Discovering the subcellular dynamics of life

ZEISS Lattice Lightsheet 7
Long-term Volumetric Imaging of Living Cells

zeiss.com/lattice-lightsheet
Lattice light sheet technology readily accessible for your live cell imaging

Light sheet fluorescence microscopy has become an established method for fast and unsurpassed gentle imaging of living specimens. By adding lattice structures to the light sheet, ZEISS Lattice Lightsheet 7 makes this technique available for live cell imaging at subcellular resolution – while also allowing you to use your standard sample carriers. With this automated, easy-to-use system the benefit of lattice light sheet microscopy – volumetric imaging of subcellular structures and dynamics over hours and days with best protection from photo damage – becomes available to everyone.

Thanks to the integrated auto-alignment procedure, you are ready to start your experiments within minutes. The inverted platform is compatible with all sample carriers commonly used for high-resolution optical microscopy. Examine the samples you already use for confocal microscopy experiments, without having to adjust your usual sample preparation. Discover the dynamics of life in unprecedented depth of detail – with the ease you never imagined possible!

**Lattice light sheet technology made accessible to everyone**
The importance of gentle light sheet imaging at high resolution cannot be overestimated for the study of subcellular processes. With Lattice Lightsheet 7, ZEISS makes access to the benefits of this advanced technology amazingly simple. Without having to adapt your usual sample preparation, you can examine living specimens directly on the standard sample carriers you already use for confocal microscopy. Complex alignment processes are performed automatically in this system so that you can focus your full attention on your experiments.

**Next to no phototoxicity and bleaching**
You want to watch the dynamics of life at subcellular resolution to study how the finest structures change over time, but your conventional imaging systems quickly reach their limits because they are too invasive and destroy what you are observing. Instead, ZEISS Lattice Lightsheet 7 provides lattice-structured light that automatically adapts to your sensitive samples, resulting in a massive reduction of photobleaching and phototoxicity, to allow your experiments to continue over hours and even days. The controlled incubation environment and an integrated auto-immersion mechanism enable unattended long-term experiments.

**High-speed volumetric imaging**
The extremely fast image acquisition of ZEISS Lattice Lightsheet 7 enables up to three volume scans per second. Dynamic imaging of full sample volumes with this high temporal resolution means no longer missing an interesting event on your coverslip. Near-isotropic resolution along the X, Y and Z axes gives you a three-dimensional image of your sample that reveals structural details in their true proportions. Fast laser switching allows for imaging using up to three colors practically simultaneously, with minimized color crosstalk.

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Access lattice light sheet imaging with your standard cell culture dishes and coverslips.

LLC-PK1 cell undergoing mitosis. Cells are expressing H2B-mCherry (cyan) and α-Tubulin mEGFP (magenta). Recording over a period of 25 hours.

Time lapse movie showing dynamics of a U2OS cell stably expressing Actin-GFP (cytoskeleton, cyan). Cells were also labeled with MitoTracker™ Red CMXRos (Mitochondria, green) and Draq 5 (Nucleus, magenta).
Your Insight into the Technology Behind It

The principle of lattice light sheet microscopy
Light sheet microscopy in general (also called Gaussian light sheet microscopy) is well known for its gentle imaging conditions at superior imaging speed. The groundbreaking concept of decoupling excitation and detection allows illumination of only the part of the specimen that is in the focal plane of the detection objective lens. By moving the sheet with respect to the sample and recording one image per focal plane, you can acquire volumetric data without exposing the out-of-focus sample areas.

Lattice light sheet microscopy combines the advantages of light sheet microscopy with near-isotropic resolution in the confocal range. Advanced beam shaping technology creates lattice-shaped light sheets that are significantly thinner than standard Gaussian light sheets and thus provide increased resolution at comparable imaging speeds. The lattice structure of the light sheet is created using a Spatial Light Modulator (SLM), then projected onto the sample after passing scanners that dither the lattice structure to create a smooth light sheet.

To allow imaging of horizontal samples such as standard cell culture dishes, excitation and detection objectives are oriented at an angle with respect to the sample. As a result, the sample is being illuminated and imaged from this angle.

