

# Andor CB2

## High Resolution Low Noise sCMOS Camera

### Key Specifications

- ✓ 5328 x 4608 pixels | 24.5 MP sCMOS
- ✓ 2.74  $\mu\text{m}$  and 5.48  $\mu\text{m}$  pixel pitch
- ✓ Very low noise: 1.3e- RMS
- ✓ Ultra low dark 0.0015 e-/p/s
- ✓ High Dynamic Range
- ✓ Global shutter
- ✓ 74 fps

### Key Applications

- ✓ Low-Mag Fluorescence Microscopy
- ✓ Luminescence
- ✓ Cell Motility & Ion Channels
- ✓ Large Sky Surveys
- ✓ Adaptive Optics & Speckle Imaging
- ✓ Fluid Dynamics
- ✓ Hyperspectral & Quantum Imaging



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# Introducing CB2



Andor CB2 is an ultra-high performance scientific camera platform which combines high sensitivity with high speed and global shutter, over a large field of view. With ultra-low dark current, CB2 is also well suited to extreme light-starved long exposure applications.

The Andor CB2 24B model features a high sensitivity **back-illuminated 24.5 Megapixel sensor**, imaging over a large field of view at high resolution. 'On-chip' 2x2 pixel binning **uniquely allows the native 2.74µm pixel to be converted to a 5.48µm pixel without doubling of the read noise.** This inherent optical flexibility significantly expands the application adaptability of the camera.

CB2 24B is also an excellent solution for **longer exposure applications** such as luminescence or astronomy, that are ordinarily not suited to sCMOS cameras. For long exposures of many seconds to minutes, dark current is the predominant noise source. CB2 24B has been designed to harness the full potential of the sensor for longer exposures, with TE cooling to -20°C minimizing dark current down to an ultra-low 0.0015 e-/p/s. This is an order of 100-1000 less than commonly used sCMOS cameras and makes CB2 24B a true alternative to deep-cooled CCD cameras for many long exposure applications. Furthermore, CB2 has been low-temperature qualified for operation down to -40°C ambient, perfect for observing in high altitude or harsh environments.

CB2 24B is also highly suited to **high-speed applications**, delivering 74 fps (full resolution) in 12-bit, boosted to 283 fps with 2x2 binning. CB2 24B can measure variability across a wide range of timescales, ideal for ion flux microscopy, cell motility, adaptive optics, speckle interferometry and quantum ion/neutral atom dynamics.

The camera uses **CoaXPress 2.0 or GigE** interfaces ensuring stable data transfer with very low latency, even over extended distances. The native C-mount provides a broad compatibility, while a TFL mount is available on request for longer optical apertures.



## Andor CB2 24B Common Features

Monochrome back-illuminated global shutter CMOS	Back-illuminated sCMOS sensor with high QE and a very low 1.3e- rms read noise which provides exceptional sensitivity through the visible spectrum. By incorporating a global shutter architecture a "snapshot" image can be taken which provides true temporal accuracy across the field of view.
High resolution sensor format	CB2 offers a 24.5 Megapixel array and small 2.76 µm pixel size, to image much wider areas at lower magnifications with full resolution.
On-chip 2x2 Binning	CB2 features on-chip 2x2 binning allowing the pixel size to be switched between the native 2.76µm and 5.48 µm without increasing read noise, opening up further application possibilities without compromise.
Low dark current sCMOS	CB2 uses sensor cooling down to -20°C for minimization of darkcurrent. Combined with low amplifier glow from stacked chip design this allows access to longer exposures, up to several minutes. This broadens the application flexibility of this model, making it ideal for long exposure luminescence measurements and astro-photometry.
Temperature Management	Air cooling provides effective cooling to 0°C for most applications. Liquid cooling can be selected to provide the lowest possible dark current at long exposures, or for vibration sensitive applications such as electrophysiology.
Low temperature qualified	CB2 has been qualified for operation down to -40°C ambient, ideal for observing in high altitude harsh environments.
Selectable readout speeds	8-bits, 10-bits, 12-bits, 16-bits modes. Trade-off between frame rate and dynamic range. HDR mode is available to capture the full image information across a very wide 16-bits data range.
Adjustable gain	Default options for selection of High gain or Low gain allows easy adjustment for sensitivity, or extended dynamic range. In addition, advanced users can fine-tune sensitivity and dynamic range to suit their specific requirements using 24dB analog gain and up to 48 dB of digital gain.
Multi-windowing and Region of Interest (ROI)	User-selectable regions of interest allow cropped sensor operation to boost frame rates, while multiple regions of interest can also be set enhancing application possibilities.
Compact design	CB2 packages a large area sensor, thermoelectric and liquid cooling and multiple connectivity options within a space efficient design, keeping the overall size of the camera to a minimum.
Lens mount	The camera has C-mount native interface. However, for configurations which require a large optical aperture, a TFL-mount can be provided upon request.
High speed data interface options	CB2 supports the high data output with high-speed data interface options. CoaXPress and 10 GigE provide stable, low latency performance over longer distances. CB2 is GigE Vision and GenICam compatible.

