Backward EMC in FullSim and Use as a TOF Device

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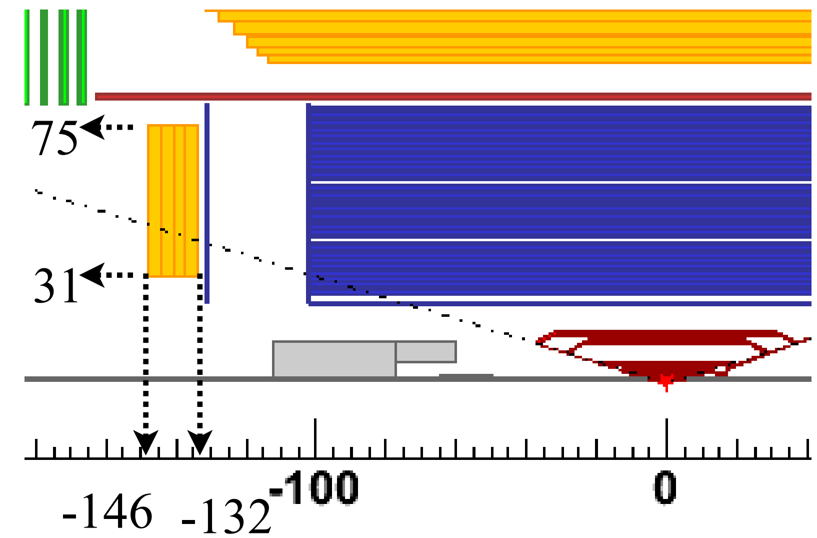
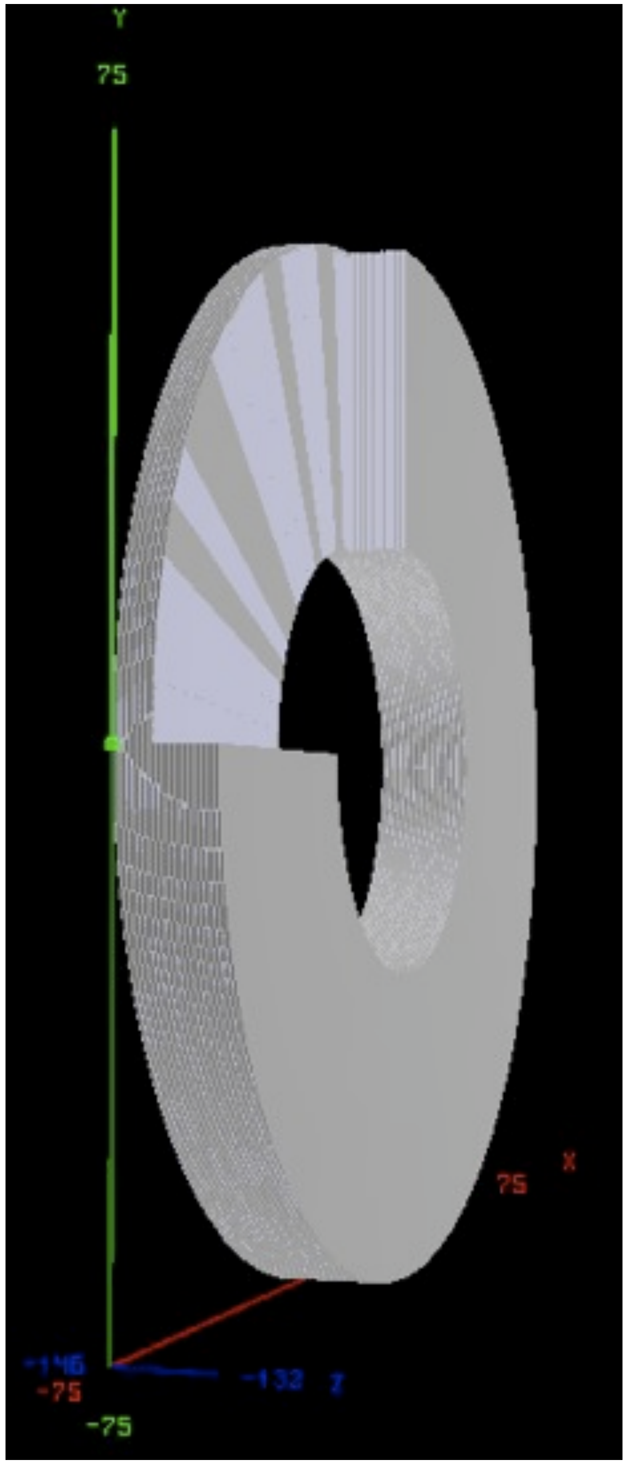
Recap of two talks in Nov/Dec. 2009

