

# EMVA 1288 Report Summary Cover Page

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

## T4040

Refer to the report corresponding with your camera configuration:

- Monochrome models, Standard mode: PDF pages 2-3
- Monochrome models, Binned mode: PDF pages 4-5
- Color models, Standard mode: PDF pages 6-9

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

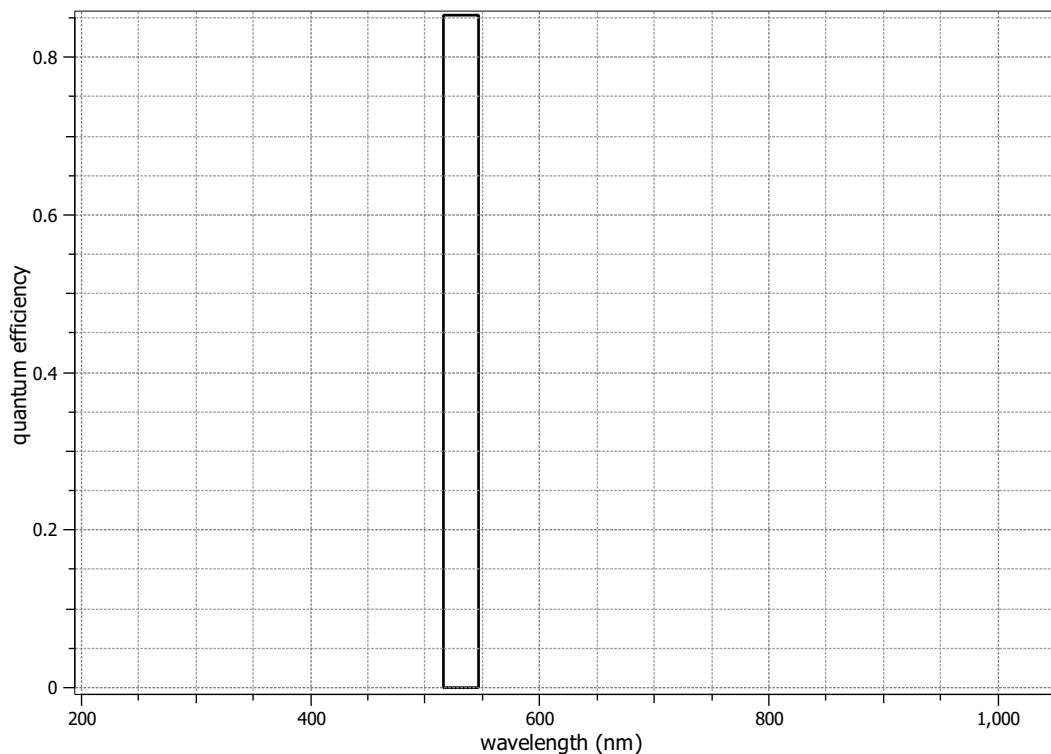
For more information on EMVA 1288 image measurements visit:  
[www.phantomhighspeed.com/emva](http://www.phantomhighspeed.com/emva)

## EMVA 1288 Data Sheet m0179

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 T-4040	<b>Operation point 1</b>	
Serial number	29686	Wavelength centroid	531.5 nm
Sensor diagonal	28.30 mm	Wavelength FWHM	31.2 nm
Lens category	F-Mount	Gain, black-level	1 / 0
Resolution	2560 × 1664, 12 bit	<b>Optional data measured</b>	
Pixel size (h×v)	9.27 μm × 9.27 μm	None	
Sensor	Vision Research Proprietary		
Sensor type	CMOS		
Shutter type	Global		
Overlap cap.	Overlapping		
Max. frame rate	9356.0 Hz		
Interface type	Ethernet		

