

## 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](http://www.standard1288.org)).

|                           |                             |                                  |                                      |
|---------------------------|-----------------------------|----------------------------------|--------------------------------------|
| Vendor                    | KAYA Instruments            | Sensor                           | IMX253                               |
| Model                     | Iron253C                    | Sensor type                      | CMOS                                 |
| Camera type               | Color                       | Shutter type                     | Global                               |
| Data type                 | Single                      | Overlap capabilities             | Overlapping                          |
| Sensor type               | CMOS                        | Frame rate                       | 28 Hz                                |
| Lens category             | C-Mount                     | Exposure control                 | by irradiance                        |
| Resolution                | 4096 x 3000 ,12 bits        | Exposure time                    | 7003.5 $\mu$ s                       |
| Pixel size                | 3.45 $\mu$ m x 3.45 $\mu$ m | Illumination                     | Variable with constant exposure time |
| Maximum readout rate      | 28 fps                      | Irradiation Steps                | 50                                   |
| Dark current compensation | No                          | Irradiation calibration accuracy | -                                    |
| Interface type            | CXP-12                      | Irradiation measurement error    | -                                    |
| Serial number             | 1320072                     | Standart version                 | 3.1                                  |
| Firmware version          | 3.1-2020.4.13               | Light source                     | Integrating Sphere                   |
| Sensor diagonal           | 16.1mm                      |                                  |                                      |

### International Distributors



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## Summary Sheet for Operation Point 1 at a Wavelength of 520 nm

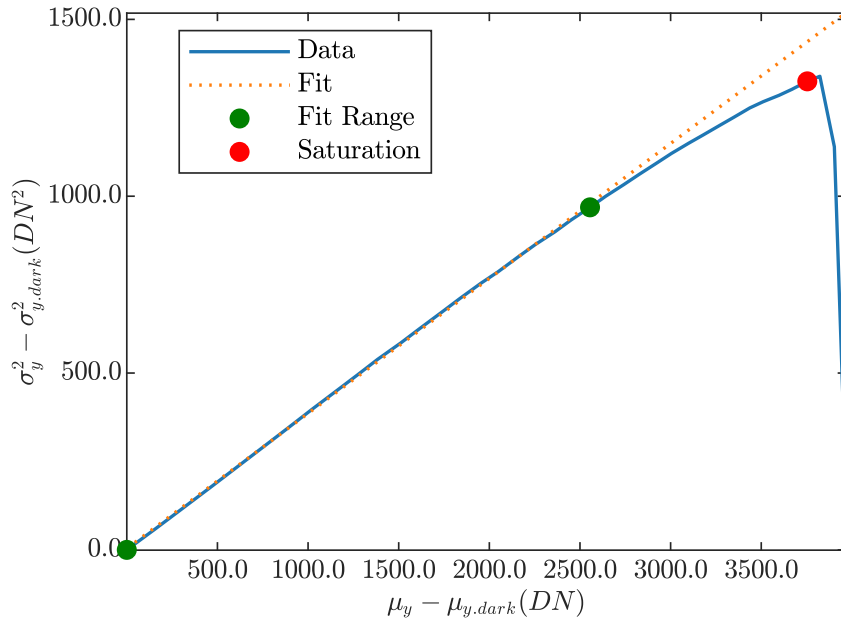
### Camera setting

|             |             |
|-------------|-------------|
| Gain        | GainLevelx1 |
| Black level | 128         |

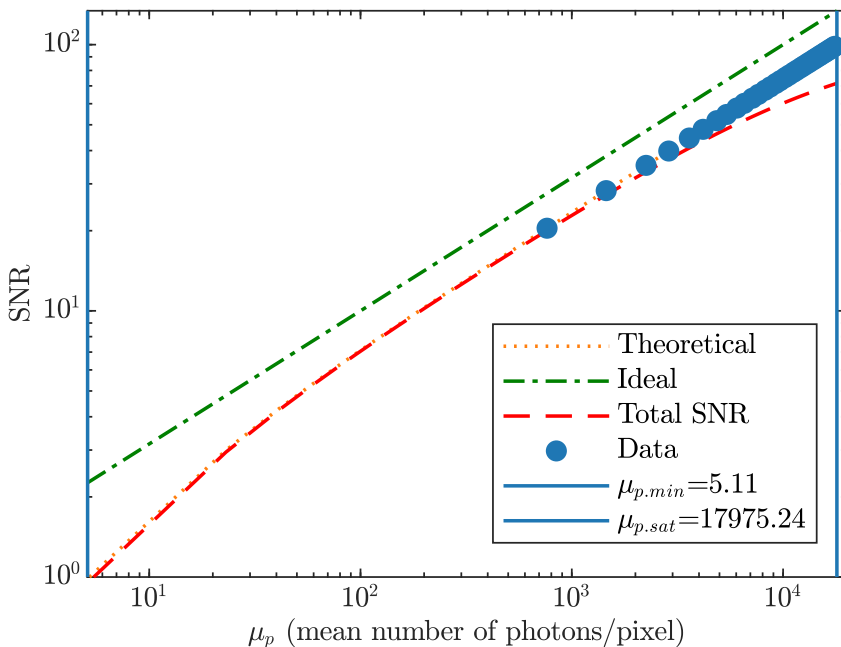
### Operation point parameters

|                           |        |
|---------------------------|--------|
| Environmental temperature | 2.75   |
| Camera body temperature   | 2.75   |
| Sensor temperature        | 38.376 |
| Processor temperature     | 37     |

### Photon Transfer



### Signal-to-Noise Ratio



### Performance

#### Quantum efficiency

|        |         |   |
|--------|---------|---|
| $\eta$ | 55.3859 | % |
|--------|---------|---|

#### System gain

|     |         |                    |
|-----|---------|--------------------|
| K   | 0.38166 | DN/e <sup>-</sup>  |
| 1/K | 2.6202  | e <sup>-</sup> /DN |

#### Temporal dark noise

|                   |         |                |
|-------------------|---------|----------------|
| $\sigma_d$        | 2.2038  | e <sup>-</sup> |
| $\sigma_{y,dark}$ | 0.88924 | DN             |

#### Signal-to-noise ratio

|                      |         |     |
|----------------------|---------|-----|
| SNR <sub>max</sub>   | 99.7785 |     |
|                      | 39.9807 | dB  |
|                      | 6.6407  | bit |
| 1/SNR <sub>max</sub> | 1.0022  | %   |

#### Absolute sensitivity threshold

|                    |         |                                 |
|--------------------|---------|---------------------------------|
| $\mu_{p,min}$      | 5.1095  | p                               |
| $\mu_{p,min,area}$ | 0.42928 | p/μm <sup>2</sup>               |
| $\mu_{e,min}$      | 2.83    | e <sup>-</sup>                  |
| $\mu_{e,min,area}$ | 0.23776 | e <sup>-</sup> /μm <sup>2</sup> |

#### Saturation capacity

|                    |            |                                 |
|--------------------|------------|---------------------------------|
| $\mu_{p,sat}$      | 17975.2408 | p                               |
| $\mu_{p,sat,area}$ | 1510.2072  | p/μm <sup>2</sup>               |
| $\mu_{e,sat}$      | 9955.7544  | e <sup>-</sup>                  |
| $\mu_{e,sat,area}$ | 836.4423   | e <sup>-</sup> /μm <sup>2</sup> |

#### Dynamic range

|    |          |     |
|----|----------|-----|
| DR | 3517.996 |     |
|    | 70.9259  | dB  |
|    | 11.7805  | bit |

#### Spatial nonuniformities

|                      |         |                |
|----------------------|---------|----------------|
| DSNU <sub>1288</sub> | 0.77353 | e <sup>-</sup> |
|                      | 0.29522 | DN             |
| PRNU <sub>1288</sub> | 0.97299 | %              |

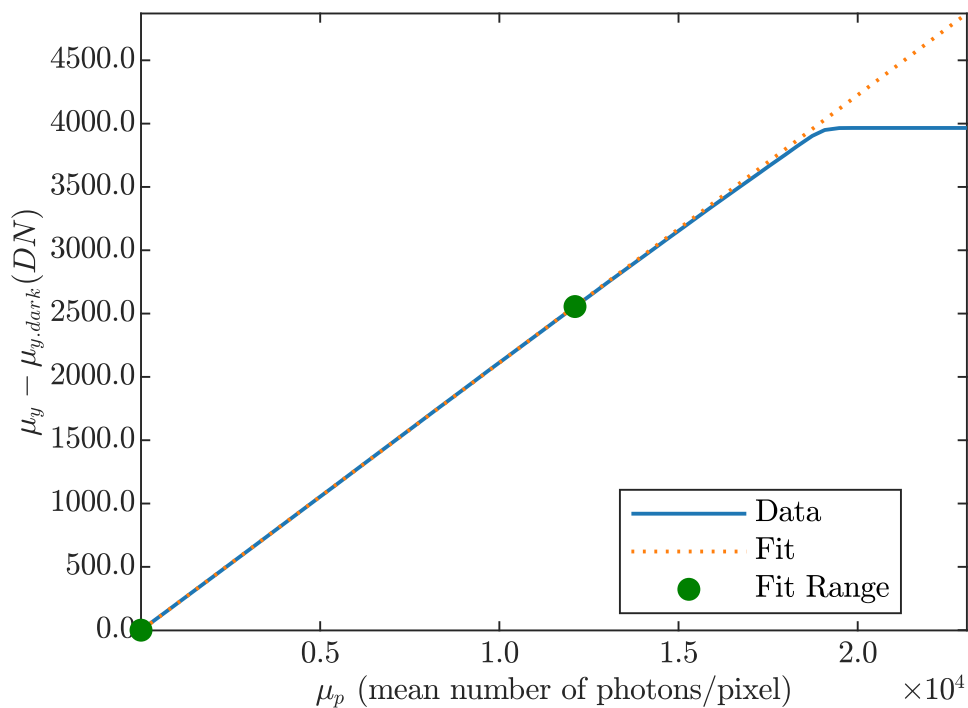
#### Linearity error

|                   |          |   |
|-------------------|----------|---|
| LE <sub>min</sub> | -0.61676 | % |
| LE <sub>max</sub> | 0.31018  | % |

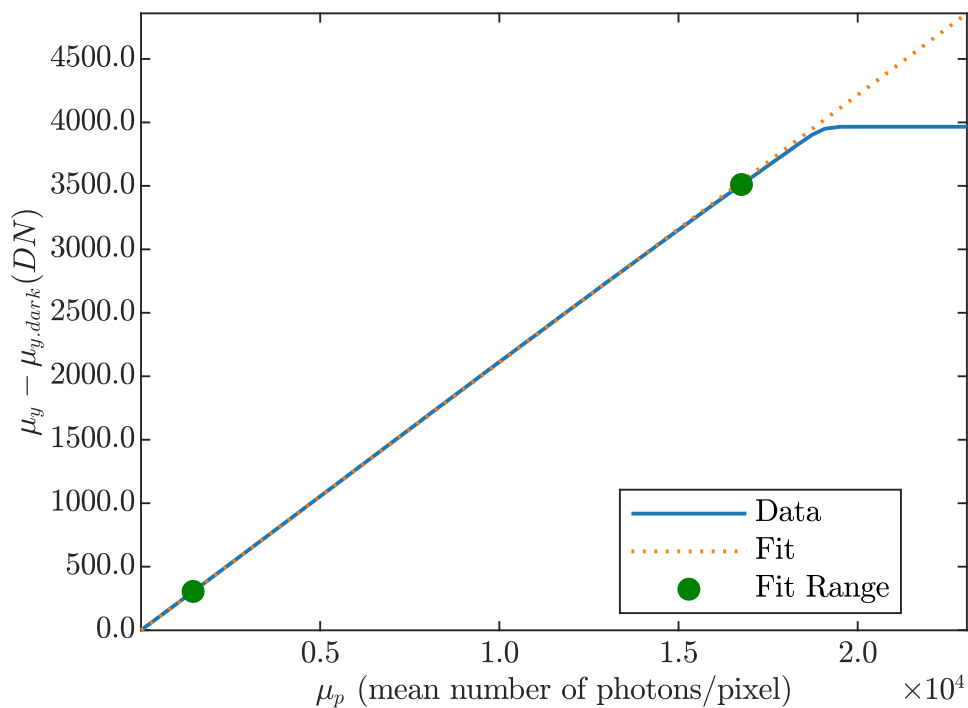
#### Dark current

|                |         |                   |
|----------------|---------|-------------------|
| $\mu_{l,mean}$ | 13.6996 | e <sup>-</sup> /s |
|                | 5.2463  | DN/s              |
| $\mu_{l,var}$  | 2.3503  | e <sup>-</sup> /s |
|                | 0.34467 | DN/s              |

