Imperial College London

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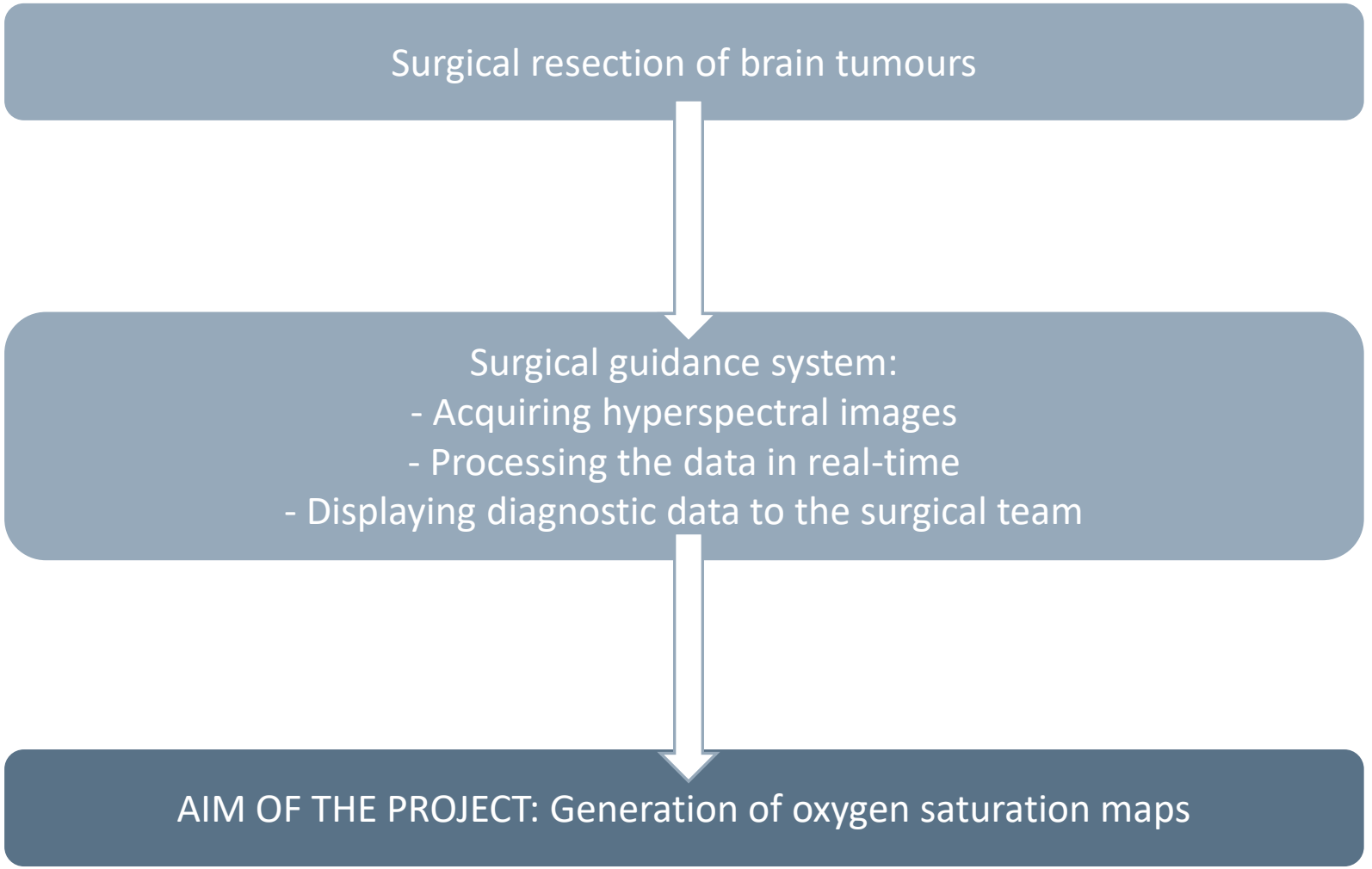
Victoire de Saléon-Terras
Supervisor: Dan Elson

MSc Individual project

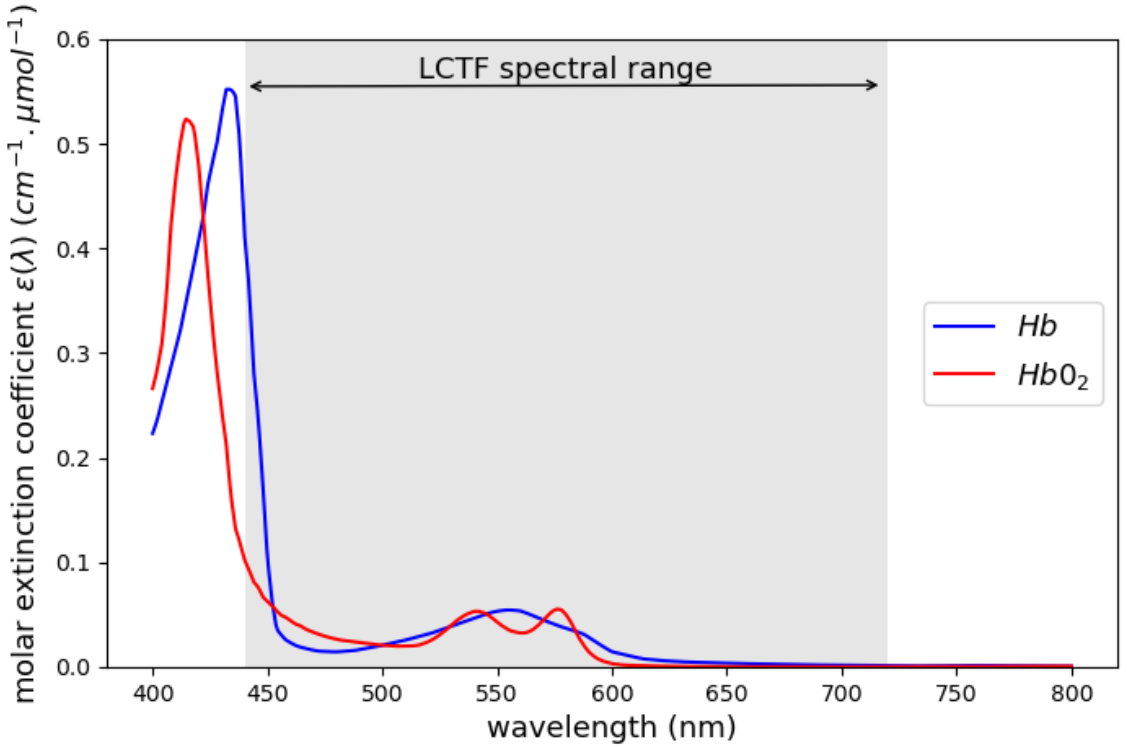
USE OF HYPERSPECTRAL IMAGES ANALYSIS IN NEUROSURGERY

Introduction
Aim of the project

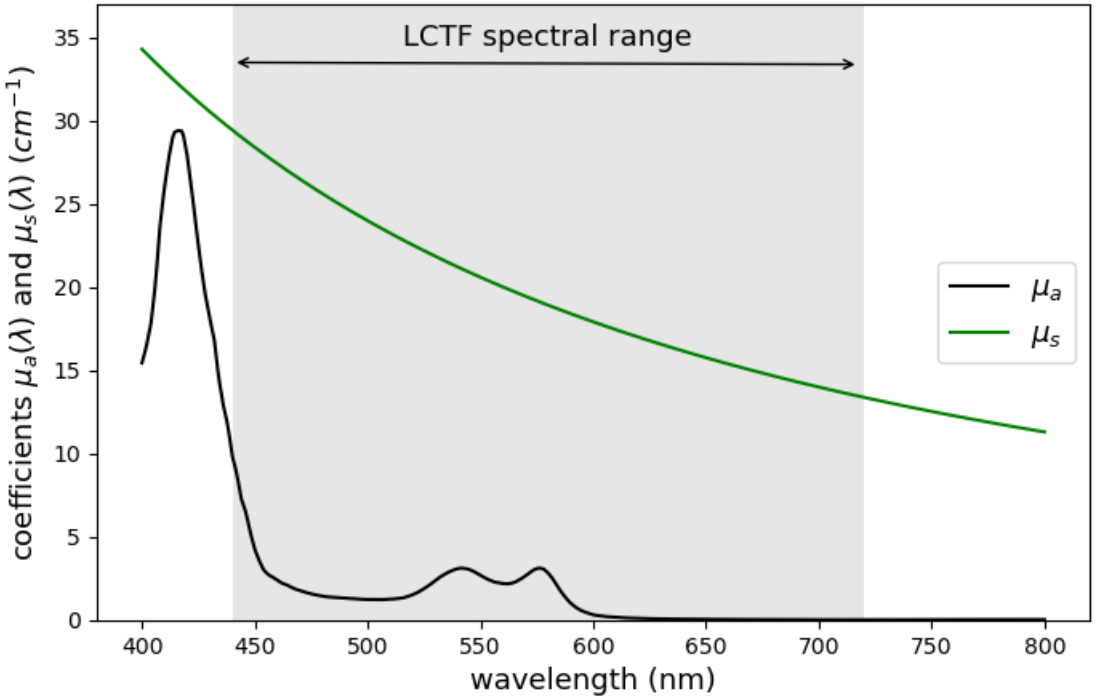


Background
Absorption and scattering

Molar extinction coefficient



Example of absorption and scattering coefficients



Absorption coefficient: $\mu_a(\lambda) = C_{HbO_2}\varepsilon_{HbO_2}(\lambda) + C_{Hb}\varepsilon_{Hb}(\lambda)$

Scattering coefficient: $\mu_s(\lambda) = \left(\frac{a}{500}\right)^{-b}$

Background
Absorptivity model

Intensity measured by the optical system

$$I(\lambda) = I_0 10^{-A(\lambda)}$$

Absorptivity model

$$A(\lambda) = \left(C_{HbO_2}\varepsilon_{HbO_2}(\lambda) + C_{Hb}\varepsilon_{Hb}(\lambda)\right) \times l(\lambda)$$

