5.1.3.2 WAC FM SENSOR BLEMISHES CALIBRATION RESULTS

As reported in Reference 5.1.3.2-1

Reference 5.1.3.2-1 - IOM 388-PAG-CCA98-1, "WAC FM Calibration Results: Sensor Blemishes - Revision 1", C. Avis, January 20, 1998, Revision Summary: Corrected last sentence of 'Introduction'

Reference 5.1.3.2-2 - "Software Design Document for Instrument Calibration - Cassini ISS", C. Avis, Version 2.1, 10 July 1995

Reference 5.1.3.2-3 - IOM 388-PAG-CCA97-6, "WAC FM Calibration Results: Linearity", C. Avis, 24 September 1997

5.1.3.2.1 INTRODUCTION

The Wide-angle Flight Model thermal/vacuum testing included the acquisition of a set of flat-field images for determination the system gain. These data were also applicable for assessing the response of each pixel over the full dynamic range of the instrument. Reference 5.1.3.2-3 reported upon the global and regional variations in linearity for the various camera modes. This report deals with the linearity of each pixel and documents those which show non-linear behavior.

Sequences of increasing exposures were taken at temperatures of +5° C and +25° C. However, the only useable set of Gain 0 data was at +5° C. All data were taken with Antiblooming 'OFF' except that Gain 2 was also taken with Antiblooming 'ON'.

Multiple input files submitted to the blemish analysis were combined at each exposure level to suppress data errors and improve the signal-to-noise ratio.

All data were taken with PC_Voltage=9. This commandable parameter, however, has no direct effect on the linearity of the pixels (at least in the value range between 4 and 10).

5.1.3.2.2 METHOD

Sensor blemishes are defined in this analysis as pixels having a light transfer function with nonlinearities greater than specified thresholds.

The characteristics of the light transfer curve of each pixel are analyzed through the use of a set of radiometric files. These are generated by fitting the data from a light transfer sequence to a linear model for each pixel. Given that

$$e = r(t - t_0)$$

where e is the 'energy' received by a pixel
r is the scene radiance
t is the commanded exposure time
t_0 is the shutter offset

Then, the linear model is defined as

$$d = ce + d_0$$

where d is the recorded DN
c is the radiometric slope
d_0 is the dark-current

The following radiometric files are created containing values for each pixel:

1. The slopes $z = 1/c$ are output to the radiometric slope file CAL (REAL*4 data).
2. The d_0 are output to the dark-current file DC as $128 \times d_0$ (16-bit integer).
3. The highest tested DN value (d_{fw}) before the pixel's response drops below a specified threshold is stored in the saturation file SAT (16-bit integer). Pixels which show no drop are given a value of 32767.
4. The maximum absolute difference (in DN) between the input data samples and the fitted curve
$$\varepsilon_{max} = max\{|ce_i + d_0 - d_i|\}$$
is stored in the error file ERR (16-bit integer).
5. The RMS error (in DN) for the fit
$$\varepsilon_{rms} = \sqrt{\frac{1}{m}\sum_{i=1}^{m}(ce_i + d_0 - d_i)^2}$$
is stored in the RMS file (16-bit integer).

The CAL, ERR, RMS, and DC files are used to identify and classify camera blemishes. The user specifies the valid range of d_0, ε_{rms}, $\varepsilon_{\max}$, and z:

1. $MINDC < d_0 < MAXDC$
2. $\varepsilon_{rms} > MAXRMS$
3. $\varepsilon_{max} > MAXERR$
4. $MINSLOPE < z < MAXSLOPE$

The criteria are checked in the order: 1 - 4. A pixel is not checked further after failing a given check. The blemishes are recorded in a Blemish File used by subsequent programs to remove blemishes.

The Blemish File is in 16-bit integer format, and defines blemishes by using vectors of the form $(line, samp, CLASS, d_{fw})$, where *line* and *samp* are the picture coordinates where the blemish occurs, d_{fw} is the DN value at which the pixel saturates at full-well, and *CLASS* classifies each blemish by which neighbors are available for interpolation to remove the blemish (see Reference 5.1.3.2-2). The format of the Blemish File was not designed to handle hundreds of thousands of low-full-well pixels. This prohibited them from being classified and stored in the Blemish File, so only the permanent blemishes are stored there, i.e., $d_{fw} = 0$ in all cases.

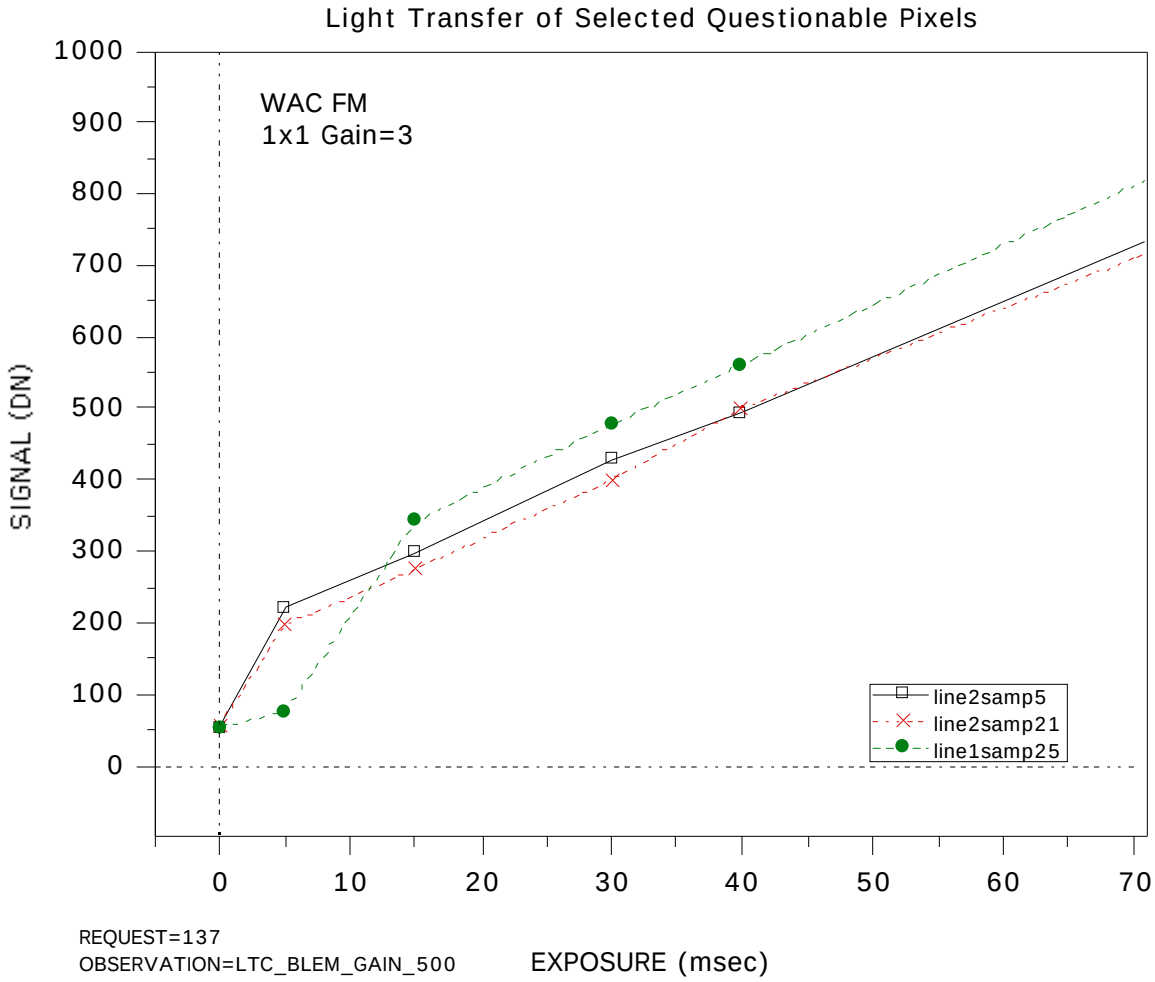
5.1.3.2.3 RESULTS: NON-LINEARITIES

The valid ranges used for the blemish tests were set as follows:

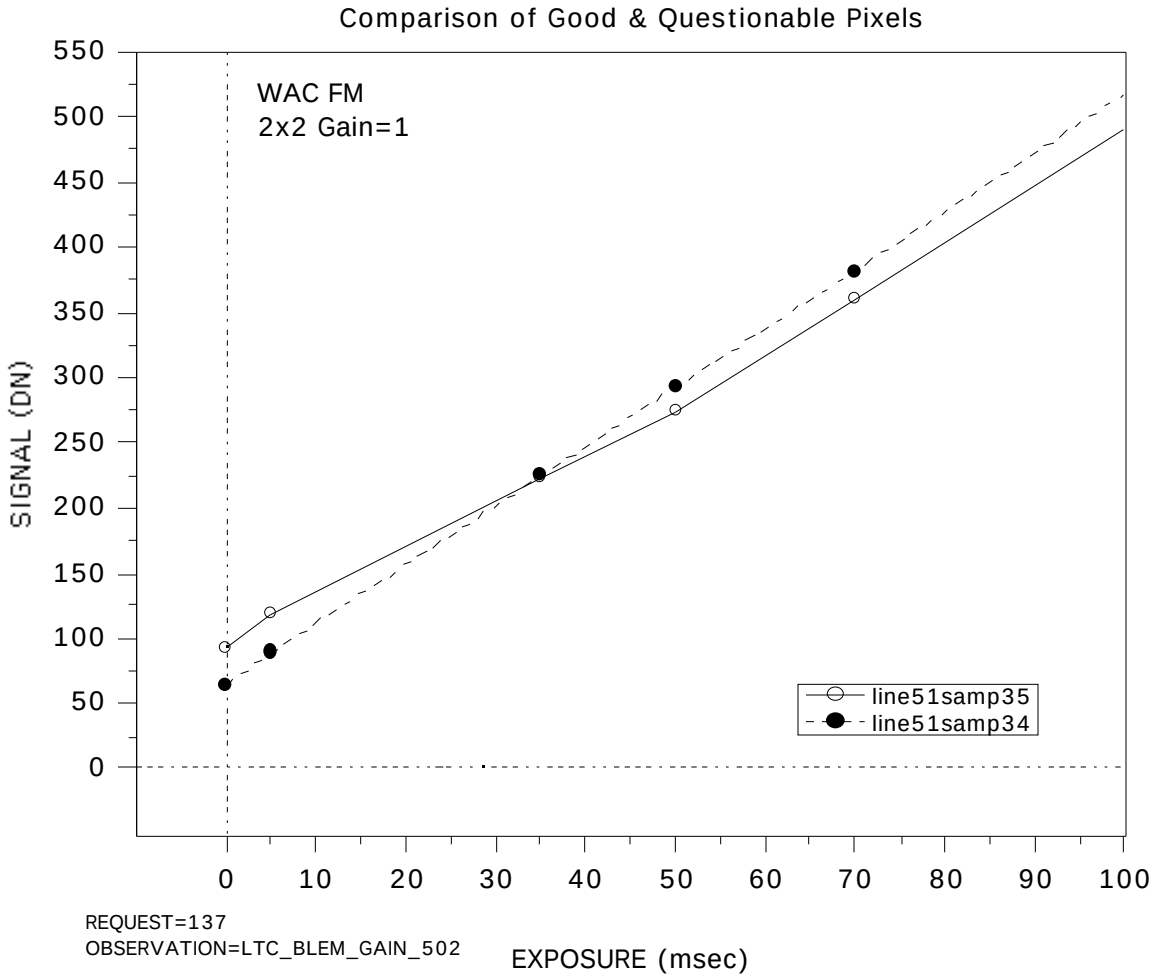
1. Slope: Any slope > 0 allowed
2. Dark-current: Any dark-current > 0 allowed
3. $\varepsilon_{\max}$ and ε_{rms}: Limits based upon the histogram of the values, but $\varepsilon_{\max}$ no larger than 40 (1% of 4095)

The distribution of the histogram of the $\varepsilon_{\max}$ and ε_{rms} clearly showed the difference between the values for normal pixels and the values for the various blemish pixels.

The following plot shows the low end of the response curve of three pixels that were flagged as permanent blemishes. All show anomalous slope changes below 15 millisecond exposures. Most edge pixels and some Line 2 pixels are bad enough to be classified as blemishes.



The following plot compares the single interior pixel flagged as a permanent blemish (2x2 mode at line 51 sample 35) with one of its neighbor pixels. The low end of the response curve is shown to again illustrate the behavior at low exposure levels.



The following tables show the number of pixels flagged as blemishes and their location.

+5° C

Gain/AB	Permanent blemishes	Blems not in first or last line, or first or last sample	Location (line,sample)
3/OFF	3106	76	in first 89 samples of line 2
2/OFF	3158	87	in first 93 samples of line 2
2/ON	1968	86	in first 109 samples of line 2
1/OFF	1617	83	82 in first 95 samples of line 2 and (51,35)
0/OFF	511	212	samples 2-213 of line 2

+25° C

Gain/AB	Permanent blemishes	Blems not in first or last line, or first or last sample	Location (line,sample)
3/OFF	3146	88	in first 101 samples of line 2
2/OFF	3155	85	in first 100 samples of line 2
2/ON	2085	94	in first 97 samples of line 2
1/OFF	1615	81	80 in first 87 samples of line 2 and (51,35)

The blemish test for the 4x4 mode was performed on the low end of the light transfer curve only. Otherwise, all pixels would also be flagged as permanent blemishes by failing the $\varepsilon_{\max}$ and ε_{rms} tests at the high exposure levels.

5.1.3.2.4 RESULTS: RESPONSE FALLOFF

In some camera modes, the high DN regime shows a falloff in sensor response. The degree of shortfall can be easily extracted from the DN of the last two exposures and the exp=0 value:

$$d'(n) = \frac{ex(n)}{ex(m)}\left(d(m) - d(0)\right) + d(0)$$

where *d'(n)* is the expected DN of the highest exposure level

ex(n) is the exposure time of highest exposure level

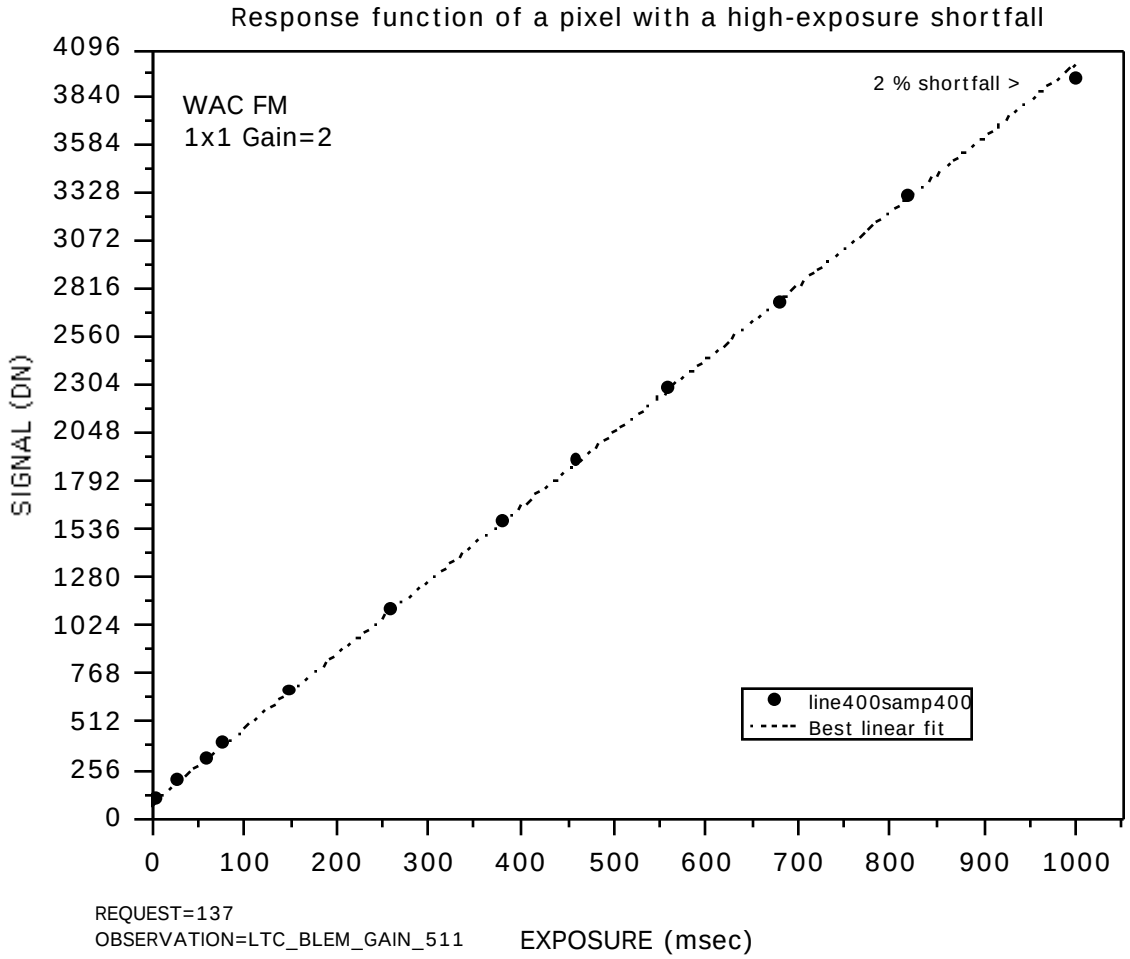
d(0) is the DN of the exp=0 frame

d(m) is the DN of highest exposure level without shortfall

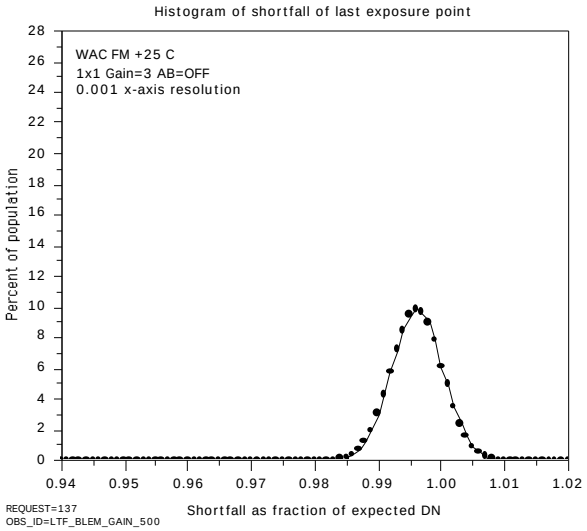
ex(m) is the exposure time of highest exposure level without shortfall