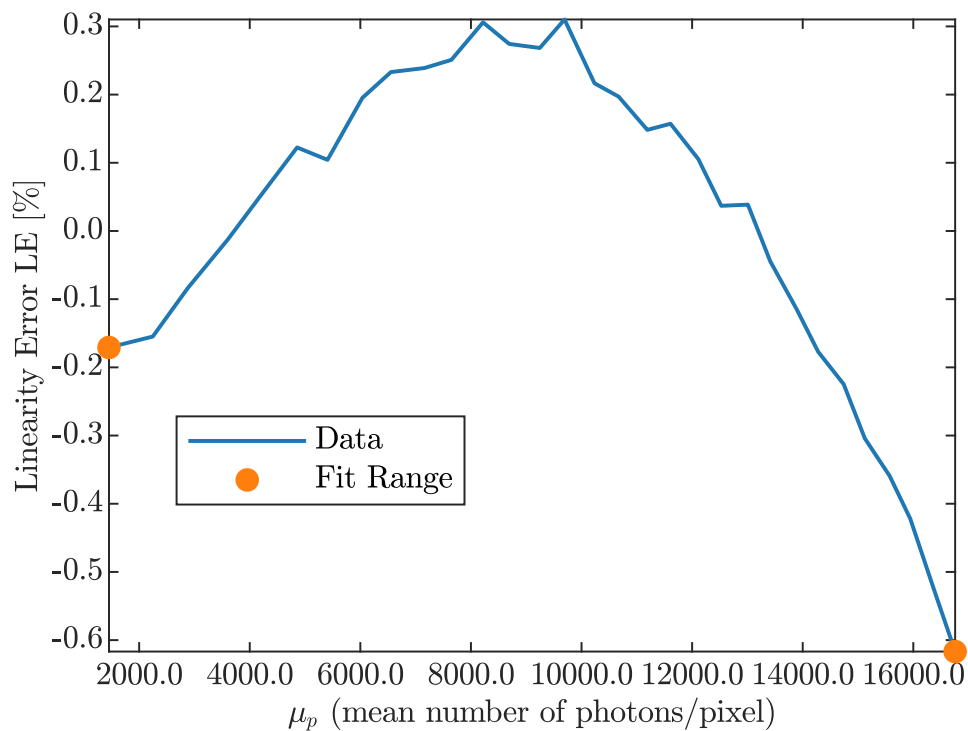
## Sensitivity



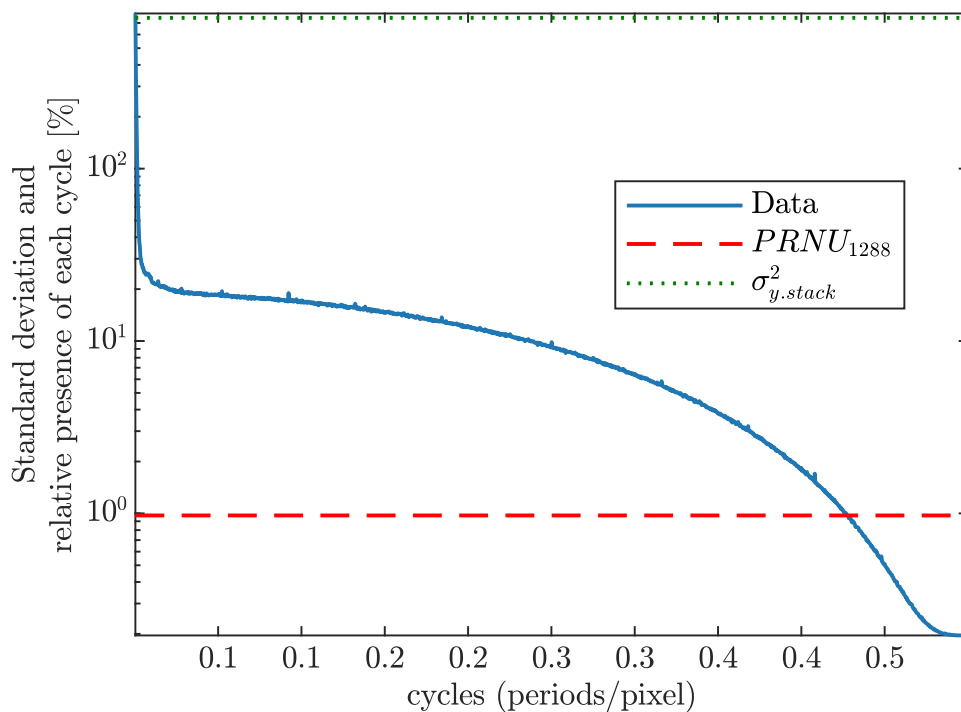
## Linearity



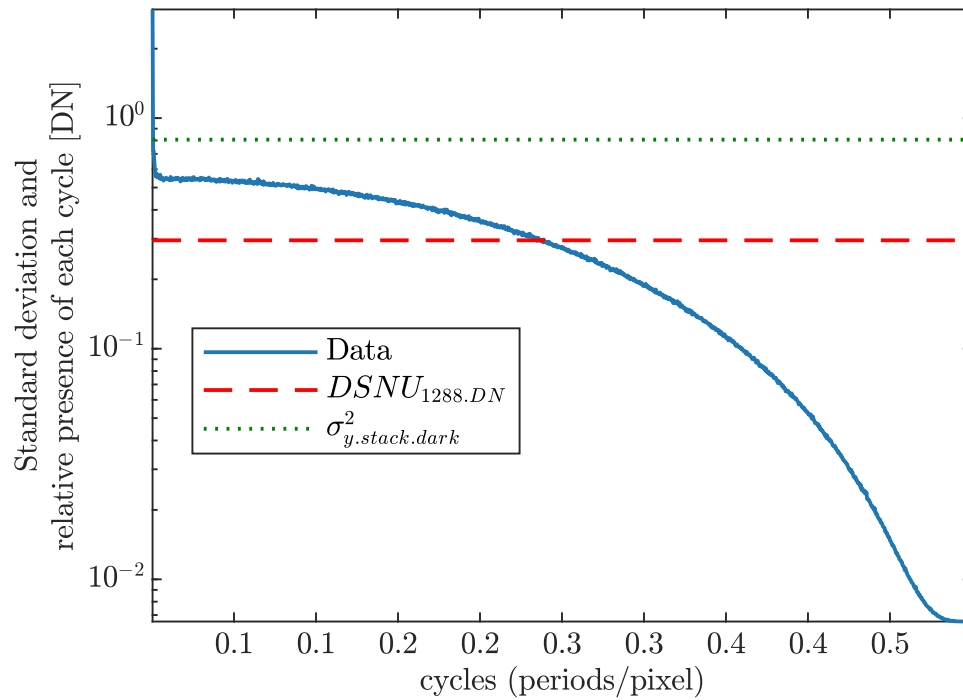
## Deviation Linearity



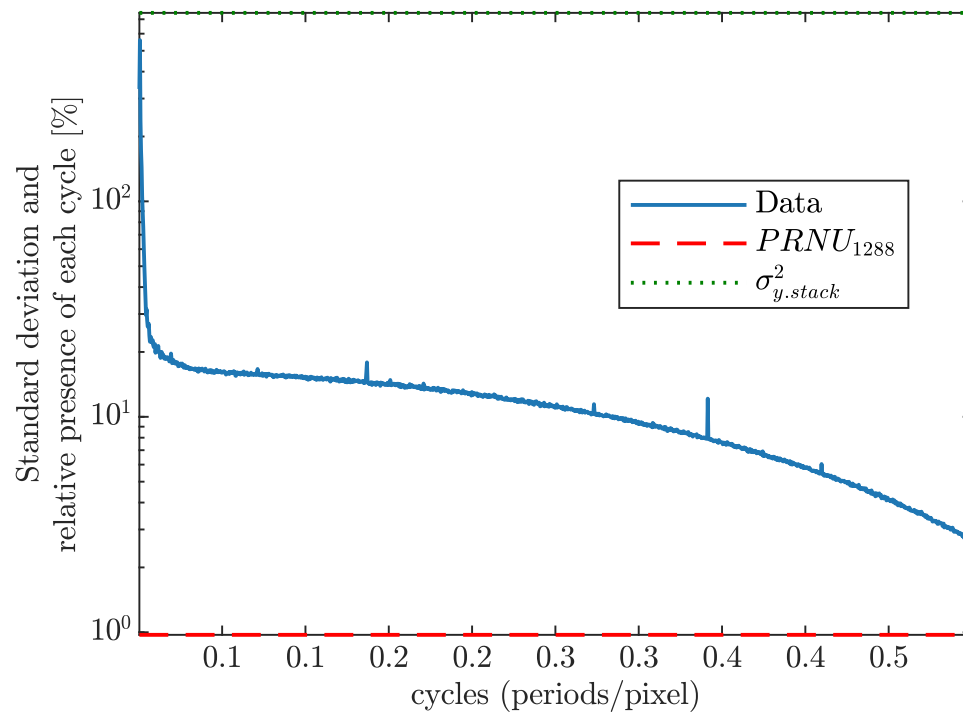
## Horizontal Spectrogram PRNU



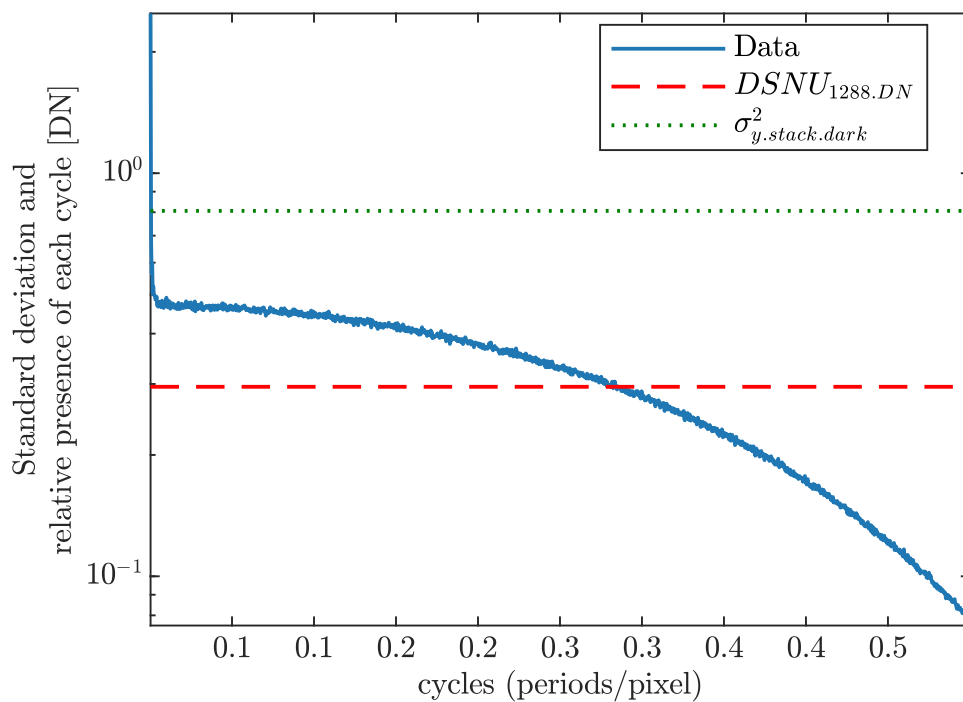
## Horizontal Spectrogram DSNU



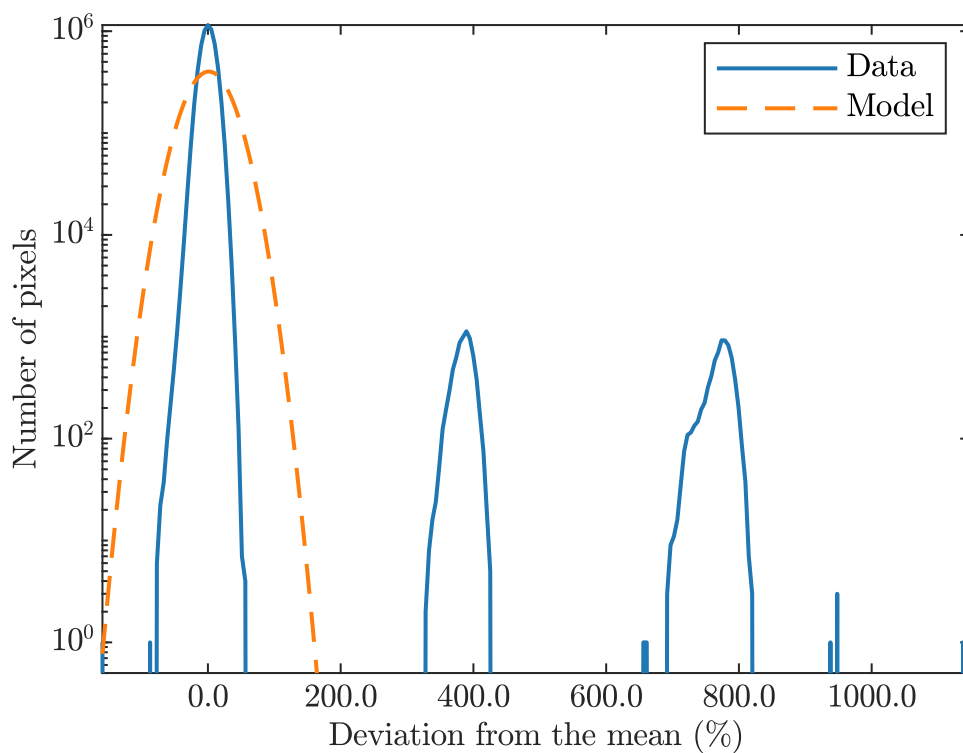
## Vertical Spectrogram PRNU



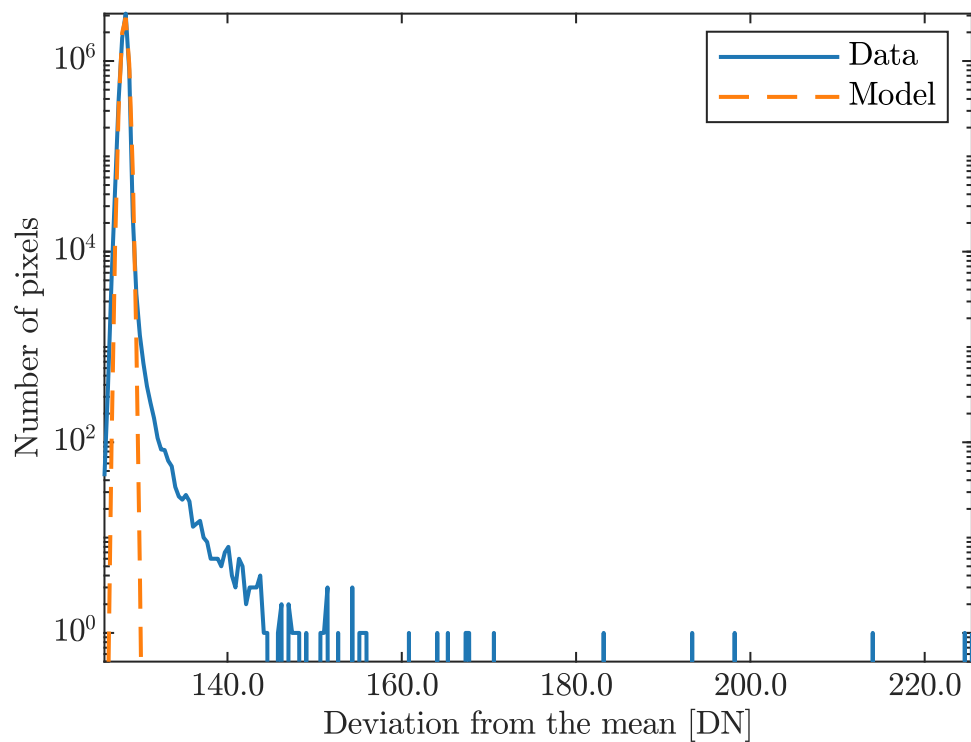
## Vertical Spectrogram DSNU



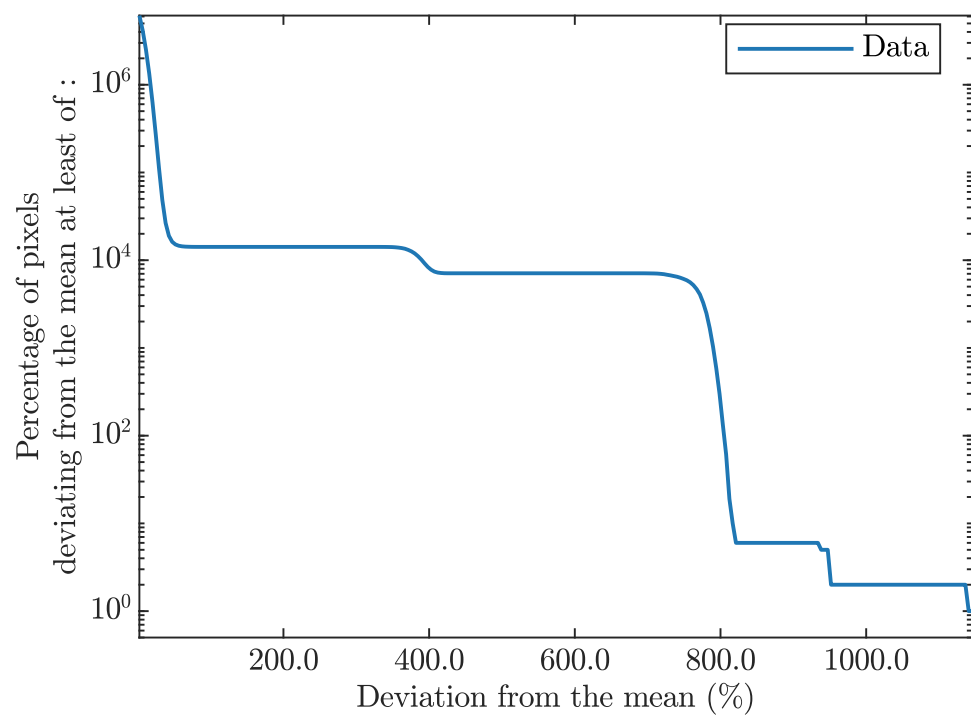
## Logarithmic Histogram PRNU



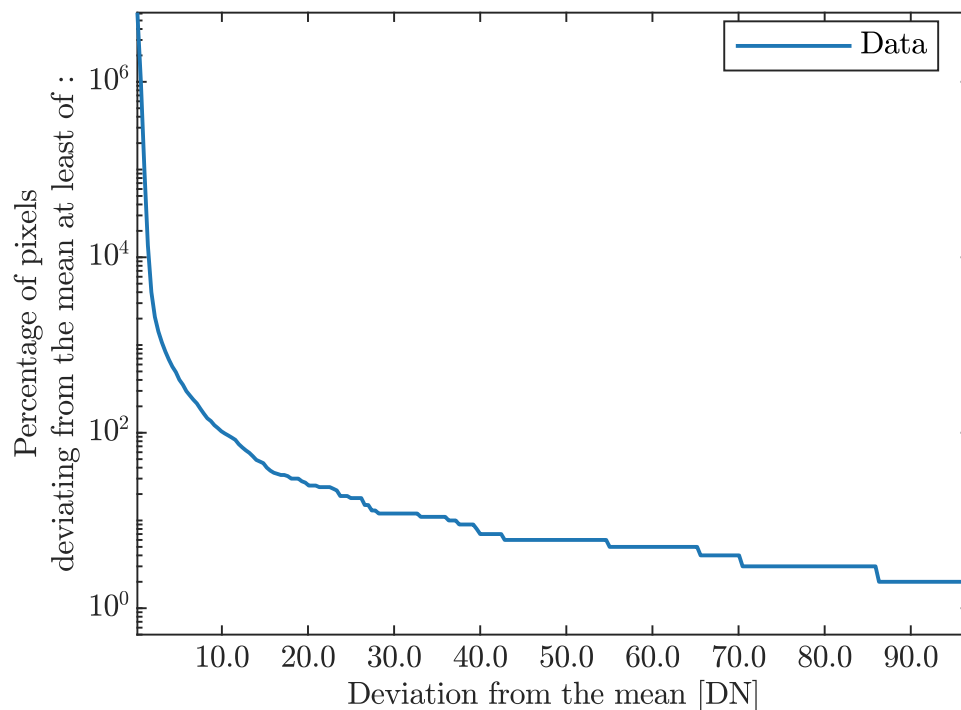
## Logarithmic Histogram DSNU



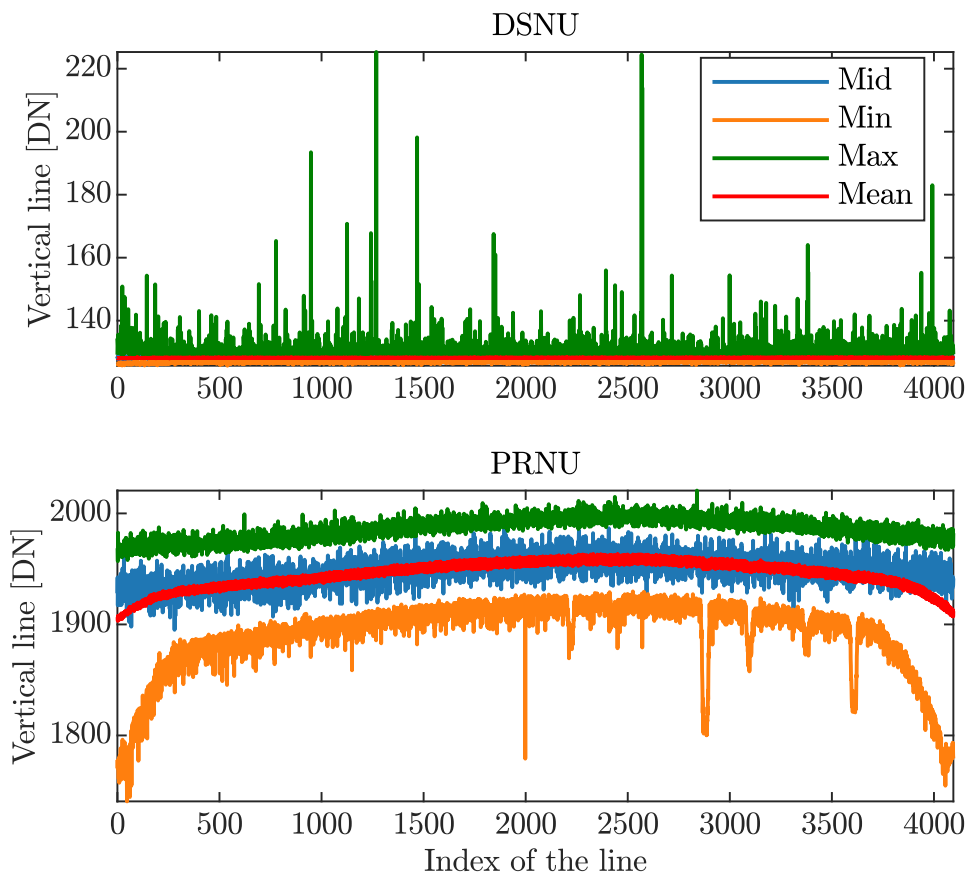
## Accumulated Log Histogram PRNU



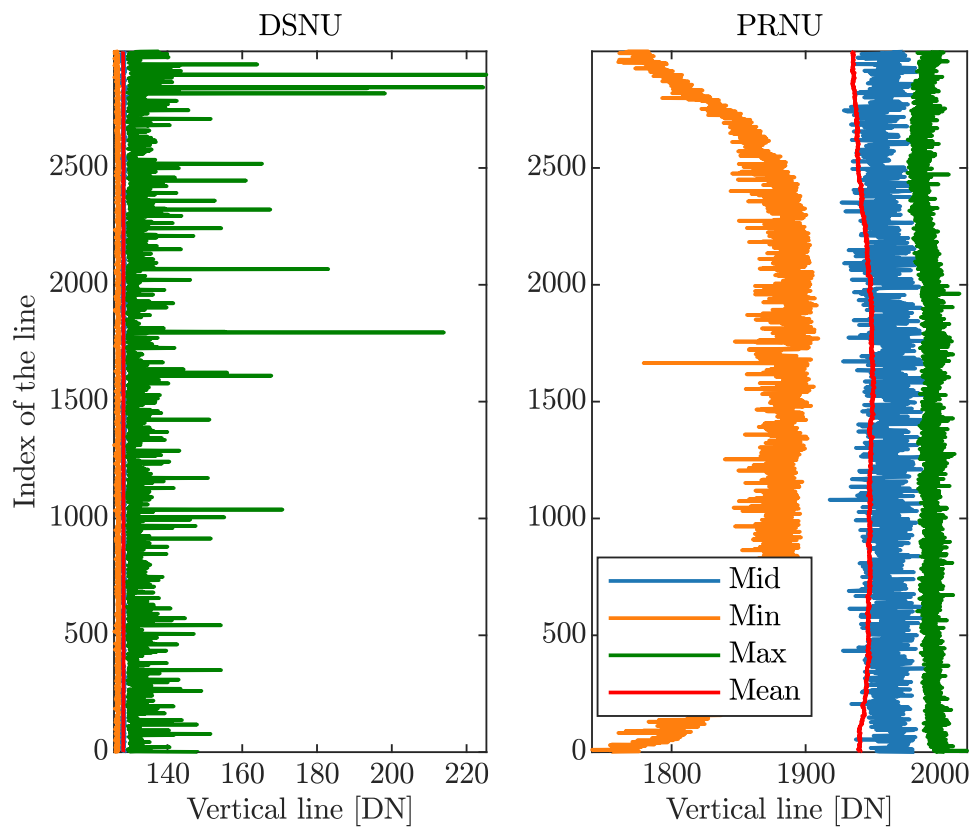
## Accumulated Log Histogram DSNU



## Horizontal Profile



## Vertical Profile



## Summary Sheet for Operation Point 2 at a Wavelength of 632 nm

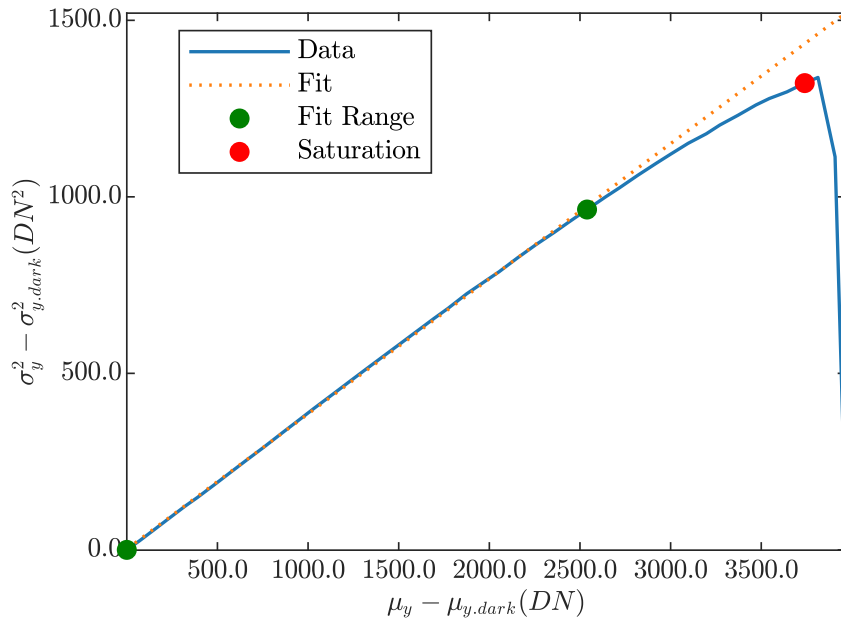
### Camera setting

|             |             |
|-------------|-------------|
| Gain        | GainLevelx1 |
| Black level | 128         |

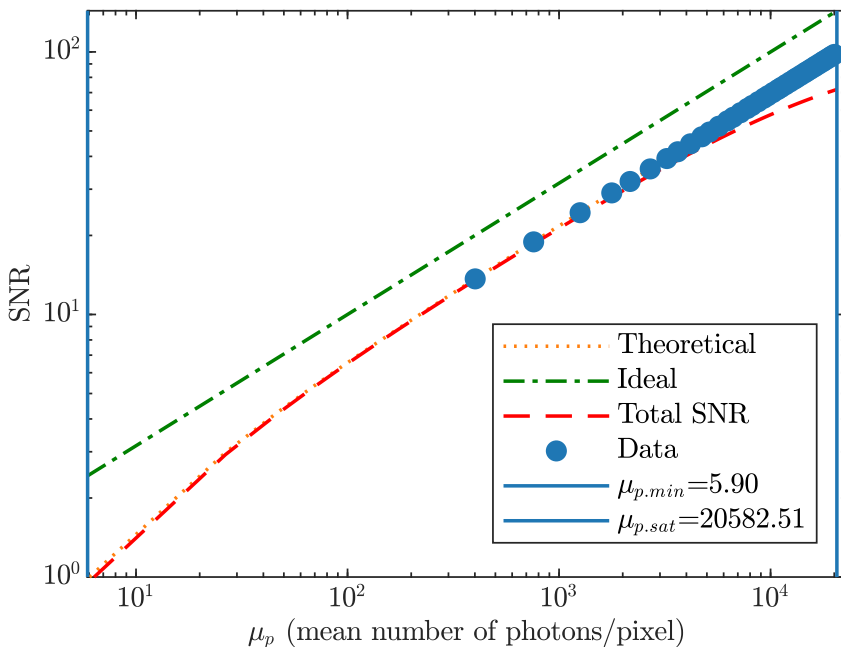
### Operation point parameters

|                           |        |
|---------------------------|--------|
| Environmental temperature | 2.68   |
| Camera body temperature   | 2.68   |
| Sensor temperature        | 38.376 |
| Processor temperature     | 37     |

### Photon Transfer



### Signal-to-Noise Ratio



### Performance

#### Quantum efficiency

|        |         |   |
|--------|---------|---|
| $\eta$ | 47.8194 | % |
|--------|---------|---|

#### System gain

|     |         |                    |
|-----|---------|--------------------|
| K   | 0.38282 | DN/e <sup>-</sup>  |
| 1/K | 2.6122  | e <sup>-</sup> /DN |