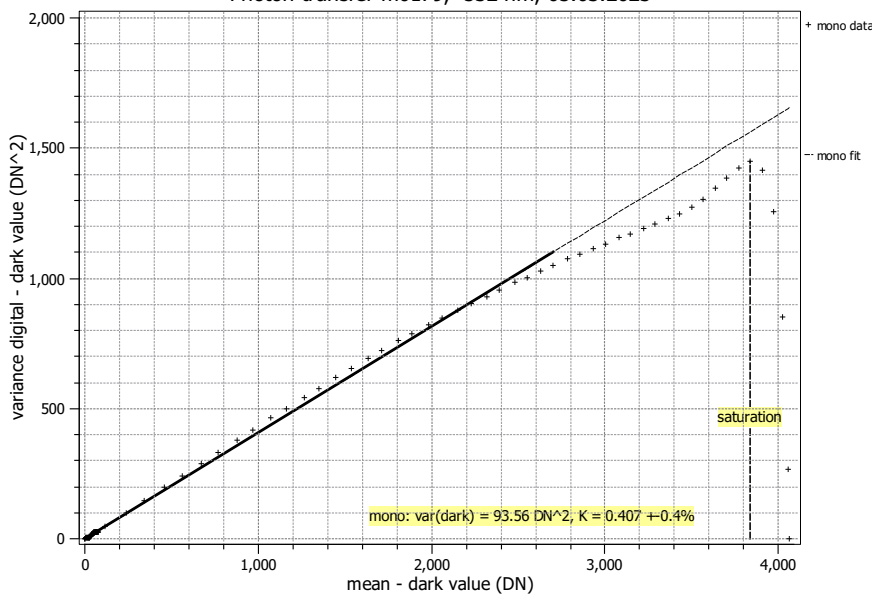


## Summary Sheet for Operation Point 1 at a Wavelength of 532 nm

Type of data	Single	Gain, black-level	1 / 0
Exposure control	By irradiance	Environmental temperature	23.0°C
Exposure time	50.00 $\mu$ s	Camera body temperature	41.9°C
Frame rate	1000.0 Hz	Internal temperature(s)	—
Data transfer mode	Mono 12	Wavelength, centr., FWHM	532 nm, 31.2 nm

