T 98: Experimentelle Methoden III

Zeit: Donnerstag 16:45–19:10 Raum: VMP8 SR 105

Gruppenbericht T 98.1 Do 16:45 VMP8 SR 105

Track reconstruction for the *Mu3e* experiment — •Alexandr Kozlinskiy for the Mu3e-Collaboration — Institut für Kernphysik, Johannes Gutenberg-Universität Mainz, Germany

The *Mu3e* experiment is designed to search for the lepton flavour violating decay $\mu^+ \to e^+e^-e^+$. To reach the sensitivity of 10^{-16}, the experiment will be performed at a beam line at the Paul-Scherrer Institute (Switzerland) providing 10^9 muons per second. The muons with a momentum of about 28 MeV/c are stopped on a target and decay at rest. The target is placed inside two double layers of 50 μm thin pixel sensors with a pixel size of 80×80 μm^2. Timing information is provided by three layers of scintillating fibres, placed just before the outer double layers, and a scintillating tile detector. To improve momentum resolution, the detector geometry allows to record additional hits when particles bend back in the 1 T magnetic field. A fast track reconstruction is needed to cope with the high occupancy environment, reaching 100 tracks per readout frame of 50 ns. The implementation of a track reconstruction with a fast multiple scattering fit, where spatial uncertainties are ignored, is described. The performance of the track reconstruction and the use of timing information from fibre and tile detector is presented.

Gruppenbericht T 98.2 Do 17:05 VMP8 SR 105

The MuSun experiment: muon capture on the deuteron — •Frederik Wauters[1,2], Peter Kammel[2], Claude Petitjean[3], Alexander Vasilyev[4], Rachel Ryan[2], Daniel Salvat[2], Ethan Muldoon[2], Michael Murray[2], David Hertzog[2], Robert Carrey[5], Frederick Gray[6], and Tim Gorringe[7] — [1]Johannes Gutenberg University of Mainz, Mainz, Deutschland — [2]University of Washington, Seattle, USA — [3]Paul Scherrer Institute, Villigen, Switzerland — [4]Petersburg Nuclear Physics Institute , Gatchina, Russia — [5]Boston University, Boston, USA — [6]Regis University, Denver, USA — [7]University of Kentuky, Lexington. USA

The MuSun experiment measures the muon capture rate on the deuteron via a precise measurement of the lifetime of negative muons in deuterium, determining unambiguously the low energy constant (LEC) related to the strengths of the axial coupling to the two nucleon-system. LEC's are part of recently developed QCD-based effective field theories, which provide a first-principles description with predictive power for few-body nuclear systems. A quantitative relationship is established between astrophysical processes which cross sections can not be measured in the laboratory, such as the pp fusion in our sun, and muon capture rates. The MuSun experiment finished data taking at the Paul Scherrer Institute (Villigen, CH) in the summer of 2015. In this talk, I will present the experimental program of the last 4 years and the progress of the data analysis towards a first physics result. I will focus on our active-target time projection chamber, which provides the event selection for the 10 ppm lifetime analysis.

T 98.3 Do 17:25 VMP8 SR 105

Track reconstruction for the P2 experiment — •Alexey Tyukin for the P2-Collaboration — JGU, Mainz, Deutschland

The P2 experiment at the future MESA accelerator in Mainz will measure elastically scattered electrons from a hydrogen or lead target in order to determine the parity violating asymmetry for different beam polarisations, which is created due to the weak charge of the target. The asymmetry can provide access to the Weinberg angle and the neutron skin of heavy nuclei. These quantities depend heavily on the momentum transfer Q^2, thus a reconstruction of single electron tracks in an inhomogeneous magnetic field is necessary. For this, the P2 detector will have four tracking planes of thin high voltage monolithic active pixel sensors (HV-MAPS).

The scattered electrons propagate through a magnetic field and hit all four planes. In order to fit the hit positions the General Broken Lines method is used. As a fast propagator, a variation of the Runge-Kutta algorithm is applied, which solves the equation of motion in an inhomogeneous magnetic field numerically, such that the final state momentum and scattering angle can be reconstructed. The initial momentum and incident angle can vary strongly due to the thickness of the target, limiting the reconstruction quality. The average single track Q^2 value of $0.006\,\mathrm{GeV}^2/c^2$ can be reconstructed with about 4% uncertainty in a first analysis of the Geant4 simulation, leading to a high total precision due to large electron numbers in the experiment.