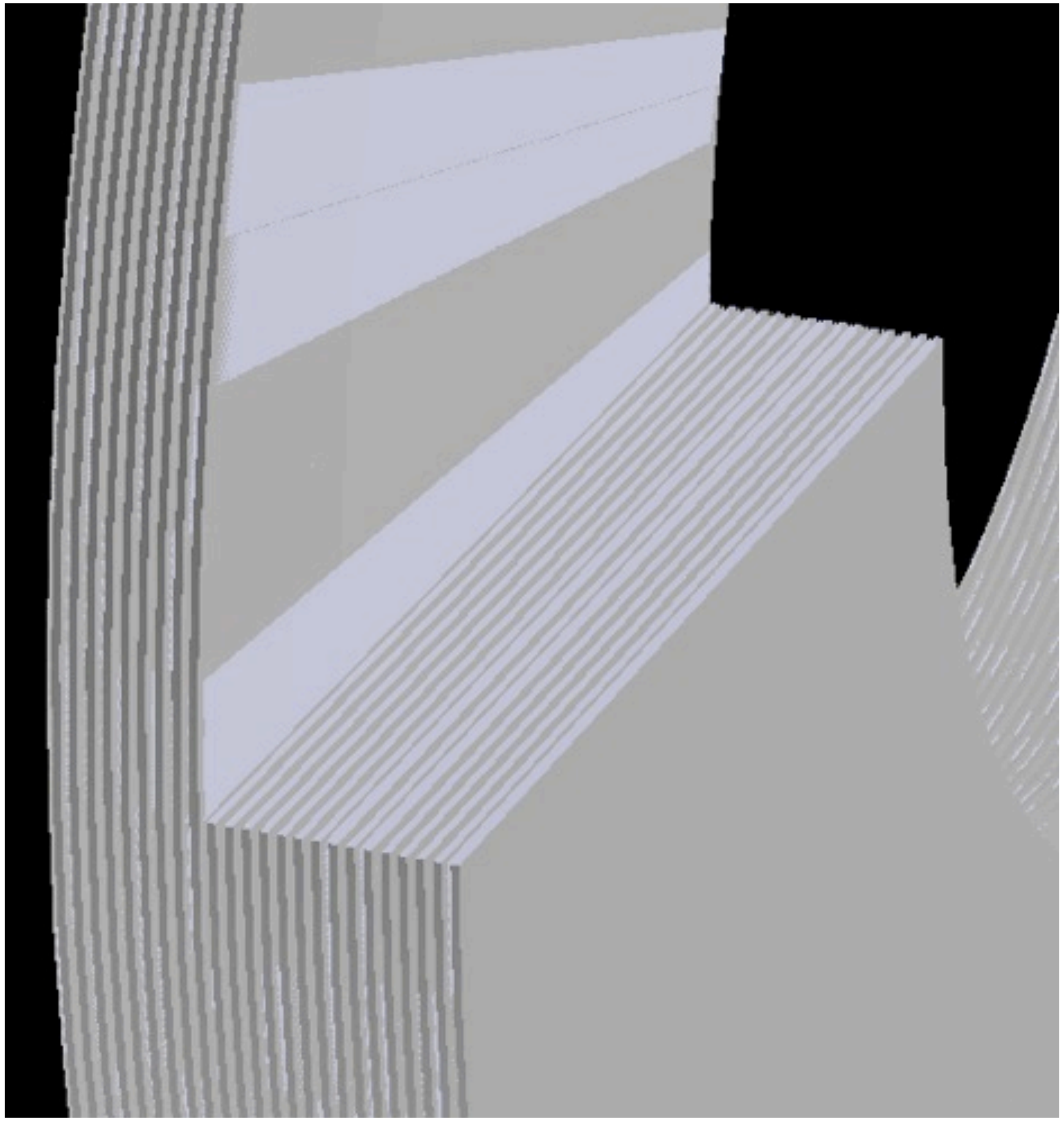
Geometry



- Twenty-four layers of Pb and plastic scintillator.
- Inner/outer radii: 310 mm / 750 mm
- Center z-coordinator: -1390 mm
- Thickness: Pb: 2.8 mm, Scintillator: 3.0 mm
- Scintillator material: [~polystyrene] d= 1.06 g/cm^3, C:H = 1:1.
- Pb side faces the IP. [probably will change to scintillator, and add one more scintillator layer at the outer most layer]
- No supporting structure.
- No segmentation in individual layer geometry description.
- GDML file: `EMC_backward_PbScint.gdml`, committed to `Bruno`. [Oct. 16, 2009]

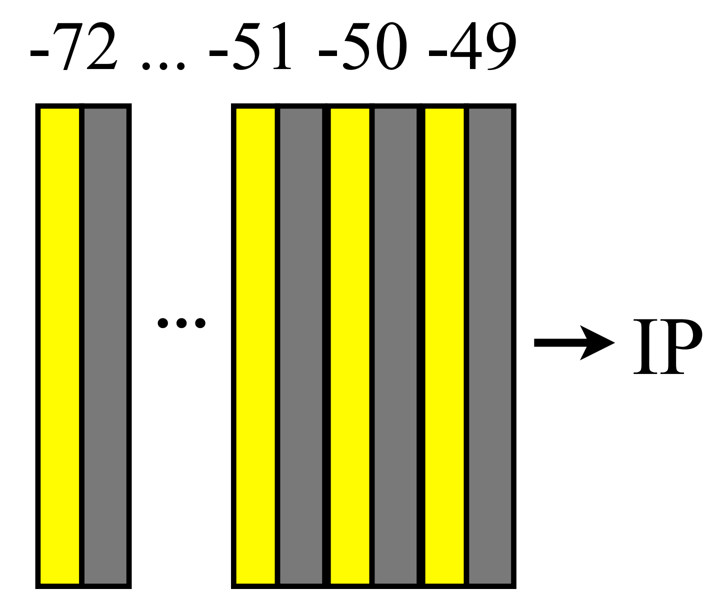
Visualization





Segmentation

- There is no segmentation in θ. We use θ index (used in barrel and forward endcap to index rings) to index layers, continuing the index for barrel (which ends at -48).
- φ segmentation is done logically. Each layer has 48 sectors. There are three types of segmentation:
  - left-handed spiral (3n+1)
  - right-handed spiral (3n+2)
  - straight sectors (3n+3)



Lower bound of φ for sector j at r.

