Proposal for a Universal Test Mirror for Characterization of Slope Measuring Instruments

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The development of third generation light sources like the Advanced Light Source (ALS) or BESSY II brought to a focus the need for high performance synchrotron optics with unprecedented tolerances for slope error and micro roughness. Proposed beamlines at Free Electron Lasers (FEL) require optical elements up to a length of one meter, characterized by a residual slope error in the range of 0.1 μrad rms, and rms values of 0.1 nm for micro roughness [1]. These optical elements must be inspected by highly accurate measuring instruments, providing a measurement uncertainty lower than the specified accuracy of the surface under test. It is essential that metrology devices in use at synchrotron laboratories be precisely characterized and calibrated to achieve this target. In this paper we discuss a proposal for a Universal Test Mirror (UTM) as a realization of a high performance calibration instrument. The instrument would provide an ideal calibration surface suitable for an arbitrary surface under test of any possible figure. The application of a sophisticated calibration instrument will allow the elimination of the majority of the systematic error from the error budget of an individual measurement with a particular optical element. We present the limitations of existing methods, initial UTM design considerations, possible calibration algorithms, and an estimation of the expected accuracy. This work was supported by the U. S. Department of Energy under contract number DE- AC02-05CH11231.

[1] M. Altarelli et all. , "*The European X-Ray Free Electron Laser – Technical Design Report*", DESY, Hamburg, July 2006