Advanced Cameras for Electrophysiology

Introduction

The Retiga ELECTRO™ from QImaging has long been the standard imaging device for electrophysiology for the reasons described in the Technical Note from Photometrics on the Retiga ELECRO, available online in the Electrophysiology Resource Center. However, there are some cases where electrophysiology imaging requirements go beyond the Retiga ELECTRO. For this reason, Photometrics recommends two other camera types that may better suit these applications; the Iris series of cameras for high resolution, large field of view imaging and the Prime series of cameras for ultimate sensitivity, speed and contrast.

Iris Cameras for Electrophysiology

The Iris 9™ and Iris 15™ Scientific CMOS cameras are two versions of the same camera that empower the researcher to choose a camera that best fits the field of view requirements of their application. The large 9 Megapixel sensor of the Iris 9 provides a 17.8 mm diagonal field of view whereas the massive 15 Megapixel sensor of the Iris 15 provides a huge, 25 mm diagonal field of view.

The Iris series of cameras are also designed to deliver extremely high-resolution images by taking advantage of small 4.25x4.25 µm pixels which provide incredible detail and allow for Nyquist spatial sampling at 40x magnification with no optical correction.

The Iris cameras have equivalent sensitivity to the Retiga ELECTRO with a 73% peak quantum efficiency (QE) but an extremely low 1.5e- read noise, five times lower than the Retiga ELECTRO, which delivers a considerable improvement in signal to noise ratio.

Many cameras used for electrophysiology applications struggle with the detection of fluorophores with emission profiles at the edges of the visible electromagnetic spectrum. The Iris cameras maintain a high QE across the entire spectrum; 66% @461 nm (Hoechst), 70% @510 nm (GFP) and 70% @650 nm (Fura Red). This is especially important when using blue light where lower exposure times are desired to reduce phototoxic effects.

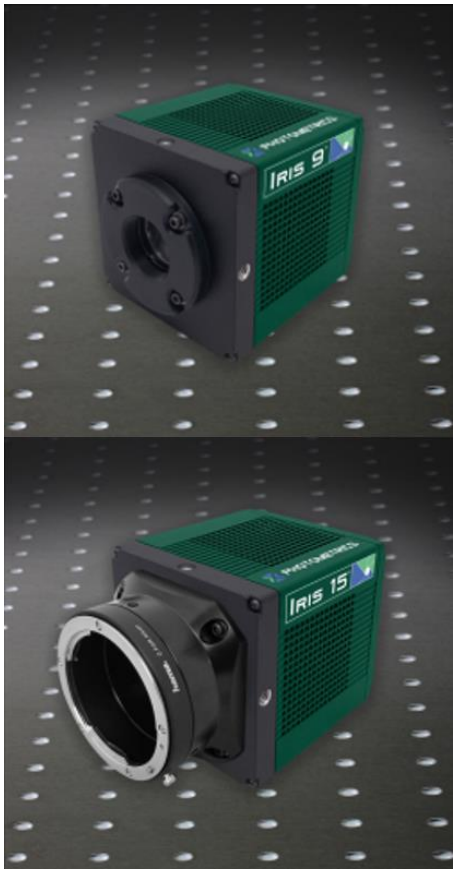

Figure 1: Iris series of cameras. *Top* Iris 9, *Bottom* Iris 15

The Iris cameras can capture dynamic events at 30 frames per second for the full frame, a 50% improvement over the Retiga ELECTRO while still maintaining a larger field of view and lower noise. Thousands of frames per second can easily be reached by making smaller regions.

Photometrics encourages anyone looking for a more advanced camera than the Retiga ELECTRO to request a demonstration of an Iris camera to take advantage of the higher signal to noise, higher resolution and the massive 25 m field of view of the Iris 15, still at an affordable price.

Prime™ Cameras for Electrophysiology

The Prime BSI™ and Prime 95B™ back-illuminated Scientific CMOS cameras are designed to deliver high sensitivity and high speed with extremely low noise characteristics.

The almost perfect, 95% quantum efficient sensors of the Prime cameras allow light intensity to be reduced substantially while maintaining a high level of signal detection. As back-illuminated devices, the Prime cameras aren't reliant on micro-lensing technology to increase detection, resulting in a 30% increase in sensitivity over other sCMOS cameras. The high QE also stays high across the entire spectrum; 86% @461 nm (Hoechst), 90% @510 nm (GFP) and 88% @650 nm (Fura Red).

The Prime BSI, with 6.5x6.5 µm pixels on a 4.2 Megapixel sensor (18.8 mm diagonal field of view), delivers the perfect balance between high-resolution imaging, sensitivity and dynamic range. Nyquist spatial sampling is achieved at 60x magnification with no optical correction and the 45,000e- linear full well capacity is 50% higher than other sCMOS cameras. Read noise is also minimized to just 1.1 e^-, ideal for reducing exposure times to minimize the damaging effects of photobleaching and photodamage.

The Prime BSI captures highly detailed images with great sensitivity while acquiring data at high frame rates. At 94 frames per second for the full frame, it is our fastest back-illuminated CMOS device for the most intensive of electrophysiology applications. By making smaller regions, this speed can be further improved to many thousands of frames per second.

Figure 2: Prime series of cameras. *Top* Prime BSI, *Bottom* Prime 95B

The Prime 95B remains our highest sensitivity CMOS device for the ultimate in high signal to noise and high contrast imaging. The large 11x11 µm pixels on a 1.44 Megapixel sensor (18.66 mm diagonal field of view) ensure the highest levels of detection, ~2.8x higher sensitivity than the Prime BSI and ~3.3x higher sensitivity than other sCMOS cameras.

Nyquist spatial sampling is achieved at 100x magnification with no optical correction and the 80,000e- linear full-well capacity is almost double the Prime BSI and almost three times higher than other sCMOS cameras. Read noise is just 1.6 e^-.

At 82 frames per second for the full frame, this high sensitivity can be achieved without compromising on speed and this speed can be further improved by making smaller regions. Photometrics encourages anyone looking for an increase in sensitivity and speed to request a demonstration of a Prime camera.

