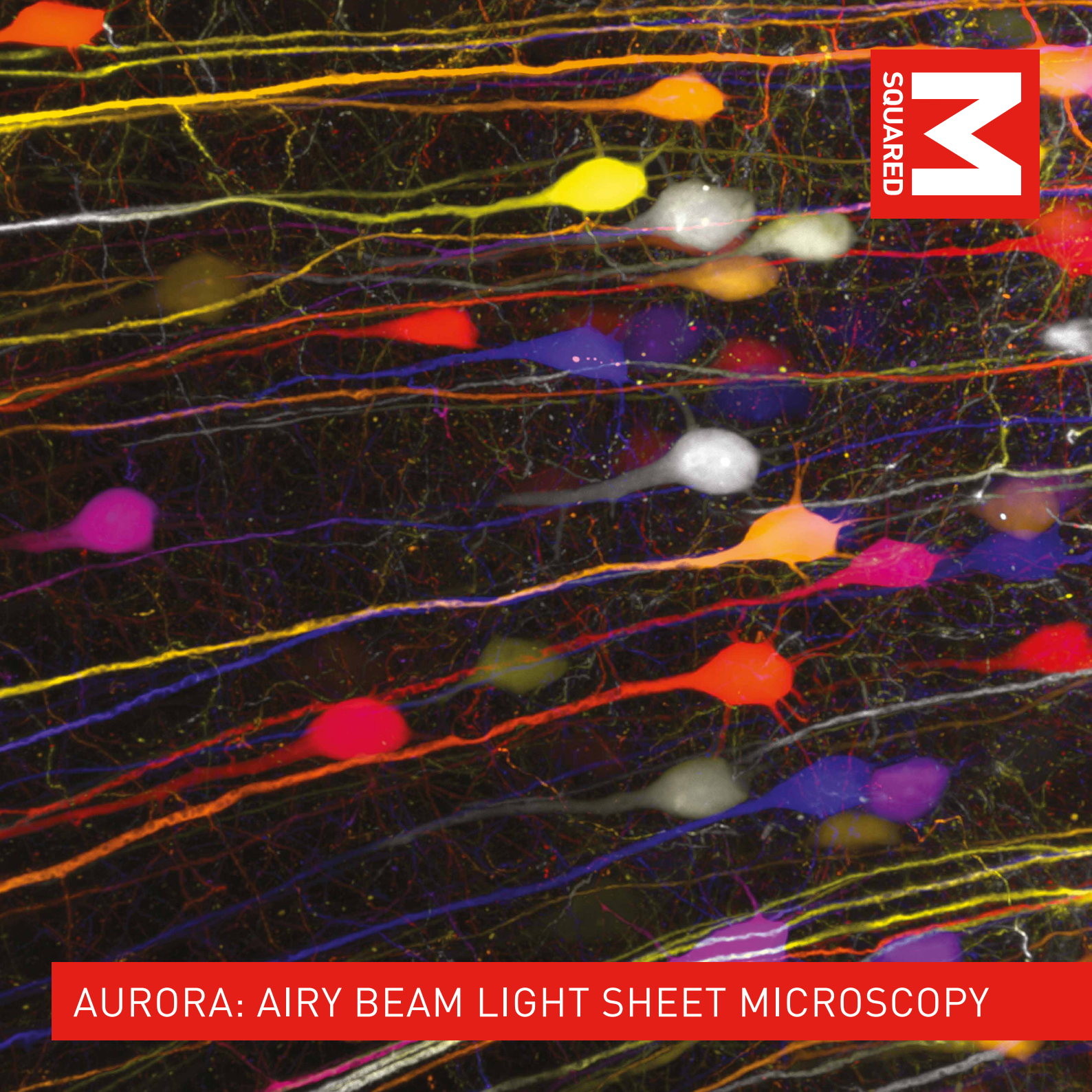
SQUARED
AURORA: AIRY BEAM LIGHT SHEET MICROSCOPY

Cover picture shows optically cleared mouse brain expressing thy1-GFP Actin, maximum intensity projected using a coloured height map. Original dataset was 600x600x640 micrometres.

Image courtesy of Dr Anthony Vernon and Robert Chesters, Department of Basic and Clinical Neuroscience, Maurice Wohl Clinical Neuroscience; MRC Centre for Neurodevelopment Disorders, King's College London.

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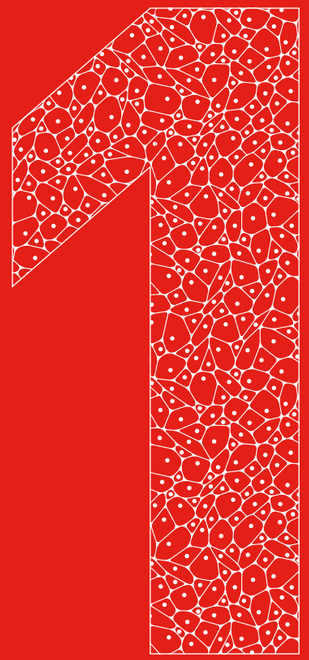


AURORA

> We use the Aurora airy beam light sheet microscope system for a wide range of volumetric fluorescence imaging experiments in our lab. In particular, we find the capability of the system to rapidly image large samples with sub µm spatial resolution make it well suited to studying 3D cell cultures and multicellular models, which is helping us to investigate structural changes in tumour organoids in response to therapeutic drug treatment.

DR MIKE SHAW

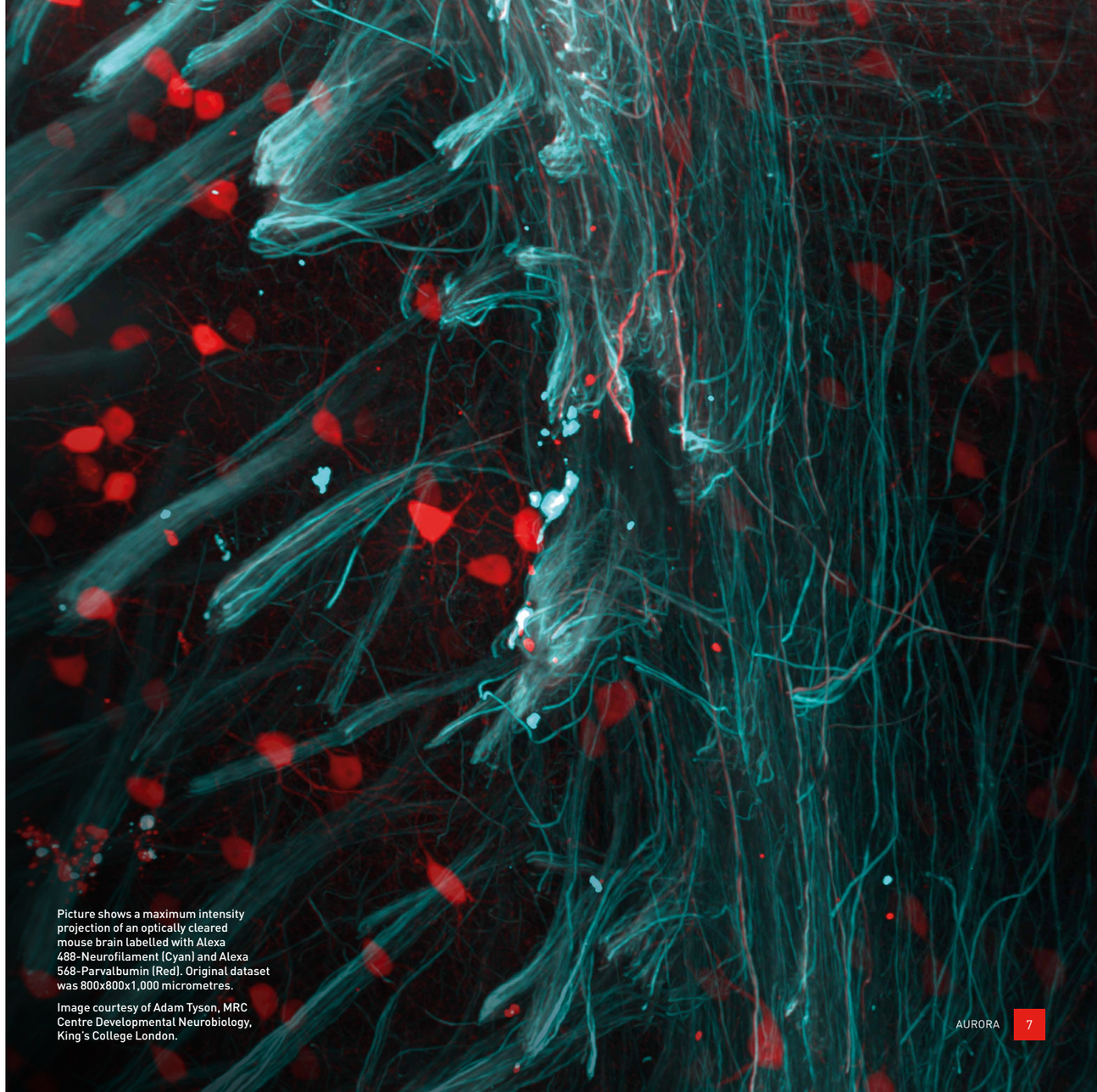
Senior Research Scientist, National Physical Laboratory

