Kuro

Back-illuminated scientific CMOS camera

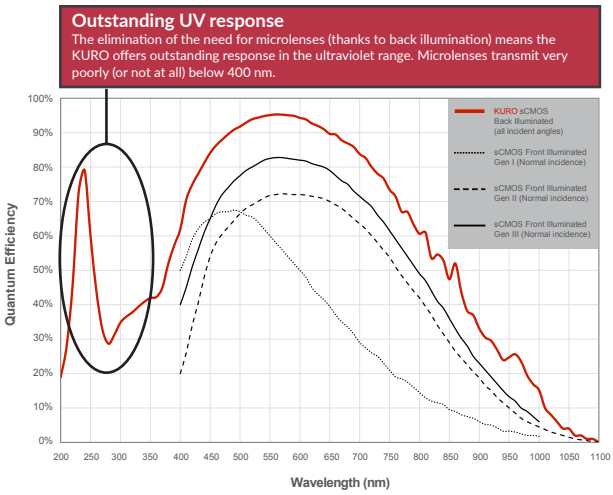
Datasheet

Princeton Instruments

Breakthrough Technology

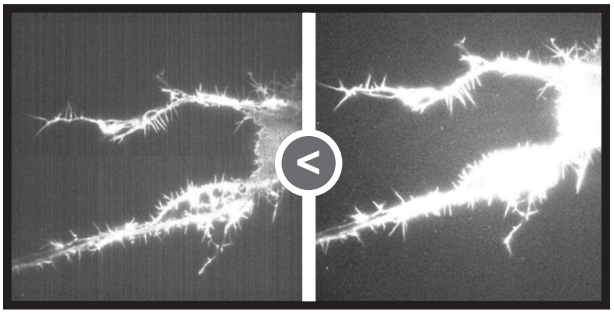
The KURO™ from Princeton Instruments is the world's first scientific CMOS (sCMOS) camera system to implement back-illuminated sensor technology with powerful software. The camera is capable of very low read noise, >95% QE, and >82 fps at full 1200 x 1200 resolution, making it ideal for many challenging low-light applications.

Applications include:
Hyperspectral imaging | Astronomy | Cold-atom imaging | Quantum imaging | Fluorescence spectroscopy | High-speed spectroscopy



Back-illuminated sCMOS detector with >95% peak QE

The KURO features a back-illuminated sensor architecture just like that of the most sensitive CCD detectors available. The back-illuminated technology utilized by the KURO allows this next-generation sCMOS camera system to deliver >95% quantum efficiency (QE) and 100% fill factor.



100 frame average of front-illuminated sCMOS camera

Reduced fixed-pattern noise

The KURO uses the latest sCMOS fabrication technology along with optimized electronics. As a result, it has a significantly better noise profile than any previous-generation, front-illuminated sCMOS camera.

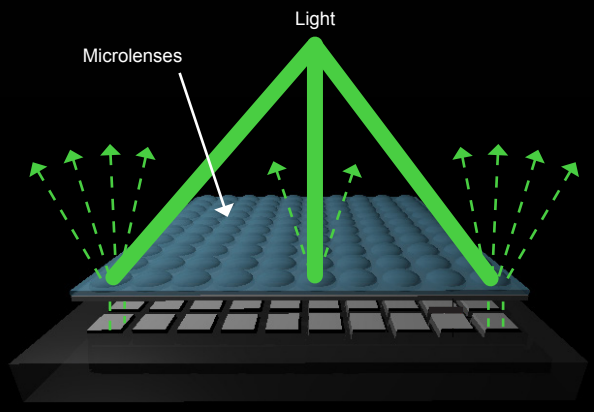
Resolution	Frame rate: fps (12 bit / 16 bit)
1200 x 1200	82 / 41
1200 x 512	192 / 96
1200 x 256	384 / 192
1200 x 128	768 / 384
1200 x 64	1536 / 768
1200 x 32	3072 / 1536

