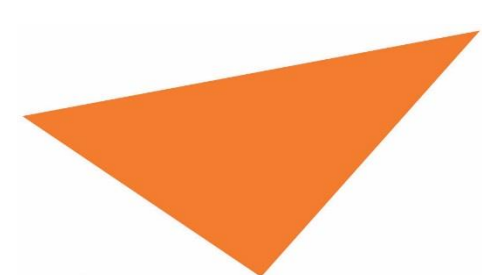# Simulation and visualisation of optical properties in an improved cross-sectional bladder model

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Abstract. Accurate diagnosis and predicted treatment response of urinary bladder diseases are often difficult to provide. We aimed to develop and describe a cross-sectional model of bladder optical properties, capable of visually representing the passage of photons through the tissue layers. Using spectrophotometry and the "LAKK-M" system, our ultimate goal was to successfully simulate the effects of varying exciting radiation wavelengths on bladder tissue to determine the effectiveness of photonics diagnostic devices.

Urinary bladder cancer (UBC).

UBC is one of the top ten most prevalent cancers worldwide, with a considerable level of patient morbidity. Due to the recurrence rate and disease progression, UBC is the single most expensive on a per-patient basis.

3D Model Construction.

Bladder sections cut into 2cm[2] sections (6-10mm thick). Samples analysed for transmission, absorption and diffuse reflectance at 1.5nm increments for 350-1800 nm range. Tissue absorption and scattering coefficients were determing based off the above measurements through a combination of the inverse adding-doubling (IAD) method with a corrective Monte-Carlo calculation [2,3]. TracePro (Lambda Software) used to simulate a muscle and mucosa 2-layer model with radiation source and detector mimicking that of the "LAKK-M" system (SPE "LAZMA" Ltd, Russia).
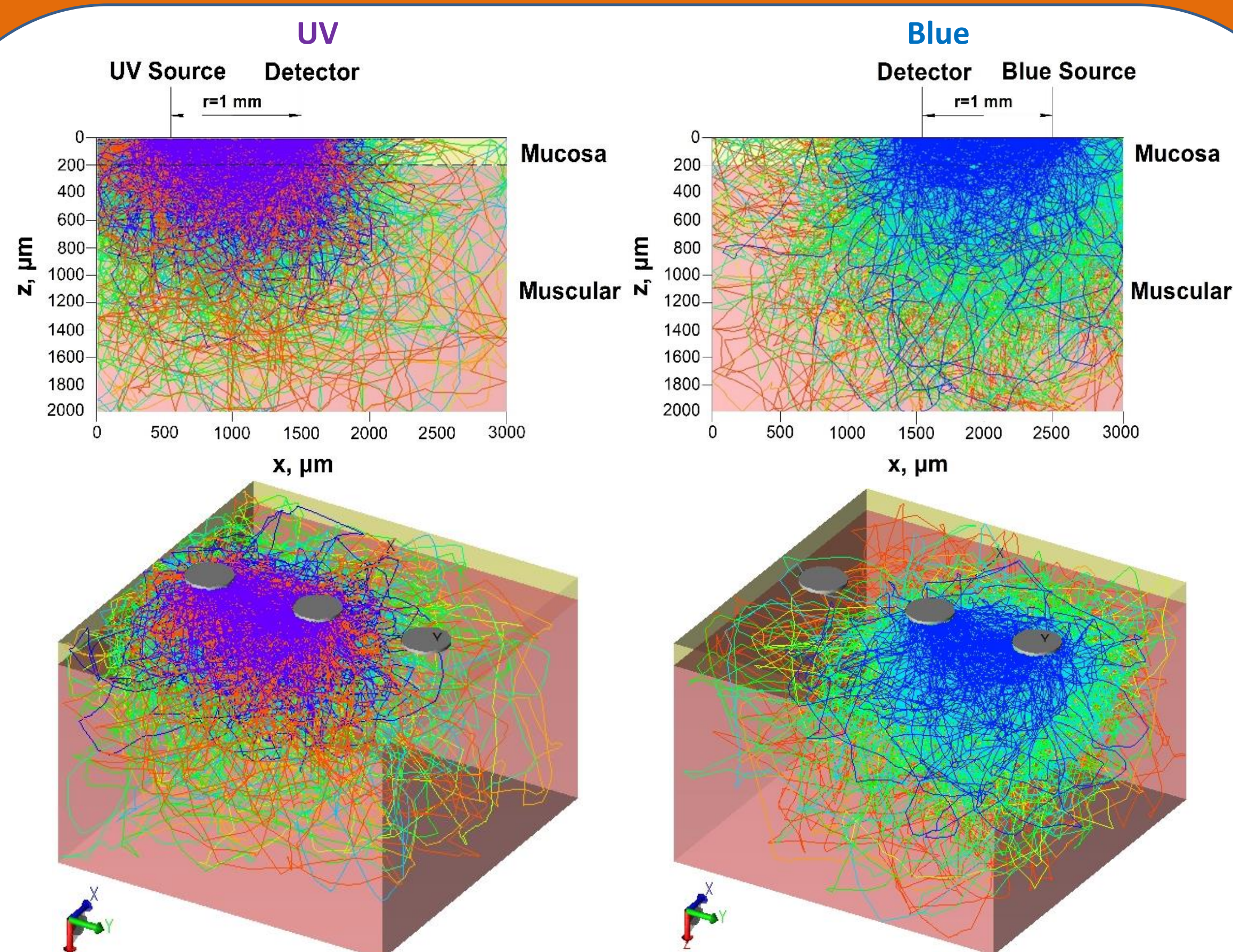

