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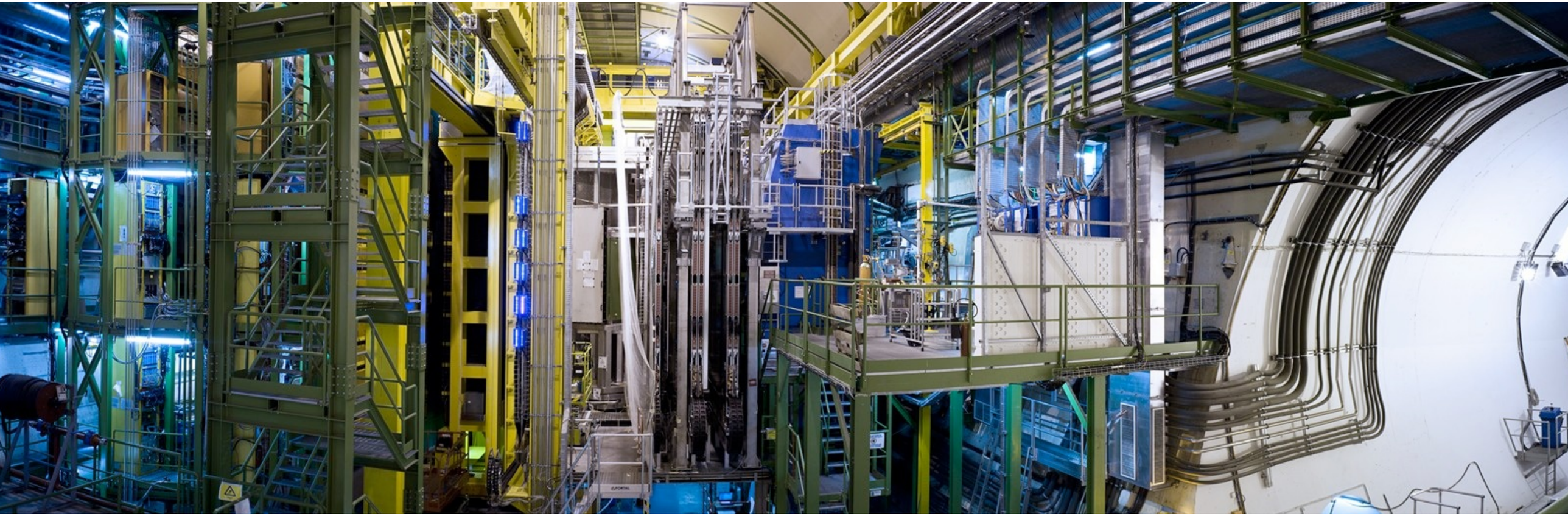


SciFi alignment updates

Sophie Hollitt + SciFi alignment + calibration team
WP4/5 meeting 27 April 2023

SciFi update topics

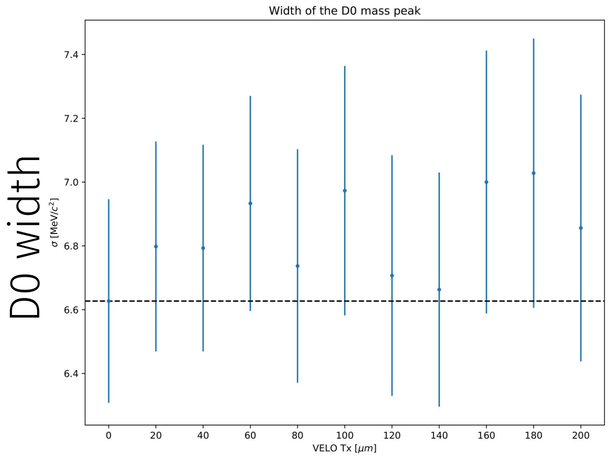
- DD4HEP and online:
  - SciFi merge into Alignment master nearly ready, last checks for tests
  - Draft for SciFi job in MooreOnline
- **Checks for 2023 alignments:**
  - Loose tracking performance/how well can we align with open VELO
  - **Further VELO drift studies**
  - Processing updated photogrammetry + survey
  - **Updates to module constraints**
- **2022 SciFiv3 alignment status**
  - Also working on: fixing efficiency discrepancy between A and C side, top/bottom half
    - **Changed starting conditions**
    - **Loose tracking**
    - **Checking z position behaviour**
  - **Want to include a mat alignment in v3 for best performance**

