VCST Internal Memo

Title: Analysis of FP-1 Part 1 On-Board Calibrator Blackbody Collect Window Determination
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References

[1] TP1544640-2213 Rev B, 'Blackbody Function DC Restore Verification (FP-1),' Raytheon.
[2] 'JPSS J1 DRB: FP-1 Part 1 Ambient OBC BB Collect Window Determination,' Raytheon, December 23, 2013.
[3] EDD154640-109 Rev A v2, 'VIIRS J1 Command, Telemetry, Science and Engineering Data Description'

1. Introduction

The VIIRS F2 test FP-1 part 1 was designed to determine the encoder values defining the on-board calibrator blackbody (OBC BB) view [1]. Preliminary Raytheon analysis has been conducted [2], and this work will verify that analysis.

Table 1 lists the UAIDs, collects, view, sector rotation, electronics side, and OBC BB temperatures. The VIIRS sensor was operated in diagnostic mode and each collect contains 50 scans. The sensor was set to fixed high gain.

2. Analysis

All the Earth view (EV) samples in the first collect for each electronic side were analyzed. For the second and third collects, only the OBC BB view was analyzed. The DN for the EV and BB sectors are averaged over all scans for each sample. The BB view data used in this work was truncated to 12 bits.

The scan encoder delta was extracted from the telemetry to determine the sector rotation angle. The scan encoder can be varied from 0 to 32767, so the sector rotation angle is defined as

$$\theta_{rotation} = \frac{360}{32768}(scan\_encdr\_delta)$$

Here the nominal EV scan encoder delta value is 0. For the rotation angles listed in Table 1 (99.99, 2.64, and -3.29 degrees), the corresponding scan encoder deltas are 9101, 240, and 16084.

The normalized EV data shows a plateau of full OBC BB views with ramps of partial views on either side in Figure 1. To determine the extent of the OBC BB plateau (where the RTA footprint falls entirely on the OBC BB), a running difference between two samples 50 M band samples apart was used (normalized to the maximum sample). The edges of the plateau are taken as the samples where the normalized difference falls below 0.01. A buffer of 40 M band samples was used to decrease the plateau width, ensuring only full views of the OBC BB were included. The measured extent of the OBC BB plateau is listed in Tables 2 and 3 for both electronics sides in sample number and scan angle.

The scan angle was determined using the telescope angle scan start, boresight angle offset, and angular extent of the samples to the leading and trailing edge of the plateau from the EV start, or

$$\theta = \theta_{EV\_start} + \theta_{boresight\_offset} + sample * 0.01786$$

Here the boresight angle offset is the angle between the beginning of the M1 EV data and the boresight angle defined by the telescope angle scan start, or ~0.60 degrees. The telescope scan start angle (EV start angle) is determined from an encoder value extracted from the telemetry (in this case 7334) and converted using the same equation as the scan encoder delta (in this case 80.6 degrees). The measured extent of the OBC BB plateau is shown for each band (HAM A, detector 9, subsample 1, electronics side A) in Figures 2 – 8 by the vertical blue lines. The angular extent of the plateau varies from 6.2 degrees (M14) to 7.6 degrees (I5).

The OBC BB collect window is denoted in Figures 2 – 8 by the vertical green lines. These collect windows are shifted by the sample offsets listed in Table 4 [3] due to the calibration views being unregistered. They were referenced to the M13 odd detector OBC BB window start at sample 1036(7) for electronics side A (side B) [2]. The collect windows and corresponding angular extents are listed in Tables 5 and 6. Note that the collect window favors the right side of the OBC BB plateau for some bands (or the side farther from the EV). The angular extent of the collect window is ~ 0.86 degrees.

The OBC BB view data in collects 2 and 3 was analyzed and overlaid onto the EV data in Figures 2 – 8 (black lines). This data was normalized to the first common sample, so the data does not always follow the same curve (however, the trends are consistent). This confirmed that the leading edge of the plateau was observed in the second collect for band M14 and the trailing edge of the plateau was observed in the third collect for M13 (these were the stressing cases).

3. Summary

FP-1 part 1 data was analyzed under ambient conditions for the VIIRS F2 sensor. Analysis showed the following:

- The OBC BB collect window is well within the edges of the OBC BB.
- The angular extent of the OBC BB is between 6.2 and 7.6 degrees depending on the band; the angular extent of the OBC BB collect window is ~0.86 degrees.
- The OBC BB collect window favors the right side of the OBC BB plateau for some bands (notably the MWIR bands).