$$\phi_{\text{left}} = -A \cdot \log(r/r_{\text{max}}) + (j-1)\Delta\phi$$

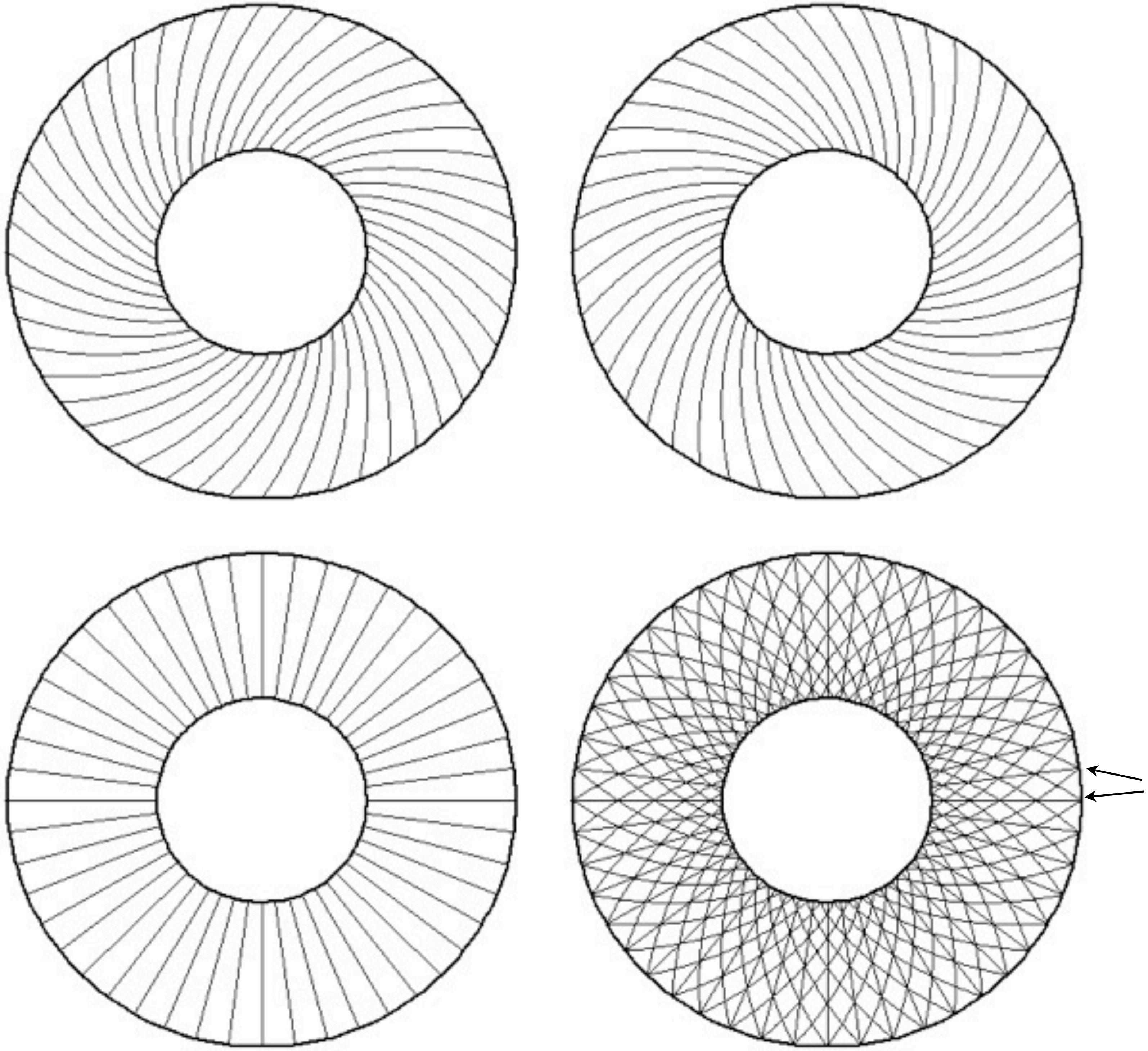
$$\phi_{\text{right}} = +A \cdot \log(r/r_{\text{max}}) + (j-1)\Delta\phi$$

