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FSP LHCb
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# Global alignment of the LHCb SciFi Tracker and Vertex Locator

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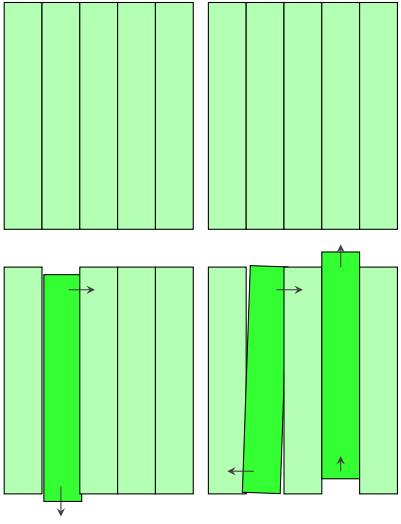
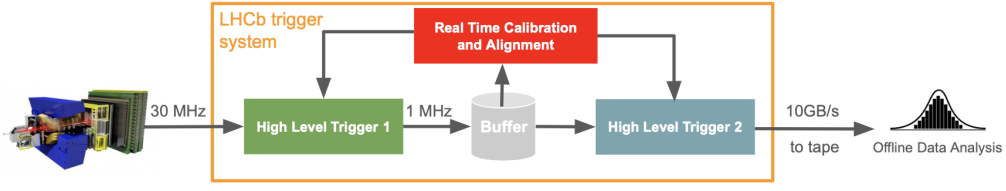
## What is Alignment and why do we need it?



- Top: ideal detector, bottom: physical detector
- Surveys are used to find the rotation and position of each detector component
- →Starting positions for software alignment
- Building tracks accurately requires positions in reconstruction to be as similar as possible to real positions

# Importance of alignments

- Alignment is part of the LHCb trigger system
- Physics performance tied to alignment performance
- with optimal alignment:
  - → remove systematic biases for asymmetry measurements
  - Best possible mass resolution



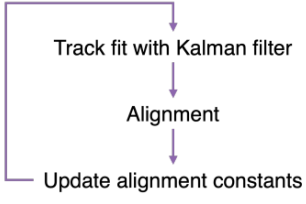
# Alignment: track fits with the Kalman Filter

measurement $m$ track model $h$

$$r_i = m_i - h_i(x, \alpha)$$

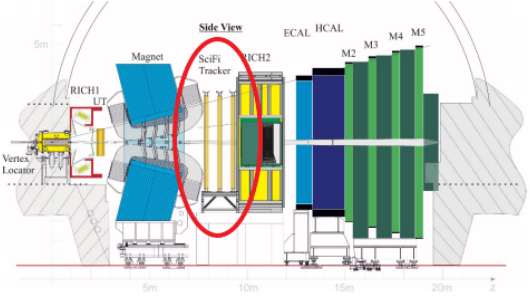
$$\chi^2 = r^T V^{-1} r$$

covariance matrix $V$

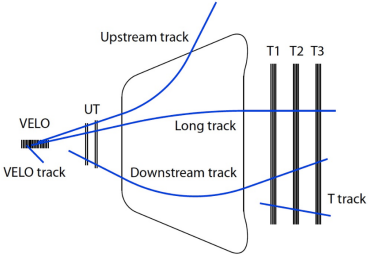



- Starting positions: positions from laser scans of detector objects (survey)
- Alignment: $\chi^2$ minimization of track residuals
- Add measurements one-by-one to fit
- Prediction of next measurement →minimize residuals →redo until track complete
- Why Kalman Filter?
  - easily models material interactions as well as multiple scattering

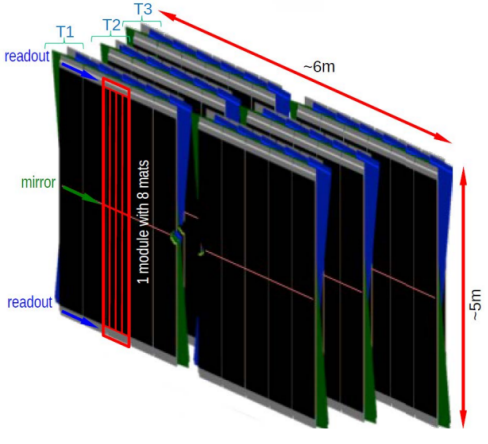
# LHCb upgraded with the SciFi




- 3 stations: T1, T2, T3
- 4 layers per station: X1, U, V, X2
- Replaces former IT and OT to cope with the increased instantaneous luminosity



# The Scintillating Fibre Tracker




- Front two stations have 5 modules per side
- Back station has 6 modules on each side
- U, V layers have a **∓5 deg** stereo angle respectively
- → Used for determining y-position of tracks by comparing hitposition at different angles

# Global alignment and motivation

## Global alignment

- alignment of the velo and the scifi simultaneously
- Motivation for global alignment
  - understanding the interplay between tracking systems
  - rotations inside the VELO →weak modes inside SciFi (VELO twisting)

