T 143: Neutrinos VII

Time: Thursday 17:30–19:00 Location: POT/0006

T 143.1 Thu 17:30 POT/0006

Development of novel water-based liquid scintillator with pulse-shape discrimination capabilities — •Hans Theodor Josef Steiger[1,2], Matthias Raphael Stock[3], Manuel Böhles[2], David Dörflinger[3], Ulrike Fahrendholz[3], Daniele Guffanti[4], Meishu Lu[3], Lothar Oberauer[3], Andreas Steiger[3], Michael Wurm[1,2], and Dorina Zundel[2] — [1]Cluster of Excellence PRISMA+ — [2]Johannes Gutenberg-Universität Mainz — [3]Technische Universität München — [4]Università degli Studi di Milano-Bicocca

Future hybrid detectors in the field of neutrino physics have to combine high-resolution energy determination down to low thresholds by scintillation light detection and directional reconstruction with the help of Cherenkov radiation. The spectrum of potential applications is broad, ranging from long-baseline oscillation experiments to the measurement of low-energy solar neutrinos. One possible detector medium for these next-generation detectors is Water-based Liquid Scintillator (WbLS). Here, organic scintillators are dissolved colloidally in small quantities in highly pure water with the aid of surfactants. In this talk, a novel WbLS (based on Triton X-100) will be presented. Particular attention will be paid to its key properties, such as micelle size, scattering length and transparency. In addition, a study of its light yield as well as pulse-shape discrimination capabilities will be presented. This work has been supported by the Clusters of Excellence PRISMA+ and ORIGINS, the DFG Sonderforschungsbereich 1258 as well as the Bundesministerium für Bildung und Forschung (Verbundprojekt 05H2018: R&D Detectors and Scintillators).

T 143.2 Thu 17:45 POT/0006

Development of novel organic liquid scintillators with slow light emission — •Manuel Böhles[1], Hans Theodor Josef Steiger[1,2], David Dörflinger[3], Lothar Oberauer[3], Matthias Raphael Stock[3], and Michael Wurm[1,2] — [1]Johannes Gutenberg-Universität Mainz — [2]Cluster of Excellence PRISMA+ — [3]Technische Universität München

One of the most promising approaches for the next generation of neutrino experiments is the realization of large hybrid Cherenkov/scintillation detectors made possible by recent innovations in photodetection technology and liquid scintillator chemistry.

This talk will focus on the development of such detector liquids with particularly slow light emission. Various attempts are currently underway, such as the use of special wavelength shifters or the use of blended multi-solvent cocktails. Several of these mixtures are compared with respect to their fundamental characteristics (scintillation efficiency, transparency, and time profile of light emission). In addition, the optimization of the admixture of wavelength shifters for a scintillator with particularly high light emission and pulse shape discrimination capability is presented. Newly developed purification methods based on column chromatography and fractional vacuum distillation for several candidate solvents are also discussed.

The work is supported by the Cluster of Excellence PRISMA+, the DFG Sonderforschungsbereich 1258 and the Bundesministerium für Bildung und Forschung (BMBF Verbundprojekt 05H2018: R&D Detectors and Scintillators).

T 143.3 Thu 18:00 POT/0006

Fluorescence Time Profiles of Slow Organic and Water-Based Liquid Scintillators using a Pulsed Neutron Beam — •Matthias Raphael Stock[1], Hans Steiger[2], Lothar Oberauer[1], David Dörflinger[1], Ulrike Fahrendholz[1], Manuel Böhles[2], Stefan Schoppmann[2,3], Luca Schweizer[1], Korbinian Stangler[1], and Dorina Zundel[2] — [1]Physik-Department, Technische Universität München — [2]Johannes Gutenberg University Mainz, Institute of Physics and Cluster of Excellence PRISMA+ — [3]University of California, Department of Physics, Berkeley, CA 94720-7300, USA

We performed two liquid scintillator (LS) characterization experiments using a pulsed neutron beam at the CN accelerator of INFN Laboratori Nazionali di Legnaro. At different energies ranging from 3.5 MeV to 5.5 MeV, one experiment measures the quenching factor of recoil protons while the other one measures the fluorescence time profile of recoil protons. This talk is about the time profile experiment, where we show studies of slow organic and water-based LS mixtures, which will be relevant for future neutrino detectors, e.g., Theia. Differences in the time profiles after gamma and neutron excitation would open the window to perform pulse shape discrimination and therefore advances the ability to distinguish the neutrino signal from background. This work is supported by the BMBF Verbundforschung 05H2018 "R&D Detektoren (Szintillatoren)", the DFG CRC 1258 "NDM", the DFG Clusters of Excellence "PRISMA+" and "Origins".

