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## The LHCb trigger system and its upgrade

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The current LHCb trigger system consists of a hardware level, which reduces the LHC inelastic collision rate of 30 MHz to 1 MHz, at which the entire detector is read out. In a second level, implemented in a farm of 20k parallel-processing CPUs, the event rate is reduced to about 5 kHz. We review the performance of the LHCb trigger system during Run I of the LHC. Special attention is given to the use of multivariate analyses in the High Level Trigger. The major bottleneck for hadronic decays is the hardware trigger. LHCb plans a major upgrade of the detector and DAQ system in the LHC shutdown of 2018, enabling a purely software based trigger to process the full 30 MHz of inelastic collisions delivered by the LHC. We demonstrate that the planned architecture will be able to meet this challenge. We discuss the use of disk space in the trigger farm to buffer events while performing run-by-run detector calibrations, and the way this real time calibration and subsequent full event reconstruction will allow LHCb to deploy offline quality multivariate selections from the earliest stages of the trigger system. We discuss the cost-effectiveness of such a software-based approach with respect to alternatives relying on custom electronics. We discuss the particular importance of multivariate selections in the context of a signal-dominated production environment, and report the expected efficiencies and signal yields per unit luminosity in several key physics benchmarks the LHCb upgrade.

### Collaboration

LHCb

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