INTRODUCING AURORA

Aurora is an award-winning Airy Beam Light Sheet imaging system designed for researchers working in fields such as neuroscience, developmental biology, cancer biology, regenerative medicine and other bioscience disciplines.

Compact, affordable and customisable, Aurora is available as a single and multiphoton light sheet fluorescence microscope for rapid, large 3D volumetric imaging, high resolution, multicolour, time-lapse imaging and live cell imaging.

Aurora uses ground-breaking Airy Beam Light Sheet imaging techniques to achieve outstanding results in the field. It is currently in use by many leading organisations delivering results previously not possible.



Picture shows a maximum intensity projection of an optically cleared mouse brain labelled with Alexa 488-Neurofilament (Cyan) and Alexa 568-Parvalbumin (Red). Original dataset was 800x800x1,000 micrometres.

Image courtesy of Adam Tyson, MRC Centre Developmental Neurobiology, King's College London.

BENEFITS OF AIRY BEAM LIGHT SHEET MICROSCOPY

Uniquely large field of view with comparable resolution

600 µm (x20 obj.) field of view that is 20 times larger than a standard Gaussian light sheet (along propagation axis).

Low phototoxicity

Peak Irradiance is 80% less than a Gaussian light sheet while retaining a similar axial resolution.

High image contrast

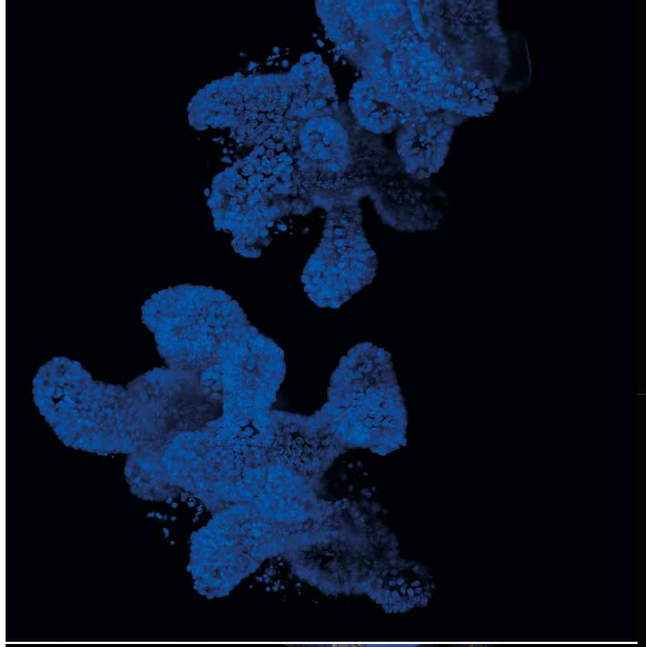
Information within the distributed pattern is not lost but regained through deconvolution resulting in a 10x signal-to-noise improvement.

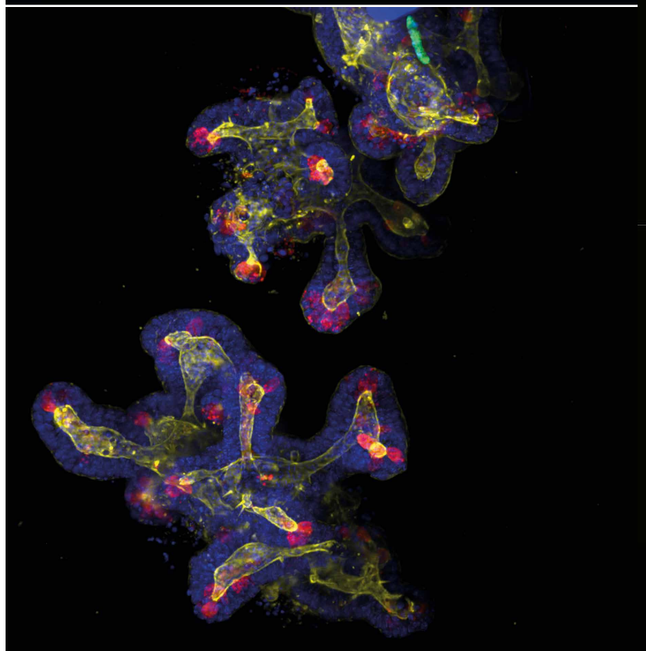
Deeper penetration and minimal scattering

Deeper penetration of sample with significantly less scattering due to asymmetric excitation pattern and distribution of power through the Airy lobes.

Self-reconstructing beam

Less shadowing due to the curved nature of the Airy beam profile.

