ANDOR
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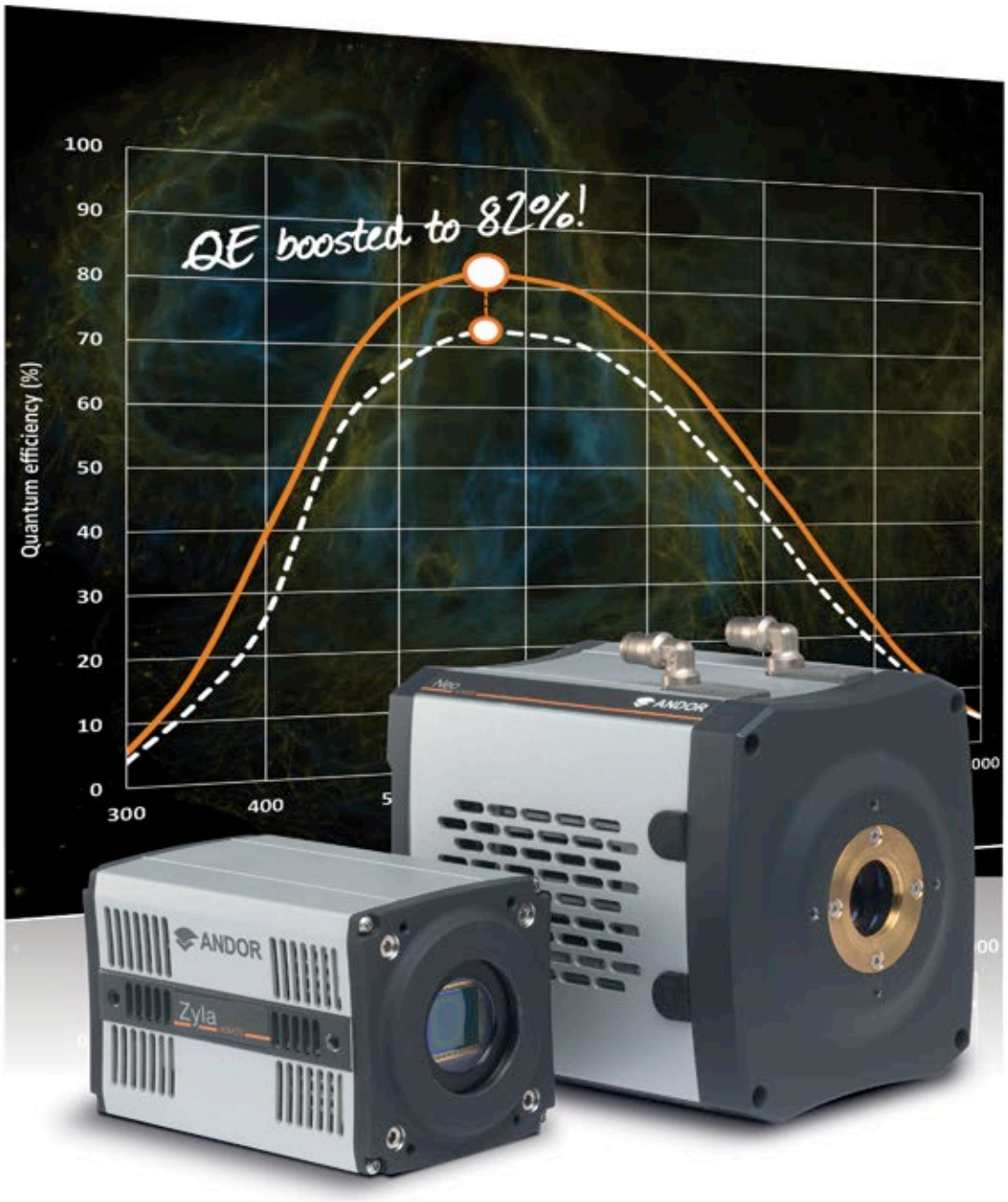
Scientific CMOS

Zyla and Neo sCMOS Cameras Widen Your Expectations



Scientific CMOS (sCMOS)

Imaging without compromise

Scientific CMOS (sCMOS) is a breakthrough technology that offers an advanced set of performance features that render it ideal to high fidelity, quantitative scientific measurement. Scientific CMOS can be considered unique in its ability to simultaneously deliver on many key performance parameters, overcoming the 'mutual exclusivity' associated with current scientific imaging technology standards, and eradicating the performance drawbacks traditionally associated with CMOS imagers.

Key sCMOS Features

- Extremely low noise
- Rapid frame rates
- Wide dynamic range
- High resolution
- Large field of view
- High Quantum Efficiency (QE)
- Rolling and Global (Snapshot) exposure modes

The multi-megapixel sensors offer a large field of view and high resolution, without compromising read noise, dynamic range or frame rate. Rolling and Global (Snapshot) shutter readout ensure maximum application flexibility.

Read noise is exceptional, even when compared to the highest performance 'slow-scan' CCDs. The fact that an sCMOS device can achieve 1 electron rms read noise while reading out up to 5.5 megapixels at 100 fps through the 10-tap cameralink interface, or 40 fps through the USB 3.0 interface renders it truly extraordinary in the market. By way of comparison, the lowest noise Interline CCD, reading out only 1.4 megapixels at ~16 fps would do so with ~10 electrons read noise.

The low noise readout is complemented by up to 33,000:1 dynamic range. Usually, for CCDs or EMCCDs to reach their highest dynamic range values, there needs to be a significant compromise in readout speed, yet sCMOS can achieve this value while delivering high frame rates. The unique dual amplifier architecture of sCMOS allows for high dynamic range by offering a large well depth, despite the relatively small 6.5 µm pixel size, alongside lowest noise. A 1.4 megapixel Interline CCD with similarly small pixels achieves only ~1,800:1 dynamic range at 16 fps.

> "Neo cameras will literally allow one to see cells in a new light with ultra sensitive imaging at speeds never achieved before - as we have seen in our tests of vesicle trafficking. These scientific CMOS cameras are not a small step, but a quantum leap, that will open up new possibilities of what can be studied in fast cellular processes, rapid screening, and super-resolution imaging."
>
> Derek Toomre, PhD., Associate Professor, Department of Cell Biology, Yale University School of Medicine, USA

Parameter	sCMOS - Zyla 4.2 PLUS	Interline CCD	EMCCD
Sensor Format	4.2 Megapixel	1.4 to 4 Megapixel	0.25 to 1 Megapixel
Pixel Size	6.5 µm	6.45 to 7.4 µm	13 to 16 µm
Read Noise	0.9e- @ 30 fps / 1.1 e- @100 fps	4 - 10 e-	< 1 e- (with EM gain)
Full Frame Rate (max)	Sustained: 100 fps full frame	3 to 16 fps	~30 fps
Quantum Efficiency (max)	82%	60%	97% 'back-illuminated'
Dynamic Range	33,000:1 (@ 30 fps)	~3,000:1 (@ 11 fps)	8,500:1 (@ 30 fps with low EM gain)
Multiplicative Noise	None	None	1.41x with EM gain

Neo 5.5 sCMOS

Driving optimal imaging performance

Image courtesy of Dr. Ulrike Engel, Nikon Imaging Center, Germany

Andor's Neo sCMOS vacuum cooled camera platform has been engineered from the ground up, specifically to realize the absolute highest sensitivity from this exciting new sensor technology.

Neo 5.5 offers an exceptionally low dark current and read noise floor detection limit, maintained even under longer acquisition times, alongside a wide dynamic range of 30,000:1. Speeds of 30 fps (full frame) can be maintained over extended kinetic series acquisitions, with 100 fps achievable in burst mode.

Neo 5.5 offers an advanced set of unique performance features and innovations, including deep vacuum TE cooling to -40°C, extensive 'on-head' FPGA data processing capability, a 4 GB memory buffer and a Data Flow Monitor. Andor's UltraVacTM vacuum process has been implemented to offer not only the necessary deep cooling capability, but also complete protection of the sensor.

These capabilities have been conceptualized to drive the best possible performance, image quality and longevity from sCMOS technology.

Neo 5.5 offers both Rolling and true Global (also known as 'Snapshot') shutter exposure mechanisms. Snapshot mode provides an exposure sequence that is analogous to that of an Interline CCD, whereby all pixels begin the exposure simultaneously and end the exposure simultaneously.

