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Longitudinal Impedance Investigations at 28.5 GeV

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Subject Longitudinal Impedance Investigations at 28.5 GeV

OBSERVATIONS AND CONCLUSION

Purpose: To attempt to measure the longitudinal coupling impedance in the AGS by stimulating coupled bunch instabilities ona 28.5 GeV flat top.

Procedure: An accelerated beam of ≈ 3 x 10^{12} was obtained with a longitudinal phase space area ≳ .6evsec. It was carried through transition with little dilution by a programmed outward radial excursion of 6mm (β_{min}) coinciding with the transition phase jump. Extraction into the FEB U line with the upstream collimator closed was the next step. Then extraction near the end of a 1sec. flat top was tried. This was also successful after provision was made to obtain a radius shift on the flat top. However, this then made it impossible to achieve the required speed of radius jump to insure no missmatch, i.e., dilution at transition. Hence tight uniform bunches, one of the requirements for the investigation, were not available. The bunch shape damper was employed to control some of the effects due to the resulting missmatch. Finally, the $\dot{B}$ servo on the "D" time comb was adjusted to give a constant frequency over ≈ .6 sec of the flat top.

Results: It was immediately evident that the coupling impedance measurement could not be attempted for two reasons. First, there was a large 60 ~ modulation on the beam frequency of ≈ 20 cycle p.p. or about .6mm in $\overline{\Delta r}$. This is most likely due to the high level rf system as one could see 60 ripple on the AGC signal the main tuning current and the vernier tuning current. Second, there was obviously already present a considerable number of coupled bunch mode instabilities early (≤ .2sec) on the flat top. These were detected by observing the output of a spectrum analyzer tuned to the 73 harmonic of the rotation frequency with a bandwidth of 10 kc. One could see beat frequency patterns corresponding to 1, 2, 3, 4 times the phase oscillation frequency of = 158 cps. If these were combinations of coupled bunch mode lines of n = 1 or 11 with the line due to unequal bunch population at h = 73 then within the bunch modes m = 1, 2, 3, 4 were present though not all at the same time on a given machine cycle. Certainly there were m = 1, 2 and most likely 3 present. The spontaneous appearances of these modes of course would interfere with attempts to stimulate a specific mode and observe its frequency. If they are present in the future when clean bunches are obtained after transition, then the intensity will have to be reduced so that growth rate will be decreased appreciably. The growth rate at 3 x 10^{12} will be of interest if it is such that any significant oscillation amplitude occurs within less than say about .1sec after the flat top starts, since injection into the ISA will require some time for synchronization and debunching prior to ejection.

Comments: The short term stability of the flat top as indicated by the constancy of the mean frequency (monitored by the output of an discriminator whose sensitivity is ≈ 143 ~/volt at zero output) was certainly better than a part in 10^{-3} but since $\Delta f \cong 4.8$ cycles per 10^{-3} in $\Delta B/B$ this is not too sensitive a measure of field reproducibility. It is planned to introduce a synchronization loop for the next run, that will lock the beam frequency to an external frequency by feeding an error signal into the radial loop. This should reduce if not eliminate the frequency ripple problem (however steps should be taken to reduce this ripple in any case).