

Simulation of BCAL Timing

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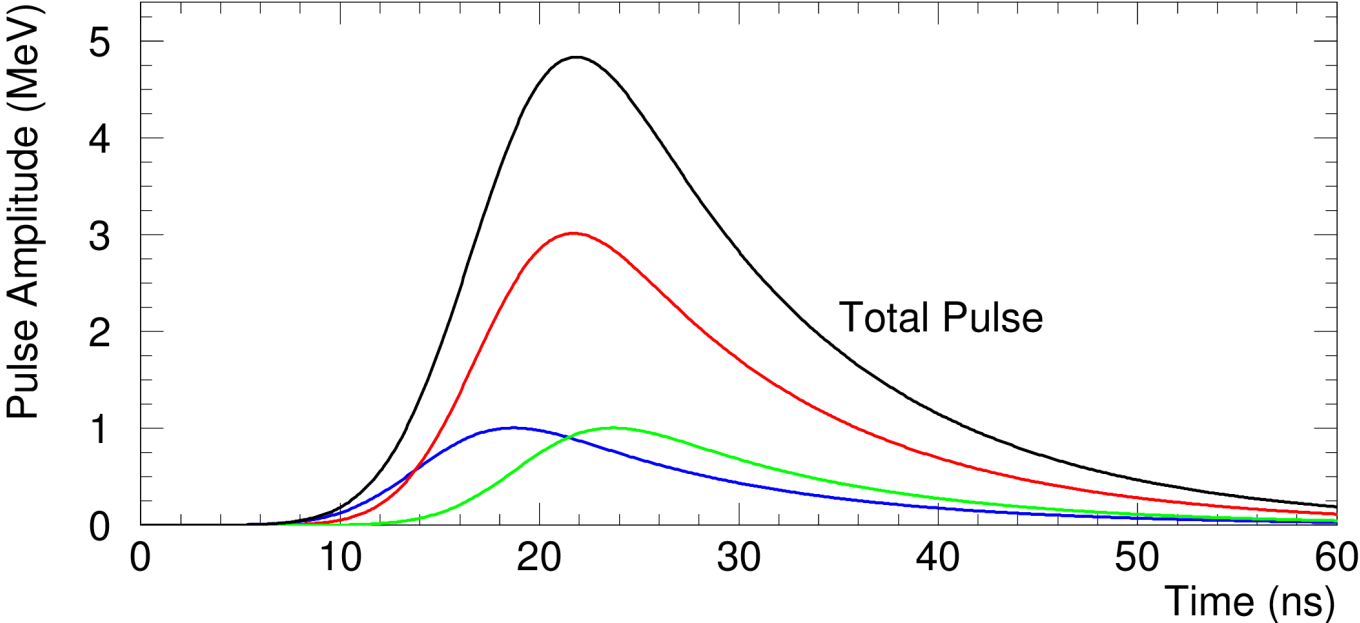
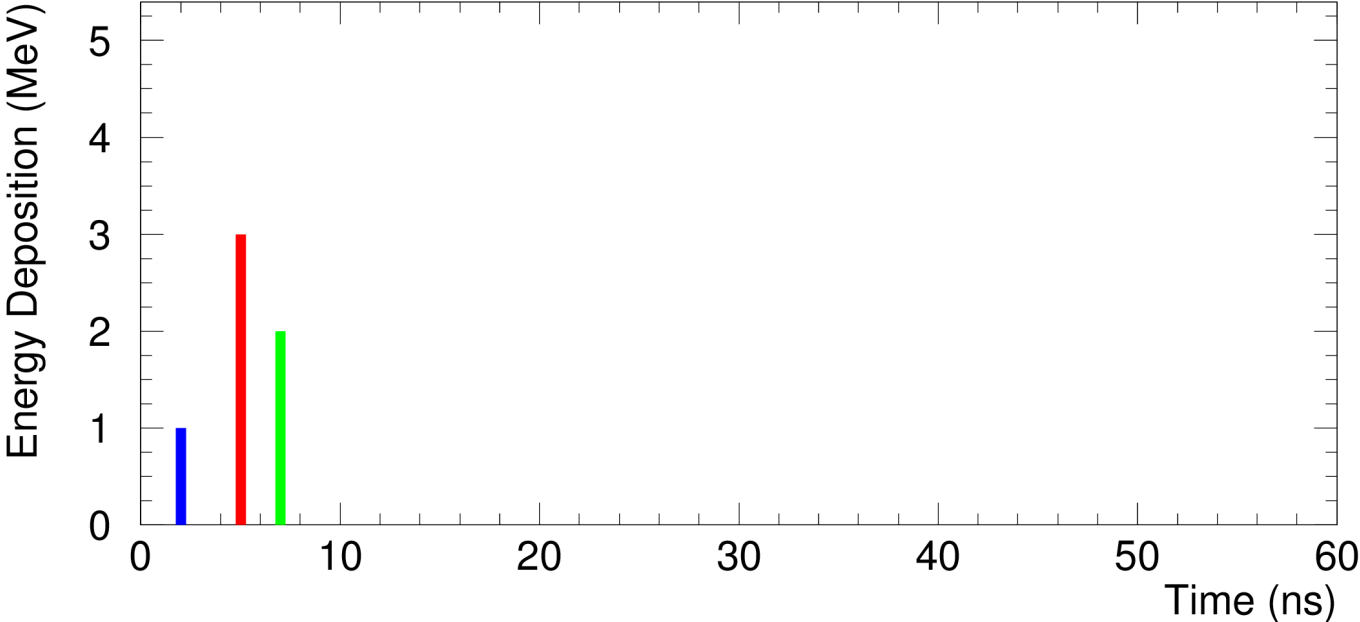
Motivation

- * Reproduce the “effects” we saw in BCAL timing
- * Check the possible systematics in Z-position reconstruction

