THE COMPUTER CONTROLLED SYSTEM FOR THE FORECAST OF BEAM PARAMETERS IN THE CERN INTERSECTING STORAGE RINGS

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(presented in summary by L. Resegotti)

Abstract

The described measurement and display system permits forecast of the ISR beam parameters. The measurements are performed in the reference magnet units connected in series with the main magnets.

1. Introduction

Measurement of field and field gradients in the reference magnet units connected in series with each of the ISR main magnets permits to calculate the value of particle momentum at central orbit as well as the expected values of the betatron oscillation frequencies and their derivatives.

Direct measurement of the magnetic field and field gradients rather than measurements of the excitation currents provides information about the main magnet setting independent of hysteresis phenomena. It has proved very useful when adjusting the magnet for the wanted particle momentum and when setting up and changing working lines using poleface windings[1].

2. The reference magnets

Two reference magnet units (one of the focusing and one of the defocusing type) for each ring were chosen amongst the magnets which showed average magnetic characteristics. The main coil, the saturation compensation winding for the short magnet units as well as the 24 poleface windings were connected in series with the corresponding circuits of the respective main magnets. In each of these units the magnetic field is measured using a flip coil mounted at the position of the central orbit. The field gradient is measured using a sliding coil at three radial positions covering the aperture of the vacuum chamber. The measuring coils were placed in the reference units at positions where, to a certain degree, the effects of magnetic saturation followed those of the complete main magnet system.

3. The measurement system

The measurement system with two of the reference magnet units is shown in Fig. 1. It is located in the power house and remotely controlled from the ISR Control Room. The block diagram in Fig. 2 shows the layout of the system.

The digital computer has a memory of 8192 16-bit words. It controls the movements of the measuring coils through a system of hydraulic motors. The computer also controls the integrator and reads its counter. The integrator was specially developed for the system. Its design was based on the principle of the dual slope integrating voltmeter.

The integration is performed both during the first movement of a measuring coil and during its return movement. The computer checks the readings and gives a warning in case of a discrepancy which, for example, might be caused by field variations during the measurement.

4. Calculations

The magnetic characteristics of each unit of the main magnet have been precisely measured[2,3] at seven different field levels. The results of these measurements are expressed in terms of $\frac{1}{B_r} \cdot \int B_z \cdot dl$ and $\frac{1}{B_r} \cdot \int \frac{dB_z}{dx} \cdot dl$ for the total of F- or D-magnets installed in each ring. B_r is the field measured in the respective reference units. By interpolation from these tables, which were stored in the computer, the magnetic characteristics for the whole magnet are obtained from the reference unit measurements.

The total bending strength is calculated as well as the corresponding particle momentum at central orbit.

The field gradient measurements permit to compute the field indices with their first and second radial derivatives for both focusing and defocusing magnets.

Experimental values of the betatron oscillation frequencies (Q_H, Q_V) and their derivatives as functions of the field indices and their derivatives are stored in the computer. This permits the calculation of the expected values of Q_H, Q_V and their derivatives.

5. Display

The computer generates an alphanumeric display on a cathode ray tube. The results of the two latest measurements in each ring can be displayed. Either magnetic field parameters (Fig. 3) or expected beam parameters (Fig. 4) can be chosen. The time when the measurements were performed is also indicated.

A special mode of operation in which only field is measured permits a faster adjustment of the main excitation current. Another mode permits the monitoring of dynamic field variations. In this mode the coils are not moved, but the integrator is connected to the field measurement coils and switched to an incremental mode. The field variation is displayed on the cathode ray tube screen in the form of an index moving along a graduated scale (Fig. 5). A special case of this mode permits simultaneous automatic zero-adjustment of the drift of both integrators. Also this adjustment can be followed on the display screen.

Acknowledgments

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References

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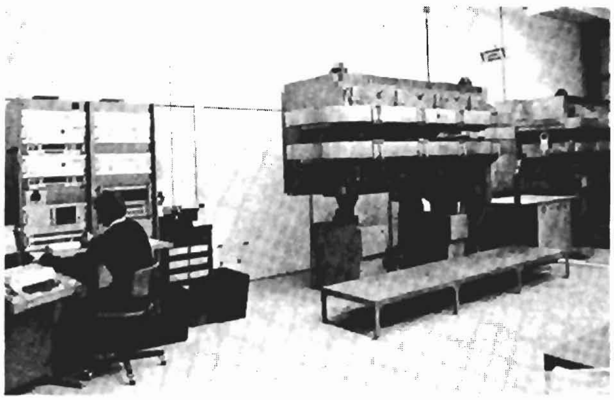

