Recent Progress in Fastsim EMC

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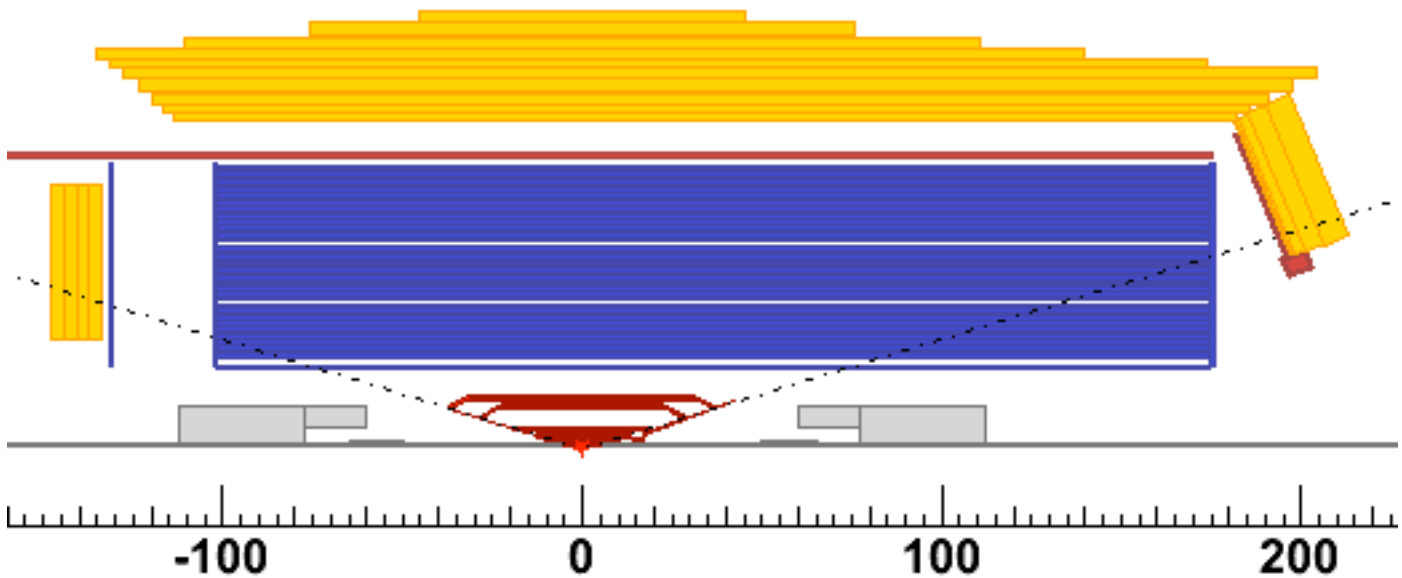
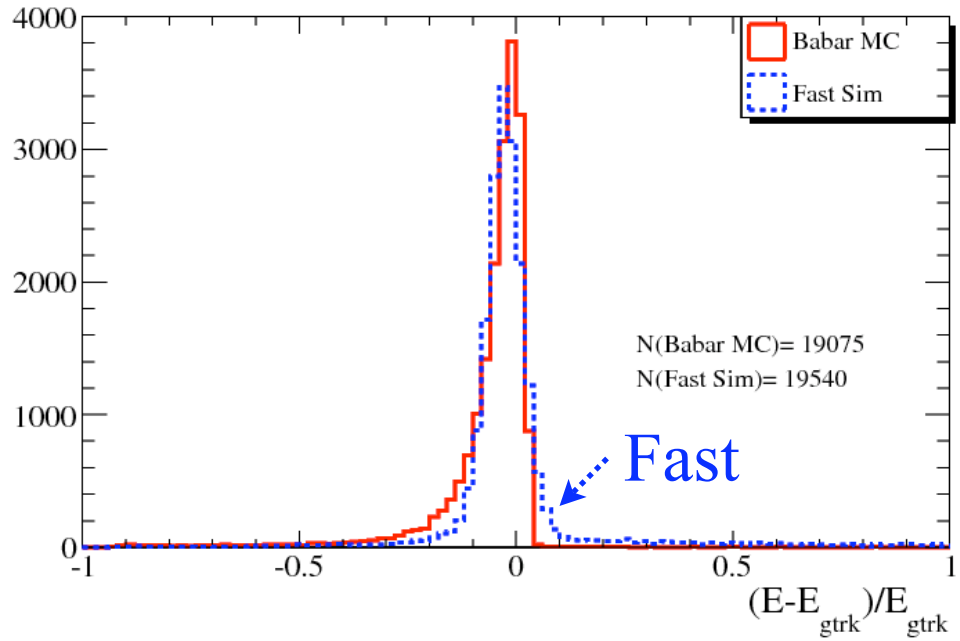
Geometry

- Modeled in layers to approximate crystal lengths in barrel.
- Parametric segmentations. Perfectly projective towards the "IP" (intersection of 90° crystal gap plane and the z-axis).
- Backward EMC is segmented in 8 rings, 60 "crystals" in each ring, even though the real design does not use crystals. The important thing for fastsim (at least so far) is to model the efficiency and resolution correctly, not to worry about reconstruction.



