T 76: Dark Matter III

Time: Thursday 16:30–19:00 Location: H-HS XIV

T 76.1 Thu 16:30 H-HS XIV

Ultra-low energy calibration of the XENON1T detector with a diluted ^{37}Ar source — •Matteo Alfonsi for the XENON-Collaboration — Institut für Physik & Exzellenzcluster PRISMA, J. Gutenberg-Universität Mainz, 55099 Mainz, Germany

In 2018 the XENON1T experiment set the most stringent constraints on the interaction cross-section between nucleons and Dark Matter in the form of Weakly Interacting Massive Particles. Due to the size of the active volume and the excellent self shielding properties of liquid xenon, the understanding of the detector response relies to a large extent on internal calibrations, based on ^{83m}Kr and ^{220}Rn gaseous isotopes diluted into the liquid xenon and uniformly distributed inside the active volume. In Autumn 2018 we introduced a new low energy calibration source, the ^{37}Ar isotope, with calibration lines at energies of 2.8 keV and 270 eV. The radioisotope was quickly and efficiently removed after two weeks of data-taking by means of cryogenic distillation. In this talk we will show the results of this calibration and the study of the detector response at these ultra low energies. We also compare these results with our Monte Carlo simulation framework of the detector response, to further validate the model used in the Dark Matter search results.

T 76.2 Thu 16:45 H-HS XIV

Dark Matter Constraints from SuperCDMS Single-Charge Sensitive Detectors — •Matthew Wilson for the SuperCDMS-Collaboration — Universität Hamburg

Direct search limits on electron-scattering dark matter and dark absorption limits are examined using prototype phonon-mediated SuperCDMS R&D detectors with sub-electron-hole pair charge resolution (CDMS HVeV, 0.93 gram CDMS Si devices). The first science run with a HVeV device (HVeV R1) achieved a resolution of 0.1 electron-hole pairs and an exposure of 0.49 gram days. The results of HVeV R1 significantly improved the experimental constraints on electron-recoiling dark matter with masses as low as 0.5 MeV/c^2, and demonstrated sensitivity to dark photons competitive with other leading approaches but using substantially less exposure. The second science run with a HVeV device (HVeV R2) achieved roughly 3 times better resolution compared to HVeV R1 with >2.5 times more exposure. The improved HVeV R2 detector design also included a second channel with the goal of fiducializing detector events to reduce backgrounds. The latest HVeV results are shown, demonstrating the scientific potential of phonon-mediated semiconductor detectors sensitive to single electron excitations.

T 76.3 Thu 17:00 H-HS XIV

Direct search for modulated Dark Matter signals with XENON1T — •Lutz Althüser for the XENON-Collaboration — Institut für Kernphysik, WWU Münster

The XENON Dark Matter Project uses a dual-phase xenon time projection chamber (TPC) to directly search for weakly interacting massive particles (WIMPs). Dark Matter particles are expected to scatter off xenon nuclei in the active detector region, leading to nuclear and electronic recoils. Both recoil types can be detected as light signals in the TPC. The measured Dark Matter count rate is expected to modulate with a certain amplitude and phase.

The concept of annual modulation assumes that Dark Matter exists as a spherical and non-rotating halo in which the Earth and Sun are contained. Given the relative movement of the Sun, Earth and galactic center, one would expect a time-dependent WIMP interaction count rate. Using this time dependent signature of the count rate could provide an additional background discrimination, one of the biggest challenges of any direct detection Dark Matter experiment.

The talk will give an introduction to the characteristics of the event rate modulation, assuming the Standard Halo Model, the current status of direct searches in the field and perspectives for the XENON1T experiment.

The work of the author is supported by Deutsche Forschungsgemeinschaft (DFG) through the Research Training Group "GRK 2149: Strong and Weak Interactions - from Hadrons to Dark Matter".

T 76.4 Thu 17:15 H-HS XIV

Optimized triggering and noise mitigation in the SuperCDMS experiment — •Hanno Meyer zu Theenhausen — University of Hamburg

The SuperCDMS SNOLAB experiment is a direct detection search for dark matter using phonon and charge signals in ultra cold Si and Ge crystals. In the search for light dark matter, axion-like particles and dark photons the sub-MeV mass range offers unexplored parameter space which becomes accessible at high exposures and low recoil energies down to 7 eV using high voltage amplified phonon detectors and down to ∼1 eV by prototype ultra-pure single crystal detectors. To reach the desired search thresholds, the experiment requires a challenging event-by-event discrimination between signal-like and noise events. This requirement concerns both the data acquisition and trigger system as well as the offline analysis. This talk reports on a study on the optimized trigger threshold and noise mitigation methods using optimal filters and machine learning techniques for the data acquisition systems and the subsequent analyses.

T 76.5 Thu 17:30 H-HS XIV

Signal corrections with the XENONnT analysis framework — •Johanna Jakob for the XENON-Collaboration — Institut für Kernphysik, WWU Münster

The upcoming dark matter experiment XENONnT is currently under construction at Laboratori Nazionali del Gran Sasso (LNGS). The detector uses a dual-phase time projection chamber (TPC) filled with liquid and gaseous xenon to detect scattering of WIMPS. The TPC design allows to perform 3D position reconstruction of the recorded events. The XENONnT TPC is designed in a way that most of the XENON1T infrastructure can be reused, featuring a maximized active detector volume. XENONnT has a novel, faster analysis framework called strax(en) which has to be verified with data from the XENON1T experiment.