Conventional (Gaussian) light sheet microscopy splits fluorescence excitation and detection into two separate light paths, allowing to generate an inherent optical section by exciting only fluorescence from the in-focus plane. Modified from Huiskens et.al, Development (2009)
Your Insight into the Technology Behind It

The ZEISS implementation of lattice light sheet microscopy

During the development of Lattice Lightsheet 7, ZEISS gave special attention to user-friendliness and compatibility with conventional sample preparation techniques. An inverse configuration is the most important prerequisite to allow the use of standard sample carriers for high-resolution microscopy.

The challenges resulting from an inverse configuration are mainly refractive index mismatches as fluorescence is emitted from the sample, passes through aqueous cell culture media, a tilted glass coverslip and water immersion, then into the detection objective.

Special ZEISS proprietary optical elements in the detection beam path compensate for refractive index mismatches and enable you to image samples as easily and quickly as with a confocal microscope.

Schematic of sample carrier and core optics module with excitation objective (1), meniscus lens (2) and detection objective with free-form optics (3). Examples show imaging without (A) and with correction of refractive index changes (B).
Your Insight into the Technology Behind It

The ZEISS implementation of lattice light sheet microscopy

The innovative design of the excitation beam path allows for rapidly changing laser lines without having to reprogram the SLM. This enables virtually simultaneous acquisition of multi-channel data sets so that you will not miss any events occurring in your sample.

Schematic of excitation beampath
Your Insight into the Technology Behind It

A system that adapts to your samples – not the other way around

ZEISS Lattice Lightsheet 7 can be used with all standard sample carriers that come with a no. 1.5 coverslip for the bottom. With the integrated transmission LEDs and oblique detection, which provide a DIC-like contrast, you can easily locate your sample. Change from white to red transmission LEDs for more gentle illumination if necessary.

Specifically designed for this system, the unique 5-axis stage not only allows movement along the X, Y and Z axes, but also tilting with the highest precision in X and Y. Leveling your sample is done automatically, which relieves you of tedious manual procedures.

For the best imaging results, the lattice light sheet must be adapted to each sample; therefore, ZEISS has implemented automatic alignment of all optical elements to eliminate time-consuming manual adjustments. The system is ready for imaging at the push of a button, ensuring a consistently efficient workflow. Your experiment startup procedure is accelerated, so you can spend your time on the more valuable data acquisition.

ZEISS Lattice Lightsheet 7 operates with our proven imaging software platform ZEN (blue edition). All features of this platform, such as advanced tiling and a powerful deconvolution algorithm, are conveniently at hand. The Direct Processing module allows you to process data during acquisition by streaming it to a separate PC.
Your Insight into the Technology Behind It

Ready for unattended long-term experiments
An ibidi stage top incubation system is integrated into Lattice Lightsheet 7. This system provides long-term stability throughout varying environmental conditions. The microscope controls and monitors temperature, CO₂ and O₂ levels, and humidity automatically, to preserve the integrity of your sample throughout the experiments. The lid with glass window allows quick and easy access to the sample to facilitate its inspection during an experimental run. And you can choose to include transmitted light illumination during long-term observations.

Prime the system to release any air, then a supply of immersion media tailored to the needs of your experiments is released automatically. Replenishing the immersion media is software-controlled, so you don’t have to worry about interfering with image acquisition. The reservoir is protected from illumination to keep bacterial growth at bay. Objectives are shielded from immersion supply; hence they remain dry, even if excess immersion media is applied.
Your Insight into the Technology Behind It

**Image Data Processing & Analysis**
Your Lattice Lightsheet 7 uses ZEN (blue edition) imaging software for data processing, giving you the advantage of the platform's rich portfolio of image processing functionality. This includes ZEISS Lattice Lightsheet Processing tool including Deskewing, Cover Glass Transformation and DCV that can be arranged in a pipeline at your needs and many other benefits. With ZEN (blue edition) you can also easily image an extended area by tiles.

For the efficient handling of extremely large datasets and complex workflows, you can use arivis Vision4D®, bringing you added advantage of processing functions like advanced stitching, channel shift, high resolution volume rendering and much more so you can visualize and quantify your data in a quick, professional manner. arivis Vision4D® is a modular software solution for working with multichannel 2D, 3D and 4D images of almost unlimited size, independent of available RAM. Your Lattice Lightsheet 7 generates huge multichannel datasets that can be handled without constraints by arivis Vision4D®, which runs on both the ZEISS Storage & Analysis PC and ACQUIFER HIVE.
Your Insight into the Technology Behind It

**Large data storage and processing**

With its high resolution and imaging speed, ZEISS Lattice Lightsheet 7 generates large datasets in a short period of time, which can place significant demands on your hardware. Data acquisition is supported by the same familiar storage system you know from our Lightsheet 7 instrument. Powerful Direct Processing and Batch Processing modules allow you to automate the processing task, so you can move on to other tasks and return when your imaging work is complete.

