

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.

First calibration:

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

What is it needed?

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

Introduction: station orientation

CM tracker workshop:

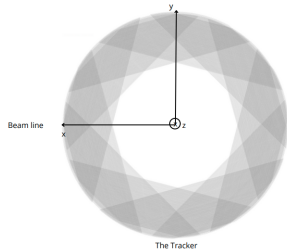
- Vertical orientation is preferred for gas system and because the station will be vertical during the experiment;
- Horizontal orientation enables an unbiased reconstruction. First VST plane calibration was horizontal.

Would running in vertical orientation provide data needed for calibrating?

A simulation has been performed to reconstruct cosmic 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

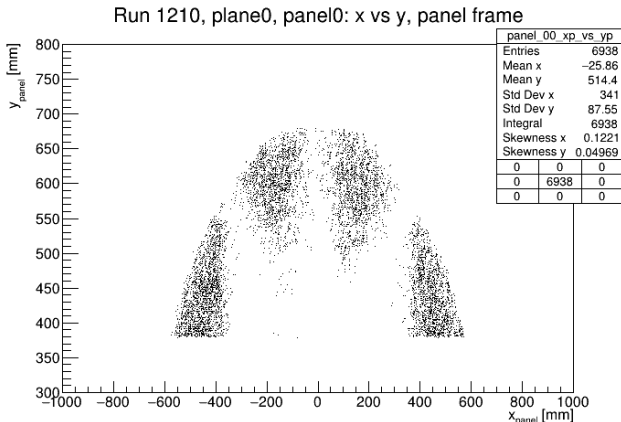
- Starting assumptions:
 - the station is not yet calibrated;
 - for reconstruction, can only use the information about the hit straws.
- To reconstruct a line, need 4 hits, one per face:
 - panel hits in each face \rightarrow combo hits;
 - 2 combo hits in a plane \rightarrow stereo hit;
 - 2 hits per plane \rightarrow reconstructed track.
- Reconstruction of the panel hit position uses:
 - the straw direction (D_x, D_y) ;
 - the straw midpoints (x, y) ;
 - the straw z coordinate of faces.



Cosmics simulation and selection criteria

- Use Production configs to simulate tracker in extracted position;
- Station in vertical orientation;
- No magnetic field;
- require hits in the first station, ignore other stations;
- To reconstruct a straight line in 3D, at least 4 hits at different z are needed: tracks selected with $nhits_{face_i} \geq 1$;
- To improve the resolution, $nhits_{panel_i} \leq 3$ were selected.

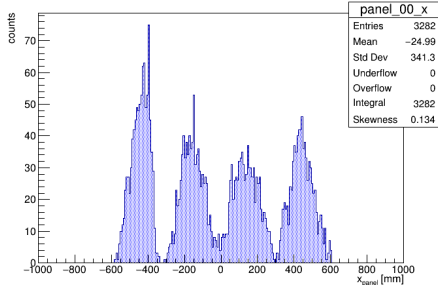
Panel illumination



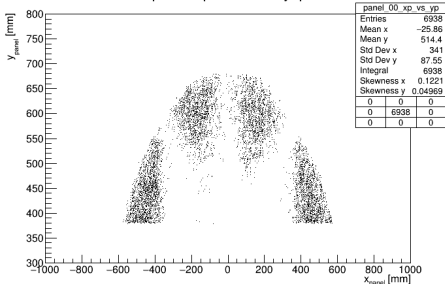
- spotty and non uniform illumination pattern;
- similar patterns for all panels;
- almost no hits in the central region.

Results: longitudinal position reconstruction

Run 1210, plane0, panel0: x, panel frame



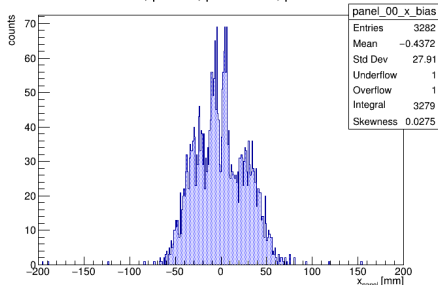
Run 1210, plane0, panel0: x vs y, panel frame



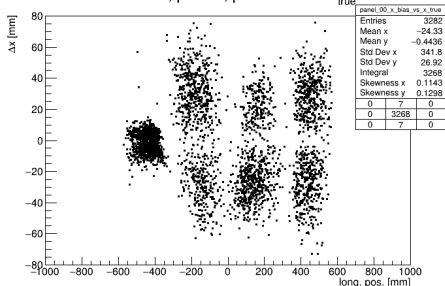
- the histogram shows longitudinal position in the panel frame;
- bumps are a consequence of the four hit faces requirement;
- different bumps correspond to different straws.

