5.5. 2 LOSSLESS COMPRESSION

As reported in Reference 5.5.2-1

Reference 5.5.2-1 IOM 388-PAG-CCA97-15, "ISS FM CALIBRATION RESULTS: LOSSLESS Compression", C. Avis, dated November 12, 1997

Reference 5.5.2-2 : Robert F. Rice and Jun-Ji Lee, "Some Practical Universal Noiseless Coding Techniques, Part II" JPL Publication 83-17, March 1,1989, p.2 - 5

5.5.2.1 INTRODUCTION

The Flight Model thermal/vacuum testing included the acquisition of images taken in the LOSSLESS compression mode. This memo reports on the efficiency of that compression versus the image entropy.

5.5.2.2 METHOD

The entropy of an image whose dynamic range is 0 to 4095 is defined as (Reference 5.5.2-2):

$$H = -\sum_{j=-4095}^{4095} p_j \log_2 p_j$$

where H is the entropy in bits/pixel,
p_j is the probability that two horizontally adjacent pixels have a difference j

This algorithm is implemented in the VICAR program ENTROPY. This program's test cases include:

1. pixel sequence 0,1,2,3,4,… (entropy = 0)
2. pixel sequence 0,1,0,1,0,1,… (entropy = 1)
3. pixel sequence 0,1,2,3,0,1,2,3,… (entropy = .811278)

The entropy calculation was performed on the raw image data which had been decompressed from its LOSSLESS compressed state. The decompression step (performed in the EGSE) calculated the Compression Ratio as the ratio of decompressed image size to the received image size.

The ISS flight software compresses either 8-bit data or 12-bit data that is packaged in 16-bit words. The theoretical compression limit is:

$$CL = \frac{n}{H}$$

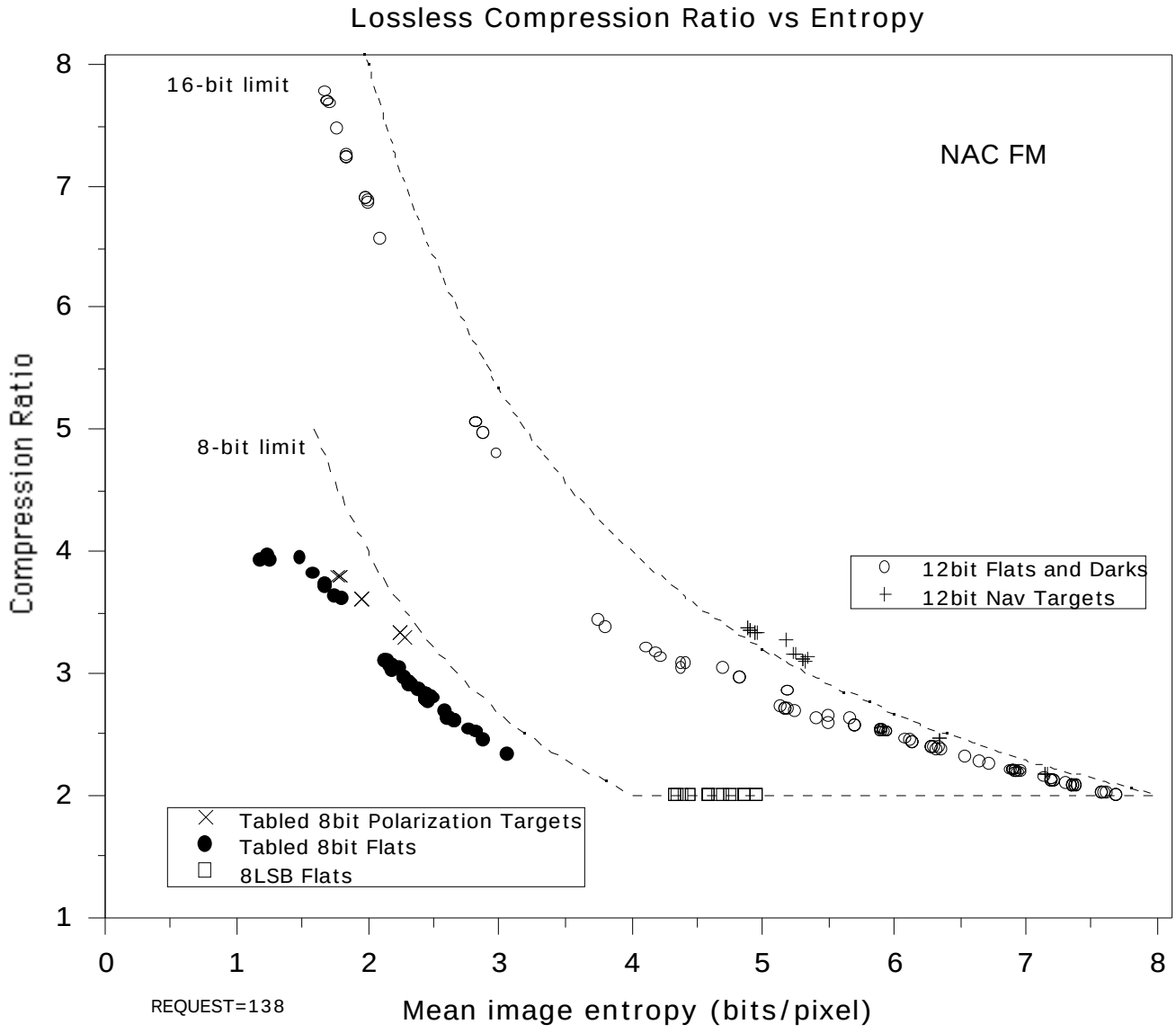
where CL is the compression limit
H is the entropy in bits/pixel
n is the number of bits representing the data (8 or 16)

