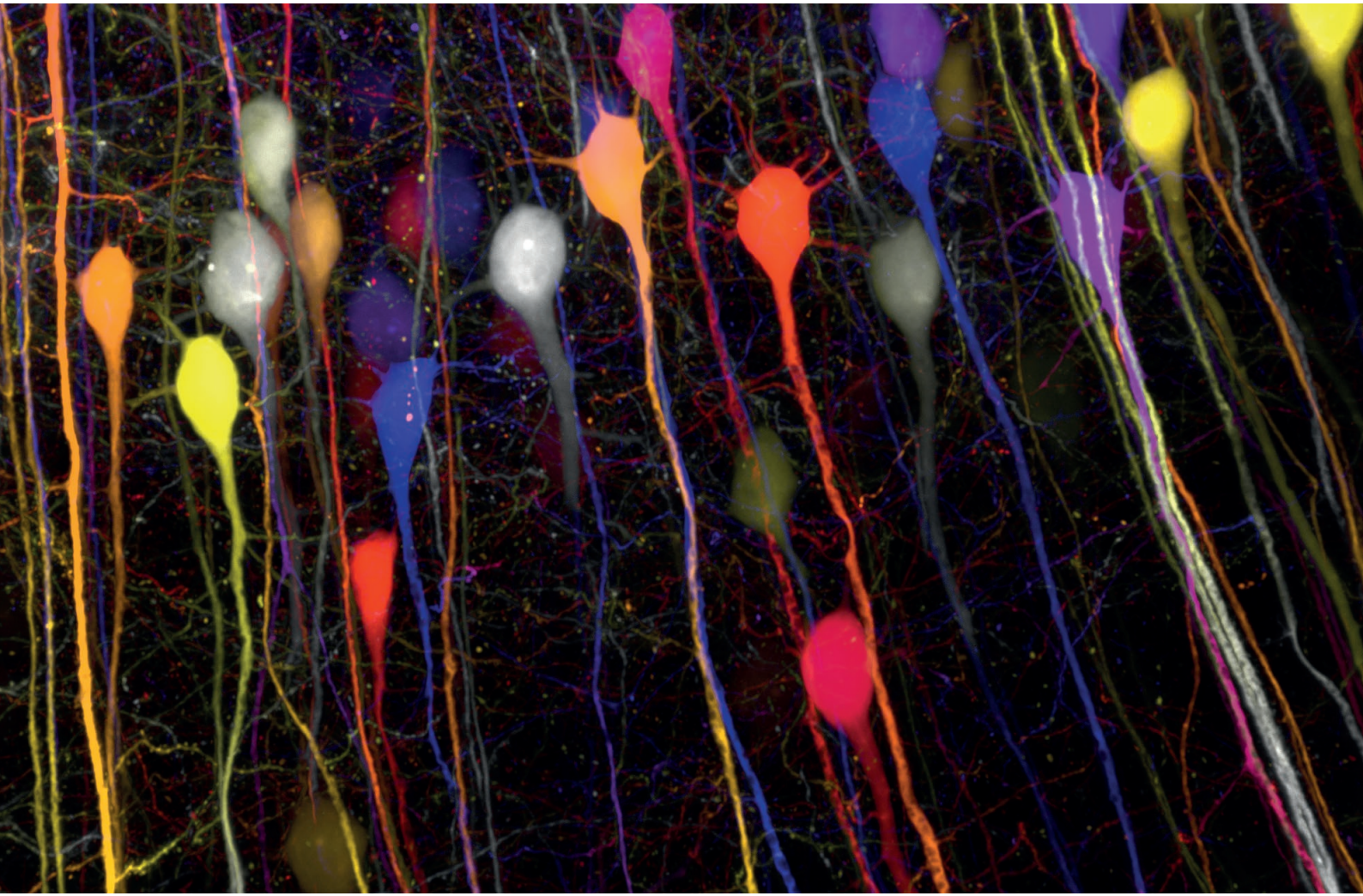
AURORA™

AIRY BEAM LIGHT SHEET IMAGING SYSTEM

M SQUARED



THE CUSTOM DEVELOPMENT PROGRAMME

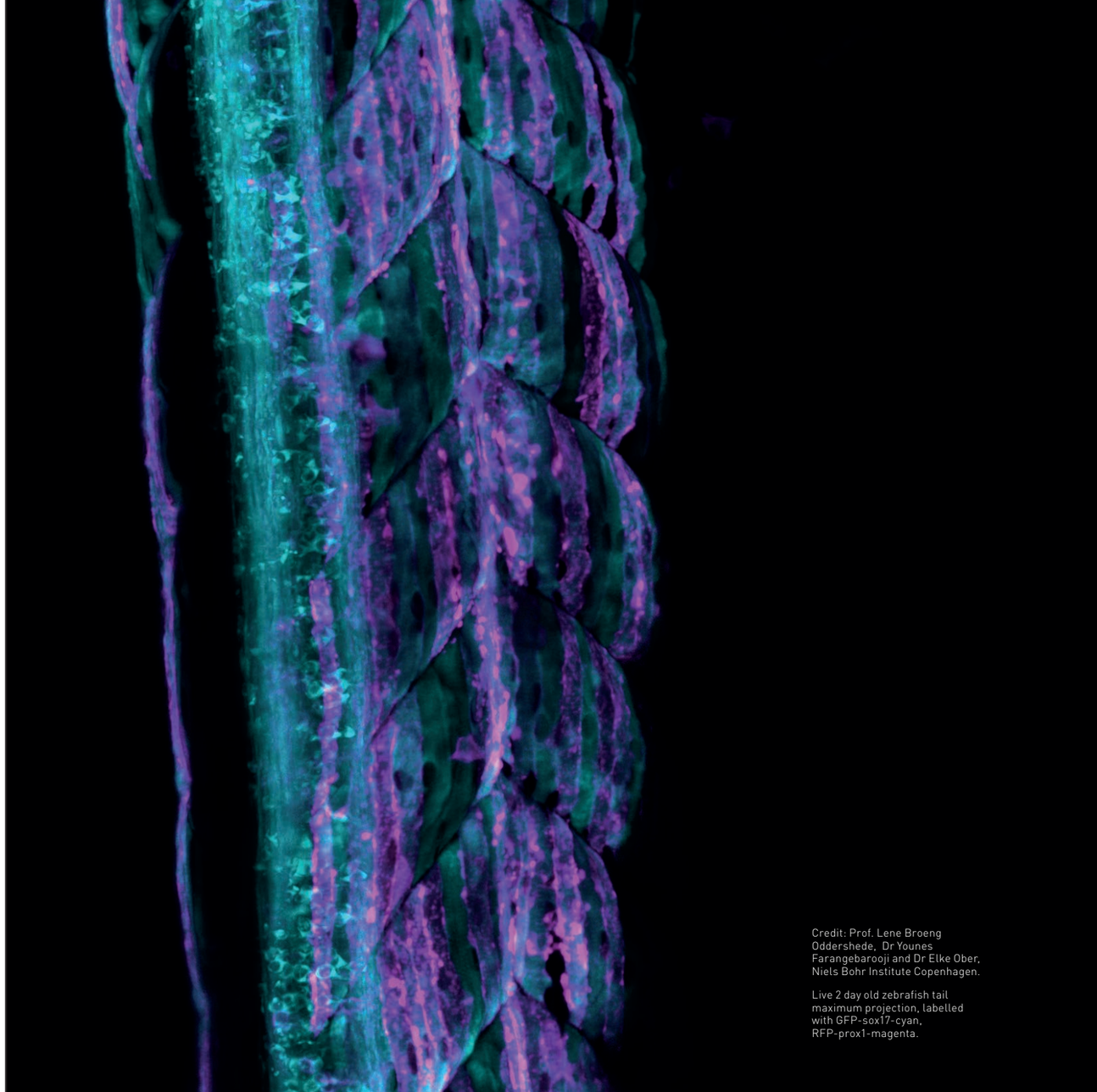
The Custom Development Programme

Collaboration breeds innovation

Our aim at M Squared Life, a new Biophotonics division within M Squared Lasers, is to facilitate the needs of researchers by placing the instrument development and required functionality directly in their hands.

