Understanding the fundamentals of life

ZEISS LSM 900 with Airyscan 2

Your Compact Confocal for Gentle Multiplex Imaging and Smart Analysis

ZEISS

Seeing beyond

# Your Compact Confocal for Fast and Gentle Multiplex Imaging

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, your compact confocal microscope, provides this with components optimized to deliver the best imaging results. And innovative LSM Plus provides 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) and the additional information only Airyscan with its 32-channel area detector can offer.
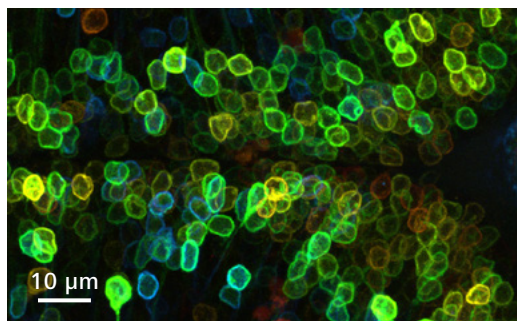

2 μm
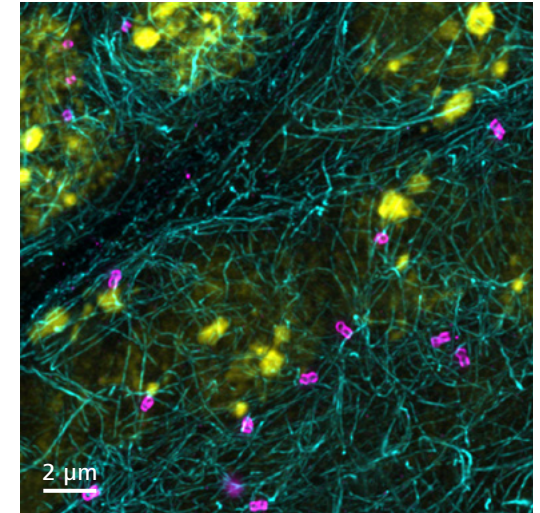
Spermatogonia in Drosophila testis. Multi-color label with asterless (magenta), acetylated tubulin (cyan), and Hoechst 33258 (yellow). Imaged with ZEISS Airyscan 2 followed by Joint Deconvolution. Courtesy of S. Song, Prof. Liou Yih-Cherng's lab, Singapore

360°

Simpler. More Intelligent. More Integrated.

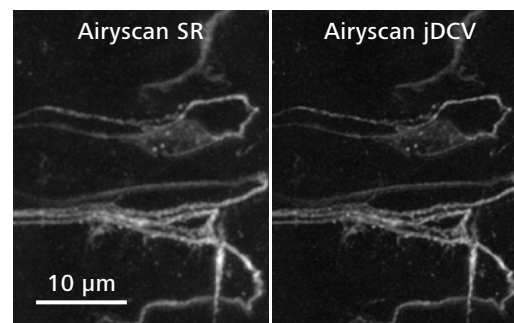### A Unique Confocal Experience in a Small Footprint

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.
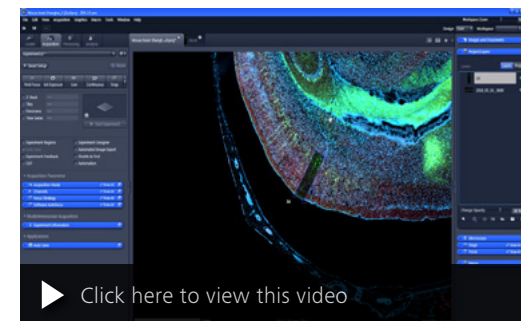
Get Better Data – Faster

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

Airyscan SR   Airyscan jDCV

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

▶ Click here to view this video

See how ZEN Connect helps to always keep your context while imaging. From acquiring an overview image, to defining ROIs, and even when changing between different imaging systems. You save time and always stay on top of things.

Your Insight into the Technology Behind It

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
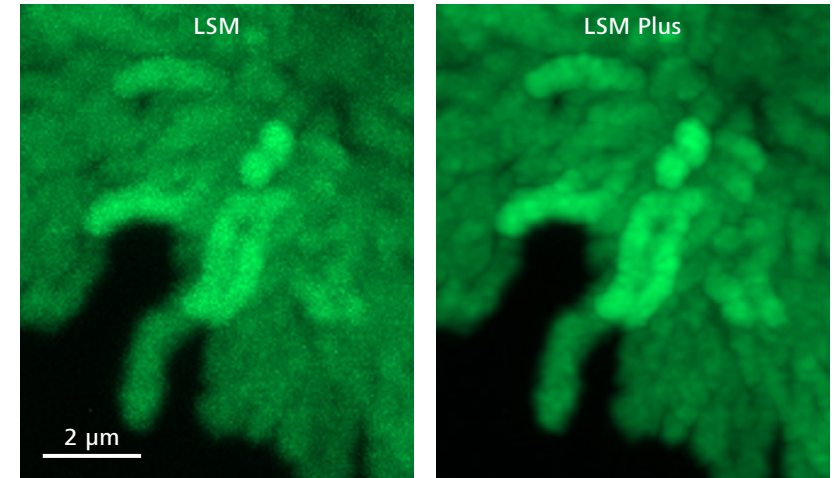
RPE1 cells transfected with H2B-GFP plasmid. Maximum intensity projection of 117 Z-planes. Comparison of without (left) and with LSM Plus (right). Courtesy of Tingsheng Liu, Mitosis Lab, Singapore
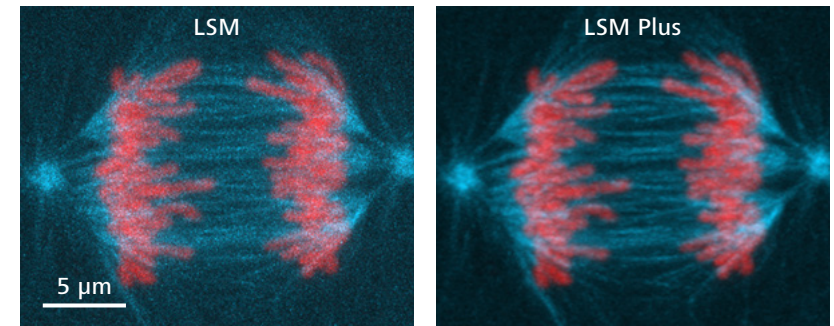
Live imaging of LLC-PK1 dividing cell (porcine kidney), expressing H2B-mCherry (red) and α-Tubulin-mEGFP (cyan). Maximum intensity projection of 37 Z-planes. Comparing without (left) and with LSM Plus (right).
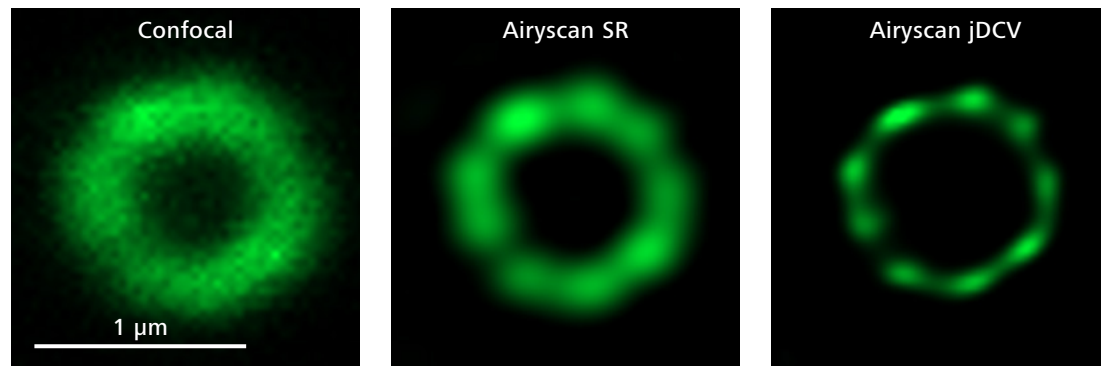
Your Insight into the Technology Behind It

The Airyscan Principle: A Unique Combination of Super-resolution Imaging and High Sensitivity
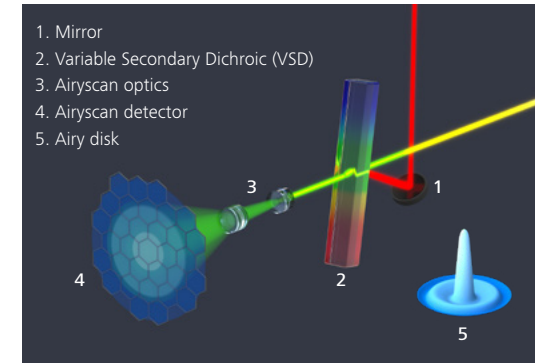
Classic confocal laser scanning microscopes use point illumination to scan the sample sequentially.
The microscope optics transform each point to an extended Airy disk. A pinhole spatially limits this Airy disk to block out-of-focus light from the detector. Closing the pinhole gives higher resolution, 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.

**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.

1. Mirror
2. Variable Secondary Dichroic (VSD)
3. Airyscan optics
4. Airyscan detector
5. Airy disk

Schematic beam path of ZEISS Airyscan.