Left – side view and full 3D view of model depicting simulated UV light within tissue. Right – side view and full 3D view of model depicting simulated Blue light within tissue. The source, detector and the tissue layers are labelled. Lines indicate the passage of individual photons.

Fluorescence measurement.

Fluorescence of tissue was required to prove effectiveness of model. The "LAKK-M" (left) is a multi-functional non-invasive diagnostic system. The available UV (365nm) and blue (450nm) excitation wavelengths were used to record fluorescence spectroscopy measurements of tissue samples after initial spectroscopic measurements.
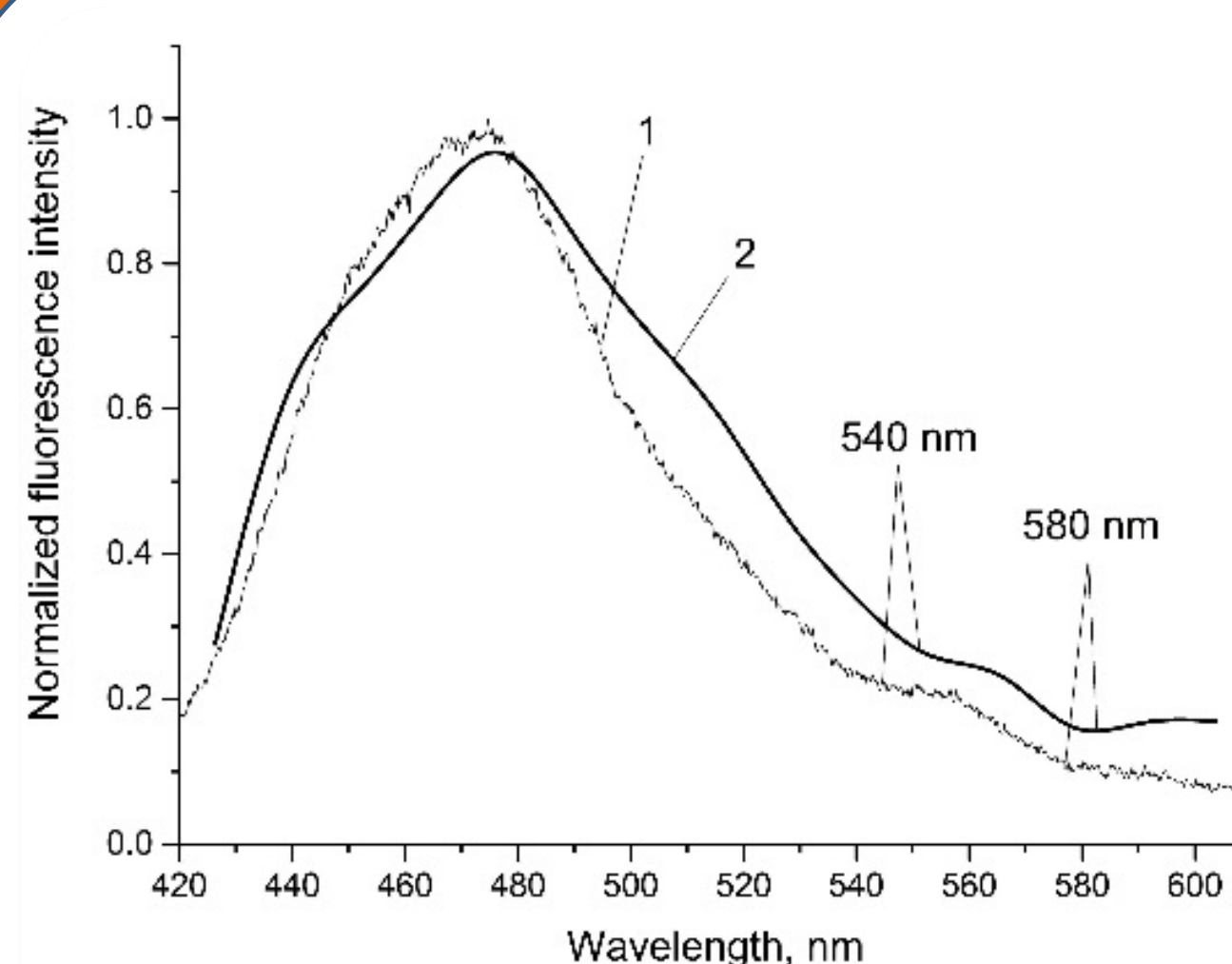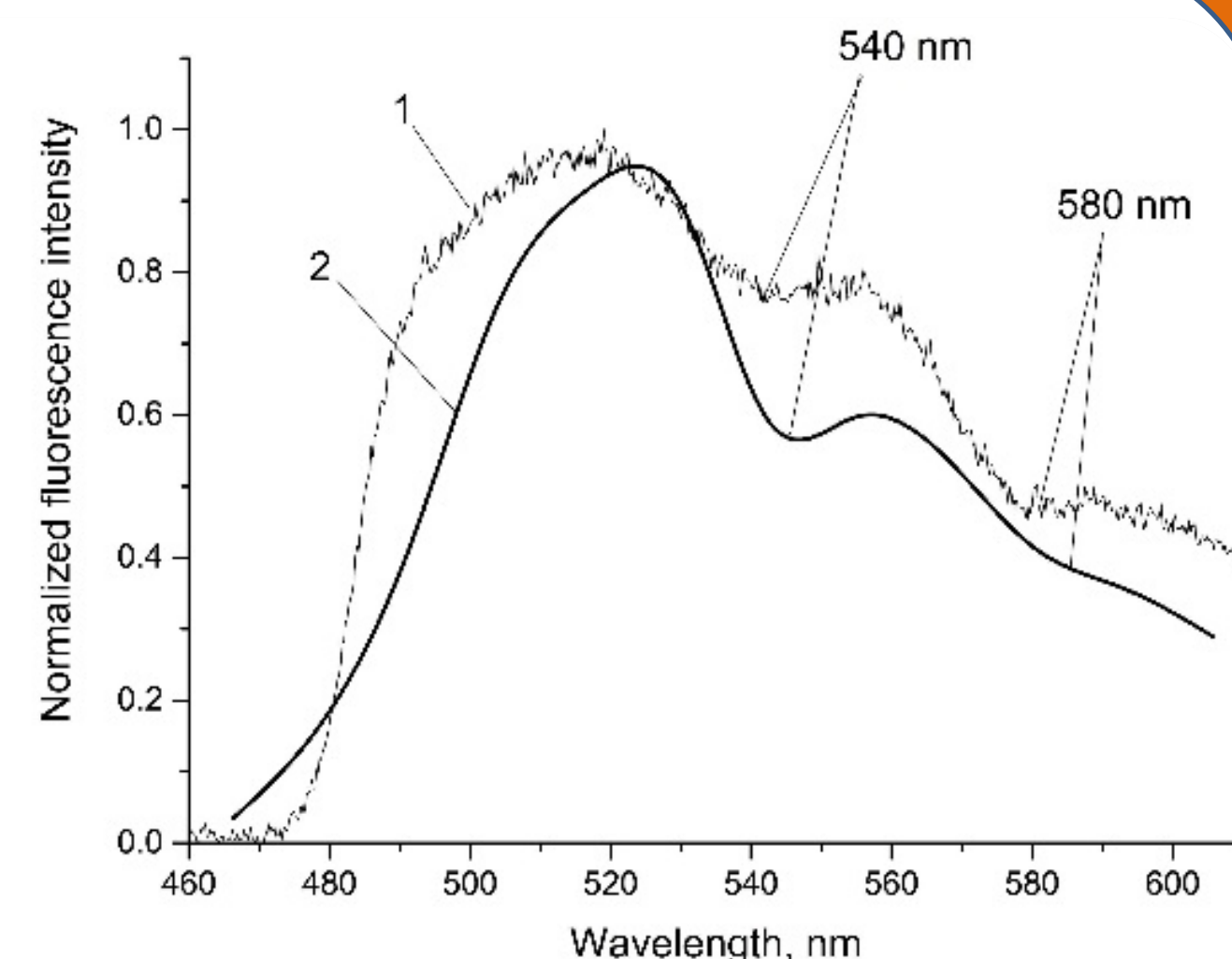
Outcomes and future prospects.

Simulated spectra were compared to experimentally obtained ones (right). High degree of accuracy, including haemoglobin peaks at 540 and 580nm, can be observed. NADH, FAD and collagen seem to heavily influence the spectra of urinary bladder tissue [4,5]. With further improved accuracy (through use of human tissue), this model can greatly aid early detection of diseases like cancer.

References:
1) I. Rafailov *et al*, SPIE Proc. 9303, 93030W (2015).
2) T. P. Moffitt, "Compact Fiber-Optic Diffuse Reflection Probes for Medical Diagnostics," (2007).
3) S. a Prahl, *et al*, Appl. Opt. 32, 559–568 (1993).
4) R. Drezek, *et al*, Photochem. Photobiol. 73, 636 (2001).
5) I. Pavlova, *et al*, Photochem. Photobiol. 77, 550 (2003).