T 15: Experimental methods I

Time: Monday 16:00–18:30 Location: To

T 15.1 Mon 16:00 To

Simulation of background reduction in KATRIN via induced de-excitation of Rydberg atoms with terahertz radiation — •Enrico Ellinger for the KATRIN-Collaboration — University of Wuppertal

A major background in the neutrino mass experiment KATRIN is supposed to originate from the ionization of Rydberg atoms within the main spectrometer (MS) volume. In Rydberg atoms one or more electrons have a high principal quantum number n resulting in a large orbital radius and long decay periods in the ms range. Once produced by radioactive processes in the surface of the MS vessel wall the neutral Rydberg atoms can travel through the whole MS before they get ionized by thermal radiation and finally accelerated towards the main detector producing the background. Terahertz radiation can be used to stimulate $\Delta n = \pm 1$ transitions to states from where spontaneous de-excitation to ground state is faster (μs range). This approach was pioneered by the anti-hydrogen community at CERN. However, due to the very different environment in comparison to atomic trap experiments the feasibility at KATRIN must be examined. This study is presented as well as the first draft of an experimental set-up for testing this new method.

T 15.2 Mon 16:15 To

Investigating the reduction in Rydberg Background — •Shivani Ramachandran for the KATRIN-Collaboration — Bergische Universitaet Wuppertal, Wuppertal, Germany

The KArlsruhe TRItium Neutrino experiment (KATRIN) is aimed at measuring the effective mass of the electron-antineutrino with a sensitivity of 0.2 eV/c2. This will be achieved by inspecting the endpoint of the beta-electron spectrum of Tritium. There are many known contributors to the background in the measured signal of the KATRIN experiment. The most dominant background source are the electrons produced by thermal ionization of Rydberg atoms which are highly excited atoms with large principal quantum numbers. In this talk the methods of de-excitation of the Rydberg atoms will be discussed and a mechanism for the same to the ground state in the KATRIN main spectrometer will also be investigated. THz and or microwave radiation allows for stimulated de-excitation hence reducing the lifetime of Rydberg atoms. This approach was pioneered by the anti-hydrogen community at CERN. The irradiative power needed for de-excitation and its efficiency will also be studied.

T 15.3 Mon 16:30 To

Angular selective detection of electrons with a microchannel plate detector — •Patrick Oelpmann, Kevin Gauda, Volker Hannen, Tim König, Alexey Lokhov, Hans-Werner Ortjohann, and Christian Weinheimer — Institut für Kernphysik, Münster, Deutschland

The Karlsruhe Tritium Neutrino Experiment (KATRIN) aims at determining the electron neutrino mass with a sensitivity of $0.2\,\mathrm{eV/c^2}$ from a precision measurement of the tritium β-decay spectrum. The analysis of the first science run allowed to set a new upper limit of $1.1\,\mathrm{eV/c^2}$ at 90 % confidence level.

To reach the target sensitivity an ultra-low background is a key requirement. However, currently the background in KATRIN exceeds its design value, creating demand for new techniques of background reduction. To this end, several background suppression methods have been proposed or have already been implemented. A promising idea is to make use of the different angular distribution of electrons produced in tritium β-decay compared to those produced by the dominant background mechanism, which is ionization of Rydberg states in the volume of the KATRIN main spectrometer. The talk will focus on first tests of angular selective detection of electrons with microchannel plate detectors.

This project is supported by BMBF under contract number 05A20PMA.

T 15.4 Mon 16:45 To

VAE-WGAN and Fast simulation of Electromagnetic Calorimeter Responses — •Jubna Irakkathil Jabbar[2], Günter Quast[2], Florian Bernlochner[1], and Pablo Goldenzweig[2] — [1]University of Bonn, Germany — [2]Karlsruhe Institute of Technology, Germany.

The simulation of particle showers in electromagnetic calorimeters with high precision is a computationally expensive and time consuming process. Fast simulation of particle showers using generative models have been suggested to significantly save computational resources.In this study, the energy responses of electromagnetic calorimeter for electrons and pion showers are used to train a deep learning generative model.The model is a combination of Wasserstein GAN and Variational Autoencoder.Once the model is trained, the generator of the model is used to generate particle shower simulations providing noise vectors as input.The generated particle showers are cross-checked with the Geant4 showers using various observables.

