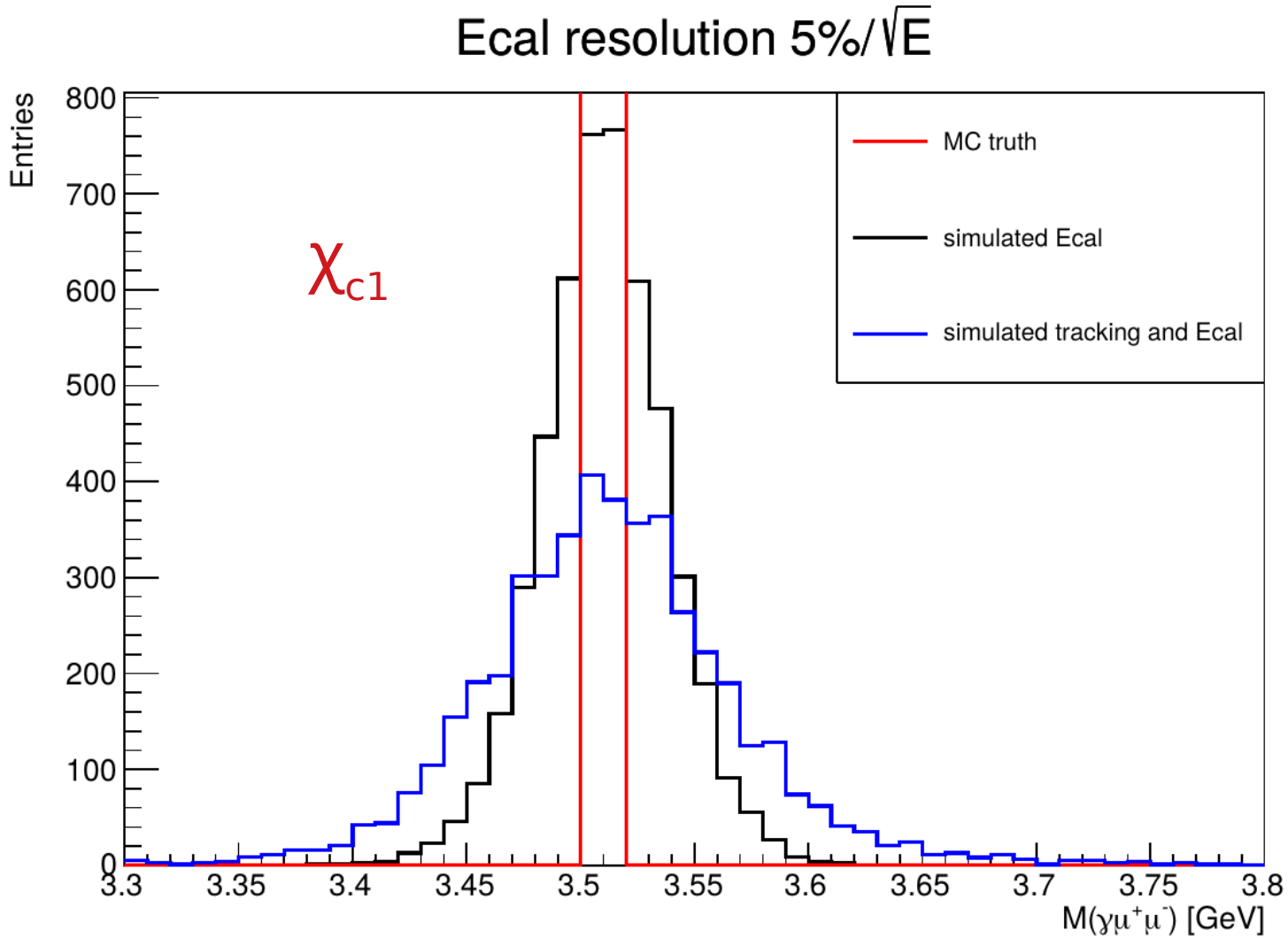

