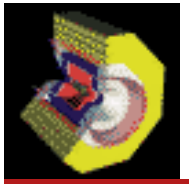


Cornell University
Laboratory for
Elementary-Particle Physics

$D_S^{*+} \to D_S^+ e^+ e^-$

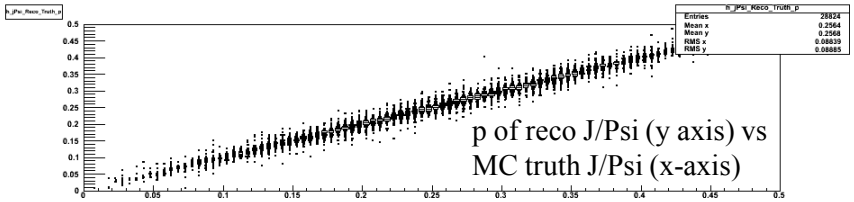
Souvik Das, Anders Ryd
Cornell University

Contents

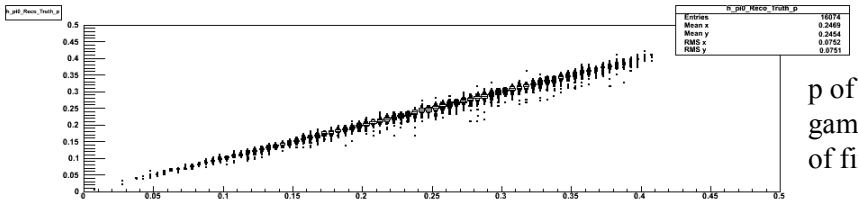
- Low Energy Electron Reconstruction Efficiency Woes
- Vertex Fitting Suggestion

15 June 2010

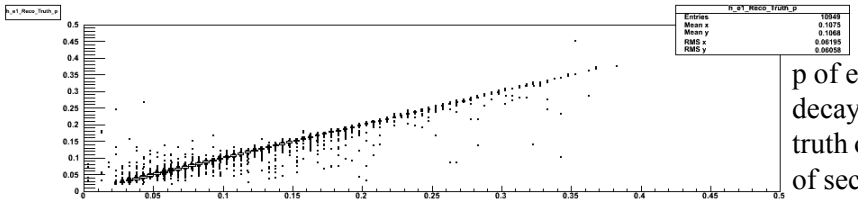
Low Energy Electron Reconstruction Efficiency



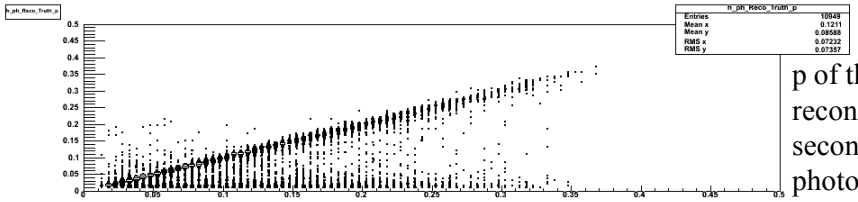
p of reco J/Psi (y axis) vs MC truth J/Psi (x-axis)



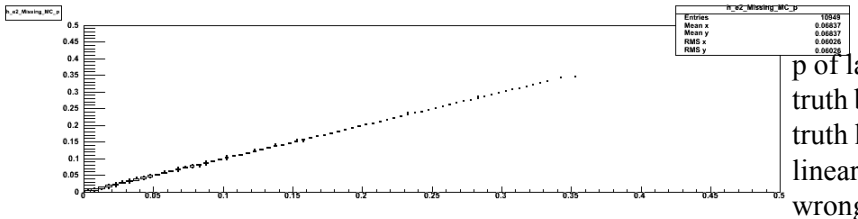
p of pi0 reconstructed from gamma, gamma vs MC truth of first pi0



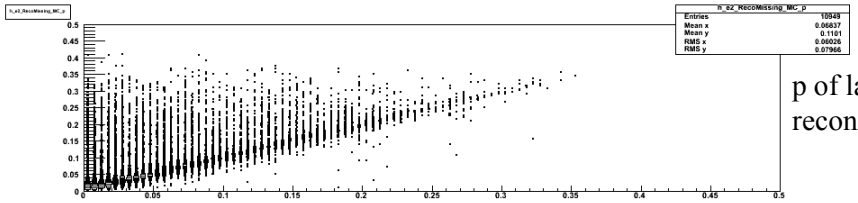
p of electron in reconstructed decay of second pi0 vs MC truth of electron from decay of second pi0



p of the photon in reconstructed decay of second pi0 vs MC truth of photon



p of last electron according to MC truth by vector addition vs the MC truth last electron. (This had to be linear or I'd be doing my math wrong)



p of last, missing electron according to reconstruction vs MC truth.

$$\psi(2S) \to J/\psi\pi^0\pi^0;$$

$$J/\psi \to e^+e^-; J/\psi \to \mu^+\mu^-$$

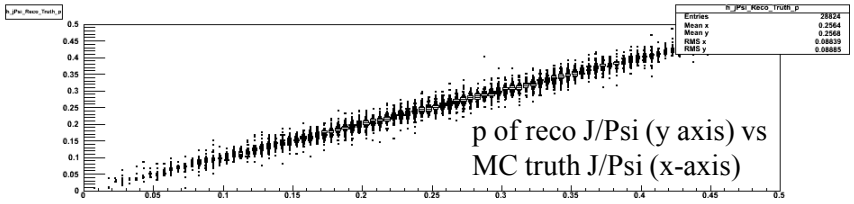
$$\pi^0 \to \gamma\gamma$$

$$\pi^0 \to \gamma e^+e^-$$

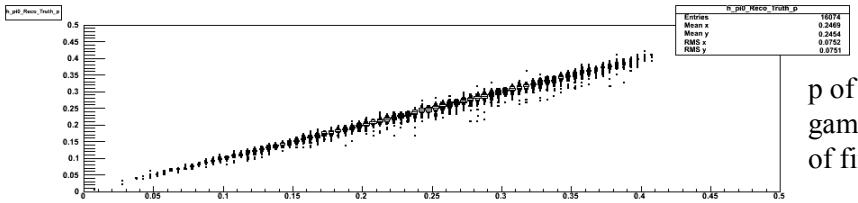
Unable to pin-point why we were getting such large inefficiencies for tracking the last electron, we resorted to looking at the MC truth and matching reconstructed objects to the truth.

We require each candidate to be MC matched in making these plots.

