OSIRIS

Optical, Spectroscopic, and Infrared Remote Imaging System

Software Interface Specification for OSIRIS Science Products

RO-RIS-MPAE-ID-023

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Prepared by:

Cecilia Tubiana

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Prepared by: *Cecilia Tubiana* (signature/date)

Approved by: *Holger Sierks* (signature/date)

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

1.3 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

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
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
RDR	Reduced Data Record
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 uses an off axis three mirror optical design. The off axis design was selected in order to minimize the straylight 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 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.

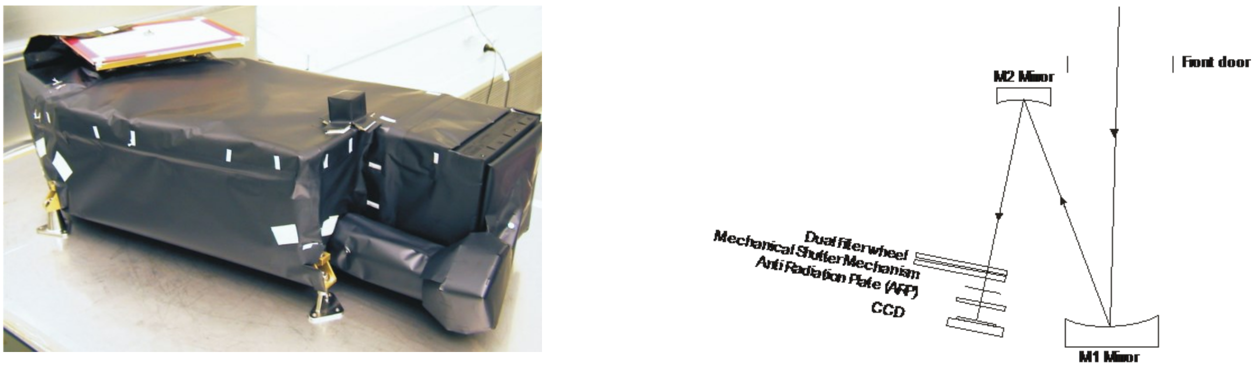

Figure 2: (Left) The OSIRIS WAC flight unit in the lab. (Right) The WAC optical path

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 v3.6 specification. The file structure is as follows:

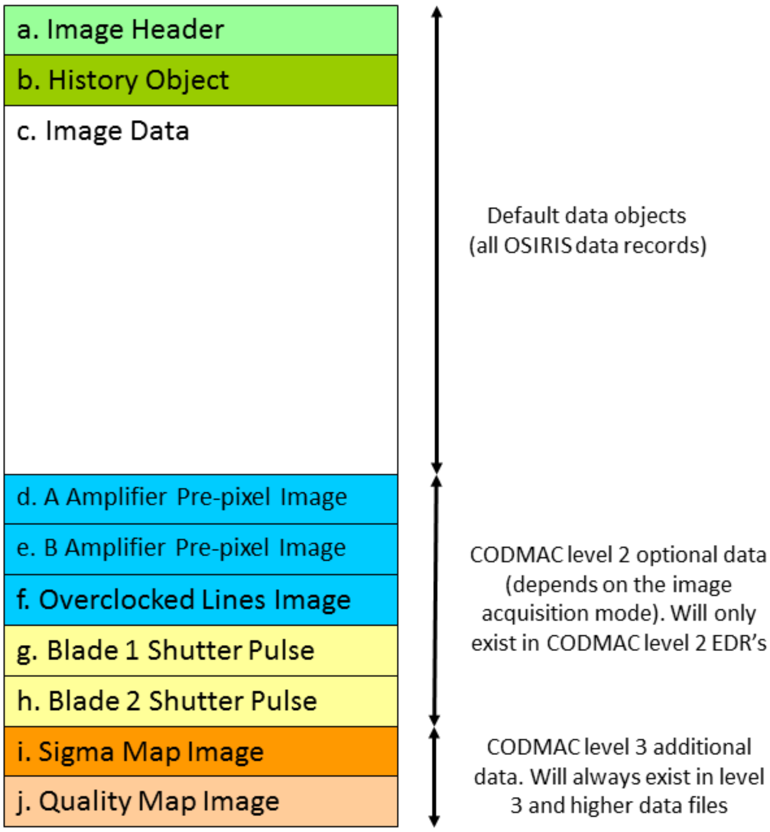

Figure 3: Layout of an OSIRIS data file

a. The **Image Header** is an embedded PDS label with associated ancillary information. The header contains object and pointer references to all other embedded objects.

b. The **History Object** is an additional PDS label containing a PDS HISTORY object. The history object contains the processing information of all the processing software used in the processing pipeline.

c. The **Image Data** contains the actual CCD image data from the exposure. The image data can be addressed using the primary IMAGE object.

d. The **A Amplifier Pre-pixel Image** data contains the image data from the pre-pixel readout phase of the amplifier A chain of the CCD readout. The pre-pixels are 48 elements in the serial register coupled to ground instead of the physical CCD. These pre-pixels could be used to estimate the CCD bias level and readout noise level. 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.

e. The **B Amplifier Pre-pixel Image** data contains the image data from the pre-pixel readout phase of the amplifier B chain of the CCD readout. The pre-pixels are 48 elements in the serial register coupled to ground instead of the physical CCD. These pre-pixels could be used to estimate the CCD bias level and readout noise level. 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.

f. 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.

g. 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.

h. 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.

i. The **Sigma Map Image** is a float image with the same dimension as the image itself. For each pixel its error is determined by the Poisson error E_p, and the (bias) readout noise E_B:

$$error_{i,j} = \sqrt{E_P^2 + E_B^2}$$

$$E_P = \frac{\sqrt{N_{i,j}}}{N_{i,j}}$$

where $N_{i,j}$ is the intensity of the pixel with coordinates (i, j) in number of electrons. Since the Poisson statistics are done using the intensity in number of electrons, the image intensity has to be converted from DN to number of electrons and this is done using:

$$I_{e^-} = I_{DN} \cdot gain$$

where I_{e^-} and I_{DN} are the intensity in number of electrons and DN, respectively, and gain is the number of electrons per DN (for OSIRIS WAC and NAC gain = 3.1 e^-/DN in HIGH gain mode and gain = 15.5 e^-/DN in LOW gain mode).

j. 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. The quality map exists for OSIRIS data level 2 and higher.

The quality estimate values stored in the quality map are generated by setting a given bit to value 1 for specific effects. If more than one effect is present in the data several different bits can be set. The following values are possible:

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Value	128	64	32	16	8	4	2	1
Effect	BAD	SAT	DIM	WARM	LOSSY	NLIN	-	VALID

BAD: Pixel is marked as bad.

SAT: Pixel was saturated during the exposure.

DIM: Pixel is marked as dim (low sensitivity).

WARM: Pixel is marked as warm (increased or varying sensitivity) use with caution.

LOSSY: Lossy image compression applied on pixel.

NLIN: Pixel was exposed into the nonlinear DN range of the CCD.

VALID: Pixel is valid. Invalid or non-existing (0) can be due to packet loss, or distortion correction.

Some flags have been removed from quality map (they are valid for the full image area):

CONV: (bit 1) Pixel has seen gauss convolution filtering as part of the image compression.

SQRT: (bit 0) Pixel has seen square root filtering as part of the image compression.

Pixel with value 0 is used to indicate lost data (lost packets).

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 needed to interpret or process the data in the file.

PDS labels are written in Object Description Language (ODL) (see PDS v3.6 specification). PDS label statements have the form:

keyword = value

Each label statement is terminated with a carriage return character (ASCII 13) and a line feed character (ASCII 10) sequence to allow the label to be read by many operating systems.

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 image 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 define the parameters for simple 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 1: Required keywords for defining a simple 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 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.

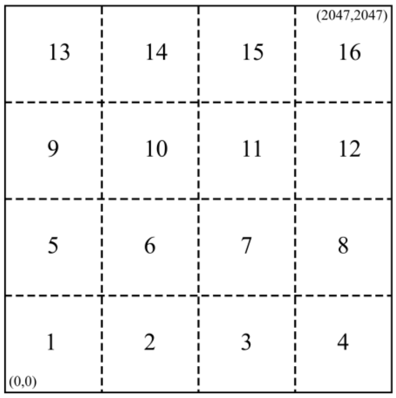

Figure 4: Example of the segmentation scheme used for an OSIRIS full frame image (2048x2048) (16 segments)

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 2.

