Juno
Jovian Auroral Distributions Experiment

For Flight Software Version 3 only
(2011-2014)

JADE Standard Product Data Record and Archive Volume Software Interface Specification

Version 01
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Prepared by

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Juno
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JADE Standard Product
Data Record and Archive Volume
Software Interface Specification

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1 Introduction

This software interface specification (SIS) describes the format and content of the Jovian Auroral Distributions Experiment (JADE) Planetary Data System (PDS) data archive. It includes descriptions of the Standard Data Products and associated metadata, and the volume archive format, content, and generation pipeline.

1.1 Distribution list

Table 1: Distribution list

Name	Organization	Email
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1.2 Document change log

Table 2: Document change log

Change	Date	Affected portion
Initial template	01/15/2010	All
First draft for JADE	04/15/2013	All
Second draft for JADE	08/30/2013	All
Level 3 SIS parts added	06/30/2014	DPID changed to DPID_COUNT Removed Bill Knopf, Michael New and Tom Morgan from the signature list (email 20th Nov '13) Version 02 Level 2 data: Change is an extra object (SCLKSCET_VERSION), and a bug in JAD_HRS_ION_TOF has been fixed from V01. Only V02 now provided to PDS.
Review Liens addressed. Level 3 SIS parts removed.	06/30/2015	All
Updates in response to comments on addressed liens	05/11/2016	Section 3.1.8 added. JADE_SIS.LBL/PDF/etc. renamed JAD_FSW3_SIS.LBL/etc. Mention of MANIFEST.TXT and CHECKSUM.TXT removed. Description of DATA_LOG_SUMS adjusted in section 6.2.6.4.5.

1.3 TBD items

Table 3 lists items that are not yet finalized.

Table 3: List of TBD items

Item	Sections	Pages(s)

1.4 Abbreviations

Table 4: Abbreviations and their meaning

Abbreviation	Meaning
ASCII	American Standard Code for Information Interchange
BLOB	Binary Large OBject, i.e. a data blob is a large array of binary data
BRT	JADE Burst mode
CAL	JADE Calibration mode
CATS	version CATS (Cassini Archive Tracking System)
CCSDS	Consultative Committee for Space Data Systems
CD-ROM	Compact Disc – Read-Only Memory
CDR	Calibrated Data Record
CFDP	CCSDS File Delivery Protocol
CHAR	Bytes representing a character string
CK	C-matrix Kernel (NAIF orientation data)
CODMAC	Committee on Data Management, Archiving, and Computing
CRC	Cyclic Redundancy Check
DAP	Data Analysis Product
DAT	PDS binary file
DDR	Derived Data Record
DER	JADE Direct Events (Raw) mode
DES	JADE Direct Events (Split-out) mode
DOUBLE	An 8-byte (double-precision) real floating point value
DMAS	Data Management and Storage
DSN	Deep Space Network
DVD	Digital Versatile Disc
DVD-R	DVD – Recordable media
E&PO	Educational and Public Outreach
EDA	End of data acquisition
EDR	Experiment Data Record
EFB	Earth Fly By
SPDR	Standard Product (Experiment and Pipeline) Data Record
FEI	File Exchange Interface
FLOAT	A 4-byte (single-precision) real floating point value
FMT	PDS Format file
FOV	Field of View
FSW	Flight Software
FTP	File Transfer Protocol
GB	Gigabyte(s)
GCR	Galactic Cosmic Ray
GSFC	Goddard Space Flight Center
HK	Housekeeping

HRS	JADE High Rate Science mode
HSK	JADE Housekeeping mode
HTML	Hypertext Markup Language
HV	High Voltage
HVENG	High Voltage ENGineering
HVCO	High Voltage Check Out
ICD	Interface Control Document
INT8	8-bit (1-byte) Signed Integer
INT16	16-bit (2-bytes) Signed Integer
INT32	32-bit (4-bytes) Signed Integer
IOT	Instrument Operations Team
ISO	International Standards Organization
JADE	Jovian Auroral Distributions Experiment
JEDI	Jupiter Energetic Particle Detector Instrument
JIRAM	Jupiter InfraRed Auroral Mapper
JOI	Jupiter Orbit Insertion
JPL	Jet Propulsion Laboratory
JSC	Johnson Spaceflight Center
JSOC	Juno Science Operations Center
LASP	Laboratory for Atmospheric and Space Physics, University of Colorado
LBL	PDS label file
LET	Lineal Energy Transport
LRS	JADE Low Rate Science mode
LUT	Look-Up Table(s)
MAG	Magnetometer Instrument
MB	Megabyte(s)
MCP	Micro Channel Plate
MOS	Mission Operations System
MWR	Microwave Radiometer Instrument
NAIF	Navigation and Ancillary Information Facility (JPL)
NASA	National Aeronautics and Space Administration
NSSDC	National Space Science Data Center
ODL	Object Description Language
PCK	Planetary Cartographic and Physical Constants Kernel (NAIF)
PDS	Planetary Data System
PPI	Planetary Plasma Interactions Node (PDS)
RDR	Reduced Data Record
RSSG	Radio Science System Group
SCET	Spacecraft Event Time
SCLK	Spacecraft Clock
SIS	Software Interface Specification
SOC	Science Operations Center

SPE	Solar Particle Event
SPICE	Spacecraft, Planet, Instrument, C-matrix, and Events (NAIF data format)
SPWG	Science Planning Working Group
SPK	SPICE (ephemeris) Kernel (NAIF)
SSH	Secure Shell
SwRI	Southwest Research Institute
TAR	Tape ARchives (file format)
TBC	To Be Confirmed
TBD	To Be Determined
TEP	Tissue Equivalent Plastic
UINT8	8-bit (1-byte) Unsigned Integer
UINT16	16-bit (2-bytes) Unsigned Integer
UINT32	32-bit (4-bytes) Unsigned Integer
UCLA	University of California, Los Angeles
UVS	Ultraviolet Spectrometer Instrument
V-EGA	Venus-Earth Gravity Assist

1.5 Glossary

Archive – An archive consists of one or more data sets along with all the documentation and ancillary information needed to understand and use the data. An archive is a logical construct independent of the medium on which it is stored.

Archive Volume – A volume is a logical organization of directories and files in which data products are stored. An *archive volume* is a volume containing all or part of an archive; i.e. data products plus documentation and ancillary files.

Archive Volume Set – When an archive spans multiple volumes, they are called an *archive volume set*. Usually the documentation and some ancillary files are repeated on each volume of the set, so that a single volume can be used alone.

Catalog Information – High-level descriptive information about a data set (e.g. mission description, spacecraft description, instrument description), expressed in Object Description Language (ODL), which is suitable for loading into a PDS catalog.

CODMAC Levels – Descriptive data labels to inform you of the amount of processing from the original raw data product (as defined by the Committee on Data Management, Archiving, and Computing). These are different to NASA levels. Note that JADE data does not require CODMAC level 4 files; the PDS will ultimately contains JADE Level 2, 3 and 5 data. See Table 5 for the different level definitions.

Data Product – A labeled grouping of data resulting from a scientific observation, usually stored in one file. A product label identifies, describes, and defines the structure of the data. An example of a data product is a planetary image, a spectral table, or a time series table.

Data Set – A data set is an accumulation of data products together with supporting documentation and ancillary files.

Experiment Data Record – An accumulation of raw output data from a science instrument, in chronological order, with duplicate records removed, together with supporting documentation and ancillary files.

Pipeline Data Record – An accumulation of calibrated data from a science instrument, derived from experiment data records, together with supporting documentation, calibration data, and ancillary files.

Standard Data Product – A data product generated in a predefined way using well-understood procedures and processed in “pipeline” fashion. Data products that are generated in a non-standard way are sometimes called *special data products*.

Table 5: CODMAC Levels of Data Descriptions and Meaning to JADE

CODMAC Level	Description	Meaning for JADE	Stored JSOC / PDS	NASA Level
1 (Raw)	Telemetry data stream as received at the ground station, with science and engineering data embedded.	Packet Data (Highly Compressed)	No	Packet Data
2 (Edited)	Instrument science data (e.g., raw voltages, counts) at full resolution, time ordered, with duplicates and transmission errors removed.	Unpacked Data (Engineering Units.)	Yes	0
3 (Calibrated)	Level 2 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-data (e.g., radiances with the calibration equations applied).	Unpacked Data (Scientific Units.)	Yes	1-A
4 (Resampled)	Irreversibly transformed (e.g., resampled, remapped, calibrated) values of the instrument measurements (e.g., radiances, magnetic field strength).	Not used for JADE (Better for images than plasma data)	N/A	1-B
5 (Derived)	Level 3 or 4 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).	e.g. Plasma Parameters, Pitch Angle Distributions [TBD]	Yes	1-C
	Geophysical parameters, generally derived from Level 3 or 4 data, and located in space and time commensurate with instrument location, pointing, and sampling.			2
	Geophysical parameters mapped onto uniform Space-time grids.			3
	Any product that also requires data from another instruments for its derivation. (i.e. electron pitch angle derivation requires both level 3 MAG and level 3 electron data.)			2

Table inspired by Appendix F of the Planetary Data System Archive Preparations Guide (APG), Version 1.4 (April 1, 2010) found at http://pds.jpl.nasa.gov/documents/apg/apg.pdf.
However they compared CODMAC Levels to NASA Levels and had a description based on NASA levels, which this author has altered in the table above to refer to CODMAC levels. This author also added the final level 5 line about products requiring additional data from other instruments.

1.6 Juno Mission Overview

Juno launched on the first day of it's launch window, 5 August 2011. The spacecraft uses a ΔV-EGA trajectory consisting of deep space maneuvers on 08 August 2012 and 14 September 2012 followed by an Earth gravity assist on 9 October 2013. Jupiter arrival is on 5 July 2016 using a 107-day capture orbit prior to commencing operations for a 1-(Earth) year long prime mission comprising 32 high inclination, high eccentricity orbits of Jupiter. The orbit is polar (90° inclination) with a periapsis altitude of 4500 km and a semi-major axis of 19.91 R_J (1 R_J is one Jovian radius, ~ 71492 km) giving an orbital period of 10.9725 days. The primary science is acquired for approximately 6 hours centered on each periapsis although fields and particles data are acquired at low rates for the remaining apoapsis portion of each orbit. Currently, 5 of the first 7 periapses are dedicated to microwave radiometry of Jupiter's deep atmosphere with the remaining orbits dedicated to gravity measurements to determine the structure of Jupiter's interior. All orbits will include fields and particles measurements of the planet's auroral regions. Juno is spin stabilized with a rotation rate of 1 – 3 revolutions per minute (RPM). For the radiometry orbits the spin axis is precisely perpendicular to the orbit plane so that the radiometer fields of view pass through the nadir. For gravity passes, the spin axis is aligned to the Earth direction, allowing for Doppler measurements through the periapsis portion of the orbit. The orbit plane is initially very close to perpendicular to the Sun-Jupiter line and evolves over the 1-year mission. Data acquired during the periapsis passes are recorded and played back over the subsequent apoapsis portion of the orbit.

Juno's instrument complement includes Gravity Science using the X and Ka bands to determine the structure of Jupiter's interior; vector fluxgate magnetometer (MAG) to study the magnetic dynamo and interior of Jupiter as well as to explore the polar magnetosphere; and a microwave radiometer (MWR) experiment covering 6 wavelengths between 1.3 and 50 cm to perform deep atmospheric sounding and composition measurements. The instrument complement also includes a suite of fields and particle instruments to study the polar magnetosphere and Jupiter's aurora. This suite includes an energetic particle detector (JEDI), a Jovian auroral (plasma) distributions experiment (JADE), a radio and plasma wave instrument (Waves), an ultraviolet spectrometer (UVS), and a Jupiter infrared auroral mapping instrument (JIRAM). The JunoCam is a camera included for education and public outreach. While this is not a science instrument, we plan to capture the data and archive them in the PDS along with the other mission data. Appendix A includes Lead Co-Is and archivists for each instrument, along with the associated PDS Discipline Node.

1.7 SIS Content Overview

Section 2 describes the JADE instrument. Section 3 describes the data sets, data flow, and validation. Section 4 describes the structure of the archive volumes and contents of each file. Section 5 describes the file formats used in the archive volumes.

Individuals responsible for generating the archive volumes are listed in Appendix A. PDS-compliant label files for all JADE standard data products are itemized and described in Appendix B, while the data products file headers and data record formats are itemized and described in section 6, Appendix C respectively.

1.8 Scope of this document

The specifications in this SIS apply to all JADE Standard Data Record products submitted for archive to the Planetary Data System (PDS), for all phases of the Juno mission. Some sections of this document describe parts of the JADE archive and archiving process that are managed by the PDS archive team. These sections have been provided for completeness of information and are not maintained by the JADE team.

While this document was originally intended for all data throughout the Juno mission, it was decided in 2014 to change the JADE flight software. This meant that the majority of data products also changed. As such this SIS and PDS data volume will only be about flight software version 3 data that was used from launch and updated in 2015, however the last data is from 2014-026. During this time only operational work on JADE was done; 8 days in 2011, 1 day in 2012 and 9 days in 2014. These were for commissioning purposes only (and only contain solar wind data, no Earth fly-by nor Jupiter data) and never intended for science use, as such there will only ever be level 2 data and no calibrated level 3 data. In April 2015 flight software version 4 was uploaded, and a different PDS volume will be used for that science data from 2015 onwards – please use that one for Juno JADE science data at Jupiter.

At time of writing, Juno was going to have ~11 day orbits, however that recently has changed to ~14 days orbits. All calculations herein still use the ~11 day orbit values, however are of little use as this flight software version 3 (commissioning) dataset ends in 2014, 18 months before Jupiter arrival and the orbits start. Please see the JADE flight software 4 PDS volume and SIS for 14-day orbit calculations.

1.9 Applicable Documents

ISO 9660-1988, Information Processing—Volume and File Structure of CD-ROM for Information Exchange, 04/15/1988.

Planetary Data System Archive Preparation Guide, Version 1.1, JPL D-31224, 08/29/2006.

Planetary Data System Standards Reference, JPL D-7669, Part 2, Version 3.8, 02/27/2009.

Planetary Science Data Dictionary Document, Planetary Data System, JPL D-7116, Version 1r65, 02/2007.

Juno Mission Operations Concept Document, JPL D-35531, Version Preliminary, 04/30/2007.
Juno Science Data Management and Archive Plan, Version Final, JPL D-34032, 08/26/2009.

The JADE Instrument Paper (also see section 2):

McComas, D.J. and Alexander, N. and Allegrini, F. and Bagenal, F. and Beebe, C. and Clark, G. and Crary, F. and Desai, M.I. and De Los Santos, A. and Demkee, D. and Dickinson, J. and Everett, D. and Finley, T. and Gribanova, A. and Hill, R. and Johnson, J. and Kofoed, C. and Loeffler, C. and Louarn, P. and Maple, M. and Mills, W. and Pollock, C. and Reno, M. and Rodriguez, B. and Rouzaud, J. and Santos-Costa, D. and Valek, P. and Weidner, S. and Wilson, P. and Wilson, R.J. and White, D. (2013), The Jovian Auroral Distributions Experiment (JADE) on the Juno Mission to Jupiter, *Space Science Reviews*. doi: 10.1007/s11214-013-9990-9

1.10 Audience

This document is useful to those wishing to understand the format and content of the JADE PDS data product archive collection. Typically, these individuals would include scientists, data analysts, or software engineers.

2 JADE Instrument Description

Rather than repeat information, we refer the reader to the **Open Access** instrument paper in Space Science Reviews for a full description of the JADE instrument. Below we provide the DOI link to the paper, reference and the abstract that gives an overview of the instrument.

DOI:
10.1007/s11214-013-9990-9

Reference:
McComas, D.J. and Alexander, N. and Allegrini, F. and Bagenal, F. and Beebe, C. and Clark, G. and Crary, F. and Desai, M.I. and De Los Santos, A. and Demkee, D. and Dickinson, J. and Everett, D. and Finley, T. and Gribanova, A. and Hill, R. and Johnson, J. and Kofoed, C. and Loeffler, C. and Louarn, P. and Maple, M. and Mills, W. and Pollock, C. and Reno, M. and Rodriguez, B. and Rouzaud, J. and Santos-Costa, D. and Valek, P. and Weidner, S. and Wilson, P. and Wilson, R.J. and White, D. (2013), The Jovian Auroral Distributions Experiment (JADE) on the Juno Mission to Jupiter, *Space Science Reviews*. doi: 10.1007/s11214-013-9990-9

Abstract:
"The Jovian Auroral Distributions Experiment (JADE) on Juno provides the critical in situ measurements of electrons and ions needed to understand the plasma energy particles and processes that fill the Jovian magnetosphere and ultimately produce its strong aurora. JADE is an instrument suite that includes three essentially identical electron sensors (JADE-Es), a single ion sensor (JADE-I), and a highly capable Electronics Box (EBox) that resides in the Juno Radiation Vault and provides all necessary control, low and high voltages, and computing support for the four sensors. The three JADE-Es are arrayed 120° apart around the Juno spacecraft to measure complete electron distributions from ~0.1 to 100 keV and provide detailed electron pitch-angle distributions at a 1 s cadence, independent of spacecraft spin phase. JADE-I measures ions from ~5 eV to ~50 keV over an instantaneous field of view of 270° x 90° in 4 s and makes observations over all directions in space each 30 s rotation of the Juno spacecraft. JADE-I also provides ion composition measurements from 1 to 50 amu with $m/\Delta m$ ~2.5, which is sufficient to separate the heavy and light ions, as well as O^+ vs. S^+, in the Jovian magnetosphere. All four sensors were extensively tested and calibrated in specialized facilities, ensuring excellent on-orbit observations at Jupiter. This paper documents the JADE design, construction, calibration, and planned science operations, data processing, and data products. Finally, the Appendix describes the Southwest Research Institute [SwRI] electron calibration facility, which was developed and used for all JADE-E calibrations. Collectively, JADE provides remarkably broad and detailed measurements of the Jovian auroral region and magnetospheric plasmas, which will surely revolutionize our understanding of these important and complex regions."

3 Data Set Overview

3.1 Data Sets

The JADE data archive is divided into 3 data sets. Each data set is subdivided in to different standard data product types. A basic description of each data set is provided in Table 6. The standard data product types are described in Table 7. A more detailed description of each data set is provided in the sections that follow these two tables.

The standard data product IDs for Level 2 data are a series of *four* three-letter codes (instrument, telemetry mode, sensor and data type, respectively) separated by an underscore, of the form:

JAD_***aaa*_*bbb*_*ccc***

These are all 15 characters long, safely below the PDS maximum of 20 characters.
The products filenames then append that with a date and version number, of the form:

JAD_***aaa*_*bbb*_*ccc*_*yyyyddd***_V**nn**.DAT
JAD_***aaa*_*bbb*_*ccc*_*yyyyddd***_V**nn**.LBL
JAD_***aaa*_*bbb*_*ccc***_V**nn**.FMT

Where:

JAD Instrument, short for JADE
aaa Telemetry mode type:
BRT, CAL, HRS, HSK or LRS – see following sections.
bbb Sensor type: ALL, ELC or ION
ELC = electron sensor(s)
ION = ion sensor
ALL = both ion and electron sensors
ccc Data type:
060 = just sensor E060
180 = just sensor E180
300 = just sensor E300
ALL = all three electron sensors
DER / DES = ion Direct Events raw / split-out
LOG = ion Logical counters
SPA = all ion species
SP***M*** = ion species number ***M***, where ***M*** is 0 to 7:
SP0, SP1, SP2, SP3, SP4, SP5, SP6 or SP7
TOF = ion Time-Of-Flight
yyyy 4-digit year
ddd 3-digit day of year
nn 2-digit version number of file

Table 6: Relationship Between Data Sets and Standard Data Products

Data Set ID	CODMAC Level	Standard Data Product ID	ID
JNO-SW-JAD-2-UNCALIBRATED-V1.0 Uncalibrated science data	2	JAD_BRT_ELC_ALL JAD_BRT_ION_LOG JAD_BRT_ION_SP***M*** JAD_BRT_ION_TOF JAD_CAL_ELC_060 JAD_CAL_ELC_180 JAD_CAL_ELC_300 JAD_CAL_ION_DER JAD_CAL_ION_DES JAD_CAL_ION_LOG JAD_CAL_ION_SP***M*** JAD_CAL_ION_TOF JAD_HRS_ELC_ALL JAD_HRS_ION_DER JAD_HRS_ION_DES JAD_HRS_ION_LOG JAD_HRS_ION_SP***M*** JAD_HRS_ION_TOF JAD_HSK_ELC_ALL JAD_HSK_ION_DER JAD_HSK_ION_DES JAD_HSK_ION_LOG JAD_HSK_ION_SPA JAD_HSK_ION_TOF JAD_LRS_ELC_060 JAD_LRS_ELC_180 JAD_LRS_ELC_300 JAD_LRS_ION_DER JAD_LRS_ION_DES JAD_LRS_ION_LOG JAD_LRS_ION_SP***M*** JAD_LRS_ION_TOF There are 8 ion species for BRT, CAL, HRS and LRS: JAD_***_ION_SP***M***. Only one of each type is listed for clarity, where ***M*** can be **0**, **1**, **2**, **3**, **4**, **5**, **6** or **7**.	P0

Table 7: Standard Data Product Contents

ID	Key/Physical Parameters	Processing Inputs	Product Format	Description
P0	Reformatted Engineering Data Record (REDR). Time ordered (duplicates removed) full resolution science data (counts at voltage levels). Time ordered counts (per accumulation or per second) vs. voltage level vs. direction.	JADE raw telemetry packets	Binary	Packets are uncompressed, bitmaps expanded to single objects, extra objects added to describe FSW and LUT versions, data units and a UTC timestamp.

The following sub-sections describe the different modes of JADE, but are best summarized in the periodic table inspired Figure 5.

3.1.1 Burst (BRT) Data Set

This is the highest data rate mode, but only occurs for a total of ~23 minutes per orbit.

The data has a minimum value removed (the MIN_SUBTRACTED_VALUE object), then is compressed from 2-byte values to 1-byte values, then losslessly compressed for transmission.

There are no Direct Events product (time is too short) and just one electron product that contains all three electron sensors.

3.1.2 MCP Calibration (CAL) Data Set

This is not intended for science use, but for the JADE instrument team to perform calibration tests. It occurs for a total of ~2 hours per orbit.

The data has a minimum value removed (the MIN_SUBTRACTED_VALUE object), then is compressed from 4-byte values to 1-byte values, then losslessly compressed for transmission.

The Direct Events products are the exception in not being compressed in any way.

3.1.3 High Rate Science (HRS) Data Set

This is the second highest data rate mode, occurring for a total of ~12 hours per orbit.

The data has a minimum value removed (the MIN_SUBTRACTED_VALUE object), then is compressed from 2-byte values to 1-byte values, then losslessly compressed for transmission. The exception is the JAD_HRS_ION_LOG which has two data products that are compressed, the one has a 4-byte to 1-byte compression, the other a 2-byte to 1-byte compression.

The Direct Events products are the exception in not being compressed in any way.

There is just one electron product that contains all three electron sensors separately but within the same record.

3.1.4 High Voltage Engineering Science (HSK) Data Set

This is not intended for science use, but for the JADE instrument team to perform tests, occurring for a total of ~1 hour per orbit.

The data is collected as total counts without any compression at all (and does not remove a minimum subtracted value).

There is just one electron product that contains all three electron sensors, and just one ion species product that contains all eight ion species.

3.1.5 Low Rate Science (LRS) Data Set

This is the most common mode and the lowest data rate, occurring for a total of ~249 hours per orbit. For about ~44 hours of that is an 'intermediate mode', still low rate, but a shorter accumulation time per record than for the other ~205 hours.

The data has a minimum value removed (the MIN_SUBTRACTED_VALUE object), then is compressed from 4-byte values to 1-byte values, then losslessly compressed for transmission.

The Direct Events products are the exception in not being compressed in any way.

3.1.6 Data units for Level 2 Products

The base data unit (for products with PACKETID >10) is total counts for that record (as such are integer numbers), with the exception of JAD_CAL_ION_SP*M*_*, JAD_LRS_ION_SP*M*_* and JAD_LRS_ELC_***_* products. These are in units of count rates as these are data products related to spin phase and the spin-period may vary slightly. The count rates are total counts divided by number of views within the accumulation time, to the nearest 1/512 of a count (represented as a float).

The number of views is simply the number of times an anode has been included in the record's accumulation time; for instance if two anodes are summed together for a product, then that's two views. If the accumulation is over many spacecraft spin periods and the product is one regarding spin-phase, then every spin the number of views increases for a particular spin-phase angle. The record normalized total counts measured by total number of views, however that is rarely equivalent to units of counts per second.

To be certain you know which units, all products have had an object added to their PDS record, DATA_UNITS, which is either 0 or 1 for total count or rate respectively.

3.1.7 DATA_TOTAL vs. DATA objects for Level 2 Products

Many JADE products onboard JUNO remove a minimum value from the data prior to compression for transmission. On the ground when we decompress these data packets we add back on this value so that the end user does not have to. This is easily identified by the object name. If the object is called DATA_TOTAL then the minimum value has already been added back on (and if you care, the MIN_SUBTRACTED_VALUE object tells you what that was). If the object is called DATA_* (without TOTAL appearing in the name), then it has not, but only because a minimum value was never removed (prior to compression) in the first place. (This is found in the HSK telemetry modes.) That said, a MIN_SUBTRACT_VALUE object may exist in those files for consistency, but if so will be set to zero, and the upper and lower valid limits for that product will be fixed at zero.

