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ABSTRACT

This note discusses placement of the dipole and quadrupole magnets received from the University of Illinois for the FET Recirculation Experiment

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Magnet Placement for the FET Recirculation Experiment

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July 26, 1991

1 Introduction

The FET recirculation experiment beam optics requires 20 dipole and 16 quadrupole magnets[1,2]. The attached layout (figure 1) shows the placement and the official names of the various magnetic elements. The recirculation optics consist of:

- the injection chicane consisting of 7 dipoles located between the quarter cromodule and the first cryomodule and is fully installed in the tunnel;
- two 180 degree bends consisting of 4 dipoles and 3 quadrupoles each;
- the return path consisting of 10 quadrupoles located between the first and second 180 degree bends;
- the energy recovery chicane consisting of 3 dipoles located between the second cryomodule and the first 180 degree bend; and
- two dipoles located on the first 180 degree bend table which guide the second pass beam to the beam dump.

This note describes the placement in the tunnel of the dipoles and quadrupoles obtained from the decommissioned University of Illinois MUSL2A accelerator based on field integral measurements using the rotating coil technique. The energy recovery chicane magnets *BNRB01, BNRB02, BNRB03* the small dipole *BNRB12* and the quadrupoles *QBRB04, QBRB05, QBRB12, QBRB13* will not be discussed in this note. The injection chicane magnets are installed in the tunnel and will not be discussed.

2 Dipole Magnet Placement

Nine dipole magnets were received from Illinois and are to be used in the recirculation experiment. Four dipoles are used in each 180 degree bend and one will be used to bend the second pass beam into a beam dump (*BNRB04, BNRB05, BNRB06, BNRB07* are the names of the dipoles used in the first 180 degree bend and *BNRB08, BNRB09, BNRB10, BNRB11* for the second). Each magnet has been mechanically modified at CEBAF to have standard water cooling and electrical connections and given a generic number between 1 and 9 which is painted on the magnet. All four dipoles in each 180 degree bend are run in series from the same power supply and it is therefore desired that each magnet have the same field integral for a given current on the hysteresis curve. The field integral of all nine magnets was measured as a function of current from 0 to 100 amperes. Based on the field integral data, table 1 was compiled and shows the assignment of each dipole given by their generic number (1 through 9) to the CEBAF beamline name.

Dipole *BNRB04* of the first 180 degree bend and dipoles *BNRB08* and *BNRB11* of the second 180 degree bend were placed because of mechanical constraints. The other dipoles of each bend were chosen because their field integrals most closely matched those of the dipoles placed due to mechanical constraints. The coil package of each dipole magnet contains in addition to the main coil a small trim coil which can easily make 5% adjustments to the field integral. The four dipoles that make up the first 180 degree bend have field integrals which vary by .5% and will probably not require much use of the trim coils to adjust the total field integral of the bend. The dipoles *BNRB08, BNRB09, BNRB10* of the second 180 degree bend have field integrals which vary by .5%. Dipole *BNRB11* however, has a field integral which is 2% lower than the other three dipoles in the second 180 degree bend so that the trim coil on *BNRB11* will most likely have to be used to increase its field integral to match the other three dipoles in the bend. Dipole *BNRB13* is used for the dump magnet for the second pass beam.

3 Quadrupole Magnet Placement

Fourteen quadrupole magnets were received from Illinois of which twelve will be used in the recirculation experiment and two will be designated as spares. The quadrupoles were given a generic number between 1 and 14 for identification as with the Illinois dipoles. Mechanically these quadrupoles can be divided into two categories: eight of them (1, 2, 3, 4, 5, 6, 12, and 13) were manufactured (coils and metal) outside of Illinois, and six (7, 8, 9, 10, 11, 14) were constructed "in house" (coils and metal). The only major mechanical difference between these two types of quadrupoles is that the "in house" quadrupoles are .5 inches shorter and have hand wound and potted coils. Both types of quadrupoles have the same length pole pieces (8 inches) and therefore have the same effective length of roughly 8.5 inches. The manufactured quadrupoles were found to have field gradient integrals which are much more nearly the same as a function of current than the "in house" quadrupoles. This fact is important for the 180 degree bends because the three quadrupoles used to correct the dispersion are run in series from one power supply and need to have the same integrated gradient strength. The "in house" manufactured quadrupoles will be used on the return path because each will be run independently from its own power supply and the manufactured quadrupoles will be reserved for the 180 degree bends. The two quadrupoles just after the first 180 degree bend (*QBRB04, QBRB05*) and the two just before the second 180 degree bend (*QBRB12, QBRB13*) will be the "*QB*" variety used in the linacs and borrowed for the recirculation experiment. Table 2 gives the beamline placement of the quadrupoles in the recirculator.

