# A NEW STANDARD FOR LOW LIGHT IMAGING

## THE INNOVATIVE HNü COMPLETELY REINVENTS THE ELECTRONICS BEHIND THE EMCCD DETECTOR


- Thermoelectric cooling down to -85°C ±0.01°C by air cooling or -90°C ±0.01°C by liquid cooling, on-chip stabilized for lowest dark current while performing full frame acquisition at 20MHz readout rate
- Highest SNR for ultra low light imaging with the lowest background signal and highest electron multiplying gain (1 - 5000)
- Frame rates exceeding 67 fps in full frame at highest readout rate
- Best detection performances thanks to grade 1 scientific EMCCD detectors
- Optimal sensitivity[1] allowing highly efficient low flux imaging, hence faster acquisitions
- Superior image quality based on greater charge transfer efficiency
- No noise-filtering algorithms: the amount of noise generated is simply lower, eliminating the risk of removing genuine photoelectrons

**Superior SNR resulting from the lowest background signal**

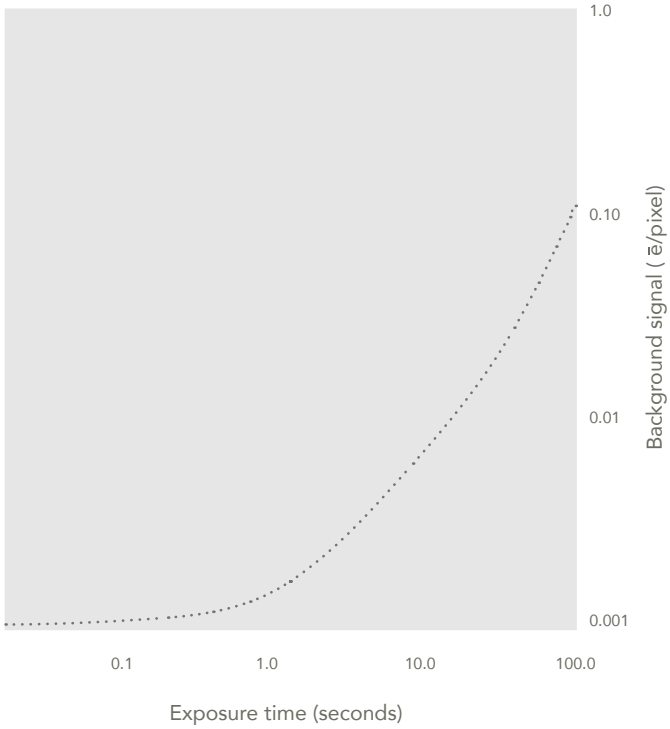



**Figure 1** Mean signal of HNü 512 dark frames as a function of exposure time
Data measured at 10MHz with an EM gain of 1000 at -85°C

# SIMPLE INTEGRATION INTO A WIDE VARIETY OF OPTICAL SYSTEMS

Nüvü Camēras now offers the new standard of EMCCD technology in a compact thermoelectrically cooled camera. The technology at the heart of HNü was originally designed for astronomy, where the need for state of the art instrumentation drives innovation. Now optimized and extended to a broad range of applications, the user-friendly HNü offers 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
› Various drivers available for commercial software
› Standard mounting features on camera
› Worldwide professional customer support

Also, consultation services are available on demand.

| Characteristics | Specifications |
|---|---|
| Digitization | 16 bits |
| Electron multiplying gain | 1 – 5000 |
| Selectable stabilized cooling temperature (at pixel readout rate of 20 MHz) | Down to -90 °C via liquid cooling<br>Down to -85 °C via air cooling |
| Quantum efficiency | > 90 % at 600nm (see Figure 3) |
| EM register pixel well depth[2] | 800 kē |
| Spectral range | 250 – 1100 nm |
| Triggering | Internal or external<br>Selectable signal polarity |
| Exposing time step | 4 ns |
| Exposing time range[3] | 4 ns – days |
| Frame rates | > 67 fps in full frame (at 20MHz) |
| Lens mount | C-mount |

**Table 1** HNü general characteristics and specifications

| Features | Benefits |
|---|---|
| EM gain range of 1 - 5000 | › Lowest effective readout noise<br>› Maximum single photon detection |
| Lowest clock-induced charges (CIC) | › Minimal CIC, the dominant source of noise in EMCCDs<br>› Highest SNR |
| CCCP: CCD Controller for Counting Photons | › Patented technology optimized for true photon counting<br>› Linear and Photon Counting modes are available in EM operation |
| High performance cooling | › Minimum dark noise<br>› High charge transfer efficiency |
| Highest horizontal charge transfer efficiency | › Clearer images<br>› No deformation due to pixel leaking |
| Inverted mode operation (IMO) | › Lowest dark current across all readout modes<br>› All Nüvü Camēras specifications are provided in IMO, a mode of operation optimized for low light imaging |
| Back-illuminated EMCCD | › Highest QE (see Figure 3)<br>› Best sensitivity available<br>› Nüvü Camēras only integrates grade 1 scientific detectors |
| Selectable output | › Fast and easy switching between conventional CCD and EMCCD and between linear mode and photon counting mode |
| C-mount with shutter | › Simple integration with most optical systems<br>› Built-in shutter for acquisition of dark frames and detector longevity<br>› Standard mounting holes on face plate with imperial and metric holes for easy attachment |

