

# EMVA 1288 Report Summary Cover Page

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

## **VEO 640, 440, E340L**

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.

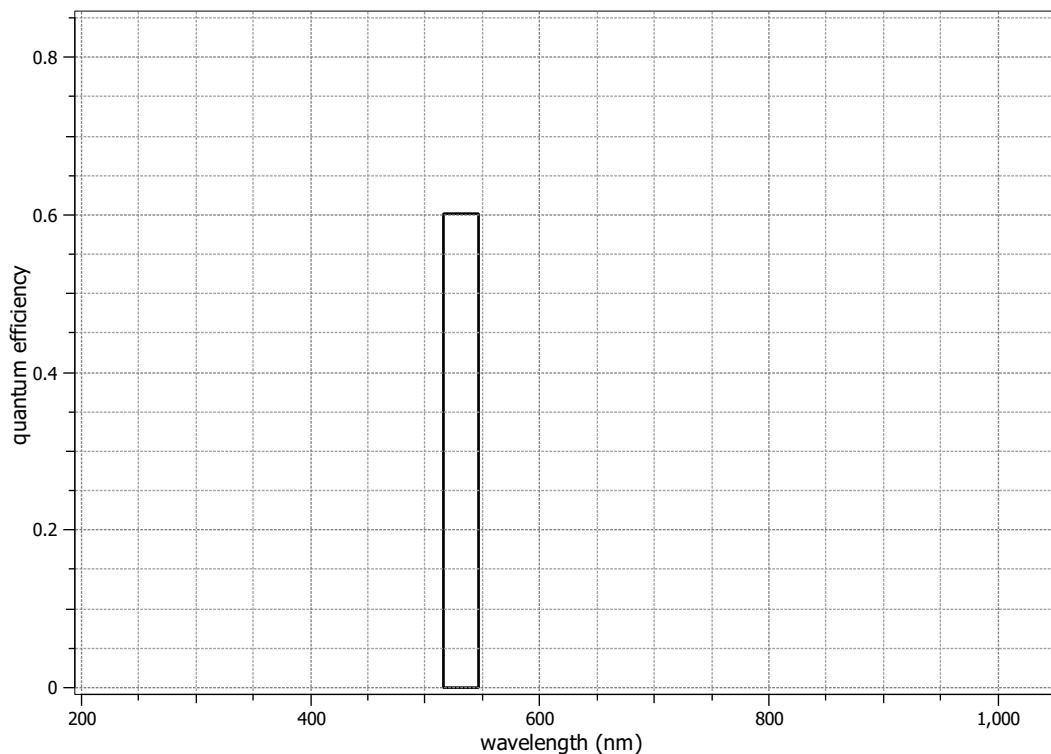
For more information on EMVA 1288 image measurements visit:  
[www.phantomhighspeed.com/emva](http://www.phantomhighspeed.com/emva)

## EMVA 1288 Data Sheet m0117

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 VEO 640L	<b>Operation point 1</b>	
Serial number	10001	Wavelength centroid	531.5 nm
Sensor diagonal	30.19 mm	Wavelength FWHM	31.2 nm
Lens category	F-Mount	Gain, black-level	1 / 0
Resolution	2560 × 1600, 12 bit	<b>Optional data measured</b>	
Pixel size (h×v)	10.00 μm × 10.00 μm	None	
Sensor	Vision Research Proprietary		
Sensor type	CMOS		
Shutter type	Global		
Overlap cap.	Overlapping		
Max. frame rate	1498.0 Hz		
Interface type	Ethernet		

