OSIRIS

Optical, Spectroscopic, and Infrared Remote Imaging System

Software Interface Specification for OSIRIS Science Products

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1a	13/2/2018 C. Tubiana		Added AD1, AD2, and RD4. Updated Sec. 4: pre-pixels description, sigma map and quality map description. Updated Sec. 4.1. Replaced .FTS with .FIT Added GS and SY in Table 5 and Table 6. Removed examples below Table 5 and Table 6. Updated Sec. 8. Updated PHASE_ANGLE and SOLAR_ELONGATION description. Updated POI_GROUP. Added SCIENCE_ACTIVITY group. Added Sec. 11.1, 11.2, 12 Added List of Figures and List of Tables Updated Examples in Appendix 1 and 2 Added Appendix 3 Updated SOLAR_ELONGATION definition Updated PRODUCT_ID definition Updated X_START, Y_START, X_END, Y_END definitions. Updated PDS Equivalent for XEND and YEND (FITs attached labels). Updated G_OQUA01, G_OQUA02, G_OQUA03, G_OQUA04. Updated LINEDIR, SMPLEDIR Updated description in PA_IMAGE object, PB_IMAGE object, OL_IMAGE object, SIGMA_MAP_IMAGE object, QUALITY_MAP_IMAGE object, FITs attached label (Sec. 11.1)
1b	1/3/2018 C. Tubiana		Updated Sec. 4. Updated Sec. 5. Added RD5. Added Sec. 8.7 (OSIRIS Level 4) Sec. 10.2: merged Blade 1 and Blade 2 sections Merged all _IMAGE objects into Sec. 10.3. Added SOFTWARE keywords to FITs attached label (Sec. 11.1). Added note about the order in which objects appear in the image header (in Sec. 4).
1c	25/04/2018 C. Güttler		Clarified OSIRIS and CODMAC levels Typos and very minor general clarifications

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1 General aspects

1.1 Scope

This document describes in detail the OSIRIS data product PDS and FITS data label.

1.2 Introduction

The purpose of this Data Product Software Interface Specification (SIS) is to provide consumers of OSIRIS Experiment Data Record (EDR, uncalibrated images) and Reduced Data Record (RDR, calibrated images) data products with a detailed description. How the data products are generated, including data sources and destinations, can be found in "Rosetta- OSIRIS To Planetary Science Archive Interface Control Document" [RD1]. The SIS is intended for the planetary science scientific community who will analyse the data.

1.3 Applicable Documents

no.	Document Name	Document Number, Iss./Rev.
AD1	Planetary Data System Standards Reference	JPL D-7669, Part 2, Version 3.8
AD2	Definition of the Flexible Image Transport System (FITS)	The FITS Standard Version 3.0: approved 2008 July 10 by the IAUFWG Document publication date: 2010 November 18

1.4 Reference Documents

no.	Document Name	Document Number, Iss./Rev.
RD1	Rosetta-OSIRIS To Planetary Science Archive Interface Control Document	RO-RIS-MPAE-ID-015
RD2	OSIRIS Calibration Pipeline OsiCalliope	RO-RIS-MPAE-MA-007
RD3	OSIRIS camera distortion correction parameters	RO-RIS-MPAE-TN-081
RD4	OSIRIS Science User Guide	RO-RIS-MPAE-MA-011
RD5	OSIRIS Georeferenced Data Products	RO-RIS-MPAE-TN-089

2 Acronyms

ASCII	American Standard Code for Information Interchange
ADC	Analog Digital Converter
CRB	CCD Readout Board
CCD	Charge Coupled Device
DDS	Data Distribution System
DPU	Data Processing Unit
DSP	Digital Signal Processor
EDR	Experiment Data Record (OSIRIS level 1 [CODMAC L2] data)
ESA	European Space Agency
HK	House Keeping data
IAA	Instituto de Astrofísica de Andalucía
IDA	Institut für Datentechnik und Kommunikationsnetze
INTA	Instituto Nacional de Técnica Aeroespacial
LAM	Laboratoire d'Astrophysique de Marseille
MCB	Motor Controller Board
MLI	Multi-Layer Insulation
MPS	Max Planck Institut für Sonnensystemforschung
NAC	Narrow Angle Camera
ODL	Object Description Language
OIOR	Orbiter Instrument Operational Request
OSIRIS	Optical, Spectroscopic, and Infrared Remote Imaging System
PCM	Power Converter Module
PDS	Planetary Data Systems
PSA	Planetary Science Archive
RDR	Reduced Data Record (OSIRIS level 2 [CODMAC L3] data and higher)
RSSD	Research and Scientific Support Department (ESA)
RO	Rosetta Orbiter
PSA	Planetary Science Archive
SPICE	Spacecraft, Planet, Instrument, C-matrix, Event kernels
SIS	Software Interface Specification
SPIHT	Set Partitioning in Hierarchical Trees (Wavelet compression algorithm)
SSMM	Solid State Mass Memory (Rosetta spacecraft storage device)
TBC	To Be Considered
TBD	To Be Determined
TMI	TeleMetry Image
UPD	Università di Padova
UPM	Universidad Politécnica de Madrid
WAC	Wide Angle Camera

3 Instrument Overview

The OSIRIS instrument was provided by the OSIRIS consortium led by the principal investigator Dr. Horst Uwe Keller at the Max Planck Institut für Sonnensystemforschung.

The OSIRIS camera system consists of a Narrow Angle Camera (NAC) and a Wide Angle Camera (WAC).

3.1 The Narrow Angle Camera (NAC)

The NAC (Figure 1) uses an off axis three mirror optical design. The off axis design was selected in order to minimize the stray light reaching the CCD (the NAC has a proven stray light attenuation of better than 10^{-9}). The optical beam is reflected by the three mirrors (M1, M2 and M3) before passing through a double filter wheel, a mechanical shutter mechanism and an anti-radiation plate (ARP) before reaching the CCD.

Figure 1: (Left) The OSIRIS NAC flight unit in the lab. (Right) The NAC optical path

3.2 The Wide Angle Camera (WAC)

The WAC (Figure 2) uses an off axis two mirror optical design. The off axis design was selected in order to minimize the stray light reaching the CCD (the WAC has a proven stray light attenuation of better than 10^{-8}).

The optical beam is reflected by the two mirrors (M1 & M2) before passing through a double filter wheel, a mechanical shutter mechanism, and an anti-radiation plate (ARP) before reaching the CCD.

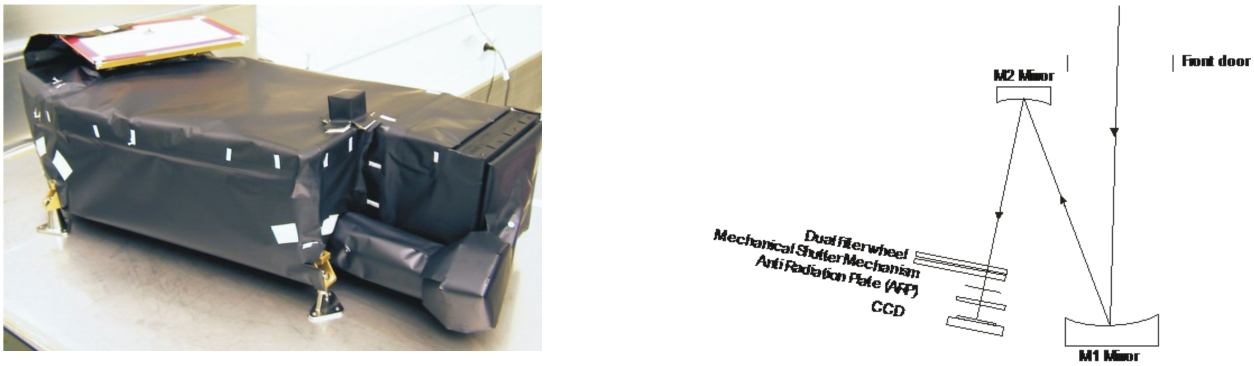

Figure 2: (Left) The OSIRIS WAC flight unit in the lab. (Right) The WAC optical path

More detailed information about the design of the cameras, the filter wheels, the mechanical shutter mechanism and the CCD can be found in:

Keller, H. U. et al. OSIRIS -- The Scientific Camera System Onboard Rosetta, *Space Science Reviews*, 2007, **128**, 433-506.

4 Data Structure for .IMG images

The OSIRIS images are stored as binary files with embedded PDS label, as described in the PDS specification [AD1]. Each image, independently from the processing level, contains three default data objects. In addition, depending on the acquisition mode and/or data level, can contain optional data objects.

The data objects of raw and calibrated OSIRIS images and derived data products (details about the processing levels can be found in Sec. 8) are summarized in Table 1. Please note that the order of the objects in Table 1 is not representative of the order in which the objects appear in the image header.

Object Name	CODMAC level			
	2	3	4	5
HEADER	✓	✓	✓	✓
HISTORY	✓	✓	✓	✓
IMAGE	✓	✓	✓	✓
PA_IMAGE	✓*			
PB_IMAGE	✓*			
OL_IMAGE	✓*			
BLADE1_PULSE_ARRAY	✓*			
BLADE2_PULSE_ARRAY	✓*			
SIGMA_MAP_IMAGE		✓	✓	
QUALITY_MAP_IMAGE		✓	✓	
DISTANCE_IMAGE				✓
EMISSION_ANGLE_IMAGE				✓
INCIDENCE_ANGLE_IMAGE				✓
PHASE_ANGLE_IMAGE				✓
FACET_INDEX_IMAGE				✓
COORDINATE_X_IMAGE				✓
COORDINATE_Y_IMAGE				✓
COORDINATE_Z_IMAGE				✓
Note: *Depends on acquisition mode.				

Table 1 Data objects in raw and calibrated OSIRIS images and derived data products.

HEADER: The image HEADER is an embedded PDS label with associated ancillary information. The header contains object and pointer references to all other embedded objects.

HISTORY: The HISTORY object is an additional PDS label that contains the processing information of all the processing software used in the processing pipeline.

IMAGE: The IMAGE data contains the actual CCD image data from the exposure. The image data can be addressed using the primary IMAGE object.

PA_IMAGE: The A amplifier Pre-pixel image data contains the image data from the readout, through the A amplifier, of the 48 pre-pixels of the serial register. The pre-pixels do not represent physical pixels of the CCD and contain valuable information for read-out noise and bias analysis. The pre-pixel image data is mapped to the PA_IMAGE object. The pre-pixel image object only exists if the pre-pixel data was transmitted to ground and only in OSIRIS level 1 (CODMAC L2) images.

PB_IMAGE: The B amplifier Pre-pixel image data contains the image data from the readout, through the B amplifier, of the 48 pre-pixels of the serial register. The pre-pixels do not represent physical pixels of the CCD and contain valuable information for read-out noise and bias analysis. The pre-pixel image data is mapped to the PB_IMAGE object. The pre-pixel image object only exists if the pre-pixel data was transmitted to ground and only in OSIRIS level 1 (CODMAC L2) images.

OL_IMAGE: The Overclocked Lines image contains image data acquired by continuing clocking out the CCD after all the physical pixels have been read. Reading out the CCD in this manner allows a measurement of the charge transfer efficiency along the column clocking direction. The over clocking lines data is mapped to the OL_IMAGE object. The image object only exists if over clocked line data was acquired during the image acquisition and only in OSIRIS level 1 (CODMAC L2) images.

BLADE1_PULSE_ARRAY: The Blade 1 shutter pulse object contains the raw timer data from the shutter mechanism motion encoder of the first shutter blade. This pulse data can be used to determine the position vs. time of the shutter blade during the exposure. This data can be used to improve the knowledge of the precise exposure time for each pixel in the image. The blade 1 shutter pulse data is stored in the BLADE1_PULSE_ARRAY array object. The object only exists if the shutter mechanism was used during the exposure and if the pulse data was downlinked to ground. This object exists only in OSIRIS level 1 (CODMAC L2) images.

BLADE2_PULSE_ARRAY: The Blade 2 shutter pulse object contains the raw timer data from the shutter mechanism motion encoder of the second shutter blade. This pulse data can be used to determine the position vs. time of the shutter blade during the exposure. This data can be used to improve the knowledge of the precise exposure time for each pixel in the image. The blade 2 shutter pulse data is stored in the BLADE2_PULSE_ARRAY array object. The object only exists if the shutter mechanism was used during the exposure and if the pulse data was downlinked to ground. This object exists only in OSIRIS level 1 (CODMAC L2) images.

SIGMA_MAP_IMAGE: The sigma map image is a float image with the same dimension as the image itself, which contains the error associated to each pixel. For a detailed description see RD2. The Sigma Map Image exists only in OSIRIS level 2 and 3 (CODMAC L3 and L4) images.

QUALITY_MAP_IMAGE: The quality map image is an 8-bit image with the same dimension as the image itself and contains a quality estimate of each pixel. For a detailed description see RD2. The Quality Map Image exists only in OSIRIS level 2 and 3 (CODMAC L3 and L4) images.

Georeferencing Layers: In addition to the default objects (HEADER, HISTORY and IMAGE) OSIRIS level 4 (CODMAC L5) images contain the image objects of the 8 georefencing layers. Details about these layers can be found in the “OSIRIS Georeferenced Data Products” document [RD5].

4.1 PDS Label

The OSIRIS EDRs and RDRs have an attached PDS label. A PDS label is object-oriented and describes the objects in the data file. The PDS label contains keywords for product identification. The label also contains descriptive information helpful to interpret or process the data in the file.

PDS labels are written in Object Description Language (ODL) (see PDS specification [AD1]). PDS label statements have the form:

keyword = value

The value of a statement is formatted according to the ODL standard and can extend over multiple lines. Each line is terminated with a carriage return character (ASCII 13) and a line feed character (ASCII 10) sequence.

Pointer statements with the following format are used to indicate the location of data objects in the file:

^object = location

The carat character (^, also called a pointer) is followed by the name of the specific data object. The location is the 1-based starting record number for the data object within the file. This record number, when used with RECORD_TYPE and RECORD_BYTES, allows the user to find where the object data starts within the file.

4.2 PDS Image Object

An IMAGE object is a two-dimensional array of values, all of the same type, each of which is referred to as a sample. IMAGE objects are normally processed with special display tools to produce a visual representation of the samples by assigning brightness levels or display colours to the values. An IMAGE consists of a series of lines, each containing the same number of samples.

The required IMAGE keywords (Table 2) define the parameters for IMAGE objects:

LINES	Number of lines in the image.
LINE_SAMPLES	Number of samples in each line.
SAMPLE_BITS	Number of bits in each individual sample.
SAMPLE_TYPE	Defines the sample data type.

Table 2: Required keywords for defining an IMAGE object

4.3 On-board image processing and compression

The OSIRIS flight software has the capability to compress the image data before transmission to ground using a number of compression algorithms and filtering schemes. OSIRIS implements a data segmentation scheme (Figure 3) to decrease sensitivity to data loss during transmission. Each image is separated into segments with a maximum size of 512x512 pixels. Each of these blocks are processed and compressed individually.

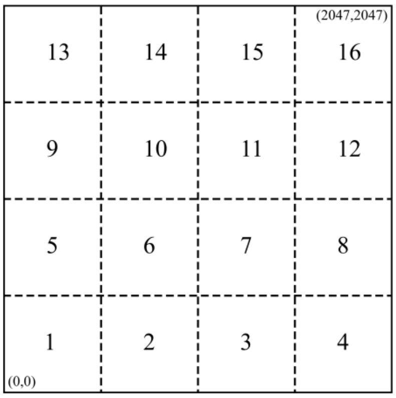

Figure 3: Example of the segmentation scheme used for an OSIRIS full frame image (2048x2048) (16 segments)

All information about compression and post processing is found in the SR_COMPRESSION group in the OSIRIS image headers. Each member of this group is a vector containing an entry for each image segment used to generate the final image. The segmentation boundaries can be found using the SEGMENT_[X, Y, W, H] members. The encoding algorithm can be found in the ENCODING member. The supported encoding algorithms are listed in Table 3.

NONE	No Compression.
SPIHT_D24	SPIHT based compression used by the OSIRIS flight software prior to release 2.0.
SPIHT_LIFT	SPIHT compression with LIFT filtering.
SPIHT_TAP	SPIHT compression with TAP filtering.
SQRT_16to8	Square rooting followed by 16 to 8 bit reduction.
PACK9BIT	The image data has been compressed by chopping the data range at 9 bits (meaning discarding the upper 7 bits).

Table 3: Supported encoding algorithms for image compression

The effective compression ratio achieved by the encoder is stored in the COMPRESSION_RATIO member.

If the encoding step was performed without information loss then the LOSSLESS_FLAG member is TRUE otherwise it is set to FALSE. Please note that LOSSLESS_FLAG only refers to the encoding step. LOSSLESS_FLAG can be TRUE even is a lossy filtering step has been performed.

To increase the quality of the SPIHT compressor OSIRIS also implement a pre-processing filtering step. A sqrt filtering step performing the transformation

$$I_{out} = \sqrt{I \cdot gain}$$

is available. If the sqrt filter has been used the SQRT_FILTER_FLAG is set to TRUE and the gain used for the transformation is written in SQRT_FILTER_GAIN.

More detailed information about the PDS Specification can be found in:

Planetary Data System -- ”Planetary Data System Standards Reference” [AD1].

https://pds.nasa.gov/tools/standards-reference.shtml

5 Data structure for .FIT images

The OSIRIS images are stored as a standard FITs file, as described in the FITs v3.0 specification [AD2], as a primary Header and Data Unit (HDU). Each image, independently from the processing level, contains these two default data objects.

IMAGE HEADER: The image header is an ASCII header containing a subset of the PDS ancillary information.
IMAGE DATA: The image data contains the actual CCD image data from the exposure. Pixels with the value 0 are used to indicate lost data (lost packets).

5.1 FITs Attached Label (Image Header)

The OSIRIS EDRs and RDRs have an attached FITs label. A FITs label contains keywords for product identification. The label also contains some descriptive information needed to interpret or process the data in the file.

FITs labels are to conform to the FITS v3.0 specification [AD2]. FITs label statements have the form of "keyword = value".

5.2 FITs Image Data

The IMAGE data is a two-dimensional array of values, all of the same type, each of which is referred to as a sample. IMAGE data is normally processed with special display tools to produce a visual representation of the samples by assigning brightness levels or display colours to the values. The IMAGE consists of a series of lines, each containing the same number of samples.

The following required FITS keywords (Table 4) define the parameters for IMAGE data:

NAXIS1	number of columns in the image (samples per line)
NAXIS2	number of rows (lines) in the image
BITPIX	number of bits in each individual sample
BSCALE/ BZERO:	defines the sample data

Table 4 Required keywords for defining IMAGE data

5.3 Detached PDS Label

In order to provide a PDS compatible delivery, every FITs image delivered to PSA has a detached PDS label, containing all the relevant information present in the PDS image header. The detached label is described in Sec. 11.2.

5.4 On-board image processing and compression

The OSIRIS flight software has the capability to compress the image data before transmission to ground using a number of compression algorithms and filtering schemes. OSIRIS implements a data segmentation scheme to decrease sensitivity to data loss during transmission. Each image is separated into segments with a maximum size of 512x512 pixels. Each of these blocks are processed and compressed individually (see Figure 3). Information regarding processing and compression is not stored within the FITS header, but can be found in the corresponding PDS image header (Sec. 4.3).

