New alignment using LongModules / tight joint constraints
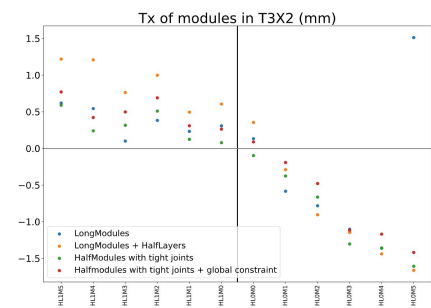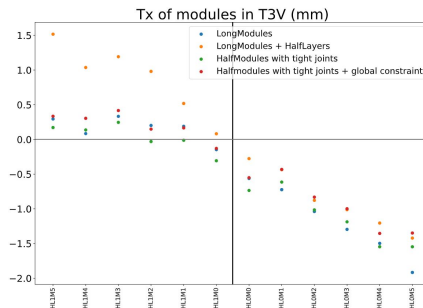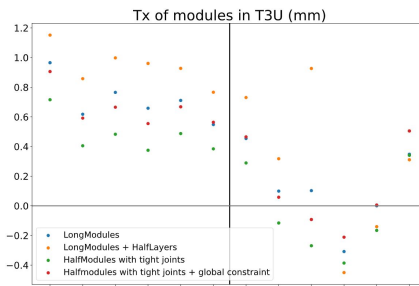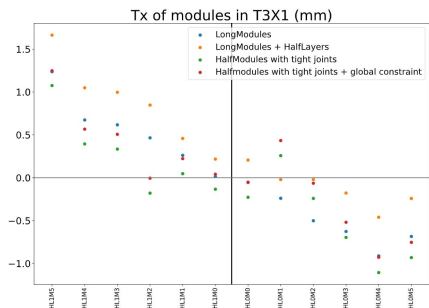
Given the large unphysical sheers and rotations between top and bottom half-modules that we have in alignment v9 we are now studying the possibility of **running the alignment on either LongModules or half-modules with very tight joint constraints**. For all the alignment jobs we use a **tight D0 selection** removing most of the D0 mass background and **joint uncertainties of 0.00001 mm/rad** for the half-modules. I will compare the results using 4 different configurations:
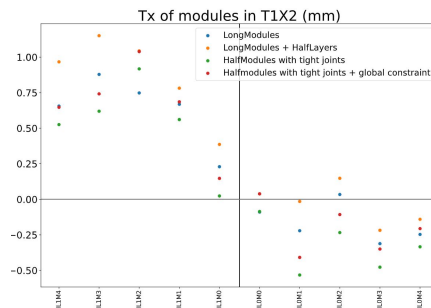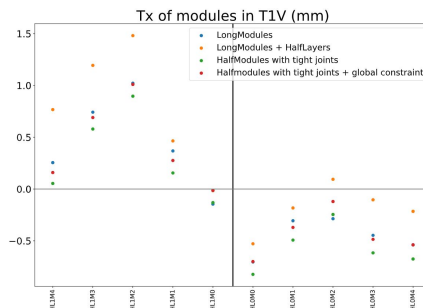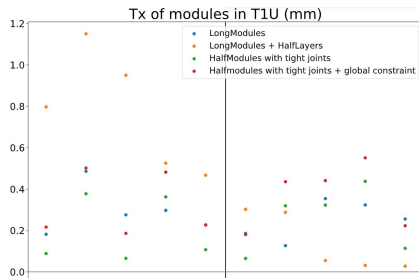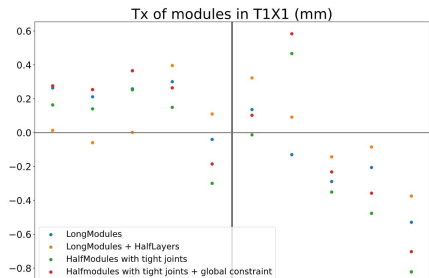
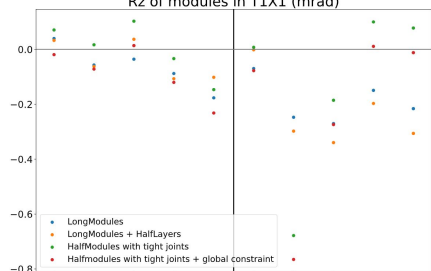| **LongModules**	**HalfModules v1**	**HalfModules v2**	**HalfModules + HalfLayers**
● Tested on full data sample from run 269045	● Tested on 500k from run 269045	● Tested on 500k from run 269045	● Tested on full dataset from runs 269045, 269031 and 269033
● Dofs: TxRz	● Dofs: TxRz	● Dofs: TxRz	● Dofs: TxRz
● Lagrange constraints on the global average motion and the last layer	● Lagrange constraints on the global average motion and the last layer	● Lagrange constraints on the last layer (no global constraint)	● Global constraint for modules. Module and HalfLayer motion constrained for layers T3V and T3X2
● Use of new pattern recognition algorithm	● Use of new pattern recognition algorithm	● Use of new pattern recognition algorithm	● Loose tracking
● Convergence in 18 iterations	● Convergence in 9 Iterations	● Convergence in 9 iterations	● Alignment starting from survey (translations only) and CFrames survey applied to the HalfLayers
			● Convergence in 8 iterations