Confocal | Airyscan SR | Airyscan jDCV

1 µm

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


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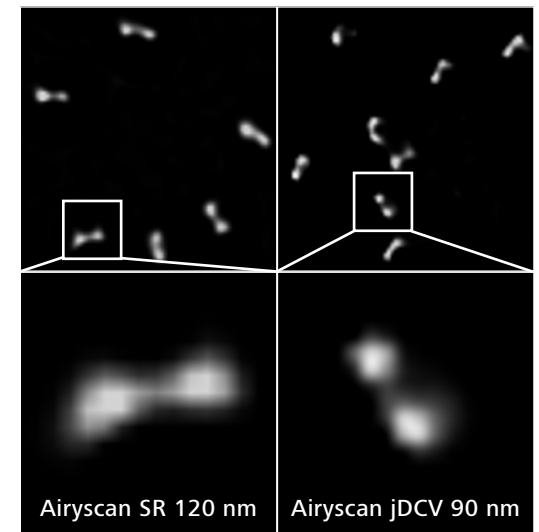
GATTA SIM nanoruler imaged with Airyscan SR (GATTA-SIM 120B, left) and Airyscan jDCV (GATTA-SIM 90B, right).

Your Insight into the Technology Behind It

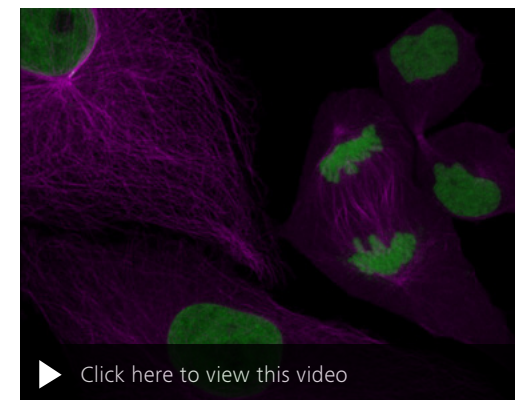**ZEISS Airyscan 2 with Multiplex**

In Multiplex modes, Airyscan detector advantages are combined with adapted illumination and readout schemes, giving you a choice of different parallelization options.
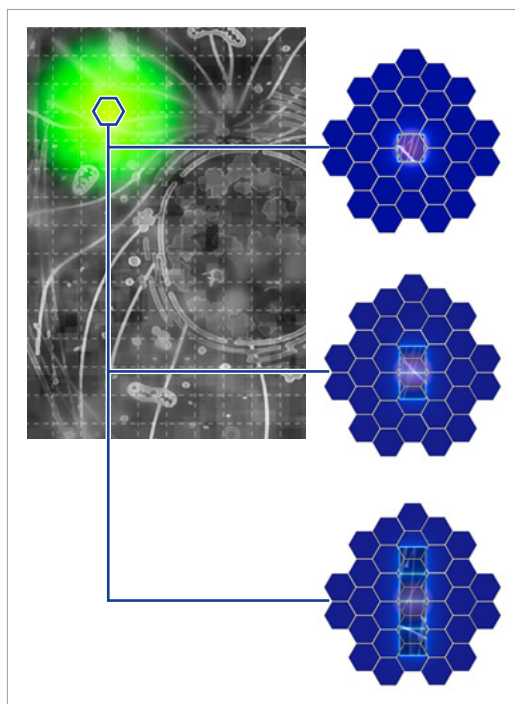
For each illumination position, Airyscan SR mode generates one superresolution image pixel. The spatial information provided by Airyscan 2 in the Multiplex modes SR-2Y / CO-2Y and SR-4Y allows to scan 2 or even 4 super-resolution image lines in a single sweep.

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.

▶ Click here to view this video

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	++	+++	++++	+++++

Your Insight into the Technology Behind It

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.

Your Insight into the Technology Behind It

**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.
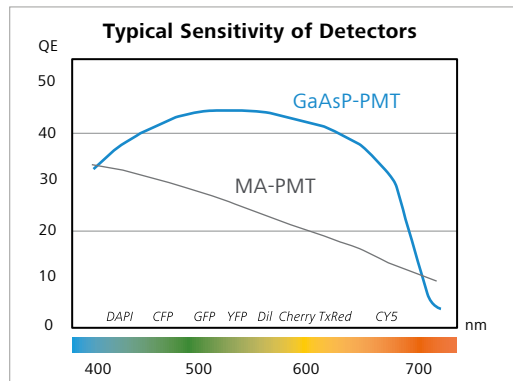
Typical spectral quantum efficiency (QE) of multi-alkali (MA-) PMT and GaAsP-PMT detectors.
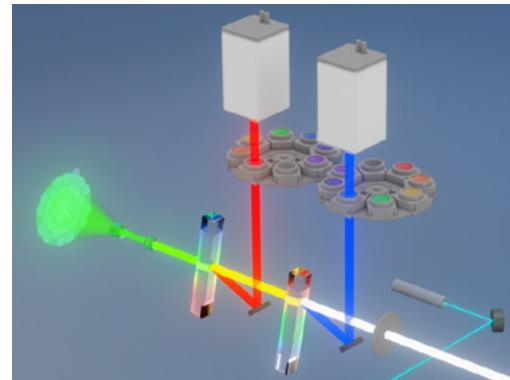
Schematic beam path of ZEISS LSM 900.
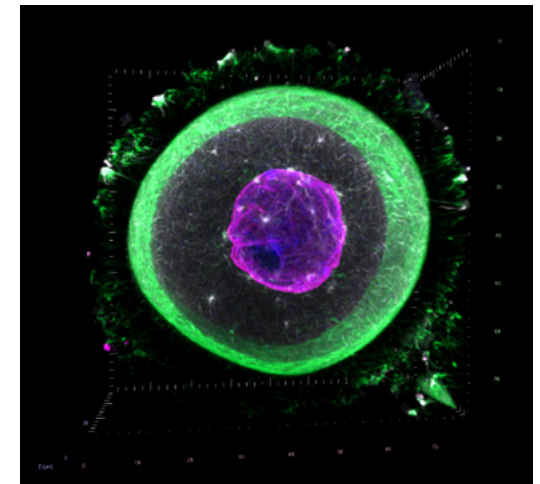
Germinal vesicle state mouse oocyte, labelled for actin (green, Pholloidin-Alexa Fluor 488), mictorubules (white), Lamin A/C (magenta) and DNA (Hoechst). Sample courtesy of K. Hara-simov, MPI for Biophysical Chemistry, Goettingen, Germany

Your Insight into the Technology Behind It

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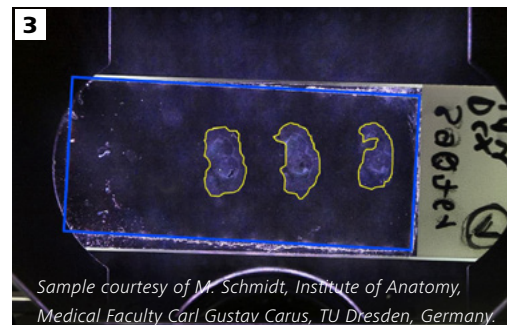
You can access all sample areas directly which allows you starting your experiment faster than ever. The AI Sample Finder greatly improves productivity as you can easily image only those regions containing sample not overlooking potentially important areas.


■ 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.

Sample courtesy of M. Schmidt, Institute of Anatomy, Medical Faculty Carl Gustav Carus, TU Dresden, Germany.