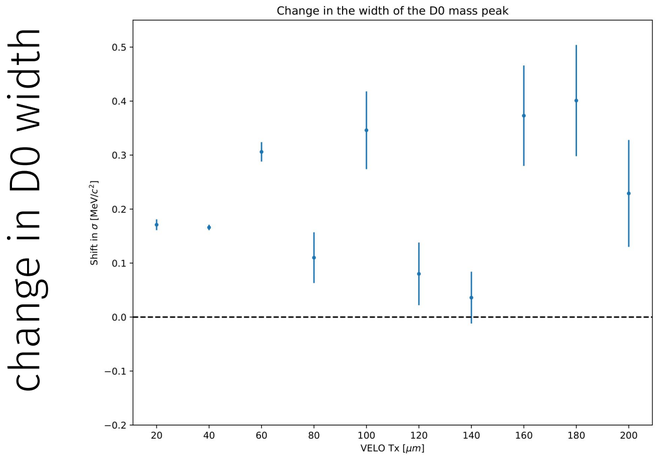
For 2023: Velo drift checks

- Last time: VELO drift/half misalignment can induce some Rz rotation in the SciFi
  (see: https://indico.cern.ch/event/1253374/contributions/5305015/attachments/2608114/4505475/VELO%20motion%20effects%20on%20SciFi%20alignment.pdf)

Effect on the mass resolution

- Now: Checking how mass resolution is affected by VELO drift + SciFi misalignment
  - On MC: 6.6 MeV -> 7.0 MeV at most, but error bars on resolution are large





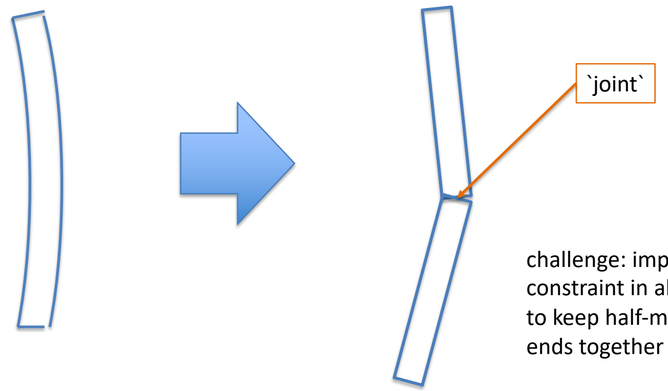
- There seems to be a clear **trend** confirming that the mass resolution gets worse
  - We are however a bit low on statistics and all values are compatible with each other when uncertainties are taken into account

- To compute the **change in σ**, values were assumed to be **100% correlated**. This might be wrong (see next slides)

Improved constraints for SciFi

- New survey will be able to constrain top + bottom halves of long SciFi module together, while still being able to adjust the halves separately (thank you Wouter!)
- Can move fixed/surveyed points of SciFi modules to outside edges

approximate model-bending in alignment



challenge: implement constraint in alignment to keep half-module ends together

New joint constraint framework (in master since last week)

Pivot point of survey

- little known feature: the 'origin' 'delta' parameters in the database (and survey) can be changed by setting a pivot point
  - essentially an extra transformation that changes the origin of the rotations
- for instance, this would apply the deltas at the top of the half-module

```
<condition classID="6" name="T1X1Q0M0">
<paramVector name="dPosXYZ" type="double">-2.137 0.257 -0.323</paramVector>
<paramVector name="dRotXYZ" type="double">-0.00028 -0.00084 0</paramVector>
<paramVector name="pivotXYZ" type="double">0 1212.75  0</paramVector>
</condition>
```

- schematic formula for chi2 contribution

$$\chi^2_{\text{joint}} = (\alpha_i - \alpha_j)^T V^{-1} (\alpha_i - \alpha_j)$$

alignment parameters for half-modules i and j in common frame

covariance matrix (chosen to be diagonal!)