Joining the Aurora development programme allows for the direct communication and dialogue with the research development team. The collaboration that is established enables researchers to tailor the configuration and specifications of an instrument to suit the demands of the intended research. Benefits of the programme include:

- Personalised instrument development programme: Tailor the programme to suit your budget or timescales.
- Develop a custom system: Choose from a range of modules, and create a system to suit your research requirements.
- Hands-on-training: Practical assistance to help you optimise sample imaging protocols.
- Priority technical support: Help from our dedicated application specialists and engineers.
- Grant application support: Access available funds with the support of our Innovations business unit grant writing team.
- Co-authored papers: Develop papers in conjunction with us and/or other programme members.
- Preferential purchase terms: Programme members receive purchase terms that reflect their collaboration input to the instrument development.



Credit: Prof. Lene Broeng Oddershede, Dr Younes Farangebarooji and Dr Elke Ober, Niels Bohr Institute Copenhagen.

Live 2 day old zebrafish tail maximum projection, labelled with GFP-sox17-cyan, RFP-prox1-magenta.

Dr Anthony Vernon and Robert Chesters, Department of Basic and Clinical Neuroscience, Maurice Wohl Clinical Neuroscience Institute, Institute of Psychiatry, Psychology and Neuroscience; MRC Centre for Neurodevelopment Disorders, King's College London. Cleared brain 600x600x640 microns thy1-GFP Actin Fire coloured height map.

Advantages of Light Sheet Microscopy

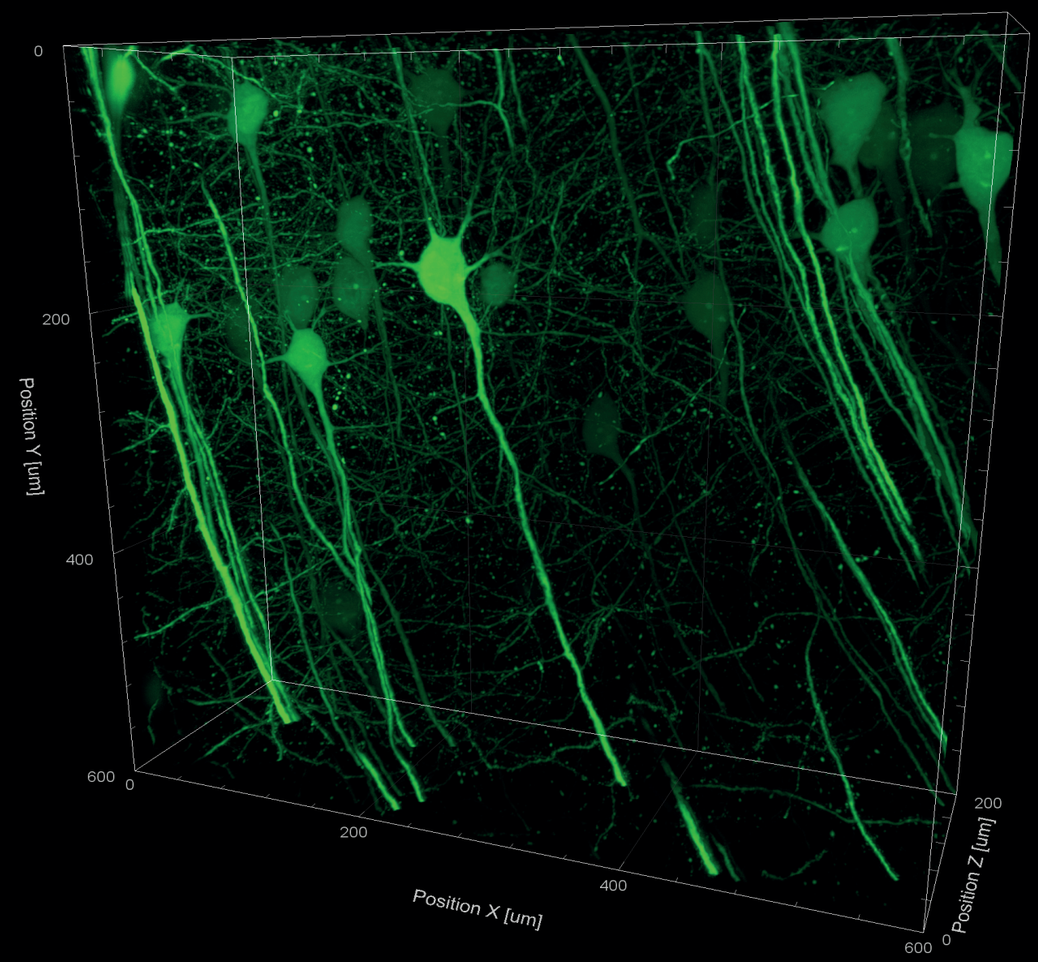
Rapid large sample imaging with minimal photo damage

