Update on Benchmarking

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DBD Benchmarking Current Status I

- DBD Benchmark Event Generation
  - WW & 4-fermion generation completed with old 1 TeV machine parameter set (may have to redo if gluon propagators not disabled in WHIZARD -see next page)
  - vvH signal generation completed with old 1 TeV machine parameter set
  - ttH signal and background generation completed with old 1 TeV machine parameter set
  - Berggren, Miyamoto and I decided we will generate a little bit of everything for 2-4-6 fermion SM background - just as we did for LOI . Generate additional SM background as needed with restricted phase space
  - New event generation features of flavor sums and off-diagonal CKM Wff' vertices successfully tested in CLIC event generation
  - Mini-jet events from two-photon interactions will be generated separately -- they slipped through the cracks in LOI generation.
  - I will begin generating the lumi_linker files this week for the recent straw man 1 TeV Machine Parameter Set

DBD Benchmarking Current Status II

- WW Benchmark
  - Ron Cassell has been looking at W/Z mass separation using 240,000 e+e- → uddu events processed through sim+reco by Norman Graf using the sidloi3 detector. The first 20,000 events were generated including gluon propagators (e.g. e+e-→uu with gluon splitting to dd). This is the default setup for the version 1.95 of WHIZARD we intend to use for the DBD, but different from any other e+e- generation including LEP2 and ILC LOI. After discussions with Mike Peskin we decided we will turn off gluon propagtors in WHIZARD and leave gluon splitting to PYTHIA QCD shower algorithm for all event generation (not just WW).
  - Ron is currently developing code to utilize beam energy-momentum constraints to improve W/Z mass separation
- ttH Benchmark
  - Jan Strube and Philipp Roloff volunteered to work on the SiD ttH DBD benchmark. Philipp is a CERN postdoc who has been working on the CLIC Chargino/Neutralino Benchmark.
- vvH Benchmark
  - No work yet beyond event generation. However, Marcel Stanitzki is interested in doing this analysis for the DBD. In addition I have in hand a complete FastMC analysis of this process at E_{cm}=1 TeV This analysis was a contribution to the Les Houches 2003 proceedings. It is interesting to note that the WHIZARD based event generation system used for the LOI and now the DBD can be traced back to this analysis.

Slides from WW benchmark analysis presented by Ron Cassell at PFA meeting Aug 4

Procedure

- Use the matched jets to find the errors in the 16 variables. (E,β,Θ,ϕ for each jet)
- Not enough events for meaningful correlations in the covariance matrix, use diagonal for now.
- Constrain $\Sigma E = 1000$, $\Sigma Px = \Sigma Py = \Sigma Pz = 0$.
- Motivation: Tim's fast MC study of ZH at 350 GeV