More detailed information about the FITS Specification can be found in:

FITS Support Office -- "Definition of the Flexible Image Transport System" [AD2]

http://fits.gsfc.nasa.gov/iaufwg/

6 File Naming Convention

6.1 The OSIRIS archive filename convention

The OSIRIS image files as archived in the project internal archive (please note NOT the PDS archive) use the following filename convention:

CCC_YYYY-MM-DDTHH.MM.SS.UUUZ_FFLI_NNNNNNNNNN_FAB.XXX

Field	Description
CCC	Either: NAC (Narrow Angle Camera) **OR** WAC (Wide Angle Camera)
YYYY	The year of acquisition
MM	The month of acquisition
DD	The day of acquisition
T	The letter T (stands for "Time")
HH	The hour of acquisition
MM	The minute of acquisition
SS	The second of acquisition
UUU	The millisecond of acquisition
Z	The letter Z
FF	The image file type: ID: Image Data (normal images) TH: Thumbnail version PA: Amplifier A pre pixels (calibration data) PB: Amplifier B pre pixels (calibration data) OL: Overclocked lines (calibration data) GS: Ghost Image SY: Synthetic Image
L	The OSIRIS processing level of the image
I	The OSIRIS processing sub-level of the image
NNNNNNNNNN	A ten digit user defined image ID number (specified by the user when writing the command timeline)
F	The letter F (stands for "Filter")
A	The position index of the filter wheel #1
B	The position index of the filter wheel #2
XXX	The file extension: IMG, FIT, JPG

Table 5: OSIRIS data file filename elements

Note! The filename contains an approximate time of acquisition. This time value is only used to uniquely identify the image and should not be used for any calculation needing high precision. The time value in the filename has not been corrected for on-board clock drift and leap seconds. The best possible knowledge about the time of acquisition can be found in the header label START_TIME (in .IMG images) and F_TSTART (in .FIT images).

6.2 The PDS archive filename convention

The OSIRIS image files as archived in the PDS use the following filename convention:

CYYYYMMDDTHHMMSSUUUFFLIFAB.XXX

Field	Description
C	Either: N (Narrow Angle Camera) **OR** W (Wide Angle Camera)
YYYY	The year of acquisition
MM	The month of acquisition
DD	The day of acquisition
T	The letter T (stands for "Time")
HH	The hour of acquisition
MM	The minute of acquisition
SS	The second of acquisition
UUU	The millisecond of acquisition
FF	The image file type: ID: Image Data (normal images) TH: Thumbnail version PA: Amplifier A pre pixels (calibration data) PB: Amplifier B pre pixels (calibration data) OL: Overclocked lines (calibration data) GS: Ghost Image SY: Synthetic Image
L	The CODMAC processing level of the image
I	The OSIRIS processing sub-level of the image (see Sect. 8 for the definition of levels)
F	The letter F (stands for "Filter")
A	The position index of the filter wheel #1
B	The position index of the filter wheel #2
XXX	The file extension: IMG, FIT, JPG

Table 6: OSIRIS data file filename elements

Note! The filename contains an approximate time of acquisition. This time value is only used to uniquely identify the image and should not be used for any calculation needing high precision. The time value in the filename has not been corrected for on-board clock drift and leap seconds. The best possible knowledge about the time of acquisition can be found in the header label START_TIME (in .IMG images) and F_TSTART (in .FIT images).

7 Coordinate Systems

There are a number of coordinate systems relevant to the interpretation of OSIRIS data. These coordinate systems can be separated into two groups: (a) pixel coordinate systems referring directly to the CCD and (b) inertial coordinate systems referring to the spacecraft and viewing geometry.

7.1 CCD Coordinate Frames

In the CCD coordinate frame, pixel (0, 0) is always the closest pixel to amplifier A, independently from which amplifier is used (see Figure 4).

The first pixel to be read-out is the closest to the used amplifier. The on board software re-arranges each line as if the CCD would have been read out through amplifier A. In this way, the first pixel in the image corresponds always to pixel (0, 0).

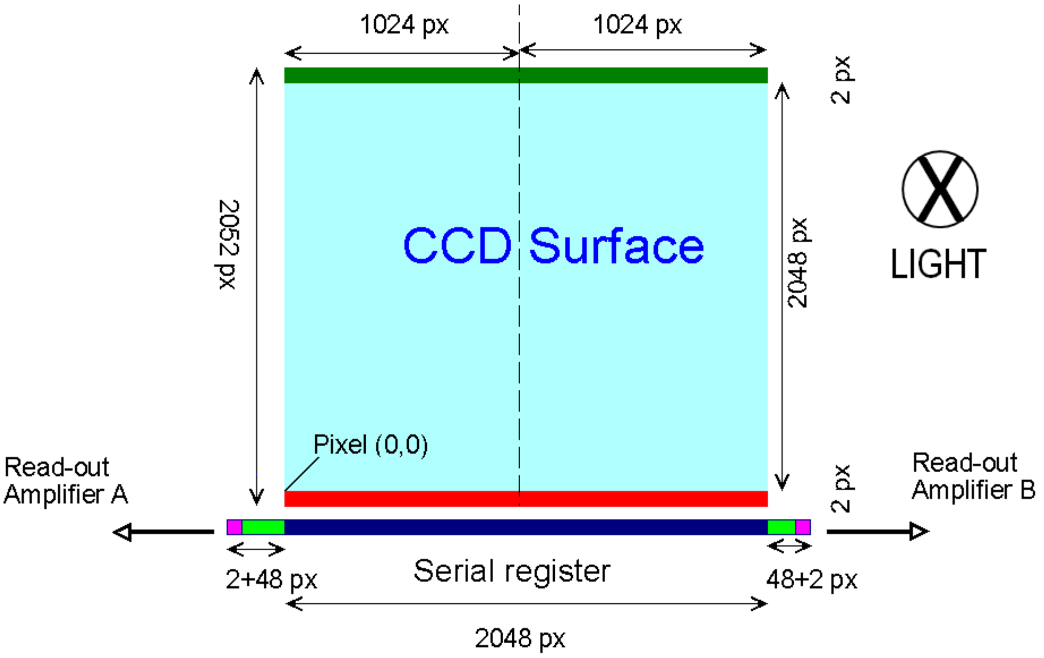

Figure 4: CCD array as seen by the science beam. CCD and S/C coordinate systems are shown

Lines are parallel to the serial register. *The line numbers* increase with distance from the serial register. Samples are perpendicular to the serial register. *The sample numbers* increase with distance from the edge of the CCD that contains read-out amplifier A.

7.2 Inertial Coordinate Frames

7.2.1 Standard Rosetta orientation

To display the images in the "standard Rosetta orientation" as most of the Rosetta products and tools (NAVCAM, 3DTool, MAPPS):

- WAC images have pixel (0,0) in the bottom right corner, the line number increases from bottom to top and the sample number increases from right to left (Figure 5, left).
- NAC images have pixel (0,0) in the bottom left corner, the line number increases from bottom to top and the sample number increases from left to right (Figure 5, right).

The direction in which the line number and the sample number increases is stored in the PDS header keywords SAMPLE_DISPLAY_DIRECTION and LINE_DISPLAY_DIRECTION, respectively. To display the images in the standard Rosetta orientation, an additional 180° rotation has to be applied to both NAC and WAC images.

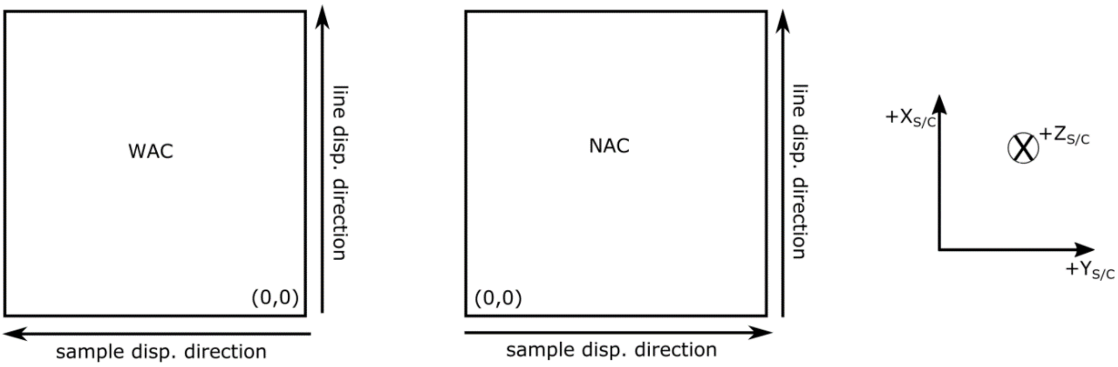

Figure 5: WAC and NAC images rotated into standard Rosetta orientation

In this orientation, the spacecraft +X axis is up and the spacecraft +Y axis to the right, meaning that the Sun is up in most images.

7.2.2 Rosetta spacecraft coordinate frame

The Rosetta spacecraft coordinate frame (S/C-COORDS) is defined with the +Z axis which is the nominal pointing of remote sensing instruments (orthogonal to the payload plane). The +Y axis is oriented along the solar panels and the +X is orthogonal to the high gain antenna mounting panel. The Rosetta spacecraft coordinate frame can be addressing in the SPICE system using the coordinate frame alias “ROS_SPACECRAFT”.

The OSIRIS cameras are mounted on the –X panel, looking nearly parallel along the +Z axis.

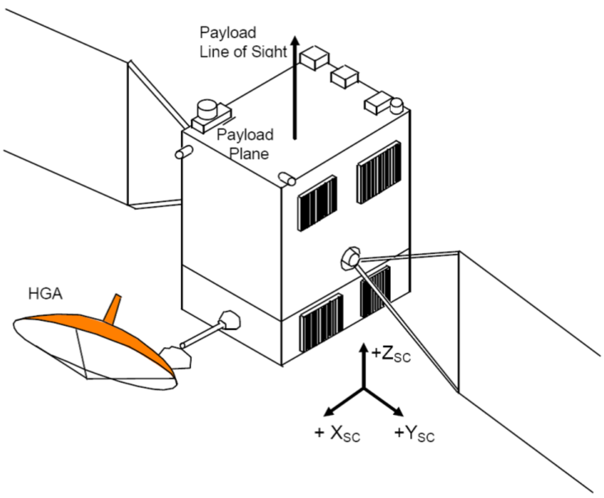

Figure 6: The Rosetta spacecraft coordinate frame (S/C-COORDS) definition

8 Product Generation

Products are generated following the process which is described in "Science Archive Interface Control Document" [RD1] and in the "OSIRIS Calibration Pipeline OsiCalliope" document [RD2].

8.1 OSIRIS Level 1 (CODMAC L2; EDR)

OSIRIS level 1 (EDR; CODMAC L2) data is generated from the telemetry data, by OsiTrap, following the generation of engineering data. OSIRIS level 1 (CODMAC L2) data includes raw image data, and a calibrated header. Pre-pixel and overclocked lines data, if they were present in the raw telemetry data, are also written into separate IMAGE objects.

8.2 OSIRIS Level 2 (CODMAC L3; RDR)

OSIRIS level 2 (RDR; CODMAC L3) data is generated by OsiCalliope, starting from OSIRIS level 1 (CODMAC L2) data, and performing the following calibration steps:

1.	IMAGE data is copied.
2.	Conversion of IMAGE data to "double" format.
3.	Correction of the tandem ADC offset and gain.
4.	Subtraction of bias.
5.	High spatial frequency flat fielding.
6.	Removal of bad pixels and bad columns.
7.	Low spatial frequency flat fielding.
8.	Normalization to exposure time.
9.	Conversion to radiometric units (absolute calibration).
10.	Generate sigma map and quality map.

Table 7: Steps performed during calibration of OSIRIS level 2 (RDR; CODMAC L3) data products

As each step is performed, the PROCESSING_FLAGS group in the PDS header is updated, indicating which steps have been performed. Additional information can also be found in the relevant HISTORY object. Calibration is described in more detail in "OSIRIS Calibration Pipeline OsiCalliope" [RD2].

Pre-pixels and overclock lines are used for the calibration when available or extrapolated from previous measurements and therefore do not explicitly appear in OSIRIS level 2 (CODMAC L3) and higher.

8.3 OSIRIS Level 3 (CODMAC L4; RDR)

OSIRIS level 3 (RDR; CODMAC L4) data is generated by OsiCalliope starting from calibrated OSIRIS level 2 (CODMAC L3) data, and applying the geometric distortion correction (resampling).

NAC and WAC optical layouts are off-axis mirror systems, which provide high transmittance from the UV to the near-IR and diffraction limited performance with low geometrical optical aberrations. However, this layout has a significant geometrical distortion that must be corrected.

The correction is performed by resampling the images according to the nonlinear distortion function of the camera, as if it had been acquired by a distortion-free camera. The image resampling is done by a bi-linear algorithm, and since the original image is in radiance units, the result is also considered radiometric corrected on large scales.

Distortion corrected OSIRIS level 3 (CODMAC L4) images have the processing flag DISTORTION_CORRECTION_FLAG set to TRUE. The geometric distortion correction is described in more detail in "OSIRIS Calibration Pipeline OsiCalliope" [RD2].

8.4 OSIRIS Level 3B (CODMAC L4, reflectance)

OSIRIS level 3B (CODMAC L4, reflectance) data are radiometric calibrated, geometric distortion corrected (resampled) images in reflectance units. OSIRIS level 3B (CODMAC L4, reflectance) images have the processing flag REFLECTIVITY_NORMALIZATION_FLAG set to TRUE. How this data level is generated is described in detail in "OSIRIS Calibration Pipeline OsiCalliope" [RD2].

8.5 OSIRIS Level 3C (CODMAC L4, straylight)

OSIRIS level 3C (CODMAC 4, straylight) data are solar stray light corrected, radiometric calibrated, geometric distortion corrected (resampled) images in radiance units. OSIRIS level 3C (CODMAC 4, straylight) images have the processing flag OUTFIELD_STRAYLIGHT_CORRECTION_FLAG set to TRUE. How this data level is generated is described in detail in "OSIRIS Calibration Pipeline OsiCalliope" [RD2].

8.6 OSIRIS Level 3D (CODMAC L4, straylight/reflectance)

OSIRIS level 3D (CODMAC L4, straylight/reflectance) data are solar stray light corrected, radiometric calibrated, geometric distortion corrected (resampled) images in reflectance units. OSIRIS level 3D (CODMAC L4, straylight/reflectance) images have the processing flag OUTFIELD_STRAYLIGHT_CORRECTION_FLAG and the REFLECTIVITY_NORMALIZATION_FLAG set to TRUE. How this data level is generated is described in detail in "OSIRIS Calibration Pipeline OsiCalliope" [RD2].

8.7 OSIRIS Level 4 (CODMAC L5)

OSIRIS level 4 (CODMAC L5) data are .IMG files with 9 layers. The first layer is the OSIRIS level 3 (CODMAC L4) radiometric calibrated and geometric distortion corrected (resampled) image data. The other 8 layers are georeferencing layers, containing pixel-precise information on distance, emission angle, incidence angle, phase angle, (shape model) facet index, and *x*/*y*/*z* coordinates. How this data level is generated is described in detail in "OSIRIS Georeferenced Data Products" document [RD5] and in the "OSIRIS Calibration Pipeline OsiCalliope" [RD2].

8.8 Conversion to FITs Format

To create FITs files, the PDS files are converted by making a copy of the IMAGE data, and converting the header into FITs format (see Sec. 5).

8.9 Conversion to JPEG Format

8.9.1 Level of images created

The JPEG images are created for OSIRIS level 1 to 4 (CODMAC L2 to L5), directly from the corresponding levels of PDS images (i.e. from the .IMG files). For the deliveries to PSA, these are used as browse products [RD1].

8.9.2 Scaling

The intensity scaling of the images is done using a ±2.5 sigma clipping on the full image around the average of the pixel intensity of an image, excluding values below zero. If M is the arithmetic average of all pixels and σ the standard deviation of the distribution around the average, the image is linearly scaled from M - 2.5σ (translated into JPEG grey value 0) to M + 2.5σ (translated into JPEG grey value 255). If M - 2.5σ is smaller than zero, the image will be linearly scaled from 0 to M + 2.5σ. The final image is in 8 bit grayscale although it is stored as a 32 bit colour image.

8.9.3 Orientation

The images are stored in the "standard Rosetta orientation" (see Sec. 7.2.1) as most of the Rosetta products and tools (NAVCAM, 3DTool, MAPPS).

8.9.4 Resizing

JPEG images are provided in the original size.

8.9.5 Compression

Standard JPEG compression with quality factor 75.

8.9.6 Header

There is no header associated with the JPEG images.

8.9.7 Detached PDS Label

In order to provide a PDS compatible delivery, every JPEG image delivered to PSA has a detached PDS label, containing all the relevant information present in the PDS image header (see Sec. 10).

9 The OSIRIS Labels for .IMG files

The header keywords of all OSIRIS .IMG images are identical, independently from the processing level. The content of certain header keywords is updated according to the processing level.

9.1 System

Label	*Group*	*Namespace*	*Datatype*	*Unit*	*Description*	*Source*
PDS_VERSION_ID			Label		PDS version identifier.	Fixed
LABEL_REVISION_NOTE			String		PDS label set version. This value represents the version of this document.	Fixed
RECORD_TYPE			Label		PDS System Label.	Fixed
RECORD_BYTES			Integer		Number of bytes in a record block.	Image converter
FILE_RECORDS			Integer		Number of records in the file.	Image converter
LABEL_RECORDS			Integer		Number of records in the PDS label header.	Image converter
FILE_NAME			String		Original filename.	Image Converter
^IMAGE			Pointer		Position of the image data within the file (in records).	Image Converter
^HISTORY			Pointer		Position of the HISTORY data within the file (in records).	Image Converter
^BLADE1_PULSE_ARRAY			Pointer		Position of the shutter blade 1 position encoder data within the file (in records). Note: This existence of this field depends on the image acquisition mode. Moreover, this field only exists in OSIRIS level 1 (CODMAC L2) images.	Image Converter

^BLADE2_PULSE_ARRAY			Pointer		Position of the shutter blade 2 position encoder data within the file (in records). Note: This existence of this field depends on the image acquisition mode. Moreover, this field only exists in OSIRIS level 1 (CODMAC L2) images.	Image Converter
^SIGMA_MAP_IMAGE			Pointer		Position of the SIGMA_MAP data within the file (in records).	Image Converter
^QUALITY_MAP_IMAGE			Pointer		Position of the QUALITY_MAP data within the file (in records).	Image Converter

9.2 Software

Label	*Group*	*Namespace*	*Datatype*	*Unit*	*Description*	*Source*
SOFTWARE_DESC			String		Description of the software that generated the PDS file.	Image converter
SOFTWARE_LICENSE_TYPE			String		Licensing category under which this software falls.	Image converter
SOFTWARE_ID			String		Short-hand notation for the software name.	Image converter
SOFTWARE_NAME			String		Name of the data processing software.	Image converter
SOFTWARE_VERSION_ID			String		Version of the data processing software.	Image converter
SOFTWARE_RELEASE_DATE			String		Release date of the data processing software.	Image converter
TELEMETRY_FORMAT_CODE		ROSETTA	String		Version of the format of the telemetry packets.	Image converter

9.3 Mission Identification

Label	Group	Namespace	Datatype	Unit	Description	Source
INSTRUMENT_HOST_ID			String		ID of the instrument host.	Fixed
INSTRUMENT_HOST_NAME			String		Name of the instrument host.	Fixed
MISSION_ID			String		ID of mission.	Fixed
MISSION_NAME			String		Name of mission.	Fixed
MISSION_PHASE_NAME			String		Commonly-used identifier of a mission phase.	Image converter

9.4 Instrument Description

Label	Group	Namespace	Datatype	Unit	Description	Source
INSTRUMENT_ID			String		ID of the instrument. Either OSINAC or OSIWAC	TM
INSTRUMENT_NAME			String		Name of the instrument.	TM/Fixed
INSTRUMENT_TYPE			String		Short description of the instrument.	TM/Fixed
DETECTOR_DESC			String		Description of the detector system.	Fixed
DETECTOR_PIXEL_WIDTH			Float	micron	Width of a single pixel.	Fixed
DETECTOR_PIXEL_HEIGHT			Float	Micron	Height of a single pixel.	Fixed
DETECTOR_TYPE			String		Type of detector.	Fixed
DETECTOR_ID			String		ID of detector.	TM/Fixed
DETECTOR_TEMPERATURE			Float	K	Temperature of the CCD detector in Kelvin.	TM
ELEVATION_FOV			Float	deg	Full Field Of View of the instrument in elevation in degrees.	Fixed