3.1.8 Occasional jitter in reported times

Occasionally the reported spacecraft clock value is a second out from where you'd expect, e.g. in a series of records all with an ACCUMULATION_TIME of 30 seconds, you may get times that are consistently 30 seconds apart, then (very occasionally) have one that is 29 or 31 seconds apart from its neighbor based on the spacecraft clock (used to make UTC). This is a known Juno feature related to having two spacecraft clocks, but any correction would be a level 5 data product, and as such, not suitable for this Level 2 SIS. The two clocks on Juno are not always synchronized, and the time message from them can occasionally have a stutter/jitter where instead of advancing 2 ticks, sometimes it advances 1, then 3, then returns to the regular 2 tick pattern. JADE data records use the onboard reported time message as is, and has no in-situ way to know if the reported time is during this stutter.

3.2 Data Flow

The Juno Data Management and Storage (DMAS) will receive packets and CCSDS File Delivery Protocol (CFDP) products from the Deep Space Network (DSN) and place these on the Project data repository system. The DMAS will provide the initial processing of the raw telemetry data bringing it to Committee on Data Management and Archive (CODMAC) Level 1 science data. The JADE Instrument Operations Team (IOT) will retrieve the CODMAC Level 1 data from the DMAS using FEI services and ancillary data from the JPL Mission Support Area (MSA) via Juno Science Operations Center (JSOC). The IOT will decompress the Level 1 data and return them to the JSOC as CODMAC Level 2 data. The JSOC will also receive and organize higher-level data products developed by the Science Investigation Teams associated with each instrument. JSOC development and operations will be carried out at SwRI, in coordination with the MOS at JPL.

The JADE Science Investigation Team will verify the content and the format will be validated. The resulting decompressed, restructured Level 2 data will constitute the lowest level of data to be archived with the PDS. JSOC will coordinate the validation of the edited (CODMAC Level 2) data archive volumes created by the IOT. The Science Investigation Team will develop higher-level data products based on the Level 2 data and ancillary data and return these to the JSOC. JSOC will support archiving the Level 2 data by building archive volumes and verifying the format of the volumes and included data and metadata. Higher-level data set archives will be coordinated through the JSOC. The Science Investigation Team will be responsible for ensuring that the metadata and documentation included with these data sets are complete and accurate. This means that both JSOC and the Science Investigation Team will need to work closely with the PDS. This coordination will be fostered via the Data Archive Working Group.

A comprehensive description of the Juno Mission System is provided in the Juno Mission Operations Concept. A data flow diagram for the downlink process is shown in Fig. 1.

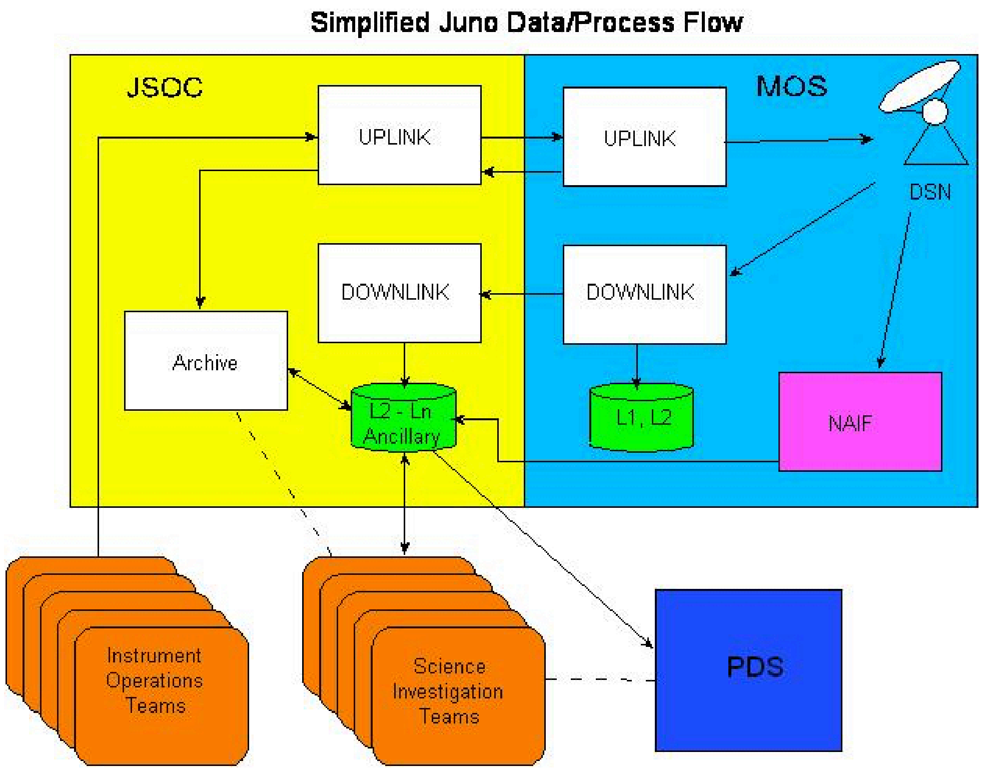


Figure 1: Juno science data flow diagram. White boxes are processes and solid arrows indicate data flow.

3.3 Data Processing and Production Pipeline

A single pipeline generates EDR records temporarily on route to generating RDR records, with the CODMAC level 2 data being the RDR records only, as shown in Figure 2.

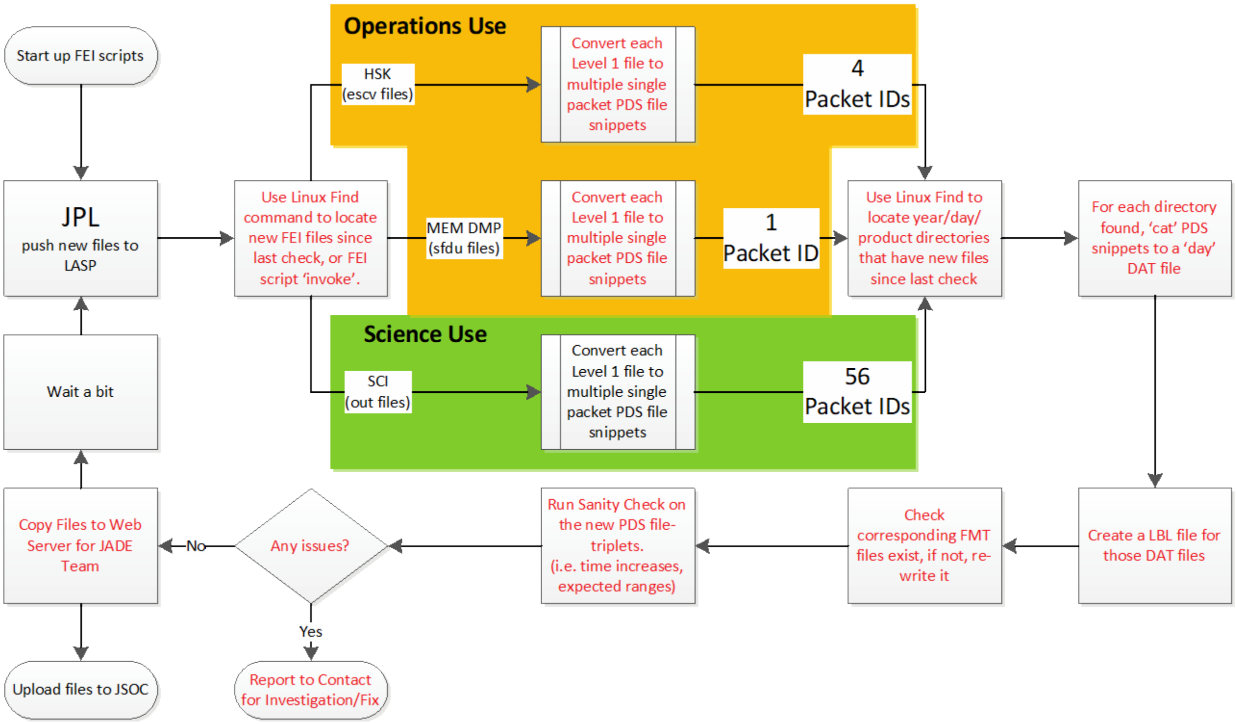


Figure 2: JADE science data pipeline diagram.

3.3.1 CODMAC Level 2 Data Production Pipeline

New data is pushed to LASP by FEI (JPL software) subscriptions to the CODMAC Level 1 data at JPL. The FEI subscriptions permanently run on a production computer hosted at LASP, with hourly cron checks to ensure the subscriptions are still running (and re-establish if necessary). In addition, a cron does a weekly check that all data available by FEI has been downloaded locally. Ingestion scripts can be triggered by FEI or by a regular cron job that looks for new local files. The binary files can contain any number of packets of any type of JADE data (PACKETID > 10), which are split out such that every unique packet is written to its own file – a PDS packet-snippet. The software that does that is written in c for speed, and every object in the packet is checked that it is within an allowed range expected for that particular packet. A few extra objects are added, such as a UTC object generated from the spacecraft clock values in the packet and converted with SPICE routines. PDS packet-snippets contain the time of day in the filename and are written in to directory structures based on date (*yyyy/yyyyddd/data_type/*), and are almost PDS compliant in that the DAT files obey the FMT file descriptions for the given product, but do not have a corresponding LBL file (LBL files are only generated once daily files are created). Duplicate packets in the FEI data simply over-write the previous PDS packet-snippet so only one is kept.

Reordering the data is now merely a cron to go through each *yyyy/yyyyddd/data_type/* directory, seeing if any files were modified/created since the last time the cron ran, and if so, concatenating the files of each product to a single file (with a Linux *cat* command). Due to the time of day being noted in the filenames, this concatenates them in the correct time order. The daily files are written to a different set of *yyyy/yyyyddd/data_type/* directories (see Figure 4), and code run to create the LBL file for each daily file. These are then fully PDS compliant CODMAC Level 2 daily files for each product available that day, ready for upload to JSOC via FTP.

3.3.2 CODMAC Level 3 Data Production Pipeline

As this dataset is all commissioning data it is not for science use, and therefore will never have any level 3 data made.

3.4 Data Validation

General PDS syntax / formatting checks are carried out at the earliest stage of processing to ensure the data obeys the PDS standards. Periodically PDS online validation tools are run on local volumes to ensure that the CODMAC Level 2 product standards are met, as well as bespoke checks carried out locally. This ensures values are within acceptable ranges (or a fill value, a.k.a. MISSING_CONSTANT), correctly ordered, and correctly labeled.

3.4.1 Instrument Team Validation

The JADE instrument team will be the first to see any data by monitoring trend plots and examining the data to ensure what was commanded occurred. In addition they will monitor the health of the various sensors and carry out regular calibration exercises. During these activities any inconsistencies that may arise will be investigated, corrected where possible, or noted in the `ERRATA.TXT` for the volume.

3.4.2 Science Team Validation

The JADE science team will provide validation by virtue of using the data and reporting any inconsistencies to the instrument team. Since each orbit takes ~11 days and there is a 3 to 6 month lag between acquiring the data and providing it to the PDS (see Table 8) there is plenty of time for the science team to work with the data prior to PDS submission.

4 Archive volume generation

The JADE Standard Data Record archive collection is produced by the JADE IOT in cooperation with the JSOC, and with the support of the PDS Planetary Plasma Interactions (PPI) Node at the University of California, Los Angeles (UCLA). The archive volume creation process described in this section sets out the roles and responsibilities of each of these groups. The assignment of tasks has been agreed by all parties. Archived data received by the PPI Node from the JADE team will be made electronically available to PDS users as soon as practicable but no later than as laid out in Table 7.

4.1 Data transfer methods and delivery schedule

The JADE team will deliver data to the PPI Node in standard product packages containing three months of data, also adhering to the schedule set out in Table 8. Each package will comprise both data and ancillary data files organized into directory structures consistent with the volume design described in Section 5, and combined into a deliverable file(s) using file archive and compression software. When these files are unpacked at the PPI Node in the appropriate location, the constituent files will be organized into the archive volume structure.

Table 8: Archive Schedule and Responsibilities

Instrument	Data Product	Provider	Earth Flyby (EFB)	Other Cruise	Orbital Phase
JADE R. J. Wilson	P0 (Level 2)	JADE Team	*JADE was off throughout EFB, => No data to archive.*	Jupiter + 4 mo.	EDA + 3 to 6 mo.
	P1, P2, P3 (Level 3)	JADE Team		N/A	N/A
	P4, P5 (Level 5)	JADE Team		N/A	N/A

N/A – This is a commissioning dataset only, so no data products higher than P0 will be delivered

EDA – End of data acquisition

The archives will be sent electronically from the JADE IOT to a user account on the PPI node using the *ssh* protocol. The IOT operator will copy each volume (see Table 10) in the form of a compressed *tar* archive (a.k.a. *tarball*) to an appropriate location within the PPI file system. Only those files that have changed since the last delivery will be included. The PPI operator will decompress the data, using the *tar* checksums to verify that the archive is complete. Each step of data submission process will be tracked in a version CATS (Cassini Archive Tracking System) which has been adapted for use by Juno.

Following receipt of a data delivery, PPI will organize the data into PDS archive volume structure within its online data system. PPI will generate all of the required files associated with a PDS archive volume (index file, read-me files, etc.) as part of its routine processing of incoming JADE data. Newly delivered data will be made available publicly through the PPI online system once accompanying labels and other documentation have been validated. It is anticipated that this validation process will require no more than fourteen working days from receipt of the data by PPI. The first two data deliveries are expected to require somewhat more time for the PPI Node to process before making the data publicly available.

The Juno prime mission begins after JOI and two subsequent correction orbits, and lasts for 33 ~11 day orbits. Table 8 formalizes the data delivery schedule for the entire Juno mission, including cruise, commissioning and prime mission phases. Data delivery from JSOC to PPI node will occur on the 15th of the month and the data will be publicly available on the 1st of the following month. Archiving of products from any extended mission period will be negotiated with the Project at a later date.

4.2 Data validation

The JADE standard data archive volume set will include all data acquired during the Juno mission. The archive validation procedure described in this section applies to volumes generated during both the cruise and prime phases of the mission.

PPI node staff will carefully examine the first archive volume that they receive that contains data from JADE to determine whether the archive is appropriate to meet the stated science objectives of the instrument. The PPI node will also review the archive product generation process for robustness and ability to detect discrepancies in the end products; documentation will be reviewed for quality and completeness.

As expertise with the instrument and data develops the JADE team may decide that changes to the structure or content of its standard data products are warranted. Should these changes be implemented, the new data product and archive volume will be subjected to a full PDS peer review, and this document will be revised to reflect the modified archive. Table 2 lists the history of all modifications to the archive structure and contents.

4.3 Data product and archive volume size estimates

JADE standard data products are organized into files that span 24 hours, breaking at 0h UTC. Files vary in size depending on the telemetry rate and allocation. Table 9 summarizes the expected sizes of the JADE standard products.

Since this PDS volume just covers 2011 to 2014 and consists of commissioning data only, the total data file size is 1.5 GB and will not increase further.

All JADE standard data are organized by the PDS team onto a single archive volume. The data on the volume are organized into one-day subdirectories.

Table 9: Data product size and archive volume production rate

Data Product	Production rate (approximate)	Size for primary mission
Level 2 Science	41 MB per day	1.5 GB for 2011-2014
Level 3 Science	N/A [This is a commissioning dataset only up to Jan 2014, so no data products higher than L2 will be delivered]	
Total	TBD GB per day	2 GB for volume

MB = Megabyte, GB = GigaByte

Following receipt of JADE data by the PPI Node it is expected that fourteen working days will be required to validate and process the delivery before the data are made available on PPI web pages. New deliveries will be added to the existing volume structure to which they belong.

4.4 Backups and duplicates

The PPI Node keeps three copies of each archive volume. One copy is the primary online archive, another is an onsite backup copy, and the final copy is an off-site backup copy. Once the archive volumes are fully validated and approved for inclusion in the archive, a copy of the data is sent to the National Space Science Data Center (NSSDC) for long-term archive in a NASA-approved deep-storage facility. The PPI Node may maintain additional copies of the archive volumes, either on or off-site as deemed necessary. The process for the dissemination, and preservation JADE archive volumes is illustrated in Figure 3

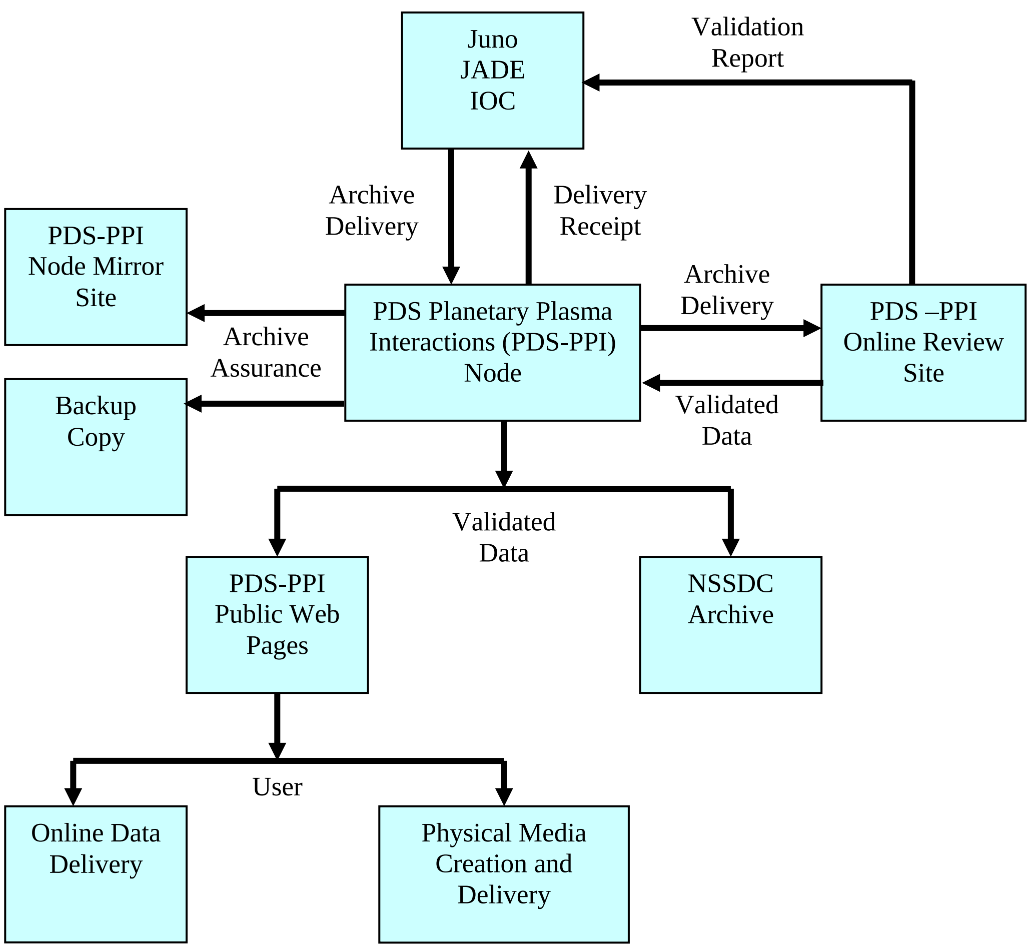


Figure 3: Duplication and dissemination of JADE standard archive volumes.

4.5 Labeling and identification

Each JADE data volume bears a unique volume ID using the last two components of the volume set ID [*PDS Standards Reference*, see §19]. For each physical medium, the volume IDs are USA_NASA_PDS_??????_*mnnn*, where ?????? is the VOLUME_SET_ID defined by the PDS and *mnnn* is the sequence number of the individual volume, where the *m* referrers to the CODMAC level of the data. Hence the first JADE Level 2 volume has the volume ID JNOJAD_2001, as shown in Table 10.

Table 10: PDS Data Set Volume Assignments

Level	DATA_SET_ID	VOLUME_ID
2	JNO-SW-JAD-2-UNCALIBRATED-V1.0	JNOJAD_2001

5 Archive volume contents

This section describes the contents of the JADE standard product archive collection volumes, including the file names, file contents, file types, and the organizations responsible for providing the files. The complete directory structure is shown in Figure 4. All the ancillary files described herein appear on each JADE standard product volume, except where noted.

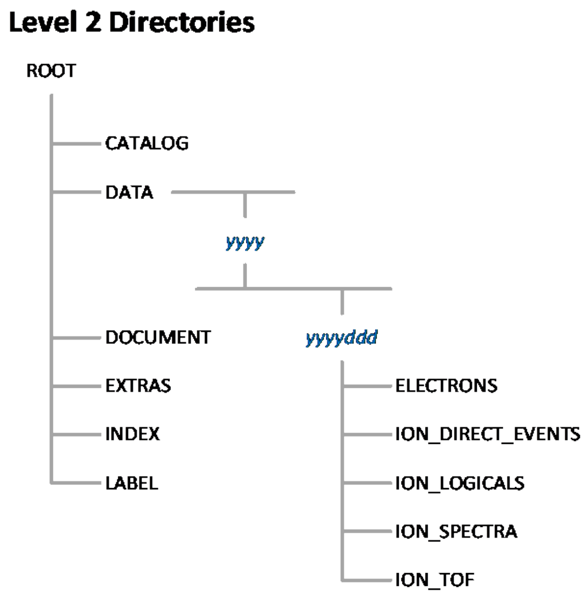


Figure 4: Archive volume directory structure

5.1 Root directory

The files listed in Table 11 are contained in the (top-level) root directory, and are produced by the JADE team in consultation with the PPI node of the PDS. With the exception of the hypertext file and its label, all of these files are required by the PDS volume organization standards.

Table 11: Root directory contents

File	Description	Responsibility
AAREADME.TXT	This file completely describes the volume organization and contents (PDS label attached)	PPI
ERRATA.TXT	A text file containing a cumulative listing of comments and updates concerning all JADE standard products on all JADE volumes in the volume set published to date	JADE team
VOLDESC.CAT	A description of the contents of this volume in a PDS format readable by both humans and computers	PPI

5.2 CATALOG directory

The files in the CATALOG directory provide a top-level understanding of the Juno mission, spacecraft, instruments, and data sets in the form of completed PDS templates. The information necessary to create the files is provided by the JADE team and formatted into standard template formats by the PPI Node. The files in this directory are coordinated with PDS data engineers at both the PPI Node and the PDS Engineering Node.

Table 12: CATALOG directory contents

File	Description	Responsibility
CATINFO.TXT	A description of the contents of this directory	PPI
JADE_INST.CAT	PDS instrument catalog description of the JADE instrument	JADE team
JADE_DS.CAT	PDS data set catalog description of the JADE data files	JADE team
JADE_REF.CAT	JADE-related references mentioned in other CAT files	JADE team
INSTHOST.CAT	A description of the Juno spacecraft	Juno Project
MISSION.CAT	PDS mission catalog description of the Juno mission	Juno Project
PERSON.CAT	PDS personnel catalog description of JADE team members and other persons involved with generation of JADE standard data products	JADE team
PROJ_REF.CAT	References mentioned in INSTHOST.CAT and MISSION.CAT	Juno Project

5.3 DATA directory

5.3.1 Contents

The DATA directory contains the data files produced by the JADE team. In the Level 2 archive, these files contain the raw binary instrument EDR's, organized into correct time sequence, time tagged, and edited to remove obviously bad data. In the higher level archives, the contents of the DATA directory are binary files that result from passing the corresponding Level 2 files through the processing pipeline.

The data files are of the highest quality possible. Any residual issues are documented in AAREADME.TXT and ERRATA.TXT files in the volume's root directory, or in JADE_DS.CAT in the CATALOG directory. Users are referred to these files for a detailed description of any outstanding matters associated with the archived data.

Table 13: DATA directory contents

File	Description	Responsibility
DATAINFO.TXT	A description of the contents of this directory	PPI
yyyy	Subdirectories containing JADE data acquired in year *yyyy*	JADE team

5.3.2 Subdirectory structure

In order to manage files in an archive volume more efficiently the DATA directory is divided into subdirectories. The two levels of division are based on time; data are organized into yearly subdirectories, which are further divided into a number of daily sub-subdirectories. The naming convention for the yearly directories is *yyyy*, and for the daily directories it is *yyyyddd*, where *ddd* is the three-digit day of year. For example, all data for the year 2011 are contained below the directory 2011, with data for Jan 1 2011 UTC found in the subdirectory 2011/2011001, and so on.

5.3.3 Required files

A PDS label describes each file in the DATA path of an archive volume. Text documentation files have attached (internal) PDS labels and data files have detached labels. Detached PDS label files have the same root name as the file they describe but have the extension LBL. The label files contain both data file content and record structure information.

5.3.4 The *yyyy/yyyyddd* subdirectory

This directory contains JADE data files and their corresponding PDS labels. As shown in Table 14 for CODMAC level 2, the data in these files span a time interval of one day, the particular day being identified from both the file name and the name of the parent directory. The names also contain a 2-digit version. The initial version is V01.

