High Resolution BSI Scientific CMOS

Prime BSI delivers the perfect balance between high resolution imaging and sensitivity with an optimized pixel design and near perfect 95% Quantum Efficiency to maximize signal detection.

A 4 Megapixel camera with 6.5µm pixels, it capture higly detailed images with great quality while acquiring data at high frame rates. This ensures that all data is collected and no event goes undetected.

Prime BSI delivers a 100% pixel fill factor and does not rely on micro-lensing technology to increase detection, resulting in a 30% increase in sensitivity over previous sCMOS cameras.

This perfect balance in performance makes the Prime BSI the most versatile imaging camera for live-cell imaging with:

- Highest Sensitivity
- High Resolution
- Large Field of View
- High Frame Rates
- Large Dynamic Range

Primary applications:

TIRF Microscopy

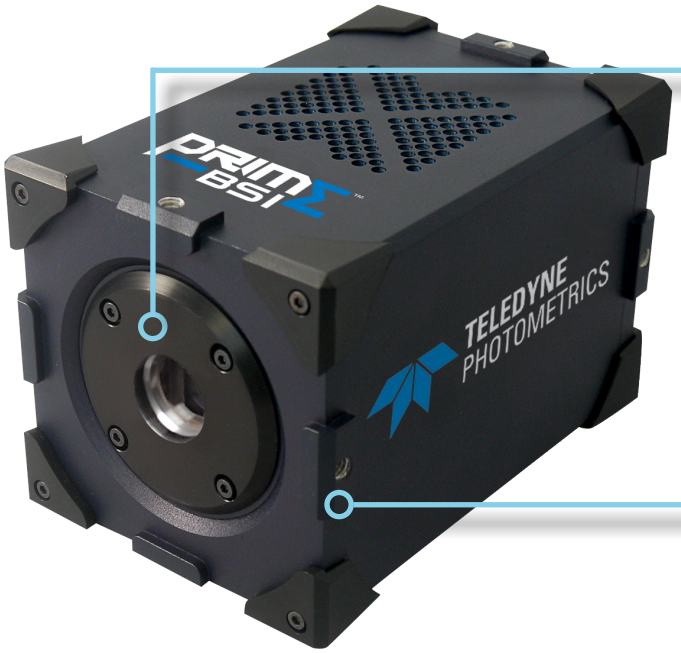
Ratiometric Imaging

Cell Motility

Light Sheet Microscopy

- **95% Quantum Efficiency**
- **6.5µm x 6.5µm Pixel Area**
- **1.0e⁻ Read Noise with Correlated Multi Sampling (CMS)**
- **43 fps @ 16-bit/ 12-bit (CMS)**
- **63 fps @ 11-bit**
- **PrimeEnhance increases SNR 3-5x**

Features	Advantages
High Quantum Efficiency 95% Peak QE	Maximizes ability to detect weak signals, enables short exposure times for high frame rates, minimizes phototoxicity across a wide range of wavelengths
Optimized 6.5µm Pixel SIze	Maximize light collection while maintaining proper spatial sampling at 60X
Extremely Low Read Noise	Maximize your ability to defect faint fluorescence
Fast Frame Rates	Capture highly dynamic events with high temporal resolution
Large Field of View	Maximize the number of cells that can be tracked and monitored per frame
Prime Enhance™	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
Enhanced Dynamic Range	Measure both bright and dim signal levels within the same image 25,000:1 Dynamic Range (88 dB)
Multiple Expose Out Triggering	Control up to four light sources for multi-wavelength acquisitions
SMART Streaming™	Faster acquisition rates with variable exposures, ideal for multi-probed live cell imaging Compatible with Multiple Expose Out Triggering
Programmable Scan Mode	Easily synchronize and control acquisitions with the rolling shutter readout



4.2 Megapixel BSI CMOS Sensor

Backside Illuminated Sensor
1.0e- Read Noise (Median)
>95% peak QE
45,000e- full well
6.5 x 6.5µm pixels
18.8mm diagonal