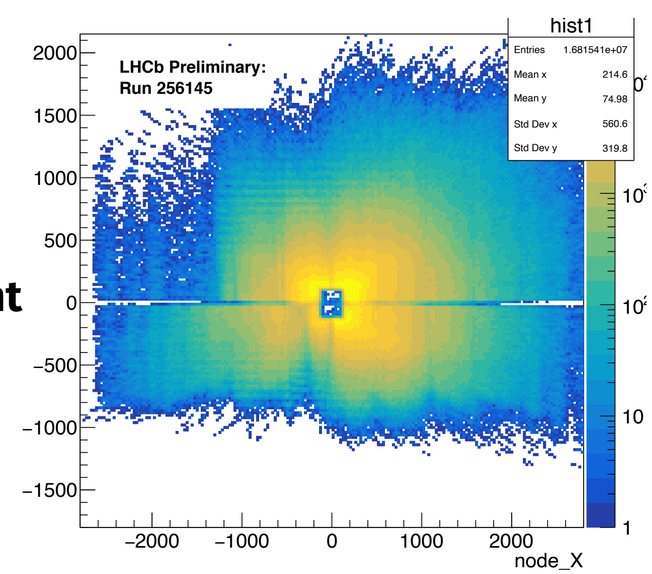
2022 input study: manually shifted starting positions

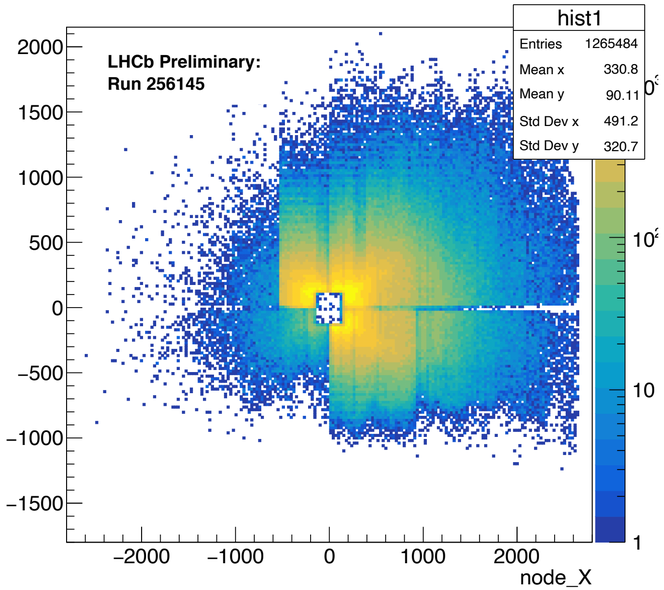
- Last time: more tracks in SciFi when T2X2Q0 + T2X2Q2 manually repositioned with v2 align
- Now: apply extra alignment iterations to improve positioning in TxRz
- Next: combine with Tz degree of freedom

