THE DESIGN OF DUAL CANTED IN-VACUUM UNDULATORS AT SSRF

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Abstract

Five new beamlines are under design and construction at SSRF to serve the synchrotron radiation for the structural biology research in the protein project. Two in-vacuum undulators with canted angle of 6mrad are arranged in a 6.5m long straight section in order to keep the potential to accommodate more beamlines in the future. Limited by the length of the straight section and the angle between two beamlines, the layout design in the straight section is rather difficult to satisfy the required photon flux to the beamline and keep the normal design of the undulator. Many main components will be redesigned in this section on the base of existing ones, including in-vacuum undulator, correction magnet, RF bellows, photon absorbers and so on. In this paper the layout design and the modified design for some key components are described.

INTRODUCTION

Shanghai Synchrotron Radiation Facility (SSRF) [1] is a third-generation of synchrotron radiation light source, with invaluable applications in science and industry. Up to now, SSRF is the biggest scientific platform for science research and technology development in China, and more than hundreds of scientists and engineers from universities, institutes and industries in domestic and even overseas can do research, experiments and R&D by using SSRF each day. There are 16 straight sections at SSRF for insert devices, and 4 long straight sections. Insert devices (wigglers and undulators) are widely used in third-generation of synchrotron radiation light source because there can provide better synchrotron radiation. SSRF have 5 insert device beamlines now, and we plan to build more. Limited by the number of straight section, we consider canted undulator straight section [2]. Arranging 3 dipoles and 2 undulators in one straight section, we can provide 2 beamlines with canted angle of 6mrad (Figure 1).

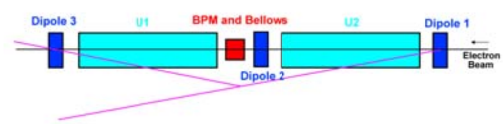

Figure 1: Schematic layout of canted undulators straight section.

LAYOUT

Two beamlines of protein project share one straight section. They are complex crystal structure beamline and small-angle scattering of biological beamline. They use in-vacuum undulators located in Cell 19, SSRF. The canted angle between 2 beamlines is 6mrad.

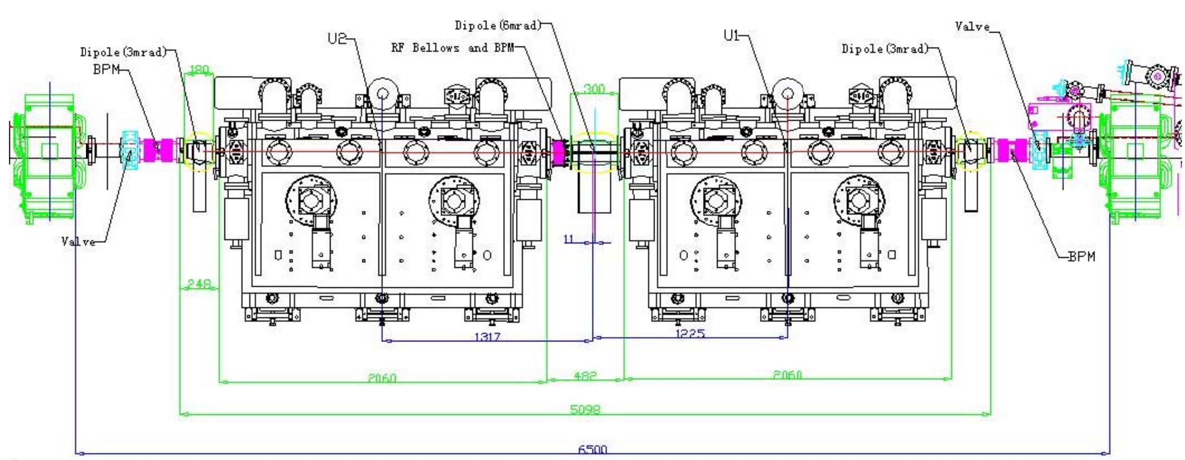

Figure 2: Layout of the components of the straight section (top view).

The total straight section length is 6500mm, but only 5098mm is available (Figure 2). Along the beam direction, there are 2 in-vacuum undulators, 3 dipoles, 1 RF bellows and 1 BPM. We redesigned the main components and make sure they will both fit in the straight section and the beamlines' requirements.

In the new design, limited by the length, the middle bending magnet is not at the center of the straight section.

In order to guide the beam back to the correct place, it is bended to the angle of 3.071mrad at first, 6mrad at middle, and 2.929mrad at the end.

We set pumps and photo absorbers in the bending magnetic chambers. All the components' bending is achieved by the bellows (Magenta parts in Figure 2).

There are 2 main components: undulators, RF Bellows & BPM.

