SARA Experimenter to Archive team Interface Control Document

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I. Acronyms and Abbreviations

Table 1-1 Acronyms and Abbreviations

Acronym	Definition
EAICD	Experiment to Archive Interface Control Document
ASCII	American Standard Code for Information Interchange
BMU	Bus Management Unit
CENA	Chandrayaan-1 Energetic Neutrals Analyzer
CH-1	CHandrayaan-1
CODMAC	Committee on Data Management and Computation
CSDA	The Chandrayaan-1 Science Data Archive
CSDAWG	CSDA Working Group
DPU	Digital Processing Unit
EDR	Experiment Data Record
ENA	Energetic Neutral Atom
ESA	European Space Agency
IRF	Swedish Institute of Space physics (Institutet för Rymdfysik)
ISRO	Indian Space Research Organisation
ISSDC	ISRO Science Data Centre
LENA	Low Energy Neutral Atom
NASA	National Aeronautics and Space Administration
NPO	Normal Phase Operations
ODR	Original Data Record
PDS	NASA Planetary Data System
SARA	Sub-keV Atom Reflecting Analyzer
S/C	Space Craft
SSR	Solid State Recorder
SPL	Space Physics Laboratory
SW	Solar Wind
SWIM	Solar WInd Monitor
TBD	To Be Decided
TM	Telemetry
VSSC	Vikram Sarabhai Space Centre

I. Glossary

Archival: Process of arranging Data Sets with all the documentation and ancillary information needed to understand and use the data.

PDS: Distributed archive of solar system data prepared in a standard format for use of scientific community.

LENA: Energetic neutral atoms having energies in the range 10 eV to few KeV

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1 Introduction

This document describes the contents and types of data sets belonging to the volumes of SARA experiment onboard the Chandrayaan-1 mission, the first Indian lunar mission. SARA consists of two sensors CENA and SWIM.

1.1 Purposes and Scope

The purpose of this EAICD (Experiment to Archive Interface Control Document) is two fold.

1. It provides users of the SARA instrument with detailed description of the data products, a description of how they were generated, including data sources and destinations. As part of this information sufficient description of the instrument is provided to help in the interpretation of the data and corresponding caveats.
2. It is the official interface between the SARA team and the Indian Space Science Data Centre (ISSDC).

1.2 Archiving Authorities

The data will be archived and managed at ISSDC (ISRO). The Planetary Data System Standard is used as archiving standard by

- NASA for U.S. planetary missions, implemented by PDS
- ESA for European planetary missions, implemented by the Research and Scientific Support Department (RSSD) of ESA

Indian Space Research Organization (ISRO) has also adopted this standard for Chandrayaan-1, the first Indian lunar mission. For the purpose of archiving Chandrayaan-1 data, version 3.7 of the PDS standard is applicable.

1.3 Documents

Applicable Documents

AD1 Planetary Data System Preparation Workbook, February 1, 1995, Version 3.1, JPL, D-7669, Part1
AD2 Planetary Data System Standards Reference, March 20, 2006, Version 3.7, JPL, D-7669, Part 2
AD3 Navigation and Ancillary Information Facility (NAIF), http://pds-naif.jpl.nasa.gov
AD4 GDP Processor and Manager Software User Manual, January 31, 2008, Draft a, ESA,SOP-RSSD-UM-018
AD5 GDP Processor Software Configuration Language Definition, January 31, 2008, Draft a,ESA, SOP-RSSD-TN-050
AD6 Chandrayaan-1 Archive Plan, CH1-SAC-PL-001,Issue 1, Rev. b, 10 Feb 2008

Reference Documents

RD1 Chandrayaan-1 Archive Plan, December 31, 2007, Version 1.a, ISRO, CH1-SAC-PL-001
RD2 Chandrayaan-1 Archive Conventions, December 31, 2007, Version 1.a, ISRO, CH1-SAC-PL-002

RD3 CENA Software Interface Control Document, February 04, 2008;CHA-SARA-DS-0006-I3R3

RD4 SWIM Software Interface Control Document, February 04, 2008 ;CHA-SARA-DS-0005-I3R2.

RD5 DPU Telemetry Interface Control Document, November 28, 2007, VSSC/DSD/CH1/SARA/TM/11/07

RD6 SAS Housekeeping Calibration Functions, CHA-SARA-CR-0002-I1R2

2 Overview of Instrument Design, Data Handling Process and Product Generation

2.1 Instrument Overview

The SARA instrument consists of three independent units

1. Chandrayaan-1 Energetic Neutral Analyzer (CENA) to detect low energy neutral atoms (LENAs) produced from lunar surface
2. Solar WInd Monitor (SWIM) to measure solar wind.
3. Digital Processing Unit (DPU)

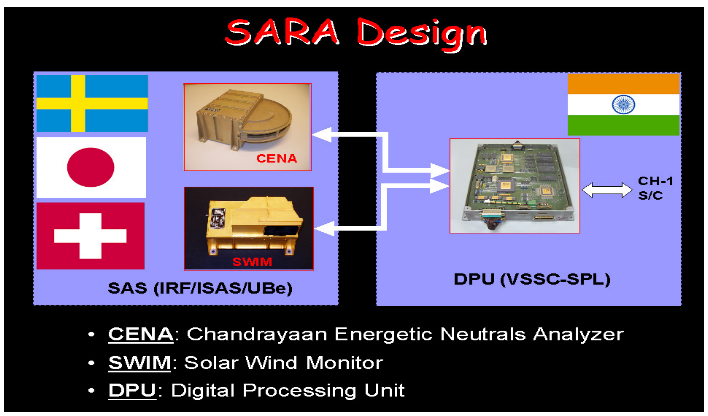

Figure 2-1 SARA Design

CENA detects neural atoms in the energy range 10 eV- 3.3 keV with an energy resolution of 50% and thereby enables to find the mass of neutral atoms sputtered from lunar surface. CENA consists of 4 subsystems, which are a Charged particle removal system, a conversion surface, an energy analysis system and a system to provide the time of flight analysis. It is capable of resolving all major mass groups H, O, Na-Mg group, K-Ca group and Fe.

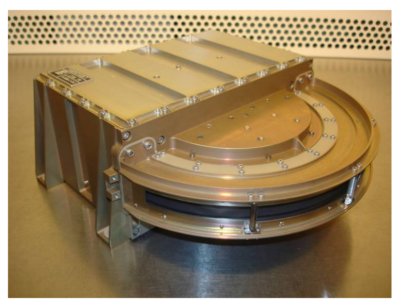

Figure 2-2 CENA

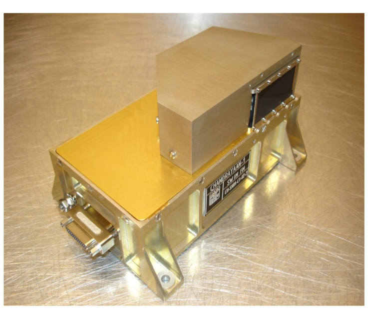

Figure 2-3 SWIM

SWIM which is basically an ion-mass analyzer which detects ions in various mass and energy bins, in the energy range 10 eV-15 keV, in the vicinity of the Moon. In other words it measures the solar wind flux precipitating on Moon. The main two components of SWIM are a sensor and the associated electronic board. The sensor consists of an electrostatic deflector, electrostatic energy analyzer and a system to provide the time of flight analysis. SWIM detects ions with an energy resolution of 7%. The two sensors CENA and SWIM are connected to spacecraft through DPU.

DPU consists of

1. A processing unit
2. Sensor interface Unit
3. Power Distribution Unit
4. Spacecraft Interface Unit

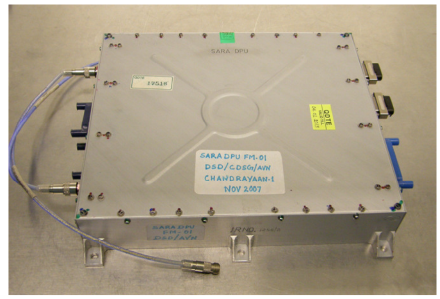

Figure 2-4 DPU

DPU acquires data from the two sensors simultaneously; process the data including time integration, binning, lossless compression, data formatting, storage, and transfer to the telemetry (TM) as per the TM requirements. Power distribution to sensors is under DPU control.

2.2 Scientific Measurements

The measurements of CENA will give the flux of neutral atoms sputtered from the lunar surface in various energy (E) bins, Mass (M) bins, Channel (C) bins and Phase (P) bins. The outputs of SWIM measurements are flux of ions (mainly solar wind ions) in various Energy (E) bins, Mass (M) bins and Direction (D) bins. The measurements by CENA will give the LENA counts of H, O, Na-Mg, K-Ca and Fe group in the energy range 10 eV-3.3 keV in the chosen mass group bins. The numbers of bins are chosen prior to the measurement and is variable. SWIM is able to resolve 6 mass groups;H+, He++, He+, O++, O+, and >20 amu in the energy range 10 eV-15 keV.

2.3 Summary of Instrument Modes

CENA sensor has 3 modes of operation

1. Coincidence Mode
2. Counter Mode
3. Engineering Mode

There are five possible telemetry modes

1. Mass Accumulation Mode
2. TOF Accumulation Mode
3. Count accumulation Mode
4. Non-Process Mode
5. Idle mode

Basic measurement cycle for both the sensors is 31.25 msec and in every 125 msec, DPU receives the data from the sensor. The content of scientific data changes with the sensor mode . After receiving the data, DPU decodes and reformats the data. The format of the data changes with the telemetry mode. When the sensor is in coincidence mode, the TM mode can be either “mass accumulation mode” or “TOF accumulation mode”.

When the sensor is in counter mode, the TM mode can be only "count accumulation mode". Non-process mode is used to acquire raw data from the CENA sensor. Idle mode is used to suppress sending the science data to the S/C while sensor is working nominally. In this mode no science data is sent to the S/C and only HK will be sent. The various sensor modes, TM modes and the corresponding data for CENA are described in the Table 2-1**.**

Table 2-1 SARA CENA TM and Sensor Modes during NPO

	Telemetry Mode	**Sensor Mode**	**Description**
CENA	Mass accumulation mode	Coincidence mode	This mode is used to obtain ENA data with mass information.
	TOF accumulation mode	Coincidence mode	This mode is used to obtain raw TOF distributions without mass information.
	Count accumulation mode	Counter mode	This mode is used to obtain detailed signal count from each preamplifier channel
	Raw mode (Non-process mode)	Coincidence mode Counter mode Engineering mode	This mode is used to obtain raw data from the sensor and is mainly used for sensor diagnostics. No data accumulation or binning takes place.
	Idle mode	Any mode	In this mode no science data is sent to the S/C but only housekeeping data.

For SWIM there is only one sensor mode of operation. The TM modes are

1. Normal mode
2. Raw mode (Calibration mode)
3. Idle mode

In normal mode the data will be the ion counts in various mass, energy and deflection bins. Raw/Calibration mode is used to obtain the raw data from SWIM. The idle mode is the same as described for CENA above. The various TM modes and the corresponding data for SWIM are described in the Table 2-2.

Table 2-2 SARA SWIM TM and Sensor Modes during NPO

	Telemetry Mode	Sensor Mode	Description
SWIM	Normal mode	Normal	To get charged particle counts in Mass, energy and deflection bins.
	Non-Process Mode (Raw mode)	Normal	This mode is used to obtain raw data from the sensor. No data accumulation or binning takes place.
	Idle mode	Normal or HK only (no TOF events need to be requested).	In this mode no science data is sent to the S/C but only housekeeping data.

2.4 Scientific Objectives

The major scientific objectives of SARA experiment, which is a low energy neutral atom imaging mass spectrometer onboard Chandrayaan-1 mission, are to study the following:

(i) Lunar surface composition.
(ii) Imaging of permanently and temporarily shadowed areas on lunar surface
(iii) Lunar surface magnetic anomalies and related physics.

In addition, SARA can be used to study space weathering on moon, sources of exospheric gases and comparative studies at the Moon and Mercury, and interplanetary LENAs (Low Energy Neutral Atoms).

2.5 Data Handling process

The following Table 2-3 gives the data Processing Level definitions of Chandrayaan-1.

Table 2-3 Data Processing Level definitions of Chandrayaan-1

Level Definition	Level Definition
0	Raw payload data along with the ancillary information, which includes ephemeris and attitude. This level of processing includes data qualification, (byte alignment, data decompression, band separated, if required) and time tagging. Also the data is given along with the calibration information.
1	Calibrated/ corrected and geometrically mapped. (For imaging sensor like TMC or HySI, the processing includes detector response normalization, framing, line/pixel loss correction and tagging the selenographic coordinate to each pixel in addition to band separation for HySI. Each pixel is given in radiances and the conversion parameters to count value will be provided)
2	Calibrated and resampled over and above the level-1 processing
3	Derived results

For the description corresponding to the different type of data and the corresponding data processing CODMAC (Committee on Data Management and Computation) levels see Appendix C: Processing Levels (PDS Processing Levels) and AD1.

The comparison of levels between CODMAC, NASA and ISRO is given in the table below.

Table 2-4 Ccomparison of data processing levels between CODMAC, NASA and ISRO

Type	Description	NASA Level	ISRO Level	CODMAC Level	Data set type ID
Raw Data	Telemetry data with data embedded.	----	----	1	UDR
Edited Data	Corrected for telemetry errors and split or decommutated into a data set for a given instrument. Sometimes called Experimental Data Record. Data are also tagged with time and location of acquisition	0	0	2	EDR

Calibrated Data	Edited data that are still in units produced by instrument, but that have been corrected so that values are expressed in or are proportional to some physical unit such as radiance. No resampling, so edited data can be reconstructed	1A	1/1b	3	RDR
Resampled Data	Data that have been resampled in time or space domains in such a way that the original edited data can not be reconstructed. Could be calibrated in addition to being resampled.	1 B	1b/2	4	
Derived Data	Derived results such as maps, reports, graphics, etc	2-5	3 and above	5	DDR

The above details can be found in AD6 Appendix A, section 11, page 24.

2.6 Data Flow

1. S/C to Ground

The following diagram (Figure 2-5) represents the data flow from DPU to S/C and from S/C to the ground. The DPU will acquire data from the CENA and SWIM sensors. The average data rate from CENA sensor to DPU is 100 Kbps and that for SWIM is 1.024 Mbps. One complete measurement cycle of CENA is 4 sec and that of SWIM is 8 sec. DPU does processing on the sensor data which consists of mass, energy, arrival direction binning, time integration and accumulation of data to 16 bit counters, which are subsequently subjected to log compression to reduce the word length to 8 bits, and then subjected to the lossless compression (if it is required). After formatting, the data will be sent to TM buffer on the DPU. Both the CENA and SWIM data streams together, with the part of DPU and sensor HK data added, will be sent to DHU on initiation from the BMU via 1553 bus, and subsequently stored in the SSR. This SARA data will be send to the ground. Since data received at the ground will have contribution from other instruments also, the SARA data is separated using an alphanumeric identifier called APID (SARA APID is 37 in Decimal or 0x25). This data will be made available to both the Payload Operation Centres (POC) of SARA.

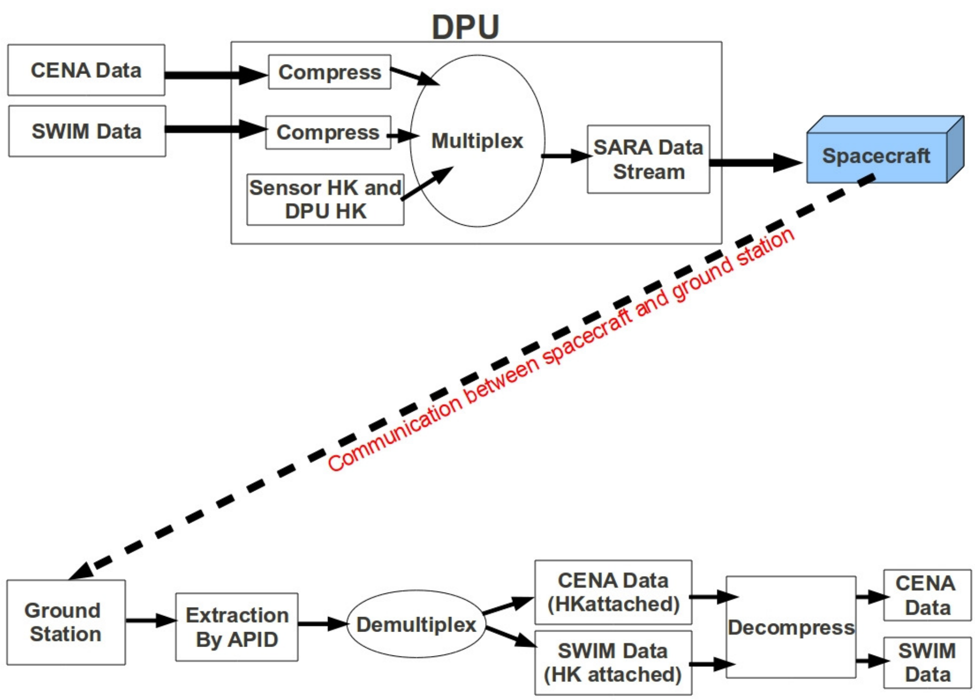

Figure 2-5 Data Flow

2. Ground

The data handling of all Chandrayaan-1 SARA data takes place at the Indian Space Science Data Centre (ISSDC), under the control of the SARA Principal Investigator. The generation of PDS level 2 data (CODMAC level 2 - raw, edited) from the telemetry data is done using the ESA's Generic Data Pipeline processor (so-called *GDP-processor).*

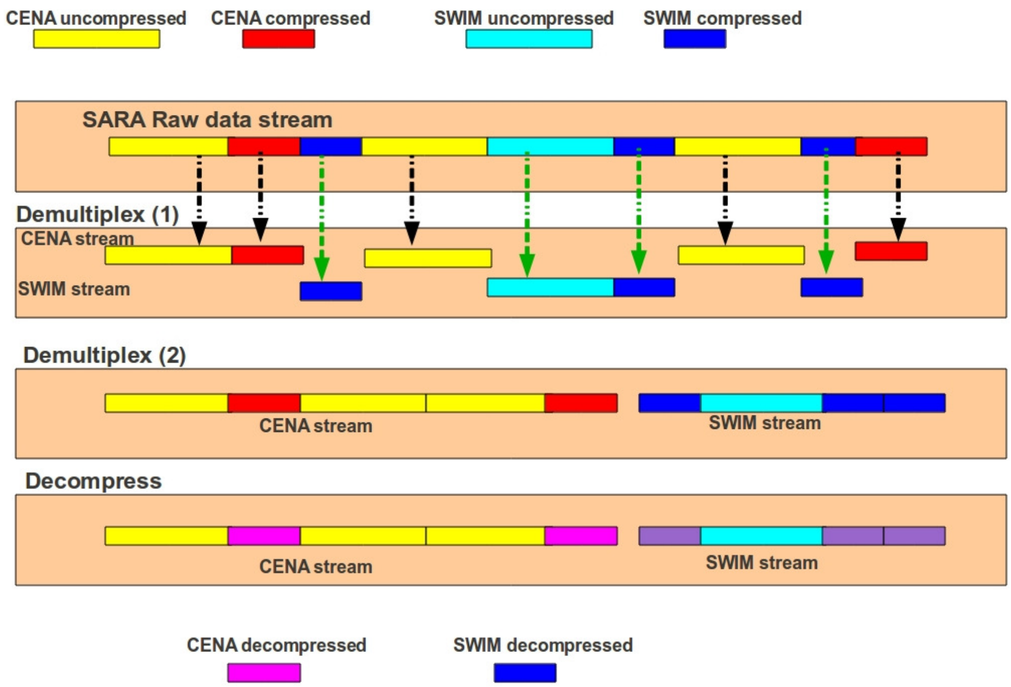

Figure 2-6 Demultiplexing of data

2.7 Overview of Data Products

2.7.1 Pre-Flight Data Products

No pre-Flight data products are planned at present.

