Kepler Data Release 25 Notes
Q0–Q17

KSCI-19065-002
Data Analysis Working Group (DAWG)
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August 8, 2016

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The correct citation for this document is: S. E. Thompson, D. A. Caldwell, J. M. Jenkins, T. Barclay, G. Barentsen, S. T. Bryson, C. J. Burke, J. R. Campbell, J. Catanzarite, J. L. Christiansen, B. D. Clarke, K. Colón, M. Cote, J. L. Coughlin, F. Girouard, M. R. Haas, J. P. Harrison, K. Ibrahim, T. C. Klaus, J. Li, S. D. McCauliff, R. L. Morris, F. R. Mullally, J. Rowe, A. Sabale, S. Seader, J. C. Smith, P. G. Tenenbaum, J. D. Twicken, A. K. Uddin, and J. Van Cleve 2016, Kepler Data Release 25 Notes (KSCI-19065-002).

DOCUMENT CHANGE LOG

CHANGE DATE	CHANGES/NOTES
December 9, 2015	Original release documenting the long cadence data
August 8, 2016	Corrected cadence data tables 1 & 2
August 8, 2016	Updated information on rolling band flags for short-cadence data, Section A.1.1
August 8, 2016	Added discussion of crowding and flux-fraction metric changes, Section A.1.2
August 8, 2016	Noted missing centroid flags in LC light-curve files, Section A.1.3
August 8, 2016	Added notes on short cadence PDC spike correction, Section A.1.4
August 8, 2016	Added notes for short cadence processing, Sections A.1.6, A.1.7, A.1.8
August 8, 2016	Updated safe mode timing in the quarterly events sections

Contents

A Introduction

These Data Release Notes provide information specific to the current reprocessing and re-export of the Q0–Q17 data. The data products included in this data release include target pixel files, light curve files, FFIs, CBVs, ARP, Background, and Collateral files. This release marks the final processing of the Kepler Mission Data. See Tables 1 and 2 for a list of the reprocessed Kepler cadence data. See Table 3 for a list of the available FFIs. The Long Cadence Data, Short Cadence Data, and FFI data are documented in these data release notes. The ancillary files (i.e., cotrending basis vectors, artifact removal pixels, background, and collateral data) are described in the Archive Manual (Thompson *et al.*, 2016).

Table 1: Contents of Data Release 25–Cadence Data, part 1

Q.m		First Cadence MJD midTime	Last Cadence MJD midTime	First Cadence UT midTime	Last Cadence UT midTime	Num CINs	Start CIN	End CIN
0	LC	54953.03815	54962.74411	02-May-2009 00:54:56	11-May-2009 17:51:31	476	568	1043
0.1	SCM1	54953.02828	54962.75399	02-May-2009 00:40:43	11-May-2009 18:05:45	14280	5500	19779
1	LC	54964.01099	54997.48122	13-May-2009 00:15:50	15-Jun-2009 11:32:58	1639	1105	2743
1.1	SCM1	54964.00112	54997.49110	13-May-2009 00:01:37	15-Jun-2009 11:47:11	49170	21610	70779
2	LC	55002.01748	55090.96492	20-Jun-2009 00:25:10	16-Sep-2009 23:09:29	4354	2965	7318
2.1	SCM1	55002.00760	55032.80035	20-Jun-2009 00:10:57	20-Jul-2009 19:12:30	45210	77410	122619
2.2	SCM2	55032.82146	55062.79687	20-Jul-2009 19:42:54	19-Aug-2009 19:07:29	44010	122650	166659
2.3	SCM3	55063.86010	55090.97480	20-Aug-2009 20:38:32	16-Sep-2009 23:23:42	39810	168220	208029
3	LC	55092.72221	55181.99660	18-Sep-2009 17:19:59	16-Dec-2009 23:55:06	4370	7404	11773
3.1	SCM1	55092.71233	55123.05554	18-Sep-2009 17:05:46	19-Oct-2009 01:19:59	44550	210580	255129
3.2	SCM2	55123.91444	55153.95114	19-Oct-2009 21:56:47	18-Nov-2009 22:49:39	44100	256390	300489
3.3	SCM3	55156.01562	55182.00647	21-Nov-2009 00:22:30	17-Dec-2009 00:09:19	38160	303520	341679
4	LC	55184.87774	55274.70384	19-Dec-2009 21:03:56	19-Mar-2010 16:53:32	4397	11914	16310
4.1	SCM1	55184.86786	55215.92625	19-Dec-2009 20:49:43	19-Jan-2010 22:13:48	45600	345880	391479
4.2	SCM2	55216.80557	55245.73887	20-Jan-2010 19:20:02	18-Feb-2010 17:43:58	42480	392770	435249
4.3	SCM3	55245.80085	55274.71371	18-Feb-2010 19:13:14	19-Mar-2010 17:07:45	42450	435340	477789
5	LC	55275.99115	55370.66003	20-Mar-2010 23:47:16	23-Jun-2010 15:50:27	4634	16373	21006
5.1	SCM1	55275.98128	55307.50964	20-Mar-2010 23:33:02	21-Apr-2010 12:13:53	46290	479650	525939
5.2	SCM2	55308.77720	55336.40275	22-Apr-2010 18:39:10	20-May-2010 09:39:58	40560	527800	568359
5.3	SCM3	55337.09818	55370.66991	21-May-2010 02:21:23	23-Jun-2010 16:04:40	49290	569380	618669
6	LC	55371.94733	55461.79386	24-Jun-2010 22:44:09	22-Sep-2010 19:03:10	4398	21069	25466
6.1	SCM1	55371.93745	55399.03173	24-Jun-2010 22:29:56	22-Jul-2010 00:45:41	39780	620530	660309
6.2	SCM2	55399.87019	55430.78555	22-Jul-2010 20:53:04	22-Aug-2010 18:51:11	45390	661540	706929
6.3	SCM3	55431.68529	55461.80374	23-Aug-2010 16:26:49	22-Sep-2010 19:17:23	44220	708250	752469
7	LC	55462.67251	55552.04909	23-Sep-2010 16:08:24	22-Dec-2010 01:10:42	4375	25509	29883
7.1	SCM1	55462.66263	55492.78108	23-Sep-2010 15:54:11	23-Oct-2010 18:44:45	44220	753730	797949
7.2	SCM2	55493.53780	55522.73674	24-Oct-2010 12:54:26	22-Nov-2010 17:40:55	42870	799060	841929
7.3	SCM3	55523.61607	55552.05897	23-Nov-2010 14:47:09	22-Dec-2010 01:24:55	41760	843220	884979
8	LC	55567.86468	55634.84602	06-Jan-2011 20:45:09	14-Mar-2011 20:18:16	3279	30657	33935
8.1	SCM1	55567.85481	55585.54963	06-Jan-2011 20:30:55	24-Jan-2011 13:11:28	25980	908170	934149
8.2	SCM2	55585.61161	55614.70837	24-Jan-2011 14:40:43	22-Feb-2011 17:00:03	42720	934240	976959
8.3	SCM3	55614.77035	55634.85590	22-Feb-2011 18:29:18	14-Mar-2011 20:32:30	29490	977050	1006539
9	LC	55641.01696	55738.42395	21-Mar-2011 00:24:25	26-Jun-2011 10:10:30	4768	34237	39004
9.1	SCM1	55641.00708	55677.41909	21-Mar-2011 00:10:12	26-Apr-2011 10:03:29	53460	1015570	1069029
9.2	SCM2	55678.11451	55706.61871	27-Apr-2011 02:44:54	25-May-2011 14:50:56	41850	1070050	1111899
9.3	SCM3	55707.25283	55738.43383	26-May-2011 06:04:05	26-Jun-2011 10:24:43	45780	1112830	1158609
10	LC	55739.34343	55832.76587	27-Jun-2011 08:14:33	28-Sep-2011 18:22:51	4573	39049	43621
10.1	SCM1	55739.33356	55769.45201	27-Jun-2011 08:00:19	27-Jul-2011 10:50:54	44220	1159930	1204149
10.2	SCM2	55770.29047	55801.73710	28-Jul-2011 06:58:16	28-Aug-2011 17:41:26	46170	1205380	1251549
10.3	SCM3	55802.57556	55832.77575	29-Aug-2011 13:48:49	28-Sep-2011 18:37:05	44340	1252780	1297119

Table 2: Contents of Data Release 25–Cadence Data, part 2

Q.m		First Cadence MJD midTime	Last Cadence MJD midTime	First Cadence UT midTime	Last Cadence UT midTime	Num CINs	Start CIN	End CIN
11	LC	55833.70579	55930.82669	29-Sep-2011 16:56:20	04-Jan-2012 19:50:26	4754	43667	48420
11.1	SCM1	55833.69591	55864.77474	29-Sep-2011 16:42:07	30-Oct-2011 18:35:38	45630	1298470	1344099
11.2	SCM2	55865.53147	55895.73165	31-Oct-2011 12:45:19	30-Nov-2011 17:33:35	44340	1345210	1389549
11.3	SCM3	55896.61098	55930.83656	01-Dec-2011 14:39:49	04-Jan-2012 20:04:39	50250	1390840	1441089
12	LC	55931.90966	56014.52273	05-Jan-2012 21:49:55	28-Mar-2012 12:32:44	4044	48473	52516
12.1	SCM1	55931.89978	55958.40149	05-Jan-2012 21:35:41	01-Feb-2012 09:38:09	38910	1442650	1481559
12.2	SCM2	55959.11735	55986.49770	02-Feb-2012 02:48:59	29-Feb-2012 11:56:41	40200	1482610	1522809
12.3	SCM3	55987.39746	56014.53260	01-Mar-2012 09:32:20	28-Mar-2012 12:46:57	39840	1524130	1563969
13	LC	56015.23787	56105.55441	29-Mar-2012 05:42:32	27-Jun-2012 13:18:21	4421	52551	56971
13.1	SCM1	56015.22799	56047.49198	29-Mar-2012 05:28:19	30-Apr-2012 11:48:27	47370	1564990	1612359
13.2	SCM2	56048.18740	56077.42721	01-May-2012 04:29:51	30-May-2012 10:15:11	42930	1613380	1656309
13.3	SCM3	56078.32697	56105.56428	31-May-2012 07:50:50	27-Jun-2012 13:32:34	39990	1657630	1697619
14	LC	56106.63736	56203.81957	28-Jun-2012 15:17:48	03-Oct-2012 19:40:11	4757	57024	61780
14.1	SCM1	56106.62748	56123.50495	28-Jun-2012 15:03:34	15-Jul-2012 12:07:07	24780	1699180	1723959
14.2	SCM2	56138.64693	56168.80625	30-Jul-2012 15:31:35	29-Aug-2012 19:21:00	44280	1746190	1790469
14.3	SCM3	56169.66514	56203.82944	30-Aug-2012 15:57:48	03-Oct-2012 19:54:24	50160	1791730	1841889
15	LC	56205.98550	56303.63768	05-Oct-2012 23:39:07	11-Jan-2013 15:18:16	4780	61886	66665
15.1	SCM1	56205.97562	56236.80925	05-Oct-2012 23:24:54	05-Nov-2012 19:25:19	45270	1845040	1890309
15.2	SCM2	56237.77031	56267.88875	06-Nov-2012 18:29:15	06-Dec-2012 21:19:48	44220	1891720	1935939
15.3	SCM3	56268.72721	56303.64756	07-Dec-2012 17:27:11	11-Jan-2013 15:32:29	51270	1937170	1988439
16	LC	56304.59804	56390.46005	12-Jan-2013 14:21:11	08-Apr-2013 11:02:28	4203	66712	70914
16.1	SCM1	56304.58817	56309.81849	12-Jan-2013 14:06:58	17-Jan-2013 19:38:37	7680	1989820	1997499
16.2	SCM2	56321.15981	56357.46965	29-Jan-2013 03:50:08	06-Mar-2013 11:16:18	53310	2014150	2067459
16.3	SCM3	56358.61461	56390.46992	07-Mar-2013 14:45:03	08-Apr-2013 11:16:41	46770	2069140	2115909
17	LC	56391.72690	56423.50115	09-Apr-2013 17:26:45	11-May-2013 12:01:40	1556	70976	72531
17.1	SCM1	56391.71703	56414.09114	09-Apr-2013 17:12:31	02-May-2013 02:11:15	32850	2117740	2150589
17.2	SCM2	56419.30239	56423.51103	07-May-2013 07:15:26	11-May-2013 12:15:53	6180	2158240	2164419

Table 3: Contents of Data Release 25–Full Frame Images

Q	Class	Filename	UT Start	UT End
2	FFI	KPLR2009231194831	2009-08-19 19:19:05	2009-08-19 19:48:31
2	FFI	KPLR2009260000800	2009-09-16 23:38:34	2009-09-17 00:08:00
3	FFI	KPLR2009292020429	2009-10-19 01:35:04	2009-10-19 02:04:29
3	FFI	KPLR2009322233047	2009-11-18 23:01:21	2009-11-18 23:30:47
3	FFI	KPLR2009351005245	2009-12-17 00:23:19	2009-12-17 00:52:45
4	FFI	KPLR2010019225502	2010-01-19 22:25:37	2010-01-19 22:55:02
4	FFI	KPLR2010020005046	2010-01-20 00:21:21	2010-01-20 00:50:46
4	FFI	KPLR2010049182302	2010-02-18 17:53:37	2010-02-18 18:23:02
4	FFI	KPLR2010078174524	2010-03-19 17:15:58	2010-03-19 17:45:24
5	FFI	KPLR2010111125026	2010-04-21 12:21:01	2010-04-21 12:50:26
5	FFI	KPLR2010140101631	2010-05-20 09:47:06	2010-05-20 10:16:31
5	FFI	KPLR2010174164113	2010-06-23 16:11:48	2010-06-23 16:41:13
6	FFI	KPLR2010203012215	2010-07-22 00:52:49	2010-07-22 01:22:15
6	FFI	KPLR2010234192745	2010-08-22 18:58:19	2010-08-22 19:27:45
6	FFI	KPLR2010265195356	2010-09-22 19:24:31	2010-09-22 19:53:56
7	FFI	KPLR2010296192119	2010-10-23 18:51:53	2010-10-23 19:21:19
7	FFI	KPLR2010326181728	2010-11-22 17:48:03	2010-11-22 18:17:28
7	FFI	KPLR2010356020128	2010-12-22 01:32:03	2010-12-22 02:01:28
8	FFI	KPLR2011024134926	2011-01-24 13:20:01	2011-01-24 13:49:26
8	FFI	KPLR2011053174401	2011-02-22 17:14:35	2011-02-22 17:44:01
9	FFI	KPLR2011116104002	2011-04-26 10:10:37	2011-04-26 10:40:02
9	FFI	KPLR2011145152723	2011-05-25 14:57:58	2011-05-25 15:27:23
9	FFI	KPLR2011177110110	2011-06-26 10:31:44	2011-06-26 11:01:10
10	FFI	KPLR2011208112727	2011-07-27 10:58:01	2011-07-27 11:27:27
10	FFI	KPLR2011240181752	2011-08-28 17:48:27	2011-08-28 18:17:52
10	FFI	KPLR2011271191331	2011-09-28 18:44:06	2011-09-28 19:13:31
11	FFI	KPLR2011303191211	2011-10-30 18:42:45	2011-10-30 19:12:11
11	FFI	KPLR2011334181008	2011-11-30 17:40:43	2011-11-30 18:10:08
11	FFI	KPLR2012004204112	2012-01-04 20:11:47	2012-01-04 20:41:12
12	FFI	KPLR2012032101442	2012-02-01 09:45:16	2012-02-01 10:14:42
12	FFI	KPLR2012060123308	2012-02-29 12:03:42	2012-02-29 12:33:08
12	FFI	KPLR2012088132324	2012-03-28 12:53:58	2012-03-28 13:23:24
13	FFI	KPLR2012121122500	2012-04-30 11:55:30	2012-04-30 12:25:00
13	FFI	KPLR2012151105138	2012-05-30 10:22:12	2012-05-30 10:51:38
13	FFI	KPLR2012179140901	2012-06-27 13:39:35	2012-06-27 14:09:01
14	FFI	KPLR2012211123923	2012-07-29 12:09:58	2012-07-29 12:39:23
14	FFI	KPLR2012242195726	2012-08-29 19:28:01	2012-08-29 19:57:26
14	FFI	KPLR2012277203051	2012-10-03 20:01:25	2012-10-03 20:30:51
15	FFI	KPLR2012310200152	2012-11-05 19:32:27	2012-11-05 20:01:52
15	FFI	KPLR2012341215621	2012-12-06 21:26:56	2012-12-06 21:56:21
15	FFI	KPLR2013011160902	2013-01-11 15:39:37	2013-01-11 16:09:02
16	FFI	KPLR2013038133130	2013-02-07 13:02:05	2013-02-07 13:31:30
16	FFI	KPLR2013065115251	2013-03-06 11:23:26	2013-03-06 11:52:51
16	FFI	KPLR2013098115308	2013-04-08 11:23:43	2013-04-08 11:53:08

