Contribution ID: **12** Type: **not specified**

The CMS ECAL Upgrade for Precision Crystal Calorimetry and Timing at the HL-LHC

Wednesday, 16 January 2019 14:20 (20 minutes)

The electromagnetic calorimeter (ECAL) of the Compact Muon Solenoid Experiment (CMS) has been operating at the Large Hadron Collider (LHC) with proton-proton collisions at 13 TeV center-of-mass energy and a bunch spacing of 25 ns since 2015. Challenging running conditions for CMS are expected after the High-Luminosity upgrade of the LHC (HL-LHC). We review the design and R&D studies for the CMS ECAL barrel crystal calorimeter upgrade and present first test beam studies performed in the SPS H4 beam line. Particular challenges at the HL-LHC are the harsh radiation environment, the increasing data rates, and the extreme level of pile-up events, with up to 200 simultaneous proton-proton collisions. We present test beam results of the new readout and trigger electronics, which must be upgraded due to the increased trigger and latency requirements at the HL-LHC. In addition, particle detectors with a timing resolution of order 10 ps can tremendously improve event reconstruction at high luminosity hadron colliders. The CMS ECAL barrel upgrade will achieve a timing resolution of around 30 ps for high energy photons and electrons. The benefits of precision timing for the ECAL event reconstruction at HL-LHC will be discussed in this presentation. Simulation and test beam studies carried out for the timing upgrade of the CMS ECAL barrel will be presented, and the prospects for a full implementation of this option will be discussed.

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Session Classification: Analysis - Timing Detectors