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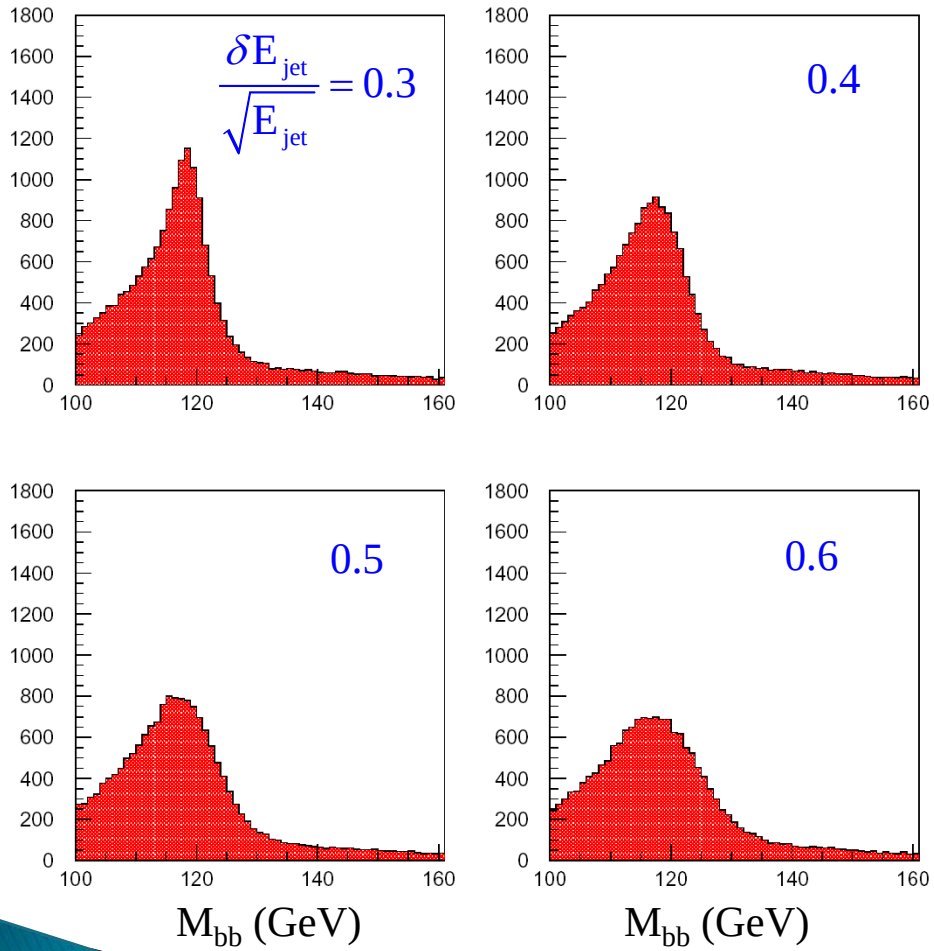
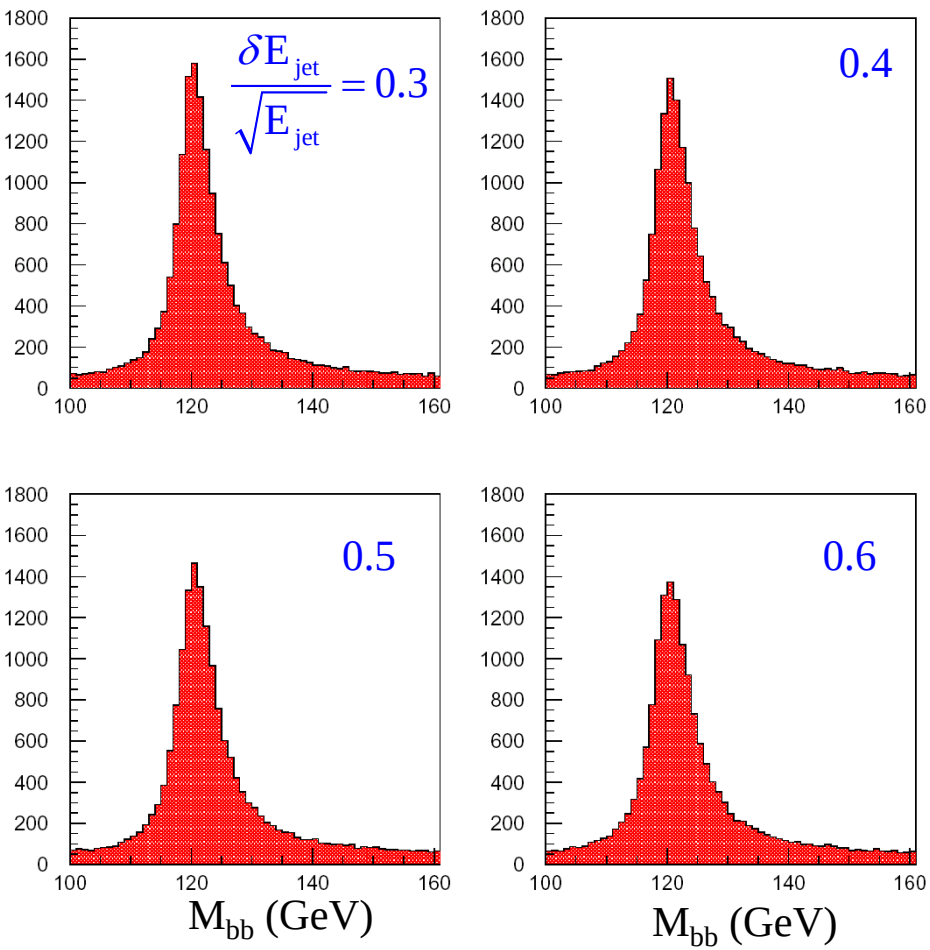
$$e^+e^- \to ZH \to qqb\bar{b}$$

