



π^0 Reconstruction in Full Detector Simulation

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1. Why ?
 2. What improvement with a dedicated reconstruction?
 3. First results in full simulation/reconstruction framework
 - ✓ Calorimeter calibration
 - ✓ Energy resolution for single π^0 s
 - ✓ Fit efficiency for single π^0 s
 4. Conclusion
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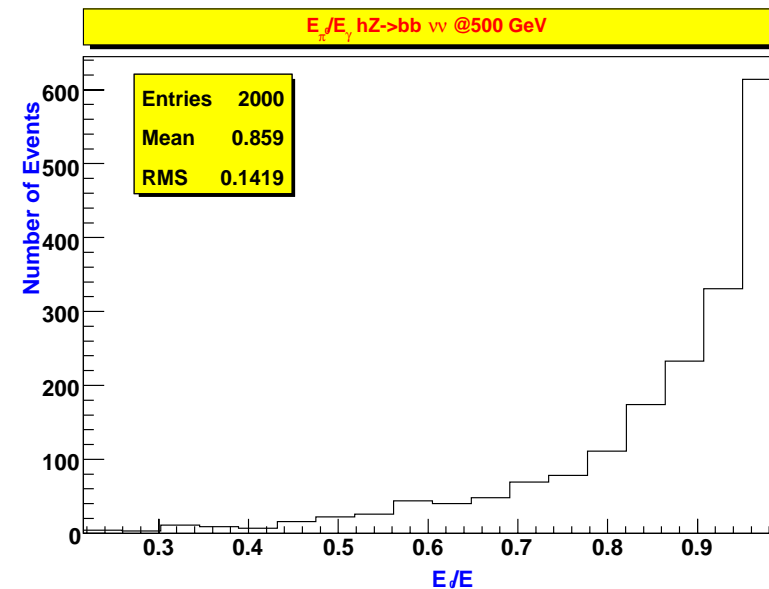
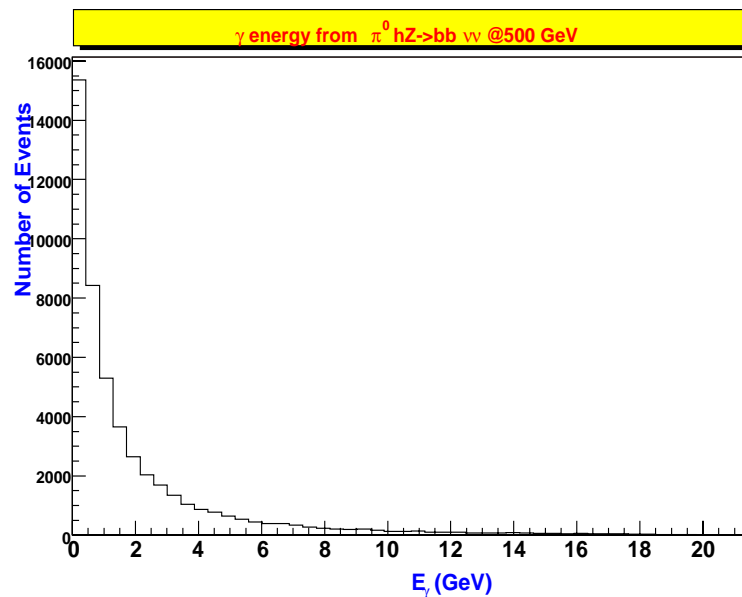
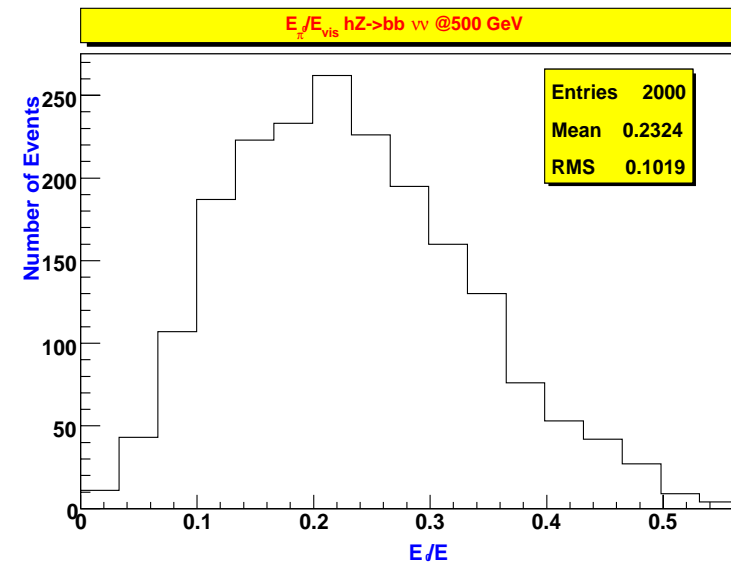
1. Why π^0 s?