T 98.4 Do 17:40 VMP8 SR 105

Parameterization-based tracking for the P2 experiment — •Iurii Sorokin for the P2-Collaboration — Institut für Kernphysik and PRISMA cluster of excellence, Mainz, Deutschland

The P2 experiment at the new MESA accelerator in Mainz aims to determine the weak mixing angle by measuring the parity-violating asymmetry in elastic electron-proton scattering at low momentum transfer. To achieve an unprecedented precision an order of 10^{11} scattered electrons per second have to be acquired. Whereas the tracking system is not required to operate at such high rates, every attempt is made to achieve as high rate capability as possible.

The P2 tracking system will consist of four planes of high-voltage monolithic active pixel sensors (HV-MAPS). With the present preliminary design one expects about 150 signal electron tracks and 20000 background hits (from bremsstrahlung photons) per plane in every 50 ns readout frame at the full rate.

In order to cope with this extreme combinatorial background in online mode, a parameterization-based tracking is considered as a possible solution. The idea is to transform the hit positions into a set of weakly correlated quantities, and to find simple (e.g. polynomial) functions of these quantities, that would give the required characteristics of the track (e.g. momentum). The parameters of the functions are determined from a sample of high-quality tracks, taken either from a simulation, or reconstructed in a conventional way from a sample of low-rate data.

T 98.5 Do 17:55 VMP8 SR 105

Track Based Alignment of the Mu3e Detector — •Ulrich Hartenstein — Institut für Kernphysik, Universität Mainz

The Mu3e emperiment searches for the lepton flavor violating decay $\mu^+ \to e^+e^-e^+$ with a sensitivity goal for the branching fraction of better than 10^{-16}. This process is heavily supressed in the standard model of particle physics (BR $< 10^{-50}$) which makes an observation of this decay a clear indication of new physics.

For track reconstruction, four barrel shaped layers consisting of about 3000 high-voltage monolithic active pixel sensors (HV-MAPS) are used. The position, orientation and possible deformations of these sensors must be known to greater precision than the assembly tolerances. A track based alignment via the General Broken Lines fit and the Millepede-II algorithm will be used to achieve this precision in the final detector.

The talk will discuss a study of the required alignment precision and preparations for aligning the detector using a detailed simulation.

T 98.6 Do 18:10 VMP8 SR 105

Design of a tritium compatible spectroscopy experiment for hydrogen istopologues for temperatures between 15-293 K — •Sebastian Mirz, Tim Brunst, Robin Grössle, and Bennet Krasch — Karlsruhe Institute of Technology (KIT), Institute for Technical Physics (ITEP), Tritium Laboratory Karlsruhe (TLK)

The Karlsruhe Tritium Neutrino Experiment (KATRIN) investigates the energy spectrum of the tritium β decay near its energetic endpoint in order to determine the electron anti-neutrino mass with a sensitivity of $200\,\mathrm{meV/c}^2$ (90% C.L.). Therefore, molecular tritium gas is decaying in a windowless gaseous tritium source (WGTS). The physical properties of the gas in the WGTS, like composition, ortho/para ratio or rotational population, need to be stabilised on a 10^{-3} level due to their direct impact on the initial state distribution of the investigated β decay. The new experiment T_2ApIR is designed to be fully tritium compatible to perform IR and Raman spectroscopic measurements on all six hydrogen isotopologues under conditions similar to the KATRIN WGTS. Therefore, T_2ApIR will provide a combination of a chemical and a coolable ortho/para catalyst, in order to produce isotope mixtures with non-equilibrium chemical and ortho-para compositions. The produced gas mixtures are examined with a second Raman analysis system, able to simultaneously determine the chemical and ortho/para composition in the gas phase. This contribution presents the design of the new T_2ApIR experiment with the focus on the investigation of molecular processes, as e.g. the formation of van-der-Waals clusters.