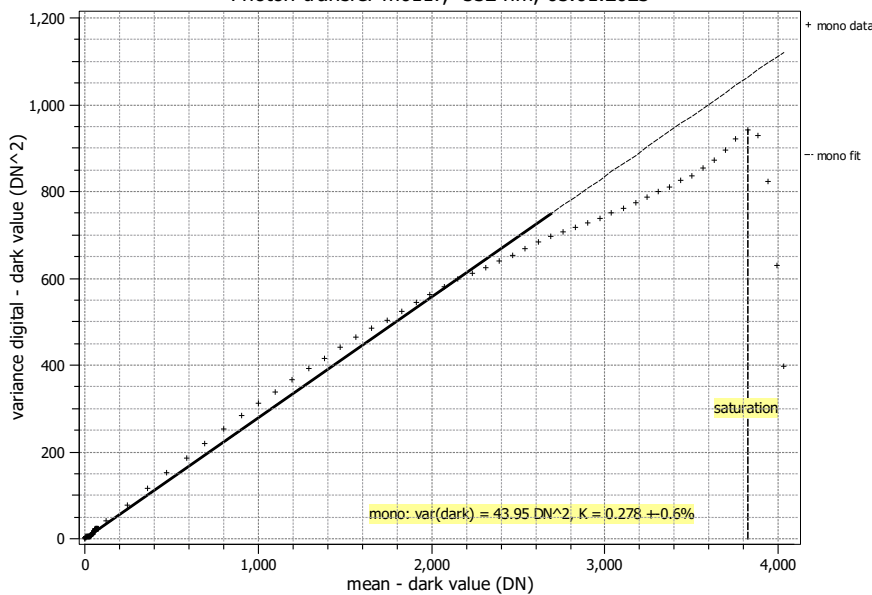


## Summary Sheet for Operation Point 1 at a Wavelength of 532 nm

Type of data	Single	Gain, black-level	1 / 0
Exposure control	By irradiance	Environmental temperature	27.3°C
Exposure time	90.00 $\mu$ s	Camera body temperature	34.0°C
Frame rate	1000.0 Hz	Internal temperature(s)	—
Data transfer mode	Mono 12	Wavelength, centr., FWHM	532 nm, 31.2 nm

