HK 63: Astroteilchenphysik

Zeit: Freitag 14:00–16:00 Raum: RW 3

HK 63.1 Fr 14:00 RW 3

PERC, a clean, bright and versatile source of neutron decay products — •Bastian Märkisch for the PERC-Collaboration — Physikalisches Institut, Universität Heidelberg

Within the Standard Model of particle physics, neutron β-decay is described by only three parameters, whereas there are many more observables accessible to experiments. Precision measurements on neutron decay observables make it therefore an ideal candidate in the search for physics beyond the SM.

We present the new facility PERC (Proton Electron Radiation Channel), a novel source of neutron decay products. PERC will be installed at the Forschungs-Neutronenquelle Heinz Maier-Leibnitz. Decay rate is largely increased compared to existing instruments like e.g. Perkeo III by using the inside of an 8 m long neutron guide as active decay volume. Electrons and protons are extracted from this volume and separated from the neutron beam by a strong magnetic field. A magnetic filter of up to 6 T serves to precisely define the phase space of the emerging decay particles. Spectra and angular distributions will be distortion-free on the level of 10^{-4}. We give an overview on the concept of the PERC instrument, observables accessible and its present status.

HK 63.2 Fr 14:15 RW 3

Superconducting magnet system for PERC — •Carmen Drescher for the PERC-Collaboration — Physikalisches Institut, Universität Heidelberg

The new PERC (Proton Electron Radiation Channel) instrument will be an extremely bright and versatile source of neutron decay products. It will feed several novel precision experiments of spectra and correlation measurements in neutron decay. Its main component is a more than 11 m long superconducting magnet system. The neutron decay volume is located inside an 8 m long neutron guide in a strong longitudinal magnetic field of 1.5T. A variable magnetic barrier of 3T to 6T serves to precisely limit the phase space of the emerging electrons and protons to control systematic errors on the 10^{-4}level. The instrument is currently under development and will be installed at the neutron-beamline Mephisto at the FRM II, Garching. In this talk we give an overview on the special characteristics and advantages of PERC's field design. We will show that with our design we can prevent magnetic traps in magnetic field and achieve a clean separation of neutrons and decay-products.

HK 63.3 Fr 14:30 RW 3

Development of non-magnetic neutron guide for PERC — •Nataliya Rebrova for the PERC-Collaboration — Physikalisches Institut, Universität Heidelberg

The future cold neutron beam station PERC (Proton Electron Radiation Channel) is developed for measurements of angular correlation coefficients in β-decay of free polarized neutrons with precision of about 10-4. The neutron guide within PERC (where the 'active decay volume' lies) should be non-depolarizing on the same level of 10-4. We present the current status of the development of non-magnetic neutron guides. We discuss possible non-magnetic supermirror coatings with nickel-molybdenum or nickel-vanadium alloys and titanium, or copper and titanium. We demonstrate the feasibility of using copper and titanium supermirrors. We present first results of depolarization measurements at the opaque test bench obtained with cold polarized neutrons, which are reflected once from a multilayer copper-titanium sample placed inside strong magnetic field.

HK 63.4 Fr 14:45 RW 3

Studies on Liquid Xenon Low Energy Scattering for Dark Matter Applications — •Pierre Sissol, Bastian Beskers, Cyril Grignon, Uwe Oberlack, and Rainer Othegraven — Johannes Gutenberg Universität Mainz

The concept of a dual-phase Xenon time projection chamber realizes with XENON100 the currently most sensitive dark matter search experiment. Its successor XENON1T is already in development phase, and detectors at the 10 ton scale (e.g. DARWIN) are being envisioned. Background suppression and discrimination are driving forces in the design of these experiments. Currently, this is accomplished by fiducialization using position sensitivity and light/charge discrimination. Additional discrimination may be achieved by pulse-shape discrimination.

The Mainz group is setting up a small 3D position-sensitive two-phase Xenon-TPC to measure charge and scintillation yield at recoil energies of a few keV and to study the liquid Xenon scintillation pulse shape. We employ MC simulations to study low energy scattering of gamma-rays and neutrons to optimize the experimental setup. Here we discuss the planned experiments and identify the dominant systematic errors.

HK 63.5 Fr 15:00 RW 3

Dark Matter Search Results from the XENON100 Experiment — •Ethan Brown for the XENON-Collaboration — Institut fuer Kernphysik, WWU Muenster

The XENON100 Experiment looks for a new unknown form of matter called Dark Matter in the form of Weakly Interacting Massive Particles (WIMPs) by looking for nuclear recoils off of a target of liquid xenon. By utilizing a dual phase Time Projection Chamber (TPC) to measure the scintillation and ionization signals, event localization and discrimination of backgrounds due to electron recoils is possible. By operating a detector with a large active mass of 62kg in an ultra-low background environment, XENON100 has achieved excellent sensitivity to the WIMP-nucleon cross section, and is capable of probing much of the favored phase space predicted by theorists.