T 98.7 Do 18:25 VMP8 SR 105

Energy reconstruction methods for large coplanar quad-grid CdZnTe detectors — •Jan-Hendrik Arling, Claus Gössling, and Kevin Kröninger — TU Dortmund, Experimentelle Physik IV, Dortmund, D

The COBRA experiment will search for neutrinoless double beta-decay ($0\nu\beta\beta$) using CdZnTe semiconductor detectors. Currently a demonstrator setup consisting of 64 coplanar-grid (CPG) CdZnTe detectors with a volume of $(1 \times 1 \times 1)\,\mathrm{cm}^3$ each is under operation at the Gran Sasso Underground Laboratory (LNGS). The next step for the experiment will be the installation of an array of nine CdZnTe detectors with a volume of $(2 \times 2 \times 1.5)\,\mathrm{cm}^3$ and four CPG sectors with parallel readout each. Advantages of these larger detectors are a higher full-energy detection efficiency and a better surface-to-volume ratio. Up to now, the reconstruction schemes developed for the $1\,\mathrm{cm}^3$ detectors are also used for the $6\,\mathrm{cm}^3$ detectors. Consequentially the potential of improvements on the energy reconstruction will be investigated. An important topic in this context is the reconstruction of the interaction depth which is possible due to the coplanar-grid design. In this talk the newest results of the investigation of the reconstruction methods for $6\,\mathrm{cm}^3$ CdZnTe detectors will be presented and discussed.

T 98.8 Do 18:40 VMP8 SR 105

Stress evaluation at the ILC positron source — •Andriy Ushakov[1], Gudrid Moortgat-Pick[1], Sabine Riemann[2], Felix Dietrich[2], Kurt Aulenbacher[3], Valery Tyukin[3], and Philipp Heil[3] — [1]Universität Hamburg, II. Institut für Theoretische Physik, Luruper Chaussee 149, 22761 Hamburg — [2]Deutsches Elektronen-Synchrotron DESY, Standort Zeuthen, Platanenallee 6, 15738 Zeuthen — [3]Johannes Gutenberg-Universität Mainz, Institut für Kernphysik, Johann-Joachim-Becher-Weg 45, 55128 Mainz

High luminosity is required at future Linear Colliders which is particularly challenging for all corresponding positron sources. At the International Linear Collider (ILC), polarized positrons are obtained from electron-positron pairs by converting high-energy photons produced by passing the high-energy main electron beam through a helical undulator. The conversion target undergoes cyclic stress with high peak values. To distribute the thermal load, the target is designed as wheel spinning in vacuum with 100 m/s. However, the cyclic stress over long time at high target temperatures could exceed the fatigue stress limit. In the talk, an overview of the ILC positron source is given. The prospects to study material parameters under conditions as expected at the ILC are discussed.

T 98.9 Do 18:55 VMP8 SR 105

Bestimmung der Strahlpolarisation am International Linear Collider (ILC) — •Robert Karl[1,2] und Jenny List[1] — [1]Deutsches Elektronen-Synchrotron DESY, Notkestraße 85, 22607 Hamburg — [2]Universität Hamburg, Institut für Experimentalphysik, Luruper Chaussee 149, 22761 Hamburg

Der ILC ist ein geplanter Elektron-Positron Collider mit Schwerpunktenergien von bis zu 500 GeV (Upgrade 1 TeV). Dabei werden der Elektronenstrahl zu 80% und der Positronenstrahl bis zu 60% polarisiert sein. Dies ermöglicht einzigartige Untersuchungen der chiralen Kopplungen von Standardmodell-Teilchen (z.B. von Top-Quarks) oder auch von potentiellen neuen Teilchen. Um das Potential des ILC voll auszuschöpfen, muss die Genauigkeit der Polarisation im Promillebereich liegen. Dies bedeutet ungefähr einen Faktor 2 bis 5 genauer als bisher bei vergleichbaren Beschleunigern erreicht wurde. Am ILC wird die Polarisation direkt im laufenden Betrieb vor und hinter deren Kollisionspunkt gemessen und anschließend durch Spintracking zum Kollisionspunkt extrapoliert. Doch die Polarisation kann auch direkt am Kollisionspunkt aus der Langzeitmessung von Wechselwirkungsquerschnitten bekannter Standardmodellprozesse, die polarisationsabhängig sind, bestimmt werden. In diesem Beitrag wird die Sensitivität verschiedener Standardmodellprozesse in Hinblick auf die erreichbaren Genauigkeiten der Polarisationsmessung diskutiert. Dabei werden sowohl statistische als auch systematische Unsicherheiten betrachtet und eine Gesamtstrategie zur Bestimmung der luminositätsgewichteten mittleren Polarisation entwickelt.