Lamp Evaluation: Qualified & Quantified.

Contents

1 Definitions

Baseline: The **baseline** is the mean value of the ADC measured values when the power to the S2D2 lamp is turned off.

For the de0002 mini-Maurice fixture, the baseline on **CHNL1_End** is $\mu_1 = 1.27 \times 10^3 \pm .01 \times 10^3$, $\sigma_1 = 0.045 \pm 0.002$.

The baseline on **CHNL0_End** is $\mu_0 = 3.80 \times 10^3 \pm .04 \times 10^3$, $\sigma_0 = 0.046 \pm 0.002$.

Envelope: The **envelope** of the ADC measured value is an approximation of the (localized) range of the lamp power output, i.e. roughly the max (or min) number of ADC counts different from the local (short time period) average.

For the de0002 fixture, the envelope for both **CHNL1_End** and **CHNL0_End** are $\pm 0.3 \times 10^3$ ADC counts.

The envelope does have some dependence on the integration time as well as the length of the local time used; the numbers stated here are for a 100ms cycle time (97938 μs integration time) and over a 20 second period.

Used here, the **envelope** is specifically defined as twice the standard deviation of the residuals to a linear fit function of the ADC measured values for a “short” time period.

Saturation: When the energy output of the S2D2 lamp over the integration time generates more electrons at the photodiode than the maximum measurement capability of the ADC, then the power output is **saturated**.

Lamp Power: The S2D2 lamp power output is measured in 24-bit ADC counts. For positive power values, this gives us 2^{23} values to measure the lamp power output for each cycle of the integration chip. The minimum value (the baseline) for **CHNL1_End** is around 1.3×10^3 corresponding to 0 power output for the lamp (lamp off) and the maximum value is $2^{23} = 8,388,608$ corresponding to saturation.

Smooth: The lamp power output is considered to be **smooth** if the difference between successive ADC count values is less than the **envelope**.

Note that the **smoothness** of the lamp power depends on the integration time.

Discontinuity: The lamp power output displays a **discontinuity** if the successive difference between ADC counts is greater than the **envelope**.

Shift: A **shift** in the lamp power output is when the ADC counts have a discontinuity and *do not return to a lamp power output in the envelope* within a short period of time.

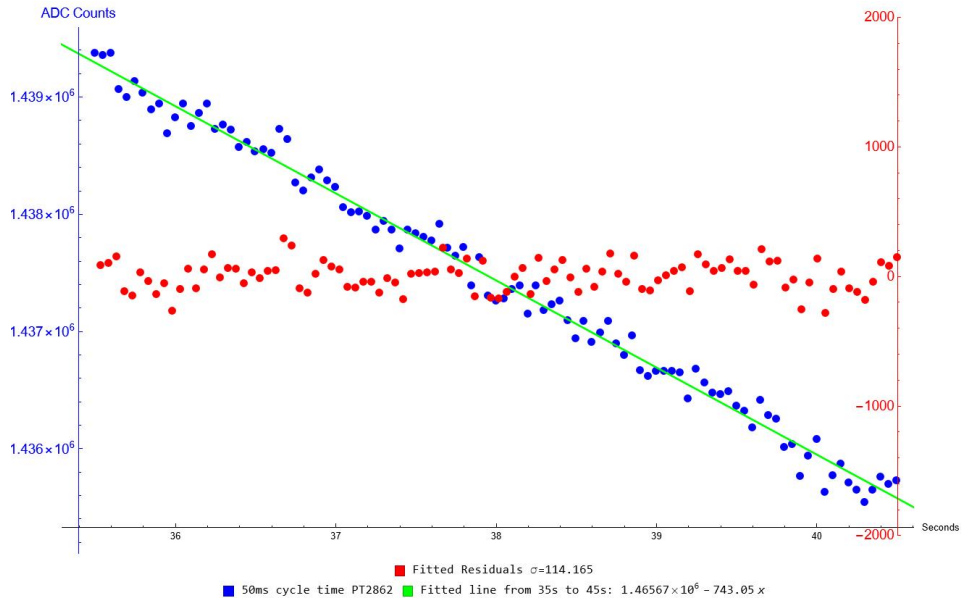
Noise: This refers to the overall collection of discontinuities in the lamp power output, whether it is from input power fluctuations, lamp power output variation, photodiode current fluctuations, voltage fluctuations at the ADC, or some other source.

