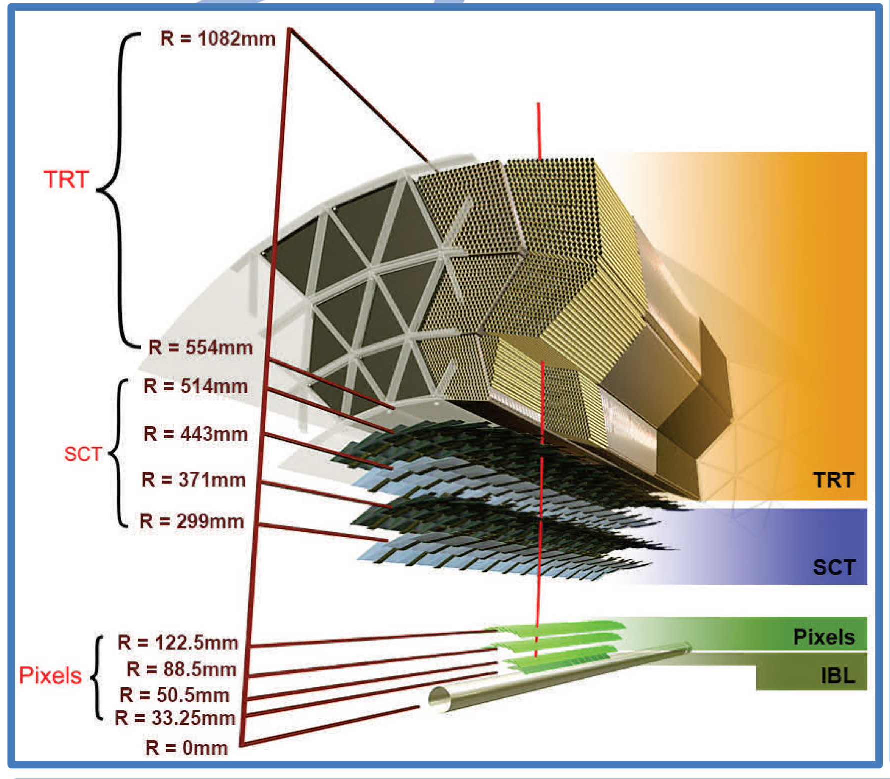
IFAE 2018, Milano - Poster Session

Updates On Long-term Alignment Monitoring and diagnostics for ATLAS ID misalignments



The ATLAS Inner Detector (ID)

The ID is the **innermost detector** of ATLAS.

- It is composed of **three sub-detectors.**
- It is immersed in a **2T solenoid magnetic field**.
- **Diameter**: 2.1 m
- **Length**: 6.2 m

Designed to provide:

- A robust **pattern** recognition.
- Excellent **momentum** resolution.
- **Vertex** measurements for charged particle tracks.

Starting from the inner layer, the sub-detectors are:

- The **Pixel** (including the innermost Insertable B-Layer or **IBL**).
- The **SCT** (Semiconductor Tracker).
- The **TRT** (Transition Radiation Tracker).

Detector	r (cm)	element size	resolution (X * Y)	hits/ track (average)	channels
Pixel	3-12.5	50 μm * 400 μm 50 μm * 250 μm (IBL)	10 μm * 115 μm	3 1 (IBL)	92x10^6
SCT	30-52	80 μm * 12 cm (stereo)	17 μm * 580 μm	4	6x10^6
TRT	56-107	4 mm * 74 cm	130 μm	30	0.4x10^6

ID alignment

Alignment is aimed to determining the **actual geometry** of the detector and to follow its eventual time changes.

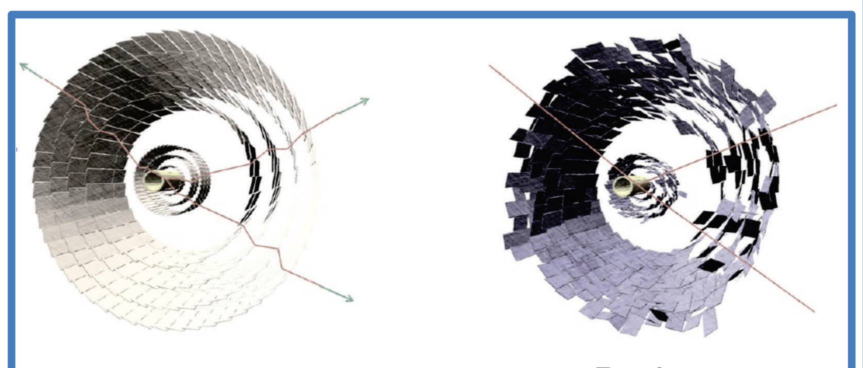
It must **maintain the quality** of the tracking **without creating biases**.

