



Non-Invasive Bilirubin Detection Capstone Project

Abby Jackson, Genaye Sanders, Jose A. Mendoza, Heavenly Ukejuh

Advisors: Dr. Larin & Andres Bryan
University of Houston - Houston, Texas



Objective

Develop a device with the ability to non-invasively measure bilirubin levels accurately and reliably

Background

- Bilirubin is a substance that results from the body's processing of old red blood cells
- Hyperbilirubinemia occurs when there are excessive bilirubin levels and if left untreated can result in jaundice and kernicterus
- Hyperbilirubinemia is most common in newborns
- Current methods to detect bilirubin levels involve blood sample extraction which is invasive

Methods

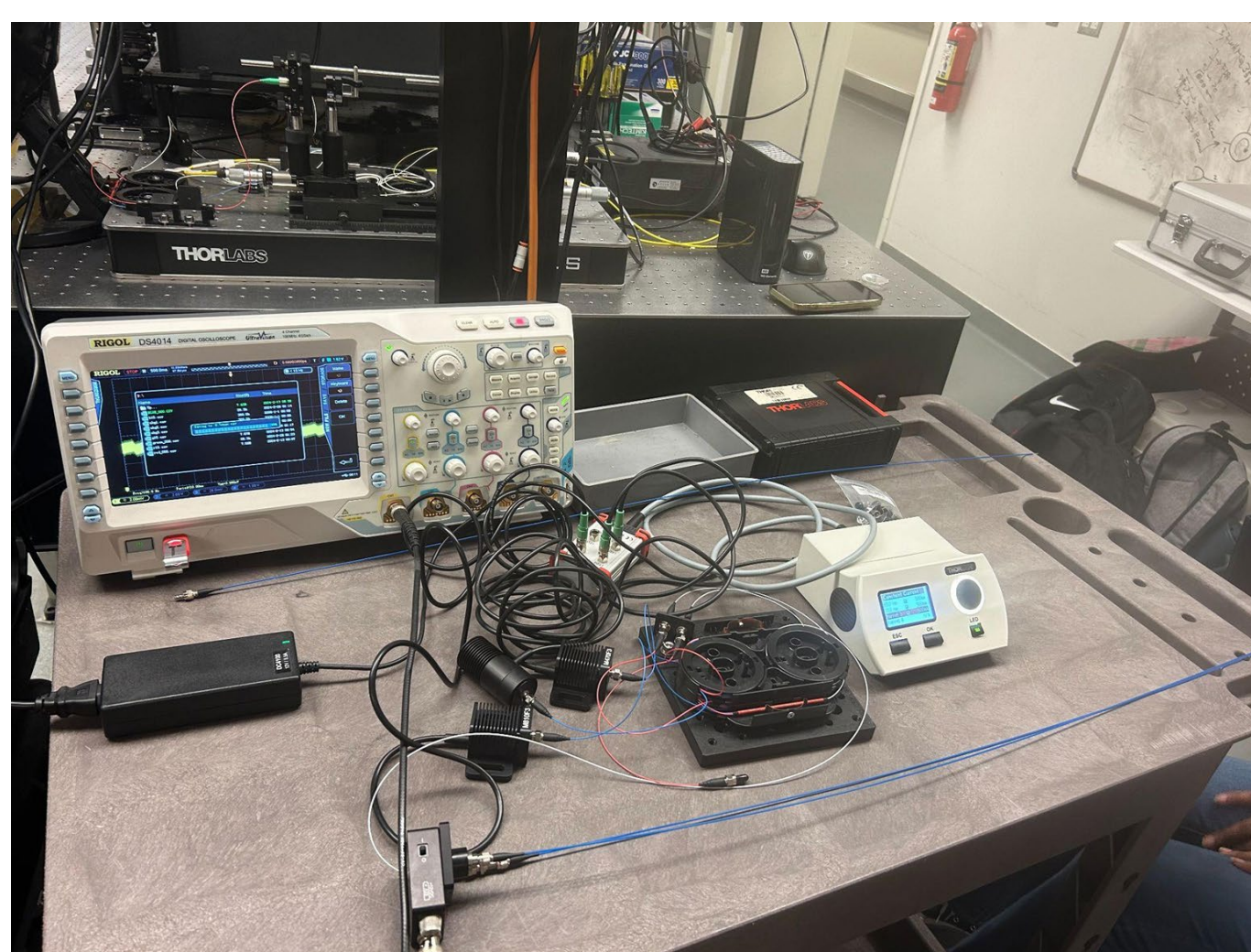


Figure 1. Device set-up

