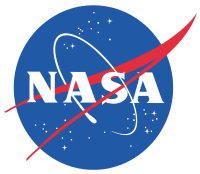

Kepler Data Release 22 Notes

Q16

KSCI-19062-001
Data Analysis Working Group (DAWG)
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Contents

1 Introduction

These Data Release Notes provide information specific to the release of Q16 data, processed with SOC Pipeline 9.0. These Notes contain the summary figures and tables for this quarter. The Kepler Data Characteristics Handbook (Christiansen et al., 2013) discusses most of the known phenomena found in the Kepler data in more detail.

1.1 Dates and Cadence Numbers for Q16

Contents of Data Release 22–Cadence Data

Q.m		First Cadence MJD midTime	Last Cadence MJD midTime	First Cadence UT midTime	Last Cadence UT midTime	Num CINs	Start CIN	End CIN
16	LC	56304.5980	56390.4600	12-Jan-2013 14:21:10	08-Apr-2013 11:02:28	4203	66712	70914
16.1	SCM1	56304.5882	56309.8185	12-Jan-2013 14:06:57	17-Jan-2013 19:38:37	7680	1989820	1997499
16.2	SCM2	56321.1598	56357.4697	29-Jan-2013 03:50:07	06-Mar-2013 11:16:17	53310	2014150	2067459
16.3	SCM3	56358.6146	56390.4699	07-Mar-2013 14:45:02	08-Apr-2013 11:16:41	46770	2069140	2115909

Contents of Data Release 22–Full Frame Images

Q	Class	Filename	UT Start	UT End
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

1.2 The SOC Pipeline for Q16

Data Release 22 was processed with the SOC Pipeline 9.0. For details on how Kepler processes the data through the front-end of the pipeline (modules CAL, PA and PDC), please see the Data Processing Handbook (Fanelli et al., 2011), Stumpe et al. (2012) and Smith et al. (2012). Notable changes and improvements to the pipeline in 9.0 include the following:

- The light curve files contain new keywords in the first data extension to inform the user about how PDC performed on individual targets. First, the PDCMETHD keyword indicates whether the light curve in the PDCSAP_FLUX column of the FITS files was computed using regular MAP or the msMAP algorithm. Second, the goodness metrics used by PDC now include an earth point goodness metric. As with all the goodness metrics, both the value and the percentile compared with targets on the same channel are reported in the FITS headers. Third, the headers describe the number of Sudden Pixel Sensitivity Dropouts (SPSDs) detected and corrected using the keywords NSPSDET and NSPSDCOR.
- The exporter module correctly reports all barycentric times in the data products in TDB (terrestrial dynamic time). See DRN 20 for more details.