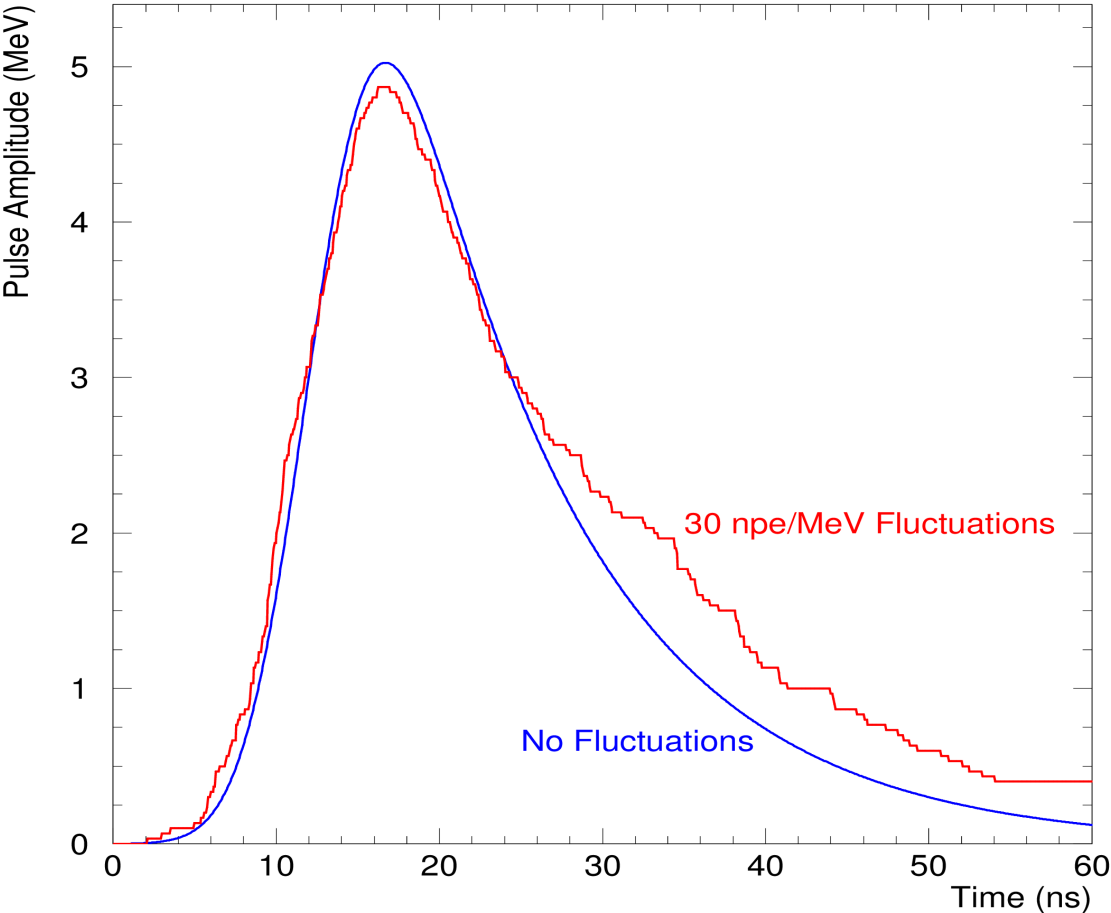
Simulation

- * 48 BCAL modules in GEANT-3
- * Fine-structure model of BCAL
- * Fixed-momentum particles from the center of the target
- * Uniform seed on Φ and Z
- * Effective velocity of the light propagation through the BCAL was assumed as 16.75 cm/ns

Timing in the Simulation



Fluctuations

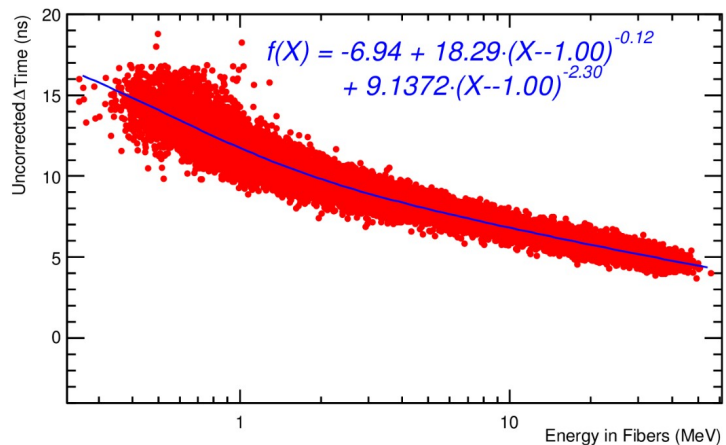


Conversion factor was measured with cosmics in 2010

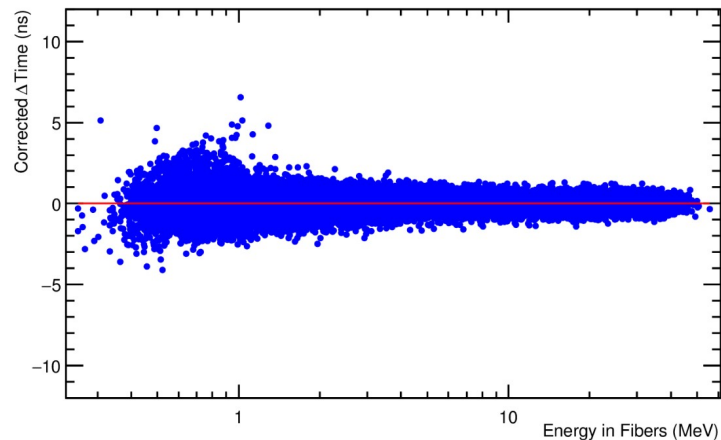
Crossing on the threshold -> "Raw" Time

Calibration (iteration #1)

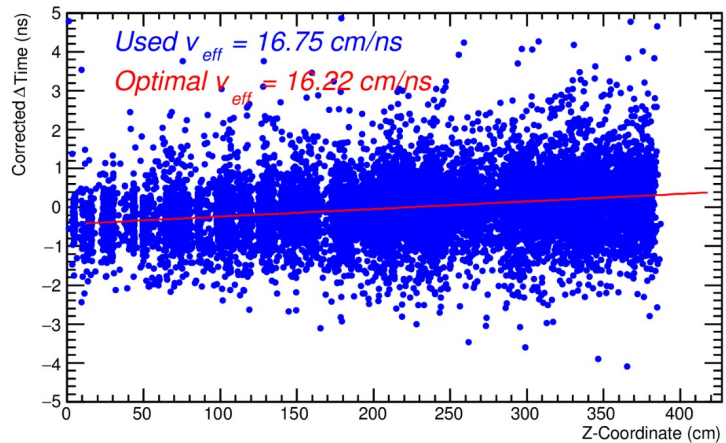
Simulation: $E_\gamma=1$ GeV, Module=13, Sector=2, Layer=2, End=0



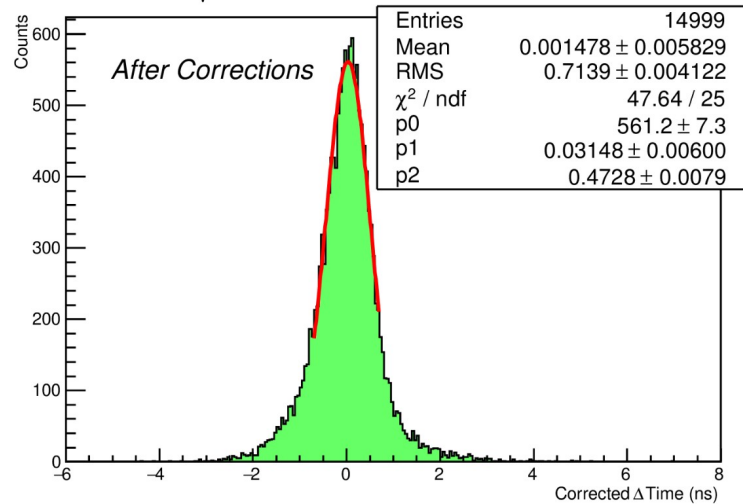
Simulation: $E_\gamma=1$ GeV, Module=13, Sector=2, Layer=2, End=0