$$\Delta A = \text{Log} \left(\frac{I_{max}}{I_{min}} \right)$$

Equation 1. Beer-Lambert's Law

$$\% \text{Oxygenation} = \frac{\Delta A_{Green LED}}{\Delta A_{Infrared LED}}$$

Equation 2. % Oxygenation Equation

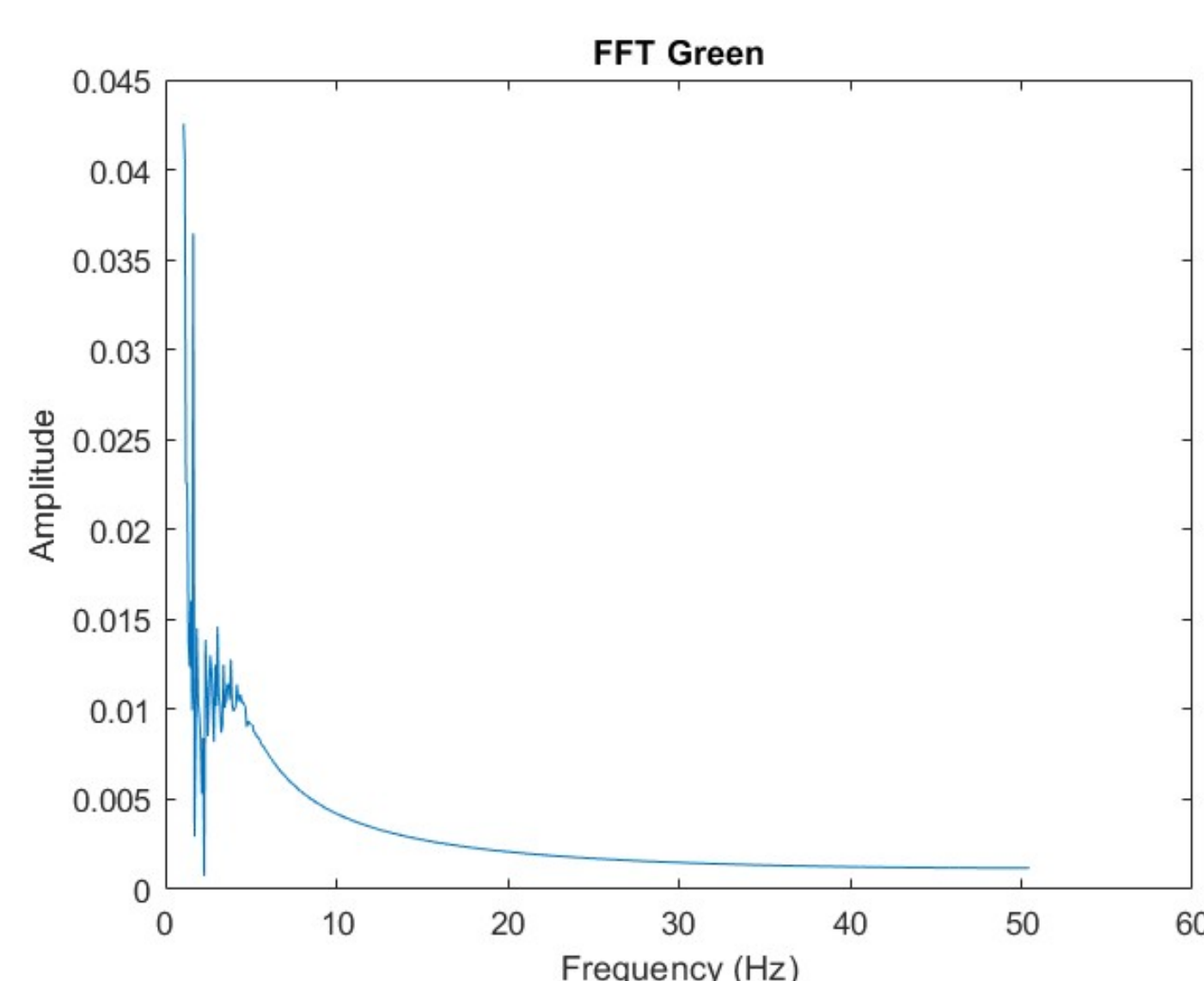


Figure 2. Fast-Fourier Transform

Design Specification

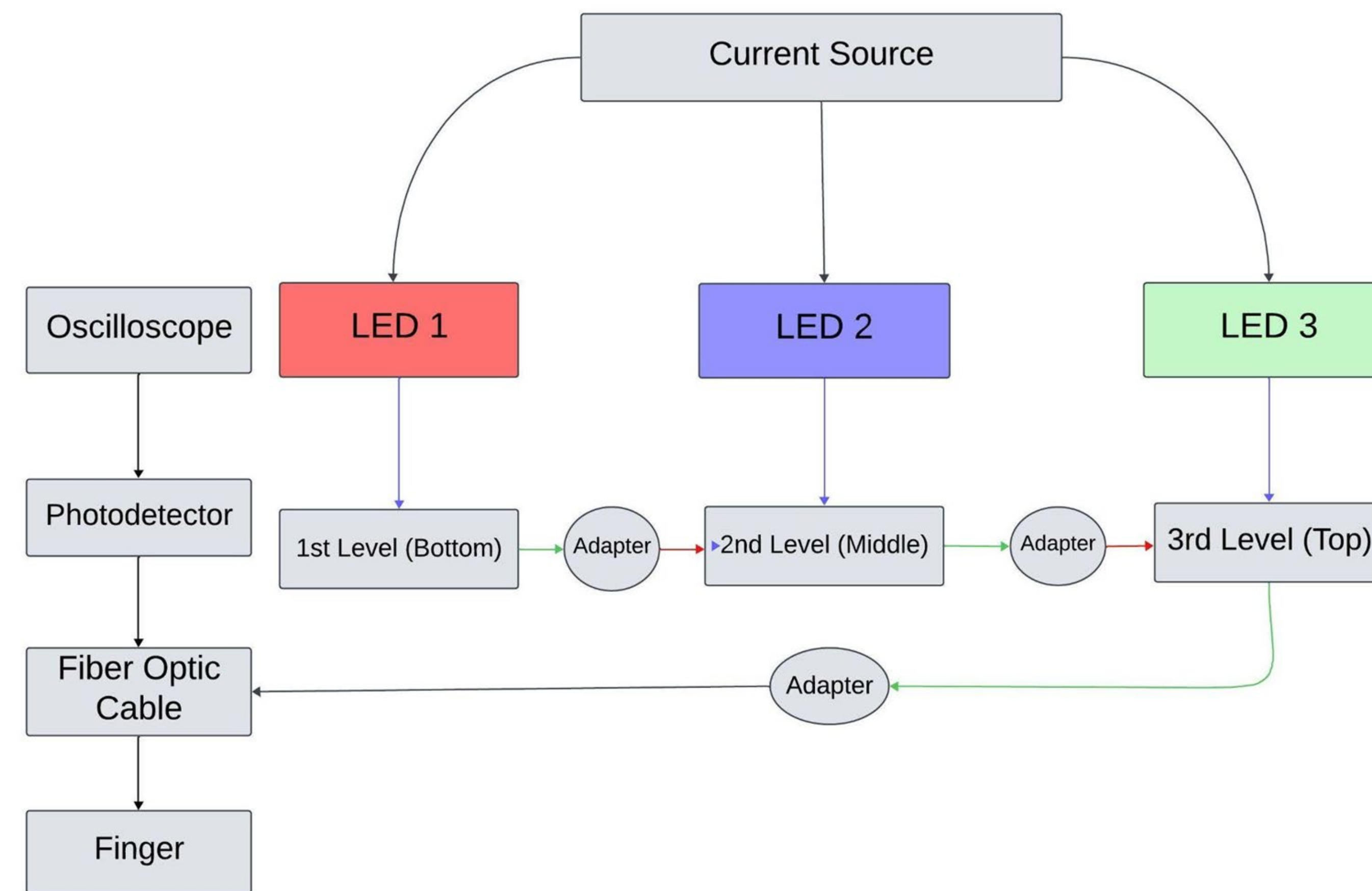


Figure 3. Device Setup Diagram

Results

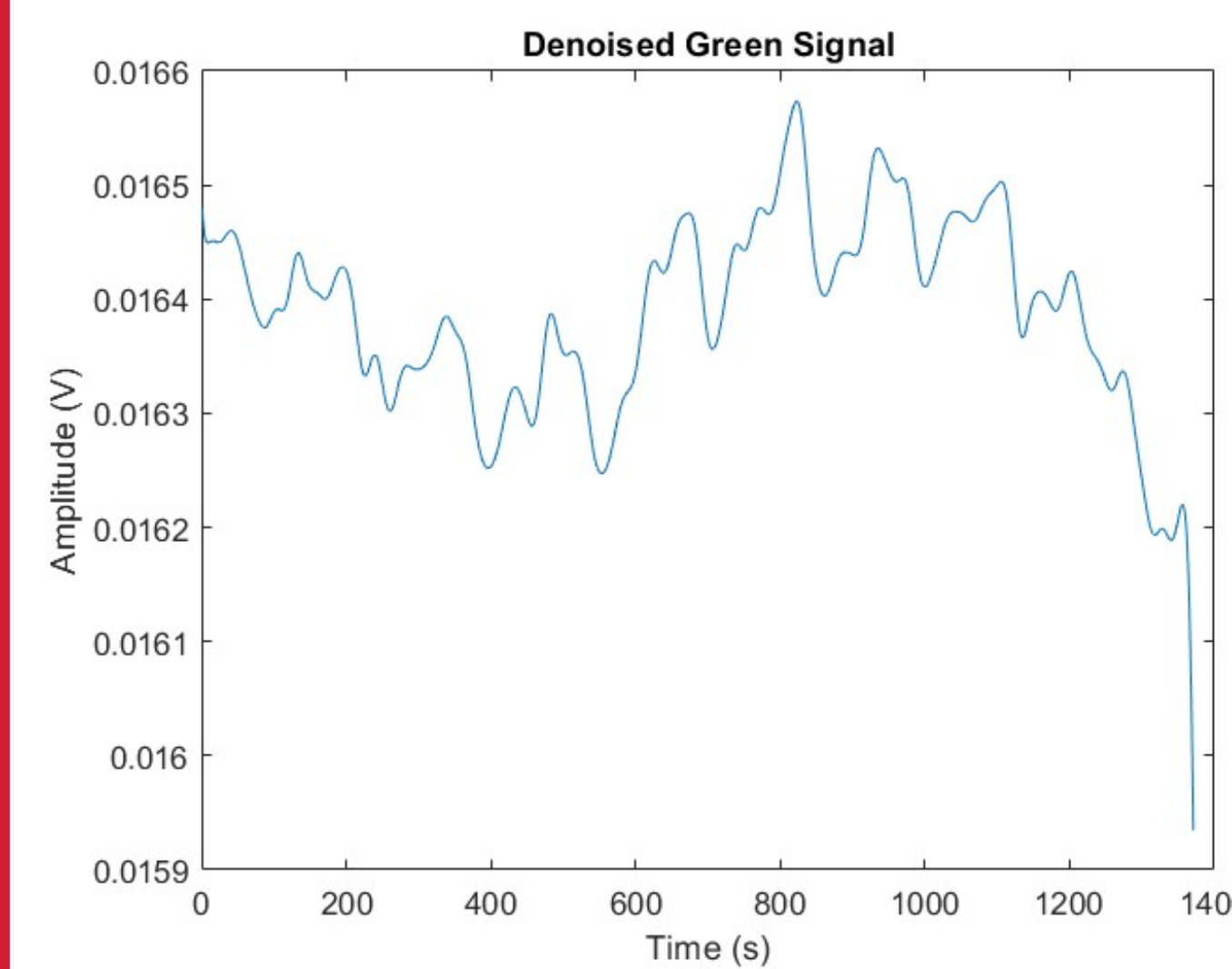


