

EMVA 1288 Datasheet

This datasheet describes the specification according to the standard 1288 Standard for Characterization and Presentation of Specification Data for Image Sensors and Cameras of European Machine Vision Association (EMVA) (See www.standard1288.org).

Vendor	Teledyne IIS	Overlap capabilities	Yes
Model	Blackfly S BFS-U3-120S6C-BD2	Maximum readout rate	32.32
Firmware	2510.11.11.0	Dark current compensation	Yes
Data type	Single, typical	Interface type	PGE
Sensor type	CMOS	Irradiation calibration accuracy	3%
Diagonal	11.223	Standard version	4.0
Lens category	C-Mount	Light source non uniformity	< 0.23%
Resolution	4096x3000 pixels	Light source	Integrating sphere
Pixel size	2.74x2.74 μm		
Shutter type	Global Shutter		

Operation Point: Red channel (Page 3)

Camera setting

Pixel Format	BayerRG16
High Conversion Gain	Off
Gain	0.0
Black level	0.10
ADC bit depth	12
Device Temperature	39.58 °C

Operation point parameters

Wavelength	627.7 nm
Exposure minimum	42.0 us
Exposure maximum	9426.0 us
Exposure steps	50
Variation of Irradiation	Constant illumination with variable exposure time

Operation Point: GreenRed channel (Page 12)

Camera setting

Pixel Format	BayerRG16
High Conversion Gain	Off
Gain	0.0
Black level	0.10
ADC bit depth	12
Device Temperature	39.58 °C

Operation point parameters

Wavelength	523.0 nm
Exposure minimum	42.0 us
Exposure maximum	7585.0 us
Exposure steps	50
Variation of Irradiation	Constant illumination with variable exposure time

Operation Point: GreenBlue channel (Page 21)

Camera setting

Pixel Format	BayerRG16
High Conversion Gain	Off
Gain	0.0
Black level	0.10
ADC bit depth	12
Device Temperature	39.58 °C

Operation point parameters

Wavelength	523.0 nm
Exposure minimum	42.0 us
Exposure maximum	7585.0 us
Exposure steps	50
Variation of Irradiation	Constant illumination with variable exposure time

Operation Point: Blue channel (Page 30)

Camera setting

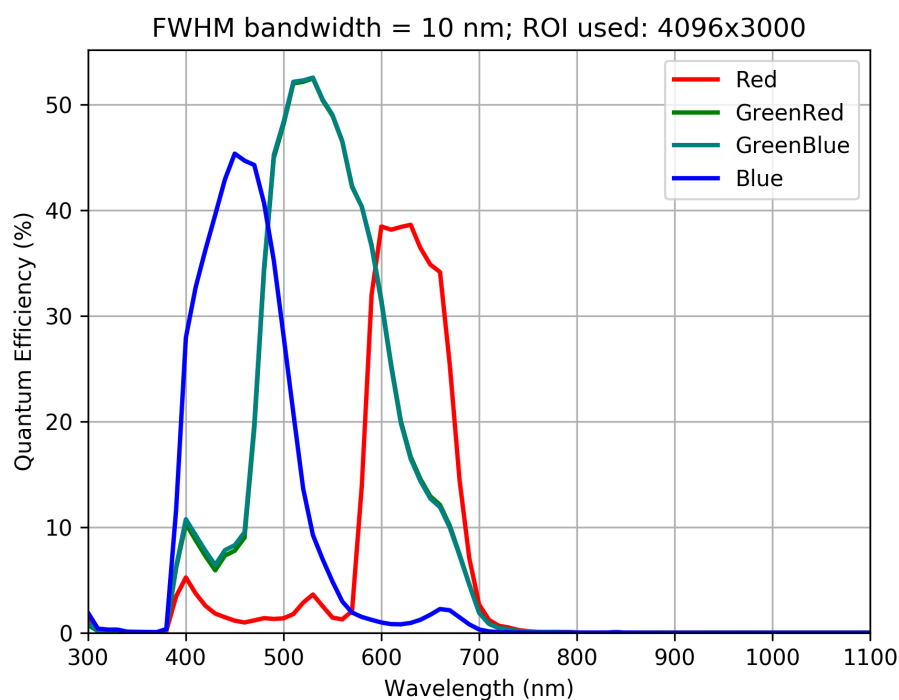
Pixel Format
High Conversion Gain
Gain
Black level
ADC bit depth
Device Temperature

BayerRG16
Off
0.0
0.10
12
39.58 °C

Operation point parameters

Wavelength
Exposure minimum
Exposure maximum
Exposure steps
Variation of Irradiation
Constant illumination with variable exposure time

456.9 nm
42.0 us
8575.0 us
50



Summary sheet for Operation Point: **Red channel** (@627.7 nm wavelength)

Camera setting

Pixel Format	BayerRG16
High Conversion Gain	Off
Gain	0.0
Black level	0.10
ADC bit depth	12
Device Temperature	39.58 °C

Operation point parameters

Wavelength	627.7 nm
Exposure minimum	42.0 us
Exposure maximum	9426.0 us
Exposure steps	50
Variation of Irradiation	Constant illumination with variable exposure time

Performance

Quantum efficiency

η	31.60 %
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System gain

K	6.912 DN/e ⁻
1/K	0.145 e ⁻ /DN

Temporal dark noise

σ_d	2.441 e ⁻
$\sigma_{y.dark}$	16.871 DN

Signal-to-Noise Ratio

SNR_{max}	96
	39.61 dB
	6.6 bit
SNR_{max}^{-1}	1.046 %

Absolute sensitivity threshold

$\mu_{p.min}$	9.307 p
$\mu_{p.min.area}$	1.240 p/ μm^2
$\mu_{e.min}$	2.941 e ⁻
$\mu_{e.min.area}$	0.392 e ⁻ / μm^2

Saturation Capacity

$\mu_{p.sat}$	28944 p
$\mu_{p.sat.area}$	3855.342 p/ μm^2
$\mu_{e.sat}$	9146 e ⁻
$\mu_{e.sat.area}$	1218 e ⁻ / μm^2

Dynamic Range

DR	3110
	69.9 dB

Spatial Nonuniformities

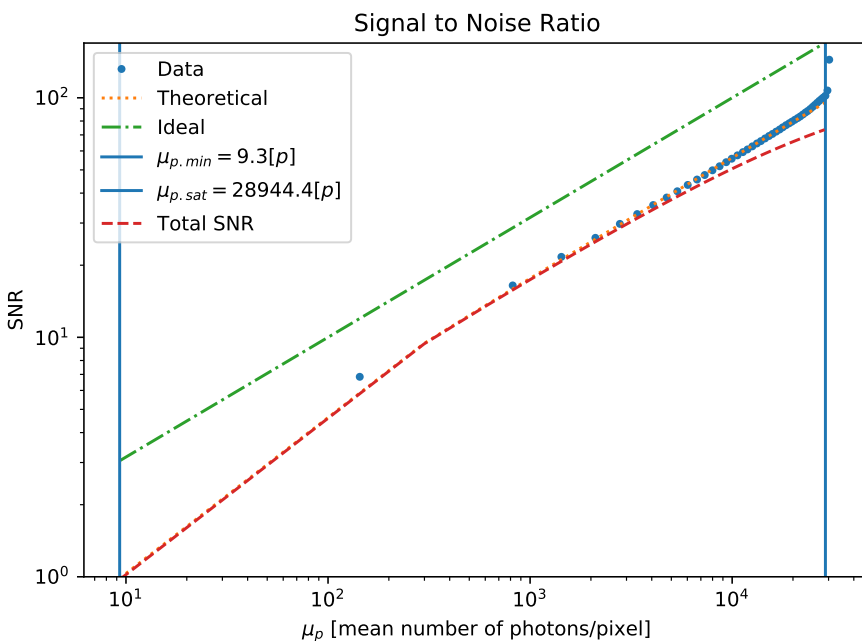
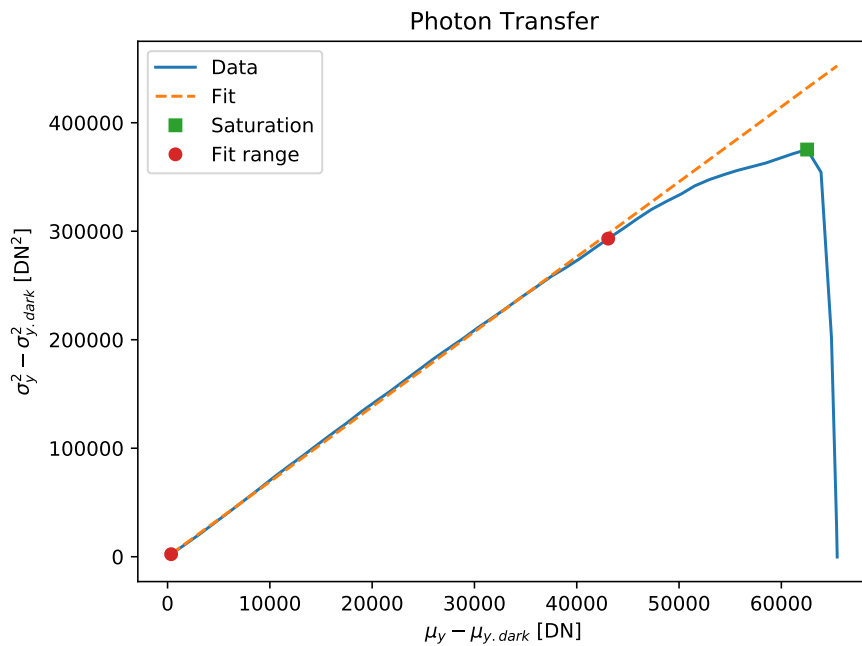
$DSNU_{1288}$	0.5 e ⁻
$DSNU_{1288.row}$	0.0 e ⁻
$DSNU_{1288.col}$	0.0 e ⁻
$DSNU_{1288.pixel}$	0.5 e ⁻
$PRNU_{1288}$	0.9 %
$PRNU_{1288.row}$	0.5 %
$PRNU_{1288.col}$	0.5 %
$PRNU_{1288.pixel}$	0.5 %

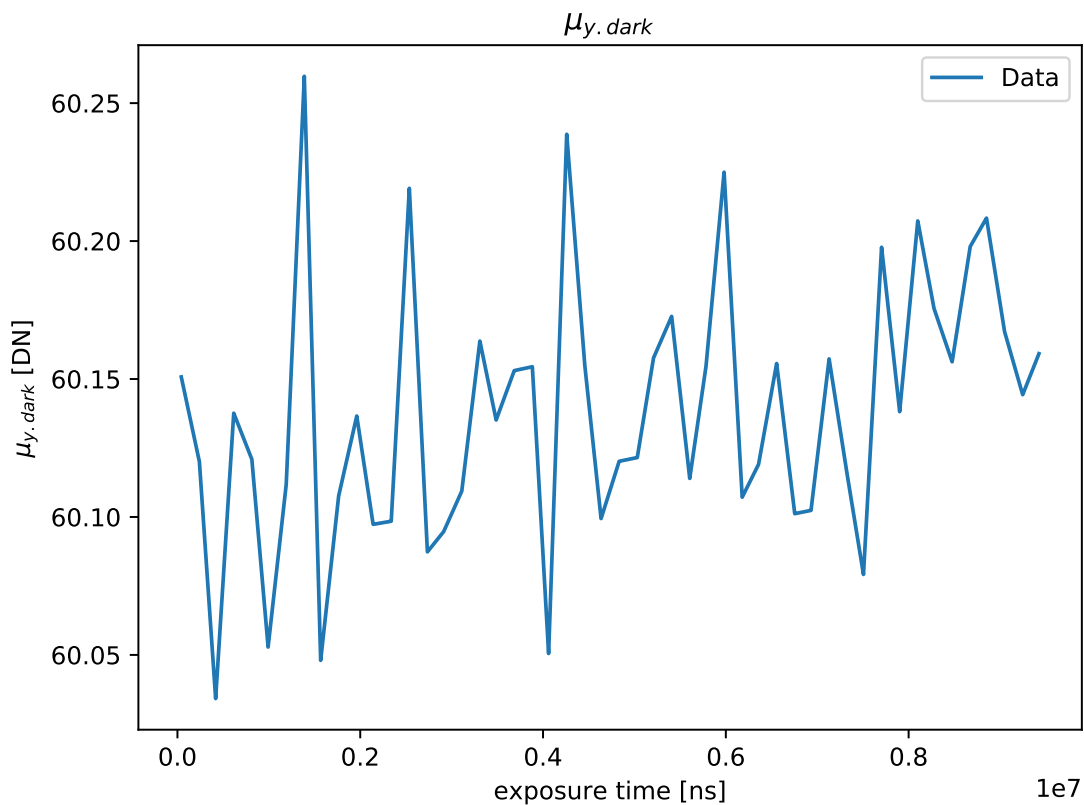
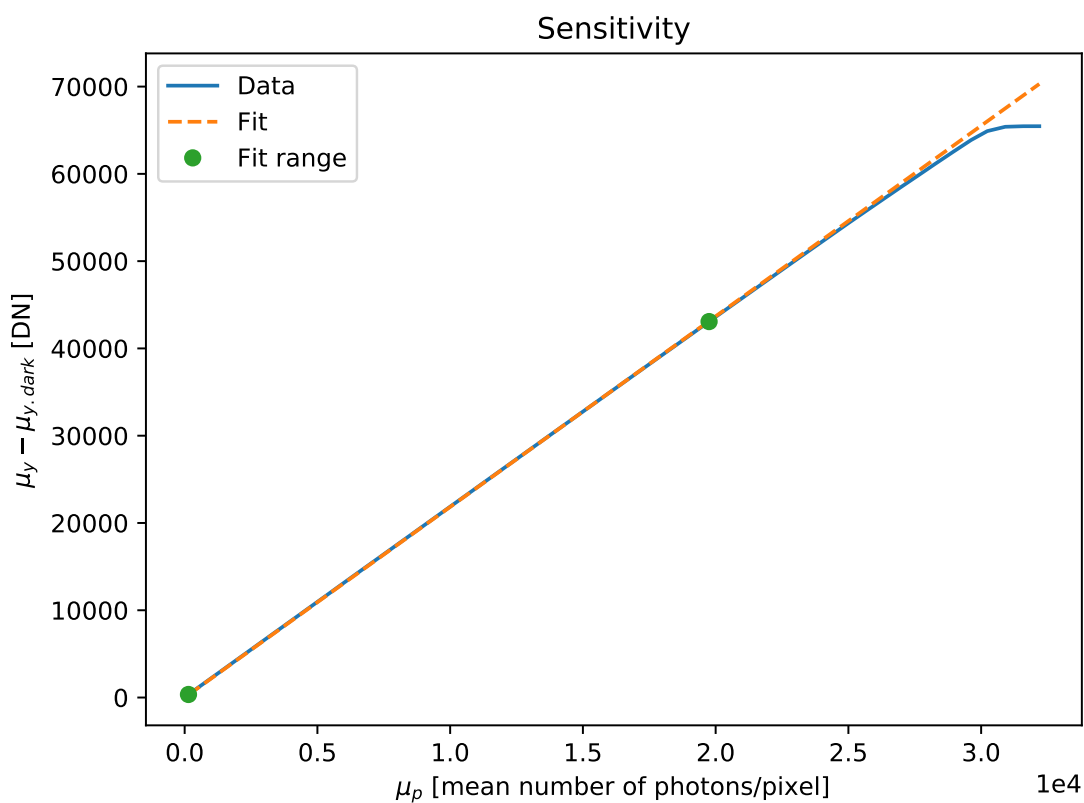
Linearity error

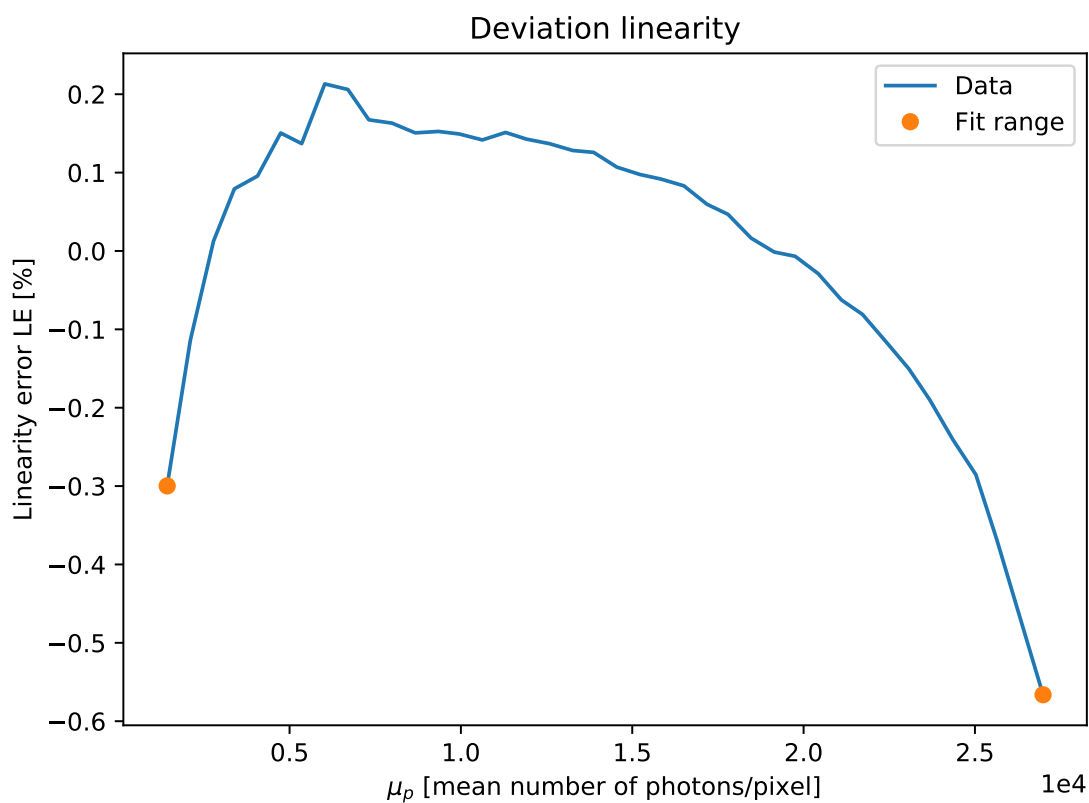
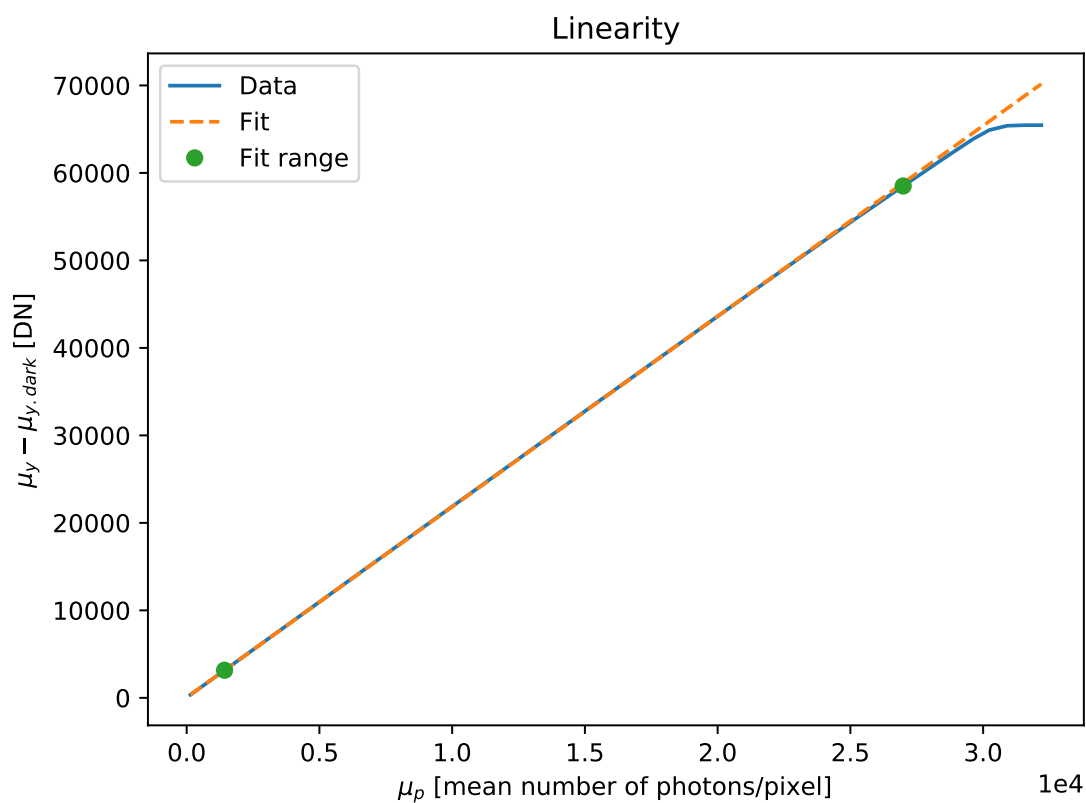
LE_{min}	-0.566 %
LE_{max}	0.213 %