2.7.2 Sub-System Tests

The sub-system tests contribute to the characterization and calibration of the instrumentation. The data generated by these tests are used to determine the data quality (e.g., noise ratios) and to compute calibrations (e.g., sensor efficiencies). The test data are not archived, but the outcomes from these test data are included in the data quality indicators in the data products and will be provided in any archived calibration data and ancillary data.
(TBD-IRF)

2.7.3 Instrument Calibrations

Ground calibration had been performed for both the sensors – CENA and SWIM. The details are provided in the calibration reports.

2.7.4 In-Cruise Data Products

There is no plan to operate the SARA during cruise from Earth to Moon.

2.7.5 In-Orbit Data Products

The in-orbit data products that shall be provided as the initial delivery to the Chandrayaan-1 Science Data Archive (CSDA) at ISSDC shall consist of PDS formatted level 2 data products. These are raw data that have been unpacked from the telemetry packets, time tagged, converted to engineering units and output in an easily readable form together with the necessary labels and auxiliary information required for ingestion into the CSDA system.

The data provided includes observations made during the "Normal Phase Operations" (NPO) phase of the mission. The level 2 data represents the full data set returned from the SARA instrument.

Descriptions of the individual products that are included in the level 2 submissions to the CSDA are provided in section 4.3 of this document.

It is to be noted that although no separate geometry index file is provided, relevant geometry information is provided in the data products for each measurement.

2.7.6 Software

The SARA processing software is based on GDP software tool provided by ESA. The GDP is written mainly in IDL. The GDP will:

- Read the level 0 telemetry files from the level-0 processing software in the spacecraft control network layer (see [RD1], Section 7.2.2, Figure 1).
- Extract parameters from the telemetry packets and convert to Level 2 engineering units.
- Re-package data and output level 2 data in PDS format.

Specific GDP configuration files for the SARA instrument are available to perform the data processing and conversion to PDS.

No software shall be provided with the datasets supplied to the CSDA. However the output data files conform to the PDS standards and therefore can be read by software such as READPDS and NASAView (see Appendix A, section 5.1).

2.7.7 Documentation

All the documents including the AICD and the related SARA documents are considered to be kept in a directory namely DOCUMENT in the archive volumes.
The suggested documents are:

1. Experiment Description:

   i. CENA Software Interface Control Document, CHA-SARA-DS-0006-I3R3
   ii. SWIM Software Interface Control Document, CHA-SARA-DS-0005-I3R2
   iii. DPU Telemetry Interface Control Document November 28, 2007, VSSC/DSD/CH1/SARA/TM/11/07

iv. SAS Flight Operation Manual, CHA-SARA-MA-0002-I2R1

2. User Manuals

   i. SARA Experiment to Archival Interface Control Document (EAICD): Latest one.

3. Calibration Reports

   i. SWIM FM Calibration Report, Issue 1, Revision 0 dated January 22, 2010.
   ii. CENA FM Calibration Report, Issue 1 Revision 0, January 24, 2010.

4. Scientific Articles

   (PDF of published papers)

1). Bhardwaj et al., Low energy neutral atom imaging on the Moon with the SARA instrument aboard Chandrayaan-1 mission , *J. Earth Syst. Sci. 114, 749-760*, 2005
2). Futaana et al. , Low energy neutral atoms imaging of the Moon , *Planet. Space Sci. 54* ,132-143, 2006.
3). Kazama et al., Energetic Neutral atom imaging mass spectroscopy of the Moon and Mercury environments, Adv Space Res. 37,38-44,2006.
4). D. McCann, S. Barabash, H. Nilsson, and A. Bhardwaj, Miniature Ion Mass Analyser, *Planetary and Space Science*, 55, 9, 1190-1196 (2007).
5) Stas Barabash, Anil Bhardwaj, Martin Wieser, R. Sridharan, Thomas Kurian, Subha Varier, E. Vijayakumar, Veena Abhirami, K. V. Raghavendra, S. V. Mohankumar, M. B. Dhanya, Satheesh Thampi, Asamura Kazushi, Herman Andersson, Futaana Yoshifumi, Mats Holmström, Rickard Lundin, Johan Svensson, Stefan Karlsson, R. Daniele Piazza, Peter Wurz, Investigation of the solar wind – Moon interaction onboard Chandrayaan-1 mission with the SARA Experiment, *Current Science*, 96, 526-532, 2009.

2.7.8 Ancillary Data Usage

The ancillary information is important for the studies using the science data of SARA experiment as it gives information on where in space and time the spacecraft is located. The ancillary information includes (see section 2.5)

i. Nadir footprint in the selenographic coordinate system
ii. Sun Vector in the spacecraft co-ordinates
iii. PVT ,AT, and viewing direction in the selenographic or sun-orbit reference frame
iv. Quality flag.

3 Archive Format and Contents

3.1 Format and Conventions

3.1.1 Deliveries and Archive Volume Format

The initial delivery shall consist of PDS level 2 data. During the "normal phase operations" mission phase (NPO), the PDS level 2 data sets for each SARA sensor (CENA and SWIM) are to be delivered to the CSDA.

One archive volume is produced for each sensor and contains a single data set covering the NPO phase observations. Each data set will consist mainly of science observations and housekeeping data from the sensor.

The delivery schedule should be as agreed with ISSDC (ref. Chandrayaan-1 Archive Plan). TBD

The archive volumes have the following naming convention:

CH1SAR_<sequence identifier YYXX> where <sequence identifier YYXX> = The first digits (YY) represent the volume set; the remaining digits (XX) represent the volume number in the set.

Table 3-1 Volume ID's, Names and Data Set ID's

Volume Name	Volume ID	Data Set ID
VOLUME 1 CHANDRAYAAN-1 SARA CENA NPO DATA	CH1SAR_1001	CH1ORB-L-SARA-2-NPO-EDR-CENA-V1.0
VOLUME 2 CHANDRAYAAN-1 SARA SWIM NPO DATA	CH1SAR_1002	CH1ORB- L-SARA-2-NPO-EDR-SWIM-V1.0

3.1.2 Data Set ID Formation

As explained in the previous section, two data sets will be made available to the CSDA archive at ISSDC. The first data set will contain CENA level 2 data from the normal operations mission phase (NPO). The second dataset will contain SWIM level 2 data from the normal operations mission phase (NPO).

Each PDS data set must have a unique identifier. PDS data set identifiers and names conform to the following format:

CH1ORB-M-SARA-<processing level>-NPO-<data type>-<sensor name>-<version>

where

CH1ORB stands for "Chandrayaan-1 Orbiter"
L denotes the target identifier: L = LUNAR
SARA stands for "Sub-KeV Atom Reflecting Analyzer"
<processing level> denotes the CODMAC level: 2
<data type> denotes the data type: EDR = "Experiment Data Record"
NPO denotes the mission phase: NPO = "Normal Phase Operations"

<sensor> denotes the sensor name:
CENA = "Chandrayaan-1 Energetic Neutrals Analyzer"
SWIM = "Solar Wind Monitor"
<version> denotes the version number (e.g. V1.0)

Table 3-2 Data Set ID's and Names

Data Set ID	Data Set Name
CH1ORB- L-SARA-2-NPO-EDR-CENA-V1.0	CHADRAYAAN-1-ORBITER MOON SARA 2 NPO EDR CENA V1.0
CH1ORB- L-SARA-2-NPO-EDR-SWIM-V1.0	CHADRAYAAN-1-ORBITER MOON SARA 2 NPO EDR SWIM V1.0

3.1.3 Data Directory Naming Conventions

At the root level, the PDS required naming scheme will be followed (DATA, DOCUMENT, INDEX, CALIB, CATALOG…). The DATA directory structure is the same for all archive volumes. The naming convention used below the DATA directory is as follows:
/DATA/<orbit number>/<filename>
Data is split per orbit. The file naming convention is described in the section below.

3.1.4 File Naming Conventions

PDS data product files conform to the following convention:

SARA_<sensor>_<instrument mode><compression mode> _<quality id> <ROOOOO> _<NN>.<EXT>

Examples:
SARA_CENA_02UN_43_R00353_01.DAT (CENA uncompressed TOF accumulation data file)
SARA_SWIM_01UN_43_R00353_01.LBL (SWIM normal mode data label)

Table 3-3 File Naming conventions

SARA	denotes the instrument name: SARA = "Sub-Kev Atom Reflecting Analyzer"
<sensor>	stands for the instrument sensor: CENA "Chandrayaan-1 Electron neutral analyzer" SWIM "Solar wind monitor"
<instrument mode>	denotes the instrument mode: CENA 00 Housekeeping data

	01 Mass accumulation data 02 TOF accumulation data 03 Counter accumulation data 04 Engineering packets data 05 Coincidence event data 06 Raw counter data 07 Raw coincidence data 08 Raw engineering data SWIM 00 Housekeeping data 01 Normal mode data 02 Raw data
<compression mode>	denotes the compression mode (optional): CM Compressed UN Uncompressed
<quality id>	Denotes the data quality identifier, formed from two components (characters): QT[1] Q 0 Unknown state 1 Bad data 2 Invalid data 3 Questionable data 4 Data useful for scientific analysis T 0 Questionable UTC time stamps 1 Jumps in UTC time stamps matched after interpolation with small deviations 2 Jumps in UTC time stamps matched after interpolation 3 No issues in UTC time stamps
<ROOOOO>	where R is mandatory and stands for “revolution”, OOOOO is the consecutive orbit number. The number will be padded by leading zeros if required, e.g. ‘R00329’.
<NN>	is a consecutive number of the file within that orbit.
<EXT>	is the extension. It can be one of the following: LBL = PDS label DAT = PDS data file TAB = PDS table file

[1]Time Quality Note

In order to correct various types of time inconsistencies found in the data, an interpolation algorithm has been applied. The algorithm assumes packets are received in the correct order and requires CENA packets to be 4s + delta apart in time and SWIM packets to be 8s + delta apart in time, with delta = 1.5s. If this is not the case then the packet counter is used to interpolate time. PDS files have been assigned a time quality id (T) based on the result of the interpolation:

- If there are no inconsistencies in the data packets, the time quality id is set to 3 (i.e. no issues in UTC time stamps).
- If the interpolation matches the calculated time stamp from OBT again after less than 74 packets, the OBT jump is identified to be artificial and interpolated time is used. In this case, the time quality id is set to 2 (i.e. jump in UTC time stamps matched after interpolation).
- If the interpolation does not match exactly after the jump, but the deviation is small and acceptable (less than a few seconds), the time quality is set to 1 (i.e. jump in UTC time stamps matched after interpolation with small deviations).
- If the interpolation does not jump back to interpolated time after 74 packets, the time is set to 0 (i.e. questionable UTC time stamp).

PDS files with questionable UTC time stamps (i.e. T equals 0) will be placed in the DATA directory under a separate subdirectory named QUESTIONABLE.

3.2 Standards Used in Data Product Generation

3.2.1 PDS Standards

PDS standard version 3.6 (August, 1st, 2003) are used for the SARA data archive production, see [AD1] and [AD2] for details.

3.2.2 Time Standards

3.2.2.1 Date and Time Formats

The dates and times used within SARA data files are the times when the data are sampled in UTC. The START_TIME and STOP_TIME values in the data labels are also in UTC and in the same format as the dates and times within the data files:yyyy-dddThh:mm:ss.sss, where yyyy is the 4-digit year, ddd is the 3-digit day of year, hh is the 2-digit hour of the day (00-23), mm is the 2-digit minute of the hour (00-59), and ss.sss indicates the seconds (including fraction) of the minute. The PRODUCT_CREATION_TIME is also in UTC and indicates the date/time that the data files and labels are generated as taken from the local computer. The dates/times of the PRODUCT_CREATION_TIME have format: yyyy-mm-ddThh:mm:ss, where yyyy is the 4-digit year, mm is a 2-digit month, dd is the 2-digit day of the month, hh is the 2-digit hour of the day, mm is a 2-digit minute of the hour, and ss indicates the seconds of the minute.

3.2.2.2 Spacecraft Clock Formats

The SPACECRAFT_CLOCK_START_COUNT and SPACECRAFT_CLOCK_STOP_COUNT values represent the on-board time counters (OBT) of the spacecraft and instrument computers. This OBT counter is given in the headers of the experiment telemetry source packets. The OBT in the telemetry packet is in 1750 processor format and is of 48 bits length. This OBT in the processor format is converted and represented as a decimal real number in floating point notation with 5 digits after the decimal point. An integer number followed by a slash represents a reset of the spacecraft clock (e.g., "1/" or "2/"). The SPACECRAFT_CLOCK_*_COUNT values in the data and index labels have the form: n/dddddddddd.ddddd, where n is an integer number, up to 10 digits after the slash, and 5 digits after the decimal point. This is the form returned by the SPICE software using the Chandrayaan-1 SCLK files.

3.2.2.3 OBT to UTC time Conversion

Project will provide a routine to convert OBT to UTC as part of SPICE library for Chandrayaan-1.

3.2.3 Reference Systems

The reference systems used for orbit, attitude, and target body follow the SPICE standards and are defined in the different SPICE kernels. Please, see [AD4] for details. Latitudes and longitudes are given in degrees, latitudes are planetocentric.

3.2.4 Other Applicable Standards

None.

3.3 Data Validation

Data Validation will be performed in 3 steps:

i. Internal team data validation
ii. PDS compliance
iii. Peer review

Regarding internal team validation, a team will be formed for internal validation of the data and the details of which will be given later.
The peer review is a three-step process consisting of

i. The Peer Review of the Archive Plan (this document) and the individual EAICDs (EAICD Review)
ii. The review of the first data delivery (initial Peer Review) and
iii. The review of all data sets together after the final delivery (Final Peer Review).

The Chandrayaan-1 Science Data Archive (CSDA) team organizes the Peer Reviews. It is proposed to form separate review panels for the individual instruments. The review team composition will be decided in the CSDAWG (CSDA Working Group). The Peer Review team verifies the data sets /documents. Issues identified during peer reviews (called "liens" in PDS jargon) will be resolved by the concerned experiment/PI teams, and the CSDA team. Corrected data sets as per the peer review recommendations do not undergo additional peer review unless a specific recommendation for this had been made by the peer review team. Depending on the result of the Peer Review, the status of the reviewed data set is noted as "Peer Review cleared“, or "Failed Peer review ". [Ref: RD1]

3.4 Content

This section provides a description of the initial data volumes to be provided to the CSDA and their content.
The volume set constitutes two volumes as depicted below.

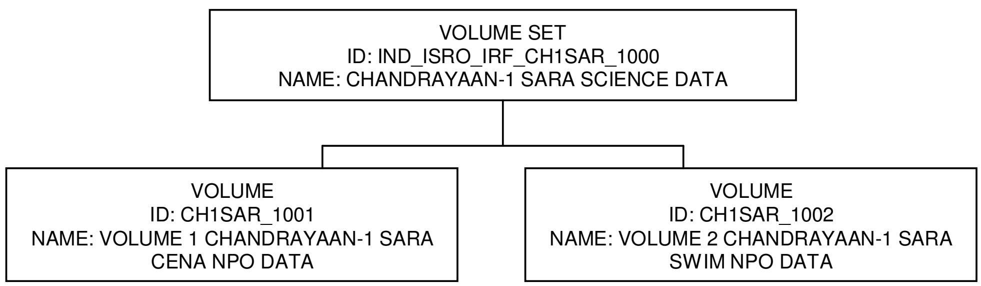

Figure 3-1 Volume Set

One data volume shall be provided for each level of data corresponding to the different sensors of the instrument, CENA and SWIM. The data volumes shall include all observations taken during the NPO phase of the mission. This will include science data, housekeeping data and raw data, together with ancillary data related to the data set.

Table 3-4 Volume Set ID and Name

Volume Set ID	Volume Set Name
IND_ISRO_IRF_CH1SAR_1000	CHANDRAYAAN-1 SARA SCIENCE DATA

Table 3-5 Volume ID's and Names

Volume Name	Volume ID	Data Set ID
VOLUME 1 CHANDRAYAAN-1 SARA CENA NPO DATA	CH1SAR_1001	CH1ORB- L-SARA-2-NPO-EDR- CENA-V1.0
VOLUME 2 CHANDRAYAAN-1 SARA SWIM NPO DATA	CH1SAR_1002	CH1ORB- L-SARA-2-NPO-EDR-SWIM-V1.0

3.4.1 Data set

Each volume consists of a single data set.

Table 3-6 Data Set, Names and Data Set ID's

Data Set ID	**Data Set Name**
CH1ORB- L-SARA-2-NPO-EDR CENA-V1.0	CHADRAYAAN-1-ORBITER MOON SARA 2 NPO EDR CENA V1.0
CH1ORB- L-SARA-2 NPO -EDR-SWIM-V1.0	CHADRAYAAN-1-ORBITER MOON SARA 2 NPO EDR SWIM V1.0

3.4.2 Directories

3.4.2.1 ROOT Directory

According to PDS standards (Ref. *PDS Standards Reference*, March 20, 2006), root directory is the top-level directory of an archive volume. The ROOT Directory is supposed to contain the following files:
The first two files are required and the last one is optional.

(i) AAREADME.TXT : Contains an overview of the contents and organization of the associated volume, general information for its use and contact information.
(ii) VOLDESC.CAT: High level descriptions of contents of volume.
(iii) ERRATA.TXT: Describes the errors, omissions and areas of non-conformance with PDS standards in the current volume and in the previous volumes of a set.

3.4.2.2 INDEX Directory

The INDEX directory contains the following files:

(i) INDXINFO.TXT : A list and description of all files in the INDEX directory.
(ii) INDEX.LBL : This is the PDS label for the volume index file, INDEX.TAB.
(iii) INDEX.TAB : This file contains the volume index in tabular format.