Simulation: $E_\gamma=1$ GeV, Module=13, Sector=2, Layer=2, End=0

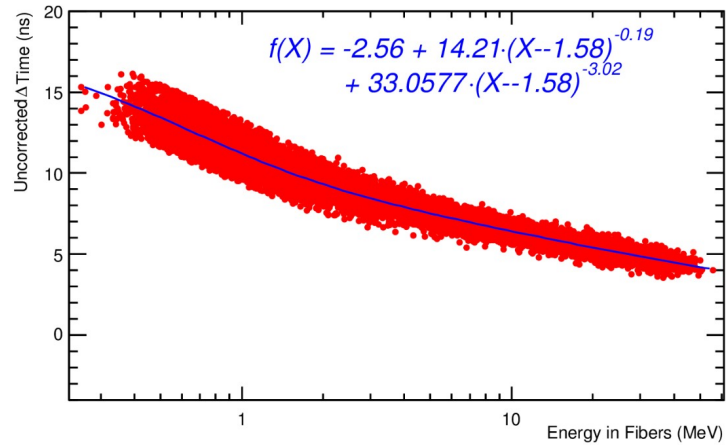


Simulation: $E_\gamma=1$ GeV, Module=13, Sector=2, Layer=2, End=0

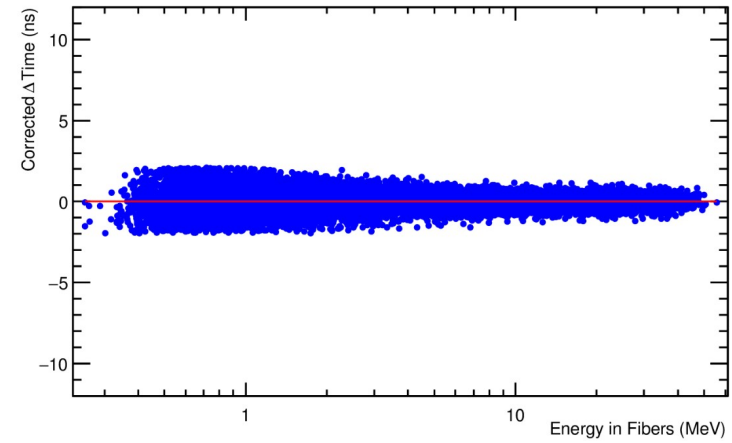


Calibration (final iteration)

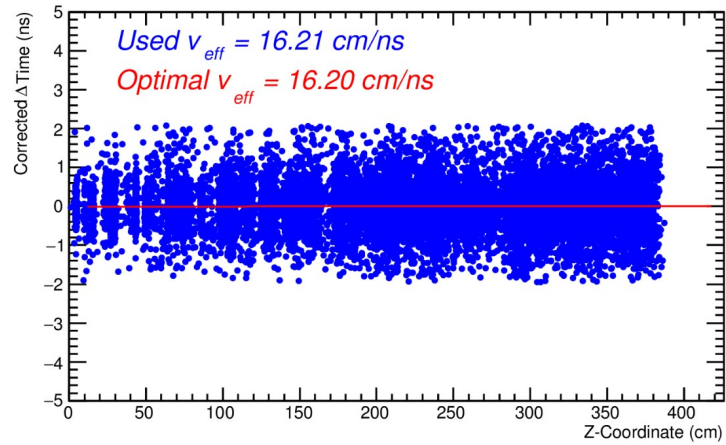
Simulation: $E_\gamma=1$ GeV, Module=13, Sector=2, Layer=2, End=0



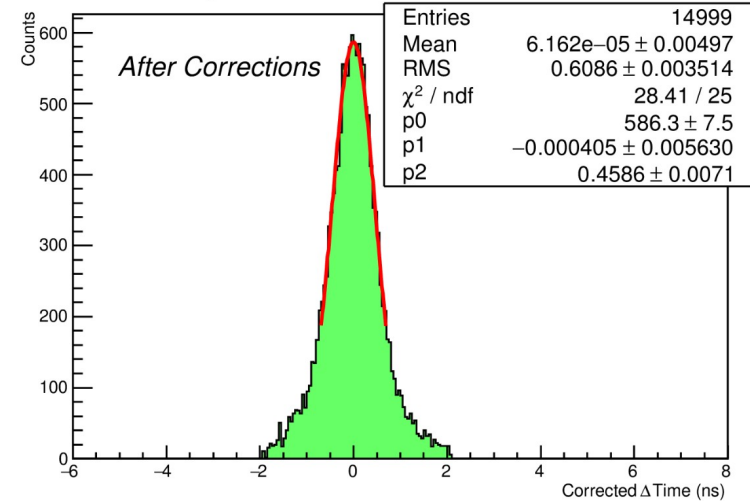
Simulation: $E_\gamma=1$ GeV, Module=13, Sector=2, Layer=2, End=0



