Lucy
SOFTWARE INTERFACE SPECIFICATION
LOng Range Reconnaissance Imager (L'LORRI)
Data Products

August 2024

SwRI® Project 22668

Document No 22668.07-LLORRI-SIS-01

Rev 0 Chg 0

Contract NNM16AA08C

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TABLE OF CONTENTS

REVISION NOTICE

Revision Number	Change Number	Sections Affected	Change Description	Release Date
0	0	All	(DRAFT, R0)	04/28/2021
0	0	All	(DRAFT, R0)	03/15/2023
0	0	All	(DRAFT, R0)	09/08/2023
0	0	2.3.4.1	File naming convention updates per PR-0313 and TCR 2311	06/13/2024
0	0	All	INITIAL RELEASE	08/2024

TBD/TBS RESOLUTION SCHEDULE

Location	Description	Resolution Date
Table 1-1	Weaver et al., 2023 DOI and publication date	12/31/2023
All	2023 PDS Peer Review updates	6/13/2024

1. INTRODUCTION

1.1 Purpose and Scope

The purpose of this Software Interface Specification (SIS) is to provide the consumers of the *Lucy* LOng Range Reconnaissance Imager (L'LORRI) raw and partially processed data products with a detailed description of the data products, and how they were generated, including data sources and destinations. The document is intended to provide enough information to enable users to read and understand the data product. This document is intended for scientists who will analyze these data, including those associated with the project and those in the general planetary science community.

Raw data products described in this SIS are uncalibrated, uncorrected data products reassembled from spacecraft telemetry as acquired by the instrument. Partially processed data products described in the SIS are corrected for instrument artifacts and are ready for absolute radiometric calibration. The *Lucy* Science Operations Center located at the Southwest Research Institute, Boulder, Colorado produces these data products and distributes them to both the *Lucy* Science Team and the Planetary Data System (PDS). This SIS describes how the L'LORRI data products are acquired by the instrument, processed, formatted, labeled, and uniquely identified. The document discusses standards used in generating the product and software that may be used to access the products.

1.1 Contents

This Data Product SIS describes how the raw data products are acquired by L'LORRI and how the products are processed, formatted, labeled, and uniquely identified. This SIS also describes how the partially processed data products are derived from the raw data. The document discusses standards used in generating the products, and software that may be used to access the products. The raw and partially processed data product structure and organization is described in sufficient detail to enable a user to read the product. Processing is described at a high level, and full definitions of all metadata attributes are provided.

1.2 Applicable Documents

This SIS is meant to be consistent with the contract negotiated between the *Lucy* Project, the L'LORRI Instrument Principal Investigator, and the *Lucy* Science Operations Center (SOC). Product label keywords/attributes may be added to future revisions of this SIS. Therefore, it is recommended that software designed to process products specified by this SIS should be robust to (new) unrecognized keywords. Similarly, entirely new products may be added over time.

This Data Product SIS is responsive to the following documents:

Table 1-1. List of Applicable Documents

Document ID	Title	Release Date	Revision
JPL D-7669, Part 2	Planetary Data System Standards Reference	June, 2023	1.20

Document ID	Title	Release Date	Revision
n/a	Data Provider's Handbook, Archiving Guide to the PDS4 Data Standards	June, 2023	1.20
n/a	Planetary Data System Common Dictionary Document	June, 2023	1.20
22702-DMAP-01	*Lucy* Data Management and Archive Plan		current revision unless revision is specified
22668.07-ST-ICD-01	*Lucy* Science Operations Center to Science Team ICD		current revision unless revision is specified
unassigned	*Weaver et al., The Lucy Long Range Reconnaissance Imager (L'LORRI), Space Science Review*	November 30, 2023	Space Science Reviews (2023) 219:82 https://doi.org/10.1007/s11214-023-01028-z

1.3 Relationship with Other Interfaces

This SIS could be affected by changes to the *Lucy* Data Management and Archive Plan (DMAP) or the *Lucy*-SBN Interface Control Document (ICD). Where possible, references are made to the DMAP or ICD rather than duplicating information in this document. This SIS may be revised by consent of the signatories. The following table is a list of other interfaces where changes may affect the contents of this SIS. The SIS will be updated when necessary.

Table 1-2. List of Interface Relationships

Name	Type	Owner
Lucy SOC Database Schema	Product	SOC
Inst Raw Data	Product	SOC
Inst Partially Processed Data	Product	SOC
Inst Calibrated Data	Product	SOC

Inst Pipeline Software	Software	SOC
Lucy SOC-SBN Configuration Control Plan	Document	SOC
Lucy SOC-SBN ICD	Document	SOC
Lucy DMAP	Document	Project

2. DATA PRODUCT CHARACTERISTICS AND ENVIRONMENT

2.1 Instrument Overview

The L'LORRI instrument provides the highest-resolution imaging for the Lucy mission. The panchromatic images will address 7 of our 17 Level 1 science requirements (Olkin et al. 2021) including searching for satellites, determining the size frequency distribution of craters, stereo imaging, and shape reconstruction. The L'LORRI instrument will also be used for optical navigation to our targets. The instrument was built at the Johns Hopkins University Applied Physics Laboratory. Dr. Harold Weaver was the original Instrument Principal Investigator (PI), but Dr. Neil Dello Russo has been the PI since October 2022.

The instrument design is derived from that of the LORRI instrument (Cheng et al. 2008) on NASA's New Horizons mission. L'LORRI uses the same detector and has the same optical design as New Horizons LORRI. The primary mirror has a diameter of 20.8 cm, the telescope has a focal length of 262 cm, and the detector is a 1024x1024 thinned back-illuminated frame transfer CCD from Teledyne e2v. Each pixel subtends 5 μrad and has a point spread function (PSF) with a full width half maximum of less than 15 μrad. Differences from the heritage instrument worth noting are the addition of redundant electronics, memory to store L'LORRI data, and differences in the instrument accommodation on the spacecraft. On New Horizons the LORRI instrument is inside of the spacecraft, but on Lucy L'LORRI is mounted on the Instrument Pointing Platform (IPP).

The L'LORRI instrument has two modes of operation: 1x1 mode (unbinned data) and 4x4 mode (binning the pixels 4x4 during CCD read out). The primary purpose for the 4x4 mode is to increase sensitivity for satellite searches. To accomplish the satellite searches, L'LORRI is required to have a SNR ≥ 7 in 4x4 mode for a 10 second exposure time on a V=15.8 magnitude source. For the high-resolution imaging of a resolved source the instrument needs to have a SNR ≥ 25 in 100 ms exposure time for I/F = 0:00148 at 5.7 AU. The I/F corresponds to a Trojan asteroid with a geometric albedo of 3% at a phase angle of 82° with a phase curve of 0.04 mag/degree. The Lucy mission can accomplish the science objectives for each encounter on just one asymptote, preferably the one with the smaller solar phase angle as it has the most illuminated terrain. Across all encounters, the minimum phase angles during the relevant time frames span from the smallest solar phase angle at Orus (54°) to the largest value 82° for Polymele. Therefore, the Lucy mission set the 82° phase angle for the SNR requirement. L'LORRI also has a requirement to not saturate when observing a target with I/F = 0:40 that covers half the field of view. This requirement was driven from the experience of Dawn at Ceres, which observed a highly reflective surface in Occator crater (de Sanctis et al. 2016).

Table 2-1. List of Instrument Properties

Attribute	Value
Mass, kg	11.9
Power, W	8.6 (not including s/c decon heater pwr)
FOV, °	0.29
iFOV, *μrad*/pixel	5.0
Spectral Range, *μm*	0.42-0.80 (at 50% QE values)
Spectral Resolution	380 nm (bandpass at 50% QE values)

2.1.1 Observation Profile and Data Acquisition

The Lucy mission consists of five flybys of Trojan asteroids to investigate the differences in their surface and internal properties across the population. From these five encounters, we will be able to observe seven Trojan asteroids: Eurybates and its small satellite Queta, Polymele, Leucus, Orus, Patroclus and Menoetius. Two of the flybys will encounter multiple Trojan asteroids. The first Lucy Trojan flyby will be of Eurybates and its recently discovered small moon (Noll et al. 2020), and the last encounter is of the near-equal size binary system: Patroclus and Menoetius. Lucy will also fly by Main Belt asteroid targets of opportunity, VD57 Dinkinesh and (52246) Donaldjohanson, prior to reaching the Trojans, and will use these encounters to test operations.

During the flybys, the spacecraft is moving relative to the Trojan asteroids with a velocity of 6-9 km/s making time a critical resource. The mission is designed to maximize the data collected around closest approach which requires efficiency in observing the Trojan asteroids.

Most observations and actions on the spacecraft are commanded to execute at a given time. However, during the close-approach subphase most science observations will be initiated based on the range of the spacecraft to the Trojan asteroid target. At the beginning of this time period, the range is estimated based on an on-board ephemeris. As the spacecraft approaches the target and the image of the target is resolved in the Terminal Tracking Cameras, the on-board terminal-tracking state estimation begins to provide an estimate of the Trojan's location relative to the spacecraft. This terminal tracking allows the Lucy spacecraft to have updated knowledge of the target which allows for a more efficient observing strategy. The large uncertainty in the target location (relative to its size) is collapsed by the on-board terminal tracking system.

2.2 Data Product Overview

L'LORRI Instrument data are natively stored as binary Flexible Image Transport System (FITS) files. Images with associated meta-data are also stored in database tables in the Lucy SOC Data Repository for further processing by the SOC systems. Housekeeping (HK) data are stored in the SOC Data Repository and are used in data processing. Calibration files necessary to process image data are stored as FITS files, or text files (for exposure time corrections), and are made available to the processing pipeline.

The specific data products described by this SIS are:

1. L'LORRI Raw Image Data - Raw instrument image data reconstructed from telemetry in units of Digital Number (DN). The raw data file is a 4-Header Data Unit (HDU) FITS file

with image data (primary HDU), histogram data (first extension), image header information (second extension), and image descriptor information (third extension).

Image data are 16-bit pixel values, with array sizes of either 1028x1024 in 1x1 binning, or 258x256 in 4x4 binning mode. Metadata attached to the raw L'LORRI images (found in the FITS headers) describes the geometry and conditions at the time of the observation.

The data in the histogram extension are an array of thirty-two 32-bit values that provides the frequency distribution of pixel intensities grouped into bins with each bin covering a range of 128 digital numbers (DN). Analysis of the image histogram indicates if the image was over or underexposed.

The data in the image header information extension is an 84-byte long array that are a subset of the data provided in the image descriptor extension. During downlink from the spacecraft, these data are sent along with the image data, providing a way to interpret the image if the image descriptor is not received.

The data in the image descriptor information extension is an 84-byte long array that indicate the state of the instrument at the time the image was acquired, providing sampled values for currents, voltages, temperatures, and instrument settings. These values are in engineering units and must be corrected or calibrated as part of the conversion to scientific units. The converted values are given in the primary HDU header. The image descriptor is sent as low-rate housekeeping data separate from the image to provide the L'LORRI instrument team with valuable information prior to downlinking the image itself.

2. L'LORRI Partially Processed Image Data – The L'LORRI partially processed data product is a three data array (HDU) FITS file. The primary data array is a 2-dimensional primary image data array of 32-bit real values in units of DN in an array size of 1024x1024 or 256x256 depending on image binning. The secondary data array is a 2-dimensional error image data array of 32-bit real values in units of DN in an array size identical to the primary array. The tertiary data array is a 2-dimensional quality flag data array of 16-bit unsigned integer values in an array size identical to the primary array. Metadata attached to the raw L'LORRI images (found in the FITS headers) describes the geometry and conditions at the time of the observation.

2.3 Data Processing

The Lucy Science Operations Center (SOC) is responsible for all Lucy science data processing. L'LORRI science and engineering telemetry are received by the SOC via the Mission Operations Center (MOC). L'LORRI raw telemetry data are reconstructed, sorted, and stored in the SOC data repository. L'LORRI science data (along with its associated engineering and housekeeping data) are retrieved from the data repository and fed into the L'LORRI-specific data processing pipeline. The pipeline produces the L'LORRI uncalibrated and partially processed science and engineering data products. Generally, data are stored in FITS file format, and are delivered to the PDS in that format. Production rates of partially processed data vary over the course of the mission and are dependent on observing campaigns during specific mission phases. Individual file sizes based on the current operational plan are as follows: L'LORRI uncalibrated science data files are approximately 2.1 MB (1x1) and 156 KB (4x4), and partially processed science data files are approximately 10.5 MB (1x1) and 674 KB (4x4).

2.3.1 Data Processing Level

The L'LORRI data products comply with NASA processing level standards as shown in Table 2-2. L'LORRI partially processed data products are derived from the raw product. Calibration file data processing levels are not discussed, as calibration files require special production techniques.

Table 2-2. Data Processing Levels

Lucy Archive Data Product	PDS4 Processing Level	Description
N/A	Telemetry	An encoded byte stream used to transfer data from one or more instruments to temporary storage where the raw instrument data will be extracted. PDS does not archive telemetry data.
Uncalibrated Data Product	Raw	Original data from an instrument. If compression, reformatting, packetization, or other translation has been applied to facilitate data transmission or storage, those processes will be reversed so that the archived data are in a PDS approved archive format. For L'LORRI this is the raw image plus housekeeping data product.
Partially Processed Data Product	Partially Processed	Data that have been processed beyond the raw stage, but which have not yet been calibrated to physical units. For L'LORRI this is the partially processed (corrected, but not yet converted to radiance) image plus housekeeping product
N/A	Calibrated	Data converted to physical units, which makes values independent of the instrument.
	Derived	Results that have been distilled from one or more calibrated data products (for example, maps, gravity or magnetic fields, or ring particle size distributions). Supplementary data, such as calibration tables or tables of viewing geometry, used to interpret observational data should also be classified as "derived" data if not easily matched to one of the other three categories.

2.3.2 Data Product Generation

The L'LORRI uncalibrated files will be generated by the SOC from the downlinked spacecraft telemetry. The uncalibrated products will contain raw, uncalibrated data, formatted according to the Raw science format defined in this SIS. New versions of the products will be identified using a version identifier in the filename, as indicated in Section 2.3.4.1 and by the version_id field in the PDS label. On successful completion through the L'LORRI data processing pipeline software, the SOC will be responsible for inserting the output file data into the SOC Data Repository. In case of errors, any messages produced as well as the error file will be saved for further diagnosis by the L'LORRI engineers.

Partially processed data products will be automatically produced by the data processing pipeline software as soon as all data for the single image has been received, reconstructed, processed, and associated geometry is available. The SOC will monitor the records being downlinked and

correlate them with the uplinked commands to ensure that all commanded data has been accounted for.

New versions of partially processed data will be generated should the raw data, the instrument/spacecraft geometry, the calibration algorithm, or the calibration software components change. Changes to the calibration algorithm and software components will be rare events. It is more likely that an update to geometry will cause re-processing. New versions of the partially processed data will be identified by incrementing the version identifiers (filename version and PDS label version_id) in the data. All versions of the data products are retained in the SOC repository for reference, however only certified valid products are released to the PDS. Should products need to be updated in the archive, the new certified valid products will replace the older (deprecated) versions

2.3.2.1 Uncalibrated Data Product Generation

L'LORRI science, engineering, and ancillary packet telemetry are received from the Mission Operations Center (MOC) via a dedicated connection. The packet data are ingested into the SOC data repository using the Database Downlink Ingestion Tool (DDIT) which is responsible for decompression, database communication, parsing, data insertion, and querying. Once L'LORRI packet data are sorted, parsed, and inserted in the SOC data repository holding tables, they are ready for instrument specific processing. Further processing starts from the holding tables.

The Pipeline Executive (PExe) process controls the SOC data processing environment by managing and initiating all pipeline functions. Using either scheduled or manual jobs, PExe calls the main Unprocessed Data Processing (UDP) module that manages the setup and execution of the individual instrument pipeline functions. The L'LORRI UDP module builds the uncalibrated data products, in FITS format, by appending packet data. The L'LORRI UDP module returns all UDP products and logfile information to the SOC data repository.

2.3.2.2 Partially Processed Data Product Generation

Once the UDP module has completed its operations and returned UDP products and logfile information to the PExe, the Calibrated Data Processing (CDP) module can be called to partially processed data products from the uncalibrated data files. In the case of L'LORRI, the CDP code is used to create what is known in PDS data processing levels as a partially processed product. This means that the output of the CDP code is not yet in physical units. A PDS calibrated product must be in physical units, however the data processing code that produces the L'LORRI partially processed data product is known as CDP. CDP is initialized with an input file containing the calibrated file specification, and any other information needed to process the data products. The CDP processing steps are described in the following paragraphs.

