Understanding the fundamentals of life

ZEISS LSM 900 with Airyscan 2

Your Compact Confocal for Gentle Multiplex Imaging and Smart Analysis

ZEISS

Seeing beyond

zeiss.com/lsm900

Your Compact Confocal for Fast and Gentle Multiplex Imaging

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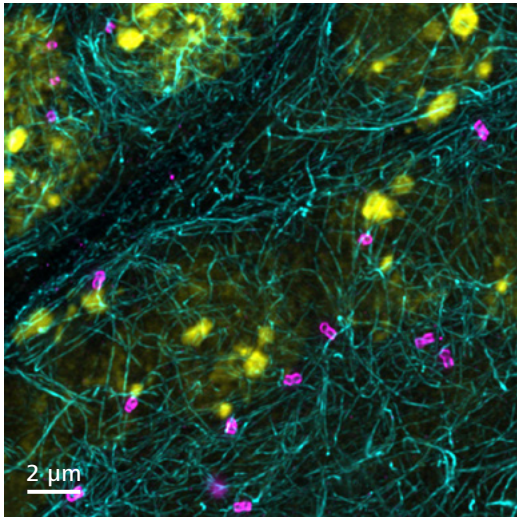
To pursue your scientific questions, you want only the best data quality. In microscopy, this translates into the best contrast and resolution while maintaining minimum light exposure. Gentle imaging eliminates phototoxic effects, allowing you to follow biological processes without disturbance, yielding data that is fit for analysis.
ZEISS LSM 900 provides this with components optimized to deliver the best imaging results, including LSM Plus for a unique confocal experience, effortlessly improving all your multi-color and live cell acquisitions. Reliably gather more information during your confocal work while increasing your productivity.
Add Airyscan 2 to combine super-resolution with gentle imaging. Capture larger fields of view or dynamic processes with the flexible Multiplex modes for fast parallel pixel acquisition. Or push resolution further to identify new structures using Airyscan Joint Deconvolution (jDCV). Discover the underlying molecular dynamics of your living samples with the additional information only Airyscan with its 32-channel area detector can offer.



Spermatogonia in Drosophila testis. Multi-color label with asterless (magenta), acetylated tubulin (cyan), and Hoechst 33258 (yellow). Imaged with ZEISS Airyscan 2 followed by Joint Deconvolution. Courtesy of S. Song, Prof. Liou Yih-Cherng's lab, Singapore

Simpler. More Intelligent. More Integrated.

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A Unique Confocal Experience in a Small Footprint

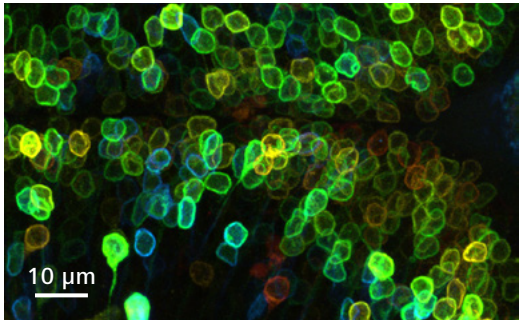
LSM 900 is packed with innovative and clever solutions for producing the best quality in confocal live cell imaging. The efficient beam path is designed for the best spectral flexibility, with each component optimized for the highest sensitivity and contrast. LSM Plus lets you easily optimize the results of your multi-color and live cell experiments. All these high-end features fit in a small footprint and come with reduced complexity, so you'll save valuable lab space, minimize the time required for user training, and reduce the cost of ownership.

Get Better Data – Faster

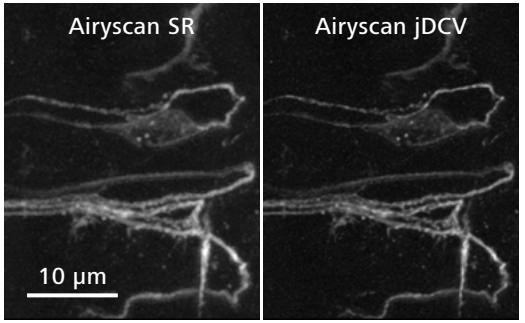
Revolutionary Airyscan 2 allows you to do more than any conventional LSM detector. Each of its 32 detector elements collects additional information, while all of them together gather even more light, yielding super-resolution quantitative results. By adding structural information with Joint Deconvolution (jDCV), you can push resolution even further. Or use the Multiplex modes to collect more information in less time. Adapted illumination and detection schemes let you image the most challenging three-dimensional samples with high framerates and beyond the diffraction limit, while still being gentle to your sensitive samples.

Increase Your Productivity

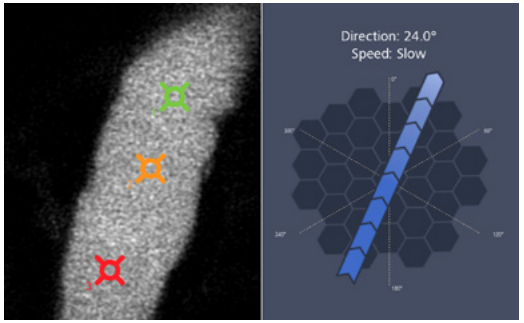
It's never been easier to set up complex confocal live cell imaging experiments. ZEN microscopy software puts a wealth of helpers at your command to achieve reproducible results in the shortest possible time. AI Sample Finder helps you quickly find regions of interest, leaving more time for experiments. Smart Setup supports you in applying best imaging settings for your fluorescent labels. Direct Processing enables parallel acquisition and data processing. ZEN Connect keeps you on top of everything, both during imaging and later when sharing the whole story of your experiment. It's easy to overlay and organize images from any source.



Live imaging with LSM Plus: Plasma membrane localized expression of Wnt3-EGFP in the developing optic tectum of 4-day-old Tg (–4.0wnt3:Wnt3EGFP) zebrafish. Color-coded maximum intensity projection of Z-stack. Courtesy of C. Teh, Centre for Bioimaging Sciences, Singapore



Drosophila peripheral nervous system.
Left: Airyscan SR; right: Joint Deconvolution.
Courtesy of J. Sellin, LIMES Institut Bonn, Germany



ZEISS Dynamics Profiler enables flow measurements to determine speed and direction of blood flow in zebrafish larvae. Sample courtesy of V. Hopfenmüller, Leibniz Institute on Aging – Fritz Lipmann Institute (FLI), Germany

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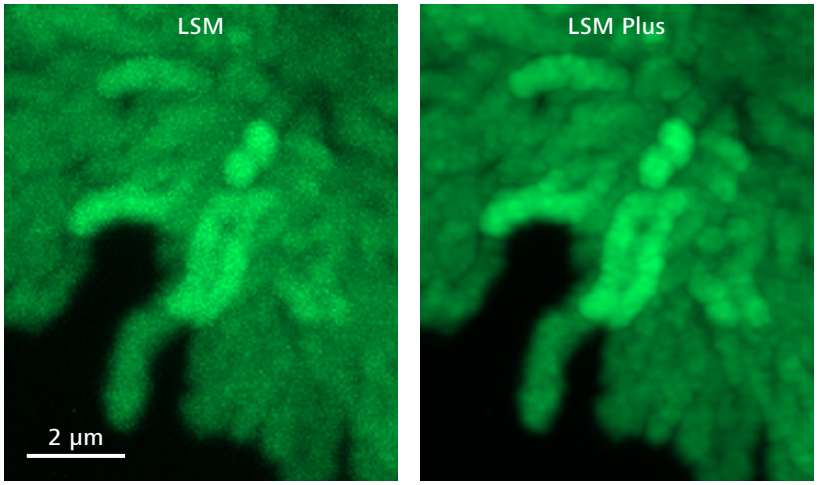
LSM Plus: Improving the Whole Confocal Experience

Laser scanning microscopy is valued for its instant, high-quality imaging of optical sections and has set the imaging standard for a wide variety of samples and experiments. It's hard to imagine how the data quality of this technology can be improved further while fully preserving its appreciated ease of use and application flexibility.

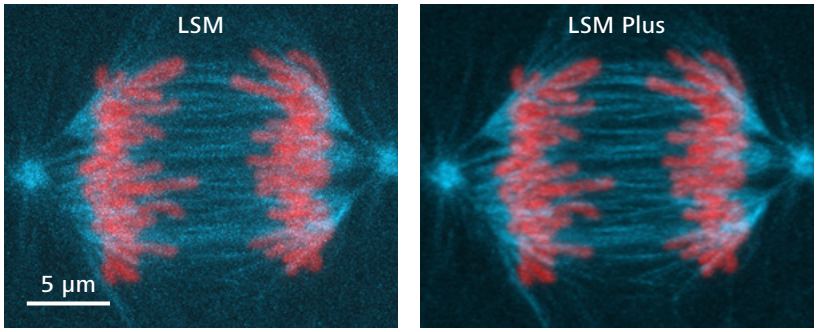
LSM Plus is doing just that: improving literally any confocal experiment with ease, independent of detection mode or emission range. Its linear Wiener filter deconvolution needs next to no interaction while still ensuring a reliable quantitative result. Just as in our time-tested Airyscan super-resolution processing, the underlying optical property information is adapted automatically based on objective lens, refractive index, and emission range.

Apply LSM Plus with no extra effort and benefit from:

- **Enhanced signal to noise (SNR)** at high acquisition speed and low laser power—particularly useful for live cell imaging with low expression levels
- **Improved resolution** of your multi-color and spectral datasets
- **More spatial information** and even greater resolution enhancement for bright samples that allow to close the pinhole of the LSM
- **Integrated workflows** to combine the advantages of LSM Plus with Airyscan super-resolution imaging



RPE1 cells transfected with H2B-GFP plasmid. Maximum intensity projection of 117 Z-planes. Comparison of without (left) and with LSM Plus (right). Courtesy of Tingsheng Liu, Mitosis Lab, Singapore



Live imaging of LLC-PK1 dividing cell (porcine kidney), expressing H2B-mCherry (red) and α-Tubulin-mEGFP (cyan). Maximum intensity projection of 37 Z-planes. Comparing without (left) and with LSM Plus (right).

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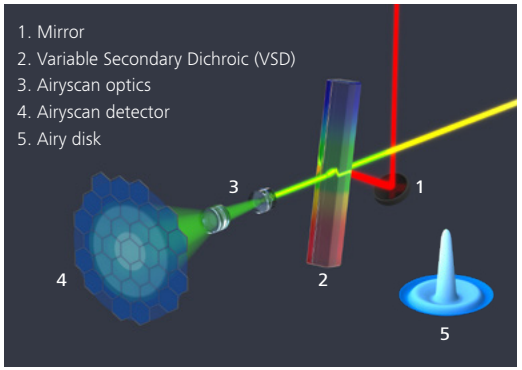
The Airyscan Principle: A Unique Combination of Super-resolution Imaging and High Sensitivity

Classic confocal laser scanning microscopes use point illumination to scan the sample sequentially. The microscope optics transform each point to an extended Airy disk. A pinhole spatially limits this Airy disk to block out-of-focus light from the detector. Closing the pinhole gives higher resolution, but at the price of detecting fewer photons—which cannot be brought back.

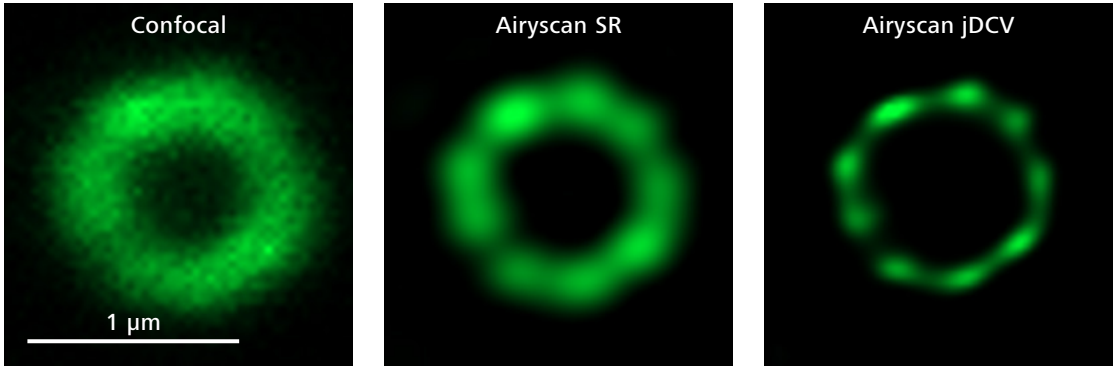
Airyscan 2 is an area detector with 32 circularly arranged detection elements. Each of these acts as a small pinhole, contributing to super-resolution information, while the complete detector area collects more light than the standard confocal setting. This produces much greater light efficiency while capturing enhanced structural information.



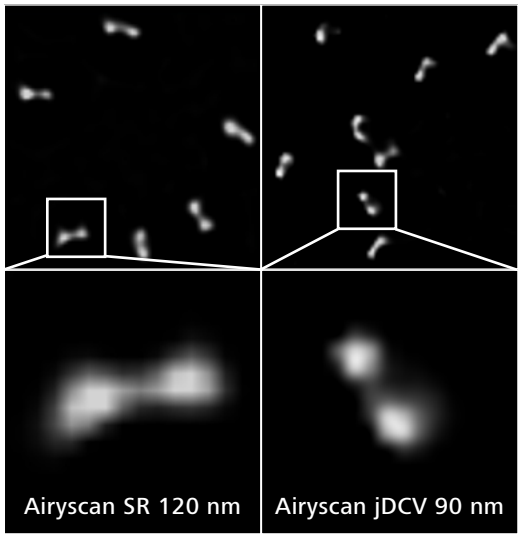
Schematic beam path of ZEISS Airyscan.

32 Views Mean More Information: Powerful Deconvolution with Airyscan jDCV

Each of the 32 detector elements has a slightly different view on the sample, providing additional spatial information that makes Joint Deconvolution possible. This reduces the distance that can be resolved between two points even further—down to 90 nm. Your super-resolution experiments will benefit from an improved separation of single or multiple labels.