High speed and low read noise

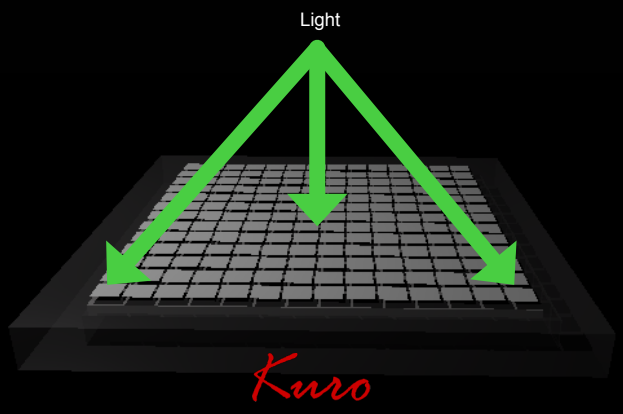
The KURO offers very high frame rates, up to 41 fps (16 bit) or 82 fps (12 bit) at full 1200 x 1200 resolution with an exceptionally low 1.3 e- rms (median) read noise. The camera is capable of delivering hundreds of frames per second with reduced resolution.

No microlenses on pixels

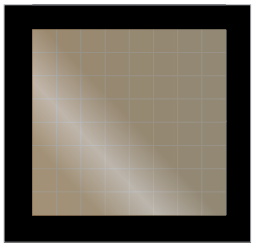
Unlike front-illuminated sCMOS cameras, which claim ~80% peak QE, the KURO does not use microlenses to recapture light from the masked area of the pixel. Microlenses significantly degrade QE when light is incident at any angle other than normal to the sensor surface.



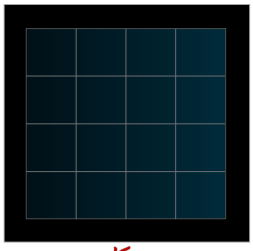
Traditional front-illuminated sCMOS with microlenses



Back-illuminated scientific CMOS camera



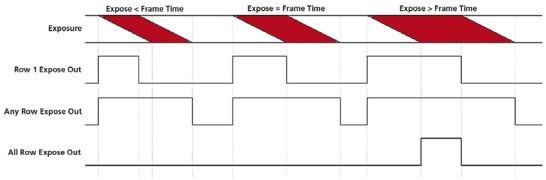
Previous-generation sCMOS pixel (6.5 μm²)



Kuro
Back-illuminated sCMOS pixel (11 μm²)

Large pixels and wide dynamic range

The 11 μm² pixel pitch of the KURO sensor captures 2.8x more photons than previous-generation sCMOS sensors. Each pixel can also handle a large full well of 80,000 electrons, allowing excellent dynamic range (61,500:1 or 95 dB).

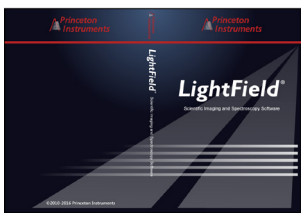


Flexible trigger modes

The KURO provides a full suite of input-output TTL signals. These signals make it easy to synchronize camera operation with external events or light sources.

Optimized for spectroscopy

Scientific CMOS sensors typically do not support on-chip binning. However, the KURO camera's low read noise and support of software binning (off-chip binning) make it ideal for high-speed spectroscopy applications. Furthermore, the pixel pitch of its sensor is a perfect match for optimal use with the award-winning, aberration-free IsoPlane® spectrometer from Princeton Instruments.