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 2: 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 else 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 IOut = SQRT(I * 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”.

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

5 Data structure for .FTS images

The OSIRIS images are stored as a standard FITS file, as described in the FITS v3.0 specification, as a primary Header and Data Unit (HDU):

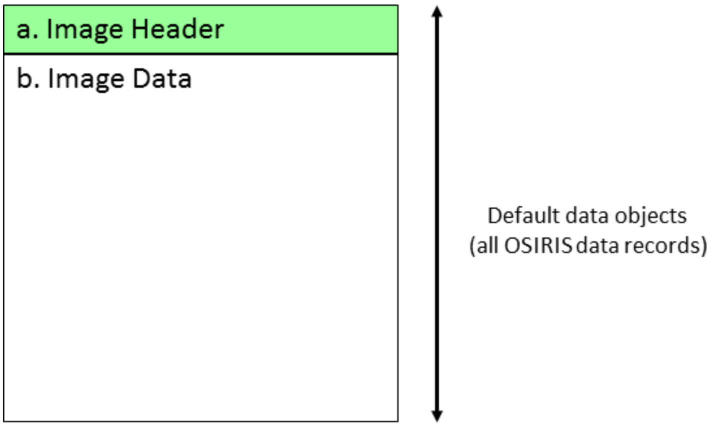

Figure 5 Layout of an OSIRIS FITS data file

a. The **Image Header** is an ASCII header containing a subset of the PDS ancillary information.
b. 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 Label

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. 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 define the parameters for simple IMAGE data:

NAXIS1	number of columns in the image
NAXIS2	number of rows in the image
BITPIX	number of bits in each individual sample
BSCALE/ BZERO:	defines the sample data

Table 3 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 some extra information defined in [RD1].

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 4).

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".

http://fits.gsfc.nasa.gov/fits_standard.html

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)
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, FTS, JPG

Table 4: OSIRIS data file filename elements

Example:

NAC_2003-10-16T13.50.05.012Z_ID10_0000000001_F82.IMG

A NAC image acquired at 2003-10-16T13:50:05.012 UTC. The file contains raw (level 1) CCD image data (image type ID). The image was acquired using the filter combination (8, 2). The processing level is 1 (project internal, not CODMAC). The time is the approximate start time of the exposure.

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 .FTS 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)
L	The CODMAC processing level of the image
I	The OSIRIS processing sub-level of the image
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, FTS, JPG

Table 5: OSIRIS data file filename elements

Example:

W20040923T071606570ID10F12.IMG

A WAC image acquired at 2004-09-23 at 07:16:06.657 UTC. The file contains raw (level 1) CCD image data (image type ID). The image was acquired using the filter combination (1, 2).

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 .FTS 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 6).

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).

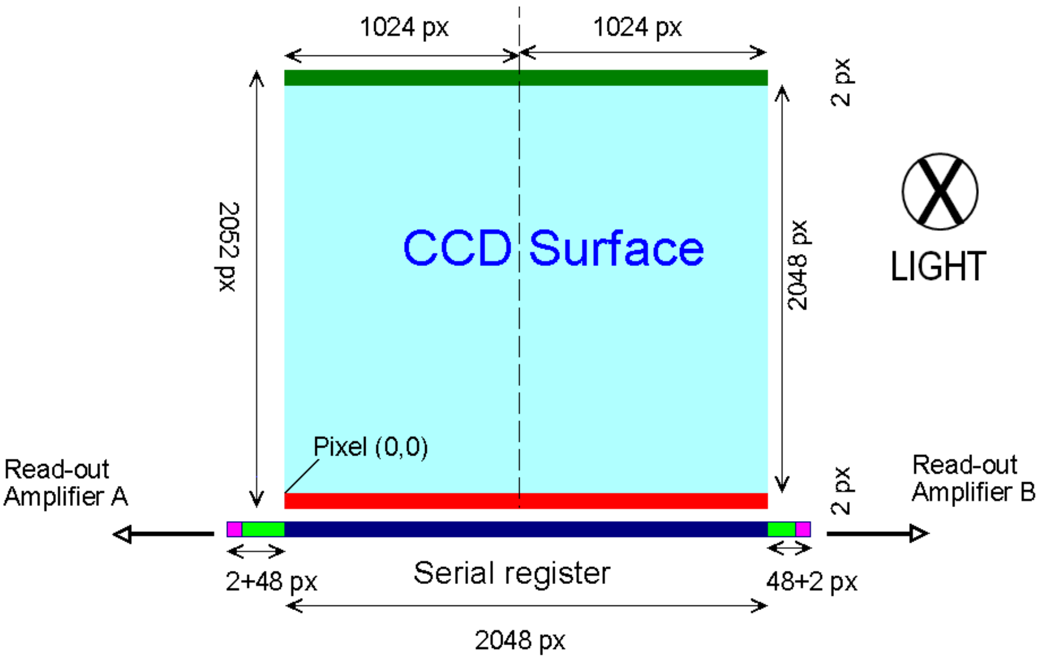

Figure 6: CCD array as seen by the science beam. CCD and S/C coordinate systems are shown

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 7, 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 7, 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.

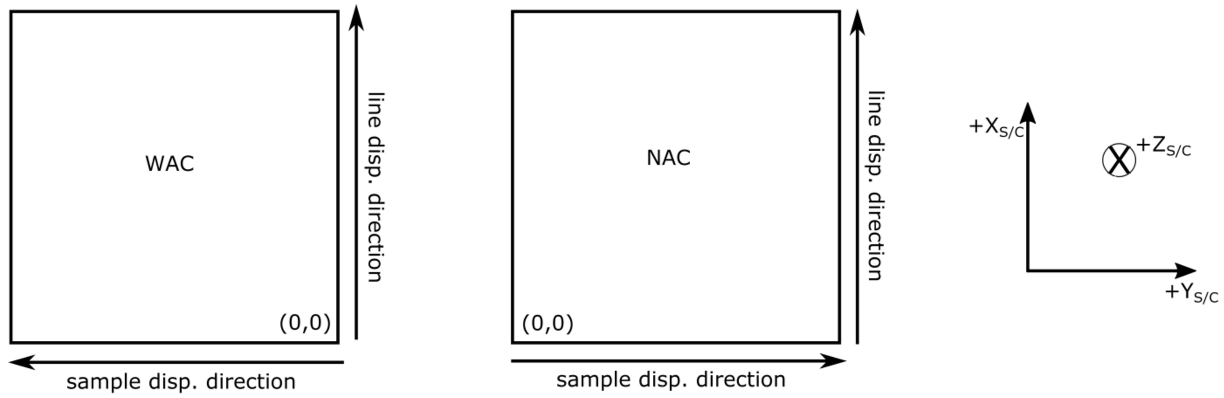

Figure 7: WAC and NAC images rotated into standard Rosetta orientation

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.

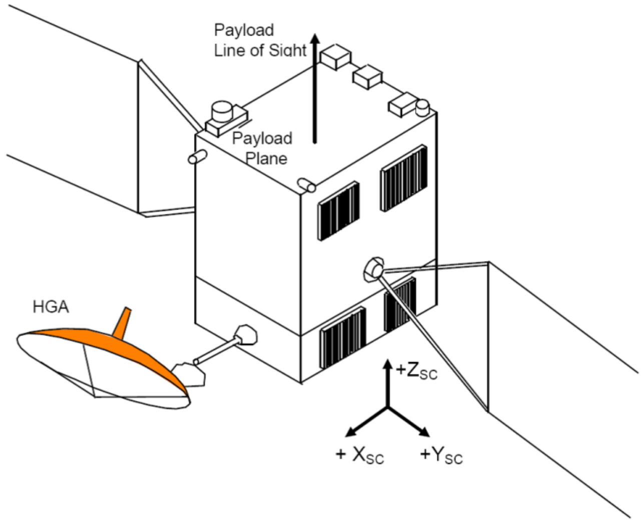

Figure 8: The Rosetta spacecraft coordinate frame (S/C-COORDS) definition

8 Product Generation

Products are generated following the process which is described in "Science Archive Interface Control Document" [RD1].