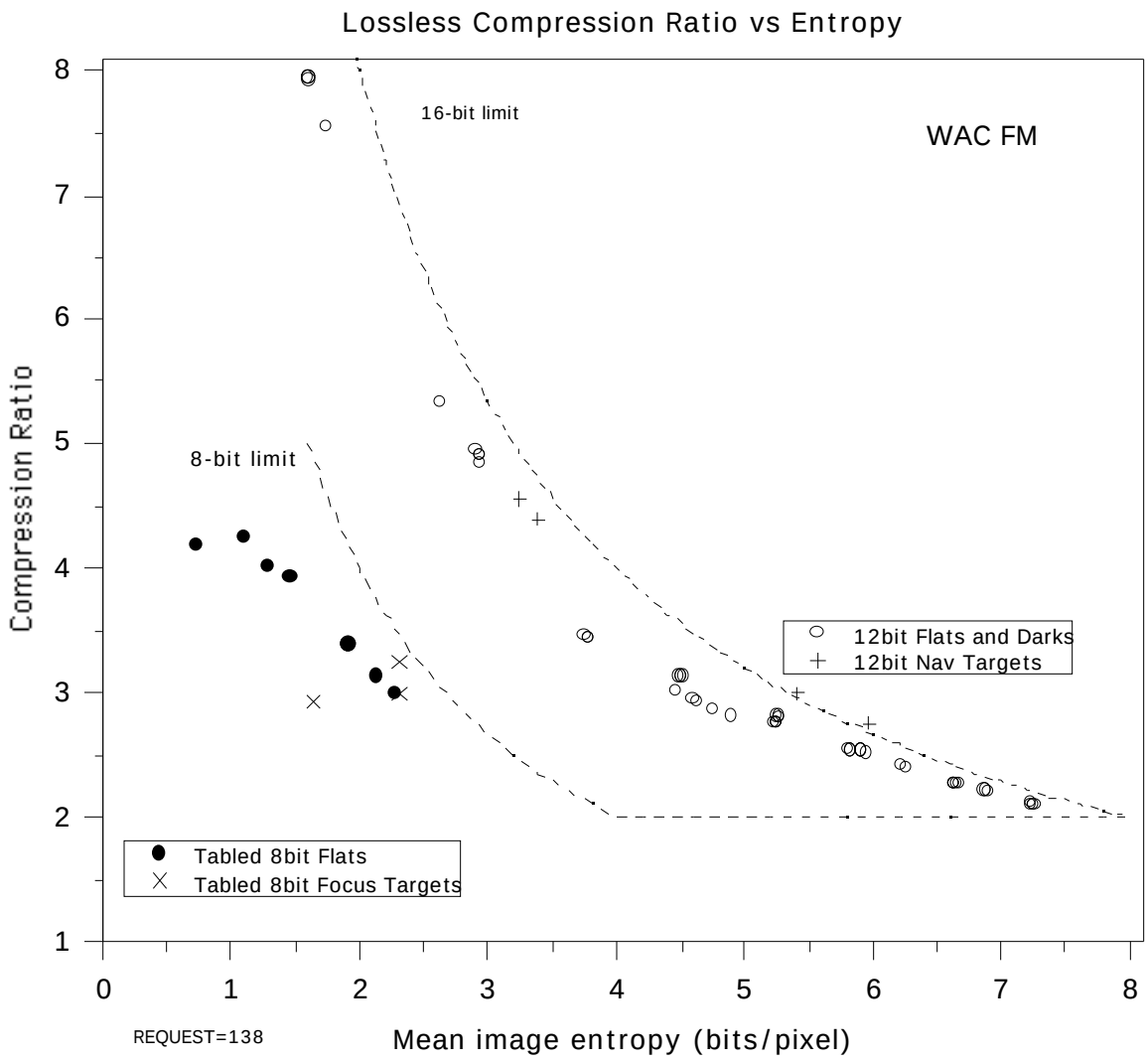
However, the ISS flight software will truncate the image lines to keep a minimum Compression Ratio of 2.0.

5.5.2.3 RESULTS

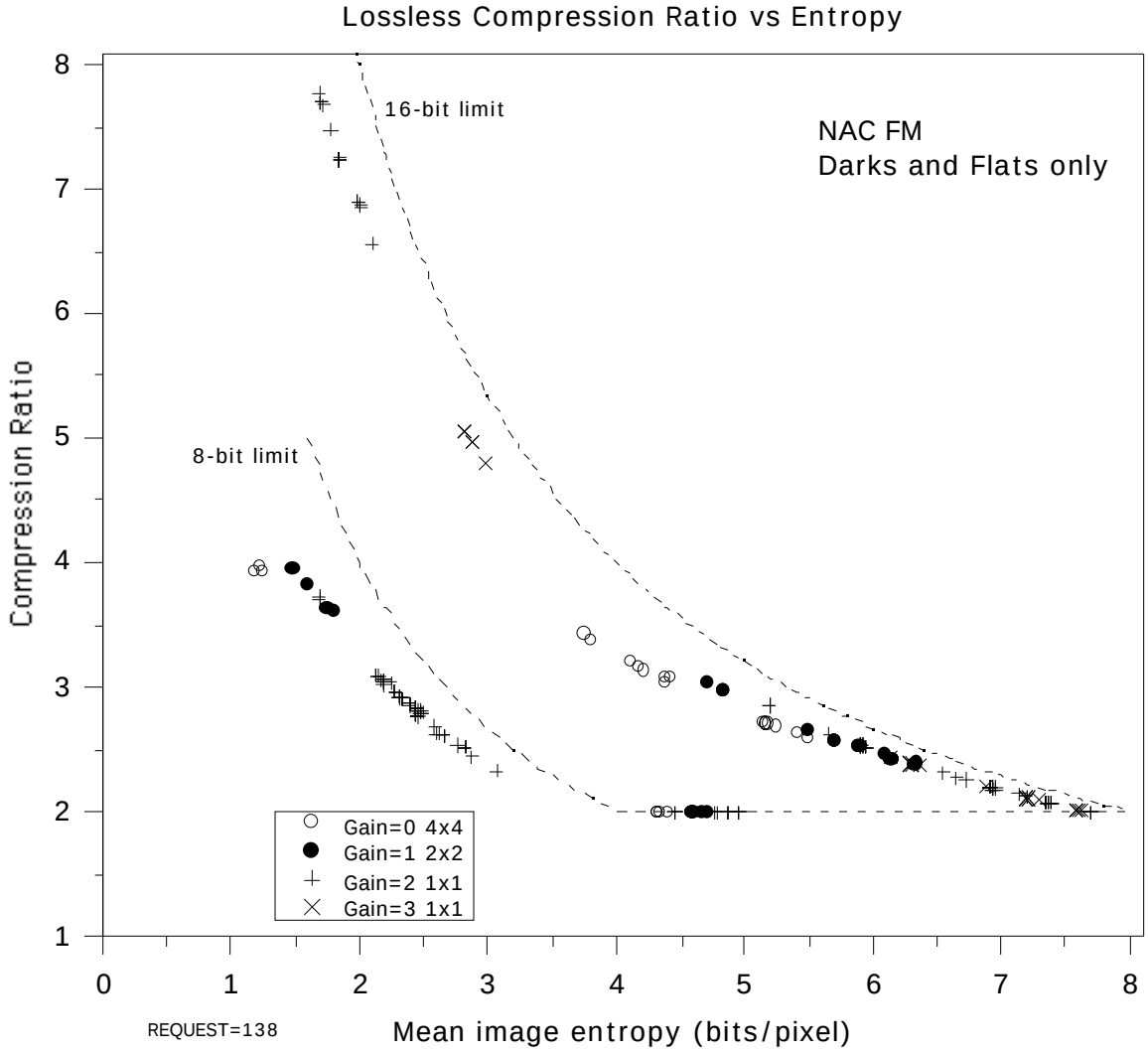
The Compression Ratio was plotted vs. the image entropy for all available LOSSLESS compressed 12-bit and 8-bit images. The 8-bit (8 LSB) images were highly exposed and therefore had rapid changes from 255 DN to 0 DN. Because of this, they always gave the minimum allowed Compression Ratio of 2.0 with much line truncation.