Table 14: CODMAC Level 2 DATA/yyyy/yyyyddd directory contents

Filename	Description
ELECTRONS	Subdirectories containing JADE electron data (all electron sensors) acquired for year/doy *yyyyddd*.
ION_DIRECT_EVENTS	Subdirectories containing JADE ion Direct Event data acquired for year/doy *yyyyddd*.
ION_LOGICALS	Subdirectories containing JADE ion Logicals data acquired for year/doy *yyyyddd*.
ION_SPECTRA	Subdirectories containing JADE ion spectra data (for various ion species) acquired for year/doy *yyyyddd*.
ION_TOF	Subdirectories containing JADE ion time of flight data acquired for year/doy *yyyyddd*.

Binary data file names have the "DAT" file extension. Each file is accompanied by a PDS label (LBL) describing its contents. The labels permit the contents of most of the products to be browsed by PDS software, e.g., *NASAView*, etc.

5.3.4.1 The *ELECTRONS* subdirectory

This directory contains JADE data files from the electron sensors and their corresponding PDS labels. As shown in Table 15, the data in these files span a time interval of one day, the particular day being identified from both the file name and the name of the parent directory. The names also contain a 2-digit version. The initial version is V01.

Table 15: DATA/yyyy/yyyyddd/ELECTRONS directory contents

Filename	Description
JAD_BRT_ELC_ALL_*yyyyddd*_V*nn*.DAT	Burst mode electron counts, all 3 sensors.
JAD_CAL_ELC_060_*yyyyddd*_V*nn*.DAT	MCP calibration mode electron counts, E060 sensor.
JAD_CAL_ELC_180_*yyyyddd*_V*nn*.DAT	MCP calibration mode electron counts, E180 sensor.
JAD_CAL_ELC_300_*yyyyddd*_V*nn*.DAT	MCP calibration mode electron counts, E300 sensor.
JAD_HRS_ELC_ALL_*yyyyddd*_V*nn*.DAT	High Rate Science electron counts, all 3 sensors.
JAD_HSK_ELC_ALL_*yyyyddd*_V*nn*.DAT	HV Engineering electron counts, all 3 sensors.
JAD_LRS_ELC_060_*yyyyddd*_V*nn*.DAT	Low Rate Science electron count rate, E060 sensor.
JAD_LRS_ELC_180_*yyyyddd*_V*nn*.DAT	Low Rate Science electron count rate, E180 sensor.
JAD_LRS_ELC_300_*yyyyddd*_V*nn*.DAT	Low Rate Science electron count rate, E300 sensor.

5.3.4.2 The *ION_DIRECT_EVENTS* subdirectory

This directory contains JADE data files from ion direct events and their corresponding PDS labels. As shown in Table 16, the data in these files span a time interval of one day, the particular day being identified from both the file name and the name of the parent directory. The names also contain a 2-digit version. The initial version is V01.

Table 16: DATA/yyyy/yyyyddd/ION_DIRECT_EVENTS directory contents

Filename	Description
JAD_CAL_ION_DER_*yyyyddd*_V*nn*.DAT	MCP calibration direct events (raw).
JAD_CAL_ION_DES_*yyyyddd*_V*nn*.DAT	MCP calibration direct events (split out).
JAD_HRS_ION_DER_*yyyyddd*_V*nn*.DAT	High Rate Science direct events (raw).
JAD_HRS_ION_DES_*yyyyddd*_V*nn*.DAT	High Rate Science direct events (split out).
JAD_HSK_ION_DER_*yyyyddd*_V*nn*.DAT	HV Engineering direct events (raw).
JAD_HSK_ION_DES_*yyyyddd*_V*nn*.DAT	HV Engineering direct events (split out).
JAD_LRS_ION_DER_*yyyyddd*_V*nn*.DAT	Low Rate Science direct events (raw).
JAD_LRS_ION_DES_*yyyyddd*_V*nn*.DAT	Low Rate Science direct events (split out).

5.3.4.3 The *ION_LOGICALS* subdirectory

This directory contains JADE data files from ion Logicals and their corresponding PDS labels. As shown in Table 17, the data in these files span a time interval of one day, the particular day being identified from both the file name and the name of the parent directory. The names also contain a 2-digit version. The initial version is V01.

Table 17: DATA/yyyy/yyyyddd/ION_LOGICALS directory contents

Filename	Description
JAD_BRT_ION_LOG_*yyyyddd*_V*nn*.DAT	Burst mode ion Logical counts.
JAD_CAL_ION_LOG_*yyyyddd*_V*nn*.DAT	MCP calibration mode ion Logical counts.
JAD_HRS_ION_LOG_*yyyyddd*_V*nn*.DAT	High Rate Science mode ion Logical counts.
JAD_HSK_ION_LOG_*yyyyddd*_V*nn*.DAT	HV Engineering mode ion Logical counts.
JAD_LRS_ION_LOG_*yyyyddd*_V*nn*.DAT	Low Rate Science mode ion Logical counts.

5.3.4.4 The *ION_SPECTRA* subdirectory

This directory contains JADE data files and their corresponding PDS labels. As shown in Table 18, the data in these files span a time interval of one day, the particular day being identified from both the file name and the name of the parent directory. The names also contain a 2-digit version. The initial version is V01.

Table 18: DATA/yyyy/yyyyddd/ION_SPECTRA directory contents

Filename	Description
JAD_BRT_ION_SP0_*yyyyddd*_V*nn*.DAT	Burst mode ion species 0 counts.
JAD_BRT_ION_SP1_*yyyyddd*_V*nn*.DAT	Burst mode ion species 1 counts.
JAD_BRT_ION_SP2_*yyyyddd*_V*nn*.DAT	Burst mode ion species 2 counts.
JAD_BRT_ION_SP3_*yyyyddd*_V*nn*.DAT	Burst mode ion species 3 counts.
JAD_BRT_ION_SP4_*yyyyddd*_V*nn*.DAT	Burst mode ion species 4 counts.
JAD_BRT_ION_SP5_*yyyyddd*_V*nn*.DAT	Burst mode ion species 5 counts.
JAD_BRT_ION_SP6_*yyyyddd*_V*nn*.DAT	Burst mode ion species 6 counts.
JAD_BRT_ION_SP7_*yyyyddd*_V*nn*.DAT	Burst mode ion species 7 counts.
JAD_CAL_ION_SP0_*yyyyddd*_V*nn*.DAT	MCP calibration mode ion species 0 count rate.
JAD_CAL_ION_SP1_*yyyyddd*_V*nn*.DAT	MCP calibration mode ion species 1 count rate.
JAD_CAL_ION_SP2_*yyyyddd*_V*nn*.DAT	MCP calibration mode ion species 2 count rate.
JAD_CAL_ION_SP3_*yyyyddd*_V*nn*.DAT	MCP calibration mode ion species 3 count rate.
JAD_CAL_ION_SP4_*yyyyddd*_V*nn*.DAT	MCP calibration mode ion species 4 count rate.
JAD_CAL_ION_SP5_*yyyyddd*_V*nn*.DAT	MCP calibration mode ion species 5 count rate.
JAD_CAL_ION_SP6_*yyyyddd*_V*nn*.DAT	MCP calibration mode ion species 6 count rate.
JAD_CAL_ION_SP7_*yyyyddd*_V*nn*.DAT	MCP calibration mode ion species 7 count rate.
JAD_HRS_ION_SP0_*yyyyddd*_V*nn*.DAT	High Rate Science mode ion species 0 counts.
JAD_HRS_ION_SP1_*yyyyddd*_V*nn*.DAT	High Rate Science mode ion species 1 counts.
JAD_HRS_ION_SP2_*yyyyddd*_V*nn*.DAT	High Rate Science mode ion species 2 counts.
JAD_HRS_ION_SP3_*yyyyddd*_V*nn*.DAT	High Rate Science mode ion species 3 counts.
JAD_HRS_ION_SP4_*yyyyddd*_V*nn*.DAT	High Rate Science mode ion species 4 counts.
JAD_HRS_ION_SP5_*yyyyddd*_V*nn*.DAT	High Rate Science mode ion species 5 counts.
JAD_HRS_ION_SP6_*yyyyddd*_V*nn*.DAT	High Rate Science mode ion species 6 counts.
JAD_HRS_ION_SP7_*yyyyddd*_V*nn*.DAT	High Rate Science mode ion species 7 counts.
JAD_HSK_ION_SPA_*yyyyddd*_V*nn*.DAT	HV Engineering for all ion species counts.
JAD_LRS_ION_SP0_*yyyyddd*_V*nn*.DAT	Low Rate Science mode ion species 0 count rate.
JAD_LRS_ION_SP1_*yyyyddd*_V*nn*.DAT	Low Rate Science mode ion species 1 count rate.
JAD_LRS_ION_SP2_*yyyyddd*_V*nn*.DAT	Low Rate Science mode ion species 2 count rate.
JAD_LRS_ION_SP3_*yyyyddd*_V*nn*.DAT	Low Rate Science mode ion species 3 count rate.
JAD_LRS_ION_SP4_*yyyyddd*_V*nn*.DAT	Low Rate Science mode ion species 4 count rate.
JAD_LRS_ION_SP5_*yyyyddd*_V*nn*.DAT	Low Rate Science mode ion species 5 count rate.
JAD_LRS_ION_SP6_*yyyyddd*_V*nn*.DAT	Low Rate Science mode ion species 6 count rate.
JAD_LRS_ION_SP7_*yyyyddd*_V*nn*.DAT	Low Rate Science mode ion species 7 count rate.

5.3.4.5 The *ION_TOF* subdirectory

This directory contains JADE data files and their corresponding PDS labels. As shown in Table 19, the data in these files span a time interval of one day, the particular day being identified from both the file name and the name of the parent directory. The names also contain a 2-digit version. The initial version is V01.

Table 19: DATA/yyyy/yyyyddd/ION_TOF directory contents

Filename	Description
JAD_BRT_ION_TOF_*yyyyddd*_V*nn*.DAT	Burst mode ion time of flight counts.
JAD_CAL_ION_TOF_*yyyyddd*_V*nn*.DAT	MCP calibration mode ion time of flight counts.
JAD_HRS_ION_TOF_*yyyyddd*_V*nn*.DAT	High Rate Science mode ion time of flight counts.
JAD_HSK_ION_TOF_*yyyyddd*_V*nn*.DAT	HV Engineering mode ion time of flight counts.
JAD_LRS_ION_TOF_*yyyyddd*_V*nn*.DAT	Low Rate Science mode ion time of flight counts.

5.4 DOCUMENT directory

The DOCUMENT directory contains a range of documentation considered either necessary or useful for users to understand the archive data set. Documents may be included in multiple forms, for example, ASCII, PDF, or HTML. PDS standards require that any documentation needed for use of the data be available in an ASCII format. “Clean” HTML is an acceptable ASCII format in addition to plain text. “Clean” HTML refers to HTML with minimal markup, and formatted in such a way as to facilitate reading in a text browser. Table 20 describes the contents of the `DOCUMENT` directory.

The Instrument paper has been provided in “Clean” HTML, however this SIS document is provided as a LaTeX file as the ASCII format. An ‘un-clean’ HTML version saved out from this Word document is additionally provided as a further format option that can be viewed in a web browser. However we expect people to treat the Word Document and the PDF produced from it as the copy of record.

Table 20: DOCUMENT directory contents

Filename	Description	Responsibility
`DOCINFO.TXT`	A description of the contents of this directory	PPI
`JADE_INST_PAPER.LBL`	A PDS detached label for the JADE Instrument paper	JADE team
`JADE_INST_PAPER.PDF`	PDF version of the published paper (open access)	JADE team
`JADE_INST_PAPER.HTM`	The JADE instrument paper in HTML format (HTML Version 3.2)	JADE team
`JADE_INST_PAPER_IMAGE_mmm.JPG/PNG`	Image files for JADE_INST_PAPER.HTM, some are JPG, others PNG, where *mmm* is a non-repeating incrementing number from 001 to 116.	JADE team
`JADE_INST_PAPER_TABLE_mm.PNG`	Image files of the 18 tables from JADE_INST_PAPER.PDF, where *mm* is a non-repeating incrementing number from 01 to 18.	JADE team
`JADE_FSW3_SIS.LBL`	A PDS detached label for the SIS document	JADE team
`JADE_FSW3_SIS.DOCX`	The SIS in MS Word format (the original)	JADE team
`JADE_FSW3_SIS.PDF`	The SIS in PDF format (created from Word)	JADE team
`JADE_FSW3_SIS.TEX`	The SIS in LaTeX format (plain ASCII)	JADE team
`JADE_FSW3_SIS_FIG_m.PNG`	Image files for JADE_FSW3_SIS.TEX and JADE_FSW3_SIS.HTM, where *m* is a non-repeating incrementing number from 1 to 7.	JADE team
`JADE_FSW3_SIS.HTM`	The SIS in HTML format (also ASCII). (HTML saved out from Word document, but not clean HTML nor HTML Version 3.2, but will work in a web browser.)	JADE team

5.5 EXTRAS directory

The EXTRAS directory contains files which facilitate the use of the archive volume but which are not considered part of the archive itself. Table 21 contains a list of the important contents of the EXTRAS directory. [Helpful Software may be included here]

Table 21: EXTRAS subdirectory contents

File	Description	Responsibility
EXTRINFO.TXT	A description of the contents of this directory	PPI
[TBD]		

5.6 INDEX directory

The INDEX.TAB file contains a listing of all data products on the archive volume. The index (INDEX.TAB) and index information (INDXINFO.TXT) files are required by the PDS volume standards. The format of these ASCII files is described in §6.2.5. An online and web-accessible index file will be available at the PPI Node while data volumes are being produced.

Table 22: INDEX directory contents

File	Description	Responsibility
INDXINFO.TXT	A description of the contents of this directory	PPI
INDEX.LBL	A PDS detached label that describes INDEX.TAB	JSOC
INDEX.TAB	A table listing all JADE data products on this volume	JSOC

5.7 LABEL directory

The LABEL directory (see Table 23) contains the format files for the files under the DATA directory. Since the formats of the PDS files do not change over the mission, they are given once here. This also means that they do not have a date in their filename, but they do keep a version number (*nn*). [A PDS naming quirk means that the label files (*.LBL) go in the same *DATA* subdirectories as the data files (*.DAT), but their format files (*.FMT) go in the LABEL directory.] The following table (Table 23, over 2 pages) lists the different files for level 2 data.

Table 23: LABEL directory contents

Filename	Description	Responsibility
LABINFO.TXT	A description of the contents of this directory	PPI
JAD_BRT_ELC_ALL_V*nn*.FMT	Burst mode electrons (all sensors) format file.	JADE team
JAD_BRT_ION_LOG_V*nn*.FMT	Burst mode ion Logicals format file.	JADE team
JAD_BRT_ION_SP0_V*nn*.FMT	Burst mode ion species 0 format file.	JADE team
JAD_BRT_ION_SP1_V*nn*.FMT	Burst mode ion species 1 format file.	JADE team
JAD_BRT_ION_SP2_V*nn*.FMT	Burst mode ion species 2 format file.	JADE team
JAD_BRT_ION_SP3_V*nn*.FMT	Burst mode ion species 3 format file.	JADE team
JAD_BRT_ION_SP4_V*nn*.FMT	Burst mode ion species 4 format file.	JADE team
JAD_BRT_ION_SP5_V*nn*.FMT	Burst mode ion species 5 format file.	JADE team
JAD_BRT_ION_SP6_V*nn*.FMT	Burst mode ion species 6 format file.	JADE team
JAD_BRT_ION_SP7_V*nn*.FMT	Burst mode ion species 7 format file.	JADE team
JAD_BRT_ION_TOF_V*nn*.FMT	Burst mode ion time-of-flight format file.	JADE team
JAD_CAL_ELC_060_V*nn*.FMT	MCP calibration electron E060 format file.	JADE team
JAD_CAL_ELC_180_V*nn*.FMT	MCP calibration electron E180 format file.	JADE team
JAD_CAL_ELC_300_V*nn*.FMT	MCP calibration electron E300 format file.	JADE team
JAD_CAL_ION_DER_V*nn*.FMT	MCP calibration direct events (raw) format file.	JADE team
JAD_CAL_ION_DES_V*nn*.FMT	MCP calibration direct events (split out) format file.	JADE team
JAD_CAL_ION_LOG_V*nn*.FMT	MCP calibration ion Logicals format file.	JADE team
JAD_CAL_ION_SP0_V*nn*.FMT	MCP calibration ion species 0 format file.	JADE team
JAD_CAL_ION_SP1_V*nn*.FMT	MCP calibration ion species 1 format file.	JADE team
JAD_CAL_ION_SP2_V*nn*.FMT	MCP calibration ion species 2 format file.	JADE team
JAD_CAL_ION_SP3_V*nn*.FMT	MCP calibration ion species 3 format file.	JADE team
JAD_CAL_ION_SP4_V*nn*.FMT	MCP calibration ion species 4 format file.	JADE team
JAD_CAL_ION_SP5_V*nn*.FMT	MCP calibration ion species 5 format file.	JADE team
JAD_CAL_ION_SP6_V*nn*.FMT	MCP calibration ion species 6 format file.	JADE team
JAD_CAL_ION_SP7_V*nn*.FMT	MCP calibration ion species 7 format file.	JADE team
JAD_CAL_ION_TOF_V*nn*.FMT	MCP calibration ion time-of-flight format file.	JADE team
JAD_HRS_ELC_ALL_V*nn*.FMT	High Rate Science electrons (all sensors) format file.	JADE team
JAD_HRS_ION_DER_V*nn*.FMT	High Rate Science direct events (raw) format file.	JADE team

Filename	Description	Responsibility
JAD_HRS_ION_DES_V*nn*.FMT	High Rate Science direct events (split out) format file.	JADE team
JAD_HRS_ION_LOG_V*nn*.FMT	High Rate Science ion Logicals format file.	JADE team
JAD_HRS_ION_SP0_V*nn*.FMT	High Rate Science ion species 0 format file.	JADE team
JAD_HRS_ION_SP1_V*nn*.FMT	High Rate Science ion species 1 format file.	JADE team
JAD_HRS_ION_SP2_V*nn*.FMT	High Rate Science ion species 2 format file.	JADE team
JAD_HRS_ION_SP3_V*nn*.FMT	High Rate Science ion species 3 format file.	JADE team
JAD_HRS_ION_SP4_V*nn*.FMT	High Rate Science ion species 4 format file.	JADE team
JAD_HRS_ION_SP5_V*nn*.FMT	High Rate Science ion species 5 format file.	JADE team
JAD_HRS_ION_SP6_V*nn*.FMT	High Rate Science ion species 6 format file.	JADE team
JAD_HRS_ION_SP7_V*nn*.FMT	High Rate Science ion species 7 format file.	JADE team
JAD_HRS_ION_TOF_V*nn*.FMT	High Rate Science ion time-of-flight format file.	JADE team
JAD_HSK_ELC_ALL_V*nn*.FMT	HV Engineering electrons (all sensors) format file.	JADE team
JAD_HSK_ION_DER_V*nn*.FMT	HV Engineering direct events (raw) format file.	JADE team
JAD_HSK_ION_DES_V*nn*.FMT	HV Engineering direct events (split out) format file.	JADE team
JAD_HSK_ION_LOG_V*nn*.FMT	HV Engineering ion Logicals format file.	JADE team
JAD_HSK_ION_SPA_V*nn*.FMT	HV Engineering ion all species (0-7) format file.	JADE team
JAD_HSK_ION_TOF_V*nn*.FMT	HV Engineering ion time-of-flight format file.	JADE team
JAD_LRS_ELC_060_V*nn*.FMT	Low Rate Science electron E060 format file.	JADE team
JAD_LRS_ELC_180_V*nn*.FMT	Low Rate Science electron E180 format file.	JADE team
JAD_LRS_ELC_300_V*nn*.FMT	Low Rate Science electron E300 format file.	JADE team
JAD_LRS_ION_DER_V*nn*.FMT	Low Rate Science direct events (raw) format file.	JADE team
JAD_LRS_ION_DES_V*nn*.FMT	Low Rate Science direct events (split out) format file.	JADE team
JAD_LRS_ION_LOG_V*nn*.FMT	Low Rate Science ion Logicals format file.	JADE team
JAD_LRS_ION_SP0_V*nn*.FMT	Low Rate Science ion species 0 format file.	JADE team
JAD_LRS_ION_SP1_V*nn*.FMT	Low Rate Science ion species 1 format file.	JADE team
JAD_LRS_ION_SP2_V*nn*.FMT	Low Rate Science ion species 2 format file.	JADE team
JAD_LRS_ION_SP3_V*nn*.FMT	Low Rate Science ion species 3 format file.	JADE team
JAD_LRS_ION_SP4_V*nn*.FMT	Low Rate Science ion species 4 format file.	JADE team
JAD_LRS_ION_SP5_V*nn*.FMT	Low Rate Science ion species 5 format file.	JADE team
JAD_LRS_ION_SP6_V*nn*.FMT	Low Rate Science ion species 6 format file.	JADE team
JAD_LRS_ION_SP7_V*nn*.FMT	Low Rate Science ion species 7 format file.	JADE team
JAD_LRS_ION_TOF_V*nn*.FMT	Low Rate Science ion time-of-flight format file.	JADE team

6 Archive volume format

Data that comprise the JADE standard product archives will be formatted in accordance with PDS specifications [see *Planetary Science Data Dictionary*, *PDS Archiving Guide*, and *PDS Standards Reference* in §1.9].

6.1 Volume format

Although the JADE team does not control the volume format to be used by the PDS, it is necessary to define the format in which the data sets are to be transmitted via network from the SOC to the PPI node. This will be in the form of compressed *tar* archives, as created by the open source *gtar* program. Pathnames, in lower-case letters only, will be relative to the ROOT directory, e.g., *"./data"*, *"./index"*, etc.

6.2 File formats

The following section describes file formats for the kinds of files contained on archive volumes. For more information, see the *PDS Archive Preparation Guide* [see §1.9].

6.2.1 Document files

Document files with a `TXT` extension exist in nearly all directories. They are ASCII files with embedded PDS labels. All TXT document files contain 80-byte fixed-length records; records are terminated with a carriage return (ASCII 13) and line feed character (ASCII 10) in the 79th and 80th byte, respectively. This format allows the files to be read by many operating systems, *e.g.*, UNIX, MacOSX, Windows, etc.

In general, documents are provided in ASCII text format. However, some documents in the `DOCUMENT` directory contain formatting and figures that cannot be rendered as ASCII text. Hence these documents are also given in additional formats such as hypertext, Microsoft Word, and Adobe Acrobat (PDF). Hypertext files contain ASCII text plus hypertext mark-up language (HTML) commands that enable them to be viewed in a web browser such as *Mozilla* or MS Internet Explorer. Hypertext documents may reference ancillary files, such as images, that are incorporated into the document by the web browser.

6.2.2 Tabular files

Tabular files (TAB extension) exist in the DATA and INDEX directories. Tabular files are ASCII files formatted for direct reading into database management systems on various computers. Columns are fixed length, separated by commas or white space, and character fields are enclosed in double quotation marks ("). Character fields are padded with spaces to keep quotation marks in the same columns of successive records. Character fields are left justified, and numeric fields are right justified. The "start byte" and "bytes" values listed in the labels do not include the commas between fields or the quotation marks surrounding character fields. The records are of fixed length, and the last two bytes of each record contain the ASCII carriage return and line feed characters. This line format allows a table to be treated as a fixed length record file on computers that support this file type and as a text file with embedded line delimiters on those that don't support it.

Detached PDS label files will describe all tabular files. A detached label file has the same name as the data file it describes, but with the extension LBL. For example, the file INDEX.TAB is accompanied by the detached label file INDEX.LBL in the same directory.

6.2.3 PDS labels

All data files in the JADE Standard Product Archive Collection have associated detached PDS labels [see the *Planetary Science Data Dictionary* and the *PDS Standards Reference* in §1.9]. These label files are named using the same prefix as the data file together with an LBL extension.

A PDS label provides descriptive information about the associated file. The PDS label is an object-oriented structure consisting of sets of "keyword = value" declarations. The object that the label refers to (*e.g.* IMAGE, TABLE, etc.) is denoted by a statement of the form:

```
^object = location
```

in which the carat character (^, also called a pointer in this context) indicates where to find the object. In a PDS label, the location denotes the name of the file containing the object, along with the starting record or byte number, if there is more than one object in the file. For example:

```
^HEADER = ("98118.TAB", 1)
^TABLE = ("98118.TAB", 1025 <BYTES>)
```

indicates that the HEADER object begins at record 1 and that the TABLE object begins at byte 1025 of the file 98118.TAB. The file 98118.TAB must be located in the same directory as the detached label file.

Below is a list of the possible formats for the ^object definition in labels in this product.

```
^object      = n
^object      = n <BYTES>
^object      = "filename.ext"
^object      = ("filename.ext", n)
^object      = ("filename.ext", n <BYTES>)
```

where

- `n` is the starting record or byte number of the object, counting from the beginning of the file (record 1, byte 1),
- `<BYTES>` indicates that the number given is in units of bytes (the default is records),
- *`filename`* is the up-to-36-character, alphanumeric upper-case file name,
- *`ext`* is the up-to-3-character upper-case file extension,
- and all detached labels contain ASCII records that terminate with a carriage return followed by a line feed (ASCII 13_{10}, 10_{10}). This allows the files to be read by most computer operating systems, e.g., UNIX, MacOS, MSWindows, etc.

