T 19: Detector systems I

Time: Monday 16:00–18:05 Location: Ts

Group Report T 19.1 Mon 16:00 Ts

The Mu2e experiment at Fermilab — •Stefan E. Müller, Anna Ferrari, Oliver Knodel, and Reuven Rachamin for the Mu2e-Collaboration — Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany

The Mu2e experiment, currently under construction at the Fermi National Accelerator Laboratory near Chicago, will search for the neutrinoless conversion of muons to electrons in the field of an aluminum nucleus. In the Standard Model, this process, which violates charged lepton flavor, is highly suppressed and therefore undetectable. However, scenarios for physics beyond the Standard Model predict small but observable rates. The Mu2e experiment aims for a sensitivity four orders of magnitude better than existing experiments. This is achieved by a rigorous control of all backgrounds that could mimic the monoenergetic conversion electron.

At the Helmholtz-Zentrum Dresden-Rossendorf, we use the ELBE radiation facility to study radiation hardness and performance of components for the Mu2e calorimeter and the detector that will monitor the rate of stopped muons in the aluminum target. Additionally, Monte Carlo simulations are performed for both the pion production target and the muon stopping target.

In the presentation, the design and status of the Mu2e experiment and its detectors will be presented, and results from the ELBE beamtimes and the simulation studies will be given.

T 19.2 Mon 16:20 Ts

Status update of the Mu3e Tile Detector — Konrad Briggl, •Hannah Klingenmeyer, Yonathan Munwes, Wei Shen, Tiancheng Zhong, and Hans-Christian Schultz-Coulon — Kirchhoff-Institut für Physik, Universität Heidelberg

The Mu3e experiment, which will be installed at the Paul Scherrer Institute (PSI) in Switzerland, is designed to search for the lepton-flavour violating decay $\mu \rightarrow eee$ with a target sensitivity of 10^{-16}. In order to determine the vertex of the three decay electrons, precise space and time measurements are required. Dedicated tracking and timing detectors are being developed for this purpose. One of the timing systems is the Mu3e Tile Detector, which allows precise timing of individual electrons with a resolution below 100 ps.

The Mu3e Tile Detector, which is currently in the pre-production phase, uses plastic scintillator tiles and silicon photomultipliers that are read out by the MuTRiG ASIC, also developed in Heidelberg. In this talk, a comprehensive overview of the current detector status is given; details on the pre-production process and first performance tests of the detector prototype are presented. In particular, the production steps, the developed production tools, and quality assurance are discussed.

T 19.3 Mon 16:35 Ts

A camera alignment system for the Mu3e experiment — •Goran Stanic for the Mu3e-Collaboration — Johannes Gutenberg University Mainz

The Mu3e experiment is going to be conducted at PSI in Switzerland and it aims at finding or excluding the lepton flavour violating decay $\mu \rightarrow eee$ at branching fractions above 10^{-16}. The Mu3e detector consists of a tracking detector built from thin high-voltage monolithic active pixel sensors (HV-MAPS) complemented by scintillating fibers and tiles for precise timing measurement. One of the main challenges of the experiment lies in precise alignment of detector elements. In order to achieve the best possible momentum resolution a track based alignment programme will be utilised. Track-based alignment can however not resolve so-called weak modes, deformations of the detector that produce tracks of equal quality. The aim of this work is to correct for the weak modes by designing and developing a high precision camera based alignment system that monitors the detector position from the outside. The system will consist of multiple infrared cameras which will observe each other and the detector set-up. The main goal is to drive the camera measurement precision to be comparable to the size of the individual tracking detector pixels, which is at $80\mu m$.

T 19.4 Mon 16:50 Ts

A 2D pixelated stilbene scintillator detector array for simultaneous radiography with fast neutrons and gammas — Ilya Aleshin, •Nina Höflich, and Oliver Pooth — III. Physikalisches Institut B, RWTH Aachen University, D-52056 Aachen

The Neutron Detectors group at the Physics Institute III B develops pixelated detectors for fast neutron imaging applications with compact neutron sources such as Americium-Beryllium sources or neutron generators. The detectors use specialized scintillators such as stilbene that enable to distinguish neutron and gamma induced signals via pulse shape discrimination. Therefore, these detectors allow for a simultaneous investigation of objects with neutrons and gammas.

In this talk, recently published results (arXiv: 2010:01870) obtained with our 16-pixel detector prototype will be presented. This prototype consists of 16 stilbene cuboids of size $5 \times 5 \times 25\,\mathrm{mm}^3$ coupled to a 4×4 SiPM array. The prototype was tested with a D-D neutron generator at the Paul Scherrer Institute in Switzerland, that emits neutrons between 2.3 and 2.8 MeV energy. Attenuating samples with different composition and thickness were placed between the generator and the 16-pixel detector. The neutron attenuation in dependence of material and thickness was studied and fast neutron macroscopic cross sections were calculated and compared to the expected ones. Geant4 simulations were used to study deviations. The detection efficiency for D-D neutrons was measured to be around 10%.

