Juno

Software Interface Specification
JunoCam Global Map Image (GMI)
Standard Data Product

M. Caplinger
Malin Space Science Systems, Inc.

Approved by:

_____
Candy Hansen, JunoCam Team Leader

_____
Leslie Lipkaman, MSSS JunoCam Archiving Lead

_____
Dave Gell, JSOC Manager

_____
William Kurth, Juno Archivist

_____
Sue Lavoie, PDS Imaging Node

Version 1.1, November 2017
(formatted November 8, 2017)

Juno

Software Interface Specification
Junocam Global/Regional Map Image
Standard Data Product

M. Caplinger
Malin Space Science Systems, Inc.

Approved by:

Candy Hansen, Junocam Team Leader

Leslie Lipkaman, MSSS Juno Archiving Lead

Dave Gell, JSOC Manager

William Kurth, Juno Archivist

Sue Lavoie, PDS Imaging Node

November 2013
(formatted November 14, 2013)

Change Log

DATE	SECTIONS CHANGED	DESCRIPTION OF CHANGES	REVISION
11/14/13	Initial Release, Version 1.0		
11/08/17	Signature Page, Change Log, Acronyms and Abbreviations, 1.3, 1.4.4, 2.2, 4.1, 4.2, 4.3, 4.4.2, 5.0, 6.0	Signature Page: added Change Log: added Acronyms and Abbreviations: added 1.3: updated references 1.4.4: section removed from V1.0, section numbers shifted 2.2: section removed from V1.0, section numbers shifted 4.1: section completely changed from V1.0, now Data Processing Levels 4.2: section completely changed from V1.0, now File Naming Convention 4.3: section completely changed from V1.0, now Structure and Organization 4.4.2: section removed from V1.0 5.0: new section added, PDS Archive Volume 6.0: new section added, Appendices A and B	1.1

Contents

Acronyms and Abbreviations

CCD	Charged Coupled Device
CFDP	CSSDS File Delivery Protocol
CODMAC	Committee on Data Management and Computation
CSSDS	Consultative Committee for Space Data Systems
DSN	Deep Space Network
EDR	Experiment Data Record
EFB	Earth Flyby
GMI	Global Map Image
ICD	Interface Control Document
ID	Identification
IOT	Instrument Operations Team
JNC	JunoCam
JPL	Jet Propulsion Laboratory
JSOC	Juno Science Operations Center
LIN	Linear inverse
MOF	Mission Operations Facility
N/A	Not applicable
NASA	National Aeronautics and Space Administration
PDS	Planetary Data System
RDR	Reduced Data Record
SFDU	Standard Format Data Unit
SIS	Software Interface Specification
SPICE	Spacecraft, Planet, Instrument, C-matrix Events kernels
SQROOT	Square root
TBD	To be determined
UNK	Unknown

1. Introduction

1.1. Purpose

This document describes the format of the JunoCam Global Map Image (GMI) Standard Data Product.

1.2. Scope

The format and content specifications in this Software Interface Specification (SIS) apply to all phases of the project for which this product is available.

1.3. Applicable Documents

This SIS is consistent with the following Planetary Data System (PDS) documents:

1. Planetary Data System Standards Reference, Version 3.8, JPL D-7669, Part 2, February 27, 2009.
2. Planetary Science Data Dictionary Document, JPL D-7116, Rev. F, October 20, 2008.

Additionally, this SIS makes reference to the following documents for technical and background information:

3. JUNO Science Operations Center (JSOC) JSOC-IOT Interface Control Document, 12029.02-JSOC_IOT_ICD-01, Rev 4 Chg 0, October 2013.
4. Software Interface Specification JunoCam Standard Data Products, M. Caplinger, Version 1.3, August 31, 2016.
5. Juno Project Mission Plan, Revision B, JPL D-35556, 29 March 2011.

1.4. Functional Description

1.4.1. Data Content Summary

The JunoCam Global Map Image product is a mosaic of one or more individual JunoCam images. Nominally, one such global product will be produced for each Juno science orbit, covering the north and south polar regions at the intrinsic resolution of JunoCam.

1.4.2. Source and Transfer Method

JunoCam products are produced by the makepds program from the format internally used at the JunoCam Mission Operations Facility (MOF). This program reads a JunoCam image file, extracts some information from its headers, formats and attaches the PDS labels, and appends the image data.