Note: The eight Q0 FFIs and the first Q2 FFI are no longer being reprocessed, but are available from DR 21.

A.1 The SOC Pipeline for Q0–Q17

Data Release 25 was processed with the SOC Pipeline 9.3 (Jenkins *et al.*, 2010). For details on how Kepler processes the data through the front-end of the pipeline (modules CAL, PA, PDC), please see the Data Processing Handbook (Fanelli *et al.*, 2011). Notable changes and improvements to the pipeline since the last data release (DR24) are stated below.

A.1.1 Rolling Band Information

The pipeline was run with the Dynablack algorithm enabled for this processing of the data. Dynablack is a module of the Kepler pipeline that accounts for time varying, instrument-induced artifacts when calibrating the data. Specifically, Dynablack corrects for time-varying crosstalk from the fine guidance sensor (FGS) clock signals, and detects the rolling band artifacts (RBA) in the images (see §6.7 of the Instrument Handbook, Van Cleve and Caldwell, 2016). To detect RBAs the residual black data is convolved with a square wave transit kernel to produce a time series of transit depths. These depths are used to produce a RBA severity level for each CCD row at each cadence. These RBA levels and the resulting flags are now available as part of Data Release 25.

Two high-level flags have been added to the QUALITY columns of the target pixel and light curve files. Bit 18 indicates that a RBA was found for some row in the optimal aperture in at least one of the measured transit durations. Bit 19 indicates that a RBA was found for some row in the target's mask in at least one of the measured transit durations.

The target pixel files contain a new column called RB_LEVEL. For every cadence, this column specifies the severity level of the rolling band on each row in the mask for all tested trial durations (the 5 trial durations are 3, 6, 12, 24, and 31 hours, as given in the header by RBTDURi). A level of 0 indicates no rolling band was detected. The detected RBAs are reported in units of the detection threshold, calibrated to be 0.016 DN/pixel/read, which is equivalent to 20 ppm when summed over the typical aperture for a 12th magnitude star.

In the black extension of the collateral pixel files, there are two new columns: RB_LEVEL and RB_FLAG. RB_LEVEL is defined the same as for the target pixel files, except that it is given for all rows. RB_FLAG is a binary image per cadence. The first bit is a flag to indicate if a bright star lies within 132 pixels of the trailing black region and thus, is likely to affect the ability to measure the rolling band. The second bit indicates whether a rolling band was detected for that row on that cadence.

The RB_LEVEL and RB_FLAG columns are not set for the DR25 short-cadence collateral data files. Since Dynablack corrections are determined only based on the long-cadence data, there is no unique rolling band information for the short-cadence data. The long cadence RB_LEVEL and RB_FLAG values are already set in the SC target pixel files. From these, users have the information needed to determine the rolling band levels for short-cadence data. Additionally, the long-cadence collateral RB_FLAG provides the information needed to deterime if a bright star is corrupting the trailing black region in the rows covered by a short-cadence aperture.

A.1.2 Improved Optimal Apertures

Optimal apertures are initially calculated during target managment in the Target Aperture Determination–Compute Optimal Aperture (TAD-COA) module using model pointing predictions and a model star field based on the Kepler Input Catalog. Prior to SOC 9.3, these optimal apertures were updated based on the measured pointing during a quarter, but still based on the model star field. With SOC 9.3, the optimal apertures are updated in the Photometric Analysis (PA-COA) module based on both the measured pointing and the observed scene for each target. For each target mask, PA-COA begins by fitting an image model to the calibrated pixel data and estimating the SNR at each pixel p and cadence c. The $SNR = s(p, c)/n(p, c)$ where s is the modeled flux due to the target star alone and n is all noise sources, including shot noise due to the observed flux and background plus read and quantization noise. Pixels are then ranked in order of their contribution to SNR across all cadences in the quarter being processed. By ranking pixels in this way we reduce the number of possible apertures in the N-pixel mask from $2N - 1$ (all possible subsets of pixels minus the empty set) to N. At this point PA can afford to compute a more costly estimate of CDPP for each of the N candidate apertures to find the aperture with the lowest CDPP. Finally, the optimal aperture used for photometry is selected from among the following options: (1) The aperture calculated by the TAD module (this is calculated in the same way as previous data releases), (2) the optimal aperture that maximizes SNR over all cadences, (3) the optimal aperture that minimizes CDPP over all cadences, (4) the 95% union of all optimal apertures found on each valid cadence. The final selection is based on a number of factors, including the CDPP of the resulting light curve and several tuned heuristics. As done previously, a single fixed optimal aperture is ultimately used to calculate the light curve for each quarter.

In addition to the optimal aperture changes, slight changes to the crowding metric (CROWDSAP) and the fraction of the target's flux falling in the optimal aperture (FLFRCSAP) are to be expected across all quarters with the SOC 9.3 update to PA. However, in rare cases, significant changes may occur in these metrics, suggesting a discrepancy in the scene as determined by the TAD and PA-COA modules. For these discrepant cases, further user scrutiny is recommended.

Note that PA-COA uses an estimate of CDPP, which is referred to as "quasi-CDPP", because it is slightly simplified compared to the one computed by TPS. As shown in Figures 1 and 2, the revised apertures reduce quasi-CDPP for the vast majority of targets and quarters, with 77% showing an improvement, 13% showing some degradation, and 10% showing no change (note the large spike in Figure 1). In 14% of the cases, quasi-CDPP is reduced by 10% or more.

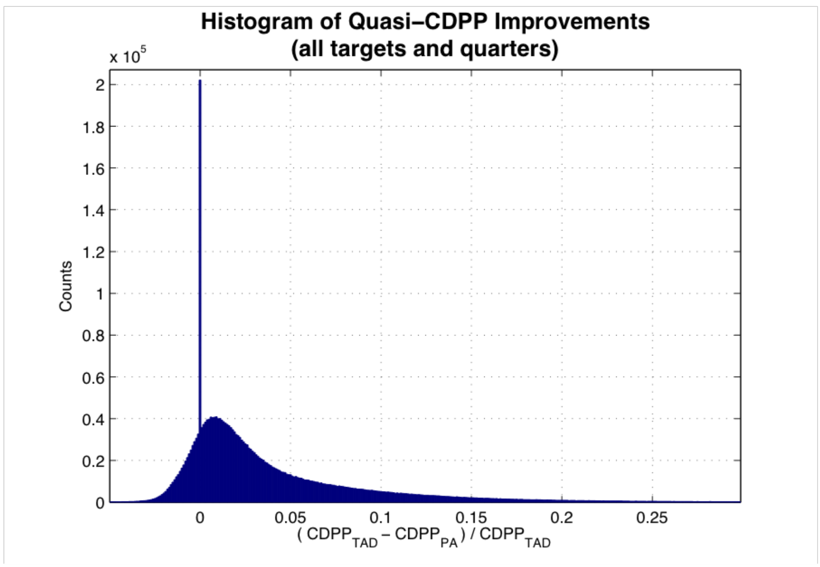


Figure 1: Histogram of fractional quasi-CDPP improvement when comparing light curves produced from revised PA-COA apertures with those produced from the TAD apertures. Positive values indicate improved photometric precision. Note that each target is counted separately for each quarter. That is, the sum of the histogram values is the sum of all targets over all quarters.

A.1.3 Missing Aperture Image Centroid Flags

In DR25, the flux-weighted centroid flag (bit 3) and the PRF centroid flag (bit 4) in the aperture image extension were not set in the long-cadence light curve files. However, they can be inferred because the flux-weighted centroids were calculated using the optimal aperture pixels along with a single halo around that aperture. The entire set of collected pixels was used to calculate the PRF centroid. The flux-weighted centroid aperture image flags are set in the DR25 short-cadence light curve files. PRF cetroiding is not performed on short-cadence data.

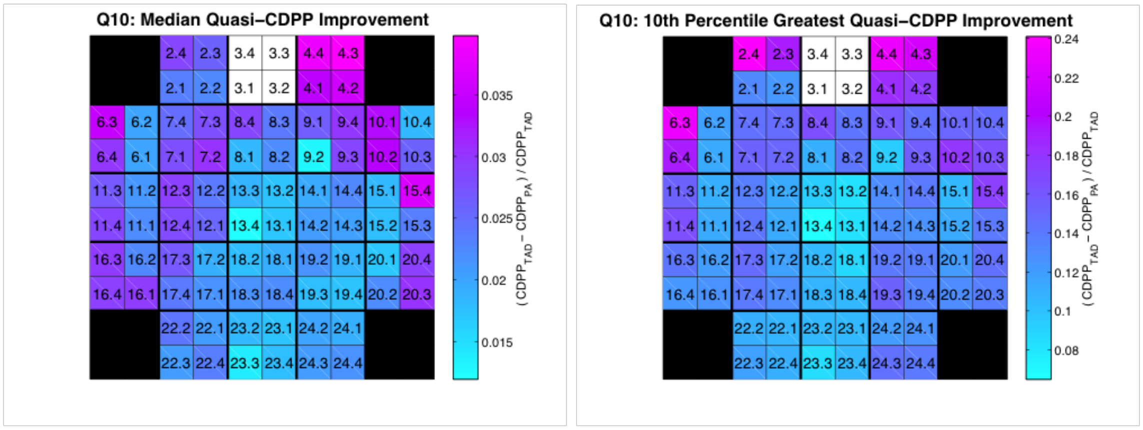


Figure 2: Spatial distribution of median (left) and top tenth percentile (right) quasi-CDPP improvement between TAD and PA-COA long-cadence apertures across the FOV in quarter 10. This spatial pattern is representative of the improvement seen in most quarters. In general, the largest improvements appear to be correlated with the most defocused stars.

A.1.4 Improvements to PDC

The two improvements to the PDC module in SOC 9.3 concentrate on the removal of high frequency and impulsive systematics. The first improvement deals with Multi-scale MAP which separates the light curves into three wavelet length scales or "bands": 1) 1024 and greater cadence length, 2) 4–1023 cadences and 3) 1–3 cadences. Band-1 applies a robust fit to its basis vectors and Band-2 applies a Bayesian fit to its basis vectors. Previously, Band-3 applied no basis vector fit. As of SOC 9.3, PDC performs a Bayesian fit in Band-3. We have demonstrated that PDC is now successfully removing high frequency systematics in the data that previously went untouched. Some quarters and channels have a significant improvement in the noise characteristics with the implementation of the Baysian fit to Band-3.

The second improvement addresses impulsive systematic "spikes" in the data. Isolated and short events (covering a couple of cadences) during Kepler data collection can result in spikes, or dips, that are systematic across many targets on the same channel. A new method has been developed to identify and isolate these systematic spikes and dips and remove them. The spikes can be subtle and cannot always be discerned by visual inspection. The spike removal has proven to be successful in significantly decreasing the number of artifacts found by the pipeline's transiting planet search module. One unintended impact of the long-cadence spike removal is a slight increase in spikiness in the short-cadence PDC-SAP light curves. Since the spikes are removed separately from the normal long-cadence PDC basis vectors, the basis vectors no longer contain all of the high-frequency information and are thus less effective at removing spikes when interpolated for use with the short-cadence data.

A.1.5 CDPP Calculation

The rmsCDPP (Root Mean Square Combined Differential Photometric Precision) values available in the headers of the light curve files (and those shown in Figures 3 and 4) use an earlier and different algorithm than that used by the Transit Planet Search (TPS) module for the SOC 9.3 transit search. An issue was discovered after the light curves were generated that required a modification to the periodic extension of each quarterly light curve to support the adaptive whitener used in TPS. In general, the CDPP values reported in the light curve file headers are smaller than those calculated during the final transit search. Also, the difference is greater for longer transit durations. While the rmsCDPP values in the light curve files are valid measures of star-to-star variability and relative noise properties, they should not be used to calculate occurrence rates. Rather, the robust rmsCDPP values and associated occurrence rate products for DR25 available at the NASA Exoplanet Archive[1] should be used to determine planet detection efficiencies (Burke *et al.*, 2015).

A.1.6 Short Cadence Black-level Calibration Correction

The Q2–Q16 short-cadence (SC) data in Data Release 24 (DR24), which was processed with the SOC 9.2 pipeline, contained an error in the module that calibrates the pixels, specifically in how it handles the black model calculated by the Dynablack algorithm. As a result, the SC calibrated pixels available in the target pixel files, and the light curves based on these pixels, were excessively noisy. All DR24 SC data processed by CAL using Dynablack were affected. DR25 corrects this error in both the target pixel files and the light curves. The DR25 reprocessing restores the precision of short cadence light curves to the levels seen in pre-SOC 9.2 archive data (DR23 and earlier) as well as correctly implementing the Dynablack model that mitigates thermal and spatial black level artifacts. Long-cadence data were were not affected by this error.

