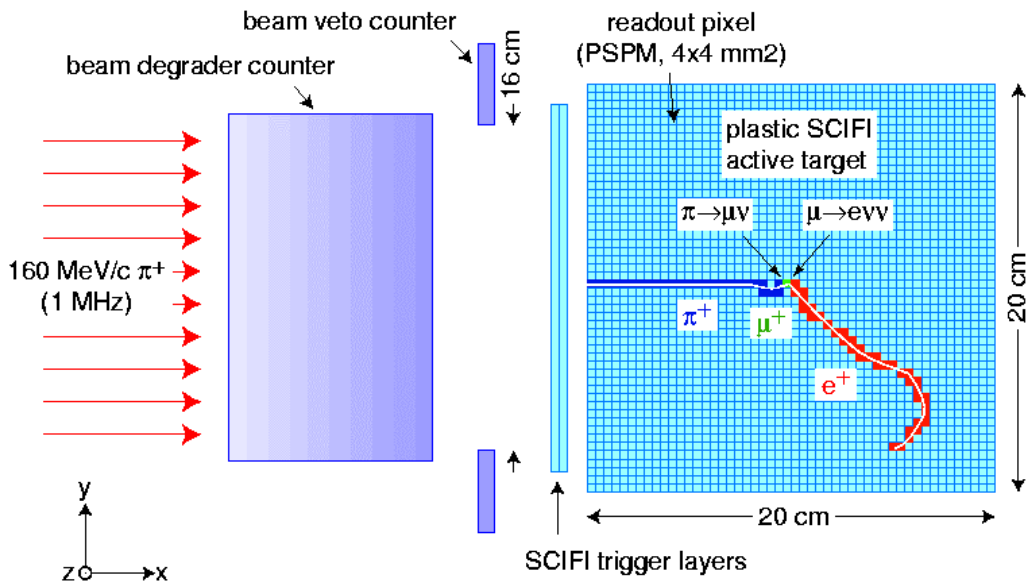
Measuring the Muon Lifetime and G_F to 1 ppm

K.M. Crowe, T. Case and P. Kammel and the FAST Collaboration at PSI †

We plan to measure the μ^+ lifetime with 1 ppm precision which represents a factor of 20 improvement compared to the current world average. This measurement determines the Fermi coupling constant G_F, one of the fundamental electro-weak couplings of the Standard Model. Whereas recent high-energy experiments have dramatically improved the precision of other electro-weak parameters, most notably the Z mass to 22 ppm, no experimental progress has been achieved for G_F over the last decade with its error remaining at 17 ppm. New 2-loop electro-weak calculations are anticipated to eliminate the theoretical uncertainty, so that the remaining 10 ppm error in G_F is completely dominated by the muon lifetime. This situation stimulated proposals at Brookhaven, Rutherford and PSI to push the experimental precision towards 1 ppm.



PSI provides the best low energy meson beams in terms of quality and intensity. We are collaborating on a new experiment[1] based on a fiber active scintillating target (FAST detector). The collaboration will develop a high granularity target of dimensions 20x20x20 cm^3 made from scintillating fibers viewed by position sensitive photo-tubes (see fig.1). The complete π-μ-e decay chain will be observed. In order to control and reduce the systematic errors, we plan to perform the measurement in two different beams with complementary systematic problems. In the first stage, the experiment will be performed with a DC beam, in the second stage with the new time structured beam, which we have been proposed to PSI[2]. The detector is designed to operate at a high average beam rate of 1 MHz, which allows to collect the required statistics of 10^{12} electrons within several weeks.

A first beam test of the detection principle demonstrated fast tracking with a reduced version of the FAST detector. The submission of the full proposal is foreseen for summer 1999.

Footnotes and References

† Bologna–CERN–ETH Zurich–PSI–LBNL, Berkeley

1. F. Navarria et al., Precision measurement of the μ^+ lifetime with the FAST detector, ETHZ-IPP PR-98-04.
2. P. Kammel et al., High intensity μ/π beam with time structure at PSI, PSI LOI, R-98-04.0, 1998