It is expected that there will be two ways to receive JunoCam products: by electronic file transfer from the JunoCam web site (and after archiving, from the Planetary Data System), and (potentially) on some archival medium such as CD-ROM or DVD.

1.4.3. Recipients and Utilization

These products will be available to JunoCam team members, the Juno science community, the planetary science community, and any other interested parties. In general, there is no proprietary period for JunoCam data.

These products will be used for engineering support, direct science analysis, and/or the construction of other science products.

1.5. Assumptions and Constraints

This file consists of calibrated, resampled, and mosaicked image data. These products will be created using the reconstructed position and attitude information available when the product is produced. Updated versions of this product, constructed with better ancillary data, software, or processing will be produced by the JunoCam team on a best-effort basis. The PRODUCT_VERSION_ID keyword will be updated accordingly.

2. Environment

2.1. Hardware Characteristics and Limitations

2.1.1. Special Equipment and Device Interfaces

Interfaces to access either CD-ROM volumes or electronic file transfer are described elsewhere; for example, see the PDS Standards Reference [Ref 1].

2.1.2. Special Setup Requirements

No special setup requirements are needed.

2.2. Failure Protection, Detection, and Recovery

Raw instrument telemetry will be archived in the PDS. Depacketized compressed image data will be archived at the JunoCam MOF, as will the GMI files and any needed ancillary data and intermediate products.

2.3. End-of-File Conventions

End-of-file labeling shall comply with SFDU standards; specifically, fixed-size records are used, the header explicitly contains the record offset of each sub-element of the dataset, and the size of each sub-element can be computed from information in the header.

3. Access

3.1. Access Tools

Existing PDS image display programs can display these files.

3.2. Input/Output Protocols
None identified.

3.3. Timing and Sequencing Characteristics
None.

4. Data Product Overview

4.1. Data Processing Levels
This documentation recognizes both the National Aeronautics and Space Administration (NASA) data processing scheme and the "Committee on Data Management and Computation" (CODMAC) data level numbering system. The JunoCam Global Map products are "NASA Level 1B" (CODMAC – Resampled – Level 4). The following table presents a breakdown of the CODMAC and NASA data processing levels.

NASA	CODMAC	Description
Packet data	Raw - Level 1	Telemetry data stream as received at the ground station, with science and engineering data embedded.
Level 0	Edited - Level 2	Instrument science data (e.g., raw voltages, counts) at full resolution, time ordered, with duplicates and transmission errors removed.
Level 1A	Calibrated - Level 3	Level 0 data that have been located in space and may have been transformed (e.g., calibrated, rearranged) in a reversible manner and packaged with needed ancillary and auxiliary data (e.g., radiances with the calibration equations applied).
Level 1B	Resampled - Level 4	Irreversibly transformed (e.g., resampled, remapped, calibrated) values of the instrument measurements (e.g., radiances, magnetic field strength).
Level 1C	Derived - Level 5	Level 1A or 1B data that have been resampled and mapped onto uniform space-time grids. The data are calibrated (i.e., radiometrically corrected) and may have additional corrections applied (e.g., terrain correction).
Level 2	Derived - Level 5	Geophysical parameters, generally derived from Level 1 data, and located in space and time commensurate with instrument location, pointing, and sampling.
Level 3	Derived - Level 5	Geophysical parameters mapped onto uniform space-time grids.

JunoCam's DATA_SET_IDs for Global Map products contain references to both the CODMAC and NASA data processing levels. See Appendix A for more information.

4.2. File Naming Convention
Each product will have a file name of the form "<id>.IMG", where the ID is not to exceed 36 characters. The ID will start with an alphabetic character and will consist of only alphanumeric characters. Each file name will be unique across all JunoCam data product files.

File names will be of the form:

JNCR_YYYYDDD_OOQNNNNN_VXX.ZZZ

JNC: JunoCam
R: RDR product type
YYYY: year at the start of image acquisition
DDD: day-of-year at the start of image acquisition
OO: orbit number
Q: map-projected product (P for color map (any combination of the R, G, or B filters), H for methane map)
NNNNN: image index within that mission phase
V: version
XX: version number starting with "01"
ZZZ: file extension (can be IMG, LBL)

4.3. Structure and Organization

All JunoCam images must be a multiple of 16 pixels in both width and height. Images are broken up into sub-images (also called fragments), and each fragment is transmitted separately. Raw and predictively compressed images are reconstructed by concatenating all of their image fragments and then processing; transform compressed images are processed a fragment at a time.