AZIMUTH_FOV			Float	deg	Full Field Of View of the instrument in azimuth in degrees.	Fixed
VERTICAL_RESOLUTION		ROSETTA	Float	rad	IFOV of instrument in rad, vertical in Rosetta standard orientation (along Rosetta X axis).	Fixed
HORIZONTAL_RESOLUTION		ROSETTA	Float	rad	IFOV of instrument in rad, horizontal in Rosetta standard orientation (along Rosetta Y axis).	Fixed
TELESCOPE_F_NUMBER			Float		Telescope F number.	Fixed
VERTICAL_FOCAL_LENGTH		ROSETTA	Float	m	Telescope focal length, vertical in Rosetta standard orientation (along Rosetta X axis).	Fixed
HORIZONTAL_FOCAL_LENGTH		ROSETTA	Float	m	Telescope focal length, horizontal in Rosetta standard orientation (along Rosetta Y axis).	Fixed

9.5 Image Identification

Label	*Group*	*Namespace*	*Datatype*	*Unit*	*Description*	*Source*
IMAGE_ID			Integer		User defined image ID number.	TM

PROCESSING_ID		ROSETTA	Integer		The OSIRIS DPU has the capability to make multiple transfers of the same set of images data (the image can, for example, be first transferred as a highly compressed thumbnail image for quick look purposes followed later by a transfer of the same pixel data as a less compressed version). The value of the PROCESSING_ID will be unique for each transfer.	TM
IMAGE_OBSERVATION_TYPE			String		Type of observation: REGULAR for normal observations BIAS for 0 sec dark exposures DARK for > 0 sec dark exposures	TM
EXPOSURE_TYPE			String		Type of exposure: AUTO for auto exposures MANUAL for manual exposures	TM
PRODUCT_ID			String		Permanent, unique identifier assigned to a data product by its producer.	Image converter
PRODUCT_TYPE			String		ID of data product: EDR, RDR, or DDR.	Fixed
PRODUCT_VERSION_ID			String		Release version of product.	Image Converter
PRODUCER_INSTITUTION_NAME			String		Name of the institution that produced the data product.	Fixed
PRODUCER_FULL_NAME			String		Name of person that generated the data product.	Fixed

PRODUCER_ID			String		ID of institution that generated the data product.	Fixed
MEDIUM_TYPE			String		The MEDIUM_TYPE element identifies the physical storage medium for a data volume.	Fixed
PUBLICATION_DATE			Date		The PUBLICATION_DATE element provides the date when a published item, such as a document or a compact disc, was issued.	Fixed
VOLUME_FORMAT			Sting		The logical format used in writing a data volume, such as ANSI, TAR, or BACKUP for tape volumes and ISO-9660, HIGH-SIERRA, for CD-ROM volumes.	Fixed
VOLUME_ID			String		Unique identifier for a data volume.	Fixed
VOLUME_NAME			String		Name of a data volume. In most cases the VOLUME_NAME is more specific than the VOLUME_SET_NAME.	Fixed
VOLUME_SERIES_NAME			String		Full, formal name that describes a broad categorization of data products or data sets related to a planetary body or a research campaign (e.g. International Halley Watch). A volume series consists of one or more volume sets that represent data from one or more missions or campaigns.	Fixed
VOLUME_SET_NAME			String		Full, formal name of one or more data volumes containing a single data set or a collection of related data sets. Volume sets are normally considered as a single orderable entity.	Fixed

VOLUME_SET_ID			String		Identifies a data volume or a set of volumes. Volume sets are normally considered as a single orderable entity.	Fixed
VOLUME_VERSION_ID			String		Identifies the version of a data volume. All original volumes should use a VOLUME_VERSION_ID of 'Version 1'. Versions are used when data products are remade due to errors or limitations in the original volumes (test volumes, for example), and the new version makes the previous volume obsolete. Enhancements or revisions to data products which constitute alternate data products should be assigned a unique volume id, not a new version id.	Fixed
VOLUMES			String		Number of physical data volumes contained in a volume set.	Fixed
DATA_SET_ID			String		ID of the PDS dataset to which the data product belongs.	Fixed
DATA_SET_NAME			String		Description of the dataset to which the data product belongs.	Fixed
PROCESSING_LEVEL_ID			String		Processing level according to Sect. 8. OSIRIS level for internal products, CODMAC levels for data delivered to PSA.	Image converter
PROCESSING_LEVEL_DESC			String		Description of the processing level.	Image converter

DATA_QUALITY_ID			Integer		Numeric key that identifies the quality of data available for a particular time period. The DATA_QUALITY_ID scheme is unique to a given instrument and is described by the associated DATA_QUALTITY_DESC element. Note that the field exists in the OSIRIS labels but will always contain the value 0. The real quality estimate is located in the QUALITY_MAP_IMAGE objects residing in the reduced data records.	
DATA_QUALTITY_DESC			String		Data quality that is associated with a particular DATA_QUALITY_ID value. The various values of DATA_QUALITY_ID and DATA_QUALTITY_DESC are instrument dependent.	

9.6 Time Identification

Unless specified otherwise, all time identifiers are expressed in the Coordinated Universal Time system (UTC). Information about the leap seconds and the drifts in the spacecraft clock are extracted from the corresponding kernels as referenced in SPACE_FILE_NAME.

Label	***Group***	***Namespace***	***Datatype***	***Unit***	***Description***	***Source***
PRODUCT_CREATION_TIME			Time	UTC	Time when the data product was generated in UTC.	Image converter

START_TIME			Time	UTC	Start of the exposure in UTC. Please note that the value stored in START_TIME is the most precise time known at the time of file generation. The START_TIME has been corrected for on board clock drift and leap seconds.	TM/SPICE
STOP_TIME			Time	UTC	Start of image readout in UTC.	TM/SPICE
SPACECRAFT_CLOCK_START_COUNT			SCLK	S/C clock count	Start of the exposure in raw spacecraft clock count. Format: <reset>/<high count>:<low count>	TM
SPACECRAFT_CLOCK_STOP_COUNT			SCLK	S/C clock count	Start of image readout in raw spacecraft clock count. Format: <reset>/<high count>:<low count>	TM

9.7 Geometry

Label	*Group*	*Namespace*	*Datatype*	*Unit*	*Description*	*Source*
TARGET_NAME			String		Name of the observation target, PSA-compliant. Refer to TARGETS.CAT for a complete list of targets.	Image converter
TARGET_TYPE			String		Type of target. PSA-compliant. Refer to TARGETS.CAT for a complete list of targets.	Image converter
SC_SUN_POSITION_VECTOR			3-vector	km	Vector from the S/C to the sun (X, Y, Z) in J2000. The vector is light-time corrected.	SPICE
SPACECRAFT_SOLAR_DISTANCE			Float	km	Spacecraft distance from the Sun.	SPICE

SOLAR_ELONGATION			Float	deg	Angle between a vector from the S/C to the sun and the camera boresight (approximately the S/C +Z axis).	SPICE
RIGHT_ASCENSION			Float	deg	The right ascension of the S/C +Z axis specified in J2000 with coordinate system centre in the S/C.	SPICE
DECLINATION			Float	deg	The declination of the S/C +Z axis specified in J2000 with coordinate system centre in the S/C.	SPICE
NORTH_AZIMUTH			Float	deg	Value of the angle between a line from the image centre to the celestial north pole and a reference line in the image plane. The reference line is a horizontal line from the image centre to the middle right edge of the image. The angle increases in the clockwise direction. The image is assumed to be displayed using the PDS header keywords SAMPLE_DISPLAY_DIRECTION and LINE_DISPLAY_DIRECTION (see Sec.7.1) such that $-Y_{SC}$ points to the right.	SPICE
SC_TARGET_POSITION_VECTOR			Float 3 vector	None or km	If *solar system object* this field contains the vector from the S/C to the target object in km. The vector is light-time corrected. If *stellar target object* this field contains a unit vector towards the target object.	SPICE
SC_TARGET_VELOCITY_VECTOR			Float 3 vector	m/s	This velocity component is the derivative with respect to time of the SC_TARGET_POSITION_VECTOR.	SPICE

TARGET_CENTER_DISTANCE			Float	km	Distance to the target object (only valid for solar system objects). See note below this table for technical details.	SPICE
SPACECRAFT_ALTITUDE			Float	km	The height of the spacecraft over the surface of an extended target object. See note below this table for technical details.	SPICE
SUB_SPACECRAFT_LATITUDE			Float	deg	With the spacecraft flying over an extended object a vector can be drawn from the centre of the planet to the spacecraft. This vector intersects the target surface at a specific latitude and longitude in the given IAU_XXX rotating coordinate system of the target. This field contains the latitude. See note below this table for technical details.	SPICE
SUB_SPACECRAFT_LONGITUDE			Float	deg	With the spacecraft flying over an extended object a vector can be drawn from the centre of the planet to the spacecraft. This vector intersects the target surface at a specific latitude and longitude in the given IAU_XXX rotating coordinate system of the target. This field contains the longitude. See note below this table for technical details.	SPICE

SUB_SOLAR_LATITUDE			Float	deg	Latitude of the subsolar point. The subsolar point is that point on a body's reference surface where a line from the body center to the sun center intersects that surface. See note below this table for technical details.	SPICE
SUB_SOLAR_LONGITUDE			Float	deg	Longitude of the subsolar point. The subsolar point is that point on a body's reference surface where a line from the body center to the sun center intersects that surface. See note below this table for technical details.	SPICE
PHASE_ANGLE			Float	deg	Angle between the boresight direction and direction to the Sun as seen from the point where the boresight direction intersects with the object's surface. Note that the phase angle is calculated as: PHASE_ANGLE = 180° - SOLAR_ELONGATION.	SPICE
SPICE_FILE_NAME			String vector		List of the spice kernels used to generate the geometry information in the label. The order of the list is identical to the loading order into SPICE.	Image converter

Note: For complex-shape bodies like 67P, geometric values can be computed with respect to an ellipsoid or to the actual shape. The shape kernel provided under SPICE_FILE_NAME determines which one is used. The same principle applies to the rotational state of the body, which can be modelled in a number of different ways. The planetary and frame kernels determine which model is used.

9.7.1 SC_COORDINATE_SYSTEM

Label	*Group*	*Namespace*	*Datatype*	*Unit*	*Description*	*Source*
COORDINATE_SYSTEM_NAME	SC_COORDINATE_SYSTEM				Name of the coordinate system. Always: “S/C-COORDS”.	Fixed
ORIGIN_OFFSET_VECTOR	SC_COORDINATE_SYSTEM		3-vector	km	Offset vector from J2000 origin to the origin of the Rosetta spacecraft coordinate system. Meaning the vector in J2000 from the origin of the J2000 coordinate system to the origin of the S/C coordinate system.	SPICE
ORIGIN_ROTATION_QUATERNION	SC_COORDINATE_SYSTEM		4-vector		Rotation quaternion for transforming from J2000 to the Rosetta spacecraft coordinate system. The quaternion is stored using the ESA quaternion convention which is [nx sin(a/2), ny sin(a/2), nz sin(a/2), cos(a/2)] To use the quaternion in the SPICE system the vector needs to be transformed to [q3, q0, q1, q2]	SPICE
QUATERNION_DESC	SC_COORDINATE_SYSTEM				Description of the quaternion.	Fixed
REFERENCE_COORD_SYSTEM_NAME	SC_COORDINATE_SYSTEM				Name of the reference coordinate system. Always EME J2000.	Fixed

9.7.2 CAMERA_COORDINATE_SYSTEM

Label	***Group***	***Namespace***	***Datatype***	***Unit***	***Description***	***Source***
COORDINATE_SYSTEM_NAME	CAMERA_COORDINATE_SYSTEM				Name of the coordinate system. Either: NAC_CAMERA_FRAME or WAC_CAMERA_FRAME	TM
ORIGIN_OFFSET_VECTOR	CAMERA_COORDINATE_SYSTEM		3-vector	km	Offset vector from S/C-COORDS origin to the origin of the camera frame. Meaning a vector in the space craft coordinate system from the origin of the space craft coordinate system to the origin of the camera coordinate system.	SPICE
ORIGIN_ROTATION_QUATERNION	CAMERA_COORDINATE_SYSTEM		4-vector		Rotation quaternion for transforming from S/C-COORDS to the camera frame. The quaternion is stored using the ESA quaternion convention which is [nx sin(a/2), ny sin(a/2), nz sin(a/2), cos(a/2)] To use the quaternion in the SPICE system the vector needs to be transformed to [q3, q0, q1, q2]	SPICE
QUATERNION_DESC	CAMERA_COORDINATE_SYSTEM				Description of the quaternion.	Fixed
REFERENCE_COORD_SYSTEM_NAME	CAMERA_COORDINATE_SYSTEM				Name of the reference coordinate system (always S/C-COORDS).	Fixed

9.8 Point of Interest

Label	*Group*	*Namespace*	*Datatype*	*Unit*	*Description*	*Source*
POINT_OF_INTEREST	IMAGE_POI	ROSETTA	String		A text description of the point of interest represented by the intercept point. Usually this would be "IMAGE_CENTER".	Image Converter
IMAGE_POI_PIXEL	IMAGE_POI	ROSETTA	Integer		Pixel coordinates of the point of interest.	Image Converter
COORDINATE_SYSTEM	IMAGE_POI	ROSETTA	String		Full name of the coordinate system to which the state vectors are referenced.	Image Converter
SURFACE_MODEL_FILE_NAME	IMAGE_POI	ROSETTA	String		The name of the surface model file used to generate the information in the label.	Image Converter
SURFACE_INTERCEPT_DISTANCE	IMAGE_POI	ROSETTA	Float	Km	Distance from the spacecraft to the point of interest.	Image Converter
SURF_INT_CART_COORD	IMAGE_POI	ROSETTA	Float vector	Km	The intercept point on the body surface, expressed as a X, Y, Z vector from the centre of the body.	Image Converter

9.9 Science Activity

Label	*Group*	*Namespace*	*Datatype*	*Unit*	*Description*	*Source*
MISSION_PHASE	SCIENCE_ACTIVITY	ROSETTA	String		Identifier of a mission phase (details in RD4).	Image Converter
RATIONALE_DESC	SCIENCE_ACTIVITY	ROSETTA	String		General scientific purpose the data product was acquired for (details in RD4).	Image Converter
OPERATIONAL_ACTIVITY	SCIENCE_ACTIVITY	ROSETTA	String		Scientific usability of the data product (details in RD4).	Image Converter

ACTIVITY_NAME	SCIENCE_ACTIVITY	ROSETTA	String		Set of observations acquired with the same acquisition parameters and serving the same scientific goal (details in RD4).	Image Converter

9.10 Data Content Flags

Label	*Group*	*Namespace*	*Datatype*	*Unit*	*Description*	*Source*
PREPIXEL_FLAG	SR_DATA_CONTENT	ROSETTA	Label		Indicates if the image contains pre-pixels (TRUE) or not (FALSE).	TM
POSTPIXEL_FLAG	SR_DATA_CONTENT	ROSETTA	Label		Indicates if the image contains post-pixels (TRUE) or not (FALSE).	TM
OVERCLOCKING_LINES_FLAG	SR_DATA_CONTENT	ROSETTA	Label		Indicates if the image contains overclocking lines (TRUE) or not (FALSE).	TM
CCD_DATA_FLAG	SR_DATA_CONTENT	ROSETTA	Label		Indicates if the image contains actual CCD image information (TRUE) or just random data (FALSE).	TM
B1_SHUTTER_PULSE_FLAG	SR_DATA_CONTENT	ROSETTA	Label		Indicates if the image contains the pulses for blade 1 of the shutter (TRUE) or not (FALSE).	TM
B2_SHUTTER_PULSE_FLAG	SR_DATA_CONTENT	ROSETTA	Label		Indicates if the image contains the pulses for blade 2 of the shutter (TRUE) or not (FALSE).	TM

9.11 Status Flags

Label	*Group*	*Namespace*	*Datatype*	*Unit*	*Description*	*Source*
SHUTTER_FOUND_IN_ERROR_FLAG	SR_STATUS_FLAGS	ROSETTA	Label		TRUE if the shutter mechanism had to be reset before executing the exposure. Otherwise, FALSE.	TM

SHUTTER_PRE_INIT_FAILED_FLAG	SR_STATUS_FLAGS	ROSETTA	Label		TRUE if the pre initiation of the shutter mechanism failed. Otherwise, FALSE.	TM
ERROR_RECOVERY_FAILED_FLAG	SR_STATUS_FLAGS	ROSETTA	Label		TRUE if error recovery of the shutter mechanism failed. Otherwise, FALSE.	TM
EXPOSURE_STATUS_ID	SR_STATUS_FLAGS	ROSETTA	Label		SUCCESS if no problems were detected during the exposure. FAILURE if an error occurred.	TM

9.12 Mechanism Status Flags

Label	*Group*	*Namespace*	*Datatype*	*Unit*	*Description*	*Source*
FILTER_NUMBER	SR_MECHANISM_STATUS		String		OSIRIS is equipped with a dual filter wheel for doing multispectral imaging. The filter number contains the index of the filter combination that was in the optical beam when the image was acquired. The index is coded as a two digit number (AB) where A is the filter index of the first filter wheel and B is the index of the second filter wheel (for example 12 would mean wheel 1 at index 1 and wheel two at index 2).	TM

FILTER_NAME	SR_MECHANISM_STATUS		String		Names of the two commanded filters in the optical path. The name is coded as <name of filter in wheel 1>_<name of filter in wheel 2> (for example Empty_Red).	TM
FRONT_DOOR_STATUS_ID	SR_MECHANISM_STATUS	ROSETTA	Label		OSIRIS is equipped with a front door that blocks the optical beam into the camera when the camera is switched off. This field tells if the front door was open or closed when the image was acquired. (Please note that many images are actually acquired with the door closed since the interior of the door acts as a calibration target for the camera). Possible values: OPEN CLOSED LOCKED UNKNOWN	

9.13 Image Acquisition Options

Label	Group	Namespace	Datatype	Unit	Description	Source
SCIENCE_DATA_LINK	SR_ACQUIRE_OPTIONS	ROSETTA	Label		OSIRIS has two data link to the spacecraft. The HIGHSPEED link is a multi-megabit per second IEEE 1355 link used for normal transfer of image data to the spacecraft. Additionally there is a low speed link (the RTU link) normally used for housekeeping acquisition and event data. Image data can also be transferred through this low speed link. Possible values: HIGHSPEED, RTU, BOTH, NONE	TM
DATA_ROUTING_ID	SR_ACQUIRE_OPTIONS	ROSETTA	Label		OSIRIS has a number of data telemetry queues for managing the order of downlink. The data routing field contains the ID of the queue used to acquire the image. IMAGEMEM, QUEUE1, QUEUE2, QUEUE3, QUEUE4, QUEUE5, PLAINFILE, STORED	TM
EXPOSURE_DURATION	SR_ACQUIRE_OPTIONS		Float	s	This field contains the exposure time used to acquire the image.	TM
COMMANDED_FILTER_NUMBER	SR_ACQUIRE_OPTIONS	ROSETTA	Integer		OSIRIS has a dual filter wheel in the optical beam. This field contains the index of the filter combination. The index is coded as a two digit number (AB) where A is the filter index of the first filter wheel and B is the index of the second filter wheel (for example 12 would mean wheel 1 at index 1 and wheel two at index 2).	TM

