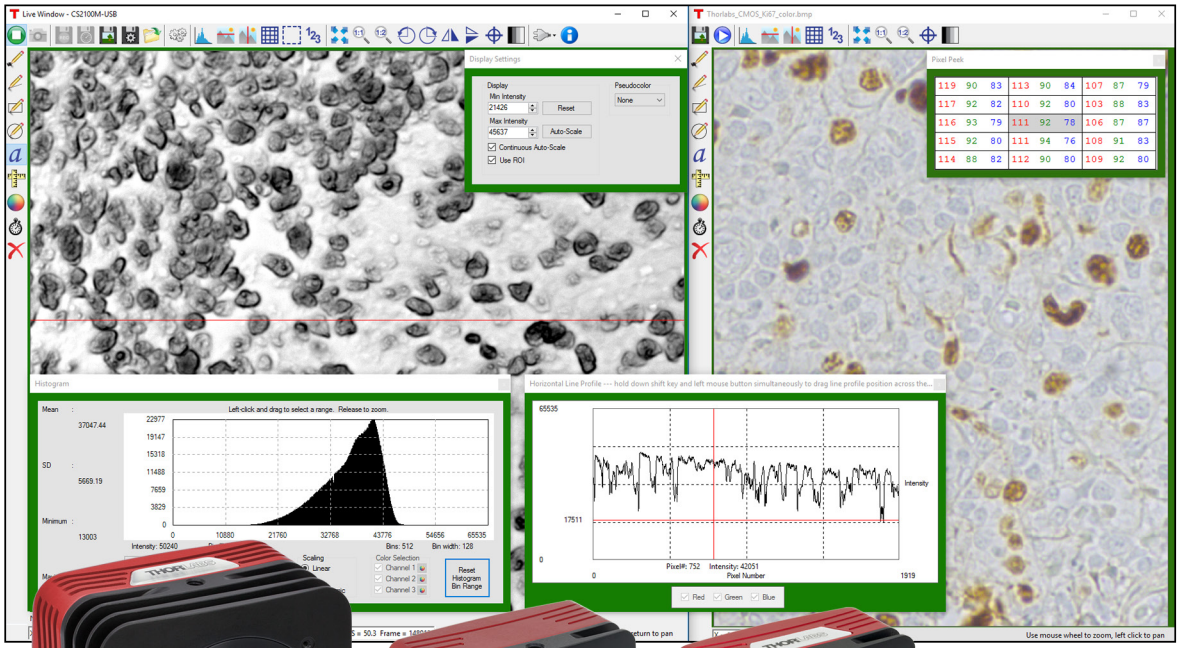
Scientific Cameras



Cooled CCD | Non-Cooled CCD | Non-Cooled CCD, Sensor Face Plate Removed | Compact Scientific

sCMOS, CMOS, and CCD Cameras

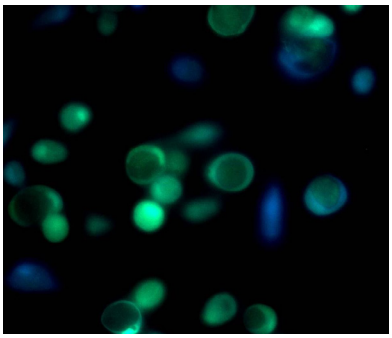
Product Families

- Compact Scientific Cameras
  - sCMOS: Quantalux® 2.1 MP Monochrome with <1 e^- Read Noise
  - CMOS: Kiralux™ 2.3 MP, 5 MP, or 8.9 MP; Monochrome, Polarization, or Color; Read Noise as Low as <2.5 e^-
  - Passive Thermal Control Reduces Dark Current
  - USB 3.0 Interface
- Scientific CCD Cameras
  - Fast Frame Rate VGA, 1.4 MP, 4 MP, and 8 MP
  - TE-Cooled Option for 1.4 MP, 4 MP, and 8 MP
  - 8 MP Option with Sensor Face Plate Removed
  - USB 3.0, Gigabit Ethernet, or Camera Link Interfaces
- ThorCam™ Software, API/SDK, and Support for Third-Party Imaging Software

Thorlabs' High-Performance, Scientific-Grade Cameras are specifically designed for microscopy and other demanding quantitative imaging applications. Based on imagers with high quantum efficiency and low noise, our cameras are ideal for multispectral imaging, fluorescence microscopy, and other imaging techniques.

THORLABS

Images from Selected Applications



Intracellular Dynamics

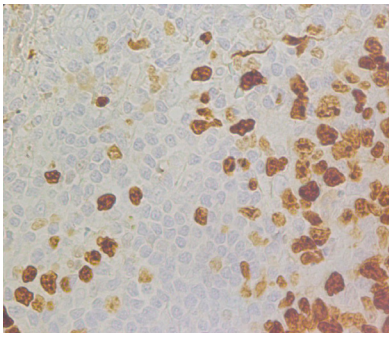
Fast frame rate cameras can be used for Ca^{2+} ratiometric studies of intracellular dynamics. High-speed imaging is made possible by the fast frame rate of the camera as two excitation wavelengths are switched in rapid succession. Alternately, quantitative imaging data can be acquired from fluorescence emission at two distinct wavelengths.

Recommended Cameras

- Quantalux® 2.1 MP sCMOS
- Fast Frame Rate CCD

Key Specifications

- High QE
- Low Noise
- Fast Readout



Brightfield Microscopy

Brightfield microscopy image showing Ki-67 labeled tonsil cells. Ki-67 is an antigen that only appears in the nuclei of cells undergoing division; therefore, it is an excellent marker to indicate the growth fraction of a cell population.

Recommended Cameras

- Kiralux™ 2.3 MP CMOS
- Kiralux 5 MP CMOS
- Kiralux 8.9 MP CMOS

Key Specifications

- High Pixel Count
- Small Pixel Size

Ophthalmology (NIR)

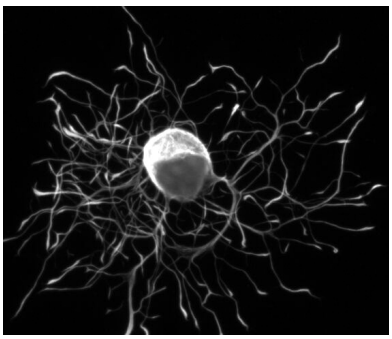
Retinal/fundus imaging in the NIR to view the blood vessels in the eye.