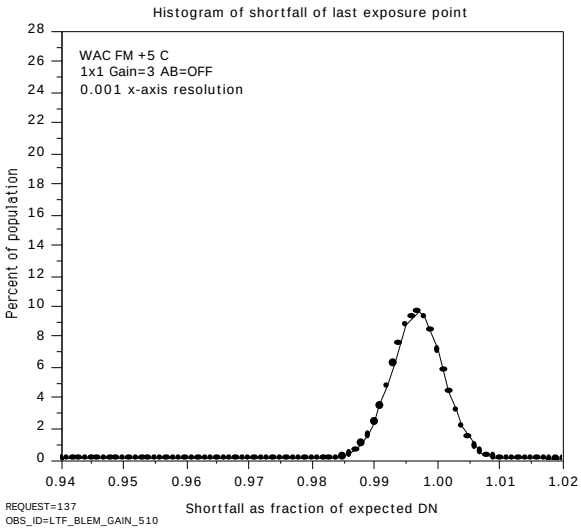
Therefore, the shortfall at the highest exposure level is defined as the ratio of the actual to the expected DN.

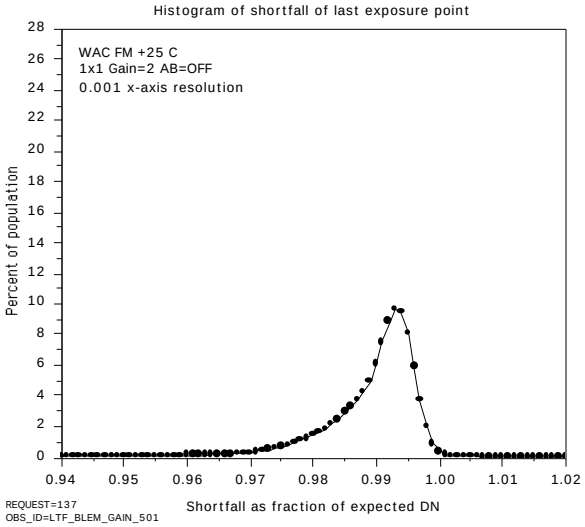
The following plot shows an example of a pixel with a 2 % shortfall.

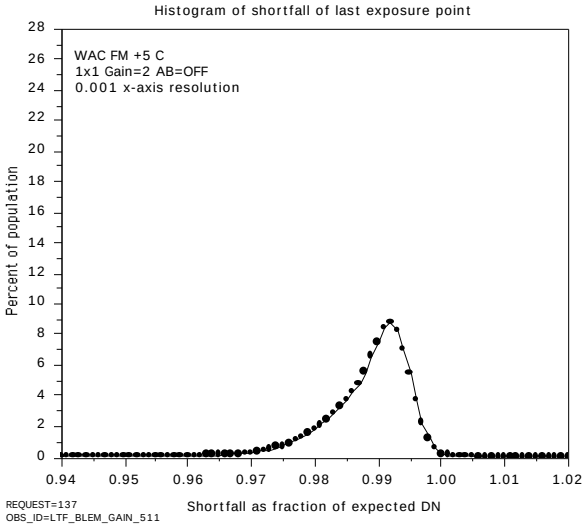


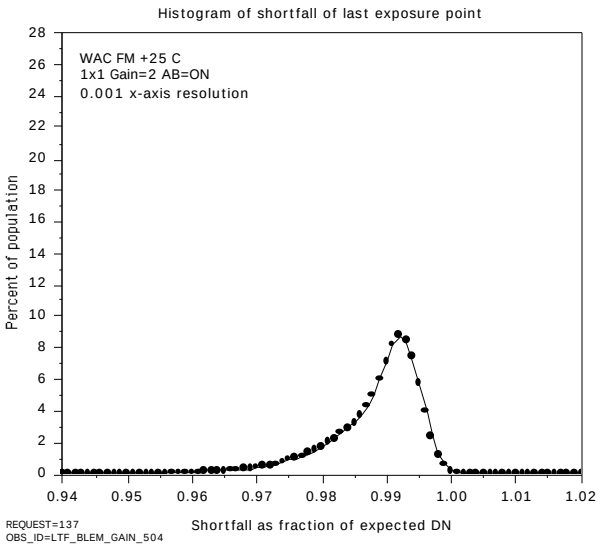
The following histograms show how many pixels have what degree of shortfall in the various camera modes. Note that the 4x4 Gain 0 plot has a different scale than the others.

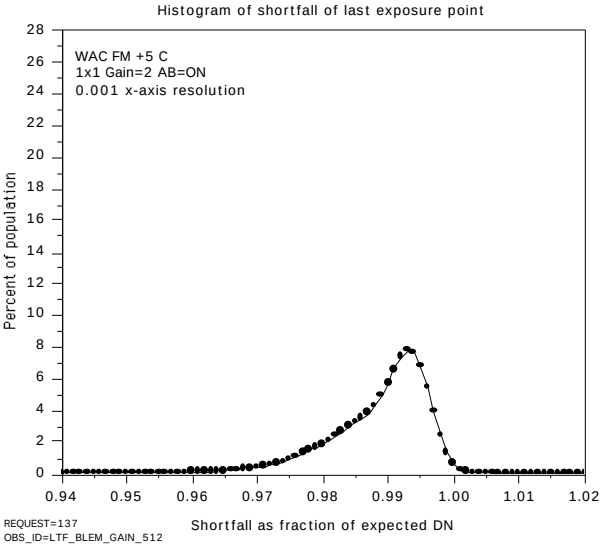


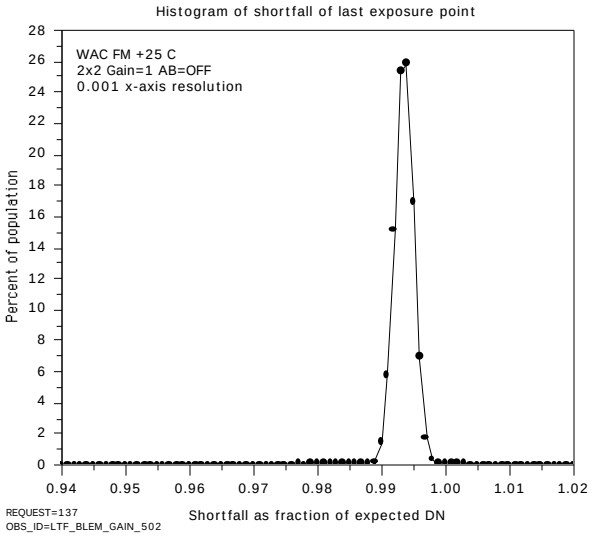


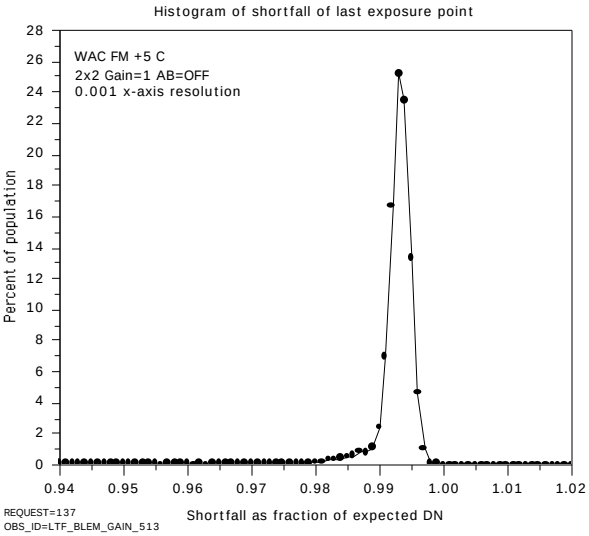


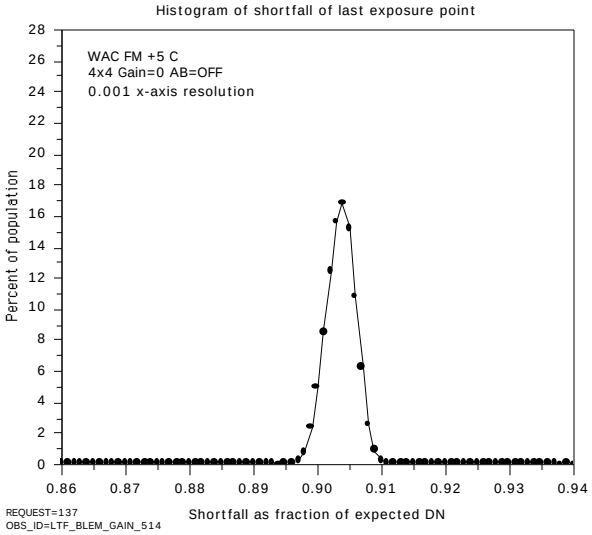



Histogram of shortfall of last exposure point
WAC FM +25 C
1x1 Gain=2 AB=ON
0.001 x-axis resolution
Percent of population
Shortfall as fraction of expected DN
REQUEST=137
OBS_ID=LTF_BLEM_GAIN_504