8.1 OSIRIS Level 1 (EDR)

OSIRIS Level 1 (EDR or CODMAC Level 2) data is generated from the telemetry data, by OsiTrap, following the generation of engineering data. Level 1 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 (RDR)

OSIRIS Level 2 (RDR or CODMAC Level 3) data is generated by OsiCalliope, taking the level 1 data, calibrating the image data, following the steps in the table below:

1.	IMAGE data is copied.
2.	Convert 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 6: Steps performed during calibration of Level 2 (RDR) 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 folded into the calibration when available or extrapolated from previous measurements and therefore do not explicitly appear in level 2 and higher.

8.3 OSIRIS Level 3 (RDR)

OSIRIS Level 3 (RDR or CODMAC Level 4) data is generated by OsiCalliope. This takes the calibrated level 2 data, and applies distortion correction.

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 the bi-linear algorithm, and since the original image is in radiance units, the result is also considered radiometrically corrected on large scales.

The resampling is based on a 2D third-order polynomial fit:

$$X_u = \sum_{i,j} kx_{i,j} \cdot X_0^i \cdot Y_0^j$$
$$Y_u = \sum_{i,j} ky_{i,j} \cdot X_0^i \cdot Y_0^j$$

where (X_u, Y_u) are the undistorted coordinates expressed as function of the original coordinates (X_0, Y_0) and kx and ky are the coefficients for the distortion removal.

During the ground calibration of OSIRIS, the distortion correction coefficients were measured, taking images of a metallic grid of 73 pinholes. During in-flight calibration campaigns, star field images were acquired to check and improve the quality of the geometric distortion correction. We have estimated that WAC distortion corrected images (OSIRIS level 3) have accuracy in the position of about 1-1.5 pixels. The accuracy in the position for the NAC images is 0.1 pixels and maximum error in the FOV is 0.5 pixels.

The amplitude of the geometric distortion is about 15 pixels for the NAC and 80 pixels for the WAC in a corner of the OSIRIS level 2 images. For both cameras, we determined the coefficients of the polynomial functions which allow the (X, Y) pixel coordinates in OSIRIS level 2 images to be converted into coordinates in OSIRIS level 3 images (and vice versa).

Distortion corrected OSIRIS level 3 images have the processing flag DISTORTION_CORRECTION_FLAG set to TRUE.

8.4 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

8.5 Conversion to JPEG Format

8.5.1 Level of images created

The thumbnail images are created for OSIRIS Level 1, 2, and 3, directly from the corresponding Level 1, 2, and 3 PDS images (i.e. from the IMG files).

8.5.2 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 $M - 2.5\sigma$ (translated into JPEG grey value 0) to $M + 2.5\sigma$ (translated into JPEG grey value 255). If $M - 2.5\sigma$ is smaller than zero, the image will be linearly scaled from 0 to $M + 2.5\sigma$.

8.5.3 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).

8.5.4 Resizing

Thumbnail images are resized from the original 2048 x 2048 pixels to 64 x 64 pixels with bilinear resampling. For images with original size differing from 2048 x 2048 pixels, the images are resized with the longest dimension being set to 64 pixels. (e.g., an image of 1024 x 512 pixels is resized to 64 x 32 pixels.)

8.5.5 Compression

Standard JPEG compression with quality factor 75.

8.5.6 Header

There is no header associated with the JPEG thumbnail images.

8.5.7 Detached PDS Label

In order to provide a PDS compatible delivery, every thumbnail image delivered to PSA has a detached PDS label, containing some extra information defined in [RD1].

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		Offset of the image data within the file (in records).	Image Converter

^BLADE1_PULSE_ARRAY			Pointer		Offset of the shutter blade 1 position encoder data within the file (in records). Note: This field only exists if blade 1 shutter pulse data exists in the data.	Image Converter
^BLADE2_PULSE_ARRAY			Pointer		Offset of the shutter blade 2 position encoder data within the file (in records). Note: This field only exists if blade 2 shutter pulse data exists in the data.	Image Converter
^HISTORY			Pointer		Offset of the HISTORY 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		Brief copyright notice.	Image converter
SOFTWARE_ID			String		Image converter project name.	Image converter

SOFTWARE_NAME			String		Filename of the image converter.	Image converter
SOFTWARE_VERSION_ID			String		Version of the image converter.	Image converter
SOFTWARE_RELEASE_DATE			String		Release date of the image converter.	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 mission.	Fixed
MISSION_ID			String		ID of mission.	Fixed
MISSION_NAME			String		Name of mission.	Fixed
MISSION_PHASE_NAME			String		Name of overall 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		Description of 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	um	Width of a single pixel.	Fixed
DETECTOR_PIXEL_HEIGHT			Float	um	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		ID of EDR.	Image converter

PRODUCT_TYPE			String		ID of data product: EDR for level 2 data RDR for > level 2 data	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 volume_format element identifies 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		The volume_id element provides a unique identifier for a data volume.	Fixed
VOLUME_NAME			String		The volume_name element contains the name of a data volume. In most cases the volume_name is more specific than the volume_set_name.	Fixed
VOLUME_SERIES_NAME			String		The volume_series_name element provides a 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		The volume_set_name element provides the 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		The volume_set_id element identifies a data volume or a set of volumes. Volume sets are normally considered as a single orderable entity.	Fixed
VOLUME_VERSION_ID			String		The volume_version_id element 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		The volumes element provides the 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: **0**: Raw TM **1**: Uncalibrated header + raw image data **2**: Calibrated header + raw image data **3**: Calibrated header + calibrated image data **4**: Calibrated header + geometrically corrected image data	Image converter
PROCESSING_LEVEL_DESC			String		Description of the processing level.	Image converter

DATA_QUALITY_ID			Integer		The data_quality_id element provides a numeric key which 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_quality_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		The data_quality_desc element describes the data quality which is associated with a particular data_quality_id value. The various values of data_quality_id and data_quality_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	The solar elongation angle (angle between a vector from the S/C to the sun, and 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	The north_azimuth element provides the 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	The sub_solar_latitude element provides the 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	The sub_solar_longitude element provides the 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	The phase_angle element provides a measure of the relationship between the instrument viewing position and incident illumination (such as solar light). Phase_angle is measured at the target; it is the angle between a vector to the illumination source and a vector to the instrument. If not specified, the target is assumed to be at the centre of the instrument field of view. If illumination is from behind the instrument, phase_ angle will be small. 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-form 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

9.7.3 GEOREFERENCING (IMAGE_POI)

Label	***Group***	***Namespace***	***Datatype***	***Unit***	***Description***	***Source***
POINT_OF_INTEREST		ROSETTA	String		A text description of the point of interest represented by the intercept point. Usually this would be "IMAGE CENTER".	Image Converter

INTERCEPT_POINT_LINE			Integer		The instrument line location of a point on the body surface.	Image Converter
INTERCEPT_POINT_LINE_SAMPLE			Integer		The instrument sample location of a point on the body surface.	Image Converter
COORDINATE_SYSTEM_NAME			String		The coordinate_system_name element provides the full name of the coordinate system to which the state vectors are referenced.	Image Converter
SURFACE_MODEL_FILE_NAME		ROSETTA	String		The name of the surface model file used to generate the information in the label.	Image Converter
SLANT_DISTANCE			Float	Km	The slant_distance element provides a measure of the distance from an observing position (e.g., a spacecraft) to a point on a target body.	Image Converter
INTERCEPT_POINT_COORD		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

9.8 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

9.9 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

9.10 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 image 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***	

9.11 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 bit 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 the binning configuration can modify this value. In case of binning, please use the FIRST_LINE_SAMPLE field 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 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 the binning configuration can modify this value. In case of binning, please use the FIRST_LINE field 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 the binning configuration can modify this value. In case of binning, please use the FIRST_LINE + 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

9.12 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 ground based 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 straylight correction was applied to the image. **TRUE** **FALSE**	Image Converter

OUTFIELD_STRAYLIGHT_CORRECTION_FLAG		ROSETTA	Label		Flag indicating whether out of field straylight correction was applied to the image. **TRUE** **FALSE**	Image Converter

9.13 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

9.14 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

9.15 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

9.16 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

9.17 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

9.18 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

9.19 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

9.20 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

9.21 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 position encoder Object

Embedded binary object containing the position encoder pulse data for the shutter blade #1. The data is reached using the data pointer ^BLADE1_PULSE_ARRAY. Note this object only exists in the PDS header if shutter pulse data for blade 1 has been downlinked. The BLADE1_PULSE_ARRAY object only exists in the EDR label.

