SOPHIA® 2048B

ULTRA-LOW-LIGHT, LOW-NOISE SCIENTIFIC CAMERAS

- >95% peak QE, UV to NIR sensitivity
- 2 e- read noise
- Fast, multiport readout
- ArcTec™ deep cooling

TELEDYNE IMAGING
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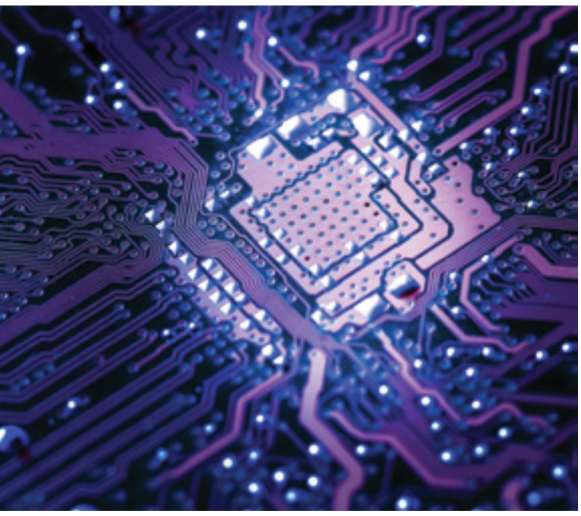
Connected Teledyne – Helping Drive Your Results

Teledyne Portfolio

Teledyne Imaging provides a collective of expertise across the spectrum. Individually, each division offers best-in-class solutions. Together, they leverage their combined strengths to provide the deepest technology portfolio in the world. From nano scales in the world of electron microscopy to space based astronomical imaging, Teledyne Imaging brings scale to the world's most difficult and demanding applications.



Working For You

Teledyne is committed to operational excellence at each step with involvement at every level of the supply chain – from pixel and sensor design to fabrication, systems and analysis, reducing our customer's exposure. By leveraging a continuous link to a network of engineers, we grant our customers full access to our proprietary technologies and developments, providing an optimal solution that surpasses any multi-component integration.

Partnerships

Teledyne Imaging has supported customer innovation needs for decades. Our partners are matched to a dedicated team of experts that ensure quick integration with software, optical, electrical, and mechanical elements. Additionally, the Teledyne team is in full consultation with their partners, supporting projects from start to end, with supply guarantees.

Highlights

Breakthrough High-Performance CCD Cameras

SOPHIA 2048B cameras are designed from the ground up for the most demanding low-light applications, such as astronomy, *in vivo* imaging, and semiconductor failure analysis:

- Back-illuminated CCD sensors with >95% peak QE
- 2048 x 2048 resolution with 13.5 and 15 micron pixels, up to 39 mm diagonal
- High frame rates with up to 4-port readout
- Cooling down to -90°C , liquid and air cooling in the same chassis

Applications include:

Semiconductor Failure Analysis | Astronomy | Photometry | Laser Beam Profiling
Luminescence and Fluorescence Imaging | *In vivo* Imaging

Designed for low-light applications

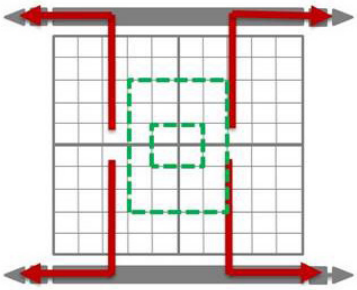
SOPHIA 2048B cameras offer optimum performance:

- Air or liquid cooling for low dark current
- High QE (peak >95%)
- Wide dynamic range (16-bit readout)

When speed is paramount

SOPHIA 2048B cameras have the newest readout electronics:

- Single-, dual-, and quad-port simultaneous readout
- Multiple ADC speeds (up to 16 MHz)
- Binning and ROI readout
- Custom readout modes for microsecond exposures



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Imaging Software Flexibility

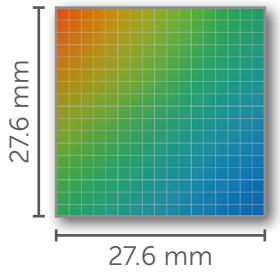
Most imaging experiments need flexibility - and the SOPHIA 2048B is a perfect fit:

- Microsoft® Windows® 10 or Linux® 64-bit operating system support
- Seamless integration of controls and data acquisition into MATLAB®
- (MathWorks), LabVIEW® (National Instruments), ASCOM, Maxim
- DL™ (Cyanogen Imaging), and Python®
- SDK / API compatible with Microsoft Windows and Linux

