every photon counts

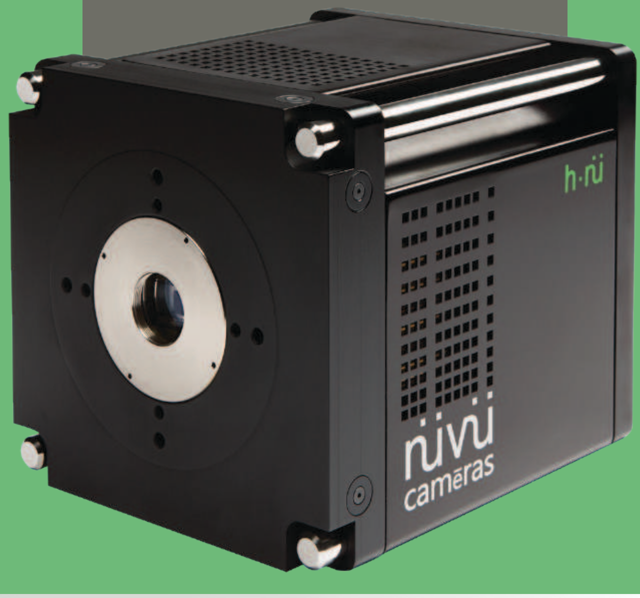
h·nü 512

BUILT FOR PERFORMANCE

INDUSTRY-LEADING LOW-LIGHT SNR, BALANCING SPEED AND FIELD OF VIEW

RETHINK EMCCD

A NEW STANDARD FOR LOW LIGHT IMAGING



OUTSTANDING SNR THANKS TO

Patented electronics eliminating inherent EMCCD camera noise for true photon counting imaging

Lowest background signal and highest electron-multiplying (EM) gain, up to 5000, in inverted mode of operation (IMO) for optimal results in ultra low-light conditions

Optimal on-chip thermoelectric cooling for minimal background signal and stabilized EM gain

Made for applications requiring the ultimate sensitivity for the fields of Space and Defense, Life Science, Physics, Industrial and more

ULTIMATE SENSITIVITY enabling highly efficient low-flux imaging, hence faster acquisitions, with frame rates exceeding 90 fps in full frame at 30 MHz readout rate

SUPERIOR IMAGE QUALITY thanks to greater charge transfer efficiency

NO NOISE-FILTERING ALGORITHMS the amount of noise generated is simply lower, eliminating the risk of removing genuine photoelectrons

PHOTON COUNTING PERFORMANCES COMPARISON

- HNü 512 (All specifications measured in IMO)
- Best achievable performance with 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.)

At least 15% more genuine photons counted

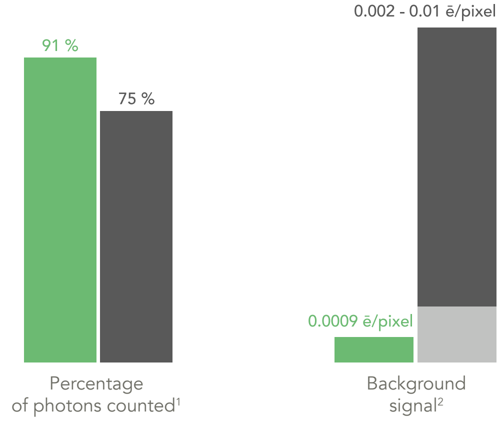


Figure 1
HNü 512 benefits for Photon Counting imaging

SIMPLE INTEGRATION INTO A WIDE VARIETY OF SOFTWARE SYSTEMS

Nüvü Camēras offers the highest standard of EMCCD technology in a compact thermoelectrically cooled camera. The technology at the heart of the HNü was originally designed for space exploration, where the need for state-of-the-art instruments drives innovation. Now optimized and extended to a broad range of applications, the user-friendly HNü provides many advantages to efficiently bridge the gaps between purchase, setup, discoveries, and publications.