Powered by LightField®

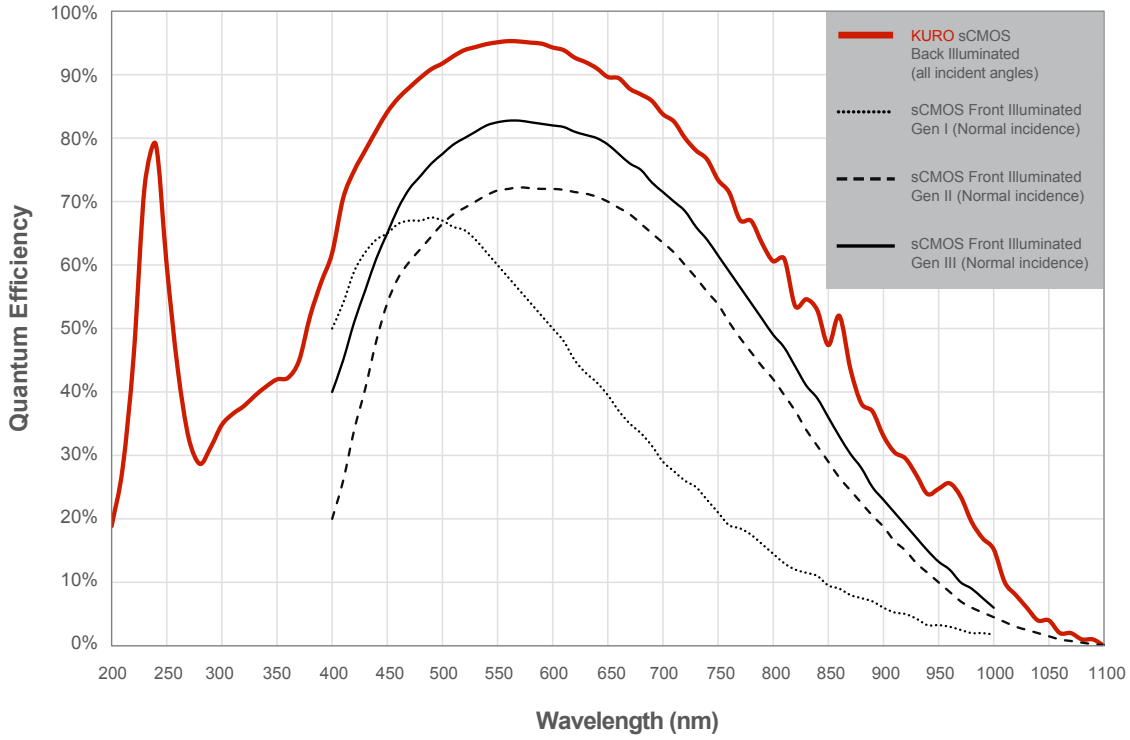
Designed for operation within the Princeton Instruments LightField software ecosystem, the KURO is easy to control and can be integrated quickly in myriad imaging and spectroscopy experiments. Camera integration for use with both MATLAB® (MathWorks) and LabVIEW® (National Instruments) is also fast and simple.

KURO Specs

Feature	Specification
Sensor	1200 x 1200 back-illuminated scientific CMOS
Quantum efficiency	>95% @ 550 nm; >70% @ 230 – 250 nm
Pixel size	11 x 11 µm
Pixel fill factor	100%
Full well	80,000 e-
Imaging area	13.2 x 13.2 mm (18.66 mm diagonal)
Window	Single window in the optical path; UV-grade fused silica
Readout noise	1.3 e- rms (median); 1.5 e- rms
Readout modes	Rolling shutter; effective global shutter
Bit depth	12 bit; 16 bit
Frame rates @ full resolution	41 fps / 16 bit; 82 fps / 12 bit (see page 2 for more frame rates)
Binning	Yes (software binning only)
Data interface	High-speed USB 3.0; PCI Express
Trigger modes	Start on single trigger; readout per trigger
TTL output signals	EXPOSE (first row, any row, all rows); READOUT; READY; SHUTTER OUT
Sensor cooling	–10°C (with air); –25°C (with liquid assist)
Fan control	Software-selectable fan speeds
Dark current	1.9 e-/p/s @ –10°C; 0.7 e-/p/s @ –25°C
Software	Princeton Instruments LightField (optional); LabVIEW (National Instruments) and MATLAB (MathWorks) supported via automation
SDK	PICam (available for free)
Operating system	Microsoft® Windows® 7/8/10 (64 bit)
Lens mounts	C-mount (standard); C-to-spectrometer mount (optional); C-to-F mount (optional)
Dimensions / weight	L x W x D: 6.15” (156.2 mm) x 4.04” (102.6 mm) x 4.04” (102.6 mm); 3.8 lbs (1.7 kg)
Operating conditions	0°C to 30°C; 80% RH non-condensing

Specifications are subject to change.

