

DESIGN MODIFICATIONS AND INSTALLATION OF THE INJECTION GIRDER SYSTEM IN TAIWAN PHOTON SOURCE

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Abstract

The prototype of TPS injection girder system was designed and installed in a temporary factory. As the leakage field of the kicker magnet in the prototype was found to be too large according to both simulation and measurement to be acceptable, the lattice was altered to fit the requirements. In this paper, we present the design modifications of the injection girder system due to the new lattice. The DC septum magnet is replaced by a pre-AC septum magnet, of which its adjustable stage must be redesigned. The positions of vacuum components in the injection girder are also altered; we add some new holes in the prototype girder. The prototype of an injection girder system after modification has been installed in the tunnel of Taiwan Photon Source. The accuracy of position of three girders installed, and the stages for the septum or kicker magnet are within 0.25 and 0.08 mm, respectively.

INTRODUCTION

The prototype of an injection section girder system was designed and installed in a temporary factory in Chutung town in Hsinchu County. We made several tests of the prototype of an injection girder system such as an assembly test, a rotating stage test and a test of high-voltage breakdown and kicker inductance [1]. In the original design of the prototype of this system [2], a DC septum was adopted because the electron beam could be deflected more widely in a smaller distance. The mass-produced power supply for the DC septum magnet was easier to manufacture than the pulsed power supply for the AC septum magnet according to the specifications of the power supply for impedance matching and the pulse-forming network (PFN). We hoped that the leakage field on the storage-ring orbit might be decreased to 0.8 % (600/75000 G-cm) when a DC septum magnet was adopted, but the decrease was only 1.5 % (1140/75000 G

-cm) according to both simulation and measurement. The DC septum magnet was hence eventually replaced with an AC septum magnet. The effect of the eddy current helps much to decrease the leakage field of the AC septum magnet. The new lattice of the injection section was hence designed to meet the requirements.

DESIGN MODIFICATIONS

As the original lattice of the injection section was altered, the design of the injection girder systems had to be modified, as the following subsections describe. The designs of the original and modified injection girder systems of TPS are compared in Fig. 1.

Redesign of the Pre-AC Septum Stage

The DC septum magnet was replaced with a pre-AC septum magnet; its adjustable stage was redesigned as shown in Fig. 2. First, the original adaptor plate of the DC septum magnet was shrunk to fit the smaller size of the pre-AC septum magnet. The rectangular edge of the adaptor plate was cut off so that the power cable of the septum magnet can pass through. The screw holes in the side of the adaptor plate of the pre-AC septum magnet stage were rearranged to prevent interference of the kicker or AC septum magnet stages upstream or downstream of the pre-AC septum magnet stage. Two cylinders (diameter 130 mm) of the pre-AC septum magnet stage were raised from 43 mm to 95.5 mm to maintain the height of the beam center at 1350 mm. Three pin holes (diameter 12 mm) to position the pre-AC septum magnet were added. The bottom plate of the pre-AC septum stage was tapped to connect to the adjustable aluminium plate with four rectangular plates; the pre-AC septum magnet thus becomes moved with the AC septum, K2 and K3 magnets synchronously in the horizontal direction.

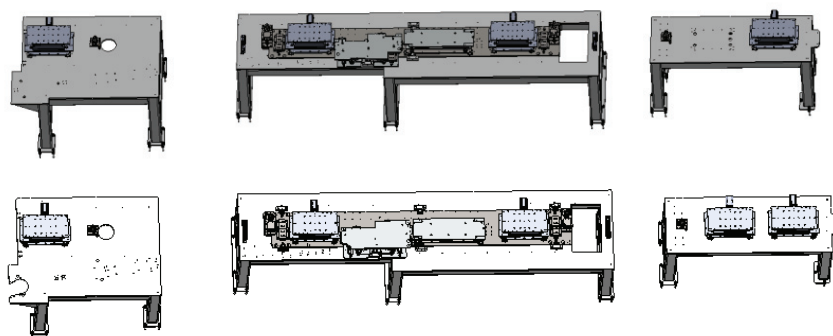


Figure 1: Designs of the original (top) and modified (bottom) injection girder system of Taiwan Photon Source.

