T 49: Detectors IV (Scintillators)

Time: Wednesday 16:15–17:45 Location: VG 1.101

T 49.1 Wed 16:15 VG 1.101

Performance of Large Area Liquid Scintillator Detectors with Wavelength-shifting Optical Modules — •Andrés Krolla for the SHiP-SBT-Collaboration — ALU Freiburg, Physikalisches Institut, 79104 Freiburg (DE)

For the mitigation of background events caused by deep inelastic scattering of muons and neutrinos, a large volume tagger system is being developed. Main requirements are accurate timing information and positional reconstruction. The detector design is organic liquid scintillator based and uses immersed Wavelength-shifting Optical Modules for light collection. Of special interest is the efficiency and quality of the light collection depending on the choice of inner lining materials, which can be diffusely or specularly reflecting. Light yield heavily influences the positional reconstruction and requirements on data acquisition. Light yield measurements from detectors with barium-sulfate paint, PTFE or aluminum reflector foil coatings as well as untreated metal surfaces will be compared.

T 49.2 Wed 16:30 VG 1.101

Testbeam Performance and Signal Yields of Prototypes for the SHiP SBT — •Fairhurst Lyons for the SHiP-SBT-Collaboration — University of Freiburg, Freiburg, Germany

We present R&D towards the surrounding background tagger (SBT) of the Search for Hidden Particles (SHiP) experiment, a general-purpose detector housed at the CERN SPS accelerator to search for light, feebly interacting particles. This is 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. Multiple such cells with different detector materials were tested at a CERN SPS μ^- testbeam; analysis of performance and comparison with simulation will be presented here.

T 49.3 Wed 16:45 VG 1.101

Testbeam measurements with prototypes of the Surrounding Background Tagger of the SHiP experiment — •Alessia Brignoli for the SHiP-SBT-Collaboration — Humboldt Universität zu Berlin

The Surrounding Background Tagger (SBT) is a crucial part of the SHiP experiment to suppress background from muons entering the decay vessel of the experiment or from muon/neutrino inelastic interactions inside the decay volume and its surroundings. The SBT is based on liquid scintillator (LAB+PPO) filled cells. Light collection is performed through PMMA Wavelength-Shifting Optical Modules (WOMs), optically coupled to an array of 40 SiPMs. We present results obtained with different prototypes. The first four-cells prototype, improving of a one-cell prototype that was tested with positrons in October 2022 at DESY, was tested in spring 2024 with muons at CERN's PS. Three one-cell prototypes that were tested with muons in CERN's PS in November 2024. The different prototyes differ in the cell construction material, steel or aluminium, as well as the material used for increasing the inner walls reflectivity, crucial for the light collection. For all the prototypes, each cell was equipped with two WOM tubes. The timing performance of the detector, which is important for the background rejection capabilities of the final SBT detector, was studied. In parallel, the comparison of data with Geant4-based photon transportation simulations results allows us to gather further information about the detector response and the quality of the built prototypes.

T 49.4 Wed 17:00 VG 1.101

On Calibration and Timing of the Mu3e Tile Detector — •Erik Steinkamp for the Mu3e-Collaboration — Kirchhoff-Institut für Physik, Heidelberg, Deutschland

The Mu3e experiment has been designed with the objective of detecting the charged lepton flavour violating decay $\mu \to eee$ with a branching ratio sensitivity of 10^{-16}, which represents the final goal for the second phase of the experiment. This would represent a four-order-of-magnitude improvement on the current limit. The primary challenge associated with the Mu3e detector is excellent background suppression. This necessitates, in addition to precise vertexing and tracking using monolithic pixel sensors, the acquisition of highly precise timing data.

The Mu3e tile detector is a scintillator-based timing detector with SiPM readout that aims at a timing resolution of less than 100 ps. In order to guarantee this level of performance, it is essential to conduct a precise calibration of the detector. This presentation will focus on the calibration process, which is primarily concerned with the configuration of the readout electronics, particularly the MuTRiG ASICs, which are responsible for SiPM readout and digitization. Furthermore, the time-walk effect, which is caused by the non-linear response of the scintillator material, in addition to the time synchronisation must be realized between the various channels within and between the ASICs. In order to evaluate the timing resolution of the detector, calibration and time walk correction methods are applied to test beam data taken at DESY. The resulting performance studies and the evaluation of the detector's timing resolution will be presented.

T 49.5 Wed 17:15 VG 1.101

Timing characterization for T2K ND280Upgrade detector — •Gioele Reina — Johannes Gutenberg- Universität Mainz

The T2K experiment is a long baseline neutrino experiment, located in Japan. It studies neutrino oscillations by detecting accelerator neutrinos with a complex of near detectors and a far detector. ND280, one of the near detectors, provides a reduction of the neutrino flux and cross section uncertainties.

The new features of the upgraded ND280 detector allow to improve these capabilities. In particular, the newly installed target, the Super Fine-Grained Detector, consists of small plastic scintillator cubes read out by three WLS fibers in the three orthogonal directions. This new detector design offers high granularity and 3D reconstruction, unlocking the sensitivity to neutron detection and reconstruction by measuring its time of flight in the detector.

In such a context, the timing characterization of this detector is crucial. Here, a new methodology to perform time calibration for any high granular detector is described. By exploiting the granularity of the detector, it is possible to evaluate offsets and time walk contributions, along with the time resolution of the detector. The application and the results of this method are presented, allowing the upgraded ND280 to detect neutrons.

T 49.6 Wed 17:30 VG 1.101

Characterisation of hybrid-opaque scintillators for the *NuDoubt*$^{++}$ experiment — •Miriam Weigand for the NuDoubt-Collaboration — Johannes Gutenberg-Universität Mainz, Institut für Physik, 55128 Mainz, Germany

The *NuDoubt*$^{++}$ experiment is dedicated to the advanced search for double beta plus decay ($2\beta^+$), a rare nuclear disintegration process with an extremely long half-life of 10^{18} to 10^{24} years. In the Standard Model (SM), each double beta decay ($2\nu2\beta^+$) produces two neutrinos, but there is also the possibility of non-SM neutrino-less double beta decays ($0\nu2\beta^+$), which would suggest the Majorana nature of the neutrino.
Central to the *NuDoubt*$^{++}$ effort is the development of an innovative detector concept based on a hybrid, slow and opaque liquid scintillator loaded with the $2\beta^+$-decaying isotope. The hybrid scintillator uses slow light emission to enhance the detection of the Cherenkov and scintillation light, which allows the distinction of particle types. Wax is added to create an opaque scintillator that locally confines the produced photons. A grid of Optimised WaveLength-shifting (OWL) fibres is distributed throughout the detector to collect the light and allow detailed energy deposition patterns to be reconstructed.
This talk will discuss the demonstrator setup designed to test the new detector concept and to improve the composition and interplay of the components used.