T 39: Suche nach dunkler Materie II

Zeit: Montag 16:45–19:05 Raum: VMP9 SR 28

Gruppenbericht T 39.1 Mo 16:45 VMP9 SR 28

XENON1T experiment: searching for Dark Matter with a ton-scale liquid xenon detector — •Matteo Alfonsi for the XENON-Collaboration — Johannes Gutenberg Universität Mainz

The XENON1T detector is the first dual-phase Time Projection Chamber (TPC) searching for Dark Matter with a ton scale ultra-pure liquid xenon target. We aim at the discovery of Weakly Interacting Massive Particles (WIMPs), well motivated particle candidates to explain the current abundance of Dark Matter in the Universe.

In Fall 2015 the construction in Hall B at the Laboratory Nazionali del Gran Sasso in Italy has been completed and the commissioning of the TPC, the active muon veto, all the cryogenics and the xenon purification infrastructures, is in a well advanced status. The first signals from the 248 ultra-low background Photomultiplier Tubes from Hamamatsu Photonics have been collected with the Data Acquisition system developed for XENON1T, and this allows for the validation of the reconstruction and analysis software as well. The first science run is expected to start in the first half of 2016: with 1 ton of xenon fiducial mass (out of a total of 3.3 ton) and 2 years exposure, we expect to reach a sensitivity to spin-indipendent WIMP-nucleon cross section better than 2×10^{-47} cm^2 (90% confidence level) .

In this talk I report about the progress of the XENON1T commissioning and the ongoing studies on novel calibration techniques with XENON100, the still operational predecessor experiment.

T 39.2 Mo 17:05 VMP9 SR 28

Commissioning of the XENON1T liquid level measurement system — •Christopher Geis — Institut für Physik, Johannes Gutenberg-Universität, Mainz

Two-phase xenon time projection chambers (TPCs) have been operated very successfully in direct detection experiments for dark matter. This kind of detector uses liquid xenon as the sensitive target and is operated in two-phase (liquid/gas) mode, where the liquid level needs to be monitored and controlled with sub-millimeter precision.

We present the installation, commissioning and first measurement data of two kinds of level meters operated in the XENON1T TPC: short level meters are three-plated capacitors measuring the level of the liquid-gas interface with a measurement range $h \approx 5\,\mathrm{mm}$ and a resolution of $\Delta C/h \approx 1\,\mathrm{pF/mm}$. The long level meters are cylindrical double-walled capacitors, measuring the overall filling level of the XENON1T TPC at a measurement range of $h = 1.4\,\mathrm{m}$ and a resolution of $\Delta C/h \approx 0.1\,\mathrm{pF/mm}$. Further, we present the design and programming of the readout electronic based on the UTI chip by Smartec, which allows to read all six levelmeters simultaneously.

T 39.3 Mo 17:20 VMP9 SR 28

XENON1T radon assay — •Stefan Brünner for the XENON-Collaboration — MPIK, Heidelberg, Deutschland

The radioactive isotope ^{222}Rn is one of the most dominant intrinsic background sources for experiments dealing with a low event rate like the XENON1T Dark Matter detector. Being part of the primordial decay chain of ^{238}U the noble gas ^{222}Rn permanently emanates from almost all materials. Therefore, it is crucial to determine the radon emanation rate of those detector components that will be in contact with the xenon target. The technique of the radon emanation measurements, making use of ultra low background proportional counters is presented as well as selected results for XENON1T.

T 39.4 Mo 17:35 VMP9 SR 28

Analyse von Verunreinigungen in Xenon für das XENON1T Experiment — •Constanze Hasterok für die XENON Kollaboration — Max Planck Institut für Kernphysik

Schwere schwach wechselwirkende Teilchen (WIMPs) sind eine populäre Erklärung für das Wesen der dunklen Materie. Bei der direkten Suche nach WIMPs wird der gerade in Betrieb genommene XENON1T Detektor eine führende Rolle einnehmen. Dieser ist mit 3.5 t Xenon gefüllt. Radioaktive Verunreinigungen wie Krypton-85, welches in der Atmosphäre vorkommt, tragen zum Untergrund bei. Elektronegative Verunreinigungen wie Sauerstoff und Wasser können Signalladungsträger wegfangen. Die Reinheit des verwendeten Xenons wurde durch graschromatographische Messungen vor der Befüllung sicher gestellt. Die Ergebnisse dieser Messungen sollen im Vortrag vorgestellt und diskutiert werden.

T 39.5 Mo 17:50 VMP9 SR 28

Commssioning of the cryogenic distillation column for the XENON1T experiment — •Michael Murra for the XENON-Collaboration — Institut für Kernphysik, WWU Münster

The recently inaugurated XENON1T experiment, located in the Laboratori Nazionali del Gran Sasso (LNGS), is the next generation experiment for the direct detection of dark matter in the form of Weakly Interacting Massive Particles (WIMPS). The new detector will utilize about 3.5 tons of liquid xenon in order to reach a projected sensitivity of $2{\cdot}10^{-47} cm^2$ for a WIMP mass of 50 GeV/c^2 . 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. Due to the difference in vapor pressure, the concentration of natural krypton in xenon can be reduced by several orders of magnitude by using cryogenic distillation. A krypton concentration of less than $0.2 \cdot 10^{-12}$ (0.2 parts per trillion) in xenon is required to achieve the desired sensitivity of the XENON1T experiment. Within this talk, the commissioning of the cryogenic distillation column, specially developed for XENON1T, at LNGS, along with the validation of a reduction factor greater 10^5, will be presented. Different aspects of this project have been funded by Großgeräte (DFG + state NRW), BMBF and Helmholtz-Alliance for Astroparticle Physics (HAP).

