

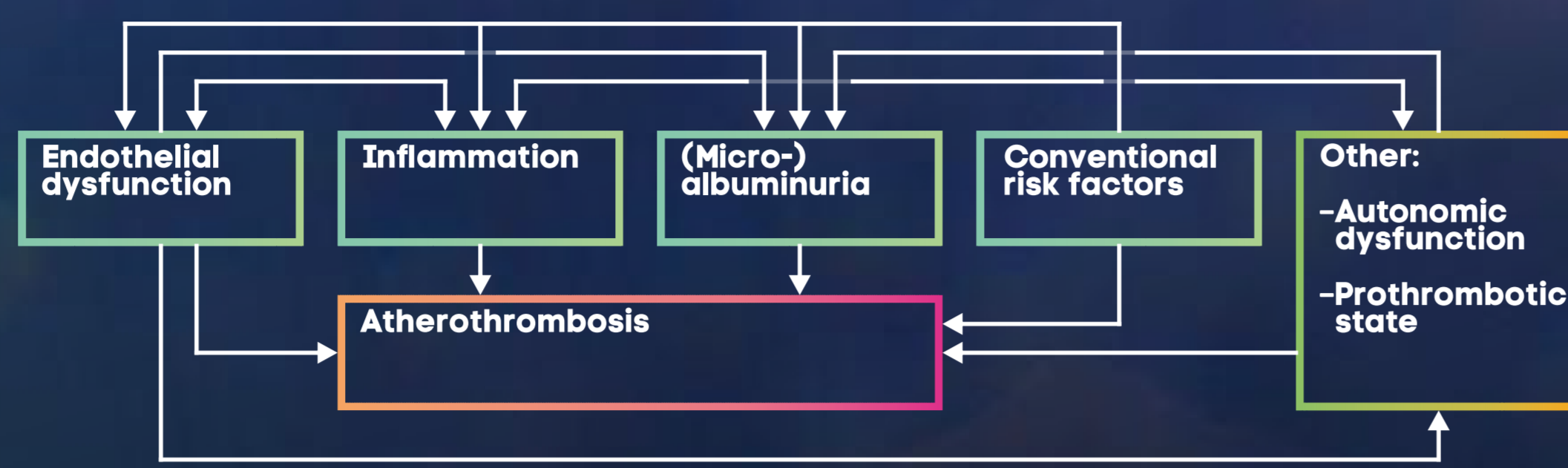
WEARABLE SENSOR SYSTEM FOR MULTIPOINT MEASUREMENTS OF BLOOD PERFUSION: PILOT STUDIES IN PATIENTS WITH DIABETES MELLITUS

E. A. Zharebtsov
E. V. Zharkikh
I. O. Kozlov
Y. I. Loktionova
A. I. Zharebtsova
I. E. Rafailov
S. G. Sokolovski
V. V. Sidorov
A. V. Dunaev
E. U. Rafilov

a,b
b
b
b
b
c
d
e
e
b
d
University of Oulu, Oulu, Finland
R&D Center of Biomedical Photonics,
Orel State University, Orel, Russia
Aston Institute of Photonic Technologies,
Aston University, Birmingham, UK
Aston Medical Technology Ltd.,
Birmingham, UK
SPE "LAZMA", Moscow, Russia

Introduction

In 2019 more than 450 million people were diagnosed with diabetes with projections to increase this number to 693 million by 2045.



This work aimed to investigate changes in microcirculatory blood flow of healthy volunteers and patients with type 2 diabetes mellitus using a novel wearable blood perfusion sensor system.

Materials and methods

Groups of volunteers		
Healthy		With type 2 diabetes
Group 1 (19.6 ± 0.6 years)	Group 2 (53.2 ± 11.4 years)	(53.2 ± 11.4 years)
16 volunteers	21 volunteers	18 patients

