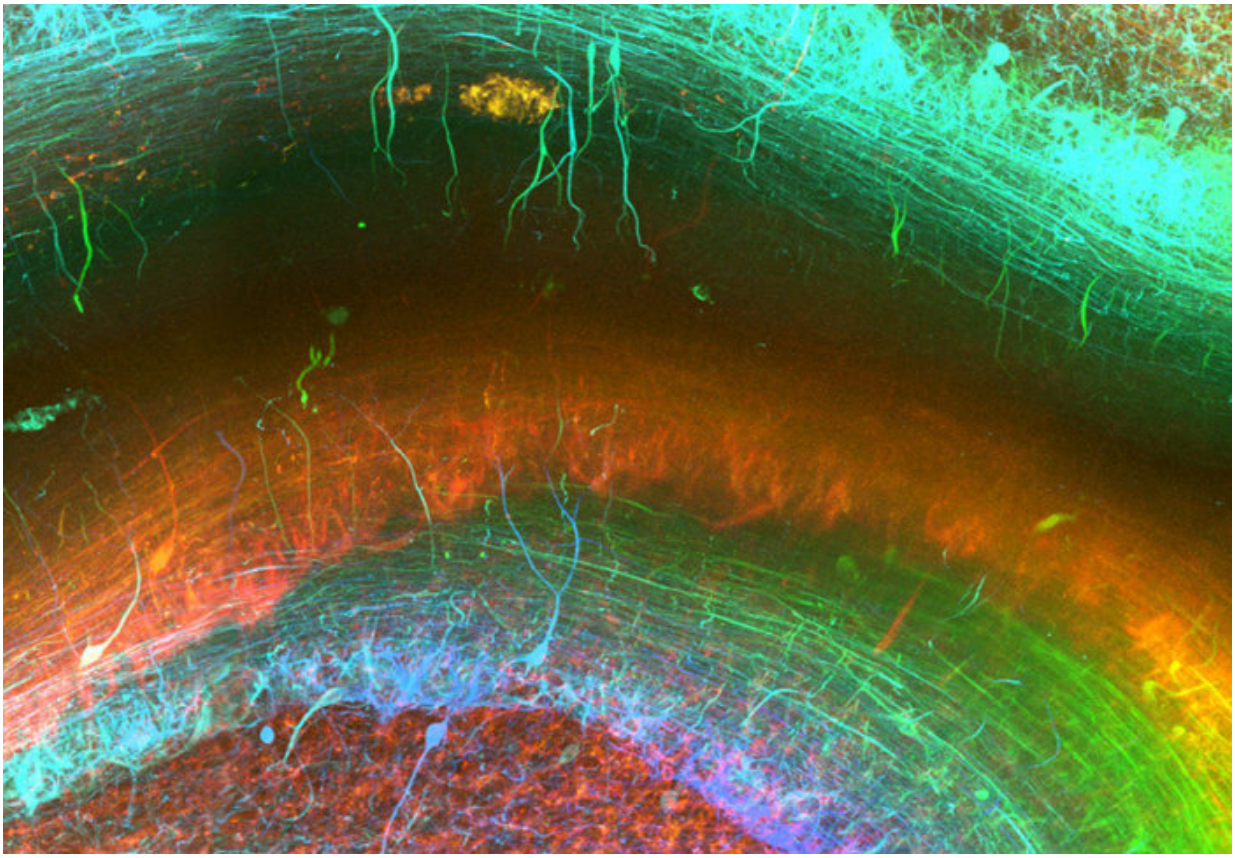
New tissue technique gives stunning 3-D insights into the human brain

March 15 2018, by Ryan O'hare



Imaging method enables researchers to generate stunning 3-D images of human brain tissue. Credit: Imperial College London

Imperial researchers have helped develop a breakthrough imaging technique which reveals the ultra-fine structure of the brain in

unprecedented detail.

