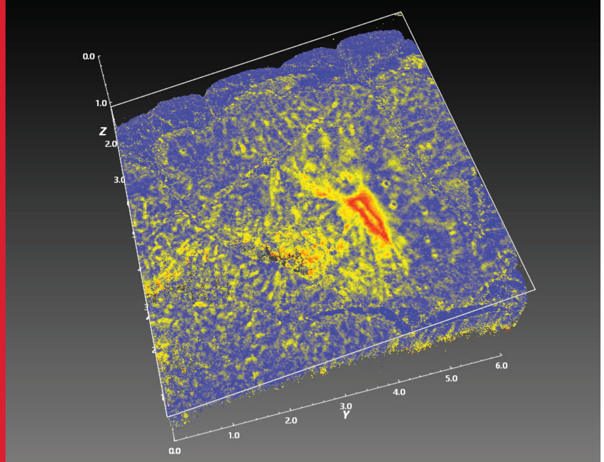
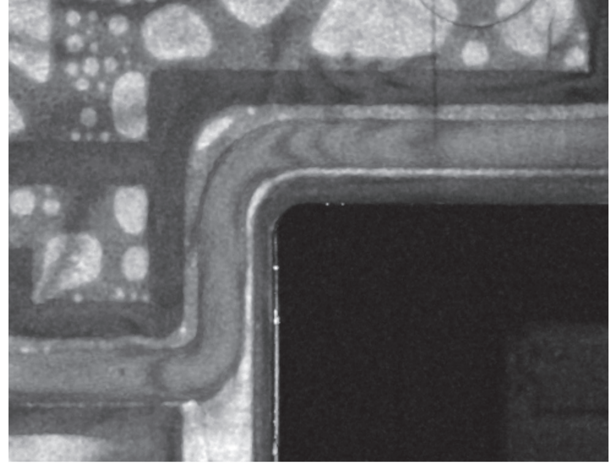
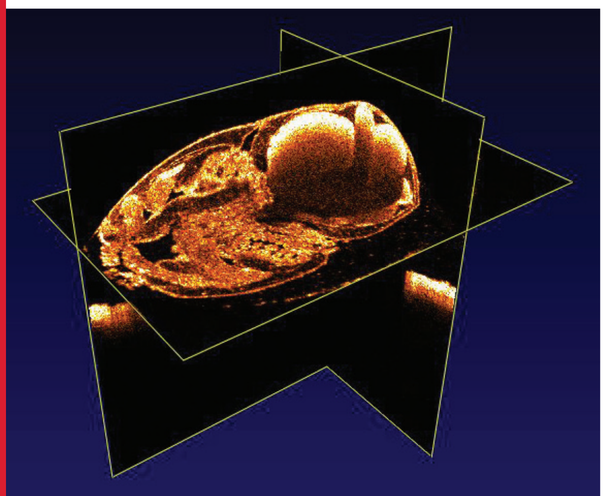
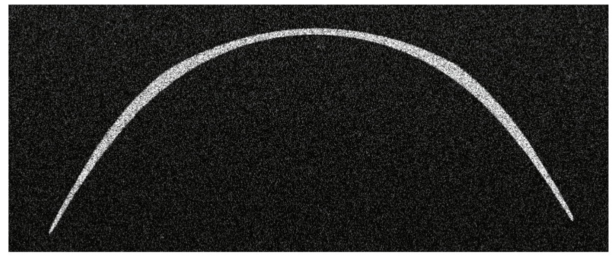
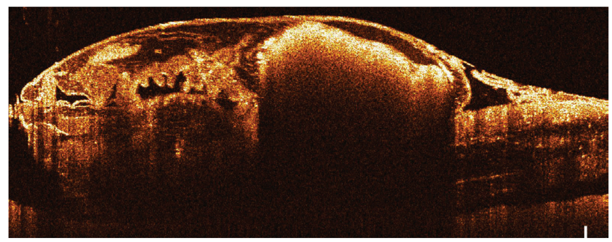
OCT



Optical Coherence Tomography

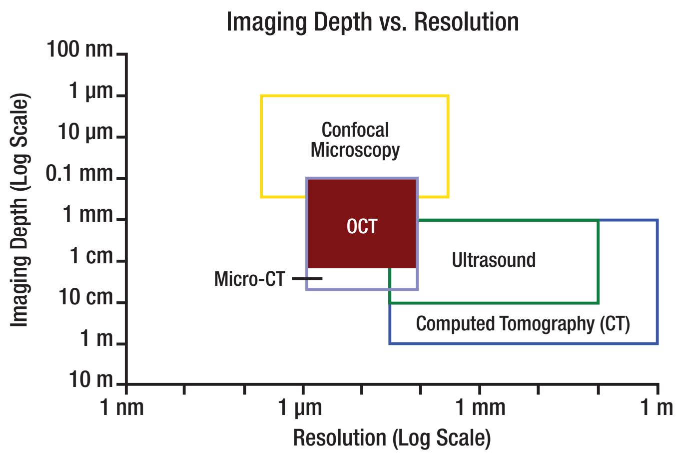
Thorlabs meets the unique and often complex requirements of each OCT imaging application by manufacturing modular OCT components that are designed to be configured into highly customizable systems. Our systems enable not only cross-sectional imaging of specimens but also real-time volumetric and micron-level imaging. Particle motion, flow, and vascular imaging are accomplished through Doppler and speckle variance OCT, and this information can be overlaid on the respective cross-sectional images.

The engine of each modular system is the OCT base unit, which includes the light source, detection optics, and hardware. Thorlabs offers a variety of OCT base units based on spectral domain and swept-source approaches, as well as a selection of beam scanning systems and scan lens kits. Modular designs, flexible configurations, high-performance data acquisition software, and a wide variety of components and accessories allow these OCT systems to meet specific requirements and be seamlessly integrated into a wide range of applications and environments.

THORLABS

Capabilities of OCT Systems

OCT Background



Optical coherence tomography is a non-invasive and non-destructive imaging technique that provides real-time, cross-sectional (2D) and sub-surface volumetric (3D) imaging of structural features with micron-level resolution. OCT bridges the gap separating the resolution and imaging depth capabilities of confocal microscopy and ultrasound imaging.

OCT images are generated by analyzing light backscattered from the different features in the sample. To collect a 1D depth scan, often called an A-Scan, the light emitted by the OCT light source is focused to a small diameter spot, positioned on the specimen, and held stationary. Samples ideal for OCT imaging are partly transparent to this light probe, which allows the light to penetrate into the sample. The OCT system collects and measures the light backscattered by the surface and sub-surface features located along the path of the probe. The backscattered light and a reference light beam form an interference pattern that is Fourier transformed to produce a 1D depth profile.

2D and 3D images are obtained by scanning the OCT light probe across the surface of the sample while collecting the measured A-Scans into datasets. The 2D scan that produces a cross-sectional image is called a B-Scan. OCT measurements can also be used to perform qualitative and quantitative motion detection through Doppler and speckle variance OCT.

Thorlabs' Modular OCT System Design

Thorlabs' modular OCT systems consist of an OCT base unit, beam scanning system, scan lens kit, and user-selected accessories. Each system component is chosen to best meet the requirements of the application. As there are interdependencies among the various performance specifications in OCT systems, no single system can meet the needs of all applications. The purpose of OCT system design is to optimize key parameters while ensuring good overall system performance.

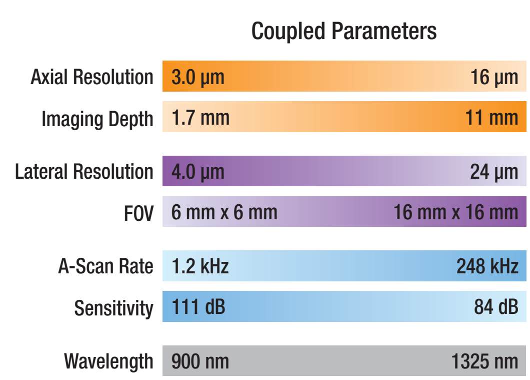
The OCT Base Unit and Scan Lens Kit are Key to OCT System Performance

Significant performance characteristics, including the axial resolution, A-Scan rate, and imaging depth, are entirely or strongly dependent on the design of the OCT base unit. The choice of scan lens kit determines other parameters, such as lateral resolution and the field of view (FOV). Thorlabs offers a variety of OCT base units and scan lens kits that provide foundations for systems with a wide range of capabilities.

Balancing Coupled Performance Parameters

In all optical systems, including OCT systems, interrelationships exist among optical parameters. Significant performance parameters that are coupled in OCT systems are shown to the right. Optimal OCT systems balance these parameters to achieve the best performance for an application.

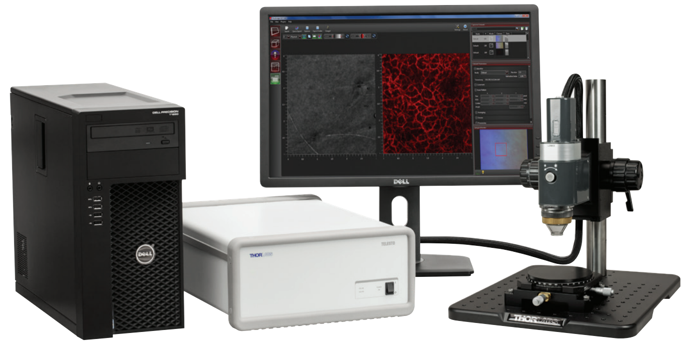
- Improving axial resolution contracts the maximum possible imaging depth.
- Improving lateral resolution contracts the field of view.
- A faster A-Scan (i.e., 1D depth scan) rate results in reduced sensitivity.
- A shorter wavelength improves lateral resolution but increases scattering from small features in tissue and other media.



Thorlabs' Modular OCT System Architecture

Building a Complete OCT System

Every OCT system is built from one each of our selection of OCT base units, beam scanning systems, and scan lens kits. Optional components include additional beam scanning systems and/or scan lens kits, as well as Z-spacers and accessories. We encourage you to contact us at OCT@thorlabs.com to discuss your particular requirements so that we may assist you in configuring a system optimal for your application.



An Example of a Complete System Shown with Z-Spacer, Stage, and Stand

OCT System Core Components

Base Unit

OCT Base Unit

LASER RADIATION
DO NOT VIEW DIRECTLY WITH OPTICAL INSTRUMENTS
CLASS 1M LASER PRODUCT

The OCT base unit includes a computer with pre-installed software and an enclosure such as the one shown to the left, which houses the optics, electronics, and light source. The OCT base unit measures the raw signal from the specimen and processes it to produce 1D depth profiles, 2D cross-sections, and 3D volumetric images. Our four series of OCT base units are called Vega, Telesto, Ganymede, and Callisto, and each is optimized for different parameters. A desktop computer and monitor ship with the Vega, Telesto, and Ganymede, and a laptop ships with the Callisto.

Beam Scanning System

The beam scanning system scans the light beam across the back aperture of the scan lens, which enables 2D cross-sectional (B-Scan) and 3D volumetric imaging of the specimen. Scanners for Telesto, Ganymede, and Callisto base units include the reference arm of the interferometer needed to generate the raw measurement (the Vega's reference arm is built into its OCT base unit). Standard, user-customizable, and handheld versions are available, and all types include a built-in high-resolution video camera. Surrounding the exit aperture of the scanner are white-light LEDs, which are not used for the OCT measurement but can be used to provide illumination for the video feed.

Beam Scanning Systems

Scan Lens Kits

Telecentric Scan Lens Kit

The scan lens directs the light beam to a specific point on the sample and collects the backscattered light from the sample. The kit includes an illumination ring that channels the white light for the video feed around the scan lens. Since the OCT probe beam passes through the scan lens and is not affected by the illumination guide, the use of the illumination guide is optional.

Optional Accessories

Z-Spacer

Locked into place between the scan lens and sample, the spacer assists in positioning the scanning system relative to the sample. Ring-type versions, which contact the sample away from the scanning area, and immersion-type varieties, which cover the scanned area with a glass plate, are available.

Z-Spacers

Stand

Our stand positions the standard and user-customizable beam scanners. The stand is useful for a wide range of applications, as it facilitates positioning the scanner at the correct height, stabilizes the scanner, and enables samples to be more easily exchanged.

Stand

Stage

Our stage offers X and Y translation and 360° rotation.

Stage

Preconfigured Systems

VEG210C1
Preconfigured OCT System

Thorlabs offers a number of preconfigured systems for each OCT series. Preconfigured systems ship with the three essential components: a base unit (including the PC), a scanning system, a scan lens kit, as well as two accessories: a scanner stand and a translation stage. These systems are optimized for out-of-the-box performance in most typical applications.

Preconfigured system specifications are strongly tied to the base unit and lens kit used in each system, which are given in the table to the right.