Comparison of the alignment constants

- For the comparison I express the alignment constants of **LongModules in global coordinates**

- For the jobs with **half-modules**, the constants are just the **average of the constants for the top and bottom halves**

- For the job including **HalfLayers** I need to **add the motion of the HalfLayers** to the motion of the modules
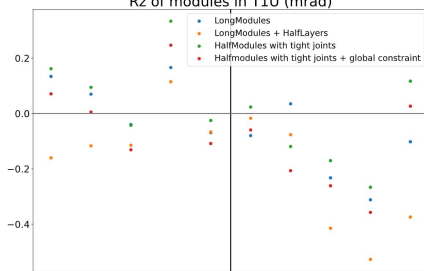
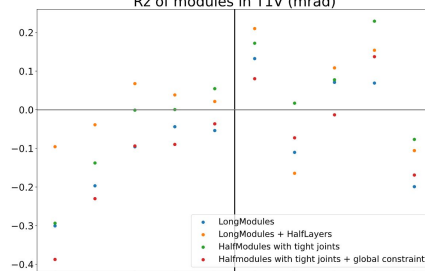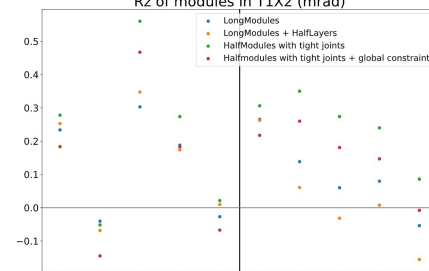# Tx