T 15.5 Mon 17:00 To

The Acoustic Module for the IceCube Upgrade — •Christoph Günther, Jürgen Borowka, Dirk Heinen, Andreas Nöll, Maximilian Scharf, Lars Steffen Weinstock, Christopher Wiebusch, and Simon Zierke for the IceCube-Collaboration — RWTH Aachen University - Physics Institute III B, Aachen, Germany

One major goal of the IceCube Upgrade is improved calibration by deploying additional calibration devices in the center of IceCube. Amongst these devices are ten stand-alone Acoustic Modules, capable of receiving and sending acoustic signals. By trilateration, these will provide a position calibration of the sensor strings with a resolution of about 10 cm. Additionally, glaciological measurements of the acoustic ice properties are planned. In view of the future IceCube-Gen2 detector, this system will provide an important proof of principle for the reliable position determination on distance scales of a few hundred meters. The design of the modules and the status of the development are presented in this talk.

T 15.6 Mon 17:15 To

Ppm precise high voltage: Advanced post regulation and absolute calibration — •Caroline Rodenbeck[1], Thomas Thümmler[2], and Sascha Wüstling[3] — [1]Institut für Kernphysik, WWU Münster — [2]IKP, Karlsruher Institut für Technologie — [3]IPE, Karlsruher Institut für Technologie

The Karlsruhe Tritium Neutrino (KATRIN) has started data taking to determine the neutrino mass using tritium beta decay spectroscopy. Use of a MAC-E filter type spectrometer enables a precise measurement of the spectrum's endpoint region. For KATRIN to reach its neutrino mass sensitivity target of $0.2\,\mathrm{eV/c^2}$ (90% C.L.), the spectrometer's retarding potential needs to be stable within 60 mV. This requires the system that creates the retarding potential as well as the system that measures it to be stable within 3 ppm at -18.6 kV on a wide range of time scales, from several months down to $1\,\mu$s (1 MHz).

Measuring the retarding potential at the ppm level is done using custom-built high-voltage dividers. Their stability has been proven with a variety of calibration methods over more than a decade. More recently, an absolute calibration technique with 1 ppm precision is being used to perform on-site calibrations. The advanced post regulation system – a feedback loop between the post regulation and one of the precision high-voltage dividers – stabilizes the high voltage on a sub-ppm level for time scales down to 1 us.

The talk presents the absolute calibration method and the advanced post regulation system. This project is supported by BMBF under contract number 05A20PMA and HGF.

T 15.7 Mon 17:30 To

Compton Scanner Messungen an Germaniumdetektoren — •Felix Hagemann für die GeDet-Kollaboration — Max-Planck-Institut für Physik, München

In der Grundlagenforschung werden Germaniumdetektoren z.B. bei der Suche nach neutrinolosem Doppelbetazerfall oder dunkler Materie verwendet. In vielen dieser Experimente ist das bestmögliche Verständnis der Physik und der Pulsentstehung in diesen Detektoren essentiell. Seit Mitte 2019 betreibt die GeDet Gruppe am Max-Planck-Institut für Physik einen Compton Scanner zur Untersuchung von Germaniumdetektoren. In diesem vollständig automatisierten Aufbau wird der zu untersuchende Detektor mit 662 keV Photonen einer kollimierten Caesiumquelle bestrahlt. Im Germanium Compton gestreute Photonen werden in einer nahe platzierten CdZnTe Kamera absorbiert. Mit Hilfe der jeweils deponierten Energien und der Position des gestreuten Photons in der Kamera kann die jeweilige Position der Streuung im Germanium rekonstruiert werden. Die gemessenen Pulsformen können so ihren Entstehungspunkten zugeordnet werden. Das ermöglicht, die Signale über das gesamte Volumen hinweg kontrolliert auf Einflüsse von Kristallachsen, Betriebsspannung und Temperatur zu untersuchen. Dies kann im Vergleich mit Simulationsergebnissen dabei helfen, Ladungsträgerbeweglichkeiten und Raumladungsdichten in Germaniumdetektoren besser zu verstehen. Erste Ergebnisse für einen vierfach segmentierten p-Typ Broad Energy Germaniumdetektor werden präsentiert und mit Simulationen des Softwarepakets `SolidStateDetectors.jl` verglichen.

