The Prime 95B™ for Spinning Disk Confocal

The Teledyne Photometrics Prime 95B is a high sensitivity CMOS camera designed for imaging at extremely low light with high speed and low noise.

The almost perfect, 95% quantum efficient (QE) sensor of the Prime 95B has equivalent sensitivity to an EMCCD camera but with the much larger field of view (1200x1200 pixels, 18.7 mm diagonal) and high speed (82 fps, full frame) expected of a CMOS device.

It also doesn't suffer from the complications associated with an EMCCD camera such as EM-gain degradation, where the effectiveness of the EM-gain process is reduced with usage. This results in EMCCD cameras needing to be regularly calibrated which is not only an annoyance, but there eventually comes a point when no more can be done and no signal improvement can be achieved when using EM-gain.

Figure 1: The Teledyne Photometrics Prime 95B Scientific CMOS Camera

The EM-gain process also introduces excess noise factor, an extra source of uncertainty caused by the probability of impact ionization creating an electron. Excess noise factor multiplies other camera noise characteristics by a factor of √2, reducing the overall signal-to-noise ratio. CMOS devices such as the Prime 95B do not suffer from any of these issues. The signal-to-noise improvement of the Prime 95B can be clearly seen in Figure 2 and Figure 3 where a comparison was performed using spinning disk confocal microscopy with the Prime 95B against a 512x512 EMCCD camera and 1024x1024 EMCCD camera, respectively. The Prime 95B image looks cleaner, details are sharper and structural elements are identified that can't be seen with the EMCCD camera.

Spinning disk confocal microscopy is, essentially, a light rejection technique so one of the main challenges is to collect as many of the emitted photons as possible so light intensity can be reduced to lessen the impact of photobleaching and photodamage on samples.

The high sensitivity of the Prime 95B means that when compared to conventional sCMOS devices, the exposure time could be reduced by up to four times and still give equivalent detection. Figure 4 shows the difference in image quality that can be achieved using the same exposure time on a conventional 82% sCMOS device binned 2x2 vs the Prime 95B. Being able to reduce the exposure time when using the Prime 95B is ideal for reducing the effects of photobleaching and photodamage, maximizing signal-to-noise ratio while minimizing the harmful effects of light illumination.

Figure 4 goes on to show the difference in image quality when using the Prime 95B against a larger format 1024x1024 EMCCD camera to show how the three camera types compare. The difference in image quality and signal to noise is still clearly in favor of the Prime 95B.

The large, 11x11 µm pixels of the Prime 95B provide additional sensitivity and have a large 80,000 e- full well capacity with a low 1.6 e- read noise, giving the 95B a very high dynamic range, ideal for performing high contrast imaging. Larger pixels also fit perfectly with high magnification objectives, achieving Nyquist sampling without the need for any additional optics with 100x magnification typically used in spinning disk confocal microscopy.

Furthermore, as research moves towards large-scale approaches, there is an increasing demand for higher throughput capabilities. To this end, a version of the Prime 95B has been created with a massive 25 mm diagonal field of view over 1600x1600 pixels. The Prime 95B 25 mm offers a significantly increased field of view over EMCCD and conventional sCMOS devices. This can be seen in Figure 5 which shows how much more of the sample can be imaged by taking advantage of a larger field of view.

We would encourage anyone considering using spinning disk confocal microscopy to request a demonstration of the Prime 95B or Prime 95B 25 mm to see the advantages they can provide.