The ability to accurately image large structures at cellular resolution is fundamental to modern biological understanding. The requirement to gain multi- dimension and multi-level (tissue to cell) information with a range of reporters, and minimal sample damage via light exposure or sample processing is the ideal for many scientists.

Light sheet fluorescence microscopy is an increasingly popular imaging modality for producing high contrast 3D volumetric images of intact biological specimens. In contrast to confocal microscopy, it is able to achieve this up to 500 times faster and with minimal damage to the specimens and fluorophores, allowing for longer imaging times.

The Aurora system is a unique approach to light sheet microscopy. It has been designed as a compact and modular instrument, which can be customised to address a range of applications and a variety of budgets to suit your research needs.

M Squared Life has developed Aurora as a flexible and affordable instrument, designed to address the current limitations in other light sheet systems. The Aurora systems novel approach utilise an Airy beam for light sheet illumination, enabling deeper penetration with a lower photon dose for longer imaging times. It also enables a wider field of view to allow more of your specimen to be imaged, but maintains at high three-dimensional resolution, which is unique to the market.



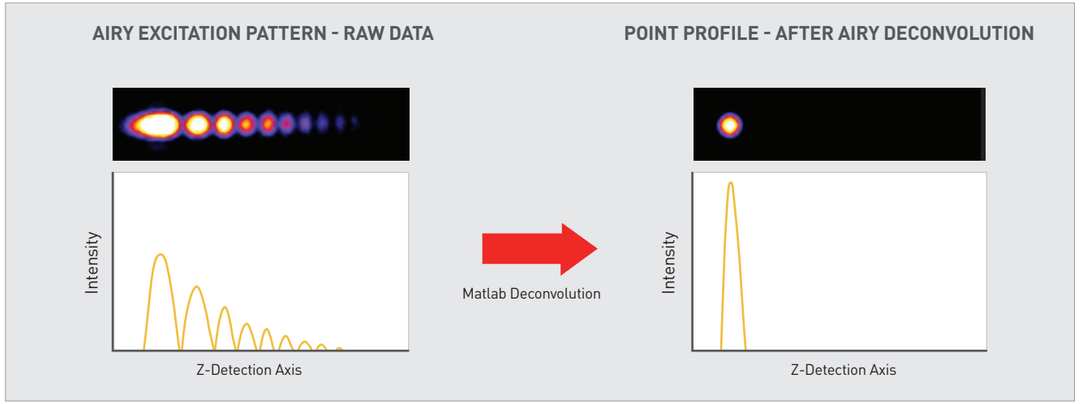
Credit: Dr Anthony Vernon and Robert Chesters IoPPN cleared brain 600x600x200 mircons– th1GFP Actin, 3D projection.

Why Airy Beam Light Sheet?

The benefits of using an airy beam light sheet

The majority of current light sheet microscopes use standard lasers that produce a Gaussian profile. The sample is illuminated by focusing the light and shaping the Gaussian beam into a sheet. The process directly affects the achievable field of view and the resolution, leading to a compromise that limits the size of the imaging plane. Other issues arise, such as shadowing caused by systems that use single side illumination, this results in scattering due to sample structures and uneven illumination along the propagation direction of the light. Another option would be to use dual illumination; however, this introduces a significant increase in complexity of image reconstruction and cost.

Aurora resolves these issues by using an Airy beam described as being "self-healing". Essentially, 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 a large field of view approximately 600 x 600 µm (x20 obj.), whilst still retaining subcellular resolution (1 µm near isotropic resolution). The asymmetric excitation pattern also provides deeper penetration and lower phototoxicity, due to the distribution of laser power through the Airy lobes. The information within the distributed pattern is not lost but regained through deconvolution and improves the signal-to-noise by a factor of 10 delivering high contrast images, see figure below.