Easily Mounted and Secured

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

Convenient Interfaces

16-bit / 12-bit Data
- 43 fps

11-bit Data
- 63 fps

Multiple Cooling Options

Forced Air Cooling
- -20°C Cooling
- Selectable Fan Speed

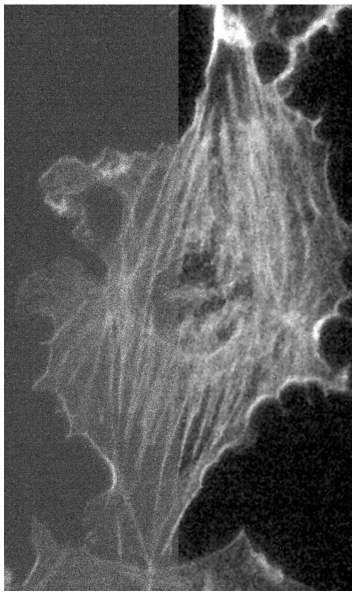
Liquid Cooling
- -30°C Cooling
- Leak-proof, quick-disconnect ports

Advanced Triggering Capabilities

Effective Global Shutter
Up to four selectable expose-out lines

TELEDYNE IMAGING
Everywhereyoulook™

Real-Time Application Optimization



With the near-perfect sensitivity of Backside Illuminated Scientific CMOS 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.

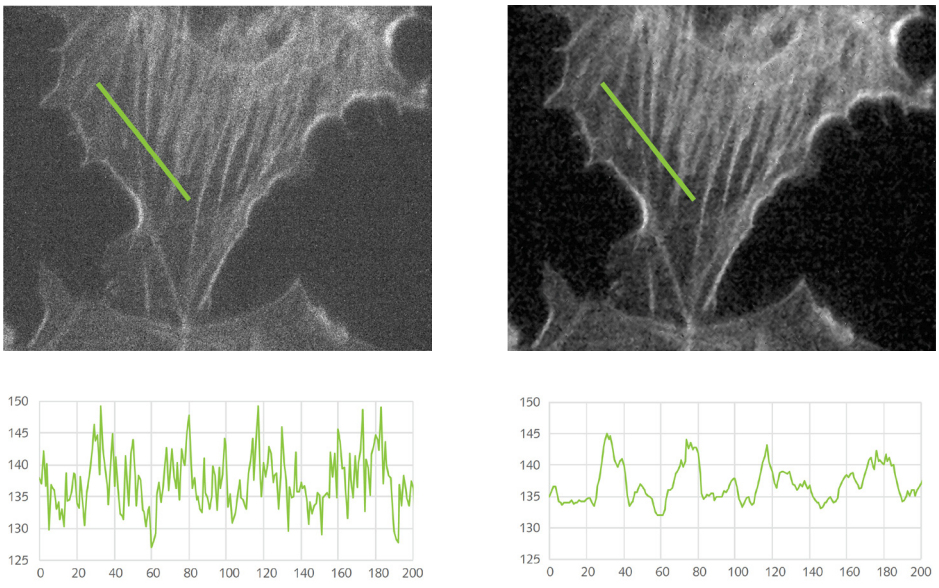
PrimeEnhance uses a quantitative SNR enhancement algorithm used in Life Science imaging to reduce the impact of photon shot-noise present in acquired images, leading to an increase in Signal to Noise Ratio (SNR) by 3x to 5x with equivalent exposure times.

With PrimeEnhance, the exposure times can be reduced by a factor of 8-10x while maintaining the Signal to Noise ratio. This reduces the effects of cellular photo-damage and extends 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.



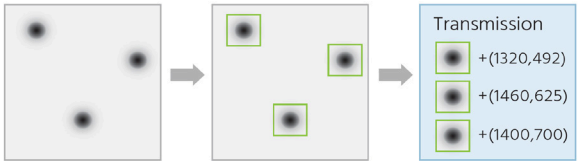
Real-Time Application Optimization

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 computer to be analyzed, creating a large amount of 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.

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

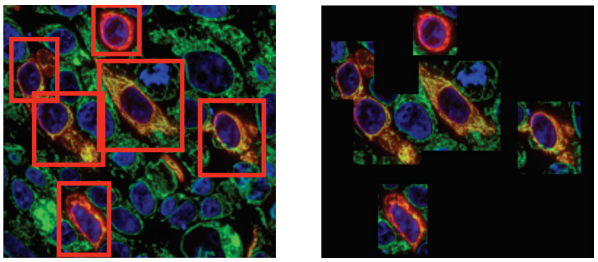


- Only the data within the patches is transferred to the host computer
- Processing time and storage requirements are easier to manage with the acquisition of only relevant data
- Ability to transfer 500 regions per frame
- Allows freedom to select preferred super-resolution localization algorithm

