# Internship project: Stabilized single fiber reflectance spectroscopy


Supervisor: Xavier Attendu

Contact: x.a.attendu@amsterdamumc.nl

Affiliation: Amsterdam UMC


## 1 Single fiber reflectance spectroscopy

Single fiber reflectance spectroscopy (SFR) is a relatively new technique that, as its name implies, uses a single optical fiber to measure the spectral reflectance of biological tissue. SFR allows the measurement of optical properties of the tissue such as absorption and scattering, which can provide information about the bio-chemical composition and the health state of tissue [1, 2]. SFR is particularly useful due to its simple system and small size, which allows measurements in a clinical setting such as through small endoscopes or even through needle probes. However, current SFR systems such as the one presented in Fig. 1 (left), are subject to significant instabilities due to several effects such as spectral power fluctuations, fiber bend losses and variability in the transmission efficiency of the bifurcated fibers. This leads to a significant variance in the measurements and limited reproducibility, which prevents widespread adoption of the technique [3, 4].

## 2 Proposed Work

In this project, the student will work on a new system configuration, presented in Fig. 1 (right). This system accounts for the effects mentioned above by adding several spectrometers to measure each one independently. The student will first investigate the expected stability of the proposed system through simulations. They will then design and carry out experiments to validate the enhanced robustness of the system. Finally, they will perform a one-to-one comparison between the old and new systems.

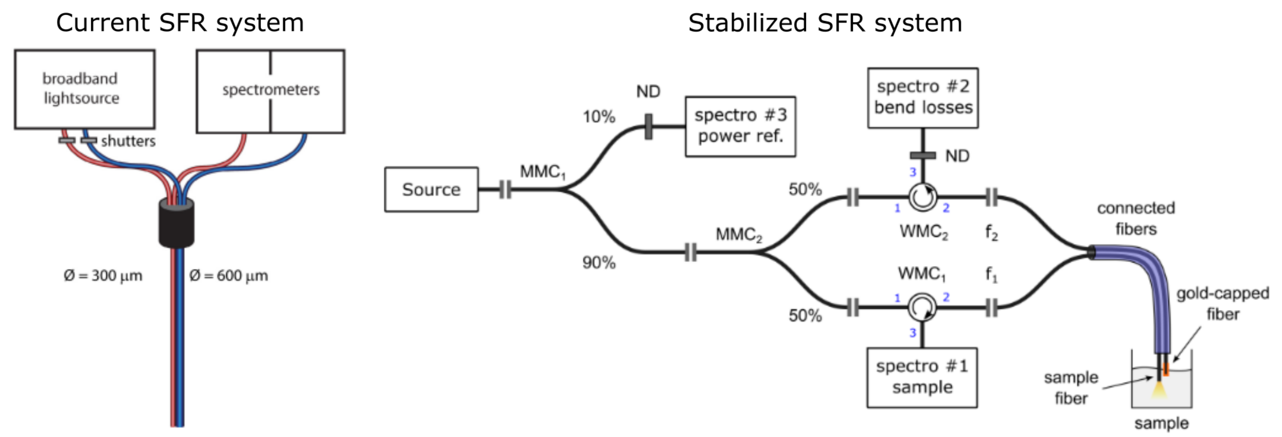


Figure 1: Current (left) and improved/stabilized (right) single fiber reflectance spectroscopy systems. Left image reproduced from [1].

## 3 Requirements & learning outcome

We are looking for a highly motivated Bachelors/Masters student with a solid background in physics and engineering, and a passion for hands-on experimental work. Some experience in programming (Matlab, Python, etc.) is essential for data analysis. Through this internship, the student will gain a in-depth knowledge into the field of optics (specifically fiber-optics) and develop valuable, highly transferable skills in system development, experimental design, and data analysis. Additionally, they will also enhance their abilities in collaboration, scientific writing, and presenting. This internship, expected to last six to nine months (with flexibility to accommodate student needs), offers an exceptional opportunity to contribute to advancements in medical diagnostics at the forefront of the field.

# References

[1] A. L. Post, D. J. Faber, H. J. Sterenborg, and T. G. van Leeuwen, "Experimental validation of a recently developed model for single-fiber reflectance spectroscopy," *Journal of Biomedical Optics*, vol. 26, no. 2, pp. 025004–025004, 2021.

[2] A. L. Post, A. J. de Groof, X. U. Zhang, A.-F. Swager, K. N. Fockens, R. E. Pouw, B. L. Weusten, D. J. Faber, D. M. de Bruin, J. J. Bergman, *et al.*, "Toward improved endoscopic surveillance with multidiameter single fiber reflectance spectroscopy in patients with barrett's esophagus," *Journal of biophotonics*, vol. 14, no. 4, p. e202000351, 2021.

[3] I. Schmidt, W. B. Nagengast, and D. J. Robinson, "Characterizing factors influencing calibration and optical property determination in quantitative reflectance spectroscopy to improve standardization," *Journal of Biomedical Optics*, vol. 27, no. 7, pp. 074714–074714, 2022.

[4] X. Attendu, A. Benk-Fortin, D. J. Faber, C. Boudoux, and T. G. van Leeuwen, "Stabilized single-fiber reflectance spectroscopy using wideband multimode circulators," in *Advanced Biomedical and Clinical Diagnostic and Surgical Guidance Systems XXII*, p. PC128310I, SPIE, 2024.