MAIN COMPONENTS

Undulator

Table 1 Main parameter of undulator

Parameter	Value	Units
Undulator type	Hybrid	
Period length	20	mm
Number of period	80	
Magnet arrange length	1600	mm
Overall length	2060	mm
Gap rang	5-30	mm
K-parameter	0.8-1.942	
Maximum magnetic field strength	1.04	T
Phase error	< 3	°

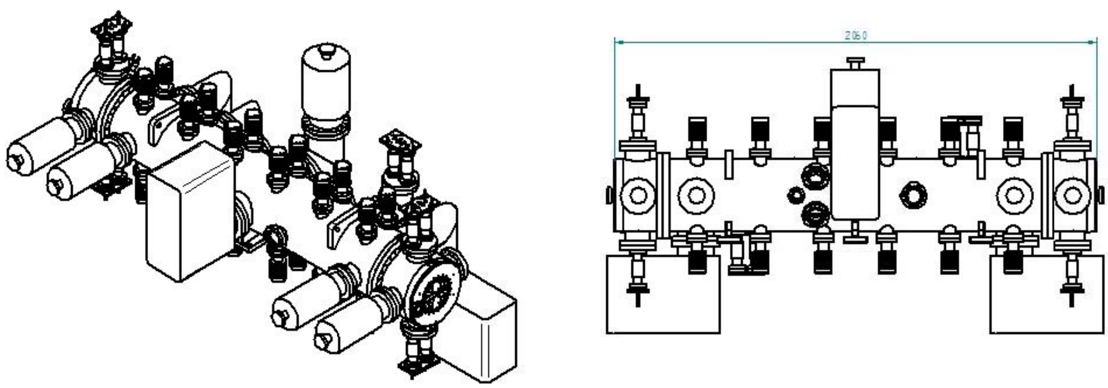

Figure 3: Schematic of In Vacuum Undulator.

As the most important components, the undulators are designed on the base of existing. We shorten the length of FTT (Flexible Taper Transitions) to get more magnetic period. We made enough length for 80 magnetic periods (20mm), which meets the beamlines' requirements.

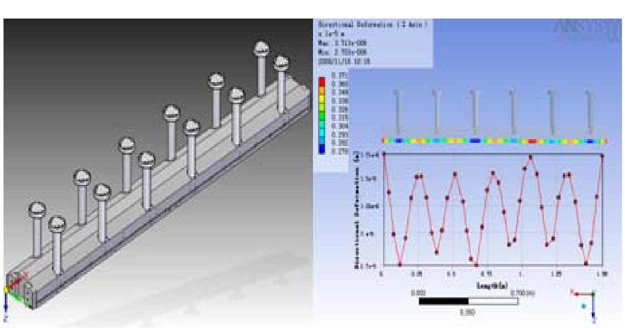

Figure 4: Schematic of inner girder Deformation.

We use 6 pairs of rods to suspend the inner girder. The magnetic force will be huge with a small undulator gap. Assuming a 1.5 ton magnetic force, we optimized the rods spacing to be 270mm.

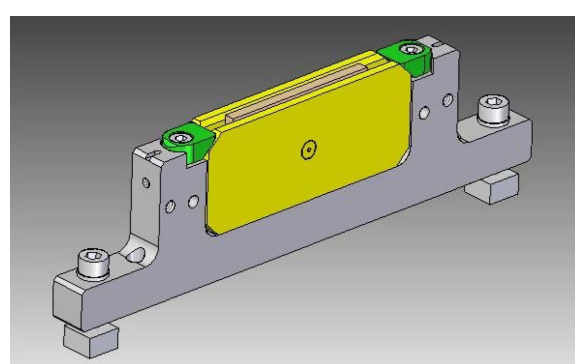

Figure 5: Schematic of Magnetic Structure.

The main magnetic structure is one pole with two magnet blocks (Figure 5). This structure is easy for exchanging and shimming.

RF Bellows & BPM

We combine RF bellows, BPM and middle bending chamber to one component to shorten length (Figure 6).

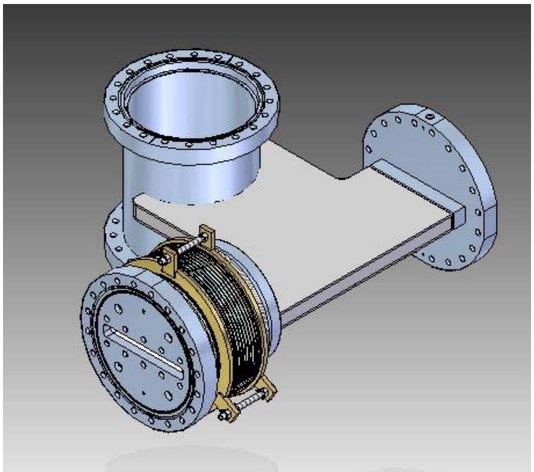

Figure 6: Schematic of RF Bellows & BPM.

Table 2 Main parameter of RF bellows

Parameter	Value	Units
Setting Length	482	mm
Extended length	＋10	mm
Compressed length	－15	mm
Offset	±2.5	mm

As the important component connecting 2 undulators, it is designed to not only compensate the vacuum chamber manufacture and installation errors, but also absorb the thermal expansion of the system during baking. It is also designed to be bended to fit the 6mrad angle. The shielding structure is improved form the previous design.

PROGRESS

We finished the undulator design, including magnet system, vacuum system, mechanical system and control system. All the subsystems are being fabricated in China. We will integrate the two sets of undulator next spring and install them on SSRF storage ring next summer.

ACKNOWLEDGEMENTS

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REFERENCES

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[2] Patric K. Den Hartog, Glenn A. Decker, Louis J. Emery DUAL CANTED UNDULATORS AT THE ADVANCED PHOTON SOURCE. Proceedings of the 2003 Particle Accelerator Conference, IEEE 2003, 833.