DESIGN OF THE LONGITUDINAL GRADIENT DIPOLE MAGNETS FOR HALF

Mingyao Wang, Zhiliang Ren,Hongliang Xu†
National Synchrotron Radiation Laboratory, USTC, Hefei 230029, China

Abstract Hefei Advanced Light Facility (HALF) is the fourth generation diffraction-limited storage ring light source project in China. The lattice of the storage ring consists of six different dipoles with longitudinal gradients. The longitudinal-gradient dipoles (LGBs) are permanent magnets. This paper presents the designed construction of LGBs and the magnetic field results using OPERA3D. By optimizing the shape of the polar surface, the magnetic field uniformity is optimized to about 5×10^{-4}. With some movable adjusting block, the magnetic field can be controlled accurately. The temperature stability of the magnet is better than 5×10^{-5} T*mm/°C by setting temperature compensating shunt.

Introduction

There are three kinds of LGBs with the same gap 26mm. Each of them is divided into five segments (called modules). In one period, there are two same LGB blocks and the distribution of field is symmetrical about the center of period.

Table1 : Parameters of LGBs

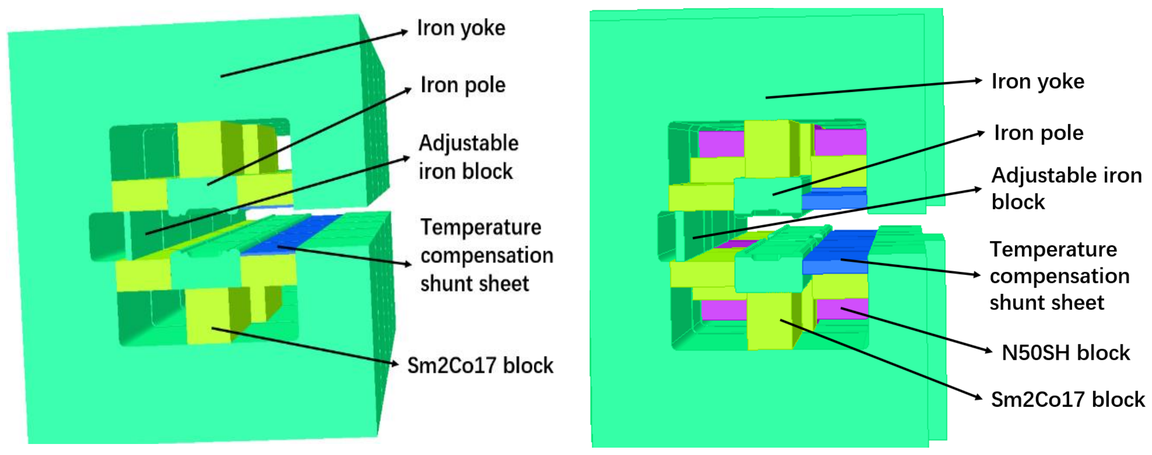
	LGB1	LGB2	LGB3
Aperture	≥26mm	≥26mm	≥26mm
Effective Length	1.05m	1.05m	0.59m
Good Field Region(GFR)	±10mm	±8mm	±8mm
Field uniformity	5×10^{-4}	5×10^{-4}	5×10^{-4}

Table2 : Magnetic field of LGBS

	LGB1	LGB2	LGB3
Module1	0.55T	0.32T	0.48T
Module2	0.42T	0.43T	0.78T
Module3	0.32T	0.58T	1.3T
Module4	0.24T	0.79T	0.78T
Module5	0.18T	0.65T	0.48T

Magnet Design

For LGB1, the constructions are composed of iron poles, iron yokes, Sm2Co17 blocks, adjustable iron blocks and temperature compensation shunt sheets. LGB2 has the same components as the LGB1. But for LGB3, N50SH blocks are added to strength the central magnetic field.



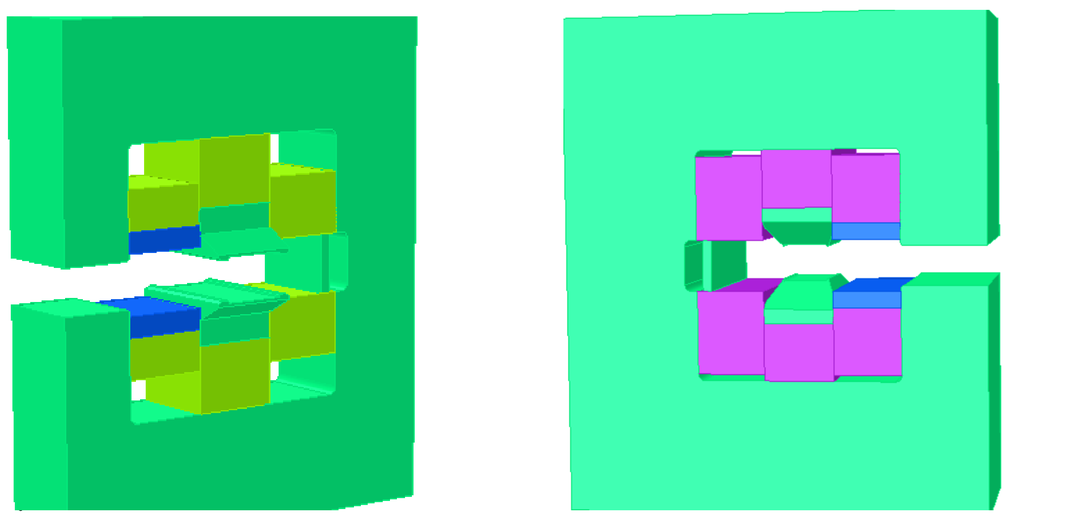
(a) Structure of LGB1 （b） Structure of LGB3

Figure 1: The structure of LGB1 and LGB3

Different magnetic field intensities are produced by filling different volumes of Sm2Co17 blocks and N50SH blocks.

