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Triggering for high-multiplicity events in pp collisions in ATLAS

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Conducting inclusive studies by the ATLAS experiment requires collecting maximally unbiased collision samples. The signature of such a collision is the presence of charged particles tracked down to a very low transverse momentum. In addition, the sample of events with high track multiplicity needs to be enriched in pp and p+Pb collisions. In the case of pp collisions, the trigger needs to be robust to select high multiplicity collisions with high purity despite not insignificant pileup. The ATLAS trigger system consists of hardware L1 and software HLT systems. The former is incapable of initiating detector readout based on the presence of reconstructed track. Instead, it provides indications of a signal in Minimum Bias Trigger Scintillators, summed energy deposit in calorimeters, or simply random events that are used to direct the events to further analysis by the HLT. The HLT in turn is capable of reconstructing tracks.
Both systems underwent an upgrade during the LHC Long Shutdown 2. In particular, the HLT software was rewritten to be multi-threaded and thus better use modern hardware. The functionality of the inclusive trigger needed to be restored.
Given that the HLT resources are limited, the sequence of selection consists of several fine-tuned steps that need modernization and adaptations. Among various triggers the selection of high multiplicity events is particularly demanding due to the high computational cost of performing tracks reconstruction online. To mitigate that, a ZFinder algorithm for finding an approximation of the collision vertices without reconstructing charged particle tracks was developed. The ZFinder uses extrapolations of approximate helix segments through multiplets of space-points from the tracking detectors. Along with the vertex position an estimate of multiplicity is obtained and can be used for triggering on high multiplicity events in pp and p+Pb.

The performance studies; efficiency, purity, and pileup robustness of the ZFinder algorithm for the high-multiplicity pp collisions will be presented in the poster.

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