$H(bb)Z(\nu\nu)$ @ 500 GeV



π^0 s are an important part of the particle content in hadronic events

- ~20% of the visible energy (tt or hZ events @500 GeV)
- most of the photons come from π^0 decays
- rather soft photons : 55% of the photons with $E < 1$ GeV



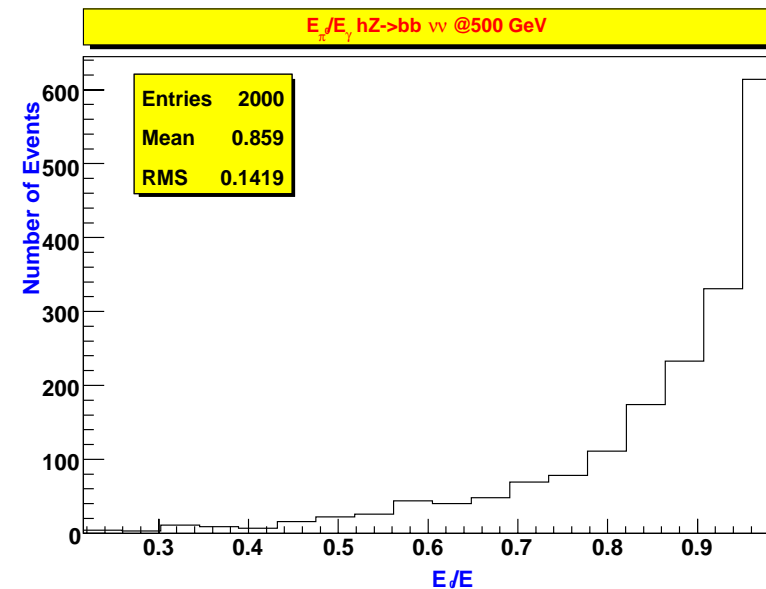
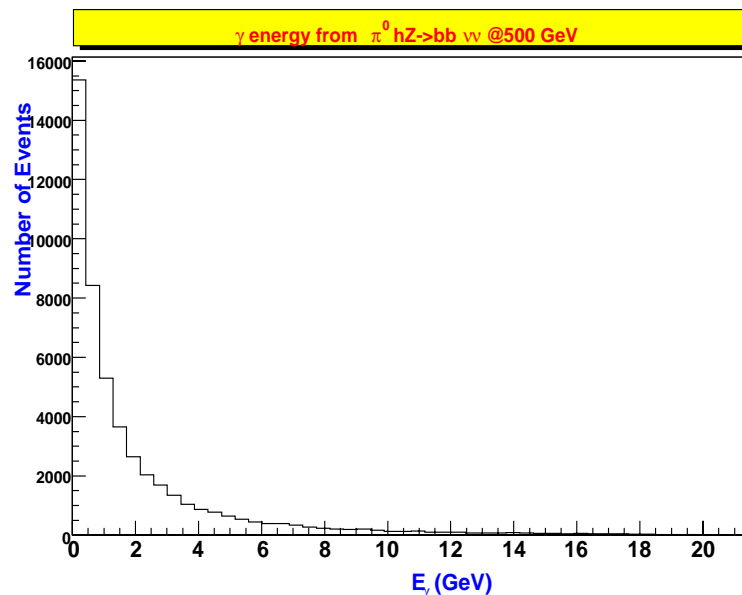
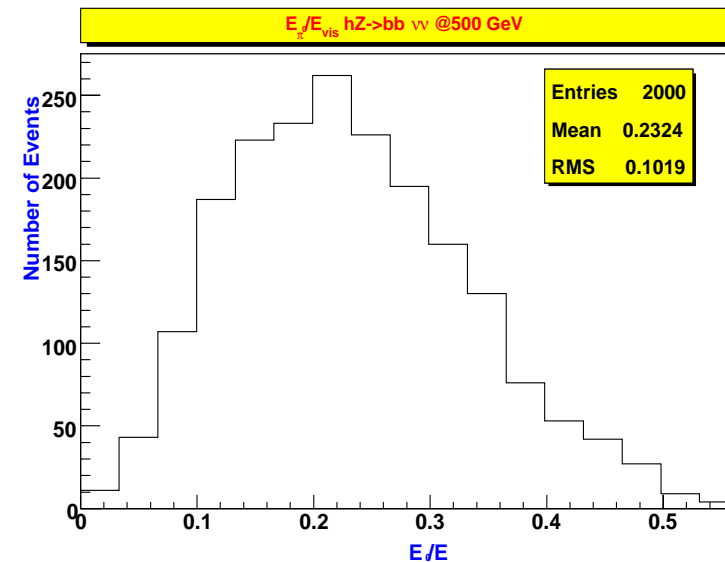
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2. What improvement with a dedicated reconstruction?