Label	***Object***	***Datatype***	***Description***
NAME	BLADE1_PULSE_ARRAY	String	Short description of the object.
DESCRIPTION	BLADE1_PULSE_ARRAY	String	Description of the object.
INTERCHANGE_FORMAT	BLADE1_PULSE_ARRAY	Label	Interchange format. Always: **BINARY**
AXES	BLADE1_PULSE_ARRAY	Integer	Number of data axes. Always: **1**

AXIS_ITEMS	BLADE1_PULSE_ARRAY	Integer	Number of data elements in array.
NAME	BLADE1_PULSE_ARRAY.ELEMENT	Label	Name of single data elements. Always: **COUNT**
DATA_TYPE	BLADE1_PULSE_ARRAY.ELEMENT	Label	Datatype of shutter pulse data array. Always: **LSB_UNSIGNED_INTEGER**
BYTES	BLADE1_PULSE_ARRAY.ELEMENT	Integer	Number of bytes per pulse sample. Always: **4**

10.3 Shutter Blade 2 position encoder Object

Embedded binary object containing the position encoder pulse data for the shutter blade #2. The data is reached using the data pointer ^BLADE2_PULSE_ARRAY. Note this object only exists in the PDS header if shutter pulse data for blade 1 has been downlinked. The BLADE1_PULSE_ARRAY object only exists in the EDR label.

Label	*Object*	*Datatype*	*Description*
NAME	BLADE2_PULSE_ARRAY	String	Short description of the object.
DESCRIPTION	BLADE2_PULSE_ARRAY	String	Description of the object.
INTERCHANGE_FORMAT	BLADE2_PULSE_ARRAY	Label	Interchange format. Always: **BINARY**

AXES	BLADE2_PULSE_ARRAY	Integer	Number of data axes. Always: **1**
AXIS_ITEMS	BLADE2_PULSE_ARRAY	Integer	Number of data elements in array.
NAME	BLADE2_PULSE_ARRAY.ELEMENT	Label	Name of single data elements. Always: **COUNT**
DATA_TYPE	BLADE2_PULSE_ARRAY.ELEMENT	Label	Datatype of shutter pulse data array. Always: **LSB_UNSIGNED_INTEGER**
BYTES	BLADE2_PULSE_ARRAY.ELEMENT	Integer	Number of bytes per pulse sample. Always: **4**

10.4 The IMAGE Object

(Required object)

The image object contains the image data from the physical CCD surface (the actual image acquired during the exposure).

Label	***Object***	***Datatype***	***Description***
INTERCHANGE_FORMAT	IMAGE	Label	The interchange format of the image data. Always: **BINARY**
LINE_SAMPLES	IMAGE	Integer	Width of the image in pixels.

LINES	IMAGE	Integer	Height of the image in pixels.
BANDS	IMAGE	Integer	Number of image planes. Always: **1**
SAMPLE_TYPE	IMAGE	Label	The binary storage data type. Normally: **LSB_UNSIGNED_INTEGER** for level 1 data
SAMPLE_BITS	IMAGE	Integer	Number of bits per pixel. Normally: **16** for level 1 data
UNIT	IMAGE	String	Data unit of the image data. Level2: **DN** Level3 – N: $\mathbf{Wm^{-2}sr^{-1}nm^{-1}}$
DERIVED_MINIMUM	IMAGE	Integer/Float	Minimum data value in image.
DERIVED_MAXIMUM	IMAGE	Integer/Float	Maximum data value in image.
MEAN	IMAGE	Integer/Float	Mean data value of image data. Note: this label is present only in CODMAC level 2 images.
STANDARD_DEVIATION	IMAGE	Integer/Float	Standard deviation value of the image data. Note: this label is present only in CODMAC level 2 images.

FIRST_LINE	IMAGE	Integer	First row of subframe in OPTICAL CCD coordinates. Please note that this value is 1 indexed! Not 0 indexed.
FIRST_LINE_SAMPLE	IMAGE	Integer	First column of subframe in OPTICAL CCD coordinates. Please note that this value is 1 indexed! Not 0 indexed.
LINE_DISPLAY_DIRECTION	IMAGE	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	IMAGE	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**

10.5 The PA_IMAGE Object

(Optional object, only for CODMAC level 2)

The OSIRIS CCD has an operation mode where the CCD first clocks out 48 pixels connected to ground before actually clocking out the real image data (the pre pixels). The pre pixels can be acquired from both the A and B amplifier chains. If data was acquired from the A amplifier chain the pre pixel image data will be found in the PA_IMAGE object.

Label	***Object***	***Datatype***	***Description***
INTERCHANGE_FORMAT	IMAGE_PA	Label	The interchange format of the image data. Always: **BINARY**
LINE_SAMPLES	IMAGE_PA	Integer	Width of the image in pixels.
LINES	IMAGE_PA	Integer	Height of the image in pixels.
BANDS	IMAGE_PA	Integer	Number of image planes. Always: **1**
SAMPLE_TYPE	IMAGE_PA	Label	The binary storage data type. Normally: **LSB_UNSIGNED_INTEGER** for level 1 data
SAMPLE_BITS	IMAGE_PA	Integer	Number of bits per pixel. Normally: **16** for level 1 data
UNIT	IMAGE_PA	Label	Data unit of the image data. Level2: **DN** Level3 – N: $\mathbf{Wm^{-2}sr^{-1}nm^{-1}}$

DERIVED_MINIMUM	IMAGE_PA	Integer/Float	Minimum data value in image.
DERIVED_MAXIMUM	IMAGE_PA	Integer/Float	Maximum data value in image.
MEAN	IMAGE_PA	Integer/Float	Mean data value of image data. Note: this label is present only in CODMAC level 2 images.
STANDARD_DEVIATION	IMAGE_PA	Integer/Float	Standard deviation value of the image data. Note: this label is present only in CODMAC level 2 images.
FIRST_LINE	IMAGE_PA	Integer	First row of subframe in OPTICAL CCD coordinates. Please note that this value is 1 indexed! Not 0 indexed.
FIRST_LINE_SAMPLE	IMAGE_PA	Integer	First column of subframe in OPTICAL CCD coordinates. Please note that this value is 1 indexed! Not 0 indexed.

10.6 The PB_IMAGE Object

(Optional object, only for CODMAC level 2)

The OSIRIS CCD has an operation mode where the CCD first clocks out 48 pixels connected to ground before actually clocking out the real image data (the pre pixels). The pre pixels can be acquired from both the A and B amplifier chains. If data was acquired from the B amplifier chain the pre pixel image data will be found in the PB_IMAGE object.

Label	*Object*	*Datatype*	*Description*

INTERCHANGE_FORMAT	IMAGE_PB	Label	The interchange format of the image data Always: **BINARY**
LINE_SAMPLES	IMAGE_PB	Integer	Width of the image in pixels.
LINES	IMAGE_PB	Integer	Height of the image in pixels.
BANDS	IMAGE_PB	Integer	Number of image planes. Always: **1**
SAMPLE_TYPE	IMAGE_PB	Label	The binary storage data type. Normally: **LSB_UNSIGNED_INTEGER** for level 1 data
SAMPLE_BITS	IMAGE_PB	Integer	Number of bits per pixel. Normally: **16** for level 1 data
UNIT	IMAGE_PB	Label	Data unit of the image data. Level2: **DN** Level3 – N: **$Wm^{-2}sr^{-1}nm^{-1}$**
DERIVED_MINIMUM	IMAGE_PB	Integer/Float	Minimum data value in image.
DERIVED_MAXIMUM	IMAGE_PB	Integer/Float	Maximum data value in image.

MEAN	IMAGE_PB	Integer/Float	Mean data value of image data. Note: this label is present only in CODMAC level 2 images.
STANDARD_DEVIATION	IMAGE_PB	Integer/Float	Standard deviation value of the image data. Note: this label is present only in CODMAC level 2 images.
FIRST_LINE	IMAGE_PB	Integer	First row of subframe in OPTICAL CCD coordinates. Please note that this value is 1 indexed! Not 0 indexed.
FIRST_LINE_SAMPLE	IMAGE_PB	Integer	First column of subframe in OPTICAL CCD coordinates. Please note that this value is 1 indexed! Not 0 indexed.

