2018 Overlay Geometry Issue

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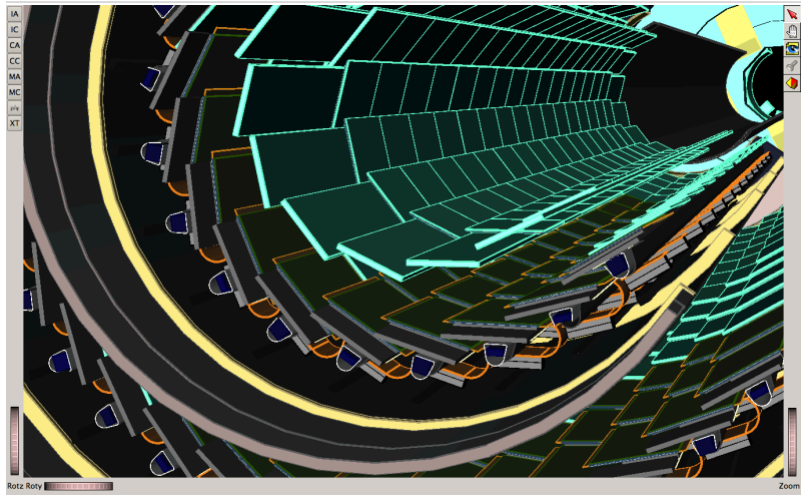
Tracking Geometry Ascii Files

```
                Trk::TrackingVolume  'InDet::Detectors::Pixel::Barrel'
                  - transform       : Translation : (0.000000, 0.000000, 0.000000)
                                      Rotation    : (1.00000000, 0.00000000, 0.00000000)
                                                    (0.00000000, 1.00000000, 0.00000000)
                                                    (0.00000000, 0.00000000, 1.00000000)
                - listing Trk::BoundarySurface objects :
Trk::Surface object of type 2
  - transform       : Translation : (0.000000, 0.000000, -447.774440)
                      Rotation    : (1.00000000, 0.00000000, 0.00000000)
                                    (0.00000000, 1.00000000, 0.00000000)
                                    (0.00000000, 0.00000000, 1.00000000)
```

TrackingVolume: Which detector::which part. E.g:: Pixel::Barrel
Tracking::Surface: type (shape), location and rotation of modules. E.g:: a module of IBL

```
Trk::Layer with LayerIndex 16
  - writing surface representation :
    Trk::Surface object of type 1
      - transform       : Translation : (0.000000, 0.000000, 0.000000)
                          Rotation    : (1.00000000, 0.00000000, 0.00000000)
                                        (0.00000000, 1.00000000, 0.00000000)
                                        (0.00000000, 0.00000000, 1.00000000)
  - contains 280 confined Trk::Surface objects.
  - listing Trk::Surface objects :
    Trk::Surface object of type 4
      - transform       : Translation : (-31.151655, -13.418575, -323.939896)
                          Rotation    : (0.11046642, -0.00076359, -0.99387956)
                                        (-0.99387647, 0.00252575, -0.11046801)
                                        (0.00259464, 0.99999652, -0.00047990)
```



Issues: difference in simulation and reconstruction

Geometry dumps - Last time

Example for InDet::Detectors::Pixel::Barrel Trk::Layer with LayerIndex 16 (IBL) first module in the list

Overlay with **2018 PbPb data** - simulation step:

```
Trk::Surface object of type 4
transform       : Translation : (-31.151995, -13.417471,  -323.944905)
                  Rotation    : (0.11046642, -0.00076189, -0.99387956)
                                (-0.99387646, 0.00252785, -0.11046802)
                                (0.00259655,  0.99999651, -0.00047798)
```

Overlay with **2018 PbPb data** - reconstruction step:

```
Trk::Surface object of type 4
transform       : Translation : (-31.151655, -13.418575,  -323.939896)
                  Rotation    : (0.11046642, -0.00076359, -0.99387956)
                                (-0.99387647, 0.00252575, -0.11046801)
                                (0.00259464,  0.99999652, -0.00047990)
```