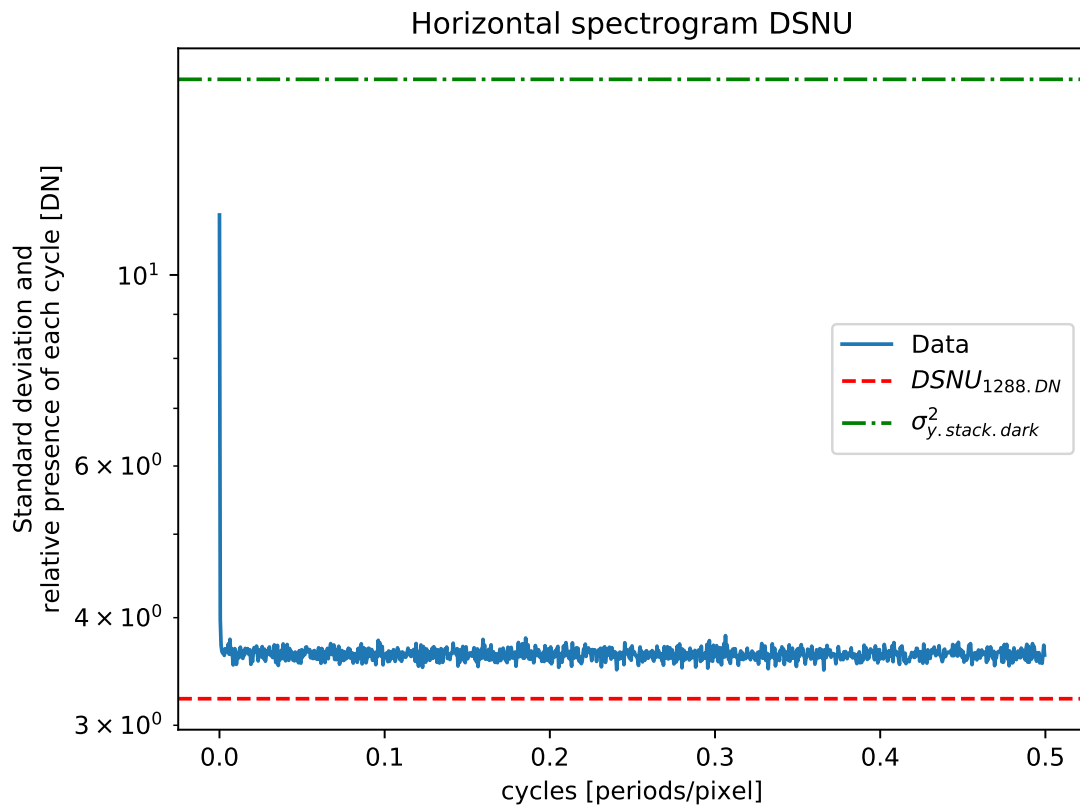
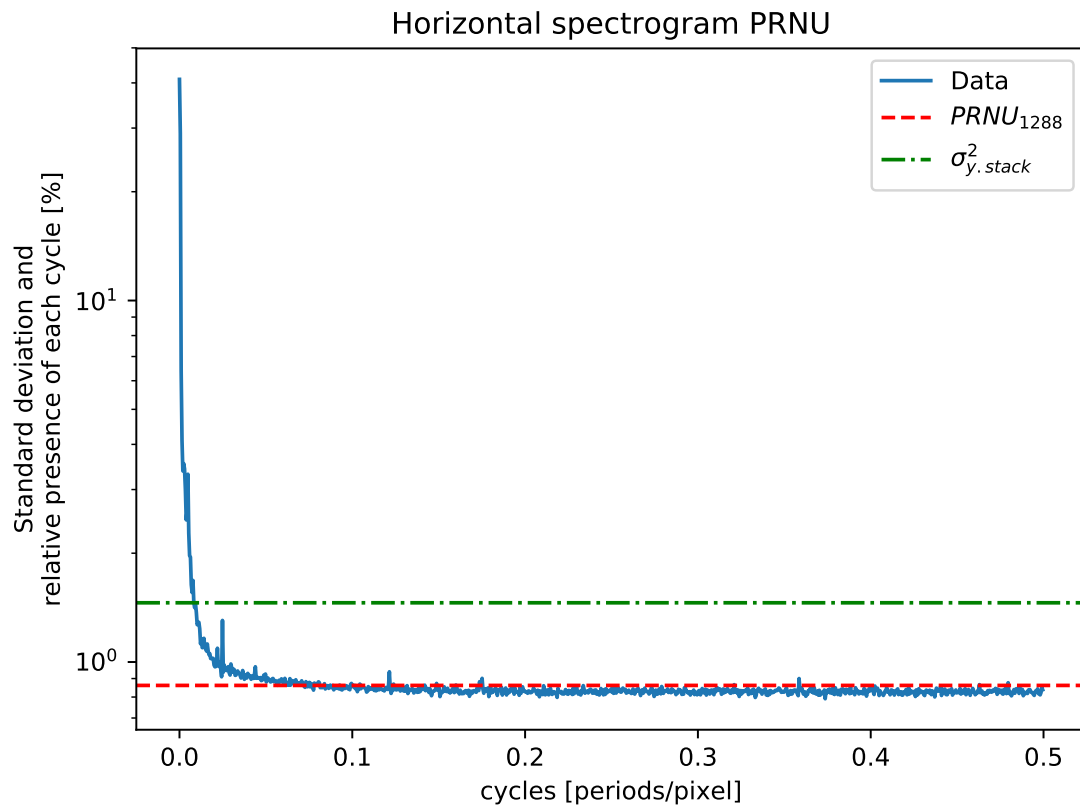
Dark current

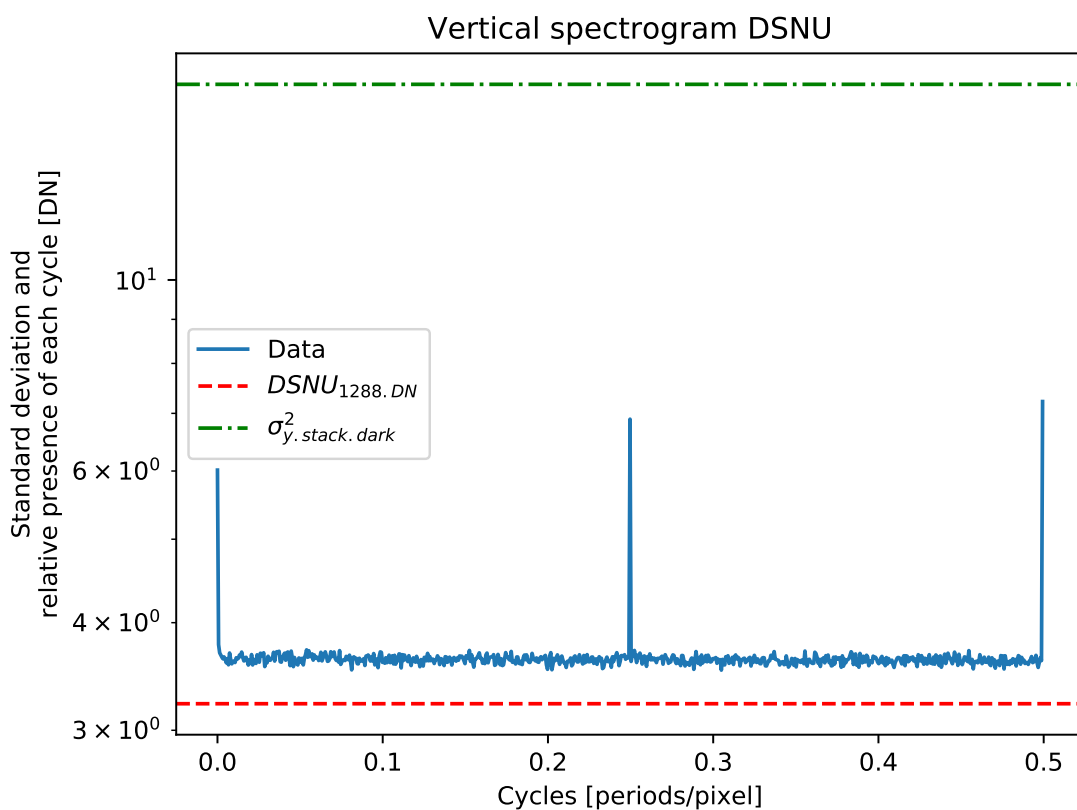
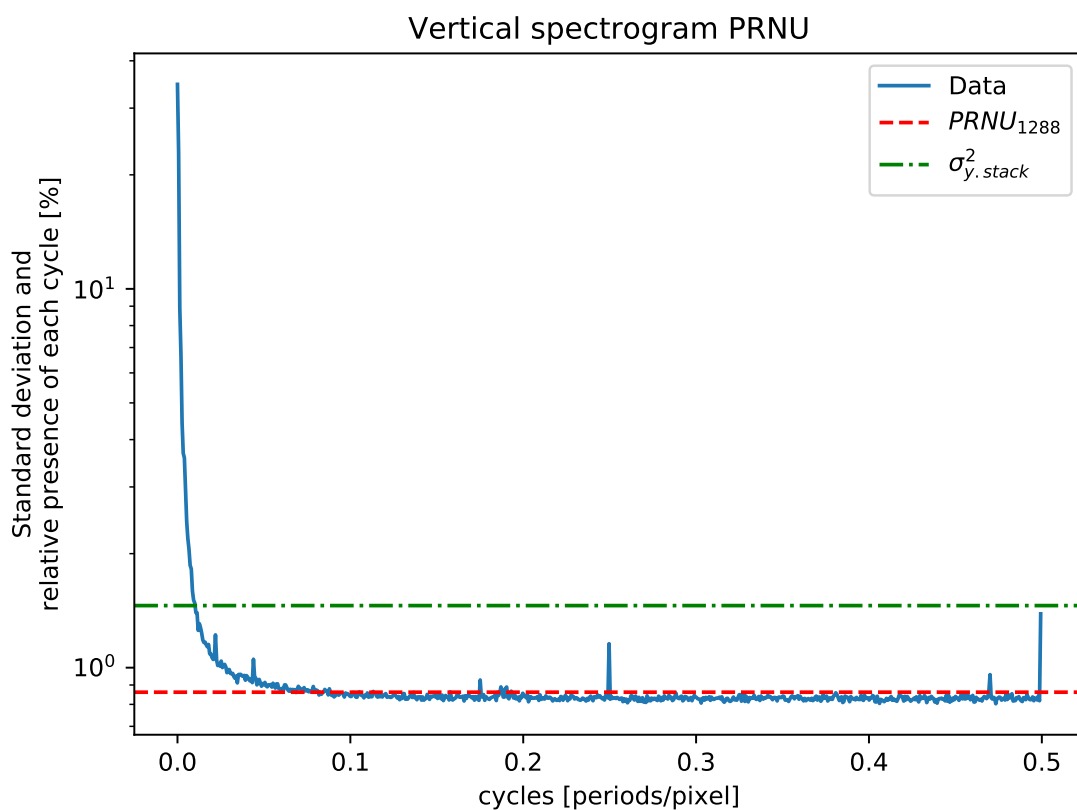
$\mu_{I.mean}$	0.674 e ⁻ /s
	4.658 DN/s
$\mu_{I.var}$	-0.001 e ⁻ /s
	-0.010 DN/s

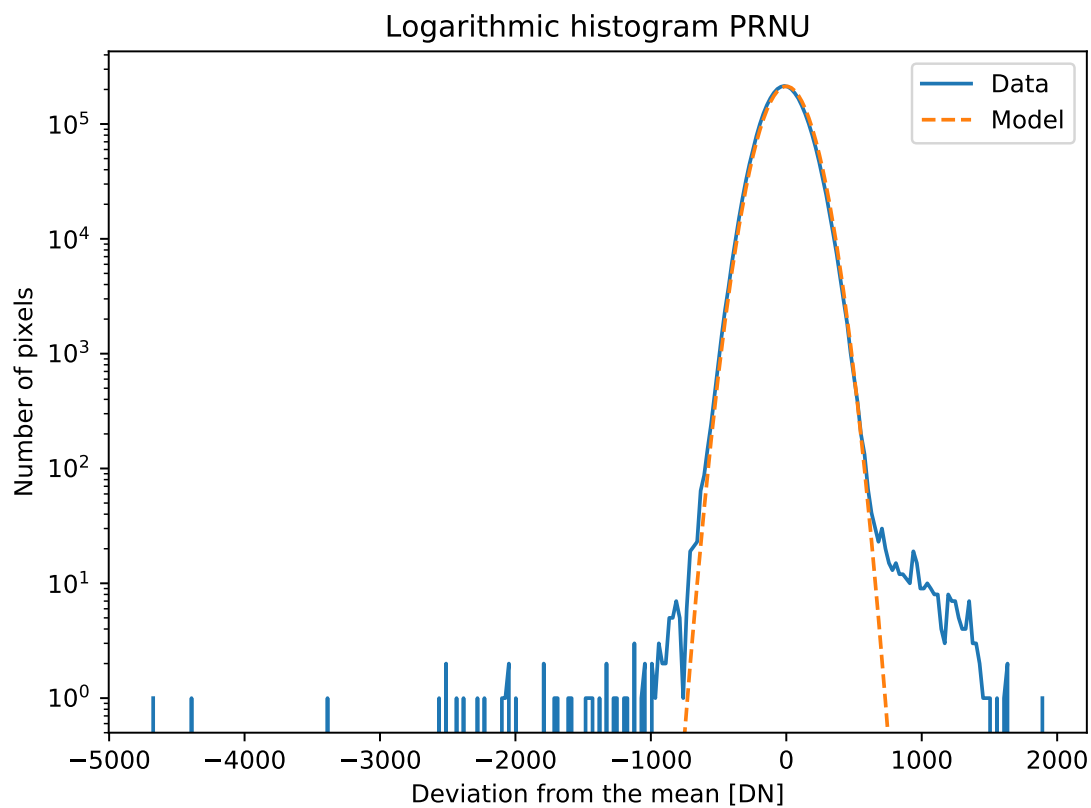
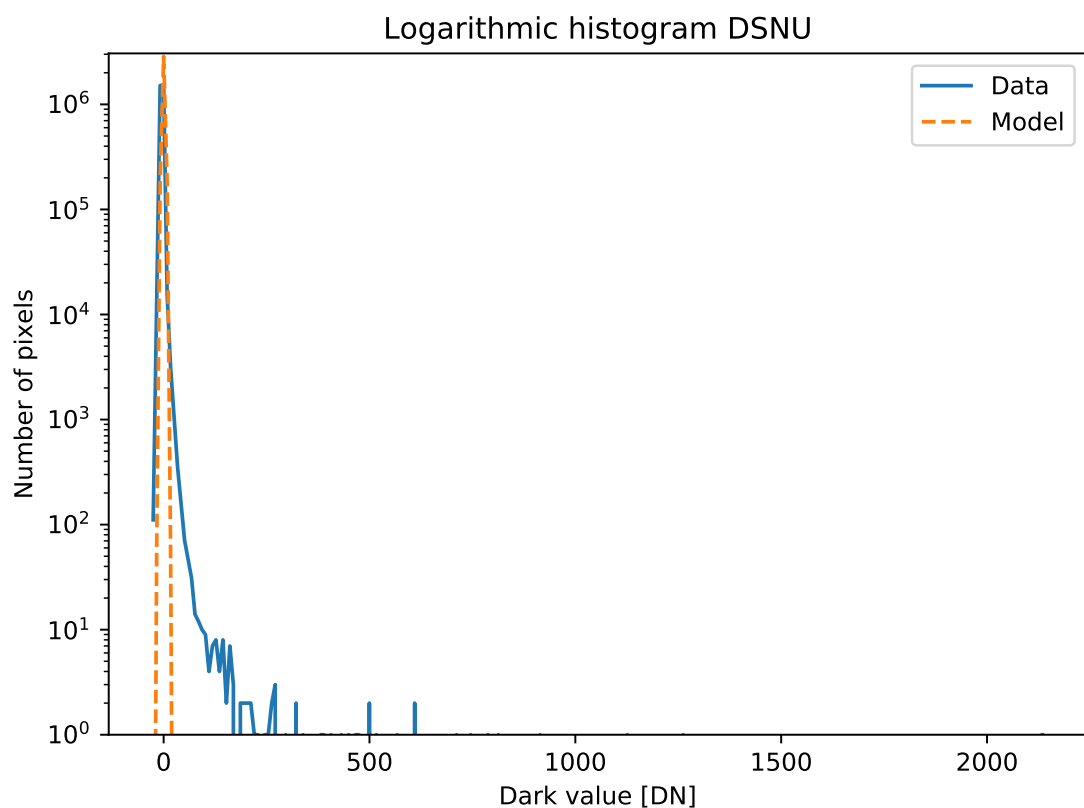