Specifications

Series Name	Preconfigured System Item #	Base Unit Item #	Scan Lens Kit Item #
Callisto	CAL110C1	CAL110	OCT-LK3-BB
Ganymede	GAN210C1	GAN210	
	GAN610C1	GAN610	
	GAN220C1	GAN220	OCT-LK2-B
	GAN620C1	GAN620	
Telesto	TEL210C1	TEL210	OCT-LK4
	TEL310C1	TEL310	
	TEL220C1	TEL220	OCT-LK3
	TEL320C1	TEL320	
Telesto PS-OCT	TEL210PSC2	TEL210PS	
	TEL220PSC2	TEL220PS	
Vega	VEG210C1	VEG210	OCT-LK4
	VEG220C1	VEG220	

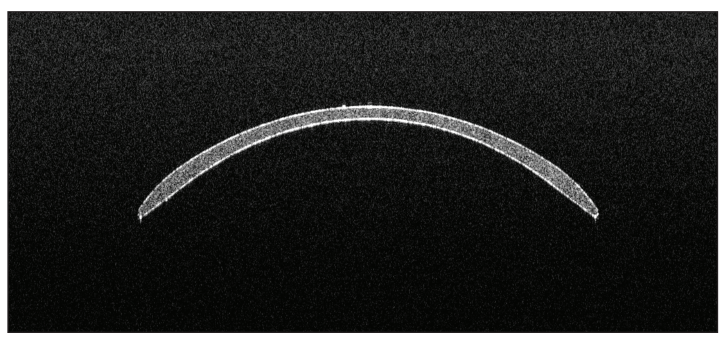
OEM System Development

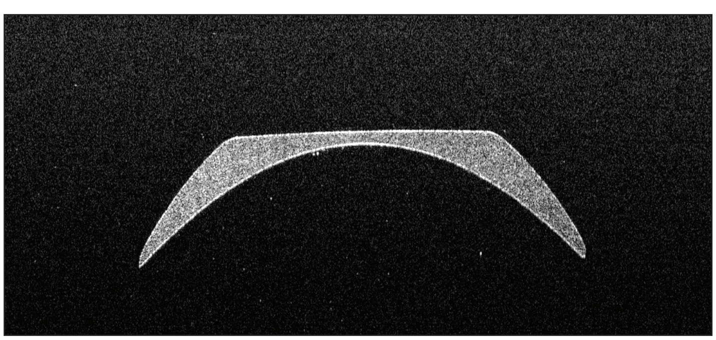
In addition to offering stocked OCT system components, Thorlabs has extensive OEM capabilities and welcomes the opportunity to work with your engineers to design a custom solution. We are able to customize the optics, mechanics, and electronics of our OCT components to achieve, for example, higher lateral resolutions, greater fields of view, or operation at different wavelengths.

One example of a customized OCT system is the Optimec *is*830, which is an instrument Optimec® Ltd. developed in close collaboration with Thorlabs. This instrument was designed to evaluate contact lenses, surrounded by an aqueous solution, for quality control purposes. The OCT measurements are used to determine parameters that include:

- Sagittal Height
- Diameter
- Curvature
- Thickness

This customized system operates in the 830 nm wavelength range and uses a custom compact OEM scanner.





2D Cross Sections of Different Contact Lenses Acquired with the Optimec *is*830. *Dimensions: 17.0 mm x 6.5 mm*

ThorImage® OCT Software

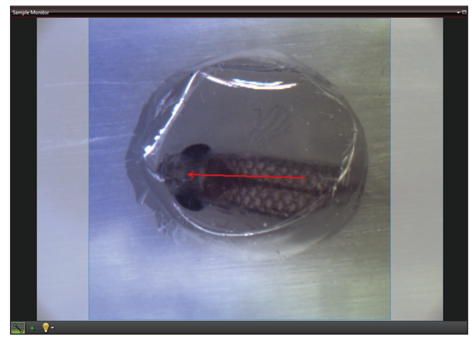
The high-performance ThorImage® OCT software is included with all Thorlabs OCT systems and is capable of data acquisition and processing, scan control, and OCT image display and manipulation. Features include:

- Interactive Scan Position Control through Video Display (Draw and Scan)
- Advanced Dataset Management
- High-Speed Volume Rendering of 3D Data
- Doppler and Speckle Variance Imaging
- Versatile Scan and Acquisition Control
- External A-Scan Trigger for Synchronization of External and OCT Experiments (Only Ganymede and Telesto Series)

Additionally, National Instuments®' LabVIEW® and C-based Software Development Kits (SDKs) are included.

Scan Control

The integrated camera provides a live video feed viewable in the software. The "Draw and Scan" feature defines the scan line for 2D scans or the area for 3D scans. Additionally, the software sets processing and averaging parameters, speed, and sensitivity.



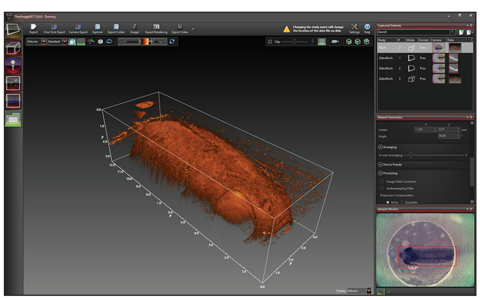
Draw and Scan 2D Guide Line on Video Image

2D Imaging Mode

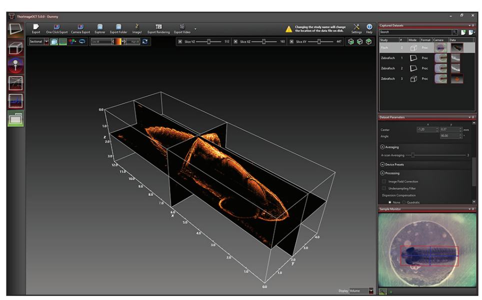
The beam scans in one direction and the OCT system acquires a cross-sectional image (B-Scan), which is displayed in real time. B-Scan averaging can be specified as well as A-Scan averaging before or after the Fourier transform.

3D Imaging Mode

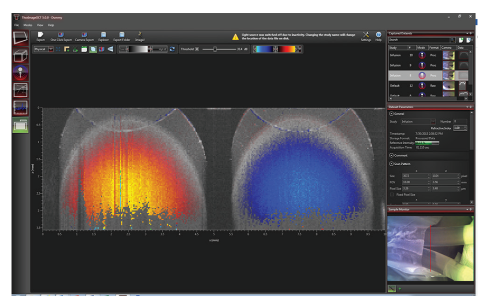
3D datasets can be viewed as volume renderings, or the content in orthogonal cross-sectional planes can be selected for exclusive display in 3D sectional views. The 3D view can be rotated as well as zoomed in and out. The fast volume rendering feature can be used to display real time lower-resolution volume images. These preview images can be helpful when a user is selecting a region of the sample over which to acquire a subsequent high-resolution volume scan.



3D Rendering View



3D Sectional View



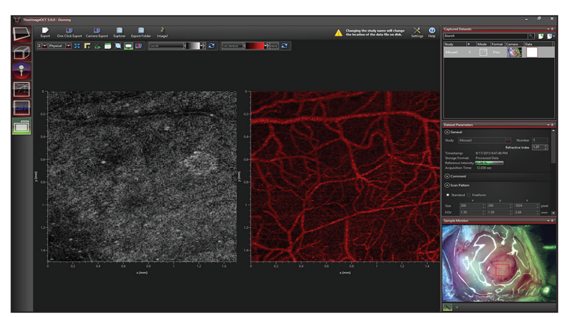
Doppler Image Showing Velocity of Rotated Plastic Stick with Opposite Flow Directions.

Doppler Mode

This mode measures movement occurring relative to the axis of the OCT probe beam. Doppler information can be overlaid on the OCT images in the form of a color map. The color coding indicates whether the flow occurred in a forward or backward direction, relative to the OCT beam.

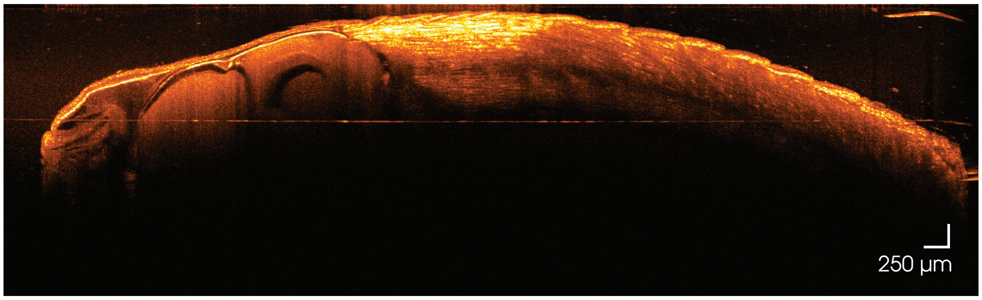
Speckle Variance Mode

By monitoring speckle patterns, this mode can highlight locations of particle movement and flow, although information about the direction of movement cannot be determined. Using this mode, significant blood flow is not required to visualize 3D vessel trees. Speckle variance images can be overlaid on the OCT image.

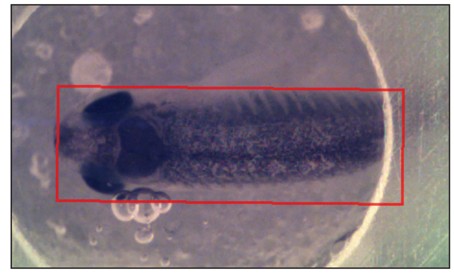


OCT Image on Left; Speckle Variance Image of Blood Vessels of a Mouse Brain on Right

In Vivo Imaging



2D Cross-Section of the Zebrafish, in which the Vertical Axis is Depth into the Specimen

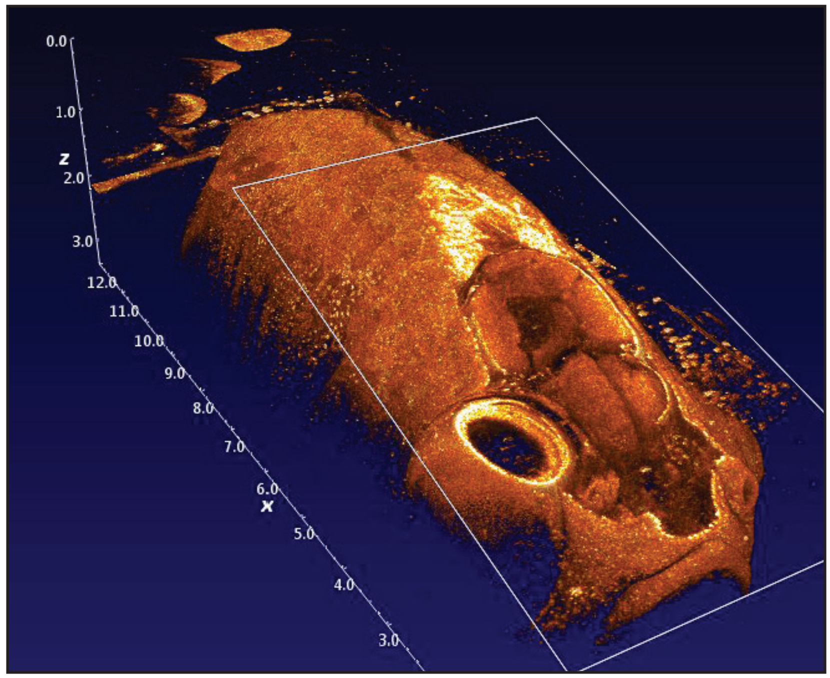


Still from the Live Video Feed of the Zebrafish Showing Area of Acquisition

The zebrafish (*danio rerio*) is a model organism used in various fields, which include cancer research and neuroscience. The images shown here were captured using a standard beam scanning system and the Telesto TEL220 base unit.

OCT imaging allows the inner organs of the same organism to be non-invasively examined and then re-examined, *in vivo*, at different stages of development.

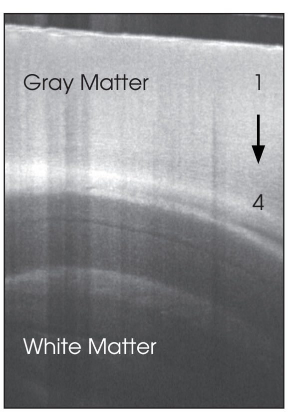
The camera and white-light LEDs integrated into the beam scanning system can be used to view a live video feed. Video is not recorded, but stills may be acquired. The video image is displayed in the ThorImage® OCT software and can be used to select an area over which to perform the 3D acquisition.



Sectioned 3D Image of the Zebrafish
Dimensions: 12 mm (X Axis), 4 mm (Y Axis), 3.6 mm (Z Axis)

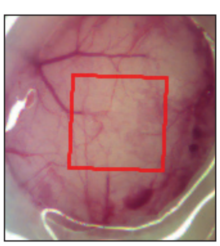
Sectioning the volume image at a user-selected plane gives a view of the interior of the subject. Post-processing the volume dataset allows cross-sectional images to be viewed in all three orthogonal planes, independent of the orientation in which the data were acquired. The view can also be rotated as well as zoomed in and out.

Vascular Imaging

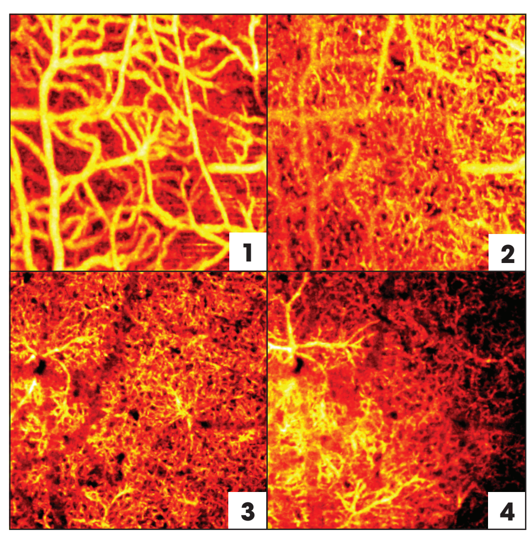


OCT Cross-Sectional Image of the Brain (B-Scan Depth Profile)
Dimensions:
2.6 mm x 1.5 mm

Vascular imaging in a mouse brain can be used to monitor the evolution of a disease or a stroke. An OCT cross-sectional image of the brain is shown on the left (B-Scan depth profile). These OCT images were acquired through a cranial window using the standard beam scanning system and the Telesto TEL220 base unit.