A.1.7 Short Cadence Collateral Smear Correction

DR25 corrects an accounting error that scrambled much of the short-cadence collateral smear data used to correct for the effects of Kepler's shutterless readout. This error has been present since launch and affects approximately half of all short-cadence targets observed by Kepler. The resulting calibration errors are present in both the short-cadence target pixel files and the short-cadence light curves for Kepler Data Releases 1-24. This error does not affect long-cadence data.

Details of this error and the fix implemented in SOC 9.3 are given in Caldwell and Van Cleve (2016). Even though the affected targets are readily identified, the science impact for any particular target may be difficult to assess. Since the smear signal is often small compared to the target signal, the effect is negligible for many targets. However, the smear signal is scene-dependent, so time-varying signals can be introduced into any target by the other stars falling on the same CCD column. A list of affected Kepler targets is available at the MAST archive[2]. Users should strongly consider updating to DR25 short-cadence data files if their target is found on this list.

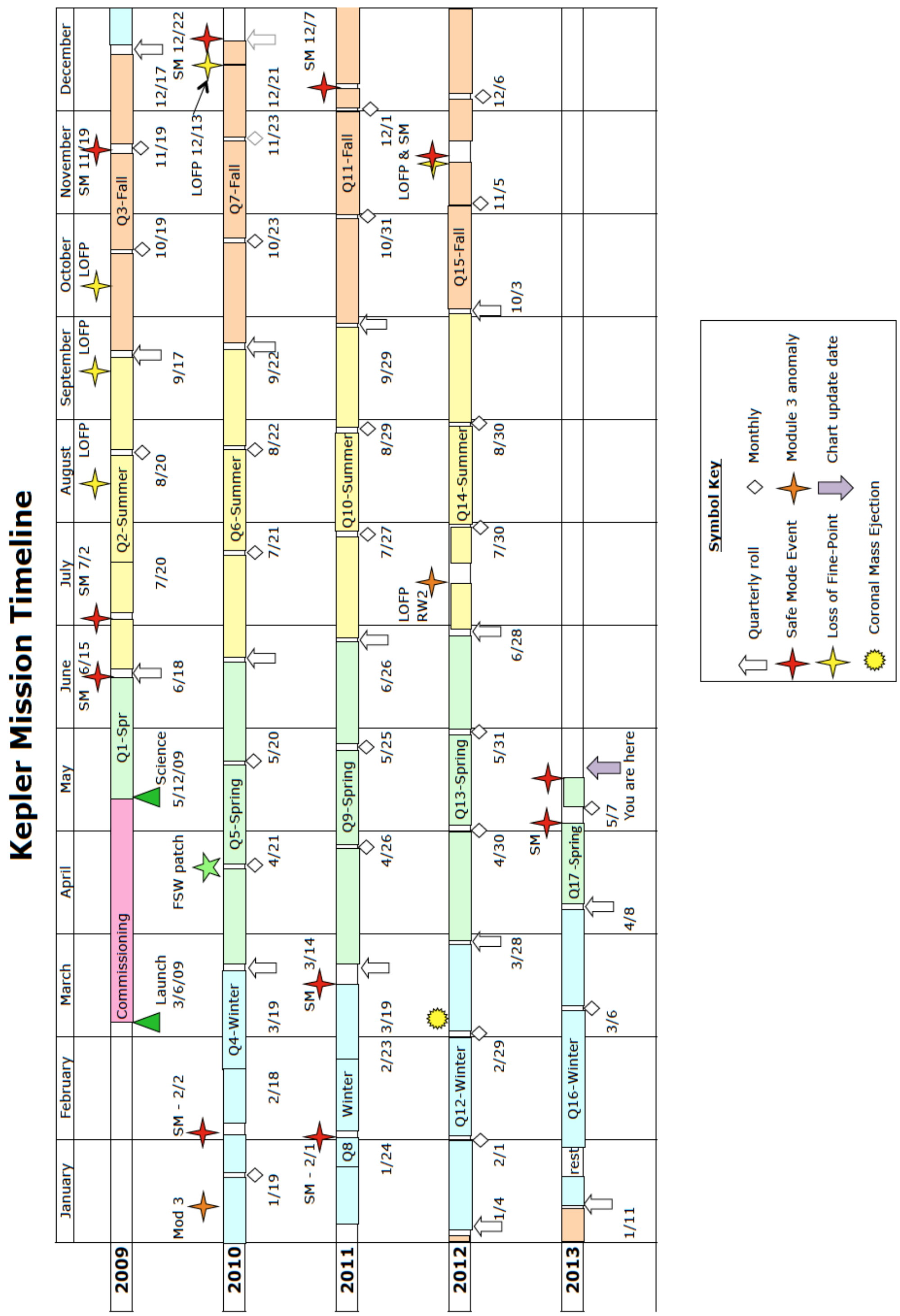
A.1.8 Corrected Short-Cadence Gapping Issue

In DR24, some short-cadence flux values were anomalous if the adjacent or coincident long cadence had data quality bits 6, 9, 15 or 16 set (see Table 2.3 of the Kepler Archive Manual). The error occured because the long- and short-cadence data anomaly flags were handled inconsistently when using the Dynablack model during pixel-level calibration (CAL). The error permitted bad long-cadence CCD bias levels to be interpolated for use in the calibration of adjacent or coincident short-cadence data. DR25 fixes this data flagging inconsistency so that the long- and short-cadence data are now consistently gapped, eliminating anomalous short-cadence values adjacent to some gaps.

[1] http://exoplanetarchive.ipac.caltech.edu/docs/Kepler_completeness_reliability.html
[2] http://archive.stsci.edu/missions/kepler/catalogs/kepler_scrambled_short_cadence_collateral_target_list.csv

A.2 Kepler Mission Timeline

The Figure shows the *Kepler* mission timeline for the entire mission.



B Data Quality in DRN 25

B.1 Evaluation of CDPP

To understand the overall performance of the pipeline, we show the Temporal Median (TM) of the CDPP time series as calculated by the TPS module for different versions of the SOC pipeline and different magnitude ranges (Figure 3 and 4). The small reduction in the reported median and tenth percentile TMCDPP statistics for each quarter is consistent with what is expected given the changes to the apertures reported in §A.1.2. The largest improvements to CDPP from the improved optimal apertures are seen in the noisiest light curves, and hence fainter stars show more improvement (compare Figure 3 and Figure 4).

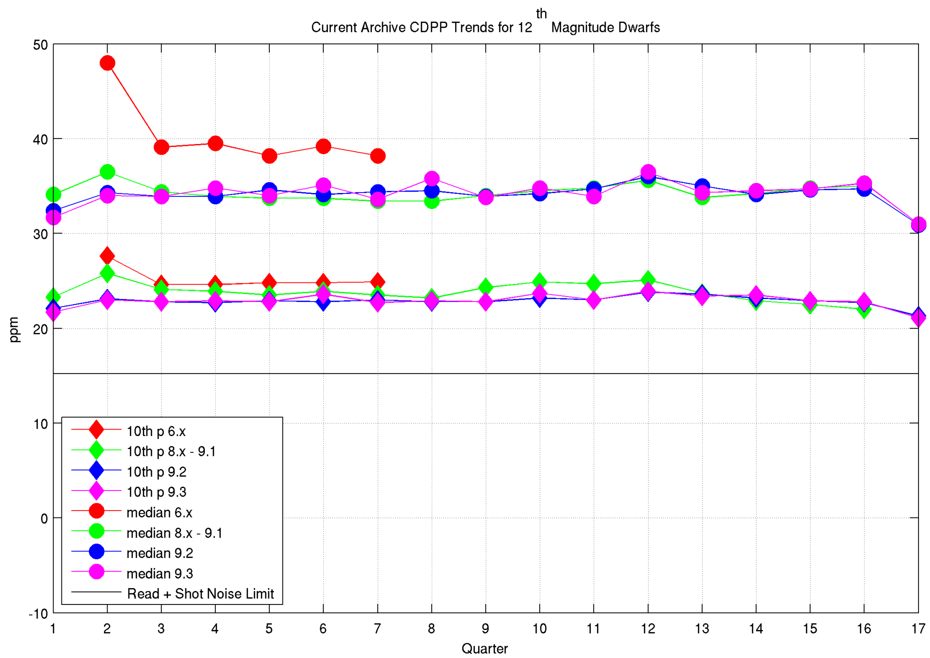


Figure 3: 6.5-h Temporal Median of the CDPP time series. The median (circles) and 10th percentile value (diamonds) for all dwarf stars between Kp=11.75–12.25 are given. The 6-h TMCDPPs have been divided by sqrt(13/12) = 1.041 to approximate 6.5-h TMCDPPs. The 6.x, 8.x and 9.x labels given in the legend refer to the version of the SOC pipeline used.

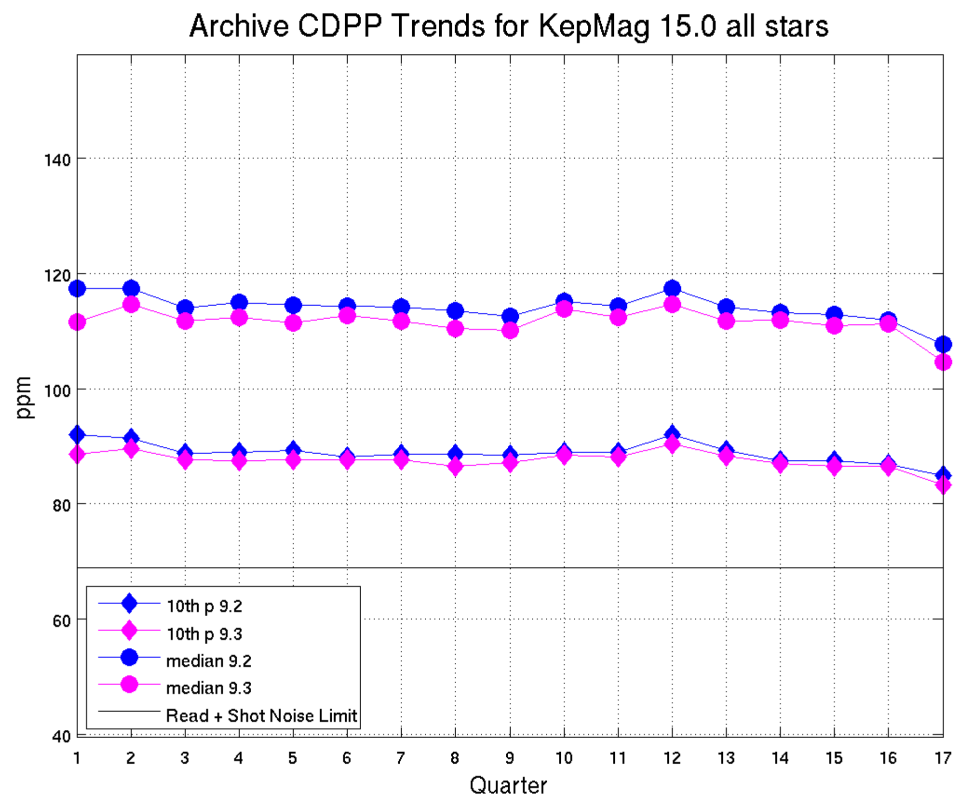


Figure 4: The same as Figure 3 except that it is shown for all stars between Kp=14.75–15.25. The results for SOC 9.2 (DR24) are in blue and the results for this release (SOC 9.3, DR25) are in magenta.

0 Q0 Notes

In this section we only discuss features of the data that are unique to Q0. For all other details about features present in the Kepler data, see the Data Characteristics Handbook (Van Cleve *et al.*, 2016).

0.1 Summary of Data Anomalies

Certain cadences are flagged to indicate a possible reduction of quality. See the QUALITY and SAP_QUALITY columns of the target pixel and light curve files, respectively. Cadences with data anomalies that affect the entire focal plane are shown in the Figure below. The meaning of the flags are explained in the Data Characteristics Handbook (Van Cleve *et al.*, 2016) and Archive Manual (Thompson *et al.*, 2016).

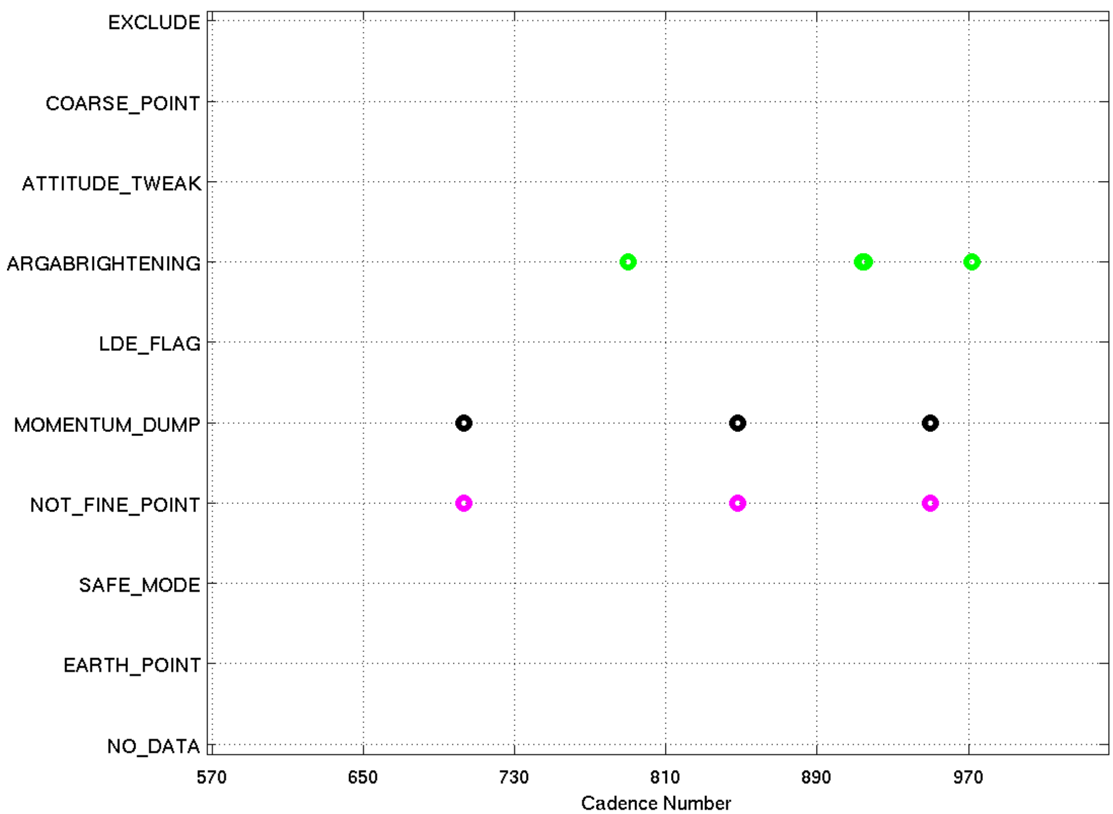


Figure 5: An overview of the location of the data anomalies flagged in Q0. ARGABRIGHTENING refers to cadences where the multiple-channel Argabrightening flag (flag bit 7, decimal value 64) was set.