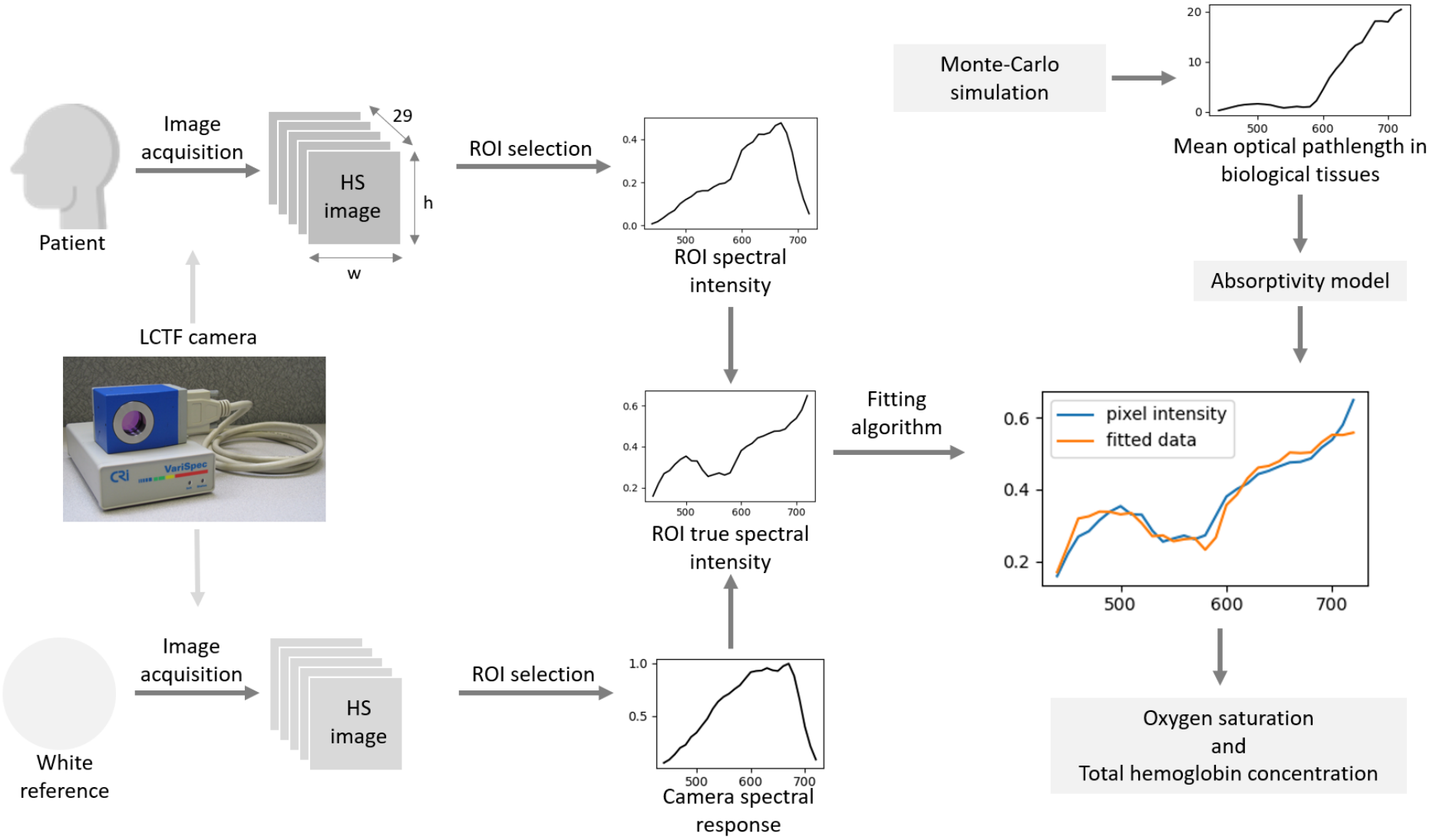
With $l(\lambda)$: mean optical pathlength → can be estimated with Monte-Carlo simulation
C_{HbO_2} and C_{Hb} are parameters for the fitting algorithm

Oxygen saturation

$$SO_2 = \frac{C_{HbO_2}}{C_{HbO_2} + C_{Hb}}$$

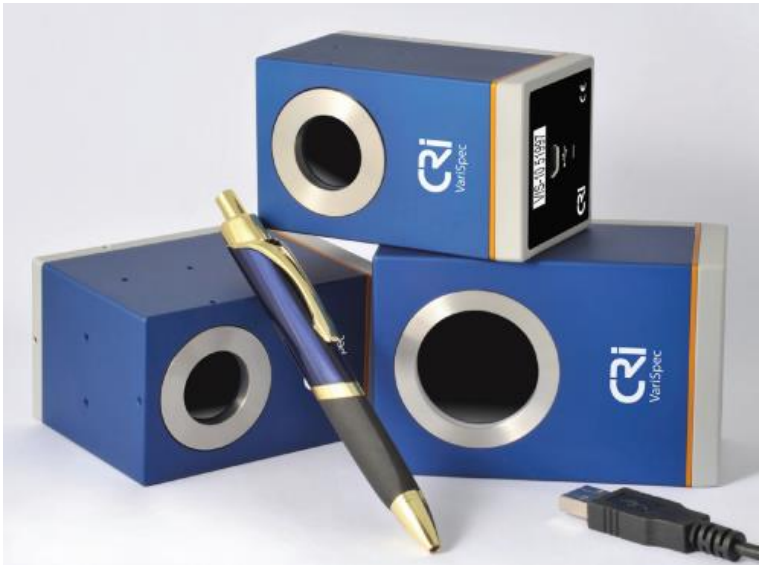
Methods

Flowchart

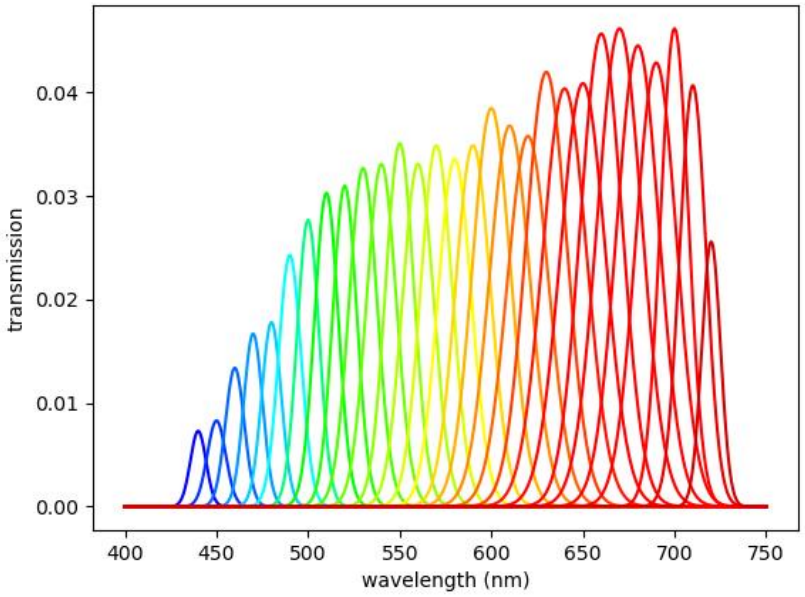


Methods

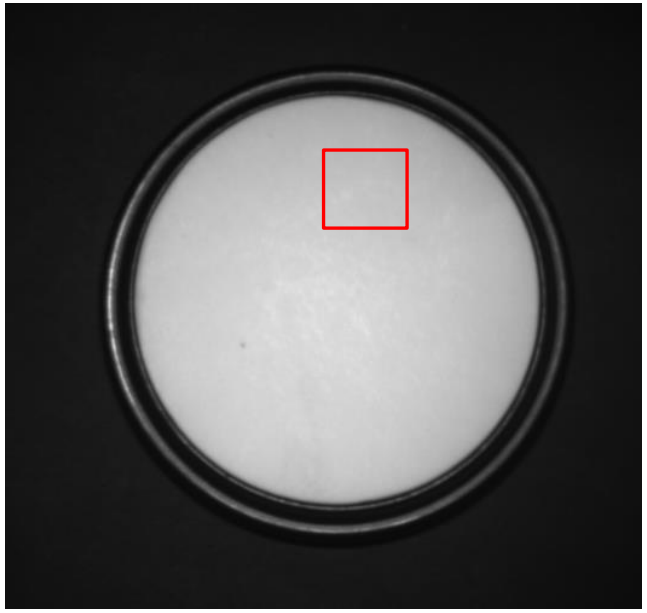
Obtaining the camera spectral response



VariSpec Liquid Crystal Tunable Filters from CRI



Transmission of the filters



White screen used as white reference
Red: region of interest selected by the user

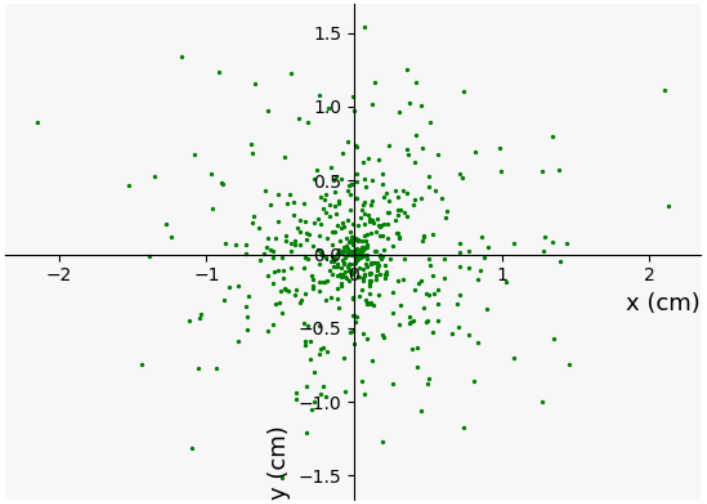
Methods

Launching of 1000 photon packets using Monte-Carlo Simulation

Photons wavelength: 500nm

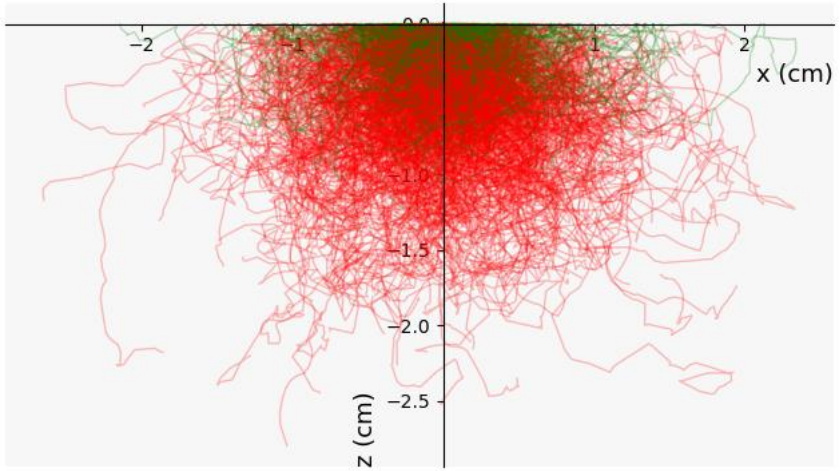
Tissue surface (xy plane)

