Государственный университет – учебно-научно-производственный комплекс

SCIENTIFIC-EDUCATIONAL CENTER
BIOMEDICAL ENGINEERING

http://www.bmecenter.ru/en

# Biomedical Photonics Instrumentation Group

Research interests include the development of biomedical optical non-invasive methods and devices for diagnostics, such as Laser Doppler Flowmetry, Tissue Reflectance Oximetry and Fluorescence Spectroscopy.

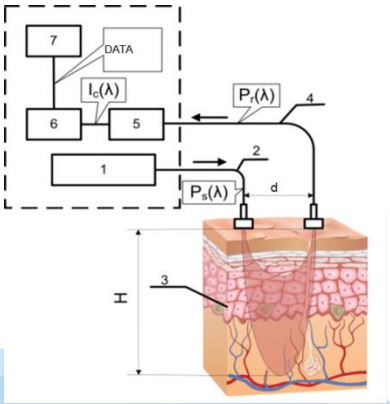
## Topics of research:

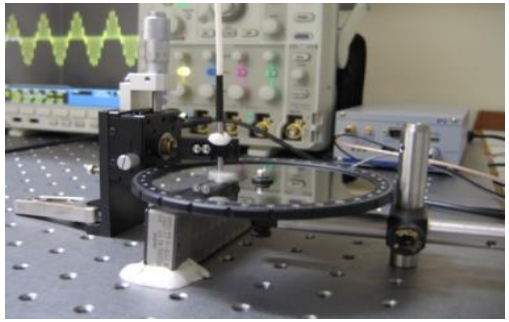
- **Metrological support of devices for laser Doppler flowmetry;**
- **Method and device for diagnostics the functional state of peripheral vessels;**
- **Method for control functional status of microcirculatory-tissue systems during the cold pressor test;**
- **Methodological and instrumentation provision of fluorescence spectroscopy for biomedical applications.**

# Metrological support of devices for laser Doppler flowmetry

One of the most common methods of optical non-invasive diagnostics today is laser Doppler flowmetry (LDF), based on measuring the Doppler frequency shifts, emerging after reflection from an ensemble of red blood cells, moving at different speeds in small vessels – arterioles, capillaries and venules. The LDF method is used for functional diagnosis of blood microcirculation, including diagnosis of diseases of the cardiovascular system. However, today the accuracy of the LDF method is rather low, and metrological support of LDF devices is virtually absent, which explains their limited use in clinical practice.

***This project proposes*** a prototype of hardware-software system for metrological support of LDF devices. It uses a piezoelectric actuator and Doppler light-diffusing layer to reproduce the desired dimension of the measurable value. This solution is capable of improving the utility of this class of medical devices.



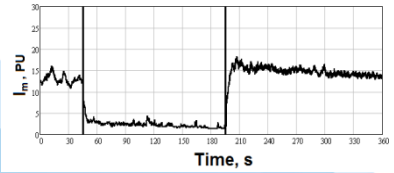
**Site for this project:**
**http://www.bmecenter.ru/en/ldf-metrology**

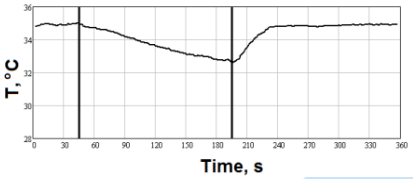
**Developers: Dr Evgeny Zherebtsov,**
**Dr Andrey Dunaev**

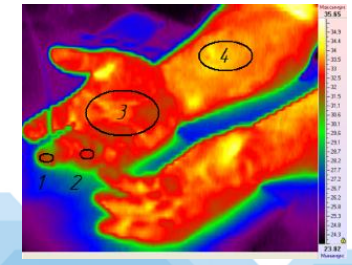
# Method and device for diagnostics the functional state of peripheral vessels

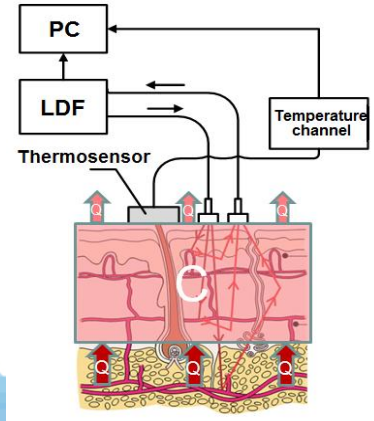
***The purpose of this research*** is a data correlation study of laser Doppler flowmetry (LDF) and cutaneous thermometry for occlusion test in patients with vibration disease (VD) or Raynaud's phenomenon (RP). It was noted that the dynamics of change in skin temperature of the palmar surface of fingers during occlusion and reactive hyperemia after occlusion corresponds qualitatively to the index of blood microcirculation, reflected by the temperature drop at the initial time after start of brachial artery occlusion and an increase above the initial level at the peak of hyperemia after occlusion. However, the derivative (rate) of temperature change over time is a little less than rate of change of perfusion, which is associated with features of the thermophysical characteristics of the skin. Thus, combined thermometry and LDF allow the investigation of changes in thermal parameters of patient's tissue during the progression of the VD/RP.

