T 57: Calorimeters I

Time: Wednesday 16:00–18:00 Location: Tg

T 57.1 Wed 16:00 Tg

Even π-er: High Fidelity Simulation of Pion Showers with High Speed — •Sascha Diefenbacher — Institut für Experimentalphysik, Universität Hamburg, Deutschland

Simulations of particle collisions play an irreplaceable part in particle physics analyses. A significant part of the time required for these simulations has to be dedicated to modeling particle showers. As collider luminosities continue to increase, the demand for simulated data, and thereby the required simulation time, increases with it. It is therefore imperative that we find ways to speed up these costly simulations. In previous works we managed to show that generative machine learning models can be used to simulate electromagnetic photon showers significantly faster than classical simulations methods. Building on this success we now attempt to extend our generative setups to simulate pion showers. Compared to the electromagnetic showers these pion showers feature significantly more variance in their structure, which presents an additional challenge for the generative models. We present ongoing results using a Generative Adversarial Network (GAN), a Wasserstein GAN (WGAN) and a Bounded Information Bottleneck Autoencoder (BIB-AE).

T 57.2 Wed 16:15 Tg

Performance of neutron irradiated SiPM for the CMS HGCAL — •Carmen Victoria Villalba Petro, Erika Garutti, and Joern Schwandt — Institut für Experimentalphysik, Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg, Deutschland

The CMS Collaboration has proposed a high granularity calorimeter (HGCAL) to replace the endcap calorimeter as part of the HL-LHC upgrade. In the region covered by plastic scintillators a fluence of 8x10^{13} n_{eq}/cm^2 is expected. Operating SiPMs in this high radiation environment increases dark count rate and correlated noise, making it not possible to detect single photons anymore. Candidate SiPMs are MPPC S14160-9766 (8480 pixels) and S14160-9768 (17520 pixels), both with pixel size 15μm. The aim of this study is to characterize Light Yield (LY) and Signal-to-Noise Ratio (SNR) of a plastic scintillator tile coupled to the SiPM in response to a MIP. SNR has been calculated as the ratio between the MIP integrated charge and the standard deviation of the pedestal. For LY the MIP integrated charge is normalized to the SiPM gain obtained with low intensity laser light illumination. It is presented a method to record charge spectra illuminating the SiPMs by a pulsed laser and using a beta source. To characterise effects before and after irradiation the analysis of the charge-voltage measurements are performed at different temperatures, irradiation fluences and integration gate lengths. It has been observed that the noise increases and the charge collection efficiency decreases with fluence. Both effects are mitigated by reducing the temperature. To obtain a maximum in SNR gate length and bias voltage can be optimized.

T 57.3 Wed 16:30 Tg

Investigation of neutron-induced radiation damage on SiPMs — •Laura Büttgen, Erika Garutti, and Jörn Schwandt — Institut für Experimentalphysik, Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg, Deutschland

Silicon Photomultipliers are photosensors employed in many HEP detectors. Their radiation hardness is subject of intense investigation. For the upgrade of the CMS detector SiPMs should be exposed to fluences up to 5×10^{13} cm^{-2} in the High Granularity Calorimeter (HGCAL) and up to 2×10^{14} cm^{-2} in the barrel timing layer. In this study twenty SiPMs from Hamamatsu with the serial number S14160-9766 and S14160-9768 were characterized and the effects of neutron irradiation with different fluences were analyzed. For the analysis current-voltage measurements, capacitance-frequency-voltage measurements and charge-voltage measurements have been performed.

Due to irradiation an increase of six orders of magnitude of dark current was found after irradiation. Furthermore an evidence of the decrease of the photodetection efficiency after irradiation will be presented. The quantification of the reduction is still subject of investigation and may depend on the effect of self-heating of the SiPM. As self-heating effects one describes the increase of temperature induced in the SiPM pixels by high currents, for instance due to high frequency dark noise, or light detection. Variations in temperature lead to a shift in the breakdown voltage, which if not corrected causes a change of all SiPM performance parameters. This effect is also described and first measurements are attempted to quantify it.

T 57.4 Wed 16:45 Tg

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, which is planned to be deployed imminently, will be given. Not only will recent developments be discussed, but future possible improvements will also be outlined.

T 57.5 Wed 17:00 Tg

Artificial Neural Networks for the Energy Reconstruction of ATLAS Liquid-Argon Calorimeter Signals — •Anne-Sophie Berthold, Nick Fritzsche, Wolfgang Mader, Arno Straessner, and Johann Christoph Voigt — Institut für Kern- und Teilchenphysik, Dresden, Deutschland

Starting in 2027, the enhanced performance of the High-Luminosity LHC will increase the number of particle collisions in the ATLAS detector significantly. The Phase-II upgrade of the detector aims to cope with that. Since up to 200 pile-up events will emerge within one bunch crossing, one important part of this upgrade will be the processing of the Liquid-Argon Calorimeter signals. It has been shown that the conventional signal processing, which applies an optimal filtering algorithm, will loose its performance due to the increase of overlapping signals and a trigger scheme with trigger accept signals in each LHC bunch crossing. That is why more sophisticated algorithms such as neural networks come into focus. This talk will deal with the development and performance of convolutional neural networks, which on the one hand aim to detect signals and reconstruct their energy under various conditions, and on the other hand need to satisfy resource restrictions.

T 57.6 Wed 17:15 Tg

Beam Tests of the first CMS HGCAL Tilemodule prototypes — •Malinda de Silva, Mathias Reinecke, Ole Bach, Katja Krüger, and Felix Sefkow — Deutsches Elektronen-Synchrotron (DESY)

For the HL-LHC phase, the calorimeter endcap of the CMS detector will be upgraded with a High Granularity Calorimeter (HGCAL), a sampling calorimeter which will use silicon sensors as well as scintillator tiles read out by silicon photomultiplier (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 5x10^13 neq/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. The first functional tile module prototypes have been constructed with HGCROC2 ASICs and SiPMs which are candidates for the HGCAL production. They have undergone beam tests at DESY and Fermilab, investigating the interplay of the components and evaluating the performance with several scintillator tile types. The first test with irradiated SiPMs was also performed. We will report on these tests, which were all performed in 2020, and the work still to come using beams.

T 57.7 Wed 17:30 Tg

New concept for a calorimeter with shower direction reconstruction — •Matei Climescu, Phi Chau, and Rainer Wanke for the SHiP-SBT-Collaboration — Universität Mainz

The SplitCAL is a mixed electromagnetic-hadronic calorimeter designed to provide both energy reconstruction through regular layers and shower direction information through high-precision layers. This can be used for fixed target experiments which require high geometrical precision. The development needs to account for low rates but large dynamic range. The technology, the performance and the challenges are presented here.

T 57.8 Wed 17:45 Tg

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