1.3 Kepler Mission Timeline to Date

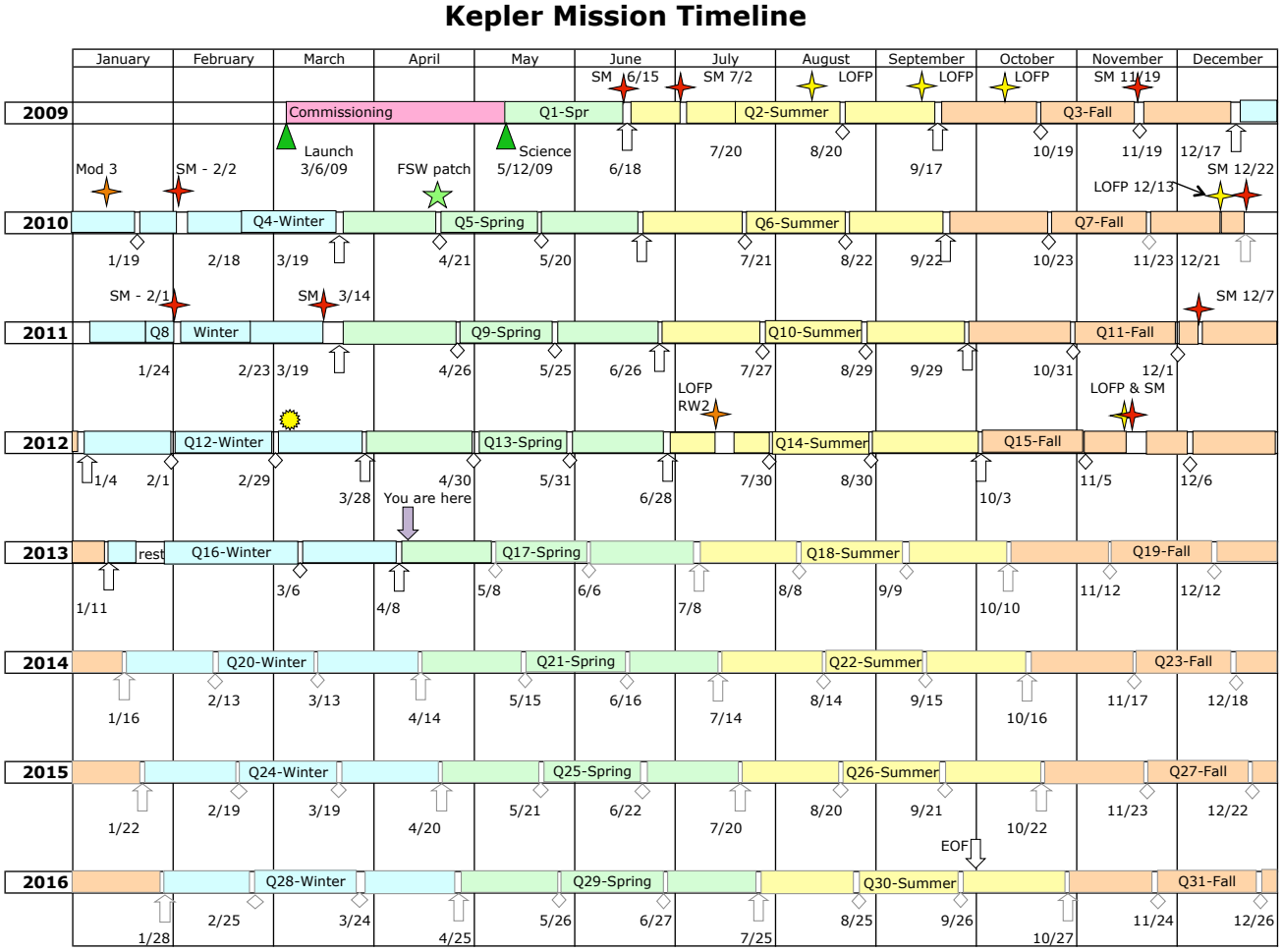

Figure 1: Kepler Mission Timeline as of the end of Q16. All future dates are tentative and subject to change.

2 Data Quality in Q16

2.1 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 pipeline for different versions of the SOC pipeline (Figure 2). We also provide the CDPP statistics for Q16 binned by magnitude in Table 1. In Q16 we see the continuuing trend of a decrease in CDPP for the 10th percentile value and a slight increase in CDPP for the median value. Note, the algorithm to calculate CDPP changed in Q13, generally causing slightly lower values of CDPP (see DRN 19).

