

# **Overview of Kepler Light Curve Format Changes**

## **How To Transition from Format v1.0 to v2.0**

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### **Introduction**

In June 2011 the Kepler mission will update their light curve FITS file format. The new format includes more information, provides consistency with the recently released target pixel file column names and keywords, and conforms to astronomical and FITS standards. All of the data that was contained in the original file format exist in the new file format; however, the column order and names have changed. Many of the FITS keywords have also changed. The quarter 0 through quarter 7 data available in this new format in 2011 have not been reprocessed, only the file format has changed; the original Data Release Notes for each quarter still apply.

The new light curve files contain three extensions: Primary, LIGHTCURVE and APERTURE. The Primary header contains keywords describing the instrument and the target. The LIGHTCURVE extension is a binary table containing the light curves and other useful time series data for that target. The APERTURE extension is an image extension that describes which pixels were collected and used to perform the aperture photometry for the specified target. This document is intended to help the experienced data user transition between the old format (v1.0) and the new format (v2.0). For more details on the v2.0 file format read the Archive Manual (KDMC-10008-002).

### **New Column Names**

In order to make the FITS files less opaque and more self-documenting, some column names have changed in the light curve FITS files and those columns that were not populated by the pipeline have been removed. Table 1 maps the v1.0 column names to the v2.0 column names and units. Note that all of the flux columns now have units of electrons per second instead of electrons per cadence. The keywords INT\_TIME and NUM\_FRM are provided to convert between these units.

### **New Columns**

New time series columns have been added to the LIGHTCURVE extension. Table 2 summarizes the contents of these columns. A quality flag column has been added to indicate when events that may impact the data are known to have occurred, such as argabrightenings, cosmic rays and reaction wheel desaturations. The table includes columns for the point-spread function centroid information for those select stars for which this information has been calculated. The last two columns of the LIGHTCURVE data table give the local image motion primarily due to differential velocity aberration, pointing drift, and the thermal effects within the instrument. These are measured using hundreds of stars across the field of view and are presented in pixels relative to the mid cadence of the light curve.

### **New Keywords**

The keywords found in each of the extensions have been overhauled to provide more information about the data and the processing. A detailed list of all the keywords can be found in the Appendix of the Archive Manual. Those keywords that describe the data processing and time system are in the LIGHTCURVE extension, including those that describe the integration time, the gain and read noise of the CCD, and how the data was processed by PDC. The keywords that describe the target mask and optimal aperture are in the APERTURE extension. These include celestial and detector WCS coordinates for all pixels available for this target.

**Table 1 Column names in v2.0 light curve FITS files mapped to their v1.0 column names.**

v1.0 Col Num	v1.0 Column	v1.0 Units	v2.0 Col Num	v2.0 Column	v2.0 Units	Description
1	barytime	days (reduced BJD)	1	TIME	days (kepler BJD)	Barycentric Julian Day calculated for the target in the file
2	timcorr	seconds	2	TIMECORR	days	Barycentric correction minus time slice correction applied to the time
3	cadence_number		3	CADENCENO		Unique cadence number
4	ap_cent_row	pixels	15	MOM_CENTR1	pixels	Moment-derived column centroid
5	ap_cent_r_err	pixels	16	MOM_CENTR1_ERR	pixels	Moment-derived column error
6	ap_cent_col	pixels	17	MOM_CENTR2	pixels	Moment-derived row centroid
7	ap_cent_c_err	pixels	18	MOM_CENTR2_ERR	pixels	Moment-derived row error
8	ap_raw_flux	e-/cad	4	SAP_FLUX	e-/s	Aperture photometry flux
9	ap_raw_err	e-/cad	5	SAP_FLUX_ERR	e-/s	Aperture photometry error
10	ap_corr_flux	e-/cad	8	PDCSAP_FLUX	e-/s	Aperture photometry flux after Pre-search Data Conditioning
11	ap_corr_err	e-/cad	9	PDCSAP_FLUX_ERR	e-/s	Aperture photometry error after Pre-search Data Conditioning

**Table 2 New column names in the v2.0 light curve FITS files.**

Col Number	New Column Name	Units	Description
6	SAP_BKG*	e-/s	Background flux in optimal aperture
7	SAP_BKG_ERR*	e-/s	Background error in optimal aperture
10	SAP_QUALITY		Bit flags describing when data phenomena occur
11	PSF_CENTR1	pixels	PSF-fitted column centroid
12	PSF_CENTR1_ERR	pixels	PSF-fitted column error
13	PSF_CENTR2	pixels	PSF-fitted row centroid
14	PSF_CENTR2_ERR	pixels	PSF-fitted row error
19	POS_CORR1	pixels	Column position correction based on bright stars
20	POS_CORR2	pixels	Row position correction based on bright stars

\* Data for the background flux columns will not appear in the Q0-Q7 light curve files until the data are reprocessed at the end of 2011.