Phoenix 2007 Mars Scout Mission

Software Interface Specification

Experiment Data Records (EDRs) for the Atmospheric Structure Experiment

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DOCUMENT CHANGE LOG

Date	Description
Dec 10, 2007	Numerous changes reflecting comments of L. Huber and J. Murphy
Nov 18, 2008	Numerous changes reflecting the nature of the data actually received from Mars as opposed to that anticipated before landing
Nov 28,2008	Updated sample PDS labels to be accurate

ACRONYMS

ASE	Atmospheric Structure Experiment
CODMAC	(NASA) Committee on Data Management and Computation
ASCII	American Standard Code for Information Interchange
DN	Data numbers (arbitrary units resolved into physical units through calibration)
EDL	Entry, Descent and Landing
EDR	Engineering Data Record
FSW	Flight Software
ICD	Interface Control Document
IMU	Inertial Measurement Unit
ITAR	International Traffic in Arms Regulations
IAU	International Astronomical Union
LMCO	Lockheed Martin Corporation
LST	Local Solar Time
NSSDC	National Space Science Data Center
PDS	Planetary Data System
RCS	Reaction Control System (referring to spacecraft thrusters)
RDR	Reduced Data Record
SCLK	Spacecraft Clock
SIS	Software Interface Specification
SOC	Science Operations Center
TBD	To Be Determined
UTC	Coordinated Universal Time (a high precision atomic time standard)
w.r.t.	with respect to

1. Purpose and Scope of this Document

The purpose of this document is to provide users of the Phoenix Atmospheric Structure Experiment's data with a detailed description of the 'Experiment Data Records' (EDRs) and how they are generated, including data sources and destinations.

The document is intended to provide enough information to enable users to read and understand the data products. Intended users of this document are scientists who will analyze the mission and supporting data, both those associated with the Phoenix Project and members of the general planetary science community.

2. Applicable Documents

1. Planetary Data System Standards Reference, JPL D-7669 part 2, version 3.7, March 20, 2006. http://pds.jpl.nasa.gov/documents/sr/
2. Phoenix Project Archive Generation, Validation and Transfer Plan, JPL D-29392, Rev. 1.0, December 20, 2004.
3. Planetary Data System Archive Preparation Guide, Aug 29, 2006. http://pds.jpl.nasa.gov/documents/apg/
4. Mars Exploration Program Data Management Plan, Arvidson et al., Rev. 3.0, March 20, 2002. http://pdsgeosciences.wustl.edu/missions/mep/index.htm
5. Data Management and Computation, Volume 1: Issues and Recommendations, Committee on Data Management and Computation, Space Science Board, Assembly of Mathematical and Physical Sciences, National Research Council, National Academy Press, Washington D.C., 1982
6. Issues and Recommendations Associated with Distributed Computation and Data Management Systems for Space Sciences, Space Science Board, Assembly of Mathematical and Physical Sciences, National Research Council, National Academy Press, Washington D.C., 1986.
7. 2007 Phoenix Mission Science Team Accelerometer ASE Cognizant Scientist and PDS Atmospheres Node Interface Control Document. January 4, 2006.

3. Relationships with Other Interfaces

This SIS document, and the products that it describes, could be affected by changes to Phoenix flight software or PDS standards. Such changes may require updates to this document as applicable.

4. Data Product Characteristics and Environment

4.1 Instrument Overview

The frictional drag of the atmosphere upon the entry vehicle results in a reduction in the speed of the entry vehicle. This deceleration depends on atmospheric density and can be used to calculate atmospheric structure, including how the atmospheric temperature changes with altitude along the flight path.

The Phoenix Lander had two Inertial Measurement Units (IMUs) that were mounted on the underside of the lander (Taylor et al., 2008). The IMUs were manufactured by Honeywell (Clearwater, FL) with model number YG9666BC. No input from scientists was possible on the device selection and location within the lander, which was done by spacecraft engineers for the cancelled 2001 Mars Lander prior to the initiation of the Phoenix project. Consequently, the IMUs were not located at the entry vehicle's center of mass. The Atmospheric Structure Experiment (ASE) is concerned with optimizing use of the IMU data to calculate the atmospheric structure during entry despite the non-optimum IMU location and performance characteristics such as noise.