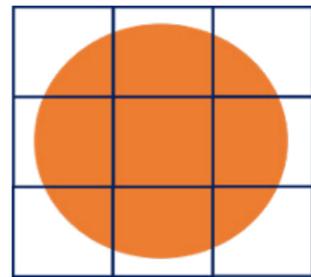
# Key Features

## 24.5 Megapixel Resolution

CB2 24B presents an ideal solution to capture a large field of view at high resolution, ideal for fine detailed microscopy on larger samples (such as organoids or tissue sections), large sky surveys in astronomy and X-Ray tomography.



(Not to scale)



## Pixel Flexibility

CB2 24B uniquely offers on-chip 2x2 binning of sCMOS pixels, allowing the native 2.74µm pixel to be converted to a 5.48µm pixel without doubling of read noise (which would otherwise be expected for sCMOS technology). This inherent optical flexibility significantly expands the application adaptability of the camera. For example, in fluorescence microscopy, a 2.74µm pixel is ideal for x10 to x40 low magnification imaging of large samples, whereas 5.48µm is better suited to high sensitivity imaging of samples with x60/High NA objective lenses. In astronomy, it also renders CB2 24B more optically adaptable to range of telescopes.

CB2 24B more optically adaptable to range of telescopes.

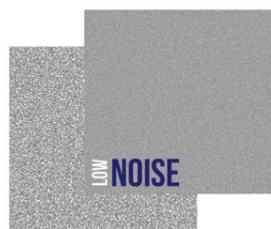
## High Speed

Delivering 74 fps (full resolution) in 12-bit and 37 fps HDR mode, and much faster still with Region of Interest and/or pixel binning, CB2 24B can measure variability across a wide range of timescales, ideal for ion flux microscopy, cell motility, wavefront sensing, imaging rapid celestial changes and fast measurements of Quantum Gas dynamics. Furthermore, the negligible readout time of a high-res sensor vastly exceeds that of CCDs, ideal for astrophotometry with minimal dead time between exposures.



## Low Noise

The massively parallel readout architecture and optimal pixel design enables CB2 24B to deliver a very low read noise performance of 1.3 e<sup>-</sup>, while still achieving maximum readout speed and full dynamic range. Ideal for live cell microscopy with minimal phototoxicity or photobleaching, photometric and astrometric measurements with high dynamic range, and Quantum Gas fluorescence measurements of low atom numbers.

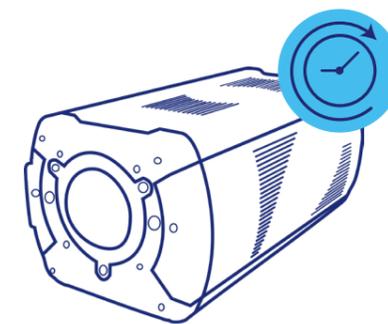


high dynamic range, and Quantum Gas fluorescence measurements of low atom numbers.

