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Longitudinal Instability on 1.5 GeV (KE) Flattop

L. Ahrens

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Collider Accelerator Department

Brookhaven National Laboratory

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Experimenter(s) L. Ahrens, J.W. Glenn, E. Gill, K. Reece, E. Raka, W. van Asselt

Reported by E. Raka

Subject Longitudinal Instability on 1.5 GeV (KE) Flattop

The AGS was set up for a 150 msec flattop at ≈ 1.5 GeV kinetic energy. Intensity was adjusted to be between 0.6 and 1 x 10^{13} which was extracted for SEB users. At 6 x 10^{12} on the flattop the n = 1, m = 1 instability was easily obtained when the flattop field was adjusted to give an rf frequency 4.17 MHz. The maximum growth rate at 6 x 10^{12} was obtained at about f_{rf} = 4.182 MHz. The bandwidth for the threshold at this intensity was $\geq \pm$ 20 kc of rf frequency change.

A systematic search for another mode (n = 2 or 11) was made by changing the flattop field in steps that gave ≈ 10 kc changes in f_{rf} at a fixed machine radius. We found no evidence of these modes for changes of - 180 kc to > + 153 kc in f_{rf}. On the low side for f_{rf} = 4.00 MHz, the kinetic energy is ≈ 1.21 GeV, i.e., essentially the expected minimum Booster extraction energy. Hence, as long as we stay below the energy corresponding to f_{rf} = 4.160 MHz, there should be no problem for Booster injection.

We note that above 4.2 MHz, there appeared an m = 2, n = 0 instability presumably due to the rf system itself. By adjusting the bunch shape damping system controls, this instability was suppressed. Again, around 4.10 MHz, a small amount of m = 2, n = 0 instability was observed when the BSD system was disabled. While sitting on the flat-top at 4.18 MHz, we observed the rf station gap voltages on the spectrum analyzer at k = 11, 12, 13, 14, 15, but could see no evidence for a large signal at (kf_{rf} - f_o).

It is not understood why an $m = 1$, $n = 2$ or 11 mode could not be excited if there is indeed a fixed tuned resonator present at $(kf_{rf} - f_o)$. If, for example, the resonator were at $3f_{rf} - f_o \approx 3 \times 4.18$ MHz $- 0.348 = 12.19$ MHz, then at $f_{rf} = 4.3$ MHz one would have $3 \times 4.3 - 2 \times 0.358 = 12.18$ MHz or within the expected bandwidth to drive the $n = 2$ mode. For other values of kf_{rf}, i.e., $k > 3$, one wold have swept through the resonance at lower values of f_{rf}. On the other hand, if $k \geq 4$, then in principle we should have seen the $n = 11$ mode since $4 \times 4.18 - 0.348 = 16.732$ MHz while 4×4.0 MHz $+ 0.333$ MHz $= 16.333$ MHz, i.e., $< f_{res}$. Further studies of the cause of this instability are planned.

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