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THE CERN MUON STORAGE RING

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(Presented by F. J. M. Farley)

A muon storage ring may be used:

to purify a muon beam by allowing time for pions to decay,

to extend the duty cycle of a pulsed accelerator

to use a multiple traversal target; but we are interested primarily in an accurate measurement of the muon magnetic moment. Here I must remind you of the muon (g-2) experiment carried out of CERN (1) in 1961. When polarized muons circulate in a magnetic field B the precession frequency of the spin relative to the momentum vector is

$$\omega_a = \frac{1}{2}(g-2)\ (e/m_0c)\ B \qquad [1]$$

By this means the anomalous moment, (g-2), was determined to 0.4% thus verifying the theory of quantum electrodynamics for muons to distances of order 0.2 fermi. This experiment was limited by the muon life-time of 2.2 microsec, which made it impossible to follow the precession for more than $1 - 1^1/_2$ periods ($T \sim 4^{-6}$ microsec).

In the new project we shall store relativistic muons of momentum 1.3 GeV/c thus dilating the life-time to 27 microsec. However as no factor γ enters in equation [1] the precession frequency will remain essentially unchanged and we should be able to see $\sim$ 20 precession cycles.

Fig. 1 shows the ring magnet 5 metres in diameter with B = 17.2 kG. The magnet is continuous

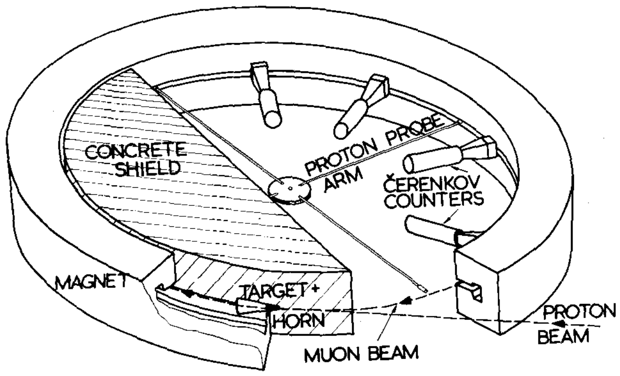

Fig. 1 - Muon storage ring.