## High Dynamic Range (HDR)

The 16-bit HDR Mode of CB2 24B uses on-chip dual-amplifier design, meaning the whole photometric range, from the noise floor up to the saturation limit, can be captured with one image.

Combine with fast image stacking (accumulation) to extend dynamic range even further.

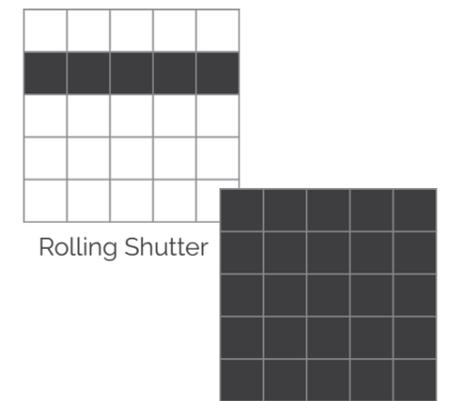


## Long Exposures

CB2 24B uses sensor cooling down to -20°C for minimization of darkcurrent. Combined with low amplifier glow from stacked chip design this allows access to longer exposures, up to several minutes. This broadens the application flexibility of this model, making it ideal for long exposure luminescence measurements and astro-photometry.

## Global Shutter

In Global Shutter, all pixels begin to expose simultaneously and at the end of the defined exposure period, each pixel transfers charge simultaneously to its readout node from which readout occurs 'behind the scenes'. Global Shutter is often referred to as 'SnapShot' exposure. It is ideal for imaging of fast process without risk of spatial distortion and is also the most efficient means of imaging when peripheral equipment needs to be moved between exposures, as is often the case in fluorescence microscopy.



Rolling Shutter

Global Shutter



## Low Maintenance Imaging

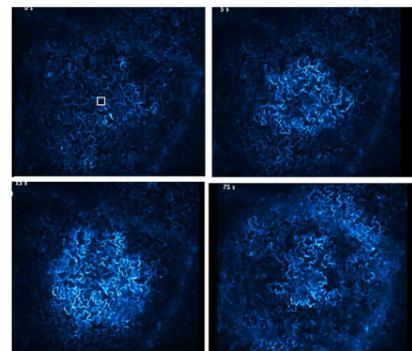
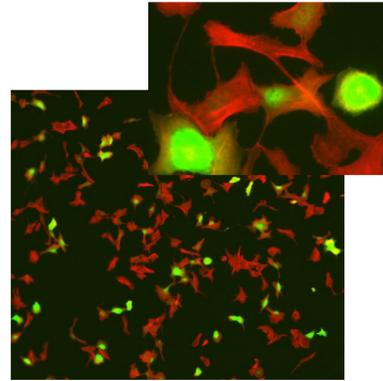
Applications that involve frequent cycling of mechanical shutters, such as Large Sky Surveys or X-Ray Tomography, require routine shutter replacements and associated down time. CB2 24B sCMOS offers on-sensor electronic Global Shutter, thus overcoming the need for mechanical shutters. Furthermore, the CB2 platform is operable down to -40°C ambient, ideal for observing in high altitude harsh environments.

# Life Sciences

## Image Large samples at Speed

Imaging at lower magnifications can provide significant boosts to throughput and productivity, as more information may be obtained in each image. However typical sCMOS cameras have a  $6.5\mu\text{m}$  pixel size which restricts their use to magnifications of 40x and above. While CMOS cameras are available with smaller pixel sizes, they lack the necessary sensitivity.

Andor's new CB2 24B is a sensitive back-illuminated sCMOS camera with a small  $2.74\mu\text{m}$  native pixel size. Using 10x and 20x objectives, up to 4x more area can be captured compared to using 40x- while maintaining detail and sensitivity. By using the unique on pixel binning, the CB2 24B can be set to an effective pixel size of  $5.48\mu\text{m}$  without impacting read noise. This means full resolution and sensitivity is possible from 10x through to 60x. With a global shutter and high-speed imaging, throughput can be maximised in low-light modalities including widefield, confocal, light sheet and TIRF.