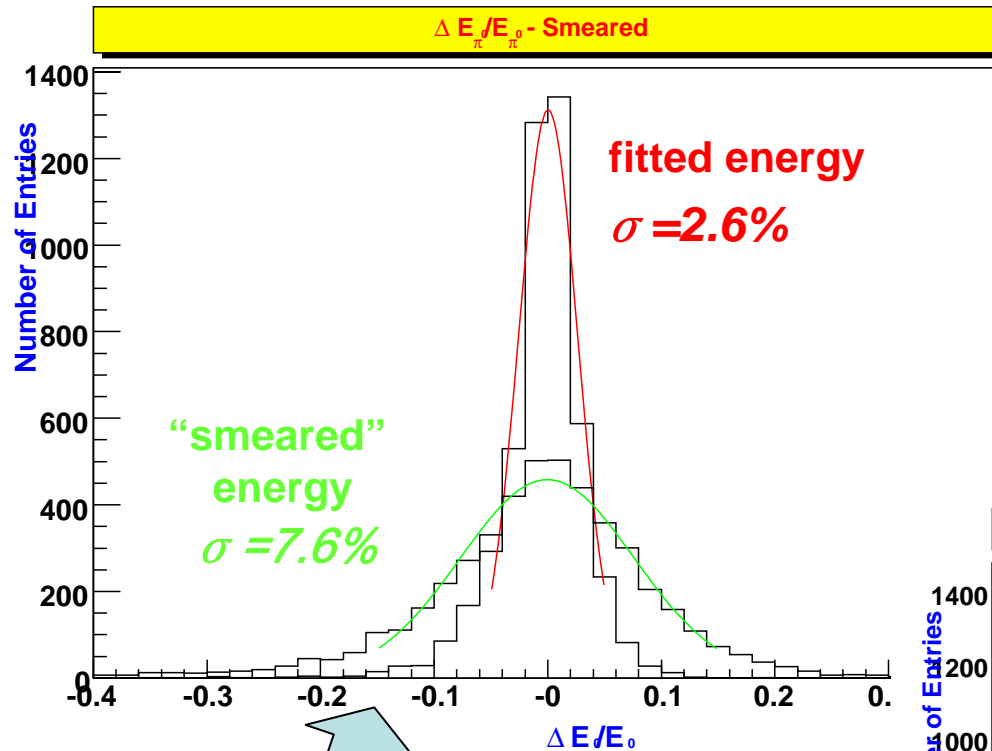
- Generate H(bb)Z($\gamma \gamma$) @ 500 GeV with [Pythia 6.3.21](#)
- Take the [MC photons from \$\pi^0\$ s](#) and [smear](#) them according to full simulation & reconstruction resolutions (see later ...)

$$\sigma_E = 11.7\% \sqrt{E} \quad \sigma_\theta = 0.2\% \theta \quad \sigma_\phi = 0.2\% \phi$$

