

Expected tracking and related performance with the future ATLAS Inner Tracker at the HL-LHC

Yassine El Ghazali on behalf of the ATLAS collaboration

Faculty of sciences, Ibn-Tofail university, Kenitra ICHEP 2022, Bologna, Italy

Abstract

To extend the potential of discoveries for new physics beyond the Standard Model as well as precision measurements, the High Luminosity (HL) phase of the large hadron collider at CERN aims to deliver an integrated luminosity of up to 4000 fb⁻¹. To face the challenging environment associated with the high number of interaction, the current ATLAS Inner Detector (ID) will be replaced with a new all-silicon Inner Tracker (ITk) which will cover up to $|\eta| < 4$. This poster presents results of the expected tracking performance as well as some representative high-level object reconstruction and identification, including primary vertices, jet flavour-tagging, electrons, and converted photons using an updated layout of the ITk pixel detector.

Future ATLAS Inner Tracker

- The HL-LHC is expected to deliver an integrated luminosity up to 4000^{-1}
- Accompanied with a challenging environment, with up to 200 interactions per bunch crossing
- In order to meet the tracking performance required by ATLAS physics program, the current Inner Detector (ID) will be replaced by a new all-silicon Inner Tracker(ITk), made of 2 subdetectors
- **Pixel Detector** (up to $|\eta| = 4$) with 4 modules in barrel and 6 disks in end-cap
- -Strip Detector (up to $|\eta| = 2.7$) with 5 modules in barrel and several vertical ring-shaped modules in end-cap

Primary vertex reconstruction and identification









Tracks are reconstructed by forming charged clusters from individual readout channels with a hit for the Strip and Pixel Detectors, respectively.

• Simulated samples of muons and $t\bar{t}$ are used to evaluate the tracking efficiency

- muon tracking efficiency is comparable with Run 2 for $|\eta| < 2.4$
- $t\bar{t}$ tracking efficiency is within 5% to the one in Run 2 in central region
- ITk is more efficient for $|\eta| > 2$



Vertex reconstruction efficiency of the ITK with new algorithm for fitting tracks outperforms Run 2
Robust Reconstruction + Selection Efficiency even at highest pileup density

Electrons and Photons

Central electrons $|\eta| \le 2.5$



Forward electrons $2.5 < |\eta| < 4.0$



Jet flavour tagging



- Similar d_0 resolution is achieved for 2 GeV muons
- Using a smaller pixel pitch yields in an improvement of up to a factor 2 in z_0 resolution, and up to a factor 4 in d_0 resolution for 100 GeV muons
- Improvement in p_T resolution driven by the better strip resolution wrt to the current TRT

Up to 20% improvement in light-jet rejection with ITk for a 77% b-jet efficiency working point





Reference: ATL-PHYS-PUB-2021-024

Conclusion

• The ITk extends η coverage to 4 (2.5 for the current ATLAS ID)

• The ITk is foreseen to provide same or better performance with respect to Run 2

• Optimized algorithms are expected to bring additional gain in performance