Geometry index or browse index TBD

3.4.2.3 DOCUMENT Directory

To be consisting of all the related documents of SARA experiment. (Section**.2.4.8)**

3.4.2.4 CATALOG Directory

Meant for files that provides the top-level understanding of SARA experiment on Chandrayaan-1 mission as well as its data products. Supposed to be consisting of Mission and Spacecraft files, information for the instrument and data set files and all files formatted in to PDS standard form. All CATALOG files may be ASCII text files.
Generally CATALOG Directory consists of the following files:

(i) CATINFO.TXT: Contains a description of each file in the CATALOG subdirectory.
(ii) MISSION.CAT : Mission description
(iii) INSTHOST.CAT: PDS catalog description of instrument host, i.e. spacecraft.
(iv) SARA_EXP.CAT: PDS catalog description of SARA experiment and the sensors CENA and SWIM.

(v) PERSON.CAT: PDS catalog description of SARA team members and other persons involved in the generation of Data Products.
(vi) SARA_XXXX_DS.CAT: PDS data catalog description of SARA data where XXXX stands for CENA and SWIM.
(vii) SOFTWARE.CAT: Description of software included in the software directory.
(viii) REF.CAT: Contains a listing of references used elsewhere in the catalog files or references that might be generally useful in working with these data.

3.4.2.5 BROWSE Directory

The BROWSE directory will have subdirectories named according to the naming conventions defined for the DATA directory. These subdirectories shall contain browse images for all data products containing quick look data plots. A detailed description of the quick look plots can be found in the label of each BROWSE product.

3.4.2.6 DATA Directory

Will be containing actual data products of SARA experiment. Each archive volume containing a single data set. DATA directory will have subdirectories named according to the naming conventions. These subdirectories will contain the actual data files.

4 Detailed Interface Specifications

This section describes the PDS data products to be supplied to the CSDA.

4.1 Structure and Organization View

A schematic overview of a dataset is given in Figure 4-1 below. For a description of the individual components see section.

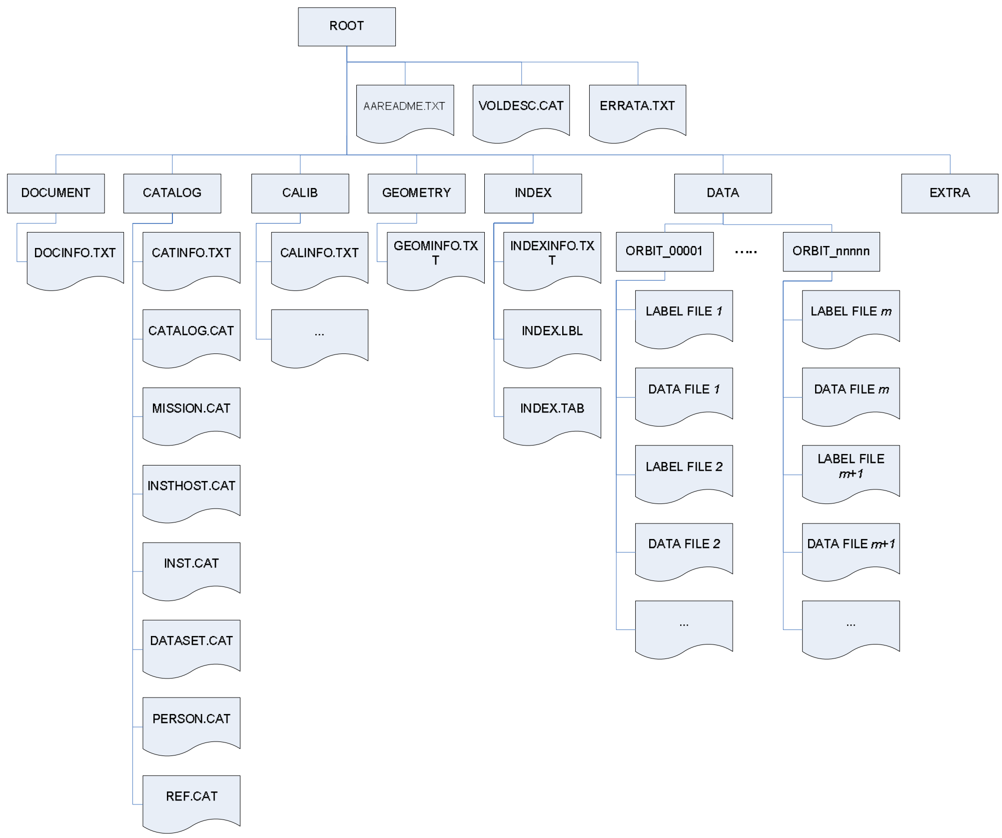

Figure 4-1 Data Set

4.2 Data Sets, Definition and Content

As described in section 4.3.

4.3 Data Product Design

A PDS data product is one component of a dataset and consists of a PDS label and the data object that it describes. In all cases, a single label is used to describe the product. All SARA PDS data product labels are detached from the data and reside in a different file, which contains a pointer to the data product file (see section 4.3.1.2). There is one detached label file for every data product file. The label file should have the same base name as its associated data file, but the extension .LBL.

4.3.1 Common Information Elements

Label Standards Identifiers

```
PDS_VERSION_ID                = PDS3
```

File Characteristic Data Elements

```
/* FILE CHARACTERISTIC DATA ELEMENTS */
```

```
FILE_NAME                      = "SARA_CENA_NE00_R00001_001.LBL"
RECORD_TYPE                    = FIXED_LENGTH
# This keyword means records in the data product file have the same length.

RECORD_BYTES                   = 102
FILE_RECORDS                   = 87
LABEL_RECORDS                  = 200
INTERCHANGE_FORMAT             = ASCII
```

Data Object Pointers

```
/* DATA OBJECT POINTERS */
^TABLE                         = ("SARA_CENA_NE00_R00001_001.TAB",1)
# This indicates that the TABLE object points to the file
# SARA_CENA_NE00_R00001_001.TAB. Pointers to data objects are always required to be
# located in the same directory as the label file, so the file in this example can
# be found the same directory as the detached label file.
```

Identification Data Elements

```
/* IDENTIFICATION DATA ELEMENTS */

DATA_SET_ID                    = "CH1ORB-L-SARA-2-NPO-EDR-CENA-V1.0"
DATA_SET_NAME                  = "CHANDRAYAAN-1-ORBITER MOON
                                  SARA 2 NPO EDR CENA V1.0"
RELEASE_ID                     = 0001
REVISION_ID                    = 0000

PRODUCT_ID                     = SARA_CENA_NEI_R00001_001
PRODUCT_CREATION_TIME          = 2008-01-24T00:04:24
PRODUCT_TYPE                   = EDR
PROCESSING_LEVEL_ID            = 2
PROCESSING_LEVEL_DESC          = "EXPERIMENT DATA RECORD”

PRODUCER_ID                    = SARA_TEAM
PRODUCER_FULL_NAME             = "M.B.DHANYA"
PRODUCER_INSTITUTION_NAME      = "VIKRAM SARABHAI SPACE CENTRE"
DATA_QUALITY_ID                = < TBD >
DATA_QUALITY_DESC              = < TBD >

MISSION_ID                     = CH1
MISSION_NAME                   = "CHANDRAYAAN-1"
INSTRUMENT_HOST_ID             = CH1ORB
NSTRUMENT_HOST_NAME            = "CHANDRAYAAN-1-ORBITER"
MISSION_PHASE_NAME             = "NORMAL PHASE OPERATIONS"

TARGET_NAME                    = "MOON"
TARGET_TYPE                    = SATELLITE
START_TIME                     = 2009-01-18T13:18:49
STOP_TIME                      = 2009-01-18T13:31:01
SPACECRAFT_CLOCK_START_COUNT   = "1/28339048"
SPACECRAFT_CLOCK_STOP_COUNT    = "1/28339780"
ORBIT_NUMBER                   = 94
```

Descriptive Data Elements

```
/* DESCRIPTIVE DATA ELEMENTS */

INSTRUMENT_ID                  = SARA
INSTRUMENT_NAME                = "SUB-KEV ATOM REFLECTING ANALYZER"
INSTRUMENT_TYPE                = "NEUTRAL PARTICLE DETECTOR"
# The instrument type is:
#                      for CENA "NEUTRAL PARTICLE DETECTOR"
#                      for SWIM "CHARGED PARTICLE DETECTOR"
#
INSTRUMENT_MODE_ID             = OPERATING
INSTRUMENT_MODE_DESC           = “OPERATING”
```

Positional Information Data Elements

```
/* POSITIONAL INFORMATION DATA ELEMENTS */
```

```
SC_SUN_POSITION_VECTOR        = < Calculated by software using SPICE library >
SC_TARGET_POSITION_VECTOR     = < Calculated by software using SPICE library >
COORDINATE_SYSTEM_ID          = < Calculated by software using SPICE library >

COORDINATE_SYSTEM_NAME        = < Calculated by software using SPICE library >

SPACECRAFT_SOLAR_DISTANCE     = < Calculated by software using SPICE library >

RIGHT_ASCENSION               = < Calculated by software using SPICE library >

DECLINATION                   = < Calculated by software using SPICE library >

FOOTPRINT_POINT_LATITUDE      = < Calculated by software using SPICE library >
FOOTPRINT_POINT_LONGITUDE     = < Calculated by software using SPICE library >
```

4.3.2 CENA Data Product Design

4.3.2.1 CENA Housekeeping Data: Data Product Format

The CENA housekeeping data product consists of a table with rows of over one hundred housekeeping parameters that describe the state of the instrument operation. The information contained in the PDS data file contains each of the parameters related to CENA extracted from the SARA 32s housekeeping data stream.
For the raw data set (CODMAC level 2) the housekeeping parameters contain the original raw values. For higher levels and where appropiate, the housekeeping parameter are converted to engineering units using the conversion defined in the CHA-SARA-CR-0002-I1R2 (SAS Housekeeping Calibration Functions) document [RD6].

The PDS TABLE is the chosen storage format for archival of these data. The TABLE is an ASCII data object containing rows with a fixed number of fields separated by field delimiters. For CENA data products, the field delimiters are always commas. The TABLE object row delimiters are always carriage-return line-feed (<CR><LF>) ASCII line termination characters. The format for the TABLE objects is a comma-separated value format in which string fields are enclosed in double quotes. The extension for the data files is TAB.

For more detailed information on the telemetry structure, see RD5 (page 20) and RD3(page 31).

```
/* DATA OBJECTS DEFINITION */

OBJECT                         = CENA_32SHK_TABLE

   INTERCHANGE_FORMAT          = ASCII

   ROWS                        = 100  < Calculated by software >

   ROW_BYTES                   = 205

   COLUMNS                     = 85

   NAME                        = "CENA HOUSEKEEPING DATA"

   DESCRIPTION                 = "THIS TABLE CONTAINS ALL 32S HOUSEKEEPING DATA FROM
                                  CENA IN ONE ORBIT. EACH ROW CONTAINS ALL
                                         HOUSEKEEPING PARAMETERS AVAILABLE IN ONE 32S
                                                 HOUSEKEEPING TRANSFER."


   OBJECT                      = COLUMN
```

```
      NAME                      = "TIME"
      BYTES                     = 23
      DATA_TYPE                 = TIME
      START_BYTE                = 1
      DESCRIPTION               = "START TIME OF MEASUREMENT (UTC)"
   END_OBJECT                   = COLUMN

   OBJECT                       = COLUMN
      NAME                      = "FLAG_P"
      BYTES                     = 1
      DATA_TYPE                 = ASCII_INTEGER
      START_BYTE                = 25
      DESCRIPTION               = "HV MAIN POWER 0=OFF/1=ON"
      VALID_MAXIMUM             = 0
      VALID_MINIMUM             = 1
   END_OBJECT                   = COLUMN

   #
   # The total number of columns is 96.
   # See table 2.2.1 for a complete list of the columns (32S HK parameters related
   # to CENA)
   #

   OBJECT                       = COLUMN
      NAME                      = <See Table 4-1>
      BYTES                     = <See Table 4-1>
      DATA_TYPE                 = <See Table 4-1>
      START_BYTE                = 27   < Calculated by software >
      DESCRIPTION               = <See Table 4-1 >
      VALID_MAXIMUM             = <See Table 4-1>
      VALID_MINIMUM             = <See Table 4-1>
   END_OBJECT                   = COLUMN

END_OBJECT                      = CENA_32SHK_TABLE

END
```

Table 4-1CENA HK Parameters in the 32S HK data stream

	NAME (max. 30 characters)	**DESCRIPTION**	**SIZE (TM)**	**BYTES (PDS)**	**TYPE**	**MIN**	**MAX**
1	FLAG_P	HV MAIN POWER 0=OFF/1=ON	1b: b0	1	ASCII_INTEGER	0	1
2	FLAG_S	HV SAFETY ENABLE 0=UNSET/1=SET	1b: b1	1	ASCII_INTEGER	0	1

3	FLAG_PE	HV ON ENABLE 0=UNSET/1=SET	1b: b4	1	ASCII_INTEGER	0	1
4	FLAG_SE	HV LEVEL SET ENABLE 0=UNSET/1=SET	1b: b5	1	ASCII_INTEGER	0	1
5	FLAG_ER	ERROR FLAG 0=ALL CHECKSUMS OK SINCE LAST CLEARING 1=COMMAND RECEIVED WITH ILLEGAL CHECKSUM	1b: b7	1	ASCII_INTEGER	0	1
6	HV_MAIN	HV MAIN MONITOR	12b	4	ASCII_INTEGER	0	4095
7	HV_STARTMCP	HV START MCP MONITOR	12b	4	ASCII_INTEGER	0	4095
8	HV_STOPMCP	HV STOP MCP MONITOR	12b	4	ASCII_INTEGER	0	4095
9	HV_TOF	HV TOF MONITOR	12b	4	ASCII_INTEGER	0	4095
10	HV_DEF	HV DEF MONITOR	12b	4	ASCII_INTEGER	0	4095
11	IFE_TEMP	IFE TEMPERATURE	12b	4	ASCII_INTEGER	0	4095
12	HVPS_TEMP	HVPS TEMPERATURE	12b	4	ASCII_INTEGER	0	4095
13	SV2	SV_WAVE2A	4b	3	ASCII_INTEGER	0	15
14	SV1	SV_WAVE1	4b	3	ASCII_INTEGER	0	15
15	SV4	SV_LENS	4b	3	ASCII_INTEGER	0	15
16	SV3	SV_WAVE2B	4b	3	ASCII_INTEGER	0	15
17	OBSERVATION_MODE	THE OBSERVATION MODE IS DEFINED WITH A CHARACTER STRING FORMED FROM TWO COMPONENTS (CHARACTERS): SM. VALID ASSIGNMENTS FOR EACH COMPONENT ARE: S 0 SYNCHRONOUS 1 ASYNCHRONOUS M 0 COINCIDENCE 1 COUNTER 2 ENGINEERING 3 NOT DEFINED	1b: b7 2b: b0-1	2	CHARACTER	-	-
18	EVENT_BITMASK	COINCIDENCE AND COUNTER MODE: EVENT SELECTION BITMASK	2B	5	ASCII_INTEGER	0	65535
19	DEAD_TIME	ACTUAL DEAD TIME DEAD_TIME*15.6/256 [ms]	1B	3	ASCII_INTEGER	0	255
20	CHANNEL_DEFINITION1	CHANNEL DEFINITION IS DEFINED WITH A CHARACTER STRING FORMED FROM TWO COMPONENTS (CHARACTERS): ED. DEFINITION AND VALID ASSIGNMENTS FOR EACH COMPONENT ARE: E MCP INPUT SIGNAL 0 DISABLE 1 ENABLE D DISCRIMINATION	4b	2	CHARACTER	-	-

		LEVEL (INTEGER VALUE FROM 0 TO 7)					
21	CHANNEL_DEFINITION2	“	4b	2	CHARACTER	-	-
22	CHANNEL_DEFINITION3	“	4b	2	CHARACTER	-	-
23	CHANNEL_DEFINITION4	“	4b	2	CHARACTER	-	-
24	CHANNEL_DEFINITION5	“	4b	2	CHARACTER	-	-
25	CHANNEL_DEFINITION6	“	4b	2	CHARACTER	-	-
26	CHANNEL_DEFINITION7	“	4b	2	CHARACTER	-	-
27	CHANNEL_DEFINITION8	“	4b	2	CHARACTER	-	-
28	CHANNEL_DEFINITION9	“	4b	2	CHARACTER	-	-
29	CHANNEL_DEFINITION10	“	4b	2	CHARACTER	-	-
30	CHANNEL_DEFINITION11	“	4b	2	CHARACTER	-	-
31	CHANNEL_DEFINITION12	“	4b	2	CHARACTER	-	-
32	CHANNEL_DEFINITION13	“	4b	2	CHARACTER	-	-
33	CHANNEL_DEFINITION14	“	4b	2	CHARACTER	-	-
34	CHANNEL_DEFINITION15	“	4b	2	CHARACTER	-	-
35	CHANNEL_DEFINITION16	“	4b	2	CHARACTER	-	-
36	CHANNEL_DEFINITION17	“	4b	2	CHARACTER	-	-
37	CHANNEL_DEFINITION18	“	4b	2	CHARACTER	-	-
38	CHANNEL_DEFINITION19	“	4b	2	CHARACTER	-	-
39	CHANNEL_DEFINITION20	“	4b	2	CHARACTER	-	-
40	PSYNC_COUNTER	NUMBER OF SYNC PULSES RECEIVED FROM DPU SINCE IFE POWER ON.	2B	5	ASCII_INTEGER	0	65535
41	BASE_COUNTER	NUMBER OF SYNC PULSE INTERVALS ELAPSED SINCE IFE POWER ON.	2B	5	ASCII_INTEGER	0	65535
42	SV_WAVE1_LEVEL1	SV WAVE1 MONITOR LEVEL 1	12b	4	ASCII_INTEGER	0	4095
43	SV_WAVE1_LEVEL2	SV WAVE1 MONITOR LEVEL 2	12b	4	ASCII_INTEGER	0	4095
44	SV_WAVE1_LEVEL3	SV WAVE1 MONITOR LEVEL 3	12b	4	ASCII_INTEGER	0	4095
45	SV_WAVE1_LEVEL4	SV WAVE1 MONITOR LEVEL 4	12b	4	ASCII_INTEGER	0	4095
46	SV_WAVE1_LEVEL5	SV WAVE1 MONITOR LEVEL 5	12b	4	ASCII_INTEGER	0	4095
47	SV_WAVE1_LEVEL6	SV WAVE1 MONITOR LEVEL 6	12b	4	ASCII_INTEGER	0	4095
48	SV_WAVE1_LEVEL7	SV WAVE1 MONITOR LEVEL 7	12b	4	ASCII_INTEGER	0	4095
49	SV_WAVE1_LEVEL8	SV WAVE1 MONITOR LEVEL 8	12b	4	ASCII_INTEGER	0	4095
50	SV_WAVE2A_LEVEL1	SV WAVE2A MONITOR LEVEL 1	12b	4	ASCII_INTEGER	0	4095
5	SV_WAVE2A_LEVEL2	SV WAVE2A MONITOR	12b	4	ASCII_INTEGER	0	4095

