Department of Physics

It is proposed to build a strong focusing ring to contain μ-mesons in a given momentum band for several μ-meson lifetimes and then eject them. If there is no further injection after a time t_o, the μ-mesons are ejected at time t, they will be filtered against π-mesons by the lifetime factor $e^{\frac{t-t_o}{\gamma \tau}}$. $t - t_o$ cannot be made arbitrarily large because of the loss of μ-mesons by decay; for typical values of $t-t_o = 4$ μs and $\gamma \sim 7$ the filtering is of the order of $e^{22} \sim 5 \times 10^9$. It is obvious that such an arrangement cannot be achieved with a linear focusing pipe because of the long distances involved.

$$\ell = t\beta c \sim 1.2 \times 10^3 \text{ meters}$$

The ring is designed to contain μ-mesons; however the injected particles are mainly (100 to 1) π-mesons and the μ-mesons are born in the ring. Because of the strong focusing (a) most of the μ-mesons remain in orbits within the vacuum chamber; (b) the large momentum compaction of a strong focusing ring will permit the capture of a large $\Delta p/p$ of μ-mesons and (c) for the same reasons a broad (in momentum space) π-beam can be accepted and survive for a few revolutions (typically one pion lifetime will correspond to 3 revolutions); finally (d) a small aperture can be used. On the other hand the large momentum compaction makes ejection difficult.

Since there is no r.f. in this system, betatron oscillations will not be damped. The vacuum requirements are normal (since such a limited lifetime is required). The problem of electron contamination has not been considered and finally it is certainly possible to provide further momentum analysis after the beam has been ejected if one desires a narrower momentum band.

As an example the parameters of the Cornell electron synchrotron have been used scaled to a maximum μ-momentum of 750 Mev/c

Orbit radius 1.9 m
Mean radius 2.2 m

Aperture width 7 cm
Aperture height 4 cm

Maximum field 13 Kg.

Field index $n_1 = n_2 = n \simeq 15$

Betatron osc freq. $Q_r = 2.25$
$Q_z = 1.75$

Rotation frequency $\simeq 22$ Mc/sec

Weight Fe 10 tons   Cu 2 tons

Sectors: 4 each double
Focusing order: $1/2F$ D $1/2F$

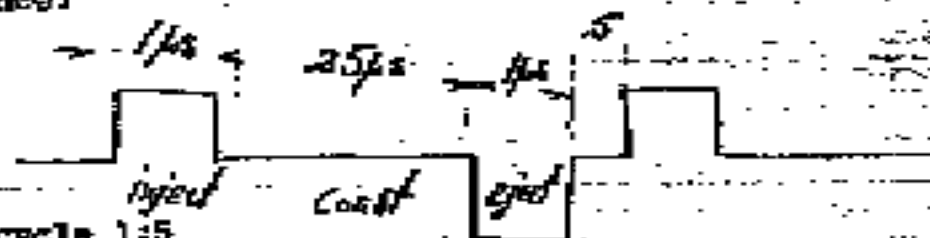Momentum Compaction $\alpha = .08$ $\dfrac{\Delta L}{L} = \alpha \dfrac{\Delta p}{p}$ $\dfrac{\Delta p}{p} \simeq 2\%$

Maximum angle of π-decay $= \dfrac{30}{750} \simeq .040$ radians.

   betatron oscill. angle (to full app)$_r$ $\dfrac{3.5 \times 4}{610} = .023$ radians

                    (to full app)$_z$ $\dfrac{2 \times 4}{790} = .010$ radians

Injector and ejector electromagnetic; beam deviation .030 radians

Sequence:

Duty cycle 1:5

Intensity considerations (optimistic)

With the parameters given above we estimate the following intensities

Capture efficiency (the solid angle of acceptance is 2×10^{-4} sr.   10%

However it is expected that a reasonably focused π-beam, 100 Mev wide
is used for injection)

Duty cycle efficiency   20%

Efficiency for capture of μ-mesons   50%

Ratio of accepted (10%) μ-meson *beam Δp to total*   20%
decay band

Ejection efficiency   30%

Survival of μ-mesons   75%

Thus the total attenuation from the original π-beam is 4.5×10^{-4}.

At the Cosmotron, a fairly well focused π-beam of 10^7/pulse could be obtained for a $\Delta p/p \simeq 20\%$. Assuming that for such a beam the capture efficiency is 50%, the μ-meson beam becomes

$$2.2 \times 10^4 /\text{pulse} \qquad \text{with} \Delta p/p = 10\%$$

At the AGS one could expect a fairly well focused beam of π's 2×10^8 so that under the same considerations the μ-mesons are 4.4×10^5/pulse with $\Delta p/p = 10\%$

The cost is estimated to less than $100,000.

If all this does not seem too unreasonable I will proceed to calculate orbits.

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