

Design of a Full-Field Optical Coherence Tomography (OCT)

3D-Scene Imaging Setup

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Background

Optical coherence tomography (OCT) is a non-destructive three dimensional (3D) medical imaging technique that produces high fidelity data without using ionizing radiation required by competitors (e.g. X-ray, computed tomography (CT), positron emission tomography (PET)). Additionally, it provides higher spatial resolution ($\sim 10\text{ }\mu\text{m}$) than other imaging modalities such as ultrasound or magnetic resonance imaging (MRI) at sample depths of 1 to 3 mm.

In OCT, two beams are produced from a broadband light source. One beam is incident on the sample while the other is reflected from a mirror and used as a reference. When the beams recombine, interference occurs and 3D data is obtained as a function of the changing reference mirror position.

OCT can be used in a variety of applications where nondestructive 3D imaging is required, such as for material characterization (material thickness in silicon wafers, surface roughness) and medical imaging. It is routinely used to image the retina of the eye, coronary arteries, and to diagnose cancer. Our goal in this project is to construct an experimental setup that measures the topography of cm scale objects using OCT.

Methodology

Equipment:

- Thorlabs KDC-101 Motor Controller
- Thorlabs MTS50-Z8 Linear Stage
- Basler acA640-750 μm Camera
- Tektronix AFG3021C Function Generator
- National Instruments BNC-2110
- HeNe femto-second pulsed laser

Software:

- LabView 2018 64-bit and MAX
- Thorlabs Kinesis

Block Diagram of Setup

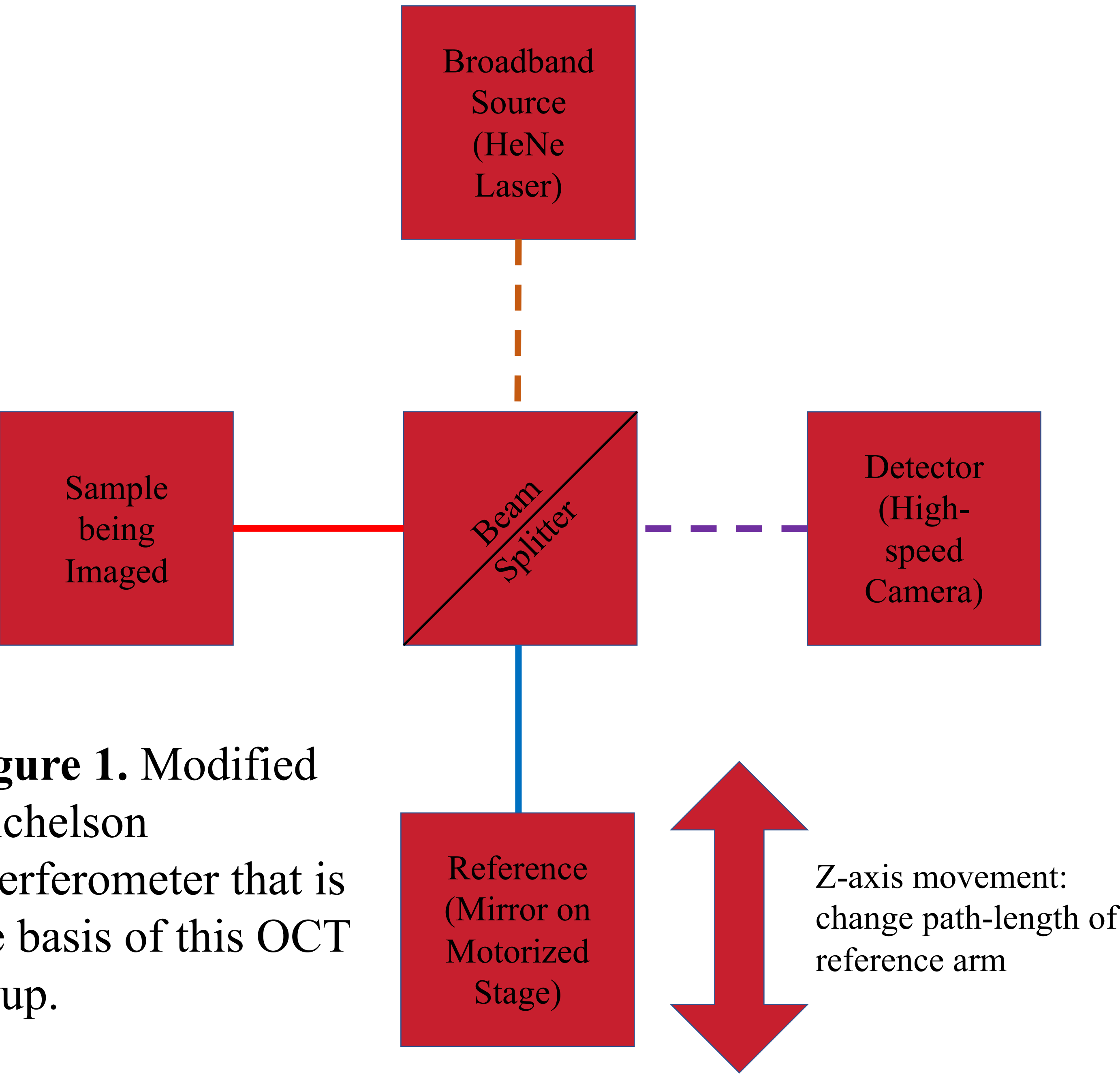


Figure 1. Modified Michelson interferometer that is the basis of this OCT setup.

Results (cont.)