## Ion Imaging

Ions such as Calcium and Magnesium serve as vital co-factors for processes within cells. The dynamics and localization of specific ions within living cells are therefore of interest to many studies, from the fundamentals of the cell machinery itself, to various disease states. Ion imaging has been made possible by development of various fluorescent dyes, and genetically encoded proteins that respond to ion concentration. To image of calcium sparks and waves a fast and sensitive sensor is vital.

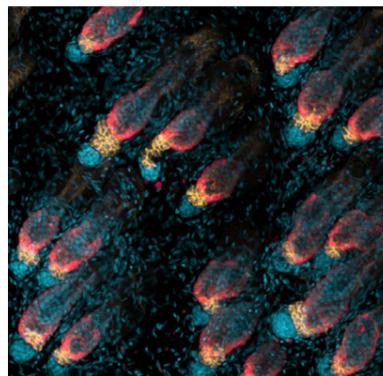
CB2 24B combines a sensitive global shutter sensor with exceptional imaging speeds achieving true temporal accuracy

across the full field of view. With the CB2 25B you can capture dynamic events such as Calcium sparks and waves with ease. The full array can provide up to 283 fps (12-bit) when 2x2 binned, with even faster speeds available through use of ROIs and/or 8-bit modes. CoaXPress and GigE interfaces provide stable data transfer and low latency.

## Cell Motility

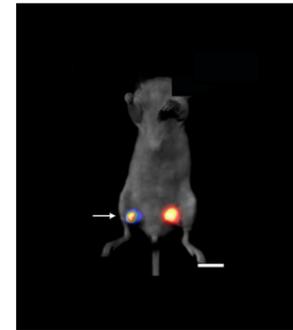
Cell motility covers many aspects. For single cellular organisms this can include chemotaxis of bacteria towards sources of food, or movement away from sources of harm. For multicellular organisms, cell motility is vital during development as differentiated cells migrate and organise to form tissues and organs. It also is important for cellular repair, or for cancer, when the normal processes are overridden. Movement of cells may be aided by flagella, or cilia that act as cellular motors, while the cytoskeleton also can elongate and shorten providing motion to the cell.

The CB 24B is an ideal detector for cell motility as the global shutter and high-speed imaging capability capture such dynamic events without motion blur. The high-resolution 25 Megapixel sensor with flexible on-chip binning provides a highly detailed image from 10x through to 60x.



## Luminescence

Bioluminescence forms the basis of many methods used in biological research. It is used in studies of gene transcription, protein expression, signalling pathways, circadian rhythms, through to cell viability. The signals involved in luminescence are typically weaker than those of fluorescence, so signal collection must be extended to many seconds to minutes. At such long exposures it is thermal noise of the detector that sets the detection limit. For this reason, deep cooled CCD cameras with orders of magnitude less thermal noise than typical sCMOS have remained the detector of choice.



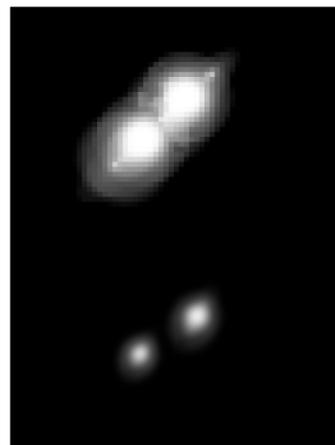
CB2 24B is a new generation of sCMOS detector, that finally brings a new option for luminescence-based imaging experiments. An ultra low dark current rivals many deep cooled CCD cameras and the stacked back-illuminated sensor provides very low sensor glow, allowing for acquisitions of many minutes duration. The high-resolution 25 Megapixel sensor provides greater detail when working at lower magnifications in model organisms.

