BNL-104036-2014-TECH

AGS.SN159;BNL-104036-2014-IR

Stopband Correction Studies: Bunch Shape at Injection vs Starting Oscillator Settings

E. Raka

December 1983

Collider Accelerator Department

Brookhaven National Laboratory

U.S. Department of Energy

USDOE Office of Science (SC)

DISCLAIMER

Number 159

AGS Studies Report

Date December 22, 1983 Time 2200 - 0300

Experimenters E. Raka and E. Gill

Reported by E. Raka

Subject Stopband Correction Studies: Bunch Shape at Injection vs Starting Oscillator Settings

Observations and Conclusion

Initial Conditions

Running FEB; 440^{+} μsec of 15 mA (tank 9 reading) H^{-} beam. First counter 2.6 - 2.7 x 10^{13}; 3 CBM 1.5 x 10^{12} and late CBM 1.3^{+} x 10^{13}.

Procedure

We put all the multipole corrections to zero including the correction current in the three SEB extraction sextupoles. Next we reduced the vertical tune using the Ortho program as the intensity was around 5 x 10^{12}. Then using the multipole correction programs, sin 17y, sin 17x, cos 17y, cos 17x, cos 26x, sin 26x, cos 26xy, sin 26xy, sin 17xy, cos 17xy, plus the two skew sextupoles located at C5 and I5 we attempted to tune the machine for high intensity.

After considerable effort, the best intensity achievable was 8 - 8.5 x 10^{12} on the late CBM with 1.95 injected and 9.2 - 0.5 on the 3 CBM. When we returned to the original settings, the readings were 2.3 x 10^{13} injected with 1.4 x 10^{13} on the 3 CBM and 1.15 on the late counter. This was due to reduced current from the Linac.

Conclusions (Part I)

Clearly some of the reduction in intensity was due to the fact that the multipoles had a significant effect on the injected beam as well as on the early accelerated beam. No attempt was made to retune injection parameters. Note also that at these intensities, the skew sextupoles had no beneficial effect whatsoever.

Certainly, one should include some procedure to optimize injection conditions if this type of study is carried out again. Also, the two additional air core skew sextupoles should be installed at appropriate locations in order to do a more complete study of the need for this type of correction since in the past they have given 5-10% intensity improvements.

Observations (Part II)

Procedure: The initial conditions were the same as in Part I above. some of the rf capture parameters were Level 1, 825; Level 2, 1440; IHRFP2955; Level 2 Slope 30; STOSC 1760; STOSLOPE 2545. These resulted in the best capture with the following readings $2.6 - 2.7 \times 10^{12}$ on 1 CBM; 1.5^{+} 3 CBM; 1.3^{+} late CBM. The bunch amplitudes during capture and early acceleration can be seen in Photo 1 which shows the F-20 current XFMR signal. It had been previsusly noted on several occasions, when the record intensities of $> 1.5 \times 10^{13}$ had been accelerated, that the settings of the starting oscillator sweep STOSC and the slope of that sweep SOS were always such that the bunching during early capture and acceleration was not a maximum but was well away from the peak that could be achieved.

This can be easily seen in Photo 2 where only STOSC was changed to 1660 and all other rf parameters were the same as Photo 1. One then had the same 1 CBM readings but 3 CBM was slightly lower, i.e., $1.5^{-} \times 10^{13}$ while the late CBM was down to $1.1^{+} \times 10^{13}$. This setting of the start of the sweep results in both a higher rf frequency at injection and a somewhat larger slope. The latter is due to the fact that the initial STO frequency is 2.480,000 MHz while the nominal frequency at injection is 2.500 MHz and the nominal $\dot{f}_{rf}$ at $\dot{B} = 4.9$ kG/sec and $\Delta R = 0$ is 33 KHz/msec so that at 1670 say, the sweep has about 1 msec to go from zero $\dot{f}$ to the rate set by the slope control. In fact, it takes several msec to reach this rate, hence it seems that the differences noted between Photos 1 and 2 is due primarily to changes in f and not in $\dot{f}$ during the injection process.