2.3.2.2.1 Exposure Time Correction

Owing to a feature in the timing of the CCD control signals, the actual exposure time is sometimes different from the exposure time commanded by the DPU. Since the offset (actual vs commanded) varies back-and-forth across a range of possible values depending on the commanded exposure time, this effect is referred to as exposure time "jitter". Based on ground tests and simulations, an algorithm was designed to calculate the jitter for all possible L'LORRI exposure times, and a table was created that is used by the pipeline to correct the commanded exposure times to their actual values, when necessary (some exposure times do not need to be corrected). These tables are found

in the L'LORRI calibration collection. The offset exposure time values are provided in a two-column ascii table with the exposure time "extra" milliseconds (i.e., beyond an integral number of seconds) in the commanded exposure time in the first column and the offset (in ms) in the second column. That is why these files only run from 0 to 999 in the first column. Based on the first column value, the second column's value is subtracted from the commanded number of milliseconds to give the actual exposure time in ms. The result is then divided by 1000 to give the actual exposure time in seconds. There are two tables, one for 1x1 format and one for 4x4 format. The commanded exposure time is found in the <exposure_duration> attribute, which is in units of "seconds".

2.3.2.2.2 Bias Subtraction

In the L'LORRI calibration pipeline, the removal of this bias is a two-step process: first, a global bias level is removed based on the average signal level for pixels sampled from the optically inactive region of the CCD, and then the pixel-to-pixel bias variation is removed using a so-called superbias image, which has a median level of 0 DN. For 1 × 1 format images, four columns in the inactive region are captured, which means a total of 4096 pixels (1024 × 4) are used to compute a robust average of the global bias level. For 4 × 4 format images, two columns in the inactive region are captured, which means a total of 512 rebinned pixels (256 × 2) are used to compute a robust average of the global bias level.

However, there is a systematic offset between the bias level in the active and inactive regions of the CCD, which is likely associated with different capacitive effects in the active and shielded regions of the CCD. The offset is 3.2 DN for 1 × 1 images and 5.1 DN for 4 × 4 images. The L'LORRI calibration pipeline accounts for these offsets. After a robust mean of the bias region is computed to create a global bias level, 3.2 DN (for 1x1 images) and 5.1 DN (for 4x4 images) is added to the bias level. The new global bias level is subtracted from each pixel in the image to be processed. The final superbias images are created by subtracting the mean value of the raw superbias image from all pixels, producing an image with mean of zero.

The bias subtraction process for the LLORRI pipeline is:

1) Compute a robust mean of the bias region to create a "global bias level".
2) For 1x1 (4x4) images, add 3.2 (5.1) DN to the level found in step (1).
3) Subtract the "new global bias level" from each pixel in the image to be processed.
4) Subtract the "superbias" image (with mean of 0) from the result in (3)
    a. Final superbias images created by subtracting the mean value of the raw superbias image from all pixels, producing an image with mean of 0.
    b. The bias-subtracted image removing pixel-to-pixel variation.

The L'LORRI superbias calibration data product is a single data array (HDU) fits file. The data array is a 2-dimensional image data array of 32-bit real values in units of DN in an array size of 1024x1024 for 1x1 binning or 256x256 for 4x4 binning. Superbias image files are named llorri_superbias_1x1.fits and llorri_superbias_4x4.fits respectively and are chosen by the calibration algorithm based on image binning. (calibration files are found in the llorri calibration collection).

2.3.2.2.3 Signal linearity and dynamic range

No correction is made in the L'LORRI pipeline for signal linearity or dynamic range limitations because these effects have negligible effect (<1%) on the recorded signals, as demonstrated by ground tests.

The dynamic range refers to the maximum net signal level (after subtraction of the bias) in the linear response portion of a single exposure divided by the electronics noise (0.9 DN). The demonstrated L'LORRI's response is linear to within ~1% and the dynamic range for a single exposure is ≥4200. This is independent of which L'LORRI DPU side is used, or which CCD format (1x1 vs 4x4) is used.

2.3.2.2.4 Charge Transfer Inefficiency (CTI)

No correction is made in the L'LORRI pipeline for CTI because its effect should be negligible (<1%) on the recorded signal levels.

2.3.2.2.5 Dark Subtraction

At the predicted in-flight CCD temperatures, the dark current is expected to be negligible (<1 DN). We measured the dark current under flight-like conditions during the post-environmental calibration at APL. By taking three consecutive pairs of 0 ms and 64,900 ms images in 4 × 4 format, and then subtracting the shorter exposure image from the longer exposure image, we were able to measure the dark current accumulation rate when the CCD was at -80 C (0.0873 e/s for 4x4 mode, 0.00546 e/s for 1x1 mode). Only pixels in the optically-inactive region of the CCD were used to avoid contamination from any residual background light. The results demonstrate that the dark current from the L'LORRI CCD is extremely small (~0.3 DN in a 64.9 s exposure), comparable to that measured for New Horizons LORRI. A dark subtraction is, therefore, not applied.

2.3.2.2.6 Smear Removal

Whenever L'LORRI is active, the CCD is exposed to whatever scene is in the FOV. The clocking of the CCD includes a "frame scrub", followed by exposure to the scene for the commanded integration time, followed by a "frame transfer" in which the CCD rows are sequentially transferred from the optically active area to the image storage region, followed by a readout of the image storage region to the downstream electronics. Owing to the finite transfer time, photons from the source continue to be integrated during the frame scrub and frame transfer processes, thereby producing the so-called transfer smear. However, if the source is not saturated, the signals accumulated during these transfers can be effectively and deterministically removed during post-processing at the cost of some additional photon noise. Unlike the case for LORRI, the L'LORRI scrub and transfer times are exactly equal (11.7762 ms), which considerably simplifies the algorithm used (described below) to remove the smear transfer signal in the calibration pipeline.

If the corrected image (with readout smear removed) is written as $P_{corr}\ (i,j)$, it can be recovered from the measured image $P_{meas}\ (i,j)$ by (here 1x1 format is assumed):

$$P_{corr}(i,j) = \left[P_{meas}(i,j) - \frac{T_f}{1024} * \frac{\sum_{all\,k} P_{meas}(i,k)}{T_{exp} + T_f * \frac{1023}{1024}} \right] * \frac{T_{exp}}{T_{exp} - \frac{T_f}{1024}}$$

Where:
i is the CCD column number
j is the CCD row number
T_f is the frame scrub/transfer time (11.7762 ms)
T_{exp} is the actual exposure time in ms (after correction, when necessary)

The same algorithm is used for 4x4 format, but "1023" in the equation above is replaced by "255" and "1024" is replaced by "256".

Note that all exposure times in the desmear equation are in milliseconds.

2.3.2.2.7 Flatfield Correction

During ground calibration testing, flatfields ("flats") were obtained by using a calibrated integrating sphere to provide uniform illumination across the full L'LORRI aperture. Two different light sources were used. and they produced flats that differed by ≤1% for the vast majority of pixels. Flats were obtained in multiple thermal environments meant to mimic in-flight conditions, but they varied by ≤0.5% for the vast majority of pixels. Flats taken with the two different L'LORRI DPUs were essentially identical at the 0.1% level. The absolute intensity of the input illumination was measured using a calibrated photodiode.

The flatfield reference file used in the L'LORRI calibration pipeline was produced by averaging 100 flats taken when the OTA was at −85 C during the post-environmental calibration using weighted averages of flats from the two different light sources. These average images were debiased and desmeared, and then normalized to an average value of 1. The raw weighted average included a ghost of the field-flattening assembly near the center of the CCD (the integrating sphere overfilled the L'LORRI aperture) and scattered light near the bottom (low CCD row numbers) and right (high CCD column numbers) edges of the CCD. Removal of both of these artifacts was attempted, but their residuals are visible in the final flat, although only at the ~1% level, or less. The "dinkinesh_" files were derived from ground calibration measurements with additional correction for ghosting and FOD (foreign object debris) that has accumulated in flight.

The L'LORRI flatfield calibration data product is a single, dimensionless data array (HDU) FITS file. The data array is a 2-dimensional image data array of 32-bit real values with an array size of 1024x1024 for 1x1 binning or 256x256 for 4x4 binning. Flatfield image files are named llorri_flat_1x1.fits and llorri_flat_4x4.fits, respectively, and are chosen by the calibration algorithm based on image binning. (Found in observational image header format or cformat keywords). The L'LORRI images are corrected with the flatfield by dividing the appropriate (1x1 or 4 x4) flatfield data product from the L'LORRI bias subtracted, desmeared image.

2.3.2.2.8 Conversion to Physical Units

The final step in the calibration is the absolute calibration. The calibration software pipeline will not perform per-pixel conversion from DN to physical units, because that conversion requires knowledge of the spectral distribution (i.e., color) of the target. Instead, the pixel values are left in their corrected (calibrated) DN units from the flat-fielding, and the absolute calibration step adds "photometry" keyword divisors to the FITS header. Each divisor scales per-pixel count rate values from DN/s/pixel to physical units according to its assumed spectral type and spatial distribution (diffuse vs. point source) for the target. For discussion on the definition of photometry keywords and values used for 1x1 and 4x4 binning modes see section 4.3 and Table 6 in Weaver et al. 2023.

2.3.2.2.9 Additional Image Extensions

LORRI partially processed FITS files have three extensions. The debiased, desmeared LORRI image is written into the primary HDU as a 2-dimensional, 64-bit real image. The unit for each data value is photometrically-corrected DN. The estimated errors in these corrected DN values are stored as a 2-dimensional, 32-bit real image in the first extension. A data quality image is stored in the second extension as a 2-dimensional, 16-bit integer image.

The error in the photometrically-corrected signal is estimated from:

$$\sigma = \frac{\sqrt{(P_{meas}/g) + (RN)^2 + (fP_{meas})^2}}{FF}$$

where "σ" is the 1-sigma error in the corrected signal for a particular pixel (DN), "P_{meas}" is the observed signal in that pixel (DN, after bias subtraction but before smear removal), "g" is the electronics gain (21.1 e/DN for 1x1, 20.0 e/DN for 4x4), "RN" is the electronics noise (0.9 DN), "f" is the estimated error in the reference flat-field image (0.005), and "FF" is the value of the reference flat-field image at the relevant pixel. The above formula neglects any noise contributed by the bias and smear removal steps, but those errors are generally expected to be small compared to the other sources of error.

The data quality image is used to flag pixels that have known artifacts and may need special consideration when performing scientific analysis. The pixel value in the quality flag image represents the sum of all quality flags present for that pixel. This pixel value can also be described as the result of the bitwise 'OR' of each quality flag value. The list of data quality values and their descriptions are listed in the table below.

Table 2-3. Quality Flags

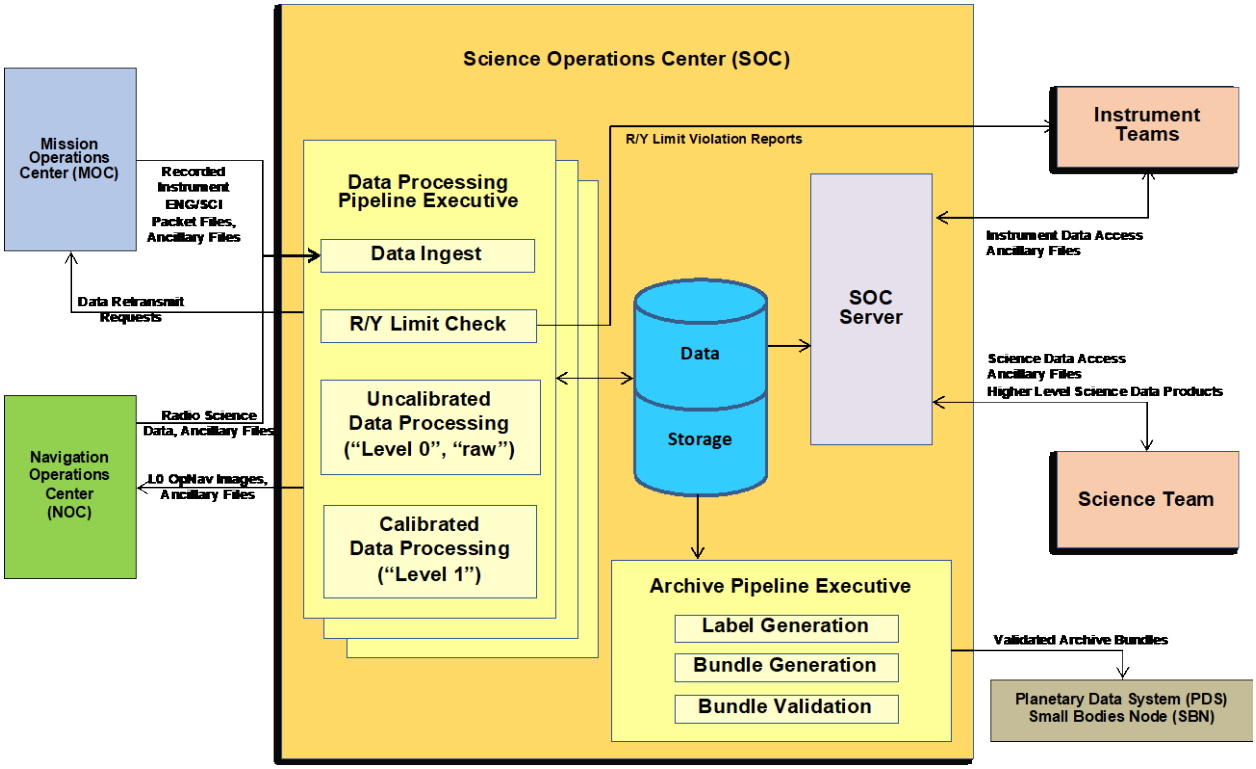
Quality Flag Value	Bit position in 2-byte word	Description
0	n/a	Good pixel
1	0	Defect in reference superbias image (set if 0 or NaN)
2	1	Defect in reference flatfield image (set if 0 or NaN)
4	2	Permanent CCD defect

8	3	Hot pixel identified
16	4	Saturated pixel in Uncalibrated Data Product
32	5	Missing data in Uncalibrated Data Product
64 and higher	6-15	unused at present

2.3.3 Data Flow

L'LORRI uncalibrated and calibrated data products are built up in sequential data processing steps addressing specific corrections or calibrations. All data products are built from raw telemetry ingested into the SOC data repository system. The L'LORRI calibration pipeline queries the SOC date repository for the raw telemetry, science, and ancillary data. Figure 2-1 illustrates the SOC L'LORRI data processing pipeline data flow. The Lucy Instrument and Science Teams access data products in the data repository through a query tool.

Figure 2-1. Lucy SOC Data Flow



2.3.4 Labeling and Identification

All L'LORRI products consist of a PDS4-compliant detached XML label that describes the content and format of the associated data files. These labels describe the content and format of the associated data product. Labels and products are associated by file name with the label having the same name as the data product except that the label file has an .xml extension. Labels are

constructed with the PDS4 Product Class, Product_Observational sub-class. The Product_Observational sub-class describes a set of information objects produced by an observing system. A representative hierarchical description of the contents of a L'LORRI Product_Observational is presented below. Note that some classes and attributes may or may not appear in the actual data product label. Classes are indicated by title case and attributes by lower case.

Product_Observational
- Identification_Area – class that contains attributes that identify and name an object.
  - logical_identifier - name/location of file
  - version_id – PDS version of product
  - title - Name of file
  - information_model_version - version of PDS4 information model used to create product.
  - product_class - attribute provides the name of the product class (Product_Observational)
  - Citation_Information – attributes that provide specific information for citing data products in journal articles, abstract services, or other reference contexts.
  - Modification_History - attributes describing changes in data product.
- Observation_Area - attributes that provide information about the circumstances under which the data were collected.
  - Time_Coordinates - time attributes of data product
  - Primary_Results_Summary - high-level description of the types of products included in the collection or bundle
  - Investigation_Area - mission, observing campaign or other coordinated, large-scale data collection attributes
  - Observing_System - observing system (spacecraft and instrument) attributes
  - Target_Identification - observation target attributes
  - Mission_Area - mission specific attributes needed to describe data product.
    - Lucy_Observation_Planning – class that contains attributes describing the planned *Lucy* observations, and instrument status.
    - Lucy_Observation_Time_Information – class that contains attributes describing the various times associated with the observation.
    - Lucy_Target_List – class that contains attributes describing target within the observation field of view.
    - Lucy_Product_Information – class containing attributes that give additional information about the data product.
    - LLORRI_Instrument_Parameters – class containing attributes specific to the L'LORRI instrument.
  - Discipline_Area – discipline specific attributes collected by specific discipline areas.
    - Geometry - discipline dictionary class that contains geometric information about the data product.
    - Imaging – discipline dictionary class that contains image and camera specific attributes.
    - Mission_Information - discipline dictionary class that contains general mission information values.
    - Processing_Information - discipline dictionary class that contains attributes describing the data processing used to create the data product.
    - Earth_Based_Telescope_Parameters – discipline dictionary that contains World Coordinate System attributes.
- Reference_List – class that provides references to products or documentation relevant to the data product.
- File_Area_Observational - describes a primary data file and one or more tagged_data_objects contained within.
  - File - identifies the file that contains one or more data objects as described below.
    - Header* – contains any attached file header information.
    - Array_2D* - contains classes that describe a number of 2D arrays, typically images or spectra.

