Primary applications:

Super-resolution Microscopy

Light Sheet Microscopy

High Speed Ratiometric Imaging

TIRF Microscopy

Confocal Microscopy

photometrics®

PRIMΣ™

4.2 Megapixel Scientific CMOS Camera

Photometrics Prime is the first intelligent scientific CMOS (sCMOS) camera to incorporate a powerful FPGA-based Embedded Signal Processing™ engine (ESP). ESP enables advanced real-time processing features:

▶ **PrimeEnhance™** quantitatively increases the Peak Signal to Noise Ratio by 3X-5X, increasing the clarity and quality of images.

▶ **PrimeLocate™** dynamically evaluates acquired images and reduces the surplus of data generated during high speed super-resolution imaging.

Designed using sCMOS sensor technology, Prime becomes an extremely versatile imaging solution for life science imaging. It is a high resolution camera with great sensitivity, extremely low noise, high frame rates and an impressive dynamic range. The large field of view is ideal for microscopy, maximizing usefulness of the imaging area.

Features	Advantages
Extremely Low Read Noise	Maximize your ability to detect faint fluorescence
Fast Frame Rates	Capture highly dynamic events with fast temporal resolution
Large Field of View	Maximize the number of cells that can be tracked and monitored per frame
Optimized Pixel Size	Properly sample your microscope's image at its full resolution
High Quantum Efficiency	Enables short exposure times to minimize phototoxicity and enable high frame rates across a wide wavelength spectrum
Enhanced Dynamic Range	Measure both bright and dim signal levels within the same image
ESP	Improve image quality and imaging efficiency with FPGA based Embedded Signal Processing engine for real-time image processing
PrimeEnhance	Real-time quantitative denoising algorithm that improves image clarity by reducing photon-shot (Poisson) noise. Delivers an increase in Peak Signal to Noise Ratio of 3X to 5X
PrimeLocate	Dynamically evaluates and acquires only the relevant data for localization based super-resolution applications
Multi-ROI (Region of Interest)	Acquire only regions of data with desired information, and reduce data glut. Define up to 15 unique regions of interest and transfer only this data to the host computer
Multiple Expose Out Triggering	Use the camera to control up-to four light sources for multi-wavelength acquisitions

4.2 Megapixel sCMOS Sensor

1.3e- read noise
72% peak QE
30,000e- full well
18.8mm diagonal

Embedded Signal Processing

PrimeEnhance
PrimeLocate
Multi-ROI

Easily Mounted and Secured

C-mount
Two ¼"-20 mounting holes per side

Dual Interface

High Speed PCI-Express
- 100fps

USB 3.0
- 31fps

Multiple Cooling Options

Forced Air Cooling
- -10ºC Cooling
- Selectable Fan Speed

Liquid Cooling
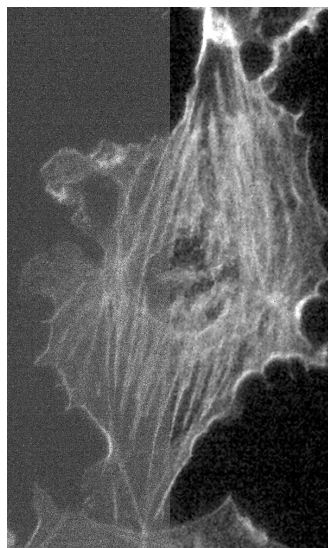- -25ºC Cooling
- Leak-proof, quick-disconnect ports

Advanced Triggering Capabilities

Effective Global Shutter
Up to four selectable expose-out lines

Embedded Signal Processing (ESP™) Features

PrimeEnhance

Due to the incredibly low electronic noise of sCMOS sensors, the latest generation of scientific cameras have enabled imaging using only a few photons per pixel. Unfortunately, these minute signals are dominated by the natural Poisson variation in light levels preventing useful quantitation.

PrimeEnhance uses a quantitative SNR enhancement algorithm used in Life Science imaging to reduce the impact of photon shot-noise present in acquired images, leading to an increase in Signal to Noise Ratio (SNR) by 3x to 5x.

When using the algorithm, exposure times can be reduced to achieve the desired SNR, which in turn reduces the effects of phototoxicity and photobleaching to extend cell lifetimes.

Invented at INRIA and further optimized for fluorescence microscopy at the Institut Curie, the denoising algorithm used in PrimeEnhance uses a patch based evaluation of image data and knowledge of the each individual camera's performance parameters to reduce the effects of photon shot-noise. The patches of image intensities and their noise characteristics are processed and evaluated with increasing neighborhood sizes during which weighted intensity averages are taken. This iterative process preserves not only the quantitative nature of the measured intensities, but also the maintains the finer features present in biological samples.

