EMC FastSim Status

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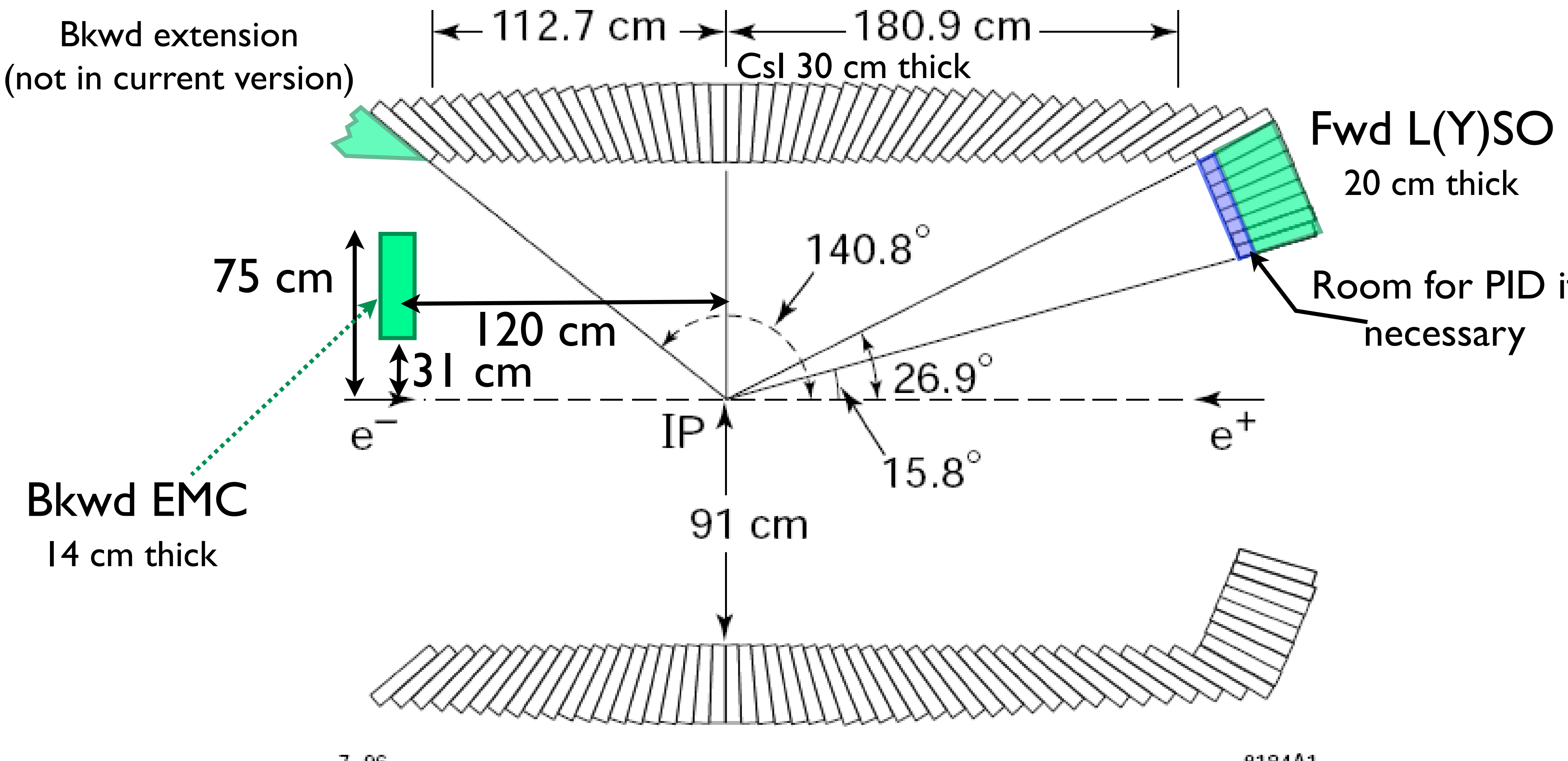
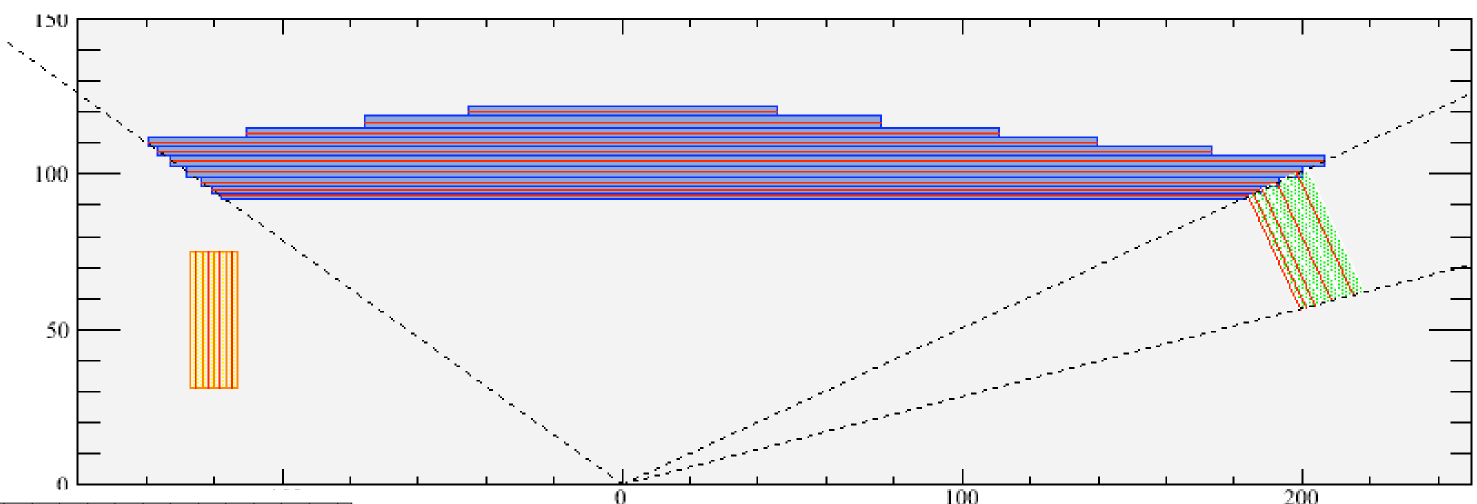
EMC geometry in the fastsim

