Active Feedback on the Infrared Beamline

The infrared (IR) beamlines have proven to be the most sensitive to microscopic motions of the ALS beam, mainly because of the interferometric selection of wavelength. Even after a long series of beam noise abatement projects in collaboration with ALS accelerator physics and engineering staff[1–4], the IR photon beam still moves in angle with an rms magnitude of a few microradians. Because of the small (0.25-mm^2) size of the IR detectors and the nature of the FTIR data reduction, this motion places noise in the IR spectrum that manifests itself in two ways. The frequencies of the noise are reproduced in the spectrum as a function of the scanning mirror speed in the interferometer, and all frequencies of the noise contribute to an overall background noise. The higher-frequency noise, particularly in the 4- to 8-kHz region, has been largely eliminated by changing the storage ring's 500-MHz rf master oscillator to a unit that produces a narrower and more stable reference frequency. Despite large improvements to the low-frequency noise in our spectra, which came from the vibrations of pumps and other sources on the ALS floor, there remains some noise on the photon beam in the region below 500 Hz that is detrimental to the overall signal quality. Having attempted to remove as much noise as possible at the source, to reduce noise further, we have now introduced an active optical feedback system into the beamline. Preliminary results obtained by using a single two-axis feedback loop are described here.

The complete feedback system is shown in Figure 1. The system, based on one used at Lawrence

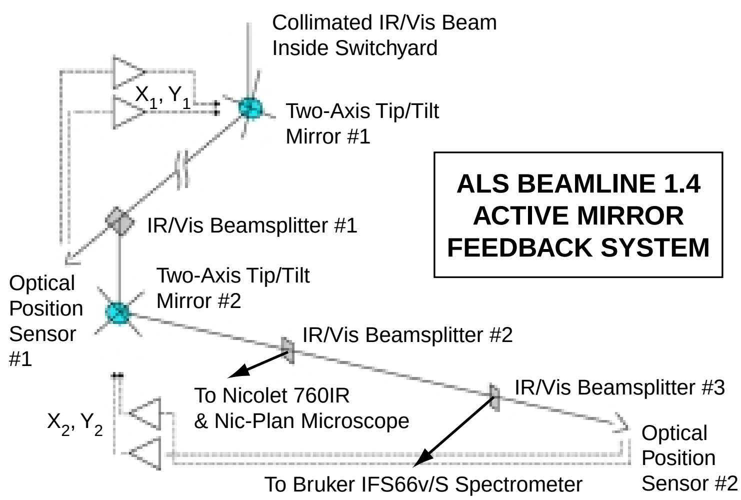

Figure 1

Schematic diagram of the planned optical active feedback system for the Beamline 1.4 complex. It consists of four feedback loops to lock the photon beam in x, y, θ, and ϕ.

[1] Byrd, J.M., M.C. Martin, and W.R. McKinney, in *1999 Particle Accelerator Conference*, edited by A. Luccio and W. MacKay (New York, 1999), p. 495.

[2] Byrd, J.M., in *1999 Particle Accelerator Conference*, edited by A. Luccio and W. MacKay (New York, 1999), p. 1806.

[3] Byrd, J.M., M. Chin, M.C. Martin, W.R. McKinney, and R. Miller, in *Accelerator-Based Sources of Infrared and Spectroscopic Applications*, edited by G.L. Carr and P. Dumas (SPIE Proceedings, Denver, 1999), Vol. 3775, p. 59.

[4] McKinney, W.R., M.C. Martin, J.M. Byrd, R. Miller, et al., in *Accelerator-Based Sources of Infrared and Spectroscopic Applications*, edited by G.L. Carr and P. Dumas (SPIE Proceedings, Denver, 1999), Vol. 3775, p. 37.

Livermore National Laboratory, employs a two-dimensional optical position sensor (Hamamatsu S1880) and a piezo-driven, two-axis, tip/tilt mirror stage (Physik Instrumente S-330). For initial testing, we used one detector and tip/tilt stage and two feedback loops in *x* and *y* corresponding to the positions of the #1 mirror and the #2 optical position sensor. Light is split off by a dichroic beam splitter (Spectra-Tech). The latter reflects 100% of the IR but transmits 50% of the visible light, which is then imaged by the optical position sensor. The electronics system is a hybrid of commercial systems and custom electronics designed by the ALS electrical engineering group.

The system performance with and without feedback is shown in Figure 2, and it can be seen that the dominant noise at 80 Hz has been reduced in intensity by a factor of 15. This correction is achieved in *x* and *y* alone, so to add correction in two-dimensional angle space requires another system. This will complete the full system as shown in Figure 1. It is scheduled for installation shortly. This may well be a system that can usefully be employed around the ALS as our requirements for highly stable beams ever increase.

A New Instrument for Submicron X-Ray Diffraction

X-ray diffraction is a ubiquitous tool in the study of thin films, from measurements of average texture (orientation of microcrystallites) to determinations of average stress. With the millimeter-wide beams typically available, only average measurements are possible. Unfortunately, the properties of materials are often determined by the characteristics of single grains rather than the average. Although single-grain measurements are clearly of great importance for materials studies, no tool has been available until now, so we set out to build a system capable of submicron x-ray diffraction to address these important issues.

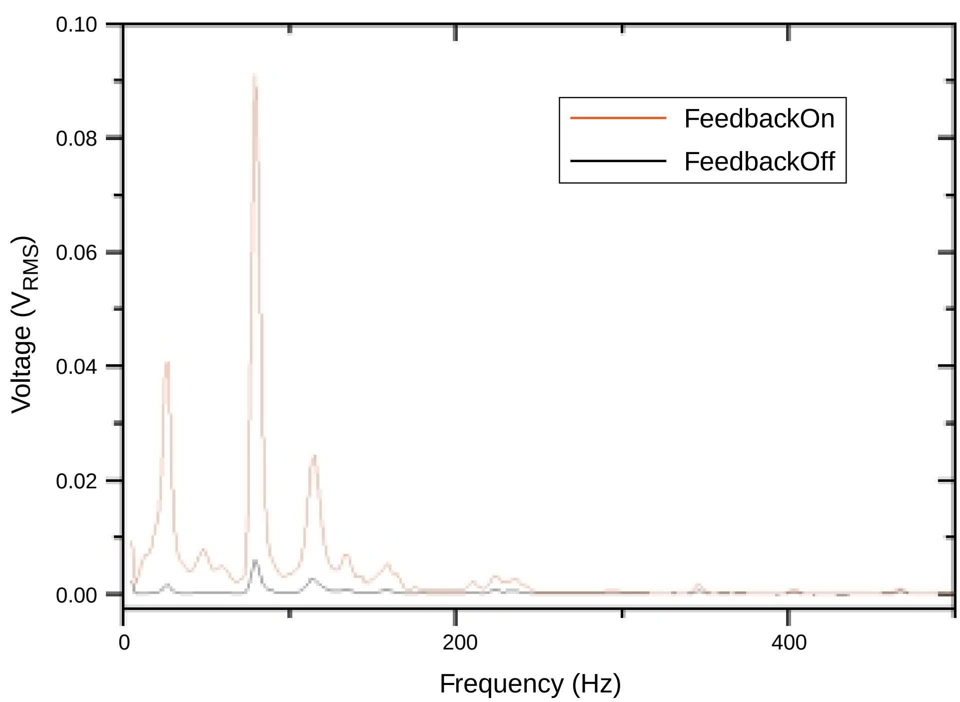

Figure 2

Measured noise spectrum for Beamline 1.4, showing horizontal beam motion at the first position-sensitive detector with and without one feedback loop.