GoodLongTrack hits in all layers

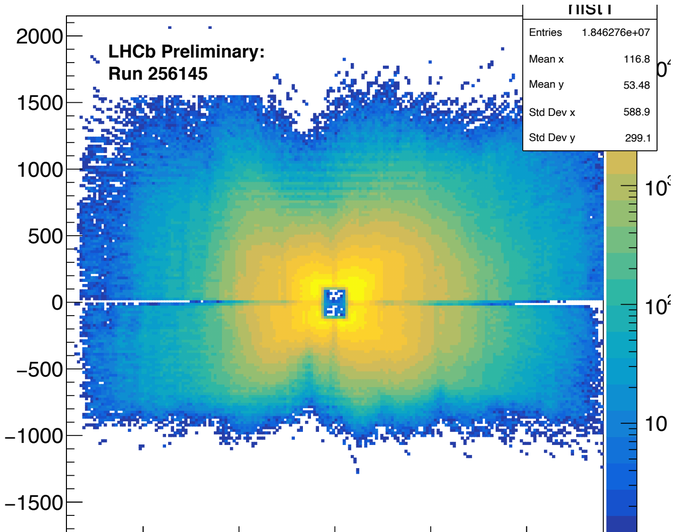
GoodLongTrack hits in T2X2

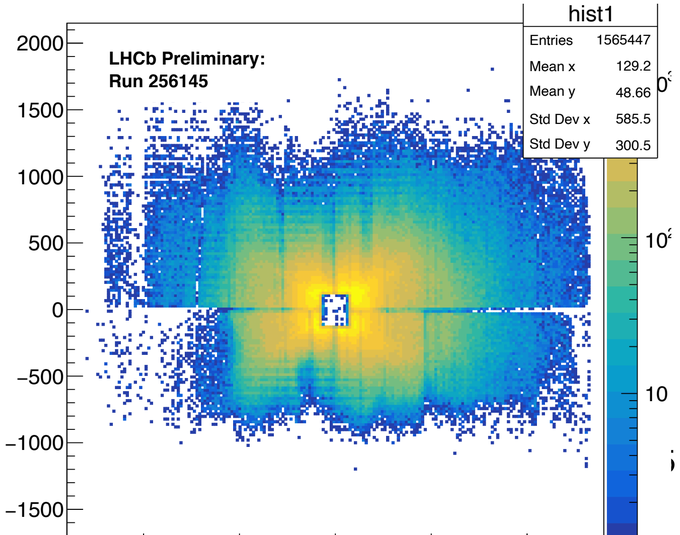
No adjustment





With starting adjustment