On Phoenix, only one IMU returned data while the other was not turned on and merely used as mission-critical backup for entry, descent and landing. The operational IMU gave output of accumulated linear velocity change (the time integral of acceleration) in three Cartesian axes and accumulated angle change (the time integral of angular rate) in three Cartesian axes. These outputs were internally compensated for biases, scale factors and alignments based on coefficients determined by factory calibration tests. For deriving atmospheric structure, linear velocity changes can be numerically differentiated w.r.t. time in order to derive linear accelerations. Angle changes can be numerically differentiated w.r.t. time in order to derive angular velocities.

Full details of the instrument are described in a PDS catalog file, INST.CAT.

4.2 Data Product Overview

The raw telemetry packet data from the IMU consists of successive frames of eleven 16-bit words produced at 200 Hz. Six of the words are the accelerometer and gyroscope data while the remaining words are frame counts and engineering status. These raw data only have relative time information and must be related to the spacecraft clock through ancillary information to add an appropriate offset.

Experiment Data Records (EDR), NASA Level 1 products, are generated directly from the spacecraft telemetry packet data. Examples of their format are given in Appendix-B. The product type available consists of IMU data in physical units in the mechanical frame of the spacecraft (NASA Level 1A).

Transforming the IMU data into a center of mass frame of the spacecraft is considered a higher-level activity for several reasons. First, it is desirable to remove noise on the IMU mechanical frame data by filtering prior to further higher order transformations, which can be done using a large number of methods. The choice is best left to the data user. Secondly, the IMU data extend from space to the landing of the spacecraft, during which time the mass properties of the spacecraft change substantially and different approaches can be taken to the data during each descent phase. Discussion of derived products is outside the scope of this document.

4.3 Data Processing overview

4.3.1 Data Processing Level

Raw output of the Phoenix IMU is NASA "packet data" (CODMAC level 0). This binary packet data is time-ordered and converted to ASCII physical units to produce the NASA Level 1 (CODMAC Level 2) data products defined in Appendix-A. RDR products at higher NASA levels may have the same general format and structure, although they are not described by this document.

4.3.2 Data Product Generation

The spacecraft contractor, LMCO, was responsible for the supply of the raw telemetry packet data to the Phoenix Science Team. EDRs/RDRs were produced by the Phoenix Science Team cognizant scientist. Raw ASE data packets were extracted from the telemetry stream and stored in data records, by product type and record length.

4.3.3 Data Flow

After generation, each data record was saved locally by the Phoenix Science Team cognizant scientist and electronically delivered to the Science Operation Center (SOC) at the University of Arizona. Upon arrival at the SOC, these files/products will be published in the product catalog.

4.4 Standards Used in Generating Products

4.4.1 Labeling and Identification standards

The EDR format described in this document will follow the Phoenix product file naming conventions. All filenames will be PDS compliant.

4.4.2 PDS Standards

ASE EDR products will comply with the Planetary Data System's standards as specified in the PDS Standards Reference (see Applicable Documents). All label keywords will be PDS compliant and registered in the PDS dictionary.

4.4.3 Time Standards

The following time standards and conventions are used by the Phoenix project for planning activities and identification of events.

Data is time-stamped according to international standards adopted by the PDS (http://pds.nasa.gov/documents/sr/Chapter07.pdf).

SCET	Spacecraft event time. This is the time when an event occurred on-board the spacecraft, in UTC. It is

	usually derived from SCLK.
SCLK	Spacecraft Clock. This is an on-board 64-bit counter, in units of nano-seconds and increments once every 100 milliseconds. Time zero corresponds to midnight on 1-Jan-1980.
Local Solar Time	Local Solar Time (LST) is the time defined by the local solar days (sols) from the landing date using a 24 “hour” clock within the current local solar day (HR:MN:SC). Since the Mars day is 24h 37m 22s long, each unit of LST is slightly longer than the corresponding Earth unit. LST is computed using positions of the Sun and the landing site. LST examples are: SOL 12 12:00:01 SOL 132 01:22:32.498 For ASE, local solar time is relevant to the conditions of atmospheric entry, such as time of night/day.
True Local Solar Time	This is the time of day based on the position of the sun, rather than a measure of time based on a midnight-to-midnight 24 hour “day”.
SOL	Solar Day Number, also known as PLANET DAY NUMBER in PDS label. This is the number of complete solar days on Mars since landing. The SOL for EDL zero, by definition.

4.4.4 Coordinate Systems and Processing of the Raw IMU Data

The following coordinate systems are used within the Phoenix project to refer to the position of the IMUs within the Phoenix entry vehicle. A clear specification and understanding of coordinate systems is essential for understanding the derivation of ASE data products from the raw data and the scientific use of ASE data products.