Still from the Live Video Feed Showing Area of Acquisition



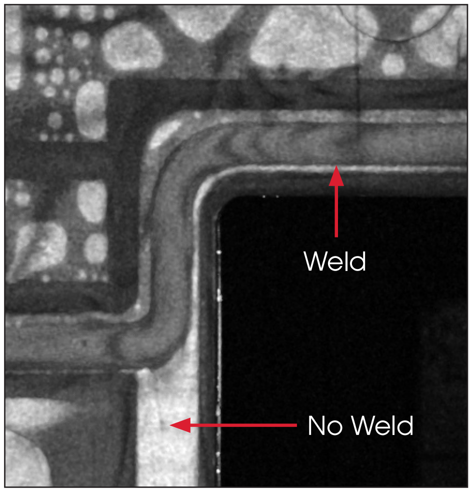
These blood vessel images were acquired using speckle variance OCT and are shown in *en face* view. Thick blood vessels are found at the top of the brain, and thinner capillaries are located deeper.
Dimensions: 1.5 mm x 1.5 mm

Images Acquired in Collaboration with MacVicar Lab, University of British Columbia

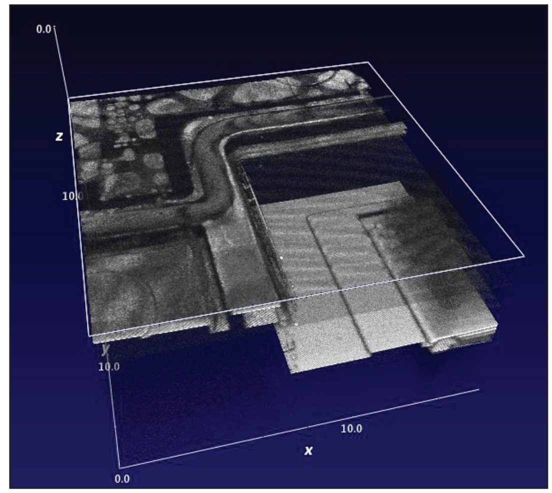
Non-Destructive Testing and Quality Control

Plastic welds are used in many industries to join individual plastic pieces. OCT imaging with the Vega VEG210 base unit and a standard beam scanner were used to inspect the welds made by the laser transmission welding technique. These images show a good quality weld and an intentionally weld-free region in a printer ink cartridge.

Standard beam scanning systems were paired with a Telesto TEL210 base unit for weld inspection (lower left) and a Ganymede GAN220 base unit to evaluate foil layer thicknesses (lower right), as described below. The stability and ease of use of our standard beam scanning system is well suited for these applications, which require 2D cross-sectional B-Scans to be acquired.



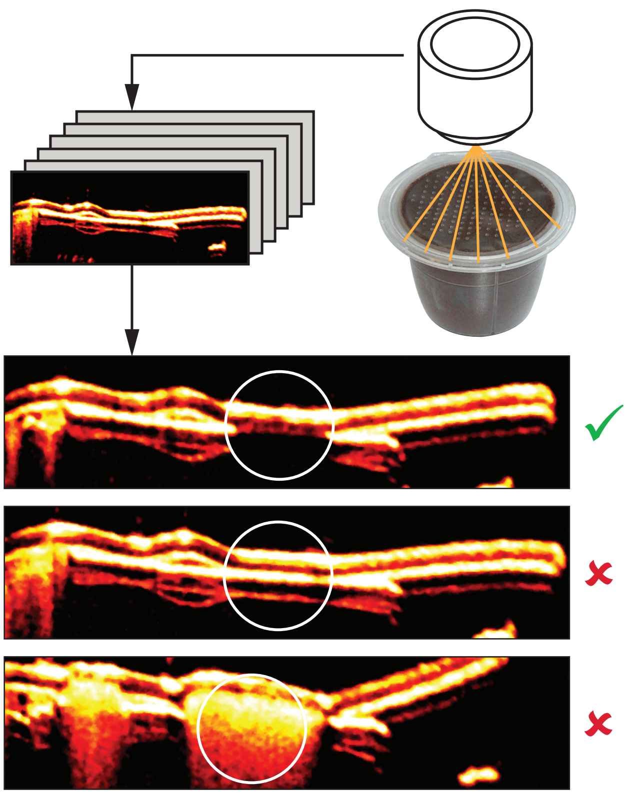
Post-Processed Image Composed of Several *En Face* Cross-Sections Viewed Together
Dimensions: 16 mm x 16 mm



3D Volumetric Rendering of a Region of the Ink Cartridge
Dimensions: 16 mm (X Axis), 16 mm (Y Axis), 11 mm (Z Axis)

Plastics Weld Inspection

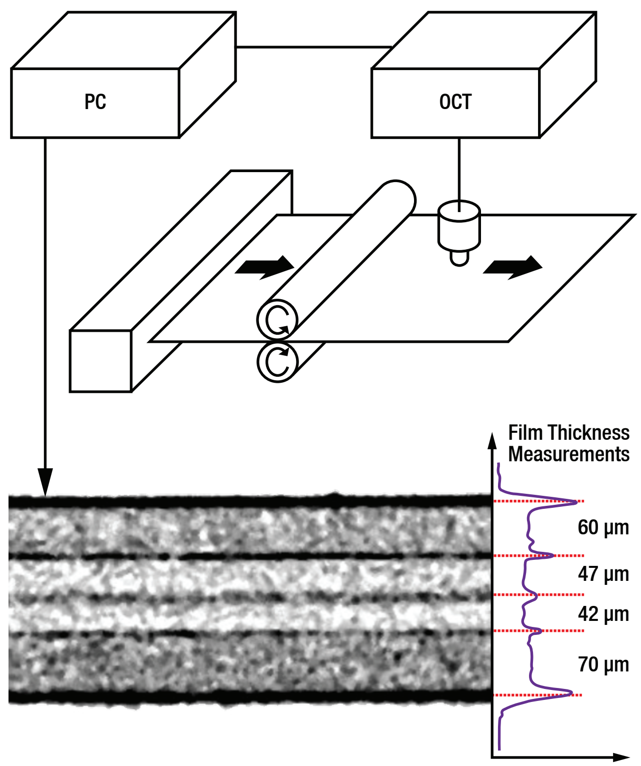
The welded seam of a coffee capsule is inspected at different positions by analyzing cross-sectional OCT images. Faulty regions can be detected by automated OCT image processing.



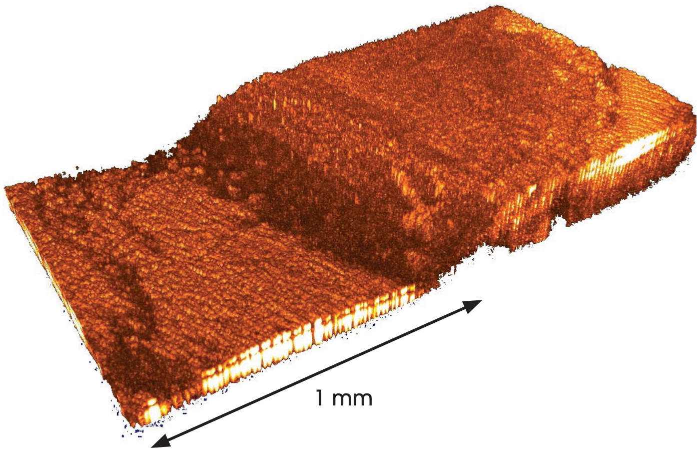
OCT imaging shows interfaces, such as between air and plastic. In the case of a successful weld, no air interface is visible between the underside of the foil and the top of the capsule.
Dimensions: 5.5 mm x 1 mm

Thickness Control

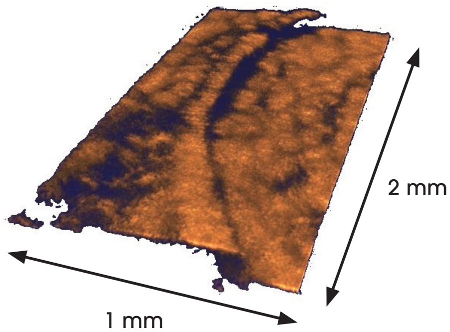
In-line thickness control of a multi-layered foil. The fixed scan head constantly acquires depth-resolved information from the moving foil. The film thickness parameters are extracted continuously and in real time through OCT image processing.

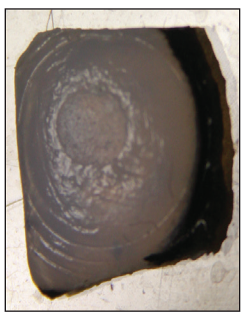


Opthalmology Research with a User-Customized Scanner

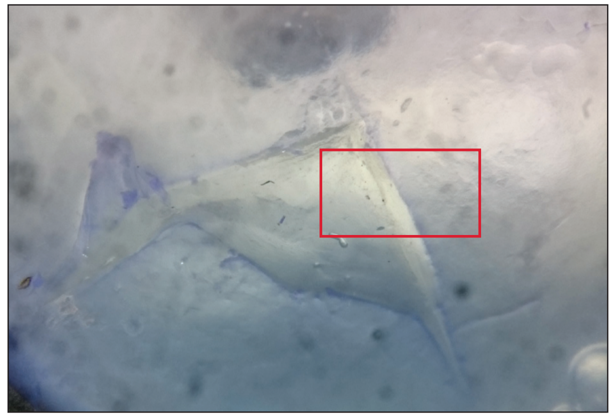


Images of a Bovine Cornea
Obtained after Ablation with a
Femtosecond Laser

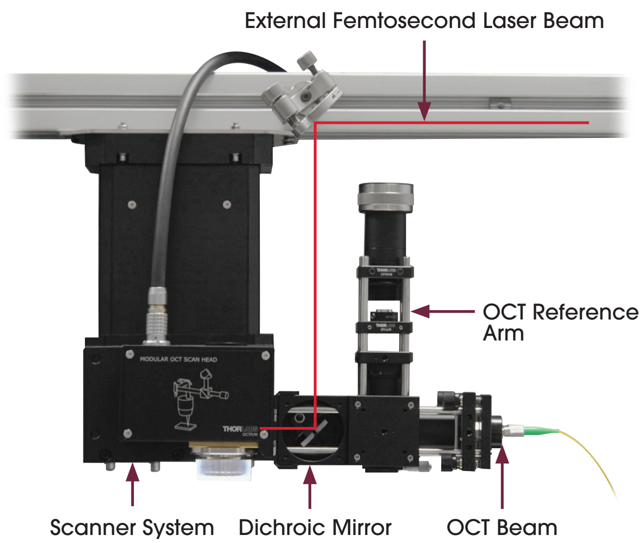




Courtesy of Fatih Ömer Ilday,
UFOLAB, Bilkent University
C. Kerse, et al., Nature **537**, 84 (2016).



Still from the Live Video Feed Showing Area of Acquisition



User-Customized OCTP-900 Beam Scanning System

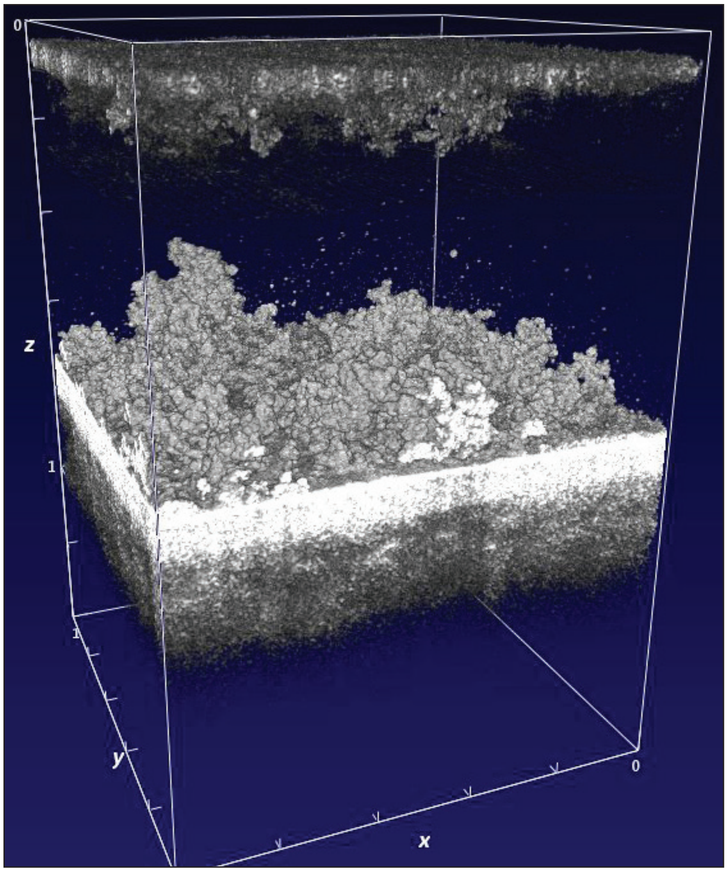
This ophthalmologic application combined a user-customized Thorlabs beam scanning system with a femtosecond laser that ablated material from a bovine cornea. The user-customized scanner enabled the femtosecond laser to be accurately positioned on the target spot of the cornea prior to ablation. After ablation, OCT imaging was used to evaluate the induced changes to the cornea.