Examples of PDS labels required for the JADE archive are shown in Appendix B.

6.2.4 Catalog files

Catalog files (extension `CAT`) exist in the `Root` and `CATALOG` directories. They are plain text files formatted in an object-oriented structure consisting of sets of `“keyword = value”` declarations.

6.2.5 Index files

The PDS team provides PDS index files. The format of these files is described in this SIS document for completeness.

A PDS index table contains a listing of all data products on an archive volume. For products described by a detached PDS label, the index file points to the label file, which in turn points to the data file. A PDS index is an ASCII table composed of required columns and optional columns (user defined). When values are constant across an entire volume, it is permissible to promote the value out of the table and into the PDS label for the index table.

To facilitate users' searches of the JADE data submission, a few optional columns will be included in the index table. In particular, the file start and stop times will be included. Table 24 contains a description of the JADE archive volume index files. Index files are by definition fixed length ASCII files containing comma-delimited fields. Character strings are quoted using double quotes, and left justified in their field, followed where necessary by trailing blanks. The “Start Byte” column in Table 24 gives the location of the first byte (counting from 1) of the column within the file, skipping over delimiters and quotation marks.

Table 24: Format of index files

Column Name	Start Byte	Bytes	Description
VOLUME_ID	2	11	Contains the value JNOJAD_nnnn, where nnnn is a 4 digit number. (See Table 10)
SID (STANDARD_DATA_PRODUCT_ID)	16	15	The "type" of the data file. (See Table 7)
DATA_SET_ID	34	30	The PDS ID of the data set of which this file is a member. (See Table 10)
PRODUCT_ID	67	23	Identifier for the product [Typically filename without version number or extension]
START_TIME	92	21	Time (UTC) of the first record in the data file.
STOP_TIME	114	21	Time (UTC) of the last record in the data file.
FILE_SPECIFICATION_NAME	137	67	The full specification name of the PDS label file (including the file name and the path) that describes the product, relative to the root of the archive volume.
CR_DATE (PRODUCT_CREATION_TIME)	206	17	Creation time of the PDS labeled data product.
PRODUCT_LABEL_MD5CHECKSUM	225	32	Labels contain product checksums, this field records the label's checksum.

6.2.6 Level 2 data files

The Level 2 data files are binary and have files ending in the extension .DAT. Accompanying them in the same directory are the label files with the same filename but the extension .LBL. The format file (same filename minus the date part, but including the version number, with the extension .FMT) accompanying (and listed in) the LBL files is found in the LABEL directory at the root of the volume.

For example, the PDS file triplicates will have the following paths in the Volume:

ROOT/DATA/*yyyy*/*yyyyddd*/*subdir*/JAD_*aaa*_*bbb*_*ccc*_*yyyyddd*_V*nn*.DAT
ROOT/DATA/*yyyy*/*yyyyddd*/*subdir*/JAD_*aaa*_*bbb*_*ccc*_*yyyyddd*_V*nn*.LBL
ROOT/LABEL/JAD_*aaa*_*bbb*_*ccc*_V*nn*.FMT

See section 3.1for the explanation of JAD_*aaa*_*bbb*_*ccc*_*yyyyddd*_V*nn*, and *subdir* is the subdirectory name given in Table 14.

There are many different Level 2 product types, but some are similar and they all have the same 15 objects as a header (for V02 files, V01 had 14 objects by not having SCLKSCET_VERSION). For instance, all the direct events formats (JAD_***_ION_DER) have the same format. As such only the first is listed in full, then later ones just show the differences, which are merely in the description and usually just refer to the product ID or mode. Those differences are shown in blue to highlight them, and do not change the format. Likewise, for MCP_CAL_SCI and LOW_RATE_SCI data, there is a separate data product for each of the 3 electron sensors, however the formats are the same, so only those for E060 are shown, with differences (only in description) provided for E180 and E300.

To save space in this document, Table 28 gives the 15-object header for the binary files for Level 2 products, which is then used throughout. This is the same for all, except the PACKETID (fixed for each product type) that gives a different description for each packet, shown in blue. In addition to the header objects, all the Burst mode products have the exact same 7-object footer; however as each Burst mode product's footer starts at a different byte number (because their Data arrays are different sizes), they are listed in full for each Burst mode product.

Other objects may have similar names in different product types, i.e. DATA_TOTAL or MIN_SUBTRACTED_VALUE, but may have different sizes or be different types (i.e. float or unsigned integer of either 2 or 4 bytes) depending on which Level 2 product they are. The exception is COMPRESSION_RATIO, which is exactly the same format/description for all products where it occurs.

Level 2 files of Version 01 were through to January 2014 (up to and including High Voltage Checkout #2, HVCO2). Since then Version 02 was used exclusively (and all past flight data re-processed to Version 02). Only Version 02 files will be included in the PDS.

There differences between version 02 and 01 are:

- Version 02 has a standard object SCLKSCET_VERSION that is not present in Version 01.
- Version 01 JAD_HRS_ION_TOF code had incorrectly unpacked the level 1 data to make the level 2 file (error in documentation about how to decode the data that went un-noticed until HVCO2). This results in non-scientific data of very high counts. Version 02 data used the correct decoding method and is suitable for science.

Where following tables list start byte of objects, it assumes version 2 or above.

CODMAC Level 1 data (not in PDS, see section 3.3.1) collects counts in the DATA object, however has a MIN_SUBTRACTED_VALUE removed from it prior to onboard compression. For CODMAC Level 2 data here we use DATA_TOTAL instead of DATA as an object, where:

DATA_TOTAL = DATA + MIN_SUBTRACTED_VALUE

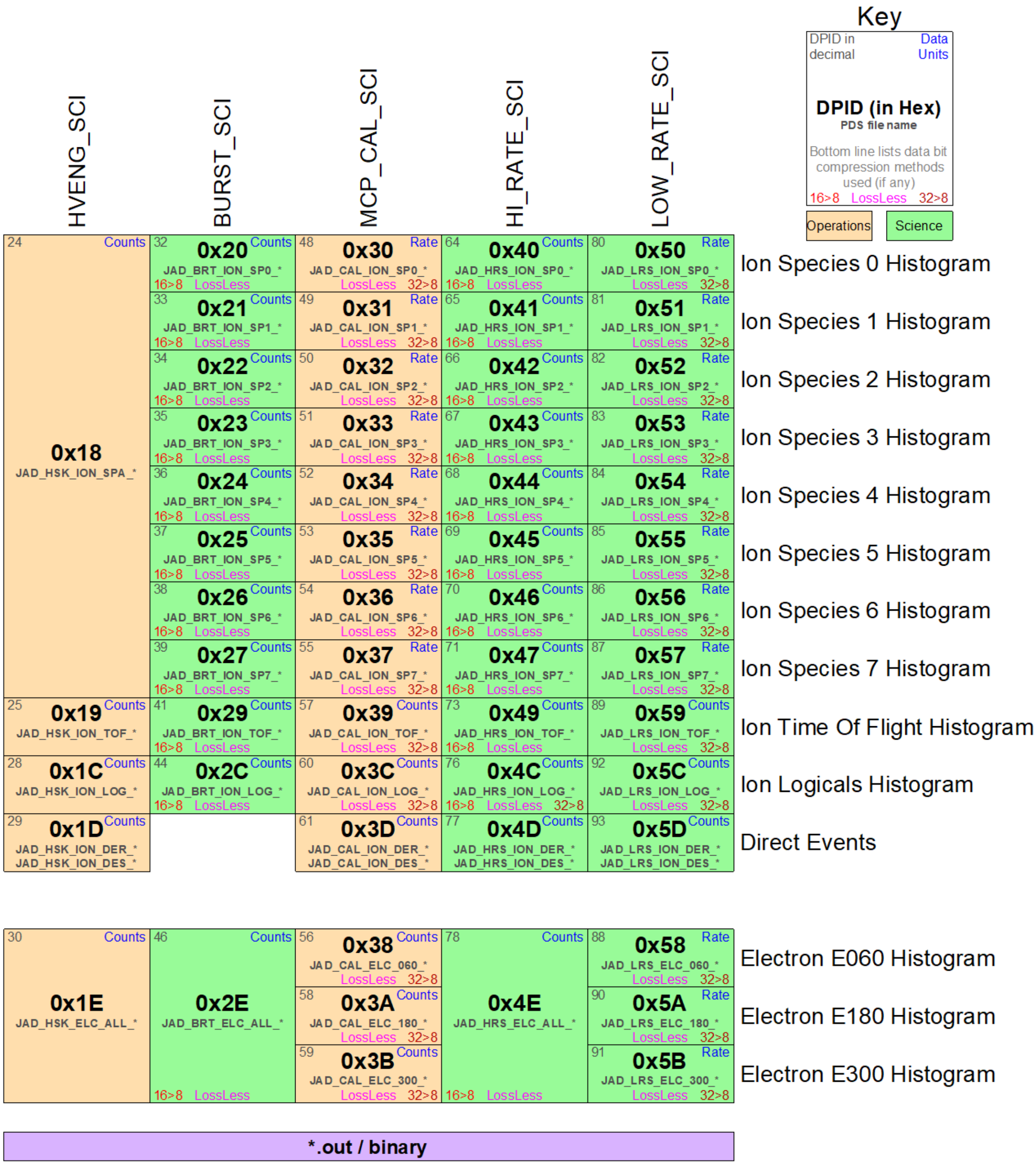
Since MIN_SUBTRACTED_VALUE is always given with DATA_TOTAL, you can work out DATA yourself if required.

Figure 5 shows all 56 different JADE *_SCI product IDs that will go in to the PDS, grouping them together in to Science and Operations. Product IDs are numerically represented in hex, and only those with PACKETIDs greater than 10 will go in to the PDS.

Table 25 and Table 26 summarize the type of data the 56 different JADE *_SCI products provide, and how they are arranged and lossy compressed. For instance 16>8 bit means that the value onboard was collected as a two-byte unsigned integer, but lossy compressed to 1 byte for transmission to ground (lossless compression may also have occurred after this step). Although low rate science can send back electron data from any individual sensor, only one is returned due to bandwidth constraints.

Note that the FMT files describe DATA_TOTAL (or DATA) as 1D vectors, while the descriptions are often 2D or 3D arrays. This is a consequence of the telemetry stream where the 1D vector should be reformed by the user to a 2D or 3D array. The 1D ordering is based on c, in that the last dimension changes fastest. i.e. if a 1D array is x=[1, 2, 3, 4, 5, 6] and that should be a 3x2 array y, then:

y[0][0] = 1; y[0][1] = 2; y[1][0] = 3; y[1][1] = 4; y[2][0] = 5; y[2][1] = 6;



Note: LossLess compression is a commanding switch, and could be turned off to give 0% compression. However the 16>8 bit and 32> 8 bit look up tables are always on.

Figure 5: 'Periodic' table comparing the different JADE products, giving their packet ID number in hex (DPID in figure key, see entry in Table 28), decimal, the PDS name fragment and information on what type of compression was used, and whether it records counts per accumulation or count rates.

Object	Data Type

8 18 18 19 18 26 35 18 18 18 18 26 19 19 19

*Figure 6: Breaking out the JADE Level 2 products in to the different Objects to allow similarities to be drawn. There are a total of 56 products, compressed here for readability, where JAD_***_ION_SPM denotes eight (SP0-SP7) products for each of BRT, CAL, HRS, and LRS.*

Table 25: Data Collection types by dimensions.
One spin is 24 E-Spin-Phase Sectors or 56 I-Spin-Phase Sectors, Defl. is short for Deflection.
'+1?' Signifies optional species, dependent on data policing.
Background anodes have been ignored for this table.

	Burst	HRS[A]		LRS[A]	MCP CAL[A]	HVENG[A]
Electrons	3 Sensors 64 Energy 16 Anodes	*3 Sensors*[B] 32 Energy 16 Fine	32 Energy 8 Coarse	1 Sensor 64 Energy 24 E-Spin-Phase	3 Sensors 64 Energy 16 Anodes	3 Sensors 16 Anodes
Ion Species	3 Species 32 Energy 8 Defl. 12 Anodes	(2+1?) Species 32 Energy 4 Defl. 12 Anodes		(1+1?) Species 32 Energy 56 I-Spin-Phase	(1+1?) Species 32 Energy 56 I-Spin-Phase	8 Species 12 Anodes
Ion TOF	32 Energy 128 TOF	16 Energy 128 TOF		16 Energy 64 TOF	16 Energy 64 TOF	128 TOF
Ion Log	32 Energy 8 Defl. 4 Logs	32 Energy 4 Defl. 4 Logs	21 Logs	25 Logs	25 Logs	25 Logs
Ion DE	N/A	DE Words		DE Words	DE Words	DE Words

A: Burst data gives the onboard maximum resolution, the other data types are collapsed from that.
B: All 3 electron sensors are used in the Fine & Coarse bin definitions, but is not a dimension.

Table 26: Data Collection types by units (green), lossy bit compression (red) and number of files (purple) and dimension of data in those files (black).

	Burst	HRS		LRS	MCP CAL	HVENG
Electrons	1 File 3 Dims. Counts 16>8 bit	1 File 2 Dims. Counts 16>8 bit	2 Dims. Counts 16>8 bit	1 File 2 Dims. *Rate* 32>8 bit	3 Files 2 Dims. Counts 32>8 bit	1 File 2 Dims. Counts None
Ion Species	3 Files 3 Dims. Counts 16>8 bit	(2+1?) Files 3 Dims. Counts 16>8 bit		(1+1?) Files 2 Dims. *Rate* 32>8 bit	(1+1?) Files 2 Dims. *Rate* 32>8 bit	1 File 2 Dims. Counts None
Ion TOF	1 File 2 Dims. Counts 16>8 bit	1 File 2 Dims. Counts 16>8 bit		1 File 2 Dims. Counts 32>8 bit	1 File 2 Dims. Counts 32>8 bit	1 File 1 Dim Counts None
Ion Log	1 File 3 Dims. Counts 16>8 bit	1 File 3 Dims. Counts 16>8 bit	1 File 1 Dim Counts 32>8 bit	1 File 1 Dim. Counts 32>8 bit	1 File 1 Dim. Counts 32>8 bit	1 File 1 Dim. Counts None
Ion DE	N/A	1 File 1 Dim. Counts None		1 File 1 Dim. Counts None	1 File 1 Dim. Counts None	1 File 1 Dim. Counts None

Counts = Total Counts,
Rate = Count rates (normalized by number of views)

Table 27 shows how a typical orbit may be split up between the different telemetry modes, typical cadences of records, and data volume. Note these are just an example and actual orbits may vary.

Table 27: Data Collection for a proposed typical ~11-day orbit.

	Burst	HRS	LRS		MCP CAL	HVENG
Orbit duration in each type of mode:						
Duration	23 minutes	12 hours	44 hours	205 hours	2 hours	1 hour
Cadence (seconds)						
Electrons	1	1	30	300	30	30
Ion Species	4	4	30	300	30	30
Ion TOF	4	4	30	300	30	30
Ion LOGs	4	4	30	300	30	30
Ion DE	N/A	600	14400	36000	600	36000
Number of records per orbit at given cadence						
Electrons	1380	43200	5280	2460	720	120
Ion SP?	1035	21600 - 32400	5280 - 10560	2460 - 4920	240 - 480	120
Ion TOF	345	10800	5280	2460	240	120
Ion LOGs	345	10800	5280	2460	240	120
Ion DE	0	72	11	20.5	12	0.1
Estimated megabyte (MB) per orbit (assuming maximum values)						
Electrons	8.7	69.1	31.3	14.6	3.0	0.03
Ion SP?	8.2	96.8	72.8	33.9	3.3	0.05
Ion TOF	2.7	42.8	20.9	9.8	1.0	0.07
Ion LOGs	0.7	12.0	0.8	0.4	0.04	0.02
Ion DE(R)	0	0.3	0.09	0.05	0.05	0.001
Ion DE(S)	0	9.8	2.8	1.5	1.6	0.02
Total	20.3	230.9	127.4	61.5	9.0	0.2
Estimated megabyte (MB) total (assuming maximum values)						
	450 MB per orbit (= 41 MB per day)					

There two types of LRS modes, the data packets are identical, just the ACCUMULATION_TIME changes.
DER and DES are the same data, DER is the data from JADE, while DES unpacks that data, just different formats.
The values above are inclusive of both the data and their required headers per record.

The following table (over 3 pages) describes the header that is identical for all the following data products (and is based on Version 02 FMT files). The names and word type (int/float/etc.) for all level 2 data is also summarized in Figure 6. Any text in *red italics* is a note that is not in the FMT file, while any text in **blue boldface** may change depending on the product (usually just the product ID or species number). This color system will apply for format tables throughout the rest of section 6.2.

Table 28: Format of Level 2 data record header for all binary data files.

Byte	Bit	Length (bits)	Name	Description
1	0	32	SYNC	JADE Sync Pattern for IDP packets. Hex value = 0xFAF33403, Decimal = 4210242563
5	0	8	DPID_COUNT	DPID Count (Source Sequence Count) Count of the number of times this product has been generated since the startup (or reset) of the generating application (Boot Program or Science Program). This count resets to 0 upon entry to the modes of BOOT, LVENG, HVENG, LOW_RATE_SCI, MCP_CAL_SCI, HI_RATE_SCI. Note: starts with 0, increments by 1, eventually rolls over at 255.
6	0	8	COMPRESSION	Lossless Compression Status. Indicates whether the data (non-header) segment of the IDP packet (IDP Data) was lossless compressed. 0 = Not Compressed **1 = Compressed** *Last line only shown if the packet could be compressed.*
7	0	16	IDPLENGTH	IDP Length, Byte Length of the IDP packet.
9	0	8	PACKETID	Packet ID (DPID), Data Product Identifier *Followed by Name of Packet ID for each product, e.g.* **High Rate Science - Ion Species Histogram Species 00: 0x40**
10	0	8	FLIGHT_OR_STL	In Flight data, or STL (ground EM tests): 0 = In flight, from JADE on Juno (via FEI) 1 = On ground, from STL tests (via FEI) 2 = On ground, from SwRI tests (not FEI) 255 = Unknown
11	0	32	ISSUES	Issues in data? 0 = All seems well *This object is a place holder with other values to be determined, currently all data files use a fill value.* 4294967295 = Fill Value / unknown
15	0	32	FSW_VERSION	Flight Software version used. Number should be to 2 decimal places.

Byte	Bit	Length (bits)	Name	Description
19	0	32	TABLES_VERSION	Tables version used onboard. All tables are combined (compression, sweeping, macros, etc.) onboard in to a large image. This is the image number, or table version. Number should be to 2 decimal places.
23	0	16	SCLKSCET_VERSION	The NAIF SPICE kernel for sclk used to generate UTC. The JUNO sclk files are used to convert the spacecraft clock timestamps to UTC time, and all have filenames JNO_SCLKSCET.nnnnn.tsc, where nnnnn is the SCLKSCET version number (with leading zeros and positive). Each kernel has a reconstructed and predicted part for it's values, typically any time after the last row of the SCLK01_COEFFICIENTS_61999 table is predicted. If TIMESTAMP_WHOLE:TIMESTAMP_SUB is in the predicted part then SCLKSCET_VERSION will be negative, the absolute value would be the version number. If a later SCLKSCET kernel version is used the UTC time will likely be different. If TIMESTAMP_WHOLE:TIMESTAMP_SUB is in the reconstructed region the number will be positive (equal to the version number) and will not vary with later kernels. e.g. If SCLKSCET_VERSION = -17 then kernel JNO_SCLKSCET.00017.tsc was used to convert to UTC, but it's a predicted UTC time. If SCLKSCET_VERSION = 18 then kernel JNO_SCLKSCET.00018.tsc was used to convert to UTC, and it's a reconstructed UTC time that will not change with later SCLKSCET kernel versions. Within the PDS archive this value should always be positive." [] *NOTE: This object was not in V01 files, and first appeared in V02. Subsequently, the Byte start of following objects have a Byte start that is 2 less than the values shown in the rest of this document.*

Byte	Bit	Length (bits)	Name	Description
25	0	168	UTC	UTC timestamp, of format yyyy-dddTHH:MM:SS.sss where yyyy = year, ddd = day of year, HH = hour, MM = minute, SS.sss = decimal seconds to millisecond resolution. Value calculated via SPICE from spacecraft clock time, TIMESTAMP_WHOLE:TIMESTAMP_SUB For Science modes this is the UTC equivalent of spacecraft clock when the data for this packet was collected (i.e. Start time). For Boot programs (operations team's housekeeping data) it is the time when or the packet was transmitted.
46	0	8	DATA_UNITS	The Data could be total counts (per accumulation) or a rate, normalized to counts per view. 0 = All counts in the accumulation period (int) 1 = All counts divided by number of views (float) 255 = Not appropriate for this dataset, or Unknown.
47	0	32	TIMESTAMP_ WHOLE	Timestamp (Whole Second), For Science modes this is the Timestamp whole second of when the data for this packet was collected (i.e. Start time). For Boot programs (operations team's housekeeping data) it is the time when or the packet was transmitted. Referenced from 12:00UTC 2000/01/01. Note: Spacecraft Clock = TIMESTAMP_WHOLE:TIMESTAMP_SUB
51	0	16	TIMESTAMP_S UB	Timestamp (Subsecond) For Science modes this is the Timestamp subsecond of when the data for this packet was collected (i.e. Start time). For Boot programs (operations team's housekeeping data) it is the time when or the packet was transmitted. Unit: Microseconds scaled to 16 bits. Note: Spacecraft Clock = TIMESTAMP_WHOLE:TIMESTAMP_SUB
53	0	16	ACCUMULATI ON_TIME	Accumulation Time Number of seconds over which the data in this product was collected (Science Program). *NOTE: This is not the collection period of a given energy step at a given angle, etc., that would be used to convert to counts/second. It is the time it took to collect all the data measured within this record.*

6.2.6.1 HVENG_SCI (JADE packet IDs 0x18 to 0x1E)

The HVENG_SCI products are mainly intended for operations use rather than science.
Unlike the others they are never compressed onboard the spacecraft. Hence there are not *MIN_SUBTRACTED_VALUE* nor *COMPRESSION_RATIO* objects listed (if there were they would always be values 0 and 1 respectively). Similarly there are no *DATA_TOTAL* objects (*DATA_TOTAL* = *MIN_SUBTRACTED_VALUE* + *DATA*), just *DATA*.

6.2.6.1.1 JAD_HSK_ION_SPA_*

The DATA object here is 2-D, 8 Species x 12 Anodes for telemetry to Earth, however has been broken up to 8 objects (DATA_SP***n***, where ***n*** is 0 to 7), each of 12 Anodes. (Note, the DAT file is the same either way, only the FMT file is different.)

*Table 29: Format of Level 2 data records for JAD_HSK_ION_SPA_**

Byte	Bit	Length (bits)	Name	Description
See Level 2 binary header from Table 28 *for bytes 1 to 54.*				
55	0	384	DATA_SP0	Counts summed for ion species 0. 12 Anodes, order: anode 0 to anode 11. The meaning of each species is described in the JADE instrument paper. 16-bit counter over 32 energies over ACCUMULATION_TIME
103	0	384	DATA_SP1	Counts summed for ion species 1. *Rest of description as for DATA_SP0, cut here to fit table on 1 page in the SIS*
151	0	384	DATA_SP2	Counts summed for ion species 2. *Rest of description as for DATA_SP0.*
199	0	384	DATA_SP3	Counts summed for ion species 3. *Rest of description as for DATA_SP0.*
247	0	384	DATA_SP4	Counts summed for ion species 4. *Rest of description as for DATA_SP0.*
295	0	384	DATA_SP5	Counts summed for ion species 5. *Rest of description as for DATA_SP0.*
343	0	384	DATA_SP6	Counts summed for ion species 6. *Rest of description as for DATA_SP0.*
391	0	384	DATA_SP7	Counts summed for ion species 7. *Rest of description as for DATA_SP0.*

6.2.6.1.2 JAD_HSK_ION_TOF_*

The DATA object here is originally 128 TOF bins for telemetry to Earth, however has been broken up to 4 objects. The first is still DATA, TOF bins 0-124 only. The final 3 are scalars that were originally noted in TOF bins 125-127, but have other meanings. (Note, the DAT file is the same either way, only the FMT file is different.) Note that "collapsed" means summed over all energies in this case.

*Table 30: Format of Level 2 data records for JAD_HSK_ION_TOF_**

Byte	Bit	Length (bits)	Name	Description
See Level 2 binary header from Table 28 *for bytes 1 to 54.*				
55	0	4000	DATA	Histogram counts summed for TOF bins 0-124. The meaning of the TOF values is described in the JADE instrument paper. This product is collapsed from the onboard 32 Energy x 128 TOF histogram to 1 Energy x 128 TOF, where this object is the first 125, and the last 3 are the following 3 objects: TOF_WITH_START_OVERLOAD, TOF_BELOW_MIN, TOF_TOO_LONG 16-bit counter over 32 energies over ACCUMULATION_TIME
555	0	32	TOF_WITH_START_OVERLOAD	TOF with Start overload. 16-bit counter over 32 energies over ACCUMULATION_TIME
559	0	32	TOF_BELOW_MIN	TOF value below minimum resolution. 16-bit counter over 32 energies over ACCUMULATION_TIME
563	0	32	TOF_TOO_LONG	TOF too long. 16-bit counter over 32 energies over ACCUMULATION_TIME

6.2.6.1.3 JAD_HSK_ION_DER_*

The formats for are identical for these four Level 2 products:
JAD_HSK_ION_DER, JAD_CAL_ION_DER, JAD_HRS_ION_DER, JAD_LRS_ION_DER
The following table is for JAD_HSK_ION_DER, but no text changes.

