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Temporal Stability of CAA Lamp Fluxes

Abstract:

We present a trending analysis to gauge the stability of the signal levels from the NIRSpec CAA lamps. For each combination of CAA lamp and dispersive element, we measure the count rates detected on a specific detector area throughout the duration of the first NIRSpec cryo-campaign in February 2011. The analysis demonstrates that over the test campaign, all lamps were stable to within less than one per cent of their average signal.

1 INTRODUCTION AND METHODOLOGY

The purpose of the calibration assembly (CAA) is to enable on-orbit calibration and monitoring of a number of important instrument parameters such as (i) the geometric distortion between the MSA and the FPA, (ii) the instrument throughput as a function of both field angle and wavelength, and (iii) the dispersion of the various spectral elements. It is therefore important to understand the behaviour of the CAA lamps throughout the NIRSpec lifetime, in particular the stability of the lamp fluxes.

To this end, we searched the database of the first NIRSpec cryo-campaign (a.k.a Cycle 1) for all full-frame[1] exposures with a given combination of lamp, dispersive element, and detector readout mode. We then selected a detector area that meets all of the following conditions:

1) well illuminated through one of the fixed slits
2) not saturated
3) free from strong spectral gradients

The latter condition is required because the non-repeatability of the GWA, and the associated signal shift in spectral direction, can mimic flux variations if the window contains sharp spectral features.

For the continuum lamps (FLAT1-5), the selected detector area was typically 128 x 19 pixels in size, while for the line lamps (LINE1-4) the window had to be matched to the relatively narrow emission peaks, typically 11 x 19 pixels. Table 1 summarizes the selected area for each CAA lamp.

We calculated the median pixel count rate within the selected area as a measure of the lamp flux. In order to correct for possible straylight contamination, we subtracted the median pixel count rate in an adjacent area of identical size which falls into the shadow of the slit mask. Figure 1 illustrates the position of the extraction windows for the case of FLAT1 with the G140H grating.

2 RESULTS

For all CAA lamps that were used with full-frame exposures on more than one day throughout Cycle 1, Figure 2 plots the median lamp signal in counts/s/pixel measured within the detector areas listed in Table 1. We normalize the measurements for each

[1] We restrict our analysis to full-frame exposures in order to facilitate a consistent choice and automated extraction of the detector area used for each lamp.

exposure to the average signal over the duration of Cycle 1. This allows a direct comparison of the two detector windows which generally fall on different wavelength regions, and thus have different signal levels.