# Physical Sciences

## Large Sky Surveys (Astronomy)

Several strands of astronomy require constant survey of large areas of the sky, monitoring for photometric or astrometric variability. This can encompass Space Domain Awareness, Exoplanet Discovery and Near-Earth Object (NEO) detection.

The large field of view, high resolution and high sensitivity of CB2 24B is well suited to such challenges, either directly visualised or by occultation. Deep cooling and associated darkcurrent minimization, alongside the low amplifier glow of the stacked back-illuminated sensor, complements usage over a wide exposure range. Fast sensor readout means negligible deadtime between consecutive exposures and minimal photon wastage, whereas the global shutter is ideal for spatially referencing moving objects against star backgrounds with temporal accuracy. Lack of mechanical shutter means shutter lifetime is not an issue, reducing the downtime of cameras in remote observing locations. The on-chip 2x2 pixel binning flexibility renders CB2 24B more optically adaptable to a range of telescopes.



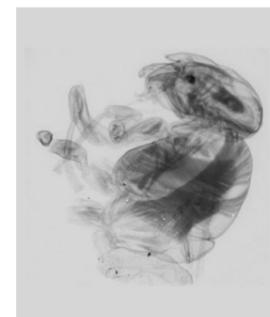
## Resolution Enhancement (Astronomy)

**Adaptive Optics Wavefront Sensing** – CB2 24B is fast, low noise wavefront sensor for Adaptive Optics, especially when on-chip 2x2 binned to a 5.48 $\mu\text{m}$  pixel pitch. The full array yields 283 fps (12-bit) when 2x2 binned, with much faster speeds available through ROI. The CoaXPress and GigE interfaces transmit data with low latency over longer distances.

**Lucky/Speckle Imaging** – CB2 24B can be used for the 'Atmospheric Freezing' techniques of Lucky and Speckle Imaging, enabling resolution enhancement of ground-based astronomy over a large field of view. 74 fps full array, 283 fps with on-chip 2x2 binning, means that enhanced resolution images can be generated within a few seconds of acquisition.

## Quantum Ion Trap & Neutral Atom

CB2 24B be readily integrated into optical systems for imaging arrays of ultracold trapped ions or neutral atoms in quantum computing systems. The low noise, good blue wavelength response and rapid frame rate of CB2 24B (especially under ROI), is ideal for fast and continuous dynamic studies of trapped species. Global shutter ensures fast purging of unwanted 'pre-acquisition' signal and low latency data transfer compliments well into feedback loop systems.

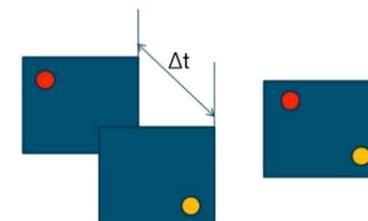


## Tomography (X-Ray or Neutron)

For high throughput 3D tomography, the high-resolution CB2 24B back-illuminated sCMOS models, featuring low noise and fast readout present a superb solution. Lens/scintillator coupled tomography using CB2 24B enables reconstruction of large objects without sacrificing resolution and clarity. Lack of mechanical shutter means shutter lifetime is not an issue, reducing downtime.

## Fluid Dynamics (PIV)

CB2 24B is well suited to the Particle Imaging Velocimetry (PIV) technique for flow visualisation. Temporal resolution between image pairs is a key requirement of this approach and the global shutter mode of this camera can be harnesses to deliver a short electronic inter-frame gap.