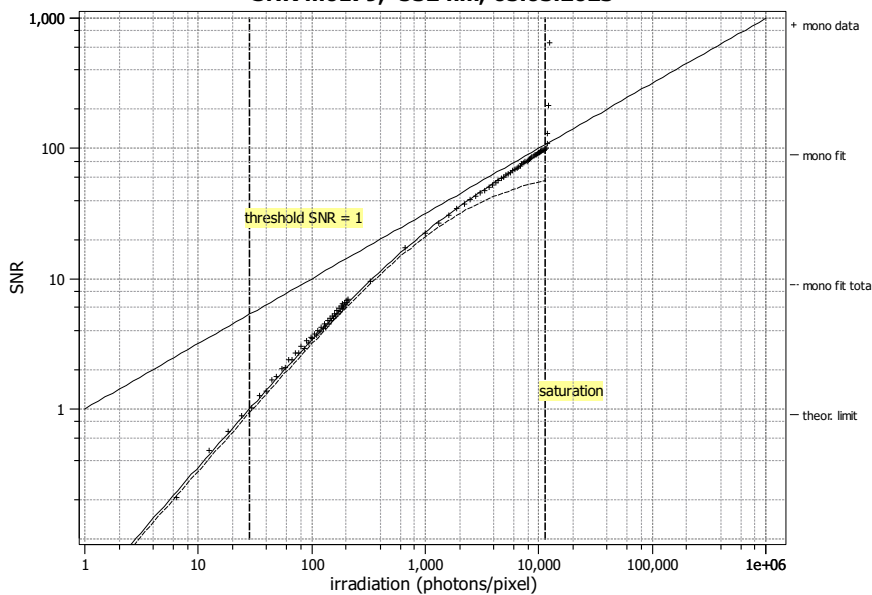
### Photon Transfer

Photon transfer m0179, 532 nm, 05.03.2023



### Signal-to-Noise Ratio

SNR m0179, 532 nm, 05.03.2023



#### Quantum efficiency

$\eta$  85.4%

#### Overall system gain

$K$  0.407 DN/e<sup>-</sup>

$1/K$  2.455 e<sup>-</sup>/DN

#### Temporal dark noise

$\sigma_d$  23.74 e<sup>-</sup>

$\sigma_{y,\text{dark}}$  9.67 DN

#### Signal-to-noise ratio

SNR<sub>max</sub> 99

39.9 dB

6.6 bit

$1/\text{SNR}_{\text{max}}$  1.02 %

#### Absolute sensitivity threshold

$\mu_{p,\text{min}}$  28.4 p

$\mu_{p,\text{min,area}}$  0.33 p/ $\mu\text{m}^2$

$\mu_{e,\text{min}}$  24.3 e<sup>-</sup>

$\mu_{e,\text{min,area}}$  0.28 e<sup>-</sup>/ $\mu\text{m}^2$

#### Saturation capacity

$\mu_{p,\text{sat}}$  11360 p

$\mu_{p,\text{sat,area}}$  132 p/ $\mu\text{m}^2$

$\mu_{e,\text{sat}}$  9703 e<sup>-</sup>

$\mu_{e,\text{sat,area}}$  113 e<sup>-</sup>/ $\mu\text{m}^2$

#### Dynamic range

DR 400

52.0 dB

8.6 bit

#### Spatial nonuniformities

DSNU<sub>1288</sub> 9.38 e<sup>-</sup>

3.82 DN

PRNU<sub>1288</sub> 1.43 %

#### Linearity error

LE<sub>min</sub> -1.77%

LE<sub>max</sub> 1.03%

#### Dark current

$\mu_{c,\text{mean}}$  38358 ± 331 e<sup>-</sup>/s

15623.4 DN/s

$\mu_{c,\text{var}}$  34797 ± 636 e<sup>-</sup>/s

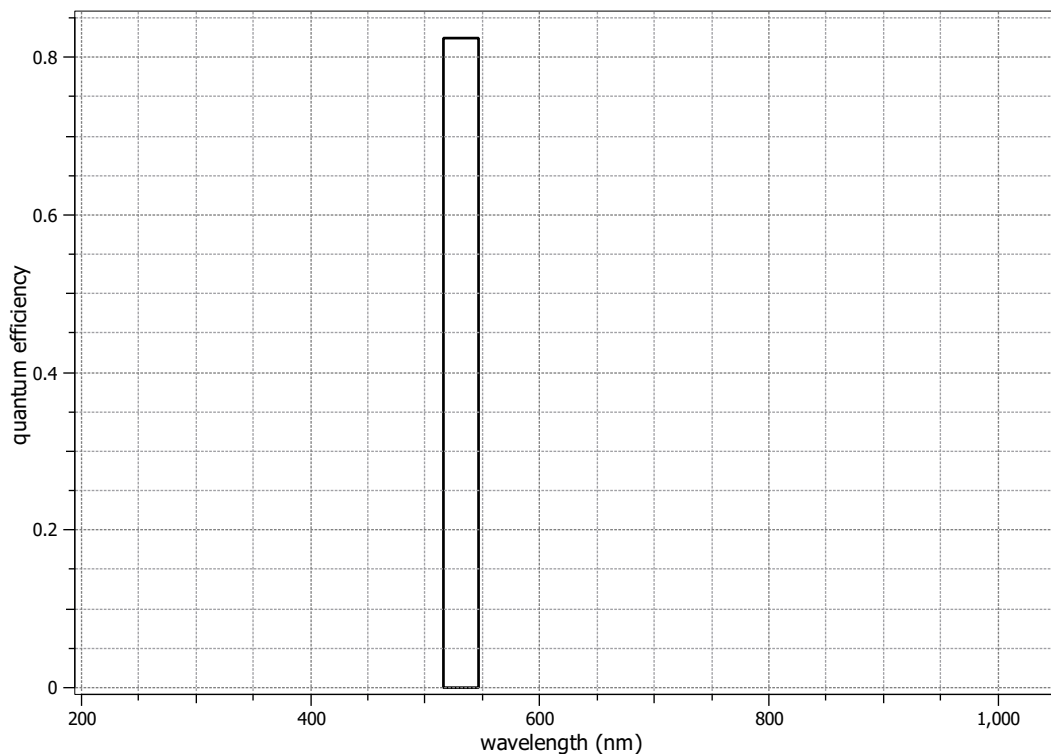
$T_d$  — °C

## EMVA 1288 Data Sheet m0180

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 T-4040	<b>Operation point 1</b>	
Serial number	29686	Wavelength centroid	531.5 nm
Sensor diagonal	28.30 mm	Wavelength FWHM	31.2 nm
Lens category	F-Mount	Gain, black-level	1 / 0
Resolution	1280 × 832, 12 bit	<b>Optional data measured</b>	
Pixel size (h×v)	18.54 μm × 18.54 μm	None	
Sensor	Vision Research Proprietary		
Sensor type	CMOS		
Shutter type	Global		
Overlap cap.	Overlapping		
Max. frame rate	37209.0 Hz		
Interface type	Ethernet		

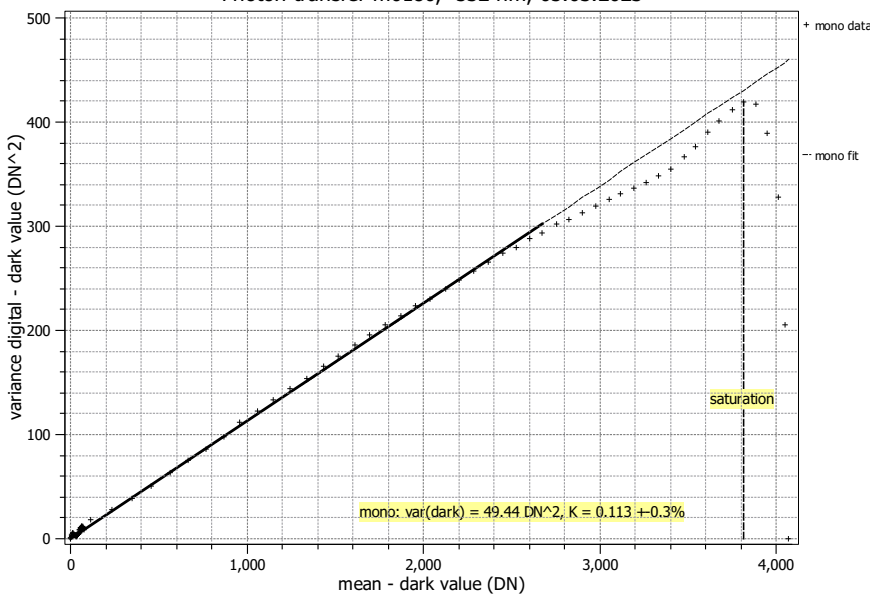


## Summary Sheet for Operation Point 1 at a Wavelength of 532 nm

Type of data	Single	Gain, black-level	1 / 0
Exposure control	By irradiance	Environmental temperature	23.0°C
Exposure time	50.00 $\mu$ s	Camera body temperature	42.0°C
Frame rate	1000.0 Hz	Internal temperature(s)	—
Data transfer mode	Mono 12 (Binning)	Wavelength, centr., FWHM	532 nm, 31.2 nm