1		LEVEL 2					
52	SV_WAVE2A_LEVEL3	SV WAVE2A MONITOR LEVEL 3	12b	4	ASCII_INTEGER	0	4095
53	SV_WAVE2A_LEVEL4	SV WAVE2A MONITOR LEVEL 4	12b	4	ASCII_INTEGER	0	4095
54	SV_WAVE2A_LEVEL5	SV WAVE2A MONITOR LEVEL 5	12b	4	ASCII_INTEGER	0	4095
55	SV_WAVE2A_LEVEL6	SV WAVE2A MONITOR LEVEL 6	12b	4	ASCII_INTEGER	0	4095
56	SV_WAVE2A_LEVEL7	SV WAVE2A MONITOR LEVEL 7	12b	4	ASCII_INTEGER	0	4095
57	SV_WAVE2A_LEVEL8	SV WAVE2A MONITOR LEVEL 8	12b	4	ASCII_INTEGER	0	4095
58	SV_WAVE2B_LEVEL1	SV WAVE2B MONITOR LEVEL 1	12b	4	ASCII_INTEGER	0	4095
59	SV_WAVE2B_LEVEL2	SV WAVE2B MONITOR LEVEL 2	12b	4	ASCII_INTEGER	0	4095
60	SV_WAVE2B_LEVEL3	SV WAVE2B MONITOR LEVEL 3	12b	4	ASCII_INTEGER	0	4095
61	SV_WAVE2B_LEVEL4	SV WAVE2B MONITOR LEVEL 4	12b	4	ASCII_INTEGER	0	4095
62	SV_WAVE2B_LEVEL5	SV WAVE2B MONITOR LEVEL 5	12b	4	ASCII_INTEGER	0	4095
63	SV_WAVE2B_LEVEL6	SV WAVE2B MONITOR LEVEL 6	12b	4	ASCII_INTEGER	0	4095
64	SV_WAVE2B_LEVEL7	SV WAVE2B MONITOR LEVEL 7	12b	4	ASCII_INTEGER	0	4095
65	SV_WAVE2B_LEVEL8	SV WAVE2B MONITOR LEVEL 8	12b	4	ASCII_INTEGER	0	4095
66	SV_LENS_LEVEL1	SV LENS MONITOR LEVEL 1	12b	4	ASCII_INTEGER	0	4095
67	SV_LENS_LEVEL2	SV LENS MONITOR LEVEL 2	12b	4	ASCII_INTEGER	0	4095
68	SV_LENS_LEVEL3	SV LENS MONITOR LEVEL 3	12b	4	ASCII_INTEGER	0	4095
69	SV_LENS_LEVEL4	SV LENS MONITOR LEVEL 4	12b	4	ASCII_INTEGER	0	4095
70	SV_LENS_LEVEL5	SV LENS MONITOR LEVEL 5	12b	4	ASCII_INTEGER	0	4095
71	SV_LENS_LEVEL6	SV LENS MONITOR LEVEL 6	12b	4	ASCII_INTEGER	0	4095
72	SV_LENS_LEVEL7	SV LENS MONITOR LEVEL 7	12b	4	ASCII_INTEGER	0	4095
73	SV_LENS_LEVEL8	SV LENS MONITOR LEVEL 8	12b	4	ASCII_INTEGER	0	4095
74	TOTAL_START_COUNTS	COUNTER VALUES REPORTED COLLECTED DURING ONE OF THE SLOTS 0 TO 7. THE SLOT NUMBER IS DETERMINED BY THE LOWER 3 BITS OF THE BASE COUNTER. THESE COUNTERS MAY BE 0 IF HV IS OFF.	2B	5	ASCII_INTEGER	0	65535
75	TOTAL_STOP_COUNTS	“	2B	5	ASCII_INTEGER	0	65535
76	TOTAL_COINCIDENCE_COUNTS	“	2B	5	ASCII_INTEGER	0	65535
77	CAL_MODE1	ALL CP VALUES OF MOST RECENTLY SENT CAL_MODE COMMAND.	1B	3	ASCII_INTEGER	0	255
78	CAL_MODE2	“	1B	3	ASCII_INTEGER	0	255
79	CAL_TIMING1	“	1B	3	ASCII_INTEGER	0	255
8	CAL_TIMING2	“	1B	3	ASCII_INTEGER	0	255

0							
81	CAL_TIMING3	“	1B	3	ASCII_INTEGER	0	255
82	CAL_TIMING4	“	1B	3	ASCII_INTEGER	0	255
83	HV_MAIN_REF	REFERENCE VALUE OF THE HV MAIN VOLTAGE	8b		ASCII_INTEGER		
84	HV_STARTMCP_REF	REFERENCE VALUE OF THE HV START MCP VOLTAGE	8b		ASCII_INTEGER		
85	HV_STOPMCP_REF	REFERENCE VALUE OF THE HV STOP MCP VOLTAGE	8b		ASCII_INTEGER		
86	HV_TOF_REF	REFERENCE VALUE OF THE HV TOF VOLTAGE	8b		ASCII_INTEGER		
87	HV_DEF_REF	REFERENCE VALUE OF THE HV DEFLECTION VOLTAGE	12b		ASCII_INTEGER		
88	DPU_SENSOR_P5V		8b		ASCII_INTEGER		
89	DPU_SENSOR_P33V		8b		ASCII_INTEGER		
90	DPU_SENSOR_P12V		8b		ASCII_INTEGER		
91	DPU_SENSOR_M12V		8b		ASCII_INTEGER		
92	DPU_P5V		8b		ASCII_INTEGER		
93	DPU_CENA_CURRENT		8b		ASCII_INTEGER		
94	DPU_FLAG1		8b		ASCII_INTEGER		
95	DPU_FLAG2		8b		ASCII_INTEGER		

4.3.2.2 CENA Science Data: Data Product Format

The format of the data coming from the CENA sensor is dependent on the instrument mode (telemetry mode and sensor mode). In Mass accumulation mode, TOF accumulation mode and Count accumulation mode, data coming from the sensor is being sorted by look-up tables and is being summed up into two types of accumulation matrixes (the accumulation matrix and the accumulation scaling matrix) during a time period.

The format and dimension of the accumulation matrixes change depending on the telemetry/sensor mode. The accumulation matrix size changes depending on the binning parameters (energy, channel, phase and mass bins).

A PDS ARRAY of COLLECTION objects is the selected storage format for archival of these data.

Each CENA PDS data product file contains an ARRAY of records of CENA measurements in one orbit. Each record is described using a COLLECTION object.

A PDS CENA COLLECTION object groups all data related to one measurement: CENA parameters (start time, compression mode, cycles of integration…), reassembled housekeeping parameters in the header of the science data, the accumulation-scaling matrix (counter data summed during a sampling period) and the accumulation matrix (event data integrated during a sampling period).

As the accumulation matrixes dimensions are dependent on the telemetry mode selected, there are three different PDS data products for CENA (described in detail in sections 4.3.2.2.1, 4.3.2.2.2 and 4.3.2.2.3).

	Accumulation scaling matrix	**Accumulation matrix**
Mass Accumulation Data Product	[E P Y]	[E P C M]
TOF Accumulation Data Product	[E Y]	[E TOF]
Count Accumulation Data Product	N/A	[E P X]

where E = energy group, C = channel group, P = phase group, M = mass group, TOF = time of flight, X = type of counters (namely START ring, START sector, STOP plate, STOP mesh, START coincidence count), and Y is the type of counters (namely Total START count, Total STOP count and Coincidence STOP count).

If the instrument mode changes within an orbit, the orbit directory contains one PDS data product file (data product depending on the selected mode) per change of mode within the same orbit.

If the binning parameters change within an orbit, the number of elements of the accumulation matrixes changes, and therefore, the orbit directory contains one PDS data product file (same data product type with different matrixes sizes) per change of binning parameters.

For more detailed information on the telemetry structure, see RD5RD5RD5RD5 RD5RD5RD5 RD5 (section 16).

4.3.2.2.1 CENA Mass Accumulation Mode: Data Product Format

```
DESCRIPTION                   = "
    THIS FILE CONTAINS DATA FROM CENA (CHANDRAYAAN-1 ENERGETIC NEUTRALS ANALYSER)
    IN MASS ACCUMULATION MODE. THIS TELEMETRY MODE REQUIRES COINCIDENCE MODE AS A
    SENSOR MODE. THIS MODE IS USED TO OBTAIN ENA DATA WITH MASS INFORMATION. DATA
    FROM THE SENSOR IS SORTED BY LOOK-UP TABLES AND SUMMED UP INTO TWO TYPES OF
    ACCUMULATION MATRIXES DURING A TIME PERIOD, THE ACCUMULATION SCALING MATRIX
    AND THE SCIENCE DATA MATRIX."


/* DATA OBJECT DEFINITIONS */

  OBJECT                      = CENA_MASS_ACCUMULATION_ARRAY
  NAME                        ="CENA MASS ACCUMULATION SCIENCE DATA ARRAY"

  INTERCHANGE_FORMAT          = ASCII
  AXES                        = 1
  AXIS_ITEMS                  = 87    < Calculated by software >

  DESCRIPTION                 = "THIS ARRAY CONTAINS ALL RECORDS OF CENA MEASUREMENTS
                                 IN MASS ACCUMULATION MODE WITHIN ONE ORBIT. EACH RECORD
                                 CONTAINS ALL DATA RELATED TO ONE 4S MEASUREMENT."

  OBJECT                      = COLLECTION
```

```
    NAME                         ="CENA_MASS_ACCUMULATION_RECORD"

    BYTES                        = 102   < Calculated by software >

    DESCRIPTION                  = "THIS RECORD CONTAINS ALL DATA RELATED TO
                                    ONE CENA 4S MEASUREMENT."

    OBJECT                       = ELEMENT
      NAME                       = TIME
      BYTES                      = 23
      DATA_TYPE                  = ASCII_INTEGER
      START_BYTE                 = 1
      DESCRIPTION                = "START TIME OF THE MEASUREMENT (UTC)"

    END_OBJECT                   = ELEMENT

    OBJECT                       = ELEMENT
      NAME                       = <See Table 4-2>
      BYTES                      = <See Table 4-2>


      DATA_TYPE                  = <See Table 4-2>
      START_BYTE                 = 25    < Calculated by software >
      DESCRIPTION                = <See Table 4-2>
    END_OBJECT                   = ELEMENT

    OBJECT                       = SCALING_ARRAY
      NAME                       = "ACC SCALING MATRIX"
      AXES                       = 3
      AXIS_ITEMS                 = (8,1,4)       < Calculated by software >

      AXIS_NAME                  = (E,P,Y)
      START_BYTE                 = 94            < Calculated by software >

      DESCRIPTION                = "ACCUMULATION SCALING MATRIX"

      OBJECT                     = ELEMENT
        NAME                     = "SCALING VALUE"
        BYTES                    = 3
        DATA_TYPE                = ASCII_INTEGER
        VALID_MAXIMUM            = 0

        VALID_MINIMUM            = 255

      END_OBJECT                 = ELEMENT

    END_OBJECT                   = SCALING_ARRAY

    OBJECT                       = SCIENCE_ARRAY
      NAME                       = "SCIENCE DATA MATRIX"
      AXES                       = 4
      AXIS_ITEMS                 = (8,1,1,1)     <Calculated by software >

      AXIS_NAME                  = (E,P,C,M)
      START_BYTE                 = 160           < Calculated by software >

      DESCRIPTION                = "SCIENCE DATA MATRIX"

      OBJECT                     = ELEMENT
        NAME                     = "DATA VALUE"
        BYTES                    = 3
        DATA_TYPE                = ASCII_INTEGER
        VALID_MAXIMUM            = 0

        VALID_MINIMUM            = 255

      END_OBJECT                 = ELEMENT

    END_OBJECT                   = SCIENCE_ARRAY

  END_OBJECT                     = COLLECTION

END_OBJECT                       = CENA_MASS_ACCUMULATION_ARRAY
```

```
END
```

Table 4-2 CENA 4S data in Mass/TOF/Count Accumulation Mode science packets

	NAME (max. 30 characters)	DESCRIPTION	SIZE (TM)	BYTES (PDS)	TYPE	MIN	MAX
1	TIME	START TIME OF MEASUREMENT (UTC)	-	23	TIME	-	-
2	PACKET_COUNTER	DPU PACKET COUNTER	2B	5	ASCII_INTEGER	0	1023
3	BINS_C	BINNING PARAMETER C: 0 = CHANNEL BINS 1 1 = CHANNEL BINS 7	1b	1	ASCII_INTEGER	0	1
4	BINS_E	BINNING PARAMETER E = ENERGY BINS - 1	3b	1	ASCII_INTEGER	0	7
5	BINS_P	BINNING PARAMETER P = PHASE BINS - 1	5b	2	ASCII_INTEGER	0	31
6	BINS_M	BINNING PARAMETER M = MASS BINS - 1	7b	3	ASCII_INTEGER	0	127
7	INTEGRATION_CYCLES	NUMBER OF CYCLES FOR INTEGRATION	2B	5	ASCII_INTEGER	0	65535
8	SWIM_MODE	SWIM STATUS 0=OFF 1=ON	1b	1	ASCII_INTEGER	0	1
9	CENA_MODE	CENA STATUS 0=OFF 1=ON	1b	1	ASCII_INTEGER	0	1
10	COMPRESSION_MODE	COMPRESSION MODE 0=DISABLE 1=ENABLE	1b	1	ASCII_INTEGER	0	1
11	TM_MODE	TELEMETRY MODE: 1=NON PROCESS MODE 2=MASS ACCUMULATION MODE 3=COUNTER MODE 4=TOF ACCUMULATION MODE	3b	1	ASCII_INTEGER	1	4
12	SENSOR_MODE	SENSOR MODE: 0=COINCIDENCE MODE 1=COUNTER MODE 2=ENGINEERING MODE	2b	1	ASCII_INTEGER	0	2
In the COLLECTION object defined to archive in PDS format the CENA science data, ELEMENTS from 13 to 99 are CENA Housekeeping Parameters, CENA reassembled HK parameters available in the header of the 4S science packets that will be archived as part of this PDS data product.							
13	FLAG_P	HV MAIN POWER 0=OFF/1=ON	1b: b0	1	ASCII_INTEGER	0	1
14	FLAG_S	HV SAFETY ENABLE 0=UNSET/1=SET	1b: b1	1	ASCII_INTEGER	0	1
15	FLAG_PE	HV ON ENABLE 0=UNSET/1=SET	1b: b4	1	ASCII_INTEGER	0	1
16	FLAG_SE	HV LEVEL SET ENABLE 0=UNSET/1=SET	1b: b5	1	ASCII_INTEGER	0	1
17	FLAG_ER	ERROR FLAG	1b:	1	ASCII_INTEGER	0	1

		0=ALL CHECKSUMS OK SINCE LAST CLEARING 1=COMMAND RECEIVED WITH ILLEGAL CHECKSUM	b7				
18	HV_MAIN	HV MAIN MONITOR	12b	4	ASCII_INTEGER	0	4095
19	HV_STARTMCP	HV START MCP MONITOR	12b	4	ASCII_INTEGER	0	4095
20	HV_STOPMCP	HV STOP MCP MONITOR	12b	4	ASCII_INTEGER	0	4095
21	HV_TOF	HV TOF MONITOR	12b	4	ASCII_INTEGER	0	4095
22	HV_DEF	HV DEF MONITOR	12b	4	ASCII_INTEGER	0	4095
23	IFE_TEMP	IFE TEMPERATURE	12b	4	ASCII_INTEGER	0	4095
24	HVPS_TEMP	HVPS TEMPERATURE	12b	4	ASCII_INTEGER	0	4095
25	SV_WAVE1	SV_WAVE1	4b	3	ASCII_INTEGER	0	15
26	SV_WAVE2A	SV_WAVE2A	4b	3	ASCII_INTEGER	0	15
27	SV_WAVE2B	SV_WAVE2B	4b	3	ASCII_INTEGER	0	15
28	SV_LENS	SV_LENS	4b	3	ASCII_INTEGER	0	15
29	OBSERVATION_MODE	THE OBSERVATION MODE IS DEFINED WITH A CHARACTER STRING FORMED FROM TWO COMPONENTS (CHARACTERS): SM. VALID ASSIGNMENTS FOR EACH COMPONENT ARE: S 0 SYNCHRONOUS 1 ASYNCHRONOUS M 0 COINCIDENCE 1 COUNTER 2 ENGINEERING 3 NOT DEFINED	1b: b7 2b: b0-1	2	CHARACTER	-	-
30	EVENT_BITMASK	COINCIDENCE AND COUNTER MODE: EVENT SELECTION BITMASK	2B	5	ASCII_INTEGER	0	6553 5
31	DEAD_TIME	ACTUAL DEAD TIME DEAD_TIME*15.6/256 [ms]	1B	3	ASCII_INTEGER	0	255
32	CHANNEL_DEFINITION1	CHANNEL DEFINITION IS DEFINED WITH A CHARACTER STRING FORMED FROM TWO COMPONENTS (CHARACTERS): ED. DEFINITION AND VALID ASSIGNMENTS FOR EACH COMPONENT ARE: E MCP INPUT SIGNAL 0 DISABLE 1 ENABLE D DISCRIMINATION LEVEL (INTEGER VALUE FROM 0 TO 7)	4b	2	CHARACTER	-	-
33	CHANNEL_DEFINITION2	“	4b	2	CHARACTER	-	-
34	CHANNEL_DEFINITION3	“	4b	2	CHARACTER	-	-
35	CHANNEL_DEFINITION4	“	4b	2	CHARACTER	-	-
36	CHANNEL_DEFINITION5	“	4b	2	CHARACTER	-	-
37	CHANNEL_DEFINITION6	“	4b	2	CHARACTER	-	-
38	CHANNEL_DEFINITION7	“	4b	2	CHARACTER	-	-

