T 94: Detektorsysteme VII

Zeit: Donnerstag 16:00–18:15 Raum: H10

T 94.1 Do 16:00 H10

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 for detectors 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. This calorimeter provides high spatial granularity and single-cell timing in order to enhance the particle separation and background rejection capability.

A 22000 channel technological prototype has been constructed and extensively tested in particle beams at CERN in 2018. This contribution is focussed on the time analysis of the data taken in the course of these test beam campaigns. It will touch upon the correction of electronic effects caused by the read-out chip and report on the achievable hit time resolution.

T 94.2 Do 16:15 H10

Timing performance of the Mu3e tile detector prototype — •Tiancheng Zhong, Yonathan Munwes, Konrad Briggl, Hannah Klingenmeyer, Huangshan Chen, Hans-Christian Schultz-Coulon, and Wei Shen — Kirchhoff Institute for Physics, University of Heidelberg

The Mu3e experiment is designed to search for the charged Lepton Flavour Violation (cLFV) decay $\mu^+ \to e^+e^+e^-$ with a sensitivity of 10^{-16}. The observation of this decay would be a significant signal for new physics beyond the Standard Model (SM). To suppress both accidental and physics background in the experiment, a precise measurement of the vertex position, the decay time and the particle momenta is required. The tile timing detector aims at a timing resolution of better than 100ps, and is based on scintillation tiles, SiPMs and a readout ASIC.

A prototype with totally 96 channels was built at the Kirchhoff Institute for Physics. It was tested by exposed to the DESY electron test beam in Hamburg in June 2018. All three submodules with separated ASICs were successfully read out by the same data acquisition (DAQ) system using separated ASICs. The single channel and submodule resolution was measured to be better than 40ps and 60ps, respectively.

T 94.3 Do 16:30 H10

Commissioning and First Image Reconstruction with a new Time-of-Flight PET Prototype — •Ole Brandt[1,2], Yonathan Munwes[3], Erika Garutti[2], and Ties Behnke[1] — [1]Desy, Notketrasse 85, 22607 Hamburg — [2]Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg — [3]Kirchhoff-Institut für Physik, Universität Heidelberg Im Neuenheimer Feld 227, 69120 Heidelberg

Within the framework of the EndoTOFPET-US project an endoscopic multimodal imaging device combining Ultrasound endoscopy and Time-of-Flight Positron Emission Tomography is developed. The design foresees a miniaturized PET head installed on a commercial ultrasound endoscope and an external detector plate, which will be positioned in close proximity to the patient's body. The prototype system described here consists of the final PET plate and an endoscopic demonstrator, which has a system time of flight resolution of 255 ps FWHM and reaches a spatial resolution of about 1.5 mm in the direction transverse to the line of sight connecting the detectors. The applications of this device are within diagnostic and surgical oncology as well as the development of new biomarkers targeted for prostate cancer. In this talk, results from the commissioning of a full sized prototype, including timing performance, first data acquisition and image reconstruction are presented.

T 94.4 Do 16:45 H10

Development and simulation of the Mu3e tile detector prototype — •Hannah Klingenmeyer — Kirchhoff-Institut für Physik, Universität Heidelberg

The tile detector is a dedicated timing detector system developed for the Mu3e experiment, which is designed to search for the lepton-flavour violating decay $\mu \to eee$ with a target sensitivity of 10^{-16}. In order to determine the vertex of the three decay electrons, precise spatial and timing measurements are necessary, resulting in the requirement of a time resolution below 100 ps for the tile detector.

The tile detector, which is currently under development, employs plastic scintillator tiles and silicon photomultipliers read out by dedicated ASICs. In this talk, the status of the first technical prototype will be presented. Measurements of the prototype in two testbeam campaigns, undertaken at DESY in 2018, show a preliminary time resolution of the order of 40 ps, well below the required 100 ps. In addition, the experience gained from the construction of the prototype provides crucial input for the definition and finalisation of the production and assembly procedures, which are needed for the final detector system.

Furthermore, the prototype design has been implemented in a CAD software with built-in simulation options, which are used to simulate the heat flow and cooling capabilities of the detector. This is of particular importance regarding the integration of the tile detector within the full experimental setup, as constraints on the final detector design can first be tested and verified in simulation studies.

T 94.5 Do 17:00 H10

Zeitauflösung eines Flüssigszintillatordetektors mit WOM- und SiPM-Auslese — •Maximilian Ehlert für die SHiP LScin SBT-Kollaboration — Humboldt-Universität zu Berlin, Institut für Physik

SHiP (Search for Hidden Particles) ist ein Vorschlag, in einem Beamdump-Experiment am CERN SPS-Beschleunigerkomplex nach sehr schwach wechselwirkenden, neutralen Teilchen im Massenbereich von 0,1 GeV - 10 GeV zu suchen. Hadronen aus den Proton-Proton-Kollisionen werden absorbiert und Myonen durch ein Magnetsystem ausgelenkt, so dass neben Neutrinos nur noch andere neutrale Teilchen in einem etwa 50m langen Volumen vorhanden sind und in diesem zerfallen können. Dieses Zerfallsvolumen soll mit Flüssigszintillator umgeben sein (Surrounding Background Tagger = SBT), um Untergrund unterdrücken zu können. Die Szintillationsphotonen sollen mit sogenannten Wavelength-Shifting-Optical-Modules (WOMs), die an Photosensoren angekoppelt werden, nachgewiesen werden. Im Vortrag wird die Zeitauflösung eines Flüssigszintillatordetektors mit WOM- + SiPM-Auslese, welcher an einem Testrahl am CERN PS-Beschleuniger getestet wurde, analysiert und diskutiert.

