Researchers develop new ultra-fast 3D microscope

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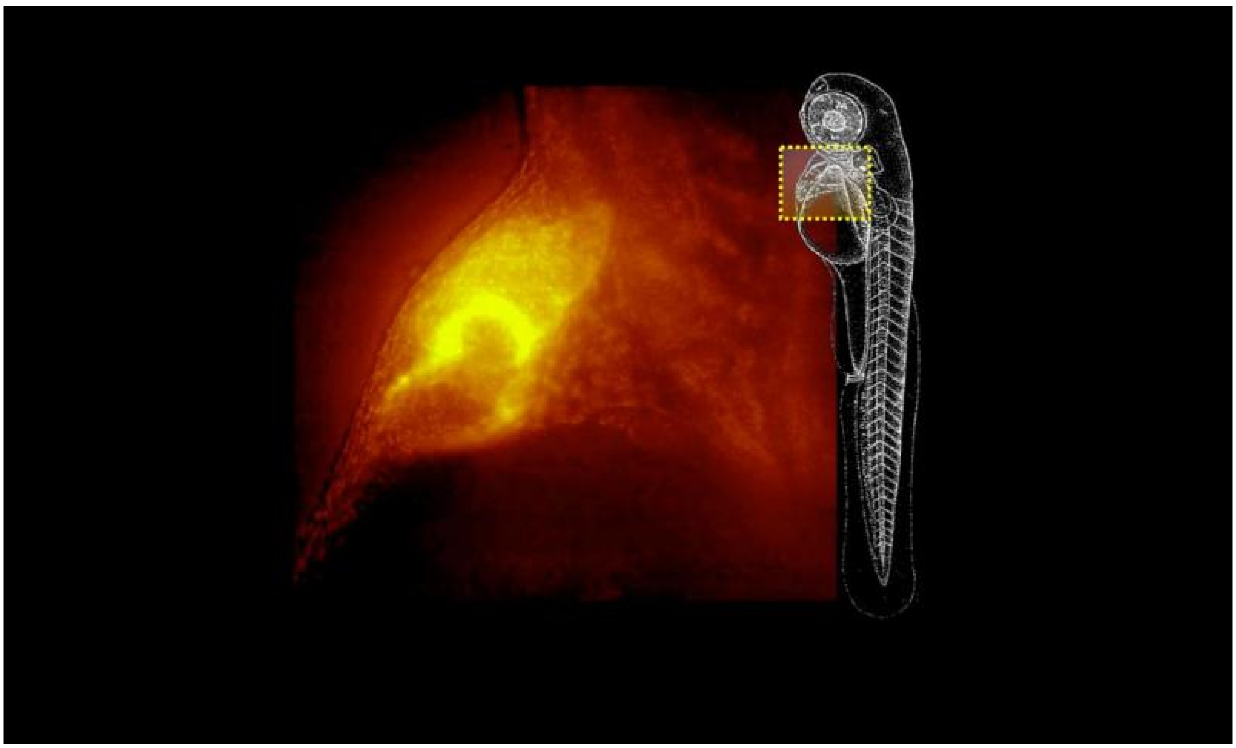

Image obtained with the Qls-Scope of the heart of a zebrafish. Credit: 4DNature

A new microscope can capture 3-D images of live organisms in real time. It's called the QIs-scope, an innovation from a spinoff of Universidad Carlos III de Madrid (UC3M), 4D Nature. The microscope can be used in biomedical research or to improve clinical diagnosis procedures.

This next-generation microscope can make three-dimensional images of small specimens (between 1 mm and 2 cm) through the use of a flat laser beam in near-real time, which makes it possible to monitor animals as they develop. "We can see how the heart of a zebrafish beats and make a 3-D reconstruction of its beat," said Jorge Ripoll, professor at the UC3M Department of Bioengineering and Aerospace Engineering and co-founder of 4D Nature with Alicia Arranz and César Nombela. "It can be used for many studies related to cardiovascular illnesses, and to better understand how the heart functions."

According to its creators, this technology represents the next step in confocal microscopy, which has revolutionized the world of biomedicine in the last two decades. The QIs-scope can capture 200 images a second, compared with the approximately five images per second of a modern confocal microscope. In addition to its speed, it can mark cells or molecular processes with different colors using its four lasers, which can be increased to six. "This makes it possible to monitor up to six different cells or six different cell types in the same specimen," said Ripoll, who conducts his research at the UC3M Biomedical Imaging and Instruments Group (BiiG).

This machine can observe what occurs at the cellular level in the development of tissue or the internal functioning of organs. "If the cells are marked with fluorescent proteins, you can do a specific monitoring of what happens at the cellular level in each organ," said Ripoll. "We generate a beam of light with a laser. That beam of light excites fluorescence, and when the beam of light is moved, we obtain a 3-D image of the specimen."

QIs-scope has applications in the sector of biomedical imaging. It is useful in molecular biology research or development laboratories for studying whole organs or in models of in vivo animals. In fact, the measurements of the zebra fish's heart were taken in collaboration with

Nadia Mercader's group from the National Center for Cardiovascular Research. Also, it might be of interest to clinics and pharmaceutical centers that use the traditional confocal microscopes. In addition, it can be used to monitor the quality of fluids and the presence of impurities to make 3-D images of transparent materials. It can be applied through the use of other wavelengths of the electromagnetic spectrum (terahertz or microwave, for example) in images of opaque materials.

The key to the functioning of the QIs-scope lies in the software, because to take measurements in different positions of a specimen at a rate of 200 images per second, it is necessary to coordinate a set of lasers, motors, cameras and filters very effectively. The high measurement speed makes it possible to observe multiple angles of the specimen. This improves the resolution and the quality of the reconstructed data, but it requires complex software to combine all these measurements. "Our goal is for the QIs-scope to be easy to use with intuitive software, so that the user can see the specimen and choose where to make the scans, choose the excitation colors and generate a three-dimensional image with as many colors as were chosen."

Provided by Carlos III University of Madrid

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