T 41: Calorimeters 1

Time: Tuesday 16:15–18:30 Location: T-H26

T 41.1 Tue 16:15 T-H26

Scintillator studies for the CALICE Analogue Hadronic Calorimeter and the DUNE ND-GAr Electromagnetic Calorimeter — Andrea Brogna[2], Peter Bernhard[2], Volker Büscher[1], Karl-Heinz Geib[1], Asma Hadef[1], •Antoine Laudrain[1], Lucia Masetti[1], Marisol Robles Manzano[1], Anna Rosmanitz[1], Christian Schmitt[1], Alfons Weber[1], and Quirin Weitzel[2] for the CALICE-D-Collaboration — [1]Institut für Physik, Johannes Gutenberg Universität, Mainz — [2]PRISMA Detector Lab, Johannes Gutenberg Universität, Mainz

The CALICE Analogue Hadronic Calorimeter (AHCal) is designed as an imaging calorimeter optimised for particle flow algorithms. It features a high granularity and timing resolution, with plastic scintillator active layers and SiPM readout. The concept of Megatile is developed to ease the assembly of a large scale detector, separating a large piece of scintillator with a glue + TiO_2 mixture and gluing a reflective sheet on both sides instead of individually wrapping smaller tiles in a reflective foil for each channel.

In the DUNE ND-GAr, neutron energy is reconstructed using the time-of-flight information provided by the Electromagnetic Calorimeter (ECal). The ECal must therefore provide neutron identification with high granularity and timing, making the AHCal with Megatiles a potential design candidate. Pulse shape discrimination is envisaged as a means to discriminate photon from neutron interaction in the ECal. A setup to study the PSD performance of various plastic scintillators with SiPM readout has been set up and first results will be presented.

T 41.2 Tue 16:30 T-H26

Exploring the intrinsic Time Resolution of the SiPM-on-Tile Technology — •Fabian Hummer, Lorenz Emberger, and Frank Simon for the CALICE-D-Collaboration — Max-Planck-Institut für Physik

The SiPM-on-Tile technology, where small plastic scintillator tiles are directly read out with SiPMs, has been developed for the CALICE Analog Hadron Calorimeter (AHCAL), and has been adopted for parts of the hadronic section of the CMS HGCAL. For future electron-positron colliders, a single cell time stamping on the sub-nanosecond level for energy deposits corresponding to single minimum-ionizing particles is desired to provide background rejection and to support pattern recognition and energy reconstruction with particle flow algorithms. To better understand the intrinsic time resolution achievable with the SiPM-on-Tile technology, detailed measurements have been performed in test beams at DESY, probing different scintillator tile sizes and materials. The study is complemented by laser measurements that provide insights into processes within the scintillator tile relevant for timing. Geant4 simulations allow us to verify our results and to find the correlations between scintillator tile size, light yield and time resolution. In this contribution, we will discuss our measurement methods, the results of our SiPM-on-Tile timing study and the implementation and performance in simulations.

T 41.3 Tue 16:45 T-H26

Latest Tests of CMS HGCAL Tilemodule Prototypes — •Malinda de Silva, Mathias Reinecke, Katja Krüger, Ole Bach, and Felix Sefkow — Deutsches Elektronen-Synchrotron (DESY), Hamburg, Germany

For the HL-LHC phase, the calorimeter endcap of the CMS detector will be upgraded with a High Granularity Calorimeter (HGCAL), a sampling calorimeter that will use silicon sensors as well as scintillator tiles read out by silicon photomultipliers (SiPMs) as active material (SiPM-on-tile). The complete HGCAL will be operated at −30 °C. The SiPMs will be used in areas where the expected radiation dose during the lifetime of the detector is up to 5×10^{13} n_{eq}/cm^2. The design of the SiPM-on-tile part is inspired by the CALICE AHCAL.

The basic detector unit in the SiPM-on-tile part is the tile module, consisting of a PCB with one or two HGCROC ASICs, reading out up to 96 tiles with SiPMs. To acquire the data as well as to send the fast and slow control commands, monitor temperature and voltages from the tile modules a dedicated DAQ system has been designed and implemented. This DAQ system was tested alongside the latest generation of tile modules at the October 2021 test beam at DESY as well as tests at −30 °C were conducted using a climate chamber. Results from these tests will be reported.

T 41.4 Tue 17:00 T-H26

Test beam results of the Megatile prototype for the CALICE AHCAL — •Anna Rosmanitz for the CALICE-D-Collaboration — Johannes Gutenberg-Universität Mainz

The CALICE collaboration is developing a highly granular Analog Hadronic Calorimeter (AHCAL) for a future e^+e^- linear collider.
The current design for the AHCAL consists of small, separately produced scintillator tiles with a size of 3x3 cm^2 read out by silicon photomultipliers (SiPM). They are separately wrapped in reflective foil and glued to the boards. In total, the AHCAL is going to consist of around 8 million tiles.
To facilitate the assembly process, a new mechanical design is currently under development. The new concept, called Megatile, is based on a larger scintillator plate, in which the optical separation is obtained via trenches filled with a glue and TiO_2 mixture for reflectivity and optical insulation. The Megatile is enclosed with reflective foil, the edges are covered with varnish.
This talk presents the performance in terms of light yield and cross talk of the latest megatile prototype, based on test beam data from recent campaigns at DESY.

