BCAL Energy Resolution

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Introduction

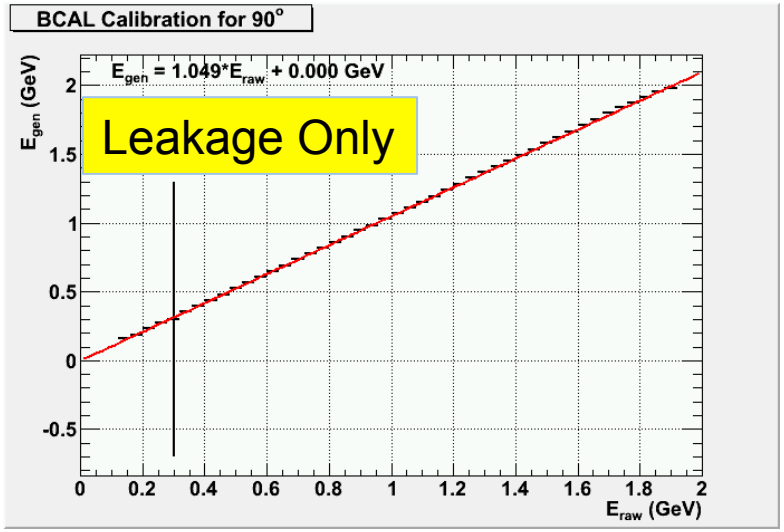
The following slides, show results of simulated/reconstructed data with varying degrees of realism added. Common conditions:

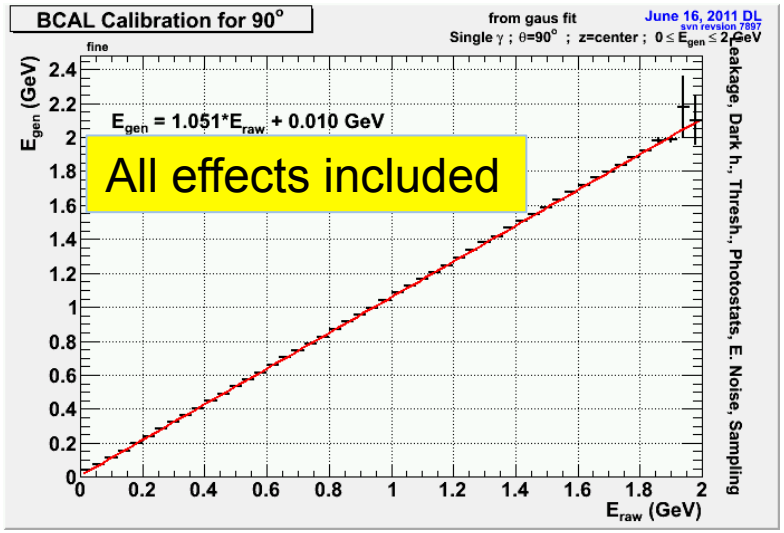
- 90^o photons generated at beamline and aimed at center of BCAL in z
- KLOE reconstruction code used

Energy resolution fits to PDG form: $$\frac{\sigma_E}{E} = \frac{a}{\sqrt{E}} \oplus b \oplus \frac{c}{E}$$

a	**Stochastic term:** • intrinsic shower fluctuations • photoelectron statistics • dead material in front of calorimeter • sampling fluctuations
b	**Constant term:** • detector non-uniformity • calibration uncertainty • non-compensation (hadronic showers) • radiation damage
c	**Noise term:** • electronic noise

Calibration





- The relationship of E_{gen} to E_{raw} was linear for these data sets.

- This differs from the previous calibration function that used:

$$E_{corr} = A \cdot E^{1+\epsilon} + B$$

where $\epsilon \approx 0.08$

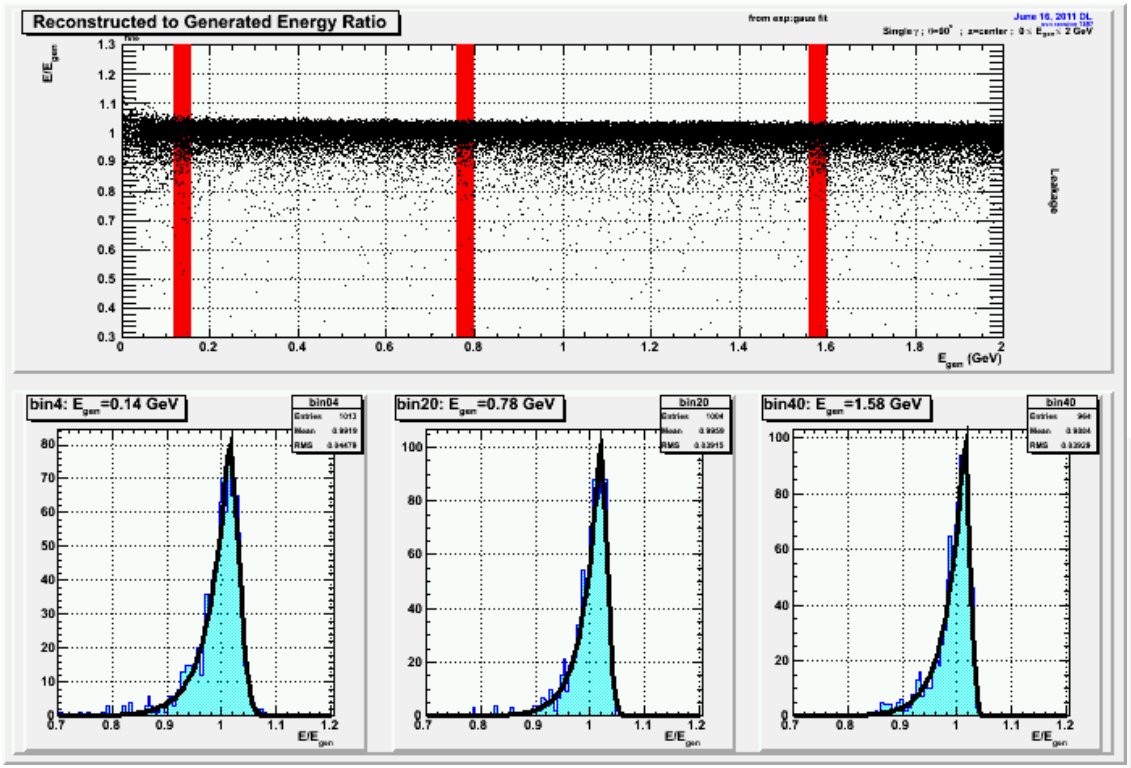
Additional degree of freedom may have been needed due to asymmetric shower distribution in z (?)

