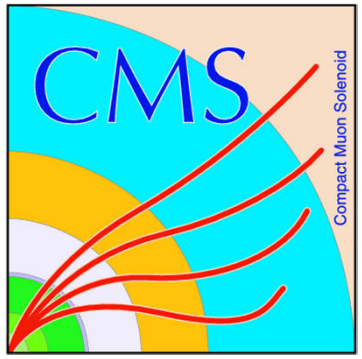
Local Alignment Parameter Error (APE) Estimation

Estimation from Width of Normalised Residuals



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DESY

Hamburg Alignment Meeting
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HELMHOLTZ ASSOCIATION

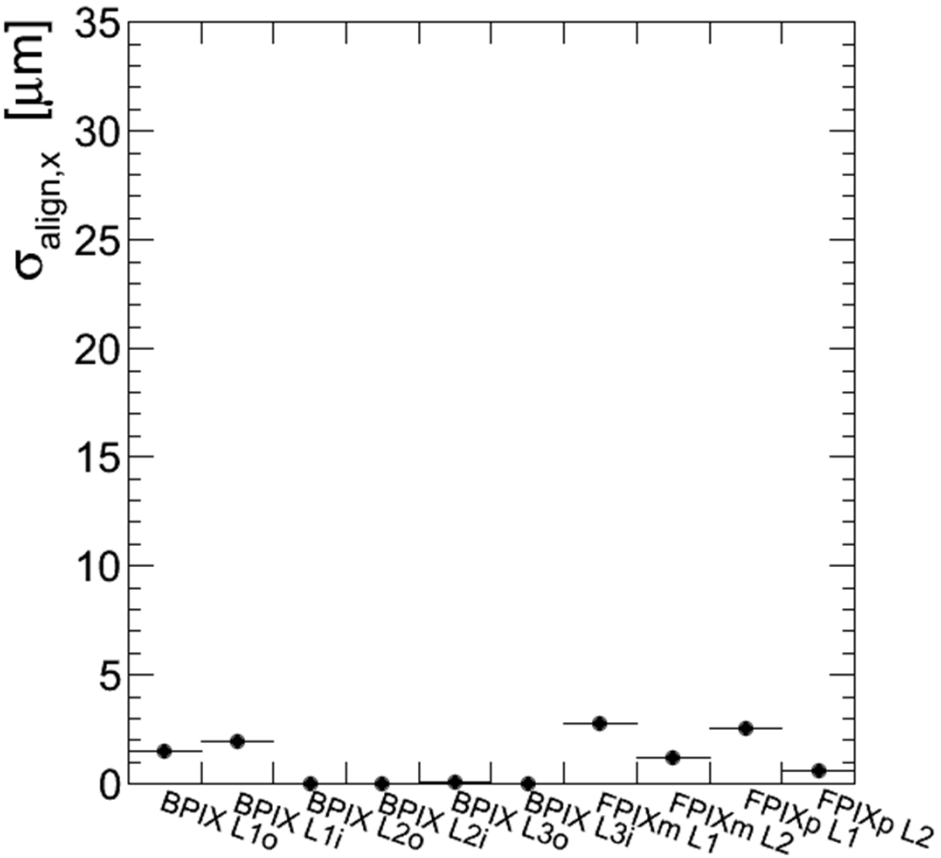
DESY

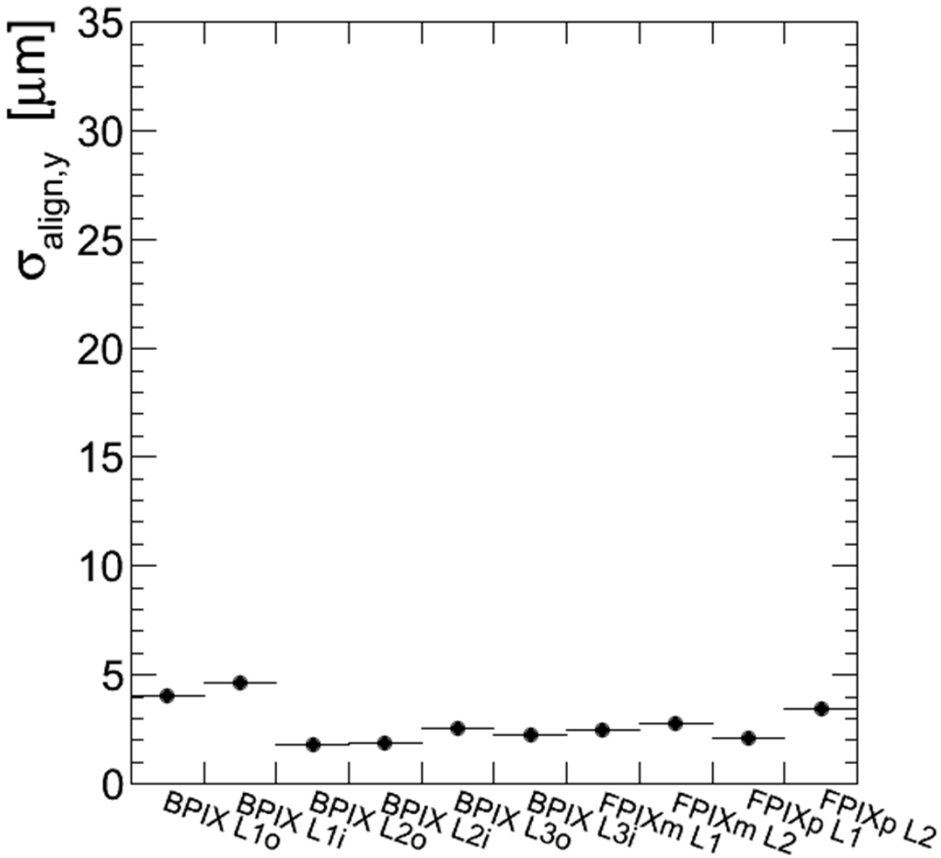
Introduction

- Calculation of APEs for recent MC misalignment scenario
  - Identical setups as for calculation on data geometry
    (no changes of selection criteria, setup of estimation tool)
- Identical to calculation of reference baseline from ideal MC, but
  - All conditions from realistic misalignment scenario
  - Use global tag **START42_V12** instead of **MC_42_V12**
  - Geometry is obtained using misalignment tools, followed by alignment procedure
- Due to outlier rejection in refit, and possibly slightly different track selection due to refit
  - Number of hits used per sector, thus hit distributions, deviate slightly (percent level)
  - Sometimes more, sometimes less hits used per sector
  - As always when using outlier rejection, also slight changes during iterations
  - Number of tracks: 1325875 (design)
    1325063 (misaligned – before iterations)
    1325242 (misaligned – after iterations)

Results in Pixel

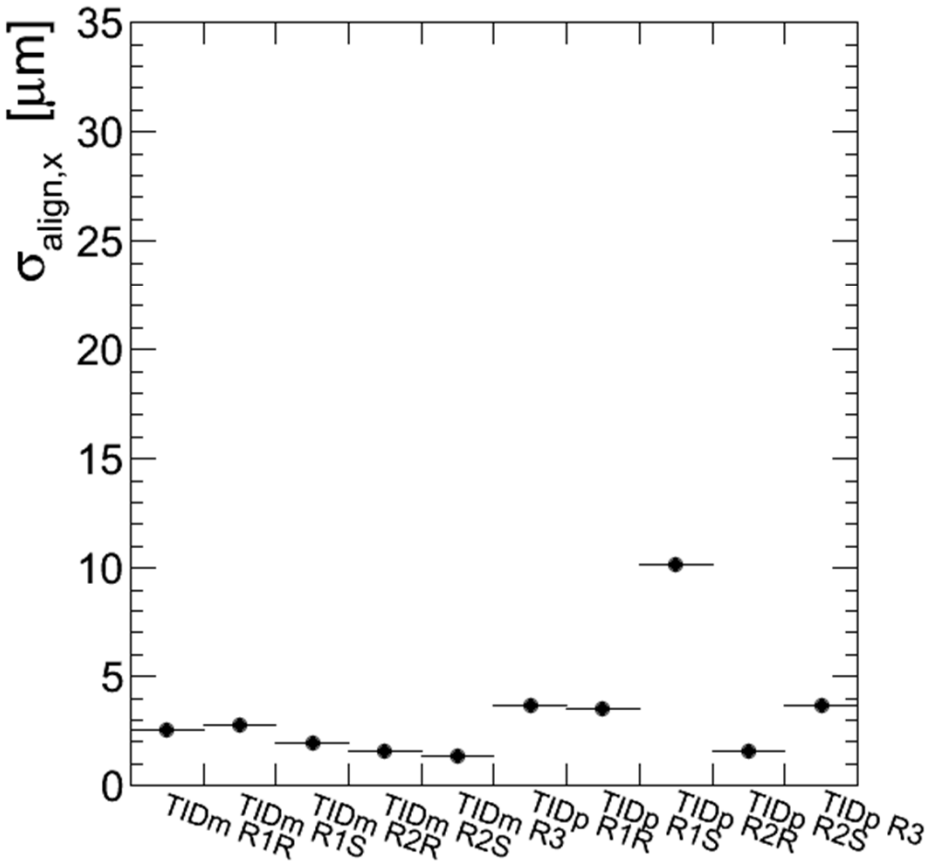
- Values in general small
- Some sectors in x with slightly imaginary APE

