



# RETHINK EMCCD

## A NEW STANDARD FOR LOW LIGHT IMAGING

### OUTSTANDING SNR THANKS TO

Patented electronics decreasing inherent EMCCD camera noise for true photon counting

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

Sealed body with fully liquid cooling to prevent unwanted airflow while eliminating thermal gradients

Run at higher frame rates to outpace the changing atmosphere with a resolution critical to focal plane wavefront sensing

**FASTER ACQUISITIONS**, thanks to frame rates up to 3015 fps in full frame and 35.5  $\mu$ s first pixel latency at 30 MHz readout rate with **ULTIMATE SENSITIVITY** enabling highly efficient low-flux imaging

**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

### PERFORMANCE COMPARISON

- HNü 240 (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.)

3x less noise and nearly 50% faster

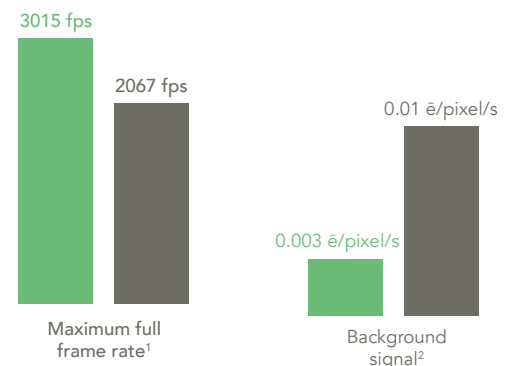


Figure 1

HNü 240 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 240

CHARACTERISTICS	SPECIFICATIONS
Sensor	CCD220
Digitization	14 bits
Electron-multiplying gain	1 - 5000
Readout rate	30 MHz
Frame rate	Up to 3015 fps full frame
First pixel latency <sup>3</sup>	35.5 $\mu$ s
Outputs	8
Effective readout noise <sup>2</sup>	< 0.2 e with EM gain
Cooling temperature <sup>1</sup>	-45°C
Background signal <sup>2</sup>	< 0.003 e/pixel/frame at EM gain 1000
Charge transfer efficiency <sup>4</sup>	> 0.99997
Linearity	< 1%
Triggering	Internal or External
Imaging area	240 x 240 pixels 24 $\mu$ m x 24 $\mu$ m pixel area
Quantum efficiency	> 95% at 650 nm (see Fig. 2)
Spectral range	250 - 1100 nm

Table 1 HNü 240 general characteristics and specifications

### FEATURES

EM gain range of 1 – 5000

Lowest clock-induced charges levels (CIC)

Patented technology optimized for true photon counting

Highest horizontal charge transfer efficiency

Ultimate cooling performance

Fully liquid cooling

Highest quantum efficiency

Pixel readout rate up to 30 MHz

Time stamping

Low latency

External trigger modes

### BENEFITS

Lowest effective readout noise  
Unmatched single photon detection capabilities

Highest SNR as a result of lowering the CIC, the dominant noise source of EMCCDs

Linear and photon counting modes are available in EM operation

Clearer images  
No pixel leaking

Negligible dark noise  
Superior charge transfer efficiency

Sealed body prevents unwanted airflow and eliminates thermal gradients

Best sensitivity available thanks to back-illuminated grade 1 EMCCD detector (Fig. 2)<sup>5</sup>

Fastest acquisition speed for a 240 x 240 EMCCD camera

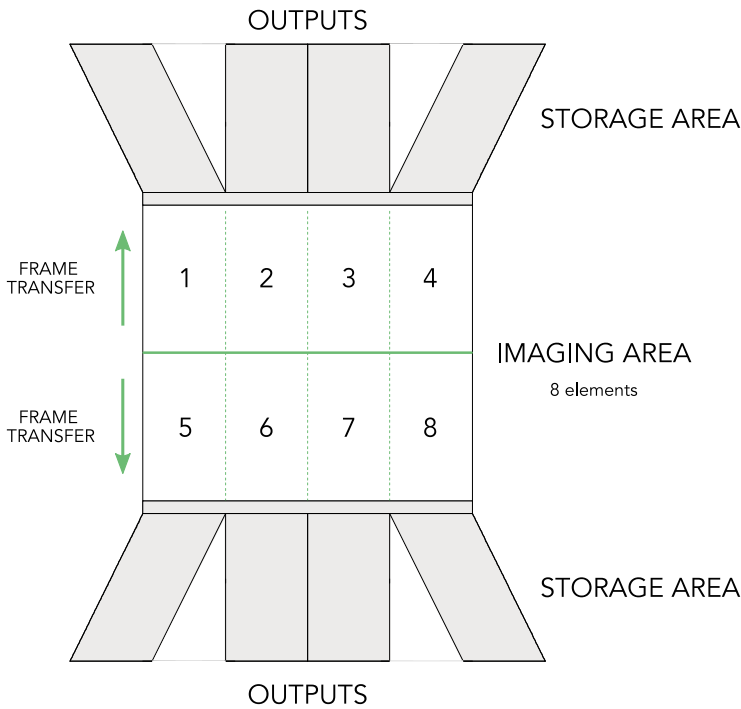
High-precision time-labelling of every acquisition

Low latency for adaptive optics applications

Multiple modes available to optimize versatility or frame rate

Table 2 HNü 240 features and benefits

## MULTIPLE OUTPUTS FOR FAST ACQUISITION



While standard EMCCDs read pixels through a single output, the HNü 240's sensor divides into 8 sections and uses a corresponding number of outputs for simultaneous readout. This allows the HNü 240 to reach unmatched frame rates, even with higher resolution.