0.2 No Events Unique to this Quarter

1 Q1 Notes

In this section we only discuss features of the data that are unique to Q1. For all other details about features present in the Kepler data, see the Data Characteristics Handbook (Van Cleve *et al.*, 2016).

1.1 Summary of Data Anomalies

Certain cadences are flagged to indicate a possible reduction of quality. See the QUALITY and SAP_QUALITY columns of the target pixel and light curve files, respectively. Cadences with data anomalies that affect the entire focal plane are shown in the Figure below. The meaning of the flags are explained in the Data Characteristics Handbook (Van Cleve *et al.*, 2016) and Archive Manual (Thompson *et al.*, 2016).

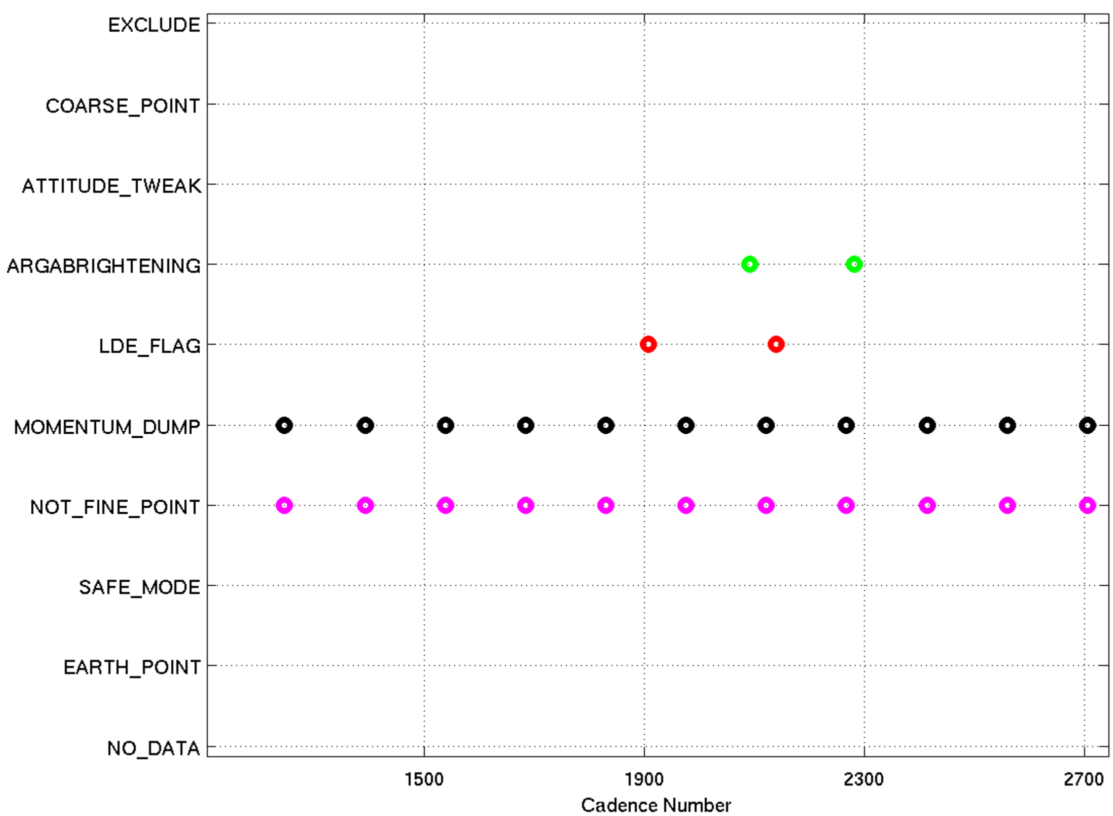


Figure 6: An overview of the location of the data anomalies flagged in Q1. ARGABRIGHTENING refers to cadences where the multiple-channel Argabrightening flag (flag bit 7, decimal value 64) was set.

1.2 No Events Unique to this Quarter

2 Q2 Notes

In this section we only discuss features of the data that are unique to Q2. For all other details about features present in the Kepler data, see the Data Characteristics Handbook (Van Cleve *et al.*, 2016).

2.1 Summary of Data Anomalies

Certain cadences are flagged to indicate a possible reduction of quality. See the QUALITY and SAP_QUALITY columns of the target pixel and light curve files, respectively. Cadences with data anomalies that affect the entire focal plane are shown in the Figure below. The meaning of the flags are explained in the Data Characteristics Handbook (Van Cleve *et al.*, 2016) and Archive Manual (Thompson *et al.*, 2016).

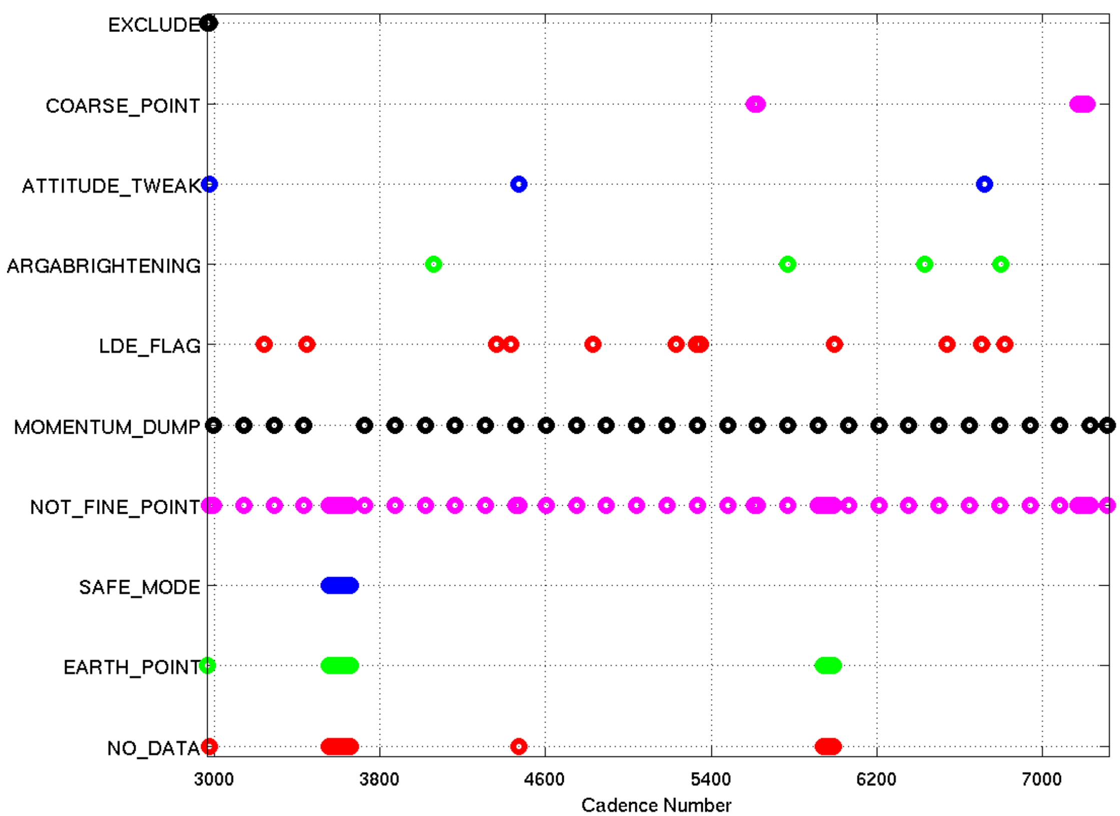


Figure 7: An overview of the location of the data anomalies flagged in Q2.

2.2 Attitude Tweak

Since continued attitude drift invalidates target aperture definitions and leads to large photometric errors, small attitude adjustments were performed. In Q2 three attitude tweaks were performed with offsets of less than 0.05 pixels (Van Cleve *et al.*, 2016).

2.3 Safe Mode

A safe mode occurred on 2009-07-02, in the middle of the first month of observations, causing a data gap spanning long-cadence Cadence Index Number (CIN) 3553-3659.

3 Q3 Notes

In this section we only discuss features of the data that are unique to Q3. For all other details about features present in the Kepler data, see the Data Characteristics Handbook (Van Cleve *et al.*, 2016).

3.1 Summary of Data Anomalies

Certain cadences are flagged to indicate a possible reduction of quality. See the QUALITY and SAP_QUALITY columns of the target pixel and light curve files, respectively. Cadences with data anomalies that affect the entire focal plane are shown in the Figure below. The meaning of the flags are explained in the Data Characteristics Handbook (Van Cleve *et al.*, 2016) and Archive Manual (Thompson *et al.*, 2016).

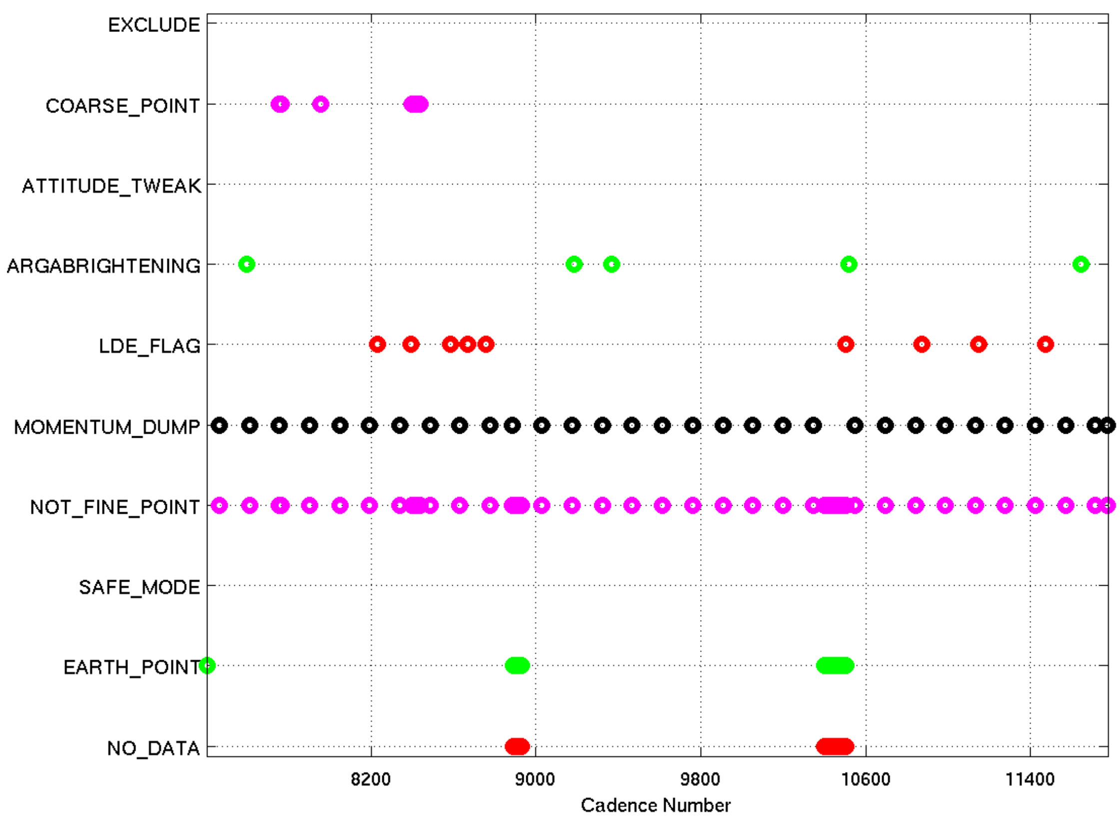


Figure 8: An overview of the location of the data anomalies flagged in Q3.

3.2 Safe Mode

A safe mode occurred between months 2 and 3 causing a slightly longer than normal monthly gap of two days.

4 Q4 Notes

In this section we only discuss features of the data that are unique to Q4. For all other details about features present in the Kepler data, see the Data Characteristics Handbook (Van Cleve *et al.*, 2016).

4.1 Summary of Data Anomalies

Certain cadences are flagged to indicate a possible reduction of quality. See the QUALITY and SAP_QUALITY columns of the target pixel and light curve files, respectively. Cadences with data anomalies that affect the entire focal plane are shown in the Figure below. The meaning of the flags are explained in the Data Characteristics Handbook (Van Cleve *et al.*, 2016) and Archive Manual (Thompson *et al.*, 2016).

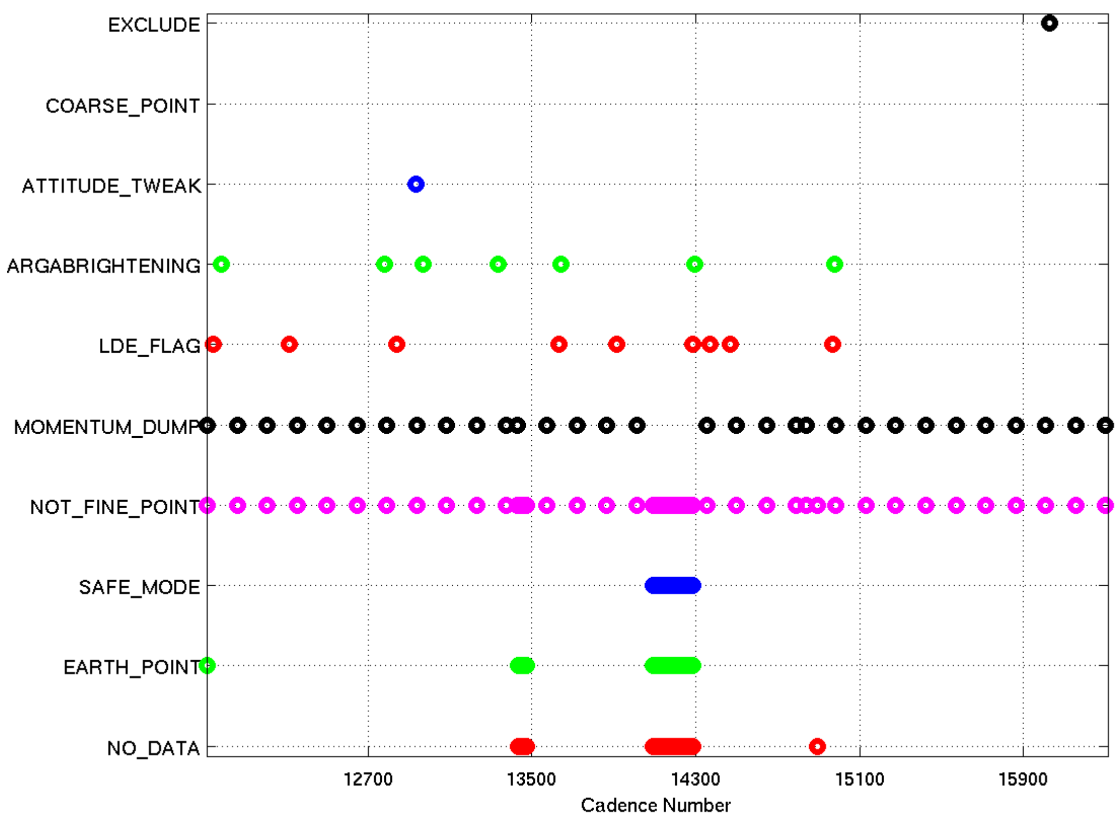


Figure 9: An overview of the location of the data anomalies flagged in Q4.

