Main Injector Dipole Magnet Acceptance Criteria

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In this paper we describe the Main Injector Dipole Magnet acceptance criteria. The acceptance criterion is defined to put magnet in two different groups. Any magnet whose strength and higher multipoles are within the acceptance limit will be placed in the ring without any serious investigation. Whereas magnets falling outside these limits will require special attention in their placement. These limits are also designed to track any systematic change in the magnet production.

The dipole magnetic strength and higher order multipole requirements were initially derived from the prototype dipoles' measurements and best knowledge of the Main Ring B2 dipole magnets. As we have learned more about Main Injector dipoles we have modified the inputs to these calculations.

The Main Injector Tracking Simulations have been done by using a tracking code TEAPOT. The Lattice includes higher order multipoles for Dipoles, Quadrupoles and Sextupoles. The lattice also includes magnet and BPM alignments. The results of TEAPOT calculations are consistent with the calculations done by MAD and Slow Extraction codes.

We define the dipole magnet acceptance at five currents. 500 Amps (Injection), 1500 Amps (Transition), 5000 Amps, 7000 Amps (Slow Extraction) and 9500 Amps (150 GeV).

Selection of a dipole magnet will be made first on its strength and second on its higher order multipoles. We are in process of developing placement schemes considering possible variations in the dipole strength of the magnets.

We have developed software to analyze the dipole measurement data. After measurement of a dipole using a particular probe has been compleated. The measurers will run the analysis software. This analysis software will use dipole magnet QC limits as described in this paper. There are two levels of QC limits.

-Limit 2 < - Limit 1 < Magnetic Quantity < Limit 1 < Limit 2

If the magnet strength or the higher multipoles fall out side limit 1 physicist should be informed to look at the data. Whereas as if the magnet strength or higher multipoles fall out side limit 2, we should compare the strength and multipoles measured by Flatcoil and Harmonics probes to make sure they are consistent. An analysis summary and QC report will be Emailed to a list of people looking at the magnet data.

This document describes the QC limit to be used for the analysis.

Dipole Strength

Dipole strength will be compared to following limits.

Below 1500 Amps

-25 Units < -20 Units < $\Delta B/B$ < 20 Units < 25 Units

At and above 1500 Amps

-20 Units < -15 Units < $\Delta B/B$ < 15 Units < 20 Units

Dipole Higher Order Multipoles

Five tables above describes the strength of the higher order multipoles and its random variation. Also shown are the random variation derived from 20 Main Injector Production dipoles.

We have decided to set the limit 1 for the higher order multipoles to be two times the FMI dipole sigma and limit 2 to be three times the acceptance sigma.

Dipoles

500 Amps

Normal Component

	Acceptance		FMI Magnet
	Mean	**Sigma**	**Sigma**
Dipole	0.0	15.0	8.5
Quadrupole	-0.6	0.45	0.1
Sextupole	-0.6	0.6	0.1
Octupole	0.0	0.15	0.03
10th	0.3	0.3	0.06
12th	0.0	0.1	0.04
14th	0.0	0.25	0.01

Skew Component

	Acceptance		FMI Magnet
	Mean	**Sigma**	**Sigma**
Quadrupole	-0.5	0.65	0.65
Sextupole	-0.2	0.2	1.2 ***
Octupole	-0.2	0.4	0.3
10th	0.1	0.15	0.1
12th	-0.3	0.5	0.5
14th	0.0	0.25	0.2

*** Recent measurement shows that skew sextupole variation is small.

1500 Amps

Normal Component

	Acceptance		FMI Magnet
	Mean	**Sigma**	**Sigma**
Dipole	0.0	10.0	5.0
Quadrupole	-0.5	0.40	0.1
Sextupole	-0.4	0.6	0.04
Octupole	0.0	0.15	0.02
10th	0.35	0.3	0.04
12th	0.0	0.1	0.02
14th	-0.1	0.25	0.02

Skew Component

	Acceptance		FMI Magnet
	Mean	**Sigma**	**Sigma**
Quadrupole	-0.5	0.6	0.6
Sextupole	-0.05	0.2	0.1
Octupole	-0.1	0.4	0.2
10th	0.0	0.1	0.02
12th	-0.15	0.25	0.25
14th	0.0	0.1	0.02

5000 Amps

Normal Component

	Acceptance		FMI Magnet
	Mean	**Sigma**	**Sigma**
Dipole	0.0	10.0	2.8
Quadrupole	-0.5	0.30	0.08
Sextupole	-0.7	0.5	0.04
Octupole	0.04	0.1	0.02
10th	0.35	0.25	0.04
12th	0.0	0.1	0.02
14th	-0.1	0.25	0.02

Skew Component

	Acceptance		FMI Magnet
	Mean	**Sigma**	**Sigma**
Quadrupole	-0.5	0.6	0.6
Sextupole	-0.06	0.2	0.1
Octupole	-0.05	0.3	0.06
10th	0.0	0.1	0.02
12th	-0.04	0.2	0.01
14th	0.0	0.1	0.02