*Header and 2D array classes are repeated for each Header Data Unit (HDU) present in a .FITS file.

Information in the preceding paragraphs was distilled from the PDS4 Information Model provided by PDS. Additional information on product labels can be found at https://pds.nasa.gov/pds4/about/index.shtml.

2.3.4.1 Product Naming

All L'LORRI data products are named using the following naming conventions:

<inst>_<acqtime>_<obsid>_<image_counter>_<image_format>_<level>_<version>.<ext>

where
inst = 3-letter instrument ID: lor (LORRI)
acqtime = 10-digit SCLK value (seconds) at the start of the acquisition
obsid = 5-digit integer observation ID
image_counter = 5-digit integer LORRI image counter (field is omitted for non-LORRI instruments)
image_format = 3-charater value LORRI image format ID: 1x1 (1x1 image format) 4x4 (4x4 image format) (field is omitted for non-LORRI instruments)
level = 3-letter data processing level: eng (uncalibrated), sci (calibrated)
version = 2-digit integer product version number
ext = 3-letter file type extension: fit (Flexible Image Transport System)

L'LORRI data products are FITS file type so therefore have suffixes of ".fit". All L'LORRI files are created with detached PDS labels, indicated by the ".xml" file extension. The labels are PDS4 compliant XML format.

2.4 Standards Used in Generating Data Products

2.4.1 PDS Standards

All data products described in this SIS conform to PDS4 standards as described in the PDS Standards document noted in the Applicable Documents section of this SIS. Prior to public release, all data products will have passed both a data product format PDS peer review and a data product production pipeline PDS peer review to ensure compliance with applicable standards.

2.4.2 Time Standards

Time Standards used by the Lucy mission conform to PDS time standards.

2.4.3 Coordinate Systems

A summary of the Lucy Mission coordinate system process is as follows. The Lucy project will establish a task force to define coordinate systems for each target. The coordinate systems will be reviewed and validated by PDS prior to data delivery, as outlined in the PDS Policy on Acceptable Body-Fixed Coordinate Systems (PDS Mission Proposer's Archiving Guide v4-r5, 21 Sept. 2016). In parallel, the Lucy team will engage the International Astronomical Union (IAU) Working Group

on Cartographic Coordinates and Rotational Elements (WGCCRE) coordinate system standards for an official approval of the proposed coordinate systems. Based on our experience, IAU may take several months to approve a coordinate system, and therefore the Lucy team will proceed with PDS delivery using the coordinate systems agreed upon by the project and the PDS. Once final approval by IAU is achieved, the Lucy project will redeliver georeferenced data to PDS, as needed. Upon PDS validation of all the coordinate systems for each Trojan asteroid, all archive instrument products will be updated with the accepted coordinate system for delivery to the PDS 4.5 months after last data downlink for each flyby (with the exception of Eurybates and Polymele). PDS will also review the science content of flyby deliverables. Derived products will be produced with the approved coordinate system or updated with this information when it becomes available.

2.4.4 Data Storage Conventions

L'LORRI data products are stored as FITS files. These files conform to the FITS 4.0 standard, https://fits.gsfc.nasa.gov/fits_standard.html.

2.5 Data Validation

The SOC has a comprehensive Verification and Validation (V&V) Plan for all software used at or developed by the SOC. All software is configuration controlled and any changes made follow the SOC Configuration Control Plan, which includes substantive testing of changes. During day-to-day production of raw data products from telemetry, check sums and spot checks are used to validate that software is producing data products correctly. In addition to software verification and validation, each *Lucy* data product has been peer reviewed for both PDS data format acceptability and scientific usefulness. No changes are expected to data formats after peer review. The SOC – SBN Configuration Control Plan governs any changes, should they be needed.

When data is prepared for submission to the PDS, both the L'LORRI and SOC Teams will use PDS / mission-provided automated validation tools for conformance to the PDS4 standards.

Validation of the science data contained within the L'LORRI data products will, however, occur as a manual inspection by the L'LORRI team and the *Lucy* science team.

3. DETAILED DATA PRODUCT SPECIFICATIONS

3.1 Data Products Structure and Organization

The *Lucy* archive is organized into bundles for each instrument/detector, bundles for each discipline-specific set of higher-order data products, and a mission bundle with mission-wide documentation, context, and schema information. Each bundle contains data collections for each mission phase and data processing level of each data type. Each PDS bundle also contains a document collection, to provide the appropriate ancillary information to properly interpret and use the data. L'LORRI data products are structured as Flexible Image Transport System (FITS) files. L'LORRI data products are organized by mission phase and data processing level.

The L'LORRI bundle structure is as follows:

Table 3-1. L'LORRI bundle/collection structure

Bundle	*Collection*	*LID*
L'LORRI		
	data_cruise1_raw	urn:nasa:pds:lucy.llorri:data_cruise1_raw
	data_cruise1_partially_processed	urn:nasa:pds:lucy.llorri:data_cruise1_partially_processed
	data_ega1_raw	urn:nasa:pds:lucy.llorri:data_ega1_raw
	data_ega1_partially_processed	urn:nasa:pds:lucy.llorri:data_ega1_partially_processed
	data_didymos_raw	urn:nasa:pds:lucy.llorri:data_didymos_raw
	data_didymos_partially_processed	urn:nasa:pds:lucy.llorri:data_didymos_partially_processed
	data_cruise2_raw	urn:nasa:pds:lucy.llorri:data_cruise2_raw
	data_cruise2_partially_processed	urn:nasa:pds:lucy.llorri:data_cruise2_partially_processed
	data_dinkinesh_raw	urn:nasa:pds:lucy.llorri:data_dinkinesh_raw
	data_dinkinesh_partially_processed	urn:nasa:pds:lucy.llorri:data_dinkinesh_partially_processed
	data_cruise3_raw	urn:nasa:pds:lucy.llorri:data_cruise3_raw
	data_cruise3_partially_processed	urn:nasa:pds:lucy.llorri:data_cruise3_partially_processed
	data_donaldjohanson_raw	urn:nasa:pds:lucy.llorri:data_donaldjohanson_raw
	data_donaldjohanson_partially_processed	urn:nasa:pds:lucy.llorri:data_donaldjohanson_partially_processed
	data_cruise4_raw	urn:nasa:pds:lucy.llorri:data_cruise4_raw
	data_cruise4_partially_processed	urn:nasa:pds:lucy.llorri:data_cruise4_partially_processed
	data_eurybates-polymele_raw	urn:nasa:pds:lucy.llorri:data_eurybates-polymele_raw
	data_eurybates-polymele_partially processed	urn:nasa:pds:lucy.llorri:data_eurybates-polymele_partially processed
	data_cruise5_raw	urn:nasa:pds:lucy.llorri:data_cruise5_raw
	data_cruise5_partially_processed	urn:nasa:pds:lucy.llorri:data_cruise5_partially_processed
	data_leucus_raw	urn:nasa:pds:lucy.llorri:data_leucus_raw
	data_leucus_partially_processed	urn:nasa:pds:lucy.llorri:data_leucus_partially_processed
	data_cruise6_raw	urn:nasa:pds:lucy.llorri:data_cruise6_raw

Bundle	*Collection*	*LID*
	data_cruise6_partially_processed	urn:nasa:pds:lucy.llorri:data_cruise6_partially_processed
	data_orus_raw	urn:nasa:pds:lucy.llorri:data_orus_raw
	data_orus_partially_processed	urn:nasa:pds:lucy.llorri:data_orus_partially_processed
	data_cruise7_raw	urn:nasa:pds:lucy.llorri:data_cruise7_raw
	data_cruise7_partially_processed	urn:nasa:pds:lucy.llorri:data_cruise7_partially_processed
	data_patroclus-menoetius_raw	urn:nasa:pds:lucy.llorri:data_patroclus-menoetius_raw
	data_patroclus-menoetius_partially_processed	urn:nasa:pds:lucy.llorri:data_patroclus-menoetius_partially_processed
	calibration	urn:nasa:pds:lucy.llorri:calibration
	document	urn:nasa:pds:lucy.llorri:document

3.2 Data Format Descriptions

The following sections describe in detail the formats of L'LORRI uncalibrated (raw) through partially processed data products.

3.2.1 Raw Data Product Format

The L'LORRI uncalibrated data product is a 4-HDU FITS file that contains image, histogram, image header, and image descriptor data. Image data are 16-bit pixel values, with array sizes of either 1028x1024 in 1x1 binning, or 258x256 in 4x4 binning. All data are in units of Digital Number (DN), unless specified otherwise.

Table 3-2 L'LORRI Uncalibrated Data Product Format

FITS Keyword	PDS XML Label Class/Attribute	Definition
SIMPLE	n/a	File conforms to FITS standard
BITPIX	/Product_Observational[1]/File_Area_Observational[1]/Array_2D_Image[1]/Element_Array[1]/data_type[1]	Pixel bit depth
NAXIS	/Product_Observational[1]/File_Area_Observational[1]/Array_2D_Image[1]/axes[1]	Number of axes in the data array (2)
NAXIS1	/Product_Observational[1]/File_Area_Observational[1]/Array_2D_Image[1]/axes[1]	Number of rows (lines)

FITS Keyword	PDS XML Label Class/Attribute	Definition
NAXIS2	/Product_Observational[1]/File_Area_Observational[1]/Array_2D_Image[1]/axes[1]	Number of columns (samples)
EXTEND	n/a	FITS dataset may contain extensions
MISSION	/Product_Observational[1]/Observation_Area[1]/Investigation_Area[1]/name[1]/node()[1]	mission name (Lucy)
HOSTNAME	/Product_Observational[1]/Observation_Area[1]/Observing_System[1]/Observing_System_Component[1]	instrument host name (Lucy)
HOSTID	/Product_Observational[1]/Observation_Area[1]/Observing_System[1]/Observing_System_Component[1]	instrument host ID (Lucy)
INSTRUME	/Product_Observational[1]/Observation_Area[1]/Observing_System[1]/Observing_System_Component[2]	name of instrument (L'LORRI)
OBSID	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:Lucy_Observation_Time_Information[1]/lucy:observation_id[1]	observation ID
OBSIDCNT	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:Lucy_Observation_Time_Information[1]/lucy:observation_id_count[1]	observation identifier count
STRTSCLK	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:Lucy_Observation_Time_Information[1]/lucy:start_sclk[1]	observation start time (SCLK seconds)
MIDSCLK	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:Lucy_Observation_Time_Information[1]/lucy:mid_sclk[1]	observation midpoint (SCLK seconds)

FITS Keyword	PDS XML Label Class/Attribute	Definition
STOPSCLK	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:Lucy_Observation_Time_Information[1]/lucy:stop_sclk[1]	observation stop time (SCLK seconds)
STARTUTC	/Product_Observational[1]/Observation_Area[1]/Time_Coordinates[1]/start_date_time[1]	observation start time (UTC, ISOT format)
MIDUTC	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:Lucy_Observation_Time_Information[1]/lucy:mid_utc[1]	observation midpoint (UTC, ISOT format)
STOPUTC	/Product_Observational[1]/Observation_Area[1]/Time_Coordinates[1]/stop_date_time[1]	observation stop time (UTC, ISOT format)
MIDSCLKS	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:Lucy_Observation_Time_Information[1]/lucy:mid_sclk_string[1]	observation midpoint (full SCLK string)
MIDUTCID	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:Lucy_Observation_Time_Information[1]/lucy:mid_utc_doy[1]	observation midpoint (UTC, ISO DOY format)
MIDUTCJD	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:Lucy_Observation_Time_Information[1]/lucy:mid_utc_jd[1]	observation midpoint (Julian date)
MIDET	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:Lucy_Observation_Time_Information[1]/lucy:mid_ephemeris_time[1]	observation midpoint (ET, seconds past J2000)
EXPTIME	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Exposure[1]/img:exposure_duration[1]	[s] Exposure time (sec)

FITS Keyword	PDS XML Label Class/Attribute	Definition
FILENAME	/Product_Observational[1]/File_Area_Observational[1]/File[1]/file_name[1]/node()[1]	product file name
DATE	/Product_Observational[1]/File_Area_Observational[1]/File[1]/creation_date_time[1]	product creation time (UTC, ISOT format)
ORIGIN	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/proc:Processing_Information[1]	organization responsible for product
LOCATION	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/proc:Processing_Information[1]/proc:Process[1]/proc:process_owner_institution_name[1]	location where product was generated
CCSDSCLK	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:Lucy_Observation_Time_Information[1]/lucy:ccsds_sclk_time[1]	CCSDS timestamp, playback time (SCLK seconds)
PRODLVL	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/proc:Processing_Information[1]/proc:Process[1]/proc:Software[1]/proc:software_id[1]	product processing level
PRODVER	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:Lucy_Product_Information[1]/lucy:internal_product_version_id[1]	Lucy internal data processing product version
UDPVER	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/proc:Processing_Information[1]/proc:Process[2]/proc:Software[1]/proc:software_version_id[1]/node()[1]	UDP software version
CDPVER	n/a	CDP software version

FITS Keyword	PDS XML Label Class/Attribute	Definition
APID	n/a	packet application ID of source data
OBSCOMPL	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:Lucy_Observation_Time_Information[1]/lucy:observation_complete[1]	observation complete?
MISSPKT	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:Lucy_Observation_Time_Information[1]/lucy:observation_missing_packets[1]	number of missing packets
UDPFILE	n/a	input UDP filename
LOADID	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:Lucy_Observation_Planning[1]/lucy:load_identifier[1]	command sequence load ID
MSNSEG	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:Lucy_Observation_Planning[1]/lucy:mission_segment[1]	mission segment
SAPID	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:Lucy_Observation_Planning[1]/lucy:sap_identifier[1]	science activity plan identifier
VISITNAM	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:Lucy_Observation_Planning[1]/lucy:visit_name[1]	visit name
SIDE	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:Lucy_Observation_Planning[1]/lucy:instrument_side[1]/node()[1]	instrument side requested
LORSTAT	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:Lucy_Observation_Planning[1]/lucy:llorri_status[1]	LORRI instrument status

FITS Keyword	PDS XML Label Class/Attribute	Definition
RLPSTAT	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:Lucy_Observation_Planning[1]/lucy:lralph_status[1]	Ralph instrument status
TESSTAT	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:Lucy_Observation_Planning[1]/lucy:ltes_status[1]	TES instrument status
TTCSTAT	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:Lucy_Observation_Planning[1]/lucy:ttcam_status[1]	TTCam instrument status
TARGET	/Product_Observational[1]/Observation_Area[1]/Target_Identification[1]/name[1]	name of intended primary target
TARGETID	/Product_Observational[1]/Observation_Area[1]/Target_Identification[1]/alternate_identification[1]	SPICE ID of intended primary target
SPCINSQA	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Image_Display_Geometry[1]/geom:Quaternion_Plus_To_From[1]	cos(theta/2), instr. -> J2000 SPICE quat.
SPCINSQX	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Image_Display_Geometry[1]/geom:Quaternion_Plus_To_From[1]	sin(theta/2)*X, instr. -> J2000 SPICE quat.
SPCINSQY	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Image_Display_Geometry[1]/geom:Quaternion_Plus_To_From[1]	sin(theta/2)*Y, instr. -> J2000 SPICE quat.
SPCINSQZ	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Image_Display_Geometry[1]/geom:Quaternion_Plus_To_From[1]	sin(theta/2)*Z, instr. -> J2000 SPICE quat.