Rz
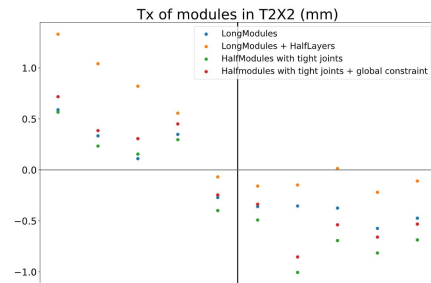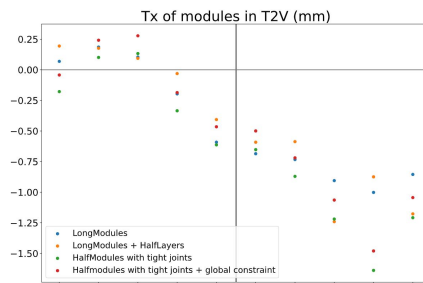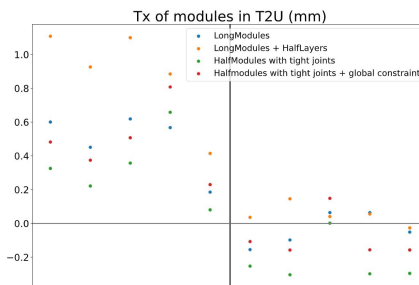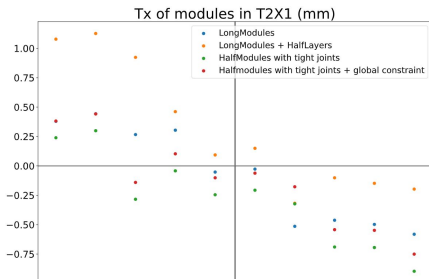
Rz of modules in T1X1 (mrad), T1U (mrad), T1V (mrad), T1X2 (mrad), T2X1 (mrad), T2U (mrad), T2V (mrad), T2X2 (mrad), T3X1 (mrad), T3U (mrad), T3V (mrad), T3X2 (mrad). Legend: LongModules, LongModules + HalfLayers, HalfModules with tight joints, Halfmodules with tight joints + global constraint.