Key Camera Features

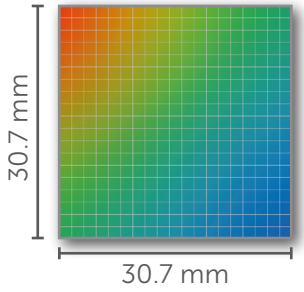
SOPHIA 2048B cameras are designed from the ground up for the most demanding low-light applications, such as astronomy, *in vivo* imaging, and semiconductor failure analysis:

SOPHIA 2048B - 132



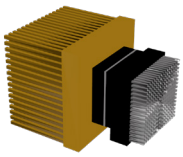
e2v CCD42-40: 2048 x 2048 resolution sensor with 13.5 micron pixels and up to 8 MHz readout (2 x 4 MHz)

SOPHIA 2048B - 152

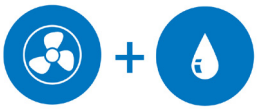


e2v CCD230-42: 2048 x 2048 resolution sensor with 15 micron pixels and up to 16 MHz readout (4 x 4 MHz)

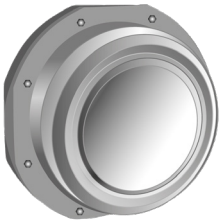
Proprietary 2-port and 4-port readout for low noise and high frame rates



Ultra-high-vacuum, all-metal seal design for deep cooling (ArcTec™) down to -90°C



Flexibility to use air, air+liquid, or liquid cooling



The latest UHV technology with all-metal construction and industry-standard CF vacuum interface for lifetime vacuum guarantee

Reliable Performance

Princeton Instruments has been designing high-performance scientific cameras for more than three decades:

- Hundreds of cameras being used at leading laboratories around the world
- Years of trouble-free operation a result of uncompromised engineering design and production
- Complete software ecosystem simplifies image acquisition and processing
- Continuous innovation to meet evolving requirements and applications
- Vacuum chamber limited lifetime warranty

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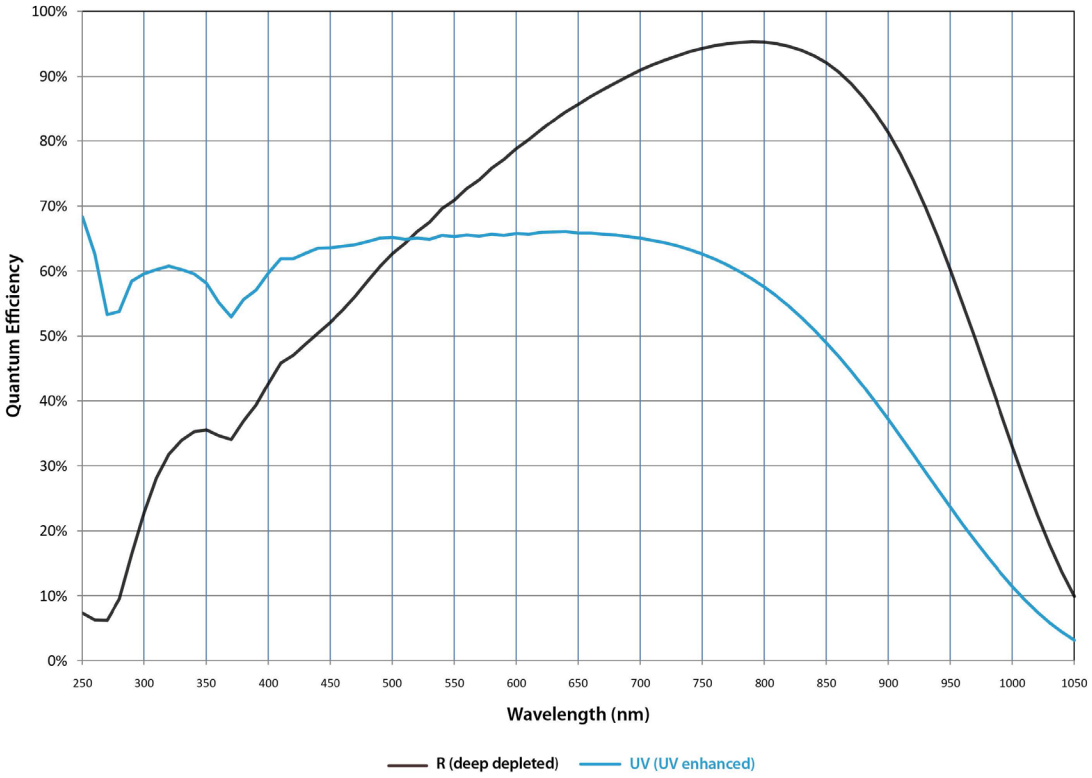
SOPHIA 2048B - 132 Specifications