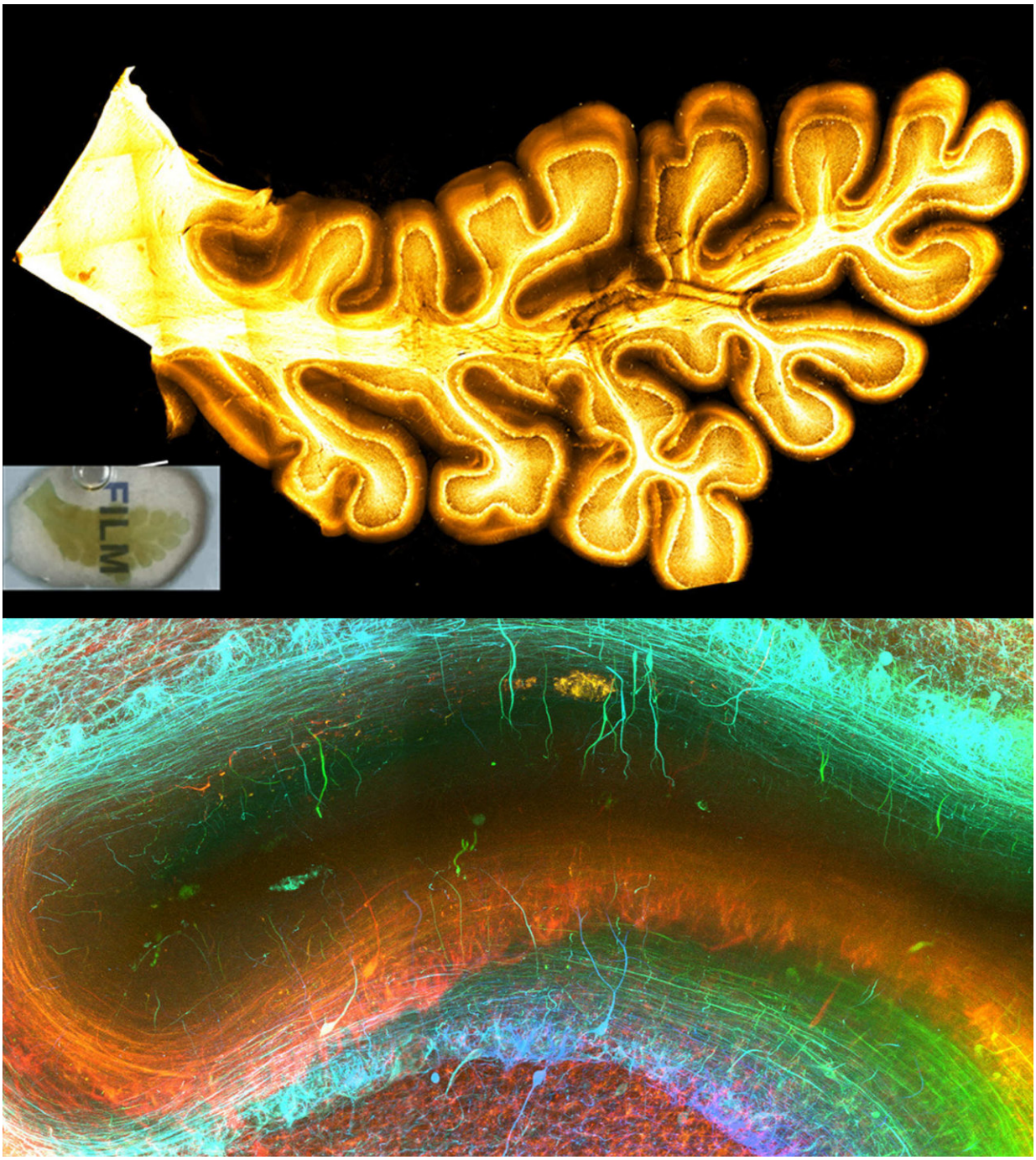
The next generation method enables researchers to generate 3-D images of fresh and archived brain tissue samples, resulting in stunning images of the human brain at the microscopic level.

Developed through an international collaboration between scientists at Imperial College London and The University of Hong Kong, the researchers believe the technique could help to shed new light on the basis of neurological diseases which affect millions around the world.

Traditionally, imaging brain samples has involved taking small tissue samples cut into ultrathin slices which can be stained to reveal characteristics of interest, such as proteins or other markers associated with disease.