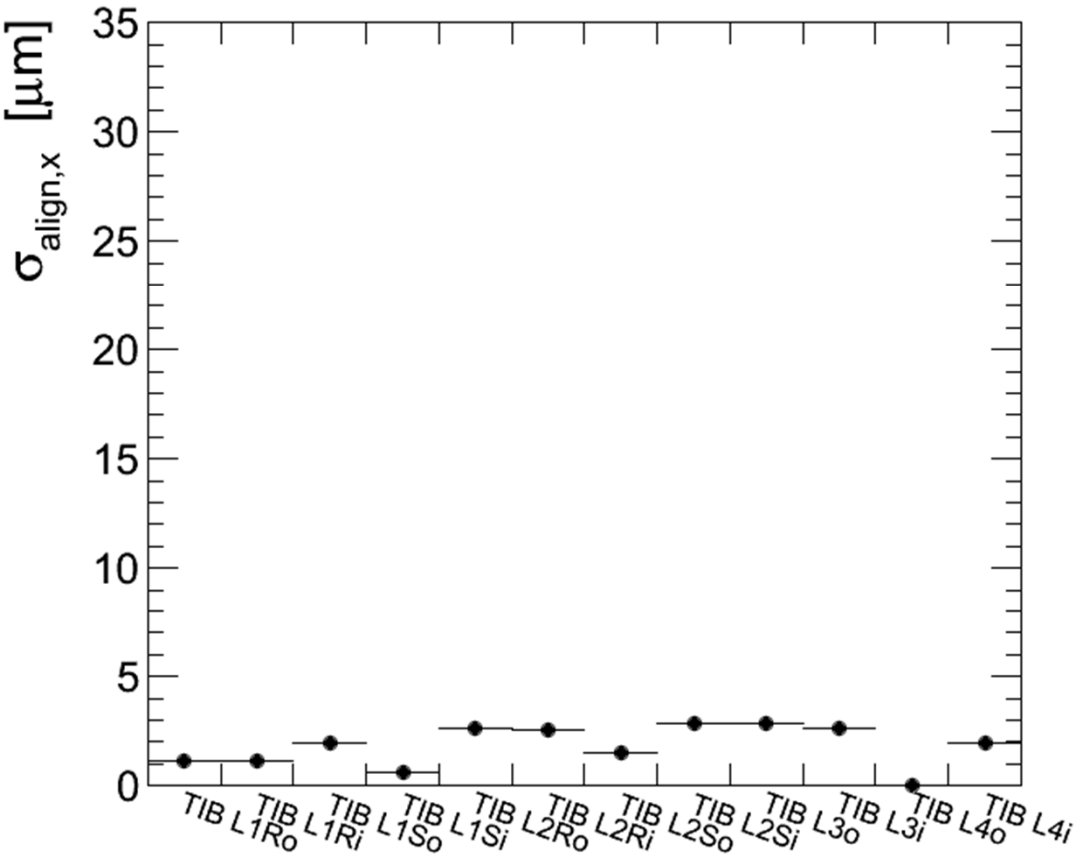




Results in TID and TIB

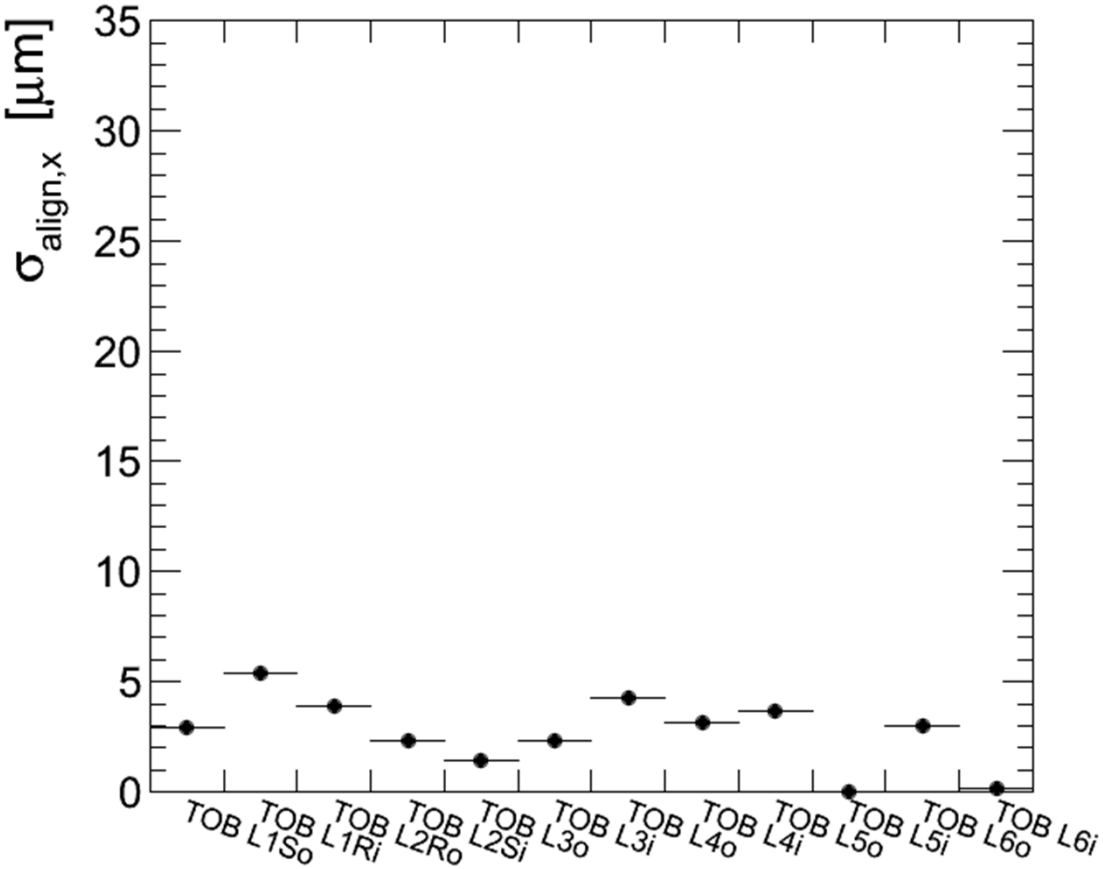
- Small values, one TID sector with bigger value ~10µm
- One TIB sector with slightly imaginary APE





