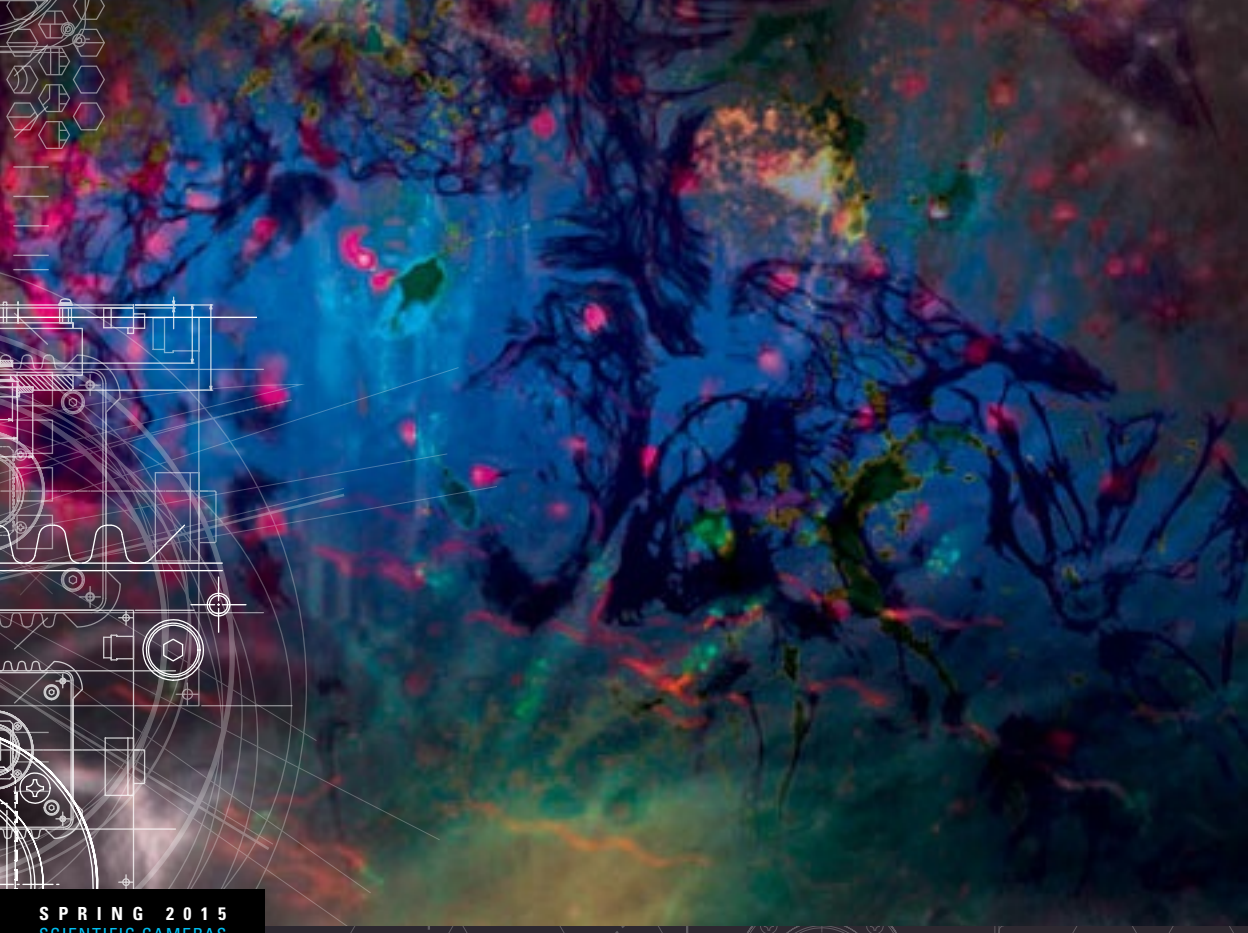


SPRING 2015
SCIENTIFIC CAMERAS

ENABLING

THE ART of SCIENTIFIC EXPLORATION

HAMAMATSU

PHOTON IS OUR BUSINESS

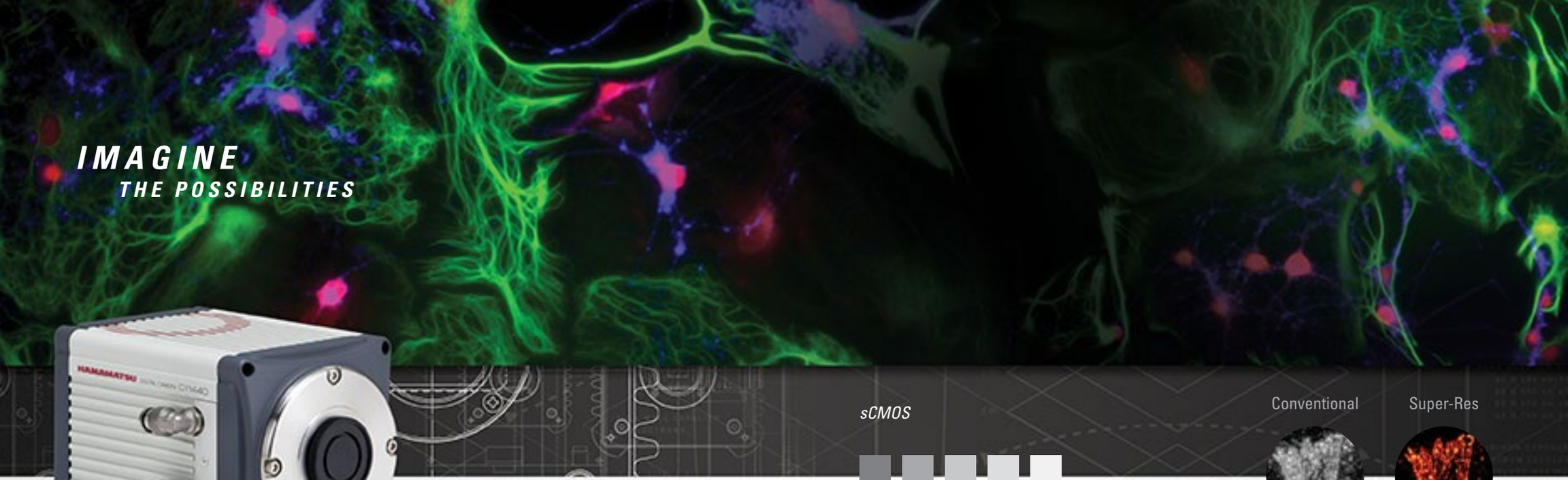
SPRING 2015

Our art is the fuel for your art—scientific discovery.

Imagine a basement room turned into a woodworking shop, full of tools and fine woods; the craftsman* at his bench painstakingly shaves a curve to get the angle just right. This artisan's care for quality and excellence is the very same driving force shared by the many scientists and engineers who develop Hamamatsu's cameras. For us, each camera we make—assembled carefully by hand—is a work of art.

But for you, our customers, each camera is just another tool that helps you in the pursuit of your art—scientific exploration and discovery. We are proud that the care we take in our art translates into better tools that can take you further in your search for answers and understanding. From routine fluorescence to cutting-edge super-resolution and light-sheet microscopy, we've assembled a set of scientific cameras designed to take your research wherever it needs to go. Just imagine the possibilities.

* *An actual member of our Hamamatsu team, who enjoys fine woodworking when he's not discussing scientific cameras*