#### Temporal dark noise

|                   |         |                |
|-------------------|---------|----------------|
| $\sigma_d$        | 2.197   | e <sup>-</sup> |
| $\sigma_{y,dark}$ | 0.88924 | DN             |

#### Signal-to-noise ratio

|                      |         |     |
|----------------------|---------|-----|
| SNR <sub>max</sub>   | 99.2091 |     |
|                      | 39.931  | dB  |
|                      | 6.6324  | bit |
| 1/SNR <sub>max</sub> | 1.008   | %   |

#### Absolute sensitivity threshold

|                    |         |                                 |
|--------------------|---------|---------------------------------|
| $\mu_{p,min}$      | 5.9031  | p                               |
| $\mu_{p,min,area}$ | 0.49596 | p/μm <sup>2</sup>               |
| $\mu_{e,min}$      | 2.8228  | e <sup>-</sup>                  |
| $\mu_{e,min,area}$ | 0.23716 | e <sup>-</sup> /μm <sup>2</sup> |

#### Saturation capacity

|                    |           |                                 |
|--------------------|-----------|---------------------------------|
| $\mu_{p,sat}$      | 20582.508 | p                               |
| $\mu_{p,sat,area}$ | 1729.2592 | p/μm <sup>2</sup>               |
| $\mu_{e,sat}$      | 9842.4415 | e <sup>-</sup>                  |
| $\mu_{e,sat,area}$ | 826.9222  | e <sup>-</sup> /μm <sup>2</sup> |

#### Dynamic range

|    |           |     |
|----|-----------|-----|
| DR | 3486.7086 |     |
|    | 70.8483   | dB  |
|    | 11.7677   | bit |

#### Spatial nonuniformities

|                      |         |                |
|----------------------|---------|----------------|
| DSNU <sub>1288</sub> | 0.81151 | e <sup>-</sup> |
|                      | 0.31067 | DN             |
| PRNU <sub>1288</sub> | 0.95592 | %              |

