T 102: Neutrino Physics without Accelerators 7

Time: Thursday 16:15–18:35 Location: T-H34

T 102.1 Thu 16:15 T-H34

Sensitivity Study with Theia Detector — •Wei-Chieh Lee, Caren Hagner, and Björn Wonsak — Institut für Experimentalphysik, Universität Hamburg, 22761 Hamburg, Germany

With new technologies exploiting the advantages of both the Cherenkov and scintillation lights, a new type of neutrino detector, Theia, is able to determine the direction and species of incoming particles while still having a good energy resolution and low threshold. In consequence, Its ability to reach high levels of background rejection would allow us to improve the precision in the measurement of oscillation parameters when employed at a long baseline neutrino experiment. For this, the realization of Theia is planned at the far site of DUNE, whose near detector also provides information to further improve the measurement of neutrino oscillation. In this experiment, Theia can have enough sensitivity to the determination of mass hierarchy and CP phase of neutrino oscillation, the two missing pieces of our knowledge in the topic. In order to simulate such experiments, a software tool called GLoBES is developed for describing the detector properties and doing analysis easily, and is used in this sensitivity study.

T 102.2 Thu 16:30 T-H34

On the road to Theia: current status of the Mainz WbLS test cell DISCO — •Manuel Böhles[1], Daniele Guffanti[1], Hans Steiger[1,2], and Michael Wurm[1] — [1]Johannes Gutenberg-Universität Mainz, Staudinger Weg 7, 55124 Mainz, Germany — [2]Technische Universität München, James-Franck-Str. 1, 85748 Garching b. München, Germany

The detection of neutrinos using water-based liquid scintillators (WbLS) is a promising method in the field of detector development. Its strength lies in combining high-resolution energy determination with a low energy threshold through the use of scintillation light and in the 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. The key point of this new technique is the discrimination between scintillation and Cherenkov photons, which can be achieved by exploiting the different chromatic features, time behaviour and angular emission. In order to characterise this innovative medium and to prove whether scintillation and Cherenkov radiation can be distinguished, we have built a test cell equipped with 16 ultrafast photomultipliers that will provide useful insights towards a new generation of detectors. In addition, complementary ultrafast photodetection systems (SiPM array, LAPPD) can be investigated in future studies. This work is supported by the BMBF Verbundprojekt 05H2018: R&D Detectors and Scintillators.

T 102.3 Thu 16:45 T-H34

Characterisation measurement of LAPPDs for ν-detectors — •Benedict Kaiser, Lukas Bieger, David Blum, Marc Breisch, Srijan Delampady, Jessica Eck, Gina Grünauer, Tobias Heinz, Frieder Kohler, Tobias Lachenmaier, Axel Müller, Tobias Sterr, Alexander Tietzsch und Jan Züfle — Universität Tübingen, Physikalisches Institut, Auf der Morgenstelle 14, 72076 Tübingen

Large Area Picosecond Photodetectors (LAPPDs) are novel photodetectors suitable for use in upcoming neutrino detection experiments. LAPPDs incorporate a square multi-alkali photocathode, a chevron pair of microchannel plates (MCPs) for photoelectron multiplication and multiple anode strips for readout, all in a hermitically sealed package.

The design of the LAPPDs results in an unprecedented time resolution better than 70 ps and a spatial resolution of 2.5 mm and 0.8 mm in x- and y-direction respectively at uniform gains of 10^6 to 10^7 over a large active detector area of more than 370 cm^2.

Currently, we are commissioning a setup to test LAPPDs for their performance and key characteristics. This talk will outline the working principle as well as characteristics of an LAPPD and measurement results of the first LAPPD received from the manufacturer will be discussed.

Group Report T 102.4 Thu 17:00 T-H34

Neutrino mass determination with ^{163}Ho-loaded MMCs – the ECHo experiment — •Arnulf Barth for the ECHo-Collaboration — Kirchhoff-Institute for Physics, Heidelberg University

The Electron Capture in ^{163}Ho experiment, ECHo, is a running experiment for the determination of the neutrino mass scale via the analysis of the end point region of the ^{163}Ho electron capture spectrum. In the first phase, ECHo-1k, about 60 MMC pixels enclosing ^{163}Ho ions for an activity of about 1 Bq per pixel have been operated for several months. The goal of this first phase is to reach a sensitivity on the effective electron neutrino mass below 20 eV/c^2 by the analysis of a ^{163}Ho spectrum with more than 10^8 events. We discuss the characterization of the single pixel performance and the stability over the measuring period. Results from the analysis of the acquired data will be presented with focus on data reduction efficiency and on the procedures to obtain the final high statistics spectrum. A preliminary analysis of the ^{163}Ho spectral shape will be described and the expected sensitivity on the effective electron neutrino mass on the basis of the properties of the presented spectrum will be discussed. In conclusion, we will present how the performance obtained by the MMC arrays used during the first phase of the ECHo experiment have led to the design of the MMC arrays for the second phase, ECHo-100k. In this phase, about 12000 MMC pixels each hosting ^{163}Ho for an activity of 10 Bq will be simultaneously operated thanks to the microwave SQUID multiplexing readout. Operating these arrays for three years will allow for reaching a sensitivity on the electron neutrino mass at the 1 eV/c^2 level.