10.7 The OL_IMAGE Object

(Optional object, only for CODMAC level 2)

The OSIRIS CCD has an operation mode where the CCD keeps clocking lines after the last physical CCD line has been read. This allows calibration of the charge transfer efficiency in the vertical clocking direction. If data was acquired using this mode then the image data will be found in the OL_IMAGE object.

Label	*Object*	*Datatype*	*Description*
INTERCHANGE_FORMAT	IMAGE_OL	Label	The interchange format of the image data. Always: **BINARY**
LINE_SAMPLES	IMAGE_OL	Integer	Width of the image in pixels.

LINES	IMAGE_OL	Integer	Height of the image in pixels.
BANDS	IMAGE_OL	Integer	Number of image planes. Always: **1**
SAMPLE_TYPE	IMAGE_OL	Label	The binary storage data type. Normally: **LSB_UNSIGNED_INTEGER** for level 1 data
SAMPLE_BITS	IMAGE_OL	Integer	Number of bits per pixel. Normally: **16** for level 1 data
UNIT	IMAGE_OL	String	Data unit of the image data. Level2: **DN** Level3 – N: $\mathbf{Wm^{-2}sr^{-1}nm^{-1}}$
DERIVED_MINIMUM	IMAGE_OL	Integer/Float	Minimum data value in image.
DERIVED_MAXIMUM	IMAGE_OL	Integer/Float	Maximum data value in image.
MEAN	IMAGE_OL	Integer/Float	Mean data value of image data. Note: this label is present only in CODMAC level 2 images.
STANDARD_DEVIATION	IMAGE_OL	Integer/Float	Standard deviation value of the image data. Note: this label is present only in CODMAC level 2 images.

FIRST_LINE	IMAGE_OL	Integer	First row of subframe in OPTICAL CCD coordinates. Please note that this value is 1 indexed! Not 0 indexed.
FIRST_LINE_SAMPLE	IMAGE_OL	Integer	First column of subframe in OPTICAL CCD coordinates. Please note that this value is 1 indexed! Not 0 indexed.

10.8 The SIGMA_MAP_IMAGE Object

(Required for CODMAC level 3 and higher)

The SIGMA_MAP_IMAGE is a float image with the same dimension as the image itself. Details regarding its content can be found in section 4 (Data Structure).

Label	*Object*	*Datatype*	*Description*
INTERCHANGE_FORMAT	SIGMA_MAP_IMAGE	Label	The interchange format of the image data. Always: **BINARY**
LINE_SAMPLES	SIGMA_MAP_IMAGE	Integer	Width of the image in pixels.
LINES	SIGMA_MAP_IMAGE	Integer	Height of the image in pixels.
BANDS	SIGMA_MAP_IMAGE	Integer	Number of image planes. Always: **1**
SAMPLE_TYPE	SIGMA_MAP_IMAGE	Label	The binary storage data type. Normally: **LSB_UNSIGNED_INTEGER** for level 1 data
SAMPLE_BITS	SIGMA_MAP_IMAGE	Integer	Number of bits per pixel. Normally: **16** for level 1 data
UNIT	SIGMA_MAP_IMAGE	String	Data unit of the image data. Level2: **DN** Level3 – N: $\mathbf{Wm^{-2}sr^{-1}nm^{-1}}$

DERIVED_MINIMUM	SIGMA_MAP_IMAGE	Integer/Float	Minimum data value in image.
DERIVED_MAXIMUM	SIGMA_MAP_IMAGE	Integer/Float	Maximum data value in image.
FIRST_LINE	SIGMA_MAP_IMAGE	Integer	First row of subframe in OPTICAL CCD coordinates. Please note that this value is 1 indexed! Not 0 indexed.
FIRST_LINE_SAMPLE	SIGMA_MAP_IMAGE	Integer	First column of subframe in OPTICAL CCD coordinates. Please note that this value is 1 indexed! Not 0 indexed.
LINE_DISPLAY_DIRECTION	SIGMA_MAP_IMAGE	Label	The LINE_DISPLAY_DIRECTION element is the preferred orientation of lines within an image viewing on a display device. The default is DOWN; meaning samples are viewed from top to bottom on the display. Allowed values: **DOWN**, **LEFT**, **RIGHT**, **UP**

SAMPLE_DISPLAY_DIRECTION	SIGMA_MAP_IMAGE	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; meaning samples are viewed from left to right on the display. Allowed values: **DOWN**, **LEFT**, **RIGHT**, **UP**

10.9 The QUALITY_MAP_IMAGE Object

(Required for CODMAC level 3 and higher)

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. The quality map exists for OSIRIS data level 2 and higher. Details regarding its content can be found in section 4 (Data Structure).

Label	***Object***	***Datatype***	***Description***
INTERCHANGE_FORMAT	QUALITY_MAP_IMAGE	Label	The interchange format of the image data. Always: **BINARY**
LINE_SAMPLES	QUALITY_MAP_IMAGE	Integer	Width of the image in pixels.
LINES	QUALITY_MAP_IMAGE	Integer	Height of the image in pixels.
BANDS	QUALITY_MAP_IMAGE	Integer	Number of image planes. Always: **1**

SAMPLE_TYPE	QUALITY_MAP_IMAGE	Label	The binary storage data type. Normally: **LSB_UNSIGNED_INTEGER** for level 1 data
SAMPLE_BITS	QUALITY_MAP_IMAGE	Integer	Number of bits per pixel. Normally: **16** for level 1 data
FIRST_LINE	QUALITY_MAP_IMAGE	Integer	First row of subframe in OPTICAL CCD coordinates. Please note that this value is 1 indexed! Not 0 indexed.
FIRST_LINE_SAMPLE	QUALITY_MAP_IMAGE	Integer	First column of subframe in OPTICAL CCD coordinates. Please note that this value is 1 indexed! Not 0 indexed.
LINE_DISPLAY_DIRECTION	QUALITY_MAP_IMAGE	Label	The LINE_DISPLAY_DIRECTION element is the preferred orientation of lines within an image viewing on a display device. The default is DOWN; meaning samples are viewed from top to bottom on the display. Allowed values: **DOWN**, **LEFT**, **RIGHT**, **UP**

SAMPLE_DISPLAY_DIRECTION	QUALITY_MAP_IMAGE	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; meaning samples are viewed from left to right on the display. Allowed values: **DOWN**, **LEFT**, **RIGHT**, **UP**

11 The OSIRIS labels for .FTS files

The FITS labels are created by translating the PDS labels. OSIRIS FITS labels are compatible with the FITS v3.0 specification (July 2008).

11.1 Required/Reserved FITS Keywords

These header entries are required by the FITS specification.

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

11.2 Mission Specific Keywords

Label	*PDS Equivalent*	*Datatype*	*Unit*	*Description*	*Source*
XEND	ROSETTA:X_END	Integer	Pixels	Last column (inclusive) of the hardware sub frame used to acquire the image. This value is specified in ELECTRICAL CCD coordinates.	TM
YEND	ROSETTA:Y_END	Integer	Pixels	Last row (inclusive) of the hardware sub frame used to acquire the image. This value is specified in ELECTRICAL CCD coordinates.	TM

DATE-OBS	START_TIME	Character String		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
F_TSTART	START_TIME	Character String		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
D_TEMP	DETECTOR_TEMPERATURE	Float	K	Temperature of the CCD detector in Kelvin.	TM
EXPTIME	EXPOSURE_DURATION	Float	s	This field contains the exposure time used to acquire the image.	TM
F_FID	COMMANDED_FILTER_NUMBER	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 2 at index 2).	TM
FILT	COMMANDED_FILTER_NAME	Character 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

