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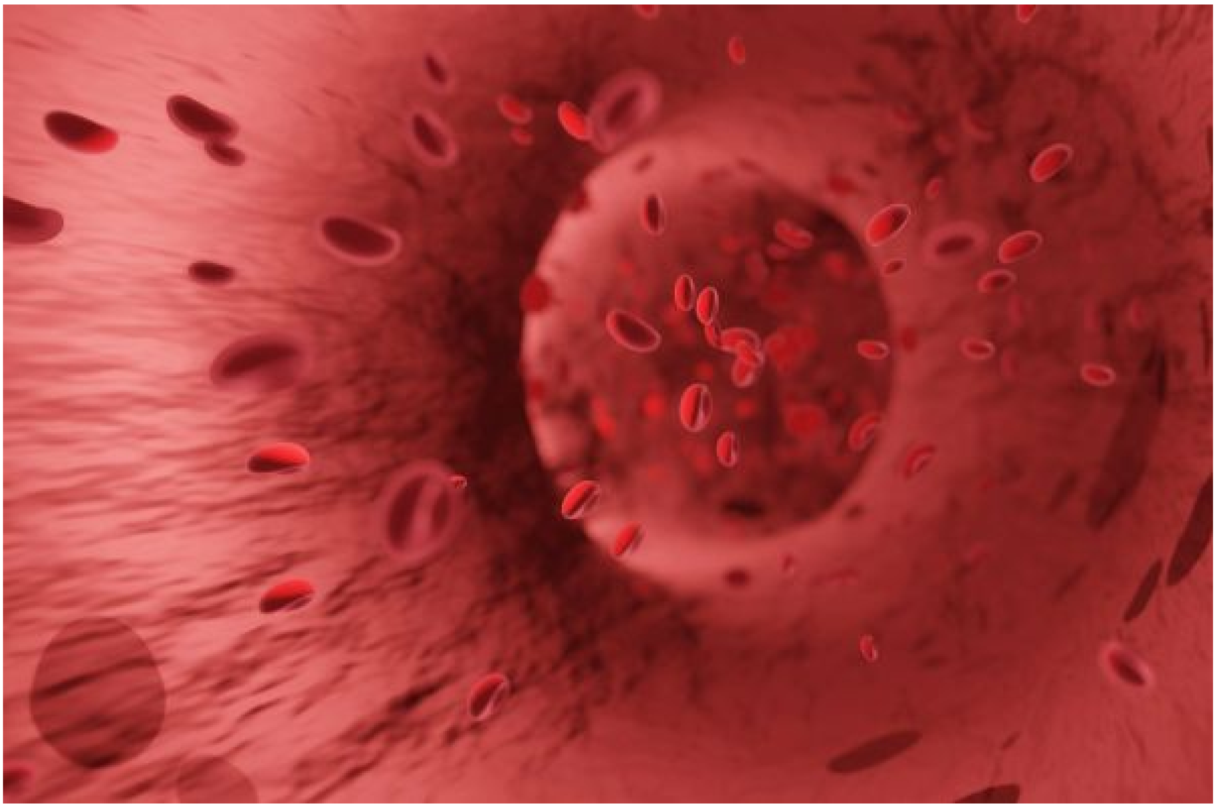

Breakthrough wearable device enables practical blood-flow monitoring

Monitoring how blood flows in our tissues in real time is essential for many medical procedures, such as supervising patients with vascular diseases or tracking blood flow in newborns' brains. Most current devices, however, are bulky, fragile, and prone to measurement noise.
A team led by ICFO researchers has now developed a new type of wearable blood flow monitor that, without sacrificing data quality, is more compact, stable, and user-friendly. This design, recently reported in Biomedical Optics Express, could make clinical monitoring in hospitals more convenient and may even be suitable for everyday use in sports, wellness, and remote home care.

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Most traditional blood flow monitors use optical fibers to collect the data. These require large lenses and cables, which make the devices fragile and, moreover, introduce subtle vibrations that add noise to the measurements.

To eliminate the need for optical fibers and address the challenges they bring, ICFO researchers **Dr. Andres Quiroga**, **Dr. Lorenzo Cortese**, **Dr. Manish Verma**, led by **ICREA Prof. at ICFO Turgut Durduran**, in collaboration with the Fraunhofer Institute for Applied Optics and Precision Engineering IOF and the University College of London, have taken a novel approach by designing a tiny array of micro-objectives that can be mounted directly on a commercial camera chip. This innovation **shrinks the entire system while still capturing the same kind of high-quality information** as traditional, fiber-based monitors.

The final design, reported in Biomedical Optics Express, is smaller, lighter, and more practical, as **it can be placed directly on the skin.** As a result, **the device is more wearable and easier to use**, and could thus be employed to examine the capillary circulation in patient with vascular disease, ensure tissue safety during surgery, or track brain blood flow i newborns more conveniently

The team tested the apparatus on both lab models and on people, confirming that it work reliably and with high precision. ï¿½The system is able to pick up capillary blood flow sign ls in real time, even detecting the subtle rhythms of the heartbeat,ï¿½ shares Dr. A dres Quiroga, first author of the article. In addition, the device can measure tissue blood fl w at multiple tissue depths simultaneously, providing a richer picture of circulation. This pens the door to tracking oxygen levels in tissue, an especially valuable insight for clinical are. With further refinement, the researchers believe **their approach could move blood-flow monitoring in tissues beyond the hospital**. For instance, the device could be used in sports and wellness for real-time feedback on muscle performance and recovery, or even at home for remote patient monitoring. ï¿½Imagine simply putting on a patch or watch-like apparat s that tracks your capillary circulation throughout the day. Doctors could then evalua e remotely whether you are at risk of a stroke due to poor autoregulation,ï¿½ adds Quir ga. While this application is still hypothetical, the team is now focused on making the techno ogy truly wearable, so it can be used comfortably over long periods and by patients with ore complex circulatory conditi

Reference:

Andres Quiroga, Lorenzo Cortese, Manish Verma, Peter Dannberg, Ilias Tachtsidis, Norbert Danz, and Turgut Durduran, "On-skin, micro-objective enabled camera module for speckle contrast optical spectroscopy/tomography," Biomed. Opt. Express 16, 4091-4103 (2025).
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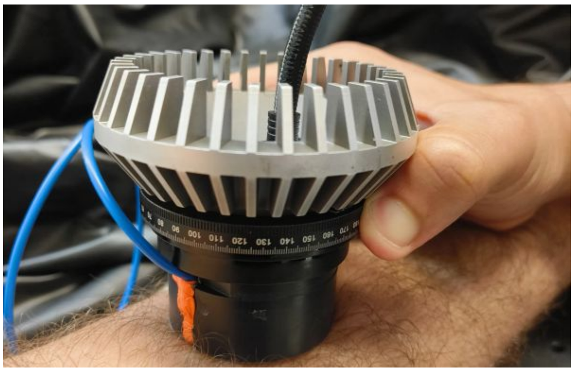

Experimental configuration for the in vivo experiment. Source: Biomedical Optics Express.