Fig. 2

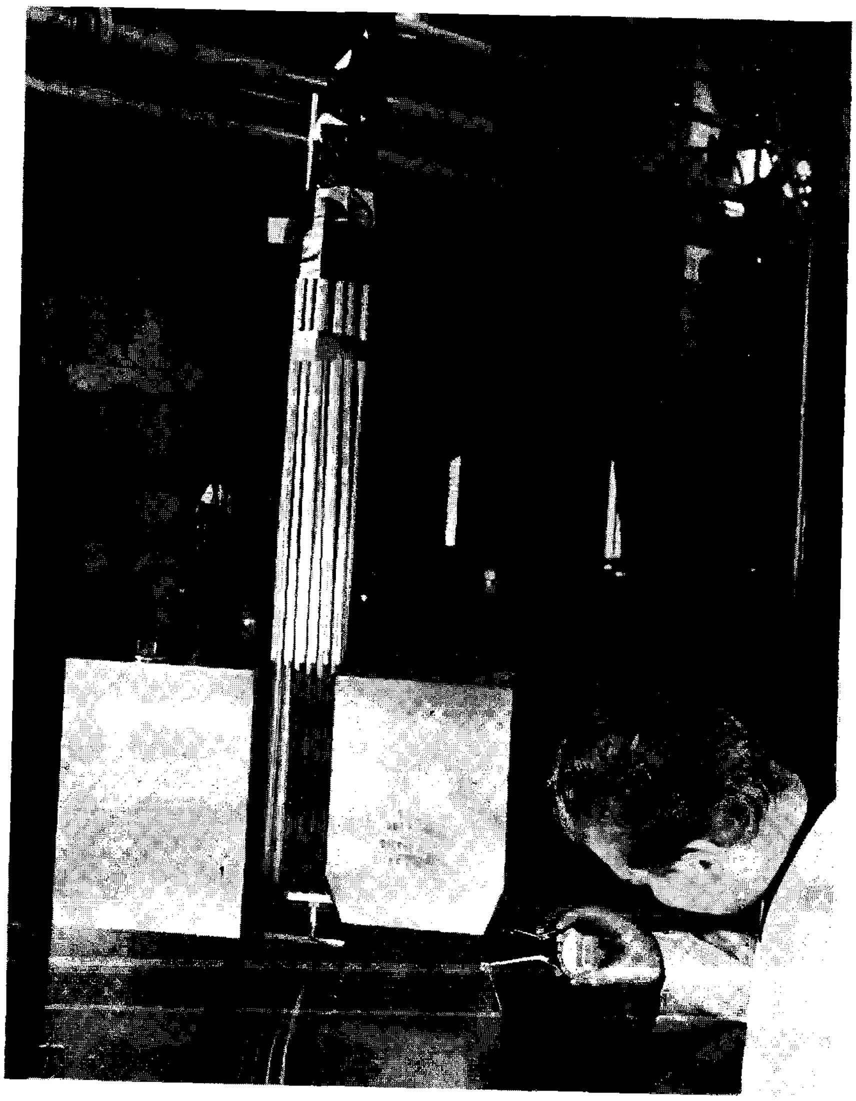

Fig. 3

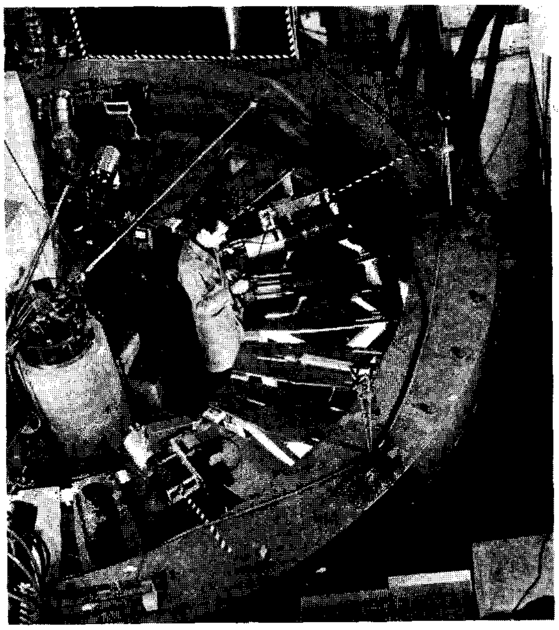

Fig. 4 - Field variation across aperture.