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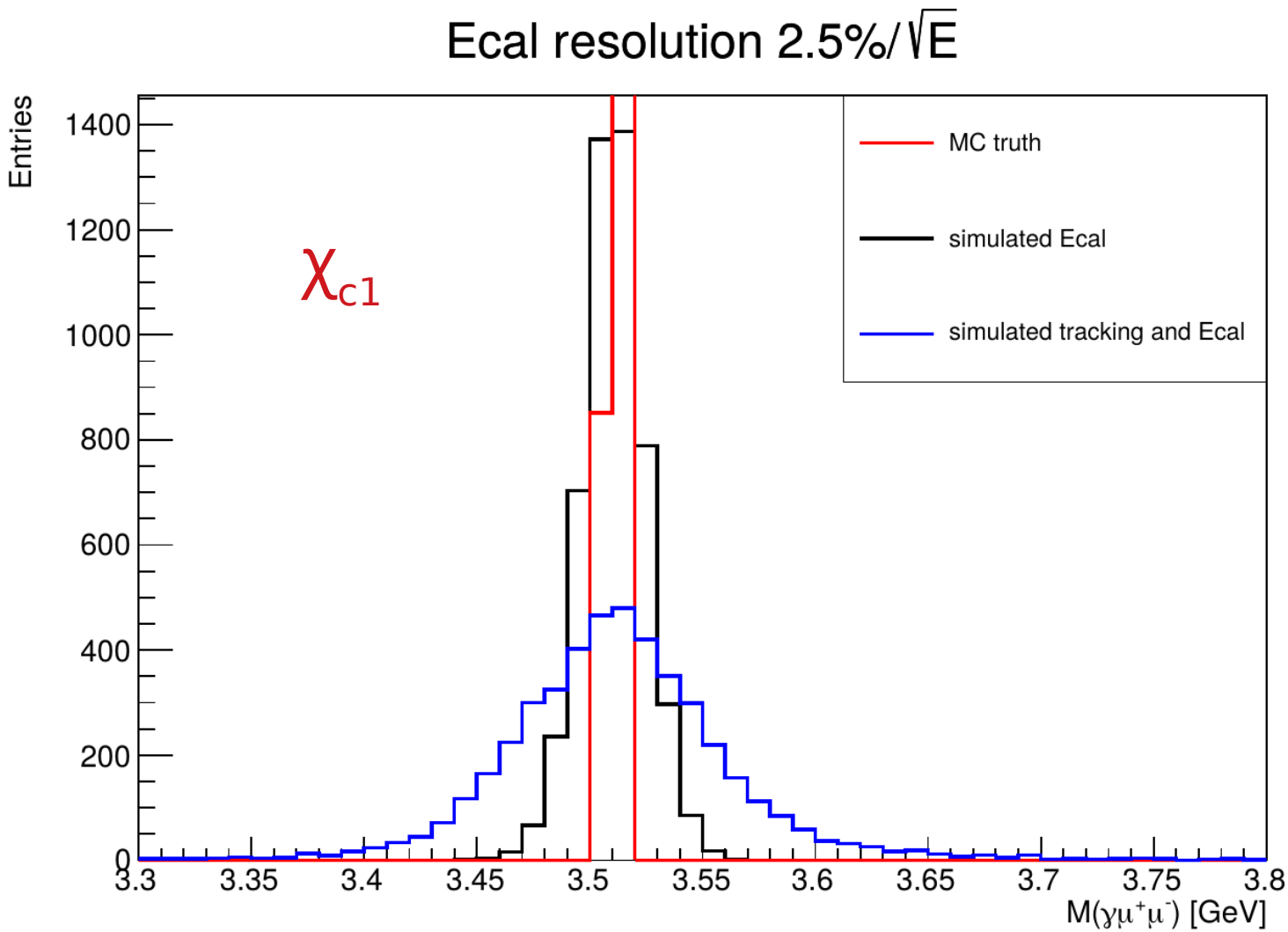