If more space is needed, the Lattice Lightsheet system can be connected to your local server structure, or a scalable storage device like the HIVE from Acquifer, via the 10 GB data transfer lines. The HIVE offers the advantage of running ZEN image processing software, so its utility extends beyond simply image storage.

Imaging the sample at an angle requires that the data must be transformed before visualization and analysis. This process, commonly known as deskewing, is implemented in ZEN (blue edition). The Lattice Lightsheet Processing module allows you to combine individual processing steps into one task. You can customize the arrangement of and perform the required steps based on your experiment needs. For example, select a coordinate transformation step to render the data set into a format familiar from your confocal and classical widefield imaging work so you never lose track of sample orientation. Or, choose the deconvolution feature to improve image quality especially when you have chosen a thinner light sheet with pronounced side lobes. By arranging your choice of processing steps into individual pipelines within the Lattice Lightsheet Processing module, you are able to work faster for subsequent experiments.
Perform experiments you would never have attempted before. ZEISS Lattice Lightsheet 7 with its large field of view and high-resolution detail allows you to observe subcellular structures and dynamics with high temporal resolution over extended time periods. Its unsurpassed gentle illumination ensures that your living samples are not damaged by phototoxicity and your experiments are not affected by photobleaching.

<table>
<thead>
<tr>
<th>Typical Applications / Typical Samples</th>
<th>Task</th>
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<tr>
<td><strong>Live cell imaging</strong></td>
<td></td>
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<tr>
<td>• Adherent cells</td>
<td>Volumetric imaging of subcellular processes with high speed: organelle morphology and dynamics, organelle-organelle interactions, vesicle trafficking</td>
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<tr>
<td>• Suspension cells</td>
<td>Volumetric imaging of membrane dynamics</td>
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<td></td>
<td>Volumetric imaging of immune cells such as T cell mobility and activation</td>
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<tr>
<td></td>
<td>Gentle imaging of live cells for hours up to days with minimal phototoxicity and photobleaching</td>
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<tr>
<td></td>
<td>Cell proliferation and apoptosis assays</td>
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<tr>
<td><strong>3D cell culture</strong></td>
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<tr>
<td>• Spheroids</td>
<td>Live imaging of spheroids or organoids with diameters up to 200 µm</td>
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<tr>
<td>• Organoids</td>
<td>Organoid self-organization</td>
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<tr>
<td>• Cysts</td>
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<td>• Cells in Hydrogel</td>
<td>Imaging of cell-cell interactions, 3D organization, migration and morphology</td>
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<td></td>
<td><em>In vitro</em> imaging of neuronal activity</td>
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<tr>
<td><strong>Small evolving organisms, e.g.</strong></td>
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<tr>
<td>• Zebrafish embryos</td>
<td>Resolving structural detail in 3D with close to isotropic resolution</td>
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<tr>
<td>• C. elegans embryos</td>
<td>Fast imaging of cellular and subcellular dynamics in embryos and small organisms up to 100 µm in diameter</td>
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<tr>
<td>• Drosophila embryos</td>
<td>Cell migration, cell-cell interaction, cell cycle, vesicle trafficking</td>
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<tr>
<td><strong>Oocytes</strong></td>
<td>Live imaging of whole oocytes in 3D with subcellular detail</td>
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<tr>
<td><strong>Expanded samples</strong></td>
<td>Water based gel expanded small samples</td>
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**ZEISS Lattice Lightsheet 7 at Work**

**Lamin B1 in action**
Lamin B1 localizes to the nuclear envelope and is involved in disassembling and reforming the nuclear envelope during mitosis. The formation of so-called ‘nuclear invaginations’ has been reported frequently for many different cell types during mitotic events at different stages of the cell cycle. Nuclear invaginations can manifest as tubular structures that extend from the nuclear envelope and cross through the nucleus. Although these unique structures have been reported frequently, most research so far has been done with fixed cells. Consequently, the function of these structures is largely unknown even though plenty of hypotheses have been proposed.

