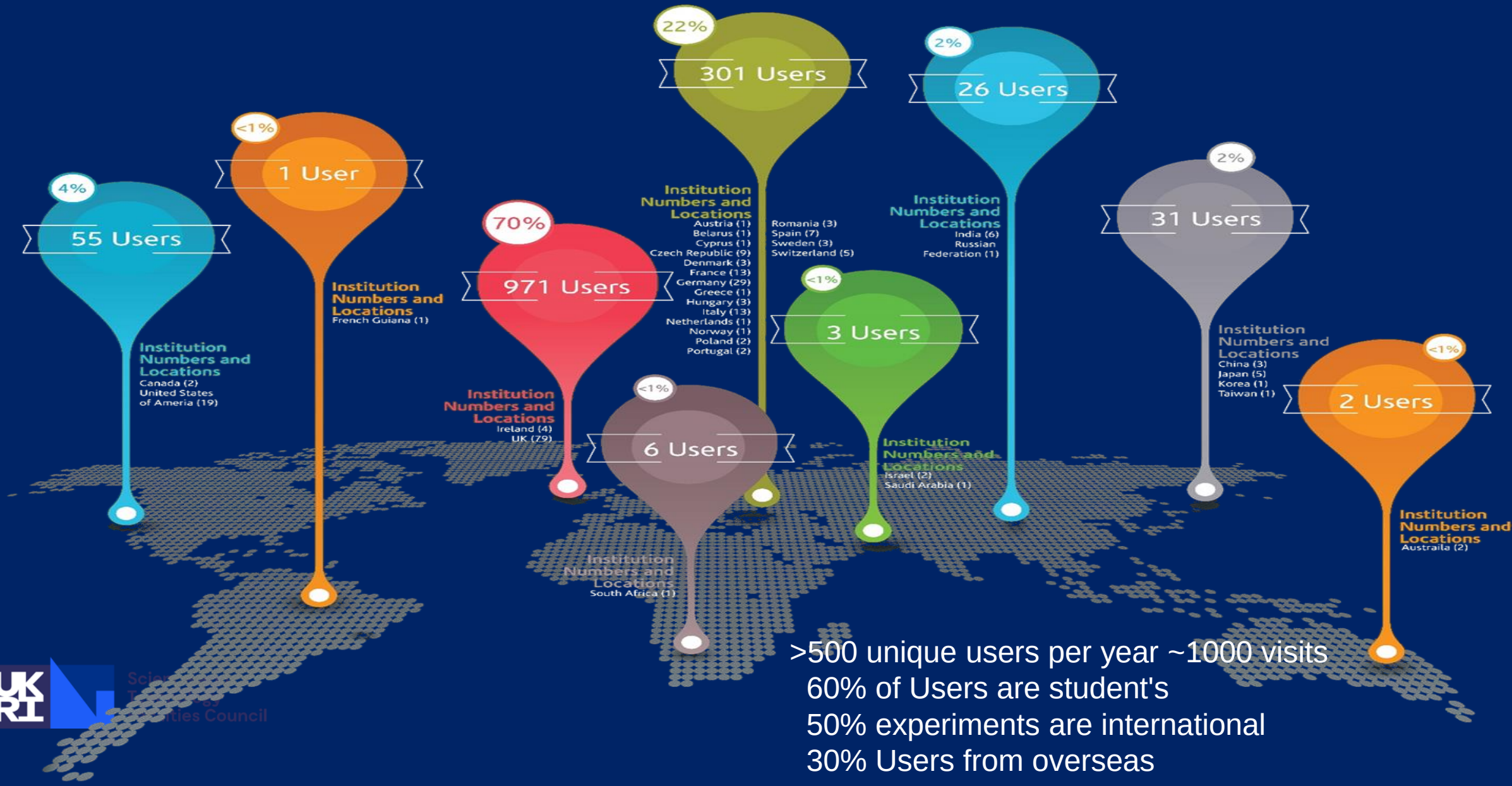
Welcome to the Central Laser Facility (CLF)

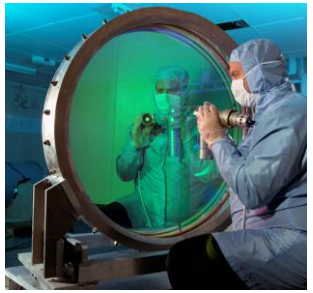
Dr Kathryn Welsby
Industry Partnership & Innovation Group Lead

We are an open access, free service, user facility



>500 unique users per year ~1000 visits
60% of Users are student's
50% experiments are international
30% Users from overseas

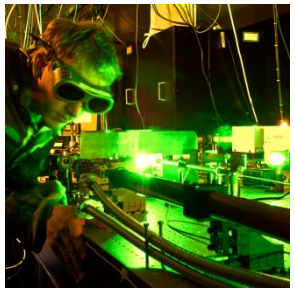
VULCAN



Ultra high-power PW laser

Focused intensity > 10^{21} Wcm^{-2}

ASTRA GEMINI

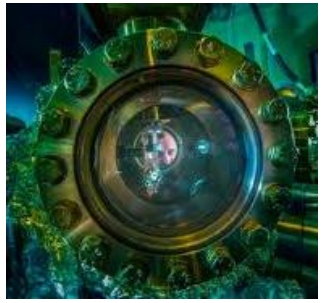


High power Ultra-short pulse dual beams 15 J, 30 fs pulses

Pulse every 20s

High-power, ultra-intense lasers for extreme conditions science, imaging applications