Specification sheets available at andor.com/neo

Key Specifications

Active pixels	2560 x 2160
Pixel size (w x h; µm)	6.5 x 6.5
Image area (mm)	16.6 x 14
Active area pixel well depth (e)	30,000
Max readout rate (MHz)	560 (280 x 2 outputs)
Frame rates (fps)	Sustained: 30 (full frame) Burst: 100 (full frame)
Read noise (e^-)	1 @ 200 MHz 1.3 @ 560 MHz
Sensor cooling	-40ºC
QE max	60%

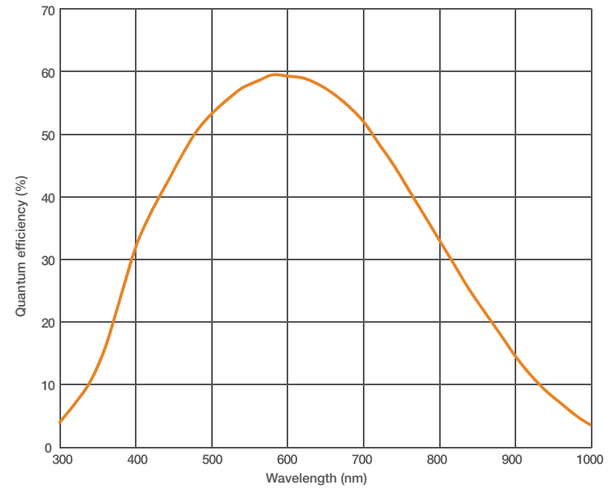
Features and Benefits

TE cooling to -40°C	Minimization of dark current to maintain low noise advantage under all exposure conditions. Minimization of hot pixel blemishes meaning more useful pixels. Fan-off mode for vibration sensitive set-ups.
Rolling and true Global (Snapshot) shutter	Maximum exposure and readout flexibility across all applications. Snapshot for 'Interline CCD' exposure capability.
1 e- read noise	Offers lower detection limit than any CCD.
5.5 megapixel sensor format and 6.5 µm pixels	Delivers extremely sharp resolution over a 22 mm diagonal field of view: ideal for cell microscopy, digital pathology, high content screening and astronomy.
Dark Noise Suppression (DNS) technology	Extremely competitive low dark current of 0.015 e^-/pix/sec with fan cooling. Maintains low noise advantage across range of exposure conditions.
Rapid frame rates	>30 fps over extended kinetic series. Burst to memory at 100 fps full frame.
UltraVac™	Sustained vacuum integrity and unequalled cooling with 5 year warranty; complete sensor protection.
Dual-Gain amplifiers	Maximum well depth and lowest noise simultaneously, affording extended dynamic range of 30,000:1.
GPU Express	Simplify and optimize data transfers from camera to Graphical Processing Unit (GPU) card to facilitate accelerated GPU processing as part of the acquisition pipeline.
4 GB on-head image buffer	Enables bursts of 100 fps @ full dynamic range. Capture extended kinetic series faster than PC write speed, avoiding prohibitively expensive PCs.
Sub-microsecond inter-frame gap	Global Shutter offers down to 100 ns inter-frame gap, ideal for PIV applications.
Extensive FPGA on-head data processing	Essential to ensure best image quality and quantitative fidelity from sCMOS technology.
Hardware timestamp	FPGA generated timestamp with 25 ns accuracy.
Dynamic baseline clamp	Essential to ensure quantitative accuracy across the image area and between successive images of a kinetic series.
Spurious noise filter	Realtime FPGA filter that identifies and compensates for spurious high noise pixels.
Data flow monitor	Innovatively manage acquisition capture rates vs data bandwidth limitations.
Comprehensive trigger modes and I/O	Communication and synchronization within intricate experimental set-ups.

Key Applications

- Neuroimaging
- Cell Motility
- Veolcimetry
- Super-resolution
- TIRF Microscopy
- FRET / FRAP
- Light sheet microscopy
- Vesicle Trafficking
- Ion Signaling
- Astronomy

Neo 5.5 QE curve



Zyla 5.5 sCMOS

High resolution camera for research and OEM

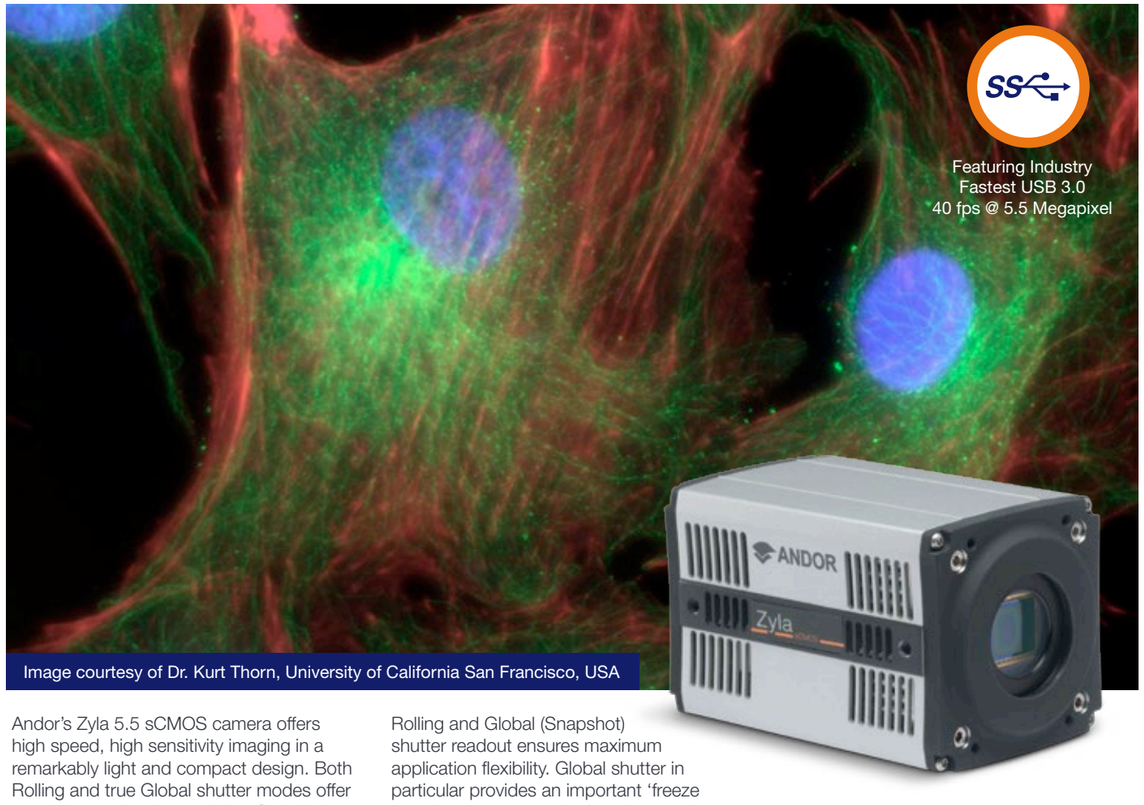


Image courtesy of Dr. Kurt Thorn, University of California San Francisco, USA

Andor's Zyla 5.5 sCMOS camera offers high speed, high sensitivity imaging in a remarkably light and compact design. Both Rolling and true Global shutter modes offer extensive application flexibility. Global shutter is ideally suited to fast multi-dimensional microscopy, offering tight synchronization to 'moving' peripheral devices such as z-stage or light source.

Zyla is ideally suited to many cutting edge applications that push the boundaries of speed, offering sustained frame rate performance of up to 100 fps (faster with ROI).

A highly cost-effective USB 3.0 version is also available, offering an unparalleled 40 fps (full frame) and 0.9 e- rms read noise, representing an ideal low light 'workhorse' camera solution for both microscopy and physical science applications, in either research or OEM environments.

Rolling and Global (Snapshot) shutter readout ensures maximum application flexibility. Global shutter in particular provides an important 'freeze frame' exposure mechanism that emulates that of an Interline CCD, overcoming the transient readout nature of Rolling shutter mode.

Zyla sCMOS for OEM

The light and compact form factor coupled with design and mounting adaptability, board level or private labelling options, and unparalleled engineering support, renders the Zyla highly suited to OEM integration.

Please call Andor to discuss how Zyla can be made to work for you.