Feature	SOPHIA 2048B-132-VS-R	SOPHIA 2048B-132-VS-UV
CCD image sensor	e2v CCD42-40; back illuminated; deep depleted; grade 1; NIMO	e2v CCD42-40; back illuminated; UV enhanced; grade 1; NIMO
Dark current @ -90°C (with ambient air @ +20°C)	0.0001 e-/p/s (typical)	
Quantum efficiency	See QE curves on next page	
CCD format	2048 x 2048 imaging pixels: 13.5 x 13.5 µm pixels: 100% fill factor	
Imaging area	27.6 x 27.6 mm (optically centered)	
Deepest cooling temperature	< -90°C (typical) with liquid chiller; < -90°C (typical) with air	
Thermostating precision	±0.05°C	
Cooling method	Thermoelectric air or liquid cooling (liquid chiller required)	
Full well	Single pixel: 100 ke- (typical), 80 ke- (minimum);	
ADC speed/16 bits	8 MHz, 2 MHz, and 200 kHz	
System read noise per port @ 100 kHz @ 1 MHz @ 4 MHz	 3.5 e- rms (typical) 7 e- rms (typical) 19 e- rms (typical)	
Vertical shift speed	24 µsec/row (programmable	
Nonlinearity	<2% @ 100 kHz	
Software-selectable gains	1, 2, 4 e-/ADU (low-noise input, typical)	
Data interface	USB 3.0 (5 m interface cable provided); Optional fiberoptic interface available for remote operation	
I/O signals	Two MCX connectors for programmable frame readout, shutter, trigger in	
Operating environment	+5°C to +30°C non-condensing	
Bake-out temperature	70°C (maximum)	
Certification	CE	
Camera head dimensions (L x W x H)	251.6 mm (9.91") x 129 mm (5.08") x 142.8 mm (5.62")	
Camera head weight	6.5 kg (14.3 lbs)	

Specifications are subject to change

SOPHIA 2048B - 132 Quantum Efficiency Curves



Frame Rates

SOPHIA 2048B - 132

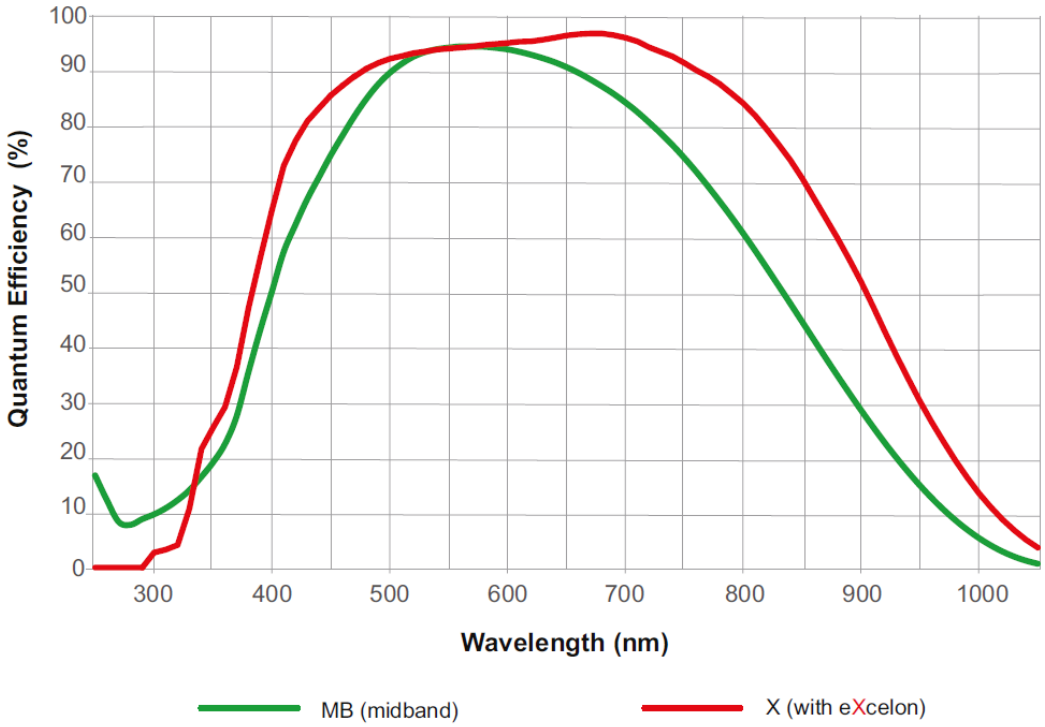
Binning	8 MHz	2 MHz	200 kHz
1 x 1	1.35	0.43	0.05
2 x 2	2.82	1.34	0.18
4 x 4	3.76	2.82	0.65
8 x 8	4.30	3.76	1.82