https://indico.cern.ch/event/908155/

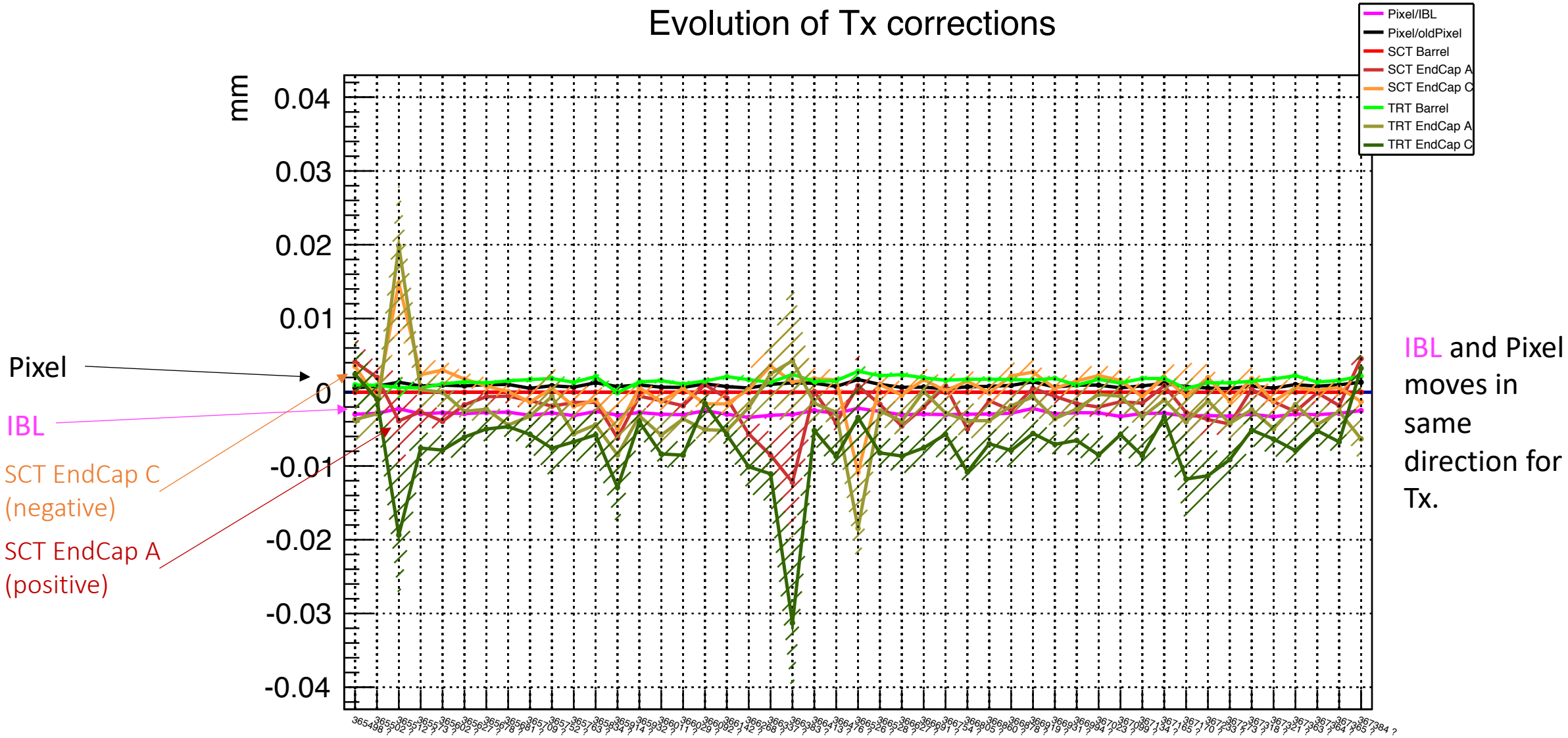
Diff:

```
transform       : Translation : (-0.00034   ,  0.001104,  -0.005009)
                  Rotation    : (0.0        , -0.0000017,  0.0       )
                                (0.00000001,  0.0000021, -0.00000001)
                                (0.00000191, -0.00000001,-0.00000192)
```