Track based alignment is based on **residual minimisation**.

The alignment proceeds **from large structures to module level** with increasing granularity.

There are three alignment levels:

- **L1**: SCT End Caps and barrel, Pixel;
- **L2**: SCT EC discs and barrel layers, Pixel EC discs and barrel layers;
- **L3**: SCT and Pixel modules.



Ideal geometry — Real geometry (enhanced distortions)

A prompt **calibration loop** is used to monitor the stability of ID during each run and to correct known instabilities.

It consists in two levels:

- **L11**: **IBL** alignment (translations, rotations and bowing) on the **whole run**;
- **L16**: **IBL** alignment (bowing) on **blocks of 100 LB.**

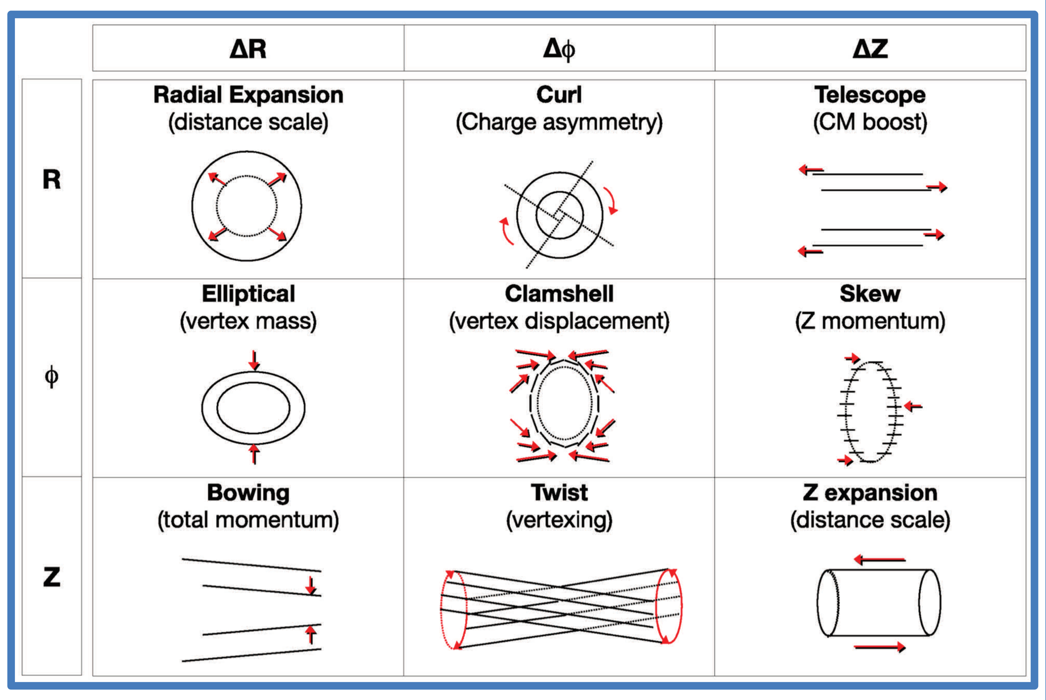
Weak Modes

There are distortions which leave the global χ^2 **almost unchanged**, because they preserve the helical shape of the track. These misalignments are called **weak modes.**

The methods currently used to monitor and constrain them are based on:

- **resonances** (Z,J/ψ,K_s);
- **external** detector **constrains** (E/p);
- **cosmic rays** tracks.

The results of these analysis can be used to update the prompt alignment and reprocessed data with new alignment constants.