Table 1: Data used in FP-1 part 1 analysis

UAID	Collects	View	Rotation	E side	OBC BB T [K]
4301750	1	EV	99.99	A	307.06
4301750	2	BB	-3.69	A	307.02
4301750	3	BB	2.64	A	307.00
4301751	1	EV	99.99	B	306.98
4301751	2	BB	-3.29	B	306.96
4301751	3	BB	2.64	B	306.95

Table 2: EV sample and angle ranges for OBC BB plateau (A side)

Band	Sample start	Sample end	Angle start	Angle end
I4 odd	1548	2364	94.99	102.28
I4 even	1556	2368	95.07	102.32
I5 odd	1539	2373	94.91	102.36
I5 even	1534	2392	94.87	102.53
M12 odd	769	1164	94.90	101.96
M12 even	777	1169	95.05	102.05
M13 odd	755	1157	94.65	101.83
M13 even	761	1161	94.76	101.91
M14 odd	847	1193	96.30	102.48
M14 even	852	1198	96.39	102.57
M15 odd	829	1189	95.98	102.41
M15 even	835	1194	96.08	102.50
M16 odd	812	1185	95.67	102.33
M16 even	819	1190	95.80	102.42

Table 3: EV sample and angle ranges for OBC BB plateau (B side)

Band	Sample start	Sample end	Angle start	Angle end
I4 odd	1549	2364	95.00	102.28
I4 even	1553	2368	95.04	102.32
I5 odd	1529	2379	94.82	102.41
I5 even	1533	2393	94.86	102.54
M12 odd	772	1165	94.96	101.98
M12 even	779	1168	95.08	102.03
M13 odd	755	1159	94.65	101.87
M13 even	761	1162	94.76	101.92
M14 odd	845	1193	96.26	102.48
M14 even	852	1198	96.39	102.57
M15 odd	830	1188	95.99	102.39
M15 even	836	1194	96.10	102.50
M16 odd	812	1185	95.67	102.33
M16 even	817	1191	95.76	102.44

Table 4: Sample offsets relative to M13 odd detectors [3]

Band	Odd detectors	Even detectors
I4	25	28
I5	25	28
M12	6	9
M13	0	3
M14	34	37
M15	28	31
M16A	16	19
M16B	22	25

Table 5: EV sample and angle ranges for OBC BB view (A side)

Band	Sample start	Sample end	Angle start	Angle end
I4 odd	2097	2192	99.49	100.34
I4 even	2100	2195	99.46	100.32
I5 odd	2097	2192	99.49	100.34
I5 even	2100	2195	99.46	100.32
M12 odd	1042	1089	99.56	100.42
M12 even	1045	1092	99.51	100.37
M13 odd	1036	1083	99.67	100.53
M13 even	1039	1086	99.62	100.48
M14 odd	1070	1117	99.07	99.92
M14 even	1073	1120	99.01	99.87
M15 odd	1064	1111	99.17	100.03
M15 even	1067	1114	99.12	99.98
M16 odd	1054	1101	99.33	100.19
M16 even	1057	1104	99.28	100.14

Table 6: EV sample and angle ranges for OBC BB view (B side)

Band	Sample start	Sample end	Angle start	Angle end
I4 odd	2098	2193	99.50	100.36
I4 even	2101	2196	99.48	100.33
I5 odd	2098	2193	99.50	100.36
I5 even	2101	2196	99.48	100.33
M12 odd	1043	1090	99.58	100.44
M12 even	1046	1093	99.53	100.39
M13 odd	1037	1084	99.69	100.55
M13 even	1040	1087	99.64	100.49
M14 odd	1071	1118	99.08	99.94
M14 even	1074	1121	99.03	99.89
M15 odd	1065	1112	99.19	100.05
M15 even	1068	1115	99.14	99.99
M16 odd	1055	1102	99.35	100.21
M16 even	1058	1105	99.30	100.16

Figure 1: EV DN for all TEB (HAM A, detector 9, SS1, Eside A) normalized to the highest response for each band