γ Energy resolution was not well modeled

- The very high energy tail was due to energy double counting. E.g., if γ converts, the energy loss of γ should not be counted because e+e- carry all its energy.
- The asymmetric feature needs a different resolution model other than a simple Gaussian.
- Calibration.



Fast sim has a long high-side tail.
Full sim is more asymmetric and has a long low-side tail.
[note: full sim does not have background frame mixed in]

Resolution model

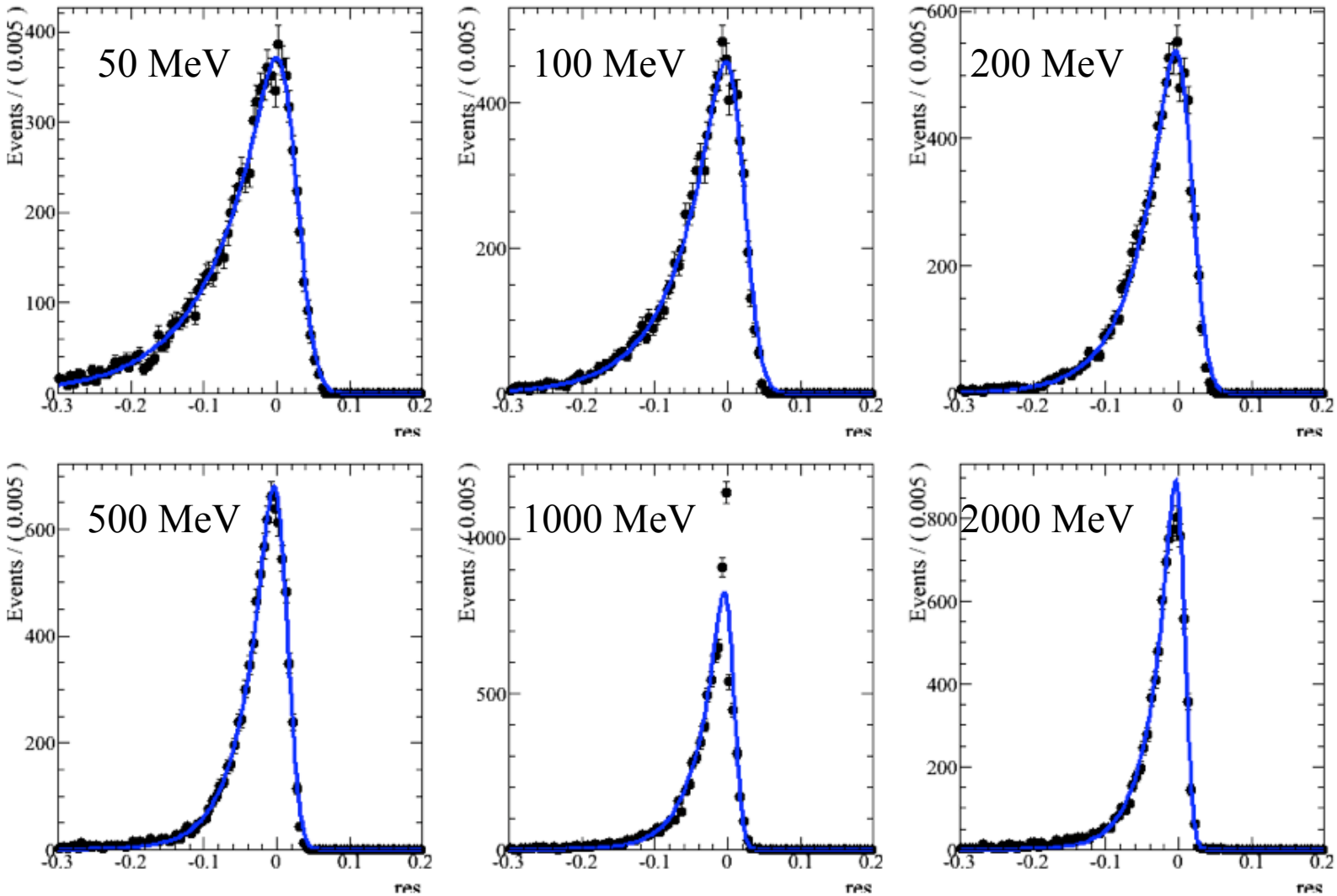
- To model the asymmetric resolution, I use a Gaussian convoluted with an exponential decay, so called GExp model

$$f(x;m,\sigma,\tau) = \frac{1}{2\tau}\exp\left(\frac{\sigma^2}{2\tau^2}+\frac{x-m}{\tau}\right)\mathrm{erfc}(\frac{\sigma}{\sqrt{2}\tau}+\frac{\mathrm{x-m}}{\sqrt{2}\sigma})$$

  - Operationally, one simply smear it with a Gaussian followed by an exponential.
- Fit the energy resolution using full simulation in BaBar.
  - Single mono-energetic γ. No background.
  - Shooting from R=90cm, just in front of the EMC, to avoid material in front of the EMC.
  - Fit for energy dependence of each parameter.