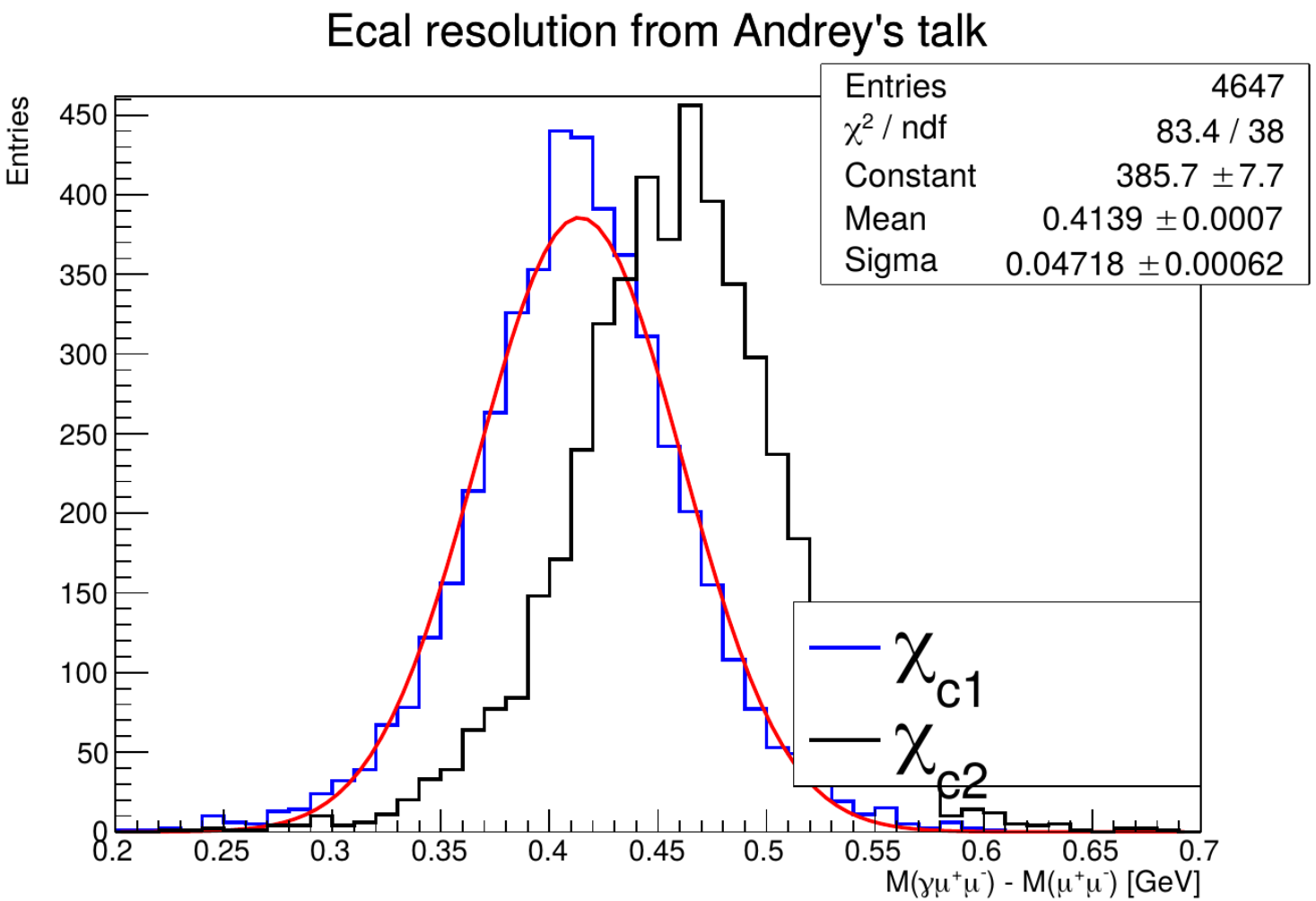