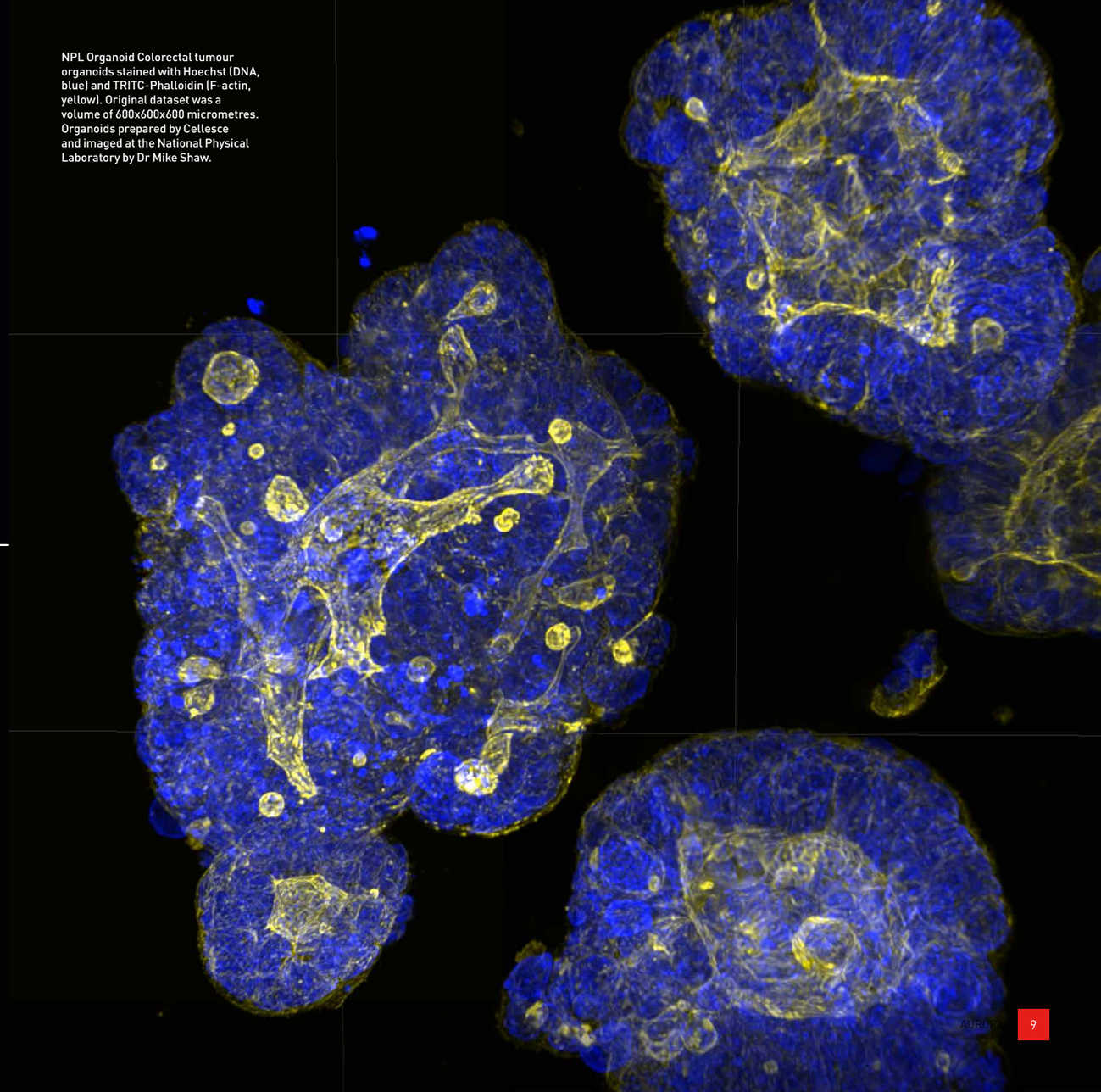




Pictures show maximum intensity projections of 2-week old mouse intestine organoids. The bottom image shows label of 4 colours: DAPI staining the nuclei (Blue), AF647-Phalloidin staining Actin, AF555-WGA staining the Paneth cells, and GFP-LGR5 expressing in the stem cells. The top image shows the stand alone DAPI signal. Original dataset was 600x600x200 micrometres.

Image courtesy of Dr Sandra Scharaw and Dr Sylvie Le Guyader, Karolinska Institute, Department of Biosciences and Nutrition.

NPL Organoid Colorectal tumour organoids stained with Hoechst (DNA, blue) and TRITC-Phalloidin (F-actin, yellow). Original dataset was a volume of 600x600x600 micrometres. Organoids prepared by Cellesce and imaged at the National Physical Laboratory by Dr Mike Shaw.



AIRY BEAM LIGHT SHEET MICROSCOPY

The ability to accurately image large structures at cellular resolution is fundamental to modern biological understanding. Light sheet fluorescence microscopy is an increasingly popular imaging technique for producing high contrast 3D volumetric images of intact biological specimens.

The fundamental principle is to illuminate the sample with a sheet of light at a 90° angle to the detection objective. The entire field of view can be recorded 500-1000x faster than laser point scanning microscopy and with minimal photon damage to the specimens and fluorophores.

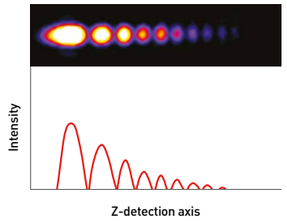
The majority of current light sheet microscopes use a Gaussian profile laser beam to illuminate a sample, which directly affects the possible field of view and the resolution, leading to a compromise that limits the size of the imaging plane.

The Aurora imaging system resolves these issues by using a 'self-healing' Airy beam, described as such due to the curved nature of the Airy profile; even after the beam has passed through the sample, the profile is retained minimising any shadowing effects.

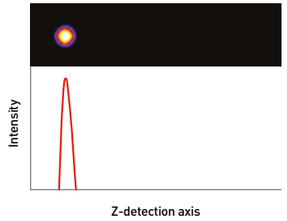
The Airy beam's ability to be extended and retain its asymmetric excitation pattern enables the full field of view (up to 870 um x 870 um) to be captured while still maintaining 1 µm near isotropic resolution. The asymmetric excitation pattern also provides deeper penetration and lower phototoxicity, due to the distribution of laser power throughout the Airy lobes.

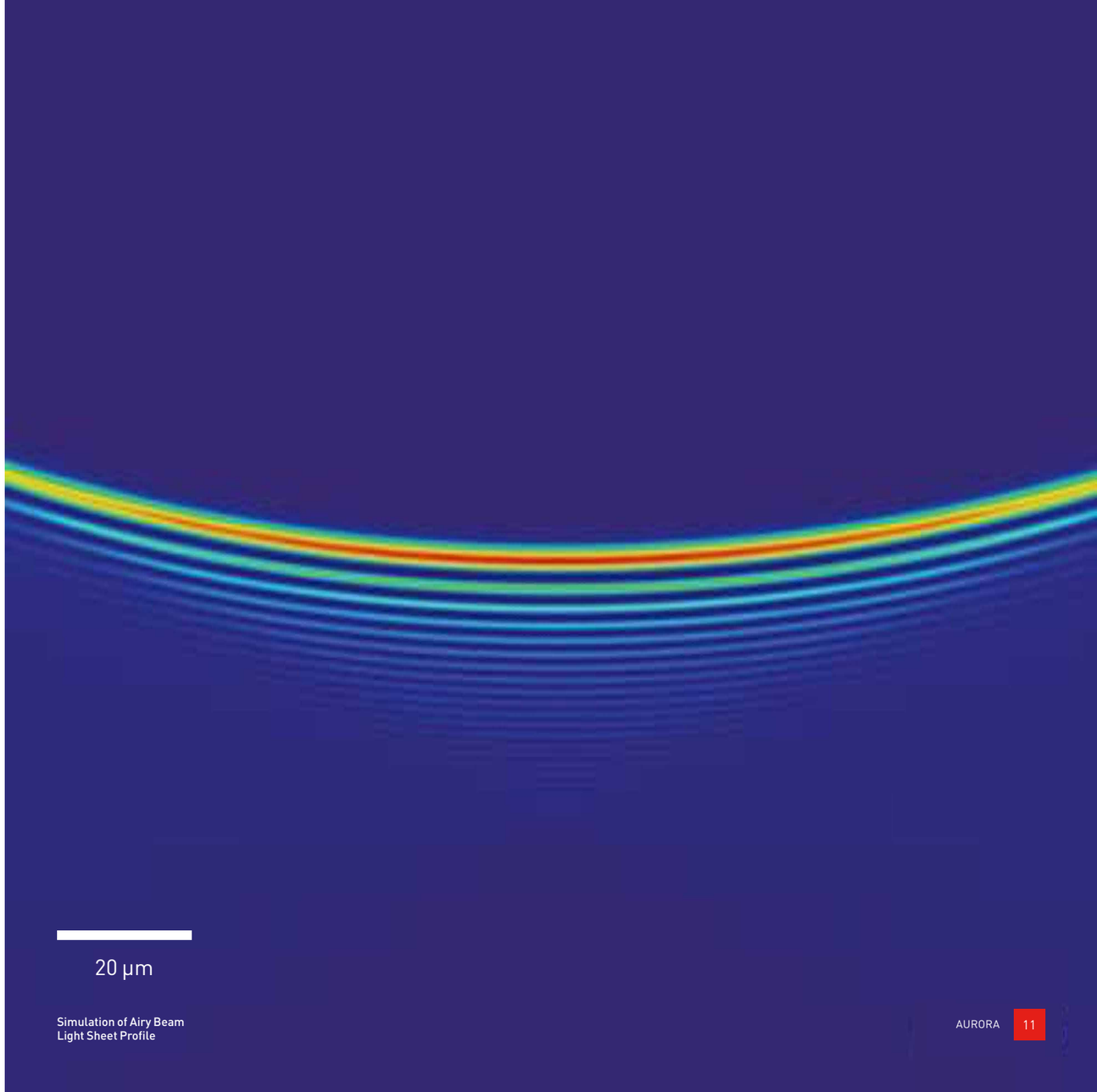
M Squared Life's Aurora Deconvolution software captures and restores the information encoded within the Airy lobes, improving signal-to-noise by a factor of 10 and delivering images with high contrast and resolution.