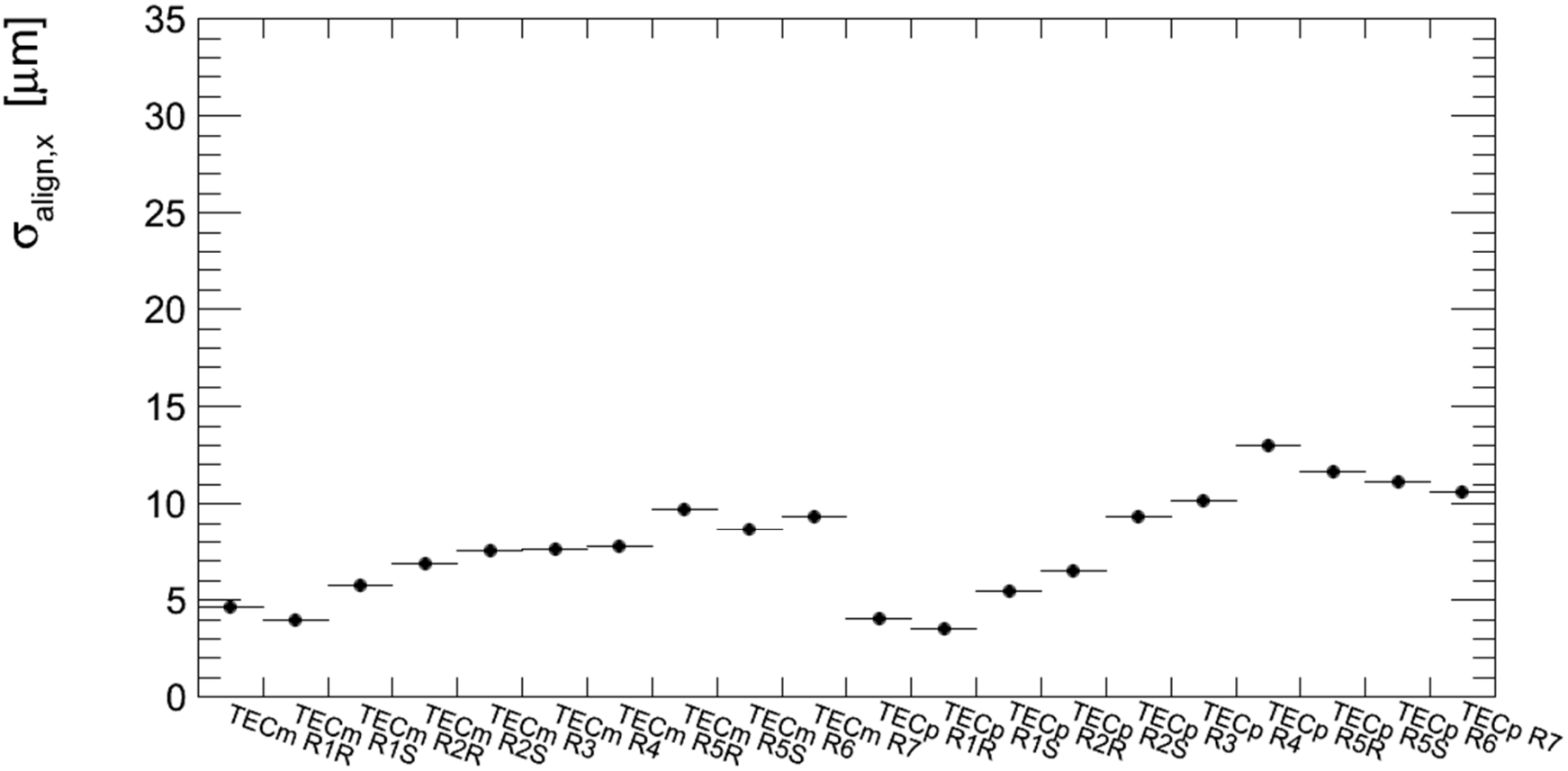
Results in TOB

- Small values
- One (two) sector with slightly imaginary APE



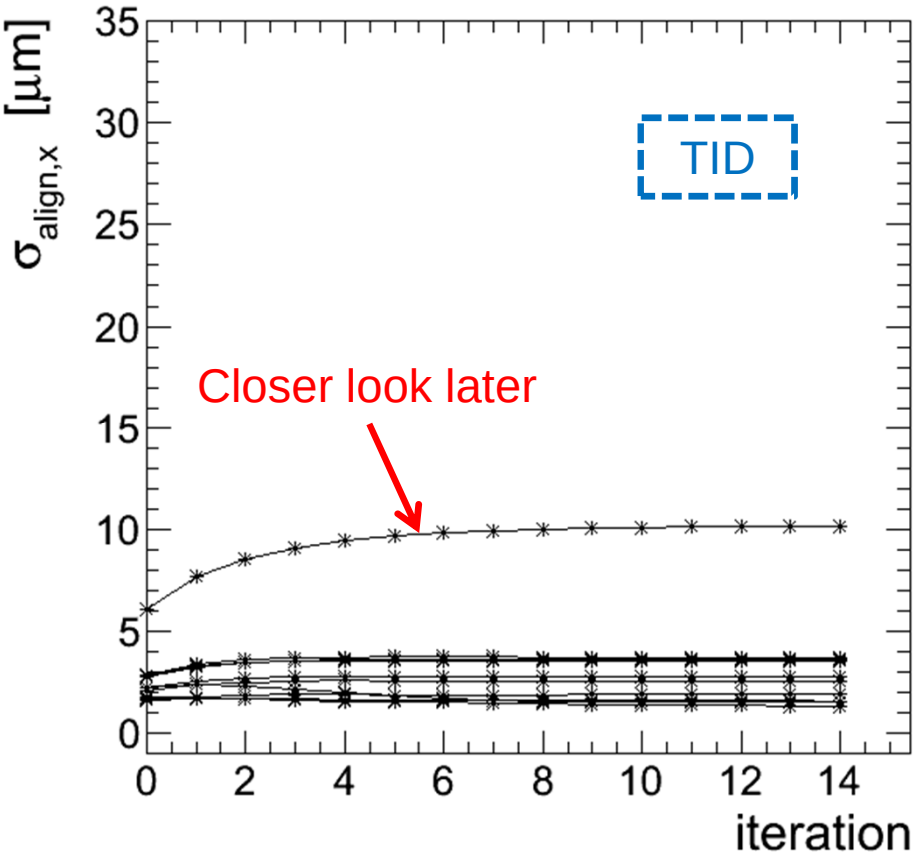
Results in TEC

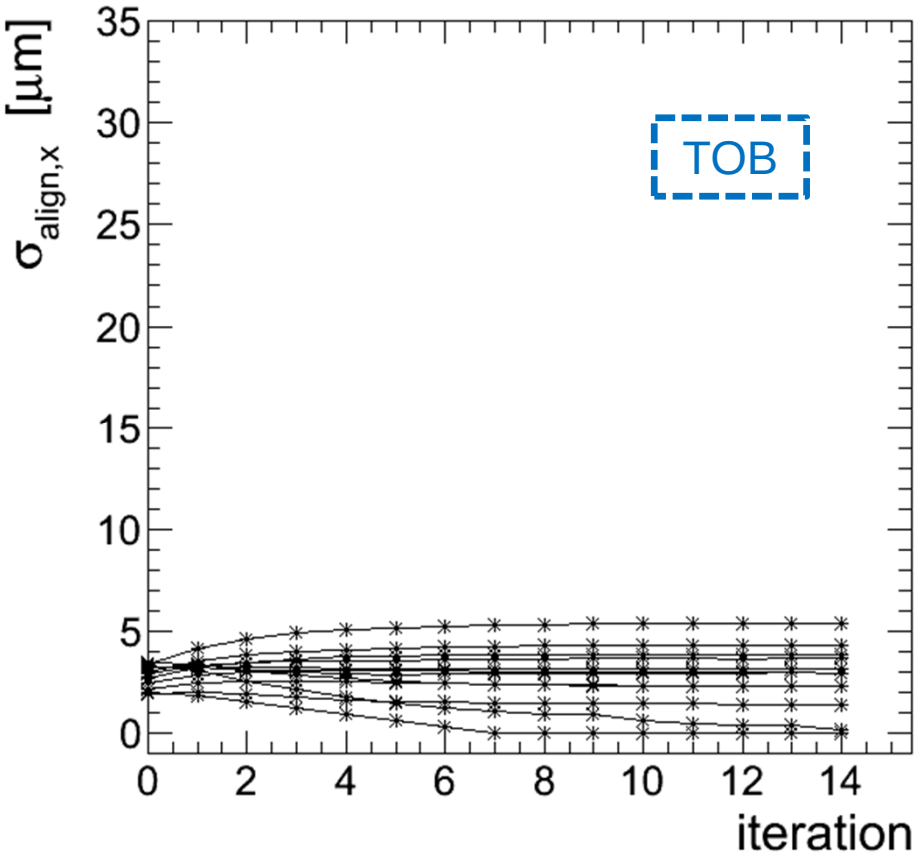
- Values bigger than in other sectors
- In general increasing size from inner to outer rings



Convergence (in TID and TOB – others in Backup)