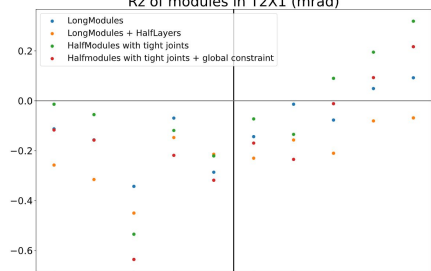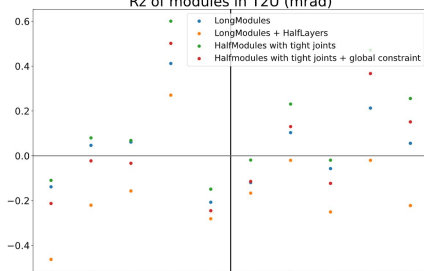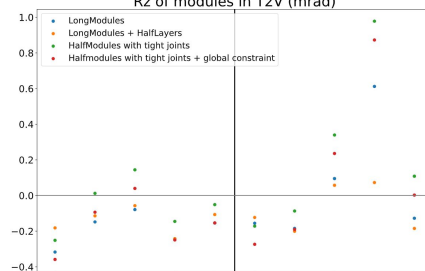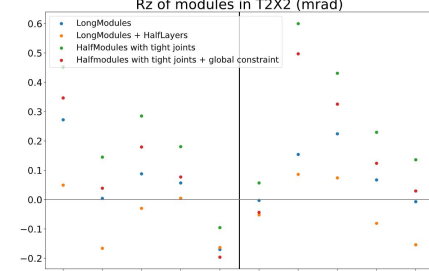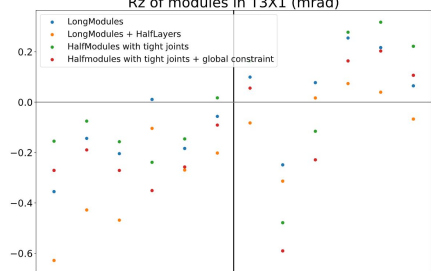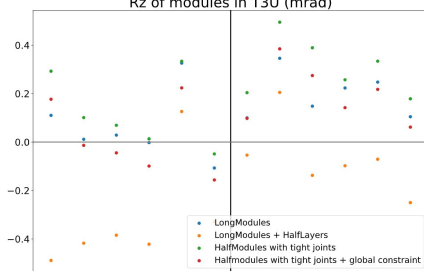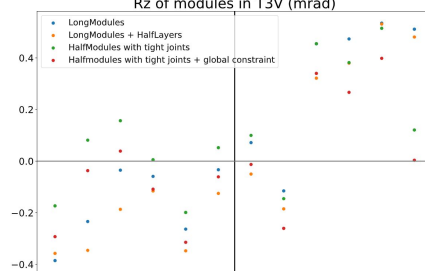
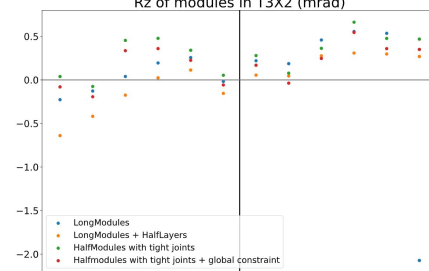# Ty and effect of the global constraint
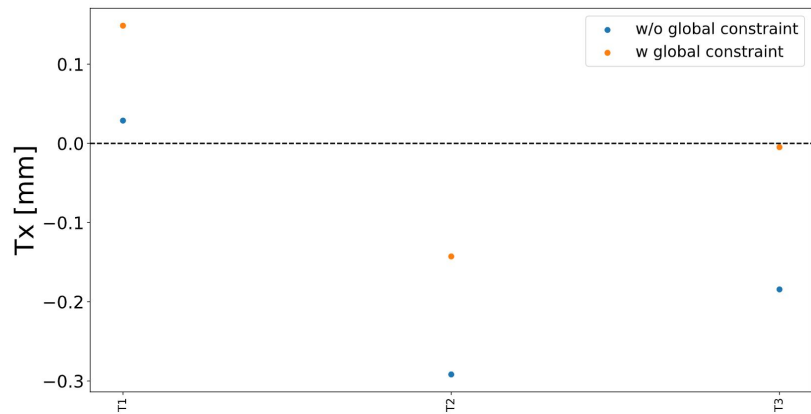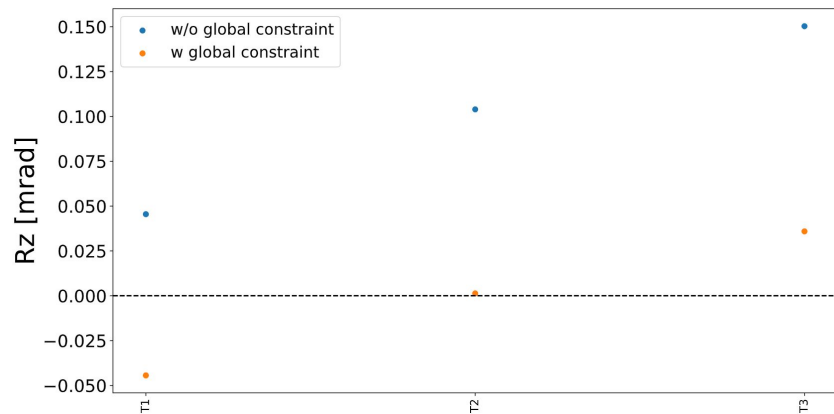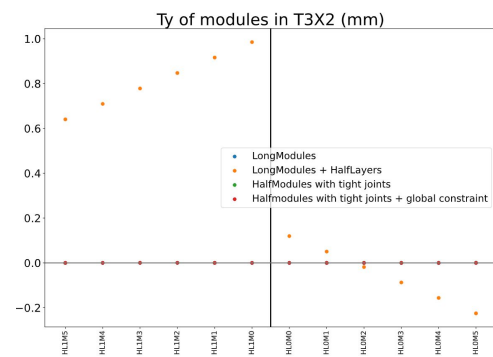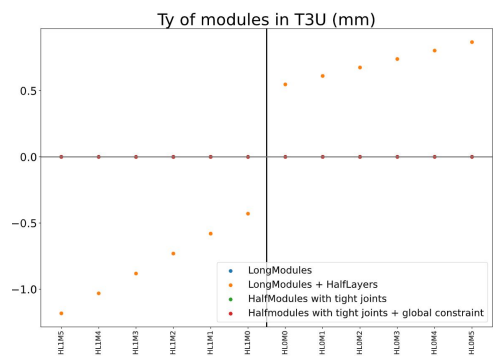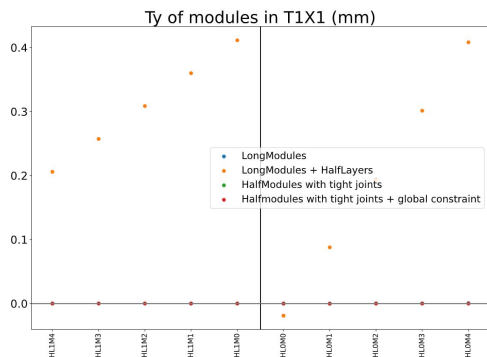
2D pattern - Traslations