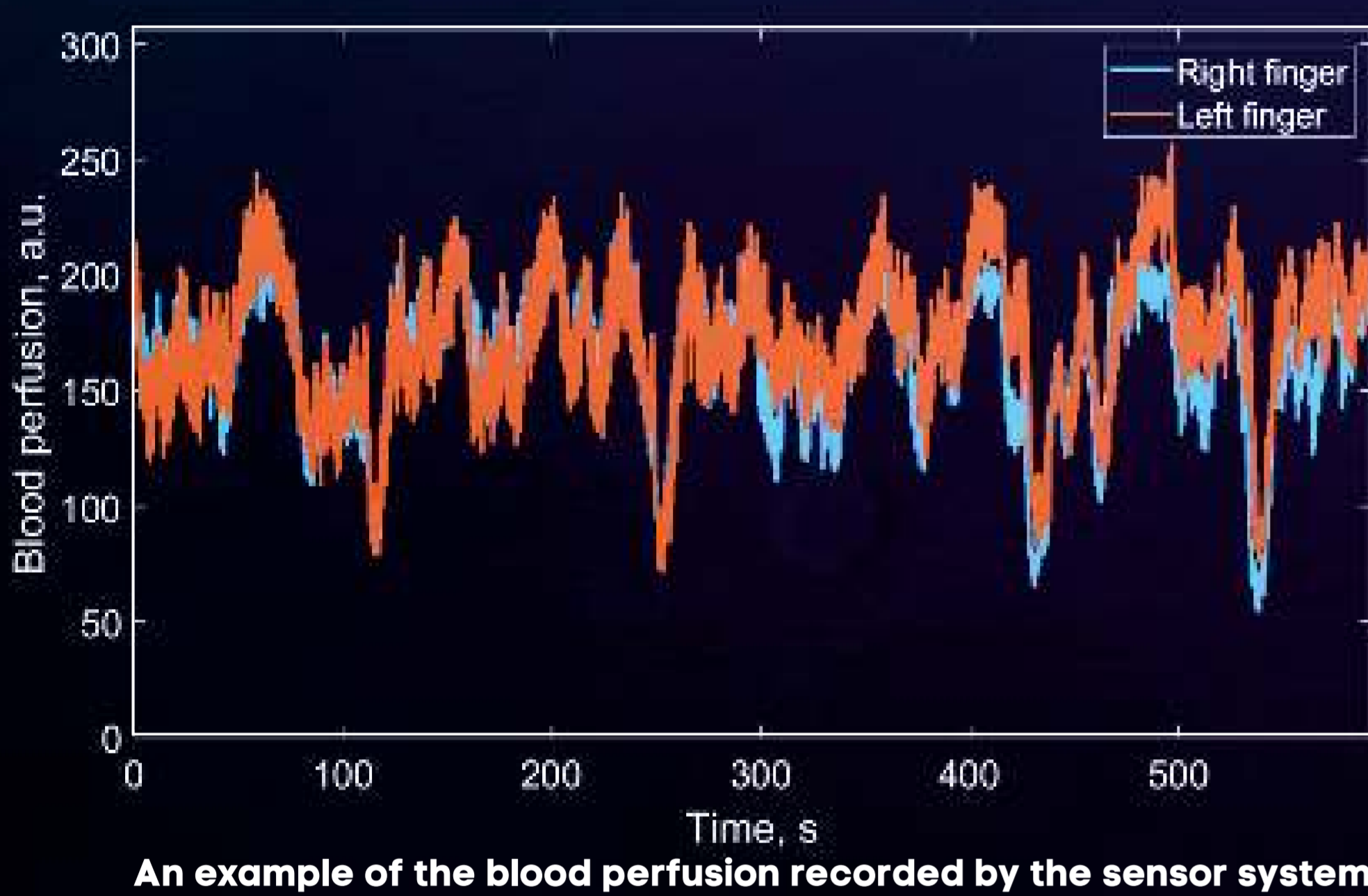
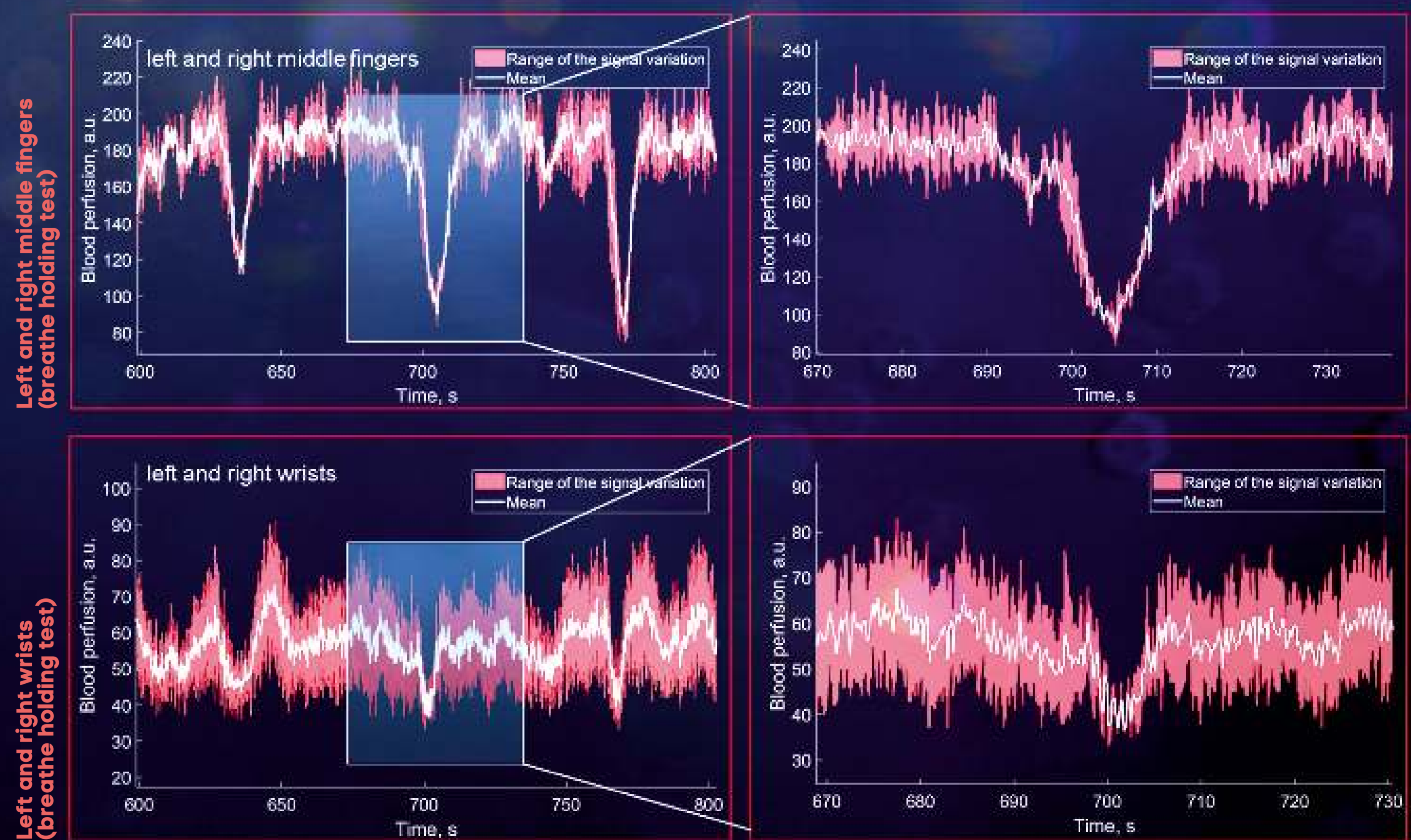
Wearable sensor system for multipoint measurements of blood perfusion

