REVEALING THE BRAIN

Iconeus One

Functional ultrasound platforms for high-resolution imaging of brain function and vasculature



Versatile functional ultrasound imaging

Advance your brain imaging capabilities to match your needs.

Since we launched Iconeus One in 2019, it's led the field in preclinical functional ultrasound (fUS), with dozens of groups worldwide relying on it for real-time imaging of cerebral blood flow and microvasculature in awake or anesthetized animals.

We're now introducing three models of Iconeus One – **Xplore**, **Xpand** and **Xcel** – allowing you to match the capabilities of Iconeus One to your requirements, at a price that suits your budget.

A functional ultrasound system perfect for you

We offer three Iconeus One models, each of which builds on the capabilities of the previous one, with a straightforward upgrade path making it easy for you to adapt to evolving research needs:



Iconeus One Xplore

Offering a versatile linear stage and easy-to-learn software for 2D imaging, Iconeus One Xplore is a powerful yet affordable option for anyone starting out with fUS.



Iconeus One Xpand

With a four-axis motorized platform, ULM capacity, and additional multi-dimensional options, Iconeus One Xpand offers the next level up in fUS functionality.



Iconeus One Xcel

If you're looking to push the boundaries of fUS, Iconeus One Xcel provides 256 channels, 3D ULM capability, expert-level software, and additional scientific support.

Advanced software for amazing insights

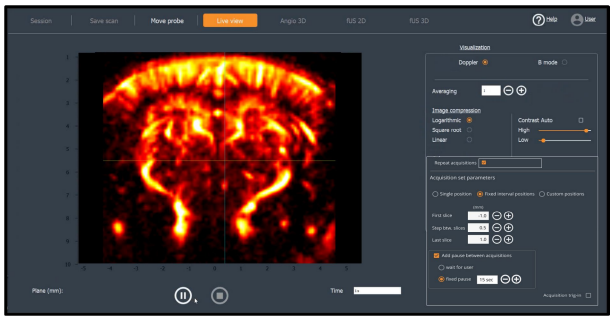
The innovation in our products doesn't stop with the hardware – we've also taken every effort to make our software powerful *and* easy to use.

User-friendly software suite for real-time analysis

All Iconeus One systems are ready to use straight out of the box – and so is the software that comes with it. To obtain research insights with fUS, you don't need to be an expert in ultrasound imaging, and you won't need to spend hours programming the equipment or carrying out laborious data-processing.

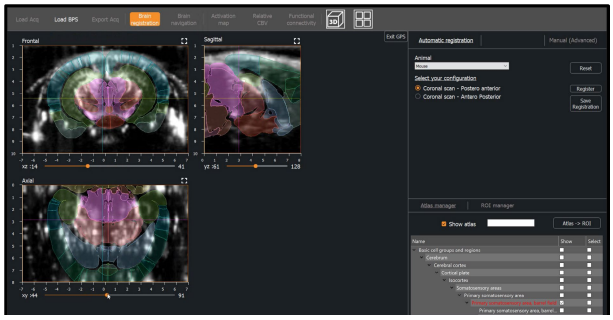
All three Iconeus One systems offer a **core fUS software bundle**, comprising three foundational modules (with additional features available under separate tabs in the Xpand and Xcel models):

- **IcoScan** is the data acquisition module, which controls the connected motorized stage. Using IcoScan, you can:
  - ✓ Acquire single-plane and multi-plane images
  - ✓ View Doppler and B-mode images as they're acquired
  - ✓ Standardize the acquisition of large datasets
  - ✓ Position probes on-the-fly in any brain region.



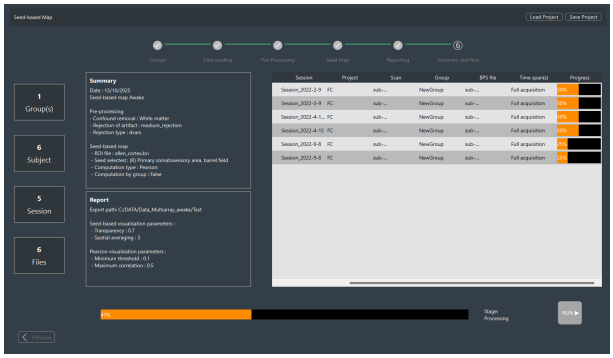
Live view of a mouse brain using IcoScan.