It is possible to mostly cancel tracking via using strong correlation in smearing of $M(\mu^+\mu^-\gamma)$ and $M(\mu^+\mu^-)$

$M(\mu^+\mu^-\gamma) - M(\mu^+\mu^-)$



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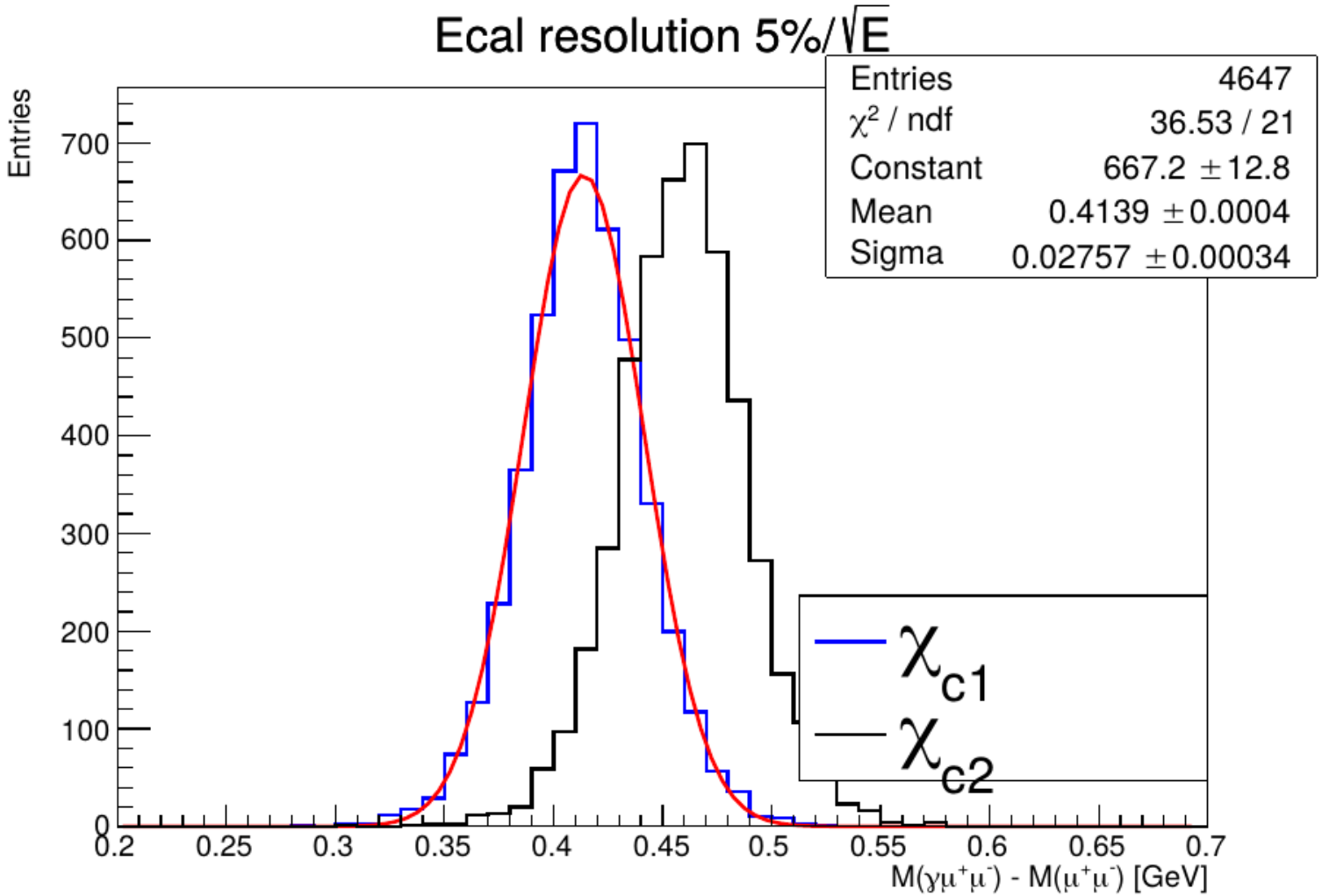