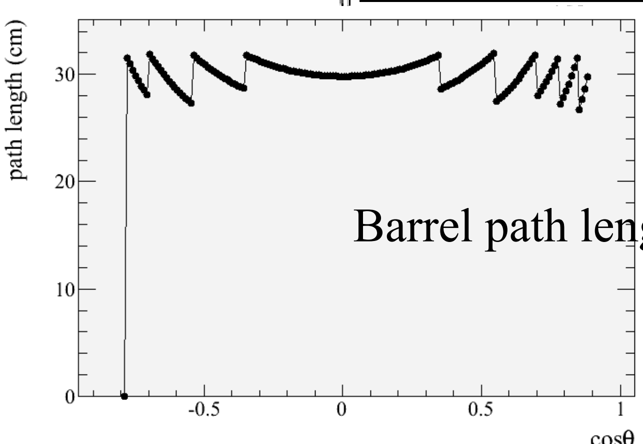
- Barrel: cylinder; Forward endcap: cone; Backward: disk



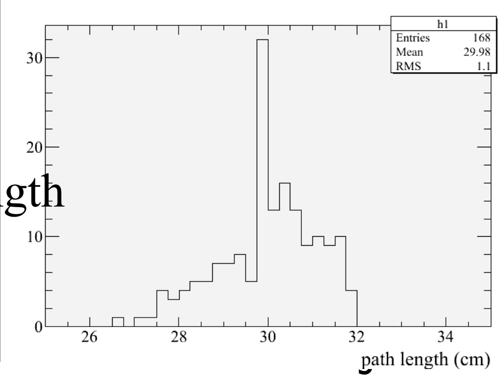
FastSim geometry representation

- Geometry is represented with a 2D surface with certain thickness. Interaction is calculated only once at each 2D surface, rather than stepping through a volume.
- We use multilayers to approximate the thickness of EMC.





Barrel path length



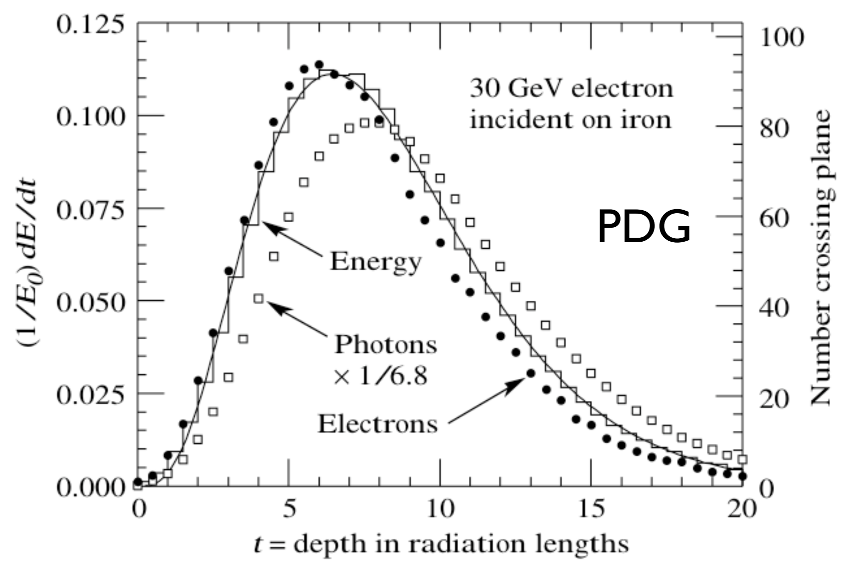
- Not simulate individual crystals. Expected energy deposition in each layer is calculated analytically and distribute laterally to nearby crystals according to a number of functions.