$$\phi_{\text{straight}} = (j-1)\Delta\phi$$

$$\Delta\phi = 2\pi/48 \qquad r_{\text{max}} = 750\text{mm}$$

$$A = 34\Delta\phi/\log(r_{\text{max}})$$

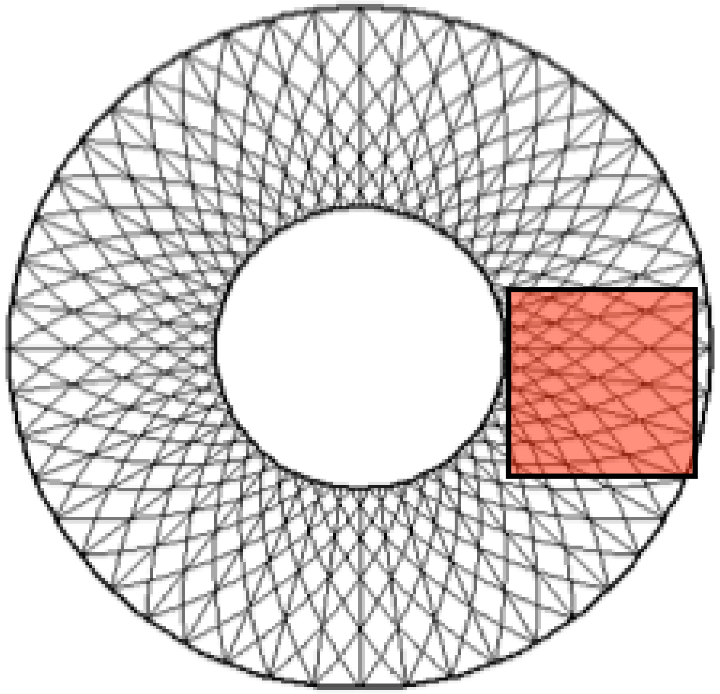
Segmentation



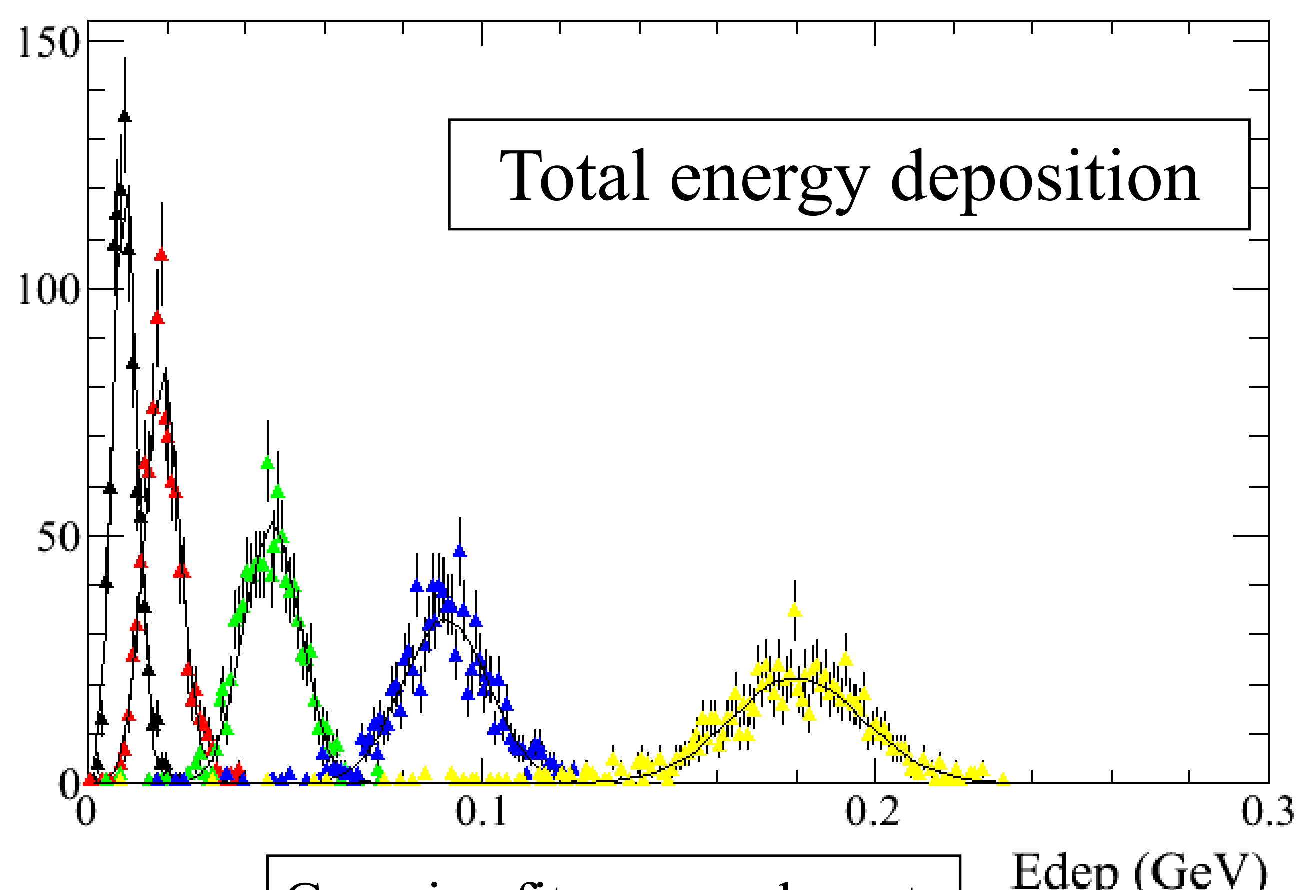
Sectors with the same index matches at r_{max}.

Test with single gammas

- Shoot single gammas toward the backward EMC along the z-axis. Starting position is right in front of the EMC (z=-132cm), and random in x-y plane within a square.



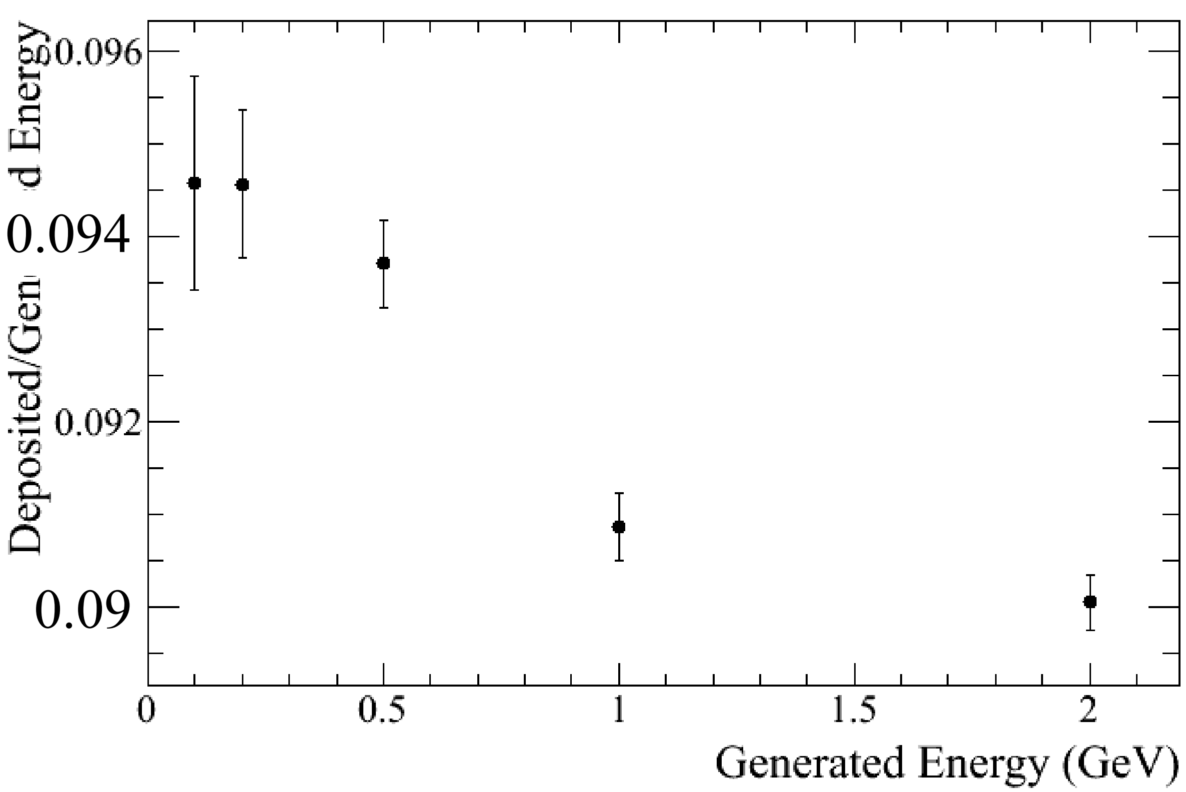
- Generate 0.1, 0.2, 0.5, 1.0, 2.0 GeV photons, 1000 photons in each job. Record all energy deposited in the scintillator.