- **IcoStudio** is the data visualization and analysis module. With just a few clicks, and in a matter of seconds, you can:
  - ✓ Generate stimulation-induced activation maps
  - ✓ Extract and normalize mean activity signals from atlas or custom ROIs
  - ✓ Compute relative CBV changes
  - ✓ Construct composite functional connectivity matrices and seed-based maps
  - ✓ Visualize ULM data at super-resolution.



Registering a brain scan within IcoStudio.

- **IcoLab** is the batch processing and reporting module, speeding up your workflow for larger projects. Using IcoLab, you can:
  - ✓ Batch-process hundreds of scans at once
  - ✓ Get complete analysis reports in a few clicks
  - ✓ Configure analysis workflows to your needs
  - ✓ Use standardized pipelines for neuroimaging analysis, including seed mapping, connectivity matrices, and ULM.



Analysis of a complete fUS dataset with IcoLab.

Iconeus One Xplore

A powerful yet affordable option for neuroscientists wanting to explore the potential of fUS.



Adopting a new imaging modality for neuroscience research is a big step to take – so that's why we've made **Iconeus One Xplore** affordable and easy to adopt.

But although it's an entry-level system, it's still got all the features you need for routine 2D fUS imaging, making it a perfect choice for anyone wanting to take their first step with the technique.

In addition, it's designed for easy upgrade to the Xpand and Xcel models – enabling you to advance to more capabilities as your budget allows.

On Iconeus One Xplore, you'll be able to take advantage of the following foundational fUS capabilities:

Acquire real-time, high-resolution 2D scans

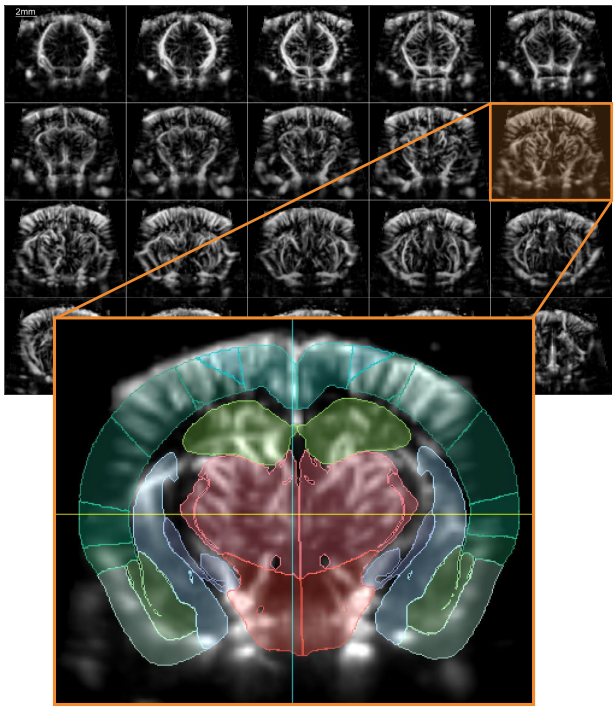
All Iconeus One models come with **128 channels** as standard.

This setting is widely used by neuroscience researchers, and it allows 2D images to be acquired in real-time at resolutions down to 100 µm, using our **core fUS software bundle** (see previous page).

Benefit from low-noise images

The built-in **2.5 Hz framerate** of Iconeus One Xplore provides a time resolution of 400 ms.

