IBCM: Internal Bunch Coordinate Monitor*

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I. Summary

The outputs of AGS pick-up electrodes have been digitized with 100 MHz transient recorders in order to study the motion of individual rf bunches during the AGS acceleration cycle.

II. Introduction

Pick-Up Electrodes (PUEs) have been used at the AGS for many years in order to locate the beam. As an RF bunch passes a pair of electrodes, a signal is induced in each electrode proportional to the bunch-electrode separation. Thus, the {inner-outer} or {upper-lower} difference signals are proportional to the bunch coordinate. For normalization, these differences are divided by the corresponding sum. The present system provides dc signals proportional to both horizontal and vertical positions at many locations around the ring averaged over several milliseconds. However, with faster electronics, waveforms can be studied on a much shorter time scale, making possible the tracking of each of the twelve rf bunches within the AGS.

III. Apparatus

Outputs from both horizontal and vertical PUEs located in the K-8 AGS straight section were fed through unipolar fast amplifiers to digitizing electronics located in a remote house above the K-18 section. Here, a pair of LeCroy 8818 (8 bit) digitizers operating at 100 MHz and slaved to the same clock sampled either the horizontal or vertical signals continuously, until stopped by an external signal. At this point, the previous 32,000 samples of data, which represent 320 microseconds, from each of a pair of PUEs was stored memory and was available for analysis. This was performed by an IBM-PC computer interfaced to the digitizers through CAMAC and to the AGS control system through RELWAY.[1] The hardware configuration is illustrated in Fig. 1.

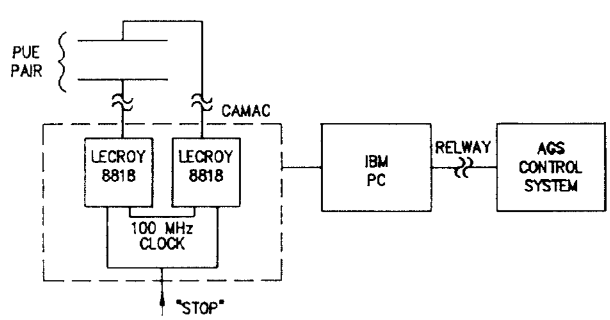

Fig. 1. IBCM digitizing hardware configuration.

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IV. Analysis

The program in the IBM-PC scanned the data in each digitizer to locate the signals indicating the passing of a rf bunch through the PUE pair. (Typically, these were peaks 50-100 ns wide, or 5-10 digitizer channels.)

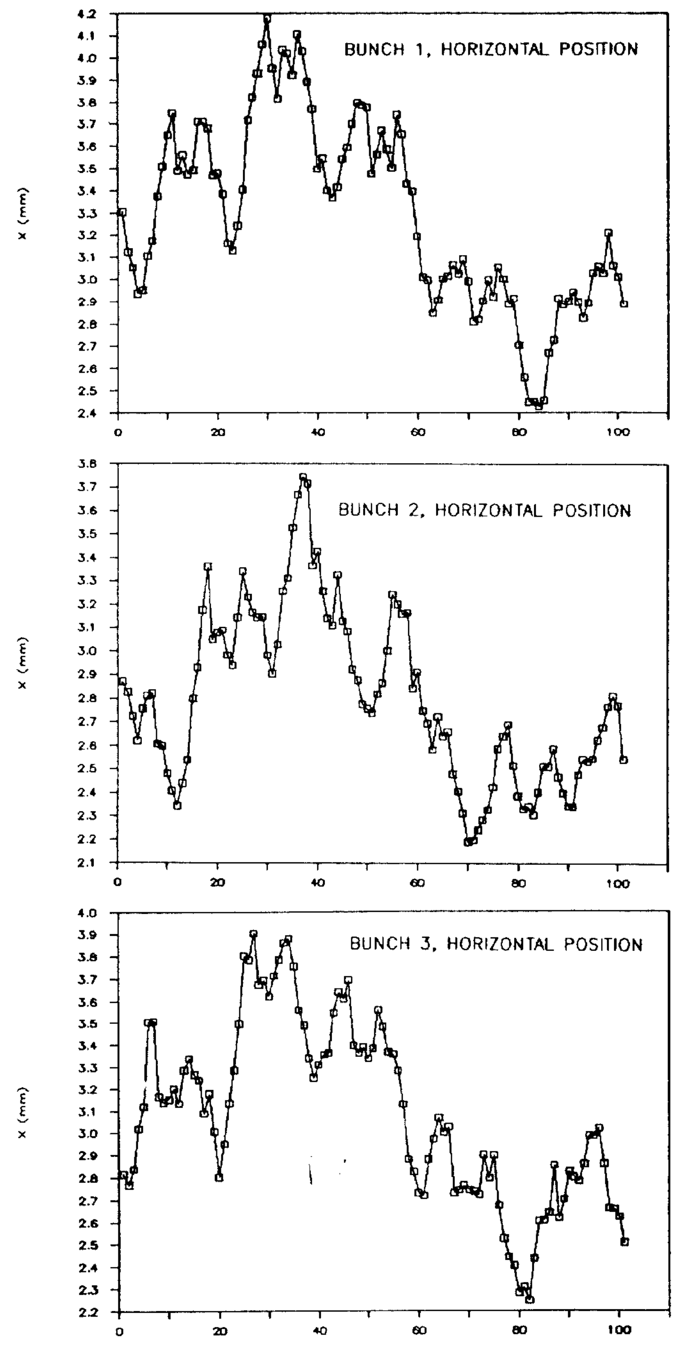

Fig. 2. Horizontal coordinates of successive bucket passings at 210 ms.

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The areas of each peak were calculated, and the horizontal (H) or vertical (V) coordinate of each bucket as it passed the PUE was determined according to:

$$H(V)(mm) = 27 \times \frac{\text{Inner (upper) Area} - \text{Outer (lower) Area}}{\text{Inner (upper) Area} + \text{Outer (lower) Area}}$$

These data are conveniently displayed by plotting the coordinate of a particluar rf bunch (every twelfth pulse) for successive passes through the PUE pair. Twelve such plots are made for each data sample, each representing about 160 revolutions. Figure 2 is a family of such plots for the horizontal coordinate taken at 210 ms into the AGS acceleration cycle. The regularities are striking. However, such dramatic effects are not visible throughout the AGS cycle; at times the distribution of bunch positions appears completely chaotic.

V. Conclusion

Oscillations at several frequencies, with peak-to-peak amplitudes of the order of a millimeter, and which beat with the 500 kHz rotation frequency are clearly visible. Furthermore, there appears to be coherence between successive bunches. The effect of these oscillations on previous measurements of the beam would have been to increase its apparent size [2]. Studies are in progress directed toward a better understanding of these phenomena.

References

[1] R. Frankel, Data Communications, 13, 145, (1984).

[2] R.E. Thern, "Space Charge Distortion in the Brookhaven Ionization Profile Monitor", this Conf.