**Table 2** HNü features and benefits

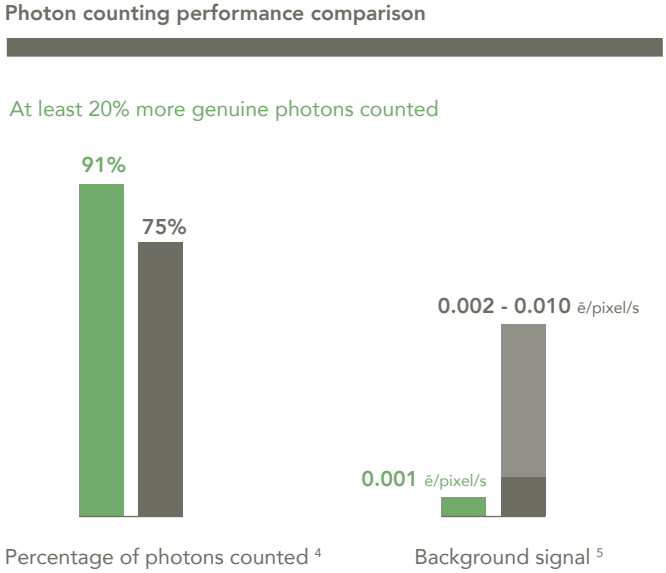



**Figure 2** HNü 512 benefits in photon counting

# FASTER FRAME RATES FOR SENSITIVE IMAGING

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

| Binning[6] | Region of interest | | | | |
|---|---|---|---|---|---|
| | 512 × 512 | 256 × 256 | 128 × 128 | 64 × 64 | 32 × 32 |
| 1 × 1 | 67 | 130 | 241 | 427 | 735 |
| 1 × 2 | 131 | 244 | 428 | 725 | 1135 |
| 1 × 4 | 245 | 432 | 710 | 1115 | 1555 |
| 1 × 8 | 434 | 704 | 1070 | 1510 | 1900 |
| 1 × 16 | 707 | 1029 | 1425 | 1820 | 2110 |
| 1 × 32 | 1031 | 1336 | 1675 | 1980 | 2170 |

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

**Table 3** HNü 512 frame rates for different binning values and regions of interest

# WHEN EVERY PHOTON COUNTS

The EMCCD is the perfect tool for applications requiring low readout noise in low lighting conditions. However, the electron multiplying (EM) gain that allows a significant reduction of the readout noise cannot be precisely determined on a per-pixel basis due to its stochastic nature. In turn, this generates an excess noise factor (ENF) that, for high EM gains, has the same effect on the signal-to-noise ratio as halving the system's quantum efficiency (QE). Nevertheless, operating the EMCCD in Photon Counting (PC) mode suppresses the ENF and allows for the detector to be used at its full efficiency.

With high gain and minimal background signal, Nüvü Camēras provides cameras sensitive enough to operate efficiently in PC mode. In fact, although the generation of a high EM gain is simple to achieve, such amplification entails more CIC, a significant noise source in EMCCD cameras. Nevertheless, the highly innovative electronics driving the HNü camera allow the highest gain on the market while producing the lowest CIC and total background signal.

| Typical characteristics[7] | | HNü 512 |
|---|---|---|
| Maximum available EM gain (linear or PC mode) : | | 5000 |
| Readout noise through:<br>EM channel with electron multiplication<br>Conventional channel | | <br>< 0.1ē @ 20MHz<br>3ē @ 100kHz |
| Vertical clock speed | EM<br>Conv | 0.3 - 5 µs<br>0.3 - 5 µs |
| Dark current[8] (All operating modes) | Maximum | 0.0002 ē/pixel/s<br>0.001 ē/pixel/s |
| Clock-induced charges[9] | | < 0.001 ē/pixel/frame |
| Charge transfer efficiency[10] | | > 0.999993 |
| Single photon detection probability (EM gain = 5000) | | > 91 % |
| Image area | | 512 × 512 pixels<br>16 µm × 16 µm pixel area<br>8.19 mm × 8.19 mm effective area |

**Table 4** HNü 512 specific characteristics

# QUALITY PRIORITY

All parts are treated in compliance with high vacuum requirements, including all metal sealed in a class 10 000 clean room to ensure the longest vacuum lifetime without maintenance. Nüvü Camēras uses at least λ/10 quality windows, which is essential for optimal image quality. In order to optimize window efficiency according to the application, NIR, VIS and VIS-NIR window transmission coatings are available.