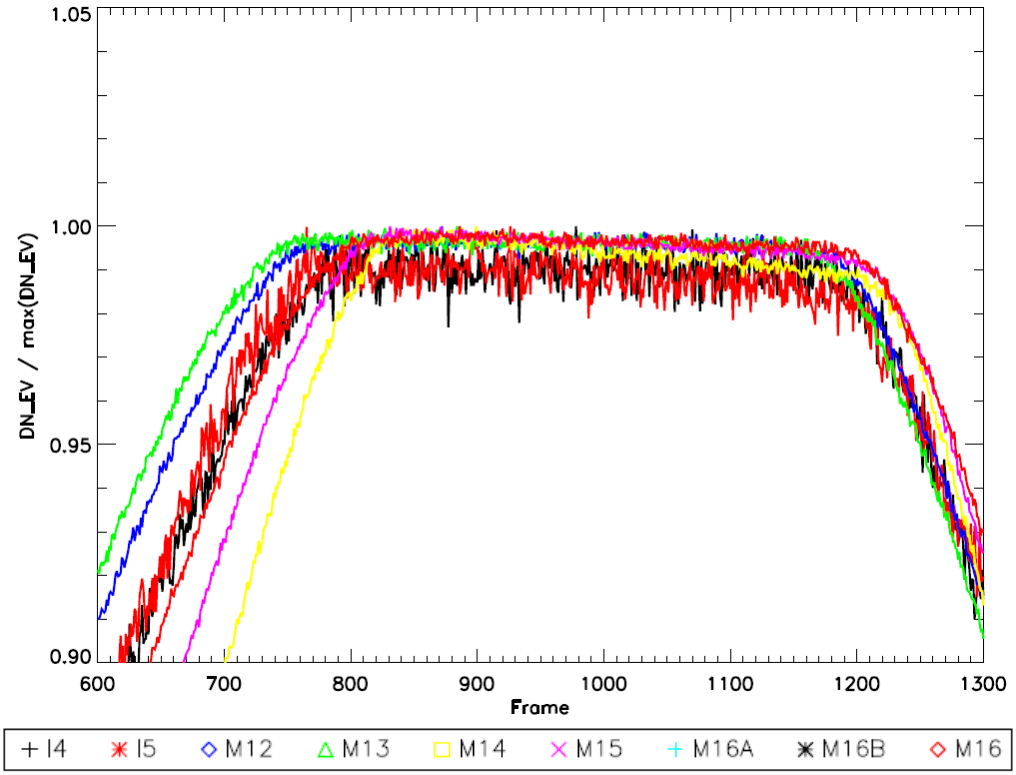

Figure 2: Normalized EV DN for I4 (HAM A, detector 9, SS1, Eside A) with extent of OBC BB plateau (blue) and view (green) shown. Sector rotated BB views are shown in black

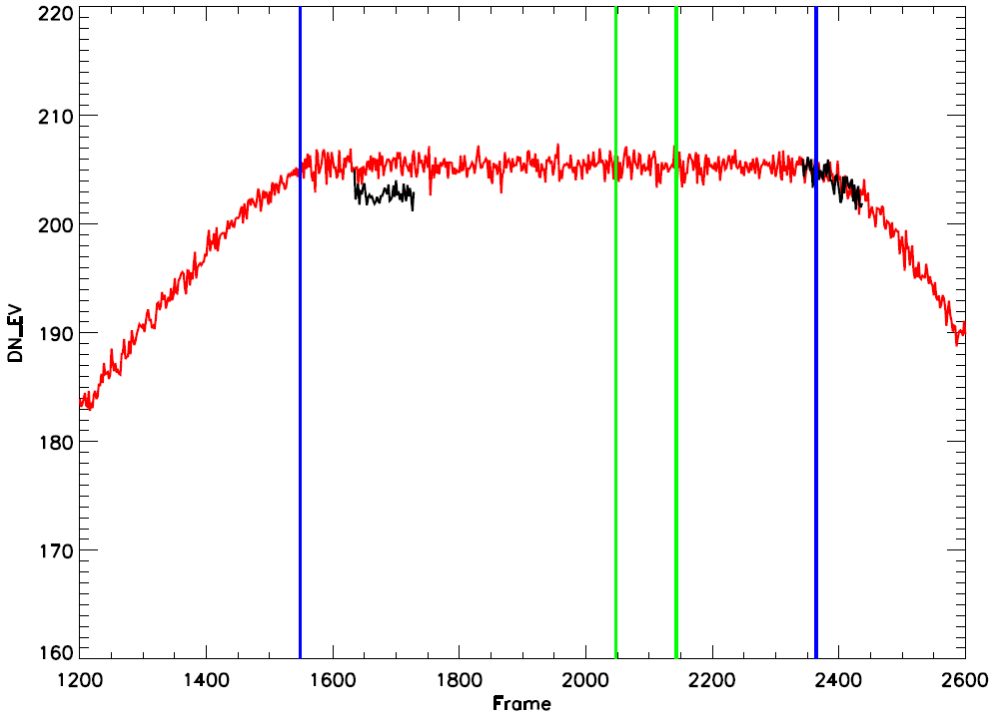

Figure 3: Normalized EV DN for I5 (HAM A, detector 9, SS1, Eside A) with extent of OBC BB plateau (blue) and view (green) shown. Sector rotated BB views are shown in black