Mars-Centered Inertial Coordinate System (MCI)

The Mars-Centered Inertial Coordinate System used by the Phoenix Lander is the Mars-Centered Mars Mean Equator and IAU-vector of Epoch J2000 (also known as the MME2000 frame). The axes are defined as follows:

$+X_{MCI}$ = IAU-vector

$+Z_{MCI}$ = Mean Mars Equator normal of Epoch J2000

$+Y_{MCI} = +Z_{MCI} \times +X_{MCI}$

The IAU-vector is defined as the line of intersection of the mean equatorial planes of Earth and Mars, directed toward the point where the Mars Mean Equator Plane of Epoch J2000 ascends through the Earth Mean Equator Plane of Epoch J2000. The Epoch J2000 corresponds to the Julian Ephemeris Date (JED) 2451545.0. Figure 1 depicts the MCI coordinate system:

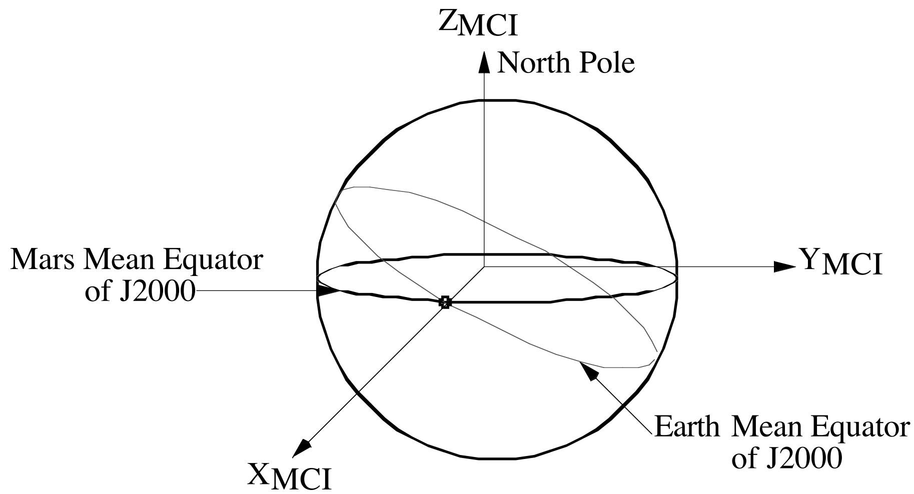

Figure 1 - MCI Coordinate System

Phoenix Mechanical (M) Frame and Cruise (C) Frame

The origin of the mechanical frame is centered on the launch vehicle separation plane and defined as follows:

$+X_M$ = Pointed Towards Foot of Deployed Lander 0˚ Leg (see Fig. 3)
$+Z_M$ = Normal to Launch Vehicle Interface Plane (in direction of flight)
$+Y_M = +Z_M \times +X_M$

Figures 2 and 3 illustrate the mechanical frame for the Lander in the cruise configuration and landed deployed configuration:

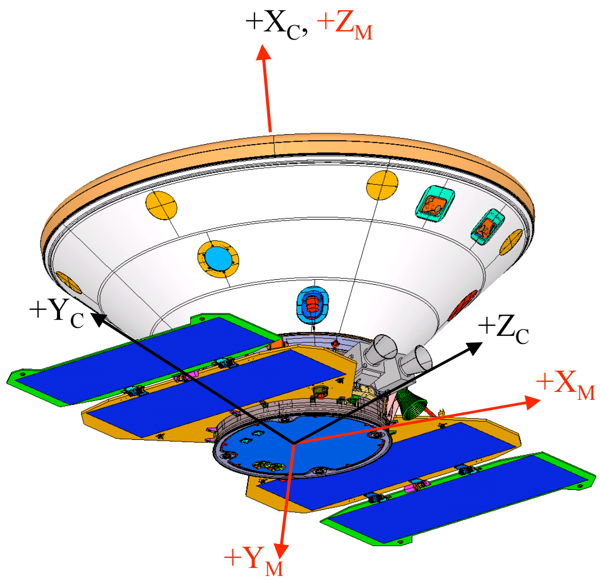

Figure 2 - Lander Mechanical Coordinate System in Cruise Configuration

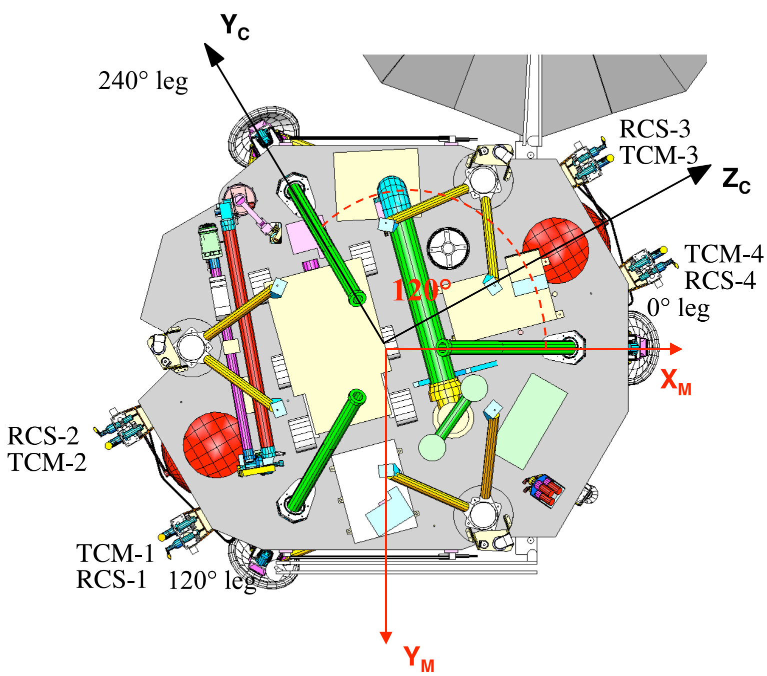

Figure 3. Lander Mechanical Coordinate System in Landed Configuration

The Lander Cruise Frame is designed to be aligned with respect to the centerline of the two spacecraft engines shown in Fig. 2. The axes of the cruise frame are defined as follows:

$+X_C = +Z_M$
$+Z_C$ = Centerline of the spacecraft engines in Fig. 2
$+Y_C = +Z_C \times +X_C$

Figures 2 and 3 depict the cruise frame with respect to the mechanical frame. The origin of both frames is centered on the launch vehicle separation plane.

The +X-axis of the cruise frame is aligned with the +Z-axis of the mechanical frame. The +Y-axis of the cruise frame is rotated -120˚ from the +X-axis of the mechanical frame, about the +X-axis of the cruise frame. The transformation from the mechanical frame to the cruise frame is as follows:

$$ {}^{C}_{M}T = \begin{bmatrix} 1 & 0 & 0 \\ 0 & \cos 120^\circ & -\sin 120^\circ \\ 0 & \sin 120^\circ & \cos 120^\circ \end{bmatrix} \begin{bmatrix} 0 & 0 & 1 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \end{bmatrix} = \begin{bmatrix} 0 & 0 & 1 \\ -0.5000000000 & -0.8660254038 & 0 \\ 0.8660254038 & -0.5000000000 & 0 \end{bmatrix} $$

Local Inertial Measurement Unit (IMU) Coordinate Frame

The local IMU coordinate frame is associated with physical design of the IMU and defined according to Fig. 4, as follows:

$+Y_{IMU}$ = Normal to Alignment Mirror, Anti-Normal to Connectors shown in Fig. 4
$+Z_{IMU}$ = Perpendicular to $+Y_{IMU}$, in the direction of the +Z mirror and in the plane of the alignment mirror normal vectors
$+X_{IMU} = +Y_{IMU} \times +Z_{IMU}$

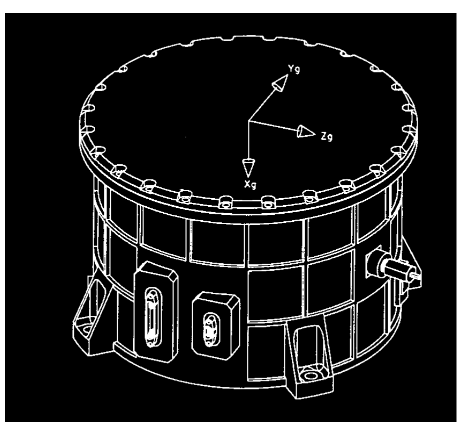

Figure 4 - IMU Local Coordinate Frame

There are two IMUs mounted on the underside of the Lander, denoted by Side A and Side B. The IMUs are mounted under the deck such that the axes of the IMU are clocked about the spacecraft mechanical axes. Figure 5 illustrates the mounting of the IMUs with respect to the spacecraft mechanical axes. The IMU orientations can be defined as a series of successive rotations as follows:

Side A:	1) No Rotation:	$+X_{IMU} = -Y_M$ $+Y_{IMU} = +X_M$ $+Z_{IMU} = +Z_M$
	2) First Rotation:	-25˚ about $+Y_M$
Side B:	1) No Rotation:	$+X_{IMU} = +Y_M$ $+Y_{IMU} = -X_M$ $+Z_{IMU} = +Z_M$
	2) First Rotation:	+25˚ about $+Y_M$

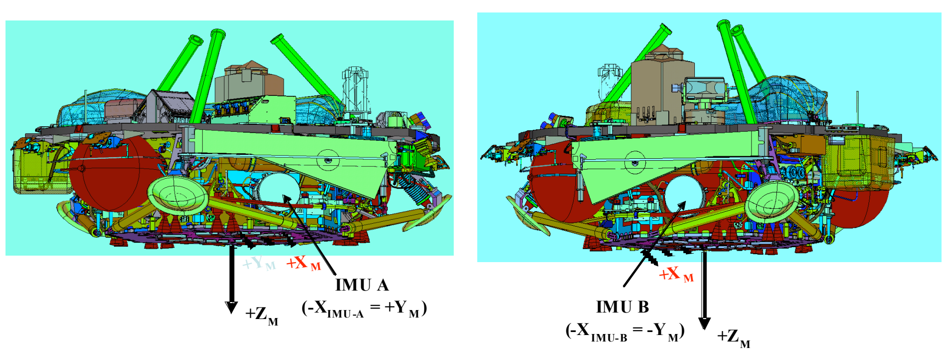

Figure 5 - IMU Orientations on Spacecraft

The transformations from the local IMU frame to the spacecraft mechanical frame for both IMUs are as follows:

$$Side A:{}_{IMU}^{M}T=\begin{bmatrix}\cos(-25^\circ) & 0 & \sin(-25^\circ)\\ 0 & 1 & 0\\ -\sin(-25^\circ) & 0 & \cos(-25^\circ)\end{bmatrix}\begin{bmatrix}0 & 1 & 0\\ -1 & 0 & 0\\ 0 & 0 & 1\end{bmatrix}=\begin{bmatrix}0 & 0.9063 & -0.4226\\ -1 & 0 & 0\\ 0 & 0.4226 & 0.9063\end{bmatrix}$$

$$Side B:{}_{IMU}^{M}T=\begin{bmatrix}\cos(25^\circ) & 0 & \sin(25^\circ)\\ 0 & 1 & 0\\ -\sin(25^\circ) & 0 & \cos(25^\circ)\end{bmatrix}\begin{bmatrix}0 & -1 & 0\\ 1 & 0 & 0\\ 0 & 0 & 1\end{bmatrix}=\begin{bmatrix}0 & -0.9063 & 0.4226\\ 1 & 0 & 0\\ 0 & 0.4226 & 0.9063\end{bmatrix}$$

IMU-A was used both cruise and descent for attitude determination. The transformations from the IMU frame to the cruise frame are as follows:

Cruise Frame:

$$Side\ A:\quad {}_{IMU}^{C}T={}_{M}^{C}T\,{}_{IMU}^{M}T=\begin{bmatrix}0 & 0 & 1\\ -0.5000 & -0.8660 & 0\\ 0.8660 & -0.5000 & 0\end{bmatrix}\begin{bmatrix}0 & 0.9063 & -0.4226\\ -1 & 0 & 0\\ 0 & 0.4226 & 0.9063\end{bmatrix}=\begin{bmatrix}0 & 0.4226 & 0.9063\\ 0.8660 & -0.4532 & 0.2113\\ 0.5000 & 0.7849 & -0.3660\end{bmatrix}$$

$$Side\ B:\quad {}_{IMU}^{C}T={}_{M}^{C}T\,{}_{IMU}^{M}T=\begin{bmatrix}0 & 0 & 1\\ -0.5000 & -0.8660 & 0\\ 0.8660 & -0.5000 & 0\end{bmatrix}\begin{bmatrix}0 & -0.9063 & 0.4226\\ 1 & 0 & 0\\ 0 & 0.4226 & 0.9063\end{bmatrix}=\begin{bmatrix}0 & 0.4226 & 0.9063\\ -0.8660 & 0.4532 & -0.2113\\ -0.5000 & -0.7849 & 0.3660\end{bmatrix}$$

IMU LOCATION MASS PROPERTIES OF THE ENTRY VEHICLE

The pre-launch best estimate of the X, Y, Z vector (in meters in the mechanical reference frame) from the center of mass of the spacecraft to the location of each IMU accelerometer was as follows:

IMU A: 0.0621, 0.5641, 0.2318
IMU B: 0.0112, -0.5641, 0.2291

The estimated uncertainty on these location specifications is 5.1 mm. Additional mass properties of the spacecraft will be documented in the archive volume documents during RDR release.