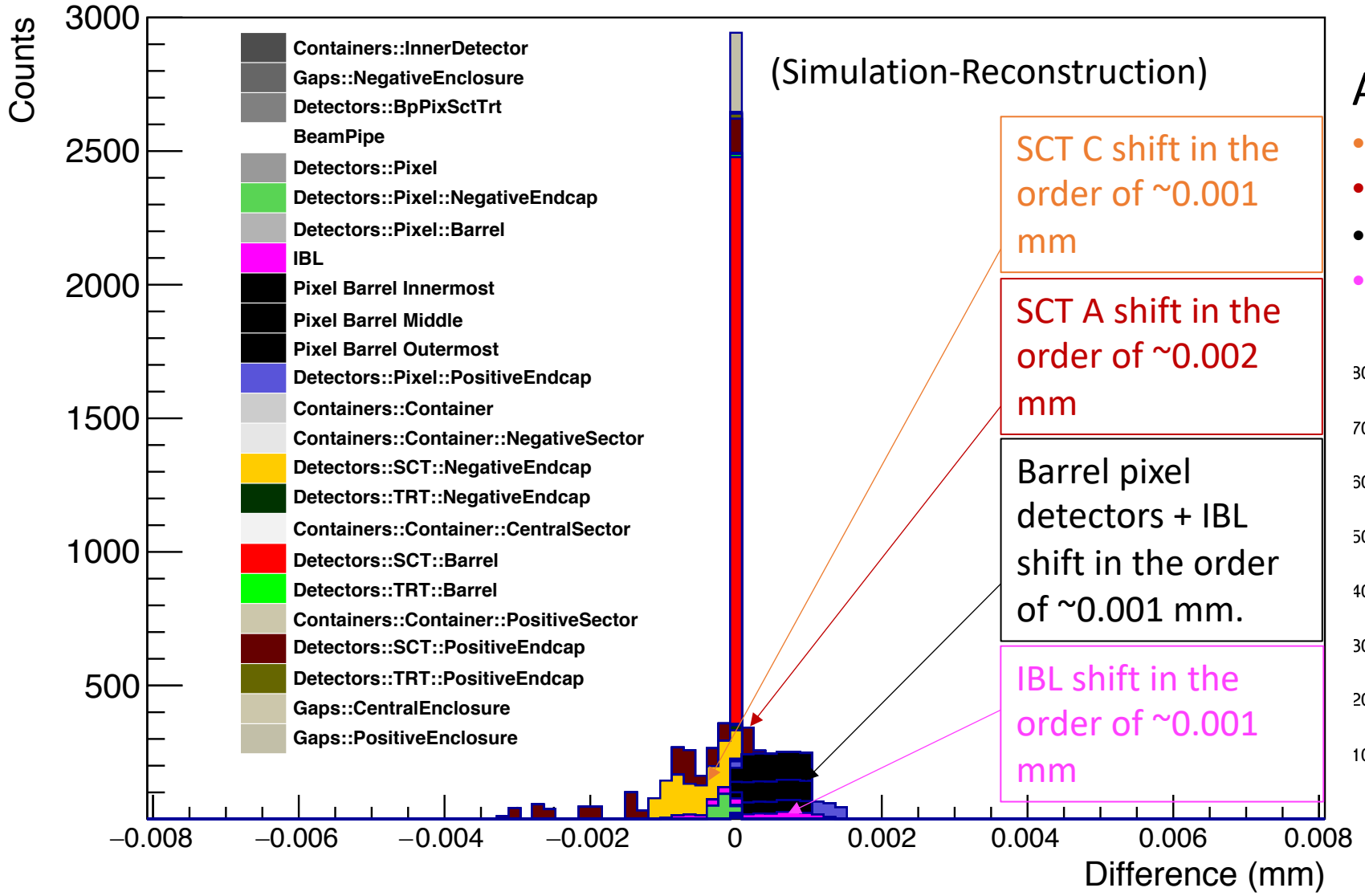
Sizable difference in x,y,z coordinates and in small difference in the angle!

- Compared x, y, z translation in 2018 overlay geometry files for run=366691 and lbn=296
  - With 2015 overlay geometry files
  - With alignments constants of ID
- Shown plots are made with simulation coordinate – reconstruction coordinate.

Change of Alignment Constants over Time for 2018 runs

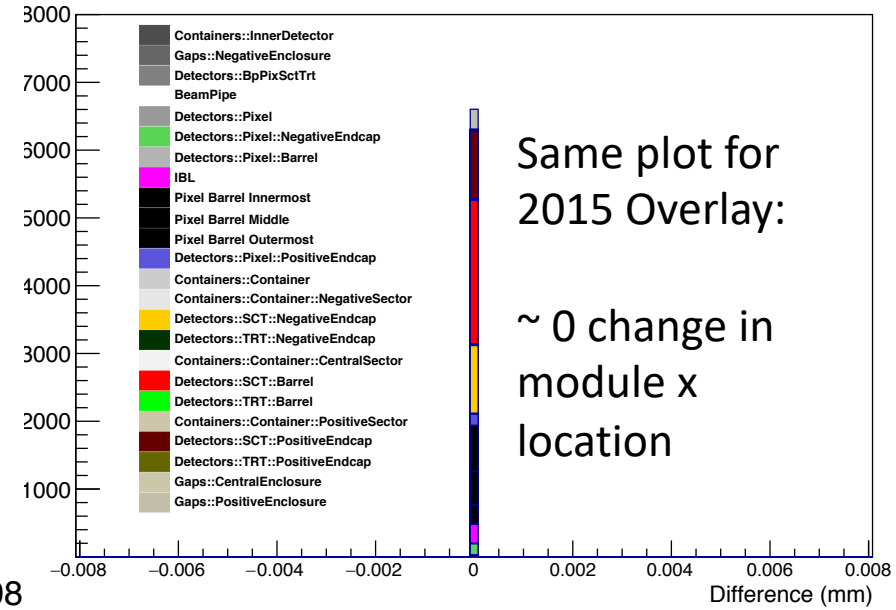


x for Comparing coordinates of modules from Simulation to Reconstruction in 2018



Alignment constants fluctuation:

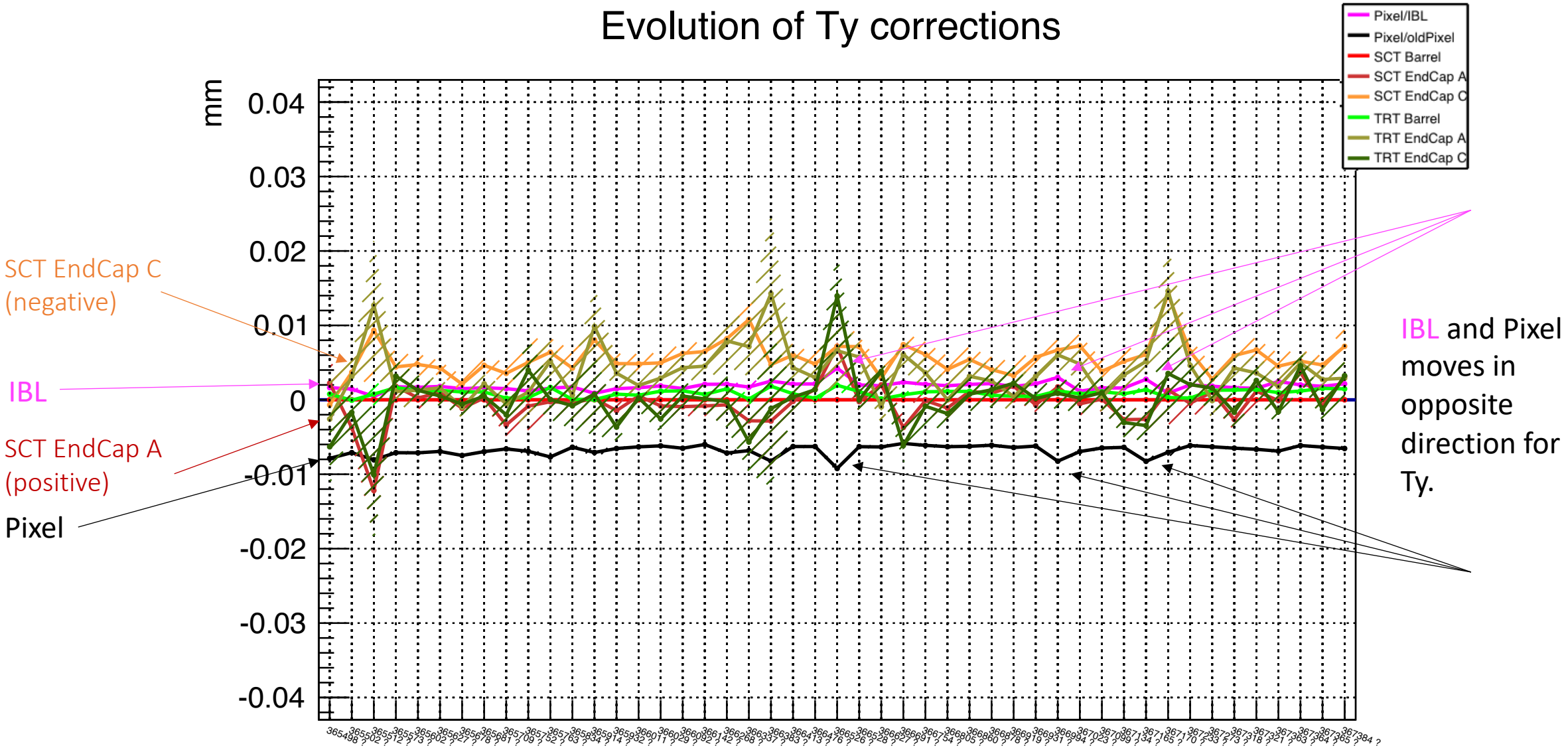
- SCT EndCap C: ~0.002 mm
- SCT EndCap A: ~0.005 mm
- Pixel: ~0.001 mm
- IBL: ~0.001 mm