39	CHANNEL_DEFINITION8	"	4b	2	CHARACTER	-	-
40	CHANNEL_DEFINITION9	"	4b	2	CHARACTER	-	-
41	CHANNEL_DEFINITION10	"	4b	2	CHARACTER	-	-
42	CHANNEL_DEFINITION11	"	4b	2	CHARACTER	-	-
43	CHANNEL_DEFINITION12	"	4b	2	CHARACTER	-	-
44	CHANNEL_DEFINITION13	"	4b	2	CHARACTER	-	-
45	CHANNEL_DEFINITION14	"	4b	2	CHARACTER	-	-
46	CHANNEL_DEFINITION15	"	4b	2	CHARACTER	-	-
47	CHANNEL_DEFINITION16	"	4b	2	CHARACTER	-	-
48	CHANNEL_DEFINITION17	"	4b	2	CHARACTER	-	-
49	CHANNEL_DEFINITION18	"	4b	2	CHARACTER	-	-
50	CHANNEL_DEFINITION19	"	4b	2	CHARACTER	-	-
51	CHANNEL_DEFINITION20	"	4b	2	CHARACTER	-	-
52	PSYNC_COUNTER	NUMBER OF SYNC PULSES RECEIVED FROM DPU SINCE IFE POWER ON.	2B	5	ASCII_INTEGER	0	65535
53	BASE_COUNTER	NUMBER OF SYNC PULSE INTERVALS ELAPSED SINCE IFE POWER ON.	2B	5	ASCII_INTEGER	0	65535
54	SV_WAVE1_LEVEL1	SV WAVE1 MONITOR LEVEL 1	12b	4	ASCII_INTEGER	0	4095
55	SV_WAVE1_LEVEL2	SV WAVE1 MONITOR LEVEL 2	12b	4	ASCII_INTEGER	0	4095
56	SV_WAVE1_LEVEL3	SV WAVE1 MONITOR LEVEL 3	12b	4	ASCII_INTEGER	0	4095
57	SV_WAVE1_LEVEL4	SV WAVE1 MONITOR LEVEL 4	12b	4	ASCII_INTEGER	0	4095
58	SV_WAVE1_LEVEL5	SV WAVE1 MONITOR LEVEL 5	12b	4	ASCII_INTEGER	0	4095
59	SV_WAVE1_LEVEL6	SV WAVE1 MONITOR LEVEL 6	12b	4	ASCII_INTEGER	0	4095
60	SV_WAVE1_LEVEL7	SV WAVE1 MONITOR LEVEL 7	12b	4	ASCII_INTEGER	0	4095
61	SV_WAVE1_LEVEL8	SV WAVE1 MONITOR LEVEL 8	12b	4	ASCII_INTEGER	0	4095
62	SV_WAVE2A_LEVEL1	SV WAVE2A MONITOR LEVEL 1	12b	4	ASCII_INTEGER	0	4095
63	SV_WAVE2A_LEVEL2	SV WAVE2A MONITOR LEVEL 2	12b	4	ASCII_INTEGER	0	4095
64	SV_WAVE2A_LEVEL3	SV WAVE2A MONITOR LEVEL 3	12b	4	ASCII_INTEGER	0	4095
65	SV_WAVE2A_LEVEL4	SV WAVE2A MONITOR LEVEL 4	12b	4	ASCII_INTEGER	0	4095
66	SV_WAVE2A_LEVEL5	SV WAVE2A MONITOR LEVEL 5	12b	4	ASCII_INTEGER	0	4095
67	SV_WAVE2A_LEVEL6	SV WAVE2A MONITOR LEVEL 6	12b	4	ASCII_INTEGER	0	4095
68	SV_WAVE2A_LEVEL7	SV WAVE2A MONITOR LEVEL 7	12b	4	ASCII_INTEGER	0	4095
69	SV_WAVE2A_LEVEL8	SV WAVE2A MONITOR LEVEL 8	12b	4	ASCII_INTEGER	0	4095
70	SV_WAVE2B_LEVEL1	SV WAVE2B MONITOR LEVEL 1	12b	4	ASCII_INTEGER	0	4095
71	SV_WAVE2B_LEVEL2	SV WAVE2B MONITOR LEVEL 2	12b	4	ASCII_INTEGER	0	4095
72	SV_WAVE2B_LEVEL3	SV WAVE2B MONITOR LEVEL 3	12b	4	ASCII_INTEGER	0	4095
73	SV_WAVE2B_LEVEL4	SV WAVE2B MONITOR LEVEL 4	12b	4	ASCII_INTEGER	0	4095
74	SV_WAVE2B_LEVEL5	SV WAVE2B MONITOR LEVEL 5	12b	4	ASCII_INTEGER	0	4095
75	SV_WAVE2B_LEVEL6	SV WAVE2B MONITOR LEVEL 6	12b	4	ASCII_INTEGER	0	4095
76	SV_WAVE2B_LEVEL7	SV WAVE2B MONITOR LEVEL 7	12b	4	ASCII_INTEGER	0	4095

77	SV_WAVE2B_LEVEL8	SV WAVE2B MONITOR LEVEL 8	12b	4	ASCII_INTEGER	0	4095
78	SV_LENS_LEVEL1	SV LENS MONITOR LEVEL 1	12b	4	ASCII_INTEGER	0	4095
79	SV_LENS_LEVEL2	SV LENS MONITOR LEVEL 2	12b	4	ASCII_INTEGER	0	4095
80	SV_LENS_LEVEL3	SV LENS MONITOR LEVEL 3	12b	4	ASCII_INTEGER	0	4095
81	SV_LENS_LEVEL4	SV LENS MONITOR LEVEL 4	12b	4	ASCII_INTEGER	0	4095
82	SV_LENS_LEVEL5	SV LENS MONITOR LEVEL 5	12b	4	ASCII_INTEGER	0	4095
83	SV_LENS_LEVEL6	SV LENS MONITOR LEVEL 6	12b	4	ASCII_INTEGER	0	4095
84	SV_LENS_LEVEL7	SV LENS MONITOR LEVEL 7	12b	4	ASCII_INTEGER	0	4095
85	SV_LENS_LEVEL8	SV LENS MONITOR LEVEL 8	12b	4	ASCII_INTEGER	0	4095
86	TOTAL_START_COUNTS	COUNTER VALUES REPORTED COLLECTED DURING ONE OF THE SLOTS 0 TO 7. THE SLOT NUMBER IS DETERMINED BY THE LOWER 3 BITS OF THE BASE COUNTER. THESE COUNTERS MAY BE 0 IF HV IS OFF.	2B	5	ASCII_INTEGER	0	65535
87	TOTAL_STOP_COUNTS	“	2B	5	ASCII_INTEGER	0	65535
88	TOTAL_COINCIDENCE_COUNTS	“	2B	5	ASCII_INTEGER	0	65535
89	CAL_MODE1	ALL CP VALUES OF MOST RECENTLY SENT CAL_MODE COMMAND.	1B	3	ASCII_INTEGER	0	255
90	CAL_MODE2	“	1B	3	ASCII_INTEGER	0	255
91	CAL_TIMING1	“	1B	3	ASCII_INTEGER	0	255
92	CAL_TIMING2	“	1B	3	ASCII_INTEGER	0	255
93	CAL_TIMING3	“	1B	3	ASCII_INTEGER	0	255
94	CAL_TIMING4	“	1B	3	ASCII_INTEGER	0	255
95	HV_MAIN_REF	REFERENCE VALUE OF THE HV MAIN VOLTAGE	8b		ASCII_INTEGER		
96	HV_STARTMCP_REF	REFERENCE VALUE OF THE HV START MCP VOLTAGE	8b		ASCII_INTEGER		
97	HV_STOPMCP_REF	REFERENCE VALUE OF THE HV STOP MCP VOLTAGE	8b		ASCII_INTEGER		
98	HV_TOF_REF	REFERENCE VALUE OF THE HV TOF VOLTAGE	8b		ASCII_INTEGER		
99	HV_DEF_REF	REFERENCE VALUE OF THE HV DEFLECTION VOLTAGE	12b		ASCII_INTEGER		
100	ACCUMULATION SCALING MATRIX	ACCUMULATION SCALING MATRIX DATA	SIZE x 1B	3	ASCII_INTEGER	0	255
101	SCIENCE DATA	CENA SCIENCE DATA	SIZE x 1B	3	ASCII_INTEGER	0	255

4.3.2.2.2 CENA TOF Accumulation Mode Data: Data Product Format

```
DESCRIPTION                    = "
    THIS FILE CONTAINS DATA FROM CENA (CHANDRAYAAN-1 ENERGETIC NEUTRALS ANALYSER)
    IN TOF ACCUMULATION MODE. THIS TELEMETRY MODE REQUIRES COINCIDENCE MODE AS A
```

```
    SENSOR MODE. THIS MODE IS USED TO OBTAIN RAW TOF DISTRIBUTIONS WITHOUT MASS
    INFORMATION. DATA FROM THE SENSOR IS SORTED BY LOOK-UP TABLES AND SUMMED UP
    INTO TWO TYPES OF ACCUMULATION MATRIXES DURING A TIME PERIOD, THE ACCUMULATION
    SCALING MATRIX AND THE SCIENCE DATA MATRIX."

/* DATA OBJECT DEFINITIONS */

OBJECT                         = CENA_TOF_ACCUMULATION_ARRAY

  NAME                         = "CENA TOF ACCUMULATION SCIENCE DATA ARRAY"

  INTERCHANGE_FORMAT           = ASCII
  AXES                         = 1
  AXIS_ITEMS                   = 87    < Calculated by software >

  DESCRIPTION                  = "THIS ARRAY CONTAINS ALL RECORDS OF CENA MEASUREMENTS
                                  IN TOF ACCUMULATION MODE WITHIN ONE ORBIT. EACH RECORD
                                  CONTAINS ALL DATA RELATED TO ONE 4S MEASUREMENT."

  OBJECT                       = COLLECTION
    NAME                       = "CENA_TOF_ACCUMULATION_RECORD"

    BYTES                      = 102   < Calculated by software >

    DESCRIPTION                = "THIS RECORD CONTAINS ALL DATA RELATED TO
                                  ONE CENA 4S MEASUREMENT."

    OBJECT                     = ELEMENT
      NAME                     = TIME
      BYTES                    = 23
      DATA_TYPE                = ASCII_INTEGER
      START_BYTE               = 1
      DESCRIPTION              = "START TIME OF THE MEASUREMENT (UTC)"

    END_OBJECT                 = ELEMENT

    OBJECT                     = ELEMENT
      NAME                     = <See Table 4-2>
      BYTES                    = <See Table 4-2>


      DATA_TYPE                = <See Table 4-2>
      START_BYTE               = 25    < Calculated by software >
      DESCRIPTION              = <See Table 4-2>
    END_OBJECT                 = ELEMENT

    OBJECT                     = SCALING_ARRAY
      NAME                     = "ACC SCALING MATRIX"
      AXES                     = 2
      AXIS_ITEMS               = (8,4)        < Calculated by software >

      AXIS_NAME                = (E,Y)
      START_BYTE               = 94           < Calculated by software >

      DESCRIPTION              = "ACCUMULATION SCALING MATRIX"

      OBJECT                   = ELEMENT
        NAME                   = "SCALING VALUE"
        BYTES                  = 3
        DATA_TYPE              = ASCII_INTEGER
        VALID_MAXIMUM          = 0

        VALID_MINIMUM          = 255

      END_OBJECT               = ELEMENT

    END_OBJECT                 = SCALING_ARRAY

    OBJECT                     = SCIENCE_ARRAY
      NAME                     = "SCIENCE DATA MATRIX"
      AXES                     = 2
```

```
      AXIS_ITEMS              = (8,1024)            < Calculated by software >

      AXIS_NAME               = (E,TOF)
      START_BYTE              = 160                 < Calculated by software >

      DESCRIPTION             = "SCIENCE DATA MATRIX"

      OBJECT                  = ELEMENT
        NAME                  = "DATA VALUE"
        BYTES                 = 3
        DATA_TYPE             = ASCII_INTEGER
        VALID_MAXIMUM         = 0

        VALID_MINIMUM         = 255

      END_OBJECT              = ELEMENT

    END_OBJECT                = SCIENCE_ARRAY

  END_OBJECT                  = COLLECTION

END_OBJECT                    = CENA_TOF_ACCUMULATION_ARRAY

END
```

4.3.2.2.3 CENA Count Accumulation Mode Data: Data Product Format

```
DESCRIPTION                   = "
    THIS FILE CONTAINS DATA FROM CENA (CHANDRAYAAN-1 ENERGETIC NEUTRALS ANALYSER)
    IN COUNT ACCUMULATION MODE. THIS TELEMETRY MODE REQUIRES COUNTER MODE AS A
    SENSOR MODE. THIS MODE IS USED TO OBTAIN DETAILED SIGNAL COUNT AT EACH MCP PLATE."


/* DATA OBJECT DEFINITIONS */

OBJECT                        = CENA_COUNT_ACCUMULATION_ARRAY

  NAME                        = "CENA COUNT ACCUMULATION SCIENCE DATA ARRAY"

  INTERCHANGE_FORMAT          = ASCII
  AXES                        = 1
  AXIS_ITEMS                  = 87   < Calculated by software >

  DESCRIPTION                 = "THIS ARRAY CONTAINS ALL RECORDS OF CENA MEASUREMENTS
                                 IN COUNT ACCUMULATION MODE WITHIN ONE ORBIT. EACH RECORD
                                 CONTAINS ALL DATA RELATED TO ONE 4S MEASUREMENT."

  OBJECT                      = COLLECTION
    NAME                      = "CENA_TOF_ACCUMULATION_RECORD"

    BYTES                     = 102  < Calculated by software >

    DESCRIPTION               = "THIS RECORD CONTAINS ALL DATA RELATED TO
                                 ONE CENA 4S MEASUREMENT."

    OBJECT                    = ELEMENT
      NAME                    = TIME
      BYTES                   = 23
      DATA_TYPE               = ASCII_INTEGER
      START_BYTE              = 1
      DESCRIPTION             = "START TIME OF THE MEASUREMENT (UTC)"

    END_OBJECT                = ELEMENT

    OBJECT                    = ELEMENT
      NAME                    = <See Table 4-2>
      BYTES                   = <See Table 4-2>


      DATA_TYPE               = <See Table 4-2>
```

```
      START_BYTE              = 25   < Calculated by software >
      DESCRIPTION             = <See Table 4-2>
    END_OBJECT                = ELEMENT

    OBJECT                    = SCIENCE_ARRAY
      NAME                    = "SCIENCE DATA MATRIX"
      AXES                    = 3
      AXIS_ITEMS              = (8,1,5)      < Calculated by software >

      AXIS_NAME               = (E,P,X)
      START_BYTE              = 160          < Calculated by software >

      DESCRIPTION             = "SCIENCE DATA MATRIX"

      OBJECT                  = ELEMENT
        NAME                  = "DATA VALUE"
        BYTES                 = 3
        DATA_TYPE             = ASCII_INTEGER
        VALID_MAXIMUM         = 0

        VALID_MINIMUM         = 255

      END_OBJECT              = ELEMENT

    END_OBJECT                = SCIENCE_ARRAY

  END_OBJECT                  = COLLECTION

END_OBJECT                    = CENA_COUNT_ACCUMULATION_ARRAY

END
```

4.3.2.3 CENA Engineering Packets Data: Data Product Format

The CENA engineering packets data product consists of a table with rows of over one hundred housekeeping parameters that describe the state of the instrument operation. The information contained in the PDS data file contains each of the parameters extracted from the SARA CENA engineering packets.

The PDS TABLE is the chosen storage format for archival of these data. The TABLE is an ASCII data object containing rows with a fixed number of fields separated by field delimiters. For CENA data products, the field delimiters are always commas. The TABLE object row delimiters are always carriage-return line-feed (<CR><LF>) ASCII line termination characters. The format for the TABLE objects is a comma-separated value format in which string fields are enclosed in double quotes. The extension for the data files is TAB.

For detailed information on the telemetry structure, see RD5 (section 16, page 64).

```
/* DATA OBJECTS DEFINITION */

OBJECT                         = CENA_ENGINEERING_TABLE

   INTERCHANGE_FORMAT          = ASCII

   ROWS                        = 100

   ROW_BYTES                   = 180

   COLUMNS                     = 90   < TBC >

   NAME                        = "CENA ENGINEERING PACKETS DATA"
```

```
   DESCRIPTION                  = "THIS TABLE CONTAINS ALL ENGINEERING PACKETS FROM
                                   CENA IN RAW ENGINEERING MODE WITHIN ONE ORBIT
                                   (TELEMETRY NON-PROCESS MODE AND SENSOR ENGINEERING
                                   MODE). EACH ROW CONTAINS ALL RELEVANT PARAMETERS
                                   AVAILABLE IN ONE PACKET."

   OBJECT                       = COLUMN
      NAME                      = "TIME"
      BYTES                     = 23
      DATA_TYPE                 = TIME
      START_BYTE                = 1
      DESCRIPTION               = "START TIME OF MEASUREMENT (UTC)"
   END_OBJECT                   = COLUMN

   OBJECT                       = COLUMN
      NAME                      = <See Table 4-3  >
      BYTES                     = <See Table 4-3  >
      DATA_TYPE                 = <See Table 4-3  >
      START_BYTE                = 25   < Calculated by software >
      DESCRIPTION               = <See Table 4-3  >
      VALID_MAXIMUM             = <See Table 4-3  >
      VALID_MINIMUM             = <See Table 4-3  >
   END_OBJECT                   = COLUMN

END_OBJECT                      = CENA_ENGINEERING_TABLE

END
```

Table 4-3 CENA Engineering data packets

	NAME (max. 30 characters)	**DESCRIPTION**	**SIZE (TM)**	**BYTES (PDS)**	**DATA_TYPE**	**MIN**	**MAX**
1	TIME	START TIME OF MEASUREMENT (UTC)	-	23	TIME		
2	PACKET_ID	PACKET IDENTIFIER	1B	3	ASCII_INTEGER	0	255
3	SLOT_ID	SLOT IDENTIFIER	1B	1	ASCII_INTEGER	0	7
4	FLAG_P	HV MAIN POWER 0=OFF/1=ON	1b: b0	1	ASCII_INTEGER	0	1
5	FLAG_S	HV SAFETY ENABLE 0=UNSET/1=SET	1b: b1	1	ASCII_INTEGER	0	1
6	FLAG_PE	HV ON ENABLE 0=UNSET/1=SET	1b: b4	1	ASCII_INTEGER	0	1
7	FLAG_SE	HV LEVEL SET ENABLE 0=UNSET/1=SET	1b: b5	1	ASCII_INTEGER	0	1
8	FLAG_ER	ERROR FLAG 0=ALL CHECKSUMS OK SINCE LAST CLEARING	1b: b7	1	ASCII_INTEGER	0	1

		1=COMMAND RECEIVED WITH ILLEGAL CHECKSUM					
9	HV_MAIN	HV MAIN MONITOR	12b	4	ASCII_INTEGER	0	4095
10	HV_STARTMCP	HV START MCP MONITOR	12b	4	ASCII_INTEGER	0	4095
11	HV_STOPMCP	HV STOP MCP MONITOR	12b	4	ASCII_INTEGER	0	4095
12	HV_TOF	HV TOF MONITOR	12b	4	ASCII_INTEGER	0	4095
13	HV_DEF	HV DEF MONITOR	12b	4	ASCII_INTEGER	0	4095
14	IFE_TEMP	IFE TEMPERATURE	12b	4	ASCII_INTEGER	0	4095
15	HVPS_TEMP	HVPS TEMPERATURE	12b	4	ASCII_INTEGER	0	4095
16	SV_WAVE1	SV_WAVE1	4b	3	ASCII_INTEGER	0	15
17	SV_WAVE2A	SV_WAVE2A	4b	3	ASCII_INTEGER	0	15
18	SV_WAVE2B	SV_WAVE2B	4b	3	ASCII_INTEGER	0	15
19	SV_LENS	SV_LENS	4b	3	ASCII_INTEGER	0	15
20	OBSERVATION_MODE	THE OBSERVATION MODE IS DEFINED WITH A CHARACTER STRING FORMED FROM TWO COMPONENTS (CHARACTERS): SM. VALID ASSIGNMENTS FOR EACH COMPONENT ARE: S 0 SYNCHRONOUS 1 ASYNCHRONOUS M 0 COINCIDENCE 1 COUNTER 2 ENGINEERING 3 NOT DEFINED	1b: b7 2b: b0-1	2	CHARACTER	-	-
21	EVENT_BITMASK	COINCIDENCE AND COUNTER MODE: EVENT SELECTION BITMASK	2B	5	ASCII_INTEGER	0	65535
22	DEAD_TIME	ACTUAL DEAD TIME DEAD_TIME*15.6/256 [ms]	1B	3	ASCII_INTEGER	0	255
23	CHANNEL_DEFINITION1	CHANNEL DEFINITION IS DEFINED WITH A CHARACTER STRING FORMED FROM TWO COMPONENTS (CHARACTERS): ED. DEFINITION AND VALID ASSIGNMENTS FOR EACH COMPONENT ARE: E MCP INPUT SIGNAL 0 DISABLE 1 ENABLE D DISCRIMINATION LEVEL (INTEGER VALUE FROM 0 TO 7)	4b	2	CHARACTER	-	-
24	CHANNEL_DEFINITION2	“	4b	2	CHARACTER	-	-
2	CHANNEL_DEFINITION3	“	4b	2	CHARACTER	-	-