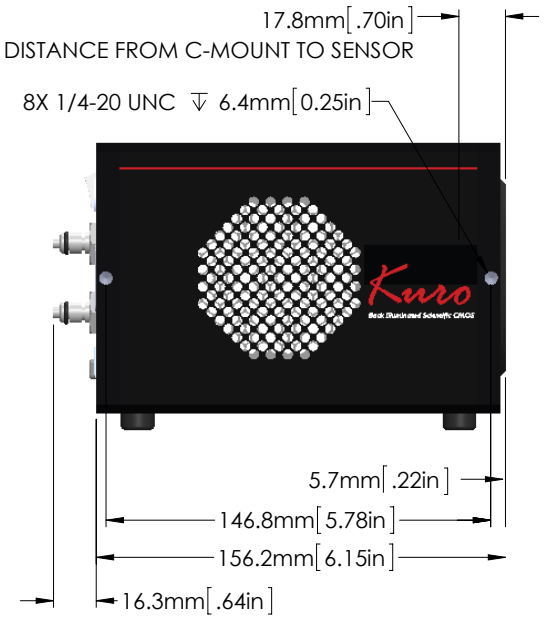
Quantum Efficiency Curve



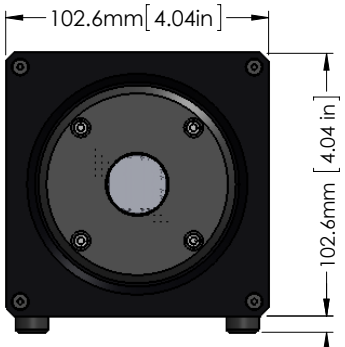
Note:
Graph shows typical QE data measured at +25°C. QE decreases at normal operating temperatures. For the best results for your application, please discuss the specific parameters of your experiment with your Princeton Instruments representative.

Outline Drawings

LEFT



FRONT

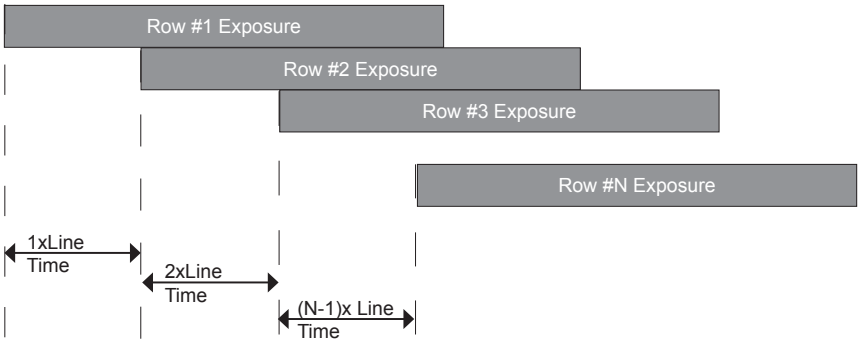


BACK

RIGHT

Rolling Shutter

Like many sCMOS sensors, the KURO sensor uses a rolling shutter mode for exposure-readout operations. This mode allows lower read noise; however, it does not allow “simultaneous” exposure of pixels. The following diagram and table describe the rolling shutter timing used by the KURO camera.

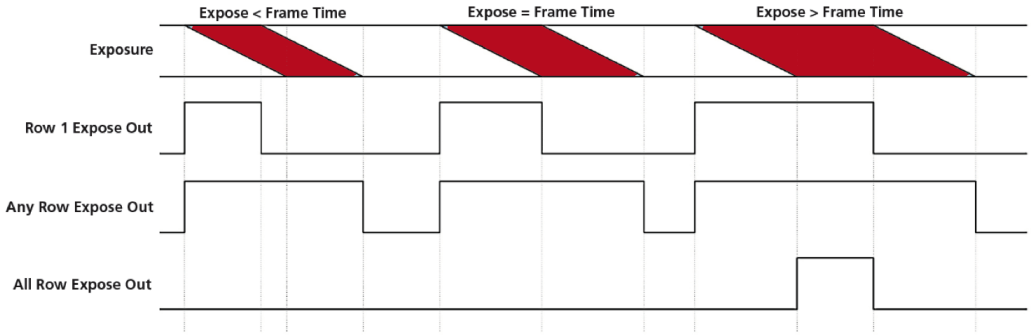


Row #	Exposure Start time	Exposure End time
1	TO	TO+EXP TIME (user entered value)
2	TO+(1xLINE TIME)	TO+(1xLINE TIME)+EXP TIME
3	TO+	
N	TO+(N-1 * LINE TIME)	TO+(N-1xLINE TIME)+EXP TIME

Effective Global Shutter

The KURO provides programmable TTL output signals that can be employed to synchronize the camera with external events or light sources. The EXPOSE OUT signal can be programmed as follows…

FIRST ROW EXPOSE: The signal is high as long as the first row of the frame is exposed.
ANY ROW EXPOSE: The signal is high from the start of the first row exposure to the end of the last row exposure.
ALL ROWS EXPOSED: The signal is high to indicate ALL sensor rows are exposed. This is useful as a strobe pulse to control an external light source and obtain “effective global shutter” operation.



See KURO technical note at princetoninstruments.com

What is in the box?

Optional:

- LightField software
- Liquid circulator
- C-to-spectrometer mount
- C-to-F mount

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