PROCESSING OF THE RAW DATA TO LEVELS FOR ARCHIVING

The IMU packet data (Table 1) consist of 200 Hz raw binary IMU data with engineering and science data embedded. In detail, the binary data file contains of multiple frames of eleven 16-bit signed integers (-32768 to +32768) sampled at 200 Hz so that each frame is separated by 1/200 = 0.005 seconds. This raw IMU data is w.r.t.the local IMU frame of reference (see above). Only IMU ‘A’ was turned on and produced data. IMU ‘B’ was not turned on and was only for back-up redundancy.

Table 1: ASE Packet Data, which is in the local IMU frame

	Flight Software field name	Format	Size (bits)	Description	Units
IMU raw binary output	frmcnt1	binary	16	frame count	DN
	frmcnt2	binary	16	frame count	DN
	status1	binary	16	status word	DN
	Xgyro	binary	16	X_{IMU} delta angle	DN
	Ygyro	binary	16	Y_{IMU} delta angle	DN
	Xgyro	binary	16	Z_{IMU} delta angle	DN
	Xvel	binary	16	X_{IMU} linear delta velocity	DN
	Yvel	binary	16	Y_{IMU} linear delta velocity	DN
	Zvel	binary	16	Z_{IMU} linear delta velocity	DN
	status2	binary	16	status word	DN
	muxwrd	binary	16	housekeeping word	DN

The packet data are converted to physical units given that for gyro data, the angle per count is 10^{-6} radians, while for velocity data, the velocity per count is 7.53e-5 m/s.

To produce the NASA Level 1A EDR data products, the physical unit data are then converted to the spacecraft mechanical frame using the matrix transformations given earlier. Time stamp is relative, starting from zero, but the absolute time corresponding to start of the time series is given as ancillary information.

4.4.5 Data Storage Conventions

We aim to retain the full detail provided in the raw telemetry packet and to provide appropriate ancillary information so that the process of how the data is converted from telemetry to the higher-level products is transparent to any interested scientist.

The raw telemetry data, known as “packet data”, is below Level 0 in NASA’s nomenclature –See Appendix A. These binary data are converted to EDR data products according to the method described in the previous section.

All ASE EDR data products will be stored as tabulated (.TAB) data files in ASCII format. PDS detached label (.LBL) files will accompany these tabulated data files with the same base name as the associated data file, and will define the information in each table column. Each keyword definition will be terminated by ASCII carriage-return and line-feed characters. These EDR products are defined as PDS TABLE objects (Applicable Document 1).

All ASE data products will contain fixed length records, although the size of the records in each file could differ between data products.

4.5 Data Validation and Peer Review

The ASE EDR product design, as described in this SIS, is subject to PDS peer review. The peer review will be completed well in advance of actual production, to allow time for changes in the design as needed. This SIS document will be updated to show any such changes.

Validation of ASE EDR products during production will be performed according to specifications in the Phoenix Archive Plan and the ICD between the PDS Atmospheres Node Phoenix and Science Team cognizant scientist (Applicable document 7). The Phoenix Science Team will validate the science content of the data products, and the Atmospheres Node will validate the products for compliance with PDS standards and for conformance with the design specified in this SIS.

5. Detailed Data Product Specifications

The ASE EDRs contain time-ordered IMU velocity and angular data as specified below.

5.1 Data Product Structure and Organization

The philosophy of the ASE data product is to retain the full detail provided in the raw telemetry packet and to provide appropriate ancillary information so that any scientist can use the data.

ASE EDRs are generated from raw telemetry. All instances of ASE EDRs will have appropriate PDS label information.

5.2 Detached Label Files

EDR products will be stored as tabulated (.TAB) data files in ASCII format. Detached label (.LBL) files will accompany tabulated data files with the same base name as the associated data file. Label files will define the sequence of data in the binary files and will define the data in each table column of the tabulated ASCII files. The PDS label in the .LBL file is an ASCII text field consisting of a series of keyword=value statements. The label carries the metadata necessary to read and understand the data product. An example of a PDS label is provided in Appendix C.