Direct Event data records the full resolution data on an event-by-event basis, as opposed to the other data products which are collapsed based on product type over an accumulation period. Whereas JAD_*_ION_TOF_* data will collect the number of incident ions at each energy step falling within each TOF bin over an accumulation period, Direct Event data record the anode, TOF bin, and ESA step on an event by event basis. Because of this the data volume of Direct Events is too large to provide a continuous record and only a subset is returned. Direct Events will be of most use in performing spot validation of the other data products.

The DE-Words contained in the JAD_*_ION_DER_* data require decoding, and have been decoded in the JAD_*_ION_DES_* files, see Table 33. As such, we expect the users to use the JAD_*_ION_DES_* products in preference to the JAD_*_ION_DER_* ones.

*Table 31: Format of Level 2 data records for JAD_HSK_ION_DER_**

Byte	Bit	Length (bits)	Name	Description
See Level 2 binary header from Table 28 *for bytes 1 to 54.*				
55	0	16	DE_COL_SUB_ SEQ_COUNT	Direct Events Collection sub-sequence count. Resets to 0 at the start of the playback of a new collection cycle. Increments for each produced packet, before data policing, thus acting as an indicator for data policing loss. Prior to 2013 this value was not in the flight software, therefore is given as MISSING_CONSTANT.
57	0	34752	DE_DATA	DE_DATA: Counts Array of 16-bit raw direct events. A Direct Event is information about each specific particle that hit the Ion sensor. [See PDS JADE SIS document for JAD_HSK_ION_DES for a table on how to decode this 2-byte word.] Note, not all 2172 bytes are used, see following Object, i.e. MISSING_CONSTANT and VALID_MAXIMUM are the same value. *Note 2172 is the maximum onboard limit for this packet.*
4401	0	16	DE_SIZE	Array size of Direct Events to use. The Above Data array can vary in size, but PDS records must be a fixed size, so the end is padded with fill values. This value tells you how many values should be used (starting from the beginning).

6.2.6.1.4 JAD_HSK_ION_DES_*

The formats for are identical for these four Level 2 products:
JAD_HSK_ION_DES, JAD_CAL_ION_DES, JAD_HRS_ION_DES, JAD_LRS_ION_DES

This is the same data as for the JAD_***_ION_DER products (from the same JADE packet IDs), except the DE_DATA object's data is split out in to it's many meanings. Table 32 describes how the two-byte word can either be an *event* word, a *boundary* word, a *sweep marker* word or a *fill value* (occasionally required for padding DE_DATA to a fixed size), and then how to split up the bit pattern for each. Each DE_DATA word then becomes an entire JAD_***_ION_DES record. As such, one JAD_***_ION_DER record can become (up to) 2,172 JAD_***_ION_DES records. If the DE_DATA word was fill then no JAD_***_ION_DES record is written. Technically the Sweep Number is a 14-bit long value, however it has a limit of 1800, which results in bits 13 to 11 always being zero. Direct Events will be of most use in performing spot validation of the other data products.

*Table 32: Description of DE_DATA two-byte words for *_DER_* files to show how it is split out for the *_DES_* files.*

Bit number	**15**	**14**	**13**	**12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Event Word	0	TOF								Anode ID				QF2	0	QF0
Boundary Word LRS/CAL/HSK	1	0	0	0	0	0	0	0	ESA Step					0	0	0
Boundary Word HRS	1	0	0	0	0	0	0	0	ESA Step					DFL Step		
Sweep Marker Word	1	1	Sweep Number (max 1800)													
			0	0	0	Sweep Number										
Fill Value	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

The format of the JAD_HSK_ION_DES_* data records is given on the next page.

The following table (over 2 pages) is for JAD_HSK_ION_DES, but no text changes for other JAD_***_ION_DES_ products.

*Table 33: Format of Level 2 data records for JAD_HSK_ION_DES_**

Byte	Bit	Length (bits)	Name	Description
See Level 2 binary header from Table 28 *for bytes 1 to 54.*				
55	0	16	DE_COL_SUB_SEQ_COUNT	Direct Events Collection sub-sequence count. Resets to 0 at the start of the playback of a new collection cycle. Increments for each produced packet, before data policing, thus acting as an indicator for data policing loss. Prior to 2013 this value was not in the flight software, therefore is given as MISSING_CONSTANT.
57	0	8	DE_ZEROS	Direct Event Zeros. (bits 14-8) Value should be zero and is only given when DE_EVENT0_BOUNDARY1_MARKER2 is 1, otherwise equals MISSING_CONSTANT.
58	0	8	DE_EVENT0_BOUNDARY1_MARKER2	Direct Event, or Boundary, or Sweep Marker, Word. 0 = Direct Event Word 1 = Boundary Word 2 = Sweep Marker Word 255 = Fill Value - all other DE_* objects should also be their MISSING_CONSTANT VALUE To decode the original bit pattern of a DE_WORD: 0 if bit 15 = 0 1 if bit 15 = 1 and bit 14 = 0 2 if bit 15 = 1 and bit 14 = 1
59	0	16	DE_SWEEP_NUMBER	Direct Event Sweep Number. (bits 13-0) Value is only given when DE_EVENT0_BOUNDARY1_MARKER2 is 2, otherwise equals MISSING_CONSTANT.
61	0	8	DE_ESA_STEP	Direct Event ESA Step. (bits 7-3) Value is only given when DE_EVENT0_BOUNDARY1_MARKER2 is 1, otherwise equals MISSING_CONSTANT.
62	0	8	DE_DFL_STEP	Direct Event DFL Step. (bits 2-0) Value is only given when DE_EVENT0_BOUNDARY1_MARKER2 is 1, otherwise equals MISSING_CONSTANT.

Byte	Bit	Length (bits)	Name	Description
63	0	16	DE_TOF	Direct Event TOF value. (bits 14-7) 0-253: Valid TOF measurement (min_TOF to 330ns) 254: Start_Stop with t < min_TOF 255: Timeout (no stop before 330 ns) 65535: Fill value = MISSING_CONSTANT (Value in telemetry is 1 byte (0-255) only, but upcast to 2 bytes here to allow a MISSING_CONSTANT value to be added.) Value is only given when DE_EVENT0_BOUNDARY1_MARKER2 is 0, otherwise equals MISSING_CONSTANT.
65	0	8	DE_ANODE_ID	Direct Event Anode ID. (bits 6-3) 0-11:Valid Anode ID, 0-11. 12-13:Reserved (should never be seen). 14 :No Anode ID between Start and Stop. 15 :Two non-adjacent Anodes IDs between Start and Stop. Value is only given when DE_EVENT0_BOUNDARY1_MARKER2 is 0, otherwise equals MISSING_CONSTANT.
66	0	8	DE_QUALITY_FLAG_2	Direct Event Quality Flag 2: (bit 2) Two Adjacent Anode IDs between Start and Stop. 0 = Flag not triggered, 1 = Flag triggered. Value is only given when DE_EVENT0_BOUNDARY1_MARKER2 is 0, otherwise equals MISSING_CONSTANT.
67	0	8	DE_QUALITY_FLAG_1	Direct Event Quality Flag 1: (bit 1) Reserved - should be 0. Value is only given when DE_EVENT0_BOUNDARY1_MARKER2 is 0, otherwise equals MISSING_CONSTANT.
68	0	8	DE_QUALITY_FLAG_0	Direct Event Quality Flag 0: (bit 0) Additional Start(s) between Start and Stop. 0 = Flag not triggered, 1 = Flag triggered. Value is only given when DE_EVENT0_BOUNDARY1_MARKER2 is 0, otherwise equals MISSING_CONSTANT.

6.2.6.1.5 JAD_HSK_ION_LOG_*

Unlike JAD_CAL_ION_LOG or JAD_LRS_CAL_LOG, this data is telemeted uncompressed (do DATA rather than DATA_TOTAL), and actually is returned as 25 separate scalar objects. To make it similar to the others though we have made it one object of 25. (Note, the DAT file is the same either way, only the FMT file is different.)

*Table 34: Format of Level 2 data records for JAD_HSK_ION_LOG_**

Byte	Bit	Length (bits)	Name	Description
See Level 2 binary header from Table 28 *for bytes 1 to 54.*				
55	0	800	DATA	DATA: Counts All 32 energies summed together. The 25 Logical counters are: [0]: Anode 0 [1]: Anode 1 [2]: Anode 2 [3]: Anode 3 *And so on to Anode 11… cut here to fit table on 1 page.* [10]: Anode 10 [11]: Anode 11 [12]: Background [13]: Start-Stop Overload [14]: All Starts [15]: All Stops [16]: Non-Adjacent Anodes [17]: Adjacent Anodes [18]: Stop without Start [19]: Dual Start [20]: Start in Process Time [21]: TOF Underflow [22]: TOF Overflow [23]: Invalid TOF Event (Invalid Start-Stop) [24]: Event Strobe (16-bit counter over 32 energies over ACCUMULATION_TIME)

6.2.6.1.6 JAD_HSK_ELC_ALL_*

The onboard 64 Energies by 51 Anodes set is collapsed during HVENG to 1 Energy x 51 Anodes; which are then ordered sensor E060 anodes 0-15, E180 anodes 0-15, E300 anodes 0-15, E060 background anode, E180 background anode and finally E300 background anode. This could be one PDS object, instead we've split them out in to 6 objects as the following table shows. (The DAT file is the same format either way, it's just the FMT file that was altered.)

*Table 35: Format of Level 2 data records for JAD_HSK_ELC_ALL_**

Byte	Bit	Length (bits)	Name	Description
See Level 2 binary header from Table 28 *for bytes 1 to 54.*				
55	0	512	DATA_E060	E060 Anodes 0-15, Counts summed. 16-bit counter over 64 energies over ACCUMULATION_TIME. Theoretical range (with max Accumulation of 1800s) is 0 to 7549632000, greater than a 4-byte unsigned int. It is extremely unlikely to fill 4-bytes, but if it does it will simply roll over to zero and keep going.
119	0	512	DATA_E180	E180 Anodes 0-15, Counts summed. 16-bit counter over 64 energies over ACCUMULATION_TIME. Theoretical range (with max Accumulation of 1800s) is 0 to 7549632000, greater than a 4-byte unsigned int. It is extremely unlikely to fill 4-bytes, but if it does it will simply roll over to zero and keep going.
183	0	512	DATA_E300	E300 Anodes 0-15, Counts summed. 16-bit counter over 64 energies over ACCUMULATION_TIME. Theoretical range (with max Accumulation of 1800s) is 0 to 7549632000, greater than a 4-byte unsigned int. It is extremely unlikely to fill 4-bytes, but if it does it will simply roll over to zero and keep going.
247	0	32	BACKGROUND_COUNTS_E060	Background Anode Counts for E060 16-bit counter over 64 energies over ACCUMULATION_TIME
251	0	32	BACKGROUND_COUNTS_E180	Background Anode Counts for E180 16-bit counter over 64 energies over ACCUMULATION_TIME
255	0	32	BACKGROUND_COUNTS_E300	Background Anode Counts for E300 16-bit counter over 64 energies over ACCUMULATION_TIME

6.2.6.2 BURST_SCI (JADE packet IDs 0x20 to 0x2E)

The Burst data all consist of the header (Table 28), DATA_TOTAL that varies in description and size, followed by a footer that is the same format for all burst products. The footer consists of the following objects:

MIN_SUBTRACTED_VALUE
COMPRESSION_RATIO
BH_PROCESSED
BH_WAVES_QUALITY_FACTOR
BH_TIMESTAMP_WHOLE_QPS
BH_TIMESTAMP_SUB_QPS
BH_TIMESTAMP_WHOLE_WQF
BH_TIMESTAMP_SUB_WQF
BH_JADE_PREEVENT_WORDS.

[Objects begin with BH_ as a shorthand reminder that these are Burst mode Headers (BH).]

However, as the DATA_TOTALs for different products are different sizes, different products start the footer on different bytes. To keep tables to a minimal number of pages, the footer is listed in full for JAD_BRT_ION_SP0, then subsequent Burst modes will have their description refer to that table (shown in red).

6.2.6.2.1 JAD_BRT_ION_SP0_* to JAD_BRT_ION_SP7_*

The formats for are identical for these eight Level 2 products:
JAD_BRT_ION_SP0, JAD_BRT_ION_SP1, JAD_BRT_ION_SP2, JAD_BRT_ION_SP3, JAD_BRT_ION_SP4, JAD_BRT_ION_SP5, JAD_BRT_ION_SP6, JAD_BRT_ION_SP7
The following table (over the next 2 pages) is for JAD_BRT_ION_**SP0**, with the **SP0** being the only text that changes for the others.

*Table 36: Format of Level 2 data records for JAD_BRT_ION_SP0_**

Byte	Bit	Length (bits)	Name	Description
See Level 2 binary header from Table 28 *for bytes 1 to 54.*				
55	0	49152	DATA_TOTAL	DATA_TOTAL: Counts 32 Energy x 8 Deflection x 12 Anodes for **SP0**. The meaning of each species is described in the JADE instrument paper. This product is the raw onboard 32 E x 8 Def. x 12 Anode cube, no collapsing.
6199	0	32	MIN_SUBTRACTED_VALUE	Min Subtracted Value Minimum value subtracted from every element in the array data blob. Note: In Burst Mode counts are stored as uint16 for use so despite this being uint32 here, it can not be greater than 65535. If this is unprocessed Burst mode (see BH_PROCESSED object) then no Min Subtracted value existed as there is no compression of any type. Instead this value is calculated on the ground so that the product more closely resembles the processed Burst mode data.
6203	0	32	COMPRESSION_RATIO	Data compression ratio of data blob when it was transmitted to Earth: Ratio = Compressed size/Uncompressed size This is the compression due to the lossless scheme, and does not include any lossy compression which may have occured prior to it, such as the 32-bit to 8-bit or 16-bit to 8-bit look up tables that are often used prior to the lossy compression. A value of 1 means there was no lossless data compression, i.e. it was turned off.
6207	0	8	BH_PROCESSED	Burst Mode processed Flag. This indicates how the data was packaged for downlink, although the final data are the same format. 0 = Unprocessed 1 = Processed When processed the onboard data has a minimum value removed, is usually 2-byte to 1-byte compressed with look up tables, and then that 1-byte value is non-lossy compressed. When Unprocessed, the 2-byte data is sent down as 2-byte words, with no compression of any type. In addition, no minimum value is removed for the downlink. Rather than give a MISSING_CONSTANT value for MIN_SUBTRACTED_VALUE in those records the minimum is calculated on the ground to better match Processed burst mode data records.

Byte	Bit	Length (bits)	Name	Description
6208	0	8	BH_WAVES_QUALITY_FACTOR	Waves Quality Factor. Quality factor associated with the saved bin received from Waves, or 0 if no quality factor.
6209	0	32	BH_TIMESTAMP_WHOLE_QPS	Quality Point Spacecraft Timestamp Seconds. The seconds field of the time when either 1) the spacecraft software processed the Waves quality factor that caused the bin, or 2) for bins with data with no quality factor, the time when the bin completed filling. Note: This is either the start (1) or stop (2) time.
6213	0	16	BH_TIMESTAMP_SUB_QPS	Quality Point Spacecraft Timestamp Subseconds. The subseconds field of the time when either 1) the spacecraft software processed the Waves quality factor that caused the bin, or 2) for bins with data with no quality factor, the time when the bin completed filling. Note: This is either the start (1) or stop (2) time.
6215	0	32	BH_TIMESTAMP_WHOLE_WQF	Waves Quality Factor Timestamp Seconds. The seconds field of the timestamp sent by the Waves instrument with the quality factor that caused the bin to be saved. For bins filled with initialization data for which there is no Waves quality factor, this value is 99999. Note: 0 was the original missing constant, as with BH_TIMESTAMP_SUB_WQF. If BH_WAVES_QUALITY_FACTOR = 0 then this 0 was altered on the ground to 99999.
6219	0	32	BH_TIMESTAMP_SUB_WQF	Waves Quality Factor Timestamp Subseconds. The subseconds field of the timestamp sent by the Waves instrument with the quality factor that caused the bin to be saved. Each count in this field represents 1/(2^16) seconds. For bins filled with initialization datafor which there is no Waves quality factor, this value is 99999. Note: 0 was the original missing constant, but that was also a valid value. If BH_WAVES_QUALITY_FACTOR = 0 then this 0 was altered on the ground to 99999.
6223	0	32	BH_JADE_PREEVENT_WORDS	JADE Pre-event Words. Number of words in the saved bin preceding the quality point. Nominally will be the configured value, but may be fewer if there are there are fewer words in the bin when the Waves quality factor is received. Will be 0 if the Waves quality factor is 0, indicating no quality factor.

6.2.6.2.2 JAD_BRT_ION_TOF_*

*Table 37: Format of Level 2 data records for JAD_BRT_ION_TOF_**

Byte	Bit	Length (bits)	Name	Description
See Level 2 binary header from Table 28 *for bytes 1 to 54.*				
55	0	65536	DATA_TOTAL	DATA_TOTAL: Counts 32 Energy x 128 TOF. The meaning of the TOF values is described in the JADE instrument paper. This product is the raw onboard 32 Energy x 128 TOF histogram, no collapsing. Of the 128 channels, the last 3 have a special meaning: TOF_WITH_START_OVERLOAD, TOF_BELOW_MIN, TOF_TOO_LONG.
8247	0	32	MIN_SUBTRACTED_VALUE	Min Subtracted Value *See* Table 36 *for description, cut here to fit on 1 page.*
8251	0	32	COMPRESSION_RATIO	Data compression ratio of data blob when it was transmitted to Earth: *See* Table 36 *for description, cut here to fit on 1 page.*
8255	0	8	BH_PROCESSED	Burst Mode processed Flag. *See* Table 36 *for description, cut here to fit on 1 page.*
8256	0	8	BH_WAVES_QUALITY_FACTOR	Waves Quality Factor. *See* Table 36 *for description, cut here to fit on 1 page.*
8257	0	32	BH_TIMESTAMP_WHOLE_QPS	Quality Point Spacecraft Timestamp Seconds. *See* Table 36 *for description, cut here to fit on 1 page.*
8261	0	16	BH_TIMESTAMP_SUB_QPS	Quality Point Spacecraft Timestamp Subseconds. *See* Table 36 *for description, cut here to fit on 1 page.*
8263	0	32	BH_TIMESTAMP_WHOLE_WQF	Waves Quality Factor Timestamp Seconds. *See* Table 36 *for description, cut here to fit on 1 page.*
8267	0	32	BH_TIMESTAMP_SUB_WQF	Waves Quality Factor Timestamp Subseconds. *See* Table 36 *for description, cut here to fit on 1 page.*
8271	0	32	BH_JADE_PREEVENT_WORDS	JADE Pre-event Words. *See* Table 36 *for description, cut here to fit on 1 page.*

6.2.6.2.3 JAD_BRT_ION_LOG_*

*Table 38: Format of Level 2 data records for JAD_BRT_ION_LOG_**

Byte	Bit	Length (bits)	Name	Description
See Level 2 binary header from Table 28 *for bytes 1 to 54.*				
55	0	16384	DATA_TOTAL	DATA_TOTAL: Counts 32 Energy x 8 Deflection x 4 Logical Counters. The counters are: [*][*][0]: All Starts [*][*][1]: Background [*][*][2]: Invalid TOF Event (Invalid Start-Stop) [*][*][3]: All Stops
2103	0	32	MIN_SUBTRACTED_VALUE	Min Subtracted Value *See* Table 36 *for description, cut here to fit on 1 page.*
2107	0	32	COMPRESSION_RATIO	Data compression ratio of data blob when it was transmitted to Earth: *See* Table 36 *for description, cut here to fit on 1 page.*
2111	0	8	BH_PROCESSED	Burst Mode processed Flag. *See* Table 36 *for description, cut here to fit on 1 page.*
2112	0	8	BH_WAVES_QUALITY_FACTOR	Waves Quality Factor. *See* Table 36 *for description, cut here to fit on 1 page.*
2113	0	32	BH_TIMESTAMP_WHOLE_QPS	Quality Point Spacecraft Timestamp Seconds. *See* Table 36 *for description, cut here to fit on 1 page.*
2117	0	16	BH_TIMESTAMP_SUB_QPS	Quality Point Spacecraft Timestamp Subseconds. *See* Table 36 *for description, cut here to fit on 1 page.*
2119	0	32	BH_TIMESTAMP_WHOLE_WQF	Waves Quality Factor Timestamp Seconds. *See* Table 36 *for description, cut here to fit on 1 page.*
2123	0	32	BH_TIMESTAMP_SUB_WQF	Waves Quality Factor Timestamp Subseconds. *See* Table 36 *for description, cut here to fit on 1 page.*
2127	0	32	BH_JADE_PREEVENT_WORDS	JADE Pre-event Words. *See* Table 36 *for description, cut here to fit on 1 page.*

6.2.6.2.4 JAD_BRT_ELC_ALL_*

*Table 39: Format of Level 2 data records for JAD_BRT_ELC_ALL_**

Byte	Bit	Length (bits)	Name	Description
See Level 2 binary header from Table 28 *for bytes 1 to 54.*				
55	0	52224	DATA_TOTAL	DATA_TOTAL: Counts 64 Energy x 51 Anodes. This product is the raw onboard 64 Energy x 51 Anodes data, with no collapsing. Anodes 0-15 are the 16 anodes of E060. Anodes 16-31 are the 16 anodes of E180. Anodes 32-47 are the 16 anodes of E300. Anode 48 is E060 background. Anode 49 is E180 background. Anode 50 is E300 background.
6583	0	32	MIN_SUBTRACTED_VALUE	Min Subtracted Value *See* Table 36 *for description, cut here to fit on 1 page.*
6587	0	32	COMPRESSION_RATIO	Data compression ratio of data blob when it was transmitted to Earth: *See* Table 36 *for description, cut here to fit on 1 page.*
6591	0	8	BH_PROCESSED	Burst Mode processed Flag. *See* Table 36 *for description, cut here to fit on 1 page.*
6592	0	8	BH_WAVES_QUALITY_FACTOR	Waves Quality Factor. *See* Table 36 *for description, cut here to fit on 1 page.*
6593	0	32	BH_TIMESTAMP_WHOLE_QPS	Quality Point Spacecraft Timestamp Seconds. *See* Table 36 *for description, cut here to fit on 1 page.*
6597	0	16	BH_TIMESTAMP_SUB_QPS	Quality Point Spacecraft Timestamp Subseconds. *See* Table 36 *for description, cut here to fit on 1 page.*
6599	0	32	BH_TIMESTAMP_WHOLE_WQF	Waves Quality Factor Timestamp Seconds. *See* Table 36 *for description, cut here to fit on 1 page.*
6603	0	32	BH_TIMESTAMP_SUB_WQF	Waves Quality Factor Timestamp Subseconds. *See* Table 36 *for description, cut here to fit on 1 page.*
6607	0	32	BH_JADE_PREEVENT_WORDS	JADE Pre-event Words. *See* Table 36 *for description, cut here to fit on 1 page.*

6.2.6.3 MCP_CAL_SCI (JADE packet IDs 0x30 to 0x3D)

6.2.6.3.1 JAD_CAL_ION_SP0_* to JAD_CAL_ION_SP7_*

The formats for are identical for these eight Level 2 products: JAD_CAL_ION_SP0, JAD_CAL_ION_SP1, JAD_CAL_ION_SP2, JAD_CAL_ION_SP3, JAD_CAL_ION_SP4, JAD_CAL_ION_SP5, JAD_CAL_ION_SP6, JAD_CAL_ION_SP7 The following table is for JAD_CAL_ION_**SP0**, with the **SP0** being the only text that changes for the others. For more information on spin-phase sectors see Table 41.

*Table 40: Format of Level 2 data records for JAD_CAL_ION_SP0_**

Byte	Bit	Length (bits)	Name	Description
See Level 2 binary header from Table 28 *for bytes 1 to 54.*				
55	0	57344	DATA_TOTAL	DATA_TOTAL: Counts per view 1 Species for **SP0**. 32 Energy x 56 Spin-Phase Sectors. The formula for mapping anodes into spin-phase sectors is described in the PDS JADE SIS and is given here in the following table, where the first column, SP, is Spin Phase (degrees), and the others are JADE-I anodes 4 to 11. SP , A4 , A5 , A6 , A7 , A8 , A9 ,A10 ,A11 -- 0 , 0 , 2 , 8 , 16 , 28 , 40 , 48 , 54 15 , 0 , 2 , 8 , 16 , 28 , 40 , 48 , 54 *Table cut here to fit on 1 page, see* Table 41 *for details.* 345 , 1 , 7 , 15 , 27 , 39 , 47 , 53 , 55 Note the data units are rates (counts per views), are floats rather than integers, and are fractions of 1/512.
7223	0	32	MIN_SUBTRACTED_VALUE	Min Subtracted Value Minimum value subtracted from every element in the array data blob. Note: the units are rates (counts per views), are floats rather than integers, and are fractions of 1/512.
7227	0	32	COMPRESSION_RATIO	Data compression ratio of data blob when it was transmitted to Earth: Ratio = Compressed size/Uncompressed size This is the compression due to the lossless scheme, and does not include any lossy compression which may have occured prior to it, such as the 32-bit to 8-bit or 16-bit to 8-bit look up tables that are often used prior to the lossy compression. A value of 1 means there was no lossless data compression, i.e. it was turned off.

