

# EMVA 1288 Report Summary Cover Page

Package includes all associated EMVA Report Summaries valid for the following Phantom camera models

## Miro C211

Refer to the report corresponding with your camera configuration:

- Monochrome models: PDF pages 2-3
- Color models: PDF pages 4-7

Each report summary was generated by Vision Research in accordance with the EMVA 1288 3.1 standard.

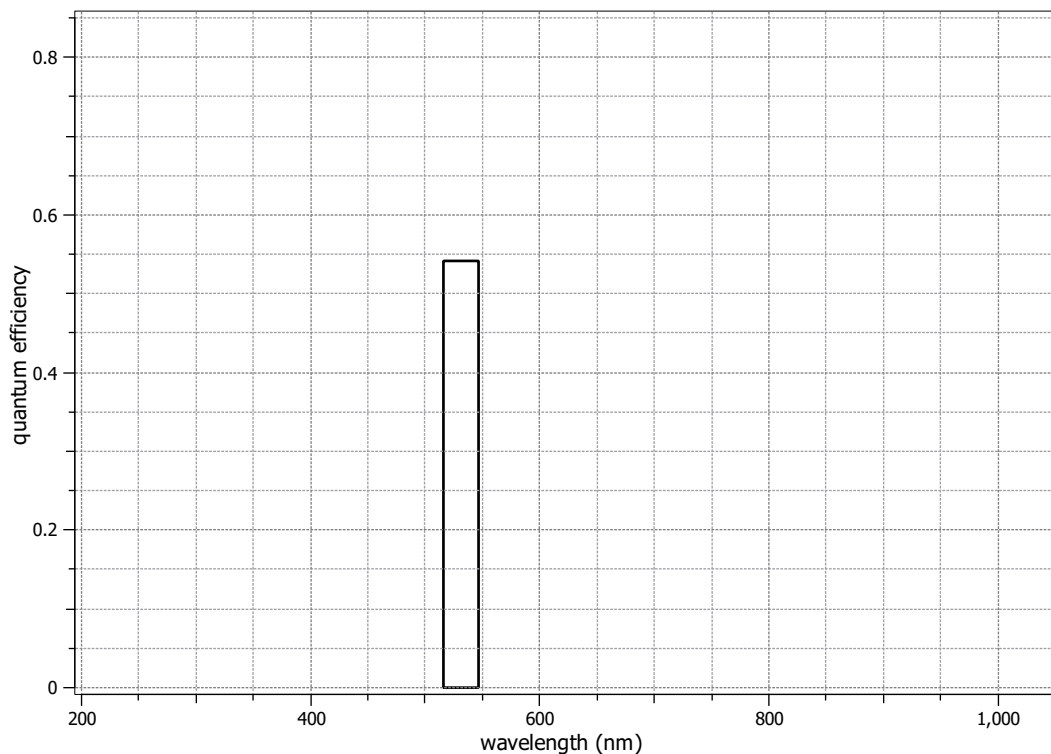
For more information on EMVA 1288 image measurements visit:  
[www.phantomhighspeed.com/emva](http://www.phantomhighspeed.com/emva)

## EMVA 1288 Data Sheet m0096

This datasheet describes the specification according to the standard 1288 release 3.1 for "Characterization and Presentation of Specification Data for Image Sensors and Cameras" issued on December 30, 2016 by the European Machine Vision Association (EMVA), published at [www.standard1288.org](http://www.standard1288.org) and the *zenodo EMVA 1288 community* with proprietary extensions from AEON. The measurements were performed with the AEON ACC2b RGB-IR, Release 9, 30.07.2018, SN 0032(AMETEK).

Measurements were performed by Vision Research. Measurements are on raw sensor data.

|                  |                             |                               |          |
|------------------|-----------------------------|-------------------------------|----------|
| Vendor           | Vision Research             | Type of data presented        | Single   |
| Model            | Phantom Miro C211           | <b>Operation point 1</b>      |          |
| Serial number    | 513                         | Wavelength centroid           | 531.5 nm |
| Sensor diagonal  | 9.18 mm                     | Wavelength FWHM               | 31.2 nm  |
| Lens category    | C-Mount                     | Gain, black-level             | 1 / 0    |
| Resolution       | 1280 × 1024, 12 bit         | <b>Optional data measured</b> |          |
| Pixel size (h×v) | 5.60 μm × 5.60 μm           | None                          |          |
| Sensor           | Vision Research Proprietary |                               |          |
| Sensor type      | CMOS                        |                               |          |
| Shutter type     | Global                      |                               |          |
| Overlap cap.     | Overlapping                 |                               |          |
| Max. frame rate  | 1800.0 Hz                   |                               |          |
| Interface type   | Ethernet                    |                               |          |