Recommended Cameras

- Kiralux 2.3 MP CMOS
- Kiralux 5 MP CMOS
- Kiralux 8.9 MP CMOS
- 1.4 MP CCD

Key Specifications

- NIR Responsivity
- Low Noise



Neuroscience

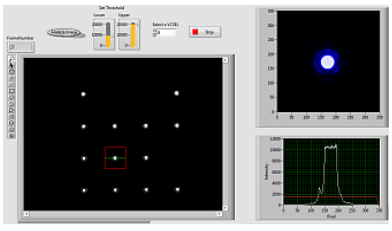
Fluorescence image of a rat neuron using 40X magnification.

Recommended Cameras

- Quantalux 2.1 MP sCMOS
- Kiralux 2.3 MP CMOS
- Kiralux 5 MP CMOS
- Kiralux 8.9 MP CMOS

Key Specifications

- High QE
- Low Noise



Large FOV Imaging

Individual emitters of a VCSEL array, imaged under magnification using our 8 MP CCD camera with the sensor face plate removed to minimize interference issues. This application leverages the high degree of uniformity over the large FOV of the CCD array, as well as the triggering and readout options of the camera.

Recommended Cameras

- 8 MP CCD with the Sensor Face Plate Removed

Key Specifications

- Readout Options to Maximize Throughput
- High Resolution
- Wedged Window

Fluorescence Microscopy

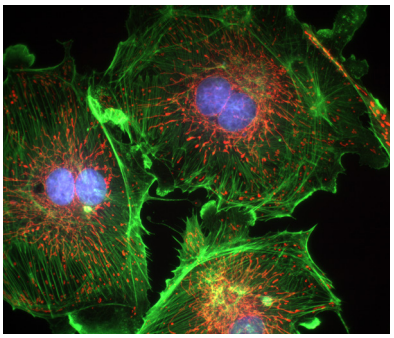
Recommended Cameras

- Quantalux 2.1 MP sCMOS
- Kiralux 2.3 MP CMOS
- Kiralux 5 MP CMOS
- Kiralux 8.9 MP CMOS

Key Specifications

- High QE
- Low Noise

Merged triple emission fluorescence microscopy image. The sample slide consists of multi-labeled bovine pulmonary artery endothelial (BPAE) cells, showing at least one example of a double nucleus.



Multispectral Imaging

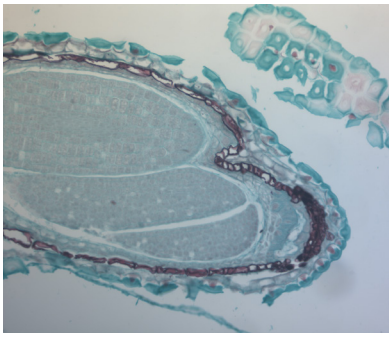
Recommended Cameras

- Quantalux 2.1 MP sCMOS
- Kiralux 2.3 MP CMOS
- Kiralux 5 MP CMOS

Key Specifications

- High QE
- Low Noise

Series of multispectral images taken with different passband wavelengths; the final stacked color image is shown. High QE scientific cameras are especially beneficial for obtaining low-light, narrowband images. This image was acquired using a Thorlabs KURIOS-WB1 Liquid Crystal Tunable Filter.



Scanning Electron Microscopy

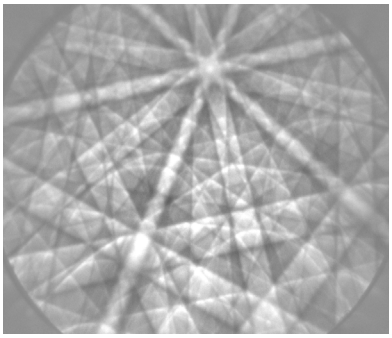
Recommended Cameras

- 1.4 MP CCD
- 4 MP CCD
- Fast Frame Rate CCD

Key Specifications

- High QE
- ROI and Binning Modes

Scanning electron microscope (SEM) image of a nickel sample. Electron backscatter diffraction (EBSD) produces Kikuchi patterns that result from the interaction between the electron beam and the sample material. Our high-QE, low-noise cameras make possible high-speed detection and analysis of these faint line patterns against relatively high backgrounds.



QA/Inspection of Optical Components under Stress

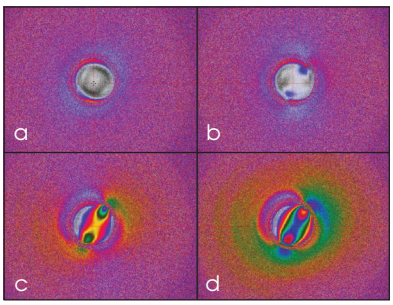
Recommended Camera

- Polarization-Sensitive Kiralux 5 MP CMOS

Key Specifications

- On-Chip Wire-Grid Polarizer Array

False-color rendering of the degree of linear polarization (DoLP) image of an optical component under stress: (a) no stress (b) low stress (c) medium stress (d) high stress. This image was acquired with the Polarization Sensitive Kiralux camera, which has an array of pixel-sized wire grid polarizers between the microlenses and the light-sensitive pixels.



Simultaneous NIR Dodt and Fluorescence

Recommended Cameras

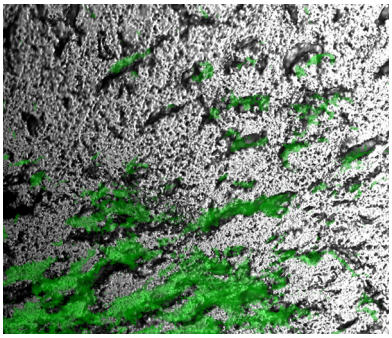
- Quantalux 2.1 MP sCMOS
- Kiralux 2.3 MP CMOS
- Kiralux 5 MP CMOS
- 1.4 MP CCD

Key Specifications

- NIR Responsivity
- High QE
- Low Noise

The image shows a live, simultaneous overlay of fluorescence and NIR Dodt contrast images of a 50 µm brain section from a CX3CR1-GFP mouse, which has been immunostained for PECAM-1 with Alexa-687 to highlight vasculature. Dodt contrast uses a gradient of light across a thick sample to reveal structural details. This image was acquired using two cameras mounted on a 2SCM1-DC adapter.