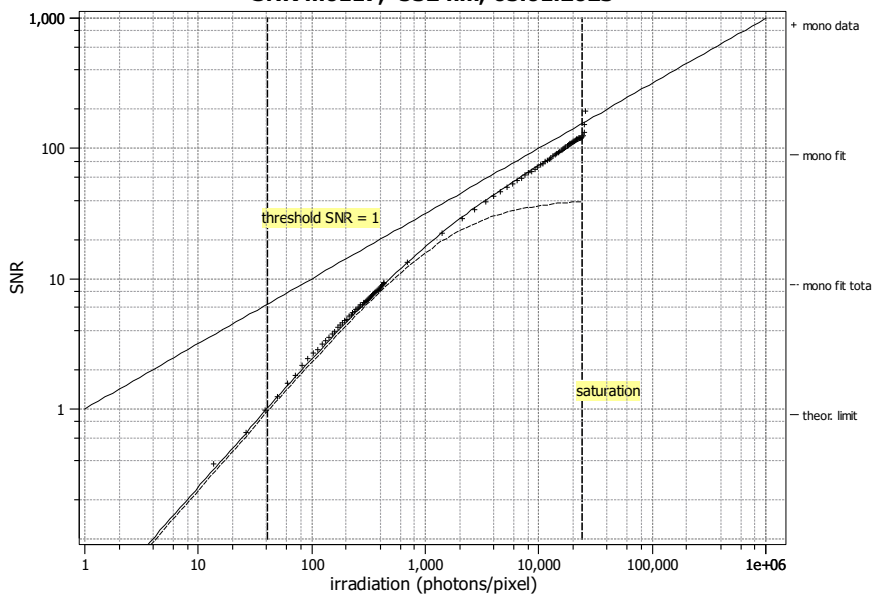
### Photon Transfer

Photon transfer m0117, 532 nm, 05.01.2023



### Signal-to-Noise Ratio

SNR m0117, 532 nm, 05.01.2023



#### Quantum efficiency

$\eta$  60.2%

#### Overall system gain

$K$  0.278 DN/ $e^-$

$1/K$  3.594  $e^-$ /DN

#### Temporal dark noise

$\sigma_d$  23.80  $e^-$

$\sigma_{y,\text{dark}}$  6.63 DN

#### Signal-to-noise ratio

$SNR_{\text{max}}$  120

41.6 dB

6.9 bit

$1/SNR_{\text{max}}$  0.83 %

#### Absolute sensitivity threshold

$\mu_{p,\text{min}}$  40.4 p

$\mu_{p,\text{min,area}}$  0.40 p/ $\mu\text{m}^2$

$\mu_{e,\text{min}}$  24.3  $e^-$

$\mu_{e,\text{min,area}}$  0.24  $e^-$ / $\mu\text{m}^2$

#### Saturation capacity

$\mu_{p,\text{sat}}$  24122 p

$\mu_{p,\text{sat,area}}$  241 p/ $\mu\text{m}^2$

$\mu_{e,\text{sat}}$  14512  $e^-$

$\mu_{e,\text{sat,area}}$  145  $e^-$ / $\mu\text{m}^2$

#### Dynamic range

DR 596

55.5 dB

9.2 bit

#### Spatial nonuniformities

$DSNU_{1288}$  8.78  $e^-$

2.44 DN

$PRNU_{1288}$  2.41 %

#### Linearity error

$LE_{\text{min}}$  -4.13%

$LE_{\text{max}}$  2.44%

#### Dark current

$\mu_{c,\text{mean}}$   $-4481 \pm 761 e^-/s$

-1246.9 DN/s

$\mu_{c,\text{var}}$   $703 \pm 638 e^-/s$

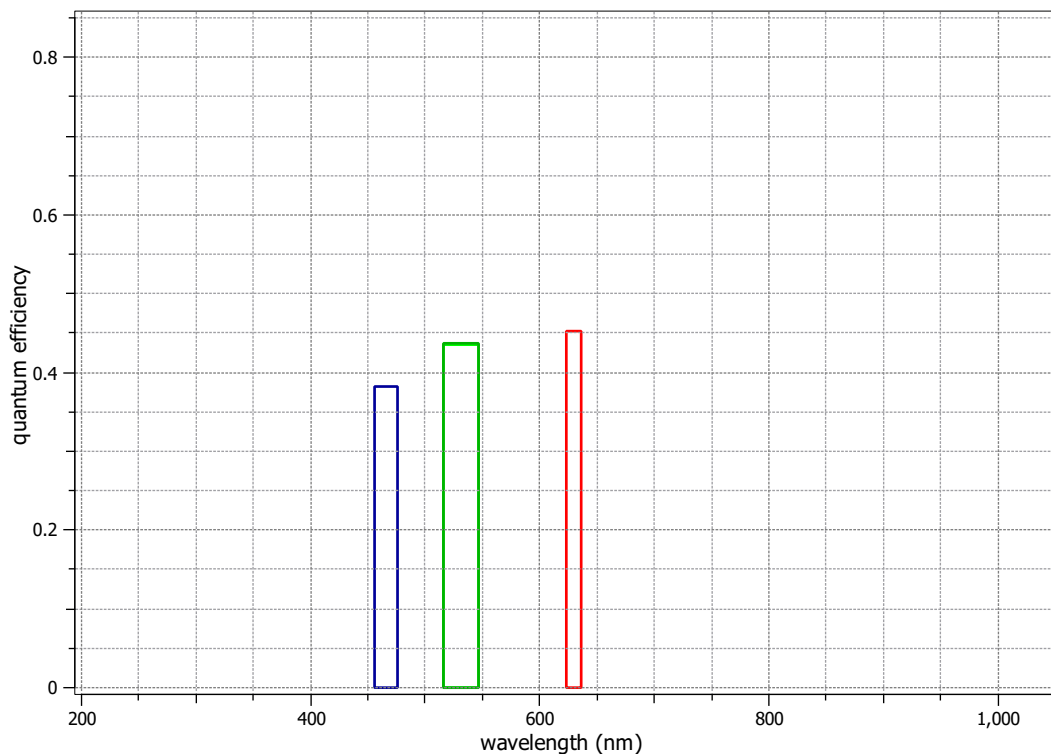
$T_d$  — °C

## EMVA 1288 Data Sheet m0214

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.