ARTEMIS

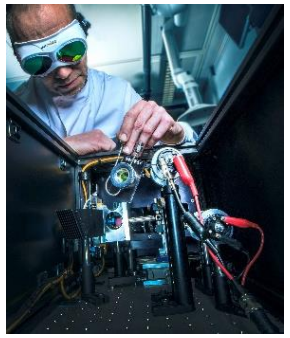


fs and as ultrafast spectroscopy

high harmonic generation

IR to soft x-ray

ULTRA



Ultrafast vibrational spectroscopy

OCTOPUS

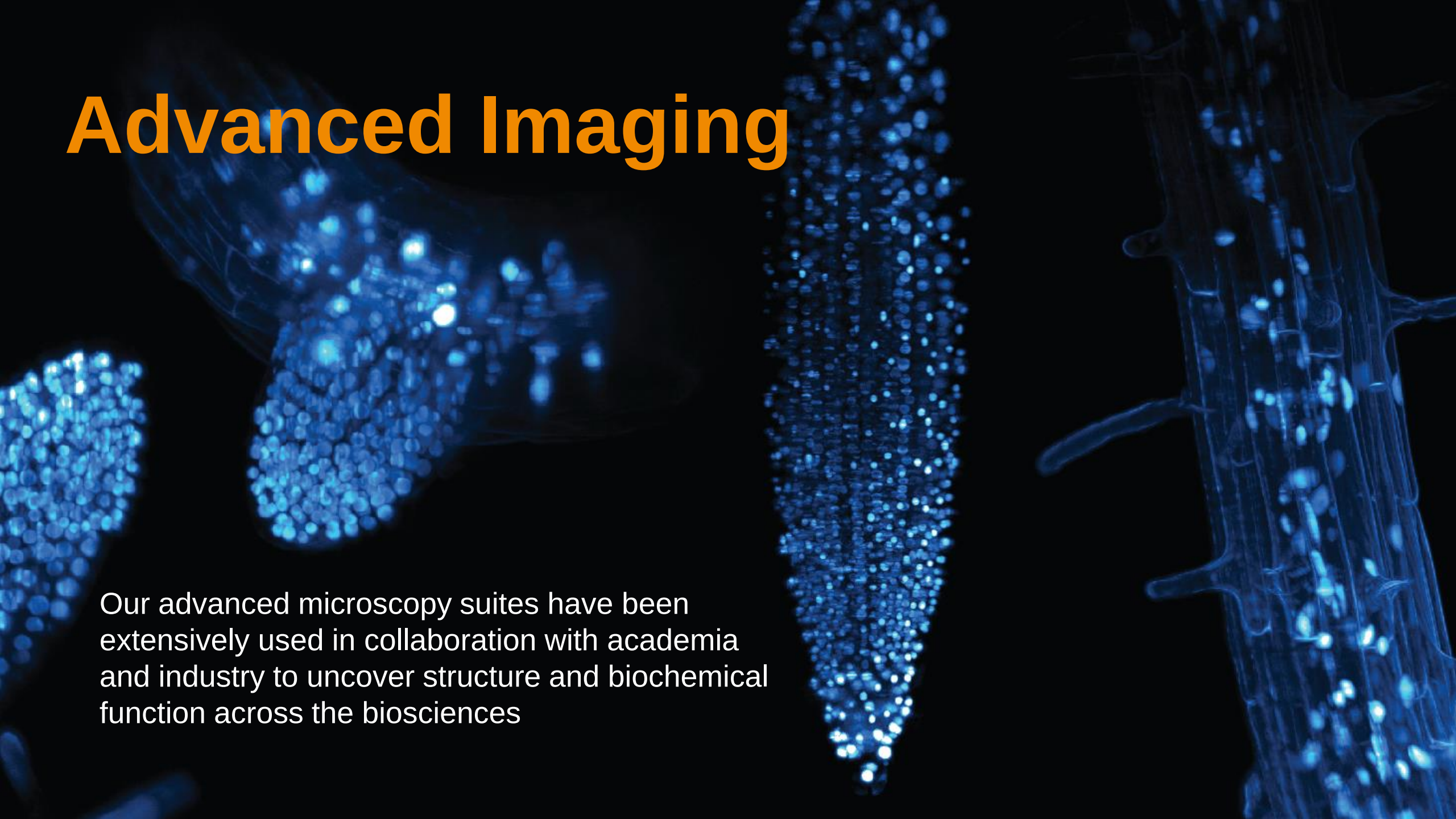
Fluorescence Imaging, laser tweezers and microscopy

Laser applications in the physical and life sciences (materials, chemistry, biology)

Science and Technology Facilities Council

central laser facility

Advanced Imaging

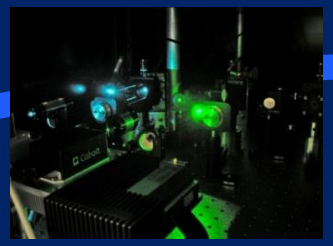


Our advanced microscopy suites have been extensively used in collaboration with academia and industry to uncover structure and biochemical function across the biosciences

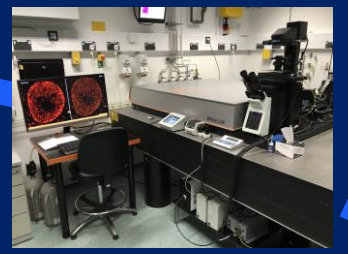
Imaging across scales


Multiphoton FLIM


Light sheet microscopy

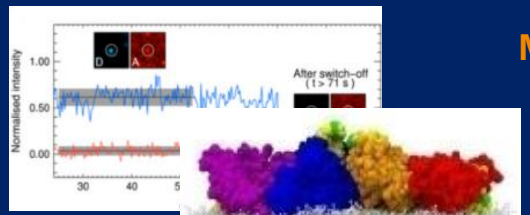

4Pi development

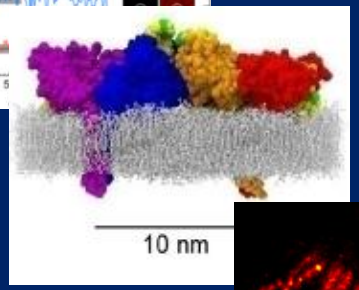

Automated FLImP **(4 nm)**


MINFLUX **(2-4 nm)**

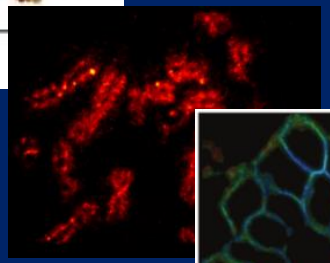

Cryo ASIL-STORM **(10 nm)**

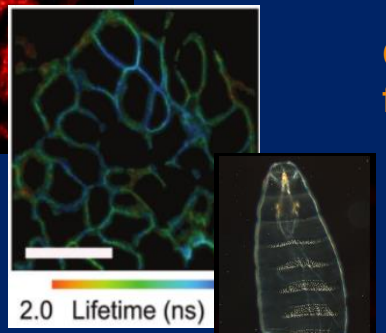
Molecular structure-function determination (1-10 nm)