The 180 degree bend quadrupoles (*QNRB01, QNRB02, QNRB03* and *QNRB14, QNRB15, QNRB16*) were chosen for integrated field gradient uniformity and differed by at most .5% in integrated field gradient at each current from 1 to 10 amperes. Placement of the final six quadrupoles on the return path is not as critical as far as field gradient uniformity because each is run from its own power supply. The quadrupoles *QNRB06-QNRB11* have gradient integrals which differ at each current from 1 to 10 amperes by no more than 1.5%

Table 1: Dipole Beamline Placement for the Recirculation Experiment

Beamline Name	Dipole #
BNRB04	5
BNRB05	2
BNRB06	3
BNRB07	9
BNRB08	4
BNRB09	8
BNRB10	1
BNRB11	7
BNRB13	6

Table 2: Quadrupole Beamline Placement for the Recirculation Experiment

Beamline Name	Quadrupole #
QNRB01	2
QNRB02	6
QNRB03	5
QNRB06	1
QNRB07	3
QNRB08	7
QNRB09	11
QNRB10	9
QNRB11	10
QNRB14	4
QNRB15	13
QNRB16	12

Finally quadrupoles numbered 8 and 14 are to be designated as spares because each has more windings (and thus a higher field integral at a given current) than the quadrupoles in table 2.

References

[1] W. Barry, J. J. Bisognano, L. S. Cardman, J. Kewisch, G. A. Krafft, N. S. Sereno, C. K. Sinclair, *A Proposal for Accelerator Physics Experiments Using a Beam Recirculated Through the Front-End-Test Accelerator at CEBAF*, CEBAF-TN-90-231, 1990.

[2] N. Sereno, *Accelerator Physics Experiments Using a Beam Recirculated through the Injection Accelerator at CEBAF*, CEBAF-TN-90-282, 1991.

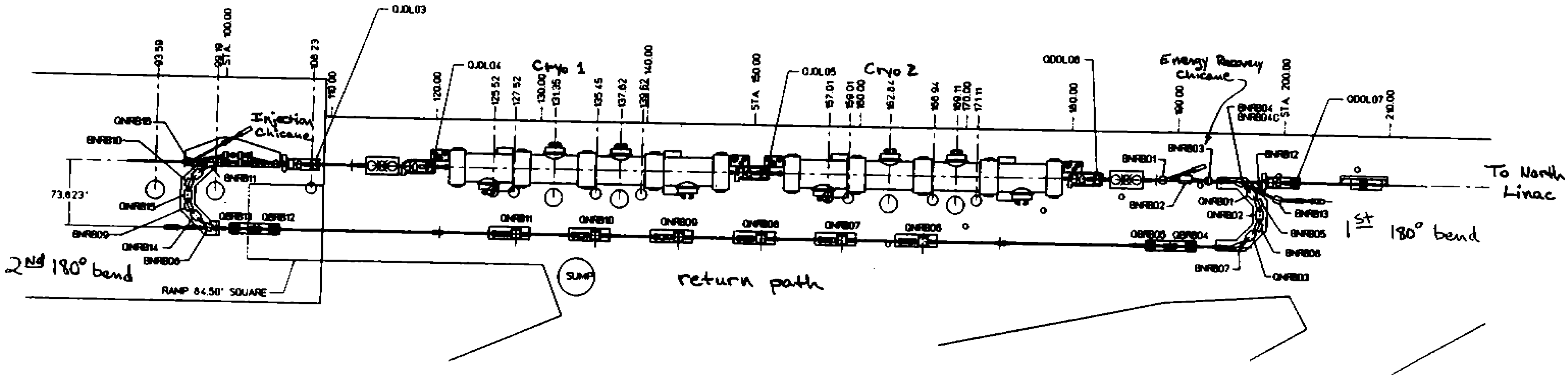

FIGURE 1
RECIRCULATOR LAYOUT
PLAN VIEW