T 109: Experimentelle Techniken der Astroteilchenphysik 2

Zeit: Montag 16:45–18:50 Raum: HSZ-101

Gruppenbericht T 109.1 Mo 16:45 HSZ-101

A liquid argon scintillation veto for the GERDA experiment — •Anne Wegmann for the GERDA-Collaboration — Max-Planck Institut für Kernphysik, Heidelberg, Germany

GERDA is an experiment to search for the neutrinoless double beta decay of ^{76}Ge. Bare germanium detectors are operated in a cryostat with 65 m^3 of liquid argon (LAr). To reach the aspired background index of $\leqslant 10^{-3}$ cts/(keV·kg·yr) for Phase II active background-suppression techniques will be applied, including an active liquid argon veto (LAr veto).

A light instrumentation of LAr installed in the LArGe test facility has demonstrated that the detection of argon scintillation light can be used to effectively suppress background events in the germanium, which simultaneously deposit energy in LAr. Based on these results, GERDA pursues several options for the light instrumentation, which have to be compatible with the stringent radiopurity requirements of the experiment and should provide a significant suppression of the background in the region of interest around $Q_{\beta\beta}$ at 2039 keV.

This talk gives an account of the competing design options under investigation in the GERDA collaboration. The design options using photomultiplier tubes (PMT) and silicon photomultipliers (SiPM) are discussed, together with their expected performance from Monte Carlo simulations. In addition, the progress of development is reported, along with the design criteria for light instrumentation in GERDA.

T 109.2 Mo 17:05 HSZ-101

LAr instrumentation studies for low background experiments — •Jozsef Janicsko Csathy for the GERDA-Collaboration — Technische Universität München

We investigated different options to instrument a large volume of liquid Argon in a low background experiment like GERDA with special regard to alternatives to PMTs. The difficulty consists in producing all the components with a radiopurity that is compatible with the background goal of the experiment. WLS fibers read out with SiPMs seem to offer the best compromise between veto efficiency and induced background. We present optimization studies for about one ton instrumented LAr volume and preliminary results from our test stand at TUM. This work is supported in part by the BMBF.

T 109.3 Mo 17:20 HSZ-101

The GERDA Phase II detector assembly — •Tobias Bode[1], Bernhard Schwingenheuer[2], and Stefan Schönert[1] for the GERDA-Collaboration — [1]Physik-Department E15, Technische Universität München, Germany — [2]Max-Planck-Institut für Kernphysik, Heidelberg, Germany

Phase II of the GERDA (Germanium Detector Array) experiment will continue the search for the neutrinoless double beta decay ($0\nu\beta\beta$) of ^{76}Ge. Prerequisites for Phase II are an increased target mass and a reduced background index of $< 10^{-3}$ cts/(keV·kg·yr). Major hardware upgrades to achieve these requirements are scheduled for 2013. They include the deployment of a new radio pure low mass detector assembly. The structural properties of available radio pure materials and reduction of mass necessitate a change of the electrical contacting used to bias and read-out the detectors. The detector assembly design and the favored contacting solution will be presented. This work was in part funded by BMBF.

T 109.4 Mo 17:35 HSZ-101

Background suppression in GERDA Phase II and its study in the LArGe low background set-up — •Dušan Budjáš for the GERDA-Collaboration — Physik-Department E15, Technische Universität München, Germany

In Phase II of the GERDA experiment additional ∼20 kg of BEGe-type germanium detectors, enriched in ^{76}Ge, will be deployed in liquid argon (LAr) to further increase the sensitivity for the half-life of neutrinoless double beta ($0\nu\beta\beta$) decay of ^{76}Ge to $>2{\cdot}10^{26}$ yr. To reduce background by a factor of 10 to the required level of $<10^{-3}$ cts/(keV·kg·yr), it is necessary to employ active background-suppression techniques, including anti-Compton veto using scintillation light detection from LAr and pulse shape discrimination exploiting the characteristic electrical field distribution inside BEGe detectors. The latter technique can identify single-site events (typical for $0\nu\beta\beta$) and efficiently reject multi-site events (mainly from γ-rays), as well as different types of background events from detector surfaces. The combined power of these techniques was studied for ^{42}K and other background sources at the low background facility LArGe. Together with extensive simulations, the information from tracking of the Phase II detector material exposure to cosmic rays and based on the background contributions observed in Phase I, the expected background level in Phase II in the region of interest at 2039 keV, the $Q_{\beta\beta}$ energy of ^{76}Ge, is estimated. The preliminary analysis shows that contributions from all expected background components after all cuts are in line with the goal of GERDA Phase II. This work is supported in part by the BMBF.

T 109.5 Mo 17:50 HSZ-101

Scintillation Properties of Liquid Argon with Ion-Beam Excitation — •Martin Hofmann[1], Thomas Dandl[2], Thomas Heindl[2], Alexander Neumeier[1], Lothar Oberauer[1], Walter Potzel[1], Stefan Schönert[1], Andreas Ulrich[2], and Jochen Wieser[3] — [1]Physik-Department E15 TU München — [2]Physik-Department E12 TU München — [3]Optimare Analytik GmbH & Co KG, Emsstraße 20, 26382 Wilhelmshaven

Liquid rare gases in general and liquid argon in particular are good detector media for the search for rare event physics, like the direct detection of Dark Matter or the search for the neutrinoless double beta decay. However, in this kind of experiments a background suppression on an event-by-event basis is needed. We investigated the scintillation properties of liquid argon both wavelength- and time-resolved with high resolution and best statistics, using different ion beams (protons, sulfur, and gold) as incident particles. The studies showed that particle discrimination using the wavelength information of the scintillation light alone is not feasible. The time information of the scintillation light, particularly the intensity ratio of its fast and slow component, however, provides the desired parameter which can be used for particle discrimination. In this talk the experimental setup used for the studies is presented and the outcome of the studies will be discussed, focussing on the application of LAr in future experiments in astroparticle physics. This work has been supported by funds of the DFG (Transregio 27: Neutrinos and beyond), the Excellence Cluster Universe and the Maier-Leibnitz-Laboratorium Garching.