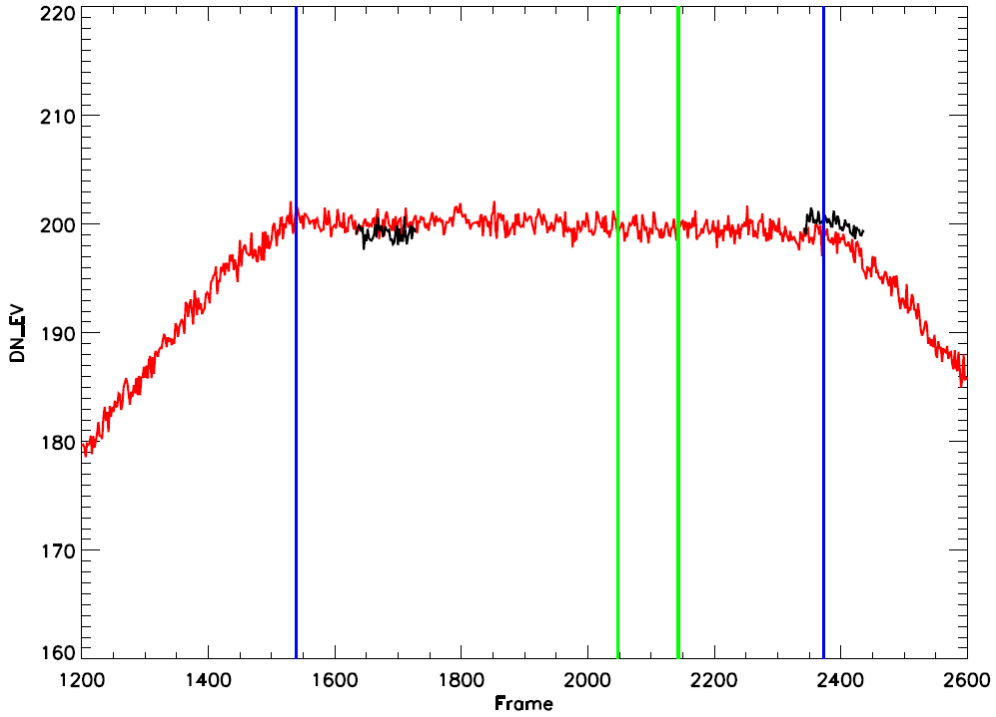

Figure 4: Normalized EV DN for M12 (HAM A, detector 9, SS1, Eside A) with extent of OBC BB plateau (blue) and view (green) shown. Sector rotated BB views are shown in black