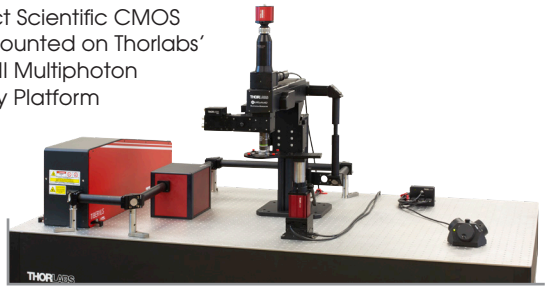
(Sample courtesy of Dr. Andrew Chojnacki, Department of Physiology and Pharmacology, Live Cell Imaging Facility, Snyder Institute for Chronic Diseases, University of Calgary.)



Solutions for Your Imaging Needs

A Scientific CCD Camera Mounted on Thorlabs' Four-Channel Confocal System

A Compact Scientific CMOS Camera Mounted on Thorlabs' Bergamo® II Multiphoton Microscopy Platform



Feature	Benefit
Optical & Imaging	
A Choice of Sensors to Suit Your Application: ◆ sCMOS: Quantalux® 2.1 MP, Monochrome ◆ CMOS: Kiralux™ 2.3 MP, 5 MP, or 8.9 MP; Monochrome, Polarization, or Color ◆ CCD: Fast Frame Rate VGA, 1.4 MP, 4 MP, or 8 MP; Monochrome or Color	Choose the Camera with the Resolution and Frame Rate Best Suited to Your Application
Removable Infrared Filter or Window Included[a]	Remove the Filter for NIR Applications or Replace with Any Ø25 mm Filter to Image Wavelengths of Interest
8 MP CCD Models Available with the Sensor Face Plate Removed and the Filter Replaced with a Wedged Window	Reduces Interference Patterns Caused by Reflections from the Sensor Faceplate
High Quantum Efficiency (See Specifications for Details)	Maximizes Camera Output and Improves SNR for a Given Amount of Light at Wavelengths of Interest
Low Read Noise (See Specifications for Details)	Improves the Threshold of Detectability under Low Light Conditions
System Integration	
Software-Selectable Pixel Clock Speed	Maximize Frame Rate for Fast Imaging or Select Slower Readout to Minimize Noise
Asynchronous Reset and Triggered Modes	Complete Timing Control for Flexible System Integration
Bulb Exposure Mode	Control the Duration and Instant of Exposure with a Single Input Pulse
Region of Interest (ROI) Mode	Select a Sub-Frame Rectangular Region for Faster Readout without Sacrificing Spatial Resolution
Binning Mode	Allows a Lower-Noise, Faster Readout of the Entire Frame at a Lower Spatial Resolution
Thermal Management: ◆ All Cameras are Fanless ◆ Compact Scientific Cameras are Designed with Passive Thermal Management ◆ Select Scientific CCD Cameras are Available with a TE-Cooling Option and Hermetically Sealed Chamber	◆ Fanless Design Minimizes Vibration, Reducing Image Blur ◆ Ideal for Low Signal Levels and Long Exposures ◆ TE Cooling Minimizes Dark Current
C-Mount (1.000"-32) Threaded Lens Mount[b]	Integrate Cameras with Microscopes or Lenses with C-Mount Threads
USB 3.0, Gigabit Ethernet, or Camera Link interface	Industry-Standard, Robust, High-Bandwidth Interfaces
Robust Design with Small Form Factor	Easily Integrates with Existing Equipment
Compatible with Thorlabs' Cage System	Integrate Cameras into a Custom Imaging System
Auxiliary Port and Available Cables and Accessories	Eases System Integration and Timing for Unique Situations
Software	
ThorCam™ Software GUI	One Package for System Control, Acquisition, and Playback of Images and Image Sequences
Support for LabVIEW®, Metamorph®, and MATLAB®[c]	Integrate Thorlabs' Cameras into a Third-Party Imaging Platform
Full-Featured API/SDK	Incorporate in Custom Applications Using C, C++, C#, Visual Basic .NET, and Other Programming Languages

a. The 8 MP models with the sensor face plate removed have an AR coated wedged window in place of the IR filter, and the optical front end should never be disassembled as this could result in damage to the sensor.

b. The 8 MP models with the sensor face plate removed have 1.375" - 32 threading.

c. The Quantalux camera does not support Metamorph.

Compact Scientific Cameras

These compact scientific cameras are equipped with passive thermal management, reducing dark current without the need for a cooling fan or thermoelectric cooler. A USB 3.0 interface provides compatibility with most computers.

They feature a compact housing (2.78" x 2.38" x 1.88") that is designed for seamless integration into a multitude of setups. An adjustable C-Mount adapter is factory-installed into the SM1-threaded optical aperture of the camera for out-of-the-box compatibility with industry-standard microscopes and camera lenses. Various mounting taps are also provided for optical post and 30 mm cage system compatibility.

quantalux® sCMOS Camera

Thorlabs' Quantalux sCMOS monochrome camera is based on a high-performance, <1 e^- median read noise imager with a rolling shutter. Ideal for demanding applications, the 2.1 MP sensor can image the full 1920 x 1080 frame at 50 fps with 16-bit digital output and offers a peak quantum efficiency of 61% at 600 nm.

Our Compact Scientific Cameras can be integrated into our 30 mm cage systems to construct custom imaging systems.

kiralux® CMOS Cameras

These cameras incorporate CMOS sensors with low read noise, 12-bit digital output, and a global shutter. They are available with monochrome, color, or polarization sensors.

The Kiralux 2.3 MP cameras feature a pixel count of 1920 (H) x 1200 (V) and a peak quantum efficiency of 78% at 500 nm. The sensors have 5.86 µm x 5.86 µm pixels with <7.0 e^- of RMS read noise. They offer a full-frame readout rate of 39.7 fps with a 1/1.2" optical format. These cameras are ideal for general lens-based imaging applications.

The Kiralux 5 MP cameras feature a peak quantum efficiency of 72% from 525 to 580 nm, <2.5 e^- of RMS read noise, and a pixel count of 2448 (H) x 2048 (V). They can generate full-frame readout at 35 fps and are compatible with 2/3" format lenses, making them a good choice for both microscopy and lens-based imaging applications. Their 3.45 x 3.45 µm pixels are under the Nyquist-limited pixel size when used with commercially available microscopes with a near-square aspect ratio, resulting in superior image resolution. For polarization-sensitive applications, the new CS505MUP camera with a 4-direction polarizer array is recommended.

