

# Design and evaluation of a Wolter-type focusing system for advanced soft X-ray spectroscopy

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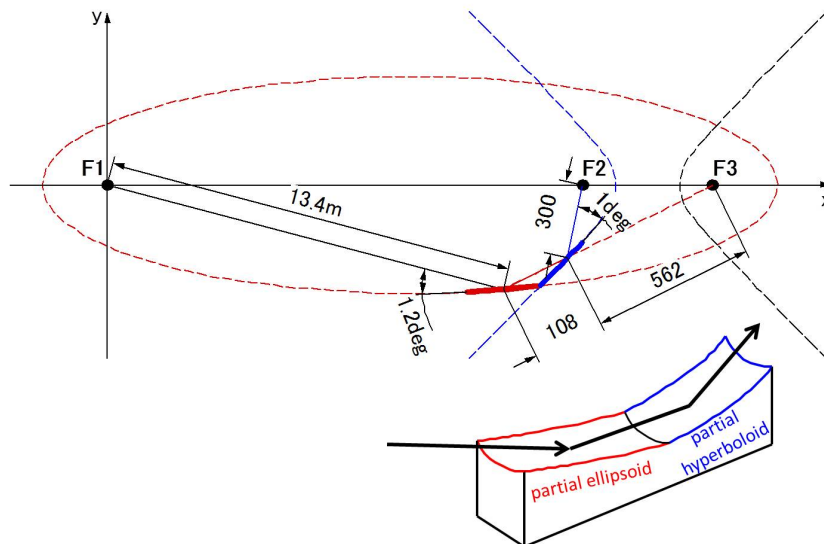
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Advanced spectroscopies such as an angle-resolved photoemission spectroscopy (ARPES) to reveal the physical properties of exotic materials demands routine delivery of high-intense micro-beam. The focusing system requires a long working distance in a few hundred of mm for installation of the large analyzer, achromatism for scanning wide range of the photon energy as well as high efficiency and high stability.

The light source of the refocusing optics is usually designed to be on the exit slit of a grating monochromator, of which the typical sizes are as large as 20  $\mu\text{m}$  in the vertical and 200  $\mu\text{m}$  in the horizontal. The vertical diverging angle of the outgoing beam from the slit is several hundred of micro-rad, so the sufficient opening of around 10 mm in vertical is necessary to accept the monochromatic beam.

Wolter mirror [1] can meet these necessary conditions and has advantage of large allowance of alignment errors due to satisfy roughly the Abbe sine condition. Therefore, we designed a partial Wolter-type configuration for sub-micron focusing optics dedicated to ARPES apparatus as shown in the figure. Recent progress of a high-precise x-ray mirror have enabled to realize both of partial ellipsoid and hyperboloid surfaces on a monolithic substrate in consideration for feasible curvature. The Wolter mirror has been fabricated precisely and performed the focusing sizes of 0.4  $\mu\text{m}$  and 4  $\mu\text{m}$  in vertical and horizontal directions, respectively as designed.



Monolithic Wolter-type focusing mirror.

## References

- [1] H. Wolter, Spiegelsysteme streifenden Einfalls als abbildende Optiken für Röntgenstrahlen, *Annalen der Physik*, vol. 10 (1952), pp. 94-114