Macromolecular architecture (20-50 nm)



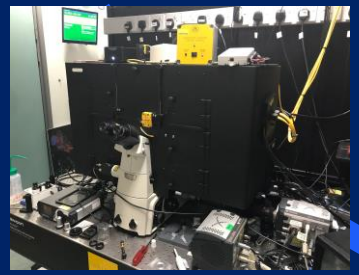


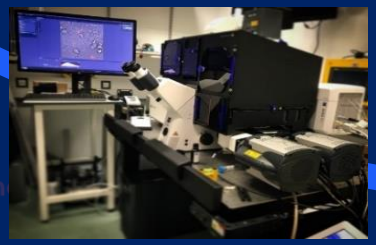
Cellular organisation-function (100-250 nm)

Organism development (200-500 mm)


Fast HPH facility


Single particle tracking


Tweezers lab


3D SIM/STORM/Airyscan Fast **(20 nm)**


3D SIM/STORM - Elyra **(20 nm)**


Gated 3D STED **(25-50 nm)**


Cryo FIB/SEM **(4 nm)**

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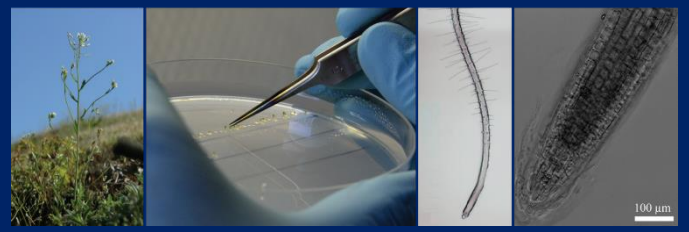
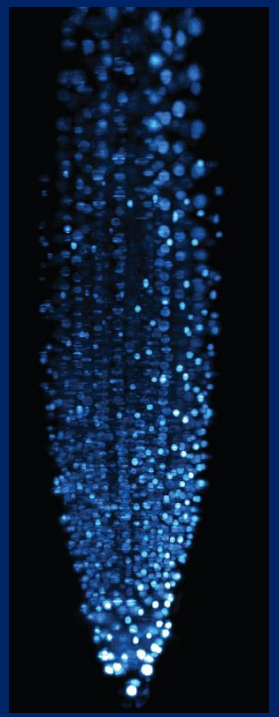
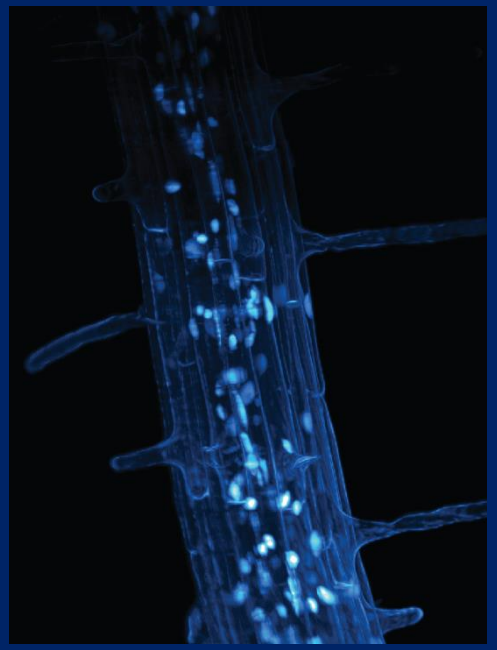


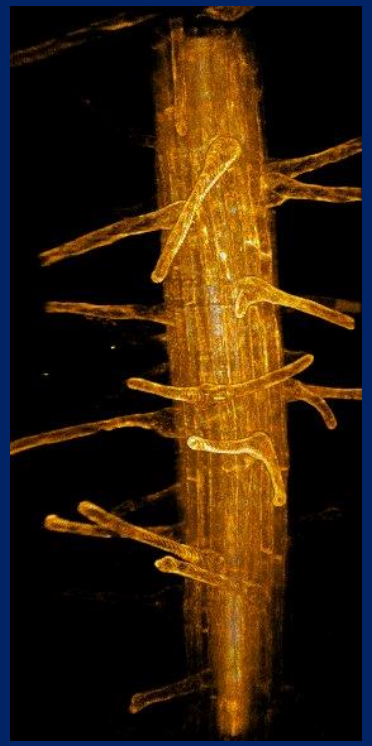
Sample growth handling & Preparation

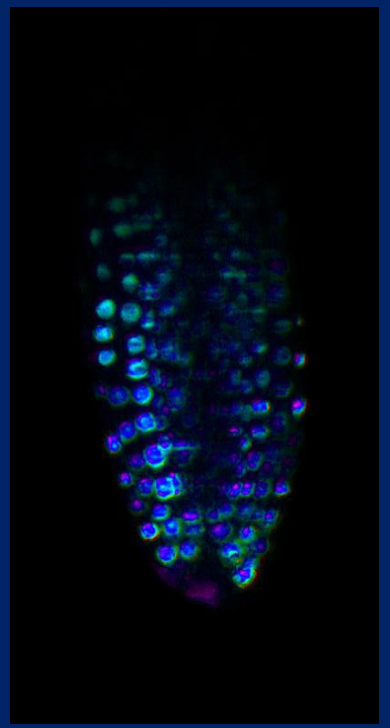
Advanced 2D, 3D & 4D Imaging

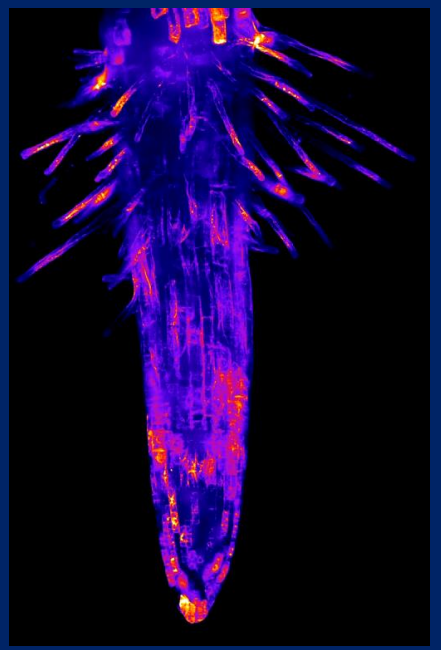
Data & image processing to extract key information