Comparing the confocal image (left) with Airyscan SR (middle) and Airyscan Joint Deconvolution (right).
HeLa cell, 4× expanded and labelled with acetylated alpha tubulin (green). Courtesy of S. Zhang, Prof. Liou Yih-Cherng's lab, Singapore



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

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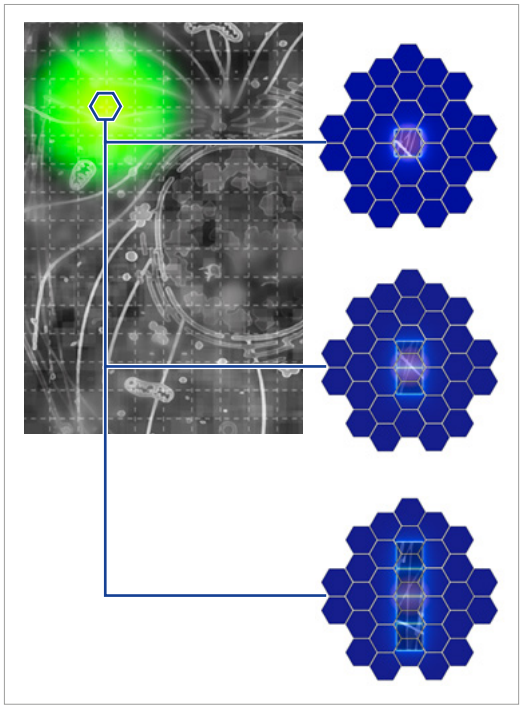
ZEISS Airyscan 2 with Multiplex

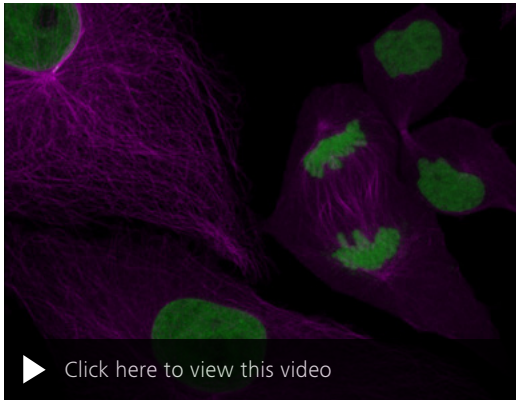
In Multiplex modes, Airyscan detector advantages are combined with adapted illumination and readout schemes, giving you a choice of different parallelization options.



For each illumination position, Airyscan SR mode generates one superresolution image pixel. The spatial information provided by Airyscan 2 in 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.

Multiplex modes use knowledge of the shape of the excitation laser spot and the location of single area detector elements to extract more spatial information, even during parallel pixel readout. This allows larger steps when sweeping the excitation laser over the field of view, improving acquisition speed. Capturing more spatial information in the pinhole plane allows final image reconstruction with better resolution than the acquisition sampling.

Airyscan 2 in Multiplex mode can acquire up to four super-resolution image lines with high SNR in a single sweep for rapid tiling of large areas, efficient live cell imaging, or for fast volumetric imaging.



Cell division of LLC-PK1 cells, alpha-tubulin (mEmerald, magenta) and H2B (mCherry, green). With the Multiplex mode for ZEISS Airyscan 2 a Z-stack of 52 slices was captured every 40 seconds for a total of 40 minutes.

ZEISS LSM 900 with Airyscan 2

	Airyscan SR	Multiplex SR-2Y	Multiplex SR-4Y	Multiplex CO-2Y
Parallelization	1	2	4	2
Resolution	120/120	140/140	140/140	180/180
FPS at 512 × 512 pixels	4	8.4	18.9	8.3
FPS at max FOV	0.4 (Zoom 1.3)	0.8 (Zoom 1.3)	3.5 (Zoom 1.3)	3.5 (Zoom 1.3)
Antibody labeling, fine structures	+++++	++++	++++	++
Antibody labeling, tiling	++	+++	+++++	+++
Live cell imaging	++	+++	++++	+++++

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ZEISS Dynamics Profiler: Add a New Dimension to Live Imaging

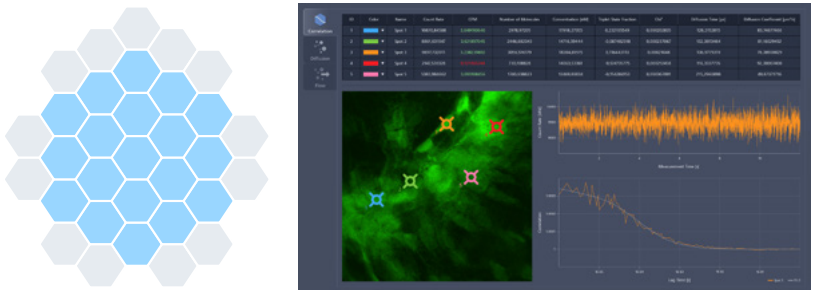
Molecular data offers new, and often overlooked, insights about living samples. Fluorescence Correlation Spectroscopy (FCS) is an established method to investigate molecular characteristics. While a precise and very sensitive method, traditionally it is limited to extremely low expression levels or molecule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

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.

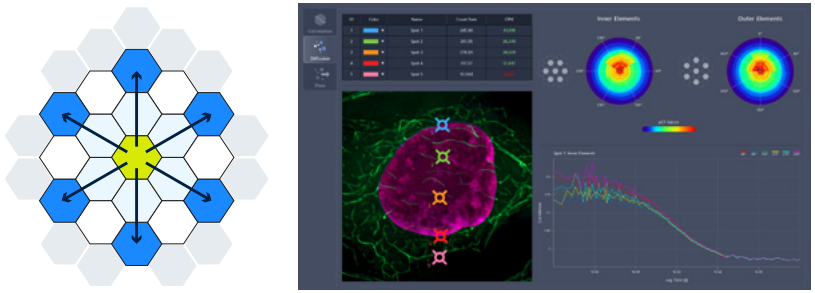
Moreover, the area detector allows a variety of spatial cross-correlation analyses by using combinations of single detector elements. Asymmetric diffusion analysis is calculated by cross-correlating the center element of the detector with the elements of the outer rings, uncovering heterogenous characteristics within one excitation volume, perfect to investigate samples such as cellular condensates. 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.

Furthermore, raw data of all 32 detector elements is saved with every single measurement, enabling you to perform your customized analysis as needed, either immediately or when the scientific question arises later.

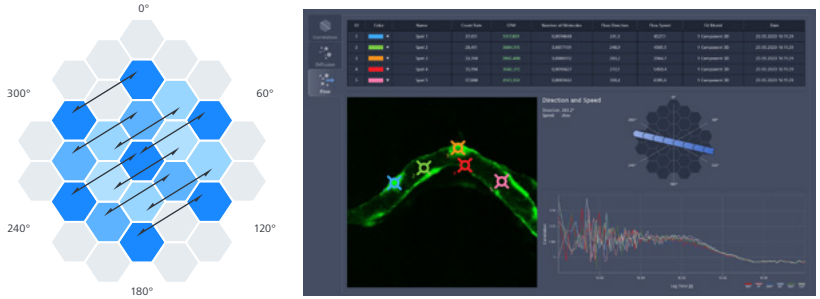
Learn more about ZEISS Dynamics Profiler:
www.zeiss.com/dynamics-profiler



Molecular concentration and diffusion data are collected with the innermost 19 elements of the Airyscan detector. The read-out of separate detectors permits measurements at much higher total intensities (brightness) than conventional FCS would allow.



To measure asymmetric diffusion, single Airyscan detector elements of the third ring are cross-correlated with the center element. Polar heatmaps visualize asymmetric diffusion behavior within a measurement spot.



To determine the flow direction and speed within a liquid, a total of 27 detector element pairs are cross-correlated along 3 different axes of the Airyscan detector.

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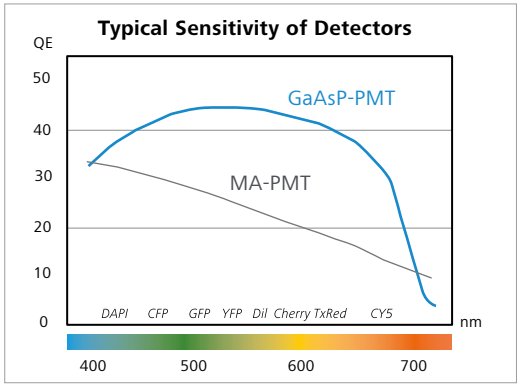
GaAsP Detectors – Your Choice for Highest Sensitivity

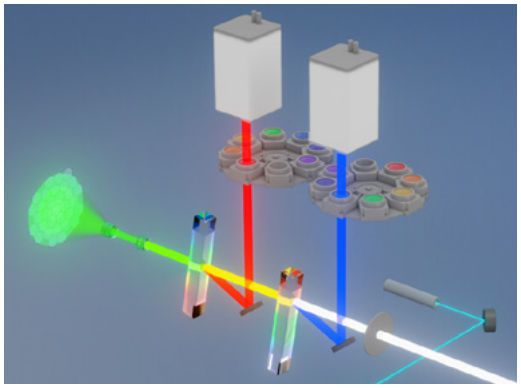
GaAsP PMTs – that is, gallium arsenide phosphide photomultiplier tubes – display high light collection efficiencies over a broad spectral range. Their low dark noise levels also render them the ideal tool for detecting faint signals. Enjoy outstanding image quality based on a superb signal-to-noise ratio (SNR). You might use this gain in SNR to increase productivity by achieving faster scan speeds while preserving excellent image quality. Or take advantage of the low laser powers needed in live cell imaging applications to avoid photobleaching and phototoxicity as much as possible. Or simply detect faint signals in low expressing cells. All that, and you can do it with up to three spectral channels simultaneously.

Benefit from up to Three Confocal Detectors

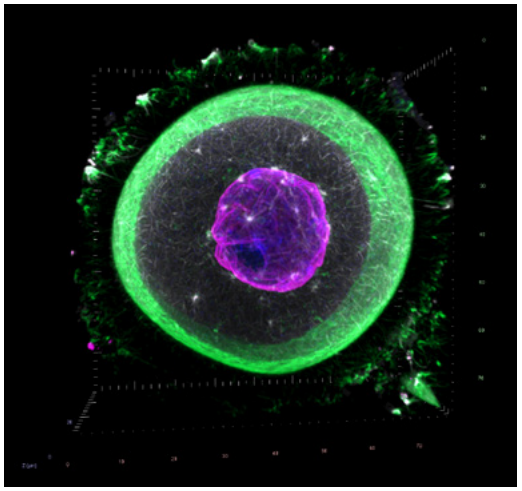
Investigations into localization and interaction of proteins often require multiple fluorescent labels with overlapping emission spectra. Now you can image up to four dyes, crosstalk free by multi-tracking. Or even more by performing a Lambda scan with spectral unmixing.



Typical spectral quantum efficiency (QE) of multi-alkali (MA-) PMT and GaAsP-PMT detectors.



Schematic beam path of ZEISS LSM 900.



Germinal vesicle state mouse oocyte, labelled for actin (green, Pholloidin-Alexa Fluor 488), mictorubules (white), Lamin A/C (magenta) and DNA (Hoechst). Sample courtesy of K. Harasimov, MPI for Biophysical Chemistry, Goettingen, Germany

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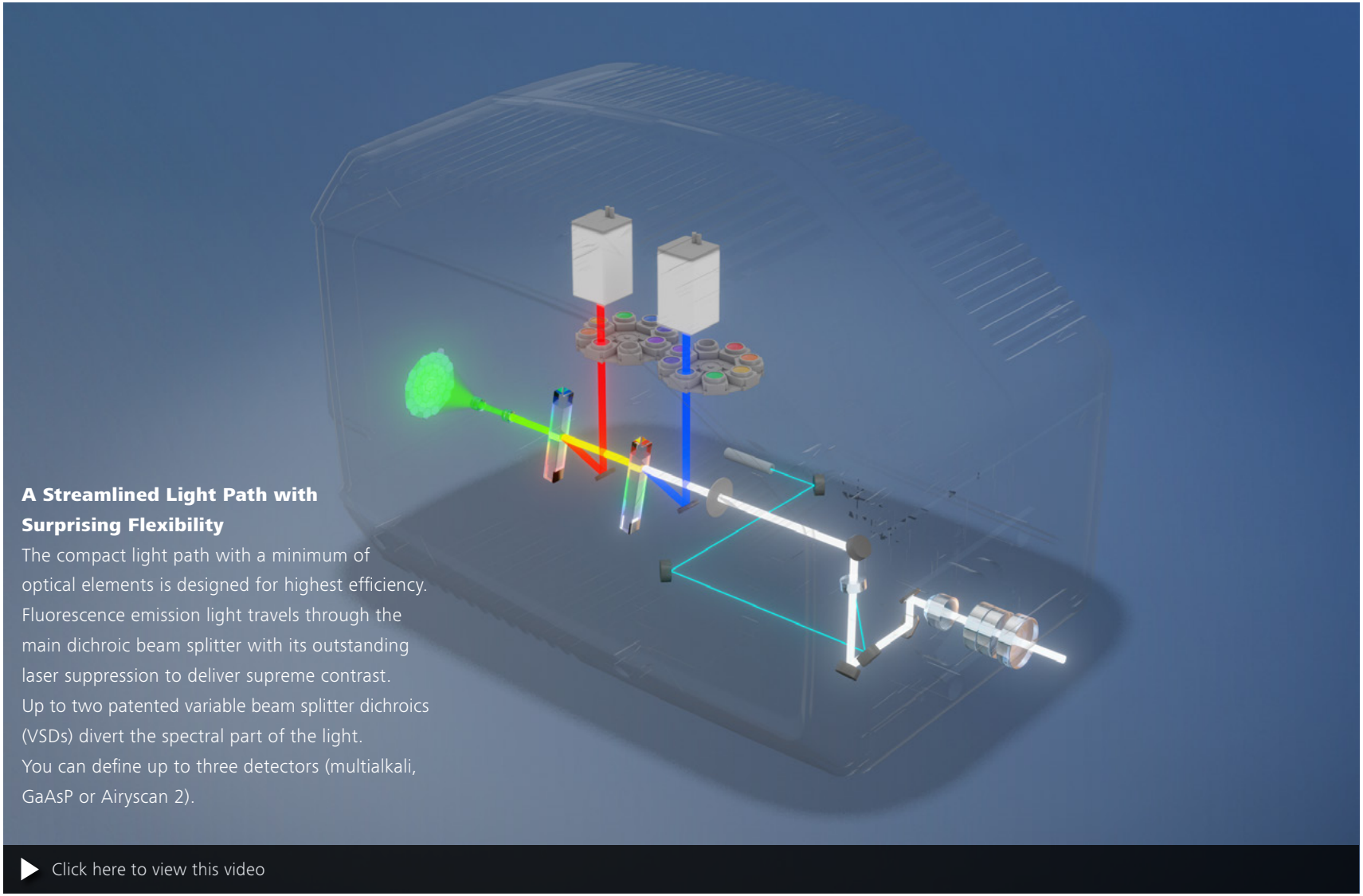

A Streamlined Light Path with Surprising Flexibility

The compact light path with a minimum of optical elements is designed for highest efficiency. Fluorescence emission light travels through the main dichroic beam splitter with its outstanding laser suppression to deliver supreme contrast. Up to two patented variable beam splitter dichroics (VSDs) divert the spectral part of the light. You can define up to three detectors (multialkali, GaAsP or Airyscan 2).