This work required combining the femtosecond laser and the OCT light beams inside the beam scanning system so that they could both be focused on the same spot on the cornea. The OCTP-900 User-Customizable Beam Scanning System was configured for this task by adding a cage system segment containing a dichroic mirror between the scanning mirror segment and the reference interferometer arm segment. The OCTP-900 scanner was then mounted on an automated translation stage, which allowed fine tuning of its height above the cornea.

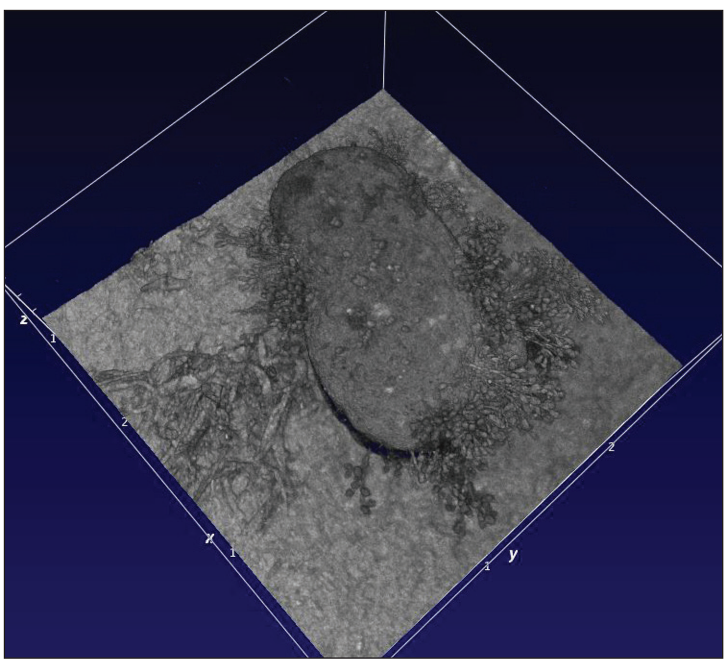
Prior to ablation, targeting was achieved by viewing the cornea using live feeds from the integrated video camera, which is a standard component of all beam scanning systems, as well as the OCT imaging system. This combination enabled the femtosecond laser ablation beam to be positioned anywhere on the cornea with high precision.

After targeting was completed, custom software controlling the beam scanning system moved the femtosecond laser beam spot over the specified area of the cornea. 3D modification of the cornea was accomplished by affixing the scanner to a vertically mounted translation stage, whose height was controlled during the ablation procedure.

After processing, high-resolution OCT images acquired using Thorlabs' ThorImage®OCT software were used to evaluate the quality of the results. The OCT base unit chosen for this work was the Callisto CAL110.



This OCT image shows the complex structure of a biofilm cultivated on a flat sheet membrane.
Courtesy of Michael Wagner, Chair of Water Chemistry and Water Technology, Karlsruhe Institute of Technology.
Dimensions: 1 mm x 1 mm x 1.4 mm



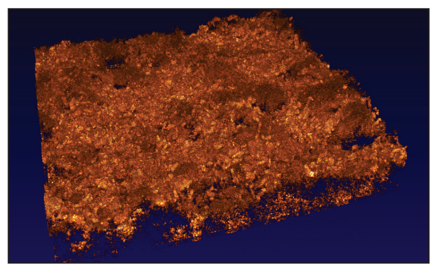
Aerobic granules, such as the one imaged above, are a subject of research in areas that include the biological treatment of wastewater in sewage treatment plants.
Courtesy of Michael Wagner, Chair of Water Chemistry and Water Technology, Karlsruhe Institute of Technology
Dimensions: 2.5 mm x 2.5 mm

Biofilms grow under harsh conditions and on various surfaces. OCT imaging is a powerful tool for investigating and understanding the growth and morphology of biofilms at the mesoscale. Particularly helpful to this study is the ability to perform real-time imaging of the biofilms under water flow.

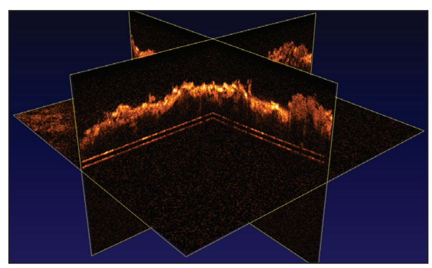
The OCT images shown on this page were obtained while the biofilms were in water, and the resulting visualizations reveal the morphology and fine structure of the biomass.

The ThorImage®OCT software enables examination from all angles by allowing the user to rotate and zoom the view. The volume data sets may also be post-processed to show cross-sectional or sectional views, in which multifaceted slices of the volume are shown by specifying the locations of the three orthogonal planes. This is illustrated by the images shown below.

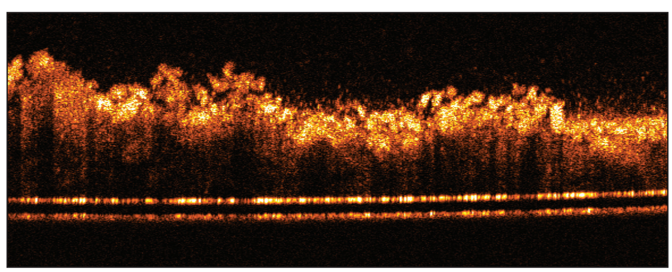
All biofilm images on this page were acquired using a Ganymede GAN210 OCT base unit and a standard beam scanning system. All volumetric image dimensions are listed in order of [X Axis] x [Y Axis] x [Z Axis].



3D Rendered Volume
Dimensions: 5 mm x 5 mm x 3 mm



3D Sectional Volume
Dimensions: 5 mm x 5 mm x 3 mm



2D Cross-Section; *Dimensions: 2.9 mm x 1.4 mm*

Biofilm images obtained in collaboration with the Chair of Separation Science and Technology, University of Kaiserslautern.

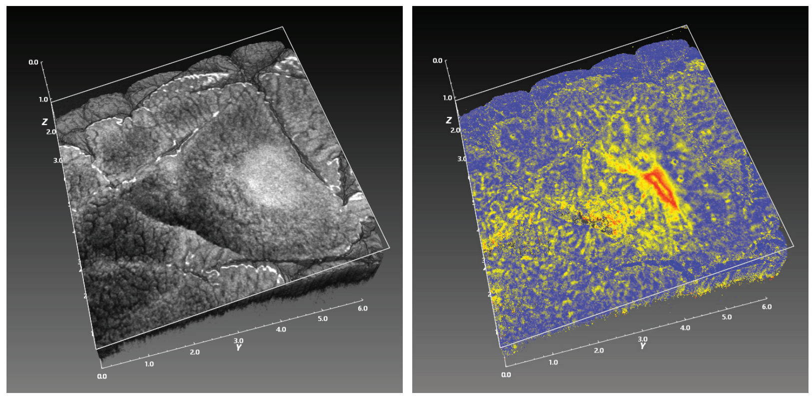
Polarization-Sensitive Imaging

Polarization-sensitive OCT (PS-OCT) systems use a polarization-maintaining design with specialized optics to enable measurement of polarization information in samples. Thorlabs' robust PS-OCT systems do not require calibration, are easy to set up, and are intuitive to use.

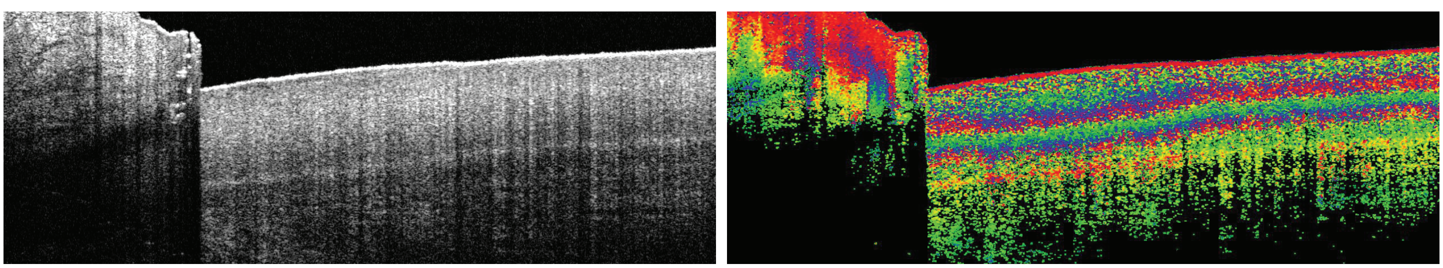
The examples shown here demonstrate the multifaceted capabilities of this cutting-edge technology, as measured using our Telesto TEL220PSC2 PS-OCT system. The grayscale images combine the intensity recorded by the dual detectors. Since each detector measures orthogonal linear polarizations of light, this eliminates banding that would occur in a traditional OCT system from birefringence in the sample.

For comparison to the grayscale intensity image of each sample, each colored image displays a unique mode of interpreting the polarization information, i.e., cumulative retardation, optic axis, or degree of polarization uniformity (DOPU). The mode ideal for each application depends on the birefringence properties of the sample.

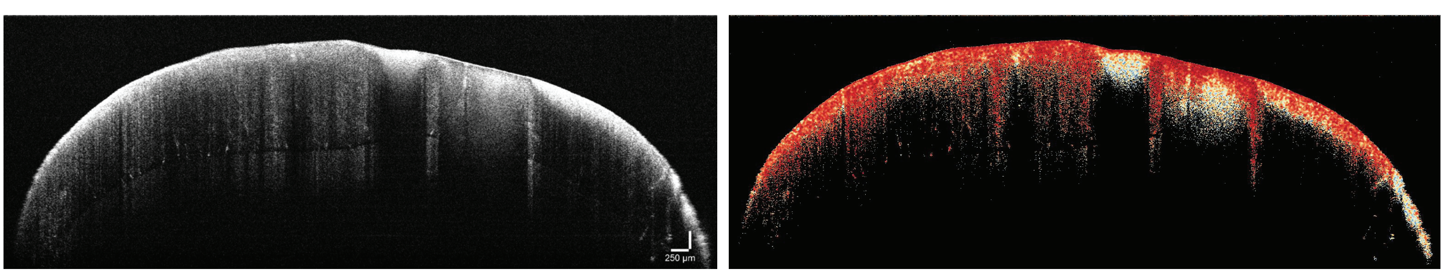
For example, the scar tissue (right) and fingernail (below) show a distinct change in polarization made visible by the retardation and optic axis modes, respectively. The tooth (bottom of the page), on the other hand, shows depolarization as the sample scatters the polarized light back as non-polarized light. This effect is clearly shown in the DOPU image, but would not be observed in either of the other two polarization modes.



In the total intensity OCT image (left), both scarred and unscarred skin appear indistinguishable. In the retardation image (right), however, the unscarred skin tissue gives a uniform signal while the scarred tissue is easily distinguished by the change in collagen structure causing retardation.
Dimensions: 6 mm (X Axis), 6 mm (Y Axis), 3.5 mm (Z Axis)



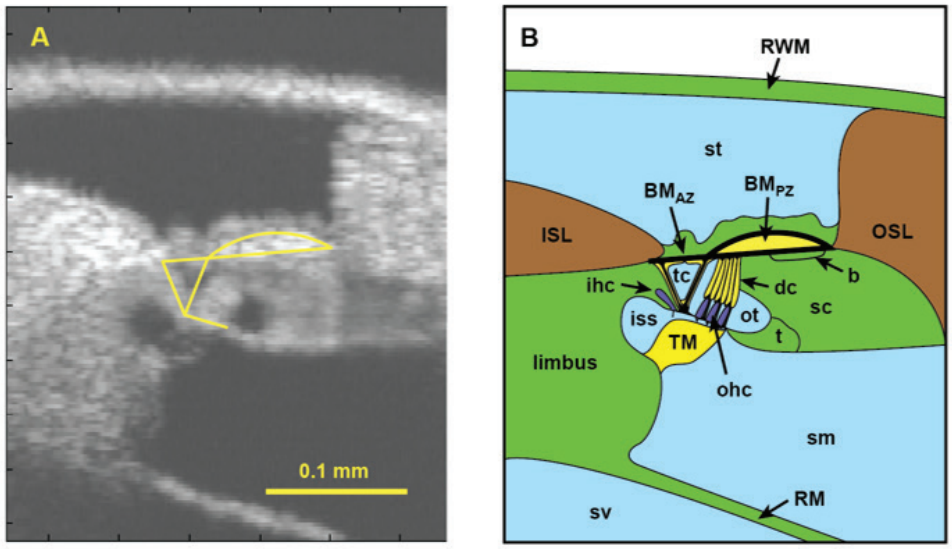
Skin is on the left and fingernail is on the right in both the intensity (left) and polarization (right) images of this nail bed. Compared to the skin tissue where only certain interfaces induce a change in the optic axis, the regularly oriented structure of the finger nail leads to a continuous change in the optic axis signal, appearing as strata.
Dimensions: 4.5 mm x 1.5 mm



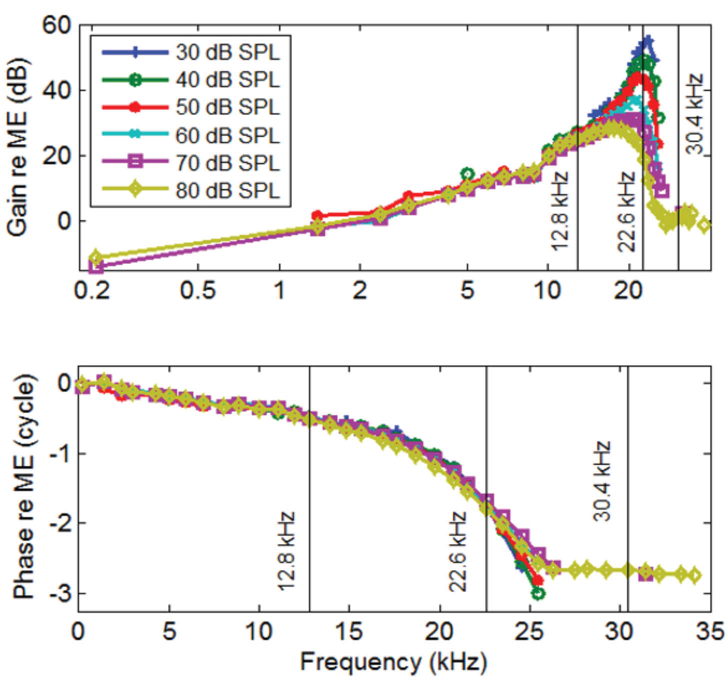
Caries lesions in the enamel of a tooth cause a destruction of the ordered structure. Although similar in intensity (left), light reflected off the lesion becomes depolarized compared to healthy enamel, as seen in the DOPU image (right).
Images Taken in Collaboration with H. Schneider, University Medical Center Leipzig, Germany
Dimensions: 10 mm x 3.5 mm

Several of the biomechanical mechanisms underlying the function of the mammalian inner ear have not been well understood because of difficulties in the microscopic scale of the structures and *in vivo* accessibility. The imaging depth and high speed offered by Thorlabs' new OCT systems facilitate new avenues of investigation into micromechanics, such as in this application. While a Telesto system was used in this experiment, the Ganymede GAN620C1 system offers even higher speeds at much finer resolution, opening up further opportunities for OCT research. Both Ganymede and Telesto OCT systems can be externally triggered using TTL pulses to align external excitation with OCT detection, as was done in this experiment with an acoustic stimulation system and a Telesto TEL320C1 system.