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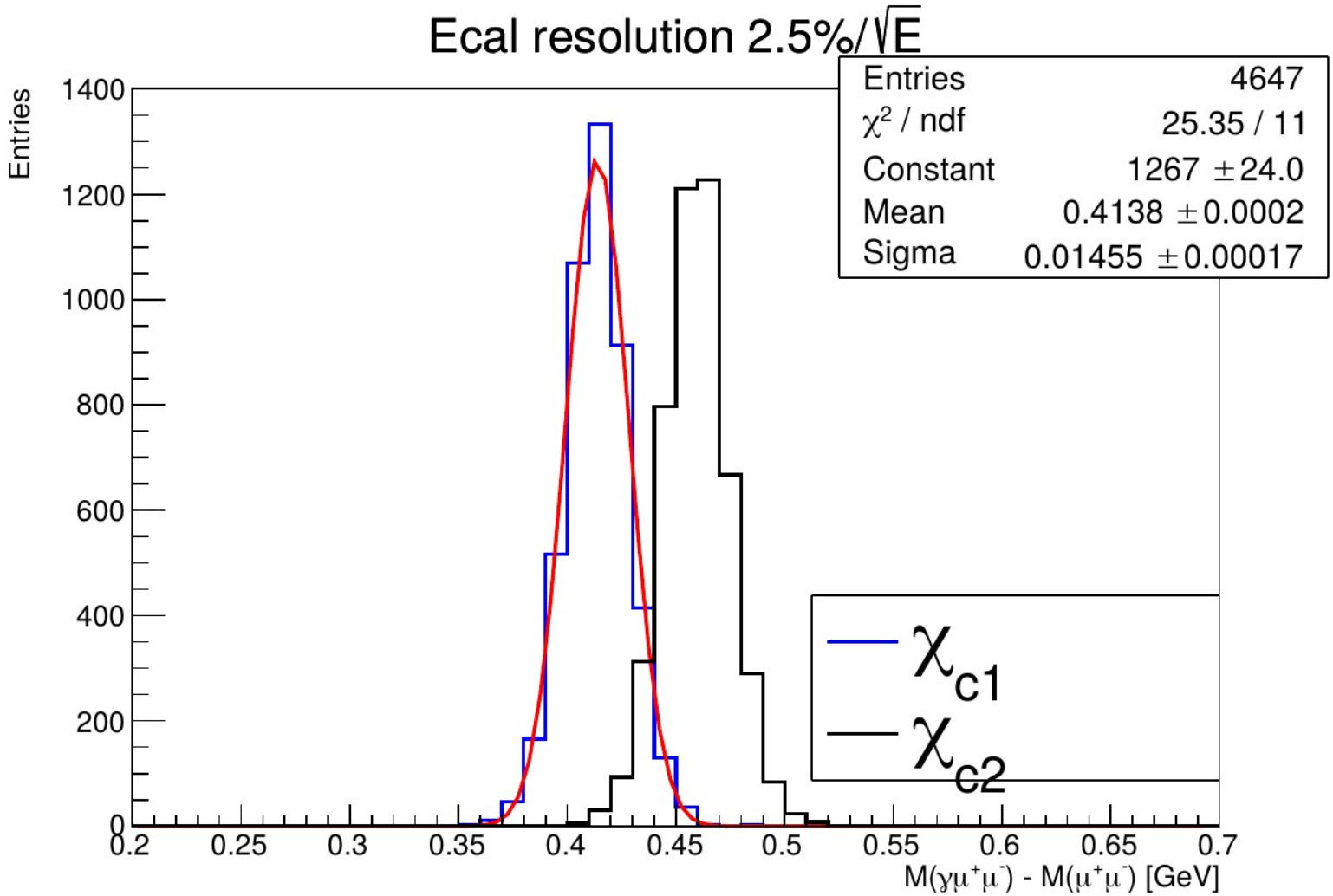
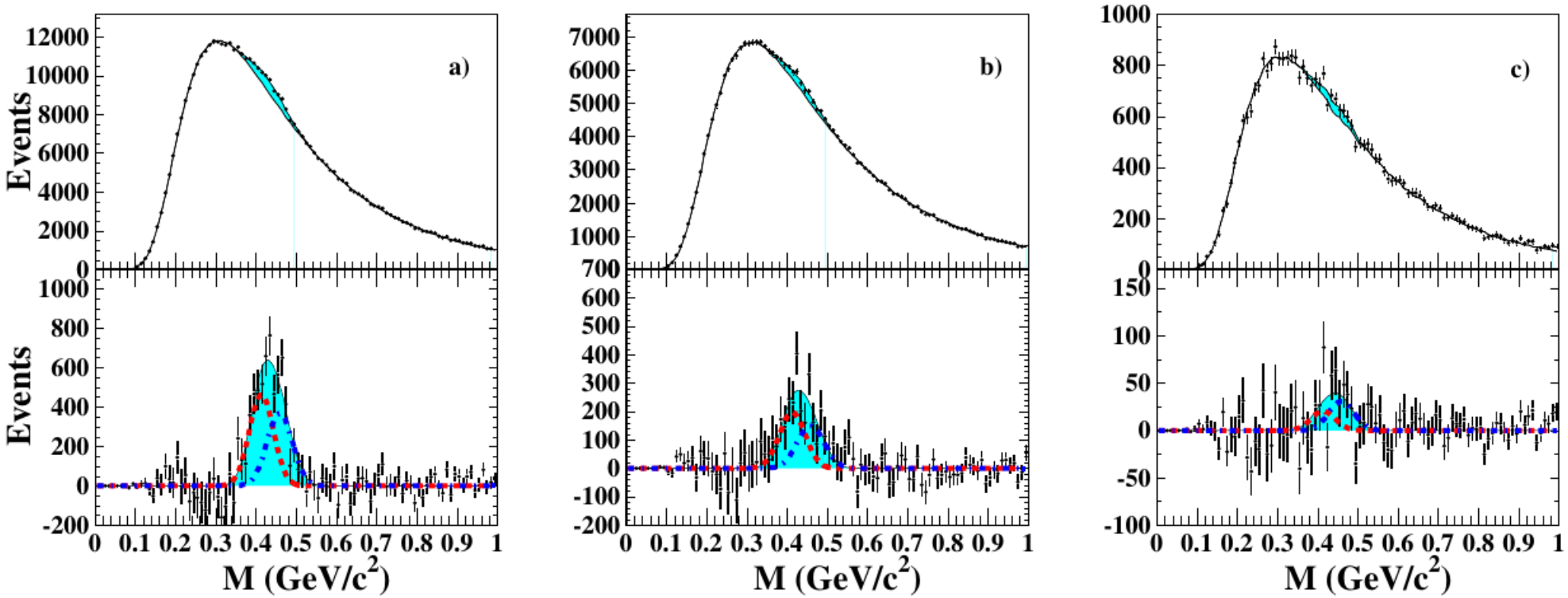


