Experimental possibilities beyond confocal standards

ZEISS LSM Airyscan

Sensitive High-Speed Super-Resolution Imaging and Molecular Characterization

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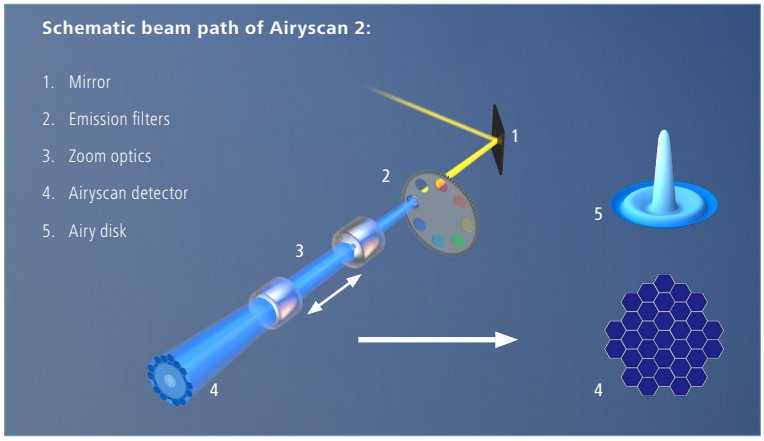
ZEISS

Seeing beyond

ZEISS LSM Airyscan

An array of options to unleash confocal imaging

ZEISS LSM systems with Airyscan enable experiments that push the boundaries of gentle super-resolution, high-speed acquisition, and molecular characterization of biological samples. By maximizing signal detection through the utilization of its unique area detector, Airyscan achieves a distinctive blend of sensitivity and enhanced spatial information. As a user-friendly technology that is fully integrated into ZEISS laser scanning microscopes, it offers you ever-evolving possibilities to go beyond traditional confocal imaging.



Gentle super-resolution imaging
Get additional spatial information from your sample

High-speed confocal image acquisition
Combine enhanced spatial and temporal resolution for new discoveries.

Dynamics Profiler
Discover the underlying molecular dynamics in your living samples.

The fact that a small pinhole leads to higher resolution has been part of confocal imaging since its inception. Airyscan takes the confocal idea beyond its conventional implementation: Instead of light passing through a pinhole to reach a single detector, Airyscan consists of 32 detector elements that act as very small pinholes, taking a pinhole-plane image at every scanned position.

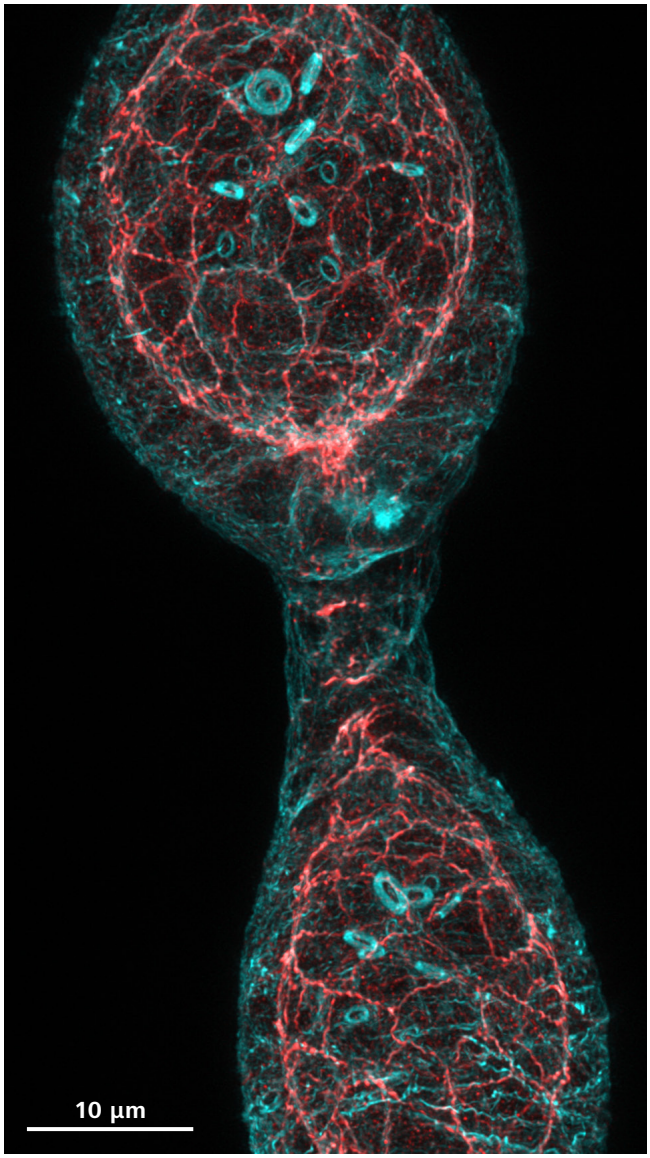
By combining 32 such small pinhole-like detectors into a large area detector, Airyscan allows more light to be collected and higher frequency information of a structure to be captured. Airyscan adds a whole new layer of spatial information to the image which can be utilized as a resource for ever-evolving imaging capabilities: from gentle super-resolution imaging of the smallest structures to high-speed acquisition of dynamic processes, to the characterization of molecular behavior.