Click here to view this video

Schematic beam path of ZEISS LSM 900.

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AI Sample Finder: Automated Sample Identification for Efficient Imaging

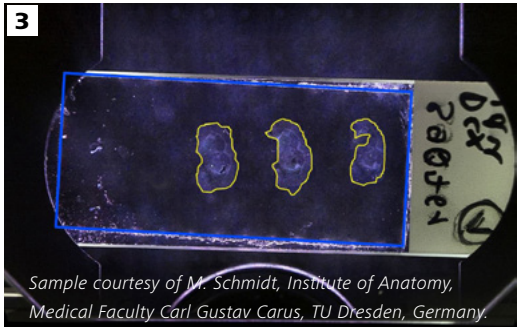
Microscopes are becoming increasingly automated. For sample placement, however, microscope parts such as the condenser arm often have to be moved manually. Focus adjustment and identification of the relevant areas on the sample carrier require additional manual steps.

The AI Sample Finder automates this sequence, eliminating time-consuming manual adjustments and reducing the time to image from minutes to just seconds.

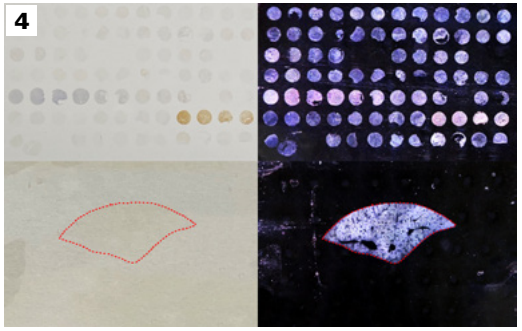
You can access all sample areas directly which allows you starting your experiment faster than ever. The AI Sample Finder greatly improves productivity as you can easily image only those regions containing sample not overlooking potentially important areas.

- After you placed the sample on the loading position, the AI Sample Finder automatically moves it to the objective.

- Without the need of manual sample positioning or focusing, an overview image for fast and convenient navigation is taken within seconds. Composite darkfield illumination creates a high-contrast image even for very low-contrast samples.



- Intelligent routines automatically identify your sample carrier, regardless if you use a petri dish, a chamber slide, or a multiwell plate. Carrier properties are automatically transferred to the software, eliminating manual settings.



- Your samples are reliably identified. Deep Learning algorithms precisely detect even unusual sample regions. You can navigate and access all sample areas directly which allows you starting your experiment faster than ever.

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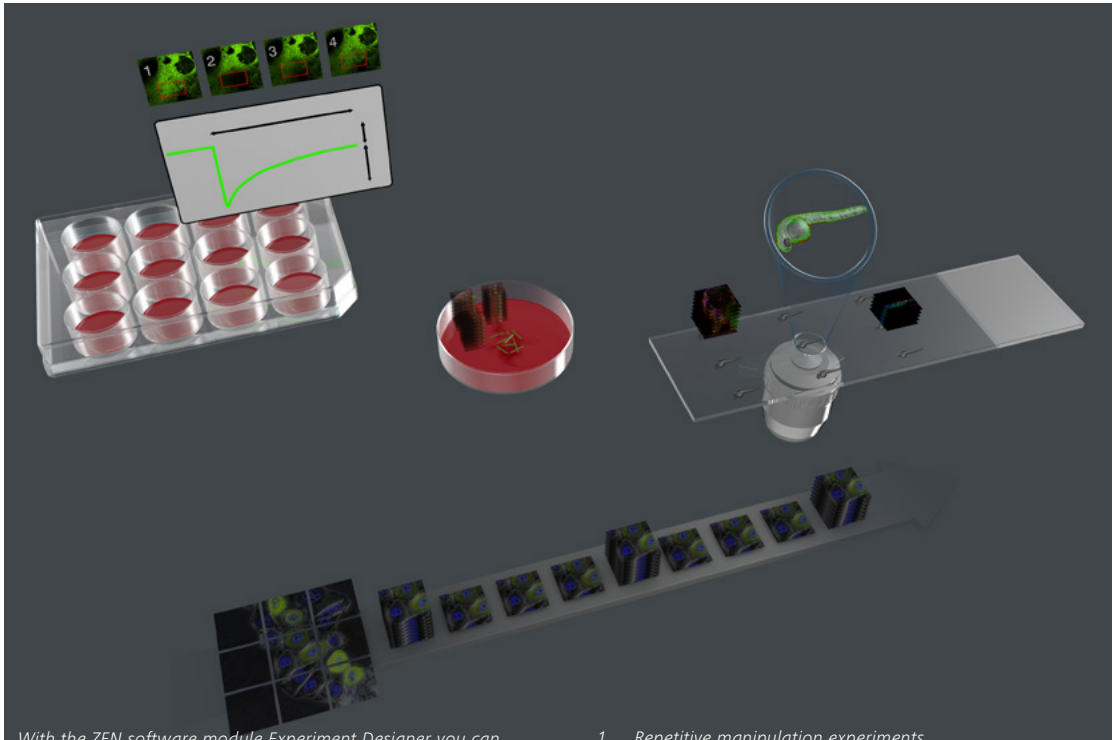
Acquire Reproducible Data with Ease

With all its various aspects and workflows, your research leaves you with no time to waste. That's why ZEN microscopy software was created—to make your confocal imaging both efficient and enjoyable.

Use Smart Setup to select your dyes and ZEN will automatically apply all necessary settings for all LSM imaging modalities. The integrated database with spectral data for more than 500 dyes helps you make an informed decision about your imaging options. You can always save imaging configurations or even whole experiments to reproduce settings quickly. The Reuse function allows you to extract and load imaging settings from the existing images. You will be amazed how easy imaging becomes when the AI Sample Finder automatically detects the sample carrier, adjusts the focus, and finds your sample regions relevant for your experiment. It takes less time to illuminate your sample and leaves you more of the precious time you've booked on the system for imaging. You can use the overview image to document all steps of your experiment and combine with other multimodal data or aspects of your sample. Sometimes your scientific questions will require complex acquisition strategies. Statistical analysis might call for repetitive imaging of a large number of samples with the same or even differing imaging conditions. Experiment Designer is a powerful yet easy-to-use module that images multiple regions with all imaging modalities of your LSM 900.
It gives you access to a number of hardware and software options which will always keep your sample in focus, even during the most demanding long-term time-lapse experiments.



With the ZEN software module Experiment Designer you can set up complex imaging routines consisting of freely defined and repeatable experiment blocks with multi-position tile scans of multichannel Z-stacks.

1. *Repetitive manipulation experiments*
2. *Multiposition Z-stack acquisition with individual heights*
3. *Screening of multiple samples*
4. *Heterogeneous time lapse imaging*

You can even view and save your valuable data during acquisition sessions to assess, analyze and react immediately.

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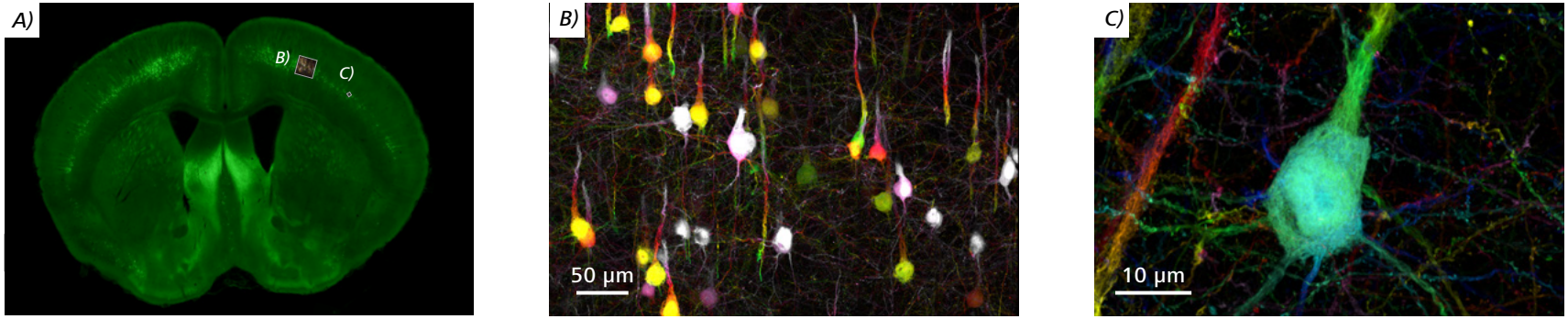
See More Details

Sometimes you need to see and assess your multi modal images during acquisition in order to plan your next steps. ZEN gives you multiple options. You can sit at your connected computer to start the new Direct Processing function for processing your Airyscan images during acquisition.

However, confocal imaging is only one part of the big picture, and you may need data from additional imaging modalities to complement the view on your sample. ZEN Connect can bring information from all your experiments together. Keep the context of your data by collecting all images of one experiment session in a single project in which you can combine overview and detailed high-resolution images, all perfectly aligned. Once you have created a project, you can always add and align content from any other imaging source, be it ZEISS, non-ZEISS or even sketches and analysis graphs. You will stay on top of things at all times – both during your experiments and months or years later. Your ZEN Connect projects keep all associated datasets together. It's never been easier to share results and collaborate with others as a team.

The powerful integrated 3Dxl Viewer, powered by ZEISS arivis, is optimized to render the large 3D and 4D image data you have acquired with your fast new LSM 900. You can create impressive renderings and movies for meetings and conferences. After all, a good picture can say more than a thousand words.



Section of a Thy1-YFP mouse brain. Thy-1 (green) is involved in the communication of cells in the nervous system. Overview image (A) acquired on ZEISS Axio Scan.Z1. Images B and C show enlarged ROIs imaged on ZEISS LSM with Airyscan (B) The neuronal network is clearly visible. The depth of the Z-stack is color-coded. (C) shows a single neuron. Sample courtesy of R. Hill, Yale University, New Haven, CT, USA

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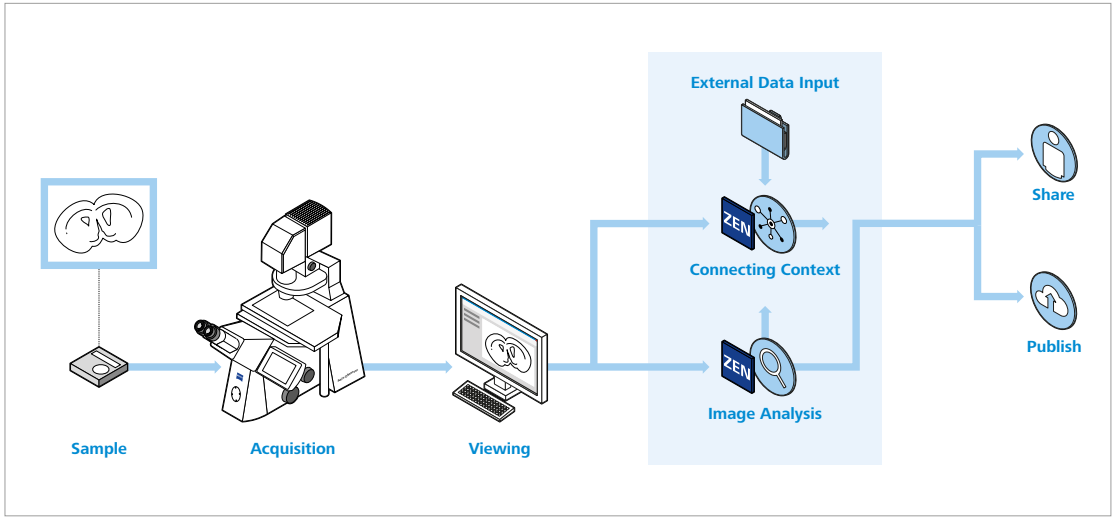
Get More Data from Your Sample

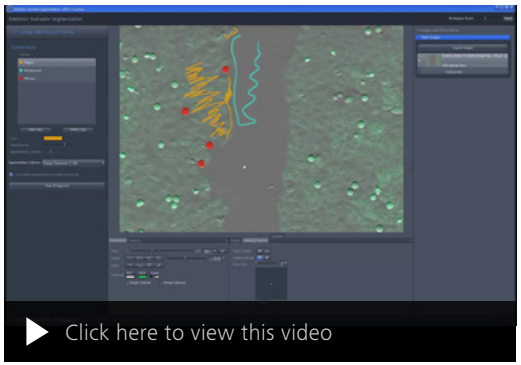
The real value of microscopy images is in the data they provide. The CZI file format of ZEN microscopy software makes sure that all important metadata of your experiments are safely stored and can be accessed openly for cross-platform data exchange. ZEN provides numerous analysis tools to extract all kinds of information from your images.

Building analysis workflows that adapt to specific applications is not an easy task. It requires knowledge of image processing and the ability to assemble a series of image operations. ZEN addresses this challenge with the Bio Apps Toolkit for efficient image analysis. Each module is optimized for one type of application, e.g., cell counting or confluency measurement, with tailored segmentation settings and streamlined data presentation. If your applications require customized workflows, the wizard-based ZEN Image Analysis module will guide you step by step to create your unique measurements.

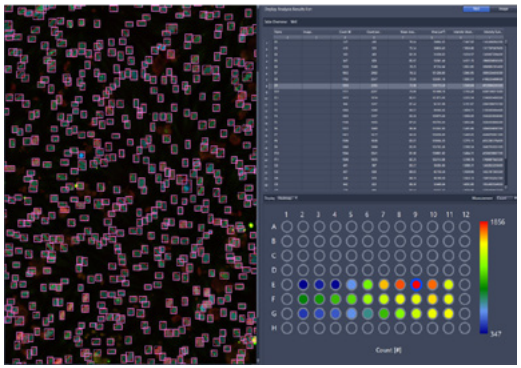
Within an image analysis workflow, segmentation and object classification are two of the most challenging steps. The AI Toolkit uses the latest machine learning algorithms to make these steps easier and more accurate, also allowing you to execute training on your own data sets. You can integrate the individual models seamlessly into your ZEN image analysis workflow.