- Slices of a histogram of E_{gen} vs. E_{raw} were fit (Gaussians) and the resulting means fit to a line.

- Linear calibration parameters determined and applied for each data set independently

Leakage Only

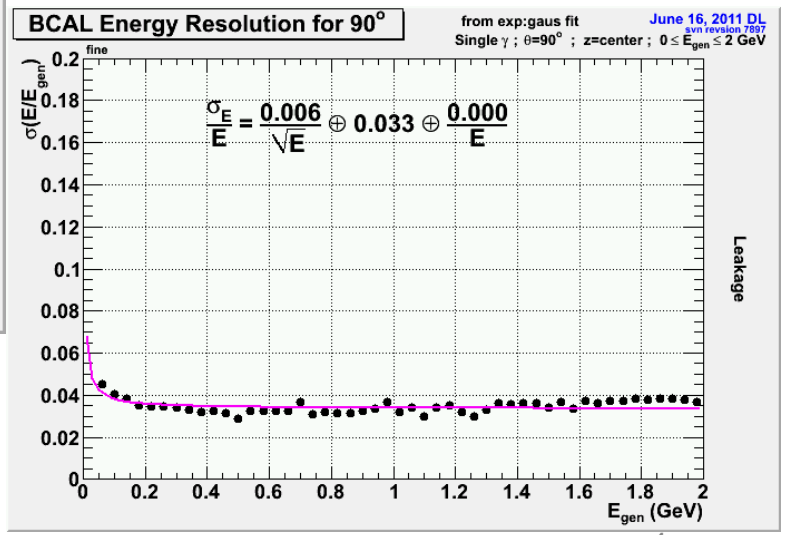
This data set included energy leakage only. All other effects were turned off. “Leakage” will include pre-shower leakage in the Aluminum plate.



RMS determined by fitting function that is exponential to left of peak and Gaussian to right.

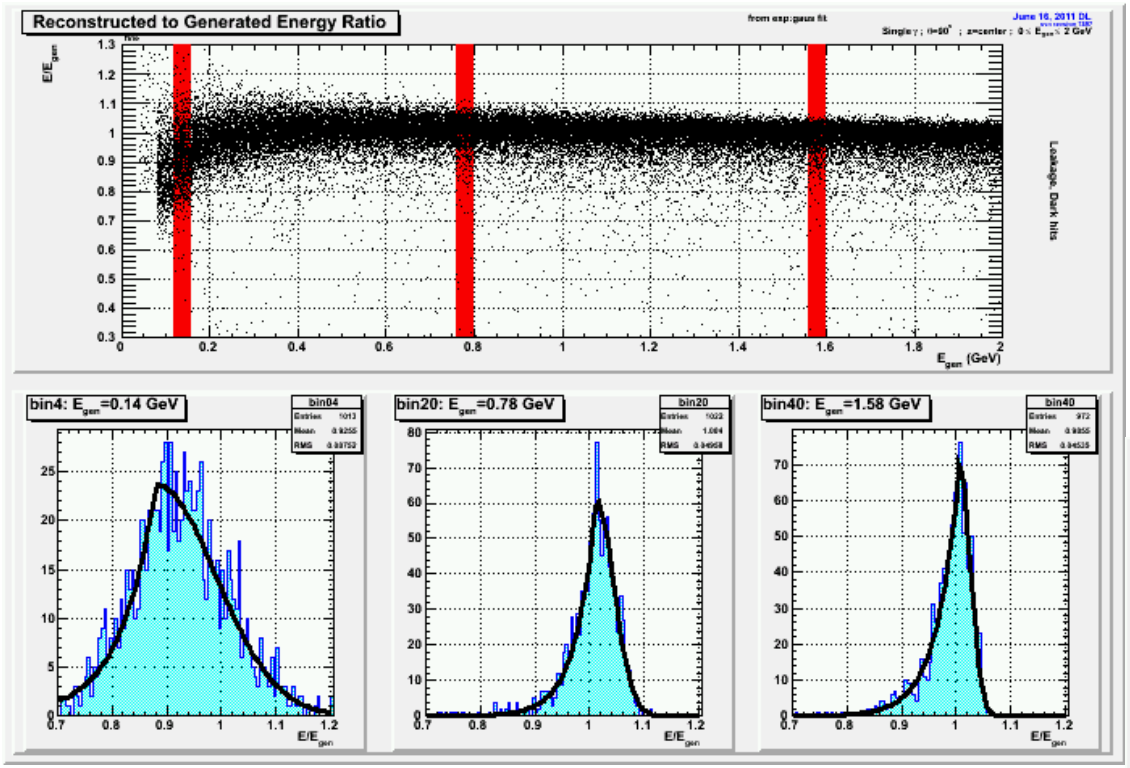
Function is continuous, but 1st derivative is not.

