Alignment stability tests and joint constraint analysis

Nils Breer

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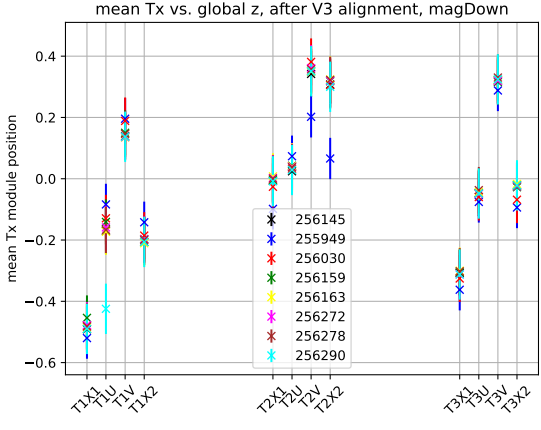
Faculty Physics

Alignment stability

- How stable is the alignment over several runs/fills?
- difference in alignment quality between magnetUp and magnetDown?

MD: black, blue, red, green

MU: yellow, magenta, brown, cyan



Config and run info

Config used:

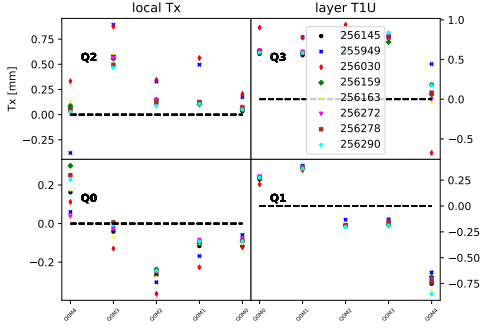
- V10 alignment tag
- DoF: TxTzRz
- surveyconstraints: data20221115dd4hep
- lagrange constraints: [”Tx”, ”Tz”, ”Rz”, ”BackLayerModules: FT/T3/X2/HL.*. : Tx Tz Rx Rz”]
- runs labeled as Good from EMTF
- mean Tx modules (in relation to nominal position) per layer vs. global z
- fill 8489: blue + red
- fill 8491: yellow + green + black
- fill 8496 magenta + brown + cyan

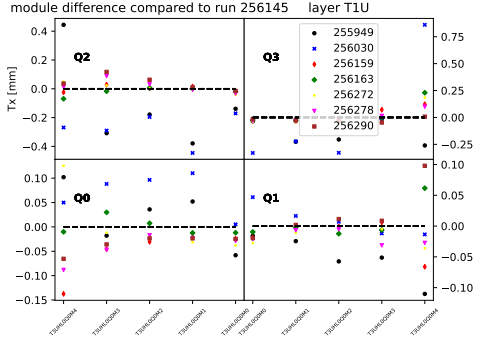
module x translation

10 iterations, converged

left plot: module position in comparison to nominal (maximum of 1mm in Tx is expected)

right plot: module position compared to 256145



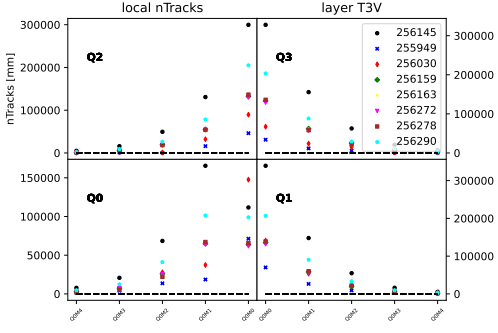


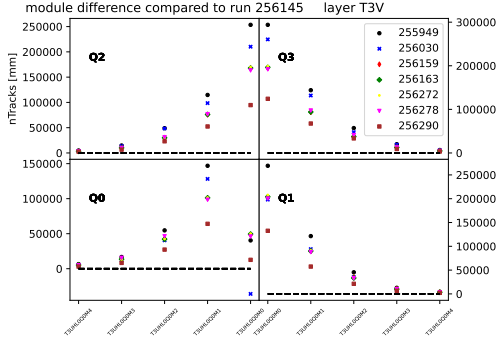
nTracks

10 iterations, converged

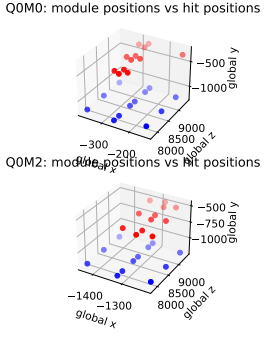
left plot: module position in comparison to nominal (maximum of 1mm in Tx is expected)

right plot: module position compared to 256145





- 256145, T3V low efficiency in Q0M0
- module position vs. hit position being off →not all hits not registered in the module
- is this just a V10 alignment issue or still visible in v7/v8?
- Good news: MD and MU runs very comparable
- Module positions with 1 mm in Tx



Analysis of joint constraint errors and chi2

long modules not in geometry, half modules joined to mimic ”banana shape”

combination of 2 Alignables →how realistic are the errors?

Plan:

instead of 1 chi2 value calculated from Cov matrix
→ calculate chi2 value for each DoF separately
run alignment with different errors and calculate chi2 again
→ tune errors to yield more or less chi2/dof = 1
at least make sure none really sticks out

Analysis of joint constraint errors and chi2

- Covariance matrix: $1/\text{errors}^2$ diagonal
- $\chi^2 = (pA - pB)^T \cdot \text{Cov} \cdot (pA - pB)$
- pA, pB: Set of parameters for tophalf- and bottomhalf modules
- initial errors: (Tx,Ty,Tz,Rx,Ry,Rz)

0.001 0.001 0.001 0.0002 0.0002 0.0002

```
Total chisquare of survey constraints: 25974.1 / 1536
Total chi2 of joint constraints: 15100/768
chi2 values for each degree of freedom:
Tx_chi2: 7633.05/768
Ty_chi2: 1121.29/768
Tz_chi2: 2586.76/768
Rx_chi2: 3086.38/768
Ry_chi2: 0.0036795/768
Rz_chi2: 672.561/768
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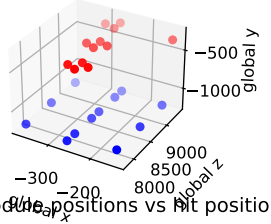
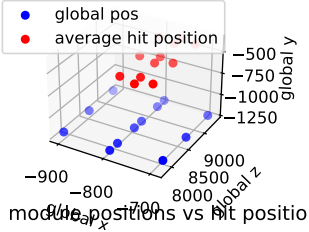
Backup

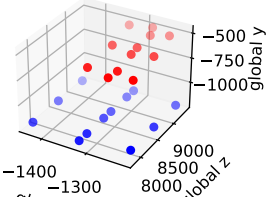
Q0M0: module positions vs hit positions



Q0M1: module positions vs hit positions



Q0M2: module positions vs hit positions



Q0M3: module positions vs hit positions