Reemitted photon packets



Photon packets trajectory

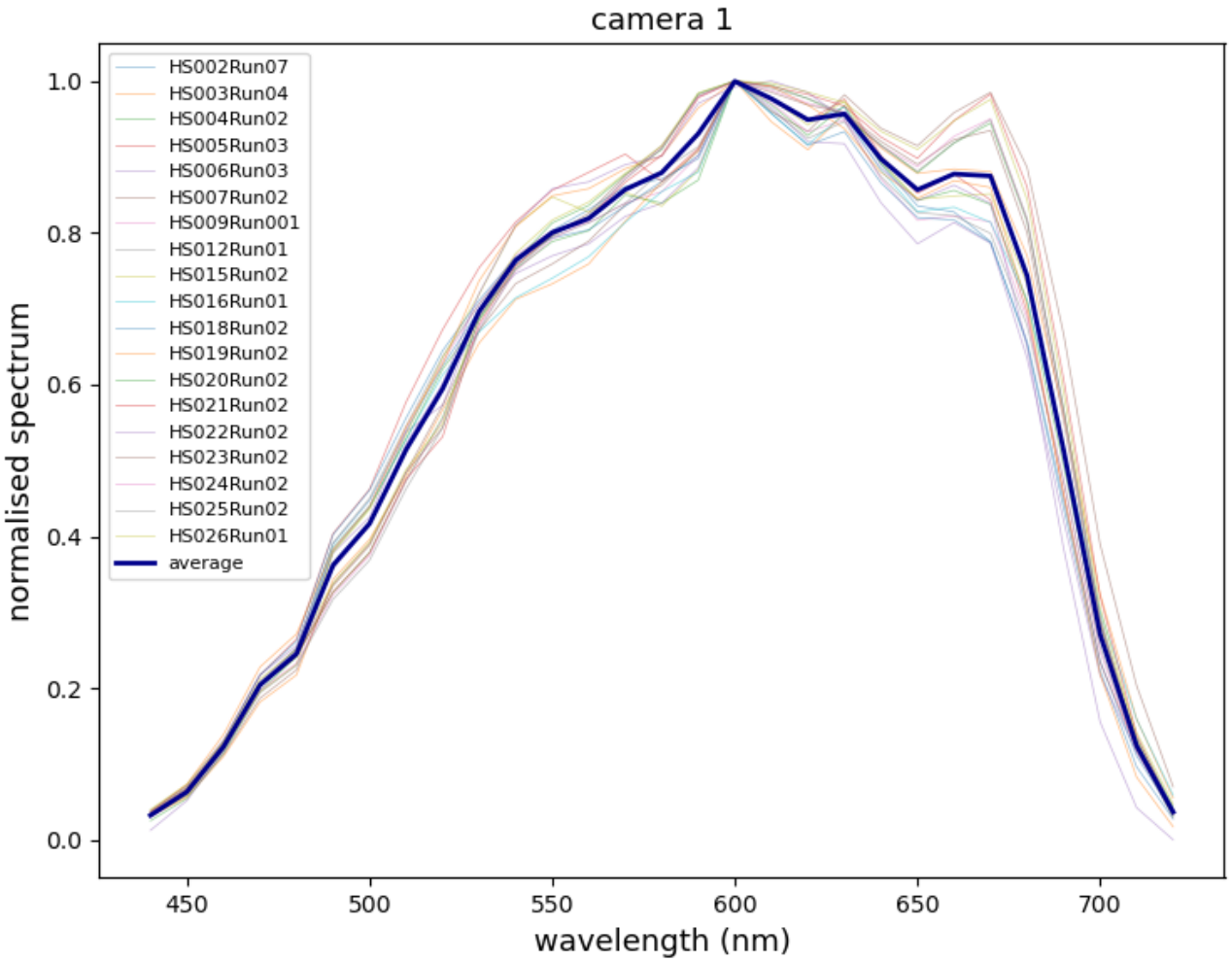
Projection of the trajectories in the xz plane