2022 input study: loose tracking

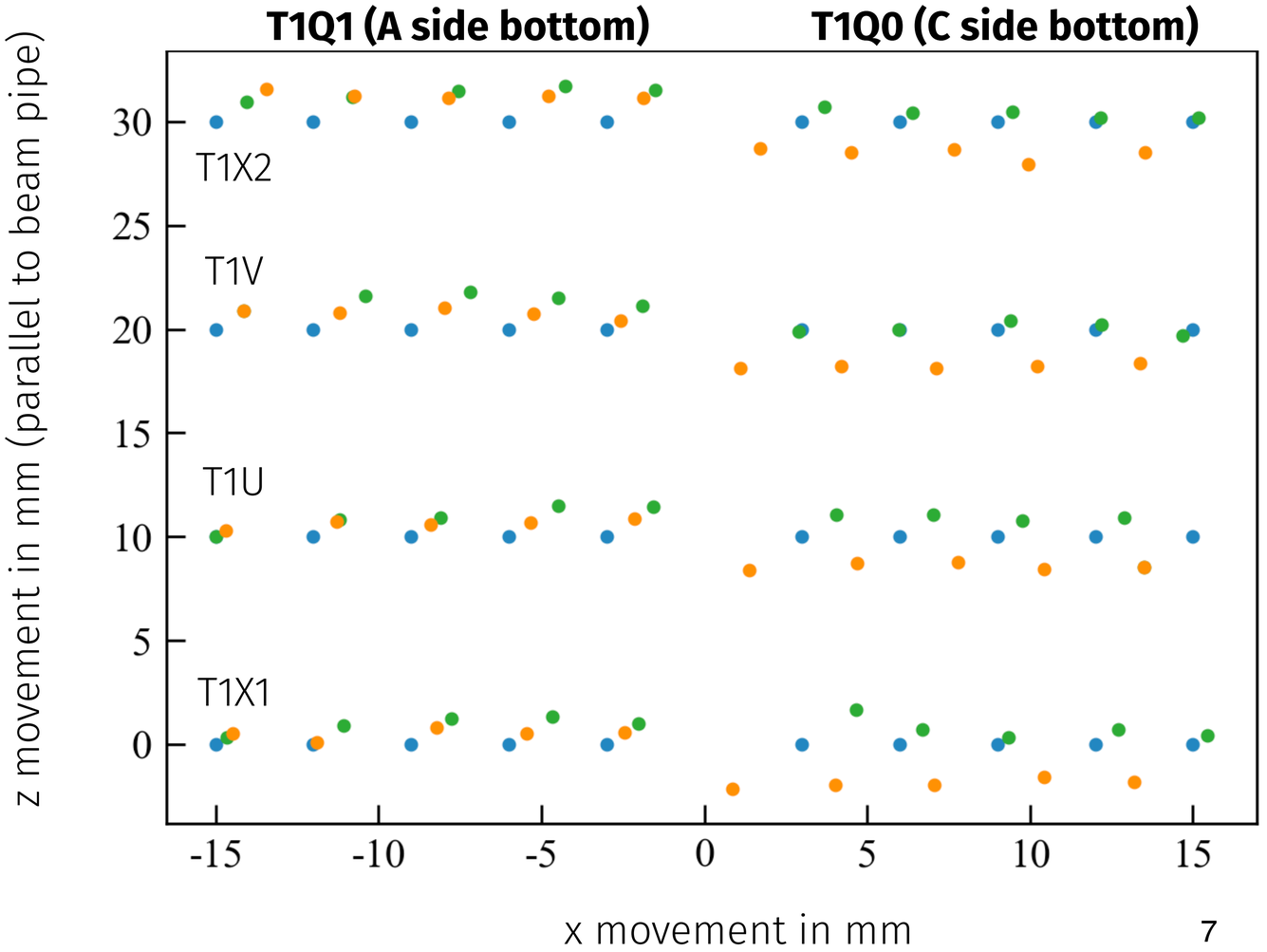
Good track selections:
5GeV < p < 200GeV
pT > 200 MeV
max chi2/dof of matching,track segments < 5