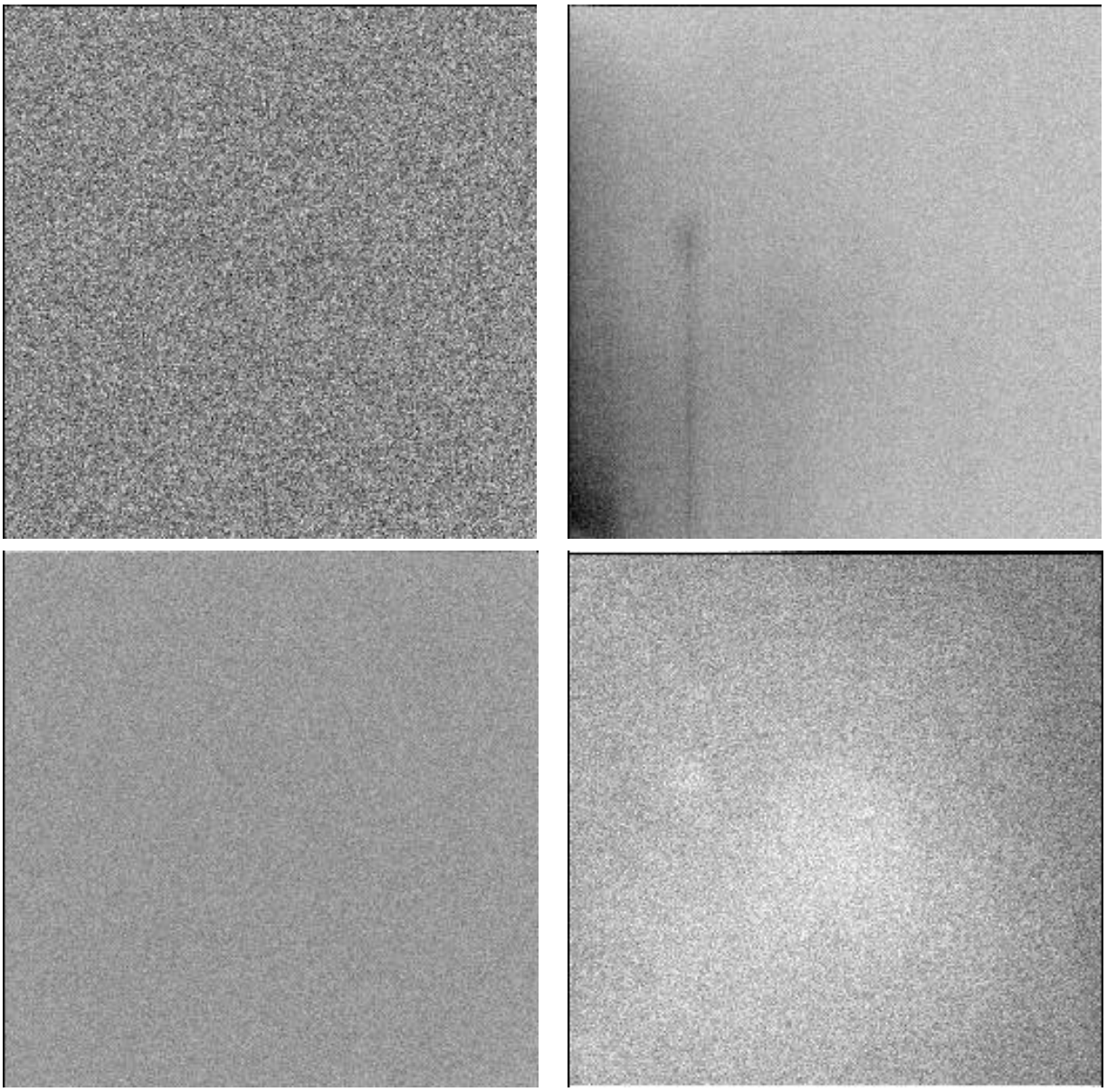

Histogram of shortfall of last exposure point
WAC FM +5 C
1x1 Gain=2 AB=ON
0.001 x-axis resolution
Percent of population
Shortfall as fraction of expected DN
REQUEST=137
OBS_ID=LTF_BLEM_GAIN_512


Histogram of shortfall of last exposure point
WAC FM +25 C
2x2 Gain=1 AB=OFF
0.001 x-axis resolution
Percent of population
Shortfall as fraction of expected DN
REQUEST=137
OBS_ID=LTF_BLEM_GAIN_502


Histogram of shortfall of last exposure point
WAC FM +5 C
2x2 Gain=1 AB=OFF
0.001 x-axis resolution
Percent of population
Shortfall as fraction of expected DN
REQUEST=137
OBS_ID=LTF_BLEM_GAIN_513


Histogram of shortfall of last exposure point
WAC FM +5 C
4x4 Gain=0 AB=OFF
0.001 x-axis resolution
Percent of population
Shortfall as fraction of expected DN
REQUEST=137
OBS_ID=LTF_BLEM_GAIN_514

The images below illustrate the spatial distribution of the shortfall in the various gain states. The top row shows Gain 3 (left) and Gain 2. The bottom row shows Gain 1 (left) and Gain 0. The images have been stretched to bring out any patterns.



5.1.3.2.5 CONCLUSIONS

1. Most of the pixels with significant errors in the linear fit (blemishes) were confined to the image borders. However, roughly the first 100 pixels of line 2 were generally bad enough to be called blemishes (about 200 in 4x4 mode). Only 1 pixel (in 2x2 mode) from the image interior was flagged as a blemish.
2. It was the low exposure behavior which generally caused the pixels to be flagged as blemishes. The reason for the sudden change is slope for some pixels is not known.
3. Gain 0 shows significant non-linearity, as expected from previous analyses of its unusual response. Gain 2 also has significant falloff in the highest exposure level. The degree of shortfall at the highest exposurre level varies according to the gain state.
    - Gain 3: 0 to 2%
    - Gain 2: 0 to 5 %
    - Gain 1: 0 to 1 %
    - Gain 0: 9 to 11 %
4. Only Gain 2 showed a significant non-random spatial distribution to the degree of shortfall. The reason for this pattern is not known.
5. Another type of anomalous behavior is inherent in the Antiblooming=ON case (but is not studied in this report). For very long exposures, some pixels will appear in bright-dark pairs aligned vertically. The data set studied here was not affected by this, but the effect needs to be analyzed.