- NüPixel control, acquisition and analysis software
- Software development kit (SDK) for customizable programming
- Windows & Linux Compatibility
- Various drivers available for commercial software
- Worldwide professional customer support

Consultation services are available on demand.

h·nü 512

CHARACTERISTICS	SPECIFICATIONS
Digitization	16 bits (HNü$^{\alpha}$ & HNü$^{\gamma}$) 14 bits (HNü$^{\Omega}$)
Electron-multiplying gain	1 - 5000
On-chip temperature stabilization	± 0,01°C
Minimum cooling T° via air cooling[3]	-85°C (HNü$^{\alpha}$) -60°C (HNü$^{\gamma}$ & HNü$^{\Omega}$)
Minimum cooling T° via liquid cooling[3]	-90°C HNü$^{\alpha}$) -70°C (HNü$^{\gamma}$ & HNü$^{\Omega}$)
Quantum efficiency	> 90% at 600 nm (see Fig. 2)
EM register pixel well depth[4]	800 kē
Spectral range	250 - 1100 nm
Triggering	Internal or external Selectable signal polarity
Timestamp resolution	4 ns
Readout noise through	EM < 0.1ē @ 20 MHz Conv 3ē @ 100 kHz
Vertical clock speed[5]	EM 0.33 - 0.5 µs Conv 0.3 – 5 µs
Charge transfer efficiency[6]	> 0.999993
Single photon detection probability at 10 MHz (EM gain = 5000)	> 91%
Imaging area	512 × 512 pixels 16 µm × 16 µm pixel area 8.19 mm × 8.19 mm effective area

Table 1 HNü 512 general characteristics and specifications

FEATURES	BENEFITS
EM gain range of 1 – 5000	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 detector (see Fig. 2)[7]
Pixel readout rate up to 30 MHz	Fastest acquisition speed for a 512 x 512 EMCCD camera
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[8] Greater acquisition versatility using customizable size and position for the cropped region of interest
Low latency	Low latency for adaptive optics applications
External trigger modes	Multiple modes available to optimize versatility on frame rate

Table 2 HNü 512 features and benefits

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 Camēras 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.

MODELS

SPECIFICATIONS	h·nü α ALPHA	h·nü γ GAMMA	h·nü Ω OMEGA
Max frame rate[3] (Frames per second)	63	63	90
Readout rates through EM channel (MHz)	10,20	10,20	30
Readout rates through conventional channel (MHz)	0.1,1,3	0.1,1,3	-
Typical clock-induced charges[9] (Electron/pixel/frame)	0.0009	0.0009	0.002
Dark current[10,11] (Electron/pixel/sec)	0.0001	0.0015	0.0015

Table 3 HNü 512 specifications for different models

FASTER FRAME RATES FOR SENSITIVE IMAGING

Crop mode included for applications requiring higher readout rates.
Other readout speeds and frame rates are also available, as are different EMCCD detector sizes.

MODELS	**REGION OF INTEREST[12]**						
	512 × 512	512 x 256	512 x 128	512 x 64	512 x 32	512 x 16	512 x 8
HNü 512 Alpha & Gamma	63	125	242	454	809	1329	1956
HNü 512 Omega	90	176	337	620	1068	1673	2333

Table 4 HNü 512 frame rates at maximum readout rate

Features

FOR FASTER ACQUISITION:

› Crop Mode
› Fast Kinetics Mode
› Time-Delay Integration (TDI) Mode
› Multiple Regions of Interest (mROI) and ROI

FOR MORE VERSATILITY:

› UV solutions
› Liquid chiller accessory
› Vacuum compatible cooling
› GPS time-stamping

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 best cooling performances without maintenance. Nüvü Camēras uses at least λ/10 quality windows, essential for optimal image quality.

COMPUTER REQUIREMENTS:

› Communication interface: PCIe Camera Link (min. x1) or GigE Vision (Gigabit Ethernet)

› Operating system: Windows and Linux (Ubuntu)