Gaussian fits seem adequate

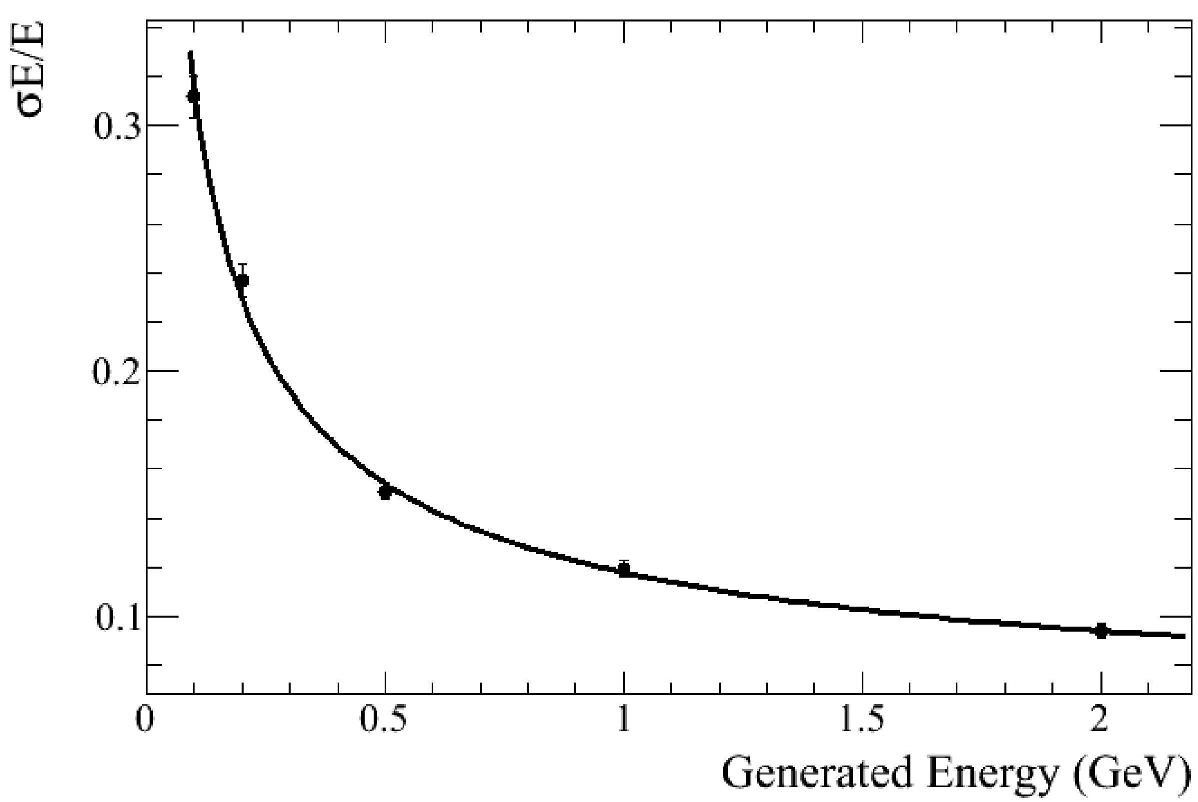
Energy resolution

Energy deposition / Generated energy



Gaussian fit width

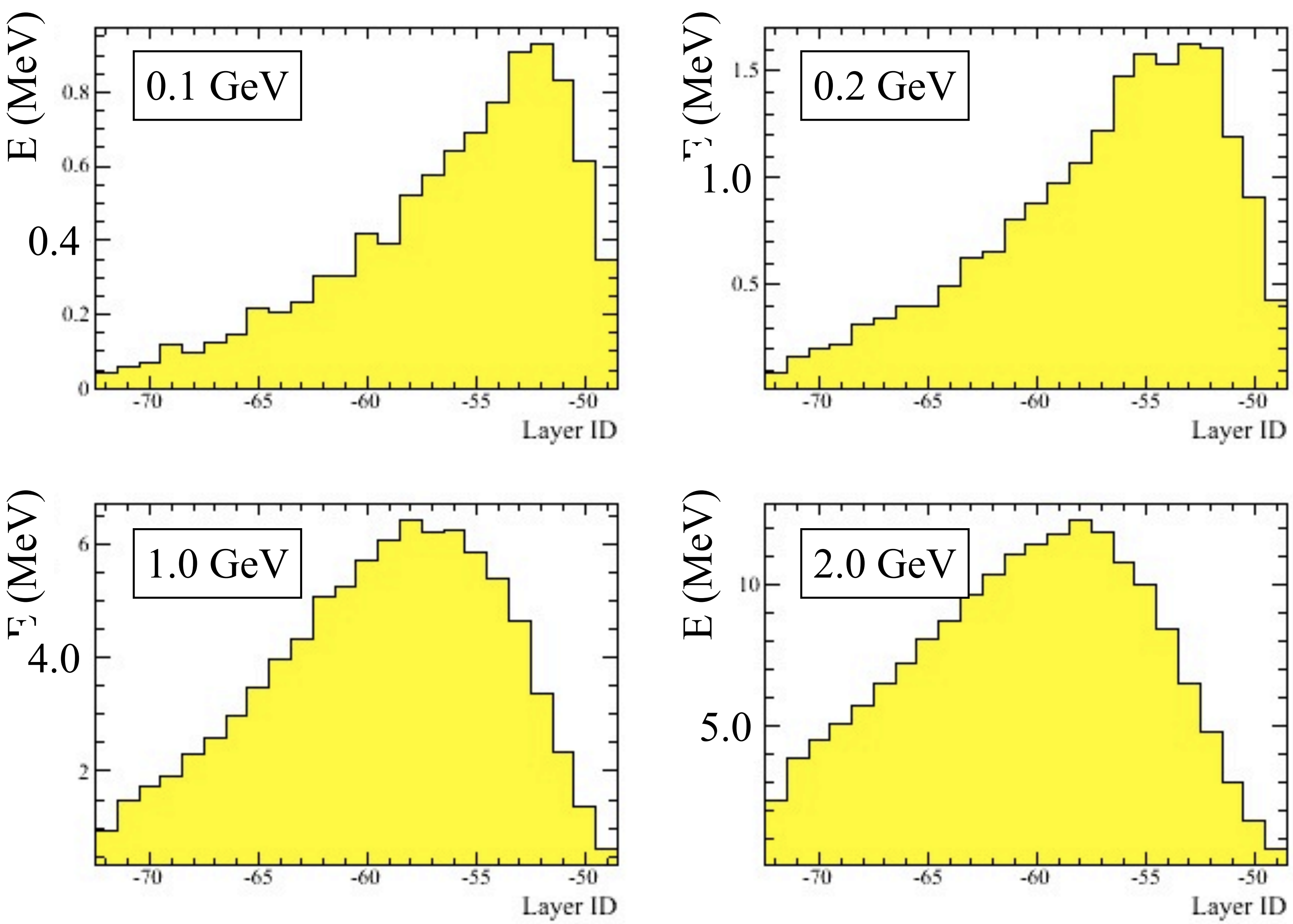
$$\frac{\sigma_E}{E} = \frac{10\%}{E(\text{GeV})^{0.485}} \oplus 6\%$$