Its ease of use in combination with the well-known advantages of an LSM system, and its linear quantitative processing, are further reasons for the rapid success of Airyscan imaging – and have quickly made it an established method of confocal microscopy that has become an essential tool for confocal imaging in the biological research community.

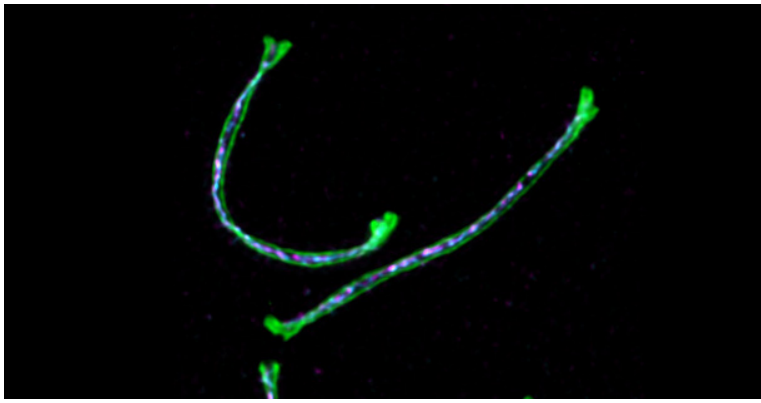
Gentle super-resolution imaging

Enhanced structural information effortlessly added to your experiment

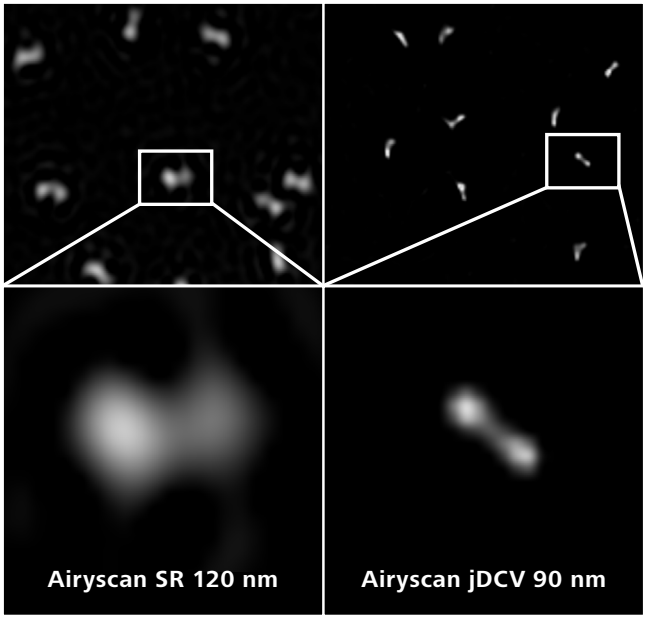
The fundamental purpose of any microscope is to reveal the unknown by resolving the smallest structures. Super-resolution has become standard in florescent imaging and is routinely employed in many microscopy experiments. However, it is crucial to select a method that is safe for living samples and yields reliable results. You don't need to be a microscopy expert to use Airyscan for your super-resolution experiments. Sample preparation and workflows remain unchanged from established confocal imaging practices. With Airyscan, you capture more structural information and collect available fluorescence signal more efficiently, which makes this super-resolution method particularly gentle to your delicate samples. Choose from a variety of processing options and easily customize them to get reliable and quantifiable data. Lateral resolution down to 90 nm is made possible by Joint Deconvolution – utilizing the additional spatial information that only Airyscan can provide.