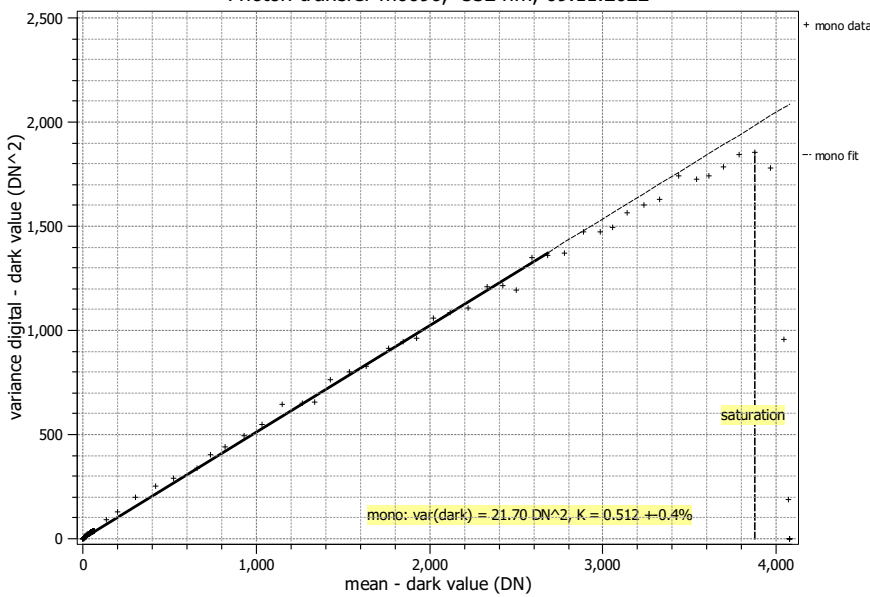


## Summary Sheet for Operation Point 1 at a Wavelength of 532 nm

|                    |               |                           |                 |
|--------------------|---------------|---------------------------|-----------------|
| Type of data       | Single        | Gain, black-level         | 1 / 0           |
| Exposure control   | By irradiance | Environmental temperature | 24.2°C          |
| Exposure time      | 998.09 μs     | Camera body temperature   | 37.2°C          |
| Frame rate         | 1000.0 Hz     | Internal temperature(s)   | —               |
| Data transfer mode | Mono 12       | Wavelength, centr., FWHM  | 532 nm, 31.2 nm |