IMAGES USED IN SENSOR BLEMISH ANALYSIS

image	day	eventtime	observation	gain	mode	exp
+25°C						
126930	180	4:43:13.0	LTC_BLEM_GAIN_500	3 (40K)	FULL	0
126931	180	4:44:42.0	LTC_BLEM_GAIN_500	3 (40K)	FULL	0
126932	180	4:46:11.0	LTC_BLEM_GAIN_500	3 (40K)	FULL	0
126933	180	4:47:40.0	LTC_BLEM_GAIN_500	3 (40K)	FULL	5
126934	180	4:49:9.0	LTC_BLEM_GAIN_500	3 (40K)	FULL	5
126935	180	4:50:38.0	LTC_BLEM_GAIN_500	3 (40K)	FULL	5
126936	180	4:51:44.0	LTC_BLEM_GAIN_500	3 (40K)	FULL	15
126937	180	4:53:13.0	LTC_BLEM_GAIN_500	3 (40K)	FULL	15
126938	180	4:54:42.0	LTC_BLEM_GAIN_500	3 (40K)	FULL	15
126939	180	4:56:11.0	LTC_BLEM_GAIN_500	3 (40K)	FULL	30
126940	180	4:57:40.0	LTC_BLEM_GAIN_500	3 (40K)	FULL	30
126941	180	4:59:9.0	LTC_BLEM_GAIN_500	3 (40K)	FULL	30
126942	180	5:0:15.0	LTC_BLEM_GAIN_500	3 (40K)	FULL	40
126943	180	5:1:44.0	LTC_BLEM_GAIN_500	3 (40K)	FULL	40
126944	180	5:3:13.0	LTC_BLEM_GAIN_500	3 (40K)	FULL	40
126945	180	5:4:42.0	LTC_BLEM_GAIN_500	3 (40K)	FULL	90
126946	180	5:6:11.0	LTC_BLEM_GAIN_500	3 (40K)	FULL	90
126947	180	5:7:40.0	LTC_BLEM_GAIN_500	3 (40K)	FULL	90
126948	180	5:8:46.0	LTC_BLEM_GAIN_500	3 (40K)	FULL	120
126949	180	5:10:15.0	LTC_BLEM_GAIN_500	3 (40K)	FULL	120
126950	180	5:11:44.0	LTC_BLEM_GAIN_500	3 (40K)	FULL	120
126952	180	5:14:42.0	LTC_BLEM_GAIN_500	3 (40K)	FULL	180
126953	180	5:16:11.0	LTC_BLEM_GAIN_500	3 (40K)	FULL	180
126969	180	6:11:48.0	LTC_BLEM_GAIN_500	3 (40K)	FULL	180
126954	180	5:17:17.0	LTC_BLEM_GAIN_500	3 (40K)	FULL	220
126955	180	5:18:46.0	LTC_BLEM_GAIN_500	3 (40K)	FULL	220
126956	180	5:20:15.0	LTC_BLEM_GAIN_500	3 (40K)	FULL	220
126957	180	5:21:44.0	LTC_BLEM_GAIN_500	3 (40K)	FULL	260
126958	180	5:23:13.0	LTC_BLEM_GAIN_500	3 (40K)	FULL	260
126959	180	5:24:42.0	LTC_BLEM_GAIN_500	3 (40K)	FULL	260
126960	180	5:25:48.0	LTC_BLEM_GAIN_500	3 (40K)	FULL	320
126961	180	5:27:17.0	LTC_BLEM_GAIN_500	3 (40K)	FULL	320
126962	180	5:28:46.0	LTC_BLEM_GAIN_500	3 (40K)	FULL	320
126963	180	5:30:15.0	LTC_BLEM_GAIN_500	3 (40K)	FULL	380
126964	180	5:31:44.0	LTC_BLEM_GAIN_500	3 (40K)	FULL	380
126965	180	5:33:13.0	LTC_BLEM_GAIN_500	3 (40K)	FULL	380
126966	180	5:34:19.0	LTC_BLEM_GAIN_500	3 (40K)	FULL	460
126967	180	5:35:48.0	LTC_BLEM_GAIN_500	3 (40K)	FULL	460
126968	180	5:37:17.0	LTC_BLEM_GAIN_500	3 (40K)	FULL	460
126836	180	1:11:35.0	LTC_BLEM_GAIN_501	2 (100K)	FULL	0
126837	180	1:13:4.0	LTC_BLEM_GAIN_501	2 (100K)	FULL	0
126838	180	1:14:33.0	LTC_BLEM_GAIN_501	2 (100K)	FULL	0
126840	180	1:17:31.0	LTC_BLEM_GAIN_501	2 (100K)	FULL	5
126841	180	1:19:0.0	LTC_BLEM_GAIN_501	2 (100K)	FULL	5
126875	180	2:11:31.0	LTC_BLEM_GAIN_501	2 (100K)	FULL	5
126842	180	1:20:6.0	LTC_BLEM_GAIN_501	2 (100K)	FULL	30
126843	180	1:21:35.0	LTC_BLEM_GAIN_501	2 (100K)	FULL	30
126844	180	1:23:4.0	LTC_BLEM_GAIN_501	2 (100K)	FULL	30
126845	180	1:24:33.0	LTC_BLEM_GAIN_501	2 (100K)	FULL	60
126846	180	1:26:2.0	LTC_BLEM_GAIN_501	2 (100K)	FULL	60
126847	180	1:27:31.0	LTC_BLEM_GAIN_501	2 (100K)	FULL	60
126849	180	1:30:6.0	LTC_BLEM_GAIN_501	2 (100K)	FULL	80
126850	180	1:31:35.0	LTC_BLEM_GAIN_501	2 (100K)	FULL	80
126876	180	2:12:37.0	LTC_BLEM_GAIN_501	2 (100K)	FULL	80
126852	180	1:34:33.0	LTC_BLEM_GAIN_501	2 (100K)	FULL	150
126853	180	1:36:2.0	LTC_BLEM_GAIN_501	2 (100K)	FULL	150
126877	180	2:14:6.0	LTC_BLEM_GAIN_501	2 (100K)	FULL	150
126854	180	1:37:8.0	LTC_BLEM_GAIN_501	2 (100K)	FULL	260
126855	180	1:38:37.0	LTC_BLEM_GAIN_501	2 (100K)	FULL	260
126856	180	1:40:6.0	LTC_BLEM_GAIN_501	2 (100K)	FULL	260
126857	180	1:41:35.0	LTC_BLEM_GAIN_501	2 (100K)	FULL	380
126858	180	1:43:4.0	LTC_BLEM_GAIN_501	2 (100K)	FULL	380
126859	180	1:44:33.0	LTC_BLEM_GAIN_501	2 (100K)	FULL	380
126861	180	1:47:8.0	LTC_BLEM_GAIN_501	2 (100K)	FULL	460
126862	180	1:48:37.0	LTC_BLEM_GAIN_501	2 (100K)	FULL	460
126878	180	2:15:12.0	LTC_BLEM_GAIN_501	2 (100K)	FULL	460
126863	180	1:50:6.0	LTC_BLEM_GAIN_501	2 (100K)	FULL	560
126864	180	1:51:35.0	LTC_BLEM_GAIN_501	2 (100K)	FULL	560
126865	180	1:53:4.0	LTC_BLEM_GAIN_501	2 (100K)	FULL	560
126866	180	1:54:10.0	LTC_BLEM_GAIN_501	2 (100K)	FULL	680
126867	180	1:55:39.0	LTC_BLEM_GAIN_501	2 (100K)	FULL	680
126868	180	1:57:8.0	LTC_BLEM_GAIN_501	2 (100K)	FULL	680
126869	180	1:58:37.0	LTC_BLEM_GAIN_501	2 (100K)	FULL	820
126871	180	2:1:35.0	LTC_BLEM_GAIN_501	2 (100K)	FULL	820
126879	180	2:16:18.0	LTC_BLEM_GAIN_501	2 (100K)	FULL	820
126872	180	2:2:41.0	LTC_BLEM_GAIN_501	2 (100K)	FULL	1000
126873	180	2:4:10.0	LTC_BLEM_GAIN_501	2 (100K)	FULL	1000
126874	180	2:5:39.0	LTC_BLEM_GAIN_501	2 (100K)	FULL	1000
126880	180	2:17:24.0	LTC_BLEM_GAIN_501	2 (100K)	FULL	1000
126881	180	2:18:53.0	LTC_BLEM_GAIN_501	2 (100K)	FULL	1000
126882	180	2:20:22.0	LTC_BLEM_GAIN_501	2 (100K)	FULL	1000
126970	180	6:55:58.0	LTC_BLEM_GAIN_502	1 (400K)	SUM2	0
126971	180	6:57:2.0	LTC_BLEM_GAIN_502	1 (400K)	SUM2	0
126972	180	6:58:6.0	LTC_BLEM_GAIN_502	1 (400K)	SUM2	0
126973	180	6:59:10.0	LTC_BLEM_GAIN_502	1 (400K)	SUM2	5
126974	180	7:0:14.0	LTC_BLEM_GAIN_502	1 (400K)	SUM2	5
126975	180	7:1:18.0	LTC_BLEM_GAIN_502	1 (400K)	SUM2	5
126976	180	7:1:57.0	LTC_BLEM_GAIN_502	1 (400K)	SUM2	35
126977	180	7:3:1.0	LTC_BLEM_GAIN_502	1 (400K)	SUM2	35
126978	180	7:4:5.0	LTC_BLEM_GAIN_502	1 (400K)	SUM2	35
126979	180	7:5:9.0	LTC_BLEM_GAIN_502	1 (400K)	SUM2	50
126980	180	7:6:13.0	LTC_BLEM_GAIN_502	1 (400K)	SUM2	50
126981	180	7:7:17.0	LTC_BLEM_GAIN_502	1 (400K)	SUM2	50
126982	180	7:8:0.0	LTC_BLEM_GAIN_502	1 (400K)	SUM2	70
126983	180	7:9:4.0	LTC_BLEM_GAIN_502	1 (400K)	SUM2	70
126984	180	7:10:8.0	LTC_BLEM_GAIN_502	1 (400K)	SUM2	70
126985	180	7:11:12.0	LTC_BLEM_GAIN_502	1 (400K)	SUM2	150
126986	180	7:12:16.0	LTC_BLEM_GAIN_502	1 (400K)	SUM2	150
126987	180	7:13:20.0	LTC_BLEM_GAIN_502	1 (400K)	SUM2	150
126988	180	7:13:59.0	LTC_BLEM_GAIN_502	1 (400K)	SUM2	220
126989	180	7:15:3.0	LTC_BLEM_GAIN_502	1 (400K)	SUM2	220
126990	180	7:16:7.0	LTC_BLEM_GAIN_502	1 (400K)	SUM2	220
126991	180	7:17:11.0	LTC_BLEM_GAIN_502	1 (400K)	SUM2	320
126992	180	7:18:15.0	LTC_BLEM_GAIN_502	1 (400K)	SUM2	320
126993	180	7:19:19.0	LTC_BLEM_GAIN_502	1 (400K)	SUM2	320
126994	180	7:20:2.0	LTC_BLEM_GAIN_502	1 (400K)	SUM2	380