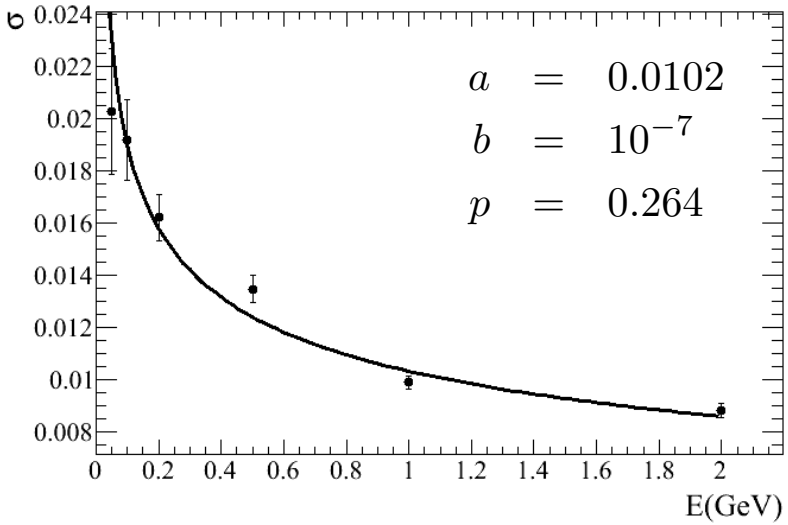
Full sim resolution

Single photon. No background frame mixed in.