TARGET	TARGET_NAME	Character String		Name of the observation target.	SPICE
G_TTYPE	TARGET_TYPE	Character String		Type of target. One of the following values: TEST_POINTING STAR MOON PLANET COMET ASTEROID NEBULA …	Image converter
CAMERA	INSTRUMENT_ID	Character String		ID of the instrument. Either **OSINAC** or **OSIWAC**.	TM
C_NAME	INSTRUMENT_NAME	Character String		Description of instrument.	TM/Fixed
M_PHASE	MISSION_PHASE_NAME	Character String		Name of overall mission phase.	Image Converter
F_SC1	SPACECRAFT_CLOCK_START_COUNT	Character String		Start of the exposure in raw spacecraft clock count. Format: <reset>/<high count>:<low count>	TM
F_SC2	SPACECRAFT_CLOCK_STOP_COUNT	Character String		Start of image readout in raw spacecraft clock count. Format: <reset>/<high count>:<low count>	TM

F_LEVEL	PROCESSING_LEVEL_ID	Character String		Processing level: **0**: Raw TM **1**: Uncalibrated header + raw image data **2**: Calibrated header + raw image data **3**: Calibrated header + calibrated image data **4**: Calibrated header + geometrically corrected image data	Image Converter
RS_FDSID	ROSETTA:FRONT_DOOR_STATUS_ID	Character String		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 image 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***	TM
G_RSS01	SC_SUN_POSITION_VECTOR	Float	km	X distance from the S/C to the Sun in J2000. The vector is light-time corrected.	SPICE
G_RSS02	SC_SUN_POSITION_VECTOR	Float	km	Y distance from the S/C to the Sun in J2000. The vector is light-time corrected.	SPICE

G_RSS03	SC_SUN_POSITION_VECTOR	Float	km	Z distance from the S/C to the Sun in J2000. The vector is light-time corrected.	SPICE
G_SSDIS	SPACECRAFT_SOLAR_DISTANCE	Float	km	Spacecraft distance from the Sun.	SPICE
G_SELONG	SOLAR_ELONGATION	Float	deg	The solar elongation angle (angle between a vector from the S/C to the sun, and the S/C +Z axis).	SPICE
G_RA	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
G_DEC	DECLINATION	Float	deg	The declination of the S/C +Z axis specified in J2000 with coordinate system centre in the S/C.	SPICE
G_AZIN	NORTH_AZIMUTH	Float	deg	The north_azimuth element provides the value of the angle between a line from the image centre to the 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. This angle increases in a clockwise direction.	SPICE
G_RST01	SC_TARGET_POSITION_VECTOR	Float	None or km	If solar system object this field contains the X distance 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

G_RST02	SC_TARGET_POSITION_VECTOR	Float	None or km	If solar system object this field contains the Y distance 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
G_RST03	SC_TARGET_POSITION_VECTOR	Float	None or km	If solar system object this field contains the Z distance 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
G_STV01	SC_TARGET_VELOCITY_VECTOR	Float	km/s	This velocity component is the derivative with respect to time of the SC_TARGET_POSITION_VECTOR.	SPICE
G_STV02	SC_TARGET_VELOCITY_VECTOR	Float	km/s	This velocity component is the derivative with respect to time of the SC_TARGET_POSITION_VECTOR.	SPICE
G_STV03	SC_TARGET_VELOCITY_VECTOR	Float	km/s	This velocity component is the derivative with respect to time of the SC_TARGET_POSITION_VECTOR.	SPICE

G_PHASEA	PHASE_ANGLE	Float	Deg	The phase_angle element provides a measure of the relationship between the instrument viewing position and incident illumination (such as solar light). Phase_angle is measured at the target; it is the angle between a vector to the illumination source and a vector to the instrument. If not specified, the target is assumed to be at the centre of the instrument field of view. If illumination is from behind the instrument, phase_ angle will be small.	SPICE
G_CNAME	COORDINATE_SYSTEM_NAME			Name of the coordinate system Always: “S/C-COORDS”.	Fixed
G_OVEC01	ORIGIN_OFFSET_VECTOR	Float	km	X component of the 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
G_OVEC02	ORIGIN_OFFSET_VECTOR	Float	km	Y component of the 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

G_OVEC03	ORIGIN_OFFSET_VECTOR	Float	km	Z component of the 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
G_OQUA01	ORIGIN_ROTATION_QUATERNION	Float		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
G_OQUA02	ORIGIN_ROTATION_QUATERNION	Float		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

G_OQUA03	ORIGIN_ROTATION_QUATERNION	Float		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
G_OQUA04	ORIGIN_ROTATION_QUATERNION	Float		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
G_NSYS	REFERENCE_COORD_SYSTEM_NAME	Character String		Name of the reference coordinate system. Always **EME J2000**.	Fixed

BINNING	HARDWARE_BINNING_ID	Character String		OSIRIS can bit 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

RS_AMPID	AMPLIFIER_ID	Character String		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
RS_GANID	GAIN_ID	Character String		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

RS_ADCID	ADC_ID	Character String		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
LINEDIR	LINE_DISPLAY_DIRECTION	Character String		The LINE_DISPLAY_DIRECTION element is the preferred orientation of lines within an image viewing on a display device. The default is DOWN; meaning samples are viewed from top to bottom on the display. Allowed values: **DOWN**, **LEFT**, **RIGHT**, **UP**	Image Converter

SMPLEDIR	SAMPLE_DISPLAY_DIRECTION	Character String		The SAMPLE_DISPLAY_DIRECTION element is the preferred orientation of samples within a line for viewing on a display device. The default is RIGHT; meaning samples are viewed from left to right on the display. Allowed values: **DOWN**, **LEFT**, **RIGHT**, **UP**	Image Converter