This data set was recorded with a cell line from the Allen Institute for Cell Science in Seattle: human induced pluripotent stem cells which endogenously express mEGFP-tagged lamin B1 (AICS-0013). The overnight experiment was recorded for close to 8 hours with one volume imaged every 1.5 min. Cells going through mitosis can be observed throughout the whole duration. Formation and dynamics of nuclear invaginations can clearly be observed in most of the cells, throughout the complete cell cycle.

Gentle illumination is crucial for imaging mitosis as this process is extremely delicate and light sensitive. To prevent replication of damaged DNA, cells arrest mitosis as soon as there is any damage from excitation light. The gentleness of Lattice Lightsheet 7 imaging and an extremely stable system is required for imaging mitotic events over longer time periods. Fast volumetric imaging in combination with near-isotropic resolution allows for looking at the sample from every angle and investigating unique subcellular structures in every detail.

ZEISS Lattice Lightsheet 7 is the perfect tool for challenging experiments like this. Applications that were impossible before turn into reality – and with its ease of use, they can also become real for your research.
ZEISS Lattice Lightsheet 7 at Work

**Gently image subcellular dynamics at highest volume speed**

Get the best of both worlds: lattice light sheet technology combines the speed and gentleness of light sheet microscopy with the resolution of confocal microscopy. The lattice light sheet illumination technique allows for extremely efficient illumination and, as a consequence, the gentlest imaging conditions.

Cos 7 cell transiently transfected with Tomm20-mEmerald and Calreticulin-tdTomato. Tomm20 labels the outer membrane of mitochondria, Calreticulin is a protein of the ER where proteins are synthesized. Both are extremely delicate and light-sensitive organelles that are difficult to image with conventional methods.

One volume every 30 secs, imaged for 1 hr 15 mins, imaged volume: 175 × 210 × 20 µm³. A total of 85,800 images was recorded; 572 volume planes for 150 time points.

Cos 7 cells transiently transfected with Calnexin-mEmerald and EB3-tdTomato. EB3 labels the growing ends of microtubules and is necessary for the regulation of microtubule dynamics. Calnexin is a protein of the ER where proteins are synthesized. Cells were imaged for 1.5 hrs every 80 secs, imaged volume: 175 × 120 × 70 µm³.

One volume every 1 sec, imaged for 7 mins, imaged volume: 85 × 15 × 20 µm³. A total of 9,300 images was recorded; 31 volume planes for 300 time points.
ZEISS Lattice Lightsheet 7 at Work

Cos 7 cells transiently transfected with mEmerald-Rab5a and Golgi7-tdTomato. Golgi7 is a protein associated to the Golgi and Golgi vesicles. Rab5a is an early endosome marker. Tracking of vesicles in 3D with near-isotropic resolution becomes reality. Tracking was performed in arivis Vision4D®.

T cell expressing Lifeact-GFP. Color-coded depth projection and maximum intensity projection side-by-side. The T cell was imaged constantly for over 1 hr; one volume every 2.5 secs. Sample courtesy of M. Fritzsche, University of Oxford, UK.

Cos 7 cell expressing Lifeact-GFP. Maximum intensity projection. The cell was imaged constantly for 9 hrs; one volume (115 x 60 x 25 µm³) every 10 secs. A total of 1,005,000 images was recorded; 201 volume planes for 5,000 time points.
ZEISS Lattice Lightsheet 7 at Work

Image developing life at early stages
Imaging of live oocytes is particularly challenging as this earliest stage in life is extremely delicate and sensitive to light. Lattice light sheet microscopy is the perfect tool to observe life at its earliest stage without disturbing the process.

Mouse metaphase II oocyte
Live mouse oocytes arrested in metaphase II and stained for mitochondria (cyan), microtubules (magenta) and chromosomes (yellow).

Mouse germinal vesicle oocytes
Fixed mouse germinal vesicle oocytes stained for the nuclear envelope (anti-lamin, cyan), actin (phalloidin, magenta), and microtubules (anti-tubulin, yellow). The Sinc3 100 x 1,800 lattice light sheet was used for imaging of the whole oocyte.

