MUST Software Status

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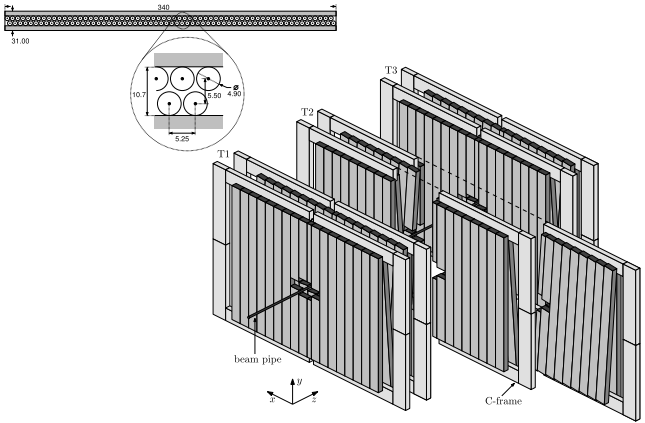
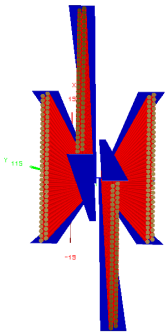
LHCb to MUST Geometry





- LHCB: 0°, −5°, 5°, 0° | 0°, −5°, 5°, 0° | 0°, −5°, 5°, 0°
- MUST: 0°, −5°, 5°, 0°, 0°, −5° | 5°, 0°, 0°, −5°, 5°, 0° : station (2) → layer (6) → module (36) → tube (128)

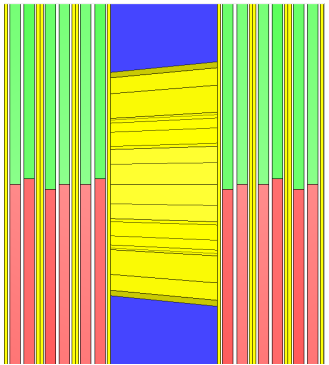
Work done by David Emschermann

MUST Geometry variants

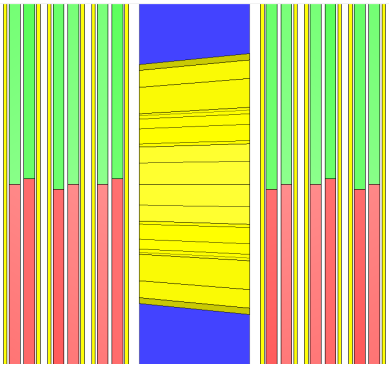
v26c LMVM	is optimized for initialization speed and to allow the overlap check to pass in a reasonable time. (Update to MUST v26a and v26b to speed up accordingly.)
v26d LMVM	modules S2 and S3 are shortened and follow the opening angle of the shield
v26e LMVM	introduces gaps of 3 cm, 2 cm, 2 cm and 3 cm between absorbers and C-frames, absorber no. 4 shifts downstream by 10 cm in z
v25c mCBM	with geometry hierarchy backported from v26c

Work done by David Emschermann

MUST Geometry



In MUST v26c the MUST layers (C-frames) are touching each other, there are no gaps.



In MUST v26e we introduced gaps between the MUST layers (C-frames), they are 2 cm wide between MUST layers and 3 cm between MUST layers and absorbers.

The MUST v26c cannot realistically be build. We think that v26e is realistically possible.

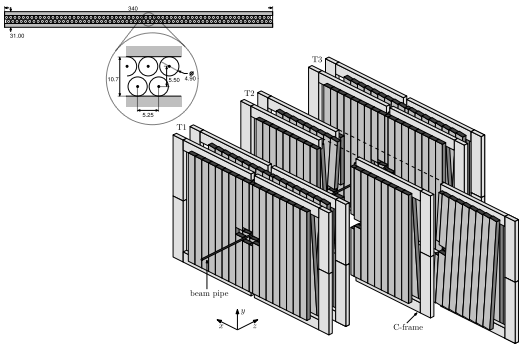
Work done by David Emschermann

Geometry handling

Different reference systems:

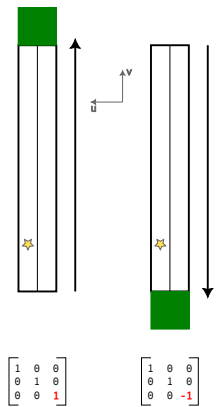
- MUST hit in the CAVE ref. sys.
- each MUST components in its own ref. sys:

CAVE → MUST → station → layer → module → tube



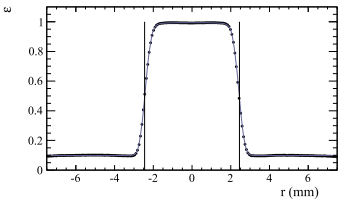
(LHCb geometry)

Readout electronics location



Encode the information in z-rotation parameter.

Drift radius and time

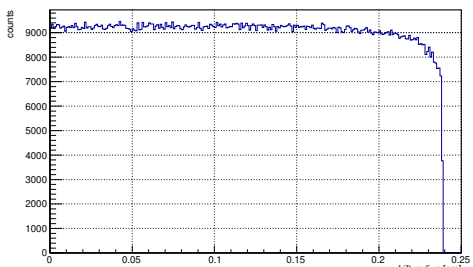


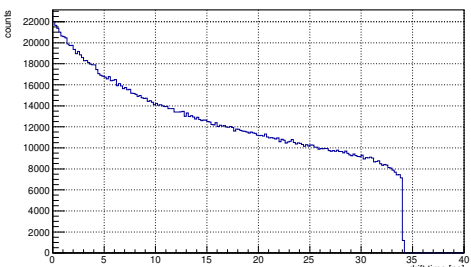
Efficiency (from LHCb):

$$\epsilon(r) = \epsilon_0 \left(1 - \exp\left(\frac{-2\sqrt{R^2 - r^2}}{\lambda}\right)\right)$$

Track residuals (distance to wire): $d = \frac{||\vec{PQ} \times \vec{n}||}{||\vec{n}||}$

Drift time (from LHCb): $T_{\text{drift}} = 20.5r + 14.85r^2$





Total measured/reconstructed time

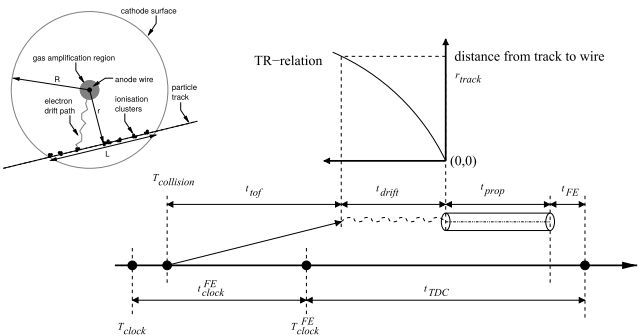
$$T_{\text{meas}} = T_{\text{flight}} + T_{\text{drift}} + T_{\text{prop}} + T_{\text{electronics}} + [2.5\,\text{ns(smearing)}]$$

T_{flight} time of flight: target to straw (from simulations),

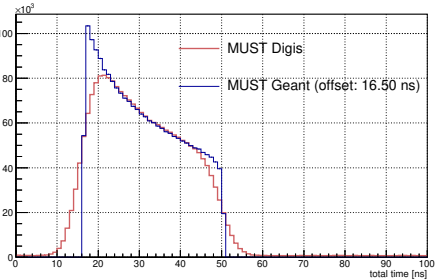
T_{drift} drift time in the straw tube (from drift radius),

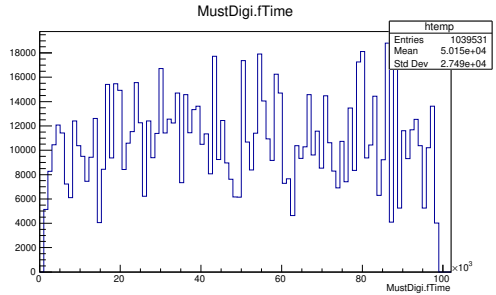
T_{prop} signal propagation in the straw (hit position along v-axis to readout),

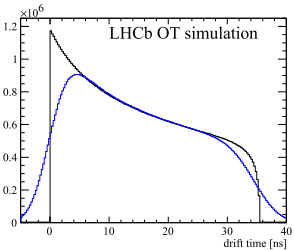
$T_{\text{electronics}}$ other delays in cables and electronics (we ignore it).