Staining of F-actin (Phalloidin, cyan) and DE-Cadherin (red) in the Drosophila germarium. *Imaged with ZEISS Airyscan 2 followed by Joint Deconvolution. Courtesy of T. Jacobs, AG Luschnig, WWU Münster; with T. Zobel, Münster Imaging Network, Germany*



Airyscan: Super-resolution imaging of the synaptonemal complex with clearly resolved tripartite structure. Courtesy of Suixing Fan, University of Science and Technology of China



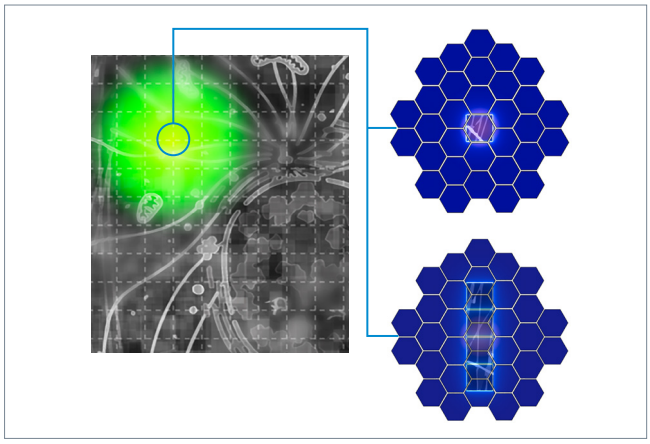
GATTA SIM nanoruler imaged with Airyscan SR (GATTA-SIM 120B, left) and Airyscan jDCV (GATTA-SIM 90B, right).

High-speed confocal image acquisition

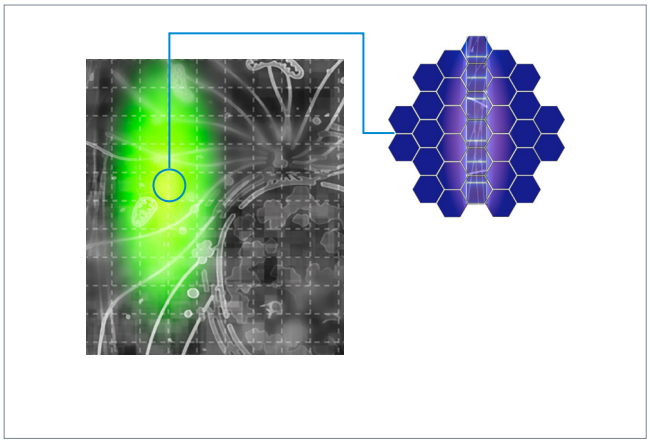
Simultaneous improvement of spatial and temporal resolution

To understand dynamic processes in living systems, spatial information must not be compromised in favor of the necessary temporal resolution. The ability to combine fast imaging with super-resolution makes Airyscan a versatile tool to observe live dynamics at subcellular resolution and efficiently image large 3D samples, enabling efficient imaging of processes in cells, spheroids, organoids, or whole organisms. The multi-element Airyscan detector facilitates rapid acquisition of 2 to 8 image lines, speeding up the imaging process and improving the acquisition of structural information. Airyscan's various parallelization options provide optimal flexibility to meet diverse experimental needs. By leveraging the unique information from the area detector, resolution can be further enhanced by Joint Deconvolution, a reliable processing method specifically optimized for Airyscan's high-speed imaging modes.