Fig. 1

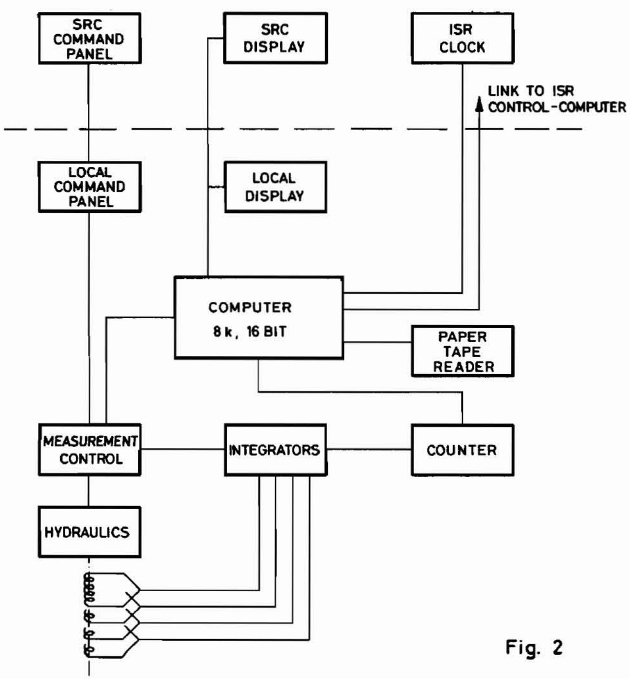

Fig. 2

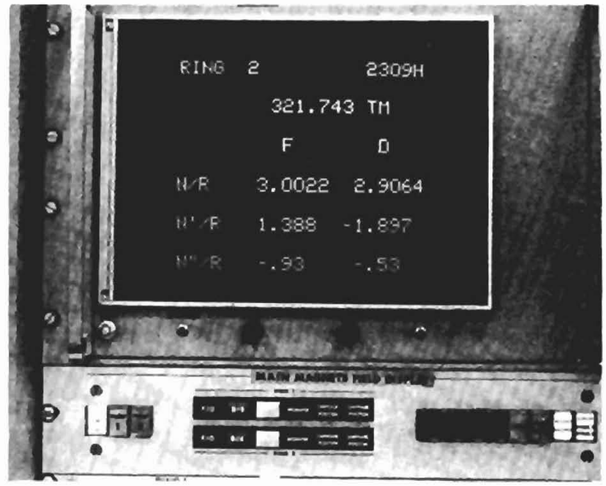

Fig. 3

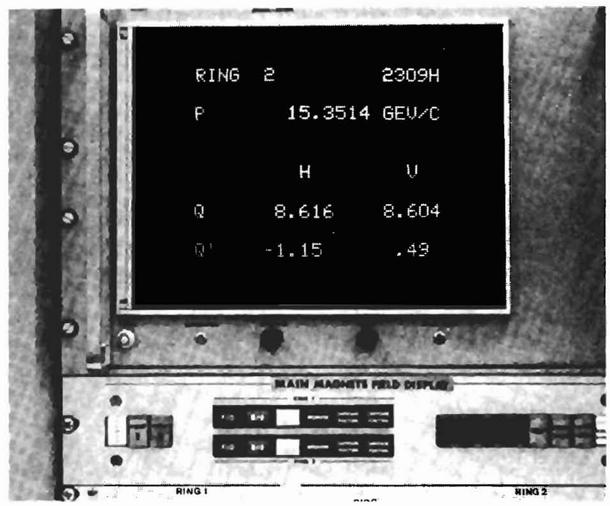

Fig. 4

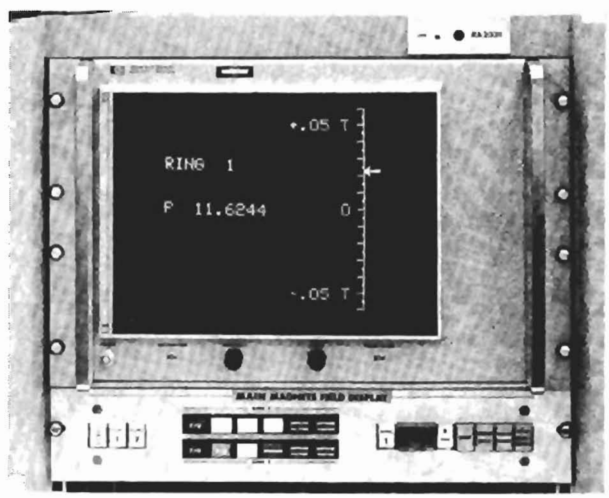

Fig. 5