- perfusion recording
- accelerometer
- built-in skin thermometer

Technical parameters:
Laser source - VCSEL laser
Receivers - 2 photodiodes
 $\lambda = 850 \text{ nm}$,
 $P = 1 \text{ mW}$

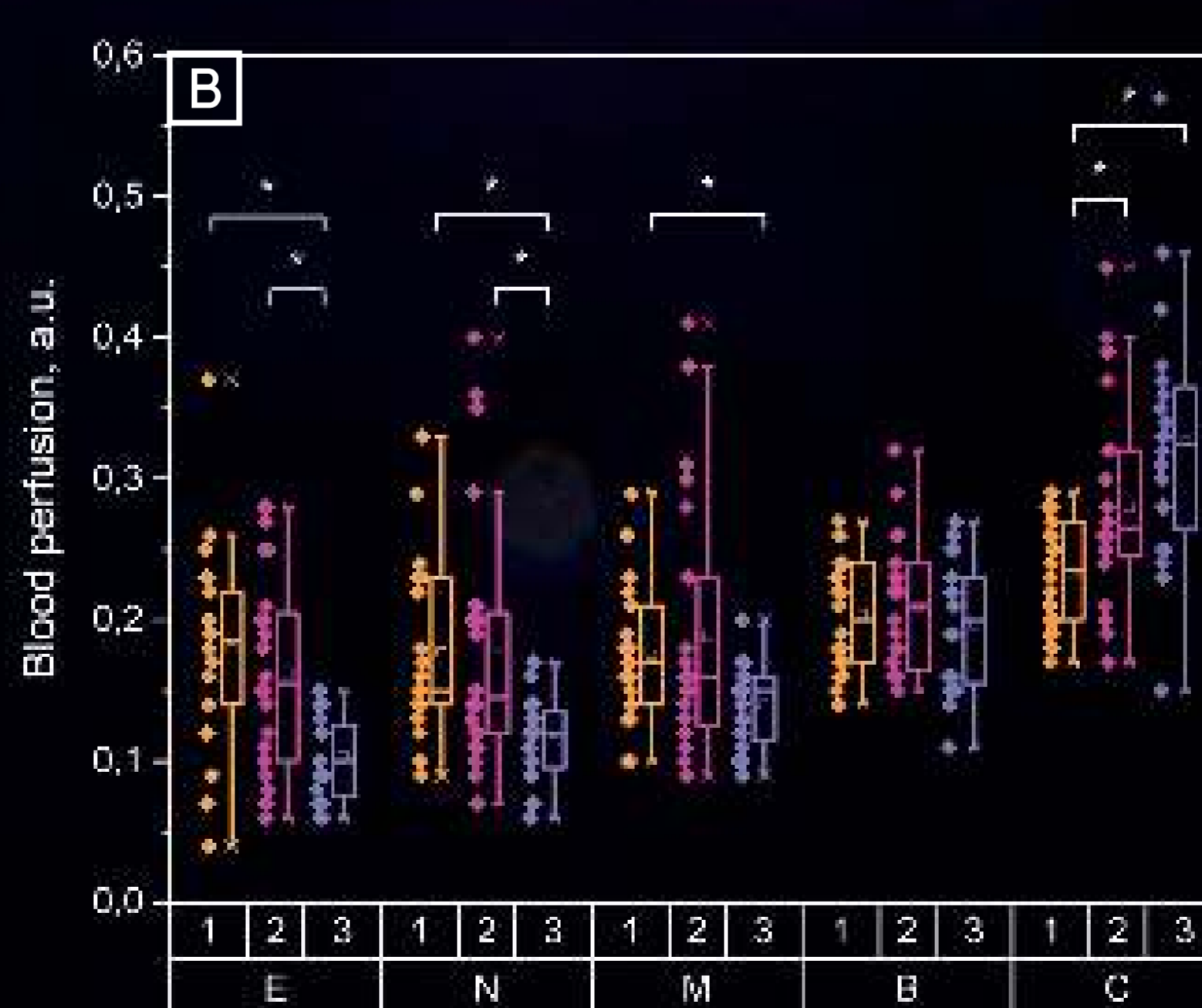
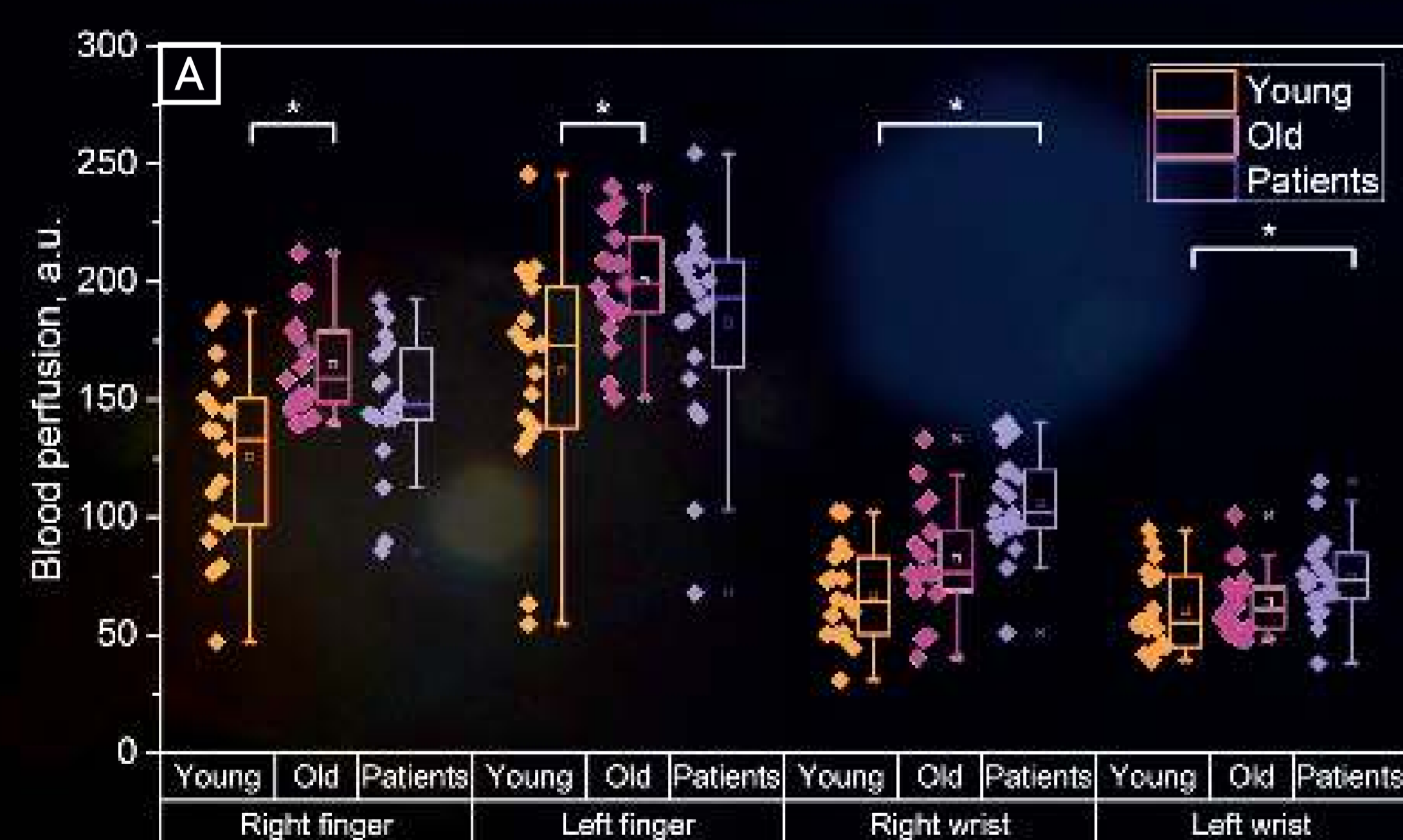


