T 78: Experimental Techniques in Astroparticle Physics 3

Time: Wednesday 16:15–18:00 Location: T-H37

T 78.1 Wed 16:15 T-H37

Monoenergetic electronic recoil calibration of LXe TPCs with 37Ar (XENON1T/nT) — •Christopher Hils for the XENON-Collaboration — Institut für Physik & Exzellenzcluster PRISMA+, Johannes Gutenberg-Universität Mainz, 55099 Mainz, Germany

Large multi-ton LXe time projection chambers like XENON1T/nT set the most stringent constraints on the interaction cross-section between nucleons and Dark Matter in form of Weakly Interacting Massive Particles. The large active volume and the excellent self shielding properties of liquid xenon make the use of internal calibration sources a necessity to understand detector responses. In the past these calibrations were mainly based on gaseous 83mKr and 220Rn isotopes diluted into the liquid xenon and distributed equally into the active volume. In the last science run of XENON1T we introduced a new low-energy calibration source, the Argon isotope 37Ar, with calibration lines at energies of 2.8 keV and 270 eV. In this talk we will present the results of the XENON1T calibration in form of a study of the detector response at these ultra low energies. We also show that the isotope can be efficiently removed by cryo distillation in the XENON1T distillation column originally designed for krypton removal, which made this isotope suitable as a regular calibration source despite ist long halflife time of 35 d. In this regard, a first calibration was already performed In XENONnT at the end of 2021 with first results about to come.

T 78.2 Wed 16:30 T-H37

Measuring the liquid xenon scintillation pulse shape and its electric field dependence — •Dominick Cichon[1], Guillaume Eurin[1,2], Florian Jörg[1], Teresa Marrodán Undagoitia[1], and Natascha Rupp[1] — [1]Max-Planck-Institut für Kernphysik, Heidelberg, Germany — [2]IRFU, CEA, Université Paris-Saclay, Gif-sur-Yvette, France

In the search for new physics, such as particle dark matter and the neutrinoless double-beta decay, liquid xenon (LXe) detectors play an important role and have provided highly competitive results over the past years. As an example, XENON1T, which utilized a LXe time projection chamber (TPC), constrained the cross-section for interactions between weakly interacting massive particles (WIMPs) and nucleons to values below $4.1 \cdot 10^{-47}$ cm^2 at a WIMP mass of 30 GeV/c^2. To push LXe detector technology to its limits and achieve even better sensitivities, a detailed understanding of the microphysics processes responsible for signal generation in LXe is necessary. One avenue to investigate such processes is the pulse shape of the prompt scintillation signal caused by excitation of LXe via particle interactions.

This talk presents measurements of the LXe scintillation pulse shape after excitation by either electrons from the isomeric transition of ^{83m}Kr or alpha particles from ^{222}Rn chain decays. For both sources, the pulse shape has been characterized at more than 25 different electric field configurations between $\sim$ 0 V/cm and $\sim$ 1200 V/cm. The results are compared to previoulsy published data and interpreted in the context of the involved microphysics processes.

T 78.3 Wed 16:45 T-H37

Gaseous xenon measurements with APIMS and gas chromatography — •Veronica Pizzella and Hardy Simgen — Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117, Heidelberg

The latest generation of dual phase gas-liquid xenon TPC detectors for rare event searches employ several tonnes of xenon. It is crucial for the success of these experiments that the chemical impurities in LXe are below ppb level. Some chemical impurities of concern are: electronegative molecules such as oxygen, since they trap the electrons; radioactive impurities such as H-3, since they increase the background in the ROI.

In this presentation, a method to measure chemical impurities below ppb level is presented. The measurement is performed using Atmospheric Pressure Ionization Mass Spectrometry (APIMS), with a commercial instrument from Thermo Scientific. This instrument uses a corona discharge to ionize helium gas at atmospheric pressure, which in turn ionizes mixed trace impurities very efficiently. The setup uses a custom chromatography setup to separate the impurities from the xenon and mix them with helium. Some of the challenges of oxygen and hydrogen quantification are illustrated and some adapted solutions are outlined. A first measurement of the xenon from the gas phase of the XENONnT experiment is reported.

T 78.4 Wed 17:00 T-H37

Scintillation and optical properties of xenon-doped liquid argon — •Christoph Vogl, Mario Schwarz, Xaver Stribl, Johanna Griessing, Patrick Krause, and Stefan Schönert — Chair for Astroparticle Physics, Department of Physics, Technical University Munich, Garching, Germany

Liquid argon (LAr) is widely employed as a scintillator in rare-event searches. Its optical and scintillation properties, as well as the impact of impurities, are being studied extensively by many groups worldwide. LAr scintillation light exhibits a main emission wavelength of 128 nm, which makes propagation and detection challenging because of short attenuation lengths and low quantum efficiencies of photo sensors in the VUV spectral range. The addition of small amounts of xenon to LAr shifts the emission wavelength towards 175 nm and reduces the overall scintillation time. Here, we present our latest study of xenon-doped LAr with focus on the primary photon yield, the effective triplet lifetime and attenuation length, with xenon concentrations ranging from 3 ppm to 300 ppm. The scintillation and optical properties were measured simultaneously with the LLAMA instrument operated inside SCARF, a 1 ton LAr test stand, and the xenon concentrations using IDEFIX, a dedicated mass spectrometer setup. This research is supported by the DFG through the Excellence Cluster ORIGINS and the SFB1258.

