W-ScFi calorimeter Update - 6

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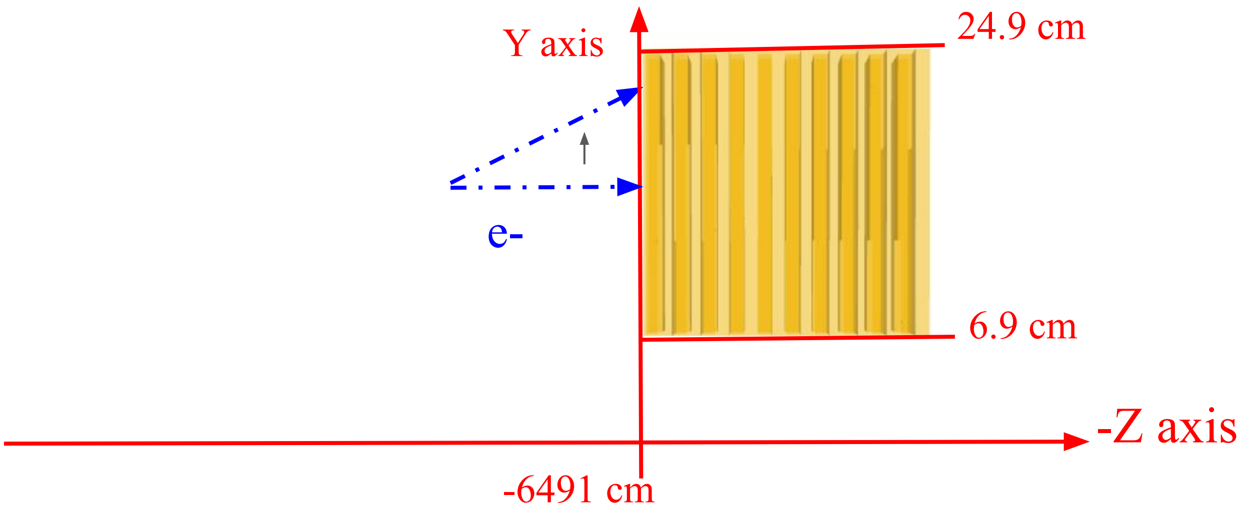
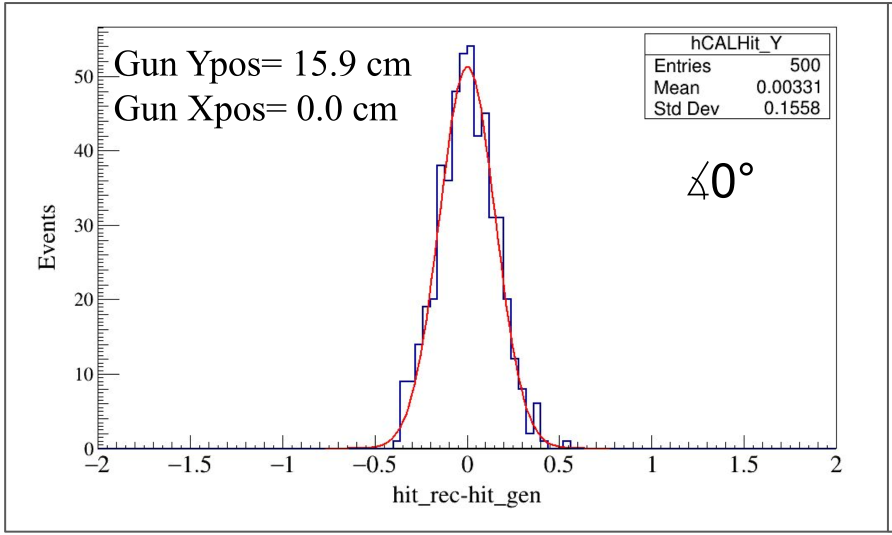
Ppt 1 (08/31/23) : Design - Energy Resolution - Sampling Frac Compare with 4:1 and 2:1 WScFi ratio
Ppt 2 (09/21/23) : Shower Profile Check with 4:1 - Position Resolution (X)
Ppt 3 (10/02/23) : Shower Profile Check with 4:1 - Angular Resolution
Ppt 4 (11/02/23) : Problem and Possible Solution with Position resolution
Ppt 5 (11/10/23) : Methodology & Challenges with Weighted Least Square Fit
Ppt 6 (11/21/23) : Challenges & cross checks with Energy weighted least square fit