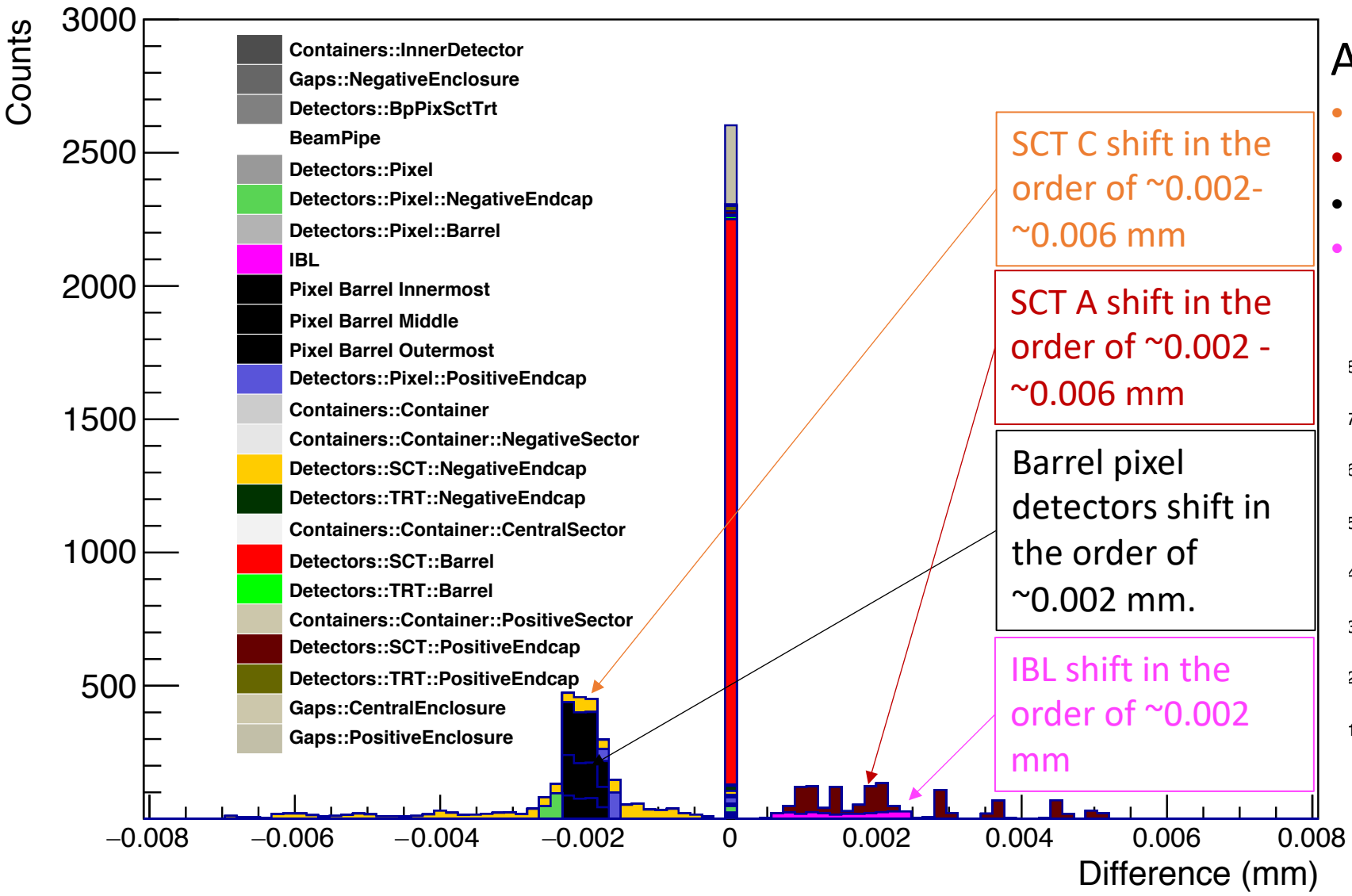
Same plot for 2015 Overlay:

~ 0 change in module x location

Change of Alignment Constants over Time for 2018 runs



y for Comparing coordinates of modules from Simulation to Reconstruction in 2018



SCT C shift in the order of ~0.002- ~0.006 mm

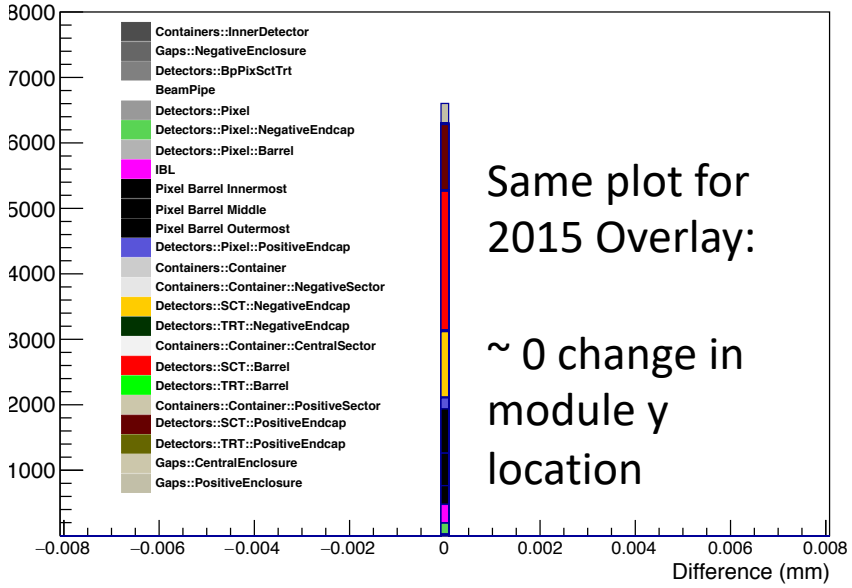
SCT A shift in the order of ~0.002 - ~0.006 mm