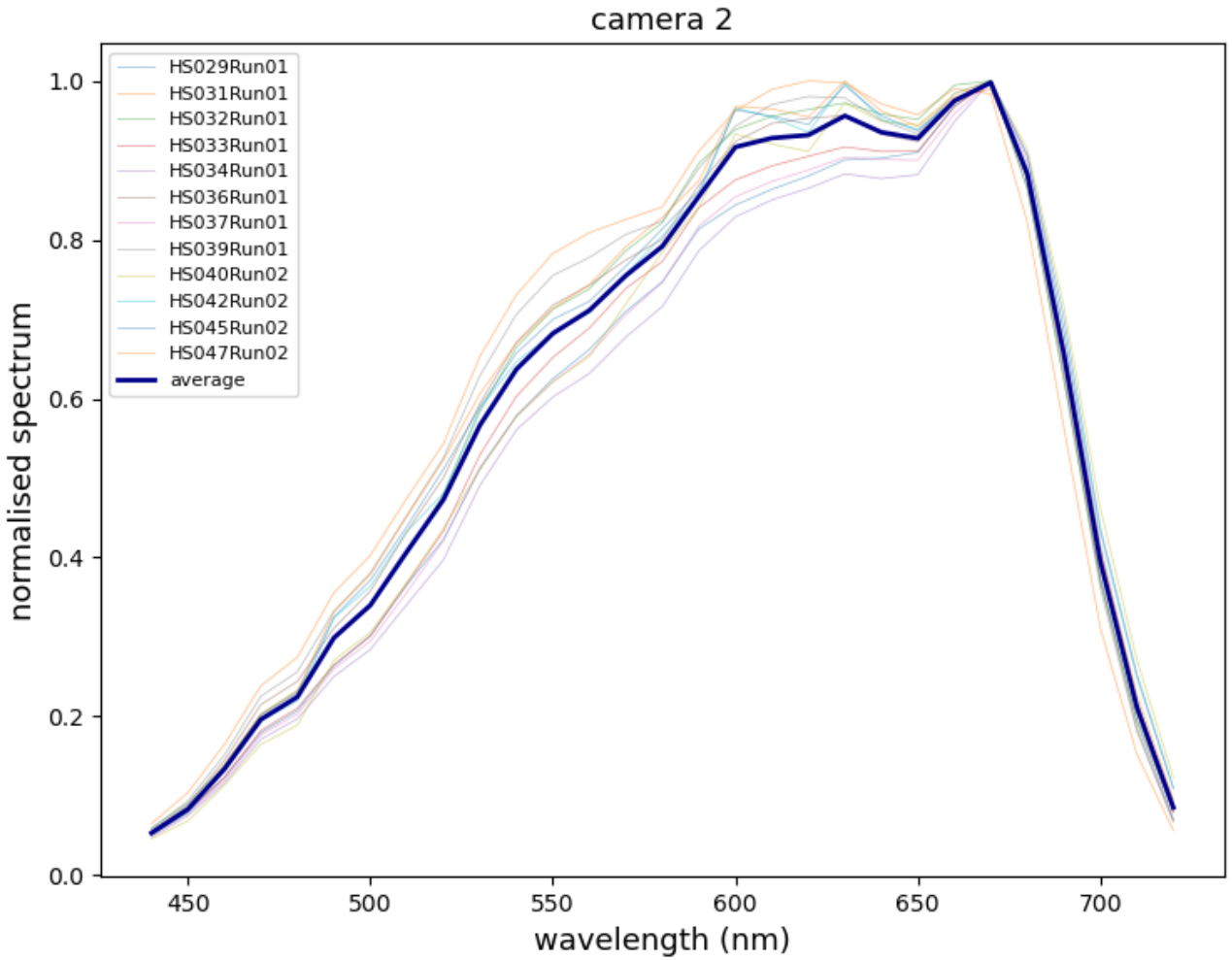


Green: reemitted (534/1000)
Red: absorbed in tissue before reemission

Results

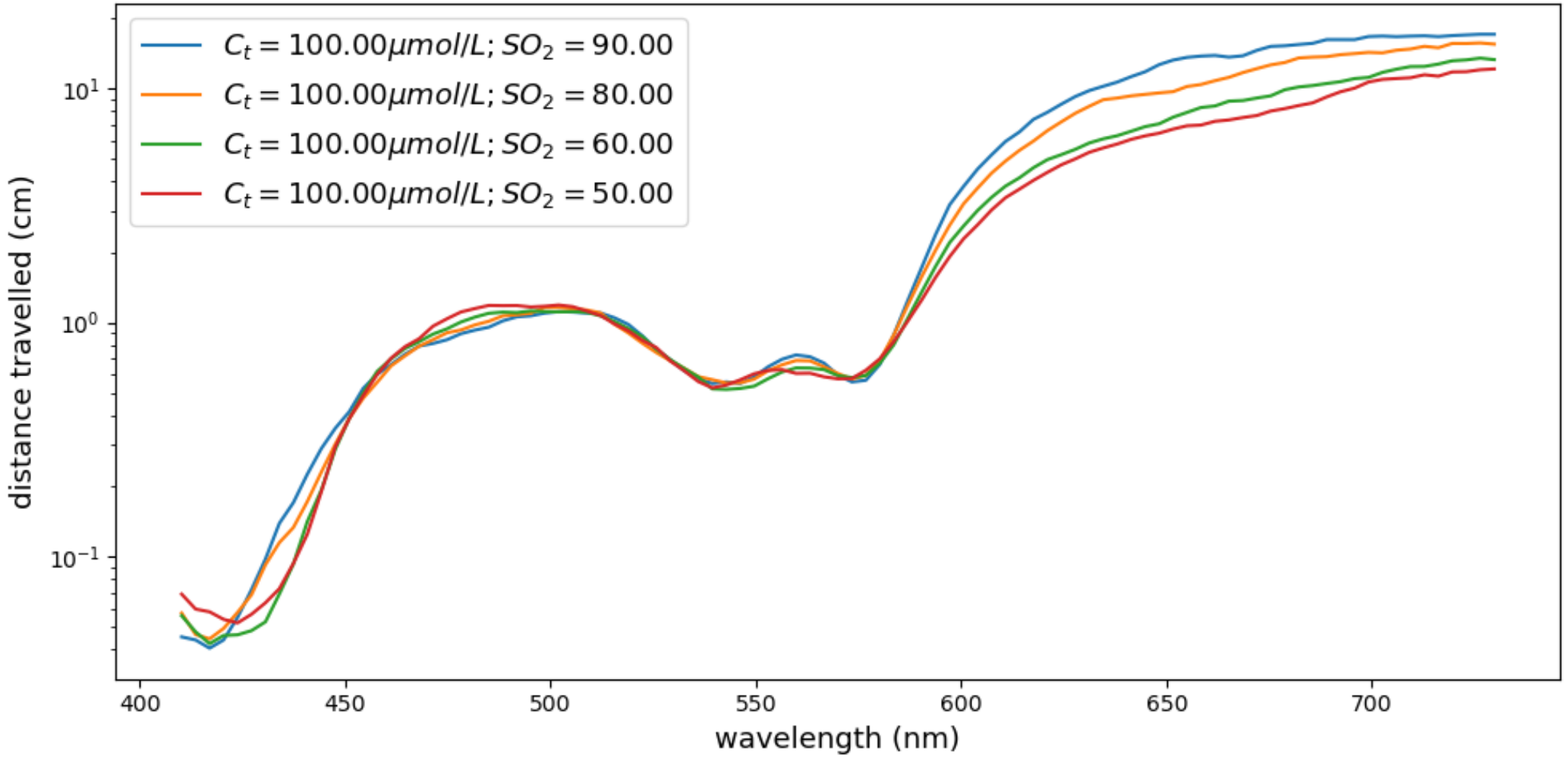
Camera spectral response





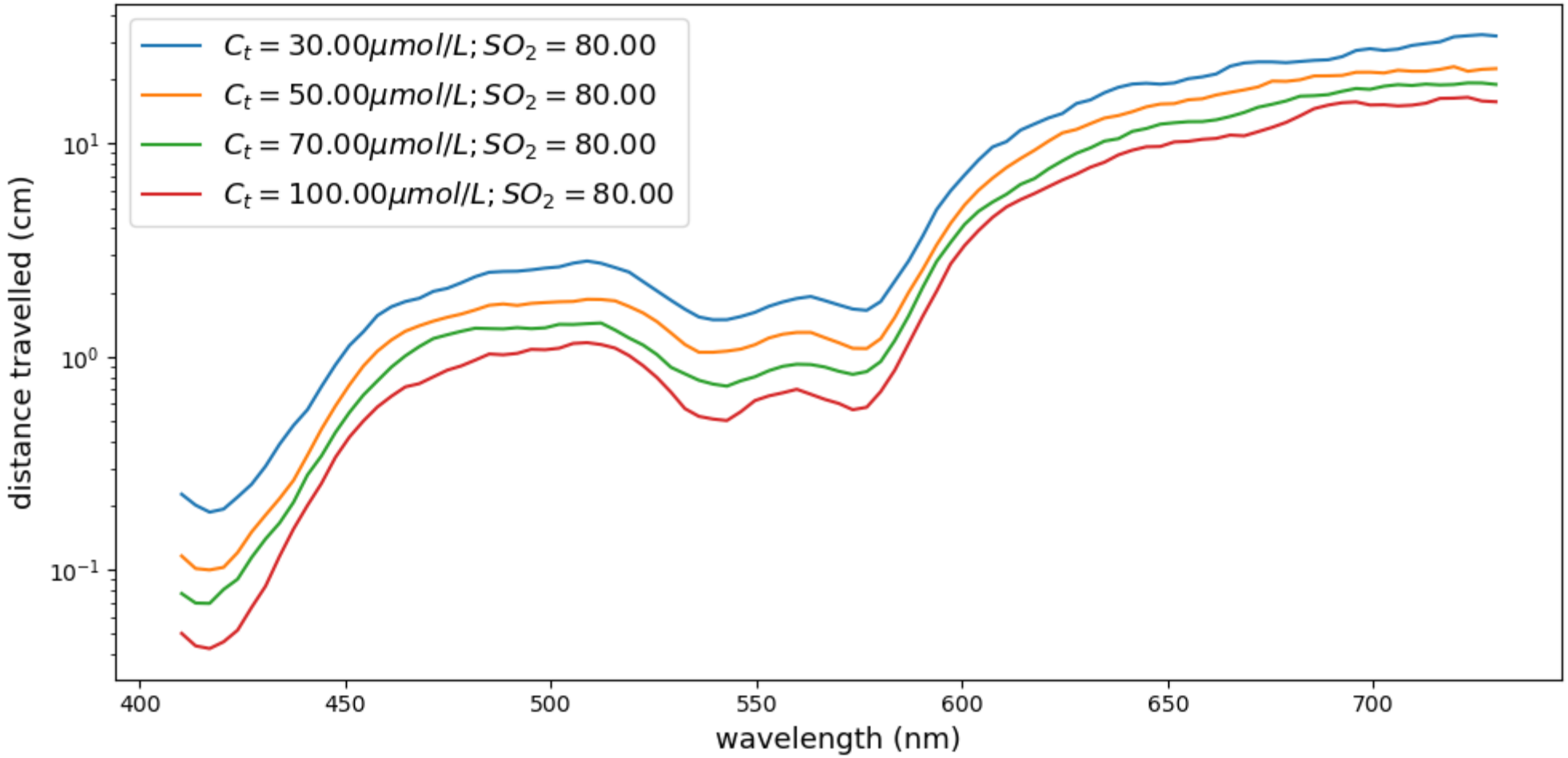
Results

Mean optical pathlength



Results

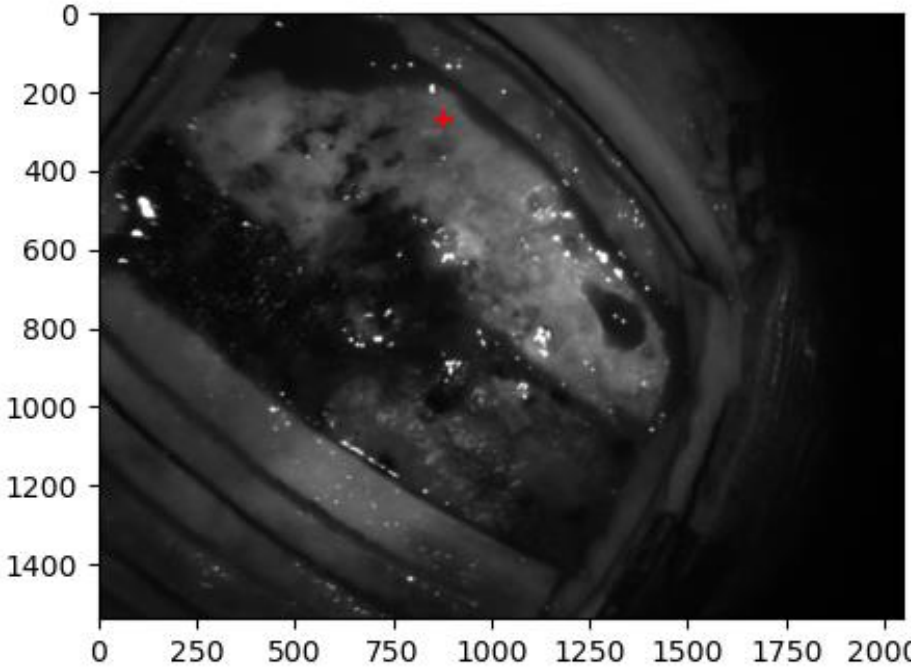
Mean optical pathlength