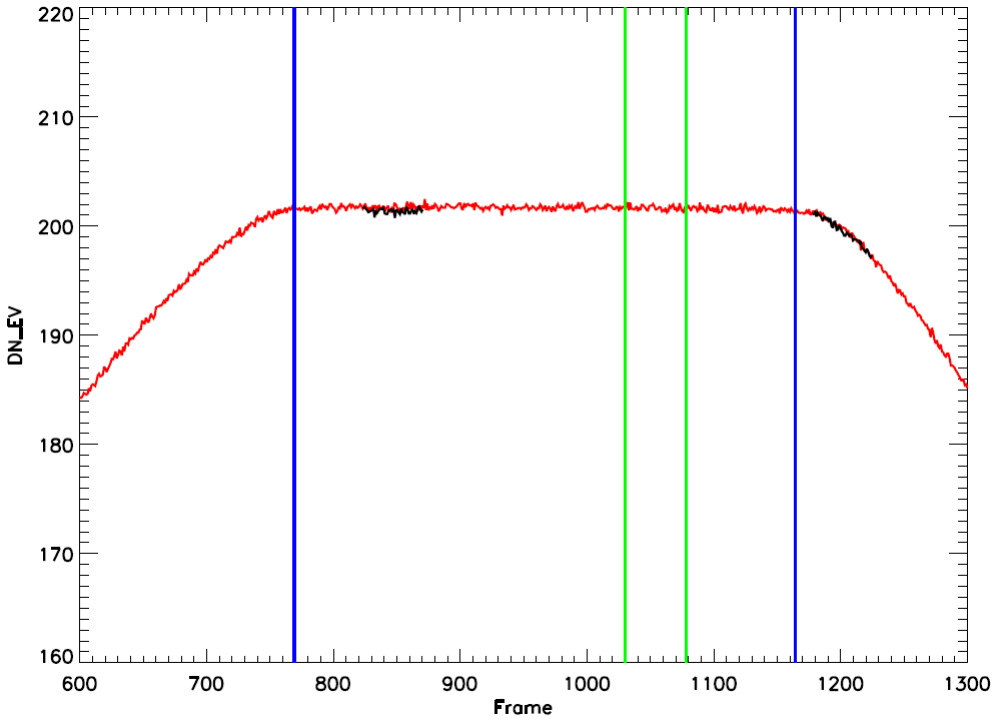

Figure 5: Normalized EV DN for M13 (HAM A, detector 9, SS1, Eside A) with extent of OBC BB plateau (blue) and view (green) shown. Sector rotated BB views are shown in black

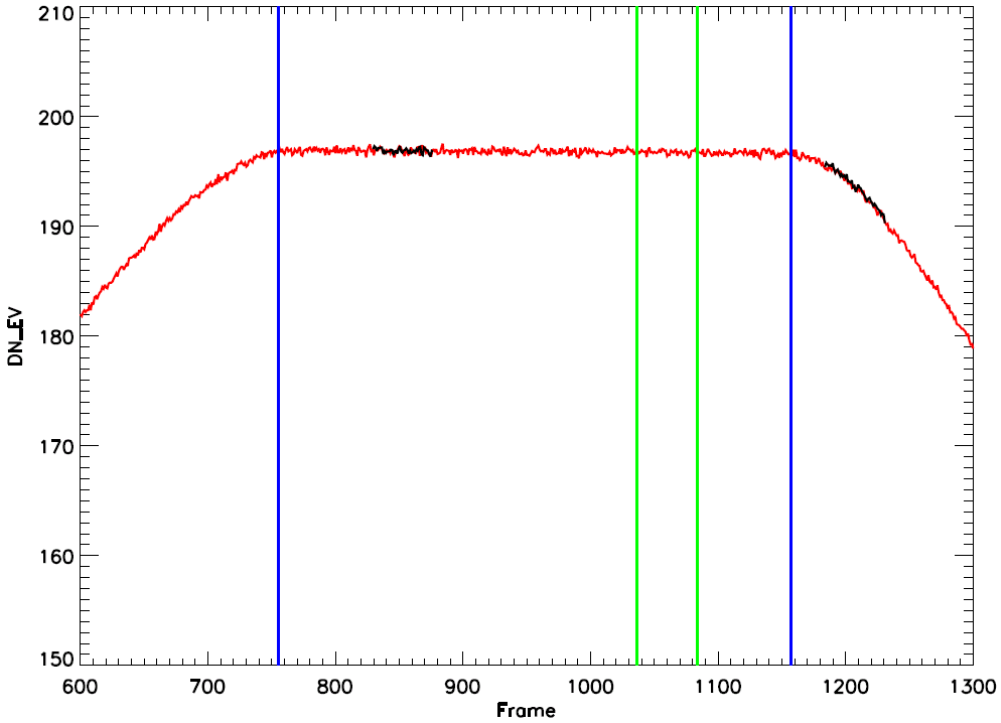

Figure 6: Normalized EV DN for M14 (HAM A, detector 9, SS1, Eside A) with extent of OBC BB plateau (blue) and view (green) shown. Sector rotated BB views are shown in black