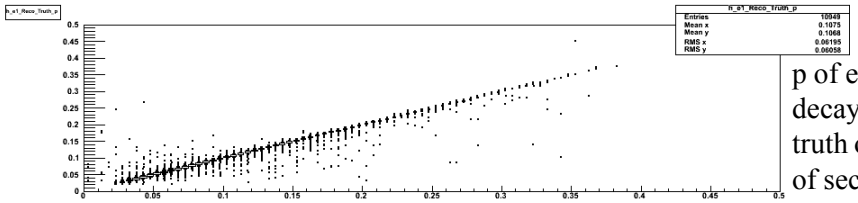
Low Energy Electron Reconstruction Efficiency



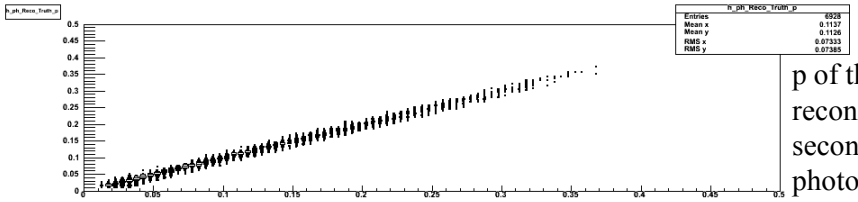
p of reco J/Psi (y axis) vs MC truth J/Psi (x-axis)



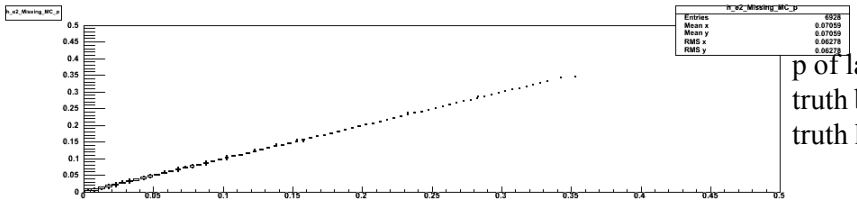
p of pi0 reconstructed from gamma, gamma vs MC truth of first pi0



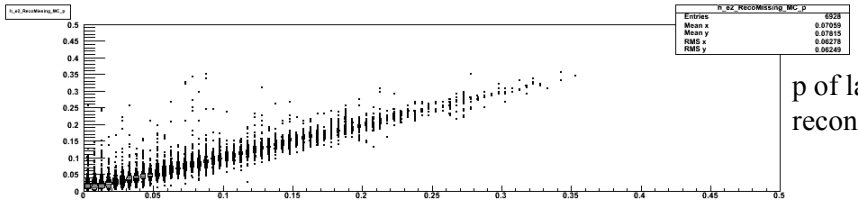
p of electron in reconstructed decay of second pi0 vs MC truth of electron from decay of second pi0



p of the photon in reconstructed decay of second pi0 vs MC truth of photon



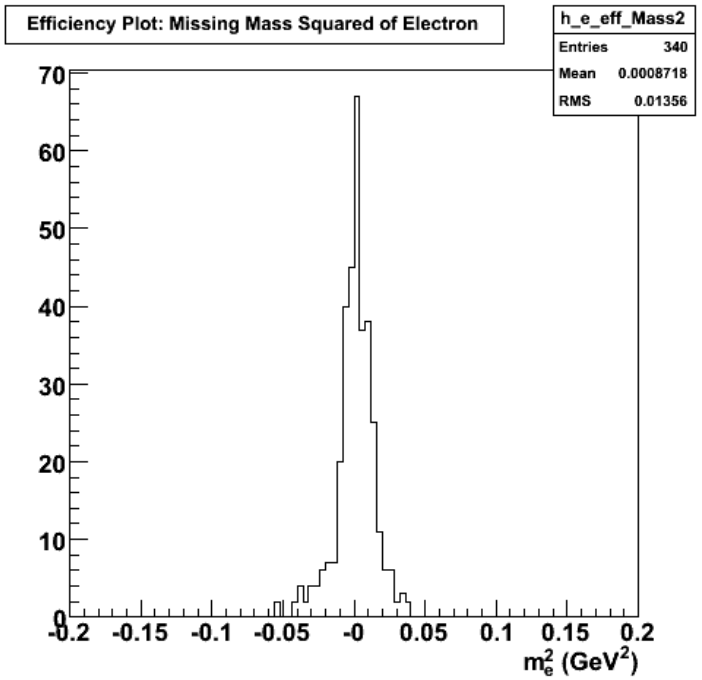
p of last electron according to MC truth by vector addition vs the MC truth last electron.

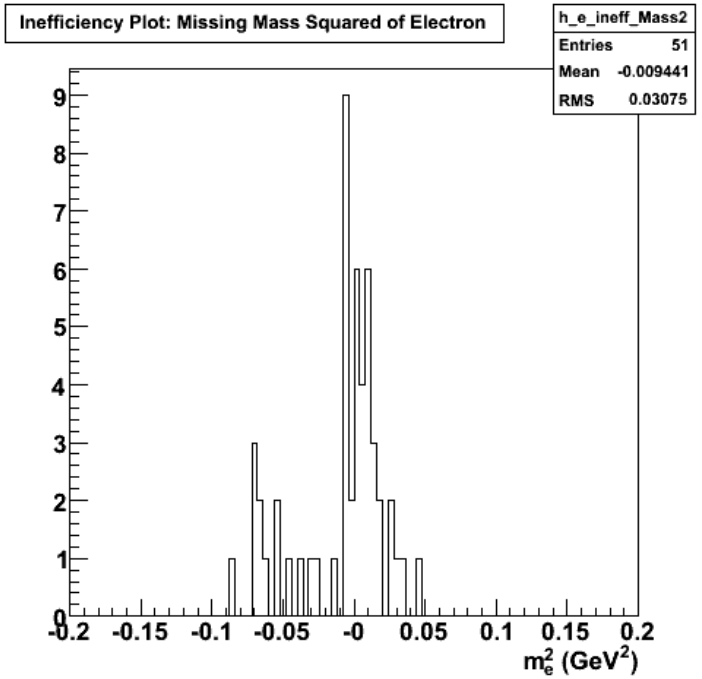


p of last, missing electron according to reconstruction vs MC truth.

Now we artificially clean up the energy of the second pi0's photon by requiring reconstructed energy to be within 20 MeV of the MC photon.

Everything improves!





Low Energy Electron Reconstruction Efficiency

Having artificially cleaned up the energy of the second pi0's photon by requiring reconstructed energy to be within 20 MeV of the MC photon, the efficiency plots seem reasonable.