Analysis Setup

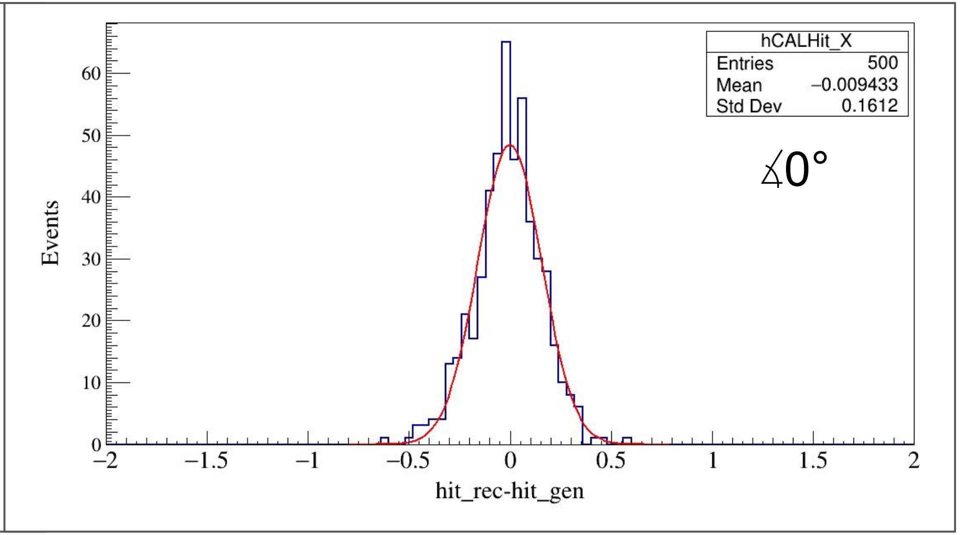


- Electrons shooted at upper CAL. Only at an angle along Y-axis (0° - 4°), keeping angle along X = 0°
- Aim : To reconstruct the hit location (where particles hits the front face of Calorimeter) with least square fit equation