5							
26	CHANNEL_DEFINITION4	"	4b	2	CHARACTER	-	-
27	CHANNEL_DEFINITION5	"	4b	2	CHARACTER	-	-
28	CHANNEL_DEFINITION6	"	4b	2	CHARACTER	-	-
29	CHANNEL_DEFINITION7	"	4b	2	CHARACTER	-	-
30	CHANNEL_DEFINITION8	"	4b	2	CHARACTER	-	-
31	CHANNEL_DEFINITION9	"	4b	2	CHARACTER	-	-
32	CHANNEL_DEFINITION10	"	4b	2	CHARACTER	-	-
33	CHANNEL_DEFINITION11	"	4b	2	CHARACTER	-	-
34	CHANNEL_DEFINITION12	"	4b	2	CHARACTER	-	-
35	CHANNEL_DEFINITION13	"	4b	2	CHARACTER	-	-
36	CHANNEL_DEFINITION14	"	4b	2	CHARACTER	-	-
37	CHANNEL_DEFINITION15	"	4b	2	CHARACTER	-	-
38	CHANNEL_DEFINITION16	"	4b	2	CHARACTER	-	-
39	CHANNEL_DEFINITION17	"	4b	2	CHARACTER	-	-
40	CHANNEL_DEFINITION18	"	4b	2	CHARACTER	-	-
41	CHANNEL_DEFINITION19	"	4b	2	CHARACTER	-	-
42	CHANNEL_DEFINITION20	"	4b	2	CHARACTER	-	-
43	PSYNC_COUNTER	NUMBER OF SYNC PULSES RECEIVED FROM DPU SINCE IFE POWER ON.	2B	5	ASCII_INTEGER	0	65535
44	BASE_COUNTER	NUMBER OF SYNC PULSE INTERVALS ELAPSED SINCE IFE POWER ON.	2B	5	ASCII_INTEGER	0	65535
45	SV_WAVE1_LEVEL1	SV WAVE1 MONITOR LEVEL 1	12b	4	ASCII_INTEGER	0	4095
46	SV_WAVE1_LEVEL2	SV WAVE1 MONITOR LEVEL 2	12b	4	ASCII_INTEGER	0	4095
47	SV_WAVE1_LEVEL3	SV WAVE1 MONITOR LEVEL 3	12b	4	ASCII_INTEGER	0	4095
48	SV_WAVE1_LEVEL4	SV WAVE1 MONITOR LEVEL 4	12b	4	ASCII_INTEGER	0	4095
49	SV_WAVE1_LEVEL5	SV WAVE1 MONITOR LEVEL 5	12b	4	ASCII_INTEGER	0	4095
50	SV_WAVE1_LEVEL6	SV WAVE1 MONITOR LEVEL 6	12b	4	ASCII_INTEGER	0	4095
51	SV_WAVE1_LEVEL7	SV WAVE1 MONITOR LEVEL 7	12b	4	ASCII_INTEGER	0	4095
52	SV_WAVE1_LEVEL8	SV WAVE1 MONITOR LEVEL 8	12b	4	ASCII_INTEGER	0	4095
53	SV_WAVE2A_LEVEL1	SV WAVE2A MONITOR LEVEL 1	12b	4	ASCII_INTEGER	0	4095
54	SV_WAVE2A_LEVEL2	SV WAVE2A MONITOR LEVEL 2	12b	4	ASCII_INTEGER	0	4095
55	SV_WAVE2A_LEVEL3	SV WAVE2A MONITOR LEVEL 3	12b	4	ASCII_INTEGER	0	4095
56	SV_WAVE2A_LEVEL4	SV WAVE2A MONITOR LEVEL 4	12b	4	ASCII_INTEGER	0	4095

57	SV_WAVE2A_LEVEL5	SV WAVE2A MONITOR LEVEL 5	12b	4	ASCII_INTEGER	0	4095
58	SV_WAVE2A_LEVEL6	SV WAVE2A MONITOR LEVEL 6	12b	4	ASCII_INTEGER	0	4095
59	SV_WAVE2A_LEVEL7	SV WAVE2A MONITOR LEVEL 7	12b	4	ASCII_INTEGER	0	4095
60	SV_WAVE2A_LEVEL8	SV WAVE2A MONITOR LEVEL 8	12b	4	ASCII_INTEGER	0	4095
61	SV_WAVE2B_LEVEL1	SV WAVE2B MONITOR LEVEL 1	12b	4	ASCII_INTEGER	0	4095
62	SV_WAVE2B_LEVEL2	SV WAVE2B MONITOR LEVEL 2	12b	4	ASCII_INTEGER	0	4095
63	SV_WAVE2B_LEVEL3	SV WAVE2B MONITOR LEVEL 3	12b	4	ASCII_INTEGER	0	4095
64	SV_WAVE2B_LEVEL4	SV WAVE2B MONITOR LEVEL 4	12b	4	ASCII_INTEGER	0	4095
65	SV_WAVE2B_LEVEL5	SV WAVE2B MONITOR LEVEL 5	12b	4	ASCII_INTEGER	0	4095
66	SV_WAVE2B_LEVEL6	SV WAVE2B MONITOR LEVEL 6	12b	4	ASCII_INTEGER	0	4095
67	SV_WAVE2B_LEVEL7	SV WAVE2B MONITOR LEVEL 7	12b	4	ASCII_INTEGER	0	4095
68	SV_WAVE2B_LEVEL8	SV WAVE2B MONITOR LEVEL 8	12b	4	ASCII_INTEGER	0	4095
69	SV_LENS_LEVEL1	SV LENS MONITOR LEVEL 1	12b	4	ASCII_INTEGER	0	4095
70	SV_LENS_LEVEL2	SV LENS MONITOR LEVEL 2	12b	4	ASCII_INTEGER	0	4095
71	SV_LENS_LEVEL3	SV LENS MONITOR LEVEL 3	12b	4	ASCII_INTEGER	0	4095
72	SV_LENS_LEVEL4	SV LENS MONITOR LEVEL 4	12b	4	ASCII_INTEGER	0	4095
73	SV_LENS_LEVEL5	SV LENS MONITOR LEVEL 5	12b	4	ASCII_INTEGER	0	4095
74	SV_LENS_LEVEL6	SV LENS MONITOR LEVEL 6	12b	4	ASCII_INTEGER	0	4095
75	SV_LENS_LEVEL7	SV LENS MONITOR LEVEL 7	12b	4	ASCII_INTEGER	0	4095
76	SV_LENS_LEVEL8	SV LENS MONITOR LEVEL 8	12b	4	ASCII_INTEGER	0	4095
77	TOTAL_START_COUNTS	COUNTER VALUES REPORTED COLLECTED DURING ONE OF THE SLOTS 0 TO 7. THE SLOT NUMBER IS DETERMINED BY THE LOWER 3 BITS OF THE BASE COUNTER. THESE COUNTERS MAY BE 0 IF HV IS OFF.	2B	5	ASCII_INTEGER	0	65535
78	TOTAL_STOP_COUNTS	“	2B	5	ASCII_INTEGER	0	65535
79	TOTAL_COINCIDENCE_COUNTS	“	2B	5	ASCII_INTEGER	0	65535
80	CAL_MODE1	ALL CP VALUES OF MOST RECENTLY SENT CAL_MODE COMMAND.	1B	3	ASCII_INTEGER	0	255
81	CAL_MODE2	“	1B	3	ASCII_INTEGER	0	255
82	CAL_TIMING1	“	1B	3	ASCII_INTEGER	0	255
83	CAL_TIMING2	“	1B	3	ASCII_INTEGER	0	255
84	CAL_TIMING3	“	1B	3	ASCII_INTEGER	0	255
85	CAL_TIMING4	“	1B	3	ASCII_INTEGER	0	255

86	HV_MAIN_REF	REFERENCE VALUE OF THE HV MAIN VOLTAGE	8b		ASCII_INTEGER		
87	HV_STARTMCP_REF	REFERENCE VALUE OF THE HV START MCP VOLTAGE	8b		ASCII_INTEGER		
88	HV_STOPMCP_REF	REFERENCE VALUE OF THE HV STOP MCP VOLTAGE	8b		ASCII_INTEGER		
89	HV_TOF_REF	REFERENCE VALUE OF THE HV TOF VOLTAGE	8b		ASCII_INTEGER		
90	HV_DEF_REF	REFERENCE VALUE OF THE HV DEFLECTION VOLTAGE	12b		ASCII_INTEGER		

4.3.2.4 CENA Coincidence Events Data: Data Product Format

The CENA coincidende events data product consists of a table with rows containing events from the sensor.

The PDS TABLE is the chosen storage format for archival of these data. The TABLE is an ASCII data object containing rows with a fixed number of fields separated by field delimiters. For CENA data products, the field delimiters are always commas. The TABLE object row delimiters are always carriage-return line-feed (<CR><LF>) ASCII line termination characters. The format for the TABLE objects is a comma-separated value format in which string fields are enclosed in double quotes. `ITEM` and `ITEM_BYTES` keywords define the number of identical parts into which a single column has been divided, i.e. each event in a coincidence event packet contains four parameters (`START_RING, START_SECTOR, STOP_PLATE, TOF`) and there are N events in one packet, which means there are N identical `START_RING` values per packet described as a single column divided in N identical parts. The maximum number of events (N) in a row depends on the data rate, which can change from packet to packet. As the number of fields (and bytes) in a row is fixed, the maximum number of events per row is the maximum number of events found in all the packets within the same orbit. Padding with N/A value (TBD) is used when the number of events is less than the maximum. One column is added containing the actual number of events to be considered. The extension for the data files is TAB.

For detailed information on the telemetry structure, see RD5 (section 16, page 64).

```
/* DATA OBJECTS DEFINITION */

OBJECT                              = CENA_COINCIDENCE_EVENT_TABLE

   INTERCHANGE_FORMAT               = ASCII
   ROWS                             = 100
   ROW_BYTES                        = 390
   COLUMNS                          = 7    < TBC >
   NAME                             = "CENA COINCIDENCE EVENTS DATA"

   DESCRIPTION                      = "THIS TABLE CONTAINS ALL COINCIDENCE EVENTS DATA
                                       FROM CENA IN ONE ORBIT. EACH ROW CONTAINS ALL
                                       EVENTS INFORMATION AVAILABLE PER TRANSFER."
```

```
  OBJECT                       = COLUMN
    NAME                       = "TIME"
    BYTES                      = 23
    DATA_TYPE                  = TIME
    START_BYTE                 = 1
    DESCRIPTION                = "START TIME OF MEASUREMENT (UTC)"
  END_OBJECT                   = COLUMN

  OBJECT                       = COLUMN
    NAME                       = <See Table 4-4>
    BYTES                      = <See Table 4-4>
    DATA_TYPE                  = <See Table 4-4>
    START_BYTE                 = 25  < Calculated by software >
    DESCRIPTION                = <See Table 4-4>
    VALID_MAXIMUM              = <See Table 4-4>
    VALID_MINIMUM              = <See Table 4-4>
  END_OBJECT                   = COLUMN

  OBJECT                       = COLUMN
    NAME                       = "TOF"
    START_BYTE                 = 42  < Calculated by software >
    ITEMS                      = 116 < Calculated by software >

    ITEM_BYTES                 = 3
    BYTES                      = 348 < Calculated by software >

    DATA_TYPE                  = ASCII_INTEGER
    VALID_MAXIMUM              = 255
    VALID_MINIMUM              = 0

    DESCRIPTION                = "TIME OF FLIGHT MEASUREMENT"
  END_OBJECT                   = COLUMN

END_OBJECT                     = CENA_COINCIDENCE_EVENT_TABLE

END
```

Table 4-4 CENA coincidence events data

	NAME (max. 30 characters)	**DESCRIPTION**	**SIZE (TM)**	**BYTES (PDS)**	**DATA_TYPE**	**MIN**	**MAX**
1	TIME	START TIME OF MEASUREMENT (UTC)	-	23	TIME	-	-
2	SLOT_ID	SLOT IDENTIFIER	1B	1	ASCII_INTEGER	0	7

3	N	NUMBER OF EVENTS	-	3	ASCII_INTEGER	1	116
4	START_RING	START RING IDENTIFIER	N x 3b	1	ASCII_INTEGER	0	7
5	START_SECTOR	START SECTOR IDENTIFIER	N x 3b	1	ASCII_INTEGER	0	7
6	STOP_PLATE	STOP PLATE IDENTIFIER	N x 4b	2	ASCII_INTEGER	0	15
7	TOF	TIME OF FLIGHT MEASUREMENT	N x10b	4	ASCII_INTEGER	0	1023

4.3.2.5 CENA Coincidence Raw Mode Data: Data Product Format

The CENA coincidende raw data product consists of a table with rows containing coincidence raw mode events from the sensor.

The PDS TABLE is the chosen storage format for archival of these data((see TABLE description in section 4.3.2.4).
For detailed information on the telemetry structure, see RD5 (section 16, page 65).

```
/* DATA OBJECTS DEFINITION */
OBJECT                          = CENA_COINCIDENCE_RAW_TABLE

   INTERCHANGE_FORMAT           = ASCII
   ROWS                         = 100
   ROW_BYTES                    = 390
   COLUMNS                      = 10   < TBC >
   NAME                         = "CENA COINCIDENCE RAW DATA"
   DESCRIPTION                  = "THIS TABLE CONTAINS ALL COINCIDENCE RAW DATA
                                   FROM CENA IN ONE ORBIT. NO DATA ACCUMULATION
                                   OR BINNING TAKES PLACE. EACH ROW CONTAINS ALL
                                   RAW COINCIDENCE DATA AVAILABLE PER TRANSFER."

   OBJECT                       = COLUMN
      NAME                      = "TIME"
      BYTES                     = 23
      DATA_TYPE                 = TIME
      START_BYTE                = 1
      DESCRIPTION               = "START TIME OF MEASUREMENT (UTC)"
   END_OBJECT                   = COLUMN

   OBJECT                       = COLUMN
      NAME                      = <See Table 4-5>
      BYTES                     = <See Table 4-5>
      DATA_TYPE                 = <See Table 4-5>
      START_BYTE                = 25   < Calculated by software >
      DESCRIPTION               = <See Table 4-5>
      VALID_MAXIMUM             = <See Table 4-5>
```

```
      VALID_MINIMUM            = <See Table 4-5>
   END_OBJECT                  = COLUMN

   OBJECT                      = COLUMN
      NAME                     = "TOF"
      START_BYTE               = 42   < Calculated by software >
      ITEMS                    = 90   < Calculated by software >

      ITEM_BYTES               = 3
      BYTES                    = 270  < Calculated by software >

      DATA_TYPE                = ASCII_INTEGER
      VALID_MAXIMUM            = 255
      VALID_MINIMUM            = 0

      DESCRIPTION              = "TIME OF FLIGHT MEASUREMENT"
   END_OBJECT                  = COLUMN

END_OBJECT                     = CENA_COINCIDENCE_RAW_TABLE

END
```

Table 4-5 CENA coincidence raw mode data

	NAME (max. 30 characters)	**DESCRIPTION**	**SIZE (TM)**	**BYTES (PDS)**	**TYPE**	**MIN**	**MAX**
1	TIME	START TIME OF MEASUREMENT (UTC)	-	23	TIME	-	-
2	SLOT_ID	SLOT IDENTIFIER	1B	1	ASCII_INTEGER	0	7
3	START_COUNTS		2B	5	ASCII_INTEGER	0	65535
4	STOP_COUNTS		2B	5	ASCII_INTEGER	0	65535
5	COINCIDENCE_STOP_COUNTS		2B	5	ASCII_INTEGER	0	65535
6	N	NUMBER OF EVENTS	-	3	ASCII_INTEGER	1	156
7	START_RING	START RING IDENTIFIER	N x 3b	1	ASCII_INTEGER	0	7
8	START_SECTOR	START SECTOR IDENTIFIER	N x 3b	1	ASCII_INTEGER	0	7
9	STOP_PLATE	STOP PLATE IDENTIFIER	N x 4b	2	ASCII_INTEGER	0	15
10	TOF	TIME OF FLIGHT MEASUREMENT	N x10b	3	ASCII_INTEGER	0	1023

4.3.2.6 CENA Counter Raw Mode Data: Data Product Format

The CENA coincidende raw data product consists of a table with rows containing the counter raw mode events from the sensor.

The PDS TABLE is the chosen storage format for archival of these data (see TABLE description in section 4.3.2.4).