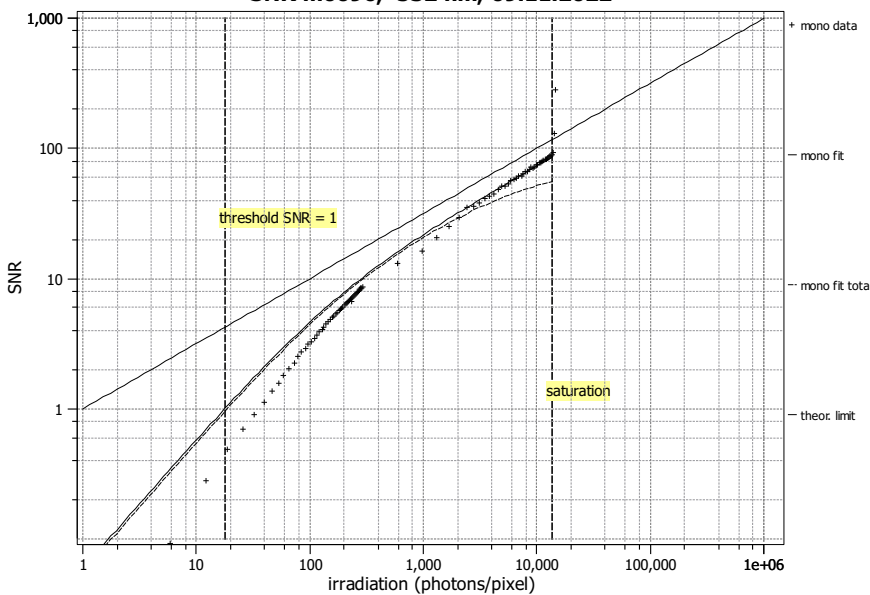
### Photon Transfer

Photon transfer m0096, 532 nm, 09.11.2022



### Signal-to-Noise Ratio

SNR m0096, 532 nm, 09.11.2022



#### Quantum efficiency

$\eta$  54.2%

#### Overall system gain

$K$  0.512 DN/e<sup>-</sup>

$1/K$  1.953 e<sup>-</sup>/DN

#### Temporal dark noise

$\sigma_d$  9.08 e<sup>-</sup>

$\sigma_{y.dark}$  4.66 DN

#### Signal-to-noise ratio

SNR<sub>max</sub> 86

38.7 dB

6.4 bit

$1/\text{SNR}_{max}$  1.16 %

#### Absolute sensitivity threshold

$\mu_{p.min}$  17.75 p

$\mu_{p.min.area}$  0.566 p/μm<sup>2</sup>

$\mu_{e.min}$  9.61 e<sup>-</sup>

$\mu_{e.min.area}$  0.307 e<sup>-</sup>/μm<sup>2</sup>

#### Saturation capacity

$\mu_{p.sat}$  13683 p

$\mu_{p.sat.area}$  436 p/μm<sup>2</sup>

$\mu_{e.sat}$  7411 e<sup>-</sup>

$\mu_{e.sat.area}$  236 e<sup>-</sup>/μm<sup>2</sup>

#### Dynamic range

DR 771

57.7 dB

9.6 bit

#### Spatial nonuniformities

DSNU<sub>1288</sub> 3.29 e<sup>-</sup>

1.69 DN

PRNU<sub>1288</sub> 1.37 %

#### Linearity error

LE<sub>min</sub> -1.33%

LE<sub>max</sub> 4.55%

#### Dark current

$\mu_{c.mean}$  216 ± 11 e<sup>-</sup>/s

110.6 DN/s

$\mu_{c.var}$  350 ± 57 e<sup>-</sup>/s

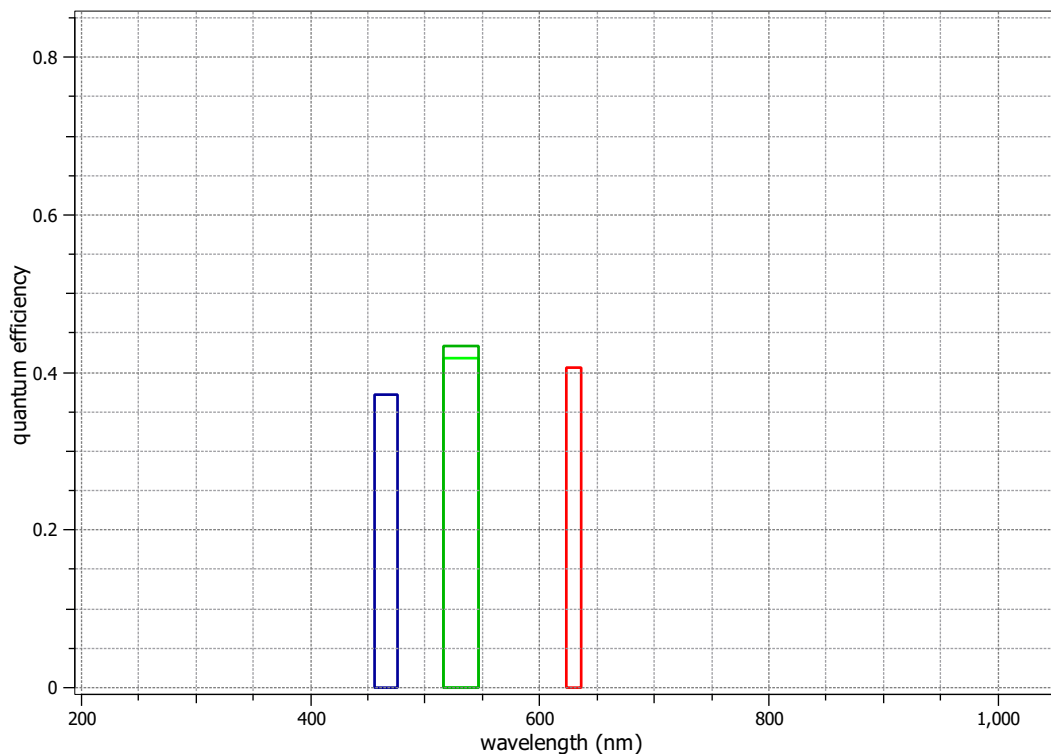
$T_d$  — °C

## EMVA 1288 Data Sheet m0226

This datasheet describes the specification according to the standard 1288 release 3.1 for "Characterization and Presentation of Specification Data for Image Sensors and Cameras" issued on December 30, 2016 by the European Machine Vision Association (EMVA), published at [www.standard1288.org](http://www.standard1288.org) and the *zenodo EMVA 1288 community* with proprietary extensions from AEON. The measurements were performed with the AEON ACC2b RGB-IR, Release 9, 30.07.2018, SN 0032(AMETEK).