ZEN microscopy software integrates all steps from your sample to reproducible data for publication.



AI Toolkit: Use the power of machine learning to easily segment your images.



Bio Apps Toolkit: From beautiful images to valuable data – analyze your images efficiently.

Expand Your Possibilities

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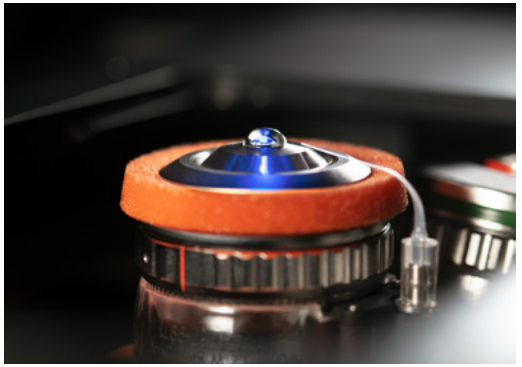
As your needs grow, LSM 900 grows with you, forming the basis for a number of enhancements. Like every system from ZEISS, LSM 900 comes with open interfaces and a modular architecture to guarantee the seamless interaction of all components, now and in the future.

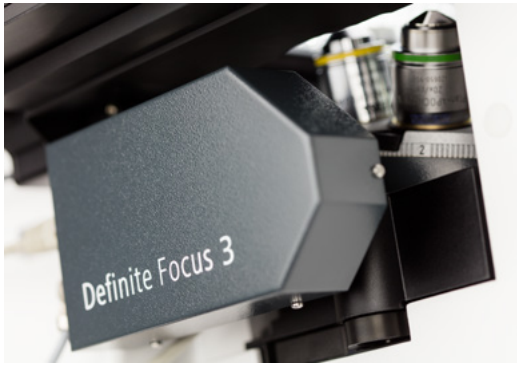
Combine your ZEISS Axio Observer 7 with integrated incubation modules to create the perfect environment for long-term live cell imaging with stable temperature conditions.

Add a choice of sensitive ZEISS Axiocams to your ZEISS LSM 900. It's very easy to acquire overview images for your multiposition experiments or to perform light efficient widefield imaging.



The Autoimmersion Module automates the application of immersion media for water immersion objectives. The immersion media is applied while maintaining objective focus and position, leaving your experiments undisturbed.

Z piezo stage and a leveling insert guarantee the precision needed for super-resolution applications using ZEISS Airyscan 2.



Definite Focus 3 stabilizes the focal position of your sample compensating Z-drift. You can now perform long-term experiments that can last for multiple days.

Enhance your microscope with ZEISS Colibri 7. This flexible and efficient LED light source allows to screen and image your delicate fluorescent samples very gently. You profit from stable illumination and extremely long lamp life.

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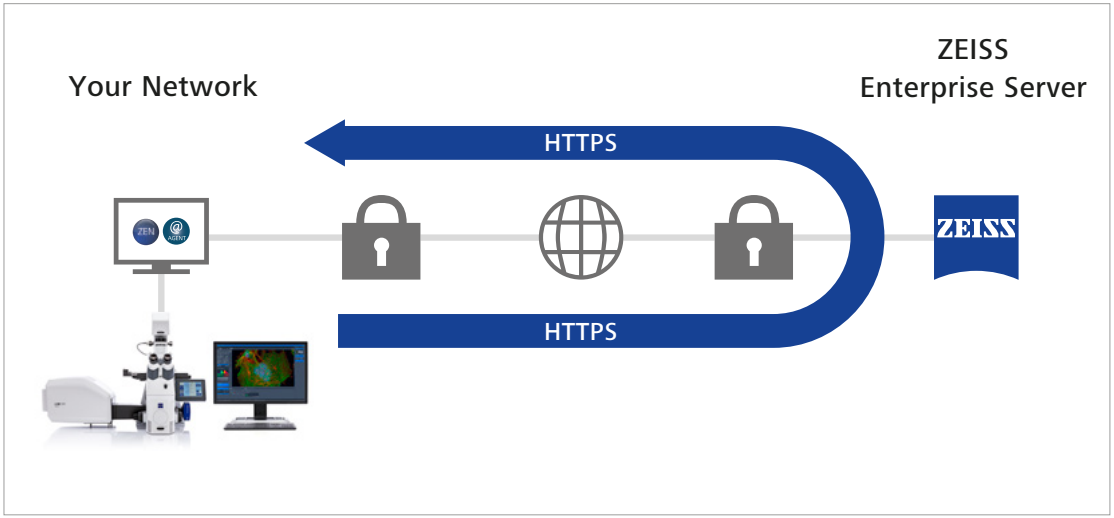
ZEISS Predictive Service
Maximizes System Uptime

Once connected to your network and activated, this advanced technology will automatically track the health status of your instrument and collect system log files in the background to improve remote diagnosis.

Relevant technical data such as operating hours, cycle counts or voltages are periodically monitored via a secure connection to our data center. The ZEISS Predictive Service application evaluates the performance of your microscope as system data can be received and analyzed.

Our support engineers will diagnose any issues by analyzing data on the Enterprise Server – remotely and without interruption to your operation.



- **Maintain highest system availability**
  Increase your uptime through close monitoring of the system's condition as remote support can often provide immediate solutions
- **Data security**
  Ensure highest data security standards using well established technologies like PTC Thingworx and Microsoft Azure Cloud. No personal or image data is uploaded, only machine data
- **Fast and competent support**
  Use secure remote desktop sharing to easily get an expert connected
- **Optimum instrument performance**
  As the status of your system is monitored, necessary actions can be planned before they become urgent

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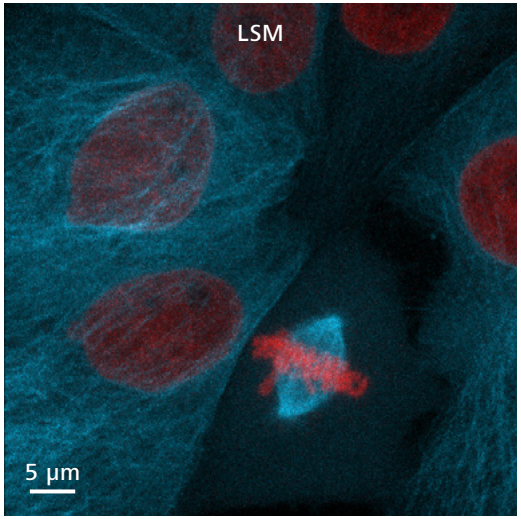
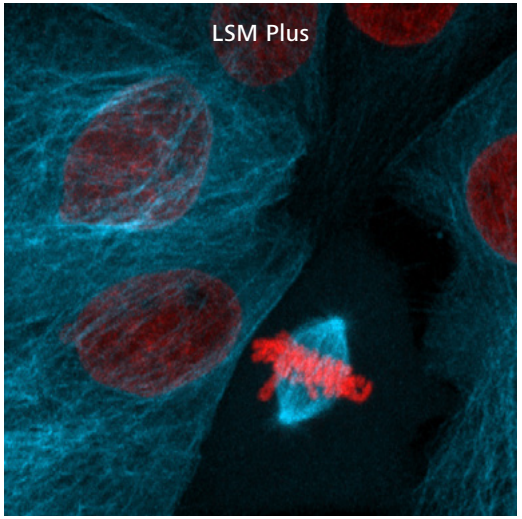
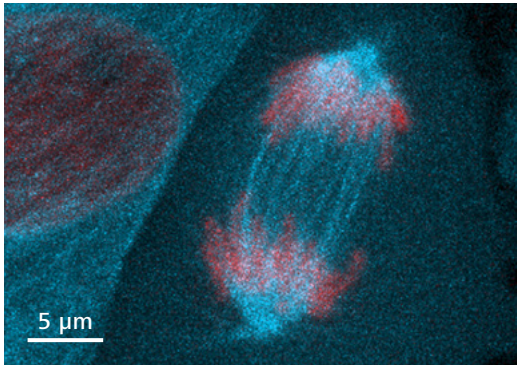
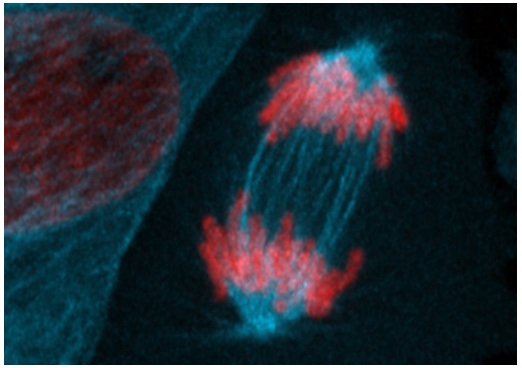
Cell Division of LLC-PK1 (Porcine Kidney)
To minimize photobleaching and damage to a live sample, it is useful to reduce acquisition time and to use minimal laser power. LSM Plus helps to improve the signal-to-noise ratio as well as the resolution of structures such as spindle fibers.

In this example, 100 Z-stacks were acquired with LSM 900 on Celldiscoverer 7 over 29 minutes. The images show a maximum intensity projection of 38 Z-planes. Cells expressing H2B-mCherry (red) and α-Tubulin-mEGFP (cyan).









Click here to view this video

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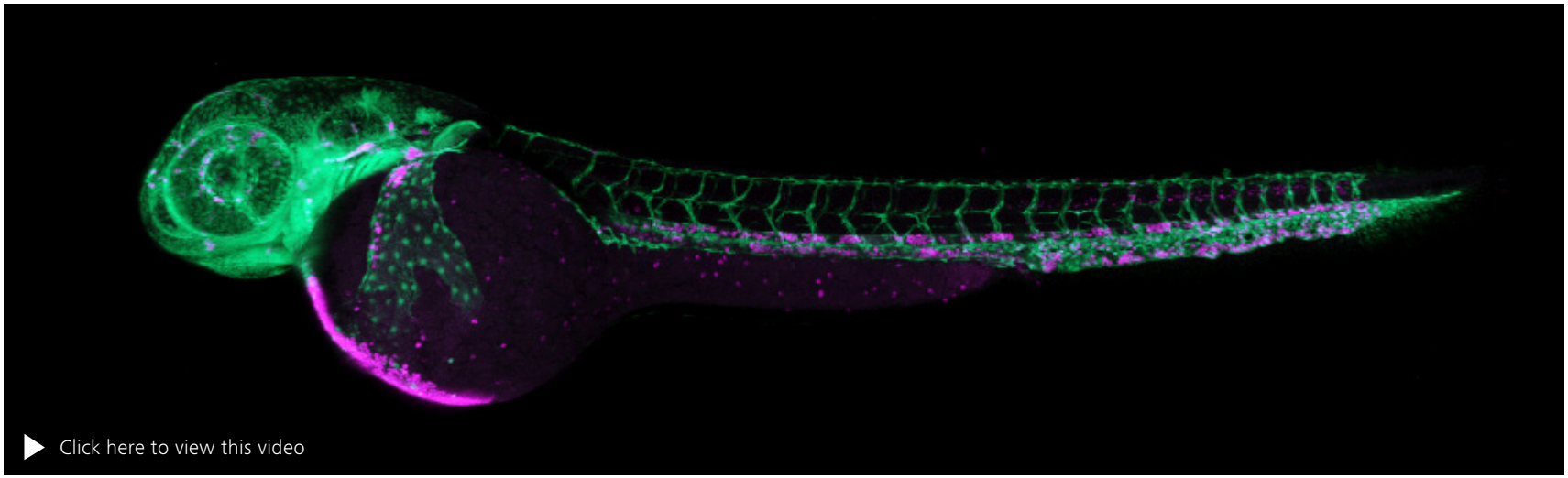
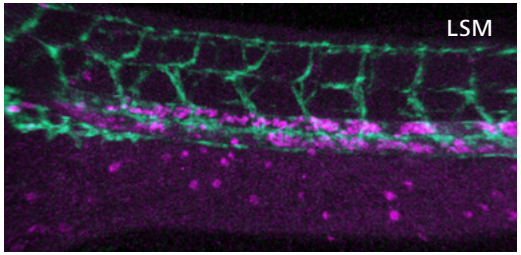
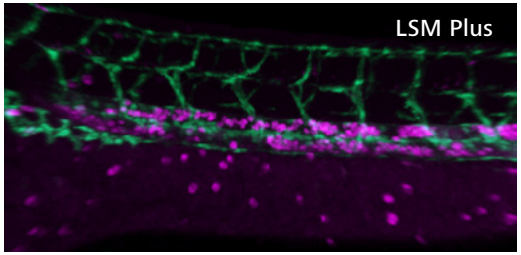


Zebrafish Embryo (2 Days)
LSM Plus helps to improve signal-to-noise ratio when imaging large volumes to be rendered in 3D. Visualization of the vasculature (green) and red blood cells (magenta) by transgenic reporter expression, lateral view, anterior to the left.
A 300 µm Z-stack with 81 planes over three tiles was imaged with LSM Plus applied. The tiles were stitched and rendered in 3D with ZEN – powered by arvis®. The zoom-in views of the 3D rendered image comparing without (left) and with (right) LSM Plus. Sample courtesy of B. Schmid, DZNE Munich, Germany





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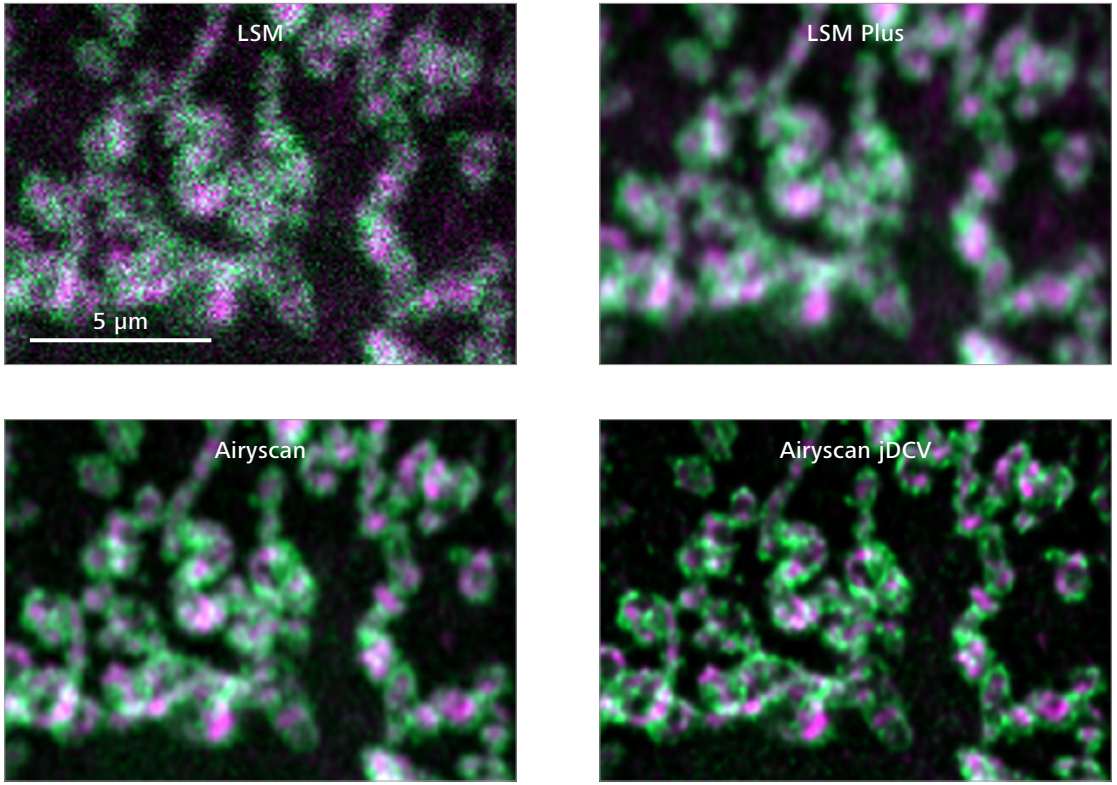
Cos7 cells stained for mitochondrial outer membrane protein Tom20 (Green, Alexa Fluor-488) and mitochondrial inner membrane protein ATP5a (Magenta, Alexa Fluor-647).