Barrel pixel detectors shift in the order of ~0.002 mm.

IBL shift in the order of ~0.002 mm

Alignment constants fluctuation:

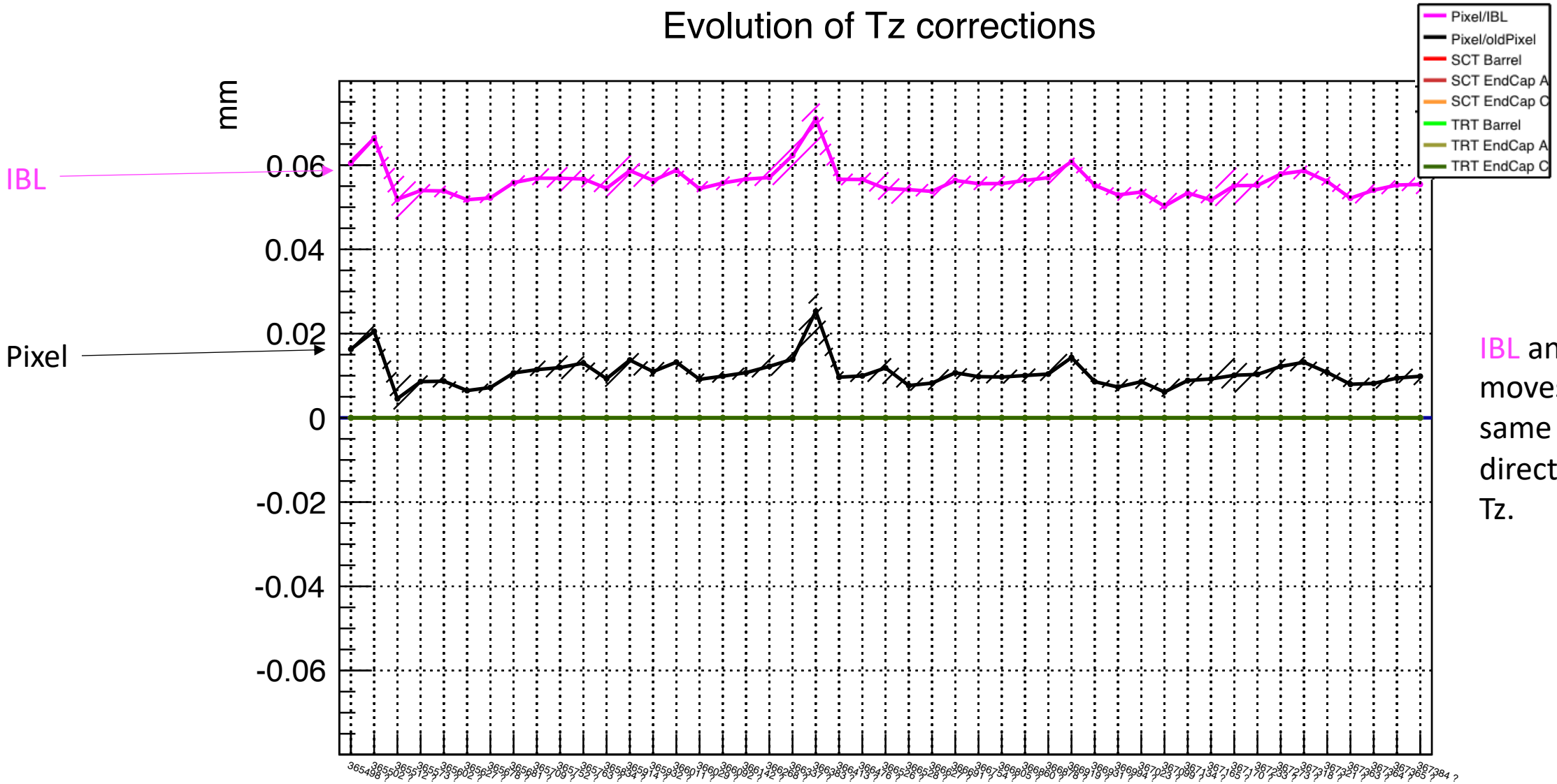
- SCT EndCap C: 0.004 mm
- SCT EndCap A: 0.002 mm
- Pixel: ~0.001- ~0.002 mm
- IBL: ~0.001 mm