4.2 Failure of Module 3

All 4 outputs of Module 3 failed at 17:52 UTC Jan 9, 2010 during LC CIN 12935. Reference pixels showed loss of stars and black levels decreased by 75 to 100 DN per frame. FFIs show no evidence of photons or electronically injected signals. The start of line ringing and FGS crosstalk are still present after the anomaly. The loss of the module led to consistent temperature drops within the LDE, telescope structure, Schmidt corrector, primary mirror, FPA modules, and acquisition/driver boards– which in turn affected photometry and centroids across the full focal plane. The impact on science observations is that 20% of the FOV suffers a one-quarter data outage every year as Kepler performs its quarterly rolls. The cadence data sets for those targets on module three only contain cadences that occurred prior to the module failure.

4.3 Safe Mode

A safe mode occurred on 2010-02-02, in the middle of the second month of observations, causing a data gap spanning long-cadence CIN 14091-14230.

5 Q5 Notes

In this section we only discuss features of the data that are unique to Q5. For all other details about features present in the Kepler data, see the Data Characteristics Handbook (Van Cleve *et al.*, 2016).

5.1 Summary of Data Anomalies

Certain cadences are flagged to indicate a possible reduction of quality. See the QUALITY and SAP_QUALITY columns of the target pixel and light curve files, respectively. Cadences with data anomalies that affect the entire focal plane are shown in the Figure below. The meaning of the flags are explained in the Data Characteristics Handbook (Van Cleve *et al.*, 2016) and Archive Manual (Thompson *et al.*, 2016).

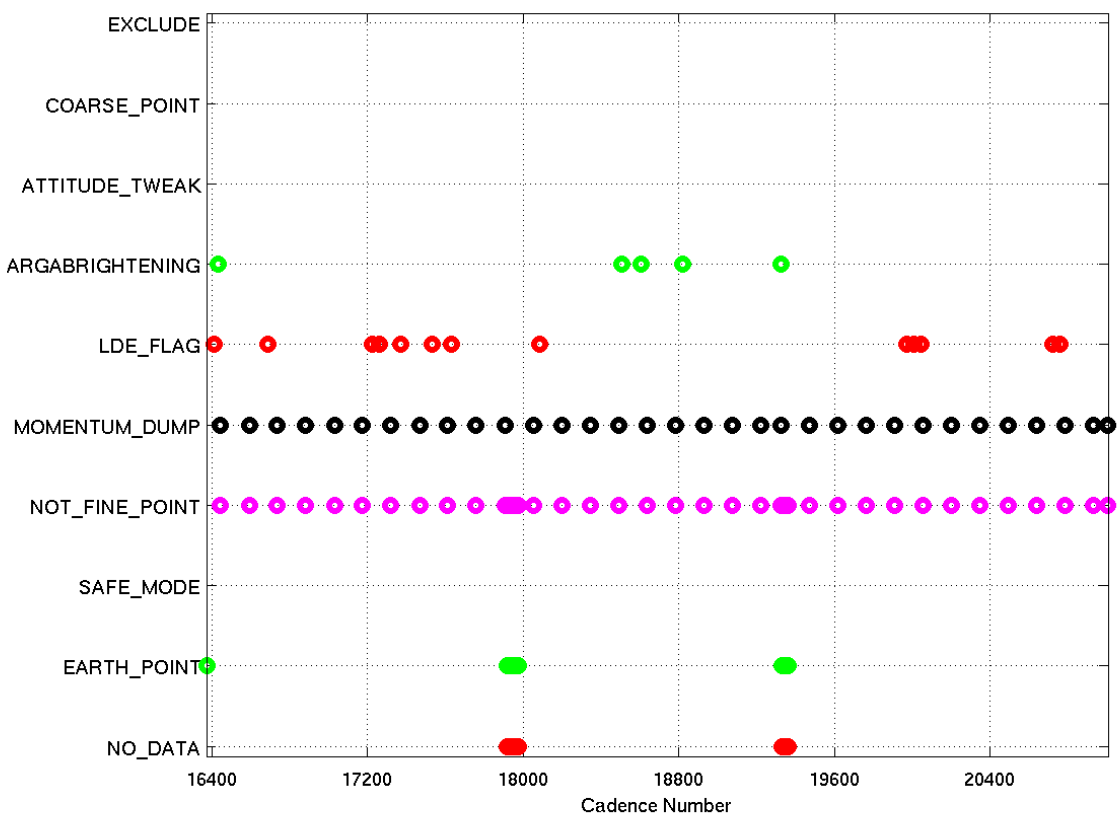


Figure 10: An overview of the location of the data anomalies flagged in Q5.

5.2 No Events Unique to this Quarter

6 Q6 Notes

In this section we only discuss features of the data that are unique to Q6. For all other details about features present in the Kepler data, see the Data Characteristics Handbook (Van Cleve *et al.*, 2016).

6.1 Summary of Data Anomalies

Certain cadences are flagged to indicate a possible reduction of quality. See the QUALITY and SAP_QUALITY columns of the target pixel and light curve files, respectively. Cadences with data anomalies that affect the entire focal plane are shown in the Figure below. The meaning of the flags are explained in the Data Characteristics Handbook (Van Cleve *et al.*, 2016) and Archive Manual (Thompson *et al.*, 2016).

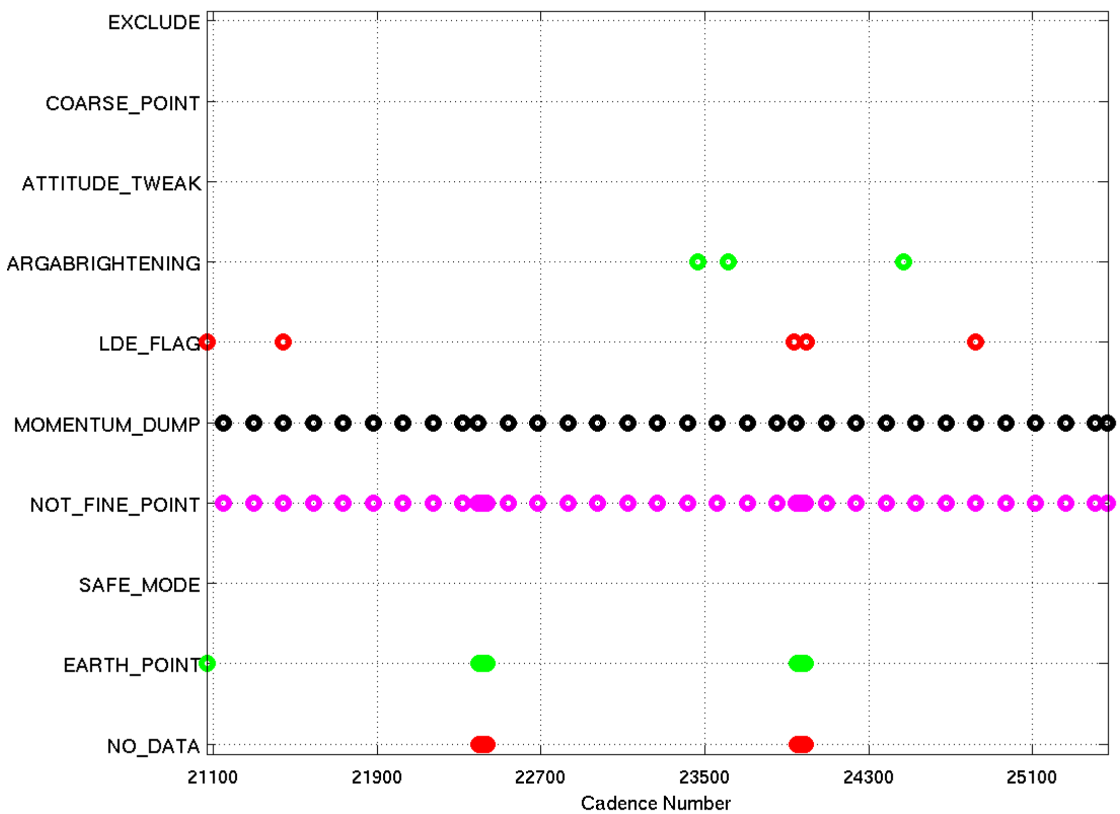


Figure 11: An overview of the location of the data anomalies flagged in Q6.

6.2 No Events Unique to this Quarter

7 Q7 Notes

In this section we only discuss features of the data that are unique to Q7. For all other details about features present in the Kepler data, see the Data Characteristics Handbook (Van Cleve *et al.*, 2016).

7.1 Summary of Data Anomalies

Certain cadences are flagged to indicate a possible reduction of quality. See the QUALITY and SAP_QUALITY columns of the target pixel and light curve files, respectively. Cadences with data anomalies that affect the entire focal plane are shown in the Figure below. The meaning of the flags are explained in the Data Characteristics Handbook (Van Cleve *et al.*, 2016) and Archive Manual (Thompson *et al.*, 2016).

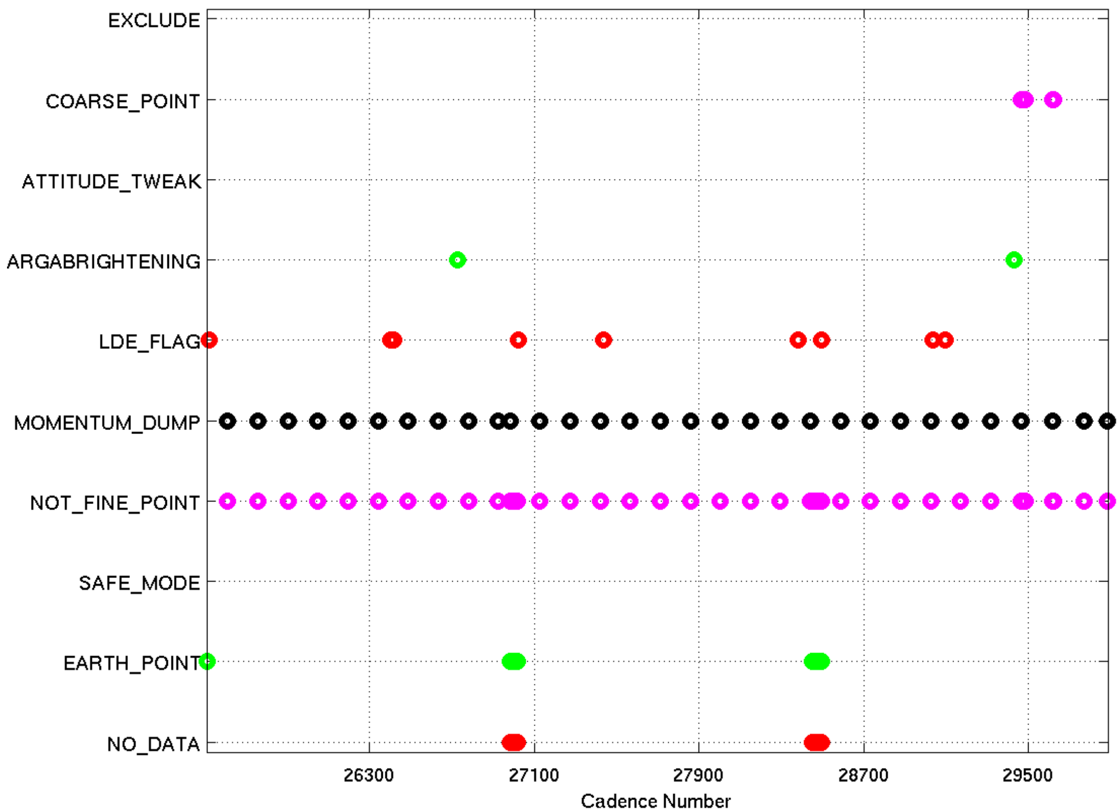


Figure 12: An overview of the location of the data anomalies flagged in Q7.

7.2 No Events Unique to this Quarter

8 Q8 Notes

In this section we only discuss features of the data that are unique to Q8. For all other details about features present in the Kepler data, see the Data Characteristics Handbook (Van Cleve *et al.*, 2016).

8.1 Summary of Data Anomalies

Certain cadences are flagged to indicate a possible reduction of quality. See the QUALITY and SAP_QUALITY columns of the target pixel and light curve files, respectively. Cadences with data anomalies that affect the entire focal plane are shown in the Figure below. The meaning of the flags are explained in the Data Characteristics Handbook (Van Cleve *et al.*, 2016) and Archive Manual (Thompson *et al.*, 2016).

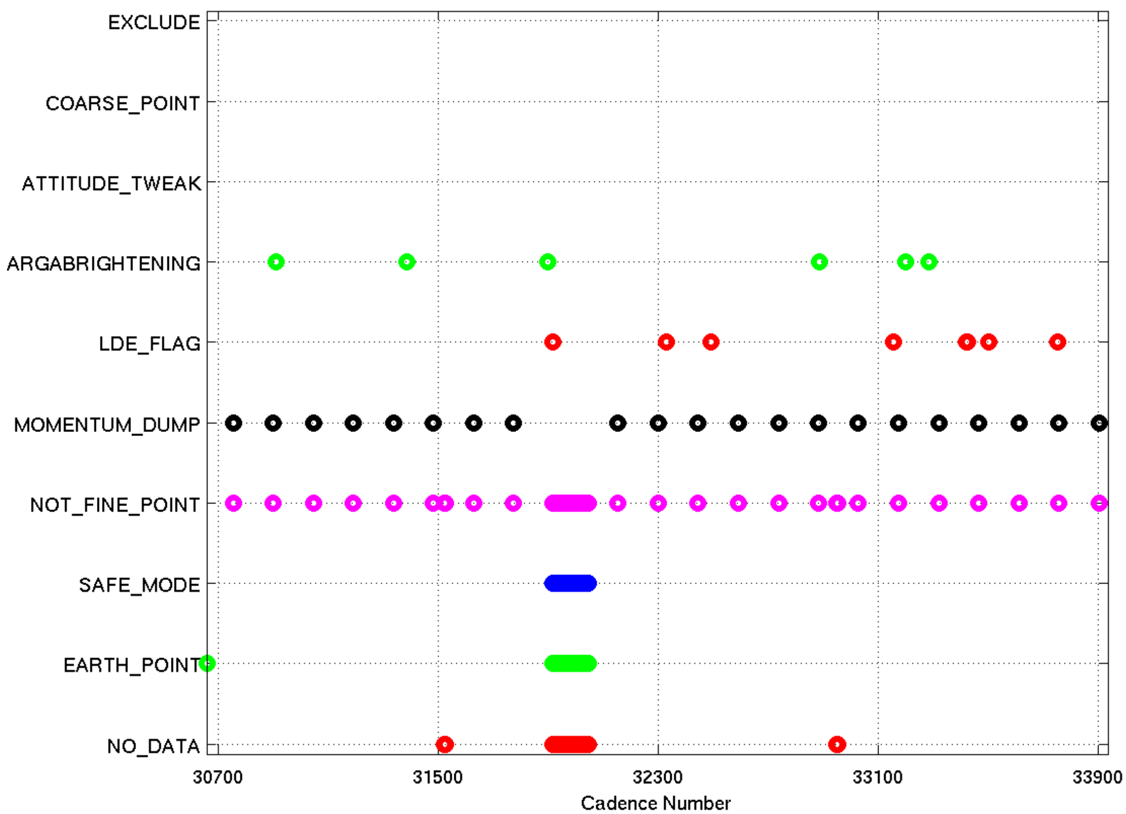


Figure 13: An overview of the location of the data anomalies flagged in Q8.