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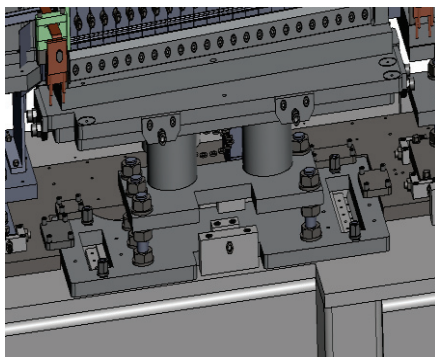


Figure 2: Pre-AC septum magnet and its stage.

Redesign of the Injection Girder

The new lattice results in interference between the ion pump and the K1 injection girder, shown in Fig. 3. The positions of vacuum components and their support are also altered. For these reasons, the desktop of K1 and the adjustable plate of the K2/septum/K3 injection girder are machined and tapped as shown in Fig. 4 and 5. On the side of the K1/K2 injection girder are also tapped some holes to mount the support of an ion pump, shown in Fig. 6.

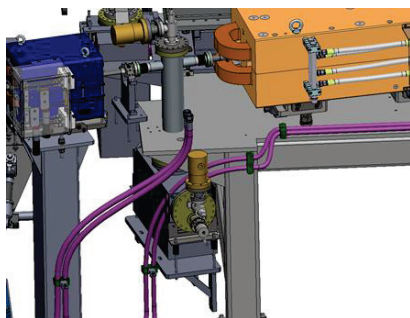


Figure 3: Interference between the ion pump and the K1 injection girder.

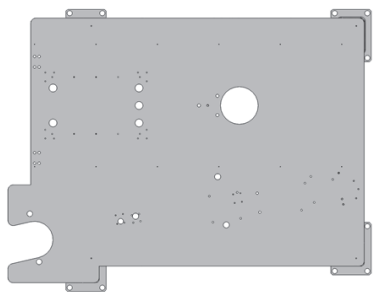


Figure 4: Modified K1 injection girder.

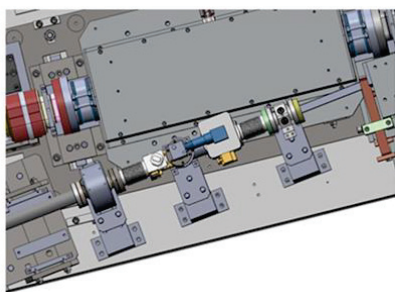


Figure 5: New holes are tapped on an adjustable plate of the K2/septum/K3 injection girder.

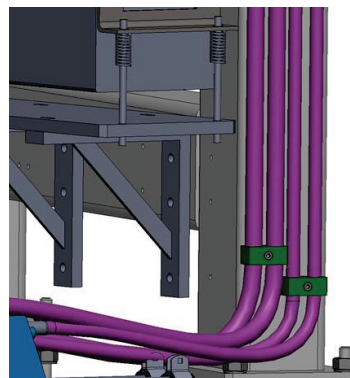


Figure 6: New holes on the side of the injection girder.

INSTALLATION AND ALIGNMENT

After the civil engineering of Taiwan Photon Source was completed, the center line of the injection girder was set using a laser tracker. The prototype of an injection girder system in a temporary factory in Chutung Town was concurrently dismantled for modification. After setting the beam direction of each injection girder in TPS, screws that support the girders were glued on the ground using a template. The modified injection girders were subsequently moved into the tunnel of TPS and then installed as shown in Fig. 7. The feet of the girders were grouted with unshrinking concrete to increase the stability of the girder. We used a laser tracker to align the girders. The results of measurement of the position error of the injection girder in three directions with use of the laser tracker are shown in Fig. 8~10. The position error of the injection girder is within 0.2mm before grouting and 0.25 mm after grouting.



Figure 7: The injection girders were installed in the tunnel of TPS.