Comparison data

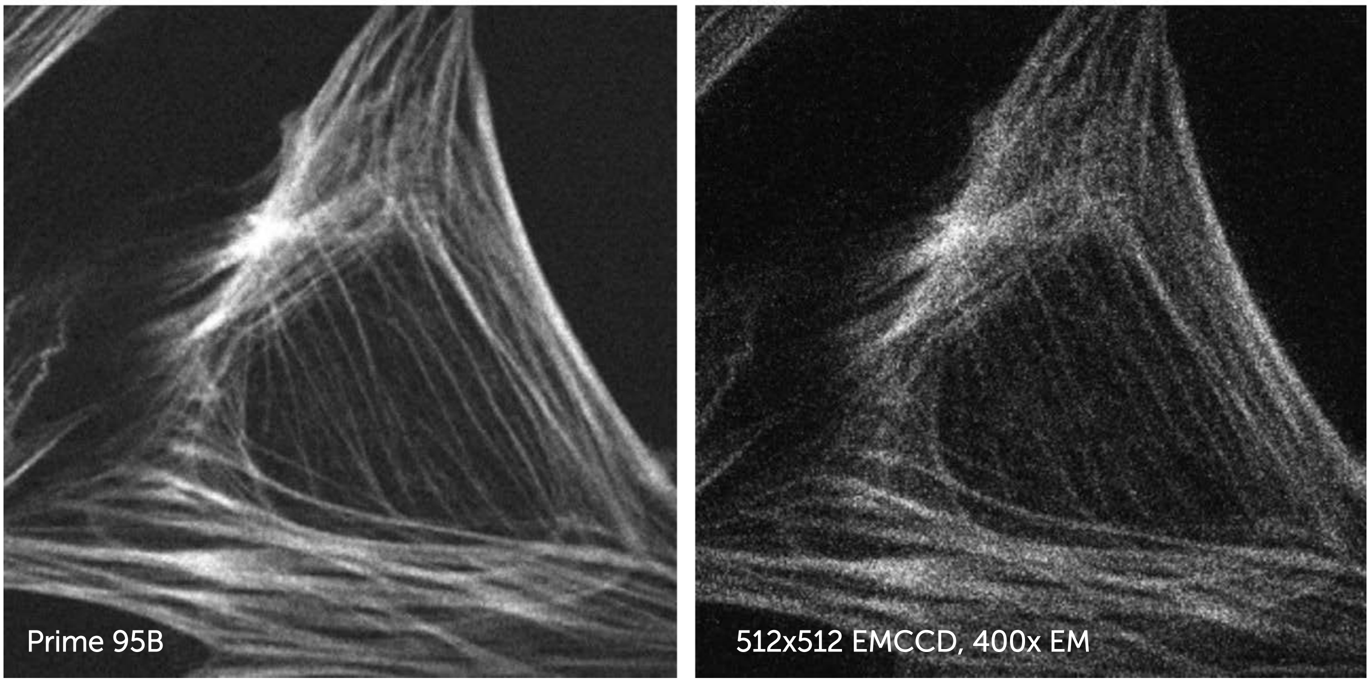

Figure 2: AlexaFlour488-Phalloidin labelled actin cytoskeletal structure imaged using spinning disk confocal microscopy.
Left Image captured using a 25 ms exposure time with the Prime 95B scientific CMOS camera,
Right Image captured using a 25 ms exposure time with a 512x512 EMCCD camera with 400x EM-gain.

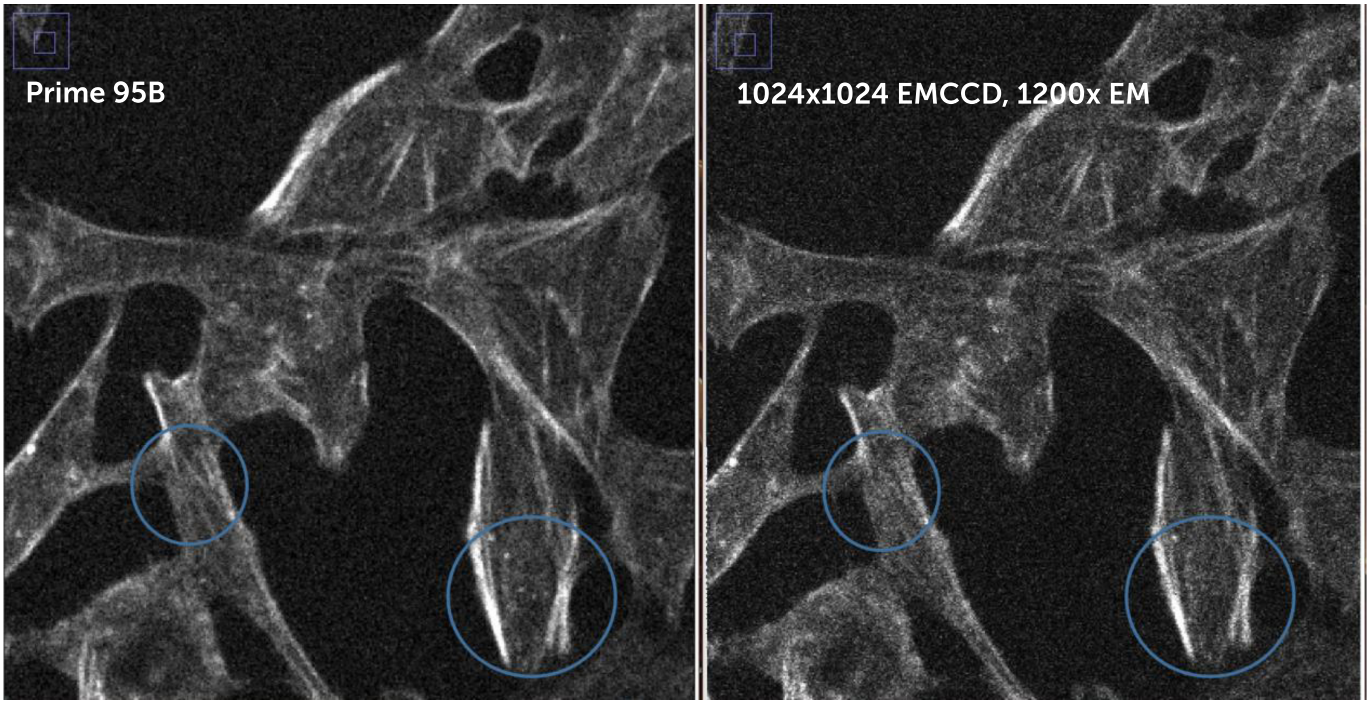

Figure 3: Comparison of image detail visible with the Prime 95B and a 1024x1024 EMCCD camera, highlighted with light blue circles.

