HK 45: Instrumentation

Zeit: Dienstag 16:45–19:00 Raum: HSZ-405

Preisträgervortrag HK 45.1 Di 16:45 HSZ-405

A new Design of a highly Segmented Neutron Detector — •Magdalena Rohrbeck — Universität Koblenz-Landau, Institut für Integrierte Naturwissenschaften - Physik, 56070 Koblenz, Germany — Laureate of the Georg-Simon-Ohm-Prize

Since neutrons carry no electric charge and therefore do not interact with matter by means of the Coulomb force, the detection of neutrons is particularly challenging. Progress in the development of neutron detectors is of great importance for neutron physics due to the poor data situation compared to experiments with protons. Disadvantages of previously used neutron detectors are their low detection efficiency and counting rate capability. The neutron detection efficiency of about 1 %/cm for typical plastic scintillators necessitates a high detector volume and the counting rate capability of applied photomultipliers of about 1 MHz limits the number of detectable events. Both the detector volume and the number of applied photomultipliers are mainly restricted by the available budget. A new design of a scintillation-based neutron detector is presented. Replacement of conventional photomultiplier tubes by low-prized silicon photon counters and usage of standardized components allow the development of a detector with a high volume and a high segmentation. Due to the planned volume of $(0.96\ \mathrm{m})^3$ a detection efficiency close to 100 % can be achieved, at the same time the counting rate load on each photon counter can be kept low because of the high segmentation with single modules with a squared diameter of 2 cm. The neutron detector will be integrated into the experimental setup of the A1 collaboration at MAMI, Mainz, and will e.g. enable precise determination of the neutron's form factors.

Gruppenbericht HK 45.2 Di 17:00 HSZ-405

The R3B experiment at FAIR: Current Status and Outlook — •Heiko Scheit for the R3B-Collaboration — TU Darmstadt

I will report on the current status of the NuSTAR experiment Reactions with Relativistic Radioactive Beams (R^3B) at the FAIR facility.

HK 45.3 Di 17:30 HSZ-405

NeuLAND prototype test experiment: simulations and first results — •Dmytro Kresan[1], Thomas Aumann[2], Konstanze Boretzky[1], Michael Heil[1], and Haik Simon[1] for the R3B-Collaboration — [1]GSI Helmholtzzentrum für Schweerionenforschung mbH — [2]Technische Universität Darmstadt

The New Large Area Neutron Detector (NeuLAND) in R3B experiment at future FAIR facility has a concept of fully active scintillator and will be used for high precision multi-neutron recognition and measurement. The test experiment with a detector prototype is required in order to study the efficiency and time resolution of scintillator bars, read out photomultipliers and electronics components. We present the simulation study as well as first results of the data analysis of the deuteron test experiment at GSI (S406). Such aspects as neutron detection efficiency, time resolution and comparison of energy deposit in the simulation and experimental data will be addressed. Supported by HIC for FAIR, GSI, and the BMBF project 06DA7047I.

HK 45.4 Di 17:45 HSZ-405

NeuLand Submodules Exposed to Fast Neutrons — •Igor Gasparic[1,2], Thomas Aumann[1,3], Konstanze Boretzky[3], Michael Heil[3], Simon Jährling[1], and Haik Simon[3] for the R3B-Collaboration — [1]Technische Universität, Darmstadt, Germany — [2]Rudjer Boskovic Institute, Zagreb, Croatia — [3]GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany

Within the R^3B collaboration (Reactions with Relativistic Radioactive Beams), a new neutron detector NeuLAND (New Large Area Neutron Detector) is being developed. The technical design was finalized in November 2011, a fully active scintillator concept was chosen. It will be a box-shaped $2.5\times2.5\times3\ \mathrm{m}^3$ detector consisting of 3000 scintillator bars arranged in 60 planes with mutually orthogonal orientation. An array of 150 NeuLAND bars was exposed to fast "mono-energetic" neutrons stemming from quasi-free deuteron breakup reactions on a CH_2 target (250 to 1500 AMeV). The experiment carried out at GSI in Nov. 2012 aims for determination of both time resolution and efficiency of NeuLAND submodules. Preliminary results of the analysis will be presented.

Supported by HIC for FAIR, GSI, and the BMBF project 06DA7047I.

HK 45.5 Di 18:00 HSZ-405

Current status of the neutron lifetime experiment PENeLOPE — •Wolfgang Schreyer for the PENeLOPE-Collaboration — TU München

The neutron lifetime is an important parameter in the Standard Model of particle physics and in Big Bang cosmology. Recent measurements disagreed about its value and lead to several corrections with increased error budgets by the Particle Data Group.

The experiment PENeLOPE, currently under construction at the Physik-Department of Technische Universität München, aims to resolve this dilemma by determining the neutron lifetime with a precision of 0.1 s. It will trap ultra-cold neutrons in a magneto-gravitational trap using a large superconducting magnet and will measure their lifetime by both neutron counting and online proton detection.