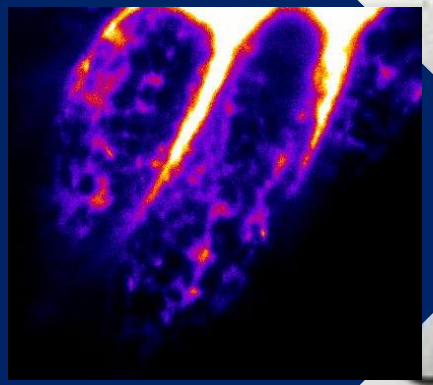








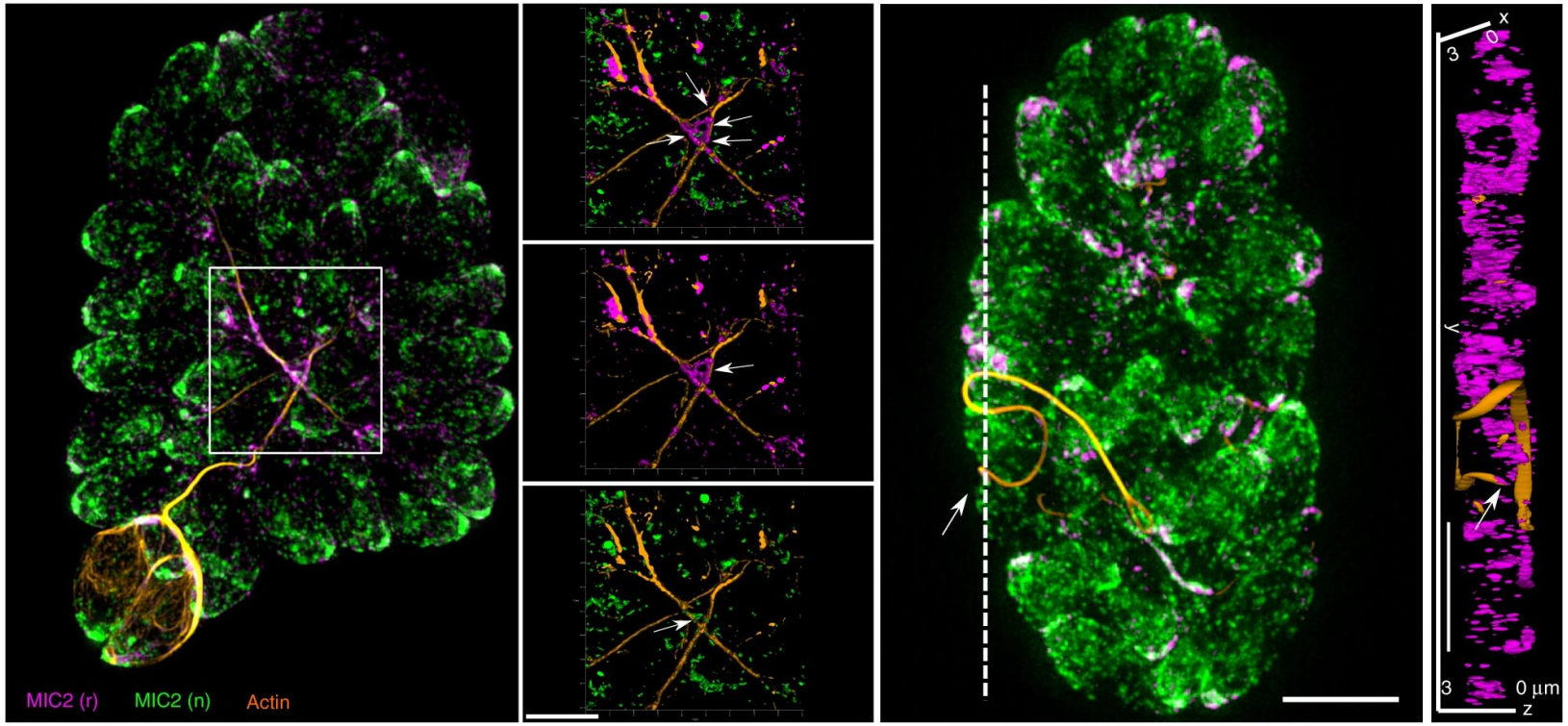




Super-resolution microscopy reveals secrets of the *Toxoplasma* parasite

Toxoplasmosis is a common parasitic infection in the population (20-30% in the UK). Infection is transmitted by cats and is hazardous to certain groups, particularly pregnant women.

- ✓ Super-resolution microscopy at the CLF has revealed how the parasite uses a molecular network to conserve its resources, opening up the possibility of targeting this network to treat infection



A highly dynamic F-actin network regulates transport and recycling of micronemes in *Toxoplasma gondii* vacuoles, Javier Periz et al., *Nature Communications* **volume 10**, 4183 (2019)