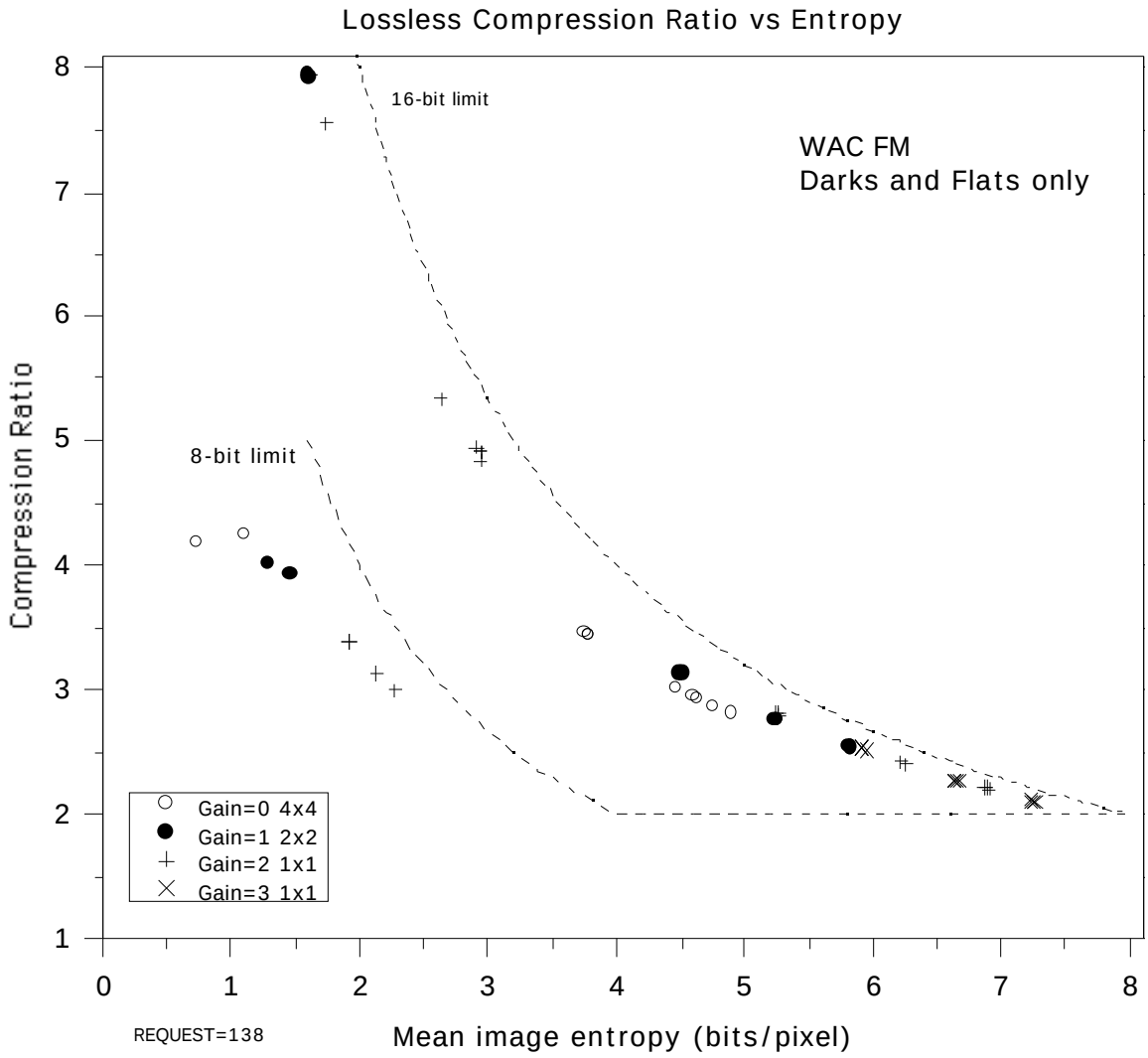
In the following plots, flat-field and dark frame images have one symbol while the Nav, Focus and Polarization target images have their own symbol. The Nav target used was one of a simulated planetary disk. The Polarization target was an illuminated rectangle almost filling one half of the image area.




Lossless Compression Ratio vs Entropy
16-bit limit
WAC FM
8-bit limit
12bit Flats and Darks
12bit Nav Targets
Tabled 8bit Flats
Tabled 8bit Focus Targets
Compression Ratio
Mean image entropy (bits/pixel)
REQUEST=138
0
1
2
3
4
5
6
7
8

The following plots show the same data as the above plots except that only dark and flat-field frames are used. In addition, the symbols represent the four gain states.





5.5.2.4 CONCLUSIONS

1. The image data followed a consistent functional relationship between image entropy and Compression Ratio for both cameras.
2. The differences in targets cause some variations in the plots. Different targets could have similar mean entropy values but give very different Compression Ratios, and vice versa.
3. The Gain 0 images (4x4 summation) naturally have the lowest entropy, but the Compression Ratio values seem to be less than expected.
4. The Compression Ratio value included in the VICAR label of all compressed data was calculated incorrectly by the EGSE software. It must be divided by 0.75 to yield the correct value. This ground software problem was fixed before affecting any flight data.

