5.1.7 LIGHT LEAK

5.1.7.1 NAC FM LIGHT LEAK CALIBRATION RESULTS

As reported in Reference 5.1.7.1-1

Reference 5.1.7.1-1 - IOM 388-PAG-CCA98-7, "NAC FM Calibration Results: Light Leak", C. Avis, April 1, 1998

Reference 5.1.7.1-2 - IOM 388-PAG-CCA97-8, "NAC FM Calibration Results: Sensitivity", C. Avis, March 12, 1997

5.1.7.1.1 INTRODUCTION

The Narrow-angle Flight Model thermal/vacuum testing included the acquisition of a set of images for characterization of any light leakage. Light leak is defined as any signal reaching the sensor with the shutter closed. Two sets of image data were taken at Gain 3 in the 1x1 mode at a temperature of +5° C. One set was taken with the shutter at 'reset' position and the other at 'activate'.

5.1.7.1.2 METHOD

Each Light Leak frame was processed to derive the signal above dark-current. The usual method of dark-current subtraction was used. This method subtracts:

- the frame's bias level (as derived from the overclocked pixel values)
- a bias frame (zero-exposure data)
- the dark-current due to the exposure time

The goal is to plot these resulting signal levels (in DN) vs. the energy that the camera was exposed to during the exposure. In this case, 'energy' is used to mean (spectral radiance * exposure time). The radiance was recorded in units of *picoamps* of current measured and exposure in *seconds*. The necessary conversion factor from *picoamps* to *nanowatts/cm^2/sr/nm* incident upon the camera was derived from the lamp calibrations and the attenuation due to the chamber window weighted by the transmission factors of the various subsystem components.

$$C = \frac{\int_{\lambda} S(\lambda) W(\lambda) O(\lambda) Q(\lambda) F_1(\lambda) F_2(\lambda) \partial\lambda}{\int_{\lambda} O(\lambda) Q(\lambda) F_1(\lambda) F_2(\lambda) \partial\lambda}$$

where
- C is the desired conversion factor for this camera and filters
- $S(\lambda)$ is the spectral radiance per *picoamp* from lamp calibration
- $W(\lambda)$ is the transmission factor of the chamber window
- $O(\lambda)$ is the transmission factor of the optics
- $Q(\lambda)$ is the quantum efficiency of the detector
- $F_1(\lambda)$ is the transmission factor of filter 1
- $F_2(\lambda)$ is the transmission factor of filter 2

For the Narrow-angle camera with both clear filters, each *picoamp* measured outside the chamber is equivalent to a spectral radiance of 0.1261 *nanowatts/cm^2/sr/nm* incident on the camera optics.

