T 22: Calorimeter / Detector Systems I

Time: Monday 16:30–18:00 Location: WIL/C133

T 22.1 Mon 16:30 WIL/C133

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

The LHC will be upgraded to become the High-Luminosity-LHC, with significantly increased numbers of simultaneous particle collisions. With this upgrade, up to 200 pile-up events are expected within one bunch crossing. To cope with that, processing of the signals of the Liquid-Argon Calorimeter will need to be improved, because conventional algorithms are expected to lose performance. Artifical neural networks provide one way to deal with this. It has been shown, that convolutional neural networks are able to detect signals and reconstruct their energy with good performance. These networks are planned to be executed on Field Programmable Gate Arrays (FPGA) which have limited resources in signal, processing units, logic and memory. This talk will deal with the quantization of neural networks, a technique to reduce the resources needed for neural networks, by reducing the precision of the weights, biases and activations, while keeping the performance.

T 22.2 Mon 16:45 WIL/C133

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

From 2029 on, the enhanced performance of the High-Luminosity LHC will increase the number of simultaneous proton-proton collisions at the ATLAS detector considerably. In order to cope with that, the so-called Phase-II upgrade is planned. Up to 200 pile-up events will emerge within one bunch crossing, which is why one important part of this upgrade will be the processing of the Liquid-Argon Calorimeter signals. It has been shown that the conventional, optimal filtering signal processing 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 deals with the application of convolutional neural networks, which on the one hand need to perform well under varying signal conditions and on the other hand need to satisfy tight resource restrictions. Different network architectures are compared. A scoring, which is visualized in a spider diagram, is introduced to evaluate the network performance with respect to different scenarios.

T 22.3 Mon 17:00 WIL/C133

Automated Photon Energy Resolution Calibration at Belle II — •Alexander Heidelbach and Torben Ferber — Institute of Experimental Particle Physics (ETP), Karlsruhe Institute of Technology (KIT)

At the Belle II experiment in Tsukuba, Japan, the electromagnetic calorimeter is used to measure the energy of photons in e^+e^- collisions. The utilization of physical observables, like the invariant mass, from measured quantities, requires precise knowledge of the uncertainties on the components of the four-momentum. To account for uncertainties of these components, the determination of the full covariance matrix is crucial. This matrix stores the variances and covariances of the differences between reconstructed and generated four-momentum vector components for data, respectively MC. At Belle II, in the case of photons, the entries of the photon covariance matrix are determined with the help of radiative dimuon decays $e^+e^- \to \mu^+\mu^-\gamma$. This talk presents the studies on the radiative dimuon decay which are used to extract the photon energy resolution from data. Additionally, it discusses the current efforts to automatize the extraction procedure for run-dependent data and the implementation into the Belle II Analysis Software Framework.

T 22.4 Mon 17:15 WIL/C133

Testbeam Performance and Light Yields of Prototype Cell for the SHiP SBT — •Fairhurst Lyons for the SHiP-SBT-Collaboration — University of Freiburg

We present R&D towards a large-area detector for energy reconstruction and tracking, which consists of many individual cells filled with liquid scintillator. Each cell is equipped with two wavelength-shifting optical modules (WOMs) that capture scintillation light and transfer it to silicon photomultipliers. This design could serve as the surrounding background tagger (SBT) of the proposed Search for Hidden Particles (SHiP) experiment, a general-purpose detector housed at the CERN SPS accelerator to search for light, feebly interacting particles. One such cell was tested at the DESY e$^-$ testbeam in October 2022; analysis of performance and light yields will be presented here. This work is funded by the Federal Ministry of Education and Research.

T 22.5 Mon 17:30 WIL/C133

Spatial information on particles crossing through a WOM-SiPM based liquid scintillator — •Constantin Eckardt for the SHiP-SBT-Collaboration — Humboldt Universität zu Berlin, Berlin, Germany

The proposed option of the SHiP surround background tagger is based on detector cells filled with liquid scintillator that are equipped with two wavelength-shifting optical modules (WOMs). A WOM is a light-guiding tube coated with a UV light-absorbing paint that emits secondary photons in the visible spectrum. By total internal reflection inside the tube walls, these photons are guided to the actual photon detector, which in this case is made of a ring array of silicon photomultipliers coupled to one end of the tube. We study the light yield distribution over the SiPMs in this ring array in a test detector equipped with one WOM as a function of the track position of cosmic muons. The possibility to obtain spatial information about this track position from the light yield distribution on the SiPM array with different optical coupling schemes between the WOM tube and the SiPM ring array is investigated.

T 22.6 Mon 17:45 WIL/C133

position reconstruction in a protoype cell of the SHiP surround background tagger — •Mahyar Jadidi for the SHiP-SBT-Collaboration — Albert Ludwigs Universität Freiburg, Freiburg im Breisgau, Germany

The future SHiP experiment at CERN aims for the discovery of long lived heavy neutral particles in a zero background experiment. To reach this challenging goal, its decay volume is surrounded by an active layer of the liquid scintillator (LAB), consisting of cells of about 1 square meter surface area. Each cell is equipped with two wavelength-shifting optical modules (WOMs) to collect the scintillation light. At each WOM, the collected light is detected by 40 silicon photomultipliers (SiPMs) arranged in a circle. With the help of a neural network, the time and the amplitude information from the SiPMs are used to reconstruct the position and possibly the direction of the particles passing the cell. First results on the position resolution measured in the test beam campaign at DESY in Fall 2022 and a comparison to Monte Carlo simulations will be presented.