Same plot for 2015 Overlay:

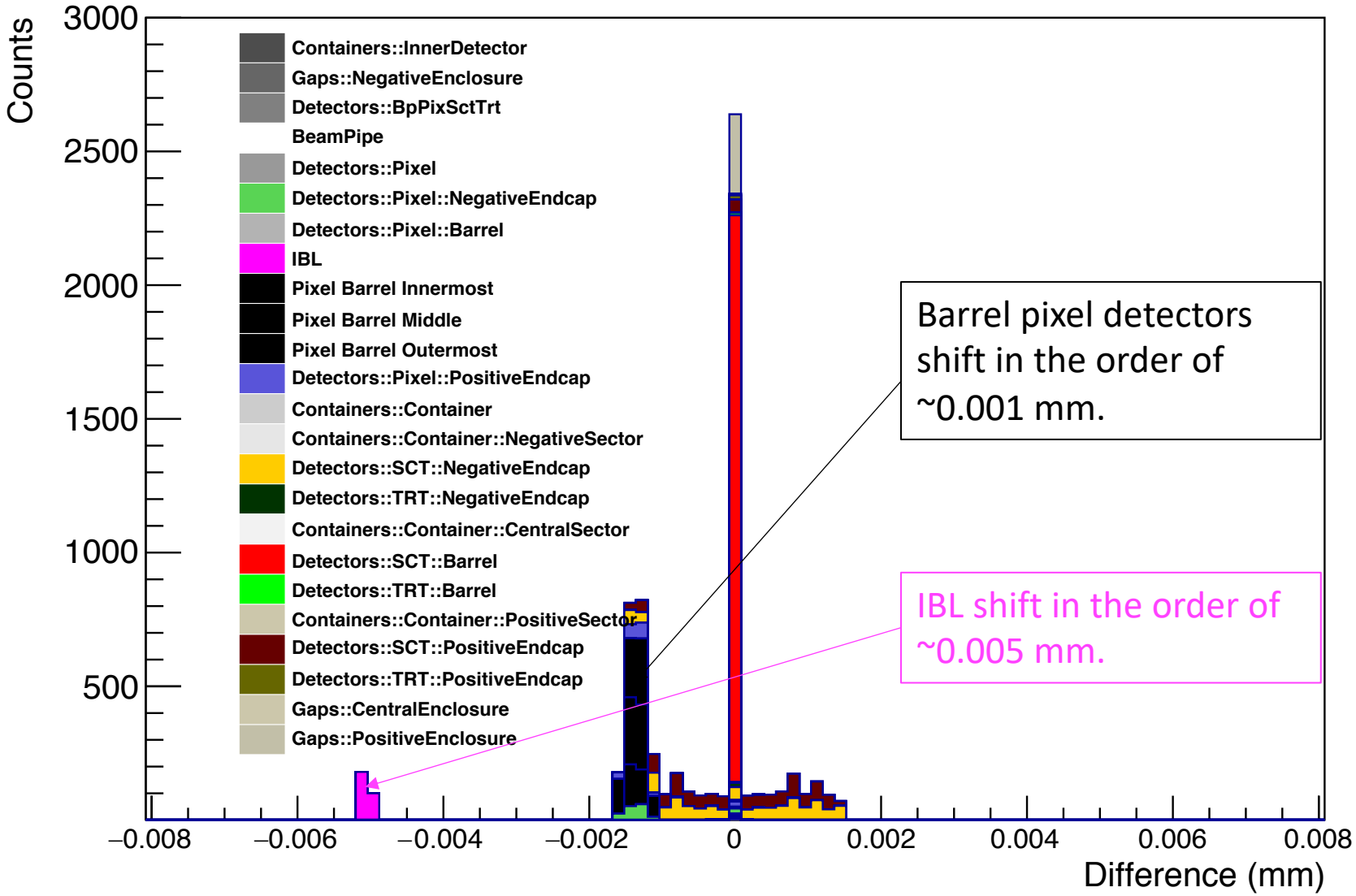
~ 0 change in module y location

Change of Alignment Constants over Time for 2018 runs



IBL and Pixel moves in same direction for Tz.