But how can we improve the reconstruction of the last photon? Our code:

```
static DChainBoolean photonSelector(CDPhoton& iPhoton)
{
 const CcShowerAttributes &atts=iPhoton.photon().attributes();
 return (0.01 < atts.energy() && atts.energy() < 2.0
        && !atts.hot() // not use hot crystals
        && atts.e9oe25UnfOK() // E9/E25 unfolded
        && iPhoton.photon().noTrackMatch()
        && (atts.goodBarrel() || atts.goodEndcap())); // might want to take away for
doing a veto... doesn't use the overlap of the calorimeters
}
```

1. We have not required the photon to exclude photons used to reconstruct the first pi0,

2. We have not required any pi0 Dalitz decay specific checks on the last pi0.

Low Energy Electron Reconstruction Efficiency

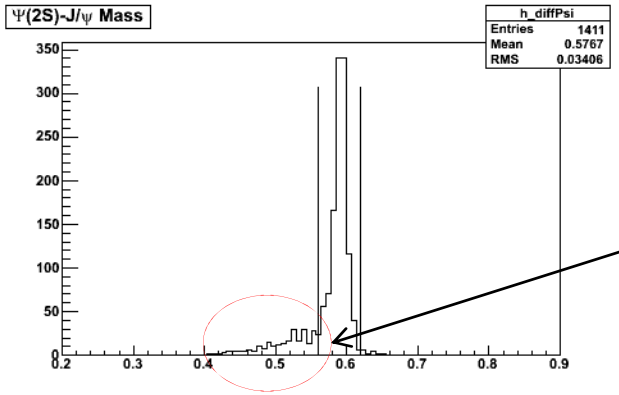
1. ~~We have not required the photon to exclude photons used to reconstruct the first pi0,~~
   - Already taken care of in the code.

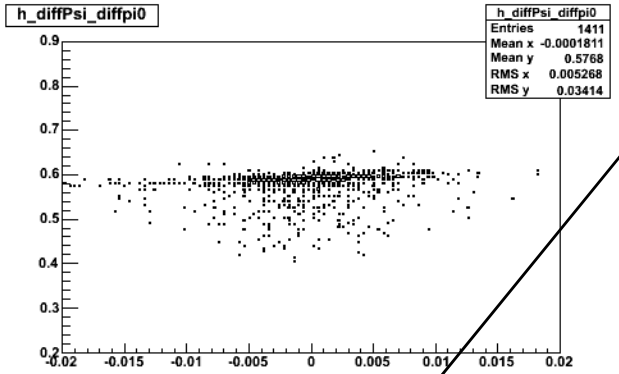
2. ~~We have not required any pi0 Dalitz decay specific checks on the last pi0.~~
   - We can't because we don't have last electron. Could be a criterion for differentiating between efficient and inefficient electrons though, apart from the Psi(2S)-J/Psi mass cut.

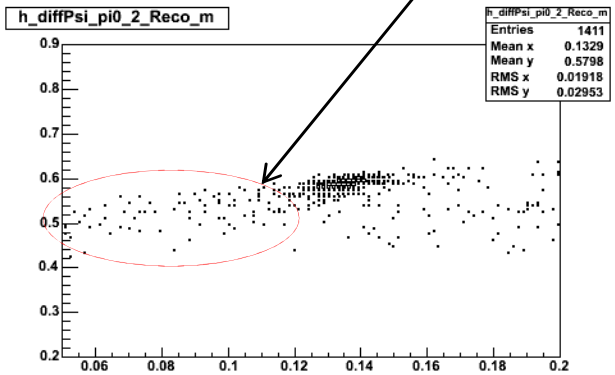
3. With everything except the last electron MC matched, what contributes to inefficient electrons?
   - A low tail on the second pi0 mass peak…
   - Which is turn comes from mis-reconstructed photons.

4. Without MC matching, what can we clean up?
   - The first pi0 from the shower energies? (Doesn't seem so.)
   - The photon of the second pi0 with E9/E25 criteria
   - … and ideas?

Low Energy Electron Reconstruction Efficiency







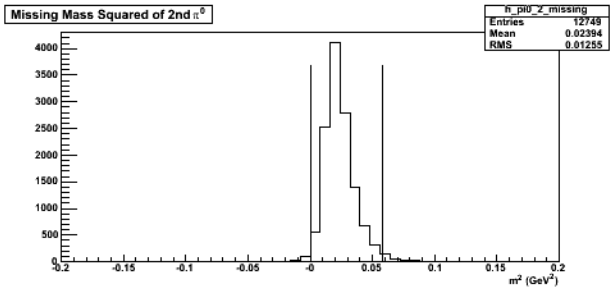
Everything except the last electron has been MC matched.

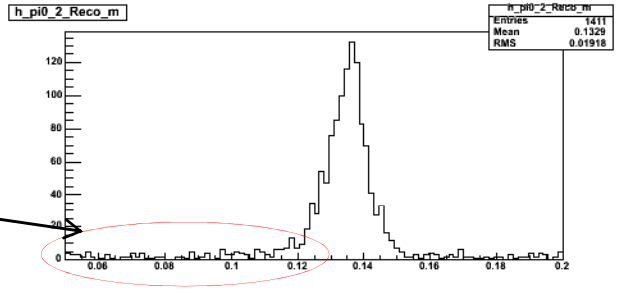
Where does the lower tail of Psi(2S)-J/Psi mass come from?

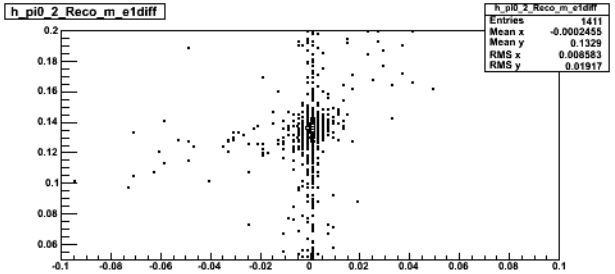
Some of it comes from the tails of the reconstructed second pi0 mass!

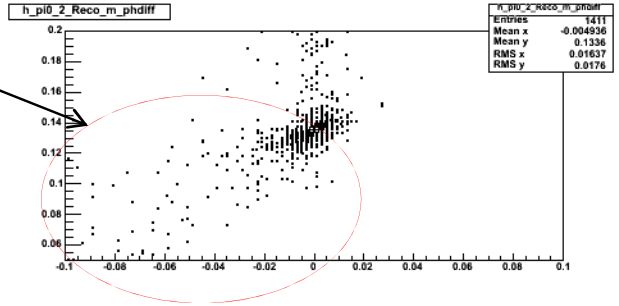
And where do the tails of the reconstructed pi0 mass come from?