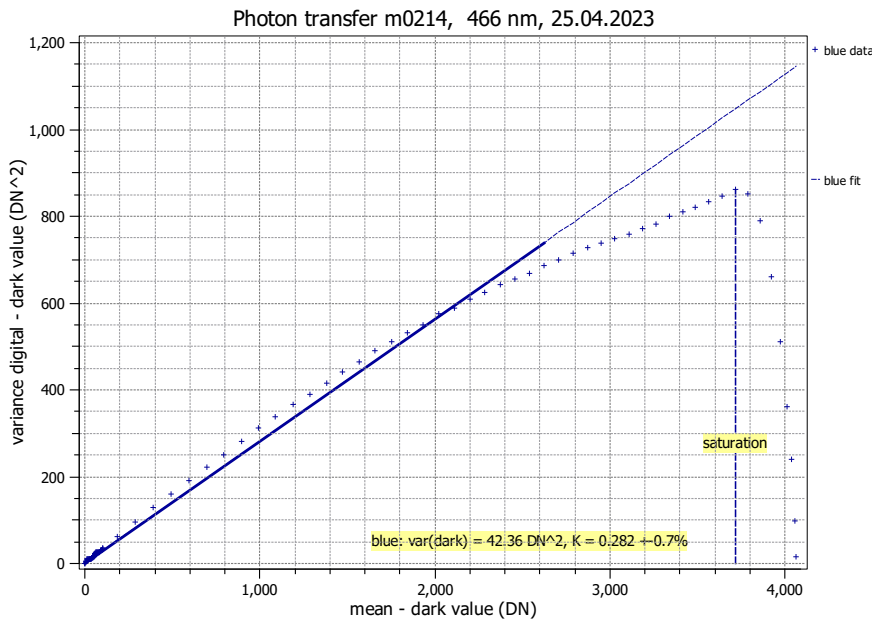
Vendor	Vision Research	Type of data presented	Single
Model	Phantom VEO 640S	<b>Operation point 1</b>	
Serial number	20667	Wavelength centroid	466.2 nm
Sensor diagonal	30.19 mm	Wavelength FWHM	20.3 nm
Lens category	F-Mount	Gain, black-level	1 / 0
Resolution	2560 × 1600, 12 bit	<b>Operation point 2</b>	
Pixel size (h×v)	10.00 μm × 10.00 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	1498.0 Hz	Wavelength FWHM	13.3 nm
Interface type	Ethernet	Gain, black-level	1 / 0
		<b>Optional data measured</b>	None



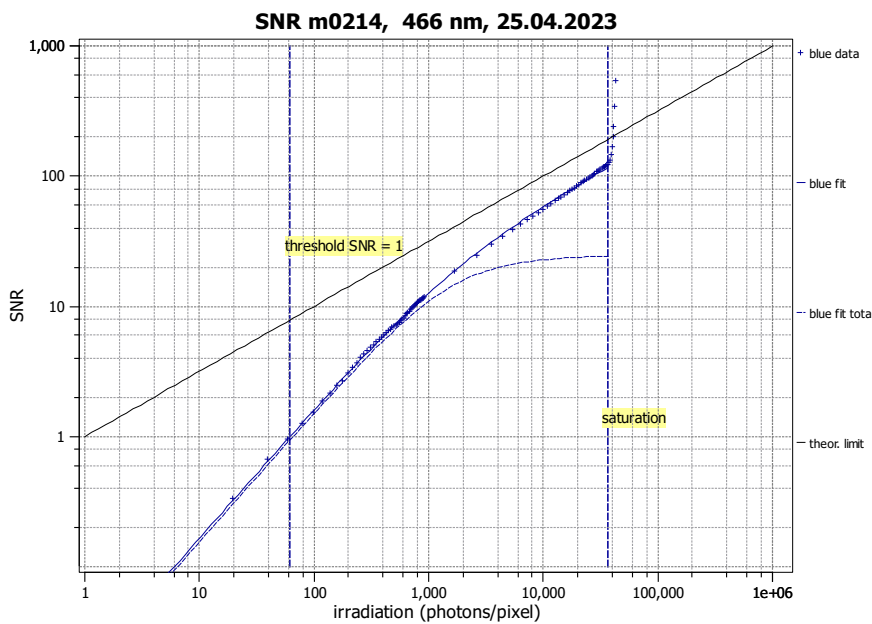
## Summary Sheet for Operation Point 1 at a Wavelength of 466 nm

Type of data	Single	Gain, black-level	1 / 0
Exposure control	By irradiance	Environmental temperature	25.5°C
Exposure time	200.00 μs	Camera body temperature	37.5°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



