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Architecture and evolution of the CMS High Level Trigger

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The CMS experiment has been designed with a 2-level trigger system: the Level 1 Trigger, implemented using FPGA and custom ASIC technology, and the High Level Trigger (HLT), implemented running a streamlined version of the CMS offline reconstruction software on a cluster of commercial rack-mounted computers, comprising thousands of CPUs.
The design of a software trigger system requires a tradeoff between the complexity of the algorithms running online, the output rate, and the selection efficiency. The complexity is limited by the available computing power, while the rate is constrained by the offline storage and processing capabilities. The main challenge faced during 2011 was the fine-tuning and optimisation of the algorithms, in order to cope with the increasing LHC luminosity without impacting the physics performance.

The flexibility of a single all-software trigger running on the full L1 output rate also allowed the introduction of different data "streams": in order to monitor the performance of the detector and the HLT itself, to collect dedicated data for the detector calibrations, and for special physics analysis.
Here we will present the architecture of the High Level Trigger, its operation and evolution.
We will outline the improvements introduced during 2011, such as particle-flow techniques, pile-up subtraction and rejection, and optimisation of the tracking algorithms, including their impact on the CPU-time of the HLT process. We will then discuss the improvements planned for the 2012 data taking.

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