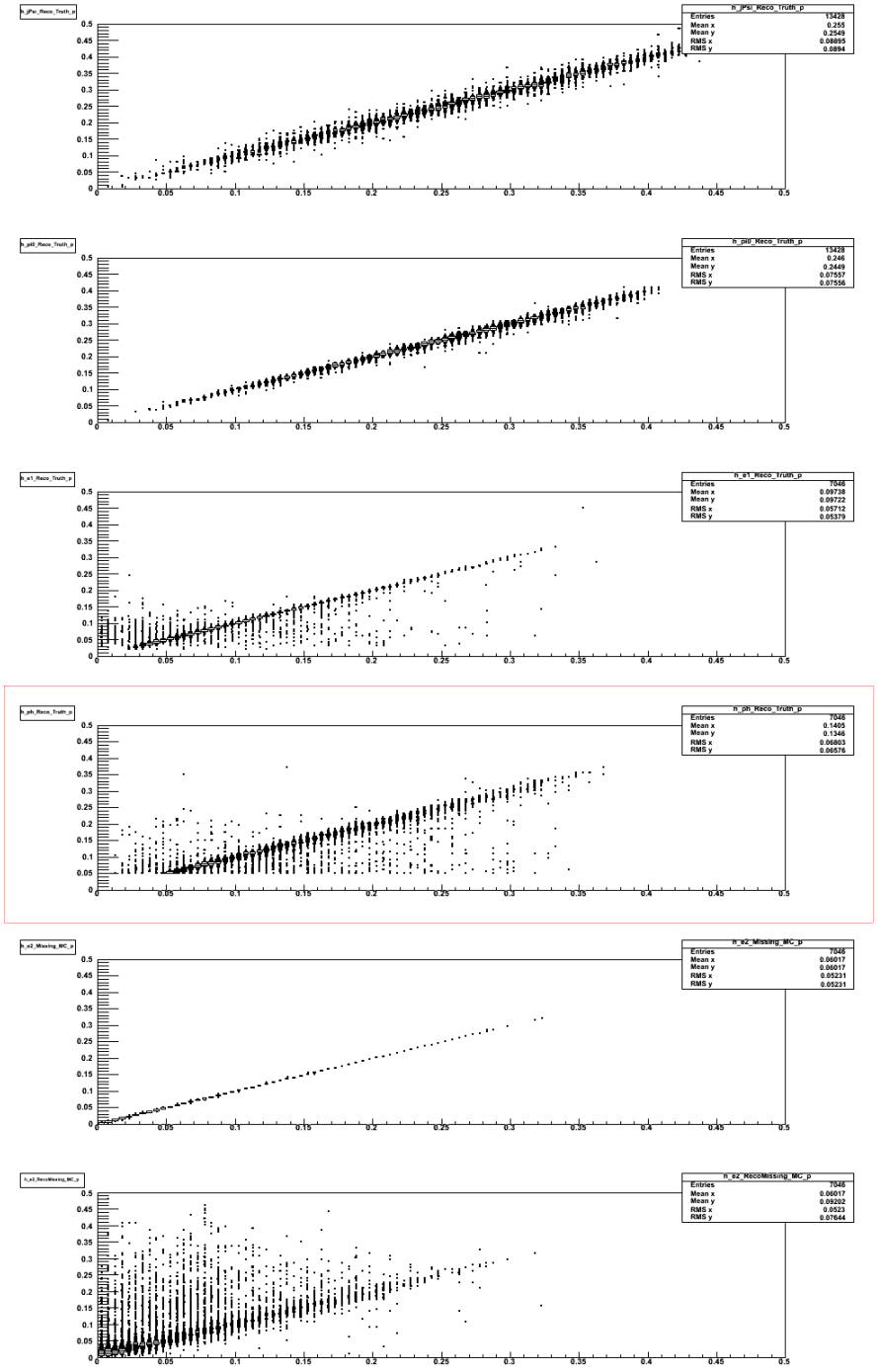
Mis-reconstructed photons from the second pi0!