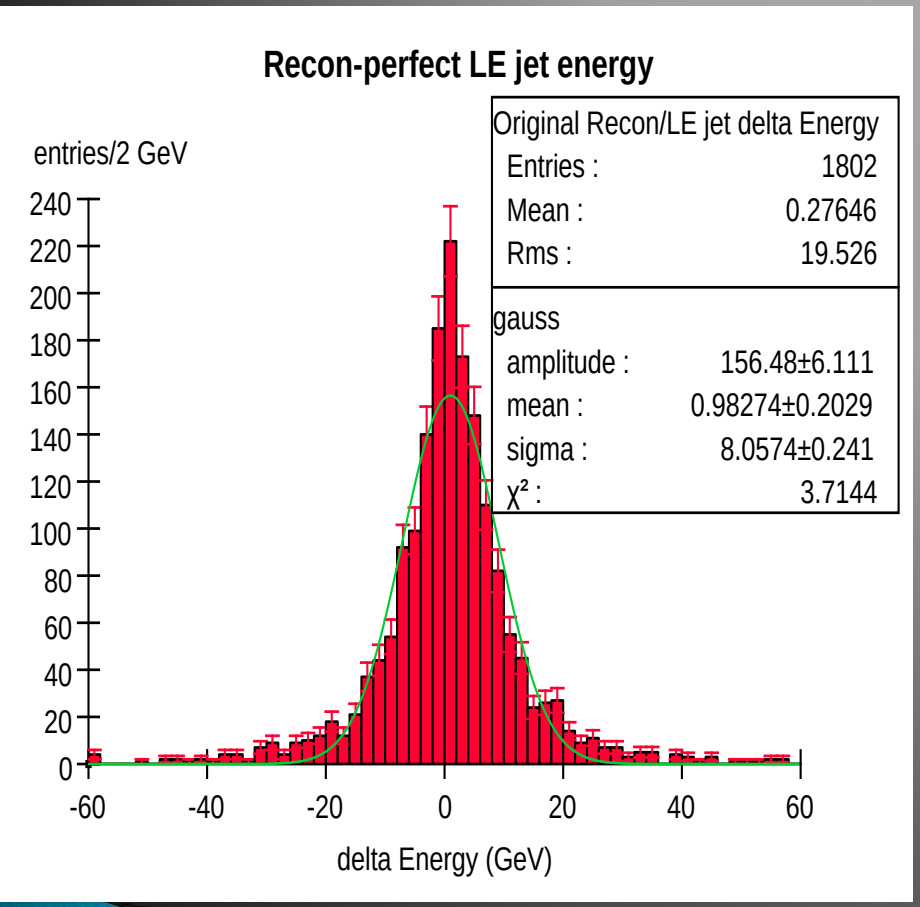
Reconstructed M_{bb}

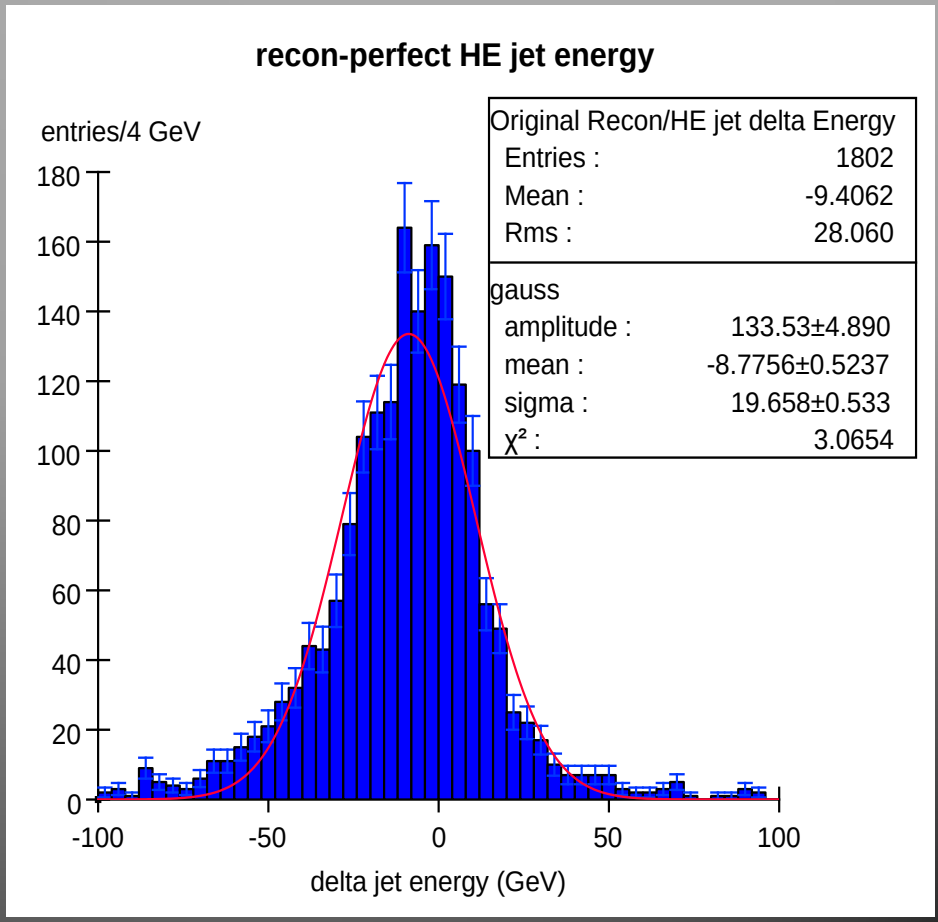


4C Fitted M_{bb}



Prefit results: Energy





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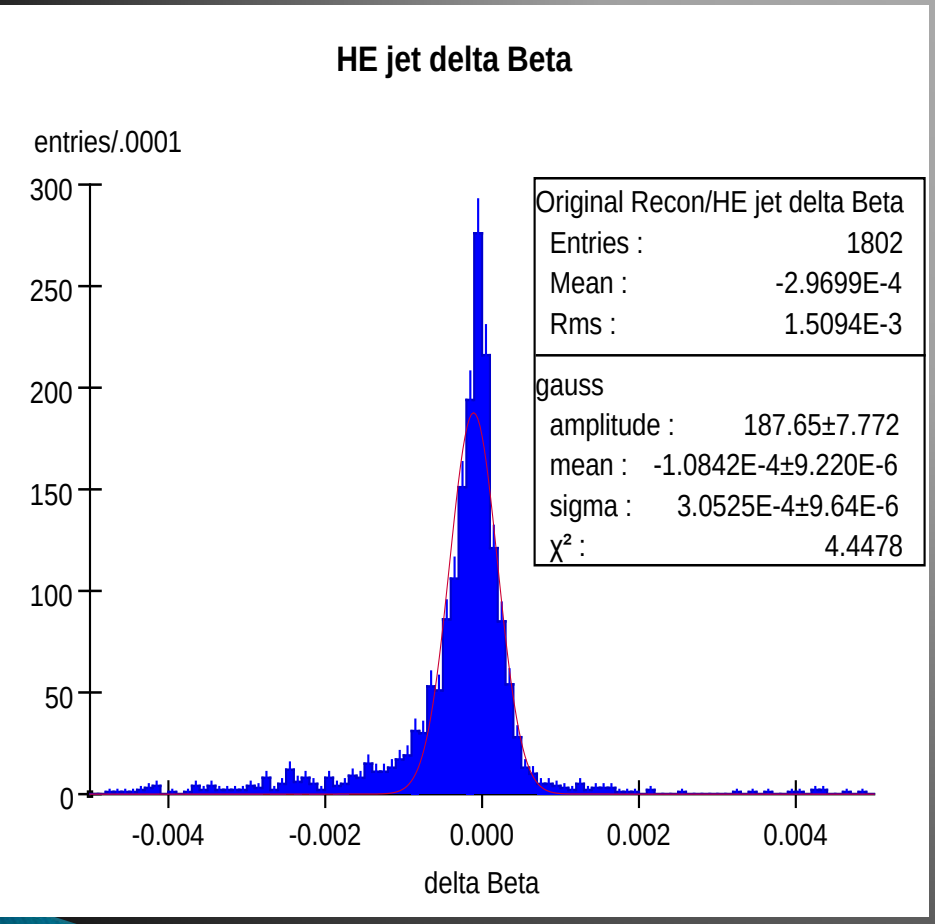