A JunoCam data product consists of one image with decompression applied. For each image file, a header (or label in PDS terminology) identifies various properties of the image and contains a file offset to the data portion of the image.

The GMI product consists of two JunoCam images, one from the north pole and one from the south pole, merged into a single, map-projected image in standard PDS uncompressed image format. In addition, each image product has two parts: the data product itself with the extension of “IMG” and a detached label with an extension of “LBL”.

The detached label (LBL) file adheres to the standards described in the PDS Standards Reference, Version 3.8, and conforms to the PDS3 format. The only accepted value for PDS_VERSION_ID in the GMI label file is “PDS3”.

The following is a sample LBL for a JunoCam GMI color product:

```
PDS_VERSION_ID                  = PDS3

/* FILE CHARACTERISTICS */

FILE_NAME                       = "JNCR_2016240_01P00000_V01.IMG"
RECORD_TYPE                     = FIXED_LENGTH
RECORD_BYTES                    = 5760
FILE_RECORDS                    = 2880
```

```
^IMAGE                          = "JNCR_2016240_01P00000_V01.IMG"

/* IDENTIFICATION DATA ELEMENTS */

SPACECRAFT_NAME                 = JUNO
MISSION_PHASE_NAME              = "SCIENCE ORBITS"
TARGET_NAME                     = JUPITER
INSTRUMENT_ID                   = "JNC"
INSTRUMENT_HOST_NAME            = "JUNO"
INSTRUMENT_NAME                 = "JUNO EPO CAMERA"
PRODUCER_ID                     = JUNO_JUNOCAM_TEAM
DATA_SET_ID                     = "JUNO-J-JUNOCAM-4-RDR-L1B-V1.0"
STANDARD_DATA_PRODUCT_ID        = "JUNOCAM-RDR"
PROCESSING_LEVEL_ID             = "4"
PRODUCT_CREATION_TIME           = 2018-05-16T16:57:49
START_TIME                      = 2016-08-27T11:59:11.588
STOP_TIME                       = 2016-08-27T13:56:23.796
SPACECRAFT_CLOCK_START_COUNT    = "525571327:208"
SPACECRAFT_CLOCK_STOP_COUNT     = "N/A"
PRODUCT_VERSION_ID              = "01"
PRODUCT_ID                      = "JNCR_2016240_01P00000_V01"
SOURCE_PRODUCT_ID               = ("JNCE_2016240_01C06162_V01",
                                   "JNCE_2016240_01C06186_V02")
FILTER_NAME                     = ('BLUE', 'GREEN', 'RED')
RATIONALE_DESC                  = "PJ01 Global Map product"

/* MAP PROJECTION INFORMATION */

OBJECT                          = IMAGE_MAP_PROJECTION
  ^DATA_SET_MAP_PROJECTION      = "DSMAP.CAT"
  COORDINATE_SYSTEM_TYPE        = "BODY-FIXED ROTATING"
  COORDINATE_SYSTEM_NAME        = "PLANETOGRAPHIC"
  MAP_PROJECTION_ROTATION       = "N/A"
  MAP_PROJECTION_TYPE           = "SIMPLE CYLINDRICAL"
  MAP_RESOLUTION                = 16 <pixel/degree>
  MAP_SCALE                     = 3.750 <km/pixel>
  MAXIMUM_LATITUDE              = 90.0
  MINIMUM_LATITUDE              = -90.0
  EASTERNMOST_LONGITUDE         = 180.0
  WESTERNMOST_LONGITUDE         = 180.0
  LINE_PROJECTION_OFFSET        = 1440.0
  SAMPLE_PROJECTION_OFFSET      = 2880.0
  A_AXIS_RADIUS                 = 71492.0 <km>
  B_AXIS_RADIUS                 = 71492.0 <km>
  C_AXIS_RADIUS                 = 66854.0 <km>
  FIRST_STANDARD_PARALLEL       = "N/A"
  SECOND_STANDARD_PARALLEL      = "N/A"
  POSITIVE_LONGITUDE_DIRECTION  = WEST
  CENTER_LATITUDE               = 0.0
  CENTER_LONGITUDE              = 0.0
  REFERENCE_LATITUDE            = "N/A"
```

```
  REFERENCE_LONGITUDE           = "N/A"
  LINE_FIRST_PIXEL              = 1
  SAMPLE_FIRST_PIXEL            = 1
  LINE_LAST_PIXEL               = 5760
  SAMPLE_LAST_PIXEL             = 2880
END_OBJECT                      = IMAGE_MAP_PROJECTION

/* IMAGE DATA ELEMENTS */

OBJECT                          = IMAGE
  LINES                         = 2880
  LINE_SAMPLES                  = 5760
  SAMPLE_TYPE                   = UNSIGNED_INTEGER
  SAMPLE_BITS                   = 8
  BANDS                         = 3
  BAND_STORAGE_TYPE             = BAND_SEQUENTIAL
  SAMPLE_BIT_MASK               = 16#ff#
  MD5_CHECKSUM                  = "debfac8586175d48f58273ec69d3b32b"
END_OBJECT                      = IMAGE

END
```