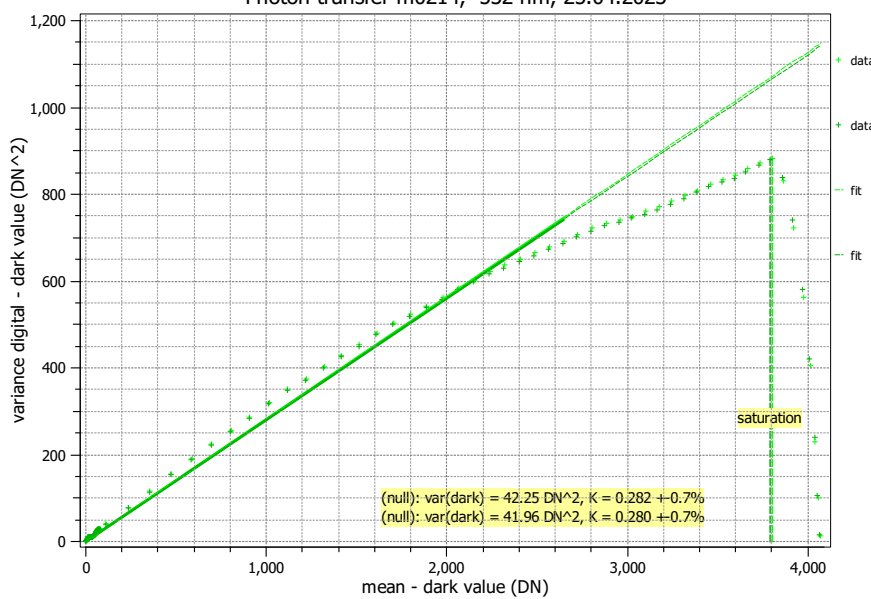
<b>Quantum efficiency</b>	
$\eta$	38.2%
<b>Overall system gain</b>	
$K$	0.282 DN/e <sup>-</sup>
$1/K$	3.548 e <sup>-</sup> /DN
<b>Temporal dark noise</b>	
$\sigma_d$	23.07 e <sup>-</sup>
$\sigma_{y.dark}$	6.51 DN
<b>Signal-to-noise ratio</b>	
$SNR_{max}$	118
	41.4 dB
	6.9 bit
$1/SNR_{max}$	0.85 %
<b>Absolute sensitivity threshold</b>	
$\mu_{p.min}$	61.8 p
$\mu_{p.min.area}$	0.62 p/μm <sup>2</sup>
$\mu_{e.min}$	23.6 e <sup>-</sup>
$\mu_{e.min.area}$	0.24 e <sup>-</sup> /μm <sup>2</sup>
<b>Saturation capacity</b>	
$\mu_{p.sat}$	36503 p
$\mu_{p.sat.area}$	365 p/μm <sup>2</sup>
$\mu_{e.sat}$	13948 e <sup>-</sup>
$\mu_{e.sat.area}$	139 e <sup>-</sup> /μm <sup>2</sup>
<b>Dynamic range</b>	
DR	591
	55.4 dB
	9.2 bit
<b>Spatial nonuniformities</b>	
DSNU <sub>1288</sub>	8.63 e <sup>-</sup>
	2.43 DN
PRNU <sub>1288</sub>	4.04 %
<b>Linearity error</b>	
LE <sub>min</sub>	-3.63%
LE <sub>max</sub>	2.47%
<b>Dark current</b>	
$\mu_{c.mean}$	7789 ± 5681 e <sup>-</sup> /s
	2195.0 DN/s
$\mu_{c.var}$	1035 ± 642 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	25.4°C
Exposure time	200.00 $\mu$ s	Camera body temperature	37.3°C
Frame rate	1000.0 Hz	Internal temperature(s)	—
Data transfer mode	Color 12	Wavelength, centr., FWHM	532 nm, 31.2 nm

