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Design studies for the Phase II upgrade of the CMS Barrel Electromagnetic Calorimeter (12' + 3')

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The High Luminosity LHC (HL-LHC) will provide unprecedented instantaneous and integrated luminosity. The lead tungstate crystals forming the barrel part of the Electromagnetic Calorimeter (ECAL) of the Compact Muon Solenoid (CMS) will still perform well, even after the expected integrated luminosity of 3000fb⁻¹ at the end of HL-LHC. The avalanche photodiodes (APDs) used to detect the scintillation light will also continue to be operational, although there will be some increase in noise due to radiation-induced dark currents. This will be mitigated by reducing the barrel operating temperature during HL-LHC running.

The front-end electronics of the ECAL barrel will be replaced, in order to remove existing constraints on trigger rate and latency and to provide additional capability to fully exploit the higher luminosity delivered by the HL-LHC. New developments in high-speed optical links will allow single-crystal readout at 40 MHz to upgraded off-detector processors, allowing maximum flexibility and enhanced triggering possibilities. Improved algorithms, currently being evaluated in Run II, are being developed to reduce the effects of out-of-time pileup on signal amplitude reconstruction.

The very-front-end system will also be upgraded, to provide improved rejection of anomalous signals in the APDs and to further mitigate the increases in APD noise and pileup. The potential to provide precise timing measurements for high energy signals (with a precision of approximately 20-30 ps) is being explored in the design of the new electronics. This should further mitigate the effects of large event pileup at HL-LHC, where around 200 interactions per 25ns bunch crossing are anticipated. The requirements of the new ECAL electronics will be reviewed and the status of design studies and evaluations of demonstrator systems will be provided. Finally, a summary of the expected performance of the upgraded detector during HL-LHC operation will be presented.

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