Simulation: $E_\gamma=1$ GeV, Module=13, Sector=2, Layer=2, End=0

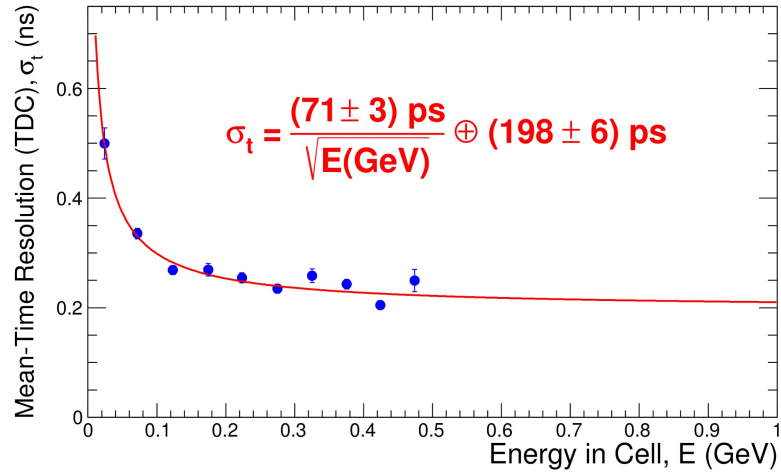


Simulation: $E_\gamma=1$ GeV, Module=13, Sector=2, Layer=2, End=0

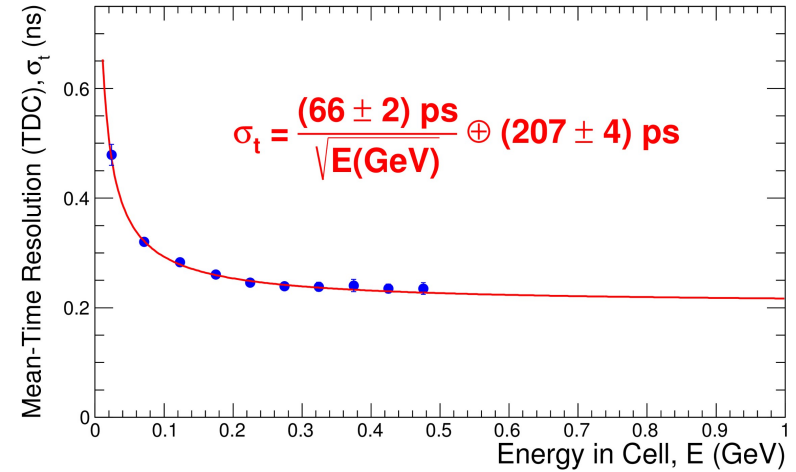


Resolution from Simulation

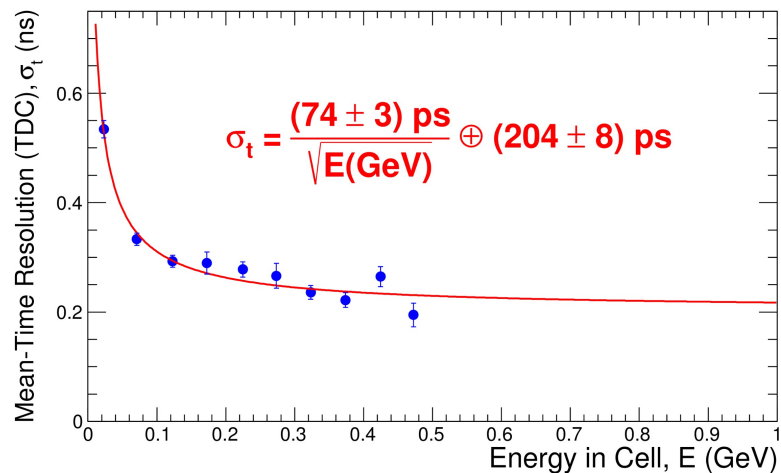
Photon Showers in BCAL: Layer 1



Photon Showers in BCAL: Layer 2

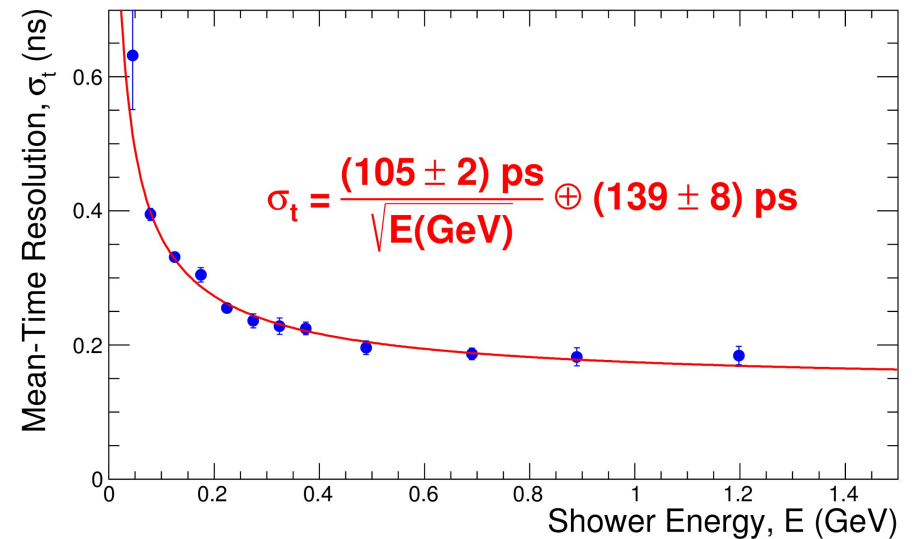


Photon Showers in BCAL: Layer 3



DATA

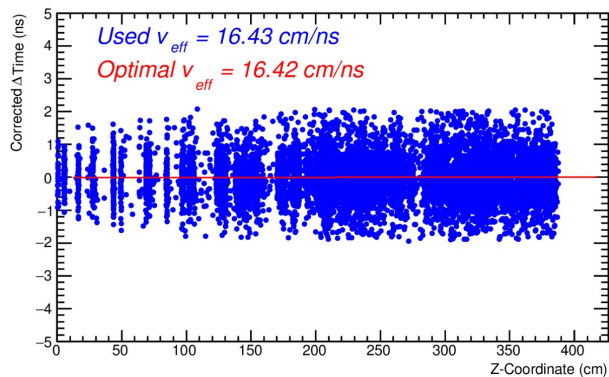
Photon Showers in BCAL (Run 10913)



Effective Velocities from Simulation

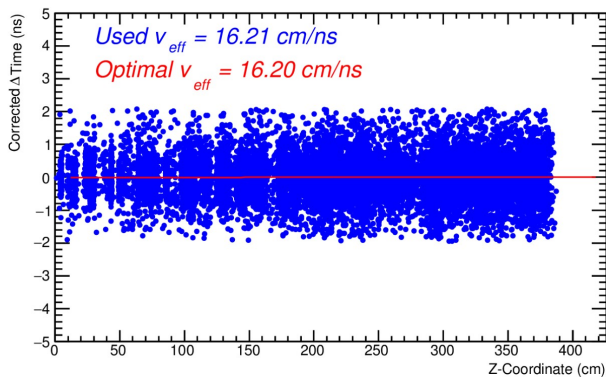
Layer 1

Simulation: $E_\gamma=1$ GeV, Module=13, Sector=2, Layer=1, End=0



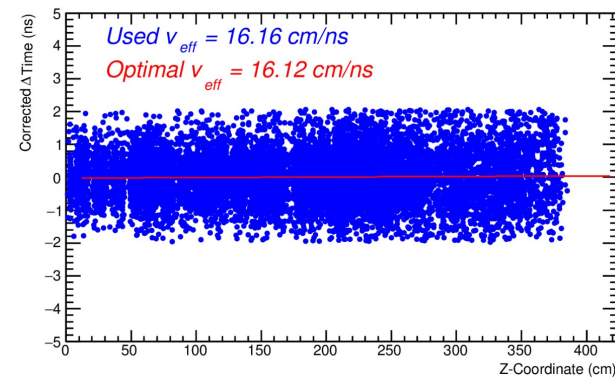
Layer 2

Simulation: $E_\gamma=1$ GeV, Module=13, Sector=2, Layer=2, End=0

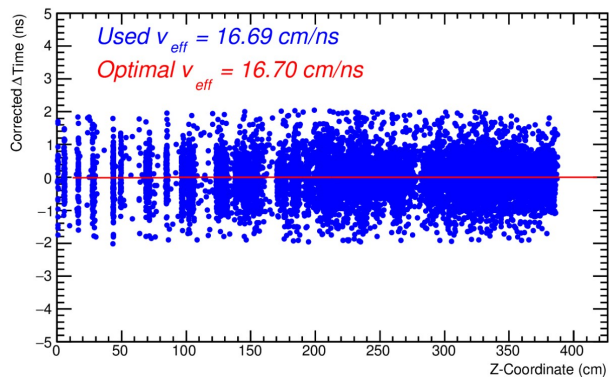


Layer 3

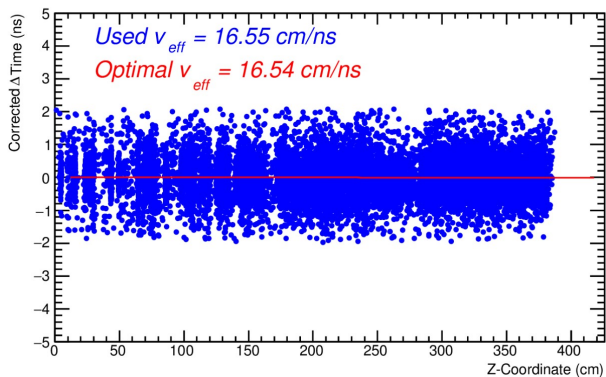
Simulation: $E_\gamma=1$ GeV, Module=13, Sector=2, Layer=3, End=0



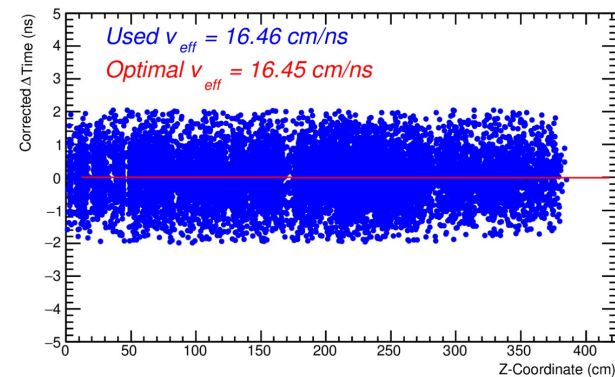
Simulation: $E_\gamma=1$ GeV, Module=13, Sector=2, Layer=1, End=1