Computer requirements :

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

Camera environment :

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

## Typical quantum efficiency

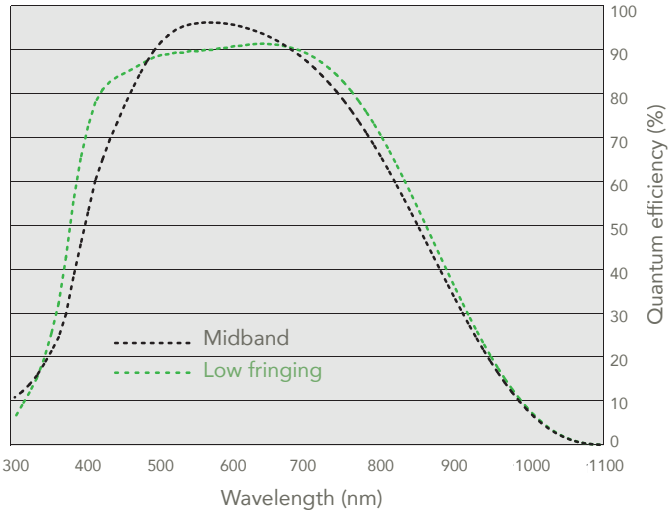
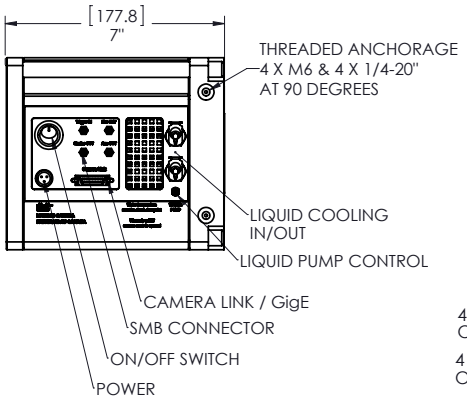
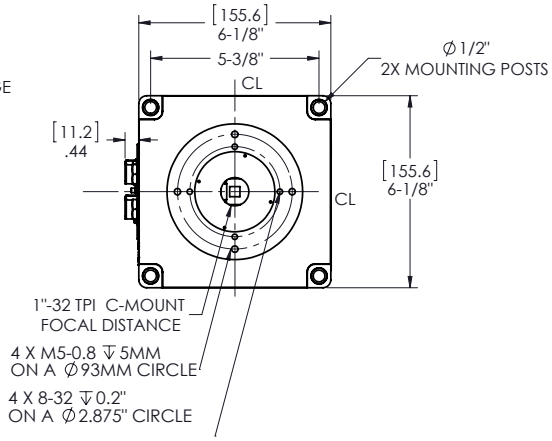


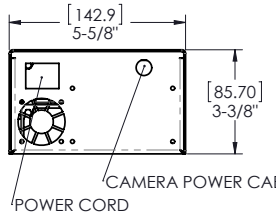

**Figure 3** Typical spectral response as a function of wavelength, as measured by the EMCCD detector manufacturer

## Technical drawings




POWER SUPPLY




Visit us at
www.nuvucameras.com

Contact us at
info@nuvucameras.com
+1 514 733 8666

5155 Decelles avenue
Pavillon JA Bombardier
Montreal (Quebec) H3T 2B1
CANADA



HNü 512 Specification Sheet (XIII)


**1** To provide superior SNR, Nüvü Camēras provides sufficiently low total background signal allowing high EM gain to be applied. Thus, HNü is capable of single photon imaging for optimal sensitivity.
**2** As per the EMCCD detector manufacturer's datasheet. Other configurations may exist.
**3** Minimum exposing time range of 4 ns is actually available when the illumination is controlled, because of the need to clear pixels prior to readout.
**4** Counted events with thresholding of 5 times the readout noise in photon counting mode. Data measured.
**5** Noise measured with an EM gain of 1000 at -85°C and 30 fps at 10 MHz.
**6** Horizontal binning does not influence maximum acquisition rates in EM mode.
**7** These numbers may slightly vary depending on the EMCCD detector.
**8** The dark current is measured at -85°C. The HNü can operate at -90°C stabilized, by liquid. Below -95°C the charge transfer efficiency degrades while improvement on dark current slows down.
**9** Background signal level expected with an EM gain of 1000 at -85°C, 10MHz readout rate and 0.5 µs vertical clock speed.
**10** Mean horizontal charge transfer efficiency measured with an EM gain of 1000 at -85°C and 10MHz readout rate.