PRNU modeling and correction using on-board LEDs during SUIT PV Phase

# Methodology

Please refer to the appendix for detailed explanation of PRNU modeling methodology and validation of the process.

### Test results from PV phase data-

Recorded LED data includes single LED and 4 LED images. PRNU modeling is done with 4 LED images for 255 and 355 nm. 20 images are recorded for 4 main and 4 redundant set of LEDs for each of the two wavelengths. The table below summarizes the number of frames available for PRNU estimation.

|  |  |  |
| --- | --- | --- |
| **Wavelength** | **Main Set (4 LEDs)** | **Redundant Set (4 LEDs)** |
| **258 nm** | 20 | 20 |
| **356 nm** | 20 | 20 |

Bias corrected and underscan removed data products are used for the PRNU modeling using previously determined kernel parameters (11px\*11px for 358 nm; 13px \* 13px for 256 nm. Refer Appendix).

The derived PRNU model is divided from one of the LED images and the normalized standard deviation within several 25\*25 px boxes are computed at various locations on the image. These boxes are chosen in areas where the illumination is fairly constant throughout the box. The same is done for the single uncorrected image, as well as the PRNU model.

The noise in a single uncorrected image has the contributions from Poisson noise, read noise and PRNU. This is given by the standard deviation of the counts within the box, normalized by diving with the mean value within the box.

Noise2single= (Poisson noise)2 + (Read Noise)2 + (PRNU)2

The corrected image is created by dividing a single LED image with the PRNU model. The normalized standard deviation within 25px \* 25px box in the corrected image gives the residual flat field error (Residual measured). This is computed by finding the standard deviation of the counts within the box and normalized by diving with the mean value within the box.

Logically, this value should be similar to the (Noise)2single within the box when the PRNU contribution is arithmetically removed from it as such, giving us the estimated residual (Residualestimate)-

Residual2estimate = Noise2Single Image- PRNU2

The practically measured residual flat field error should match the arithmetically estimated value. This signifies the flat fielding methodology is working effectively and can help us get reliable photometry.

# Results

The results are tabulated below-

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **356 nm main** | | **356 nm redt** | | **258 nm main** | | **258 nm redt** | |
| **(25 \* 25) px box attributes** | **Loc 1** | **Loc 2** | **Loc 1** | **Loc 2** | **Loc 1** | **Loc 2** | **Loc 1** | **Loc 2** |
| **Mean count inside box** | 33853 | 47214 | 39020 | 26967 | 33091 | 6280 | 29510 | 4774 |
| **Normalised st dev in Single image**  **(Noise single)** | 1.02% | 0. 71% | 0.76% | 0.99% | 1.82% | 1.62% | 1.81% | 1.65% |
| **Residual noise after correction**  **(Residualmeasured)** | 0.68% | 0. 34% | 0.32% | 0.48% | 0.38% | 0.78% | 0.38% | 0.89% |
| **PRNU** | 0.75% | 0.61% | 0.67% | 0.81% | 1.77% | 1.44% | 1.79% | 1.40% |
| **Arithmetically calculated Residual**  **(Residualestimate)** | 0.70% | 0.37% | 0.35% | 0.57% | 0.39% | 0.73% | 0.29% | 0.88% |

The noise in each of these parameters are determined by calculating the standard deviation divided by the mean within a 25px \* 25 px box. This is repeated for main and redundant LEDs of both wavelengths at 2 different locations for each of the LED combinations.

# Conclusion

The practically measured residual flat field error (Residualmeasured) matches the arithmetically estimated (Residualestimate)value. This signifies the flat fielding methodology is working effectively and can help us get reliable photometry. It is to be noticed that the residual noise after PRNU correction is more in regions where the mean counts within the box is comparatively lesser. This can be attributed to larger shot noise in these regions of diminished illumination.

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