The Kiralux 8.9 MP cameras feature a high pixel count of 4096 (H) x 2160 (V), <2.5 e^- of RMS read noise, and a peak quantum efficiency of 72% from 525 to 580 nm. These cameras also feature 3.45 x 3.45 µm pixels. They offer a full-frame readout rate of 20.8 fps with a 1" optical format. These cameras are ideal for low-light applications such as fluorescence microscopy.

A C-Mount lens mount allows integration with our family of machine vision camera lenses.

A compact scientific camera can be directly installed on a Cerna® Mini microscope using our thread adapters and SM1-threaded accessories.

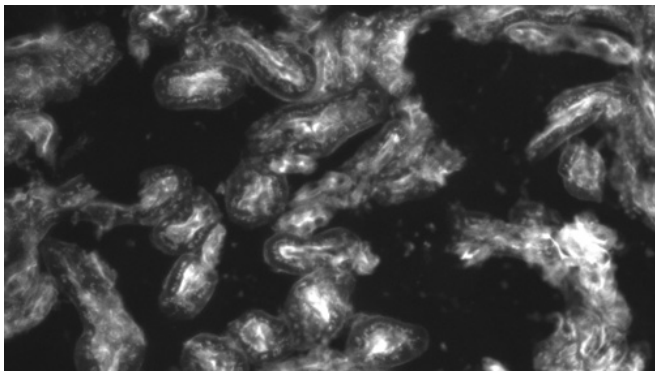
Quantalux® sCMOS Camera

Our Quantalux sCMOS camera is ideal for applications such as fluorescence microscopy due to its low read noise and high dynamic range. Below is an analysis of how these superior specifications lead to better images, and thus better quantitative results, at low light levels.

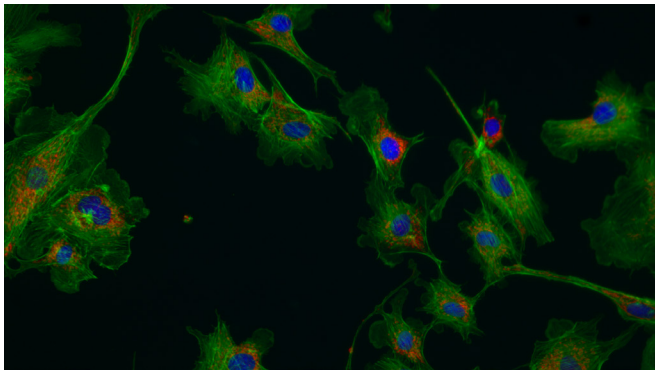
High Sensitivity with <1 e^- Read Noise

The Quantalux sCMOS camera has significantly lower read noise, with similar quantum efficiency, compared to the CCD sensors used in more conventional scientific cameras. The relative impact of read noise on quantitative measurements will depend upon its contribution to the total noise, relative to the signal-dependent photon shot noise. The Signal-to-Noise-Ratio (SNR) under different light levels is an ideal measure of the efficacy of a camera sensor's performance. The left plot below shows the SNR for our Quantalux camera, a typical conventional CCD camera, and an ideal, shot-noise-limited detector (with no read noise and 100% quantum efficiency) over a range of light levels. The right plot below shows the same results normalized to the SNR of an ideal, shot-noise-limited detector under the same conditions.

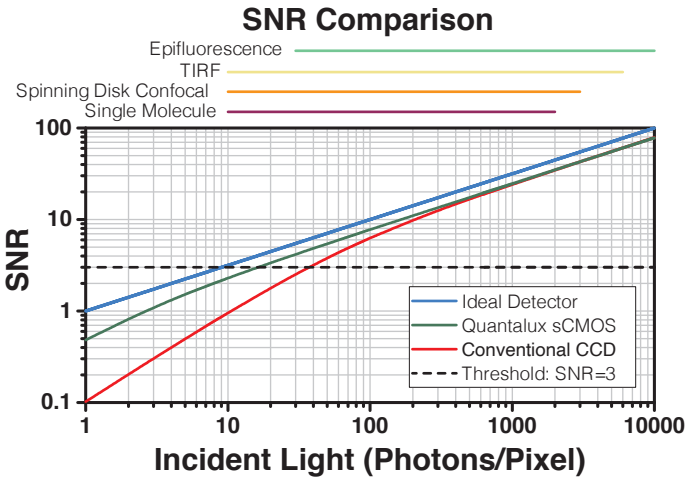
As shown in the plots, our Quantalux camera can be expected to produce images with a higher SNR than a conventional CCD camera under conditions in which less than 1000 photons/pixel are expected to be captured in a given exposure. The specifications of a Quantalux camera make it an ideal choice for a wide range of fluorescence microscope imaging needs and other low-light applications.



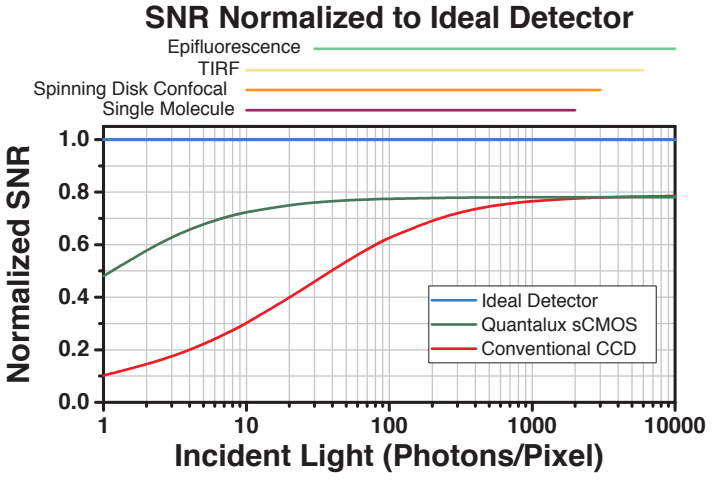
FluoCells® Mouse Kidney Fluorescence Slide Imaged with our Monochrome Quantalux Camera



Merged Three-Channel Fluorescence Image of FluoCells® Prepared Slide of BPAE Cells Acquired Using Our Quantalux Camera



Estimated SNR vs. incident light for an ideal detector, Quantalux sCMOS, and conventional scientific CCD cameras. The bars above the plot show estimated photon/pixel counts for different imaging modalities.