5.5.2.5 IMAGES USED FOR ANALYSIS

ISSNAC

image	day	time	observation	target	gain	mode	conversion
OPEN	66	10:30:10.0	PTP_200		2 (100K)	FULL	12BIT
110430	66	10:32:38.0	PTP_200	OPEN	2 (100K)	FULL	TABLE
110436	66	10:38:29.0	PTP_200	OPEN	1 (400K)	SUM2	12BIT
110438	66	10:39:38.0	PTP_200	OPEN	1 (400K)	SUM2	TABLE
110444	66	10:43:32.0	PTP_200	OPEN	0 (1400K)	SUM4	12BIT
110452	66	10:50:52.0	PTP_200	OPEN	2 (100K)	FULL	12BIT
110454	66	10:53:12.0	PTP_200	OPEN	2 (100K)	FULL	TABLE
110917	71	6:56:27.0	PTP_201	OPEN	2 (100K)	FULL	12BIT
110918	71	6:58:53.0	PTP_201	OPEN	2 (100K)	FULL	12BIT
110921	71	7:7:27.0	PTP_201	OPEN	2 (100K)	FULL	TABLE
110936	71	7:29:58.0	PTP_201	OPEN	1 (400K)	SUM2	12BIT
110938	71	7:32:51.0	PTP_201	OPEN	1 (400K)	SUM2	TABLE
110956	71	8:1:4.0	PTP_201	OPEN	0 (1400K)	SUM4	12BIT
110958	71	8:8:5.0	PTP_201	OPEN	0 (1400K)	SUM4	TABLE
110966	71	8:35:32.0	PTP_201	OPEN	2 (100K)	FULL	TABLE
112352	75	17:14:56.0	PTP_202	OPEN	2 (100K)	FULL	12BIT
112355	75	17:22:23.0	PTP_202	OPEN	2 (100K)	FULL	TABLE
112365	75	17:37:2.0	PTP_202	OPEN	1 (400K)	SUM2	12BIT
112367	75	17:39:44.0	PTP_202	OPEN	1 (400K)	SUM2	TABLE
112378	75	17:49:45.0	PTP_202	OPEN	0 (1400K)	SUM4	12BIT
112380	75	18:31:41.0	PTP_202	OPEN	0 (1400K)	SUM4	TABLE
112386	75	18:47:2.0	PTP_202	OPEN	2 (100K)	FULL	12BIT
112388	75	18:49:39.0	PTP_202	OPEN	2 (100K)	FULL	TABLE
114602	93	17:51:1.0	NAV_TEST_1_200	NAVIGATION_1	3 (40K)	FULL	12BIT
114603	93	17:52:33.0	NAV_TEST_1_201	NAVIGATION_1	3 (40K)	FULL	12BIT
114604	93	17:53:43.0	NAV_TEST_1_201	NAVIGATION_1	3 (40K)	FULL	12BIT
114605	93	17:55:12.0	NAV_TEST_1_202	NAVIGATION_1	3 (40K)	FULL	12BIT
114606	93	17:56:41.0	NAV_TEST_1_202	NAVIGATION_1	3 (40K)	FULL	12BIT
114607	93	17:58:10.0	NAV_TEST_1_203	NAVIGATION_1	3 (40K)	FULL	12BIT
114608	93	17:59:39.0	NAV_TEST_1_203	NAVIGATION_1	3 (40K)	FULL	12BIT
114609	93	18:9:4.0	NAV_TEST_1_200	NAVIGATION_1	3 (40K)	FULL	12BIT
114610	93	18:13:2.0	NAV_TEST_1_200	NAVIGATION_1	3 (40K)	FULL	12BIT
114611	93	18:14:34.0	NAV_TEST_1_201	NAVIGATION_1	3 (40K)	FULL	12BIT
114614	93	18:18:42.0	NAV_TEST_1_202	NAVIGATION_1	3 (40K)	FULL	12BIT
114615	93	18:20:11.0	NAV_TEST_1_203	NAVIGATION_1	3 (40K)	FULL	12BIT
114617	93	18:31:5.0	NAV_TEST_1_204	NAVIGATION_1	3 (40K)	FULL	12BIT
114618	93	18:32:34.0	NAV_TEST_1_204	NAVIGATION_1	3 (40K)	FULL	12BIT
114619	93	19:2:25.0	NAV_TEST_1_200	NAVIGATION_1	3 (40K)	FULL	12BIT
114620	93	19:6:23.0	NAV_TEST_1_200	NAVIGATION_1	3 (40K)	FULL	12BIT
114857	94	10:56:14.0	NAV_TEST_1_204	NAVIGATION_1	3 (40K)	FULL	12BIT
114858	94	10:57:43.0	NAV_TEST_1_204	NAVIGATION_1	3 (40K)	FULL	12BIT
114859	94	11:1:44.0	NAV_TEST_1_204	NAVIGATION_1	3 (40K)	FULL	12BIT
115003	94	18:37:14.0	PTP_203	OPEN	2 (100K)	FULL	12BIT
115004	94	18:38:21.0	PTP_203	OPEN	2 (100K)	FULL	12BIT
115005	94	18:39:46.0	PTP_203	OPEN	2 (100K)	FULL	12BIT
115009	94	18:45:21.0	PTP_203	OPEN	2 (100K)	FULL	TABLE
115020	94	19:4:14.0	PTP_203	OPEN	1 (400K)	SUM2	12BIT
115021	94	19:4:50.0	PTP_203	OPEN	1 (400K)	SUM2	12BIT
115025	94	19:8:23.0	PTP_203	OPEN	1 (400K)	SUM2	TABLE
115039	94	19:21:34.0	PTP_203	OPEN	0 (1400K)	SUM4	12BIT
115040	94	19:22:0.0	PTP_203	OPEN	0 (1400K)	SUM4	12BIT
115044	94	19:24:44.0	PTP_203	OPEN	0 (1400K)	SUM4	TABLE
115061	94	20:12:26.0	PTP_203	OPEN	2 (100K)	FULL	12BIT
115063	94	20:15:15.0	PTP_203	OPEN	2 (100K)	FULL	TABLE
116575	111	22:16:57.0	ELECTRICAL_NOISE_208	OPEN	3 (40K)	FULL	12BIT
116576	111	22:18:27.0	ELECTRICAL_NOISE_208	OPEN	3 (40K)	FULL	12BIT
116577	111	22:19:56.0	ELECTRICAL_NOISE_208	OPEN	3 (40K)	FULL	12BIT
116578	111	22:21:25.0	ELECTRICAL_NOISE_208	OPEN	3 (40K)	FULL	12BIT
116579	111	22:22:32.0	ELECTRICAL_NOISE_209	OPEN	2 (100K)	FULL	12BIT
116580	111	22:24:2.0	ELECTRICAL_NOISE_209	OPEN	2 (100K)	FULL	12BIT
116581	111	22:25:31.0	ELECTRICAL_NOISE_209	OPEN	2 (100K)	FULL	12BIT
116582	111	22:27:0.0	ELECTRICAL_NOISE_209	OPEN	2 (100K)	FULL	12BIT
116583	111	22:31:25.0	ELECTRICAL_NOISE_208	OPEN	3 (40K)	FULL	12BIT
116584	111	22:32:54.0	ELECTRICAL_NOISE_208	OPEN	3 (40K)	FULL	12BIT
116585	111	22:34:24.0	ELECTRICAL_NOISE_208	OPEN	3 (40K)	FULL	12BIT
116586	111	22:35:53.0	ELECTRICAL_NOISE_208	OPEN	3 (40K)	FULL	12BIT
116660	112	1:15:18.0	ELECTRICAL_NOISE_208	OPEN	3 (40K)	FULL	12BIT
116661	112	1:16:48.0	ELECTRICAL_NOISE_208	OPEN	3 (40K)	FULL	12BIT
116662	112	1:18:17.0	ELECTRICAL_NOISE_208	OPEN	3 (40K)	FULL	12BIT
116663	112	1:19:46.0	ELECTRICAL_NOISE_208	OPEN	3 (40K)	FULL	12BIT
116664	112	1:20:53.0	ELECTRICAL_NOISE_209	OPEN	2 (100K)	FULL	12BIT
116665	112	1:22:23.0	ELECTRICAL_NOISE_209	OPEN	2 (100K)	FULL	12BIT
116666	112	1:23:52.0	ELECTRICAL_NOISE_209	OPEN	2 (100K)	FULL	12BIT
116667	112	1:25:21.0	ELECTRICAL_NOISE_209	OPEN	2 (100K)	FULL	12BIT
116668	112	1:26:28.0	ELECTRICAL_NOISE_210	OPEN	1 (400K)	SUM2	12BIT