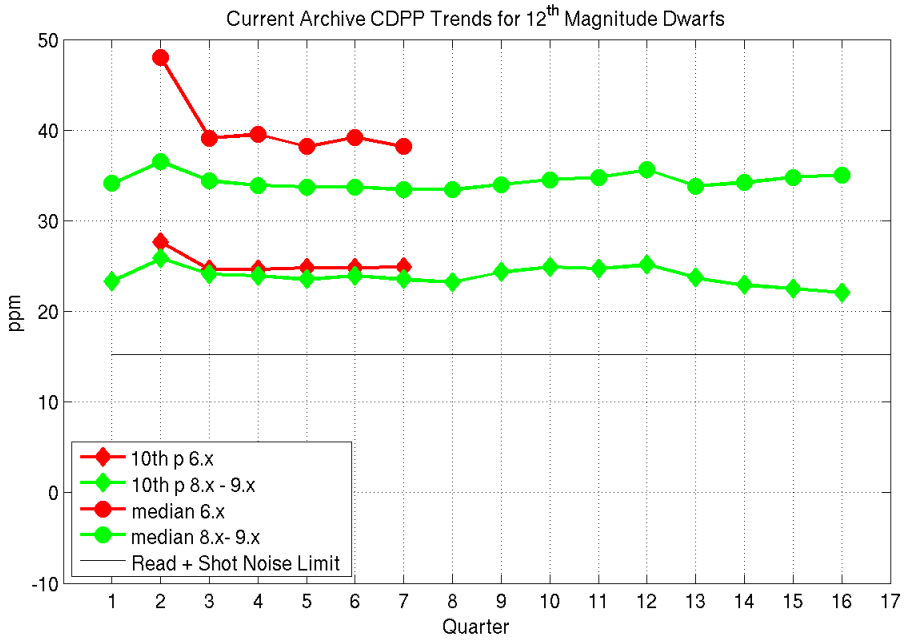

Figure 2: 6.5-h Temporal Median of the CDPP time series. The median (circles) and 10th percentile value (diamonds) for all dwarf stars between Kp=11.75–12.25 are given. The 6-h TMCDPPs have been divided by sqrt(13/12) = 1.041 to approximate 6.5-h TMCDPPs. A detailed discussion of the CDPP values is given in the Kepler Data Characteristics Handbook. The 6.x, 8.x and 9.x labels given in the legend refer to the version of the SOC pipeline used.

Table 1: Aggregate statistics for the TMCDPPs by magnitude. Column Definitions: (1) Kepler Magnitude at the center of the bin. Bins are ± 0.25 mag, for a bin of width 0.5 mag centered on this value. (2) Number of dwarfs (log g > 4) in the bin. (3) 10th percentile TMCDPP for dwarfs in the bin. (4) Median TMCDPP for dwarfs in the bin. (5) Number of all stars in the bin. (6) 10th percentile TMCDPP of all observed stars in the bin. (7) Median TMCDPP for all stars in the bin. (8) Simplified noise model CDPP.

Kp mag	No. dwarfs	10th prctile	Median	No. stars	10th prctile	Median	Noise model
9.0	53	8.5	19.6	182	9.2	42.5	3.8
10.0	161	11.3	28.6	585	13.1	54.6	6.0
11.0	637	15.8	30.8	1714	18.3	61.5	9.5
12.0	2231	22.1	35.0	4010	23.3	47.6	15.2
13.0	7037	31.9	43.7	9670	32.9	50.1	24.4
14.0	14511	49.3	64.5	16637	49.9	66.3	40.1
15.0	28800	87.3	114.4	28804	87.3	114.4	68.8
16.0	15006	161.4	210.4	15006	161.4	210.4	127.8

2.2 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 Figure 3. The meaning of the flags are explained in the Data Characteristics Handbook (Christiansen et al., 2013) and Archive Manual (Thompson & Fraquelli, 2012).

To prolong the life of the remaining reaction wheels, Kepler opted to rest for 11.3 days during Q16. The rest started on January 17, 2013 (CIN 66968) and ended on January 29, 2013 (CIN 67522). No data was collected during this rest. For more details see Section 3.1.

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 in the region, we have marked cadences 67996 and 68010–68013 as COARSE_POINT because they crossed our 0.5 millipixel pointing-deviation threshold. Users should be suspicious of unusual events in their lightcurves in this region.

We marked a single cadence (CIN 69724) with the EXCLUDE flag due to the impact of a solar flare on spacecraft pointing. See Section 3.3 for more information.