# Technical Specifications

## Specifications<sup>•1</sup>

Sensor Specifications	Andor CB2 24B
Sensor Type	Back illuminated stacked sensor
Active pixels (W x H)	5328 x 4608 CMOS (24.5 Megapixel)
Pixel Size	2.74 $\mu\text{m}$ 5.48 $\mu\text{m}$ with 2x2 on-chip binning
Sensor Size	19.3 mm diagonal
Shutter Architecture	Global shutter
Maximum Quantum Efficiency	74 %
Readout Noise (in 12 bits, 24 dB analogic gain at 50 $\mu\text{s}$ )	1.30 $e^-$
Air Cooling	0°C (@ +25°C ambient)
Liquid Cooling	-20°C (@ +25°C liquid)
Dark Current	0.0015 $e^-/p/s$ (@ -20°C) 0.0044 $e^-/p/s$ (@ 0°C)
Image Full well capacity (0 dB analogic gain)	9.5 $ke^-$

Additional Features	Andor CB2 24B
Synchronization	Internal & External
Analog gain	0 to 24 dB
Quantization A/D	8, 10, 12 bits
Data Range with HDR (High Dynamic Range)	16 bits
Binning	2x2 on-chip
Region of Interest	Up to 64 user-defined regions
Interface options	CoaXPress 2.0 (CXP-12)   High speed SFP+ 10 GigE interface with Ethernet or Fiber
Optical interface	C Mount + TFL Mount (Optional)

CoaXPress Camera Specifications (4 ports)		
Maximum speed in full frame fps	8-bit	106 fps
	10-bit	102 fps
	12-bit	74 fps
	16-bit (HDR)	37 fps
Maximum speed in 2x2 binning full frame	8-bit	386 fps
	10-bit	361 fps
	12-bit	283 fps
	16-bit (HDR)	N/A
Minimum integration time	8-bit	4,412 $\mu\text{s}$
	10-bit	4,496 $\mu\text{s}$
	12-bit	5,274 $\mu\text{s}$
	16-bit (HDR)	5,274 $\mu\text{s}$

GigE Vision Camera Specifications (1 port)		
Maximum speed in full frame fps	8-bit	48 fps
	10-bit	32 fps
	12-bit	32 fps
	16-bit (HDR)	24 fps
Maximum speed in 2x2 binning full frame	8-bit	188 fps
	10-bit	125 fps
	12-bit	129 fps
	16-bit (HDR)	N/A
Minimum integration time	8-bit	6,769 $\mu\text{s}$
	10-bit	8,911 $\mu\text{s}$
	12-bit	8,911 $\mu\text{s}$
	16-bit (HDR)	6,783 $\mu\text{s}$

Region of Interest Frame Rate Table in 8, 10, 12 and 16 HDR for CXP Output					
Lines		8-bit	10-bit	12-bit	16-bit (HDR)
	16	2560	2458	1973	1366
	32	2370	2276	1812	1216
	64	2064	1982	1558	997
	128	1641	1576	1216	734
	256	1163	1117	845	480
	512	735	706	525	283
	624	633	608	450	240
	1104	397	381	280	145
	2208	214	205	149	76
4608	106	102	74	37	

Region of Interest Frame Rate Table in 8, 10, 12 and 16 HDR for GigE Vision Output					
Lines		8-bit	10-bit	12-bit	16-bit (HDR)
	16	2560	2458	1973	1366
	32	2370	1790	1812	1216
	64	1636	1088	1184	891
	128	1017	679	726	566
	256	622	414	434	340
	512	361	241	248	192
	624	306	204	209	161
	1104	186	124	126	96
	2208	98	65	66	50
4608	48	32	32	24	

# Creating The Optimum Product for You

## Step 1. Select the camera type

Camera Type	Description	Code
	CB2: 5328 x 4608 Monochrome CMOS camera, up to 106 FPS, 1.30 e- RON typ., CoaXPress interface	<b>PAC-CB2-CXP-V24</b>
	CB2: 5328 x 4608 Monochrome CMOS camera, up to 48 FPS, 1.30 e- RON typ., GigE Vision 10GB Eth or Fiber interface	<b>PAC-CB2-SFP-V24</b>

## Step 2. Select the required accessories

The part codes above **DO NOT** include grabber cards or cables. Please order either grabber kits or individual grabber cards and cables from the below accessory list, as required for either CoaXPress or GigE models.