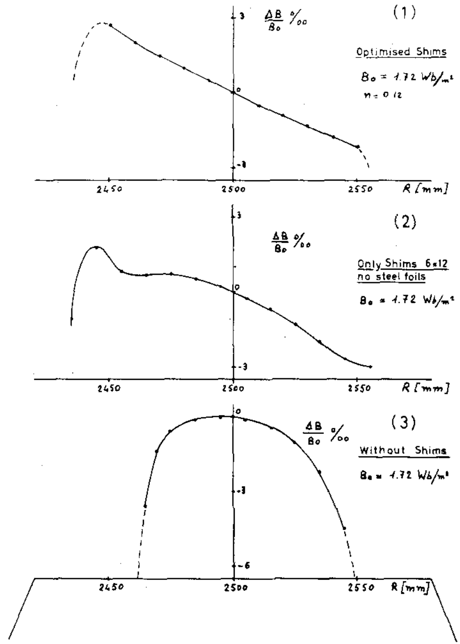

Fig. 5

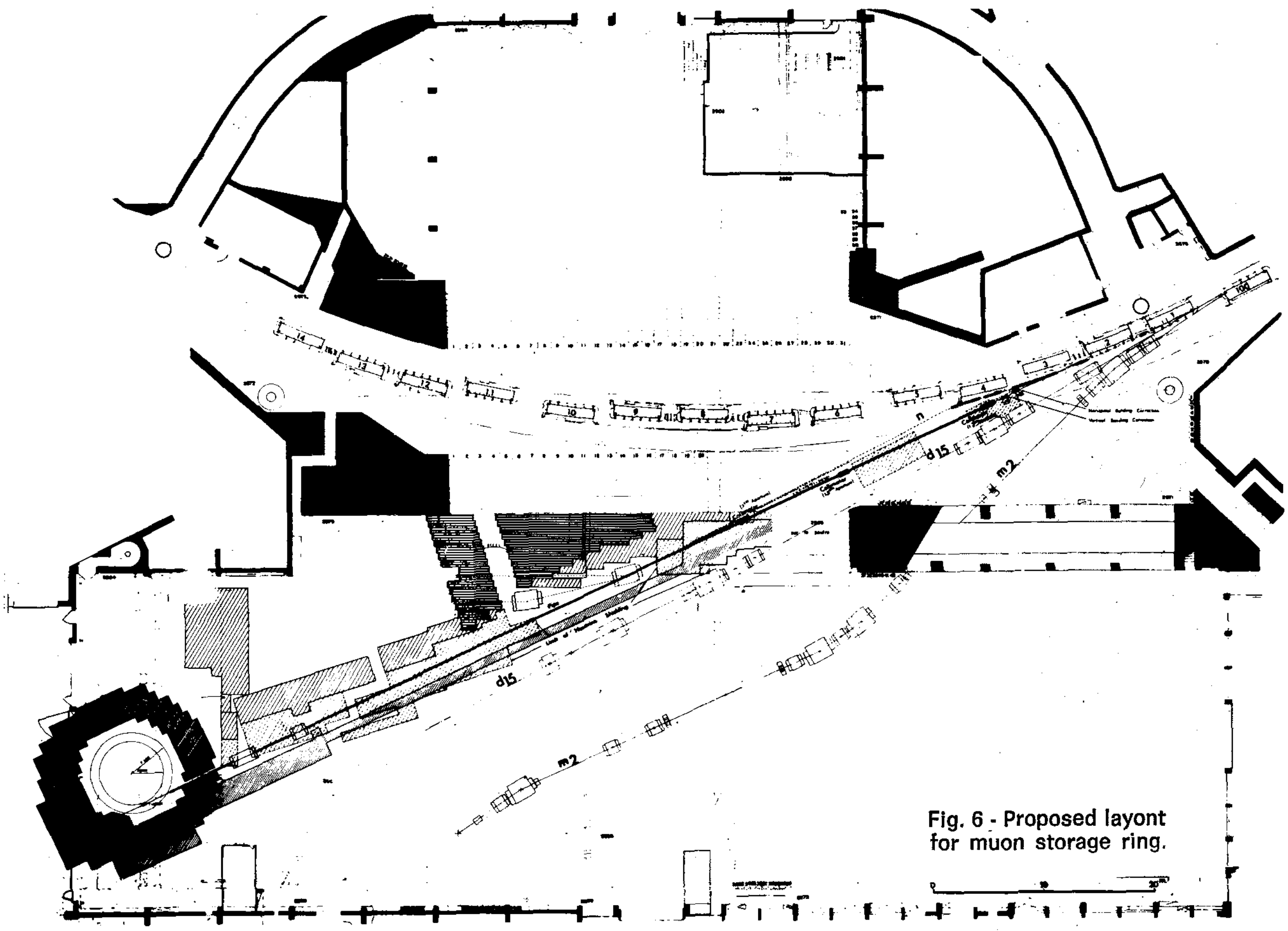

Fig. 6 - Proposed layont for muon storage ring.

and circular with n = 0.12 giving focusing. The section is C — Shaped with the yoke on the out-side.

A short pulse (10 nanosec) of protons ejected from the PS falls on a target in the ring. Pions of momentum 1.3 GeV/c are concentrated forward by a magnetic horn and make 1 turn before again hitting the target assembly. During this time(50 nanosec) about 20% of the pions decay and the forward emitted muons have almost exactly the same momentum. They can therefore remain in the ring. Some of the muons however have slightly less momentum, which causes the orbit to contract inwards away from the horn. These muons can therefore fall into permanently stored orbits. We thus use the $\pi - \mu$ decay process to inject, and do not need an electromagnetic inflector. Using 1/20th of the P. S. beam (1 of the 20 r.f. bunches) we expect to store on each cycle ~ 1500 muons with 95% polarization.

When the muon decays in flight the decay electron must have less energy and therefore emerges on the inside of the ring, where it will be detected by a series of lead glass Cherenkov counters. By demanding a large pulse height we ensure that only high energy ($E > 750$ MeV) electrons are detected, and these can come only from forward decay.

As the muon precesses according to eq. [1] the counting rate will therefore be modulated allowing the frequency ω_a to be measured. The figure also shows the thick concrete needed to protect the counters from direct radiation from the target during injection.

Fig. 2 is a photograph of the ring during assembly. Fig. 3 is a close up showing the magnet gap with the windings emerging vertically through a slot in the yoke.

Fig. 4 shows the magnetic field obtained with a region of linear gradient, $\eta = 0.12$, obtained after some shimming of the predesigned pole shape which was not completely correct. Variations of field in azimuth have been corrected by introducing aluminium foil spacers in the yoke and the median plane can be controlled by adjusting the supports. We now have a field which is suitable for storing muons, and reproducible in shape from day to day to ~ 30 ppm.

Fig. 5 shows the counters being installed; the cheese shielding them from the target area can be seen on the right.

Fig. 6 shows the layout with the ejected beam crossing the South Hall to the storage ring on the left.

The statuts now is that we are ready to run, and hope to see some stored muons in the near future.

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μ-MESON AND ANTIPROTON TRAP AT SLAC *

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(Presented by F. Lobkowicz)

The Stanford 2-mile linear accelerator will provide an intense source of muons having energies from a few BeV up to nearly the maximum primary electron energy. Clement and Kessler (1) have calculated the muon yields from Lithium and Lead. Interpolating their values for copper, one finds that there will be 2×10^{-7} μ/BeV/c per electron at 10 BeV produced in a thick ($\geqslant$ 3 r.l.) target. The assumed primary energy is 20 BeV. 80% of these muons will emerge at less than 1° with respect to the electron beam. Assuming an electron beam of 30 μA, one thus gets 2.5×10^7 μ/sec in a $\pm$ 4% band around 10 BeV/c. This beam can be quite efficiently purified by filtering through a low-Z absorber of some 15 nuclear mean-free-paths. The energy loss by ionisation (3-4 BeV) and multiple scattering (5-10 mrad) are quite tolerable as long as the final muon energy is to be greater than 5 BeV. Somewhat paradoxically, it is very difficult to make use of the full achievable intensity of such a beam. This is due mainly to the very poor duty cycle of the linear accelerator (a few hundredths of a percent). In addition, some experiments require that the muon energy be restricted within

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