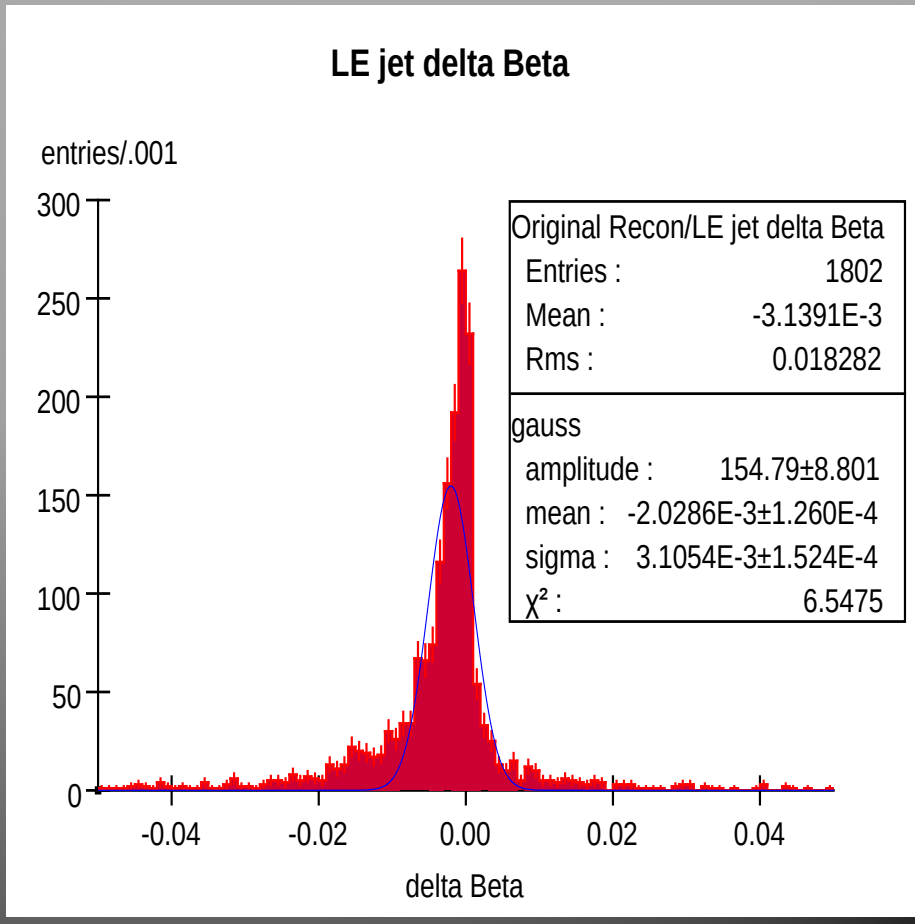
Prefit results: Beta





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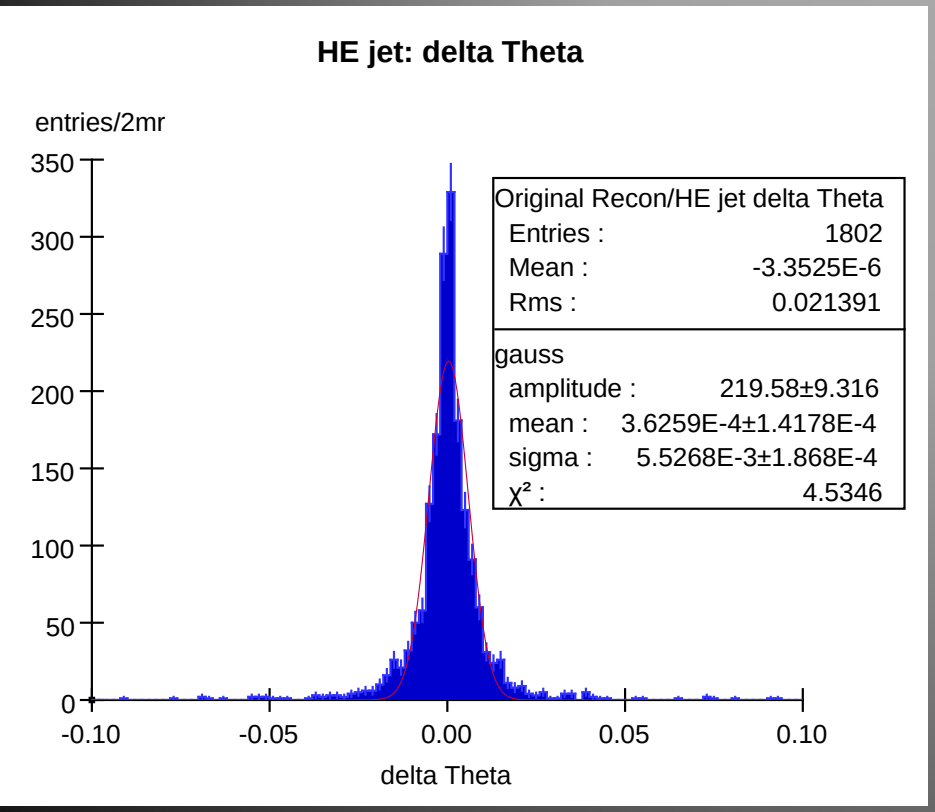
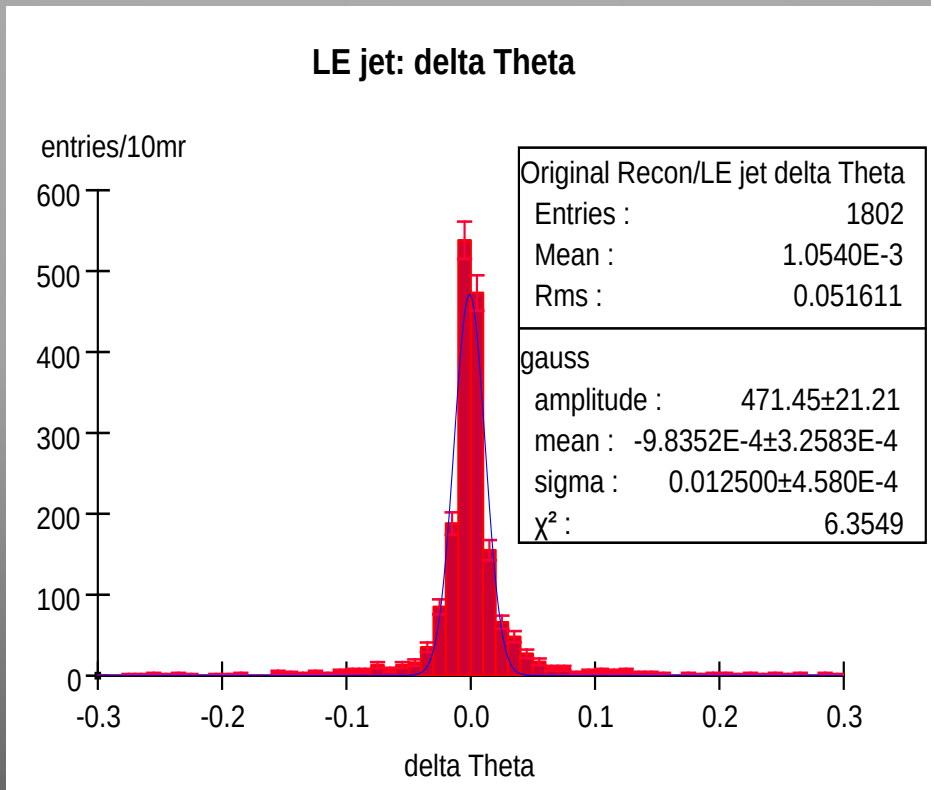
Prefit results: Theta