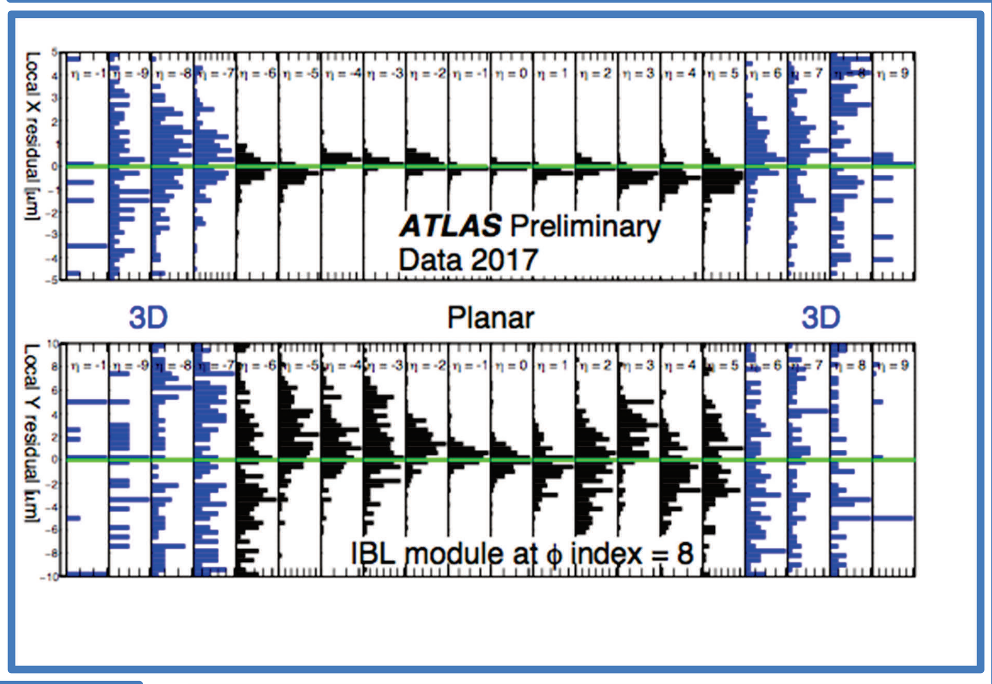


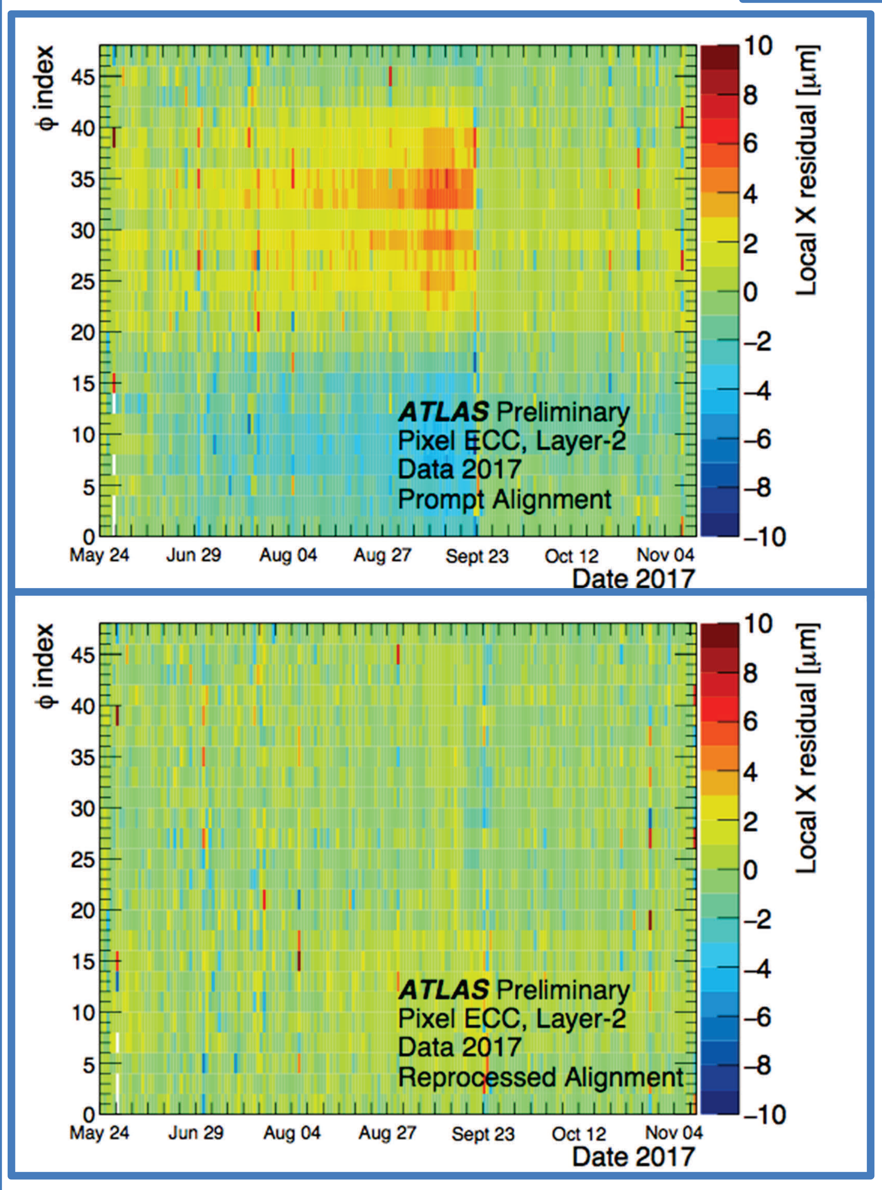
IBL residual monitoring

IBL residual monitoring is important since it **is not stable**[1].

