ALICE Inner Tracking System performance in the initial stage of Run 3

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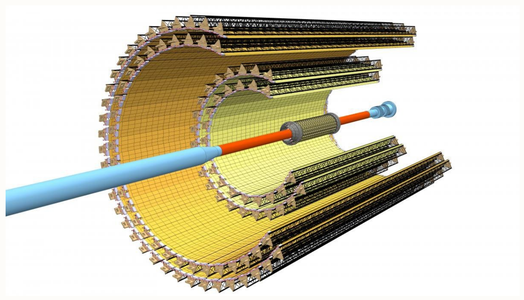
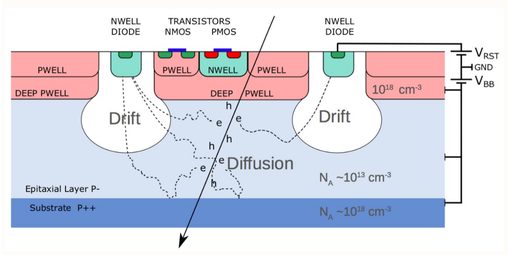
ALICE Inner Tracking System for Run 3:

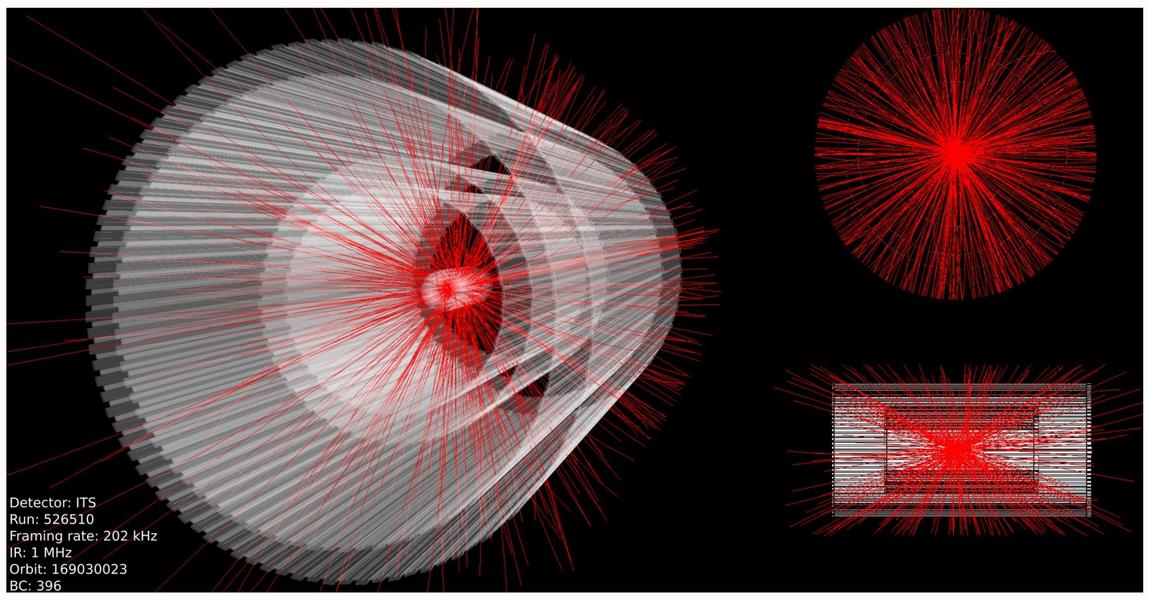


- 7 layers of ALPIDE MAPS
- Radial position of L0: 24 mm
- 10 m^2 active silicon area
- 12.5 × 10^9 pixels
- Low material budget:
  - 0.35 % X_0/layer Inner Barrel (IB)
  - 1 % X_0/layer Outer Barrel (OB)

Monolithic Active Pixel Sensor ALPIDE:

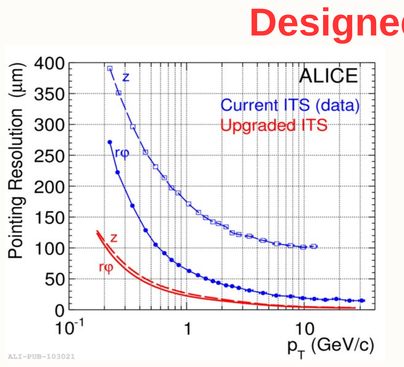


- 180 nm CMOS TowerJazz imaging process
- Pixel pitch 29 µm × 27 µm
- Power consumption < 40 mW cm^{-2}
- Fake-hit rate (FHR) < **10^{-6}** /hits/pixel/event (10^{-8} nominal)
- Radiation load for the IB (10× safety factor)
  - **T**otal **I**onizing **D**ose: 270 krad
  - **N**on **I**onizing **E**nergy **L**osses ~ 1.7·10^{13} 1MeV n_{eq} cm^{-2}