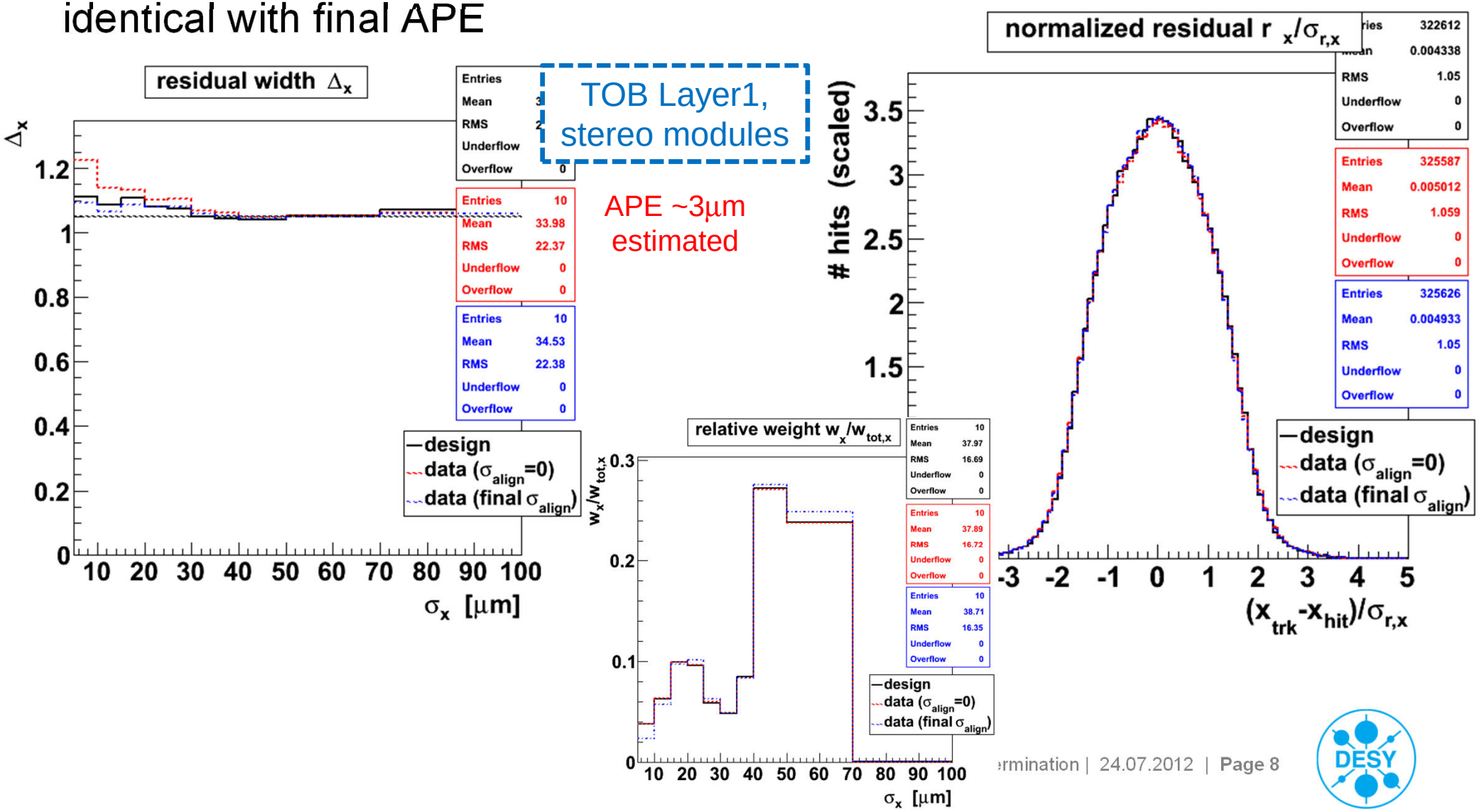
- In first iteration all APEs >0μm, but in BPIX *x*-direction all below 2μm
- Some imaginary values, but estimated squared correction always <1μm^2
- For other subdetectors than TID, TOB changes with iterations mainly small



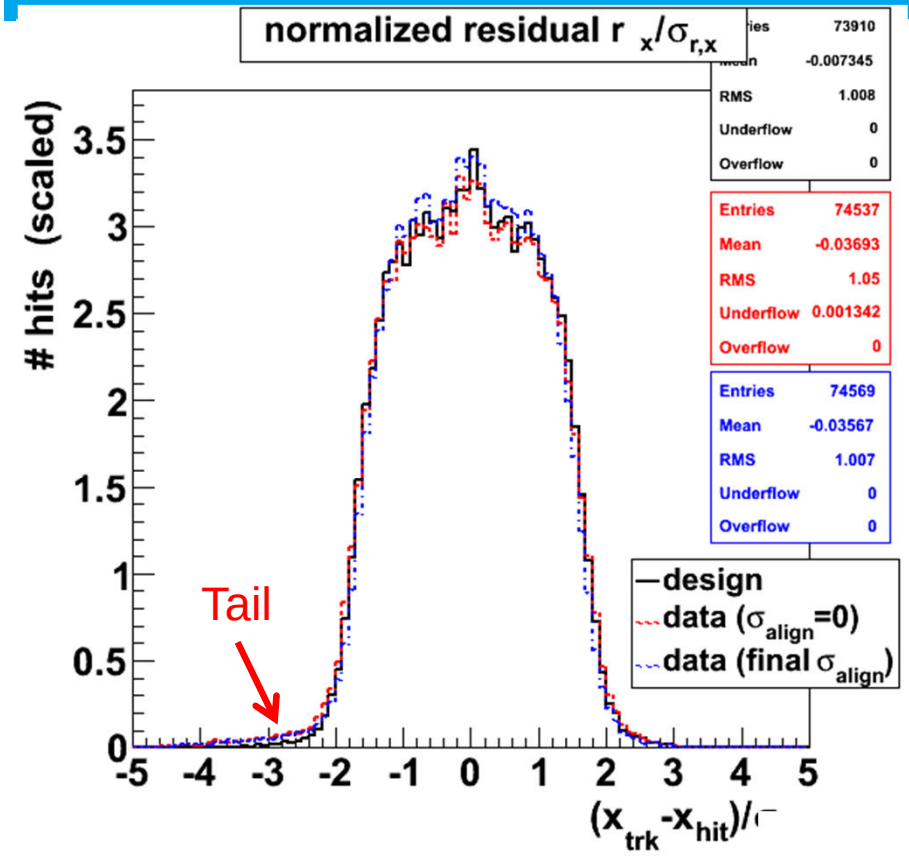


Examples of Residual Distributions I

- Small misalignment → residual dependence not showing up as clearly
- RMS values in all sectors bigger than for design with APE=0, identical with final APE

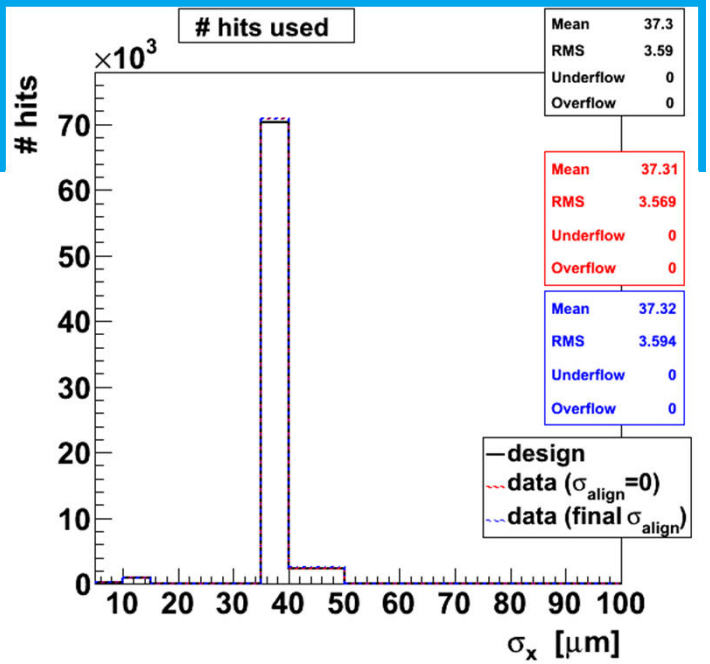


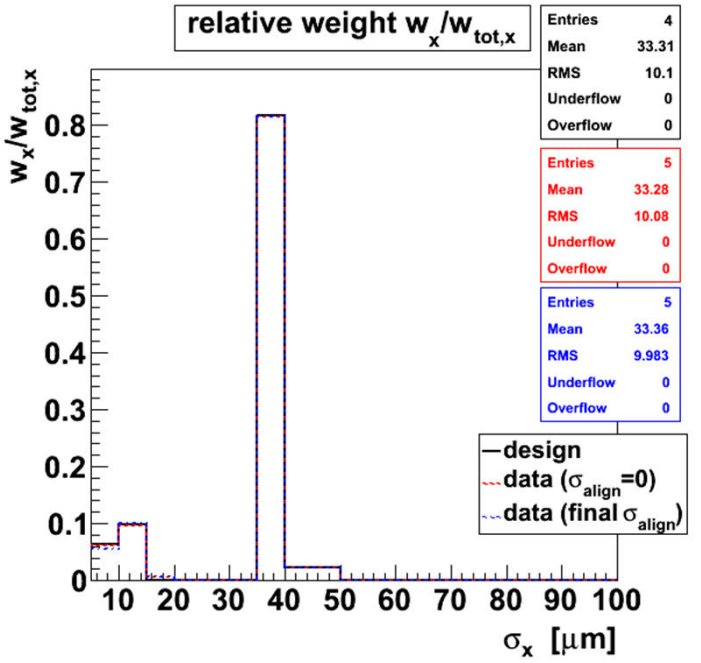
Examples of Residual Distributions II

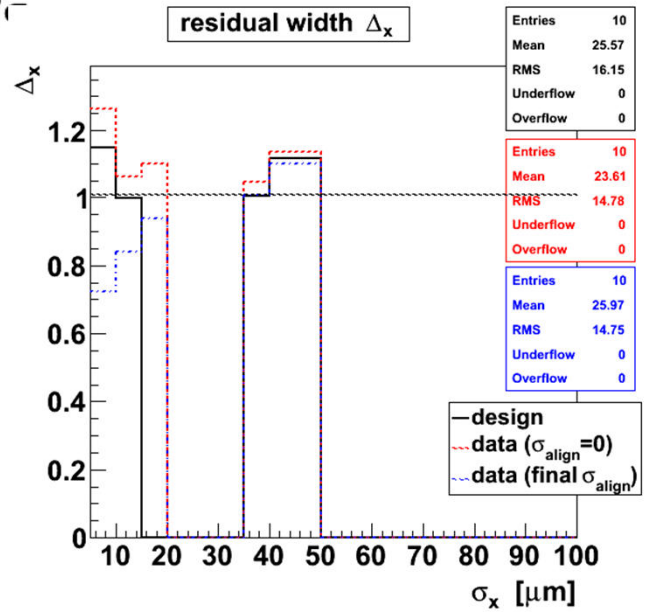


TID+ Ring2,
$r\phi$-modules

APE ~10µm
estimated,
overestimation
due to tail?