Measurements were performed by Vision Research. Measurements are on raw sensor data.

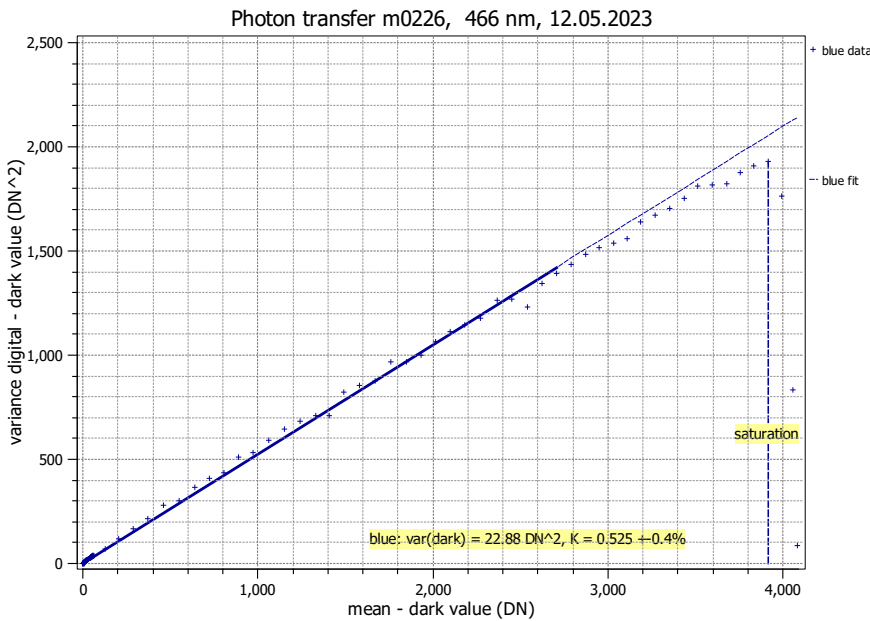
|                  |                             |                               |          |
|------------------|-----------------------------|-------------------------------|----------|
| Vendor           | Vision Research             | Type of data presented        | Single   |
| Model            | Phantom Miro C211           | <b>Operation point 1</b>      |          |
| Serial number    | 18636                       | Wavelength centroid           | 466.2 nm |
| Sensor diagonal  | 9.18 mm                     | Wavelength FWHM               | 20.3 nm  |
| Lens category    | F-Mount                     | Gain, black-level             | 1 / 0    |
| Resolution       | 1280 × 1024, 12 bit         | <b>Operation point 2</b>      |          |
| Pixel size (h×v) | 5.60 μm × 5.60 μm           | Wavelength centroid           | 531.5 nm |
| Sensor           | Vision Research Proprietary | Wavelength FWHM               | 31.2 nm  |
| Sensor type      | CMOS                        | Gain, black-level             | 1 / 0    |
| Shutter type     | Global                      | <b>Operation point 3</b>      |          |
| Overlap cap.     | Overlapping                 | Wavelength centroid           | 629.4 nm |
| Max. frame rate  | 1800.0 Hz                   | Wavelength FWHM               | 13.3 nm  |
| Interface type   | Ethernet                    | Gain, black-level             | 1 / 0    |
|                  |                             | <b>Optional data measured</b> | None     |