Appendix 1: Example OSIRIS header for .IMG files

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

```
PDS_VERSION_ID                  = PDS3
LABEL_REVISION_NOTE             = "RO-RIS-MPAE-ID-022 1/d"

/*  FILE CHARACTERISTICS  */

RECORD_TYPE                     = FIXED_LENGTH
RECORD_BYTES                    = 512
FILE_RECORDS                    = 73777
LABEL_RECORDS                   = 42
FILE_NAME                       = "NAC_2014-03-24T03.03.57.573Z_ID30_1251276900_F22.IMG"
PROCESSING_HISTORY_TEXT         = "Level 3 PDS file created - OsiCalliope 2017-09-12"

/*  POINTERS TO DATA OBJECTS  */

^HISTORY                        = 43
^IMAGE                          = 50
^SIGMA_MAP_IMAGE                = 32818
^QUALITY_MAP_IMAGE              = 65586

/*  SOFTWARE  */
```

```
SOFTWARE_DESC                    = "OSIRIS calibration pipeline"
SOFTWARE_LICENSE_TYPE            = "COMMERCIAL"
SOFTWARE_ID                      = "OSICALLIOPE"
SOFTWARE_NAME                    = "OsiCalliope.exe"
SOFTWARE_VERSION_ID              = "1.45.0"
SOFTWARE_RELEASE_DATE            = 2017-09-12
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             = 147.87 <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                         = 1004900
ROSETTA:PROCESSING_ID            = 0
IMAGE_OBSERVATION_TYPE           = "REGULAR"
EXPOSURE_TYPE                    = "MANUAL"
PRODUCT_ID                         = "NAC_2014-03-24T03.03.57.573Z_ID30_1251276900_F22.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                 = 2017-08-15
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                       = "RO-X-OSIRIS-1-RVM2-RENDEZVOUS_MANOEUVRE_2-V1.0"
DATA_SET_NAME                     = "ROSETTA-ORBITER RENDEZVOUS MANOEUVRE 2 OSIRIS 1 EDR data"
PROCESSING_LEVEL_ID                 = "3"
PROCESSING_LEVEL_DESC               = "Radiometrically calibrated, geometric distortion corrected data, in radiance
units"
DATA_QUALITY_ID                   = 0
DATA_QUALITY_DESC                 = "Zero is good non zero is bad"

/*   TIME IDENTIFICATION   */

PRODUCT_CREATION_TIME               = 2017-09-12T16:14:04
START_TIME                        = 2014-03-24T03:05:01.817
STOP_TIME                         = 2014-03-24T03:06:01.817
SPACECRAFT_CLOCK_START_COUNT      = "1/354251037.37600"
SPACECRAFT_CLOCK_STOP_COUNT       = "1/354251097.37600"

/*   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        = (-89886162.338 <km>, 552130005.605 <km>, 303783808.503 <km>)
SPACECRAFT_SOLAR_DISTANCE     = 636562383.100 <km>
SOLAR_ELONGATION              = 147.07052 <DEG>
RIGHT_ASCENSION               = 247.83522 <DEG>
DECLINATION                   = -13.23669 <DEG>
NORTH_AZIMUTH                 = 212.61008 <DEG>
SC_TARGET_POSITION_VECTOR     = (-1783849.158 <km>, -4394391.080 <km>, -1110194.907 <km>)
SC_TARGET_VELOCITY_VECTOR     = (285.684 <m/s>, 706.597 <m/s>, 176.490 <m/s>)
TARGET_CENTER_DISTANCE        = 4870864.76050 <km>
SPACECRAFT_ALTITUDE           = 4870863.02908 <km>
SUB_SPACECRAFT_LATITUDE       = 39.17923 <DEG>
SUB_SPACECRAFT_LONGITUDE      = 249.52615 <DEG>
SUB_SOLAR_LATITUDE            = 49.72902 <DEG>
SUB_SOLAR_LONGITUDE           = 293.50254 <DEG>
PHASE_ANGLE                   = 32.92948 <DEG>

GROUP                         = SC_COORDINATE_SYSTEM
    COORDINATE_SYSTEM_NAME    = "S/C-COORDS"
```

```
    ORIGIN_OFFSET_VECTOR      = (89888268.919 <km>, -552142942.414 <km>, -303790926.424 <km>)
    ORIGIN_ROTATION_QUATERNION = (0.28579149, -0.07125727, 0.78050808, -0.55140980)
    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_145_01_______00216.BSP", "spk\CORB_DV_145_01_______00216.BSP", "fk\ROS_V28.TF",
"ck\RATT_DV_145_01_01____00216.BC", "ik\ROS_OSIRIS_V14.TI", "fk\ROS_CHURYUMOV_V01.TF", "fk\ROS_CHURYUMOV_V01.TF",
"pck\ROS_CGS_RSOC_V03.TPC", "ck\CATT_DV_145_01_______00216.BC")

/*   DATA CONTENT FLAGS   */

GROUP                         = SR_DATA_CONTENT
    ROSETTA:PREPIXEL_FLAG     = TRUE
    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                 = "22"
    FILTER_NAME                   = "FFP-Vis_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    = QUEUE1
EXPOSURE_DURATION          = 60.0000 <s>
ROSETTA:COMMANDED_FILTER_NUMBER = 22
ROSETTA:COMMANDED_FILTER_NAME = "FFP-Vis_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 = FALSE
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            = -48
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 = 1
    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)
    ROSETTA:SEGMENT_X          = (0, 512, 1024, 1536, 0, 512, 1024, 1536, 0, 512, 1024, 1536, 0, 512, 1024, 1536)
    ROSETTA:SEGMENT_Y          = (0, 0, 0, 0, 512, 512, 512, 512, 1024, 1024, 1024, 1024, 1536, 1536, 1536, 1536)
    ROSETTA:SEGMENT_W          = (512, 512, 512, 512, 512, 512, 512, 512, 512, 512, 512, 512, 512, 512, 512, 512)
    ROSETTA:SEGMENT_H          = (512, 512, 512, 512, 512, 512, 512, 512, 512, 512, 512, 512, 512, 512, 512, 512)
    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)
    ROSETTA:COMPRESSION_RATIO = (  2.6,   2.6,   2.6,   2.6,   2.6,   2.5,   2.6,   2.6,   2.6,   2.6,   2.5,   2.5,
2.6,   2.6,   2.5,   2.6)
    ROSETTA:LOSSLESS_FLAG      = (TRUE, TRUE, TRUE, TRUE, TRUE, TRUE, TRUE, TRUE, TRUE, TRUE, TRUE, TRUE, TRUE, TRUE,
TRUE, TRUE)
    ROSETTA:SPIHT_PYRAMID_LEVELS = (8, 8, 8, 8, 8, 8, 8, 8, 8, 8, 8, 8, 8, 8, 8, 8)
    ROSETTA:SPIHT_THRESHOLD_BITS = (12, 14, 14, 14, 14, 14, 15, 15, 14, 14, 14, 14, 14, 14, 14, 15)
    ROSETTA:SPIHT_MEAN         = (236, 238, 238, 236, 241, 240, 238, 236, 241, 239, 243, 237, 240, 238, 238, 237)
    ROSETTA:SPIHT_MEAN_SHIFT   = (0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0)
    ROSETTA:SPIHT_WAVE_LEVELS = (4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4)
    PIXEL_AVERAGING_WIDTH      = (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)
    ROSETTA:SMOOTH_FILTER_ID   = (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)
    ROSETTA:SQRT_GAIN          = ( 0.0,  0.0,  0.0,  0.0,  0.0,  0.0,  0.0,  0.0,  0.0,  0.0,  0.0,  0.0,  0.0,  0.0,
0.0,  0.0)
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 = 1.498 <W>
    ROSETTA:NAC_RED_FDM_POWER = 0.000 <W>
    ROSETTA:NAC_MAIN_PPE_POWER = 4.495 <W>
    ROSETTA:NAC_RED_PPE_POWER = 0.000 <W>
    ROSETTA:WAC_MAIN_STR1_POWER = 2.466 <W>
    ROSETTA:WAC_RED_STR1_POWER = 0.000 <W>
    ROSETTA:WAC_MAIN_STR2_POWER = 2.566 <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 = OFF
    ROSETTA:WAC_CCDANNEALHEATER_FLAG = OFF
    ROSETTA:WAC_CRB_PRIMEPOWER_FLAG = OFF
    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 = MAIN
END_GROUP                     = SR_SWITCH_STATUS

/*   POWER SYSTEM STATUS   */

GROUP                         = SR_POWER_STATUS
    ROSETTA:V_28_MAIN         = 28.4 <V>
    ROSETTA:V_28_REDUNDANT    = 3.3 <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       = 25.0 <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       = -5.2 <V>
```

```
    ROSETTA:I_28_MAIN          = 1430.2 <mA>
    ROSETTA:I_28_REDUNDANT     = -94.4 <mA>
    ROSETTA:I_5                = 1827.5 <mA>
    ROSETTA:I_3                = 129.7 <mA>
    ROSETTA:I_15               = 110.3 <mA>
    ROSETTA:I_M15              = 50.4 <mA>
    ROSETTA:CAMERA_I_24        = 17.8 <mA>
    ROSETTA:CAMERA_I_8         = 11.6 <mA>
    ROSETTA:CAMERA_I_M12       = 61.2 <mA>
    ROSETTA:CAMERA_I_5_ANALOG = 93.2 <mA>
    ROSETTA:CAMERA_I_5_DIGITAL = 123.7 <mA>
    ROSETTA:CAMERA_I_M5        = 65.0 <mA>
END_GROUP                      = SR_POWER_STATUS

/*   CALIBRATED TEMPERATURES   */

GROUP                          = SR_TEMPERATURE_STATUS
    ROSETTA:T_MAIN_PCM         = 288.4 <K>
    ROSETTA:T_REDUNDANT_PCM    = 284.0 <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 = 285.0 <K>
    ROSETTA:T_WAC_STRUCTURE_REDUNDANT_2 = 285.5 <K>
    ROSETTA:T_WAC3             = 288.0 <K>
    ROSETTA:T_WAC4             = 286.8 <K>
```

```
ROSETTA:T_WAC_WHEEL_MOTOR_1 = 281.4 <K>
ROSETTA:T_WAC_WHEEL_MOTOR_2 = 281.4 <K>
ROSETTA:T_WAC_DOOR_MOTOR  = 282.7 <K>
ROSETTA:T_NAC_CCD_VIA_MCB = 205.7 <K>
ROSETTA:T_WAC_CCD_VIA_MCB = 170.9 <K>
ROSETTA:T_NAC_WHEEL_MOTOR_1 = 253.7 <K>
ROSETTA:T_NAC_WHEEL_MOTOR_2 = 254.8 <K>
ROSETTA:T_NAC_DOOR_MOTOR  = 253.0 <K>
ROSETTA:T_NAC_DOOR_IF_MAIN = 248.2 <K>
ROSETTA:T_NAC_MIRROR_2    = 224.0 <K>
ROSETTA:T_NAC_PPE_IF_REDUNDANT = 255.5 <K>
ROSETTA:T_NAC_DOOR_IF_REDUNDANT = 248.2 <K>
ROSETTA:T_NAC_PPE_IF_MAIN = 255.5 <K>
ROSETTA:T_NAC_MIRROR_1_AND_3 = 223.3 <K>
ROSETTA:T_DSP_MAIN        = 290.6 <K>
ROSETTA:T_DSP_REDUNDANT   = 283.5 <K>
ROSETTA:T_BOARD_CONTROLLER = 288.5 <K>
ROSETTA:T_BOARD_DRIVER    = 286.8 <K>
ROSETTA:CAMERA_TCCD       = 147.9 <K>
ROSETTA:CAMERA_T_SENSORHEAD = 264.3 <K>
ROSETTA:CAMERA_T_ADC_1    = 275.2 <K>
ROSETTA:CAMERA_T_ADC_2    = 275.0 <K>
ROSETTA:CAMERA_T_SHUTTER_MOTOR_1 = 255.7 <K>
ROSETTA:CAMERA_T_SHUTTER_MOTOR_2 = 255.3 <K>
ROSETTA:CAMERA_T_POWER_CONVERTER = 297.5 <K>
```

```
    ROSETTA:CAMERA_T_DOSIMETER = 271.2 <K>
END_GROUP                     = SR_TEMPERATURE_STATUS

/*   RADIATION ENVIRONMENT   */

GROUP                         = SR_RADIATION_STATUS
    ROSETTA:CAMERA_DOSIS      = 455.9 <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                 = -4.86166e-09
    DERIVED_MAXIMUM                 = 7.72989e-06
    MEAN                            = 1.40941e-09
```

```
    STANDARD_DEVIATION              = 2.95907e-08
    FIRST_LINE                      = 1
    FIRST_LINE_SAMPLE               = 1
    LINE_DISPLAY_DIRECTION          = DOWN
    SAMPLE_DISPLAY_DIRECTION        = LEFT
END_OBJECT                      = IMAGE

OBJECT                          = SIGMA_MAP_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                 = 0
    DERIVED_MAXIMUM                 = 3.4301e-06
    MEAN                            = 7.04978e-08
    STANDARD_DEVIATION              = 2.59127e-08
    FIRST_LINE                      = 1
    FIRST_LINE_SAMPLE               = 1
    LINE_DISPLAY_DIRECTION          = DOWN
    SAMPLE_DISPLAY_DIRECTION        = LEFT
END_OBJECT                      = SIGMA_MAP_IMAGE
```

```
OBJECT                              = QUALITY_MAP_IMAGE
    INTERCHANGE_FORMAT                  = BINARY
    LINE_SAMPLES                        = 2048
    LINES                               = 2048
    BANDS                               = 1
    SAMPLE_TYPE                         = LSB_UNSIGNED_INTEGER
    SAMPLE_BITS                         = 8
    FIRST_LINE                          = 1
    FIRST_LINE_SAMPLE                   = 1
    LINE_DISPLAY_DIRECTION              = DOWN
    SAMPLE_DISPLAY_DIRECTION            = LEFT
END_OBJECT                          = QUALITY_MAP_IMAGE
END
```