T 143.4 Thu 18:15 POT/0006

Background investigations with passive transverse energy filters at KATRIN — •Dominic Hinz for the KATRIN-Collaboration — Karlsruhe Institute of Technology (KIT)

The measurement of the absolute mass scale of neutrinos with an unprecedented sensitivity of $0.2\,\mathrm{eV/c^2}$ is the key goal of the KATRIN experiment. This requires a detailed understanding of background processes in the large main spectrometer. Currently, the measured background level exceeds the design value by more than one order. An initial model assigned background events to originate from Rydberg H-states generated by the decay of traces of surface-implanted Pb-210. Highly-excited Rydberg states from the inner spectrometer surface are long-lived and can be ionised by thermal radiation. The resulting low-energy electrons on the meV-scale are then accelerated by the retarding potential, thus they only possess a very small transverse energy, which is in contrast to signal electrons. In a first step we have performed measurements with a passive transverse energy filter (pTEF) implemented as a micro-structured honeycomb gold plate. In this talk we present the measured transmission of background electrons through the pTEF and compare results at different magnetic field values with the initial and refined background models.

This work is supported by the Helmholtz Association (HGF), the Ministry for Education and Research BMBF (05A17PM3, 05A17PX3, 05A17VK2, and 05A17WO3), the Helmholtz Alliance for Astroparticle Physics (HAP), and the Helmholtz Young Investigator Group (VH-NG-1055).

T 143.5 Thu 18:30 POT/0006

Background reduction at the KATRIN experiment with an active transverse energy filter (aTEF) — •Sonja Schneidewind[1,4], Kevin Gauda[1,4], Kyrill Blümer[1,4], Christian Gönner[1,4], Volker Hannen[1,4], Hans-Werner Ortjohann[1,4], Wolfram Pernice[2,3], Lukas Pöllitsch[1,4], Richard Salomon[1,4], Maik Stappers[2], and Christian Weinheimer[1,4] — [1]Institute for Nuclear Physics, University of Münster — [2]CeNTech and Physics Institute, University of Münster — [3]Kirchhoff-Institute for Physics, University of Heidelberg — [4]KATRIN Collaboration

The KATRIN experiment aims at the direct measurement of the incoherent sum of neutrino masses via precision endpoint spectroscopy of the tritium β-decay. Despite advances in background reduction, the elevated background level prohibits to achieve the target sensitivity of $0.2\ \mathrm{eV/c^2}$ (90% C.L.).

One option to reduce the background is the implementation of an active Transverse Energy Filter (aTEF, Eur. Phys. J. C 82, 922 (2022)), which makes use of the specific angular distribution of the background and discriminates electrons at the detector based on their pitch angle. The contribution presents studies concerning the potential background reduction and related sensitivity improvement from an implementation of an aTEF at KATRIN.

This work is supported by BMBF under contract number 05A20PMA and Deutsche Forschungsgemeinschaft DFG (Research Training Group GRK 2149) in Germany.

T 143.6 Thu 18:45 POT/0006

Investigation of electron backscattering for the TRISTAN project — •Daniela Spreng — Technical University Munich, James-Franck-Straße 1, 85748 Garching bei München

One open question in the field of neutrino physics is the existence of keV-sterile neutrinos, which would be a possible Dark Matter candidate. They are experimentally accessible through their mixing with the active neutrino flavours and would therefore lead to a kink-like distortion in the beta-decay spectrum. The KATRIN experiment aims to search for this kink-like structure in the tritium beta-decay spectrum by installing a new multi-pixel silicon drift detector named TRISTAN.

To resolve the kink, the detector electron response has to be very well understood. In this talk the effect of the backscattering on the detected electron spectrum for different initial electron energies and incident angles will be presented. To analyse these effects, a dedicated test stand was build and measurements were compared to Geant4 simulations.

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