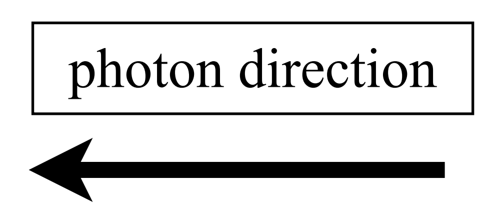


Compare with what we put in the fast sim: $\frac{\sigma_E}{E} = \frac{14\%}{\sqrt{E(\text{GeV})}} \oplus 1\%$

Energy by layer

- Average energy deposition in each layer per event.

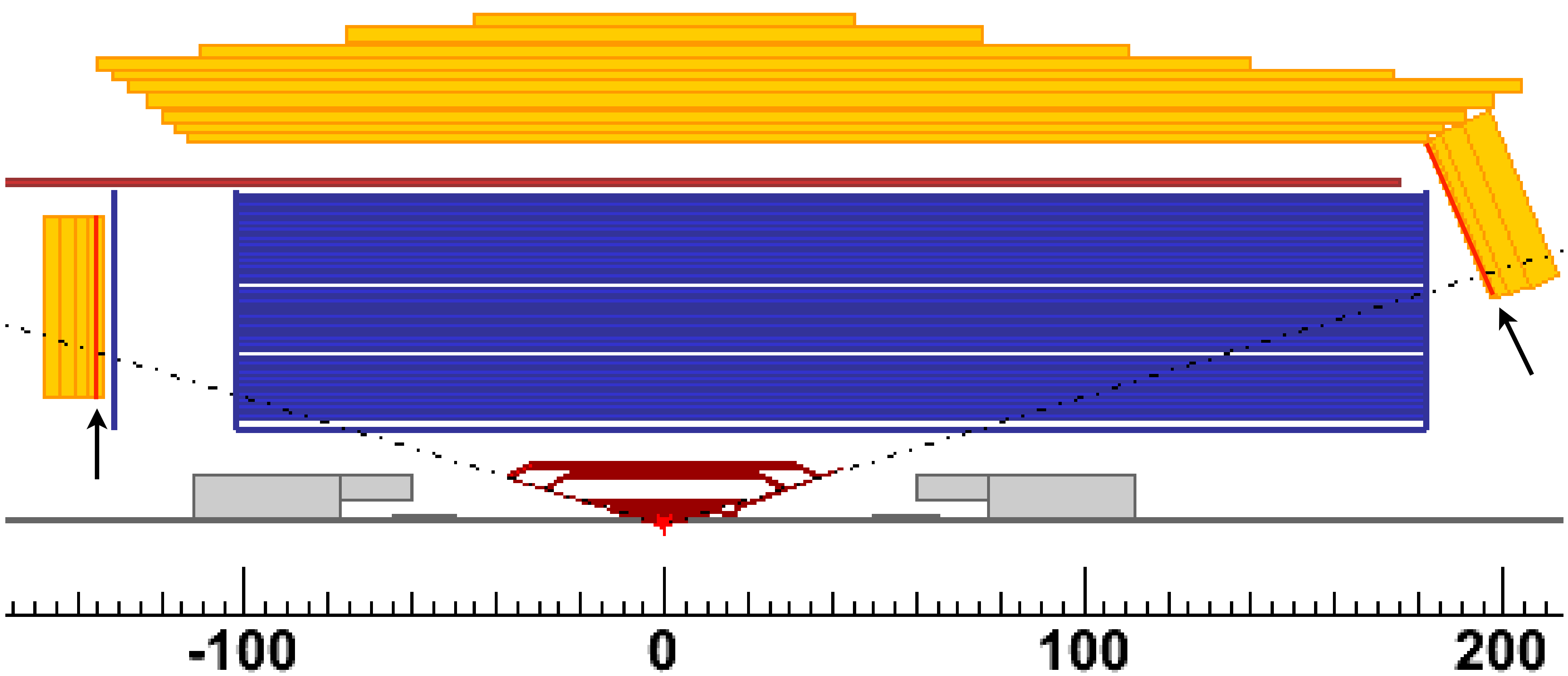




Longitudinal shower profile can aid particle ID such as e/π separation.