Simulation: $E_\gamma=1$ GeV, Module=13, Sector=2, Layer=2, End=1



Simulation: $E_\gamma=1$ GeV, Module=13, Sector=2, Layer=3, End=1



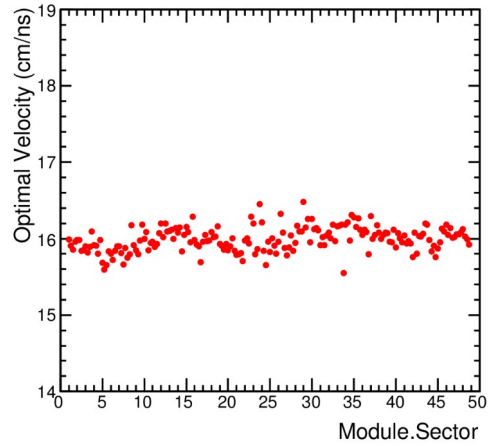
$$V_D - V_U = 0.28 \text{ cm/ns}$$

$$V_D - V_U = 0.34 \text{ cm/ns}$$

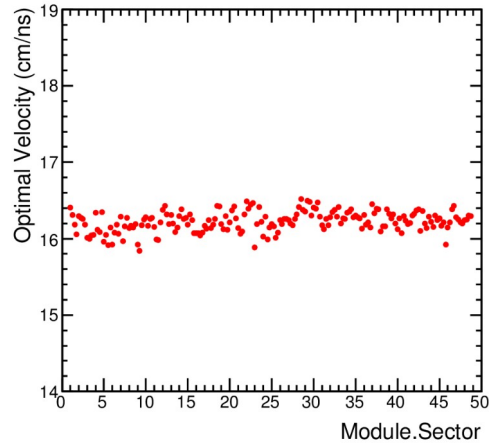
$$V_D - V_U = 0.33 \text{ cm/ns}$$

Effective Velocities from Data

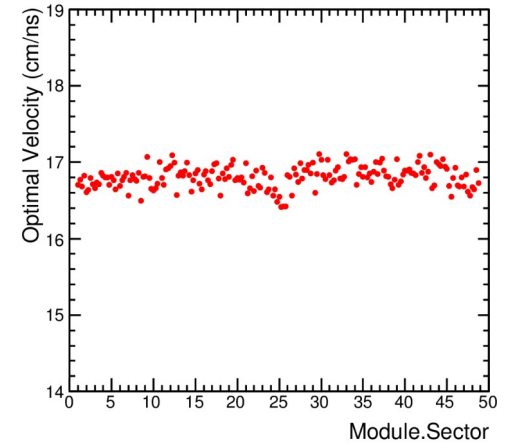
Calibration on $(\pi + \gamma)$: Upstream, Layer 1



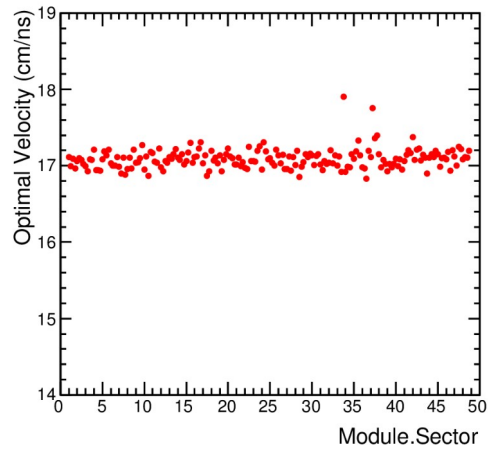
Calibration on $(\pi + \gamma)$: Upstream, Layer 2



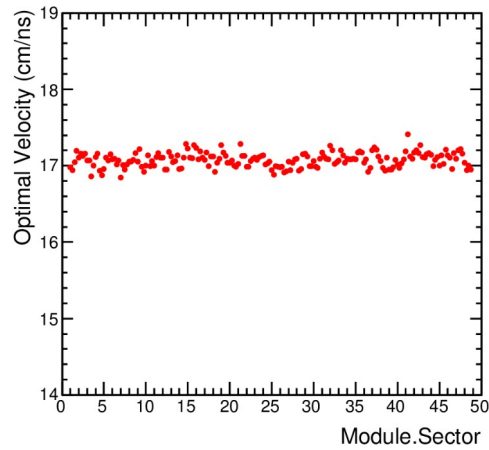
Calibration on $(\pi + \gamma)$: Upstream, Layer 3



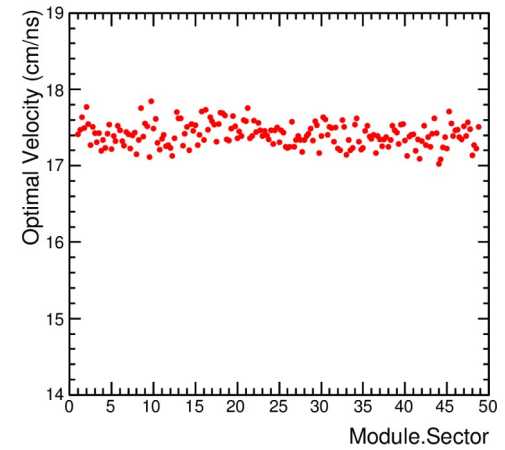
Calibration on $(\pi + \gamma)$: Downstream, Layer 1



Calibration on $(\pi + \gamma)$: Downstream, Layer 2

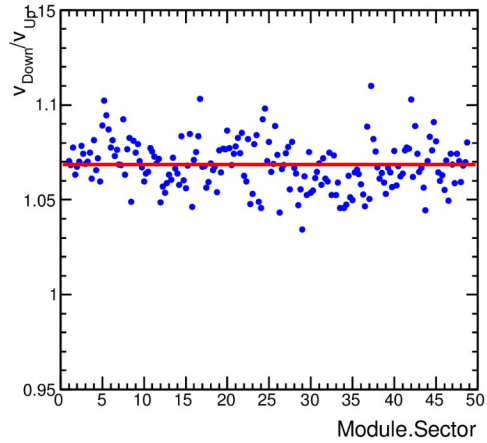


Calibration on $(\pi + \gamma)$: Downstream, Layer 3

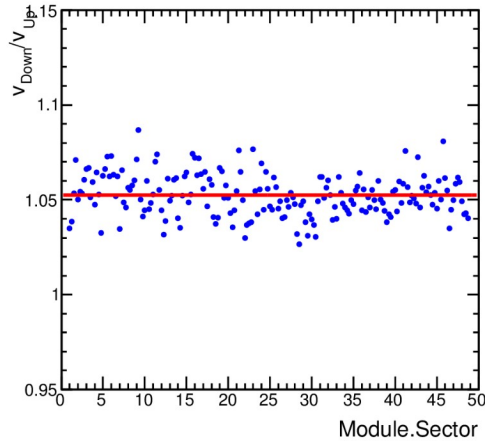


Effective Velocities from Data

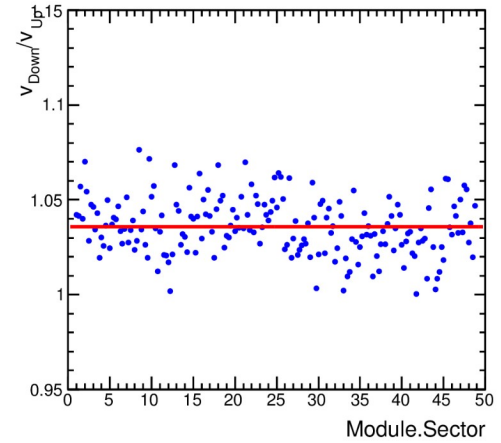
Calibration on $(\pi + \gamma)$: Layer 1



