**Optical Coherence Tomography for Classifying the Blood Flow Patterns in Arterial Grafts**

Reece Fratus*, Siyu Ma and Bruce Gao
Undergraduate Researcher, Clemson University, Post-Doctoral Fellow, Massachusetts General Hospital, Professor, Clemson University

**Introduction:** When a patient requires an artery bypass, a graft from a vein is used. This vein has a larger diameter than the artery and thus causes changes in the blood-flow patterns near the entrance region. These altered blood flow patterns are hypothesized to cause phenotypic changes in smooth muscle cells of the arterial graft. Optical coherence tomography (OCT) is an imaging technique that uses low coherence interferometry to image a sample non-invasively with high resolution. These properties make OCT imaging a perfect solution to measuring the blood-flow patterns in an arterial graft. The lateral and axial resolutions, depth range and depth of field are important factors to consider when developing an OCT system for a specific application. For our experiment, we require a large depth of field without losing lateral resolution to perform flow visualization. Shaping techniques, such as using and apodizing filter, allow for a greater depth of focus by using a Bessel-like beam. Bessel beams are theoretical beams that are solutions to the Bessel function and are thus non-diffracting beams meaning they fit the diffraction-free mode solutions for the Helmholtz equation. This allows the beam to travel a great distance while not diffracting or losing intensity. It also provides a greater depth of focus to allow more of the imaged sample to be in focus. A high frame rate is also needed to measure flow in a small area. A high frame rate will be achieved using a streak scanner device that uses a resonating mirror that will streak the output beam across an area scan camera. These properties will allow flow cytometry to be performed and make it possible to image blood flow in a sample.

**Methods:** The OCT design consisted of an incident, Gaussian beam that passed through an apodizing filter to produce a reference beam and a sample beam that becomes a Bessel beam due to the effects of the filter. The two arms are nearly symmetrical with a 4f lens system and an objective to focus the light onto the sample/reflective surface. The sample arm has a 2D galvo scanner and the reference arm has a translational stage to move the reflective surface. This allows the length of the reference beam to be altered to achieve interference. The streak mode scanner is place after the two beams have recombined. The beam first passes through a diffraction grating and is then focused onto the streak scanner with a 4f lens system. A 75mm lens is used to expand the light onto the area scan camera.

**Results:** A spectrum that covered about 50% of the camera height was achieved with a light bandwidth of 50 nm. The desired bandwidth will be 100 nm so we expect the height of the spectrum to double and cover the entire camera. The streak scanner was tested and set to a desired magnitude so that the streak spectrum fully covered the area scan camera.

**Conclusions:** The symmetry between the reference and sample arms due to the introduction of the apodizing filter allowed for easy interference measurements. The streak scanner produced the desired frame rate for this experiment as expected.

**References:** J. Durnin, “Diffraction-Free Beams,” 1987, Physical Review Letters, 58 [15] 1499-1501.
Center for Medical Physics and Bioengineering Medical University of Vienna, “Extended Focus Optical Coherence Microscopy,” 2008.
Optical+Biomedical Engineering Laboratory, “Beam Shaping,” 2018.