

A NEW STANDARD FOR LOW LIGHT IMAGING

THE INNOVATIVE EM N2
COMPLETELY REINVENTS THE
ELECTRONICS BEHIND THE
EMCCD DETECTOR



- › Powerful liquid nitrogen cooling, stabilized down to $-110 \pm 0.01 \text{ }^\circ\text{C}$, for all EMCCD operation requirements
- › Outstanding SNR thanks to:
 - + Patented electronics decreasing inherent EMCCD camera noise for true photon counting
 - + Lowest background signal and highest electron-multiplying gain, up to 5,000, in inverted mode of operation (IMO) for optimal results for ultra low-light imaging
- › Ultimate sensitivity enabling highly efficient low-flux imaging, hence faster acquisitions, with frame rates exceeding 63 fps in full frame at 20 MHz readout rate
- › Superior image quality thanks to greater charge transfer efficiency
- › Flexible architecture for the development of next generation low light imaging instruments²
- › No noise-filtering algorithms: the amount of noise generated is simply lower, eliminating the risk of removing genuine photoelectrons

Lowest background signal for superior SNR

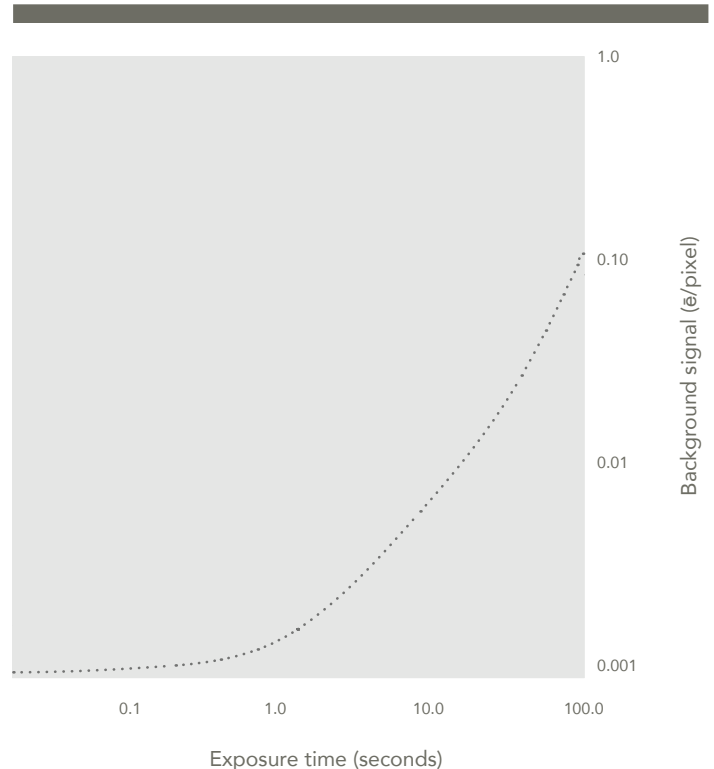


Figure 1 EM N2 512 dark frame mean signal as a function of exposure time.
Data measured at 10 MHz with an EM gain of 1,000 at -85°C .

PERFORMANCE AND FLEXIBILITY FOR UNIQUE APPLICATIONS

With the EM N2, Nüvü Cameras offers a state-of-the-art liquid nitrogen cooled EMCCD camera. The technology at the heart of the EM N2 was originally designed for astronomy, where the need for cutting edge instruments drives innovation. Now optimized for accessibility and flexibility, the user-friendly EM N2 provides many advantages to bridge the gaps between purchase, setup, discoveries, and publications.

- › Capacity to access the controller for ultimate control of the EMCCD detector with CCCPSuite software bundle³
- › Possibility of changing the EMCCD sensor to standard or custom detector

Consultation services are available on demand.

Characteristics	Specifications
Digitization	16 bits
Electron-multiplying gain	1 – 5,000
Cooling temperature	Down to -110°C, stabilized
LN2 reservoir capacity	1 L
Quantum efficiency	> 90% at 600 nm (see Figure 3)
EM register pixel well depth ⁴	800 ke
Spectral range	250 – 1,100 nm
Triggering	Internal or external Selectable signal polarity
Exposing time step	25 ns
Exposing time range ⁵	4 ns – days