This presentation will give an overview over the recent progress and the next steps of the project.

The project is supported by the Maier-Leibnitz-Laboratorium (Garching), the Deutsche Forschungsgemeinschaft and the Excellence Cluster "Origin and Structure of the Universe".

HK 45.6 Di 18:15 HSZ-405

Protonendetektion im Neutronenlebensdauerexperiment PENeLOPE — •Christian Tietze für die PENeLOPE-Kollaboration — Technische Universität München

Obwohl die Lebensdauer τ_n des freien Neutrons eine wichtige Rolle im Standardmodell der Teilchenphysik spielt ist sie bisher nur unzureichend genau bekannt und oft diskutiert. So wurde der offizielle Mittelwert der Particle Data Group in den letzten zwei Jahren um insgesamt 5,1 (neue) Standardabweichungen auf $880,1 \pm 1,1$s gesenkt.

Das Präzisionsexperiment PENeLOPE wird derzeit an der TU München entwickelt um zur Klärung dieses Sachverhaltes beizutragen. Hierbei ist neben der verlustfreien magnetischen Speicherung von ultrakalten Neutronen im Multipolfeld supraleitender Spulen und anschließender Messung der überlebenden Neutronen die simultane Detektion der Zerfallsprotonen während der Speicherphase entscheidend. Die Kombination beider Messvarianten resultiert zusammen mit den guten Möglichkeiten zur Handhabung der systematischen Fehler in einer bisher bei der Neutronenlebensdauer nicht erreichten Präzision von 0,1s.

Dieser Beitrag soll auf die Herausforderungen der Protonendetektion eingehen und insbesondere das entwickelte Konzept mit der Verwendung von Lawinenphotodioden (APDs) zur direkten Protonendetektion vorstellen. Dabei werden die bei einem Prototypen mit angepasster Frontend-Elektronik gewonnenen Ergebnisse präsentiert.

Das Projekt wird gefördert vom Exzellenzcluster „Origin and Structure of the Universe“, der Deutschen Forschungsgemeinschaft sowie dem Maier-Leibnitz-Laboratorium, Garching.

HK 45.7 Di 18:30 HSZ-405

A Scintillator Based Proton Detector with Silicon Photomultiplier Readout for the Neutron Lifetime Experiment PENeLOPE — •Wolfgang Gebauer for the PENeLOPE-Collaboration — Technische Universität München, Physik Department, E18

The lifetime of the free neutron, a major characteristic in the Standard Model of particle physics, is still not sufficiently well known: the previous measurements showed large discrepancies. Due to this fact, the new neutron lifetime experiment PENeLOPE is developed at Physik-Department of Technische Universität München.

Therefore ultra-cold neutrons are stored in a superconducting magneto-gravitational trap. Beside the detection of the neutrons, the low-energy protons emerging from the neutron beta decay will be accelerated and used for the determination of the neutron lifetime.

As the proton detector is located in the cryostat above the storage volume, it has to work at cryogenic temperatures and in high magnetic fields of about 1 T. A possible solution would be a scintillation detector using pure CsI crystals which have a high light yield at low temperatures. Due to the low energy of the irradiating protons the light emission is still low, thus silicon photomultipliers (SiPM) are a good option for the light detection system.

This contribution shows the characterization of SiPM and the development of CsI readout with SiPM at cryogenic temperatures.

This work is supported by the Excellence Cluster "Origin and Structure of the Universe", the Deutsche Forschungsgemeinschaft and the Maier-Leibnitz-Laboratorium, Garching.

HK 45.8 Di 18:45 HSZ-405

Direct detection of low energy protons using large-area avalanche photodiodes (LAAPDs) — •Thomas Pöschl for the PENeLOPE-Collaboration — Technische Universität München, Physik Department, E18

In the last couple of years the average of the measured neutron lifetime has decreased steadily. Discrepancies by more than 6σ from the world average value demand new precise measurements of this quantity. One promising experiment is PENeLOPE, which is developed at the Physics Department of Technische Universität München. This magnetic-bottle experiment is not only based on counting the surviving neutrons, but also on detecting the protons from the neutron decay in order to obtain better precision. Although the protons are accelerated by an electric field of about 30 keV, the detection is challenging because of their little penetration depth of only a few hundred nanometers in most materials.

In our work we investigate the response of a large-area avalanche photodiode (LAAPD) to protons, H_2^+ and H_3^+ ions with kinetic energies up to 30 keV. We already achieved to detect protons down to 10 keV with a good resolution of 2.8 keV (FWHM) at room temperature. For this measurements we used the linear accelerator $PAFF$ which has been built as a test facility for detector characterization.

This work is supported by the Excellence Cluster "Origin and Structure of the Universe", Deutsche Forschungsgemeinschaft and the Maier-Leibnitz-Laboratorium Garching.