T 19.5 Mon 17:05 Ts

Gamma spectroscopy of an Americium-Beryllium source with a High Purity Germanium detector in a neutron radiography setup — •Ilya Aleshin, Nina Höflich, and Oliver Pooth — III. Physikalisches Institut B, RWTH Aachen University, D-52056 Aachen

The neutron radiography group at the Physics Institute III B, RWTH Aachen University, develops a multi-pixel detector for fast neutron radiography.

The purpose of fast neutron radiography is to resolve structures in heterogeneous test objects that cannot be well investigated by X-ray radiography. As a neutron source, 2 Americium-Beryllium radioactive sources (16.5 GBq and 16.9 GBq) are used. These sources produce neutrons as well as gamma-rays. For neutron detection, the organic scintillator stilbene ($C_{14}H_{12}$) is used. This scitntillator allows to distinguish neutron- and gamma-induced signals via their pulse shape.

For the sake of future analyses like for example the prompt gamma neutron activation analysis, which explores the characteristic gamma rays produced by interaction of fast neutrons with matter, precise gamma spectra of the radiography setup (and especially of the Americium-Beryllium sources) are necessary. This talk will focus on the measurement of this spectra with a High Purity Germanium detector and on the spectra themselves. The mode of operation of such a Germanium detector, the positions of this detector with respect to the Americium-Beryllium sources during measurements and the spectra themselves will be presented in this talk.

T 19.6 Mon 17:20 Ts

Tracking of charged particles using an FE-I4B pixel telescope and moving emulsion films — •Nikolaus Owtscharenko[1], Markus Cristinziani[1], Vadim Kostyukhin[2], Christopher Betancourt[3], Fabian Hügging[4], Jens Janssen[4], David-Leon Pohl[4], Antonia Di Crescenzo[5], and Antonio Iuliano[5] — [1]Center for Particle Physics Siegen, Experimentelle Teilchenphysik, Universität Siegen — [2]University of Sheffield — [3]Universität Zürich — [4]Physikalisches Institut, Universität Bonn — [5]Sezione INFN di Napoli

The SHiP collaboration proposes a general purpose fixed-target experiment to search for hidden particles at the new beam-dump facility at CERN SPS. To estimate the charm production cross section in the experiment, which includes hadronic cascade production, several dedicated measurements have been proposed. A first run was performed in summer 2018. Protons from SPS interacted with a thick multilayer target, interleaved with tracking emulsion films. While the emulsion detector offered high spatial resolution, it did not provide timing information. For full event reconstruction a 6-plane telescope made of ATLAS IBL double-chip modules was assembled and placed downstream of the target to provide a high timing resolution. An occupancy limit on the emulsion films made a movement of the target during and in between spills necessary. The matching of track candidates reconstructed in the moving emulsion detector with those reconstructed in the fixed pixel detector is presented.

T 19.7 Mon 17:35 Ts

A low-background Silicon Drift Detector system for IAXO
— •Thibaut Houdy[1,2] and Susanne Mertens[1,2] — [1]Max-Planck-Institut für Physik, Föhringer Ring 6, D-80805 München, Germany — [2]Physik-Department, Technische Universität München, D-85747 Garching, Germany

The nature of dark matter is among the most challenging question of modern physics. Axions are invoked to solve the strong CP problem and are dark matter candidates. IAXO is the new generation helioscope, designed to discover solar axions by measuring x-rays induced by axion-photon conversion. The requirement for the detector to reach an extremely low background level below 10 keV is very challenging.

The TRISTAN project is developing a new detection system using silicon drift detector (SDD) for upgrading the KATRIN experiment and search for keV sterile neutrino. We propose to use this unique technology as an x-ray detector for the IAXO experiment. A first prototype detector revealed excellent spectroscopic quality, matching each IAXO requirements however the required background level remains to be demonstrated.

A dedicated test-bench have been built to assess the intrinsic background level. This includes simulations of the expected external background, design of the shields, determination of the natural radioactivity of detector board and front-end electronics. In this talk, first results of measurements in the Munich shallow underground laboratory will be reported. Secondly, conceptual design studies of the final detector system, meeting the required background level, will be presented.

T 19.8 Mon 17:50 Ts

Development of the Detector Control System for the ATLAS ITk-Pixel Demonstrator
— •Andrés Melo, Jason Veatch, and Stan Lai — II. Physikaliches Institut, Georg-August-Universität Göttingen

The High-Luminosity LHC Upgrade will allow the ATLAS experiment to collect an order of magnitude more data than Run 3. Since the new Inner Tracker (ITk) must cope with this increased occupancy, bandwidth and radiation damage, a sophisticated prototype, called the ITk-Demonstrator, has been built. The ITk-Demonstrator allows the investigation and proof-of-principle for the ITk to be established, with powering, data acquisition, and the Detector Control System (DCS) to be tested in detail.

This talk discusses the tests of the DCS system planned for the ITk and tested with the Demonstrator. Among the technical issues tested were CANMoPs, a package that communicates with a CAN protocol interface, and the serial power protection chips (PSPP) of the Demonstrator. Furthermore, the user interface of the power supply (Wiener PL512) is being redesigned. Among other things, a migration from the Siemens program WinCC for supervisory control and data acquisition from version 3.15 to 3.16 was investigated. This allows the program to run on a Linux operating system, removing the dependence on MS Windows.