IMAGINE
THE POSSIBILITIES

LARGE DYNAMIC RANGE

QUANTITATIVE

FAST FRAME RATES

LIGHT-SHEET READOUT MODE

sCMOS

2048 x 2048

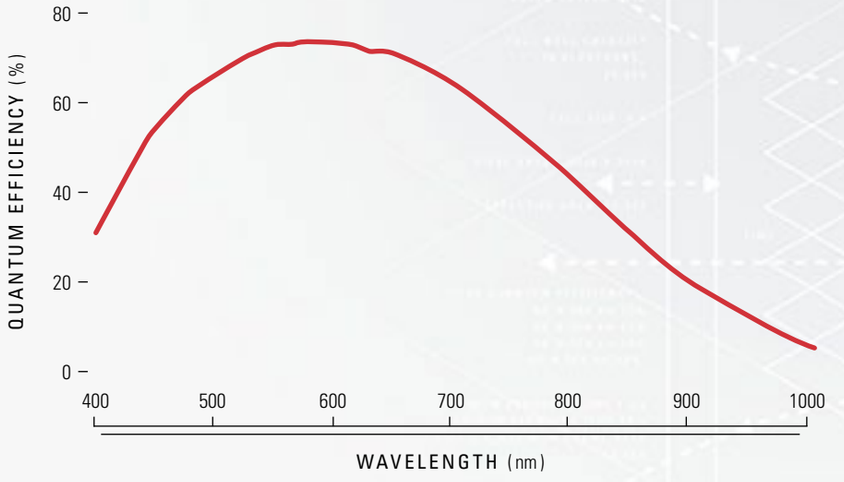
Conventional

Super-Res

ORCA-Flash4.0 V2

What if your scientific camera could enable—and perhaps even improve on—any imaging technique your research needed? And not just your research needs for today, but whatever they end up being next year or the year after that? Single molecule fluorescence; quantitative measurements; high-speed, live-cell imaging; light-sheet microscopy; TIRF…Bring it on—the ORCA-Flash4.0 V2 can handle all that and then some. With fast frame rates, wide fields-of-view, and a large dynamic range, this sensitive, versatile camera is precision engineered to support your scientific exploration, wherever it may take you.

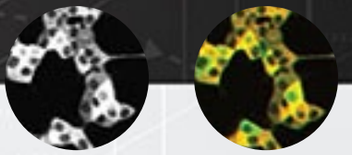
The ORCA-Flash4.0 V2 has already delivered beautiful images and groundbreaking science for hundreds of investigators worldwide. What will it help you explore?



1.4 *ELECTRONS RMS*
MINIMUM READ NOISE

100 *FPS*
MAX FULL RESOLUTION FRAME RATE

sCMOS



USB 3.0 CONNECTIVITY

W-VIEW MODE

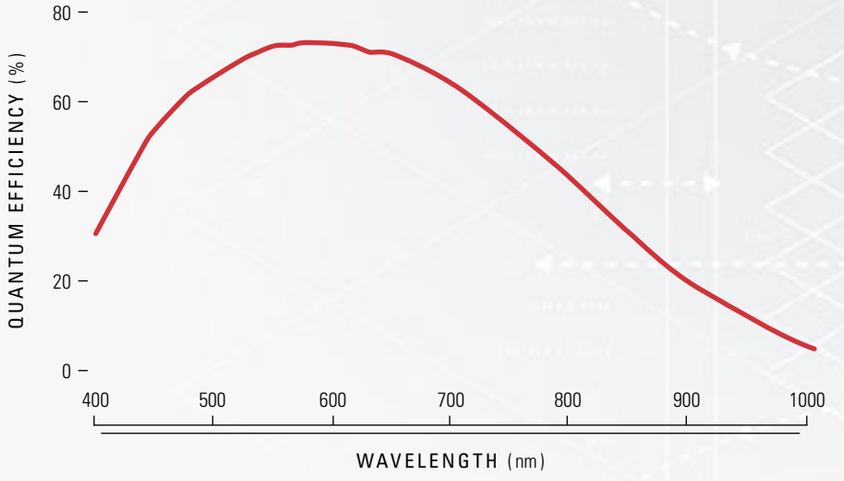
VERSATILE

LARGE DYNAMIC RANGE

ORCA-Flash4.0 LT

Ready for the flexibility and sensitivity of a scientific CMOS (sCMOS) camera but don't need really fast frame rates? Want simpler, more reliable multicolor fluorescence imaging? This little sister of the ORCA-Flash4.0 V2 is designed to bring all the advantages of sCMOS technology—wide fields-of-view, low-light sensitivity, and large dynamic range—to every research lab. Easy connectivity and powerful performance help you explore your pressing biological questions. And when your green channel is screaming but your red is ho-hum horrible, the LT's new "W-VIEW Mode" (see the W-VIEW GEMINI, p.12) ensures more balanced exposure for reliably quantitative dual wavelength imaging.

With high-end capabilities at an affordable price, the ORCA-Flash4.0 LT fits into any experiment that needs simple connectivity, moderately fast frame rates, and great sensitivity. Think of all that LT can help you discover.