FITS Keyword	PDS XML Label Class/Attribute	Definition
SPCSCQA	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Image_Display_Geometry[1]/geom:Quaternion_Plus_To_From[2]	cos(theta/2), S/C -> J2000 SPICE quat.
SPCSCQX	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Image_Display_Geometry[1]/geom:Quaternion_Plus_To_From[2]	sin(theta/2)*X, S/C -> J2000 SPICE quat.
SPCSCQY	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Image_Display_Geometry[1]/geom:Quaternion_Plus_To_From[2]	sin(theta/2)*Y, S/C -> J2000 SPICE quat.
SPCSCQZ	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Image_Display_Geometry[1]/geom:Quaternion_Plus_To_From[2]	sin(theta/2)*Z, S/C -> J2000 SPICE quat.
RATEX	n/a	angular rate about inst. frame +X axis (urad/s)
RATEY	n/a	angular rate about inst. frame +Y axis (urad/s)
RATEZ	n/a	angular rate about inst. frame +Z axis (urad/s)
RATEXY	n/a	magnitude of [RATEX,RATEY] pair (urad/s)
RATEYZ	n/a	magnitude of [RATEY,RATEZ] pair (urad/s)
RATEXZ	n/a	magnitude of [RATEX,RATEZ] pair (urad/s)
RATEMAG	n/a	magnitude of [RATEX,RATEY,RATEZ] vec. (urad/s)
IPIGANG	n/a	IPP inner gimbal angle (deg)
IPIGRATE	n/a	IPP inner gimbal angle rate (deg/sec)

FITS Keyword	PDS XML Label Class/Attribute	Definition
IPOGANG	n/a	IPP outer gimbal angle (deg)
IPOGRATE	n/a	IPP outer gimbal angle rate (deg/sec)
BSRASTRT	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Image_Display_Geometry[1]/geom:Object_Orientation_RA_Dec[1]/geom:right_ascension_angle[1]	Boresight RA at obs start (deg)
BSDCSTRT	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Image_Display_Geometry[1]/geom:Object_Orientation_RA_Dec[1]/geom:declination_angle[1]	Boresight Dec at obs start (deg)
BSRAMID	n/a	Boresight RA at mid-obs time (deg)
BSDCMID	n/a	Boresight Dec at mid-obs time (deg)
BSRASTOP	n/a	Boresight RA at obs end (deg)
BSDCSTOP	n/a	Boresight Dec at obs end (deg)
TRGFOV1	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:Lucy_Target_List[1]/lucy:target_fov_name[1]	Target 1 in Field of View
TRGFOVN	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:Lucy_Target_List[1]/lucy:target_fov_count[1]	number of possible targets in FOV (SPICE-derived)
PA_XINST	n/a	pos. ang. +X axis, E of proj. EMEJ2K N (deg)
PA_YINST	n/a	pos. ang. +Y axis, E of proj. EMEJ2K N (deg)
PA_ZINST	n/a	pos. ang. +Z axis, E of proj. EMEJ2K N (deg)
PA_SUN	n/a	pos. ang. proj. Sun, E of proj. EMEJ2K N (deg)
PA_SUN_X	n/a	pos. ang. proj. Sun, E of inst. +X axis (deg)

FITS Keyword	PDS XML Label Class/Attribute	Definition
PA_SUN_Y	n/a	pos. ang. proj. Sun, E of inst. +Y axis (deg)
PA_SUN_Z	n/a	pos. ang. proj. Sun, E of inst. +Z axis (deg)
TGT_ELON	n/a	ang. betw. target and inst. boresight (deg)
SOL_ELON	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Illumination_Geometry[1]/geom:Illumination_Specific[1]/geom:solar_elongation[1]	ang. betw. Sun and inst. boresight (deg)
EAR_ELON	n/a	ang. betw. Earth and inst. boresight (deg)
SPCQUAL	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:SPICE_Kernel_Files[1]/geom:SPICE_Kernel_Identification[1]/geom:kernel_provenance[1]	SPICE quality
SPCSTAT	n/a	SPICE status
SPCSCNM	n/a	SPICE spacecraft bus frame name
SPCSCID	n/a	SPICE spacecraft bus frame ID
SPCINSNM	n/a	SPICE instrument frame name
SPCINSID	n/a	SPICE instrument frame ID
SPCTSCX	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Vectors[1]/geom:Vectors_Cartesian_Specific[1]/geom:Vector_Cartesian_Position_Spacecraft_To_Target[1]/geom:x_position[1]	S/C pos vec wrt target, X, EMEJ2000 (km)

FITS Keyword	PDS XML Label Class/Attribute	Definition
SPCTSCY	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Vectors[1]/geom:Vectors_Cartesian_Specific[1]/geom:Vector_Cartesian_Position_Spacecraft_To_Target[1]/geom:y_position[1]	S/C pos vec wrt target, Y, EMEJ2000 (km)
SPCTSCZ	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Vectors[1]/geom:Vectors_Cartesian_Specific[1]/geom:Vector_Cartesian_Position_Spacecraft_To_Target[1]/geom:z_position[1]	S/C pos vec wrt target, Z, EMEJ2000 (km)
SPCTSCVX	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Vectors[1]/geom:Vectors_Cartesian_Specific[1]/geom:Vector_Cartesian_Velocity_Spacecraft_Relative_To_Target[1]/geom:x_velocity[1]	S/C vel vec wrt target, X, EMEJ2000 (km/s)
SPCTSCVY	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Vectors[1]/geom:Vectors_Cartesian_Specific[1]/geom:Vector_Cartesian_Velocity_Spacecraft_Relative_To_Target[1]/geom:y_velocity[1]	S/C vel vec wrt target, Y, EMEJ2000 (km/s)
SPCTSCVZ	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Vectors[1]/geom:Vectors_Cartesian_Specific[1]/geom:Vector_Cartesian_Velocity_Spacecraft_Relative_To_Target[1]/geom:z_velocity[1]	S/C vel vec wrt target, Z, EMEJ2000 (km/s)

FITS Keyword	PDS XML Label Class/Attribute	Definition
SPCTRANG	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Distances[1]/geom:Distances_Specific[1]/geom:spacecraft_target_center_distance[1]	S/C range to target center (km)
SPCTPHAS	n/a	Sun-target-S/C angle (deg)
SPCTSOX	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Vectors[1]/geom:Vectors_Cartesian_Specific[1]/geom:Vector_Cartesian_Position_Sun_To_Spacecraft[1]/geom:x_position[1]	Sun pos vec wrt target, X, EMEJ2000 (km)
SPCTSOY	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Vectors[1]/geom:Vectors_Cartesian_Specific[1]/geom:Vector_Cartesian_Position_Sun_To_Spacecraft[1]/geom:y_position[1]	Sun pos vec wrt target, Y, EMEJ2000 (km)
SPCTSOZ	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Vectors[1]/geom:Vectors_Cartesian_Specific[1]/geom:Vector_Cartesian_Position_Sun_To_Spacecraft[1]/geom:z_position[1]	Sun pos vec wrt target, Z, EMEJ2000 (km)
SPCTSOVX	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Vectors[1]/geom:Vectors_Cartesian_Specific[1]/geom:Vector_Cartesian_Velocity_Target_Relative_To_Sun[1]/geom:x_velocity[1]	Sun vel vec wrt target, X, EMEJ2000 (km/s)

FITS Keyword	PDS XML Label Class/Attribute	Definition
SPCTSOVY	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Vectors[1]/geom:Vectors_Cartesian_Specific[1]/geom:Vector_Cartesian_Velocity_Target_Relative_To_Sun[1]/geom:y_velocity[1]	Sun vel vec wrt target, Y, EMEJ2000 (km/s)
SPCTSOVZ	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Vectors[1]/geom:Vectors_Cartesian_Specific[1]/geom:Vector_Cartesian_Velocity_Target_Relative_To_Sun[1]/geom:z_velocity[1]	Sun vel vec wrt target, Z, EMEJ2000 (km/s)
SPCTSORN	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Distances[1]/geom:Distances_Specific[1]/geom:target_heliocentric_distance[1]	Sun center range to target center (km)
SPCTEOX	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Vectors[1]/geom:Vectors_Cartesian_Specific[1]/geom:Vector_Cartesian_Position_Earth_To_Target[1]/geom:x_position[1]	Earth pos vec wrt target, X, EMEJ2000 (km)
SPCTEOY	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Vectors[1]/geom:Vectors_Cartesian_Specific[1]/geom:Vector_Cartesian_Position_Earth_To_Target[1]/geom:y_position[1]	Earth pos vec wrt target, Y, EMEJ2000 (km)

FITS Keyword	PDS XML Label Class/Attribute	Definition
SPCTEOZ	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Vectors[1]/geom:Vectors_Cartesian_Specific[1]/geom:Vector_Cartesian_Position_Earth_To_Target[1]/geom:z_position[1]	Earth pos vec wrt target, Z, EMEJ2000 (km)
SPCTEOVX	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Vectors[1]/geom:Vectors_Cartesian_Specific[1]/geom:Vector_Cartesian_Velocity_Target_Relative_To_Earth[1]/geom:x_velocity[1]	Earth vel vec wrt target, X, EMEJ2000 (km/s)
SPCTEOVY	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Vectors[1]/geom:Vectors_Cartesian_Specific[1]/geom:Vector_Cartesian_Velocity_Target_Relative_To_Earth[1]/geom:y_velocity[1]	Earth vel vec wrt target, Y, EMEJ2000 (km/s)
SPCTEOVZ	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Vectors[1]/geom:Vectors_Cartesian_Specific[1]/geom:Vector_Cartesian_Velocity_Target_Relative_To_Earth[1]/geom:z_velocity[1]	Earth vel vec wrt target, Z, EMEJ2000 (km/s)
SPCTEORN	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Distances[1]/geom:Distances_Specific[1]/geom:target_geocentric_distance[1]	Earth center range to target center (km)

FITS Keyword	PDS XML Label Class/Attribute	Definition
SPCSCSX	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Vectors[1]/geom:Vectors_Cartesian_Specific[1]/geom:Vector_Cartesian_Position_Sun_To_Spacecraft[1]/geom:x_position[1]	Sun pos vec wrt S/C, X, EMEJ2000 (km)
SPCSCSY	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Vectors[1]/geom:Vectors_Cartesian_Specific[1]/geom:Vector_Cartesian_Position_Sun_To_Spacecraft[1]/geom:y_position[1]	Sun pos vec wrt S/C, Y, EMEJ2000 (km)
SPCSCSZ	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Vectors[1]/geom:Vectors_Cartesian_Specific[1]/geom:Vector_Cartesian_Position_Sun_To_Spacecraft[1]/geom:z_position[1]	Sun pos vec wrt S/C, Z, EMEJ2000 (km)
SPCSCSVX	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Vectors[1]/geom:Vectors_Cartesian_Specific[1]/geom:Vector_Cartesian_Velocity_Spacecraft_Relative_To_Sun[1]/geom:x_velocity[1]	Sun vel vec wrt S/C, X, EMEJ2000 (km/s)
SPCSCSVY	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Vectors[1]/geom:Vectors_Cartesian_Specific[1]/geom:Vector_Cartesian_Velocity_Spacecraft_Relative_To_Sun[1]/geom:y_velocity[1]	Sun vel vec wrt S/C, Y, EMEJ2000 (km/s)

FITS Keyword	PDS XML Label Class/Attribute	Definition
SPCSCSVZ	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Vectors[1]/geom:Vectors_Cartesian_Specific[1]/geom:Vector_Cartesian_Velocity_Spacecraft_Relative_To_Sun[1]/geom:z_velocity[1]	Sun vel vec wrt S/C, Z, EMEJ2000 (km/s)
SPCSCSRN	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Distances[1]/geom:Distances_Specific[1]/geom:spacecraft_heliocentric_distance[1]	Sun center range to S/C (km)
SPCESCX	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Vectors[1]/geom:Vectors_Cartesian_Specific[1]/geom:Vector_Cartesian_Position_Earth_To_Spacecraft[1]/geom:x_position[1]	S/C pos vec wrt Earth, X, EMEJ2000 (km)
SPCESCY	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Vectors[1]/geom:Vectors_Cartesian_Specific[1]/geom:Vector_Cartesian_Position_Earth_To_Spacecraft[1]/geom:y_position[1]	S/C pos vec wrt Earth, Y, EMEJ2000 (km)
SPCESCZ	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Vectors[1]/geom:Vectors_Cartesian_Specific[1]/geom:Vector_Cartesian_Position_Earth_To_Spacecraft[1]/geom:z_position[1]	S/C pos vec wrt Earth, Z, EMEJ2000 (km)

FITS Keyword	PDS XML Label Class/Attribute	Definition
SPCESCVX	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Vectors[1]/geom:Vectors_Cartesian_Specific[1]/geom:Vector_Cartesian_Velocity_Spacecraft_Relative_To_Earth[1]/geom:x_velocity[1]	S/C vel vec wrt Earth, X, EMEJ2000 (km/s)
SPCESCVY	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Vectors[1]/geom:Vectors_Cartesian_Specific[1]/geom:Vector_Cartesian_Velocity_Spacecraft_Relative_To_Earth[1]/geom:y_velocity[1]	S/C vel vec wrt Earth, Y, EMEJ2000 (km/s)
SPCESCVZ	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Vectors[1]/geom:Vectors_Cartesian_Specific[1]/geom:Vector_Cartesian_Velocity_Spacecraft_Relative_To_Earth[1]/geom:z_velocity[1]	S/C vel vec wrt Earth, Z, EMEJ2000 (km/s)
SPCESCRN	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Distances[1]/geom:Distances_Specific[1]/geom:spacecraft_geocentric_distance[1]	S/C range to Earth center (km)
SPCKMK	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:SPICE_Kernel_Files[1]/geom:SPICE_Kernel_Identification[1]/geom:kernel_type[1]/node()[1]	SPICE metakernel
SPCKNUM	n/a	count of loaded SPICE kernels

FITS Keyword	PDS XML Label Class/Attribute	Definition
SPCK[n]	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:SPICE_Kernel_Files[1]/geom:SPICE_Kernel_Identification[number]	SPICE kernel [n], one entry for each SPICE kernel used.
CRPIX1	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:Reference_Frame_Parameters[1]/ebt:World_Axis[1]/ebt:horizontal_coordinate_pixel[1]	WCS x-coordinate of reference pixel
CRPIX2	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:Reference_Frame_Parameters[1]/ebt:World_Axis[1]/ebt:vertical_coordinate_pixel[1]	WCS y-coordinate of reference pixel
CD1_1	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:Coordinate_Frame_Transformation_Matrix[1]/ebt:Transformation_Element[1]/ebt:element_value[1]	WCS dRA/dNAXIS lin xform param
CD1_2	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:Coordinate_Frame_Transformation_Matrix[1]/ebt:Transformation_Element[3]/ebt:element_value[1]	WCS dRA/dNAXIS2 lin xform param

FITS Keyword	PDS XML Label Class/Attribute	Definition
CD2_1	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:Coordinate_Frame_Transformation_Matrix[1]/ebt:Transformation_Element[2]/ebt:element_value[1]	WCS dDEC/dNAXIS1 lin xform param
CD2_2	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:Coordinate_Frame_Transformation_Matrix[1]/ebt:Transformation_Element[4]/ebt:element_value[1]	WCS dDEC/dNAXIS2 lin xform param
CTYPE1	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:Reference_Frame_Parameters[1]/ebt:World_Axis[1]/ebt:coordinate_name[1]	WCS coordinate type for the first axis (sample)
CTYPE2	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:Reference_Frame_Parameters[1]/ebt:World_Axis[2]/ebt:coordinate_name[1]	WCS coordinate type for the second axis (line)

FITS Keyword	PDS XML Label Class/Attribute	Definition
RADESYS	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:Reference_Frame_Parameters[1]/ebt:Reference_Frame_Identification[1]/ebt:name[1]	WCS inertial reference frame
EQUINOX	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:Reference_Frame_Parameters[1]/ebt:Reference_Frame_Identification[1]/ebt:frame_spice_name[1]	WCS reference epoch
CUNIT1	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:Reference_Frame_Parameters[1]/ebt:World_Axis[1]/ebt:world_coordinate_reference_point[1]/@unit	WCS units for the first axis (sample)
CUNIT2	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:Reference_Frame_Parameters[1]/ebt:World_Axis[2]/ebt:world_coordinate_reference_point[1]/@unit	WCS units for the second axis (line)

FITS Keyword	PDS XML Label Class/Attribute	Definition
CRVAL1	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:Reference_Frame_Parameters[1]/ebt:World_Axis[1]/ebt:world_coordinate_reference_point[1]	WCS RA of ref pix (deg); this is the boresight
CRVAL2	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:Reference_Frame_Parameters[1]/ebt:World_Axis[1]/ebt:world_coordinate_reference_point[1]	WCS Dec of ref pix (deg); this is the boresight
A_ORDER	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:SIP_Distortion_Terms[1]/ebt:A_ORDER[1]	forward SIP A order
A_2_0	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:SIP_Distortion_Terms[1]/ebt:A_ORDER[1]/ebt:SIP_Element[1]/ebt:element_value[1]	forward SIP; x^2 * y^0
A_1_1	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:SIP_Distortion_Terms[1]/ebt:A_ORDER[1]/ebt:SIP_Element[2]/ebt:element_value[1]	forward SIP; x^1 * y^1

FITS Keyword	PDS XML Label Class/Attribute	Definition
A_0_2	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:SIP_Distortion_Terms[1]/ebt:A_ORDER[1]/ebt:SIP_Element[3]/ebt:element_value[1]	forward SIP; x^0 * y^2
A_3_0	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:SIP_Distortion_Terms[1]/ebt:A_ORDER[1]/ebt:SIP_Element[4]/ebt:element_value[1]	forward SIP; x^3 * y^0
A_2_1	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:SIP_Distortion_Terms[1]/ebt:A_ORDER[1]/ebt:SIP_Element[5]/ebt:element_value[1]	forward SIP; x^2 * y^1
A_1_2	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:SIP_Distortion_Terms[1]/ebt:A_ORDER[1]/ebt:SIP_Element[6]/ebt:element_value[1]	forward SIP; x^1 * y^2

