

THE POSSIBILITIES OF OPTICAL NON-INVASIVE DIAGNOSTICS FOR STUDYING MICROCIRCULATION DISORDERS IN TISSUES IN PATIENTS WITH DIABETES MELLITUS

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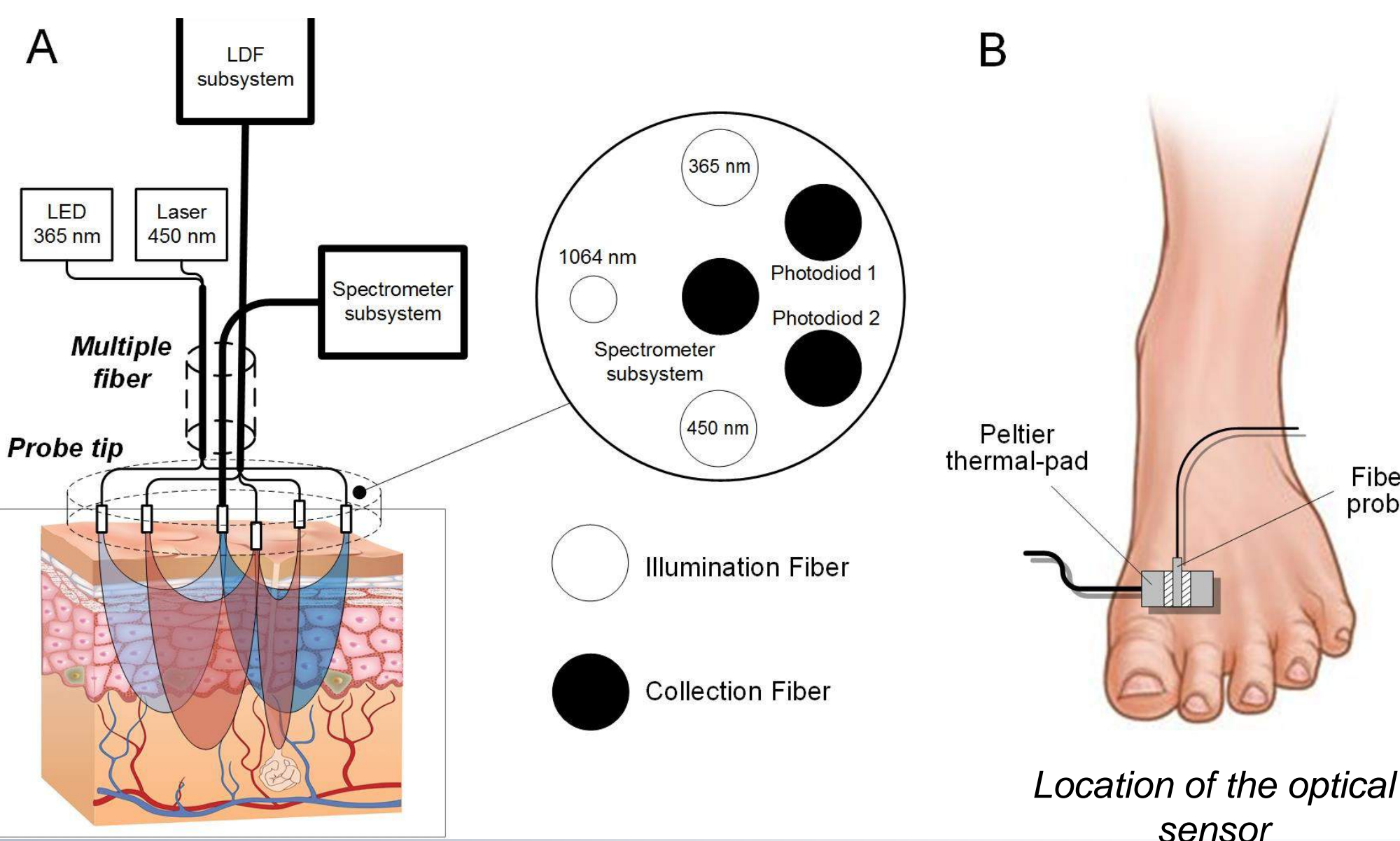
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INTRODUCTION

The problem of diabetes mellitus (DM) has attracted scientists of different specialties, as its prevalence is increasing worldwide and assumes the character of a pandemic. For today, the combined use of various optical non-invasive methods is promising and informative for complex diagnosis of complications in diabetes, for example, laser Doppler flowmetry (LDF) and fluorescence spectroscopy (FS) methods. The aim of this study was to explore the possibility of joint application of laser Doppler flowmetry and fluorescence spectroscopy methods to assess the severity of trophic disorders in diabetes mellitus.