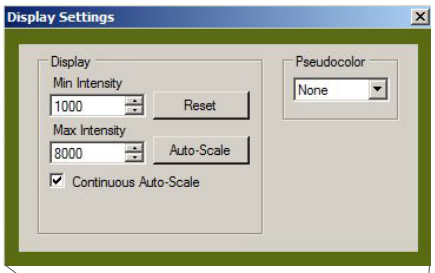
Estimated SNR normalized to an ideal detector vs. incident light for Quantalux sCMOS and conventional scientific CCD cameras. The bars above the plot show estimated photon/pixel counts for different imaging modalities.

High 87 dB Dynamic Range for Capturing Dim Details and Bright Features

A common problem in scientific imaging is the loss of contrast when bright features overlay a dim background. If the camera doesn't have a large enough dynamic range, saturation and floor limitations inhibit the simultaneous capture of both bright and dim details.

With the Quantalux camera's high dynamic range of 87 dB, a single exposure gathers sufficient contrast of bright, moderate, and dim objects at once. The images below show how a single high dynamic range image can be analyzed and visualized to highlight features over any one of these brightness ranges.

Figure 1: The contrast Dialog Window. These settings were adjusted to process the images shown in Figures 2 through 3c. The contrast settings can also be adjusted during live imaging.



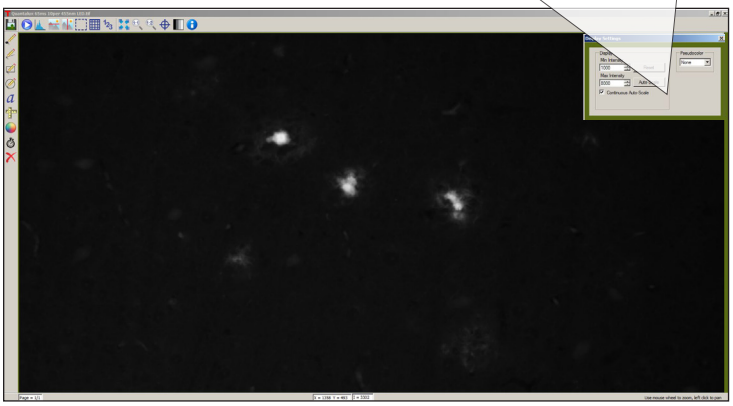


Figure 2: ThorCam™ screenshot of an unprocessed image taken using our monochrome Quantalux sCMOS camera. The sample is a ~20 µm thick slice of 5xFAD mouse with amyloid plaques stained with Thioflavin S. The image was acquired at 65 ms exposure using a 20X, 0.75 NA immersion objective with water, corrected for the #1.5 coverslip used.

Images are courtesy of Craig Brideau, University of Calgary, Alberta, Canada.

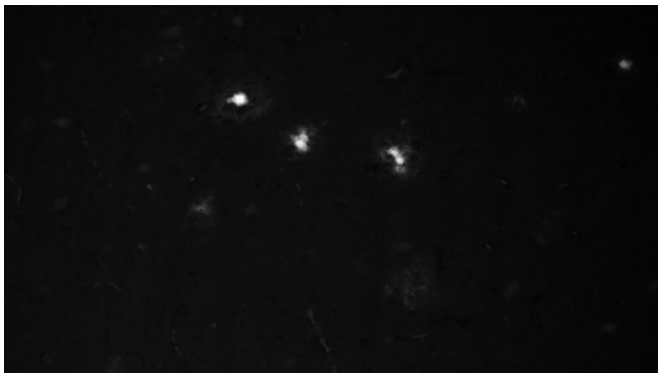


Figure 3a: The image contrast from Figure 2 has been adjusted to highlight the amyloid plaque core details. The background, including fibrils and cells, is hidden from view.

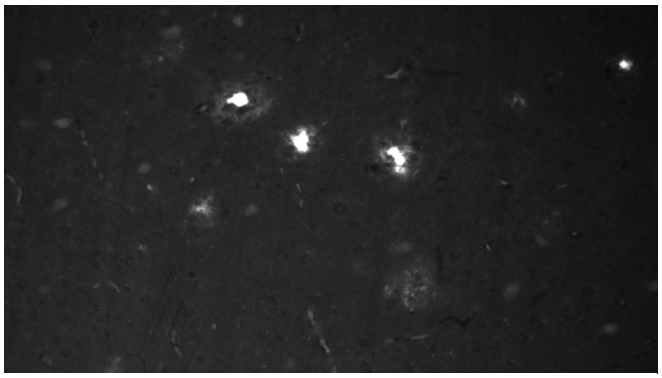


Figure 3b: The contrast from Figure 2 has been adjusted to highlight the fibrils in the sample, resulting in saturation of the plaque core details in the original image.

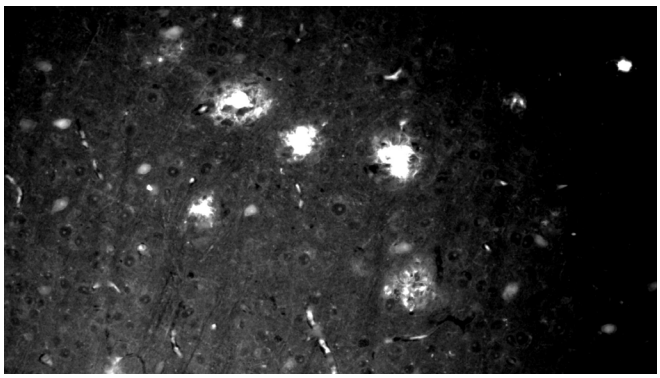
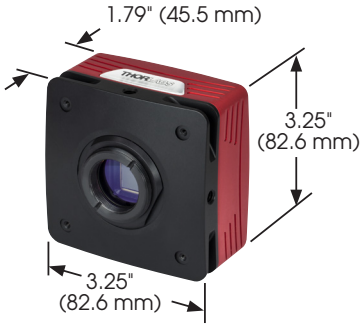


Figure 3c: Maximizing the background contrast shows nearby cell bodies and nuclei for cytometry; however, the contrast adjustment saturates both the fibrils and the plaque cores.