Results



Reconstructed - Generated Y Hit Location

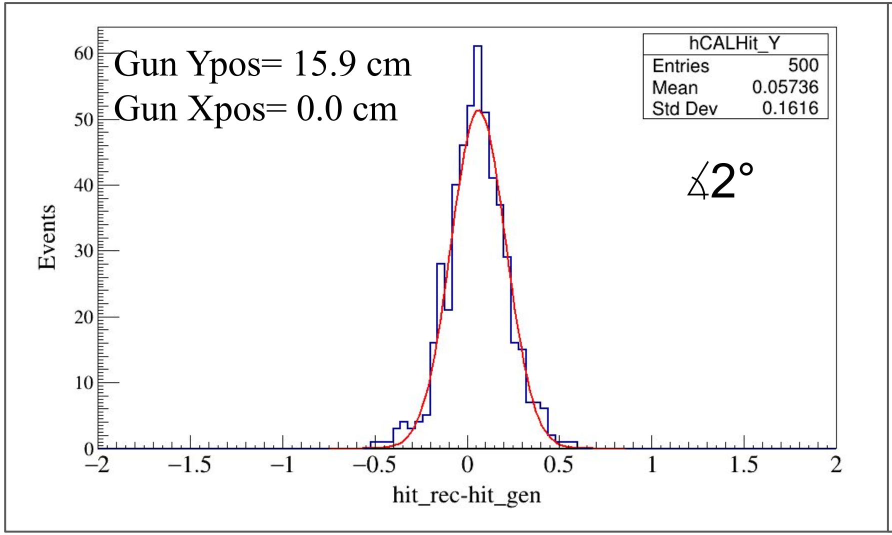


Reconstructed - Generated X Hit Location

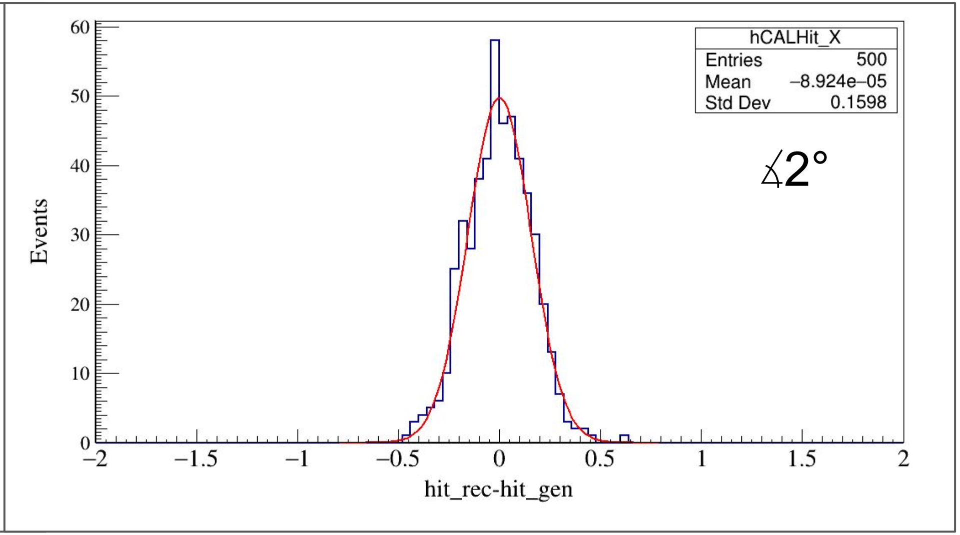
At ∡0° , direct hit on face of calorimeter

- The X-Y resolution (Std Dev of hit_rec - hit_gen) ~ 1.6 mm
- The Shift (Mean of hit_rec - hit_gen) ~ negligible

