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Application of time-invariant linear filter approximation to parameterization of one- and two-dimensional surface metrology with high quality x-ray optics

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Numerical simulations of the performance of new x-ray beamlines and those under upgrade require sophisticated and reliable information about the expected surface slope and height distributions of prospective beamline optics before they are fabricated. Ideally, such information has to be based on metrology data obtained with existing optics, which are fabricated by the same vendor and technology, but generally, with different sizes, and slope and height rms variations. In a recent work [Opt. Eng. 51(4), 046501, 2012], it has been demonstrated that autoregressive moving average (ARMA) modeling of one-dimensional (1D) slope measurements with x-ray mirrors allows a high degree of confidence when fitting the metrology data with a limited number of parameters. With the parameters of the ARMA model, the surface slope profile of an optic with the newly desired specification can reliably be forecast. Here, we investigate the time-invariant linear filter (TLF) approach to optimally parameterize surface metrology of high quality x-ray optics thought of as a stationary uniform random process. We show that the TLF approximation has all advantages of one-sided AR and ARMA modeling, but it additionally gains in terms of fewer filter parameters and better spectral accuracy. Moreover, the suggested TLF approach can be directly generalized to 2D random fields. This work is supported by the U.S. Department of Energy under Contract No. DE-AC02-05CH11231.

Keywords: surface metrology, time-invariant linear filter, autoregressive moving average, power spectral density, fabrication tolerances, metrology of x-ray optics

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