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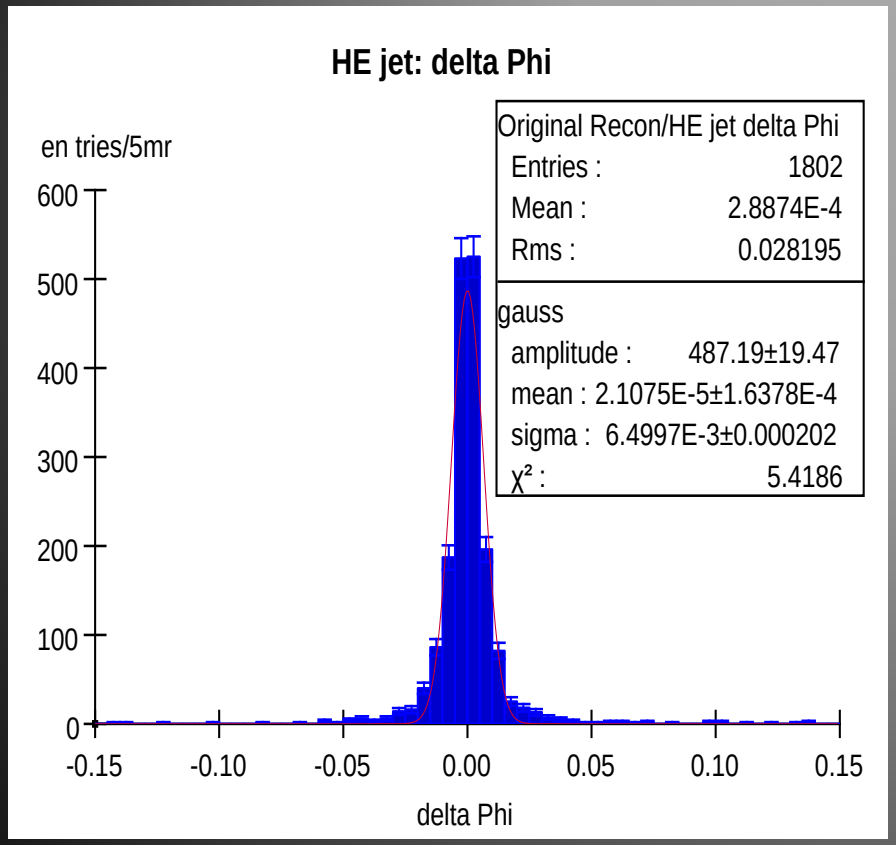
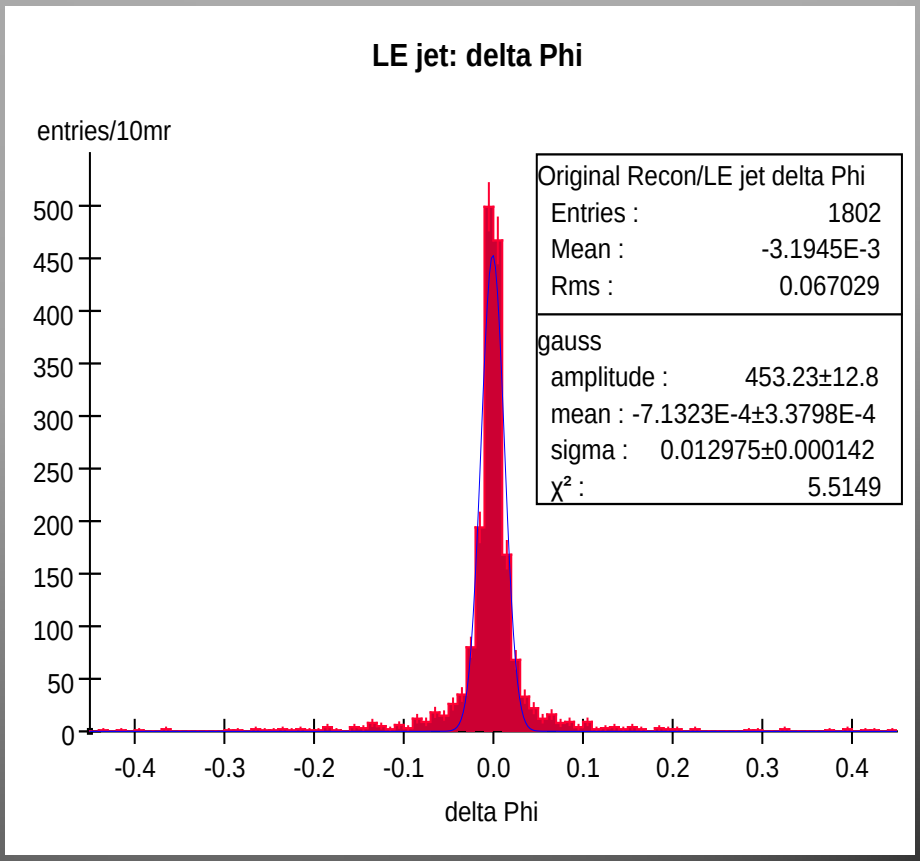
Prefit results: Phi