RMS as a function E_{gen} is fit to standard resolution formula from PDG.



Leakage + Dark Hits

This data set included energy leakage and dark pulses, but with no threshold cut. Many showers formed here because every cell is “hit” with dark pulses.



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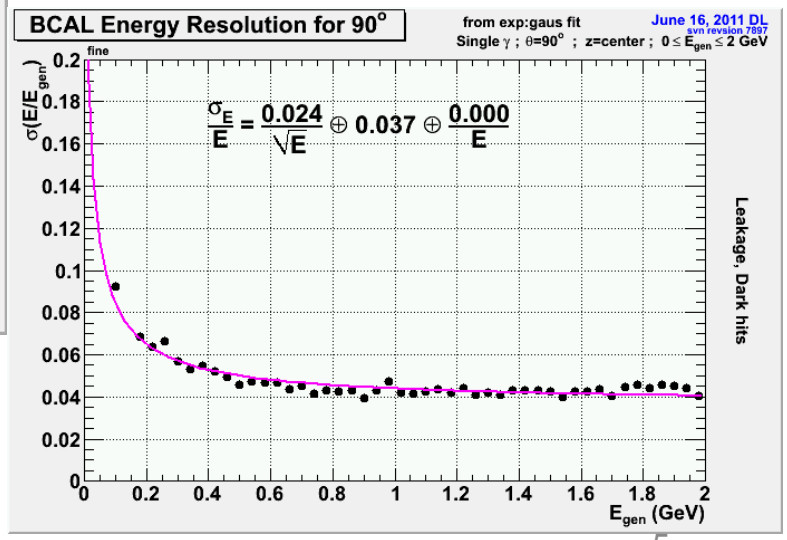
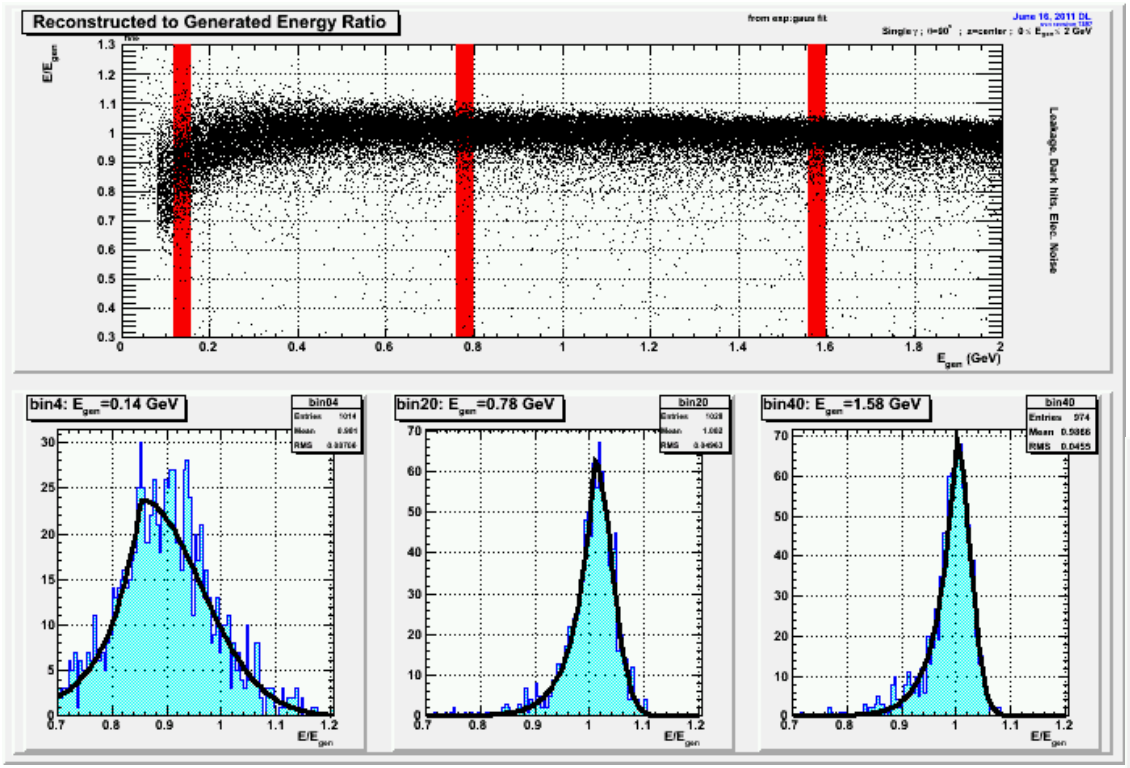


Nrecon==1 cut replaced with E_{raw}>150MeV

Leakage + Dark Hits + Electronic Noise

This data set included energy leakage, dark pulses, and electronic noise, but with no threshold cut. Many showers formed here because every cell is “hit” with dark pulses.