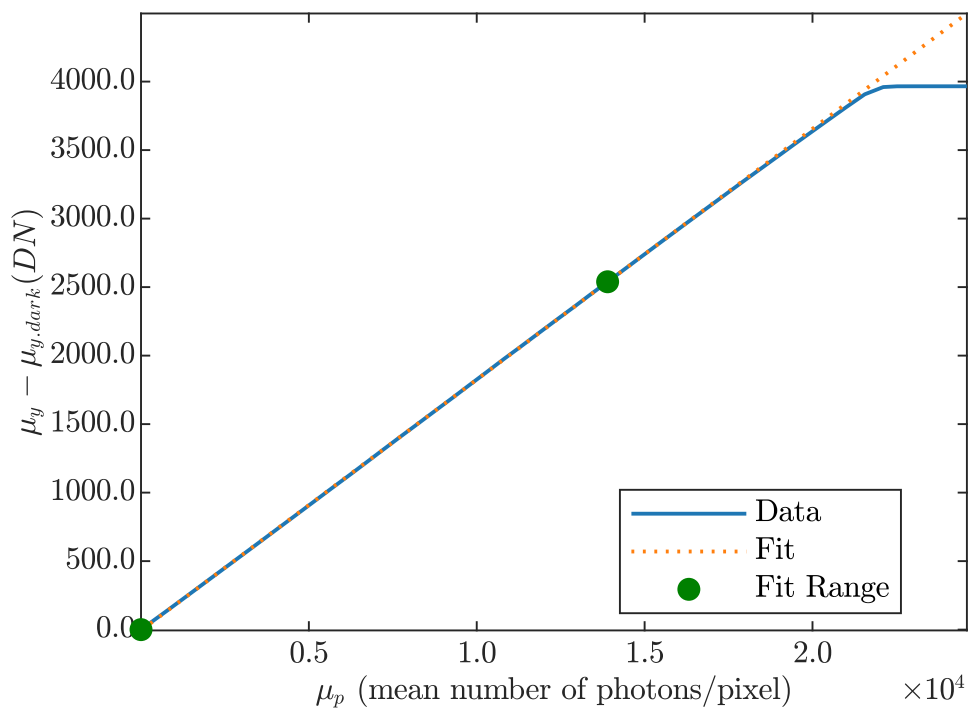
#### Linearity error

|                   |          |   |
|-------------------|----------|---|
| LE <sub>min</sub> | -0.27121 | % |
| LE <sub>max</sub> | 0.35531  | % |

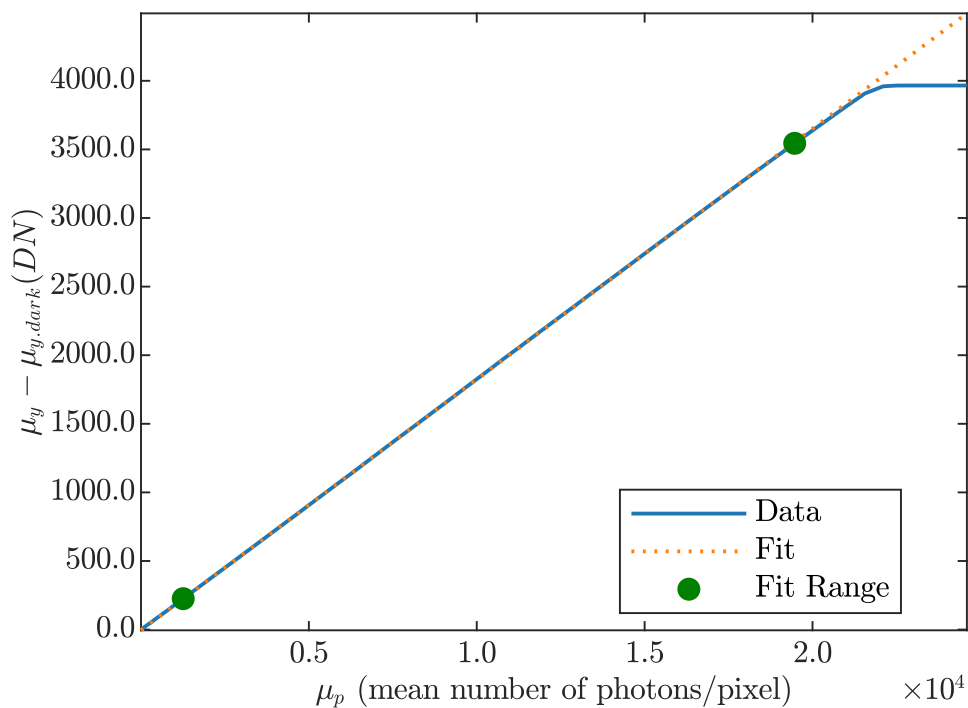
#### Dark current

|                |         |                   |
|----------------|---------|-------------------|
| $\mu_{l,mean}$ | 13.6996 | e <sup>-</sup> /s |
|                | 5.2463  | DN/s              |
| $\mu_{l,var}$  | 2.3503  | e <sup>-</sup> /s |
|                | 0.34467 | DN/s              |