Operating at a central wavelength of 1300 nm, the TEL320C1 system provided cross-sectional and axial images at a sampling rate of 111.6 kHz. Cooper, et al. were able to image the inner cochlea of a gerbil with unprecedented spatial resolution by going through the round window. As shown in the images to the right, the cross-sectional intensity image of a living, intact gerbil cochlea could be directly mapped onto known anatomical structures.



Cross Section of the Gerbil Cochlear Partition: In Vivo OCT Image (Left) and Schematic Diagram (Right); Key Visible Structures: Basilar Membrane (BM), Round Window Membrane (RWM), Inner/Outer Spiral Lamina (ISL/OSL), Tectorial Membrane (TM), and Reissner's Membrane (RM)



Basilar Membrane Tuning Measured by OCT Vibrometry Shown as Magnitude and Phase Curves, Normalized by Stapes Motion

Vibration measurements (M-scans) were taken at specific loci in the XY plane guided by the intensity images. M-scans are axial OCT images taken at a single spot over time. At each locus, a series of about 1.5 million M-scans were recorded, so the movement of each structure could be determined in response to the input sound wave, normalized for the motion of the stapes. By analyzing the phase of the OCT signal instead of the intensity, a much higher axial resolution can be achieved, enabling vibrometry measurements with noise-floors down to ~3 pm/√Hz in the middle ear.

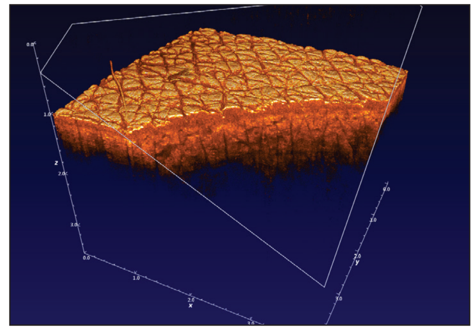
The magnitude of the vibration response in the basilar membrane is shown in the top-left graph. Since both the sound generation and vibration detection were triggered at the same time using TTL pulses, the phase shift between excitation and response of the cochlea could be analyzed (see bottom-left graph).

Images Courtesy of N.P. Cooper, A. Vavakou, and M.V.D. Heijden, Nature Communications **9**, 3054 (2018).
Data Courtesy of Marcel van der Heijden of Erasmus MC Rotterdam.

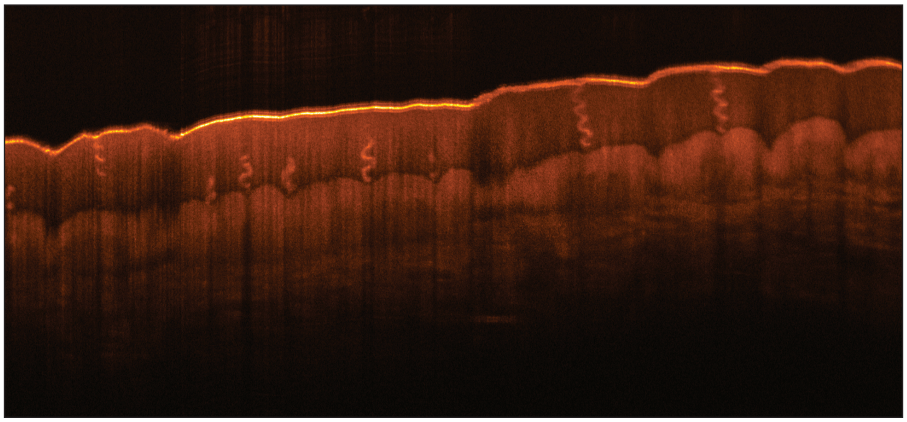
Skin Imaging

OCT imaging can be used to monitor the thickness of skin layers, detect wrinkles, and differentiate between fake and real fingerprints.

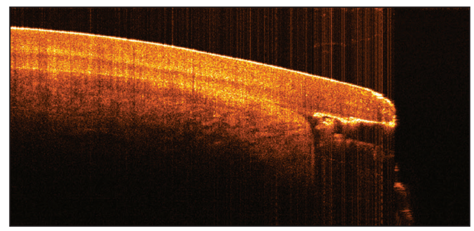
These images were acquired using a standard beam scanner and the Telesto high-resolution base unit. Stable *in vivo* imaging is facilitated by the use of spacers to minimize motion artifacts, such as the OCT-AIR3, OCT-IMM3, or OCT-IMM4 spacers for standard scanning systems.



3D Volumetric Image of a Forearm
Dimensions: 4 mm (X Axis), 4 mm (Y Axis), 3 mm (Z Axis)



In this 2D cross-section of a fingertip, the sweat ducts in the epidermis top layer are clearly visible, as is the underlying dermis.
Dimensions: 6 mm x 3 mm



2D Cross-Section of a Fingernail and Underlying Skin
Dimensions: 7.5 mm x 3.6 mm

Callisto OCT Base Unit

High Sensitivity and Economical Imaging

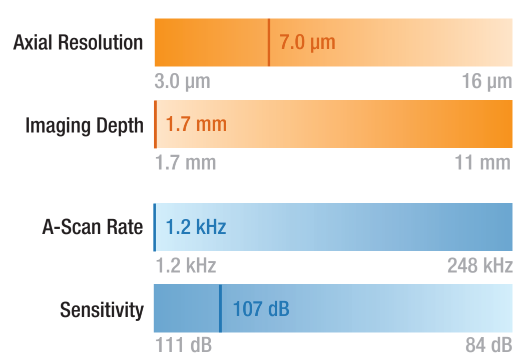
The Callisto CAL110 OCT base unit performs high-sensitivity imaging of *in vitro* and excised samples while being an appealing economical choice for many research and educational institutions. It is compatible with the full range of beam scanning systems, scan lens kits, options, and accessories used by the Ganymede series OCT base units.

Systems built using the Callisto base unit are easily ported between benchtops or classrooms. The portability of the systems is enhanced by the Callisto base unit's inclusion of a laptop computer, rather than the desktop computer that ships with the Vega, Telesto, and Ganymede base units.

Specifications

High Sensitivity Imaging

OCT Base Unit	CAL110
Center Wavelength	930 nm
Light Source	Single SLD
Axial Resolution (Air/Water)	7.0 µm/5.3 µm
Imaging Depth (Air/Water)	1.7 mm/1.3 mm
A-Scan Line Rate	1.2 kHz
Sensitivity	107 dB



High-Resolution Imaging

Our GAN220 and GAN620 very-high-resolution base units feature Thorlabs' highest resolution OCT imaging capability and operate at a center wavelength of 900 nm. Their 3.0 µm axial resolution in air translates into even better resolution in more optically dense media, such as tissue. This performance is achieved through optimized system design, operation around 900 nm, and use of an extended bandwidth light source. The GAN220 is well suited for general purpose imaging, while the GAN620 is capable of much higher A-Scan rates.

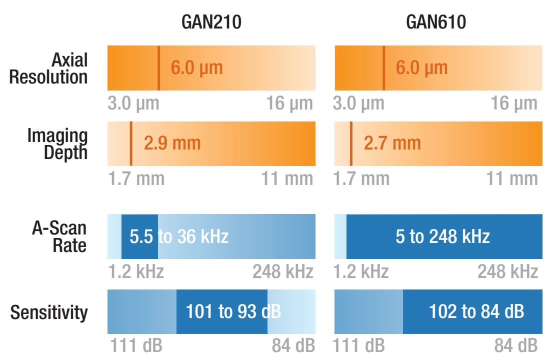
The GAN210 and GAN610 high-resolution base units operate at a center wavelength of 930 nm. The GAN210 is well suited for applications that do not require operation at the highest speeds or imaging to the deepest levels. The GAN610 is capable of much higher scan rates.

It is possible to tune the sensitivity of these base units by adjusting the A-Scan rate; decreasing the A-Scan rate increases the sensitivity of the OCT system by enabling longer integration times. Due to the low absorption of water at 900 nm, the Ganymede OCT base units are our recommended choice for imaging samples in water.

Specifications

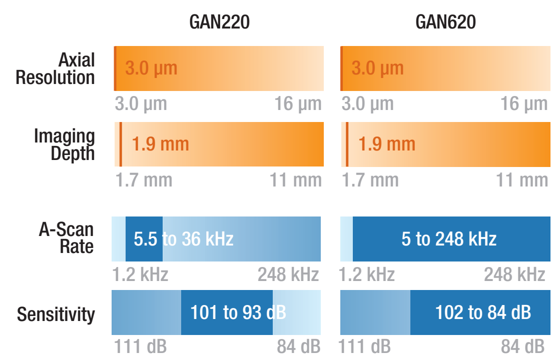
High Axial Resolution

OCT Base Unit	GAN210	GAN610
Center Wavelength	930 nm	
Light Source	Single SLD	
Axial Resolution (Air/Water)	6.0 µm/4.5 µm	
Imaging Depth (Air/Water)	2.9 mm/2.2 mm	2.7 mm/2.0 mm
A-Scan Line Rate	5.5 kHz to 36 kHz	5 kHz to 248 kHz
Sensitivity	93 dB - 101 dB (36 kHz - 5.5 kHz)	84 dB - 102 dB (248 kHz - 5kHz)



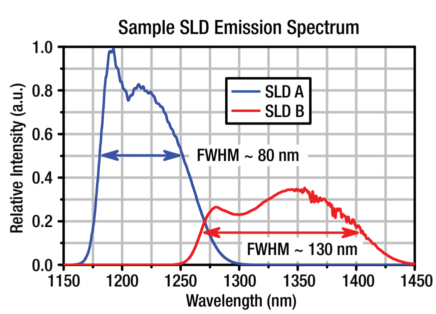
Very High Axial Resolution

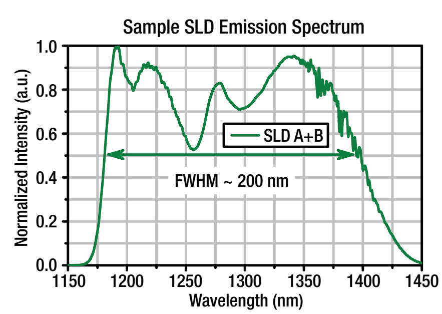
OCT Base Unit	GAN220	GAN620
Center Wavelength	900 nm	
Light Source	Dual SLD, Extended Bandwidth	
Axial Resolution (Air/Water)	3.0 µm/2.2 µm	
Imaging Depth (Air/Water)	1.9 mm/1.4 mm	
A-Scan Line Rate	5.5 kHz to 36 kHz	5 kHz to 248 kHz
Sensitivity	93 dB - 101 dB (36 kHz - 5.5 kHz)	84 dB - 102 dB (248 kHz - 5kHz)



Extended-Bandwidth Sources for High-Resolution Imaging

The extended-bandwidth sources in our very high-axial-resolution 900 nm Ganymede (GAN220 and GAN620) and 1300 nm Telesto (TEL220, TEL220PS, and TEL320) spectral domain OCT base units combine the emission of a pair of hand-picked SLDs. The extended-range light source used in the TEL220, TEL220PS, and TEL320 has a spectrum similar to that of the combined A and B SLDs, shown in the graphs below. In contrast, the Telesto long-range systems use SLDs with emission spectra similar to SLD B.