SOPHIA 2048B - 152 Specifications

Feature	2048B-152-VS-X	2048B-152-VS-MB
CCD image sensor	Back-illuminated eXcelon CCD. Highest sensitivity in the visible region. High sensitivity in the NIR. Extremely low etaloning. 100x lower dark charge than deep-depleted sensors.	Back-illuminated CCD. Highest sensitivity in the visible region. Basic midband (MB) AR coating.
	Princeton Instruments' proprietary CCD; grade 1; AIMO	e2v CCD230-42; grade 1; AIMO
Dark current @ -90°C (with ambient air @ +20°C)	0.00025 e-/p/s (typical)	
CCD processing	Optional CCD processing for UV and NIR	
Quantum efficiency	See QE curves on next page	
CCD format	2048 x 2048 imaging pixels: 15 x 15 µm pixels: 100% fill factor	
Imaging area	30.7 x 30.7 mm (optically centered)	
Lens mount	F-mount with integral 45 mm shutter	
Deepest cooling temperature	< -90°C (typical) with liquid chiller; < -90°C (typical) with air	
Thermostating precision	±0.05°C	
Cooling method	Thermoelectric air or liquid cooling (liquid chiller required)	
Full well	Single pixel: 150 ke- (typical)	
ADC speed/16 bits	16 MHz, 4 MHz, and 400 kHz	
System read noise per port @ 100 kHz @ 1 MHz @ 4 MHz	 3.6 e- rms (typical) 8.5 e- rms (typical) 22 e- rms (typical)	
Vertical shift speed	24 µsec/row (programmable	
Nonlinearity	<2% @ 100 kHz	
Software-selectable gains	1, 2, 4 e-/ADU (low-noise input, typical)	
Data interface	USB 3.0 (5 m interface cable provided); Optional fiberoptic interface available for remote operation	
I/O signals	Two MCX connectors for programmable frame readout, shutter, trigger in	
Operating environment	+5°C to +30°C non-condensing	
Certification	CE	
Camera head dimensions (L x W x H)	251.6 mm (9.91") x 129 mm (5.08") x 142.8 mm (5.62")	
Camera head weight	6.5 kg (14.3 lbs)	

Specifications are subject to change

SOPHIA 2048B - 152 Quantum Efficiency Curves



Frame Rates

SOPHIA 2048B - 152

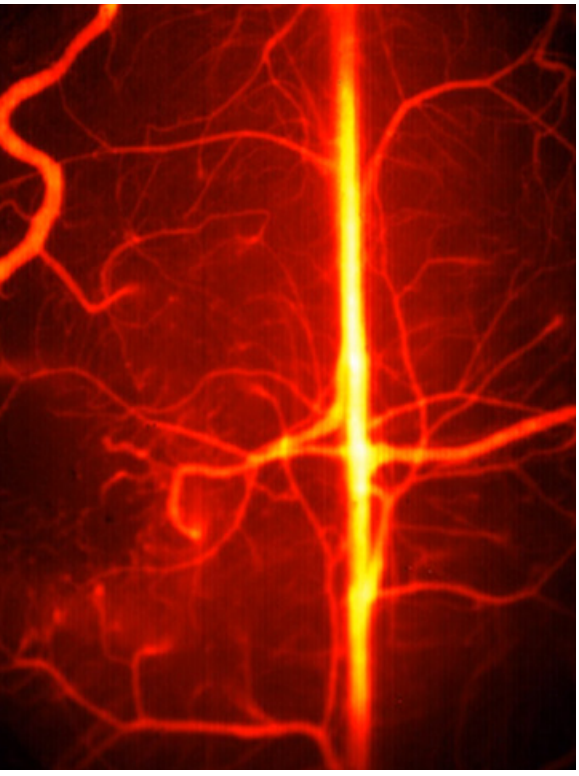
Binning	16 MHz	4 MHz	400 kHz
1 x 1	3.2	0.9	0.09
2 x 2	7.4	2.9	0.33
4 x 4	14.3	7.7	1.05
8 x 8	22.2	15.4	2.9

Applications

Astronomy

Ground-based optical astronomy covers an expansive range of scientific research. Longer exposures are common due to the faint signal of objects within space. The SOPHIA, with deep cooling down to -90°C, has ultra-low dark noise, making it ideal for longer exposure experiments. With a peak quantum efficiency of >95%, the SOPHIA is optimized for high sensitivity over the visible wavelength range.