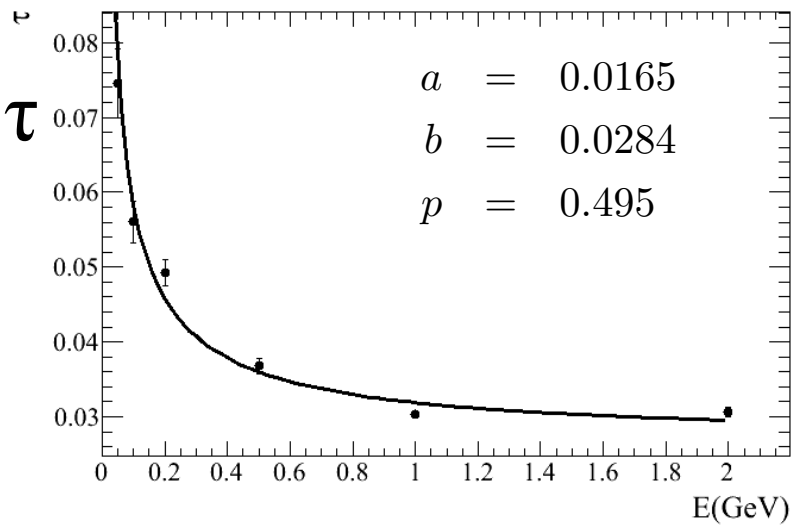


Energy dependence

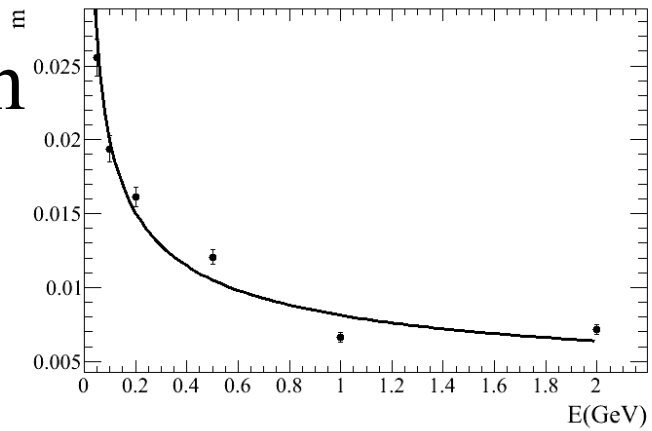
σ



τ



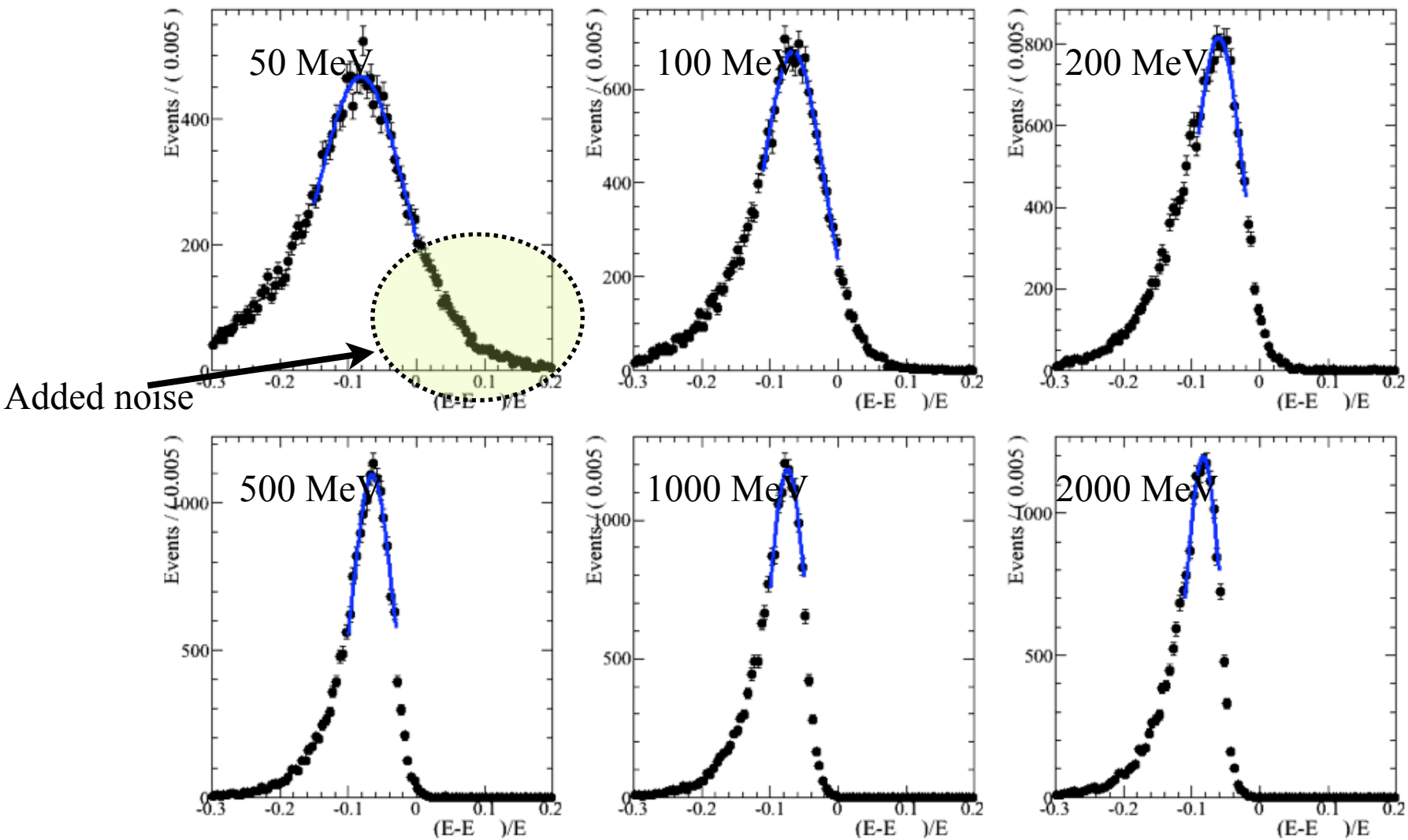
m



- Fit to $f(E) = \sqrt{\left(\frac{a}{E^p}\right)^2 + b^2}$
- Assume m=0; will calibrate out the shift.
- Smear the entire cluster's energy after splitting/merging, based on the ~true energy deposition, modulo loss in the gaps.

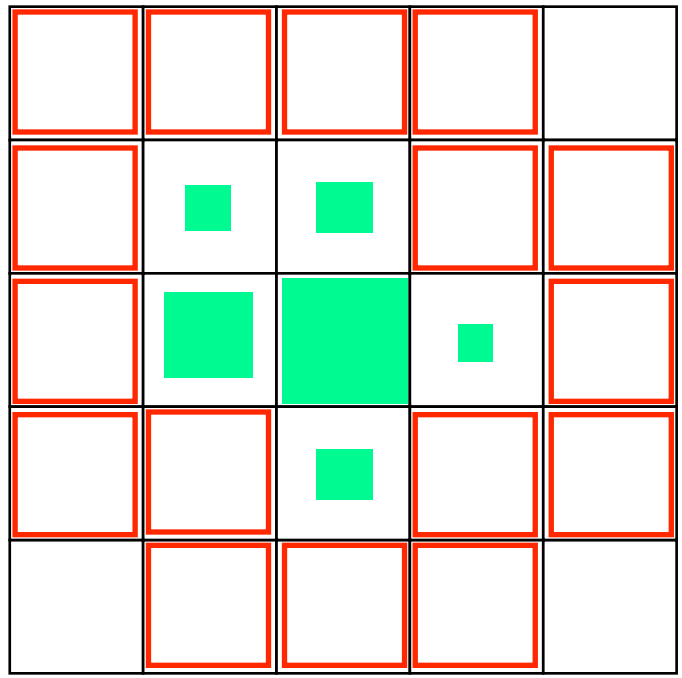
Fast sim resolution (no calibration)

- Fit the peak using a Gaussian.