image	day	time	observation	target	gain	mode	conversion
116669	112	1:27:32.0	ELECTRICAL_NOISE_210	OPEN	1 (400K)	SUM2	12BIT
116670	112	1:28:37.0	ELECTRICAL_NOISE_210	OPEN	1 (400K)	SUM2	12BIT
116671	112	1:29:41.0	ELECTRICAL_NOISE_210	OPEN	1 (400K)	SUM2	12BIT
116672	112	1:30:23.0	ELECTRICAL_NOISE_211	OPEN	0 (1400K)	SUM4	12BIT
116673	112	1:31:14.0	ELECTRICAL_NOISE_211	OPEN	0 (1400K)	SUM4	12BIT
116674	112	1:32:6.0	ELECTRICAL_NOISE_211	OPEN	0 (1400K)	SUM4	12BIT
116675	112	1:32:57.0	ELECTRICAL_NOISE_211	OPEN	0 (1400K)	SUM4	12BIT
116676	112	1:56:36.0	LIGHT_TRANSFER_205	OPEN	2 (100K)	FULL	12BIT
116677	112	1:58:5.0	LIGHT_TRANSFER_205	OPEN	2 (100K)	FULL	12BIT
116678	112	1:59:34.0	LIGHT_TRANSFER_205	OPEN	2 (100K)	FULL	12BIT
116679	112	2:1:3.0	LIGHT_TRANSFER_205	OPEN	2 (100K)	FULL	12BIT
116680	112	2:2:32.0	LIGHT_TRANSFER_205	OPEN	2 (100K)	FULL	12BIT
116682	112	2:5:7.0	LIGHT_TRANSFER_205	OPEN	2 (100K)	FULL	12BIT
116683	112	2:6:36.0	LIGHT_TRANSFER_205	OPEN	2 (100K)	FULL	12BIT
116684	112	2:8:5.0	LIGHT_TRANSFER_205	OPEN	2 (100K)	FULL	12BIT
116685	112	2:9:34.0	LIGHT_TRANSFER_205	OPEN	2 (100K)	FULL	12BIT
116686	112	2:11:3.0	LIGHT_TRANSFER_205	OPEN	2 (100K)	FULL	12BIT
116687	112	2:12:32.0	LIGHT_TRANSFER_205	OPEN	2 (100K)	FULL	12BIT
116688	112	2:18:28.0	LIGHT_TRANSFER_205	OPEN	2 (100K)	FULL	12BIT
116917	112	14:23:44.0	LIGHT_TRANSFER_260	OPEN	2 (100K)	FULL	TABLE
116918	112	14:24:54.0	LIGHT_TRANSFER_261	OPEN	2 (100K)	FULL	TABLE
116919	112	14:26:23.0	LIGHT_TRANSFER_261	OPEN	2 (100K)	FULL	TABLE
116920	112	14:27:52.0	LIGHT_TRANSFER_261	OPEN	2 (100K)	FULL	TABLE
116921	112	14:29:22.0	LIGHT_TRANSFER_261	OPEN	2 (100K)	FULL	TABLE
116922	112	14:30:51.0	LIGHT_TRANSFER_261	OPEN	2 (100K)	FULL	TABLE
116923	112	14:32:20.0	LIGHT_TRANSFER_261	OPEN	2 (100K)	FULL	TABLE
116927	112	14:37:58.0	LIGHT_TRANSFER_262	OPEN	2 (100K)	FULL	TABLE
116928	112	14:39:27.0	LIGHT_TRANSFER_262	OPEN	2 (100K)	FULL	TABLE
116929	112	14:40:56.0	LIGHT_TRANSFER_262	OPEN	2 (100K)	FULL	TABLE
116930	112	14:42:3.0	LIGHT_TRANSFER_262	OPEN	2 (100K)	FULL	TABLE
116931	112	14:43:32.0	LIGHT_TRANSFER_262	OPEN	2 (100K)	FULL	TABLE
116932	112	14:45:2.0	LIGHT_TRANSFER_262	OPEN	2 (100K)	FULL	TABLE
116933	112	14:46:31.0	LIGHT_TRANSFER_262	OPEN	2 (100K)	FULL	TABLE
116934	112	14:48:0.0	LIGHT_TRANSFER_262	OPEN	2 (100K)	FULL	TABLE
116935	112	14:49:29.0	LIGHT_TRANSFER_262	OPEN	2 (100K)	FULL	TABLE
116939	112	14:54:48.0	LIGHT_TRANSFER_263	OPEN	2 (100K)	FULL	TABLE
116940	112	14:56:28.0	LIGHT_TRANSFER_263	OPEN	2 (100K)	FULL	TABLE
116941	112	14:58:8.0	LIGHT_TRANSFER_263	OPEN	2 (100K)	FULL	TABLE
116942	112	14:59:32.0	LIGHT_TRANSFER_263	OPEN	2 (100K)	FULL	TABLE
116943	112	15:1:20.0	LIGHT_TRANSFER_263	OPEN	2 (100K)	FULL	TABLE
116944	112	15:3:9.0	LIGHT_TRANSFER_263	OPEN	2 (100K)	FULL	TABLE
116945	112	15:4:43.0	LIGHT_TRANSFER_263	OPEN	2 (100K)	FULL	TABLE
116946	112	15:6:47.0	LIGHT_TRANSFER_263	OPEN	2 (100K)	FULL	TABLE
116947	112	15:8:51.0	LIGHT_TRANSFER_263	OPEN	2 (100K)	FULL	TABLE
116951	112	15:14:10.0	LIGHT_TRANSFER_264	OPEN	2 (100K)	FULL	TABLE
116952	112	15:15:50.0	LIGHT_TRANSFER_264	OPEN	2 (100K)	FULL	TABLE
116953	112	15:17:30.0	LIGHT_TRANSFER_264	OPEN	2 (100K)	FULL	TABLE
116954	112	15:19:10.0	LIGHT_TRANSFER_264	OPEN	2 (100K)	FULL	TABLE
116955	112	15:21:14.0	LIGHT_TRANSFER_264	OPEN	2 (100K)	FULL	TABLE
116956	112	15:23:19.0	LIGHT_TRANSFER_264	OPEN	2 (100K)	FULL	TABLE
116957	112	15:25:9.0	LIGHT_TRANSFER_264	OPEN	2 (100K)	FULL	TABLE
116958	112	15:27:29.0	LIGHT_TRANSFER_264	OPEN	2 (100K)	FULL	TABLE
116959	112	15:29:49.0	LIGHT_TRANSFER_264	OPEN	2 (100K)	FULL	TABLE
116963	112	15:35:27.0	LIGHT_TRANSFER_265	OPEN	2 (100K)	FULL	TABLE
116964	112	15:36:56.0	LIGHT_TRANSFER_265	OPEN	2 (100K)	FULL	TABLE
116965	112	15:38:25.0	LIGHT_TRANSFER_265	OPEN	2 (100K)	FULL	TABLE
116966	112	15:39:30.0	LIGHT_TRANSFER_265	OPEN	2 (100K)	FULL	TABLE
116967	112	15:40:59.0	LIGHT_TRANSFER_265	OPEN	2 (100K)	FULL	TABLE
116968	112	15:42:29.0	LIGHT_TRANSFER_265	OPEN	2 (100K)	FULL	TABLE
116969	112	15:43:31.0	LIGHT_TRANSFER_265	OPEN	2 (100K)	FULL	TABLE
116970	112	15:45:3.0	LIGHT_TRANSFER_265	OPEN	2 (100K)	FULL	TABLE
116971	112	15:46:35.0	LIGHT_TRANSFER_265	OPEN	2 (100K)	FULL	TABLE
119369	137	15:57:37.0	ELECTRICAL_NOISE_220	OPEN	3 (40K)	FULL	12BIT
119370	137	15:59:6.0	ELECTRICAL_NOISE_220	OPEN	3 (40K)	FULL	12BIT
119371	137	16:0:35.0	ELECTRICAL_NOISE_220	OPEN	3 (40K)	FULL	12BIT
119372	137	16:2:4.0	ELECTRICAL_NOISE_220	OPEN	3 (40K)	FULL	12BIT
119373	137	16:3:12.0	ELECTRICAL_NOISE_221	OPEN	2 (100K)	FULL	12BIT
119374	137	16:4:41.0	ELECTRICAL_NOISE_221	OPEN	2 (100K)	FULL	12BIT
119375	137	16:6:10.0	ELECTRICAL_NOISE_221	OPEN	2 (100K)	FULL	12BIT
119376	137	16:7:39.0	ELECTRICAL_NOISE_221	OPEN	2 (100K)	FULL	12BIT
119377	137	16:8:47.0	ELECTRICAL_NOISE_222	OPEN	1 (400K)	SUM2	12BIT
119378	137	16:9:51.0	ELECTRICAL_NOISE_222	OPEN	1 (400K)	SUM2	12BIT
119379	137	16:10:55.0	ELECTRICAL_NOISE_222	OPEN	1 (400K)	SUM2	12BIT
119380	137	16:11:59.0	ELECTRICAL_NOISE_222	OPEN	1 (400K)	SUM2	12BIT
119381	137	16:12:42.0	ELECTRICAL_NOISE_223	OPEN	0 (1400K)	SUM4	12BIT
119382	137	16:13:33.0	ELECTRICAL_NOISE_223	OPEN	0 (1400K)	SUM4	12BIT
119383	137	16:14:24.0	ELECTRICAL_NOISE_223	OPEN	0 (1400K)	SUM4	12BIT
119384	137	16:15:15.0	ELECTRICAL_NOISE_223	OPEN	0 (1400K)	SUM4	12BIT
119385	137	18:22:7.0	ELECTRICAL_NOISE_221	OPEN	2 (100K)	FULL	12BIT