EXPERIMENTAL METHOD

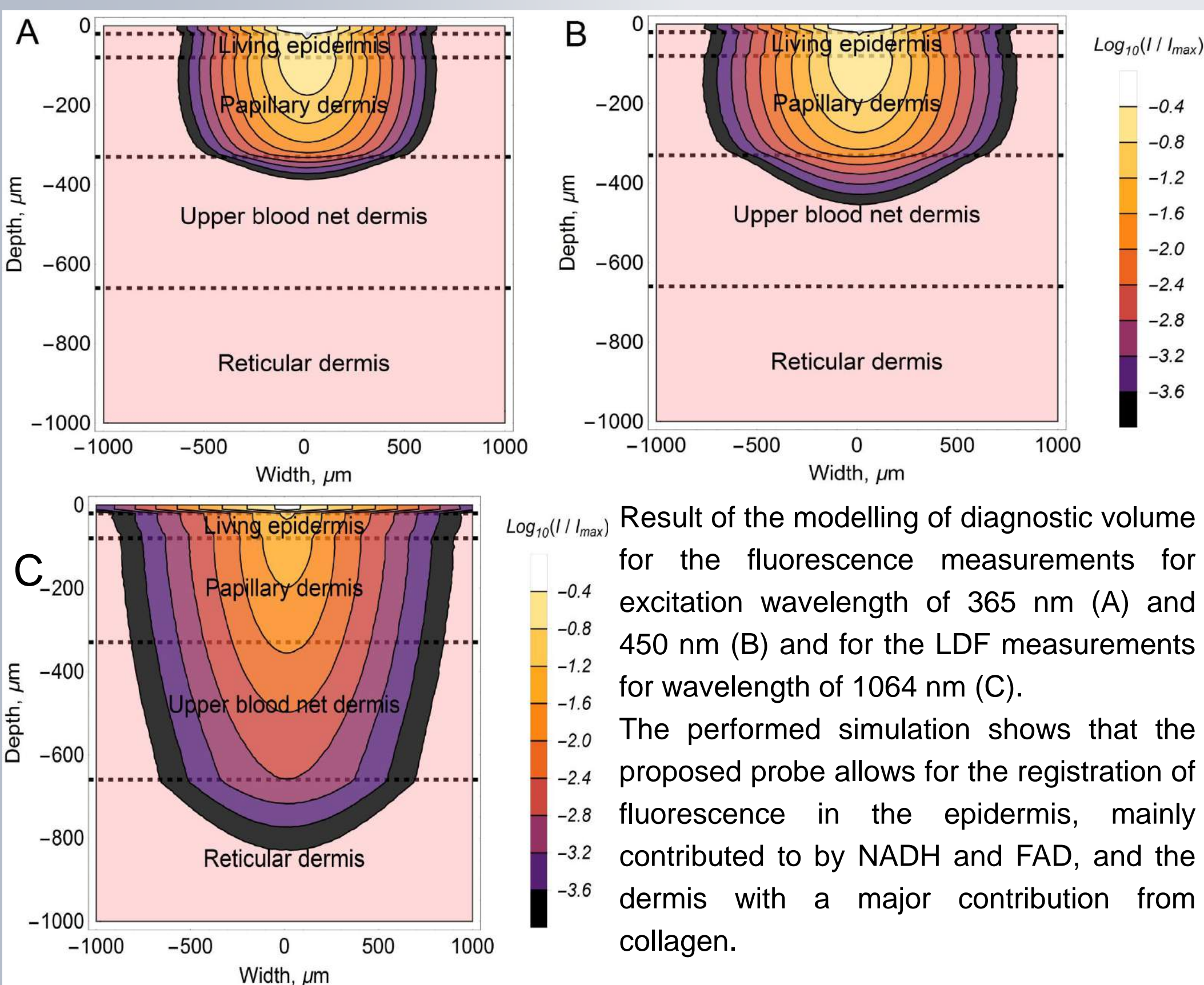
Measurements were carried out on 76 patients diagnosed with diabetes and 46 healthy volunteers.



