

## Longitudinal Instability on 1.5 GeV (KE) Flattop

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The AGS was set up for a 150 msec flattop at  $\approx 1.5$  GeV kinetic energy. Intensity was adjusted to be between  $0.6$  and  $1 \times 10^{13}$  which was extracted for SEB users. At  $6 \times 10^{12}$  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  $6 \times 10^{12}$  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  $\approx 10$  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  $\approx 1.21$  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 flattop 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  $3f_{rf} - f_o \approx 3 \times 4.18 \text{ MHz} - 0.348 = 12.19 \text{ MHz}$ , then at  $f_{rf} = 4.3 \text{ MHz}$  one would have  $3 \times 4.3 - 2 \times 0.358 = 12.18 \text{ MHz}$  or within the expected bandwidth to drive the  $n = 2$  mode. For other values of  $kf_{rf}$ , i.e.,  $k > 3$ , one would 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  $4 \times 4.18 - 0.348 = 16.732 \text{ MHz}$  while  $4 \times 4.0 \text{ MHz} + 0.333 \text{ MHz} = 16.333 \text{ MHz}$ , i.e.,  $< f_{res}$ . Further studies of the cause of this instability are planned.

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