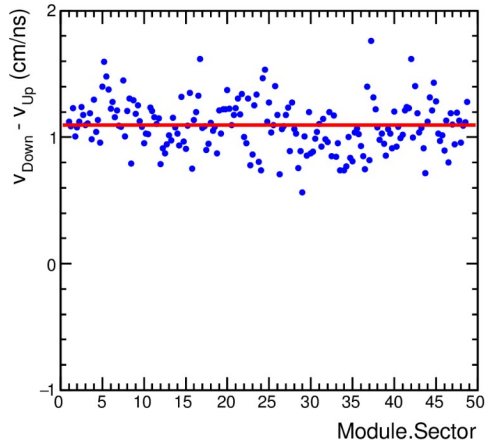
Calibration on $(\pi + \gamma)$: Layer 2



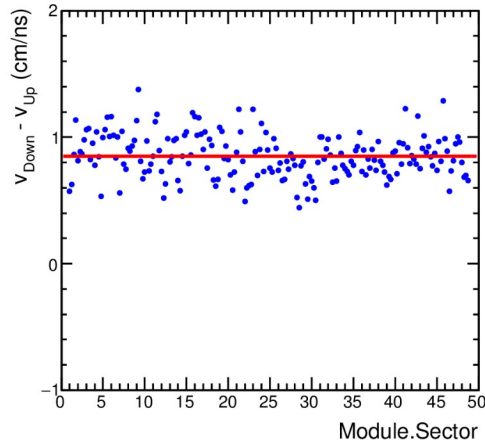
Calibration on $(\pi + \gamma)$: Layer 3



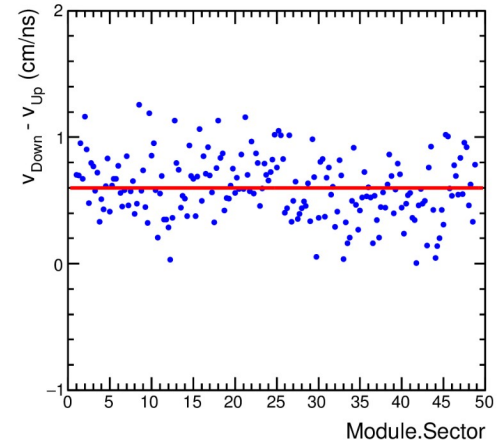
Calibration on $(\pi + \gamma)$: Layer 1



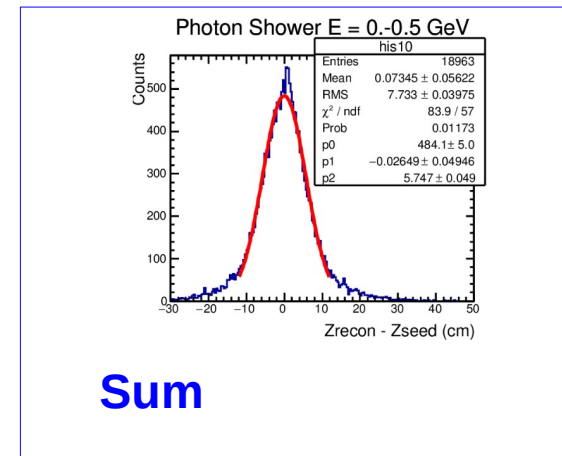
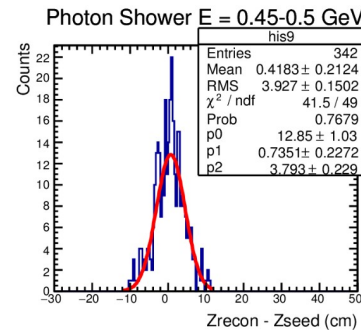
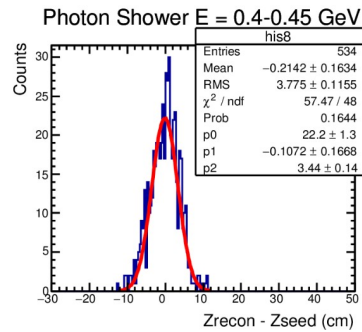
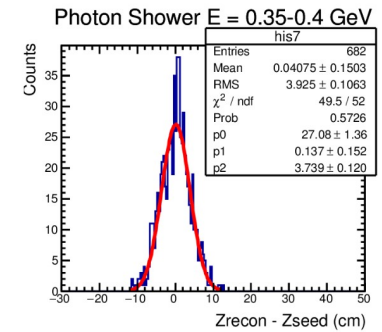
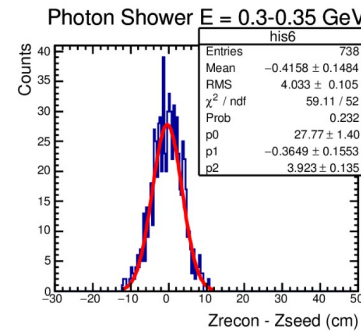
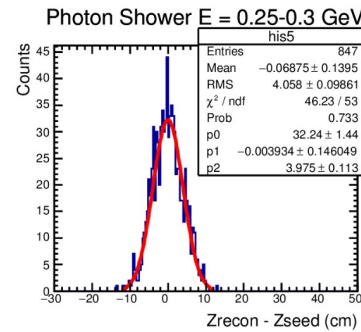
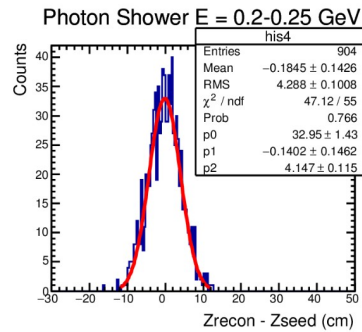
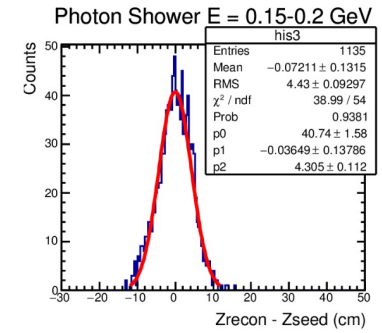
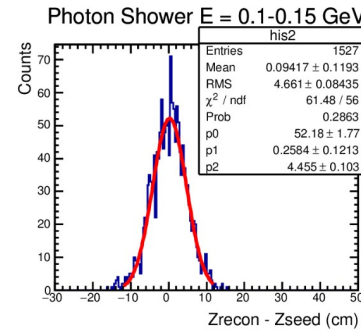
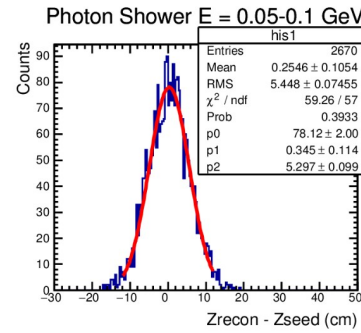
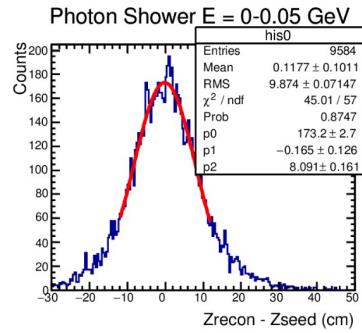
Calibration on $(\pi + \gamma)$: Layer 2