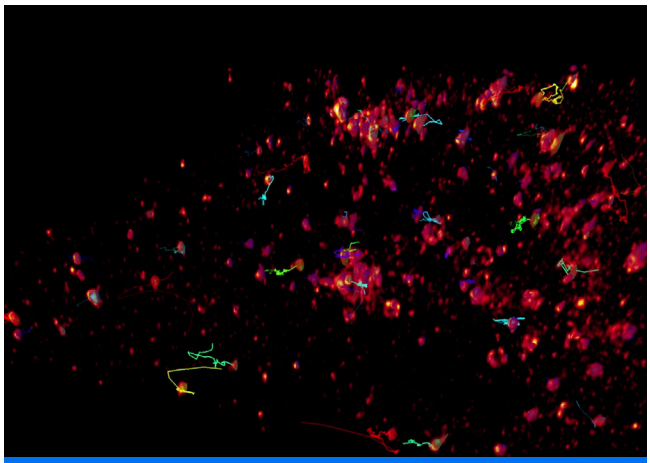
HeLa cells stained for DNA (blue, Hoechst 44432), microtu- bules (yellow, anti-tubulin Alexa 488) and F-actin (magenta, phalloidin Abberior STAR Red). Imaged with ZEISS Airyscan 2 in Multiplex mode for efficient super-resolution imaging of a large field of view. Courtesy of A. Politi, J. Jakobi and P. Lenart, MPI for Biophysical Chemistry, Göttingen, Germany



Unlike the Airyscan SR mode which generates one super-resolution image pixel for each illumination position, the spatial information provided by the Multiplex modes SR-2Y / CO-2Y and SR-4Y allows to scan 2 or even 4 super-resolution image lines in a single sweep.

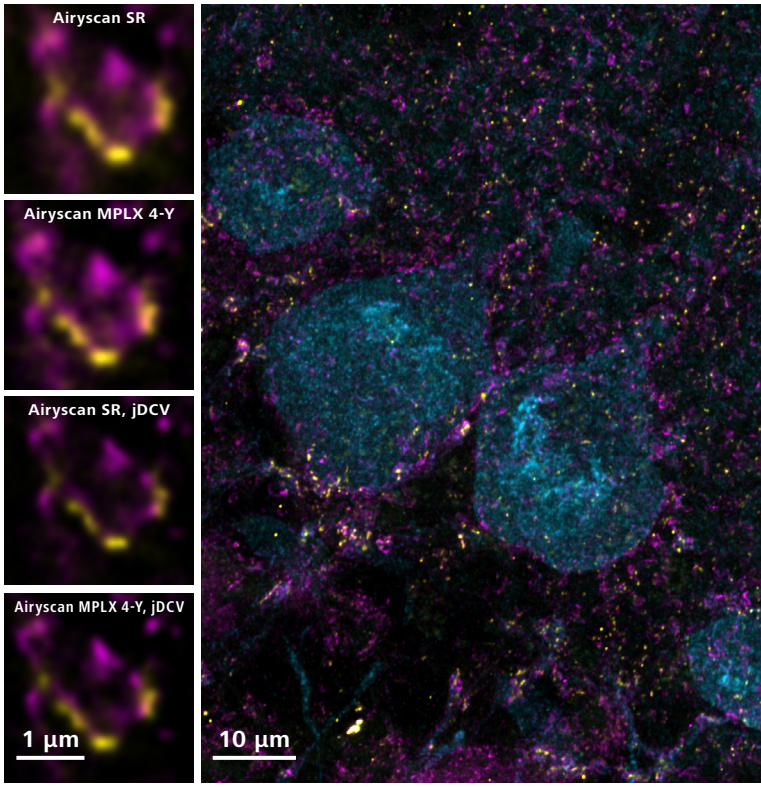


For Airyscan Multiplex SR-8Y and CO-8Y, the illumination laser spot is vertically elongated to capture 8 image pixels for each illumination position. Sampling can be done in super-resolution (SR) or confocal (CO) resolution. Use this speed advantage for ultrafast time series of single slices, rapid tiling of large areas, or fast volumetric time-lapse imaging.



Click here to view this video

Investigating vesicular transport in mammalian live cells
The unique combination of the gentle illumination provided by the Airyscan technology and its high-speed capabilities enables effective imaging of vesicle movement in 3D.
The example shows fast movement of early endosomes in mammalian cells, acquired with Airyscan 2 using the MPLX CO-8Y mode. Thanks to the resolution improvement with Airyscan jDCV, the vesicles could be segmented and tracked with ZEISS arivis Pro through the cellular volume in time.



