Contribution ID: **103** Type: **not specified**

CMS ECAL techniques, calibration and performance towards run 3

Tuesday, November 8, 2022 12:30 PM (15 minutes)

Many physics analyses using the CMS detector at the LHC require accurate, high resolution electron and photon energy measurements. Excellent energy resolution is crucial for studies of Higgs boson decays with electromagnetic particles in the final state, as well as searches for very high mass resonances decaying to energetic photons or electrons. The CMS electromagnetic calorimeter (ECAL) is a fundamental component of these analyses, and its energy resolution is crucial for the Higgs boson mass measurement in the H->ZZ->4l and H->gg channels.

The energy response of the calorimeter has been precisely calibrated exploiting the full Run 2 (2015-18) dataset, and has been used for the legacy reprocessing of these data. A dedicated calibration of each detector channel has been performed. This talk will summarize the improved ECAL performance that has been achieved, and will describe how this impacts on the sensitivity of the Higgs mass measurement in the H->ZZ->4l and H->gg channels. The calibration plans currently being developed to achieve and maintain the optimum ECAL performance during LHC Run 3 (2022-25) will also be discussed. A new system has been developed to automatically execute the calibration workflows on a daily basis during data taking in Run 3. This new development aims to reduce the time needed to provide the best possible performance for physics analyses by one order of magnitude. The general structure of the system will be presented, along with results from the first year of operation in 2022.

Nearly all physics analyses at CMS rely on the precise reconstruction of particles from their signatures observed in the experiment's calorimeters. This involves both energy reconstruction, including the recovery of energy lost in gaps and cracks within the detector volumes, and particle identification. These tasks have traditionally been performed by classical algorithms and BDT regressions, both of which rely on human-engineered high-level quantities.

Bypassing human "feature engineering", and instead training deep learning algorithms on low-level signals, has the potential to recover lost information and improve the overall reconstruction performance. We have developed novel algorithms for particle reconstruction in the CMS calorimeters based on graph neural networks (GNNs) which allow us to represent the energy deposits recorded in the calorimeter directly in our models. We have also developed end-to-end mass regression techniques using convolutional neural networks (CNNs), that allow us to reconstruct merged photons from highly Lorentz-boosted decays, such as H->aa->4g, using low-level detector information.

In this work we will show the performance of our machine learning architectures in energy clustering, energy estimation and mass regression in the CMS Electromagnetic Calorimeter (ECAL). We will demonstrate the impact of these techniques in terms of improved energy resolution, significantly improved mass resolution for merged photon decays, and better resilience to effects such as detector gaps, early showering upstream of the calorimeter, and pileup, with respect to the previous state-of-the-art approaches.

Type of talk

Experimental measurements

Presenter: JAIN, Shilpi (Science and Technology Facilities Council STFC (GB))

Session Classification: Tuesday Session A

Track Classification: Physics Topics: Precision measurements