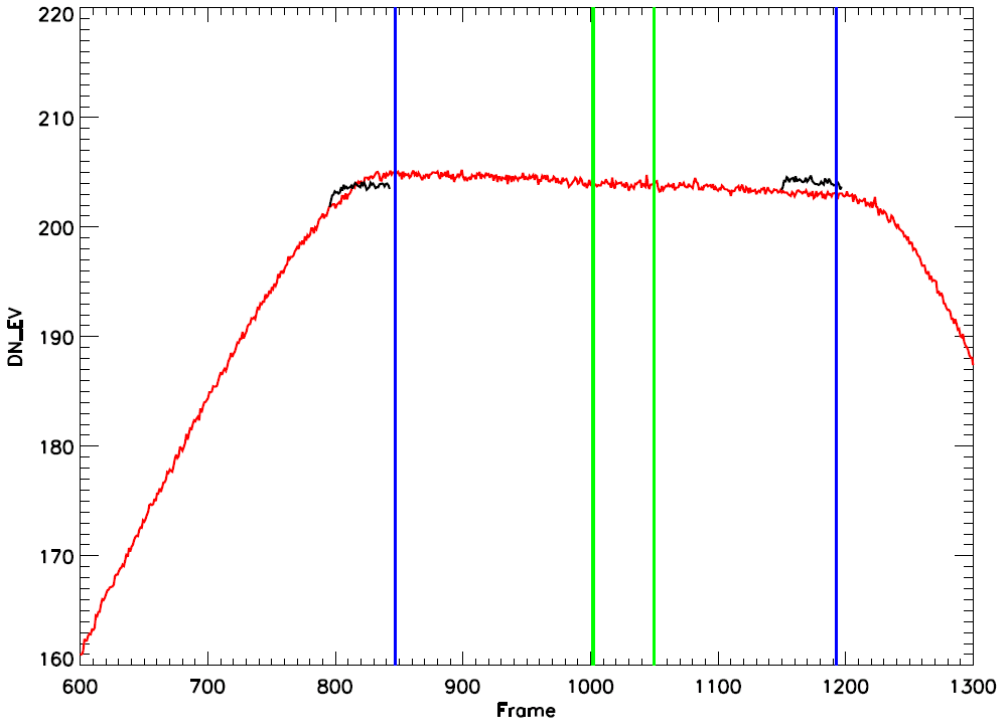

Figure 7: Normalized EV DN for M15 (HAM A, detector 9, SS1, Eside A) with extent of OBC BB plateau (blue) and view (green) shown. Sector rotated BB views are shown in black

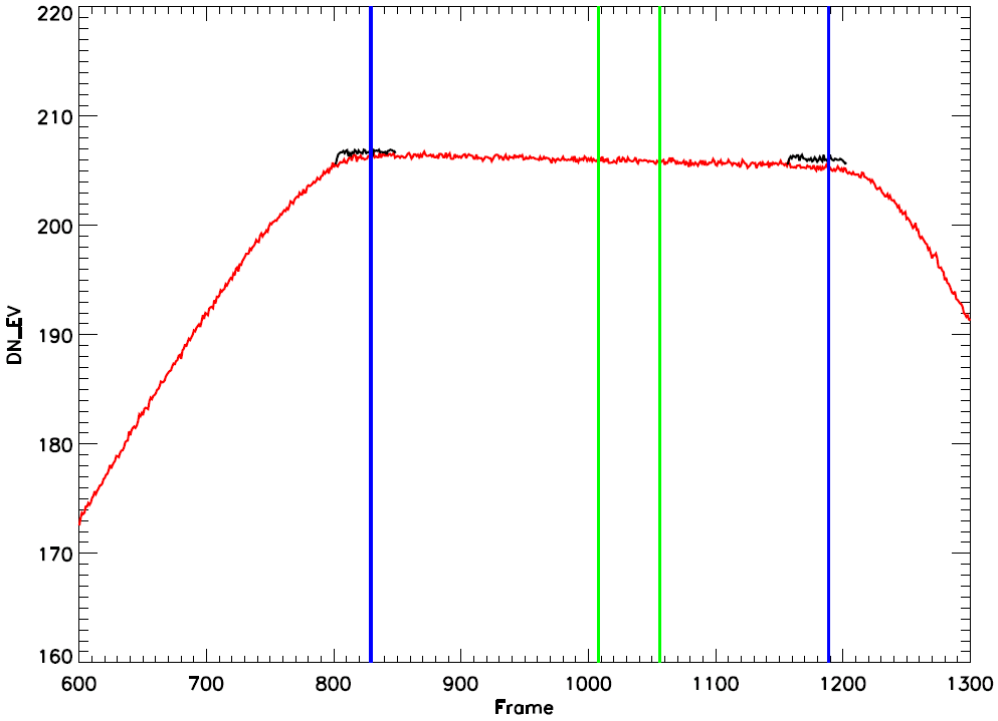

Figure 8: Normalized EV DN for M16 (HAM A, detector 9, SS1, Eside A) with extent of OBC BB plateau (blue) and view (green) shown. Sector rotated BB views are shown in black