Images were acquired with LSM 900 on ZEISS Celldiscoverer 7 using confocal GaAsP detectors (top row) and Airyscan 2 in HS mode (bottom row). Confocal images with LSM Plus (top, right) enhancing SNR and improving resolution of mitochondrial structures. Airyscan Joint Deconvolution (bottom, right) resolves the inner and outer membrane architecture even better compared to Airyscan HS (bottom left).

Sample courtesy of Zhang Y, University of Science and Technology of China, China



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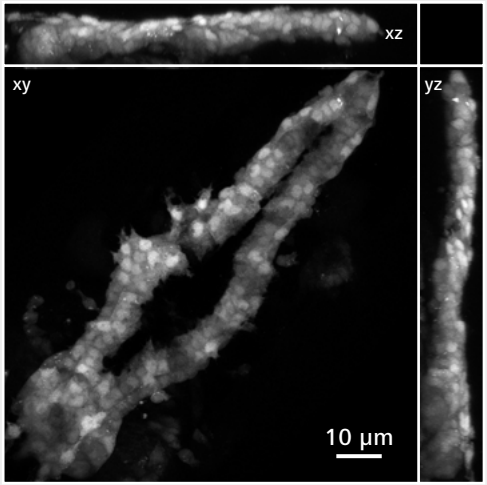
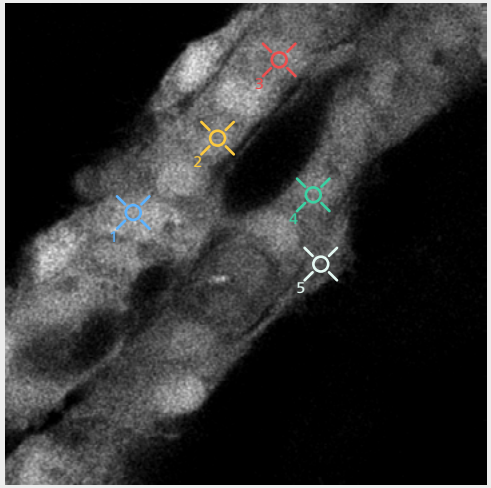
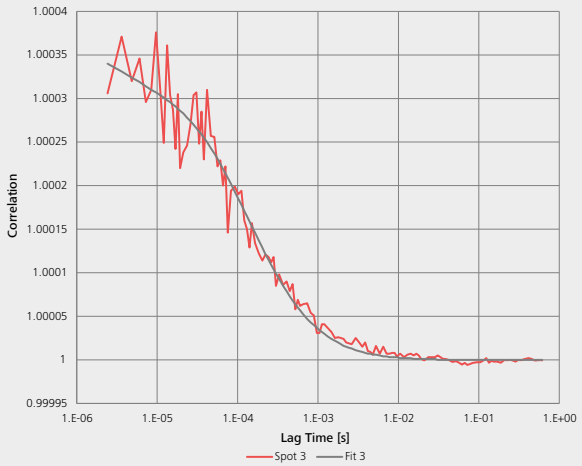
Live cell experiment



Z- stack with Airyscan 2
Ortho Maximum Intensity Projection

Dynamics and concentration measurements





ID	Count Rate [kHz]	CPM [kHz]	Concentration [nM]	Diffusion Time [µs]
Spot 1	10870.8	3.6	2979.0	128.2
Spot 2	8861.6	3.6	2446.7	132.3
Spot 3	9897.7	3.2	3056.5	137.0
Spot 4	7862.5	3.4	2338.1	116.3
Spot 5	5384.0	3.1	1740.6	215.3

Dynamics Profiler – Easily gain more information in your current imaging experiments using model organisms. Fluorescent protein dynamics and concentration measurements can effortless be added to a confocal experiment such as the analysis of the embryonic Drosophila heart. ZEISS Dynamics Profiler uniquely allows these measurements even in bright and challenging samples.
The sample shows *Drosophila melanogaster* embryo expressing mCherry under control of the hand cardiac and hematopoietic enhancer (Han and Olson, 2005), located in the third intron. The expression of the reporter mimics endogenous hand expression in the heart and is maintained throughout embryogenesis in cardioblasts as well as in pericardial cells.

Sample courtesy of Prof. Dr. Achim Paululat and Dr. Christian Meyer, Osnabrück University, Department of Zoology and Developmental Biology, Germany.

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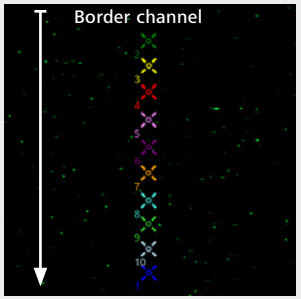
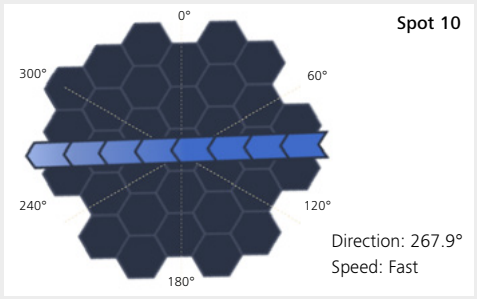
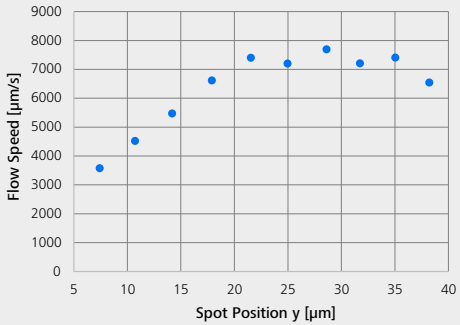
Flow





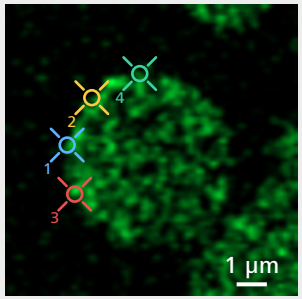
ID	Flow Direction [°]	Flow Speed [µm/s]
1	269.11	6543.78
2	266.97	3571.54
3	268.09	4518.62
4	267.85	5468.81
5	267.64	6613.50
6	267.73	7395.74
7	267.71	7200.19
8	268.03	7693.98
9	268.33	7202.56
10	267.91	7407.19

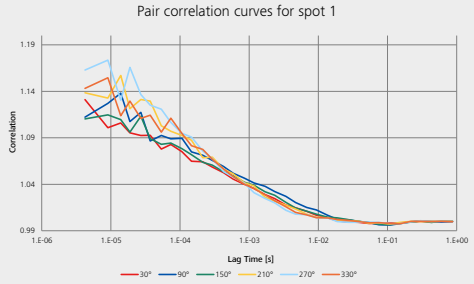


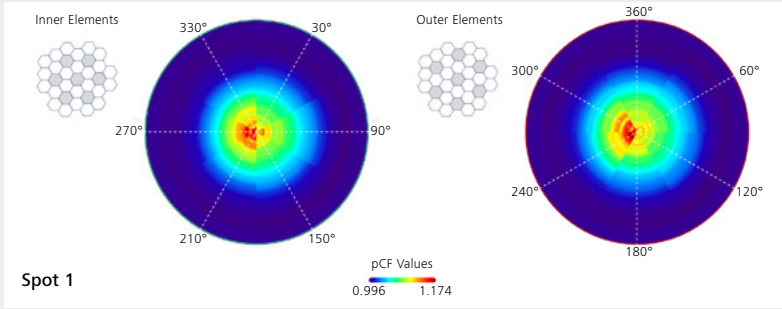
Dynamics Profiler – Flow measurements that provide unique new data related to microfluidics. Flow speed and direction of active movement in liquids can be determined for defined spots across a microfluidics channel.
Here an, in-house fabricated pressure-based microfluidic flow cell (50 mbar, 50 µm channel width) was used through which a solution flows that contains green fluorescent 100-nm beads. Laminar flow can thus be characterized.

Sample courtesy: PhD student Stijn Dilissen, under supervision of Prof. Jelle Hendrix (www.uhasselt.be/dbi, Dynamic Bioimaging Lab, Advanced Optical Microscopy Centre, Biomedical Research Institute, Hasselt University).

Asymmetric Diffusion Behavior







Dynamics Profiler – Spatial information collected with ZEISS Airyscan lets you characterize heterogenous diffusion behavior, ideal to investigate protein condensates formed via liquid-liquid phase separation, to which nanomolar concentrations of a green fluorescent dye were added. A reference image helps to orient within the sample and to position the spots that indicate the actual area analyzed.

Sample courtesy: PhD student Pedro Silva, under supervision of Prof. Jelle Hendrix (www.uhasselt.be/dbi, Dynamic Bioimaging Lab, Advanced Optical Microscopy Centre, Biomedical Research Institute, Hasselt University)

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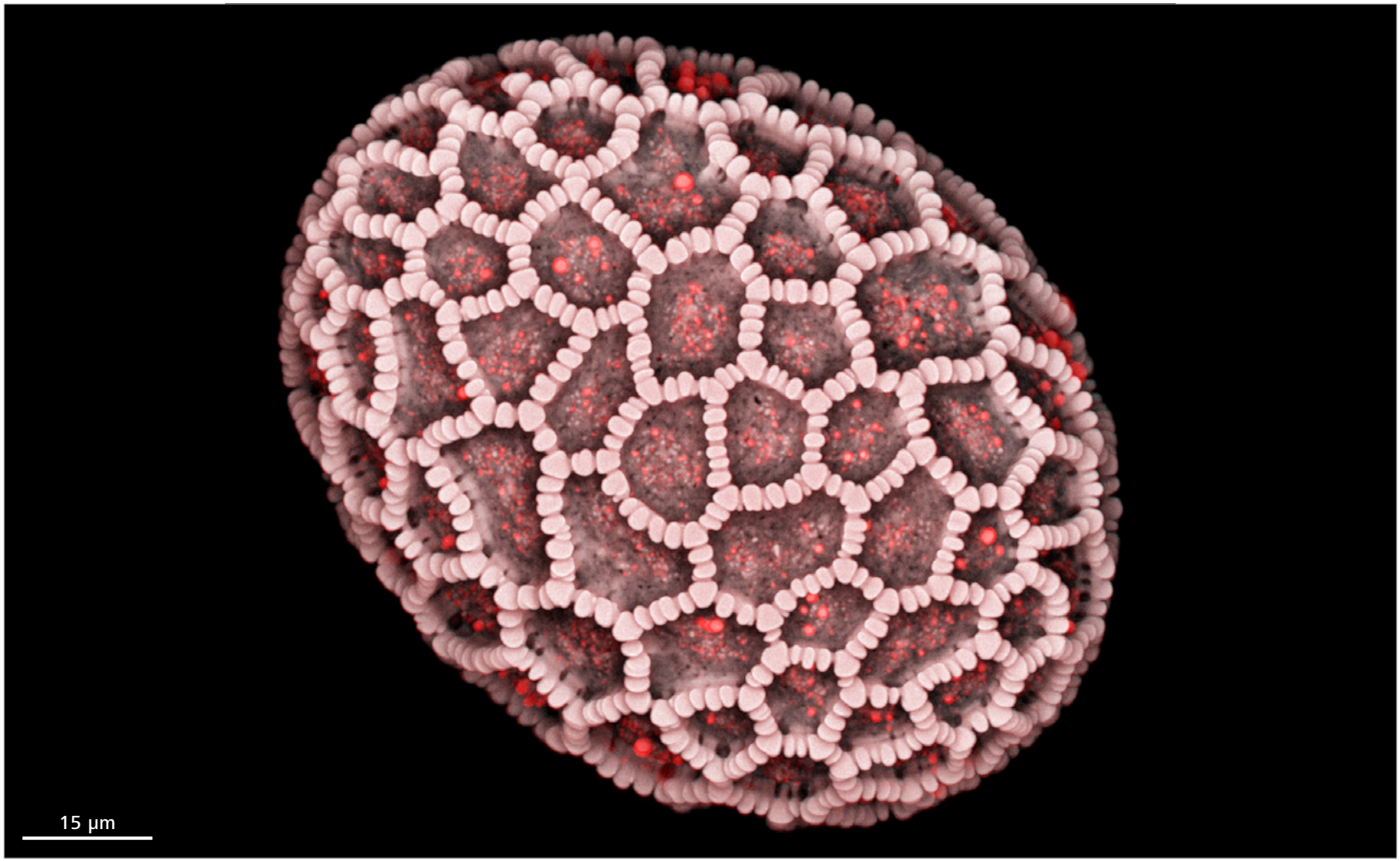

The micrograph shows a Lilium auratum *pollen grain, acquired with Airyscan 2 in Multiplex mode. Image courtesy of J. Michels, Zoological Institute, Kiel University, Germany*