Research method using temperature tests

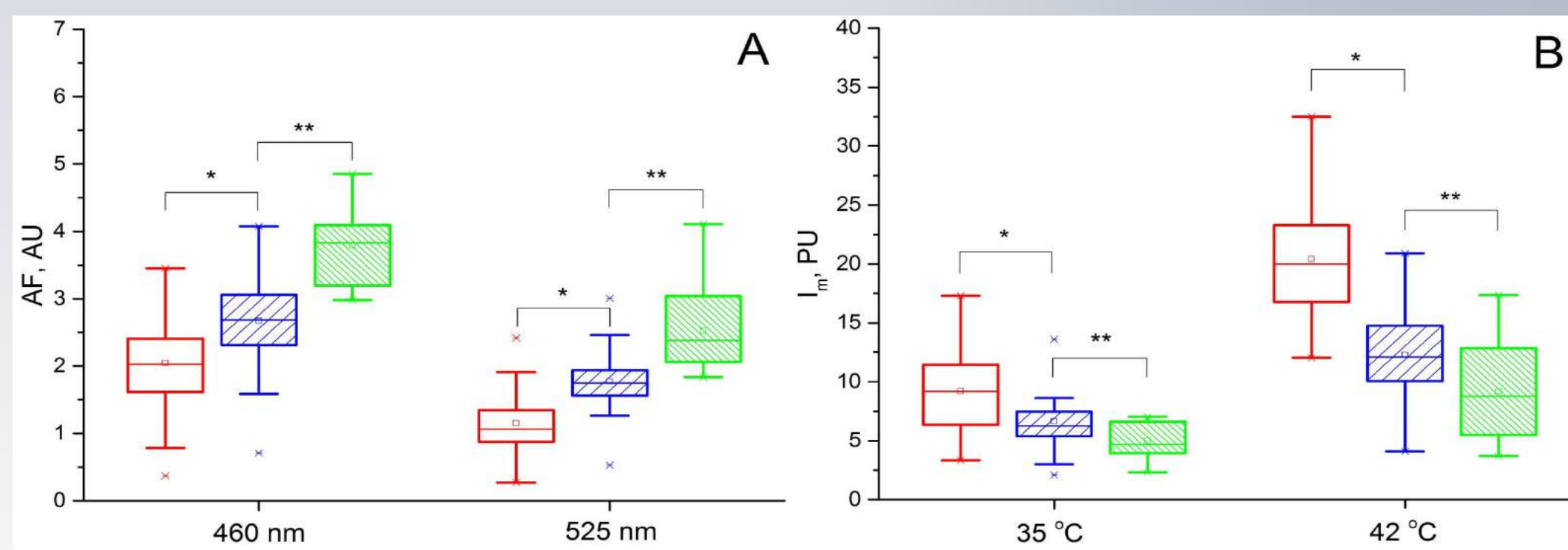
№ of stage	1	2	3	4
Methods	FS+LDF	LDF	LDF	LDF
T°C	Body temperature	25	35	42
Duration	4 min	4 min	4 min	10 min