Configuration

- Geometry is specified in three config xml files (fwd, barrel, bwd)
  - material, dimension, measurement type
- EMC properties are specified in one config xml file.
  - segmentations (# rings, # crystals in each ring)
  - Moliere radii
  - Energy fluctuations
  - Shape parameters
  - Calibration parameters
  - etc...

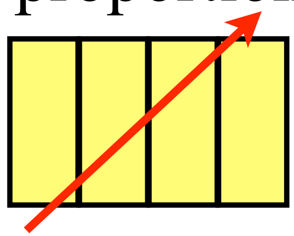
Interactions

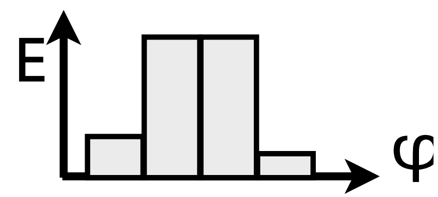
- Allow bremsstrahlung, γ conversion, nuclear interaction, Compton scattering, EM and hadronic shower.
- If a particle interacts before showing, we simulate all particles it produces.
  - e.g., if $\gamma \rightarrow e+e- \rightarrow e+e-\gamma$, simulate all three showers and merge them if they are close to each other
- If a particle showers, it distributes its remaining energy along its direction to subsequent layers according to a approximate gamma distribution.
  - leak to the back is simulated.



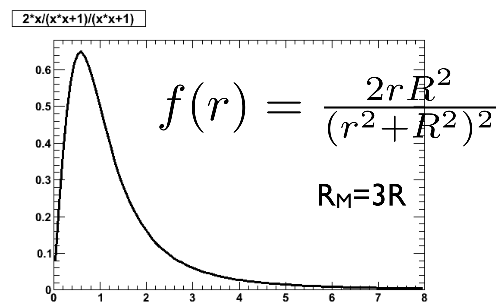
Cluster forming

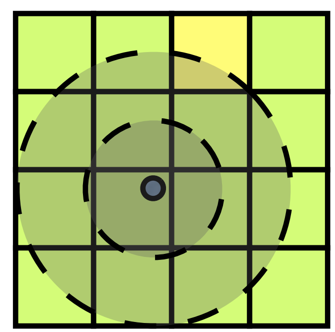
- Three types of clusters:
  - Minimal ionizing: assuming a straight line going through crystals; energy proportional to path length.

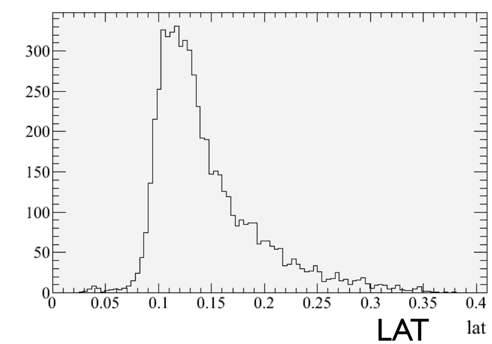




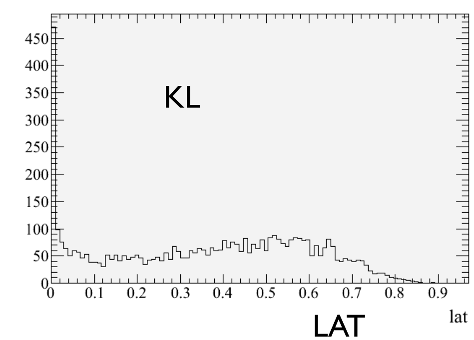
  - EM shower





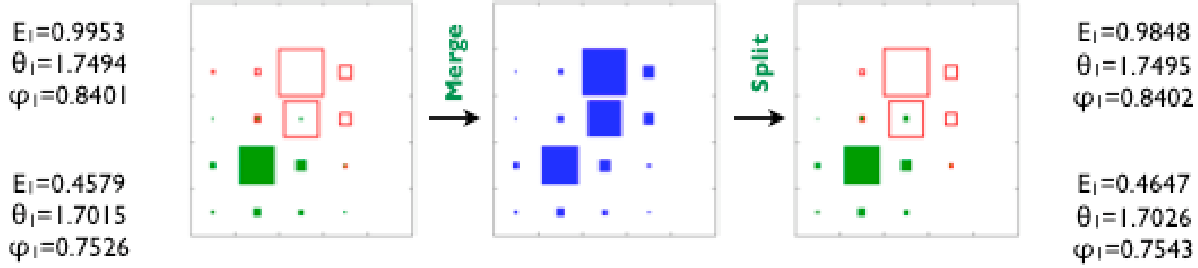


  - Hadron shower
    - fraction of energy to form a EM-like cluster
    - remaining energy to form an irregular cluster using random walk.