Adjustable iron blocks are installed between the upper and lower permanent magnetic blocks. As the blocks move horizontally, the magnetic field decreases and increases correspondingly.

A sharp tip pole of module3 in LGB3 focus the flux and improves the field. The poles of module2 and module4 of LGB3 are designed as a step structure to avoid field drop between modules.

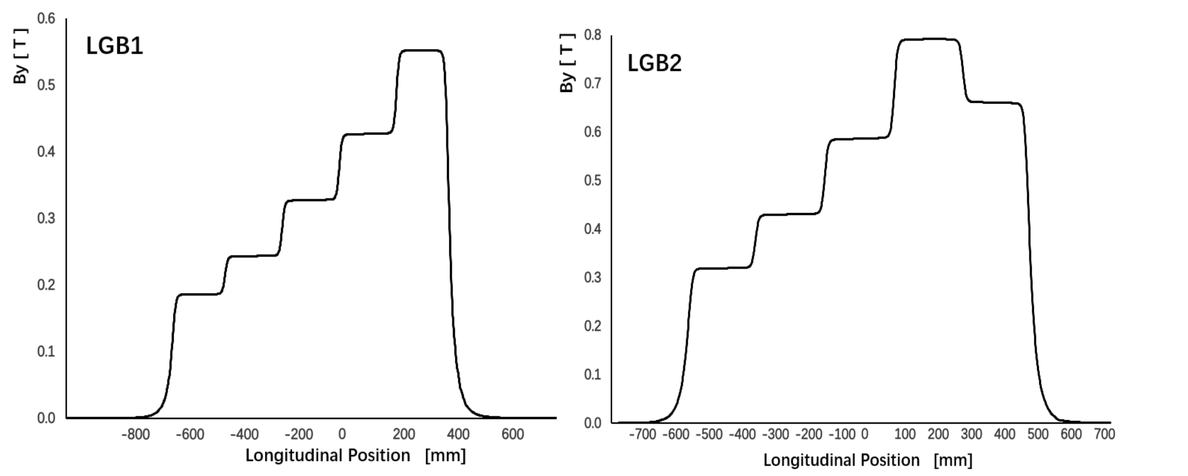


(a)Polar surface shape of Module2 (b) Polar surface shape of Module3

Figure2: Special polar surface shape of LGB3

Optimization results

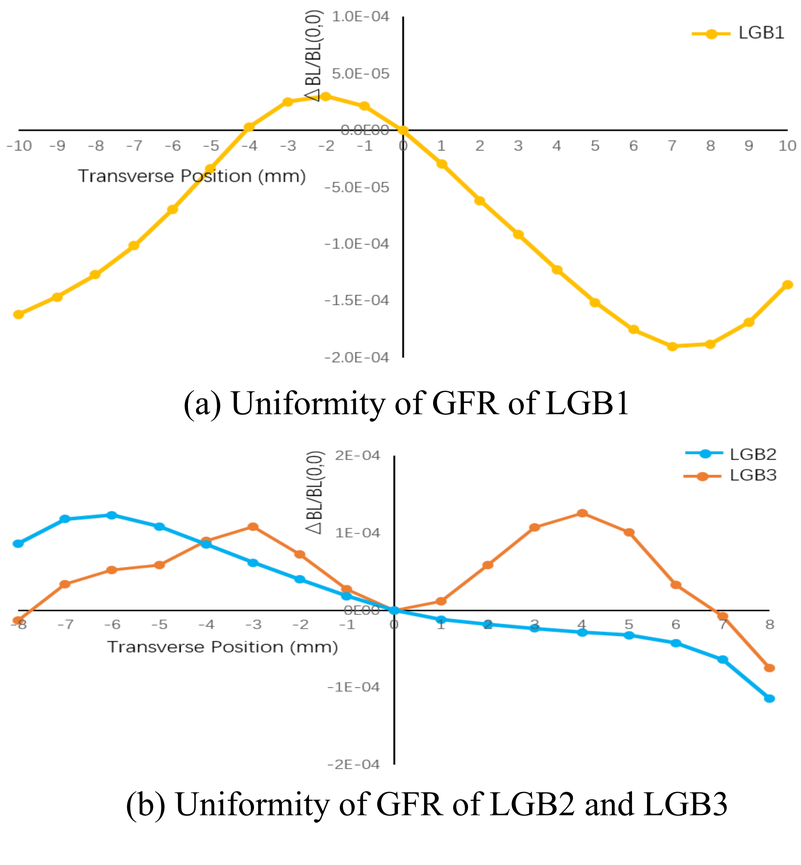
After the optimization, the longitudinal field distribution and the better uniformity of good field area can be obtained.



(a) Longitudinal field distribution of LGB1 (b) Longitudinal field distribution of LGB2

(c) Longitudinal field distribution of LGB3

Figure 3 : Longitudinal field distribution of LGBs



(a) Uniformity of GFR of LGB1

(b) Uniformity of GFR of LGB2 and LGB3

Figure 4 : Uniformity of GFR of LGBs

Conclusion

The physical design of LGBS has been completed. Considering the possible mechanical errors caused by the practical design, some allowance has been reserved at the beginning of the design. These physical models can be used to guide the actual manufacturing process of magnet mechanical elements and has practical value.