A design of non-harmonic soft x-ray beam line at BSRF

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Abstracts: *High-order harmonic contaminates, originated in higher-orders diffraction of gratings, are inescapable in synchrotron radiation grating monochromators. A novel single-order grating for x-ray, proposed by Cao, can give only ±1st orders diffraction, and restrain high-orders effectually. It may blaze a new path in the purer monochromatic beam. In this report, it will be introduced that a laboratory prototype of the non-harmonic monochromator with single-order grating and its test results first, and then a new design of a non-harmonic beam line with single-order gratings at BSRF.*

The diffraction grating is a kind of ancient optical elements and has been thought as the most contributed single tool to the progress of modern physics and the single device giving most important information to every field of science. Synchrotron radiation as the most ideal vacuum ultraviolet (VUV) and soft x-ray light source so far has become an indispensable research tool in many frontier research fields, and also produced a spate of exciting and innovative research results. It is "processed" to some monochromatic light beams with strict requirements for the photon flux, spectral resolution, spectral purity, and spot sizes to meet different needs of kinds of experimental stations. In VUV and soft x-ray bands, the process is realized by the grating monochromator composed of reflection gratings, an imaging system and necessary slits for wavelength selection. Harmonics existed in the output monochromatic light come from the high-order diffraction of gratings, which are diffracted in the same direction as the fundamental and depress the spectrum purity terribly.

To solve the problem radically, a new single-order grating in x-ray region has been developed by Cao, which can suppress higher-order diffraction components effectively by quasi-randomly distributing a large number of nanometer scale pinholes on an aurum substrate.

In this report, based on single-order gratings, a laboratory prototype of the non-harmonic monochromator was built. To calibrate its energy resolution, the spectrum of the laser plasma of the argon was measured: the monochromator formed a sharp spectrum with $E/\Delta E>1000$. A transmission spectrometer was installed after the exit slit of the monochromator to test the spectral purity of the output beam when the monochromator equipped a single-order grating and a conventional grating. The comparison of spectrograms measured by the spectrometer illustrated that the harmonic elements were restrained effectively when equipped a single-order grating. In the end, a new design of a non-harmonic beam line working at 10~100 eV of the BSRF was introduced.