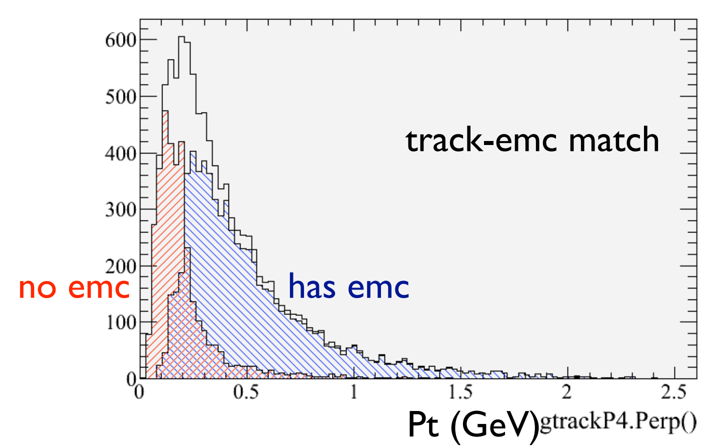


Some features

- Cluster split and merge. Final clusters all have single local maximum.



- Cluster-to-GTrack weight map for truth matching.
- Track-cluster matching using track poca w.r.t. cluster centroid.



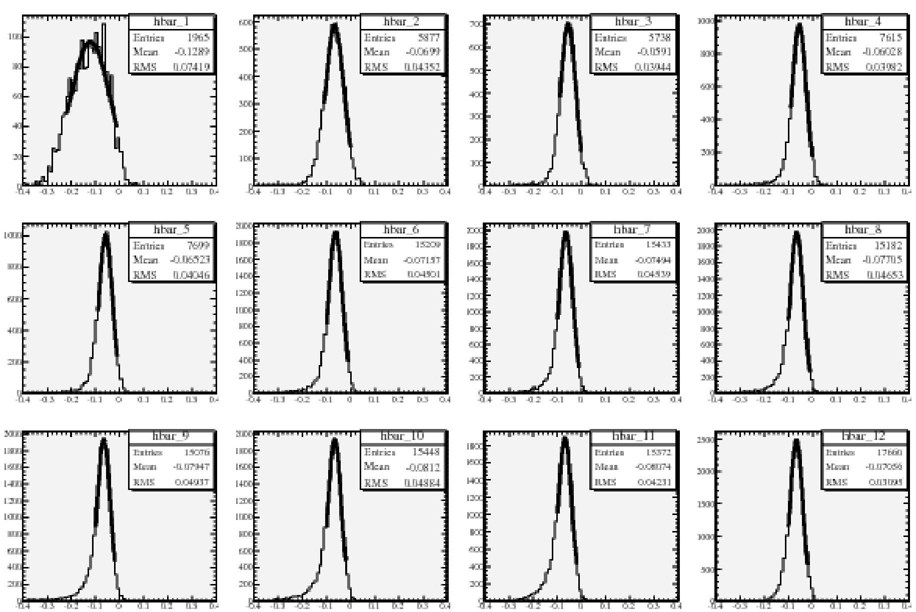
- Each digi's energy is fluctuated by

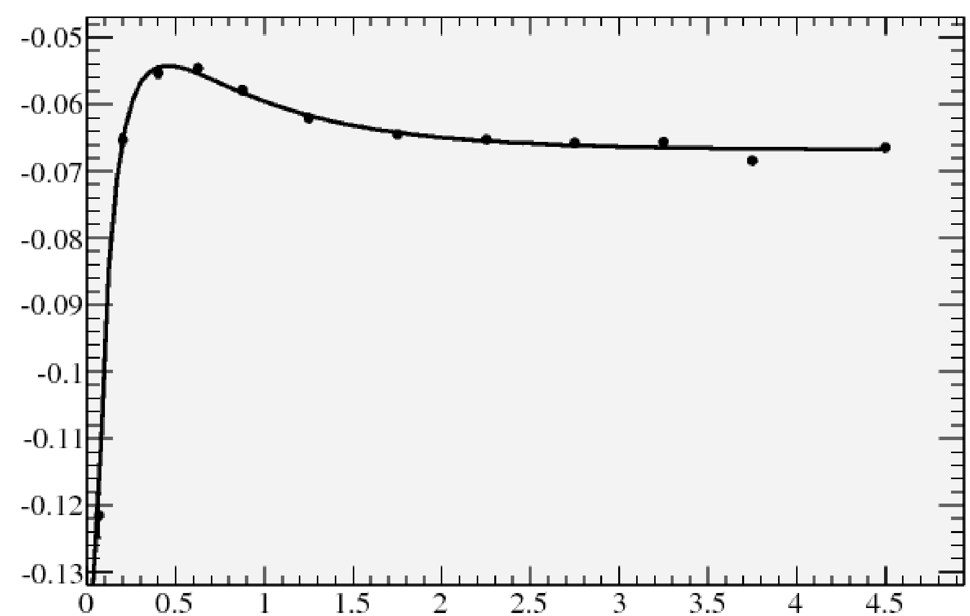
$$\frac{\sigma(E)}{E} = \frac{A}{E^n} \oplus B$$