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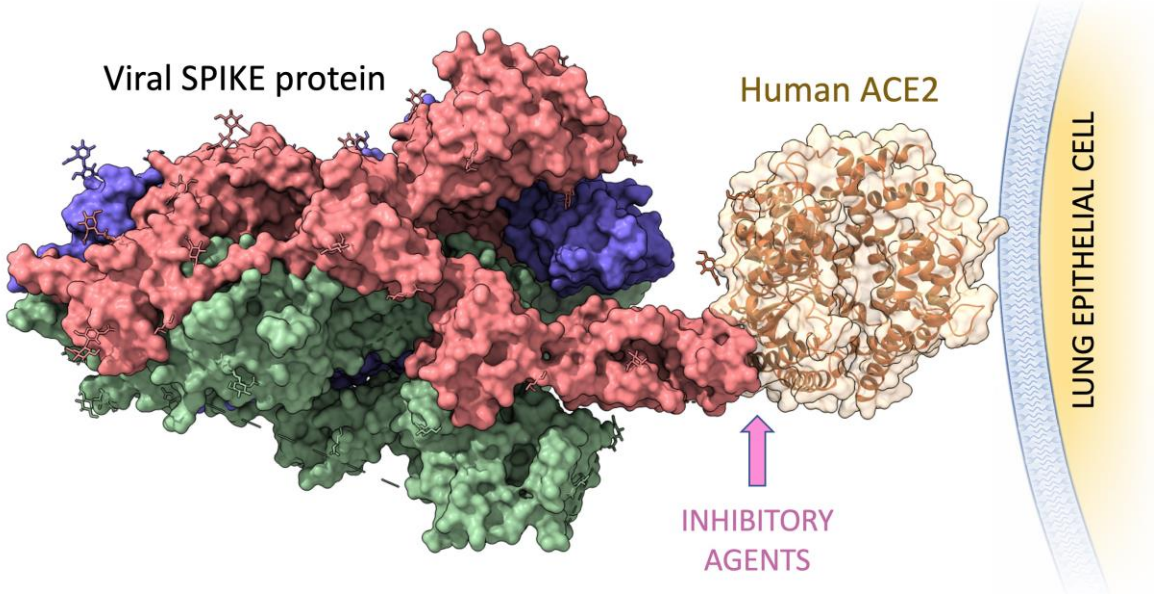
University of Glasgow

CLF's COVID Rapid Access

Understanding interaction of SARS-CoV-2 Spike protein with mammalian ACE2 receptor in the membrane using FLIM-FRET



Consortium of academic and industrial partners working towards identifying how COVID proteins enter lung epithelial cells

Protein Production UK

UKRI Science and Technology Facilities Council

LGC

The NativeAntigen COMPANY

The Rosalind Franklin Institute

stream bio

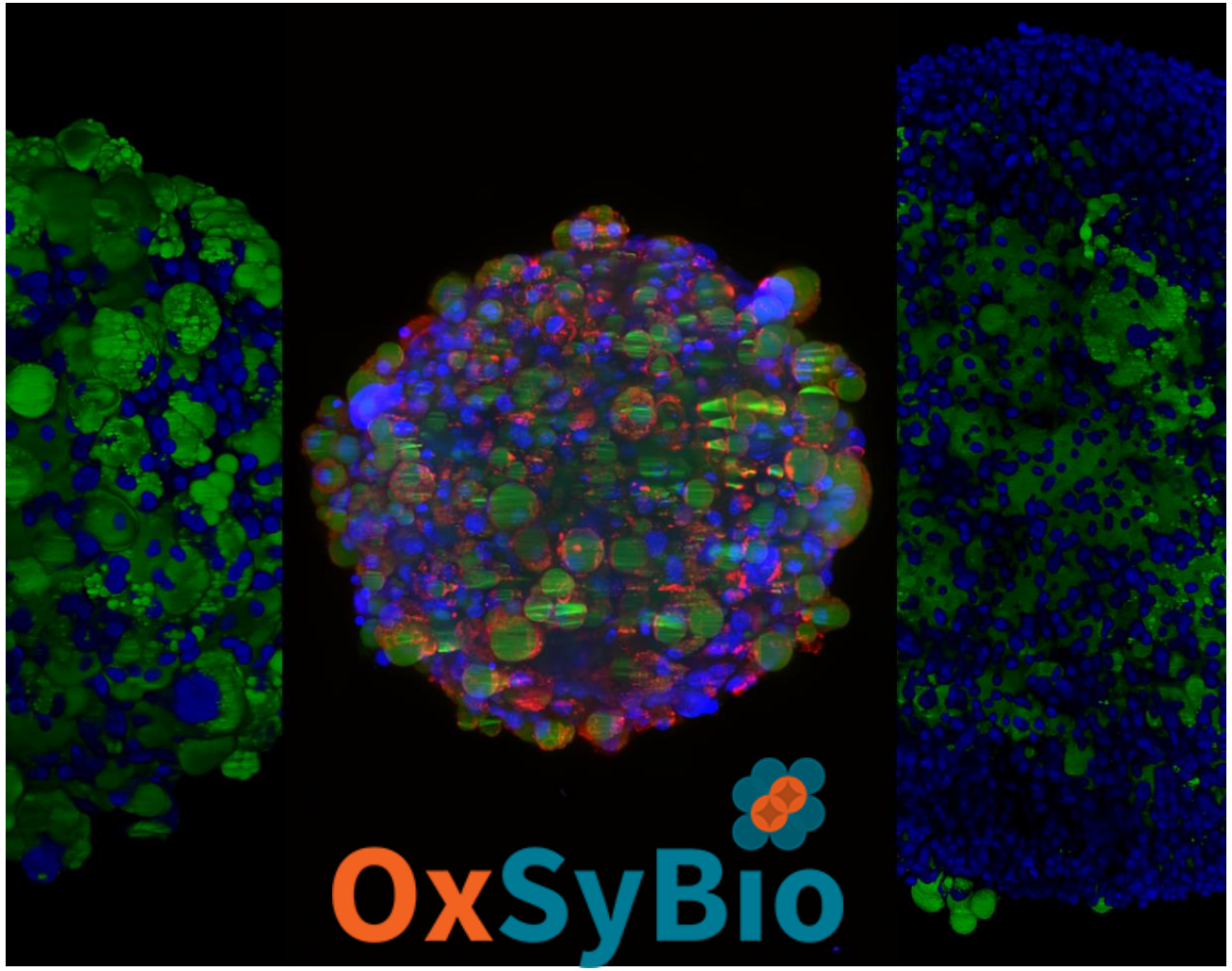
OxSyBio Collaboration

OxSyBio were awarded funding to utilise the CLF's expertise in fluorescence imaging in order to image 3D tissue models and understand how these models change over time.

OxSyBio, an Oxford University spinout utilised the CLF's Light Sheet Microscope to image and watch whole 3D tissue models.

"An improved understanding of the lipid morphology of the 3D adipose models will greatly improve the quality of the in vitro environment that we are aiming to model."