Note: During 2011 (launch) through 2014 inclusive there was no flight data taken for the following products:
JAD_CAL_ION_SP0, JAD_CAL_ION_SP1, JAD_CAL_ION_SP2,
JAD_CAL_ION_SP4, JAD_CAL_ION_SP5, JAD_CAL_ION_SP7
However JAD_CAL_ION_SP3 and JAD_CAL_ION_SP5 data products do exist.
[Likewise in this period there are no flight data from these products either:
JAD_LRS_ION_SP0, JAD_LRS_ION_SP4, JAD_LRS_ION_SP6, JAD_LRS_ION_SP7]

The 56 Spin-Phase sectors (for all eight species of JAD_CAL_ION_**SP?** and JAD_LRS_ION_**SP?**) are made up from one spin of data using only JADE-I anodes 4 to 11. The following table tells you how to map the 56 Spin Phase sectors back to anodes and a spin phase. Anodes 0 to 3 are not used as they are redundant (viewing the same as anodes 4 to 7 at a different point in spin phase.).

Note: Spin phase referred here is the spin phase of the spacecraft +X vector, and not the spin phase of JADE-I's view, which is 195 degrees from spacecraft +X (in the direction towards +Y).

Table 41: Mapping JAD_CAL_ION_SP? or JAD_LRS_ION_SP? to spin-phase sectors

<table>
<tr><th>Spin Phase (Degrees)</th><th>JADE-I Anode 4</th><th>JADE-I Anode 5</th><th>JADE-I Anode 6</th><th>JADE-I Anode 7</th><th>JADE-I Anode 8</th><th>JADE-I Anode 9</th><th>JADE-I Anode 10</th><th>JADE-I Anode 11</th></tr>
<tr><td>**0**</td><td rowspan="12">0</td><td rowspan="4">2</td><td rowspan="3">8</td><td rowspan="2">16</td><td rowspan="2">28</td><td rowspan="3">40</td><td rowspan="4">48</td><td rowspan="12">54</td></tr>
<tr><td>**15**</td></tr>
<tr><td>**30**</td><td rowspan="2">17</td><td rowspan="2">29</td></tr>
<tr><td>**45**</td><td rowspan="3">9</td><td rowspan="3">41</td></tr>
<tr><td>**60**</td><td rowspan="4">3</td><td rowspan="2">18</td><td rowspan="2">30</td><td rowspan="4">49</td></tr>
<tr><td>**75**</td></tr>
<tr><td>**90**</td><td rowspan="3">10</td><td rowspan="2">19</td><td rowspan="2">31</td><td rowspan="3">42</td></tr>
<tr><td>**105**</td></tr>
<tr><td>**120**</td><td rowspan="4">4</td><td rowspan="2">20</td><td rowspan="2">32</td><td rowspan="4">50</td></tr>
<tr><td>**135**</td><td rowspan="3">11</td><td rowspan="3">43</td></tr>
<tr><td>**150**</td><td rowspan="2">21</td><td rowspan="2">33</td></tr>
<tr><td>**165**</td></tr>
<tr><td>**180**</td><td rowspan="12">1</td><td rowspan="4">5</td><td rowspan="3">12</td><td rowspan="2">22</td><td rowspan="2">34</td><td rowspan="3">44</td><td rowspan="4">51</td><td rowspan="12">55</td></tr>
<tr><td>**195**</td></tr>
<tr><td>**210**</td><td rowspan="2">23</td><td rowspan="2">35</td></tr>
<tr><td>**225**</td><td rowspan="3">13</td><td rowspan="3">45</td></tr>
<tr><td>**240**</td><td rowspan="4">6</td><td rowspan="2">24</td><td rowspan="2">36</td><td rowspan="4">52</td></tr>
<tr><td>**255**</td></tr>
<tr><td>**270**</td><td rowspan="3">14</td><td rowspan="2">25</td><td rowspan="2">37</td><td rowspan="3">46</td></tr>
<tr><td>**285**</td></tr>
<tr><td>**300**</td><td rowspan="4">7</td><td rowspan="2">26</td><td rowspan="2">38</td><td rowspan="4">53</td></tr>
<tr><td>**315**</td><td rowspan="3">15</td><td rowspan="3">47</td></tr>
<tr><td>**330**</td><td rowspan="2">27</td><td rowspan="2">39</td></tr>
<tr><td>**345**</td></tr>
</table>

6.2.6.3.2 JAD_CAL_ION_TOF_*

*Table 42: Format of Level 2 data records for JAD_CAL_ION_TOF_**

Byte	Bit	Length (bits)	Name	Description
See Level 2 binary header from Table 28 *for bytes 1 to 54.*				
55	0	32768	DATA_TOTAL	DATA_TOTAL: Counts 16 Energy x 64 TOF. The meaning of the TOF values is described in the JADE instrument paper. This product is collapsed from the onboard 32 Energy x 128 TOF histogram. Of the 64 channels, the last 3 have a special meaning: TOF_WITH_START_OVERLOAD, TOF_BELOW_MIN, TOF_TOO_LONG. (16-bit counter per second, summed over 30 seconds, adjacents summed in row/col)
4151	0	32	MIN_SUBTRACTED_VALUE	Min Subtracted Value Minimum value subtracted from every element in the array data blob.
4155	0	32	COMPRESSION_RATIO	Data compression ratio of data blob when it was transmitted to Earth: Ratio = Compressed size/Uncompressed size This is the compression due to the lossless scheme, and does not include any lossy compression which may have occured prior to it, such as the 32-bit to 8-bit or 16-bit to 8-bit look up tables that are often used prior to the lossy compression. A value of 1 means there was no lossless data compression, i.e. it was turned off.

6.2.6.3.3 JAD_CAL_ION_DER_*

This is the exact same format as JAD_HSK_ION_DER_*, see Table 31.

6.2.6.3.4 JAD_CAL_ION_DES_*

This is the exact same format as JAD_HSK_ION_DES_*, see Table 33.

6.2.6.3.5 JAD_CAL_ION_LOG_*

*Table 43: Format of Level 2 data records for JAD_CAL_ION_LOG_**

Byte	Bit	Length (bits)	Name	Description
See Level 2 binary header from Table 28 *for bytes 1 to 54.*				
55	0	800	DATA_TOTAL	DATA_TOTAL: Counts All 32 energies summed together. The 25 Logical counters are: [0]: Anode 0 [1]: Anode 1 [2]: Anode 2 [3]: Anode 3 *And so on to Anode 11… cut here to fit table on 1 page.* [10]: Anode 10 [11]: Anode 11 [12]: Background [13]: Start-Stop Overload [14]: All Starts [15]: All Stops [16]: Non-Adjacent Anodes [17]: Adjacent Anodes [18]: Stop without Start [19]: Dual Start [20]: Start in Process Time [21]: TOF Underflow [22]: TOF Overflow [23]: Invalid TOF Event (Invalid Start-Stop) [24]: Event Strobe (16-bit counter per second, summed over 32 energies over 30 sec)
155	0	32	MIN_SUBTRACTED_VALUE	Min Subtracted Value Minimum value subtracted from every element in the array data blob.
159	0	32	COMPRESSION_RATIO	Data compression ratio of data blob when it was transmitted to Earth: Ratio = Compressed size/Uncompressed size This is the compression due to the lossless scheme, and does not include any lossy compression which may have occured prior to it, such as the 32-bit to 8-bit or 16-bit to 8-bit look up tables that are often used prior to the lossy compression. A value of 1 means there was no lossless data compression, i.e. it was turned off.

6.2.6.3.6 JAD_CAL_ELC_060_*, JAD_CAL_ELC_180_* and JAD_CAL_ELC_300_*

The formats for are identical for these three Level 2 products: JAD_CAL_ELC_060, JAD_CAL_ELC_180, JAD_CAL_ELC_300 The following table is for JAD_CAL_ELC_**060**, with the E**060** being the only text that changes for the others.

Note: The JADE packets off the spacecraft orders the data as 17 Anodes x 64 Energy in order to get better compression, instead of the more usual Energy x Anodes. Since all other products begin Energy first, the ground software has transposed this data to be 64 Energy x 17 Anodes such that all JADE data with multi-dimensional data begins with Energy as the first dimension always.

*Table 44: Format of Level 2 data records for JAD_CAL_ELC_060_**

Byte	Bit	Length (bits)	Name	Description
See Level 2 binary header from Table 28 *for bytes 1 to 54.*				
55	0	34816	DATA_TOTAL	DATA_TOTAL: Counts 64 Energy x 17 Anodes for sensor E**060**. This product is the raw onboard 64 Energy x 17 Anodes data, with no collapsing. The first 16 anodes are positional. The 17th anode is the background anode. (16-bit counter per second, summed over 30 seconds).
4407	0	32	MIN_SUBTRACTED_VALUE	Min Subtracted Value Minimum value subtracted from every element in the array data blob.
4411	0	32	COMPRESSION_RATIO	Data compression ratio of data blob when it was transmitted to Earth: Ratio = Compressed size/Uncompressed size This is the compression due to the lossless scheme, and does not include any lossy compression which may have occured prior to it, such as the 32-bit to 8-bit or 16-bit to 8-bit look up tables that are often used prior to the lossy compression. A value of 1 means there was no lossless data compression, i.e. it was turned off.

6.2.6.4 HI_RATE_SCI (JADE packet IDs 0x40 to 0x4E)

6.2.6.4.1 JAD_HRS_ION_SP0_* to JAD_HRS_ION_SP7_*

The formats for are identical for these eight Level 2 products: JAD_HRS_ION_SP0, JAD_HRS_ION_SP1, JAD_HRS_ION_SP2, JAD_HRS_ION_SP3, JAD_HRS_ION_SP4, JAD_HRS_ION_SP5, JAD_HRS_ION_SP6, JAD_HRS_ION_SP7 The following table is for JAD_HRS_ION_**SP0**, with the **SP0** being the only text that changes for the others.

*Table 45: Format of Level 2 data records for JAD_HRS_ION_SP0_**

Byte	Bit	Length (bits)	Name	Description
See Level 2 binary header from Table 28 *for bytes 1 to 54.*				
55	0	24576	DATA_TOTAL	DATA_TOTAL: Counts 32 Energy x 4 Deflection x 12 Anodes for **SP0**. The meaning of each species is described in the JADE instrument paper. This product is collapsed from the onboard 32 Energy x 8 Def. x 12 Anode cube. Note: Value is capped at 16 bits.
3127	0	32	MIN_SUBTRACTED_VALUE	Min Subtracted Value Minimum value subtracted from every element in the array data blob.
3131	0	32	COMPRESSION_RATIO	Data compression ratio of data blob when it was transmitted to Earth: Ratio = Compressed size/Uncompressed size This is the compression due to the lossless scheme, and does not include any lossy compression which may have occured prior to it, such as the 32-bit to 8-bit or 16-bit to 8-bit look up tables that are often used prior to the lossy compression. A value of 1 means there was no lossless data compression, i.e. it was turned off.

6.2.6.4.2 JAD_HRS_ION_TOF_*

Warning: JAD_HRS_ION_TOF_*_V01.DAT files are useless for science as they incorrectly decoded the level 1 data due to a documentation typo that was not realized until HVCO2. This was fixed for JAD_HRS_ION_TOF_*_V02.DAT, so always use the highest version data file you can find.

*Table 46: Format of Level 2 data records for JAD_HRS_ION_TOF_**

Byte	Bit	Length (bits)	Name	Description
See Level 2 binary header from Table 28 *for bytes 1 to 54.*				
55	0	32768	DATA_TOTAL	DATA_TOTAL: Counts 16 Energy x 128 TOF. The meaning of the TOF values is described in the JADE instrument paper. This product is collapsed from the onboard 32 Energy x 128 TOF histogram. Of the 128 channels, the last 3 have a special meaning: TOF_WITH_START_OVERLOAD, TOF_BELOW_MIN, TOF_TOO_LONG. Note: Value is capped at 16 bits.
4151	0	32	MIN_SUBTRACTED_VALUE	Min Subtracted Value Minimum value subtracted from every element in the array data blob.
4155	0	32	COMPRESSION_RATIO	Data compression ratio of data blob when it was transmitted to Earth: Ratio = Compressed size/Uncompressed size This is the compression due to the lossless scheme, and does not include any lossy compression which may have occured prior to it, such as the 32-bit to 8-bit or 16-bit to 8-bit look up tables that are often used prior to the lossy compression. A value of 1 means there was no lossless data compression, i.e. it was turned off.

6.2.6.4.3 JAD_HRS_ION_DER_*

This is the exact same format as JAD_HSK_ION_DER_*, see Table 31.

6.2.6.4.4 JAD_HRS_ION_DES_*

This is the exact same format as JAD_HSK_ION_DES_*, see Table 33.

6.2.6.4.5 JAD_HRS_ION_LOG_*

*Table 47: Format of Level 2 data records for JAD_HRS_ION_LOG_**

Byte	Bit	Length (bits)	Name	Description
See Level 2 binary header from Table 28 *for bytes 1 to 54.*				
55	0	8192	DATA_TOTAL	DATA_TOTAL: Counts 32 Energy x 4 Deflection x 4 Logical Counters. The counters are: [*][*][0]: Background [*][*][1]: All Starts [*][*][2]: All Stops [*][*][3]: Invalid TOF Event (Invalid Start-Stop) Note: Value is capped at 16 bits.
1079	0	32	MIN_SUBTRACTED_VALUE	Min Subtracted Value Minimum value subtracted from every element in the array data blob.
1083	0	32	COMPRESSION_RATIO	Data compression ratio of data blob when it was transmitted to Earth: Ratio = Compressed size/Uncompressed size This is the compression due to the lossless scheme, and does not include any lossy compression which may have occured prior to it, such as the 32-bit to 8-bit or 16-bit to 8-bit look up tables that are often used prior to the lossy compression. A value of 1 means there was no lossless data compression, i.e. it was turned off.
1087	0	672	DATA_LOG_SUMS	DATA_LOG_SUMS: This data is independent to MIN_SUBTRACTED_VALUE, and was not losslessly compressed, however a lossy 32-bit to 8-bit Look Up Table (LUT 32_2) was used. 1 Energy x 21 Logical Counters. (These are summed over all energies, effectively one wide energy bin.) The counters are: [0]: Anode0 [1]: Anode1 *And so on to Anode 11… cut here to fit table on 1 page.* [11]: Anode 11 [12]: Start-Stop Overload [13]: Non-Adjacent Anodes [14]: Adjacent Anodes [15]: Stop without Start [16]: Dual Start [17]: Start in Process Time [18]: TOF Underflow [19]: TOF Overflow [20]: Event Strobe

6.2.6.4.6 JAD_HRS_ELC_ALL_*

The High Rate Science electron product uses all 3 electron sensors simultaneously, using the 16 anodes of each sensor to get full 360° coverage in spacecraft azimuth. These are then split up in to 16 fine bins (2 sets of 8) and 8 coarse bins (2 sets of 4) according to the magnetic field vector. A fine bin is just a single anode, whereas a coarse bin is the sum of 4 anodes (and those 4 anodes can cross sensor boundaries). The following figure is taken from the JADE instrument paper to explain this, and shows that the two (first & second) sets of adjacent fine and adjacent coarse bins are opposite each other.

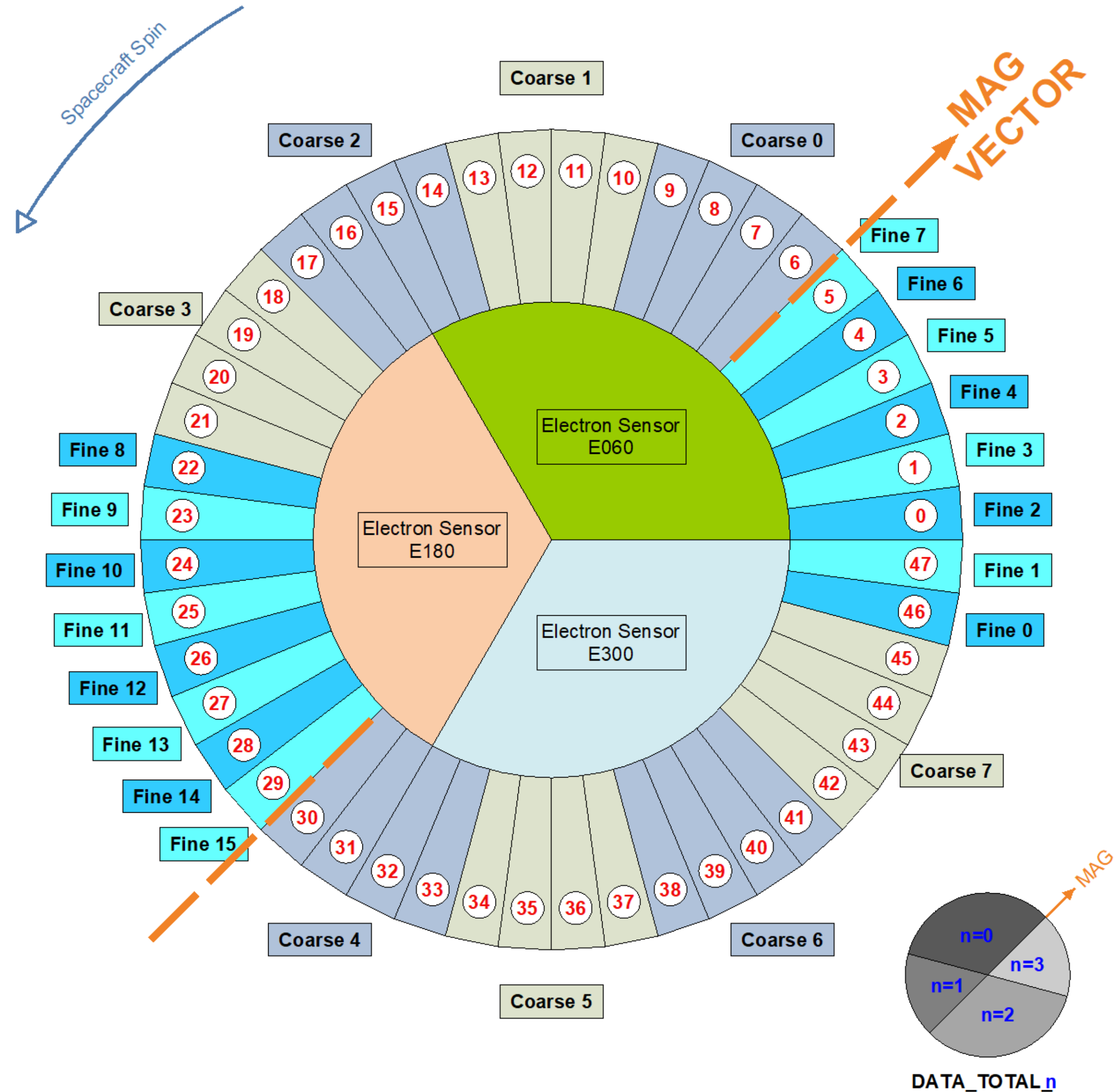


Figure 7: JADE-E Data Collapse Based on Broadcast magnetic field data.

The format of this Level 2 product is provided on the following pages.

The following table runs over 3 pages.

The order of DATA_TOTAL_3, DATA_TOTAL_1, DATA_TOTAL_0 and DATA_TOTAL_2 may seem a bit weird, but see the lower right inset of Figure 7 to show how they really line up. The data blob from the raw back is actually 32 Energy by 24 bins, where the first 16 bins are Fine bins 0-15, then the last 8 bins are Coarse bins 0-7. As such splitting this is split out in to 4 more useful data products where the number on the end indicates the order.
Likewise ANODE_MAP_FINE_3, ANODE_MAP_FINE_1, ANODE_MAP_COARSE_0 and ANODE_MAP_COARSE_2 have the final numbers to match. (Note, the DAT file is the same either way, only the FMT file is different.)
This product requires knowledge of the magnetic field direction, and includes several MAG related objects:

MAG_TIME_DIR specifies whether the MAG vector timestamp was in the past or future compared to the JADE timestamp.

MAG_FIRST_DFL is a diagnostic that reports the first DAC value of the sensor the MAG vector landed on.

MAG_ELEVATION is the elevation angle of the MAG vector from the spacecraft Cartesian x-y plane, i.e. Latitude angle.

MAG_ANODE provides look direction number (0-47) that the MAG vector fell in on the spacecraft Cartesian x-y plane, i.e. Longitude in different units.

*Table 48: Format of Level 2 data records for JAD_HRS_ELC_ALL_**

Byte	Bit	Length (bits)	Name	Description
See Level 2 binary header from Table 28 *for bytes 1 to 54.*				
55	0	4096	DATA_TOTAL_3	DATA_TOTAL_3: Counts: Fine Bins (1st set) 32 Energy x 8 Fine Bins. Collapsing of product dimensions and a description of Fine Bins are described in the JADE instrument paper. (Collapsed from original onboard 64 E x 51 Anode set.) Also see objects ANODE_MAP_FINE and ANODE_MAP_COARSE. Note: Value is capped at 16 bits.
567	0	4096	DATA_TOTAL_1	DATA_TOTAL_1: Counts: Fine Bins (2nd set) 32 Energy x 8 Fine Bins. Collapsing of product dimensions and a description of Fine Bins are described in the JADE instrument paper. (Collapsed from original onboard 64 E x 51 Anode set.) Also see objects ANODE_MAP_FINE and ANODE_MAP_COARSE. Note: Value is capped at 16 bits.
1079	0	2048	DATA_TOTAL_0	DATA_TOTAL_0: Counts: Coarse Bins (1st set) 32 Energy x 4 Coarse Bins. Collapsing of product dimensions and a description of Coarse Bins are described in the JADE instrument paper. (Collapsed from original onboard 64 E x 51 Anode set.) Also see objects ANODE_MAP_FINE and ANODE_MAP_COARSE. Note: Value is capped at 16 bits.

Byte	Bit	Length (bits)	Name	Description
1335	0	2048	DATA_TOTAL_2	DATA_TOTAL_2: Counts: Coarse Bins (2nd set) 32 Energy x 4 Coarse Bins. Collapsing of product dimensions and a description of Coarse Bins are described in the JADE instrument paper. (Collapsed from original onboard 64 E x 51 Anode set.) Also see objects ANODE_MAP_FINE and ANODE_MAP_COARSE. Note: Value is capped at 16 bits.
1591	0	32	MIN_SUBTRACTED_VALUE	Min Subtracted Value Minimum value subtracted from every element in the array data blob.
1595	0	32	COMPRESSION_RATIO	Data compression ratio of data blob when it was transmitted to Earth: Ratio = Compressed size/Uncompressed size This is the compression due to the lossless scheme, and does not include any lossy compression which may have occured prior to it, such as the 32-bit to 8-bit or 16-bit to 8-bit look up tables that are often used prior to the lossy compression. A value of 1 means there was no lossless data compression, i.e. it was turned off.
1599	0	32	BACKGROUND_COUNTS_E060	Background Anode Counts for E060 (16-bit counter summed over 64 energies)
1603	0	32	BACKGROUND_COUNTS_E180	Background Anode Counts for E180 (16-bit counter summed over 64 energies)
1607	0	32	BACKGROUND_COUNTS_E300	Background Anode Counts for E300 (16-bit counter summed over 64 energies)
1611	0	8	MAG_TIME_DIR	MAG Time Direction. Indicates whether the MAG_TIME_LATENCY object indicates a past or future latency. 0: (time_received - time_in_packet) 1: (time_in_packet - time_received)
1612	0	8	MAG_ANODE	MAG Anode number from 0 to 47. Which electron anode the MAG vector fell on. E060 has anodes 0 to 15 E180 has anodes 16 to 31 E300 has anodes 32 to 47 e.g. Anodes 15 and 16 are neighbors in terms of field of view, as are anodes 47 and 0. Note: Background anodes (per sensor) are not included for this mapping.
1613	0	16	MAG_FIRST_DFL	First Deflection. First Deflection value written to the electron sweep table for the sensor the mag vector landed on. (1-bit range/gain (MSb) + 12-bit DAC value).