4.4. Substructure Definition and Format

For JunoCam label file (.LBL) keyword definitions and valid values, see Appendix A.

4.4.1. Header/Trailer Description Details

See above. No trailers are present.

4.5. Data Volume, Size, and Frequency Estimates

Nominally, RGB and Methane global maps at 1/16 degree per pixel will be produced for each mapping orbit from the north and south polar imaging. Each per-orbit total is therefore about 215 megabytes (MB).

5. PDS Archive Volume

5.1. Archive Structure

Every archive delivery contains data for a set period of time. These data are archived in the GLOBAL_MAPS directory. As there will only be one color map and one Methane map per orbit, no sub-directories are necessary.

In addition, there are several static directories and files that will also be delivered with each volume. The structure of these directories and corresponding files can be found in Appendix B.

6. Appendices

Appendix A – JunoCam Keywords, Definitions, and Valid Values & Entries

Keyword	Group	Definition	Valid Values
PDS_VERSION_ID		The PDS_version_id data element represents the version number of the PDS standards documents that is valid when a data product label is created. Values for the PDS_version_id are formed by appending the integer for the latest version number to the letters 'PDS'. Examples: PDS3, PDS4.	PDS3, N/A, NULL, UNK
	FILE CHARACTERISTICS		
FILE_NAME		The file_name element provides the location independent name of a file. It excludes node or volume location, directory path names, and version specification. For JunoCam products, extension is .IMG.	string (see section 4.2 of this document), N/A, NULL, UNK
RECORD_TYPE		The record_type element indicates the record format of a file. Note: In the PDS, when record_type is used in a detached label file it always describes its corresponding detached data file, not the label file itself. For JunoCam products, nearly always FIXED_LENGTH.	FIXED_LENGTH, N/A, NULL, UNK

RECORD_BYTES		The record_bytes element indicates the number of bytes in a physical file record, including record terminators and separators.	integer, 0 to n, N/A, NULL, UNK
FILE_RECORDS		The file_records element indicates the number of physical file records, including both label records and data records. The last record will be padded with zeros if necessary.	integer, 0 to n, N/A, NULL, UNK
^IMAGE		Pointer to the starting record of an image product. For JunoCam products, nearly always identical to FILE_NAME with the extension .IMG.	string (see section 4.2 of this document), N/A, NULL, UNK
	INDENTIFICATION DATA ELEMENTS		
SPACECRAFT_NAME		The spacecraft_name element provides the full, unabbreviated name of a spacecraft.	JUNO, N/A, NULL, UNK
MISSION_PHASE_NAME		The mission_phase_name element provides the commonly used identifier of a mission phase.	SCIENCE ORBITS, DEORBIT, N/A, NULL, UNK
TARGET_NAME		The target_name element identifies a target. The target may be a planet, satellite, ring, region, feature, asteroid or comet.	JUPITER, N/A, NULL, UNK
INSTRUMENT_ID		The instrument_id element provides an abbreviated name or acronym, which identifies an instrument.	JNC, N/A, NULL, UNK
INSTRUMENT_HOST_NAME		The instrument_host_name element provides the full name of the host on which an instrument is based.	JUNO, N/A, NULL, UNK
INSTRUMENT_NAME		The instrument_name element provides the full name of an instrument.	JUNO EPO CAMERA, N/A, NULL, UNK