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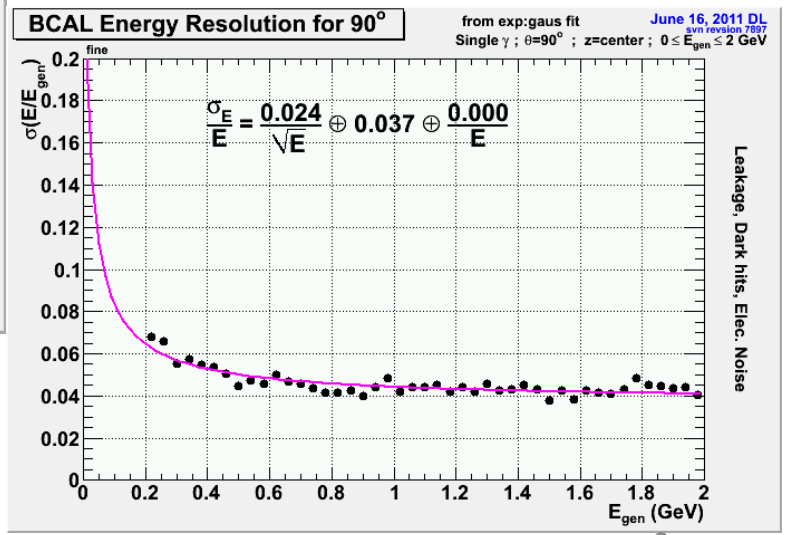

Nrecon==1 cut replaced with E_{raw}>150MeV

Leakage + Dark Hits + Electronic Noise + Threshold

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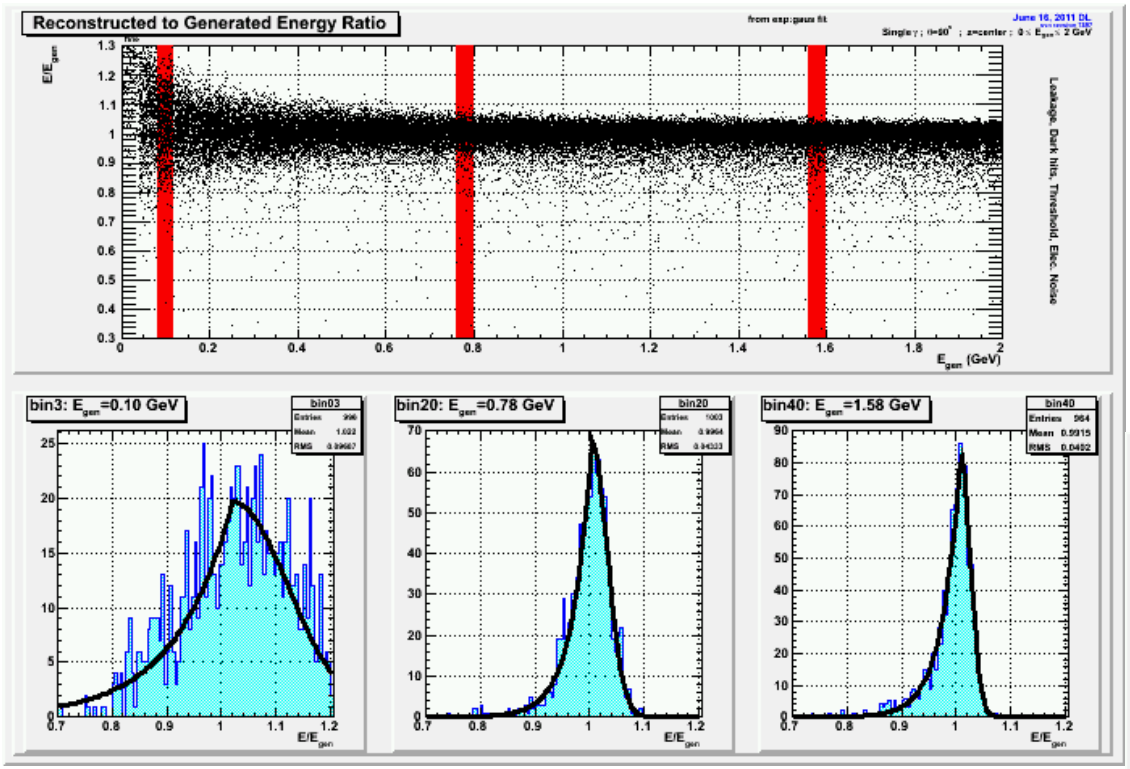

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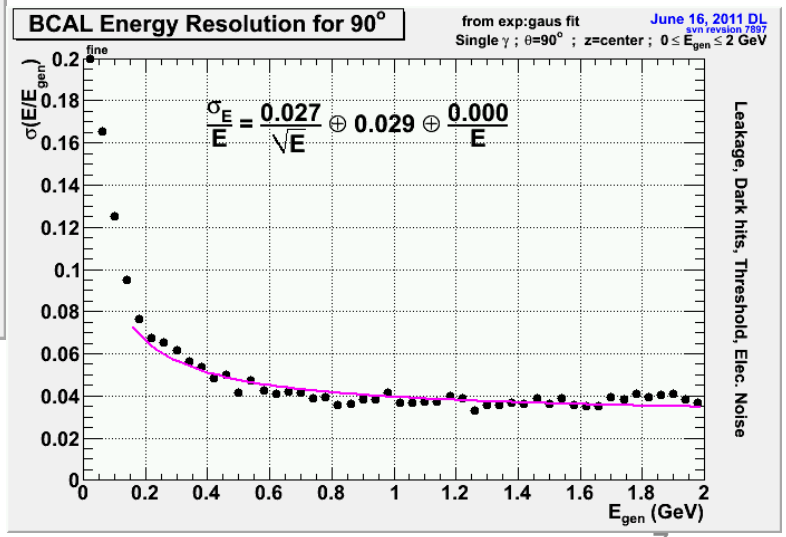

