CMS tracker performance in Run3

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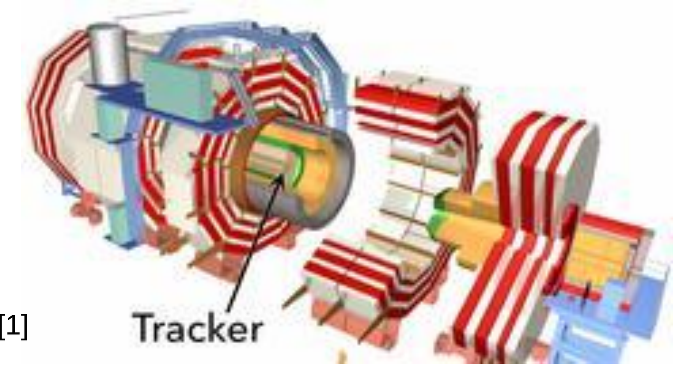
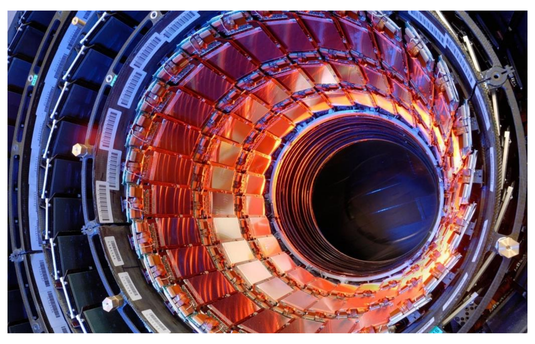
on behalf of the CMS Collaboration

The CMS Tracker
Largest fully silicon-based detector



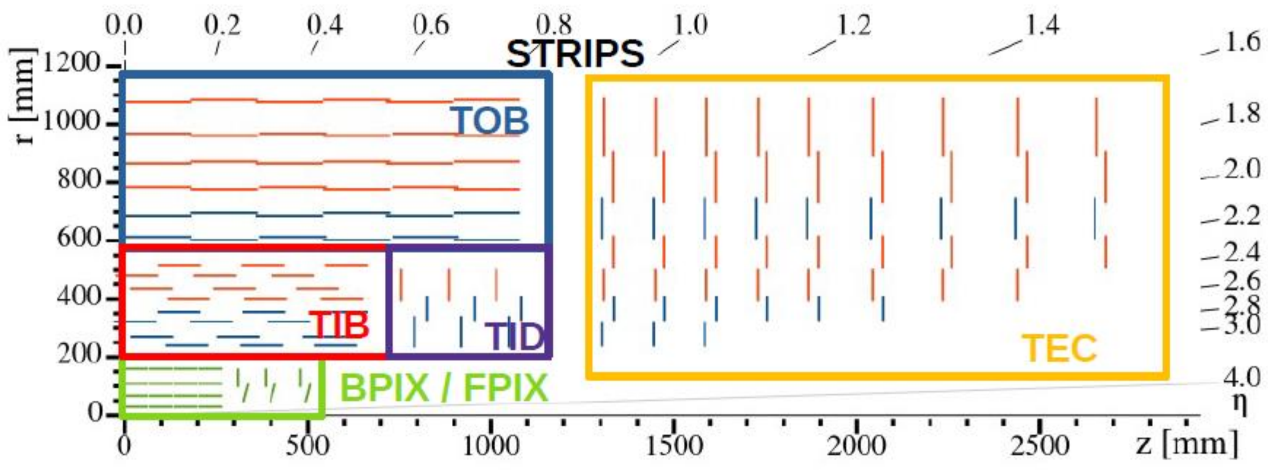
[1]



[2]

Innermost CMS detector, with more than 17000 detector modules in two subsystems:

- **The pixel detector** closest to the interaction point, 1856 modules in 4 cylindrical barrel layers (**BPIX**) and 3 pairs of endcap discs (**FPIX**)
- **The strip detectors** 15148 modules. Four subsystems: Tracker Inner Barrel (**TIB**), Tracker inner Disk (**TID**),Tracker Outer Barrel (**TOB**), Tracker Endcap (**TEC**)



[3]

