T 40: Detectors 5 (scintillators)

Time: Tuesday 16:00–18:00 Location: Geb. 30.23: 2/17

T 40.1 Tue 16:00 Geb. 30.23: 2/17

Sensitivity Study of a Scintillating Active Transverse Energy Filter for Background Suppression at the KATRIN Experiment — •Nathanael Simon Gutknecht for the KATRIN-Collaboration — Karlsruhe Institute of Technology (KIT)

The **Ka**rlsruhe **Tr**itium **N**eutrino (KATRIN) experiment aims to determine the mass of the electron antineutrino by precise measurement of the energy spectrum of β-electrons from tritium decay using a MAC-E-Filter setup. After a total measurement time of 1000 days in 2025, a final sensitivity better than $0.3\,\mathrm{eV/c^2}$ (90 % C.L.) is expected.

At the moment, one sensitivity limiting factor is the spectrometer background which consists of electrons that are generated in the main-spectrometer volume. Due to their small initial energy, the background electrons have a different angular distribution than the signal electrons at the point of detection.

A scintillating structure acting as an angular selective detector (scint-aTEF) has potential to discriminate between β- and background electrons. This talk will discuss the concept of the scint-aTEF and its expected impact on background reduction and neutrino mass sensitivity, based on simulations.

This work is supported by the Helmholtz Association and by the Ministry for Education and Research BMBF (grant numbers 05A23PMA, 05A23PX2, 05A23VK2, and 05A23WO6).

T 40.2 Tue 16:15 Geb. 30.23: 2/17

Online Radiopurity Analysis with BiPo coincidences in the JUNO Pre-Detector OSIRIS — •Konstantin Schweizer[1], Lothar Oberauer[1], Kai Loo[4], and Michael Wurm[2,3] — [1]Technische Universität München, Physik Department, James-Franck-Str., 85748 Garching, Germany — [2]Institute of Physics, Johannes Gutenberg University Mainz Staudingerweg 7, 55128 Mainz, Germany — [3]Institute of Physics and Excellence Cluster PRISMA+, Johannes-Gutenberg Universität Mainz, Mainz, Germany — [4]University of Jyväskylä, Faculty of Mathematics and Science, Ylistönrinne (YF) Survontie 9 B, Jyväskylä, Finland

The organic liquid scintillator-based JUNO experiment (Jiangmen Underground Neutrino Observatory) aims to resolve the neutrino mass hierarchy. This goal requires the radiopurity of the scintillator to be very high.

The 20^3 OSIRIS pre-detector will monitor the level of radioactive contaminations in the liquid scintillator as the last device in the scintillator production chain. OSIRIS will determine the radiopurity right before filling the JUNO central detector. We will measure the level of U/Th contaminations by exploiting the coincident signals of a Bi β-decay to Po immediately followed by an α-decay to Pb. This talk presents the status of developing an in-situ analysis of this method within the OSIRIS online monitoring software framework.

This work is supported by the DFG Research Unit "JUNO" (FOR2319).

T 40.3 Tue 16:30 Geb. 30.23: 2/17

Testbeam measurements with the first multi-cell prototype of the Surrounding Background Tagger of the proposed 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 in the decay vessel walls and its surrounding. SBT is based on liquid scintillator (LAB-PPO) filled cells. Light collection is performed through Wavelength-Shifting Modules (WOMs) made of PMMA and dip-coated with a wavelength shifting dye. We present results obtained with the first multi-cell prototype, consisting of four cells, and implemented with improvements over the previous design of a one-cell prototype, which was successfully tested with positrons in October 2022 at DESY, Hamburg [arXiv:2311.07340]. In October 2023, the four-cell prototype has been tested with muons and electrons at CERN's PS. Each cell was equipped with two WOM tubes, equidistant from the center along the vertical axis. A study about timing resolution of the detector was performed to achieve a better comprehension on the possibility of event reconstruction in the final SBT detector. In parallel, an accurate and detailed Geant4 simulation of the prototype has been built, including the simulation of the electronic signal of the detector. The comparison of the simulation results with the data from the testbeam allows us to gather further information about the detector response and the quality of the built prototype.

T 40.4 Tue 16:45 Geb. 30.23: 2/17

Reflective Coating in the SHiP Surround Background Tagger — •Patrick Deucher, Annika Hollnagel, Manuel Böhles, and Michael Wurm for the SHiP-SBT-Collaboration — Johannes Gutenberg Universität Mainz, Institut für Physik, Staudingerweg 7, 55128 Mainz

The Surround Background Tagger (SBT) is a liquid-scintillator-based background detector in the SHiP Experiment. Divided into segments, it envelops the vacuum decay vessel made of Corten Steel. WOMs with SiPM arrays are used for light detection with a high angular acceptance. The efficiency of such a detector type can be increased by optimizing the light collection, enhancing the transparency of the scintillator (purification and addition of different fluorophores) and increasing the reflectivity of the inner detector walls. Following results of Photon Transport Simulations that indicate an increase of light yield by a factor of 4-5 by applying a highly diffuse reflector to the inner walls of a detector, a Bariumsulfate-based reflective coating ("OPRC" by Berghof Fluoroplastic Technology GmbH) has been developed. This talk will discuss results of a second large-scale application of the reflective coating in a 4-cell liquid scintillator detector for the test beam 2023 at CERN. Several improvements were made compared to the first application in a 1-cell prototype in 2022, such as using a rust protection primer to prevent yellowing of the coating through a reaction with the Corten Steel. This work is supported by the BMBF Project 05H2018 - High-D and the Cluster of Excellence PRISMA+.