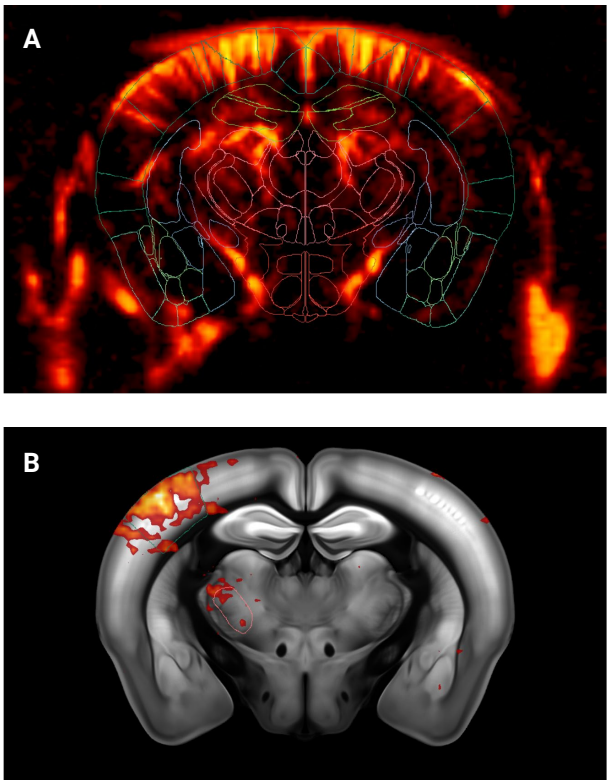
This ensures a high data sampling rate per frame, meaning that you get low-noise images without risk of bias from cardiac pulsatility. It also avoids the need to optimize data processing settings, making it perfect for anyone starting out with fUS.



Montage visualization of the mouse brain vasculature with 100 µm in-plane resolution, and showing manual registration of a transcranial 3D scan to the Allen Mouse Brain Reference Atlas.

Carry out a variety of experiment types

With Iconeus One Xplore, you can routinely carry out **foundational preclinical experiments** with high sensitivity and fast quantitative readouts. These include evaluating sensory stimulation towards evoked responses, mapping resting-state functional connectivity, and studying neurovascular responses to drugs.



Transcranial fUS imaging (A) in the mouse brain, co-registered to the Allen Brain Atlas. The activation map (B) shows voxels responding to right-whisker stimulation, and the corresponding fUS signal in the left primary somatosensory cortex (C) displays a +15–20% rCBV increase during the five stimulation periods (highlighted).

Work with a range of animal models

All Iconeus One systems come with our versatile **IcoPrime fUS probe**.

This provides great results with head-fixed mice, rats and several other animal models, and has been cited in over 80% of research publications using Iconeus One systems.

However, if you're planning to do awake imaging in a mobile configuration, you may wish to consider the **IcoPrime-Lite** or **IcoPrime-Mini**, which are smaller and lighter.



Our 15 MHz IcoPrime probe is ideal for the vast majority of preclinical fUS research setups.

Streamline your acquisitions

For studying head-fixed rodents and other small animals, Iconeus One Xplore comes with a **standalone linear motor**. This allows precise, robust positioning of the probe before starting recordings, as well as enabling quick whole-brain angiographic scans to be taken for atlas registration.



The linear motor supplied with Iconeus One Xplore enables probe positioning with micron-level precision across a 26 mm travel range.

Move Iconeus One where you need it

All the instrumentation for generating and processing the ultrasound signals is contained in the Iconeus One **portable imaging station**, which is wheeled so you can easily move it around the lab.

An **attached keyboard and monitor** allow you to visualise the results as they come in, as well as carry out initial data analysis.

Iconeus One Xpand

The next level up in functionality for customers wanting to make the most of the capabilities of fUS for routine experiments.



Finding the right balance of functionality for neuroscience imaging is not always easy, but by building on the capabilities of the Xplore model, **Iconeus One Xpand** checks all the right boxes.

