T 105: Experimentelle Methoden der Astroteilchenphysik 4

Zeit: Donnerstag 16:45–19:00 Raum: P7

T 105.1 Do 16:45 P7

Performance test of the GERDA Phase II detector assembly — •Tobias Bode[1], Konstantin Gusev[1], Bernhard Schwingenheuer[2], and Victoria Wagner[2] for the GERDA-Collaboration — [1]Technische Universität München, München — [2]Max-Planck Institut für Kernphysik, Heidelberg

After the successful completion of Phase I the GERDA (Germanium Detector Array) experiment will continue the search for the neutrinoless double beta decay ($0\nu\beta\beta$) of ^{76}Ge with the improved setup of Phase II. To achieve a half-life sensitivity of 10^{26} yr the target mass will be doubled and a reduction of background index to $< 10^{-3}$ cts/(keV kg yr) is aimed for. Major hardware modifications and upgrades are currently on going. They include the deployment of a new radio pure low mass detector assembly and use of radio pure close-by preamplifying electronics. The performance of the Phase II detector assembly will be presented. This work was partly funded by BMBF 05A11W01.

T 105.2 Do 17:00 P7

Studies of the reflectivity properties of teflon for VUV light in liquid xenon — •Cecilia Levy, Karen Bokeloh, Ethan Brown, Christian Huhmann, Stephan Rosendahl, and Christian Weinheimer — Institut fuer Kernphysik, Wilhelm-Klemm Str 9, 48149 Muenster

Ordinary matter makes up only 5% of the universe as we know it. Out of the remaining 95%, 25% are composed of a new type of matter called dark matter. By looking for the interaction of dark matter particles with liquid xenon and the resulting scintillation, the XENON project attempts to discover dark matter in the form of Weakly Interacting Massive Particles (WIMPs). The current experiment XENON100 has achieved a sensitivity of $\sigma < 2.0 * 10^{-45} cm^2$ to the WIMP-nucleon cross section. The experiment now in its next phase, XENON1T, will increase this sensitivity by two orders of magnitude. In order to have a high scintillation collection to detect the low energy recoils of dark matter interactions, a teflon reflector is used, whose reflection properties need to be better understood. For this purpose, a deuterium lamp has been set up, which shines 178 nm light on a teflon sample contained in a VUV transparent quartz tube filled with liquid xenon. The reflected light is then viewed by a movable PMT. This setup allows to measure the specular and diffuse reflectivity of teflon at varying angles of incidence and reflection, allowing for a full model of the reflection process in liquid xenon. Results of these measurements will be discussed. The project is supported by DFG and Helmholtz Allianz for Astroparticle Physics HAP.

T 105.3 Do 17:15 P7

EDELWEISS-III Elektronik und zeitaufgelöster Ionisationskanal — •Bernhard Siebenborn für die EDELWEISS-Kollaboration — Karlsruher Institut für Technologie Postfach 3640 76021 Karlsruhe

Das EDELWEISS Experiment benutzt kryogene (T=18mK) Germanium-Monokristalle (Bolometer) zur direkten Suche nach Dunkler Materie. Ein Ge-Kernrückstoß aufgrund einer elastischen Streuung eines WIMPs kann dabei durch gleichzeitige charakteristische Phonon- und Ladungs-Signale identifiziert werden. In der aktuellen EDELWEISS-III Messphase werden 40 Bolometer mit je 800g Masse und 6 Kanälen (4x Ionisation + 2x Wärme) installiert und mit einer Sampling-Rate von 100kS/s ausgelesen. Ein am KIT entwickeltes, modulares und skalierbares Datenauslesesystem ermöglicht eine Datenaufnahme aller 240 Kanäle. Externe Detektoren wie das Muon-Veto-System werden in der DAQ bei der Datenaufnahme integriert. Koinzidenzen zwischen Bolometern oder zwischen Bolometersignalen und dem Veto werden sofort erkannt und berücksichtigt. Ein FPGA-basierter Trigger in der Eingangskarte ermöglicht ein temporäres Auslesen der Ionisationskanäle mit 40MS/s. Diese zeitaufgelösten Ionisationssignale können zur Erkennung oberflächennaher Ereignisse im Bolometer beitragen. Eine Übersicht über die Elektronik, die zugehörige Software und erste Ergebnisse des zeitaufgelösten Kanals werden präsentiert.