In recent years, however, advances in molecular tagging techniques and the availability of laser microscopes have led to the development of modern tissue clearing techniques.

These techniques make brain tissue transparent and enable researchers to see the anatomical structure in 3-D. However, these techniques were originally developed for rodent brain tissues and there have been very few studies on human tissue.



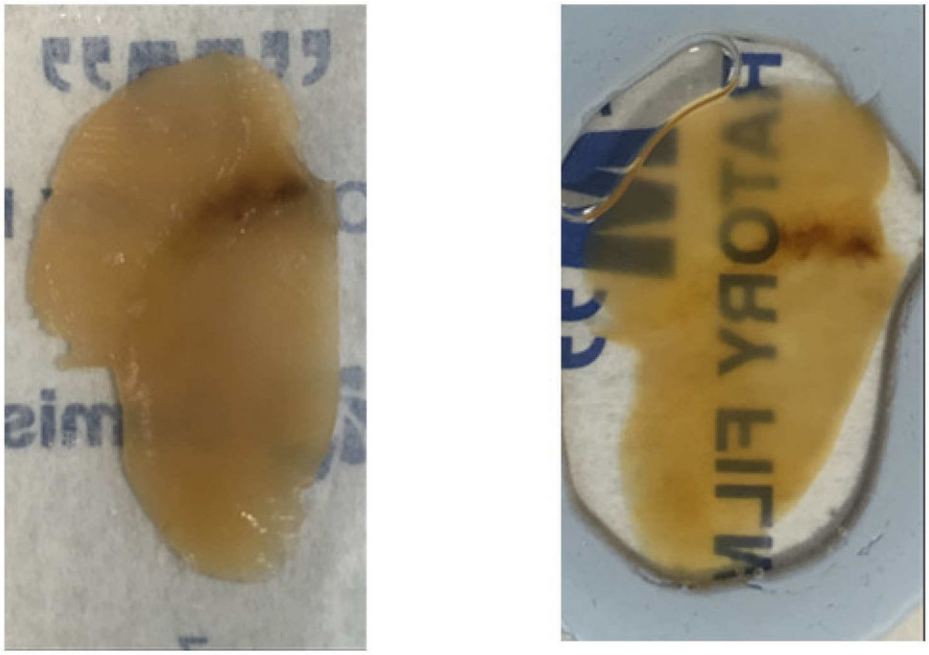
Technique reveals microscopic brain structures. Top: A small cross section of the cerebellum; Bottom: The close up of a fragment of the same sample, revealing networks of brain cells. Credit: Imperial College London

Many of the problems centred around the unique properties of the human brain, as well as preservation and processing of human tissue at post mortem.

To overcome these problems the team, led by 3 medical students, have developed a new tissue clearing solution, OPTIClear, enabling a wide range of molecular labelling methods for 3-D visualisation of fresh and archival human brain tissue.

Using this new approach, they have been able to stain nerve cells, glial cells and blood vessels, as well as pathological markers such as tangles of tau protein found in the brains of Alzheimer's patients, in exquisite detail and determine how they relate to each other in 3-D space.