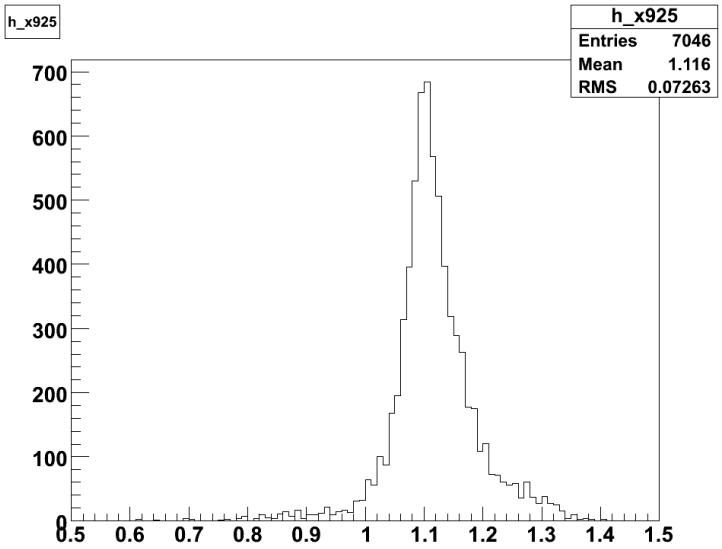


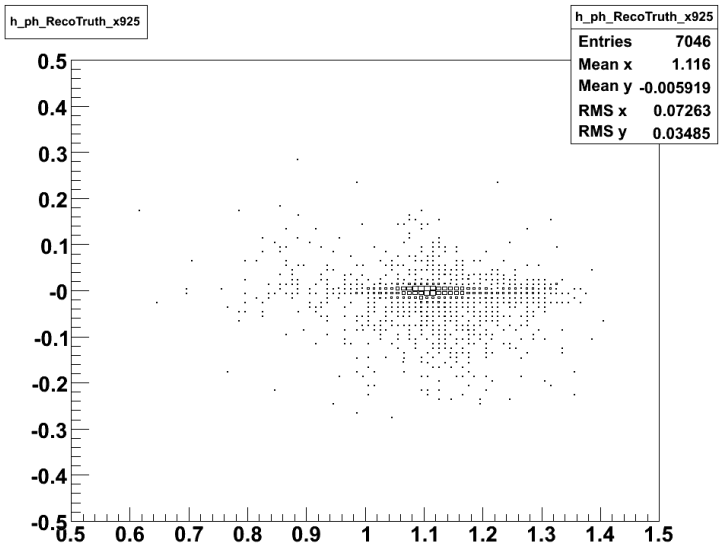




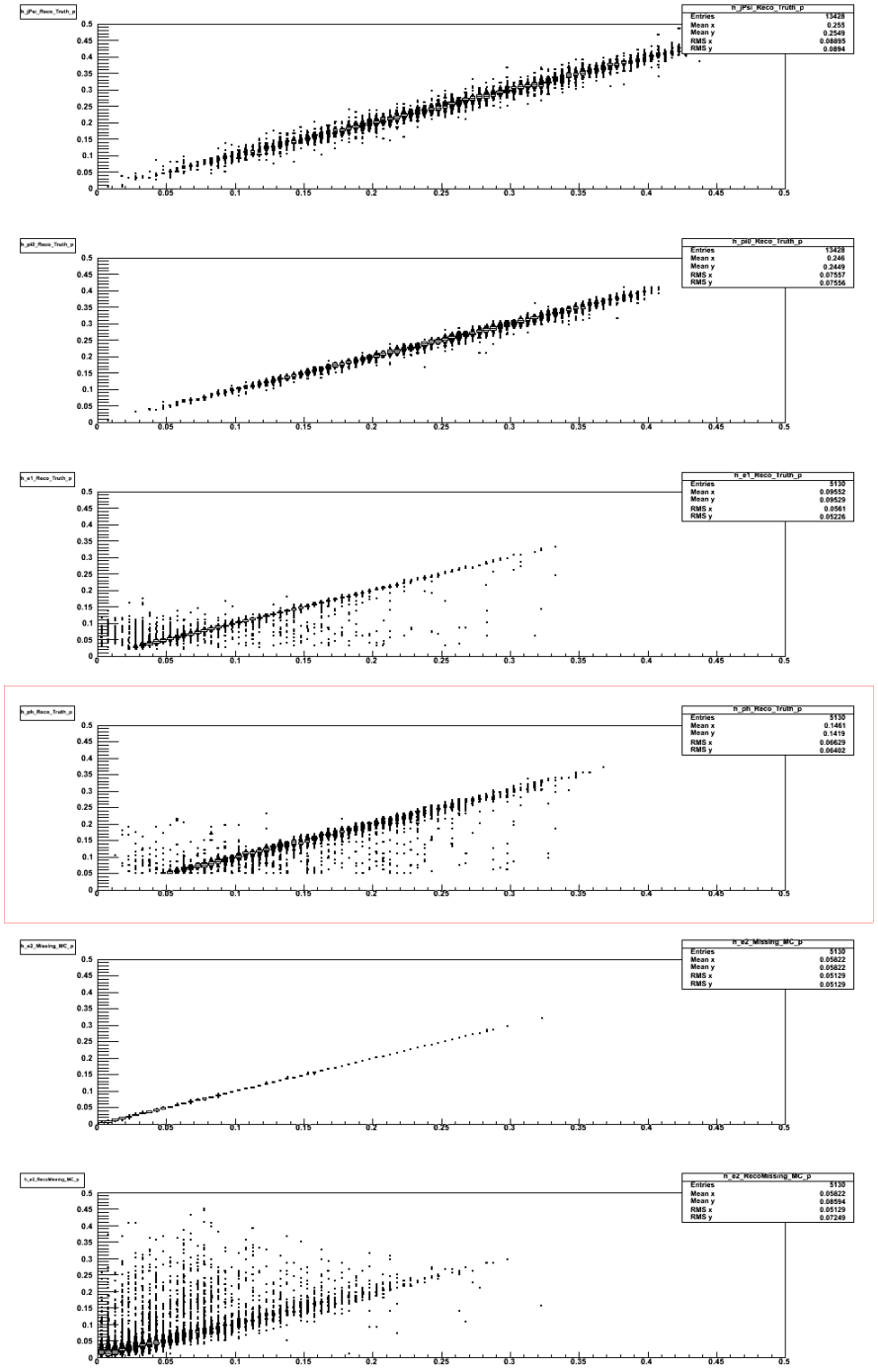
So how can we clean the photon from the second pi0?

1. A simple momentum cut requiring p > 50 MeV
2. A cut on x925Unf between 1.05 – 1.17



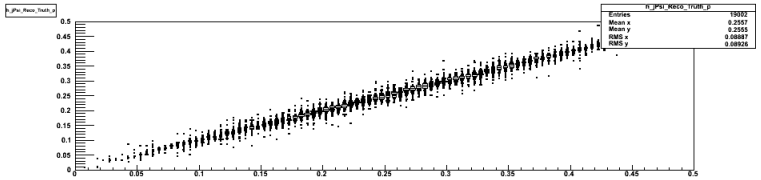


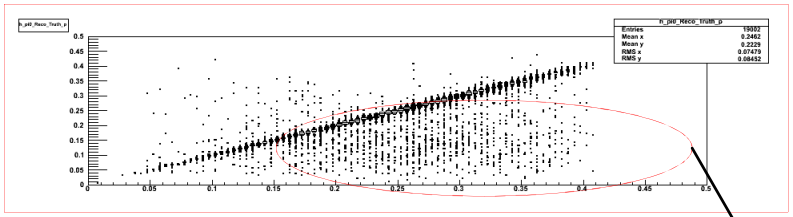
Low Energy Electron Reconstruction Efficiency

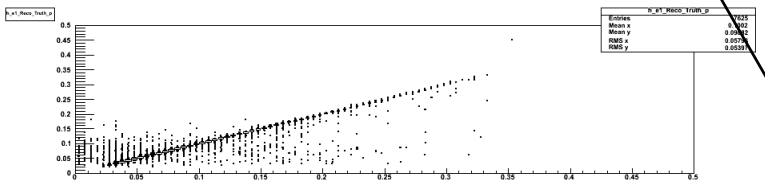


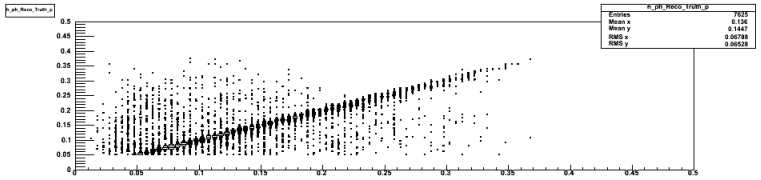
The x925Unf cut removes some of the drizzle.