Results



Reconstructed - Generated Y Hit Location

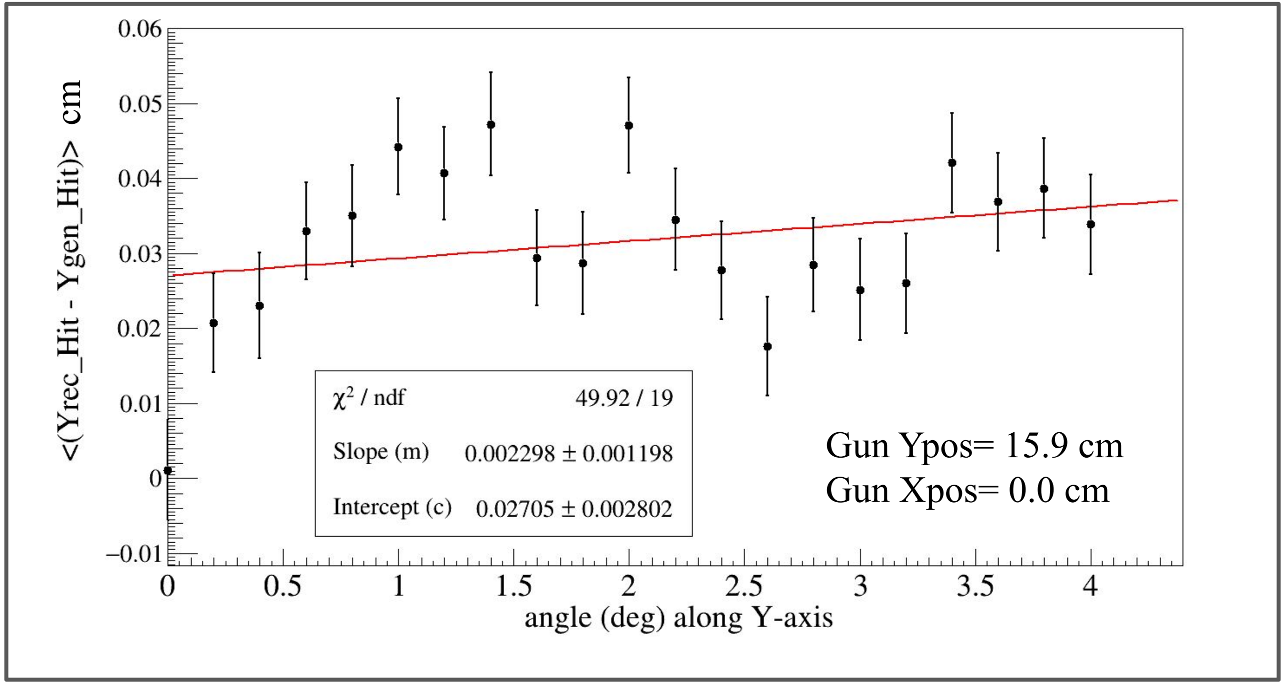


Reconstructed - Generated X Hit Location

At ∡2° along Y-axis,

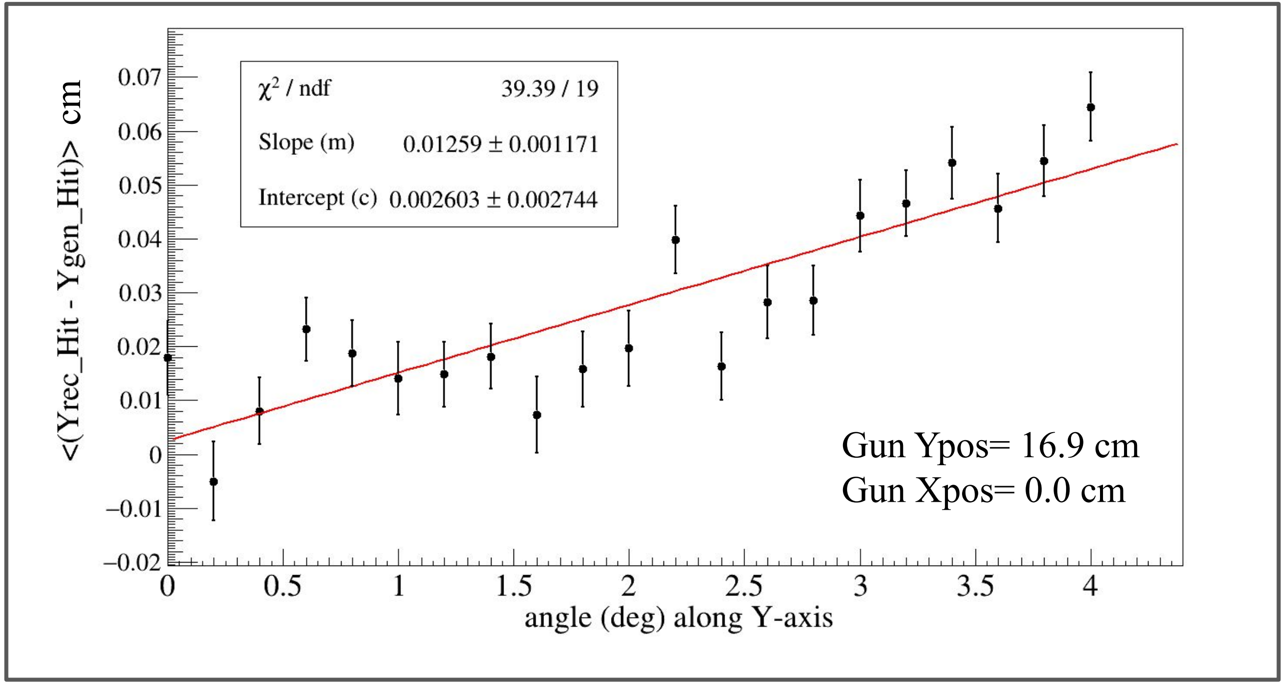
- The X-Y resolution ~ 1.6 mm
- The Y-Shift ~ 0.6 mm
- The X-Shift ~ negligible