10 µm mouse brain section, Calbindin-A488 (blue), Gephyrin-A568 (yellow), VGAT-A647 (magenta).Sample courtesy of Luisa Cortes, Microscopy Imaging Center of Coimbra, CNC, University of Coimbra, Portugal

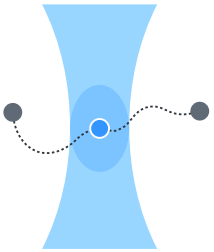
Dynamics Profiler

Easy access to underlying molecular dynamics in living samples

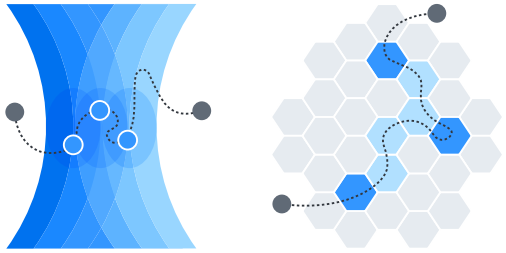
ZEISS Dynamics Profiler gives you easy access to molecular concentration and dynamics in living samples. Information collected with the ZEISS Airyscan detector lets you characterize heterogenous diffusion behavior, ideal to investigate cellular condensates. Flow measurements determine the speed and direction of active movement in liquids and provide unique new data related to microfluidics and organs-on-a-chip. Explore even your most delicate samples without excessive light exposure or prolonged experiment time and expand your data collection to enhance your research.

Molecular data offers new, and often overlooked, insights about living samples. Fluorescence Correlation Spectroscopy (FCS) is an established method to investigate molecular characteristics. While a precise and very sensitive method, traditionally it is limited to extremely low expression levels or molecule concentrations that can be well below the experimental expression levels in live research samples.

ZEISS Airyscan uniquely employs all its detector elements to collect 32 individual FCS intensity traces per measurement. The mean value of the inner 19 elements provides robust and reliable measurements on molecular concentration and dynamics, even for bright samples. Moreover, the area detector allows a variety of spatial cross-correlation analyses by using combinations of single detector elements.



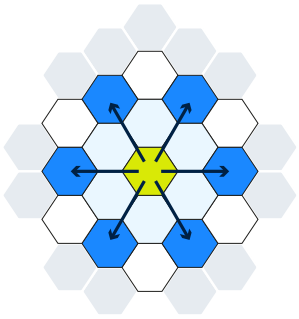
FCS principle



Dynamics Profiler principle

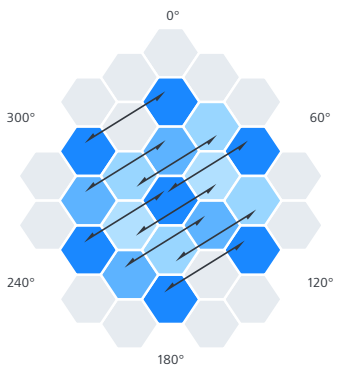
Asymmetric Diffusion Measurement

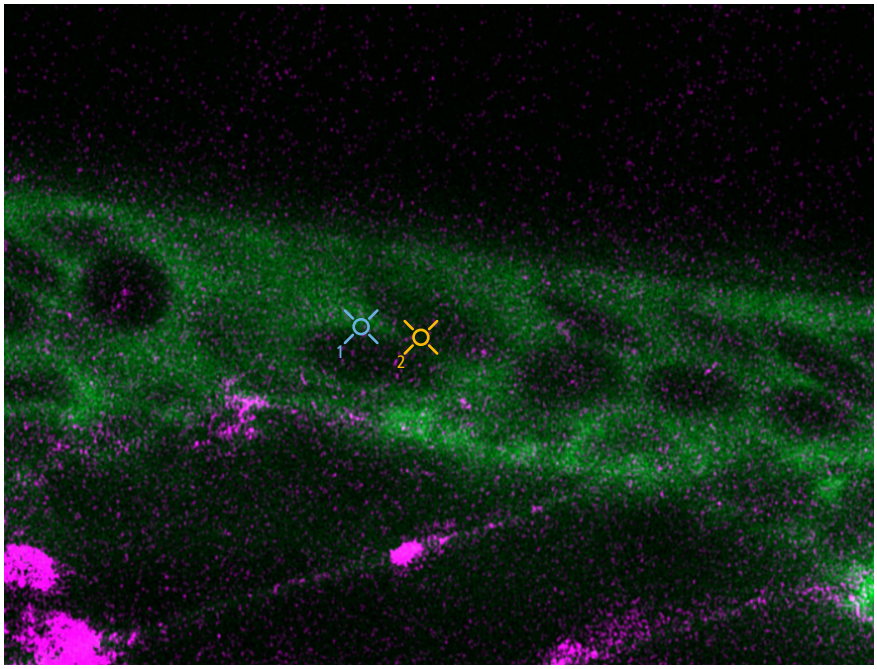
Asymmetric diffusion analysis is calculated by cross-correlating the center element of the detector with the elements of the outer rings, uncovering heterogenous characteristics within one excitation volume, perfect to investigate samples such as cellular condensates.