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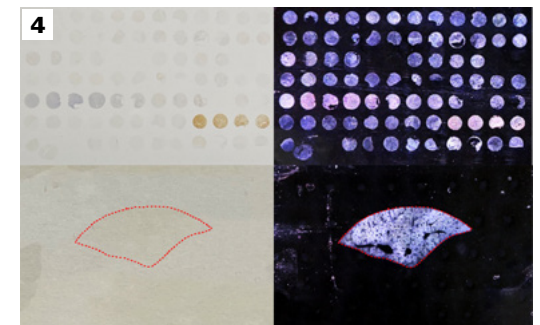
■ Your samples are reliably identified. Deep Learning algorithms precisely detect even unusual sample regions. You can navigate and access all sample areas directly which allows you starting your experiment faster than ever.
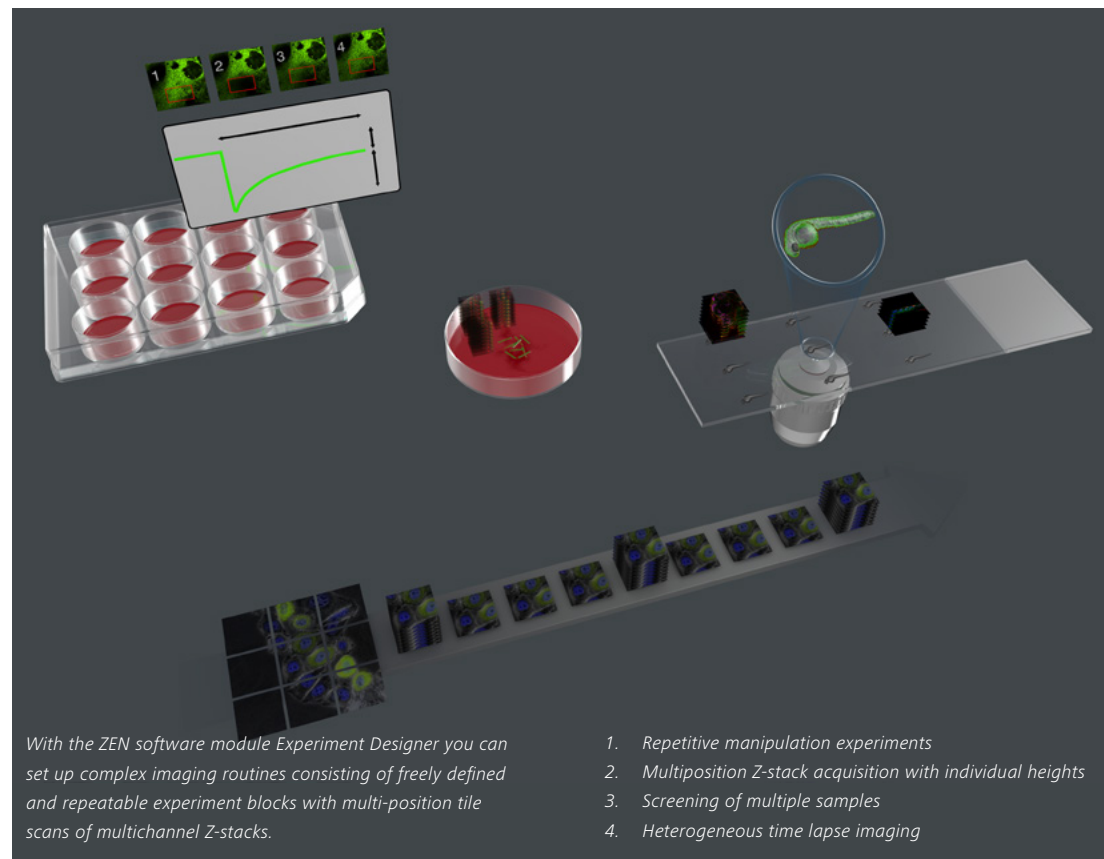
Expand Your Possibilities

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. ZEN – ZEISS Efficient Navigation - is the only user interface you will ever see on all imaging systems from ZEISS. This familiar and easy-to-learn interface will help you get reproducible results in the shortest possible time.

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. In addition, you can use the overview image to document all steps of your experiment and load it in ZEN Connect to combine with other multimodal data or aspects of your sample.

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*

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

Expand Your Possibilities

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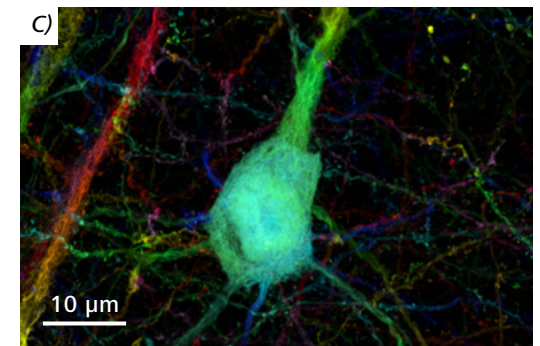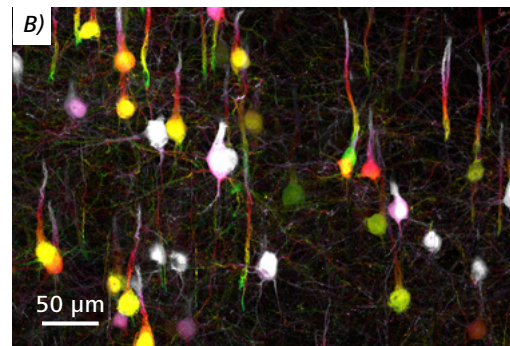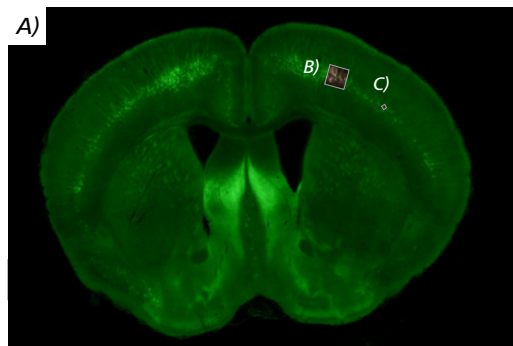
Section of a Thy1-YFP mouse brain. Thy-1 (green) is involved in the communication of cells in the nervous system. Overview image (A) acquired on ZEISS Axio Scan.Z1. Images B and C show enlarged ROIs imaged on ZEISS LSM with Airyscan (B) The neuronal network is clearly visible. The depth of the Z-stack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

Expand Your Possibilities

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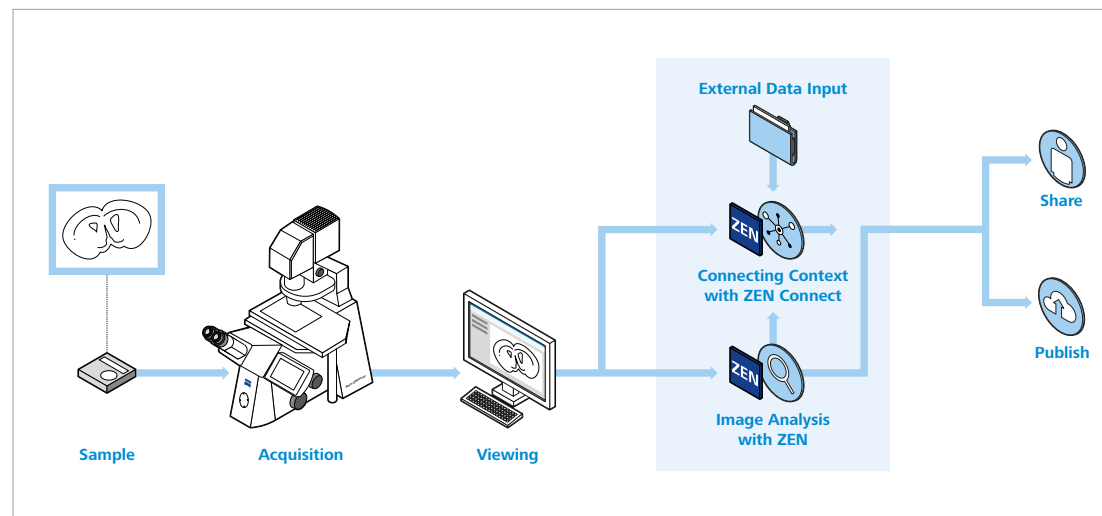
ZEN microscopy software integrates all steps from your sample to reproducible data for publication.

ZEN Intellesis: Use the power of machine learning to easily segment your images.
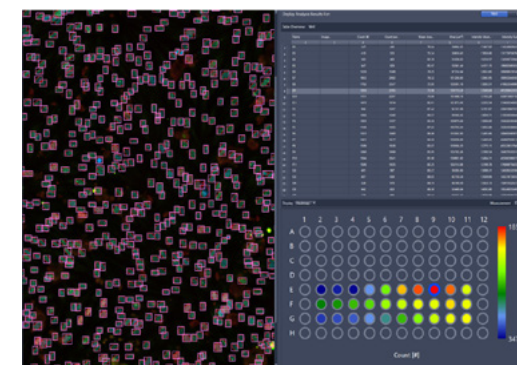
ZEN BioApps: From beautiful images to valuable data – analyze your images efficiently.

Expand Your Possibilities

**OAD is Your Interface
to ZEN Microscopy Software**

- Use Python scripts to customize and automate your workflows.
- Integrate external image analysis applications into your workflows.
- Exchange image data with external programs like ImageJ, Fiji, MATLAB, KNIME or Python.
- Use feedback for smart experiments.
- Get more reliable data in less time. It's your choice.