- Apply a [constraint mass fit on \$\gamma\$'s](#) and look at the [\$\pi^0\$ energy resolution](#)

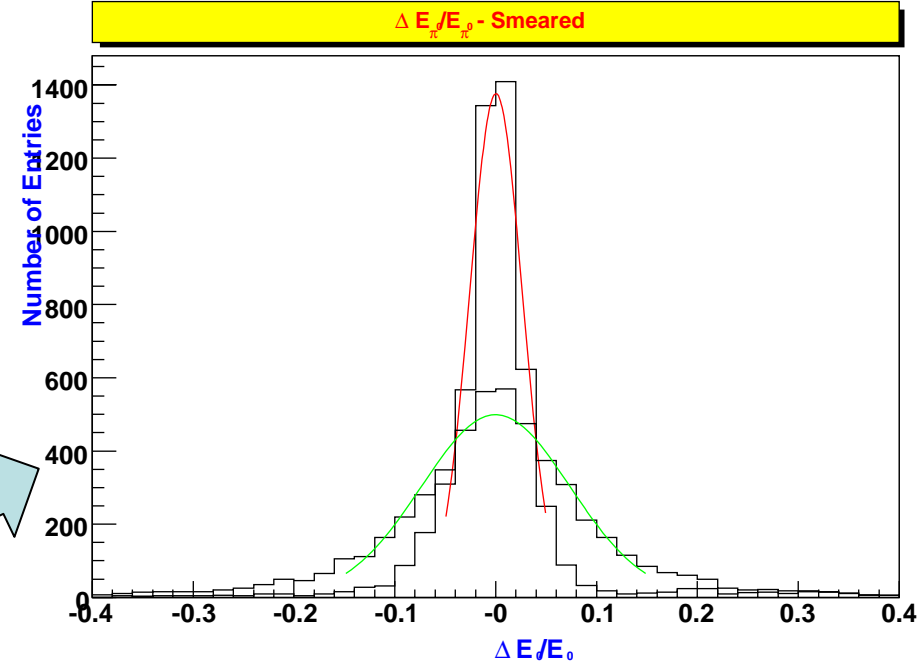
$$\chi^2 = \sum_{i=0}^1 \frac{(E_i^{cl} - E_i)^2}{\sigma_{E_i}^2} + \sum_{i=0}^1 \frac{(\theta_i^{cl} - \theta_i)^2}{\sigma_{\theta_i}^2} + \sum_{i=0}^1 \frac{(\phi_i^{cl} - \phi_i)^2}{\sigma_{\phi_i}^2} \quad n_{iter} \leq 4 \quad \chi^2 \leq 3.9$$

2. What improvement with a dedicated reconstruction?



$$E_{\pi^0}^{\text{smeared}} = E_{\gamma_1}^{\text{smeared}} + E_{\gamma_2}^{\text{smeared}}$$

$$E_{\pi^0}^{\text{fitted}} = E_{\gamma_1}^{\text{fitted}} + E_{\gamma_2}^{\text{fitted}}$$