	Fwd	Barrel	Bkwd
A	0.023	0.023	0.14
B	0.014	0.014	0.03
n	0.25	0.25	0.50

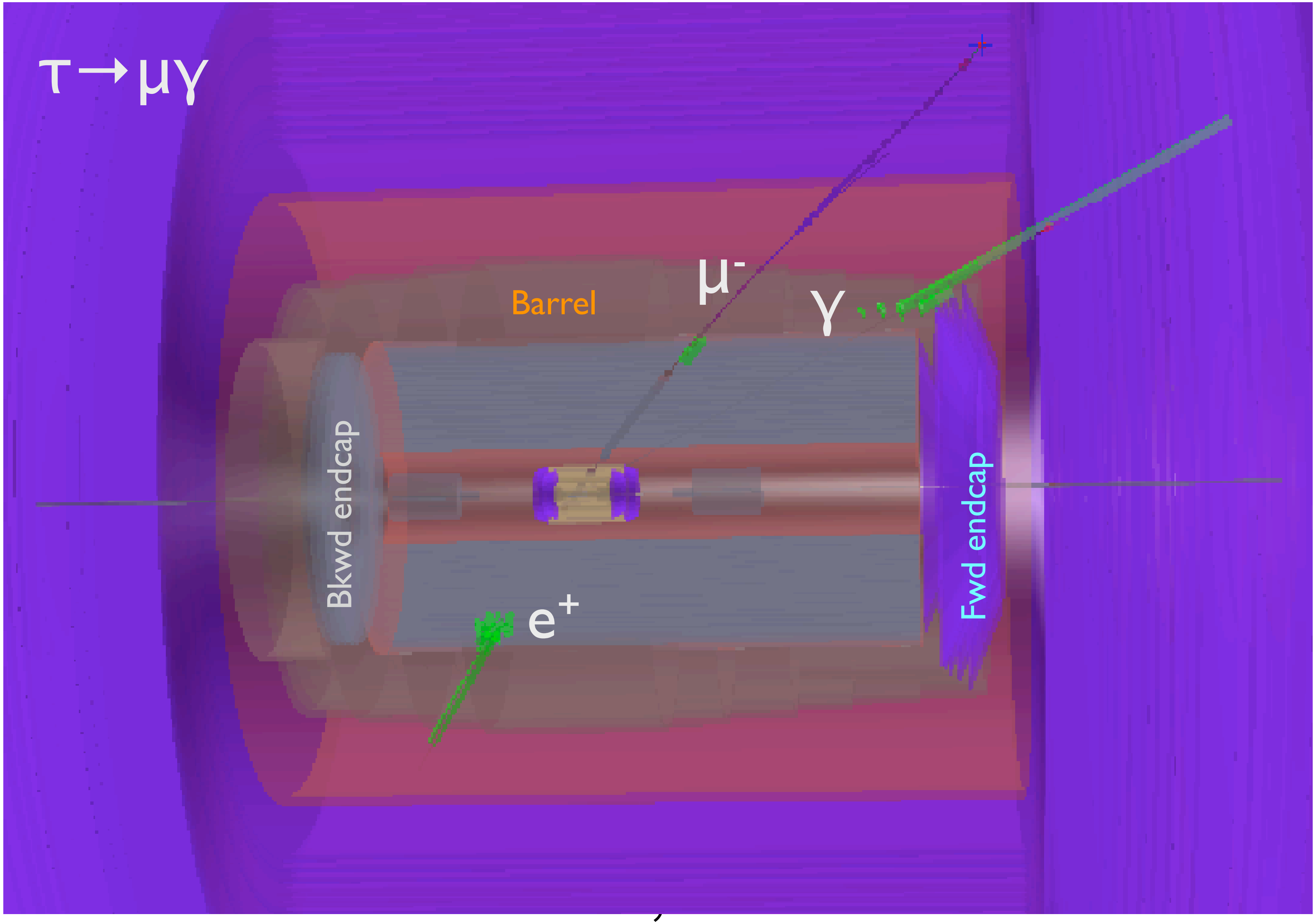
Energy calibration

- Fit energy pull to a Gaussian in bins of cluster energy to an empirical function $p_0 + p_1 log(p_2 E) e^{-(p_2 E)^{P_3}}$ and correct for it.