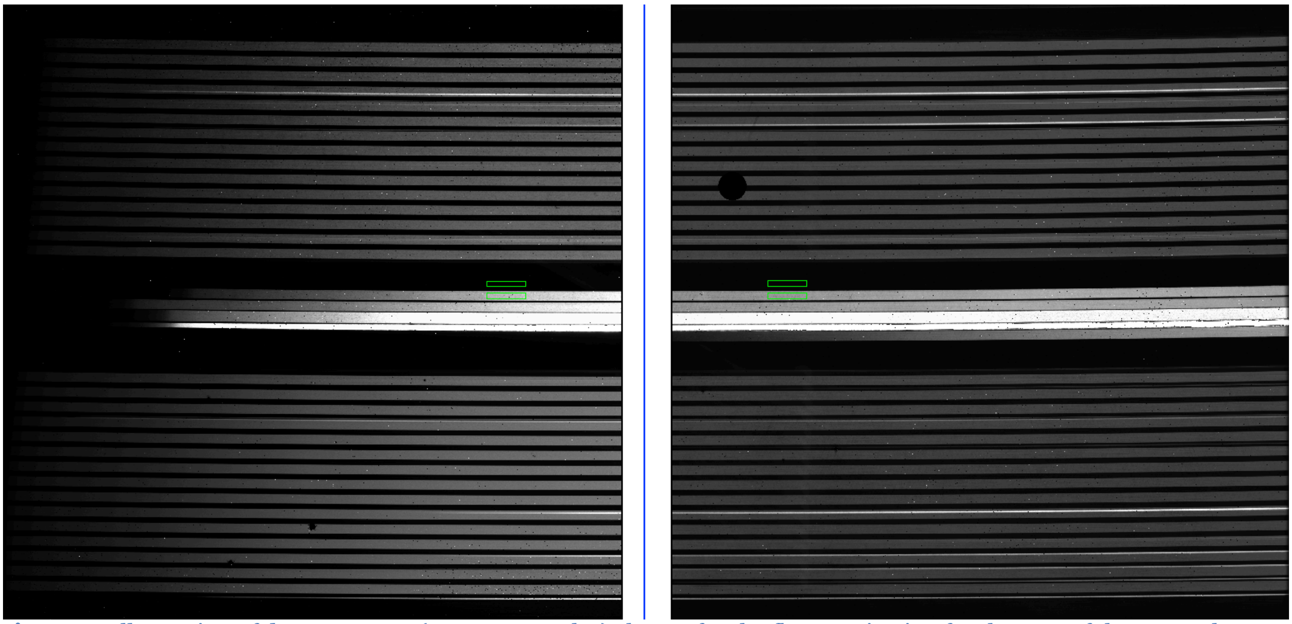

Figure 1: Illustration of detector areas (green rectangles) chosen for the flux monitoring for the case of the FLAT1 lamp used with the G140H grating.

Table 1: Detector areas used for the calculation of lamp signals

Lamp name	GWA position	SCA491 window	SCA492 window	comment
FLAT 1	G140M G140H	[1069,1600,1087,1727] [1069,1600,1087,1727]	[962,1600,980,1727] [962,1600,980,1727]	
FLAT 2	G235M G235H	[1069,1600,1087,1727] [1073,1600,1091,1727]	[962,1600,980,1727] [958,1600,976,1727]	
FLAT 3	G395M G395H	[1055,1600,1073,1727] [1075,1600,1093,1727]	[976,1600,994,1727] [956,1600,974,1727]	
FLAT 4	G140M G140H	[1069,1600,1087,1727] [1069,1600,1087,1727]	[962,1600,980,1727] [962,1600,980,1727]	
FLAT 5	PRISM	-	-	no full frame data
LINE 1	G140M G140H	[1073,1019,1091,1029] [1073,1019,1091,1029]	[956,1080,974,1090] [956,1080,974,1090]	
LINE 2	G235M G235H	[1073,985,1091,995] [1078,955,1096,965]	[961,1840,979,1850] [960,1368,978,1378]	
LINE 3	G395M G395H	[1054,1239,1072,1249] [1076,1393,1094,1403]	[975,1413,993,1423] [955,1450,973,1460]	
LINE 4	PRISM	-	-	no full frame data
REF	G140M G140H	[1070,1227,1087,1354] [1067,1900,1085,2027]	[1095,1327,1113,1454] [962,1620,980,1747]	
TEST	MIRROR	[985,1409,995,1419]	-	S1600 image on 491 only