single π^0 s accepted
by the constraint fit

all single π^0 s

2. What improvement with a dedicated reconstruction?



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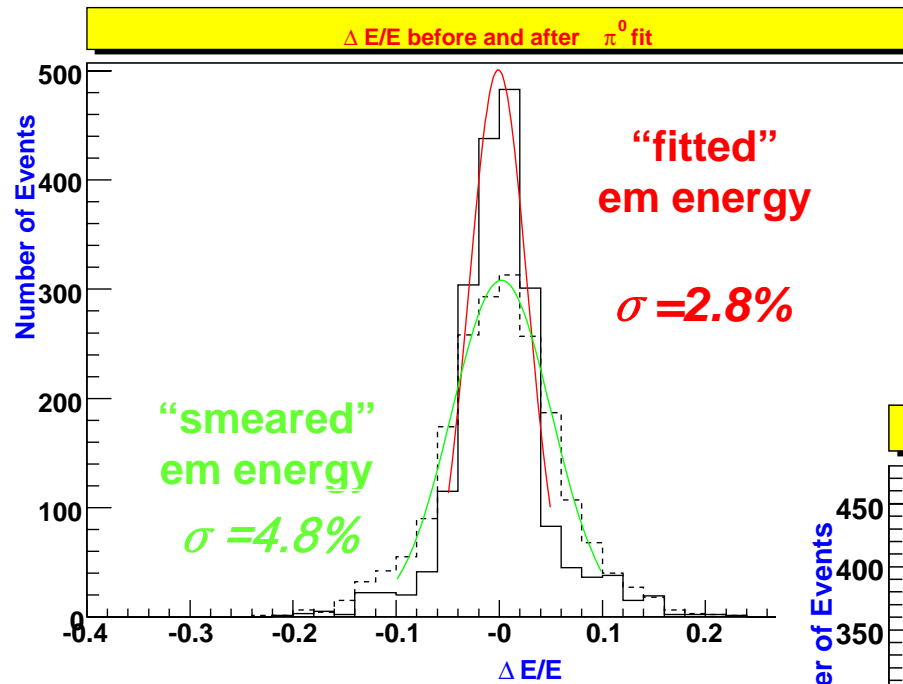
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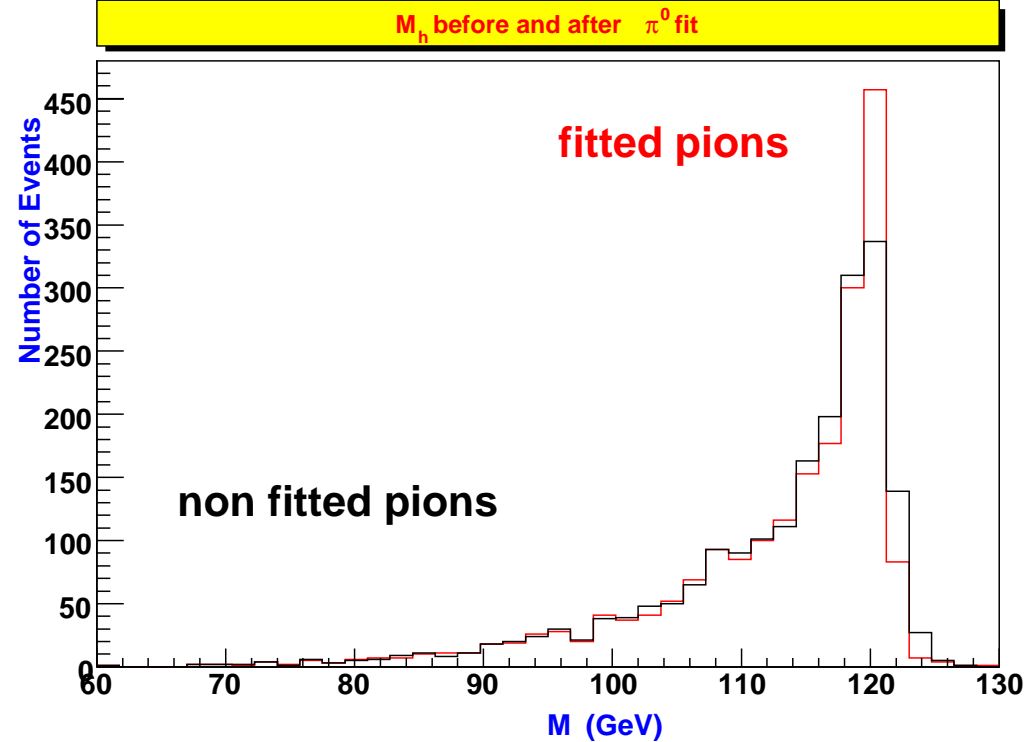
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- Check the [fit influence on](#) some relevant [global variables](#), as
 - the « reconstructed » Higgs mass (invariant mass of the visible event)
 - total EM energy of the event,
.... supposing all other particles perfectly reconstructed.