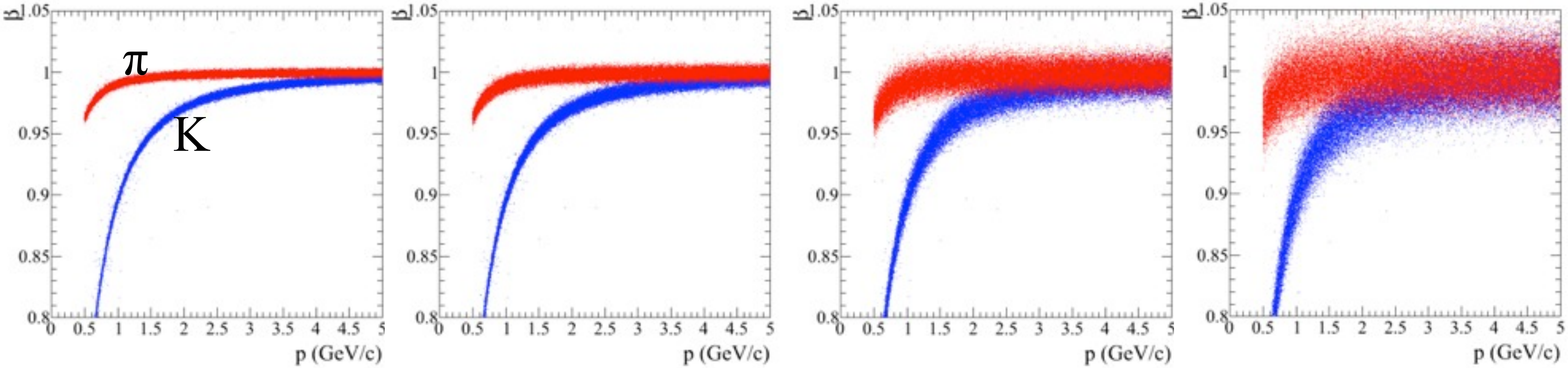
Timing device at or in front of EMC

- Test K/π separation using fastsim:
  - store track timing at the first layer of EMC fastsim model at sim-track level (i.e., true time)
  - smear timing with a Gaussian at given resolution.
  - use reconstructed path length to calculate velocity (measured length/ smeared time).