Results



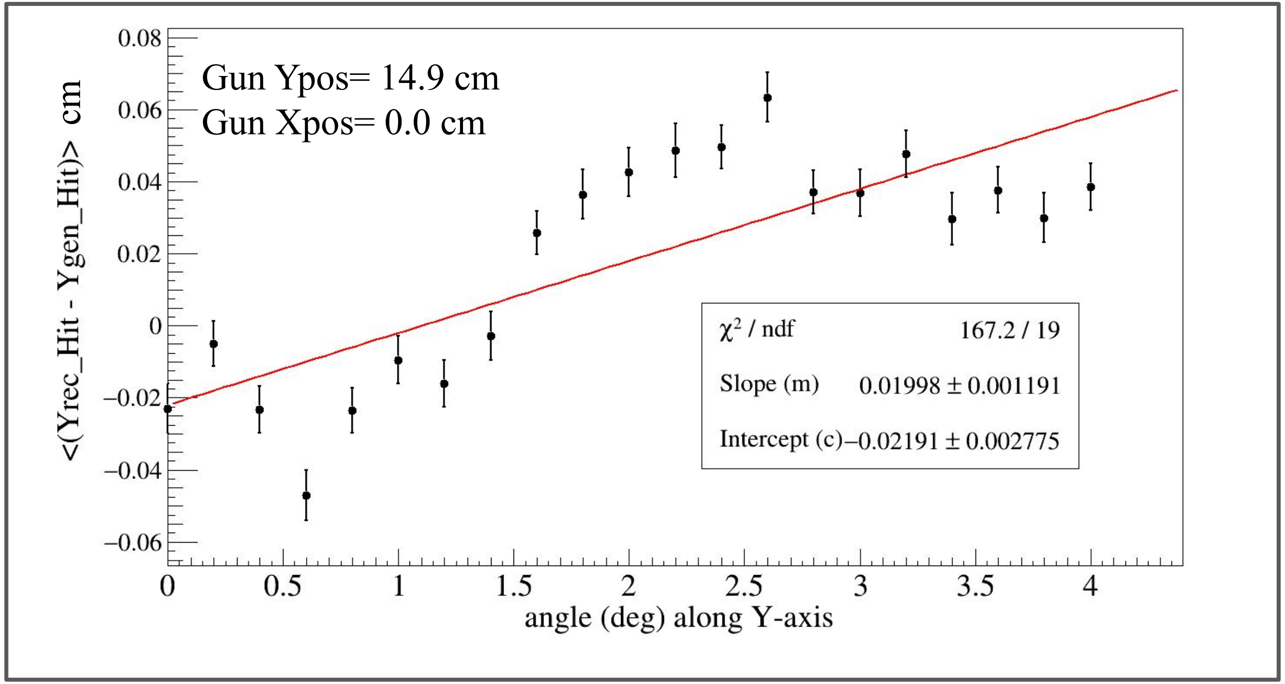
<(Yrec_Hit - Ygen_Hit)> cm
angle (deg) along Y-axis
χ² / ndf 49.92 / 19
Slope (m) 0.002298 ± 0.001198
Intercept (c) 0.02705 ± 0.002802
Gun Ypos= 15.9 cm
Gun Xpos= 0.0 cm

Results



χ2 / ndf 39.39 / 19
Slope (m) 0.01259 ± 0.001171
Intercept (c) 0.002603 ± 0.002744
<(Yrec_Hit - Ygen_Hit)> cm
angle (deg) along Y-axis
Gun Ypos= 16.9 cm
Gun Xpos= 0.0 cm