AIRY BEAM PSF - BEFORE DECONVOLUTION



AIRY BEAM PSF - AFTER DECONVOLUTION





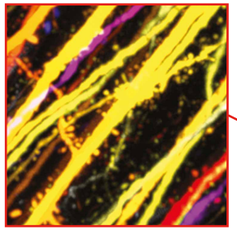
Simulation of Airy Beam Light Sheet Profile

IMAGING AT SCALE

Aurora is able to image at sub-cellular resolution over entire organisms. These images show whole organisms >10mm across down to sub-cellular components <1 µm across. This makes Aurora a versatile instrument ideal for multi-user facilities or if you have a wide range of specimen sizes to image.

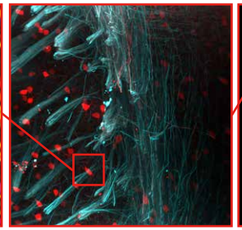
SUB-CELLULAR COMPONENTS		CELLS	TISSUE	ORGAN	ORGANISM
500 nm	1 µm	20 µm	500 µm	1 mm	1 cm

Spinal dendrite

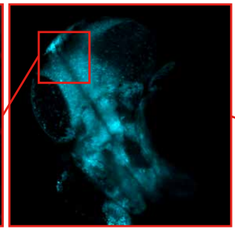


Neuron

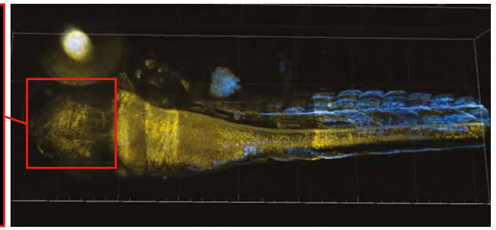
Neuron connections



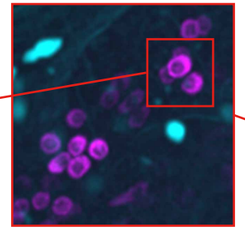
Brain



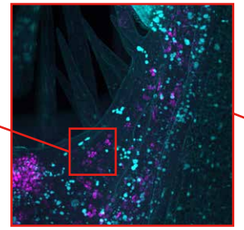
Organism - Zebra fish



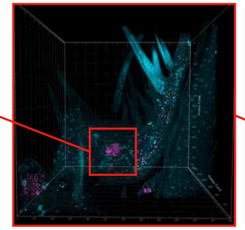
Plant cells



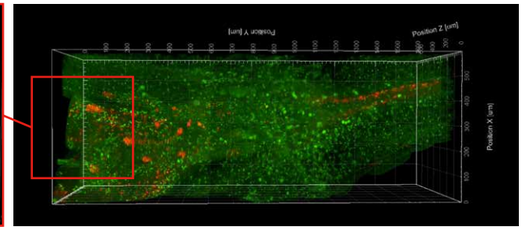
Cell interaction



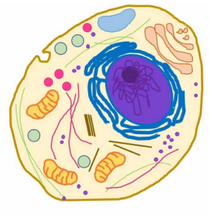
Meristem



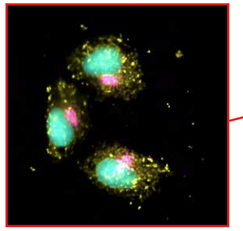
Organism - Plant



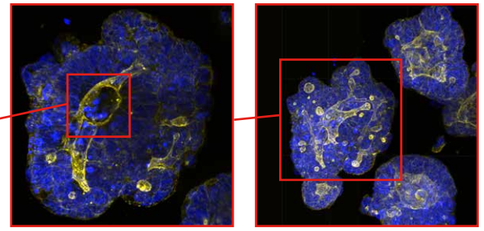
Golgi, Mitochondria, Nucleus



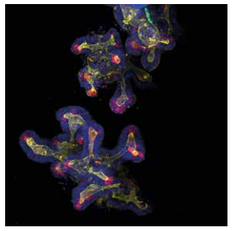
Cell nuclei



Inside Organoids



Multiple Organoids



KEY FEATURES

Our Aurora imaging system uses an Airy beam for light sheet illumination, enabling deeper penetration with a lower photon dose for longer imaging times. A wider field of view allows more of a specimen to be imaged whilst maintaining a high three-dimensional resolution, which is unique to the market.

Aurora is not only transformative; it is a flexible and affordable instrument that addresses the current limitations in other light sheet systems.

Wide field of view

Image larger specimens

High isotropic resolution

Maintain a large field of view with sub-cellular resolution

Low photo-bleaching

Minimise sample degradation and image for longer

Intuitive user interface

Minimal training together with personalised functions and code

Modular design

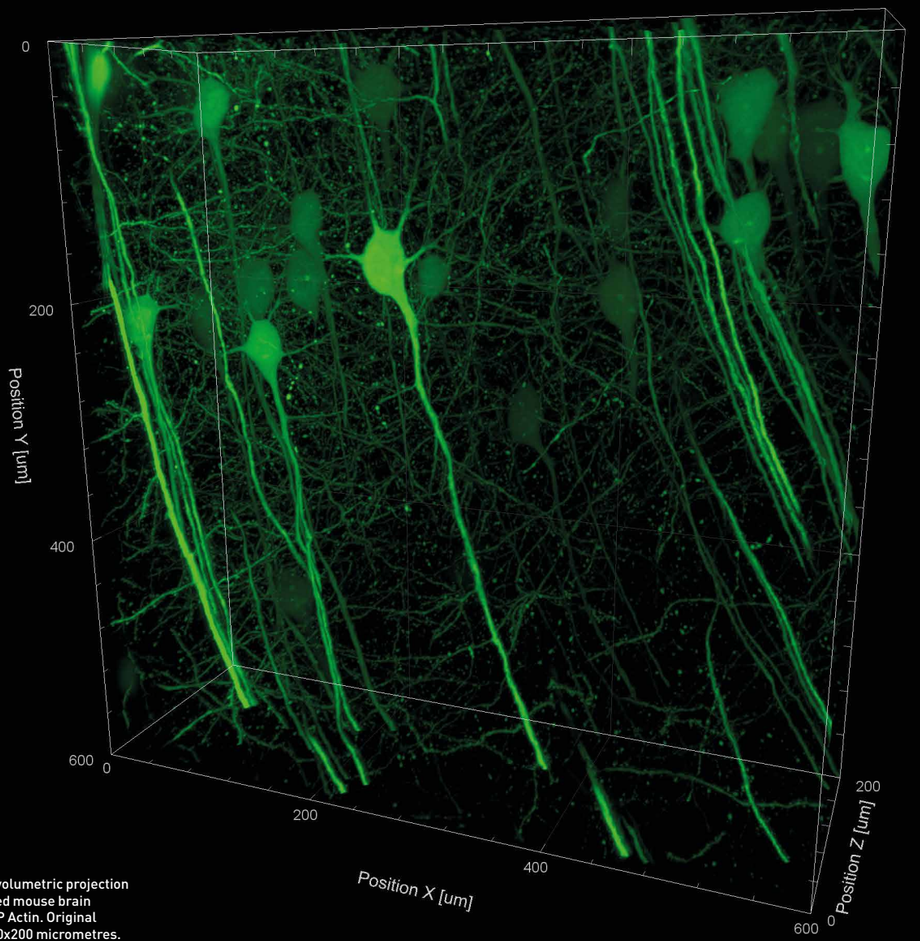
Create custom systems to meet your research needs and budget

Flexible specimen preparation

Live or fixed samples, monolayer, 3D culture or tissues; incorporated incubation and perfusion

Compact bench-top systems

Entry-level system only
60 x 50 x 70 cm
(length x depth x height)



Picture shows a 3D volumetric projection of an optically cleared mouse brain expressing thy1-GFP Actin. Original dataset was 600x600x200 micrometres.