1.5 ELECTRONS RMS
MINIMUM READ NOISE

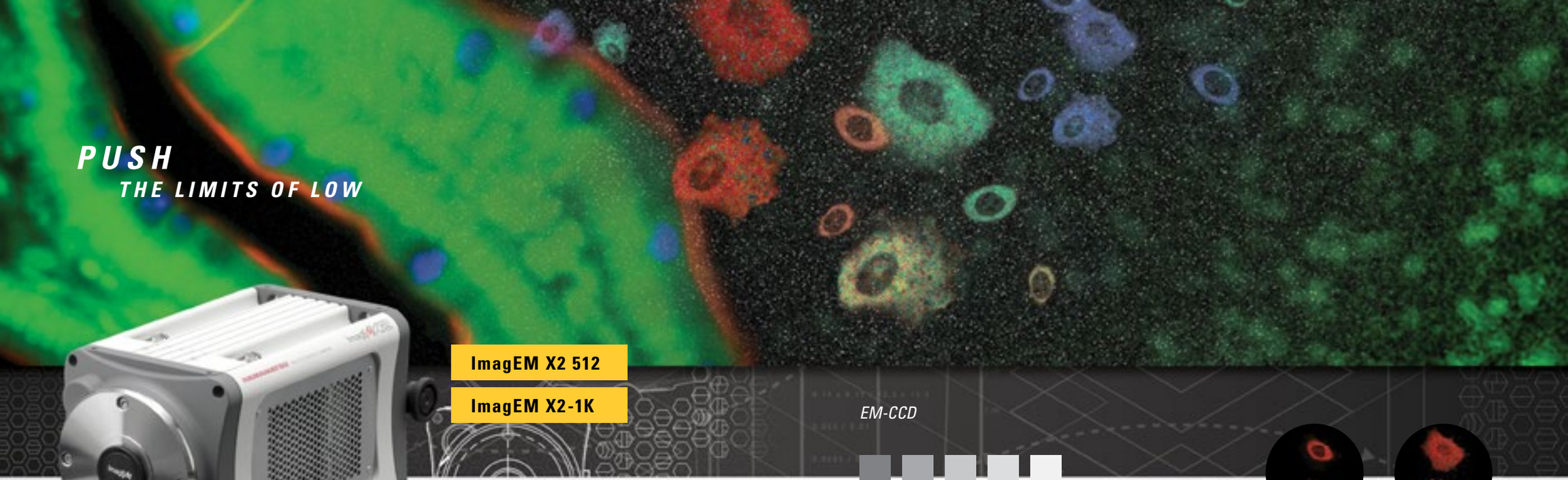
30 FPS
MAX FULL RESOLUTION FRAME RATE

The Living Image

CELEBRATING THE LITTLE THINGS IN LIFE

As we said in the introduction, knowing that our cameras are helping scientists explore the biological world is an important part of the satisfaction and pride we take in our art. Last year, we decided to share this excitement with the community through The Living Image (thelivingimage.hamamatsu.com), a website that celebrates the science being done with our cameras. By shining a light on recent research in our Bench Stories, we hope you can experience the same thrill we do at seeing the smart and creative studies scientists are conducting. And through the library of articles and interactive tools in the Resources section, we hope to make it easier for you to understand the technology in your camera, so you can make the most of this important tool.

Please visit The Living Image and enjoy our celebration of science. And, by all means, contact us if you'd like to see your work as a Bench Story—we'd love to help you share your art. Because we know that for many microscopists, it's the little things in life that are important.