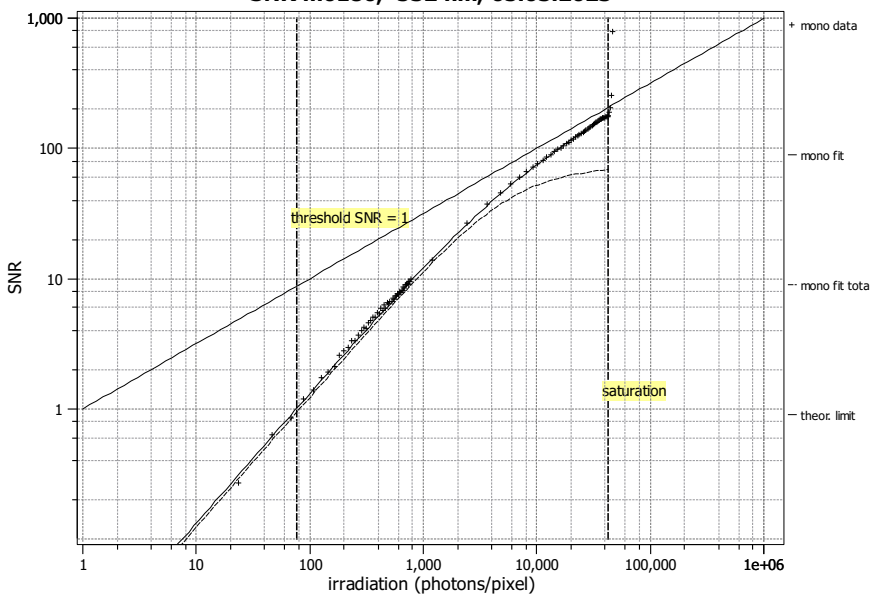
### Photon Transfer

Photon transfer m0180, 532 nm, 05.03.2023



### Signal-to-Noise Ratio

SNR m0180, 532 nm, 05.03.2023



#### Quantum efficiency

$\eta$  82.4%

#### Overall system gain

$K$  0.113 DN/e<sup>-</sup>

1/ $K$  8.856 e<sup>-</sup>/DN

#### Temporal dark noise

$\sigma_d$  62.21 e<sup>-</sup>

$\sigma_{y.dark}$  7.03 DN

#### Signal-to-noise ratio

SNR<sub>max</sub> 186

45.4 dB

7.5 bit

1/SNR<sub>max</sub> 0.54 %

#### Absolute sensitivity threshold

$\mu_{p.min}$  76.2 p

$\mu_{p.min.area}$  0.22 p/ $\mu$ m<sup>2</sup>

$\mu_{e.min}$  62.8 e<sup>-</sup>

$\mu_{e.min.area}$  0.18 e<sup>-</sup>/ $\mu$ m<sup>2</sup>

#### Saturation capacity

$\mu_{p.sat}$  42107 p

$\mu_{p.sat.area}$  122 p/ $\mu$ m<sup>2</sup>

$\mu_{e.sat}$  34684 e<sup>-</sup>

$\mu_{e.sat.area}$  101 e<sup>-</sup>/ $\mu$ m<sup>2</sup>

#### Dynamic range

DR 553

54.8 dB

9.1 bit

#### Spatial nonuniformities

DSNU<sub>128</sub> 4.22 e<sup>-</sup>

2.74 DN