Table 1 EM N2 general characteristics and specifications

Features	Benefits
EM gain range of 1 – 5,000	› Lowest effective readout noise › Unmatched single photon detection capabilities
Lowest clock-induced charges levels (CIC)	› Highest SNR as a result of lowering the CIC, the dominant noise source of EMCCDs
Patented technology optimized for true photon counting	› Linear and photon counting modes are available in EM operation
Highest horizontal charge transfer efficiency	› Clearer images › No pixel leaking
Ultimate cooling performance	› Negligible dark noise › Superior charge transfer efficiency
Highest quantum efficiency	› Best sensitivity available thanks to back-illuminated grade 1 EMCCD (see Figure 3)
Selectable output	› Fast and easy switching between conventional CCD and EMCCD operations
Time stamping	› High-precision time-labelling of every acquisition › GPS input for absolute time tagging (optional)
mROI	› Select multiple customizable regions of interest on the detector to increase acquisition rates
Cropped-sensor mode	› Faster acquisition rates for a region of interest by masking part of the EMCCD detector ⁶ › Greater acquisition versatility using customizable size and position for the cropped region of interest

Table 2 EM N2 features and benefits

Photon counting performances comparison

- Best performance of other EMCCD cameras

(Other manufacturers do not specify the mode of operation – IMO or NIMO – used to measure one specific characteristic. These are two mutually exclusive EMCCD operation modes whose benefits cannot be combined.)

- EM N2 512 (All Nüvü Cameras specifications measured in IMO)

At least 15% more genuine photons counted

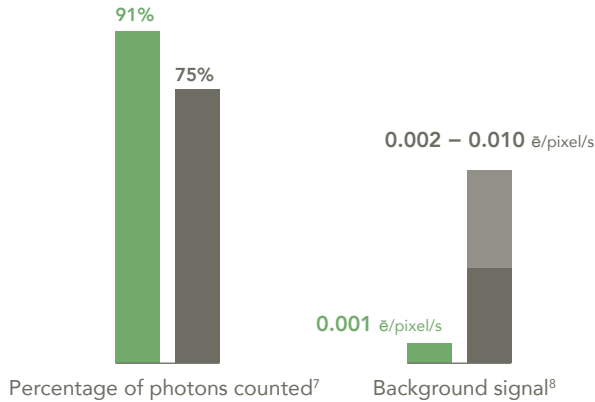


Figure 2 EM N2 512 benefits for photon counting

FASTER FRAME RATES FOR SENSITIVE IMAGING

Available readout rates through the EM channel are 1 MHz, 5 MHz, 10 MHz, and 20 MHz. The conventional channel provides readout rates of 0.1 MHz, 1 MHz, and 3 MHz.

Binning ⁹	Region of interest				
	512 × 512	256 × 256	128 × 128	64 × 64	32 × 32
1 × 1	63	124	240	448	789
1 × 2	123	237	443	783	1,267
1 × 4	233	436	770	1,250	1,814
1 × 8	421	747	1,216	1,776	2,304
1 × 16	704	1,159	1,703	1,820	2,110
1 × 32	1,051	1,574	2,096	2,512	2,785
Cropped-sensor mode	234	687	1,483	2,188	

Table 3 EM N2 512 frame rates for different binning values and regions of interest

Frame rates are measured at 20 MHz in EM mode. Other readout speeds and frame rates are also available, as are different EMCCD sizes.

WHEN EVERY PHOTON COUNTS

The EMCCD technology is perfectly suited for low-light applications requiring minimal background noise due to its negligible effective read-out noise enabled through high EM gain. In linear mode of operation, the EM gain cannot be precisely determined on a per-pixel basis because of its stochastic nature. It however generates an excess noise factor (ENF) that, for high EM gains, leads to a degraded SNR. In fact, it affects the SNR the same way halving the quantum efficiency would. With photon counting (PC) mode of operation, Nüvü Cameras efficiently suppresses the ENF, thus allowing single photon sensitivity.

Nüvü™’s ultra-sensitive cameras successfully operate in PC mode thanks to their high EM gains and minimal background noise. Although attaining large EM gains is simple, the electron-multiplying process entails more clock-induced charges (CIC), a dominant EMCCD noise source. The innovative electronics driving HNü cameras virtually eliminates CIC and lowers the total background signal while providing the highest gain on the market. The results: better data in low lighting conditions.

Typical characteristics ¹⁰	EM N2 512
Maximum available EM gain (linear or PC mode):	5,000
Readout noise through:	
EM channel with electron multiplication	< 0.1e ⁻ @ 20 MHz
Conventional channel	3e ⁻ @ 100 kHz
Vertical clock speed	EM 0.3 – 5µs Conv 0.3 – 5µs
Dark current ¹¹ (All operating modes)	0.000 2 e ⁻ /pixel/s
Clock-induced charges ⁸	0.001 e ⁻ /pixel/frame
Charge transfer efficiency ¹²	> 0.999 993
Single photon detection probability (EM gain = 5,000)	> 91%
Imaging area	512 × 512 pixels 16µm × 16µm pixel area 8.19 mm × 8.19 mm effective area

Table 4 EM N2 512 specific characteristics

QUALITY PRIORITY

All parts are treated in compliance with high vacuum requirements, including all metal sealed in a Class 10,000 cleanroom to ensure the longest vacuum lifetime without maintenance.