Telesto Series OCT Base Units

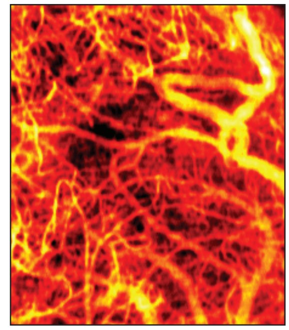
Deep and High-Resolution Imaging in Scattering Media

Deep imaging in scattering media is enabled in part by having the Telesto light sources operating at center wavelengths of 1300 nm or 1325 nm, as scattering effects are less pronounced at longer wavelengths. In general, axial resolution is better when the OCT light source possesses a higher bandwidth. Because of this, all of our spectral domain OCT base units include superluminescent diodes (SLDs) with broad spectral widths.

The 1325 nm SLD sources in the Telesto long-range OCT base units (TEL210 and TEL310) deep imaging in scattering media, such as tissue. The Telesto high-resolution OCT base units (TEL220 and TEL320) adapt the Telesto design to achieve even finer resolution. This is done in part by coupling the emission of two SLDs with offset center wavelengths, which further increases the bandwidth of the OCT light source.

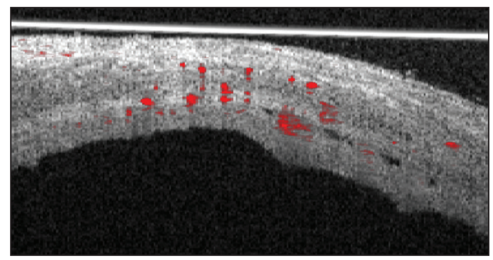
The most significant difference between the two Telesto high-resolution OCT base units, as well as between the two Telesto deep imaging versions, is the maximum A-Scan rate. A-Scan rates of up to 76 kHz can be specified for the standard versions, and rates up to 146 kHz can be achieved by the high-speed versions. The standard and high-speed versions for each model produce equal image quality when the two operate at the same speed.

Sensitivity improves as the A-Scan rate decreases. The user can tune the sensitivity of each Telesto OCT base unit by adjusting its A-Scan rate; decreasing the A-Scan rate increases the sensitivity of the OCT system by enabling longer integration times.



The *en face* view at left shows the vascular system of a sheep's ovary produced using speckle variance OCT and a TEL220 base unit. *Dimensions: 2.3 mm x 2.6 mm*

The 2D OCT profile view (B-Scan) below shows red vascular highlights located using speckle variance OCT and overlaid on the OCT image. Scans were acquired using the OCT-IMM3 Z-Spacer to achieve deeper imaging into the sample.
Dimensions: 2.4 mm x 1.5 mm



Images Acquired in Collaboration with Vassilis Sboros from Heriot-Watt University and Colin Duncan at the MRC Centre for Reproductive Health, The University of Edinburgh

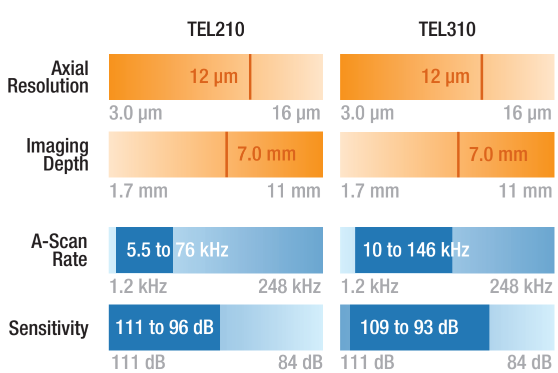
Specifications

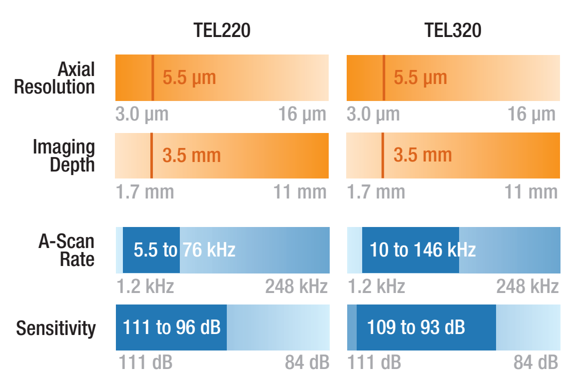
Deep Imaging in Scattering Media

OCT Base Unit	TEL210	TEL310
Center Wavelength	1325 nm	
Light Source	Single SLD	
Axial Resolution (Air/Water)	12 µm/9.0 µm	
Imaging Depth (Air/Water)	7.0 mm/5.3 mm	
A-Scan Rate	5.5 kHz to 76 kHz	10 kHz to 146 kHz
Sensitivity	96 dB - 111 dB (76 kHz - 5.5 kHz)	93 dB - 109 dB (146 kHz - 10 kHz)

High Axial Resolution in Scattering Media

OCT Base Unit	TEL220	TEL320
Center Wavelength	1300 nm	
Light Source	Dual SLD, Extended Bandwidth	
Axial Resolution (Air/Water)	5.5 µm/4.2 µm	
Imaging Depth (Air/Water)	3.5 mm/2.6 mm	
A-Scan Rate	5.5 kHz to 76 kHz	10 kHz to 146 kHz
Sensitivity	96 dB - 111 dB (76 kHz - 5.5 kHz)	93 dB - 109 dB (146 kHz - 10 kHz)



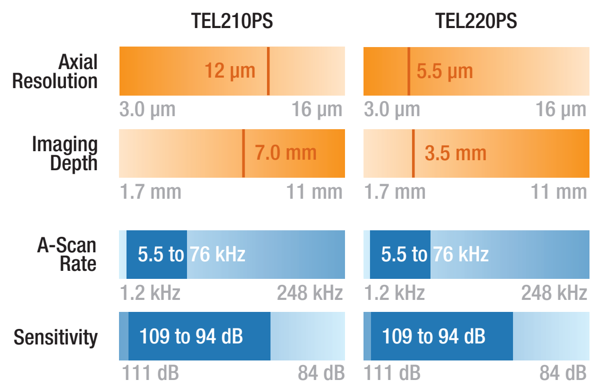


Polarization-Sensitive OCT (PS-OCT) Imaging

The Telesto PS-OCT base units (TEL210PS and TEL220PS) build on the basic Telesto design, incorporating a dual-detector design and specialized optics to enable the capture of polarization information as well as high-quality intensity images. This polarization information can be characterized as cumulative retardation, optic axis, or degree of polarization uniformity (DOPU), providing an additional layer of contrast to a standard OCT image. The additional contrast may reveal typically unobserved features that result from the internal microstructure of samples (e.g. tissue, plastic, or crystals).

Specifications

OCT Base Unit	TEL210PS	TEL220PS
Center Wavelength	1325 nm	1300 nm
Light Source	Single SLD	Dual SLD, Extended Bandwidth
Axial Resolution (Air/Water)	12 µm / 9.0 µm	5.5 µm / 4.2 µm
Imaging Depth (Air/Water)	7.0 mm / 5.3 mm	3.5 mm / 2.6 mm
A-Scan Rate	5.5 kHz to 76 kHz	5.5 kHz to 76 kHz
Sensitivity	94 dB – 109 dB (76 kHz – 5.5 kHz)	



Complete PS-OCT System

A complete PS-OCT system consists of one base unit, a scanning system, and a scan lens kit, as described by the schematic diagram to the right. The base unit houses the superluminescent diode (SLD) broadband source and polarization-sensitive detection module, while the scanning system contains both arms of the interferometer, including two quarter-wave plates.

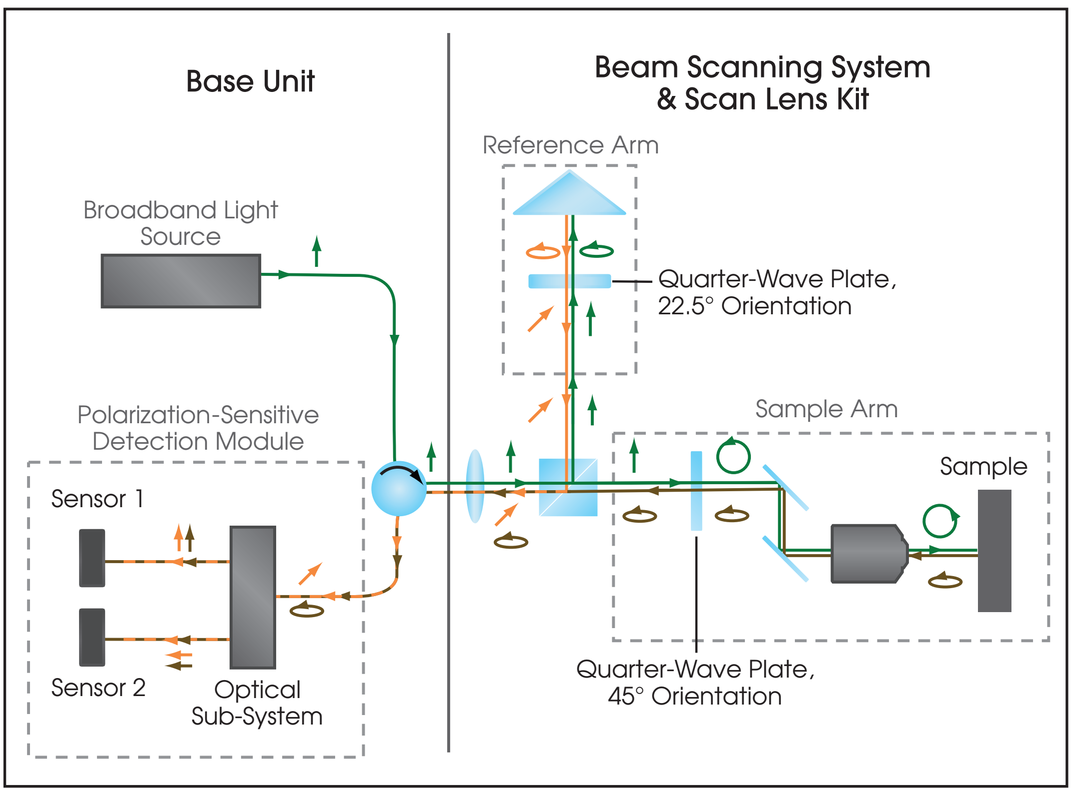


Diagram of Complete Telesto PS-OCT System, including Base Unit, Scanning System, and Lens Kit

Starting with the linearly polarized light from the SLD, the quarter-wave plate in the reference arm orients the light returning to the beamsplitter at a 45° angle relative to the input light. The quarter-wave plate in the sample arm causes circularly polarized light to be incident on the sample. At the detection module, the light from both arms is split into its two orthogonal linear polarization components, sending one orientation to Sensor 1 and the other to Sensor 2.

The interference of the components from each arm provides the polarization information which the PS-OCT system can use to calculate the Stokes vectors for each image point, which are the basis for the special polarization modes of this OCT system. The dual-detector system also removes birefringence-induced extinction banding effects from intensity images.

Vega Series OCT Base Unit

VEG210
Base Unit

Long-Range Imaging at High Scan Rates

The swept-source design of the Vega OCT base units enables an extensive imaging depth range while delivering high A-Scan rates. Please note that optical absorption and scattering effects of the specimen frequently limit the depth to which the light probe can penetrate. For an OCT system to provide valid measurements over the full quoted imaging depth range, the light probe must be able to penetrate the sample to a depth equal to the imaging depth.

The VEG210 base unit offers the deepest imaging capabilities of all Thorlabs OCT systems at 11 mm in air. The VEG220 base unit maintains a comparable 8.0 mm imaging depth in air while offering a 200 kHz A-scan rate.

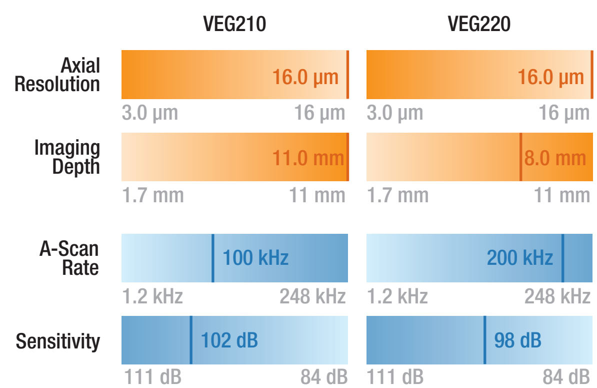
The swept-wavelength laser source used in the Vega base units always emits a narrow linewidth laser beam with long coherence length. During operation, the center wavelength of this single mode emission is quickly tuned across a broad spectral range. As the wavelength sweeps, a detector records the backscattered intensity from the sample as a function of time (wavelength).

Because the laser's power is always concentrated at a single wavelength, instead of spread across a wide spectral width, it produces a stronger backscattered signal at each wavelength than is possible with a broadband source possessing comparable total output power.