COMMANDED_FILTER_NAME	SR_ACQUIRE_OPTIONS	ROSETTA	String		Names of the two commanded filters in the optical path. The name is coded as <name of filter in wheel 1>_<name of filter in wheel 2> (for example Empty_Red).	TM
GRAYSCALE_TESTMODE_FLAG	SR_ACQUIRE_OPTIONS	ROSETTA	Label		The OSIRIS CCD readout electronics has a test mode where the electronics transmits a synthetic grayscale test pattern. This test pattern can be used to diagnose problems with the communication links inside OSIRIS. This field is a Boolean telling if the image were acquired using this test mode. TRUE FALSE	TM
HARDWARE_BINNING_ID	SR_ACQUIRE_OPTIONS	ROSETTA	String		OSIRIS can bin data two ways: (1) in a *software* pixel averaging mode and (2) using a *hardware* driven binning mode. The hardware binning id specifies what hardware mode were used. The following modes are possible 1x1: Each input pixel becomes an output pixel 2x2: Each 2x2 input block becomes an output pixel 4x4: Each 4x4 input block becomes an output pixel 8x8: Each 8x8 input block becomes an output pixel Please note that the hardware binning mode has an influence on the effective exposure time: 1x1 -> time 2x2 -> 4 x time 4x4 -> 16 x time 8x8 -> 64 x time	TM

AMPLIFIER_ID	SR_ACQUIRE_OPTIONS	ROSETTA	Label		OSIRIS can clock the CCD out using three methods: **A**: The data is clocked left in the horizontal direction and passed through the A amplifier chain. **B**: The data is clocked right in the horizontal direction and passed through the B amplifier chain. **BOTH**: Where the left half of the CCD is clocked through the A channel and the right half of the CCD is clocked through the B channel. This field specifies what amplifier chains were used: A, B, BOTH	TM
GAIN_ID	SR_ACQUIRE_OPTIONS	ROSETTA	Label		OSIRIS can be operated with two fixed amplifier gain settings (LOW and HIGH). This field tells what gain setting was used to acquire the image: LOW, HIGH	TM
ADC_ID	SR_ACQUIRE_OPTIONS	ROSETTA	Label		OSIRIS has a 16 bit digital converter that is actually composed of two 14 bit analogue to digital converters working in series. OSIRIS can be operated in three ADC mode: LOW : only the low 14 bit ADC is used HIGH: only the high 14 bit ADC is used TANDEM: Both low and high ADC is used to build the final 16 data number.	TM

OVERCLOCKING_LINES_FLAG	SR_ACQUIRE_OPTIONS	ROSETTA	Label		OSIRIS has an operation mode where the CCD ready keep clocking for an additional number of lines after having clocked out all the physical pixels of the CCD. The mode allows calibration of the charge transfer efficiency of the CCD in the vertical clocking direction. This field is a boolean telling if this operational mode was used: TRUE FALSE	TM
OVERCLOCKING_PIXELS_FLAG	SR_ACQUIRE_OPTIONS	ROSETTA	Label		OSIRIS has an operation mode where the CCD ready keep clocking for an additional number of pixels after having clocked out all the physical pixels of the CCD. The mode allows calibration of the charge transfer efficiency of the CCD in the horizontal clocking direction. This field is a boolean telling if this operational mode was used: TRUE FALSE	TM
CCD_ENABLED_FLAG	SR_ACQUIRE_OPTIONS	ROSETTA	Label		OSIRIS can be configured to skip the readout of the CCD when acquiring an image. This field is a boolean telling if the CCD data was actually read out: TRUE FALSE	TM

ADC_ENABLED_FLAG	SR_ACQUIRE_OPTIONS	ROSETTA	Label		OSIRIS can be configured to either keep the analogue to digital converters (ADC) powered always or to only power the ADC when an image is acquired. This field is a boolean telling if the ADC were kept powered (the default): TRUE FALSE	TM
BLADE1_PULSES_ENABLED_FLAG	SR_ACQUIRE_OPTIONS	ROSETTA	Label		OSIRIS can be configured to retrieve or discard shutter pulse data during operations of the mechanical shutter mechanism. This field is a boolean telling if shutter pulses were acquired for the first blade of the shutter: TRUE FALSE	TM
BLADE2_PULSES_ENABLED_FLAG	SR_ACQUIRE_OPTIONS	ROSETTA	Label		OSIRIS can be configured to retrieve or discard shutter pulse data during operations of the mechanical shutter mechanism. This field is a boolean telling if shutter pulses were acquired for the second blade of the shutter: TRUE FALSE	TM

BULBMODE_ENABLED_FLAG	SR_ACQUIRE_OPTIONS	ROSETTA	Label		OSIRIS has an operational mode for acquiring very long exposures. In this mode the exposure is commanded to start followed by another command to stop the exposure. This mode is only used for exposures longer than 2^23 milliseconds. This field is a boolean telling if the this operational mode was used: TRUE FALSE	TM
FRAMETRANSFER_ENABLED_FLAG	SR_ACQUIRE_OPTIONS	ROSETTA	Label		OSIRIS has an emergency fall-back failsafe mode for acquiring images in case the mechanical shutter would fail during the mission. This field is a boolean telling if the this operational mode was used: TRUE FALSE	TM
WINDOWING_ENABLED_FLAG	SR_ACQUIRE_OPTIONS	ROSETTA	Label		OSIRIS can acquire images using a software windowing mode or a hardware windowing mode. (Meaning reading out only a small part of the full CCD surface) This field is a boolean telling if the hardware windowing mode was used during the exposure: TRUE FALSE	TM

SHUTTER_ENABLED_FLAG	SR_ACQUIRE_OPTIONS	ROSETTA	Label		OSIRIS is equipped with a mechanical shutter mechanism. This field is a boolean telling if the mechanical shutter was operated during the exposure: TRUE FALSE	TM
DITHERING_ENABLED_FLAG	SR_ACQUIRE_OPTIONS	ROSETTA	Label		At high CCD temperature OSIRIS can be operated in a special noise reduction mode (called clock dithering). This field is a boolean telling if the this operational mode was used: TRUE FALSE	TM
CRB_DUMP_MODE	SR_ACQUIRE_OPTIONS	ROSETTA	Integer		Internal CRB configuration.	TM
CRB_PULSE_MODE	SR_ACQUIRE_OPTIONS	ROSETTA	Integer		Internal CRB configuration.	TM
SUBFRAME_COORDINATE_ID	SR_ACQUIRE_OPTIONS	ROSETTA	String		Identifies the subframe coordinate system used in the X_START, X_END, Y_START, Y_END tags. OPTICAL, ELECTRICAL	Fixed
X_START	SR_ACQUIRE_OPTIONS	ROSETTA	Integer	pixels	First column of the hardware sub frame used to acquire the image. This value is specified in ELECTRICAL CCD coordinates. Note that: (1) for software windowing, this value does not represent the pixels in the data. (2) the binning configuration can modify this value. In case of binning, please use the FIRST_LINE_SAMPLE + LINES fields in the IMAGE object.	TM

X_END	SR_ACQUIRE_OPTIONS	ROSETTA	Integer	pixels	Last column (inclusive) of the hardware sub frame used to acquire the image. This value is specified in ELECTRICAL CCD coordinates. Note that: (1) for software windowing, this value does not represent the pixels in the data. (2) the binning configuration can modify this value. In case of binning, please use the FIRST_LINE_SAMPLE + LINES fields in the IMAGE object.	TM
Y_START	SR_ACQUIRE_OPTIONS	ROSETTA	Integer	pixels	First row of the hardware sub frame used to acquire the image. This value is specified in ELECTRICAL CCD coordinates. Note that: (1) for software windowing, this value does not represent the pixels in the data. (2) the binning configuration can modify this value. In case of binning, please use the FIRST_LINE_SAMPLE + LINES fields in the IMAGE object.	TM

Y_END	SR_ACQUIRE_OPTIONS	ROSETTA	Integer	pixels	Last row (inclusive) of the hardware sub frame used to acquire the image. This value is specified in ELECTRICAL CCD coordinates. Note that: (1) for software windowing, this value does not represent the pixels in the data. (2) the binning configuration can modify this value. In case of binning, please use the FIRST_LINE_SAMPLE + LINES fields in the IMAGE object.	TM
SHUTTER_PRETRIGGER_DURATION	SR_ACQUIRE_OPTIONS	ROSETTA	Float	s	The time between the end of the shutter motion and the start of the CCD readout.	TM
CRB_TO_PCM_SYNC_MODE	SR_ACQUIRE_OPTIONS	ROSETTA	Integer		Internal CRB configuration parameter (synchronization between the CRB and the CRB power converter).	TM
AUTOEXPOSURE_FLAG	SR_ACQUIRE_OPTIONS	ROSETTA	Label		The OSIRIS flight software has the option of having the camera try to optimize the best exposure time for the scene being imaged. This field is a boolean telling if the this operational mode was used: TRUE FALSE	TM

LOWPOWER_MODE_FLAG	SR_ACQUIRE_OPTIONS	ROSETTA	Label		OSIRIS can acquire image using a special low power mode (used during the early comet detection phase of the mission where the spacecraft has no power margin). This field is a boolean telling if the this operational mode was used: TRUE FALSE	TM
DUAL_EXPOSURE_FLAG	SR_ACQUIRE_OPTIONS	ROSETTA	Label		OSIRIS has an operation mode where the narrow angle camera and the wide angle camera can be commanded to acquire image synchronized to within a few milliseconds. This field is a Boolean telling if the this operational mode was used: TRUE FALSE	TM

9.14 Processing Flags

Label	*Group*	*Namespace*	*Datatype*	*Unit*	*Description*	*Source*
BAD_PIXEL_REPLACEMENT_FLAG			Label		Flag indicating whether on-board bad pixel replacement correction was used. TRUE FALSE	Image Converter
ADC_OFFSET_CORRECTION_FLAG		ROSETTA	Label		Flag indicating if ADC offset and gain correction was applied to the image. TRUE FALSE	Image Converter

BIAS_CORRECTION_FLAG		ROSETTA	Label		Flag indicating if BIAS correction was applied to the image. TRUE FALSE	Image Converter
COHERENT_NOISE_CORRECTION_FLAG		ROSETTA	Label		Flag indicating whether coherent noise correction was applied to the image data. TRUE FALSE	Image Converter
DARK_CURRENT_CORRECTION_FLAG			Label		Flag indicating whether dark current correction was applied to the image data. TRUE FALSE	Image Converter
FLATFIELD_HI_CORRECTION_FLAG		ROSETTA	Label		Flag indicating whether high spatial frequency flatfield correction was applied to the image data. TRUE FALSE	Image Converter
BAD_PIXEL_REPLACEMENT_GROUND_FLAG		ROSETTA	Label		Flag indicating whether on ground bad pixel replacement correction was applied to the image. TRUE FALSE	Image Converter
FLATFIELD_LO_CORRECTION_FLAG		ROSETTA	Label		Flag indicating whether low spatial frequency flatfield correction was applied to the image data. TRUE FALSE	Image Converter

EXPOSURETIME_CORRECTION_FLAG		ROSETTA	Label		Flag indicating whether exposure time correction was applied to the image data. TRUE FALSE	Image Converter
RADIOMETRIC_CALIBRATION_FLAG		ROSETTA	Label		Flag indicating whether radiometric calibration factors were applied to the image data. TRUE FALSE	Image Converter
GEOMETRIC_DISTORTION_CORRECTION_FLAG		ROSETTA	Label		Flag indicating whether geometric distortion correction was applied to the image data. TRUE FALSE	Image Converter
REFLECTIVITY_NORMALIZATION_FLAG		ROSETTA	Label		Flag indicating whether reflectivity normalization was applied to the image data. TRUE FALSE	Image Converter
INFIELD_STRAYLIGHT_CORRECTION_FLAG		ROSETTA	Label		Flag indicating whether infield stray-light correction was applied to the image. TRUE FALSE	Image Converter
OUTFIELD_STRAYLIGHT_CORRECTION_FLAG		ROSETTA	Label		Flag indicating whether out of field stray-light correction was applied to the image. TRUE FALSE	Image Converter

9.15 Shutter Config

Label	*Group*	*Namespace*	*Datatype*	*Unit*	*Description*	*Source*
PROFILE_ID	SR_SHUTTER_CONFIG	ROSETTA	String		Timestamp in seconds since epoch 2000 when the shutter mechanism power profile was generated.	TM
CONTROL_MASK	SR_SHUTTER_CONFIG	ROSETTA	String		Raw control byte used to drive the shutter electronics.	TM
TESTMODE_FLAG	SR_SHUTTER_CONFIG	ROSETTA	Label		The shutter can be operated using a special test mode where the number of transmitted pulse data points is only limited by time. When this mode is switched OFF the shutter will always deliver a maximum of 440 pulse points per shutter blade. Was the shutter test mode enabled: TRUE FALSE	TM
ZEROPULSE_FLAG	SR_SHUTTER_CONFIG	ROSETTA	Label		The zero position encoder is a hall sensor located at a known position relative to the edge of the CCD. When the zero pulse flag is enabled the shutter electronics only starts to transmit pulse data after the shutter blade has passed this encode. The field is a Boolean telling is the zero pulse was enable during the exposure: TRUE FALSE	TM

LOCKING_ENCODER_FLAG	SR_SHUTTER_CONFIG	ROSETTA	Label		The shutter mechanism has a mechanical latch that catches the shutter blade #1 and keeps the shutter open for long exposure times. The shutter mechanism has a hall sensor for detecting hat the blade #1 was actually caught by the latch mechanism. This sensor can be enabled or disabled. The field is a Boolean that is TRUE is the sensor was enabled. TRUE FALSE	TM
CHARGEMODE_ID	SR_SHUTTER_CONFIG	ROSETTA	Label		The shutter mechanism is driven using two motors. The motors draws power from a bank of capacitors that buffers the large power consumption needed during the short time of the actual blade motion. This capacitor bank can be recharged using four different mode: OFF: No recharge SLOW: 32 s to recharge NORMAL: 1s to recharge FAST: 0.5 s to recharge	TM
SHUTTER_OPERATION_MODE	SR_SHUTTER_CONFIG	ROSETTA	String		The shutter is usually operated in “NORMAL” mode. The WAC shutter could also be operated in “BALLISTIC”, “BALLISTIC_STACKED” and “BALLISTIC_DUAL” modes. If this value reads “UNKNOWN”, then the camera could not be identified from the telemetry.	Image Converter
NUM_OF_EXPOSURES	SR_SHUTTER_CONFIG	ROSETTA		Integer	Number of times that the CCD was exposed to light before being read out.	Image Converter

9.16 Shutter Status

Label	*Group*	*Namespace*	*Datatype*	*Unit*	*Description*	*Source*
STATUS_MASK	SR_SHUTTER_STATUS	ROSETTA	String		Raw status value as returned from the CRB.	TM
ERROR_TYPE_ID	SR_SHUTTER_STATUS	ROSETTA	Label		Identifies the error (if any) that occurred during the exposure. NONE LOCKING_ERROR_A MEMORY_ERROR_B UNLOCKING_ERROR_C SHE_RESET_ERROR_D	TM

9.17 Data Compression And Segmentation

The image compression group contains information about the data compression and pre-processing performed on the transmitted image. All labels are vectors of length N where N is the number of image segments used to transmit the image.

Label	*Group*	*Namespace*	*Datatype*	*Unit*	*Description*	*Source*
LOST_PACKETS	SR_COMPRESSION	ROSETTA	Integer vector	packets	Number of lost packets for each image segment.	TM
SEGMENT_X	SR_COMPRESSION	ROSETTA	Integer vector		First column in each image segment (zero indexed).	TM
SEGMENT_Y	SR_COMPRESSION	ROSETTA	Integer vector		First row in each image segment (zero indexed).	TM
SEGMENT_W	SR_COMPRESSION	ROSETTA	Integer vector		Width of each image segment.	TM
SEGMENT_H	SR_COMPRESSION	ROSETTA	Integer vector		Height of each image segment.	TM

ENCODING	SR_COMPRESSION	ROSETTA	Label vector		Name of the compression algorithm used to compress the image. Valid values: "**NONE**": No encoding "**SPIHT_D24**": SPIHT wavelet based compression used by the OSIRIS flight software before release v2.0 "**SPIHT_TAP**": SPIHT wavelet based compression using TAP filtering (lossy) "**SPIHT_LIFT**": SPIHT wavelet based compression using LIFT filtering (normally lossless) "**SQRT_16to8**": Sqrt based 16 to 8 bit scaling "**PACK9BIT**": A compression where the data numbers are simply truncated at 9 bit thus discarding the high 7 bits.	TM
COMPRESSION_RATIO	SR_COMPRESSION	ROSETTA	Float vector		The effective compression ratio obtained by the image encoder. Example value 16 means 16:1 compression.	TM
LOSSLESS_FLAG	SR_COMPRESSION	ROSETTA	Label vector		A flag indicating if the performed compression was lossless. Either: TRUE: lossless compression FALSE: lossy compression	TM
SPIHT_PYRAMID_LEVELS	SR_COMPRESSION	ROSETTA	Integer vector		Number of pyramid levels used by the SPIHT compressor. NA for other encodings than SPIHT.	TM
SPIHT_THRESHOLD_BITS	SR_COMPRESSION	ROSETTA	Integer vector		Number of threshold bits used by the SPIHT compressor. NA for other encodings than SPIHT.	TM

SPIHT_MEAN	SR_COMPRESSION	ROSETTA	Integer vector		Mean value used by the SPIHT compressor. NA for other encodings than SPIHT.	TM
SPIHT_MEAN_SHIFT	SR_COMPRESSION	ROSETTA	Integer vector		Mean shift value used by the SPIHT compressor. NA for other encodings than SPIHT.	TM
SPIHT_WAVE_LEVELS	SR_COMPRESSION	ROSETTA	Integer vector		Number of wave levels used by the SPIHT compressor. NA for other encodings than SPIHT.	TM
PIXEL_AVERAGING_WIDTH	SR_COMPRESSION	ROSETTA	Integer vector		The OSIRIS flight software allows the image to be averaged in blocks to reduce the data volume before transmission to ground. The pixel averaging width specified the box width used by the processing pipeline. 1 means 1xN pixel averaging 2 means 2xN pixel averaging And so forth… Pre- and post-pixels are typically binned 8x8.	TM

PIXEL_AVERAGING_HEIGHT	SR_COMPRESSION	ROSETTA	Integer vector		The OSIRIS flight software allows the image to be averaged in blocks to reduce the data volume before transmission to ground. The pixel averaging height specified the box height used by the processing pipeline. 1 means Nx1 pixel averaging 2 means Nx2 pixel averaging And so forth… Pre- and post-pixels are typically binned 8x8.	TM
SMOOTH_FILTER_ID	SR_COMPRESSION	ROSETTA	Label vector		The OSIRIS flight software gives the option of passing the image data through a 5x5 convolution filter before passing the image data through the image compressor. Possible values: **NONE**: No filtering **CONVOL_KERNEL_1**: 0.5 FWHM gauss filter **CONVOL_KERNEL_2**: 0.8 FWHM gauss filter **CONVOL_KERNEL_3**: 1.0 FWHM gauss filter	TM

SQRT_FILTER_FLAG	SR_COMPRESSION	ROSETTA	Label vector		The OSIRIS flight software gives the option of transforming the images using the equation: Filtered DN = sqrt(image DN * gain) This flag indicating if the sqrt filter has been applied by the flight software. Possible Values: TRUE FALSE	TM
SQRT_GAIN	SR_COMPRESSION	ROSETTA	Float vector		If SQRT_FILTER_FLAG is TRUE then SQRT_GAIN contains the gain factor used by the filter (see SQRT_FILTER_FLAG).	TM

9.18 Subsystem Hardware Identification

Label	*Group*	*Namespace*	*Datatype*	*Unit*	*Description*	*Source*
DATA_PROCESSING_UNIT_ID	SR_HARDWARE_CONFIG	ROSETTA	Label		Hardware ID of the data processing unit: EM, QM, FM, FS	TM
POWER_CONVERTER_ID	SR_HARDWARE_CONFIG	ROSETTA	Label		Hardware ID of the main power converter: EM, QM, FM, FS	TM
MOTOR_CONTROLLER_ID	SR_HARDWARE_CONFIG	ROSETTA	Label		Hardware ID of the motor controller unit: EM, QM, FM, FS	TM
NAC_CCD_READOUT_BOX_ID	SR_HARDWARE_CONFIG	ROSETTA	Label		Hardware ID of the NAC CCD Readout Box (CRB): EM, QM, FM, FS	TM

WAC_CCD_READOUT_BOX_ID	SR_HARDWARE_CONFIG	ROSETTA	Label		Hardware ID of the WAC CCD Readout Box (CRB): EM, QM, FM, FS	TM
NAC_CAMERA_ID	SR_HARDWARE_CONFIG	ROSETTA	Label		Hardware ID of the NAC Camera/Focal plane hardware: EM, QM, FM, FS	TM
WAC_CAMERA_ID	SR_HARDWARE_CONFIG	ROSETTA	Label		Hardware ID of the WAC Camera/Focal plane hardware: EM, QM, FM, FS	TM

9.19 System Heater Status

Label	*Group*	*Namespace*	*Datatype*	*Unit*	*Description*	*Source*
CCD_HEATER_POWER	SR_HEATER_STATUS	ROSETTA	Float	W	Power used by the CCD operation heater.	TM
NAC_MAIN_FDM_POWER	SR_HEATER_STATUS	ROSETTA	Float	W	Power used by the main NAC front door operational heater.	TM
NAC_RED_FDM_POWER	SR_HEATER_STATUS	ROSETTA	Float	W	Power used by the redundant NAC front door operational heater.	TM
NAC_MAIN_PPE_POWER	SR_HEATER_STATUS	ROSETTA	Float	W	Power used by the main PPE structure operational heater.	TM
NAC_RED_PPE_POWER	SR_HEATER_STATUS	ROSETTA	Float	W	Power used by the redundant PPE structure operational heater.	TM
WAC_MAIN_STR1_POWER	SR_HEATER_STATUS	ROSETTA	Float	W	Power used by the main WAC structure #1 operational heater.	TM
WAC_RED_STR1_POWER	SR_HEATER_STATUS	ROSETTA	Float	W	Power used by the redundant WAC structure #1 operational heater.	TM
WAC_MAIN_STR2_POWER	SR_HEATER_STATUS	ROSETTA	Float	W	Power used by the main WAC structure #2 operational heater.	TM
WAC_RED_STR2_POWER	SR_HEATER_STATUS	ROSETTA	Float	W	Power used by the redundant WAC structure #2 operational heater.	TM

9.20 Power Converter Switch Status

Contains the state of the various power switches inside OSIRIS.