The SOPHIA has a large format CCD sensor, increasing light capture and throughput. This is perfect for capturing larger objects, for enhancing object calibration by imaging more reference stars per frame, and for ultra-low light capture of faint objects. The quad-port readout architecture allows for faster readout speeds with similar read noise, for dynamic object capture. Deep-depletion technology and enhanced near infrared sensitivity, with >95% QE over the 700-850 nm range, also makes the SOPHIA a great fit for NIR applications such as exoplanet characterization.



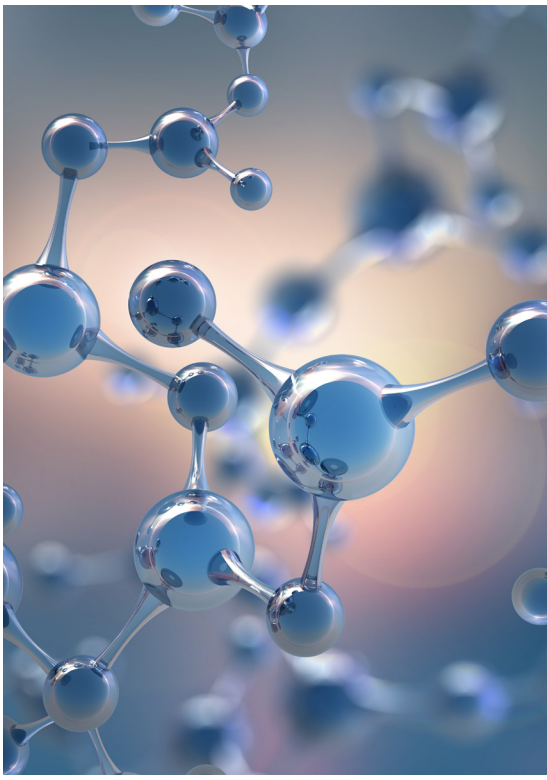
In vivo imaging

Small animal research is key for translational medical research. Optical imaging detection is a common technique used within medical imaging and can provide important information for research areas such as disease detection and medicinal drug efficacy.

The SOPHIA camera has a large format CCD sensor for high throughput *in vivo* imaging over the 300 - 1000 nm range. The large field of view offers high efficiency, allowing for greater visualization of target tissue while reducing sample photodamage. As more of the sample area can be imaged, more quantitative analysis can be done on each acquired frame.

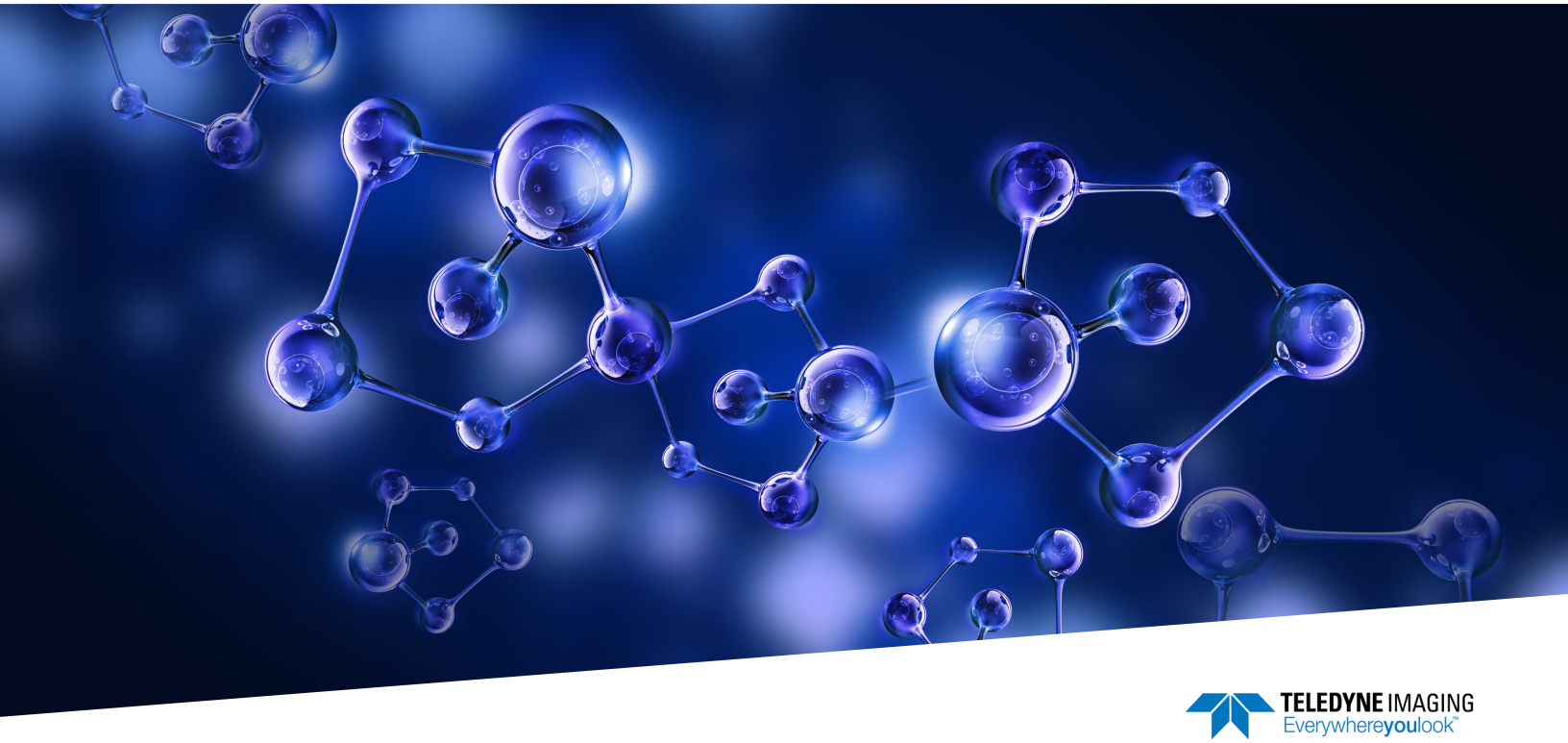
With deep cooling down, a high dynamic range and >95% quantum efficiency, the SOPHIA is often chosen for ultra-low light imaging, common within *in vivo* studies. The low noise of the SOPHIA makes it perfect for long integration times, providing effective acquisition over a large imaging area.