The results of a 100 live day dark matter search with the XENON100 detector will be presented, with an emphasis on background studies and detector characterization via calibrations. Additionally, the Profile Likelihood Analysis method will be discussed in the context of applying a statistical analysis of the experimental results, which allows for a robust statement of the interpretation of the results.

The work of the author has been supported by DFG (for XENON100, GZ: WE1 843/7-1) and BMBF (for XENON1T, GZ: 05A11PM1).

HK 63.6 Fr 15:15 RW 3

Determining the reflectivity of PTFE in the VUV — •Karen Bokeloh for the XENON-Collaboration — IKP, WWU Münster

In the hunt for dark matter the XENON collaboration searches for weakly interacting massive particles (WIMPS) by detecting their recoil from Xenon nuclei in a dual phase time-projection chamber (TPC). The ratio between the emitted light S1 and charge - the latter is converted into a second light signal S2 by electroluminescence - allows to discriminate nuclear recoils as caused by WIMPS or neutrons against electron recoils, the main background stemming from γs and electrons. For this separation it is essential that the complete primary light signal S1, that intrinsically is very low in intensity, is collected from the entire of the TPC with high efficiency. PTFE panels are implemented as boundaries of the TPC for two purposes - as electric insulator it is used to place wires for the electric field shaping and as reflector for the vacuum-UV light emitted in the Xenon scintillation process.

The reflection properties of the PTFE used in the Xenon100 experiment are not known in detail. In addition studies need to be conducted to evaluate the reflection properties of different low radioactivity PTFE samples as well as their mechanical and chemical treatment for use in the successor experiment Xe1t. Therefore, an ultrahigh vacuum reflection chamber has been designed and commissioned with a wavelength selective VUV light source. First measurements to show the functionality of the experiment will be presented. This work has been supported by DFG (for XENON100, GZ: WE1 843/7-1) and BMBF (for XENON1T, GZ: 05A11PM1).

HK 63.7 Fr 15:30 RW 3

Purification Methods for Xenon — •Stephan Rosendahl, Ethan Brown, Volker Hannen, Christian Huhmann, Hans Kettling, Johannes Schulz, and Christian Weinheimer — Institut für Kernphysik, Universität Münster

The Xenon Project uses a 2 phase time projection Chamber (TPC) to search for dark matter by detecting a nuclear recoil signal, induced by Weakly Interacting Massive Particles (WIMPs). An interaction between WIMPS and the target nuclei produces scintillation and charge signals. The electrons are drifted in an electric field to the gas phase where they are extracted to produce fluorescence light in xenon gas. Both light signals are detected by arrays of photomultiplier tubes on the top and bottom of the detector. The drift length of the electrons in liquid xenon strongly depends on the content of electronegative impurities. Furthermore Kr-85, which contributes to radioactive backgrounds, must be removed from the commercial xenon to the ppt level.

In Münster we set up a system to remove the electronegative impurities with a zirconium purifier and using cryogenic distillation to remove Kr-85 isotopes from the xenon. The quality of the xenon is investigated, using a dual phase xenon TPC, in combination with a laser based moisture analyzer and a quadrupol mass filter to have a complementary setup of different tools. The whole system is designed to perform R&D studies for the Xenon1T experiment, which is the next generation of direct dark matter detectors.

The project is supported by DFG and the state NRW, contractnumber INST 211/528-1 FUGG and by BMBF, number 05A11PM1.

HK 63.8 Fr 15:45 RW 3

Study of a Muon Veto Cherenkov Detector for the XENON1T Experiment — •Serena Fattori for the XENON-Collaboration — Johannes Gutenberg-Universität: Institut für Physik, Mainz, Deutschland

XENON is a dark matter direct detection experiment, consisting of a time-projection chamber (TPC) using xenon in double phase as sensitive detector medium. The XENON project is currently taking dark matter data at the Gran Sasso Underground Laboratory (Italy) with the XENON100 experiment (100 kg scale mass of target volume) devoted to explore the spin-independent elastic WIMP-nucleon scattering cross section at the sensitivity in the order of $\sim 10^{-45} cm^2$. In parallel to the operation of XENON100 an intensive R&D program for the next generation experiment (of ton scale mass) of the XENON project, XENON1T, is currently taking place. XENON1T will have a goal to reduce the background by two orders of magnitude compared to XENON100, pointing to a sensitivity in the order of $10^{-47} cm^2$. In order to achieve this background level the employment of a passive shield is not sufficient and it must be complemented with an active system able to veto the underground residual muon flux. In this study we optimized, with a series of Monte Carlo simulations based on the toolkit GEANT4, a water Cherenkov detector for the XENON1T experiment. Results showed the possibility to reach very high detection efficiencies in tagging the passage of both the muon and the shower secondary particles coming from the interaction of the muon in the rock.