Label	Group	Namespace	Datatype	Unit	Description	Source
WAC_SHUTFAILSAFEEXEC_FLAG	SR_SWITCH_STATUS	ROSETTA	Label		Indicates that the WAC shutter failsafe execution switch is switched on or off. ON OFF	TM
NAC_SHUTFAILSAFEEXEC_FLAG	SR_SWITCH_STATUS	ROSETTA	Label		Indicates that the NAC shutter failsafe execution switch is switched on or off. ON OFF	TM
WAC_DOORFAILSAFEEXEC_FLAG	SR_SWITCH_STATUS	ROSETTA	Label		Indicates that the WAC door failsafe execution switch is switched on or off. ON OFF	TM
NAC_DOORFAILSAFEEXEC_FLAG	SR_SWITCH_STATUS	ROSETTA	Label		Indicates that the NAC door failsafe execution switch is switched on or off. ON OFF	TM
PCM_PASSCTRLACTIVE_FLAG	SR_SWITCH_STATUS	ROSETTA	Label		Indicates that the PCM passive controller switch is switched on or off. ON OFF	TM
WAC_SHUTFAILSAFE_ENAB_FLAG	SR_SWITCH_STATUS	ROSETTA	Label		Indicates that the WAC shutter failsafe enable switch is switched on or off. ON OFF	TM
WAC_SHUTTERPOWER_FLAG	SR_SWITCH_STATUS	ROSETTA	Label		Indicates that the WAC shutter electronics switch is switched on or off. ON OFF	TM

WAC_CCDANNEALHEATER_FLAG	SR_SWITCH_STATUS	ROSETTA	Label		Indicates that the WAC CCD annealing heater switch is switched on or off. ON OFF	TM
WAC_CRB_PRIMEPOWER_FLAG	SR_SWITCH_STATUS	ROSETTA	Label		Indicates that the WAC primary CRB power switch is switched on or off. ON OFF	TM
NAC_SHUTFAILSAFE_ENAB_FLAG	SR_SWITCH_STATUS	ROSETTA	Label		Indicates that the NAC shutter failsafe enabling switch is switched on or off. ON OFF	TM
NAC_SHUTTERPOWER_FLAG	SR_SWITCH_STATUS	ROSETTA	Label		Indicates that the NAC shutter electronics power switch is switched on or off. ON OFF	TM
NAC_CCDANNEALHEATER_FLAG	SR_SWITCH_STATUS	ROSETTA	Label		Indicates that the NAC CCD annealing heater switch is switched on or off. ON OFF	TM
NAC_CRB_PRIMEPOWER_FLAG	SR_SWITCH_STATUS	ROSETTA	Label		Indicates that the NAC primary CRB power switch is switched on or off. ON OFF	TM
WAC_STRUCTUREHEATER_R_FLAG	SR_SWITCH_STATUS	ROSETTA	Label		Indicates that the WAC redundant structure heater switch is switched on or off. ON OFF	TM

WAC_STRUCTUREHEATER_M_FLAG	SR_SWITCH_STATUS	ROSETTA	Label		Indicates that the WAC main structure heater switch is switched on or off. ON OFF	TM
WAC_RED_CALLAMP_FLAG	SR_SWITCH_STATUS	ROSETTA	Label		Indicates that the WAC redundant calibration lamp switch is switched on or off. ON OFF	TM
WAC_MAIN_CALLAMP_FLAG	SR_SWITCH_STATUS	ROSETTA	Label		Indicates that the WAC main calibration lamp switch is switched on or off. ON OFF	TM
WAC_DOORFAILSAFE_ENAB_FLAG	SR_SWITCH_STATUS	ROSETTA	Label		Indicates that the WAC door failsafe enable switch is switched on or off. ON OFF	TM
NAC_IFPLATEHEATER_R_FLAG	SR_SWITCH_STATUS	ROSETTA	Label		Indicates that the NAC redundant IFP (PPE) heater switch is switched on or off. ON OFF	TM
NAC_IFPLATEHEATER_M_FLAG	SR_SWITCH_STATUS	ROSETTA	Label		Indicates that the NAC main IFP (PPE) heater switch is switched on or off. ON OFF	TM
NAC_RED_CALLAMP_FLAG	SR_SWITCH_STATUS	ROSETTA	Label		Indicates that the NAC redundant calibration lamp switch is switched on or off. ON OFF	TM

NAC_MAIN_CALLAMP_FLAG	SR_SWITCH_STATUS	ROSETTA	Label		Indicates that the NAC main calibration lamp switch is switched on or off. ON OFF	TM
NAC_DOORFAILSAFE_ENAB_FLAG	SR_SWITCH_STATUS	ROSETTA	Label		Indicates that the NAC door failsafe enable switch is switched on or off. ON OFF	TM
MCB_RED_MOTORPOWER_FLAG	SR_SWITCH_STATUS	ROSETTA	Label		Indicates that the redundant MCB motor power switch is switched on or off. ON OFF	TM
MCB_MAIN_MOTORPOWER_FLAG	SR_SWITCH_STATUS	ROSETTA	Label		Indicates that the main MCB motor power switch is switched on or off. ON OFF	TM
MCB_FLAG	SR_SWITCH_STATUS	ROSETTA	Label		Indicates the MCB power mode. The MCB is the motor controller board which is also used to readout all the analogue housekeeping channels. Possible values: MAIN: Main MCB active REDUNANT: Redundant MCB active OFF: MCB powered OFF	TM
PRIMARY_POWER_RAIL_FLAG	SR_SWITCH_STATUS	ROSETTA	Label		Indicates which primary power rail has been selected (primary spacecraft power switch). MAIN REDUNDANT	TM

9.21 Power System Status

Contains current and voltage measurements of the various power rails used by OSIRIS.

Label	*Group*	*Namespace*	*Datatype*	*Unit*	*Description*	*Source*
V_28_MAIN	SR_POWER_STATUS	ROSETTA	Float	V	Voltage of the main 28 V power rail.	TM
V_28_REDUNDANT	SR_POWER_STATUS	ROSETTA	Float	V	Voltage of the redundant 28 V power rail.	TM
V_5	SR_POWER_STATUS	ROSETTA	Float	V	Main power converter 5V rail voltage.	TM
V_3	SR_POWER_STATUS	ROSETTA	Float	V	Main power converter 3V rail voltage.	TM
V_15	SR_POWER_STATUS	ROSETTA	Float	V	Main power converter 15V rail voltage.	TM
V_M15	SR_POWER_STATUS	ROSETTA	Float	V	Main power converter -15V rail voltage.	TM
V_NAC_REFERENCE	SR_POWER_STATUS	ROSETTA	Float	V	NAC reference voltage.	TM
V_WAC_REFERENCE	SR_POWER_STATUS	ROSETTA	Float	V	WAC reference voltage.	TM
CAMERA_V_24	SR_POWER_STATUS	ROSETTA	Float	V	Camera CRB power converter 24V rail voltage.	TM
CAMERA_V_8	SR_POWER_STATUS	ROSETTA	Float	V	Camera CRB power converter 8V rail voltage.	TM
CAMERA_V_M12	SR_POWER_STATUS	ROSETTA	Float	V	Camera CRB power converter -12V rail voltage.	TM
CAMERA_V_5_ANALOG	SR_POWER_STATUS	ROSETTA	Float	V	Camera CRB power converter 5V analogue rail voltage.	TM
CAMERA_V_5_DIGITAL	SR_POWER_STATUS	ROSETTA	Float	V	Camera CRB power converter 5V digital rail voltage.	TM
CAMERA_V_M5	SR_POWER_STATUS	ROSETTA	Float	V	Camera CRB power converter -5V rail voltage.	TM
I_28_MAIN	SR_POWER_STATUS	ROSETTA	Float	mA	Current measurement of the main 28 V power rail.	TM
I_28_REDUNDANT	SR_POWER_STATUS	ROSETTA	Float	mA	Current measurement of the redundant 28 V power rail.	TM
I_5	SR_POWER_STATUS	ROSETTA	Float	mA	Current measurement of the main power converter 5V rail.	TM
I_3	SR_POWER_STATUS	ROSETTA	Float	mA	Current measurement of the main power converter 3V rail.	TM
I_15	SR_POWER_STATUS	ROSETTA	Float	mA	Current measurement of the main power converter 15V rail.	TM

I_M15	SR_POWER_STATUS	ROSETTA	Float	mA	Current measurement of the main power converter -15V rail.	TM
CAMERA_I_24	SR_POWER_STATUS	ROSETTA	Float	mA	Current measurement of the camera CRB power converter 24V rail.	TM
CAMERA_I_8	SR_POWER_STATUS	ROSETTA	Float	mA	Current measurement of the camera CRB power converter 8V rail.	TM
CAMERA_I_M12	SR_POWER_STATUS	ROSETTA	Float	mA	Current measurement of the Camera CRB power converter -12V rail.	TM
CAMERA_I_5_ANALOG	SR_POWER_STATUS	ROSETTA	Float	mA	Current measurement of the camera CRB power converter 5V analogue rail.	TM
CAMERA_I_5_DIGITAL	SR_POWER_STATUS	ROSETTA	Float	mA	Current measurement of the camera CRB power converter 5V digital rail.	TM
CAMERA_I_M5	SR_POWER_STATUS	ROSETTA	Float	mA	Current measurement of the camera CRB power converter -5V rail.	TM

9.22 Calibrated Temperatures

Contains temperature measurements of various parts of the OSIRIS instrument

Label	*Group*	*Namespace*	*Datatype*	*Unit*	*Description*	*Source*
T_MAIN_PCM	SR_TEMPERATURE_STATUS	ROSETTA	Float	K	Temperature of the Main power converter electronics board.	TM
T_REDUNDANT_PCM	SR_TEMPERATURE_STATUS	ROSETTA	Float	K	Temperature of the Redundant power converter electronics board.	TM
T_WAC_STRUCTURE_MAIN_1	SR_TEMPERATURE_STATUS	ROSETTA	Float	K	WAC structure temperature sensor #1 (main).	TM
T_WAC_STRUCTURE_REDUNDANT_1	SR_TEMPERATURE_STATUS	ROSETTA	Float	K	WAC structure temperature sensor #1 (redundant).	TM
T_WAC_STRUCTURE_MAIN_2	SR_TEMPERATURE_STATUS	ROSETTA	Float	K	WAC structure temperature sensor #2 (main).	TM
T_WAC_STRUCTURE_REDUNDANT_2	SR_TEMPERATURE_STATUS	ROSETTA	Float	K	WAC structure temperature sensor #2 (redundant).	TM

T_WAC3	SR_TEMPERATURE_STATUS	ROSETTA	Float	K	WAC mirror temperature sensor #3.	TM
T_WAC4	SR_TEMPERATURE_STATUS	ROSETTA	Float	K	WAC mirror temperature sensor #4.	TM
T_WAC_WHEEL_MOTOR_1	SR_TEMPERATURE_STATUS	ROSETTA	Float	K	WAC filter wheel #1 motor temperature sensor.	TM
T_WAC_WHEEL_MOTOR_2	SR_TEMPERATURE_STATUS	ROSETTA	Float	K	WAC filter wheel #2 motor temperature sensor.	TM
T_WAC_DOOR_MOTOR	SR_TEMPERATURE_STATUS	ROSETTA	Float	K	WAC filter front door motor temperature sensor.	TM
T_NAC_CCD_VIA_MCB	SR_TEMPERATURE_STATUS	ROSETTA	Float	K	NAC CCD temperature as read By the MCB HK board.	TM
T_WAC_CCD_VIA_MCB	SR_TEMPERATURE_STATUS	ROSETTA	Float	K	WAC CCD temperature as read By the MCB HK board.	TM
T_NAC_WHEEL_MOTOR_1	SR_TEMPERATURE_STATUS	ROSETTA	Float	K	NAC filter wheel #1 motor temperature sensor.	TM
T_NAC_WHEEL_MOTOR_2	SR_TEMPERATURE_STATUS	ROSETTA	Float	K	NAC filter wheel #2 motor temperature sensor.	TM
T_NAC_DOOR_MOTOR	SR_TEMPERATURE_STATUS	ROSETTA	Float	K	NAC filter front door motor temperature sensor.	TM
T_NAC_DOOR_IF_MAIN	SR_TEMPERATURE_STATUS	ROSETTA	Float	K	Temperature of NAC front door interface plate (main).	TM
T_NAC_MIRROR_2	SR_TEMPERATURE_STATUS	ROSETTA	Float	K	Temperature of NAC M2 mirror.	TM
T_NAC_PPE_IF_REDUNDANT	SR_TEMPERATURE_STATUS	ROSETTA	Float	K	Temperature of NAC PPE Redundant Interface Plate (mounting plate for filter wheel, shutter and focal plane).	TM
T_NAC_DOOR_IF_REDUNDANT	SR_TEMPERATURE_STATUS	ROSETTA	Float	K	Temperature of NAC front door Redundant Interface Plate.	TM
T_NAC_PPE_IF_MAIN	SR_TEMPERATURE_STATUS	ROSETTA	Float	K	Temperature of NAC PPE Main Interface Plate (mounting plate for filter wheel, shutter and focal plane).	TM

T_NAC_MIRROR_1_AND_3	SR_TEMPERATURE_STATUS	ROSETTA	Float	K	Temperature of NAC M1 and M3 mirror mounting plate.	TM
T_DSP_MAIN	SR_TEMPERATURE_STATUS	ROSETTA	Float	K	Temperature of main DSP (processing unit).	TM
T_DSP_REDUNDANT	SR_TEMPERATURE_STATUS	ROSETTA	Float	K	Temperature of redundant DSP (processing unit).	TM
T_BOARD_CONTROLLER	SR_TEMPERATURE_STATUS	ROSETTA	Float	K	Temperature of motor controller board.	TM
T_BOARD_DRIVER	SR_TEMPERATURE_STATUS	ROSETTA	Float	K	Temperature of motor controller driver state.	
CAMERA_TCCD	SR_TEMPERATURE_STATUS	ROSETTA	Float	K	CCD Temperature as read out by the CRB electronics.	TM
CAMERA_T_SENSORHEAD	SR_TEMPERATURE_STATUS	ROSETTA	Float	K	Temperature of the CCD sensor head electronics board.	TM
CAMERA_T_ADC_1	SR_TEMPERATURE_STATUS	ROSETTA	Float	K	Temperature of ADC #1.	TM
CAMERA_T_ADC_2	SR_TEMPERATURE_STATUS	ROSETTA	Float	K	Temperature of ADC #2.	TM
CAMERA_T_SHUTTER_MOTOR_1	SR_TEMPERATURE_STATUS	ROSETTA	Float	K	Temperature of shutter motor #1.	TM
CAMERA_T_SHUTTER_MOTOR_2	SR_TEMPERATURE_STATUS	ROSETTA	Float	K	Temperature of shutter motor #2.	TM
CAMERA_T_POWER_CONVERTER	SR_TEMPERATURE_STATUS	ROSETTA	Float	K	Temperature of CRB electronics power converter module.	TM
CAMERA_T_DOSIMETER	SR_TEMPERATURE_STATUS	ROSETTA	Float	K	Temperature of dosimeter.	TM

9.23 Radiation Environment

Label	***Group***	***Namespace***	***Datatype***	***Unit***	***Description***	***Source***
CAMERA_DOSIS	SR_RADIATION_STATUS	ROSETTA	Float	rad	Total radiation doses measured by the radiation MOSFET.	TM
SREM_PROTONS_GT_20MEV	SR_RADIATION_STATUS	ROSETTA	Float	DN	SREM doses of >20MeV protons.	TM
SREM_PROTONS_50_TO_70MEV	SR_RADIATION_STATUS	ROSETTA	Float	DN	SREM doses of 50-70 MeV protons.	TM
SREM_ELECTRONS_LT_2MEV	SR_RADIATION_STATUS	ROSETTA	Float	DN	SREM doses of < 2 MeV electrons.	TM

10 PDS Objects in .IMG files

10.1 The HISTORY Object

The HISTORY object is an attached secondary PDS label with additional information about the processing history if the image. The history object data can be extracted from the PDS label via the ^HISTORY pointer specifying the offset of the history label. The history label is terminated using an END statement (same as a normal PDS label). The history object contains a single object called HISTORY with a varying number of sub fields defined by the various processing steps.

HISTORY objects are not part of the PDS specification, and so are not detailed in this document. Example HISTORY objects can be found in the appendices of this document.

10.2 Shutter Blade 1 and Blade 2 position encoder Object

Embedded binary object containing the position encoder pulse data for the shutter blade #1 (BLADE1_PULSE_ARRAY) or blade #2 (BLADE2_PULSE_ARRAY). The data is reached using the data pointer ^BLADE1_PULSE_ARRAY and ^BLADE2_PULSE_ARRAY, respectively. Note this objects only exists in the PDS header if shutter pulse data has been downlinked. The BLADE1_PULSE_ARRAY and BLADE2_PULSE_ARRAY objects only exist in OSIRIS level 1 (CODMAC L2) data labels.