Key Specifications

Active pixels	2560 x 2160
Pixel size (w x h; µm)	6.5 x 6.5
Image area (mm)	16.6 x 14
Active area pixel well depth (e)	30,000
Max readout rate (MHz)	560 (280 x 2 outputs)
Frame rates (fps)	Camera Link: 100 USB 3.0: 40
Read noise (e^-)	0.9 @ 200 MHz 1.2 @ 560 MHz
Sensor cooling	0ºC (up to +30ºC ambient)
QE max	60%

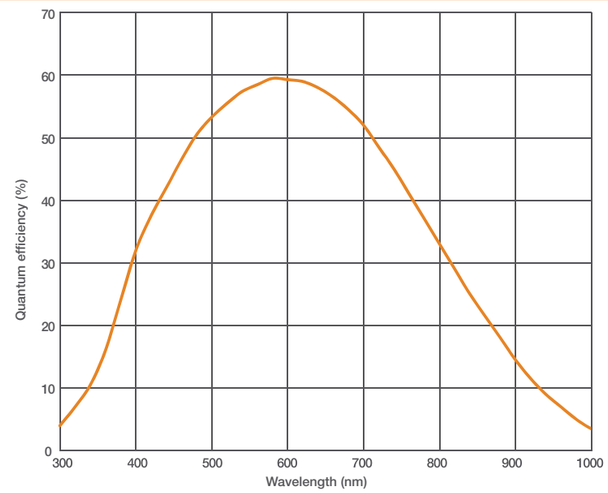
Features and Benefits

Compact and light	Highest QE sCMOS sensor, providing optimal signal to noise in low light applications.
Rolling and true Global (Snapshot) shutter	Maximum exposure and readout flexibility across all applications. Snapshot for 'Interline CCD mode' freeze frame capture of fast moving/changing events.
Industry fastest frame rates	100 fps sustained via Camera Link (full frame). Industry fastest USB 3.0 frame rates.
FCS Mode	Offers a market-leading speed of 27,057 fps from a 2560(h) x 8(v) region of interest, ideally matched to the temporal demands associated with Fluorescence Correlation Spectroscopy.
Low fan vibration	Designed with vibration sensitive experiments in mind, such as super-resolution microscopy.
5.5 megapixel sensor format and 6.5 µm pixels	Delivers extremely sharp resolution over a 22 mm diagonal field of view: Ideal for cell microscopy, digital pathology, high content screening and astronomy.
Dual-gain amplifiers	Maximum well depth and lowest noise simultaneously, affording extended dynamic range of 33,000:1.
12-bit and 16-bit modes	12-bit for smaller file size and absolute fastest frame rates through USB 3.0; 16-bit for full dynamic range.
GPU Express	Simplify and optimize data transfers from camera to Graphical Processing Unit (GPU) card to facilitate accelerated GPU processing as part of the acquisition pipeline.
Sub-microsecond inter-frame gap	Global Shutter offers down to 100 ns inter-frame gap, ideal for PIV applications.
Water cooled option	Access lowest possible vibration and -10ºC cooling.
Extensive FPGA on-head data processing	Essential to ensure best image quality and quantitative fidelity from sCMOS technology.
Hardware timestamp	FPGA generated timestamp with 25 ns accuracy.
Dynamic baseline clamp	Essential to ensure quantitative accuracy across the image area and between successive images of a kinetic series.
Spurious noise filter	Real time FPGA filter that identifies and compensates for spurious high noise pixels.

Key Applications

- Cell Motility
- Stem Cells imaging
- Localization microscopy
- Flow and turbulence studies
- Microfluidics
- Fluorescence Correlation Microscopy
- Light sheet microscopy
- Vesicle Trafficking
- Ion Signaling
- High throughput screening

Zyla 5.5 QE curve



Zyla 4.2 PLUS sCMOS

High and broad QE workhorse imaging solution

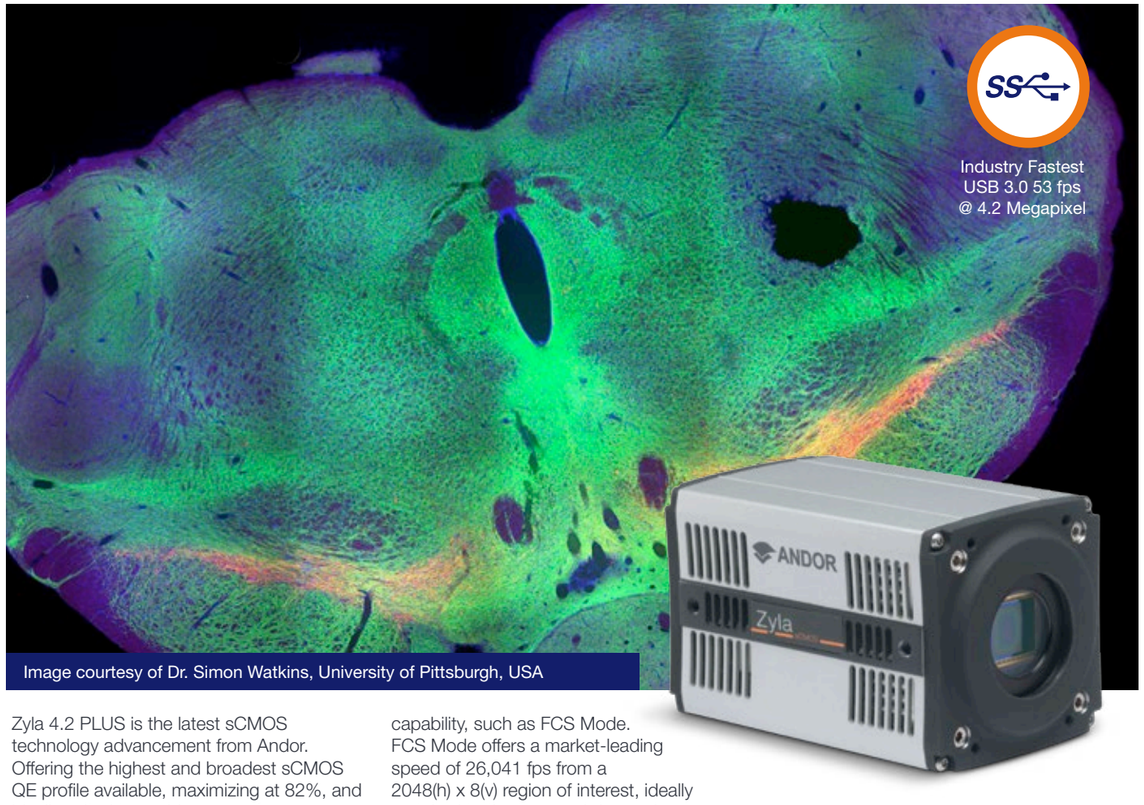


Image courtesy of Dr. Simon Watkins, University of Pittsburgh, USA

Zyla 4.2 PLUS is the latest sCMOS technology advancement from Andor. Offering the highest and broadest sCMOS QE profile available, maximizing at 82%, and ideally suited to a wide range of common fluorophores.

The Zyla 4.2 PLUS is also uniquely speed-optimized to deliver a sustained 53 fps at full resolution through a convenient USB 3.0 interface, 77% faster than competing sCMOS cameras. New on-camera intelligence delivers a significant linearity improvement, providing unparalleled quantitative measurement accuracy across the full dynamic range.

The high resolution 4.2 megapixel camera delivers QE performance that is 10% higher than the previous gold-standard sCMOS sensor, coupled with < 1 e- read noise and 33,000:1 dynamic range in a light, compact, low vibration design, intended for both research and OEM usage. The Zyla 4.2 PLUS also includes application specific capability, such as FCS Mode. FCS Mode offers a market-leading speed of 26,041 fps from a 2048(h) x 8(v) region of interest, ideally matched to the temporal demands associated with Fluorescence Correlation Spectroscopy.

New GPU Express facilitates real time data processing.

The Zyla 4.2 PLUS differs fundamentally from Zyla 5.5 in terms of shutter flexibility. Whereas Zyla 5.5 offers both Rolling and true Global shutter modes, the Zyla 4.2 PLUS operates in Rolling shutter mode. However, a mechanism called 'Simulated Global Exposure' is available, whereby a TTL output from the camera can be used to activate a pulsed light source, emulating the Global shutter exposure condition, albeit with less efficiency.

Key Specifications

Active pixels	2048 x 2048
Pixel size (w x h; µm)	6.5 x 6.5
Image area (mm)	13.3 x 13.3
Active area pixel well depth (e)	30,000
Max readout rate (MHz)	540
Frame rates (fps)	Camera Link: 100 USB 3.0: 53
Read noise (e^-)	0.9 @ 216 MHz 1.1 @ 540 MHz
Sensor cooling	0ºC (up to +27ºC ambient)
QE max	82%