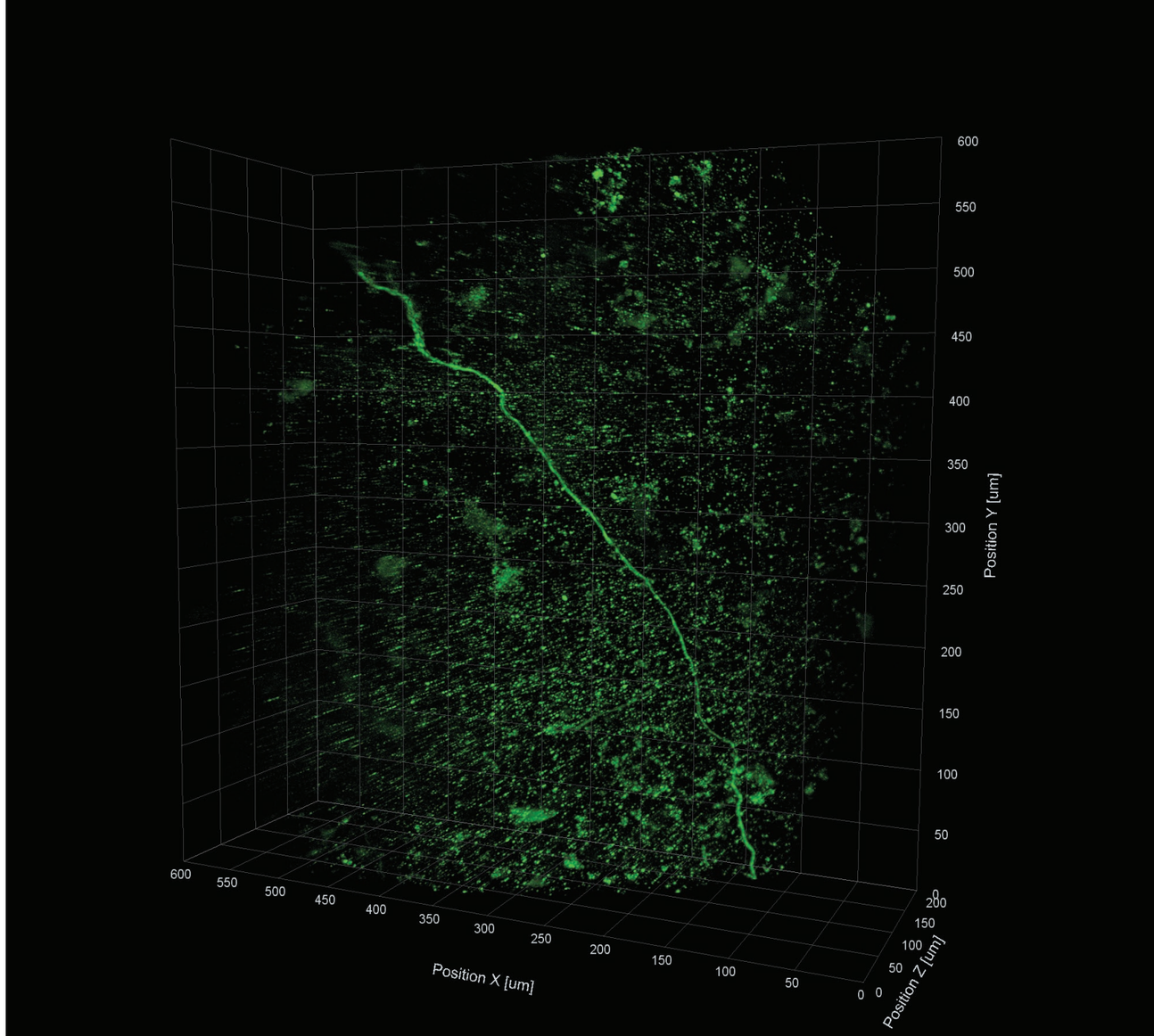


Image courtesy of James Crowe and Deepak Srivastava, IOPPN, KCL, GFP-expressing hCS Neurite

The Aurora lightsheet: a compact benchtop system

THE ENTRY LEVEL SYSTEM

The entry level Aurora system is a compact bench-top light system with a footprint of 60x50x70cm (length x depth x height) and features:

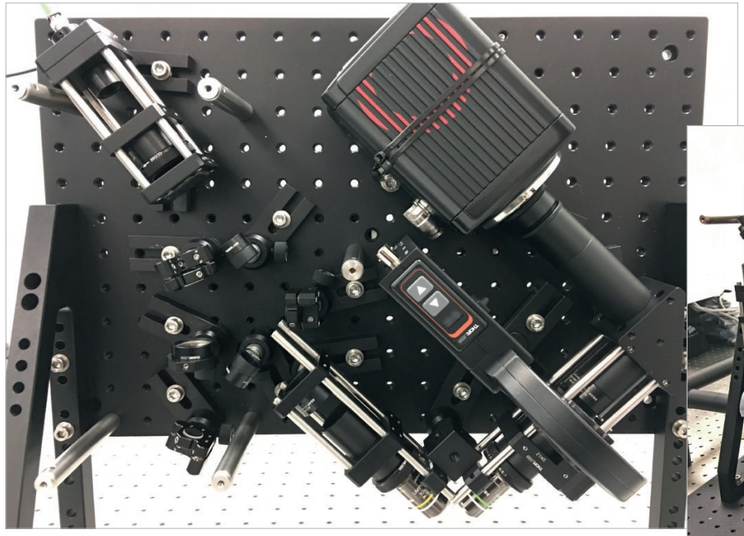
- **High spatial resolution:** Sub-cellular 1 µm isotropic resolution (20x obj.).
- **Low phototoxicity:** Peak Irradiance is 80% less than a Gaussian light sheet, whilst retaining a similar axial resolution[1].
- **Unique large FOV with high resolution:** 600 µm (20x obj.) field of view; 20 times larger than a standard Gaussian light sheet (XY axis).
- **Rapid 3D imaging:** 500x faster than confocal microscopy.
- **High image contrast:** 10x increase in signal-to-noise after Airy deconvolution.

MODULARITY

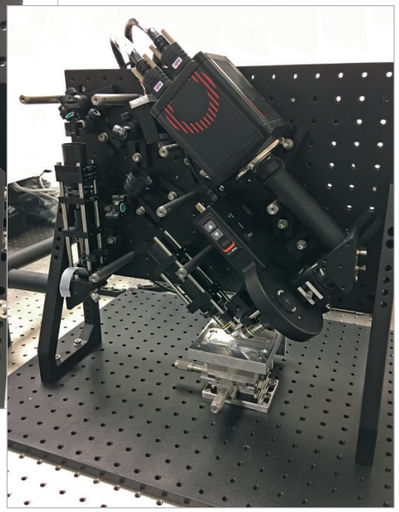
As part of this development the Aurora system can be tailored to meet your specific scientific requirement. You choose the initial level of system complexity and can then add a range of modules or laser lines as your research demands. Current available options (note this list will increase with time):

- Wide range of continuous wave laser lines available
- Single and or Multiphoton light sheet imaging configuration
- Fully or partially automated stage
- Environmental control sample chamber

1 - Kishan Dholakia et al., Light sheet Microscopy using an Airy Beam, Nature Methods 11, 541–544 (2014).



Single photon system with 4 Axis motorised stage.

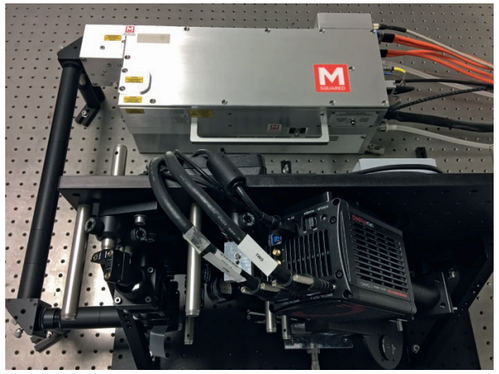


Multi photon system with M Squared Sprite XT Ultrafast Laser source.

