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# Global alignment update

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Tested various configurations for aligning the VELO and the SciFi together  
VELO halves always aligned in "TxTyTz";  
SciFi aligned in "TxRz(Rx)"

Here: Reconstruction sequence from the SciFi is used

Joint constraints used everywhere and set a very small Rx survey uncertainty  
constrain readout side to nominal position of the C-Frame

example called 'v1' here

```
def configureGlobalAlignment(halfdofs="TxTyTzRy"):  
    setup = AlignmentScenario('GlobalAlignment')  
    setup.SubDetectors += ['VP', 'FT']  
  
    elements = Alignables()  
    elements.VP("None")  
    elements.VPRight(halfdofs)  
    elements.VPLeft(halfdofs)  
    elements.FTHalfModules("TxRxRz")  
  
    setup.Elements += list(elements)  
  
    surveyconstraints = SurveyConstraints()  
    if UseDD4Hep:  
        surveyconstraints.VP(ver='2023_dd4hep')  
        surveyconstraints.FT(addHalfModuleJoints=True)  
    else:  
        surveyconstraints.VP(ver='latest')  
    setup.SurveyConstraints = surveyconstraints  
  
    constraints = []  
    constraints.append("VPHalfAverage : .*?VP(Left|Right) : Tx Ty Tz Ry")  
    constraints.append("FTBackFramesFixed : FT/T3/X2/HL.*?M. : Tx Rz")  
    setup.LagrangeConstraints = constraints  
  
    return setup
```

## Alignment configurations

v1: SciFi (TxRxRz), no SciFi survey

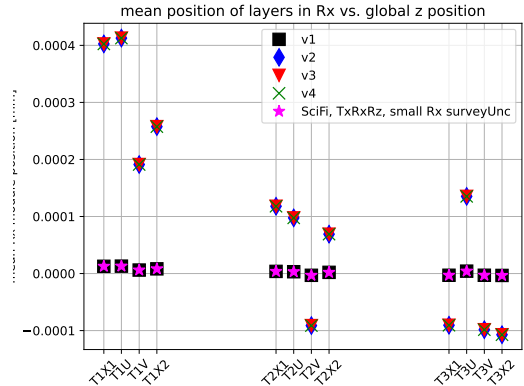
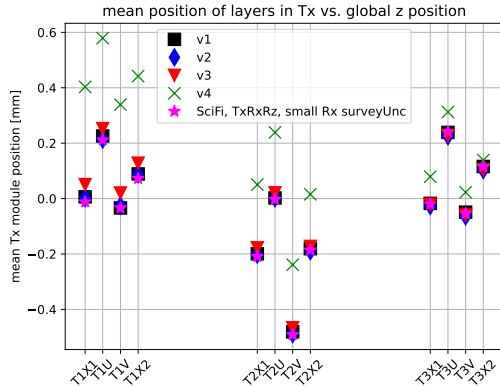
v2: SciFi (TxRz), no SciFi survey

v3: SciFi (TxRz), SciFi C-Frames survey

v4: SciFi (TxRz), SciFi C-Frames survey, constrain (U|V) layer in T2 for Tx Rz

## Global alignment: Tx, Rx vs global z position

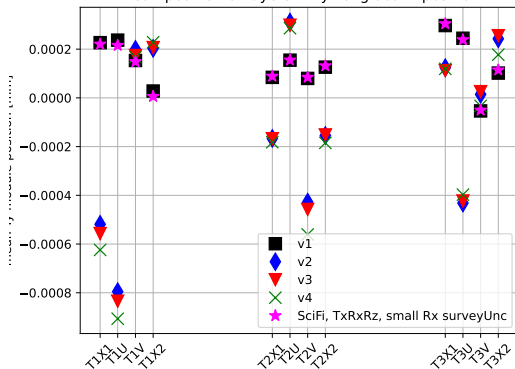
mean Tx in [mm], Rx in [rad] of each layer



