T 33: Neutrino-Detektoren I

Zeit: Dienstag 16:00–18:30 Raum: S07

T 33.1 Di 16:00 S07

Development of an on-line attenuation length monitor for JUNO — •Heike Enzmann and Michael Wurm for the JUNO-Collaboration — Johannes Gutenberg-Universität, Mainz, Germany

The future neutrino experiment JUNO (Jiangmen Underground Neutrino Observatory) will determine the neutrino mass hierarchy by observing reactor neutrinos in liquid scintillator. To reach the required energy resolution of 3 % @ 1MeV, a very good LS transparency (attenuation length $a \leq$ b 20 m @ 430 nm) is required. There are several purification processes for the LS during the liquid handling in Juno Before filling, the quality of the LS will be monitored by measuring the attenuation length. This talk covers the development and testing of an on-line attenuation length monitor for LS quality control. In a relative measurement over two scintillator samples, potential changes in the attenuation length will be monitored. This work is supported by DFG research unit "JUNO".

T 33.2 Di 16:15 S07

Radon Monitoring in gaseous Nitrogen used for the Filling of the Central Detector of JUNO and OSIRIS — •Hans Theodor Josef Steiger, Alexander Gardanow, Philipp Landgraf, and Lothar Oberauer for the JUNO-Collaboration — Physik Department der Technischen Universität München, James-Franck-Straße 1, 85748 Garching bei München

The planned JUNO (Jiangmen Underground Neutrino Observatory) Detector will use 20 kt of liquid scintillator (LS) based on LAB (Linear AlkylBenzene) as neutrino target within an acrylic sphere with a diameter of 35.4 m. For the filling of this sphere as well as for the filling of OSIRIS (Online Scintillator Internal Radioactivity Investigation System) with LS pressurized nitrogen will be used. To avoid a contamination of the LS with ^{222}Rn, it's content in the nitrogen gas will be monitored. In this talk the status of a prototype radon monitoring system based on a proportional chamber operated in pure nitrogen will be presented as well as pulse shape analysis techniques applied for efficient background reduction. This work is supported by the DFG Cluster of Excellence "Origin and Structure of the Universe", the DFG research unit "JUNO" and the Maier-Leibnitz-Laboratorium.

T 33.3 Di 16:30 S07

Attenuation length measurement of liquid scintillators with CELLPALS — •Tobias Heinz, Axel Müller, David Blum, Alexander Tietzsch, Tobias Sterr, Marc Breisch, and Tobias Lachenmaier — Eberhard Karls Universität Tübingen

In large liquid scintillator detectors like the JUNO detector a high optical transparency for the scintillation light is one of the key requirements. To quantify the optical transparency, a measurement of the attenuation length is crucial. The measurement of attenuation lengths of several tens of meters is difficult due to the necessity of a sufficient long light path through the sample to lead to a measurable decrease of the light intensity.

This talk will present the newly developed CELLPALS technique to measure the attenuation length of liquid scintillators using an optical cavity to extend the effective light path through the medium and therefore providing a more precise measurement of the attenuation length. The current status of the experimental setup and first results will be presented.

This work is supported by the Deutsche Forschungsgemeinschaft.

T 33.4 Di 16:45 S07

Status update on AURORA — •Wilfried Depnering and Michael Wurm for the JUNO-Collaboration — Johannes Gutenberg - Universität, Institut für Physik, Staudingerweg 7, 55122 Mainz, Germany

The Jiangmen Underground Neutrino Observatory (JUNO) is a reactor antineutrino experiment which aims to determine the neutrino mass hierarchy with at least 3σ significance. In order to reach that goal, an energy resolution of 3% @ 1 MeV is required. Therefore, the transparency of the LS (attenuation length $\geq 20\,\mathrm{m}$ @ 430 nm) has to be sufficiently high and stable during the whole operation time. One device for *in-situ* monitoring of the optical LS quality is AURORA (**A** **U**nit for **R**esearching **O**n-line the LSc t**RA**nsparency) inside the central detector of JUNO. It allows to detect potential aging effects of the liquid and a gradient in its refractive index. The latter can be caused by a temperature gradient and would lead to curved light propagation, which would need to be taken into account during the event reconstruction. This talk presents the current status of AURORA. The development is funded by the DFG Research Unit "JUNO".

