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Focusing properties of photon sieves and compound zone plates

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Photon sieves are diffractive focusing optics proposed by Kipp *et al.* that use pinholes to sample an underlying zone plate geometry [1]. While certain values of pinhole diameter must be chosen, the pinholes can be much larger than the width of the underlying zone, giving a focus that is smaller than the minimum structure size. In comparison, Fresnel zone plates operated in first order have a focus that is larger than the minimum structure size. For this reason, Kipp *et al.* have suggested photon sieves as replacements for Fresnel zone plates in certain high-resolution x-ray optics applications.

Compound zone plates [2] are zone plates that operate in first diffraction order up to a certain radius, and in higher diffraction orders at larger radii. They also have the property that the focus can be finer than the minimum structure size. In addition, Kipp *et al*. have added the idea of modulating the optic's radial transmission function to reduce sidelobe "ringing" around the focus spot, and one can consider using a similar modification to the mark-to-space ratio of binary zones.

We have undertaken numerical simulations of photon sieves and compound zone plates to compare the relative merits of these two optics. Photon sieves and compound zone plates have been generated on identical arrays with identical minimum structure size. These optics are then compared in terms of their focusing efficiency, resolution and defocused probe properties. Results of these calculations can be used to assess the suitability of the two approaches for various imaging experiments.

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[1] – Kipp *et al.*, *Nature* **414**, 184, (2001).
[2] – Michette, A.G. *Optical Systems for Soft X-Rays,* 193-203 (Plenum, New York 1986)