For detailed information on the telemetry structure, see RD5 (section 16, page 65).

```
/* DATA OBJECTS DEFINITION */

OBJECT                          = CENA_COUNTER_RAW_TABLE
   INTERCHANGE_FORMAT           = ASCII
   ROWS                         = 100
   ROW_BYTES                    = 390
   COLUMNS                      = 13  < TBC >
   NAME                         = "CENA COUNTER RAW DATA"
   DESCRIPTION                  = "THIS TABLE CONTAINS ALL COUNTER RAW DATA
                                   FROM CENA IN ONE ORBIT. NO DATA ACCUMULATION
                                   OR BINNING TAKES PLACE. EACH ROW CONTAINS ALL
                                   RAW COUNTER DATA AVAILABLE PER TRANSFER."


   OBJECT                       = COLUMN
      NAME                      = "TIME"
      BYTES                     = 23
      DATA_TYPE                 = TIME
      START_BYTE                = 1
      DESCRIPTION               = "START TIME OF MEASUREMENT (UTC)"
   END_OBJECT                   = COLUMN

   OBJECT                       = COLUMN
      NAME                      = <See Table 4-6>
      BYTES                     = <See Table 4-6>
      DATA_TYPE                 = <See Table 4-6>
      START_BYTE                = 25  < Calculated by software >
      DESCRIPTION               = <See Table 4-6>
      VALID_MAXIMUM             = <See Table 4-6>
      VALID_MINIMUM             = <See Table 4-6>
   END_OBJECT                   = COLUMN

   OBJECT                       = COLUMN
      NAME                      = "TOF"
      START_BYTE                = 42  < Calculated by software >
      ITEMS                     = 100  < Calculated by software >

      ITEM_BYTES                = 3
      BYTES                     = 300  < Calculated by software >

      DATA_TYPE                 = ASCII_INTEGER
```

```
    VALID_MAXIMUM           = 255
    VALID_MINIMUM           = 0

    DESCRIPTION             = "TIME OF FLIGHT MEASUREMENT"
  END_OBJECT                = COLUMN

END_OBJECT                  = CENA_COUNTER_RAW_TABLE

END
```

Table 4-6 CENA countermode raw data

	NAME (max. 30 characters)	DESCRIPTION	SIZE (TM)	BYTES (PDS)	TYPE	MIN	MAX
1	TIME	START TIME OF MEASUREMENT (UTC)	-	23	TIME	-	-
2	SLOT_ID	SLOT IDENTIFIER	1B	1	ASCII_INTEGER	0	7
3	START_RING_SECTOR_COUNT		4 x 7 x 2B	5	ASCII_INTEGER	0	65535
4	START_RING_COUNT		4 x 2B	5	ASCII_INTEGER	0	65535
5	START_SECTOR_COUNT		7 x 2B	5	ASCII_INTEGER	0	65535
6	STOP_PLATE_COUNT		8 x 2B	5	ASCII_INTEGER	0	65535
7	STOP_MESH_COUNT		2B	5	ASCII_INTEGER	0	65535
8	START_SECTOR_COINCIDENCE_COUNT		7 x 2B	5	ASCII_INTEGER	0	65535
9	N	NUMBER OF EVENTS	-	3	ASCII_INTEGER	1	115
10	START_RING	START RING IDENTIFIER	N x 3b	1	ASCII_INTEGER	0	7
11	START_SECTOR	START SECTOR IDENTIFIER	N x 3b	1	ASCII_INTEGER	0	7
12	STOP_PLATE	STOP PLATE IDENTIFIER	N x 4b	2	ASCII_INTEGER	0	15
13	TOF	TIME OF FLIGHT MEASUREMENT	N x 10b	3	ASCII_INTEGER	0	1023

4.3.2.7 CENA Engineering Raw Mode Data: Data Product Format

The CENA engineering raw data product consists of a table with rows of over one hundred housekeeping parameters that describe the state of the instrument operation. The information contained in the PDS data file contains each of the parameters extracted from the SARA CENA engineering raw packets.

The PDS TABLE is the chosen storage format for archival of these data (see TABLE description in section 4.3.2.4).

For detailed information on the telemetry structure, see RD5 (section 16, page 66).

```
/* DATA OBJECTS DEFINITION */
```

```
OBJECT                          = CENA_ENGINEERING_RAW_TABLE
   INTERCHANGE_FORMAT           = ASCII
   ROWS                         = 100
   ROW_BYTES                    = 390
   COLUMNS                      = 90   < TBC >
   NAME                         = "CENA ENGINEERING RAW DATA"
   DESCRIPTION                  = "THIS TABLE CONTAINS ALL ENGINEERING RAW DATA
                                   FROM CENA IN ONE ORBIT. EACH ROW CONTAINS ALL
                                   RAW ENGINEERING PARAMETERS AVAILABLE PER
                                   TRANSFER."

   OBJECT                       = COLUMN
      NAME                      = "TIME"
      BYTES                     = 23
      DATA_TYPE                 = TIME
      START_BYTE                = 1
      DESCRIPTION               = "START TIME OF MEASUREMENT (UTC)"
   END_OBJECT                   = COLUMN

   OBJECT                       = COLUMN
      NAME                      = "PACKET_ID"
      BYTES                     = 3
      DATA_TYPE                 = ASCII_INTEGER
      START_BYTE                = 25
      DESCRIPTION               = "PACKET IDENTIFIER"
   END_OBJECT                   = COLUMN

   OBJECT                       = COLUMN
      NAME                      = <See Table 4-7>
      BYTES                     = <See Table 4-7>
      DATA_TYPE                 = <See Table 4-7>
      START_BYTE                = 29   < Calculated by software >
      DESCRIPTION               = <See Table 4-7>
      VALID_MAXIMUM             = <See Table 4-7>
      VALID_MINIMUM             = <See Table 4-7>
   END_OBJECT                   = COLUMN

END_OBJECT                      = CENA_ENGINEERING_RAW_TABLE

END
```

Table 4-7 CENA Engineering mode raw data

	NAME	DESCRIPTION	SIZE	BYTES	TYPE	MIN	MAX

	(max. 30 characters)		**(TM)**	**(PDS)**			
1	TIME	START TIME OF MEASUREMENT (UTC)	-	23	TIME	-	-
2	PACKET_ID	PACKET IDENTIFIER	1B	3	ASCII_INTEGER	0	255
3	SLOT_ID	SLOT IDENTIFIER	1B	1	ASCII_INTEGER	0	7
4	FLAG_P	HV MAIN POWER 0=OFF/1=ON	1b: b0	1	ASCII_INTEGER	0	1
5	FLAG_S	HV SAFETY ENABLE 0=UNSET/1=SET	1b: b1	1	ASCII_INTEGER	0	1
6	FLAG_PE	HV ON ENABLE 0=UNSET/1=SET	1b: b4	1	ASCII_INTEGER	0	1
7	FLAG_SE	HV LEVEL SET ENABLE 0=UNSET/1=SET	1b: b5	1	ASCII_INTEGER	0	1
8	FLAG_ER	ERROR FLAG 0=ALL CHECKSUMS OK SINCE LAST CLEARING 1=COMMAND RECEIVED WITH ILLEGAL CHECKSUM	1b: b7	1	ASCII_INTEGER	0	1
9	HV_MAIN	HV MAIN MONITOR	12b	4	ASCII_INTEGER	0	4095
10	HV_STARTMCP	HV START MCP MONITOR	12b	4	ASCII_INTEGER	0	4095
11	HV_STOPMCP	HV STOP MCP MONITOR	12b	4	ASCII_INTEGER	0	4095
12	HV_TOF	HV TOF MONITOR	12b	4	ASCII_INTEGER	0	4095
13	HV_DEF	HV DEF MONITOR	12b	4	ASCII_INTEGER	0	4095
14	IFE_TEMP	IFE TEMPERATURE	12b	4	ASCII_INTEGER	0	4095
15	HVPS_TEMP	HVPS TEMPERATURE	12b	4	ASCII_INTEGER	0	4095
16	SV_WAVE1	SV_WAVE1	4b	3	ASCII_INTEGER	0	15
17	SV_WAVE2A	SV_WAVE2A	4b	3	ASCII_INTEGER	0	15
18	SV_WAVE2B	SV_WAVE2B	4b	3	ASCII_INTEGER	0	15
19	SV_LENS	SV_LENS	4b	3	ASCII_INTEGER	0	15
20	OBSERVATION_MODE	THE OBSERVATION MODE IS DEFINED WITH A CHARACTER STRING FORMED FROM TWO COMPONENTS (CHARACTERS): SM. VALID ASSIGNMENTS FOR EACH COMPONENT ARE: S 0 SYNCHRONOUS 1 ASYNCHRONOUS M 0 COINCIDENCE 1 COUNTER 2 ENGINEERING 3 NOT DEFINED	1b: b7 2b: b0-1	2	CHARACTER	-	-
21	EVENT_BITMASK	COINCIDENCE AND COUNTER MODE: EVENT SELECTION BITMASK	2B	5	ASCII_INTEGER	0	65535
22	DEAD_TIME	ACTUAL DEAD TIME DEAD_TIME*15.6/256 [ms]	1B	3	ASCII_INTEGER	0	255

23	CHANNEL_DEFINITION1	CHANNEL DEFINITION IS DEFINED WITH A CHARACTER STRING FORMED FROM TWO COMPONENTS (CHARACTERS): ED. DEFINITION AND VALID ASSIGNMENTS FOR EACH COMPONENT ARE: E MCP INPUT SIGNAL 0 DISABLE 1 ENABLE D DISCRIMINATION LEVEL (INTEGER VALUE FROM 0 TO 7)	4b	2	CHARACTER	-	-
24	CHANNEL_DEFINITION2	"	4b	2	CHARACTER	-	-
25	CHANNEL_DEFINITION3	"	4b	2	CHARACTER	-	-
26	CHANNEL_DEFINITION4	"	4b	2	CHARACTER	-	-
27	CHANNEL_DEFINITIONS5	"	4b	2	CHARACTER	-	-
28	CHANNEL_DEFINITION6	"	4b	2	CHARACTER	-	-
29	CHANNEL_DEFINITION7	"	4b	2	CHARACTER	-	-
30	CHANNEL_DEFINITION8	"	4b	2	CHARACTER	-	-
31	CHANNEL_DEFINITION9	"	4b	2	CHARACTER	-	-
32	CHANNEL_DEFINITION10	"	4b	2	CHARACTER	-	-
33	CHANNEL_DEFINITION11	"	4b	2	CHARACTER	-	-
34	CHANNEL_DEFINITION12	"	4b	2	CHARACTER	-	-
35	CHANNEL_DEFINITION13	"	4b	2	CHARACTER	-	-
36	CHANNEL_DEFINITION14	"	4b	2	CHARACTER	-	-
37	CHANNEL_DEFINITION15	"	4b	2	CHARACTER	-	-
38	CHANNEL_DEFINITION16	"	4b	2	CHARACTER	-	-
39	CHANNEL_DEFINITION17	"	4b	2	CHARACTER	-	-
40	CHANNEL_DEFINITION18	"	4b	2	CHARACTER	-	-
41	CHANNEL_DEFINITION19	"	4b	2	CHARACTER	-	-
42	CHANNEL_DEFINITION20	"	4b	2	CHARACTER	-	-
43	PSYNC_COUNTER	NUMBER OF SYNC PULSES RECEIVED FROM DPU SINCE IFE POWER ON.	2B	5	ASCII_INTEGER	0	65535
44	BASE_COUNTER	NUMBER OF SYNC PULSE INTERVALS ELAPSED SINCE IFE POWER ON.	2B	5	ASCII_INTEGER	0	65535
45	SV_WAVE1_LEVEL1	SV WAVE1 MONITOR LEVEL 1	12b	4	ASCII_INTEGER	0	4095
46	SV_WAVE1_LEVEL2	SV WAVE1 MONITOR LEVEL 2	12b	4	ASCII_INTEGER	0	4095

47	SV_WAVE1_LEVEL3	SV WAVE1 MONITOR LEVEL 3	12b	4	ASCII_INTEGER	0	4095
48	SV_WAVE1_LEVEL4	SV WAVE1 MONITOR LEVEL 4	12b	4	ASCII_INTEGER	0	4095
49	SV_WAVE1_LEVEL5	SV WAVE1 MONITOR LEVEL 5	12b	4	ASCII_INTEGER	0	4095
50	SV_WAVE1_LEVEL6	SV WAVE1 MONITOR LEVEL 6	12b	4	ASCII_INTEGER	0	4095
51	SV_WAVE1_LEVEL7	SV WAVE1 MONITOR LEVEL 7	12b	4	ASCII_INTEGER	0	4095
52	SV_WAVE1_LEVEL8	SV WAVE1 MONITOR LEVEL 8	12b	4	ASCII_INTEGER	0	4095
53	SV_WAVE2A_LEVEL1	SV WAVE2A MONITOR LEVEL 1	12b	4	ASCII_INTEGER	0	4095
54	SV_WAVE2A_LEVEL2	SV WAVE2A MONITOR LEVEL 2	12b	4	ASCII_INTEGER	0	4095
55	SV_WAVE2A_LEVEL3	SV WAVE2A MONITOR LEVEL 3	12b	4	ASCII_INTEGER	0	4095
56	SV_WAVE2A_LEVEL4	SV WAVE2A MONITOR LEVEL 4	12b	4	ASCII_INTEGER	0	4095
57	SV_WAVE2A_LEVEL5	SV WAVE2A MONITOR LEVEL 5	12b	4	ASCII_INTEGER	0	4095
58	SV_WAVE2A_LEVEL6	SV WAVE2A MONITOR LEVEL 6	12b	4	ASCII_INTEGER	0	4095
59	SV_WAVE2A_LEVEL7	SV WAVE2A MONITOR LEVEL 7	12b	4	ASCII_INTEGER	0	4095
60	SV_WAVE2A_LEVEL8	SV WAVE2A MONITOR LEVEL 8	12b	4	ASCII_INTEGER	0	4095
61	SV_WAVE2B_LEVEL1	SV WAVE2B MONITOR LEVEL 1	12b	4	ASCII_INTEGER	0	4095
62	SV_WAVE2B_LEVEL2	SV WAVE2B MONITOR LEVEL 2	12b	4	ASCII_INTEGER	0	4095
63	SV_WAVE2B_LEVEL3	SV WAVE2B MONITOR LEVEL 3	12b	4	ASCII_INTEGER	0	4095
64	SV_WAVE2B_LEVEL4	SV WAVE2B MONITOR LEVEL 4	12b	4	ASCII_INTEGER	0	4095
65	SV_WAVE2B_LEVEL5	SV WAVE2B MONITOR LEVEL 5	12b	4	ASCII_INTEGER	0	4095
66	SV_WAVE2B_LEVEL6	SV WAVE2B MONITOR LEVEL 6	12b	4	ASCII_INTEGER	0	4095
67	SV_WAVE2B_LEVEL7	SV WAVE2B MONITOR LEVEL 7	12b	4	ASCII_INTEGER	0	4095
68	SV_WAVE2B_LEVEL8	SV WAVE2B MONITOR LEVEL 8	12b	4	ASCII_INTEGER	0	4095
69	SV_LENS_LEVEL1	SV LENS MONITOR LEVEL 1	12b	4	ASCII_INTEGER	0	4095
70	SV_LENS_LEVEL2	SV LENS MONITOR LEVEL 2	12b	4	ASCII_INTEGER	0	4095
71	SV_LENS_LEVEL3	SV LENS MONITOR LEVEL 3	12b	4	ASCII_INTEGER	0	4095
72	SV_LENS_LEVEL4	SV LENS MONITOR LEVEL 4	12b	4	ASCII_INTEGER	0	4095
73	SV_LENS_LEVEL5	SV LENS MONITOR LEVEL 5	12b	4	ASCII_INTEGER	0	4095
74	SV_LENS_LEVEL6	SV LENS MONITOR LEVEL 6	12b	4	ASCII_INTEGER	0	4095
75	SV_LENS_LEVEL7	SV LENS MONITOR LEVEL 7	12b	4	ASCII_INTEGER	0	4095
76	SV_LENS_LEVEL8	SV LENS MONITOR LEVEL 8	12b	4	ASCII_INTEGER	0	4095
77	TOTAL_START_COUNTS	COUNTER VALUES REPORTED COLLECTED DURING ONE OF THE SLOTS 0 TO 7. THE SLOT NUMBER IS DETERMINED BY THE LOWER 3 BITS OF THE	2B	5	ASCII_INTEGER	0	65535

		BASE COUNTER. THESE COUNTERS MAY BE 0 IF HV IS OFF.						
78	TOTAL_STOP_COUNTS	"	2B	5	ASCII_INTEGER	0	65535	
79	TOTAL_COINCIDENCE_COUNTS	"	2B	5	ASCII_INTEGER	0	65535	
80	CAL_MODE1	ALL CP VALUES OF MOST RECENTLY SENT CAL_MODE COMMAND.	1B	3	ASCII_INTEGER	0	255	
81	CAL_MODE2	"	1B	3	ASCII_INTEGER	0	255	
82	CAL_TIMING1	"	1B	3	ASCII_INTEGER	0	255	
83	CAL_TIMING2	"	1B	3	ASCII_INTEGER	0	255	
84	CAL_TIMING3	"	1B	3	ASCII_INTEGER	0	255	
85	CAL_TIMING4	"	1B	3	ASCII_INTEGER	0	255	
86	HV_MAIN_REF	REFERENCE VALUE OF THE HV MAIN VOLTAGE	8b		ASCII_INTEGER			
87	HV_STARTMCP_REF	REFERENCE VALUE OF THE HV START MCP VOLTAGE	8b		ASCII_INTEGER			
88	HV_STOPMCP_REF	REFERENCE VALUE OF THE HV STOP MCP VOLTAGE	8b		ASCII_INTEGER			
89	HV_TOF_REF	REFERENCE VALUE OF THE HV TOF VOLTAGE	8b		ASCII_INTEGER			
90	HV_DEF_REF	REFERENCE VALUE OF THE HV DEFLECTION VOLTAGE	12b		ASCII_INTEGER			

4.3.3 SWIM Data Product Design

4.3.3.1 SWIM Housekeeping Data: Data Product Format

The SWIM housekeeping data product consists of a table with rows of over one hundred housekeeping parameters that describe the state of the instrument operation. The information contained in the PDS data file contains each of the parameters related to SWIM extracted from the SARA 32s housekeeping data stream.
For the raw data set (CODMAC level 2) the housekeeping parameters contain the original raw values. For higher levels and where appropiate, the housekeeping parameter are converted to engineering units using the conversion defined in the CHA-SARA-CR-0002-I1R2 (SAS Housekeeping Calibration Functions) document [RD6].

The PDS TABLE is the chosen storage format for archival of these data. The TABLE is an ASCII data object containing rows with a fixed number of fields separated by field delimiters. For CENA data products, the field delimiters are always commas. The TABLE object row delimiters are always carriage-return line-feed (<CR><LF>) ASCII line termination characters. The format for the TABLE objects is a comma-separated value format in which string fields are enclosed in double quotes. The extension for the data files is TAB.

