Advancing deflectometric form measurement of beamline optics: Current state and future strategies

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Over the last two decades, deflectometric profilometry using commercial autocollimators has successfully established itself as the standard in high precision form measurement of beam-shaping optics for synchrotrons and free electron lasers. Despite this progress, we are still a long way from reaching the fundamental limits of this measurement technology. This is due to the fact that angle measurement with autocollimators depends on a variety of influencing factors, some of which have so far only been characterized to a limited extent. In addition, methods already developed to compensate for these influences have not yet established themselves in the metrology community. In addition, many of these influences interact with the path length of the autocollimator measuring beam, which returns to the autocollimator after reflection at the specimen surface. This length is subject to major changes with most deflectometers, which scan the test specimen by means of a movable pentaprism. We present an overview of the known influencing factors that limit deflectometric form measurement. These include the reflectivity and the radius of curvature of the surface under test, the position and shape of the aperture diaphragm, which limits the beam cross-section on the specimen, optical aberrations and adjustment deviations of the optomechanical components of the autocollimator, as well as the influence of environmental parameters such as temperature, air pressure and humidity. Particular attention is paid to the discussion of strategies for avoiding or compensating for these influencing variables.