Environment aware track reconstruction using ACTS

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In the upcoming phase of the ATLAS experiment's physics program, a significant upgrade is planned as a part of the High Luminosity LHC (HL-LHC) operations. In this upgrade, the inner detector of the ATLAS experiment will be replaced with the Inner Tracker (ITk), an all-silicon inner detector that is designed to cope with the increased number of collisions per bunch crossing (pile-up), data rates and radiation levels of the HL-LHC. (Gonella 2023) Additionally, as part of the Phase-2 ATLAS upgrade track reconstruction preparation, the integration of the High-Granularity Timing Detector (HGTD) into the inner tracking system will take place. HGTD will be installed in front of the end-cap calorimeters to help in charged-particle assignment to vertices and luminosity measurement by introducing two double-sided silicon sensor layers per end-cap to provide precision timing information with a resolution at 30-70 ps per track (Jia 2024). The new detector configuration is being implemented into existing ATLAS software framework, Athena, and to A Common Tracking Software, ACTS (Ai et al. 2021), for the upcoming phase of data taking.

ACTS (A Common Tracking Software) is an experiment-independent toolkit for charged particle track reconstruction in high-energy physics experiments, implemented in modern C++. The ACTS project offers high-level track reconstruction modules that can be applied to any tracking detector, with an optimized geometry description for efficient navigation and rapid track extrapolation. Over recent years, the ACTS track reconstruction software has matured within the ATLAS experiment, notably with vertex reconstruction being deployed in the Run-3 phase of ATLAS. As part of the Run-4 upgrade, integrating the HGTD into ACTS is essential. In the first part of this talk, the preliminary work conducted in implementing HGTD sensors into ACTS and complementarily, into Athena will be presented.

One of the track reconstruction algorithms, Large Radius Tracking (LRT), is a specialized tuning of charged particle track reconstruction algorithms, designed for particles originating far from the main interaction point and it has been integrated into the ATLAS experiment's primary particle reconstruction workflow as of Run-3. The commissioning of LRT in Run-4 is crucial, particularly for the BSM physics program, that includes studies on long-lived particles. In the second part of this talk, the work made on the necessary adaptation and optimization of LRT within the Athena framework will be presented. The effectiveness of LRT, strongly linked to both physics and computing performance, is also examined in this study.

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