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# Radial Control of Magnetic Field or a 6.75 GeV/c Flat Top

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Subject Radial Control of Magnetic Field or a 6.75 GeV/c Flat Top

## OBSERVATIONS AND CONCLUSION

Purpose: To close a servo loop between the radial position of the beam and the flat top voltage control loop with the AGS beam frequency phase locked to an external oscillator.

Introduction: As noted in Studies Report #110, when flat topping at energies near the transition energy of ≈ 8 GeV the pulse to pulse variations in momentum can be as large as ± .1% or more. At fixed frequency this results in large (>1cm) radial position variations on the flat top. Thus it seemed reasonable to use this fluctuation to control the flat top voltage so that the final radial position would be defined by a given pick-up electrode. By fixing both frequency and position the momentum would then be reproduced with great accuracy from pulse to pulse.

Procedure: A low intensity beam ($< 2 \times 10^{12}$) was used and time comb "F" was introduced to give a flat top at a $\beta\gamma$ of ≈ 7.19. Then the frequency synchronization loop was adjusted to provide a phase locked frequency of 4,414700 ~ (Gauss clock ≈ 13,340). This provided a radial offset at I-7 of ≈ 0 cm. It should be noted that the peak to peak radial excursions were less than half those observed on 4/13/78.

Then shortly after the frequency loop was closed the output of the I-7 radial position detector was gated into the $\dot{B}$ servo input. This signal then is effectively added to the reference that controls the flat top voltage. The resulting loop then changes the magnet voltage and hence field. With the maximum gain available of one volt/cm from the radial detector chassis, a simple exponential response was observed when this loop was closed.

Results: The time contant of the decay was measured to be 50-55 msec for the gain mentioned above. This is a factor of two larger than calculated from a previous measurement of the gain of the $\dot{B}$ servo loop, to a step input. The reproducibility of the final radius from pulse to pulse was better than ± .5 mm. At constant frequency and for this momentum, that corresponds to a $\Delta B/B = -19\ \Delta R/R \cong 19 \times .1 \times 10^{-3}/12.85 \simeq 1.5 \times 10^{-4}$.

Discussion: This reproducibility along with excitation of the horizontal sextupoles to minimize the nonlinear effect at transition (see Studies Report 110), should make it possible to measure the longitudinal coupling impedance with sufficient accuracy in the region of the transition energy.

Since the response of the loop was still a simple exponential, it should be possible to decrease the time constant further by increasing the radial signal gain by up to a factor of two or more. It is planned to do this soon as well as to repeat more carefully the gain and response measurements of the flat top voltage control loop.