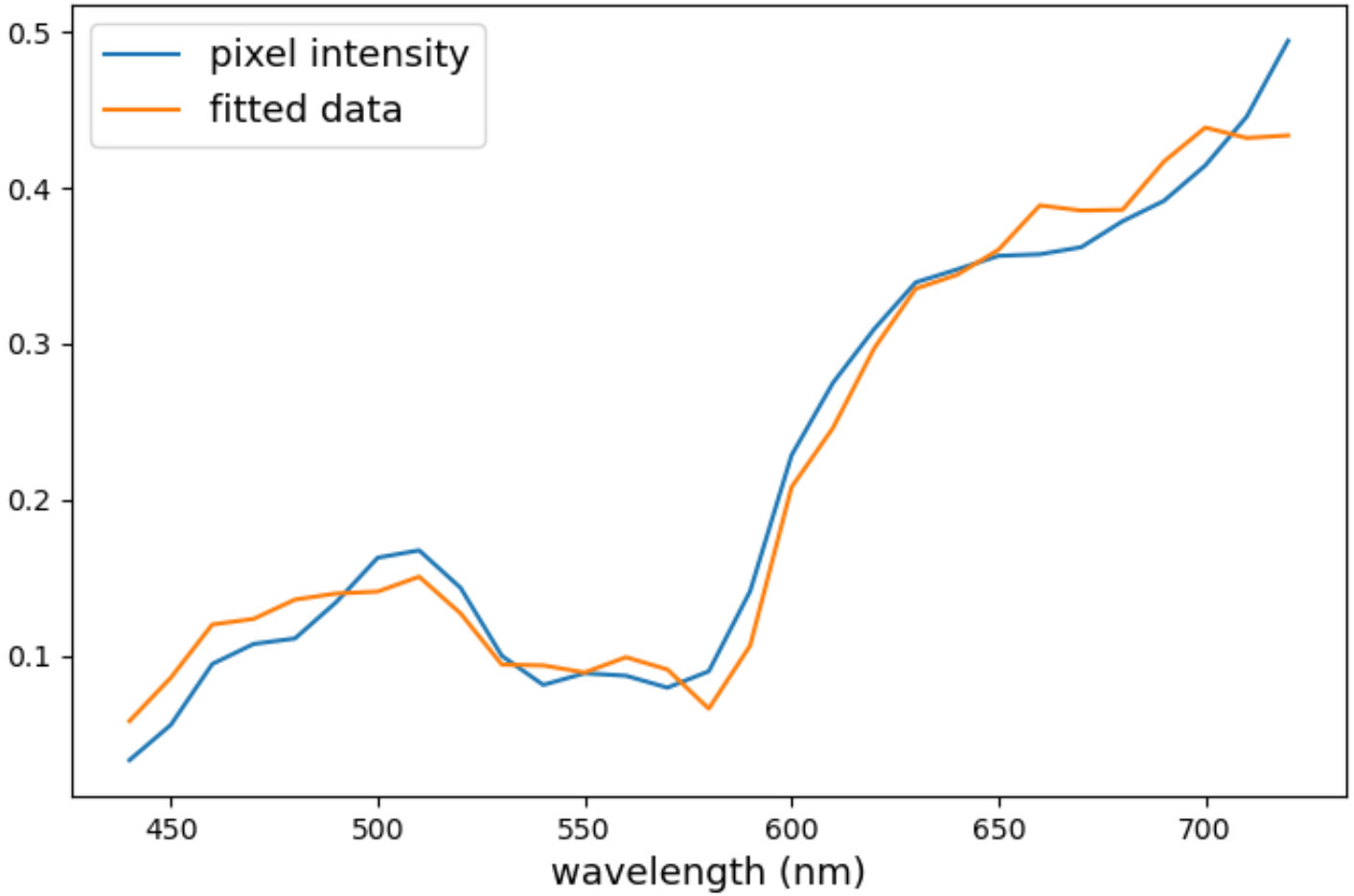


Results

Simple fitting algorithm

Image HS046 Run 04 – fitting algorithm on one pixel





Results

$SO_2 = 0.76$

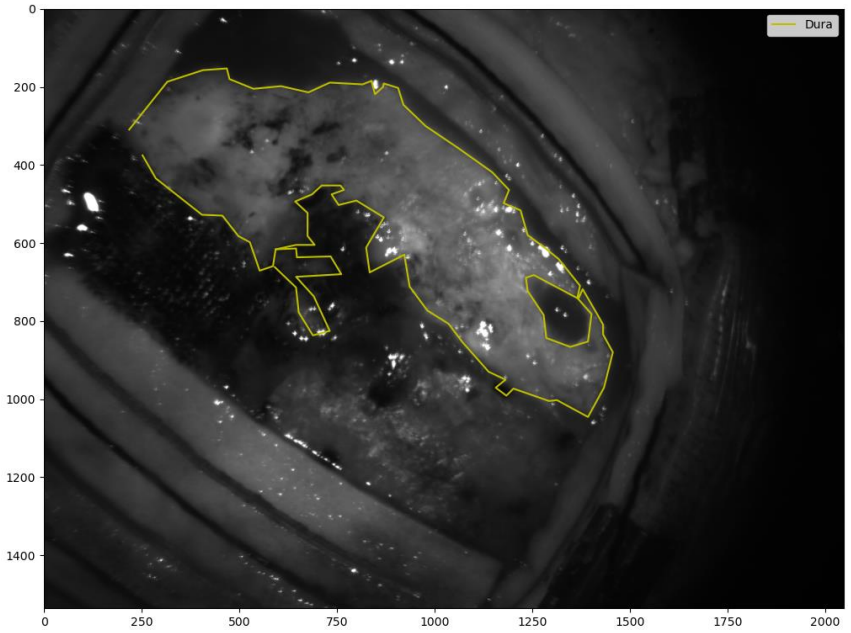
$C_t = 21.0 \mu mol/L$

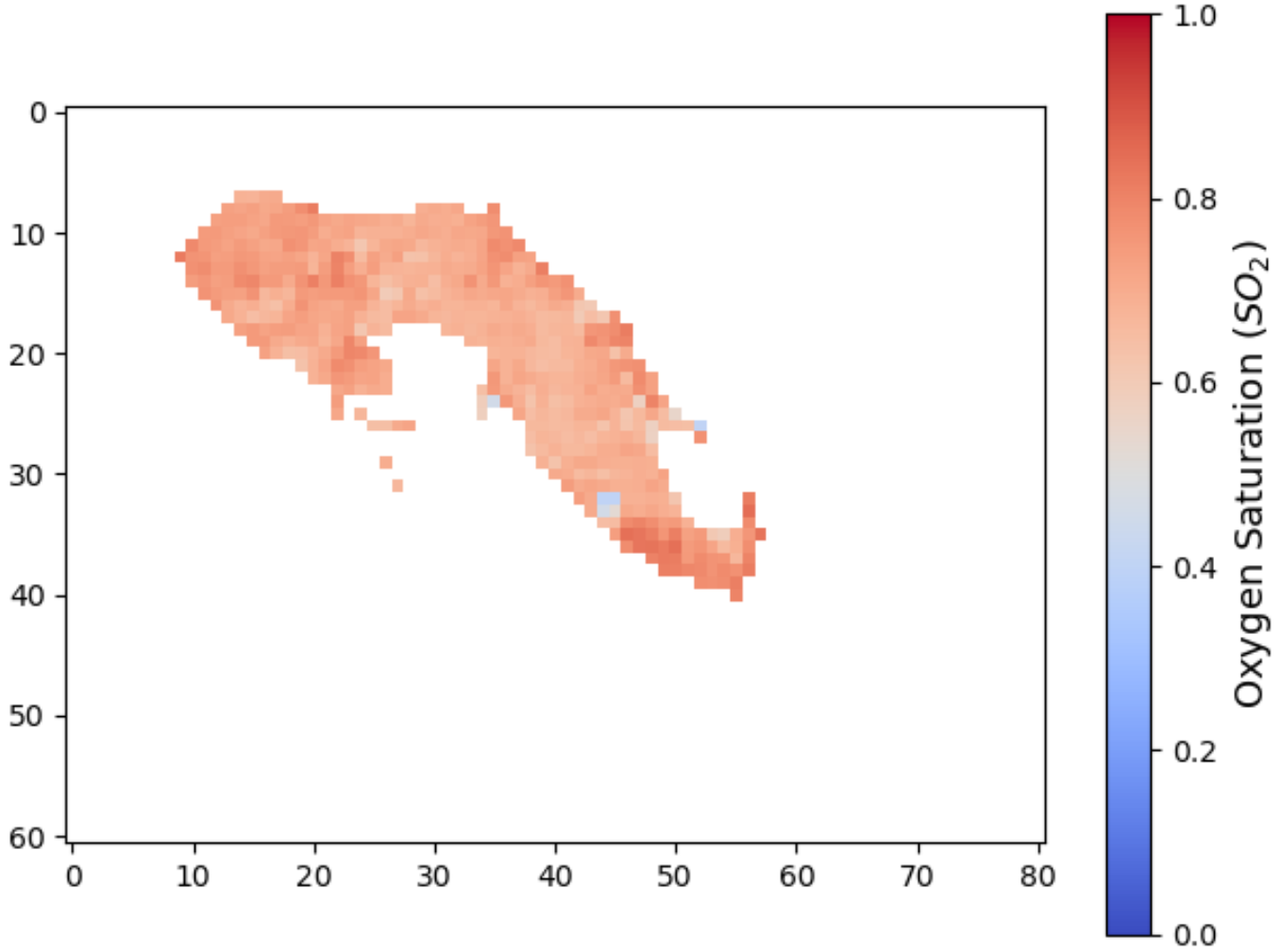
$I_0 = 0.79$

Results

Oxygen saturation mapping

Image HS046 Run 04 – fitting algorithm on 25x25 blocs of the Dura