PUSH
THE LIMITS OF LOW

ImagEM X2 512

ImagEM X2-1K

EM-CCD

EXTREME LOW-LIGHT PERFORMANCE

FAST FRAME RATES

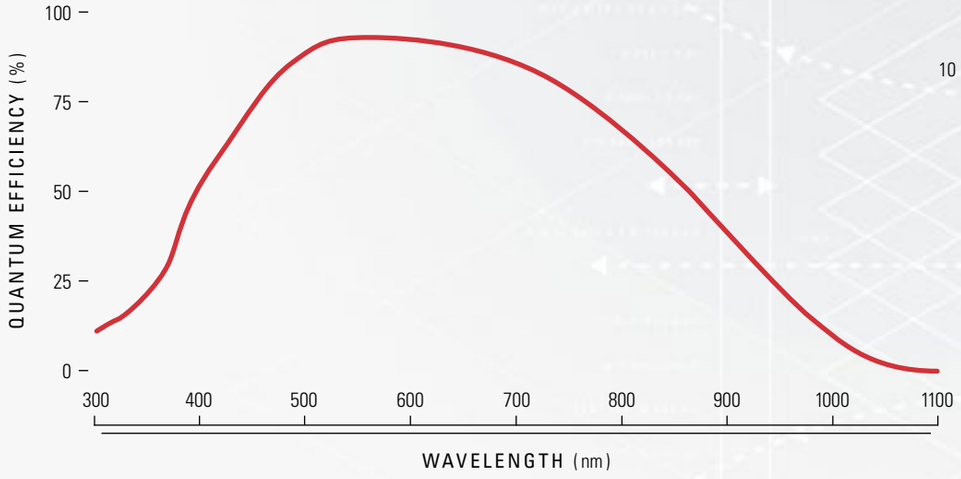
LONG EXPOSURE CAPABILITY

HIGH-SPEED READOUT

ImagEM X2 SERIES

What do you do when light levels are truly low? Like in the low hundreds-of-photons-per-single-molecule-range low (background photons in the single digits)? In these demanding situations where photons are scarce, the EM-CCD technology in our ImagEM X2 series of cameras really shines. Why? It's all in the EM-CCD's larger pixel size and specialized architecture, which multiplies the weak electron signal before it reaches the amplifier and the unavoidable addition of readout noise. With the ImagEM X2 (512 (H) x 512 (V) pixels) and its big brother, the ImagEM X2-1K (1024 (H) x 1024 (V) pixels), a wider range of lower-light luminescence studies, very dim spinning disc confocal methods, and TIRF experiments are all now within your reach.

Pushing the boundaries of low-light imaging, the ImagEM X2 cameras know how to make every photon count. Imagine what you might find when you push the limits of low with the ImagEM X2 or ImagEM X2-1K.



1076 MAXIMUM FRAME RATE *ImagEM X2*

314 MAXIMUM FRAME RATE *ImagEM X2–1K*

GET CLOSER
TO THE BIOLOGY

Simultaneous Dual Wavelength Imaging

W-VIEW GEMINI

Have you ever thought, “Optical splitters—great idea but so hard to use!” They hold out the promise of more efficient multi-wavelength imaging, but need careful alignment. The slightest bump of the microscope table or stomp in the neighboring lab can disrupt the setup. The team at Hamamatsu understands how important it is for tools to get out of your way and just work. They’ve taken on the optical splitter problem and crafted the W-VIEW GEMINI. Optically and mechanically stable, chromatically corrected, with simple software-assisted alignment and flexible configurations, the W-VIEW GEMINI lives up to the promise of what an optical splitter should be. And when you don’t need a splitter, just switch to “bypass mode”—it’s as though there’s nothing between your camera and your microscope.

Simplifying multi-wavelength experiments like FRET, the W-VIEW GEMINI gets out of your way to bring you closer to the biology. What biological processes will the W-VIEW GEMINI bring closer to you?