Multi-ROI

The surplus of data generated by sCMOS devices 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

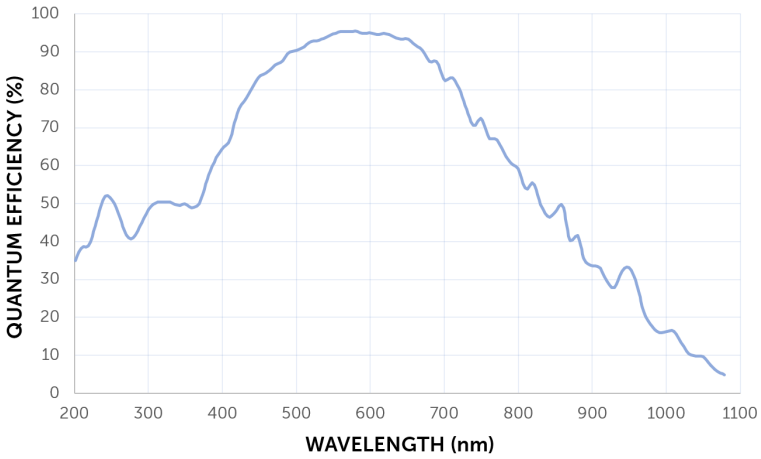
Specifications		Camera Performance
Sensor		Gpixel GSENSE2020BSI Scientific CMOS Sensor
Active Array Size		2048 x 2048 (4.2 Megapixel)
Pixel Area		6.5µm x 6.5µm (42.25µm²)
Sensor Area		13.3mm x13.3mm 18.8mm diagonal
Peak QE%		>95%
Read Noise:	Correlated Multi-Sampling (CMS)	1.0e⁻ (Median) 1.1e⁻ (RMS)
	Combined/High Gain	1.6e⁻ (Median) 1.8e⁻ (RMS)
Full-Well Capacity		45,000e⁻ (Combined Gain) 10,000e⁻ (High Gain) 1,000e⁻ (CMS)
Dynamic Range		25,000:1 (Combined Gain)
Bit Depth		16-bit (Combined Gain) 12-bit (CMS) 11-bit (High Gain)
Readout Mode		Rolling Shutter Effective Global Shutter Programmable Scan Mode (PCI-E only)
Binning		2x2 (on FPGA)
Linearity		>99.5%

Cooling Performance	Sensor Temperature	Dark Current
Air Cooled	-20ºC @ 30ºC Ambient	0.5e⁻/pixel/second
Liquid Cooled	-30ºC @ 30ºC Ambient	0.12e⁻/pixel/second

Specification	Camera Interface
Digital Interface	PCIe, USB 3.0
Lens Interface	C-Mount
Mounting Points	2x 1/4"-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	Any Row: Expose signal is high while any rows acquiring data Rolling Shutter: Effective Global Shutter - Expose signal is high when all rows are acquiring data Signal is High for set Exposure time - Readout Time First Row: Expose signal is high while first row is acquiring data. Line Output: Expose signal provides rising edge for each row advanced by the rolling shutter readout
Output Trigger Signals	Expose Out (up to four signals), Read Out, Trigger Ready

Programmable Scan Mode	Function
Scan Modes	Auto: Normal camera operation Line Delay: Control rolling shutter propagation rate by adding delays to the line time Scan Width: Control number of rows between reset and readout signal in the rolling shutter
Scan Direction	Down: Rolling shutter readout begins at the top of the sensor Up: Rolling shutter readout begins at the bottom of the sensor Down/Up Alternate: Rolling shutter readout alternates direction after starting at the top of the sensor



Accessories (Included)

USB 3.0 Cable

Trigger Cable

Power Supply

Quickstart Guide

Frame Rate

	PCI-Express		USB 3.0	
Array Size	16-bit / 12-bit	11-bit	16-bit / 12-bit	11-bit
2048 x 2048	43	63	43	63
2048 x 1024	87	125	87	125
2048 x 512	173	250	173	250
2048 x 256	346	497	346	497
2048 x 128	687	979	687	979

Accessories (Additional)

PCIe Card/Cable

Liquid Circular

Liquid Cooling Tubes

Distance from C-mount to sensor