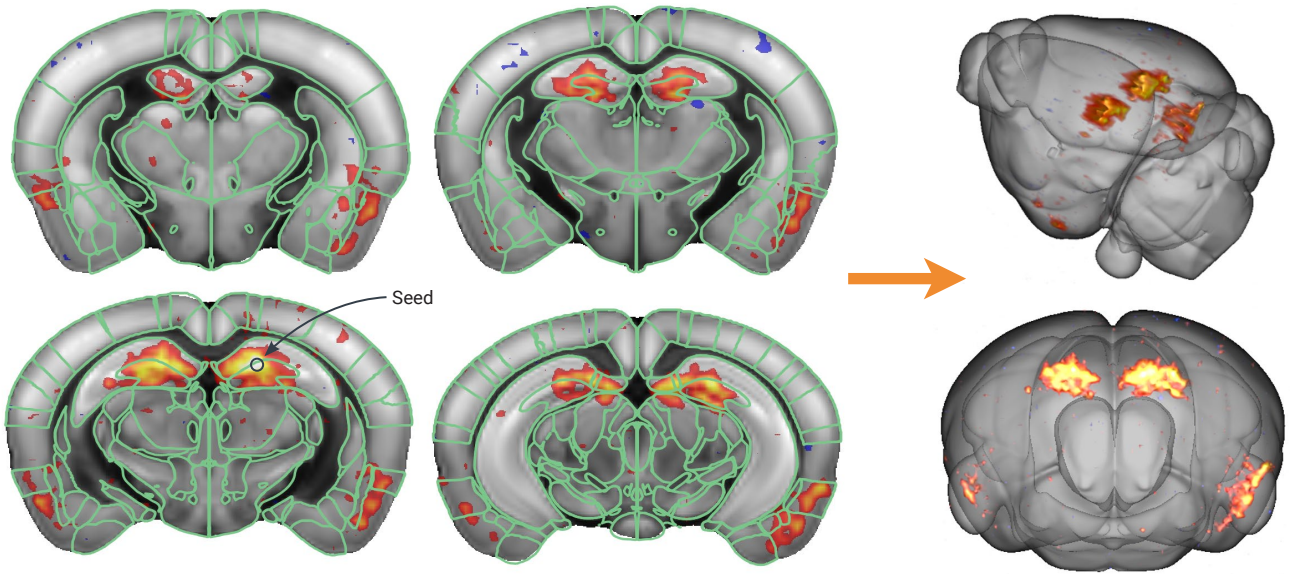
With a four-axis motorized platform (pictured), Ultrasound Localization Microscopy capacity, and functional 3D imaging, Iconeus One Xpand is an excellent choice for researchers able to invest in a strong feature set from day one.

And don't forget that Iconeus One Xpand is easily upgraded to the Xcel, enabling you to extend your capabilities further when you're ready.

With Iconeus One Xpand, you can do everything you can with the Xplore, plus lots more:

Explore the potential of 3D multislicing

The **four-axis motorized scanning platform** that comes with Iconeus One Xpand allows 3D time-separated multislice imaging of head-fixed animals – a powerful way of visualizing responses to stimuli within multiple sagittal or coronal planes.



Adapted (with permission from the authors) from JoVE, 2021, DOI: 10.3791/62267.

3D functional connectivity mapping, achieved with the multislicing capability of Iconeus One Xpand. By combining multiple brain slices (Bregma –1 mm to +2.5 mm), the system reveals deep brain correlations from a seed in the right hippocampal formation (indicated), illustrating the power of 3D functional imaging across regions.

Streamlining 3D acquisition and interpretation is the **3D multislice software bundle**, which provides:

- Automatic sequential recordings for faster, hands-off workflows
- Easily configurable multislice acquisition – define start/end coordinates and slice spacing to precisely cover the region of interest
- Automatic brain atlas registration for precise anatomical correlation, coupled with the 'Brain Positioning System' for accurate placement of the probe over targeted brain regions
- 3D volume reconstruction and visualization tools, making it easy to explore brain activity across slices and orientations.

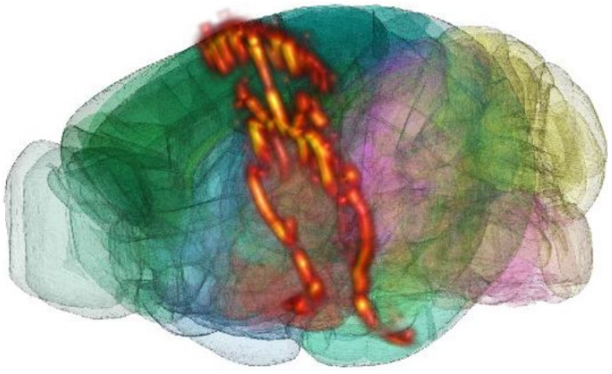
Cross-reference mouse brain images

ALLEN INSTITUTE for BRAIN SCIENCE

The **Allen Mouse Brain Reference Atlas** Common Coordinate Framework is the gold-standard for brain mapping, and is fully integrated into Iconeus One Xpand.

