MAGNETIC MEASUREMENTS OF THE BOOSTER DIPOLE MAGNETS FOR THE ALBA SYNCHROTRON

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Abstract

The paper presents the magnetic measurements of the 32 long dipoles and 8 short dipoles magnet manufactured and measured by Sigmaphi for the ALBA synchrotron booster based in Spain. An extensive set of measurements based on search coils was made by Sigmaphi to characterize the magnetic field at different currents. This paper describes the magnetic measurements results. The measurements show the maximum field integral deviation between the magnets is within +/- 3.10^{-3} as expected.

INTRODUCTION

The Consortium for the Construction, Equipment and Exploitation of a Synchrotron Light Laboratory (CELLS) is responsible for the construction of a new synchrotron radiation facility, named ALBA, based in Spain near Barcelona [1]. The facility comprises a a 3 GeV electron storage ring, injected from a 100 MeV Linac through a full energy booster synchrotron. This paper introduces the magnetic measurement results for the 32 long dipoles and 8 shorts dipoles which are part of the booster magnets.

MAGNET PARAMETERS

The Table 1 gives the magnet parameters and Fig. 1 and 2 show a 3D view for each model.

Table 1: The Magnet Parameters

	Long dipole	Short dipole
Gap	Variable (minimum free air gap = 19,85 mm)	Variable (minimum free air gap = 19,85 mm)
Peak field	0,8733 T	0,8733 T
Deviation angle	10°	5°
Effective length	2000 mm	1000 mm
Yoke length	1972 mm	972 mm
Yoke steel	lamination	lamination
Total weight	780 Kg	400 Kg

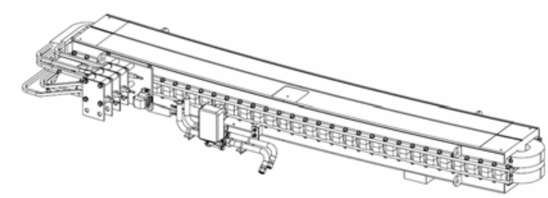

Figure 1: Long dipole.

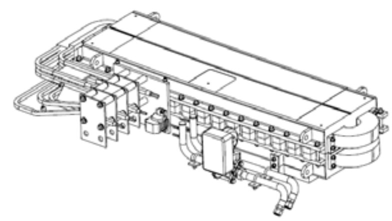

Figure 2: Short dipole.

MAGNETIC MEASUREMENT SYSTEM DESCRIPTION

The objective of the magnetic measurement is to check that the integrated field is similar between all the manufactured magnets. The measurement is based on the comparison between a reference magnet with all the manufactured magnets. The maximum expected deviation between the magnets is +/- 3.10-3 @ nominal current. For this purpose we built 2 search coils supports and developed a specific measurement program [2].

The measurement is based on the flux variation generated by a current ramping. The Fig. 3 below shows the measurement chain.

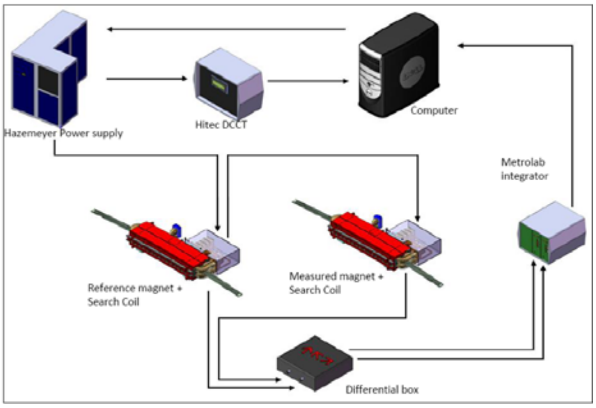

Figure 3: Measurement chain.

Each search coils is made up of 3 circuits of ten turns each. The circuits integrate the flux along the radius R_0-15mm , R_0, R_0+15mm.

The Fig 4. shows the cross section of the search coil support relying on the bottom yoke.

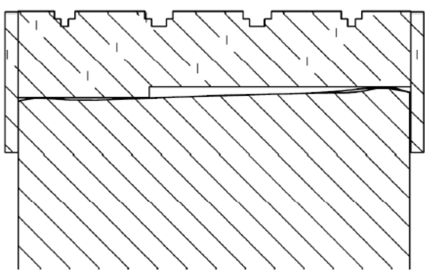

Figure 4: Search coil support (upper yoke not shown for clarity).