Figure 4. Denoised Green Signal

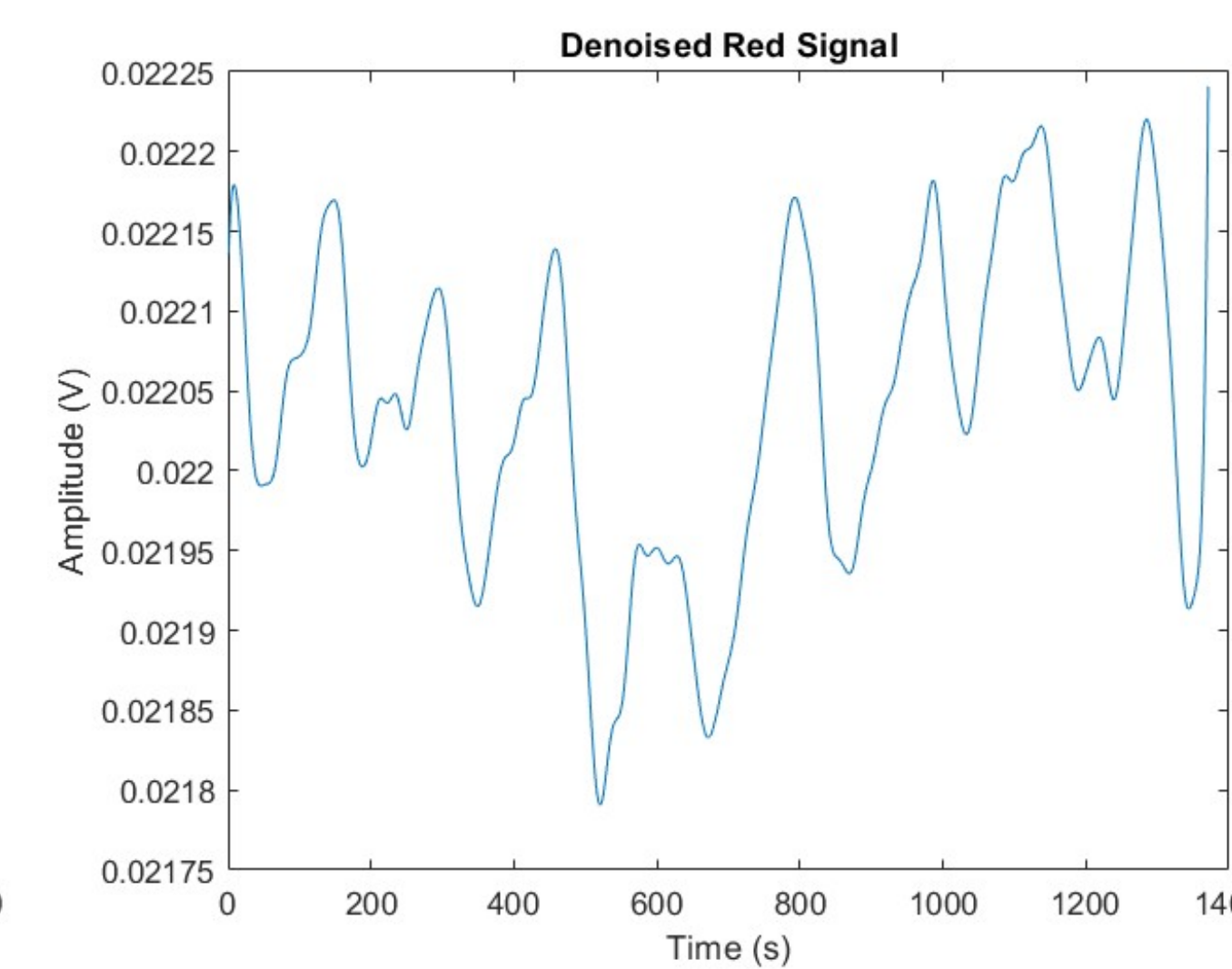


Figure 5. Denoised Red Signal

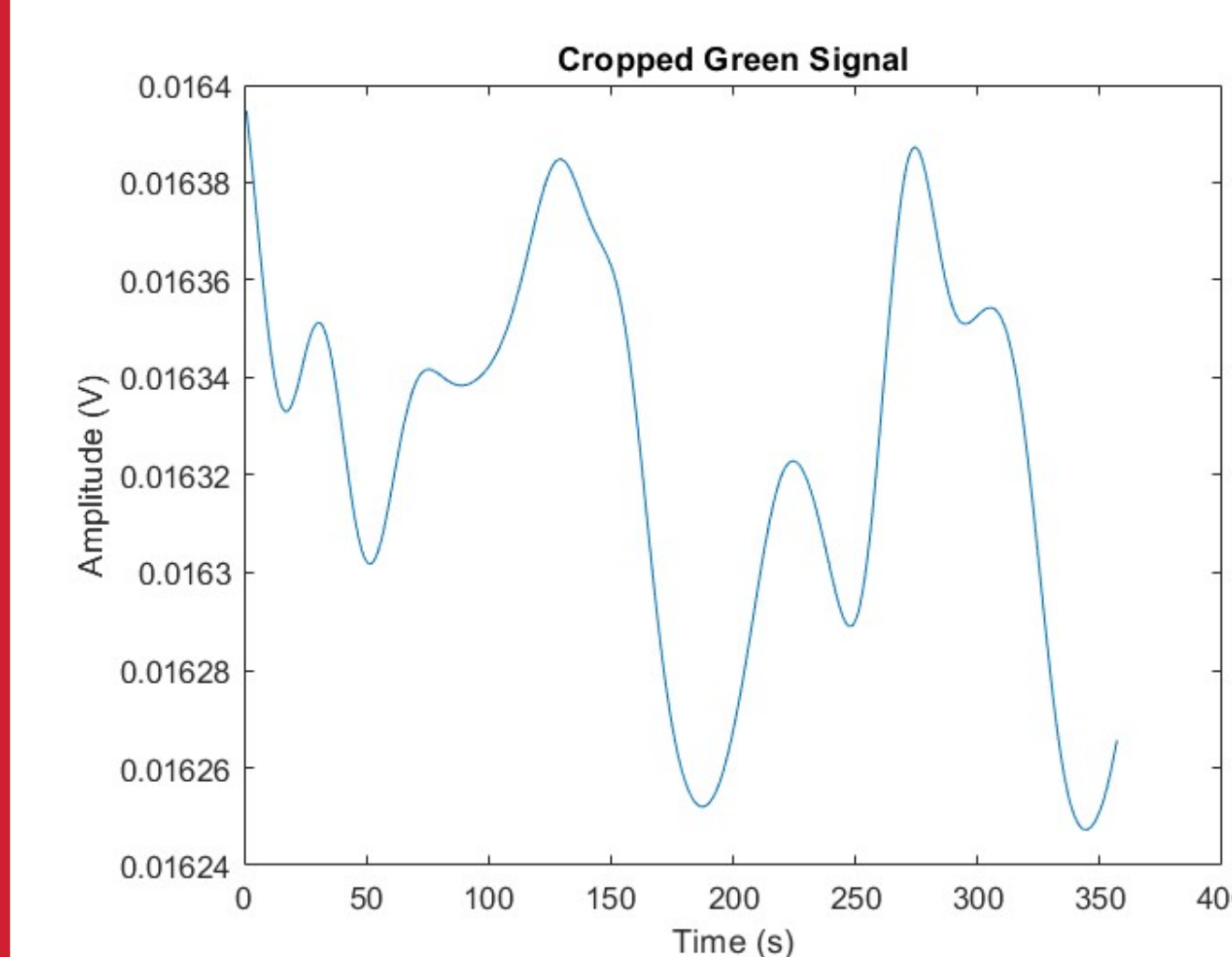


Figure 6. Cropped Green Signal

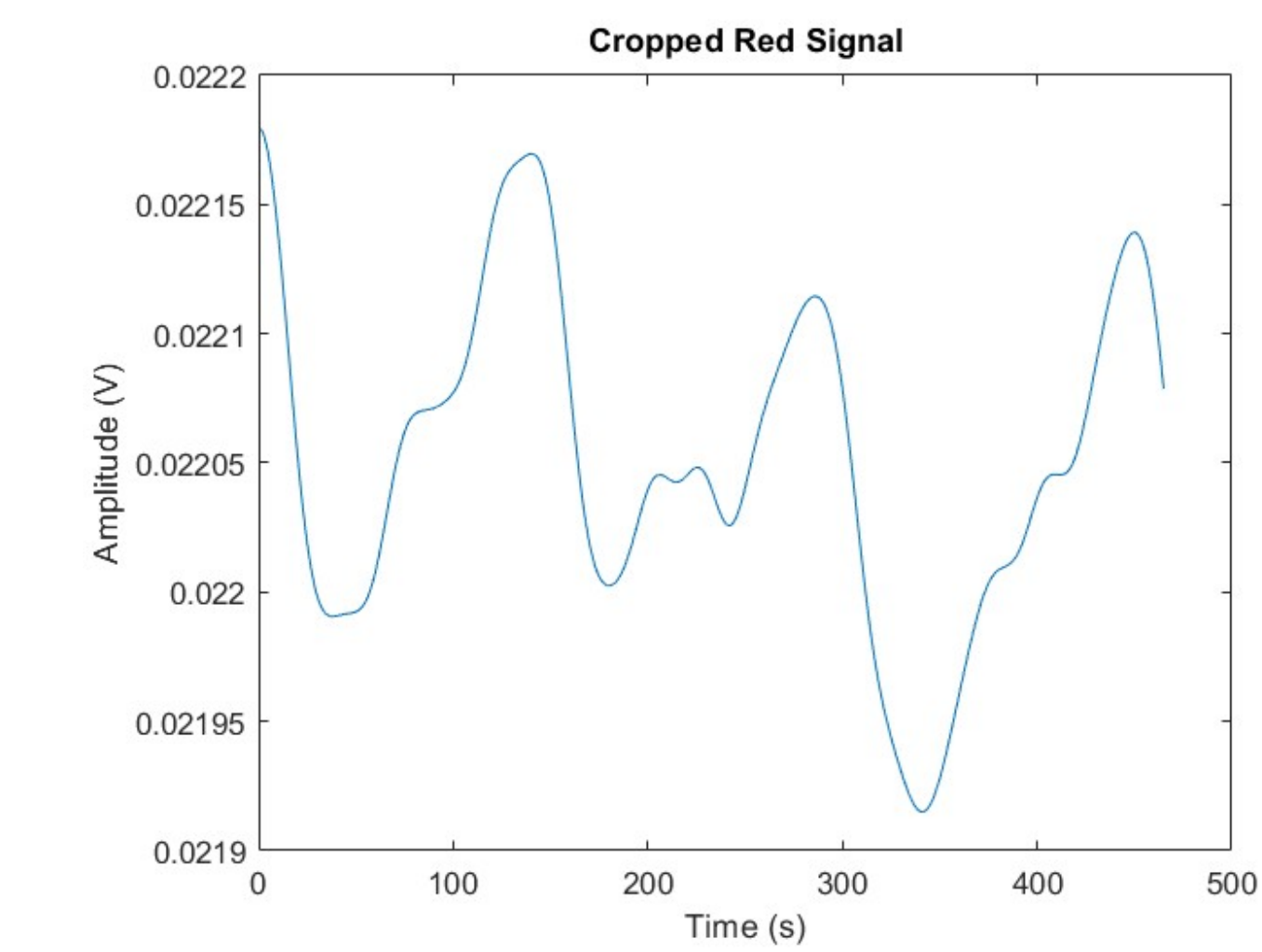


Figure 7. Cropped Red Signal

Conclusion

- Developed a non-invasive device that can calculate percent oxygenation accurately using the Beer-Lambert law
- This device could be used in the future to achieve the original goal of measuring bilirubin levels
- Future directions involve making the experiments reproducible and accurate by changing how the LED fiber is placed on the finger and increasing the intensity of the LED

References

- McEwen, M., & Reynolds, K. (2014). Noninvasive Detection of Bilirubin in Discrete Vessels. 650-654. Paper presented at World Congress on Engineering 2014.
- Mcewen, Mark & Reynolds, Karen. (2006). Noninvasive detection of bilirubin using pulsatile absorption. Australasian physical & engineering sciences in medicine.
- Sinex, J. E. (1999). Pulse oximetry: Principles and limitations. The American Journal of Emergency Medicine, 17(1), 59-66. [https://doi.org/10.1016/s0735-6757\(99\)90019-0](https://doi.org/10.1016/s0735-6757(99)90019-0)
- Chan, E. D., Chan, M. M., & Chan, M. M. (2013). Pulse oximetry: Understanding its basic principles facilitates appreciation of its limitations. Respiratory Medicine, 107(6), 789-799. <https://doi.org/10.1016/j.rmed.2013.02.004>

Acknowledgements

- Our group would like to acknowledge Dr. Larin and his PhD student Andres Bryan for their support in developing this project