## Configuration

First Longmodules then Halfmodules TxRxRz

Full VELO RxRz + VELO halves TxTyTz

VELO halves TxTyTz

CFrames to be able to absorb for the average movement

lagrage constraint in T2

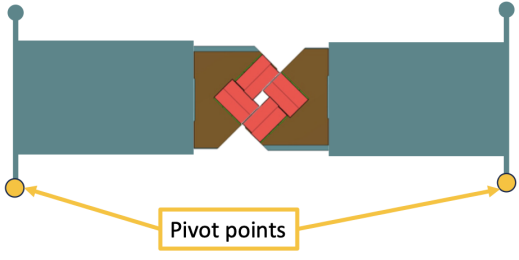
# VELO global rotation

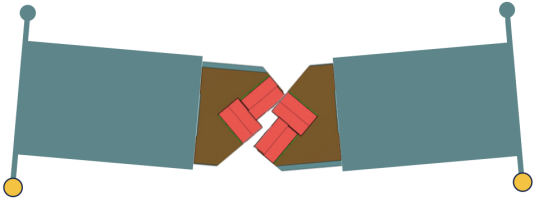
rotation Rz leading to shifts in x and y

half alignment sensitive to x shift

global movement in y

can not be corrected for by half alignment



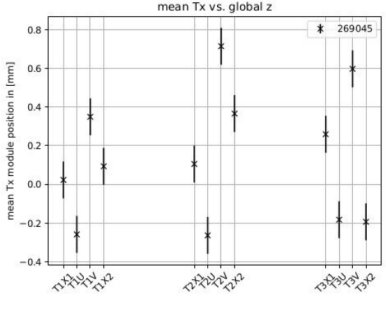
## Comparison of SciFi only to global alignment

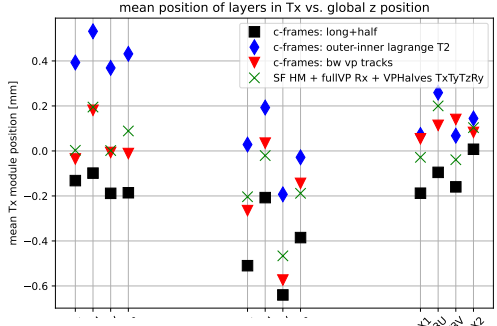
- zig-zag pattern still unknown origin

→correlated with Tz shifting showing similar trend

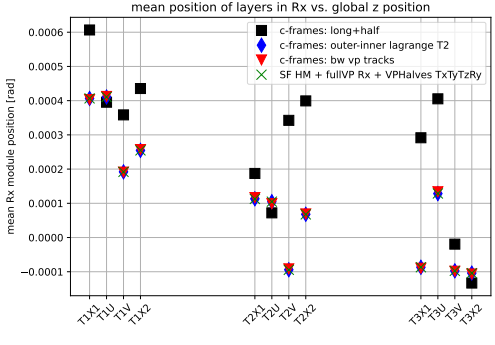
- small improvement in comparison to SciFi only

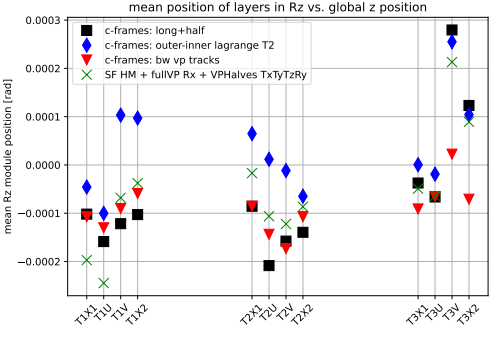
→layer movement has still issues from VELO rotation present in SciFi



# Comparison of SciFi only to global alignment



## Issues and possible solutions

- zig-zag pattern of stereo layers in Tx difficult to fix

→similar pattern in Tz →cannot fix one without the other

- global VELO Rx might be overthrown by survey constrains acting on Rx →Rx not being picked up in the alignment
- Testing different survey uncertanties to study the impact on global VELO rotation
- Testing different settings in the alignment on stereo layers in Tx

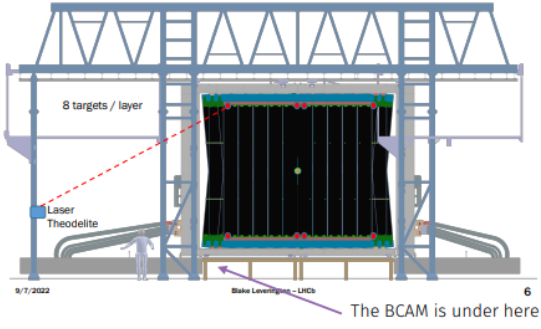
make sure VELO Rx is being picked up in the alignment

## Summary

- global alignment improving the position of the T-stations
- still unknown phenomena (zig-zag pattern, offset T2 position)
- survey constraints might counteract the global VELO Rx
- A lot more tests to do until data taking which look promising
- **Thank you for your attention!**

## The survey: what is it and the different types

- Measure distance of some points on the detector with a laser




- Layer survey: find corners of layers
- Module survey: reflective stickers, calculate module plane
- Compare survey to simulation