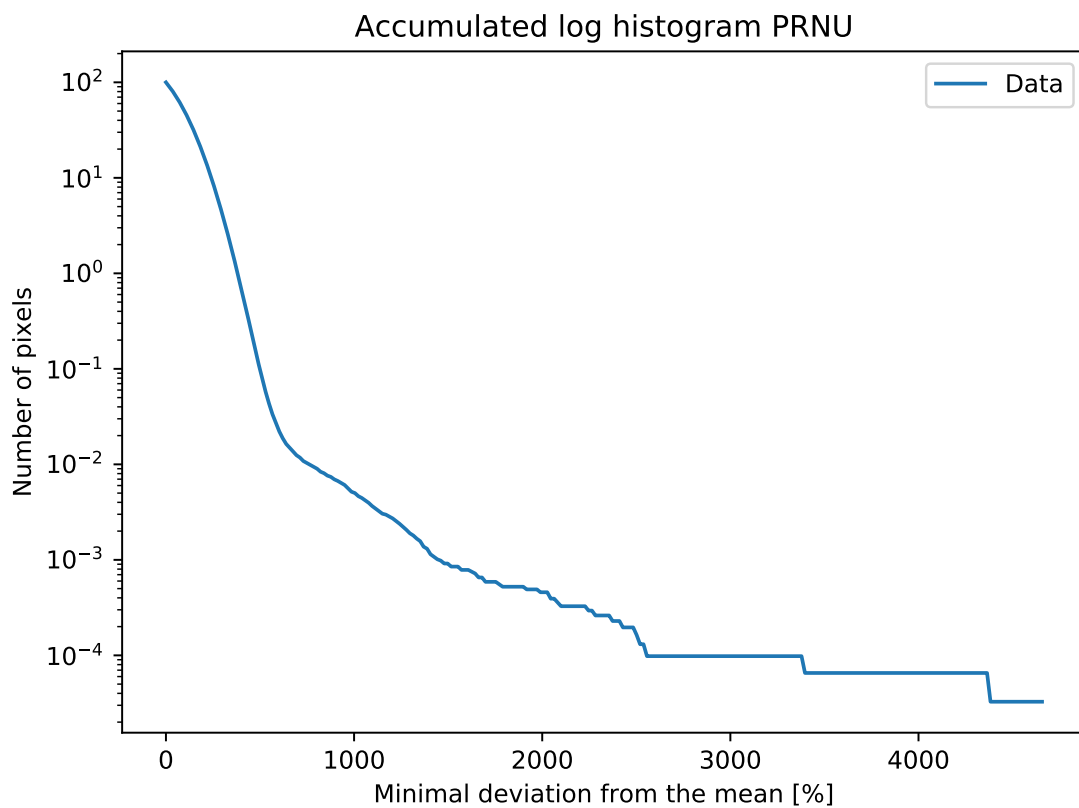
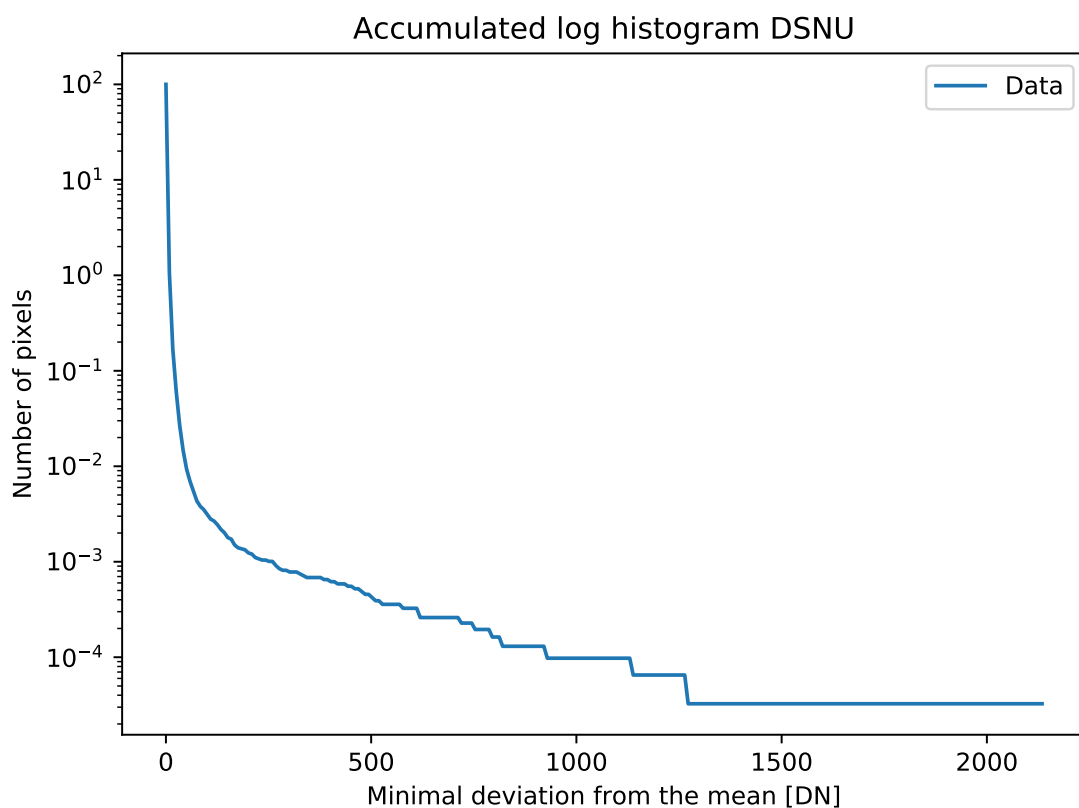


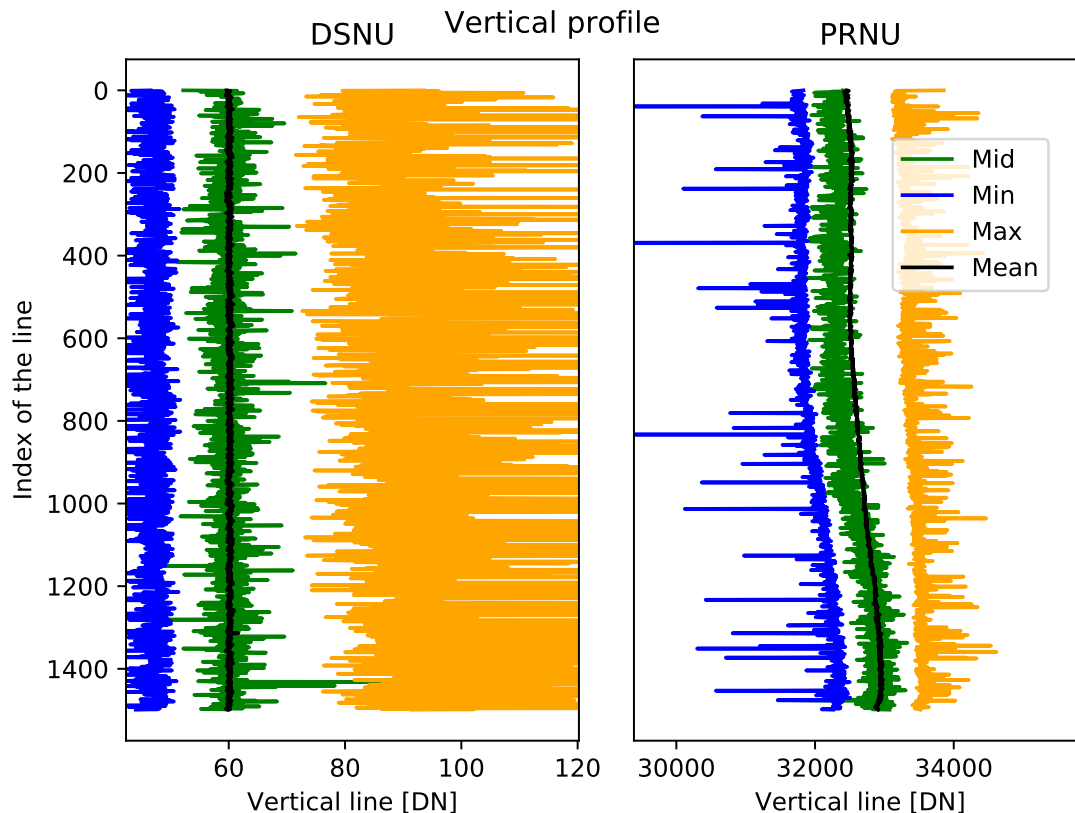
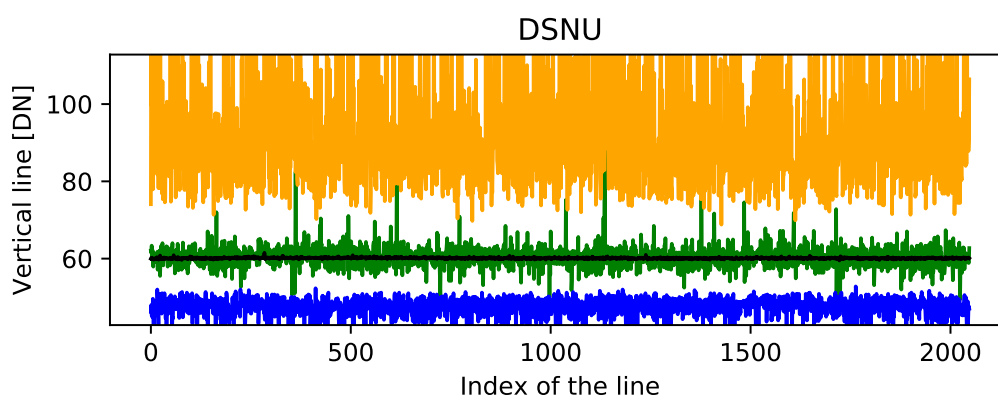
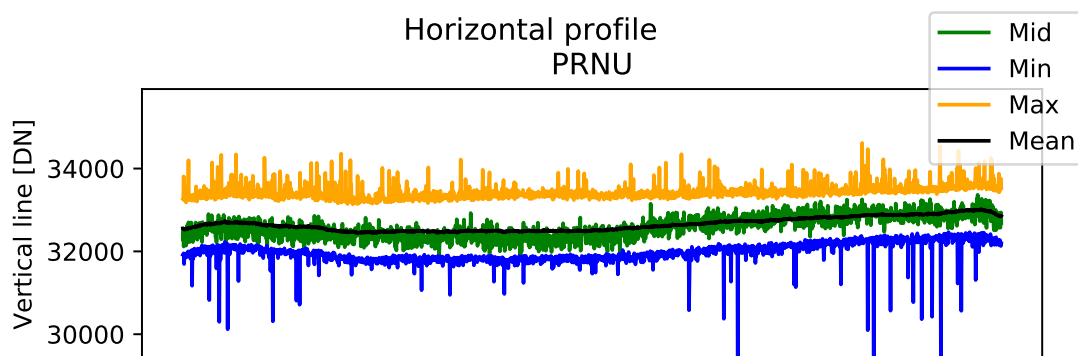


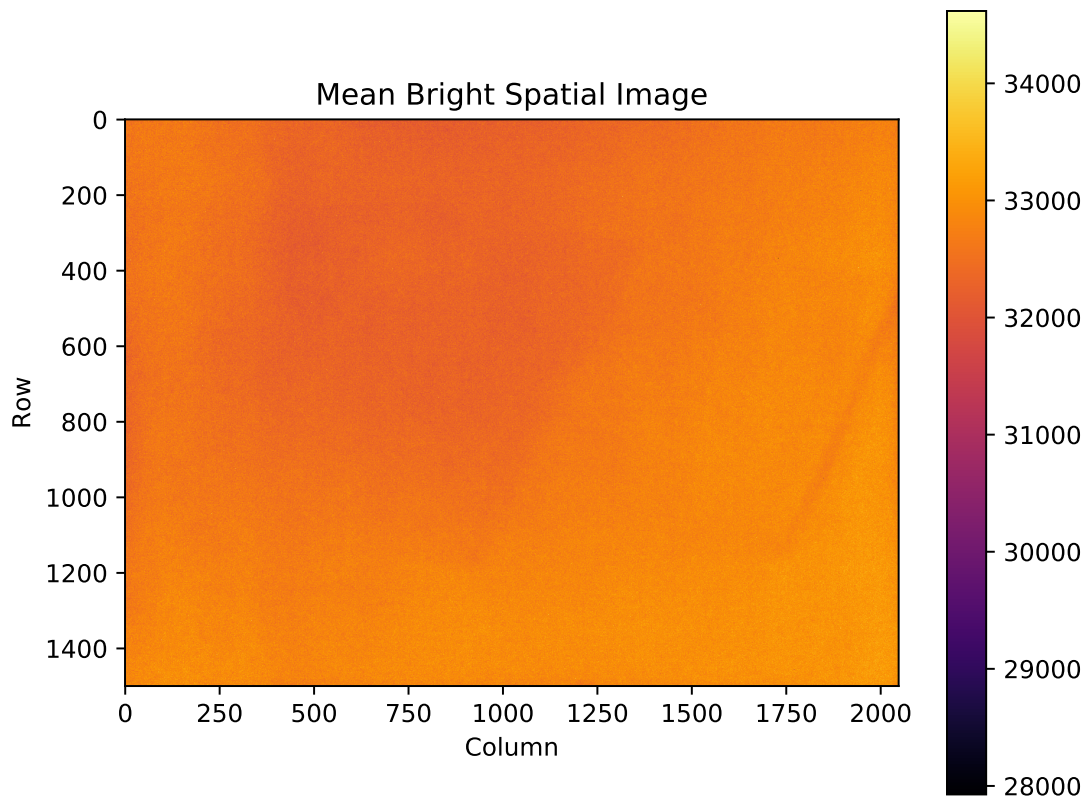
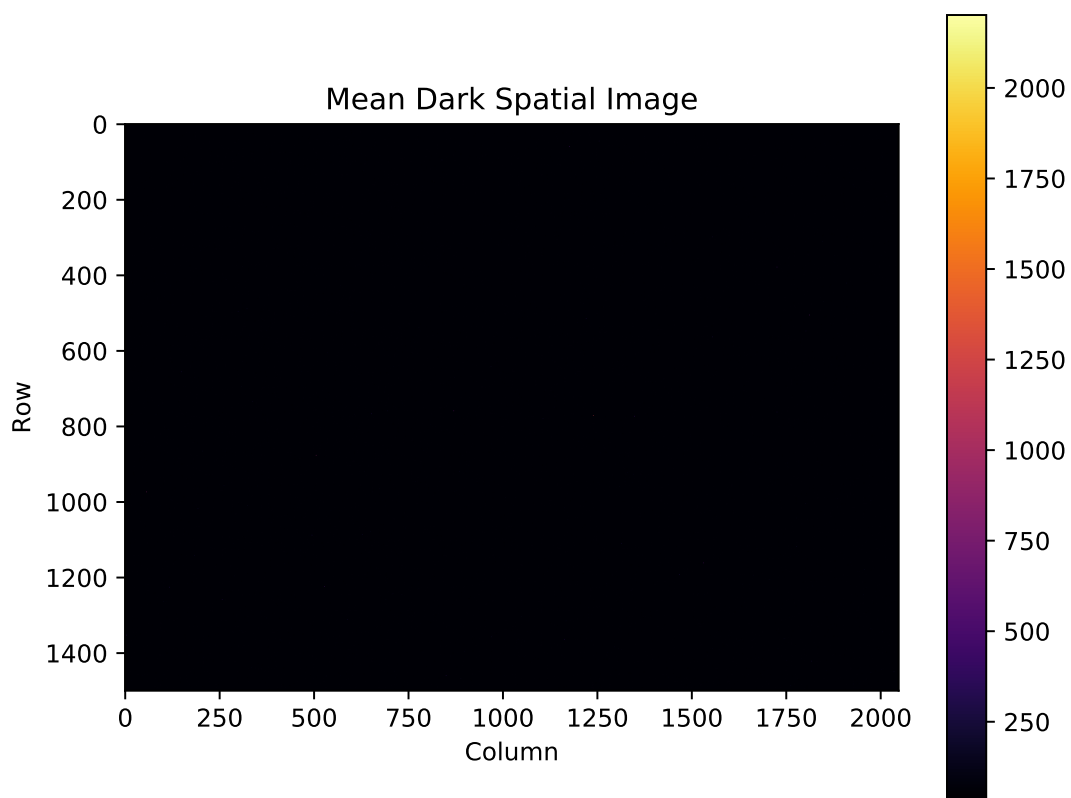












Summary sheet for Operation Point: **GreenRed channel** (@523.0 nm wavelength)

Camera setting

Pixel Format	BayerRG16
High Conversion Gain	Off
Gain	0.0
Black level	0.10
ADC bit depth	12
Device Temperature	39.58 °C

Operation point parameters

Wavelength	523.0 nm
Exposure minimum	42.0 us
Exposure maximum	7585.0 us
Exposure steps	50
Variation of Irradiation	Constant illumination with variable exposure time

Performance

Quantum efficiency

η 49.32 %

System gain

K 6.928 DN/e⁻
1/K 0.144 e⁻/DN

Temporal dark noise

σ_d 2.432 e⁻
 $\sigma_{y.dark}$ 16.849 DN

Signal-to-Noise Ratio

SNR_{max} 96
39.64 dB
6.6 bit
 SNR_{max}^{-1} 1.043 %

Absolute sensitivity threshold

$\mu_{p.min}$ 5.945 p
 $\mu_{p.min.area}$ 0.792 p/ μm^2
 $\mu_{e.min}$ 2.932 e⁻
 $\mu_{e.min.area}$ 0.391 e⁻/ μm^2

Saturation Capacity

$\mu_{p.sat}$ 18653 p
 $\mu_{p.sat.area}$ 2484.559 p/ μm^2
 $\mu_{e.sat}$ 9199 e⁻
 $\mu_{e.sat.area}$ 1225 e⁻/ μm^2

Dynamic Range

DR 3137
69.9 dB

Spatial Nonuniformities

$DSNU_{1288}$ 0.5 e⁻
 $DSNU_{1288.row}$ 0.0 e⁻
 $DSNU_{1288.col}$ 0.0 e⁻
 $DSNU_{1288.pixel}$ 0.5 e⁻
 $PRNU_{1288}$ 0.6 %
 $PRNU_{1288.row}$ 0.2 %
 $PRNU_{1288.col}$ 0.2 %
 $PRNU_{1288.pixel}$ 0.5 %