FITS Keyword	PDS XML Label Class/Attribute	Definition
A_0_3	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:SIP_Distortion_Terms[1]/ebt:A_ORDER[1]/ebt:SIP_Element[7]/ebt:element_value[1]	forward SIP; x^0 * y^3
B_ORDER	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:SIP_Distortion_Terms[1]/ebt:B_ORDER[1]	forward SIP B order
B_2_0	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:SIP_Distortion_Terms[1]/ebt:B_ORDER[1]/ebt:SIP_Element[1]/ebt:element_value[1]	forward SIP; x^2 * y^0
B_1_1	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:SIP_Distortion_Terms[1]/ebt:B_ORDER[1]/ebt:SIP_Element[2]/ebt:element_value[1]	forward SIP; x^1 * y^1
B_0_2	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:SIP_Distortion_Terms[1]/ebt:B_ORDER[1]/ebt:SIP_Element[3]/ebt:element_value[1]	forward SIP; x^0 * y^2

FITS Keyword	PDS XML Label Class/Attribute	Definition
B_3_0	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:SIP_Distortion_Terms[1]/ebt:B_ORDER[1]/ebt:SIP_Element[4]/ebt:element_value[1]	forward SIP; x^3 * y^0
B_2_1	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:SIP_Distortion_Terms[1]/ebt:B_ORDER[1]/ebt:SIP_Element[5]/ebt:element_value[1]	forward SIP; x^2 * y^1
B_1_2	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:SIP_Distortion_Terms[1]/ebt:B_ORDER[1]/ebt:SIP_Element[6]/ebt:element_value[1]	forward SIP; x^1 * y^2
B_0_3	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:SIP_Distortion_Terms[1]/ebt:B_ORDER[1]/ebt:SIP_Element[7]/ebt:element_value[1]	forward SIP; x^0 * y^3
AP_ORDER	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:SIP_Distortion_Terms[1]/ebt:AP_ORDER[1]	reverse SIP AP order

FITS Keyword	PDS XML Label Class/Attribute	Definition
AP_2_0	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:SIP_Distortion_Terms[1]/ebt:AP_ORDER[1]/ebt:SIP_Element[1]/ebt:element_value[1]	reverse SIP; x^2 * y^0
AP_1_1	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:SIP_Distortion_Terms[1]/ebt:AP_ORDER[1]/ebt:SIP_Element[2]/ebt:element_value[1]	reverse SIP; x^1 * y^1
AP_0_2	n/a	reverse SIP; x^0 * y^2
AP_3_0	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:SIP_Distortion_Terms[1]/ebt:AP_ORDER[1]/ebt:SIP_Element[3]/ebt:element_value[1]	reverse SIP; x^3 * y^0
AP_2_1	n/a	reverse SIP; x^2 * y^1
AP_1_2	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:SIP_Distortion_Terms[1]/ebt:AP_ORDER[1]/ebt:SIP_Element[4]/ebt:element_value[1]	reverse SIP; x^1 * y^2

FITS Keyword	PDS XML Label Class/Attribute	Definition
AP_0_3	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:SIP_Distortion_Terms[1]/ebt:AP_ORDER[1]	reverse SIP; x^0 * y^3
BP_ORDER	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:SIP_Distortion_Terms[1]/ebt:BP_ORDER[1]	reverse SIP BP order
BP_2_0	n/a	reverse SIP; x^2 * y^0
BP_1_1	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:SIP_Distortion_Terms[1]/ebt:BP_ORDER[1]/ebt:SIP_Element[1]/ebt:element_value[1]	reverse SIP; x^1 * y^1
BP_0_2	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:SIP_Distortion_Terms[1]/ebt:BP_ORDER[1]/ebt:SIP_Element[2]/ebt:element_value[1]	reverse SIP; x^0 * y^2
BP_3_0	n/a	reverse SIP; x^3 * y^0

FITS Keyword	PDS XML Label Class/Attribute	Definition
BP_2_1	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:SIP_Distortion_Terms[1]/ebt:BP_ORDER[1]/ebt:SIP_Element[3]/ebt:element_value[1]	reverse SIP; x^2 * y^1
BP_1_2	n/a	reverse SIP; x^1 * y^2
BP_0_3	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:SIP_Distortion_Terms[1]/ebt:BP_ORDER[1]/ebt:SIP_Element[4]/ebt:element_value[1]	reverse SIP; x^0 * y^3
ASM	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:LLORRI_Instrument_Parameters[1]/lucy:attached_sync_marker_dec[1]	[dec] attached sync marker
OBS_ID	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:Lucy_Observation_Time_Information[1]/lucy:observation_id[1]	observation ID
OBS_ID_C	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:Lucy_Observation_Time_Information[1]/lucy:observation_id_count[1]	observation ID count
IMGTYPE	/Product_Observational[1]/Observation_Area[1]/Primary_Result_Summary[1]/purpose[1]	image type: 0=science, 1=opnav
START_S	n/a	[SCLK s] time tag of exposure start
START_F	n/a	[SCLK minor ticks] time tag of exposure start
END_S	n/a	[SCLK s] time tag of exposure end

FITS Keyword	PDS XML Label Class/Attribute	Definition
END_F	n/a	[SCLK minor ticks] time tag of exposure end
FPU_L_I	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Currents[1]/img:Device_Current[1]/img:current_value[1]	[DN] current - FPU low
DPU_5V_I	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Currents[1]/img:Device_Current[2]/img:current_value[1]	[DN] current - 5V DPU
FPU_H_I	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Currents[1]/img:Device_Current[3]/img:current_value[1]	[DN] current - FPU high
HEAT18VI	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Currents[1]/img:Device_Current[4]/img:current_value[1]	[DN] current - 18V heater
PRIM_I	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Currents[1]/img:Device_Current[5]/img:current_value[1]	[DN] current - primary input
FPU_V_L	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Voltages[1]/img:Device_Voltage[1]/img:voltage_value[1]	[DN] voltage - FPU low
FPU_V_H	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Voltages[1]/img:Device_Voltage[2]/img:voltage_value[1]	[DN] voltage - FPU high

FITS Keyword	PDS XML Label Class/Attribute	Definition
DPU_5V_V	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Voltages[1]/img:Device_Voltage[3]/img:voltage_value[1]	[DN] voltage - 5V DPU
HEAT18VV	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Voltages[1]/img:Device_Voltage[4]/img:voltage_value[1]	[DN] voltage - 18V heater
DPU_P0_T	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Temperatures[1]/img:Device_Temperature[1]/img:temperature_value[1]	[DN] temp. - P0 DPU, DPU chassis
FPU_P1_T	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Temperatures[1]/img:Device_Temperature[2]/img:temperature_value[1]	[DN] temp. - P1 FPU, FPU chassis
CCD_T	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Temperatures[1]/img:Device_Temperature[3]/img:temperature_value[1]	[DN] temp. - P2 OTA 1, CCD carrier plate
BAFFLE_T	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Temperatures[1]/img:Device_Temperature[4]/img:temperature_value[1]	[DN] temp. - P3 OTA 2, baffle ring

FITS Keyword	PDS XML Label Class/Attribute	Definition
LVPS_T	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Temperatures[1]/img:Device_Temperature[5]/img:temperature_value[1]	[DN] temp. - spare P2, LVPS PWB in DPU
DPU_33VV	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Voltages[1]/img:Device_Voltage[5]/img:voltage_value[1]	[DN] voltage - 3.3V DPU
CCDSUB_T	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Temperatures[1]/img:Device_Temperature[6]/img:temperature_value[1]	[DN] temp. - CCD, sub-board on dogbone
FPE_T	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Temperatures[1]/img:Device_Temperature[7]/img:temperature_value[1]	[DN] temp. - focal plane electronics
CCD_OSR	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Voltages[1]/img:Device_Voltage[6]/img:voltage_value[1]	[DN] output transistor src of CCD, right amp
FPE_29VV	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Voltages[1]/img:Device_Voltage[9]/img:voltage_value[1]	[DN] voltage - 29V focal plane electronics

FITS Keyword	PDS XML Label Class/Attribute	Definition
CCD_OSL	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Voltages[1]/img:Device_Voltage[7]/img:voltage_value[1]	[DN] output transistor src of CCD, left amp
FPE_13VV	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Voltages[1]/img:Device_Voltage[8]/img:voltage_value[1]	[DN] voltage - 13V focal plane electronics
FPE_6V_V	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Voltages[1]/img:Device_Voltage[10]/img:voltage_value[1]	[DN] voltage - 6V focal plane electronics
LATCHCNT	n/a	[DN] latchup count
EXPOSURE	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Exposure[1]/img:exposure_duration[1]	[ms] commanded exposure time
CLMP2	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:LLORRI_Instrument_Parameters[1]/lucy:calibration_lamp_level_1[1]	[DN] cal lamp #2 level
CLMP1	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:LLORRI_Instrument_Parameters[1]/lucy:calibration_lamp_level_2[1]	[DN] cal lamp #1 level
DPU_ID	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Component_States[1]/img:Device_Component_State[1]/img:device_state[1]	DPU in use: 0=DPU0, 1=DPU1

FITS Keyword	PDS XML Label Class/Attribute	Definition
CLMP2PE	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Component_States[1]/img:Device_Component_State[1]/img:device_state[1]	cal lamp #2 power enable: 0=OFF, 1=ON
CLMP1PE	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Component_States[1]/img:Device_Component_State[3]/img:device_state[1]	cal lamp #1 power enable: 0=OFF, 1=ON
SOURCE	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Component_States[1]/img:Device_Component_State[4]/img:device_state[1]	0=CCD,1=FPU_TP1,2=FPU_TP2,3=DPU_TP1,4=DPU_TP2
FORMAT	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Downsampling[1]/img:Pixel_Averaging_Dimensions[1]	image format: 0=1x1, 1=4x4
EXPMODE	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Exposure[1]/img:exposure_type[1]	exposure mode: 0=MANUAL, 1=AUTOMATIC
FLUSH	n/a	definition? (TBS)
POSTAMBL	n/a	[dec] postamble
CRC	n/a	[dec] image packet cyclic redundancy check
HDRSRC	n/a	IMAGE or IMAGE_DESCRIPTOR
ASM_X	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:LLORRI_Instrument_Parameters[1]/lucy:attached_sync_marker_hex[1]	[hex] attached sync marker

FITS Keyword	PDS XML Label Class/Attribute	Definition
CIMGTYPE	/Product_Observational[1]/Observation_Area[1]/Primary_Result_Summary[1]/purpose[1]	image type
CFPU_LI	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Currents[1]/img:Device_Current[1]/img:current_value[1]	[mA] current - FPU low
CDPU_5VI	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Currents[1]/img:Device_Current[2]/img:current_value[1]	[mA] current - 5V DPU
CFPU_HI	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Currents[1]/img:Device_Current[3]/img:current_value[1]	[mA] current - FPU high
CHT18VI	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Currents[1]/img:Device_Current[4]/img:current_value[1]	[mA] current - 18V heater
CPRIM_I	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Currents[1]/img:Device_Current[5]/img:current_value[1]	[mA] current - primary input
CFPU_VL	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Voltages[1]/img:Device_Voltage[1]/img:voltage_value[1]	[volts] voltage - FPU low

FITS Keyword	PDS XML Label Class/Attribute	Definition
CFPU_VH	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Voltages[1]/img:Device_Voltage[3]/img:voltage_value[1]	[volts] voltage - FPU high
CDPU_5VV	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Voltages[1]/img:Device_Voltage[2]/img:voltage_value[1]	[volts] voltage - 5V DPU
CHT18VV	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Voltages[1]/img:Device_Voltage[4]/img:voltage_value[1]	[volts] voltage - 18V heater
CDPU_P0T	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Temperatures[1]/img:Device_Temperature[1]/img:temperature_value[1]	[deg C] temp. - P0 DPU, DPU chassis
CFPU_P1T	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Temperatures[1]/img:Device_Temperature[2]/img:temperature_value[1]	[deg C] temp. - P1 FPU, FPU chassis
C_CCD_T	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Temperatures[1]/img:Device_Temperature[3]/img:temperature_value[1]	[deg C] temp. - P2 OTA 1, CCD carrier plate

FITS Keyword	PDS XML Label Class/Attribute	Definition
C_BAFL_T	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Temperatures[1]/img:Device_Temperature[4]/img:temperature_value[1]	[deg C] temp. - P3 OTA 2, baffle ring
C_LVPS_T	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Temperatures[1]/img:Device_Temperature[5]/img:temperature_value[1]	[deg C] temp. - spare P2, LVPS PWB in DPU
CDPU33VV	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Voltages[1]/img:Device_Voltage[5]/img:voltage_value[1]	[volts] voltage - 3.3V DPU
CCCDSB_T	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Temperatures[1]/img:Device_Temperature[6]/img:temperature_value[1]	[deg C] temp. - CCD, sub-board on dogbone
C_FPE_T	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Temperatures[1]/img:Device_Temperature[7]/img:temperature_value[1]	[deg C] temp. - focal plane electronics
C_CCDOSR	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Voltages[1]/img:Device_Voltage[6]/img:voltage_value[1]	[volts] output transistor src of CCD, right amp

FITS Keyword	PDS XML Label Class/Attribute	Definition
CFPE29VV	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Voltages[1]/img:Device_Voltage[9]/img:voltage_value[1]	[volts] voltage - 29V focal plane electronics
C_CCDOSL	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Voltages[1]/img:Device_Voltage[7]/img:voltage_value[1]	[volts] output transistor src of CCD, left amp
CFPE13VV	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Voltages[1]/img:Device_Voltage[8]/img:voltage_value[1]	[volts] voltage - 13V focal plane electronics
CFPE_6VV	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Voltages[1]/img:Device_Voltage[10]/img:voltage_value[1]	[volts] voltage - 6V focal plane electronics
CCLMP2	n/a	[DN] cal lamp #N level (0-255)", where N = 1 or 2. These are basically just the high byte of the values CLMP2 and CLMP1 above, which run from 0-4095.
CCLMP1	n/a	[DN] cal lamp #N level (0-255)", where N = 1 or 2. These are basically just the high byte of the values CLMP2 and CLMP1 above, which run from 0-4095.
CDPU_ID	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Component_States[1]/img:Device_Component_State[1]/img:device_state[1]	DPU in use

FITS Keyword	PDS XML Label Class/Attribute	Definition
CCLMP2PE	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Component_States[1]/img:Device_Component_State[2]/img:device_state[1]	cal lamp #2 power enable
CCLMP1PE	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Component_States[1]/img:Device_Component_State[3]/img:device_state[1]	cal lamp #1 power enable
CSOURCE	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Component_States[1]/img:Device_Component_State[4]/img:device_state[1]	image source
CFORMAT	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Downsampling[1]/img:Pixel_Averaging_Dimensions[1]	image format
CEXPMODE	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Exposure[1]/img:exposure_type[1]	exposure mode
SCTLMTIM	n/a	[ISO cal] SCET time of s/c telemetry
M2T	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Temperatures[1]/img:Device_Temperature[8]/img:temperature_value[1]	[deg C] LLORRI OTA M2 temp.

FITS Keyword	PDS XML Label Class/Attribute	Definition
M1T	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Temperatures[1]/img:Device_Temperature[9]/img:temperature_value[1]	[deg C] LLORRI OTA M1 temp. at bulkhead
FPET1	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Temperatures[1]/img:Device_Temperature[10]/img:temperature_value[1]	[deg C] LLORRI FPE temp. 1
FPET2	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Temperatures[1]/img:Device_Temperature[11]/img:temperature_value[1]	[deg C] LLORRI FPE temp. 2
DPUT1	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Temperatures[1]/img:Device_Temperature[12]/img:temperature_value[1]	[deg C] LLORRI DPU temp. 1
DPUT2	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Temperatures[1]/img:Device_Temperature[13]/img:temperature_value[1]	[deg C] LLORRI DPU temp. 2
CCDT1	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Temperatures[1]/img:Device_Temperature[14]/img:temperature_value[1]	[deg C] LLORRI det. temp. 1, CCD carrier plate

FITS Keyword	PDS XML Label Class/Attribute	Definition
CCDT2	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Temperatures[1]/img:Device_Temperature[15]/img:temperature_value[1]	[deg C] LLORRI det. temp. 2, CCD carrier plate
SCOTAHTR	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Component_States[1]/img:Device_Component_State[5]/img:device_state[1]	LLORRI OTA survival heater control mode
SCFPEHTR	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Component_States[1]/img:Device_Component_State[6]/img:device_state[1]	LLORRI FPE survival heater control mode
SPLORDEC	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Component_States[1]/img:Device_Component_State[7]/img:device_state[1]	LLORRI decontamination heater set pt status
SPLORDPU	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Component_States[1]/img:Device_Component_State[8]/img:device_state[1]	LLORRI DPU survival heater set pt status
SPLORFPE	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Component_States[1]/img:Device_Component_State[9]/img:device_state[1]	LLORRI FPE survival heater set pt status

FITS Keyword	PDS XML Label Class/Attribute	Definition
SPLORTEL	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Component_States[1]/img:Device_Component_State[10]/img:device_state[1]	LLORRI telescope survival heater set pt status
CHECKSUM	n/a	HDU checksum updated 2023-09-04T03:25:24
DATASUM	n/a	data unit checksum updated 2023-09-04T03:25:24
END	n/a	FITS End Keyword
HDU[0]	/Product_Observational[1]/File_Area_Observational[1]/Array_2D_Image[1]	LLORRI 1x1 or 4x4 2D image array
HDU[1]	/Product_Observational[1]/File_Area_Observational[1]/Array_1D[1]	LLORRI 1D image histogram array
HDU[2]	/Product_Observational[1]/File_Area_Observational[1]/Array_1D[2]	LLORRI 1D image header array
HDU[3]	/Product_Observational[1]/File_Area_Observational[1]/Array_1D[3]	LLORRI 1D image descriptor array

3.2.2 Partially Processed Data Product Format

The L'LORRI partially processed data product is a three data array (HDU) fits file. The primary data array is a 2-dimensional primary image data array of 64-bit real values in units of DN/s in an array size of 1024x1024 or 256x256 depending on image binning. The secondary data array is a 2-dimensional error image data array of 64-bit real values in units of DN/s in an array size identical to the primary array. The tertiary data array is a 2-dimensional quality flag data array of 16-bit unsigned integer values in an array size identical to the primary array.