Microcirculation was recorded for 10 minutes.



An example of the blood perfusion recorded by the sensor system

Results and discussion



*-statistically significant difference with $p < 0.05$ according to the Wilcoxon signed-rank test.

Evaluated blood perfusion parameters in patients with type 2 diabetes and healthy volunteers.

E – endothelial;
N – neurogenic;
M – myogenic;
B – breathing;
C - cardiac

■ young healthy volunteers (age of 19.6 ± 0.6)
■ middle-age healthy volunteers (age of 52.6 ± 10.2)
■ middle-age patients with type 2 diabetes (age of 53.2 ± 11.4)

A) averaged levels of perfusion;
B) amplitudes of the blood perfusion oscillations:

Conclusions

- The novel wireless sensor system for multipoint recordings of blood perfusion has demonstrated a good quality of recorded blood perfusion signals from areas of skin with different levels of microvascular bed density.
- The conducted experiments have showed that the fibre-free wearable device implementation is convenient solution to be applied as a point-of-care testing.
- The measurements in the groups of different age allowed for registration of age specific changes in the blood perfusion as well as changes which can be associated with the development of diabetes.

Acknowledgments

- This study was funded by the **Russian Science Foundation** (the research project 18-79-00237).
- Evgeny Zharebtsov kindly acknowledges for personal support from the **grant of Academy of Finland No.318281**.



Contact details

Yuliya Loktionova
julya-loktionova@mail.ru

Dr. Evgeny Zharebtsov
Evgenii.Zharebtsov@oulu.fi

<http://www.bmecenter.ru/en>



BIOMEDICAL PHOTONICS