Mouse germinal vesicle oocyte
Fixed mouse germinal vesicle oocytes stained for the nuclear envelope (anti-lamin, cyan), actin (phalloidin, magenta), and microtubules (anti-tubulin, yellow). The Sinc3 15 x 650 lattice light sheet was used for high-resolution imaging of microtubule and actin structures. Follow the 3D structure of the microtubules in the movie.

Sample courtesy of C. So, MPI Göttingen, Germany
Sample courtesy of C. So, MPI Göttingen, Germany
Sample courtesy of C. So, MPI Göttingen, Germany
ZEISS Lattice Lightsheet 7 at Work

Image developing life of small evolving organisms

Zebrafish embryo
DeltaD-YFP transgenic zebrafish embryo (Liao et al. 2016, Nature Communications). Fusion protein driven by a transgene containing the endogenous regulatory regions, expression in the tailbud and pre-somatic mesoderm. Signal visible in the cell cortex, and in puncta corresponding to trafficking vesicles (green). Nuclei in magenta. The embryo was imaged for 5 minutes constantly; one volume (150×50×90 µm³) every 8 sec.

Zebrafish embryo
High-speed movie of zebrafish embryo. Volumetric imaging of trafficking mRNA molecules (green). Nuclei are shown in magenta. Data is displayed as maximum intensity projection. One volume (86×80×12 µm³) was recorded every 2.5 sec.

Zebrafish embryo
 Trafficking mRNA molecules were tracked in aris Vision4D®. The movement of the zebrafish embryo was first corrected using a nucleus reference track. Then individual mRNA molecules were tracked over time to result statistics such as speed and directionality.

Sample courtesy of Prof. A. Oates, EPFL, Switzerland
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ZEISS Lattice Lightsheet 7 at Work

Image developing life of small evolving organisms

**C. elegans embryo**

C. elegans embryo stained for nuclei. The movie shows a color-coded depth projection of the embryo. The embryo was imaged for 10+ hours constantly; one volume every 700 msec.

Imaged volume: $115 \times 50 \times 30 \, \mu\text{m}^3$. A total of 101,000 images was recorded; 101 volume planes for 1,000 time points.

**C. elegans embryo**

C. elegans embryo stained for nuclei. The movie shows a color-coded depth projection of the embryo. The embryo was imaged for 19+ hours every 5 minutes and can be observed going through its normal sleep-wake cycle.

Imaged volume: $115 \times 50 \times 30 \, \mu\text{m}^3$. A total of 23,836 images was recorded; 101 volume planes for 236 time points.

**C. elegans embryo**

C. elegans embryo at the late bean stage (~400 min post fertilization) with ~560 nuclei marked with HIS-58::mCherry (magenta) and centrioles marked by GFP::SAS-7 (green).

Cells in mitosis show condensed signal of HIS-58::mCherry and centrioles at spindle poles.

Sample courtesy of N. Kalbfuss, Gönczy Lab, EPFL, Switzerland

Customer sample

Customer sample

Sample courtesy of N. Kalbfuss, Gönczy Lab, EPFL, Switzerland

Click here to view this video

Click here to view this video

Click here to view this video
ZEISS Lattice Lightsheet 7 at Work

**Image developing life of small evolving organisms**

**Drosophila embryo**

*Drosophila melanogaster* is a model organism in many research fields such as biomedical research. Many genetically modified variants are available to researchers. This video shows a drosophila embryo with GFP labeling as it moves over time. A total of 91,100 images were taken, 911 volume planes, 100 time points. One volume, every 15 secs; imaging duration 25 mins, imaging volume: $300 \times 455 \times 145 \ \mu m^3$.

Maximum intensity projection of a Drosophila embryo with GFP labeling.

Color-coded depth projection of a Drosophila embryo with GFP labeling.
ZEISS Lattice Lightsheet 7 at Work

**Image developing 3D cell models**
Spheroids and organoids are in vitro models of organs – much smaller and simpler but easy to produce and thus for developmental biologists an invaluable tool to study organ development. Unlike cell cultures, which usually consist of a monolayer of cells only, cells in spheroids/organoids form three-dimensional structures, allowing for the investigation of cell migration and differentiation inside 3D cell models. With lattice light sheet microscopy, imaging the development and self-organization of organoids becomes reality. Here, we can see a 3D rendering of a spheroid consisting of cells expressing H2B-mCherry (cyan) and α-Tubulin-mEGFP (magenta). Not every cell is labelled.