Final countdown to LHC Run 3
Pixel detector Phase-1 refurbishment

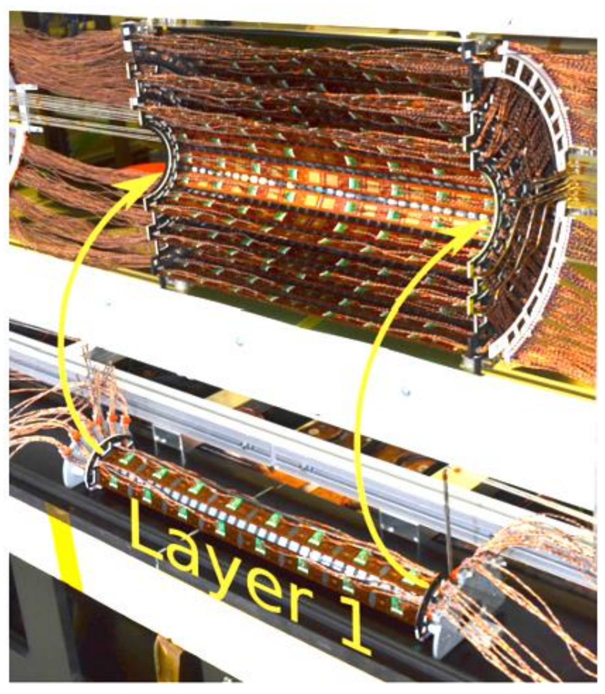
A series of improvements and repairs carried out to improve the quality of the collected data and to enhance the Pixel detector performance

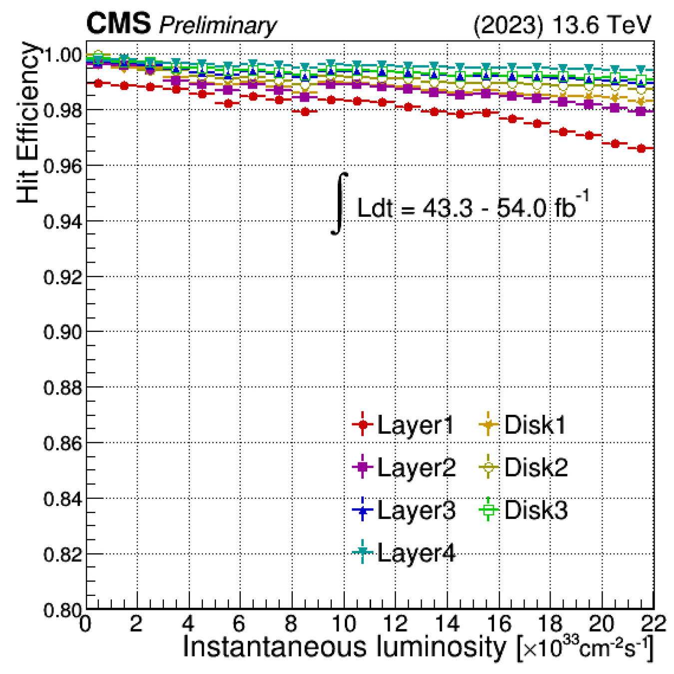
Innermost barrel pixel layer replaced in 2021, featuring:

- New modules and improved front-end readout chips
- Components with increased HV tolerance up to 800V (450V in Run 2)
- Complete readout chain designed to cope with a particle hit rate up to $600\ MHz/cm^2$

Repairs to individual module's and system-level issues in other layers/disks

[3]