Table 3-3 L'LORRI Partially Processed Data Product Format

FITS Keyword	PDS XML Label Class/Attribute	Definition
SIMPLE	n/a	File conforms to FITS standard
BITPIX	/Product_Observational[1]/File_Area_Observational[1]/Array_2D_Image[1]/Element_Array[1]/data_type[1]	Pixel bit depth

FITS Keyword	PDS XML Label Class/Attribute	Definition
NAXIS	/Product_Observational[1]/File_Area_Observational[1]/Array_2D_Image[1]/axes[1]	Number of axes in the data array (2)
NAXIS1	/Product_Observational[1]/File_Area_Observational[1]/Array_2D_Image[1]/axes[1]	Number of rows (lines)
NAXIS2	/Product_Observational[1]/File_Area_Observational[1]/Array_2D_Image[1]/axes[1]	Number of columns (samples)
EXTEND	n/a	FITS dataset may contain extensions
MISSION	/Product_Observational[1]/Observation_Area[1]/Investigation_Area[1]/name[1]/node()[1]	mission name (Lucy)
HOSTNAME	/Product_Observational[1]/Observation_Area[1]/Observing_System[1]/Observing_System_Component[1]	instrument host name (Lucy)
HOSTID	/Product_Observational[1]/Observation_Area[1]/Observing_System[1]/Observing_System_Component[1]	instrument host ID (Lucy)
INSTRUME	/Product_Observational[1]/Observation_Area[1]/Observing_System[1]/Observing_System_Component[2]	name of instrument (LLORRI)
OBSID	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:Lucy_Observation_Time_Information[1]/lucy:observation_id[1]	observation ID
OBSIDCNT	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:Lucy_Observation_Time_Information[1]/lucy:observation_id_count[1]	observation identifier count
STRTSCLK	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:Lucy_Observation_Time_Information[1]/lucy:start_sclk[1]	observation start time (SCLK seconds)

FITS Keyword	PDS XML Label Class/Attribute	Definition
MIDSCLK	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:Lucy_Observation_Time_Information[1]/lucy:mid_sclk[1]	observation midpoint (SCLK seconds)
STOPSCLK	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:Lucy_Observation_Time_Information[1]/lucy:stop_sclk[1]	observation stop time (SCLK seconds)
STARTUTC	/Product_Observational[1]/Observation_Area[1]/Time_Coordinates[1]/start_date_time[1]	observation start time (UTC, ISOT format)
MIDUTC	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:Lucy_Observation_Time_Information[1]/lucy:mid_utc[1]	observation midpoint (UTC, ISOT format)
STOPUTC	/Product_Observational[1]/Observation_Area[1]/Time_Coordinates[1]/stop_date_time[1]	observation stop time (UTC, ISOT format)
MIDSCLKS	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:Lucy_Observation_Time_Information[1]/lucy:mid_sclk_string[1]	observation midpoint (full SCLK string)
MIDUTCID	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:Lucy_Observation_Time_Information[1]/lucy:mid_utc_doy[1]	observation midpoint (UTC, ISO DOY format)
MIDUTCJD	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:Lucy_Observation_Time_Information[1]/lucy:mid_utc_jd[1]	observation midpoint (Julian date)
MIDET	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:Lucy_Observation_Time_Information[1]/lucy:mid_ephemeris_time[1]	observation midpoint (ET, seconds past J2000)

FITS Keyword	PDS XML Label Class/Attribute	Definition
EXPTIME	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Exposure[1]/img:exposure_duration[1]	[s] Exposure time (sec)
FILENAME	/Product_Observational[1]/File_Area_Observational[1]/File[1]/file_name[1]/node()[1]	product file name
DATE	/Product_Observational[1]/File_Area_Observational[1]/File[1]/creation_date_time[1]	product creation time (UTC, ISOT format)
ORIGIN	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/proc:Processing_Information[1]	organization responsible for product
LOCATION	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/proc:Processing_Information[1]/proc:Process[1]/procprocess_owner_institution_name[1]	location where product was generated
CCSDSCLK	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:Lucy_Observation_Time_Information[1]/lucy:ccsds_sclk_time[1]	CCSDS timestamp, playback time (SCLK seconds)
PRODLVL	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/proc:Processing_Information[1]/proc:Process[1]/proc:Software[1]/proc:software_id[1]	product processing level
PRODVER	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:Lucy_Product_Information[1]/lucy:internal_product_version_id[1]	Lucy internal data processing product version
UDPVER	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/proc:Processing_Information[1]/proc:Process[2]/proc:Software[1]/proc:software_version_id[1]/node()[1]	UDP software version

FITS Keyword	PDS XML Label Class/Attribute	Definition
CDPVER	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/proc:Processing_Information[1]/proc:Process[1]/proc:Software[2]/proc:software_version_id[1]	CDP software version
APID	n/a	packet application ID of source data
OBSCOMPL	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:Lucy_Observation_Time_Information[1]/lucy:observation_complete[1]	observation complete?
MISSPKT	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:Lucy_Observation_Time_Information[1]/lucy:observation_missing_packets[1]	number of missing packets
UDPFILE	/Product_Observational[1]/Reference_List[1]/Internal_Reference[1]/lid_reference[1]	input UDP filename
LOADID	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:Lucy_Observation_Planning[1]/lucy:load_identifier[1]	command sequence load ID
MSNSEG	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:Lucy_Observation_Planning[1]/lucy:mission_segment[1]	mission segment
SAPID	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:Lucy_Observation_Planning[1]/lucy:sap_identifier[1]	science activity plan identifier
VISITNAM	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:Lucy_Observation_Planning[1]/lucy:visit_name[1]	visit name

FITS Keyword	PDS XML Label Class/Attribute	Definition
SIDE	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:Lucy_Observation_Planning[1]/lucy:instrument_side[1]/node()[1]	instrument side requested
LORSTAT	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:Lucy_Observation_Planning[1]/lucy:llorri_status[1]	LORRI instrument status
RLPSTAT	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:Lucy_Observation_Planning[1]/lucy:lralph_status[1]	Ralph instrument status
TESSTAT	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:Lucy_Observation_Planning[1]/lucy:ltes_status[1]	TES instrument status
TTCSTAT	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:Lucy_Observation_Planning[1]/lucy:ttcam_status[1]	TTCam instrument status
TARGET	/Product_Observational[1]/Observation_Area[1]/Target_Identification[1]/name[1]	name of intended primary target
TARGETID	/Product_Observational[1]/Observation_Area[1]/Target_Identification[1]/alternate_identification[1]	SPICE ID of intended primary target
SPCINSQA	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Image_Display_Geometry[1]/geom:Quaternion_Plus_To_From[1]	cos(theta/2), instr. -> J2000 SPICE quat.
SPCINSQX	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Image_Display_Geometry[1]/geom:Quaternion_Plus_To_From[1]	sin(theta/2)*X, instr. -> J2000 SPICE quat.

FITS Keyword	PDS XML Label Class/Attribute	Definition
SPCINSQY	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Image_Display_Geometry[1]/geom:Quaternion_Plus_To_From[1]	sin(theta/2)*Y, instr. -> J2000 SPICE quat.
SPCINSQZ	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Image_Display_Geometry[1]/geom:Quaternion_Plus_To_From[1]	sin(theta/2)*Z, instr. -> J2000 SPICE quat.
SPCSCQA	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Image_Display_Geometry[1]/geom:Quaternion_Plus_To_From[2]	cos(theta/2), S/C -> J2000 SPICE quat.
SPCSCQX	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Image_Display_Geometry[1]/geom:Quaternion_Plus_To_From[2]	sin(theta/2)*X, S/C -> J2000 SPICE quat.
SPCSCQY	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Image_Display_Geometry[1]/geom:Quaternion_Plus_To_From[2]	sin(theta/2)*Y, S/C -> J2000 SPICE quat.
SPCSCQZ	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Image_Display_Geometry[1]/geom:Quaternion_Plus_To_From[2]	sin(theta/2)*Z, S/C -> J2000 SPICE quat.
RATEX	n/a	angular rate about inst. frame +X axis (urad/s)
RATEY	n/a	angular rate about inst. frame +Y axis (urad/s)
RATEZ	n/a	angular rate about inst. frame +Z axis (urad/s)

FITS Keyword	PDS XML Label Class/Attribute	Definition
RATEXY	n/a	magnitude of [RATEX,RATEY] pair (urad/s)
RATEYZ	n/a	magnitude of [RATEY,RATEZ] pair (urad/s)
RATEXZ	n/a	magnitude of [RATEX,RATEZ] pair (urad/s)
RATEMAG	n/a	magnitude of [RATEX,RATEY,RATEZ] vec. (urad/s)
IPIGANG	n/a	IPP inner gimbal angle (deg)
IPIGRATE	n/a	IPP inner gimbal angle rate (deg/sec)
IPOGANG	n/a	IPP outer gimbal angle (deg)
IPOGRATE	n/a	IPP outer gimbal angle rate (deg/sec)
BSRASTRT	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Image_Display_Geometry[1]/geom:Object_Orientation_RA_Dec[1]/geom:right_ascension_angle[1]	Boresight RA at obs start (deg)
BSDCSTRT	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Image_Display_Geometry[1]/geom:Object_Orientation_RA_Dec[1]/geom:declination_angle[1]	Boresight Dec at obs start (deg)
BSRAMID	n/a	Boresight RA at mid-obs time (deg)
BSDCMID	n/a	Boresight Dec at mid-obs time (deg)
BSRASTOP	n/a	Boresight RA at obs end (deg)
BSDCSTOP	n/a	Boresight Dec at obs end (deg)
TRGFOV1	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:Lucy_Target_List[1]/lucy:target_fov_name[1]	Target 1 in Field of View

FITS Keyword	PDS XML Label Class/Attribute	Definition
TRGFOVN	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:Lucy_Target_List[1]/lucy:target_fov_count[1]	number of possible targets in FOV (SPICE-derived)
PA_XINST	n/a	pos. ang. +X axis, E of proj. EMEJ2K N (deg)
PA_YINST	n/a	pos. ang. +Y axis, E of proj. EMEJ2K N (deg)
PA_ZINST	n/a	pos. ang. +Z axis, E of proj. EMEJ2K N (deg)
PA_SUN	n/a	pos. ang. proj. Sun, E of proj. EMEJ2K N (deg)
PA_SUN_X	n/a	pos. ang. proj. Sun, E of inst. +X axis (deg)
PA_SUN_Y	n/a	pos. ang. proj. Sun, E of inst. +Y axis (deg)
PA_SUN_Z	n/a	pos. ang. proj. Sun, E of inst. +Z axis (deg)
TGT_ELON	n/a	ang. betw. target and inst. boresight (deg)
SOL_ELON	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Illumination_Geometry[1]/geom:Illumination_Specific[1]/geom:solar_elongation[1]	ang. betw. Sun and inst. boresight (deg)
EAR_ELON	n/a	ang. betw. Earth and inst. boresight (deg)
SPCQUAL	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:SPICE_Kernel_Files[1]/geom:SPICE_Kernel_Identification[1]/geom:kernel_provenance[1]	SPICE quality
SPCSTAT	n/a	SPICE status
SPCSCNM	n/a	SPICE spacecraft bus frame name
SPCSCID	n/a	SPICE spacecraft bus frame ID
SPCINSNM	n/a	SPICE instrument frame name
SPCINSID	n/a	SPICE instrument frame ID

FITS Keyword	PDS XML Label Class/Attribute	Definition
SPCTSCX	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Vectors[1]/geom:Vectors_Cartesian_Specific[1]/geom:Vector_Cartesian_Position_Spacecraft_To_Target[1]/geom:x_position[1]	S/C pos vec wrt target, X, EMEJ2000 (km)
SPCTSCY	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Vectors[1]/geom:Vectors_Cartesian_Specific[1]/geom:Vector_Cartesian_Position_Spacecraft_To_Target[1]/geom:y_position[1]	S/C pos vec wrt target, Y, EMEJ2000 (km)
SPCTSCZ	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Vectors[1]/geom:Vectors_Cartesian_Specific[1]/geom:Vector_Cartesian_Position_Spacecraft_To_Target[1]/geom:z_position[1]	S/C pos vec wrt target, Z, EMEJ2000 (km)
SPCTSCVX	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Vectors[1]/geom:Vectors_Cartesian_Specific[1]/geom:Vector_Cartesian_Velocity_Spacecraft_Relative_To_Target[1]/geom:x_velocity[1]	S/C vel vec wrt target, X, EMEJ2000 (km/s)
SPCTSCVY	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Vectors[1]/geom:Vectors_Cartesian_Specific[1]/geom:Vector_Cartesian_Velocity_Spacecraft_Relative_To_Target[1]/geom:y_velocity[1]	S/C vel vec wrt target, Y, EMEJ2000 (km/s)

FITS Keyword	PDS XML Label Class/Attribute	Definition
SPCTSCVZ	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Vectors[1]/geom:Vectors_Cartesian_Specific[1]/geom:Vector_Cartesian_Velocity_Spacecraft_Relative_To_Target[1]/geom:z_velocity[1]	S/C vel vec wrt target, Z, EMEJ2000 (km/s)
SPCTRANG	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Distances[1]/geom:Distances_Specific[1]/geom:spacecraft_target_center_distance[1]	S/C range to target center (km)
SPCTPHAS	n/a	Sun-target-S/C angle (deg)
SPCTSOX	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Vectors[1]/geom:Vectors_Cartesian_Specific[1]/geom:Vector_Cartesian_Position_Sun_To_Spacecraft[1]/geom:x_position[1]	Sun pos vec wrt target, X, EMEJ2000 (km)
SPCTSOY	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Vectors[1]/geom:Vectors_Cartesian_Specific[1]/geom:Vector_Cartesian_Position_Sun_To_Spacecraft[1]/geom:y_position[1]	Sun pos vec wrt target, Y, EMEJ2000 (km)
SPCTSOZ	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Vectors[1]/geom:Vectors_Cartesian_Specific[1]/geom:Vector_Cartesian_Position_Sun_To_Spacecraft[1]/geom:z_position[1]	Sun pos vec wrt target, Z, EMEJ2000 (km)

FITS Keyword	PDS XML Label Class/Attribute	Definition
SPCTSOVX	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Vectors[1]/geom:Vectors_Cartesian_Specific[1]/geom:Vector_Cartesian_Velocity_Target_Relative_To_Sun[1]/geom:x_velocity[1]	Sun vel vec wrt target, X, EMEJ2000 (km/s)
SPCTSOVY	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Vectors[1]/geom:Vectors_Cartesian_Specific[1]/geom:Vector_Cartesian_Velocity_Target_Relative_To_Sun[1]/geom:y_velocity[1]	Sun vel vec wrt target, Y, EMEJ2000 (km/s)
SPCTSOVZ	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Vectors[1]/geom:Vectors_Cartesian_Specific[1]/geom:Vector_Cartesian_Velocity_Target_Relative_To_Sun[1]/geom:z_velocity[1]	Sun vel vec wrt target, Z, EMEJ2000 (km/s)
SPCTSORN	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Distances[1]/geom:Distances_Specific[1]/geom:target_heliocentric_distance[1]	Sun center range to target center (km)
SPCTEOX	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Vectors[1]/geom:Vectors_Cartesian_Specific[1]/geom:Vector_Cartesian_Position_Earth_To_Target[1]/geom:x_position[1]	Earth pos vec wrt target, X, EMEJ2000 (km)

