HK 20: Fundamental Symmetries

Time: Wednesday 16:30–18:45 Location: H4

Group Report HK 20.1 Wed 16:30 H4

Probing charged lepton flavor violation with the Mu2e experiment — •Stefan E. Müller, Anna Ferrari, Oliver Knodel, and Reuven Rachamin for the Mu2e-Collaboration — Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany

The Mu2e experiment, currently under construction at the Fermi National Accelerator Laboratory near Chicago, will search for the neutrinoless conversion of muons to electrons in the field of an aluminum nucleus. In the Standard Model, this process, which violates charged lepton flavor conservation, is highly suppressed and undetectable. However, scenarios for physics beyond the Standard Model predict small but observable rates. The Mu2e experiment aims for a sensitivity which is four orders of magnitude better than previous experiments. This is achieved by rigorous control of all backgrounds that could mimic the monoenergetic conversion electron signal.

At the Helmholtz-Zentrum Dresden-Rossendorf, we use the ELBE radiation facility to study the performance of the detectors that will monitor the rate of stopped muons in the aluminum target. For these detectors we have ported several software analysis algorithms to FPGA hardware using High-Level Synthesis, which will be tested at the next ELBE beamtime. Additionally, we perform extensive Monte Carlo simulations for shielding studies and rate comparisons.

In the presentation, the design and status of the Mu2e experiment and its detectors will be presented, and results from ELBE beamtimes and the simulation studies will be shown.

Group Report HK 20.2 Wed 17:00 H4

Parity violating electron carbon scattering at the P2 experiment — Sebastian Baunack[1], Kathrin Imai[1], Rahima Krini[1], Frank Maas[1,2,3], Tobias Rimke[1], David Rodriguez Pineiro[2], and •Malte Wilfert[1] for the P2-Collaboration — [1]Institut für Kernphysik, Johannes Gutenberg-Universität Mainz — [2]Helmholtz-Institut Mainz, Johannes Gutenberg-Universität Mainz — [3]PRISMA Cluster of Excellence, Johannes Gutenberg-Universität Mainz

The weak mixing angle $\sin^2\theta_W$ can be measured in parity violating elastic electron-proton scattering. The aim of the P2 experiment is a very precise measurement of the weak mixing angle with a precision of 0.15% at a low four-momentum transfer of $Q^2 = 4.5\cdot10^{-3}\,\mathrm{GeV}^2$. This precision is comparable to existing measurements at the Z pole. The experiment will be built at the future MESA accelerator in Mainz.

In addition to the measurement using a liquid hydrogen target, the possibility of other targets for measuring the parity violating elastic electron scattering are considered. The motivation and challenges for a measurement using a solid carbon target will be discussed in this talk.

Group Report HK 20.3 Wed 17:30 H4

The search for electric dipole moments of charged particles on storage rings — •Vera Shmakova for the JEDI-Collaboration — IKP, Forschungszentrum Jülich, 52425 Jülich, Germany

One of the main problems of modern particle physics is the inability of the Standard Model (SM) of Particle Physics to explain the matter-antimatter asymmetry in the Universe. The pursuit of physics beyond the SM is required and one way to achieve it is to strive for the highest precision in the search for electric dipole moments (EDMs). Permanent EDMs of particles violate both time reversal and parity invariance and, through the CPT-theorem they also violate the combined CP symmetry. Hence, EDM measurements of fundamental particles are capable to probe new sources of CP-violation, and finding an EDM would be a convincing indicator for physics beyond the SM. Storage rings make it possible to measure EDMs of charged particles by observing the effect of the EDM on the spin motion in the ring. The direct search for proton and deuteron EDMs bears the potential to reach sensitivity beyond 10^{-29} e cm. The Cooler Synchrotron COSY at the Forschungszentrum Jülich provides polarized protons and deuterons with momenta up to 3.7 GeV/s, which is an ideal starting point for such an experimental program. The JEDI (Jülich Electric Dipole moment Investigations) collaboration is currently aiming at the first direct (precursor) measurement of the deuteron EDM in COSY. The technical design of the prototype EDM storage ring is the next milestone of the JEDI research program. The talk will present the JEDI program for the measurement of proton and deuteron EDMs and discuss recent results.