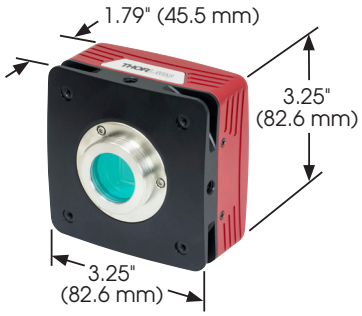
Scientific CCD Cameras

Thorlabs' scientific CCD cameras feature electronic global shutters and are offered in three package styles: a non-cooled standard package, a non-cooled package with the sensor face plate removed, and a hermetically sealed package with a two-stage TEC. The fan-free cooler design provides optimal CCD cooling without vibration, critical for capturing long-exposure images in low-light conditions. For applications with high light levels that require short exposure times (<1 second), our non-cooled cameras are recommended. Our non-cooled 8 MP monochrome CCD camera is available with the sensor face plate removed and a wedged window placed in front of the sensor. This configuration is ideal for inspection and other applications that are sensitive to interference patterns caused by reflections from the sensor face plate.

CCD cameras are available with either a USB 3.0, Gigabit Ethernet (GigE), or Camera Link interface. The cameras in non-cooled standard, and hermetically sealed cooled packages feature standard C-Mount threading and Thorlabs provides a full line of thread-to-thread adapters for compatibility with other thread standards. The cameras with the sensor face plate removed have 1.375"-32 threading on the front end for users interested in designing custom mounts. The front face of all CCD cameras comes equipped with 4-40 tapped holes for compatibility with our 60 mm cage system. Additionally, four 1/4"-20 tapped holes, one on each side of the housing, are compatible with our Ø1" Posts. These features make Thorlabs' cameras an ideal choice of CCD imager for both DIY and commercial imaging systems for microscopy.



Passively Cooled CCD Cameras

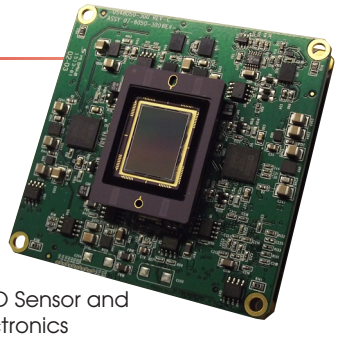


Passively Cooled CCD Cameras with the Sensor Face Plate Removed

TE-Cooled, Hermetically Sealed CCD Cameras

Custom Cameras

In addition to our large selection of standard scientific cameras, we have the capability of building custom cameras designed for unique scientific applications. Options include high-performance board-level cameras, custom camera housings, and software. Our engineering team simplifies the customization process by following the two steps below. If you have special requirements, a custom application, or general questions about our capabilities, please contact us at sales.tsi@thorlabs.com.


CCD Sensor and Electronics

Step 1: Analyze Your Custom Requirements

Imaging Specifications
- Sensitivity
- Wavelength
- Resolution
- Speed

System Requirements
- Operating Environment
- Space Constraints
- Interfaces
- Software

Application Space
- Compliance Issues
- Future Developments
- Logistics

Step 2: Configure a Solution

Imager Options
- UV, Visible, or NIR
- sCMOS, CMOS, or CCD

Camera Body Options
- Standard Non-Cooled
- Hermetically Sealed with Two-Stage TEC
- Private Labeling

I/O Options
- Gigabit Ethernet
- USB 3.0

Electronics Modifications
- Customized Firmware
- Application-Specific Timing and Triggering Modes

Optics Mounting Options
- C-Mount Threading is Standard

Supply Chain
- Kanban Stocking Agreements

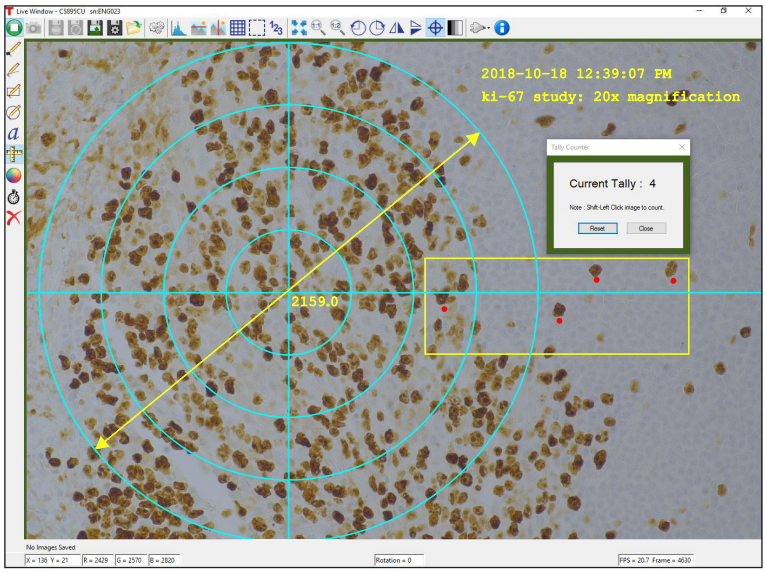
Software
- Initial Evaluation Using ThorCam™ GUI for Cameras
- Algorithm Development Using Popular Third-Party Support Such as MATLAB® and LabVIEW®
- API / SDK Provided for Software Developers and OEMs

ThorCam™ is a powerful graphical user interface (GUI) software program for 32- and 64-bit Windows® 7 or 10 systems. This easy-to-use application communicates with the camera to provide system control, image acquisition, and image review. Single-image capture and image sequences are supported.