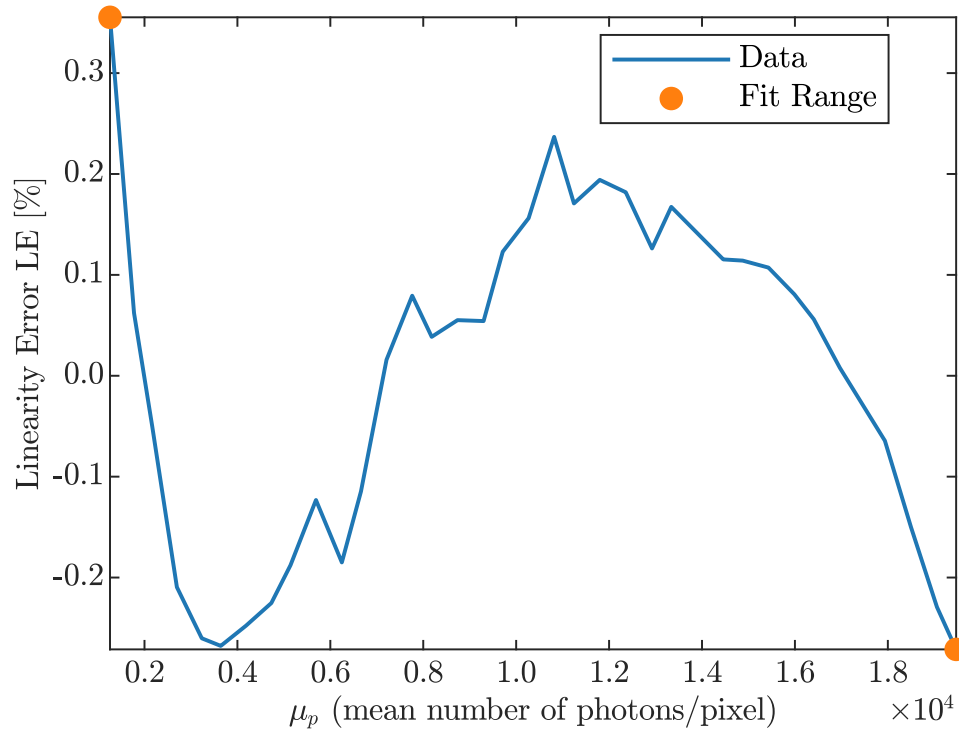
## Sensitivity



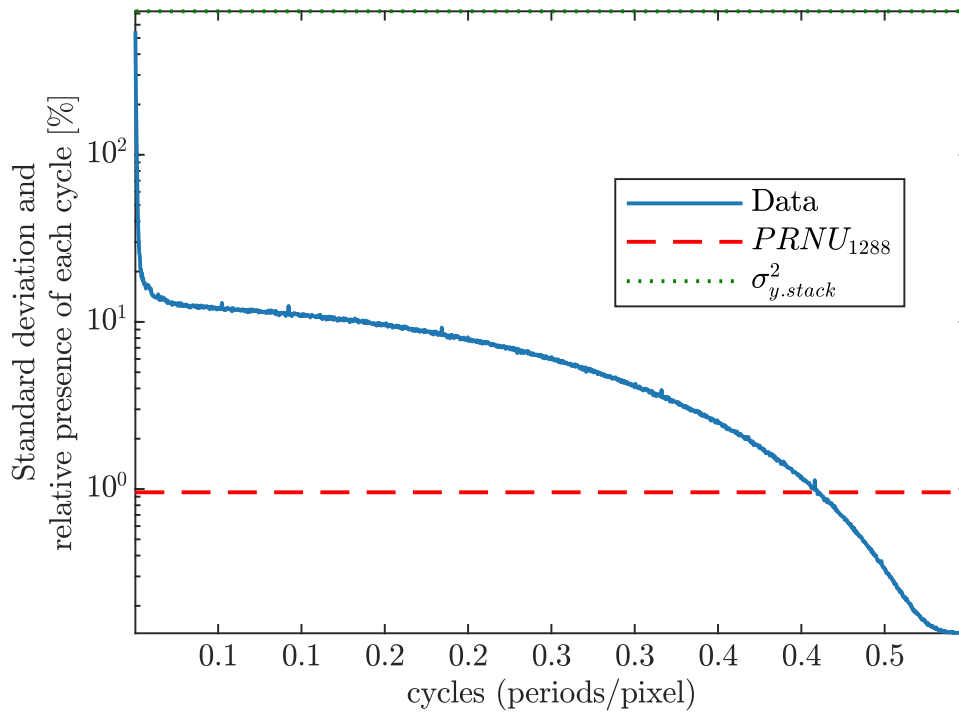
## Linearity



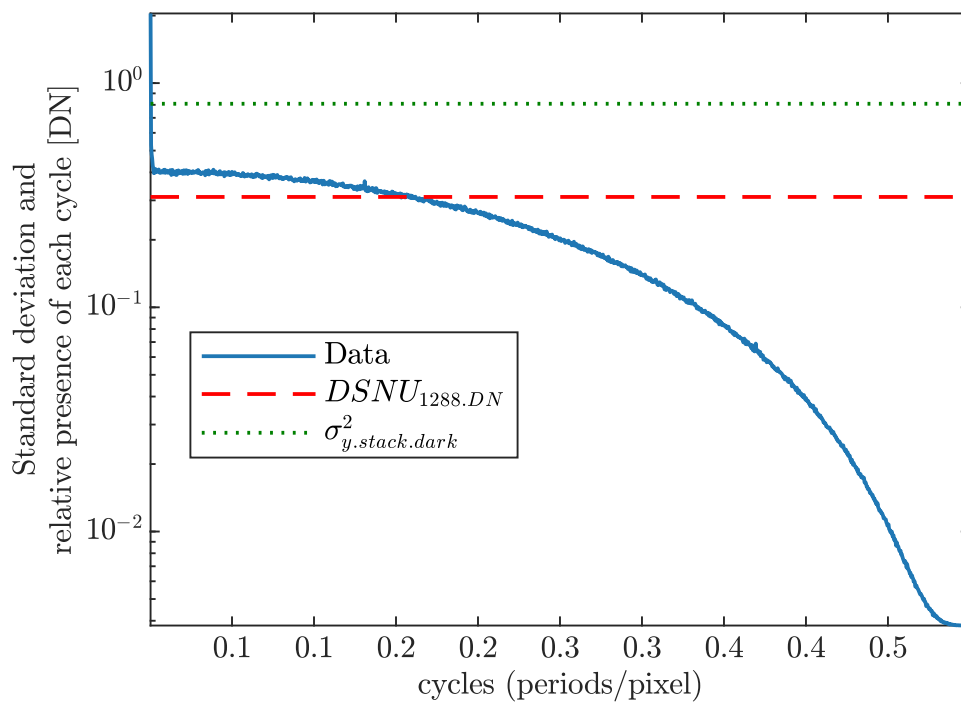
## Deviation Linearity



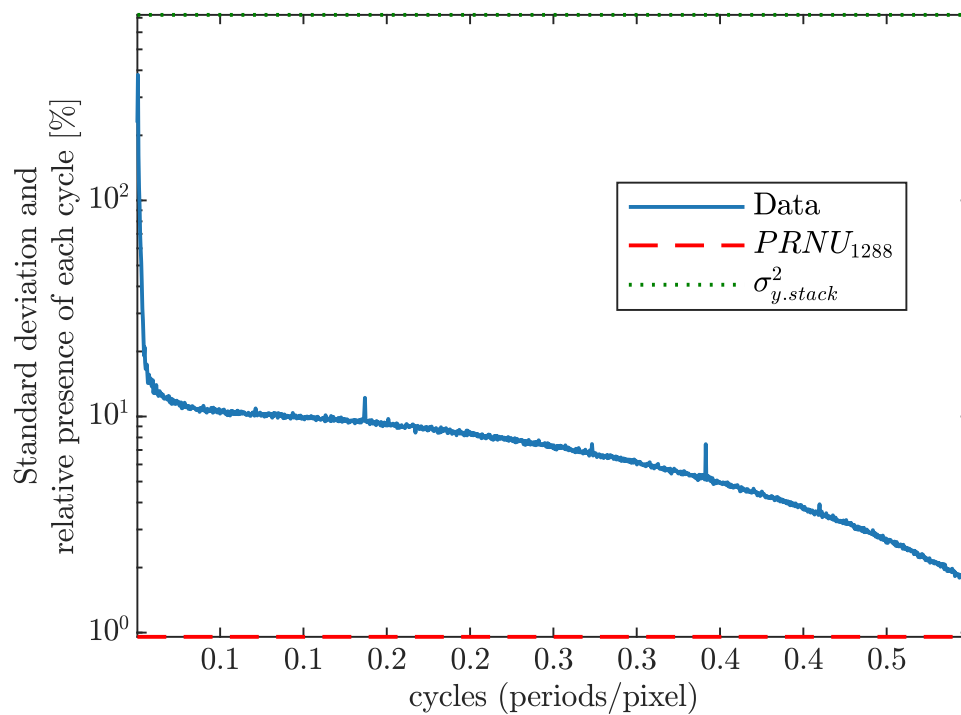
## Horizontal Spectrogram PRNU



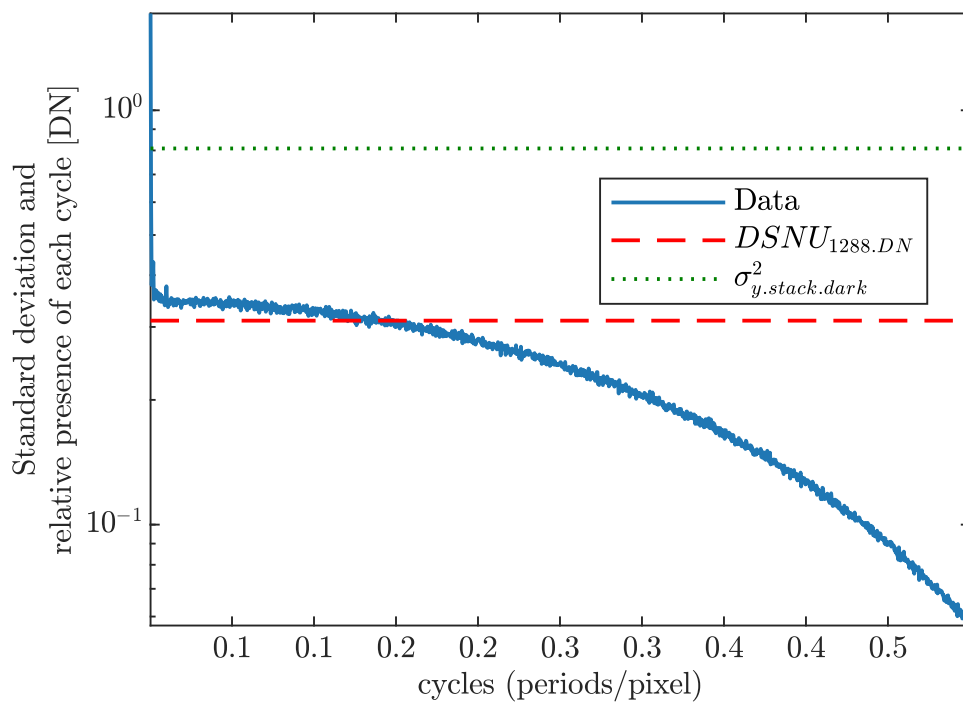
## Horizontal Spectrogram DSNU



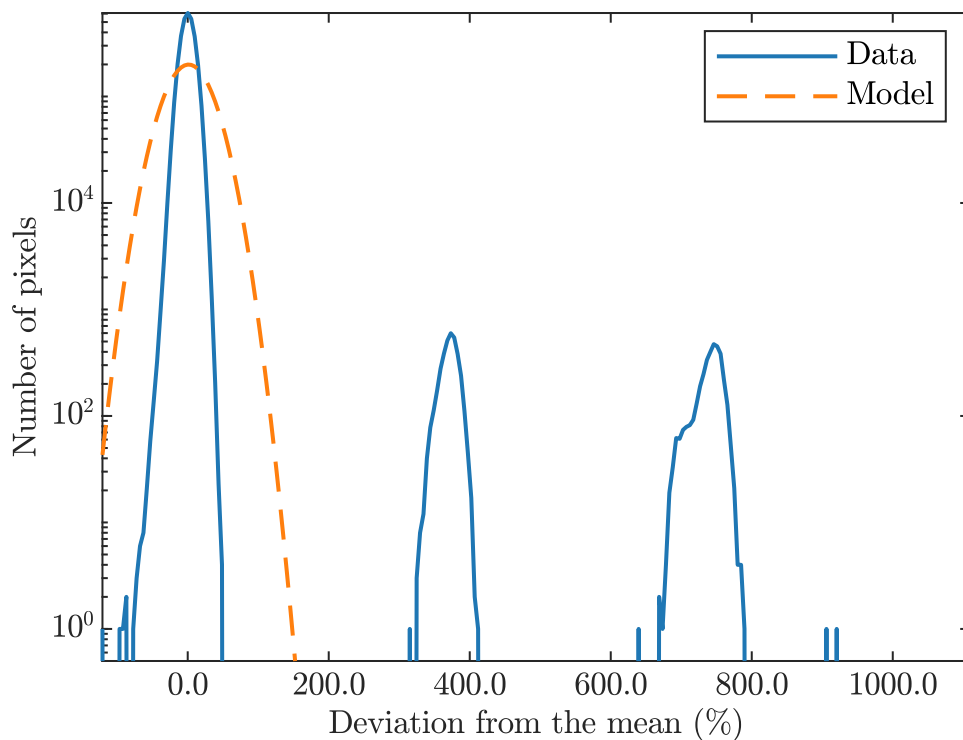
## Vertical Spectrogram PRNU



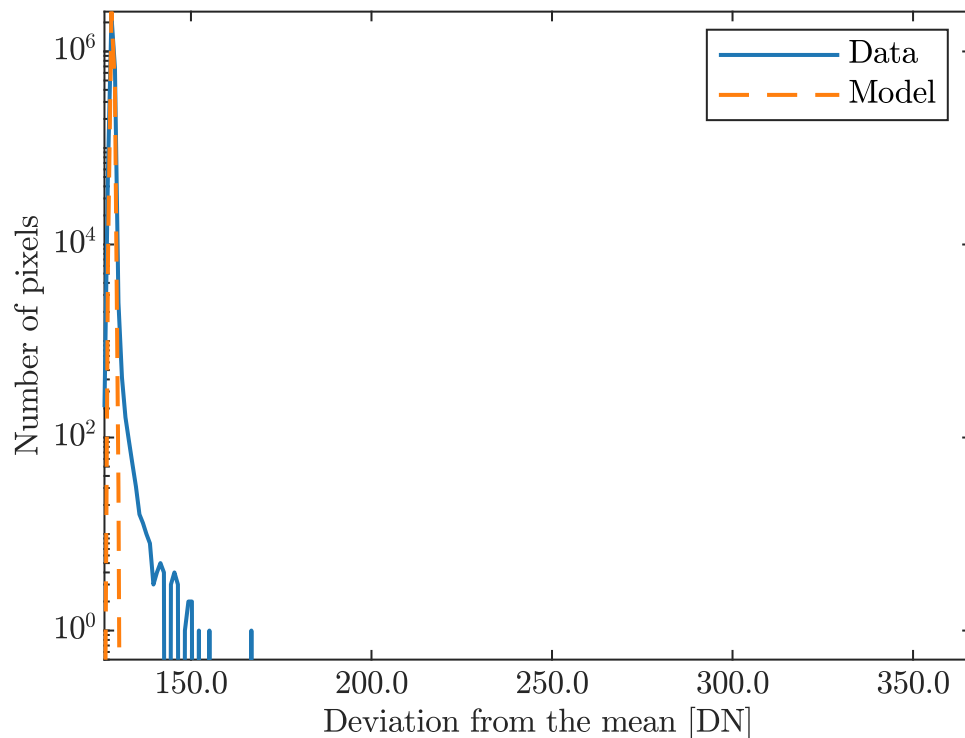
## Vertical Spectrogram DSNU



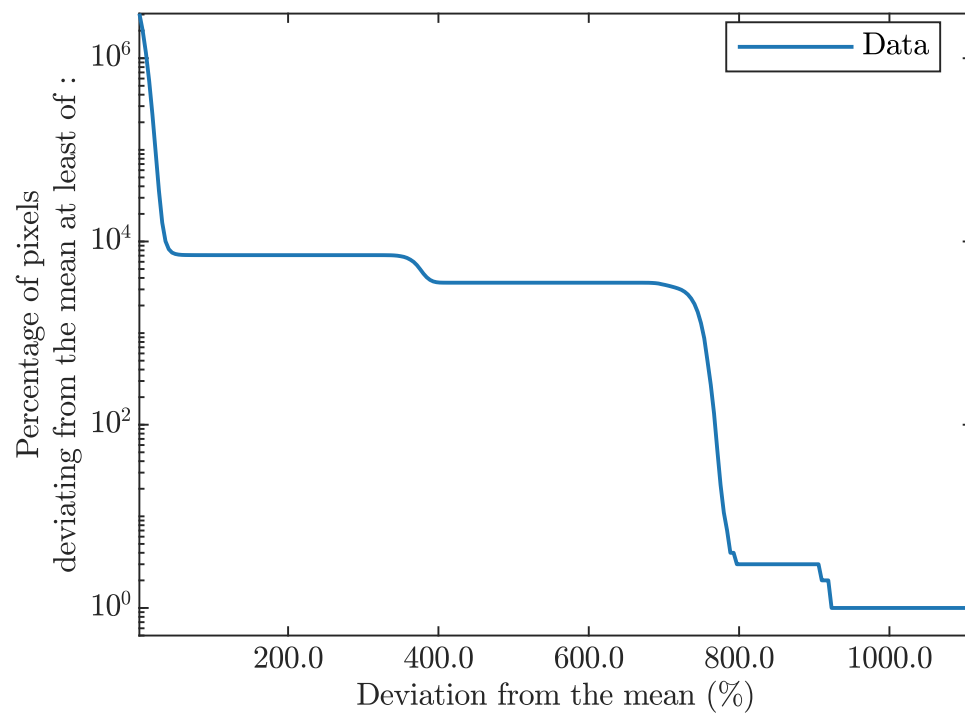
## Logarithmic Histogram PRNU



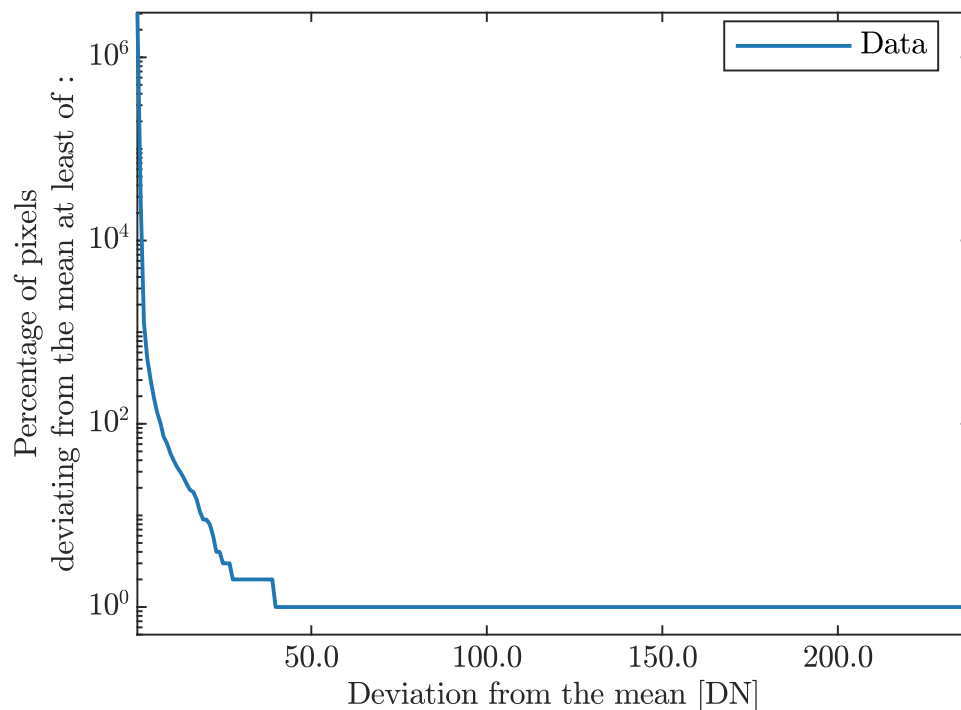
### Logarithmic Histogram DSNU



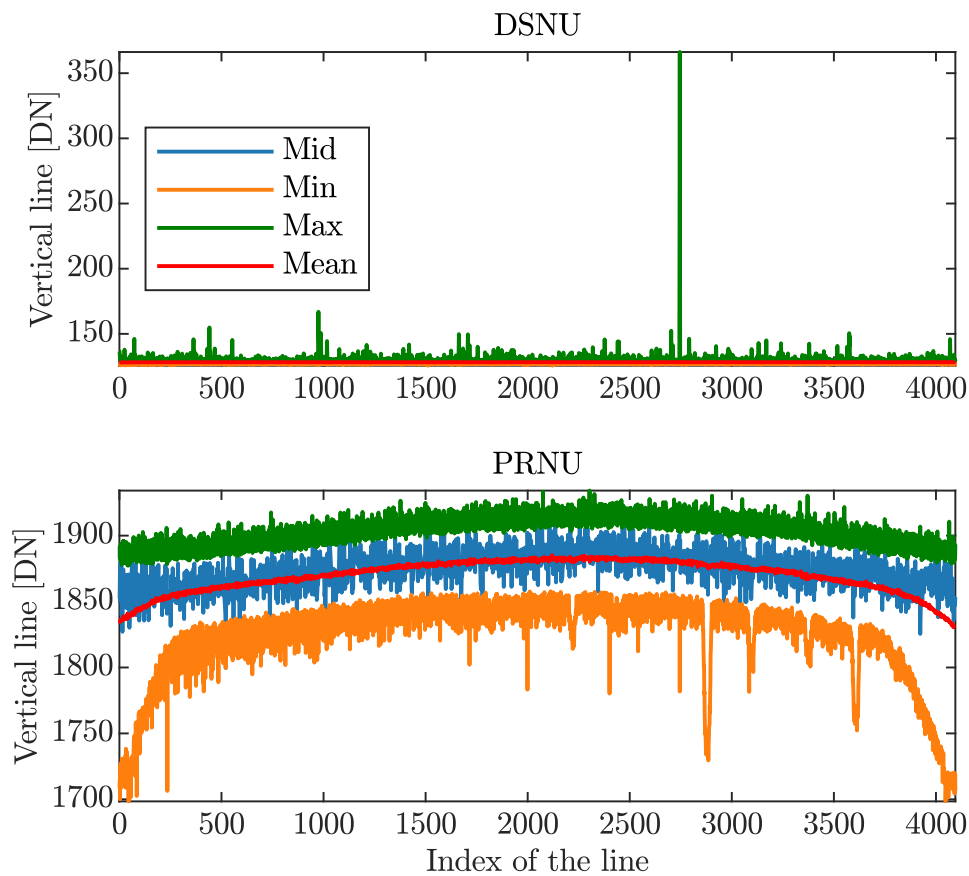
### Accumulated Log Histogram PRNU



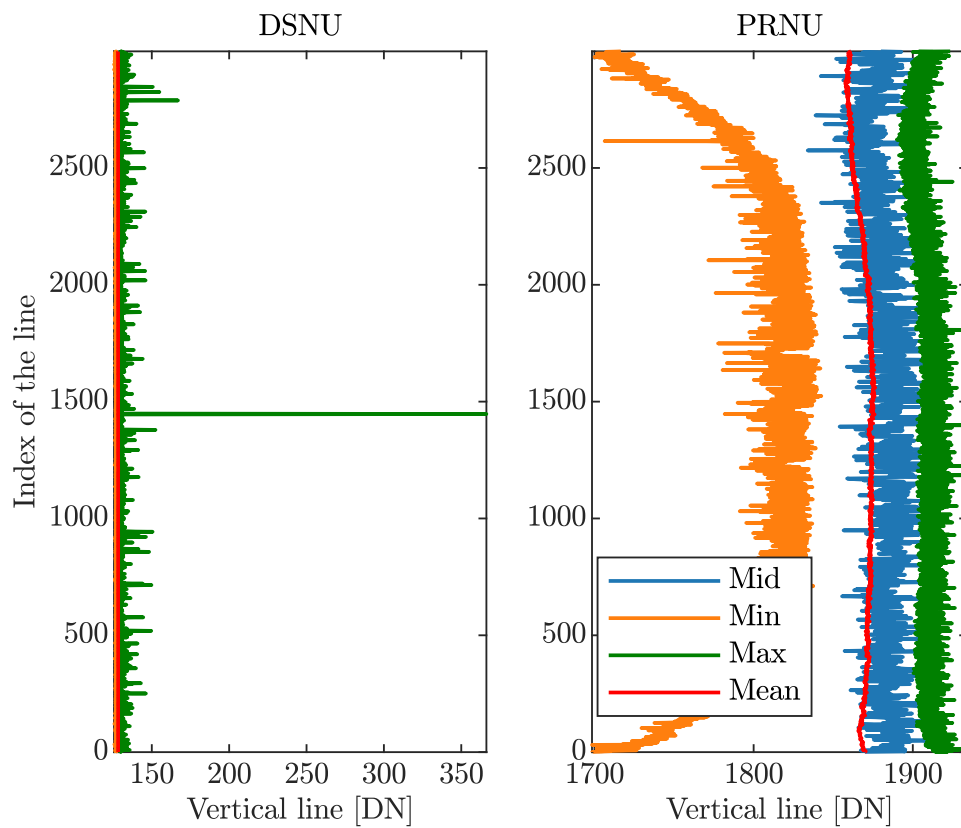
## Accumulated Log Histogram DSNU



## Horizontal Profile



## Vertical Profile



## Summary Sheet for Operation Point 3 at a Wavelength of 448 nm

### Camera setting

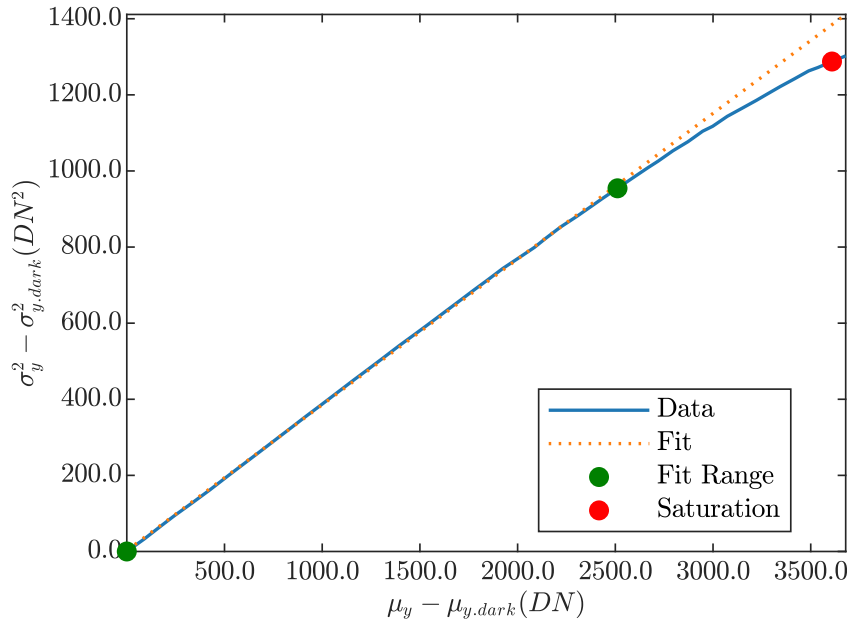
Gain  
Black level

GainLevelx1  
128

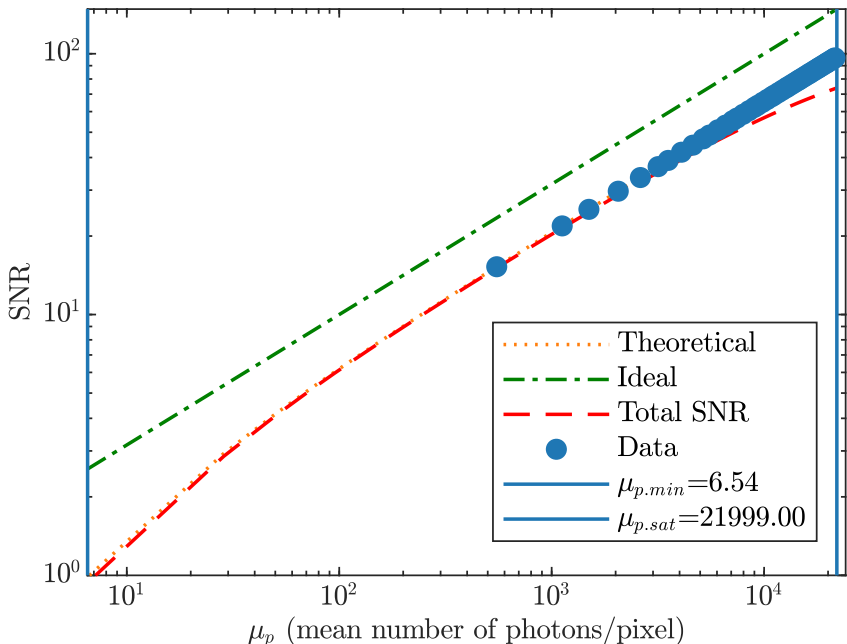
### Operation point parameters

Environmental temperature 2.68  
Camera body temperature 2.68  
Sensor temperature 38.68  
Processor temperature 38

### Photon Transfer



### Signal-to-Noise Ratio



### Performance

#### Quantum efficiency

η 43.1573 %