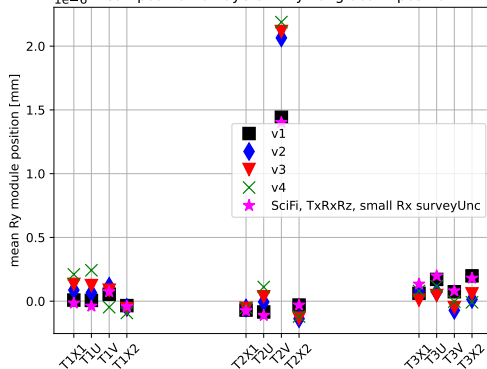
## Global alignment: Ty, Ry vs global z position

mean Ty in [mm], Ry in [rad] of each layer

mean position of layers in Ty vs. global z position

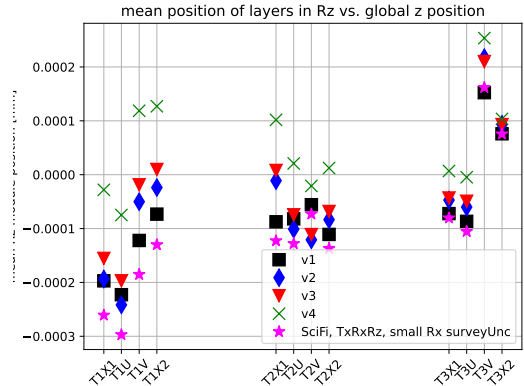
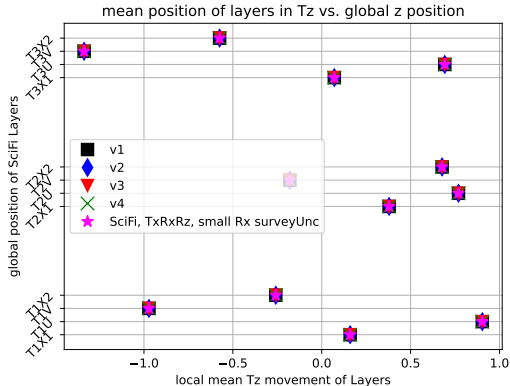


1e-6 mean position of layers in Ry vs. global z position



## Global alignment: Tz, Rz vs global z position

mean Tz in [mm], Rz in [rad] of each layer

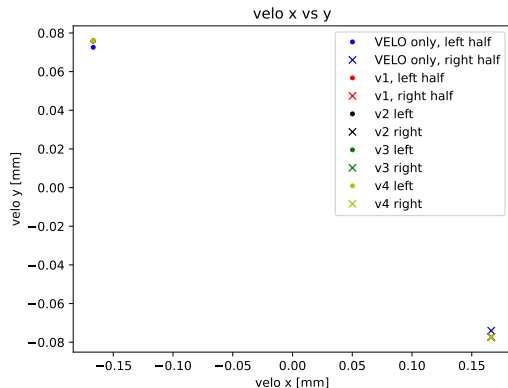


without aligning Rx there will be a non-zero Rx; maximum 0.4 mrad  
visible but small z-rotation across stations

Tx constraint in v4 shifted everything closer to zero but didn't solve the problem for Tx  
behaviour

Ty worse when NOT aligning for Rx → joint constraint or C-Frame survey cannot correct for  
that

## Comparison VELO only vs global constants



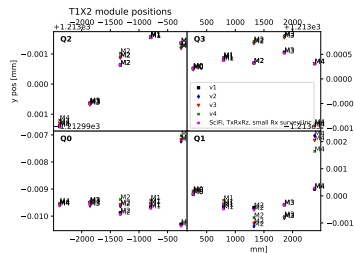
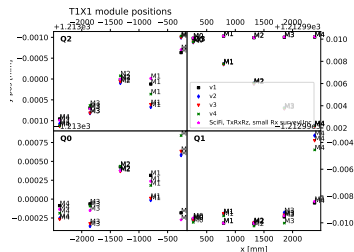
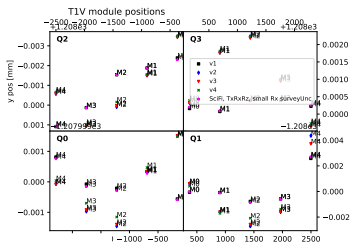
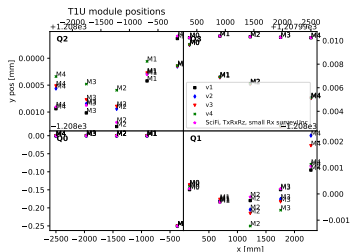
dots: left velo half; crosses: right velo half  
v1 → v4 nearly identical (on top of each other)