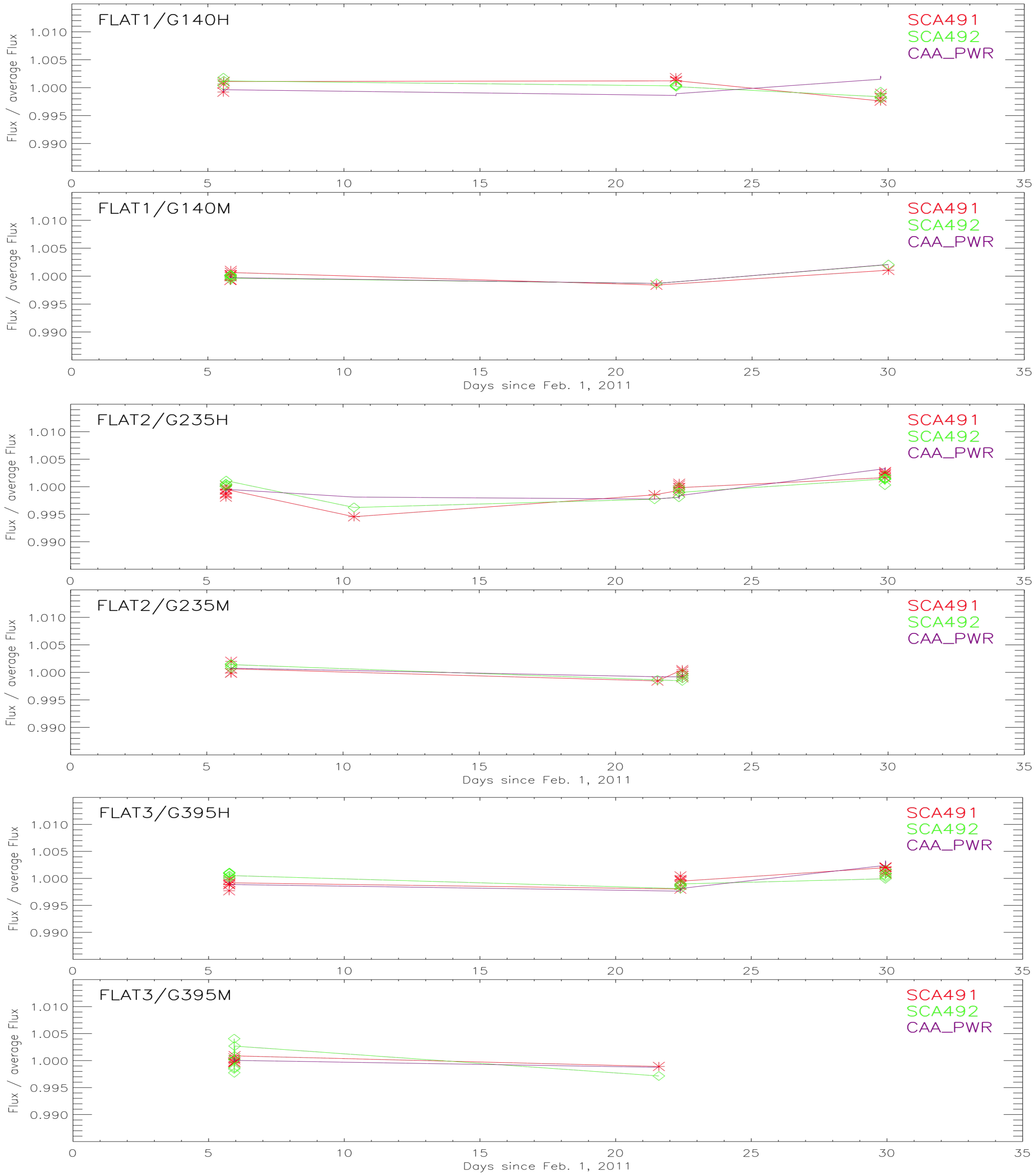

Figure 2: Trending plots of measured CAA lamp signal, relative to the average signal over the duration of Cycle 1. Plotted are the median lamp signal (in counts/s/pixel) for the extraction windows on SCA491 (red) and SCA492 (green) defined in Table 1. Also shown is the lamp power, calculated as the product of the telemetry values CAA_VOLT and CAA_CURR.

