In-Situ Metrology for Adaptive X-Ray Optics with an Array of Interferometric Absolute Distance Measuring Sensors

Vivek G. Badami*[1], Lei Huang[2], and Mourad Idir[2]

[1]*Zygo Corporation, Middlefield, CT, USA*

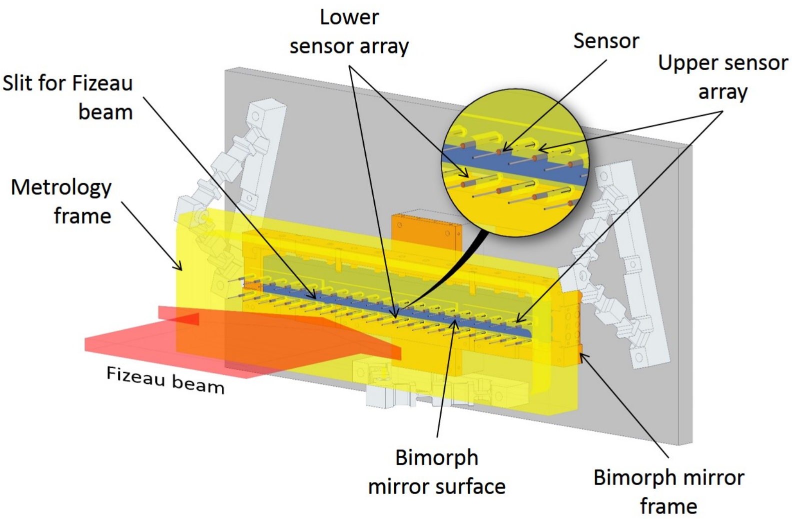
[2]*Brookhaven National Laboratory - NSLS II, Upton, NY, USA*

**vivek.badami@ametek.com*

Demands for higher resolution imaging are driving the next generation of brighter and more coherent x-ray sources towards smaller focal spot sizes. The stringent requirements on the size and location of the focal spot is driving the use of adaptive optics in x-ray beamlines to minimize the effects of environmental perturbations and mirror shape changes due to, for example, heat loading, micro-creep, actuator hysteresis and other unwanted changes to the mirror shape.

Current adaptive optics operate open loop without direct *in situ* measurements of the mirror shape, leaving the operator blind to undesirable deviations in mirror shape. We propose an arrangement for *in situ* metrology of an adaptive x-ray optic using an array of interferometric absolute position sensors capable of sub-nm precision and noise performance [1], and demonstrate its performance by simultaneous comparison to a Fizeau interferometer measurement. The sensor array is borne by an independent stable metrology frame and measures changes in mirror shape, position and orientation in real time, thereby providing feedback for control of these parameters using a closed loop controller.

We perform the comparison to a Fizeau interferometer using the setup shown in the figure below. The *reflecting surface* of a ∼0.5 m long piezo-actuated bimorph mirror is directly monitored by two linear arrays of 19 sensors, spaced ∼23 mm apart. A simultaneous Fizeau measurement of the same surface through a slit in the metrology frame between the two arrays is compared to the measurements made by the array. We describe details of the measurement setup and the results of the comparison.



Overview of setup - Metrology frame is shown transparent to show mirror assembly behind it. Mirror surface is visible through slit in the metrology frame. Inset shows a close-up of sensor array.

References

[1] Abruna, E., 2017. Multiwavelength-interferometry-based sensor redefines precision position metrology. *Laser Focus World*, ***53***(7), pp.38-41.