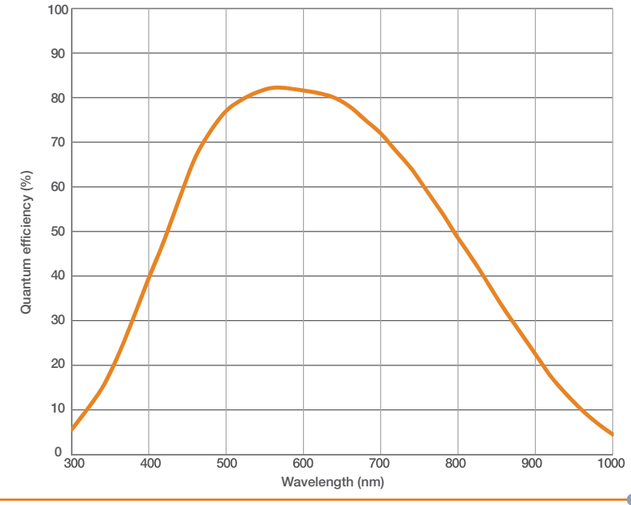
Features and Benefits

82% QE	Highest available photon capture efficiency across visible/NIR, optimized for all common fluorophores.
Market leading USB 3.0 speed	Superb USB 3.0 data transfer efficiency and Zyla's unique 12-bit high speed mode deliver up to 53 fps full resolution, 77% faster than competing sCMOS. Follow dynamic processes with improved temporal resolution.
FCS Mode	Offers a market-leading speed of 26,041 fps from a 2048(h) x 8(v) region of interest, ideally matched to the temporal demands associated with Fluorescence Correlation Spectroscopy.
LightScan PLUS	Reduce background and improve contrast and resolution in scattering samples. Designed to allow users to maximise signal and confocality concurrently in applications such as Scanned Light Sheet Microscopy and Line Scanning Confocal Microscopy.
Low fan vibration	Designed with vibration sensitive experiments in mind, such as super-resolution microscopy.
4.2 megapixel sensor format and 6.5 µm pixels	Delivers extremely sharp resolution over a 18.8 mm diagonal field of view; ideal for cell microscopy and astronomy.
Rolling shutter and simulated Global Exposure	Rolling shutter mode optimizes read noise and frame rate. Employ simulated Global shutter method if possibility of Rolling shutter spatial distortion.
Dual-gain amplifiers	Maximum well depth and lowest noise simultaneously, affording extended dynamic range of 33,000:1.
> 99.8 % linearity (> 99.9% in low light range)	Unparalleled quantitative accuracy of measurement across the full dynamic range.
GPU Express	Simplify and optimize data transfers from camera to Graphical Processing Unit (GPU) card to facilitate accelerated GPU processing as part of the acquisition pipeline.
Dark Noise Suppression (DNS) technology	Extremely competitive low dark current of 0.10 e^-/pix/sec with fan cooling. Maintains low noise advantage across range of exposure conditions.
Water cooled option	Access lowest possible vibration and -10ºC cooling.
Hardware timestamp	FPGA generated timestamp with 25 ns accuracy.
Dynamic baseline clamp	Essential to ensure quantitative accuracy across the image area and between successive images of a kinetic series.
Spurious noise filter	Real time FPGA filter that identifies and compensates for spurious high noise pixels.
iCam	Market leading exposure switching with minimal overheads.

Key Applications

- Light sheet microscopy
- Cell Biology
- Neuroimaging
- Photoelastic Ptychography
- Plant fluorescence
- TIRF
- FRET
- Vesicle Trafficking
- Ion Signaling
- Microfluidics
- *C. elegans* behavioral mapping
- Co-imaging with AFM

Zyla 4.2 QE curve



Zyla - Biologist's Choice

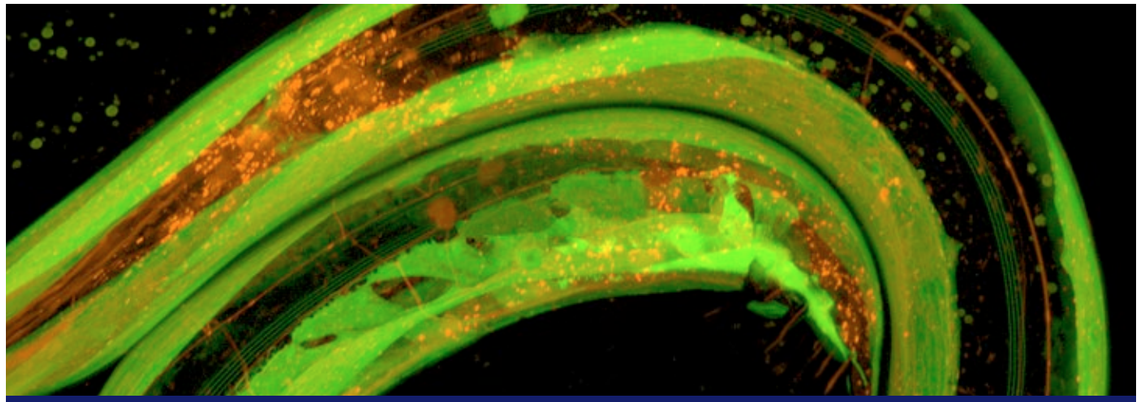


Image courtesy of Laura Mellor, Faculty of Life Sciences, University of Manchester, UK

Zyla sCMOS has proven a superb camera choice - a price/performance 'workhorse' imager with which to replace or upgrade their existing CCDs including interline cameras.

Example Areas of Application

Lightsheet Microscopy
LightScan PLUS is a new Light Sheet feature set available on Zyla 4.2 PLUS and it has the following benefits:
- Optimize signal to noise AND confocality concurrently
- CycleMax - Maximum frame rates with reduced dead-time, no need to reset light sheet for each alternate frame

TIRF Microscopy
The Zyla's fine pixel resolution, great sensitivity, large field of view and fast imaging speed offers a superb choice of platform for following/tracking fast processes at the cell membrane. Multi wavelength TIRF may benefit from Zyla 5.5 in Global shutter.

Super Resolution Microscopy
The low vibration, high QE, low noise and speed capability of Zyla 4.2 PLUS is well suited to single molecule based 'STORM / PALM' approaches. Note, this should be considered distinct from the general needs of single molecule microscopy, which are best served by back-illuminated EMCCD cameras (see Andor iXon EMCCD range)

Physiology / Ion Imaging
The fast frame rate and excellent sensitivity of Zyla is well suited to ion signalling microscopy. Zyla 4.2 PLUS offers sensitivity at speed, but electrophysiology may require the Global shutter exposure mode of Zyla 5.5 to ensure temporal correlation across the whole image.

Cell Motility
Motile cells can be imaged extremely well by the Zyla sCMOS. Its Rolling shutter is suitable for such imaging, but care must be taken of distortive effects if the cell is moving fast. It has been noted that the Global shutter mode was required in Zyla 5.5 to image highly motile sperm cells.

Quality, Throughput and Performance

High Sensitivity and Wide Dynamic Range - quantify very weak and very bright structures with one image.
Superb Image Quality - large FOV and high resolution and uniform backgrounds for publication-quality imaging.
Blazingly Fast - studies of cell processes require ever greater temporal resolution.
GPU Express for real time data processing.
Ease of use - designed to get you up and imaging in no time
Flexible - fast or slow, big or small, weak or bright … Zyla is adaptable all of your imaging

Zyla - Physicist's Choice

Image courtesy of Qiu Peng, National Astronomical Observatories, Chinese Academy of Sciences (NAOC), China

Zyla sCMOS has become a well established detector amongst physicists, biophysicists and astronomers; the advanced combination of speed, sensitivity and dynamic range enabling new ground to be broken.

Example Areas of Application

Lucky / Speckle Imaging
Zyla's fast frame rate and large field of view are ideal for this resolution enhancing technique. GPU Express for real time data processing.

Solar Astronomy
Fast frame rates, wide dynamic range and great linearity present a very formidable solution to the specific detector needs of next generation large solar telescopes.

Adaptive Optics
Accessing > 1000 fps using ROIs renders the Zyla an ideal Wavefront detector. Use with a data splitter to enable direct data access. GPU Express for real time data processing.

Bose Einstein Condensation
The QE profile of Zyla PLUS is very good in the red/NIR region, ideal for BEC of Rb.

Particle Imaging Velocimetry (PIV)
The true Global Shutter mode of Zyla 5.5 facilitates an inter-frame gap of down to 100 ns.

Fluorescence Correlation Spectroscopy
Fluorescence Correlation Spectroscopy
The FCS mode, now available on Zyla 4.2 PLUS provides market leading speeds of 26,041 fps from a 2048(h)x8(v) region of interest.

X-Ray / Neutron Tomography
The Zyla can be readily lens coupled to scintillators and phosphors, presenting a high resolution, sensitive and fast solution for tomography.*

Zyla sCMOS HF

Check out Andor's new Zyla HF Fiber Optic coupled camera, superb for fast indirect X-Ray applications such as tomography or non-destructive testing.

Performance and Adaptability

Dual Amplifier - access lowest read noise and full well depth simultaneously.
1,000 fps - extremely fast frame rates through user definable Region of Interest control. GPU Express for real time data processing.
Global shutter - this important mode completely avoids spatial distortion, and ensures temporal correlation across all regions of the sensor. Sub-microsecond interframe gap - ideal for PIV applications.
Low dark current - extremely low dark current ensuring minimized hot pixel blemishes.
Cooling options - standard camera air cools to 0ºC up to +35ºC ambient. Water cooled option is available.
Blemish correction maps and advanced control are available upon request
Compact and Light - the extremely small volume footprint of Zyla renders it adaptable to intricate optical set-ups.

Upgrade your performance

Zyla sCMOS - Disruptive technology, familiar price.

What was the benchmark imaging detector?