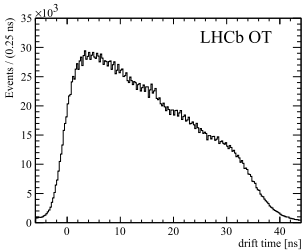


Total reconstructed time – comparison with LHCb

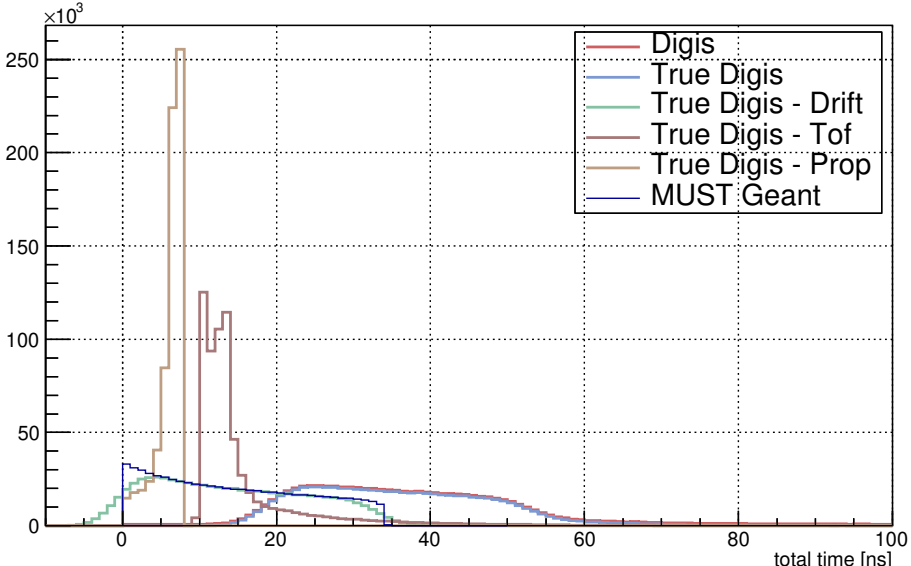




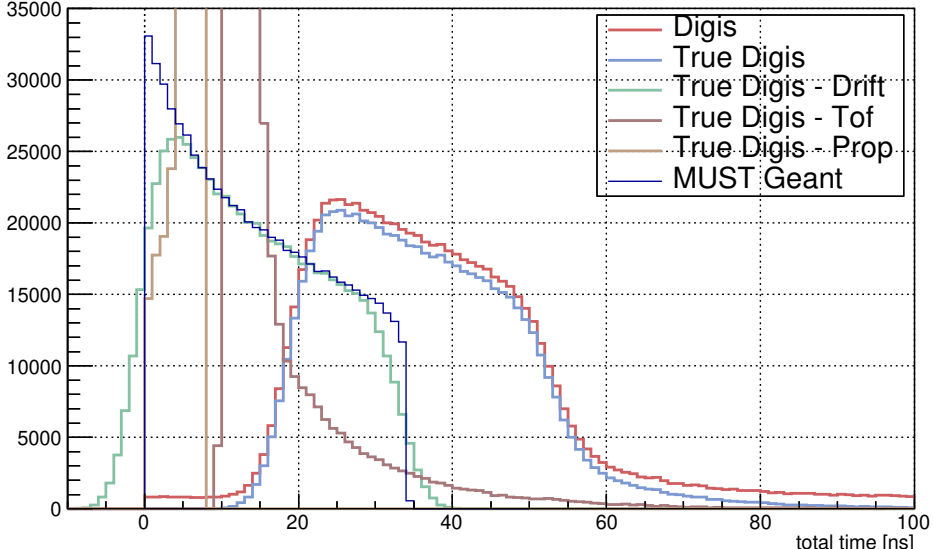




Full detector simulation



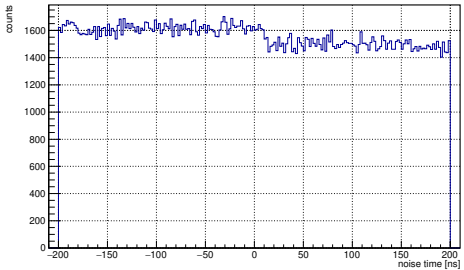
Full detector simulation

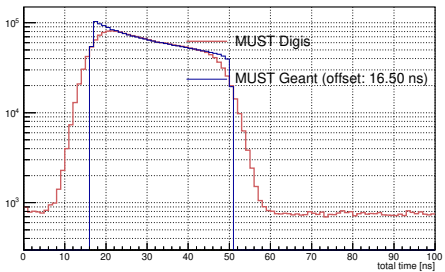


Digitizer summary

Digitizer parameters:

```
################################################
# Class:   CbmMustDigiPar
# Context: TestDefaultContext
################################################
//-----------------------------------------------
[CbmMustDigiPar]
Vprop :              Float_t     24.0
dEdxThreshold:       Float_t     0.0
TimeRes:             Float_t     2.5
NoiseRes:            Float_t     0.0
IonisationLength:    Float_t     0.079
NominalEfficiency:   Float_t     0.98
NoiseWindow:         Float_t     -200.0 200.0
NoiseProbability:    Float_t     0.02