To enable you to capitalize on this capability, Iconeus One Xpand features a dedicated software module that automatically registers fUS angiographic images to the atlas, providing immediate anatomical segmentation without any manual input.

Complementing this feature is the **Brain Positioning System (BPS)®**, which uses the same atlas framework to guide precise probe placement over targeted regions of interest, ensuring standardized acquisitions and reliable access to even the smallest brain structures.

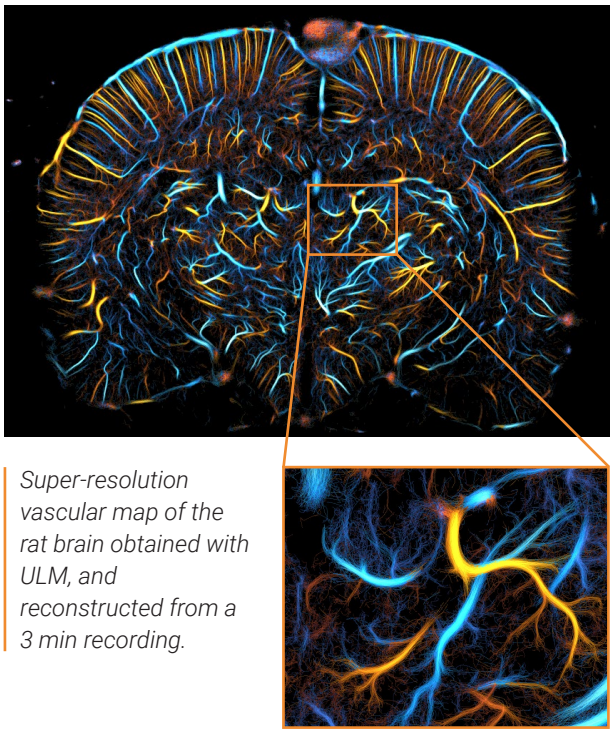


Single 2D fUS slice automatically co-registered with the Allen Mouse Brain Reference Atlas using Iconeus One Xpand.

Precisely map micro-vascular networks

An exciting feature of Iconeus One Xpand is **Ultrasound Localization Microscopy (ULM)**, which uses fUS to track injected microbubbles within blood vessels. This allows images of the micro-vasculature to be generated using the **ULM software bundle**, with resolution as low as 10 µm.

For more on ULM, see our separate brochure.



Super-resolution vascular map of the rat brain obtained with ULM, and reconstructed from a 3 min recording.

Investigate higher framerates

Iconeus One Xpand provides the option to increase to a **10 Hz framerate**, equivalent to a 100 ms time resolution. This is a useful option for researchers confident with balancing the benefits this brings against the constraints of higher signal variability and lower signal-to-noise.

Get quick answers to technical questions

As part of the Iconeus One Xplore package, we provide a **free preventive maintenance visit** in the first year, plus **ongoing remote scientific support** – enabling you to make the most of the exciting capabilities at your fingertips!

Iconeus One Xcel

Join a select band of researchers who are exploring the exciting frontiers of fUS applications.



Pushing the boundaries of neuroscience research depends on having access to imaging equipment with the latest features.

That's exactly what you'll get with the top-of-the-range **Iconeus One Xcel**. With a 256-channel imaging system, 3D ULM capability, full volumetric fUS (vfUS) capability, expert-level software, and access to raw data files, your experimental designs and data-processing will be only limited by your imagination!

And if you prefer to stage your Iconeus One investment over several years, remember that there's an easy upgrade path from Xplore to Xpand and Xcel – just ask us for details.

With Iconeus One Xcel, you'll have all the capabilities of the Xplore and Xpand, as well as being able to:

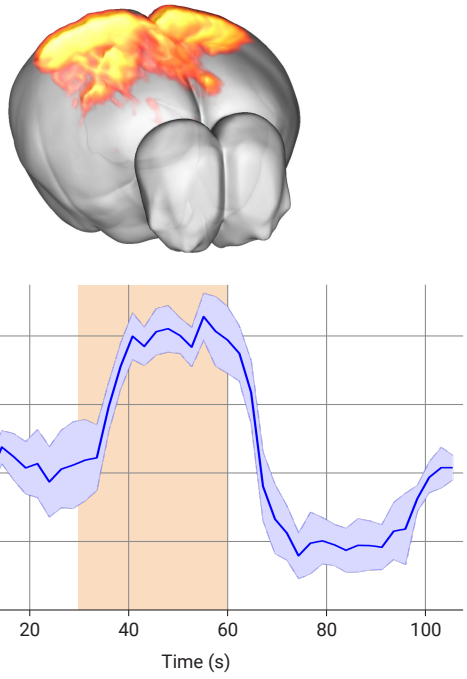
Carry out whole-brain functional imaging in seconds