Interline CCD technology has been the dominant 'workhorse' detector type for fluorescence cell microscopy for almost 15 years, the benchmark sensor being a 1.4 megapixel, 6.45 µm pixel size device, offering typical read noise floor between 5 and 8 e- rms at modest frame rates of 11-12 fps.

Upgrade your microscope using the imaging superiority of Zyla sCMOS:

Fundamentally, sCMOS technology has been conceptualized as a vastly superior alternative to Interline CCDs. Indeed, Andor's Zyla sCMOS offers dramatically higher performance, yet remains within the same price bracket as Interline cameras, and is ideally placed to become the new gold standard 'workhorse' laboratory detector. Importantly, Zyla uniquely comes with both Rolling and true Global (Snapshot) shutter.

In particular, Global shutter offers a simple Snapshot imaging capability, directly analogous to that of Interline CCDs, offering zero image distortion and perfect for synchronizing to peripheral devices.

Benefits of upgrading...

4x more pixels | **5x** more sensitive | **10x** more sensitive | **16x** faster

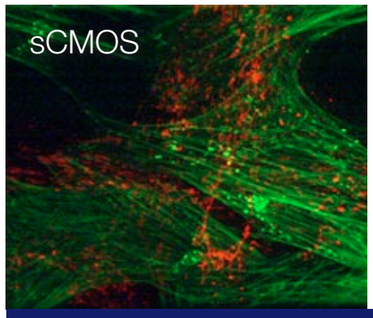
The table below compares some typical performance specifications of a 1.4MP Interline CCD to those of the new Zyla sCMOS, outlining the approximate factor improvement that is available.

Parameter	Typical Interline CCD	Zyla 5.5 sCMOS	sCMOS Factor Improvement
Read noise	6 e-	0.9 e-	5x more sensitive
Sustained frame rate	12 fps @ 1.4 MP	100 fps @ 5.5 Megapixel* | 200 fps @ 1.4 Megapixel ROI*	16x faster
Dynamic range	2,250:1	33,000:1	10x more dynamic range
Sensor format	1.4 Megapixel	5.5 Megapixel	4x more pixels

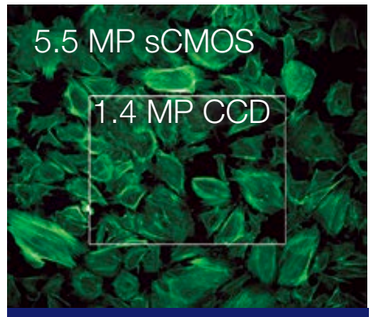
* Frame rates provided are for the '10-tap' Cameralink model. An even more affordable USB 3.0 model is available, in the case of the Zyla 5.5 offering 40 fps sustained at full 5.5 megapixel resolution.

Why is Zyla such an impressive all-round imager?

- Superior performance - vastly superior to Interline across key performance parameters.
- Rolling and Global exposures (Zyla 5.5) - Zyla is unique in offering both these exposure modes in one camera. Global shutter (Snapshot) is directly analogous to the Interline exposure mechanism.
- Image quality - a huge amount of effort and on-camera (FPGA) intelligence has gone into optimizing image quality in Zyla.
- Flexibility - fast, slow, weak, bright, pixel binned, region of interest, Rolling shutter, Snapshot shutter… Zyla is adaptable to a broad gamut of application requirements.
- Affordable price - with so many superb features, we have endeavoured to make the Zyla accessible to every lab. Request a quote, you'll be pleasantly surprised!
- USB 3.0 - 'Plug and play' interface with industry fastest frame rates.



5x more sensitive



4x larger field of view

Key Biological Applications

Live cell imaging
Widefield fluorescence microscopy
Developmental biology
Embryo studies
Physiology / Ion Imaging
Neuroscience / Vesicle Transport
Parasitology
Cell Motility

Performance & Innovations

Extended Dynamic Range

The Andor Neo and Zyla cameras are designed to make use of the innovative dual 'column-level' amplifier design of the sensors.

Traditionally, sensors require that the user must select up-front between high or low amplifier gain (i.e. sensitivity) settings, depending on whether they want to optimize for low noise or maximum well depth. The dual amplifier architecture of the sCMOS sensor circumvents this need, in that signal can be sampled simultaneously by both high and low gain amplifiers. As such, the lowest noise of the chip can be harnessed alongside the maximum well depth, affording widest possible dynamic range of up to 33,000:1.

12-bit & 16-bit

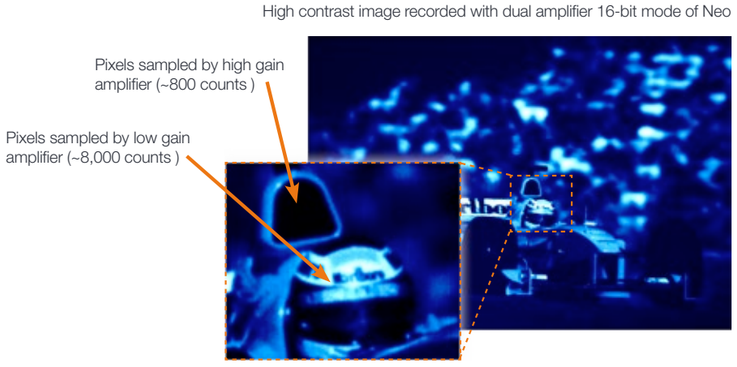
Zyla uniquely offers both **12-bit and 16-bit modes**. **12-bit** for smaller file size & absolute fastest frame rates through USB 3.0; **16-bit** for full dynamic range.

Dual Amplifier Architecture

Each column within each half of the sensor is equipped with dual column level amplifiers and dual analog-to-digital converters (ADC).

This architecture was designed to simultaneously minimize read noise and maximize dynamic range. The dual column level amplifier/ADC pairs have independent gain settings, and the final image is reconstructed by combining pixel readings from both the high gain and low gain readout channels to achieve an unprecedented intra-scene dynamic range from the relatively small 6.5 µm pixel pitch.

High contrast image recorded with dual amplifier 16-bit mode of Neo



Visit andor.com/learning to read the 'Dual Amplifier Dynamic Range' technical note

Lowest Noise Floor

Andor's ultra sensitive sCMOS cameras have broken new ground in offering down to 0.9 electron rms read noise, without signal amplification technology.

What is truly extraordinary is that this performance level is achievable at 30 fps, representing 200 MHz pixel readout speed. Furthermore, even at full readout speed, the read noise floor is negligibly compromised, maintaining down to 1.3 e- rms at 100 fps. For the best CCD cameras to even approach 2 electrons noise, a readout speed of 1 MHz or slower is required. This minimal detection limit renders Andor's sCMOS cameras suitable for a wide variety of challenging low light imaging applications.

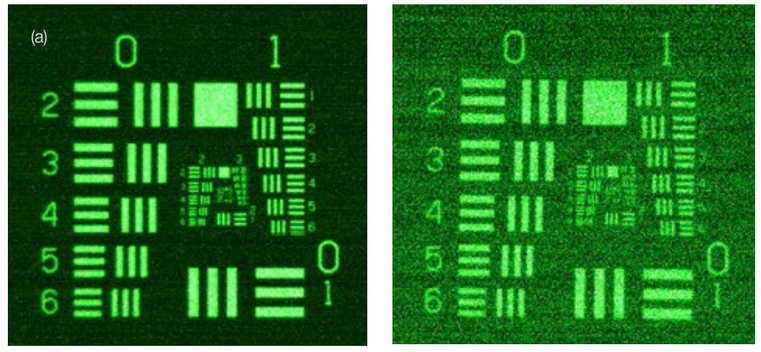
Spurious Noise Filter

Neo and Zyla platforms both come equipped with an optional in-built FPGA filter that operates in realtime to reduce the frequency of the occurrence of high noise pixels that would otherwise appear as spurious 'salt and pepper' noise spikes in the image background.

Visit andor.com/learning to read the 'Understanding Read Noise' technical note

Readout Speed (MHz)	Neo 5.5 Readout Noise (e^-)	
	Rolling Shutter	Global Shutter
200	1	2.3
560	1.3	2.5

Readout Speed (MHz)	Zyla 4.2 PLUS Readout Noise (e^-)
	Rolling Shutter
200	0.9
540	1.1



Comparative low light images taken with Neo sCMOS (1.3 electrons read noise @ 560 MHz) vs. Interline CCD (5 electrons read noise @ 20 MHz), displayed with same relative intensity scaling.

(a) LED signal in a light-tight imaging enclosure, intensity ~30 photons/pixel;
(b) Fluorescently labelled fixed cell using a CSU-X spinning disk confocal microscope (x60 oil objective), each 100 ms exposure, same laser power,

Performance & Innovations

Rapid Frame Rates

The parallel readout nature of sCMOS means it is capable of reaching very rapid frame rates of up to 100 full frames per second, and much faster with region of interest.