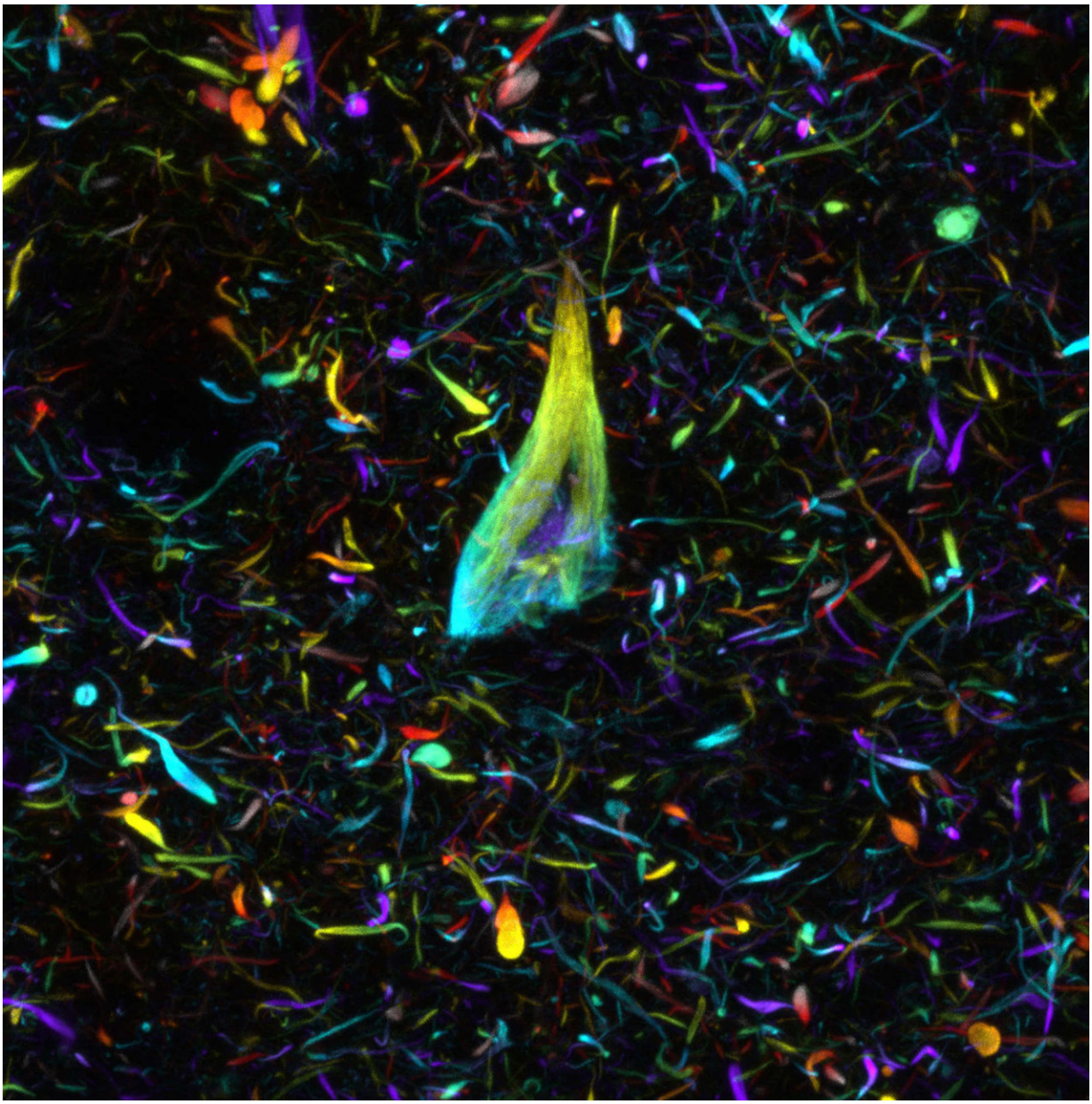
"These techniques enable us to reveal the microscopic structure of the human brain in spectacular detail," said Professor Steve Gentleman, Scientific Director of the Parkinson's UK Brain Bank at Imperial College London.



The OPIClear technique enables researchers to 'see through' the tissue (Left: before treatment; Right: After treatment). Credit: Imperial College London

He added: "By using tools such as these in the lab we will be able to visualise how cells interact with each other in 3-D and learn more about the pathways and connections that are damaged in the common neurodegenerative brain conditions which have such an enormous impact on people's lives.