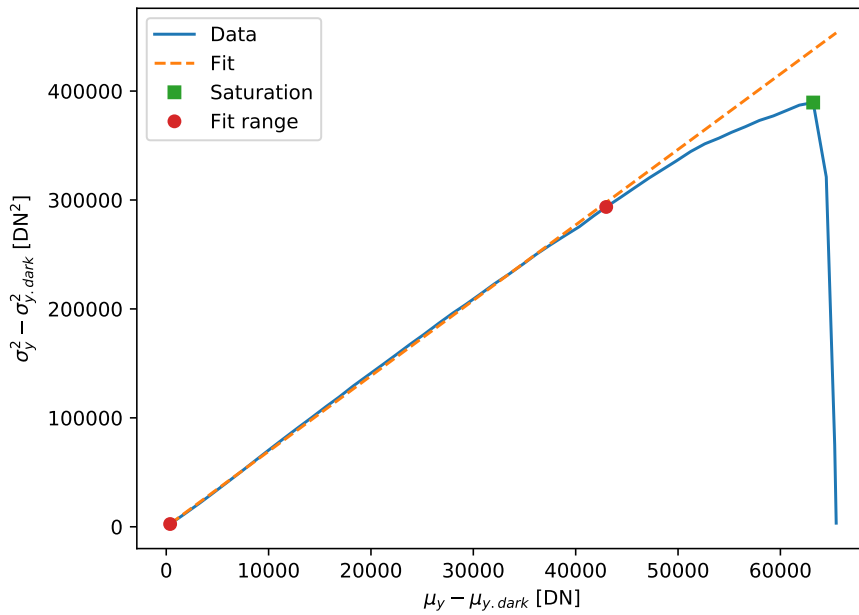
Linearity error

LE_{min} -0.462 %
 LE_{max} 0.189 %

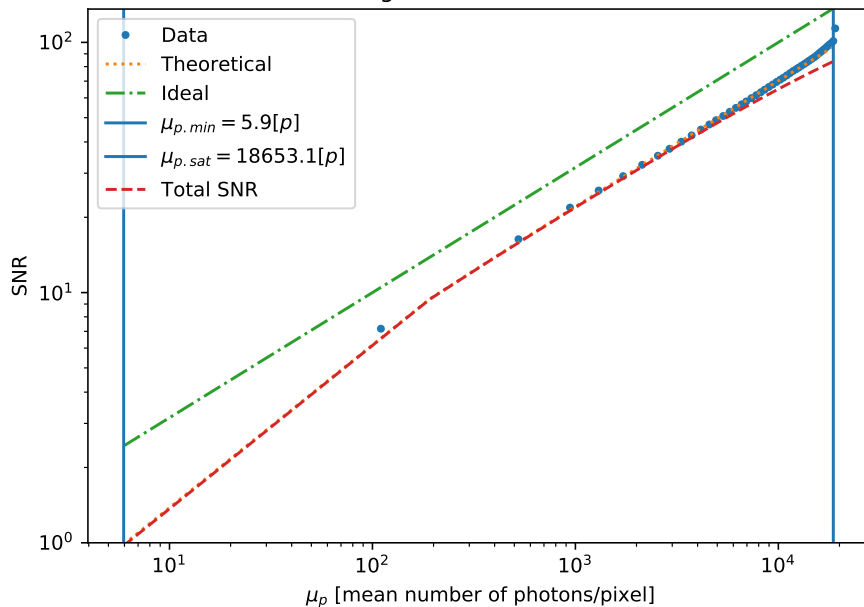
Dark current

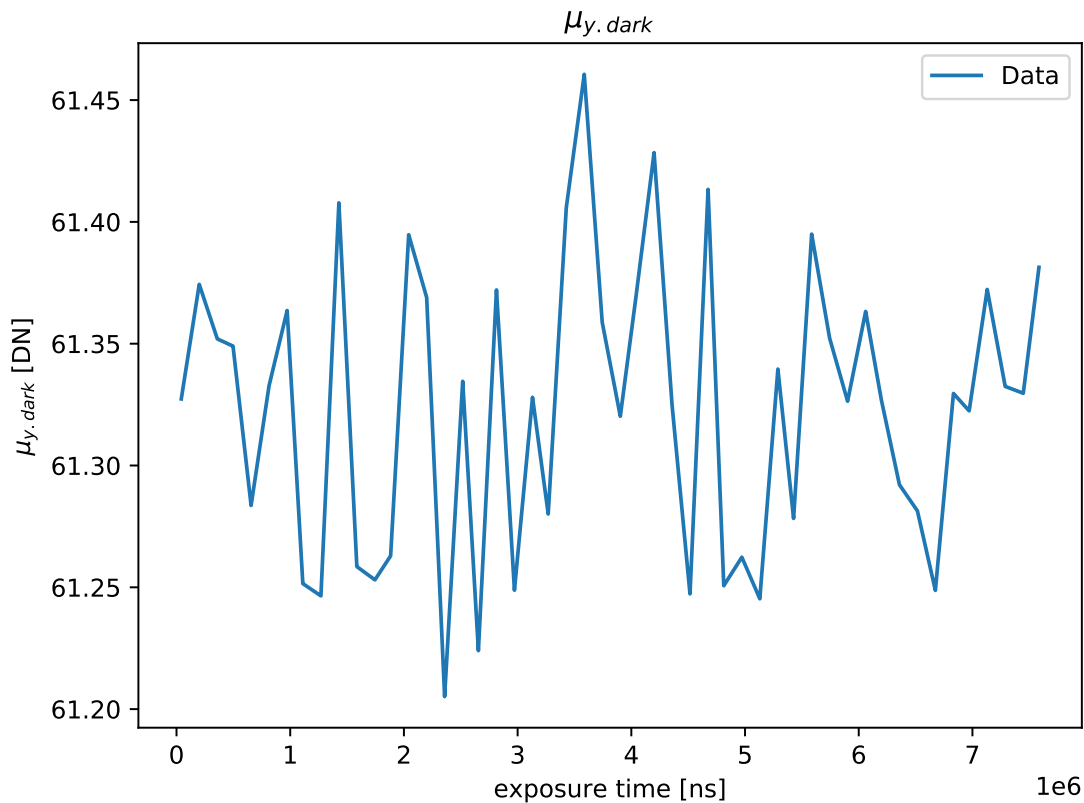
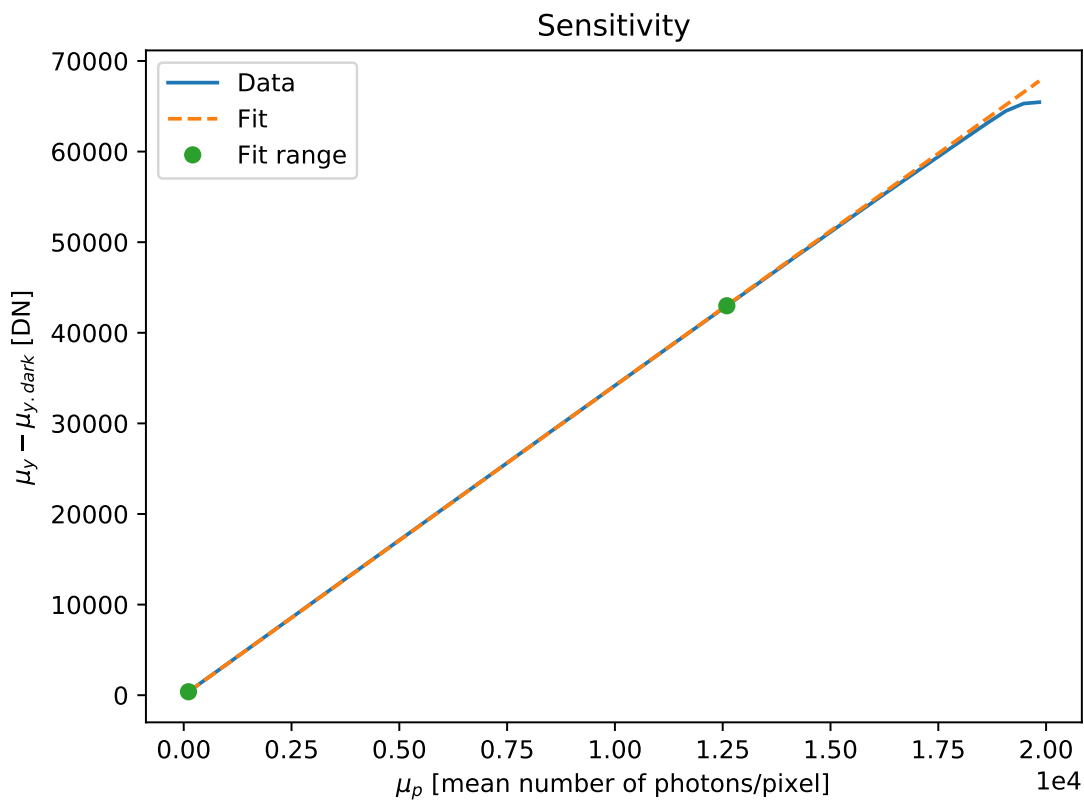
$\mu_{I.mean}$ 0.699 e⁻/s
4.845 DN/s
 $\mu_{I.var}$ -0.000 e⁻/s
-0.001 DN/s

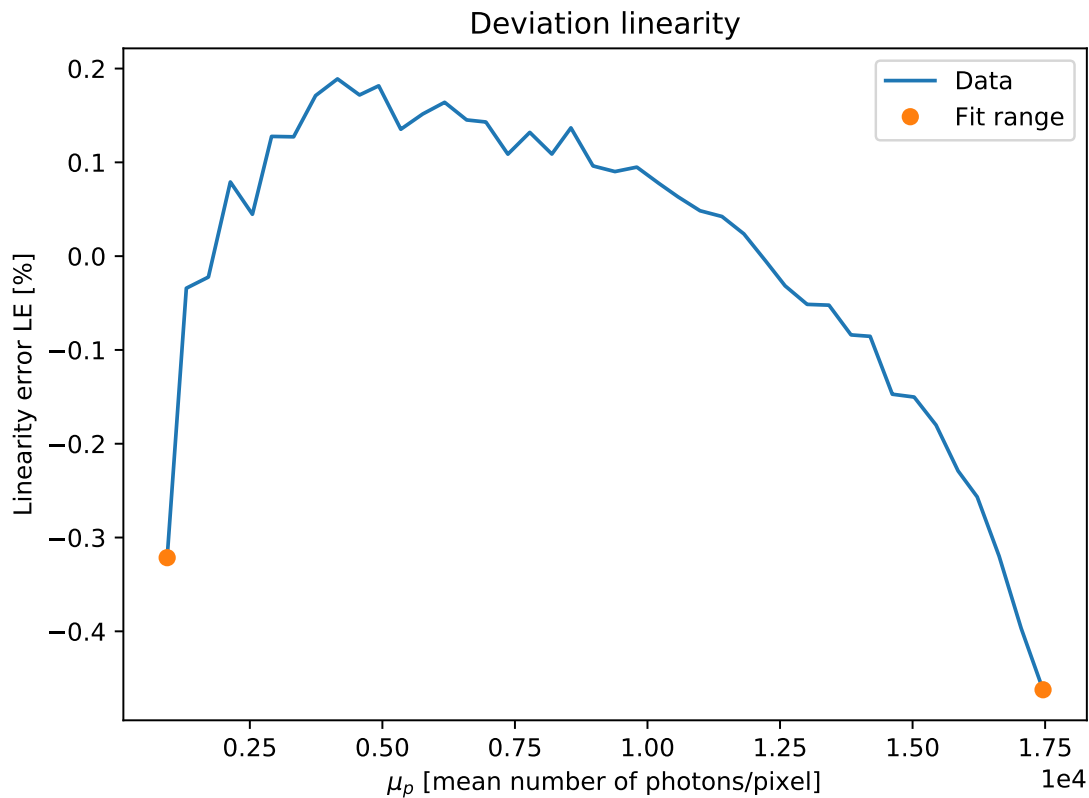
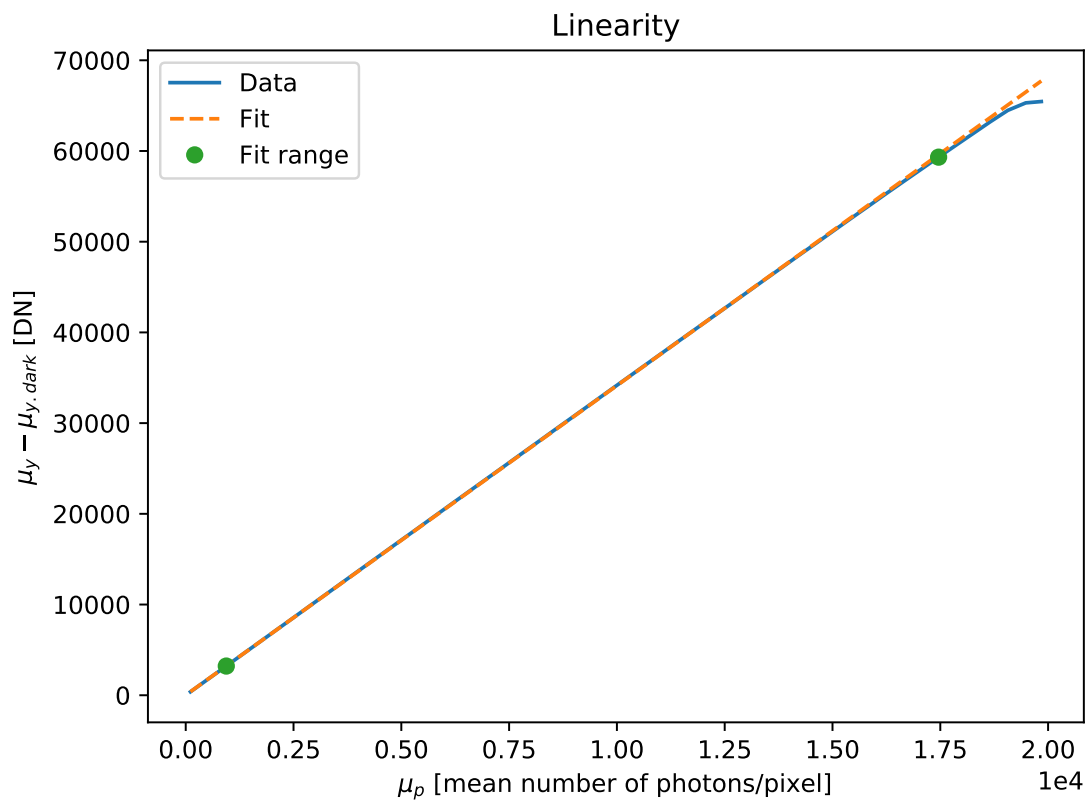
Photon Transfer

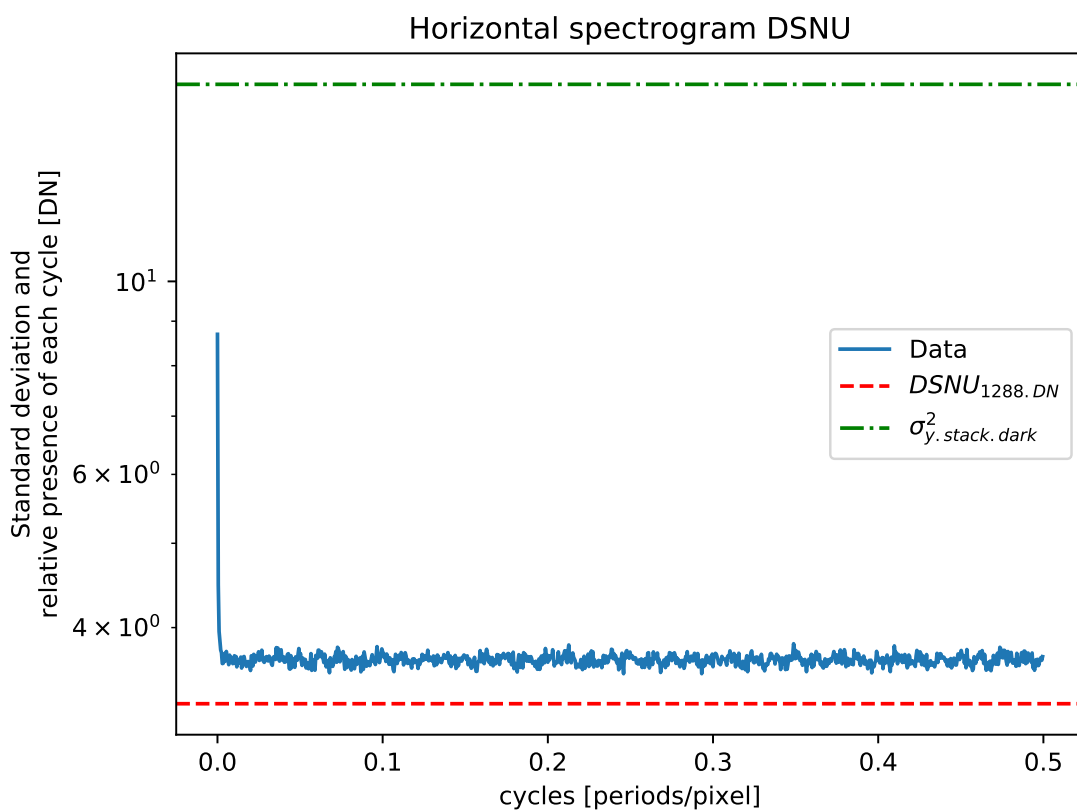
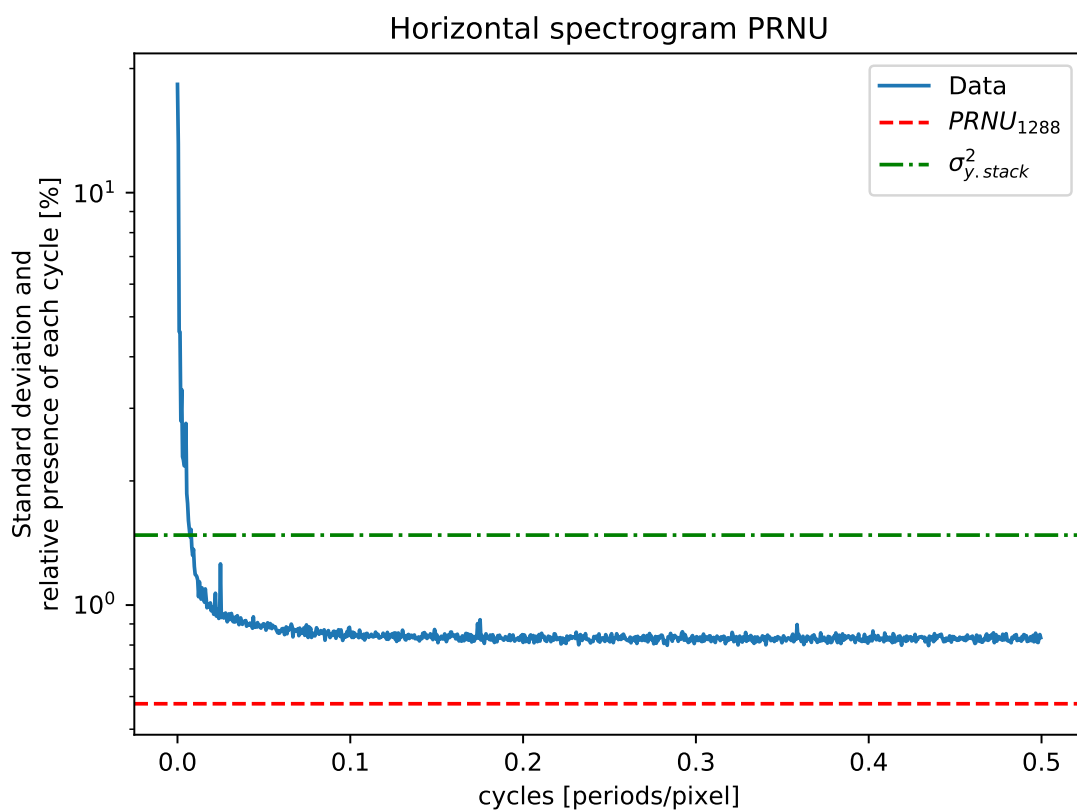


