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Development of beam dividing and focusing system in studying multi-photon processes in VUV region

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Introduction

The coherence is the most important property for the synchrotron radiation (SR) generated by the third-generation light sources, and the multi-photon process caused by the SR has been attracted in utilizing the property of the coherence. In the soft x-ray and VUV regions, however, the multi-photon processes with the SR have never been observed. The non-linear electric susceptibility $\chi^{(2)}$ is a typical physical value relating to the two-photon process. In order to measure $\chi^{(2)}$ in the VUV region, we have developed a beam dividing and focusing system.

Experimental

A simple illustration of the optical system is shown in Fig. 1. The system was installed in a vacuum chamber of the intensity interferometer [1]. The pressure in the vacuum chamber was kept bellow 1×10^{-7} torr.

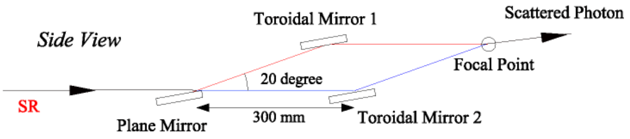

Figure1: Outline of the optical system.

The monochromatized light from the beamline monochromator is incident to the edge of a plane mirror. The mirror reflects the half of the beam and another half of the beam goes through the mirror. The two beams are reflected by two toroidal mirrors, respectively, and are focused on a focal point. The paths of the two beams form a diamond shape, and the angle between two beams is 20 degree, and the distance between the plane mirror and each toroidal mirror is 300 mm. The curvature radii of the toroidal mirrors are 4100 mm in the longitudinal direction and 108 mm in the transverse direction, respectively. The incident angle to the plane mirror and the toroidal mirror 1 can be adjusted, but that of the toroidal mirror 2 is fixed.

We have measured the beam size in the transverse direction to investigate the focusing property. We have used a tungsten-wire scanner for the beam-profile measurement. The thickness of the wire was 50 μm and the spatial resolution of the wire in the Gaussian approximation was $50/3^{1/2} = 29$ μm. The widths of the entrance and exit slits for the beamline monochromator were 100 μm, and the energy of the monochromatized photon was 96 eV.

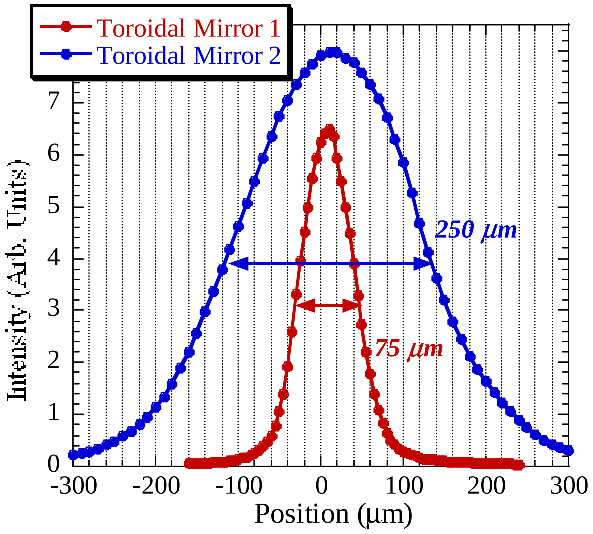

Figure 2: Beam profiles at the focal point.

Fig. 2 shows the beam profile measured at the focal point. "Toroidal Mirror 1" denotes the beam profile where the beam is reflected by the plane mirror and toroidal mirror 1 (red line in Fig. 1). "Toroidal Mirror 2" denotes the beam profile where beam goes through the plane mirror and is reflected by the toroidal mirror 2 (blue line in Fig. 1). By deconvoluting the wire thickness, the beam size for "Toroidal Mirror 1" σ_1 is estimated as 69 μm. This value is almost consistent with the expected value. The beam size for "Toroidal Mirror 2" σ_2 is 248 μm which is much larger than σ_1, because the incident angle of the toroidal mirror 2 could not be adjusted. In the future, we will attach the adjusting mechanism for the toroidal mirror 2 and put a suitable matter which causes the non-linear optical process at the focal point. By measuring the intensity of the scattered photon from the sample in the direction indicated in Fig.1, $\chi^{(2)}$ will be estimated in a high accuracy.

References

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