A New Study of the Main Ring Physical Aperture

G. Wu , S. Pruss, D. Capista
Fermi National Accelerator Laboratory
P.O. Box 500, Batavia, IL 60510

Abstract

Changes made to the Fermilab Main Ring lattice and the Main Ring's future importance for the HEP program require a new study of its physical aperture. This task has been carried out using a computer program that automatically and systematically measures the available aperture around the ring. This program and its performance are described along with a preliminary analysis of the results. Further systematic analysis of aperture data is underway in preparation for modifications to be made in the coming summer shutdown.

I. INTRODUCTION

The random misalignments of Fermilab Main Ring elements are responsible for reduced transverse and momentum aperture and are the cause of high ramped dipole corrector currents. This has been one of sources of frequent power supply failures. In the past, aperture scanning, a process to measure physical apertures, has been done manually, and has involved tedious human intervention, precious beam time, and yet has resulted in incomplete information. The new automated aperture scan program is more than a convenience in that detailed and accurate aperture pictures can be achieved with minimum human interventions in a repetitive, reproducable process. In relatively short time, detailed 2-dimensional aperture pictures were obtained at all 216 beam position monitor(BPM) locations. Work to identify the locations in the Main Ring which should be modified or resurveyed during the upcoming summer shutdown is in progress.

II. THE PROGRAM

A goal in the program design is to relieve the operator of time consuming and error prone manipulations while achieving sufficiently detailed and accurate data within limited time. This is largely facilitated by the now much improved Fermilab ACNET[1] utility software that interface data pool, central file sharing system, network communications, TV and graphics I/O. The core of the program is the coordinated control of reading and setting C453 ramp cards (CAMAC modules that control corrector currents), and reading beam intensities and BPMs. For a given location, it forms a local 3-bump in one plane and a 4-bump in the other plane. By resetting those C453 cards for the seven correctors involved, the beam is stepped in 2-dimensions from center toward the 'edge' of the aperture. The 'edge' is recognized when the beam intensity is reduced to a preset level. At each step, horizontal and vertical beam positions together with the beam intensity are displayed in a 2-dimensional aperture map. When one location is done all information including closure of the bumps are logged into a file and the scan of the next location is started. The program has proven to be fairly robust and reliable. When questions arise regarding losses at certain locations, one can review the aperture pictures on file or re-scan for a new map to aide in tuning the machine.

III. PRELIMINARY RESULTS

In the coming summer shutdown, some of the Main Ring beam line elements will be resurveyed based on these aperture maps. While systematic study and test are needed to understand all major problems, some problems are very obvious by just looking at the map. Fig. 1 is a typical normal map. whereas Fig. 2 to Fig. 4 are maps for problem locations. In the plot the numbers represent the percentage of surviving beam current measured at those coordinates. These problems may call for realignment of the lattice elements or require an investigation for obstacles in the beam tube. Some problem may be due to misalignments of the BPM detectors. To aide systematic study, multiple aperture maps can be plotted in order of their positions around the ring in one plot. Fig. 5 is