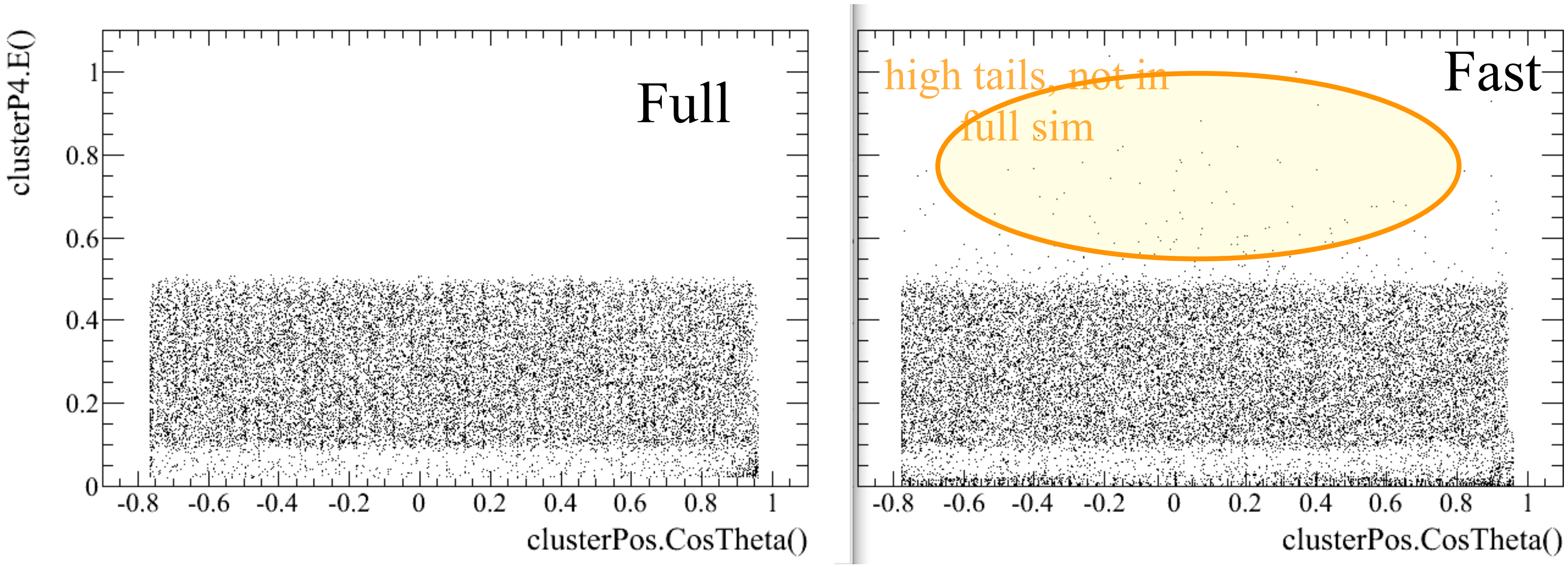


Event display



Comparisons using single γ

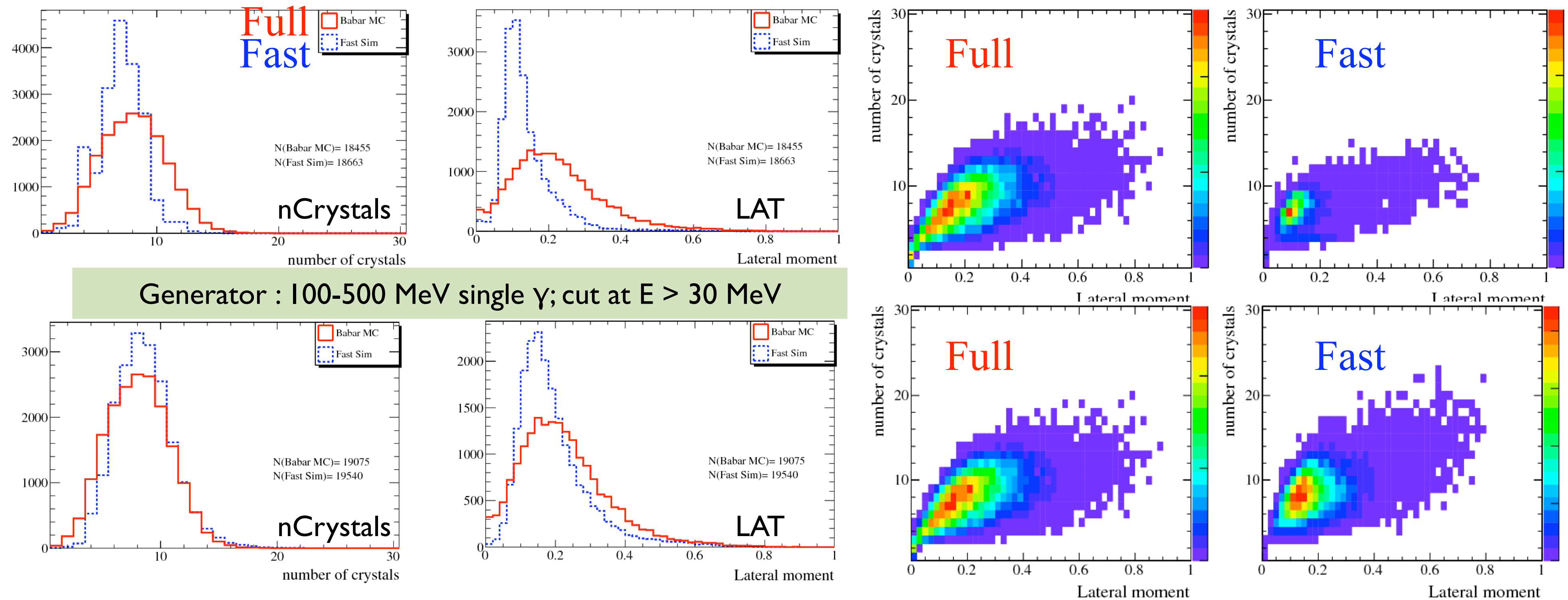
- Generate $100MeV<E\gamma<500MeV$, flat in $E\gamma,\cos\theta,\varphi$. No background mixing in full sim. Compare “CalorNeutral” list.