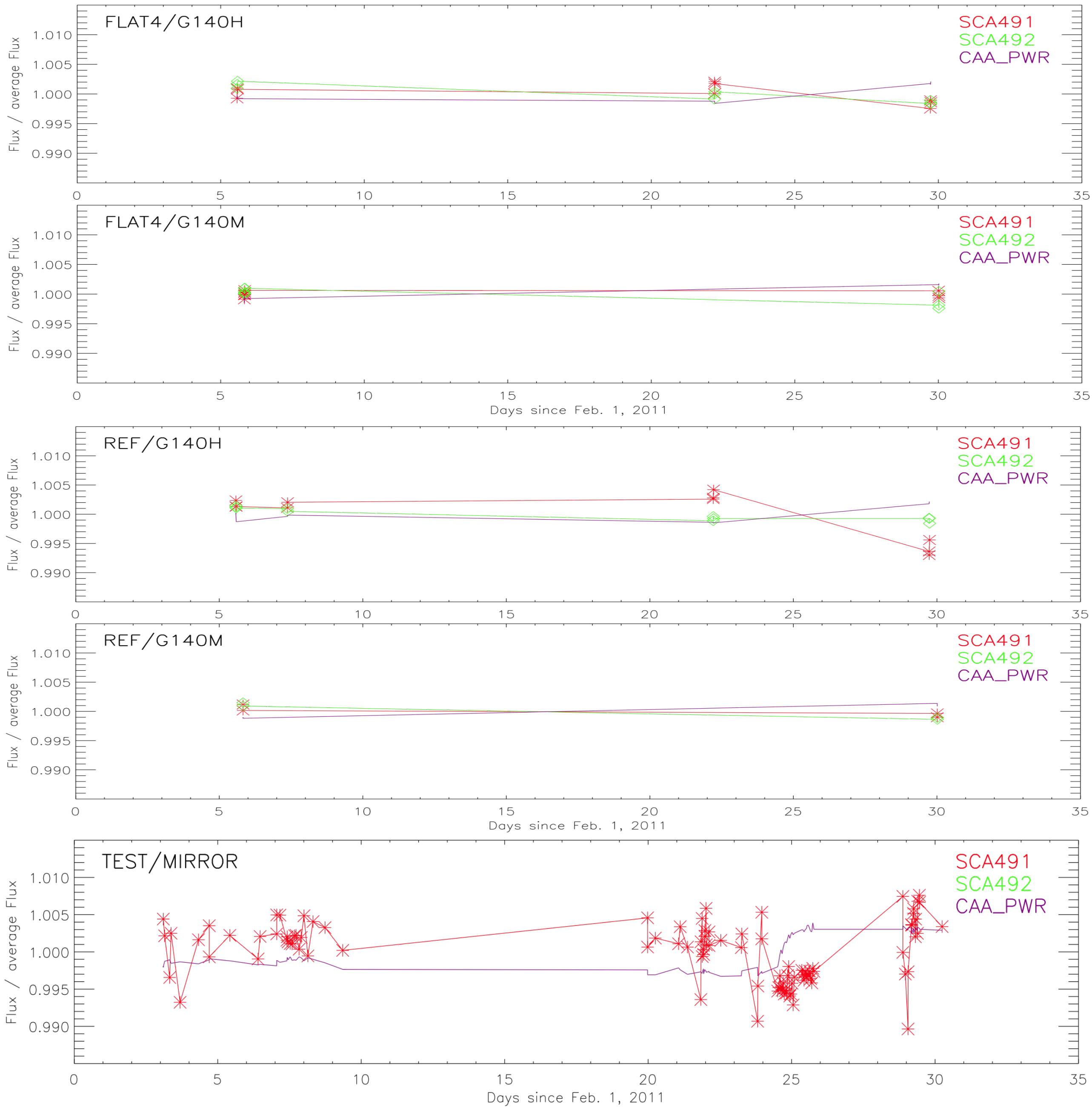

Figure 2 (continued)

