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First Physics Results from the MuCap Experiment at PSI[1]

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The MuCap experiment will measure the rate of the muon capture reaction μ + p $\rightarrow$ n + ν on the free proton to 1% precision. This directly determines the pseudoscalar form factor $g_P$at q^2 = -0.88 m_μ^2 to 7%. The pseudoscalar is the least well-known of the basic nucleon form factors characterizing the structure of its charged electro weak current. Modern effective theories based on the chiral symmetry of QCD and its breaking can calculate g_P to 3%. In spite of efforts spanning the last 30 years, experimental results are still controversial and subject to large uncertainties in their interpretation. While the first radiative muon capture experiment on hydrogen recently observed a four standard deviation discrepancy from the precise chiral prediction, new results on muonic atomic physics processes in hydrogen underscore the model dependence of the present g_P determinations. The resulting uncertainty in g_P is as large as 50 percent. The MuCap experiment is designed to overcome the problems that plagued earlier efforts. The method requires a combination of novel and challenging detector techniques. The capture rate will be determined from the difference of the μ^+ and μ^- lifetimes measured after muons are stopped in a time projection chamber operating with 10 bar hydrogen gas. Electrons from muon decay are reconstructed with an electron tracking system. A sophisticated gas system maintains and monitors the ultra-high purity of the deuterium-depleted H_2 gas used as an active target. In 2004 the hardware for the complex detector was commissioned and 20% of our final statistics was recorded. After additional performance upgrades in 2005, the experiment successfully reached the proposed goal of 10^{10} events in 2006. The 2004 data analysis is at an advanced stage. The data surpass all previous experiments both in statistics and in reduction of systematic uncertainties. First results on the μp capture rate will be presented at this conference. As a possible second stage, we are exploring a precision measurement of the related muon capture reaction on deuterium. A measurement at the 1% level could be compared with recent high-precision calculations, provide direct information on the two-nucleon axial current and calibrate fundamental neutrino reactions.

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