OAD enables the analysis of data acquired with ZEN microscopy software by other programs like ImageJ. Transfer your results back to ZEN for further analysis and display.
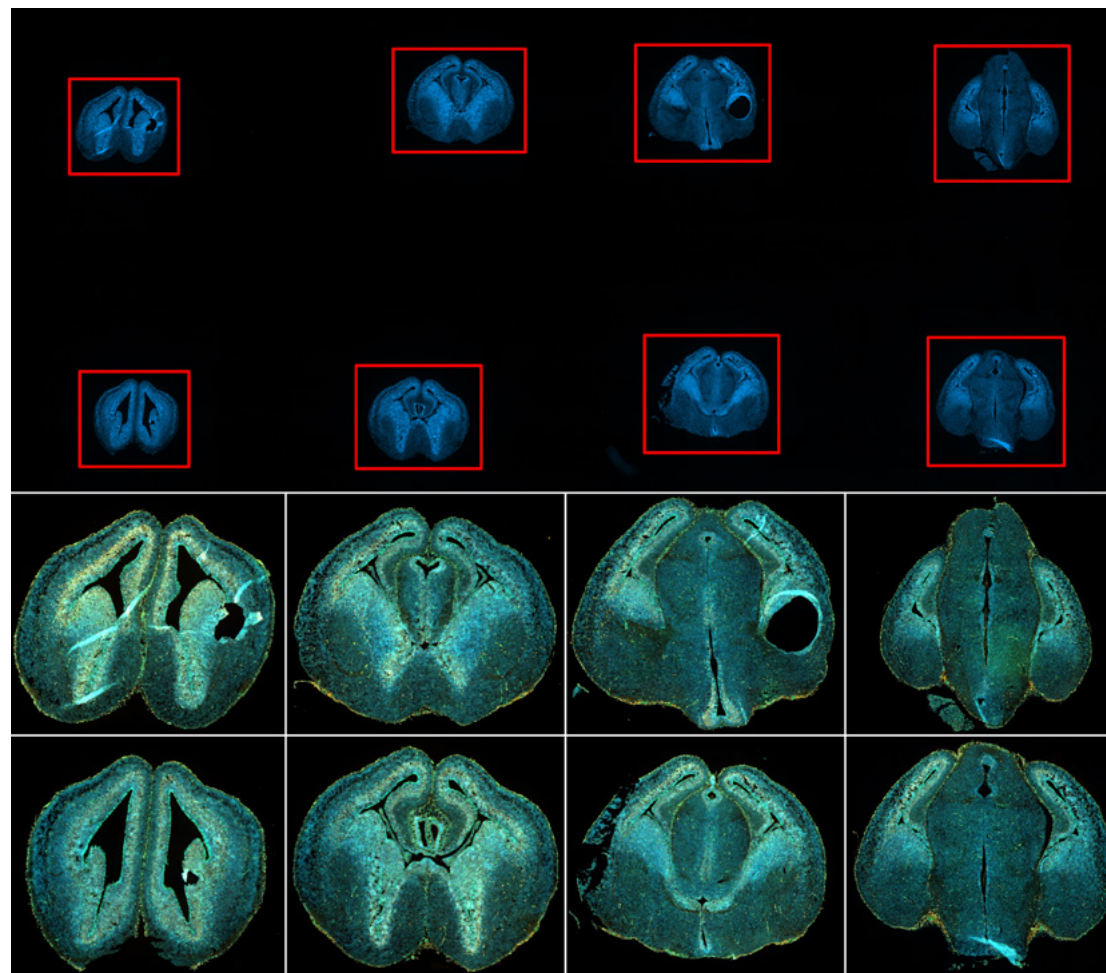
The result of overview scan using low magnification (top panel) was used to automatically detect the brain slices via image analysis. The results (XYZ position and the height / width of detected objects) were used in a automated subsequent scan using high NA objectives, where the system carried out an individual tile scan for every detected object in a complete automated fashion without any additional user interaction. Sample: courtesy of P. Grigaravicius, FLI – Leibniz Institute on Aging, Jena, Germany.

Expand Your Possibilities

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.
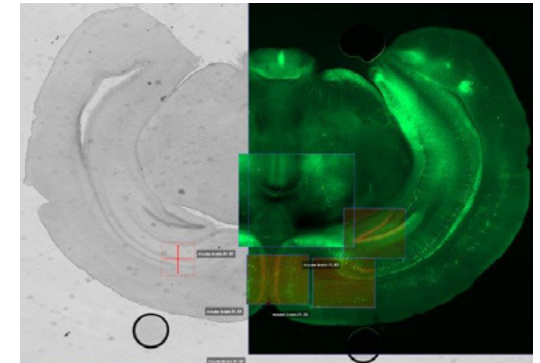
ZEN Connect 2D and 3D Add-on is your gateway to correlative light and electron microscopy (CLEM). Combine the specificity of functional fluorescence imaging with ultrastructural information.

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.

Expand Your Possibilities

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.
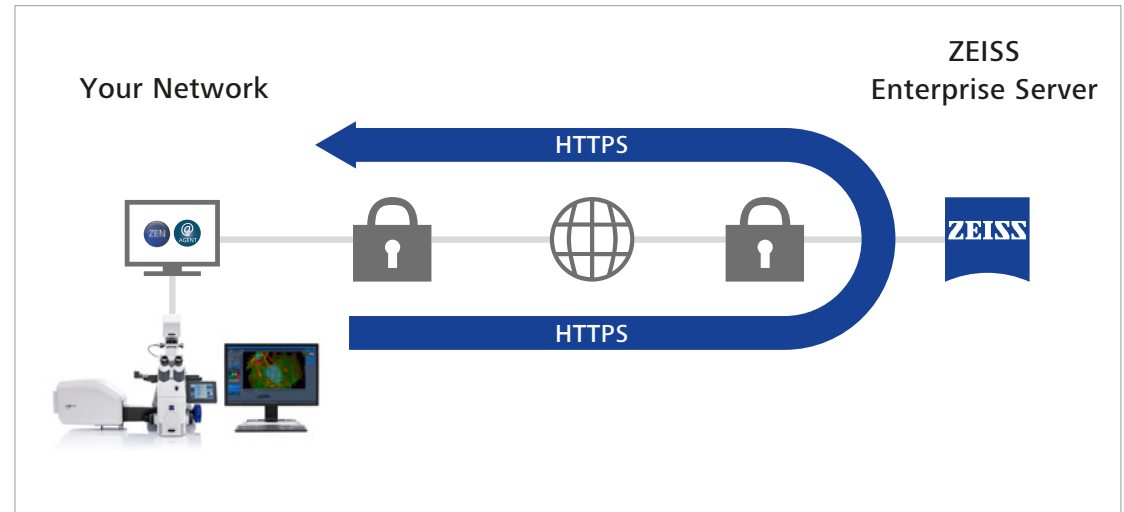
■ **Maintain highest system availability**
Increase your uptime through close monitoring of the system's condition as remote support can often provide immediate solutions

■ **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

Tailored Precisely to Your Applications

| Typical Applications, Typical Samples	Task	ZEISS LSM 900 Offers
Antibody stained tissue slices	Resolve morphological structures down to 90 nm (xy) / 270 nm (z) at 488 nm excitation while avoiding photobleaching	Airyscan 2 SR mode with Joint Deconvolution for efficient super-resolution imaging.
	Image large field of views and conduct tiling experiments for large specimen	Use low magnification lenses for a large field of view combined with LSM Plus for high image quality at fast acquisition.
		Use Multiplex modes to combine super-resolution and high-speed acquisition.
Live cell culture	Study the motility of vesicles and organelles	Up to 8 frames per second confocal time lapse imaging Or use Airyscan 2 in Multiplex mode for up to 18 frames per second.
	Screen and document cells expressing the desired fluorescent label in response to pharmacological treatment	Widefield imaging using Axiocam
Live cell culture with two labels	Study the motility of subcellular structures	Airyscan 2 with GaAsP detector and Multiplex mode for time lapse imaging in 2D or 3D at up to 9 frames per second
	Explore the interaction of two proteins exploiting the Förster Resonance Energy Transfer (FRET) effect	FRET analysis tool
Live cells with multiple labels	Conduct time laps experiments of cell culture or whole organisms using multiple labels to follow morphological changes.	Capture all your signals simultaneously and use LSM Plus to improve structural information, even at lowered laser power.
	Image over a long time in an automated way	Experiment Designer software to automatically record complex multi-color experiment. Combine different acquisition modes, e.g. spectral imaging, superresolution imaging. Combine the experiment in ZEN Connect
Live or fixed cells with multiple labels and overlapping emission signals	Examine the interplay of multiple proteins	Parallel acquisition of all signals with three spectral channels and linear unmixing, combined with LSM Plus for enhanced image quality
Cellular structures with weak labels	Image subcellular structures at physiological expression levels	Choose Airyscan 2 for super-resolution at best sensitivity, pushing structural information even further with Joint Deconvolution.
Study molecular dynamics	Photomanipulation	FRAP analysis tool, classical timed bleaching or flexible interactive bleaching strategies
Plants	Follow the changes of subcellular structures over time with high resolution	Airyscan 2 with GaAsP detector for 140 nm super-resolution imaging beyond 40 µm deep into tissue with up to 18 frames per second in SR-4Y mode (512×512 pixel)
	Follow morphological changes over time while avoiding phototoxic effects on the living plant sample.	Capture your signals simultaneously on up to 3 GaAsP detectors and use LSM Plus to improve structural information even at lowered laser power.
	Increase spatial resolution down to 90 nm.	Use Airyscan 2 with Joint Deconvolution for light-efficient super-resolution imaging.
Model organisms, e.g. Zebrafish, *Drosophila* or *C. elegans, Arabidopsis*	See fine details of the organization and dynamics of endogenously expressed fluorescent proteins	Airyscan 2 with GaAsP detector for super-resolution imaging beyond 40 µm deep into tissue with a 40×/1.0, or a 20×/1.0 water dipping objective available for confocal imaging with LSM 900 on Axio Examiner.Z1
	Image large fields of view at high volume rates to capture developmental processes	Flexibly adjust the required resolution. Ensure reduced laser exposure for all your labels and high image quality with LSM Plus.
Cleared samples	Image whole organs or entire organisms	Specialized objectives with long working distance and optimized for specific refractive indices are available for LSM 900 on Axio Examiner.Z1