PRNU<sub>128</sub> 1.35 %

#### Linearity error

LE<sub>min</sub> -1.58%

LE<sub>max</sub> 1.17%

#### Dark current

$\mu_{c.mean}$  155449 ± 1697 e<sup>-</sup>/s

17553.7 DN/s

$\mu_{c.var}$  157967 ± 13727 e<sup>-</sup>/s

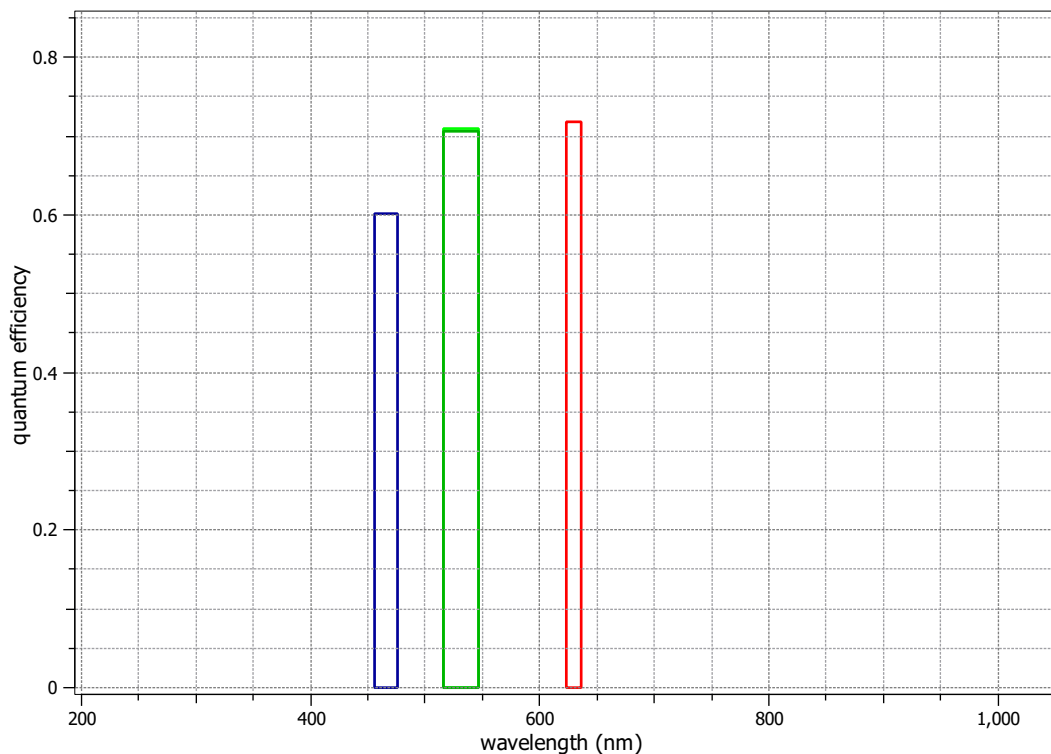
$T_d$  — °C

## EMVA 1288 Data Sheet m0175

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.

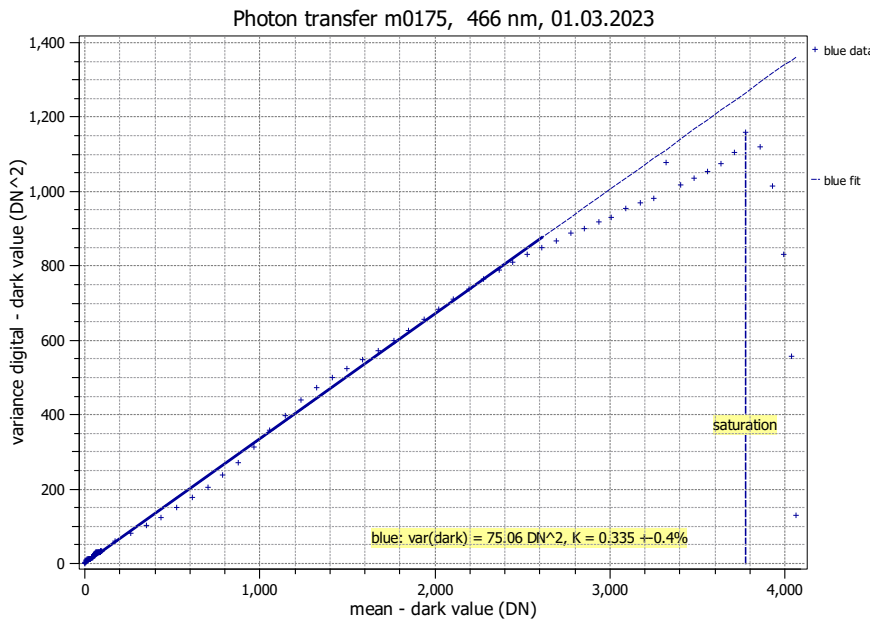
Vendor	Vision Research	Type of data presented	Single
Model	Phantom T-4040	<b>Operation point 1</b>	
Serial number	30142	Wavelength centroid	466.2 nm
Sensor diagonal	28.30 mm	Wavelength FWHM	20.3 nm
Lens category	F-Mount	Gain, black-level	1 / 0
Resolution	2560 × 1664, 12 bit	<b>Operation point 2</b>	
Pixel size (h×v)	9.27 μm × 9.27 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	9356.0 Hz	Wavelength FWHM	13.3 nm
Interface type	Ethernet	Gain, black-level	1 / 0
		<b>Optional data measured</b>	
		None	



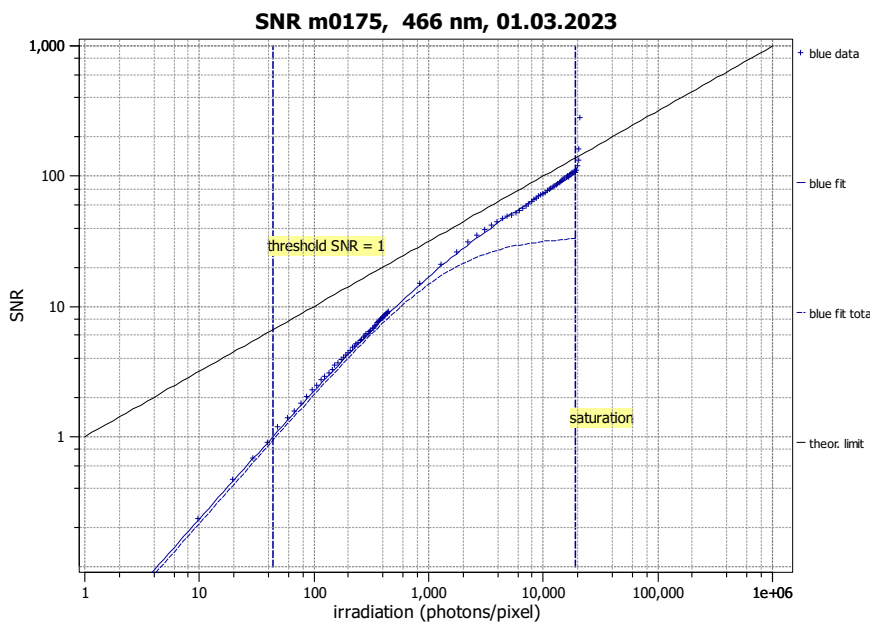
## Summary Sheet for Operation Point 1 at a Wavelength of 466 nm

