technische universität dortmund

FSP LHCb
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Bundesministerium für Bildung und Forschung

Precision studies for 2024 SciFi Alignment

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RTA: WP4/5 Alignment and Calibration

- **Goal**: obtain precision of the SciFi alignment on 2024 data

Procedure:

1. Run alignment with a set configuration for several runs across multiple months
2. 200k events using the first run of each fill (if possible) on data starting at run 303874 (2024 alignment update in august)
3. Calculate the variation of each subsequent run w.r.t. the reference run
4. Histogrammed distributions per object, width as a metric for the precision

List of runs:
303963,304094,304191,304449,304528,304649,304802,304936,305071,305197,305291,305446,305498,305559,305641,305684,305850,306109,306356,306532,306608,306711,307071,30518,307587,307654,307758,307868,307897,307947,308073,308256

Configurations

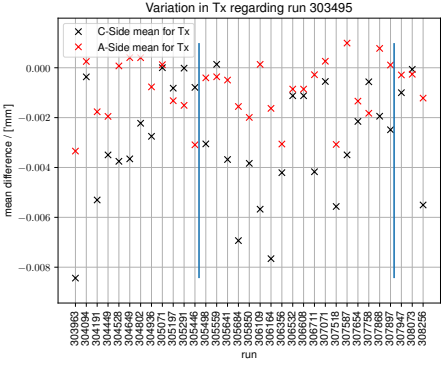
- Config 1: CFrames Tx, Modules TxRz
- Config 2: CFrames Tx, Halfmodules Rx
- Config 3: CFrames Tx, Halfmodules TxRz

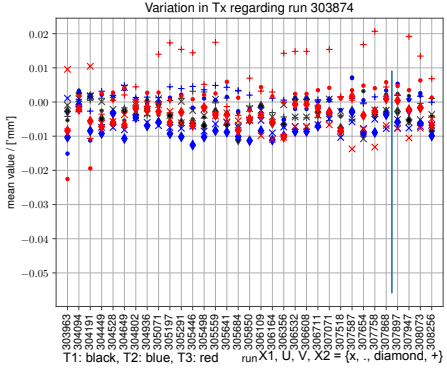
Constraints:

- Constraint to remove x-dependent translations and rotations (SxTx and SxRx) of modules in T3X2
- Halfmodule joint constraint
- z coordinate of module halves fixed to 0 on read-out edge

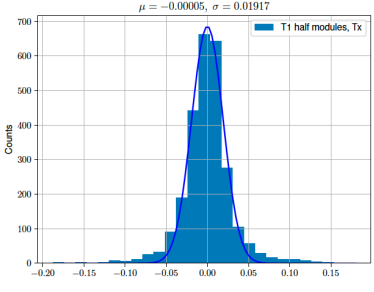
Detectorposition in 2024, halfmodules TxRz alignment

- Halfmodules aligned in TxRz and CFrames in Tx
- Per layer, movement looks consistent over all runs →expected

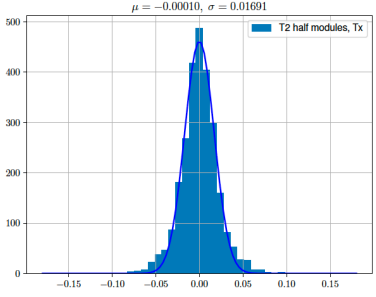




Config 3: CFrames Tx

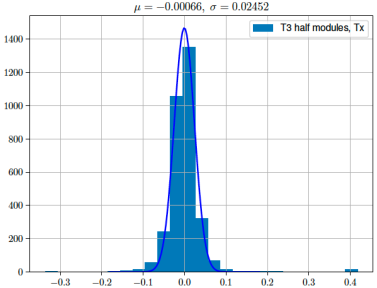


Station 1



Station 2

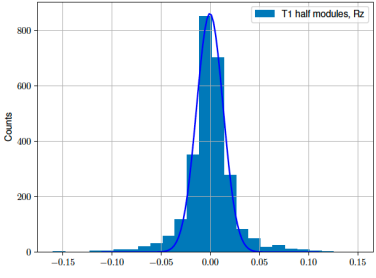
WIth M5 modules included



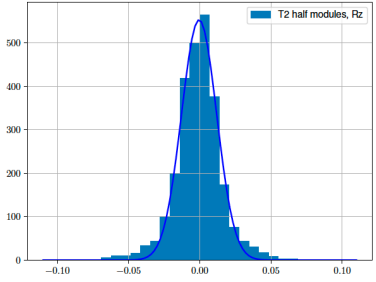
Station 3

Config 3: CFrames Rz

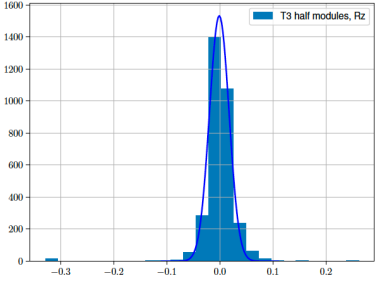
Station	Rz width [μrad]
T1	13.5 ± 0.2
T2	12.4 ± 0.2
T3	18.4 ± 0.3



Station 1



Station 2



Station 3

CFrames Tx (values in μm)

	T1	T2	T3
2024 data	19.2 ± 0.3	16.9 ± 0.3	24.5 ± 0.4
MC	16.5 ± 0.1	19.8 ± 0.2	37.0 ± 0.5

Values grouped by Modules

		M0	M1	M2	M3	M4	M5
Tx	2024 data	17.8 ± 0.4	15.3 ± 0.4	14.2 ± 0.3	21.1 ± 0.5	32 ± 0.8	39.9 ± 1.7
[μm]	MC	22.0 ± 0.4	22.4 ± 0.4	21.2 ± 0.4	17.4 ± 0.1	27.2 ± 0.3	135 ± 3
Rz	2024 data	9.8 ± 0.2	10.8 ± 0.2	12.8 ± 0.3	15.1 ± 0.4	27.1 ± 0.7	39.1 ± 1.7
[μrad]	MC	15.3 ± 0.5	16.6 ± 0.3	16.0 ± 0.2	12.8 ± 0.2	8.5 ± 0.3	44 ± 1

Conclusion

- Good sensitivity to align modules and CFrames and we are below the single hit resolution ≈100 μm
- Results are comparable with MC-simulated data
- CFrame precision is station dependent →set a high enough threshold for all stations or set separate thresholds per station
- For values on MC-simulated data see Miguel's slides here
- the full documentation of the SciFi alignment in run 3 including these stability studies will be in the internal note