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A DESIGN OF AN X-RAY MONOCHROMATIC ADJUSTABLE SLIT FOR HEPS BEAMLINES*

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Abstract

The monochromatic slit is a commonly used device in HEPS beamlines. It can limit the synchrotron beam-spot within a desired size required by the downstream optical equipment. In addition, the four-blade structure is the most widely used form of slit. The slit with this form usually consists of a pair or two parallel tungsten carbide blades. With their edges close to each other, a slit can be formed, and the size of which can be controlled by micromechanical guides. This structure is very suitable for the case of large beam size. In this work, we have designed a monochromatic slit based on the four-blade form for BF beamline in HEPS. It can be used in ultra-high vacuum, high luminous flux working environment. The maximum opening range is up to 30*10 mm^2 (H*V), while it can allow a white beam of 136*24 mm^2 (H*V) to pass through. Furthermore, we adopted a point to surface contact design, which can effectively avoid the over-constraint problem between two guide rails.

INTRODUCTION

The test beamline (ID42) is under construction at HEPS. Its main function is to perform comprehensive testing and evaluation of some high-performance optical elements and detectors before they go online [1]. That means it can provide various modes of beam, including white, pink, monochromatic, and focused beam [2]. Therefore, the design of general optical equipment on this beam is usually very challenging: we have to consider the compatibility between different modes.

This monochromatic slit is designed for the test beamline. Its major functional requirements are that the maximum opening range is up to 30*10 mm^2 (H*V), while it can allow a white beam of 136*24 mm^2 (H*V) to pass through. The working environment is ultra-high vacuum, and the energy range is 5-45 keV.

DESIGN

Overall Description

The monochromatic slit consists of three parts: horizontal tungsten blade module, vertical tungsten blade module, vacuum chamber and a height-adjustable granite base. The assembly drawing is sketched in Fig. 1. It is well known that one of the most important technical parameters of an adjustable slit is the parallelism between the blades, which directly affects the spot quality. For this reason, drive and guide components with good precision are essential [3]. At present, there are many technologically mature products with integrated drive and guide on the market, and their motion accuracy can even reach the manometer level [4]. Considering practicality and economy, we mainly choose these standard products as driving and guiding components.

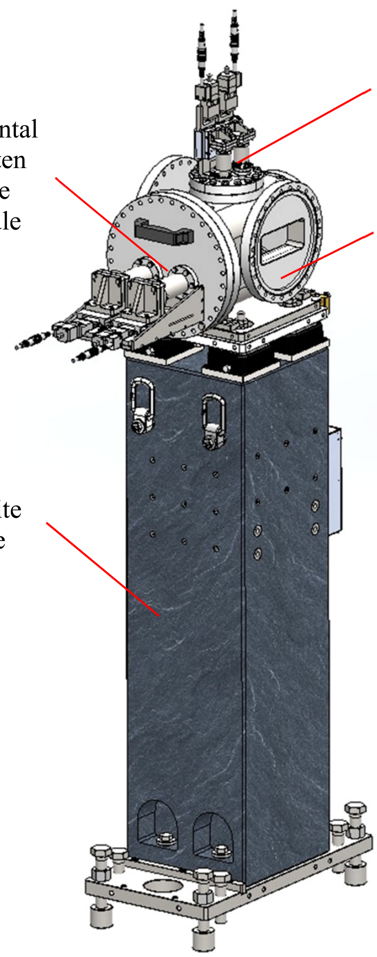

Figure 1: Overview of the monochromatic adjustable slit.

Horizontal Tungsten Blade Module

The design of the horizontal tungsten blade module is shown in Fig. 2, which consists of two KOHZU slide models (SXA0575-R01) as drive components to move the tungsten blades in the vacuum chamber by a connecting rod. The blade holder is located on an AML slide. In this way, the parallelism between the two tungsten blades depends on the parallelism between the two slide guides. However, the motion guidance of the slide itself can be over-constrained with the guide rails inside the vacuum. For this reason, a flexible connection is proposed. As shown in Fig. 3, the end side of the connecting rod is machined into

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a spherical surface, which is in point surface contact with the tungsten blade holder and by applying a certain preload force through the two springs, it can be ensured that the connecting rod is always in contact with the holder, but not hindering the relative swing between them. This way is simple and effective to solve the problem of over-constraint and guarantee the motion accuracy [4].

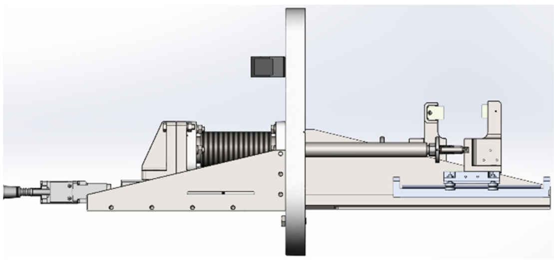

Figure 2: Horizontal tungsten blade module.

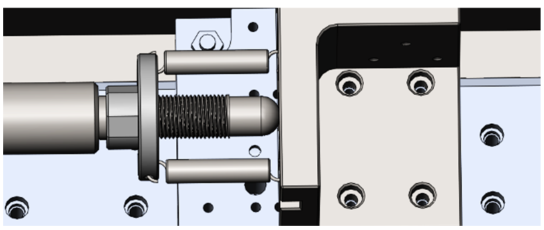

Figure 3: Flexible connection method.

Vertical Tungsten Blade Module

The basic idea of design, sketched in Fig. 4, the vertical tungsten blade module also consists of two KOHZU slides (SXA0530) as drive components to move the tungsten blades in the vacuum chamber by a connecting rod. The structure adopts modular design and has an interchangeability with other monochromatic slits on the beamline. In the vertical direction, the moving range of the blade is ±15 mm and when both blades are in the -15 mm position, it can give way to the white beam path. We used a standard block to calibrate the tungsten blade edge, after which it was measured and the parallelism of blade edge is better than 0.5 mrad.

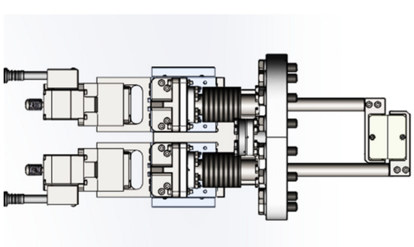

Figure 4: The vertical tungsten blade module.

The Height-Adjustable Granite Base

In order to ensure the stability of the equipment and considering the actual installation space, we adopt the granite base design with the cross-section size of 300*300 mm^2, as shown in Fig. 5. The granite base is poured together with the ground and according to the simulation results, the first order natural frequency of the granite base is higher than 86 Hz. The height of the base is adjusted by four M24 bolts at the bottom, and the level of the equipment is adjusted by four AIRLOC. There are two relatively movable stainless-steel plates at the top, one of which is connected to the cavity and the other to the base. The entire chamber can be adjusted horizontally by adjusting the screws on the side with a travel of ±15mm.

Figure 5: The height-adjustable granite base.

CONCLUSION

The integrated shutter incorporates many functional modules, which means that the corresponding control system and collimation calibration work will be challenging. At present, the machining of shutter parts is in progress, and we will carry out further work on the collimation calibration, motion control and accurate response time test of equipment in the future.

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