Resolution fit done for E_{gen}>150MeV

Leakage + Dark Hits + Threshold + Photostatistics + Electronic Noise

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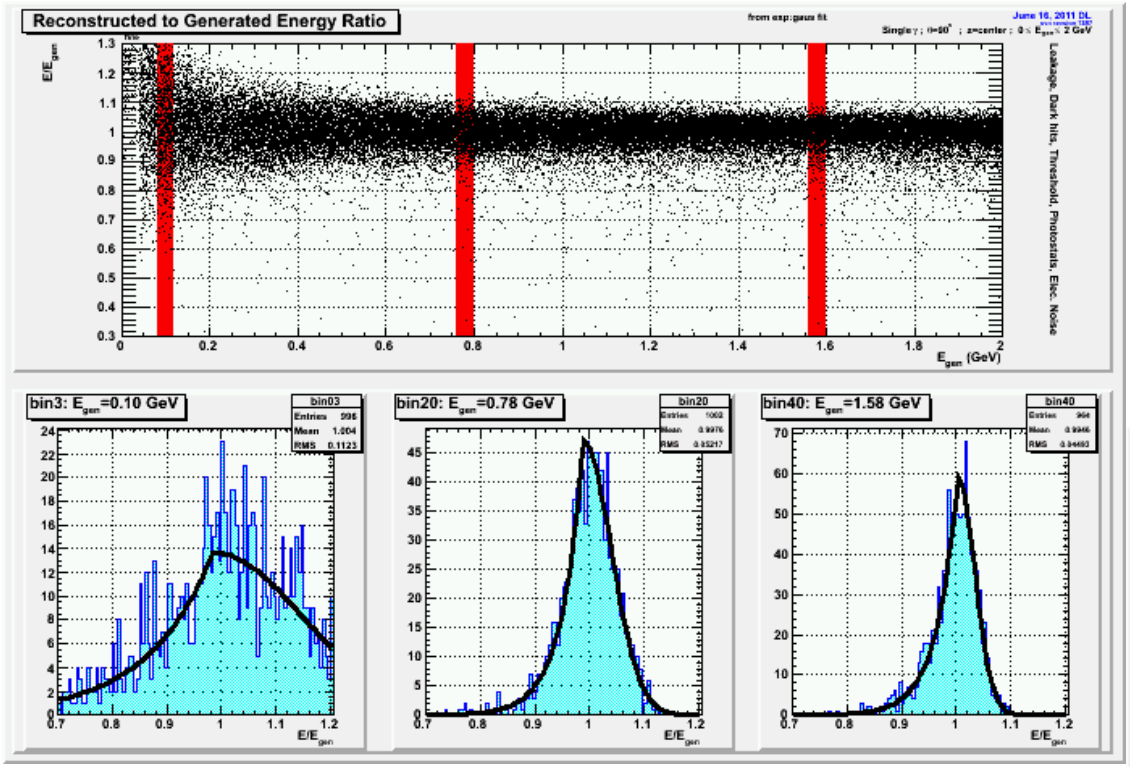

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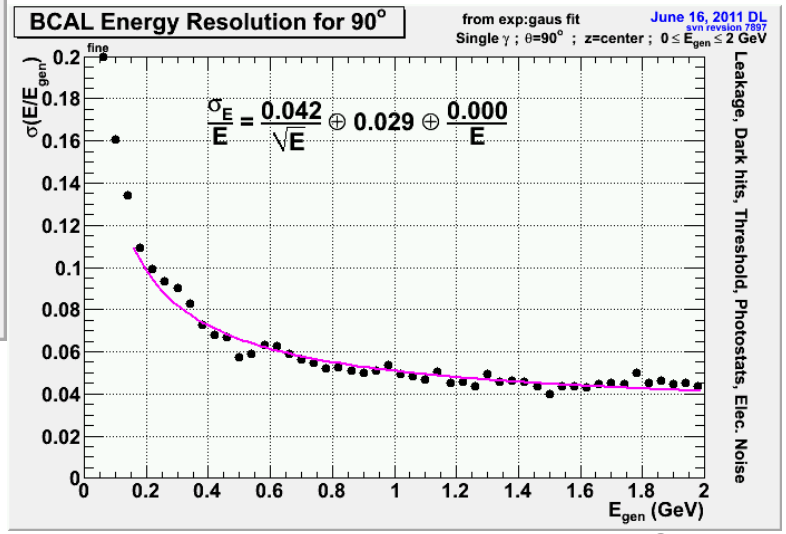
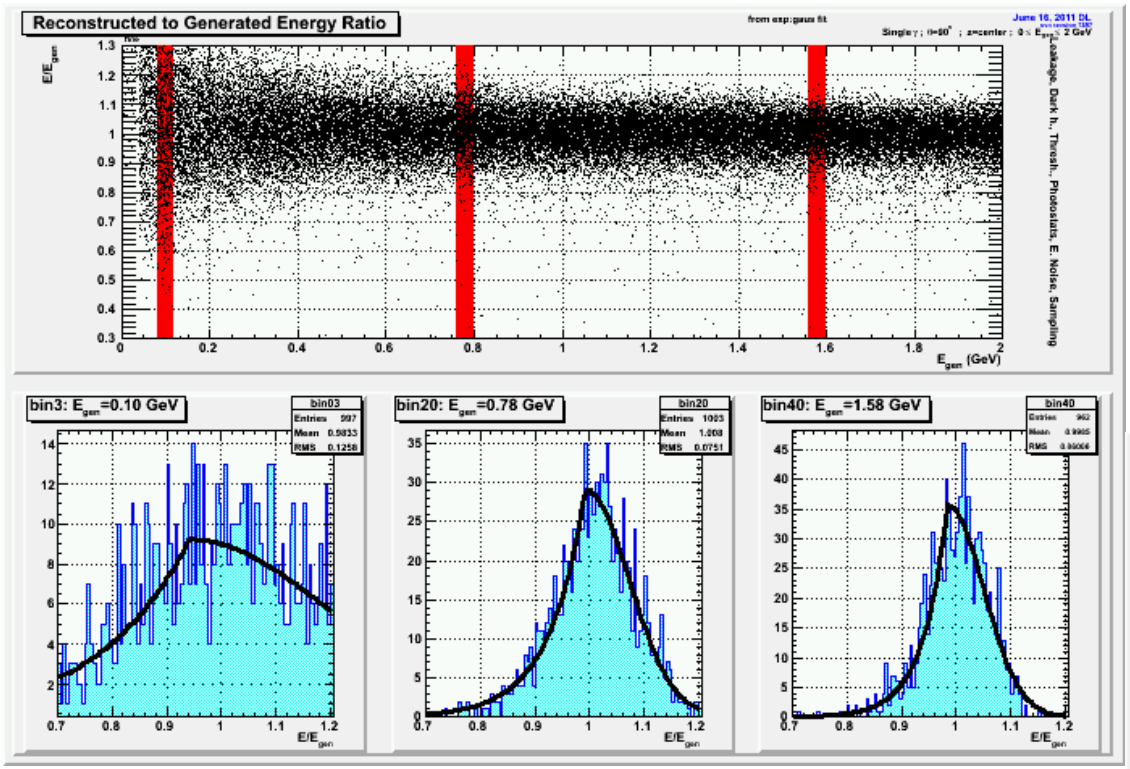