The first search coil "SC1" is installed inside the reference magnet and the second search coil "SC2" is installed inside the magnet to measure. The measurement are done at 8 currents from 22A to 660 A.. At each current the flux linked by "SC1" and "SC2" are integrated and compared. The Fig. 5 shows an example of measurement result for the magnet N°4 compared to the reference magnet.

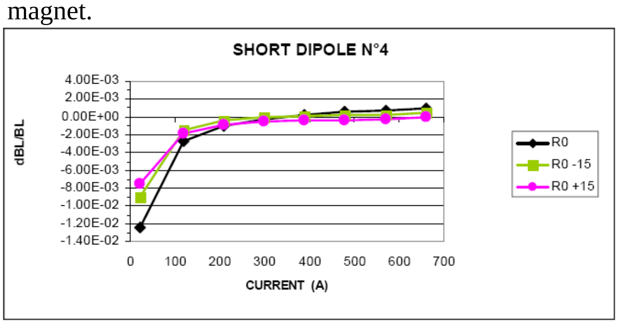

Fig.ure 5: Example of measurement.

The measurement at 22 A are not significant as the voltage flux linked is not high enough compared to the voltmeter integrator accuracy.

MAGNETIC MEASUREMENT SYSTEM QUALIFICATION

The system repeatability was checked by removing completely the search coil and installing it again for a new set of measurement one day later [3]. This operation was done several times with different short and long magnets and the overall repeatability, including the search coil removal, is between 5.10^{-4} and 1.10^{-3}. The Fig. 6 show typical results.

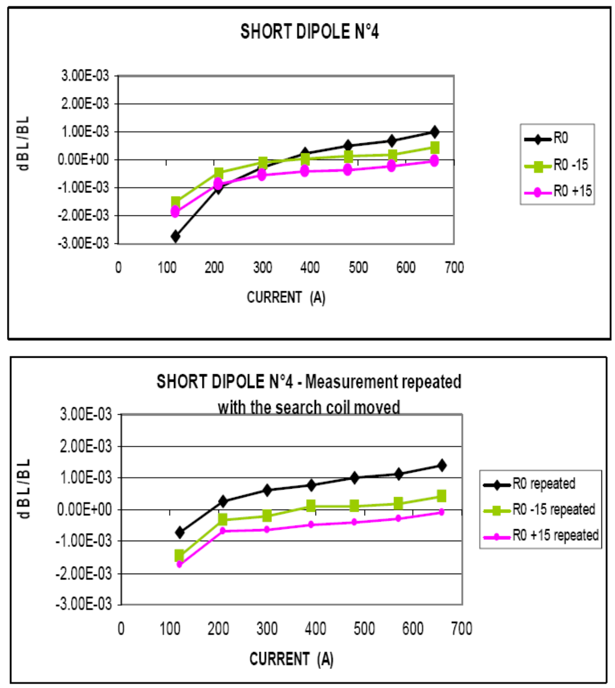

Figure 6: Example of repeatability tests.

It is important to note that the magnet field is designed as a gradient following the transverse direction. Therefore a transverse error of only 0,2 mm is equivalent to a field variation of 5.10^{-4}. This mechanical tolerance is already a tight tolerance considering the very small space available in the magnet to do the search coil positioning.

MAGNETIC MEASUREMENT RESULTS

We have measured 32 long dipoles and 8 short dipoles according to the measurement procedure described in the previous sections. The Fig. 7 and 8 show the measurement results for the currents 120, 300 and 660 A. Each plot gives at one current the integrated field variation between the measured magnet and the reference magnet.

