# Non-Contact Surface Mapping of Slit Blades

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**Abstract.** The high brilliance of third-generation synchrotron radiation sources necessitates the use of small beam sizes, extending below 10 µm [1]. This is of great interest for probing micrometer-sized objects, for diffraction at very small angles or for speckle and coherent scattering experiments. In x-ray diffraction experiments, imperfections of the optics make it necessary to use slits (or pinholes), either to limit the beam size or to reduce background scattering.

Using a powerful mapping and analysis software we are able to provide surface information (3-D interferometric profiling) which provides information on the texture, shape and finish of surfaces [2]. Complete mapping options allow three-dimensional pictures to be drawn, profiles examined and color output to be printed. Our surface mapping system has RMS repeatability (standard mode): 1 nm; RMS repeatability (precision mode): 0.1 nm and RMS repeatability (single wavelength): 0.05 nm.

**FIGURE 1.** Typical graphical illustrations obtained from microscope

## DISCUSSION

ADC has worked with the Cornell High Energy Synchrotron Source (CHESS) for several years developing a polishing process that produces the best slit blade knife-edges in the synchrotron community. The benefits of removing signal noise from X-ray experiments have been well established with high quality slits. In fluorescence X-ray absorption spectroscopy (XAS), with non-energy-dispersive detectors, the use of fluorescence-suppressing and scatter-removing slits combined with X-ray filters specially eliminates unwanted signal noise.

We have recently developed the capabilities to do “Non-Contact Surface Mapping of Slits Blade profile”. We now can measure roughness, finish and texture of surfaces of slits blade tip.

Using a powerful mapping and analysis software we are able to provide our customers, surface information (3-D interferometric profiling) which provide information on the texture, shape and finish of surfaces. Complete mapping options allow three-dimensional pictures to be drawn, profiles examined and color output to be printed. Our surface mapping system has RMS repeatability (standard mode): 1 nm; RMS repeatability (precision mode): 0.1 nm and RMS repeatability (single wavelength): 0.05 nm. Figure 1 shows typical graphical illustrations obtained from reading surface profile using the powerful microscope shown in Figure 2.

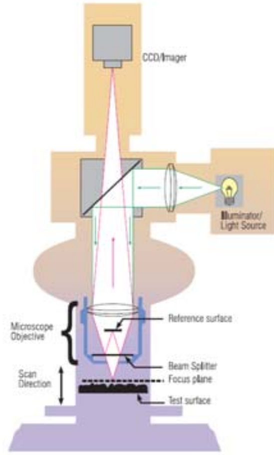



**FIGURE 2.** CAD illustration of microscope

## Testing & Quality Control

High precision slits requires tests of all relevant aspects of the slit systems to ensure the highest quality for experimenters. Important testing and quality control includes; accuracy, repeatability, parallelism of each set of blades, Frequency Response of Slits, and Blade Polishing.

## Repeatability

ADC uses a Keyence Optical non-contact micrometer, shown in Figure 3, to precisely measure motions. Inlet and outlet flanges are sealed with windows. The Keyence sender and receiver look through these windows to measure slit blade position in vacuum. The high speed LED/CCD optical micrometer is capable of 2400 samples/second high-speed sampling with repeatability of ±0.06µm.