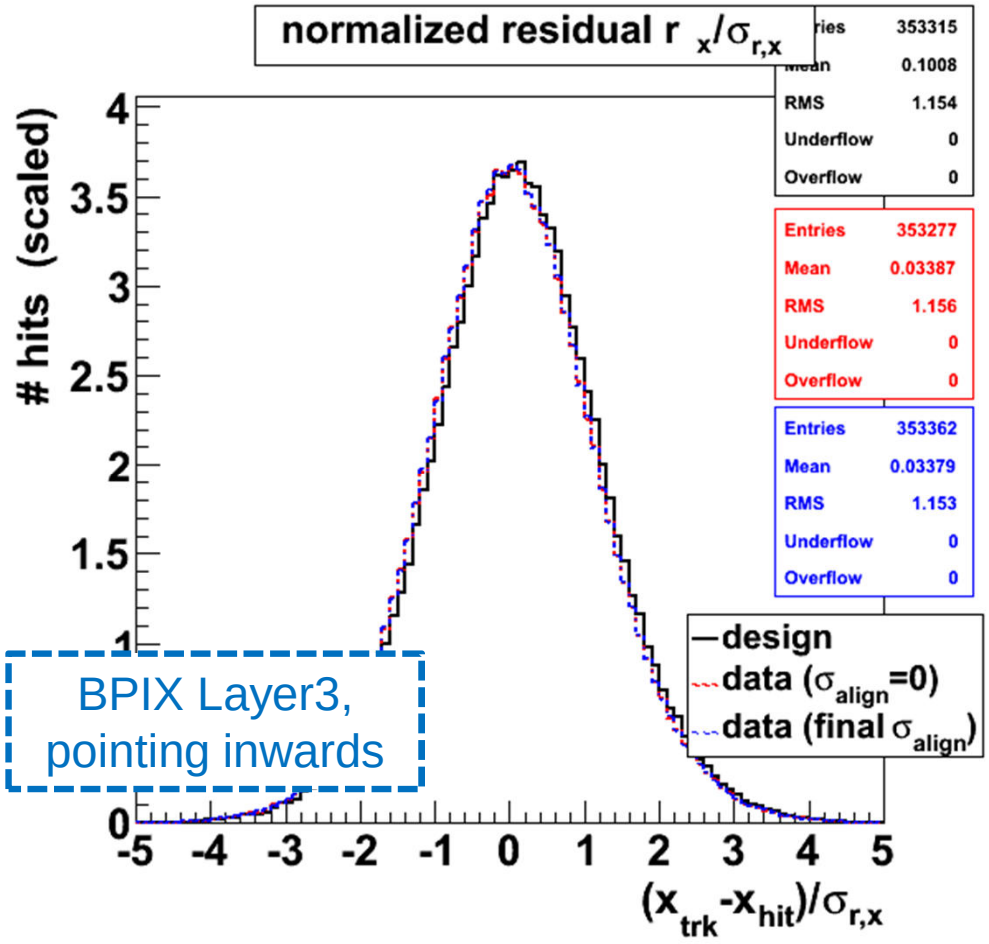


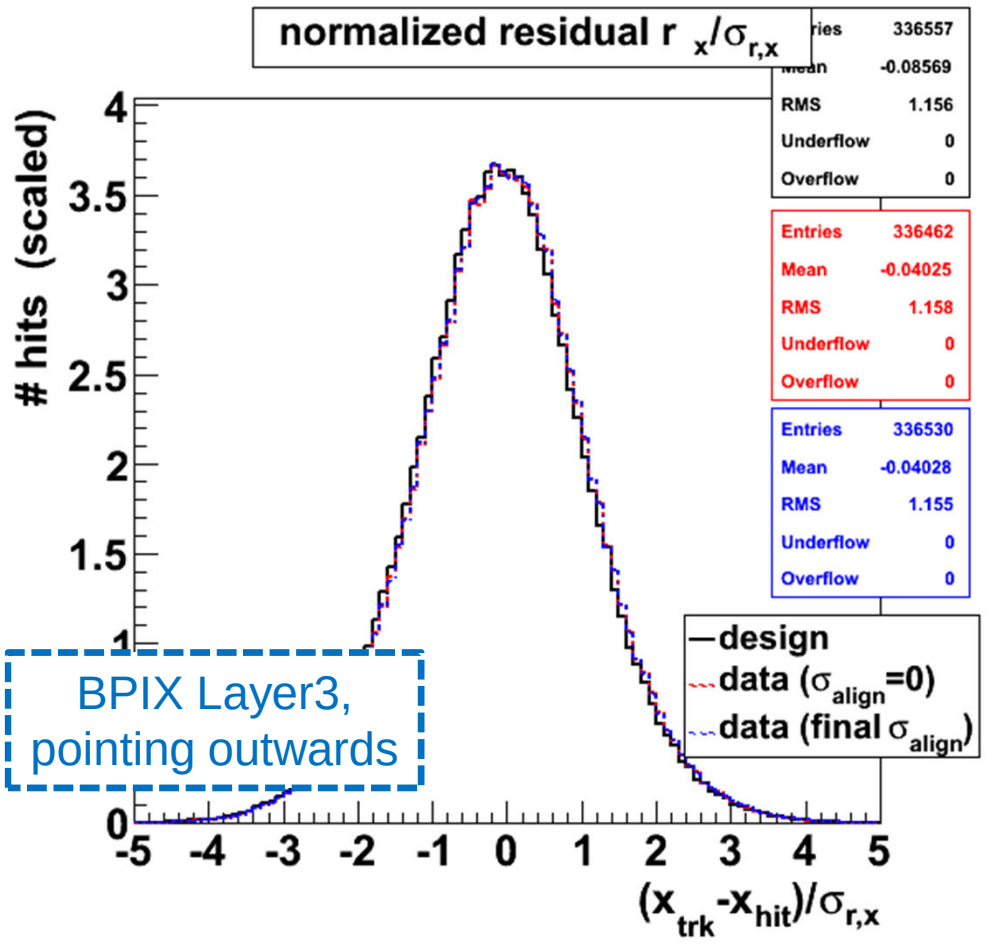




Suspicious Residual Behaviour in BPIX *x*-Direction I

- Mean values in design geometry shifted, like Lorentz angle effect
  - Corresponding in absolute residuals to about +1µm (inwards pointing), -1µm (outwards)
  - Mainly recovered in misaligned geometry, due to alignment procedure
- RMS values not (or only slightly) affected