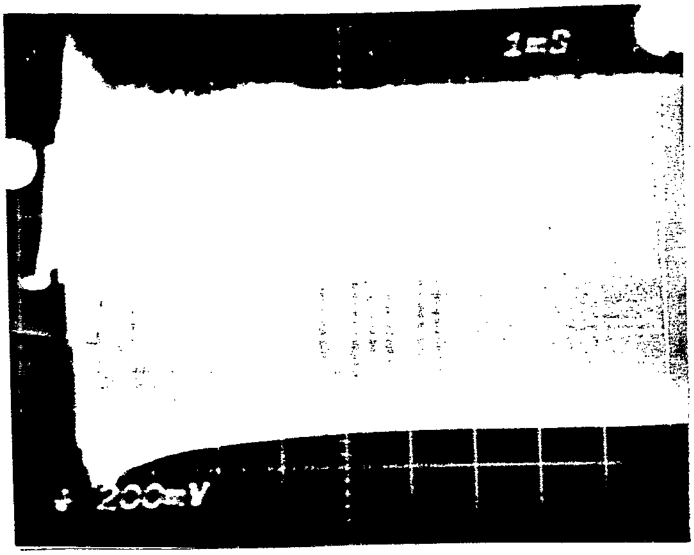
One sees more clearly the difference between these two cases when he examines the individual bunches using the conventional mountian range display. Photos 3 and 4 show an individual bunch on a few successive turns at about 11 msec after injection. In Photo 3 we see a well rounded bunch with less density in the center than the bunch shown in Photo 4. The latter, of course, corresponds to the conditions in Photo 2 above, etc. Again, in Photos 5 and 6 taken some 21 msec from injection, we see the same contrast. One notes that the tail of the bunch in Photo 6 is now well defined and that the bunch is indeed slightly longer than the one shown in Photo 5.

Conclusions

Clearly much more work remains to be done in order to understand the details of the present mode of rf capture. A simple explanation of the difference between the intensity accelerated for these two cases would be that space charge effects would be less for the rounded bunches. One notes also that although the tighter bunches seem longer, the final intensity is less. However, one must have a detailed understanding of how the bunches are formed before he can ascribe the observed differences in intensity to space charge rather than the capture process itself.

mvh

Distribution: Dept. S&P



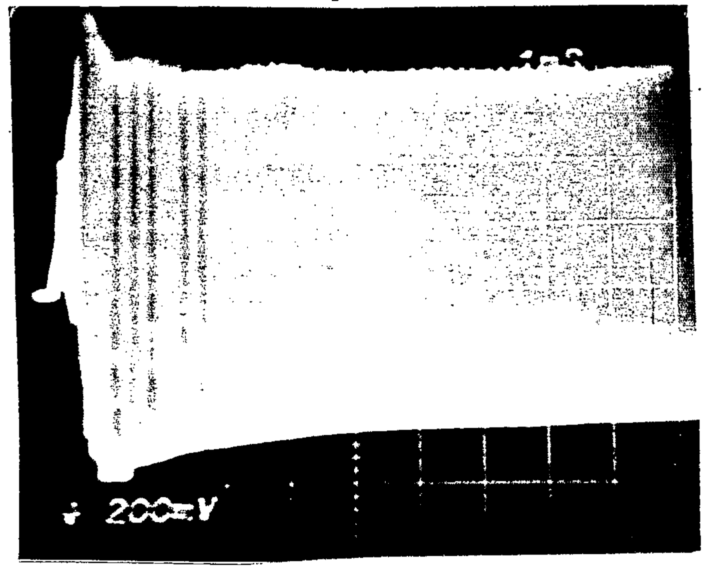
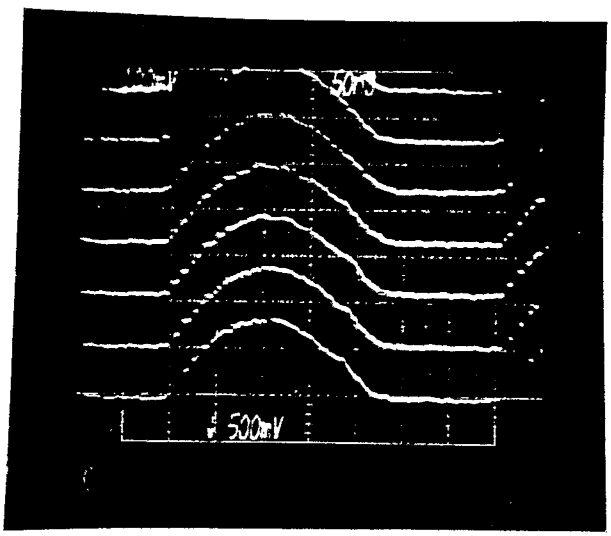