Nanotechnology Characterization



Nanotechnology encompasses a variety of research characterizing dimensions that are less than approximately 100 nanometers, including the development of faster electronics, the enhancement of biomedical imaging, and the creation of ultra-strong, extremely lightweight materials.

With a peak quantum efficiency of greater than 95% and a large format sensor for high throughput, the SOPHIA provides high sensitivity for nanoparticle detection. The large field of view offers more quantitative analysis per frame whilst deep cooling provides ultra-low dark noise, meaning longer exposures can be used for measuring extremely faint signals. Nanotechnology can be characterized via imaging and spectroscopy, each providing complementary information. The SOPHIA can be utilized for both, providing high quality acquisition regardless of technique used. The addition of eXcelon technology, with high NIR and UV quantum efficiency alongside reduced etaloning (fringing), offers better imaging and spectral quality for low-light nanoparticles in this range.



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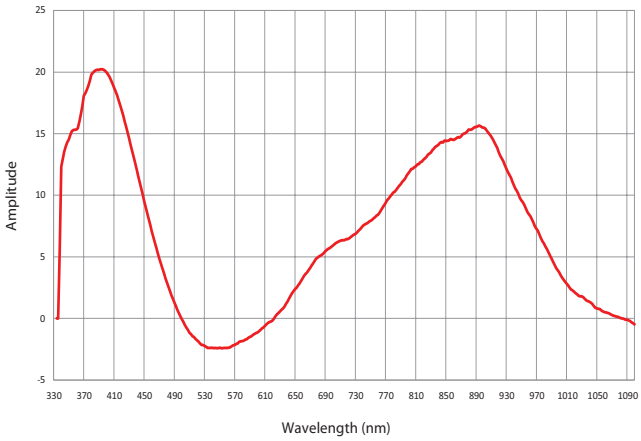
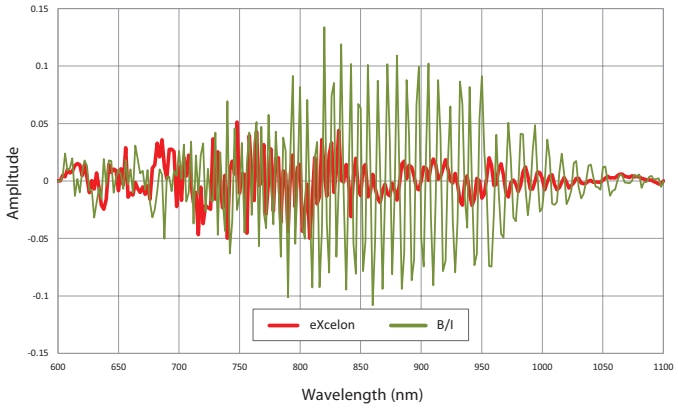
eXcelon® Advantages



% QE Increase (eXcelon : BI)