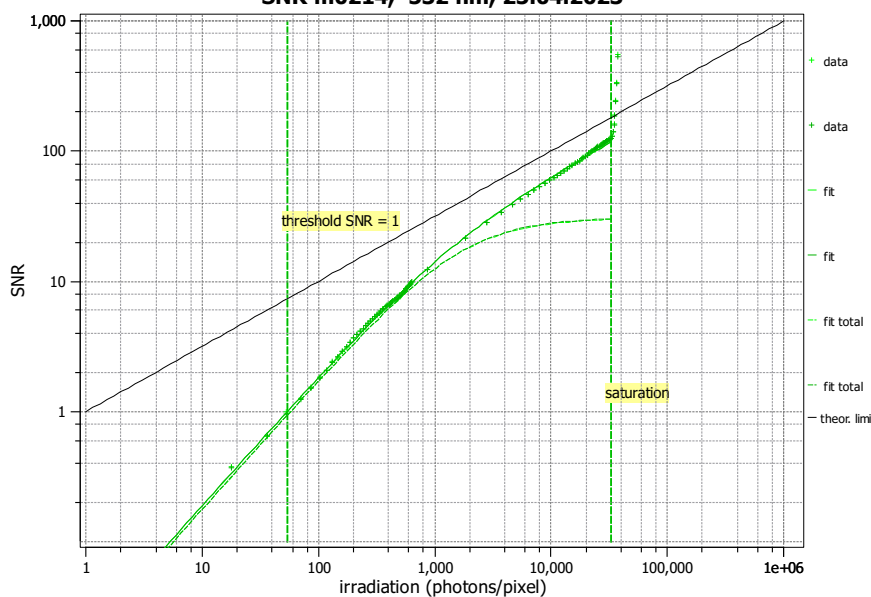
### Photon Transfer

Photon transfer m0214, 532 nm, 25.04.2023



### Signal-to-Noise Ratio

SNR m0214, 532 nm, 25.04.2023



#### Quantum efficiency

$\eta$  43.6%

#### Overall system gain

$K$  0.282 DN/ $e^-$

$1/K$  3.546  $e^-$ /DN

#### Temporal dark noise

$\sigma_d$  23.02  $e^-$

$\sigma_{y,\text{dark}}$  6.50 DN

#### Signal-to-noise ratio

$SNR_{\text{max}}$  120

41.6 dB

6.9 bit

$1/SNR_{\text{max}}$  0.84 %

#### Absolute sensitivity threshold

$\mu_{p,\text{min}}$  54.1 p

$\mu_{p,\text{min},\text{area}}$  0.54 p/ $\mu\text{m}^2$

$\mu_{e,\text{min}}$  23.6  $e^-$

$\mu_{e,\text{min},\text{area}}$  0.24  $e^-$ / $\mu\text{m}^2$

#### Saturation capacity

$\mu_{p,\text{sat}}$  32905 p

$\mu_{p,\text{sat},\text{area}}$  329 p/ $\mu\text{m}^2$

$\mu_{e,\text{sat}}$  14335  $e^-$

$\mu_{e,\text{sat},\text{area}}$  143  $e^-$ / $\mu\text{m}^2$

#### Dynamic range

DR 609

55.7 dB

9.2 bit

#### Spatial nonuniformities

$DSNU_{1288}$  8.62  $e^-$

2.43 DN

$PRNU_{1288}$  3.24 %

#### Linearity error

$LE_{\text{min}}$  -3.87%

$LE_{\text{max}}$  2.57%

#### Dark current

$\mu_{c,\text{mean}}$  7757  $\pm$  5667  $e^-$ /s

2187.6 DN/s

$\mu_{c,\text{var}}$  1021  $\pm$  637  $e^-$ /s

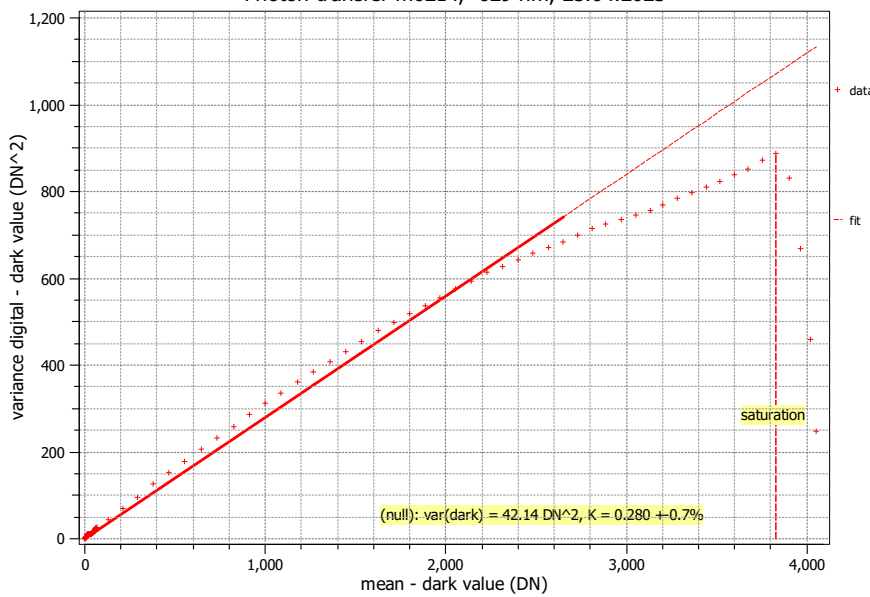
$T_D$  — °C

## 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	25.3°C
Exposure time	200.00 $\mu$ s	Camera body temperature	37.4°C
Frame rate	1000.0 Hz	Internal temperature(s)	—
Data transfer mode	Color 12	Wavelength, centr., FWHM	629 nm, 13.3 nm