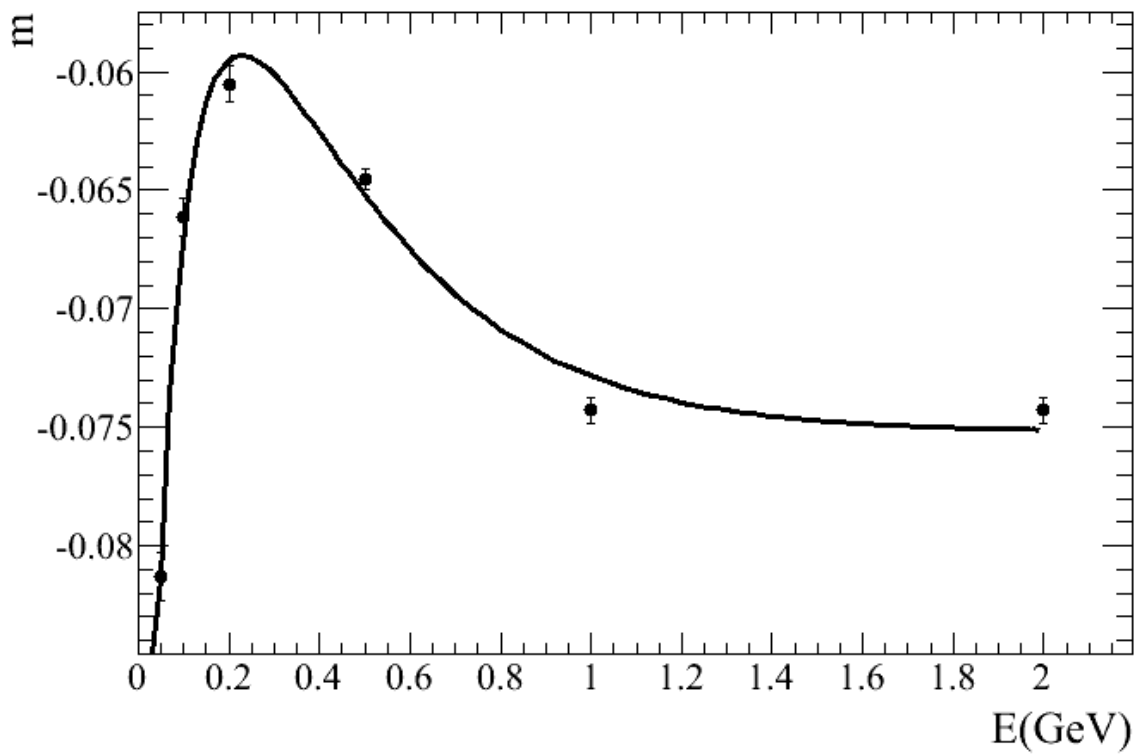


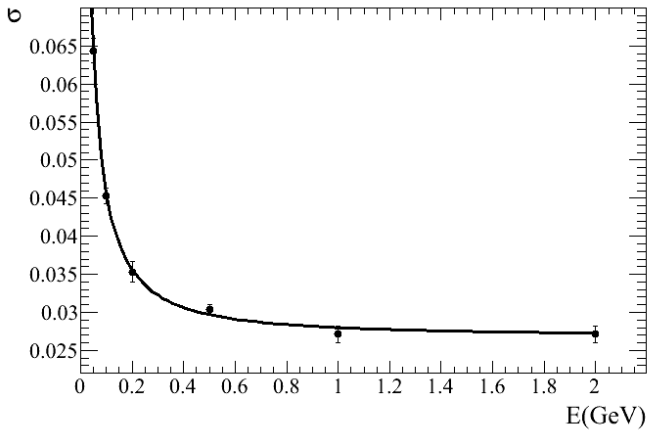
Added “electronic” noise

- For each cluster, add some energy to some crystals around it.
- Occupancy : (10 ± 5)%
- Energy: (1 + ε) MeV, where ε is a random number from $e^{-\varepsilon/1\mathrm{MeV}}$.