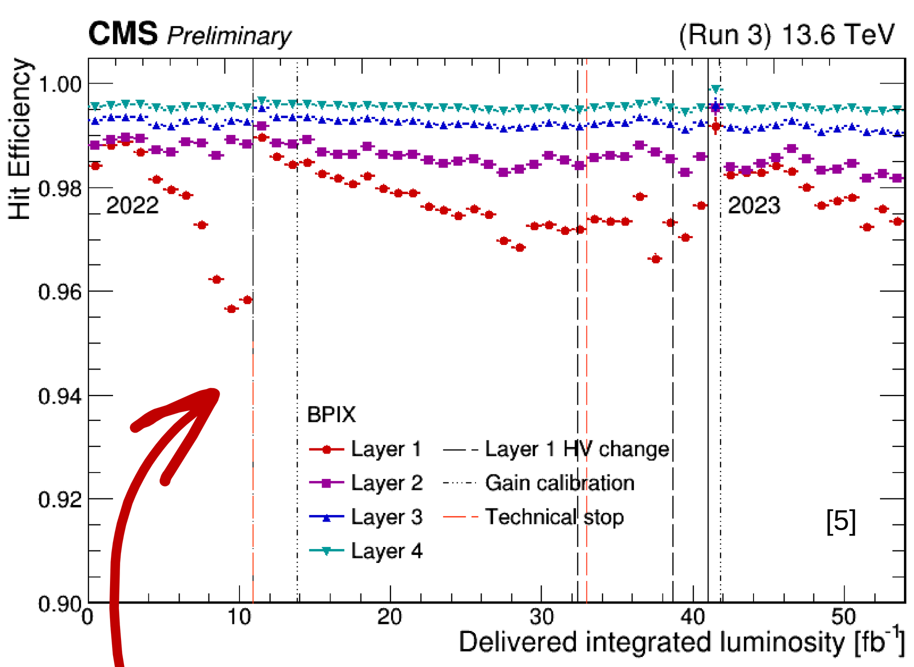


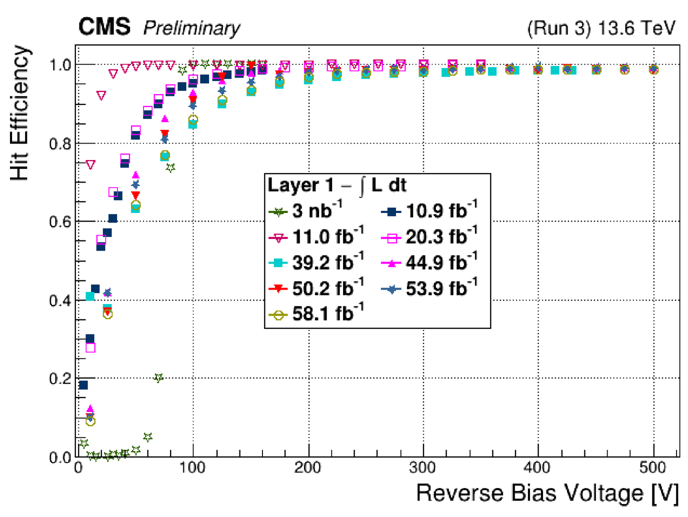


[5]

An extreme environment!
Pixel detector performance

The pixel detector is the closest to the interaction point. Therefore, it's exposed to high radiation doses and hit rates, particularly affecting the **innermost layer**