Results: longitudinal position reconstruction bias

Run 1210, plane0, panel0: Δx , panel frame

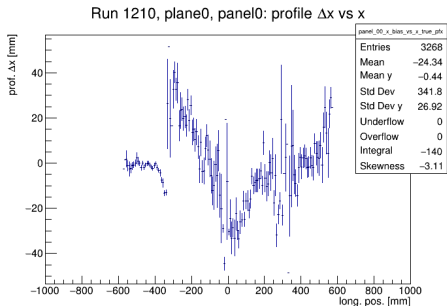


Run 1210, plane0, panel0: Δx vs x_{true}



- $\Delta x = x_{\text{rec}} - x_{\text{true}}$;
- the longitudinal position bias range is about $-6 \div 6$ cm;
- 2D distribution of Δx versus x_{true} shows eight different spots corresponding to the overlap regions;
- the first two spots (CAL side) corresponds to ninety degrees panels overlap.

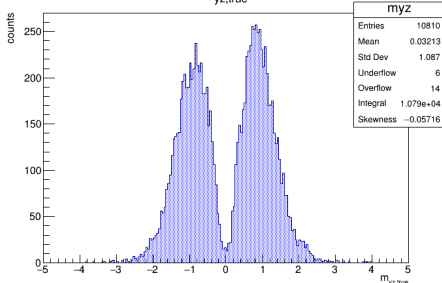
Results: systematics on longitudinal position reconstruction



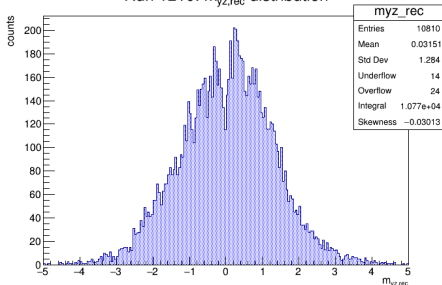
- profile of the Δx versus x_{true} shows a systematic effect in determining the longitudinal position of a range greater than $-4 \div 4$ cm;
- the first part (CAL side) is referred to ninety degrees panels overlap;
- the mean is not a good estimator - see previous slide.

Direction of the reconstructed line

Run 1210: $m_{yz,true}$ distribution



Run 1210: $m_{yz,rec}$ distribution



- $m_{yz} = \frac{\Delta y}{\Delta z}$;
- 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.

Conclusions

In a vertical configuration of the station:

- illumination of panels is very non uniform, no hits in the central part of panels;
- systematic effects (\sim cm) in determining the longitudinal position;
- systematics depends on the panel orientation;
- expect calibration to become a challenge.

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:

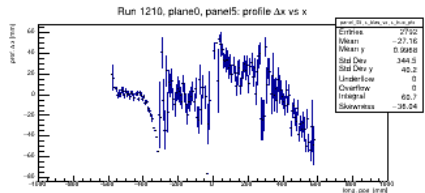
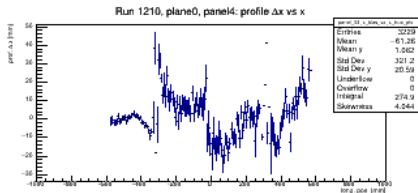
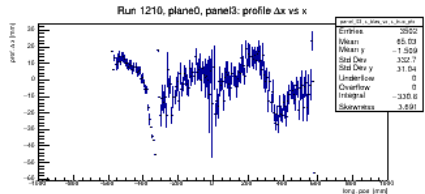
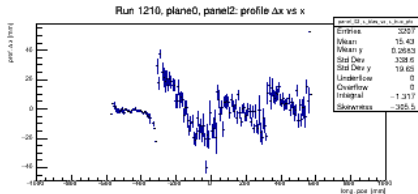
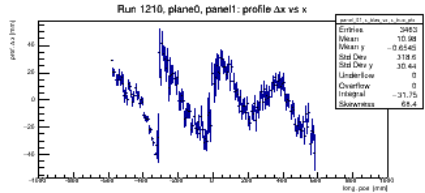
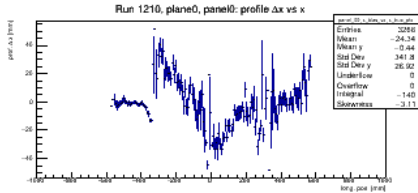
- intersection point (x, y) using the two straws directions and midpoints from two panels;
- mean of z coordinate between the two faces.