Label	*Object*	*Datatype*	*Description*
NAME	BLADE1_PULSE_ARRAY or BLADE2_PULSE_ARRAY	String	Short description of the object.
DESCRIPTION	BLADE1_PULSE_ARRAY or BLADE2_PULSE_ARRAY	String	Description of the object.
INTERCHANGE_FORMAT	BLADE1_PULSE_ARRAY or BLADE2_PULSE_ARRAY	Label	Interchange format. Always: BINARY
AXES	BLADE1_PULSE_ARRAY or BLADE2_PULSE_ARRAY	Integer	Number of data axes. Always: 1
AXIS_ITEMS	BLADE1_PULSE_ARRAY or BLADE2_PULSE_ARRAY	Integer	Number of data elements in array.
NAME	BLADE1_PULSE_ARRAY.ELEMENT or BLADE2_PULSE_ARRAY.ELEMENT	Label	Name of single data elements. Always: COUNT

DATA_TYPE	BLADE1_PULSE_ARRAY.ELEMENT or BLADE2_PULSE_ARRAY.ELEMENT	Label	Datatype of shutter pulse data array.
BYTES	BLADE1_PULSE_ARRAY.ELEMENT or BLADE2_PULSE_ARRAY.ELEMENT	Integer	Number of bytes per pulse sample. Always: 4

10.3 The _IMAGE Objects

All _IMAGE objects described in Sec. 4 (IMAGE, PA_IMAGE, PB_IMAGE, OL_IMAGE, SIGMA_MAP_IMAGE, QUALITY_MAP_IMAGE, DISTANCE_IMAGE, EMISSION_ANGLE_IMAGE, INCIDENCE_ANGLE_IMAGE, PHASE_ANGLE_IMAGE, FACET_INDEX_IMAGE, COORDINATE_X_IMAGE, COORDINATE_Y_IMAGE, COORDINATE_Z_IMAGE) have the same structure, which is described in the following table. Please note that not all labels are mandatory (e.g. UNIT), thus not all labels are present in all _IMAGE objects.

Label	***Object***	***Datatype***	***Description***
INTERCHANGE_FORMAT		Label	The interchange format of the image data. Always: BINARY
LINE_SAMPLES		Integer	Width of the image in pixels.
LINES		Integer	Height of the image in pixels.
BANDS		Integer	Number of image planes. Always: 1
SAMPLE_TYPE		Label	The binary storage data type.
SAMPLE_BITS		Integer	Number of bits per pixel.
UNIT		String	Data unit of the image data.
DERIVED_MINIMUM		Integer/Float	Minimum data value in image.
DERIVED_MAXIMUM		Integer/Float	Maximum data value in image.
MEAN		Integer/Float	Mean data value of image data. Note: this label is present only in OSIRIS level 1 (CODMAC L2) images.
STANDARD_DEVIATION		Integer/Float	Standard deviation value of the image data. Note: this label is present only in OSIRIS level 1 (CODMAC L2) images.

FIRST_LINE		Integer	First row of subframe in OPTICAL CCD coordinates. Please note that this value is 1 indexed! Not 0 indexed.
FIRST_LINE_SAMPLE		Integer	First column of subframe in OPTICAL CCD coordinates. Please note that this value is 1 indexed! Not 0 indexed.
LINE_DISPLAY_DIRECTION		Label	The LINE_DISPLAY_DIRECTION element is the preferred orientation of lines within an image viewing on a display device. The default is DOWN. Note that the display is rotated 180° with respect to the Rosetta standard orientation (see Sec. 7.2.1). Allowed values: DOWN, LEFT, RIGHT, UP
SAMPLE_DISPLAY_DIRECTION		Label	The SAMPLE_DISPLAY_DIRECTION element is the preferred orientation of samples within a line for viewing on a display device. The default is RIGHT for the WAC and LEFT for the NAC. Note that the display is rotated 180° with respect to the Rosetta standard orientation (see Sec. 7.2.1). Allowed values: DOWN, LEFT, RIGHT, UP

11 The OSIRIS labels for .FIT files

The FITs images have an attached label (image header), described in Sec. 11.1, and a detached label, described in Sec. 11.2.

11.1 FITs attached label

Label	*PDS Equivalent*	*Datatype*	*Unit*	*Description*	*Source*
SIMPLE		Boolean		Logical constant indicating that the file conforms to the FITS standard. T: TRUE F: FALSE	Image converter
BITPIX		Integer		The number of bits used to represent the data values in the data array.	Image converter
NAXIS		Integer		The number of axes in the data array.	Image converter
NAXIS1		Integer		The number of elements along axis 1 (columns).	Image converter
NAXIS2		Integer		The number of elements along axis 2 (rows).	Image converter
EXTEND		Boolean		Indicates if the file may contain conforming extensions following the primary HDU. T: TRUE F: FALSE	Image converter
BSCALE		Float		Used with BZERO to scale the array pixel values, using the equation: physical value = BZERO + BSCALE × array value	Image converter
BZERO		Float		Used with BSCALE to scale the array pixel values, using the equation: physical value = BZERO + BSCALE × array value	Image converter

Label	*PDS Equivalent*	*Datatype*	*Unit*	*Description*	*Source*
SOFTDESC	SOFTWARE_DESC	String		See SOFTWARE_DESC in Sec. 9.2.	Image converter
SOFT_LIC	SOFTWARE_LICENSE_TYPE	String		See SOFTWARE_LICENSE_TYPE Sec. 9.2.	Image converter
SOFT_ID	SOFTWARE_ID	String		See SOFTWARE_ID in Sec. 9.2.	Image converter
SOFTNAME	SOFTWARE_NAME	String		See SOFTWARE_NAME in Sec. 9.2.	Image converter
SOFT_VER	SOFTWARE_VERSION_ID	String		See SOFTWARE_VERSION_ID in Sec. 9.2.	Image converter
SOFT_REL	SOFTWARE_RELEASE_DATE	String		See SOFTWARE_RELEASE_DATE in Sec. 9.2.	Image converter
XEND	LINE_SAMPLES	Integer	Pixels	See LINE_SAMPLES in Sec. 10.3.	TM
YEND	LINES	Integer	Pixels	See LINES in Sec. 10.3.	TM
DATE-OBS	START_TIME	Character String		See START_TIME in Sec. 9.6.	TM/SPICE
F_TSTART	START_TIME	Character String		See START_TIME in Sec. 9.6.	TM/SPICE
D_TEMP	DETECTOR_TEMPERATURE	Float	K	See DETECTOR_TEMPERATURE in Sec. 9.4.	TM
EXPTIME	EXPOSURE_DURATION	Float	s	See EXPOSURE_DURATION in Sec. 9.13.	TM
F_FID	COMMANDED_FILTER_NUMBER	Integer		See COMMANDED_FILTER_NUMBER in Sec. 9.13.	TM
FILT	COMMANDED_FILTER_NAME	Character String		See COMMANDED_FILTER_NAME in Sec. 9.13.	TM
TARGET	TARGET_NAME	Character String		See TARGET_NAME in Sec. 9.7.	SPICE
G_TTYPE	TARGET_TYPE	Character String		See TARGET_TYPE in Sec. 9.7.	Image converter
CAMERA	INSTRUMENT_ID	Character String		See INSTRUMENT_ID in Sec. 9.4.	TM
C_NAME	INSTRUMENT_NAME	Character String		See INSTRUMENT_NAME in Sec. 9.4.	TM/Fixed

M_PHASE	MISSION_PHASE_NAME	Character String		See MISSION_PHASE_NAME in Sec. 9.3.	Image Converter
F_SC1	SPACECRAFT_CLOCK_START_COUNT	Character String		See SPACECRAFT_CLOCK_START_COUNT in Sec. 9.6.	TM
F_SC2	SPACECRAFT_CLOCK_STOP_COUNT	Character String		See SPACECRAFT_CLOCK_STOP_COUNT in Sec. 9.6.	TM
F_LEVEL	PROCESSING_LEVEL_ID	Character String		See PROCESSING_LEVEL_ID in Sec. 9.5.	Image Converter
RS_FDSID	ROSETTA:FRONT_DOOR_STATUS_ID	Character String		See FRONT_DOOR_STATUS_ID in Sec. 9.12.	TM
G_RSS01	SC_SUN_POSITION_VECTOR	Float	km	X component of SC_SUN_POSITION_VECTOR (see Sec. 9.7).	SPICE
G_RSS02	SC_SUN_POSITION_VECTOR	Float	km	Y component of SC_SUN_POSITION_VECTOR (see Sec. 9.7).	SPICE
G_RSS03	SC_SUN_POSITION_VECTOR	Float	km	Z component of SC_SUN_POSITION_VECTOR (see Sec. 9.7)..	SPICE
G_SSDIS	SPACECRAFT_SOLAR_DISTANCE	Float	km	See SPACECRAFT_SOLAR_DISTANCE in Sec. 9.7.	SPICE
G_SELONG	SOLAR_ELONGATION	Float	deg	See SOLAR_ELONGATION in Sec. 9.7.	SPICE
G_RA	RIGHT_ASCENSION	Float	deg	See RIGHT_ASCENSION in Sec. 9.7.	SPICE
G_DEC	DECLINATION	Float	deg	See DECLINATION in Sec. 9.7.	SPICE
G_AZIN	NORTH_AZIMUTH	Float	deg	See NORTH_AZIMUTH in Sec. 9.7.	SPICE
G_RST01	SC_TARGET_POSITION_VECTOR	Float	None or km	X component of SC_TARGET_POSITION_VECTOR (see Sec. 9.7).	SPICE
G_RST02	SC_TARGET_POSITION_VECTOR	Float	None or km	Y component of SC_TARGET_POSITION_VECTOR (see Sec. 9.7).	SPICE

G_RST03	SC_TARGET_POSITION_VECTOR	Float	None or km	Z component of SC_TARGET_POSITION_VECTOR (see Sec. 9.7).	SPICE
G_STV01	SC_TARGET_VELOCITY_VECTOR	Float	km/s	X component of SC_TARGET_VELOCITY_VECTOR (see Sec. 9.7).	SPICE
G_STV02	SC_TARGET_VELOCITY_VECTOR	Float	km/s	Y component of SC_TARGET_VELOCITY_VECTOR (see Sec. 9.7).	SPICE
G_STV03	SC_TARGET_VELOCITY_VECTOR	Float	km/s	Z component of SC_TARGET_VELOCITY_VECTOR (see Sec. 9.7).	SPICE
G_PHASEA	PHASE_ANGLE	Float	Deg	See PHASE_ANGLE in Sec. 9.7.	SPICE
G_CNAME	COORDINATE_SYSTEM_NAME			See COORDINATE_SYSTEM_NAME in Sec. 9.7.1.	Fixed
G_OVEC01	ORIGIN_OFFSET_VECTOR	Float	km	X component of ORIGIN_OFFSET_VECTOR (see Sec. 9.7.1).	SPICE
G_OVEC02	ORIGIN_OFFSET_VECTOR	Float	km	Y component of ORIGIN_OFFSET_VECTOR (see Sec. 9.7.1).	SPICE
G_OVEC03	ORIGIN_OFFSET_VECTOR	Float	km	Z component of ORIGIN_OFFSET_VECTOR (see Sec. 9.7.1).	SPICE
G_OQUA01	ORIGIN_ROTATION_QUATERNION	Float		First element of ORIGIN_ROTATION_QUATERNION (see Sec. 9.7.1).	SPICE
G_OQUA02	ORIGIN_ROTATION_QUATERNION	Float		Second element of ORIGIN_ROTATION_QUATERNION (see Sec. 9.7.1).	SPICE
G_OQUA03	ORIGIN_ROTATION_QUATERNION	Float		Third element of ORIGIN_ROTATION_QUATERNION (see Sec. 9.7.1).	SPICE
G_OQUA04	ORIGIN_ROTATION_QUATERNION	Float		Fourth element of ORIGIN_ROTATION_QUATERNION (see Sec. 9.7.1).	SPICE
G_NSYS	REFERENCE_COORD_SYSTEM_NAME	Character String		See REFERENCE_COORD_SYSTEM_NAME in Sec. 9.7.1.	Fixed

BINNING	HARDWARE_BINNING_ID	Character String		See HARDWARE_BINNING_ID in Sec. 9.13.	TM
RS_AMPID	AMPLIFIER_ID	Character String		See AMPLIFIER_ID in Sec. 9.13.	TM
RS_GANID	GAIN_ID	Character String		See GAIN_ID in Sec. 9.13.	TM
RS_ADCID	ADC_ID	Character String		See ADC_ID in Sec. 9.13.	TM
LINEDIR	LINE_DISPLAY_DIRECTION	Character String		See LINE_DISPLAY_DIRECTION in Sec. 10.3.	Image Converter
SMPLEDIR	SAMPLE_DISPLAY_DIRECTION	Character String		See SAMPLE_DISPLAY_DIRECTION in Sec. 10.3	Image Converter

11.2 FITs detached label

FITs detached labels contain all the relevant information present in the labels of PDS images. For details about specific keywords, see Sec. 10.

12 The OSIRIS labels for .JPG files

JPEG detached labels contain all the relevant information present in the labels of PDS images. For details about specific keywords, see Sec. 10.

Appendix 1: Example OSIRIS image header

The header keywords of all OSIRIS .IMG data products are identical, independently from the processing level. The content of certain header keywords is updated according to the processing level.