8.2 Safe Mode

Three safe modes occurred in Q8 causing less data to be collected than originally scheduled. The first occurred shortly after the end of Q7 on 2010-12-22 and caused a delay in starting the Q8 observations. The second occurred on 2011-02-01, in the middle of the second month, causing a data gap spanning long-cadence CIN 31915-32045. The third occurred on 2011-03-14, causing Q8 to end prematurely.

9 Q9 Notes

In this section we only discuss features of the data that are unique to Q9. For all other details about features present in the Kepler data, see the Data Characteristics Handbook (Van Cleve *et al.*, 2016).

9.1 Summary of Data Anomalies

Certain cadences are flagged to indicate a possible reduction of quality. See the QUALITY and SAP_QUALITY columns of the target pixel and light curve files, respectively. Cadences with data anomalies that affect the entire focal plane are shown in the Figure below. The meaning of the flags are explained in the Data Characteristics Handbook (Van Cleve *et al.*, 2016) and Archive Manual (Thompson *et al.*, 2016).

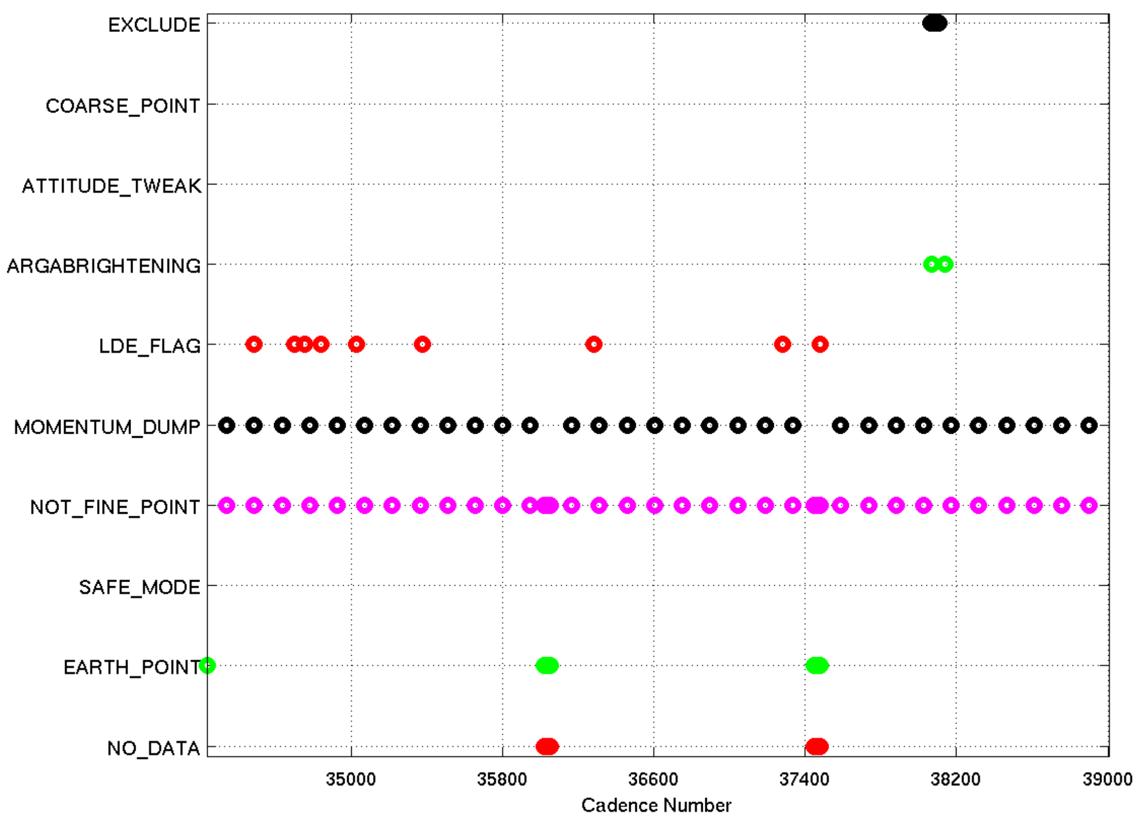


Figure 14: An overview of the location of the data anomalies flagged in Q9.

9.2 Safe Mode before Q9

As mentioned in section §8.2, a Safe Mode occurred on 2011-03-14, before the beginning of Q9. It has no apparent impact on the Q9 data.

9.3 LDE Out of Sync

During Q9 the Local Detector Electronics (LDE) became out of sync after the second Earth-point. This resulted in the first 30 short cadences not being processed; only raw pixel data exists for these cadences. This is the first instance of this anomaly.

10 Q10 Notes

In this section we only discuss features of the data that are unique to Q10. For all other details about features present in the Kepler data, see the Data Characteristics Handbook (Van Cleve *et al.*, 2016).

10.1 Summary of Data Anomalies

Certain cadences are flagged to indicate a possible reduction of quality. See the QUALITY and SAP_QUALITY columns of the target pixel and light curve files, respectively. Cadences with data anomalies that affect the entire focal plane are shown in the Figure below. The meaning of the flags are explained in the Data Characteristics Handbook (Van Cleve *et al.*, 2016) and Archive Manual (Thompson *et al.*, 2016).

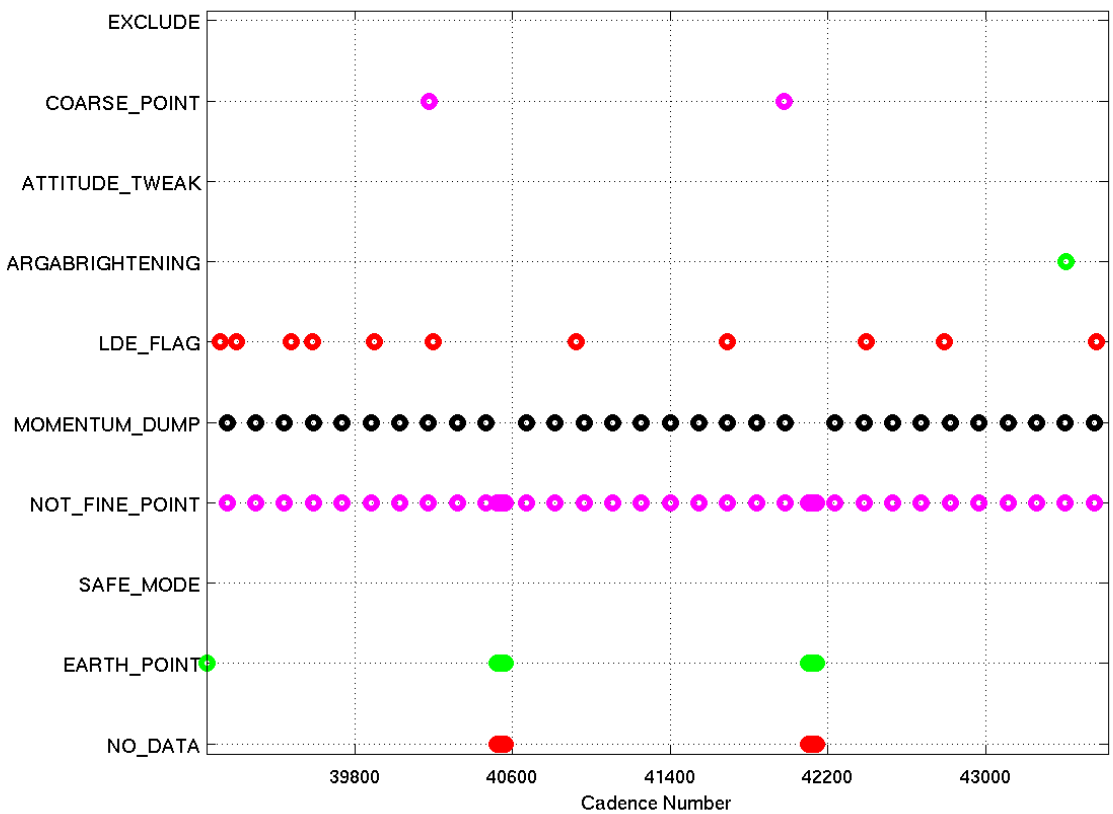


Figure 15: An overview of the location of the data anomalies flagged in Q10.

10.2 No Events Unique to this Quarter

11 Q11 Notes

In this section we only discuss features of the data that are unique to Q11. For all other details about features present in the Kepler data, see the Data Characteristics Handbook (Van Cleve *et al.*, 2016).

11.1 Summary of Data Anomalies

Certain cadences are flagged to indicate a possible reduction of quality. See the QUALITY and SAP_QUALITY columns of the target pixel and light curve files, respectively. Cadences with data anomalies that affect the entire focal plane are shown in the Figure below. The meaning of the flags are explained in the Data Characteristics Handbook (Van Cleve *et al.*, 2016) and Archive Manual (Thompson *et al.*, 2016).

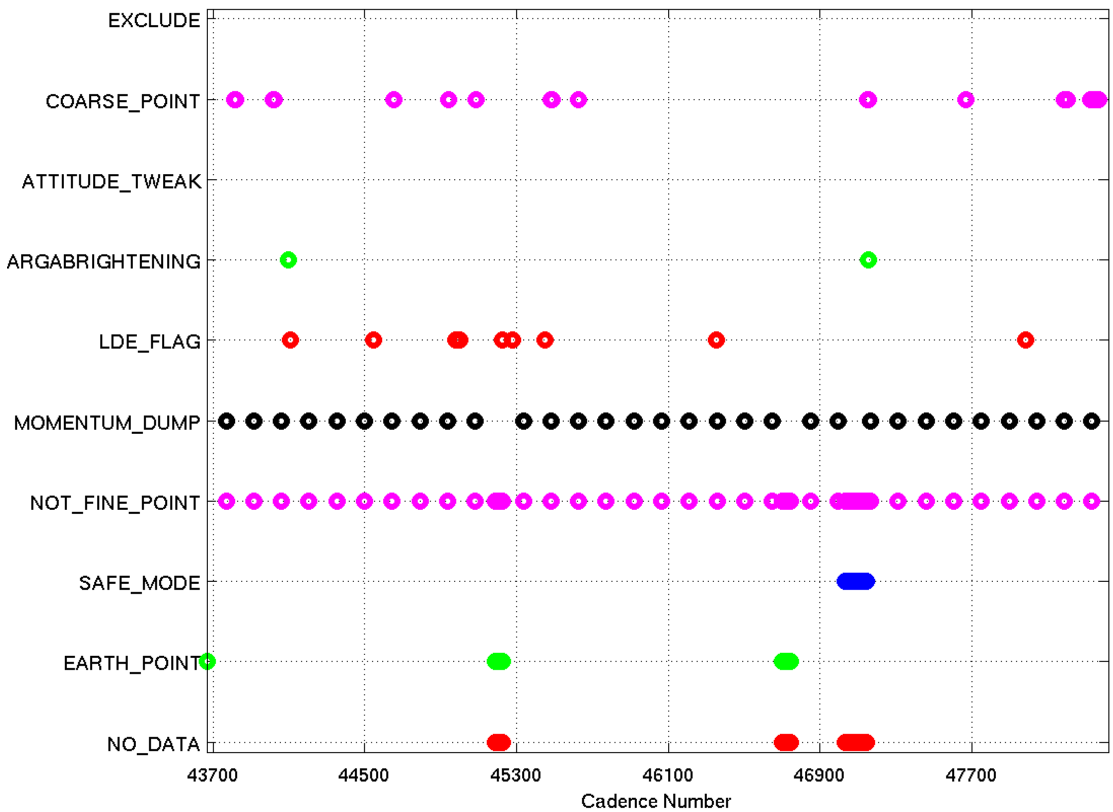


Figure 16: An overview of the location of the data anomalies flagged in Q11.

11.2 Safe Mode

A safe mode occurred on 2011-12-07, in the third month of observations, causing a data gap spanning long-cadence CIN 47035 - 47148.

12 Q12 Notes

In this section we only discuss features of the data that are unique to Q12. For all other details about features present in the Kepler data, see the Data Characteristics Handbook (Van Cleve *et al.*, 2016).

12.1 Summary of Data Anomalies

Certain cadences are flagged to indicate a possible reduction of quality. See the QUALITY and SAP_QUALITY columns of the target pixel and light curve files, respectively. Cadences with data anomalies that affect the entire focal plane are shown in the Figure below. The meaning of the flags are explained in the Data Characteristics Handbook (Van Cleve *et al.*, 2016) and Archive Manual (Thompson *et al.*, 2016).