Clarifications on select flags in Figure 3 are listed here:

- ARGABRIGHTENING refers to cadences where the multiple-channel Argabrightening flag (flag 0x07, decimal value 64) was set. The single channel Argabrightening flag (0x0D, decimal value 4096) is not represented on this plot.
- COARSE_POINT refers to cadences where the pointing of the telescope drifted by more than 0.5 millipixels from the nominal value. NOT_FINE_POINT refers to cadences where the telescope's fine guidance sensor reported that the telescope was not in fine point mode. These flags are combined as flag 0x03 (decimal value 4) in the FITS files.
- LDE_FLAG refers to flags set by the Spacecraft when a error was detected in the Local Detector Electronics (LDE) or the on-board memory. The pipeline does not process these cadences and only raw pixels are available.

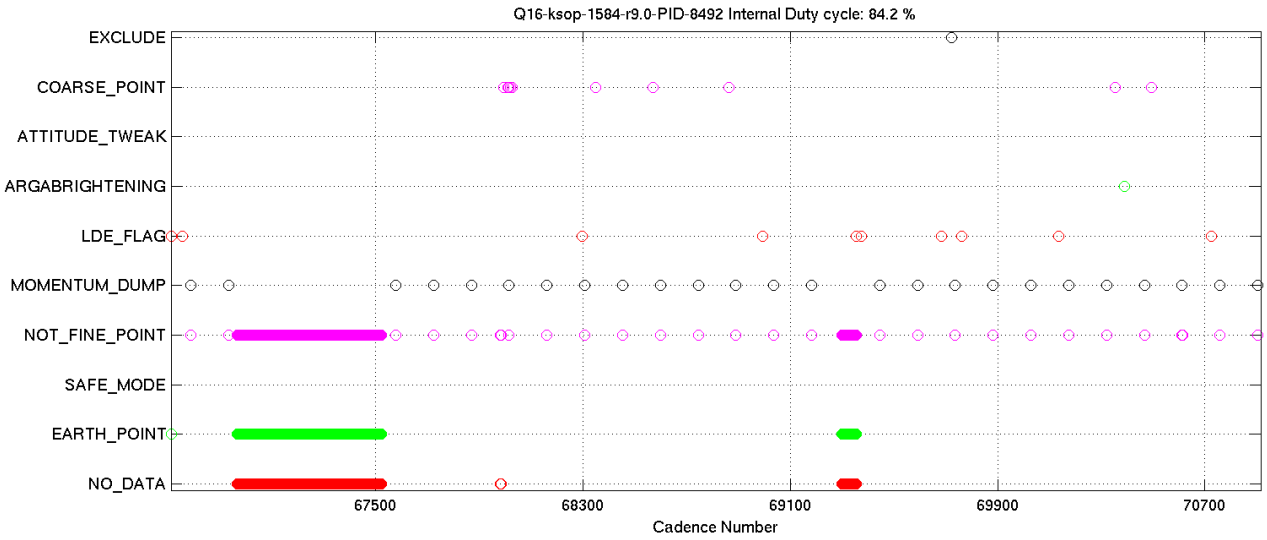

Figure 3: An overview of the location of the data anomalies flagged in Q16. "No_Data" is not an anomaly flag and simply indicates those cadences with no data collected (e.g., during Earth-point or Safe Mode events).

3 Notable Features of the Q16 Data

In this section we discuss features of the data that occurred during collection or processing that are either new to Q16, significantly different than previous quarters, or not discussed in the Data Characteristics Handbook (Christiansen et al., 2013). A more complete listing of events that are known to affect the data are discussed in the Data Characteristics Handbook.

3.1 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.

3.2 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 a ten-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.

3.3 Solar Weather

There were a number of small solar flares 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 impact of a solar flare on spacecraft pointing. A number of cadences immediately before and after this cadence also show elevated dark current, but theses have smaller pointing excursions.

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