The header is also representative for detached labels of .FIT and .JPG products, which have the same header keywords.

```
PDS_VERSION_ID                   = PDS3
LABEL_REVISION_NOTE              = "RO-RIS-MPAE-ID-023 1/-"

/*  FILE CHARACTERISTICS  */

RECORD_TYPE                      = FIXED_LENGTH
RECORD_BYTES                     = 512
FILE_RECORDS                     = 294976
LABEL_RECORDS                    = 57
FILE_NAME                        = "NAC_2014-08-03T11.21.14.567Z_ID40_1397549400_F82.IMG"
PROCESSING_HISTORY_TEXT          = "Level 4 PDS file created - OsiCalliope 2018-03-02"

/*  POINTERS TO DATA OBJECTS  */

^HISTORY                         = 58
^IMAGE                           = 65
^DISTANCE_IMAGE                  = 32833
^EMISSION_ANGLE_IMAGE            = 65601
^INCIDENCE_ANGLE_IMAGE           = 98369
^PHASE_ANGLE_IMAGE               = 131137
^FACET_INDEX_IMAGE               = 163905
^COORDINATE_X_IMAGE              = 196673
^COORDINATE_Y_IMAGE              = 229441
^COORDINATE_Z_IMAGE              = 262209

/* SOFTWARE */

SOFTWARE_DESC                    = "OSIRIS CALIBRATION PIPELINE"
SOFTWARE_LICENSE_TYPE            = "COMMERCIAL"
SOFTWARE_ID                      = "OSICALLIOPE"
SOFTWARE_NAME                    = "OSICALLIOPE.EXE"
```

```
SOFTWARE_VERSION_ID              = "2.4.0"
SOFTWARE_RELEASE_DATE            = 2018-02-02
ROSETTA:TELEMETRY_FORMAT_CODE    = "210"

/*   MISSION IDENTIFICATION   */

INSTRUMENT_HOST_ID               = "RO"
INSTRUMENT_HOST_NAME             = "ROSETTA-ORBITER"
MISSION_ID                       = "ROSETTA"
MISSION_NAME                     = "INTERNATIONAL ROSETTA MISSION"
MISSION_PHASE_NAME               = ""

/*   INSTRUMENT DESCRIPTION   */

INSTRUMENT_ID                    = "OSINAC"
INSTRUMENT_NAME                  = "OSIRIS - NARROW ANGLE CAMERA"
INSTRUMENT_TYPE                  = "FRAME CCD REFLECTING TELESCOPE"
DETECTOR_DESC                    = "2048x2048 PIXELS BACKLIT FRAME CCD DETECTOR"
DETECTOR_PIXEL_WIDTH             = 13.5 <micron>
DETECTOR_PIXEL_HEIGHT            = 13.5 <micron>
DETECTOR_TYPE                    = "SI CCD"
DETECTOR_ID                      = "EEV-243"
DETECTOR_TEMPERATURE             = 149.51 <K>
ELEVATION_FOV                    = 2.210 <DEGREES>
AZIMUTH_FOV                      = 2.210 <DEGREES>
ROSETTA:VERTICAL_RESOLUTION      = 1.882000e-05 <RAD>
ROSETTA:HORIZONTAL_RESOLUTION    = 1.882000e-05 <RAD>
TELESCOPE_F_NUMBER               = 8.000000
ROSETTA:VERTICAL_FOCAL_LENGTH    = 0.7173 <m>
ROSETTA:HORIZONTAL_FOCAL_LENGTH  = 0.7173 <m>

/*   IMAGE IDENTIFICATION   */

IMAGE_ID                         = 11047400
ROSETTA:PROCESSING_ID            = 0
IMAGE_OBSERVATION_TYPE           = "REGULAR"
EXPOSURE_TYPE                    = "MANUAL"
PRODUCT_ID                       = "NAC_2014-08-03T11.21.14.567Z_ID40_1397549400_F82.IMG"
```

```
PRODUCT_TYPE                    = "RDR"
PRODUCT_VERSION_ID              = "1"
PRODUCER_INSTITUTION_NAME       = "Max Planck Institute for Solar System Research"
PRODUCER_FULL_NAME              = "PABLO GUTIERREZ-MARQUES"
PRODUCER_ID                     = "MPS"
MEDIUM_TYPE                     = "ELECTRONIC"
PUBLICATION_DATE                = 2017-11-21
VOLUME_FORMAT                   = "ANSI"
VOLUME_ID                       = "N/A"
VOLUME_NAME                     = "N/A"
VOLUME_SERIES_NAME              = "ROSETTA SCIENCE ARCHIVE"
VOLUME_SET_NAME                 = "N/A"
VOLUME_SET_ID                   = "N/A"
VOLUME_VERSION_ID               = "N/A"
VOLUMES                         = "UNK"
DATA_SET_ID                     = "N/A"
DATA_SET_NAME                   = "N/A"
PROCESSING_LEVEL_ID             = "4"
PROCESSING_LEVEL_DESC              = "Radiometrically calibrated, geometric distortion corrected data, with geo-
referencing, in radiance units"
DATA_QUALITY_ID                 = 0
DATA_QUALITY_DESC               = "Zero is good non zero is bad"

/*   TIME IDENTIFICATION   */

PRODUCT_CREATION_TIME           = 2018-03-02T12:28:29
START_TIME                      = 2014-08-03T11:22:22.803
STOP_TIME                       = 2014-08-03T11:22:24.431
SPACECRAFT_CLOCK_START_COUNT    = "1/365685674.37168"
SPACECRAFT_CLOCK_STOP_COUNT     = "1/365685676.12788"

/*   GEOMETRY   */

NOTE                             = "The values of the keywords SC_SUN_POSITION_VECTOR SC_TARGET_POSITION_VECTOR and
SC_TARGET_VELOCITY_VECTOR are related to the Earth Mean Equator J2000 reference frame.
          The values of SUB_SPACECRAFT_LATITUDE and  SUB_SPACECRAFT_LONGITUDE are northern latitude and eastern
longitude in the  standard planetocentric IAU_<TARGET_NAME> frame.
All values are computed for the time t = START_TIME.
```

```
          Distances are given in <km> velocities in <km/s>, Angles in <deg>."
TARGET_NAME                      = "67P/CHURYUMOV-GERASIMENKO 1 (1969 R1)"
TARGET_TYPE                      = COMET
SC_SUN_POSITION_VECTOR           = (-183197788.788 <km>, 441051626.292 <km>, 253765364.023 <km>)
SPACECRAFT_SOLAR_DISTANCE        = 540818663.555 <km>
SOLAR_ELONGATION                 = 139.89622 <deg>
RIGHT_ASCENSION                  = 324.55739 <deg>
DECLINATION                      = -2.00967 <deg>
NORTH_AZIMUTH                    = 136.60358 <deg>
SC_TARGET_POSITION_VECTOR        = (238.114 <km>, -167.407 <km>, -7.756 <km>)
SC_TARGET_VELOCITY_VECTOR        = (-0.587 <m/s>, 0.656 <m/s>, -0.187 <m/s>)
TARGET_CENTER_DISTANCE           = 291.17589 <km>
SPACECRAFT_ALTITUDE              = 289.05287 <km>
SUB_SPACECRAFT_LATITUDE          = 7.69471 <deg>
SUB_SPACECRAFT_LONGITUDE         = 304.50536 <deg>
SUB_SOLAR_LATITUDE               = 44.77191 <deg>
SUB_SOLAR_LONGITUDE              = 285.22944 <deg>
PHASE_ANGLE                      = 40.10378 <deg>

GROUP                            = SC_COORDINATE_SYSTEM
COORDINATE_SYSTEM_NAME           = "S/C-COORDS"
ORIGIN_OFFSET_VECTOR             = (183203785.234 <km>, -441066061.027 <km>, -253773669.335 <km>)
ORIGIN_ROTATION_QUATERNION       = (0.45581064, -0.71591710, -0.07012400, -0.52419652)
QUATERNION_DESC                     = "J2000 to Rosetta Coordinate System quaternion (nx sin(a/2), ny sin(a/2), nz
sin(a/2), cos(a/2)"
REFERENCE_COORD_SYSTEM_NAME      = "EME J2000"
END_GROUP                        = SC_COORDINATE_SYSTEM

GROUP                            = CAMERA_COORDINATE_SYSTEM
COORDINATE_SYSTEM_NAME           = "NAC_CAMERA_FRAME"
ORIGIN_OFFSET_VECTOR             = (-0.001052 <km>, -0.000325 <km>, 0.002429 <km>)
ORIGIN_ROTATION_QUATERNION       = (-0.00007285, 0.00023825, -0.70724684, -0.70696665)
QUATERNION_DESC                   = "Rosetta Coordinate System to camera coordinate system quaternion (nx sin(a/2),
ny sin(a/2), nz sin(a/2), cos(a/2)"
REFERENCE_COORD_SYSTEM_NAME      = "S/C-COORDS"
END_GROUP                        = CAMERA_COORDINATE_SYSTEM
SPICE_FILE_NAME                                = ("lsk\NAIF0011.TLS", "sclk\ROS_160929_STEP.TSC", "spk\DE405.BSP",
"spk\RORB_DV_257_03___T19_00345.BSP",             "spk\CORB_DV_257_03___T19_00345.BSP",             "fk\ROS_V31.TF",
```

```
"ck\RATT_DV_145_01_01_T6_00216.BC",         "ik\ROS_OSIRIS_V15.TI",         "fk\ROS_V31.TF",         "fk\ROS_V31.TF",
"pck\ROS_CG_RAD_V10.TPC", "ck\CATT_DV_145_02_______00216.BC", "dsk\ROS_CG_M003_OSPCLPS_N_V1.BDS")

/*   IMAGE POINT OF INTEREST   */

GROUP                             = IMAGE_POI
ROSETTA:POINT_OF_INTEREST         = "N/A"
ROSETTA:IMAGE_POI_PIXEL           = "N/A"
ROSETTA:COORDINATE_SYSTEM         = "N/A"
ROSETTA:SURFACE_INTERCEPT_DISTANCE = "N/A"
ROSETTA:SURF_INT_CART_COORD       = "N/A"
END_GROUP                         = IMAGE_POI

/*   SCIENCE ACTIVITY   */

GROUP                             = SCIENCE_ACTIVITY
ROSETTA:MISSION_PHASE             = ("LTP001", "MTP006", "STP011")
ROSETTA:RATIONALE_DESC            = "NUCLEUS"
ROSETTA:OPERATIONAL_ACTIVITY      = "TAG_NUCLEUS_COLOR"
ROSETTA:ACTIVITY_NAME             = "STP011_GCOMPMAP_001"
END_GROUP                         = SCIENCE_ACTIVITY

/*   DATA CONTENT FLAGS   */

GROUP                             = SR_DATA_CONTENT
ROSETTA:PREPIXEL_FLAG             = FALSE
ROSETTA:POSTPIXEL_FLAG            = FALSE
ROSETTA:OVERCLOCKING_LINES_FLAG   = FALSE
ROSETTA:CCD_DATA_FLAG             = TRUE
ROSETTA:B1_SHUTTER_PULSE_FLAG     = TRUE
ROSETTA:B2_SHUTTER_PULSE_FLAG     = TRUE
END_GROUP                         = SR_DATA_CONTENT

/*   STATUS FLAGS   */

GROUP                             = SR_STATUS_FLAGS
ROSETTA:SHUTTER_FOUND_IN_ERROR_FLAG = FALSE
ROSETTA:SHUTTER_PRE_INIT_FAILED_FLAG = FALSE
```

```
ROSETTA:ERROR_RECOVERY_FAILED_FLAG = FALSE
ROSETTA:EXPOSURE_STATUS_ID       = SUCCESS
END_GROUP                        = SR_STATUS_FLAGS

/*   MECHANISM STATUS FLAGS   */

GROUP                            = SR_MECHANISM_STATUS
FILTER_NUMBER                    = "82"
FILTER_NAME                      = "Neutral_Orange"
ROSETTA:FRONT_DOOR_STATUS_ID     = OPEN
END_GROUP                        = SR_MECHANISM_STATUS

/*   IMAGE ACQUISITION OPTIONS   */

GROUP                            = SR_ACQUIRE_OPTIONS
ROSETTA:SCIENCE_DATA_LINK        = HIGHSPEED
ROSETTA:DATA_ROUTING_ID          = QUEUE2
EXPOSURE_DURATION                = 1.6280 <s>
ROSETTA:COMMANDED_FILTER_NUMBER  = 82
ROSETTA:COMMANDED_FILTER_NAME    = "Neutral_Orange"
ROSETTA:GRAYSCALE_TESTMODE_FLAG  = FALSE
ROSETTA:HARDWARE_BINNING_ID      = "1x1"
ROSETTA:AMPLIFIER_ID             = B
ROSETTA:GAIN_ID                  = HIGH
ROSETTA:ADC_ID                   = TANDEM
ROSETTA:OVERCLOCKING_LINES_FLAG  = FALSE
ROSETTA:OVERCLOCKING_PIXELS_FLAG = FALSE
ROSETTA:CCD_ENABLED_FLAG         = TRUE
ROSETTA:ADC_ENABLED_FLAG         = TRUE
ROSETTA:BLADE1_PULSES_ENABLED_FLAG = TRUE
ROSETTA:BLADE2_PULSES_ENABLED_FLAG = TRUE
ROSETTA:BULBMODE_ENABLED_FLAG    = FALSE
ROSETTA:FRAMETRANSFER_ENABLED_FLAG = FALSE
ROSETTA:WINDOWING_ENABLED_FLAG   = TRUE
ROSETTA:SHUTTER_ENABLED_FLAG     = TRUE
ROSETTA:DITHERING_ENABLED_FLAG   = FALSE
ROSETTA:CRB_DUMP_MODE            = 0
ROSETTA:CRB_PULSE_MODE           = 0
```

```
ROSETTA:SUBFRAME_COORDINATE_ID   = "ELECTRICAL"
ROSETTA:X_START                  = 0
ROSETTA:X_END                    = 2048
ROSETTA:Y_START                  = 0
ROSETTA:Y_END                    = 2048
ROSETTA:SHUTTER_PRETRIGGER_DURATION = 0.2500 <s>
ROSETTA:CRB_TO_PCM_SYNC_MODE     = 17
ROSETTA:AUTOEXPOSURE_FLAG        = FALSE
ROSETTA:LOWPOWER_MODE_FLAG       = FALSE
ROSETTA:DUAL_EXPOSURE_FLAG       = FALSE
END_GROUP                        = SR_ACQUIRE_OPTIONS

/*   PROCESSING FLAGS   */

GROUP                            = SR_PROCESSING_FLAGS
BAD_PIXEL_REPLACEMENT_FLAG       = FALSE
ROSETTA:ADC_OFFSET_CORRECTION_FLAG = TRUE
ROSETTA:BIAS_CORRECTION_FLAG     = TRUE
ROSETTA:COHERENT_NOISE_CORRECTION_FLAG = FALSE
DARK_CURRENT_CORRECTION_FLAG     = FALSE
ROSETTA:FLATFIELD_HI_CORRECTION_FLAG = TRUE
ROSETTA:BAD_PIXEL_REPLACEMENT_GROUND_FLAG = TRUE
ROSETTA:FLATFIELD_LO_CORRECTION_FLAG = TRUE
ROSETTA:EXPOSURETIME_CORRECTION_FLAG = TRUE
ROSETTA:RADIOMETRIC_CALIBRATION_FLAG = TRUE
ROSETTA:GEOMETRIC_DISTORTION_CORRECTION_FLAG = TRUE
ROSETTA:REFLECTIVITY_NORMALIZATION_FLAG = FALSE
ROSETTA:INFIELD_STRAYLIGHT_CORRECTION_FLAG = FALSE
ROSETTA:OUTFIELD_STRAYLIGHT_CORRECTION_FLAG = FALSE
END_GROUP                        = SR_PROCESSING_FLAGS

/*   SHUTTER CONFIG   */

GROUP                            = SR_SHUTTER_CONFIG
ROSETTA:PROFILE_ID               = "4294967295"
ROSETTA:CONTROL_MASK             = "16#39#"
ROSETTA:TESTMODE_FLAG            = FALSE
ROSETTA:ZEROPULSE_FLAG           = TRUE
```

```
ROSETTA:LOCKING_ENCODER_FLAG     = TRUE
ROSETTA:CHARGEMODE_ID            = SLOW
ROSETTA:SHUTTER_OPERATION_MODE   = "NORMAL"
ROSETTA:NUM_OF_EXPOSURES         = 1
END_GROUP                        = SR_SHUTTER_CONFIG

/*   SHUTTER STATUS   */

GROUP                            = SR_SHUTTER_STATUS
ROSETTA:STATUS_MASK              = "16#6000600#"
ROSETTA:ERROR_TYPE_ID            = SHUTTER_ERROR_NONE
END_GROUP                        = SR_SHUTTER_STATUS

/*   DATA COMPRESSION AND SEGMENTATION   */

GROUP                            = SR_COMPRESSION
ROSETTA:LOST_PACKETS             = (0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0)
ROSETTA:SEGMENT_X                  = (0, 496, 992, 1488, 1984, 0, 496, 992, 1488, 1984, 0, 496, 992, 1488, 1984, 0,
496, 992, 1488, 1984, 0, 496, 992, 1488, 1984)
ROSETTA:SEGMENT_Y                  = (0, 0, 0, 0, 0, 496, 496, 496, 496, 496, 992, 992, 992, 992, 992, 1488, 1488,
1488, 1488, 1488, 1984, 1984, 1984, 1984, 1984)
ROSETTA:SEGMENT_W                  = (512, 512, 512, 512, 64, 512, 512, 512, 512, 64, 512, 512, 512, 512, 64, 512,
512, 512, 512, 64, 512, 512, 512, 512, 64)
ROSETTA:SEGMENT_H                 = (512, 512, 512, 512, 512, 512, 512, 512, 512, 512, 512, 512, 512, 512, 512, 512,
512, 512, 512, 512, 64, 64, 64, 64, 64)
ROSETTA:ENCODING                        = (SPIHT_LIFT, SPIHT_LIFT, SPIHT_LIFT, SPIHT_LIFT, SPIHT_LIFT, SPIHT_LIFT,
SPIHT_LIFT,  SPIHT_LIFT,  SPIHT_LIFT,  SPIHT_LIFT,  SPIHT_LIFT,  SPIHT_LIFT,  SPIHT_LIFT,  SPIHT_LIFT,  SPIHT_LIFT,
SPIHT_LIFT,  SPIHT_LIFT,  SPIHT_LIFT,  SPIHT_LIFT,  SPIHT_LIFT,  SPIHT_LIFT,  SPIHT_LIFT,  SPIHT_LIFT,  SPIHT_LIFT,
SPIHT_LIFT)
ROSETTA:COMPRESSION_RATIO         = (  2.6,   2.6,   2.6,   2.6,   2.6,   2.6,   2.6,   2.6,   2.6,   2.6,   2.7,
2.5,   2.2,   2.6,   2.7,   2.7,   2.2,   2.0,   2.6,   2.7,   2.7,   2.7,   2.7,   2.7,   2.7)
ROSETTA:LOSSLESS_FLAG              = (TRUE, TRUE, TRUE, TRUE, TRUE, TRUE, TRUE, TRUE, TRUE, TRUE, TRUE, TRUE, TRUE,
TRUE, TRUE, TRUE, TRUE, TRUE, TRUE, TRUE, TRUE, TRUE, TRUE, TRUE, TRUE)
ROSETTA:SPIHT_PYRAMID_LEVELS     = (8, 8, 8, 8, 5, 8, 8, 8, 8, 5, 8, 8, 8, 8, 5, 8, 8, 8, 8, 5, 5, 5, 5, 5, 5)
ROSETTA:SPIHT_THRESHOLD_BITS     = (11, 10, 10, 9, 5, 9, 8, 9, 10, 7, 12, 12, 11, 12, 7, 12, 11, 14, 14, 7, 8, 8, 8,
8, 5)
ROSETTA:SPIHT_MEAN                = (238, 239, 239, 239, 238, 239, 239, 239, 239, 239, 239, 447, 972, 324, 245, 239,
300, 465, 285, 246, 239, 241, 251, 247, 240)
```

```
ROSETTA:SPIHT_MEAN_SHIFT         = (0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 0)
ROSETTA:SPIHT_WAVE_LEVELS        = (4, 4, 4, 4, 3, 4, 4, 4, 4, 3, 4, 4, 4, 4, 3, 4, 4, 4, 4, 3, 3, 3, 3, 3, 3)
PIXEL_AVERAGING_WIDTH            = (1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1)
PIXEL_AVERAGING_HEIGHT           = (1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1)
ROSETTA:SMOOTH_FILTER_ID          = (NONE, NONE, NONE, NONE, NONE, NONE, NONE, NONE, NONE, NONE, NONE, NONE, NONE,
NONE, NONE, NONE, NONE, NONE, NONE, NONE, NONE, NONE, NONE, NONE, NONE)
ROSETTA:SQRT_FILTER_FLAG           = (FALSE, FALSE, FALSE, FALSE, FALSE, FALSE, FALSE, FALSE, FALSE, FALSE, FALSE,
FALSE, FALSE, FALSE, FALSE, FALSE, FALSE, FALSE, FALSE, FALSE, FALSE, FALSE, FALSE, FALSE, FALSE)
ROSETTA:SQRT_GAIN                 = ( 1.8,  1.8,  1.8,  1.8,  1.8,  1.8,  1.8,  1.8,  1.8,  1.8,  1.8,  1.8,  1.8,
1.8,  1.8,  1.8,  1.8,  1.8,  1.8,  1.8,  1.8,  1.8,  1.8,  1.8,  1.8)
END_GROUP                        = SR_COMPRESSION

/*   SUBSYSTEM HARDWARE IDENTIFICATION   */

GROUP                            = SR_HARDWARE_CONFIG
ROSETTA:DATA_PROCESSING_UNIT_ID  = FS
ROSETTA:POWER_CONVERTER_ID       = FS
ROSETTA:MOTOR_CONTROLLER_ID      = FS
ROSETTA:NAC_CCD_READOUT_BOX_ID   = FM
ROSETTA:WAC_CCD_READOUT_BOX_ID   = FM
ROSETTA:NAC_CAMERA_ID            = FM
ROSETTA:WAC_CAMERA_ID            = FM
END_GROUP                        = SR_HARDWARE_CONFIG

/*   SYSTEM HEATER STATUS   */

GROUP                            = SR_HEATER_STATUS
ROSETTA:CCD_HEATER_POWER         = 0.000 <W>
ROSETTA:NAC_MAIN_FDM_POWER       = 1.328 <W>
ROSETTA:NAC_RED_FDM_POWER        = 0.000 <W>
ROSETTA:NAC_MAIN_PPE_POWER       = 3.778 <W>
ROSETTA:NAC_RED_PPE_POWER        = 0.000 <W>
ROSETTA:WAC_MAIN_STR1_POWER      = 1.973 <W>
ROSETTA:WAC_RED_STR1_POWER       = 0.000 <W>
ROSETTA:WAC_MAIN_STR2_POWER      = 2.615 <W>
ROSETTA:WAC_RED_STR2_POWER       = 0.000 <W>
END_GROUP                        = SR_HEATER_STATUS
```

```
/*   POWER CONVERTER SWITCH STATUS   */

GROUP                            = SR_SWITCH_STATUS
ROSETTA:WAC_SHUTFAILSAFEEXEC_FLAG = OFF
ROSETTA:NAC_SHUTFAILSAFEEXEC_FLAG = OFF
ROSETTA:WAC_DOORFAILSAFEEXEC_FLAG = OFF
ROSETTA:NAC_DOORFAILSAFEEXEC_FLAG = OFF
ROSETTA:PCM_PASSCTRLACTIVE_FLAG  = OFF
ROSETTA:WAC_SHUTFAILSAFE_ENAB_FLAG = OFF
ROSETTA:WAC_SHUTTERPOWER_FLAG    = ON
ROSETTA:WAC_CCDANNEALHEATER_FLAG = OFF
ROSETTA:WAC_CRB_PRIMEPOWER_FLAG  = ON
ROSETTA:NAC_SHUTFAILSAFE_ENAB_FLAG = OFF
ROSETTA:NAC_SHUTTERPOWER_FLAG    = ON
ROSETTA:NAC_CCDANNEALHEATER_FLAG = OFF
ROSETTA:NAC_CRB_PRIMEPOWER_FLAG  = ON
ROSETTA:WAC_STRUCTUREHEATER_R_FLAG = OFF
ROSETTA:WAC_STRUCTUREHEATER_M_FLAG = OFF
ROSETTA:WAC_RED_CALLAMP_FLAG     = OFF
ROSETTA:WAC_MAIN_CALLAMP_FLAG    = OFF
ROSETTA:WAC_DOORFAILSAFE_ENAB_FLAG = OFF
ROSETTA:NAC_IFPLATEHEATER_R_FLAG = OFF
ROSETTA:NAC_IFPLATEHEATER_M_FLAG = OFF
ROSETTA:NAC_RED_CALLAMP_FLAG     = OFF
ROSETTA:NAC_MAIN_CALLAMP_FLAG    = OFF
ROSETTA:NAC_DOORFAILSAFE_ENAB_FLAG = OFF
ROSETTA:MCB_RED_MOTORPOWER_FLAG  = OFF
ROSETTA:MCB_MAIN_MOTORPOWER_FLAG = ON
ROSETTA:MCB_FLAG                 = MAIN
ROSETTA:PRIMARY_POWER_RAIL_FLAG  = REDUNDANT
END_GROUP                        = SR_SWITCH_STATUS

/*   POWER SYSTEM STATUS   */

GROUP                            = SR_POWER_STATUS
ROSETTA:V_28_MAIN                = 3.5 <V>
ROSETTA:V_28_REDUNDANT           = 27.9 <V>
ROSETTA:V_5                      = 5.2 <V>
```

```
ROSETTA:V_3                    = 3.4 <V>
ROSETTA:V_15                   = 15.0 <V>
ROSETTA:V_M15                  = -15.0 <V>
ROSETTA:V_NAC_REFERENCE        = -9.9 <V>
ROSETTA:V_WAC_REFERENCE        = -10.0 <V>
ROSETTA:CAMERA_V_24            = 24.9 <V>
ROSETTA:CAMERA_V_8             = 8.3 <V>
ROSETTA:CAMERA_V_M12           = -12.2 <V>
ROSETTA:CAMERA_V_5_ANALOG      = 5.3 <V>
ROSETTA:CAMERA_V_5_DIGITAL     = 5.2 <V>
ROSETTA:CAMERA_V_M5            = -5.3 <V>
ROSETTA:I_28_MAIN              = -79.6 <mA>
ROSETTA:I_28_REDUNDANT         = 879.1 <mA>
ROSETTA:I_5                    = 1803.0 <mA>
ROSETTA:I_3                    = 133.3 <mA>
ROSETTA:I_15                   = 119.3 <mA>
ROSETTA:I_M15                  = 56.0 <mA>
ROSETTA:CAMERA_I_24            = 17.7 <mA>
ROSETTA:CAMERA_I_8             = 12.3 <mA>
ROSETTA:CAMERA_I_M12           = 63.2 <mA>
ROSETTA:CAMERA_I_5_ANALOG      = 95.2 <mA>
ROSETTA:CAMERA_I_5_DIGITAL     = 124.4 <mA>
ROSETTA:CAMERA_I_M5            = 64.1 <mA>
END_GROUP                      = SR_POWER_STATUS

/*   CALIBRATED TEMPERATURES   */

GROUP                          = SR_TEMPERATURE_STATUS
ROSETTA:T_MAIN_PCM             = 295.0 <K>
ROSETTA:T_REDUNDANT_PCM        = 297.1 <K>
ROSETTA:T_WAC_STRUCTURE_MAIN_1   = 285.2 <K>
ROSETTA:T_WAC_STRUCTURE_REDUNDANT_1 = 285.7 <K>
ROSETTA:T_WAC_STRUCTURE_MAIN_2   = 285.2 <K>
ROSETTA:T_WAC_STRUCTURE_REDUNDANT_2 = 285.5 <K>
ROSETTA:T_WAC3                 = 288.0 <K>
ROSETTA:T_WAC4                 = 286.5 <K>
ROSETTA:T_WAC_WHEEL_MOTOR_1    = 282.4 <K>
ROSETTA:T_WAC_WHEEL_MOTOR_2    = 282.4 <K>
```

```
ROSETTA:T_WAC_DOOR_MOTOR         = 282.2 <K>
ROSETTA:T_NAC_CCD_VIA_MCB        = 202.7 <K>
ROSETTA:T_WAC_CCD_VIA_MCB        = 172.7 <K>
ROSETTA:T_NAC_WHEEL_MOTOR_1      = 253.7 <K>
ROSETTA:T_NAC_WHEEL_MOTOR_2      = 254.8 <K>
ROSETTA:T_NAC_DOOR_MOTOR         = 253.5 <K>
ROSETTA:T_NAC_DOOR_IF_MAIN       = 249.2 <K>
ROSETTA:T_NAC_MIRROR_2           = 225.3 <K>
ROSETTA:T_NAC_PPE_IF_REDUNDANT   = 255.3 <K>
ROSETTA:T_NAC_DOOR_IF_REDUNDANT  = 249.2 <K>
ROSETTA:T_NAC_PPE_IF_MAIN        = 255.0 <K>
ROSETTA:T_NAC_MIRROR_1_AND_3     = 224.3 <K>
ROSETTA:T_DSP_MAIN               = 304.5 <K>
ROSETTA:T_DSP_REDUNDANT          = 295.9 <K>
ROSETTA:T_BOARD_CONTROLLER       = 299.2 <K>
ROSETTA:T_BOARD_DRIVER           = 297.2 <K>
ROSETTA:CAMERA_TCCD              = 149.5 <K>
ROSETTA:CAMERA_T_SENSORHEAD      = 267.6 <K>
ROSETTA:CAMERA_T_ADC_1           = 290.3 <K>
ROSETTA:CAMERA_T_ADC_2           = 289.5 <K>
ROSETTA:CAMERA_T_SHUTTER_MOTOR_1 = 255.4 <K>
ROSETTA:CAMERA_T_SHUTTER_MOTOR_2 = 255.0 <K>
ROSETTA:CAMERA_T_POWER_CONVERTER = 312.0 <K>
ROSETTA:CAMERA_T_DOSIMETER       = 286.7 <K>
END_GROUP                        = SR_TEMPERATURE_STATUS

/*   RADIATION ENVIRONMENT   */

GROUP                            = SR_RADIATION_STATUS
ROSETTA:CAMERA_DOSIS             = 524.3 <rad>
ROSETTA:SREM_PROTONS_GT_20MEV    = 0
ROSETTA:SREM_PROTONS_50_TO_70MEV = 0
ROSETTA:SREM_ELECTRONS_LT_2MEV   = 0
END_GROUP                        = SR_RADIATION_STATUS

/*  DATA OBJECT DEFINITIONS  */

OBJECT                           = IMAGE
```

```
INTERCHANGE_FORMAT                = BINARY
LINE_SAMPLES                      = 2048
LINES                             = 2048
BANDS                             = 1
SAMPLE_TYPE                       = PC_REAL
SAMPLE_BITS                       = 32
UNIT                              = "W/M**2/SR/NM"
DERIVED_MINIMUM                   = -1.31549e-05
DERIVED_MAXIMUM                   = 0.00284623
MEAN                              = 4.05713e-05
STANDARD_DEVIATION                = 0.000139602
FIRST_LINE                        = 1
FIRST_LINE_SAMPLE                 = 1
LINE_DISPLAY_DIRECTION            = DOWN
SAMPLE_DISPLAY_DIRECTION          = LEFT
END_OBJECT                        = IMAGE

OBJECT                            = DISTANCE_IMAGE
INTERCHANGE_FORMAT                = BINARY
LINE_SAMPLES                      = 2048
LINES                             = 2048
BANDS                             = 1
SAMPLE_TYPE                       = PC_REAL
SAMPLE_BITS                       = 32
UNIT                              = "KM"
DERIVED_MINIMUM                   = 0
DERIVED_MAXIMUM                   = 292.346
MEAN                              = 26.7136
STANDARD_DEVIATION                = 83.9277
FIRST_LINE                        = 1
FIRST_LINE_SAMPLE                 = 1
LINE_DISPLAY_DIRECTION            = DOWN
SAMPLE_DISPLAY_DIRECTION          = LEFT
END_OBJECT                        = DISTANCE_IMAGE

OBJECT                            = EMISSION_ANGLE_IMAGE
INTERCHANGE_FORMAT                = BINARY
LINE_SAMPLES                      = 2048
```

```
LINES                            = 2048
BANDS                            = 1
SAMPLE_TYPE                      = PC_REAL
SAMPLE_BITS                      = 32
UNIT                             = "RAD"
DERIVED_MINIMUM                  = 0
DERIVED_MAXIMUM                  = 3.00874
MEAN                             = 0.0641369
STANDARD_DEVIATION               = 0.223103
FIRST_LINE                       = 1
FIRST_LINE_SAMPLE                = 1
LINE_DISPLAY_DIRECTION           = DOWN
SAMPLE_DISPLAY_DIRECTION         = LEFT
END_OBJECT                       = EMISSION_ANGLE_IMAGE

OBJECT                           = INCIDENCE_ANGLE_IMAGE
INTERCHANGE_FORMAT               = BINARY
LINE_SAMPLES                     = 2048
LINES                            = 2048
BANDS                            = 1
SAMPLE_TYPE                      = PC_REAL
SAMPLE_BITS                      = 32
UNIT                             = "RAD"
DERIVED_MINIMUM                  = 0
DERIVED_MAXIMUM                  = 3.01203
MEAN                             = 0.0795994
STANDARD_DEVIATION               = 0.282162
FIRST_LINE                       = 1
FIRST_LINE_SAMPLE                = 1
LINE_DISPLAY_DIRECTION           = DOWN
SAMPLE_DISPLAY_DIRECTION         = LEFT
END_OBJECT                       = INCIDENCE_ANGLE_IMAGE

OBJECT                           = PHASE_ANGLE_IMAGE
INTERCHANGE_FORMAT               = BINARY
LINE_SAMPLES                     = 2048
LINES                            = 2048
BANDS                            = 1
```

```
SAMPLE_TYPE                      = PC_REAL
SAMPLE_BITS                      = 32
UNIT                             = "RAD"
DERIVED_MINIMUM                  = 0
DERIVED_MAXIMUM                  = 0.716211
MEAN                             = 0.0652946
STANDARD_DEVIATION               = 0.205141
FIRST_LINE                       = 1
FIRST_LINE_SAMPLE                = 1
LINE_DISPLAY_DIRECTION           = DOWN
SAMPLE_DISPLAY_DIRECTION         = LEFT
END_OBJECT                       = PHASE_ANGLE_IMAGE

OBJECT                           = FACET_INDEX_IMAGE
INTERCHANGE_FORMAT               = BINARY
LINE_SAMPLES                     = 2048
LINES                            = 2048
BANDS                            = 1
SAMPLE_TYPE                      = LSB_INTEGER
SAMPLE_BITS                      = 32
UNIT                             = "INTEGER"
DERIVED_MINIMUM                  = 0
DERIVED_MAXIMUM                  = 4.03451e+06
MEAN                             = 159019.3
STANDARD_DEVIATION               = 594243.4
FIRST_LINE                       = 1
FIRST_LINE_SAMPLE                = 1
LINE_DISPLAY_DIRECTION           = DOWN
SAMPLE_DISPLAY_DIRECTION         = LEFT
END_OBJECT                       = FACET_INDEX_IMAGE

OBJECT                           = COORDINATE_X_IMAGE
INTERCHANGE_FORMAT               = BINARY
LINE_SAMPLES                     = 2048
LINES                            = 2048
BANDS                            = 1
SAMPLE_TYPE                      = PC_REAL
SAMPLE_BITS                      = 32
```

```
UNIT                              = "KM"
DERIVED_MINIMUM                   = -2.43177
DERIVED_MAXIMUM                   = 2.62691
MEAN                              = 0.0272506
STANDARD_DEVIATION                = 0.41637
FIRST_LINE                        = 1
FIRST_LINE_SAMPLE                 = 1
LINE_DISPLAY_DIRECTION            = DOWN
SAMPLE_DISPLAY_DIRECTION          = LEFT
END_OBJECT                        = COORDINATE_X_IMAGE

OBJECT                            = COORDINATE_Y_IMAGE
INTERCHANGE_FORMAT                = BINARY
LINE_SAMPLES                      = 2048
LINES                             = 2048
BANDS                             = 1
SAMPLE_TYPE                       = PC_REAL
SAMPLE_BITS                       = 32
UNIT                              = "KM"
DERIVED_MINIMUM                   = -1.76759
DERIVED_MAXIMUM                   = 1.46343
MEAN                              = -0.0700342
STANDARD_DEVIATION                = 0.285929
FIRST_LINE                        = 1
FIRST_LINE_SAMPLE                 = 1
LINE_DISPLAY_DIRECTION            = DOWN
SAMPLE_DISPLAY_DIRECTION          = LEFT
END_OBJECT                        = COORDINATE_Y_IMAGE

OBJECT                            = COORDINATE_Z_IMAGE
INTERCHANGE_FORMAT                = BINARY
LINE_SAMPLES                      = 2048
LINES                             = 2048
BANDS                             = 1
SAMPLE_TYPE                       = PC_REAL
SAMPLE_BITS                       = 32
UNIT                              = "KM"
DERIVED_MINIMUM                   = -1.67636
```

```
DERIVED_MAXIMUM                 = 1.66233
MEAN                            = 0.0175513
STANDARD_DEVIATION              = 0.241313
FIRST_LINE                      = 1
FIRST_LINE_SAMPLE               = 1
LINE_DISPLAY_DIRECTION          = DOWN
SAMPLE_DISPLAY_DIRECTION        = LEFT
END_OBJECT                      = COORDINATE_Z_IMAGE
END
```