difference between VELO only and from the global alignment:  $3.5 \mu\text{m}$

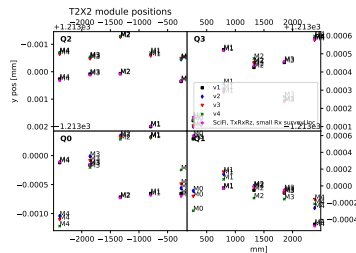
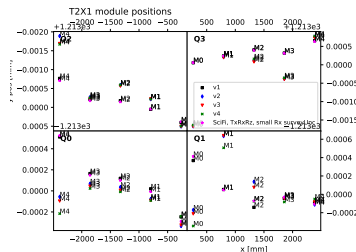
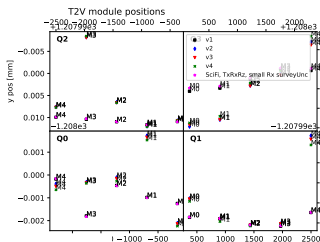
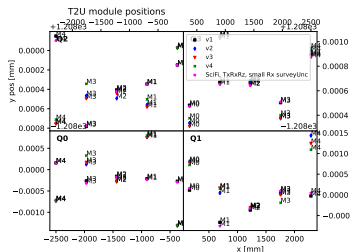
→ is this within the VELO acceptance or is  $3.5 \mu\text{m}$  problematic?



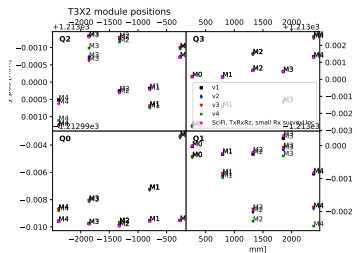
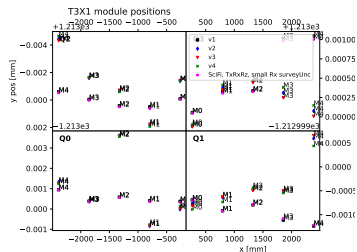
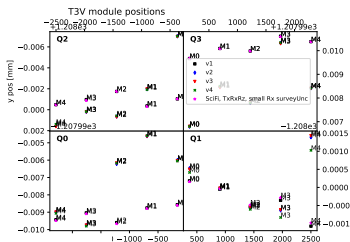
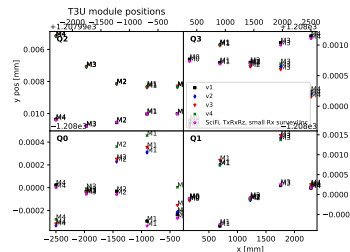
## T1 SciFi module constants in global: x vs y



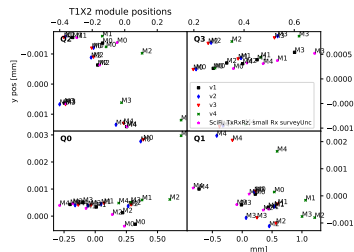
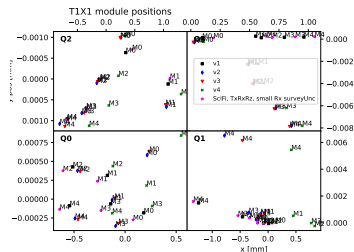
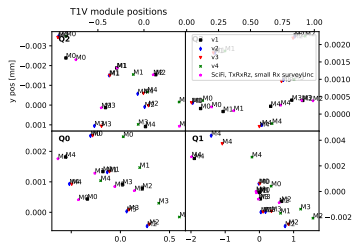
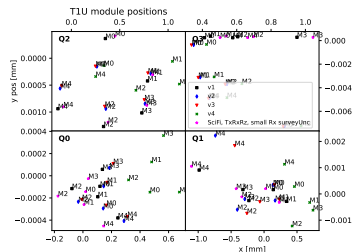
## T2 SciFi module constants in global: x vs y