image	day	time	observation	target	gain	mode	conversion
119386	137	18:23:36.0	ELECTRICAL_NOISE_221	OPEN	2 (100K)	FULL	12BIT
119387	137	18:24:44.0	ELECTRICAL_NOISE_222	OPEN	1 (400K)	SUM2	12BIT
119388	137	18:25:48.0	ELECTRICAL_NOISE_222	OPEN	1 (400K)	SUM2	12BIT
119389	137	18:26:52.0	ELECTRICAL_NOISE_222	OPEN	1 (400K)	SUM2	12BIT
119390	137	18:27:56.0	ELECTRICAL_NOISE_222	OPEN	1 (400K)	SUM2	12BIT
119391	137	18:28:39.0	ELECTRICAL_NOISE_223	OPEN	0 (1400K)	SUM4	12BIT
119392	137	18:29:30.0	ELECTRICAL_NOISE_223	OPEN	0 (1400K)	SUM4	12BIT
119393	137	18:30:21.0	ELECTRICAL_NOISE_223	OPEN	0 (1400K)	SUM4	12BIT
119394	137	18:31:12.0	ELECTRICAL_NOISE_223	OPEN	0 (1400K)	SUM4	12BIT
119434	137	20:35:43.0	LIGHT_TRANSFER_270	OPEN	2 (100K)	FULL	12BIT
119435	137	20:37:11.0	LIGHT_TRANSFER_270	OPEN	2 (100K)	FULL	12BIT
119436	137	20:38:41.0	LIGHT_TRANSFER_270	OPEN	2 (100K)	FULL	12BIT
119437	137	20:40:10.0	LIGHT_TRANSFER_270	OPEN	2 (100K)	FULL	12BIT
119438	137	20:41:39.0	LIGHT_TRANSFER_270	OPEN	2 (100K)	FULL	12BIT
119439	137	20:43:8.0	LIGHT_TRANSFER_270	OPEN	2 (100K)	FULL	12BIT
119440	137	20:44:13.0	LIGHT_TRANSFER_270	OPEN	2 (100K)	FULL	12BIT
119441	137	20:45:42.0	LIGHT_TRANSFER_270	OPEN	2 (100K)	FULL	12BIT
119442	137	20:47:12.0	LIGHT_TRANSFER_270	OPEN	2 (100K)	FULL	12BIT
119443	137	20:48:41.0	LIGHT_TRANSFER_270	OPEN	2 (100K)	FULL	12BIT
119445	137	20:51:39.0	LIGHT_TRANSFER_270	OPEN	2 (100K)	FULL	12BIT
120425	140	4:41:42.0	ELECTRICAL_NOISE_232	OPEN	3 (40K)	FULL	12BIT
120426	140	4:43:11.0	ELECTRICAL_NOISE_232	OPEN	3 (40K)	FULL	12BIT
120427	140	4:44:40.0	ELECTRICAL_NOISE_232	OPEN	3 (40K)	FULL	12BIT
120428	140	4:46:10.0	ELECTRICAL_NOISE_232	OPEN	3 (40K)	FULL	12BIT
120429	140	4:47:17.0	ELECTRICAL_NOISE_233	OPEN	2 (100K)	FULL	12BIT
120431	140	4:50:15.0	ELECTRICAL_NOISE_233	OPEN	2 (100K)	FULL	12BIT
120432	140	4:51:45.0	ELECTRICAL_NOISE_233	OPEN	2 (100K)	FULL	12BIT
120433	140	4:52:52.0	ELECTRICAL_NOISE_234	OPEN	1 (400K)	SUM2	12BIT
120434	140	4:53:56.0	ELECTRICAL_NOISE_234	OPEN	1 (400K)	SUM2	12BIT
120435	140	4:55:0.0	ELECTRICAL_NOISE_234	OPEN	1 (400K)	SUM2	12BIT
120436	140	4:56:4.0	ELECTRICAL_NOISE_234	OPEN	1 (400K)	SUM2	12BIT
120437	140	4:56:47.0	ELECTRICAL_NOISE_235	OPEN	0 (1400K)	SUM4	12BIT
120438	140	4:57:38.0	ELECTRICAL_NOISE_235	OPEN	0 (1400K)	SUM4	12BIT
120439	140	4:58:29.0	ELECTRICAL_NOISE_235	OPEN	0 (1400K)	SUM4	12BIT
120440	140	4:59:20.0	ELECTRICAL_NOISE_235	OPEN	0 (1400K)	SUM4	12BIT
120916	141	21:46:20.0	LIGHT_TRANSFER_311	OPEN	2 (100K)	FULL	TABLE
120917	141	21:47:37.0	LIGHT_TRANSFER_311	OPEN	2 (100K)	FULL	TABLE
120918	141	21:49:6.0	LIGHT_TRANSFER_314	OPEN	2 (100K)	FULL	TABLE
120919	141	21:50:16.0	LIGHT_TRANSFER_315	OPEN	2 (100K)	FULL	TABLE
120920	141	21:51:22.0	LIGHT_TRANSFER_315	OPEN	2 (100K)	FULL	TABLE
120921	141	21:52:32.0	LIGHT_TRANSFER_316	OPEN	2 (100K)	FULL	TABLE
121310	142	19:46:42.0	LIGHT_TRANSFER_359	OPEN	2 (100K)	FULL	12BIT
121311	142	19:48:11.0	LIGHT_TRANSFER_359	OPEN	2 (100K)	FULL	12BIT
121312	142	19:49:40.0	LIGHT_TRANSFER_359	OPEN	2 (100K)	FULL	12BIT
121313	142	19:51:10.0	LIGHT_TRANSFER_359	OPEN	2 (100K)	FULL	12BIT
121314	142	19:52:39.0	LIGHT_TRANSFER_359	OPEN	2 (100K)	FULL	12BIT
121315	142	19:54:8.0	LIGHT_TRANSFER_359	OPEN	2 (100K)	FULL	12BIT
121316	142	19:55:13.0	LIGHT_TRANSFER_359	OPEN	2 (100K)	FULL	12BIT
121317	142	19:56:42.0	LIGHT_TRANSFER_359	OPEN	2 (100K)	FULL	12BIT
121318	142	19:58:11.0	LIGHT_TRANSFER_359	OPEN	2 (100K)	FULL	12BIT
121320	142	20:1:10.0	LIGHT_TRANSFER_359	OPEN	2 (100K)	FULL	12BIT
121321	142	20:2:39.0	LIGHT_TRANSFER_359	OPEN	2 (100K)	FULL	12BIT
121322	142	20:6:51.0	LIGHT_TRANSFER_359	OPEN	2 (100K)	FULL	12BIT
122552	147	0:11:41.0	POLARIZATION_200	POLARIZATION	2 (100K)	FULL	TABLE
122553	147	0:13:10.0	POLARIZATION_200	POLARIZATION	2 (100K)	FULL	TABLE
122554	147	0:14:39.0	POLARIZATION_200	POLARIZATION	2 (100K)	FULL	TABLE
122778	147	10:25:46.0	POLARIZATION_204	POLARIZATION	2 (100K)	FULL	TABLE
122779	147	10:27:14.0	POLARIZATION_204	POLARIZATION	2 (100K)	FULL	TABLE
122780	147	10:28:44.0	POLARIZATION_204	POLARIZATION	2 (100K)	FULL	TABLE
122781	147	10:30:2.0	POLARIZATION_205	POLARIZATION	2 (100K)	FULL	TABLE
122782	147	10:31:43.0	POLARIZATION_205	POLARIZATION	2 (100K)	FULL	TABLE
122783	147	10:33:23.0	POLARIZATION_205	POLARIZATION	2 (100K)	FULL	TABLE
134561	212	22:9:29.0	ELECTRICAL_NOISE_708	OPEN	3 (40K)	FULL	12BIT
134562	212	22:10:58.0	ELECTRICAL_NOISE_708	OPEN	3 (40K)	FULL	12BIT
134563	212	22:12:28.0	ELECTRICAL_NOISE_708	OPEN	3 (40K)	FULL	12BIT
134564	212	22:13:57.0	ELECTRICAL_NOISE_708	OPEN	3 (40K)	FULL	12BIT
134565	212	22:15:4.0	ELECTRICAL_NOISE_709	OPEN	2 (100K)	FULL	12BIT
134566	212	22:16:33.0	ELECTRICAL_NOISE_709	OPEN	2 (100K)	FULL	12BIT
134567	212	22:18:3.0	ELECTRICAL_NOISE_709	OPEN	2 (100K)	FULL	12BIT
134568	212	22:19:32.0	ELECTRICAL_NOISE_709	OPEN	2 (100K)	FULL	12BIT
134569	212	22:20:39.0	ELECTRICAL_NOISE_710	OPEN	1 (400K)	SUM2	12BIT
134570	212	22:21:43.0	ELECTRICAL_NOISE_710	OPEN	1 (400K)	SUM2	12BIT
134571	212	22:22:47.0	ELECTRICAL_NOISE_710	OPEN	1 (400K)	SUM2	12BIT
134572	212	22:23:51.0	ELECTRICAL_NOISE_710	OPEN	1 (400K)	SUM2	12BIT
134573	212	22:24:34.0	ELECTRICAL_NOISE_711	OPEN	0 (1400K)	SUM4	12BIT
134574	212	22:25:25.0	ELECTRICAL_NOISE_711	OPEN	0 (1400K)	SUM4	12BIT
134575	212	22:26:16.0	ELECTRICAL_NOISE_711	OPEN	0 (1400K)	SUM4	12BIT
134576	212	22:27:7.0	ELECTRICAL_NOISE_711	OPEN	0 (1400K)	SUM4	12BIT
110429	66	10:31:34.0	PTP_200	OPEN	2 (100K)	FULL	8LSB

