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THE STATUS OF A GRATING MONOCHROMATOR FOR SOFT X-RAY SELF-SEEDING EXPERIMENT AT SHINE

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Introduction

The research status of a grating monochromator for soft X-ray self-seeding experiment at SHINE has been presented in this paper. The monochromator system includes the vacuum cavity, optical elements and me-chanical movement device. Until now, the vacuum cavity has finished manufactured process completely, the optical mirrors have finished machining and meas-ured by the longitudinal trace profiler (LTP) and atomic force microscope (AFM). To make sure the mono-chromator system can achieve an optical resolution of 1/10000 at the photon energy of 700-1300eV, the sys-tem has been integrated and tested recently. In this year, the previous online experiment will be performed in the shanghai soft X-ray free-electron laser (FEL) user facility.

Overview

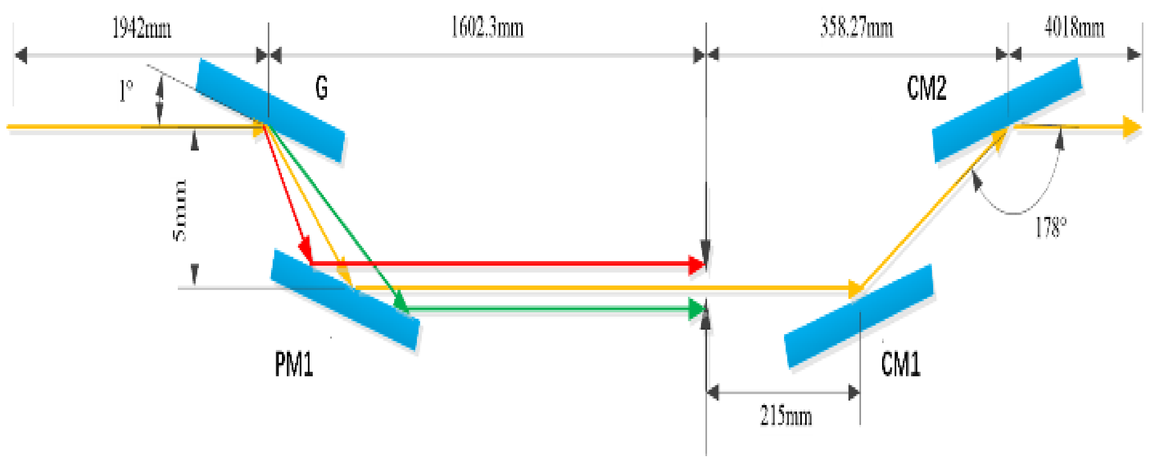


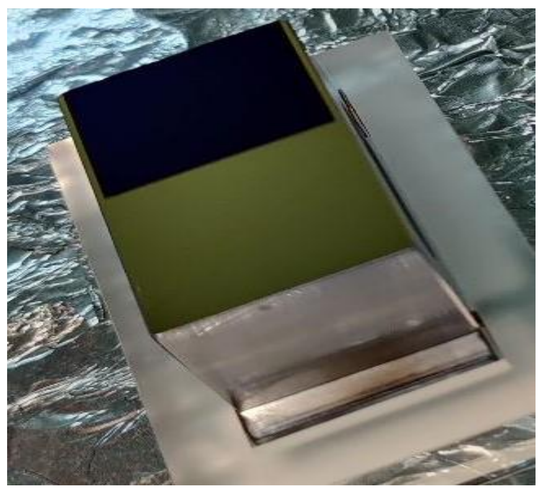
Figure 1: The layout of soft X-ray self-seeding monochromator

Vacuum cavity

Figure 2: The outside view of the vacuum cavities of soft X-ray self-seeding.

In the monochromator system, there are two vacuum cavities, the grating and the plane mirror are installed in the first vacuum cavity, the two cylindrical mirrors are installed in the second vacuum cavity. To achieve a sufficient optical resolution, the mechanical section can be moved with a precision of 2 μm and a rotation precision of 8″. The cavities began to be manufactured from two years ago, the manufactured process has finished and the cavities have been integrated in this year and finished the factory acceptance. Figure. 2 shows the outside view of the vacuum cavities, which can satisfy the requirement of self-seeding optical system. According to the measurement results, the degree of vacuum can arrive 5×10^{-8} Pa and the vacuum magnetic permittivity is lower than 1.05. Besides, the water-cooling systems are also considered in both vacuum cavities to increase the operated repetition rate of SHINE.

Grating



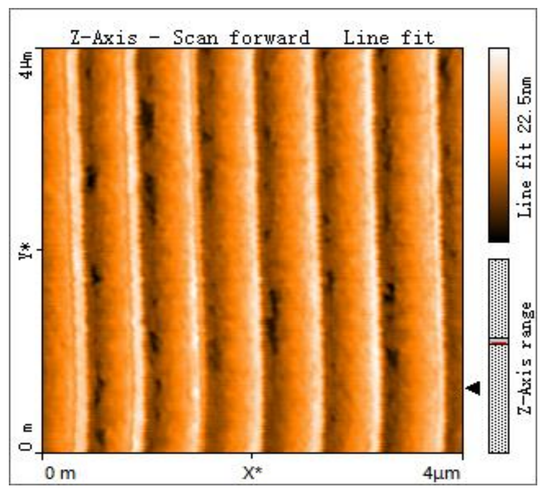


Figure 3: The picture of real VLS grating with two coating materials

Figure 4: The measurement results of cylindrical VLS blazed grating.