z for Comparing coordinates of modules from Simulation to Reconstruction in 2018

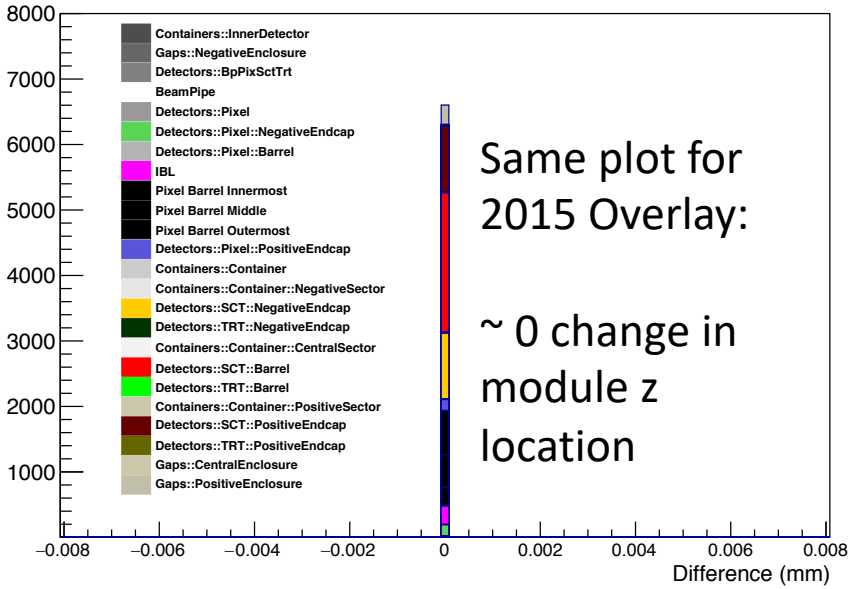


Barrel pixel detectors shift in the order of ~0.001 mm.

IBL shift in the order of ~0.005 mm.

Alignment constants fluctuation:

- Pixel: ~0.005mm
- IBL: ~0.005 mm



Same plot for 2015 Overlay:

~ 0 change in module z location

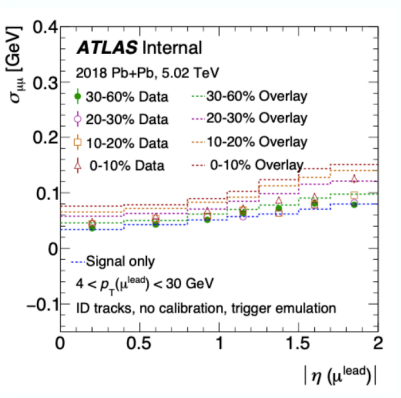
Summary

- X,Y,Z shifts are approximately on the same scale with alignment constants' fluctuation, and the direction of moving is consistent with alignment constants' curves.
  - It might come from using wrong alignment constant.
  - Question: why would IBL in z for this event has a much larger shift in comparison to other Barrel Pixel detector modules?

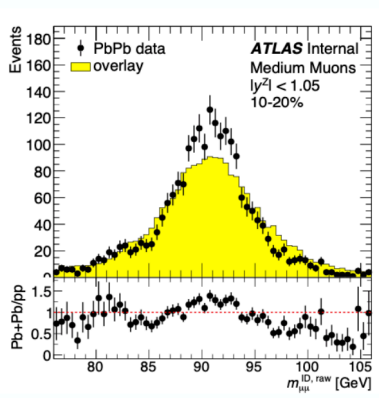
Back up

The problem (from ATLHI-299)

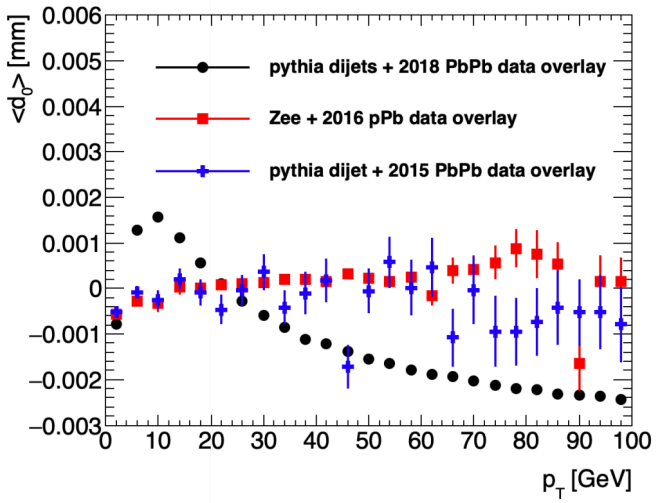
Samples with 2018 data overlay



J/ψ->$\mu\mu$ invariant mass resolution in data and Overlay using ID momentum



Z->$\mu\mu$ invariant mass resolution in data and Overlay using ID momentum



Looks like only 2018 data overlay samples are affected