Distinctively, this is accomplished without significantly sacrificing read noise performance, markedly distinguishing the technology from CCDs. Andor's sCMOS cameras are uniquely designed to harness this speed potential.

Zyla's speed optimized USB 3.0 interface delivers an unparalleled **40 fps** from **16-bit mode** and **53 fps** from Zyla's unique **12-bit mode** (4.2 megapixel array).

USB 3.0

Array Size	Zyla 5.5 USB 3.0 Rolling Shutter	Global Shutter	Zyla 5.5 10-tap Rolling Shutter	Global Shutter
2560 x 2160	40(30)	40 (30)	100 (75)	49 (49)
2048 x 2048	53 (40)	52 (39)	105 (98)	52 (52)
1920 x 1080	107 (80)	98 (80)	200 (200)	97 (97)
512 x 512	422 (422)	201 (201)	422 (422)	201 (201)
128 x 128	1,691 (1,691)	716 (716)	1,691 (1,691)	716 (716)
2048 x 8 (FCS mode)	13,020 (10,250)	4,008 (4,008)	27,057 (27,057)	4,008 (4,008)

Array Size	Zyla 4.2 PLUS 10-tap Rolling Shutter	Zyla 4.2 PLUS USB 3.0 Rolling Shutter
2560 x 2160	-	-
2048 x 2048	101 (101)	53 (40)
1920 x 1080	192 (192)	107 (80)
512 x 512	406 (406)	406 (406)
128 x 128	1,627 (1,627)	1,627 (1,627)
2048 x 8 (FCS mode)	26,041 (26,041)	13,020 (10,250)

Maximum frame rates achievable from the Zyla 5.5 and Zyla 4.2 PLUS sCMOS USB 3.0 and 10-tap Camera Link versions 12-bit (16-bit)

iCam Fast Exposure Switching

Neo and Zyla benefit from Andor's iCam technology, an innovation that ensures minimal overheads associated with fast exposure switching.

This is particularly important during multi-color microscopy acquisition protocols, whereby it is necessary to repeatedly and rapidly flip between pre-set exposure times matched to the relative signal intensity of each fluorophore.

iCam offers market leading acquisition efficiency, whether software or externally triggered.

GPU Express

The Andor GPU Express library has been created to simplify and optimize data transfers from camera to a CUDA-enabled NVidia Graphical Processing Unit (GPU) card to facilitate accelerated GPU processing as part of the acquisition pipeline. Integrates easily with Andor SDK3.

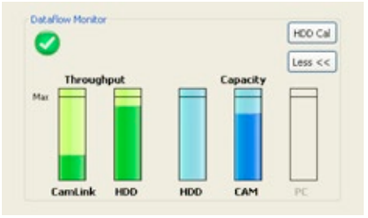
Data Flow Monitor

The sCMOS sensor in Neo and Zyla is capable of extremely fast data read rates, but this in itself imposes considerable challenges.

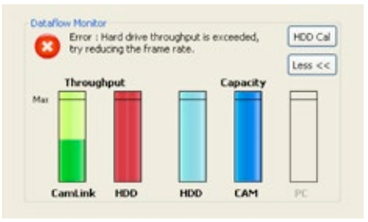
For sustained kinetic series measurements it is possible to be rate limited by:
(a) bandwidth of the Camera Link interface connecting the
camera to the PC
(b) hard drive write speed

In such circumstances the true frame rate threshold also depends on many set-up factors, including exposure time, ROI size, binning, pixel readout rate and choice of single or dual amplifier data.

The Data Flow Monitor, available through Andor Solis acquisition and analysis software, has been innovated to provide a simple visual tool that enables you to instantly ascertain if your acquisition parameters will result in a rate of data transfer that is too fast for either interface or hard drive. It will also determine if the kinetic series size is within the capacity of camera memory, hard drive space or PC RAM.



e.g. 1 - Requested kinetic series within capability of Camera Link data transfer bandwidth and Hard Disk Drive write speed.



e.g. 2 - Hard Disk Drive will not write data fast enough for the requested kinetic series. Advised to first reduce data rate.

> Our experiments with Andor's new sCMOS camera have been highly encouraging. The combination of very low noise sensitivity at rapid frame rates, coupled with high pixel resolution and large dynamic range, will enable us to investigate single molecules at timescales which were previously not accessible.
>
> Prof Stefan Diez, Heisenberg Professorship for BioNanoTools, Max Planck Institute of Molecular Cell Biology and Genetics, Dresden, Germany

Performance & Innovations

Rolling and Global (Snapshot) Shutter Modes

Neo 5.5 and Zyla 5.5 are distinct in offering both Rolling shutter and true Global shutter modes from the same sensor, such that the most appropriate mode can be selected dependent on application requirements.

The 5.5 megapixel sCMOS sensor that is in Zyla 5.5 and Neo 5.5 sCMOS cameras uniquely offers both Rolling and Global exposure modes. This provides superior application and synchronization flexibility and the ability, through Global exposure, to closely emulate the familiar 'Snapshot' exposure mechanism of Interline CCDs.

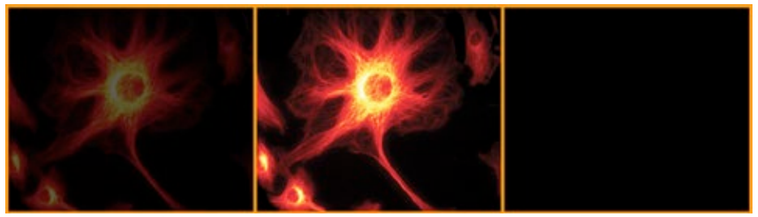
Rolling and Global Shutter Mechanisms

Rolling and true Global shutter modes describe two distinct types of exposure and readout sequence.

In Rolling shutter, available in all Andor sCMOS cameras, different lines of the array are exposed at different times as the read out 'wave' sweeps through the sensor. 10 ms are required at the start to 'activate' the sensor to expose, and then 10 ms are required at the end to readout the sensor. Use when not synchronizing to peripheral devices and only when there is a minimal risk of spatial distortion from slow moving sample.

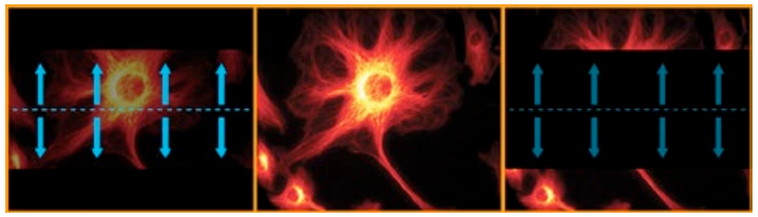
In true Global shutter, offered in both Neo 5.5 and Zyla 5.5 models, each pixel in the sensor begins the exposure simultaneously and ends the exposure simultaneously. This provides a true 'Snapshot' exposure capability for moving samples that is both 'photon-efficient' and easy to synchronize to, especially useful for 3D / 4D microscopy. Zyla 4.2 PLUS, while utilizing a Rolling shutter sensor, offers a Simulated Global Exposure mechanism to overcome risk of spatial distortion. This mechanism is more elaborate and less photon/time efficient than true Global shutter. True Global Shutter is also essential for applications such as Particle Imaging Velocimetry (PIV), where sub-microsecond inter-frame gaps are required.

Global shutter exposure and readout (single scan)



Exposure start | Exposure | Exposure end

Rolling shutter exposure and readout (single scan)



Exposure start | Exposure | Readout

What should I be aware of as a buyer? Beware of 'Gen II' claims!

This topic carries particular relevance, as not all 'scientific CMOS' cameras on the market offer a choice of Rolling and true Global exposure. Most offer one or the other. In fact, a sensor that is currently being widely positioned in the market as "Gen II", is actually the sensor used in the Zyla 4.2 PLUS. However, we would not go so far as to describe this as a 2nd generation sensor, as it achieves a higher Quantum Efficiency at the notable expense of true Global shutter capability.

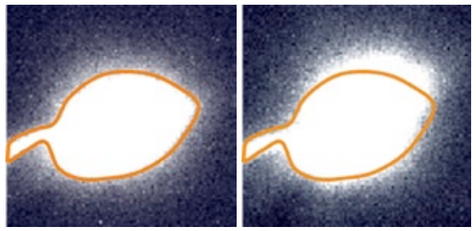
The customer is highly advised to make an informed choice before purchasing, since in microscopy the more photon-efficient Global shutter approach can actually result in a higher signal to noise, faster synchronized frame rates and non-distorted images.

To find out more about how to synchronize to Rolling and Global shutter (and to view our FAQs) visit andor.com/learning and read the **'Synchronizing to Andor sCMOS Cameras'** technical note.

Global Exposure is Distortion Free

If light is falling on the sensor during the 'transient' phases (first 10 ms and final 10 ms) of the Rolling shutter exposure mechanism, and an object is moving during this time, then there is a chance of some degree of spatial distortion. The degree of distortion is dictated by the relative size, direction and speed of the object. Global shutter avoids spatial distortion since there are no 'transient' exposure phases.