126995	180	7:21:6.0	LTC_BLEM_GAIN_502	1 (400K)	SUM2	380
126996	180	7:22:10.0	LTC_BLEM_GAIN_502	1 (400K)	SUM2	380
126997	180	7:23:14.0	LTC_BLEM_GAIN_502	1 (400K)	SUM2	460
126998	180	7:24:18.0	LTC_BLEM_GAIN_502	1 (400K)	SUM2	460
126999	180	7:25:22.0	LTC_BLEM_GAIN_502	1 (400K)	SUM2	460
127000	180	7:26:5.0	LTC_BLEM_GAIN_502	1 (400K)	SUM2	560
127001	180	7:27:9.0	LTC_BLEM_GAIN_502	1 (400K)	SUM2	560
127002	180	7:28:13.0	LTC_BLEM_GAIN_502	1 (400K)	SUM2	560
127003	180	7:29:17.0	LTC_BLEM_GAIN_502	1 (400K)	SUM2	680
127004	180	7:30:21.0	LTC_BLEM_GAIN_502	1 (400K)	SUM2	680
127005	180	7:31:25.0	LTC_BLEM_GAIN_502	1 (400K)	SUM2	680
127006	180	7:32:6.0	LTC_BLEM_GAIN_502	1 (400K)	SUM2	820
127007	180	7:33:10.0	LTC_BLEM_GAIN_502	1 (400K)	SUM2	820
127008	180	7:34:14.0	LTC_BLEM_GAIN_502	1 (400K)	SUM2	820
127116	183	6:29:40.0	LTC_BLEM_GAIN_503	0 (1400K)	SUM4	0
127118	183	6:31:22.0	LTC_BLEM_GAIN_503	0 (1400K)	SUM4	0
127120	183	6:33:4.0	LTC_BLEM_GAIN_503	0 (1400K)	SUM4	5
127121	183	6:33:55.0	LTC_BLEM_GAIN_503	0 (1400K)	SUM4	5
127122	183	6:34:23.0	LTC_BLEM_GAIN_503	0 (1400K)	SUM4	15
127124	183	6:36:5.0	LTC_BLEM_GAIN_503	0 (1400K)	SUM4	15
127126	183	6:37:47.0	LTC_BLEM_GAIN_503	0 (1400K)	SUM4	25
127127	183	6:38:38.0	LTC_BLEM_GAIN_503	0 (1400K)	SUM4	25
127128	183	6:39:8.0	LTC_BLEM_GAIN_503	0 (1400K)	SUM4	30
127130	183	6:40:50.0	LTC_BLEM_GAIN_503	0 (1400K)	SUM4	30
127132	183	6:42:32.0	LTC_BLEM_GAIN_503	0 (1400K)	SUM4	70
127133	183	6:43:23.0	LTC_BLEM_GAIN_503	0 (1400K)	SUM4	70
127134	183	6:43:53.0	LTC_BLEM_GAIN_503	0 (1400K)	SUM4	120
127136	183	6:45:35.0	LTC_BLEM_GAIN_503	0 (1400K)	SUM4	120
127138	183	6:47:17.0	LTC_BLEM_GAIN_503	0 (1400K)	SUM4	150
127139	183	6:48:8.0	LTC_BLEM_GAIN_503	0 (1400K)	SUM4	150
127140	183	6:48:36.0	LTC_BLEM_GAIN_503	0 (1400K)	SUM4	180
127142	183	6:50:18.0	LTC_BLEM_GAIN_503	0 (1400K)	SUM4	180
127144	183	6:52:0.0	LTC_BLEM_GAIN_503	0 (1400K)	SUM4	260
127145	183	6:52:51.0	LTC_BLEM_GAIN_503	0 (1400K)	SUM4	260
127146	183	6:53:19.0	LTC_BLEM_GAIN_503	0 (1400K)	SUM4	320
127148	183	6:55:1.0	LTC_BLEM_GAIN_503	0 (1400K)	SUM4	320
126883	180	2:47:22.0	LTC_BLEM_GAIN_504	2 (100K)	FULL	0
126884	180	2:48:51.0	LTC_BLEM_GAIN_504	2 (100K)	FULL	0
126885	180	2:50:20.0	LTC_BLEM_GAIN_504	2 (100K)	FULL	0
126886	180	2:51:49.0	LTC_BLEM_GAIN_504	2 (100K)	FULL	5
126887	180	2:53:18.0	LTC_BLEM_GAIN_504	2 (100K)	FULL	5
126888	180	2:54:47.0	LTC_BLEM_GAIN_504	2 (100K)	FULL	5
126889	180	2:55:53.0	LTC_BLEM_GAIN_504	2 (100K)	FULL	30
126890	180	2:57:22.0	LTC_BLEM_GAIN_504	2 (100K)	FULL	30
126891	180	2:58:51.0	LTC_BLEM_GAIN_504	2 (100K)	FULL	30
126892	180	3:0:20.0	LTC_BLEM_GAIN_504	2 (100K)	FULL	60
126893	180	3:1:49.0	LTC_BLEM_GAIN_504	2 (100K)	FULL	60
126894	180	3:3:18.0	LTC_BLEM_GAIN_504	2 (100K)	FULL	60
126895	180	3:4:24.0	LTC_BLEM_GAIN_504	2 (100K)	FULL	80
126923	180	4:23:39.0	LTC_BLEM_GAIN_504	2 (100K)	FULL	80
126928	180	4:32:55.0	LTC_BLEM_GAIN_504	2 (100K)	FULL	80
126898	180	3:8:51.0	LTC_BLEM_GAIN_504	2 (100K)	FULL	150
126899	180	3:10:20.0	LTC_BLEM_GAIN_504	2 (100K)	FULL	150
126924	180	4:25:8.0	LTC_BLEM_GAIN_504	2 (100K)	FULL	150
126902	180	3:14:36.0	LTC_BLEM_GAIN_504	2 (100K)	FULL	260
126903	180	3:16:5.0	LTC_BLEM_GAIN_504	2 (100K)	FULL	260
126925	180	4:26:14.0	LTC_BLEM_GAIN_504	2 (100K)	FULL	260
126904	180	3:17:34.0	LTC_BLEM_GAIN_504	2 (100K)	FULL	380
126905	180	3:19:3.0	LTC_BLEM_GAIN_504	2 (100K)	FULL	380
126906	180	3:20:32.0	LTC_BLEM_GAIN_504	2 (100K)	FULL	380
126907	180	3:21:38.0	LTC_BLEM_GAIN_504	2 (100K)	FULL	460
126908	180	3:23:7.0	LTC_BLEM_GAIN_504	2 (100K)	FULL	460
126929	180	4:34:1.0	LTC_BLEM_GAIN_504	2 (100K)	FULL	460
126910	180	3:26:5.0	LTC_BLEM_GAIN_504	2 (100K)	FULL	560
126911	180	3:27:34.0	LTC_BLEM_GAIN_504	2 (100K)	FULL	560
126912	180	3:29:3.0	LTC_BLEM_GAIN_504	2 (100K)	FULL	560
126913	180	3:30:9.0	LTC_BLEM_GAIN_504	2 (100K)	FULL	680
126914	180	3:31:38.0	LTC_BLEM_GAIN_504	2 (100K)	FULL	680
126915	180	3:33:7.0	LTC_BLEM_GAIN_504	2 (100K)	FULL	680
126917	180	3:36:5.0	LTC_BLEM_GAIN_504	2 (100K)	FULL	820
126918	180	3:37:34.0	LTC_BLEM_GAIN_504	2 (100K)	FULL	820
126927	180	4:28:36.0	LTC_BLEM_GAIN_504	2 (100K)	FULL	820
126919	180	3:38:40.0	LTC_BLEM_GAIN_504	2 (100K)	FULL	1000
126920	180	3:40:9.0	LTC_BLEM_GAIN_504	2 (100K)	FULL	1000
126921	180	3:41:38.0	LTC_BLEM_GAIN_504	2 (100K)	FULL	1000
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129873	194	13:37:20.0	LTC_BLEM_GAIN_510	3 (40K)	FULL	0
129874	194	13:38:49.0	LTC_BLEM_GAIN_510	3 (40K)	FULL	0
129875	194	13:40:18.0	LTC_BLEM_GAIN_510	3 (40K)	FULL	0
129876	194	13:41:48.0	LTC_BLEM_GAIN_510	3 (40K)	FULL	5
129877	194	13:43:17.0	LTC_BLEM_GAIN_510	3 (40K)	FULL	5
129878	194	13:44:46.0	LTC_BLEM_GAIN_510	3 (40K)	FULL	5
129879	194	13:45:51.0	LTC_BLEM_GAIN_510	3 (40K)	FULL	15
129880	194	13:47:20.0	LTC_BLEM_GAIN_510	3 (40K)	FULL	15
129881	194	13:48:49.0	LTC_BLEM_GAIN_510	3 (40K)	FULL	15
129882	194	13:50:19.0	LTC_BLEM_GAIN_510	3 (40K)	FULL	30
129883	194	13:51:48.0	LTC_BLEM_GAIN_510	3 (40K)	FULL	30
129884	194	13:53:17.0	LTC_BLEM_GAIN_510	3 (40K)	FULL	30
129885	194	13:54:22.0	LTC_BLEM_GAIN_510	3 (40K)	FULL	40
129886	194	13:55:51.0	LTC_BLEM_GAIN_510	3 (40K)	FULL	40
129887	194	13:57:20.0	LTC_BLEM_GAIN_510	3 (40K)	FULL	40
129888	194	13:58:50.0	LTC_BLEM_GAIN_510	3 (40K)	FULL	90
129889	194	14:0:19.0	LTC_BLEM_GAIN_510	3 (40K)	FULL	90
129912	194	14:39:33.0	LTC_BLEM_GAIN_510	3 (40K)	FULL	90
129891	194	14:2:53.0	LTC_BLEM_GAIN_510	3 (40K)	FULL	120
129892	194	14:4:22.0	LTC_BLEM_GAIN_510	3 (40K)	FULL	120
129893	194	14:5:51.0	LTC_BLEM_GAIN_510	3 (40K)	FULL	120
129894	194	14:7:21.0	LTC_BLEM_GAIN_510	3 (40K)	FULL	180
129895	194	14:8:50.0	LTC_BLEM_GAIN_510	3 (40K)	FULL	180
129896	194	14:10:19.0	LTC_BLEM_GAIN_510	3 (40K)	FULL	180
129897	194	14:11:24.0	LTC_BLEM_GAIN_510	3 (40K)	FULL	220
129898	194	14:12:53.0	LTC_BLEM_GAIN_510	3 (40K)	FULL	220
129900	194	14:15:52.0	LTC_BLEM_GAIN_510	3 (40K)	FULL	260
129901	194	14:17:21.0	LTC_BLEM_GAIN_510	3 (40K)	FULL	260
129902	194	14:18:50.0	LTC_BLEM_GAIN_510	3 (40K)	FULL	260
129914	194	14:45:6.0	LTC_BLEM_GAIN_510	3 (40K)	FULL	260