Resolution fit done for E_{gen}>150MeV

Leakage + Dark Hits + Threshold + Photostatistics + Electronic Noise + Sampling Fluctuations

This data set includes all effects, including energy smearing due to sampling fluctuations using $\sigma_{sf} = \frac{4.2\%}{\sqrt{E}} \oplus 1.3\%$



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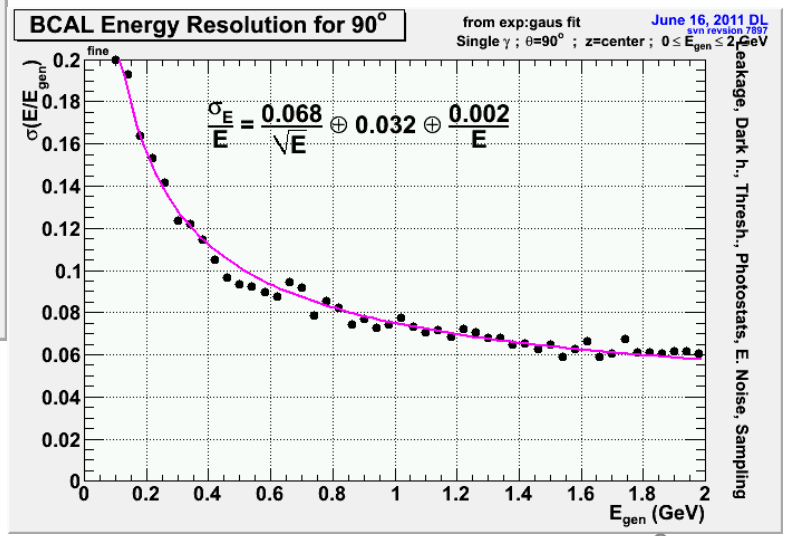