T 40.5 Tue 17:00 Geb. 30.23: 2/17

Testbeam Performance and Photoelectron Yields of 4-cell Prototype for the SHiP SBT — •Fairhurst Lyons for the SHiP-SBT-Collaboration — Universitaet 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. Four such cells were tested at a CERN $\mu-$ testbeam in October 2023; analysis of performance and photoelectron yields will be presented here.

T 40.6 Tue 17:15 Geb. 30.23: 2/17

Background suppression in the SHiP experiment with the Surround Background Tagger — •Anupama Reghunath — Institut für Physik, Humboldt- Universität zu Berlin, Berlin, Germany

The Search for Hidden Particles (SHiP) experiment at CERN is proposed as a dedicated proton beam dump facility in the ECN3 cavern, aiming to explore feebly interacting particles produced by 400 GeV/c protons impinging on a heavy metal target. Over a 15-year span, the objective is to accumulate $6 \cdot 10^{20}$ proton on target with a detector setup that allows suppression of possible background to a negligible level. The experiment focuses on optimizing sensitivity for models featuring long-lived exotic particles below 10 GeV/c^2 and minimizing Standard Model (SM) particle flux. The Surround Background Tagger (SBT) is a critical component surrounding the 50 m long decay vessel, instrumental in suppressing background by detecting charged particles either entering the vacuum vessel from outside, or produced in inelastic interactions in the vacuum vessel walls. This is crucial for distinguishing actual signals from background, particularly as long-lived SM particles produced in these interactions can mimic the signatures of hidden sector particles. This presentation will discuss simulation studies showing how different background sources are vetoed robustly with the focus of the Surrounding Background Tagger (SBT).

T 40.7 Tue 17:30 Geb. 30.23: 2/17

Stilbene scintillation anisotropy for neutron source localisation — •Glen Kiely, Nina Höflich, and Oliver Pooth — III.

Physikalisches Institut B, RWTH Aachen University, 52074 Aachen

Stilbene is a widely used scintillator material which is best known for its pulse shape discrimination capability, allowing for the distinction between neutron and gamma-ray interactions. This ability is utilised in neutron and gamma ray tomography at the neutron detectors research group at RWTH Aachen. Stilbene has also recently been applied in the field of nuclear non-proliferation for the detection of special nuclear materials.

The scintillation properties of stilbene crystals were investigated, with a particular focus on anisotropy of the scintillation light output. The anisotropy has been characterised by previous studies, and the crystal axes of maximum and minimum response have been identified. The scintillation anisotropy was implemented into Geant4 for the first time through a modification of the G4Scintillation class. A Geant4 model of a detector capable of neutron source localisation was then simulated, which leverages the inherent scintillation anisotropy through rotation of the detector, to determine the location of a neutron source relative to the crystal axes.

T 40.8 Tue 17:45 Geb. 30.23: 2/17

Simultaneous tomography with fast neutrons and gamma rays using the scintillator stilbene — •Nina Höflich, Glen Kiely, and Oliver Pooth — III. Physikalisches Institut B, RWTH Aachen University, 52074 Aachen

The neutron detectors group at the III. Physics Institute B, RWTH Aachen University, develops a multi-pixel detector for a compact fast neutron imaging setup. Imaging with fast neutrons in addition to X- or gamma ray imaging can provide complementary information about the object of interest.
The scintillator stilbene, cut into 16 cuboids arranged in a 4×4 array, is used for particle detection. The scintillation light is detected with a SiPM array. The pixel size is $(6 \times 6)\,\mathrm{mm}^2$. The usage of stilbene allows to distinguish neutron- and gamma-induced signals in the detector. An Americium-Beryllium neutron source delivers fast neutrons of up to 11 MeV as well as gamma rays of 4.44 MeV for our measurements. Tomographic measurements of simple test objects were performed, combining the measured fast neutron and gamma attenuation.
Additionally, a Geant4 simulation was developed enabling to simulate various configurations for imaging with fast neutrons and gammas. It allows to simulate tomographies with the current detector, but also various configurations (e.g. detector pixel sizes, arrangements, etc) for tomography with a future, larger detector.
In this talk, setup and results of both the tomographic measurements and the Geant4 simulation will be presented.