Accessories

Description	Order Code
Grabber kit Quad CXP 5m	<b>ACC-GRA-CXP-004</b>
Grabber kit 10 GB Ethernet 10m	<b>ACC-GRA-10G-ETH-CB2</b>
Grabber kit 10 GB Fiber 10m	<b>ACC-GRA-10G-FIB-CB2</b>
Cooling Pack (chiller unit, connectors and hoses)	<b>PAC-COO-200-000</b>
Quick coupling set	<b>ACC-QCS-CAM-001</b>
Synchro cables 1m	<b>ACC-CAB-SYN-000</b>
Synchro cables 3m	<b>ACC-CAB-SYN-001</b>
Grabber Quad CXP Matrox	<b>ACC-GRA-CXP-003</b>
Coax Cables 10m (4x required)	<b>ACC-CAB-CXP-000</b>
Coax Cables 3m (4x required)	<b>ACC-CAB-CXP-001</b>
Grabber SFP	<b>ACC-GRA-SFP-000</b>
Ethernet cables 10m (2x required)	<b>ACC-CAB-ETH-000</b>
Fiber-Optic cable 10m (2x required)	<b>ACC-CAB-FIB-000</b>
TFL Mount	<b>ACC-MNT-TFL-000</b>

## Step 3. Software

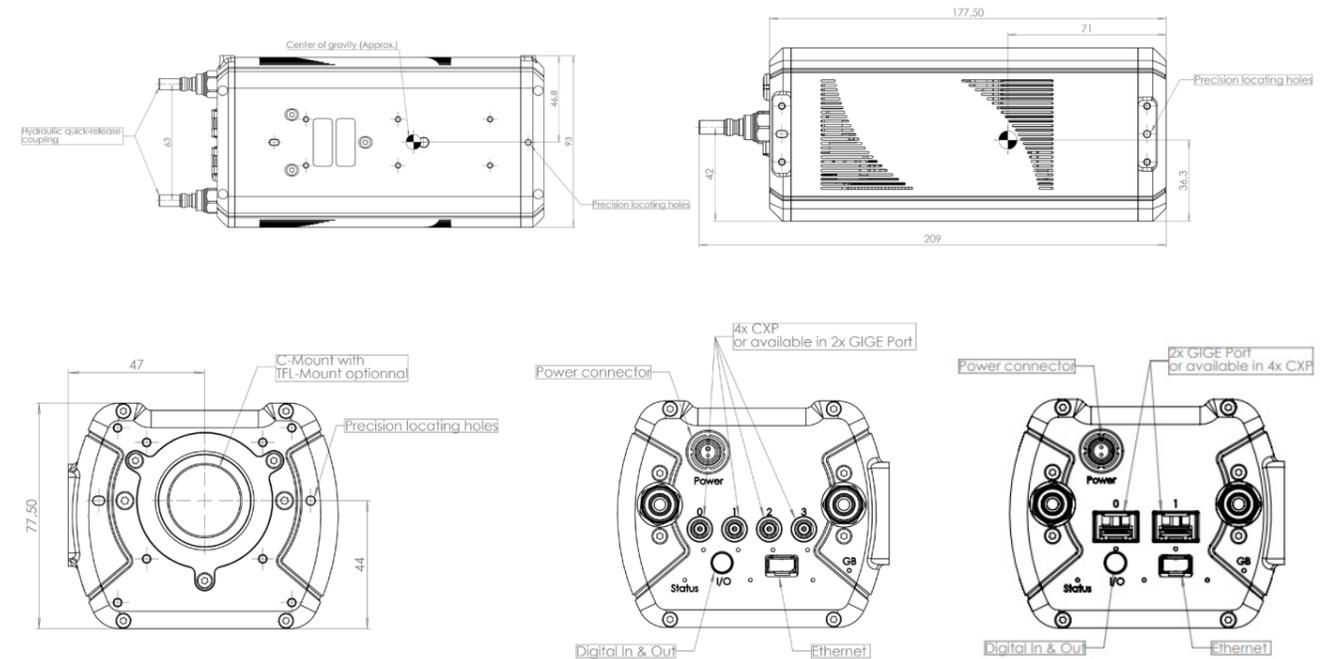


Software

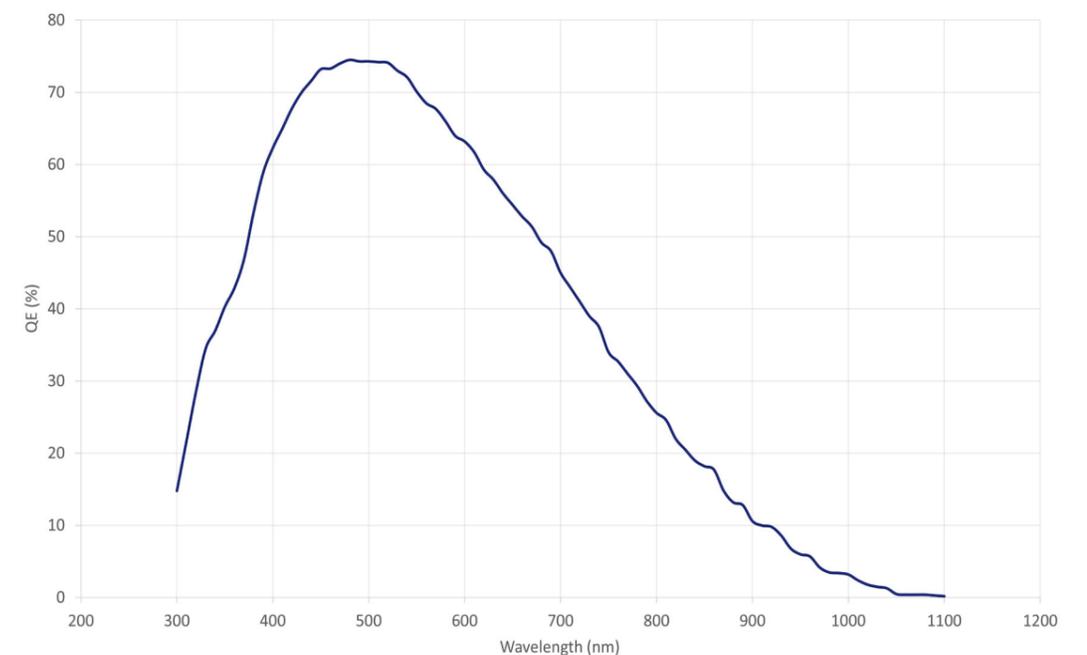
Your product is provided with the following software:  
 Graphical User Interface: First Light Vision, µManager  
 Software Development Kit: (C, C++, C#, Python, LabVIEW, MatLab)

# Product Drawings

Dimensions in mm [inches]  
 Air or Liquid Cooling  
 Weight 1.1 kg



## Quantum Efficiency (QE) Curve



# Order Today

Need more information? At Andor we are committed to finding the correct solution for you. With a dedicated team of technical advisors, we are able to offer you one-to-one guidance and technical support on all Andor products.

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## China

Beijing | Shanghai |  
Phone +86 (400) 678 0609  
Fax +86 (10) 5884 7901



### Items shipped with your camera:

- 1x Camera (model as ordered)
- 1x Power supply
- 1x Power supply cable
- 1x Quick start guide

### Minimum Computer Requirements:

- RAM: 8 GB minimum
- Processor: Intel® Core™ i5 or higher
- Screen resolution: at least 1920 x 1080
- PC data transfer rate capability for maximum frame rate of 74 fps (12-bit) - 5037 MBytes/s

See [system requirements](#) for more information.

### Operating and Storage Conditions

- Operating Temperature: -40°C to +50°C
- Relative Humidity: (non-condensing)
- Storage Temperature: -40°C to +50°C

### Power Requirements

- 100 - 240 VAC 50 - 60 Hz
- Max. power consumption: 60 W

### Footnotes: Specifications are subject to change without notice

1. Figures are typical unless otherwise stated.