2. What could be gained with a dedicated reconstruction?



$$\frac{E_{MC}^{em} - E_{REC}^{em}}{E_{MC}^{em}}$$





- MC generator: *PYTHIA 6.321*
- detector simulation: *Mokka v05-06 (LDC00)*
- reconstruction: *Marlin v0.9.1 (TrackWiseClustering)*

- *detector calibration with single, mono-energetic photons*
- *effect of the constrained fit on single, mono-energetic π^0 s*
- *single π^0 s extracted from $H(bb)Z(\nu\nu)$ @ 500 GeV events*

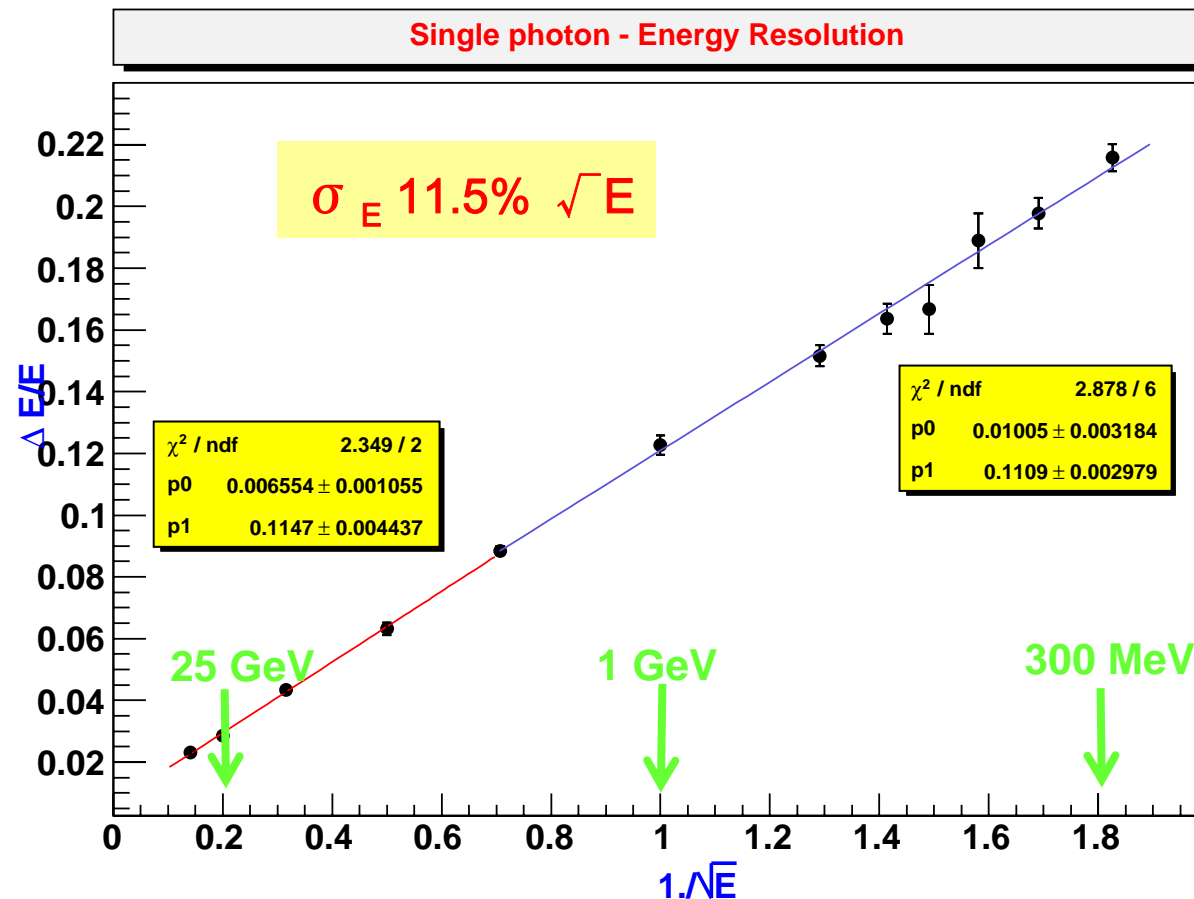


Calibration with single photons:

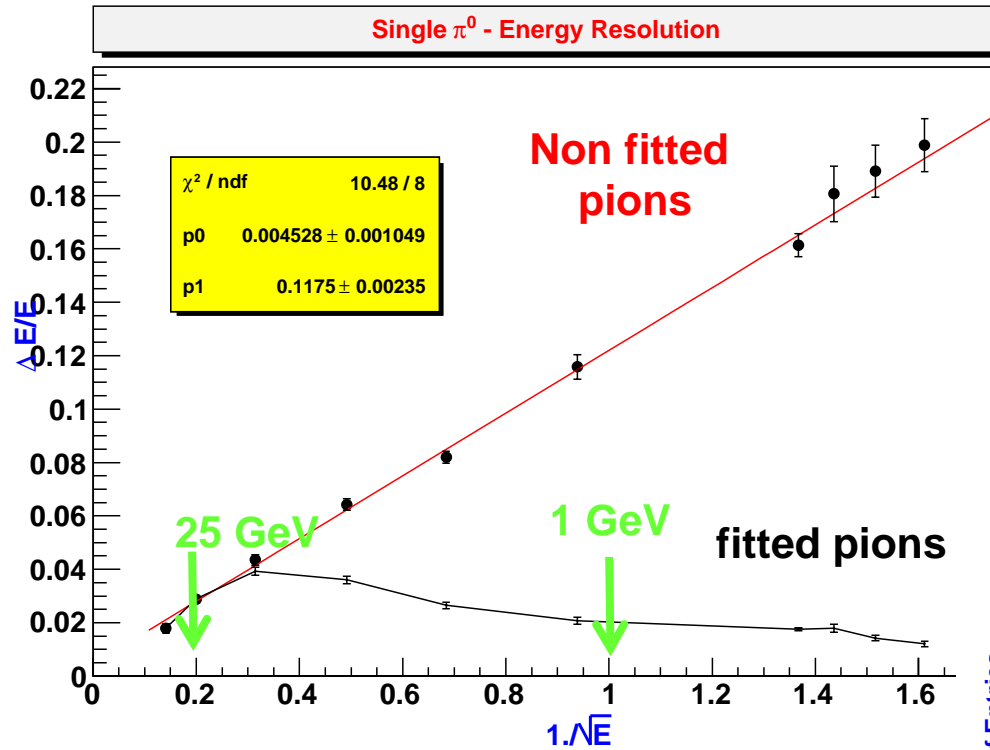
$$E_{\text{cluster}} = \alpha E_{30} + \beta E_{40}, \quad \alpha = 28, \quad \beta = 78.9$$

$$\sigma_{\theta} / \theta = 2 \text{ mrad}$$

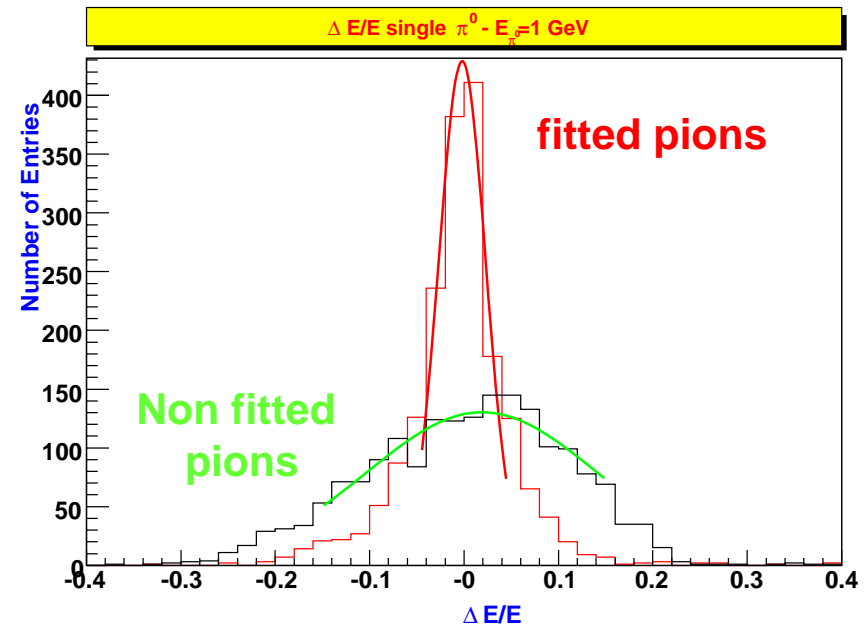
$$\sigma_{\phi} / \phi = 2 \text{ mrad}$$



