

Tracker Meeting: simulation of the first station calibration in a vertical orientation

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Introduction: VST and calibration

- The first station is expected soon;
- Reconstructing cosmic tracks and understanding resolutions requires calibrating the station.

Timing calibration:

• signal propagation and channel-to-channel delays for each straw.

What is it needed for this purpose?

• unbiased reconstruction of the track longitudinal position in a straw.

Introduction: station orientation

During CM, there was a discussion related to the orientation of the station:

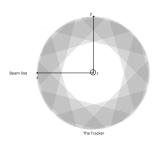
- Vertical orientation is preferred for gas system and because the station will be vertical during the experiment;
- Horizontal orientation enables an unbiased reconstruction. First VST plane calibration was horizonal.

Would running in vertical orientation provide data needed for calibrating?

A simulation has been performed to reconstruct cosmics tracks with vertically oriented station, aiming to understand possible biases in determining longitudinal position caused by the non-uniform illumination of a panel.

Reconstruction of Cosmic tracks

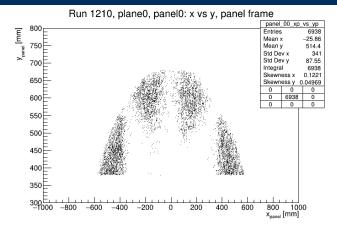
- The station is not yet calibrated: whether a straw has been hit or not is the only info we have;
- 4 hits per face to reconstruct one line:
 - panel hits in each face → combo hits;
 - 2 combo hits in a plane → stereo hit;
 - 2 hits per plane → reconstructed track.
- The reconstruction of the hit position is performed using:
 - the straw direction (D_x, D_y) ;
 - the straw midpoints (x, y);
 - the straw z coordinate of faces.



Cosmics simulation and selection criteria

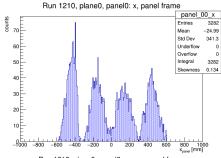
- Simulated cosmics crossing only one station;
- Station in vertical orientation in extracted position;
- No magnetic field;
- To reconstruct a straight line in 3D, at least 4 hits at different z are needed: tracks selected with nhits_{facei} ≥ 1;
- To improve the resolution, $nhits_{panel_i} \leq 3$ were selected.

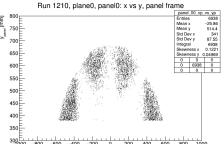
Panel illumination



- spotty and non uniform illumination pattern of a panel in a vertical orientation (panel frame);
- same for all panels;
- wires have no hits in the center.

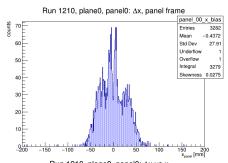
Results: longitudinal position reconstruction

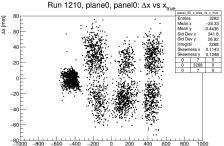




- the histogram shows longitudinal position in the panel frame;
- reconstructed longitudinal position distribution presents peaks in the overlaps with other panels;
- different straws make different peaks.

Results: longitudinal position reconstruction bias





 reconstructed longitudinal position distribution presents peaks in the overlaps with other panels;

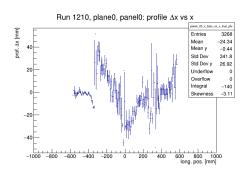
•
$$\Delta x = x_{rec} - x_{true}$$
;

- the longitudinal position bias range is about -6÷6 cm;
- 2D distribution of Δx versus x_{true} shows four different spots referring to the overlap regions;
- the first spot (CAL side) is referred to ninety degrees panels overlap.

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 VST
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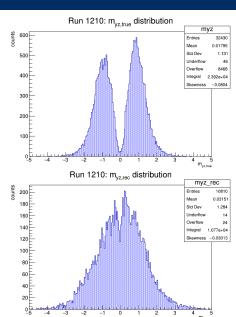
long, pos. [mm]

Results: systematics on longitudinal position reconstruction



- profile of the Δx versus x_{true} shows a systematic effect in determining the longitudinal position of a range greater than -4÷4 cm;
- the first part (CAL side) is referred to ninety degrees panels overlap;
- the mean is not a good estimator of the bias, because the distribution is referred to multiple straws.

Direction of the reconstructed line



- $m_{yz} = \frac{\Delta y}{\Delta z}$;
- first histogram shows true m_{yz} ;
- second histogram shows the reconstructed m_{yz} ;
- true hits position far away from the straws midpoint lead to the misreconstructed zy and xy direction lines.

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Conclusions

In a vertical configuration of the station:

- illumination of panels is very non uniform, no hits in the central part of wires;
- there will be systematic effects in determining the longitudinal position (~ cm) due to the panel orientation;
- calibration is expected to be very difficult in these conditions.

Backup Slide: Combo, Stereo Hits and Reconstructed line

1. Geometrical Combo Hits

Determination of a unique straw in a panel:

- mean of straws midpoint (x_m, y_m, z_m) ;
- straws direction (D_x, D_y) .

2. Geometrical Stereo Hits

Determination of the hit point in a plane:

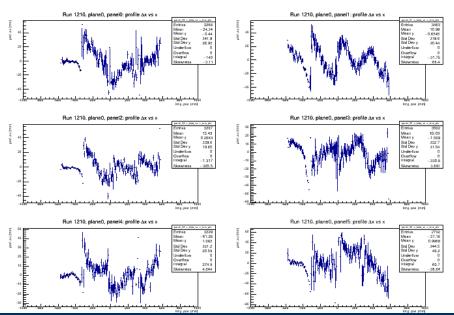
- intersection point (x, y) using the two straws directions and midpoints from two panels;
- mean of z coordinate between the two faces.

3. Reconstructed Line

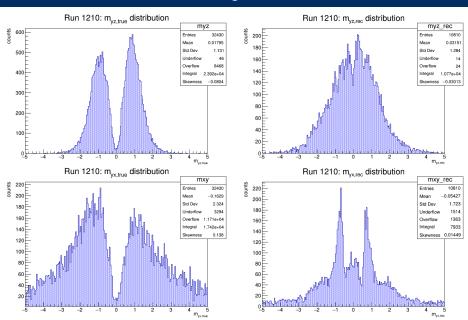
Determination of a unique reconstructed track:

- one stereo hit per plane: one line reconstructed geometrically;
- the intersection point of the line with panels is found knowing the z_m coordinate.

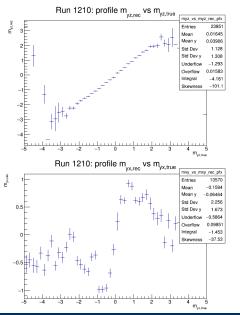
Backup Slide



Backup Slide



Results: systematics on track direction reconstruction



•
$$m_{yz} = \frac{\Delta y}{\Delta z}$$
 and $m_{yx} = \frac{\Delta y}{\Delta x}$;

- first histogram shows the mean of reconstructed m_{yz} versus the true one and it shows a systematic effect in determining the zy track direction (-4÷3);
- second histogram shows the mean of reconstructed m_{yx} versus the true one and it shows a systematic effect in determining the xy track direction (-1÷1);
- true hits position far away from the straws midpoint lead to the misreconstructed zy and xy direction lines.

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