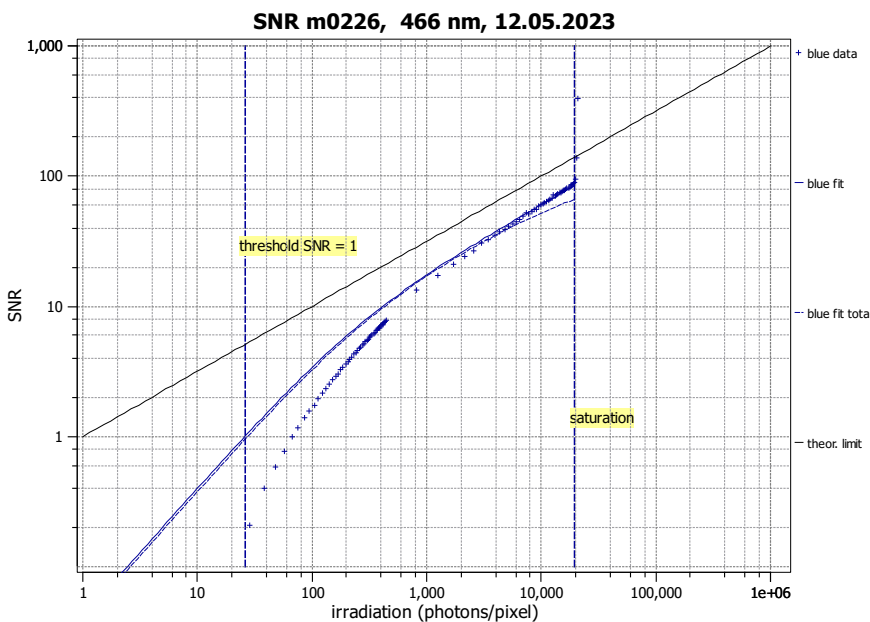
## Summary Sheet for Operation Point 1 at a Wavelength of 466 nm

|                    |                |                           |                 |
|--------------------|----------------|---------------------------|-----------------|
| Type of data       | Single         | Gain, black-level         | 1 / 0           |
| Exposure control   | By irradiance  | Environmental temperature | 23.9°C          |
| Exposure time      | 300.00 $\mu$ s | Camera body temperature   | 32.2°C          |
| Frame rate         | 1000.0 Hz      | Internal temperature(s)   | —               |
| Data transfer mode | Color 12       | Wavelength, centr., FWHM  | 466 nm, 20.3 nm |