3. Reconstructed Line

Determination of a unique reconstructed track:

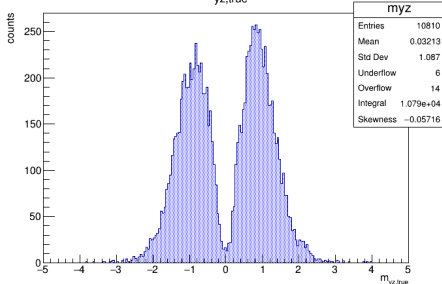
- one stereo hit per plane: one line reconstructed geometrically;
- the intersection point of the line with panels is found knowing the z_m coordinate.

Backup Slide

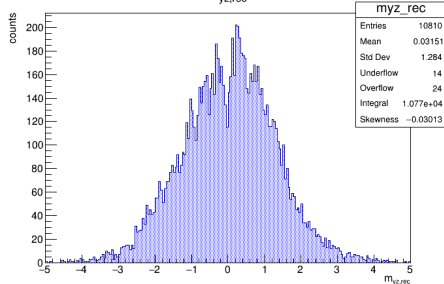


Backup Slide

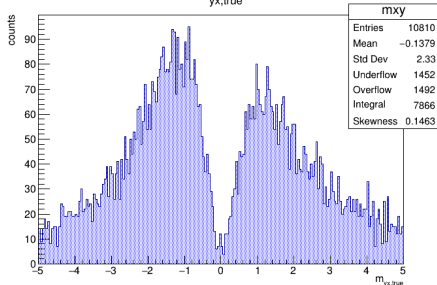
Run 1210: $m_{yz,true}$ distribution



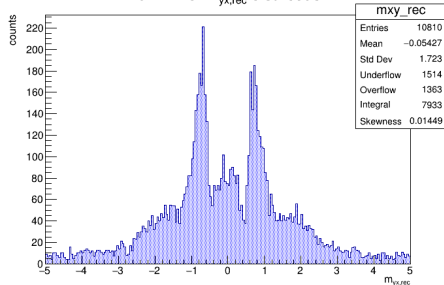
Run 1210: $m_{yz,rec}$ distribution



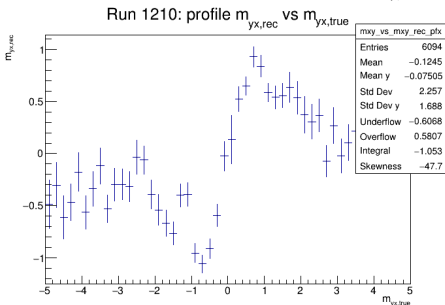
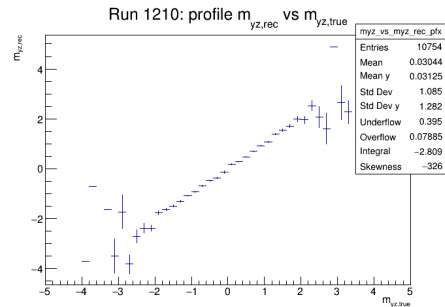
Run 1210: $m_{yx,true}$ distribution



Run 1210: $m_{yx,rec}$ distribution



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 ($-4 \div 3$);
- 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 ($-1 \div 1$);
- true hits position far away from the straws midpoint lead to the misreconstructed zy and xy direction lines.