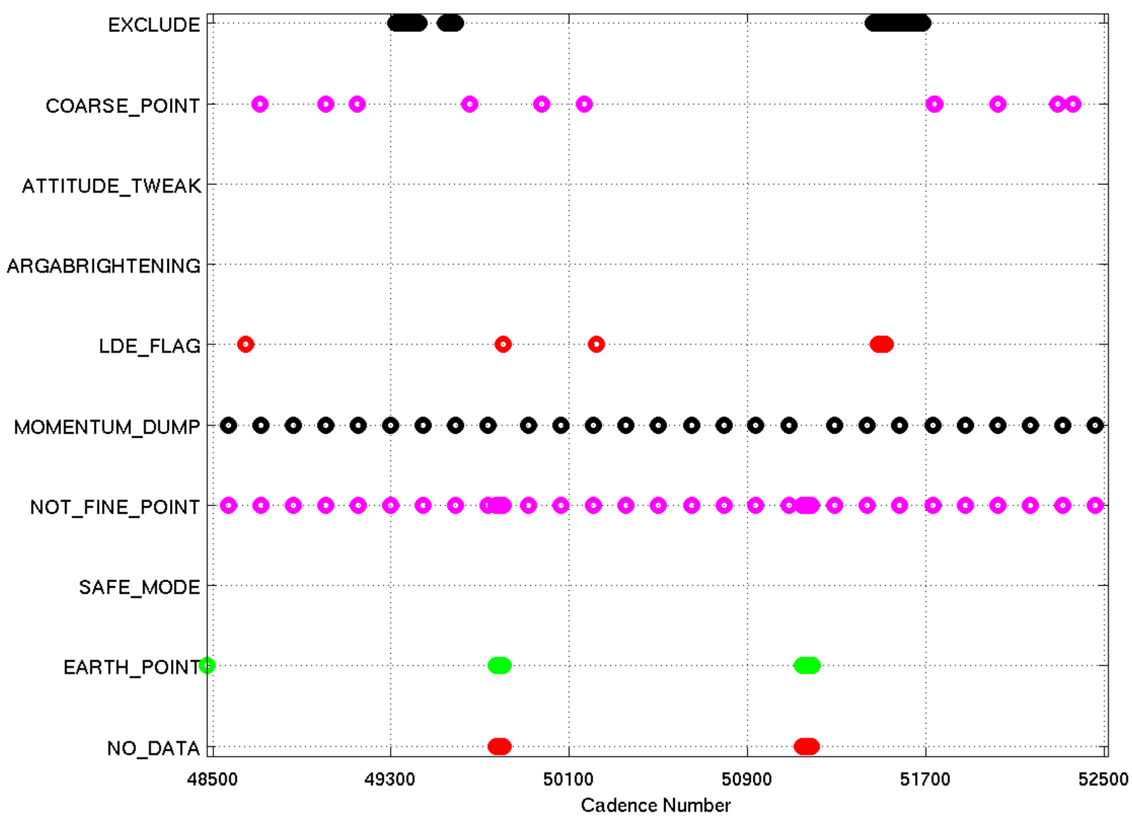


Figure 17: An overview of the location of the data anomalies flagged in Q12.

12.2 Data Loss and Detector Changes from Coronal Mass Ejections

Data quality during Q12 was affected by three coronal mass ejections (CMEs). Cadences impacted by the CMEs were marked with the Manual Exclude flag (0x09, decimal 256) in the SAP_QUALITY column of the light curve files (and the QUALITY column in the target pixel files). Users are strongly discouraged from using the data collected during these events.

During these CMEs, the flux of charged particles from the sun impacting the spacecraft increased by many orders of magnitude causing an increase in measured dark current and the"cosmic ray" count. The fine guidance sensors were also impacted, so the pointing of the spacecraft deviated from the nominal value by many milli-pixels.

Users should note that the detector underwent some long-term changes after the CMEs. These effects are particularly noticeable after the third, and most powerful, CME. In particular:

- The dark current rose slightly. This increase does not materially affect data quality.
- A small number of pixels show a pronounced drop in sensitivity after the largest CME. When a target star falls on one or more of these pixels, the mean measured flux will be lower after the CME than before. In the majority of such cases, the pixel-sensitivity dropout corrector in PDC is unable to correct for these discontinuities because of the intervening gapped cadences. PDC can only correct global systematic errors and thus these sensitivity dropouts cannot be dealt with effectively by the algorithm. Hence, PDC fails to correct most of them and often introduces additional low-frequency artifacts into the light curve (see Figure 18).

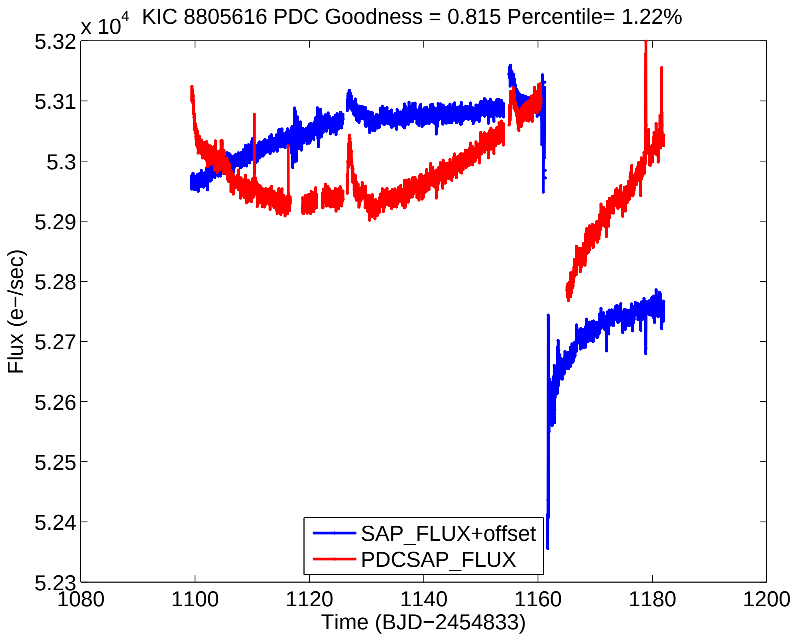


Figure 18: Flux time series showing a discontinuity that can happen after the CME. The blue and red curves show the PA and PDC light curves, respectively. Notice that since the SPSD detector does not attempt to correct the discontinuities following the CME, PDC introduces a long term trend into the data.

13 Q13 Notes

In this section we only discuss features of the data that are unique to Q13. For all other details about features present in the Kepler data, see the Data Characteristics Handbook (Van Cleve *et al.*, 2016).

13.1 Summary of Data Anomalies

Certain cadences are flagged to indicate a possible reduction of quality. See the QUALITY and SAP_QUALITY columns of the target pixel and light curve files, respectively. Cadences with data anomalies that affect the entire focal plane are shown in the Figure below. The meaning of the flags are explained in the Data Characteristics Handbook (Van Cleve *et al.*, 2016) and Archive Manual (Thompson *et al.*, 2016).

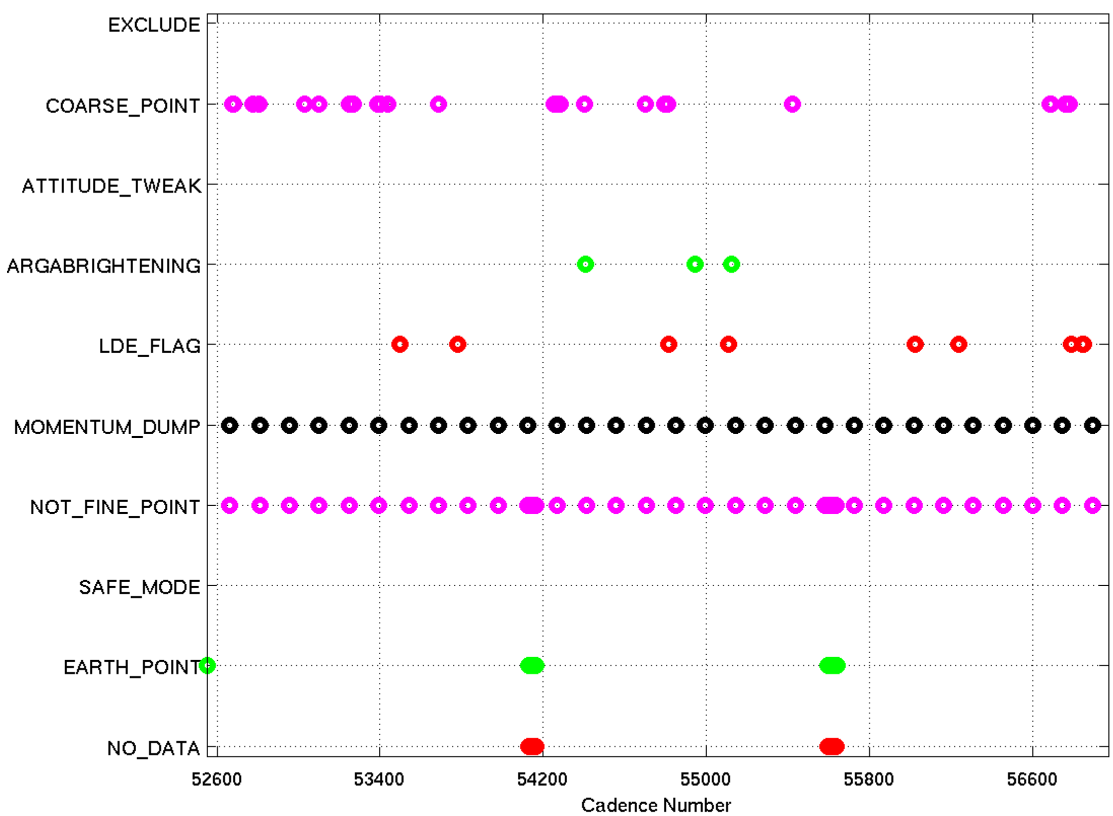


Figure 19: An overview of the location of the data anomalies flagged in Q13.

13.2 Reaction Wheel Zero Crossings

A software change on the spacecraft was implemented that prevents the reaction wheel velocities from crossing zero. This is the cause for the absence of cadences with the zero-crossing flag (QUALITY flag 0x05, decimal value 16) being set in Q13 and all subsequent quarters.

14 Q14 Notes

In this section we only discuss features of the data that are unique to Q14. For all other details about features present in the Kepler data, see the Data Characteristics Handbook (Van Cleve *et al.*, 2016).

14.1 Summary of Data Anomalies

Certain cadences are flagged to indicate a possible reduction of quality. See the QUALITY and SAP_QUALITY columns of the target pixel and light curve files, respectively. Cadences with data anomalies that affect the entire focal plane are shown in the Figure below. The meaning of the flags are explained in the Data Characteristics Handbook (Van Cleve *et al.*, 2016) and Archive Manual (Thompson *et al.*, 2016).

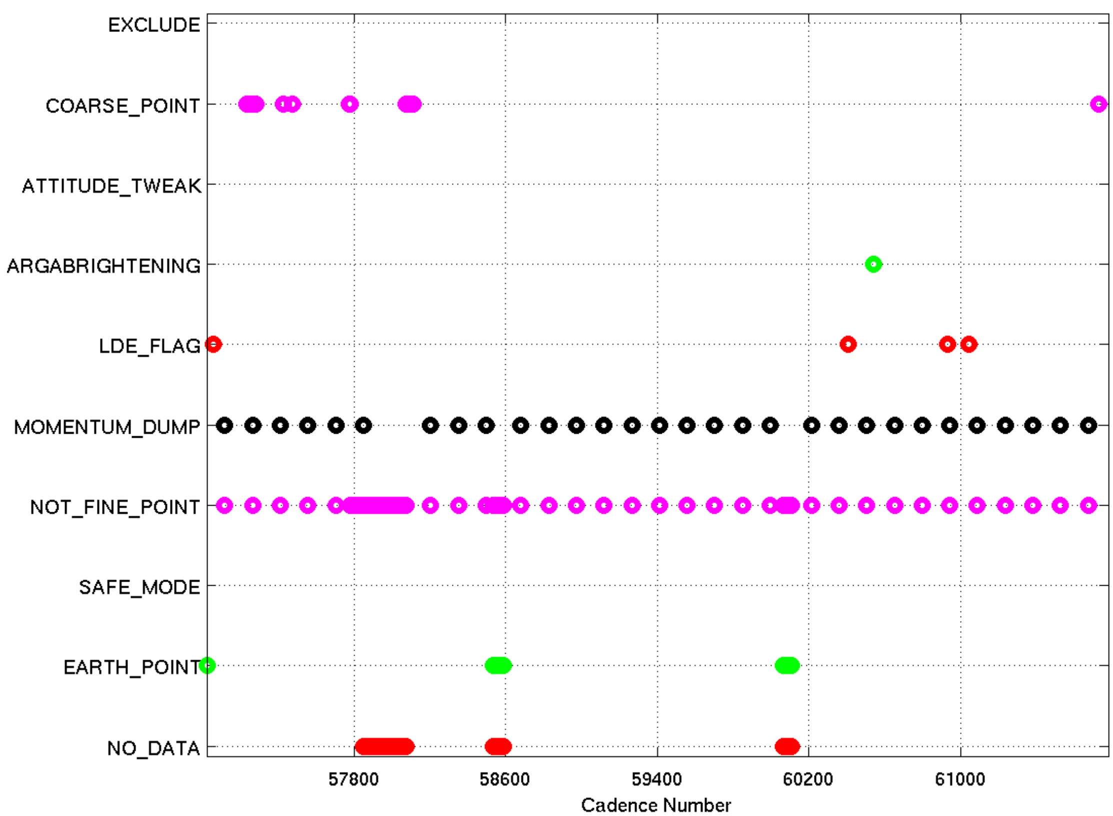


Figure 20: An overview of the location of the data anomalies flagged in Q14.

14.2 The Leap Second Cadence

During Q14, a leap second was applied to Coordinated Universal Time (UTC). The start time reported to the SOC for the cadence containing the leap second (CIN 57140) was incorrect, causing the mid-exposure time (MJD and BKJD times) for this cadence to be misreported in all FITS files. The error is on the order of one second. The times reported for all other cadences are expected to be correct. Note, the exposure time for CIN 57140 is the same as all other cadences.

14.3 Reaction Wheel Failure

Kepler lost reaction wheel 2 due to excess friction on 2012-07-14 (MJD 56122) and returned to science data collection using three reaction wheels on 2012-07-20 (MJD 56128). The intervening six days of data has been excluded, as is normally the case for coarse point data. This change in attitude control occurred midway through Q14 month 1. However, Kepler's performance on three wheels appears nominal, so the three- and four-wheel data have been processed and exported as usual (i.e., by month for short-cadence and by quarter for long-cadence).

14.4 Missing Short Cadence Flags

A small number of short cadences were not marked as COARSE_POINT during the reaction wheel failure. These cadences are not suitable for science, and should be removed before analyzing short cadence data. The affected short cadences range from 1721709 to 1731878, or MJD 56121.975 to 56128.902.

14.5 Coronal Mass Ejection

The spacecraft was effected by a small Coronal Mass Ejection on 2012-06-25, in the first month of Q14 data. The effects can be seen for an approximately 16-hour period, from long cadences 57519 to 57551, in the collateral data and in the background flux time series. Data quality was not degraded to the point of flagging or exclusion.

15 Q15 Notes

In this section we only discuss features of the data that are unique to Q15. For all other details about features present in the Kepler data, see the Data Characteristics Handbook (Van Cleve *et al.*, 2016).