FITS Keyword	PDS XML Label Class/Attribute	Definition
SPCTEOY	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Vectors[1]/geom:Vectors_Cartesian_Specific[1]/geom:Vector_Cartesian_Position_Earth_To_Target[1]/geom:y_position[1]	Earth pos vec wrt target, Y, EMEJ2000 (km)
SPCTEOZ	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Vectors[1]/geom:Vectors_Cartesian_Specific[1]/geom:Vector_Cartesian_Position_Earth_To_Target[1]/geom:z_position[1]	Earth pos vec wrt target, Z, EMEJ2000 (km)
SPCTEOVX	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Vectors[1]/geom:Vectors_Cartesian_Specific[1]/geom:Vector_Cartesian_Velocity_Target_Relative_To_Earth[1]/geom:x_velocity[1]	Earth vel vec wrt target, X, EMEJ2000 (km/s)
SPCTEOVY	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Vectors[1]/geom:Vectors_Cartesian_Specific[1]/geom:Vector_Cartesian_Velocity_Target_Relative_To_Earth[1]/geom:y_velocity[1]	Earth vel vec wrt target, Y, EMEJ2000 (km/s)
SPCTEOVZ	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Vectors[1]/geom:Vectors_Cartesian_Specific[1]/geom:Vector_Cartesian_Velocity_Target_Relative_To_Earth[1]/geom:z_velocity[1]	Earth vel vec wrt target, Z, EMEJ2000 (km/s)

FITS Keyword	PDS XML Label Class/Attribute	Definition
SPCTEORN	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Distances[1]/geom:Distances_Specific[1]/geom:target_geocentric_distance[1]	Earth center range to target center (km)
SPCSCSX	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Vectors[1]/geom:Vectors_Cartesian_Specific[1]/geom:Vector_Cartesian_Position_Sun_To_Spacecraft[1]/geom:x_position[1]	Sun pos vec wrt S/C, X, EMEJ2000 (km)
SPCSCSY	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Vectors[1]/geom:Vectors_Cartesian_Specific[1]/geom:Vector_Cartesian_Position_Sun_To_Spacecraft[1]/geom:y_position[1]	Sun pos vec wrt S/C, Y, EMEJ2000 (km)
SPCSCSZ	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Vectors[1]/geom:Vectors_Cartesian_Specific[1]/geom:Vector_Cartesian_Position_Sun_To_Spacecraft[1]/geom:z_position[1]	Sun pos vec wrt S/C, Z, EMEJ2000 (km)
SPCSCSVX	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Vectors[1]/geom:Vectors_Cartesian_Specific[1]/geom:Vector_Cartesian_Velocity_Spacecraft_Relative_To_Sun[1]/geom:x_velocity[1]	Sun vel vec wrt S/C, X, EMEJ2000 (km/s)

FITS Keyword	PDS XML Label Class/Attribute	Definition
SPCSCSVY	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Vectors[1]/geom:Vectors_Cartesian_Specific[1]/geom:Vector_Cartesian_Velocity_Spacecraft_Relative_To_Sun[1]/geom:y_velocity[1]	Sun vel vec wrt S/C, Y, EMEJ2000 (km/s)
SPCSCSVZ	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Vectors[1]/geom:Vectors_Cartesian_Specific[1]/geom:Vector_Cartesian_Velocity_Spacecraft_Relative_To_Sun[1]/geom:z_velocity[1]	Sun vel vec wrt S/C, Z, EMEJ2000 (km/s)
SPCSCSRN	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Distances[1]/geom:Distances_Specific[1]/geom:spacecraft_heliocentric_distance[1]	Sun center range to S/C (km)
SPCESCX	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Vectors[1]/geom:Vectors_Cartesian_Specific[1]/geom:Vector_Cartesian_Position_Earth_To_Spacecraft[1]/geom:x_position[1]	S/C pos vec wrt Earth, X, EMEJ2000 (km)
SPCESCY	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Vectors[1]/geom:Vectors_Cartesian_Specific[1]/geom:Vector_Cartesian_Position_Earth_To_Spacecraft[1]/geom:y_position[1]	S/C pos vec wrt Earth, Y, EMEJ2000 (km)

FITS Keyword	PDS XML Label Class/Attribute	Definition
SPCESCZ	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Vectors[1]/geom:Vectors_Cartesian_Specific[1]/geom:Vector_Cartesian_Position_Earth_To_Spacecraft[1]/geom:z_position[1]	S/C pos vec wrt Earth, Z, EMEJ2000 (km)
SPCESCVX	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Vectors[1]/geom:Vectors_Cartesian_Specific[1]/geom:Vector_Cartesian_Velocity_Spacecraft_Relative_To_Earth[1]/geom:x_velocity[1]	S/C vel vec wrt Earth, X, EMEJ2000 (km/s)
SPCESCVY	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Vectors[1]/geom:Vectors_Cartesian_Specific[1]/geom:Vector_Cartesian_Velocity_Spacecraft_Relative_To_Earth[1]/geom:y_velocity[1]	S/C vel vec wrt Earth, Y, EMEJ2000 (km/s)
SPCESCVZ	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Vectors[1]/geom:Vectors_Cartesian_Specific[1]/geom:Vector_Cartesian_Velocity_Spacecraft_Relative_To_Earth[1]/geom:z_velocity[1]	S/C vel vec wrt Earth, Z, EMEJ2000 (km/s)
SPCESCRN	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:Geometry_Orbiter[1]/geom:Distances[1]/geom:Distances_Specific[1]/geom:spacecraft_geocentric_distance[1]	S/C range to Earth center (km)

FITS Keyword	PDS XML Label Class/Attribute	Definition
SPCKMK	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:SPICE_Kernel_Files[1]/geom:SPICE_Kernel_Identification[1]/geom:kernel_type[1]/node()[1]	SPICE metakernel
SPCKNUM	n/a	count of loaded SPICE kernels
SPCK[n]	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/geom:Geometry[1]/geom:SPICE_Kernel_Files[1]/geom:SPICE_Kernel_Identification[number]	SPICE kernel [n], one entry for each SPICE kernel used.
CRPIX1	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:Reference_Frame_Parameters[1]/ebt:World_Axis[1]/ebt:horizontal_coordinate_pixel[1]	WCS x-coordinate of reference pixel
CRPIX2	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:Reference_Frame_Parameters[1]/ebt:World_Axis[1]/ebt:vertical_coordinate_pixel[1]	WCS y-coordinate of reference pixel
CD1_1	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:Coordinate_Frame_Transformation_Matrix[1]/ebt:Transformation_Element[1]/ebt:element_value[1]	WCS dRA/dNAXIS lin xform param

FITS Keyword	PDS XML Label Class/Attribute	Definition
CD1_2	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:Coordinate_Frame_Transformation_Matrix[1]/ebt:Transformation_Element[3]/ebt:element_value[1]	WCS dRA/dNAXIS2 lin xform param
CD2_1	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:Coordinate_Frame_Transformation_Matrix[1]/ebt:Transformation_Element[2]/ebt:element_value[1]	WCS dDEC/dNAXIS1 lin xform param
CD2_2	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:Coordinate_Frame_Transformation_Matrix[1]/ebt:Transformation_Element[4]/ebt:element_value[1]	WCS dDEC/dNAXIS2 lin xform param
CTYPE1	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:Reference_Frame_Parameters[1]/ebt:World_Axis[1]/ebt:coordinate_name[1]	WCS coordinate type for the first axis (sample)

FITS Keyword	PDS XML Label Class/Attribute	Definition
CTYPE2	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:Reference_Frame_Parameters[1]/ebt:World_Axis[2]/ebt:coordinate_name[1]	WCS coordinate type for the second axis (line)
RADESYS	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:Reference_Frame_Parameters[1]/ebt:Reference_Frame_Identification[1]/ebt:name[1]	WCS inertial reference frame
EQUINOX	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:Reference_Frame_Parameters[1]/ebt:Reference_Frame_Identification[1]/ebt:frame_spice_name[1]	WCS reference epoch
CUNIT1	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:Reference_Frame_Parameters[1]/ebt:World_Axis[1]/ebt:world_coordinate_reference_point[1]/@unit	WCS units for the first axis (sample)

FITS Keyword	PDS XML Label Class/Attribute	Definition
CUNIT2	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:Reference_Frame_Parameters[1]/ebt:World_Axis[2]/ebt:world_coordinate_reference_point[1]/@unit	WCS units for the second axis (line)
CRVAL1	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:Reference_Frame_Parameters[1]/ebt:World_Axis[1]/ebt:world_coordinate_reference_point[1]	WCS RA of ref pix (deg); this is the boresight
CRVAL2	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:Reference_Frame_Parameters[1]/ebt:World_Axis[1]/ebt:world_coordinate_reference_point[1]	WCS Dec of ref pix (deg); this is the boresight
A_ORDER	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:SIP_Distortion_Terms[1]/ebt:A_ORDER[1]	forward SIP A order
A_2_0	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:SIP_Distortion_Terms[1]/ebt:A_ORDER[1]/ebt:SIP_Element[1]/ebt:element_value[1]	forward SIP; x^2 * y^0

FITS Keyword	PDS XML Label Class/Attribute	Definition
A_1_1	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:SIP_Distortion_Terms[1]/ebt:A_ORDER[1]/ebt:SIP_Element[2]/ebt:element_value[1]	forward SIP; x^1 * y^1
A_0_2	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:SIP_Distortion_Terms[1]/ebt:A_ORDER[1]/ebt:SIP_Element[3]/ebt:element_value[1]	forward SIP; x^0 * y^2
A_3_0	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:SIP_Distortion_Terms[1]/ebt:A_ORDER[1]/ebt:SIP_Element[4]/ebt:element_value[1]	forward SIP; x^3 * y^0
A_2_1	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:SIP_Distortion_Terms[1]/ebt:A_ORDER[1]/ebt:SIP_Element[5]/ebt:element_value[1]	forward SIP; x^2 * y^1

FITS Keyword	PDS XML Label Class/Attribute	Definition
A_1_2	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:SIP_Distortion_Terms[1]/ebt:A_ORDER[1]/ebt:SIP_Element[6]/ebt:element_value[1]	forward SIP; x^1 * y^2
A_0_3	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:SIP_Distortion_Terms[1]/ebt:A_ORDER[1]/ebt:SIP_Element[7]/ebt:element_value[1]	forward SIP; x^0 * y^3
B_ORDER	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:SIP_Distortion_Terms[1]/ebt:B_ORDER[1]	forward SIP B order
B_2_0	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:SIP_Distortion_Terms[1]/ebt:B_ORDER[1]/ebt:SIP_Element[1]/ebt:element_value[1]	forward SIP; x^2 * y^0
B_1_1	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:SIP_Distortion_Terms[1]/ebt:B_ORDER[1]/ebt:SIP_Element[2]/ebt:element_value[1]	forward SIP; x^1 * y^1

FITS Keyword	PDS XML Label Class/Attribute	Definition
B_0_2	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:SIP_Distortion_Terms[1]/ebt:B_ORDER[1]/ebt:SIP_Element[3]/ebt:element_value[1]	forward SIP; x^0 * y^2
B_3_0	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:SIP_Distortion_Terms[1]/ebt:B_ORDER[1]/ebt:SIP_Element[4]/ebt:element_value[1]	forward SIP; x^3 * y^0
B_2_1	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:SIP_Distortion_Terms[1]/ebt:B_ORDER[1]/ebt:SIP_Element[5]/ebt:element_value[1]	forward SIP; x^2 * y^1
B_1_2	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:SIP_Distortion_Terms[1]/ebt:B_ORDER[1]/ebt:SIP_Element[6]/ebt:element_value[1]	forward SIP; x^1 * y^2

FITS Keyword	PDS XML Label Class/Attribute	Definition
B_0_3	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:SIP_Distortion_Terms[1]/ebt:B_ORDER[1]/ebt:SIP_Element[7]/ebt:element_value[1]	forward SIP; x^0 * y^3
AP_ORDER	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:SIP_Distortion_Terms[1]/ebt:AP_ORDER[1]	reverse SIP AP order
AP_2_0	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:SIP_Distortion_Terms[1]/ebt:AP_ORDER[1]/ebt:SIP_Element[1]/ebt:element_value[1]	reverse SIP; x^2 * y^0
AP_1_1	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:SIP_Distortion_Terms[1]/ebt:AP_ORDER[1]/ebt:SIP_Element[2]/ebt:element_value[1]	reverse SIP; x^1 * y^1
AP_0_2	n/a	reverse SIP; x^0 * y^2

FITS Keyword	PDS XML Label Class/Attribute	Definition
AP_3_0	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:SIP_Distortion_Terms[1]/ebt:AP_ORDER[1]/ebt:SIP_Element[3]/ebt:element_value[1]	reverse SIP; x^3 * y^0
AP_2_1	n/a	reverse SIP; x^2 * y^1
AP_1_2	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:SIP_Distortion_Terms[1]/ebt:AP_ORDER[1]/ebt:SIP_Element[4]/ebt:element_value[1]	reverse SIP; x^1 * y^2
AP_0_3	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:SIP_Distortion_Terms[1]/ebt:AP_ORDER[1]	reverse SIP; x^0 * y^3
BP_ORDER	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:SIP_Distortion_Terms[1]/ebt:BP_ORDER[1]	reverse SIP BP order
BP_2_0	n/a	reverse SIP; x^2 * y^0

FITS Keyword	PDS XML Label Class/Attribute	Definition
BP_1_1	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:SIP_Distortion_Terms[1]/ebt:BP_ORDER[1]/ebt:SIP_Element[1]/ebt:element_value[1]	reverse SIP; x^1 * y^1
BP_0_2	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:SIP_Distortion_Terms[1]/ebt:BP_ORDER[1]/ebt:SIP_Element[2]/ebt:element_value[1]	reverse SIP; x^0 * y^2
BP_3_0	n/a	reverse SIP; x^3 * y^0
BP_2_1	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:SIP_Distortion_Terms[1]/ebt:BP_ORDER[1]/ebt:SIP_Element[3]/ebt:element_value[1]	reverse SIP; x^2 * y^1
BP_1_2	n/a	reverse SIP; x^1 * y^2
BP_0_3	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/ebt:Earth_Based_Telescope_Parameters[1]/ebt:Telescope_Geometry[1]/ebt:World_Coordinate_System[1]/ebt:SIP_Distortion_Terms[1]/ebt:BP_ORDER[1]/ebt:SIP_Element[4]/ebt:element_value[1]	reverse SIP; x^0 * y^3
ASM	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:LLORRI_Instrument_Parameters[1]/lucy:attached_sync_marker_dec[1]	[dec] attached sync marker

FITS Keyword	PDS XML Label Class/Attribute	Definition
OBS_ID	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:Lucy_Observation_Time_Information[1]/lucy:observation_id[1]	observation ID
OBS_ID_C	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:Lucy_Observation_Time_Information[1]/lucy:observation_id_count[1]	observation ID count
IMGTYPE	/Product_Observational[1]/Observation_Area[1]/Primary_Result_Summary[1]/purpose[1]	image type: 0=science, 1=opnav
START_S	n/a	[SCLK s] time tag of exposure start
START_F	n/a	[SCLK minor ticks] time tag of exposure start
END_S	n/a	[SCLK s] time tag of exposure end
END_F	n/a	[SCLK minor ticks] time tag of exposure end
FPU_L_I	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Currents[1]/img:Device_Current[1]/img:current_value[1]	[DN] current - FPU low
DPU_5V_I	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Currents[1]/img:Device_Current[2]/img:current_value[1]	[DN] current - 5V DPU
FPU_H_I	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Currents[1]/img:Device_Current[3]/img:current_value[1]	[DN] current - FPU high

FITS Keyword	PDS XML Label Class/Attribute	Definition
HEAT18VI	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Currents[1]/img:Device_Current[4]/img:current_value[1]	[DN] current - 18V heater
PRIM_I	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Currents[1]/img:Device_Current[5]/img:current_value[1]	[DN] current - primary input
FPU_V_L	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Voltages[1]/img:Device_Voltage[1]/img:voltage_value[1]	[DN] voltage - FPU low
FPU_V_H	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Voltages[1]/img:Device_Voltage[2]/img:voltage_value[1]	[DN] voltage - FPU high
DPU_5V_V	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Voltages[1]/img:Device_Voltage[3]/img:voltage_value[1]	[DN] voltage - 5V DPU
HEAT18VV	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Voltages[1]/img:Device_Voltage[4]/img:voltage_value[1]	[DN] voltage - 18V heater
DPU_P0_T	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Temperatures[1]/img:Device_Temperature[1]/img:temperature_value[1]	[DN] temp. - P0 DPU, DPU chassis