RESULTS AND DISCUSSION

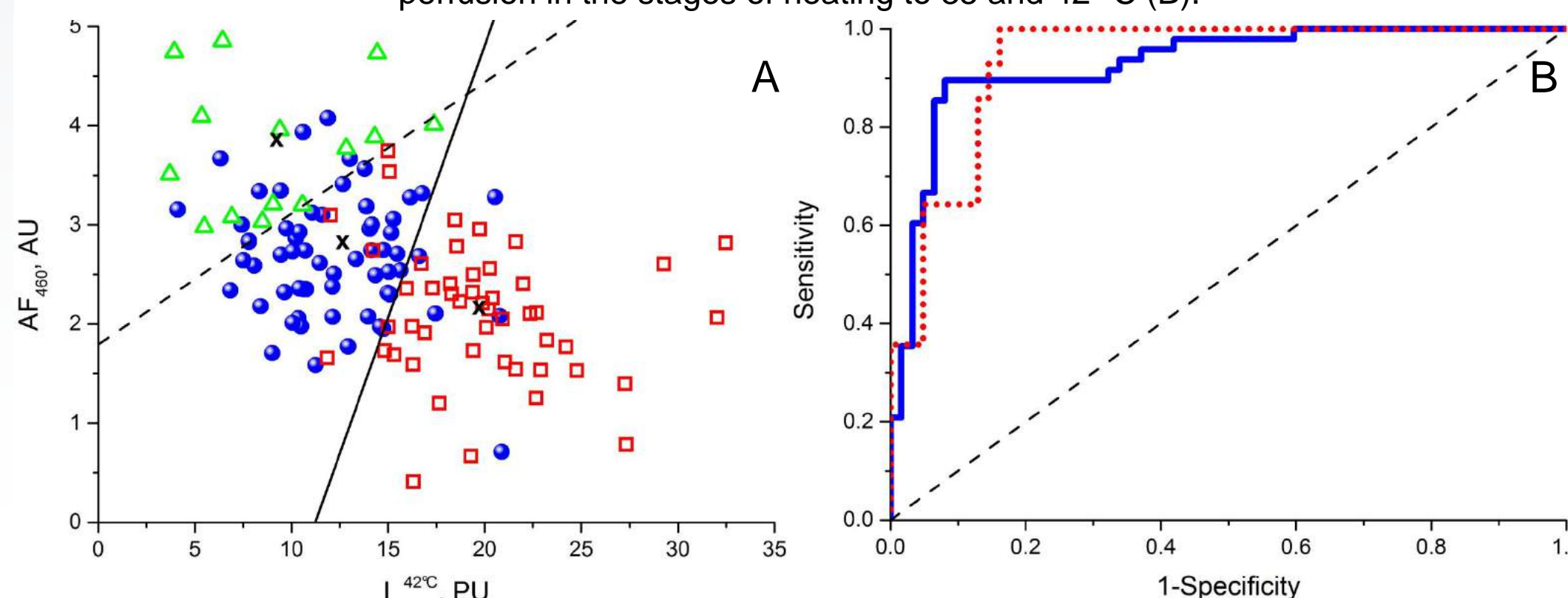


Result of the modelling of diagnostic volume for the fluorescence measurements for excitation wavelength of 365 nm (A) and 450 nm (B) and for the LDF measurements for wavelength of 1064 nm (C).

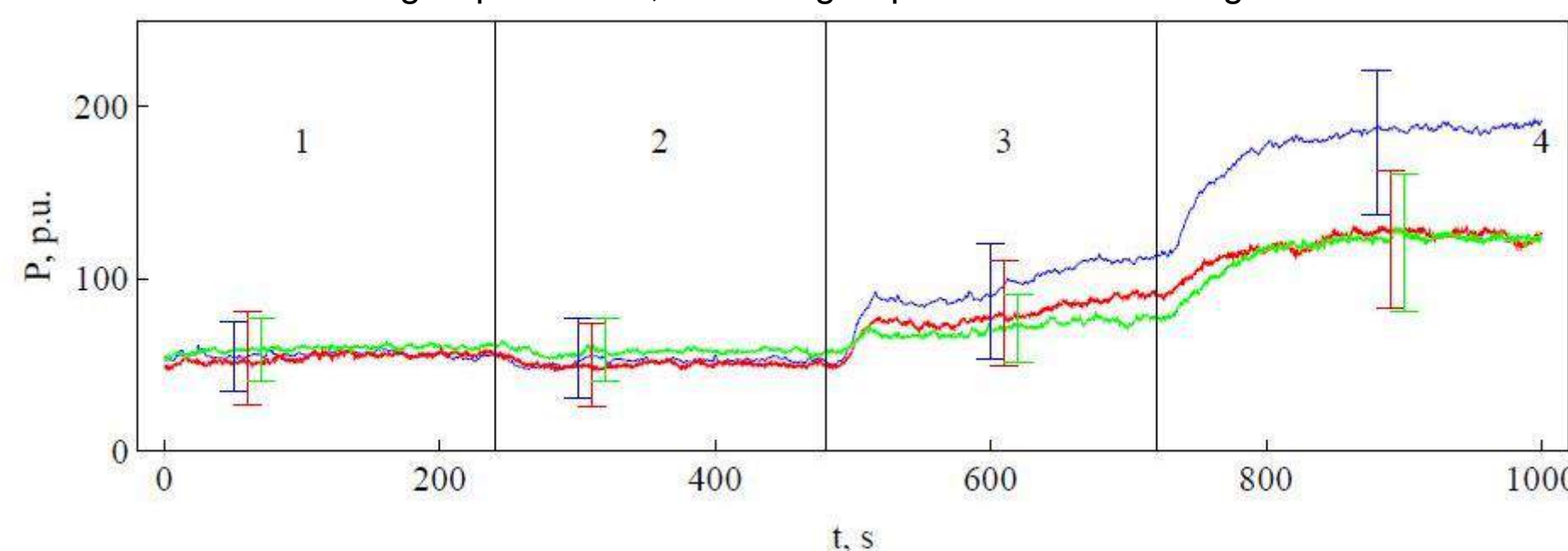
The performed simulation shows that the proposed probe allows for the registration of fluorescence in the epidermis, mainly contributed to by NADH and FAD, and the dermis with a major contribution from collagen.