Head of Scientific Operation



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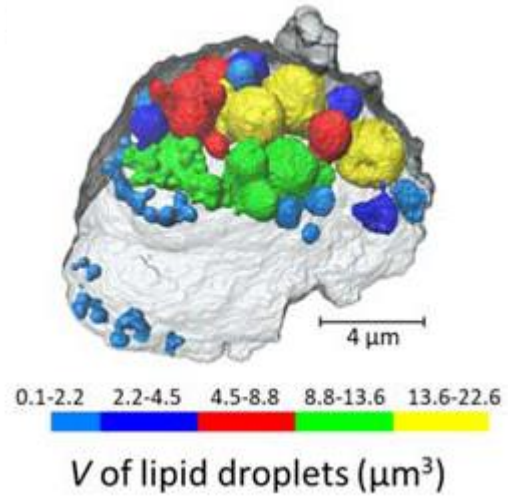
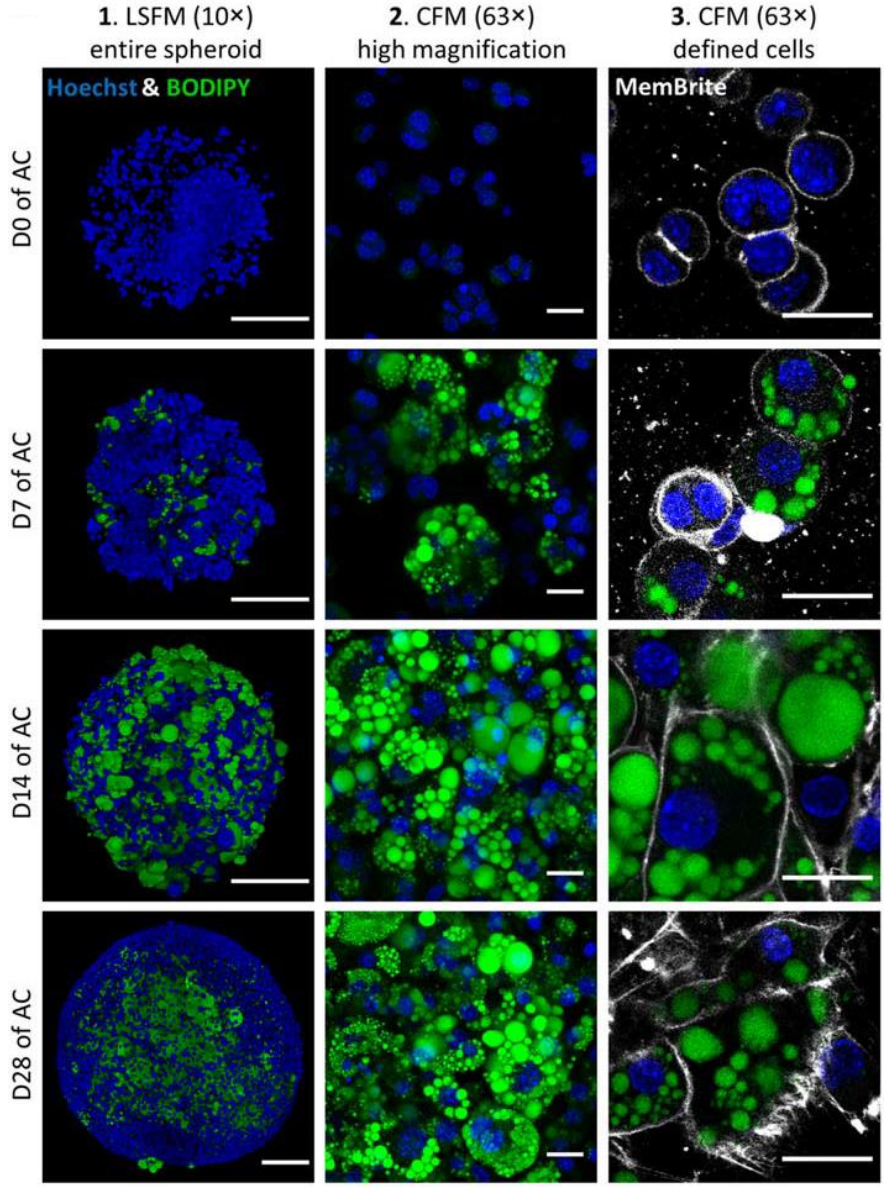
Light sheet microscopy helps to develop tissue models

The project developed a drug-responsive 3D model of adipose tissue that has potential as a powerful scalable tool for compound screening and for investigating adipose biology

Light sheet microscopy allows us to visualise in 3D the development of the model system, and to study how it interacts with drug molecules.