15.1 Summary of Data Anomalies

Certain cadences are flagged to indicate a possible reduction of quality. See the QUALITY and SAP_QUALITY columns of the target pixel and light curve files, respectively. Cadences with data anomalies that affect the entire focal plane are shown in the Figure below. The meaning of the flags are explained in the Data Characteristics Handbook (Van Cleve *et al.*, 2016) and Archive Manual (Thompson *et al.*, 2016).

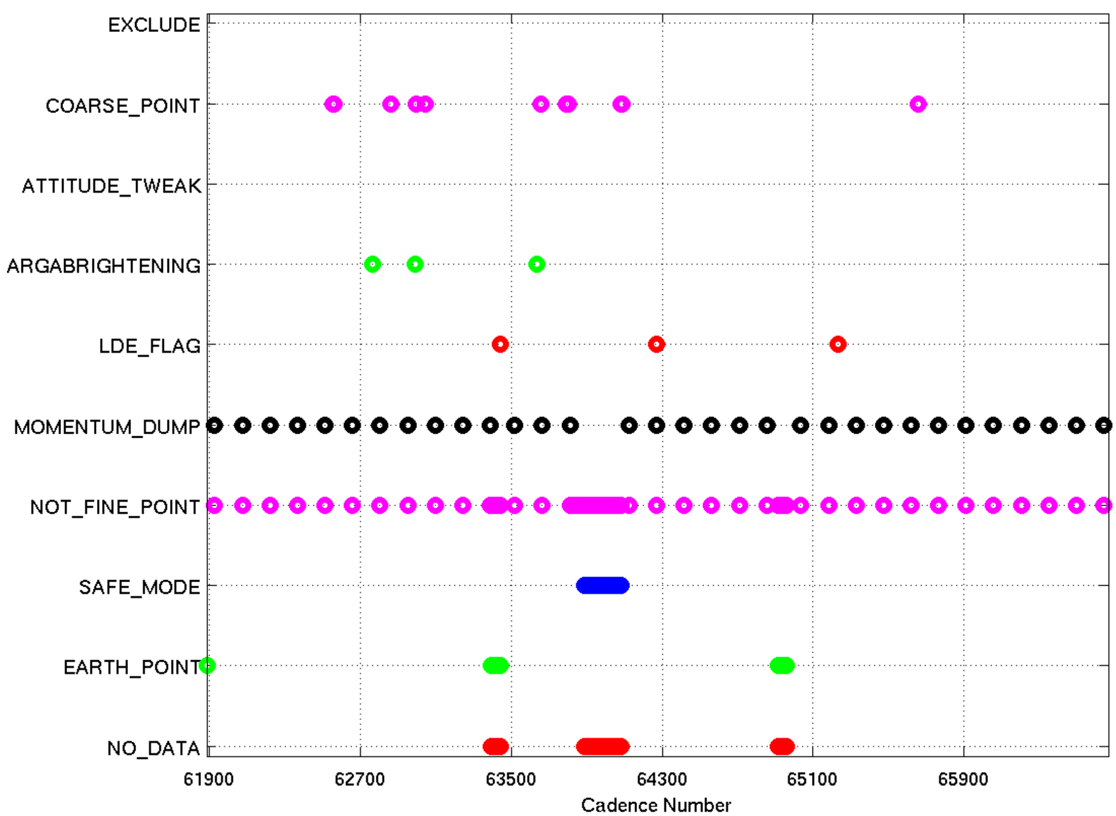


Figure 21: An overview of the location of the data anomalies flagged in Q15.

15.2 Safe Mode

A safe mode occurred on 2012-11-15, in the middle of the second month of observations, causing a nearly 4-day data gap spanning long-cadence CIN 63887 - 64083.

16 Q16 Notes

In this section we only discuss features of the data that are unique to Q16. For all other details about features present in the Kepler data, see the Data Characteristics Handbook (Van Cleve *et al.*, 2016).

16.1 Summary of Data Anomalies

Certain cadences are flagged to indicate a possible reduction of quality. See the QUALITY and SAP_QUALITY columns of the target pixel and light curve files, respectively. Cadences with data anomalies that affect the entire focal plane are shown in the Figure below. The meaning of the flags are explained in the Data Characteristics Handbook (Van Cleve *et al.*, 2016) and Archive Manual (Thompson *et al.*, 2016).

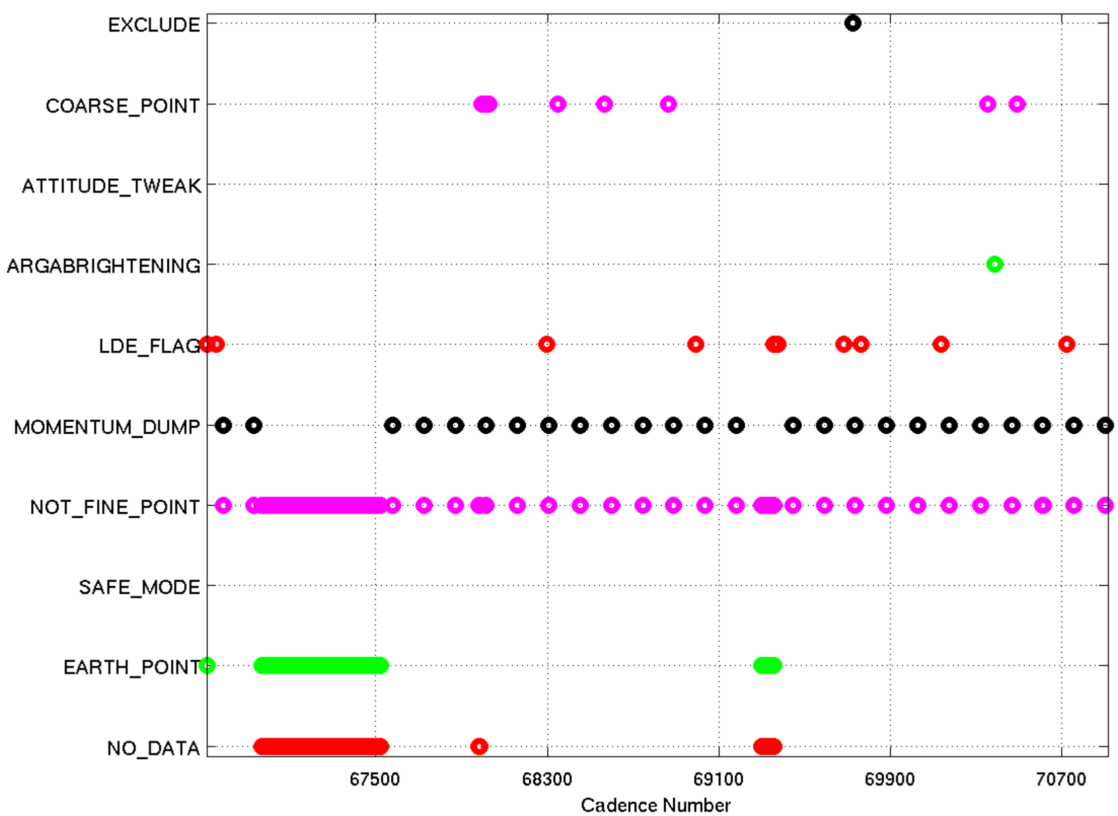


Figure 22: An overview of the location of the data anomalies flagged in Q16.

16.2 Reaction Wheel 4

Reaction wheel 4 suffered a temporary increase in friction between approximately CIN 67920 and 68100, which coincided with a slight degradation in pointing stability. Although a cursory analysis did not show any loss of data quality during this time, we have marked cadences 67996 and 68010–68013 as COARSE_POINT (see Figure 22) because they crossed our 0.5 millipixel pointing-deviation threshold. Users should be suspicious of unusual events in their light curves during this time.

16.3 Resting the Spacecraft

Because of a detected increase in the amount of torque required to spin one of the three remaining reaction wheels, Kepler opted to place the spacecraft in a "wheel rest" safe mode for a period of 11.3 days. Resting the wheels provided an opportunity to redistribute internal lubricant in the reaction wheels and hopefully cause the friction levels to return to normal. The rest started on January 17, 2013 (CIN 66968) and ended on January 29, 2013 (CIN 67522). No data was collected during this rest.

Following the rest, the target tables for month two were loaded and CIN 67523 marks the beginning of the second month of observations for Q16. The result is a short, first month of data, lasting only 5.2 days, and a somewhat longer, second month of data, lasting 36.3 days. At the normal monthly gap (February 2, 2013), the science collection was paused for 1.5 hours to collect an FFI for Q16.

16.4 Thermal Changes Following the Spacecraft Rest

The centroid offsets measured by the PA portion of the pipeline showed a rapid change in position in the few weeks following an eleven-day rest of the spacecraft (January 17 to 29, 2013). Because the rest occurred at a non-science attitude, the telescope underwent extensive thermal changes during this time. The unusually large centroid deviations which occurred upon return to science data collection are a result of the re-equilibration that occurred once science attitude was restored. This is confirmed by measurements of the temperatures of the primary mirror, Schmidt corrector, LDE central acquisition board, and Driver board, which all show a thermal settling that is correlated with the unusual centroid measurements. Users may notice an increase in systematic errors due to the thermal and pointing changes during this period, similar to what is observed at the start of a quarter or a return from safe-mode.

16.5 Solar Weather

There were a number of small solar flares during this quarter. Small flares increase the observed dark current so their effect is most noticeable for faint targets. Stronger flares can reduce pointing accuracy, and therefore affect the photometry of all stars, by interfering with the Fine Guidance Sensors. We marked a single cadence (CIN 69724) with the EXCLUDE flag due to the effect of a solar flare on spacecraft pointing. A number of cadences immediately before and after this cadence also show elevated dark current, but these have smaller pointing excursions.

17 Q17 Notes

In this section we only discuss features of the data that are unique to Q17. For all other details about features present in the Kepler data, see the Data Characteristics Handbook (Van Cleve *et al.*, 2016).

17.1 Summary of Data Anomalies

Certain cadences are flagged to indicate a possible reduction of quality. See the QUALITY and SAP_QUALITY columns of the target pixel and light curve files, respectively. Cadences with data anomalies that affect the entire focal plane are shown in the Figure below. The meaning of the flags are explained in the Data Characteristics Handbook (Van Cleve *et al.*, 2016) and Archive Manual (Thompson *et al.*, 2016).

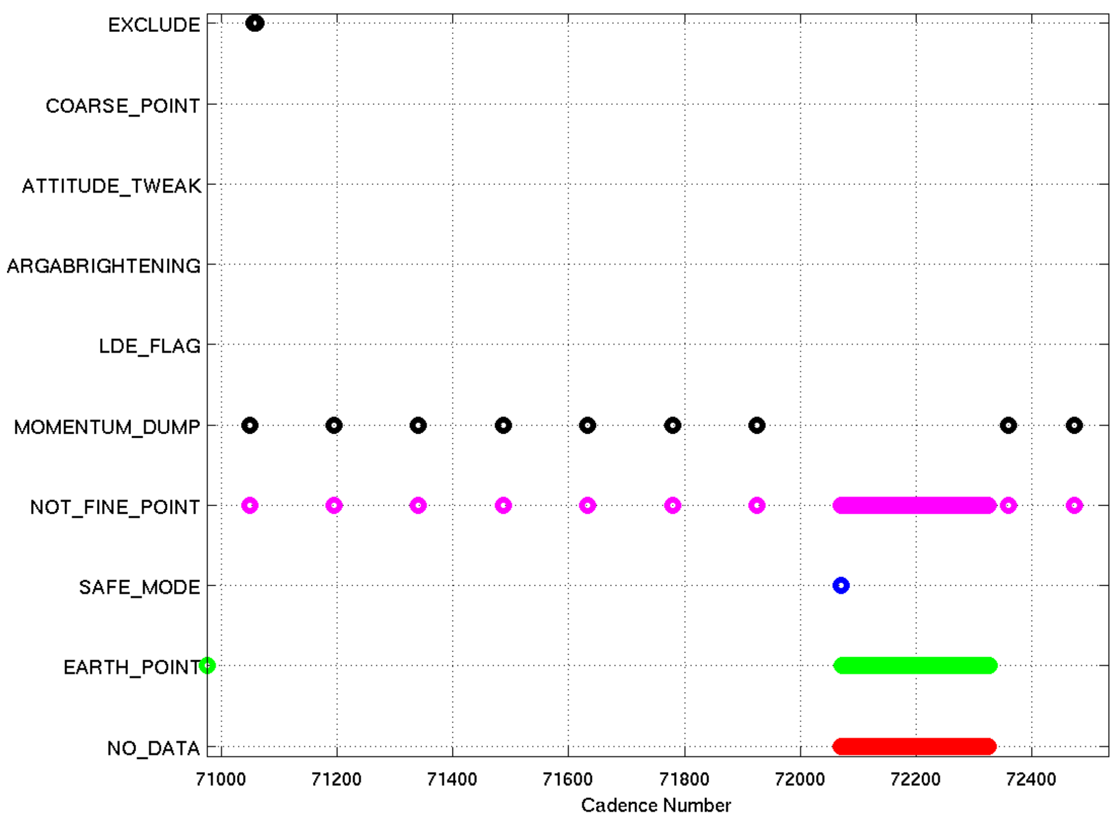


Figure 23: An overview of the location of the data anomalies flagged in Q17.

17.2 Solar Flare

The sun emitted a series of X-ray flares on and around CIN 71058 in month 1 of Q17. Cadences 71056 to 71060 were gapped with the EXCLUDE flag to indicate that this data is of bad quality. However, the dark current remained elevated for several hours after the peak of the event, and users may notice degraded quality, especially for fainter stars.

17.3 PDC Corrected Short Cadence Data

As discussed in §5.15 of the Data Characteristics Handbook (Van Cleve *et al.*, 2016), PDC attenuates signals with timescales longer than approximately one third the quarter duration. For Q17, this timescale is shorter than normal, ∼7-10 days, instead of the typical ∼20–30 days for full-length quarters.

In short cadence, MAP is applied on a monthly basis. Since Q17M2 is less than a week long, signals with timescales longer than a few days are removed. Short cadence data for this month should not be used to examine phenomena with timescales of days or longer.

17.4 Safe Mode

A safe mode occurred on 2013-05-02, ending month 1 early and resulting in a longer than normal monthly break of approximately 5 days, spanning CIN 72071-72325.

17.5 Final Data Set Collected

The second month of Q17 was terminated after less than 5 days of observations by a safe mode event on 2013-05-11. After the spacecraft was commanded to return to science attitude, reaction wheel 4 failed and the spacecraft returned to safe mode. Extensive analysis concluded that neither of the two failed wheels could be recovered. With only two wheels, it is not possible to point at the Kepler field for the purpose of collecting high precision photometry. No futher data will be collected for the original Kepler Mission; but a re-purposed mission, known as *K2*, is using the *Kepler* spacecraft to look at fields along the ecliptic and began on 2014-03-12 (Howell *et al.*, 2014).

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