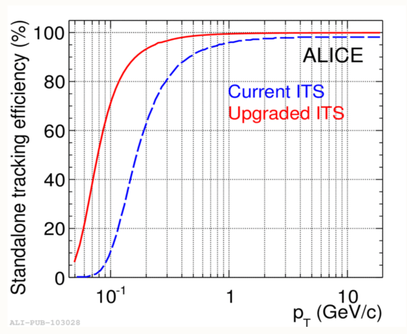


ALICE ITS event display for pp collisions at 14 TeV during Run 3

Designed performance of ITS2:

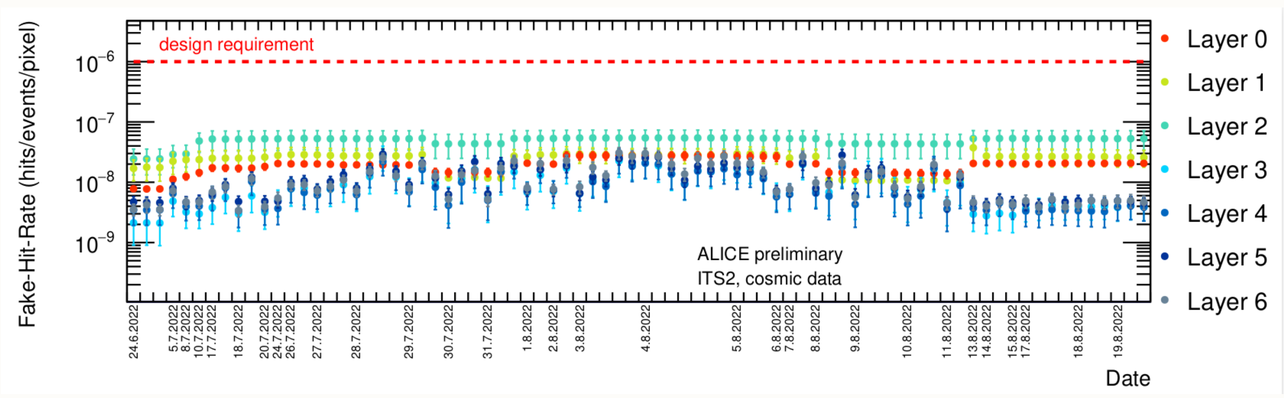


Improvement in position resolution:
- 6 times in *z* direction for p_T < 1 GeV/*c*
- 3 times in *rφ* direction for p_T < 1 GeV/*c*



ITS standalone tracking efficiency will be significanly increased below p_T < 1 GeV/*c*

Run 3 Performance



ITS2 Average FHR time trend for various ITS layers during cosmic runs longer than 30 minutes. FHR is below the project goals and stable over time. Small fluctuations in FHR can be explained by single noisy pixels, which can disappear after power cycles.

ITS Commissioning

General timeline of the upgrade:

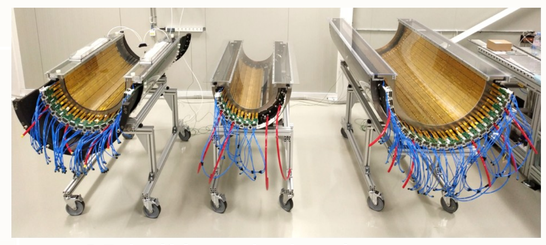
May 2019: Start of the ITS commissioning in clean room:
- Threshold scans
- Tests of noise performance
- Temperature and current control
- Cosmic runs data recording