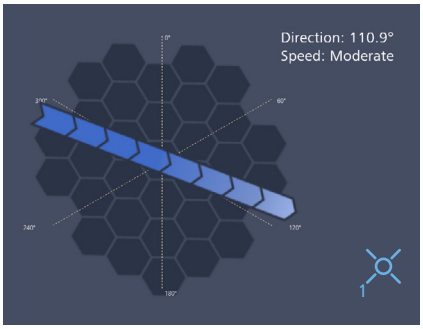


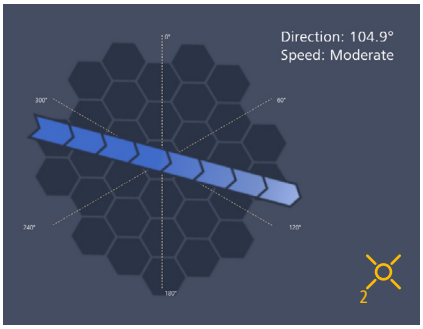
Flow Measurement

Cross-correlation of detector pairs that are grouped and aligned in multiple directions along the excitation volume can measure speed and direction of actively moved molecules, such as fluorophores in microfluidic systems or within the bloodstream.



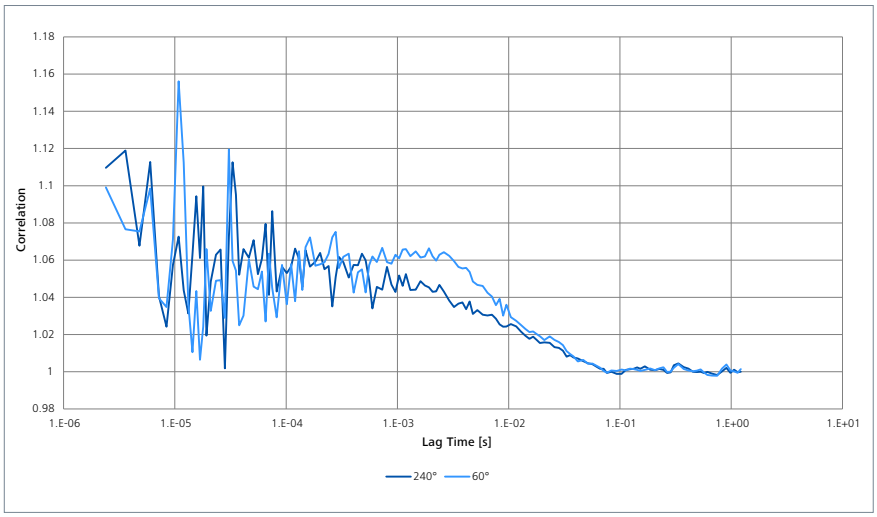


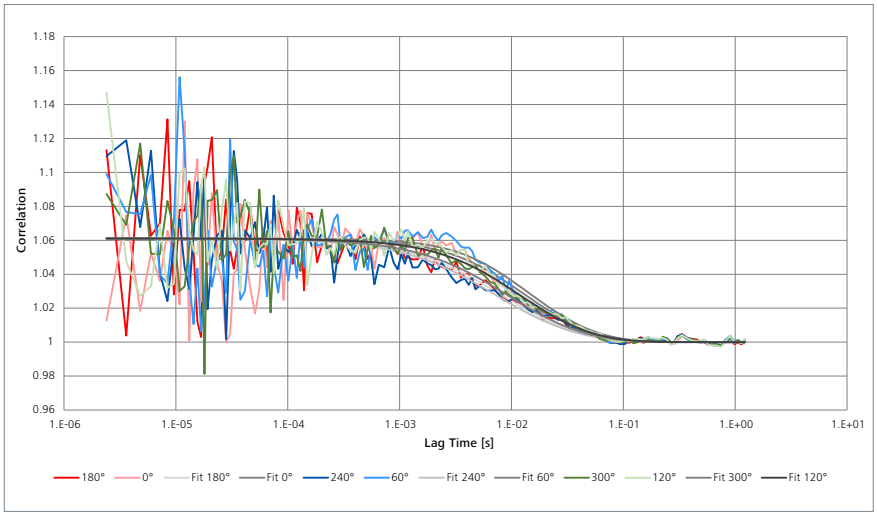




Measure the flow speed in blood vessels of zebrafish larvae

The spatial information provided by the Airyscan detector allows analyses to determine the flow speed of molecules in the blood. Tetramethylrhodamine-labeled Dextran (10 kDa, Dynamics Profiler measurement) and Fluorescein-labeled Dextran (40 kDa, labeling blood vessels) were injected into blood vessels of a 5-day-old zebrafish larvae that was embedded in 1% low melt agarose.





Reference image and Dynamics Profiler data acquired with LSM 980 with Airyscan 2 and a 40×/1.2 W autocorr objective. Direction and speed of molecule flow through the blood vessel were measured at two different spots. The graphs (right) show the correlation curves of the measurement within spot 1: correlation curves of selected angles (top), actual flow speed and direction results out of the 6 cross-correlations along three axis (bottom).Courtesy of V. Hopfenmüller, Leibniz Institute on Aging – Fritz Lipmann Institute (FLI), Germany

More information:

Dynamics Profiler
Add a new dimension to live imaging

Choose your platform

Add Airyscan to your LSM and go beyond confocal standards

ZEISS LSM 910

Understanding the fundamentals of life

Compact confocal microscope for innovative imaging and smart analysis