3. First results in full simulation & reconstruction *Single π^0 s energy resolution*



factor of 6 to 10 improvement
below 1 GeV



3. First results in full simulation & reconstruction

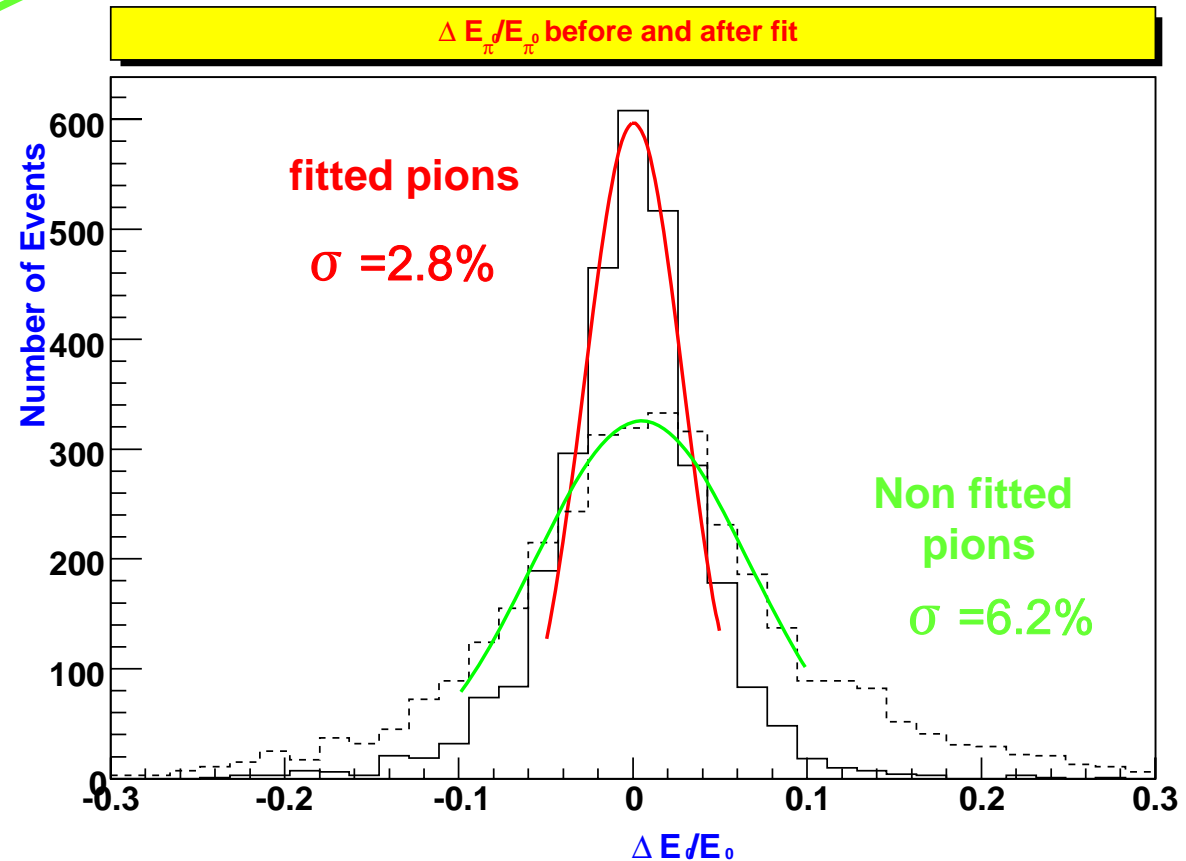
Single π^0 s from HZ



reconstructed clusters	0	1	2	≥ 3
fraction of π^0 s (%)	2.4	24.6	66	6.8

~90% have a low energy photon (< 200 MeV), whereas TrackWiseClustering requires at least 10 hits (~ 150 MeV)

86% of the 2-clusters pions are successfully fitted





As expected, the constrained mass fit nicely improves the π^0 s energy resolution: factor of 6 to 10 below 1 GeV where most of the statistics is, 6.2% to 2.8% overall

Still to be addressed ...

- ✓ The impact of the dedicated reconstruction to be checked within a real particle flow algorithm, eg PandoraPDF
- ✓ Evaluate the performance in context of background (cluster pairing, photon id)