NoiseAmplitude:      Float_t     1
MergeWindow:         Float_t     100.0
//-----------------------------------------------
```





LSM basic formalism

Line equations: $x(z) = x_0 + T_x \cdot z$ and $y(z) = y_0 + T_y \cdot z$

χ^2 - functional: $\chi^2 = \sum_{i=1}^{N_{planes}} \left[\frac{(x(z)-x_i)^2}{\sigma_{x_i}^2} + \frac{(y(z)-y_i)^2}{\sigma_{y_i}^2} \right]$ with coordinates (x_i, y_i) and errors $(\sigma_{xi}, \sigma_{y_i})$, z_i - detector plane positions.

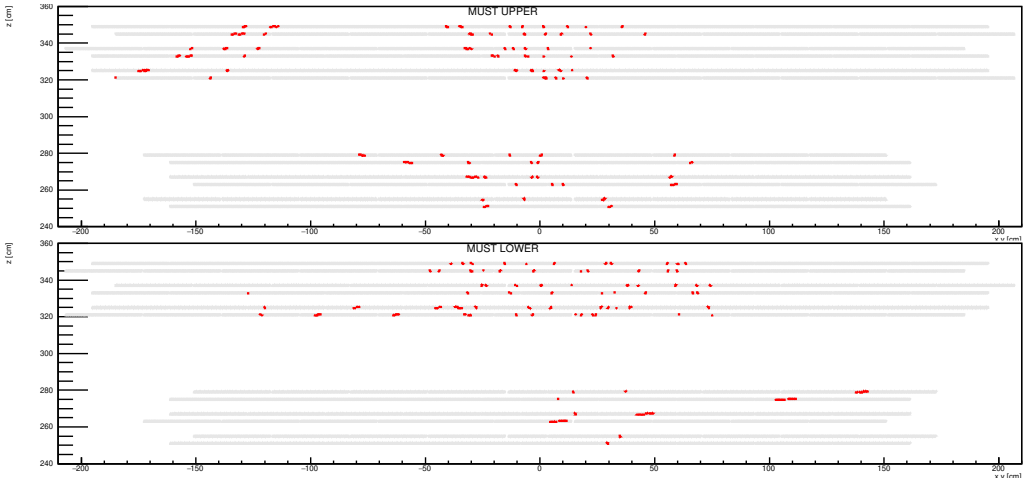
Minimum of χ^2: take partial derivatives and set them to 0. Resulting system of equations (for GEMs):

$$\sum_i \begin{pmatrix} 1 & 0 & z_i & 0 \\ 0 & 1 & 0 & z_i \\ z_i & 0 & z_i^2 & 0 \\ 0 & z_i & 0 & z_i^2 \end{pmatrix} \begin{pmatrix} x_0 \\ y_0 \\ T_x \\ T_y \end{pmatrix} = \sum_i \begin{pmatrix} x_i \\ y_i \\ x_i \cdot z_i \\ y_i \cdot z_i \end{pmatrix}.$$