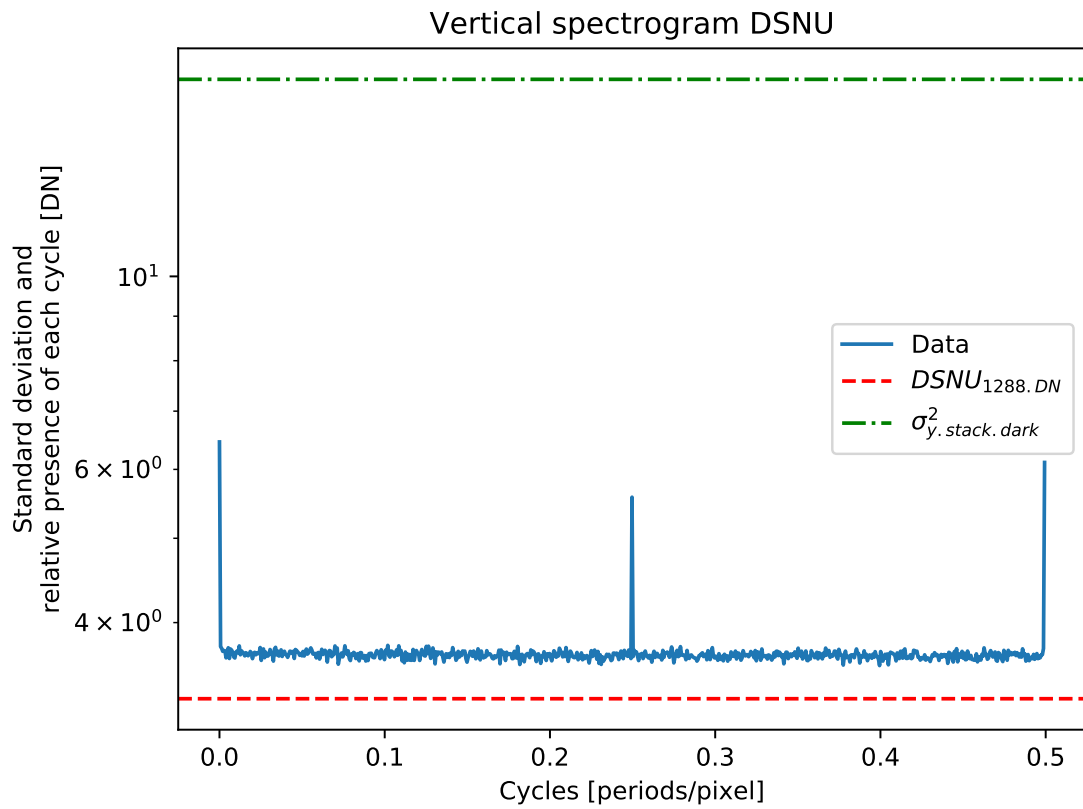
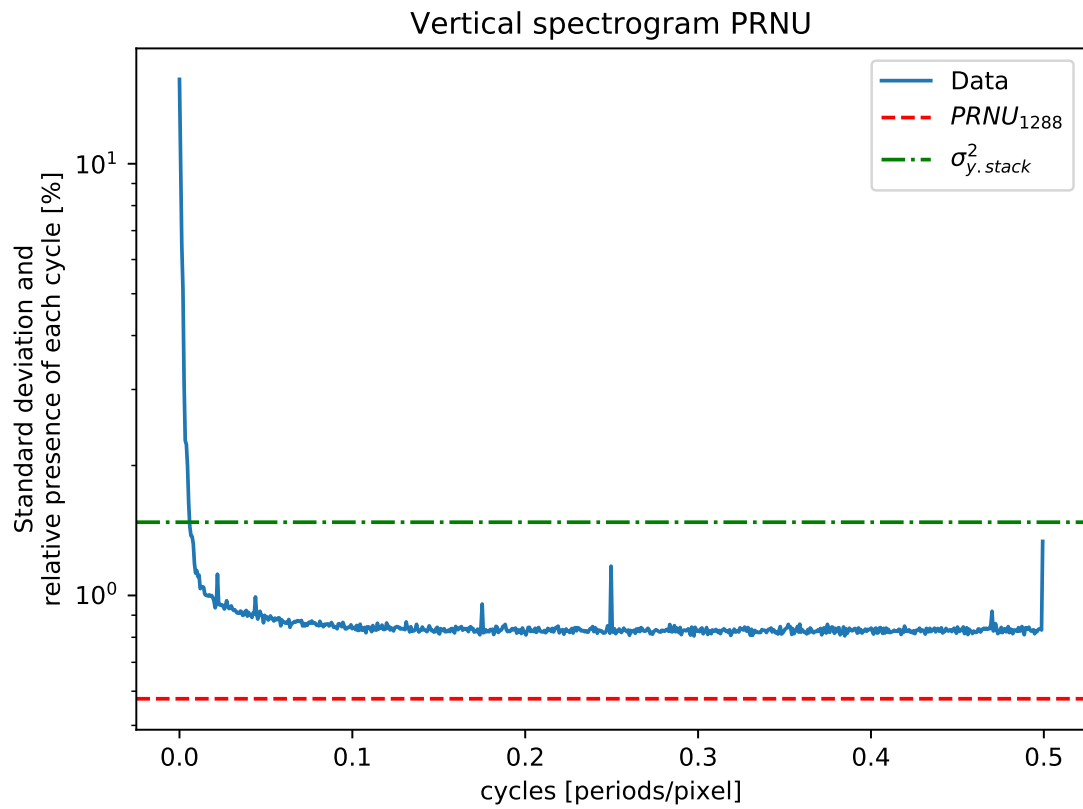
Signal to Noise Ratio

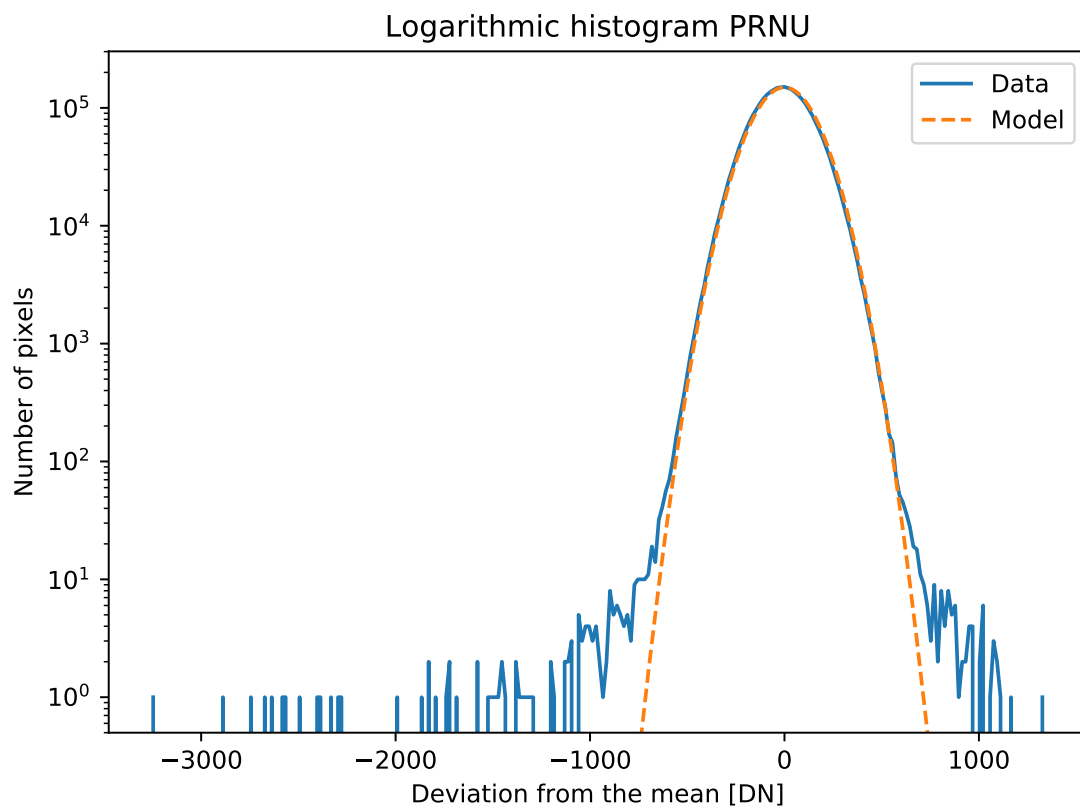
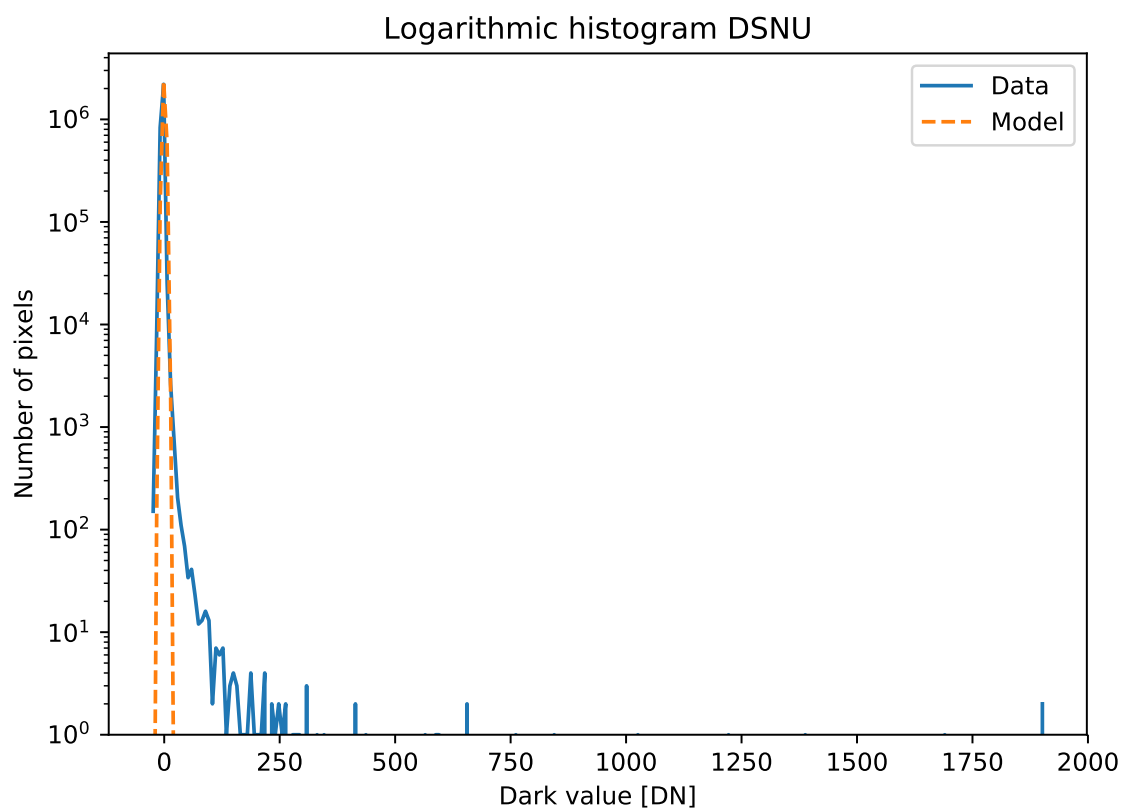


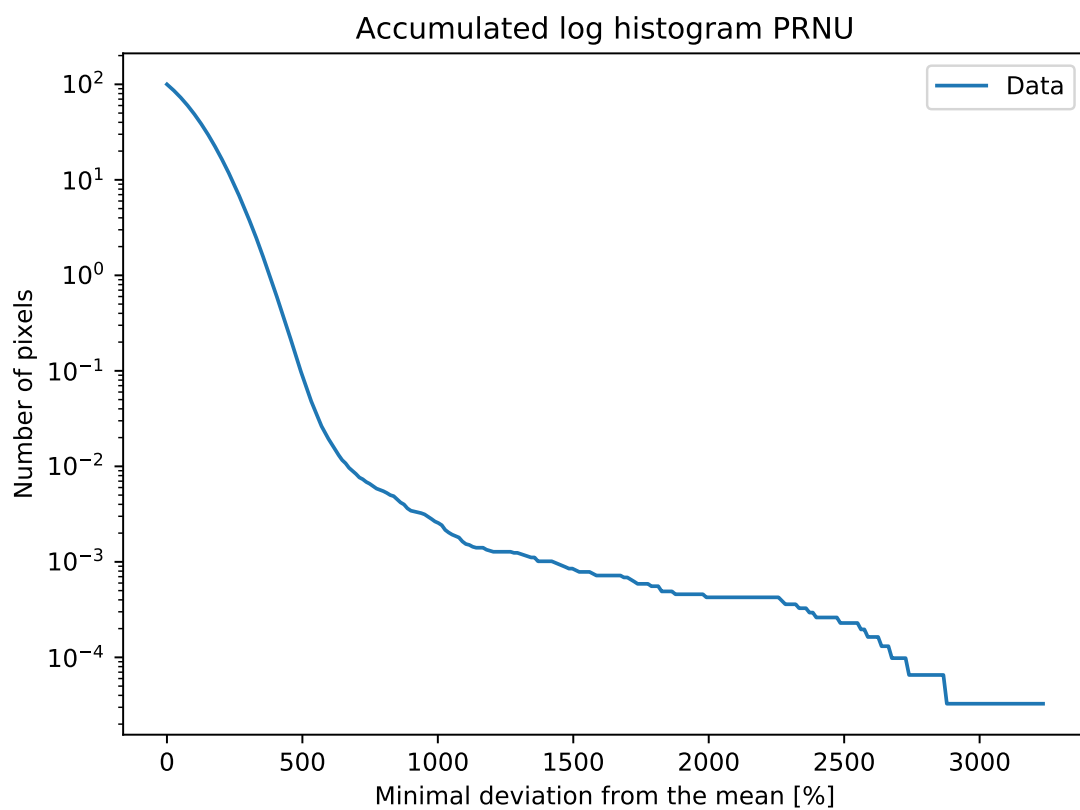
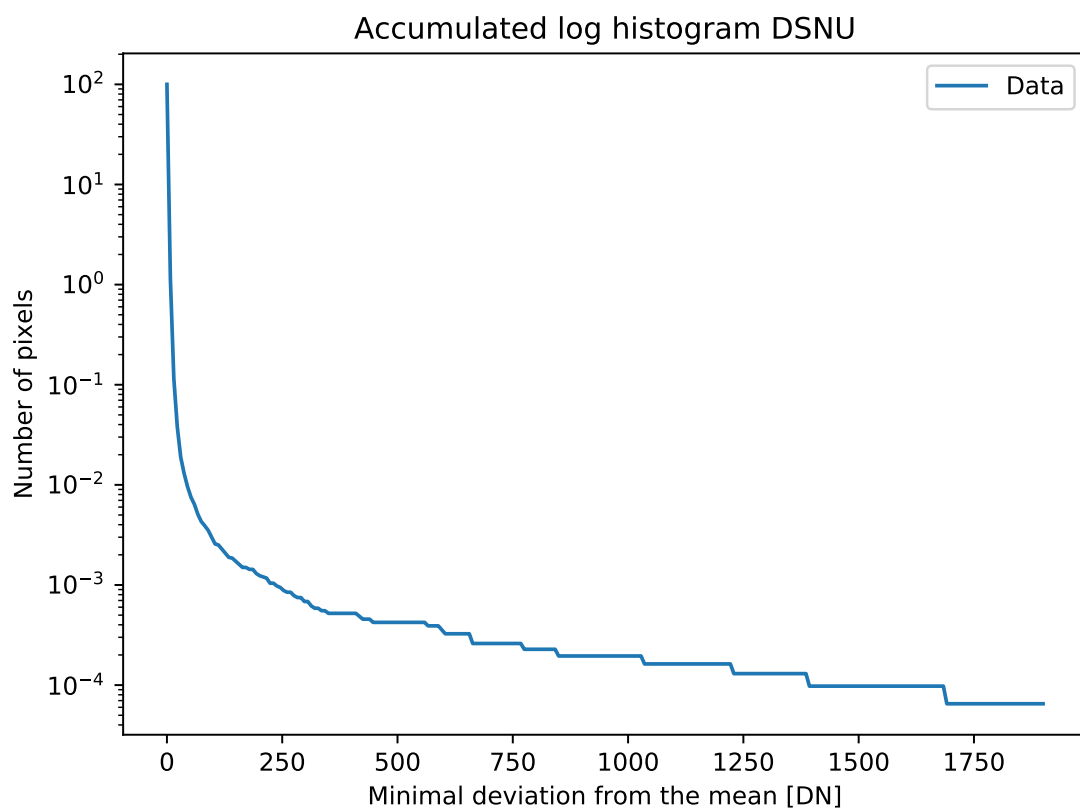


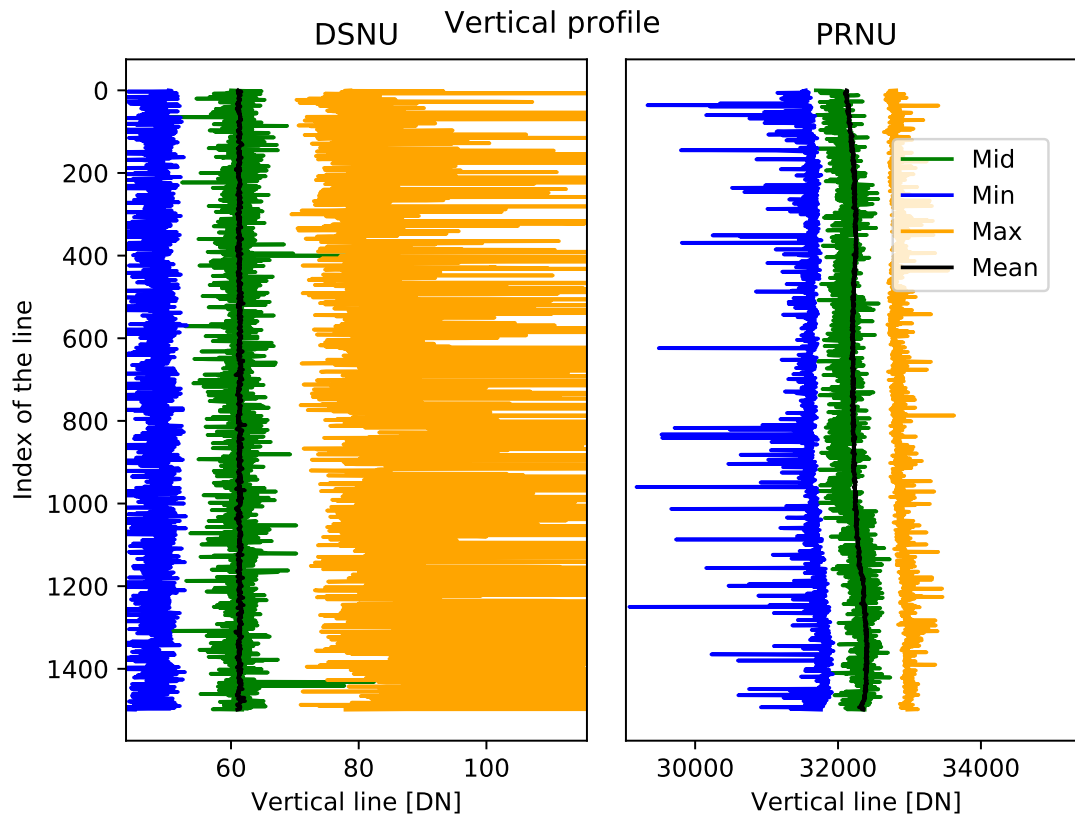
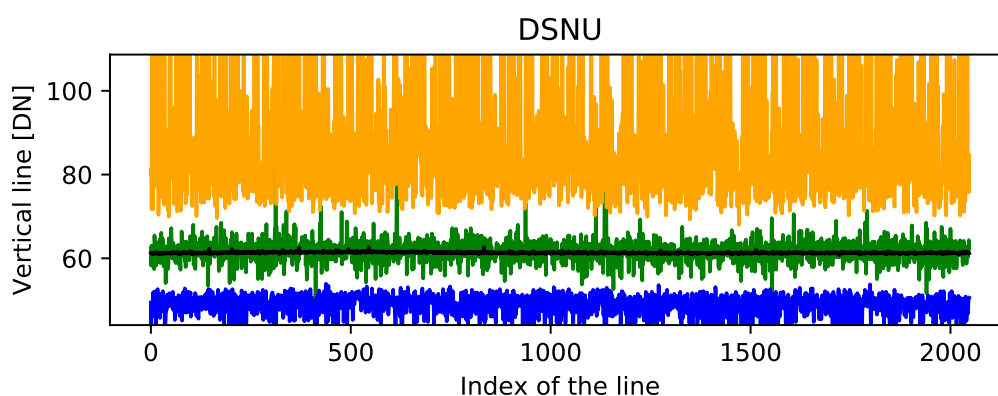
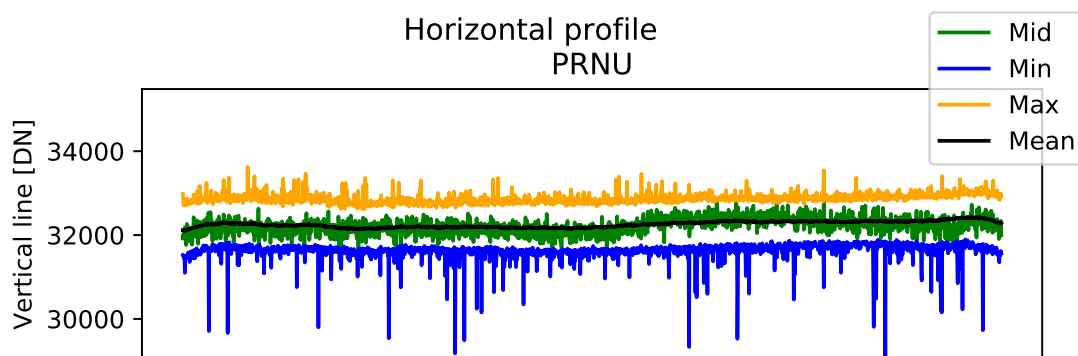