Low E clusters comes from split-offs due to artificially added “noises” (explained later)

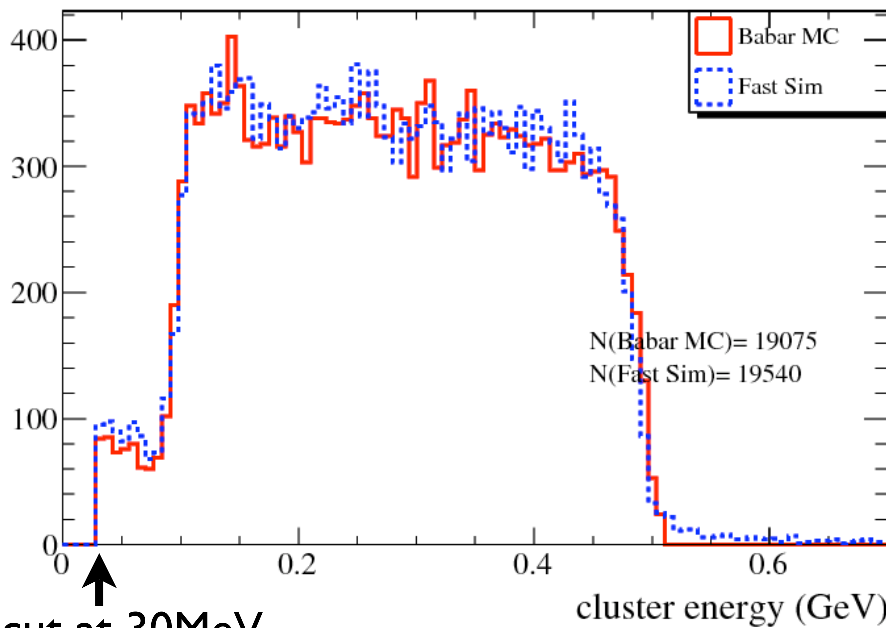
Low E clusters should be cut off
(full sim has a cut at E>20MeV (?))

Cluster shape

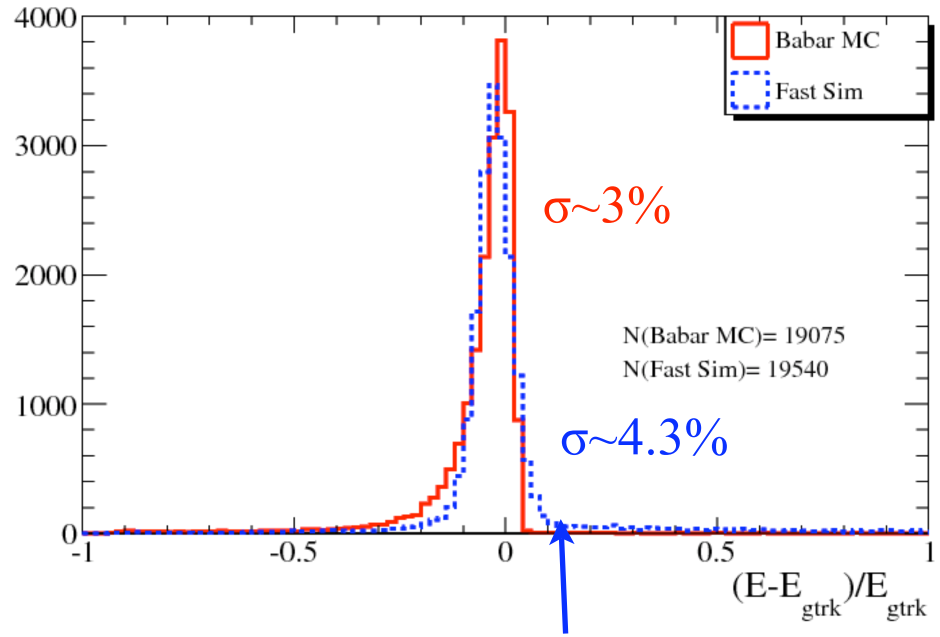


- Upper: cluster generated from the smooth function (& digiE fluctuation)
- Lower: add energies to cluster’s digis and its immediate neighboring digis, assuming 10% occupancy, energy distributed as f(E)~ exp(-(E-1MeV)/1MeV)