OxSyBio

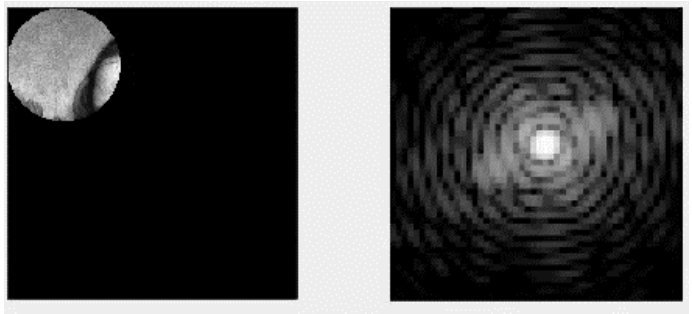
UNIVERSITY OF OXFORD

UKRI Science and Technology Facilities Council

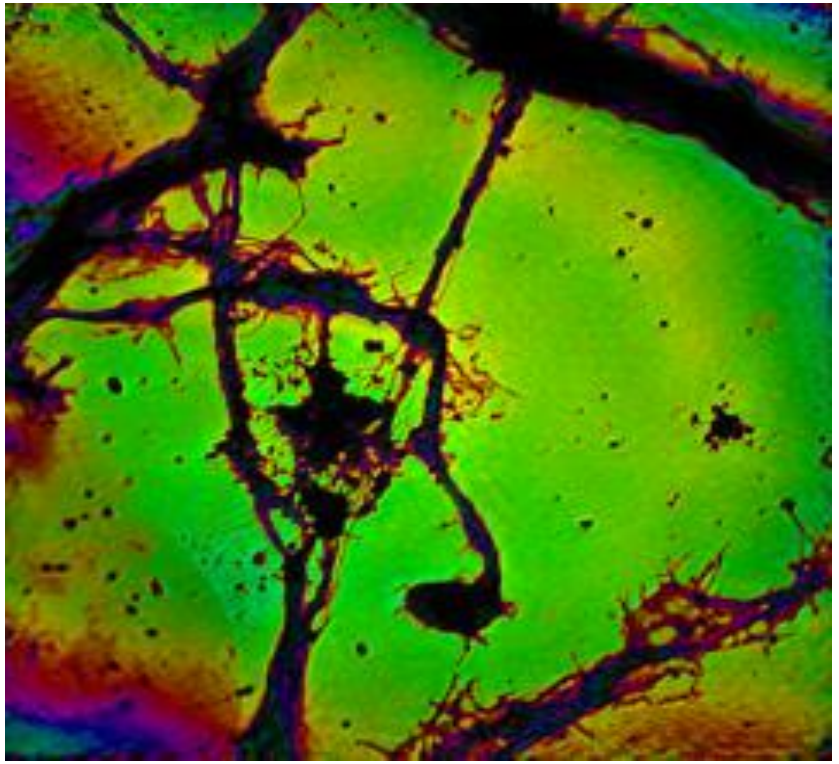
UKRI Medical Research Council

Coherent lensless imaging on Artemis

- 7-day old mouse neurons grown on substrate
- Imaged using 42 nm extreme ultraviolet pulses with good spatial coherence
- Ptychography: wide area image built up by scanning over the sample
- No lens used, so scatter pattern recorded at each point
- Iterative algorithm used to calculate image



For two areas of illumination which overlap, the **object** must be the same for each



- ✓ 80 nm resolution over 80 micron field of view achieved
- ✓ Both intensity and phase retrieved

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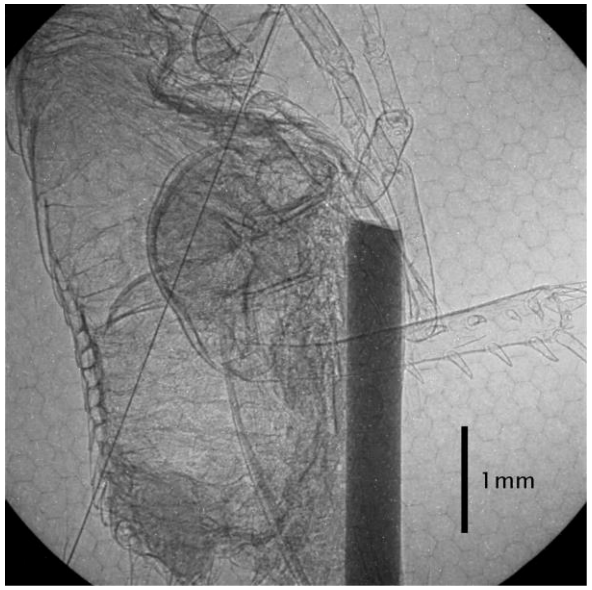
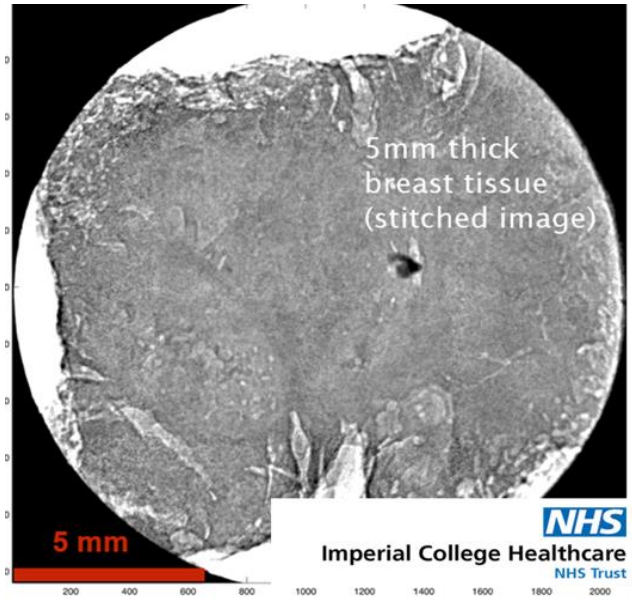
Small source in laser-based accelerators gives high resolution & improves phase contrast



- At high photon energies, attenuation is low and phase is more sensitive
- Clearer distinction between similar densities



- X-ray histology is an emerging technique
- Fast scans allow **intra-operative** μCT

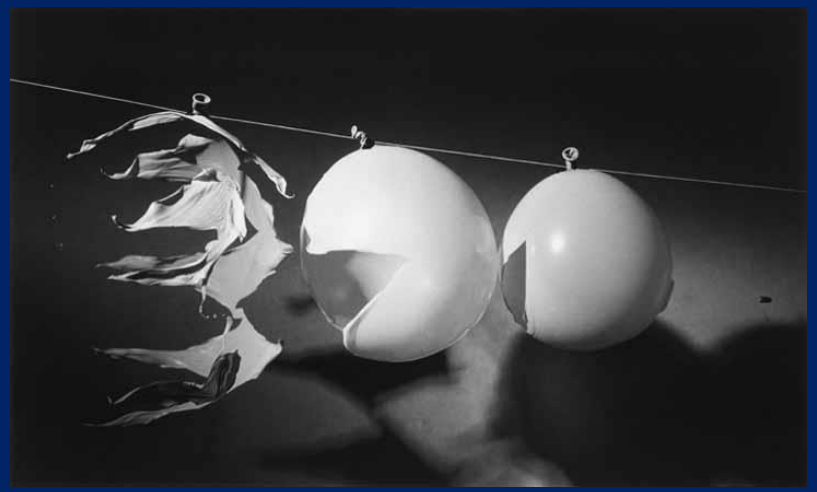
- Fast scanning at **higher resolution**
- Blur-free live animal imaging