3D rendering of a spheroid consisting of cells expressing H2B-mCherry (cyan) and α-Tubulin-mEGFP (magenta). Not every cell is labelled.
**ZEISS Lattice Lightsheet 7 at Work**

**Imaging developing plants and plant seeds**

**Pollen Grain**
Polen tube stained for mitochondria (MitoTracker Green, green) and Lyso-somes (Lysotracker Red, red). Watch the pollen tube extend from the crack in the pollen grain (visualized by its autofluorescence).

Mitochondria don't quite advance to the very tip of the pollen tube but stop a few microns before the tip. Rendering of the data set was performed in arivis Vision4D®.

**Pollen Tube**
Watch mitochondrial dynamics inside the pollen tube. Mitochondria move towards the tip at the edges and back in the middle of the tube.

While trafficking, mitochondria constantly fuse and divide for repair processes and to share and distribute biological molecules.
Your Flexible Choice of Components

1 Microscope
- Lattice Lightsheet 7

2 Objectives
- Illumination: 13.3× / NA 0.4
- Detection: 44.83× / NA 1.0

3 Illumination
- LED (white & red) for transmitted light
- Laser (488 nm, 561 nm, 640 nm) for reflected light & epi-fluorescence

4 Cameras
- Pco.edge 4.2 CLHS

5 Filters
- LBF 405/488/561/642
- BP 495-550/BP 570-620
- BP 495-550+LP655
- BP 570-620+LP655
- EF LP 570
- EF LP 488
- Empty
- ND filter

6 Software
- ZEN 3.3 (blue edition)
- Lattice Lightsheet Processing Module
ZEISS Lattice Lightsheet 7: System Overview

- In Brief
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- The Applications
- The System
- Technology and Details
- Service
## Technical Specifications

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| **Core Optics**     | - Illumination objective lens 13.3× / 0.4 (at 30° angle to cover glass) with static phase element  
- Detection objective lens 44.83× / 1.0 (at 60° angle to cover glass) with Alvarez manipulator  
- Meniscus lens; relay of core optics to cover slip of sample carrier  
- Autoimmersion: water, motorized dispenser                                                                                                       |
| **Illumination**    | - Transmitted light: LED (white centered and side, red centered illumination) with oblique contrast for sample positioning and overview; no Köhler illumination, not specified for high quality imaging  
- Reflected light and epifluorescence: laser (488 nm, 561 nm, 640 nm) for beam adjustment and fluorescence imaging                                                                 |
| **Detection Modules** | - Pco.edge 4.2 CLHS sCMOS camera; requires liquid cooling; single camera port  
- Pixel size: 6.5 μm; Max. pixel format: 2,048 × 2,048 (4.2 Megapixel); Bit depth: 16 bit; QE: up to 82%                                                                                   |
| **Image Acquisition Speed** | - Volume: 3 Vols @ 300 μm × 50 μm × 20 μm  
- Plane: 400 frames/s @ 300 μm × 20 μm  
- Up to 3 colors fast sequential (framework or stackwise switch)                                                                                                    |
| **Light Sheets**    | - Beam shaping by cylinder lens and spatial light modulator (SLM)  
- Pre-defined Sinc3 beams with length [μm] × thickness [nm]:  
  - 15 × 550 (w/ side lobes) & 15 × 650 (w/o side lobes)  
  - 30 × 700 (w/ side lobes) & 30 × 1,000 (w/o side lobes)  
  - 100 × 1,400 (w/ side lobes) & 100 × 1,800 (w/o side lobes)                                                                                                       |
| **Immersion and Incubation Media** | - Sample carriers and optics designed for aqueous media (n_d = 1.33)                                                                                      |
| **Sample Mounting** | - Standard glass bottom cell culture dishes and multi-well plates (glass 1.5; 0.15 μm – 0.19 μm); skirt <0.5 mm                                                                                      |
| **Sample Carrier Frames** | - Sample carrier frame Dish 35: for 35 mm cell culture dishes  
- Sample carrier frame Slide: for slides 26 mm × 76 mm; also suitable for multi-well glass-bottom slides 26 mm × 76 mm  
- Sample carrier frame Chamber slide: for LabTekR chambers 25 mm × 57 mm; also suitable for multi-well glass-bottom slides 25 mm × 57 mm  
- Sample carrier frame Multiswell: for multiswell microplates 85.48 mm × 127.76 mm                                                                 |
| **Resolution (xyz)** | - Light sheet selection (from 6 pre-defined sheets)  
- Deskewed: 330 nm × 330 nm × 500–1,000 nm; Deskewed w/DCV: 290 nm × 290 nm × 450 nm–900 nm (z-res. = light sheet thickness if ≤1,000 nm)        |
| **Voxel size (xyz)** | - Skewed image: 145 nm × step size × 145 nm  
- Deskewed image: 145 nm × step size / 2 × 145 nm  
- Glass cover transformed image: 145 nm × 145 nm × 145 nm  
- Step-size for Nyquist sampling: 200 nm                                                                                                            |
| **Penetration Depth** | - Up to 200 μm                                                                                                                                                |
| **Field of View (FOV)** | - x: 300 μm; y: defined by scan range                                                                                                                        |
| **Spectral Range of Detection** | - 490 nm – 740 nm                                                                                                                                             |
## Technical Specifications