T 33.5 Di 17:00 S07

Status of the Ho-163 Source Preparation, Purification and Characterization for the ECHo Neutrino Mass Measurement — •Klaus Wendt, Holger Dorrer, Christoph Düllmann, and Tom Kieck for the ECHo-Collaboration — Johannes Gutenberg-Universität Mainz

The ECHo collaboration addresses the determination of the electron neutrino mass by recording the spectrum following electron capture of Ho-163. After production from enriched Er-162 in the ILL high flux nuclear reactor the Ho-163 is separated and purified before implantation into the tiny 0.18 mm x 0.18 mm Au-absorbers of the metallic magnetic calorimeters of the ECHo detector array. Highly efficient laser resonance ionization and high transmission mass spectrometric selection is carried out at the 30 kV RISIKO magnetic sector field mass separator. This step ensures elemental and isotopic selectivity for ultra-pure Ho-163 ion implantation with sub-millimeter beam spot size and minimum losses of the precious radioisotopic material. In-situ deposition of Au onto the implantation area of the absorbers using pulsed laser deposition is performed in parallel with the ion implantation, ensuring homogeneous Ho-163/Au-layer formation and reducing disturbing erosion from the sputtering process during implantation. The purity of the ECHo source material during the whole preparation process is monitored by a variety of analytical techniques, including gamma spectrometry, neutron activation, and different mass spectrometric approaches, i.e. ICP-MS, AMS and RIMS. Specifications achieved are discussed in comparison to the needs for the ECHo experiment.

T 33.6 Di 17:15 S07

Results of the commissioning of the gaseous Kr-83m calibration source of KATRIN — •Hendrik Seitz-Moskaliuk for the KATRIN-Collaboration — Karlsruher Institut für Technologie, Institut für Experimentelle Teilchenphysik, Hermann-von-Helmholtz-Platz 1, 76344 Eggenstein-Leopoldshafen

The metastable isotope Kr-83m de-excites via internal conversion and offers several intense conversion electron lines in the range from 7-32 keV with natural line widths of 1-2 eV. This makes it an ideal nuclear standard for the calibration of high-precision spectroscopic experiments like KATRIN. KATRIN will measure the electron antineutrino mass with an unprecedented precision of 0.2 eV/c^2 and utilizes three different kinds of Kr-83m sources for calibration and monitoring purposes. The first commissioning measurements of the gaseous Kr-83m source were performed in summer 2017. This talk summarizes the results. Important benchmarks for future calibration measurements are set and the outstanding capabilities for high-resolution spectroscopy with KATRIN are demonstrated. This work is supported by BMBF (05A14VK2) and the Helmholtz Association.

T 33.7 Di 17:30 S07

Atomic Tritium Source Design for Project 8 — •Alec Lindman, Sebastian Böser, and Peter Peiffer — PRISMA+ Cluster of Excellence, Johannes Gutenberg Universität Mainz

Project 8 is a phased approach to measuring the absolute neutrino mass with Cyclotron Radiation Emission Spectroscopy of tritium β decay electrons. All existing tritium β decay m_ν measurements use molecular T_2, which has a relatively broad final state spectrum. An atomic T source and a $\sim$ 10 m^3 fiducial trap volume will enable the design sensitivity. This talk will discuss the motivations for an atomic T source in light of engineering feasibility and the design sensitivity, including recent results from a hydrogen test stand. Parallel technology development efforts in Project 8 aim to deliver a trap with magnetic field uniformity of 10^{-7}, filled with T having a T_2 contamination less than 10^{-6} and instrumented with a spatially resolving antenna array to measure the femtowatt CRES signals. In such a trap, one year of runtime with 10^{18} T atoms should provide 40 meV sensitivity to the neutrino mass.

T 33.8 Di 17:45 S07

Development of MMC based combined photon and phonon detector for rare event searches — •Freerik Forndran[1], Felix Ahrens[1], Christian Enss[1], Andreas Fleischmann[1], Loredana Gastaldo[1], Sebastian Kempf[1], Yong-Hamb Kim[2], Daniel Unger[1], and Clemens Velte[1] — [1]Kirchhoff Institute for Physics, Heidelberg University, Germany — [2]IBS Center for Underground Physics, Daejeon, Rep. of Korea.