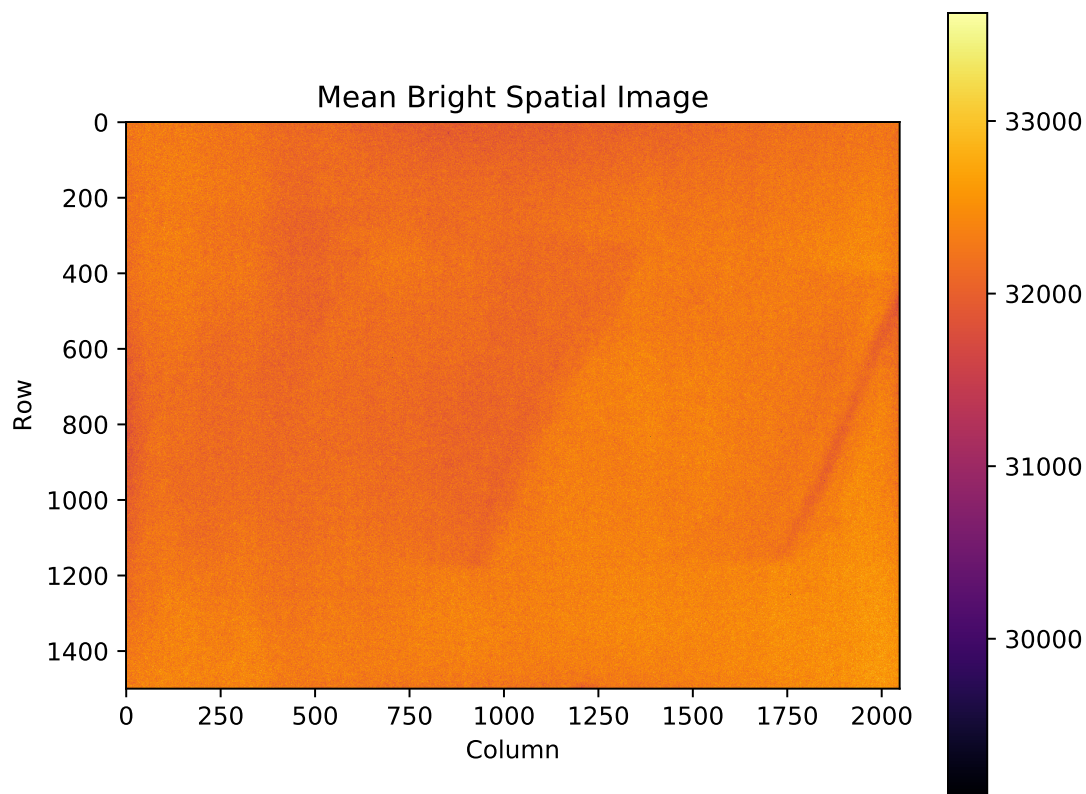
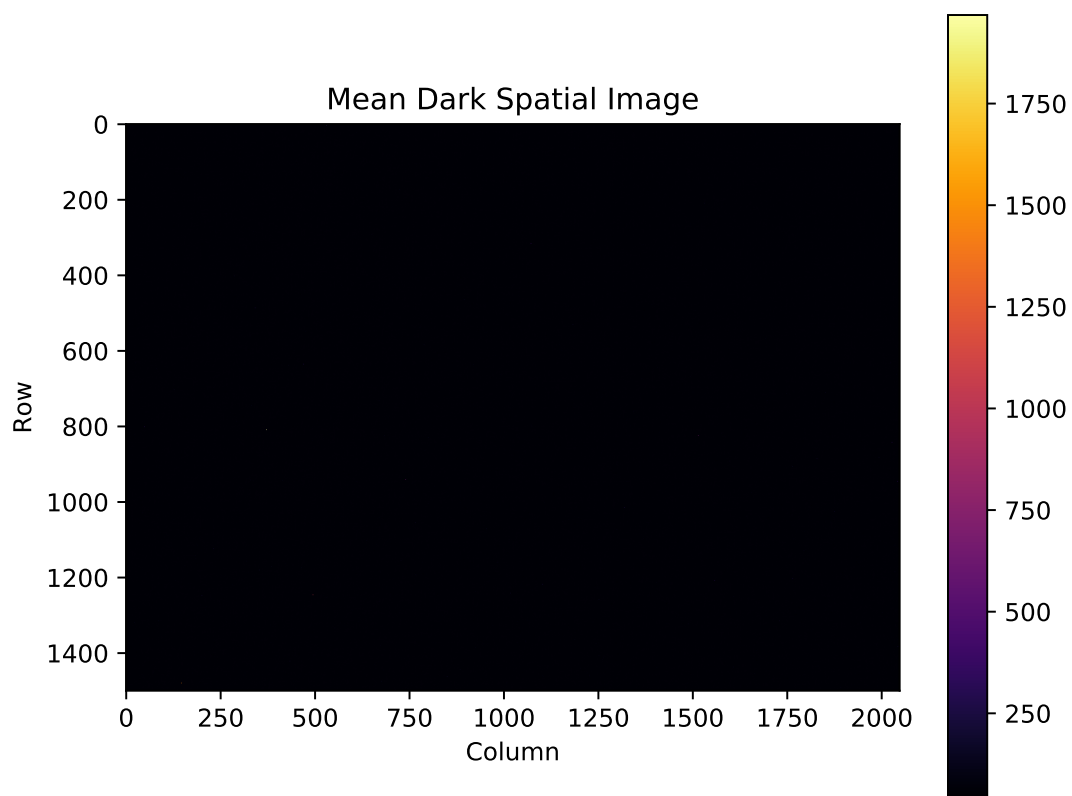












Summary sheet for Operation Point: **GreenBlue channel** (@523.0 nm wavelength)

Camera setting

Pixel Format	BayerRG16
High Conversion Gain	Off
Gain	0.0
Black level	0.10
ADC bit depth	12
Device Temperature	39.58 °C

Operation point parameters

Wavelength	523.0 nm
Exposure minimum	42.0 us
Exposure maximum	7585.0 us
Exposure steps	50
Variation of Irradiation	Constant illumination with variable exposure time

Performance

Quantum efficiency

η 49.43 %

System gain

K 6.921 DN/e⁻
1/K 0.144 e⁻/DN

Temporal dark noise

σ_d 2.433 e⁻
 $\sigma_{y.dark}$ 16.844 DN

Signal-to-Noise Ratio

SNR_{max} 96
39.64 dB
6.6 bit
 SNR_{max}^{-1} 1.042 %

Absolute sensitivity threshold

$\mu_{p.min}$ 5.936 p
 $\mu_{p.min.area}$ 0.791 p/ μm^2
 $\mu_{e.min}$ 2.934 e⁻
 $\mu_{e.min.area}$ 0.391 e⁻/ μm^2

Saturation Capacity

$\mu_{p.sat}$ 18640 p
 $\mu_{p.sat.area}$ 2482.859 p/ μm^2
 $\mu_{e.sat}$ 9213 e⁻
 $\mu_{e.sat.area}$ 1227 e⁻/ μm^2

Dynamic Range

DR 3140
69.9 dB

Spatial Nonuniformities

$DSNU_{1288}$ 0.6 e⁻
 $DSNU_{1288.row}$ 0.0 e⁻
 $DSNU_{1288.col}$ 0.0 e⁻
 $DSNU_{1288.pixel}$ 0.6 e⁻
 $PRNU_{1288}$ 0.6 %
 $PRNU_{1288.row}$ 0.2 %
 $PRNU_{1288.col}$ 0.3 %
 $PRNU_{1288.pixel}$ 0.5 %

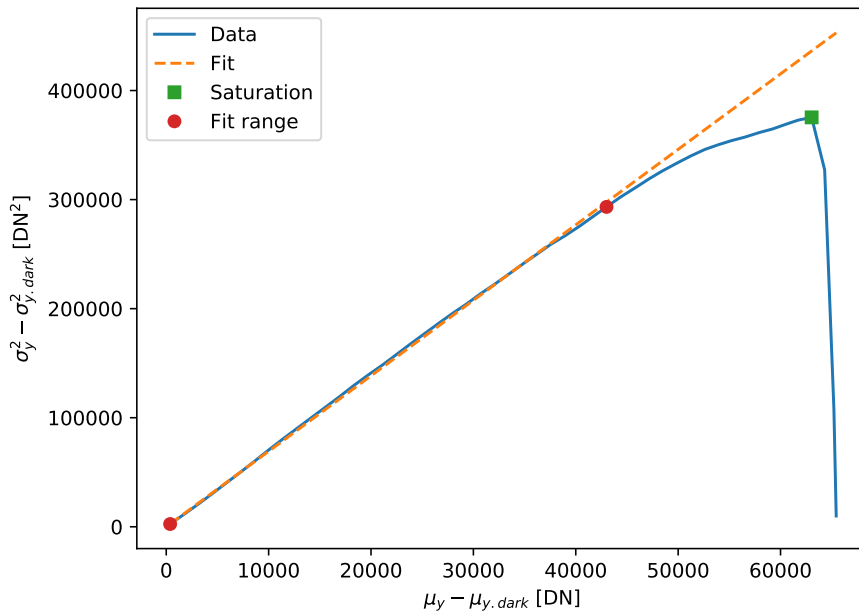
Linearity error

LE_{min} -0.606 %
 LE_{max} 0.223 %

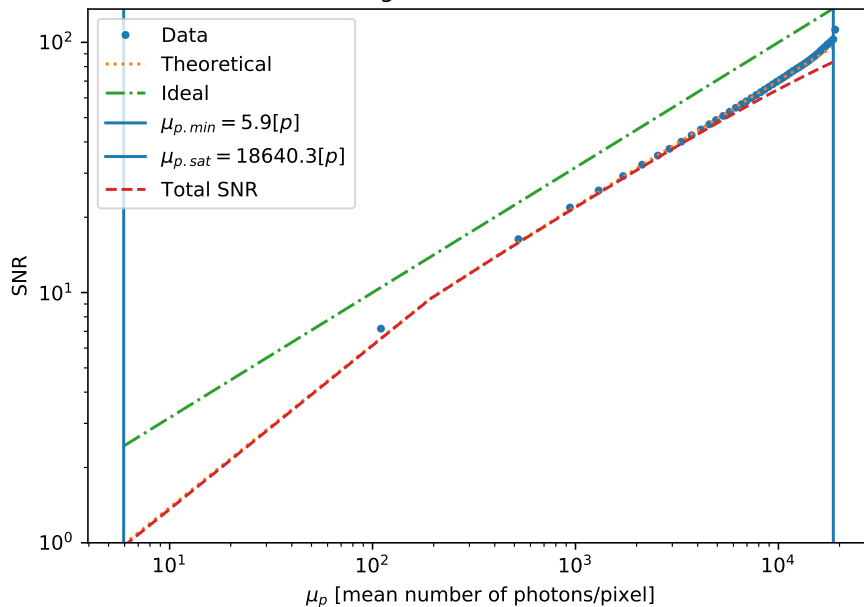
Dark current

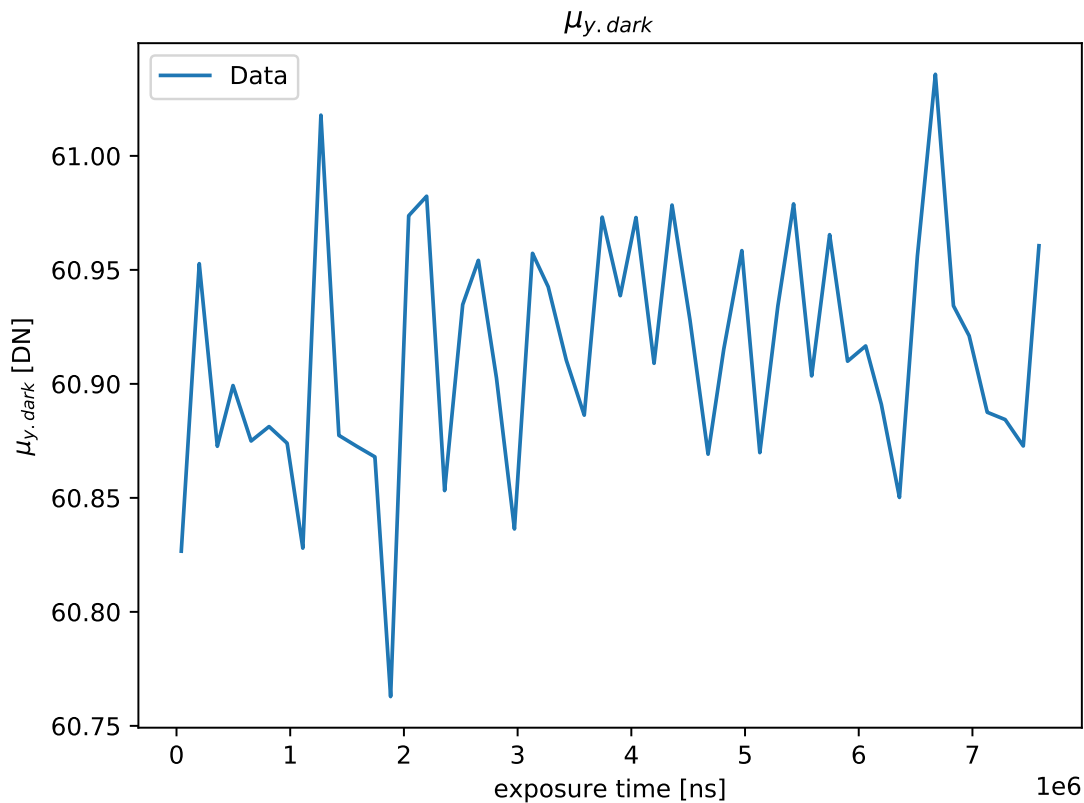
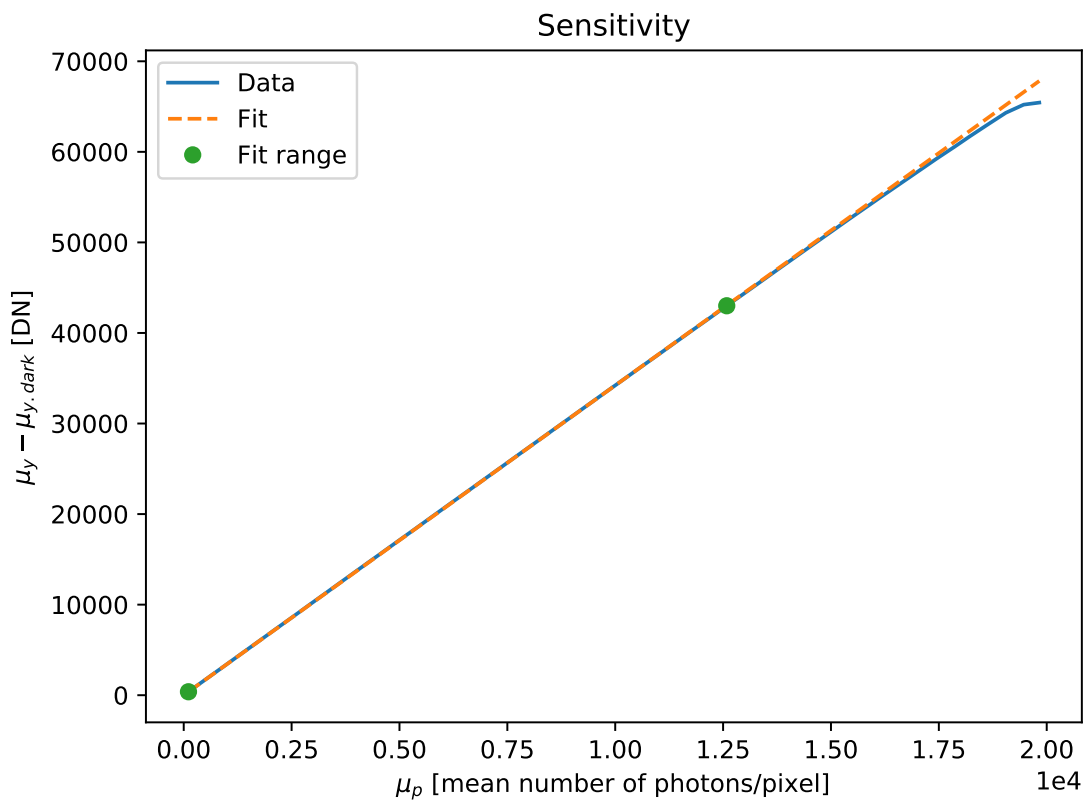
$\mu_{I.mean}$ 0.735 e⁻/s
5.089 DN/s
 $\mu_{I.var}$ 0.000 e⁻/s
0.002 DN/s

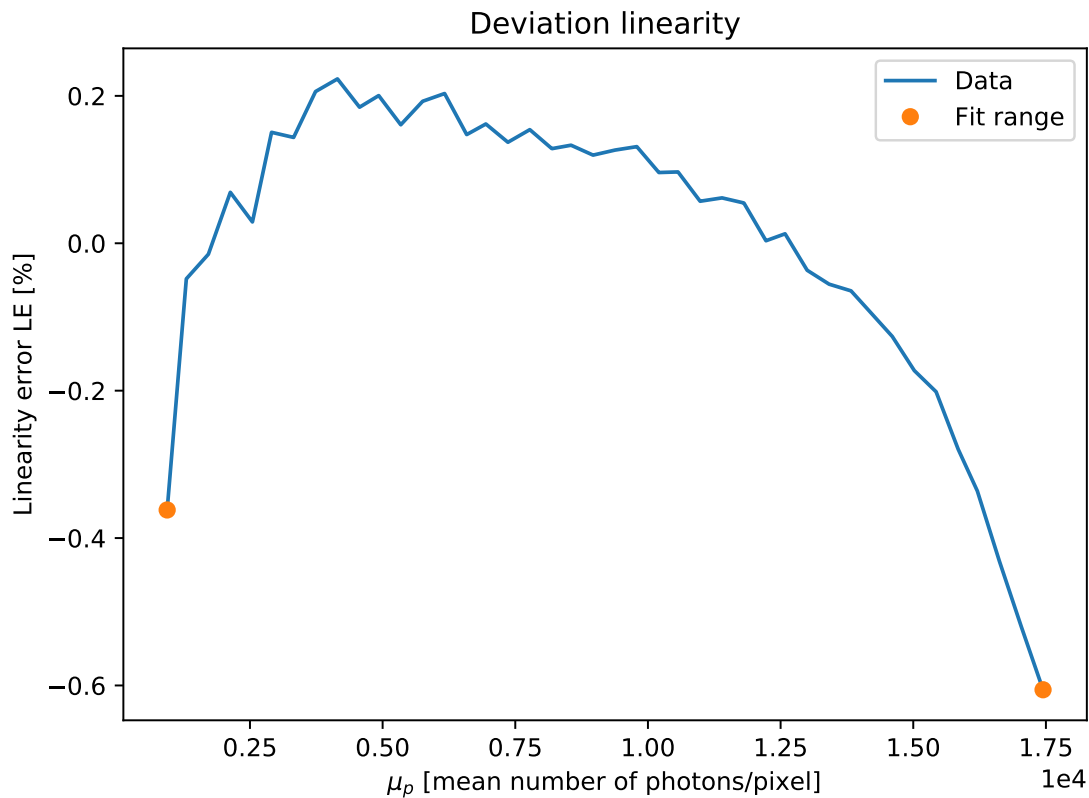
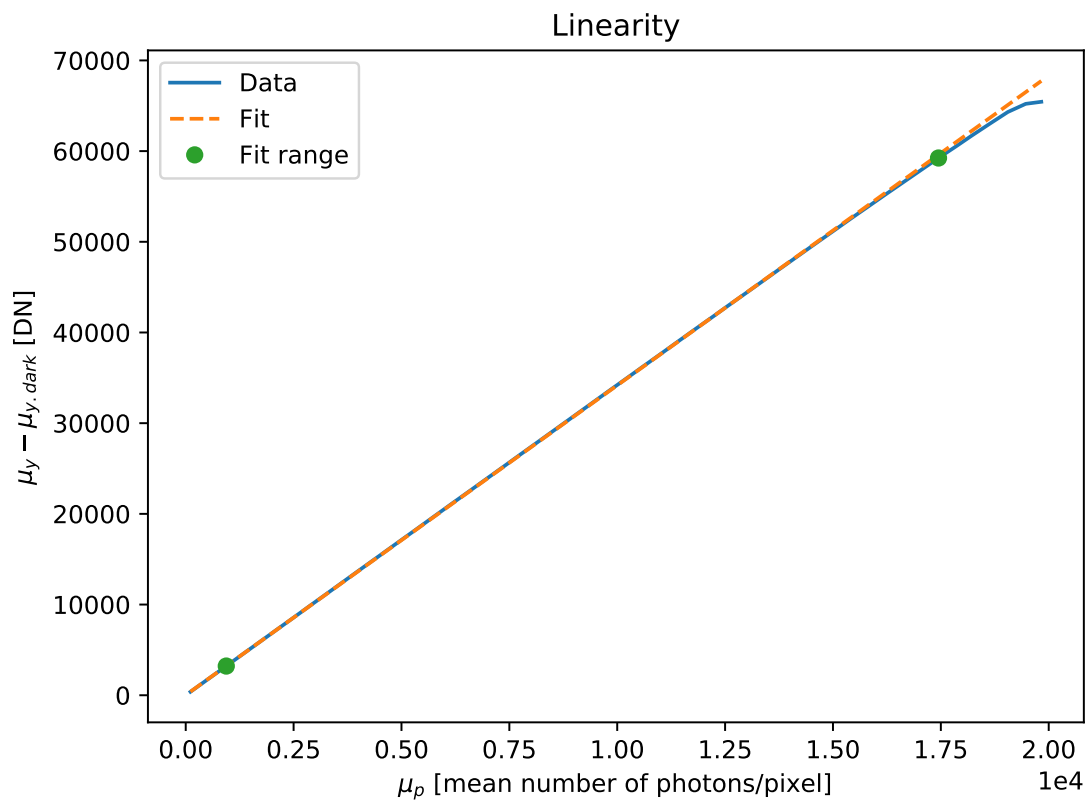
Photon Transfer