These images show the head of a moving sperm cell, imaged by the Neo sCMOS in both Global and Rolling shutter. Distortion of the shape of the sperm head is evident in Rolling shutter.



Correct | Distorted

Key Benefits of true Global shutter (Zyla 5.5 and Neo 5.5)

Global shutter in particular is viewed as an important mode for the biologist, as its benefits are deeply synergistic with the core imaging requirements of live cell microscopy.

No spatial distortion - avoiding the spatial distortion risk of Rolling exposure
3D / 4D microscopy - recommended for synching to peripheral switching devices
Higher signal to noise due to reduced dead time offering higher 'effective' QE
Simplicity - all the benefits of an 'Interline exposure mode'
Compatible with continuous or pulsed light sources
Sub-microsecond inter-frame gap, ideal for PIV applications

> For our work on quantifying red blood cell velocity in the retinal capillaries we elected to operate in Global shutter mode, which produces minimally distorted images. When operating in Rolling shutter mode we observed significant image warping, even for moderate eye movements.
>
> Dr. Phillip Bedggood, Metha Laboratory, Department of Optometry and Vision Sciences, University of Melbourne, Australia

Performance & Innovations

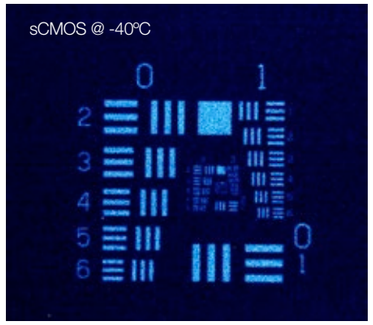
Deep Thermoelectric Cooling

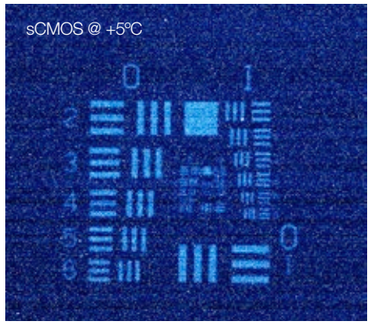
Andor's Neo offers the deepest sensor cooling available from any CMOS imaging camera on the market, minimizing both dark current and hot pixel blemishes. Additionally, through the use of water cooling, the fan can be switched off in the software to minimize camera vibration; ideal for set-ups that are particularly vibration sensitive.

Neo Cooling Temperature	Dark current (e^-/pix/sec)
-30ºC (fan cooling)	0.015
-40ºC (10ºC liquid)	0.007

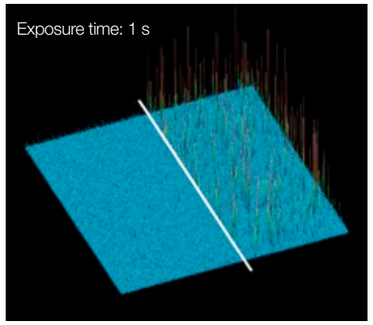
THERMOSTATIC PRECISION

The temperature sensor in the **Neo** and **Zyla sCMOS** cameras measures with a **thermostatic precision of 0.05ºC.**





Thermal noise can sacrifice the sCMOS low detection limit. Low light images recorded with a Neo sCMOS camera at +5ºC and -40ºC sensor cooling temperatures; 50 sec exposure time; 200 MHz readout giving 1 electron read noise.



Hot pixel blemishes are significantly reduced at deeper cooling temperatures, requiring much reduced pixel correction. Uncorrected images are shown above for 1 sec exposure.

Deep TE cooling is useful for a number of reasons:

Minimization of dark current

sCMOS cannot be considered a truly flexible, workhorse camera unless dark current contribution has been minimized. Deep cooling means the low noise advantage can be maintained under all exposure conditions.

Visit andor.com/learning to read the 'Importance of TE Cooling' technical note

Minimization of hot pixel blemishes

Hot pixels are spurious pixels with significantly higher dark current than the average and can be problematic even under relatively short exposure times. Cooling has a major influence in minimizing the occurrence of such events, offering both an aesthetically cleaner image and a greater number of unfiltered, usable pixels.

Minimization of vibration

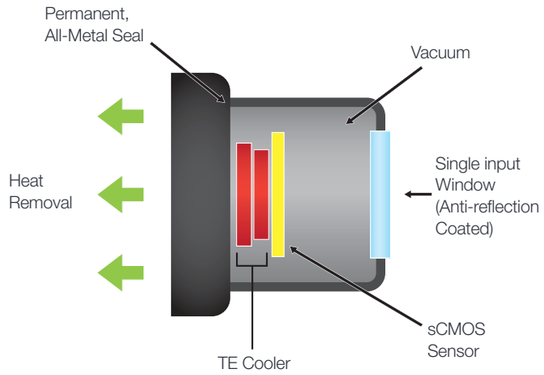
Many optical configurations are sensitive to vibrations from the camera fan. Andor's Neo offers:
(a) Two fan speeds
(b) The ability to turn off the fan, either temporarily or permanently if flowing liquid through the camera (the latter also allows the Neo to be stabilized at -40ºC)

UltraVac™ (Neo only)

The Andor Neo is the only vacuum housed CMOS sensor available on the market, offering superior quality, performance and longevity.

Andor's proprietary UltraVac™ process has a proven track record of field reliability, accumulated over more than 15 years of shipping high-end vacuum cameras. Using a proprietary technique, we have adapted these process for use with the additional connections associated with the sCMOS sensor.

Key Features
Permanent hermetic vacuum seal
Sustained deep TE cooling
No maintenance / re-pumping
No risk of condensation
Minimize out-gassing



Schematic of the Neo sCMOS permanent vacuum head

NEO SCMOS 5 YEAR VACUUM WARRANTY

5 Year Vacuum Warranty

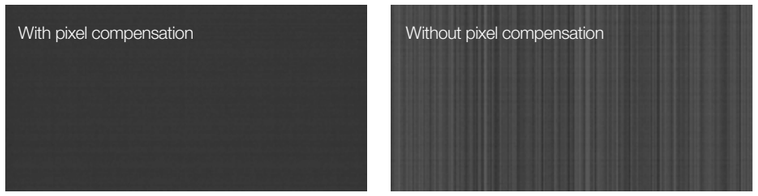
Our faith in the unique sCMOS vacuum process used in Neo means that we are proud to offer an extensive 5 year warranty on the vacuum enclosure.

Performance & Innovations

Advanced FPGA On-head Processing

Andor's Neo and Zyla cameras are each equipped with considerable FPGA processing power. This is essential in order to dynamically normalize data at the pixel level for minor variations in bias offset, thus eradicating fixed pattern noise associated with this CMOS phenomenon.

This superior dynamic processing capability is also utilized to optionally filter the small percentage of spurious noise pixels from the image.



CMOS data requires compensation for fixed pattern variation. This is accomplished in real time for every pixel within the FPGA of Andor's sCMOS cameras, essentially eliminating this noise source from the image.

Pixel-level bias offset compensation

The advanced processing power and memory capacity permits implementation of bias offset compensation for every pixel in the array. This ultimately relates to a lower noise background.

Dynamic baseline clamp

A real time algorithm that uses dark reference pixels on each row to stabilize the baseline (bias) offset. Necessary to ensure quantitative accuracy across each image and between successive images.

Spurious noise filter

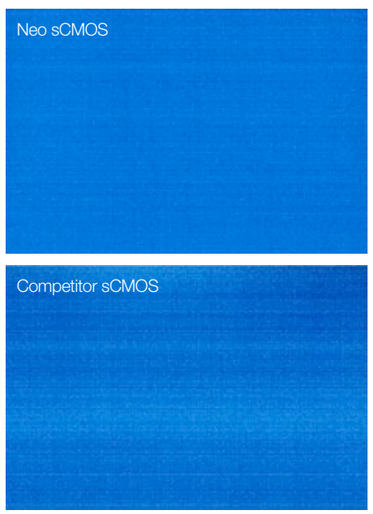
An optional real time filter that identifies and compensates for 'spurious' high noise pixels that are greater than 5 electrons (< 1% of all pixels).

Andor offer the capability to switch off interpolative pixel filtering and provision of custom blemish maps, important for applications such as super-resolution microscopy or astronomy.

6.5 µm pixel size combined with 30,000 electron well depth

The 6.5 µm pixel present in Neo and Zyla has been specifically designed to offer an optimal balance of optical resolution, photon collection area and well depth. This pixel size has been determined to provide ideal over-sampling of the diffraction limit in typical cell microscopy with x 60 and x 100 objectives.