→ zeiss.com/lsm-910

ZEISS LSM 990

Freedom to explore

Top-class multimodal imaging combined in one confocal system

→ zeiss.com/lsm-990

LSM 910 with Airyscan 2	Airyscan SR	MPLX SR-2Y	MPLX SR-4Y	MPLX CO-2Y
Parallelization	1	2	4	2
FPS at max FOV	0.4 (Zoom 1.3)	0.8 (Zoom 1.3)	3.5 (Zoom 1.3)	3.5 (Zoom 1.3)
FPS at 512 × 512 pixels	4	8.4	18.9	8.3
	Processing method Wiener DCV			
Resolution X/Y*	120 nm	140 nm	140 nm	180 nm
Resolution Z**	350 nm	450 nm	450 nm	550 nm
	Processing method jDCV			
Resolution X/Y*	90 nm	120 nm	120 nm	–
Resolution Z (FWHM***)	200 nm	250 nm	250 nm	–
Beads FWHM X/Y***	80 nm	80 nm	80 nm	–
	Recommended applications			
Antibody labeling, fine structures	+++++	++++	++++	++
Antibody labeling, tiling	++	+++	+++++	+++
Live cell imaging	++	+++	++++	+++++

LSM 990 with Airyscan 2	Airyscan SR	MPLX SR-4Y	MPLX SR-8Y	MPLX CO-8Y
Parallelization	1	4	8	8
FPS at max FOV	0.2 (Zoom 1.7)	1.0 (Zoom 1)	2.0 (Zoom 1)	9.6 (Zoom 1)
FPS at 512 × 512 pixels	4.7	25	47.5	34.4
	Processing method Wiener DCV			
Resolution X/Y*	120 nm	140 nm	120/160 nm	Confocal or better
Resolution Z**	350 nm	450 nm	450 nm	Confocal or better
	Processing method jDCV			
Resolution X/Y*	90 nm	120 nm	120 nm	–
Resolution Z (FWHM***)	200 nm	250 nm	250 nm	–
Beads FWHM X/Y***	80 nm	80 nm	80 nm	–
	Recommended applications			
Antibody labeling, fine structures	+++++	++++	+++	++
Antibody labeling, tiling	++	++++	+++++	+++
Live cell imaging	++	+++	++++	+++++

* Nanoruler 488 nm with specific distance
** FWHM Beads 100 nm, wavelength 488 nm, with z-Piezo
*** FWHM Beads 23 nm (e.g. from Gattaquant), wavelength 488 nm, with z-Piezo

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