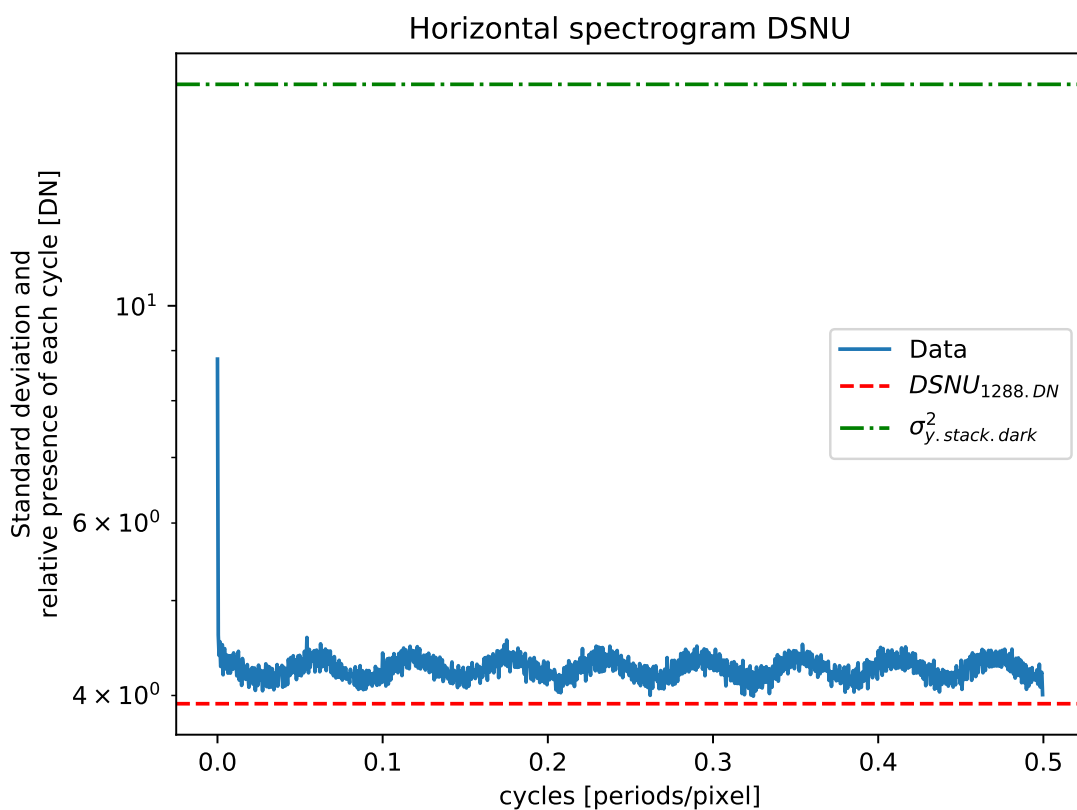
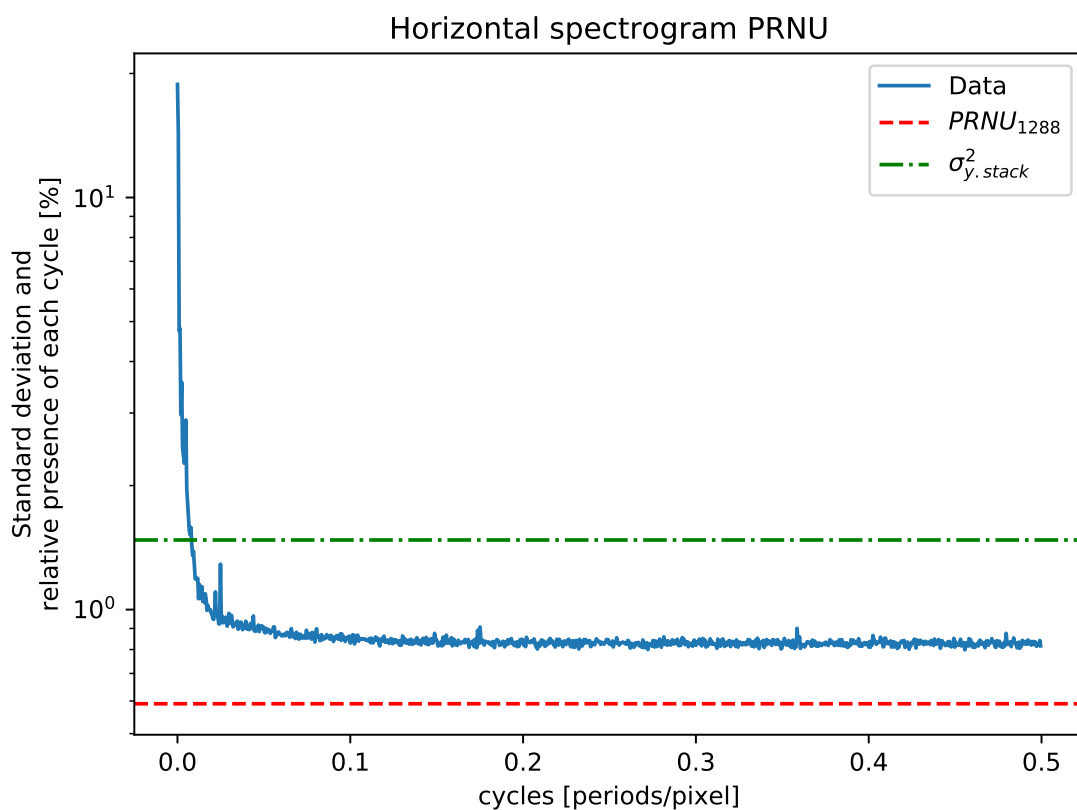


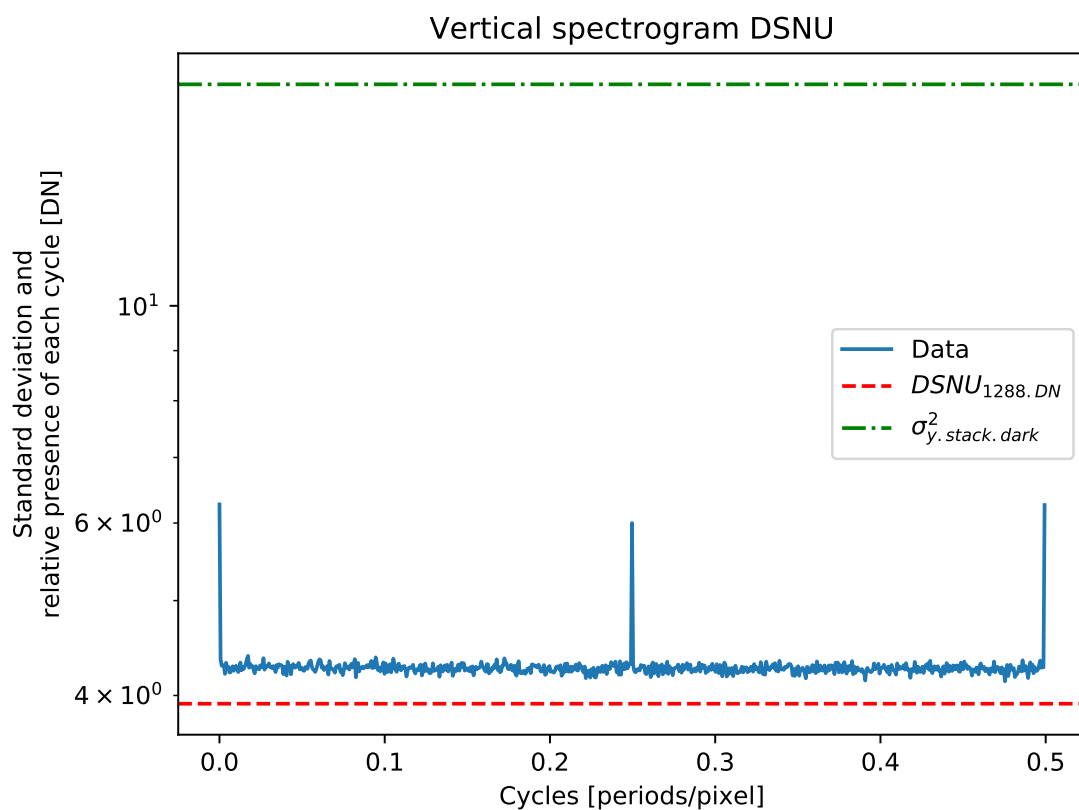
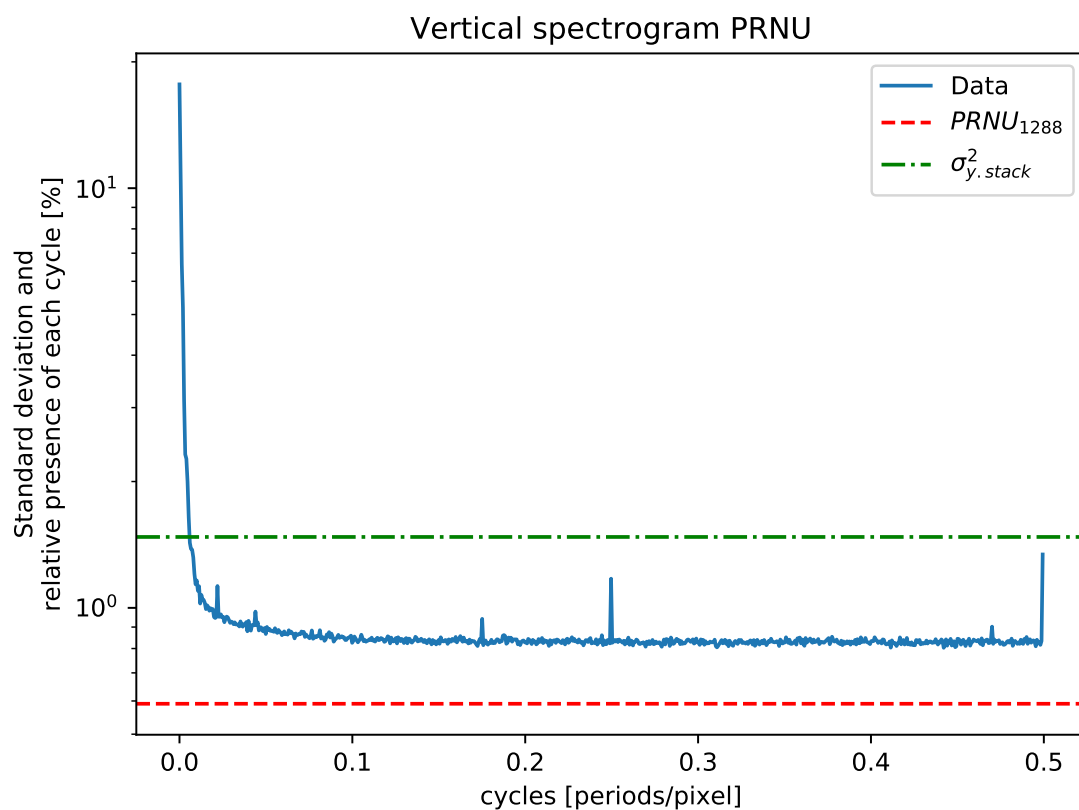
Signal to Noise Ratio