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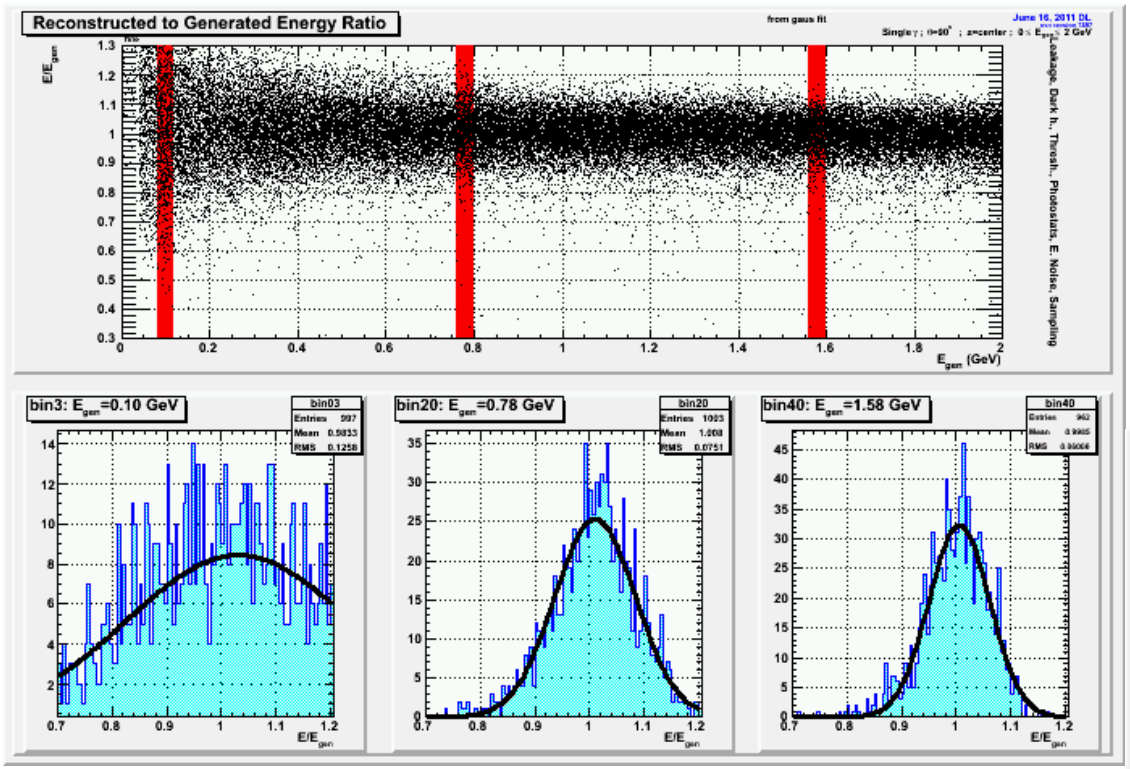
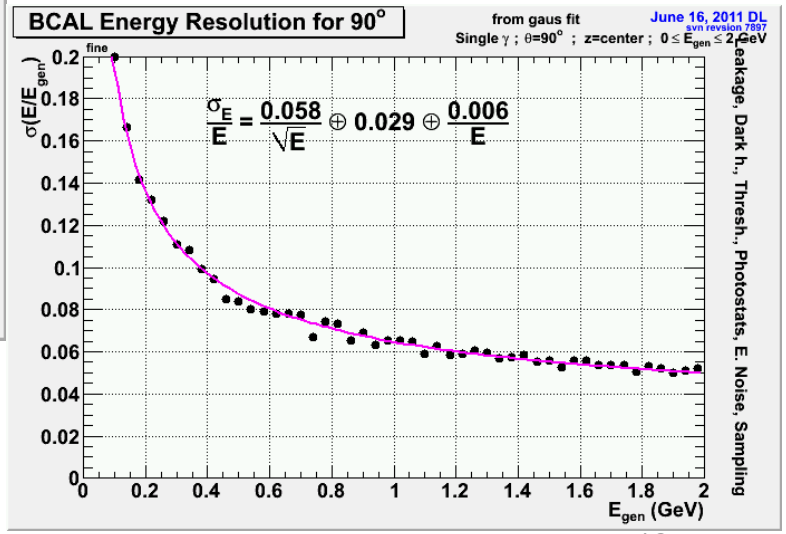


RMS determined by Gaussian function

Stochastic term is ~6% when fit to Gaussian (~7% when fit to exp:gauss).

Other terms roughly constant



Summary of contributors to resolution for fine segmentation

The table below summarizes the fit results for the energy resolution as various effects are added. **Conclusions:**

- *Leakage is only significant contributor to constant term*
- *No significant contributors to noise term*

$$\frac{\sigma_E}{E} = \frac{a}{\sqrt{E}} \oplus b \oplus \frac{c}{E}$$

	a 1/sqrt(E)	b constant	c 1/E
Leakage only	0.6%	3.3%	0.0%
+ Dark hits	2.4%	3.7%*	0.0%
+ Elec. Noise	2.4%	3.7%*	0.0%
+ Threshold	2.7%	2.9%	0.0%
+ Photostatistics	4.2%	2.9%	0.0%
+ Sampling Fluct.	5.8%	2.9%	0.6%

All three terms (a,b,c) allowed to float in fit

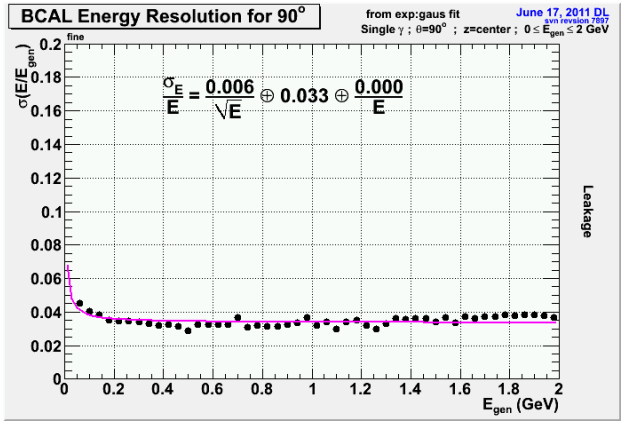
a	**Stochastic term:** • intrinsic shower fluctuations • photoelectron statistics • dead material in front of calorimeter • sampling fluctuations
b	**Constant term:** • detector non-uniformity • calibration uncertainty • non-compensation (hadronic showers) • radiation damage
c	**Noise term:** • electronic noise

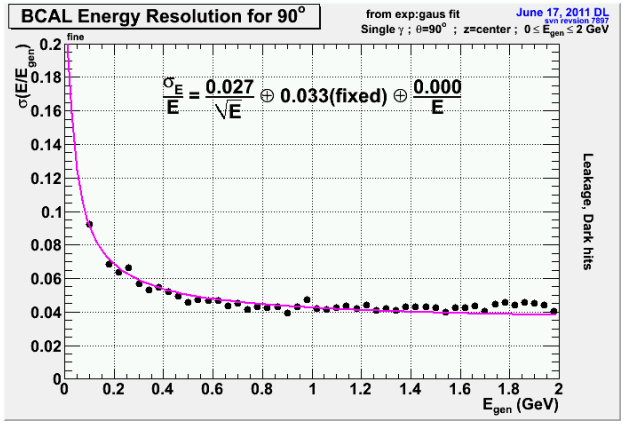
$\sigma_{sf} = \frac{4.2\%}{\sqrt{E}} \oplus 1.3\%$, Gauss fit