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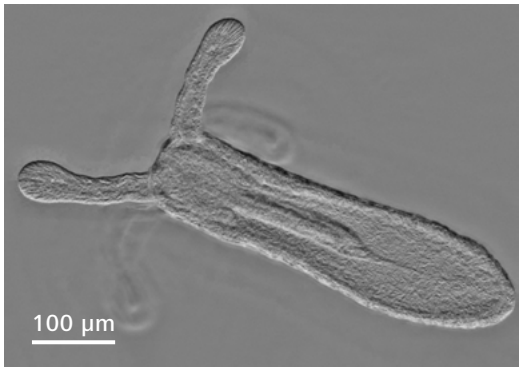
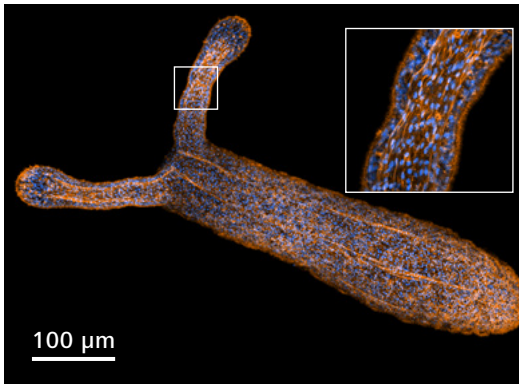
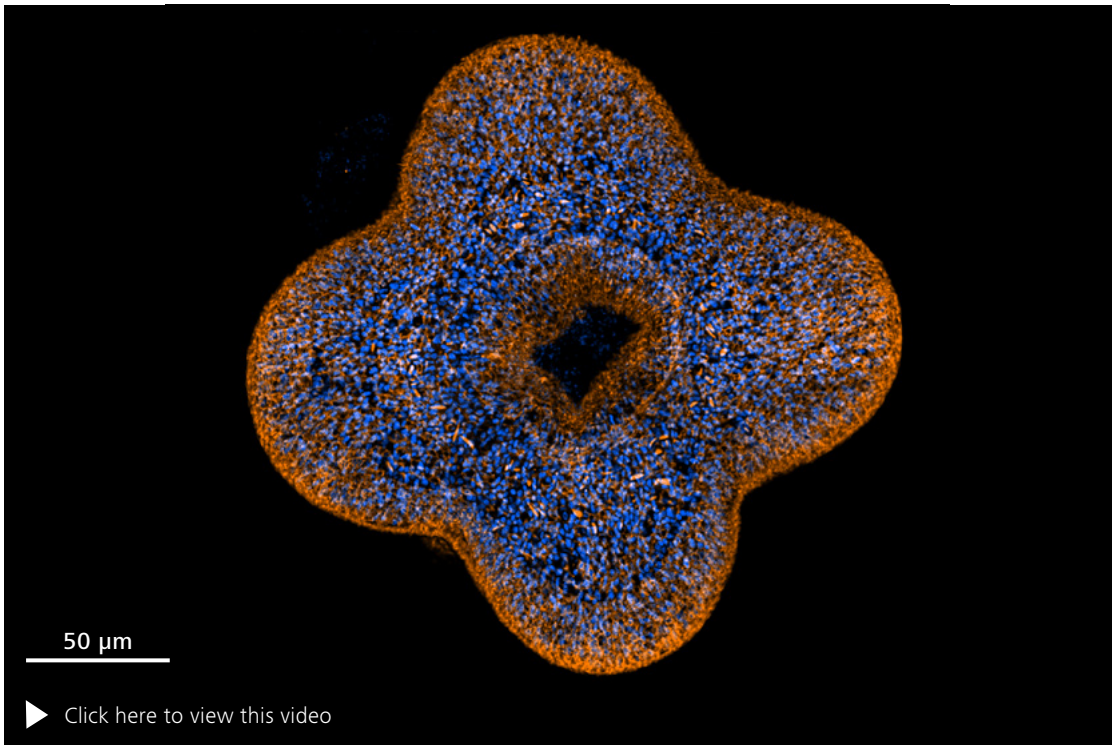




Fixed starlet sea anemone *(Nematostella vectensis)* stained with Hoechst (nuclei) and Phalloidin (actin). Side view imaged with LSM 900 on Celldiscoverer 7, seamlessly combining camera based phase gradient contrast mode (top) and high sensitivity mode with Airyscan 2 (bottom). Maximum intensity projection of 19 z-planes.



Sample courtesy of A. Stokkermans, Ikmi Group, EMBL, Heidelberg, Germany

Video: Top view of a young animal, showing mouth and four tentacle buds. Maximum intensity projection of 69 z planes imaged with Airyscan 2 Multiplex. Images were acquired using the water immersion objective with a total magnication of 25× and a numerical aperture of 1.2.

Fine image details and high signal to noise ratio can clearly be seen on the insert in the top right image, showing an enlarged view of a tentacle area.

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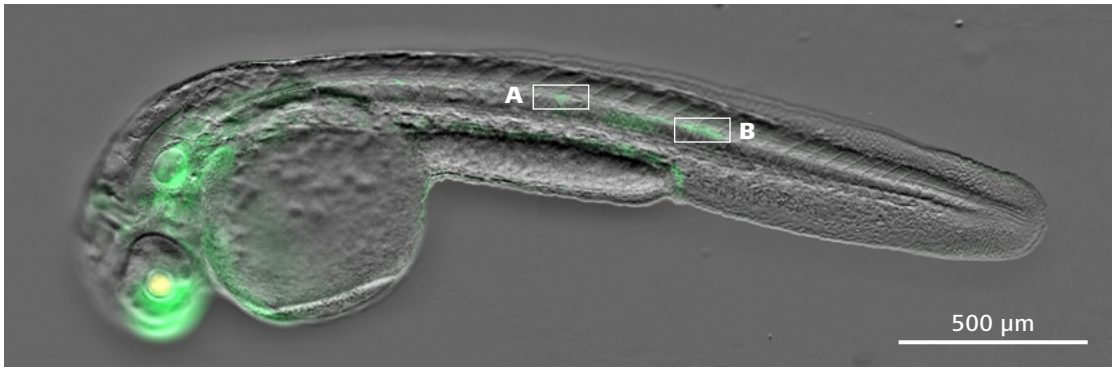

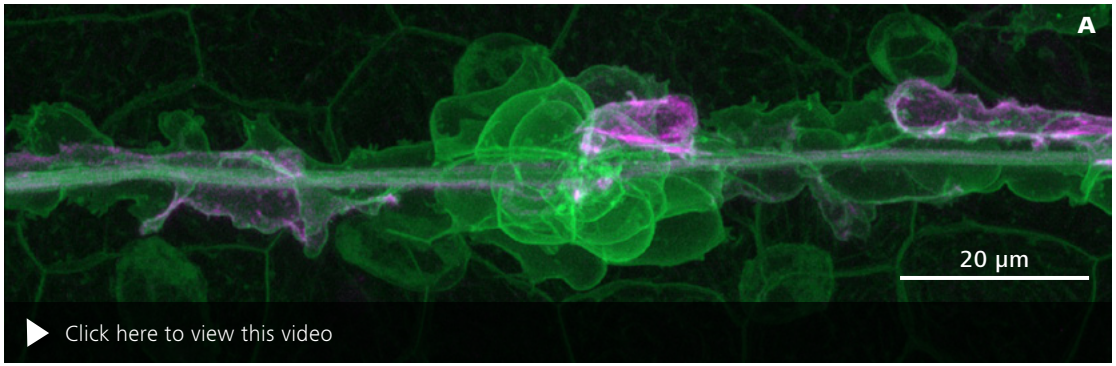

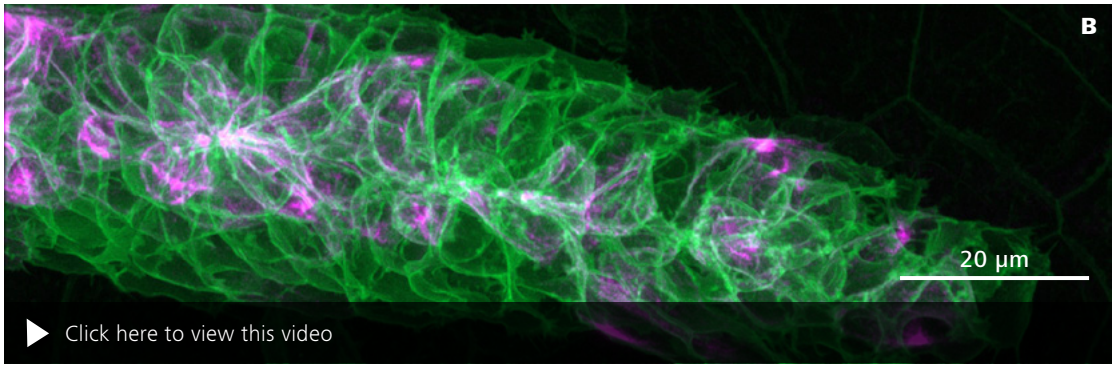

Lateral line primordium migration and deposition of immature neuromasts in a Zebrafish embryo *(Danio rerio)*. Animals were anesthetized and embedded using low concentrated agarose in a glass bottom petri dish.
Using Celldiscoverer 7 with integrated LSM 900 and Airyscan 2 allows to combine the best imaging modes seamlessly. Quick and easy sample navigation (top) is done by camera-based imaging of Phase Gradient Contrast and fluorescence. Subsequent high resolution imaging with Airyscan 2 in Multiplex mode was done on individual positions identified in the widefield image (white boxes).

A) Maximum intensity projections of an immature neuromast (127 z-planes).

B) Maximum intensity projections of the lateral line primordium tip migrating through the animal (155 z-planes).

Green: LYN-eGFP (membranes);
Red: tagRFP-T-UTRCH (actin).

The gentle and fast image acquisition that is inherent to the Airyscan 2 Multiplex mode is very beneficial for this kind of application. The animal is unperturbed by the imaging while images with a very high signal-to-noise ratio as well as level of detail can be acquired at the same time.

Sample courtesy of J. Hartmann and D. Gilmour, EMBL, Heidelberg, Germany

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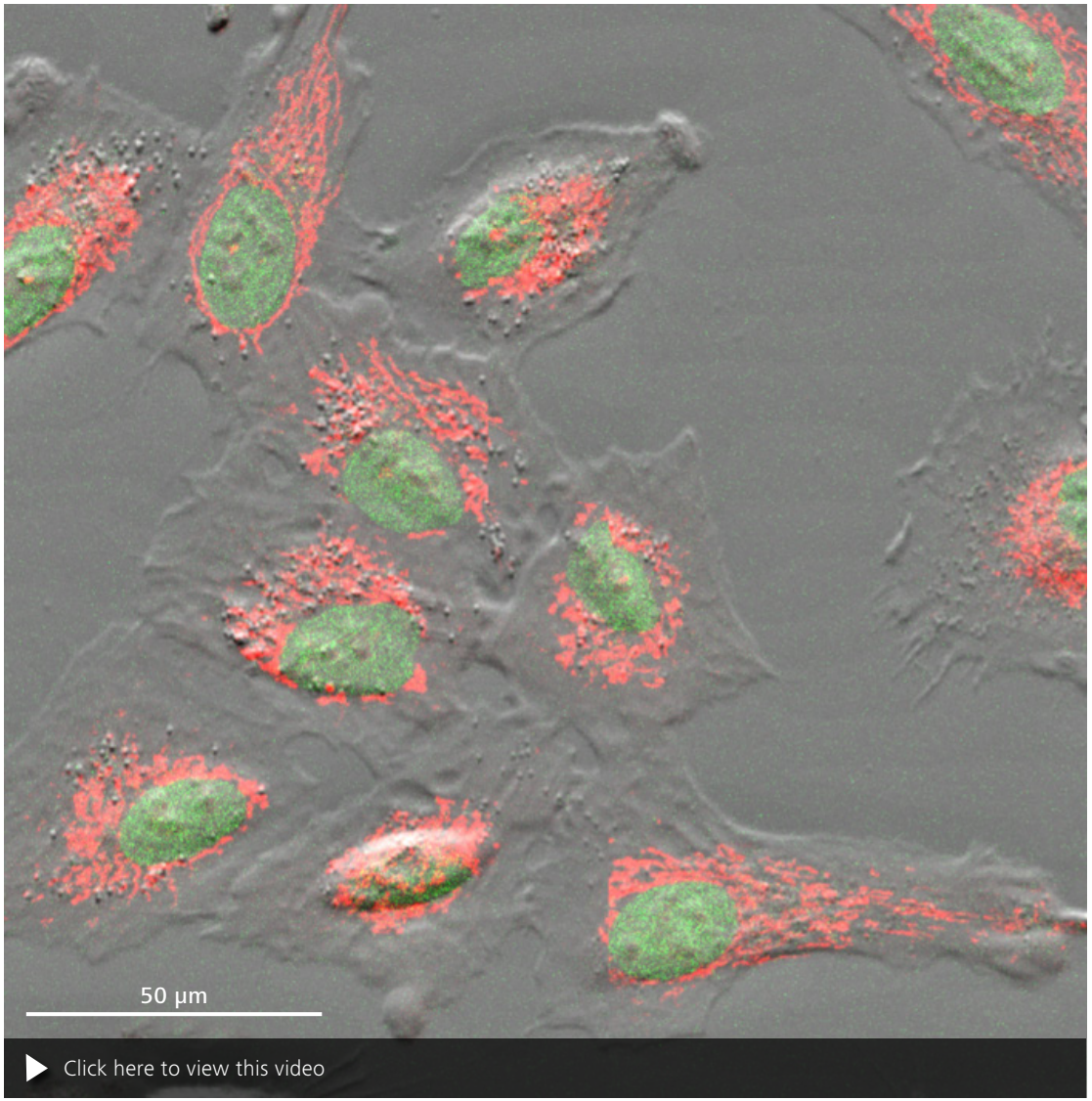
Human lung epithelial cell line A549 stained with MitoTracker® Orange (mitochondria) and SIR-DNA (nuclei).

With Celldiscoverer 7 and LSM 900 you seamlessly combine two imaging modes. Fluorescent channels were acquired in confocal mode using highly sensitive GaAsP detectors while the Phase Gradient Contrast was acquired with a camera.

A timelapse of 2.5 h was acquired using a 40× magnification with a numerical aperture of 0.95.



Sample courtesy of A.C. Hocke, Charité, Berlin, Germany.