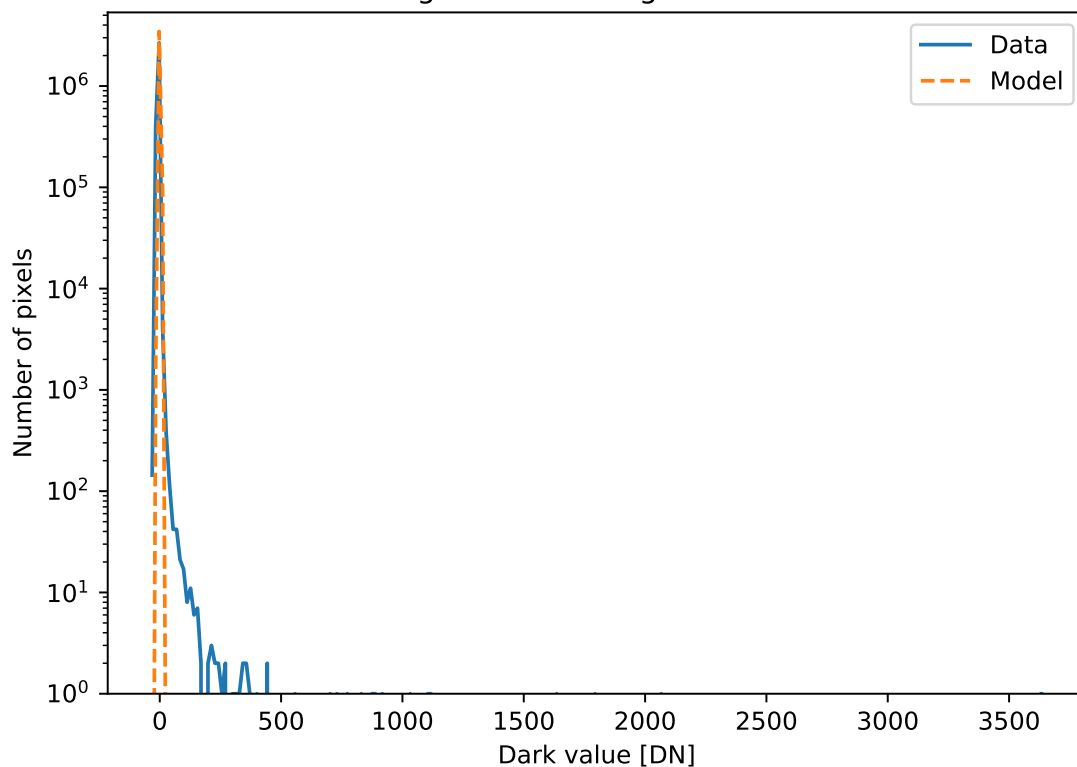




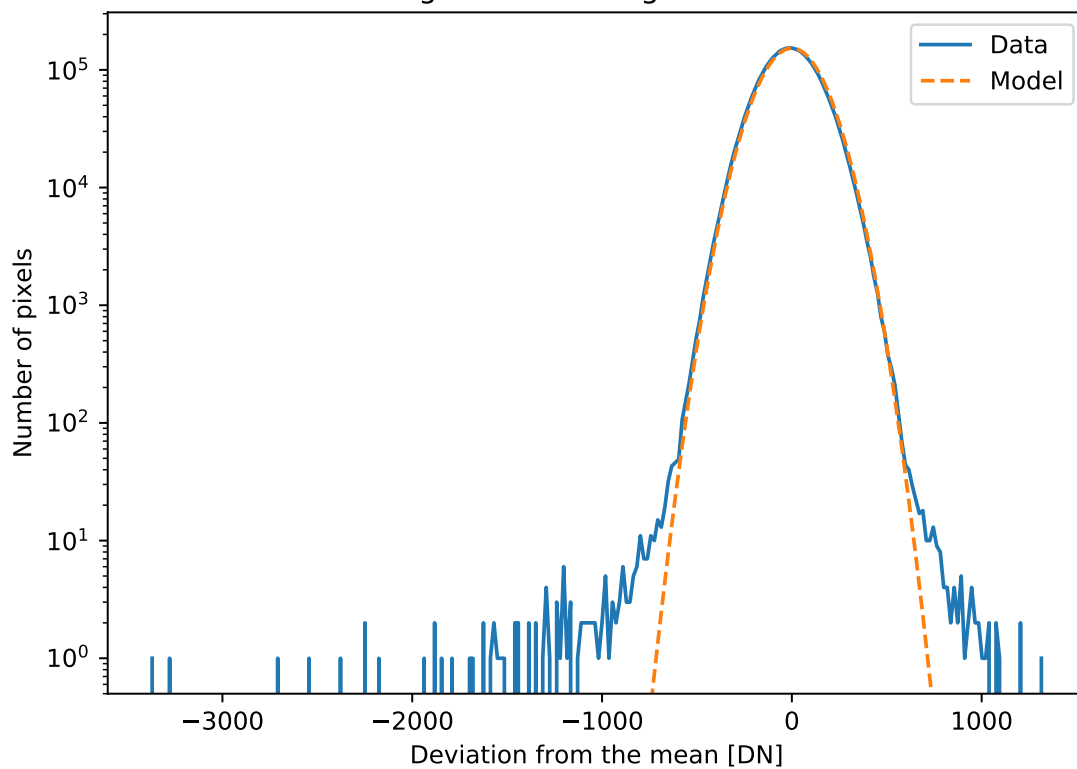


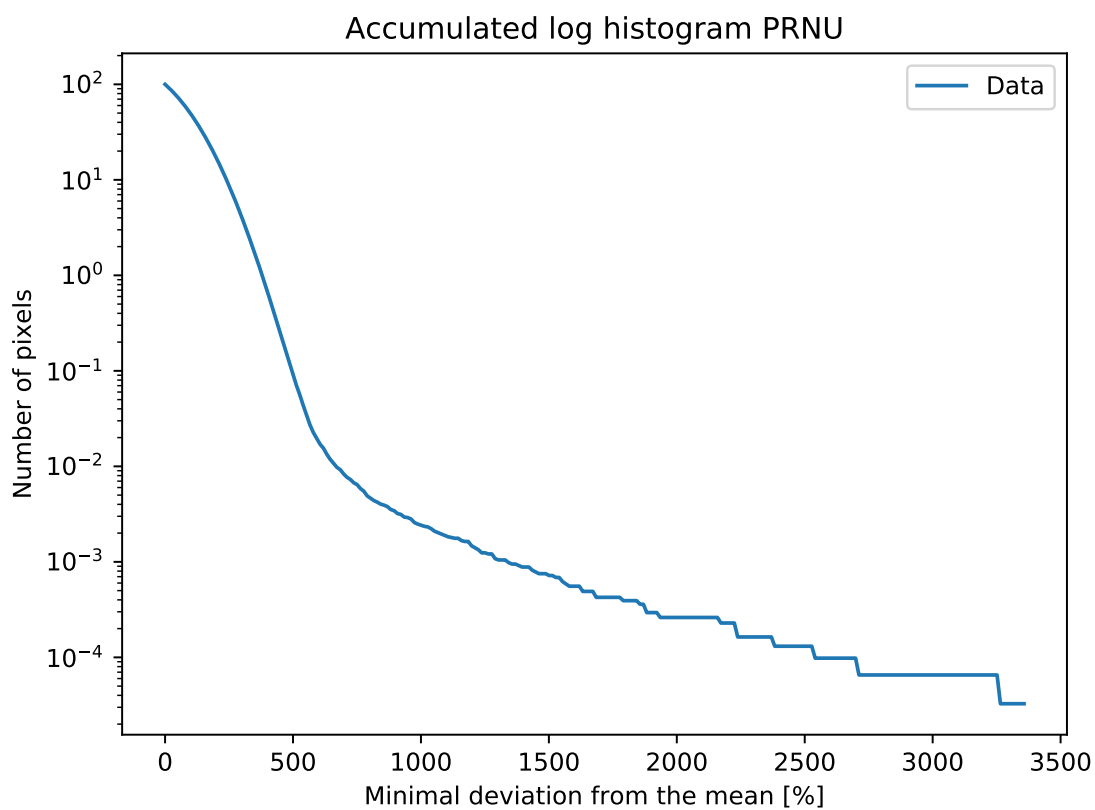
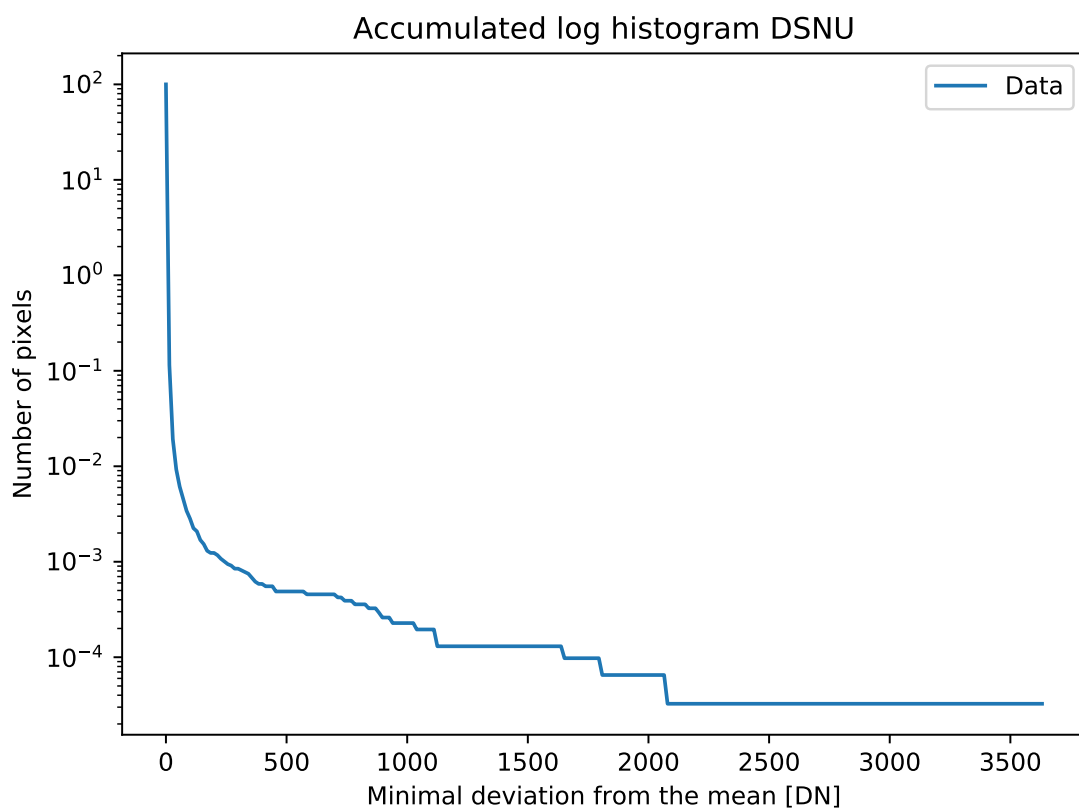


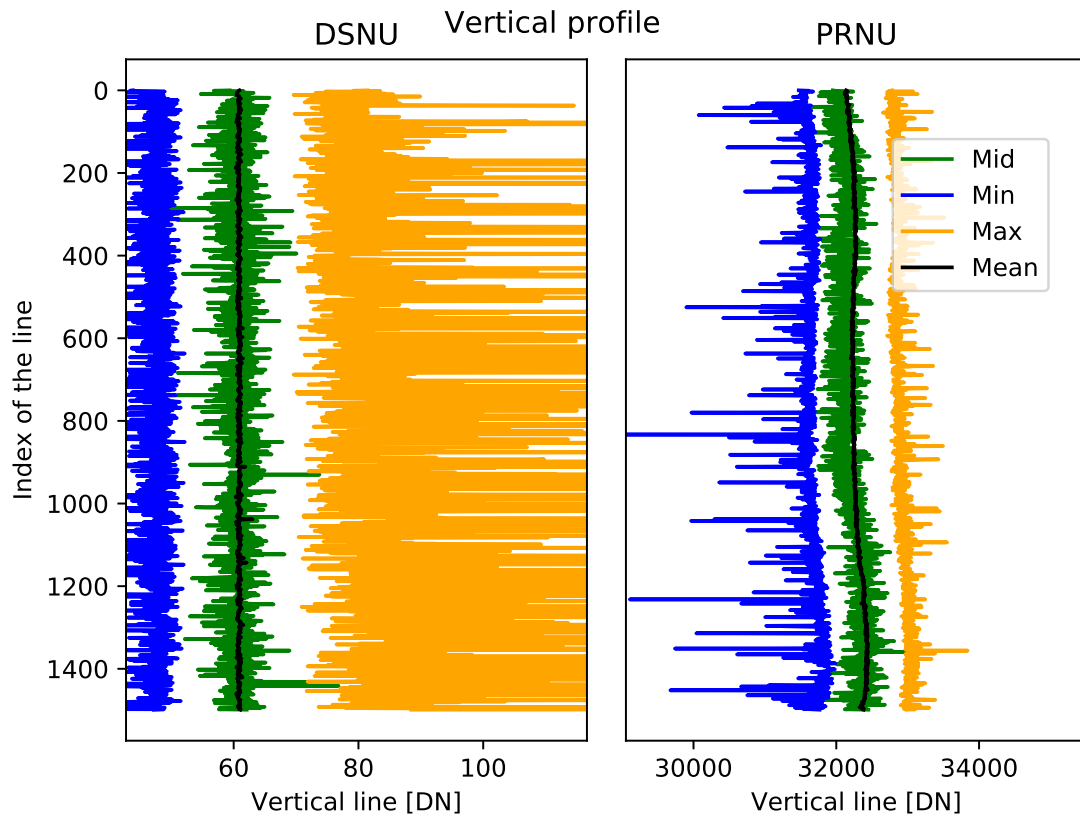
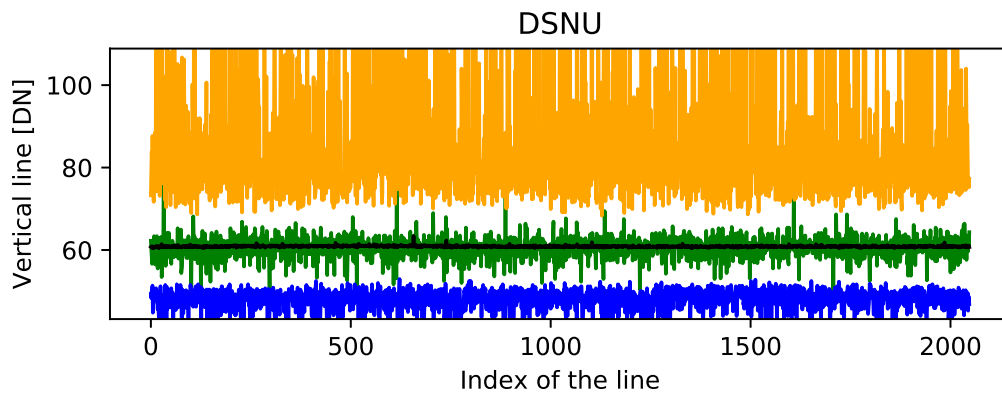
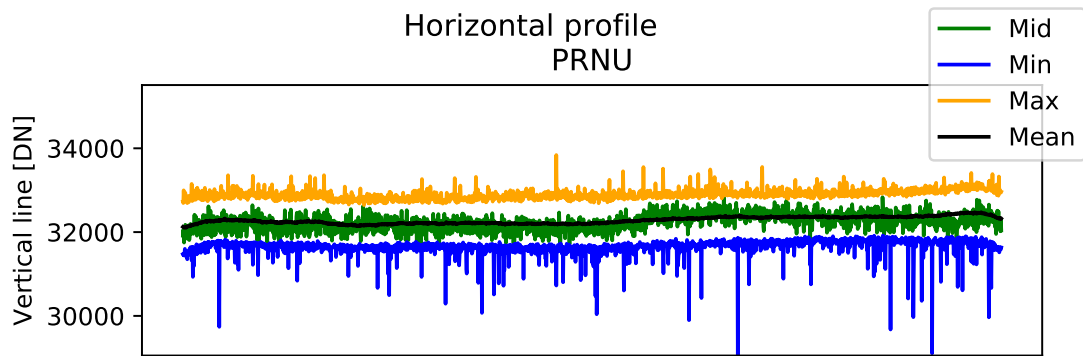
Logarithmic histogram DSNU

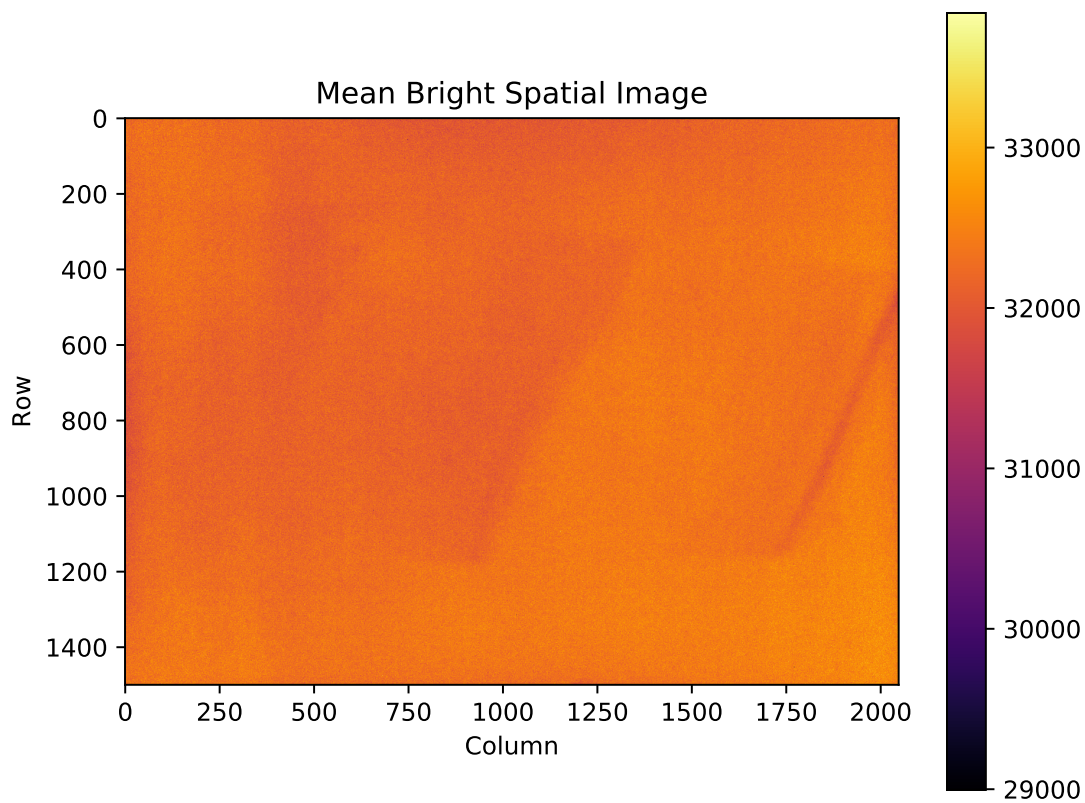
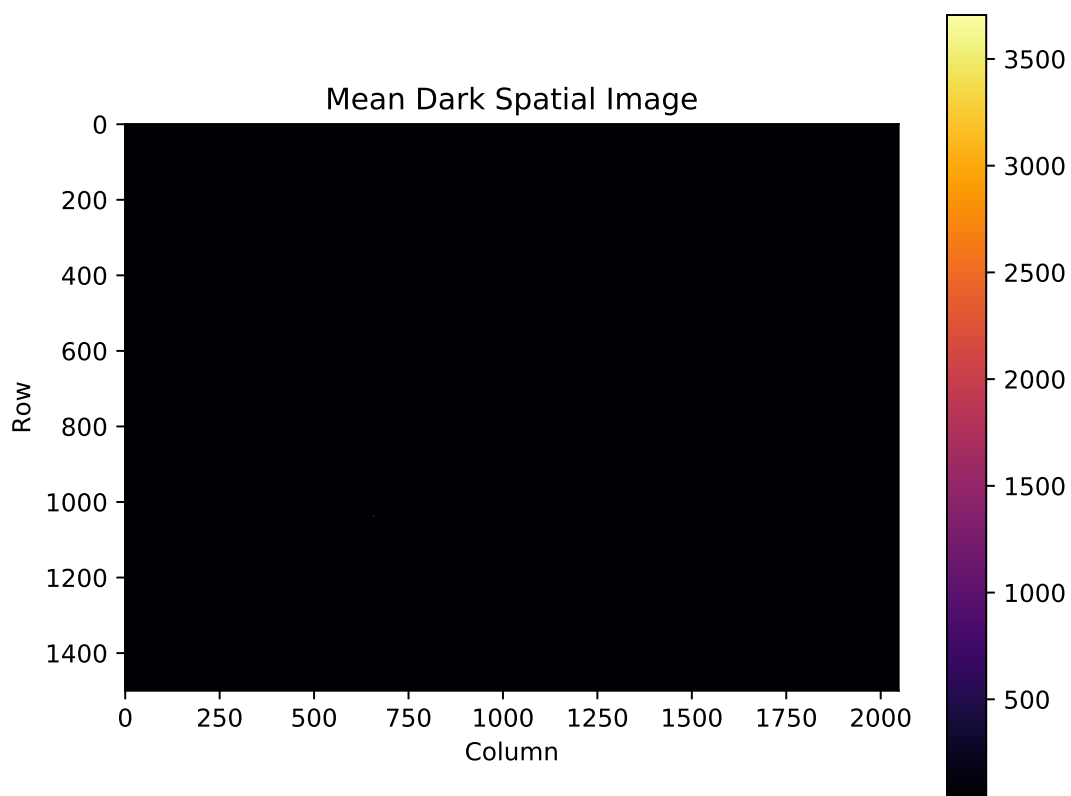


Logarithmic histogram PRNU









Summary sheet for Operation Point: **Blue channel** (@456.9 nm wavelength)

Camera setting

Pixel Format	BayerRG16
High Conversion Gain	Off
Gain	0.0
Black level	0.10
ADC bit depth	12
Device Temperature	39.58 °C

Operation point parameters

Wavelength	456.9 nm
Exposure minimum	42.0 us
Exposure maximum	8575.0 us
Exposure steps	50
Variation of Irradiation	Constant illumination with variable exposure time

Performance

Quantum efficiency

η	42.67 %
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System gain

K	6.914 DN/e ⁻
1/K	0.145 e ⁻ /DN

Temporal dark noise

σ_d	2.434 e ⁻
$\sigma_{y.dark}$	16.834 DN

Signal-to-Noise Ratio

SNR_{max}	96
	39.67 dB
	6.6 bit
SNR_{max}^{-1}	1.039 %

Absolute sensitivity threshold

$\mu_{p.min}$	6.878 p
$\mu_{p.min.area}$	0.916 p/ μm^2
$\mu_{e.min}$	2.935 e ⁻
$\mu_{e.min.area}$	0.391 e ⁻ / μm^2

Saturation Capacity

$\mu_{p.sat}$	21729 p
$\mu_{p.sat.area}$	2894.280 p/ μm^2
$\mu_{e.sat}$	9271 e ⁻
$\mu_{e.sat.area}$	1235 e ⁻ / μm^2

Dynamic Range

DR	3159
	70.0 dB

Spatial Nonuniformities

$DSNU_{1288}$	0.5 e ⁻
$DSNU_{1288.row}$	0.0 e ⁻
$DSNU_{1288.col}$	0.0 e ⁻
$DSNU_{1288.pixel}$	0.5 e ⁻
$PRNU_{1288}$	0.6 %
$PRNU_{1288.row}$	0.2 %
$PRNU_{1288.col}$	0.2 %
$PRNU_{1288.pixel}$	0.5 %

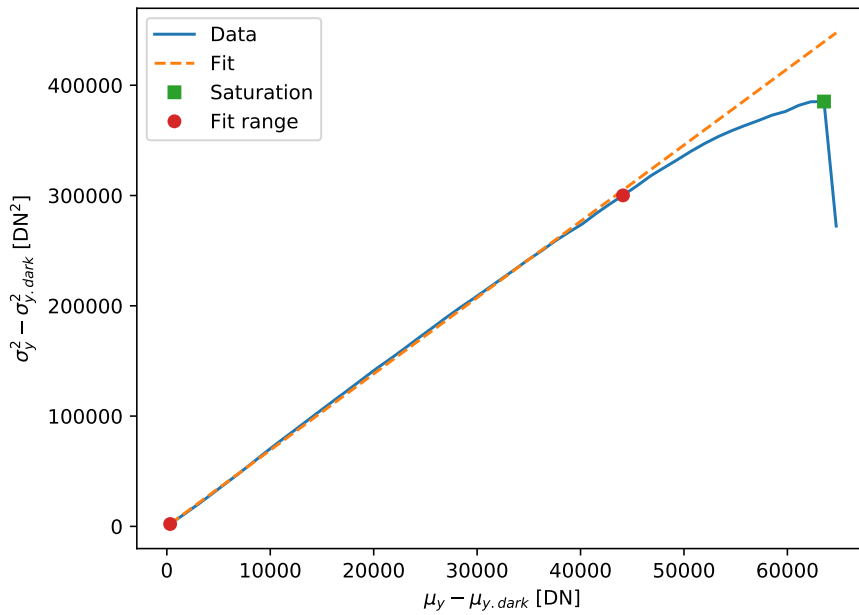
Linearity error

LE_{min}	-0.501 %
LE_{max}	0.195 %

Dark current

$\mu_{I.mean}$	0.729 e ⁻ /s
	5.038 DN/s
$\mu_{I.var}$	0.001 e ⁻ /s
	0.005 DN/s

Photon Transfer



Signal to Noise Ratio

