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Design plane varied-line-spacing grating in complex optical layout using step-by-step ray tracing method

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Varied-line-spacing grating is a key optical element in the light facilities, concerning lithography, holography, tomography, as well as spatially resolved monochromator/spectrometer. In the last decades, the grooves parameters of varied-line-spacing gratings are necessary to be strictly deduced through the light path function and the Fermat's principle. This method is of great importance to analytically solve the spot focusing, correcting aberrations and compressing the pulse stretching. However, one needs to develop sophisticated light path function with Taylor expansion, and even with the efforts, coma and aberrations in high order cannot be totally corrected. In this article, we report a visual and universal method to analytically calculate the groove parameters for plane varied-line-spacing grating in a Hettrick-Underwood type spectrometer using step-by-step ray tracing, and have a great agreement with the Fermat's principle with Maclaurin series. Additionally, we use a semi-analytic approach to fast find out the focus point for a whole energy range based on the ray-tracing method. This framework provides new insights into optical design, manufacture, and metrology.

Journal of Synchrotron Radiation Special Issue: will you submit your contribution?

yes

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