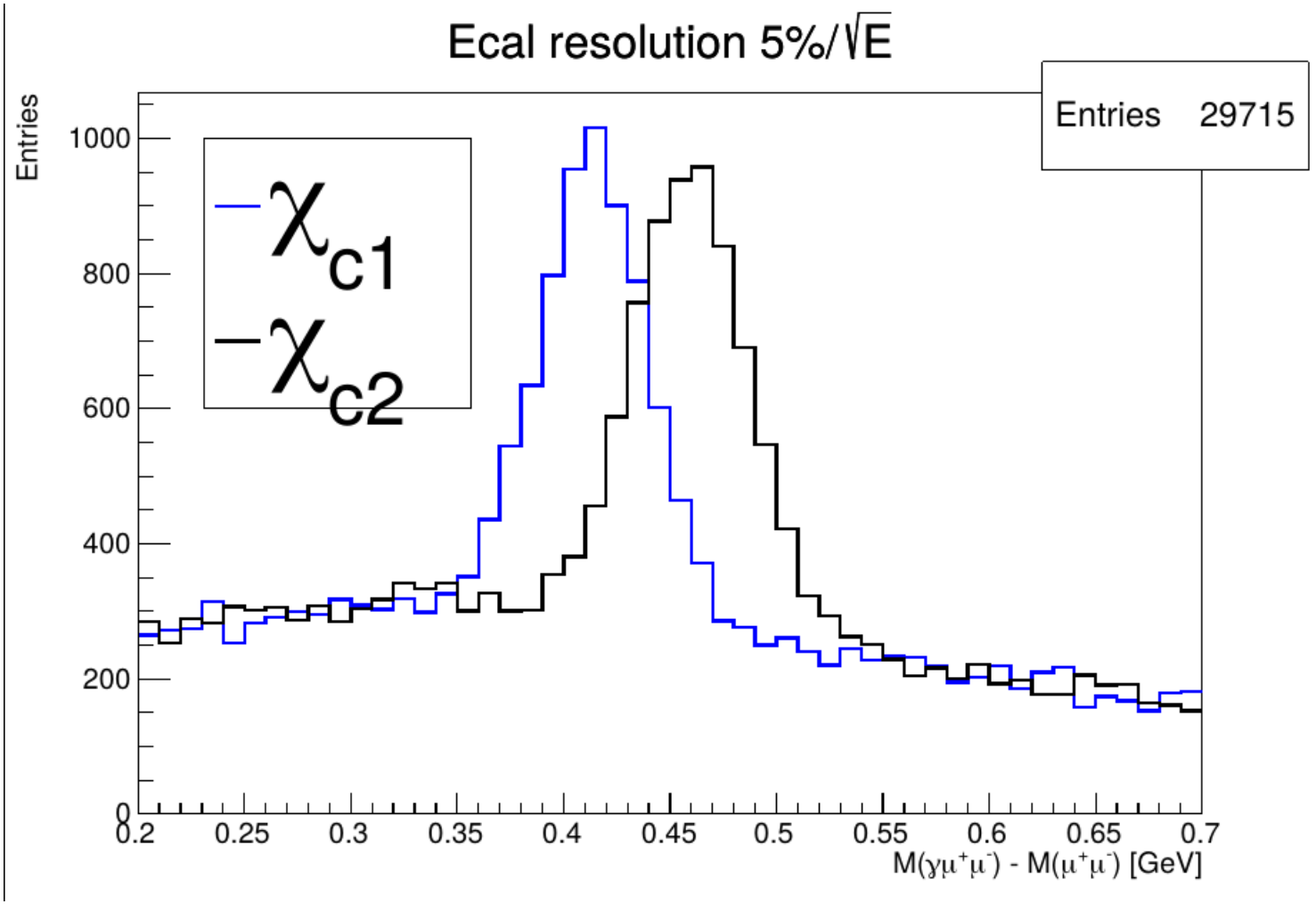
HERA-B

Phys.Rev.D79:012001,2009



$\sigma_{\chi c1}$~30 MeV

Photon combinatorial bg. for signal events



Summary

1. For the Ecal resolution of sampling calorimeter studied by Andrey Maltsev the χ_{c1} and χ_{c2} fractions may not be determined. The resolution of $5\%\sqrt{E}$ is close to the minimum requirement.

2. The CsI calorimeter would be a great option, but if installed only in endcaps, the acceptance will be quite low.

3. The estimation of background levels (and following studies) crucially depends on performance of RS. We may have a better signal to background ration than shown here.

4. The improvement momentum resolution must be considered, as we currently use weak magnetic fields.