Correcting Heat Load Induced Deformations on a XUV Beamline

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A major problem affecting the performance of XUV monochromators is the impairment in resolution and/or spot size due to the power absorbed on the optics. A common approach to reduce the effect of heat load on the resolution in a vertical dispersing monochromator without an exit slit is to use a horizontally deflecting mirror as the first optical element. However, for high resolution beamlines this is not enough and it also increases the horizontal spot size.

We have recently proposed a beamline design [1] that is flexible enough to preserve both the very high resolution and small spot size at the sample even when the absorbed power densities in the first (M1, deflecting horizontally) and second (M2, deflecting in the dispersion plane) optical elements are as high as 0.92 and 0.36 W/mm^2, respectively. The beamline is based on a variable line spacing (VLS) plane grating monochromator illuminated with collimated light along the dispersion direction [1] and is the basis for the soft x-ray undulator beamlines planned for NSLS-II [2]. In this design the beam is focused at all photon energies by illuminating the VLS at the required angle of incidence with the help of the plane pre mirror (M2).

The centerline deformation and slope error along the M2 mirror length obtained from finite element analysis when the power density absorbed by the water cooled mirror is 0.36 W/mm^2 (236 W total) are presented in Figure 1. As seen in the figure, the slope error is almost linear in the region illuminated by the central cone (<40 mm). From this slope one obtains an approximate constant convex radius of curvature equal to 16 km.

With this beamline design one can correct the defocusing induced by the absorbed heat load along the dispersion direction via a modification of the *c* value ($\cos\beta/\cos\alpha$)

as demonstrated in the ray tracings seen in Figure 2. Clearly, the original spot size, i.e., same resolution, is recovered.

Similarly, the use of a horizontally deflecting bendable plane elliptical mirror allows canceling the five-fold increase in the horizontal spot size at the sample due to the deformations induced on M1.

References

[1] R. Reininger, K. Kriesel, S. L. Hulbert, C. Sánchez-Hanke and D. A. Arena, Rev. Sci. Intrum. 79 (2008) 033108

[2] http://www.bnl.gov/nsls2/.

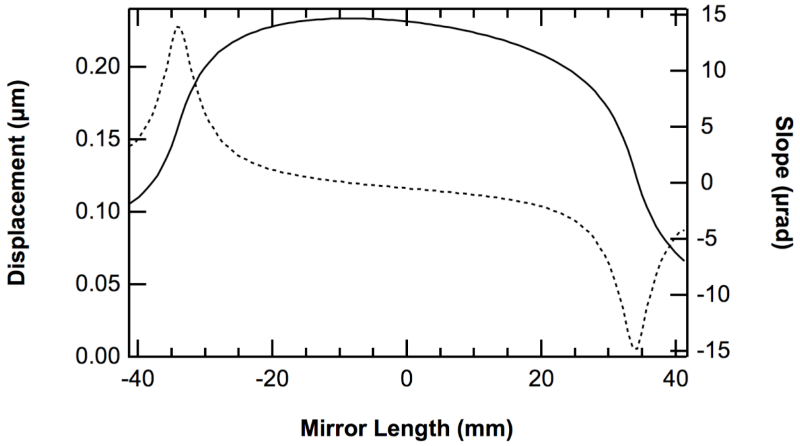

Figure 1: Displacement (solid line) and slope error (dashed line) along the M2 mirror length at half its width.

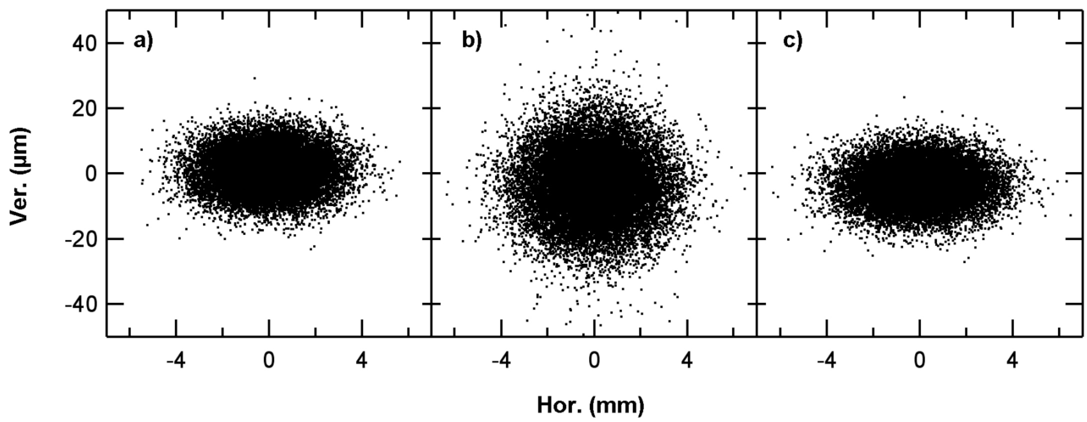

Figure 2: Spot patterns at the exit slit. a) Perfect optics; b) With slope errors on M1 and M2 due to the absorbed power on the mirrors; c) As b) after correction done by monochromator tuning.

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