

The Phase-2 Upgrade of the CMS Data Acquisition

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The High Luminosity LHC (HL-LHC), will start operating in 2027 after the third Long Shutdown (LS3), and is designed to provide an ultimate instantaneous luminosity of $7.5 \times 10^{34} \text{ cm}^{-2} \text{ s}^{-1}$, at the price of extreme pileup of up to 200 interactions per crossing. The number of overlapping interactions in HL-LHC collisions, their density, and the resulting intense radiation environment, warrant an almost complete upgrade of the CMS detector.

The upgraded CMS detector will be read out by approximately fifty thousand high-speed front-end optical links at an unprecedented data rate of up to 80 Tb/s, for an average expected total event size of approximately 7 – 10 MB.

Following the present established design, the CMS trigger and data acquisition system will continue to feature two trigger levels, with only one synchronous hardware-based Level-1 Trigger (L1), consisting of custom electronic boards and operating on dedicated data streams, and a second level, the High Level Trigger (HLT), using software algorithms running asynchronously on standard processors and making use of the full detector data to select events for offline storage and analysis.

The upgraded CMS data acquisition system will collect data fragments for Level-1 accepted events from the detector back-end modules at a rate up to 750 kHz, aggregate fragments corresponding to individual Level-1 accepts into events, and distribute them to the HLT processors where they will be filtered further. Events accepted by the HLT will be stored permanently at a rate of up to 7.5 kHz.

This paper describes the baseline design of the DAQ and HLT systems for the Phase-2 operation of CMS.

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