T 73: Calorimeters I

Time: Thursday 16:15–17:45 Location: KH 01.012

T 73.1 Thu 16:15 KH 01.012

Quality Control of Scintillator Tiles for the CMS Endcap High Granularity Upgrade — •Mohammed Adnan Ali — University of Hamburg, Mittelweg 177, 20148 Hamburg — Deutsches Elektronen-Synchrotron (DESY), Notkestr. 85, 22607 Hamburg, Germany)

Preparing the CMS detector for the High-Luminosity LHC (HL-LHC) requires major upgrades, including the installation of the High Granularity Calorimeter (HGCAL) to replace the existing endcap calorimeters. In its hadronic section, plastic scintillator tiles coupled with SiPMs are used in regions exposed to moderate radiation levels.

HGCAL achieves its fine spatial resolution through the use of approximately 280,000 scintillator tiles, with sizes ranging from 2 cm^2 to 30 cm^2; around 160,000 of these tiles will be wrapped and quality-controlled at DESY. Each tile is individually wrapped and integrated through an automated assembly procedure, and the detector design imposes strict mechanical tolerances on their final geometry.

In this talk, I will present the quality control strategy developed at DESY, which includes micron-level dimensional checks after wrapping as well as standardized measurements of the light-yield performance. These studies are essential to ensure uniform detector response and to meet the performance requirements of the HGCAL upgrade.

T 73.2 Thu 16:30 KH 01.012

Ensuring Quality of High Granularity Calorimeter Tileboards for the High-Luminosity upgrade of CMS — •Faruk Kurtulus — University of Hamburg Mittelweg 177, 20148 Hamburg, Germany — Deutsches Elektronen-Synchrotron (DESY) Notkestraße 85, 22607 Hamburg, Germany

The CMS experiment is preparing for an upgrade to operate in the harsh environment of the High-Luminosity Large Hadron Collider (HL-LHC). To function reliably under these conditions, CMS must replace its current end-cap calorimeters, which are already losing detection capability, with the High Granularity Calorimeter (HGCAL), designed to withstand the increased luminosity and pile-up of HL-LHC operation.

In the lower-radiation region of HGCAL, the SiPM-on-Tile technology is used, coupling Silicon Photo-Multipliers (SiPMs) to thin scintillator tiles. SiPMs are soldered onto a common PCB with readout electronics and later combined with scintillators to form a Tilemodule. Before scintillators are installed, the unit is referred to as a Tileboard. Each Tileboard hosts one or two readout chips providing readout for 72 channels. The detector will contain about 3800 Tileboards. Before Tilemodule assembly, a quality-control (QC) procedure is required to verify electrical functionality and readout stability.

This presentation will outline the QC procedure developed for Tileboard certification, including the sequence of tests and qualification criteria. Results from several hundred production boards will be shown, highlighting common issues and the overall readiness of Tileboards for the HGCAL upgrade.

T 73.3 Thu 16:45 KH 01.012

Changes and Upgrades for the ATLAS Liquid Argon Purity System — •Maximilian Linkert, Christopher Engel, and Stefan Tapprogge — Institut für Physik, Johannes Gutenberg-Universität, Mainz

With the high luminosity LHC and the Phase 2 upgrade of the ATLAS Detector the Liquid Argon Purity System faces new operational challenges. The purpose of the system is to measure possible contaminations of the liquid argon, hence calculating the impurity level. Therefore 30 devices with ionization chambers are distributed throughout the calorimeter. Due to upgrades of the low voltage power supply used to power the front end electronics the voltages will change from a positive and negative to a single positive line. Since the purity devices rely critically on the negative voltage, a modified version of the bPOL48V buck DCDC converter will be needed. Moreover the software has been updated to ensure proper operation in the future. The current status of the purity system, the DCDC converter and extended functionalities for the maintenance workflow will be presented.

T 73.4 Thu 17:00 KH 01.012

Shower Direction Reconstruction with the SHiP High-Granularity ECAL — •Sebastian Ritter, Volker Büscher, Rainer Wanke, Matei Climescu, and Claudia Delogu — Johannes-Gutenberg Universität, Mainz

The SHiP experiment at CERN targets the hidden sector by, among others, searching for neutral long-lived particles (LLPs) produced in a high-intensity beam dump. To reconstruct LLP decays into photons, the experiment requires a pointing electromagnetic calorimeter (ECAL). In this talk, test-beam results of the SHiP ECAL prototype are presented.

Using SPS electron beams in the 10*288 GeV range, we measure the transverse and longitudinal shower development to reconstruct the shower direction and extract the pointing resolution based on the calorimeter response and put it into perspective with the physics requirements. Comparisons with GEANT4 simulations are outlined.

We conclude with a status update on preparations for calorimeter construction in Mainz and the installation of the detector in the SHiP experiment at the upgraded beam dump facility.

T 73.5 Thu 17:15 KH 01.012

Processing of ATLAS Liquid Argon Calorimeter Signals by Convolutional Neural Networks and its Impact on Calorimeter Energy Reconstruction — •Manuel Gutsche, Markus Helbig, Arno Straessner, Johann Christoph Voigt, and Philipp Welle — Technische Universität Dresden

During the Phase-II upgrade of the ATLAS detector, over 500 high-performance FPGAs will be installed in the off-detector electronics of the Liquid Argon Calorimeter to cope with the increased luminosity and, therefore, pileup. Under these challenging conditions, the energies of the 182468 detector cells will be reconstructed by the FPGAs. Different methods are being considered. One possible approach is the implementation of 1-dimensional convolutional neural networks (CNNs), which are limited by resource constraints of the Intel Agilex-7 FPGAs to about 400 parameters.

A total of 23 dedicated CNNs are applied to account for differences between cells, mainly in terms of pulse shape and noise. This is achieved by grouping similar cells into clusters, and then training a model of fixed architecture on simulated data expected for a representative cell of each cluster.

These CNNs are integrated into the ATLAS simulation and analysis framework, Athena, in order to compare the performance of the energy reconstruction by CNNs with the current implementation based on an optimal filter. The impact of the two methods on the calculated cell energies, as well as on reconstructed physics objects, is studied.

T 73.6 Thu 17:30 KH 01.012

Fast Hadron Shower Simulation Methods with the CALICE AHCAL Prototype — •André Wilhahn and Stan Lai — Georg-August-Universität Göttingen, Göttingen, Germany

Extensive simulations of particle showers are crucial for high energy physics experiments. As many calorimeters are designed with increasing granularity, while having to cope with higher energy deposits and higher luminosity conditions, the accurate simulation of particle showers in a computationally efficient manner is of utmost importance. This talk describes investigations into a data-driven fast calorimeter simulation that is meant to describe particle showers accurately, without simulating every individual particle interaction with the calorimeter material.

We start by investigating pion showers in the CALICE AHCAL (Analogue Hadron Calorimeter) prototype, which is a highly granular hadronic calorimeter comprising a total of 38 active layers embedded in a stainless-steel absorber structure. Each active layer contains a grid of 24×24 scintillator tiles that are read out individually via silicon photomultipliers. Correlated hit energies have been simulated to obtain good modelling for kinematic shower variables with the help of kernel density estimators. The results and future plans for improving and expanding the fast calorimeter simulation will be discussed.