January 2021: Start of the ITS installation in the ALICE cavern

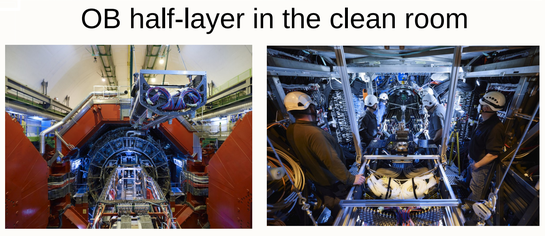
July 2021: Global commissioning

October 2021: Pilot beam test

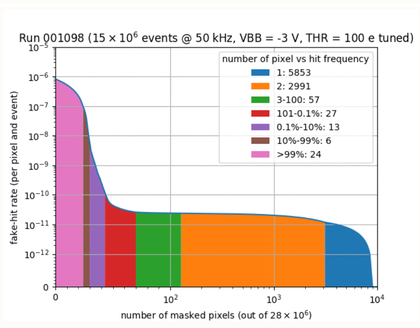
July 2022: Start of the Run 3



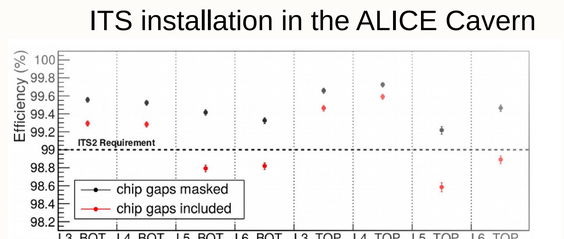
OB half-layer in the clean room



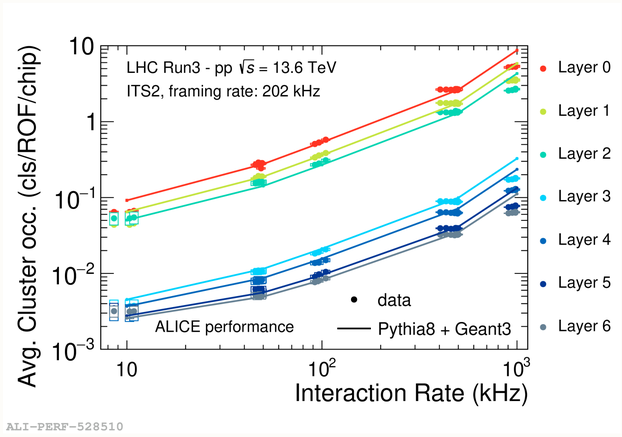
ITS installation in the ALICE Cavern



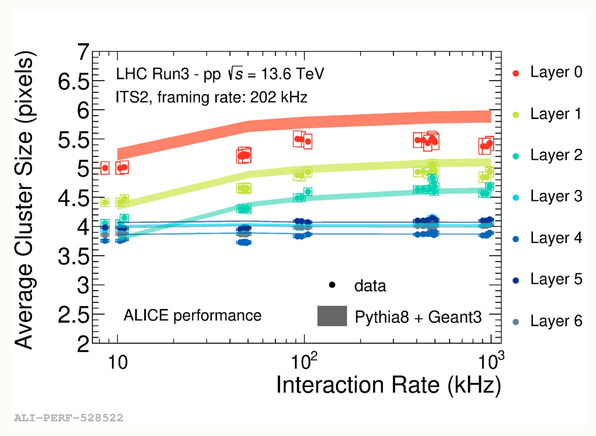
FHR ~ 10^{-10} /hits/pixel/event after masking out noisy pixels



OB tracking efficiency during comissioning for cosmic data



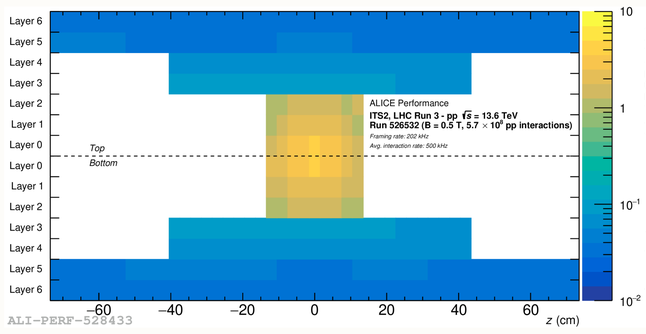
ITS2 cluster occupancy shows a linear increase with the rise of interaction rate.

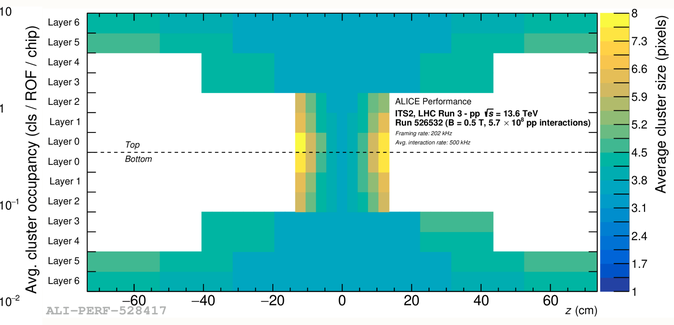


ITS2 cluster size for all layers almost inpedendent of the interaction rate.

Quality Control

QC provides a quick automatic quality assessment of data recording and primary reconstruction





Both average cluster size and occupancy values are uniform for top and bottom sides of the detector. IB demonstrates higher occupancy and cluster size values due to its closer location to the interaction point. Cluster size variation within one layer can be explained by larger inclination track angles.

QC comprises 8 independent modules:

1) **Fake-hit rate**: level of FHR and detector occupancy
2) **Front-End Electronics**: status of the detector readout
3) **Clusters**: various information about clusterization
4) **Tracks**: quality of the ITS tracking
5) **Calibration**: visualization of the detector calibration
6) **Decoding error**: errors in decoding raw data
7) **Noise Pixel**: online information about noise pixels
8) **Tracking Efficiency**: MC tool to study ITS tracking

Conclusion

- On-surface ITS commissioning showed detector stability and successfully confirmed compliance with the upgrade project goals.
- ITS2 was fully installed in the ALICE cavern.
- ITS2 performance was verified in pilot beams and with cosmic rays.
- ITS2 demonstrated good performance for pp collisions of the max centre-of-mass energy and high interaction rate.

Acknowledgment:

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