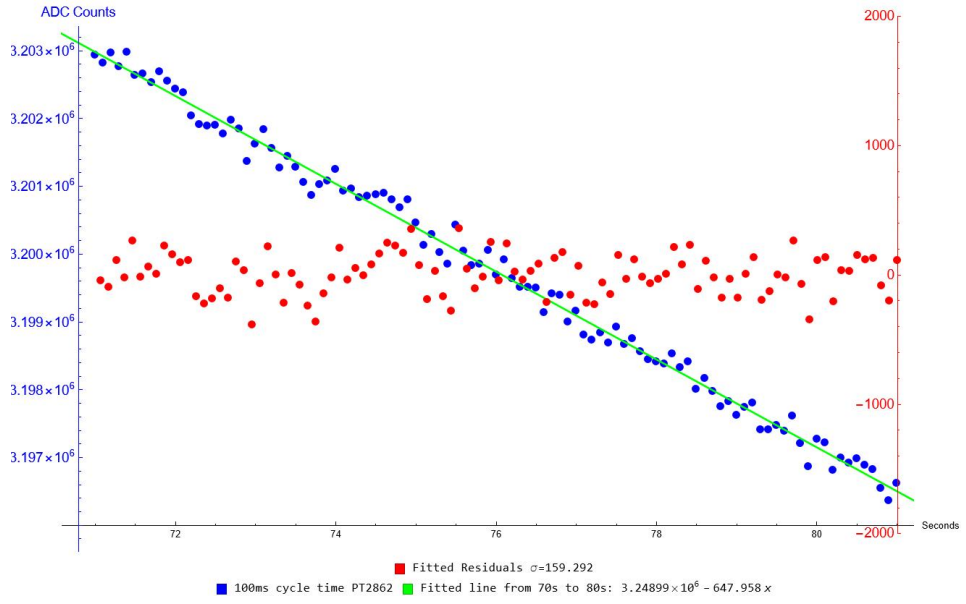
2 Evaluating Lamps

The following graphs of the S2D2 lamp output data for a collection of the three lamps PT2862, PU3710, and PU2553 will be used to demonstrate the defined terms above.

2.1 Evaluating the "Envelope" using S2D2 Lamp PT2862

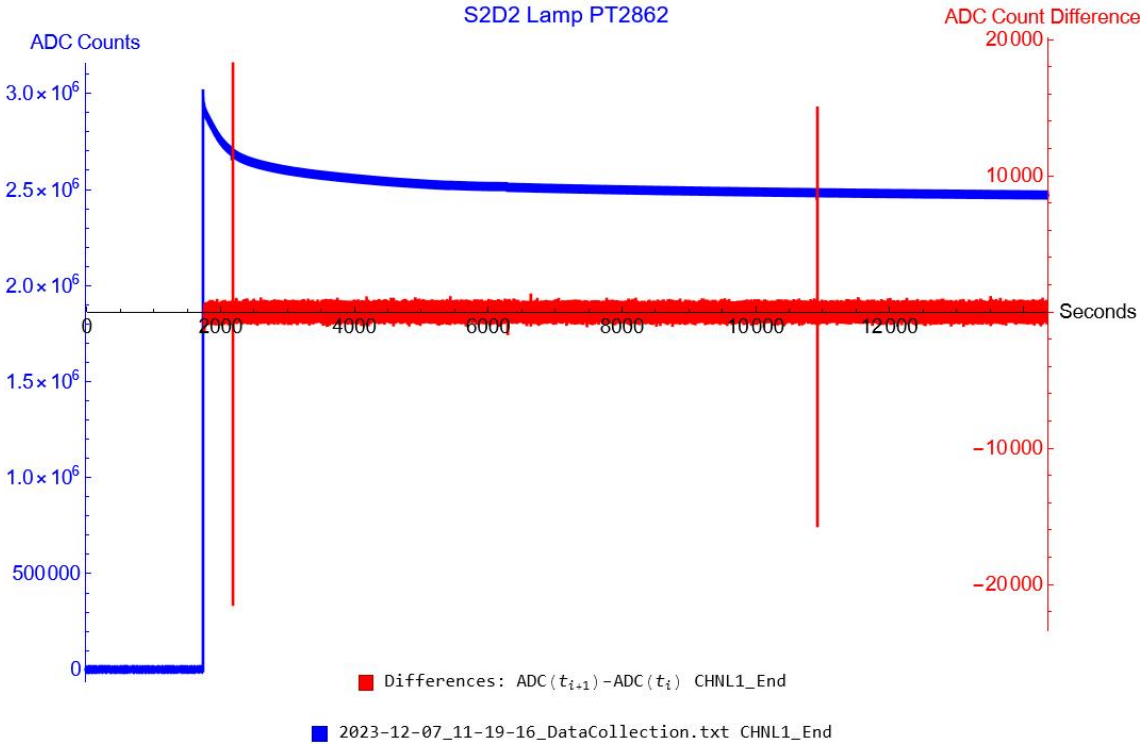
The power output over a convenient sample of time was used to evaluate the envelope. This can be better quantified if the lamp has been properly warmed up (the slope of the fitted curve is smaller). The blue scale to the left shows the lamp PT2862 power output. This output is fit to a line, then the residuals are shown in red. The red scale and twice the standard deviation (2σ captures 95%) quantifies the envelope.