The talk will focus on using the new XENONnT data analysis framework with calibration data already used for the dark matter search with the XENON1T experiment. Light Collection Efficiency (LCE) maps, used to compensate the position-dependent light yield, are extracted and compared to the former data processor (PAX).

T 76.6 Thu 17:45 H-HS XIV

Radiogenic Background Simulations for XENONnT — •Diego Ramírez García for the XENON-Collaboration — Albert-Ludwigs-Universität Freiburg, Freiburg im Breisgau, Germany

The XENON1T experiment at the Laboratori Nazionali del Gran Sasso has achieved the world-leading sensitivity in the direct search for dark matter in the form of Weakly Interacting Massive Particles (WIMPs). Its upgrade to XENONnT will use a liquid xenon target of 5.9 t, aiming at further improving this sensitivity by an order of magnitude, and will be operative in 2019.

For a multi ton-scale time projection chamber, the background signals induced by radioisotopes from the detector materials will become relevant in the WIMP search region of interest. Using the material-intrinsic levels of radioactivity measured in screening campaigns, Monte Carlo simulations have been performed in order to estimate this contribution. This talk will briefly describe the utilized framework to model the detector response and summarize the result on the predicted radiogenic background.

T 76.7 Thu 18:00 H-HS XIV

Cosmic muon induced neutron measurement with the MINIDEX experiment — •Xiang Liu, Iris Abt, Christopher Gooch, Oliver Schulz, and Raphael Kneissl for the GeDet-Collaboration — Max-Planck-Institut für Physik, Föhringer Ring 6, D-80805 München, Bayern

Cosmic-ray muon induced neutrons are an important source of background in low-background experiments searching for rare phenomena, like neutrinoless double beta decay or dark matter. These neutrons can generate radioactive isotopes in the shielding materials or in the detector itself, creating background which can not be easily removed by a cosmic muon veto, due to the time delay. The Muon-Induced Neutron Indirect Detection EXperiment, MINIDEX, running in the shallow undergound laboratory at the University of Tübingen, measures the production of muon-induced neutrons in a variety of high-Z materials. Recently, the experiment has been upgraded to measure the neutron production not only from through-going muons but also from

stopped muons. The design of the experiment and the upgrade are presented as well as selected results.

T 76.8 Thu 18:15 H-HS XIV

A cryogenic distillation system for continuous radon removal at XENONnT — •Denny Schulte for the XENON-Collaboration — Institut für Kernphysik, Westfälische Wilhelms- Universität Münster

The forthcoming XENONnT experiment is a next generation 8 t liquid xenon detector for the direct detection of dark matter in the form of the Weakly Interacting Massive Particle (WIMP). After extensive efforts of material selection and cleaning, the intrinsic contamination of the ultra-pure xenon by Rn-222 will be the main background. This radioactive impurity can be removed by cryogenic distillation making use of the difference in vapor pressure between radon and xenon. Since radon is continuously emanated from detector components, the reduction depends not only on the separation efficiency but also on the recirculation speed. Therefore, a high flux distillation system is under developement.

This talk will focus on the design and the technical challenges of building a removal system with a 20 times larger throughput compared to the previous distillation column used at the XENON1T experiment.

The project is funded by BMBF under contract 05A17PM2.

T 76.9 Thu 18:30 H-HS XIV

Designing the XENONnT electric field — •Francesco Toschi for the XENON-Collaboration — Physikalisches Institut, Universität Freiburg, 79104 Freiburg, Germany

The XENONnT experiment is the next phase of the XENON project and aims at the direct detection of dark matter via WIMP-nucleus scattering. Its dual-phase Time Projection Chamber (TPC) filled with 5.9 ton of liquid Xenon allows position reconstruction and interaction-type discrimination, necessary for WIMP detection. The applied electric field plays a crucial role in its detection capabilities: uniformity in the drift field means homogeneous response in the full active volume, while high intensity fields in the liquid-gas interface are needed for electron extraction. Numerical simulations are used both to optimize the design of the detector and to have a better understanding of the expected signals.

This talk will focus on the field shaping elements of the TPC and how the electric field simulations drove their design.

T 76.10 Thu 18:45 H-HS XIV

Search for dark matter production in association with a top quark and a W boson — •Baishali Dutta, Paul Moder, Priscilla Pani, and Claudia Seitz — DESY, Germany

Searches for dark matter are extensively pursued by the ATLAS experiment based on specific theoretical models of interest and with various experimental signatures. This talk presents a search for dark matter in association with a top quark and a W boson in the final state, a unique signature not covered by the ATLAS experiment so far. The analysis focuses on a two-Higgs-doublet model with an additional pseudo-scalar mediator, which decays to the dark matter candidates (2HDM+a) and utilises the full LHC Run-2 data collected by the ATLAS detector, comprising an integrated luminosity of 139 fb^{-1} at a centre-of-mass energy of $\sqrt{s} = 13$ TeV.

The signal candidate events contain two W bosons, a b-tagged jet and a significant amount of missing transverse momentum due to the dark matter candidates escaping detection. Based on the subsequent decay of the two W bosons, the analysis is optimised individually for one or two leptons in the final state. The two channels are eventually combined to extend the sensitivity of the analysis to cover a large parameter space of the dark matter model considered. In this talk, the analysis strategy and interpretation of the obtained results are presented.