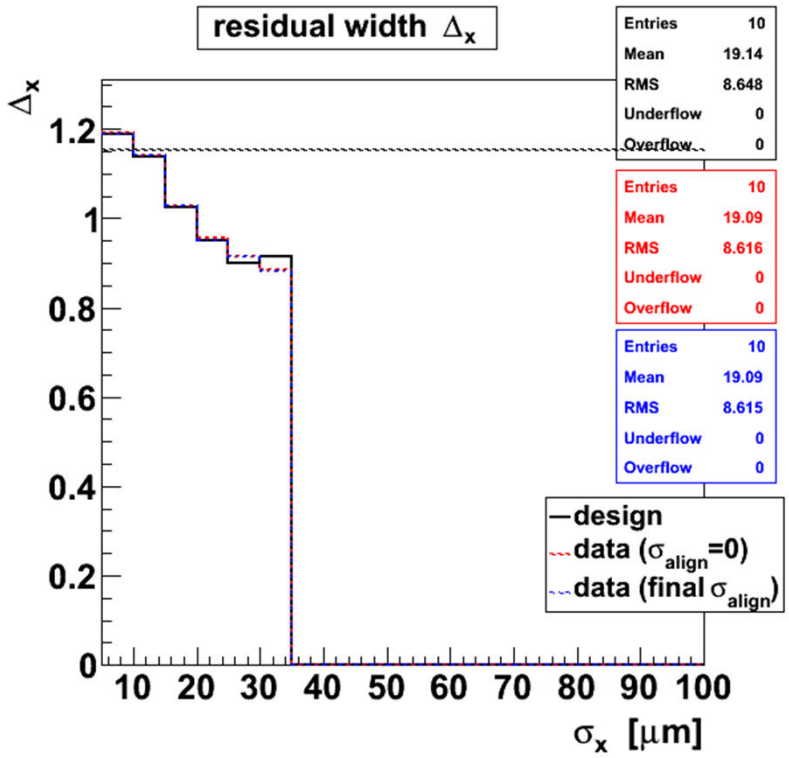




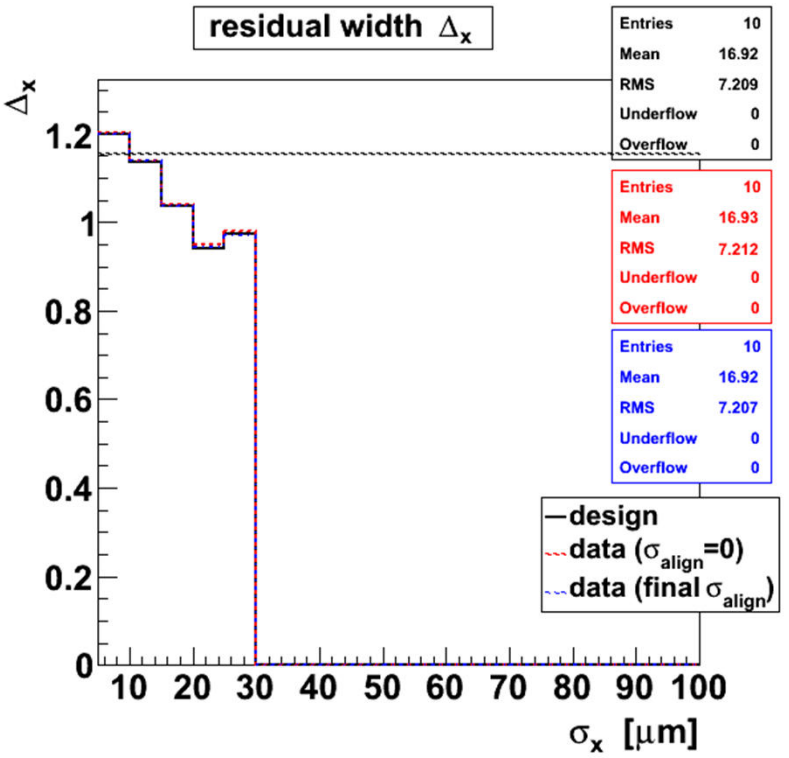
Suspicious Residual Behaviour in BPIX *x*-Direction II