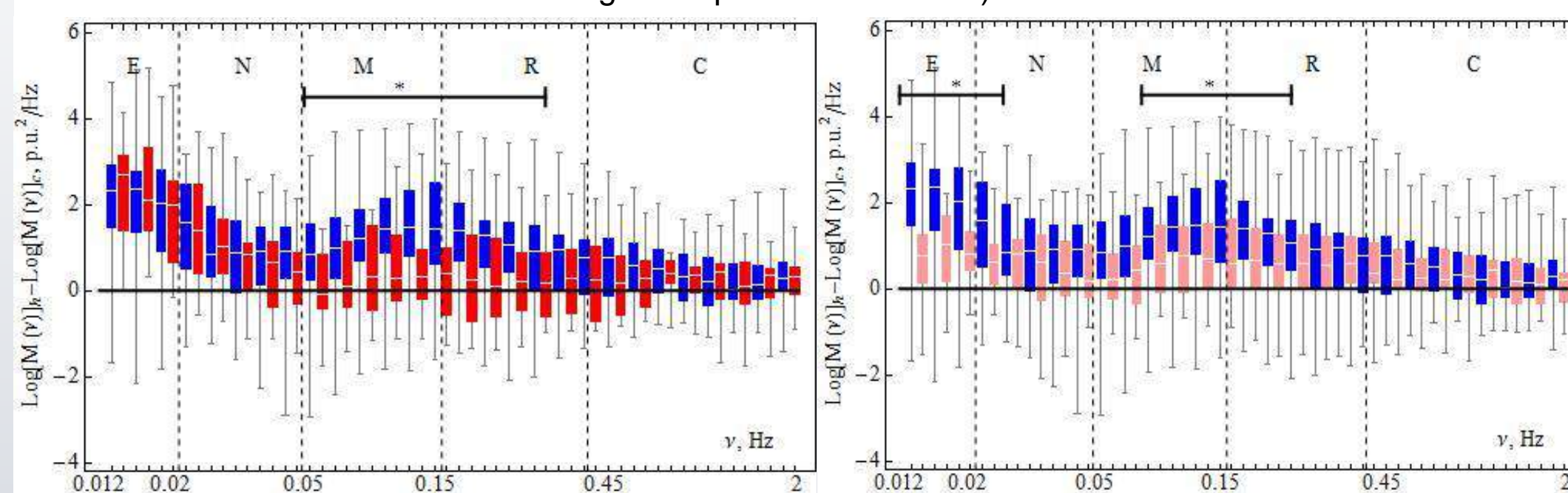
Comparison of parameters between control (empty red bars), diabetic (loose blue shading) and diabetic with ulcers (tight green shading) groups: the normalized fluorescence amplitude (A) and the average perfusion in the stages of heating to 35 and 42 °C (B).



The scatter plot with applied discriminant lines, obtained by linear discriminant analysis method (A) and ROC-curves for assessing the effectiveness of the classifiers (B). A healthy group is shown by squares, diabetic group – circles, diabetic group with ulcers – triangles.



Dynamics of perfusion averaged over all measurements (blue - controls, red - patients with DM1, green - patients with DM2).



Variation of the spectral energy ($M(h) - M(b)$) caused by the heating up to 35 °C. Blue boxes result for the control group, red - diabetic patients (type 1 on the left panel, type 2 – on the right).

CONCLUSIONS

- The proposed original method can be used to diagnose peripheral arterial diseases at the level of microcirculation and disorders in metabolism in the lower limbs.
- It can also be used to assess therapeutic interventions aimed at preventing or reversing the progression of these diabetic complications.
- A promising direction for future research within this field is the differentiation of AGEs and NADH and FAD contributions to the resultant fluorescence signal.

ACKNOWLEDGEMENTS

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