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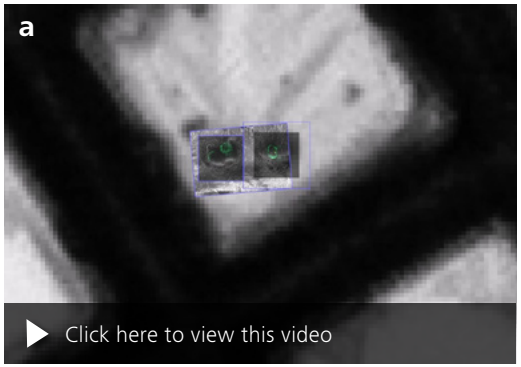
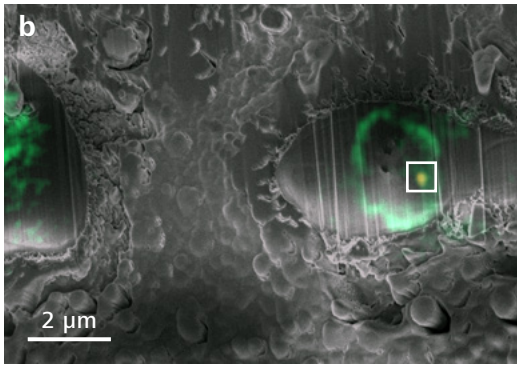
Correlative Cryo Microscopy:
Image the Near-to-native State

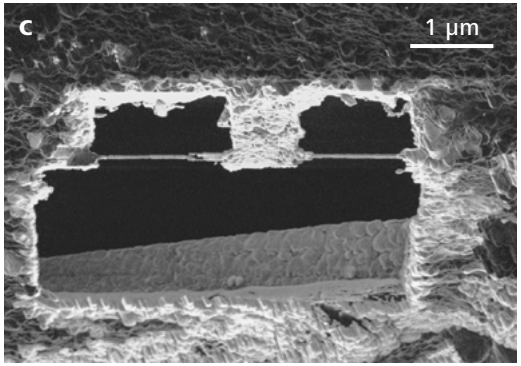
Spindle pole bodies are difficult to localize within yeast cells. They are small and rarely occurring structures. ZEISS Correlative Cryo Workflow lets you precisely identify and image such cellular structures in the near-to-native state.
The LSM with the Airyscan detector makes the identification of these structures even easier so further details can be imaged. All images – from a large overview of the entire cell to high-resolution images of these tiny structures – are organized in a ZEN Connect project, providing all data needed to re-locate these cellular structures in the FIB-SEM.

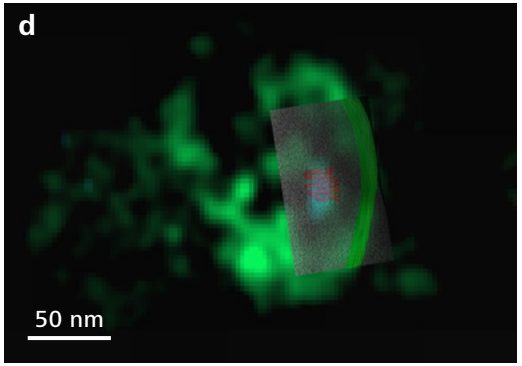
Using ZEISS Crossbeam, TEM lamella of the identified regions can be prepared for cryo electron tomography. Volume imaging is possible as well. Furthermore, the workflow solution allows you to reconnect all data after image acquisition. Images from the Crossbeam or tomograms from the TEM can be combined with the LSM data and can be rendered in three-dimensional context.

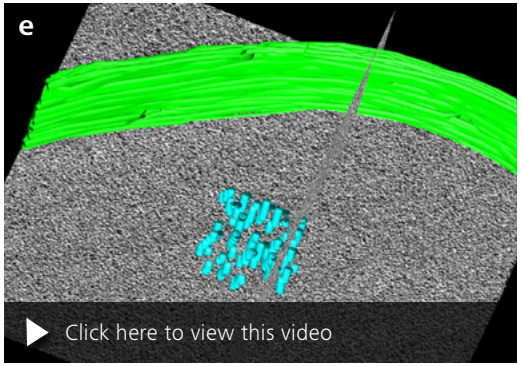
Learn more about ZEISS Correlative Cryo Workflow:
www.zeiss.com/cryo











Yeast cells labeled with NUP (nuclear pore complex)-GFP and CNM67-tdTomato. Sample and tomogram courtesy of M. Pilhofer, ETH Zürich, Switzerland

a) ZEN Connect movie shows the overlay of an LM and EM dataset – from the grid overview to the region of interest identified for further TEM tomography.
b) Early state of the milling process: Lamella is prepared around the marked region which was identified at the LSM.
c) FIB image of the prepared lamella; lamella thickness: 230 nm
d) 3D overlay of the reconstructed and segmented tomogram with LSM dataset (Spindle pole body is false-colored in cyan); nuclear membrane and microtubules were segmented using IMOD.
e) Segmented and reconstructed tomogram

Your Flexible Choice of Components

1 Microscope

- Inverted stands: Axio Observer 7, Celldiscoverer 7
- Upright stands: Axio Imager.M2, Axio Imager.Z2, Axio Examiner.Z1
- AI Sample Finder for Axio Observer
- Camera port
- Manual or motorized stages
- Incubation solutions
- Fast Z piezo inserts (for inverted stands)
- Definite Focus

2 Objectives

- C-Apochromat, C Plan-Apochromat
- Plan-Apochromat
- LD LCI Plan-Apochromat
- EC Plan-Neofluar
- W Plan-Apochromat, Clr Plan-Apochromat, Clr Plan-Neofluar

3 Illumination

- Diode lasers: 405, 488, 561 and 640 nm

4 Detection

- 2 channel GaAsP PMT, or 2 channel multialkali (MA) PMT; 1 additional GaAsP PMT, MA PMT,
- or 40× / 63× / 100× Airyscan 2 detector
- Electronically switchable illumination and detection module (ESID) or transmitted light detector (T-PMT).

5 Software

- ZEN microscopy software, highlighted modules: LSM Plus, Airyscan Joint Deconvolution, Dynamics Profiler, Tiles & Positions, Experiment Designer, Sample Navigator, FRAP, FRET, Direct Processing, 3D Toolkit

ZEISS LSM 900: System Overview

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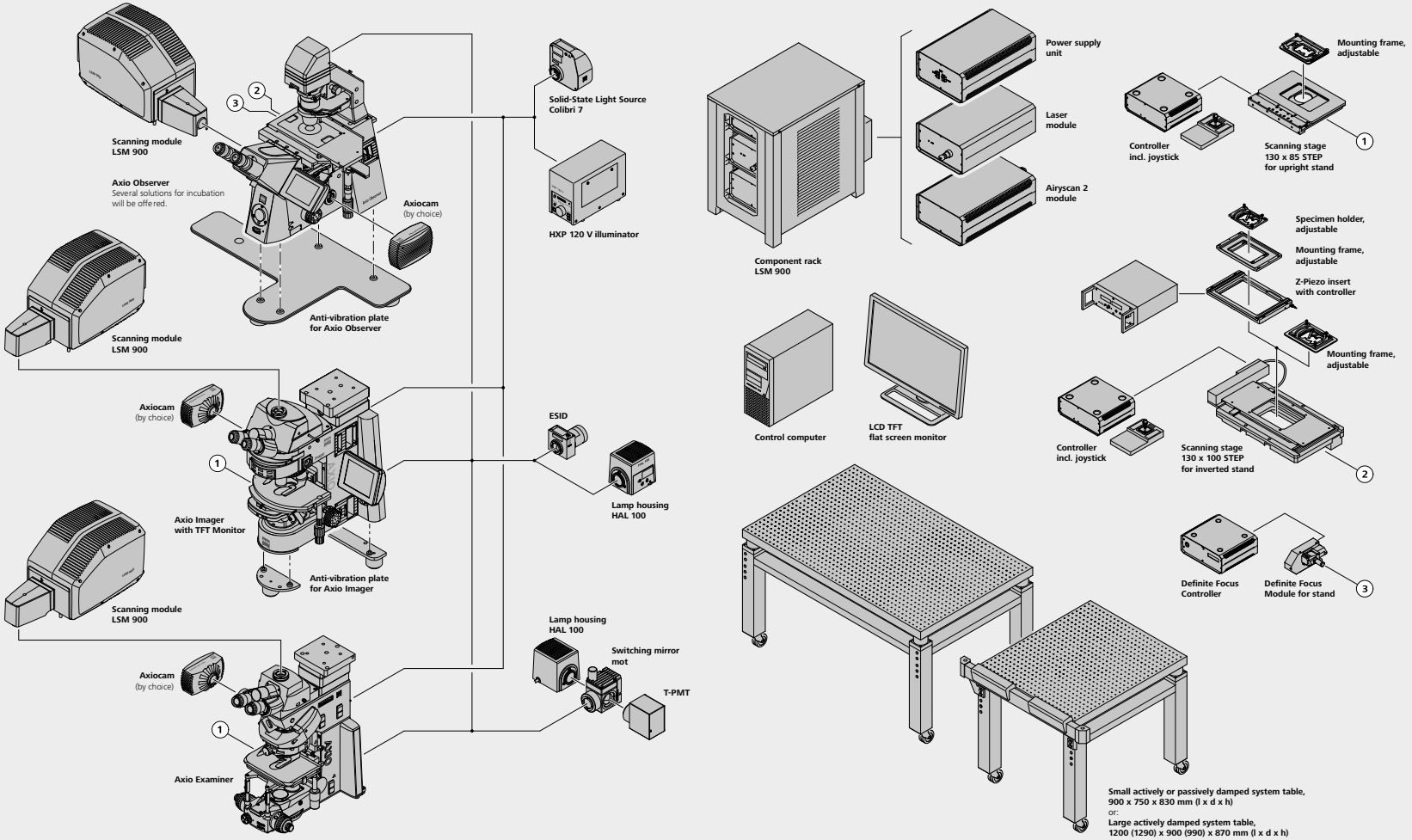

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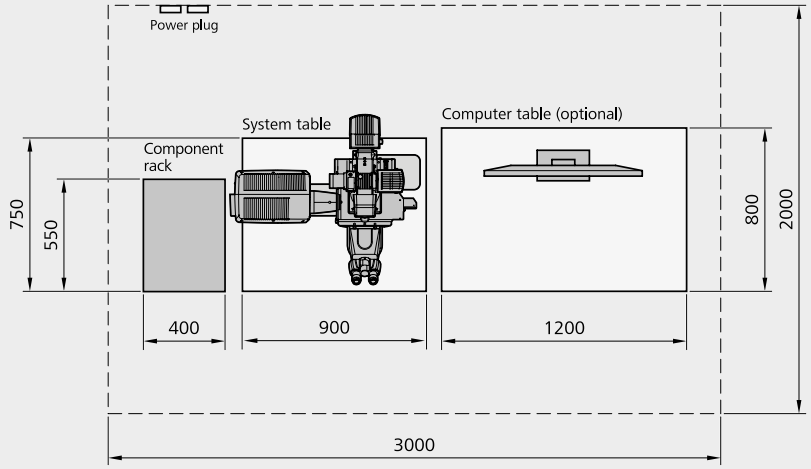
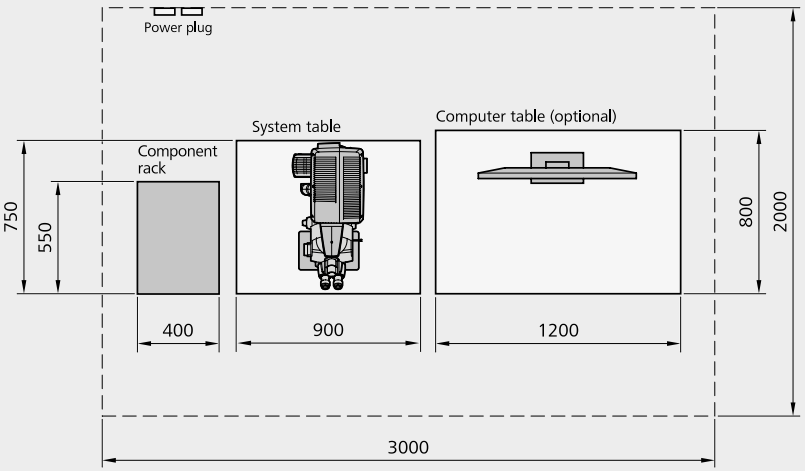
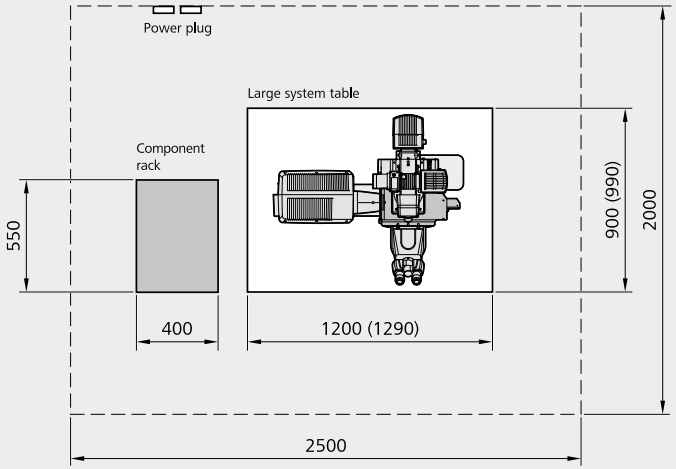
LSM 900 with Axio Observer on small system table



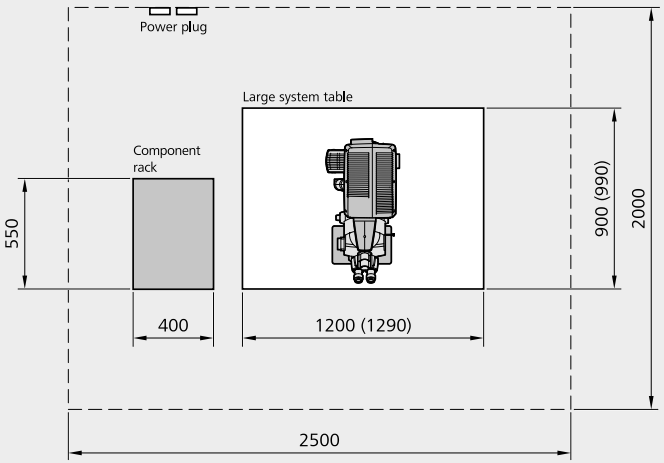
LSM 900 with Axio Imager or Axio Examiner on small system table