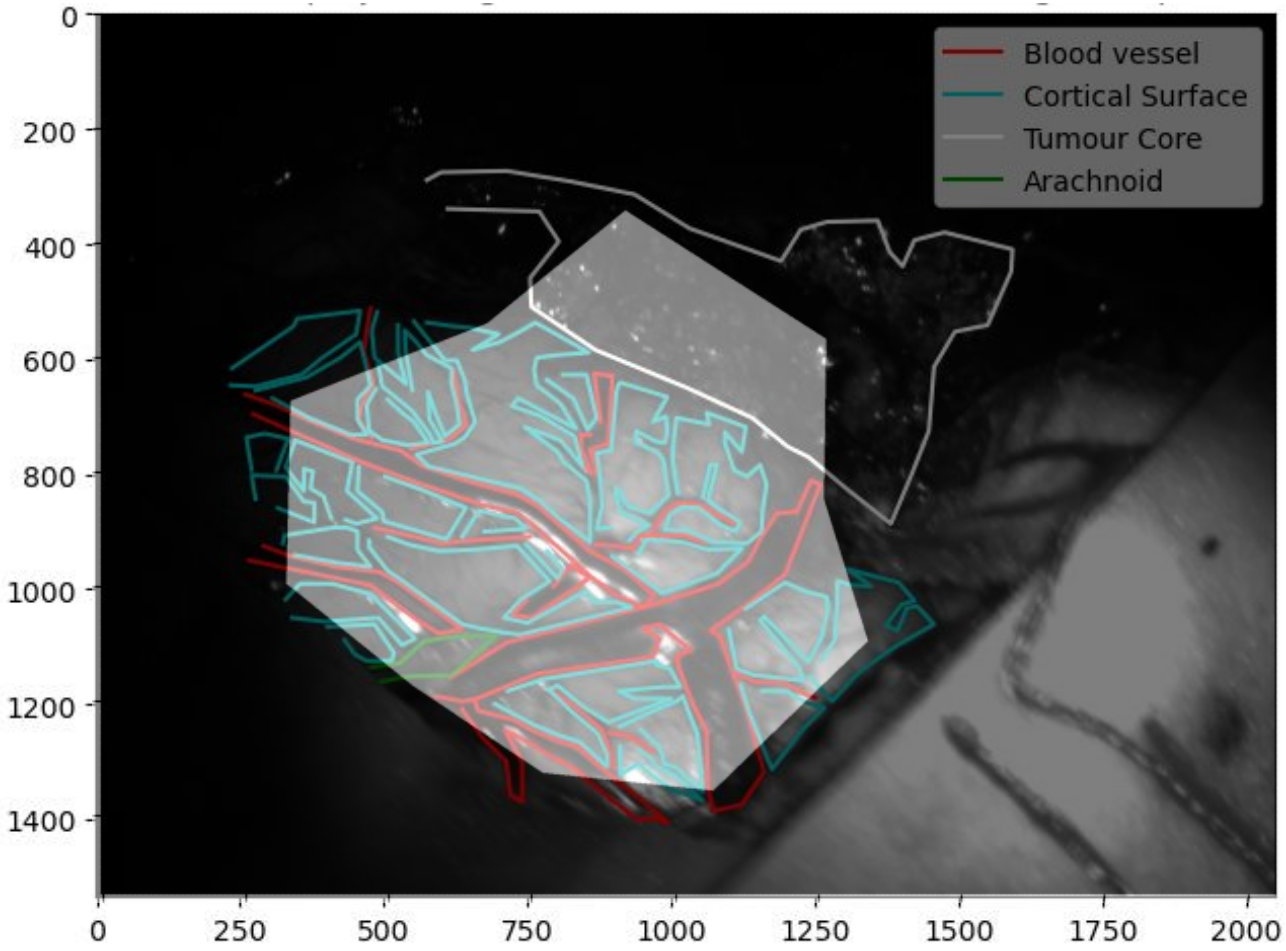




Results

Oxygen saturation mapping

HS033 Run 04 – Segmented tissues

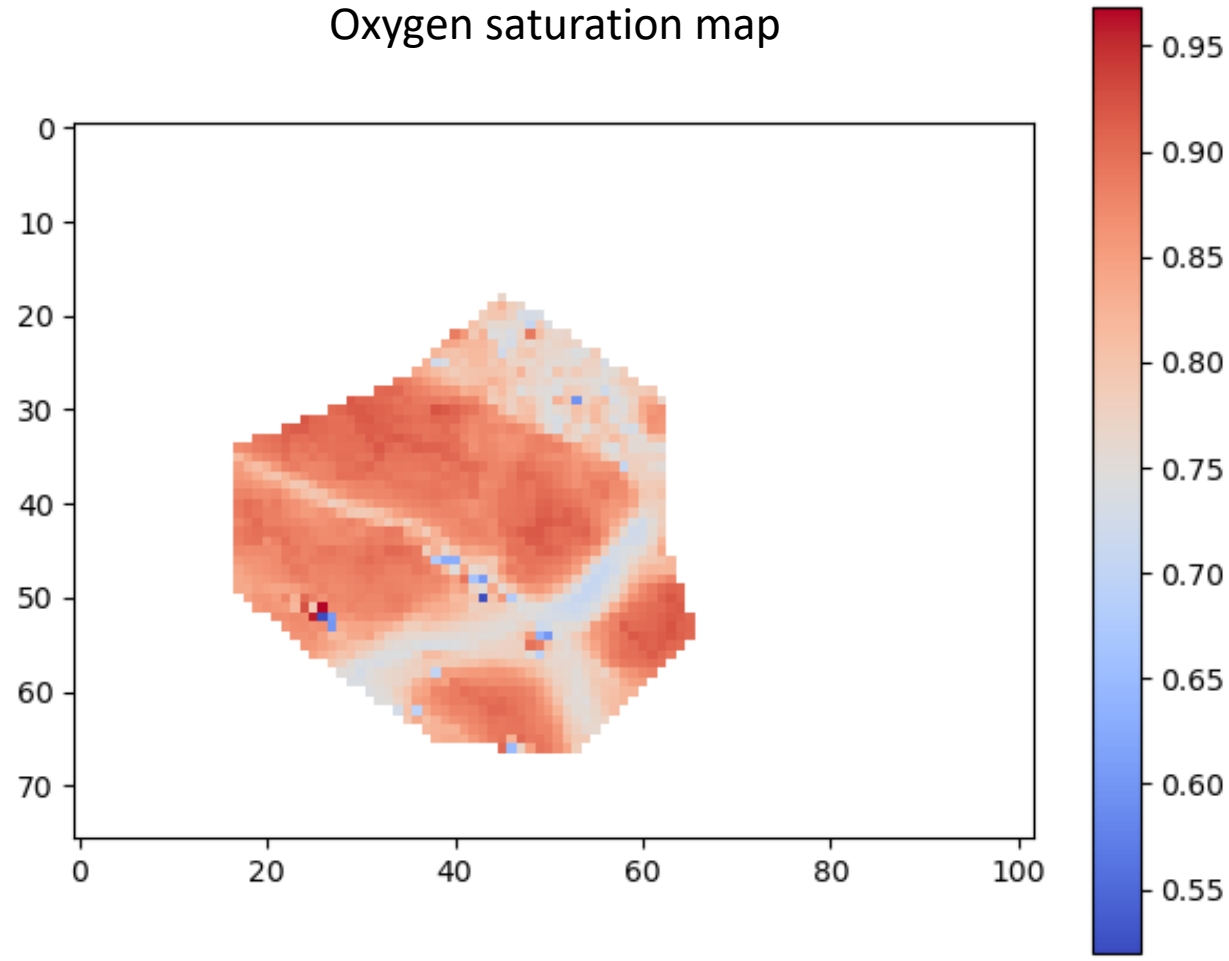


Results

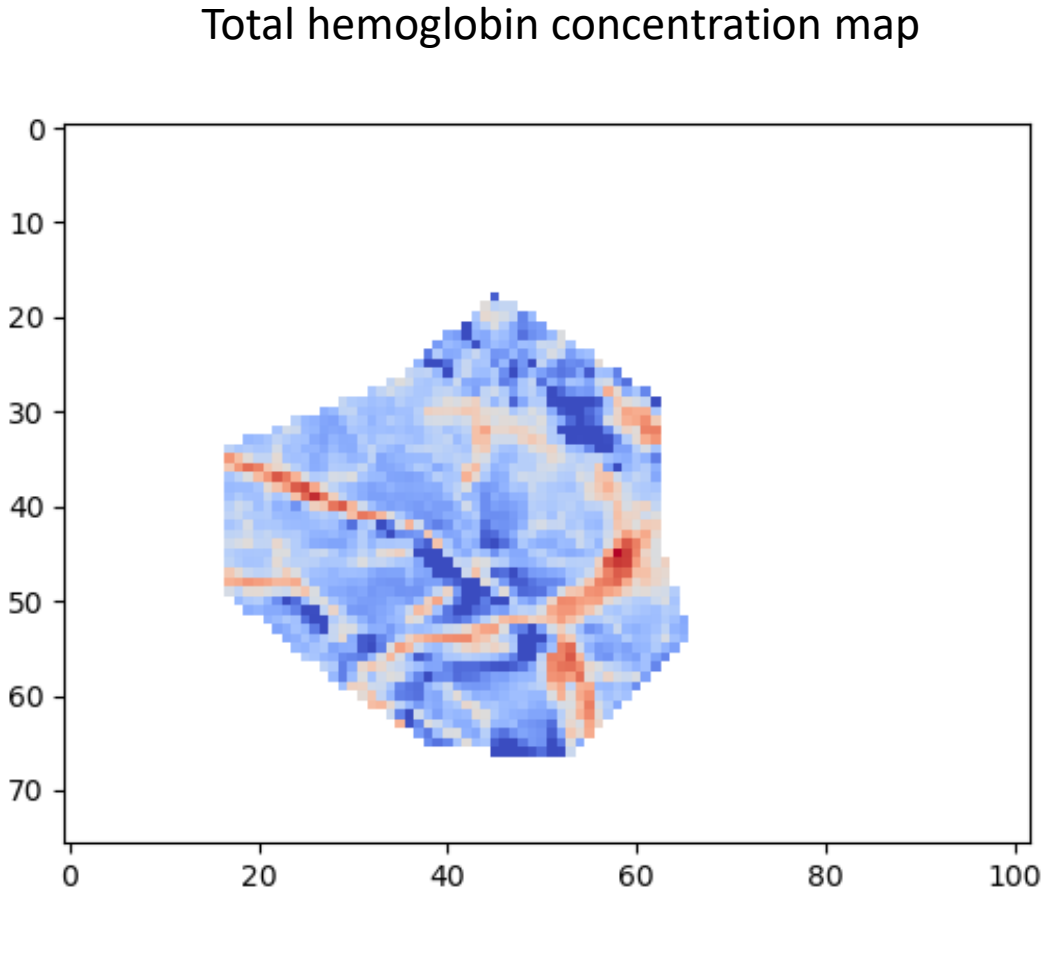
Oxygen saturation mapping

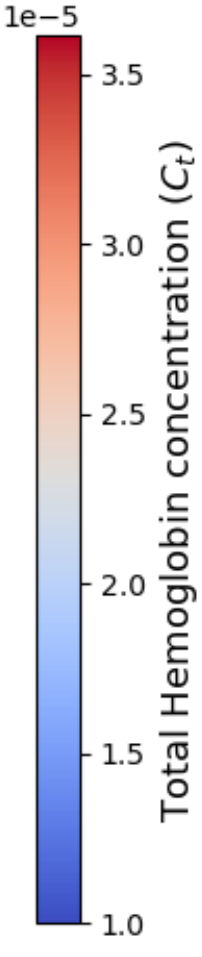
HS033 Run 05 – Fitting algorithm on 20x20 blocs in selected polygon