Table 3 HNü 240 model specifications

## 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.

## 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.

BINNING	REGION OF INTEREST <sup>6</sup>				
	240 x 240	240 x 60	240 x 30	240 x 15	240 x 7
1 x 1	3058	5526	9265	13999	19243
1 x 2	5255	8828	13374	18439	22744
1 x 4	8246	12536	17351	21474	24371

Table 4 HNü 240 frame rates with different acquisition configurations.

## Features

FOR FLEXIBLE ACQUISITION:

- › Liquid chiller accessory
- › Vacuum compatible cooling
- › Region of interest (ROI)
- › Binning

# QUALITY PRIORITY

All parts are treated in compliance with the highest requirements and assembled in a Class 10,000 cleanroom to ensure the longest lifetime without maintenance. All our cameras come with a standard year warranty.

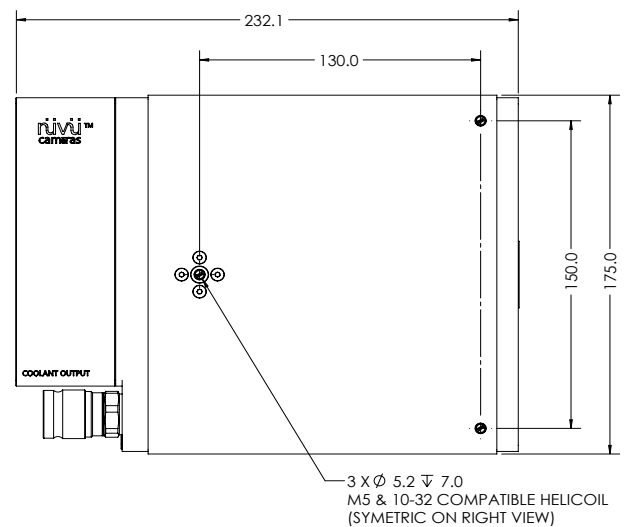
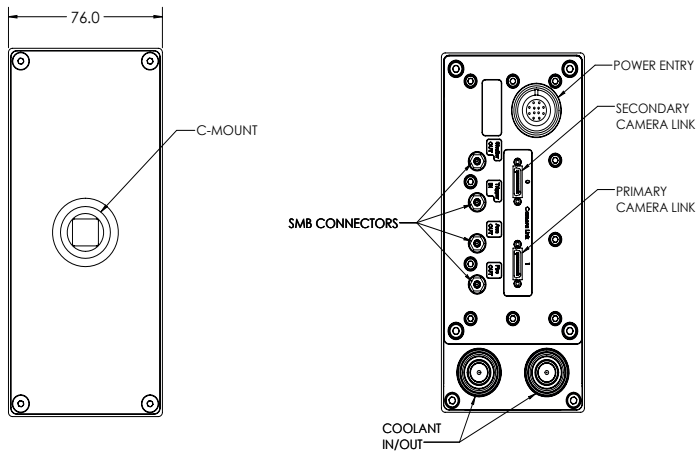
## COMPUTER REQUIREMENTS:

- › Communication interface: PCIe Camera Link Extended Full
- › Operating system: Windows (10) and Linux (CentOS & Ubuntu)

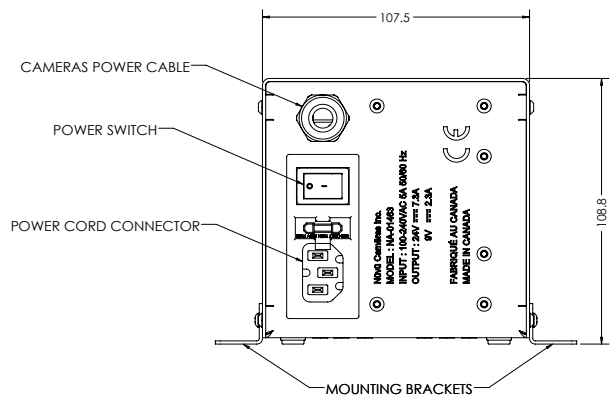
## CAMERA ENVIRONMENT:

- › 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 At maximum horizontal speed, full frame readout.
- 2 Data measured at 30 MHz, 3015 fps.
- 3 From end of exposure trigger. Lower latency available with windowing.
- 4 Mean horizontal charge transfer efficiency measured with an EM gain of 1000 at 10 MHz readout rate.
- 5 Nüvü gives only the specifications of the EMCCD detector's manufacturer for grade 1 sensors (e.g. Quantum efficiency, aesthetic specifications, blemishes).
- 6 ROI configurations are chosen for optimal frame rates.



## TYPICAL QUANTUM EFFICIENCY

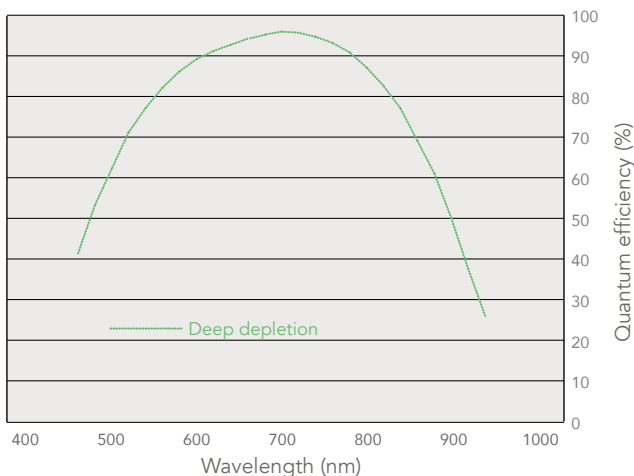


Fig 2. Typical spectral response as a function of wavelength, as specified by the detector manufacturer

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 HNü 240 Specification Sheet 3.4.5  
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