Longitudinal non-uniformality



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Shape of average shower energy deposition.

$$\Box \overline{E}(z_i) = \frac{1}{10000} \sum_{k=1}^{10000} E_k(z_i)$$

 $\Box E_k(z_i)$ - energy deposited in the i-th slice during k-th event.









Event wise weighted deposited E. distribution .

 $\Box E_k = \sum_{i=1}^{400} E_k(z_i)$

 $\Box E_k(z_i)$ – energy deposited in the i-th slice during k-th event.









Average Z coordinate of the shower

$$\Box \overline{Z_k} = \frac{\sum_{i=1}^{400} z_i E_k(z_i)}{\sum_{i=1}^{400} E_k(z_i)}$$

 $\Box E_k(z_i)$ - energy deposited in the i-th slice during k-th event.



electron, 1 GeV, event wise distribution of average Z, no attenuation



gamma, 25 GeV, event wise distribution of average Z, no attenuation



electron, 25 GeV, event wise distribution of average Z, no attenuation



4X0/25X0 vs 25X0 correlations

Correlation of two variables:

- 1. energy deposited in the entire detector
- 2. ratio of energy deposited in the first 64 mm (4X0) to energy deposited in the entire detector













Slice weight calculation

■ No mirrors at the entry facet:

$$W(z_i) = Ae^{-\frac{500[mm] - z_i[mm]}{L}}$$
■ With mirrors at the entry facet:

$$W(z_i) = A\left(e^{-\frac{500[mm] - z_i[mm]}{L}} + 0.7e^{-\frac{500[mm] + z_i[mm]}{L}}\right)$$

Coefficient A ensures that $\int W(z) dz = 1$

$$\Box L = 667 \text{ mm for O2 fibers}$$
$$\Box L = 1500 \text{ mm for Y11 fibers}$$

25 GeV Gamma

Average weighted energy deposition shape. 25 GeV, y

$$\Box \overline{E}(z_i) = \frac{1}{10000} \sum_{k=1}^{10000} E_k(z_i) W(z_i)$$

 $\Box E_k(z_i)$ - energy deposited in the i-th slice during k-th event.

 $\Box W(z_i)$ - attenuation weight



Event wise weighted deposited E. distribution . 25 GeV, y

 $\Box E_k = \sum_{i=1}^{400} E_k(z_i) W(z_i)$

 $\Box E_k(z_i)$ – energy deposited in the i–th slice during k–th

 $\Box W(z_i)$ - attenuation weight

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4X0/25X0 vs 25X0 weighted correlations. 25 GeV, y

Correlation of two variables:

- 1. energy deposited in the entire detector
- 2. ratio of energy deposited in the first 64 mm (4X0) to energy deposited in the entire detector
- Energy deposited for each corresponding slice was weighted



 10^{-1}





205002100021500220002250023000235002400024500

Energy deposited in 25X₀ [MeV]

0.10

gy

uni 0.05

0.00

Aggregated numbers

Variable	Fiber type	Mirror	25 GeV gamma	25 GeV electron	1 GeV gamma	1 GeV electron
Energy resolution σ/μ	no attenuation		3,47E-03	3,20E-03	1,09E-02	1,07E-02
	02	no mirror	2,73E-02	1,85E-02	3,40E-02	2,47E-02
		with mirror	1,01E-02	7,07E-03	1,57E-02	1,32E-02
	Y11	no mirror	1,18E-02	8,13E-03	1,86E-02	1,49E-02
		with mirror	3,72E-03	3,38E-03	1,14E-02	1,09E-02
Correlations 4X0/totval vs total	no attenuation		0,304	0,183	-0,025	-0,035
	02	no mirror	-0,814	-0,781	-0,814	-0,756
		with mirror	-0,781	-0,698	-0,604	-0,445
	Y11	no mirror	-0,813	-0,742	-0,695	-0,548
		with mirror	-0,204	-0,227	-0,281	-0,190



Conclusions

□ The system with O2 optical fiber gives energy resolution worse than 2%.

- The energy resolution for gammas is slightly worse than for electrons.
- The energy deposited in the first 4X0 (64 mm) is correlated with totally deposited energy. Interesting: the worse the resolution is the better the correlation.