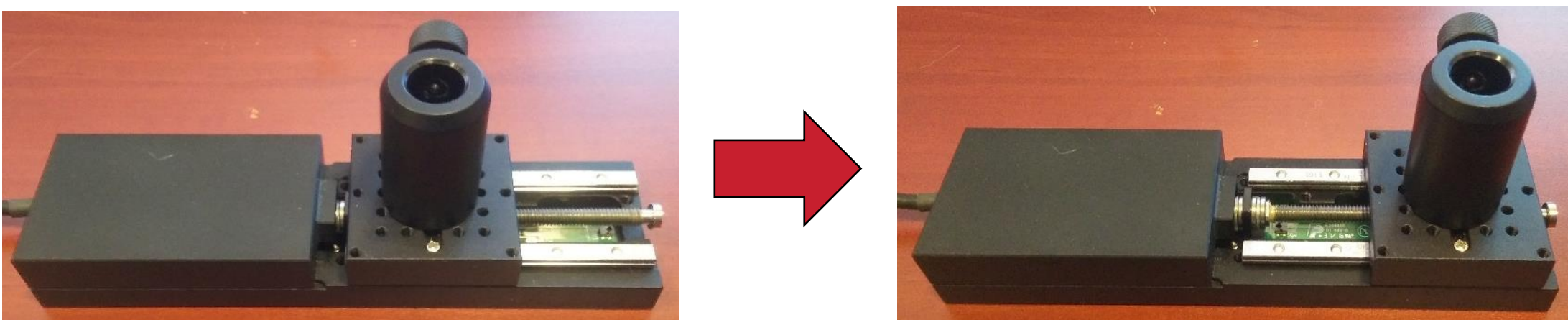
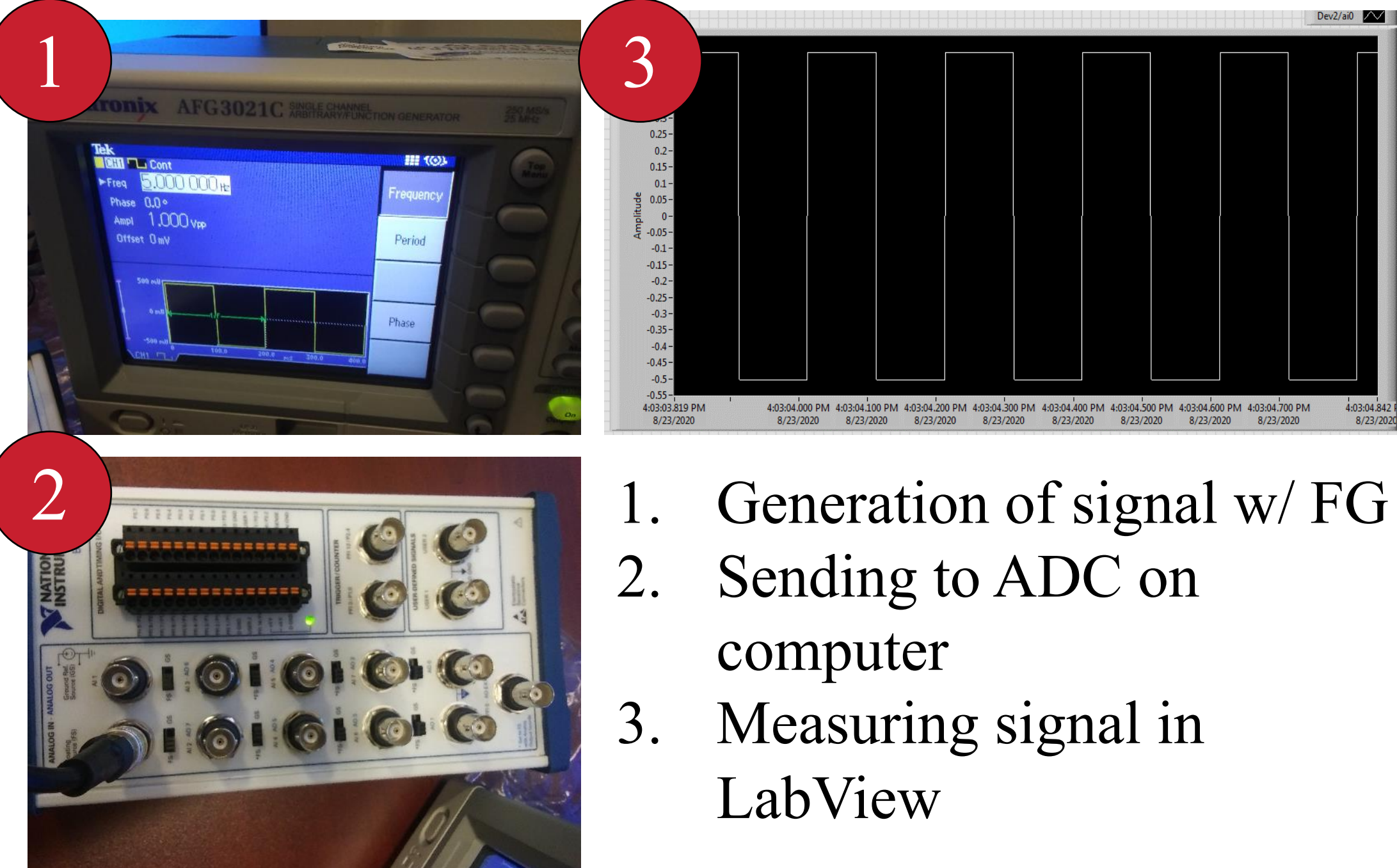


Figure 3. Motion of the linear stage.

The motion of the stage and image capture has been programmed successfully; however, these two actions must be synchronized with triggering using a common TTL clock signal.



1. Generation of signal w/ FG
2. Sending to ADC on computer
3. Measuring signal in LabView

Conclusion

After learning how to use LabView, motion control and image capture were successfully implemented using LabView. The motion control was tested using a Thorlabs KDC-101 Motor Controller connected to a Thorlabs MTS50-Z8 Linear Stage, and the image capture was tested with a Basler acA640-750 μm camera.

There are two remaining steps in this project. First, the stage's motion and camera's image capture must be synchronized with hardware trigger signals. Second, imaging of cm-scale objects remains to be done after the hardware synchronization is achieved.