Type of data	Single	Gain, black-level	1 / 0
Exposure control	By irradiance	Environmental temperature	22.9°C
Exposure time	100.00 $\mu$ s	Camera body temperature	42.7°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>	
$\eta$	60.1%
<b>Overall system gain</b>	
$K$	0.335 DN/e <sup>-</sup>
$1/K$	2.984 e <sup>-</sup> /DN
<b>Temporal dark noise</b>	
$\sigma_d$	25.83 e <sup>-</sup>
$\sigma_{y,\text{dark}}$	8.66 DN
<b>Signal-to-noise ratio</b>	
$\text{SNR}_{\text{max}}$	107
	40.6 dB
	6.7 bit
$1/\text{SNR}_{\text{max}}$	0.94 %
<b>Absolute sensitivity threshold</b>	
$\mu_{p,\text{min}}$	43.8 p
$\mu_{p,\text{min},\text{area}}$	0.51 p/ $\mu\text{m}^2$
$\mu_{e,\text{min}}$	26.4 e <sup>-</sup>
$\mu_{e,\text{min},\text{area}}$	0.31 e <sup>-</sup> / $\mu\text{m}^2$
<b>Saturation capacity</b>	
$\mu_{p,\text{sat}}$	18982 p
$\mu_{p,\text{sat},\text{area}}$	221 p/ $\mu\text{m}^2$
$\mu_{e,\text{sat}}$	11415 e <sup>-</sup>
$\mu_{e,\text{sat},\text{area}}$	133 e <sup>-</sup> / $\mu\text{m}^2$
<b>Dynamic range</b>	
DR	433
	52.7 dB
	8.8 bit
<b>Spatial nonuniformities</b>	
$\text{DSNU}_{1288}$	9.72 e <sup>-</sup>
	3.26 DN
$\text{PRNU}_{1288}$	2.87 %
<b>Linearity error</b>	
$\text{LE}_{\text{min}}$	-1.40%
$\text{LE}_{\text{max}}$	1.38%
<b>Dark current</b>	
$\mu_{c,\text{mean}}$	49652 $\pm$ 331 e <sup>-</sup> /s
	16641.5 DN/s
$\mu_{c,\text{var}}$	47493 $\pm$ 1831 e <sup>-</sup> /s
$T_d$	— °C

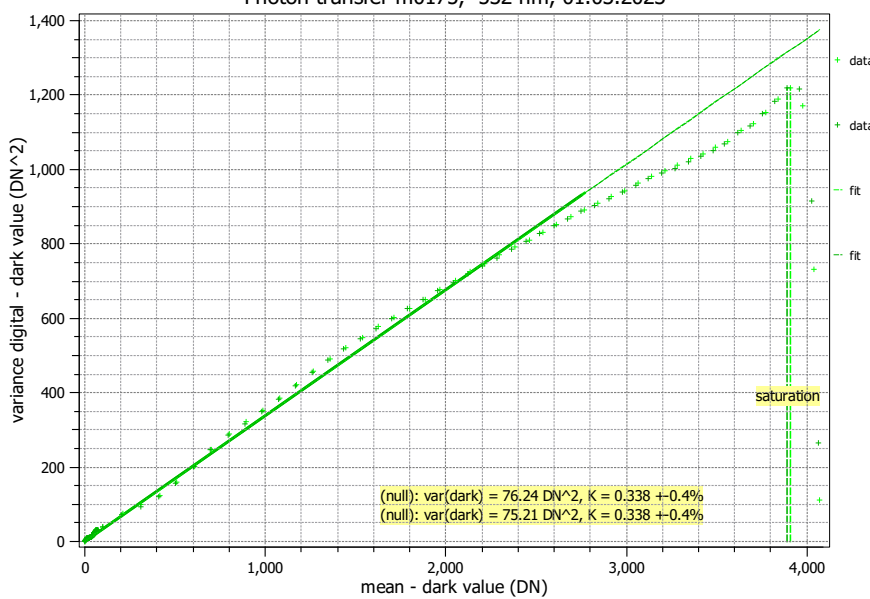


## Summary Sheet for Operation Point 2 at a Wavelength of 532 nm

Type of data	Single	Gain, black-level	1 / 0
Exposure control	By irradiance	Environmental temperature	22.9°C
Exposure time	100.00 $\mu$ s	Camera body temperature	42.7°C
Frame rate	1000.0 Hz	Internal temperature(s)	—
Data transfer mode	Color 12	Wavelength, centr., FWHM	532 nm, 31.2 nm