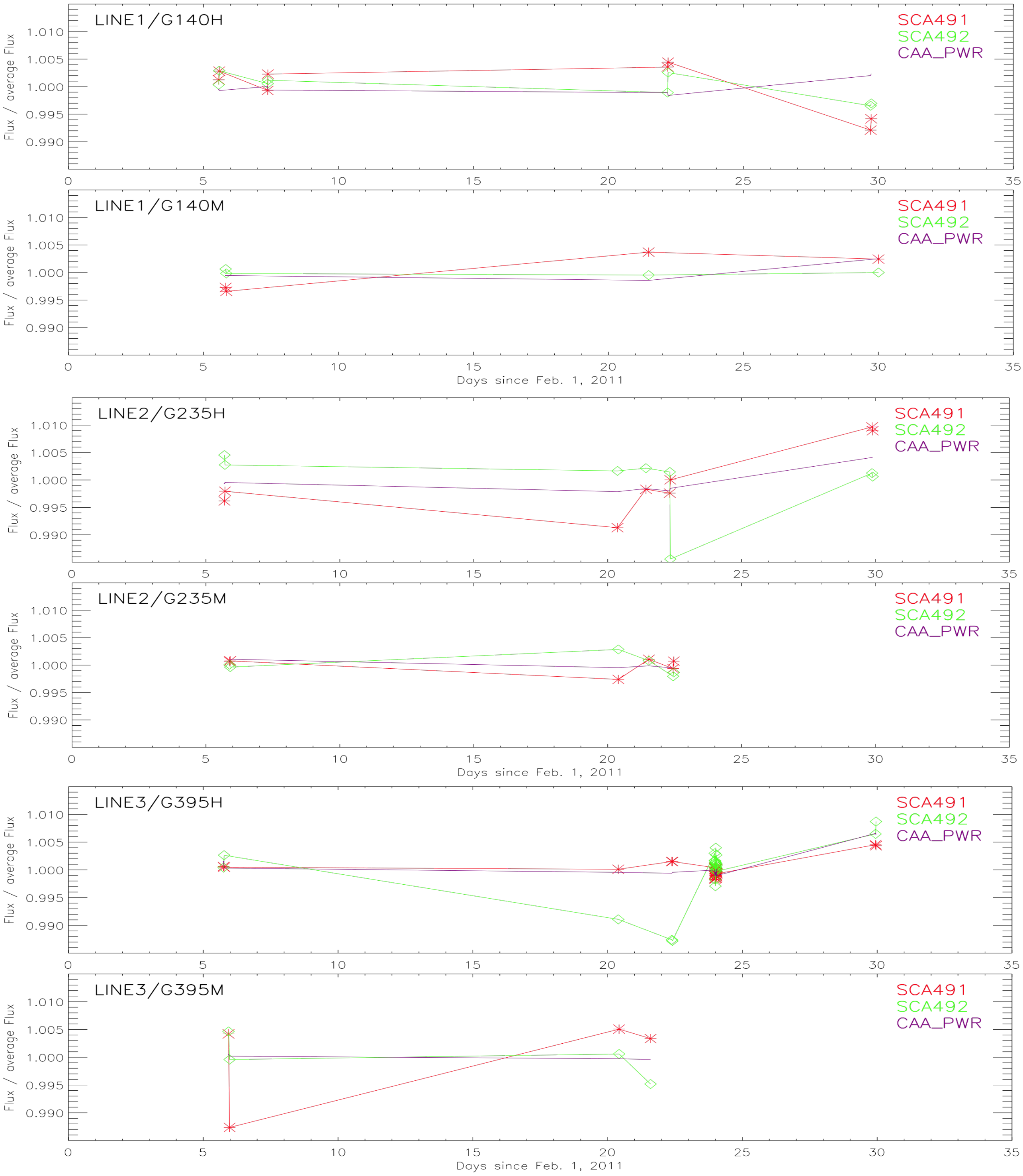

Figure 2 (continued)

3 SUMMARY

The analysis presented here demonstrates that none of the CAA lamps show signal variations of more than 1% relative to the average signal over the Cycle 1 duration. This is likely a conservative estimate because, especially for the line lamps, any apparent signal variation can plausibly be attributed to effects other than the lamp output, such as the grating wheel non-repeatability (which can cause spectral shifts over the extracted detector area) or fluctuations in the detector response over the rather small number of pixels studied. These and similar effects should be studied more carefully once longer timeline data are available.

The results presented here are intended to serve as a first-order baseline for comparison with later test campaigns. It should be kept in mind, however, that since Cycle 1 was concluded, all CAA lamps except TEST have undergone a mechanical re-design of their feeder telescopes which will change their absolute output signal in future NIRSpec test campaigns, so that continuity with Figure 2 can only be expected for the TEST lamp.

APPENDIX A IDL CODE

The procedure outlined above is executed by running a single IDL function called `lamp_trend.pro`. For each combination of CAA lamp and dispersive element, the function performs a database query for appropriate exposures, and for each identified exposure calculates the median pixel signal within the defined detector area. It returns a structure containing, for all identified exposures, the Julian date, the median pixel signal for the two SCAs, as well as the following telemetry values extracted from the FITS header: filament current (header keyword CAA_CURR), filament voltage (CAA_VOLT), and OBA temperature (T_BP1).

A second IDL procedure (`make_lamp_plots.pro`) then acts as a wrapper to call `lamp_trend.pro` for each combination of lamp and disperser, and to produce the plots shown in Figure 2.