Calibration curve

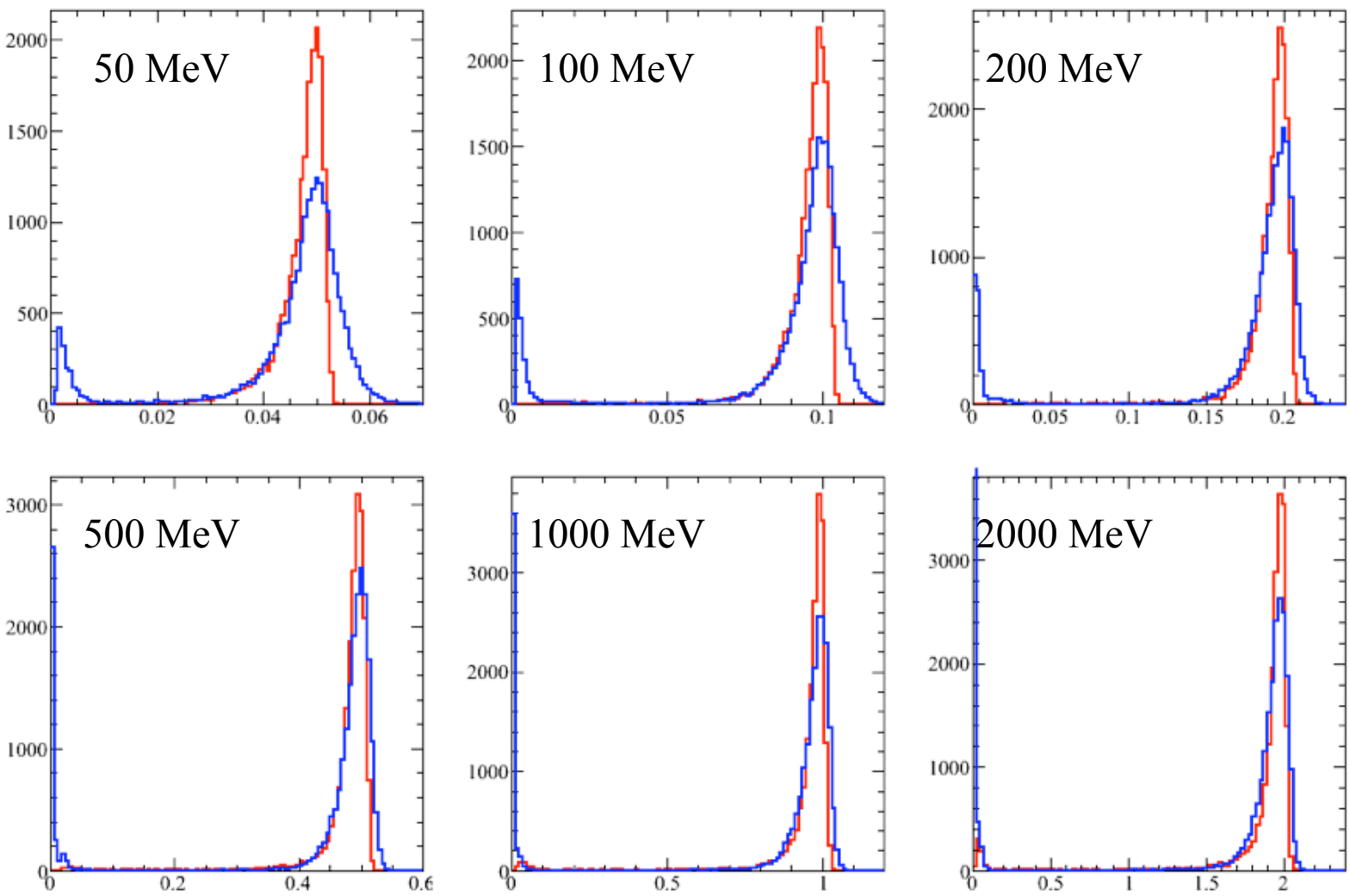




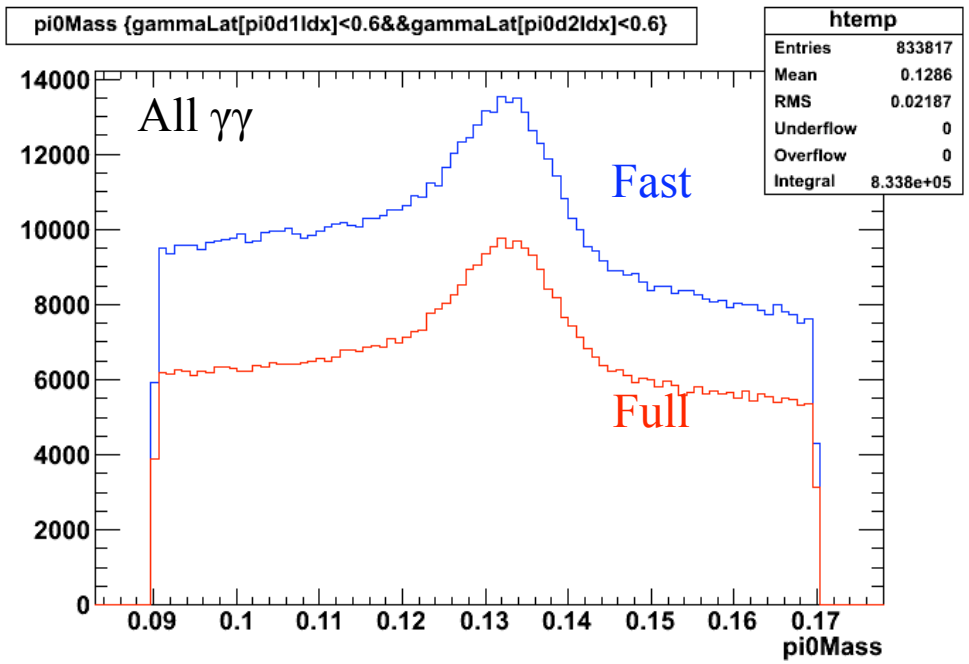
- Fit Gaussian mean to $f(E) = p_0 + p_1[(\log(p_2 E) + p_3]e^{-p_2 E}$