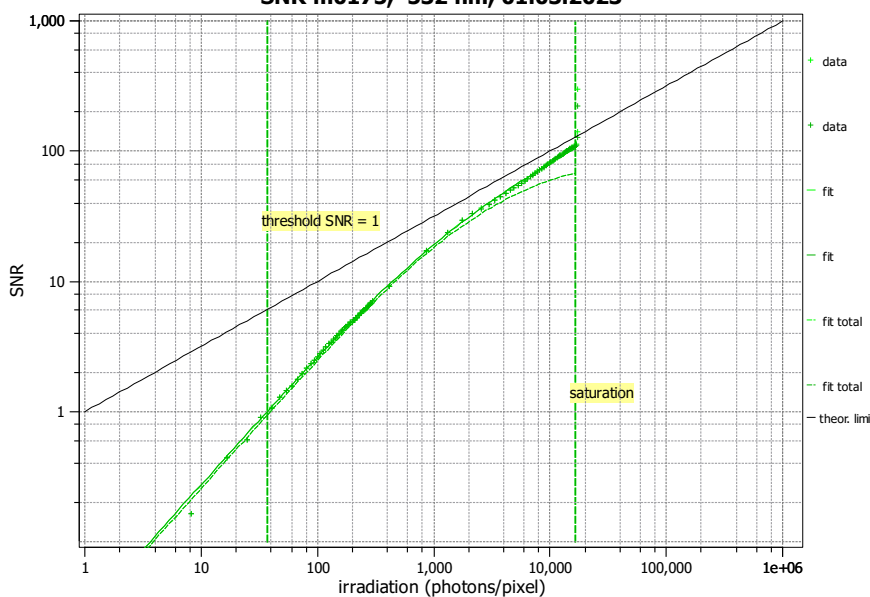
### Photon Transfer

Photon transfer m0175, 532 nm, 01.03.2023



### Signal-to-Noise Ratio

SNR m0175, 532 nm, 01.03.2023



#### Quantum efficiency

$\eta$  71.0%

#### Overall system gain

$K$  0.338 DN/e<sup>-</sup>

1/ $K$  2.958 e<sup>-</sup>/DN

#### Temporal dark noise

$\sigma_d$  25.81 e<sup>-</sup>

$\sigma_{y,\text{dark}}$  8.73 DN

#### Signal-to-noise ratio

SNR<sub>max</sub> 108

40.7 dB

6.8 bit

1/SNR<sub>max</sub> 0.92%

#### Absolute sensitivity threshold

$\mu_{p,\text{min}}$  37.1 p

$\mu_{p,\text{min,area}}$  0.43 p/ $\mu$ m<sup>2</sup>

$\mu_{e,\text{min}}$  26.3 e<sup>-</sup>

$\mu_{e,\text{min,area}}$  0.31 e<sup>-</sup>/ $\mu$ m<sup>2</sup>

#### Saturation capacity

$\mu_{p,\text{sat}}$  16526 p

$\mu_{p,\text{sat,area}}$  192 p/ $\mu$ m<sup>2</sup>

$\mu_{e,\text{sat}}$  11733 e<sup>-</sup>

$\mu_{e,\text{sat,area}}$  137 e<sup>-</sup>/ $\mu$ m<sup>2</sup>

#### Dynamic range

DR 446

53.0 dB

8.8 bit

#### Spatial nonuniformities

DSNU<sub>1288</sub> 9.74 e<sup>-</sup>

3.29 DN

PRNU<sub>1288</sub> 1.12%

#### Linearity error

LE<sub>min</sub> -1.44%

LE<sub>max</sub> 1.60%

#### Dark current

$\mu_{c,\text{mean}}$  49081 ± 327 e<sup>-</sup>/s

16594.6 DN/s

$\mu_{c,\text{var}}$  46070 ± 1543 e<sup>-</sup>/s

$T_d$  — °C

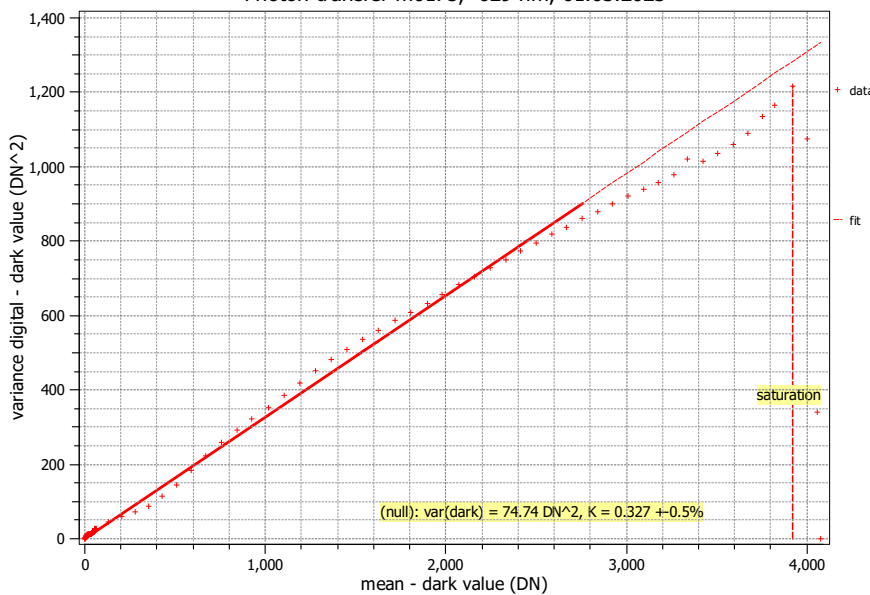


## Summary Sheet for Operation Point 3 at a Wavelength of 629 nm

Type of data	Single	Gain, black-level	1 / 0