image	day	time	observation	target	gain	mode	conversion
110437	66	10:39:6.0	PTP_200	OPEN	1 (400K)	SUM2	8LSB
110453	66	10:52:20.0	PTP_200	OPEN	2 (100K)	FULL	8LSB
110919	71	7:3:19.0	PTP_201	OPEN	2 (100K)	FULL	8LSB
110920	71	7:5:51.0	PTP_201	OPEN	2 (100K)	FULL	8LSB
110937	71	7:31:10.0	PTP_201	OPEN	1 (400K)	SUM2	8LSB
110957	71	8:6:56.0	PTP_201	OPEN	0 (1400K)	SUM4	8LSB
110965	71	8:34:35.0	PTP_201	OPEN	2 (100K)	FULL	8LSB
112353	75	17:16:35.0	PTP_202	OPEN	2 (100K)	FULL	8LSB
112366	75	17:38:43.0	PTP_202	OPEN	1 (400K)	SUM2	8LSB
112387	75	18:48:12.0	PTP_202	OPEN	2 (100K)	FULL	8LSB
115006	94	18:41:28.0	PTP_203	OPEN	2 (100K)	FULL	8LSB
115007	94	18:42:29.0	PTP_203	OPEN	2 (100K)	FULL	8LSB
115008	94	18:43:24.0	PTP_203	OPEN	2 (100K)	FULL	8LSB
115022	94	19:5:58.0	PTP_203	OPEN	1 (400K)	SUM2	8LSB
115023	94	19:6:28.0	PTP_203	OPEN	1 (400K)	SUM2	8LSB
115024	94	19:6:56.0	PTP_203	OPEN	1 (400K)	SUM2	8LSB
115041	94	19:22:49.0	PTP_203	OPEN	0 (1400K)	SUM4	8LSB
115042	94	19:23:15.0	PTP_203	OPEN	0 (1400K)	SUM4	8LSB
115043	94	19:23:38.0	PTP_203	OPEN	0 (1400K)	SUM4	8LSB
115062	94	20:13:48.0	PTP_203	OPEN	2 (100K)	FULL	8LSB