LSM 900 with Axio Observer on large system table



LSM 900 with Axio Imager or Axio Examiner on large system table



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Physical Dimensions	Length (cm)	Width (cm)	Height (cm)	Weight (kg)
Small actively and passively damped system table	90	75	83	130
Large actively damped system table (incl. corner pieces)	120 (129)	90 (99)	87	180
Vibraplate for Axio Imager (consists of three pedestals)	32	30	4.5	1.5
Vibraplate for Axio Observer	52.5	80	4.5	7
Scanning Module LSM 900	40	25.5	28	15
Axio Imager.Z2; Axio Imager.M2	56	39	70	20
Axio Examiner.Z1	70	39	82	24
Axio Observer 7	61	39	65	20
Component rack	55	40	60	35
Laser module (LM)	40	25	14.5	10
Airyscan 2 (40×, 63×, 100×)	40	25	14.5	5
Power supply unit (PSU)	40	25	14.5	6
Fiber optic cable, VIS	300			
Cables	300			

Microscopes	
Stands	Upright: Axio Imager.Z2, Axio Imager.M2, Axio Examiner.Z1 Inverted: Axio Observer 7 with side port , AI Sample Finder (optional); Celldiscoverer 7
Z Drive	Smallest increment Axio Imager.Z2: Axio Observer 7: 10 nm; Axio Imager.M2, Axio Examiner: 25 nm; Z-Piezo stage available; Definite Focus 3 for Axio Observer 7
XY Stage (optional)	Motorized XY scanning stage, for Mark & Find function (xy) as well as Tile Scan (Mosaic Scan); smallest increment of 0.25 µm (Axio Observer 7), 0.2 µm (Axio Imager.Z2), 0.25 µm (Axio Examiner.Z1)

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Scanning Module	
Scanner	Two independent, galvanometric scanning mirrors with ultrashort line and frame flyback
Scanning resolution	32 × 1 to 6,144 × 6,144 pixels (Airyscan 2 max. 4,096 × 4,096 pixels), also for multiple channels, continuously adjustable (for each axis)
Scanning speed	At 512 × 512 pixels: confocal – up to 8 fps; Airyscan SR – up to 4 fps; Multiplex SR-2Y – 8.4 fps; Multiplex SR-4Y – 18.9 fps At 512 × 64 pixels: confocal – up to 64 fps
Scanning zoom	0.45× to 40×; continuously adjustable
Scanning rotation	Can be rotated freely (360°), adjustable in increments of 0.1°, freely adjustable xy offset
Scanning field	20 mm diagonal in the intermediate image plane, with full pupil illumination
Pinhole	Master pinhole with preset size and position; can be adjusted as desired for multitracking and short wavelengths (such as 405 nm); automatic alignment
Beam path	One major beam splitter for four laser lines (405, 488, 561 and 640 nm) at 10 degree with excellent laser line suppression. The 640 nm laser line can be used for internal autofocusing. Depending on the system, either one or two patented Variable Secondary Dichroics (VSD) can be used to flexibly divert the respective spectral range of light to chosen channels. Emission filters can be used to clean up the signal when imaging autofluorescent or highly scattering samples.

Detection Options	
Detectors	2 spectral detection channels, GaAsP (typical QE 45 %) or multialkali (MA) PMT (typical QE 25 %); LSM Plus: resolution down to 160* nm lateral, 500 nm axial with pinhole at 0.8 AU; resolution down to 120* nm lateral, 500 nm axial with pinhole at 0.3 AU
	1 additional GaAsP PMT, MA PMT or Airyscan 2 detector
	Airyscan 2 for spatial detection (GaAsP) with 40×, or 63×, or 100× objectives; for super-resolution (down to 120* nm lateral, 350 nm axial; with jDCV 90* nm lateral, 270 nm axial) or Multiplex acquisition (down to 140 nm)
	Transmitted light detector (ESID or T-PMT); unique transmitted fluorescence Sample Navigation with T-PMT
Spectral detection	>8 sequential confocal fluorescence channels, up to three parallel confocal fluorescence channels, based on low-noise GaAsP or MA PMTs; adjustable in increments of 1 nm
Data depth	8-bit and 16-bit available
Real-time electronics	Microscope, laser, scanning module and additional accessory control; data acquisition and synchronization management through real-time electronics; oversampling read-out logic for best sensitivity; data transfer between real-time electronics and user PC via LVDS with the ability to evaluate the data online during image acquisition

* Measured with respective nanoruler samples

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ZEN Microscopy Software	
GUI configuration	Workspace to conveniently configure all of the motorized functions of the scanning module, laser and microscope; save and restore application configurations as experiment settings or use acquired images (Reuse)
Maintenance and calibration tools	Calibration objective and software tools to calibrate the system
Recording modes, Smart Setup	Z-Stack, Lambda Stack, Time Series and all combinations (xyz, lambda, t), online calculation of signal intensities, average and summation (by line/image, adjustable), Step Scan (for higher image frame rates); quick set up of imaging conditions using Smart Setup by simply selecting the labelling dye
Crop function	Easily select scanning areas (simultaneously select zoom, offset, rotation)
Real ROI Scan	Scan of designated ROIs (regions of interest) as desired and pixel-by-pixel laser blanking
ROI bleaching	Localized bleaching in bleach ROIs for applications such as uncaging; use of different speeds for bleaching and imaging, use of different laser lines for different ROIs; flexibly define your bleaching experiments during the acquisition with Interactive Bleaching
Multitracking	Rapidly change excitation lines when recording multiple fluorescences for the purpose of minimizing signal crosstalk and increasing dynamic range
Lambda scan	Sequential acquisition of image stacks with spectral information for every pixel
Linear Unmixing	Acquisition of crosstalk-free, multiple fluorescence images using simultaneous excitation; offline unmixing; advanced unmixing logic with indication of reliability
Visualization	XY, orthogonal (XY, XZ, YZ), Cut (3D section); 2.5D for time series of line scans, projections (maximum intensity); animations; depth coding (inverse colors), brightness, gamma and contrast settings; color table selection and modification (LUT), character functions
Image analysis and operations	Co-localization and histogram analysis with individual parameters, profile measurement along user-defined lines, measurement of lengths, angles, areas, intensities and much more; operations: addition, subtraction, multiplication, division, ratio, shift, filters (low-pass, median, high-pass, etc., also user-definable)
Image Management	Features for managing images and the corresponding imaging parameters
Advanced Acquisition Toolkit	Z-stack and enhanced depth of focus functionality
	Tiles & Positions: Scanning of predefined sample areas (tiles) and / or position lists
	Software Autofocus: Determination of the optimal focus position in the sample
3D Toolkit	Combined 2D and 3D visualization in one screen
	Rapid 3D and 4D reconstructions and animations
	3D segmentation to quantify 3D microscopy data based on thresholding and machine learning models

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Optional Software	
Direct Processing	Processing of large data during acquisition by streaming, including e.g., Airyscan, LSM Plus; analysis and storage on second PC
Deconvolution Toolkit	3D image restoration based on calculated point-spread functions (modes: nearest neighbor, maximum likelihood, constrained iterative)
Molecular Quantification Toolkit	Physiology (Dynamics): Comprehensive evaluation software for online and offline ratio imaging with various pre-defined formulas
	Acquisition of FRET (Förster resonance energy transfer) image data with subsequent evaluation; Acceptor Photobleaching and Sensitized Emission methods supported
	Acquisition of FRAP (fluorescence recovery after photobleaching) experiments with subsequent evaluation of intensity kinetics
Developer Toolkit	Python scripting interface for automation & customization; experiment feedback for Smart Experiments and open interface to third party software (e.g. ImageJ)
Smart Acquisition Toolkit	Experiment Designer: Definition of advanced automated imaging
	Guided Acquisition: Automated and targeted acquisition of objects of interest
Connect Toolkit	Exchange and alignment of image data from multiple image acquisition systems in 2D and 3D, enabling correlative workflows
AI Toolkit	Image analysis and structure detection via computational self learning technology
AI Sample Finder, Sample Navigator (requires additional HW)	Easy to perform sample overview scan with autofocus function using Axiocam or transmitted fluorescence with T-PMT (AI Sample Finder requires Axio Observer)
Bio Apps Toolkit	Easy-to-use and modular image analysis for common assays
Airyscan RAW data	Optional export of complete Airyscan single channel data and the Sheppard sum for external processing, e.g. correlations, deconvolution, AI etc.
Airyscan Joint Deconvolution	Postprocessing joint deconvolution for Airyscan SR data, increased resolution down to 90 nm lateral
LSM Plus	Increased resolution for confocal/spectral datasets down to 160 nm lateral (120 nm with closed pinhole = 0.3 AU), preview and Auto strength
Dynamics Profiler	Easy-to-use Airyscan-based data collection that captures the underlying dynamics of living samples to provide molecular concentration, asymmetric diffusion, and flow information (Axio Observer)

Lasers	
Laser module URGB (pigtailed; 405, 488, 561, 640 nm)	Single-mode polarization preserving fiber
	Typical total dynamic range of 10.000:1; direct modulation 500:1
	Diode laser 405 nm (15 mW nominal power of laser before fiber coupling, 5 mW ex fiber); laser class 3B
	Diode laser 488 nm (25 mW nominal power of laser before fiber coupling, 10 mW ex fiber); laser class 3B
	Diode (SHG) laser 561 nm (25 mW nominal power of laser before fiber coupling, 10 mW ex fiber); laser class 3B
	Diode laser 640 nm (15 mW nominal power of laser before fiber coupling, 5 mW ex fiber); laser class 3B
Laser module GB (pigtailed; 488, 561 nm)	Single-mode polarization preserving fiber
	Typical total dynamic range of 10.000:1; direct modulation 500:1
	Diode laser 488 nm (25 mW nominal power of the laser before fiber coupling, 10 mW ex fiber); laser class 3B
	Diode (SHG) laser 561 nm (25 mW nominal power of laser before fiber coupling, 10 mW ex fiber); laser class 3B

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Power Requirements		
LSM 900 has country specific main power supply cords.		
Line voltage	100 V AC … 125 V AC (±10 %)	220 V AC … 240 V AC (±10 %)
Line frequency	50 … 60 Hz	50 … 60 Hz
Max. current	1 phase at 9 A	1 phase at 4.5 A
Power plug	NEMA 5/15	Country specific connectors
Power consumption	900 VA (continuous operation; maximum)	900 VA (continuous operation; maximum)
	260 VA (standby operation)	280 VA (standby operation)
	0.011 VA (off mode)	0.025 VA (off mode)
Heat Emission	700 W, maximum	700 W, maximum

EMC Test
according to DIN EN 61326-1 1. Noise emission according to CISPR 11 / DIN EN 55011 2. Noise immunity according to table 2 (industrial sector)

Environmental Requirements	
For operation, the system has to be placed in a closed room.	
1. Operation, specified performance	T = 22 °C ±3 °C without interruption (24 h a day independently whether system is operated or switched off) It has to be ensured that the airflow of the air-conditioning is not directed at the system.
2. Operation, reduced performance	T = 15 °C to 35 °C, any conditions different from item 1. and 4.
3. Storage, less than 16 h	T = −20 °C to 55 °C
4. Temperature gradient	±0.5 °C/h
5. Warm-up time	1 h for standard imaging; ≥2 h for high-precision and/or long-term measurements
6. Relative humidity	<65 % at 30 °C
7. Operation altitude	max. 2,000 m
8. Loss of heat	700 W, maximum

LSM 900 meets the requirements according to IEC 60825-1:2014

ZEISS Service – Your Partner at All Times

Your microscope system from ZEISS is one of your most important tools. For over 175 years, the ZEISS brand and our experience have stood for reliable equipment with a long life in the field of microscopy. You can count on superior service and support - before and after installation. Our skilled ZEISS service team makes sure that your microscope is always ready for use.

Procurement

- Lab Planning & Construction Site Management
- Site Inspection & Environmental Analysis
- GMP-Qualification IQ/OQ
- Installation & Handover
- IT Integration Support
- Startup Training

Operation

- Predictive Service Remote Monitoring
- Inspection & Preventive Maintenance
- Software Maintenance Agreements
- Operation & Application Training
- Expert Phone & Remote Support
- Protect Service Agreements
- Metrological Calibration
- Instrument Relocation
- Consumables
- Repairs

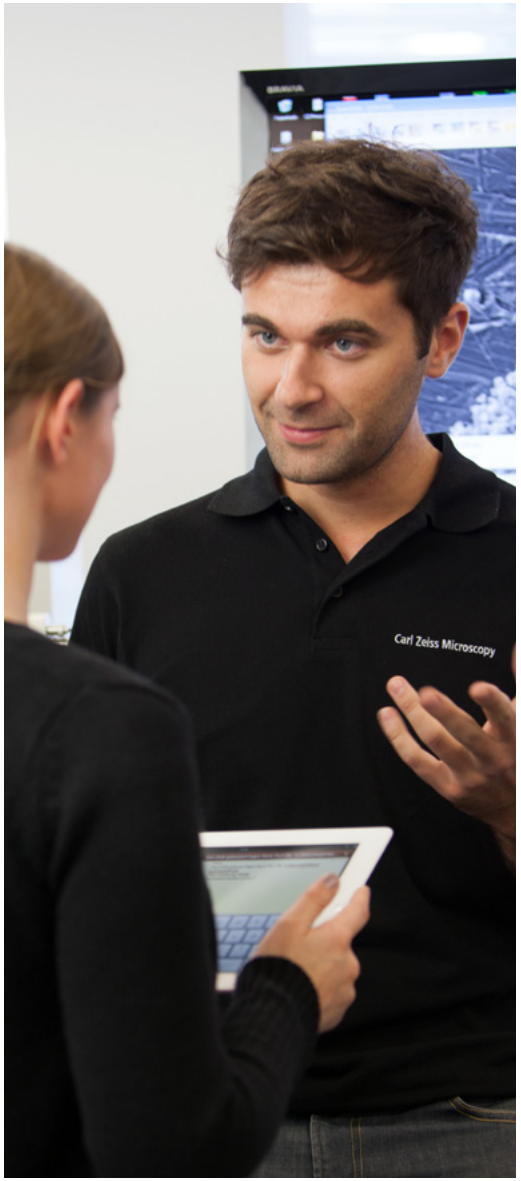
New Investment

- Decommissioning
- Trade In

Retrofit

- Customized Engineering
- Upgrades & Modernization
- Customized Workflows via arivis Cloud

Please note: Availability of services depends on product line and location



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Carl Zeiss Microscopy GmbH
07745 Jena, Germany
microscopy@zeiss.com
www.zeiss.com/lsm900