- In binned normalised residual distributions no effect visible

BPIX Layer3, pointing inwards

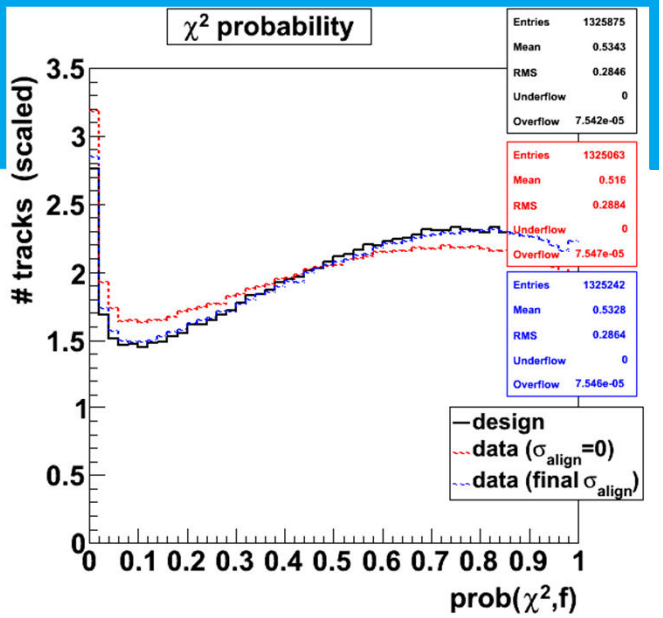


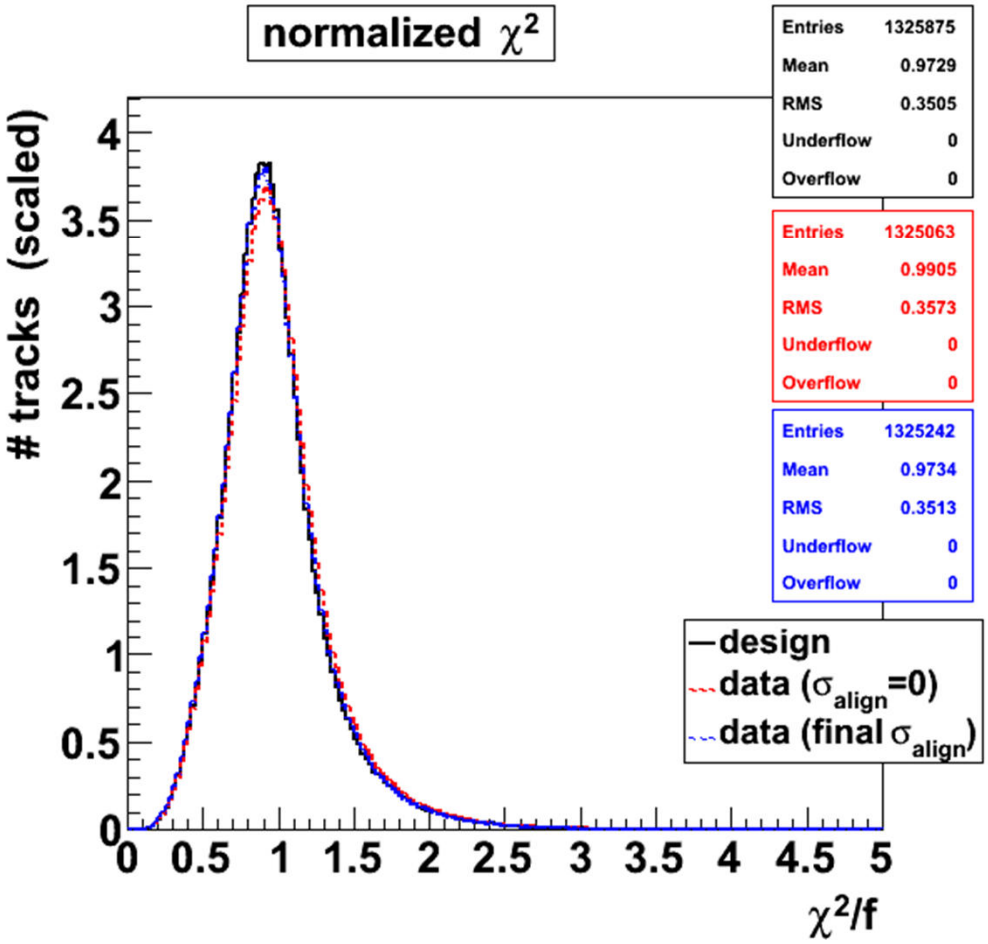
BPIX Layer3, pointing outwards

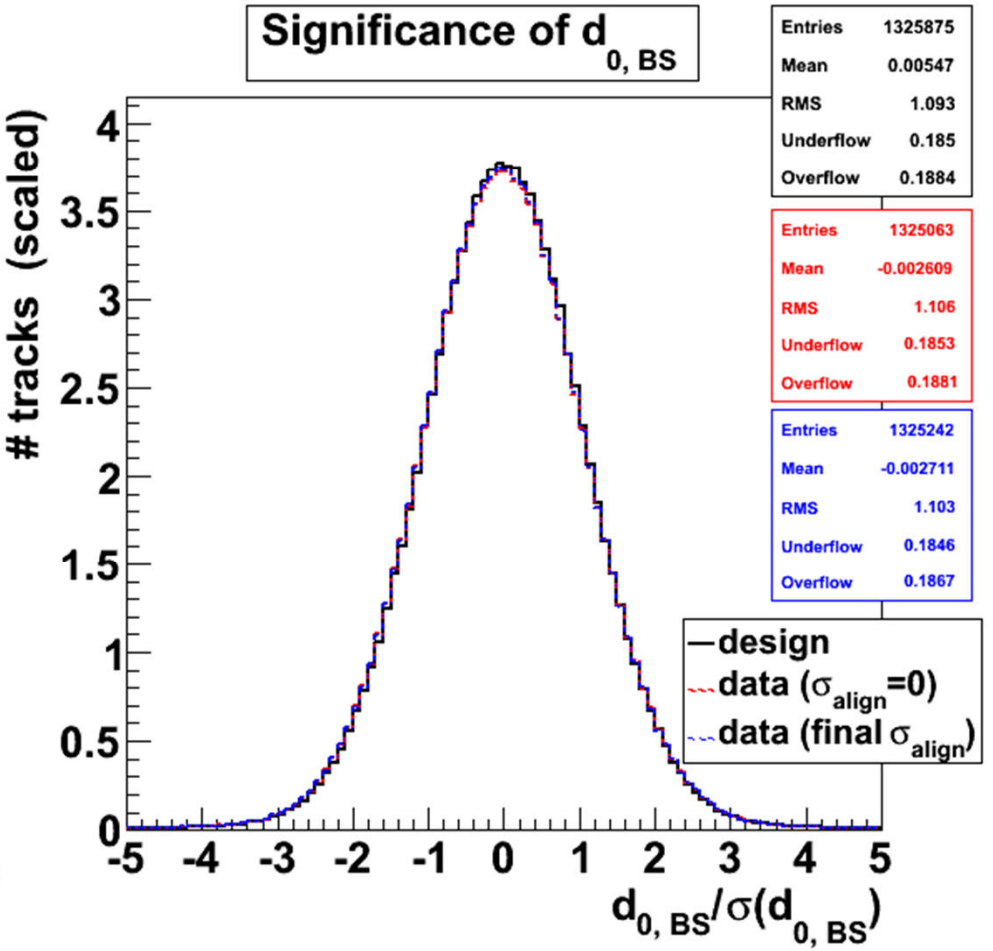


Influence on Track Parameters

- Small, but finite APEs
  - Central values of track parameters unchanged, errors with slight increase
  - Values get close to design







Summary

- APEs for recent misalignment scenario estimated
  - Identical setup of estimation tool as for presented studies on data
- Values mainly small, smaller than in data
  - Few cases with slightly imaginary APE values
- Most sectors look reasonable
  - One sector in TID seems to have overestimated value ~10µm
  - BPIX *x*-direction shows Lorentz angle like effect using design geometry (+ideal conditions)
- Final APE value brings track distributions close to those of design geometry

Backup

Datasets

- TkAlMuonIsolated stream
- Select tracks like in future ALCARECO selection
  - Select muons with good ID and isolation via CRAB on AOD skims
  - Then match to tracks in TkAlMuonIsolated via η, ϕ, p_t
  - Two different isolation criteria, since old isolation applied on ALCARECO production
- Private sub-skim of ALCARECOs
  - Contains only relevant products, preselection of useful events
  - Allows for fast iterations
- Assemble simulated samples with isolated muons and notable cross sections
  - QCD muon enriched (p_t>15 GeV)
  - W→μν
  - Z→μμ and lower mass Drell-Yan

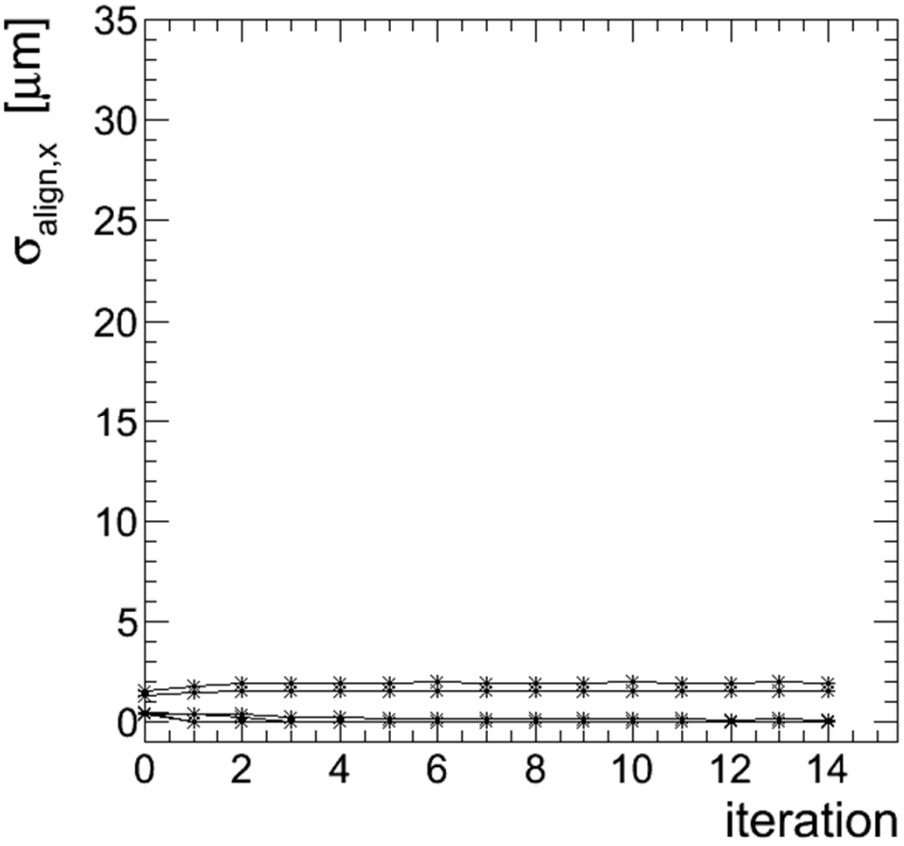
Event and Track Selection

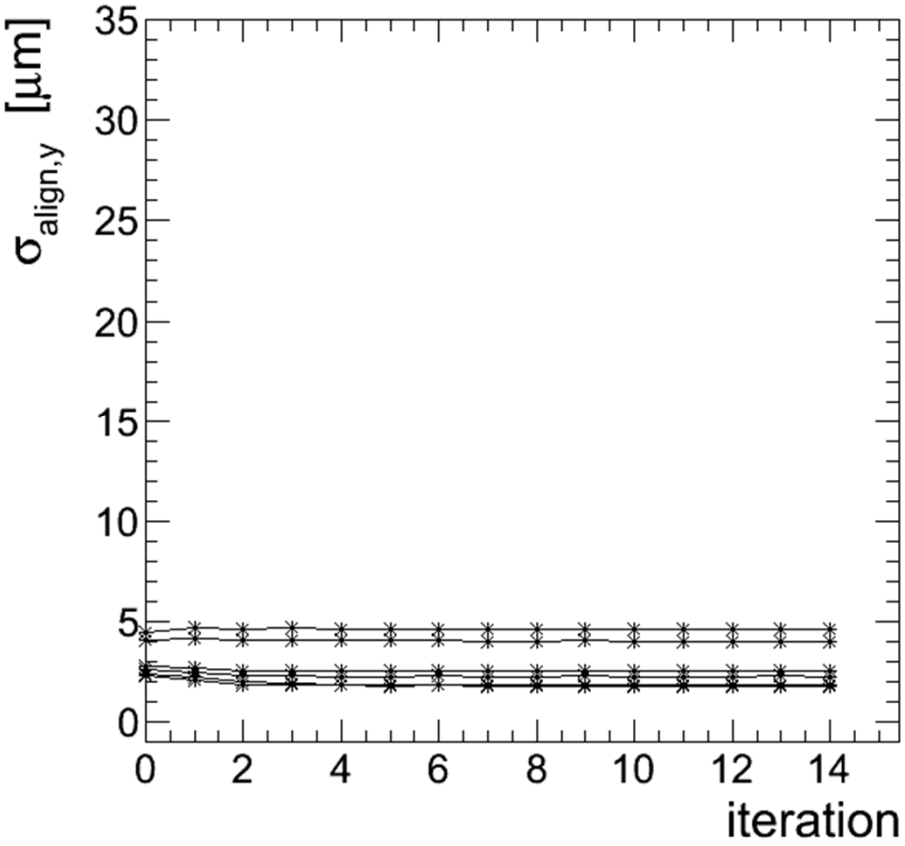
- 250 pb^{-1} of data, PromptRecoV4
  - Model with similar amount of MC events (no scaling)
- Trigger selection
  - HLT_IsoMu17_v*
- Track selection
  - default muon ID and relative combined isolation <0.15
  - highPurity flag
  - # hits (pixel) $\in$ [2,7]
  - # hits (strip) $\in$ [11,35]
  - $p_t \in$ [25 GeV, 150 GeV]
  - $|d_0| \leq 0.02$ cm
  - $|d_z| \leq 15$ cm
  - $\chi^2/\text{ndf} \leq 5$

