SPECO-PICO Spectrally resolved *picosecond photon tagging for ultrathin clinical endoscopes*

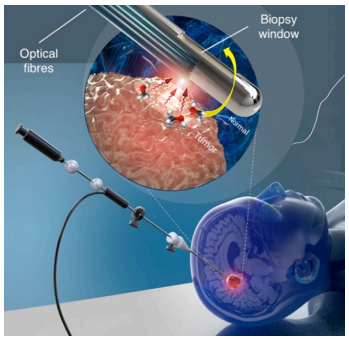
Motivation

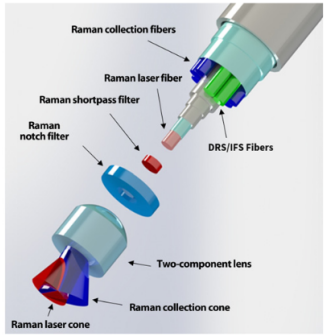
Endoscopic Raman spectroscopy via optical fibers opens opportunities for intraoperative tissue analysis.

Challenge Fiber signal ~10^2 x tissue signal.

State of the art

Multi-fiber probes which are too big to be inserted at depth (diameter 1-2 mm).

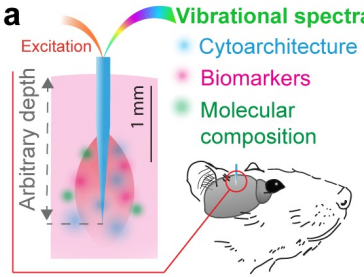


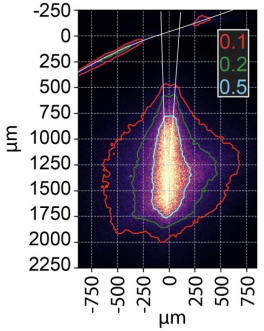


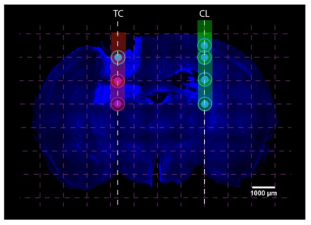
Desroches et al., Sci Rep 2018
Desroches et al., Biomed Opt Expr 2016

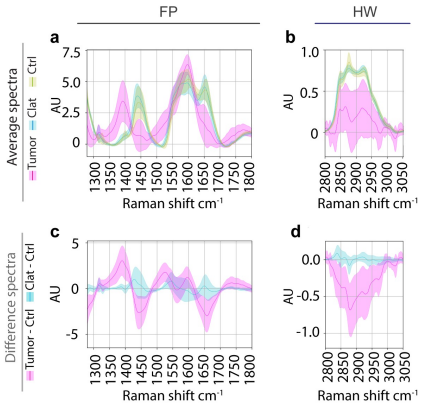
Preliminary data

A single fiber probe (max diameter 200 um) can detect enough signal to discriminate healthy tissue from cancer invaded one.





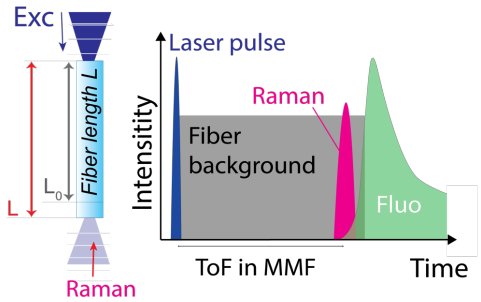


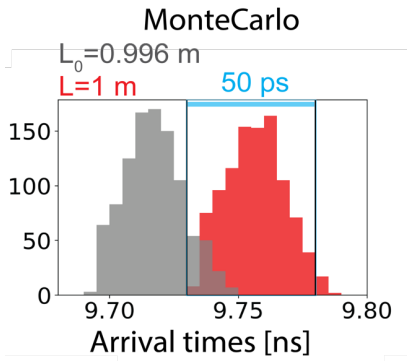


Pisano et al, Nature Methods, accepted

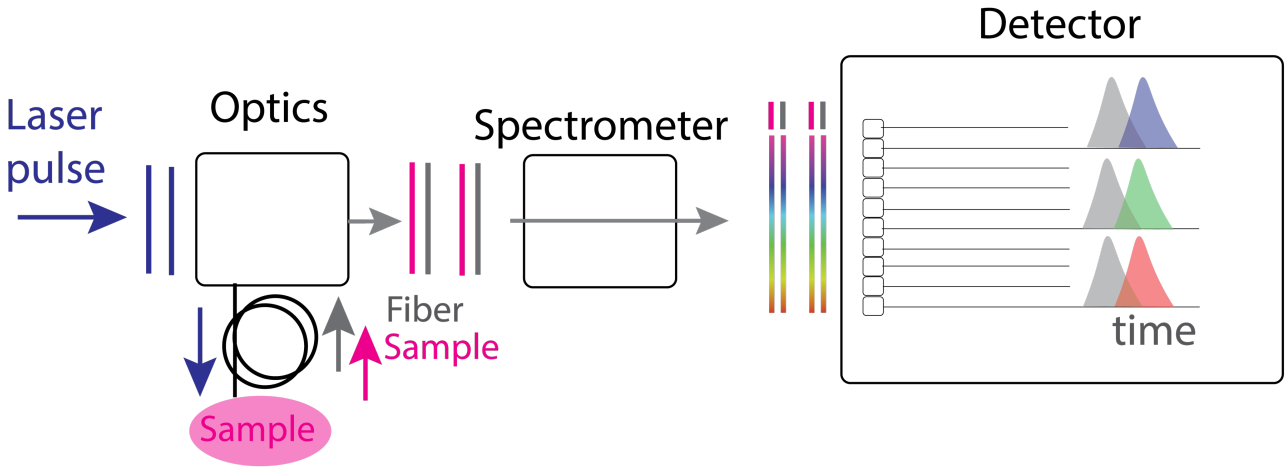
Main idea

Raman scattering is fast (ps).
The tissue signal can be discriminated from the fiber signal using a pulsed excitation and a photon time-of-flight detection.





Methodology



Objectives

Objective 1

- Numerical model of optical propagation in turbid media.
- Resolved in space,time and spectral components.
- Multimode fiber (NA, core size) and biological tissue (scattering and absorption coefficients

Objective 2

- Compact optical system for time-of-flight fiber Raman spectroscopy.
- Ps pulses laser source, optical routing, fiber coupling, SPAD-CMOS detection combined with spectrometer.
- Time-of-flight vs time-gated operation

Objective 3

- Data analysis pipeline: real time extraction of signal and spectral reconstruction.
- Validation in solution and. tissue phantoms (agarose gel).
- Validation in brain slices/synthetic cultures.