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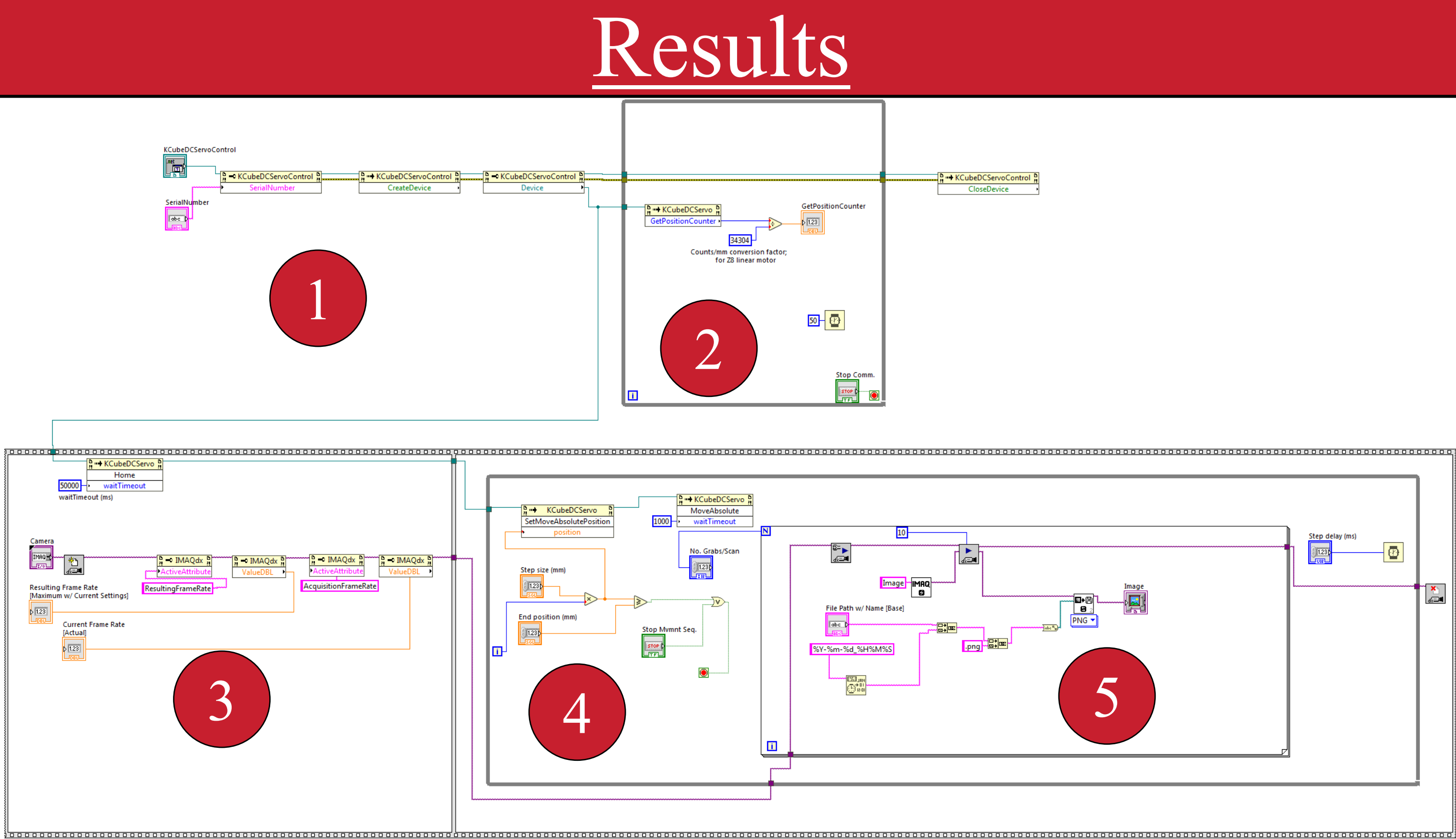


Figure 2. LabView code that controls the motion of the stage and image capture of the camera in the OCT setup.

1. Initialize motor controller
2. Query stage position
3. Home motor and initialize camera
4. Move motor to current position in the iterated movement sequence
5. Image capture with high-speed camera; image is saved to computer as a .JPG or .PNG file