Photo1

F-20 XFMR

Photo2



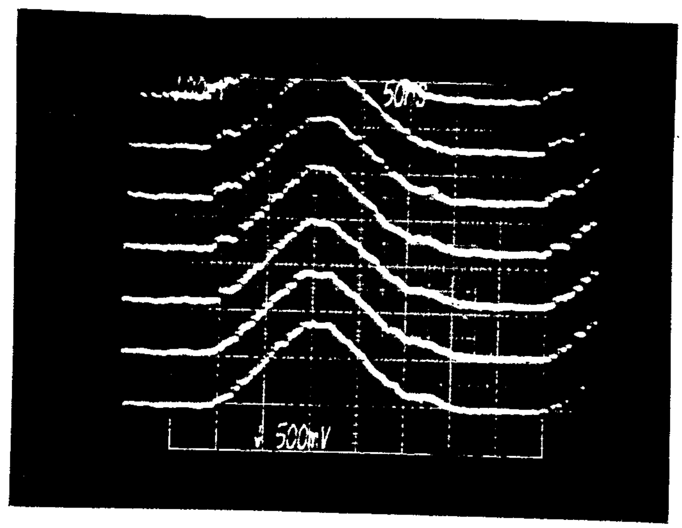
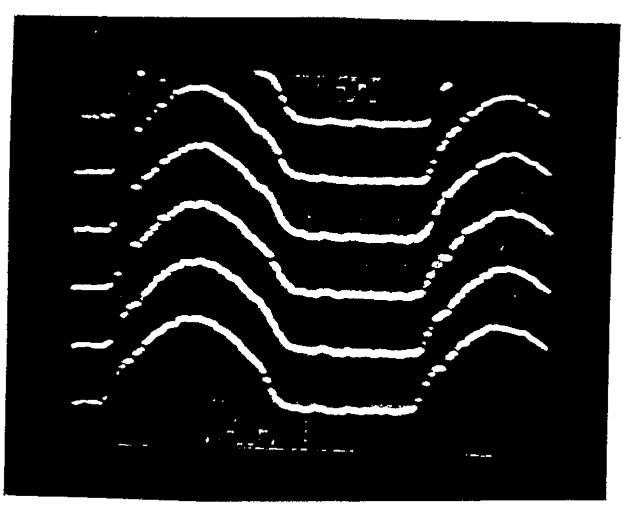


Photo3

W.B WALL MON.

Photo 4



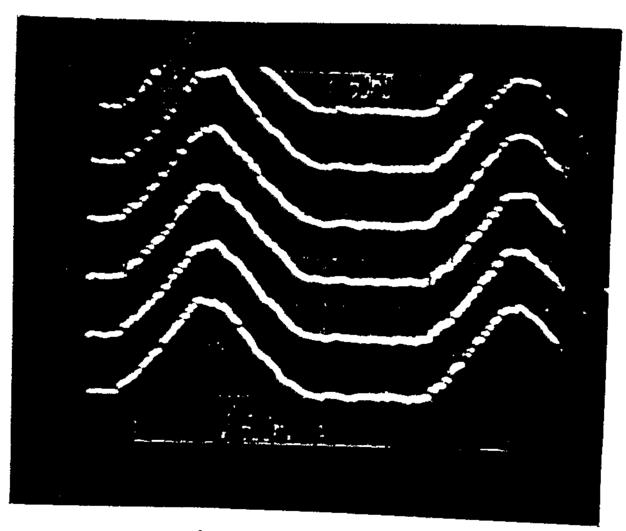


Photo 5

WALL MON.

Photo 6