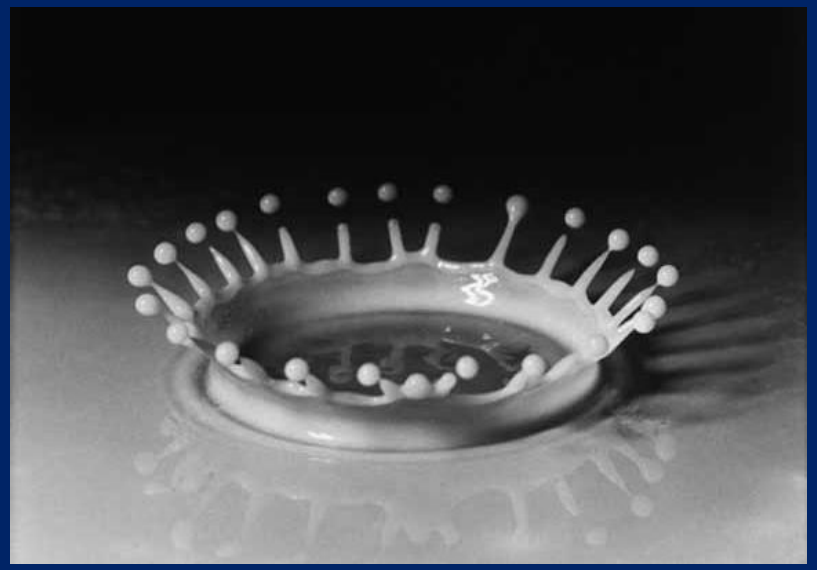
Science and Technology Facilities Council

Medical Research Council

Imperial College London
John Adams Institute for Accelerator Science

Ultrafast science: lasers as strobes





Strobe photography lets us freeze-frame motion on millisecond timescales

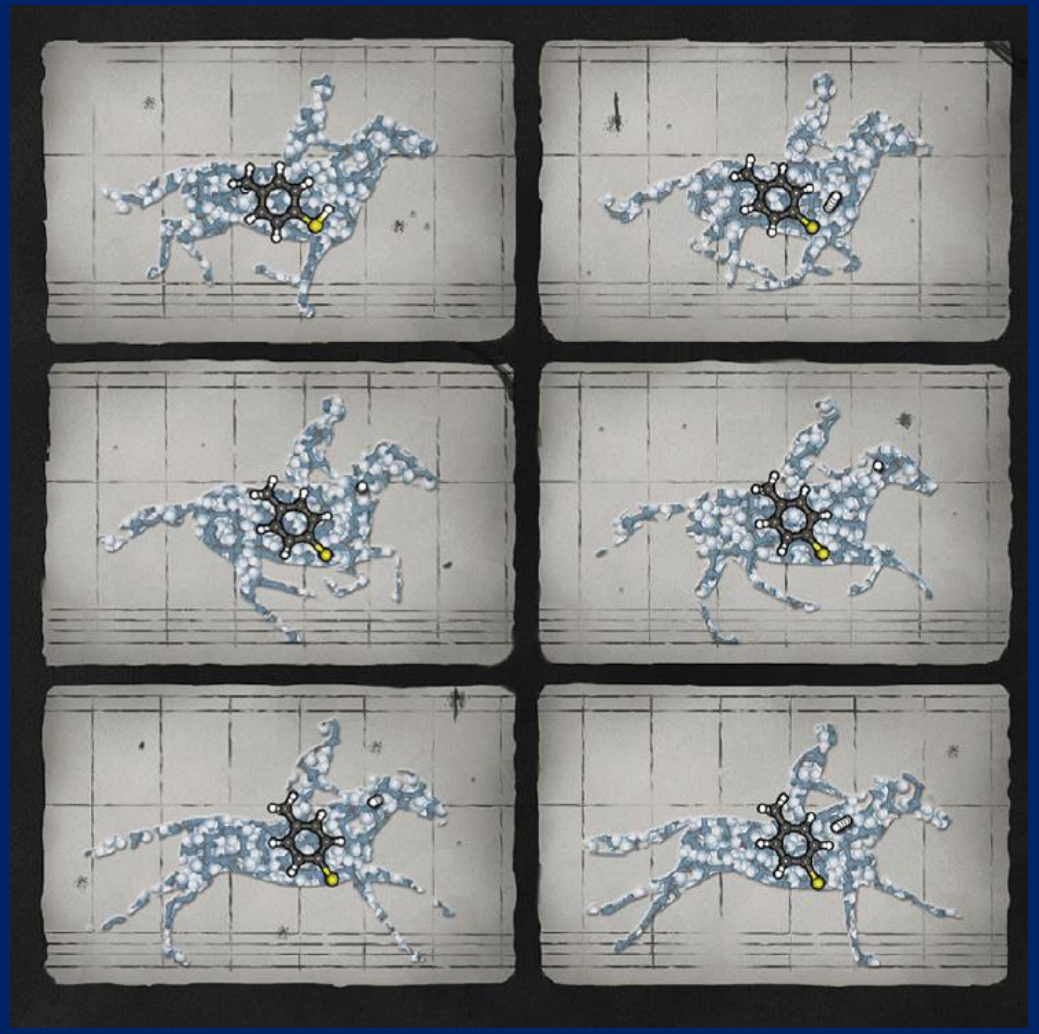
Lasers let us look at **much** faster timescales

Harold E. Edgerton. Back dive; Bullet through three balloons; Milk Drop Coronet. http://edgerton-digital-collections.org

Dynamic Spectroscopy

CLF has 2 facilities for spectroscopy and dynamics

Our spectroscopic techniques can watch how chemical and biochemical changes in materials happen in real-time, helping academia and industry understand efficiency, improve design and optimise systems and products



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UCB Pharma Collaboration

UCB collaborates with CLF and University of York scientists to investigate proteins in support of drug design.

CLF's Ultra system is one of the world's most sensitive 2D-IR spectrometers and is used to investigate the dynamics of complex biological systems such as the protein Calmodulin.

UCB, University of York and CLF also have a long-term partnership to look at how 2DIR can be used diagnostically.

Inspired by patients. Driven by science.

UNIVERSITY of York

Science and Technology Facilities Council

The Coconut COLLABORATIVE®

Coconut Collaborative

Assessing the feasibility of using spectroscopy to detect traces of rancid coconut cream ahead of its use in the production of coconut yogurt.

Innovate UK Analysis for Innovator's funded a multi-facility investigation to determine a potential new quality control spectroscopic application.

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Central Laser Facility (CLF)

Dr Kathryn Welsby
Industry Partnership & Innovation Group Lead