IMAGES USED IN SENSOR BLEMISH ANALYSIS

129903	194	14:19:55.0	LTC_BLEM_GAIN_510	3 (40K)	FULL	320
129904	194	14:21:24.0	LTC_BLEM_GAIN_510	3 (40K)	FULL	320
129905	194	14:22:53.0	LTC_BLEM_GAIN_510	3 (40K)	FULL	320
129906	194	14:24:23.0	LTC_BLEM_GAIN_510	3 (40K)	FULL	380
129907	194	14:25:52.0	LTC_BLEM_GAIN_510	3 (40K)	FULL	380
129908	194	14:27:21.0	LTC_BLEM_GAIN_510	3 (40K)	FULL	380
129909	194	14:28:32.0	LTC_BLEM_GAIN_510	3 (40K)	FULL	460
129910	194	14:30:1.0	LTC_BLEM_GAIN_510	3 (40K)	FULL	460
129911	194	14:31:30.0	LTC_BLEM_GAIN_510	3 (40K)	FULL	460
130102	195	3:8:13.0	LTC_BLEM_GAIN_511	2 (100K)	FULL	0
130103	195	3:9:42.0	LTC_BLEM_GAIN_511	2 (100K)	FULL	0
130104	195	3:11:11.0	LTC_BLEM_GAIN_511	2 (100K)	FULL	0
130106	195	3:14:9.0	LTC_BLEM_GAIN_511	2 (100K)	FULL	5
130107	195	3:15:38.0	LTC_BLEM_GAIN_511	2 (100K)	FULL	5
130141	195	4:13:6.0	LTC_BLEM_GAIN_511	2 (100K)	FULL	5
130108	195	3:16:44.0	LTC_BLEM_GAIN_511	2 (100K)	FULL	30
130109	195	3:18:13.0	LTC_BLEM_GAIN_511	2 (100K)	FULL	30
130110	195	3:19:42.0	LTC_BLEM_GAIN_511	2 (100K)	FULL	30
130111	195	3:21:11.0	LTC_BLEM_GAIN_511	2 (100K)	FULL	60
130112	195	3:22:40.0	LTC_BLEM_GAIN_511	2 (100K)	FULL	60
130113	195	3:24:9.0	LTC_BLEM_GAIN_511	2 (100K)	FULL	60
130114	195	3:25:15.0	LTC_BLEM_GAIN_511	2 (100K)	FULL	80
130116	195	3:28:13.0	LTC_BLEM_GAIN_511	2 (100K)	FULL	80
130142	195	4:14:12.0	LTC_BLEM_GAIN_511	2 (100K)	FULL	80
130118	195	3:31:11.0	LTC_BLEM_GAIN_511	2 (100K)	FULL	150
130119	195	3:32:40.0	LTC_BLEM_GAIN_511	2 (100K)	FULL	150
130143	195	4:15:41.0	LTC_BLEM_GAIN_511	2 (100K)	FULL	150
130120	195	3:33:46.0	LTC_BLEM_GAIN_511	2 (100K)	FULL	260
130121	195	3:35:15.0	LTC_BLEM_GAIN_511	2 (100K)	FULL	260
130122	195	3:36:44.0	LTC_BLEM_GAIN_511	2 (100K)	FULL	260
130123	195	3:38:13.0	LTC_BLEM_GAIN_511	2 (100K)	FULL	380
130124	195	3:39:42.0	LTC_BLEM_GAIN_511	2 (100K)	FULL	380
130125	195	3:41:11.0	LTC_BLEM_GAIN_511	2 (100K)	FULL	380
130126	195	3:42:17.0	LTC_BLEM_GAIN_511	2 (100K)	FULL	460
130127	195	3:43:46.0	LTC_BLEM_GAIN_511	2 (100K)	FULL	460
130128	195	3:45:15.0	LTC_BLEM_GAIN_511	2 (100K)	FULL	460
130129	195	3:46:44.0	LTC_BLEM_GAIN_511	2 (100K)	FULL	560
130130	195	3:48:13.0	LTC_BLEM_GAIN_511	2 (100K)	FULL	560
130131	195	3:49:42.0	LTC_BLEM_GAIN_511	2 (100K)	FULL	560
130132	195	3:50:48.0	LTC_BLEM_GAIN_511	2 (100K)	FULL	680
130133	195	3:52:17.0	LTC_BLEM_GAIN_511	2 (100K)	FULL	680
130144	195	4:16:47.0	LTC_BLEM_GAIN_511	2 (100K)	FULL	680
130135	195	3:55:15.0	LTC_BLEM_GAIN_511	2 (100K)	FULL	820
130137	195	3:58:13.0	LTC_BLEM_GAIN_511	2 (100K)	FULL	820
130145	195	4:18:16.0	LTC_BLEM_GAIN_511	2 (100K)	FULL	820
130139	195	4:0:48.0	LTC_BLEM_GAIN_511	2 (100K)	FULL	1000
130140	195	4:2:17.0	LTC_BLEM_GAIN_511	2 (100K)	FULL	1000
130146	195	4:19:22.0	LTC_BLEM_GAIN_511	2 (100K)	FULL	1000
130147	195	8:48:58.0	LTC_BLEM_GAIN_512	2 (100K)	FULL	0
130148	195	8:50:27.0	LTC_BLEM_GAIN_512	2 (100K)	FULL	0
130149	195	8:51:56.0	LTC_BLEM_GAIN_512	2 (100K)	FULL	0
130150	195	8:53:26.0	LTC_BLEM_GAIN_512	2 (100K)	FULL	5
130151	195	8:54:55.0	LTC_BLEM_GAIN_512	2 (100K)	FULL	5
130152	195	8:56:24.0	LTC_BLEM_GAIN_512	2 (100K)	FULL	5
130153	195	8:57:29.0	LTC_BLEM_GAIN_512	2 (100K)	FULL	30
130154	195	8:58:58.0	LTC_BLEM_GAIN_512	2 (100K)	FULL	30
130186	195	9:53:17.0	LTC_BLEM_GAIN_512	2 (100K)	FULL	30
130156	195	9:1:56.0	LTC_BLEM_GAIN_512	2 (100K)	FULL	60
130157	195	9:3:26.0	LTC_BLEM_GAIN_512	2 (100K)	FULL	60
130158	195	9:4:55.0	LTC_BLEM_GAIN_512	2 (100K)	FULL	60
130159	195	9:6:0.0	LTC_BLEM_GAIN_512	2 (100K)	FULL	80
130161	195	9:8:58.0	LTC_BLEM_GAIN_512	2 (100K)	FULL	80
130187	195	9:54:23.0	LTC_BLEM_GAIN_512	2 (100K)	FULL	80
130162	195	9:10:28.0	LTC_BLEM_GAIN_512	2 (100K)	FULL	150
130163	195	9:11:57.0	LTC_BLEM_GAIN_512	2 (100K)	FULL	150
130164	195	9:13:26.0	LTC_BLEM_GAIN_512	2 (100K)	FULL	150
130166	195	9:16:0.0	LTC_BLEM_GAIN_512	2 (100K)	FULL	260
130188	195	9:55:29.0	LTC_BLEM_GAIN_512	2 (100K)	FULL	260
130189	195	9:56:58.0	LTC_BLEM_GAIN_512	2 (100K)	FULL	260
130168	195	9:18:59.0	LTC_BLEM_GAIN_512	2 (100K)	FULL	380
130170	195	9:21:57.0	LTC_BLEM_GAIN_512	2 (100K)	FULL	380
130171	195	9:23:2.0	LTC_BLEM_GAIN_512	2 (100K)	FULL	460
130172	195	9:24:31.0	LTC_BLEM_GAIN_512	2 (100K)	FULL	460
130173	195	9:26:0.0	LTC_BLEM_GAIN_512	2 (100K)	FULL	460
130174	195	9:27:30.0	LTC_BLEM_GAIN_512	2 (100K)	FULL	560
130175	195	9:28:59.0	LTC_BLEM_GAIN_512	2 (100K)	FULL	560
130176	195	9:30:28.0	LTC_BLEM_GAIN_512	2 (100K)	FULL	560
130177	195	9:31:33.0	LTC_BLEM_GAIN_512	2 (100K)	FULL	680
130179	195	9:34:31.0	LTC_BLEM_GAIN_512	2 (100K)	FULL	680