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T 105.4 Do 17:30 P7

Normalization procedure of Pulse Shape Discrimination for Broad Energy Germanium Detector — •heng-ye liao for the GERDA-Collaboration — Max-Planck-Institut für Physik, Germany

First results on the half life of neutrinoless double beta decay for the Gerda (GERmanium Detector Array) Phase I have been published. $0\nu\beta\beta$ events are single-site events (SSE) confined to a volume of about one millimeter. However, a significant fraction of background events in the ROI are multi-site events (MSE). Broad Energy Germanium detectors (BEGes) provide very good pulse shape recognition efficiencies of signal-like events and background-like events. Using this detector type for the second Phase of the Gerda experiment offers the potential to reduce the background index from 10^{-2} cts/(keV·kg·yr) to 10^{-3}cts/(keV·kg·yr). A total exposure of 2.4 kg·yr was taken with four BEGe detectors. Data analysis procedures to enhance the PSD performance have been implemented. The working principle, normalization procedure for the energy dependence of PSD and the deviations between physics data and calibration data will be presented.

T 105.5 Do 17:45 P7

Dead layer and active volume determination of enriched BEGe detectors for the GERDA experiment — •Raphael Falkenstein for the GERDA-Collaboration — Eberhard Karls Universität Tübingen, Germany

The Gerda experiment is designed to search for the neutrinoless double beta ($0\nu\beta\beta$) decay of ^{76}Ge. It uses bare High-Purity Germanium detectors, enriched in ^{76}Ge that are operated in liquid argon.
In GERDA phase I (Nov 2011-May 2013) mainly semi-coaxial Ge detectors were deployed. In phase II, which is planned to start in spring 2014, 30 new Broad Energy Germanium (BEGe) detectors will be added. The detectors have been tested in the HADES underground laboratory at SCK•CEN in Belgium, close to the detector manufacturer.
For GERDA, one of the key parameters and major source of systematic uncertainties is the active volume fraction of the detectors, since it directly affects the half life analysis. In this contribution, precise techniques for the dead layer and active volume determination using different calibration sources are presented. In addition, the DL and AV results as well as their systematic uncertainties will be discussed.
This work was partly supported by the BMBF.

T 105.6 Do 18:00 P7

Position-Resolved Pulse-Shape Measurements in HPGe with CdZnTe detectors — •Oliver Schulz[1] and Nuno Barros[2] — [1]Max-Planck-Institut f. Physik, München — [2]Technische Universität Dresden

Many experiments based on high-purity germanium (HPGe) detectors rely on the characteristics of the detector charge or current pulse shapes during analysis. Especially low-background experiments, like double beta decay searches, depend on pulse shape analysis for background suppression. Precise knowledge of these pulse shapes, which depend on the position of the charge deposition inside the detector, is therefore essential. While the pulses can be simulated, position-resolved measurements of detector pulse shapes are necessary to verify and improve those simulations.

A well established technique for such measurements is based on 90° Compton-Scattering: The detector under study is illuminated using a mono-energetic γ-ray source (such as ^{137}Cs) and detectors with slit collimators are placed at a 90° angle around the target detector. Usually, HPGe detectors are used to detect the Compton-scattered photons.

We present an approach to utilize z-sensitive CdZnTe detectors to achieve the same goal. Due to the nature of the detectors, less collimation and no cryogenic cooling are required, leading to a more efficient, less costly and easily portable setup.