HK 20.4 Wed 18:00 H4

Frequency extraction of NMR signal to measure the magnetic field in the Fermilab Muon g − 2 experiment — •Mohammad Ubaidullah Hassan Qureshi, René Reimann, and Martin Fertl for the Muon g-2-Collaboration — Institute of Physics and Excellence Cluster PRISMA+, Johannes Gutenberg University Mainz, 55099 Mainz, Germany

The Fermilab Muon g − 2 collaboration recently published its first result for the anomalous magnetic moment of the muon, a_μ, to an unprecedented precision of 460 ppb. The new result deviates of 3.2σ from the latest Muon g−2 Standard Model Theory Initiative prediction and combined with Brookhaven National Laboratory (BNL) result the deviation increases to 4.2 sigma. The Muon g − 2 experiment determines the ratio of the muon anomalous precession frequency, w_a, to the proton spin precession frequency, w_p. The w_p value allows us to precisely account for the magnetic field experienced by the precessing muons. In this talk I will discuss the current methodology of precisely measuring the magnetic field using nuclear magnetic resonance (NMR) probes. This is achieved by extracting the frequency of the NMR signal generated due to spin precession of hydrogen atoms in our probe. Furthermore, I will also talk through plans for upcoming Run 2/3 analysis to systematically check and improve probe frequency extraction to a value below the Run 1 uncertainty for frequency extraction.

HK 20.5 Wed 18:15 H4

Tracking the magnetic field in the Fermilab Muon g–2 storage ring — •René Reimann, Mohammad Ubaidullah Hassan Qureshi, and Martin Fertl for the Muon g-2-Collaboration — Institute of Physics and Excellence Cluster PRISMA+, Johannes Gutenberg University Mainz, 55099 Mainz, Germany

Recently the Muon g–2 collaboration published the most precise measurement of the anomalous magnetic moment of the muon, a_μ, with a 460 ppb uncertainty based on the Run 1 data. The measurement principle is based on a clock comparison between the anomalous spin precession frequency of spin-polarized muons, which is the deviation of the Larmor- from the cyclotron-frequency, and a high-precision measurement of the magnetic field environment using nuclear magnetic resonance (NMR) techniques, expressed by the (free) proton spin-precession frequency. To achieve the ultimate goal of a 140 ppb uncertainty on a_μ, the magnetic field in the storage region of the muons needs to be tracked with an uncertainty better then 70 ppb. The magnetic field tracking is composed of three main components, an absolute calibrated NMR probe, a movable array of NMR probes that can be pulled through the storage region of the muons and a set of NMR probes in the vicinity of the storage region. In this talk, we present the measurement and tracking principle of magnetic field and point out improvements for the upcoming analysis of the Run 2 and 3 data.

HK 20.6 Wed 18:30 H4

Coalescence in MC generators and implications for cosmic ray studies — •Maximilian Horst, Laura Serksnyte, Luca Barioglio, and Laura Fabbietti — Technische Universität München

Coalescence is one of the main models used to describe the formation of light (anti)nuclei in high-energy collisions. It is based on the assumption that two nucleons close in phase space can coalesce and form a nucleus. Coalescence has been successfully tested in hadron collisions with various experiments, from small (pp collisions) to large collision systems (Au-Au and Pb-Pb collisions). However, in Monte Carlo simulations (anti)nuclear production is not described by event generators. A possible solution is given by the implementation of so-called coalescence afterburners, which can describe nuclear production on an event-by-event basis. This idea finds its application especially in astrophysical studies, allowing for precise description of (anti)nuclear fluxes in cosmic rays, which are crucial for indirect Dark Matter searches.

In this talk we present the implementation of event-by-event coalescence afterburners for MC generators. Different approaches to this implementation will be discussed, and the comparison with available experimental results from various collision systems will be shown.