I have tested the scripts on the yaml file corresponding to the v9 alignment version (v9 warm)

Tx

Tz

We also see **patterns on the translations**. These however are correlated with the patterns observed on the rotations due to the joint constraints (see next slides)

2D pattern - Tight constraints

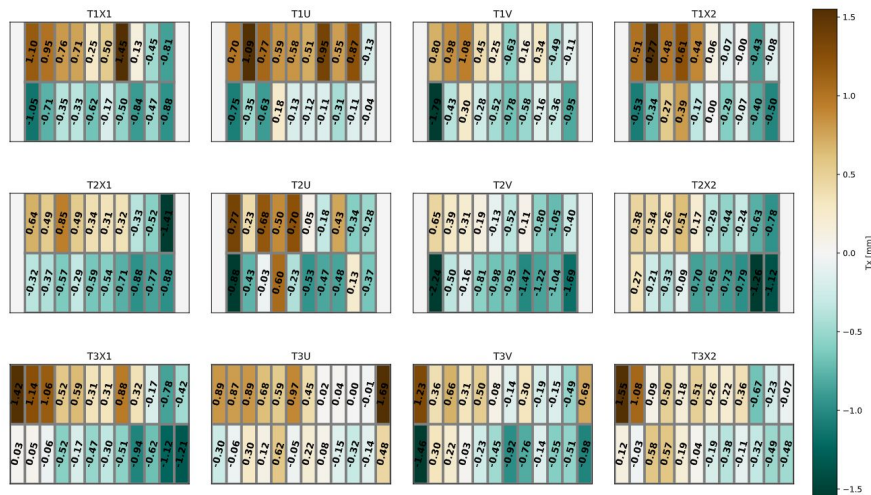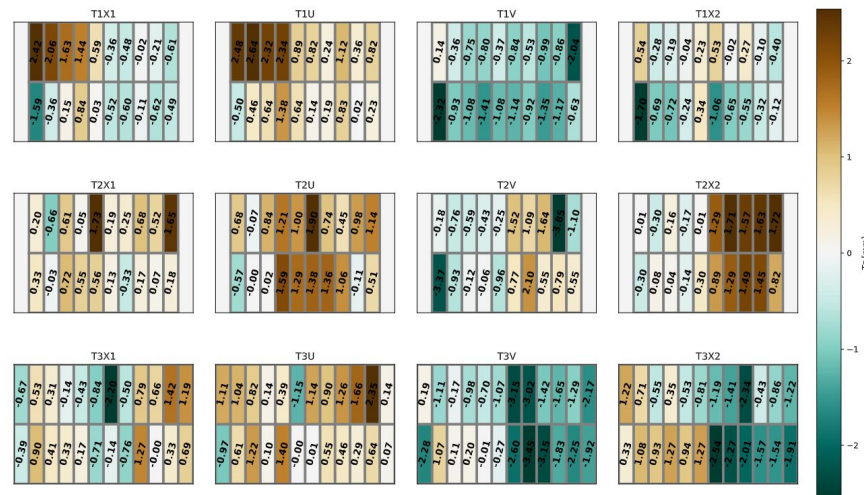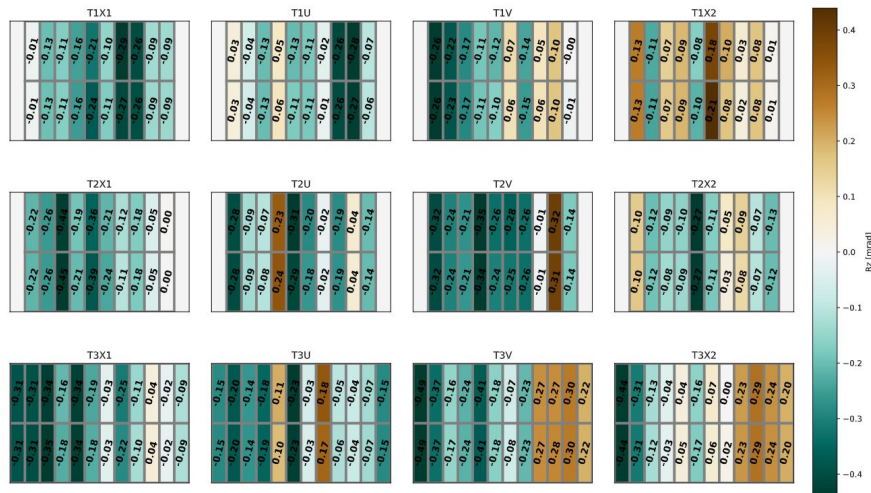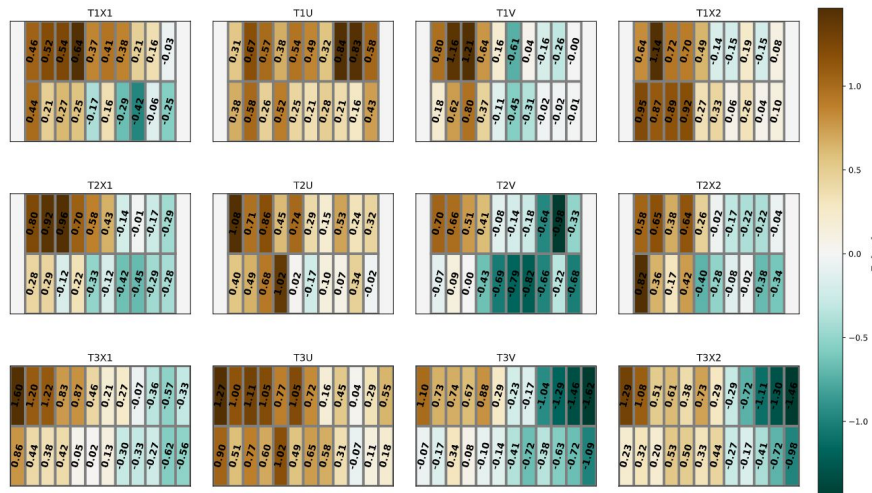I ran a simple test on **50k events from run 269045** with j**oint uncertainties of 0.000001** mm/rad for translations/rotations and using **Tx and Rz** as dof. I only run **3 iterations starting from the design module positions** to remove any biases so the results are coming from a **non-converging alignment**