T 39.6 Mo 18:05 VMP9 SR 28

Geant4 simulations of the Münster dual phase xenon TPC — •Lutz Althüser — IKP, Westfälische Wilhelms-Universität Münster

The XENON Dark Matter Project uses the concept of a dual phase xenon time projection chamber (TPC) for a direct detection of weakly interacting massive particles (WIMPs). In the current operating step, XENON1T, the sensitivity of the detector will be increased by two orders of magnitude compared to its predecessor XENON100.

In order to investigate and test new systems for this experiment, as well as to do further studies, a small dual phase xenon TPC (height: 17 cm, diameter: 8 cm) with a light readout by 14 photomultiplier tubes (PMTs) was built at Muenster. For calibration of such a TPC regarding its light yield (LY) and light collection efficiency (LCE), radioactive sources can be placed near or inside the detector. The penetration of these sources depends on the inner volume of the detector, due to the self shielding effect of xenon, and on the used materials. The suitability of available radioactive sources can be determined by a Geant4 simulation package of the Münster TPC, which was used to test different calibration scenarios. This includes an internal low energy calibration with ^{83m}Kr.

Within this talk an introduction to the Geant4 Münster package and the simulation of different calibration possibilities of the Münster TPC is shown.

T 39.7 Mo 18:20 VMP9 SR 28

Measuring radon reduction in xenon boil-off gas — Stefan Bruenner, •Dominick Cichon, Sebastian Lindemann, Teresa Marrodán Undagoitia, and Hardy Simgen — MPIK, Heidelberg, Germany

^{222}Rn, which originates from the decay of primordial ^{238}U, is one of the major background sources for ultra-low background noble gas detectors. One of them is XENON1T, which is a dark matter direct detection experiment looking for hypothetical weakly interacting massive particles (WIMPs). It uses liquid xenon (LXe) as a detection medium and aims to be sensitive to spin-independent WIMP-nucleon cross-sections of $\sigma \sim 2 \cdot 10^{-47} cm^2$ at a WIMP mass of ~ 50 GeV/c^2. To achieve this goal, radon activity inside the detector must be limited to a few mBq/kg.

One possible way for reducing the concentration of ^{222}Rn inside such an LXe detector is using the so-called "boil-off method". It takes advantage of the fact, that the radon concentration in boil-off xenon is smaller compared to the concentration in the liquid xenon from which the boil-off xenon evaporated. This can be understood by the different vapor pressures of radon and xenon. In this talk, tests conducted at the MPIK are outlined which probe the feasibility and effectiveness of the boil-off method. The results prove, that a reduction of the radon concentration can indeed be achieved. In addition, an outlook for possible

future applications of this technique is given.

T 39.8 Mo 18:35 VMP9 SR 28

Characterization of a cryogenic distillation column with a Kr-83m tracer method — •Stephan Rosendahl[1], Ion Cristescu[2], Alexander Fieguth[1], Chrisian Huhmann[1], Michael Murra[1], and Christian Weinheimer[1] — [1]Institut für Kernphysik, Wilhelm-Klemm Strasse 9, 48149 Münster — [2]Karlsruher Institut für Technologie, Tritium Laboratory, Hermann-von-Helmholtz-Platz 1, 76344 Eggenstein-Leopoldshafen, Germany

The XENON1T experiment aims for the direct detection of dark matter with unreached precision of $2 \times 10^{-47}\, cm^2$ for the spin-independent WIMP-nucleon cross section. The cryogenic distillation is an important tool to reduce the intrinsic contamination with radioactive ^{85}Kr which undergoes a beta-becay with an endpoint energy of 687 keV, being one major source of background. Hence, a novel cryogenic distillation column has been designed and constructed in order to reduce the krypton concentration to $^{\mathbf{nat}}$Kr/Xe$<$0.2 ppt.

For the investigation of the performance and the dynamics of the distillation process on the sub-ppt level, a new $^{\mathbf{83m}}$Kr tracer method has been applied. For the $^{\mathbf{83m}}$Kr detection custom made PMT based detectors are used. In this talk the method as well as the results of the studies of the krypton seperation are presented.

Different aspects of the project are funded by DFG-Großgeräte, BMBF and Helmholtz-Alliance for Astroparticle Physics HAP.

T 39.9 Mo 18:50 VMP9 SR 28

Qualification Tests of 248 Photomultiplier Tubes for XENON1T — •Ludwig Rauch — Max-Planck-Insitut für Kernphysik, Heidelberg, Deutschland

The dark matter direct-detection experiment XENON1T employs photosensors with high detection efficiencies to obtain a low energy threshold of the detector enabling a search for small WIMP masses. In addition, the tube is designed for a low intrinsic radioactivity to minimize the background of the experiment. The expected sensitivity of the dark matter interaction cross sections to the xenon nucleon reaches $2{\times}10^{47}$ cm^2 with a particle with mass of 50 GeV/c^2.

This talk presents the setups and test procedures of the 248 installed photomultiplier tubes (PMTs) for XENON1T in order to decide whether they fulfil the experiment's requirements. In addition, an analysis of the performance of the used PMTs is presented and the implications for a dark matter search are outlined.