T 15.8 Mon 17:45 To

Gas cooling of test masses for future gravitational-wave observatories — Christoph Reinhardt[1], •Alexander Franke[2], Jörn Schaffran[1], Roman Schnabel[2], and Axel Lindner[1] — [1]Deutsches Elektronen Synchrotron (DESY), 22607 Hamburg, Germany — [2]Institut für Laserphysik und Zentrum für Optische Quantentechnologien der Universität Hamburg, Hamburg, Germany

Recent observations made with Advanced LIGO and Advanced Virgo have initiated the era of gravitational-wave astronomy. The number of events detected by current observatories is partially limited by noise arising from temperature-induced position fluctuations of the test mass mirror surfaces used for probing space time dynamics. Future gravitational-wave observatories address this limitation by using cryogenically cooled test masses; current approaches for continuously removing heat (resulting from absorbed laser light) rely on black-body radiation or conduction through suspension fibers.

We investigate cooling via helium gas impinging on the test mass in the free molecular flow regime and develop a relation between gas-induced cooling power and corresponding added observatory strain noise. The application of our analytical models and numerical simulations is presented with regard to the conceptual design of the Einstein Telescope.

T 15.9 Mon 18:00 To

LUXE: A new experiment to study non-perturbative QED in e^--LASER and γ-LASER collisions — Oleksandr Borysov[1], Maryna Borysova[1], John Hallford[1,2], Beate Heinemann[1,3], Louis Helary[1], Marius Hoffmann[1], •Ruth Jacobs[1], Jenny List[1], Rajendra Prasad[1], and Matthew Wing[1,2] — [1]Deutsches Elektronen-Synchrotron (DESY), Hamburg, Germany — [2]University College London, London, United Kingdom — [3]Albert-Ludwigs-Universität Freiburg, Freiburg, Germany

The LUXE experiment (LASER Und XFEL Experiment) is a new experiment in planning at DESY Hamburg using the electron beam of the European XFEL. LUXE is intended to study collisions between a high-intensity optical LASER and 16.5 GeV electrons from the XFEL electron beam, as well as collisions between the optical LASER and high-energy secondary photons. The physics objective of LUXE are processes of Quantum Electrodynamics (QED) at the strong-field frontier, where the electromagnetic field of the LASER is above the Schwinger limit. In this regime, QED is non-perturbative. This manifests itself in the creation of physical electron-positron pairs from the QED vacuum, similar to Hawking radiation from black holes. LUXE intends to measure the positron production rate in an unprecedented LASER intensity regime. This group report gives an overview of the LUXE experimental setup and its context within the field of high-intensity particle physics. The foreseen detector systems and their sensitivity are presented. Finally, the prospects of a modified LUXE setup for studying BSM physics are discussed.

T 15.10 Mon 18:15 To

Surface cleaning for background reduction and its influence on liquid xenon TPC performance — •Natascha Rupp[1], Dominick Cichon[1], Florian Joerg[1], Teresa Marrodan Undagoitia[1], and Stefan Bruenner[2] — [1]Max-Planck-Institut fuer Kernphysik, Heidelberg — [2]NIKHEF, Amsterdam

One main challenge in the direct detection of dark matter particles with liquid xenon TPCs (Time Projection Chambers) is the background reduction to a minimal rate. The plate-out of Rn222 daughters on the surfaces in contact with the liquid xenon can cause background events. We investigated different cleaning procedures that mitigate this background source. In order to apply them in future TPCs like DARWIN it has to be verified that they don't affect the xenon purity which strongly influences the signal production and hence the discrimination power of signal and background. This talk presents different cleaning procedures for PTFE and shows results of the xenon purity evolution after applying a strong nitric acid treatment to the PTFE surface of a TPC.