Byte	Bit	Length (bits)	Name	Description
1615	0	8	MAG_ELEVATION	MAG elevation. Elevation angle of the mag vector, rounded to the nearest degree.
1616	0	8	MAG_TIME_LATENCY	MAG Time Latency. Time difference (in 250 ms blocks) between the timestamp of the MAG vector and the time it was received by JADE. Values map to: 0 = 0.000 - 0.249 s, 1 = 0.250 - 0.499 s 2 = 0.500 - 0.749 s, 3 = 0.750 - 0.999 s etc. 14 = 3.750 - 3.999 s, 15 = 4.000 - infinity s
1617	0	32	MAG_TIMESTAMP_WHOLE	Timestamp (whole second) for MAG vector, (MAG timestamp subsecond is not returned in JADE packets.) Referenced from 12:00UTC 2000/01/01.
1621	0	96	MAG_VECTOR	MAG vector in nT, 3 components [X, Y, Z] MAG range is +/- 16 G, hence limits. The coordinate system is spacecraft based, with: +X is between E060 and E300, along the 0 degree mark where E060 anode 0 starts +Y is 90 degrees, between E060 anodes 11 and 12, +Z is the spin axis. Note: these are signed integers.
1633	0	64	ANODE_MAP_FINE_3	Fine Anode Mapping. (1st set) Which anodes (0-47) the 8 Fine bins (ordered 0-7) fall in. c.f. MAG_ANODE object.
1641	0	64	ANODE_MAP_FINE_1	Fine Anode Mapping. (2nd set) Which anodes (0-47) the 8 Fine bins (ordered 8-15) fall in. c.f. MAG_ANODE object.
1649	0	128	ANODE_MAP_COARSE_0	Coarse Anode Mapping. (1st set) Which anodes (0-47) the 4 Coarse bins (ordered 0-3) fall in. c.f. MAG_ANODE object. This is a 2D object, as 4 anodes (denoted a-d) make each coarse bin, this objects data is ordered: 0a 0b 0c 0d 1a 1b 1c 1d 2a 2b 2c 2d 3a 3b 3c 3d.
1665	0	128	ANODE_MAP_COARSE_2	Coarse Anode Mapping. (2nd set) Which anodes (0-47) the 4 Coarse bins (ordered 4-7) fall in. c.f. MAG_ANODE object. This is a 2D object, as 4 anodes (denoted a-d) make each coarse bin, this objects data is ordered: 4a 4b 4c 4d 5a 5b 5c 5d 6a 6b 6c 6d 7a 7b 7c 7d.

6.2.6.5 LOW_RATE_SCI (JADE packet IDs 0x50 to 0x5D)

6.2.6.5.1 JAD_LRS_ION_SP0_* to JAD_LRS_ION_SP7_*

The formats are identical for these eight Level 2 products:
JAD_LRS_ION_SP0, JAD_LRS_ION_SP1, JAD_LRS_ION_SP2, JAD_LRS_ION_SP3, JAD_LRS_ION_SP4, JAD_LRS_ION_SP5, JAD_LRS_ION_SP6, JAD_LRS_ION_SP7
The following table is for JAD_LRS_ION_**SP0**, with the **SP0** being the only text that changes for the others. For more information on spin-phase sectors see Table 41. See note on next page.

*Table 49: Format of Level 2 data records for JAD_LRS_ION_SP0_**

Byte	Bit	Length (bits)	Name	Description
See Level 2 binary header from Table 28 *for bytes 1 to 54.*				
55	0	57344	DATA_TOTAL	DATA_TOTAL: Counts per view 1 Species for **SP0**. 32 Energy x 56 Spin-Phase Sectors. The formula for mapping anodes into spin-phase sectors is described in the PDS JADE SIS and is given here in the following table, where the first column, SP, is Spin Phase (degrees), and the others are JADE-I anodes 4 to 11. SP , A4 , A5 , A6 , A7 , A8 , A9 ,A10 ,A11 -- 0 , 0 , 2 , 8 , 16 , 28 , 40 , 48 , 54 *Table cut here to fit on 1 page, see* Table 41 *for details.* The meaning of each species is described in the JADE instrument paper. Note the data units are rates (counts per views), are floats rather than integers, and are fractions of 1/512. Note 2: Rate is independent of accumulation time.
7223	0	32	MIN_SUBTRACTED_VALUE	Min Subtracted Value Minimum value subtracted from every element in the array data blob. Note: the units are rates (counts per views), are floats rather than integers, and are fractions of 1/512.
7227	0	32	COMPRESSION_RATIO	Data compression ratio of data blob when it was transmitted to Earth: Ratio = Compressed size/Uncompressed size This is the compression due to the lossless scheme, and does not include any lossy compression which may have occured prior to it, such as the 32-bit to 8-bit or 16-bit to 8-bit look up tables that are often used prior to the lossy compression. A value of 1 means there was no lossless data compression, i.e. it was turned off.

Note: During 2011 (launch) through 2014 inclusive there was no flight data taken for the following products:
JAD_LRS_ION_SP0, JAD_LRS_ION_SP4, JAD_LRS_ION_SP6, JAD_LRS_ION_SP7.

6.2.6.5.2 JAD_LRS_ION_TOF_*

*Table 50: Format of Level 2 data records for JAD_LRS_ION_TOF_**

Byte	Bit	Length (bits)	Name	Description
See Level 2 binary header from Table 28 *for bytes 1 to 54.*				
55	0	32768	DATA_TOTAL	DATA_TOTAL: Counts 16 Energy x 64 TOF. The meaning of the TOF values is described in the JADE instrument paper. This product is collapsed from the onboard 32 Energy x 128 TOF histogram. Of the 64 channels, the last 3 have a special meaning: TOF_WITH_START_OVERLOAD, TOF_BELOW_MIN, TOF_TOO_LONG. Note: summations are from 16-bit counter, adjacents summed in row/col, accumulated over 600 seconds.
4151	0	32	MIN_SUBTRACTED_VALUE	Min Subtracted Value Minimum value subtracted from every element in the array data blob.
4155	0	32	COMPRESSION_RATIO	Data compression ratio of data blob when it was transmitted to Earth: Ratio = Compressed size/Uncompressed size This is the compression due to the lossless scheme, and does not include any lossy compression which may have occured prior to it, such as the 32-bit to 8-bit or 16-bit to 8-bit look up tables that are often used prior to the lossy compression. A value of 1 means there was no lossless data compression, i.e. it was turned off.

6.2.6.5.3 JAD_LRS_ION_DER_*

This is the exact same format as JAD_HSK_ION_DER_*, see Table 31.

6.2.6.5.4 JAD_LRS_ION_DES_*

This is the exact same format as JAD_HSK_ION_DES_*, see Table 33.

6.2.6.5.5 JAD_LRS_ION_LOG_*

*Table 51: Format of Level 2 data records for JAD_LRS_ION_LOG_**

Byte	Bit	Length (bits)	Name	Description
See Level 2 binary header from Table 28 *for bytes 1 to 54.*				
55	0	800	DATA_TOTAL	DATA_TOTAL: Counts 1 Energy x 25 Logical Counters. The 25 Logical counters are: [0]: Anode 0 [1]: Anode 1 [2]: Anode 2 [3]: Anode 3 *And so on to Anode 11… cut here to fit table on 1 page.* [10]: Anode 10 [11]: Anode 11 [12]: Background [13]: Start-Stop Overload [14]: All Starts [15]: All Stops [16]: Non-Adjacent Anodes [17]: Adjacent Anodes [18]: Stop without Start [19]: Dual Start [20]: Start in Process Time [21]: TOF Underflow [22]: TOF Overflow [23]: Invalid TOF Event (Invalid Start-Stop) [24]: Event Strobe Note: summations are from 16-bit counter summed over 32 energies accumulated over 600 seconds.
155	0	32	MIN_SUBTRACTED_VALUE	Min Subtracted Value Minimum value subtracted from every element in the array data blob.
159	0	32	COMPRESSION_RATIO	Data compression ratio of data blob when it was transmitted to Earth: Ratio = Compressed size/Uncompressed size This is the compression due to the lossless scheme, and does not include any lossy compression which may have occured prior to it, such as the 32-bit to 8-bit or 16-bit to 8-bit look up tables that are often used prior to the lossy compression. A value of 1 means there was no lossless data compression, i.e. it was turned off.

6.2.6.5.6 JAD_LRS_ELC_060_*, JAD_LRS_ELC_180_* and JAD_LRS_ELC_300_*

The formats are identical for these three Level 2 products:
JAD_LRS_ELC_060, JAD_LRS_ELC_180, JAD_LRS_ELC_300
The following table is for JAD_LRS_ELC_**060**, with the E**060** being the only text that changes for the others. See the next page for more on the spin sector formula.

*Table 52: Format of Level 2 data records for JAD_LRS_ELC_060_**

Byte	Bit	Length (bits)	Name	Description
See Level 2 binary header from Table 28 *for bytes 1 to 54.*				
55	0	49152	DATA_TOTAL	DATA_TOTAL: Counts per view 64 Energy x 24 Spin-Phase Sectors. The formula for mapping anodes into spin-phase sectors is described in the PDS JADE SIS, and is: SP_sector = ((s_phase+s_id+7.5*a_id)/15 - 4) MOD 24 where: Spin-Phase Sector (SP_sector) is in the range [0-23] SP_sector is an integer (round down) such that two anodes fall in the same sector bin. spin_phase (s_phase) where 0 <= s_phase < 360 sensor id (s_id) is either 060, 180, or 300 depending on which sensor it is for. In this case, s_id = **060** anode id (a_id) is one of the 16 anodes, 0-15 7.5 degrees is the width of one anode. Note the data units are rates (counts per views), are floats rather than integers, and are fractions of 1/512. Note 2: Rate is independent of accumulation time.
6199	0	32	MIN_SUBTRACTED_VALUE	Min Subtracted Value Minimum value subtracted from every element in the array data blob. Note: the units are rates (counts per views), are floats rather than integers, and are fractions of 1/512.
6203	0	32	COMPRESSION_RATIO	Data compression ratio of data blob when it was transmitted to Earth: Ratio = Compressed size/Uncompressed size This is the compression due to the lossless scheme, and does not include any lossy compression which may have occured prior to it, such as the 32-bit to 8-bit or 16-bit to 8-bit look up tables that are often used prior to the lossy compression. A value of 1 means there was no lossless data compression, i.e. it was turned off.
6207	0	32	BACKGROUND_COUNTS	Background counts. The background counter for electron sensor E**060**. This is a total count, not a rate.

The formula for mapping anodes into spin phase is:

spin_sector = ((*spin_phase* + *sensor_id* + 7.5**anode_id*)/15 - 4) MOD 24;

where:

spin_sector becomes a number in the range 0 to 23.
spin_phase is in the range 0 to 360.
sensor_id is either 60, 180, or 300, depending on which sensor it is for.
anode_id is one of the 16 anodes, 0-15.

The spin-sector is an integer (rounded down), such that a given spin-sector represents two anodes. 7.5 degrees is the width of one anode.

Spin_phase (degrees) is based on the spacecraft +X vector, which is also along the edge of E060 anode 0.

6.2.7 Level 3 data files

There are no CODMAC Level 3 JADE products, as this data set spanning launch to 2014 (prior to Jupiter) is only commissioning data that is not intended for science use.

6.2.8 Level 4 data files

There are no CODMAC Level 4 JADE products, as this is a level more designed for cameras than particle data (see Table 5). As such JADE goes from Level 3 to level 5 directly.

6.2.9 Level 5 data files

There are no CODMAC Level 5 JADE products, as this data set spanning launch to 2014 (prior to Jupiter) is only commissioning data that is not intended for science use.

Appendix A Support staff and cognizant persons

Table 53: Archive collection support staff

JADE team			
Name	**Address**	**Phone**	**Email**
Dr Rob Wilson JADE ground data processing / Archivist	LASP, Space Science Building, University of Colorado Boulder 3665 Discovery Drive Boulder, CO 80303-7813	+001 303 492 5476	Rob.Wilson@ lasp.colorado.edu
Dr David McComas JADE Principle Investigator	Office of the Vice President for Princeton Plasma Physics Laboratory Peyton Hall Princeton, NJ 08544		DMcComas@princeton.edu
Dr Phil Valek JADE Ion Instrument Scientist	Southwest Research Institute 6220 Culebra Road San Antonio, TX 78238-5166	+001 210 522 3385	PValek@swri.edu
Dr Frederic Allegrini JADE Electron Instrument Scientist	Southwest Research Institute 6220 Culebra Road San Antonio, TX 78238-5166		fallegrini@swri.edu
Dr Chad Loeffler JADE Flight Software	Southwest Research Institute 6220 Culebra Road San Antonio, TX 78238-5166		cloeffler@swri.edu

UCLA			
Name	**Address**	**Phone**	**Email**
Dr. Steven Joy PPI Operations Manager	IGPP, University of California 405 Hilgard Avenue Los Angeles, CA 90095-1567 USA	+001 310 825 3506	sjoy@igpp.ucla.edu
Mr. Joseph Mafi PPI Data Engineer	IGPP, University of California 405 Hilgard Avenue Los Angeles, CA 90095-1567 USA	+001 310 206 6073	jmafi@igpp.ucla.edu

Appendix B PDS label files

All JADE instrument data files are accompanied by PDS label files, possessing the same names are the files they describe, but with the extension LBL. The basic content for these label files is as follows, where the NOTE field is reserved for product-specific comments:

Font below is Courier New (to equally space characters) and size 9 in order to get 78 characters to a line. This matches the PDS files that are 80 characters to a line, but the last two are \r\n.

B.1 Sample LBL file for JAD_LRS_ELC_060

```
PDS_VERSION_ID = PDS3
DATA_SET_ID    = "JNO-SW-JAD-2-UNCALIBRATED-V1.0"

/* Input file  : JAD_LRS_ELC_060_2011322_V02.DAT */
/* File written: 2015/06/30 14:34:05 local time  */

STANDARD_DATA_PRODUCT_ID = "JAD_LRS_ELC_060"
PRODUCT_ID               = "JAD_LRS_ELC_060_2011322"
PRODUCT_VERSION_ID       = "02"
PRODUCT_TYPE             = "DATA"
PRODUCT_CREATION_TIME    = 2015-181T20:34:05 /* UTC 2015-06-30 */
PROCESSING_LEVEL_ID      = "2"

RECORD_TYPE  = FIXED_LENGTH
RECORD_BYTES = 6210
FILE_RECORDS = 11

START_TIME                   = 2011-322T22:17:18.633 /* 2011-11-18 */
STOP_TIME                    = 2011-322T23:35:09.694 /* 2011-11-18 */
SPACECRAFT_CLOCK_START_COUNT = "374926658.54386" /* WHOLE.SUB (SUB 0-65535)*/
SPACECRAFT_CLOCK_STOP_COUNT  = "374931330.00000" /* Rounded nearest */
/* JADE records have start time SPACECRAFT CLOCK, so to get end time */
/* of last record, I've added the Accumulation time value to both    */
/* UTC seconds and SPACECRAFT CLOCK, - although those are not equal. */
/* Hence the SPACECRAFT_CLOCK_STOP_COUNT is rounded for now.         */

INSTRUMENT_HOST_NAME = "JUNO"
INSTRUMENT_HOST_ID   = "JNO"
TARGET_NAME          = {"SOLAR WIND"}
MISSION_PHASE_NAME   = "COMMISSIONING"
INSTRUMENT_NAME      = "JOVIAN AURORAL DISTRIBUTIONS EXPERIMENT"
INSTRUMENT_ID        = "JAD" /* JADE */

DESCRIPTION = "This is the required LBL file for flight software version 3
               data.  Flight software version 4 was uploaded in 2015 prior to
               arrival at Jupiter, hence all version 3 data is solar wind
               data.  In addition it is all high-voltage checkouts or other
               operational tests, and is not recommended for science use.
               Flight software version 4 data (containing data at Jupiter)
               is found in a separate PDS volume."
MD5_CHECKSUM = "34c148e1b20f2370fe96b80ddddf7e6f"

NOTE = "See the PDS JADE SIS Document for more details on the formats."

^TABLE = "JAD_LRS_ELC_060_2011322_V02.DAT"
OBJECT = TABLE
  INTERCHANGE_FORMAT = "BINARY"
  ROWS         = 11
  COLUMNS      = 19
```

```
  ROW_BYTES   = 6210
  ^STRUCTURE  = "JAD_LRS_ELC_060_V02.FMT"
  DESCRIPTION = "Describes the structure and content of the data file."
END_OBJECT = TABLE
END
```

B.2 Sample LBL file for JAD_LRS_ION_SP1

```
PDS_VERSION_ID = PDS3
DATA_SET_ID    = "JNO-SW-JAD-2-UNCALIBRATED-V1.0"

/* Input file  : JAD_LRS_ION_SP1_2011322_V02.DAT */
/* File written: 2015/06/30 14:34:58 local time  */

STANDARD_DATA_PRODUCT_ID = "JAD_LRS_ION_SP1"
PRODUCT_ID               = "JAD_LRS_ION_SP1_2011322"
PRODUCT_VERSION_ID       = "02"
PRODUCT_TYPE             = "DATA"
PRODUCT_CREATION_TIME    = 2015-181T20:34:58 /* UTC 2015-06-30 */
PROCESSING_LEVEL_ID      = "2"

RECORD_TYPE  = FIXED_LENGTH
RECORD_BYTES = 7230
FILE_RECORDS = 14

START_TIME                   = 2011-322T22:17:18.633 /* 2011-11-18 */
STOP_TIME                    = 2011-323T00:05:32.710 /* 2011-11-19 */
SPACECRAFT_CLOCK_START_COUNT = "374926658.54386" /* WHOLE.SUB (SUB 0-65535)*/
SPACECRAFT_CLOCK_STOP_COUNT  = "374933153.00000" /* Rounded nearest */
/* JADE records have start time SPACECRAFT CLOCK, so to get end time */
/* of last record, I've added the Accumulation time value to both    */
/* UTC seconds and SPACECRAFT CLOCK, - although those are not equal. */
/* Hence the SPACECRAFT_CLOCK_STOP_COUNT is rounded for now.         */

INSTRUMENT_HOST_NAME = "JUNO"
INSTRUMENT_HOST_ID   = "JNO"
TARGET_NAME          = {"SOLAR WIND"}
MISSION_PHASE_NAME   = "COMMISSIONING"
INSTRUMENT_NAME      = "JOVIAN AURORAL DISTRIBUTIONS EXPERIMENT"
INSTRUMENT_ID        = "JAD" /* JADE */

DESCRIPTION = "This is the required LBL file for flight software version 3
               data.  Flight software version 4 was uploaded in 2015 prior to
               arrival at Jupiter, hence all version 3 data is solar wind
               data.  In addition it is all high-voltage checkouts or other
               operational tests, and is not recommended for science use.
               Flight software version 4 data (containing data at Jupiter)
               is found in a separate PDS volume."
MD5_CHECKSUM = "7e27263e90468fbbdc97dbd0cc7b5dc9"

NOTE = "See the PDS JADE SIS Document for more details on the formats."

^TABLE = "JAD_LRS_ION_SP1_2011322_V02.DAT"
OBJECT = TABLE
  INTERCHANGE_FORMAT = "BINARY"
  ROWS        = 14
  COLUMNS     = 18
  ROW_BYTES   = 7230
  ^STRUCTURE  = "JAD_LRS_ION_SP1_V02.FMT"
  DESCRIPTION = "Describes the structure and content of the data file."
END_OBJECT = TABLE
END
```

Appendix C   Level 2 data record formats

This section describes the format of the Level 2 data files.

While Section 6.2.6 ("Level 2 data files") cover this to some level, the real description is within the FMT files for each product. Here are two examples in full, but see the FMT files in the LABEL directory for specifics.

Font below is Courier New (to equally space characters) and size 9 in order to get 78 characters to a line. This matches the PDS files that are 80 characters to a line, but the last two are \r\n.