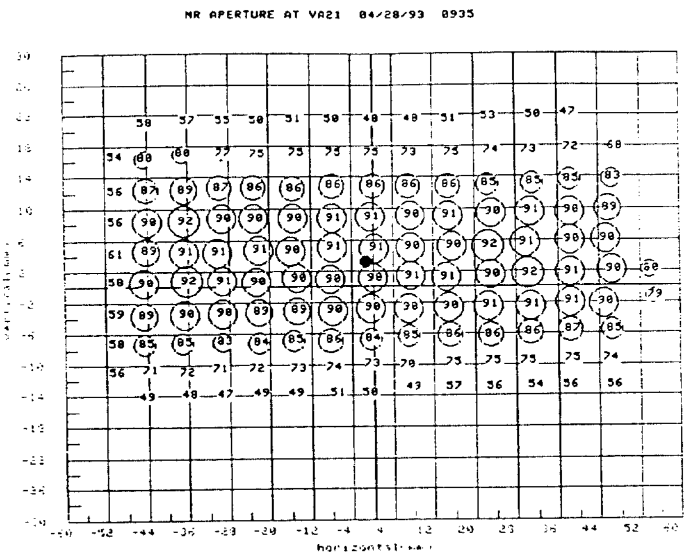

Fig. 1

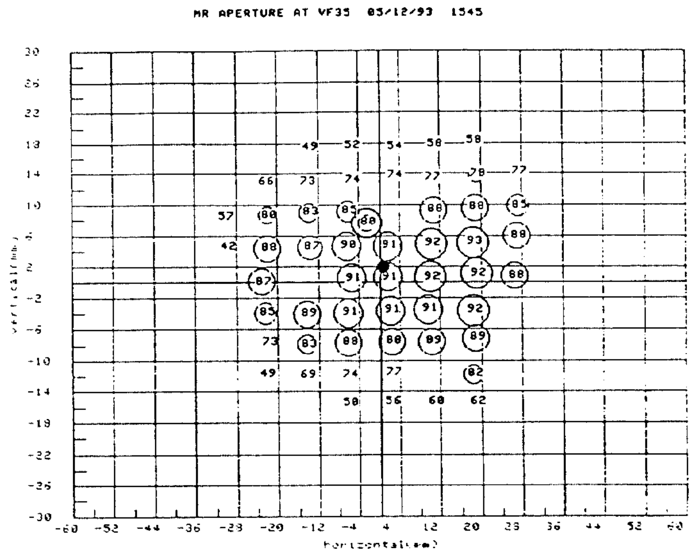

Fig. 4

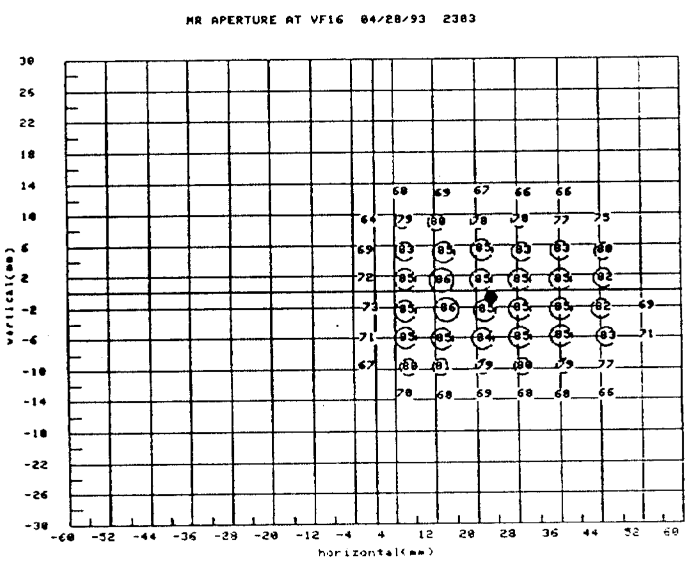

Fig. 2

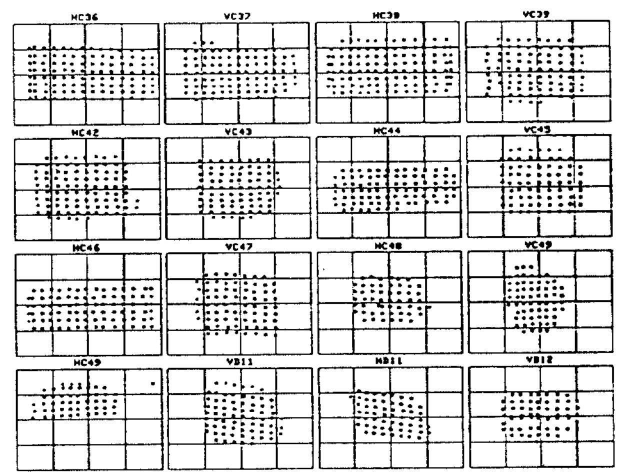

Fig. 5

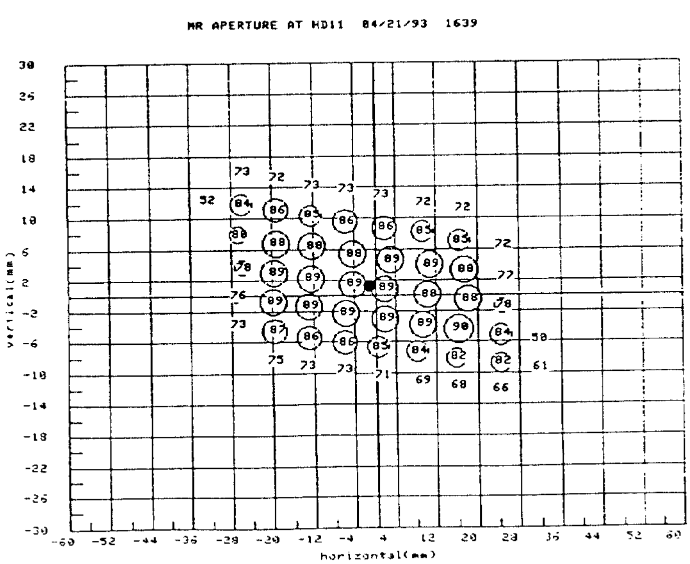

Fig. 3

such a plot in which beam intensities are indicated by different colors.

V. ACKNOWLEDGMENTS

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VI. REFERENCES

[1] P. Lucas, "Updated Overview of the Tevatron Control System", Control Systems for Experimental Physics, CERN 90-08, p71, 1987.