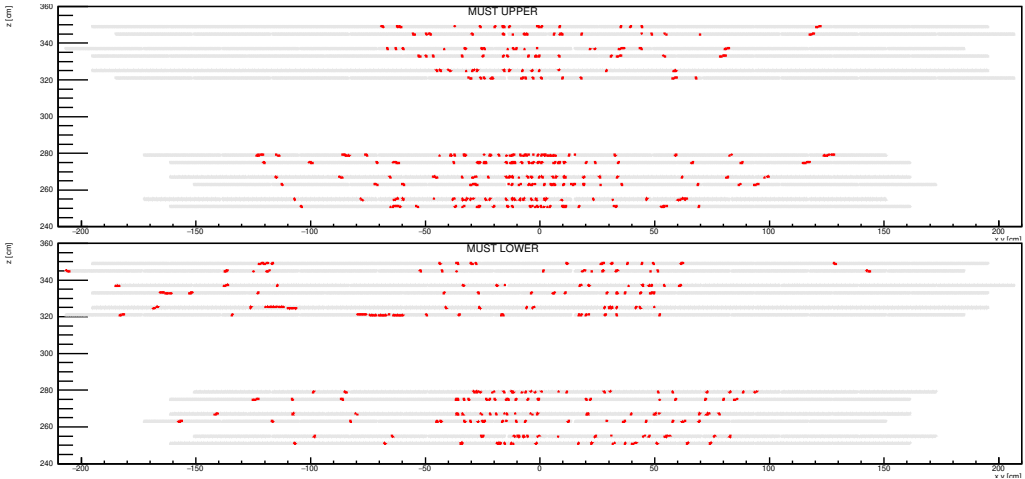
System matrix **A**

Vector covariance matrix: $\mathbf{V} = \sigma^2 \cdot \mathbf{A}^{-1}$.

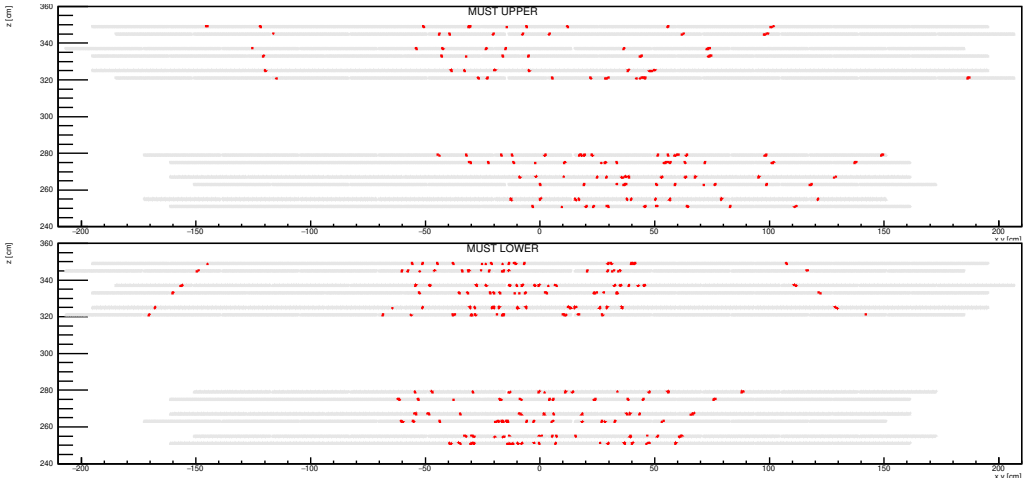
Tracking - event viewer (no noise)



Tracking - event viewer (no noise)

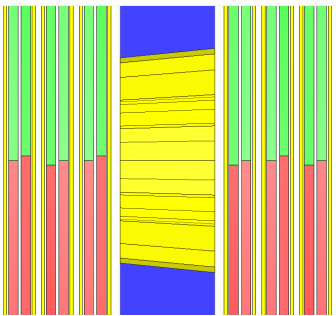


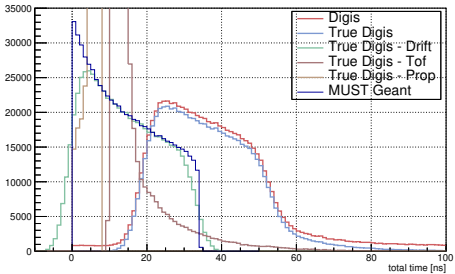
Tracking - event viewer (no noise)