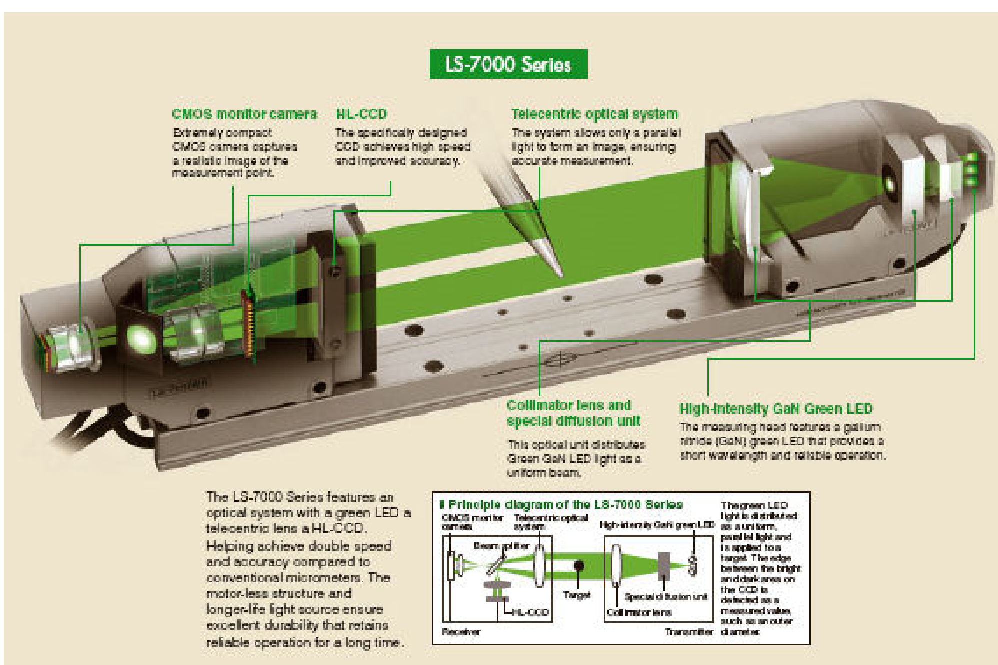



**FIGURE 3.** CAD illustration of Keyence Optical micrometer

## Frequency Response of Slits

The vibrational response of slits are measured using an accelerometer. Data are recorded on an oscilloscope and exported to Excel for further processing. Using Excel's Fourier Analysis Add-in, we are able to provide a graph of the frequency response. An example is shown in Figure 4.

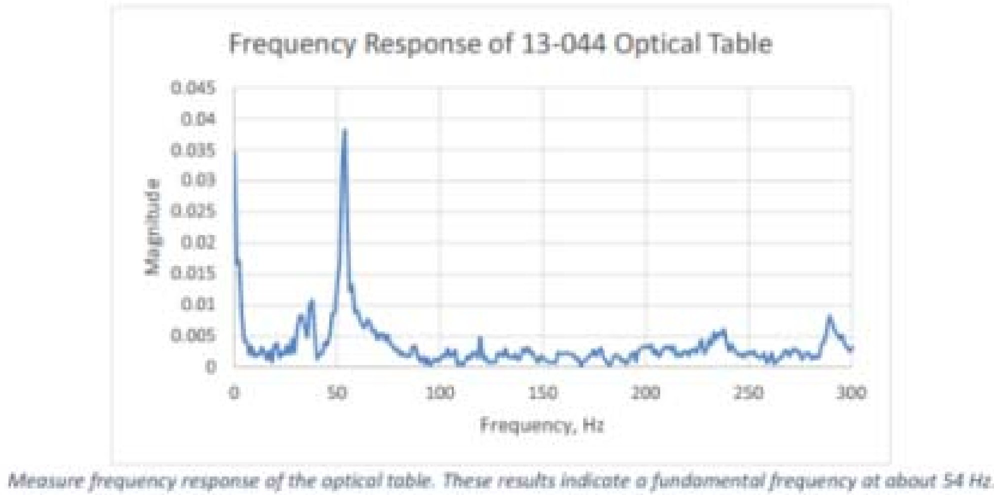



**FIGURE 4.** Example frequency response graph

## Blade Polishing

The tests were conducted on a rotating anode source at Cornell University's lab with an evacuated flight path and a CCD. Pictures of the set up are shown in Figure 5.