C.1 Sample FMT file for JAD_LRS_ELC_060_V02.FMT

```
/* Filename: Version02/JAD_LRS_ELC_060_V02.FMT                              */
/* File written: 2015/06/29 18:43:10                                        */
/* Will code useful Python based letters to describe each object            */
/* see http://docs.python.org/library/struct.html for codes                 */
/* formats will comma separated beginning with "RJW," as key then           */
/* {NAME}, {FORMAT}, {Number of dims}, {Size Dim 1}, {Size Dim 2}, ...      */
/* where {FORMAT} is the Python code for the type, i.e. I for uint32        */
/* and there are as many Size Dim's as number of dimensions.                */
/* Remember to remove the comment markers at either end                     */

/* RJW, BYTES_PER_RECORD, 6210 */
/* RJW, OBJECTS_PER_RECORD, 19 */

OBJECT               = COLUMN
  NAME               = SYNC
  DATA_TYPE          = LSB_UNSIGNED_INTEGER
  START_BYTE         = 1
  BYTES              = 4
  VALID_MINIMUM      = 4210242563
  VALID_MAXIMUM      = 4210242563
  MISSING_CONSTANT   = 0      /* If no Sync pattern there is no record */
  DESCRIPTION        = "JADE Sync Pattern for IDP packets.
                        Hex value = 0xFAF33403, Decimal = 4210242563"
/* RJW, SYNC, I, 1, 1 */
END_OBJECT           = COLUMN

OBJECT               = COLUMN
  NAME               = DPID_COUNT
  DATA_TYPE          = LSB_UNSIGNED_INTEGER
  START_BYTE         = 5
  BYTES              = 1
  VALID_MINIMUM      = 0
  VALID_MAXIMUM      = 255
  DESCRIPTION        = "DPID Count (Source Sequence Count)
                        Count of the number of times this product has been
                        generated since the startup (or reset) of the
                        generating application (Boot Program or Science
                        Program).  This count resets to 0 upon entry to
                        the modes of BOOT, LVENG, HVENG, LOW_RATE_SCI,
                        MCP_CAL_SCI, HI_RATE_SCI.
                        Note: starts with 0, increments by 1, eventually
                        rolls over at 255."
/* RJW, DPID_COUNT, B, 1, 1 */
END_OBJECT           = COLUMN
```

```
OBJECT              = COLUMN
  NAME              = COMPRESSION
  DATA_TYPE         = LSB_UNSIGNED_INTEGER
  START_BYTE        = 6
  BYTES             = 1
  VALID_MINIMUM     = 0
  VALID_MAXIMUM     = 1
  MISSING_CONSTANT  = 255
  DESCRIPTION       = "Lossless Compression Status.
                       Indicates whether the data (non-header) segment of
                       the IDP packet (IDP Data) was lossless compressed.
                         0 = Not Compressed
                         1 = Compressed"
/* RJW, COMPRESSION, B, 1, 1 */
END_OBJECT          = COLUMN

OBJECT              = COLUMN
  NAME              = IDPLENGTH
  DATA_TYPE         = LSB_UNSIGNED_INTEGER
  START_BYTE        = 7
  BYTES             = 2
  VALID_MINIMUM     = 0
  VALID_MAXIMUM     = 65534
  MISSING_CONSTANT  = 65535
  DESCRIPTION       = "IDP Length,
                       Byte Length of the IDP packet."
/* RJW, IDPLENGTH, H, 1, 1 */
END_OBJECT          = COLUMN

OBJECT              = COLUMN
  NAME              = PACKETID
  DATA_TYPE         = LSB_UNSIGNED_INTEGER
  START_BYTE        = 9
  BYTES             = 1
  VALID_MINIMUM     = 88    /* 0x58 */
  VALID_MAXIMUM     = 88    /* 0x58 */
  MISSING_CONSTANT  = 255
  DESCRIPTION       = "Packet ID (DPID), Data Product Identifier
                       Low Rate Science - Electron Histogram:  0x58
                       Sensor E060."
/* RJW, PACKETID, B, 1, 1 */
END_OBJECT          = COLUMN

OBJECT              = COLUMN
  NAME              = FLIGHT_OR_STL
  DATA_TYPE         = LSB_UNSIGNED_INTEGER
  START_BYTE        = 10
  BYTES             = 1
  VALID_MINIMUM     = 0
  VALID_MAXIMUM     = 2
  MISSING_CONSTANT  = 255
  DESCRIPTION       = "In Flight data, or STL (ground EM tests):
                         0 = In flight, from JADE on Juno (via FEI)
                         1 = On ground, from STL tests (via FEI)
                         2 = On ground, from SwRI tests (not FEI)
                       255 = Unknown"
/* RJW, FLIGHT_OR_STL, B, 1, 1 */
END_OBJECT          = COLUMN

OBJECT              = COLUMN
  NAME              = ISSUES
  DATA_TYPE         = LSB_UNSIGNED_INTEGER
```

```
  START_BYTE        = 11
  BYTES             = 4
  VALID_MINIMUM     = 0
  VALID_MAXIMUM     = 4294967294
  MISSING_CONSTANT  = 4294967295
  DESCRIPTION       = "Issues in data?
/* Saw Tooth, Voltage Pulsing, Mag Latency, Flight or STL, make binary*/
                       0 = All seems well
                       4294967295 = Fill Value / unknown"
/* RJW, ISSUES, I, 1, 1 */
END_OBJECT          = COLUMN

OBJECT              = COLUMN
  NAME              = FSW_VERSION
  DATA_TYPE         = PC_REAL
  START_BYTE        = 15
  BYTES             = 4
  VALID_MINIMUM     = 0.00
  VALID_MAXIMUM     = 9.99
  MISSING_CONSTANT  = 255
  DESCRIPTION       = "Flight Software version used.
                       Number should be to 2 decimal places."
/* RJW, FSW_VERSION, f, 1, 1 */
END_OBJECT          = COLUMN

OBJECT              = COLUMN
  NAME              = TABLES_VERSION
  DATA_TYPE         = PC_REAL
  START_BYTE        = 19
  BYTES             = 4
  VALID_MINIMUM     = 0.00
  VALID_MAXIMUM     = 99.99 /* Probably should be max number of orbits */
  MISSING_CONSTANT  = 255
  DESCRIPTION       = "Tables version used onboard.
                       All tables are combined (compression, sweeping,
                       macros, etc.) onboard in to a large image.
                       This is the image number, or table version.
                       Number should be to 2 decimal places."
/* RJW, TABLES_VERSION, f, 1, 1 */
END_OBJECT          = COLUMN

OBJECT              = COLUMN
  NAME              = SCLKSCET_VERSION
  DATA_TYPE         = LSB_INTEGER
  START_BYTE        = 23
  BYTES             = 2
  VALID_MINIMUM     = -32767
  VALID_MAXIMUM     =  32767
  MISSING_CONSTANT  = -32768
  DESCRIPTION       = "The NAIF SPICE kernel for sclk used to generate UTC.
                       The JUNO sclk files are used to convert the spacecraft
                       clock timestamps to UTC time, and all have filenames
                       JNO_SCLKSCET.nnnnn.tsc, where nnnnn is the SCLKSCET
                       version number (with leading zeros and positive).
                       Each kernel has a reconstructed and predicted part for
                       it's values, typically any time after the last row of
                       the SCLK01_COEFFICIENTS_61999 table is predicted.
                       If TIMESTAMP_WHOLE:TIMESTAMP_SUB is in the predicted
                       part then SCLKSCET_VERSION will be negative, the
                       absolute value would be the version number.  If a later
                       SCLKSCET kernel version is used the UTC time will
                       likely be different.
                       If TIMESTAMP_WHOLE:TIMESTAMP_SUB is in the
```

```
                       reconstructed region the number will be positive
                       (equal to the version number) and will not vary with
                       later kernels.
                       e.g. If SCLKSCET_VERSION = -17 then kernel
                       JNO_SCLKSCET.00017.tsc was used to convert to UTC, but
                       it's a predicted UTC time.
                       If SCLKSCET_VERSION = 18 then kernel
                       JNO_SCLKSCET.00018.tsc was used to convert to UTC, and
                       it's a reconstructed UTC time that will not change with
                       later SCLKSCET kernel versions.
                       Within the PDS archive this value should always be
                       positive."
/* RJW, SCLKSCET_VERSION, h, 1, 1 */
END_OBJECT           = COLUMN

OBJECT               = COLUMN
  NAME               = UTC
  DATA_TYPE          = DATE  /* ASCII character string */
  START_BYTE         = 25
  BYTES              = 21
  VALID_MINIMUM      = 2011-217T00:00:00.001
                       /* SC Clock 365774402:0, JUNO Launch */
  VALID_MAXIMUM      = 2018-001T00:00:00.000
  MISSING_CONSTANT   = 0001-001T00:00:00.000
  DESCRIPTION        = "UTC timestamp, of format yyyy-dddTHH:MM:SS.sss
                        where yyyy = year, ddd = day of year,
                        HH = hour, MM = minute,
                        SS.sss = decimal seconds to millisecond resolution.
                        Value calculated via SPICE from spacecraft clock time,
                        {TIMESTAMP_WHOLE}:{TIMESTAMP_SUB}

                        For Science modes this is the UTC equivalent of
                        spacecraft clock when the data for this packet was
                        collected (i.e. Start time).
                        For Boot programs (operations team's housekeeping data)
                        it is the time when or the packet was transmitted."
/* RJW, UTC, c, 1, 21 */
END_OBJECT           = COLUMN

OBJECT               = COLUMN
  NAME               = DATA_UNITS
  DATA_TYPE          = LSB_UNSIGNED_INTEGER
  START_BYTE         = 46
  BYTES              = 1
  VALID_MINIMUM      = 0
  VALID_MAXIMUM      = 1
  MISSING_CONSTANT   = 255
  DESCRIPTION        = "The Data could be total counts (per accumulation)
                        or a rate, normalized to counts per view.
                          0 = All counts in the accumulation period (int)
                          1 = All counts divided by number of views (float)
                        255 = Not appropriate for this dataset, or Unknown."
/* RJW, DATA_UNITS, B, 1, 1 */
END_OBJECT           = COLUMN

OBJECT               = COLUMN
  NAME               = TIMESTAMP_WHOLE
  DATA_TYPE          = LSB_UNSIGNED_INTEGER
  START_BYTE         = 47
  BYTES              = 4
  VALID_MINIMUM      = 365774402 /* 2011-Aug-05: Juno Launch */
  VALID_MAXIMUM      = 568037064 /* ~ 2018-Jan-01            */
  MISSING_CONSTANT   = 0
```

```
  DESCRIPTION       = "Timestamp (Whole Second),
                        For Science modes this is the Timestamp whole second
                        of when the data for this packet was collected (i.e.
                        Start time).
                        For Boot programs (operations team's housekeeping data)
                        it is the time when or the packet was transmitted.
                        Referenced from 12:00UTC 2000/01/01.
                        Note: Spacecraft Clock = TIMESTAMP_WHOLE:TIMESTAMP_SUB"
/* RJW, TIMESTAMP_WHOLE, I, 1, 1 */
END_OBJECT          = COLUMN

OBJECT              = COLUMN
  NAME              = TIMESTAMP_SUB
  DATA_TYPE         = LSB_UNSIGNED_INTEGER
  START_BYTE        = 51
  BYTES             = 2
  VALID_MINIMUM     = 0
  VALID_MAXIMUM     = 65535
  MISSING_CONSTANT  = 0
  DESCRIPTION       = "Timestamp (Subsecond)
                        For Science modes this is the Timestamp subsecond
                        of when the data for this packet was collected (i.e.
                        Start time).
                        For Boot programs (operations team's housekeeping data)
                        it is the time when or the packet was transmitted.
                        Unit: Microseconds scaled to 16 bits.
                        Note: Spacecraft Clock = TIMESTAMP_WHOLE:TIMESTAMP_SUB"
/* RJW, TIMESTAMP_SUB, H, 1, 1 */
END_OBJECT          = COLUMN

OBJECT              = COLUMN
  NAME              = ACCUMULATION_TIME
  DATA_TYPE         = LSB_UNSIGNED_INTEGER
  START_BYTE        = 53
  BYTES             = 2
  VALID_MINIMUM     = 30
  VALID_MAXIMUM     = 600
  MISSING_CONSTANT  = 0
  UNIT              = "SECONDS"
  DESCRIPTION       = "Accumulation Time
                        Number of seconds over which the data in this product
                        was collected (Science Program)."
/* RJW, ACCUMULATION_TIME, H, 1, 1 */
END_OBJECT          = COLUMN

OBJECT              = COLUMN
  NAME              = DATA_TOTAL
  DATA_TYPE         = PC_REAL /* i.e. a float in little endian format */
  START_BYTE        = 55
  ITEMS             = 1536
  ITEM_BYTES        = 4
  BYTES             = 6144
  VALID_MINIMUM     = 0
  VALID_MAXIMUM     = 131070
  MISSING_CONSTANT  = 4294967295
  UNIT              = "COUNTS/VIEW"
  DESCRIPTION       = "DATA_TOTAL: Counts per view
                        64 Energy x 24 Spin-Phase Sectors.
                        The formula for mapping anodes into spin-phase
                        sectors is described in the PDS JADE SIS, and is:
                        SP_sector = ((s_phase+s_id+7.5*a_id)/15 - 4) MOD 24
                        where:
                          Spin-Phase Sector (SP_sector) is in the range [0-23]
```

```
                              SP_sector is an integer (round down) such that
                              two anodes fall in the same sector bin.
                          Spin phase (s_phase) where 0 <= s_phase < 360
                          Sensor id (s_id) is either 60, 180, or 300
                              depending on which sensor it is for.
                              In this case, s_id = 060
                          Anode id (a_id) is one of the 16 anodes, 0-15
                          7.5 degrees is the width of one anode.
                        Note the data units are rates (counts per views),
                        are floats rather than integers, and are fractions
                        of 1/512.
                        Note 2: Rate is independent of accumulation time."
/* Should be, DATA_TOTAL, f, 2, 64, 24 */
/* RJW, DATA_TOTAL, f, 1, 1536 */
END_OBJECT           = COLUMN

OBJECT               = COLUMN
  NAME               = MIN_SUBTRACTED_VALUE
  DATA_TYPE          = PC_REAL /* i.e. a float in little endian format */
  START_BYTE         = 6199
  BYTES              = 4
  VALID_MINIMUM      = 0
  VALID_MAXIMUM      = 131070
  MISSING_CONSTANT   = 4294967295
  UNIT               = "COUNTS/VIEW"
  DESCRIPTION        = "Min Subtracted Value
                        Minimum value subtracted from every element in
                        the array data blob.
                        Note: the units are rates (counts per views),
                        are floats rather than integers, and are fractions
                        of 1/512."
/* RJW, MIN_SUBTRACTED_VALUE, f, 1, 1 */
END_OBJECT           = COLUMN

OBJECT               = COLUMN
  NAME               = COMPRESSION_RATIO
  DATA_TYPE          = PC_REAL /* i.e. a float in little endian format */
  START_BYTE         = 6203
  BYTES              = 4
  VALID_MINIMUM      = 0
  VALID_MAXIMUM      = 1
  MISSING_CONSTANT   = -1
  DESCRIPTION        = "Data compression ratio of data blob when it was
                        transmitted to Earth:
                            Ratio = {Compressed size}/{Uncompressed size}
                        This is the compression due to the lossless
                        scheme, and does not include any lossy compression
                        which may have occured prior to it, such as the
                        32-bit to 8-bit or 16-bit to 8-bit look up tables
                        that are often used prior to the lossy compression.
                        A value of 1 means there was no lossless data
                        compression, i.e. it was turned off."
/* RJW, COMPRESSION_RATIO, f, 1, 1 */
END_OBJECT           = COLUMN

OBJECT               = COLUMN
  NAME               = BACKGROUND_COUNTS
  DATA_TYPE          = LSB_UNSIGNED_INTEGER
  START_BYTE         = 6207
  BYTES              = 4
  VALID_MINIMUM      = 0
  VALID_MAXIMUM      = 2516544000
  MISSING_CONSTANT   = 4294967295
```

```
  UNIT              = "COUNTS"
  DESCRIPTION       = "Background counts.
                       The background counter for electron sensor E060.
                       This is a total count, not a rate."
/* Should be, BACKGROUND_COUNTS, I, 1, 1*/
/* RJW, BACKGROUND_COUNTS, I, 1, 1 */
END_OBJECT          = COLUMN
```

C.2 Sample FMT file for JAD_HRS_ION_SP0_V02.FMT

```
/* Filename: Version02/JAD_HRS_ION_SP0_V02.FMT                            */
/* File written: 2015/06/29 18:43:10                                      */
/* Will code useful Python based letters to describe each object          */
/* see http://docs.python.org/library/struct.html for codes               */
/* formats will comma separated beginning with "RJW," as key then         */
/* {NAME}, {FORMAT}, {Number of dims}, {Size Dim 1}, {Size Dim 2}, ...    */
/* where {FORMAT} is the Python code for the type, i.e. I for uint32      */
/* and there are as many Size Dim's as number of dimensions.              */
/* Remember to remove the comment markers at either end                   */

/* RJW, BYTES_PER_RECORD, 3134 */
/* RJW, OBJECTS_PER_RECORD, 18 */

OBJECT              = COLUMN
  NAME              = SYNC
  DATA_TYPE         = LSB_UNSIGNED_INTEGER
  START_BYTE        = 1
  BYTES             = 4
  VALID_MINIMUM     = 4210242563
  VALID_MAXIMUM     = 4210242563
  MISSING_CONSTANT  = 0      /* If no Sync pattern there is no record */
  DESCRIPTION       = "JADE Sync Pattern for IDP packets.
                       Hex value = 0xFAF33403, Decimal = 4210242563"
/* RJW, SYNC, I, 1, 1 */
END_OBJECT          = COLUMN

OBJECT              = COLUMN
  NAME              = DPID_COUNT
  DATA_TYPE         = LSB_UNSIGNED_INTEGER
  START_BYTE        = 5
  BYTES             = 1
  VALID_MINIMUM     = 0
  VALID_MAXIMUM     = 255
  DESCRIPTION       = "DPID Count (Source Sequence Count)
                       Count of the number of times this product has been
                       generated since the startup (or reset) of the
                       generating application (Boot Program or Science
                       Program).  This count resets to 0 upon entry to
                       the modes of BOOT, LVENG, HVENG, LOW_RATE_SCI,
                       MCP_CAL_SCI, HI_RATE_SCI.
                       Note: starts with 0, increments by 1, eventually
                       rolls over at 255."
/* RJW, DPID_COUNT, B, 1, 1 */
END_OBJECT          = COLUMN

OBJECT              = COLUMN
  NAME              = COMPRESSION
  DATA_TYPE         = LSB_UNSIGNED_INTEGER
  START_BYTE        = 6
  BYTES             = 1
```

```
  VALID_MINIMUM     = 0
  VALID_MAXIMUM     = 1
  MISSING_CONSTANT  = 255
  DESCRIPTION       = "Lossless Compression Status.
                       Indicates whether the data (non-header) segment of
                       the IDP packet (IDP Data) was lossless compressed.
                         0 = Not Compressed
                         1 = Compressed"
/* RJW, COMPRESSION, B, 1, 1 */
END_OBJECT          = COLUMN

OBJECT              = COLUMN
  NAME              = IDPLENGTH
  DATA_TYPE         = LSB_UNSIGNED_INTEGER
  START_BYTE        = 7
  BYTES             = 2
  VALID_MINIMUM     = 0
  VALID_MAXIMUM     = 65534
  MISSING_CONSTANT  = 65535
  DESCRIPTION       = "IDP Length,
                       Byte Length of the IDP packet."
/* RJW, IDPLENGTH, H, 1, 1 */
END_OBJECT          = COLUMN

OBJECT              = COLUMN
  NAME              = PACKETID
  DATA_TYPE         = LSB_UNSIGNED_INTEGER
  START_BYTE        = 9
  BYTES             = 1
  VALID_MINIMUM     = 64    /* 0x40 */
  VALID_MAXIMUM     = 64    /* 0x40 */
  MISSING_CONSTANT  = 255
  DESCRIPTION       = "Packet ID (DPID), Data Product Identifier
                       High Rate Science - Ion Species Histogram
                       Species 00: 0x40"
/* RJW, PACKETID, B, 1, 1 */
END_OBJECT          = COLUMN

OBJECT              = COLUMN
  NAME              = FLIGHT_OR_STL
  DATA_TYPE         = LSB_UNSIGNED_INTEGER
  START_BYTE        = 10
  BYTES             = 1
  VALID_MINIMUM     = 0
  VALID_MAXIMUM     = 2
  MISSING_CONSTANT  = 255
  DESCRIPTION       = "In Flight data, or STL (ground EM tests):
                         0 = In flight, from JADE on Juno (via FEI)
                         1 = On ground, from STL tests (via FEI)
                         2 = On ground, from SwRI tests (not FEI)
                       255 = Unknown"
/* RJW, FLIGHT_OR_STL, B, 1, 1 */
END_OBJECT          = COLUMN

OBJECT              = COLUMN
  NAME              = ISSUES
  DATA_TYPE         = LSB_UNSIGNED_INTEGER
  START_BYTE        = 11
  BYTES             = 4
  VALID_MINIMUM     = 0
  VALID_MAXIMUM     = 4294967294
  MISSING_CONSTANT  = 4294967295
  DESCRIPTION       = "Issues in data?
```

```
/* Saw Tooth, Voltage Pulsing, Mag Latency, Flight or STL, make binary*/
                       0 = All seems well
                       4294967295 = Fill Value / unknown"
/* RJW, ISSUES, I, 1, 1 */
END_OBJECT           = COLUMN

OBJECT               = COLUMN
  NAME               = FSW_VERSION
  DATA_TYPE          = PC_REAL
  START_BYTE         = 15
  BYTES              = 4
  VALID_MINIMUM      = 0.00
  VALID_MAXIMUM      = 9.99
  MISSING_CONSTANT   = 255
  DESCRIPTION        = "Flight Software version used.
                       Number should be to 2 decimal places."
/* RJW, FSW_VERSION, f, 1, 1 */
END_OBJECT           = COLUMN

OBJECT               = COLUMN
  NAME               = TABLES_VERSION
  DATA_TYPE          = PC_REAL
  START_BYTE         = 19
  BYTES              = 4
  VALID_MINIMUM      = 0.00
  VALID_MAXIMUM      = 99.99 /* Probably should be max number of orbits */
  MISSING_CONSTANT   = 255
  DESCRIPTION        = "Tables version used onboard.
                       All tables are combined (compression, sweeping,
                       macros, etc.) onboard in to a large image.
                       This is the image number, or table version.
                       Number should be to 2 decimal places."
/* RJW, TABLES_VERSION, f, 1, 1 */
END_OBJECT           = COLUMN

OBJECT               = COLUMN
  NAME               = SCLKSCET_VERSION
  DATA_TYPE          = LSB_INTEGER
  START_BYTE         = 23
  BYTES              = 2
  VALID_MINIMUM      = -32767
  VALID_MAXIMUM      =  32767
  MISSING_CONSTANT   = -32768
  DESCRIPTION        = "The NAIF SPICE kernel for sclk used to generate UTC.
                       The JUNO sclk files are used to convert the spacecraft
                       clock timestamps to UTC time, and all have filenames
                       JNO_SCLKSCET.nnnnn.tsc, where nnnnn is the SCLKSCET
                       version number (with leading zeros and positive).
                       Each kernel has a reconstructed and predicted part for
                       it's values, typically any time after the last row of
                       the SCLK01_COEFFICIENTS_61999 table is predicted.
                       If TIMESTAMP_WHOLE:TIMESTAMP_SUB is in the predicted
                       part then SCLKSCET_VERSION will be negative, the
                       absolute value would be the version number.  If a later
                       SCLKSCET kernel version is used the UTC time will
                       likely be different.
                       If TIMESTAMP_WHOLE:TIMESTAMP_SUB is in the
                       reconstructed region the number will be positive
                       (equal to the version number) and will not vary with
                       later kernels.
                       e.g. If SCLKSCET_VERSION = -17 then kernel
                       JNO_SCLKSCET.00017.tsc was used to convert to UTC, but
                       it's a predicted UTC time.
```

```
                       If SCLKSCET_VERSION = 18 then kernel
                       JNO_SCLKSCET.00018.tsc was used to convert to UTC, and
                       it's a reconstructed UTC time that will not change with
                       later SCLKSCET kernel versions.
                       Within the PDS archive this value should always be
                       positive."
/* RJW, SCLKSCET_VERSION, h, 1, 1 */
END_OBJECT           = COLUMN

OBJECT               = COLUMN
  NAME               = UTC
  DATA_TYPE          = DATE  /* ASCII character string */
  START_BYTE         = 25
  BYTES              = 21
  VALID_MINIMUM      = 2011-217T00:00:00.001
                      /* SC Clock 365774402:0, JUNO Launch */
  VALID_MAXIMUM      = 2018-001T00:00:00.000
  MISSING_CONSTANT   = 0001-001T00:00:00.000
  DESCRIPTION        = "UTC timestamp, of format yyyy-dddTHH:MM:SS.sss
                       where yyyy = year, ddd = day of year,
                       HH = hour, MM = minute,
                       SS.sss = decimal seconds to millisecond resolution.
                       Value calculated via SPICE from spacecraft clock time,
                       {TIMESTAMP_WHOLE}:{TIMESTAMP_SUB}

                       For Science modes this is the UTC equivalent of
                       spacecraft clock when the data for this packet was
                       collected (i.e. Start time).
                       For Boot programs (operations team's housekeeping data)
                       it is the time when or the packet was transmitted."
/* RJW, UTC, c, 1, 21 */
END_OBJECT           = COLUMN

OBJECT               = COLUMN
  NAME               = DATA_UNITS
  DATA_TYPE          = LSB_UNSIGNED_INTEGER
  START_BYTE         = 46
  BYTES              = 1
  VALID_MINIMUM      = 0
  VALID_MAXIMUM      = 1
  MISSING_CONSTANT   = 255
  DESCRIPTION        = "The Data could be total counts (per accumulation)
                       or a rate, normalized to counts per view.
                         0 = All counts in the accumulation period (int)
                         1 = All counts divided by number of views (float)
                       255 = Not appropriate for this dataset, or Unknown."
/* RJW, DATA_UNITS, B, 1, 1 */
END_OBJECT           = COLUMN

OBJECT               = COLUMN
  NAME               = TIMESTAMP_WHOLE
  DATA_TYPE          = LSB_UNSIGNED_INTEGER
  START_BYTE         = 47
  BYTES              = 4
  VALID_MINIMUM      = 365774402 /* 2011-Aug-05: Juno Launch */
  VALID_MAXIMUM      = 568037064 /* ~ 2018-Jan-01            */
  MISSING_CONSTANT   = 0
  DESCRIPTION        = "Timestamp (Whole Second),
                       For Science modes this is the Timestamp whole second
                       of when the data for this packet was collected (i.e.
                       Start time).
                       For Boot programs (operations team's housekeeping data)
                       it is the time when or the packet was transmitted.
```

```
                      Referenced from 12:00UTC 2000/01/01.
                      Note: Spacecraft Clock = TIMESTAMP_WHOLE:TIMESTAMP_SUB"
/* RJW, TIMESTAMP_WHOLE, I, 1, 1 */
END_OBJECT          = COLUMN

OBJECT              = COLUMN
  NAME              = TIMESTAMP_SUB
  DATA_TYPE         = LSB_UNSIGNED_INTEGER
  START_BYTE        = 51
  BYTES             = 2
  VALID_MINIMUM     = 0
  VALID_MAXIMUM     = 65535
  MISSING_CONSTANT  = 0
  DESCRIPTION       = "Timestamp (Subsecond)
                      For Science modes this is the Timestamp subsecond
                      of when the data for this packet was collected (i.e.
                      Start time).
                      For Boot programs (operations team's housekeeping data)
                      it is the time when or the packet was transmitted.
                      Unit: Microseconds scaled to 16 bits.
                      Note: Spacecraft Clock = TIMESTAMP_WHOLE:TIMESTAMP_SUB"
/* RJW, TIMESTAMP_SUB, H, 1, 1 */
END_OBJECT          = COLUMN

OBJECT              = COLUMN
  NAME              = ACCUMULATION_TIME
  DATA_TYPE         = LSB_UNSIGNED_INTEGER
  START_BYTE        = 53
  BYTES             = 2
  VALID_MINIMUM     = 4
  VALID_MAXIMUM     = 4
  MISSING_CONSTANT  = 0
  UNIT              = "SECONDS"
  DESCRIPTION       = "Accumulation Time
                      Number of seconds over which the data in this product
                      was collected (Science Program)."
/* RJW, ACCUMULATION_TIME, H, 1, 1 */
END_OBJECT          = COLUMN

OBJECT              = COLUMN
  NAME              = DATA_TOTAL
  DATA_TYPE         = LSB_UNSIGNED_INTEGER
  START_BYTE        = 55
  ITEMS             = 1536
  ITEM_BYTES        = 2
  BYTES             = 3072
  VALID_MINIMUM     = 0
  VALID_MAXIMUM     = 65534
  MISSING_CONSTANT  = 65535
  UNIT              = "COUNTS"
  DESCRIPTION       = "DATA_TOTAL: Counts
                      32 Energy x 4 Deflection x 12 Anodes for SP0.
                      The meaning of each species is described in
                      the JADE instrument paper.  This product is collapsed
                      from the onboard 32 Energy x 8 Def. x 12 Anode cube.
                      Note: Value is capped at 16 bits."
/* Should be, DATA_TOTAL, H, 3, 32, 4, 12 */
/* RJW, DATA_TOTAL, H, 1, 1536 */
END_OBJECT          = COLUMN

OBJECT              = COLUMN
  NAME              = MIN_SUBTRACTED_VALUE
  DATA_TYPE         = LSB_UNSIGNED_INTEGER
```

```
  START_BYTE        = 3127
  BYTES             = 4
  VALID_MINIMUM     = 0
  VALID_MAXIMUM     = 65534
  MISSING_CONSTANT  = 65535
  UNIT              = "COUNTS"
  DESCRIPTION       = "Min Subtracted Value
                       Minimum value subtracted from every element in
                       the array data blob."
/* RJW, MIN_SUBTRACTED_VALUE, I, 1, 1 */
END_OBJECT          = COLUMN

OBJECT              = COLUMN
  NAME              = COMPRESSION_RATIO
  DATA_TYPE         = PC_REAL /* i.e. a float in little endian format */
  START_BYTE        = 3131
  BYTES             = 4
  VALID_MINIMUM     = 0
  VALID_MAXIMUM     = 1
  MISSING_CONSTANT  = -1
  DESCRIPTION       = "Data compression ratio of data blob when it was
                       transmitted to Earth:
                           Ratio = {Compressed size}/{Uncompressed size}
                       This is the compression due to the lossless
                       scheme, and does not include any lossy compression
                       which may have occured prior to it, such as the
                       32-bit to 8-bit or 16-bit to 8-bit look up tables
                       that are often used prior to the lossy compression.
                       A value of 1 means there was no lossless data
                       compression, i.e. it was turned off."
/* RJW, COMPRESSION_RATIO, f, 1, 1 */
END_OBJECT          = COLUMN
```