- The instability (mainly due to the stave **bowing**) can be monitored from the **cumulative distribution** of the residuals.
- It gives an overview of the **detector stability** and **alignment efficiency**.

The plot is filled with an entry for each run of 2017 data taking.





Residual time evolution monitoring

The **time evolution** of the residual can be displayed as a function of the run, to show **time-dependent behaviour** of the detector.

- This approach was used to follow up the behaviour of **pixel End Cap C** during 2017.
- The problem was contained using the alignment constants from the same **reference run.**
- It has been **completely solved** in the data reprocessing campaign performed at the end of the data taking.

Future CL upgrades

The issues of the Pixel End Cap C in 2017 lead the group to investigate the possibility to **insert Pixel EC alignment in L16** of the CL.

Studies of the response of the alignment to the modification are ongoing.

Z^0 as diagnostics for weak modes

The general idea is to monitor the $Z\to\mu^+\mu^-$ characteristics, such as **the mass and the mass resolution**, to reveal the possible weak mode distortions as a function of the (η,Φ) position. Two **markers** have been designed for this purpose:

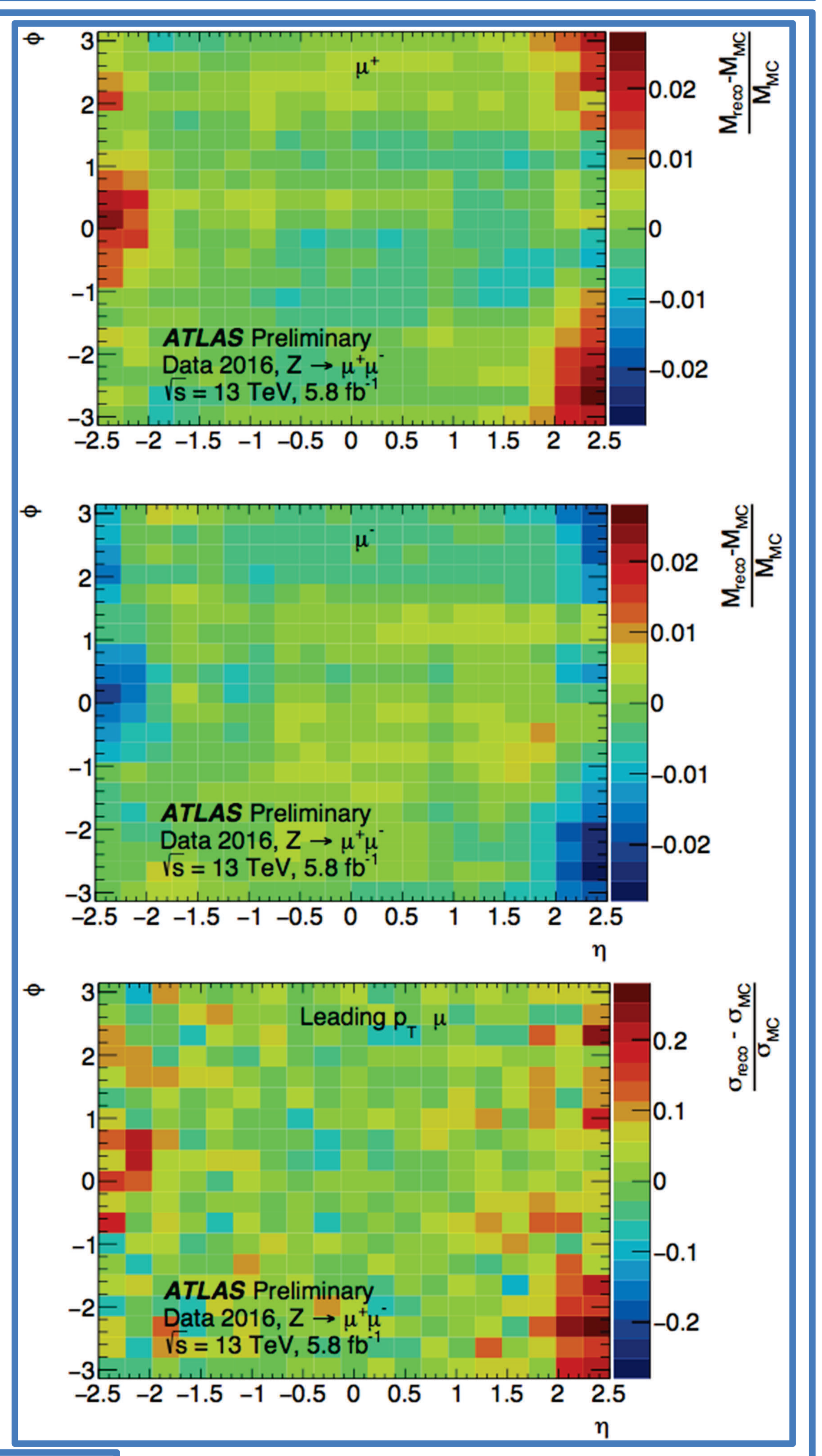
- $\dfrac{M_{reco}-M_{MC}}{M_{MC}}$;
- $\dfrac{\sigma_{reco}-\sigma_{MC}}{\sigma_{MC}}$.