The **256-channel capability** of Iconeus One Xcel opens up the options for 3D imaging using our **4D-capable probes**:

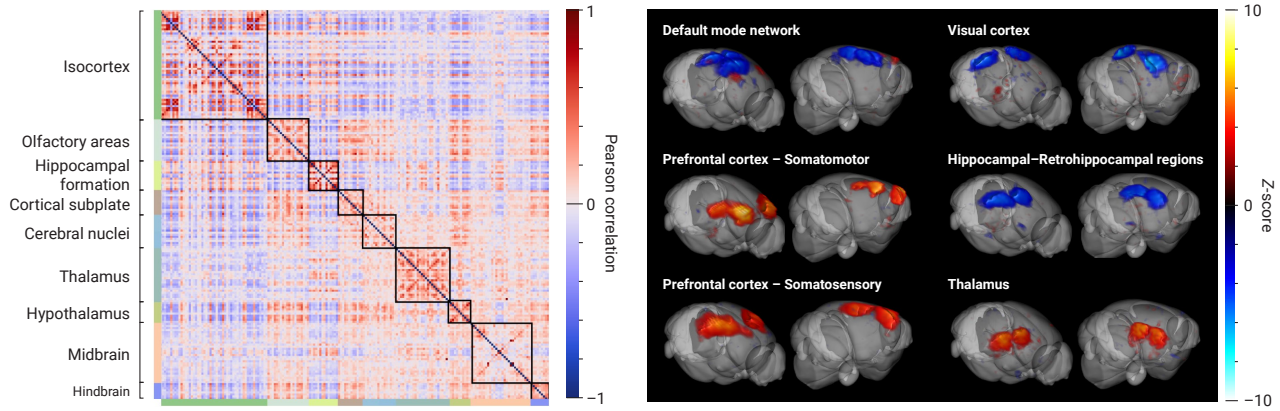
- The IcoPrime-4D MultiArray for brain-wide transcranial imaging and activation mapping in the mouse using the simultaneous multislicing acquisition method
- The IcoPrime-4D RCA using the latest row-column addressed technology, allowing true volumetric functional imaging with a functional resolution of just 100 µm^3.

Enjoy additional expert support

The **premium support package** that comes with Iconeus One Xcel provides three extra preventive maintenance visits, a data science consultation, and two extra days of on-site training.



Top: A 3D projection of a brain-wide activation map of the mouse obtained following exposure to strobe lighting for 30 s, showing significant activation in brain areas involved in visual processing. Bottom: Mean relative change of CBV in activated voxels during the visual stimulation (n = 8).

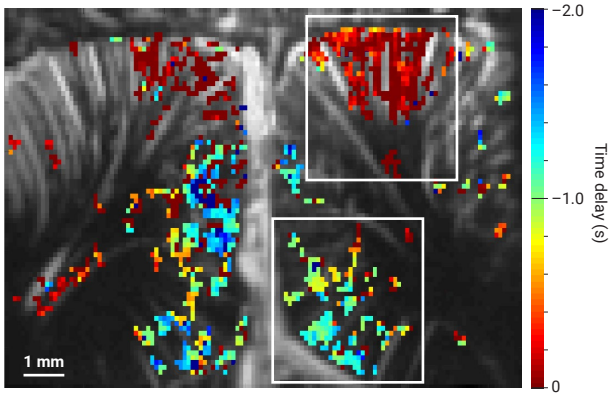


Left: Mean functional connectivity matrix (n = 5) derived for more than 200 cortical and subcortical structures in the Allen Atlas, with boxed areas indicating regions with synchronized activity. Right: Corresponding resting-state networks identified using independent component analysis (ICA), showing brain regions or networks with unique patterns of activity.