ZEISS LSM 900 at Work

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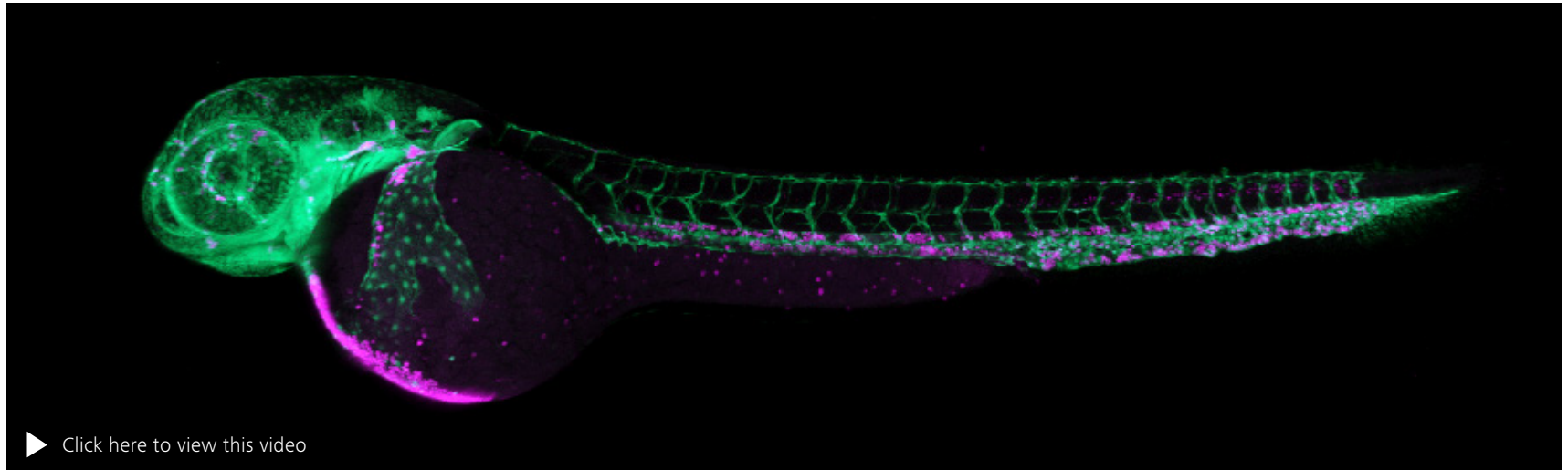
In this example, 100 Z-stacks were acquired with LSM 900 on Celldiscoverer 7 over 29 minutes. The images show a maximum intensity projection of 38 Z-planes. Cells expressing H2B-mCherry (red) and α-Tubulin-mEGFP (cyan).
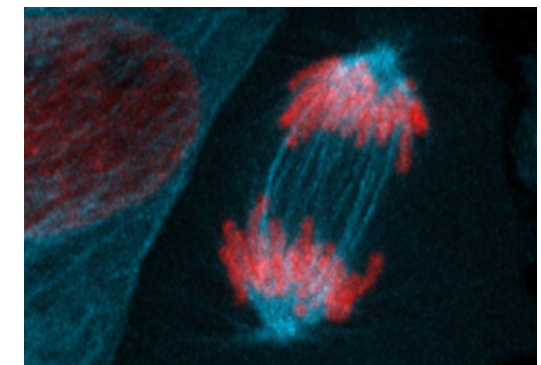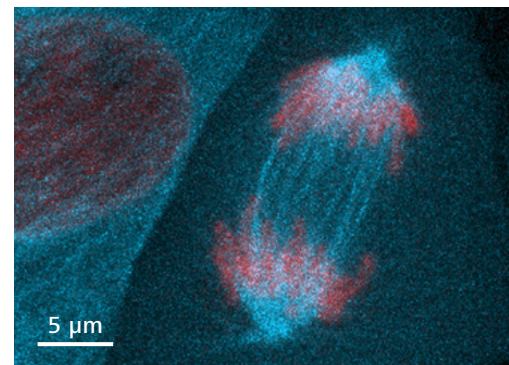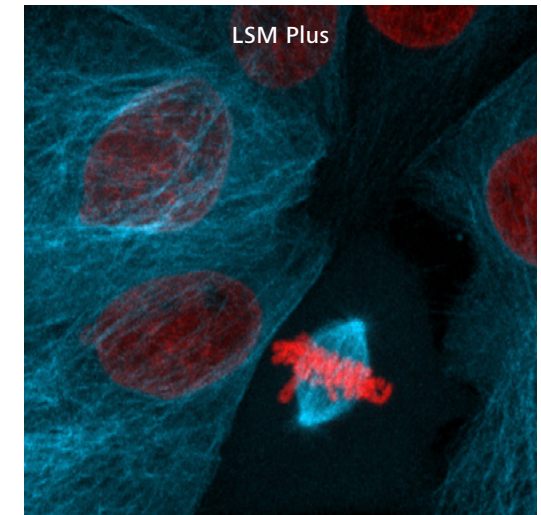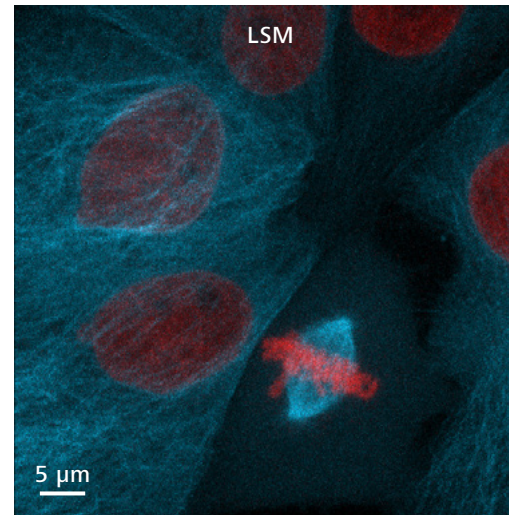

▶ Click here to view this video

ZEISS LSM 900 at Work

▶ Click here to view this video

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
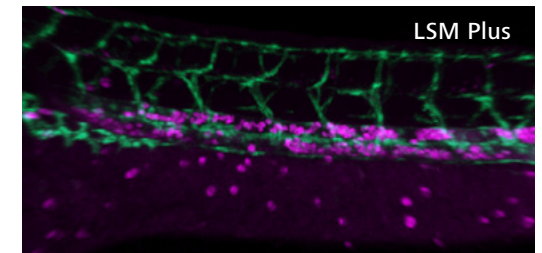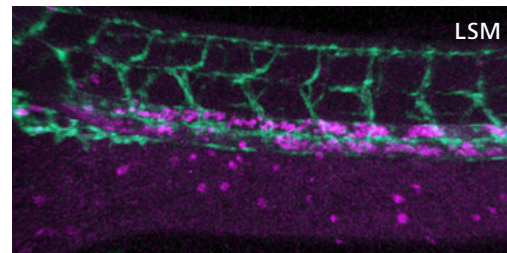
ZEISS LSM 900 at Work

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
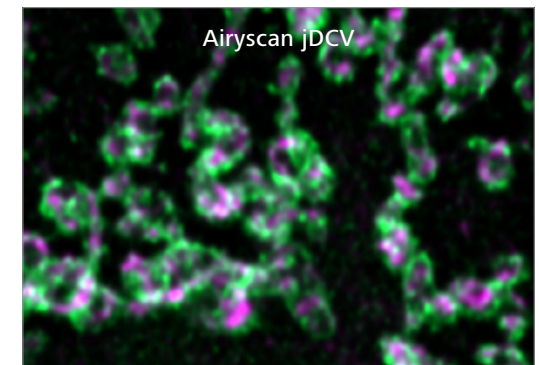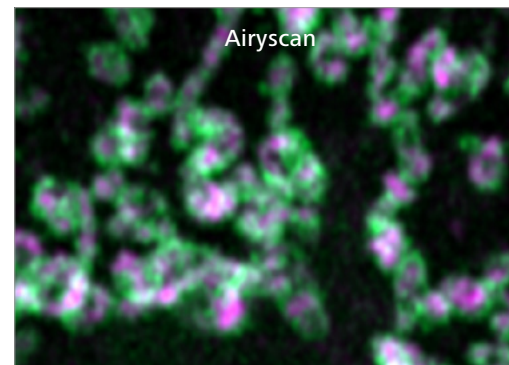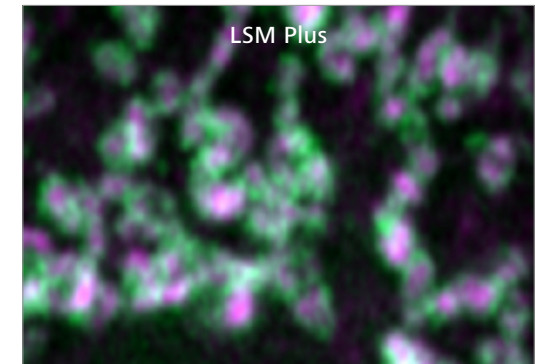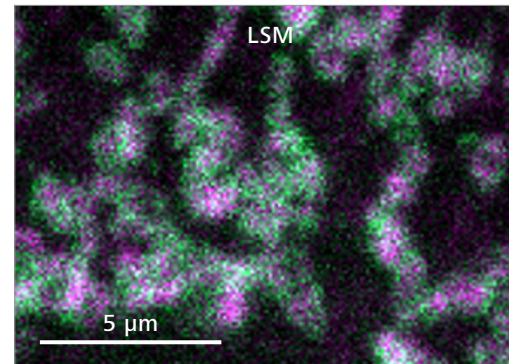
ZEISS LSM 900 at Work

