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HV stability and aging phenomena observed in the drift chamber system of the MEG experiment

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The MEG experiment (phase 1) at the Paul Scherrer Institute, searching for the charged lepton flavor violating decay mu -> e + gamma, took physics data from 2009 until 2013. The analysis of the combined data sample resulted in an upper limit of 4.2·10E{-13} (90%CL) on the branching ratio that is still the most stringent limit on this decay to date.

The drift chamber system was designed to ensure the precision measurement of 52.8 MeV/c positrons. The system consisted of 16 drift chamber modules and was part of the innovative spectrometer of the MEG experiment. The drift chambers were supplied with a gas mixture of helium:ethane (50:50) and were placed inside a helium atmosphere to reduce multiple scattering of the decay positrons. The drift chambers were operated at a gain of 5·10E5 and in the central part, they had to cope with a particle rate of ˜30 kHz/cmˆ2. This resulted in an accumulated charge of ˜1C / 8 months of operation on the anode wires. The cathodes of the drift chamber consisted of an aluminized polyimide foil with an etched Vernier pattern.

The operation with a helium-based gas mixture and inside a helium atmosphere initially led to a gradual degradation of the HV stability, but this was recovered by a proper potting and an improved design to avoid a hidden “helium pocket”that increasingly filled with helium, resulting in a reduced breakdown voltage.

The operation at high gain and high rate lead to polymerization of the hydrocarbon component in the counting gas and resulted in a growing layer on the anodes wires that could be analysed using scanning electron microscope (SEM) technique. Energy-dispersed x-ray spectroscopy (EDX) confirmed carbon as the main component of the anode wire coating.

Some drift chamber modules suffered from Malter effect, showing remaining and fluctuating currents during beam off periods, most likely caused by remaining photo resist on the cathode foils. An improved cleaning procedure by the manufacturer resulted in a better performance of new and replaced drift chamber modules.

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