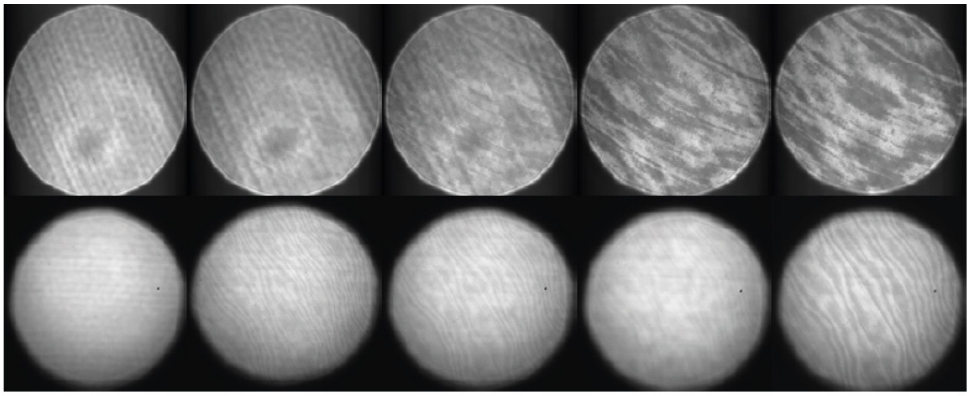
B_eXcelon provides superior QE over the standard back-illuminated ("B/I") version in the UV-NIR range.



Etaloning Performance Comparison - eXcelon : B/I

B_eXcelon provides significantly lower etaloning (unwanted fringes) compared to standard back-illuminated ("B/I") version.

eXcelon is available as an option for most Teledyne CCD and CMOS sensors



Data taken with white light source through a monochromator comparing etaloning performance of eXcelon vs. back-illuminated CCDs.

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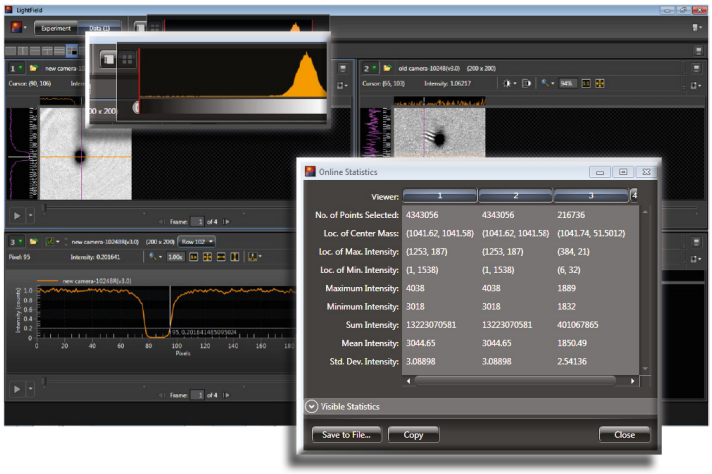
LightField® Software

The Future of Scientific Imaging and Spectroscopy Software

The combination of LightField and the SOPHIA 2048B provides researchers with the most advanced and reliable toolset for experimental setup, data acquisition, and post processing:

- Powerful 64-bit software package includes Microsoft Windows 10 support
- Complete control of Teledyne Princeton Instruments cameras and spectrometers
- Dependable data integrity via automatic saving to disk, time stamping, and retention of both raw and corrected data
- Full experimental details and system settings are archived and can be reloaded for future experiments ensuring maximum reproducibility



- For light-sensitive experiments, the user interface offers “low light” and “no light” modes during data acquisition
- LightField works seamlessly in multi-user facilities, remembering each user’s hardware and software configurations
- Simple math functions and complex transforms can be applied to live or stored data, with an included easy-to-use editor to create your own formulas
- Integrated LabVIEW®, MATLAB™, Python™, ASCOM® and Maxim DL™
- Exports to your favorite file formats, including TIFF, FITS, ASCII, AVI, IGOR, and Origin
- Demo camera mode allows the user to view all of the settings and parameters associated with any camera without physically connecting the camera
- Live data processing operations provide real-time evaluation of incoming data to optimize experimental parameters

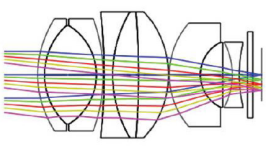
Accessories

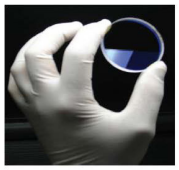
SOPHIA 2048B cameras can be provided in custom configurations to suit your experiment. Please contact your local Teledyne Princeton Instruments representative. The most common configurations are listed below:

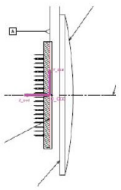
SOPHIA 2048B
Camera

Optional accessories and customization:

- LightField software
- PICam SDK/API for Linux and Microsoft Windows (provided for free)
- Customized coatings and filters from UV to NIR
- Custom optical assemblies







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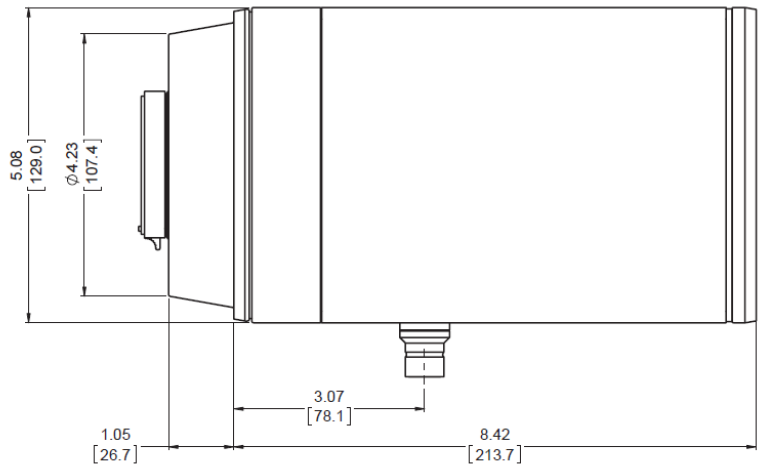

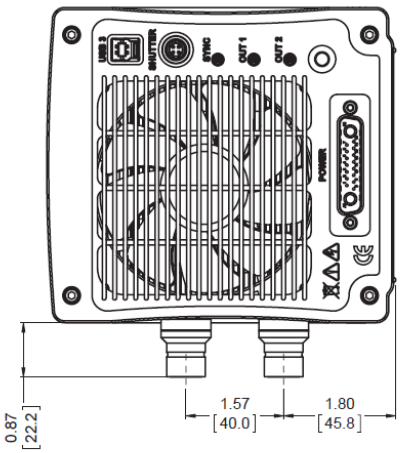

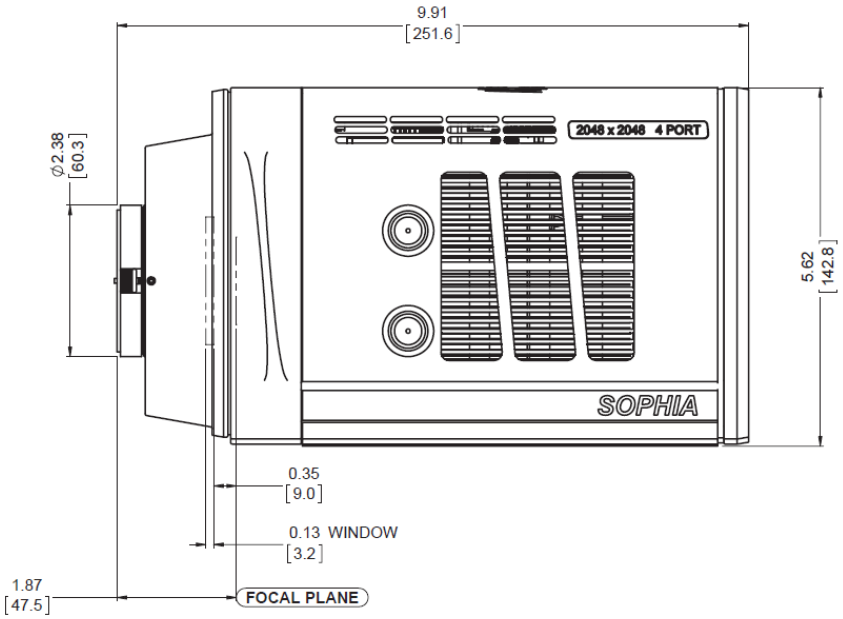

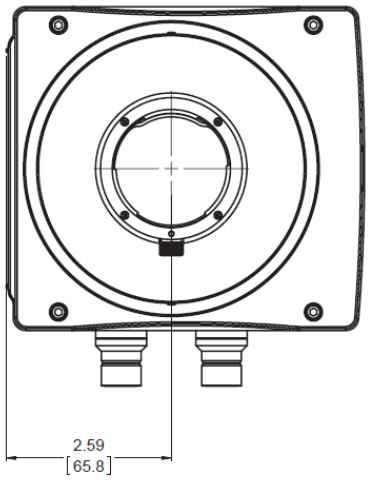

Weight: 6.5 kg (14.3 lbs)

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SOPHIA® 2048B

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