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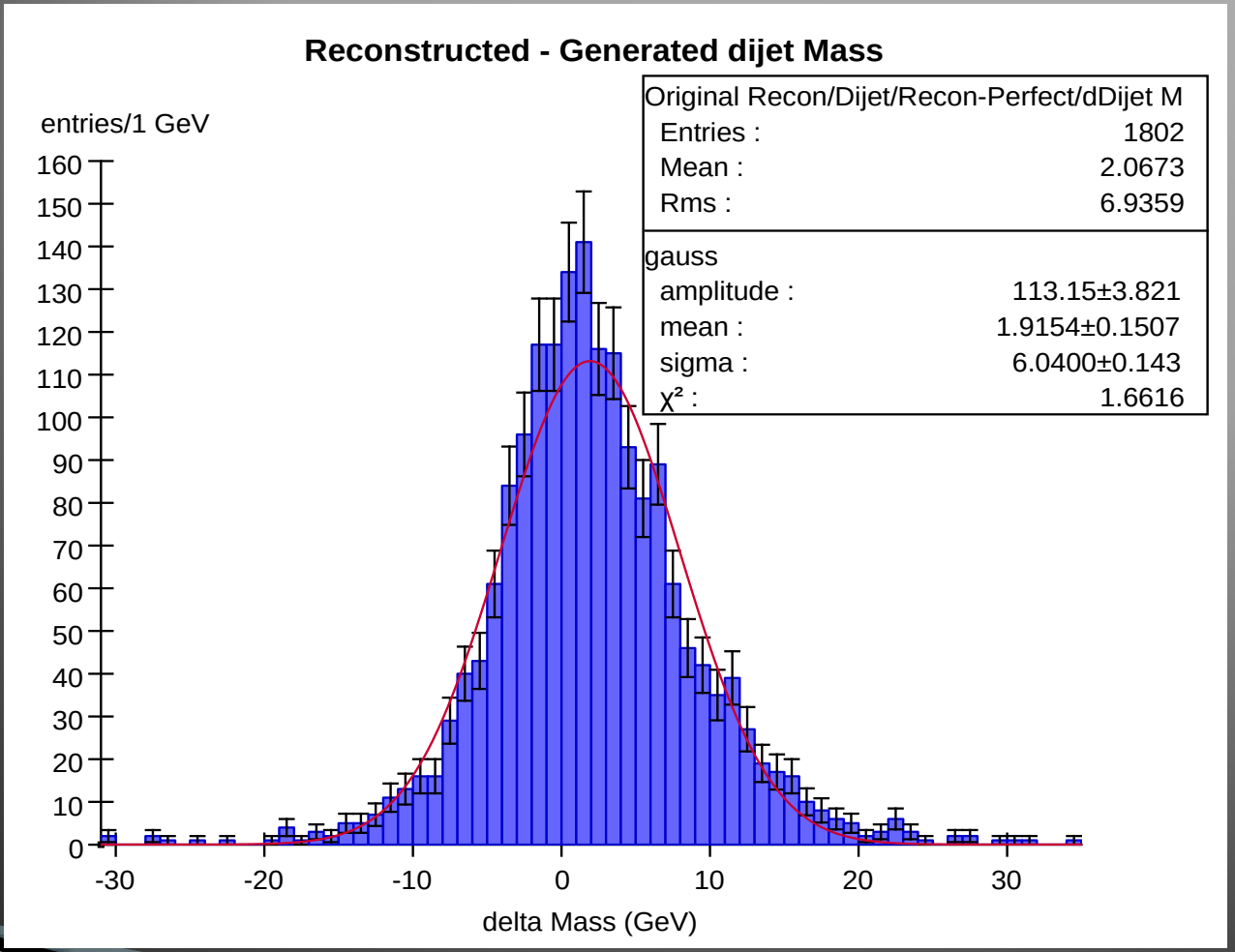
Prefit results: Mass