#### System gain

K 0.38295 DN/e<sup>-</sup>  
1/K 2.6113 e<sup>-</sup>/DN

#### Temporal dark noise

σ<sub>d</sub> 2.1963 e<sup>-</sup>  
σ<sub>y,dark</sub> 0.88924 DN

#### Signal-to-noise ratio

SNR<sub>max</sub> 97.4381  
39.7746 dB  
6.6064 bit  
1/SNR<sub>max</sub> 1.0263 %

#### Absolute sensitivity threshold

μ<sub>p,min</sub> 6.539 p  
μ<sub>p,min,area</sub> 0.54938 p/μm<sup>2</sup>  
μ<sub>e,min</sub> 2.8221 e<sup>-</sup>  
μ<sub>e,min,area</sub> 0.2371 e<sup>-</sup>/μm<sup>2</sup>

#### Saturation capacity

μ<sub>p,sat</sub> 21998.9978 p  
μ<sub>p,sat,area</sub> 1848.267 p/μm<sup>2</sup>  
μ<sub>e,sat</sub> 9494.1739 e<sup>-</sup>  
μ<sub>e,sat,area</sub> 797.6622 e<sup>-</sup>/μm<sup>2</sup>

#### Dynamic range

DR 3364.2554  
70.5378 dB  
11.7161 bit

#### Spatial nonuniformities

DSNU<sub>1288</sub> 0.93052 e<sup>-</sup>  
0.35634 DN  
PRNU<sub>1288</sub> 0.88073 %

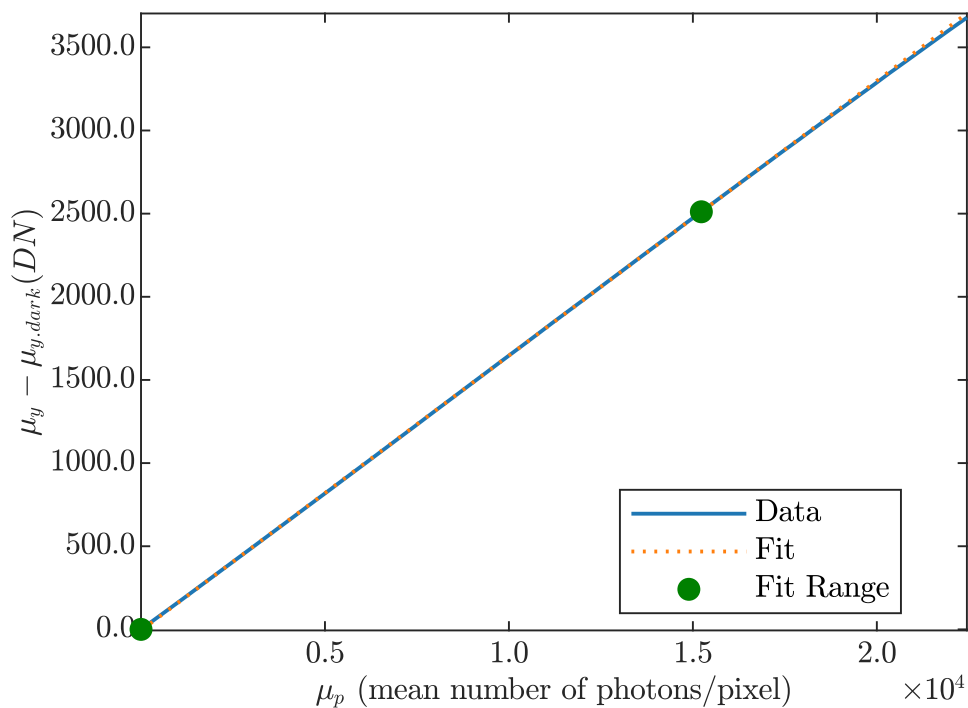
#### Linearity error

LE<sub>min</sub> -0.32477 %  
LE<sub>max</sub> 0.40711 %

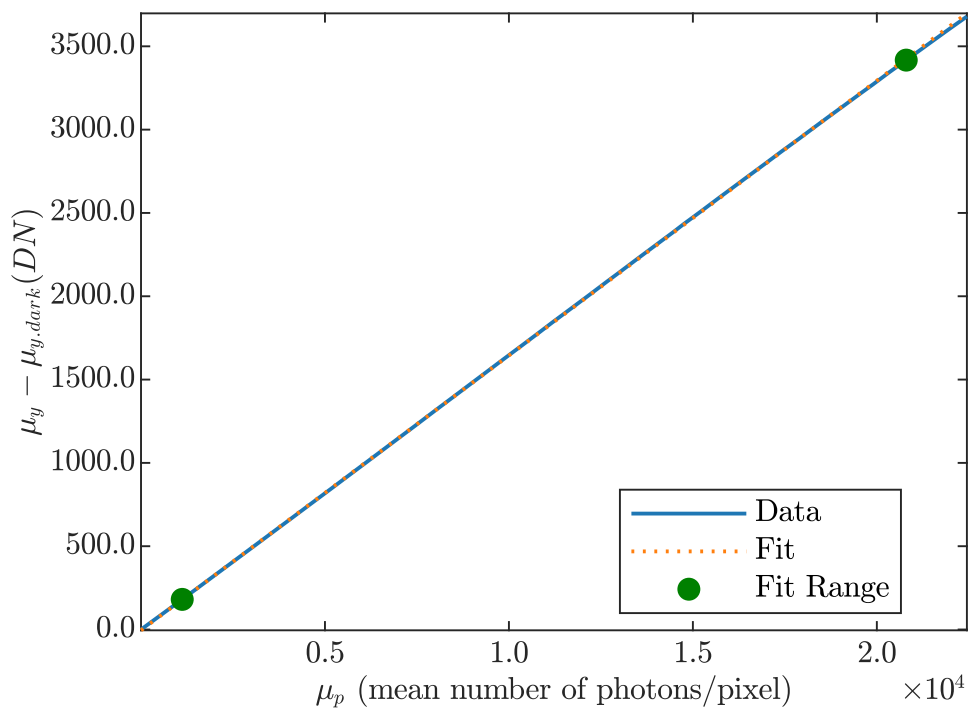
#### Dark current

μ<sub>l,mean</sub> 13.6996 e<sup>-</sup>/s  
5.2463 DN/s  
μ<sub>l,var</sub> 2.3503 e<sup>-</sup>/s  
0.34467 DN/s

