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FNSNF

Development of a Fluorescence Lifetime Imaging Reader for Monitoring Wound Healing

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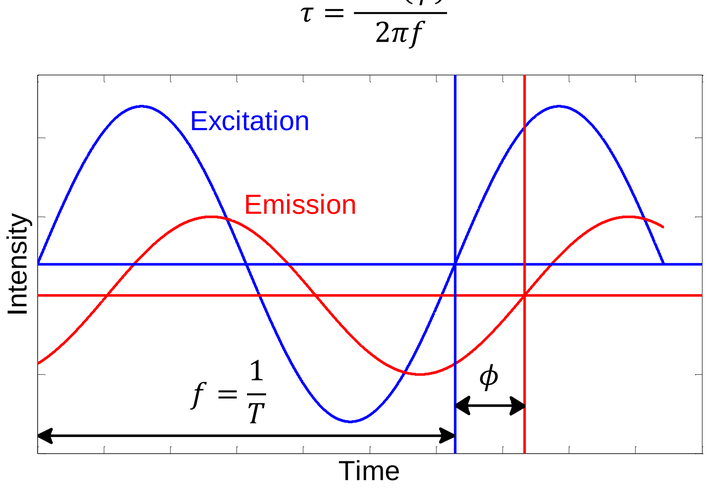
Motivation

Wound healing is a complex process, which, under normal circumstances does not require constant monitoring. However, when wounds are associated with chronic infections and/or underlying diseases such as diabetes, a much more significant threat is presented to the patient that can result in death. FlusiTex is developing a textile based sensing system to monitor wound healing. We combine fluorescence based chemical and biochemical recognition methods with advanced optical readout technologies. The coatings will be integrated in a fabric in order to monitor wound healing, where different physical, chemical and biological parameters will be detected simultaneously.

Fluorescence lifetime determination

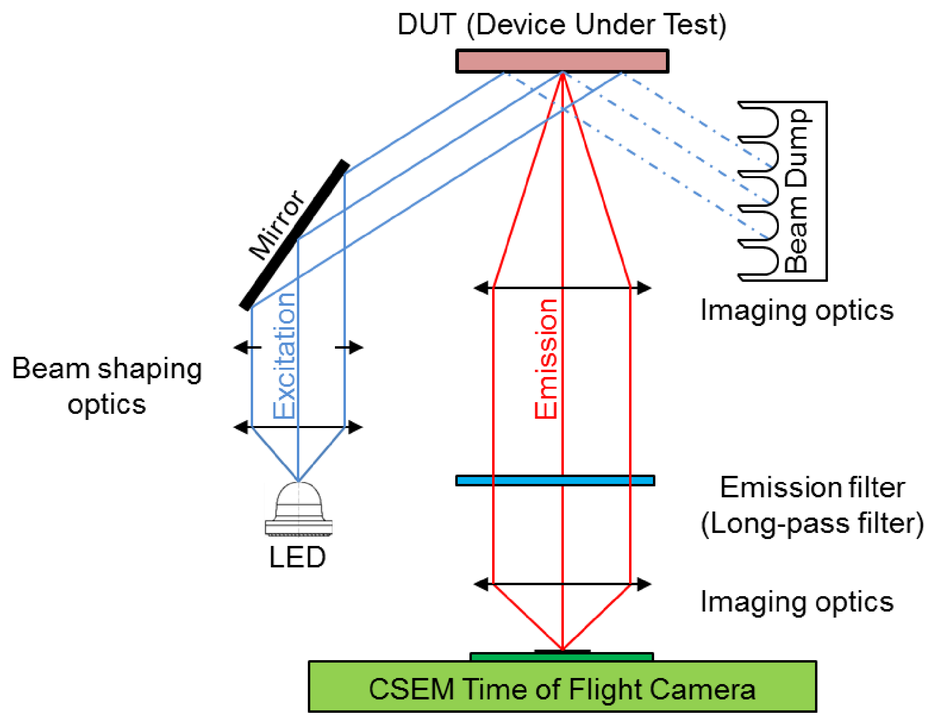
Fluorescence life-time can either be determined in the time domain by using a pulsed source or in the frequency domain by using a sinus modulated light source. The developed fluorescence life-time imaging reader is based on the frequency domain. The lifetime (τ) is calculated according to the following equation which is depending on the phase-shift (ϕ) between the excitation wavelength and the emission wavelength and the modulation frequency (f) :