In the search for rare events, a simultaneous measurement of photons and phonons produced after an event in a scintillating crystal operated at mK temperatures enables an efficient background rejection. This is due to the fact that the light yield depends on the mass, allowing for particle discrimination. This approach can be used for an investigation of the neutrinoless double beta decay as well as for a direct detection of dark matter. We present the design of a combined photon and phonon detector based on metallic magnetic calorimeters (MMCs). Simulations predict an energy resolution of $\Delta E_{\mathrm{FWHM}} < 10\,\mathrm{eV}$, a signal rise time of $\tau_0 < 50\,\mu\mathrm{s}$ and a signal decay time of $\tau_1 < 10\,\mathrm{ms}$ for the photon detector and $\Delta E_{\mathrm{FWHM}} < 100\,\mathrm{eV}$, $\tau_0 < 200\,\mu\mathrm{s}$ and $\tau_1 < 10\,\mathrm{ms}$ for the phonon detectors. The combined photon and phonon detector design will be described with emphasis on the tower design of the detector setup able to host several crystals. The challenges of the fabrication steps will be discussed. In conclusion we will present the characterization of first prototypes of photon and phonon detectors.

T 33.9 Di 18:00 S07

Effects of Holmium ions embedded in absorbers of ECHo detector arrays — •Andreas Reifenberger, Matthew Herbst, Clemens Velte, Federica Mantegazzini, Andreas Reiser, Andreas Fleischmann, Loredana Gastaldo, Sebastian Kempf, and Christian Enss for the ECHo-Collaboration — Kirchhoff Institute for Physics, Heidelberg University

We investigate dilute alloys of holmium in gold and silver in order to determine the impact of their specific heat on the performance of the microcalorimeters in the neutrino mass experiment ECHo. In particular, we focus on alloys with atomic concentrations of $x_{\mathrm{Ho}} = 0.01\,\% - 1\,\%$ at temperatures between 10 mK and 800 mK. Due to the large total angular momentum $J = 8$ and nuclear spin $I = 7/2$ of holmium, the specific heat of Ag:Ho and Au:Ho depends on the detailed interplay of various interactions. This makes it unfeasible to accurately determine the specific heat of these materials numerically. Instead, we acquire the desired information through experiment, using three different experimental set-ups. The results from measurements on five holmium alloys show that the specific heat of these materials is dominated by a large Schottky anomaly with its maximum at $T \approx 250\,\mathrm{mK}$, which we attribute to hyperfine splitting and crystal field interactions. RKKY and dipole-dipole interactions between the holmium atoms cause additional, concentration-dependent effects. We discuss differences between Ag:Ho and Au:Ho, and conclude that alloys with $x_{\mathrm{Ho}} \approx 1\%$ are suitable for ECHo, where detectors are operated at $T \leq 30\,\mathrm{mK}$.

T 33.10 Di 18:15 S07

Ionisation of Pb-210 induced Rydberg atoms in the KATRIN experiment — •Dominic Hinz for the KATRIN-Collaboration — Karlsruhe Institute of Technology (KIT), ETP, Postfach 3640, 76021 Karlsruhe

The **Ka**rlsruhe **Tri**tium **N**eutrino (KATRIN) experiment aims to measure the effective neutrino mass of electron anti neutrinos in a model-independent way by precise determination of the beta-spectrum of molecular tritium. Dedicated commissioning measurements showed that the sensitivity is affected by background electrons which are correlated to radioactive decays of a ^{210}Pb contamination of the inner spectrometer surfaces. To achieve the sensitivity of $m_\nu = 0.2\,\mathrm{eV/c^2}$ (90% C.L.) on the effective neutrino mass, knowledge of statistical and systematic uncertainties as well as the background processes is essential. The sensitivity of the KATRIN experiment is currently limited by a higher than anticipated background. Therefore, an understanding of the remaining background processes induced by radioactivity is of high relevance. The background model presented in this talk describes the generation of background electrons by ionisation of atoms in excited states which are sputtered from the main spectrometer vessel by alpha decays of ^{210}Po, a daughter nuclei of long-living ^{210}Pb.

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