T 94.6 Do 17:15 H10

Development of a Detector Control System for the ATLAS High Granularity Timing Detector — •Davide Caforio, Michael Düren, and Hasko Stenzel — II. Physikalisches Institut, Justus-Liebig-Universität Gießen, Heinrich-Buff-Ring 16, 35392 Gießen

The high-luminosity phase of the LHC will require important upgrades of the ATLAS detector. The experimental challenges are related to the high mean number of interactions per bunch crossing ($\mu \approx 200$) and the harsh radiation environment. The High Granularity Timing Detector will be able to mitigate the impact from pile-up by an improved track-to-vertex association using a timing measurement with about 30ps resolution. In order to ensure an efficient and safe operation, a detector control system is designed. All relevant detector parameters are continuously monitored and archived for debugging and performance studies, and a system of alert handles signals of abnormal behavior. Interfaces with DAQ, trigger and the accelerator, with interlock signal in case of critical situations, must also be implemented. The large number of read-out channels, the severe environmental conditions characterized by high radiation levels and magnetic fields, the limited space, and the required fast response time of the system are the main challenges faced by the HGTD DCS system.

T 94.7 Do 17:30 H10

Simulation of a High-Granularity Timing Detector for the ATLAS Phase-II Upgrade — •Alexander Basan[1], Lucia Masetti[1], Dirk Zerwas[2], Eftychia Tzovara[1], and Peter Berta[1] — [1]Johannes Gutenberg University Mainz — [2]Universite de Paris-Sud

The high-luminosity Large Hadron Collider (HL-LHC), scheduled to start in 2026, will deliver an instantaneous luminosity of up to $7.5\times10^{34}\,\mathrm{cm^{-2}s^{-1}}$, which is approximately 5 times larger than the typical luminosities of Run 2. The corresponding increase in the average number of simultaneous *pp* interactions per bunch crossing (pileup) poses a challenge for the tracking detectors to efficiently assign the charged particles to the production vertices. The performance in terms of heavy-flavor tagging, lepton isolation and the identification of pileup jets will deteriorate especially in the forward region where the spatial resolution is much larger than the inverse of the average pileup density.

The High-Granularity Timing Detector (HGTD) enables the use of high-precision timing information in the forward region to distinguish between collisions occurring very close in space but well-separated in time. With an expected time resolution for minimum-ionising particles of approximately 30 ps and a spread of collision times over a bunch crossing of 175 ps, the amount of pileup can be reduced by a factor of $175/30 \approx 6$.

This talk presents the simulation software for the HGTD and studies on the performance for muons.

T 94.8 Do 17:45 H10

Analysis of test beam measurements for the ATLAS High Granularity Timing Detector — •Jens Soengen, Lucia Masetti, and Marisol Robles — Johannes Gutenberg-Universitaet

The high-luminosity upgrade to the LHC(HL-LHC) is foreseen to start operating in 2026 and will boost the potential of discovering new particles substantially. However, the increased instantaneous luminosity of up to $7.5 \cdot 10^{34}$ $cm^{-2}s^{-1}$ also implies rising requirements to the ATLAS detector. In order to guarantee the correct assignment of particles from hard-scattering events, a High-Granularity Timing Detector(HGTD) is planned to mitigate the effect of pile-up. The most appropriate candidate is a silicon-based avalanche detector with low-gain(LGAD) and reduced thickness in the magnitude of 50 μm, promising an excellent time resolution below 30 ps. Its capabilities are examined under testbeam conditions with a 120 GeV pion beam at the CERN SPS. This talk will outline the central work steps of the analysis process as well its current status. Finally the crucial qualities, such as timing-performance and efficiency are presented for the latest testbeam campaigns in 2018.

T 94.9 Do 18:00 H10

Charakterisierung hoch-zeitauflösender Sensoren (LGAD) — Jörn Grosse-Knetter, Jörn Lange, Arnulf Quadt und •Marike Schwickardi — II. Physikalisches Institut, Georg-August-Universität Göttingen

Im Rahmen des Ausbaus des ATLAS-Detektors werden zeitaufgelöste Messungen angestrebt, welche zur Pile-Up-Unterdrückung am Hochluminositäts-LHC eingesetzt werden können. Dafür wird ein neues Silizium-Detektorkonzept mit geringer interner Verstärkung entwickelt, das als Low Gain Avalanche Detector (LGAD) bekannt ist. Von diesem Detektor wird erwartet, dass er genaue Zeitinformationen für geladene Teilchen mit einer Zeitauflösung von etwa 30 Pikosekunden liefert.

Für diese Art von Sensor gibt es verschiedene Hersteller, welche jeweils die Dotierung der Verstärkungsschicht sowie den Abstand zwischen den Pads variieren, um ein optimales Design zu finden. Dabei werden sowohl einzelne Pads mit 1.3×1.3 mm^2 Größe als auch Arrays von diesen Pads untersucht, welche zwischen 2×2 und 15×15 Pads beinhalten, also zum ersten Mal Sensoren der angestrebten Größe des Auslesechips von ca. 2×2 cm^2.

Das Strom-Spannungs (IV)-Verhalten wird mit einer automatischen Probe Station gemessen und liefert zum ersten Mal Ergebnisse für Sensoren in dieser Größenordnung. Darüberhinaus werden die Ladung, Verstärkung und Homogenität der Sensoren, insbesondere auch zwischen den Pads, mit einem ortsaufgelösten Laser-Aufbau (TCT) gemessen.