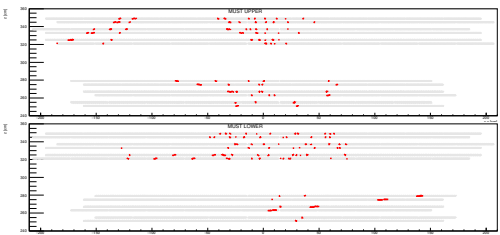


Summary

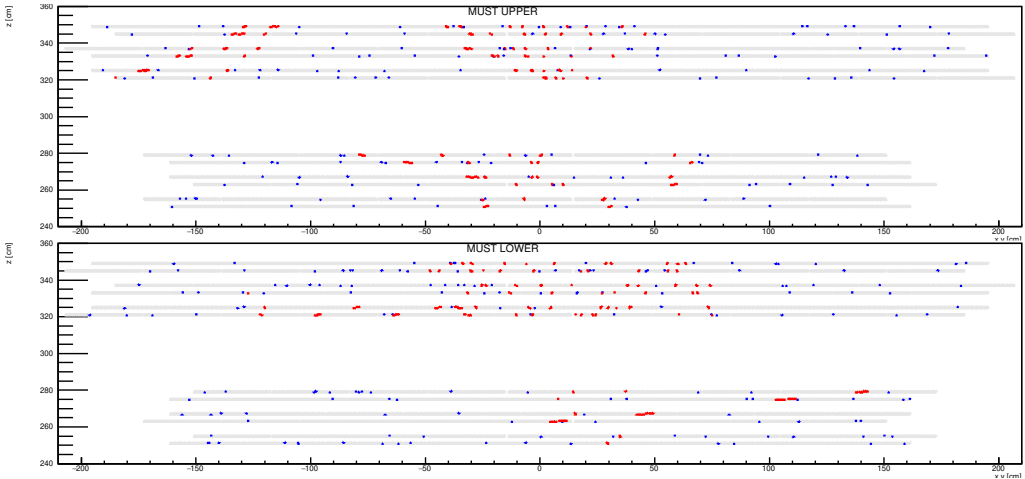
- Multiple geometry models
  - some are more realistic than other
- PASTA unpackers (B. Sobół [UJ])
- Digitizer imlemented
  - optimisation required (noise rate)
- Tracking ongoing
  - specify requirements for tracking
  - search for efficient algorithm



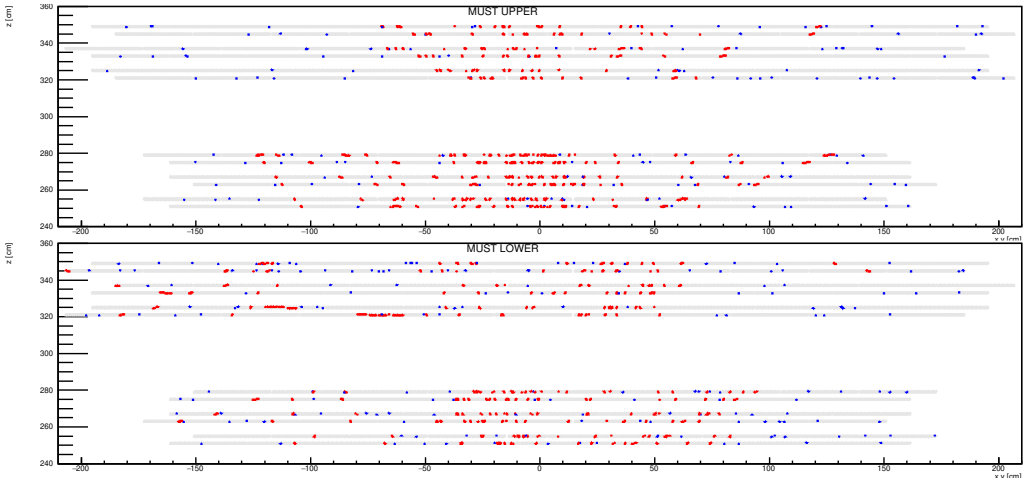




Tracking - event viewer (with noise)



Tracking - event viewer (with noise)



Tracking - event viewer (with noise)