KEY FEATURES

- 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 required opportunity for users to develop their own functions/code

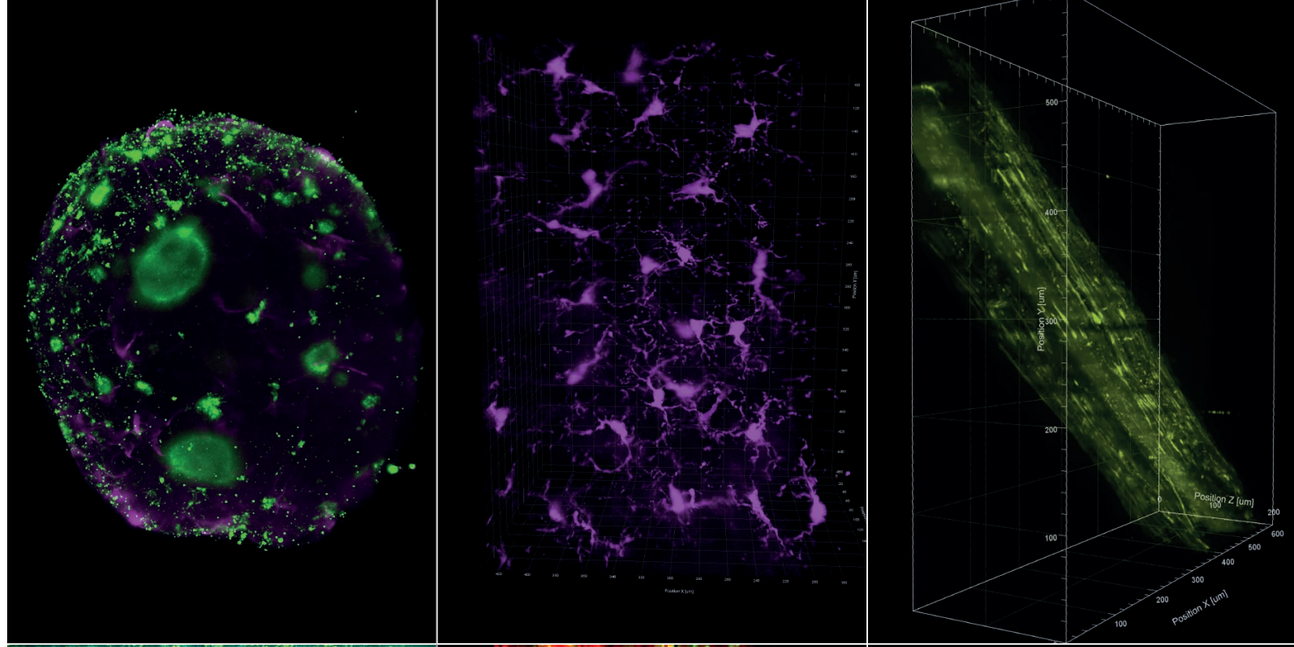
- Modular design – build a system that meets your research needs at a budget that suits you
- Flexible specimen preparation – live or fixed samples, monolayer, 3D culture or tissues; incorporated incubation and perfusion facilitated.