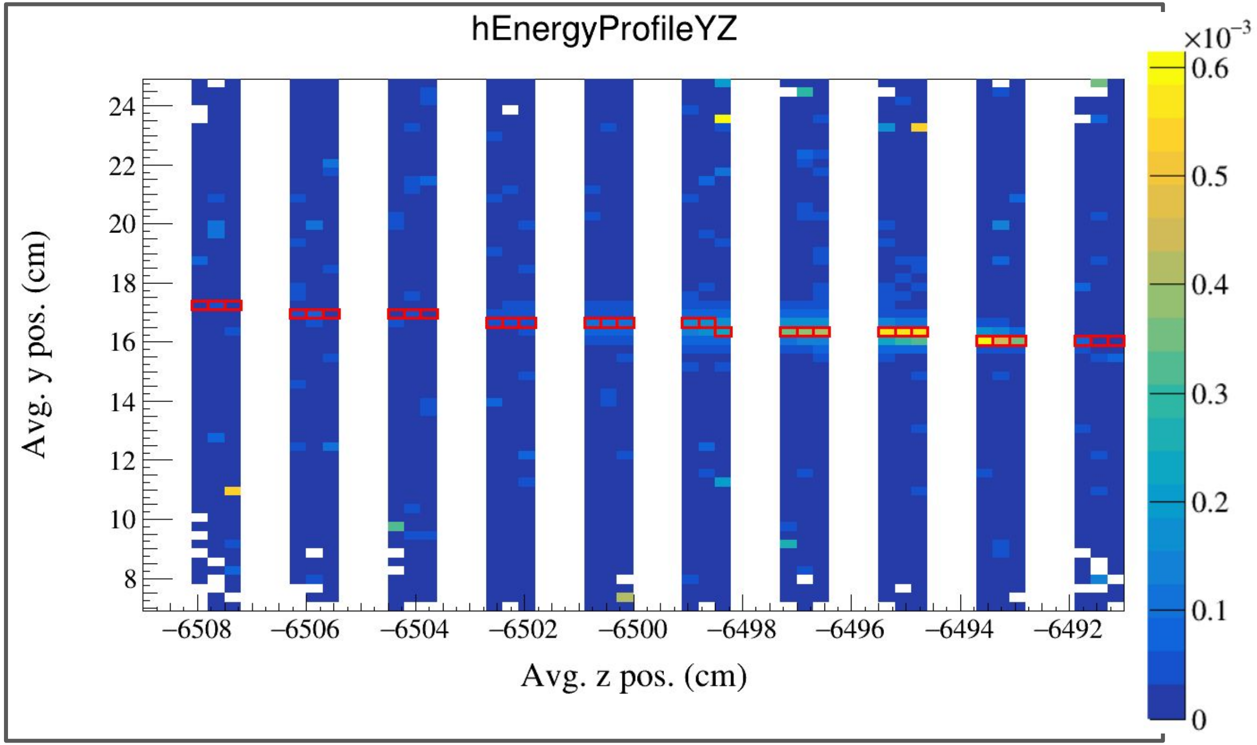
Results



From ∡0° - ∡4° along Y only

- The Y-Shift (Mean of hit_rec - hit_gen) increases slightly with angle and depends on the hit location.
- The maximum Y-Shift will be ~ 0.6 mm.

Results



- Gun Ypos= 15.9 cm
- ∡4°
- All 500 events considered for finding the slope & intercept.
- Coloured columns represent avg. y_pos of energy deposition of shower.
- Hollow red boxes : Ideal position of energy deposition (y_pos = z*m_gen + c_gen)

- The Y-shift (Mean of hit_rec - hit_gen) increases slightly with angle.
- The Y-shift is ~ 0.6 mm = Y-shift we attain doing event-by-event for the same angle.

Discussion and Questions

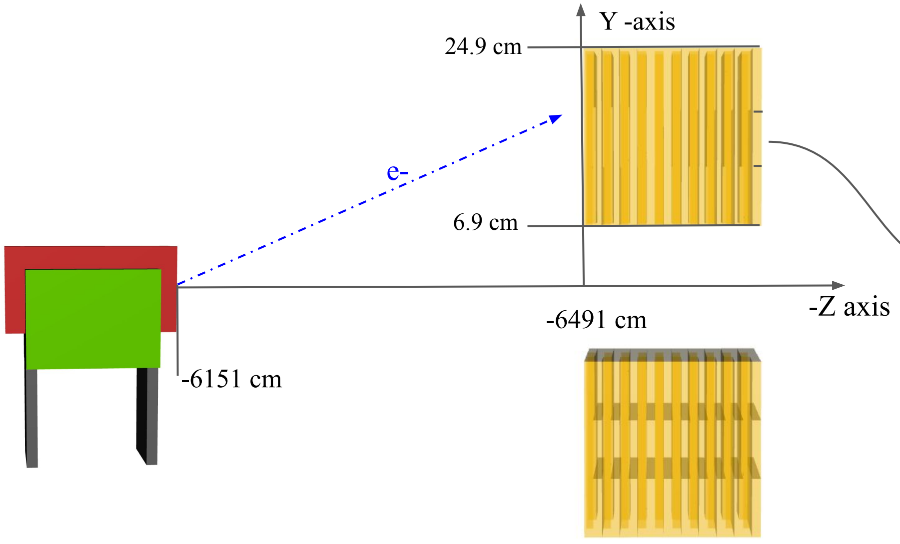
1. How to remove this small shift (~0.6 mm) in hit location.
2. How to reduce the X-Y resolution (Std. Dev) which is ~ 1.6 mm.
3. Is the size of SiPM (3 mm) responsible for this small shift ? or Size of layer (9 mm).