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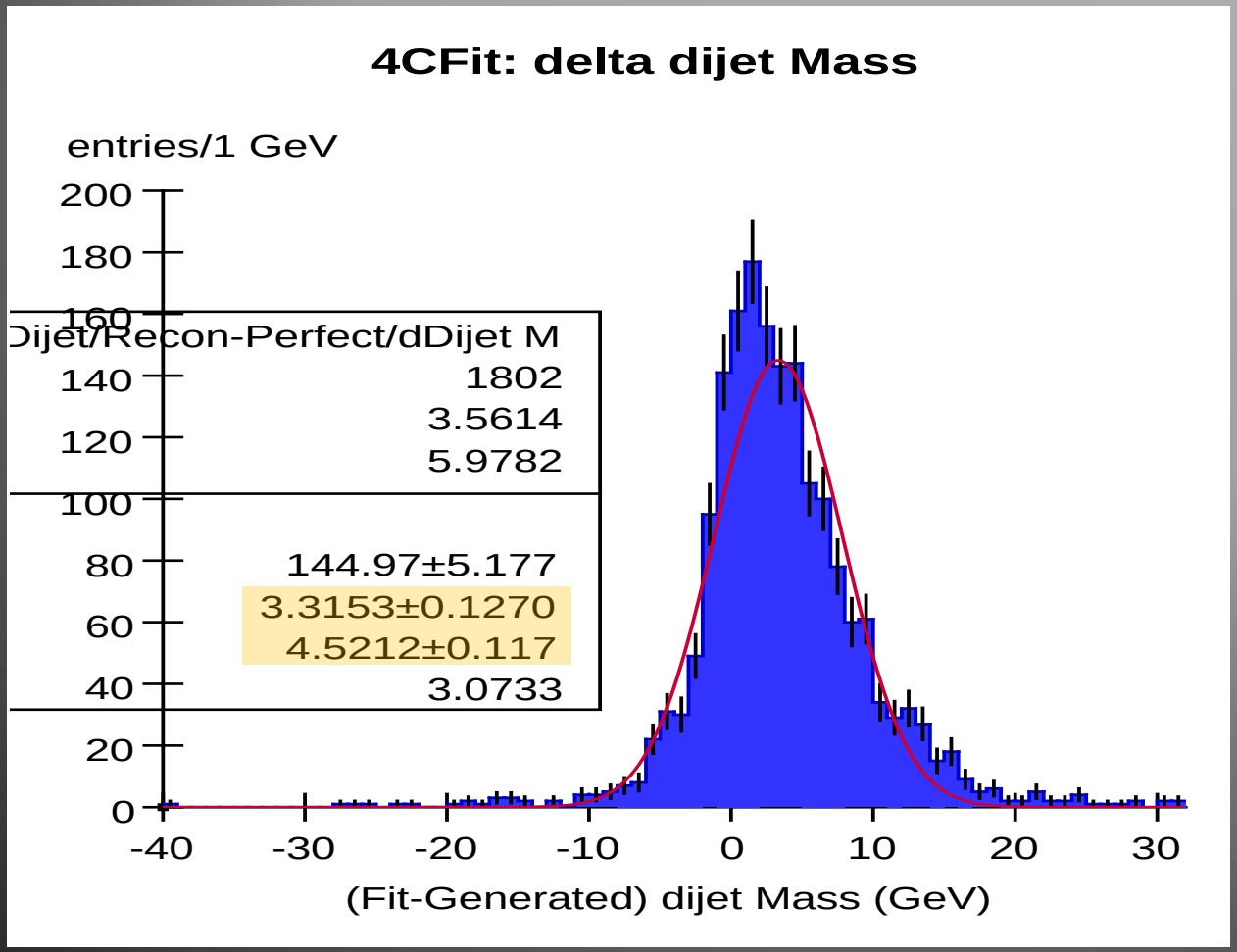
Observations

- Offset in Energy expected.
- Offset in Beta unexpected.
- Offset in Mass opposite to what I expected.