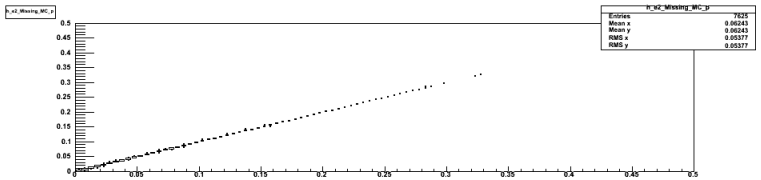
Low Energy Electron Reconstruction Efficiency

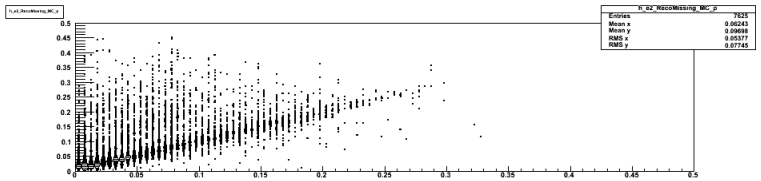






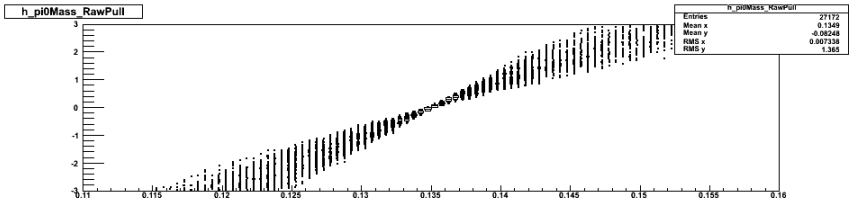


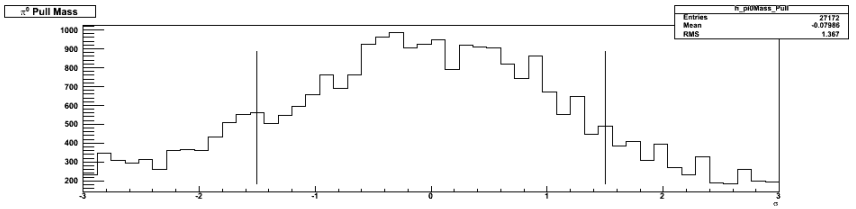


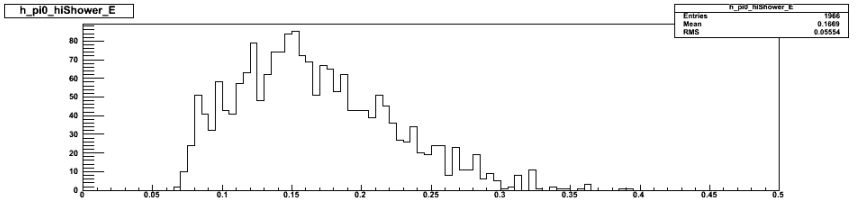


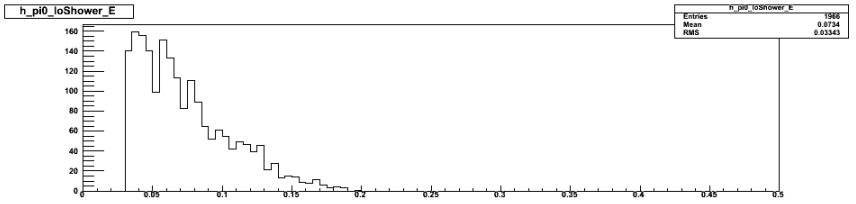
Clear some first pi0 drizzle?

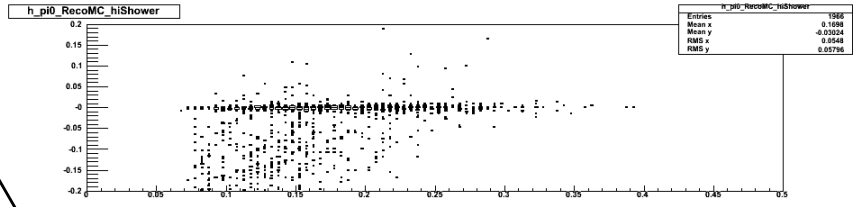
Cut on **loShower** of first pi0!