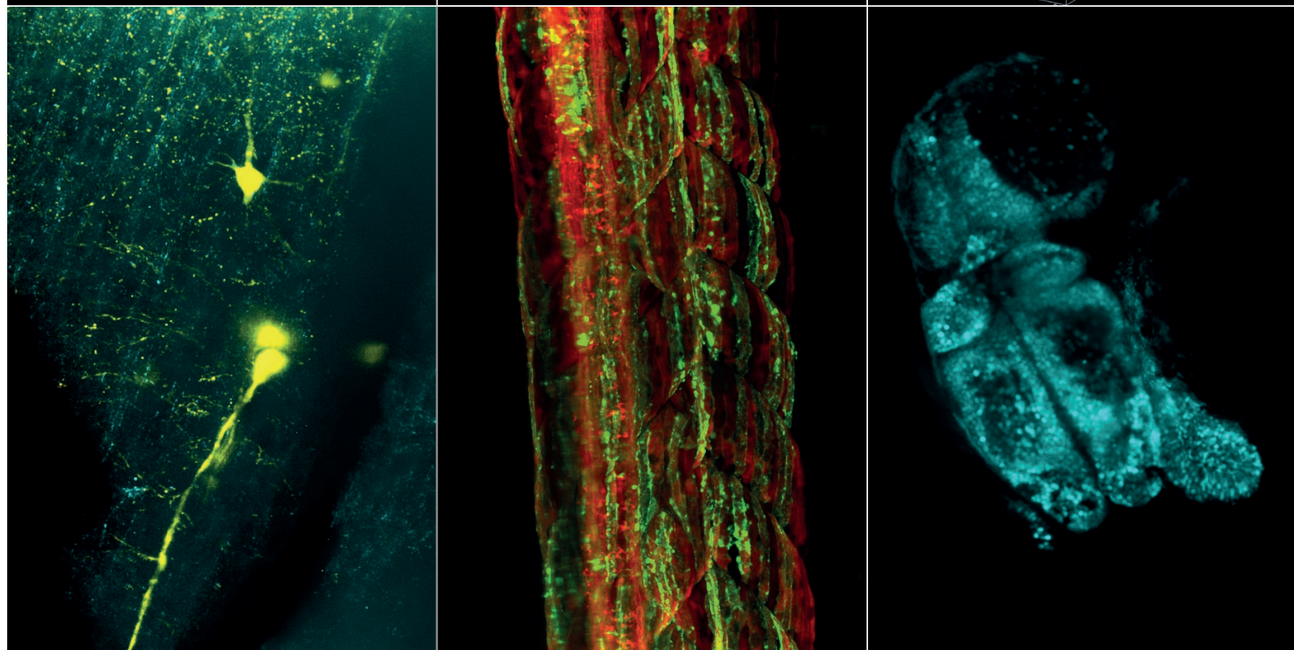


List of collaborators

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

- Department of Basic and Clinical Neuroscience, Maurice Wohl Clinical Neuroscience Institute, Institute of Psychiatry, Psychology and Neuroscience, King's College London
- Centre for Developmental Neurobiology, Institute of Psychiatry, Psychology & Neuroscience King's College London
- StemPhys Center, Niels Bohr Institute, University of Copenhagen
- Department of Pharmacology, University of Oxford
- Institute for Life Sciences, University Southampton
- Living Systems Institute, University of Exeter
- Division of Chemical Systems & Synthetic Biology, Institute for Infectious Disease & Molecular Medicine (IDM) Faculty of Health Sciences, Department of Integrative Biomedical Sciences, University Cape Town
- National Physical Laboratory (NPL)





TOP LEFT - Image courtesy of James Crowe and Deepak Srivastava, Department of Basic and Clinical Neuroscience, Maurice Wohl Clinical Neuroscience Institute Institute of Psychiatry, Psychology and Neuroscience; MRC Centre for Neurodevelopment Disorders, King's College London, GFP and CY5 positive hCS organoid.

TOP MIDDLE - Image courtesy of Robert Chesters and Anthony Vernon, Department of Basic and Clinical Neuroscience, Maurice Wohl Clinical Neuroscience Institute Institute of Psychiatry, Psychology and Neuroscience; MRC Centre for Neurodevelopment Disorders, King's College London CX3CR1-gfp mouse hindbrain.

TOP RIGHT - Image courtesy of Stefan Sassmann University of Exeter, College of Life and Environmental Sciences, 488nm excitation; auto fluorescence in plant root.

BOTTOM LEFT - Image courtesy of Dr Anthony Vernon and Robert Chesters, Wohl Cellular Imaging Centre Department of Basic and Clinical Neuroscience, Maurice Wohl Clinical Neuroscience Institute Institute of Psychiatry, Psychology and Neuroscience; MRC Centre for Neurodevelopmental Disorders King's College London. Mouse Cortex 2 Photon Excitation Two-Colour Autofluorescence and GFP.

BOTTOM MIDDLE - Image courtesy of Prof. Lene Broeng Oddershede, Dr Younes Farahangibarooji and Dr Elke Ober, Niels Bohr Institute Copenhagen. Live 2 day old Zebra fish tail maximum projection, labelled with GFP-sox17-cyan & RFP-prox1-magenta.

BOTTOM RIGHT - Image courtesy of Thomas Shallcross and Thomas Sainsbury, Centre for Developmental Neurobiology, King's College London. Week-old zebrafish larvae with transgenic expression of GCaMP in the brain.

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Contact us

Aurora is brought to you by M Squared's specialist biophotonics division M Squared Life

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