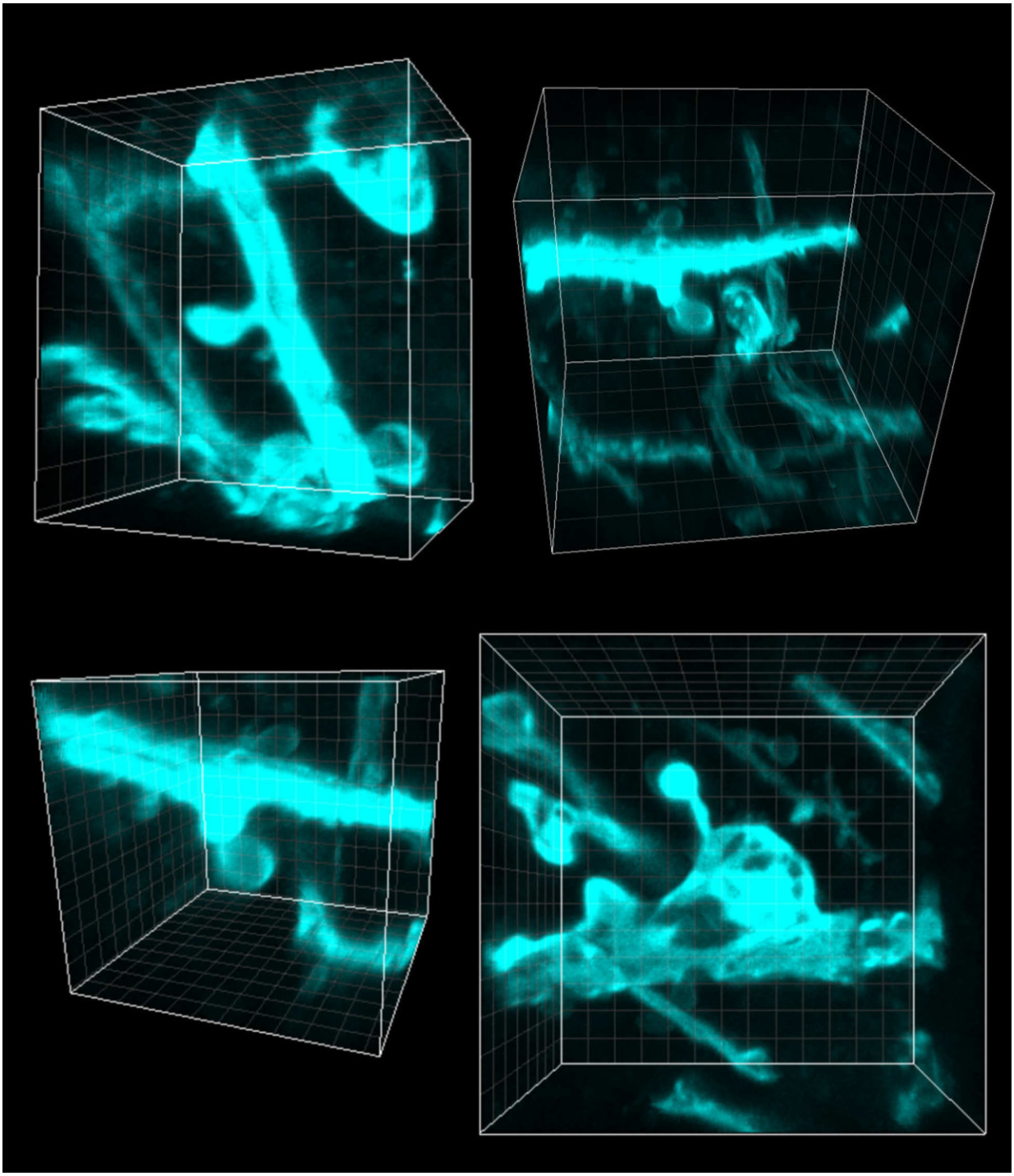
"This work is only made possible by the wonderful altruism of our brain donors and their families."



Researchers can use the technique to visualise markers of disease, such as tangles of tau protein in Alzheimer's (pictured). Credit: Imperial College London

According to the researchers, the method is relatively inexpensive, is time efficient and easy to carry out, and is likely to form the basis for further technique development.

It is hoped that a better understanding of the connections and circuitry of the brain at this level will help uncover the pathologies that underlie the common degenerative diseases of the brain, such as Alzheimer's and Parkinson's disease.



The approach also enables researchers to see the intricate structure of cells themselves. Pictured are dendritic spines—protrusions on the axon 'tail' of brain cells, which allow signals to pass from one cell to another. Credit: Imperial College London

More information: Hei Ming Lai et al. Next generation histology methods for three-dimensional imaging of fresh and archival human brain tissues, *Nature Communications* (2018). DOI: 10.1038/s41467-018-03359-w

Provided by Imperial College London