Specifications

Deep Imaging in Scattering Media

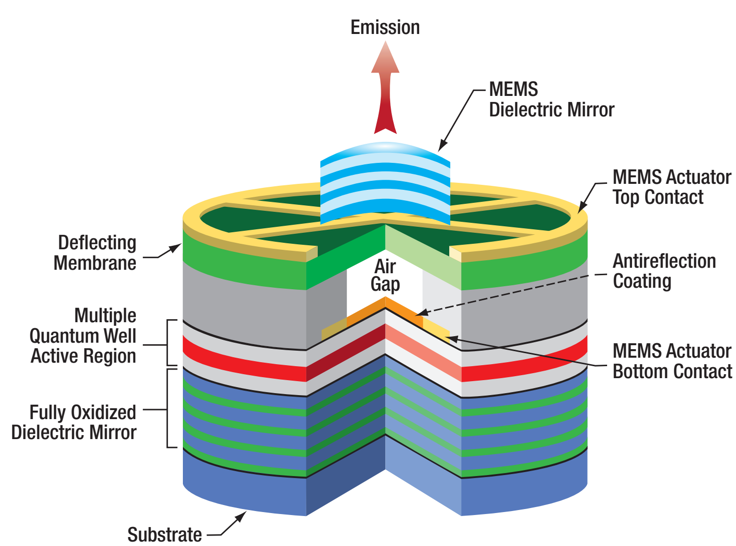
OCT Base Unit	VEG210	VEG220
Center Wavelength	1300 nm	
Light Source	Swept-Wavelength MEMS VCSEL	
Axial Resolution (Air/Water)	16 µm/12 µm	
Imaging Depth (Air/Water)	11 mm/8.3 mm	8.0 mm/6.0 mm
A-Scan Line Rate	100 kHz	200 kHz
Sensitivity	102 dB	98 dB



MEMS-VCSEL Source for OCT

The swept laser source is a vertical cavity surface emitting laser (VCSEL) that possesses a micro-electromechanical (MEMS) mirror and a single-longitudinal-mode cavity. The laser operates mode-hop-free throughout its entire tuning range, which is in excess of 100 nm.

The laser was developed by Praevium Research in collaboration with Thorlabs and MIT. It overcomes the modest output power and wavelength tuning ranges that characterize other VCSELs through its low mass MEMS mirror and the use of a semiconductor optical amplifier (SOA), which also makes the output more uniform across the spectrum.



Beam Scanning Systems and Scan Lens Kits

Beam Scanning Systems

Scanning systems rapidly sweep the OCT light beam across the back aperture of the scan lens, which enables 2D cross-sectional (B-Scan) and 3D volumetric imaging of the specimen. Any beam scanning system type is exchangeable with the other types, making it possible to choose the best option for a given application.

Each beam scanning system consists of up to three separate subsystems:

- A mirror system that scans the light beam across the back aperture of the scan lens.
- The reference arm of the measurement interferometer, whose output is the raw optical signal. (This is true for the Telesto, Ganymede, and Callisto base units. The reference arm of the Vega is in its base unit.)
- A built-in and high-resolution video camera with white-light LEDs surrounding the exit aperture that provides illumination for the live video feed.

Standard (OCTG)

The standard model, which offers stability and ease of use, is ideal for general-purpose OCT imaging applications. Packaged in a rugged and light-tight housing, the standard scanner prevents misalignment of the scanning beam.

User-Customizable (OCTP)

For users who require flexibility in configuring the optical beam path in their OCT imaging system, the user-customizable models are built with Thorlabs' SM1 and 30 mm cage system components to support customization.

Handheld (OCTH)

Applications that benefit from the use of the portable handheld model include imaging samples spread over a large area, or areas that are difficult to reach. It is lightweight, ergonomic, and easily maneuverable, and its user-configurable buttons make it convenient to use.

Standard Model

User-Customizable Model

Handheld Model

Scan Lens Kit

Whether your application requires high lateral resolution, long working distance, increased depth of focus, or a balance, our OCT scan lens kits are designed for optimal OCT image quality across a large field of view. These telecentric objective lenses direct the OCT light beam to a specific point on the sample and collect the backscattered light.

These easily interchanged scan lens kits include:

- Telecentric Objective Scan Lens
- Illumination Tube
- IR Card (Not Shown)
- Calibration Target (Not Shown)

When exchanging scan lenses mounted to a standard beam scanning system, a reference arm adapter is required. Please contact us at OCT@thorlabs.com for more details. The illumination tube channels white light from the ring of LEDs on the beam scanner to the sample for acquiring video. While included in the kit, its use is not required.

Options and Accessories

Sample Z-Spacers Provide Imaging Stability

Thorlabs' Sample Z-Spacers enable optimal positioning of a beam scanning system relative to the sample. Fine adjustments can be made to their height, and then they can be locked into place for increased stability. Ring types contact the sample away from the scanned area, while immersion types press a glass window into contact with the scanned area. This can result in better penetration of the OCT beam into the sample by reducing strong back reflections that often occur at the sample's surface.

Spacers are particularly important for the handheld probes, as they maintain a fixed distance between the sample and the probe, which keeps the sample in focus during operation.

OCTH-1300 Handheld Scanner Shown with OCTH-AIR30 Z-Spacer

Immersion-Type Z-Spacers

Ring-Type Z-Spacer

Convenient Imaging Accessories

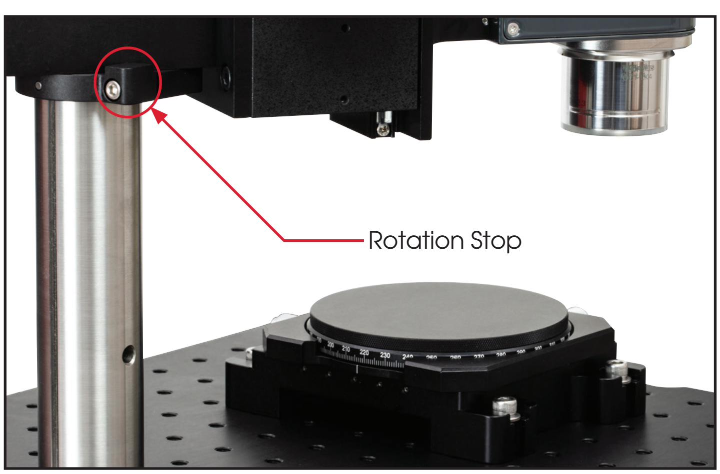
Leveraging Thorlabs' long history of optomechanical design expertise, we offer a stand for mounting our standard and user-customizable beam scanning systems and a sample positioning stage, which provides X and Y translation as well as 360° rotation.


OCT-XYR1
Sample Positioning Stage

Both accessories are offered with either imperial or metric taps (the latter denoted by a /M at the end of the item #). The OCT-STAND(/M) consists of a post-mounted focus block with knobs that provide both coarse (40 mm/rev) and fine (225 µm/rev) Z translation. The focus block slides along the included Ø1.5" post which is secured to a 12" x 14" (300 mm x 350 mm) aluminum breadboard.

The aluminum breadboard is designed to accommodate the mounting of the OCT-XYR1(/M) sample positioning stage as well. This stage features precise translation and rotation of a solid plate, enabling easy sample mounting and cleaning. The X and Y micrometers offer 1/2" (13 mm) of travel with graduations every 0.001" (10 µm) and the engraved angular scale has graduations every 1° for setting rotational position of the stage.


OCT-STAND
Stand for Scanning System



Rotation and Height Collar Allows Scanner to be Moved for Sample Stage Access Without Misalignment

Compatible with all Standard and User-Customizable Scanning Systems, these two accessories are designed to be a simple solution for securely, repeatably positioning the scanner and sample. The rotation and height collar included with the OCT-STAND(/M) allows the focus block to rotate 45° away from a sample centered on the OCT-XYR1(/M) stage mounted to the breadboard. As shown in the image to the left, this enables a user to access the sample between scans and return the scanner to its original position without misalignment.

OCT System Component Overview

OCT Base Units[a]

Item #	Callisto CAL110	Ganymede GAN210	Ganymede GAN610	Ganymede GAN220	Ganymede GAN620	Telesto TEL210PS	Telesto TEL220PS
OCT System Type	Spectral Domain						
Key Performance Features	Laptop PC for Maximum Portability	High Resolution		Very High Resolution		High Imaging Depth	High Resolution
		General Purpose	High Speed	General Purpose	High Speed	Polarization-Sensitive Imaging	
Center Wavelength	930 nm	930 nm		900 nm		1325 nm	1300 nm
Light Source	Single SLD	Single SLD		Dual SLD		Single SLD	Dual SLD
Optical Bandwidth	>100 nm	>100 nm		>170 nm		>100 nm	>170 nm
Axial Resolution (Air/Water)	7.0 µm/5.3 µm	6.0 µm/4.5 µm		3.0 µm/2.2 µm		12 µm/9.0 µm	5.5 µm/4.2 µm
Imaging Depth[b] (Air/Water)	1.7 mm/1.3 mm	2.9 mm/2.2 mm	2.7 mm/2.0 mm	1.9 mm/1.4 mm		7.0 mm/5.3 mm	3.5 mm/2.6 mm
A-Scan Rate	1.2 kHz	5.5, 15, & 36 kHz	5, 10, 25, 50, 100, 200, & 248 kHz	5.5, 15, & 36 kHz	5, 10, 25, 50, 100, 200, & 248 kHz	5.5, 28, 48, & 76 kHz	
Sensitivity	107 dB	93 to 101 dB (36 to 5.5 kHz)	84 to 102 dB (248 to 5 kHz)	93 to 101 dB (36 to 5.5 kHz)	84 to 102 dB (248 to 5 kHz)	94 to 109 dB (76 to 5.5 kHz)	

Item #	Telesto TEL210	Telesto TEL310	Telesto TEL220	Telesto TEL320	Vega VEG210	Vega VEG220
OCT System Type	Spectral Domain				Swept Source	
Key Performance Features	High Imaging Depth		High Resolution		Long Imaging Range	
	General Purpose	High Speed	General Purpose	High Speed	General Purpose	High Speed
Center Wavelength	1325 nm		1300 nm		1300 nm	
Light Source	Single SLD		Dual SLD		MEMS-VCSEL	
Optical Bandwidth	>100 nm		>170 nm		>100 nm	
Axial Resolution (Air/Water)	12 µm/9.0 µm		5.5 µm/4.2 µm		16 µm/12 µm	
Imaging Depth[b] (Air/Water)	7.0 mm/5.3 mm		3.5 mm/2.6 mm		11 mm/8.3 mm	8.0 mm/6.0 mm
A-Scan Rate	5.5, 28, 48, & 76 kHz	10, 28, 76, & 146 kHz	5.5, 28, 48, & 76 kHz	10, 28, 76, & 146 kHz	100 kHz	200 kHz
Sensitivity	96 to 111 dB (76 to 5.5 kHz)	93 to 109 dB (146 to 10 kHz)	96 to 111 dB (76 to 5.5 kHz)	93 to 109 dB (146 to 10 kHz)	102 dB	98 dB

a. The Vega, Telesto and Ganymede OCT base units include a high-performance desktop computer, monitor, and necessary cabling. The Callisto OCT base unit includes a laptop computer and necessary cabling.

b. Optical absorption and scattering can limit the penetration of the light probe inta a sample. For an OCT system to provide valid measurements over the full quoted imaging depth range, the light probe must be able to penetrate the sample to a depth equal to the imaging depth.

Scan Lens Kits

Item #	OCT-LK2	OCT-LK3	OCT-LK4	OCTH-LK20	OCTH-LK30
Compatible Scanner	Standard: OCTG-1300[a] or OCTG-1300NR[c] User-Customizable: OCTP-1300[a], OCTP-1300PS[b], or OCTP-1300NR[c]			Handheld: OCTH-1300[a] or OCTH-1300NR[c]	
Design Wavelength	1300 nm/1325 nm			1300 nm/1325 nm	
Lateral Resolution[d]	7 µm	13 µm	20 µm	16 µm	24 µm
Focal Length	18 mm	36 mm	54 mm	20 mm	30 mm
Working Distance	3.4 mm[e]	24.9 mm[e]	41.6 mm[e]	12 mm	22 mm
Field of View	6 mm x 6 mm	10 mm x 10 mm	16 mm x 16 mm	Ø8 mm	Ø10 mm

Item #	OCT-LK2-BB	OCT-LK3-BB	OCT-LK4-BB	OCTH-LK20-BB	OCTH-LK30-BB
Compatible Scanner	Standard: OCTG-900, User-Customizable: OCTP-900			Handheld: OCTH-900	
Design Wavelength	900 nm/930 nm			900 nm/930 nm	
Lateral Resolution[d]	4 µm	8 µm	12 µm	9 µm	14 µm
Focal Length	18 mm	36 mm	54 mm	20 mm	30 mm
Working Distance	3.4 mm[e]	24.9 mm[e]	41.6 mm[e]	12 mm	22 mm
Field of View	6 mm x 6 mm	10 mm x 10 mm	16 mm x 16 mm	Ø8 mm	Ø10 mm

a. Compatible with the Telesto OCT Base Units
b. Compatible with the Telesto PS-OCT Base Units
c. Compatible with the Vega OCT Base Unit
d. $1/e^2$ Beam Diameter at Focus
e. The working distance is limited due to the illumination tube, which can be removed.

Thorlabs OCT products are for research purposes only.

Application Support

Modular designs, flexible configurations, and a wide variety of components and accessories allow Thorlabs' OCT systems to be seamlessly integrated into any laboratory, research and development, or industry environment. We encourage customers to partner with our dedicated OCT application engineers to identify the optimal system configuration that meets their individual imaging requirements.

A Ganymede-Based OCT System in our Lübeck, Germany Demo Room

Additionally, we have dedicated lab space in our Sterling, Virginia and Lübeck, Germany facilities where our engineers can configure an ideal OCT system and test it under specific application conditions. After testing, we provide comparative data to further guide the decision-making process. For larger feasibility studies, Thorlabs offers extensive support to validate OCT imaging processes and provides statistical data for larger sample quantities. Please contact us to discuss such potential projects.

We have implemented OCT imaging solutions for a wide range of applications in various fields with different levels of customization. The solution for your application will be based on our extensive experience in designing and manufacturing hundreds of active systems in the field.