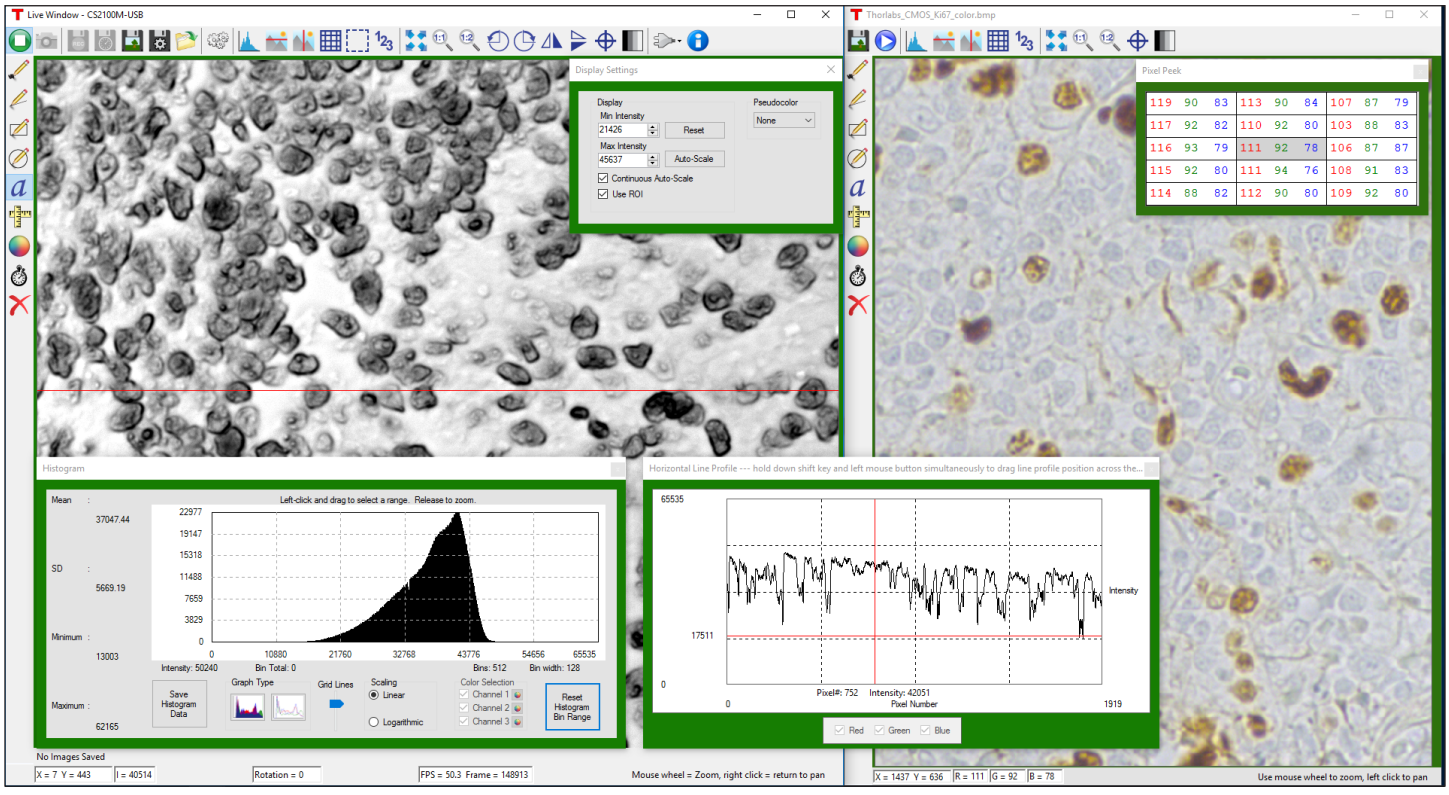
Application programming interfaces (APIs) and a software development kit (SDK) are included for the development of custom applications by OEMs and developers. The SDK provides easy integration with a wide variety of programming languages, such as C, C++, C#, and Visual Basic .NET. Support for third-party software packages, such as LabVIEW®, MATLAB®, and MetaMorph®, is provided.

ThorCam Features

- Image Acquisition and Review
- Quantitative Measurements
  - Line Profile Displays Pixel Value
  - Pixel Peek Shows Numerical Values for Specific Pixels
  - Calculate Distances Between Features
  - Histogram of Image Data
- Image Annotation
  - Draw Lines, Circles, Rectangles, and Freehand Shapes
  - Overlay Text Annotations
- Compatible with Image Sets and Time Series Data

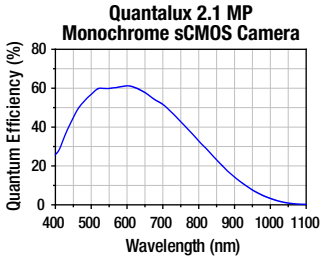
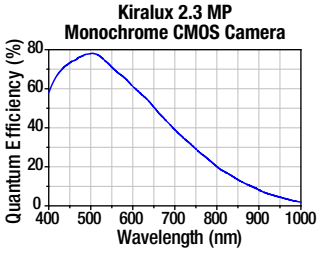
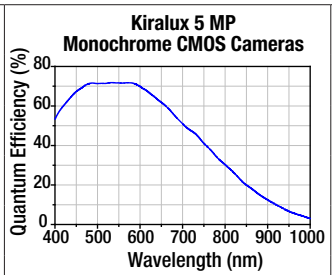
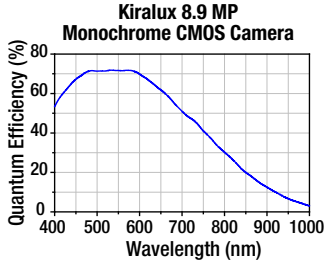
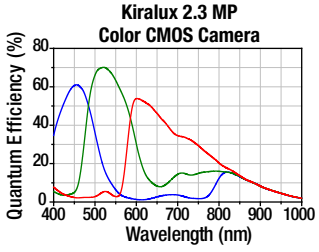
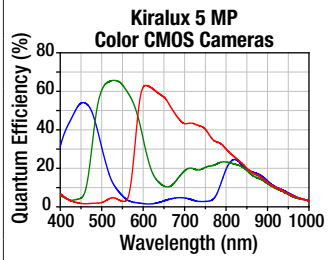
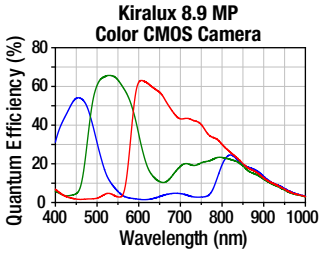


A screenshot of the ThorCam software showing some of the analysis and annotation features. The Tally function was used to mark four locations in the image. A blue crosshair target that is locked to the center of the image is enabled to provide a point of reference.