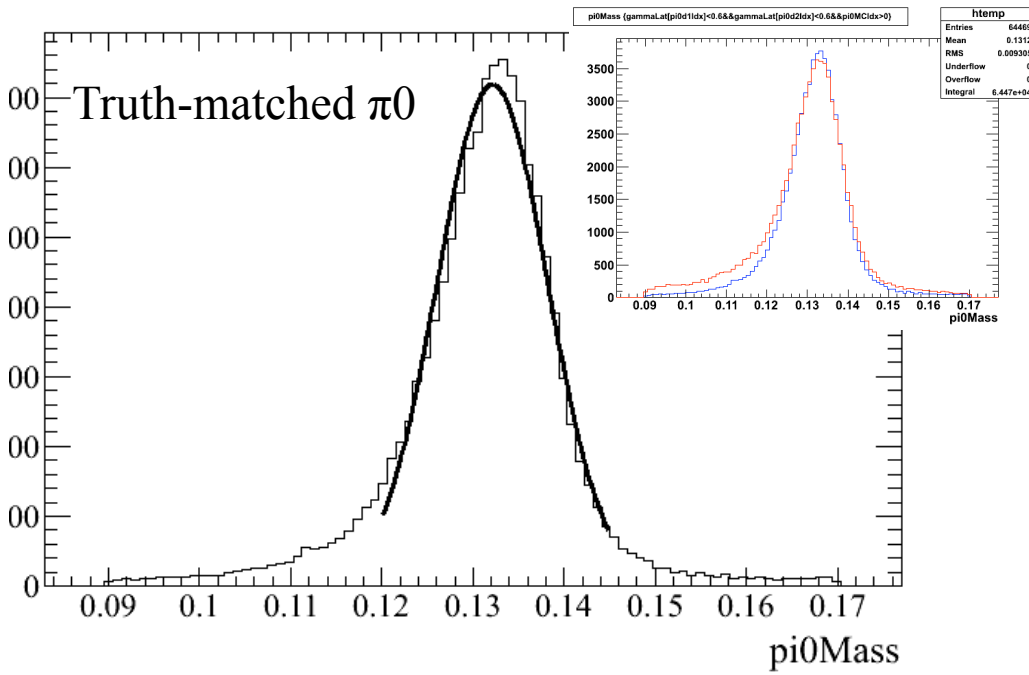
After calibration

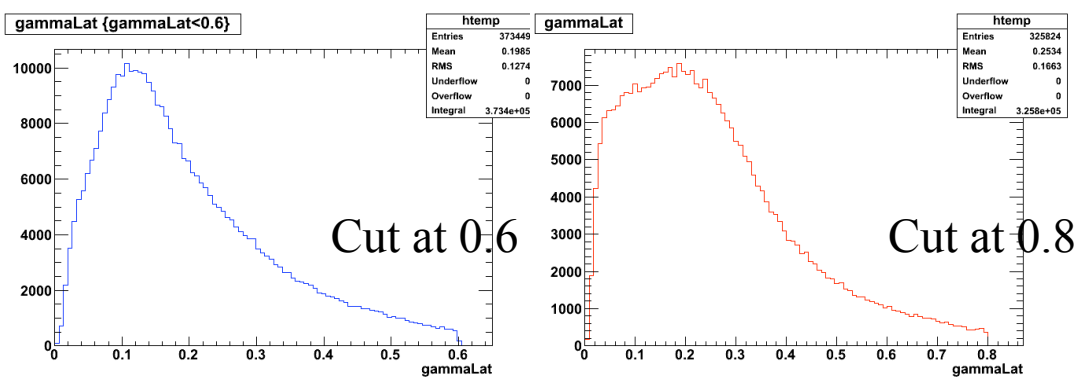
Full sim, no background; Fast sim



π^0 mass in generic B







γ candidate LAT
Tighter cut for fast sim to make them look similar

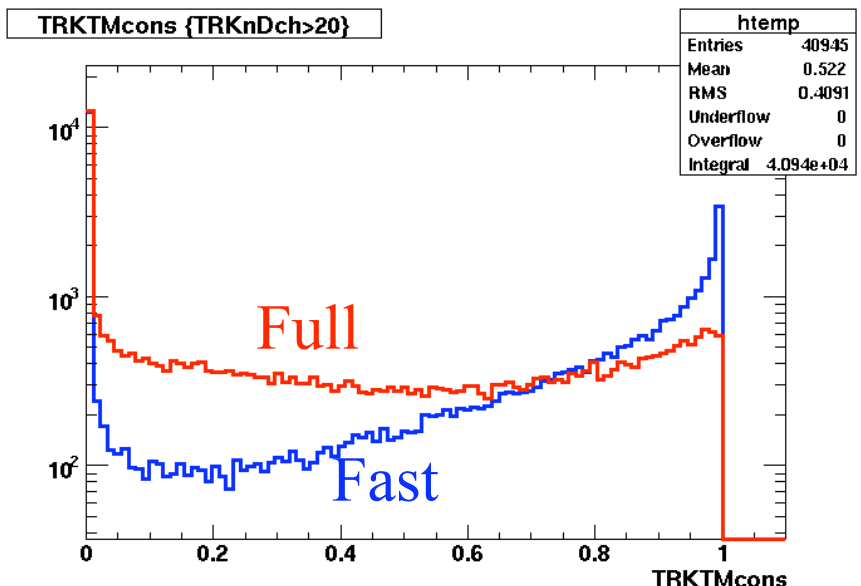
- Single Gaussian fit between 120 and 145 MeV: m= 132.1 MeV σ= 6.1 MeV Real peak is around 133 MeV.
- Truth-matched π^0 look similar, but way too many π^0 candidates in fast sim (too many γ's).
  - Track-matching problem?

Comments

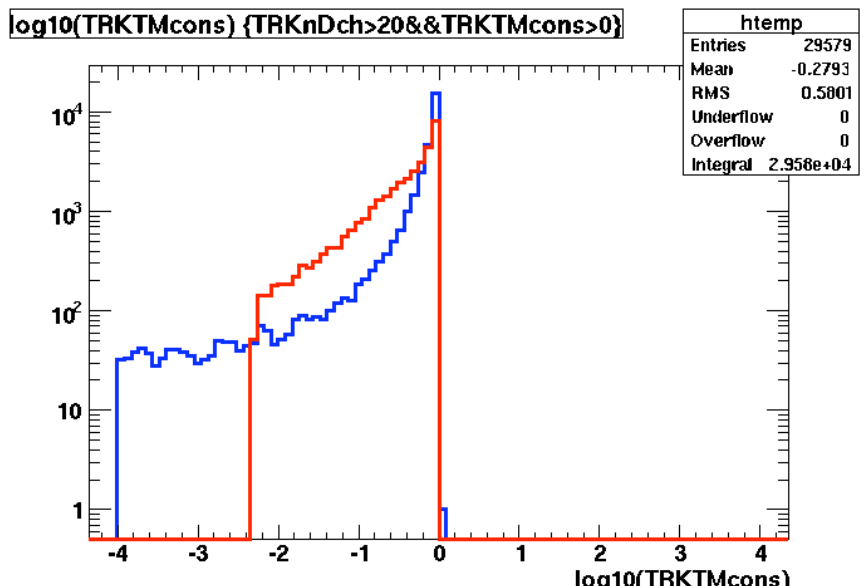
- Energy resolution modeling is getting better.
- Model is only based on BaBar barrel. We assume SuperB forward EMC has the same resolution as barrel => need LYSO full sim input. Backward EMC is a wild guess. → $\frac{14\%}{\sqrt{E}} \oplus 3\%$
- Cluster shape (e.g. LAT) is quite hard to tune. Probably good enough.

Track-cluster matching

- Fastsim: Find the cluster that has the highest consistency to a track, using DOCA and cluster size to calculate consistency.
- Not exactly the same algorithm in BaBar.
- Consistency distribution looks wrong (wrong degrees of freedom? I use dof=3.).
- Efficiency seems too low. Why?



Matching consistency



same plot, just log10(consistency)

Gap between crystals

- Added a simple model to simulate the effect of the gaps between crystals.
- Detector material doesn't change at all.
- Simply make the active region of each crystal smaller, size according to xml configuration. Thus energy collected is slightly less.
- (no plots here, sorry)

Signal timing

- Simple model of the electronic signal for each PacSimHit at the calorimeter: A linear rise (from t0 to tp) followed by an exponential decay.
- For each PacSimHit, we calculate the integral of this shape within a certain window, and take the ratio of this integral to the integral with t0 = 0. Only deposit energy= PacSimHit energy change times this ratio.
- Current set up:
- forward: window = +/- 0.1 μs, tp= 0.01 μs, τ= 0.1μs.
- barrel/backward: window = +/- 1 μs, tp= 0.1 μs, τ= 1μs.