For more detailed information on the telemetry structure, see RD5 (page 20) and RD3 (page 31).

```
/* DATA OBJECTS DEFINITION */
```

```
OBJECT                          = SWIM_32SHK_TABLE
   INTERCHANGE_FORMAT           = ASCII
   ROWS                         = 100  < Calculated by software >
   ROW_BYTES                    = 205
   COLUMNS                      = 85

   NAME                         = "SWIM 32S HOUSEKEEPING DATA"
   DESCRIPTION                  = "THIS TABLE CONTAINS ALL SWIM HOUSEKEEPING DATA
                                   IN ONE ORBIT. EACH ROW CONTAINS ALL RELEVANT
                                   HOUSEKEEPING PARAMETERS AVAILABLE IN ONE 32S
                                   HOUSEKEEPING TRANSFER."

   OBJECT                       = COLUMN
      NAME                      = "TIME"
      BYTES                     = 23
      DATA_TYPE                 = TIME
      START_BYTE                = 1
      DESCRIPTION               = "START TIME OF MEASUREMENT (UTC)"
   END_OBJECT                   = COLUMN

   OBJECT                       = COLUMN
      NAME                      = "HV_MAIN_MONITOR"
      BYTES                     = 4
      DATA_TYPE                 = ASCII_INTEGER
      START_BYTE                = 25
      DESCRIPTION               = "MONITOR VALUE OF THE HV MAIN"
      VALID_MAXIMUM             = 0
      VALID_MINIMUM             = 4095
   END_OBJECT                   = COLUMN

   #
   # The total number of columns is 16.
   # See Table 4-8 for a complete list of the columns (32S HK parameters related
   # to SWIM)
   #

   OBJECT                       = COLUMN
      NAME                      = <See Table 4-8>
      BYTES                     = <See Table 4-8>
      DATA_TYPE                 = <See Table 4-8 >
      START_BYTE                = 30   < Calculated by software >
      DESCRIPTION               = <See Table 4-8>
```

```
      VALID_MAXIMUM          = <See Table 4-8>
      VALID_MINIMUM          = <See Table 4-8>
   END_OBJECT                = COLUMN

END_OBJECT                   = SWIM_32SHK_TABLE

END
```

Table 4-8. SWIM HK Parameters in the 32S HK data stream

	NAME (max. 30 characters)	DESCRIPTION	SIZE (TM)	BYTES (PDS)	TYPE	MIN	MAX
1	HV_MAIN_MONITOR	MONITOR VALUE OF THE HV MAIN	12b	4	ASCII_INTEGER	0	4095
2	CCEM_VOLTAGE		12b	4	ASCII_INTEGER	0	4095
3	UPPER_DEFLECTOR_VOLTAGE		12b	4	ASCII_INTEGER	0	4095
4	LOWER_DEFLECTOR_VOLTAGE		12b	4	ASCII_INTEGER	0	4095
5	HV_ANYZ	ANALYZER VOLTAGE	12b	4	ASCII_INTEGER	0	4095
6	TOF_CELL_VOLTAGE		12b	4	ASCII_INTEGER	0	4095
7	TOF_BOARD_TEMP		12b	4	ASCII_INTEGER	0	4095
8	SWIM_STATUS_BYTE						
9	DPU_SENSOR_P5V		8b		ASCII_INTEGER		
10	DPU_SENSOR_P33V		8b		ASCII_INTEGER		
11	DPU_SENSOR_P12V		8b		ASCII_INTEGER		
12	DPU_SENSOR_M12V		8b		ASCII_INTEGER		
13	DPU_P5V		8b		ASCII_INTEGER		
14	DPU_CENA_CURRENT		8b		ASCII_INTEGER		
15	DPU_SWIM_CURRENT		8b		ASCII_INTEGER		
16	DPU_FLAG1		8b		ASCII_INTEGER		
17	DPU_FLAG2		8b		ASCII_INTEGER		

4.3.3.2 SWIM Normal Mode Data: Data Product Format

Data coming from the SWIM sensor is a 3 dimensional array with counts (successfully detected particles) per energy, direction and mass interval, sampled during a number of measurement cycles. These data are being sorted by look-up tables and is being summed up into two types of accumulation matrixes (the accumulation matrix and the accumulation scaling matrix) during a time period. The total number of elements of the accumulation matrixes changes depending on the selected binning parameters.

A PDS ARRAY of COLLECTION objects (comparable to the CENA PDS data product design) is the selected storage format for archival of these data.

Each SWIM PDS data product file contains an ARRAY of records of SWIM measurements in one orbit. Each record is described using a COLLECTION object.

A PDS SWIM COLLECTION object contains all relevant data for each measurement: SWIM parameters (start time, compression mode, cycles of integration…), housekeeping data, the accumulation scaling matrix and the accumulation matrix.

The accumulation scaling matrix and the accumulation matrix are described as PDS three dimensional ARRAY objects.

If the binning parameters change within an orbit, the number of elements of the accumulation matrixes changes, and therefore, the orbit directory contains one PDS data product file (same data product type with different matrixes sizes) per change of binning parameters.

For detailed information on the telemetry structure, see RD5 (section 16).

```
DESCRIPTION                   = "
    THIS FILE CONTAINS DATA FROM SWIM (SOLAR WIND MONITOR) IN NORMAL MODE. THIS MODE IS
    USED TO OBTAIN THE ION COUNTS IN VARIOUS MASS, ENERGY AND DEFLECTION BINS."


/* DATA OBJECTS DEFINITION */

OBJECT                        =                                       SWIM_NORMAL_MODE_ARRAY

  NAME                        =    "SWIM    NORMAL    MODE    SCIENCE    DATA    ARRAY"

  INTERCHANGE_FORMAT          = ASCII
  AXES                        = 1
  AXIS_ITEMS                  = 87   < Calculated by software >

  DESCRIPTION                 = "THIS ARRAY CONTAINS ALL RECORDS OF SWIM MEASUREMENTS
                                 TAKEN WITH THE SENSOR IN NORMAL MODE WITHIN ONE ORBIT.
                                 EACH  RECORD  IS  DESCRIBED  USING  A  COLLECTION  OBJECT,

                                 WHICH CONTAINS ALL DATA RELATED TO ONE 8S MEASUREMENT.
                                 THE ACCUMULATION SCALING MATRIX AND THE ACCUMULATION
                                 MATRIX ARE DESCRIBED AS MULTIDIMENSIONAL ARRAY OBJECTS."

  OBJECT                      = COLLECTION
    NAME                      = "SWIM_RECORD"
    BYTES                     = TBC
    DESCRIPTION               = "THIS COLLECTION CONTAINS ALL DATA AVAILABLE IN ONE
                                 4S TRANSFER: TIME STAMP, BINNING PARAMETERS, MODE,
                                 STATUS,  HOUSEKEEPING  PARAMETERS  AND  SCIENCE  MATRIXES."



    OBJECT                    = ELEMENT
      NAME                    = TIME
      BYTES                   = 23
      DATA_TYPE               = ASCII_INTEGER
      START_BYTE              = 1
      DESCRIPTION             =    "START    TIME    OF    THE    MEASUREMENT    (UTC)"

    END_OBJECT                = ELEMENT

    OBJECT                    = ELEMENT
      NAME                    = <See Table 4-9>

      BYTES                   = <See Table 4-9>

      DATA_TYPE               = <See Table 4-9>

      START_BYTE              = 25   < Calculated by software >
```

```
      DESCRIPTION             = <See Table 4-9>
    END_OBJECT                = ELEMENT

    OBJECT                    = SCALING_ARRAY
      NAME                    = "ACC SCALING MATRIX"
      AXES                    = 3
      AXIS_ITEMS              = (32,1,5)     < Calculated by software >

      AXIS_NAME               = (E,D,R)
      START_BYTE              = 102   < Calculated by software >

      DESCRIPTION             = "ACCUMULATION SCALING MATRIX"

      OBJECT                  = ELEMENT
        NAME                  = "SCALING VALUE"
        BYTES                 = 3
        DATA_TYPE             = ASCII_INTEGER
      END_OBJECT              = ELEMENT

    END_OBJECT                = SCALING_ARRAY

    OBJECT                    = SCIENCE_ARRAY
      NAME                    = "SCIENCE MATRIX"
      AXES                    = 3
      AXIS_ITEMS              = (32,1,32)    < Calculated by software >

      AXIS_NAME               = (E,D,M)
      START_BYTE              = 205   < Calculated by software >

      DESCRIPTION             = "SCIENCE DATA MATRIX"

      OBJECT                  = ELEMENT
       NAME                   = "DATA VALUE"
       BYTES                  = 4
       DATA_TYPE              = ASCII_INTEGER
       VALID_MAXIMUM          = 255

       VALID_MINIMUM          = 0
      END_OBJECT              = ELEMENT

    END_OBJECT                = SCIENCE_ARRAY

  END_OBJECT                  = COLLECTION

END_OBJECT                    =                                     SWIM_NORMAL_MODE_ARRAY

END
```

Table 4-9 SWIM normal mode data

	NAME (max. 30 characters)	**DESCRIPTION**	**SIZE (TM)**	**BYTES (PDS)**	**TYPE**	**MIN**	**MAX**
1	TIME	START TIME OF MEASUREMENT (UTC)	-	23	TIME	-	-
2	PACKET_COUNTER	DPU PACKET COUNTER	2B	5	ASCII_INTEGER	0	65535
3	BINS_P	BINNING PARAMETER: POST ACCELERATION INDEX	1B	3	ASCII_INTEGER	0	255
4	BINS_M	BINNING PARAMETER: MASS BINS	1B	3	ASCII_INTEGER	0	255

5	BINS_D	BINNING PARAMETER: DEFLECTION BINS	1B	3	ASCII_INTEGER	0	255
6	BINS_E	BINNING PARAMETER: ENERGY BINS	1B	3	ASCII_INTEGER	0	255
7	INTEGRATION_CYCLES	NUMBER OF CYCLES FOR INTEGRATION	2B	5	ASCII_INTEGER	0	6553 5
8	SWIM_STATUS	SWIM STATUS BYTE: MODE 0=IDLE 1 SAMPLING SELECTED MEMORY BANK HVPS OSCILLATOR STATUS 0=DISABLED 1=ENABLED TDC LATCH UP STATUS 0=TDC WORKING 1=TDC SHUT DOWN (LATCH UP PROTECCION ENABLED) TDC LATCH UP PROTECCION SETTING 0=DISABLED 1=ENABLED TDC POWER STATUS 0=OFF 1=ON	1B	6	CHARACTER	-	-
9	SWIM_MODE	SWIM STATUS 0=OFF 1=ON	1b	1	ASCII_INTEGER	0	1
10	CENA_MODE	CENA STATUS 0=OFF 1=ON	1b	1	ASCII_INTEGER	0	1
11	COMPRESSION_MODE	COMRESSION MODE 0=DISABLE 1=ENABLE	1b	1	ASCII_INTEGER	0	1
12	HEATH_CHECK_EVENT	HEALTH CHECK EVENT: 0=NO HEALTH CHECK EVENT OCCURRED 1=HEALTH CHECK EVENT OCCURRED DURING THIS INTEGRATION CYCLES TIME	1b	1	ASCII_INTEGER	0	1
In the COLLECTION object defined to archive in PDS format the SWIM science data, ELEMENTS from 13 to 19 are SWIM Housekeeping Parameters available in the header of every 8S science packet. These parameters will be archived as part of this PDS data product.							
13	HV_MAIN_MONITOR	MONITOR VALUE	12b	4	ASCII_INTEGER	0	4095

		OF THE HV MAIN					
14	CCEM_VOLTAGE		12b	4	ASCII_INTEGER	0	4095
15	UPPER_DEFLECTOR_VOLTAGE		12b	4	ASCII_INTEGER	0	4095
16	LOWER_DEFLECTOR_VOLTAGE		12b	4	ASCII_INTEGER	0	4095
17	HV_ANYZ	ANALYZER VOLTAGE	12b	4	ASCII_INTEGER	0	4095
18	TOF_CELL_VOLTAGE		12b	4	ASCII_INTEGER	0	4095
19	TOF_BOARD_TEMP		12b	4	ASCII_INTEGER	0	4095
20	ACC_SCALING_MATRIX	ACCUMULATION SCALING MATRIX DATA	SIZE x 1B	SIZE x 3	ASCII_INTEGER	0	255
21	SCIENCE_DATA	SWIM SCIENCE DATA	SIZE x 1B	SIZE x 3	ASCII_INTEGER	0	255

4.3.3.3 SWIM Raw Mode Data: Data Product Format

The SWIM raw data product consists of a table with rows containing time of flight (TOF) values from the sensor.

The PDS TABLE is the chosen storage format for archival of these data. The TABLE is an ASCII data object containing rows with a fixed number of fields separated by field delimiters. For SWIM data products, the field delimiters are always commas. The TABLE object row delimiters are always carriage-return line-feed (<CR><LF>) ASCII line termination characters. The format for the TABLE objects is a comma-separated value format in which string fields are enclosed in double quotes. `ITEM` and `ITEM_BYTES` keywords define the number of identical parts into which a single column has been divided, i.e. each packets in a SWIM raw data packet contains N time of flight values (TOF), which are described as a single column divided in N identical parts. The maximum number of TOF values (N) in a row depends on the data rate, which can change from packet to packet. As the number of fields (and bytes) in a row is fixed, the maximum number of events per row is the maximum number of N found in all packets within the same orbit. Padding with zeroes is used when the number of TOF values is less than the maximum and one column contains the actual number of events to be considered. The extension for the data files is TAB.

For detailed information on the telemetry structure, see RD4 (section 10.12).

```
/* DATA OBJECTS DEFINITION */

OBJECT                         = SWIM_RAW_MODE_TABLE

   INTERCHANGE_FORMAT          = ASCII
   ROWS                        = 100
   ROW_BYTES                   = 210
   COLUMNS                     = 8    < TBC >
   NAME                        = "SWIM RAW DATA"
   DESCRIPTION                 = "THIS TABLE CONTAINS ALL SWIM RAW DATA
                                  IN ONE ORBIT. EACH ROW CONTAINS ALL SWIM
                                  EVENTS INFORMATION AVAILABLE PER TRANSFER."
```

```
   OBJECT                      = COLUMN
      NAME                     = "TIME"
      BYTES                    = 23
      DATA_TYPE                = TIME
      START_BYTE               = 1
      DESCRIPTION              = "START TIME OF MEASUREMENT (UTC)"
   END_OBJECT                  = COLUMN

   OBJECT                      = COLUMN
      NAME                     = <See Table 4-10>
      BYTES                    = <See Table 4-10>
      DATA_TYPE                = <See Table 4-10>
      START_BYTE               = 25
      DESCRIPTION              = <See Table 4-10>
      VALID_MAXIMUM            = <See Table 4-10>
      VALID_MINIMUM            = <See Table 4-10>
   END_OBJECT                  = COLUMN

   OBJECT                      = COLUMN
      NAME                     = "TOF"
      START_BYTE               = 42   < Calculated by software >
      ITEMS                    = 100  < Calculated by software >

      ITEM_BYTES               = 3
      BYTES                    = 300  < Calculated by software >

      DATA_TYPE                = ASCII_INTEGER
      VALID_MAXIMUM            = 255
      VALID_MINIMUM            = 0

      DESCRIPTION              = "TIME OF FLIGHT MEASUREMENT"
   END_OBJECT                  = COLUMN

END_OBJECT                     = SWIM_RAW_MODE_TABLE

END
```

Table 4-10 SWIM raw mode data

	NAME (max. 30 characters)	DESCRIPTION	SIZE (TM)	BYTES (PDS)	TYPE	MIN	MAX
1	TIME	START TIME OF MEASUREMENT (UTC)	-	23	TIME	-	-
2	SLOT_ID	SLOT IDENTIFIER	1B	1	ASCII_INTEGER	0	7

3	START_COUNTS	START COUNTER	2B	5	ASCII_INTEGER	0	6553 5
4	STOP_COUNTS	STOP COUNTER	2B	5	ASCII_INTEGER	0	6553 5
5	OVER_COUNTS	OVER COUNTER	2B	5	ASCII_INTEGER	0	6553 5
6	UNDER_COUNTS	UNDER COUNTER	2B	5	ASCII_INTEGER	0	6553 5
7	N	NUMBER OF TIME OF FLIGHT EVENTS PRESENT IN THIS TRANSFER	-	4	ASCII_INTEGER	0	4089
8	TOF	TIME OF FLIGHT MEASUREMENT	N x 1B	N x 3	ASCII_INTEGER	0	255

5 Appendix

5.1 Appendix A: Available Software to read PDS files

NASAView
NASAView is a PDS archive product display program that runs on multiple platforms in a GUI environment.

http://pds.jpl.nasa.gov/tools/software_download.cfm

READPDS
READPDS was created at the Small Bodies Node (SBN) of the Planetary Data System (PDS) to read PDS image and data files.

http://pdssbn.astro.umd.edu/nodehtml/software.shtml

5.2 Appendix B: Example of Directory Listing of Data Set X

This is an example for a data set; depending on the final outcome of what will be included in the CSDA, updates may be necessary.

```
ROOT DIRECTORY
|
|- VOLDESC.CAT
|- AAREADME.TXT
|
|- CATALOG
| |- CATINFO.TXT
| |- INSTRUMENT.CAT
| |- DATA_SET.CAT
| |- INSTRUMENT_HOST.CAT
| |- MISSION.CAT
| |- SOFTWARE.CAT
| |- REFERENCE.CAT
| |- TARGET.CAT[optional]
| |- RELEASE.CAT [optional]
|
|- DATA
| |- SUBDIRECTORIES_AS_REQUIRED [contains your data products]
|
|- INDEX
| |-INDXINFO.TXT [PVV can create this for you]
| |- INDEX.LBL [PVV can create this for you]
| |- INDEX.TAB [a table of all data products in the volume. PVV can create this for you]
| |- OTHER_INDEXES_AS_REQUIRED
|
|- CALIB [if you provide calibration software and products, we would like you to
| include this folder]
| |- CALINFO.TXT
| |- CALIBRATION_FILES_AS_REQUIRED
|
|- DOCUMENT [contains supplementary and ancillary documents to help understand
| the data products on the volume]
| |- DOCINFO.TXT
| |- DOCUMENTS_AS_REQUIRED
```

```
|
|- EXTRAS [contains additional items beyond the scope of the PDS requirements]
| |- EXTRINFO.TXT
|
|- GAZETTER [contains gazetteer info such as crater names on the Moon etc.]
| |- GAZINFO.TXT
| |- GAZATTER.TXT
| |- GAZATTER.LBL
| |- GAZATTER.TAB
||
|- GEOMETRY [contains files needed to describe the observation geometry (e.g.
| SPICE)]
| |- GEOMINFO.TXT
|
|- LABEL [contains labels and include files not packaged in the DATA directory]
| |- LABINFO.TXT
| |- Include_files as required
|
|- SOFTWARE [contains software, libraries etc. for viewing, accessing or processing
| the data]
| |- SOFTINFO.TXT
```

5.3 Appendix C: Processing Levels

The table below lists the different PDS processing levels.

Table 5-1 Data Processing Levels

Level	Type	Processing Level Description
1	Raw Data	Telemetry data with data embedded.
2	Edited Data	Corrected for telemetry errors and split or decommutated into a data set for a given instrument. Sometimes called Experimental Data Record. Data are also tagged with time and location of acquisition. Corresponds to NASA Level 0 data.
3	Calibrated Data	Edited data that are still in units produced by instrument, but that have been corrected so that values are expressed in or are proportional to some physical unit such as radiance. No resampling, so edited data can be reconstructed. NASA Level 1A.
4	Resampled Data	Data that have been resampled in the time or space domains in such a way that the original edited data cannot be reconstructed. Could be calibrated in addition to being resampled. NASA Level IB.
5	Derived Data	Derived results, as maps, reports, graphics, etc. NASA Levels 2 through 5.
6	Ancillary Data	Non-science data needed to generate calibrated or resampled data sets. Consists of instrument gains, offsets, pointing information for scan platforms, etc.
7	Correlative Data	Other science data needed to interpret space-based data sets. May include ground based data observations such as soil type or ocean buoy measurements of wind drift.

8	User Description	Description of why the data were required, any peculiarities associated with the data sets, and enough documentation to allow secondary user to extract information from the data.
N	N	Not Applicable

5.4 Appendix D: SARA Data Products Samples

TODO include product labels for all products.

CENA Science Data Product Sample

CENA Housekeeping Data Product Sample

CENA Raw Data Product Sample

SWIM Science Data Product Sample

SWIM Housekeeping Data Product Sample

SWIM Raw Data Product Sample