**Site for this project:** [http://www.bmecenter.ru/en/vascular-control](http://www.bmecenter.ru/en/vascular-control)






**Developers: Angelina Zherebtsova,**
**Dr Andrey Dunaev**

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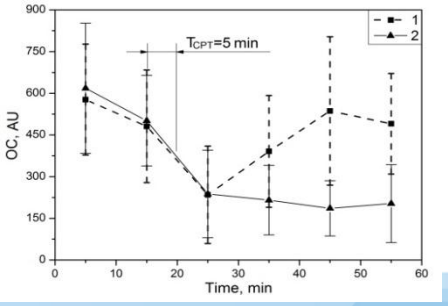
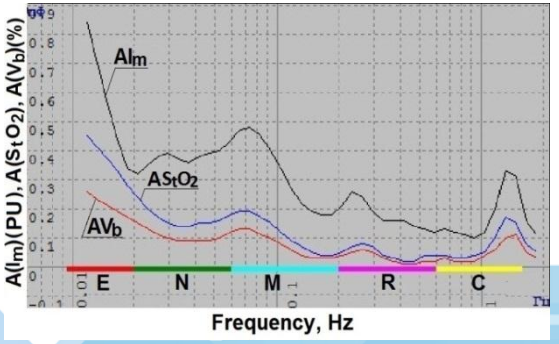
# Method for control functional status of microcirculatory-tissue systems during the cold pressor test

Using non-invasive optical methods of laser Doppler flowmetry (LDF), tissue reflectance oximetry (TRO) and pulse oximetry, we may investigate the dynamics of parameter changes of microcirculatory-tissue systems (MTS) when using cold pressor test (CPT). According to differences in the recovery rate of oxygen consumption during CPT, volunteers can be conditionally divided into two groups: displaying normal physiology and with a tendency to angiospasm and lack of functional recovery of the MTS. Use of the CPT for functional assessment of MTS allows us not only to estimate the reserve capabilities of the MTS, but also to identify – at a pre-clinical stage- propensity to angiospasm, which has practical value in the clinic.

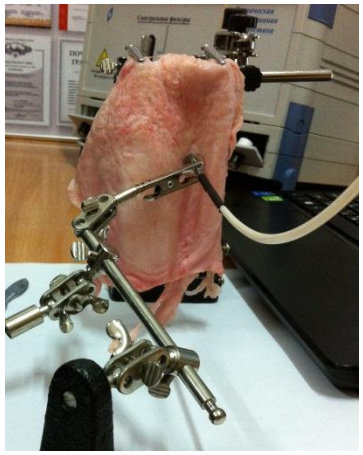
**Site for this project: http://www.bmecenter.ru/en/vascular-control**



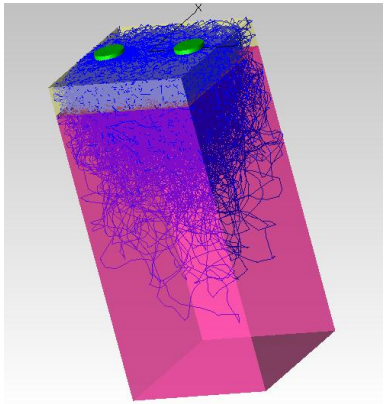




**Developers: Irina Novikova,**
**Dr Andrey Dunaev** Biomedical Photonics Instrumentation Group

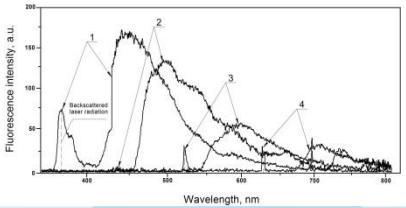
# Methodological and instrumentation provision of fluorescence spectroscopy for biomedical applications

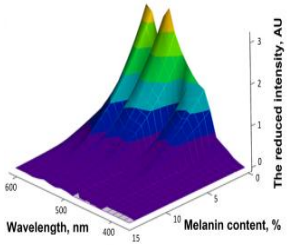


The fluorescent spectroscopy (FS) provides effective and non-invasive optical diagnostics, primarily in medical areas such as oncology, transplantation, cosmetology and surgery. FS for medicine is a complicated technique that depends on the temperature, topological heterogeneity, different properties of each sample, etc. Therefore, the reliability of FS is affected by multiple factors, including the availability of data concerning the scattering and absorbing properties of specific tissues in specific conditions (for example, the contribution of skin melanin), light pollution at optical fibre tip and instrument errors such as excitation source instability, photodetector limitations, light filter precision, grating precision, CCD performance, etc. To achieve clinically significant and reliable results, issues of accuracy, convergence and dispersion measurement also need to be addressed.



**Developers: Victor Dremin,**
**Dr Andrey Dunaev**




**Site for this project:** [http://www.bmecenter.ru/en/fluorescence_spectroscopy_in_vivo](http://www.bmecenter.ru/en/fluorescence_spectroscopy_in_vivo)

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