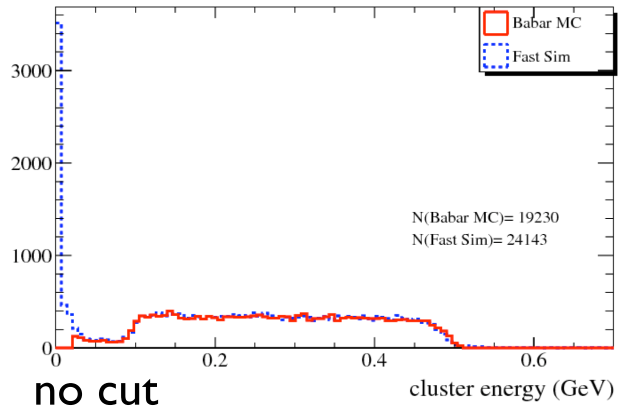
Energy resolution



cut at 30MeV



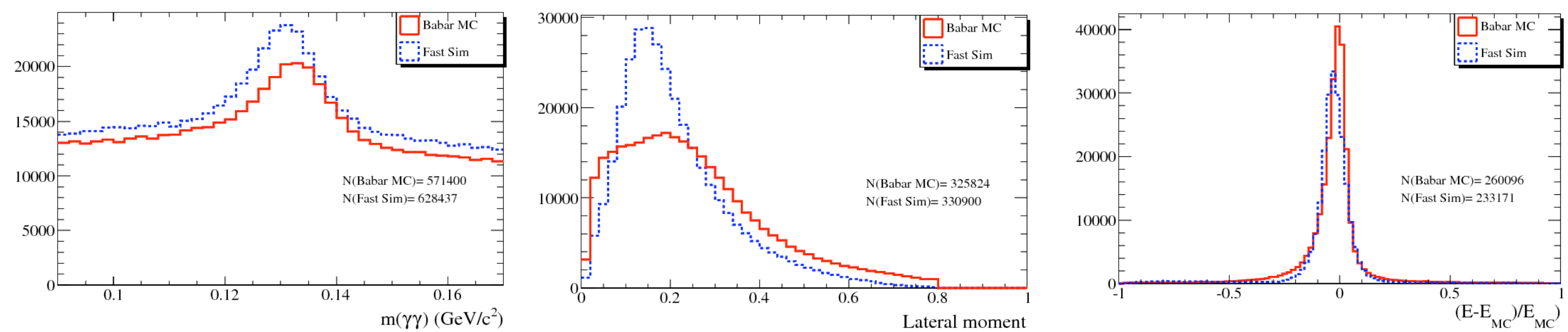
Fast sim has a long high-side tail.
Full sim is more asymmetric and has a long low-side tail.

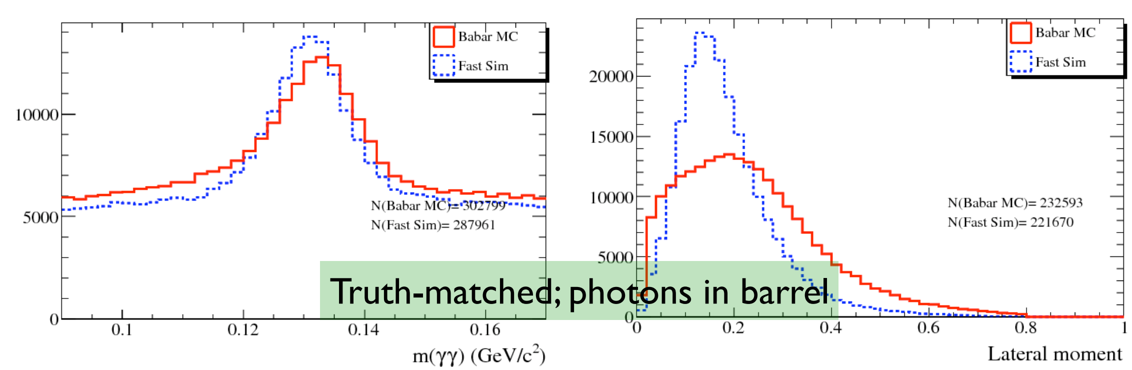


no cut

Comparison with BaBar generic B^0

- Reconstruct $\pi^0 \to \gamma\gamma$ in generic B events
  - GoodPhotonLoose, 0.001<LAT<0.8, E_γ>30MeV





Note that truth match here is sub-optimal.
A better matching algorithm is just implemented
in the fastsim.

- Energy resolution is shifted little.
- Too many neutrals?
- γ efficiency is smaller (after truth match)
- LAT distribution is too narrow.

Conclusions

- Basic features have been implemented.
  - Question: any other features are missing?
- A number of basic validations are performed.
  - Question: what validation/tuning has higher priority?
  - My next step is to tune energy resolution and efficiency, and then study material effect. What else?
- Other projects: hadron shower tuning; track-emc matching validation; speed optimization; gaps between crystals; tune LYSO parameters... ... (who?)