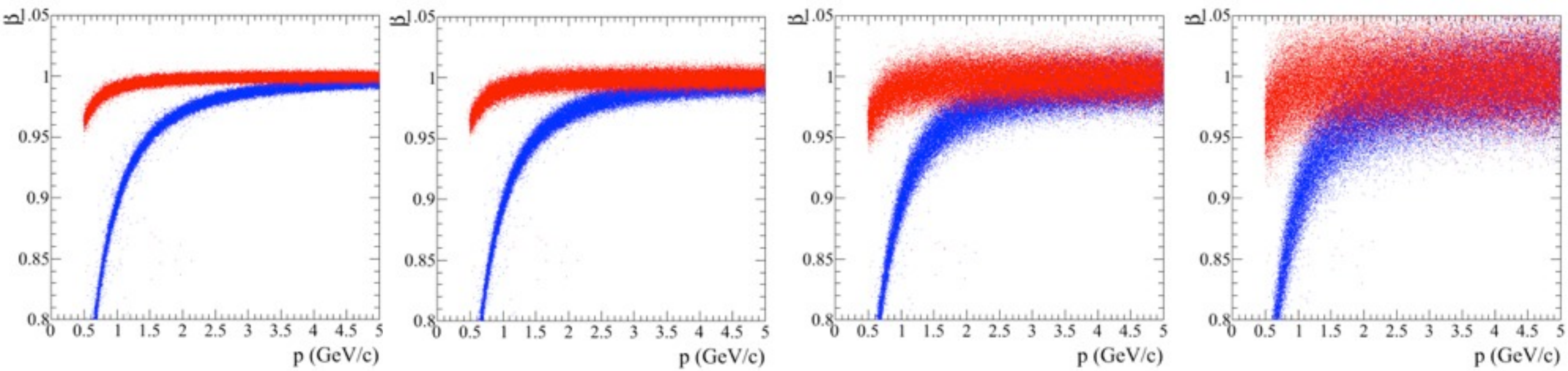


K/π separation in forward and backward

FORWARD

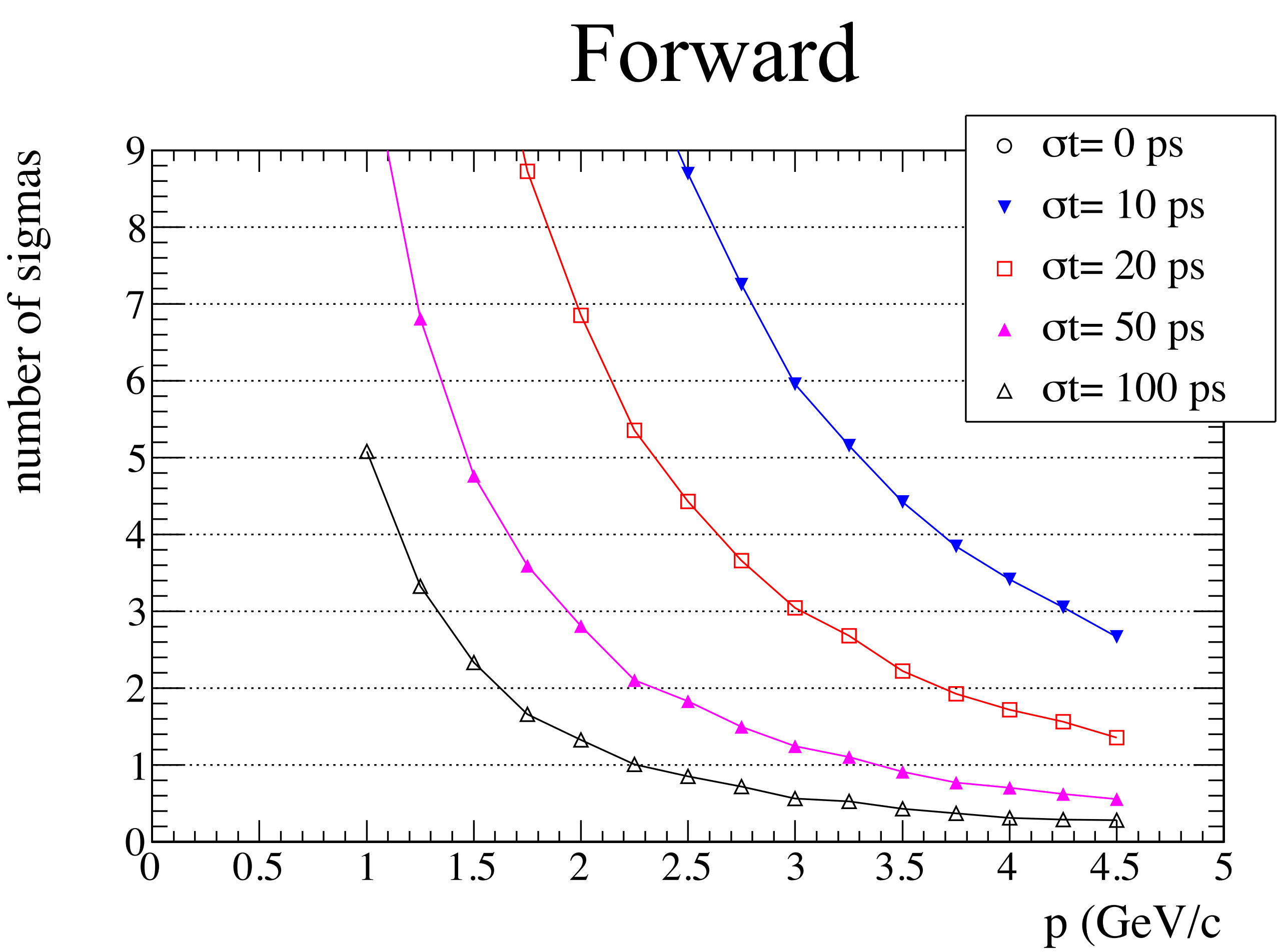


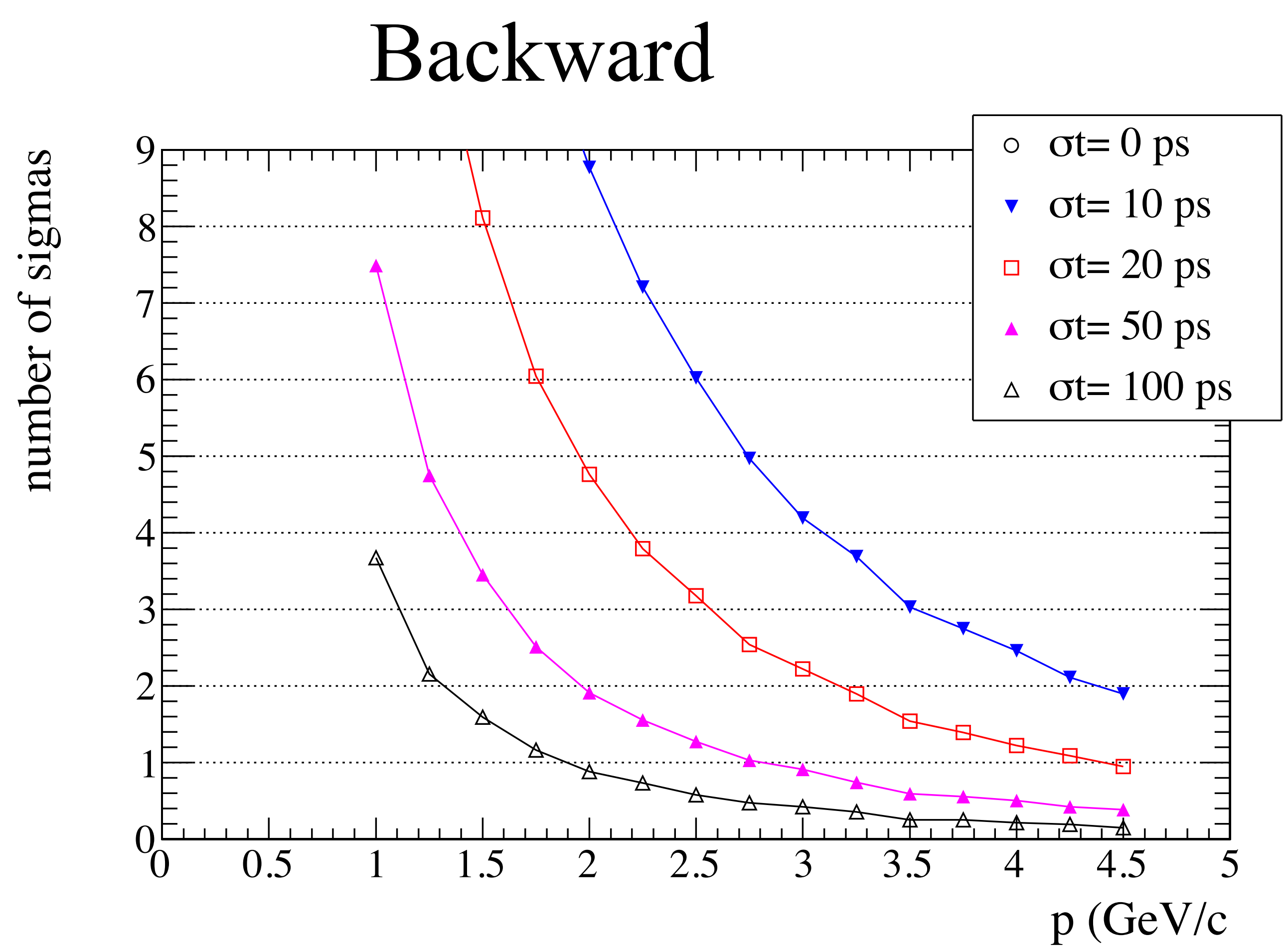
σt = 10 ps σt = 20 ps σt = 50 ps σt = 100 ps



BACKWARD

K/π separation in forward and backward





- Backward EMC can provide >3σ K/π separation around 1 GeV with timing resolution of 100 ps. (EMC front face at $z \sim -132$cm)