Calibration on $(\pi + \gamma)$: Layer 3

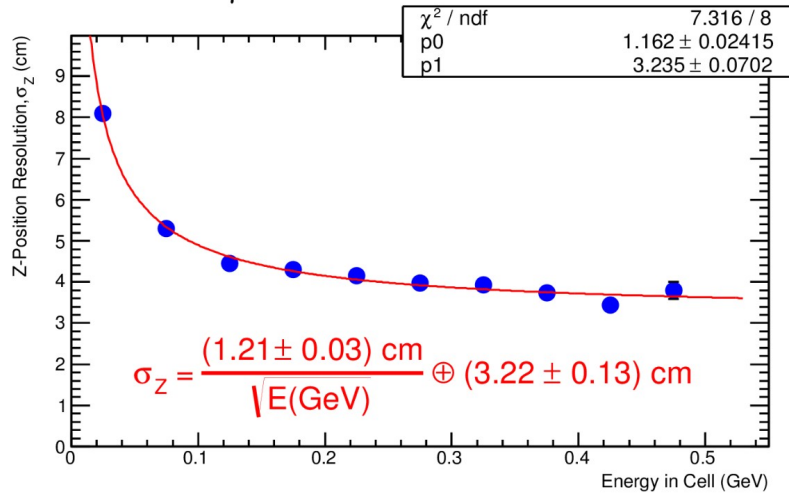


“Reconstructed” Z vs Thrown Z

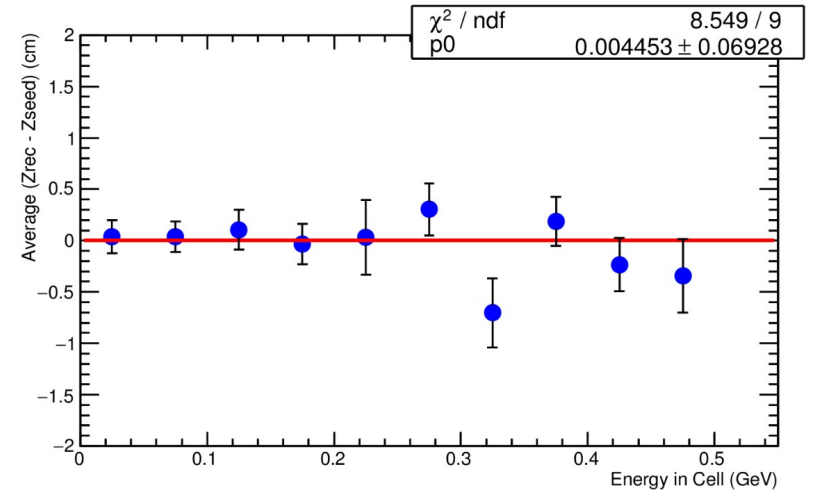
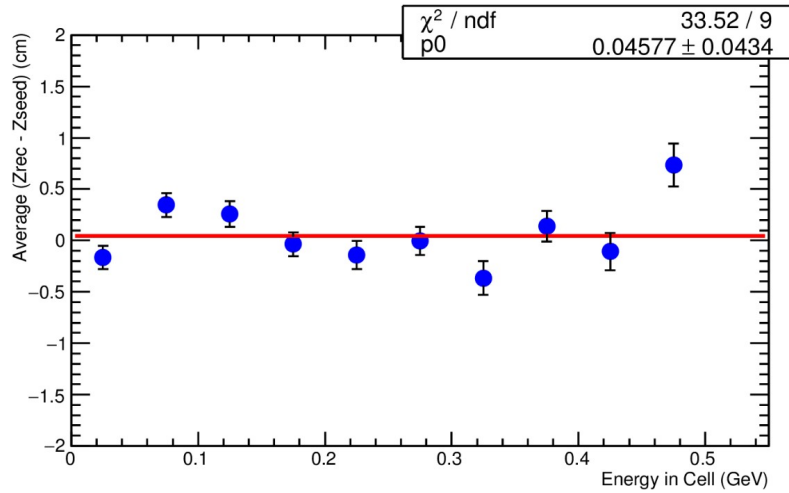
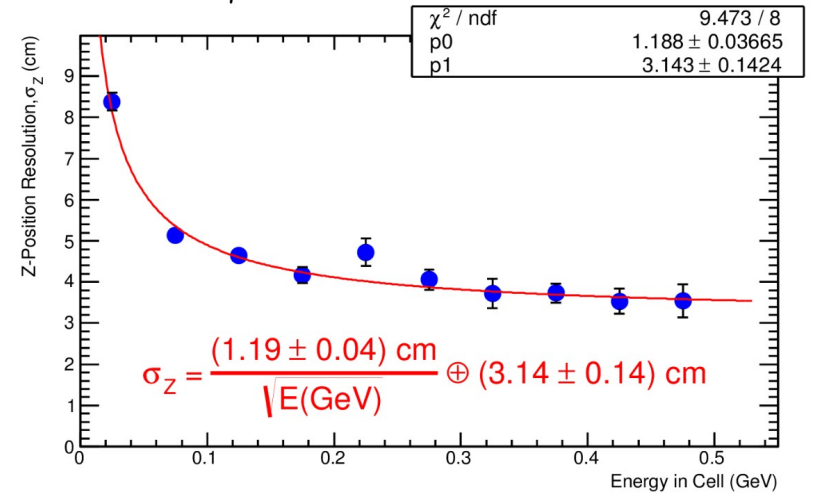


“Reconstructed” Z vs Thrown Z

Simulation: $E_\gamma=1$ GeV, Module=13, Sector=2, Layer=2

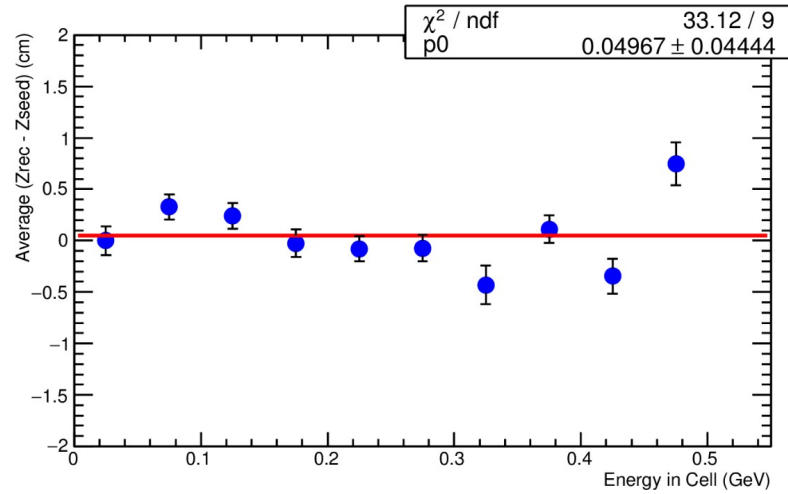
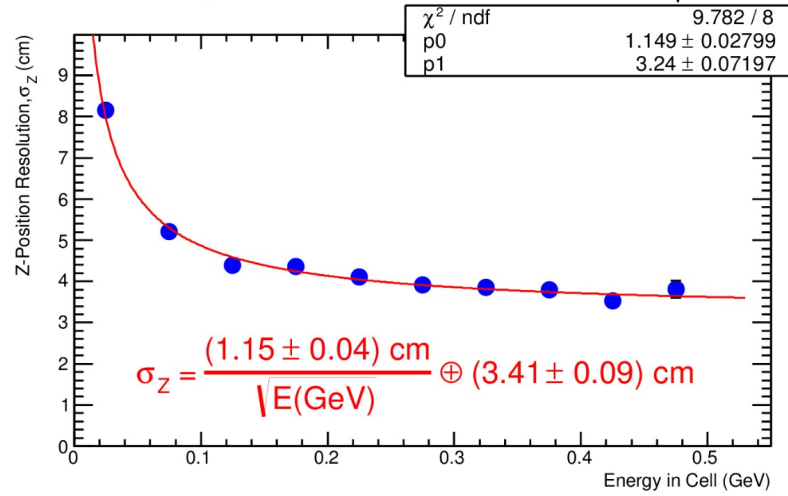