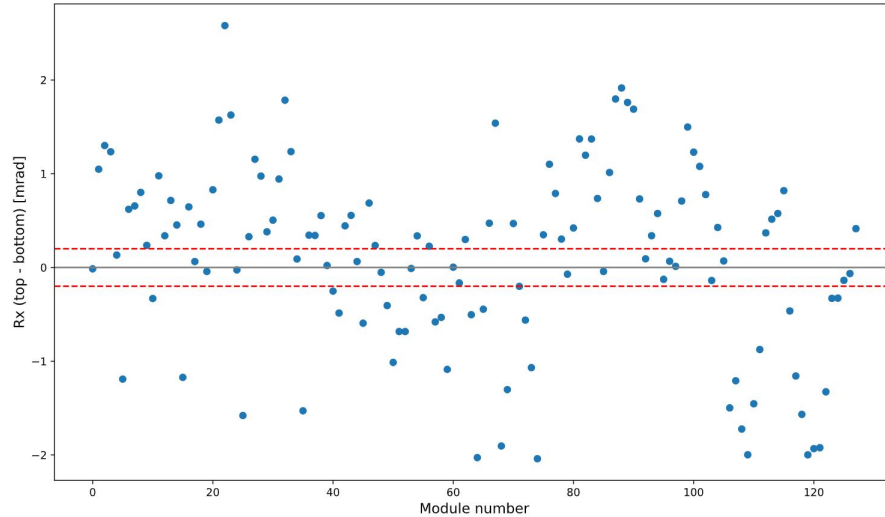**Rz**   **Tx**

Rotations of the top and bottom halves are now tightly correlated and pattern on Tx can be explained by comparing it with the Rz pattern
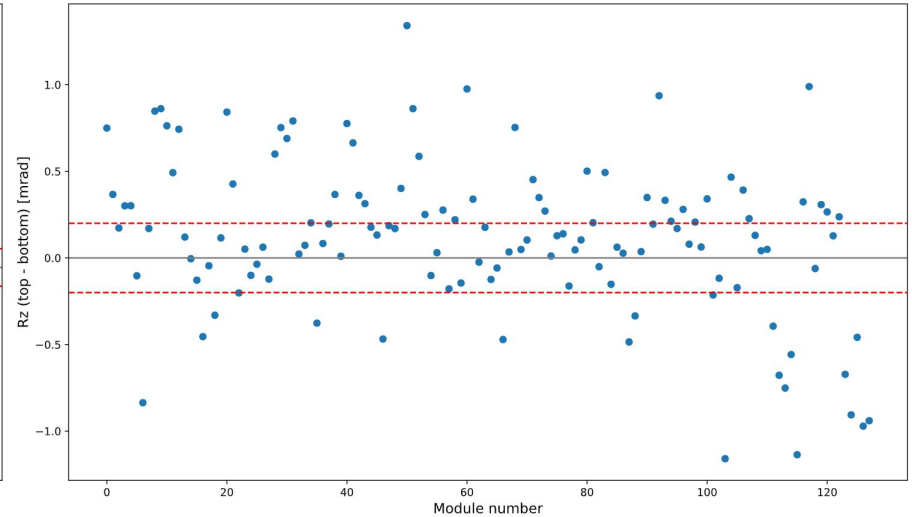
Joint differences - Rotations