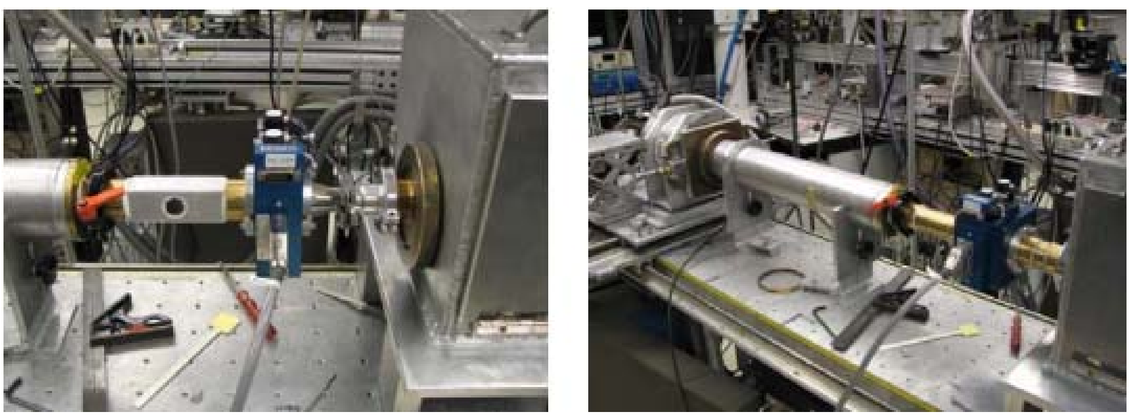


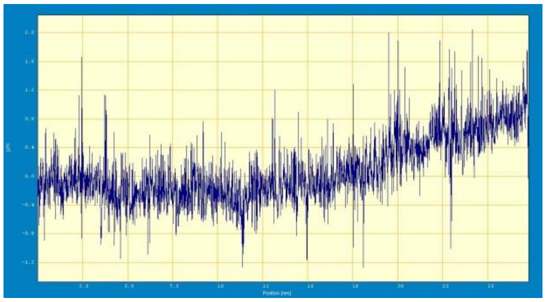
**FIGURE 5.** Pictures from Cornell University Lab CCD Set up

This is a small-angle setup on a laboratory source with an approximately 1 meter path length, the wavelength was about 1.5 A. We did not use a calibrant here, so I don't know exactly -how- low of an angle we achieved at the beamstop, but based on this typical configuration I would expect at least down to q = 0.01 (2Pi Sing(theta)/lambda) or equivalently (d-spacing of maybe 600 A).

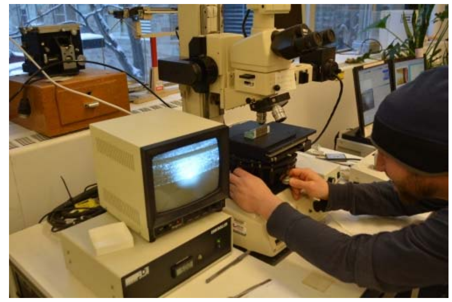
The setup already has beam defining slits and guard slits in place. We place a single blade half way in the direct beam (in vacuo) after the guard slits and compare the scattering with what we see without the blade. We know that the blade cuts through 1/2 the beam due to PIN diode readings in the beamstop. We are not measuring slit width, only the cleanness of a single blade at a time.

## Non-Contact Surface Mapping

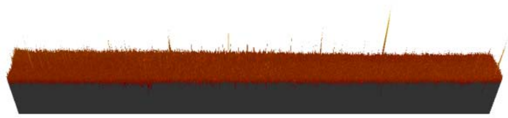
Using a powerful microscope ADC is able to map the texture, shape and finish of surfaces, shown in Figure 6. Complete mapping options allow three-dimensional pictures to be drawn, profiles examined and color output to be printed. This surface mapping system has RMS repeatability (standard mode): 1 nm; RMS repeatability (precision mode): 0.1 nm and RMS repeatability (single wavelength): 0.05 nm.



(a)



(b)



(c)

**FIGURE 6.** (a) 2D image of surface profile, (b) actual microscope being utilized for mapping surface profile, (c) 3D images of surface profile

## CONCLUSIONS

Over a period of 14 years working with many synchrotron facilities around the world, ADC has developed a complete quality control that is instrumental designing high quality slits and being able to take measurements for verification.

## REFERENCES

1. BRIGHTNESS AND COHERENCE OF SYNCHROTRON RADIATION AND FELs∗; SLAC-PUB-15449 The 4th International Particle Accelerator Conference Shanghai, China, May 12-17, 2013
2. Surface Profilers, Multiple Wavelength, and White Light Intereferometry; Optical Shop Testing, Third Edition Edited by Daniel Malacara