6. Applicable Software

ASE EDRs can be read with any programming language capable of interpreting ASCII sequential data. As a courtesy to the scientific community, tools will be made available by the Phoenix Science Team for importing these EDRs into an IDL programming environment.

7. References

P. A. Taylor, D. C. Catling, M. Daly, C. S. Dickinson, H. O. Gunnlaugsson, A-M. Harri, C. F. Lange, Temperature, pressure and wind instrumentation on the Phoenix meteorological package, *J. Geophys. Res.,* 113, EA0A10, doi:10.1029/2007JE003015, 2008.

APPENDIX A: **Definitions of Data Processing Levels**

This table shows definitions of processing levels as defined by NASA and by CODMAC, the Committee on Data Management and Computation (Applicable Documents 5 and 6)

Table A.1 Data Processing Levels

NASA	CODMAC	Description
Packet data	Raw - Level 1	Telemetry data stream as received at the ground station, with science and engineering data embedded.
Level-0	Edited - Level 2	Instrument science data (e.g., raw voltages, counts) at full resolution, time ordered, with duplicates and transmission errors removed.
Level 1A	Calibrated - Level 3	Level 0 data that have been located in space and may have been transformed (e.g., calibrated, rearranged) in a reversible manner and packaged with needed ancillary and auxiliary data (e.g., radiances with the calibration equations applied).
Level 1B	Resampled – Level 4	Irreversibly transformed (e.g., resampled, remapped, calibrated) values of the instrument measurements (e.g., radiances, magnetic field strength).
Level 1C	Derived - Level 5	Level 1A or 1B data that have been resampled and mapped onto uniform space-time grids. The data are calibrated and may have additional corrections applied (e.g., terrain correction).
Level 2	Derived - Level 5	Geophysical parameters, generally derived from Level 1 data, and located in space and time commensurate with instrument location, pointing, and sampling.
Level 3	Derived - Level 5	Geophysical parameters mapped onto uniform space-time grids.
	Ancillary – Level 6	Data needed to generate calibrated or resampled products.

APPENDIX B: ASE Record Structures

Data Structure Overview

ASE EDR products will be stored as tabulated (.TAB) data files in ASCII format. PDS detached label (.LBL) files will accompany these tabulated data files with the same base name as the associated data file, and will define the numerical information in each table column, as well as the record length.

Detached Label description

All ASE data products are described by detached label (.LBL) files. A PDS label is an ASCII text field consisting of a series of keyword=value statements. The label carries the metadata necessary to read and understand the data product. An example of a PDS label files is provided in Appendix C.

Tabular ASCII data description

Each ASCII EDR contains a series of ASCII records of the same type, where the type is specified in the PDS detached label file. In the complete EDR, the number of records in the product will be specified in the PDS label file. Records will be sorted in chronological order.

Record descriptions are presented in the following sections.

The ASE data levels are described in Table A.2.

Table A.2 Phoenix ASE EDR Low Data Level Descriptions

NASA	CODMAC	Description
Level 1A	Calibrated - Level 3	IMU data in ASCII that has been converted to physical units, transformed in space to the mechanical frame of the spacecraft, and packaged with needed ancillary and auxiliary data.

NASA Level 1A data

NASA Level 1A data (Table A.3) are derived from the packet data according to the description given in Sec. 4.4 and consist of 200 Hz IMU science data in ASCII format and physical units. The data are also transformed in space to the mechanical frame of the spacecraft through the transformation described in Sec. 4.4. Time in seconds is relative, starting from zero. A data product exists for IMU ‘A’ only.

Table A.3: ASE physical data transformed to the mechanical (M) frame of the spacecraft

Flight Software field name	Format	Data type	Description	Units
dt	ASCII	real	time vector	seconds
delta_angle(0)	ASCII	real	X_M delta angle	rad
delta_angle(1)	ASCII	real	Y_M delta angle	rad
delta_angle(2)	ASCII	real	Z_M delta angle	rad
delta_vel(0)	ASCII	real	X_M linear delta velocity	m/s
delta_vel(1)	ASCII	real	Y_M linear delta velocity	m/s
delta_vel(2)	ASCII	real	Z_M linear delta velocity	m/s