### Component Description

#### Filters
1. LBF 405 / 488 / 561 / 642
2. BP 495-550 / BP 570-620
3. BP 495-550+LP655
4. BP 570-620+LP655
5. EF LP 570
6. EF LP 488
7. Empty
8. ND filter (accessible by service only)

#### System PC / Workstation
- **HP Z6 G4 Rev2 workstation**
- **Chipset:** Intel C622
- **Memory:** max. 192 GB RAM
- **SSD:** 1× 512 GB M.2 NVMe
- **Hard Drives:** 2× 6 TB SATA 7,200 rpm (configured as 6 TB RAID 10 hard drive); increase capacity from 6 TB (RAID 10) to 12 TB (RAID 10)
- **Processor:** Intel® Xeon® Gold 6234 (3.2 GHz, 24.75 MB cache, 8 cores)
- **Graphics Card:** NVIDIA Quadro RTX6000 24 GB DB
- **Network Adapter:** 2× 10 GbE RJ45 (hp Z6); additional network adapter 2× 10 GbE RJ45 (hp Z6) e.g. for connection of storage systems
- **Operating System:** Windows 10 IoT Enterprise 2019 LTSC Embedded x64

#### Storage and Data Analysis PC
- **CPU:** Intel P XEON E5-2620V3 2.4 GHz LGA2011 L3 15MB Box
- **Graphics Card:** NVIDIA Quadro P4000 8 GB DP or NVIDIA Quadro P6000 24 GB DP
- **Memory:** 64 GB (4× 16 GB) included, max. 256 GB RAM;
- **Memory slots:** 16x DIMM slots
- **Hard Drives:** 6× HDD 8 TB, RAID 5 configured to 36 TB data storage volume; 2x Solid State Drive 240 GB for pagefile and operating system
- **10 Gbit Ethernet on motherboard and 10 GbE cable to connect with PC for system control (high speed data streaming)**
- **Network Adapter:** LAN: 2× 10 GbE
- **5x USB 3.0, 4x USB 2.0 ports**
- **Operating system:** Windows 10

#### Monitor
- **TFT 27**: HP Z27n G2 (68 cm)
- **TFT 32**: HP Dream color Z32x (80 cm)

#### Trigger
- **Trigger-out signal via BNC connector. High level of 3.3 V (nominal value of the high level: > 3.2 V < 4.0 V and nominal value of the low level: 0 V ±0.4 V). The minimal working resistance is 5 kΩ.**

#### Data Acquisition Rate
- **With dedicated Lattice Lightsheet 7 storage module > 400 Mb/s**

#### Software Processing
- **Lattice Lightsheet 7 Processing (Deconvolution, Deskew, Cover glass Transformation)**
- **3DXL, arivis Vision4D® (optional)**
- **Direct and Batch Processing**

#### Software Acquisition
- **Multidimensional imaging (time, positions, tiles); combination of multidimensions possible**
- **Light sheet selection (from 6 pre-defined sheets)**
- **Autoimmersion**
- **Environmental control (temperature, CO₂ and humidity; O₂ via N₂ optional)**
## Technical Specifications