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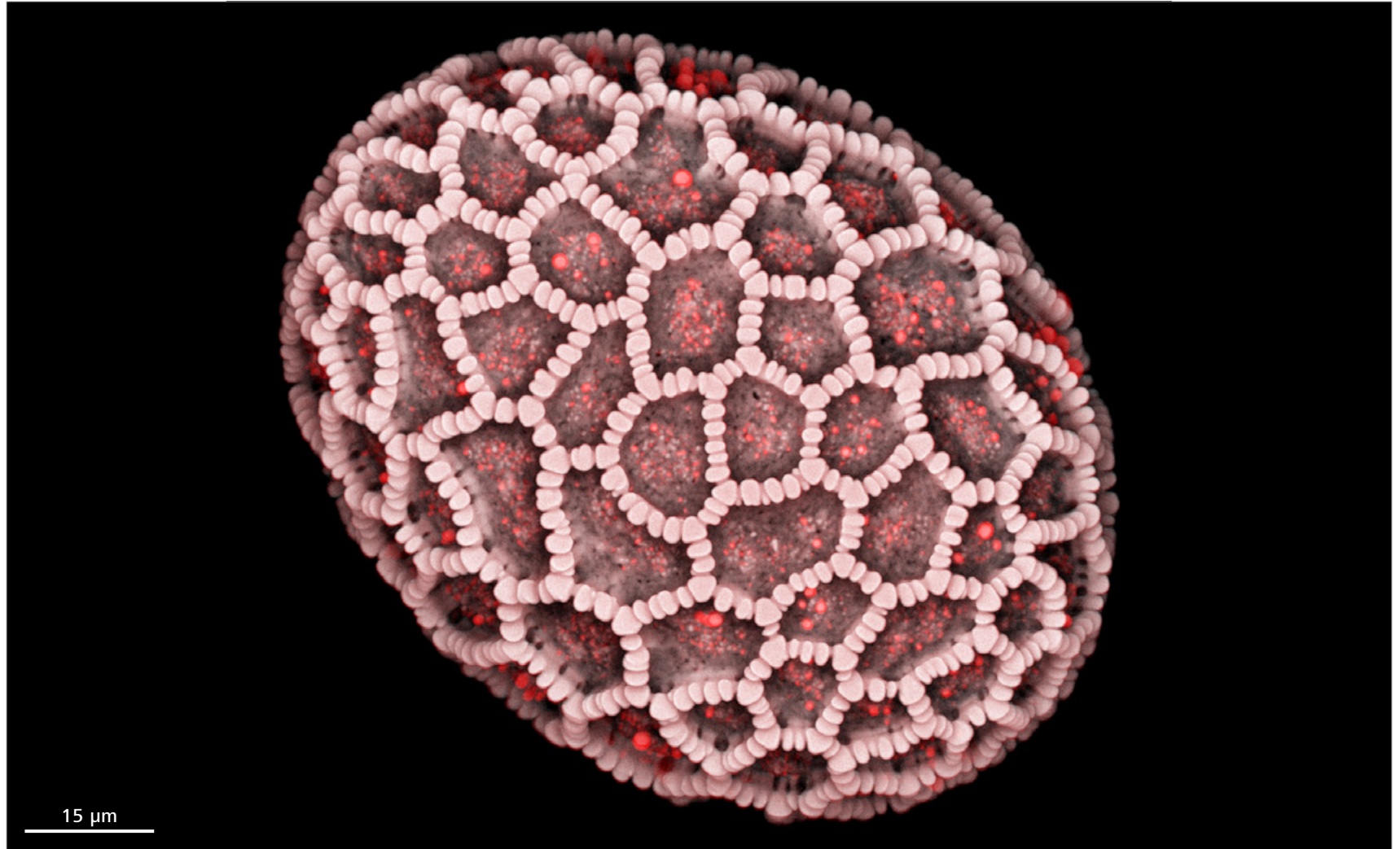
The micrograph shows a Lilium auratum *pollen grain, acquired with Airyscan 2 in Multiplex mode. Image courtesy of J. Michels, Zoological Institute, Kiel University, Germany*

ZEISS LSM 900 at Work

100 µm

100 µm

50 µm

▷ Click here to view this video

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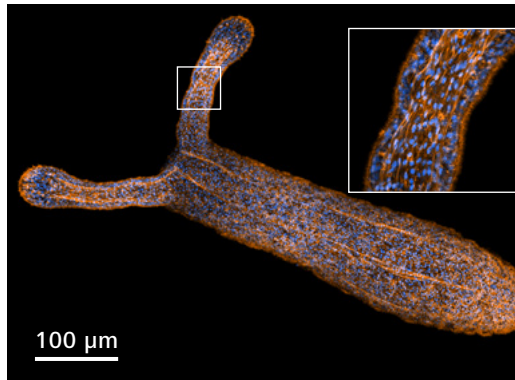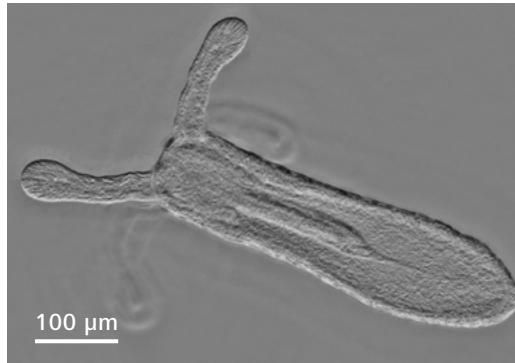
Fixed starlet sea anemone *(Nematostella vectensis)* stained with Hoechst (nuclei) and Phalloidin (actin). Side view imaged with LSM 900 on Celldiscoverer 7, seamlessly combining camera based phase gradient contrast mode (top) and high sensitivity mode with Airyscan 2 (bottom). Maximum intensity projection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

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.

ZEISS LSM 900 at Work

500 µm

A

20 µm

▶ Click here to view this video

B

20 µm

▶ Click here to view this video
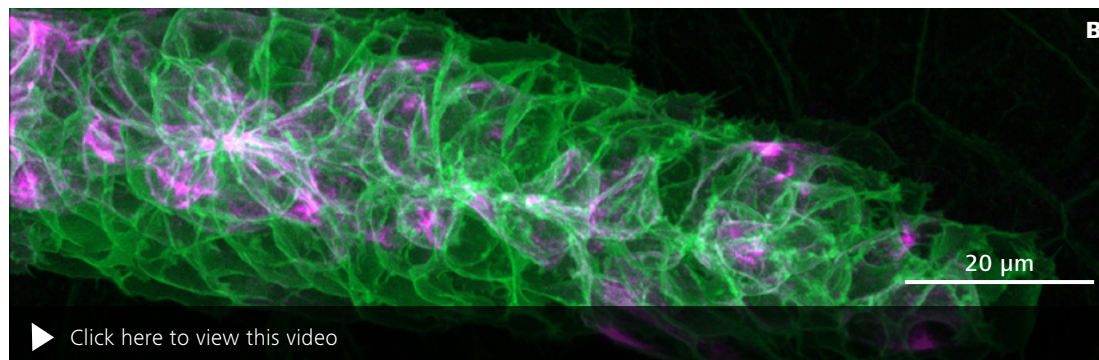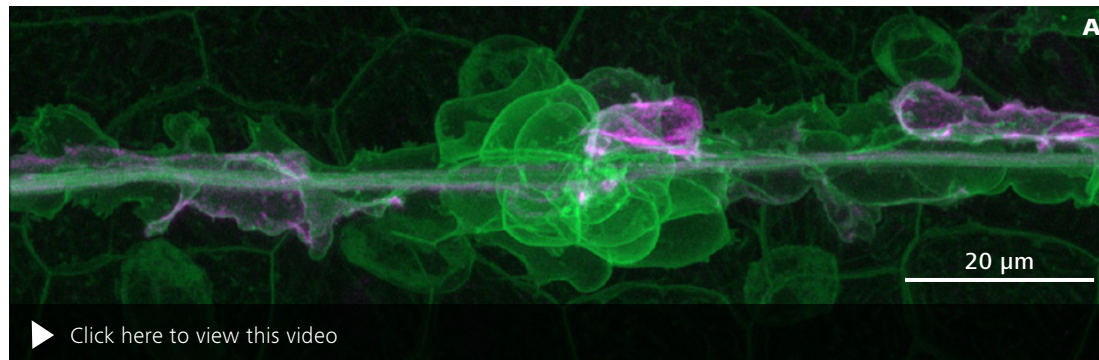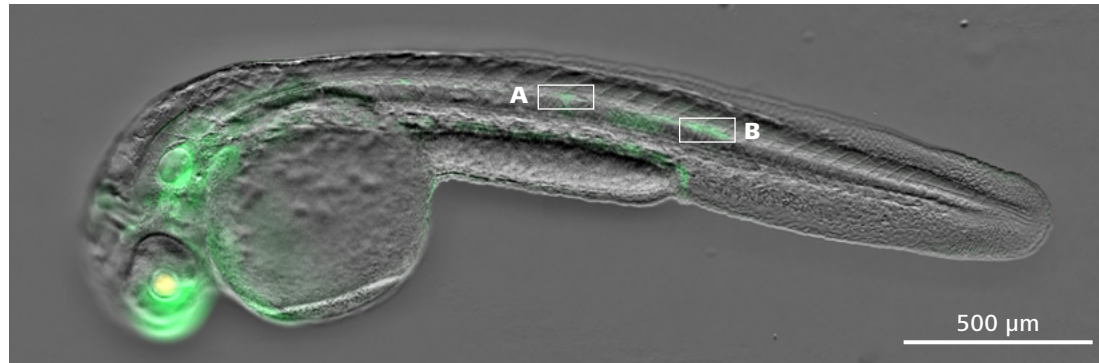
Lateral line primordium migration and deposition of immature neuromasts in a Zebrafish embryo *(Danio rerio)*. Animals were anesthetized and embedded using low concentrated agarose in a glass bottom petri dish.