- ▶ Increase SNR 3x to 5x at low light levels by reducing photon shot-noise

- ▶ Preserve signal intensities ensuring quantitative measurements

- ▶ Extend cell lifetimes with reduced phototoxicity and photobleaching

- ▶ Extremely useful for low light imaging applications dominated by noise

Detailed performance and methodology of the algorithm is available in the following publication:
Patch-based nonlocal functional for denoising fluorescence microscopy image sequences.
Boulanger J, Kervrann C, Bouthemy P, Elbau P, Sibarita JB, Salamero J. IEEE Trans. *Med Imaging* 2010 Feb.
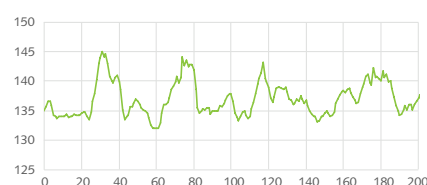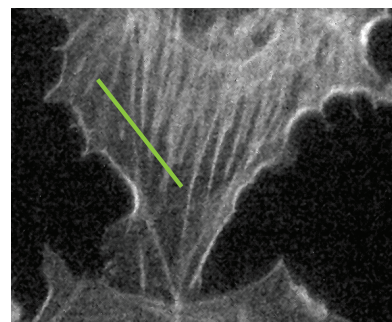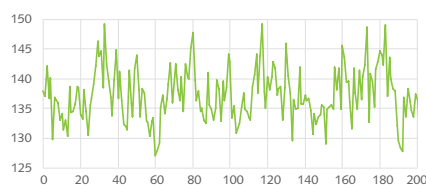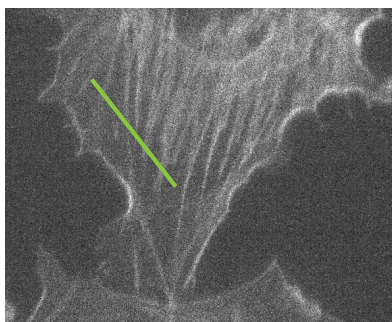
Embedded Signal Processing (ESP™) Features

PrimeLocate

Localization based super-resolution microscopy requires a sparsity of data to ensure proper localization of emitting molecules. Even with this sparsity, the full image frame is transferred to the host to be analyzed, creating a large amount data to be processed without adding useful information.

PrimeLocate dynamically evaluates image data and locates 500 regions per frame containing single molecule data relevant for super-resolution localization. Only these 500 regions are transferred to the host computer, drastically reducing the amount of data and time required for analysis. This then allows for 100fps acquisition of super-resolution data over USB 3.0.

By transferring only the relevant raw data, users have the freedom to use their preferred localization algorithm to generate super-resolution images.
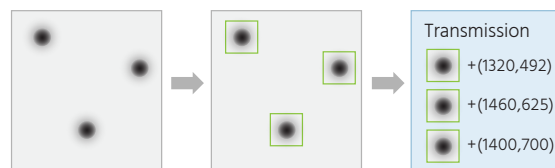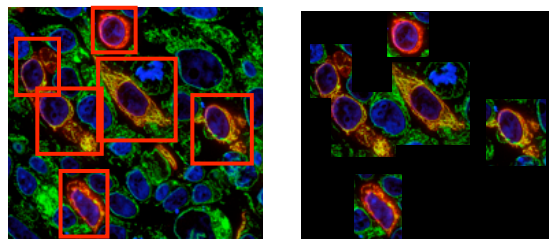

- Only the data within the patches is transferred to the host computer

- Reduces full-frame acquisition data rate from 800MB per second to 12MB per second reducing processing time and storage requirements

- 100fps acquisition of super-resolution data over USB 3.0

- Ability to transfer 500 regions per frame

- Allows freedom to select preferred super-resolution localization algorithm

Multi-ROI

The surplus of data generated by sCMOS devices – 800MB per second – is challenging to acquire, analyze, and store, requiring special interfaces and expensive SSDs. While a large Field of View (FOV) is convenient for imaging, at times, only certain areas contain the desired information.

Multi-ROI allows users to select up to 15 unique ROIs within the FOV, and only these selected regions are transferred to the host computer. This allows for a large reduction in the amount of data acquired but ensures that the critical information is obtained.