130190	195	9:58:4.0	LTC_BLEM_GAIN_512	2 (100K)	FULL	680
130180	195	9:36:1.0	LTC_BLEM_GAIN_512	2 (100K)	FULL	820
130181	195	9:37:30.0	LTC_BLEM_GAIN_512	2 (100K)	FULL	820
130182	195	9:38:59.0	LTC_BLEM_GAIN_512	2 (100K)	FULL	820
130183	195	9:40:4.0	LTC_BLEM_GAIN_512	2 (100K)	FULL	1000
130184	195	9:41:33.0	LTC_BLEM_GAIN_512	2 (100K)	FULL	1000
130185	195	9:43:2.0	LTC_BLEM_GAIN_512	2 (100K)	FULL	1000
130191	195	10:38:4.0	LTC_BLEM_GAIN_513	1 (400K)	SUM2	0
130192	195	10:39:8.0	LTC_BLEM_GAIN_513	1 (400K)	SUM2	0
130193	195	10:40:13.0	LTC_BLEM_GAIN_513	1 (400K)	SUM2	0
130194	195	10:41:17.0	LTC_BLEM_GAIN_513	1 (400K)	SUM2	5
130195	195	10:42:21.0	LTC_BLEM_GAIN_513	1 (400K)	SUM2	5
130196	195	10:43:25.0	LTC_BLEM_GAIN_513	1 (400K)	SUM2	5
130197	195	10:44:3.0	LTC_BLEM_GAIN_513	1 (400K)	SUM2	35
130198	195	10:45:7.0	LTC_BLEM_GAIN_513	1 (400K)	SUM2	35
130199	195	10:46:11.0	LTC_BLEM_GAIN_513	1 (400K)	SUM2	35
130200	195	10:47:16.0	LTC_BLEM_GAIN_513	1 (400K)	SUM2	50
130201	195	10:48:20.0	LTC_BLEM_GAIN_513	1 (400K)	SUM2	50
130202	195	10:49:24.0	LTC_BLEM_GAIN_513	1 (400K)	SUM2	50
130203	195	10:50:6.0	LTC_BLEM_GAIN_513	1 (400K)	SUM2	70
130204	195	10:51:10.0	LTC_BLEM_GAIN_513	1 (400K)	SUM2	70
130205	195	10:52:14.0	LTC_BLEM_GAIN_513	1 (400K)	SUM2	70
130206	195	10:53:19.0	LTC_BLEM_GAIN_513	1 (400K)	SUM2	150
130207	195	10:54:23.0	LTC_BLEM_GAIN_513	1 (400K)	SUM2	150
130208	195	10:55:27.0	LTC_BLEM_GAIN_513	1 (400K)	SUM2	150
130209	195	10:56:5.0	LTC_BLEM_GAIN_513	1 (400K)	SUM2	220
130210	195	10:57:9.0	LTC_BLEM_GAIN_513	1 (400K)	SUM2	220
130211	195	10:58:13.0	LTC_BLEM_GAIN_513	1 (400K)	SUM2	220
130212	195	10:59:18.0	LTC_BLEM_GAIN_513	1 (400K)	SUM2	320
130213	195	11:0:22.0	LTC_BLEM_GAIN_513	1 (400K)	SUM2	320
130214	195	11:1:26.0	LTC_BLEM_GAIN_513	1 (400K)	SUM2	320
130215	195	11:2:8.0	LTC_BLEM_GAIN_513	1 (400K)	SUM2	380
130216	195	11:3:12.0	LTC_BLEM_GAIN_513	1 (400K)	SUM2	380
130217	195	11:4:16.0	LTC_BLEM_GAIN_513	1 (400K)	SUM2	380
130218	195	11:5:21.0	LTC_BLEM_GAIN_513	1 (400K)	SUM2	460
130219	195	11:6:25.0	LTC_BLEM_GAIN_513	1 (400K)	SUM2	460
130220	195	11:7:29.0	LTC_BLEM_GAIN_513	1 (400K)	SUM2	460
130221	195	11:8:11.0	LTC_BLEM_GAIN_513	1 (400K)	SUM2	560
130222	195	11:9:15.0	LTC_BLEM_GAIN_513	1 (400K)	SUM2	560
130223	195	11:10:19.0	LTC_BLEM_GAIN_513	1 (400K)	SUM2	560
130224	195	11:11:24.0	LTC_BLEM_GAIN_513	1 (400K)	SUM2	680
130225	195	11:12:28.0	LTC_BLEM_GAIN_513	1 (400K)	SUM2	680
130226	195	11:13:32.0	LTC_BLEM_GAIN_513	1 (400K)	SUM2	680
130230	195	12:26:10.0	LTC_BLEM_GAIN_514	0 (1400K)	SUM4	0
130231	195	12:27:1.0	LTC_BLEM_GAIN_514	0 (1400K)	SUM4	0
130232	195	12:27:52.0	LTC_BLEM_GAIN_514	0 (1400K)	SUM4	0
130233	195	12:28:44.0	LTC_BLEM_GAIN_514	0 (1400K)	SUM4	5
130234	195	12:29:35.0	LTC_BLEM_GAIN_514	0 (1400K)	SUM4	5
130235	195	12:30:26.0	LTC_BLEM_GAIN_514	0 (1400K)	SUM4	5
130236	195	12:30:53.0	LTC_BLEM_GAIN_514	0 (1400K)	SUM4	15
130237	195	12:31:44.0	LTC_BLEM_GAIN_514	0 (1400K)	SUM4	15
130238	195	12:32:35.0	LTC_BLEM_GAIN_514	0 (1400K)	SUM4	15
130239	195	12:33:27.0	LTC_BLEM_GAIN_514	0 (1400K)	SUM4	25
130240	195	12:34:18.0	LTC_BLEM_GAIN_514	0 (1400K)	SUM4	25
130241	195	12:35:9.0	LTC_BLEM_GAIN_514	0 (1400K)	SUM4	25
130242	195	12:35:38.0	LTC_BLEM_GAIN_514	0 (1400K)	SUM4	30
130243	195	12:36:29.0	LTC_BLEM_GAIN_514	0 (1400K)	SUM4	30
130244	195	12:37:20.0	LTC_BLEM_GAIN_514	0 (1400K)	SUM4	30
130245	195	12:38:12.0	LTC_BLEM_GAIN_514	0 (1400K)	SUM4	70
130246	195	12:39:3.0	LTC_BLEM_GAIN_514	0 (1400K)	SUM4	70
130247	195	12:39:54.0	LTC_BLEM_GAIN_514	0 (1400K)	SUM4	70
130248	195	12:40:23.0	LTC_BLEM_GAIN_514	0 (1400K)	SUM4	120
130249	195	12:41:14.0	LTC_BLEM_GAIN_514	0 (1400K)	SUM4	120
130250	195	12:42:5.0	LTC_BLEM_GAIN_514	0 (1400K)	SUM4	120
130251	195	12:42:57.0	LTC_BLEM_GAIN_514	0 (1400K)	SUM4	150
130252	195	12:43:48.0	LTC_BLEM_GAIN_514	0 (1400K)	SUM4	150
130253	195	12:44:39.0	LTC_BLEM_GAIN_514	0 (1400K)	SUM4	150
130254	195	12:45:6.0	LTC_BLEM_GAIN_514	0 (1400K)	SUM4	180
130255	195	12:45:57.0	LTC_BLEM_GAIN_514	0 (1400K)	SUM4	180
130256	195	12:46:48.0	LTC_BLEM_GAIN_514	0 (1400K)	SUM4	180
130257	195	12:47:40.0	LTC_BLEM_GAIN_514	0 (1400K)	SUM4	260
130258	195	12:48:31.0	LTC_BLEM_GAIN_514	0 (1400K)	SUM4	260
130259	195	12:49:22.0	LTC_BLEM_GAIN_514	0 (1400K)	SUM4	260
130260	195	12:49:49.0	LTC_BLEM_GAIN_514	0 (1400K)	SUM4	320
130261	195	12:50:40.0	LTC_BLEM_GAIN_514	0 (1400K)	SUM4	320
130262	195	12:51:31.0	LTC_BLEM_GAIN_514	0 (1400K)	SUM4	320
130263	195	12:52:23.0	LTC_BLEM_GAIN_514	0 (1400K)	SUM4	380
130264	195	12:53:14.0	LTC_BLEM_GAIN_514	0 (1400K)	SUM4	380
130265	195	12:54:5.0	LTC_BLEM_GAIN_514	0 (1400K)	SUM4	380