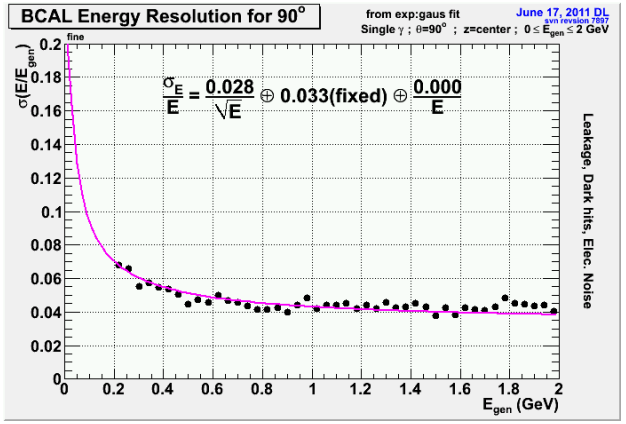
* E_{raw}>150MeV used instead of N_{recon}==1

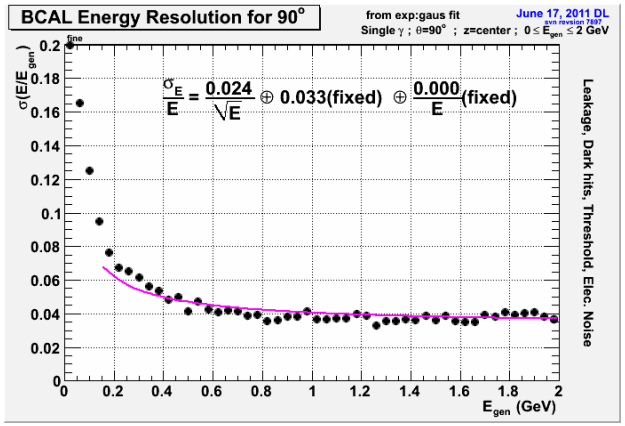
Refit with constant term and noise term fixed

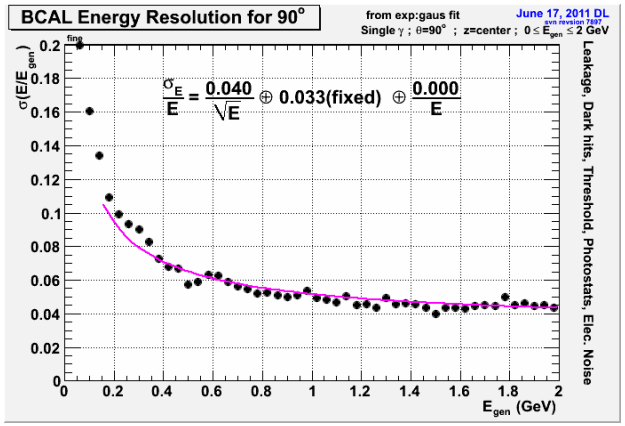
- Assume constant term comes only from leakage and is fixed at 3.3%
- Fix noise term at 0%
- Refit to find stochastic contribution of various effects

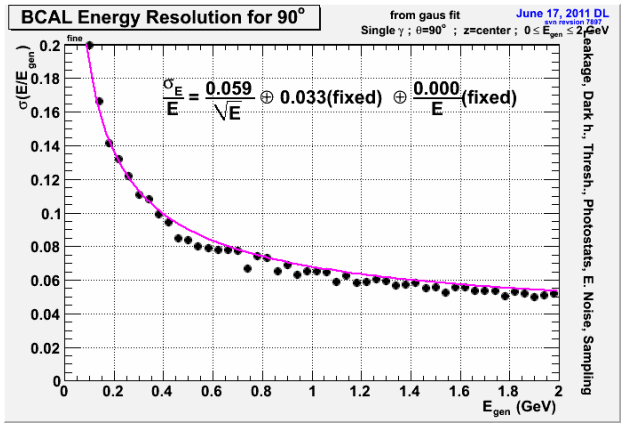












Summary of contributors to resolution for fine segmentation (refit)

Only *a* allowed to float in fit

	a (total)	a (contrib)
Leakage only	0.6%	0.6%
+ Dark hits	2.7%*	2.6%
+ Elec. Noise	2.8%*	0.7%
+ Threshold	2.4%	-1.4%
+ Photostatistics	4.0%	3.2%
+ Sampling Fluct.	5.9%	

Dark hits + threshold contribute 2.2%

$\sigma_{sf} = \frac{4.2\%}{\sqrt{E}} \oplus 1.3\%$, Gauss fit

** E_{raw}>150MeV used instead of N_{recon}==1*

$$\frac{\sigma_E}{E} = \frac{2.2\% \oplus 3.2\%}{\sqrt{E}} \oplus 3.3\%$$

$$= \frac{3.9\%}{\sqrt{E}} \oplus 3.3\%$$

No sampling fluctuations

Summary for 90^{o} Tracks

Stochastic Term summary

	NIM article	sim-recon
Sampling Fluctuations	4.5%	4.2% (calibDB)
Photo-statistics	3.1% (2.7% KLOE)	3.2%
Dark Hits	0.0%	2.2%
Total	5.4%	5.7%

Recommendations:

- *Sim-recon currently has 1.3% in calibDB for constant term. This is primarily due to leakage so should be set to 0 so that it is not included twice*

- *Leave Sampling fluctuations at 4.2% until energy dependent function is derived*

(?Andrei or Irina using Fluka?)