### Photon Transfer



### Signal-to-Noise Ratio



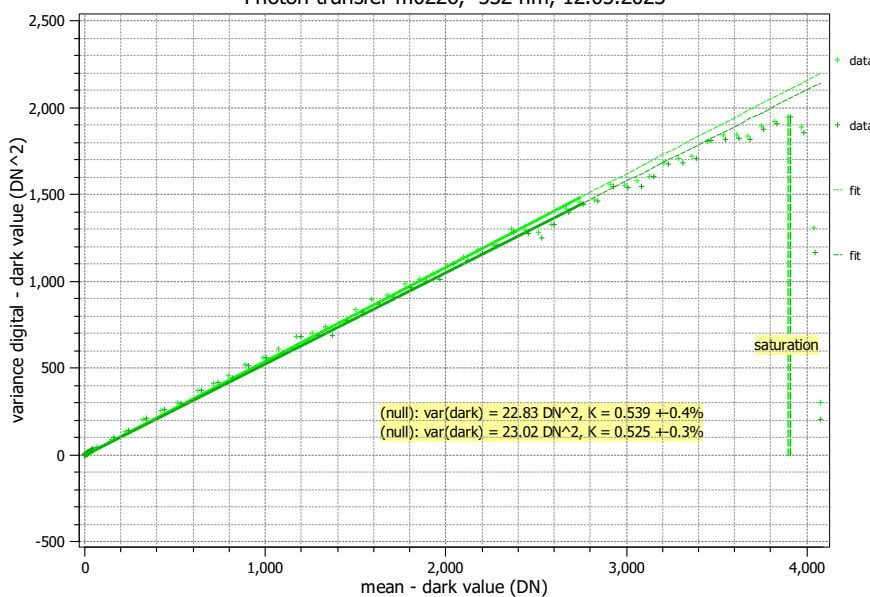
|                                       |                           |                               |
|---------------------------------------|---------------------------|-------------------------------|
| <b>Quantum efficiency</b>             | $\eta$                    | 37.1%                         |
| <b>Overall system gain</b>            | $K$                       | 0.525 DN/ $e^-$               |
|                                       | $1/K$                     | 1.905 $e^-$ /DN               |
| <b>Temporal dark noise</b>            | $\sigma_d$                | 9.10 $e^-$                    |
|                                       | $\sigma_{y,\text{dark}}$  | 4.78 DN                       |
| <b>Signal-to-noise ratio</b>          | $SNR_{\text{max}}$        | 85                            |
|                                       |                           | 38.6 dB                       |
|                                       |                           | 6.4 bit                       |
|                                       | $1/SNR_{\text{max}}$      | 1.17 %                        |
| <b>Absolute sensitivity threshold</b> | $\mu_{p,\text{min}}$      | 25.92 p                       |
|                                       | $\mu_{p,\text{min,area}}$ | 0.826 p/ $\mu\text{m}^2$      |
|                                       | $\mu_{e,\text{min}}$      | 9.63 $e^-$                    |
|                                       | $\mu_{e,\text{min,area}}$ | 0.307 $e^-$ / $\mu\text{m}^2$ |
| <b>Saturation capacity</b>            | $\mu_{p,\text{sat}}$      | 19612 p                       |
|                                       | $\mu_{p,\text{sat,area}}$ | 625 p/ $\mu\text{m}^2$        |
|                                       | $\mu_{e,\text{sat}}$      | 7284 $e^-$                    |
|                                       | $\mu_{e,\text{sat,area}}$ | 232 $e^-$ / $\mu\text{m}^2$   |
| <b>Dynamic range</b>                  | DR                        | 757                           |
|                                       |                           | 57.6 dB                       |
|                                       |                           | 9.6 bit                       |
| <b>Spatial nonuniformities</b>        | $DSNU_{1288}$             | 3.31 $e^-$                    |
|                                       |                           | 1.74 DN                       |
|                                       | $PRNU_{1288}$             | 0.95 %                        |
| <b>Linearity error</b>                | $LE_{\text{min}}$         | -2.20%                        |
|                                       | $LE_{\text{max}}$         | 2.97%                         |
| <b>Dark current</b>                   | $\mu_{c,\text{mean}}$     | -0.3 $\pm$ 4.1 $e^-$ /s       |
|                                       |                           | -0.15 DN/s                    |
|                                       | $\mu_{c,\text{var}}$      | 9.9 $\pm$ 44.7 $e^-$ /s       |
|                                       | $T_d$                     | — °C                          |

## Summary Sheet for Operation Point 2 at a Wavelength of 532 nm

|                    |                |                           |                 |
|--------------------|----------------|---------------------------|-----------------|
| Type of data       | Single         | Gain, black-level         | 1 / 0           |
| Exposure control   | By irradiance  | Environmental temperature | 24.0°C          |
| Exposure time      | 300.00 $\mu$ s | Camera body temperature   | 32.4°C          |
| Frame rate         | 1000.0 Hz      | Internal temperature(s)   | —               |
| Data transfer mode | Color 12       | Wavelength, centr., FWHM  | 532 nm, 31.2 nm |