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

ZEISS LSM 900 at Work

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.

50 μm

▶ Click here to view this video
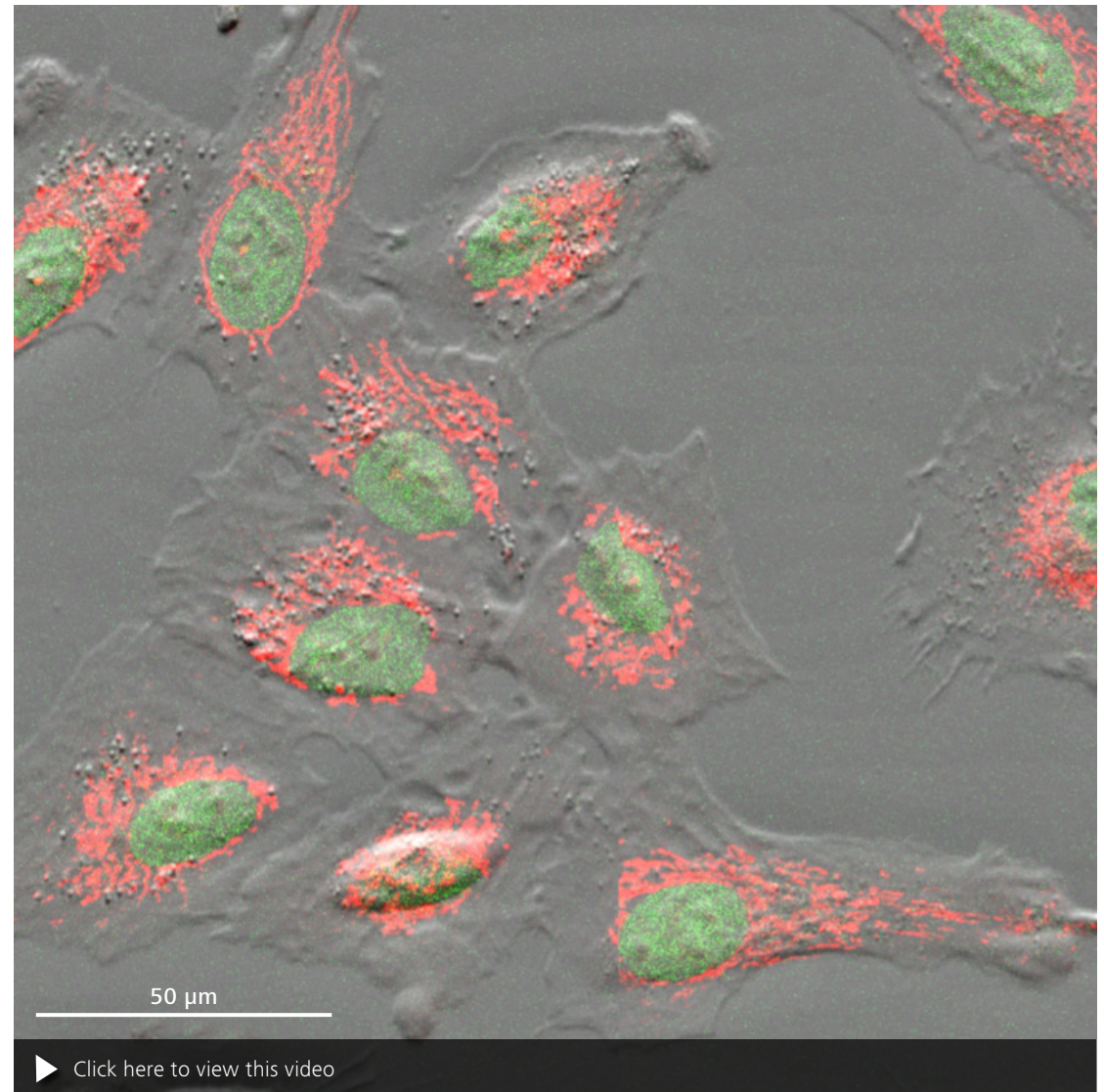
Sample courtesy of A.C. Hocke, Charité, Berlin, Germany.

ZEISS LSM 900 at Work

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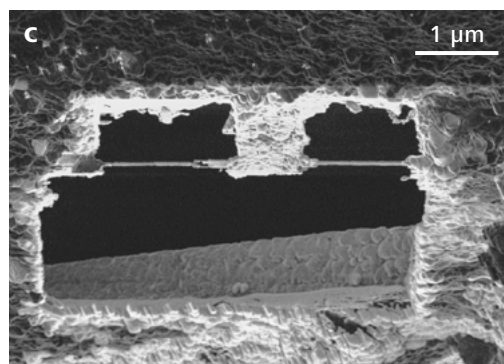
Yeast cells labeled with NUP (nuclear pore complex)-GFP and CNM67-tdTomato. Sample and tomogram courtesy of M. Pilhofer, ETH Zürich, Switzerland

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
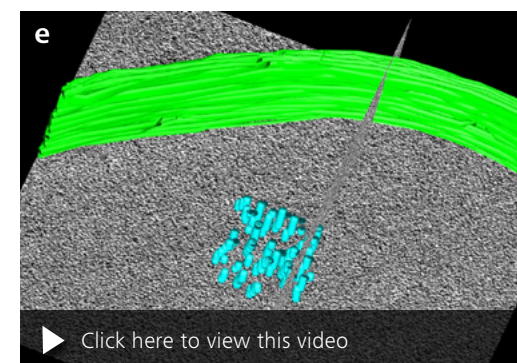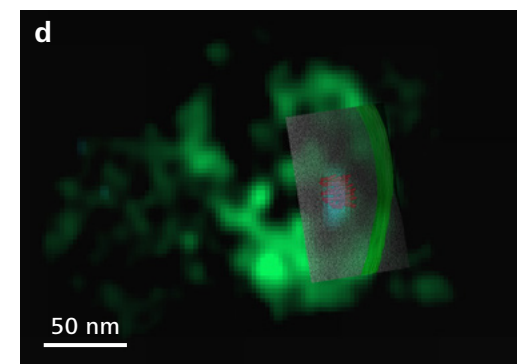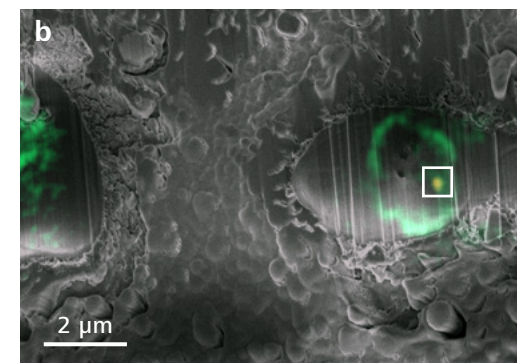
Your Flexible Choice of Components

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, optional: LSM Plus
- or 40× / 63× / 100× Airyscan 2 detector,optional: jDCV, Multiplex mode
- 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, Tiles & Positions, Experiment Designer, Sample Navigator, FRAP, FRET, Direct Processing, 3Dxl Viewer and 3D Image Analysis – powered by arivis®

ZEISS LSM 900: System Overview

Scanning module
LSM 900

Axio Observer
Several solutions for incubation
will be offered.