Maximize acquisition framerates

On Iconeus One Xcel, you have the option to increase to a **100 Hz framerate**, equivalent to a time resolution of just 10 ms.

This setting is designed for advanced users who wish to explore fast functional dynamics, such as transient vascular responses, short bursts of neural activation, or rapid brain-state transitions.



Adapted from *Nature Communications*, 2019, DOI: 10.1038/s41467-019-09349-w (licensed under CC BY 4.0).

Time-delay maps (millisecond scale) reveal directional connectivity between cortical regions and across cortical layers during an antisaccade task.

Access advanced software settings

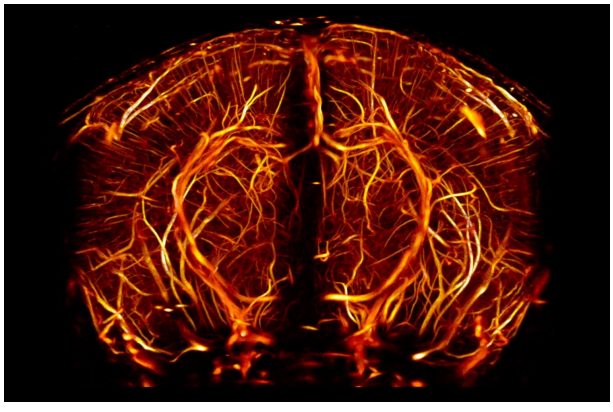
Using Iconeus One Xcel, you have access to the **'Expert mode'** in IcoScan, IcoStudio and IcoLab, which allows access to a variety of options for advanced users:

- Access raw/scan data for expert-level processing of unfiltered ultrasound acquisitions and physiological monitoring
- Customize acquisition sequences for fully tailored experimental designs
- Set acquisition frame rates up to 100 Hz for ultra-fast, time-resolved data capture
- Export files in the 'Brain Imaging Dataset Structure' (BIDS) format for easier data-sharing
- Enjoy live data streaming enabling closed-loop brain–computer interface (BCI) applications
- Use integrated analysis and statistical tools for deeper data exploration (coming soon).

All these are contained with a separate software panel – meaning that if you're starting out with fUS, you'll have access to the capabilities of the Xcel model without having to deal with complex settings.

Locate microbubbles with 10 µm resolution

Using the IcoPrime-4D RCA probe on Iconeus One Xcel, you'll be able to achieve true **three-dimensional ULM**, allowing you to reconstruct the intricate web of blood vessels in the brain with an astonishing resolution of 10 µm.



3D rendering of vULM maps obtained non-invasively in the anesthetized mouse, showing vessel density across the whole mouse brain at capillary scale.

Everything you need for fUS

From hardware to software, and from installation to ongoing support – when it comes to the practical aspects of fUS, we've got it covered.

Model summary

Use this table to quickly compare the three Iconeus One models, and work out which is best for you.

	XPLORE	XPAND	XCEL
Hardware			
Portable imaging station	128 channels	128 channels	256 channels
Scanning capability	One-axis	Four-axis	Four-axis
Probe(s)	IcoPrime (15 MHz)	IcoPrime (15 MHz)	IcoPrime (15 MHz) + IcoPrime-4D MultiArray or IcoPrime-4D RCA (15 MHz)
Height-adjustable keyboard and monitor	✓	✓	✓ (Two monitors)
3D fUS capacity	×	✓ (Time-separated multislicing)	✓ (Simultaneous multislicing & Volumetric)
ULM capacity	×	✓ (2D)	✓ (2D, 3D)
Software*			
Core fUS bundle	✓	✓	✓
3D fUS bundle	×	✓	✓
ULM bundle	×	✓	✓
Expert bundle	×	×	✓
Support			
Installation, training & one-year warranty	✓	✓	✓
Annual routine maintenance visit(s)	×	1	3
Remote tech support	✓	✓	✓
Scientific support	×	✓	✓ (Extended)

* Provided with one user license and three additional licenses for off-line data analysis.