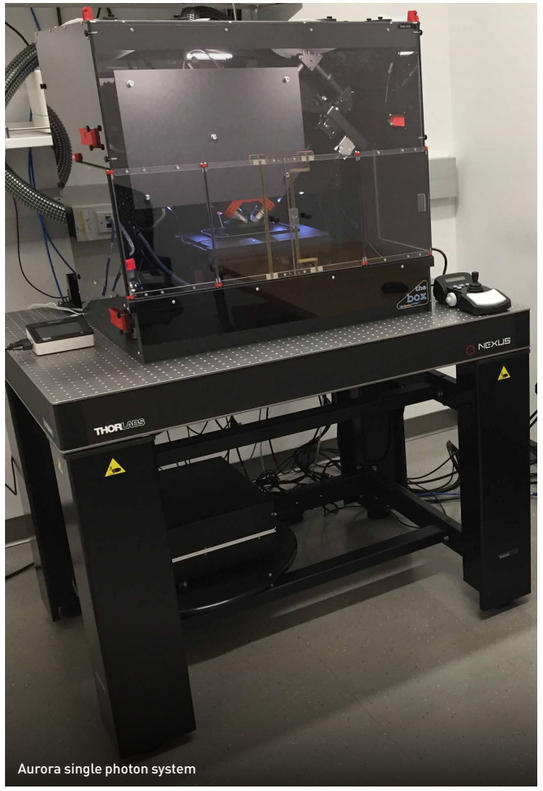
Image courtesy of Dr Anthony Vernon and Robert Chesters, Department of Basic and Clinical Neuroscience, Maurice Wohl Clinical Neuroscience; MRC Centre for Neurodevelopment Disorders, King's College London.

AURORA SYSTEM AND SOFTWARE

Aurora is very flexible and can be tailored to meet your specific scientific research requirements. When you join our custom development programme our team will consult with you to determine the best configuration to meet your application needs. Having chosen the initial level of system complexity, in the future you may add a range of modules, or laser lines as your research demands.

Available options currently include:

- A wide range of continuous-wave laser lines
- Single and/or multiphoton light sheet imaging configuration
- Fully or partially automated stage
- Environmental control sample chamber

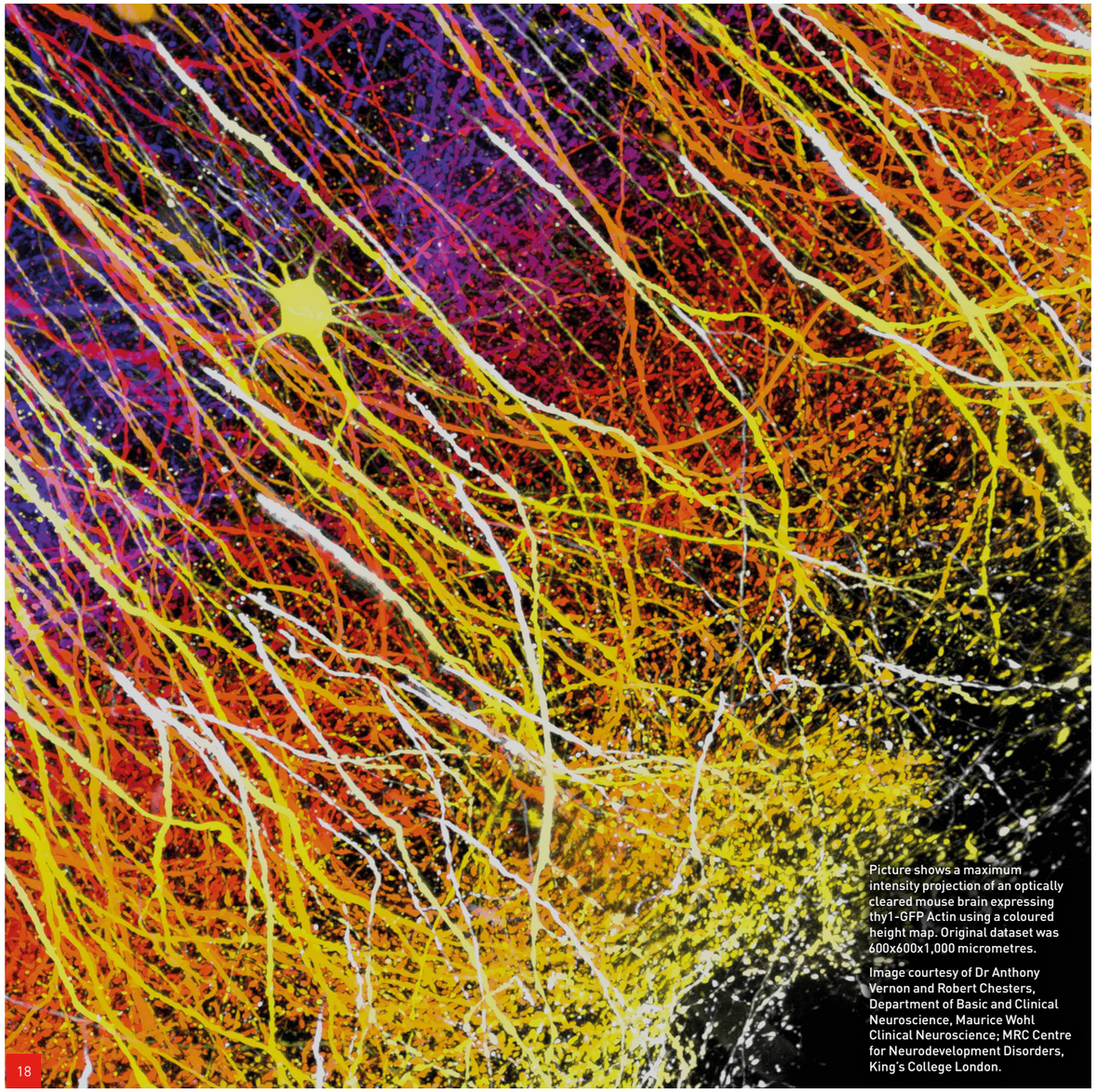


Aurora single photon system

AURORA GRAPHICAL USER INTERFACE

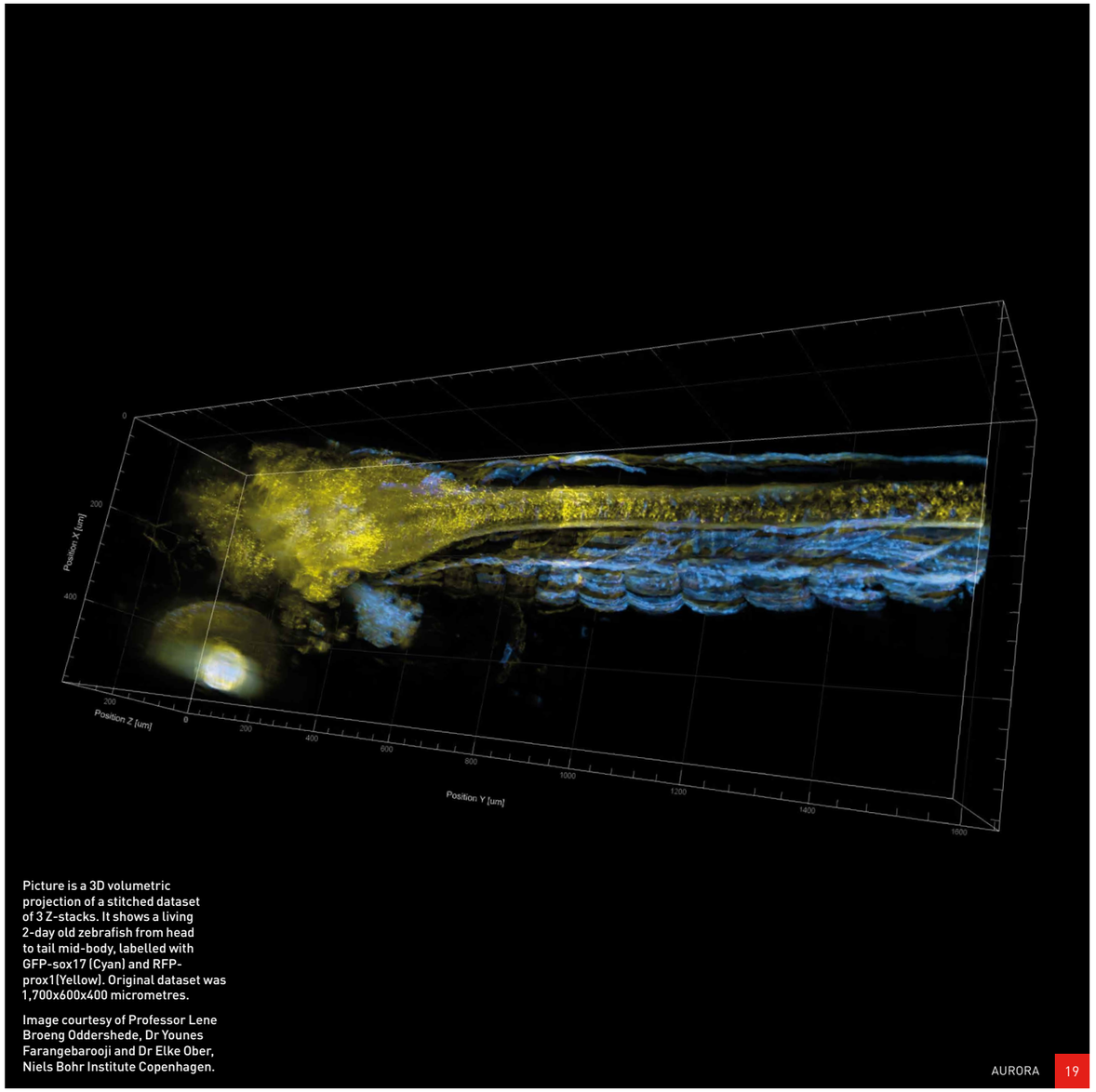
Aurora's user driven evolution has guided the development of a fully featured user friendly graphical user interface, which has been designed to allow you to flexibly build your experiments then automatically control the microscope.