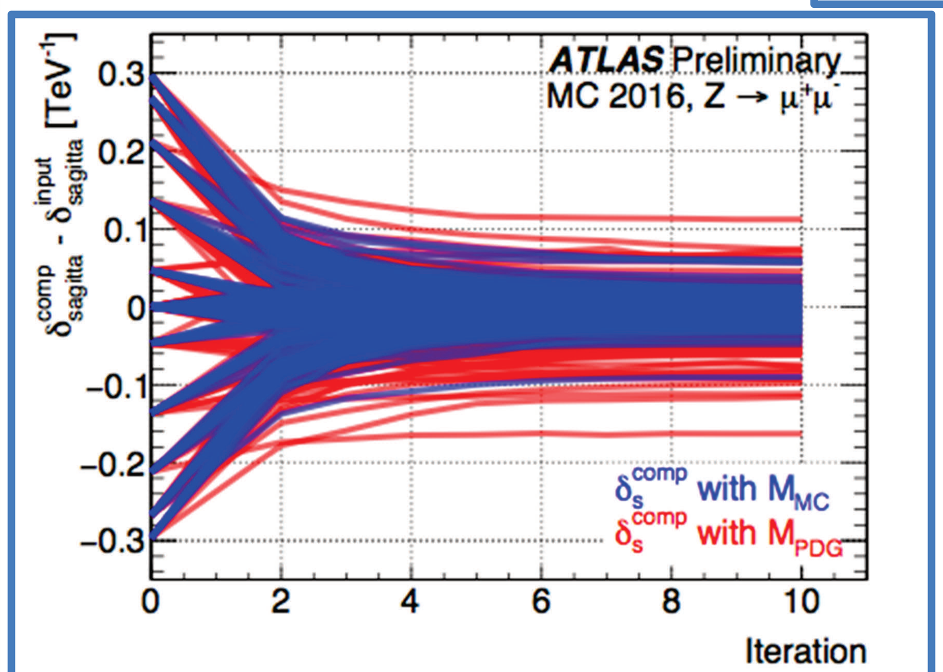
where M_{reco} and σ_{reco} are estimated by using Data 2016 with prompt alignment, while M_{MC} and σ_{MC} are form simulated events with perfect aligned detector geometry.

From the plots can be seen that Data 2016 have a **sagitta bias**, which affects the pT reconstruction.

The sagitta bias is calculated with the following formula:

$$\frac{m_{d\mu\mu}^2-m_{0\mu\mu}^2}{m_{d\mu\mu}^2}=(p_{Td}^{+}\delta_s^{+}-p_{Td}^{-}\delta_s^{-})$$





To improve our correction for a sagitta distortion, an **input sagitta bias map** was introduced to modify an MC sample.

The convergence over 10 iterations is checked comparing two methods:

- **using** M_{PDG} to compute the sagitta correction;
- **using** M_{MC} from a perfectly aligned MC sample.

Future upgrades

The usage of these new histograms and of the MC mass may be an **option for ID DQ monitoring.**

References

[1] ATL-INDET-PUB-2015-001

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ATLAS EXPERIMENT