WAC FM

image	day	time	observation	target	gain	mode	conversion
123120	158	5:51:11.0	PTP_500	OPEN	2 (100K)	FULL	TABLE
123129	158	6:3:14.0	PTP_500	OPEN	1 (400K)	SUM2	TABLE
123140	158	6:20:59.0	PTP_500	OPEN	0 (1400K)	SUM4	TABLE
123158	158	7:35:38.0	PTP_500	OPEN	2 (100K)	FULL	TABLE
123513	160	10:14:0.0	PTP_501	FOCUS	2 (100K)	FULL	TABLE
123522	160	10:28:7.0	PTP_501	FOCUS	1 (400K)	SUM2	TABLE
123536	160	10:43:8.0	PTP_501	FOCUS	0 (1400K)	SUM4	TABLE
123835	162	1:9:2.0	PTP_502	OPEN	2 (100K)	FULL	TABLE
123862	162	1:51:58.0	PTP_502	OPEN	1 (400K)	SUM2	TABLE
123872	162	2:3:44.0	PTP_502	OPEN	0 (1400K)	SUM4	TABLE
123884	162	2:30:4.0	PTP_502	OPEN	2 (100K)	FULL	TABLE
128493	189	11:1:36.0	NAV_TEST_1_504	NAVIGATION_1	3 (40K)	FULL	12BIT
128494	189	11:3:8.0	NAV_TEST_1_504	NAVIGATION_1	3 (40K)	FULL	12BIT
128499	189	11:12:9.0	NAV_TEST_1_505	NAVIGATION_1	3 (40K)	FULL	12BIT
128500	189	11:13:38.0	NAV_TEST_1_505	NAVIGATION_1	3 (40K)	FULL	12BIT
129605	193	5:8:38.0	ELECTRICAL_NOISE_500	OPEN	3 (40K)	FULL	12BIT
129606	193	5:9:37.0	ELECTRICAL_NOISE_500	OPEN	3 (40K)	FULL	12BIT
129607	193	5:10:36.0	ELECTRICAL_NOISE_500	OPEN	3 (40K)	FULL	12BIT
129608	193	5:11:35.0	ELECTRICAL_NOISE_500	OPEN	3 (40K)	FULL	12BIT
129609	193	5:12:43.0	ELECTRICAL_NOISE_501	OPEN	2 (100K)	FULL	12BIT
129610	193	5:13:42.0	ELECTRICAL_NOISE_501	OPEN	2 (100K)	FULL	12BIT
129611	193	5:14:41.0	ELECTRICAL_NOISE_501	OPEN	2 (100K)	FULL	12BIT
129612	193	5:15:40.0	ELECTRICAL_NOISE_501	OPEN	2 (100K)	FULL	12BIT
129613	193	5:16:48.0	ELECTRICAL_NOISE_502	OPEN	1 (400K)	SUM2	12BIT
129614	193	5:17:9.0	ELECTRICAL_NOISE_502	OPEN	1 (400K)	SUM2	12BIT
129615	193	5:17:30.0	ELECTRICAL_NOISE_502	OPEN	1 (400K)	SUM2	12BIT
129616	193	5:17:51.0	ELECTRICAL_NOISE_502	OPEN	1 (400K)	SUM2	12BIT
129617	193	5:18:21.0	ELECTRICAL_NOISE_503	OPEN	0 (1400K)	SUM4	12BIT
129618	193	5:18:36.0	ELECTRICAL_NOISE_503	OPEN	0 (1400K)	SUM4	12BIT
129619	193	5:18:51.0	ELECTRICAL_NOISE_503	OPEN	0 (1400K)	SUM4	12BIT
129620	193	5:19:6.0	ELECTRICAL_NOISE_503	OPEN	0 (1400K)	SUM4	12BIT
129807	194	6:16:6.0	ELECTRICAL_NOISE_512	OPEN	3 (40K)	FULL	12BIT
129809	194	6:18:4.0	ELECTRICAL_NOISE_512	OPEN	3 (40K)	FULL	12BIT
129810	194	6:19:3.0	ELECTRICAL_NOISE_512	OPEN	3 (40K)	FULL	12BIT
129811	194	6:20:10.0	ELECTRICAL_NOISE_513	OPEN	2 (100K)	FULL	12BIT
129812	194	6:21:10.0	ELECTRICAL_NOISE_513	OPEN	2 (100K)	FULL	12BIT
129814	194	6:23:8.0	ELECTRICAL_NOISE_513	OPEN	2 (100K)	FULL	12BIT
129815	194	6:24:15.0	ELECTRICAL_NOISE_514	OPEN	1 (400K)	SUM2	12BIT
129816	194	6:24:36.0	ELECTRICAL_NOISE_514	OPEN	1 (400K)	SUM2	12BIT
129817	194	6:24:58.0	ELECTRICAL_NOISE_514	OPEN	1 (400K)	SUM2	12BIT
129818	194	7:31:24.0	ELECTRICAL_NOISE_512	OPEN	3 (40K)	FULL	12BIT
129819	194	7:32:22.0	ELECTRICAL_NOISE_512	OPEN	3 (40K)	FULL	12BIT
129820	194	7:33:21.0	ELECTRICAL_NOISE_512	OPEN	3 (40K)	FULL	12BIT
129822	194	7:35:0.0	ELECTRICAL_NOISE_514	OPEN	1 (400K)	SUM2	12BIT
129823	194	7:35:21.0	ELECTRICAL_NOISE_514	OPEN	1 (400K)	SUM2	12BIT
129824	194	7:35:42.0	ELECTRICAL_NOISE_514	OPEN	1 (400K)	SUM2	12BIT
129825	194	7:36:3.0	ELECTRICAL_NOISE_514	OPEN	1 (400K)	SUM2	12BIT
129826	194	7:36:33.0	ELECTRICAL_NOISE_515	OPEN	0 (1400K)	SUM4	12BIT
129827	194	7:36:48.0	ELECTRICAL_NOISE_515	OPEN	0 (1400K)	SUM4	12BIT
129828	194	7:37:3.0	ELECTRICAL_NOISE_515	OPEN	0 (1400K)	SUM4	12BIT
129829	194	7:37:18.0	ELECTRICAL_NOISE_515	OPEN	0 (1400K)	SUM4	12BIT
129830	194	7:52:17.0	ELECTRICAL_NOISE_512	OPEN	3 (40K)	FULL	12BIT
129831	194	7:53:16.0	ELECTRICAL_NOISE_512	OPEN	3 (40K)	FULL	12BIT
129832	194	7:54:15.0	ELECTRICAL_NOISE_512	OPEN	3 (40K)	FULL	12BIT
129833	194	7:55:14.0	ELECTRICAL_NOISE_512	OPEN	3 (40K)	FULL	12BIT
132277	201	7:52:41.0	ELECTRICAL_NOISE_524	OPEN	3 (40K)	FULL	12BIT

image	day	time	observation	target	gain	mode	conversion
132278	201	7:53:40.0	ELECTRICAL_NOISE_524	OPEN	3 (40K)	FULL	12BIT
132279	201	7:54:39.0	ELECTRICAL_NOISE_524	OPEN	3 (40K)	FULL	12BIT
132280	201	7:55:38.0	ELECTRICAL_NOISE_524	OPEN	3 (40K)	FULL	12BIT
132281	201	7:56:46.0	ELECTRICAL_NOISE_525	OPEN	2 (100K)	FULL	12BIT
132282	201	7:57:45.0	ELECTRICAL_NOISE_525	OPEN	2 (100K)	FULL	12BIT
132283	201	7:58:44.0	ELECTRICAL_NOISE_525	OPEN	2 (100K)	FULL	12BIT
132284	201	7:59:43.0	ELECTRICAL_NOISE_525	OPEN	2 (100K)	FULL	12BIT
132285	201	8:0:51.0	ELECTRICAL_NOISE_526	OPEN	1 (400K)	SUM2	12BIT
132286	201	8:1:12.0	ELECTRICAL_NOISE_526	OPEN	1 (400K)	SUM2	12BIT
132287	201	8:1:33.0	ELECTRICAL_NOISE_526	OPEN	1 (400K)	SUM2	12BIT
132288	201	8:1:54.0	ELECTRICAL_NOISE_526	OPEN	1 (400K)	SUM2	12BIT
132289	201	8:2:24.0	ELECTRICAL_NOISE_527	OPEN	0 (1400K)	SUM4	12BIT
132290	201	8:2:40.0	ELECTRICAL_NOISE_527	OPEN	0 (1400K)	SUM4	12BIT
132291	201	8:2:54.0	ELECTRICAL_NOISE_527	OPEN	0 (1400K)	SUM4	12BIT