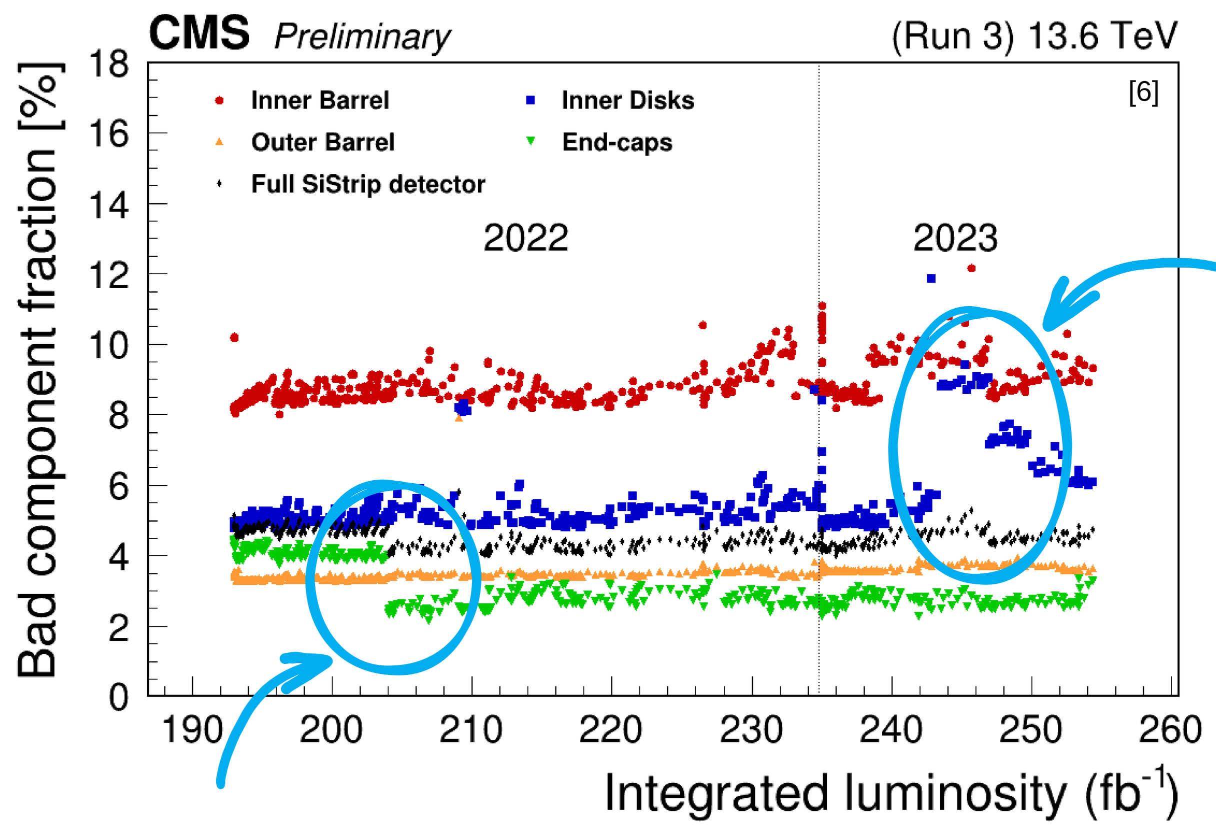




Visible degradation on hit-efficiency

Compensation by increasing reverse bias voltage and continuous calibrations

Strips stability



Other than **these**, rather stable trend during Run3, with a fraction of active channels of about 96%

No major issues affecting data quality

Tracker Alignment

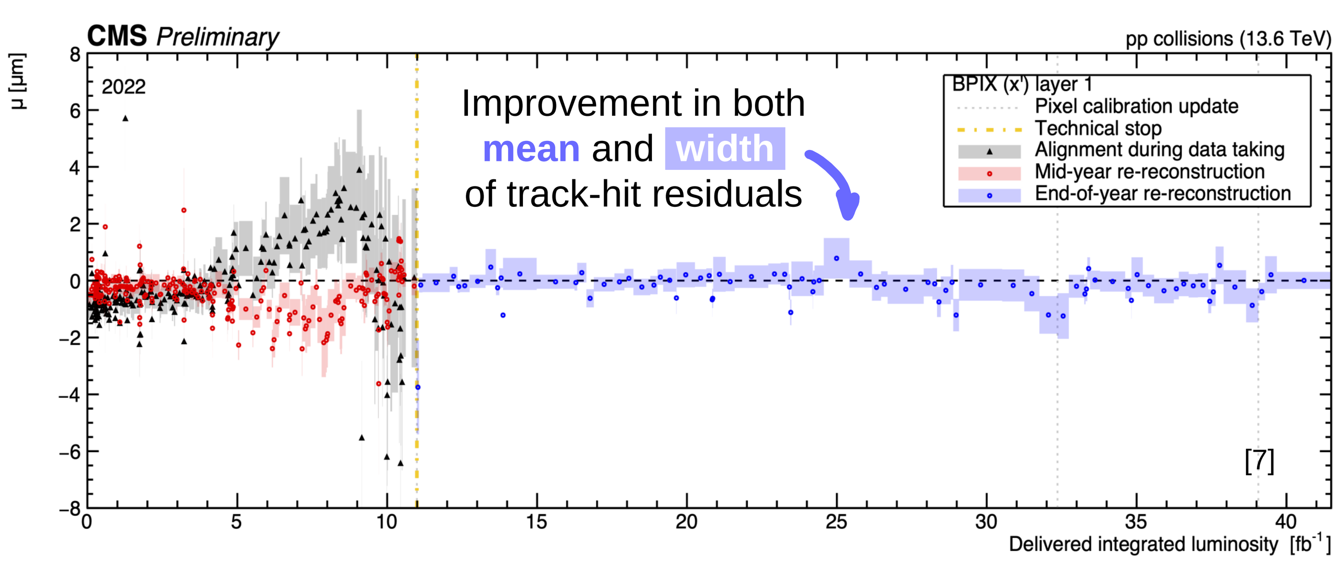
CMS's excelled hit resolution $\sigma_{hit} \approx 10\ \mu m$ but the mechanical alignment precision $\sigma_{align} \approx 100\ \mu m$