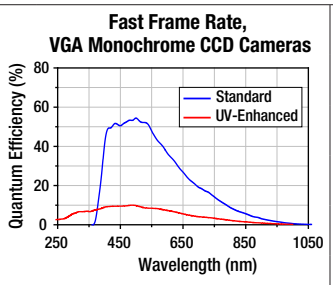
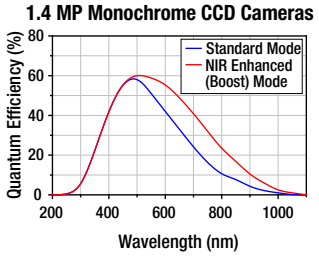
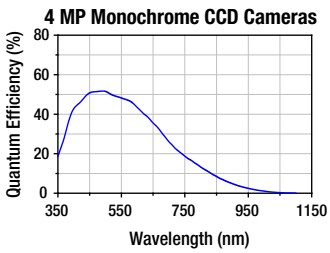
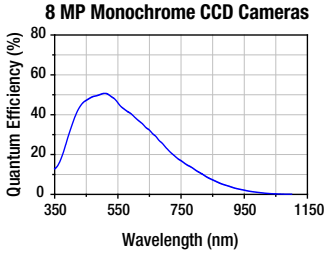
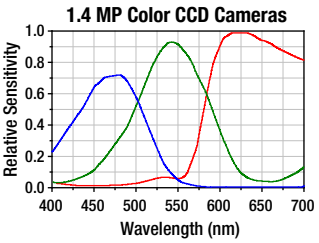
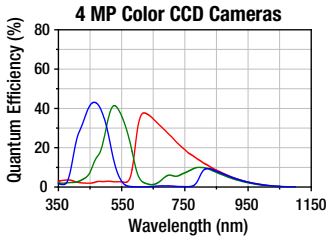
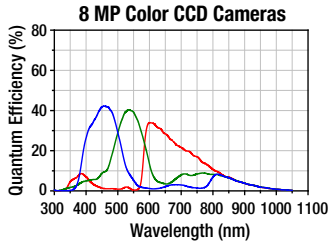
ThorCam Software GUI

Compact Scientific Camera Specifications

Description	Quantalux® 2.1 MP Monochrome Camera	Kiralux™ 2.3 MP Monochrome and Color Cameras	Kiralux 5 MP Monochrome, Color, and Polarization Cameras	Kiralux 8.9 MP Monochrome and Color Cameras
Item # Prefix	CS2100	CS235	CS505	CS895
Sensor Technology	sCMOS	CMOS	CMOS	CMOS
Electronic Shutter	Rolling Shutter[a]	Global Shutter	Global Shutter	Global Shutter
Effective Number of Pixels (H x V)	1920 x 1080	1920 x 1200	2448 x 2048	4096 x 2160
Pixel Size	5.04 µm x 5.04 µm	5.86 µm x 5.86 µm	3.45 µm x 3.45 µm	3.45 µm x 3.45 µm
Optical Format	2/3" (11 mm Diagonal)	1/1.2" (13.4 mm Diagonal)	2/3" (11 mm Diagonal)	1" (16 mm Diagonal)
Max Frame Rate (Full Sensor)	50 fps	39.7 fps	35 fps	20.8 fps
Read Noise	<1 e^- Median <1.5 e^- RMS	<7.0 e^- RMS	<2.5 e^- RMS	<2.5 e^- RMS
Digital Output (Max)	16 Bit	12 Bit	12 Bit	12 Bit
Cooling	Passive Thermal Management			
Available PC Interfaces	USB 3.0			
Lens Mount	SM1 (1.035"-40) with Factory-Installed C-Mount Adapter			
Dimensions (W x H x D)	2.38" x 1.88" x 3.02"			
Built-in Optics	Removable Window R_{avg} <0.5% per Surface (400 - 700 nm)	Monochrome: Removable Window, R_{avg} <0.5% per Surface (400 - 700 nm) Color: Removable IR Blocking Filter		
Quantum Efficiency (Monochrome Cameras)				
Quantum Efficiency / Relative Sensitivity (Color Cameras)	N/A			

a. Rolling Shutter with Equal Exposure Pulse (EEP) Mode for Synchronizing the Camera and Light Sources for Even Illumination

Scientific CCD Camera Specifications

Fast Frame Rate, VGA Monochrome Cameras	1.4 MP Monochrome and Color Cameras	4 MP Monochrome and Color Cameras	8 MP Monochrome and Color Cameras	8 MP Monochrome Cameras, Sensor Face Plate Removed
340	1501	4070	8051	S805MU
Interline CCD	Interline CCD	Interline CCD	Interline CCD	
Global Shutter	Global Shutter	Global Shutter	Global Shutter	
640 x 480	1392 x 1040	2048 x 2048	3296 x 2472	
7.4 µm x 7.4 µm	6.45 µm x 6.45 µm	7.4 µm x 7.4 µm	5.5 µm x 5.5 µm	
1/3" (5.92 mm Diagonal)	2/3" (11 mm Diagonal)	4/3" (21.4 mm Diagonal)	4/3" (22 mm Diagonal)	
200.7 fps (at 40 MHz Dual-Tap Readout)	23 fps (at 40 MHz Single-Tap Readout)	25.8 fps (at 40 MHz Quad-Tap Readout)[b]	17.1 fps (at 40 MHz Quad-Tap Readout)[c]	
<15 e^- RMS at 20 MHz	<7 e^- RMS at 20 MHz (Standard Models) <6 e^- RMS at 20 MHz (TE-Cooled Models)	<12 e^- RMS at 20 MHz	<10 e^- RMS at 20 MHz	
14 Bit[d]	14 Bit	14 Bit[d]	14 Bit[d]	
None	TE-Cooled, Hermetically Sealed Versions Available			None
USB 3.0, Gigabit Ethernet, or Camera Link				
C-Mount (1.000"-32)				1.375"-32 Threading
3.25" x 3.25" x 1.79"	3.25" x 3.25" x 1.79" (Standard); 3.90" x 3.90" x 2.61" (TE Cooled)			3.25″ x 3.25″ x 1.79″
Removable IR Blocking Filter				AR Coated Wedged Window
				
N/A				

b. Limited to 13 fps at 40 MHz dual-tap readout for Gigabit Ethernet cameras; quad-tap readout is unavailable for Gigabit Ethernet cameras.
c. Limited to 8.5 fps at 40 MHz dual-tap readout for Gigabit Ethernet cameras; quad-tap readout is unavailable for Gigabit Ethernet cameras.
d. Gigabit Ethernet cameras operating in dual-tap readout mode are limited to 12-bit digital output.

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