### Microscope

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<tr>
<th>Component</th>
<th>Physical Dimensions</th>
<th>Approx. Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main System Module Lightsheet 7</td>
<td>600 mm × 425 mm × 380 mm</td>
<td>48 kg</td>
</tr>
<tr>
<td>Component Rack (houses Laser module, Power supply unit &amp; Stage Motion Controller)</td>
<td>550 mm × 740 mm × 600 mm</td>
<td>56 kg</td>
</tr>
<tr>
<td>System Table for main System Module Lattice Lightsheet 7, Level regulated</td>
<td>900 mm × 750 mm × 830 mm</td>
<td>130 kg</td>
</tr>
</tbody>
</table>

### Incubation

- **Heating System**
  - Heating of sample chamber (no cooling)
  - T: ambient to 42 °C ± 0.1 °C; up to 1.5 °C/min heating, up to 1.0 °C/min cooling

- **Gas Mixer System**
  - Requires compressed air, CO₂ (and N₂) supply; adjustable concentration
  - CO₂: 0% to 15% ±0.35%
  - O₂: 1% to 21% ±0.20%
  - Humidity: 20% – 99% ±2.50%

### Stage

- **Stage**
  - Five-axis multi-coordinate stage with Piezo motors
  - Specifications: x / y / z / x-tilt / y-tilt (after homing)

- **Travel Range**
  - ±36 mm / ±54 mm / ±0.5 mm / ±0.5° / ±0.5°

- **Reproducibility (±)**
  - 400 nm / 400 nm / 200 nm / 0.1° / 0.1°

- **Smallest Increment**
  - 200 nm / 200 nm / 100 nm / 0.05° / 0.05°

### Laser Module

- **Laser Class**
  - All Lasers are class 3B
  - The installed system as a whole is laser class 2

- **Laser Wavelengths**
  - Laser line Type Power output (in pupil)
  - 488 nm diode 10 mW (2 mW)
  - 561 nm diode (SHG) 10 mW (2 mW)
  - 640 nm diode 5 mW (1 mW)
Technical Specifications

### Environmental Conditions

<table>
<thead>
<tr>
<th>Operation</th>
<th>Permissible ambient temperature (specified performance)</th>
<th>22 °C ± 1 °C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Permissible ambient temperature (reduced performance)</td>
<td>15 °C to 30 °C</td>
</tr>
<tr>
<td></td>
<td>Permissible relative air humidity (no condensation)</td>
<td>&lt; 65 % at 30 °C</td>
</tr>
<tr>
<td>Max. altitude of installation site</td>
<td>Max. 2,000 m</td>
<td></td>
</tr>
<tr>
<td>Warm-up Time</td>
<td>60 min</td>
<td>For high precision and/or long-term measurements ≥ 3 h</td>
</tr>
<tr>
<td>Vibrations</td>
<td>To be operated in conformance with Vibration Class C. VC-C, 12.5 μm/s RMS amplitude of frequency band 8 – 80 Hz (RMS = root mean square) according to ISO 10811</td>
<td></td>
</tr>
</tbody>
</table>

### Electrics and Power

<table>
<thead>
<tr>
<th>Mains Voltage</th>
<th>220 V AC to 240 V AC (±10 %)</th>
<th>100 V AC to 125 V AC (±10 %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Frequency</td>
<td>50 to 60 Hz</td>
<td>50 to 60 Hz</td>
</tr>
<tr>
<td>Lattice Lightsheet 7 System</td>
<td>Max. current</td>
<td>Single 4.5 A phase</td>
</tr>
<tr>
<td>Power consumption</td>
<td>800 VA max.</td>
<td>800 VA max.</td>
</tr>
<tr>
<td>Data Analysis PC</td>
<td>Power consumption</td>
<td>400 VA max.</td>
</tr>
<tr>
<td>Protection Class / Protection Type</td>
<td>I / IP 20</td>
<td></td>
</tr>
<tr>
<td>Overvoltage Category</td>
<td>II</td>
<td></td>
</tr>
<tr>
<td>EMC Inspection</td>
<td>According to DIN EN 61326-1 (10/2006)</td>
<td></td>
</tr>
<tr>
<td>Emitted Interference</td>
<td>According to CISPR 11/DIN EN 55011 (05/2010)</td>
<td></td>
</tr>
</tbody>
</table>

### Heat Loss

<table>
<thead>
<tr>
<th>System Lattice Lightsheet 7 (incl. Lasers and Accessories)</th>
<th>700 W</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Analysis PC</td>
<td>350 W</td>
</tr>
</tbody>
</table>

### Patents which apply for Lattice Lightsheet 7

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