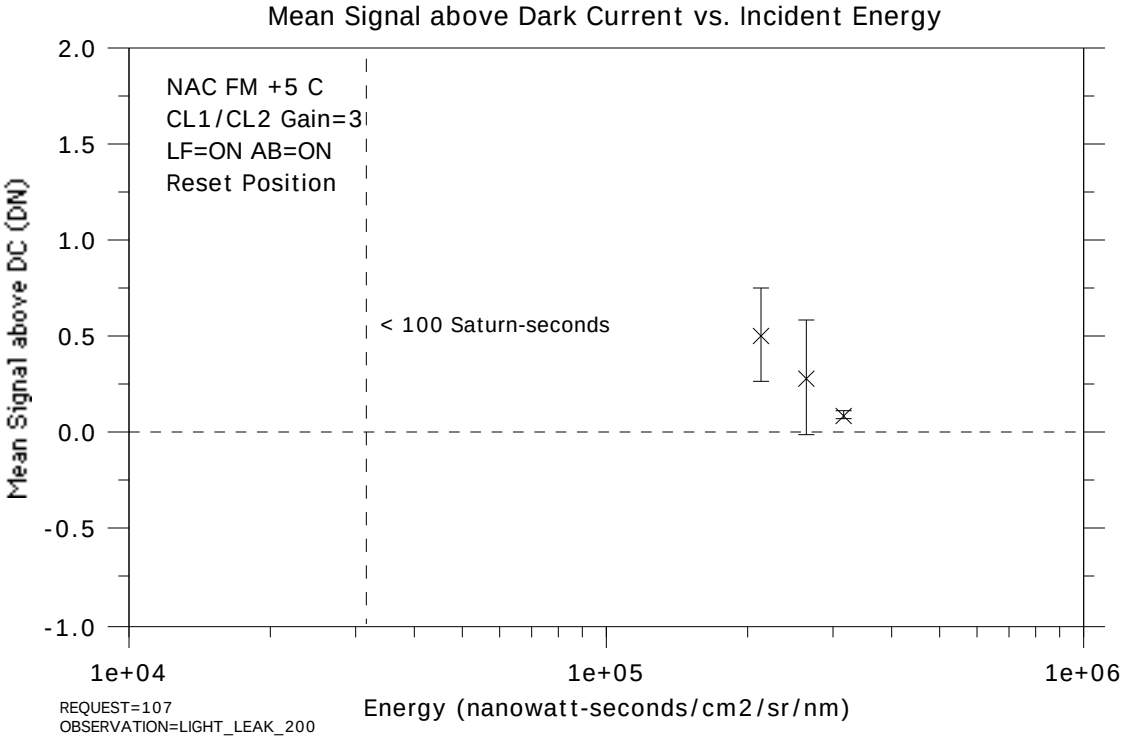
5.1.7.1.3 RESULTS

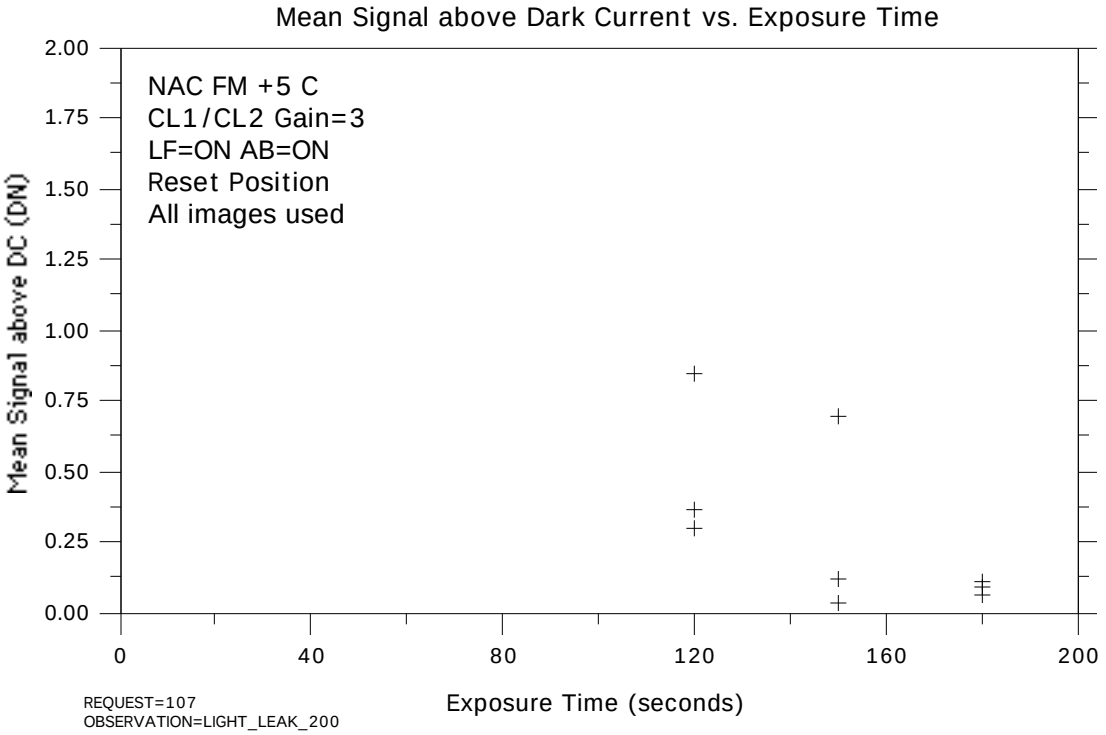
The table below lists the energy in both sets of units as well as the mean and sigma of the measurement at the three available light levels. Three images were recorded at each light level (i.e., exposure time). The processed versions of these were combined to generate the listed mean and standard deviation. Also included is the estimate of the energy relative to full-well if the shutter had been enabled for the listed exposure time. This is based upon the mean sensitivity in these filters according to Reference 5.1.7.1-2.