PRODUCER_ID		The producer_id element provides a short name or acronym for the producer or producing team/group of a dataset.	JUNO_JUNOCAM_TEAM, N/A, NULL, UNK
DATA_SET_ID		The data_set_id element is a unique alphanumeric identifier for a data set or a data product. The data_set_id value for a given data set or product is constructed according to flight project naming conventions. In most cases the data_set_id is an abbreviation of the data_set_name. Note: In the PDS, the values for both data_set_id and data_set_name are constructed according to standards outlined in the Standards Reference.	JUNO-J-JUNOCAM-4-RDR-L1B_V1.0, N/A, NULL, UNK
STANDARD_DATA_PRODUCT_ID		The STANDARD_DATA_PRODUCT_ID element is used to link a data product (file) to a standard data product (collection of similar files) described within software interface specification document for a particular data set.	JUNOCAM-RDR, N/A, NULL, UNK
PROCESSING_LEVEL_ID		The processing_level_id element identifies the processing level of a set of data according to the eight-level CODMAC standard. For JunoCam Global Map images, it will typically be 4.	4, N/A, NULL, UNK
PRODUCT_CREATION_TIME		The product_creation_time element defines the UTC system format time when a product was created.	YYYY-MM-DDThh:mm:ss, N/A, NULL, UNK

START_TIME		The start_time element provides the date and time of the beginning of an event or observation (whether it be a spacecraft, ground-based, or system event) in UTC. This time will be the start time of the first frame of a JunoCam image.	YYYY-MM-DDThh:mm:ss.fff, N/A, NULL, UNK
STOP_TIME		The stop_time element provides the date and time of the end of an observation or event (whether it be a spacecraft, ground-based, or system event) in UTC. This time will be the start time of the last frame of a JunoCam image.	YYYY-MM-DDThh:mm:ss.fff, N/A, NULL, UNK
SPACECRAFT_CLOCK_START_COUNT		The spacecraft_clock_start_count element provides the value of the spacecraft clock at the actual start of image acquisition. There may be small inconsistencies with START_TIME due to varying correlation between UTC and the spacecraft clock. For purposes of data analysis the spacecraft clock value should be used. The format of this field is compatible with the NAIF Toolkit software where s = seconds converted from the clock's coarse counter and m = seconds converted from the clock's fine counter (up to three decimals).	sssssssss:m[m][m], N/A, NULL, UNK

SPACECRAFT_CLOCK_STOP_COUNT		The spacecraft_clock_stop_count element provides the value of the spacecraft clock at the end of a time period of interest. For JunoCam, this value is not applicable because the timing of a JunoCam image, once started, is independent of the spacecraft clock.	N/A, NULL, UNK
PRODUCT_VERSION_ID		The first_product_id data element indicates the product_id that appears in the label of the first data product on an archive medium.	string, N/A, NULL, UNK
PRODUCT_ID		The product_id data element represents a permanent, unique identifier assigned to a data product by its producer. No extension is included.	string (see section 4.2 of this document), N/A, NULL, UNK
SOURCE_PRODUCT_ID		The source_product_id data element identifies a product, or products, used as input to create a new product.	string array (see section 4.2 of this document), N/A, NULL, UNK
FILTER_NAME		The filter_name element provides the commonly-used name of the instrument filter through which an image or measurement was acquired or which is associated with a given instrument mode. This is a string array up to four values in length with nominal values of RED, GREEN, BLUE, and/or METHANE.	string array, N/A, NULL, UNK

RATIONALE_DESC		The rationale_desc element describes the rationale for performing a particular observation. For some specific images, this string will contain a description of the image as actually received; for routine mapping operations, it will more likely be the goal of the image as targeted (which may not be met if the image missed its target significantly, image parameters were set inappropriately, etc.)	string, N/A, NULL, UNK
	MAP PROJECTION INFORMATION		
^DATA_SET_MAP_PROJECTION		Pointer to the Data Set Map Projection CATALOG file located in the CATALOG directory	DSMAP.CAT, N/A, NULL, UNK
COORDINATE_SYSTEM_TYPE		There are three basic types of coordinate systems: body-fixed rotating, body-fixed non-rotating and inertial. A body-fixed coordinate system is one associated with a body (e.g., planetary body or satellite). In contrast to inertial coordinate systems, a body-fixed coordinate system is centered on the body and rotates with the body (unless it is a non-rotating type).	BODY-FIXED ROTATING, N/A, NULL, UNK

