MAGNETIC FIELD MEASUREMENT OF THE MOSCOW MESON FACTORY EXPERIMENTAL AREA MAGNETS

M.Akopyan, V.Aseev, V.Gorbunov, M.Gratchev,
I.Zaikovski, V. Yabzhanov

Institute for Nuclear Research of Russian Academy of
Sciences, Moscow, 117 312, USSR

Abstract

This note describes the logistics of the measurement of the Moscow Meson Factory experimental area (MMF EA) transfer lines and proton storage ring magnets. The integrating field coil probe and the Hall probe measurement sets are described. The results of the measurements of the quadrupoles for the proton transfer lines are given.

Introduction

The MMF experimental area transfer lines and the proton storage ring will work with a high intensity partical beam. The magnetic field produced by the magnets should be controlled thoroughly provided that the loss of the beam due to the collision with the walls of the vacuum vessel is to be avoided. In order to reduce the spilled beam down to acceptable level and to optimize the performance of the transfer lines and the storage ring it will be necessary to measure the parameters of the fields strength, field uniformity and harmonic content for every magnet manufactured.

In addition, to perform the measurements at the construction site we can immediately repair the magnets which don't meet the required specification and arrange the magnets with good qualification directly on their permanent places in the experimental area.

There will be required approximately 200 magnets of various kinds, both ac and dc excited [1] at the MMF experimental area. The matter is that the most of them (101) are the "20LK35-8" type radiation resistant quadrupoles [2], and the rest consist of about 12 types of different in size and construction magnets.

The techniques used for magnetic field measurement hardly has changed for the last 20 years, however the data acquisition and the data logging with the help of a computer can be used to meet our measurement requirements.

"Coil probe" Field Measurement set

The well known coil probe technique was chosen for the transfer line quadrupoles measurement set. It uses a coil which rotates stepwise round the symmetry axis of the magnet. The harmonic coefficients of the magnetic potential are determined by a numerical harmonic analysis of the flux linked by the coil. The precision is achieved by using of a coil which measures only the azimuthal component of the field. To suppress the main harmonic and to measure only the higher multypole content of the field the compensation coil is used.

The coil were wound on glassfibreepoxy bars, a multifilamentary wire was used. The finished coils were fixed up in an aluminum cylinder. Its outer radius was chosen to be close to the magnet aperture radius.

The "coil probe" set block diagram is shown in Fig.1. The probe is rotated in a static magnetic field by a step-motor. A single step angular is 108 min. The voltages induced in the probe coils during each step are integrated by a specially developed multychannel ADC and stored by μ-computer.
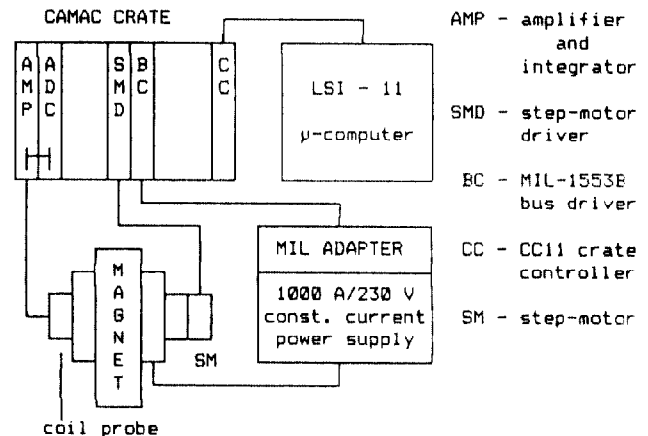

Fig.1. Magnet Field Measurement System

AMP –	amplifier and integrator
SMD –	step-motor driver
BC –	MIL-1553B bus driver
CC –	CC11 crate controller
SM –	step-motor

After the data have been acquired μ-computer performs a Fourier transform on the values stored during two completed turns of probe in the array. The stored signal represents oscillations of a cosine waveform with some perturbation due to the higher order multipoles. The table of the field components may be plotted versus harmonic number. The data set measurement is repeated for increasing step by step current from the constant current power supply.

Each quadrupole data set is logged to a floppy-disk of LSI and a hard disk of a DEC machine.

The same method of the field measurement was used for small aperture dipoles. The corresponding size "coil probe" was constructed.

The Hall Probe Measurement Set

A Hall probe measurement station was developed for the secondary beam line and proton storage ring magnets (bumps, kickers etc.). A number of Hall generators were used to measure the fields of many different spatial points simultaneously.

This helped to reduce the measurement time and also helped to manipulate the probe in the three-dimensional space. The simplified cross-sectional view of magnets is shown in Fig.2. The magnets aperture parameters are given in Table 1. L – is the size of the aperture in Z-axis.