Axiocam
(by choice)

Anti-vibration plate
for Axio Observer

Scanning module
LSM 900

Axiocam
(by choice)

Axio Imager
with TFT Monitor

Anti-vibration plate
for Axio Imager

Scanning module
LSM 900

Axiocam
(by choice)

Axio Examiner

Solid-State Light Source
Colibri 7

HXP 120 V illuminator

ESID

Lamp housing
HAL 100

Lamp housing
HAL 100

Switching mirror
mot

T-PMT

Power supply
unit

Laser
module

Airyscan 2
module

Component rack
LSM 900

Control computer

LCD TFT
flat screen monitor

Controller
incl. joystick

Controller
incl. joystick

Scanning stage
130 x 85 STEP
for upright stand

Scanning stage
130 x 100 STEP
for inverted stand

Mounting frame,
adjustable

Specimen holder,
adjustable

Mounting frame,
adjustable

Z-Piezo insert
with controller

Mounting frame,
adjustable

Definite Focus
Controller

Definite Focus
Module for stand

Small actively or passively damped system table,
900 x 750 x 830 mm (l x d x h)
or:
Large actively damped system table,
1200 (1290) x 900 (990) x 870 mm (l x d x h)

Technical Specifications

LSM 900 with Axio Observer on small system table

Power plug

Component rack

System table

Computer table (optional)

750 / 550 / 400 / 900 / 1200 / 800 / 2000 / 3000
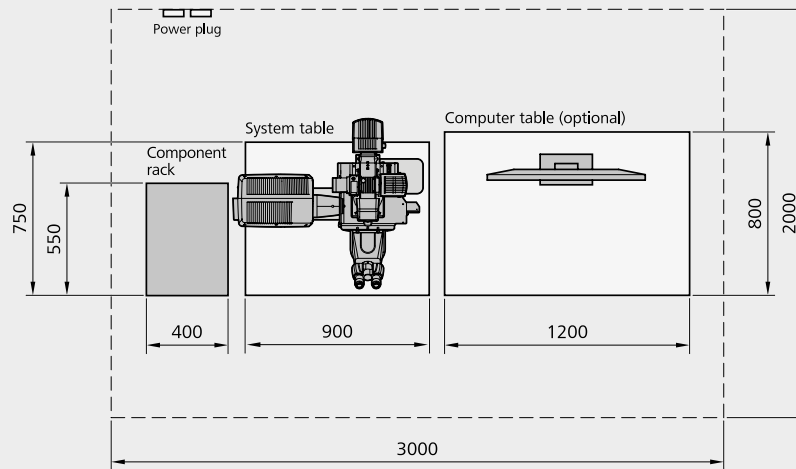
LSM 900 with Axio Imager or Axio Examiner on small system table

Power plug

Component rack

System table

Computer table (optional)

750 / 550 / 400 / 900 / 1200 / 800 / 2000 / 3000
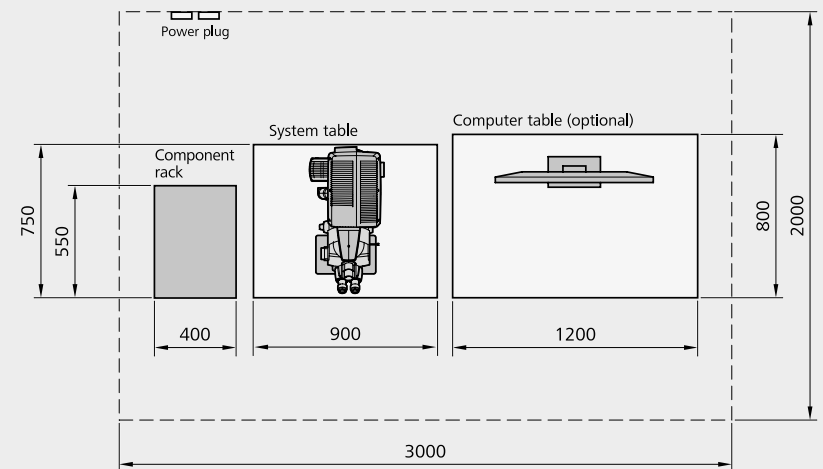
LSM 900 with Axio Observer on large system table

Power plug

Component rack

Large system table

550 / 400 / 1200 (1290) / 900 (990) / 2000 / 2500
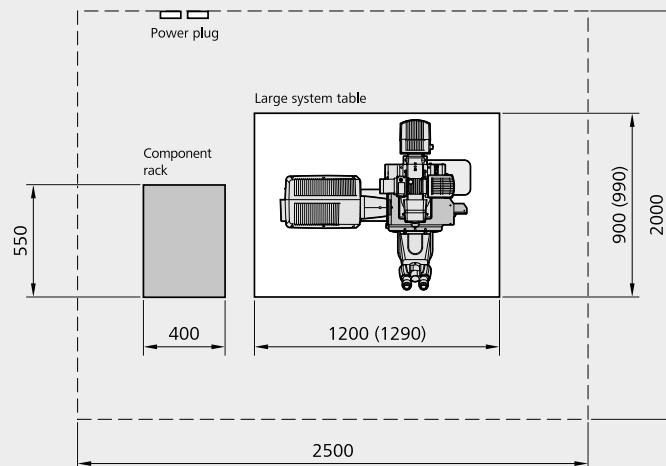
LSM 900 with Axio Imager or Axio Examiner on large system table
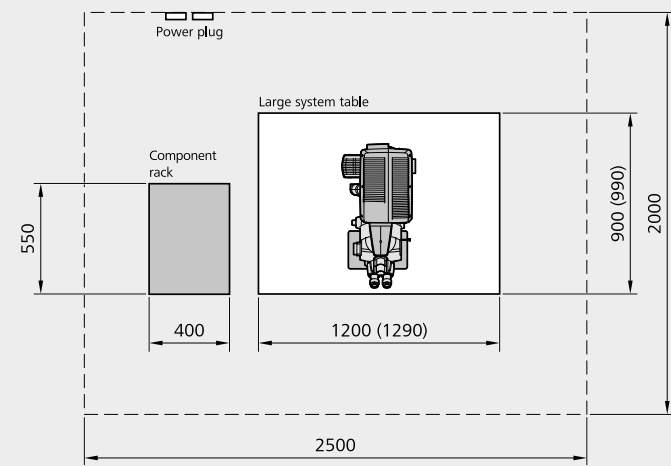
Power plug

Component rack

Large system table

550 / 400 / 1200 (1290) / 900 (990) / 2000 / 2500

Technical Specifications

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)

Technical Specifications

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

Technical Specifications

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
3Dxl Viewer – powered by arivis®	Visualization of very large data sets, fully integrated in ZEN microscopy software. Rapid 3D and 4D reconstructions and animations

Technical Specifications

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	3D image restoration based on calculated point-spread functions (modes: nearest neighbor, maximum likelihood, constrained iterative)
Physiology (Dynamics)	Comprehensive evaluation software for online and offline ratio imaging with various pre-defined formulas
FRET	Acquisition of FRET (Förster resonance energy transfer) image data with subsequent evaluation; Acceptor Photobleaching and Sensitized Emission methods supported
FRAP Efficiency Analysis	Acquisition of FRAP (fluorescence recovery after photobleaching) experiments with subsequent evaluation of intensity kinetics
Open Application Development (OAD)	Python scripting interface for automation & customization; experiment feedback for Smart Experiments and open interface to third party software (e.g. ImageJ)
Experiment Designer	Definition of advanced automated imaging
ZEN Connect and ZEN Connect 2D / 3D Add-ons	Exchange and alignment of image data from multiple image acquisition systems in 2D and 3D, enabling correlative workflows
ZEN Intellesis	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)
Guided Acquisition	Automated and targeted acquisition of objects of interest
Tiles & Positions	Scanning of predefined sample areas (tiles) and/or position lists
3Dxl Plus	Combine 2D and 3D visualization in one screen
BioApps	Easy-to-use and modular image analysis for common assays
3D Image Analysis	3D segmentation to quantify 3D microscopy data based on thresholding and machine learning models
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

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

Technical Specifications

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

Warning
LASER RADIATION
Avoid exposure to beam
Class 3 B laser product
IEC 60825-1: 2014

DANGER
LASER RADIATION
Avoid direct exposure to beam
Class IIIb Laser product

RoHS COMPLIANT   C E   CSA 176045 C US   DQS ISO 9001:2008   DQS ISO 13485:2016

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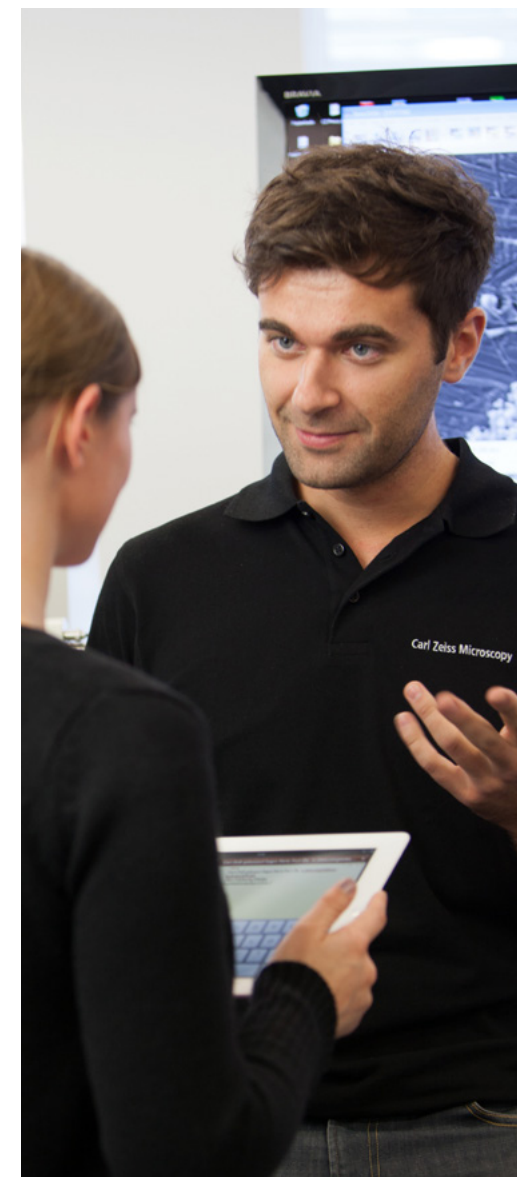
Please note: Availability of services depends on product line and location

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