COORDINATE_SYSTEM_NAME		The coordinate_system_name element provides the full name of the coordinate system to which the state vectors are referenced. PDS has currently defined body-fixed rotating coordinate systems. The Planetographic system has an origin at the center of mass of the body.	PLANETOGRAPHIC, N/A, NULL, UNK
MAP_PROJECTION_ROTATION		The map_projection_rotation element provides the clockwise rotation, in degrees, of the line and sample coordinates with respect to the map projection origin.	N/A, NULL, UNK
MAP_PROJECTION_TYPE		The map_projection_type element identifies the type of projection characteristic of a given map.	SIMPLE CYLINDRICAL, N/A, NULL, UNK
MAP_RESOLUTION		The map_resolution element identifies the scale of a given map in pixel/degrees.	integer, 0 to n, N/A, NULL, UNK
MAP_SCALE		The map_scale element identifies the scale of a given map. The scale is defined as the ratio of the actual distance between two points on the surface of the target body to the distance between the corresponding points on the map; reported in km/pixel.	float, N/A, NULL, UNK
MAXIMUM_LATITUDE		The maximum_latitude element specifies the northernmost latitude of a spatial area, such as a map, mosaic, bin, feature, or region.	float, N/A, NULL, UNK

MINIMUM_LATITUDE		The minimum_latitude element specifies the southernmost latitude of a spatial area, such as a map, mosaic, bin, feature, or region	float, N/A, NULL, UNK
EASTERNMOST_LONGITUDE		The easternmost (rightmost) longitude of a spatial area (e.g.,a map, mosaic, bin, feature or region) is the maximum numerical value of longitude unless it crosses the Prime Meridian.	float, N/A, NULL, UNK
WESTERNMOST_LONGITUDE		For Planetographic coordinates in which longitude increases toward the west (prograde rotator), the westernmost (leftmost) longitude of a spatial area (e.g., a map, mosaic, bin, feature or region) is the maximum numerical value of longitude unless it crosses the Prime Meridian.	float, N/A, NULL, UNK
LINE_PROJECTION_OFFSET		The line_projection_offset element provides the line offset value of the map projection origin position from the line and sample 1,1 (line and sample 1,1 is considered the upper left corner of the digital array). Note: that the positive direction is to the right and down.	float, N/A, NULL, UNK
SAMPLE_PROJECTION_OFFSET		The sample_projection_offset element provides the sample offset value of the map projection origin position from line and sample 1,1 (line and sample 1,1 is considered the upper left corner of the digital array). Note: that the positive direction is to the right and down.	float, N/A, NULL, UNK

A_AXIS_RADIUS		The a_axis_radius element provides the value of the semimajor axis of the ellipsoid that defines the approximate shape of a target body. 'A' is usually in the equatorial plane. For JunoCam, the units are km.	float, N/A, NULL, UNK
B_AXIS_RADIUS		The b_axis_radius element provides the value of the intermediate axis of the ellipsoid that defines the approximate shape of a target body. 'B' is usually in the equatorial plane. For JunoCam, the units are km.	float, N/A, NULL, UNK
C_AXIS_RADIUS		The c_axis_radius element provides the value of the semiminor axis of the ellipsoid that defines the approximate shape of a target body. 'C' is normal to the plane defined by 'A' and 'B'. For JunoCam, the units are km.	float, N/A, NULL, UNK
FIRST_STANDARD_PARALLEL		The first_standard_parallel element is used in Conic projections. If a Conic projection has a single standard parallel, then the first_standard_parallel is the point of tangency between the sphere of the planet and the cone of the projection.	N/A, NULL, UNK
SECOND_STARDARD_PARALLEL		If there are two standard parallels (first_standard_parallel, second_standard_parallel), these parallel are the intersection lines between the sphere of the planet and the cone of the projection. The map_scale is defined at the standard parallels.	N/A, NULL, UNK

POSITIVE_LONGITUDE_DIRECTION		The positive_longitude_direction element identifies the direction of longitude (e.g. EAST, WEST) for a planet. The IAU definition for direction of positive longitude is adopted. Typically, for planets with prograde rotations, positive longitude direction is to the WEST.	WEST, N/A, NULL, UNK
CENTER_LATITUDE		The center_latitude element provides a reference latitude for certain map projections.	float, N/A, NULL, UNK
CENTER_LONGITUDE		The center_longitude element provides a reference longitude for certain map projections.	float, N/A, NULL, UNK
REFERENCE_LATITUDE		The reference_latitude element provides the new zero latitude in a rotated spherical coordinate system that was used in a given map_projection_type.	N/A, NULL, UNK
REFERENCE_LONGITUDE		The reference_longitude element defines the zero longitude in a rotated spherical coordinate system that was used in a given map_projection_type.	N/A, NULL, UNK
LINE_FIRST_PIXEL		The line_first_pixel element provides the line index for the first pixel that was physically recorded at the beginning of the image array.	integer, 1 to n, N/A, NULL, UNK
SAMPLE_FIRST_PIXEL		The sample_first_pixel element provides the sample index for the first pixel that was physically recorded at the beginning of the image array.	integer, 1 to n, N/A, NULL, UNK

