Optimization of graded multilayer designs for hard X-ray telescopes

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When comparing the performance of astronomical x-ray telescopes, one typically quotes three (energy dependent) numbers: the on-axis collecting area, the field of view, and the half-power diameter. The first two quantities, which are the focus of this presentation, depend on the mirror packing arrangement and the multilayer coating design. We have developed a figure-of-merit (FOM) that depends on a coating's response over a specified range of energies and off-axis angles. We use this FOM to search for optimal coating designs and to understand tradeoffs between performance and coating thickness. Given an off-axis weighting function and the mirror packing arrangement, we calculate the distribution of incidence angles on each mirror shell, including the effects of vignetting. With the incidence angle distributions in hand, we can calculate an average effective area, and hence the FOM, for any multilayer design from its reflectance vs. energy and incidence angle matrix. We have used this method to optimize power-law bilayer thickness distributed graded multilayers with identical fractional thicknesses (Γ) within each bilayer. We use a power-law of the form $d(i) = a/(b+i)^c$ to parameterize the bilayer thickness distribution. In the equation, a,b, and c are constants, i is the layer index and $d(i)$ is the thickness of the ith bilayer. We will show how the results of these calculations can be used to quantify tradeoffs between coating thickness and performance.