- Only the data within the user-defined ROIs is transferred to the host computer

- Select up to 15 unique regions

- Significantly reduce the amount of data being acquired

Specifications	Camera Performance
Sensor	BAE CIS-2020F sCMOS
Array Size	2048 x 2048 pixels (4.2 Megapixel)
Pixel Area	6.5µm x 6.5µm
Sensor Area	13.312mm x 13.312mm 18.8mm diagonal
Peak QE%	72%
Read Noise	1.3e- (RMS) 1.1e- (Median)
Full-Well Capacity	30,000e-
Dynamic Range	30,000:1
Bit Depth	16-bit
Readout Mode	Rolling Shutter Effective Global Shutter
Binning	2x2 (on FPGA)

Cooling Performance	Sensor Temperature	Dark Current
Air Cooled	-10ºC @ 30ºC Ambient	0.06 e-/pixel/s
Liquid Cooled	-25ºC @ 30ºC Ambient	0.01 e-/pixel/s

Specifications	Camera Interface
Digital Interface	PCI-Express USB 3.0
Lens Interface	C-Mount
Mounting Points	2 x ¼ 20" mounting points per side to prevent rotation
Liquid Cooling	Quick Disconnect Ports

Triggering Mode	Function
Input Trigger Modes	Trigger-First – Sequence triggered on first rising edge Edge – Each frame triggered on rising edge SMART Streaming – Fast iteration through multiple exposure times
Output Trigger Modes	First Row – Expose signal is high while first row is acquiring data Any Row – Expose signal is high while any row is acquiring data All Rows – Effective Global Shutter – Expose signal is high when all rows are acquiring data
Output Trigger Signals	Expose Out (up to four signals), Read Out, Shutter Out, Trigger Ready

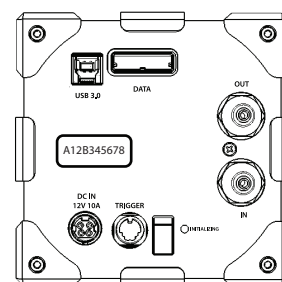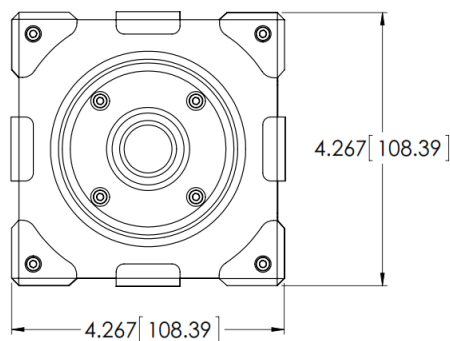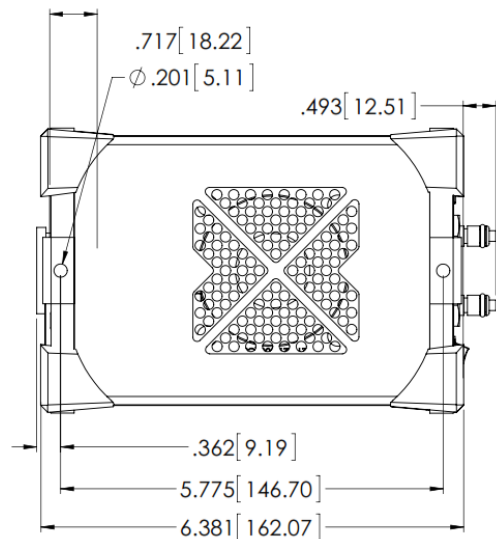| Array Size	PCI-Express	USB 3.0
2048 x 2048	100	31
1024 x 1024	204	62
512 x 512	400	400
256 x 256	833	833
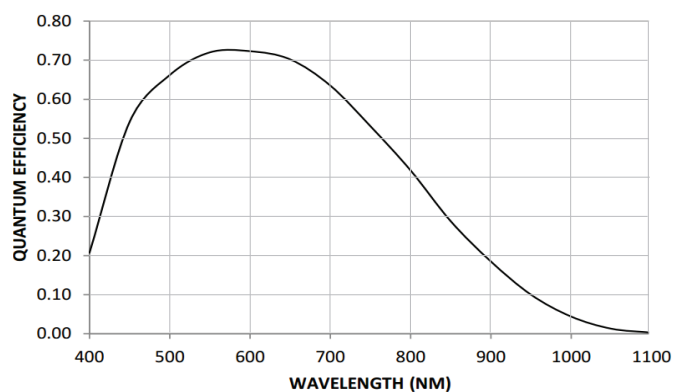
Accessories

INCLUDED

PCI-Express Interface Card

PCI-Express Cable

USB 3.0 Cable

Trigger Cable

Power Supply

Manuals and QuickStart Guide

Performance and Gain Calibration Test Data

ADDITIONAL

Liquid Circulator

Liquid Cooling Tubes

Distance from C-mount to sensor

Weight: 3.8 lbs / 1.7 Kg

2016 R&D 100 FINALIST

Vision*Systems* DESIGN 2016 **Innovators Awards**

PHOTOMETRICS

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