Iconeus One system specifications

Spatial resolution	100 × 100 × 400 µm at 15 MHz
Temporal resolution	Down to 10 ms
Data capacity	10 TB, >25 Tflops
Imaging station dimensions	810 mm (W) × 974 mm (D) × 651 mm (H)

Probes for every application

Our IcoPrime probe is a great all-rounder probe for mice and rats, and comes as standard with all Iconeus One models. With the Xcel model you also get your choice of IcoPrime-4D probe for volumetric functional ultrasound imaging and dynamic 3D acquisitions with high spatial and temporal resolution.

But if you're thinking about special applications, then we also have a selection of other probes, helping you to achieve the ideal balance of sensitivity and weight for other animal models (including marmosets, pigs, and non-human primates), in both fixed-head configurations and mobile setups. See our probe brochure for more information.



Using Iconeus One with an application-optimized probe, you'll be able to see what's happening in the brain at the finest scales, on awake and moving animals.



> **Functional ultrasound is an amazing technology**, taking neuroimaging to a whole new level.
>
> Coming from the MRI world, the small footprint, open setup and sensitive miniature sensor of fUS unlocks capabilities that were previously unavailable to us and our clients.

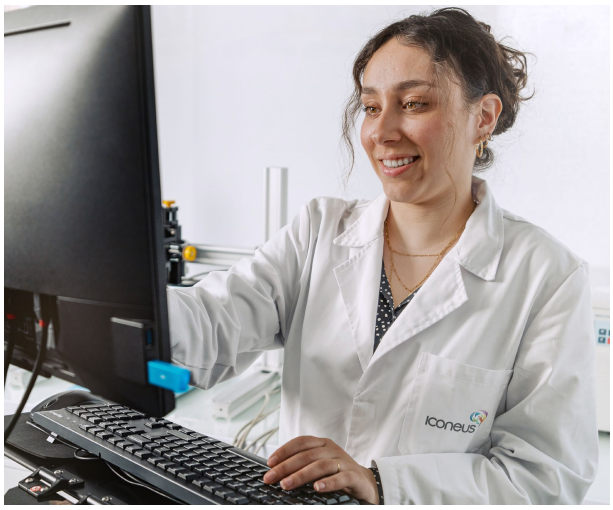
Artem Shatillo, M.D.
Charles River Laboratories, Finland

Let's talk!

We're dedicated to helping researchers get the most of what fUS has to offer, so please get in touch to:

- Talk about your research and discover how fUS could help
- Discuss probe options and animal compatibility
- Enquire about creating a tailored system
- ...or anything else.

SEND EMAIL



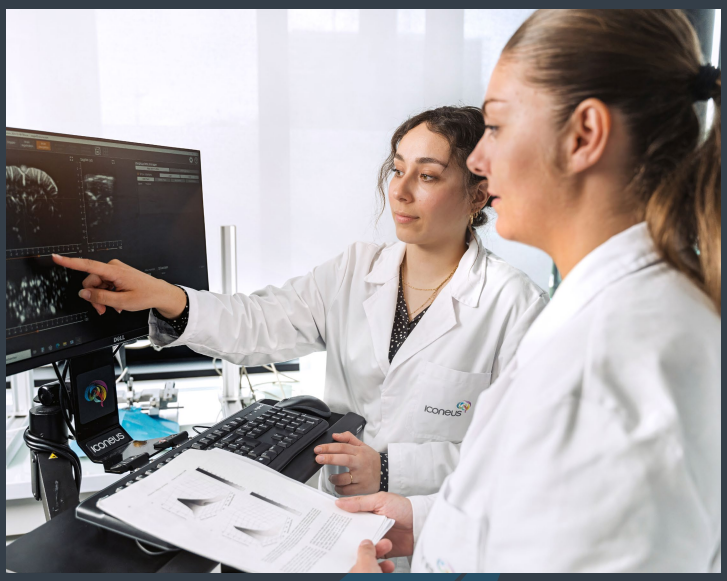
About Iconeus

Welcome to the future of brain imaging

We're Iconeus – a Paris-based company helping researchers to gain new insights into neuroscience using our groundbreaking functional ultrasound technology.

Our team of over 30 neuroscientists, software engineers and ultrasound physicists is dedicated to ensuring functional ultrasound achieves its full potential, by helping you integrate it into your research.

We look forward to hearing from you!



Iconeus

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