Key Features
Ideal balance of resolution, photon collection and well depth
Superb 30,000 electron well depth
No pixel binning required = no doubling of read noise
No demagnification optics = no wasteful photon loss



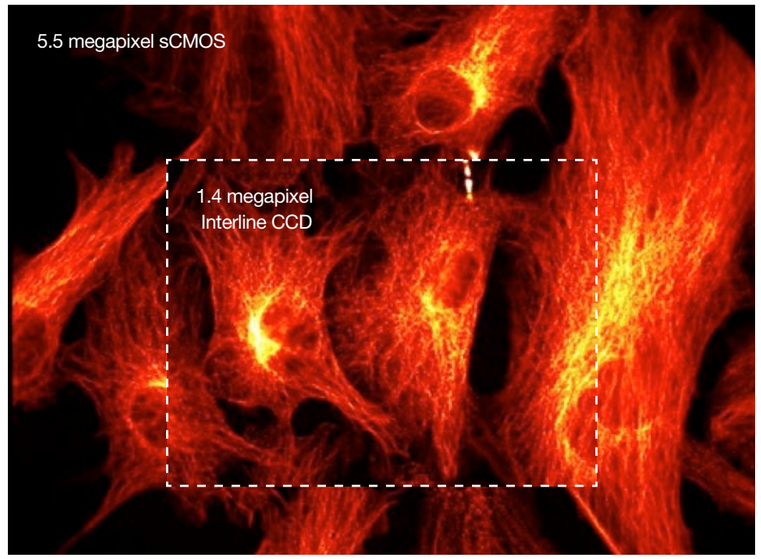
Dynamic Baseline Clamp affords superior background image quality (Dark image, Rolling shutter, 10 ms exposure)

Large Field of View

The multi-megapixel sensors present in the Neo and Zyla offer an extended field of view, markedly exceeding the FOV available from alternative Interline CCD devices.

Flexibility is key however, and if a large FOV is not required for a particular application, Neo and Zyla offer a range of pre-selected ROI sizes at the click of a button, as well as user defined (with single pixel granularity).

Key Features
21.8 mm diagonal (Zyla 5.5 and Neo 5.5); 18.8 mm diagonal (Zyla 4.2 PLUS)
Closely matched to modern microscopes
Pre-selected ROIs to quickly opt for smaller FOV if required
x 3.5 larger than popular 512 x 512 EMCCD sensor
x 3.9 larger than popular 1.4 MP Interline CCD sensor
Combine large FOV with dual wavelength image splitter (OptoSplit)



Field of View Comparison
Neo 5.5 and Zyla 5.5 Field of View vs popular 1.4 megapixel Interline CCD

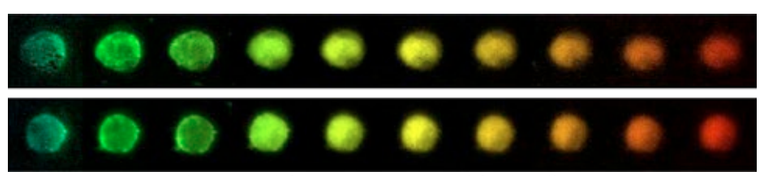
Comprehensive trigger functionality

Neo and Zyla offer a selection of advanced trigger modes, designed to provide tight synchronization of the camera within a variety of experimental set-ups. Triggering is compatible with both Rolling and Global shutter modes.

- External TTL, Software and Internal trigger (including Simulated Global Exposure - Zyla 4.2 PLUS)
- 'Time Lapse' and 'Continuous' (overlapped) kinetic series
- Fast exposure switching (iCam)

Trigger Mode	Description
Time Lapse	Each exposure started by a trigger event (e.g. TTL rising edge). Exposure duration is internally defined.
Continuous	Exposures run back to back with no time delay between them. Exposure time defined by time between consecutive trigger events.
External Exposure	Exposure time defined by TTL width (sometimes known as 'bulb mode').
External Start	TTL rising edge triggers start of internally defined kinetic series.

Available Neo and Zyla trigger modes, applicable to both Rolling and Global shutter.



Hyperspectral Imaging of Fluorescent Beads. Image courtesy of Dr. Ethan Schonbrun.

Software Solutions

Andor Solis
Solis is a ready to run Windows package with rich functionality for data acquisition and image analysis/processing. Available on 32-bit and 64-bit versions of Windows (7, 8 and 10). Andor Basic provides macro language control of data acquisition, processing, display and export.

Andor iQ
A comprehensive multi-dimensional imaging software package. Offers tight synchronization of EMCCD with a comprehensive range of microscopy hardware, along with comprehensive rendering and analysis functionality. Modular architecture for best price/performance package on the market.

Andor SDK
A software development kit that allows you to control the Andor range of cameras from your own application. Available as 32 and 64-bit libraries for Windows (7, 8 and 10) and Linux. Compatible with C/C++, C#, Delphi, VB6, VB.NET, LabView and Matlab.

Bitplane Imaris®
Imaris delivers all the necessary functionality for visualization, segmentation and interpretation of multidimensional datasets. By combining speed, precision and intuitive ease-of-use, Imaris provides a complete set of features for handling multi-channel image sets of any size up to 50 gigabytes.

Third party software compatibility
Drivers are available so that the iXon range can be operated through a large variety of third party imaging packages, including:

Metamorph (Molecular Devices Corporation)
NIS Elements (Nikon)
LAS (Leica)
Xcellence (Olympus)
Image Pro (Media Cybernetics)
MicroManager (UCSF)
Till Photonics Live Acquisition (Till Photonics)
Imaging Workbench (Indec)
WinFluor (University of Strathclyde)
Maxim DL (Diffraction Limited)
LabView (National Instruments)
Matlab (MathWorks)

Windows 7 Windows 8 Windows 10 Linux

Extensive Imaging Portfolio

The Andor Imaging Range

Have you found what you are looking for? As an alternative to the sCMOS cameras, Andor offers an extensive portfolio of high performance low light imaging camera technologies.

iKon CCD

Deep cooled, low noise CCD
-100ºC cooling
Back-illuminated > 90% QE
1 Megapixel to 4 Megapixel
Enhanced NIR versions
'PV Inspector' model (Optimized for EL / PL in-line inspection)
USB 2.0 true plug and play

iXon EMCCD

High performance EMCCD platform
Single photon sensitive and back-illuminated
Industry fastest frame rates
-100ºC cooling
Flexible yet intuitive
Quantify in electrons or photons

Zyla sCMOS

Fast, sensitive, compact, light sCMOS
< 1 electron read noise @ 30 fps
5.5 and 4.2 Megapixel sensors / 6.5 µm
QE up to 82%
0ºC cooling at +27°C ambient
100 fps sustained (10-tap Camera Link)
Cost effective USB 3.0 option
16-bit data range

Neo sCMOS

Vacuum cooled, lowest noise sCMOS
1 electron read noise @ 30 fps
5.5 Megapixel / 6.5 µm
-40ºC vacuum cooling
30 fps sustained; 100 fps burst
4 GB on head memory
16-bit data range
Fan off vibration free mode

Notes

Application & Technical Notes

The following section is dedicated to providing a greater depth of understanding of the performance and innovations associated with the Andor scientific CMOS camera platform. Deeper insight is provided into areas such as the unique dual amplifier architecture (for extended dynamic range), sCMOS read noise distribution, dark noise effects, vacuum sensor protection and Rolling vs. Global shutter readout modes.

We also present a comprehensive overview of how new sCMOS technology compares to existing ‘gold standard’ scientific imaging cameras such as Interline CCD and EMCCD technology.

Visit the Learning Center now to discover more at andor.com/learning.

Key sCMOS resources include:

- LightScan PLUS
- Rolling and Global Shutter
- Dual Amplifier Dynamic Range
- The Importance of TE Cooling to sCMOS Technology
- Comparing sCMOS With Other Scientific Detectors
- Andor sCMOS PC Recommendations and Data Flow Considerations
- Understanding Read Noise in sCMOS
- Interpolative Blemish Corrections on sCMOS
- PIV Mode for Neo and Zyla

ANDOR
an Oxford Instruments company

Customer Support

Andor products are regularly used in critical applications and we can provide a variety of customer support services to maximize the return on your investment and ensure that your product continues to operate at its optimum performance.

Andor has customer support teams located across North America, Asia and Europe, allowing us to provide local technical assistance and advice. Requests for support can be made at any time by contacting our technical support team at andor.com/support.

Andor offers a variety of support under the following format:

- On-site product specialists can assist you with the installation and commissioning of your chosen product
- Training services can be provided on-site or remotely via the Internet
- A testing service to confirm the integrity and optimize the performance of existing equipment in the field is also available on request.

A range of extended warranty packages are available for Andor products giving you the flexibility to choose one appropriate for your needs. These warranties allow you to obtain additional levels of service and include both on-site and remote support options, and may be purchased on a multi-year basis allowing users to fix their support costs over the operating life cycle of the products.

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