Again, the script was tested on the **v9 alignment constants**

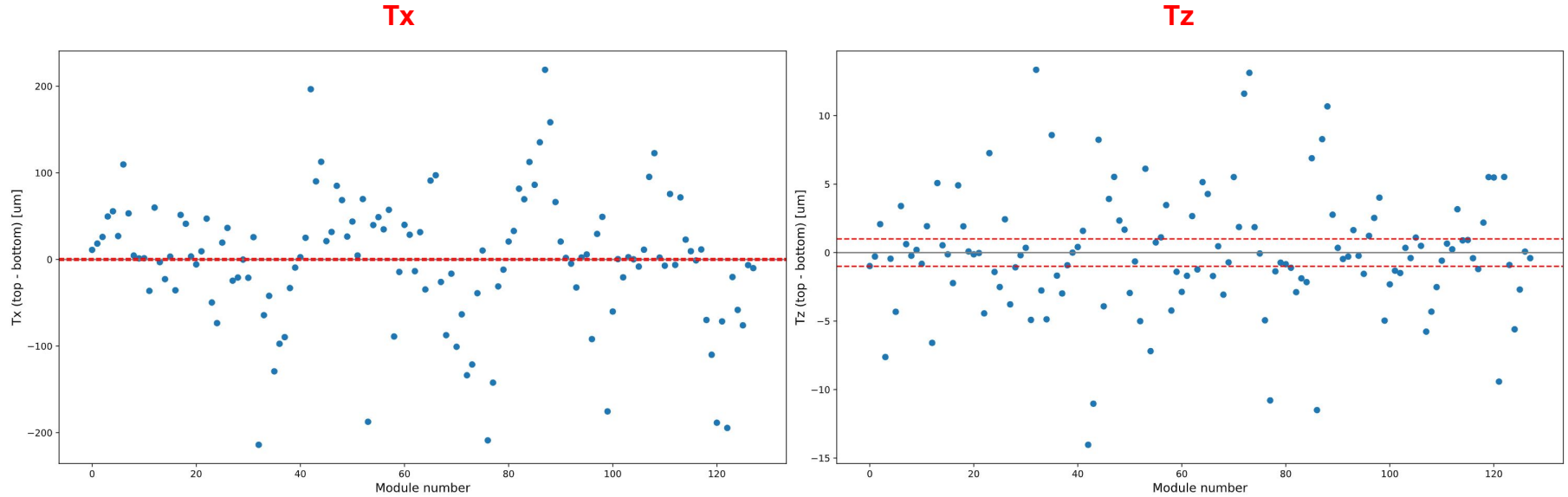**Rx**   **Rz**

There is a strange pattern on Rx (probably expected given the observed weak mode when looking at the global motion) but points are more uniformly distributed and more or less within the joint uncertainty