4C fit results



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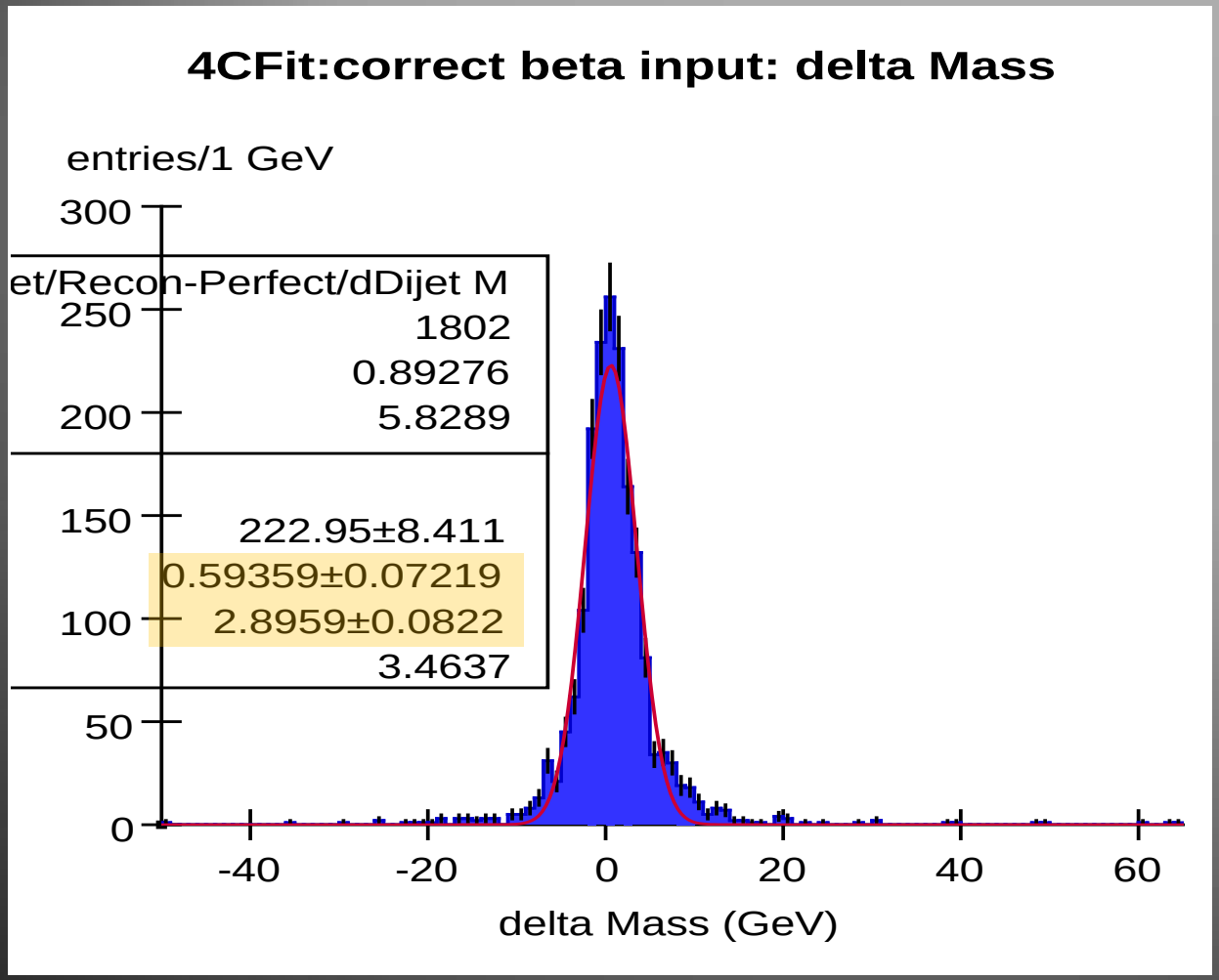
4C Fit Cheat using reco β = true β



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The approximate expression for the two-jet mass M is

$$M^2 \approx 2E_1E_2(1-\cos\theta)$$

$$\frac{\Delta M}{M} \approx \frac{1}{2}\left[\frac{\Delta E_1}{E_1} \oplus \frac{\Delta E_2}{E_2}\right]$$

but the full expression is

$$M^2 = m_1^2 + m_2^2 + 2E_1E_2(1-\beta_1\beta_2\cos\theta) \quad , \quad \beta_j = \left(1-\frac{m_j^2}{E_j^2}\right)^{\frac{1}{2}}$$

$$\frac{\Delta M}{M} \approx \frac{1}{2}\left[\frac{\Delta E_1}{E_1} \oplus \frac{\Delta E_2}{E_2} \oplus \frac{\theta\sin\theta}{1-\cos\theta}\frac{\Delta\theta}{\theta} \oplus \frac{1+r^{-1}\cos\theta}{1-\cos\theta}\frac{m_1^2}{E_1E_2}\frac{\Delta m_1}{m_1} \oplus \frac{1+r\cos\theta}{1-\cos\theta}\frac{m_2^2}{E_1E_2}\frac{\Delta m_2}{m_2}\right]$$

$$r = \frac{E_1}{E_2}$$

Using the variable β_1 and β_2 in place of m_1 and m_2 the full expression is

$$\frac{\Delta M}{M} \approx \frac{1}{2}\left[\left(1+(1-\beta_1^2)^2\left(\frac{r+\cos\theta}{1-\cos\theta}\right)^2\right)^{1/2}\frac{\Delta E_1}{E_1} \oplus \left(1+(1-\beta_2^2)^2\left(\frac{r^{-1}+\cos\theta}{1-\cos\theta}\right)^2\right)^{1/2}\frac{\Delta E_2}{E_2}\right.$$
$$\left. \oplus \frac{\theta\sin\theta}{1-\cos\theta}\frac{\Delta\theta}{\theta} \oplus \frac{r+\cos\theta}{1-\cos\theta}\beta_1\Delta\beta_1 \oplus \frac{r^{-1}+\cos\theta}{1-\cos\theta}\beta_2\Delta\beta_2\right]$$

For $1-\beta_j \ll \theta \ll 1$ this becomes

$$\frac{\Delta M}{M} \approx \frac{1}{2}\left[\frac{\Delta E_1}{E_1} \oplus \frac{\Delta E_2}{E_2} \oplus 2\frac{\Delta\theta}{\theta} \oplus \frac{2(r+1)}{\theta^2}\Delta\beta_1 \oplus \frac{2(r^{-1}+1)}{\theta^2}\Delta\beta_2\right]$$

Next steps for WW Analysis

- 100k of each polarization generated, need to process.
- Should allow full covariance matrix calculation
- Need to understand “low β” in reconstruction
  - Some progress recently (after Aug 4) in improving reconstructed beta using a minimum neutral hadron PFO energy cut
- Analyze 20k events at Ecm=350 GeV to separate FastMC effects from center-of-mass energy effects

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