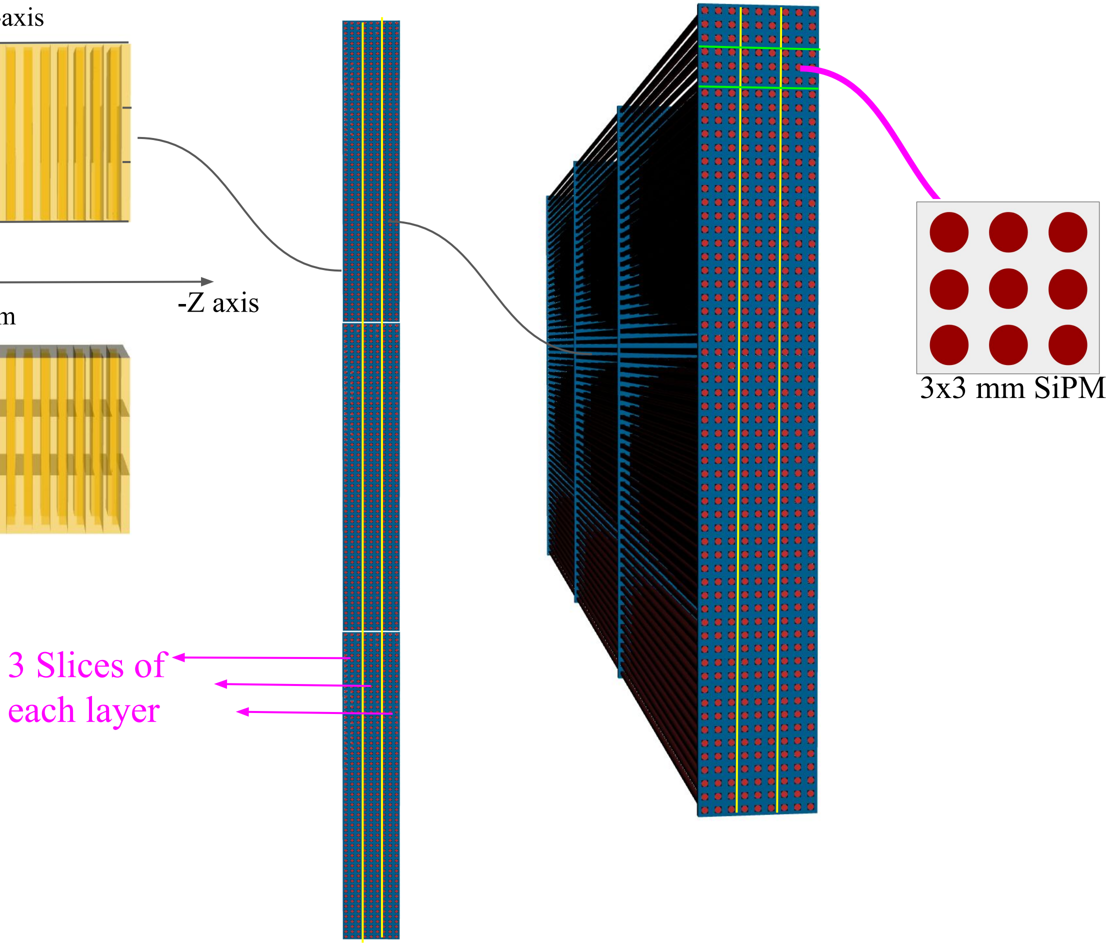
Both BPC modules are segmented tungsten-scintillator sampling calorimeters, permitting simultaneous measurement of the electron's energy and transverse position of impact. The passive layers contain 26 plates of 3.5-mm thick tungsten alloy. These 24 electromagnetic radiation lengths (X_0) are more than adequate for longitudinal containment in this application. The active elements consist of scintillator fingers, alternating after each plate in the x and y directions, each finger 7.9 mm wide and 2.6 mm thick. One end of each finger is aluminized to provide an efficient end reflector. Each scintillator is optically decoupled from its neighbors by a wrapping of 27.5 µm aluminum foil. The net effective width of each finger, including wrapping and air gaps, is 8.0 mm.