Unique to the Aurora system is its continuous velocity acquisition, allowing imaging of specimen volumes with no delay thereby speeding up your image acquisition routines.



Picture shows a maximum intensity projection of an optically cleared mouse brain expressing thy1-GFP Actin using a coloured height map. Original dataset was 600x600x1,000 micrometres.

Image courtesy of Dr Anthony Vernon and Robert Chesters, Department of Basic and Clinical Neuroscience, Maurice Wohl Clinical Neuroscience; MRC Centre for Neurodevelopment Disorders, King's College London.



Picture is a 3D volumetric projection of a stitched dataset of 3 Z-stacks. It shows a living 2-day old zebrafish from head to tail mid-body, labelled with GFP-sox17 (Cyan) and RFP-prox1(Yellow). Original dataset was 1,700x600x400 micrometres.

Image courtesy of Professor Lene Broeng Oddershede, Dr Younes Farangebarooji and Dr Elke Ober, Niels Bohr Institute Copenhagen.

COLLABORATION

> The layout of the Aurora instrument provides an extremely flexible specimen area with an incredible observation volume. For a microscopy service unit in particular, the wide flexibility of the system is of immense interest as you may use it to address a lot of different challenges. The potential of the system is very promising which is leading us to think of new imaging approaches we never had in mind before.

DR STEFAN VOLKERY

Max Planck Institute for Molecular Biomedicine,
Bio-optic Service Unit

CUSTOM DEVELOPMENT PROGRAMME

The Aurora Custom Development Programme enables you to customise an instrument with the functionality to suit your research. It has proven extremely beneficial to leading laboratories across many fields of study.

Once you join the programme, you'll start collaborating with M Squared's imaging specialists who will focus on your research and tailor the configuration and specifications of your Aurora system to your needs.

Personalise the programme

Tailor the programme to suit your budget and timescales

Develop a custom system

Choose from a range of modules to create a customised system

Dedicated application support

Our Application Specialists will work with you to optimise your applications imaging parameters

Priority technical support

Dedicated application specialists and engineers on hand to support you

Hands-on-training

Practical assistance to help you optimise sample imaging protocols

Grant application support

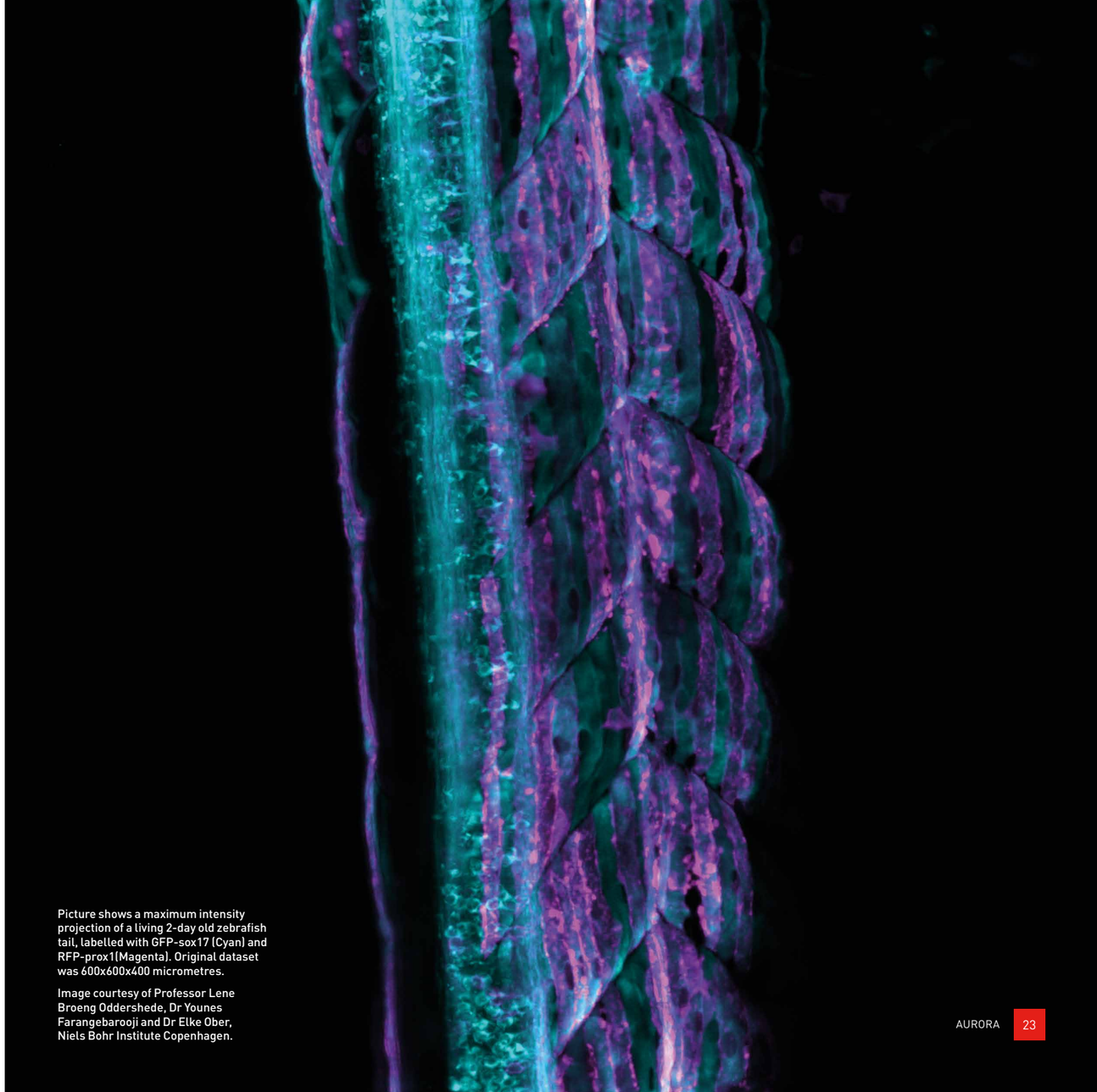
Access available funds with support from M Squared's grant writing team