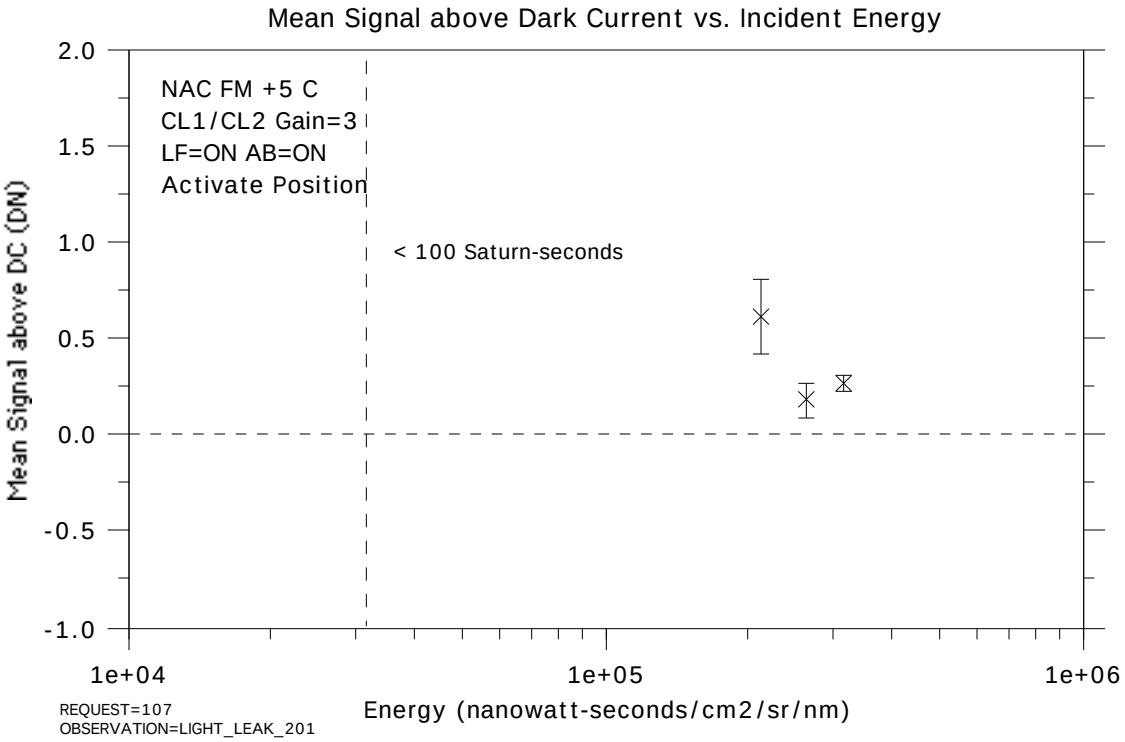
EXPOSURE *seconds*	ENERGY *picoamp-sec*	ENERGY *nw-sec/cm^2/sr/nm*	MEAN SIGNAL (Reset)	SIGMA (Reset)	MEAN SIGNAL (Activate)	SIGMA (Activate)
120.0	1680000	211848 (8611 fw)	0.5042	0.2421	0.6113	0.1938
150.0	2100000	264810 (10764 fw)	0.2816	0.2955	0.1760	0.0935
180.0	2520000	317772 (12918 fw)	0.0866	0.0206	0.2669	0.0402

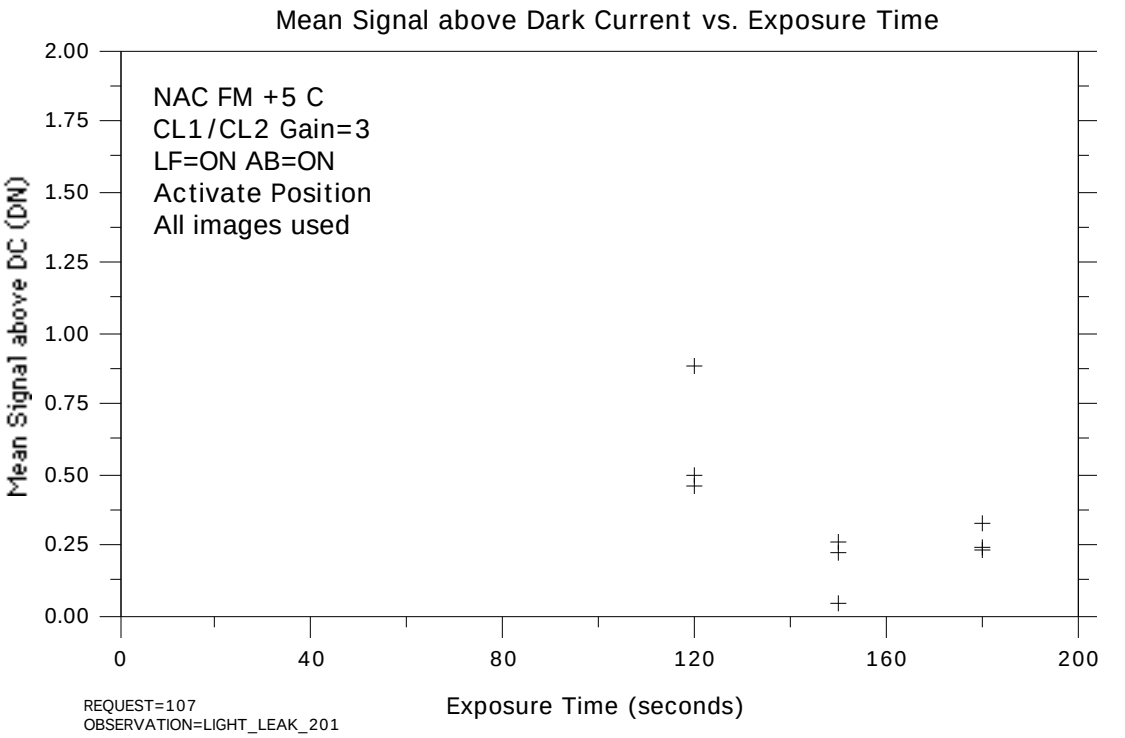
Information from Bob West was used to relate the brightness of the source to that of Saturn. Saturn's radiance is 1.9 *w/m^2/sr* over a bandpass of 300 - 900 nm or 316.7 *nanowatts/cm^2/sr/nm.* An energy value of 100 Saturn-seconds is marked on the plots below as a measure of the required light level of 100 times Saturn.