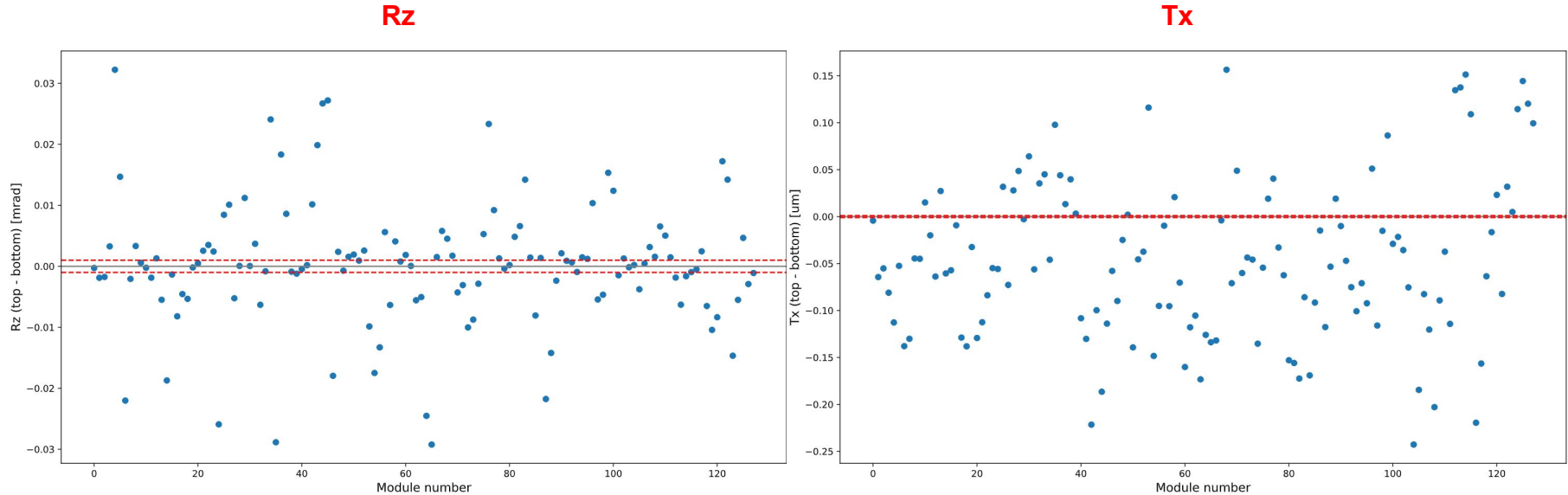# Joint differences - Rotations

Again, the script was tested on the **v9 alignment constants**

Tx **Tz**

Translations look a bit works, especially for Tx the joint constraints do not seem to be very effective
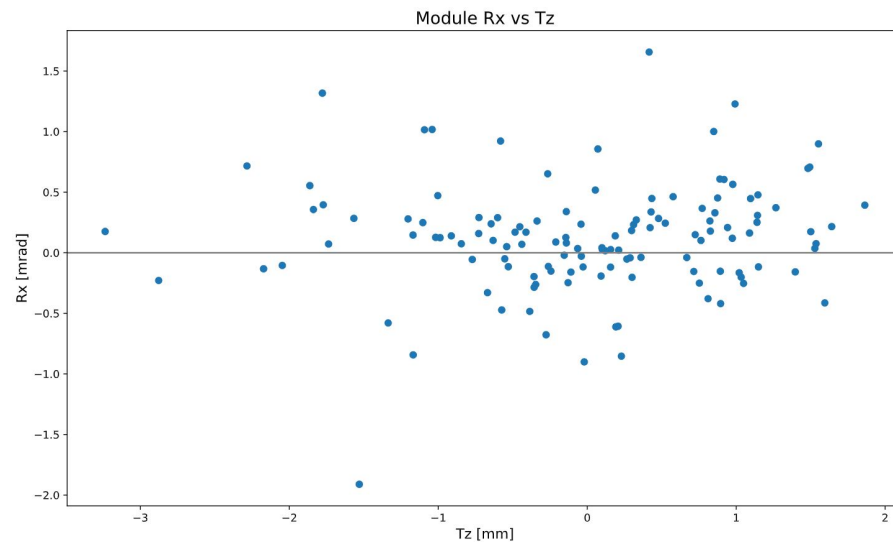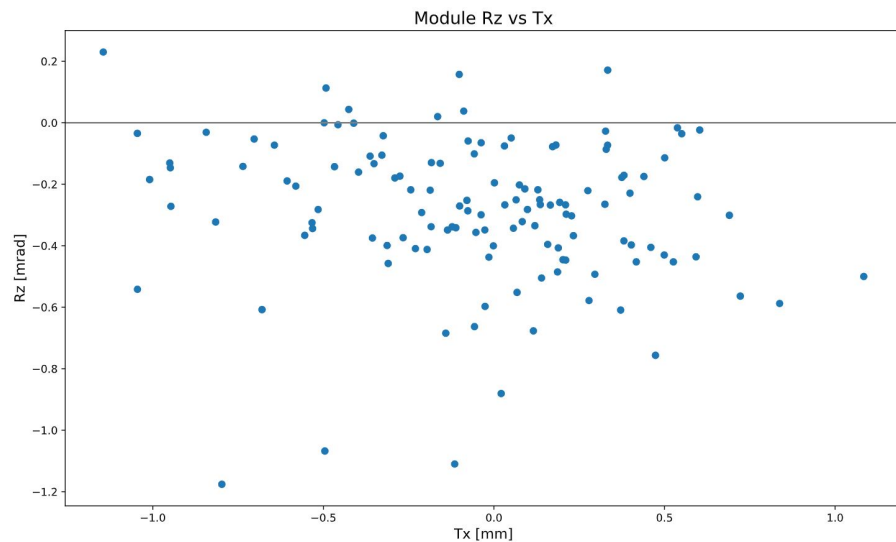
Joint differences - Tight constraints

Results after the **tight constraint configuration**

Rz

Tx

Again, the **constraint on Tx is not being very effective**. Maybe results get better if I let the full alignment run until convergence?
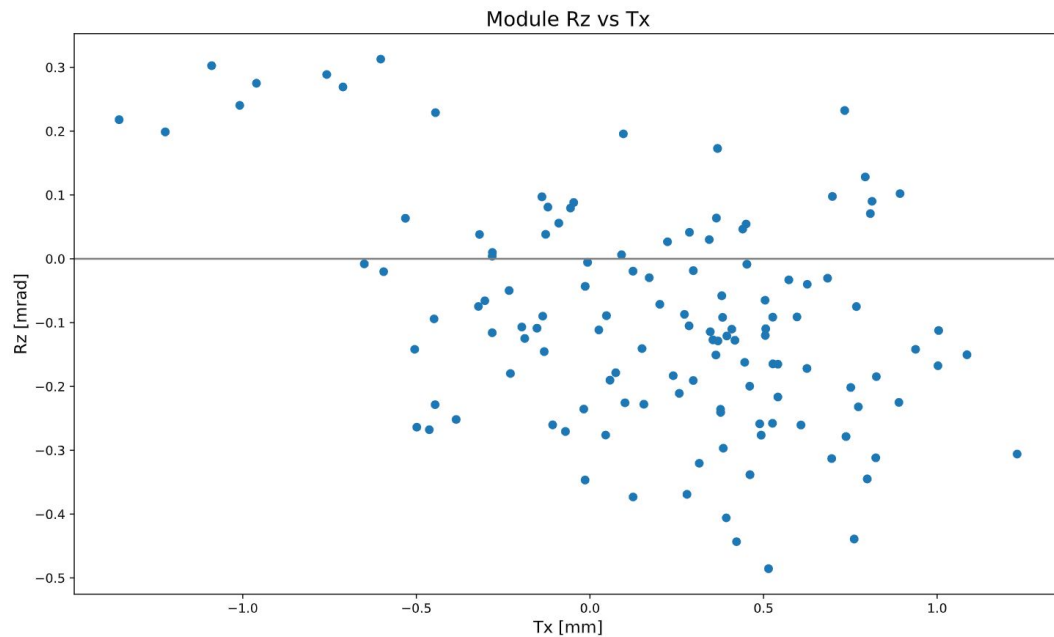
Correlation plots - Rotations

Script first tested on the **v9 yaml file**

Small negative correlation between Rz and Tx with no apparent effect on Rx and Tz

Correlation plots - tight constraints

Clear correlation which will most likely go away when the alignment has converged