Oxygen saturation map



Total hemoglobin concentration map

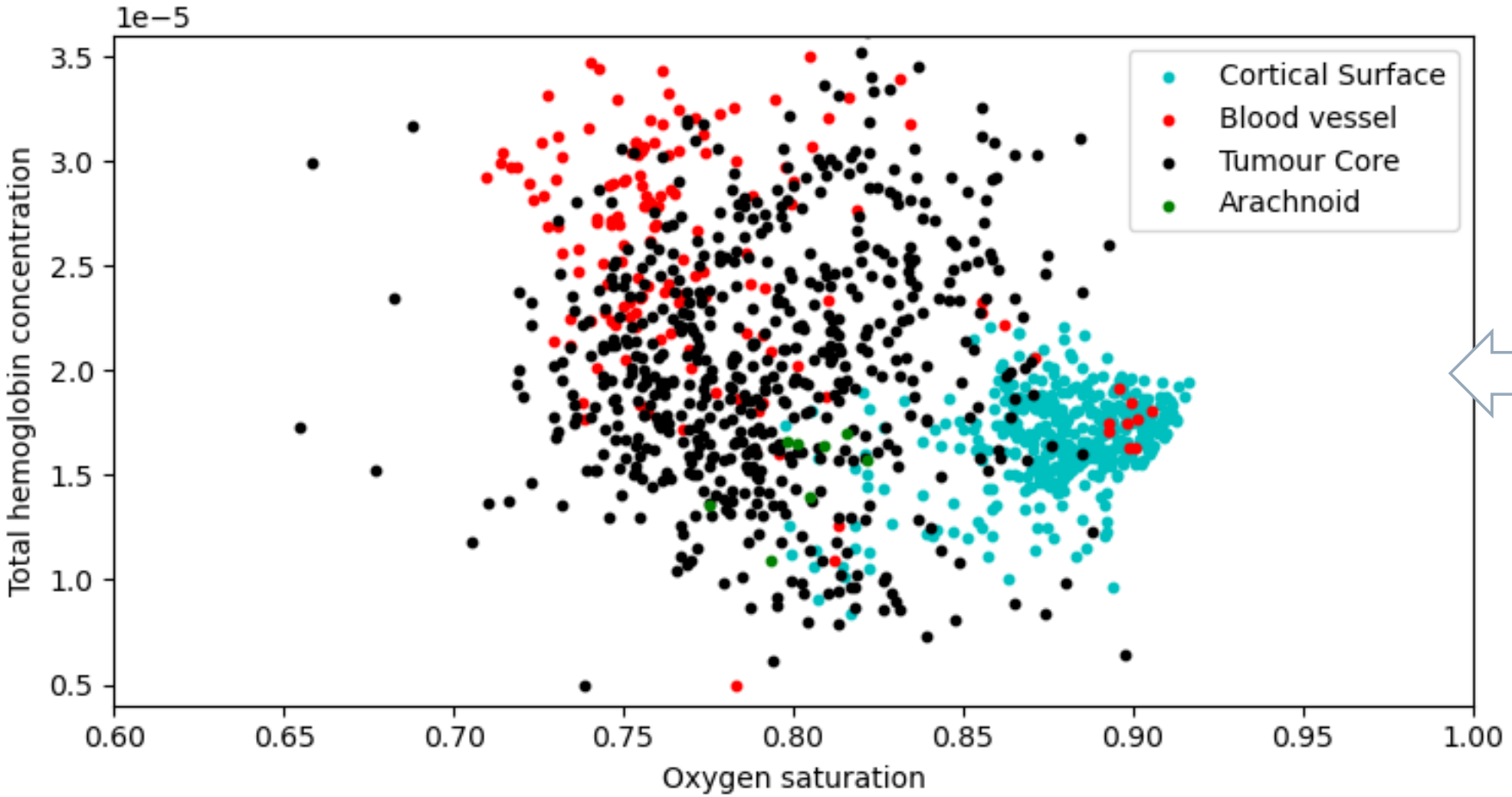




Results

Oxygen saturation mapping

HS033 Run 05 - SO_2 and C_t of the segmented tissues

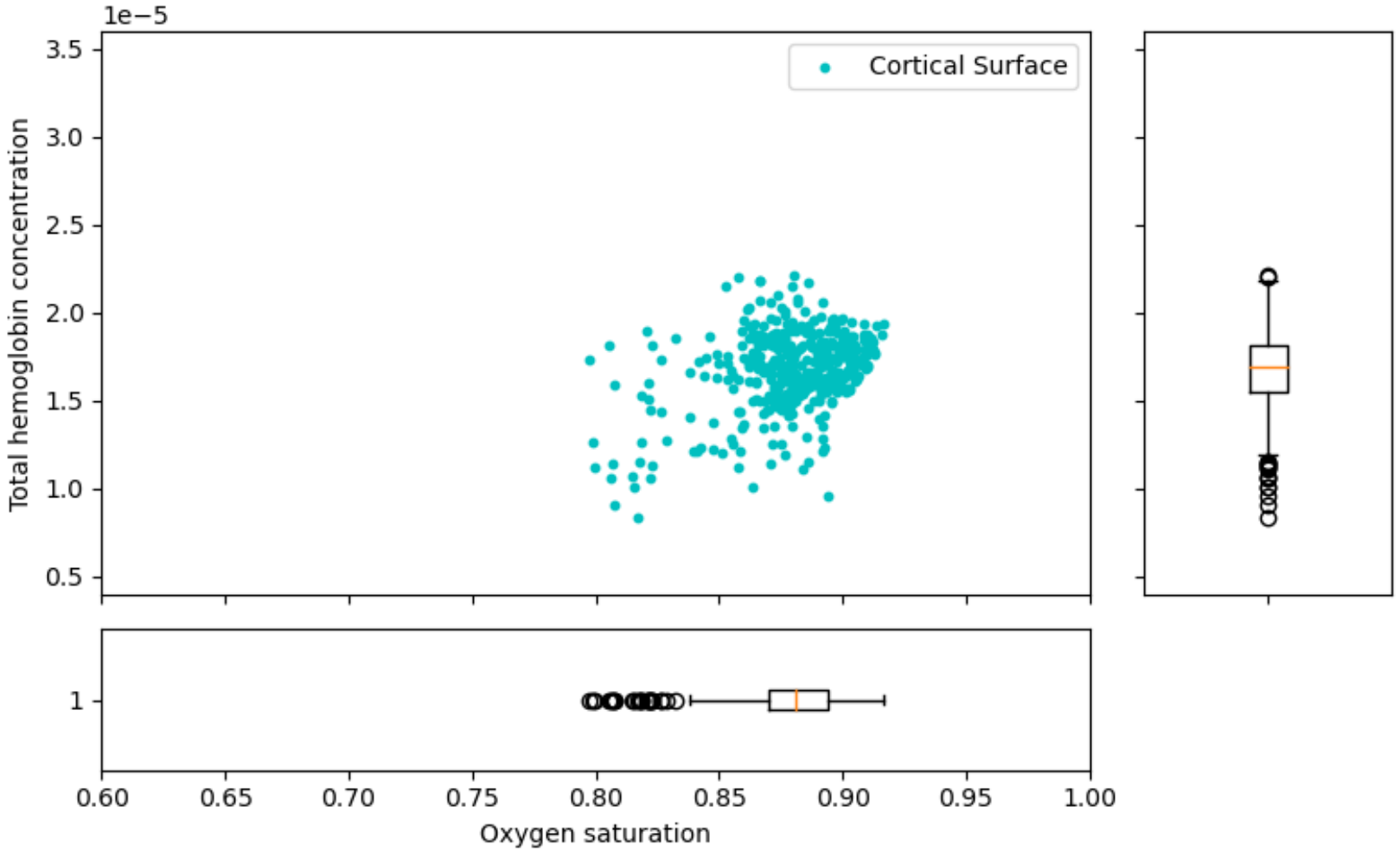


Can be used in SVM algorithms to classify the tissues (supervised machine learning)

