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Novel real-time alignment and calibration and track reconstruction for the upgrade at the LHCb detector.

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LHCb has introduced a novel real-time detector alignment and calibration strategy for LHC Run 2. Data collected at the start of the fill is processed in a few minutes and used to update the alignment, while the calibration constants are evaluated for each run. This procedure will improve the quality of the online alignment. Critically, this new real-time alignment and calibration procedure allows identical constants to be used in the online and offline reconstruction, thus improving the correlation between triggered and offline selected events. This offers the opportunity to optimise the event selection in the trigger by applying stronger constraints. The required computing time constraints are met thanks to a new dedicated framework using the multi-core farm infrastructure for the trigger. This combined to the improved tracking sequence allows to run in the software trigger the same reconstruction with the same performance as offline. Specific challenges of this novel configuration are discussed, as well as the working procedures of the framework and its performance.

A similar scheme is planned to be used in the LHCb upgrade foreseen for 2020. At that time LHCb will run at an instantaneous luminosity of $2 \times 10^{33} \text{ cm}^{-2} \text{ s}^{-1}$ with a fully software based trigger with a read-out of the detector at a rate of 40 MHz. A full new tracking system is being developed: a vertex detector based on silicon pixel sensors, a new silicon micro-strip detector with a high granularity and the scintillating fibre tracker. The new tighter time constraint in the trigger, where only about 13ms are available per event, combined with a higher luminosity by a factor 5 represent a big challenge for the tracking. A new track finding strategy has been considered and new algorithms, partly based on GPUs, and using SIMD instructions are under study.

We will present the new strategy and the new fast track reconstruction, including the performance and the highlights of the improvements with respect to the current tracking system of LHCb.

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