FITS Keyword	PDS XML Label Class/Attribute	Definition
FPU_P1_T	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Temperatures[1]/img:Device_Temperature[2]/img:temperature_value[1]	[DN] temp. - P1 FPU, FPU chassis
CCD_T	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Temperatures[1]/img:Device_Temperature[3]/img:temperature_value[1]	[DN] temp. - P2 OTA 1, CCD carrier plate
BAFFLE_T	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Temperatures[1]/img:Device_Temperature[4]/img:temperature_value[1]	[DN] temp. - P3 OTA 2, baffle ring
LVPS_T	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Temperatures[1]/img:Device_Temperature[5]/img:temperature_value[1]	[DN] temp. - spare P2, LVPS PWB in DPU
DPU_33VV	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Voltages[1]/img:Device_Voltage[5]/img:voltage_value[1]	[DN] voltage - 3.3V DPU
CCDSUB_T	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Temperatures[1]/img:Device_Temperature[6]/img:temperature_value[1]	[DN] temp. - CCD, sub-board on dogbone

FITS Keyword	PDS XML Label Class/Attribute	Definition
FPE_T	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Temperatures[1]/img:Device_Temperature[7]/img:temperature_value[1]	[DN] temp. - focal plane electronics
CCD_OSR	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Voltages[1]/img:Device_Voltage[6]/img:voltage_value[1]	[DN] output transistor src of CCD, right amp
FPE_29VV	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Voltages[1]/img:Device_Voltage[9]/img:voltage_value[1]	[DN] voltage - 29V focal plane electronics
CCD_OSL	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Voltages[1]/img:Device_Voltage[7]/img:voltage_value[1]	[DN] output transistor src of CCD, left amp
FPE_13VV	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Voltages[1]/img:Device_Voltage[8]/img:voltage_value[1]	[DN] voltage - 13V focal plane electronics
FPE_6V_V	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Voltages[1]/img:Device_Voltage[10]/img:voltage_value[1]	[DN] voltage - 6V focal plane electronics
LATCHCNT	n/a	[DN] latchup count
EXPOSURE	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Exposure[1]/img:exposure_duration[1]	[ms] commanded exposure time

FITS Keyword	PDS XML Label Class/Attribute	Definition
CLMP2	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:LLORRI_Instrument_Parameters[1]/lucy:calibration_lamp_level_1[1]	[DN] cal lamp #2 level
CLMP1	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:LLORRI_Instrument_Parameters[1]/lucy:calibration_lamp_level_2[1]	[DN] cal lamp #1 level
DPU_ID	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Component_States[1]/img:Device_Component_State[1]/img:device_state[1]	DPU in use: 0=DPU0, 1=DPU1
CLMP2PE	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Component_States[1]/img:Device_Component_State[1]/img:device_state[1]	cal lamp #2 power enable: 0=OFF, 1=ON
CLMP1PE	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Component_States[1]/img:Device_Component_State[3]/img:device_state[1]	cal lamp #1 power enable: 0=OFF, 1=ON
SOURCE	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Component_States[1]/img:Device_Component_State[4]/img:device_state[1]	0=CCD,1=FPU_TP1,2=FPU_TP2,3=DPU_TP1,4=DPU_TP2
FORMAT	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Downsampling[1]/img:Pixel_Averaging_Dimensions[1]	image format: 0=1x1, 1=4x4

FITS Keyword	PDS XML Label Class/Attribute	Definition
EXPMODE	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Exposure[1]/img:exposure_type[1]	exposure mode: 0=MANUAL, 1=AUTOMATIC
FLUSH	n/a	definition? (TBS)
POSTAMBL	n/a	[dec] postamble
CRC	n/a	[dec] image packet cyclic redundancy check
HDRSRC	n/a	IMAGE or IMAGE_DESCRIPTOR
ASM_X	/Product_Observational[1]/Observation_Area[1]/Mission_Area[1]/lucy:LLORRI_Instrument_Parameters[1]/lucy:attached_sync_marker_hex[1]	[hex] attached sync marker
CIMGTYPE	/Product_Observational[1]/Observation_Area[1]/Primary_Result_Summary[1]/purpose[1]	image type
CFPU_LI	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Currents[1]/img:Device_Current[1]/img:current_value[1]	[mA] current - FPU low
CDPU_5VI	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Currents[1]/img:Device_Current[2]/img:current_value[1]	[mA] current - 5V DPU
CFPU_HI	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Currents[1]/img:Device_Current[3]/img:current_value[1]	[mA] current - FPU high
CHT18VI	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Currents[1]/img:Device_Current[4]/img:current_value[1]	[mA] current - 18V heater

FITS Keyword	PDS XML Label Class/Attribute	Definition
CPRIM_I	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Currents[1]/img:Device_Current[5]/img:current_value[1]	[mA] current - primary input
CFPU_VL	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Voltages[1]/img:Device_Voltage[1]/img:voltage_value[1]	[volts] voltage - FPU low
CFPU_VH	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Voltages[1]/img:Device_Voltage[3]/img:voltage_value[1]	[volts] voltage - FPU high
CDPU_5VV	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Voltages[1]/img:Device_Voltage[2]/img:voltage_value[1]	[volts] voltage - 5V DPU
CHT18VV	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Voltages[1]/img:Device_Voltage[4]/img:voltage_value[1]	[volts] voltage - 18V heater
CDPU_P0T	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Temperatures[1]/img:Device_Temperature[1]/img:temperature_value[1]	[deg C] temp. - P0 DPU, DPU chassis
CFPU_P1T	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Temperatures[1]/img:Device_Temperature[2]/img:temperature_value[1]	[deg C] temp. - P1 FPU, FPU chassis

FITS Keyword	PDS XML Label Class/Attribute	Definition
C_CCD_T	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Temperatures[1]/img:Device_Temperature[3]/img:temperature_value[1]	[deg C] temp. - P2 OTA 1, CCD carrier plate
C_BAFL_T	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Temperatures[1]/img:Device_Temperature[4]/img:temperature_value[1]	[deg C] temp. - P3 OTA 2, baffle ring
C_LVPS_T	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Temperatures[1]/img:Device_Temperature[5]/img:temperature_value[1]	[deg C] temp. - spare P2, LVPS PWB in DPU
CDPU33VV	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Voltages[1]/img:Device_Voltage[5]/img:voltage_value[1]	[volts] voltage - 3.3V DPU
CCCDSB_T	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Temperatures[1]/img:Device_Temperature[6]/img:temperature_value[1]	[deg C] temp. - CCD, sub-board on dogbone
C_FPE_T	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Temperatures[1]/img:Device_Temperature[7]/img:temperature_value[1]	[deg C] temp. - focal plane electronics

FITS Keyword	PDS XML Label Class/Attribute	Definition
C_CCDOSR	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Voltages[1]/img:Device_Voltage[6]/img:voltage_value[1]	[volts] output transistor src of CCD, right amp
CFPE29VV	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Voltages[1]/img:Device_Voltage[9]/img:voltage_value[1]	[volts] voltage - 29V focal plane electronics
C_CCDOSL	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Voltages[1]/img:Device_Voltage[7]/img:voltage_value[1]	[volts] output transistor src of CCD, left amp
CFPE13VV	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Voltages[1]/img:Device_Voltage[8]/img:voltage_value[1]	[volts] voltage - 13V focal plane electronics
CFPE_6VV	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Voltages[1]/img:Device_Voltage[10]/img:voltage_value[1]	[volts] voltage - 6V focal plane electronics
CCLMP2	n/a	[DN] cal lamp #N level (0-255)", where N = 1 or 2. These are basically just the high byte of the values CLMP2 and CLMP1 above, which run from 0-4095.
CCLMP1	n/a	[DN] cal lamp #N level (0-255)", where N = 1 or 2. These are basically just the high byte of the values CLMP2 and CLMP1 above, which run from 0-4095.

FITS Keyword	PDS XML Label Class/Attribute	Definition
CDPU_ID	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Component_States[1]/img:Device_Component_State[1]/img:device_state[1]	DPU in use
CCLMP2PE	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Component_States[1]/img:Device_Component_State[2]/img:device_state[1]	cal lamp #2 power enable
CCLMP1PE	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Component_States[1]/img:Device_Component_State[3]/img:device_state[1]	cal lamp #1 power enable
CSOURCE	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Component_States[1]/img:Device_Component_State[4]/img:device_state[1]	image source
CFORMAT	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Downsampling[1]/img:Pixel_Averaging_Dimensions[1]	image format
CEXPMODE	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Exposure[1]/img:exposure_type[1]	exposure mode
SCTLMTIM	n/a	[ISO cal] SCET time of s/c telemetry

FITS Keyword	PDS XML Label Class/Attribute	Definition
M2T	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Temperatures[1]/img:Device_Temperature[8]/img:temperature_value[1]	[deg C] LLORRI OTA M2 temp.
M1T	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Temperatures[1]/img:Device_Temperature[9]/img:temperature_value[1]	[deg C] LLORRI OTA M1 temp. at bulkhead
FPET1	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Temperatures[1]/img:Device_Temperature[10]/img:temperature_value[1]	[deg C] LLORRI FPE temp. 1
FPET2	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Temperatures[1]/img:Device_Temperature[11]/img:temperature_value[1]	[deg C] LLORRI FPE temp. 2
DPUT1	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Temperatures[1]/img:Device_Temperature[12]/img:temperature_value[1]	[deg C] LLORRI DPU temp. 1
DPUT2	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Temperatures[1]/img:Device_Temperature[13]/img:temperature_value[1]	[deg C] LLORRI DPU temp. 2

FITS Keyword	PDS XML Label Class/Attribute	Definition
CCDT1	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Temperatures[1]/img:Device_Temperature[14]/img:temperature_value[1]	[deg C] LLORRI det. temp. 1, CCD carrier plate
CCDT2	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Temperatures[1]/img:Device_Temperature[15]/img:temperature_value[1]	[deg C] LLORRI det. temp. 2, CCD carrier plate
SCOTAHTR	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Component_States[1]/img:Device_Component_State[5]/img:device_state[1]	LLORRI OTA survival heater control mode
SCFPEHTR	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Component_States[1]/img:Device_Component_State[6]/img:device_state[1]	LLORRI FPE survival heater control mode
SPLORDEC	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Component_States[1]/img:Device_Component_State[7]/img:device_state[1]	LLORRI decontamination heater set pt status
SPLORDPU	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Component_States[1]/img:Device_Component_State[8]/img:device_state[1]	LLORRI DPU survival heater set pt status

FITS Keyword	PDS XML Label Class/Attribute	Definition
SPLORFPE	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Component_States[1]/img:Device_Component_State[9]/img:device_state[1]	LLORRI FPE survival heater set pt status
SPLORTEL	/Product_Observational[1]/Observation_Area[1]/Discipline_Area[1]/img:Imaging[1]/img:Instrument_State[1]/img:Device_Component_States[1]/img:Device_Component_State[10]/img:device_state[1]	LLORRI telescope survival heater set pt status
IMGSUBTR	to be updated	image subtraction step
BIASCORR	to be updated	bias subtraction step
SLINCORR	to be updated	signal linearization step
CTICORR	to be updated	charge transfer inefficiency step
DARKCORR	to be updated	dark subtraction step
SMEARCOR	to be updated	smear removal step
FLATCORR	to be updated	flat-fielding step
GEOMCORR	to be updated	geometric correction step
MASKCORR	to be updated	mask missing data step
AVSCORR	to be updated	absolute calibration step
COMPERR	to be updated	compute error estimate
COMPQUAL	to be updated	compute quality flags
REFDEBIA	/Product_Observational[1]/Reference_List[1]/Internal_Reference[3]/lid_reference[1]	debias image file name

FITS Keyword	PDS XML Label Class/Attribute	Definition
REFFLAT	/Product_Observational[1]/Reference_List[1]/Internal_Reference[2]/lid_reference[1]	flatfile
REFTEXPO	/Product_Observational[1]/Reference_List[1]/Internal_Reference[4]/lid_reference[1]	exposure time offset file
DIFFUNIT	to be updated	Diffuse trgt Rxxx keyword units=(DN/s/pixel)/(erg/cm^2/s/A/sr)
PNTUNITS	to be updated	Point trgt Pxxx keyword units=(DN/s)/(erg/cm^2/s/A)
BIASLEVL	to be updated	mean bias level of dark columns, units=DN
RDNOISE	to be updated	Read noise, units=DN
CCDGAIN	to be updated	CCD gain, units=e/DN
BIASOFF	to be updated	bias offset between active and inactive regions
TFRAME	to be updated	frame scrub/transfer time
PIVOT	to be updated	LLORRI pivot wavelength. units=angstroms
RSOLAR	to be updated	Conv to radiance for solar source
RTROJANR	to be updated	Conv to radiance for red trojans
RTROJANG	to be updated	Conv to radiance for gray trojans
RDINKY	to be updated	Conv to radiance for Dinkinesh
PSOLAR	to be updated	Conv to irradiance for solar source
PTROJANR	to be updated	Conv to irradiance for red trojans
PTROJANG	to be updated	Conv to irradiance for gray trojans
PHOTZPT	to be updated	Zero point for visual magnitude, V
CHECKSUM	n/a	HDU checksum updated 2023-09-04T03:25:24
DATASUM	n/a	data unit checksum updated 2023-09-04T03:25:24
END	n/a	FITS End Keyword

FITS Keyword	PDS XML Label Class/Attribute	Definition
HDU[0]	/Product_Observational[1]/File_Area_Observational[1]/Array_2D_Image[1]	LLORRI 1x1 or 4x4 2D image array
HDU[1]	/Product_Observational[1]/File_Area_Observational[1]/Array_2D[1]	LLORRI 2D error image array
HDU[2]	/Product_Observational[1]/File_Area_Observational[1]/Array_2D[2]	LLORRI 2D quality image array

3.3 Label and Header Descriptions

All L'LORRI data products are produced with PDS4 compliant detached XML labels. Examples of these labels can be found in the mission bundle, document collection.

As L'LORRI data products are formatted as FITS files, each Header Data Unit (HDU) contains an ASCII header. All information contained in the FITS headers that is needed to search for or interpret the data product is found in the PDS4 .XML label file.

4. APPLICABLE SOFTWARE

Any software that can read and parse FITS-format files, including those with extensions, will enable a user read or use the FITS data products.

PDS4 XML labels can be opened using most XML aware text editors.

PDS4 utility programs such as the PDS4 Viewer and other IDL- and Python based PDS4 readers are available through the PDS Tool Registry (https://pds.nasa.gov/tools/tool-registry/)

4.1 Utility Programs

As the L'LORRI images are formatted as FITS files, any FITS library can be used to manipulate the images. A good list of these libraries and software programs can be found at the FITS Support Office at the Goddard Space Flight Center (https://fits.gsfc.nasa.gov/).

4.2 Applicable PDS Software Tools

The PDS supplies several software tools that can be used in conjunction with PDS data products. Please refer to the PDS4 software website (https://pds.nasa.gov/tools/about/) for additional information on these tools.

4.3 Software Distribution and Update Procedures

There are no plans to distribute software specific to L'LORRI to the PDS. If these plans change, they will be noted here.

5. APPENDICES

5.1 ACRONYM LIST

Table 5-1: Acronym List

Acronym	Definition
APL	Applied Physics Laboratory
CCD	Charge Coupled Device
CTI	Charge Transfer Inefficiency
DMAP	Data Management and Archive Plan
DPI	Deputy Principal Investigator
DPU	Data Processing Unit
HDU	Header Data Unit
ICD	Interface Control Document
LDAT	*Lucy* Data Archive Team
LEISA	Linear Etalon Imaging Spectral Array
L'LORRI	*Lucy* Long Range Reconnaissance Imager
L'Ralph	Instrument comprised of LEISA and MVIC
L'TES	*Lucy* Thermal Emission Spectrometer
MGSS	Multi-Mission Ground System and Services
MOC	Mission Operations Center
MVIC	Multi-spectral Visible Imaging Camera
NAIF	Navigation and Ancillary Information Facility
NAV	Navigation
NOC	Navigation Operations Center
NSSDCA	National Space Science Data Coordinated Archive
OPS	Operations
PDS	Planetary Data System
PI	Principal Investigator
SBN	Small Bodies Node
SC	Spacecraft
SIS	Software Interface Specification
SOC	Science Operations Center

SPICE	Data sets that are called kernel files and stand for: • **S**pacecraft trajectory, given as a function of time (SPK kernels). • **P**lanet, satellite, comet, asteroid, associated physical, and cartographic constants (PCK kernels). • **I**nstrument information, including internal timing and other geometric information (IK kernels). • **C** matrix, time-tagged orientation data of mounted structures and instruments (CK kernels). • **E**vents for the spacecraft and ground data system, both planned and unplanned (EK kernels).
ST	Science Team
SwRI	Southwest Research Institute
TBD	To Be Determined
TBR	To Be Rectified
TTCAM	Terminal Tracking Camera