T 105.7 Do 18:15 P7

Determination of Krypton concentration in cryogenic destilled Xenon gas with a quadrupole mass spectrometer following a cold-trap at a temporarily reduced pumping speed — •A. Fieguth, E. Brown, C. Levy-Brown, M. Murra, S. Rosendahl, S. Schneider, and C. Weinheimer — Institut für Kernphysik WWU

Liquid xenon detectors are extremly competitive for particle physics research, especially in the field of dark matter and neutrinoless beta decay search. In order to achieve the required sensitivity backgrounds must be reduced substantially. One important background is the beta-decay of ^{85}Kr. A method proven to be able to reduce this uniform background isotope by reducing the natural krypton concentration to the ppt-level is cryogenic distillation. At this stage gas diagonistics become difficult. A new method for measuring the concentration of Krypton in Xenon (E.Brown et al. JINST 8 (2013) P02011) has been applied to determine the efficiency of the cryogenic distillation column for the XENON1T experiment, expanding on the combined technique of a cold trap and a Residual Gas Analyzer. By using a liquid nitrogen cold trap, the difference in vapor pressue of krypton in xenon is used to freeze most of the xenon gas while allowing the krypton to pass unaffected. Here, only a few milliliters of xenon is expended in the measurement, while achieving a sensitivity of sub-ppb. The key change is the use of a butterfly valve to partially close the opening in front of the turbomolecular pump, thereby reducing the effective pumping speed and enhancing the RGA signal. Results of measurements on this distillation column will be presented. This work is funded by DFG.

T 105.8 Do 18:30 P7

Distillation Column for XENON1T Dark Matter Project — •Michael Murra[1], Ethan Brown[1], Stephan Rosendahl[1], Ion Cristescu[2], Christian Huhmann[1], Alexander Fieguth[1], and Christian Weinheimer[1] — [1]Institut für Kernphysik, Universität Münster — [2]Karlsruhe Institute of Technology

The XENON1T experiment is the next generation experiment for the direct detection of dark matter in the form of Weakly Interacting Massive Particles (WIMPS). While current limits set by XENON100 and other experiments constrain the WIMP-nucleon cross section to $\sigma < 2 \times 10^{-45}$ cm^2, XENON1T will achieve an increased sensitivity by 1.5 orders of magnitude by utilizing about 2.6 tons of liquid xenon. A key requirement to reach this sensitivity is the reduction of radioactive backgrounds such as ^{85}Kr, which has a beta-decay with an endpoint energy of 687 keV. To reach the final sensitivity, the xenon has to be purified to a concentration of < 0.1 ppt (parts per trillion) natural krypton in xenon. Because of different boiling points of Kr and Xe a cryogenic distillation column for XENON1T is being constructed and characterized to purify ∼3 tons of xenon. In the first construction phase, a 3 m test column was designed and assembled. The design and set up of this column will be presented, along with a status of current measurements and results such as the separation efficiency.

Different aspects of this project have been funded by DFG-Großgeräte, BMBF and Helmholtz-Alliance for Astroparticle Physics (HAP).

T 105.9 Do 18:45 P7

Scintillation of Liquid Noble Gases — •Andreas Ulrich[1], Thomas Dandl[1], Thomas Heindl[1], Martin Hofmann[1], Alexander Neumeier[1], Lothar Oberauer[1], Walter Potzel[1], Stefan Schönert[1], and Jochen Wieser[2] — [1]Physik Department E12/E15, TU-München, James-Franck-Str. 1, 85748 Garching — [2]Excitech GmbH, Branterei 33, 26419 Schortens

Liquid noble gases are frequently used as scintillating detector material in rare event physics. For studying the optical properties of this material we have developed techniques to induce the scintillation light by particle beams, both electron and ion beams. In this presentation we will summarize the results which have been obtained using time resolved optical spectroscopy for liquid argon and mixtures of liquid argon with xenon. The focus is on the emission features which have been observed, so far, in a wide wavelength range from 120 to 3000 nm [1,2]. The results will be compared with emission spectra in the gas phase. The attenuation of vacuum ultraviolet light in liquid argon [3] and argon xenon mixtures relevant for large detector installations will be discussed in a separate presentation.

[1] T. Heindl et al., Eur. Phys. Lett. 91, 62002 (2010)
[2] M. Hofmann et al., Eur. Phys. J. C 73:2618 (2013)
[3] A. Neumeier et al., Eur. Phys. J. C 72:2190 (2012)

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