Hit Selection

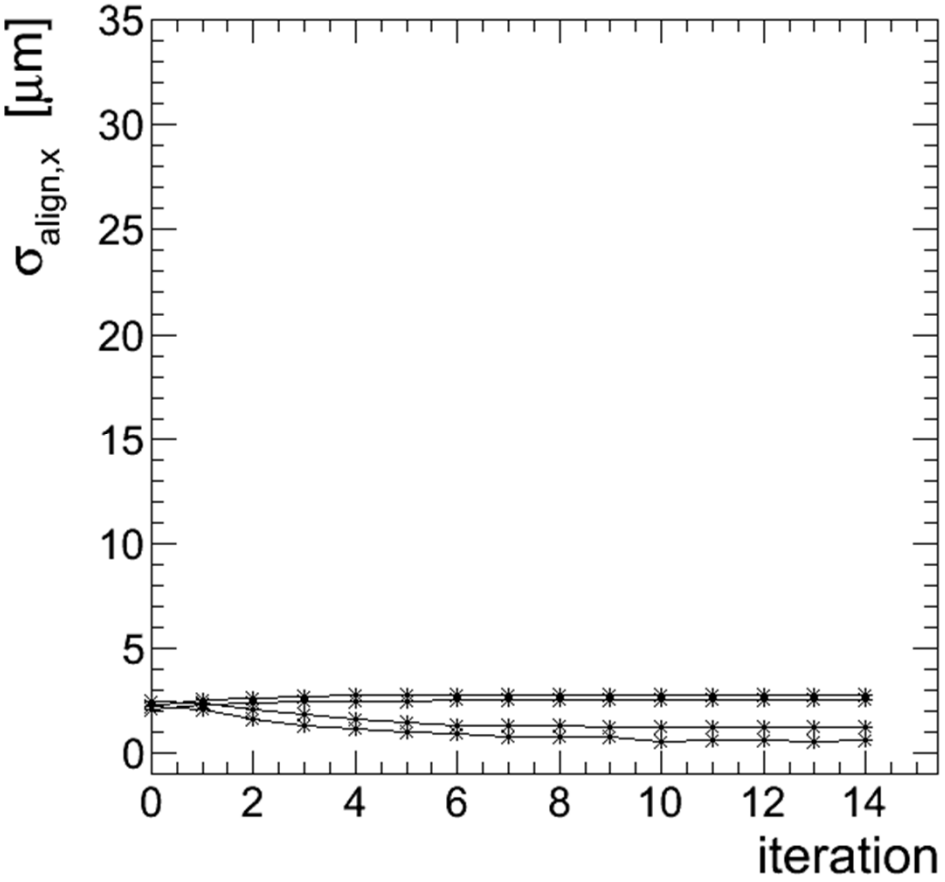
- Strip clusters
  - Exactly 3 strips
  - Maximum charge on middle strip: $c_M > c_L$, $c_M > c_R$
  - Charge profile visible: $c_L + c_R \leq c_M$
  - 20<s/N<50
- Pixel clusters
  - Quality flag qBin $\in$ [1,3] – exclude clusters with low charge or unphysical value
  - $q \geq 10000$ e – probably already excluded by qBin
  - Deselect clusters on module edges
  - logClusterProbability ≥ -5 (template matching)
  - Treat *x*- and *y*-measurement independently:
    cluster width at least 2 pixels in concerned coordinate

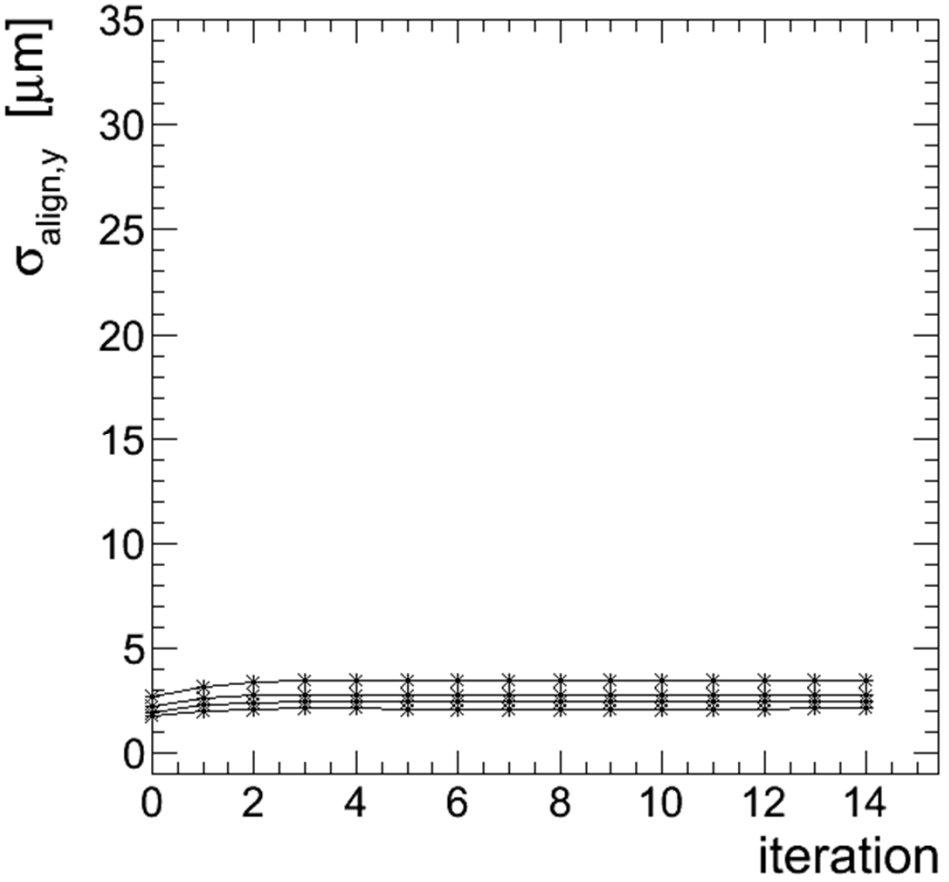
Convergence in BPIX



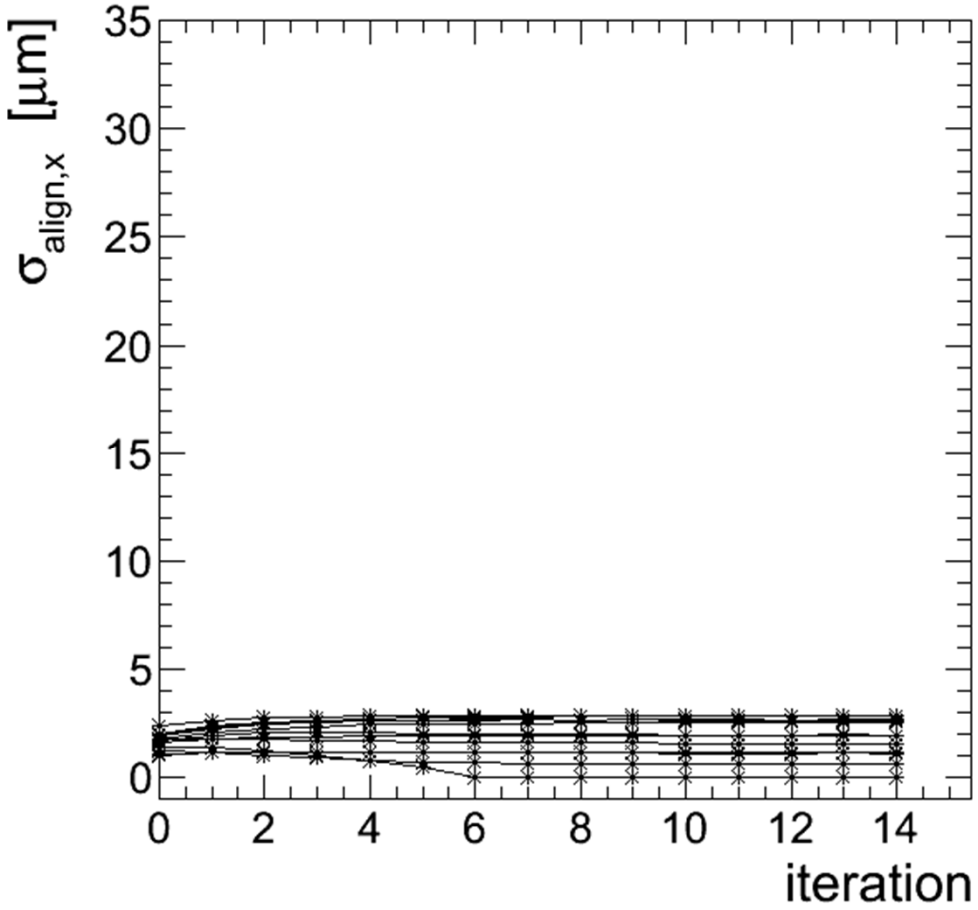


Convergence in FPIX





Convergence in TIB



Convergence in TEC