Simulation: $E_\gamma=1.8$ GeV, Module=13, Sector=1, Layer=1



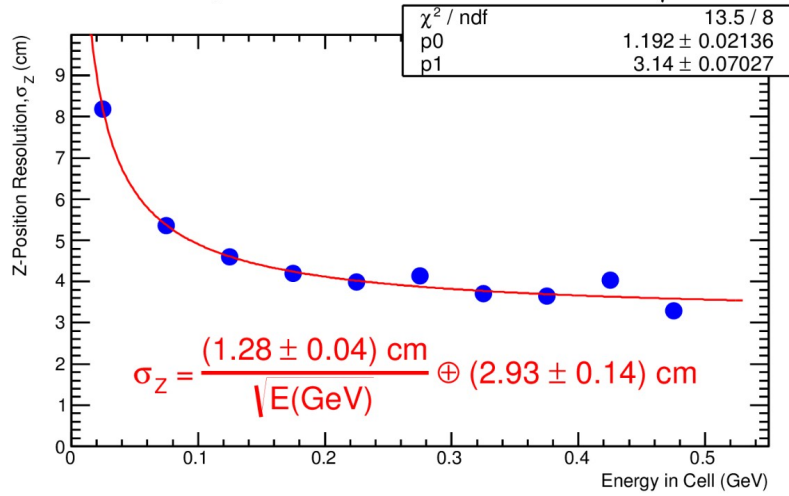
Calibration Stability

Simulation: $E_\gamma=1.0$ GeV, M13 ,S2, L2, Calib with $E_\gamma=2.0$ GeV

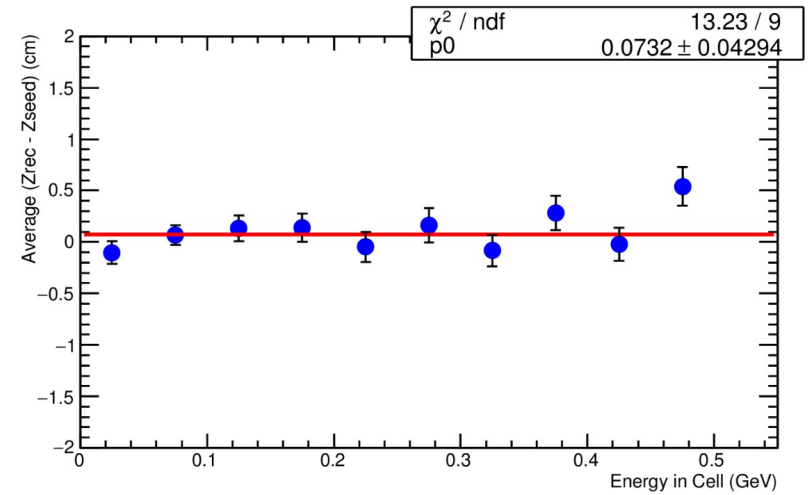
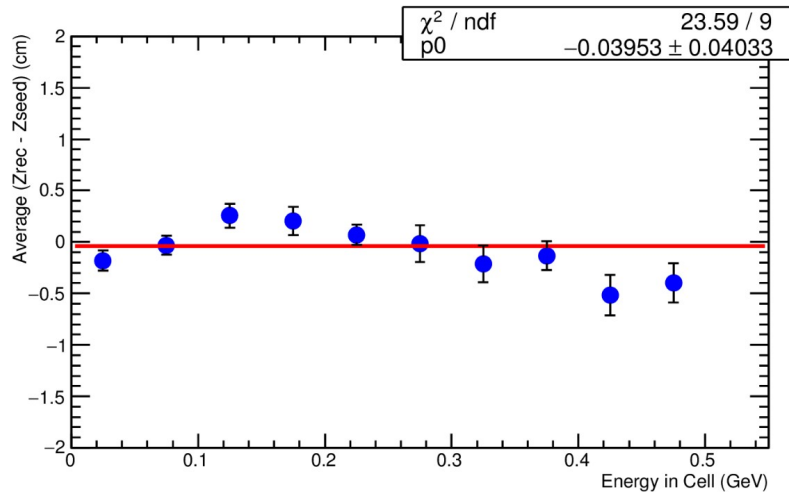
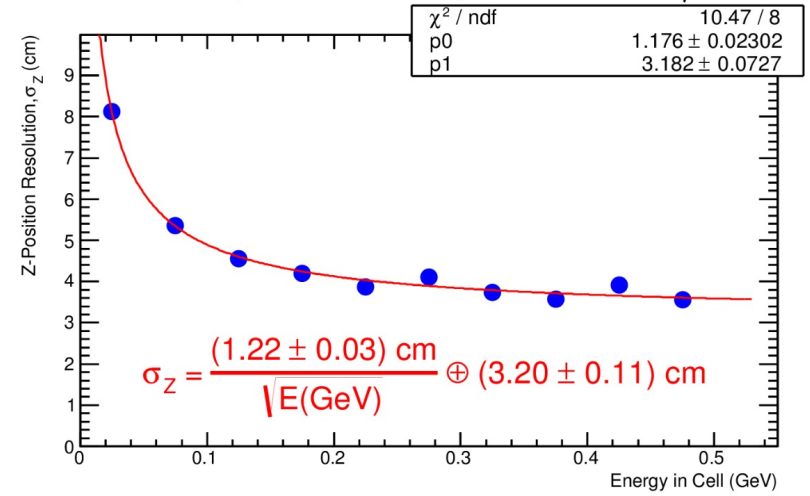


Calibration Stability

Simulation: $E_\gamma=2$ GeV, M13 ,S2, L2, Calib with $E_\gamma=0.4$ GeV



Simulation: $E_\gamma=2$ GeV, M13 ,S2, L2, Calib with $E_\gamma=1$ GeV



Conclusions

- * With realistic assumptions, we can reproduce (in general) BCAL time resolution
- * Comparison with the data suggests that the volume of the energy deposition in the shower is not the only cause of the “two-velocity” effect in BCAL
- * The systematics in the Z-reconstruction is small (consistent with zero)
- * In this simulation model (!), the timing calibration on gamma is stable (viz., only one calibration set can be used for the reliable Z-reconstruction of the gamma shower)