Appendix 2: Example OSIRIS .IMG History Object

The HISTORY object consists of groups. OSIRIS Level 1 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       = "1.54.0"
    VERSION_DATE              = 2017-08-15
    DATE_TIME                 = 2017-08-15T12:49:30.000Z
    GROUP                     = PARAMETERS
        FILENAME              =
    "NAC_2014-03-24T03.03.57.573Z_ID10_1251276900_F22.IMG"
    END_GROUP                 = PARAMETERS
END_GROUP                     = LEVEL_1_GENERATION
GROUP                           = OSICALLIOPE
    SOFTWARE_DESC                   = "OSIRIS calibration pipeline"
    SOFTWARE_VERSION_ID             = "1.45.0"
    DATA_VERSION_ID                 = "OSICALLIOPE_V04.TXT"
    PRODUCER_FULL_NAME              = "G. KOVACS"
    USER_NAME                       = "Carsten Guettler"
    DATE_TIME                       = "2017-09-12T16:14:03"
    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         = (24, 0.00 <%>)
    ADC_OFFSET_VALUES             = (36 <DN>, 36 <DN>)
    BIAS_FILE                     = "NAC_FM_BIAS_V01.TXT"
    BIAS_BASE_VALUES              = (234.960 <DN>, 234.960 <DN>)
    BIAS_TEMP                     = (275.2 <K>, 275.0 <K>)
    BIAS_TEMP_DELTA               = (-6.265 <DN>, -6.265 <DN>)
    FLAT_HI_FILE                  = "NAC_FM_FLATHI_00_V01.IMG"
    BAD_PIXEL_FILE                = "NAC_FM_BAD_PIXEL_V01.TXT"
    FLAT_LO_FILE                  = "NAC_FM_FLAT_22_V01.IMG"
    EXPOSURE_CORRECTION_TYPE      = "NORMAL_PULSES"
    EXPOSURE_CORRECTION_FILE      = "PULSE_DATA"
    NUM_OF_EXPOSURES              = 1
    MEAN_EFFECTIVE_EXPOSURETIME   = 59.9973 <s>
```

```
            ABSCAL_FILE                    = "NAC_FM_ABSCAL_V01.TXT"
            ABSCAL_FACTOR                  = 1.21235e+08 <(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
    END_GROUP                        = PARAMETERS
END_GROUP                        = OSICALLIOPE
END_OBJECT                       = HISTORY
```

Appendix 3: Example OSIRIS header for .FTS 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= '2014-03-24T03:05:01.817'
F_TSTART= '2014-03-24T03:05:01.817'
D_TEMP  =               147.87
EXPTIME =                   60
F_FID   =                   22
FILT    = 'FFP-Vis_Orange'
TARGET  = '67P/CHURYUMOV-GERASIMENKO (1969 R1)'
G_TTYPE = 'COMET'
CAMERA  = 'OSINAC            '
C_NAME  = 'OSIRIS - NARROW ANGLE CAMERA'
M_PHASE = ''
F_SC1   = '1/354251037.37600'
F_SC2   = '1/354251097.37600'
F_LEVEL = '1'
RS_FDSID= 'OPEN'
```

```
G_RSS01 =        -89886162.34 / [SC_SUN_POSITION_VECTOR]
G_RSS02 =         552130005.6 / [SC_SUN_POSITION_VECTOR]
G_RSS03 =         303783808.5 / [SC_SUN_POSITION_VECTOR]
G_SSDIS =         636562383.1 / [SPACECRAFT_SOLAR_DISTANCE]
G_SELONG=           147.07052 / [SOLAR_ELONGATION]
G_RA    =           247.83522 / [RIGHT_ASCENSION]
G_DEC   =           -13.23669 / [DECLINATION]
G_AZIN  =           327.38992 / [NORTH_AZIMUTH]
G_RST01 =        -1783849.158 / [SC_TARGET_POSITION_VECTOR]
G_RST02 =         -4394391.08 / [SC_TARGET_POSITION_VECTOR]
G_RST03 =        -1110194.907 / [SC_TARGET_POSITION_VECTOR]
G_STV01 =             285.684 / [SC_TARGET_VELOCITY_VECTOR]
G_STV02 =             706.597 / [SC_TARGET_VELOCITY_VECTOR]
G_STV03 =              176.49 / [SC_TARGET_VELOCITY_VECTOR]
G_PHASEA=            32.92948 / [PHASE_ANGLE]
G_CNAME = 'S/C-COORDS'
G_OVEC01=         89888268.92 / [ORIGIN_OFFSET_VECTOR]
G_OVEC02=        -552142942.4 / [ORIGIN_OFFSET_VECTOR]
G_OVEC03=        -303790926.4 / [ORIGIN_OFFSET_VECTOR]
G_OQUA01=          0.28579149 / [ORIGIN_ROTATION_QUATERNION]
G_OQUA02=         -0.07125727 / [ORIGIN_ROTATION_QUATERNION]
G_OQUA03=          0.78050808 / [ORIGIN_ROTATION_QUATERNION]
G_OQUA04=          -0.5514098 / [ORIGIN_ROTATION_QUATERNION]
G_NSYS  = 'EME J2000'
BINNING = '1x1'
RS_AMPID= 'B'
RS_GANID= 'HIGH'
```

```
RS_ADCID= 'TANDEM'
LINEDIR = 'DOWN'
SMPLEDIR= 'LEFT'
END
```