- 1st look at “loose tracking” config
  - allows larger chi2 of seed + velo track parts in matching
  - matching constraint, hit finding constraints a bit looser
- Loose tracks too loose to use all of them, more susceptible to weak modes/drift/scaling
- Loose tracks with selections:
  - Reconstructs **more particles** for similar number of selected tracks
  - Similar “dead areas” with insufficient hits
  - Better eigenvalue behaviour/control of scaling
- **Running two v3 candidates: GoodLongTracks vs LooseGoodLongTracks**
- More detailed MC/data studies to prep for 2023 ongoing

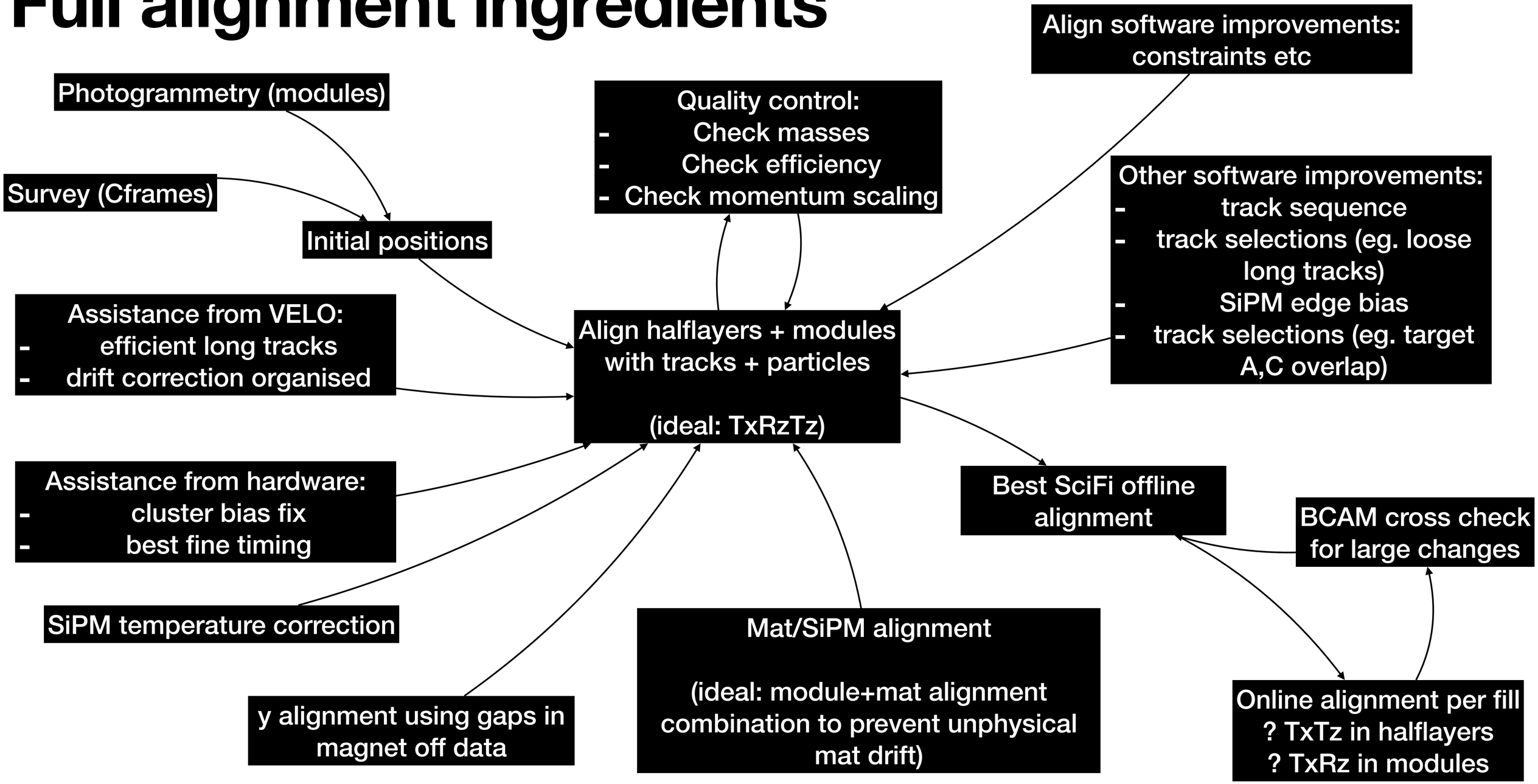
	GoodLongTracks	**LooseGoodTracks**
Events	200k	200k
nTracks	3216433	3167647
nVertices	193007	191564
nParticles	**249**	**1494**
track chi2 dof	**1.32**	**1.67**
vertex chi2 dof	1.66	1.64
insufficient stats	12	11
eigenvalues <1	**14**	**5**

2022 input study: z scaling

- SciFiv2 align (in AlignV9) fixes z positions of modules to survey
- Test alignment with module z movement
  - Plot in TxTz plane
  - Blue: design position
  - Orange: 2022 survey position
  - Green: v3 align prototype
- Difference in z between survey+align position on Q0 larger on all layers
  - Partial explanation for alignment problems
  - Puzzling: consistent slope of shifts in TxTz



Full alignment ingredients



2022 alignment “version flow”

Initial positions from survey+photogrammetry — SciFi v0

Modules TxRz align (long tracks) — SciFi v1

Correct beam angle in survey
Improvements to timing

Modules TxRz align (long tracks) — SciFi v2

Cross check of VELO drift effect size

Diagnose low efficiency: T2X2 C side starting position

Ability to run in DD4HEP/master

Mat adjustment needed to correct for SiPM position

Module continuity constraint?

Loose track matching/params on iteration 0-2?

halflayers+ Modules TxRzTz align (long tracks + D0 particle)
+ Tx Mat alignment — SciFi v3

SciFi v3 needed
early next week for LHCP

Working hard on this!

Roadblocks passed:

- software/stack issues
- multithreading issues

Roadblocks remaining:

- z position scaling/drift/curvature checks

current estimate for
finishing checks: MONDAY
1st May