□ The characteristics of the system with Y11 fibers are close to the system without attenuation at all.





1 GeV Gamma

Average weighted energy deposition shape. 1 GeV, y

$$\Box \overline{E}(z_i) = \frac{1}{10000} \sum_{k=1}^{10000} E_k(z_i) W(z_i)$$

 $\Box E_k(z_i)$ - energy deposited in the i-th slice during k-th event.

 $\Box W(z_i)$ - attenuation weight



1 GeV gamma, 10000 events average, O2 fiber, no mirrors

1.2





Event wise weighted deposited E. distribution . 1 GeV, y

 $\Box E_k = \sum_{i=1}^{400} E_k(z_i) W(z_i)$

 $\Box E_k(z_i)$ – energy deposited in the i–th slice during k–th

 $\Box W(z_i)$ - attenuation weight

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4X0/25X0 vs 25X0 weighted correlations. 1 GeV, y

Correlation of two variables:

- energy deposited in the entire 1. detector
- 2. ratio of energy deposited in the first 64 mm (4X0) to energy deposited in the entire detector
- Energy deposited for each corresponding slice was weighted



 $\frac{1}{X_0}$ vs 25X₀ vs 25X₀ correlations, gamma, 1 GeV, Y11 fiber, no mirrors 0.7 · 10²









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1 GeV Electrons

Average weighted energy deposition shape. 1 GeV, e-

$$\Box \overline{E}(z_i) = \frac{1}{10000} \sum_{k=1}^{10000} E_k(z_i) W(z_i)$$

 $\Box E_k(z_i)$ - energy deposited in the i-th slice during k-th event.

 $\Box W(z_i)$ - attenuation weight

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1 GeV electron, 10000 events average, O2 fiber, no mirrors





Event wise weighted deposited E. distribution . 1 GeV, e-

$$\Box E_k = \sum_{i=1}^{400} E_k(z_i) W(z_i)$$

 $\Box E_k(z_i)$ – energy deposited in the i–th slice during k–th

 $\Box W(z_i)$ - attenuation weight

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4X0/25X0 vs 25X0 weighted correlations. 1 GeV, e-

Correlation of two variables:

- energy deposited in the entire 1. detector
- 2. ratio of energy deposited in the first 64 mm (4X0) to energy deposited in the entire detector
- Energy deposited for each corresponding slice was weighted

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100

 10^{-1}





825

850 875

Energy deposited in 25X0 [MeV]

900 925 950

4X₀/25X₀ 0.6

atio

gy

0.5

0.4

0.3

0.2

0.1

775 800

25 GeV Electrons

Average weighted energy deposition shape. 25 GeV, e-

$$\Box \overline{E}(z_i) = \frac{1}{10000} \sum_{k=1}^{10000} E_k(z_i) W(z_i)$$

 $\Box E_k(z_i)$ - energy deposited in the i-th slice during k-th event.

 $\Box W(z_i)$ - attenuation weight



400

1.0

weight

- 0.6 등

0.2

0.0

1.0

0.8

. 9.0 weight

.0. Attenuation v

0.2

0.0

400

Event wise weighted deposited E. distribution . 25 GeV, e-

$$\Box E_k = \sum_{i=1}^{400} E_k(z_i) W(z_i)$$

 $\Box E_k(z_i)$ – energy deposited in the i–th slice during k–th

 $\Box W(z_i)$ - attenuation weight

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25 GeV electron, 10000 events, O2 fiber, with mirrors



22600 22800 23000 23200 23400 23600 23800 240 Effective detected energy [MeV]



4X0/25X0 vs 25X0 weighted correlations. 25 GeV, e-

Correlation of two variables:

- 1. energy deposited in the entire detector
- 2. ratio of energy deposited in the first 64 mm (4X0) to energy deposited in the entire detector
- Energy deposited for each corresponding slice was weighted

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Energy deposited in 25X₀ [MeV

 $X_0/25X_0$ vs 25X₀ correlations, electron, 25 GeV, O2 fiber, no mirrors





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