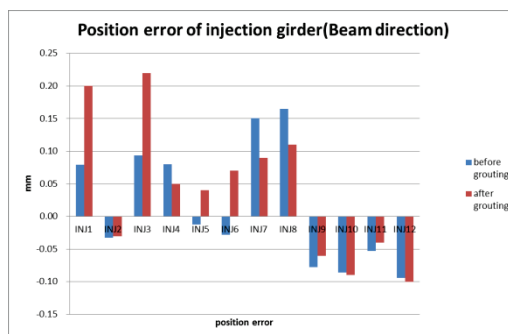


Figure 8: Position error of the injection girder in the beam direction.

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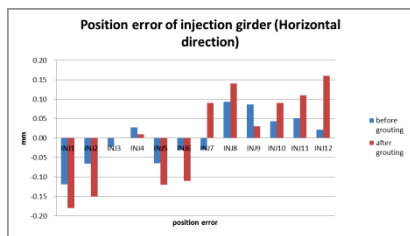


Figure 9: Position error of the injection girder in the horizontal direction.

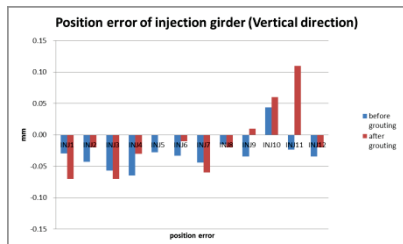


Figure 10: Position error of the injection girder in the vertical direction.

After three injection girders were installed, the adjustable aluminium plate was installed in the middle girder of the injection section and aligned with four fiducial holes on it within 0.05 mm. The Rapson-slide mechanism, stages for the kicker and pre-AC/AC septum were installed on the aluminium plate or girder in a sequence, shown in Fig. 11. The results of measurement of stages for kicker magnets in three directions are shown in Fig. 12~14. The position error of stages for the kicker magnet is within 0.08 mm.



Figure 11: The adjustable plate, the Rapson-slide mechanism, stages for the kicker and pre-AC/AC septum were installed and aligned.

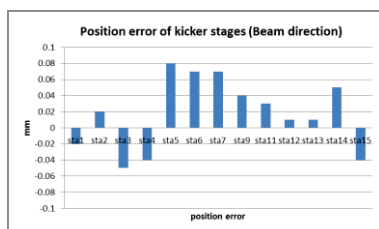


Figure 12: Position error of the kicker stage in the beam direction.

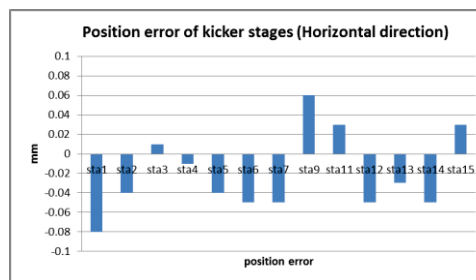


Figure 13: Position error of the kicker stage in the horizontal direction.

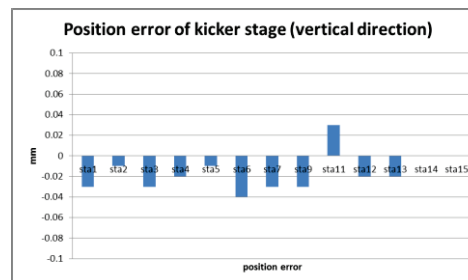


Figure 14: Position error of the kicker stage in the vertical direction.

CONCLUSION

This paper presents the design modifications of the injection girder system due to the new lattice of the injection section in TPS. The stage of the pre-AC septum magnet was redesigned and fabricated. The injection girders were also altered and moved into the tunnel of TPS. The installation of the injection girder system is described. The position errors of the injection girder and the stages for the kicker magnet are within 0.25 and 0.08 mm, respectively. The results of the alignment meet the requirements of our specifications and help us to install the magnets and vacuum system in the next stage.

REFERENCES

- [1] Y.H. Liu et al., "TPS SR Kicker Prototype Installation Status", THPC147, Proceedings of IPAC2011.
- [2] K.H. Hsu et al., "Integration Design and installation of girder systems in the injection section of Taiwan Photon Source", Intelligent Technologies and Engineering Systems Lecture Notes in Electrical Engineering , Volume 234 , p. 885-891 (2013)