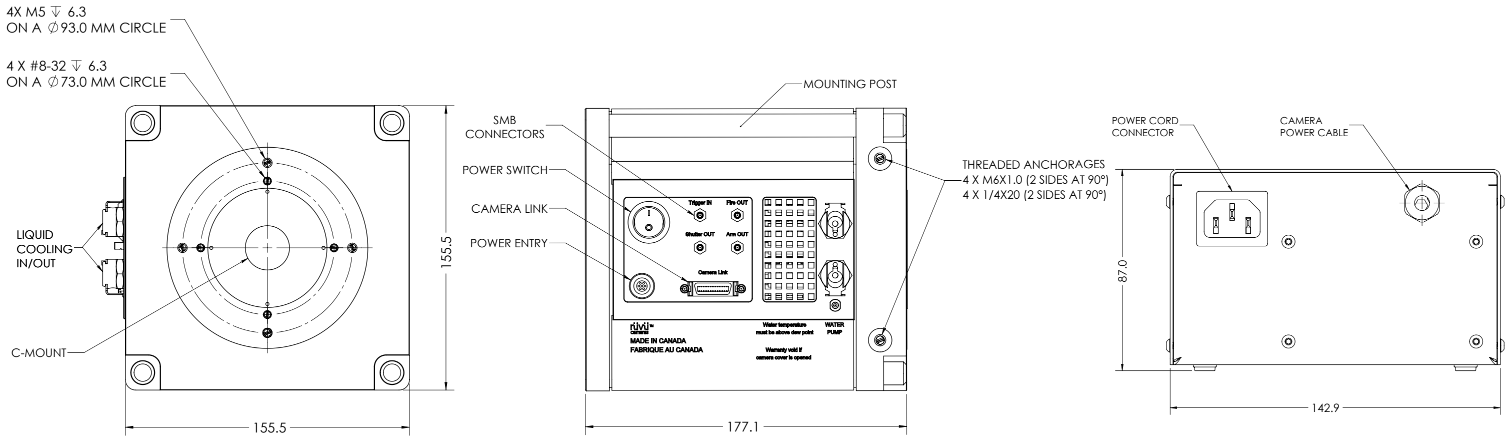
CAMERA ENVIRONMENT:

› Operating temperature: 0°C to 30°C

› Humidity: < 90 % (non-condensing)

› Power Input: 100 – 240 V, 50 – 60 Hz, max. 3 A

TECHNICAL DRAWINGS



1 Detected events with signal 5 times greater than readout noise in photon counting mode. Measured data.

2 Expected signal level at an EM gain of 1000 at minimum cooling temperature via air cooling and maximum frame rate in continuous exposure at 10 MHz.

3 At maximum horizontal speed, full frame readout.

4 As per the EMCCD detector manufacturer's datasheet. Other configurations may exist.

5 More clock speeds available upon request.

6 Mean horizontal charge transfer efficiency measured with an EM gain of 1000 at -85°C and 10 MHz readout rate.

7 Nüvü gives only the specifications of the EMCCD detector's manufacturer for grade 1 sensors (e.g. Quantum efficiency, aesthetic specifications, blemishes).

8 Optical mask not included.

9 Typical signal level at an EM gain of 1000 at maximum frame rate in continuous exposure at 10 MHz, -85 °C (HNü$^{\alpha}$), 10 MHz, -60°C (HNü$^{\gamma}$) or 30 MHz, -60°C (HNü$^{\Omega}$).

10 Below -85°C, charge transfer efficiency degrades while improvement on the dark current decreases slowly.

11 Typical values measured with liquid cooling. These numbers may vary depending on the EMCCD detector.

12 ROI configurations are chosen for optimal frame rates.

TYPICAL QUANTUM EFFICIENCY

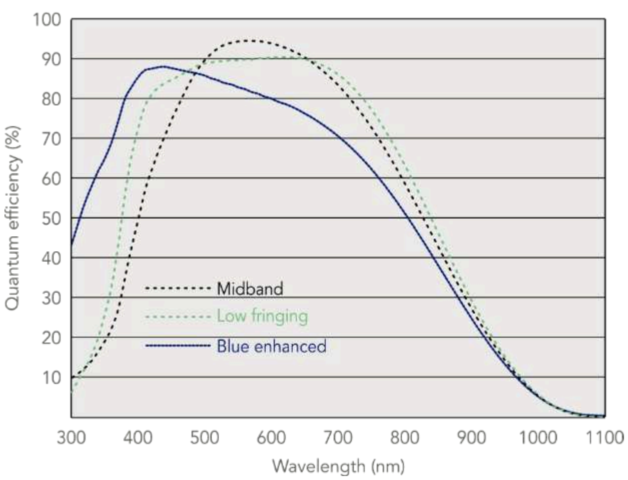


Figure 2

Typical spectral response as a function of wavelength, as specified by the EMCCD detector manufacturer

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HNü 512 Specification Sheet 3.4.6