$\sigma_{align} \gg \sigma_{hit} \rightarrow$ *limited performance!*

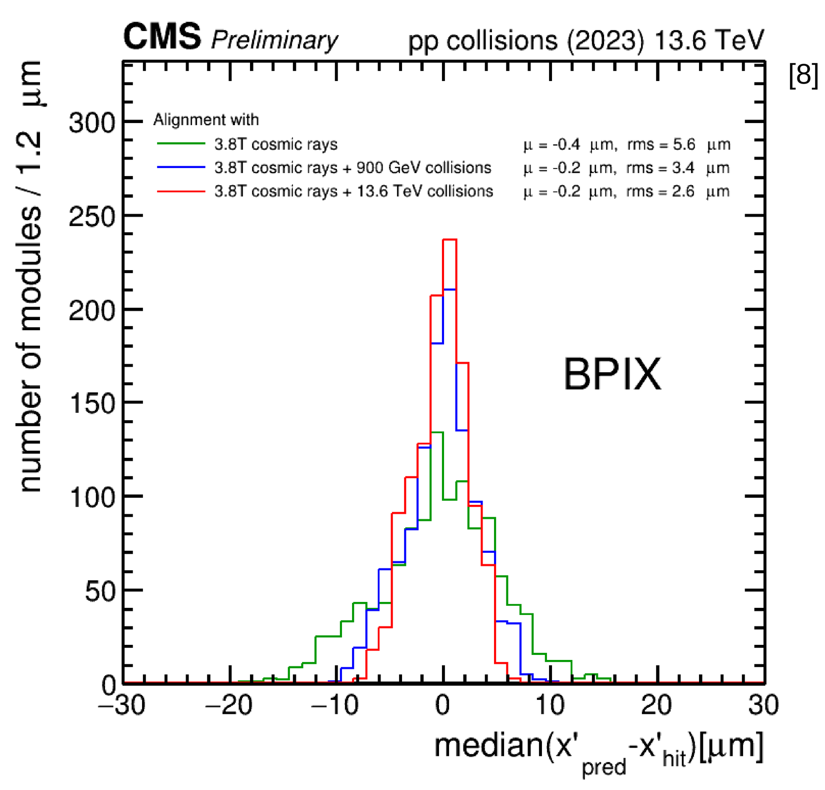
$\sigma_{align} \approx \sigma_{hit} \rightarrow$ *tracker alignment goal*

$\mathcal{O}(100k)$ alignment parameters derived minimizing sum of squares of track-hit residuals

- Regular movements expected from magnet cycles, cooling, irradiation ...
- Automated alignment running online at the Prompt Calibration loop
- Regular offline refinement with more statistics and higher granularity



New automated alignment with increased granularity ⇒ improved alignment already during data taking



Alignment improved iteratively during 2023

Summary

- The CMS tracker system plays a crucial role in data-taking
- Successfully operating during Run 3 at high pile-up (peak PU ~ 62)
- Continuous efforts carried out to guarantee optimal performance
- We look forward to continue taking high quality data

THIS POSTER

[1] https://cms.desy.de/activities/detector_upgrade/phase_2_outer_tracker/
[2] https://cms.cern/detector/identifying-tracks
[3] CMS collaboration, CERN-LHCC-2017-009 ; CMS-TDR-014
[4] CMS collaboration, 2022 JINST 17 C09017
[5] CMS collaboration, CMS DP -2023/041
[6] CMS collaboration, CMS DP -2023/040
[7] CMS collaboration, CMS DP -2022/070
[8] CMS collaboration, CMS DP -2023/039

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