ZEUS PS CAL Description

BACK UP

Calorimeter design & setup





Avg. position (x,y) of shower is calculated per slices (10 layers * 3 = 30 slices)

Algorithm for slope

- Total energy deposition (Edep_i) in 9 fibers of each SiPM is associated with a position, Pos_i
    - where i = {SiPMs in one slice }
- The centre of SiPM is the associated position , **Pos_i = {**
    - **x_centre, or**
    - **y_centre } depending on layer**
- For a slice say j, in Suppose X|| layers, the mean y_j is

$$y_j = \frac{\sum_i^{i \in j} y_i E_{dep}^i}{\sum_i^{i \in j} E_{dep}^i}$$

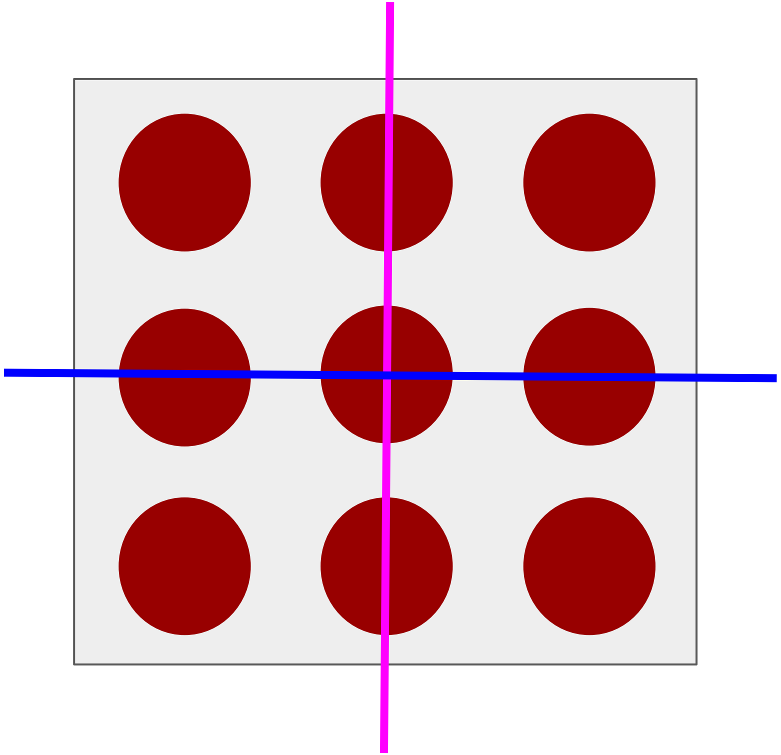


Fig.:Single SiPM with 9 fibers

Algorithm for slope - Barlow's Equation

$$m = \frac{\overline{yz} - \bar{y}\bar{z}}{\overline{z^2} - \bar{z}^2}$$

$$\bar{t} = \frac{\sum_{j}^{j \in slices} t_j E_{dep}^{j}}{\sum_{j}^{j \in slices} E_{dep}^{j}} \qquad t \in y, z$$

- 'z' is the centre position of the slices
- Same for Y|| layers, y changed to x in each formula.