T 109.6 Mo 18:05 HSZ-101

Bremsstrahlung and fluorescence in PMTs causing fast afterpulses — •Marc Tippmann, Max Knötig, Simon Appel, German Beischler, Jill Kaindl, Timo Lewke, Quirin Meindl, Randolph Möllenberg, Lothar Oberauer, Patrick Pfahler, Ludwig Prade, Tobias Stempfle, Jürgen Winter, and Vincenz Zimmer — for the LAGUNA-LENA working group — Technische Universität München, Physik Department E15, James Franck Straße, 85748 Garching

LENA (Low Energy Neutrino Astronomy) is a next-generation liquid-scintillator neutrino detector with 50kt target mass. The broad spectrum of physics goals ranging from the sub-MeV to the GeV regime sets high demands on the photosensors. Currently, photomultipliers (PMTs) are the sensor of choice. However, besides detecting photons, they also emit light through bremsstrahlung or fluorescence induced by the electron avalanche in the dynode chain, which can produce further pulses in the same PMT or adjacent sensors.

In order to study these effects and their connection to afterpulses occurring in the PMT, measurements of light emission and fast afterpulses have been carried through in collaboration with the CTA project. Both bremsstrahlung and fluorescence have been observed, with the first also being the origin of a type of fast afterpulses.

This work has been supported by the Max-Planck-Gesellschaft, the Maier-Leibnitz-Laboratorium, the TR 27 'Neutrinos and Beyond' and the cluster of excellence 'Origin and Structure of the Universe'.

T 109.7 Mo 18:20 HSZ-101

Herstellung von multi-PMT Modulen für PINGU — •Lew Classen — ECAP, FAU Erlangen, Germany

Mit der Fertigstellung von IceCube im Jahr 2010 steht ein Neutrinoteleskop mit einem Volumen von $\sim 1\,\mathrm{km}^3$ für die Untersuchung von Neutrinoquellen im TeV-Bereich zur Verfügung. Durch eine Erweiterung des Detektors (PINGU) wird die untere Energiegrenze drastisch

gesenkt. Zu Testzwecken sollen bei PINGU auch sogenannte multi-PMT Module zum Einsatz kommen. Optische Module nach diesem Konstruktionsprinzip bestehen aus einer Anordnung von mehreren vergleichsweise kleinen PMTs innerhalb einer transparenten Druckkammer. Gegenüber dem konventionellen Design hat der neuartige Aufbau einige Vorteile.

Für den Einsatz in PUNGU wurde das bewährte KM3NeT-Modul den Gegebenheiten in Eis angepasst, was sich unter anderem in einem zylindrischen Druckkörper mit reduziertem Durchmesser äußert.

Erste Prototypen entsprechender Glaszylinder werden in Kürze ausgeliefert und getestet. Daneben werden am ECAP unterschiedliche Herstellungsverfahren für die PMT-Halterstruktur erprobt. Dabei kommt unter anderem Rapid-Prototyping zum Einsatz. Mittels Ray-Tracing Simulationen werden darüber hinaus die optischen Eigenschaften des Moduls untersucht.

Der Vortrag stellt den aktuellen Stand dieser Entwicklung vor.

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T 109.8 Mo 18:35 HSZ-101

Ein akustisches Positionierungs System in Eis für den Enceladus Explorer (EnEx*) — •Ruth Hoffmann — Bergische Universität Wuppertal

In dem Projekt EnEx** soll die Eissonde IceMole weiterentwickelt werden, welche sich in Eis frei bewegen und dabei Proben nehmen kann. Das Ziel von EnEx ist die Erkundung wassergefüllter Spalten auf dem Saturnmond Enceladus, wozu die Sonde mit einem geeigneten Navigationssystem ausgerüstet wird. Eine Möglichkeit stellt das akustische Positionierungs-System dar, bestehend aus vier Empfängern im IceMole und mehreren Schallsendern (Pinger) auf der Gletscheroberfläche. Die Position der Sonde wird mittels Trilaterationsalgorithmen aus den Laufzeiten zwischen Pingern und IceMole berechnet, was ein gutes Verständnis von Schallausbreitung in Eis erfordert. Eine Verbesserung dieses Verständnisses wird mittels verschiedener Feldtests und der Simulation unterschiedlicher Szenarien erreicht. Die ersten Messungen der Schallgeschwindigkeit wurden im Juli 2012 erfolgreich auf dem Morteratschgletscher in der Schweiz durchgeführt. Die Ergebnisse dieser Messungen werden bei der Simulation der Positionierung berücksichtigt. Insgesamt tragen die so gewonnenen Erkenntnisse auch zum Design eines zukünftigen akustischen Neutrinodetektors bei. *https://extsites.dlr.de/musc/SELiME/Enceladus**gefördert vom DLR