2.2 S2D2 Lamp PT2862

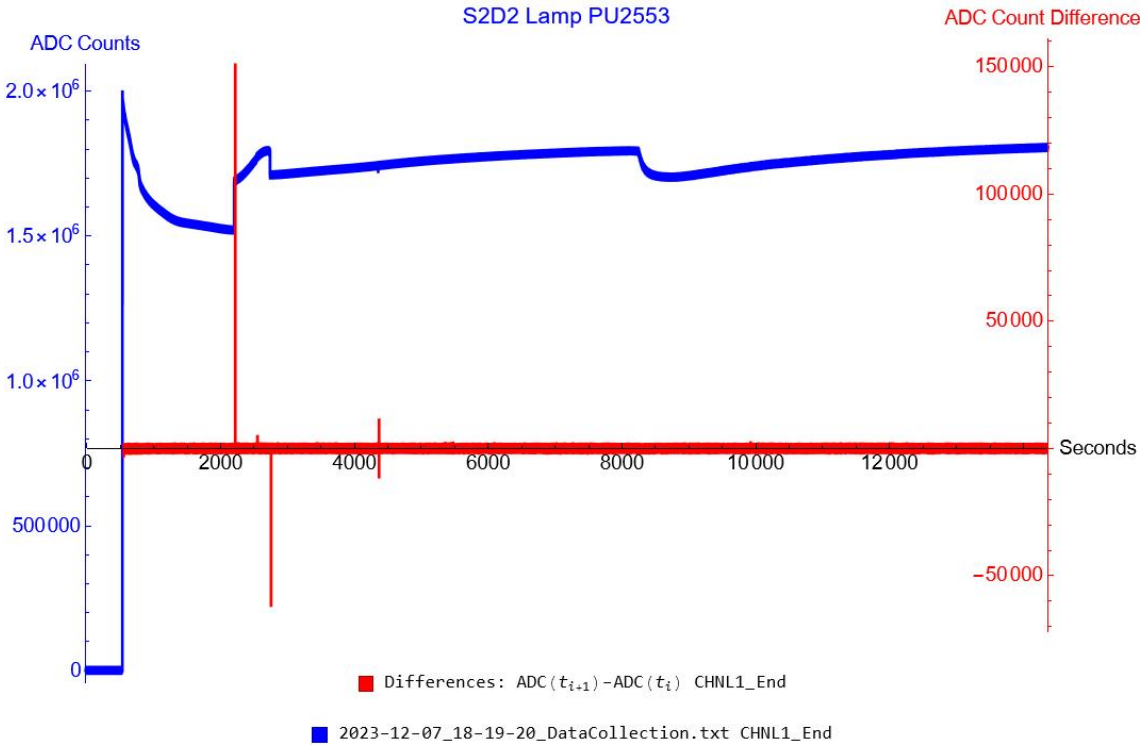
The lamp PT2862 produces a lamp power output of around 2.5×10^6 ADC counts after a warm-up period. This is a good level of lamp output power (light) for a cycle time of 100ms. The red scale demonstrated that there is a maximum variation in the difference between successive ADC counts of around $20,000$[1]. This **discontinuity** is shown as a small downward spike in the data, but the ADC counts recover within the **envelope** very quickly. Overall, there is very little **noise** in the data collection of the lamp power for PT2862. This lamp is considered **smooth** with the exception of two **discontinuities**.



[1] This corresponds to an error on the order of 1% which has an impact on assay data.

2.3 S2D2 Lamp PU2553

The lamp power for PU2553 is low. **Discontinuities** are displayed within the first 5000 seconds. Additionally, during the first hour of operation ($t \leq 3600$s), there is a positive **shift** in the lamp power and then a negative shift in the lamp power. At around 8000 seconds, there is a loss in the lamp power, but the change is **smooth**; the successive differences in the ADC counts are within the envelope of the lamp power. Ideally, we would not see changes in the lamp power as shown around the 8000 second time.



2.4 S2D2 Lamp PU3710

The lamp power for a cycle time of 100ms is excellent at around 3.7×10^6, but the lamp power performance displays many **discontinuities** (each of the red spikes with little symmetry) which are **shifts** in the lamp power. These shifts occur on the order of 5% of the lamp power output. Around 6500 seconds there is a discontinuity (the red spike with symmetry). Also note that there appears to be persistent **noise** in the envelope starting around the $11,000$s time.