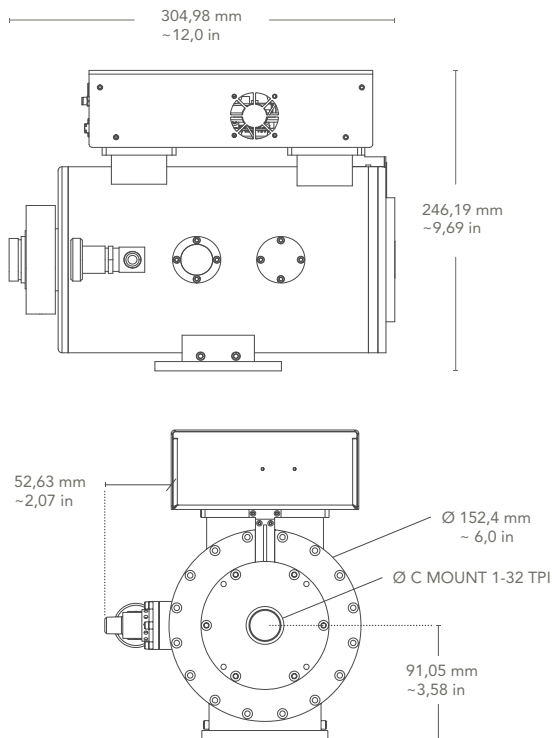
Computer requirements:

- › Communication interface:
PCIe Camera Link (min. 4X)
standard or GigE Vision
(Gigabit Ethernet) optional
- › Operating system:
Windows (XP, 7 & 10), Linux
- › Minimum hard disk space: 100 MB
- › Recommended processor: 2.0 GHz
- › Recommended memory: 4 GB

Camera environment:

- › Operating temperature:
0°C to 30°C
- › Humidity:
< 90% (non-condensing)
- › Power Input:
100 – 240V, 50 – 60Hz,
max. 3A

Technical drawings



Typical quantum efficiency

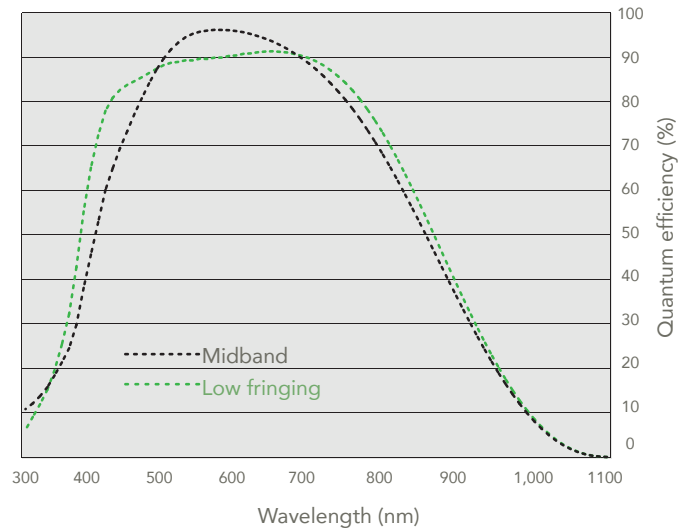


Figure 3 Typical spectral response as a function of wavelength, as measured by the EMCCD detector manufacturer

More information

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EM N2 512 Specification Sheet (XII)
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1 Nüvü Caméras recommends keeping the selectable stabilized detector temperature at -95 °C. Below such temperature, CTE degrades while dark current improvements decrease slowly; however, some very specific applications may require to reach lower temperatures.
2 Nüvü Caméras does not manufacture EMCCD detectors, but offers consultation services to help with the integration of another

third-party detector. For even greater adaptability, consultation services are available to access the EMCCD controller, although this voids the product warranty.
3 Controller access is available for purchase. Contact us for more information.
4 As per the EMCCD detector manufacturer's datasheet. Other configurations may exist.
5 Minimum 25 ns exposure time available

in controlled illumination conditions due to pixels clearing prior to readout.
6 Optical mask not included.
7 Detected events with signal 5 times greater than readout noise in photon counting mode. Measured data.
8 Expected signal level at an EM gain of 1,000 at -85°C and maximum frame rate in continuous exposure at 10 MHz.

9 Horizontal binning does not influence maximum acquisition rates in EM mode at 10 and 20 MHz pixel rates.
10 These numbers may slightly vary depending on the EMCCD detector.
11 Dark current measured at -85°C.
12 Mean horizontal charge transfer efficiency measured with an EM gain of 1,000 at -85°C and 10 MHz readout rate.