Preferential purchase terms

Earn purchase terms that reflect your collaboration input

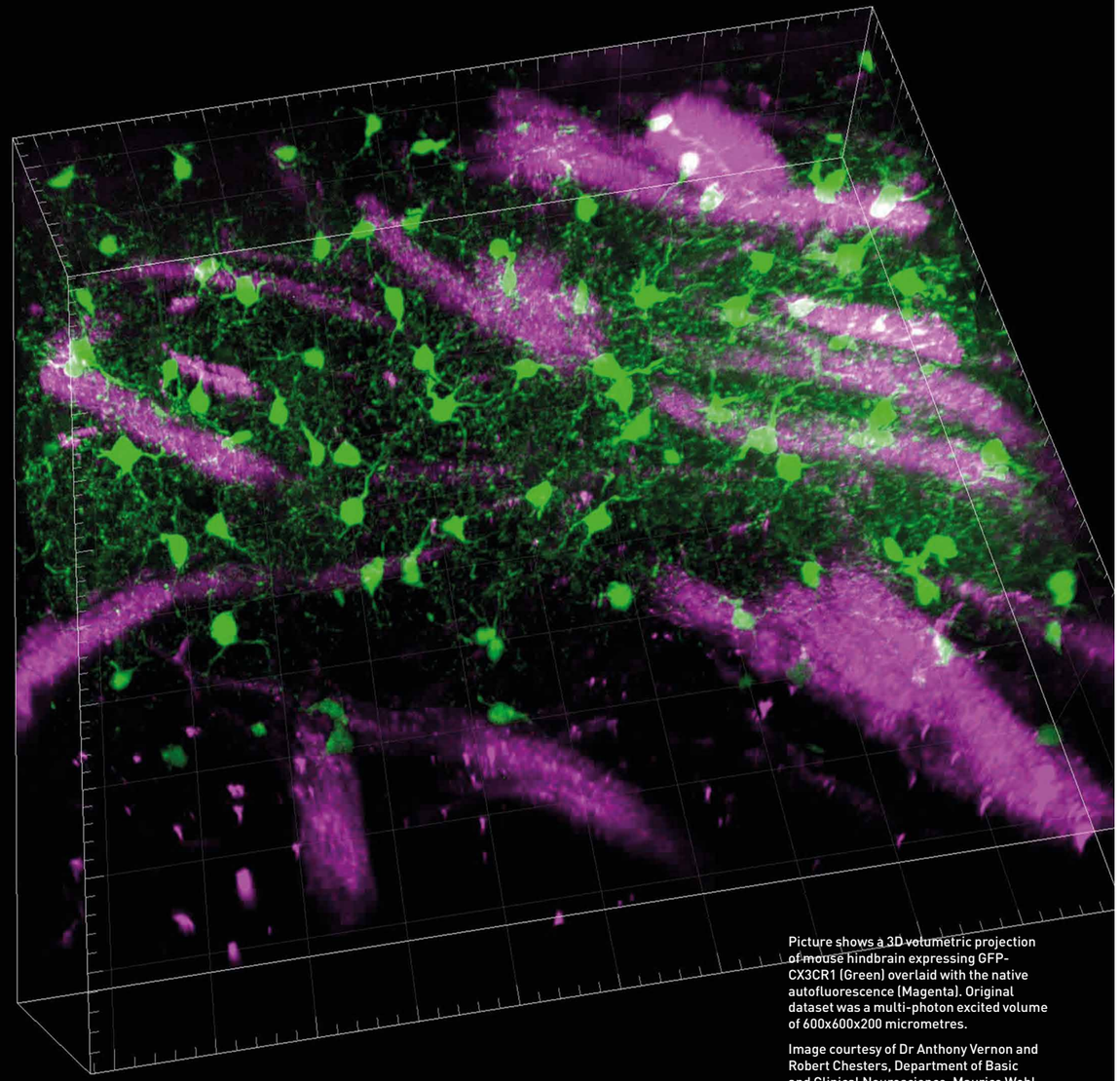
Co-author papers

Produce papers in conjunction with M Squared and other programme members



Picture shows a maximum intensity projection of a living 2-day old zebrafish tail, labelled with GFP-sox17 (Cyan) and RFP-prox1(Magenta). Original dataset was 600x600x400 micrometres.

Image courtesy of Professor Lene Broeng Oddershede, Dr Younes Farangebarooji and Dr Elke Ober, Niels Bohr Institute Copenhagen.



Picture shows a 3D volumetric projection of mouse hindbrain expressing GFP-CX3CR1 (Green) overlaid with the native autofluorescence (Magenta). Original dataset was a multi-photon excited volume of 600x600x200 micrometres.

Image courtesy of Dr Anthony Vernon and Robert Chesters, Department of Basic and Clinical Neuroscience, Maurice Wohl Clinical Neuroscience; MRC Centre for Neurodevelopment Disorders, King's College London.

CURRENT PARTNERS

Aurora is being used in the field by many leading organisations with outstanding results.

King's College London

NPL National Physical Laboratory

University of Cape Town · Universiteit Kaapstad · Yunivesithi yaseKapa

University of Copenhagen

The University of Edinburgh

University of Exeter

University of Oxford

University of Southampton

Max Planck Institute for Molecular Biomedicine

Karolinska Institutet

Åbo Akademi

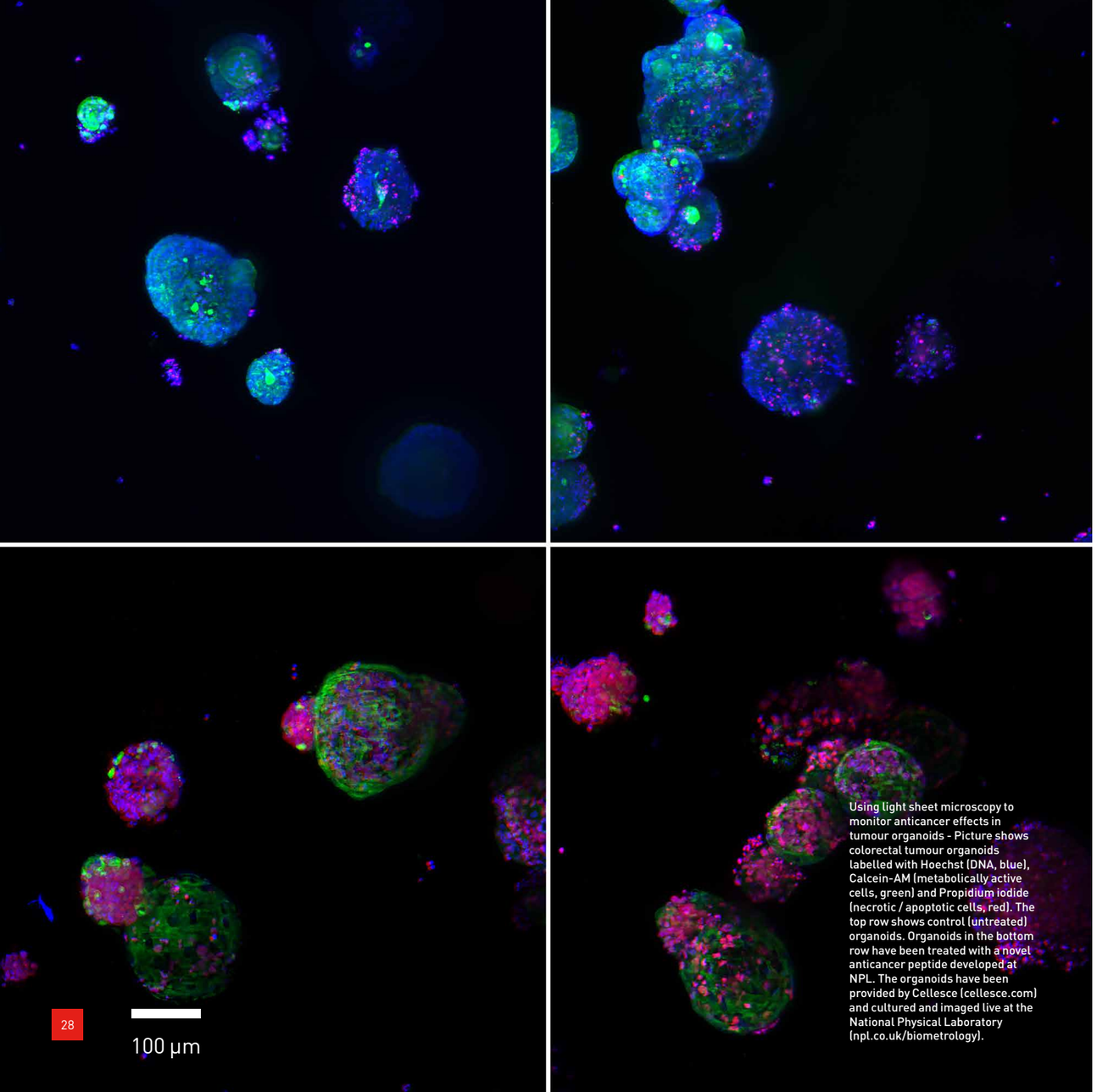
University of Southern California 1880

ABOUT US

> Our biology collaborators have been trying to image the zebrafish using competing light sheet imaging modalities, but the three-dimensional pictures of the forming gut region deep inside the living zebrafish taken by the Aurora light sheet microscope have a quality which is by far superior to the competing modalities.