T 102.5 Thu 17:20 T-H34

From Temperature pulses to high statistic Ho-163 spectrum: Analysis Algorithms for the ECHo Experiment — •Markus Griedel, Arnulf Barth, Robert Hammann, Daniel Hengstler, Neven Kovac, Federica Mantegazzini, Andreas Fleischmann, and Loredana Gastaldo — Kirchhoff-Institute for Physics, Heidelberg University

The goal of the Electron Capture in Ho-163 (ECHo) experiment is the determination of the effective electron neutrino mass by analysing the electron capture (EC) spectrum of Ho-163. The ECHo experiment uses Metallic magnetic calorimeters (MMCs) operating at millikelvin temperatures, in which the Ho-163 has been implanted. In order to reliably infer the energy of Ho-163 events and discard triggered noise or pile-up events, fast and robust analysis algorithms are required. For this, algorithms based on filters acting on the trigger time of the events and on filters using pulse shape information were developed. To convert the measured temperature pulses into an energy spectrum, further steps are takes, as corrections for temperature shifts and energy calibration.

We describe the steps we took for the reduction of the data acquired during the first phase of the ECHo experiment, ECHo-1k; as well as the process to build a high statistic Ho-163 spectrum from data acquired with several single Ho-163 implanted MMCs.

T 102.6 Thu 17:35 T-H34

From ECHo-1k to ECHo-100k: Optimisation of the high-resolution metallic magnetic calorimeters with embedded ^{163}Ho for the determination of the electron neutrino mass — •Neven Kovac[1], Federica Mantegazzini[1], Loredana Gastaldo[1], Arnulf Barth[1], Markus Griedel[1], Andreas Fleischmann[1], Matthew Herbst[1], Daniel Hengstler[1], Andreas Reifenberger[1], Christian Enss[1], Christoph Düllmann[2], Holger Dorrer[2], Tom Kieck[3], Nina Kneip[3], and Klaus Wendt[3] — [1]Kirchhoff-Institut für Physik, Universität Heidelberg — [2]Department of Chemistry - TRIGA Site, Johannes Gutenberg-Universität Mainz — [3]Institute of Physics, Johannes Gutenberg-Universität Mainz

Large arrays of metallic magnetic calorimeters have been selected for the ECHo experiment due to the excellent energy resolution, the fast response time and the almost linear detector response which allows for a reliable energy calibration. Based on the performance achieved with the detector array developed for the first phase of the ECHo experiment, ECHo-1k, the design of the ECHo-100k arrays has been conceived. This new design features an optimized single pixel geometry, upgrade of the on-chip thermalisation layout and a high operational flexibility. First wafers with ECHo-100k arrays have been fabricated and several arrays have been fully characterized. We summarise the performance achieved with the ECHo-1k and the newly developed

ECHo-100k arrays in comparison with the design performance. We discuss how these results are important for achieving the goals defined for the ECHo-100k experiment.

T 102.7 Thu 17:50 T-H34

The MONUMENT Experiment; ordinary muon capture as a benchmark for $0\nu\beta\beta$ decay nuclear structure calculations — Elisabetta Bossio[1], Elizabeth Mondragon[1], Stefan Schönert[1], •Mario Schwarz[1], and Christoph Wiesinger[1,2] for the MONUMENT-Collaboration — [1]Physik-Department, Technische Universität München, Garching — [2]Max-Planck-Institut für Physik, München

Extracting particle physics properties from neutrinoless double-beta ($0\nu\beta\beta$) decay requires a detailed understanding of the involved nuclear structures. Still, modern calculations of the corresponding nuclear matrix elements (NMEs) differ by factors 2-3. The high momentum transfer of Ordinary Muon Capture (OMC) provides insight into highly excited states similar to those that contribute virtually to $0\nu\beta\beta$ transitions. The precise study of the γ's following the OMC process makes this a promising tool to validate NME calculations. The MONUMENT collaboration is performing a series of explorative OMC measurements involving typical $\beta\beta$ decay daughter isotopes such as ^{76}Se and ^{136}Ba, as well as other benchmark isotopes. In this talk the experiment carried out at the Paul Scherrer Institute and first results from the beamtime in 2021 will be presented. This research is supported by the DFG Grant 448829699.

T 102.8 Thu 18:05 T-H34

Antineutrino Monitoring with Liquid Organic Time Projection Chambers — Johannes Bosse, Sarah Friedrich, Malte Göttsche, Helge Haveresch, •Thomas Radermacher, Stefan Roth, Georg Schwefer, and Hagen Weigel — RWTH Aachen University - Physics Institute III B, Aachen, Germany

For the first few hundreds of years the dominant radioactivity of nuclear waste comes from long-lived beta-decaying elements that are emitting antineutrinos in the low-energy region below 5 MeV. In a newly envisioned application for nuclear monitoring purposes, we want to use these antineutrinos to monitor the content of nuclear waste repositories. We are investigating a time projection chamber filled with an organic liquid aiming at full reconstruction of inverse beta decay events. In the low energy region, the direction of the neutron in IBD is strongly correlated to the direction of the incoming antineutrino. For this we study to which extend the neutron direction can be reconstructed by its first few elastic scatterings with the nuclei of the detector medium. This talk gives an overview on our project and the progress of our simulation studies.

T 102.9 Thu 18:20 T-H34

Development of the comprehensive analysis tools for the Supernova neutrino detectors — •Vsevolod Orekhov and Michael Wurm — Institute of Physics and Cluster of Excellence PRISMA+, JGU Mainz, Germany

A galactic Supernova explosion is a unique neutrino source: detecting the neutrinos from deep inside the star will help us understand both the physics of the core collapse and properties of the neutrino themselves. If a SN neutrino burst arrived at Earth today or in the near future, it would be detected by a variety of ton to kiloton scale neutrino detectors based on different technologies and target media. By combining the analysis of the possible explosion in multiple next generation neutrino experiments, one could significantly improve the precision of determining the neutrino spectra parameters such as the mean energy and spectral index. In this contribution it is shown what one could achieve by doing a simultaneous fit of the energy spectra of JUNO, DUNE and IceCube-like detectors assuming a common flavour-dependent neutrino signal. This work was supported by funds of the DFG.