Study of Aging Properties of a Wire Chamber Operating with High–Pressure Hydrogen Designed for a Precision Measurement of the μp–Capture Rate.

V.A. Andreev[1], A.A. Fetisov[1], V.A. Ganzha[1], G.E. Gavrilov[1], A.G. Krivchitch[1], E.V. Kuznetsova[1], V.M. Lebedev[1], E.M. Maev[1], O.E. Maev[1], C. Petitjean[2], G.E. Petrov[1], G.N. Schapkin[1], G.G. Semenchuk[1], M. Soroka[1], L.A. Schipunov[1], and A.A. Vorobyov[1]

presented by **Evgeny Maev**

1) Petersburg Nuclear Physics Institute (PNPI), 188350 Gatchina, Russia
2) Paul Scherrer Institute, PSI, CH-5232 Villigen PSI, Switzerland

The project for high precision studies of muon capture in hydrogen is based on the application of a multi-wire proportional chamber (MWPC) operating in ultra pure deuterium-depleted hydrogen (protium) at high pressure. A special test setup was constructed at PNPI to investigate the MWPC performance at the expected experimental conditions. The chambers were tested inside a vessel filled with clean hydrogen at 10 bar pressure. The aging studies of the MWPCs were performed under intense irradiation from an alpha-source (^{241}Am) and a beta-source (^{90}Sr). For example, after 45 days of continuous irradiation by alpha-particles with four intermediate gas re-fillings we did not see any changes in the currents, in the signal shapes, and in the counting rates. It was demonstrated that the MWPCs can operate without degradation at least up to accumulated charges of 0.1 C/cm of wire. These irradiation conditions are much more severe than in the real experiment. The electron microscopic and X-ray analysis of the anode and cathode wires revealed no serious signs of destruction of the wire surfaces. However, in several radiation tests an appearance of dark currents was observed (up to 10 μA), the nature of which is not yet clearly understood. During the study of the MWPC we have observed the appearance of short duration (about 20 ns) signals with amplitudes an order of magnitude larger than for normal signals from the alpha particles. The number of such signals ("streamers") strongly depends on HV. We shall continue these tests in the future with the goal to obtain more detailed information about aging properties of the MWPCs operating with high-pressure hydrogen.

Summary of Poster: A new experiment for high precision studies of muon capture in hydrogen is based on the application of a special Time Projection Chamber (TPC) for detection of the incoming muons and the outgoing decay electrons. The TPC contains four multi-wire planes. The idea of using the TPC as an active target for this experiment is based on ten years of working experience with a TPC operating in ionization mode. The switch to the proportional regime was prompted by the necessity to simultaneously register the heavily ionizing particles (slow muons) and weakly ionizing particles (the decay electrons). This is possible with a gas gain above 10,000. The target pressure was chosen to be 10 bar. As the world-wide experience with using multi-wire proportional chambers (MWPCs) in hydrogen at such conditions was very limited we had to carry out detailed studies of their performance. The MWPCs were tested in a special setup filled with clean hydrogen at 10 bar pressure with gas contamination (N_2, O_2, H_2O) of about 10 ppm. After design optimization, the following basic parameters of the MWPCs have been chosen: cathodes- Fe wires, 50 μm diameter, 0.5 mm spacing; anode-W(Au) wires, 25 μm diameter, 4 mm spacing; the anode-cathode gap is 3.5 mm. The MWPCs showed stable operation up to HV=7.0 kV providing a gain of up to 20,000 and 5,000 while detecting relativistic electrons and alpha-particles, respectively. The difference of the gains is a result of the space charge effect. The aging studies of the MWPCs were performed under intense irradiation from the alpha source (^{241}Am, energy 5.5 MeV). The nominal HV was 6.5 kV. The current from the chamber (determined by the source intensity) was 360 nA. The maximum current from a single wire was 50 nA. These currents are comparable to the currents in the real experiment with a 50 kHz muon beam. For example, the current in the entrance muon chamber will be 5 nA per wire (i.e. an order of magnitude less than in our tests) and in the TPC the current per wire will be about 20 nA. Note that the signals from alpha particles have much higher amplitudes than even the muon signals from the muon-stop wires. Some preliminary results: after 45 days of continuous irradiation by alpha-particles with four intermediate gas refilling we did not see any changes in the currents, in the signal shapes, and in the counting rates. The maximum collected charge per 1 cm of wire was 0.1 C/cm. So we may conclude that MWPCs can operate reliably in hydrogen with life times considerably exceeding the running time of the experiment. Note that these studies have been done with contaminations of the hydrogen of 1ppm just after the filling up to about 10ppm several days after the filling. We plan to repeat these studies with ultra-clean hydrogen (with the concentration of impurities less than 0.1ppm) using a special circulation system.