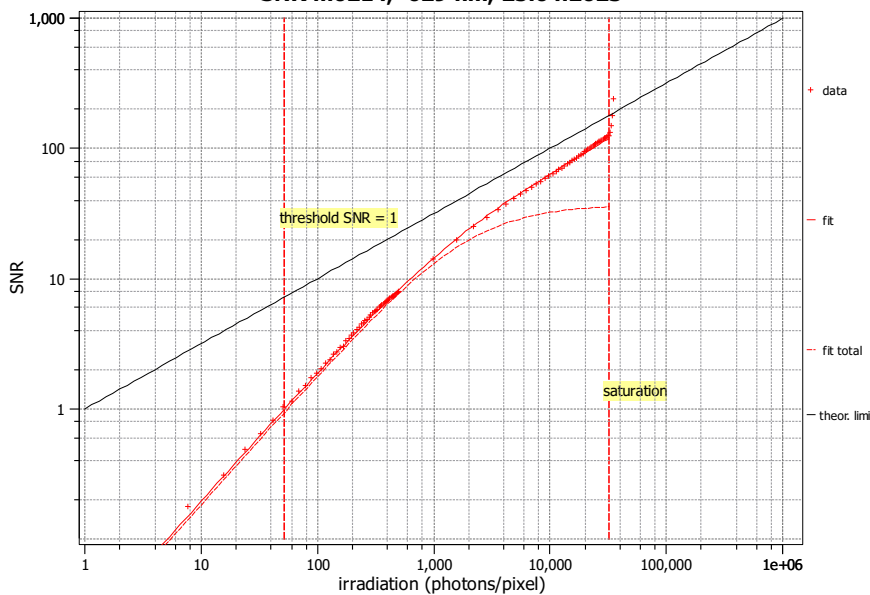
### Photon Transfer

Photon transfer m0214, 629 nm, 25.04.2023



### Signal-to-Noise Ratio

SNR m0214, 629 nm, 25.04.2023



<b>Quantum efficiency</b>	
$\eta$	45.3%
<b>Overall system gain</b>	
$K$	0.280 DN/e <sup>-</sup>
$1/K$	3.572 e <sup>-</sup> /DN
<b>Temporal dark noise</b>	
$\sigma_d$	23.16 e <sup>-</sup>
$\sigma_{y,\text{dark}}$	6.49 DN
<b>Signal-to-noise ratio</b>	
SNR <sub>max</sub>	121
	41.6 dB
	6.9 bit
$1/\text{SNR}_{\text{max}}$	0.83 %
<b>Absolute sensitivity threshold</b>	
$\mu_{p,\text{min}}$	52.3 p
$\mu_{p,\text{min,area}}$	0.52 p/ $\mu\text{m}^2$
$\mu_{e,\text{min}}$	23.7 e <sup>-</sup>
$\mu_{e,\text{min,area}}$	0.24 e <sup>-</sup> / $\mu\text{m}^2$
<b>Saturation capacity</b>	
$\mu_{p,\text{sat}}$	32164 p
$\mu_{p,\text{sat,area}}$	322 p/ $\mu\text{m}^2$
$\mu_{e,\text{sat}}$	14559 e <sup>-</sup>
$\mu_{e,\text{sat,area}}$	146 e <sup>-</sup> / $\mu\text{m}^2$
<b>Dynamic range</b>	
DR	614
	55.8 dB
	9.3 bit
<b>Spatial nonuniformities</b>	
DSNU <sub>1288</sub>	8.67 e <sup>-</sup>
	2.43 DN
PRNU <sub>1288</sub>	2.68 %
<b>Linearity error</b>	
LE <sub>min</sub>	-4.22%
LE <sub>max</sub>	2.63%
<b>Dark current</b>	
$\mu_{c,\text{mean}}$	7777 $\pm$ 5698 e <sup>-</sup> /s
	2181.3 DN/s
$\mu_{c,\text{var}}$	1016 $\pm$ 649 e <sup>-</sup> /s
$T_d$	— °C