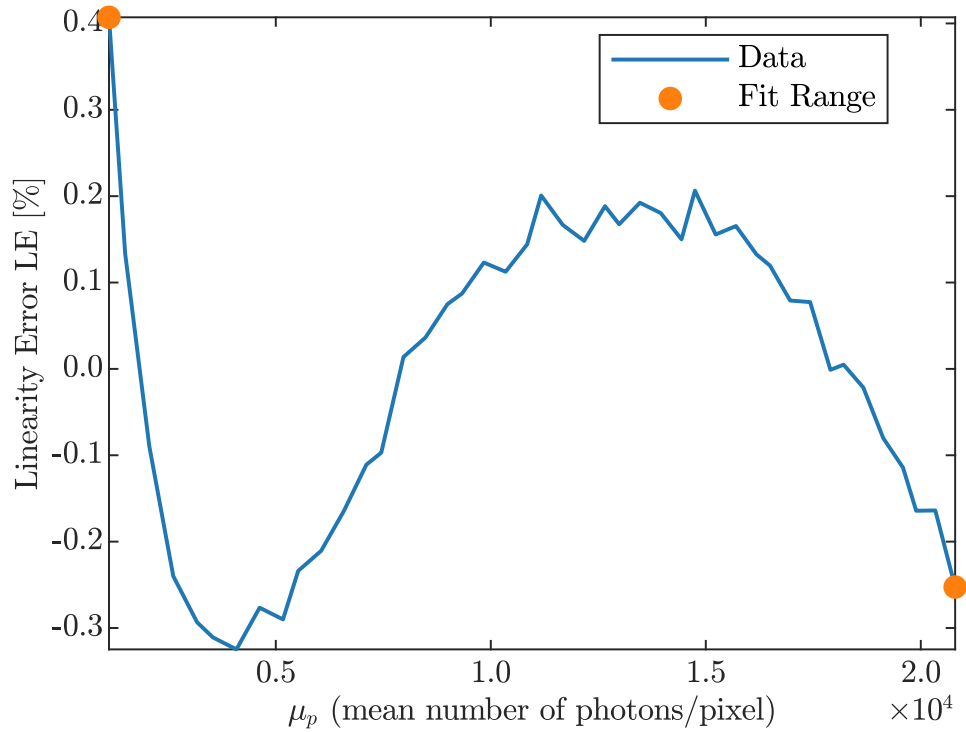
## Sensitivity



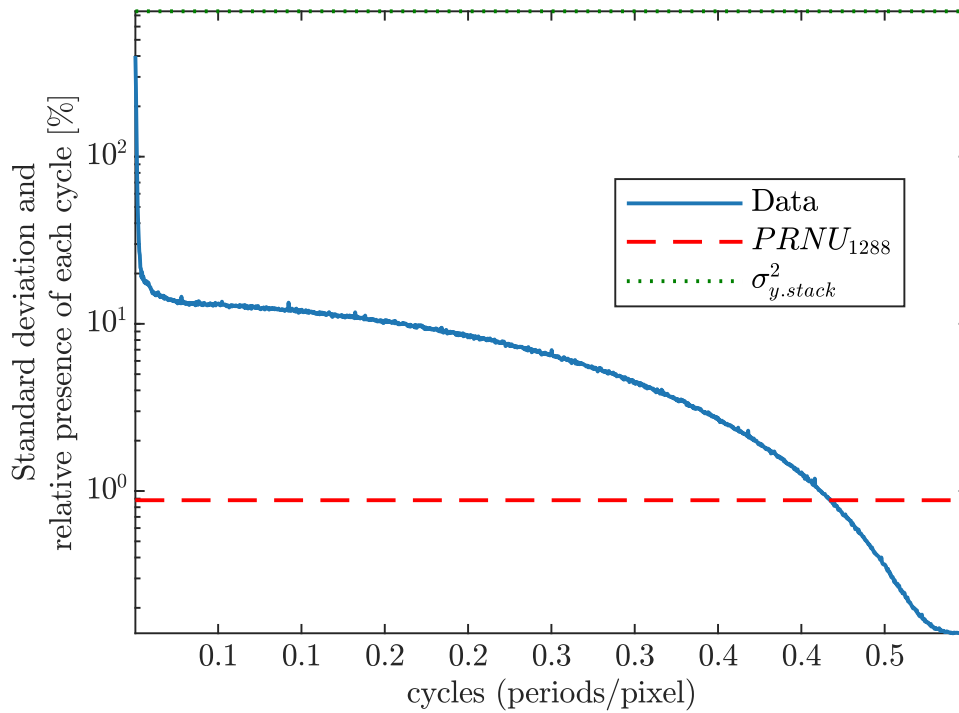
## Linearity



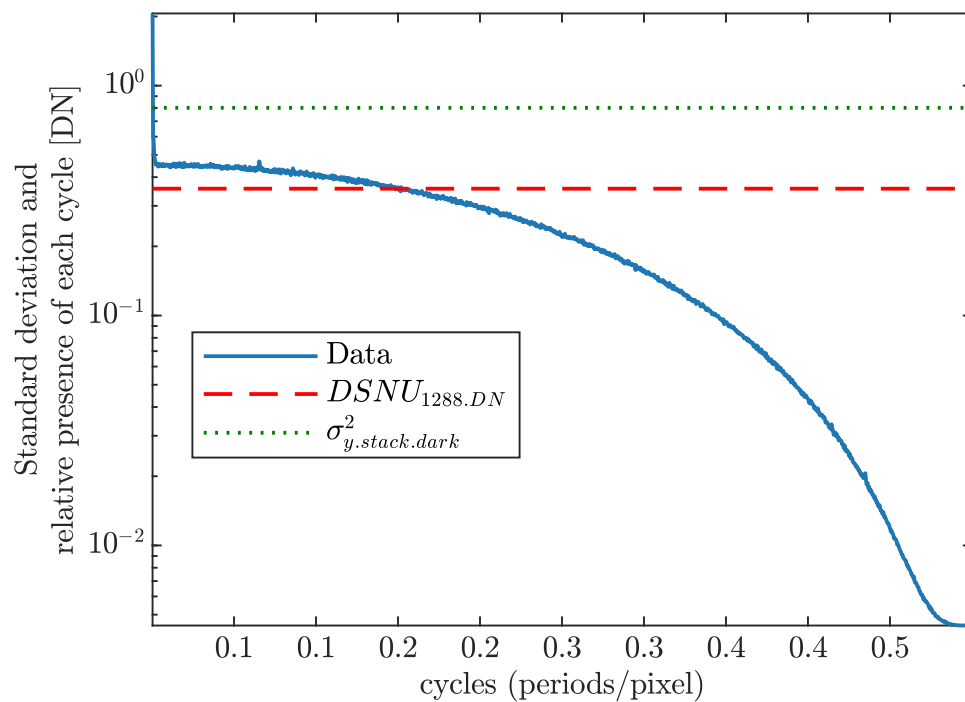
## Deviation Linearity



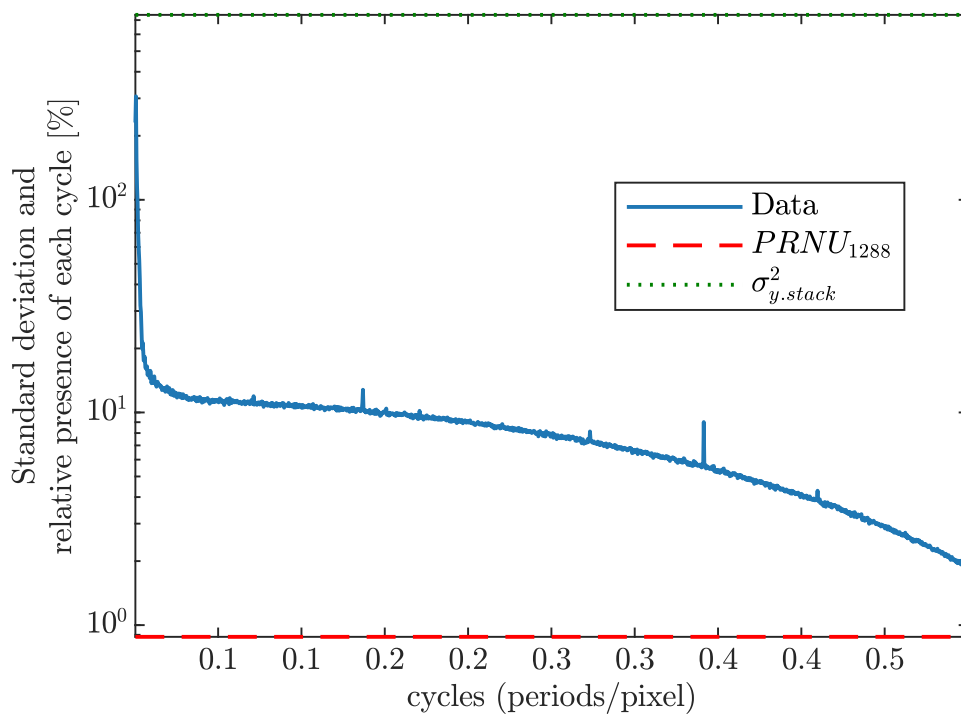
## Horizontal Spectrogram PRNU



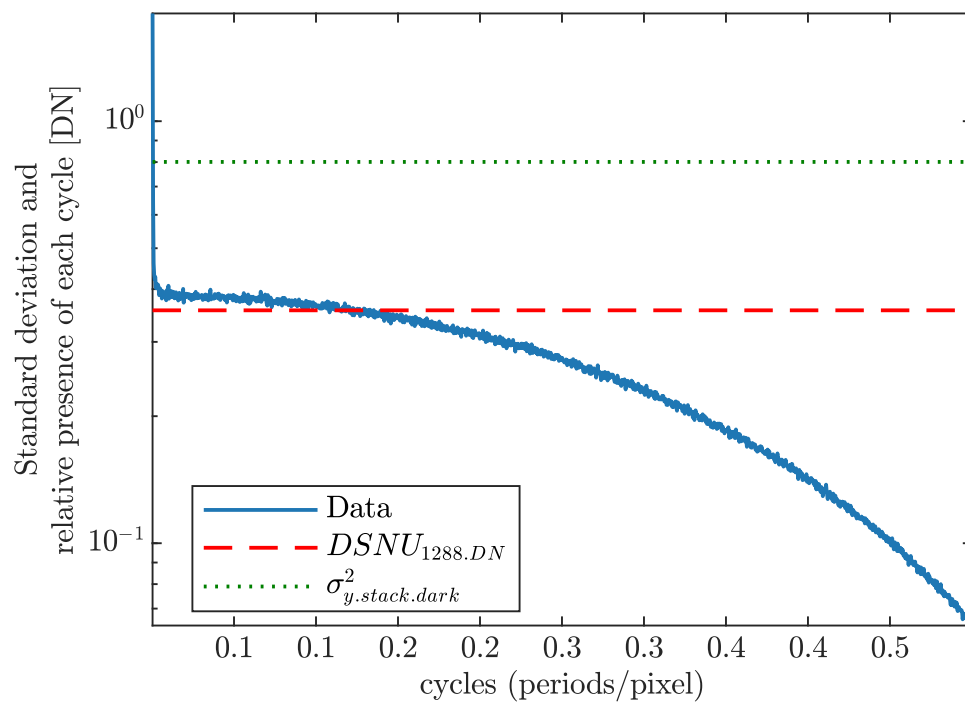
## Horizontal Spectrogram DSNU



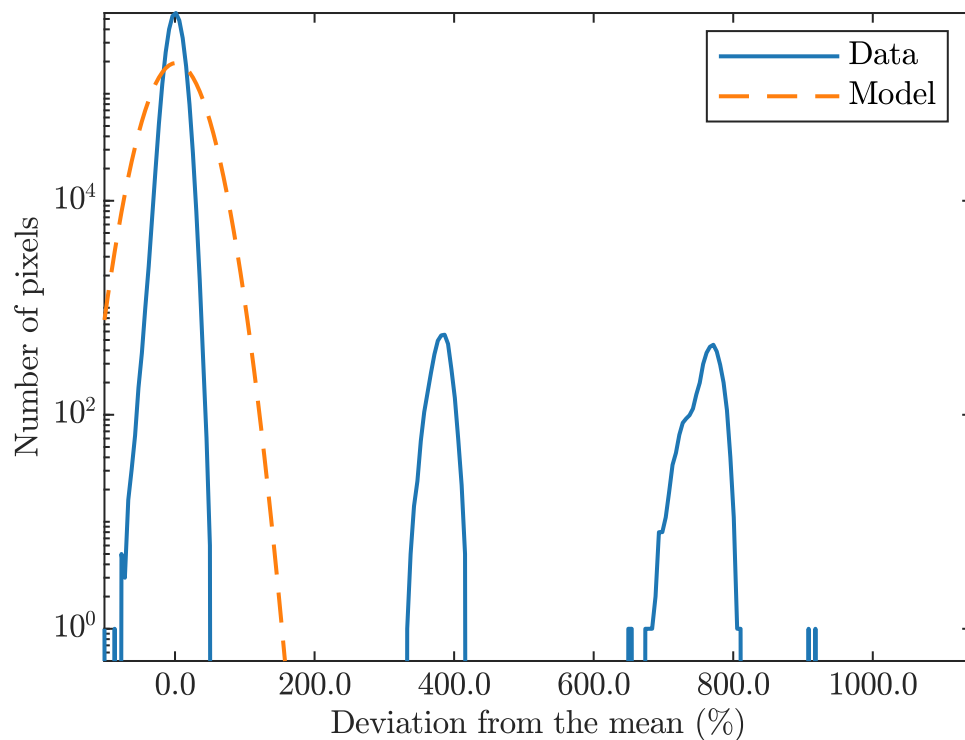
## Vertical Spectrogram PRNU



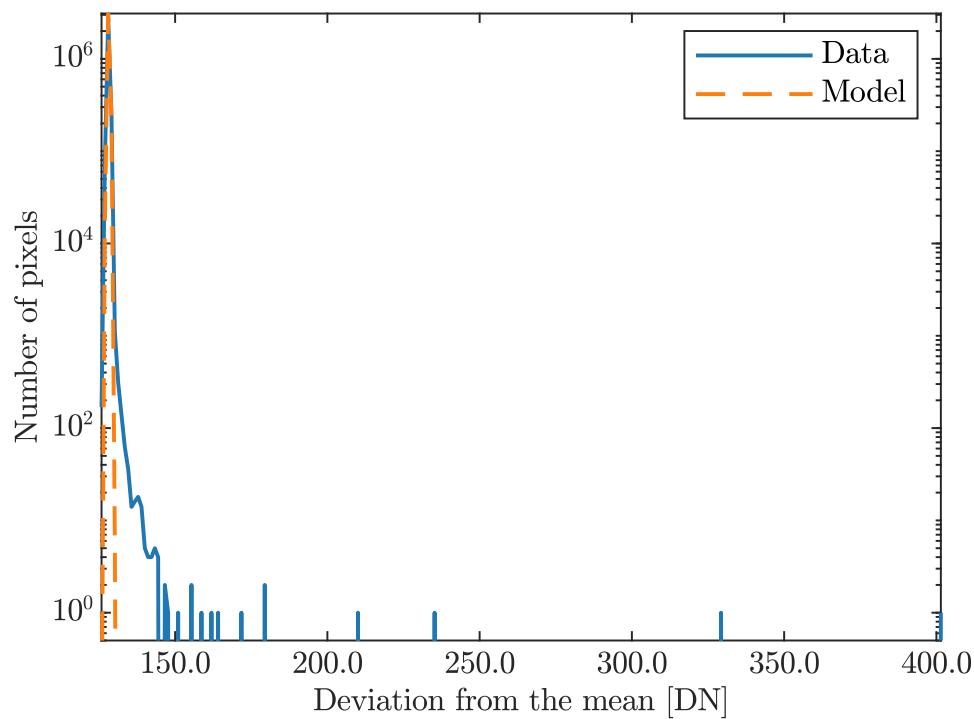
## Vertical Spectrogram DSNU



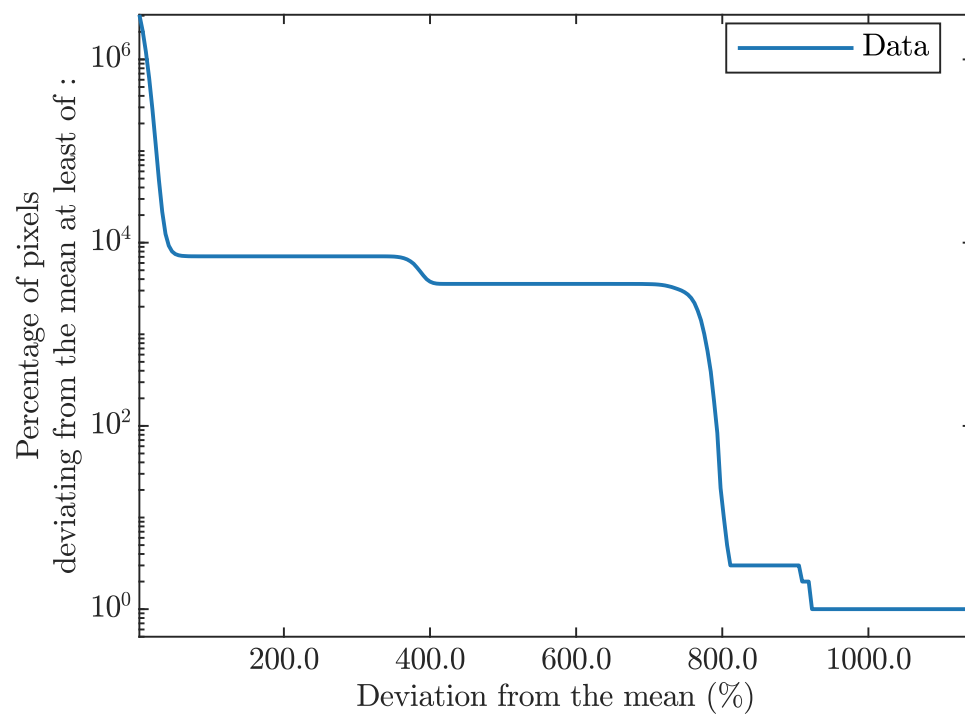
## Logarithmic Histogram PRNU



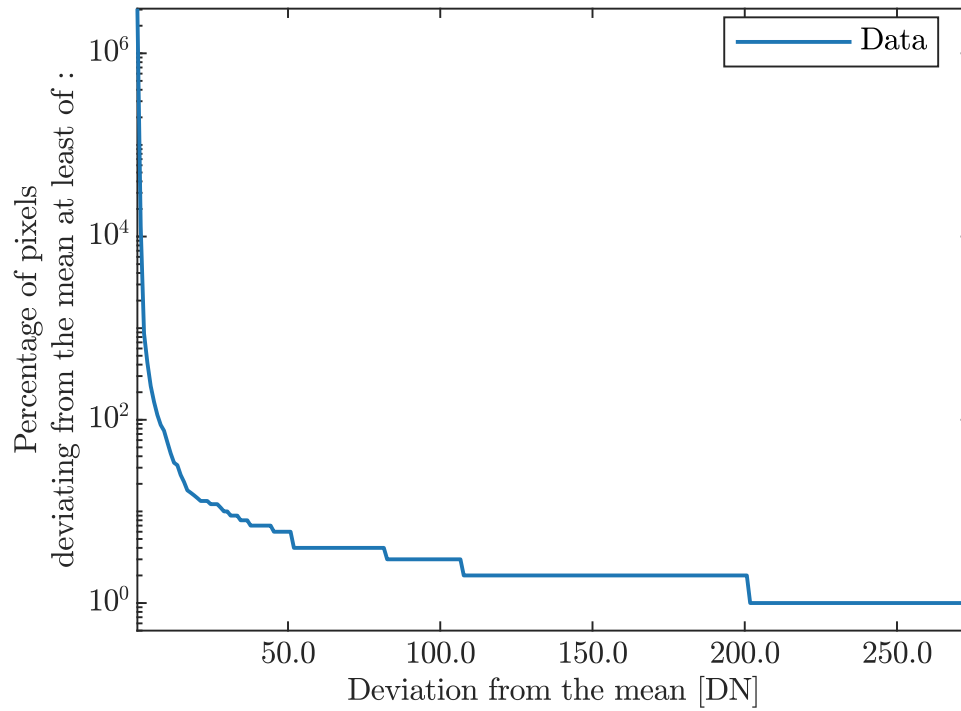
### Logarithmic Histogram DSNU



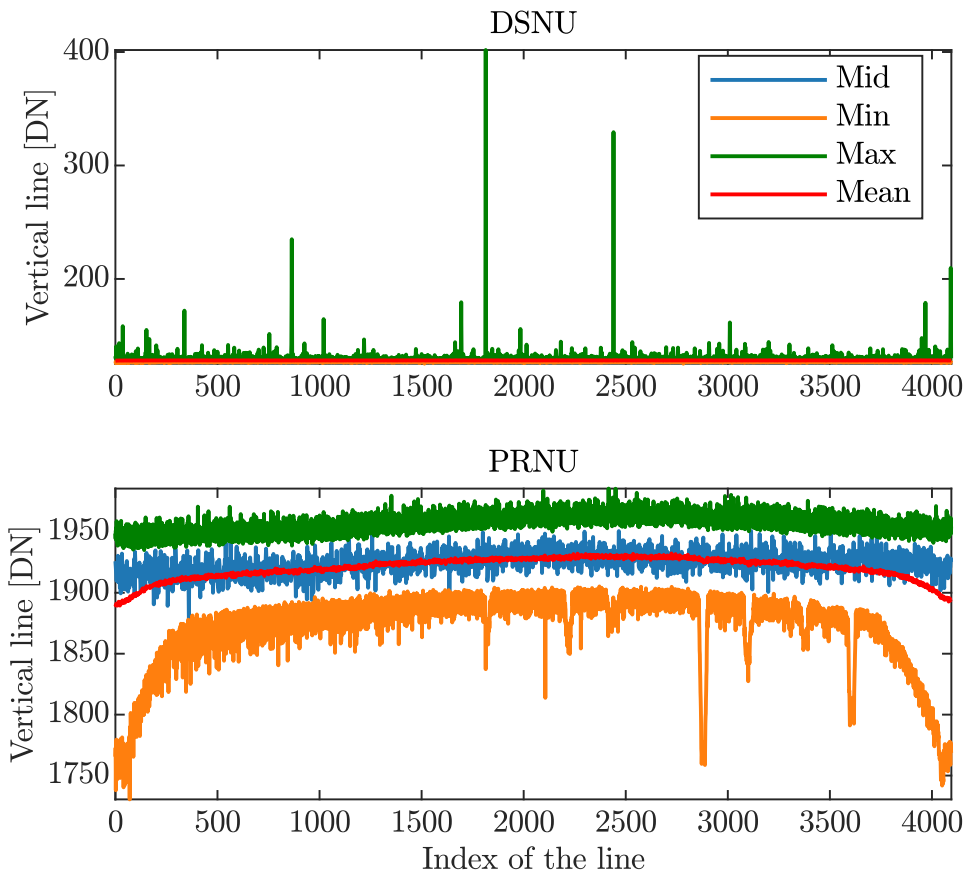
### Accumulated Log Histogram PRNU



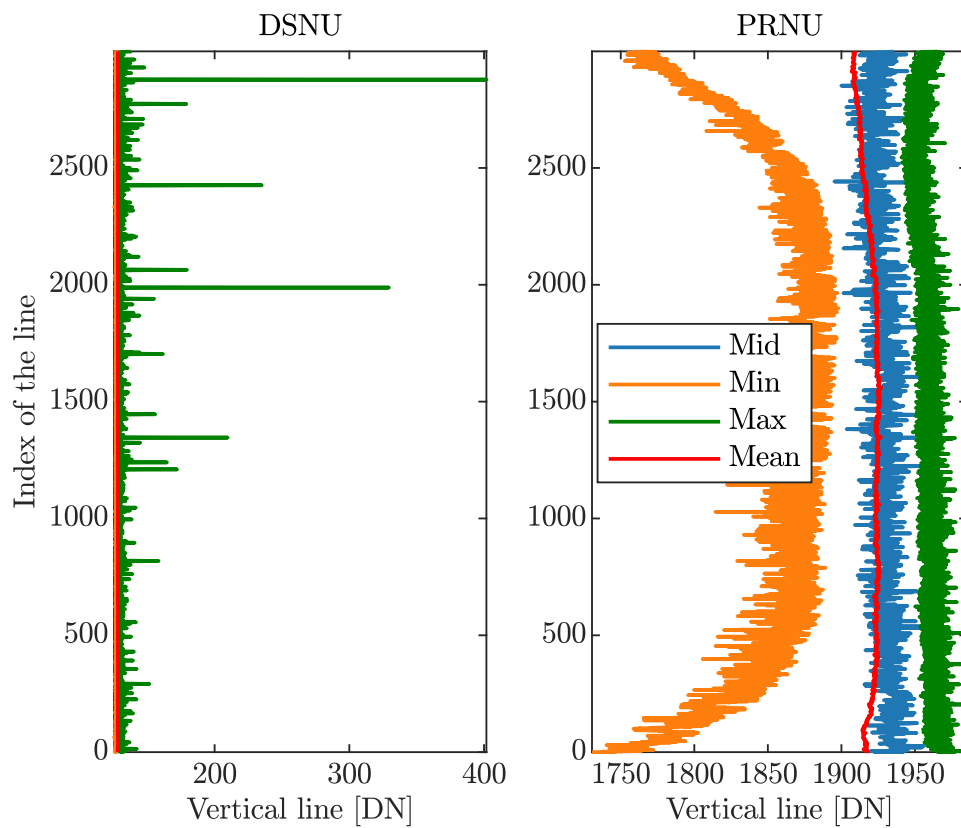
## Accumulated Log Histogram DSNU



## Horizontal Profile

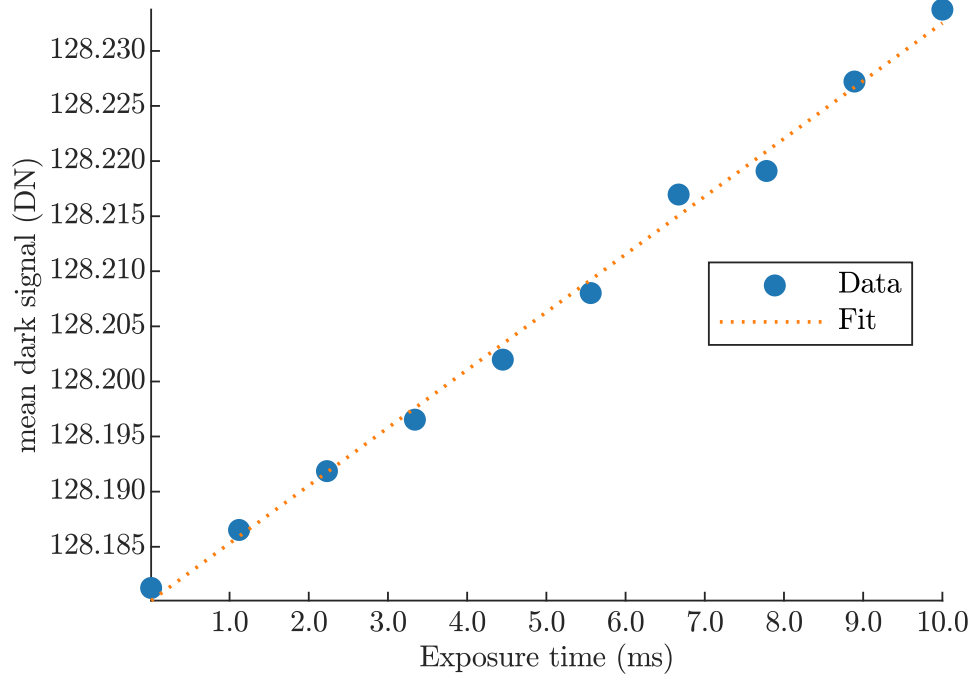


## Vertical Profile

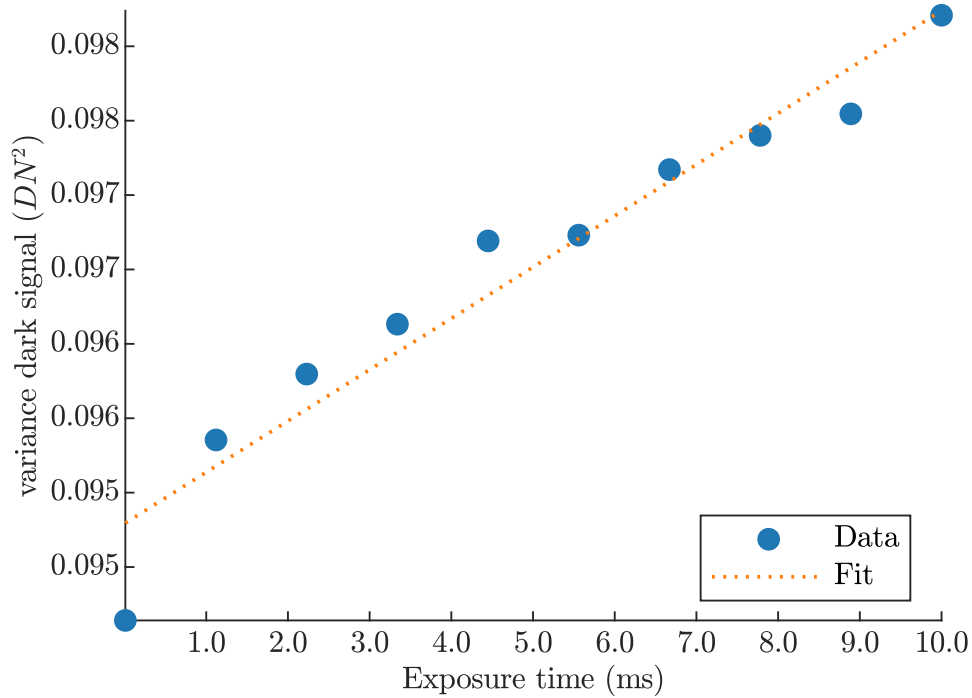


## Dark Current

### Dark Current from Mean



### Dark Current from Variance



## Acceptance Test Result (Not part of EMVA1288 standard)

Test Date

17-Nov-2020 18:06:32

Tester Name

Tester

Table 1: Acceptance test summary (Not part of EMVA1288 standard)

| Test Number | Test Name     | Test Status | Numeric Value  | Margins                   | Failure Description |
|-------------|---------------|-------------|----------------|---------------------------|---------------------|
| 1           | Dead Pixels   | Pass        | 0              | $\leq 10$                 |                     |
| 2           | Dead Clusters | Pass        | 0              | $\leq 1$                  |                     |
| 3           | QE            | Pass        | 55.4 47.8 43.2 | $\geq 48 \geq 47 \geq 42$ |                     |
| 4           | SNR           | Pass        | 40.0 39.9 39.8 | $\geq 38$                 |                     |
| 5           | DR            | Pass        | 70.9 70.8 70.5 | $\geq 67$                 |                     |
| 6           | Flash         | Pass        | -              | -                         |                     |
| 7           | Uart          | Pass        | -              | -                         |                     |
| 8           | SensorControl | Pass        | -              | -                         |                     |
| 9           | SensorLVDS    | Pass        | -              | -                         |                     |