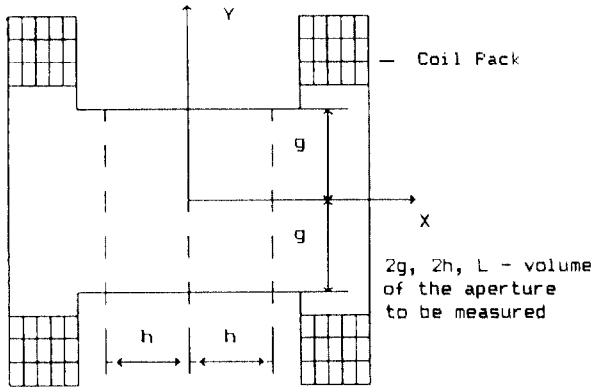| type of magnet	g [mm]	h [mm]	L [mm]
MB	65		300
3M	30	50	800
1M	50		500
11M	75		450
2M	30		1740
1M			
storage ring 2M	50	105	1150
storage ring	100		1000

Table 1. The Magnets Aperture Parameters.

Fig.2. Simplified Cross-sectioned View of the Dipole Magnets

- the Hall generators measures B_y component of magnetic field;
- the Hall probe consists of five Hall generators, placed in the points X=-h; X=-h/4; X=0; X=h/4; X=h;
- the Hall probe moves along the Z-coordinate on measuring distance L+10g by step g/5;
- three sets of measuring are made for Y=-3/4g; Y=0; Y=3/4g.
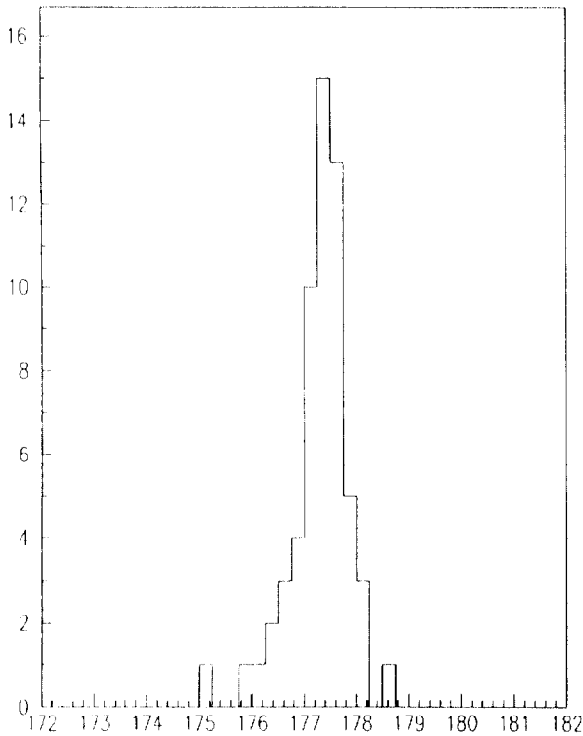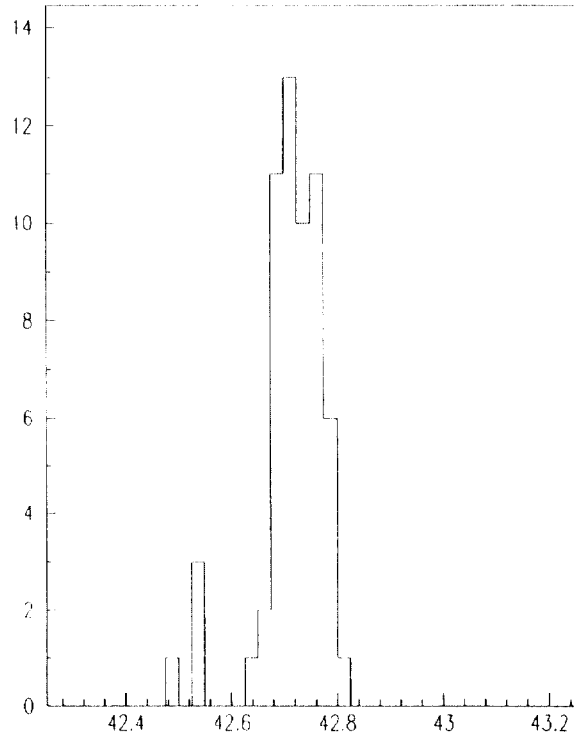

Fig.3. Gradient in Gauss/cm (200 A)

Fig.4. Effective length in cm (200 A)

An apparatus is composed of the search Hall probe, a system for moving the probe along the Z-axis and data acquisition system including a multi-channel Hall generator service (stable current source for each Hall generator and individual thermostabilisation) and a multi-channel ADC.

All electronic parts of the measurement set are controlled and logged by an on-line computer.

Summary

- the low cost, flexible magnet field measurement set for all kinds of the MMF experimental area magnets has been designed and constructed;

- the representative parameters of 101 quadrupole focusing magnets were measured with the "coil probe" set;

- the summarized results of "20LK35-8" type quadrupoles for the current 200 A are given in Fig.3 and Fig.4;

- the Hall probe set has been designed and constructed and now is ready to start the measurements of the secondary beam line dipoles and proton storage ring magnets.

References

[1] M.I.Gratchev et al., "Experimental Area of Moscow Meson Factory", in Proceedings of the XIV International Conference on High Energy Accelerators, Particle Accelerators, vol. 27, pp. 51-58, 1990.

[2] M.V.Akopyan et al., "The Radiation Resistant Quadrupole", in Proceedings of the International Seminar on Intermediate Energy Physics, pp. 94-97.