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Upgrade of the CMS Electromagnetic Calorimeter for High-Luminosity LHC

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The upcoming High Luminosity upgrade of the CERN LHC (HL-LHC) will provide detectors with unparalleled instantaneous and integrated luminosities. This improvement will be accompanied by an increase of the average number of proton-proton collisions per bunch crossing to a value of 200. To cope with these challenges, the CMS detector is undergoing an extensive Phase-2 upgrade program, including the improvement of the electromagnetic calorimeter (ECAL). While novel detectors will be installed in the endcap regions, the ECAL barrel's lead tungstate crystals and photodetectors will withstand the new conditions. Nevertheless, the entire readout and trigger electronics system will require replacement to meet the challenges posed by the HL-LHC environment and heightened trigger latency demands.

Each of the 61,200 ECAL barrel crystals will be equipped with two custom ASICs: one for signal amplification with two gains, the other an ADC with a sampling rate of 160 MHz and lossless data compression for transmitting channel data to off-detector electronics. Trigger primitive generation, facilitated by updated reconstruction algorithms, as well as a new data acquisition, will be executed on potent FPGA processor boards. This upgrade in ECAL electronics will serve to maintain the outstanding energy resolution and to significantly enhance the time resolution of electrons and photons above 30 GeV, down to a few tens of picoseconds.

This presentation will illustrate the design and current status of the individual components of the upgraded ECAL barrel detector, as well as the outcomes of energy and time resolution assessments conducted using a prototype full readout chain system during recent test beam campaigns at the CERN SPS. Additionally, it will outline the anticipated impact on several benchmark physics analyses within the CMS framework.

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