T 80: Calorimeters

Time: Thursday 16:30–18:50 Location: H-1.003

Group Report T 80.1 Thu 16:30 H-1.003

A Highly Granular Electromagnetic Calorimeter Concept for the DUNE Near Detector — •Lorenz Emberger[1], Eldwan Brianne[2], and Frank Simon[1] — [1]Max-Planck-Institut für Physik — [2]DESY

The near detector (ND) of the Deep Underground Neutrino Experiment (DUNE) will play an important role in the search of CP violation in the neutrino sector. Additionally, as a standalone complex, it will be an excellent laboratory to study a wide range of neutrino interactions. The ND design study consists of three independent subdetectors, placed downstream of the neutrino production target. One of these detectors, a Multi Purpose Detector (MPD), consists of a high pressure gaseous Argon time projection chamber (TPC), surrounded by an electromagnetic calorimeter (ECAL) and a muon system. One key aspect of the ECAL is the reconstruction of neutral particles such as neutral pions and neutrons invisible in the TPC. We present a concept study of the MPD system featuring a highly granular electromagnetic calorimeter inspired by the SiPM-on-Tile technology developed by the CALICE collaboration. First studies of the reconstruction of neutral pions decaying into two photons inside the TPC will be covered. Additionally, we will touch on background studies carried out in the full MPD geometry.

T 80.2 Thu 16:50 H-1.003

Development and performance of Megatile prototypes for the CALICE AHCAL — •Rosmanitz Anna for the CALICE-D-Collaboration — Johannes Gutenberg-Universität Mainz, Institut für Physik

The CALICE collaboration is developing a highly granular Analog Hadronic Calorimeter (AHCal) for a future e+e- linear collider. At the moment, the detector consists of 3x3 cm^2 scintillating tiles, singularly wrapped in reflective foil, glued to an electronic board, and read out by silicon photomultipliers (SiPM). To simplify and speed up the assembly process, the Megatile was developed at the University of Mainz as an alternative concept. It is built from a single scintillator plate with cut-out trenches that are filled with a TiO2-glue mixture to maintain the same granularity. Several full-scale prototypes have been built and tested with cosmic rays in the lab and with an electron beam. This talk presents the Megatile concept and its performance in particular in terms of light yield and cross talk.

T 80.3 Thu 17:05 H-1.003

Time Measurements with the CALICE Analogue Hadronic Calorimeter Prototype — •Lorenz Emberger for the CALICE-D-Collaboration — Max-Planck-Institut für Physik

One of the main design drivers at future energy-frontier e^+e^- colliders is the precise determination of the energy of particle jets. This is achieved with detector designs optimized for particle flow algorithms.

CALICE is an R&D collaboration focussed on the development of highly granular calorimeters optimized to aid this paradigm by providing high spatial resolution. The Analogue Hadronic Calorimeter (AHCAL) is one of the detector concepts based on scintillating tiles read out by Silicon Photomultipliers. It is a 22000 channel sampling calorimeter with steel absorber. The high spatial granularity and single-cell timing enhances the particle separation and background rejection capability.

This contribution is focussed on the hit time measurement of the AHCAL using data collected in extensive beam test campaigns at CERN in 2018. The calibration procedure and correction of electronic effects will be introduced and the achievable hit time distribution will be reported. It will also touch upon first results of the hit time analysis of hadronic showers in simulation as well as in data.

T 80.4 Thu 17:20 H-1.003

Evaluation of Scintillator Tiles for Highly Granular Calorimeters — •Malinda de Silva, Frank Simon, and Lorenz Emberger — Max-Planck-Institut für Physik, München

Plastic scintillator tiles are key elements of highly granular imaging calorimeters being developed for HL-LHC upgrades and for experiments at future colliders and in neutrino beams. The scintillation light emitted by the tiles are read out by silicon photomultipliers placed underneath the tile. The amount of scintillation light obtained from the combination of the scintillator and the SiPM (light yield), as well as the spatial response uniformity of the scintillator elements, are crucial for the overall performance of the detectors.

In this contribution we discuss detailed studies of the impact of misalignment on the spatial response uniformity of different scintillator tiles of varying shapes, sizes and materials, performed with a uniformity scanning setup based on a radioactive source. Furthermore, a simulation-based on GEANT4 is used to simulate an electromagnetic sampling calorimeter in the context of the DUNE neutrino experiment, using non-uniformity data to evaluate the impact of misalignment on the calorimeter*s overall energy resolution.

T 80.5 Thu 17:35 H-1.003

The new fast calorimeter simulation of the ATLAS detector — •Joshua Beirer[1,2], Michael Duehrssen[1], and Stan Lai[2] — [1]CERN — [2]Georg-August-Universität Göttingen

The simulation of physics processes is one of the most essential tools for all types of measurements and searches at hadron colliders. However, the production of simulated events is a highly CPU intensive task and the limited amount of Monte Carlo (MC) events is already one of the largest sources of systematic uncertainties in many ATLAS physics analyses. The main bottleneck of the simulation is the detailed detector simulation with Geant4, for which most of the simulation time is needed to simulate the calorimeter response. In order to increase the amount of produced MC events, ATLAS has successfully employed a fast calorimeter simulation (FastCaloSim) during Run 1 and 2 of the LHC. FastCaloSim parametrizes the energy response of particles in the calorimeter cells, taking into account the lateral shower profile and the correlation between the energy depositions in the various layers of the calorimeter. In recent years, an improved version of FastCaloSim has been developed, which uses machine learning techniques such as principal component analysis and neural networks, and has been shown to considerably improve the simulation while reducing the required CPU time per simulated event.