LINE_LAST_PIXEL		The line_last_pixel element provides the line index for the last pixel that was physically recorded at the end of the image array.	integer, 1 to n, N/A, NULL, UNK
SAMPLE_LAST_PIXEL		The sample_last_pixel element provides the sample index for the last pixel that was physically recorded at the end of the image array.	integer, 1 to n, N/A, NULL, UNK
	IMAGE DATA ELEMENTS		
LINES		The lines element indicates the total number of data instances along the vertical axis of an image, or, the number of lines in the decompressed image.	integer, 1 to n, N/A, NULL, UNK
LINE_SAMPLES		The line_samples element indicates the total number of data instances along the horizontal axis of an image, or, the number of samples per line in the decompressed image.	integer, 1 to n, N/A, NULL, UNK
SAMPLE_TYPE		The sample_type element indicates the data storage representation of sample value. For JunoCam, nearly always UNSIGNED_INTEGER.	UNSIGNED_INTEGER, N/A, NULL, UNK

SAMPLE_BITS		The sample_bits element indicates the stored number of bits, or units of binary information, contained in a line_sample value; for the JunoCam EDR product, always 8, and for the JunoCam RDR product, always 16. Additionally, for the RDR product, the pixel value is normalized such that a value of 10000 would be produced for a white Lambertian target with an incidence angle of 0 at a solar distance of the target at the time of imaging.	8, 16, N/A, NULL, UNK
BANDS		The BANDS element indicates the number of bands in an image or other object.	integer, 1 to n, N/A, NULL, UNK
BAND_STORAGE_TYPE		The band_storage_type element indicates the storage sequence of lines, samples and bands in an image. The values describe, for example, how different samples are interleaved in image lines, or how samples from different bands are arranged sequentially.	BAND_SEQUENTIAL, N/A, NULL, UNK
SAMPLE_BIT_MASK		The sample_bit_mask element identifies the active bits in a sample.	16#ff#, 16#ffff#, N/A, NULL, UNK
MD5_CHECKSUM		The MD5 algorithm takes as input a file (message) of arbitrary length and produces as output a 128-bit 'fingerprint' or 'message digest' of the input. This field will be used for data validation.	string, N/A, NULL, UNK

Appendix B – Archive Volume Structure

The following is the PDS directory structure for the JunoCam archive volume.

```
| -- AAREADME.TXT
| -- CATALOG
     | -- CATINFO.TXT
     | -- DSMAP.CAT
     | -- JNC_EDR_IMG_DS.CAT
     | -- JNC_GLOBAL_MAP_DS.CAT
     | -- JNC_INST.CAT
     | -- JNC_PERSON.CAT
     | -- JNC_RDR_IMG_DS.CAT
     | -- JNC_REF.CAT
     | -- JUNO_INSTHOST.CAT
     | -- JUNO_MISSION.CAT
     | -- JUNO_REF.CAT
| -- DATA
     | -- EDR
          | -- CRUISE
          | -- EFB
          | -- JUPITER
               | -- ORBIT_##
     | -- RDR
          | -- CRUISE
          | -- EFB
          | -- JUPITER
               | -- ORBIT_##
     | -- GLOBAL_MAPS
| -- DOCUMENT
     | -- DOCINFO.TXT
     | -- JUNO_JNC_EDR_RDR_DPSIS.HTM
     | -- JUNO_JNC_EDR_RDR_DPSIS.LBL
     | -- JUNO_JNC_EDR_RDR_DPSIS.PDF
     | -- JUNO_JNC_GLOBAL_MAP_SIS.HTM
     | -- JUNO_JNC_GLOBAL_MAP_SIS.LBL
     | -- JUNO_JNC_GLOBAL_MAP_SIS.PDF
| -- ERRATA.TXT
| -- INDEX*
| -- VOLDESC.CAT
```

* Directory and subsequent files will be provided by JSOC.