$$\tau = \frac{tan(\phi)}{2\pi f}$$



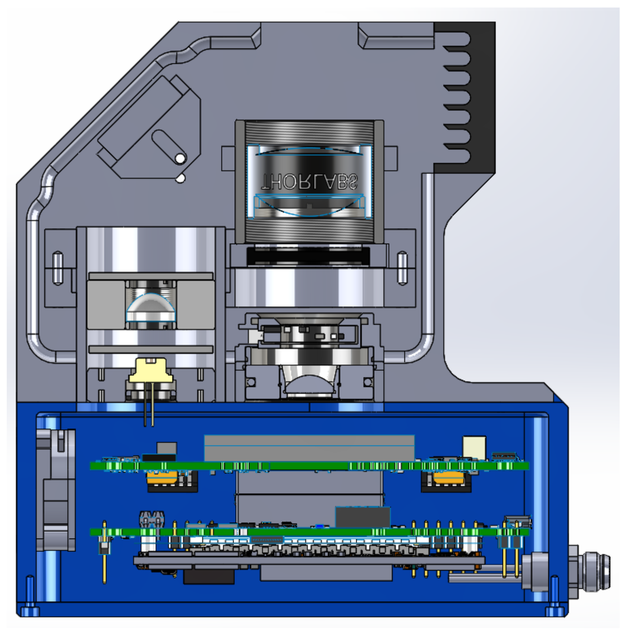
System setup

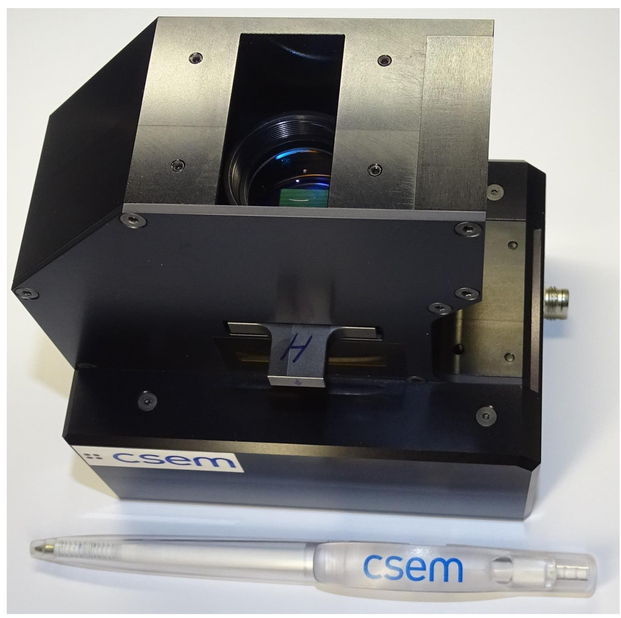
The system is based on CSEM's lock-in pixel technology, which was originally developed for 3D Time-of-Flight (TOF) cameras. The setup consists of a modulated LED light source, a CMOS lock-in imager, optical components, electronics and software interface. The schematics below shows the system setup of the fluorescence lifetime imaging reader.



Mechanical setup

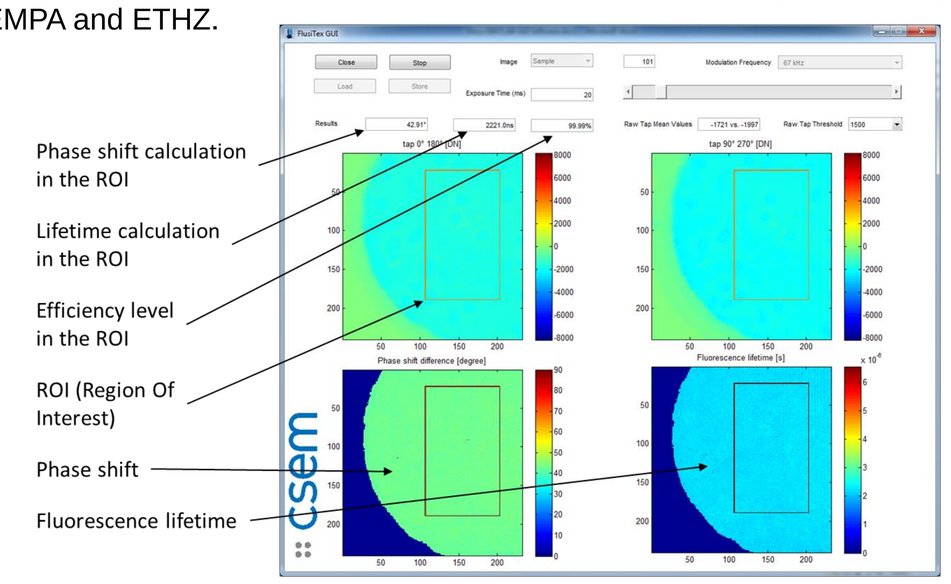
We have developed a compact, robust system for real-time wide-field fluorescence lifetime imaging in the ns-µs range (frequency domain). The CAD schematic below shows the cross-section of the system. In the lower part the printed circuit boards and in the upper part the optics system is visible. The picture below shows the actual prototype and its compact dimensions.





Measurement results

The fluorescence lifetime reader was tested with various fluorescence dyes. A screen shoot of a ruthenium-based dye measurement is shown in the picture below. Furthermore the picture indicates some of the features of the developed software. A more detailed characterization of the system is ongoing at EMPA and ETHZ.



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