T 78.5 Wed 17:15 T-H37

Characterization of Wavelength Shifters for LAr Instrumentation Using VUV Spectrofluorometry — •Andreas Leonhardt[1], Gabriela R. Araujo[2], Patrick Krause[1], Laszlo Papp[1], Tina R. Pollmann[3], and Stefan Schönert[1] — [1]Physik Department, Technische Universität München, Garching, Germany — [2]Physik-Institut, Universität Zürich, Zurich, Switzerland — [3]Nikhef National Institute for Subatomic Physic, Amsterdam, Netherlands

Experiments searching for dark matter or neutrinoless double-beta decay commonly use liquid argon (LAr) as a target or instrumented shielding medium. Particle interactions in the LAr produce vacuum-ultraviolet (VUV) light flashes peaking at 128 nm, which are converted to longer wavelengths by wavelength shifters (WLSs). Due to the short LAr scintillation wavelength and low LAr temperature, the characterization of WLSs requires VUV optics and a cooling system in vacuum. We present the developed custom spectrofluorometer, which enables us to characterize WLSs at VUV excitation and low temperatures. The setup consists of a high-intensity deuterium light source coupled to a VUV monochromator and a vacuum-tight sample chamber. The wavelength shifting material can be mounted on a cryocooler coldhead to measure the wavelength-resolved and wavelength-integrated photoluminescence light yield at the relevant LAr temperature. We describe the characterization campaign of the wavelength-shifting reflector of the LEGEND-200 experiment with the VUV spectrofluorometer and summarize the results. This research is supported by the DFG through the Excellence Cluster ORIGINS and the SFB1258.

T 78.6 Wed 17:30 T-H37

Development of an Organic Plastic Scintillator based Muon Veto Operating at Sub-Kelvin Temperatures for the NUCLEUS Experiment — •Andreas Erhart[1,2], Victoria Wagner[1], Ludwig Klinkenberg[1], Thierry Lasserre[2], David Lhuillier[2], Claudia Nones[2], Tobias Ortmann[1], Luca Pattavina[1], Rudolph Rogly[2], Johannes Rothe[1], Vladimir Savu[2], Nicole Schermer[1], Raimund Strauss[1], and Matthieu Vivier[2] — [1]Physik-Department, Technische Universität München, D-85748 Garching — [2]IRFU, CEA, Université Paris Saclay, F-91191 Gif-sur-Yvette

The NUCLEUS experiment aims to measure coherent elastic neutrino nucleus scattering of reactor anti-neutrinos using cryogenic calorimeters. Operating at an overburden of 3m.w.e., muon-induced backgrounds are expected to be dominant. It is therefore essential to develop an efficient muon veto, with a detection efficiency of more than 99%. A novel concept has been investigated, featuring a plastic scintillator based muon veto operating inside the NUCLEUS cryostat at sub-Kelvin temperatures. The required investigation of the detector's

low temperature behavior led to the first reported measurements of organic plastic scintillators at sub-Kelvin temperatures. The functionality of the principal scintillation process has thereby been confirmed. A disc-shape muon veto equipped with wavelength shifting fibers and a silicon photomultiplier has been developed. The research was supported by the DFG through the Excellence Cluster ORIGINS and the SFB1258, and the ERC Starting Grant 2018 "NU-CLEUS".

T 78.7 Wed 17:45 T-H37

Vibration Decoupling System for the NUCLEUS Experiment — •Alexander Wex, Raimund Strauss, Johannes Rothe, Luca Pattavina, Nicole Schermer, Andreas Erhart, Tobias Ortmann, Victoria Wagner, and Margarita Kaznacheeva — Technische Universität München, Physik Department Lehrstuhl E15, James-Franck-Straße 1, D-85748 Garching

The coherent neutrino nucleus scattering experiment NUCLEUS deploys a new-generation dry dilution refrigerator. Vibrations induced by the cryostat's pulse tube cooler are a challenge for stable detector operation. To achieve detector performance undisturbed by pulse tube operation, a dedicated spring-decoupling system is being developed for NUCLEUS. Recent results and benchmark measurements for the design of this cryogenic vibration decoupling system are presented. The research was supported by the DFG through the Excellence Cluster ORIGINS and the SFB1258, and the ERC Starting Grant 2018 "NU-CLEUS".