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STUDY ON THE LEAKAGE FIELDS OF THE SEPTUM AND LAMBERTSON MAGNETS DURING THE BEAM COMMISSIONING*

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Abstract

For China Spallation Neutron Source (CSNS), the septum magnets are the key parts of the injection system and the lambertson magnet is the key part of the extraction system. If the leakage fields of the septum and lambertson magnets are large enough, the circular beam orbit of rapid cycling synchrotron (RCS) would be affected. In this paper, during the beam commissioning, the leakage fields of the septum and lambertson magnets will be studied and their effects on the circular beam orbit will be given and discussed.

INTRODUCTION

China Spallation Neutron Source (CSNS) is a high power proton accelerator-based facility [1] whose technical acceptance had been completed in March 2018. Its accelerator consists of an 80 MeV H^- Linac and a 1.6 GeV rapid cycling synchrotron (RCS) with a repetition rate of 25 Hz which accumulates an 80 MeV injection beam, accelerates the beam to the designed energy of 1.6 GeV and extracts the high energy beam to the target. The design goal of beam power for CSNS is 100 kW and can be upgraded to 500 kW [2].

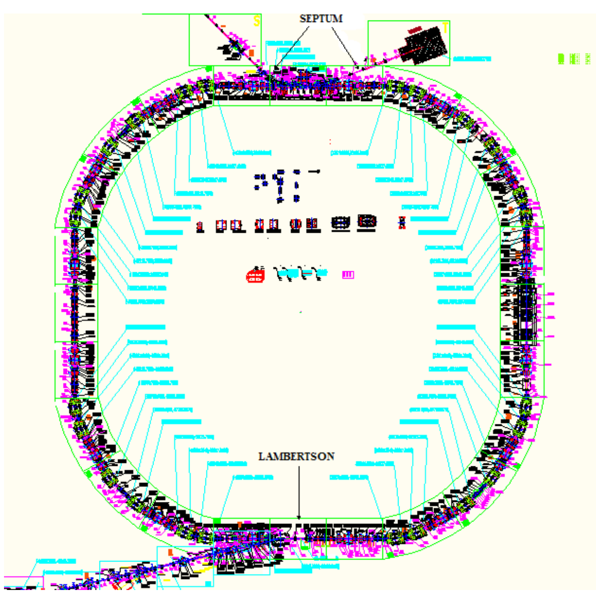

Figure 1: Layout of the CSNS/RCS system.

For CSNS, the septum magnets are the key parts of the injection system and the lambertson magnet is the key part of the extraction system [3, 4]. Figure 1 shows the layout of the CSNS/RCS system. The magnetic test results show that the leakage fields of the septum and lambertson magnets are very small and meet the physical design requirements [5]. During the beam commissioning, in order to obtain the accurate circular beam orbit, the leakage fields of the septum and lambertson magnets should be studied and their effects on the circular beam orbit should be discussed and removed.

LEAKAGE FIELDS OF THE SEPTUM MAGNETS

There are two septum magnets (septum-1 and septum-2) in the injection system. The magnetic test results show that the maximum leakage field value of the septum magnets is 12 Gs and the leakage field value at the position where the circular beam passes is smaller than 1 Gs. Therefore, the leakage fields of the two septum magnets meet the physical design requirements.

Figure 2: Horizontal circular beam orbits while the power of the septum-2 magnet is on (above) or off (below).

During the beam commissioning, in order to confirm that the leakage fields of the septum magnets have no effects on the circular beam, the leakage fields of the septum magnets need to be studied and measured. By comparing different circular beam orbits while the powers of the septum magnets are on and off, the effects of the leakage fields of the septum magnets on the circular beam can be estimated. Figure 2 shows different horizontal circular beam orbits while the power of the septum-2 magnet is on or off. Figure 3 shows different vertical circular beam orbits while the power of the septum-2

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magnet is on or off. It can be found that, no matter the power of the septum-2 magnet is on or off, the horizontal and vertical circular beam orbits are nearly unchanged. Therefore, it can be confirmed that the leakage fields of the septum magnets have no effects on the horizontal and vertical circular beam orbits.

Figure 3: Vertical circular beam orbits while the power of the septum-2 magnet is on (above) or off (below).

LEAKAGE FIELD OF THE LAMBERTSON MAGNET

There is only one lambertson magnet in the extraction system. The magnetic test results show that the maximum leakage field value of the lambertson magnet is 4 Gs and the leakage field value at the position where the circular beam passes is smaller than 2 Gs. Therefore, the leakage field of the lanbertson magnet meets the physical design requirements.

Similar to the septum magnets, during the beam commissioning, whether the leakage field of the lambertson magnet has effects on the circular beam should be confirmed. Or else the accurate circular beam orbit cannot be obtained. By comparing different circular beam orbits while the power of the lambertson magnet is on and off, the effects of the leakage field of the lambertson magnet on the circular beam can be estimated. Figure 4 shows different horizontal circular beam orbits while the power of the lambertson magnet is on or off. Figure 5 shows different vertical circular beam orbits while the power of the lambertson magnet is on or off. It can be found that, no matter the power of the lambertson magnet is on or off, the horizontal and vertical circular beam orbits are nearly unchanged. Therefore, it can be confirmed that the leakage field of the lambertson magnet has no effects on the horizontal and vertical circular beam orbits.

Figure 4: Horizontal circular beam orbits while the power of the lambertson magnet is on (above) or off (below).

Figure 5: Vertical circular beam orbits while the power of the lambertson magnet is on (above) or off (below).

CONCLUSIONS

There are two septum magnets in the injection system and one lambertson magnet in the extraction system. The magnetic test results show that the leakage fields of the septum and lambertson magnets are very small and meet the physical design requirements. However, during the beam commissioning, in order to obtain the accurate circular beam orbit, the leakage fields of the septum and lambertson magnets need to be studied and their effects on the circular beam orbit should be discussed and removed. In this paper, by comparing different circular beam orbits while the powers of the septum and lambertson magnets are on and off, the effects of the leakage fields of the septum and lambertson magnets on the circular beam were estimated. It can be confirmed that the leakage fields of the septum and lambertson magnets have no effects on the horizontal and vertical circular beam orbits.

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