T 41.5 Tue 17:15 T-H26

Timing analysis of testbeam data with the KLauS6 ASIC for a Silicon Photomultiplier on Scintillator Tile Setup — •Erik Warttmann for the CALICE-D-Collaboration — Kirchhoff-Institute for Physics, Heidelberg

The CALICE collaboration is developing highly-granular scintillator-based calorimeters with the need of sophisticated readout solutions. For this purpose, the KLauS ASIC has been developed. It is designed to dissipate very little power and features precise charge measurement optimized for low-gain SiPMs, covering their full dynamic range. Additionally, the sixth iteration of the chip provides timing information via a Phase-Locked-Loop (PLL) driven TDC with a bin size of 200 ps. The chip has been evaluated in a SiPM-on-Tile setup at the DESY test-beam facility, using an arrangement of four layers of scintillating tiles air-coupled to SiPMs. Various calibration measurements have been carried out to ensure precise charge and time measurements. The influence of multiple chip parameters on timing at the single MIP level has been investigated. To study the dependence of timing on the deposited energy, measurements with absorbers have been carried out. For the analysis of single MIP and absorber data, a stable and versatile timewalk correction has been implemented. We present the time measurement capabilities of KLauS6 using the SiPM-on-Tile arrangement, discuss the calibration routines and critical ASIC parameters. The results from single MIP runs and the absorber data regarding the time measurement are presented, which are comparable to the intrinsic resolution of the setup.

T 41.6 Tue 17:30 T-H26

Apply Computer Vision Algorithm to High Granularity Calorimetry — •Julian Utehs and Stan Lai for the CALICE-D-Collaboration — II. Institute of Physics, Georg-August-University Göttingen, Germany

In the course of the development of the new ILC detector, there is extensive research towards high granularity calorimeters. The CALICE collaboration has developed a prototype, the Analog Hadron Calorimeter, which uses SiPM technology to read out highly granular scintillator tiles. Test beam data provides unprecedented opportunities to investigate particle shower reconstruction with highly granular calorimetry.

This talk will concentrate on the opportunities of shower shapes analysis, that are given by the usage of well-known computer vision algorithms. These algorithms, coming from object detection and industry robotics and automation, will be applied on AHCAL calorimetry data. Their application allows for opportunities to reconstruct and resolve sub-shower activity and possibly estimate the electromagnetic fraction of hadronic showers. This can be input into energy reconstruction and particle identification techniques, and possible improvements for these are investigated.

T 41.7 Tue 17:45 T-H26

New shower direction reconstructing calorimeter — •Matei Climescu and Rainer Wanke — Johannes Gutenberg Universität Mainz

The so-called SplitCAL detector is a new design of a mixed electromagnetic-hadronic calorimeter which provides both energy reconstruction through layers of scintillating strips, read-out with wavelength shifting fibres and SiPMs, and shower direction information through high-precision layers. This can be used for fixed target experiments which require high geometrical precision and directional reconstruction of photon showers. The development needs to account for low rates but large dynamic range. The whole concept is presented with specific focus on the link of the scintillating fibres to the SiPMs and the readout.

T 41.8 Tue 18:00 T-H26

Convolutional Neural Networks for the Energy Reconstruction of ATLAS Liquid-Argon Calorimeter Signals — Anne-Sophie Berthold, Nick Fritzsche, •Christian Gutsche, Max Märker, Johann Christoph Voigt, and Arno Straessner — Institut für Kern- und Teilchenphysik, TU Dresden, Germany

In 2027, it is planned to start the High-Luminosity LHC, which will push the possibilities of research in particle physics with ATLAS to a new level. But since a higher trigger rate and more simultaneous collisions imply more pile-up the readout electronics of the detector will face a new challenge. The signal processing of the LAr Calorimeter is currently using an optimal filter algorithm which will reach its limits in performance with increasing overlapping signals. New approaches for energy-reconstruction are needed, and neural networks are promising candidates for such a task. While it is not hard to build a neural network which reconstructs energies reliably with a lot of trainable parameters, the problem is the limited availability of resources on the FPGAs which are foreseen for the digital signal processing.

In this talk, a possible solution for this task using convolutional neural networks (CNNs) will be presented. It will be shown how CNNs can be structured and trained in such a way that they will fit to the above-mentioned requirements. Special attention will be paid to the energy resolution for signals with a small temporal distance, having the pile-up at the HL-LHC in mind.

T 41.9 Tue 18:15 T-H26

ATLAS Liquid Argon Calorimeter Readiness for LHC Run 3 — •Tom Kresse, Arno Straessner, and Rainer Hentges — Institut für Kern- und Teilchenphysik, Dresden, Deutschland

Liquid argon (LAr) sampling calorimeters are employed by ATLAS for all electromagnetic calorimetry in the pseudo-rapidity region $|\eta| <$ 3.2, and for hadronic and forward calorimetry in the region from $|\eta| =$ 1.5 to $|\eta| = 4.9$. After detector consolidation during a long shutdown, LHC Run 2 started in 2015 and about 150fb-1 of data at a center-of-mass energy of 13 TeV was recorded. Phase-I detector upgrades began after the end of Run 2. New trigger readout electronics of the ATLAS LAr Calorimeter have been developed. Installation began at the start of the LHC shutdown in 2019 and is expected to be completed in 2021. A commissioning campaign is underway in order to realise the capabilities of the new, higher granularity and higher precision level-1 trigger hardware in Run 3 data taking. This contribution will give an overview of the new trigger readout commissioning, including the first data taken of the recommissioned LAr system in the October 2021 Pilot run, as well as its preparations for Run 3 detector operation.