Left, Image captured using a 100 ms exposure time with the Prime 95B

Right, Image captured using a 100 ms exposure time with a 1024x1024 EMCCD camera with 1200 EM-gain

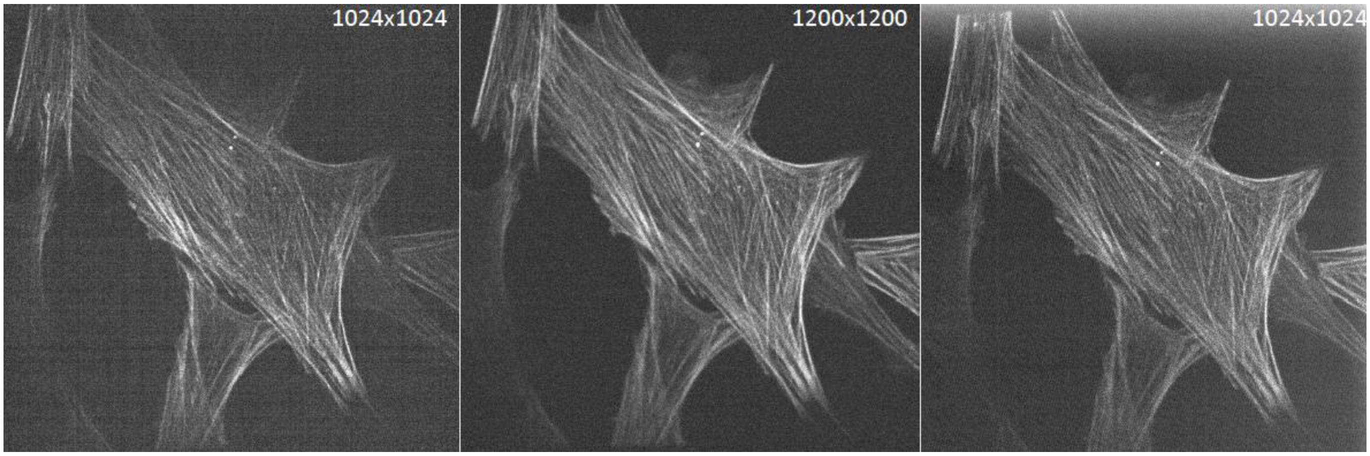

Figure 4: AlexaFluor488-Phalloidin labeled actin cytoskeletal structure imaged using spinning disk confocal microscopy.

Left, Image captured using a 25 ms exposure time on a typical sCMOS device binned 2x2

Middle, Image captured using a 25 ms exposure time with the Prime 95B

Right, Image captured using a 25 ms exposure time with a 1024x1024 EMCCD camera with 400 EM-gain

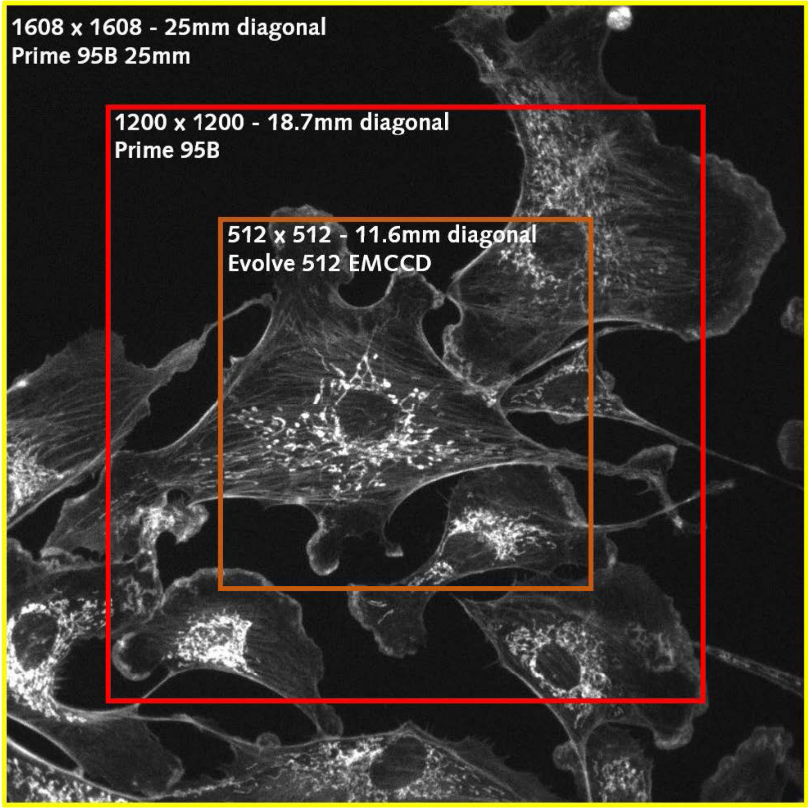

Figure 5: Field of view comparison between a 512x512 EMCCD with an 11.6 mm diagonal, the Prime 95B with an 18.7 mm diagonal and the Prime 95B 25 mm with a 25 mm diagonal