MATCHED TO THE PERFORMANCE OF GEN II SCMOS CAMERAS

CHROMATICALLY CORRECTED

USER-DEFINED FILTER COMBINATIONS

EASILY ALIGNED AND STABLE

HIGH TRANSMITTANCE

SPECS

	ORCA-Flash4.0 V2 USB 3.0	ORCA-Flash4.0 V2 With Camera Link Option	ORCA-Flash4.0 LT USB 3.0	ImagEM X2 512	ImagEM X2 1K
Product Number	C11440-22CU	C11440-22CU	C11440-42U	C9100-23B	C9100-24B
Imaging Device	sCMOS	sCMOS	sCMOS	Back-Thinned EM-CCD	Back-Thinned EM-CCD
Cell (pixel) **Size** (μm^2)	6.5	6.5	6.5	16	13
Pixel Array (horizontal by vertical)	2048 x 2048	2048 x 2048	2048 x 2048	512 x 512	1024 x 1024
Effective Area (horizontal by vertical in mm)	13.312 x 13.312	13.312 x 13.312	13.312 x 13.312	8.19 x 8.19	13.3 x 13.3
Dark Current (electrons/pixel/sec.) – Air Cooled	0.06	0.06	0.6	0.005	0.01
Dark Current (electrons/pixel/sec.) – Water Cooled	0.006	0.006	N/A	0.0005	0.001
Full Well Capacity in electrons (typ.)	30,000	30,000	30,000	370,000	400,000
Readout Noise (N_r) median in electrons (typ.) slow scan	0.8 @ 30 fps	0.8 @ 30 fps	0.9 @ 30 fps	-	-
Readout Noise (N_r) **rms in electrons** (typ.) **slow scan**	**1.4 @ 30 fps**	**1.4 @ 30 fps**	**1.5 @ 30 fps**	**8 @ 4x gain**	**3 @ 10x gain**
Readout Noise (N_r) median in electrons (typ.) standard scan	1.0 @ 30 fps	1.0 @ 100 fps	1.3 @ 30 fps	-	-
Readout Noise (N_r) **rms in electrons** (typ.) **standard scan**[1]	**1.6 @ 30 fps**	**1.6 @ 100 fps**	**1.9 @ 30 fps**	**<1 @ 1200x gain**	**<1 @ 1200x gain**
Dynamic Range (typ.)	37,000:1	37,000:1	33,000:1	Gain Dependent	Gain Dependent
Peak Quantum Efficiency (QE)	(QE) **73%** @ 580 nm	(QE) **73%** @ 580 nm	(QE) **73%** @ 580 nm	(QE) **92%** @ 580 nm	(QE) **92%** @ 580 nm
Quantum Efficiency (QE) @ 500 nm	(QE) **67%** @ 500 nm	(QE) **67%** @ 500 nm	(QE) **67%** @ 500 nm	(QE) **91%** @ 500 nm	(QE) **91%** @ 500 nm
Quantum Efficiency (QE) @ 670 nm	(QE) **68%** @ 670 nm	(QE) **68%** @ 670 nm	(QE) **68%** @ 670 nm	(QE) **83%** @ 670 nm	(QE) **83%** @ 670 nm
Quantum Efficiency (QE) @ 750 nm	(QE) **53%** @ 750 nm	(QE) **53%** @ 750 nm	(QE) **53%** @ 750 nm	(QE) **66%** @ 750 nm	(QE) **66%** @ 750 nm
Noise Factor (F_n)[2]	1	1	1	1.4	1.4
Minimum Exposure Time	1 ms[4]	1 ms[4]	1 ms[4]	13.85 ms[5]	52.7 ms[5]
Maximum Exposure Time	10 s	10 s	10 s	2 hours	2 hours
In-Camera Binning	2 x 2, 4 x 4 (digital)	2 x 2, 4 x 4 (digital)	2 x 2, 4 x 4 (digital)	2 x 2, 4 x 4[6]	2 x 2, 4 x 4
Subarray	Yes	Yes	Yes	Yes	Yes
Maximum Full Resolution Frame Rate (fps)	30	100	30	70.4	18.5
Absolute Maximum Frame Rate (fps)[3]	25,655	25,655	25,000	1076	314
Electron Multiplying Gain	N/A	N/A	N/A	4 - 1200x	10 - 1200x
Analog Gain	No	No	No	Yes	Yes
A/D Converter	16 bit	16 bit	16 bit	16 bit	16 bit
Interface Type	USB 3.0	CameraLink	USB 3.0	IEEE 1394b	IEEE 1394b
Lens Mount	C-mount	C-mount	C-mount	C-mount	C-mount

[1] 2.0 electrons rms, guaranteed.

[2] If this value is greater than 1, multiplicative noise is present.

[3] Using maximum binning and/or smallest subarray.

[4] 40 µs using internal trigger and subarray.

[5] 10 µs using external trigger.

[6] 8 x 8, 16 x 16 binning optional.

IMAGES COURTESY OF:

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HHMI

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HAMAMATSU

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