Implemented OCT Systems

Industrial

- Carbon Fiber Composite
- Multilayer Thin Film Thickness
- Plastic Seal Monitoring
- Ceramic Thin Film Inspection
- Coating Qualification

Material Inspection

- Art Inspection
- Contact Lens Production

Biomedical

- Brain Imaging
- Biofilm Imaging
- Breast Cancer Screening
- Skin Imaging
- Anterior Imaging
- Human Lens Measurements
- Vascular Imaging
- Retinal Imaging
- Developmental Biology

Thorlabs' Office in Lübeck, Germany

If you would like to arrange for sample testing or a technical consultation, have any questions or feedback, or would like to request a quote, please contact us at OCT@thorlabs.com.

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Spectral Domain OCTS Engine

DeepView® OCT Near-Infrared (NIR) Series

BaySpec's all new *DeepView*® Fourier or Spectral-Domain (SD) OCT-800 Series Spectral Engine incorporates a high speed digital line scan camera with a robust *VPG*®-based Spectrograph simultaneously covering multiple wavelengths for precise and rapid optical coherence tomography measurements.

DeepView™ NIR Series spectral engine shown with example camera

The *DeepView*® Spectral Engine provides convenience for researchers and OEM users assembling Fourier or spectral-domain optical coherence tomography (SD-OCT), white light interferometry (WLI) or VIS-NIR spectroscopy systems. This flat-field spectral analyzer design is based on highly efficient transmission *Volume Phase Grating* (VPG®) and mounts on an ultra-fast digital line scan camera. The spectral engine accepts single-mode fiber optic inputs and is customizable via grating inserts to match the spectral bandwidth and center wavelength of the users' light source.

The OCTS 800 Series spectral engine employs a highly efficient *Volume Phase Grating* (VPG®) as the spectral dispersion element and an ultra-sensitive CMOS detector array as the detection element, thereby providing high-speed parallel processing and continuous spectrum measurements. The signal is spectrally dispersed with the VPG®, and the diffracted field is focused onto the CMOS array detector. The control electronics read out the processed digital signal to extract required information. Both the raw data and the processed data are available to the host.

Applications:

- Fourier or Spectral-Domain Optical Coherence Tomography (SD-OCT)
- High-speed SD-OCT for cancer detection
- High-resolution spectral OCT in retinal diagnostics and measurements in ophthalmology
- Spectral OCT guidance on implant and surgery
- High speed and fast turn-around Spectral OCT assessment of surgical outcome
- Catheter/Endoscopic SD OCT image guided diagnostics, image-guided surgery, and image-guided therapy
- In vivo and in vitro general medical diagnostics and imaging
- In vivo and in vitro operation room and surgical procedure Quality Assurance
- Non-invasive skin cancer and skin disease diagnostics and detection
- Industrial applications such as non-destructive testing

Key Features:

- Rugged and reliable spectrometer featuring no moving parts
- Highly-efficient, high-resolution *Volume-Phase Grating*®
- Flexible options for center wavelength and spectral bandwidth, selectable at time of order; contact factory for custom solutions and packaging different camera types.
- Grating and optical bench customizable for your light source and application
- Single-mode fiber coupled input
- Mounted on digital line scan camera; other input fiber options available

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Email: sales@bayspec.com

Spectral Domain OCTS Engine

DeepView® OCT Near-Infrared (NIR) Series

Parameter	Specification
Optical	
Image plane size [1]	26 mm wide
Optical spot size (single mode fiber)	10 µm across detector
Vertical positioning stability	≤5 µm over time
Alignment access	Tip and tilt Camera fine rotation to level spectrum with detector array
Aperture (f#)	f/4
Focal length (nominal)	100 mm
Single fiber input	to read 1 spectra
Mechanical	
Length x Width x Height:	185 x 210 x 102 mm[3] Height includes fiber mount and camera mounting plate Specifications are subject to change without notice
Weight:	< 900 g (spectrograph) < 220 g (camera)
Fiber optic interface	Keyed FC/APC (inquire about PM or alternate types)
Camera compatibility	AViiVA SM2 CL spL4096-140k other upon request
Focus adjustment	Available

[1]with single-mode fiber input (core diameter of 5 µm)
[2]Full alignment procedures shipped with spectrograph

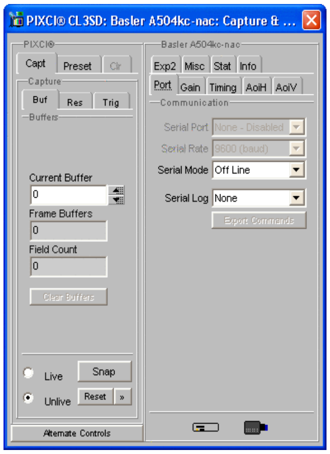
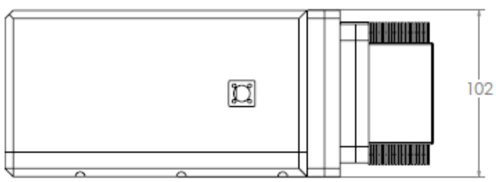
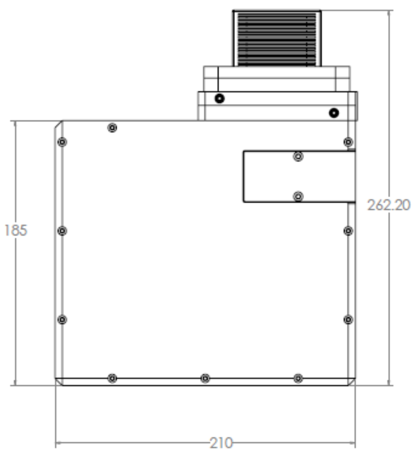


Image Processing Software included for ease of integration





Note: picture shows example camera only. All in mm.

Consider using with:

- Fast Digital Line Scan Cameras, we can customize to any available model
- Mini-Wide Light Sources
- ASE Light Sources
- Fiber-optic Bundles & Accessories

Ordering Information:

(grating options – ordering suffix[3], other options by request)

	-780-840-900
Center wavelength (nm)	840
Bandwidth (nm) [4]	120
Wavelength range (nm)	780-900
Wavelength dispersion (nm_{avg}/pixel) [5]	0.10
Stray light(% of peak 100 pixels away[6]	0.1%

[3]Spectrometer model number is OCTS-XXX-YYY-ZZZ; Replace YYY with nominal center wavelength; replace XXX with starting wavelength; ZZZ for ending wavelength
[4]Over 20 mm image plane
[5]With 10 µm pixel pitch
[6]Test laser wavelengths used: 800 nm, as appropriate for grating option selected

Specifications are subject to change without notice

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BaySpec

Pervasive Spectroscopy

Spectral Domain OCTS Engine

DeepView® OCT Shortwave-Infrared (SWIR) Series

DeepView™ SWIR Series spectral engine shown with example camera

BaySpec's all new *DeepView*® Fourier or Spectral-Domain OCT Spectral Engine is an InGaAs line scan camera with an integrated *VPG*®-based Spectrograph simultaneously covering multiple wavelengths for precise and rapid optical coherence tomography measurements.

The *DeepView*® Spectral Engine provides convenience for researchers and OEM users assembling fourier or spectral-domain optical coherence tomography (SD-OCT), white light interferometry (WLI) or infrared spectroscopy systems. This flat-field spectral analyzer design is based on highly efficient transmission *Volume Phase Grating* (VPG®) and mounts on an ultra-fast digital line scan camera. The spectral engine accepts single-mode fiber optic inputs and is customizable via grating inserts to match the spectral bandwidth and center wavelength of the users' light source.

The OCTS SWIR Series spectral engine employs a highly efficient *Volume Phase Grating* (VPG®) as the spectral dispersion element and an ultra-sensitive InGaAs array detector as the detection element, thereby providing high-speed parallel processing and continuous spectrum measurements. The signal is spectrally dispersed with the *VPG*®, and the diffracted field is focused onto an InGaAs array detector. The control electronics read out the processed digital signal to extract required information. Both the raw data and the processed data are available to the host.

Applications:

- High-speed spectral OCT for cancer detection in the biologically interested wave bands of 0.8-2.2 μm range
- High-resolution NIR spectral OCT in retinal diagnostics and measurements in ophthalmology
- Spectral OCT guidance on implant and surgery
- High speed and fast turn-around Spectral OCT assessment of surgical outcome
- Catheter/Endoscopic SD OCT image guided diagnostics, image-guided surgery, and image-guided therapy
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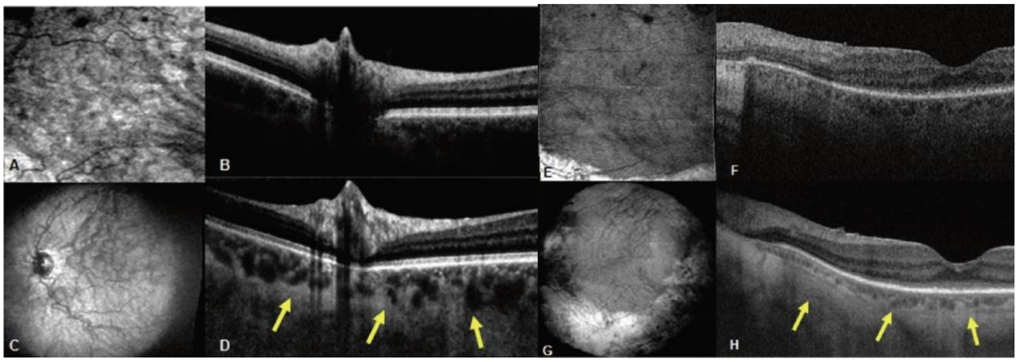
- Flexible options for center wavelength and spectral bandwidth, selectable at time of order; contact factory for custom solutions and packaging with user camera.
- Grating and optical bench customizable for your light source and application
- Single-mode fiber coupled inputs; other input fiber options available



3D Optical Coherence Tomography (OCT) at 800 and 1060nm of (A)–(D); a normal retina and (E)–(H) a patient with retinitis pigmentosa. (A, E) En-face zoomed-in fundus image of the choroid using 1060nm 3D OCT. Arrows indicate enhanced choroidal visualization. (Courtesy Cardiff University)

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Spectral Domain OCTS Engine

DeepView® OCT Shortwave-Infrared (SWIR) Series

Parameter	Specification
Optical	
Image plane size [1]	26 mm wide
Optical spot size (single mode fiber)	25 µm diameter
Aperture (f#)	f/4
Focal length (nominal)	100 mm
Mechanical	
Length x Width x Height:	260 x 240 x 116 mm^3 Height includes fiber mount and camera mounting plate size subject to change based on specifications
Weight:	< 800 g (spectrograph only) < 450 g (camera)
Fiber optic interface	Keyed FC/APC (inquire about PM or alternate types)
Camera compatibility	SU1024LDH2-1.7RT-0500/LC, inquire on other types
Camera mount	Optional

[1]with single-mode fiber input (core diameter of 9 µm)

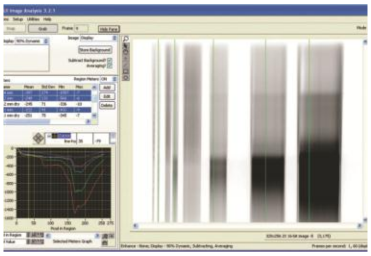
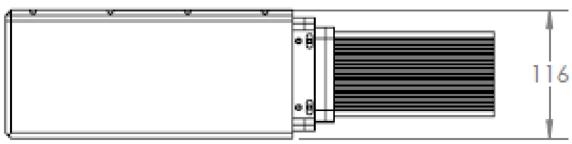
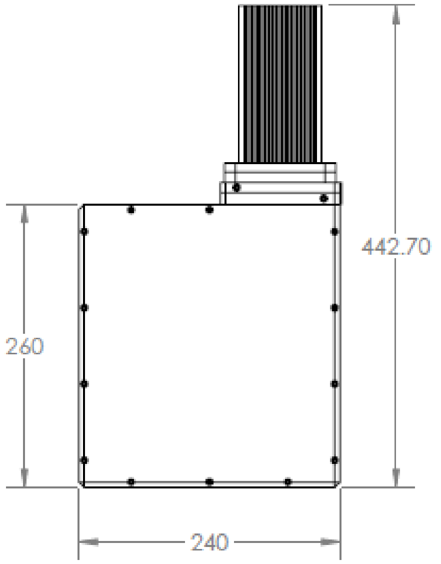


Image Analysis Software with each spectral engine purchase





Note: picture shows example camera only. All in mm.

Consider using with:

- Fast Digital Line Scan Cameras, we can customize to any available model
- Mini-Wide Light Sources
- ASE Light Sources
- Fiber-optic Bundles & Accessories

Ordering Information:

(grating options – ordering suffix[2], other options by request)

	-1280-1310-1340
Center wavelength (nm)	1310
Bandwidth (nm) [3]	60 or custom
Wavelength range (nm)	1280 (0px) – 1340 (~1024px)
Wavelength dispersion (nm_{avg}/pixel) [4]	0.05
Wavelength dispersion (nm_{avg}/mm)	1.95
Stray light(% of peak 100 pixels away[5]	0.1%

[2]Spectrometer model number is OCTS-XXX-YYY-ZZZ; Replace YYY with nominal center wavelength; replace XXX with starting wavelength; ZZZ for ending wavelength
[3]Over 20 mm image plane
[4]With 10 µm pixel pitch
[5]Test laser wavelengths used: 800 nm, as appropriate for grating option selected

Specifications are subject to change without notice

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