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The upgrade of the CMS Electromagnetic Calorimeter for HL-LHC

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Authors: talk to be given on behalf of the CMS collaboration

The High Luminosity upgrade of the Large Hadron Collider (HL-LHC) at CERN aims to achieve unprecedented levels of instantaneous and integrated luminosities, approximately $5 \times 10^3 4\,\mathrm{cm}^-2.\mathrm{s}-1$ and 3000 /fb, respectively. It is anticipated that each bunch-crossing will result in an average of 140 to 200 collisions (pileup). While the lead tungstate crystals and avalanche photodiodes (APDs) in the electromagnetic calorimeter (ECAL) of the Compact Muon Solenoid (CMS) in the barrel region will remain effective, the readout and trigger electronics will undergo complete replacement to keep the current level of performance.

A dual gain trans-impedance amplifier and an application-specific integrated circuit (ASIC) will be installed, providing two 160 MHz analog-to-digital converter (ADC) channels, gain selection, and data compression. The increase in noise within the APDs, due to radiation-induced dark current, will be alleviated by reducing the operating temperature of the ECAL. Additionally, the trigger primitive formation will be shifted away from the detector and handled by powerful and flexible field-programmable gate array (FPGA) processors.

The upgraded ECAL will significantly enhance the time resolution for photons and electrons with energies above 10 GeV. Furthermore, a new timing detector will be introduced, enabling measurements with a resolution of a few tens of picoseconds for minimum ionizing particles. As a result, even with 140-200 pileup interactions per event, the CMS detector will be capable of accurately reconstructing the primary interaction vertex.

During the presentation, the complete ECAL barrel readout chain de-

sign and the current state of research and development for each individual component will be discussed. The outcomes of recent test beam campaigns conducted at the CERN SPS, utilizing electron beams with energies of up to 250 GeV, will also be summarized. Notably, measurements pertaining to the energy and timing resolution performance of the latest prototypes of HL-LHC ECAL readout electronics will be presented.