PROFESSOR LENE BROENG ODDERSHEDE

Niels Bohr Institute, University of Copenhagen



Using light sheet microscopy to monitor anticancer effects in tumour organoids - Picture shows colorectal tumour organoids labelled with Hoechst (DNA, blue), Calcein-AM (metabolically active cells, green) and Propidium iodide (necrotic / apoptotic cells, red). The top row shows control (untreated) organoids. Organoids in the bottom row have been treated with a novel anticancer peptide developed at NPL. The organoids have been provided by Cellesce (cellesce.com) and cultured and imaged live at the National Physical Laboratory (npl.co.uk/biometrology).

M SQUARED LIFE

M Squared is a leading developer of photonics and quantum technology, harnessing the power of light to drive society changing innovation.

M Squared designs and manufactures lasers that are used by Nobel Prize-winning scientists, some of the world's top universities and innovative manufacturers across fields including quantum technology, biophotonics and chemical sensing. In industry, they are utilised in advanced manufacturing, oil and gas research, space technology and the medical sector. Cross-sector partnerships have led to breakthroughs in areas as diverse as dementia research, cancer diagnosis and whiskey maturation.

Founded in Scotland, M Squared has offices throughout the UK, Europe and the USA, serving an international customer base. Its contribution to science and industry has been recognised with the Queen's Award for Enterprise in Innovation and the Institute of Physics Business Innovation Award. It has also featured in the Deloitte Technology Fast 50 and The Sunday Times Fast Track 100.

M Squared opened its specialised biophotonics division, M Squared Life, at the Surrey Research Park in 2015. Since its formation, M Squared has worked closely with Kishan Dholakia's group at the University of St Andrews to develop a portfolio of products using innovative biological imaging techniques. Its award-winning Aurora imaging systems are the first transformative imaging technologies to be released into the market.

Learn more about M Squared and its imaging systems at m2lasers.com.

CONTACT US

Whether you are looking for information or you'd like a question answered, don't hesitate to reach out to our biophotonics team.

T: +44 (0)1483 685 170
E: life@m2lasers.com

m2lasers.com | @m2lasers

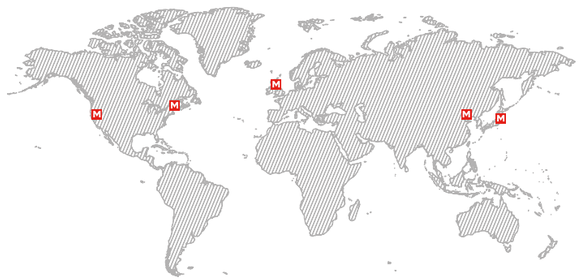
GLOBAL LOCATIONS

UK – SURREY

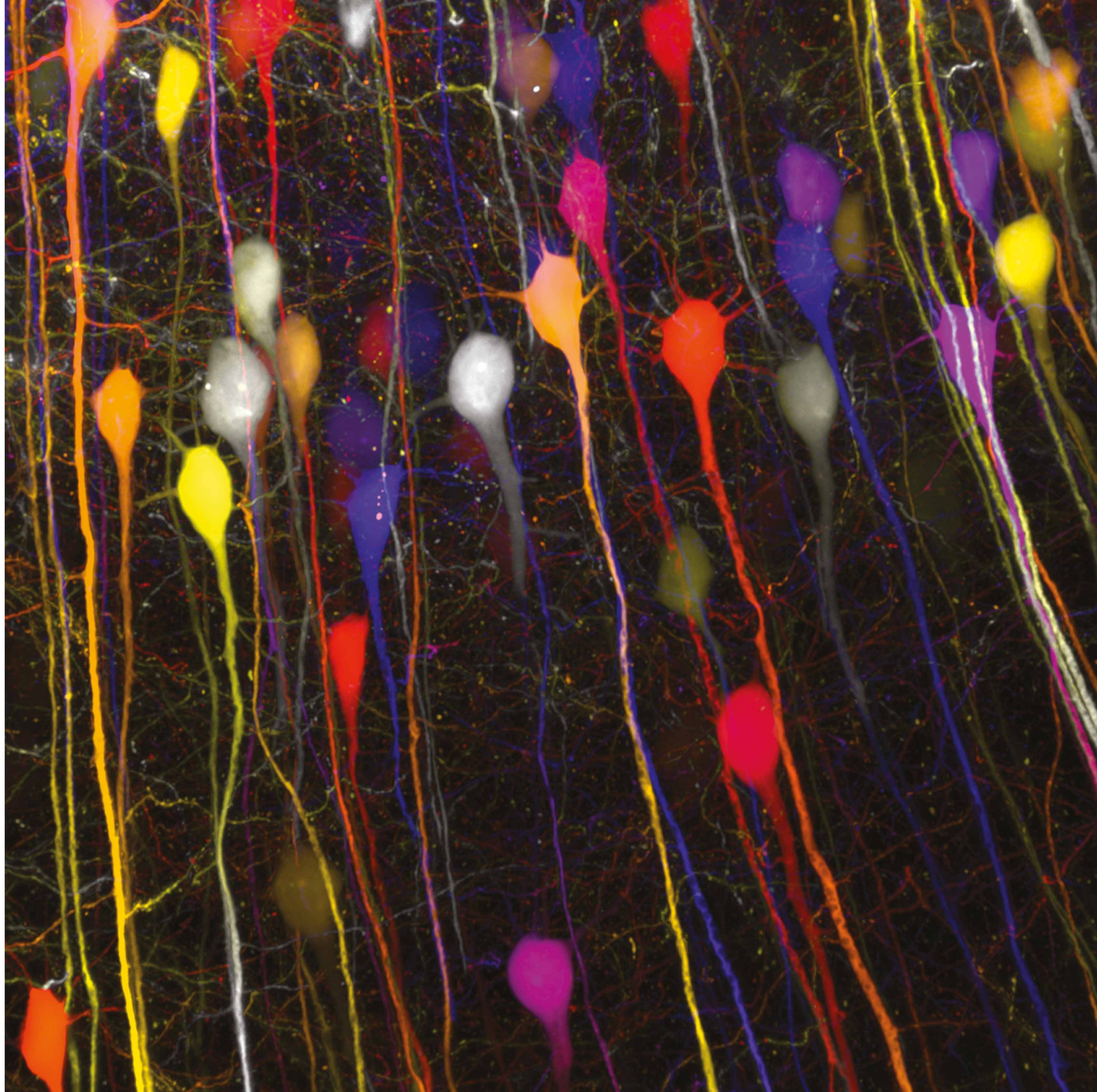
M Squared Life
The Surrey Technology Centre,
40 Occam Road, Guildford,
Surrey, GU2 7YG
United Kingdom

UK – HEADQUARTERS

M Squared
1 Kelvin Campus, West of Scotland
Science Park, Glasgow,
G20 0SP
United Kingdom



A complete list of our global locations is available on our website.



THE FUTURE, MADE POSSIBLE