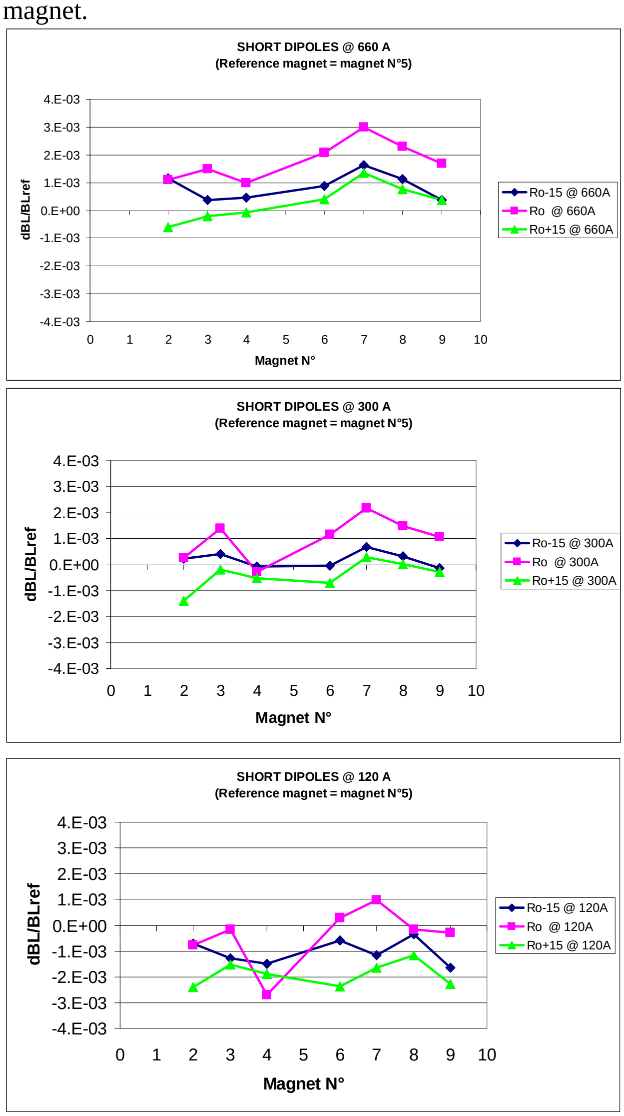

Figure 7: Short dipoles measurement @ 120, 300 and 660 A.

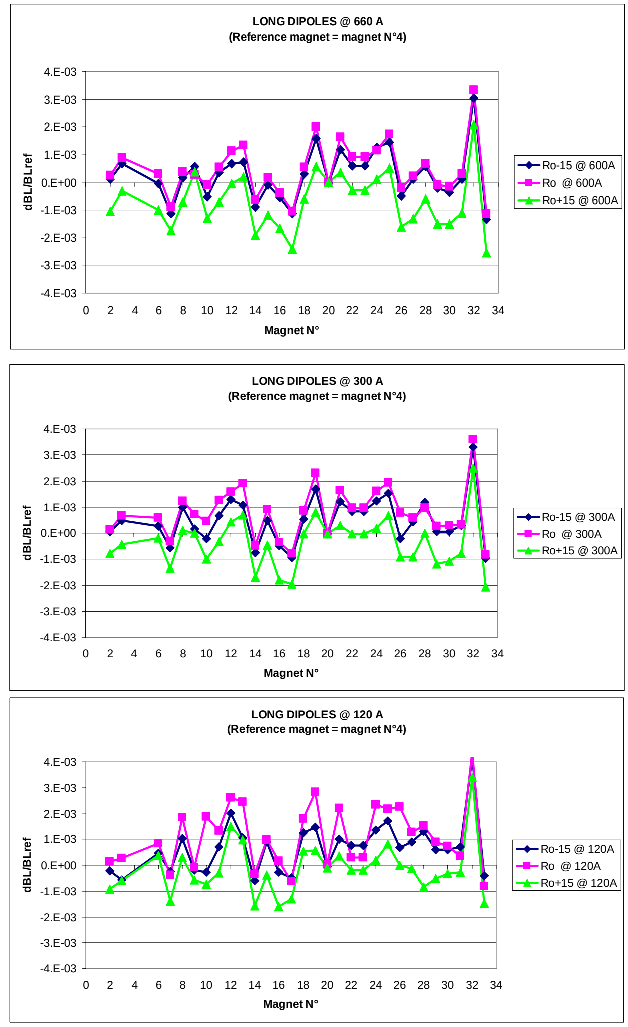

Figure 8: Long dipoles measurement @ 120, 300 and 660 A.

SUMMARY

The system measurement based on search coils and comparison with a reference magnet operates properly with a good accuracy for long and short dipoles measurement. The measurements show a good field identity between the magnets with a maximum deviation within +/- 3.10^{-3} as expected.

REFERENCES

[1] M. Pont, D. Einfeld – Technical Specifications for the Engineering Design, Manufacturing, Testing and Delivery of the Booster Dipole Magnets for the ALBA Synchrotron.

[2] F. Forest - CELLS 25331-25332 – Search coil measurement parameters - Sigmpahi private report.

[3] F. Forest, T. Février - CELLS 25331/25332 Magnetic measurement Qualification report - Sigmaphi private report.