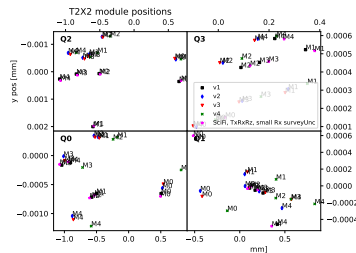
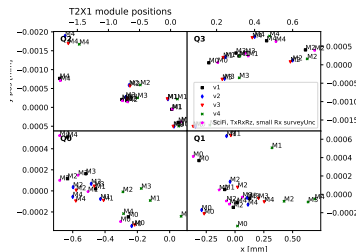
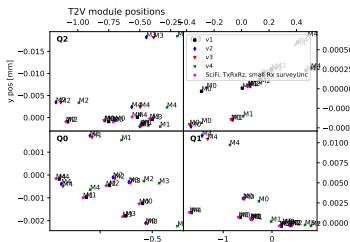
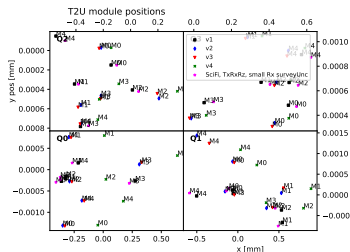
## T3 SciFi module constants in global: x vs y



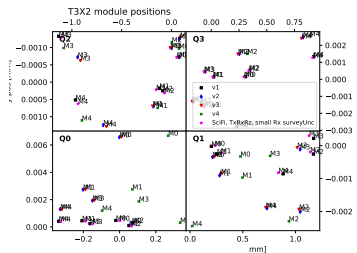
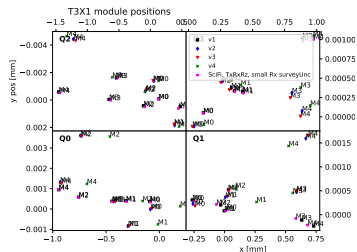
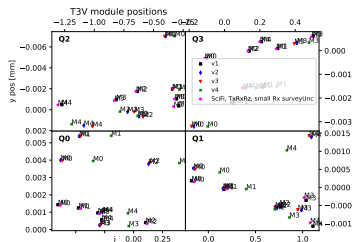
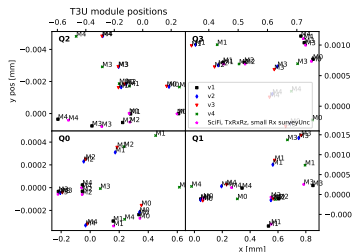
# T1 SciFi module constants in local: x vs y



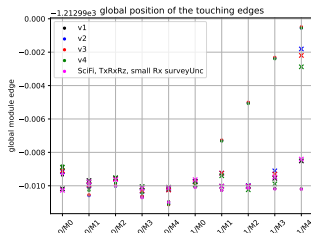
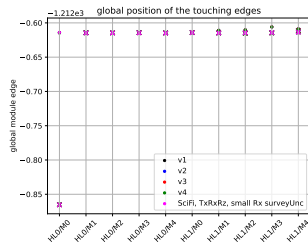
## T2 SciFi module constants in local: x vs y



## T3 SciFi module constants in local: x vs y



## module edge difference in y direction



dots: middle edge of top half  
module, cross: middle edge of  
bottom half module

joints uncertainties: 0.01 0.0012  
0.0019 0.0004 0.0002 0.00017

→ half modules fairly close  
everywhere, but T1UQ0M0

T1X1: Q1 is drifting from Q3