Exposure control	By irradiance	Environmental temperature	22.9°C
Exposure time	100.00 $\mu$ s	Camera body temperature	42.7°C
Frame rate	1000.0 Hz	Internal temperature(s)	—
Data transfer mode	Color 12	Wavelength, centr., FWHM	629 nm, 13.3 nm

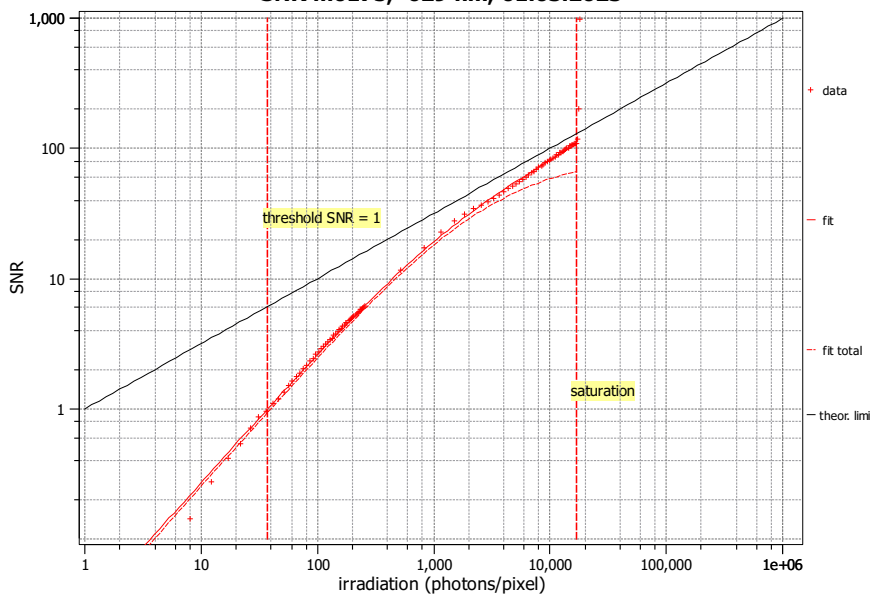
### Photon Transfer

Photon transfer m0175, 629 nm, 01.03.2023



### Signal-to-Noise Ratio

SNR m0175, 629 nm, 01.03.2023



#### Quantum efficiency

$\eta$  71.8%

#### Overall system gain

$K$  0.327 DN/e<sup>-</sup>

1/ $K$  3.055 e<sup>-</sup>/DN

#### Temporal dark noise

$\sigma_d$  26.40 e<sup>-</sup>

$\sigma_{y.dark}$  8.65 DN

#### Signal-to-noise ratio

SNR<sub>max</sub> 110

40.9 dB

6.8 bit

1/SNR<sub>max</sub> 0.91%

#### Absolute sensitivity threshold

$\mu_{p.min}$  37.5 p

$\mu_{p.min.area}$  0.44 p/ $\mu$ m<sup>2</sup>

$\mu_{e.min}$  26.9 e<sup>-</sup>

$\mu_{e.min.area}$  0.31 e<sup>-</sup>/ $\mu$ m<sup>2</sup>

#### Saturation capacity

$\mu_{p.sat}$  16943 p

$\mu_{p.sat.area}$  197 p/ $\mu$ m<sup>2</sup>

$\mu_{e.sat}$  12168 e<sup>-</sup>

$\mu_{e.sat.area}$  142 e<sup>-</sup>/ $\mu$ m<sup>2</sup>

#### Dynamic range

DR 452

53.1 dB

8.8 bit

#### Spatial nonuniformities

DSNU<sub>1288</sub> 9.97 e<sup>-</sup>

3.26 DN

PRNU<sub>1288</sub> 1.18%

#### Linearity error

LE<sub>min</sub> -2.08%

LE<sub>max</sub> 2.44%

#### Dark current

$\mu_{c.mean}$  48444 ± 325 e<sup>-</sup>/s

16375.4 DN/s

$\mu_{c.var}$  45807 ± 1574 e<sup>-</sup>/s

$T_d$  — °C