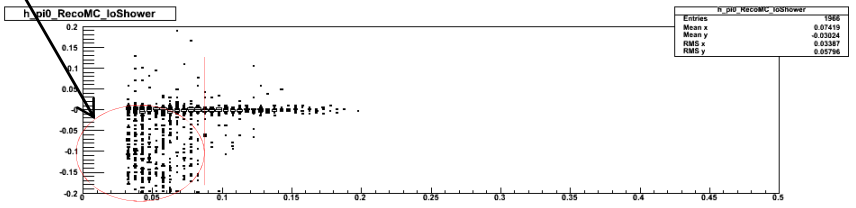




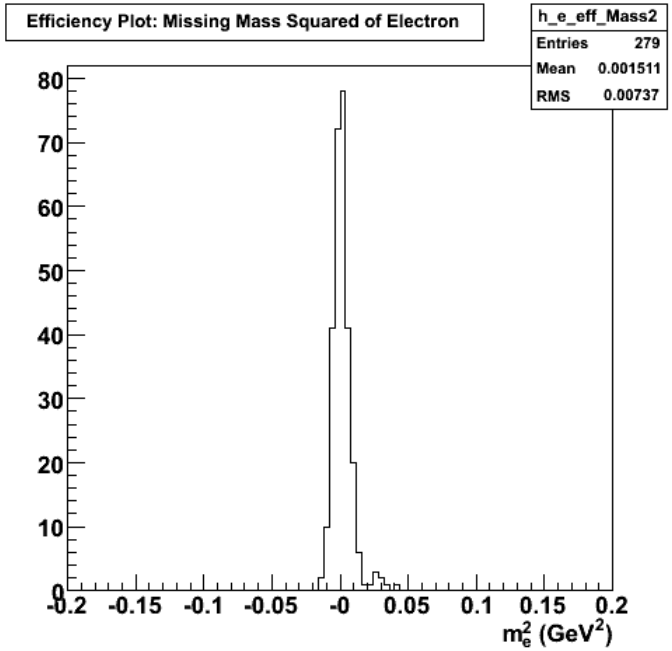


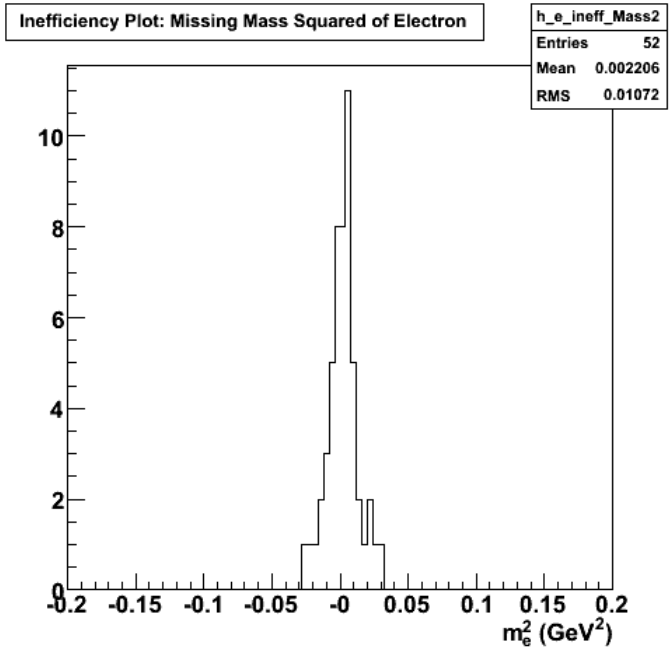






Low Energy Electron Reconstruction Efficiency



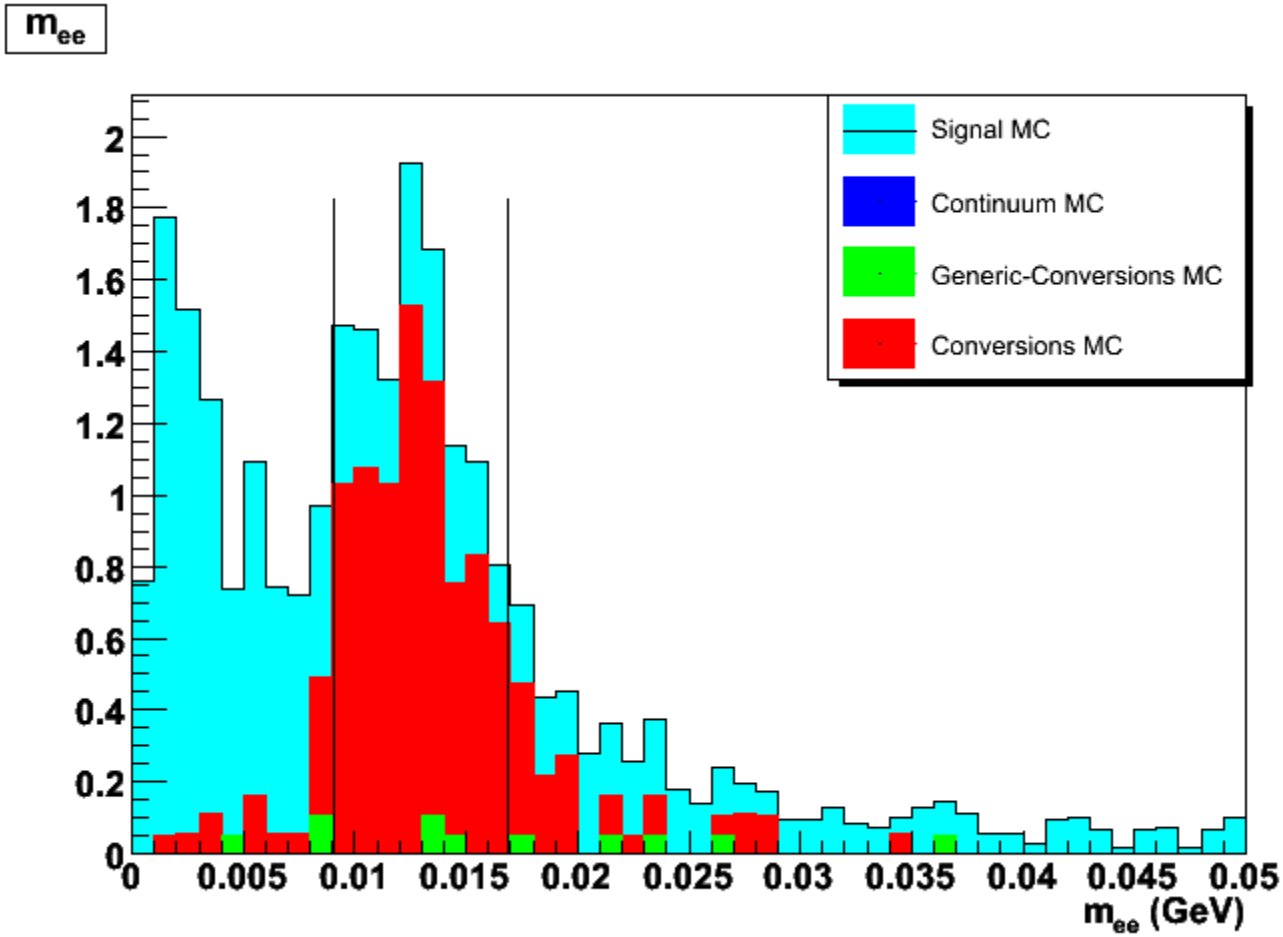


Missing energy of last electron between 150 and 200 MeV.

No nice extended combinatoric background under the peak in the inefficiency plot.

Must rack brain some more…

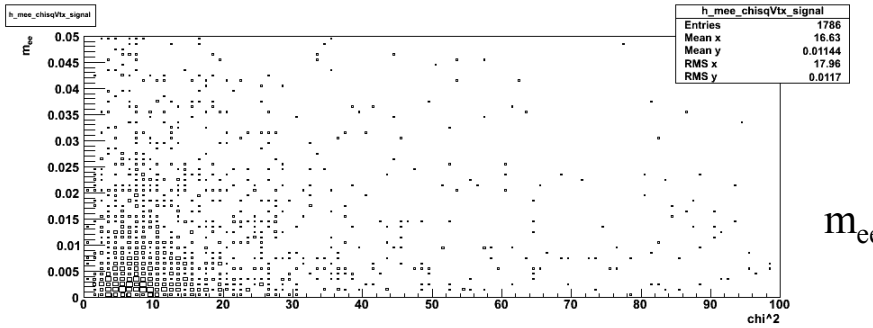
m_{ee} versus Vertex Fitting χ^2



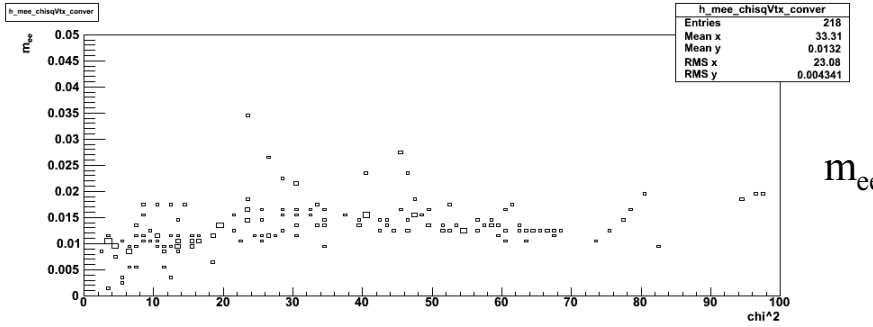
We were veto-ing the peak in m_{ee} [$|m_{ee} - 0.013| > 0.00389$ GeV] found in the conversion MC after we did a vertex fit of all tracks in the KKpi mode, and requiring $\chi^2 > 0$. It was shown to be not as powerful as the Δd_0 and $\Delta \varphi_0$ cuts in our analysis, and also unable to add significant power on top of our cuts.