In this talk, an overview of the new fast simulation of the ATLAS calorimeter will be given and future possible improvements will be outlined.

T 80.6 Thu 17:50 H-1.003

Detailed studies of electromagnetic and hadronic showers in a SiPM-on-tile highly granular calorimeter — •Olin Lyod Pinto for the CALICE-D-Collaboration — Deutsches Elektronen-Synchrotron, Hamburg, Germany

The analog hadron calorimeter prototype is a highly granular calorimeter based on steel absorbers and SiPM-on-tile readout, developed by the CALICE Collaboration. It has acquired sizeable data sets with precise five-dimensional information on electromagnetic and hadronic showers in two test beam periods at the CERN SPS beam test facility. The unprecedented granularity of the detector provides detailed information about the properties of electromagnetic and hadronic showers, which helps to constrain shower models through comparisons with model calculations. Results on longitudinal and lateral shower profiles compared to GEANT4 shower models will be discussed which were measured for electrons and pions in the energy range 10 - 100GeV. The comparison of longitudinal and lateral shower profiles to simulations with a variety of different hadronic shower models can provide input for further development of these models.

T 80.7 Thu 18:05 H-1.003

Particle identification using boosted decision trees for the CALICE highly granular SiPM-on tile calorimeter. — •Vladimir Bocharnikov for the CALICE-D-Collaboration — DESY, Hamburg, Germany — MEPhI, Moscow, Russia

The Analog Hadron Calorimeter (AHCAL) is a highly granular SiPM-on-tile sampling calorimeter developed by the CALICE collaboration for future e^+e^- colliders such as the International Linear Collider (ILC) or the Compact Linear Collider (CLIC). The AHCAL technological prototype consists of 39 active layers alternating with 1.72 cm steel absorber plates. Each active layer is equipped with 576 3×3 cm^2 scintillator tiles with individual readout by silicon photomultipliers. The prototype was tested with muon, electron and pion beams at the CERN SPS facilities in 2018. The high granularity provides detailed spatial information about energy depositions of particles in the detector material that can be used for the event characterisation. We perform a gradient boosted decision tree method to classify events according to incoming particle type. Monte-Carlo simulations were used to train and test the classification model. In this contribution, the particle identification method, its efficiency in simulations and the results of data purification will be discussed.

T 80.8 Thu 18:20 H-1.003

Pandora Particle Flow Algorithm Studies of the CALICE AHCAL 2018 Technological Prototype Test Beam Data and Simulation — •Daniel Heuchel for the CALICE-D-Collaboration — Deutsches Elektronen-Synchrotron (DESY), Hamburg, Germany

The CALICE collaboration is developing highly granular calorimeters for a future e^+e^- collider, like ILC or CLIC. To achieve the desired jet energy resolutions of 3-4% for jet energies between 40-500 GeV in such an experiment the Pandora Particle Flow Algorithm (PandoraPFA) can be used. The basic concept of PandoraPFA is to use the energy measurement of the sub-detector providing the best resolution for each individual particle. This means that charged particles are measured in the tracker, neutral particles in the calorimeters. In this pattern recognition framework high granularity in the calorimeter systems is crucial to correctly assign particle tracks to shower clusters and efficiently separate charged and neutral particles. The current Analog Hadronic Calorimeter (AHCAL) technological prototype features 38 active layers with a total of 21888 channels each consisting of a 3x3cm2 scintillating tile read-out by a Silicon Photomultiplier. Three test beam periods at the SPS CERN have been performed in 2018 to proof the scalability to a full collider detector and record different particles for detailed shower analysis. In this contribution, we will present first results of the application of PandoraPFA to a AHCAL standalone scenario. Focusing on the case of single particle reconstruction and the separation of a neutral hadron in the presence of charged one, we are validating the algorithms performance on test beam data and simulated events.

T 80.9 Thu 18:35 H-1.003

New developments on the residual pile-up subtraction for small R jets in ATLAS — •Pablo Rivadeneira[1], Michaela Queitsch-Maitland[2], and Krisztian Peters[1] for the ATLAS-Collaboration — [1]DESY Hamburg — [2]CERN

In-time and out-of-time pile-up produce energy deposits in the calorimeters generating a dependence of the reconstructed transverse momentum (pT) of jets on the pile-up. In order to correct for this dependence in the ATLAS calibration workflow, first, a correction based on the area of the jet is applied and later a residual correction is needed. The residual calibrations uses the number of primary vertex (NPV) as an estimator of in-time and the mean number of interactions per bunch crossing (mu) as an estimator of out-of-time pile-up. This correction has the limitation that it does not consider any correlation between mu and NPV. Also, the dependence on the pile-up is dependent on the jet pT. This dependence on the pT is set as an uncertainty. A new method that removes the pile-up dependence considering the correlation between mu and NPV, and the dependence on the pT of the jet has been developed and will be part of the new recommendations provided by the JET/ETMiss group to the ATLAS collaboration.