Appendix 2: Example OSIRIS .IMG History Object

The HISTORY object consists of groups. OSIRIS level 1 (CODMAC L2) images contain only the group LEVEL_1_GENERATION, while higher levels, processed by OsiCalliope, contain a second group OSICALLIOPE.

```
OBJECT                          = HISTORY
GROUP                         = LEVEL_1_GENERATION
    SOFTWARE_DESC             = "OSIRIS LEVEL 1 PDS FILE GENERATOR"
    SOFTWARE_VERSION_ID       = "1.57.0"
    VERSION_DATE              = 2017-11-20
    DATE_TIME                 = 2017-11-21T10:53:00.000Z
    GROUP                     = PARAMETERS
        FILENAME              =
    "NAC_2014-08-03T11.21.14.567Z_ID10_1397549400_F82.IMG"
    END_GROUP                 = PARAMETERS
END_GROUP                     = LEVEL_1_GENERATION
GROUP                           = OSICALLIOPE
    SOFTWARE_DESC                   = "OSIRIS CALIBRATION PIPELINE"
    SOFTWARE_VERSION_ID             = "2.4.0"
    DATA_VERSION_ID                 = "OSICALLIOPE_V06.TXT"
    PRODUCER_FULL_NAME              = "G. KOVACS"
    USER_NAME                       = "Gabor Kovacs"
    DATE_TIME                       = "2018-03-02T12:28:22"
    GROUP                           = PARAMETERS
        ROSETTA:ADC_OFFSET_CORRECTION_FLAG = TRUE
        ROSETTA:BIAS_CORRECTION_FLAG    = TRUE
        ROSETTA:COHERENT_NOISE_CORRECTION_FLAG = FALSE
        DARK_CURRENT_CORRECTION_FLAG    = FALSE
        ROSETTA:FLATFIELD_HI_CORRECTION_FLAG = TRUE
        ROSETTA:BAD_PIXEL_REPLACEMENT_GROUND_FLAG = TRUE
        ROSETTA:FLATFIELD_LO_CORRECTION_FLAG = TRUE
        ROSETTA:EXPOSURETIME_CORRECTION_FLAG = TRUE
        ROSETTA:RADIOMETRIC_CALIBRATION_FLAG = TRUE
        ROSETTA:GEOMETRIC_DISTORTION_CORRECTION_FLAG = TRUE
        ROSETTA:REFLECTIVITY_NORMALIZATION_FLAG = FALSE
        ROSETTA:INFIELD_STRAYLIGHT_CORRECTION_FLAG = FALSE
        ROSETTA:OUTFIELD_STRAYLIGHT_CORRECTION_FLAG = FALSE
```

```
            SATURATION_LEVEL               = 54000 <DN>
            SATURATED_PIXEL_COUNT          = (0, 0.00 <%>)
            ADC_OFFSET_VALUES              = (36 <DN>, 36 <DN>)
            BIAS_FILE                      = "NAC_FM_BIAS_V01.TXT"
            BIAS_BASE_VALUES               = (235.160 <DN>, 235.160 <DN>)
            BIAS_TEMP                      = (290.3 <K>, 289.5 <K>)
            BIAS_TEMP_DELTA                = (3.101 <DN>, 3.101 <DN>)
            FLAT_HI_FILE                   = "NAC_FM_FLATHI_00_V01.IMG"
            BAD_PIXEL_FILE                 = "NAC_FM_BAD_PIXEL_V02.TXT"
            FLAT_LO_FILE                   = "NAC_FM_FLAT_82_V01.IMG"
            EXPOSURE_CORRECTION_TYPE       = "NORMAL_PULSES"
            EXPOSURE_CORRECTION_FILE       = "PULSE_DATA"
            NUM_OF_EXPOSURES               = 1
            MEAN_EFFECTIVE_EXPOSURETIME    = 1.6252 <s>
            ABSCAL_FILE                    = "NAC_FM_ABSCAL_V01.TXT"
            ABSCAL_FACTOR                  = 3.27823e+06 <(DN/s)/(W/m**2/nm/sr)>
            BINNING_FACTOR                 = 1
            GEOMETRIC_CORRECTION_FILE      = "NAC_FM_DISTORTION_V01.TXT"
            GEOMETRIC_CORRECTION_METHOD    = (POLY3_2D, POLY3_2D)
            GEOMETRIC_CORRECTION_AVERAGE   = 5.02
            GEO_CREATION_TIME              = "2017-12-13T19:21:57"
            GEO_SHAPE_MODEL                = "cg-dlr_spg-shap7-v1.0_4Mfacets-spc-v2.0.ver"
    END_GROUP                        = PARAMETERS
END_GROUP                        = OSICALLIOPE
END_OBJECT                       = HISTORY
```

Appendix 3: Example OSIRIS attached label for .FIT files

```
SIMPLE  =                    T / file does conform to FITS standard
BITPIX  =                   16 / number of bits per data pixel
NAXIS   =                    2 / number of axes
NAXIS1  =                 2048 / columns
NAXIS2  =                 2048 / rows
EXTEND  =                    T / FITS dataset may contain extensions
XEND    =                 2048 / columns
YEND    =                 2048 / rows
BSCALE  =                    1
BZERO   =                32768
DATE-OBS= '2015-03-17T01:02:05.560'
F_TSTART= '2015-03-17T01:02:05.560'
D_TEMP  =               167.29
EXPTIME =                 0.24
F_FID   =                   18
FILT    = 'Empty_VIS610'
TARGET  = '67P/CHURYUMOV-GERASIMENKO 1 (1969 R1)'
G_TTYPE = 'COMET'
CAMERA  = 'OSIWAC            '
C_NAME  = 'OSIRIS - WIDE ANGLE CAMERA'
M_PHASE = ''
F_SC1   = '1/385174850.58336'
F_SC2   = '1/385174851.8528'
F_LEVEL = '1'
RS_FDSID= 'OPEN'
G_RSS01 =         -270992662.5 / [SC_SUN_POSITION_VECTOR]
G_RSS02 =          121948530.8 / [SC_SUN_POSITION_VECTOR]
G_RSS03 =          93740646.36 / [SC_SUN_POSITION_VECTOR]
G_SSDIS =          311601951.4 / [SPACECRAFT_SOLAR_DISTANCE]
G_SELONG=            133.43736 / [SOLAR_ELONGATION]
G_RA    =            344.15993 / [RIGHT_ASCENSION]
G_DEC   =            -63.71283 / [DECLINATION]
G_AZIN  =            259.04705 / [NORTH_AZIMUTH]
G_RST01 =               32.014 / [SC_TARGET_POSITION_VECTOR]
G_RST02 =               -7.918 / [SC_TARGET_POSITION_VECTOR]
G_RST03 =              -67.477 / [SC_TARGET_POSITION_VECTOR]
```

```
G_STV01 =                0.081 / [SC_TARGET_VELOCITY_VECTOR]
G_STV02 =                 0.31 / [SC_TARGET_VELOCITY_VECTOR]
G_STV03 =               -0.143 / [SC_TARGET_VELOCITY_VECTOR]
G_PHASEA=             46.56264 / [PHASE_ANGLE]
G_CNAME = 'S/C-COORDS'
G_OVEC01=          271004737.4 / [ORIGIN_OFFSET_VECTOR]
G_OVEC02=         -121953963.6 / [ORIGIN_OFFSET_VECTOR]
G_OVEC03=         -93744822.72 / [ORIGIN_OFFSET_VECTOR]
G_OQUA01=           0.22991444 / [ORIGIN_ROTATION_QUATERNION]
G_OQUA02=          -0.22576325 / [ORIGIN_ROTATION_QUATERNION]
G_OQUA03=          -0.94659758 / [ORIGIN_ROTATION_QUATERNION]
G_OQUA04=           0.01110547 / [ORIGIN_ROTATION_QUATERNION]
G_NSYS  = 'EME J2000'
BINNING = '1x1'
RS_AMPID= 'B'
RS_GANID= 'HIGH'
RS_ADCID= 'TANDEM'
LINEDIR = 'DOWN'
SMPLEDIR= 'RIGHT'
END
```