APPENDIX C: SAMPLE LABEL (.LBL) FILE

Below is an example .LBL file for Level 1B data corresponding to Table A.3

```
PDS_VERSION_ID            = PDS3

RECORD_TYPE               = FIXED_LENGTH
RECORD_BYTES              = 7972830
FILE_RECORDS              = 93798
^TABLE                    = "IMU_A_EDR_M.TAB"

DATA_SET_ID               = "PHX-IMU-A-EDL-V1.0"
MISSION_NAME              = "PHOENIX"
INSTRUMENT_HOST_NAME      = "PHOENIX"
INSTRUMENT_NAME           = "ATMOSPHERIC STRUCTURE EXPERIMENT"
PRODUCT_ID                = "PHX-IMU-A-EDR-V1.0"
TARGET_NAME               = "MARS"
SPACECRAFT_CLOCK_START_COUNT = "896225513.881"
SPACECRAFT_CLOCK_STOP_COUNT  = "896225982.871"
START_TIME                = 2008-05-25T23:30:47.918
STOP_TIME                 = 2008-05-25T23:38:36.899
PRODUCT_CREATION_TIME     = 2008-11-24

OBJECT                    = TABLE
 INTERCHANGE_FORMAT       = ASCII
 ROW_BYTES                = 85
 ROWS                     =   93798
 COLUMNS                  = 7


 OBJECT                   = COLUMN
  NAME                    = "RELATIVE TIME"
  DATA_TYPE               = ASCII_REAL
  START_BYTE              = 1
  BYTES                   = 7
  FORMAT                  = "F7.3"
  UNIT                    = SECOND
```

```
  DESCRIPTION = "Time of the spacecraft sample acquisition relative
  to the initial spacecraft clock start count ."
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
  NAME                  = "PHX_IMUA_RATES_X"
  DATA_TYPE             = ASCII_REAL
  START_BYTE            = 10
  BYTES                 = 11
  FORMAT                = "F11.8"
  UNIT                  = "RADIANS"
  DESCRIPTION = "Angle change (or delta-angle) about the spacecraft
                mechanical frame X-axis during one time interval of 5 milliseconds"
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
  NAME                  = "PHX_IMUA_RATES_Y"
  DATA_TYPE             = ASCII_REAL
  START_BYTE            = 23
  BYTES                 = 11
  FORMAT                = "F11.8"
  UNIT                  = "RADIANS"
 DESCRIPTION = "Angle change (or delta-angle) about the spacecraft
                mechanical frame Y-axis during one time
                interval of 5 milliseconds"
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
  NAME                  = "PHX_IMUA_RATES_Z"
  DATA_TYPE             = ASCII_REAL
  START_BYTE            = 36
  BYTES                 = 11
  FORMAT                = "F11.8"
  UNIT                  = "RADIANS"
  DESCRIPTION           = "Angle change (or delta-angle) about the spacecraft
                mechanical frame Z-axis during one time
                interval of 5 milliseconds"
```

```
END_OBJECT = COLUMN

OBJECT = COLUMN
  NAME = "PHX_IMUA_DELTA_VEL_X"
  DATA_TYPE = ASCII_REAL
  START_BYTE = 49
  BYTES = 11
  FORMAT = "F11.8"
  UNIT = "METERS/SECOND"
  DESCRIPTION = "Linear velocity change (or delta-velocity) along
                the spacecraft mechanical frame X-axis during one time
                interval of 5 milliseconds"
END_OBJECT = COLUMN

OBJECT = COLUMN
  NAME = "PHX_IMUA_DELTA_VEL_Y"
  DATA_TYPE = ASCII_REAL
  START_BYTE = 62
  BYTES = 11
  FORMAT = "F11.8"
  UNIT = "METERS/SECOND"
  DESCRIPTION = "Linear velocity change (or delta-velocity) along
                the spacecraft mechanical frame Y-axis during one time
                interval of 5 milliseconds"
END_OBJECT = COLUMN

OBJECT = COLUMN
  NAME = "PHX_IMUA_DELTA_VEL_Z"
  DATA_TYPE = ASCII_REAL
  START_BYTE = 75
  BYTES = 11
  FORMAT = "F11.8"
  UNIT = "N/A"
  DESCRIPTION = "Linear velocity change (or delta-velocity) along
                the spacecraft mechanical frame Z-axis during one time
                interval of 5 milliseconds"
END_OBJECT = COLUMN
```

```
END_OBJECT              = TABLE

END
```