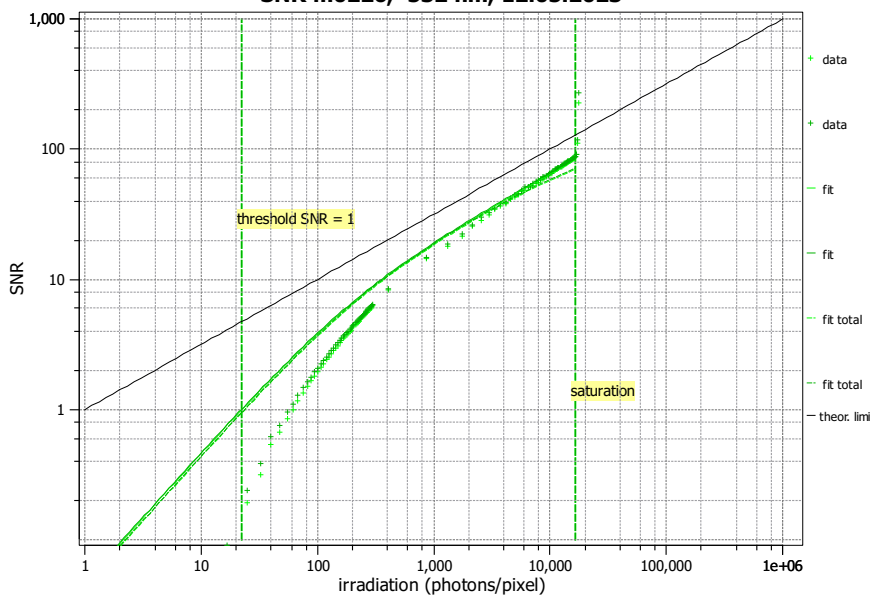
### Photon Transfer

Photon transfer m0226, 532 nm, 12.05.2023



### Signal-to-Noise Ratio

SNR m0226, 532 nm, 12.05.2023



### Quantum efficiency

$\eta$  41.7%

### Overall system gain

$K$  0.539 DN/e<sup>-</sup>

$1/K$  1.855 e<sup>-</sup>/DN

### Temporal dark noise

$\sigma_d$  8.85 e<sup>-</sup>

$\sigma_{y,\text{dark}}$  4.78 DN

### Signal-to-noise ratio

$\text{SNR}_{\text{max}}$  83

38.4 dB

6.4 bit

$1/\text{SNR}_{\text{max}}$  1.20 %

### Absolute sensitivity threshold

$\mu_{p,\text{min}}$  22.46 p

$\mu_{p,\text{min,area}}$  0.716 p/ $\mu\text{m}^2$

$\mu_{e,\text{min}}$  9.38 e<sup>-</sup>

$\mu_{e,\text{min,area}}$  0.299 e<sup>-</sup>/ $\mu\text{m}^2$

### Saturation capacity

$\mu_{p,\text{sat}}$  16704 p

$\mu_{p,\text{sat,area}}$  533 p/ $\mu\text{m}^2$

$\mu_{e,\text{sat}}$  6972 e<sup>-</sup>

$\mu_{e,\text{sat,area}}$  222 e<sup>-</sup>/ $\mu\text{m}^2$

### Dynamic range

DR 744

57.4 dB

9.5 bit

### Spatial nonuniformities

$\text{DSNU}_{1288}$  3.19 e<sup>-</sup>

1.72 DN

$\text{PRNU}_{1288}$  0.77 %

### Linearity error

$\text{LE}_{\text{min}}$  -1.36%

$\text{LE}_{\text{max}}$  1.89%

### Dark current

$\mu_{c,\text{mean}}$  1  $\pm$  6 e<sup>-</sup>/s

0.5 DN/s

$\mu_{c,\text{var}}$  34  $\pm$  41 e<sup>-</sup>/s

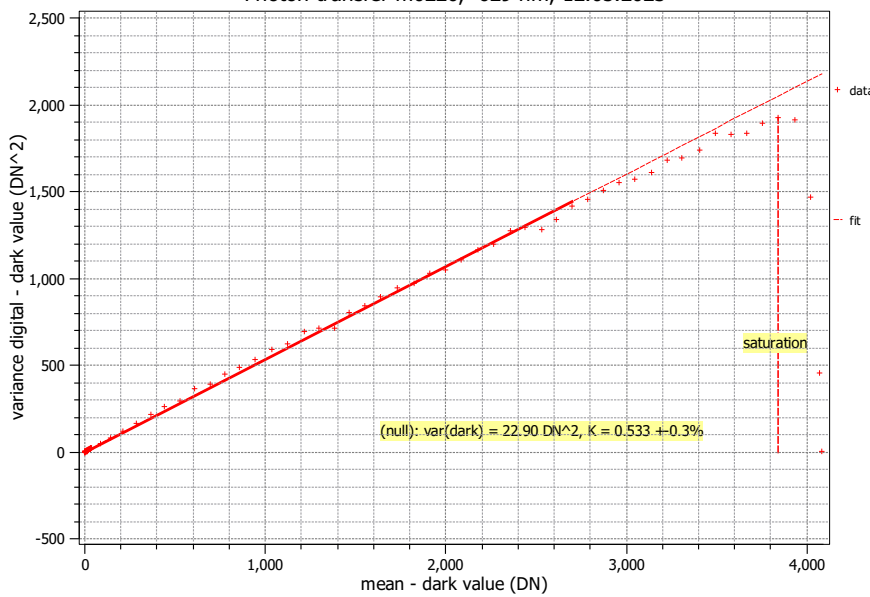
$T_d$  — °C

## Summary Sheet for Operation Point 3 at a Wavelength of 629 nm

|                    |                |                           |                 |
|--------------------|----------------|---------------------------|-----------------|
| Type of data       | Single         | Gain, black-level         | 1 / 0           |
| Exposure control   | By irradiance  | Environmental temperature | 24.0°C          |
| Exposure time      | 300.00 $\mu$ s | Camera body temperature   | 32.4°C          |
| Frame rate         | 1000.0 Hz      | Internal temperature(s)   | —               |
| Data transfer mode | Color 12       | Wavelength, centr., FWHM  | 629 nm, 13.3 nm |