The following plots show the signal values versus the log of the input energy and versus exposure time. A true light leak should show increased signal as the exposure time increases. The error bars are taken from the tabulated sigmas. The target energy level of 100 times Saturn is indicated as 100 seconds of exposure to Saturn shown on the plots.






Mean Signal above Dark Current vs. Incident Energy
NAC FM +5 C
CL1/CL2 Gain=3
LF=ON AB=ON
Activate Position
< 100 Saturn-seconds
Mean Signal above DC (DN)
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
1e+04
1e+05
1e+06
Energy (nanowatt-seconds/cm2/sr/nm)
REQUEST=107
OBSERVATION=LIGHT_LEAK_201


Mean Signal above Dark Current vs. Exposure Time
NAC FM +5 C
CL1/CL2 Gain=3
LF=ON AB=ON
Activate Position
All images used
Mean Signal above DC (DN)
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
0
40
80
120
160
200
Exposure Time (seconds)
REQUEST=107
OBSERVATION=LIGHT_LEAK_201

5.1.7.1.4 CONCLUSION

1. In both positions, the signal through the closed shutter is .6 DN or less out to 1000 seconds of exposure to Saturn or 12000 times what would have given a full-well response.
2. The signal showed no trend with exposure time so no actual leakage is suspected.
3. The recorded signal is greater than the required maximum average of 0.1 DN but the input energy was well above the requirement level.
4. Structure was apparent only in three processed images. These images (121730, 121739 and 121748) all showed significantly bright corners. All other images were extremely uniform. The cause of the bright corners is not understood.

5.1.7.1.5 IMAGES USED IN LIGHT LEAK ANALYSIS

image	day	eventtime	observation	gain	mode	expos	radiance
121730	143	17:0:12.0	LIGHT_LEAK_200	3 (40K)	FULL	120000	14000.00
121731	143	17:4:10.0	LIGHT_LEAK_200	3 (40K)	FULL	120000	14000.00
121732	143	17:8:8.0	LIGHT_LEAK_200	3 (40K)	FULL	120000	14000.00
121734	143	17:16:11.0	LIGHT_LEAK_200	3 (40K)	FULL	150000	14000.00
121735	143	17:20:9.0	LIGHT_LEAK_200	3 (40K)	FULL	150000	14000.00
121748	143	18:22:58.0	LIGHT_LEAK_200	3 (40K)	FULL	150000	14000.00
121736	143	17:24:14.0	LIGHT_LEAK_200	3 (40K)	FULL	180000	14000.00
121737	143	17:28:12.0	LIGHT_LEAK_200	3 (40K)	FULL	180000	14000.00
121738	143	17:32:10.0	LIGHT_LEAK_200	3 (40K)	FULL	180000	14000.00
121739	143	17:36:48.0	LIGHT_LEAK_201	3 (40K)	FULL	120000	14000.00
121740	143	17:40:46.0	LIGHT_LEAK_201	3 (40K)	FULL	120000	14000.00
121741	143	17:44:44.0	LIGHT_LEAK_201	3 (40K)	FULL	120000	14000.00
121742	143	17:48:49.0	LIGHT_LEAK_201	3 (40K)	FULL	150000	14000.00
121743	143	17:52:47.0	LIGHT_LEAK_201	3 (40K)	FULL	150000	14000.00
121749	143	18:27:7.0	LIGHT_LEAK_201	3 (40K)	FULL	150000	14000.00
121745	143	18:1:0.0	LIGHT_LEAK_201	3 (40K)	FULL	180000	14000.00
121746	143	18:4:58.0	LIGHT_LEAK_201	3 (40K)	FULL	180000	14000.00
121747	143	18:8:56.0	LIGHT_LEAK_201	3 (40K)	FULL	180000	14000.00