We were asked, could a $\chi^2 >$ non-zero number help in improving the power?

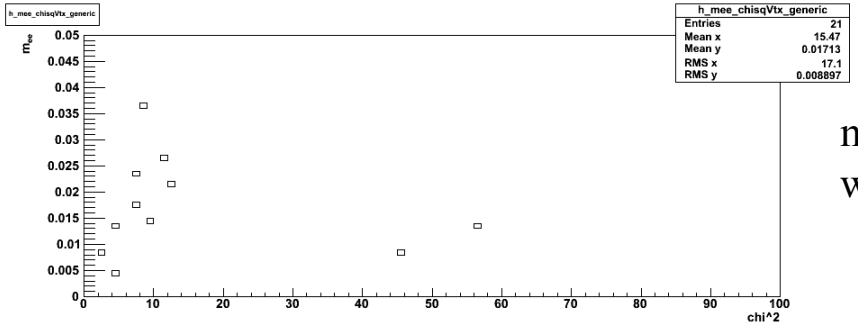
m_{ee} versus Vertex Fitting χ^2



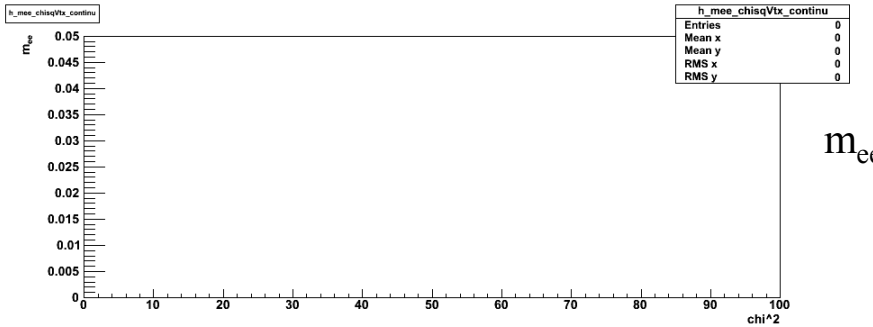
m_{ee} vs χ^2 in signal MC



m_{ee} vs χ^2 in conversion MC



m_{ee} vs χ^2 in generic MC with conversions vetoed



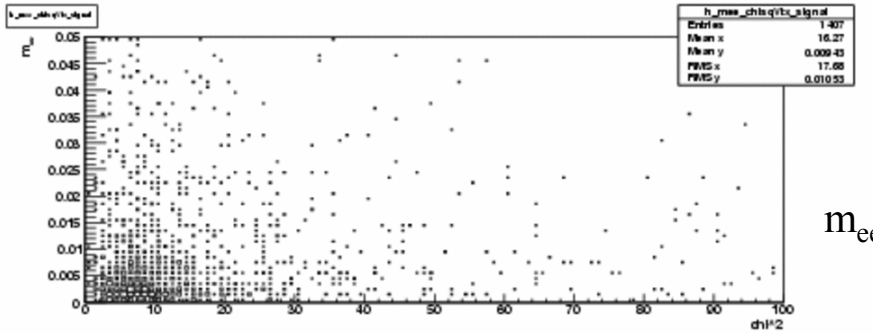
m_{ee} vs χ^2 in continuum MC

The peak in the conversion MC's m_{ee} around 13 MeV can be improved by increasing χ^2 to > 10

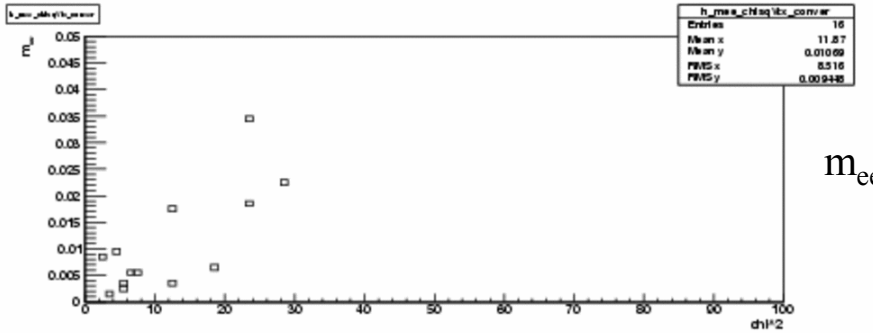
But by then we'll have lost most of our signal events!

Alternatively we might want to require $\chi^2 < 10$ or 15!

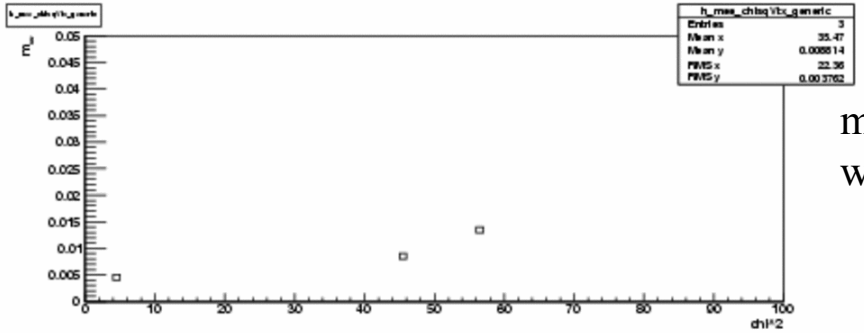
m_{ee} versus Vertex Fitting χ^2



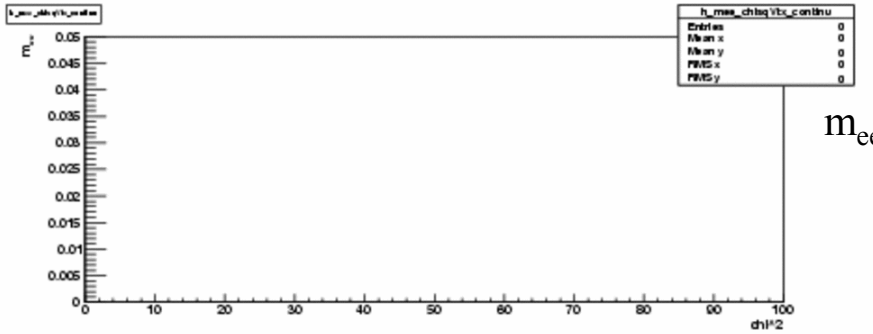
m_{ee} vs χ^2 in signal MC



m_{ee} vs χ^2 in conversion MC



m_{ee} vs χ^2 in generic MC
with conversions vetoed



m_{ee} vs χ^2 in continuum MC

Alternatively we might want to require $\chi^2 < 10$ or 15!

Naah… won't help AFTER the dPhi and diffd0 cuts.