Results

Oxygen saturation mapping

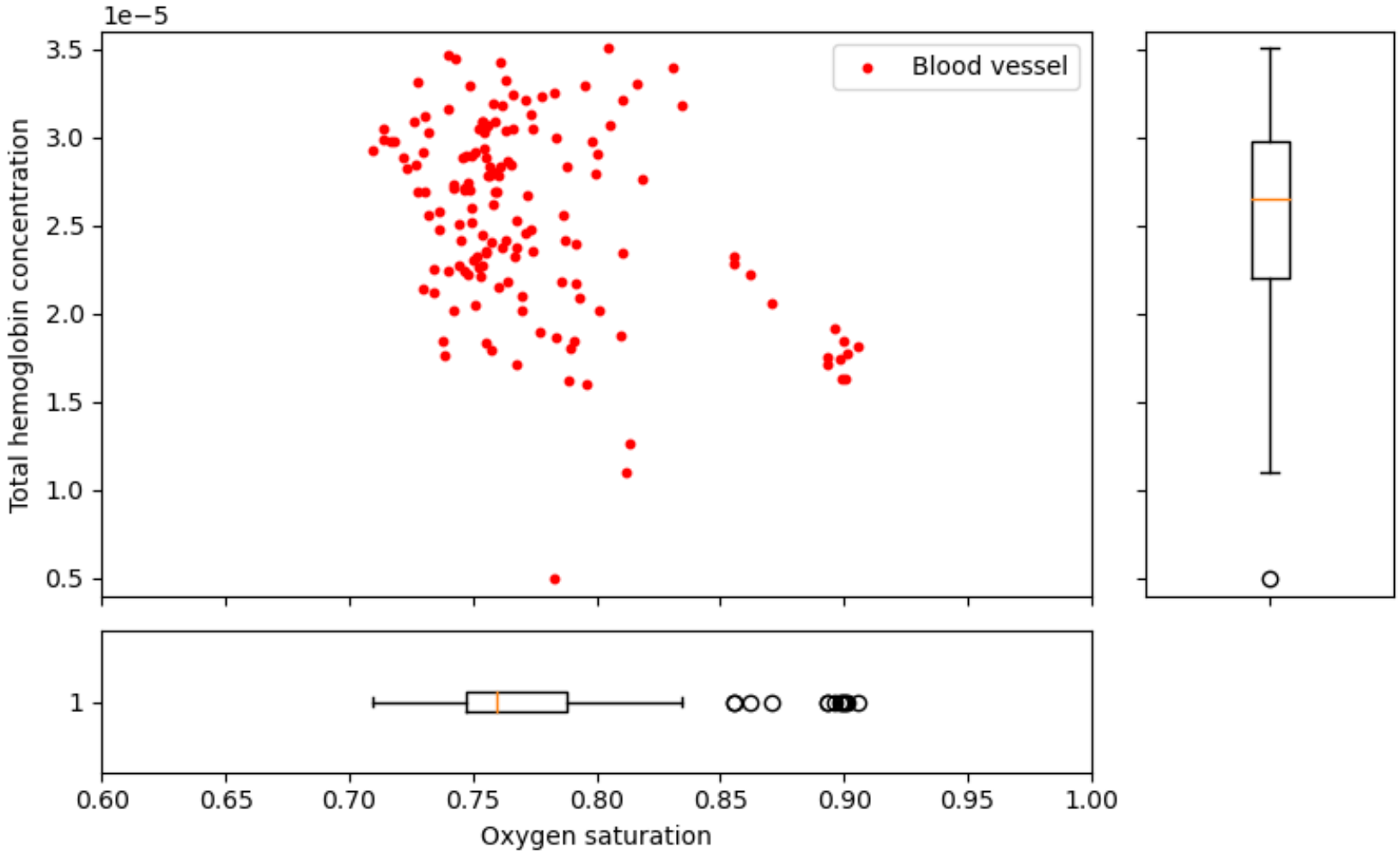
HS033 Run 05 - SO_2 and C_t of the segmented tissues



Results

Oxygen saturation mapping

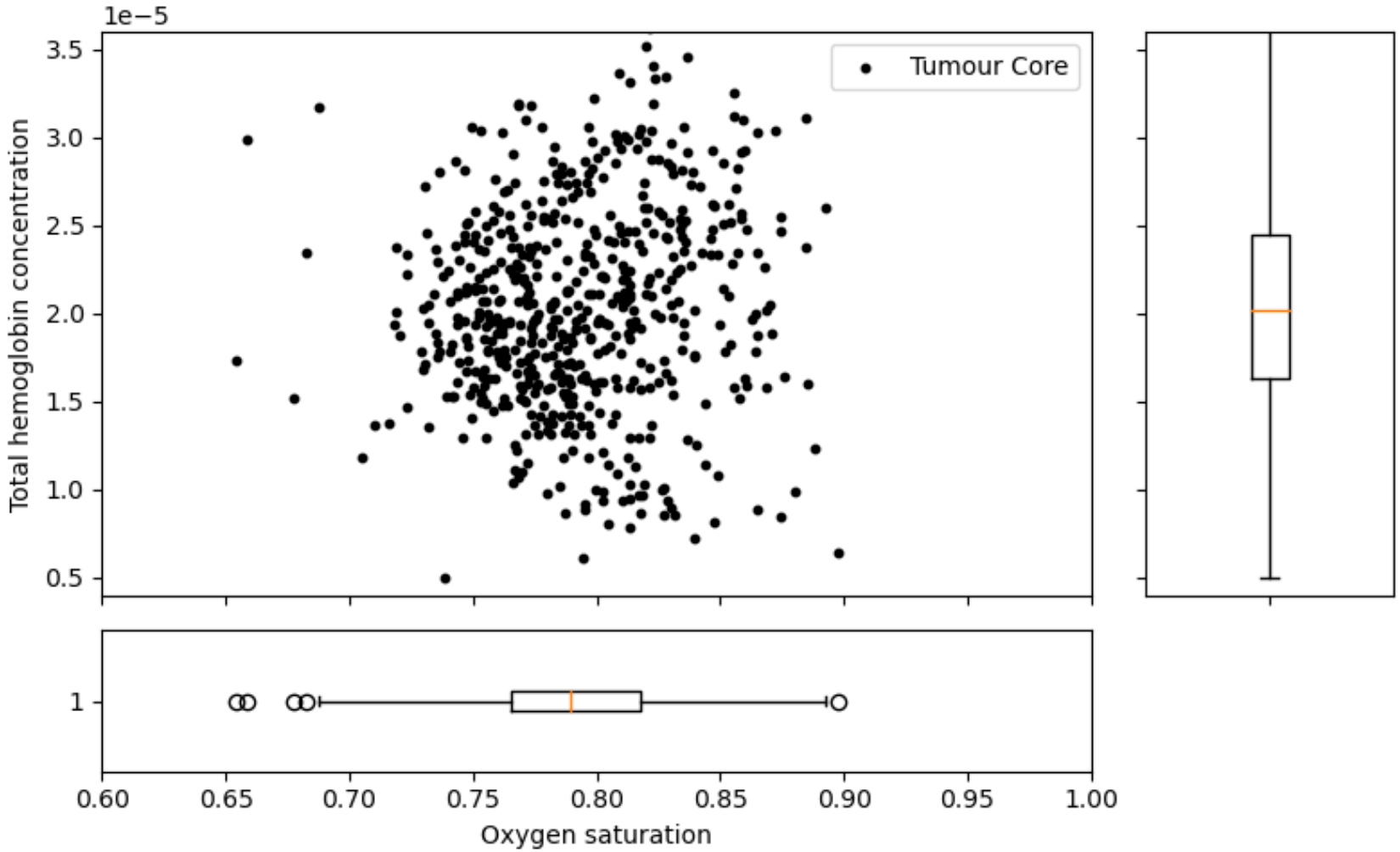
HS033 Run 05 - SO_2 and C_t of the segmented tissues



Results

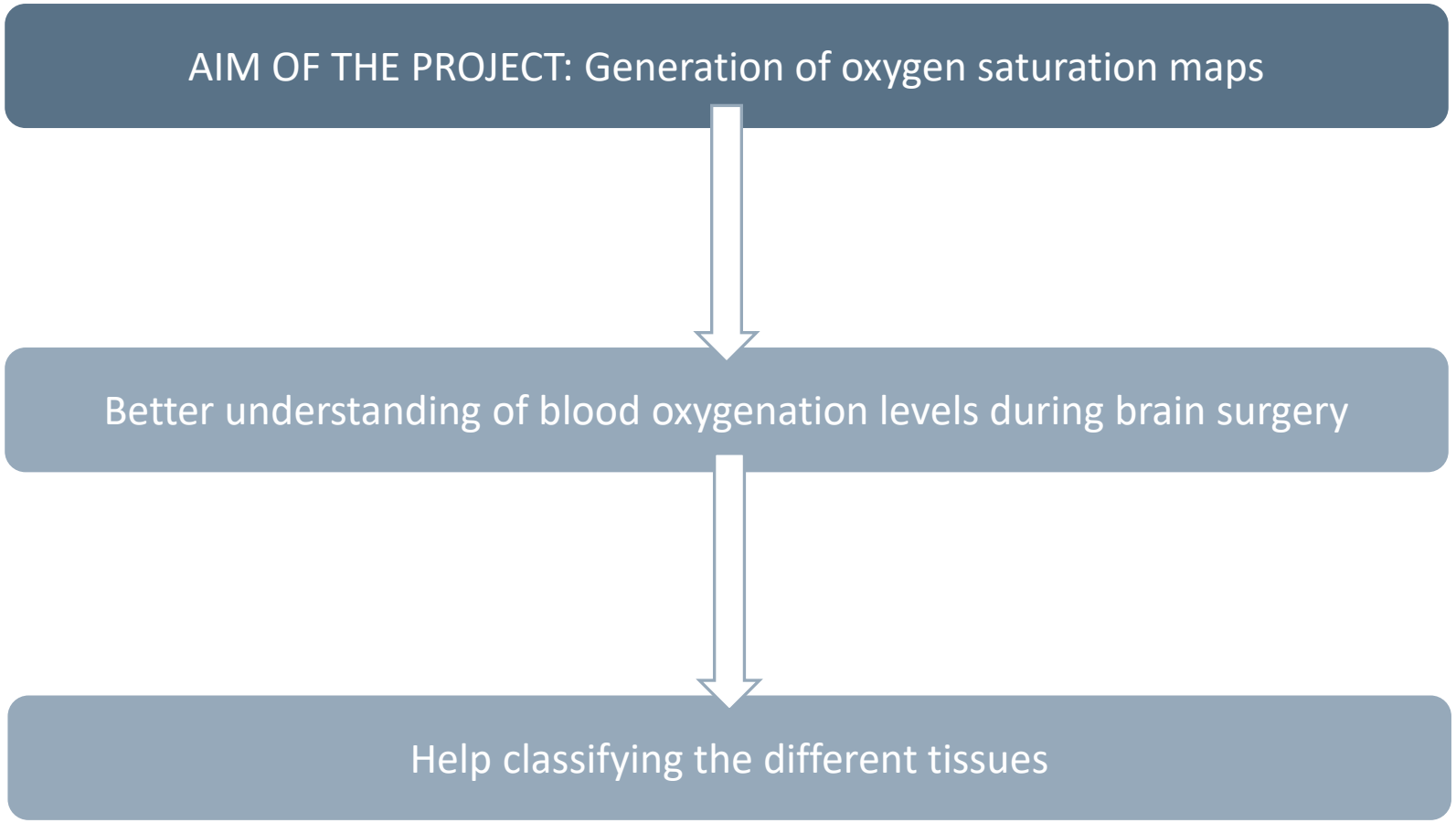
Oxygen saturation mapping

HS033 Run 05 - SO_2 and C_t of the segmented tissues



Discussion and conclusion

Clinical insight



Thank you

FOR YOUR ATTENTION