The basic grating parameters are measured by the atomic force microscope (AFM) of SSRF, the coatings of Au and B_4 C were measured separately, the results are presented in Figure. 3. From Figure. 3, one can conclude that the grating line density is about 1800 lines/mm, the blazed angle is about 1.876° , which can satisfy the requirement of designed parameters.

Optical mirrors

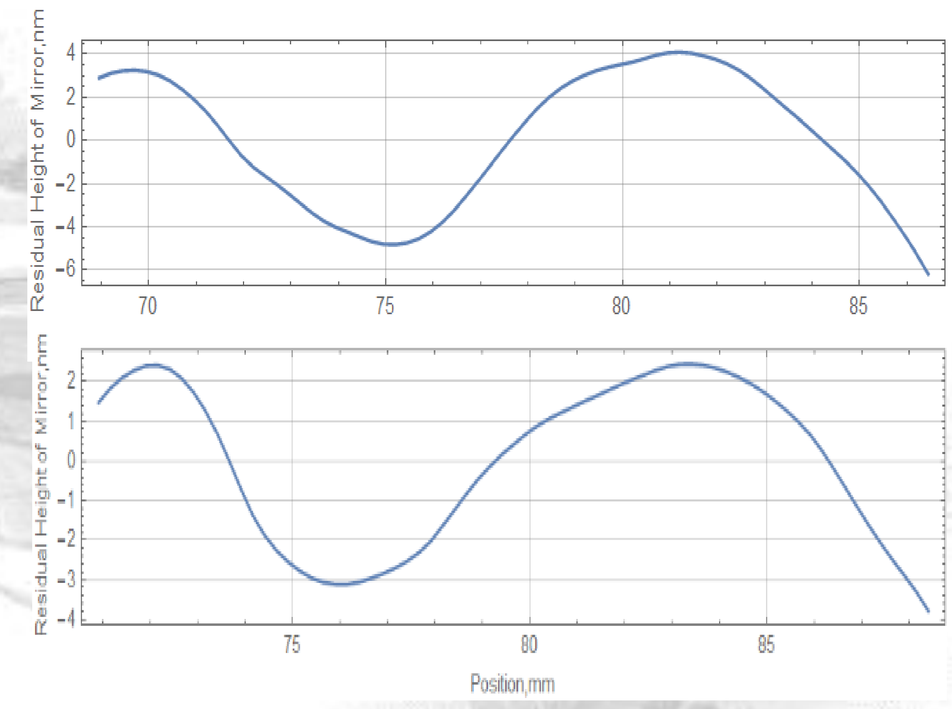
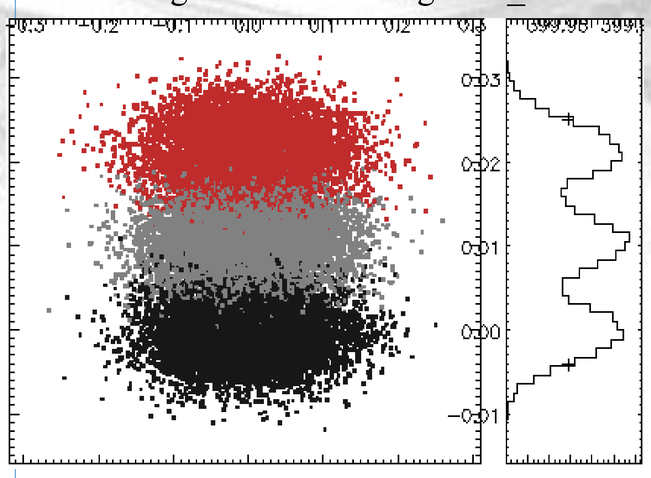


Figure 5: the measurement results of taking 17.5mm as the optical clear length for two coatings: : B_4 C.



According to the measurement results of CM2, the slope errors are larger than the designed parameters, which will have impact on the optical resolution. Here, we consider the case with an optical clear length of 17.5mm, a slope error of 1.2 μrad, a radius error of 1% and a roughness of 0.9 nm. The monochromatic pro-cesses are simulated with SHADOW.

Conclusion

The status of a grating monochromator system for soft X-ray self-seeding experiment at SHINE is presented. The manufactured process of the vacuum cavities in the monochromator system are firstly introduced. And then, the designed parameters of the optical elements are presented. Lastly, the manufactured optical elements and the measured results of these elements are present-ed, and the results shows that it can satisfy the require-ments. In this year, the monochromator system will be installed at the optical beamline of the SXFEL user facility, the properties of the monochromator system will be tested. Further works will focus on the self-seeding online experiment and the optimization of the final self-seeding output characteristics.