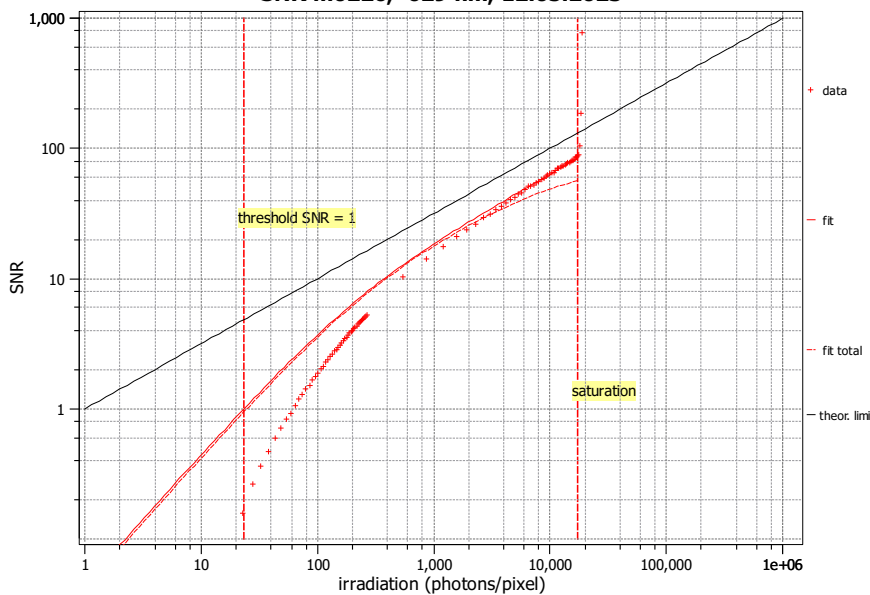
### Photon Transfer

Photon transfer m0226, 629 nm, 12.05.2023



### Signal-to-Noise Ratio

SNR m0226, 629 nm, 12.05.2023



#### Quantum efficiency

$\eta$  40.6%

#### Overall system gain

$K$  0.533 DN/e<sup>-</sup>

1/ $K$  1.875 e<sup>-</sup>/DN

#### Temporal dark noise

$\sigma_d$  8.96 e<sup>-</sup>

$\sigma_{y,\text{dark}}$  4.78 DN

#### Signal-to-noise ratio

SNR<sub>max</sub> 84

38.5 dB

6.4 bit

1/SNR<sub>max</sub> 1.19%

#### Absolute sensitivity threshold

$\mu_{p,\text{min}}$  23.38 p

$\mu_{p,\text{min,area}}$  0.746 p/ $\mu$ m<sup>2</sup>

$\mu_{e,\text{min}}$  9.49 e<sup>-</sup>

$\mu_{e,\text{min,area}}$  0.302 e<sup>-</sup>/ $\mu$ m<sup>2</sup>

#### Saturation capacity

$\mu_{p,\text{sat}}$  17367 p

$\mu_{p,\text{sat,area}}$  554 p/ $\mu$ m<sup>2</sup>

$\mu_{e,\text{sat}}$  7047 e<sup>-</sup>

$\mu_{e,\text{sat,area}}$  225 e<sup>-</sup>/ $\mu$ m<sup>2</sup>

#### Dynamic range

DR 743

57.4 dB

9.5 bit

#### Spatial nonuniformities

DSNU<sub>1288</sub> 3.22 e<sup>-</sup>

1.72 DN

PRNU<sub>1288</sub> 1.31%

#### Linearity error

LE<sub>min</sub> -1.64%

LE<sub>max</sub> 3.56%

#### Dark current

$\mu_{c,\text{mean}}$  -1  $\pm$  6 e<sup>-</sup>/s

-0.5 DN/s

$\mu_{c,\text{var}}$  50  $\pm$  50 e<sup>-</sup>/s

$T_d$  — °C