| 10          | Temperature   | Pass        | -              | -                         |                     |
| 11          | Voltages      | Pass        | -              | -                         |                     |
| 12          | MACOM         | Pass        | -              | -                         |                     |
| 13          | GPIO          | Pass        | -              | -                         |                     |
| 14          | DRAM          | Pass        | -              | -                         |                     |

Table 2: Dead pixels summary (Not part of EMVA1288 standard)

| Number | Column | Row | Deviation from mean DSNU [DN] | Deviation from mean PRNU [%] |
|--------|--------|-----|-------------------------------|------------------------------|
| -      | -      | -   | -                             | -                            |

## Summary Sheet for calibration of User Set Factory (Not part of EMVA1288 standard)

| Camera setting |                | Operation point parameters |        |
|----------------|----------------|----------------------------|--------|
| Gain           | GainLevelx1    | Environmental temperature  | 2.75   |
| Black level    | 128            | Camera body temperature    | 2.75   |
| Frame rate     | 28 Hz          | Sensor temperature         | 38.376 |
| Exposure time  | 7003.5 $\mu$ s |                            |        |

### Spectrum of Calibration light source

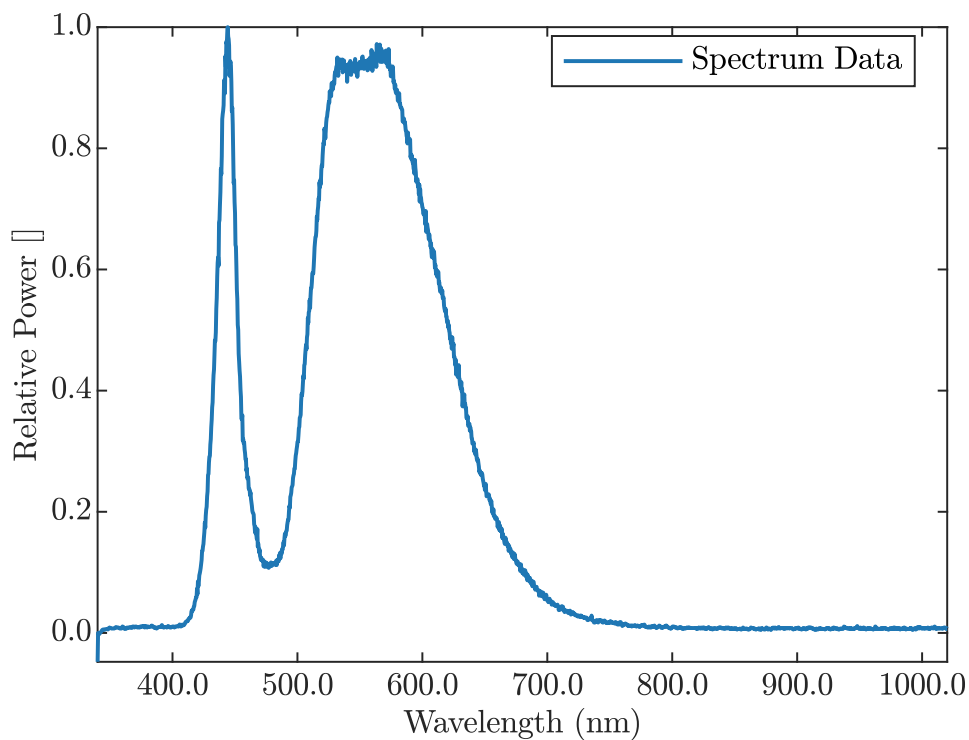


Table 3: Calibrated features summary

| Number | Feature       | Calibration Status |
|--------|---------------|--------------------|
| 1      | DSNU          | Yes                |
| 2      | PRNU          | Yes                |
| 3      | Bad Pixels    | Yes                |
| 4      | White Balance | Yes                |

Table 4: White Balance calibrated gains

| Gain  | Value |
|-------|-------|
| Red   | 1.421 |
| Green | 1     |
| Blue  | 1.613 |

## Dead Pixels

Table 5: Dead pixels summary

| Number | Column | Row | Deviation from mean DSNU [DN] | Deviation from mean PRNU [%] |
|--------|--------|-----|-------------------------------|------------------------------|
| -      | -      | -   | -                             | -                            |

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