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May 31, 2006

Mars Express ASPERA-3 to Planetary Science Archive Interface Control Document

For The

Swedish Institute of Space Physics
Institutet för Rymdfysik (IRF)
Kiruna, Sweden

SwRI® Project No. 15-03561

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ASPERA-3 STANDARD DATA PRODUCTS ARCHIVE VOLUMES MARS EXPRESS ASPERA to PLANETARY SCIENCE ARCHIVE INTERFACE CONTROL DOCUMENT (SOFTWARE INTERFACE SPECIFICATION) (ASPERA-3 Archive Volumes EAICD/SIS)

Version 1.2

Rev. May 31, 2006

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DOCUMENT CHANGE HISTORY

Table 2: Document Change History

Change	Date	Affected Portions
Initial Draft	November 7, 2003	All
Updated Draft	March 31, 2004	All
Updated Draft – based on feedback from PDS-PPI and PSA; also addressed some TBD's	April 2, 2004	Signature Page, Sections 1.8, 1.9, 2.1.4, 2.1.6, 2.3, 2.4, 2.5.4, 3.2.2, 3.4.2, & Section 4
Version 1.0 – based on discussions with PDS-PPI and PSA in developing a test archive data set	June 11, 2004	TBD Items – Table 3, Sections 2.4.6, 3.1.1, 3.1.3, 3.4.1, 3.4.2, & 4.3.2.2
Version 0.8 – Document not ready for signatures, so backed off version number to 0.8 (~80% complete); updates based on Data Review Item Discrepancies (RIDs) and ongoing discussions with PSA and PDS-PPI	September 15, 2004	TBD Items – Table 3, Sections 1.6, 1.7, 2.3.2, 2.3.3, 2.4.6, 3.2.2, 3.4.2.4, 3.4.2.8, & 3.4.2.10
Version 0.85 – (~85% complete); updates based on Data Review Item Discrepancies (RIDs) and ongoing discussions with PSA and PDS-PPI	October 11, 2004	TBD Items – Table 3, 2.3.4, 2.4.6, 3.1.3, 3.2.2, 3.4.2.2, 3.4.2.4, 3.4.2.8, & 3.4.2.10
Version 0.90 – (~90% complete); updates based on Data Review Item Discrepancies (RIDs) and ongoing discussions with PSA and PDS-PPI	October 22, 2004	2.3.1, 2.4.6, 3.4.2.2, 3.4.2.4, 4.3.1
Version 0.91 – (~91% complete); updates based on Data Review Item Discrepancies (RIDs) and ongoing discussions with PSA and PDS-PPI	November 5, 2004	TBD Items – Table 3, 1.6, 2.3.4, 2.4.7, 3.1.1, 3.1.3, 3.2.2, 3.4.1, 3.4.2.8, 3.4.2.10
Version 0.95 – (~95% complete); updates based on Data Review Item Discrepancies (RIDs) and ongoing discussions with PSA and PDS-PPI	December 6, 2004	TBD Items – Table 3, 1.6, 2.1, Tables 7, 8, & 9; 2.3.2, 2.3.4, 2.4.2, 2.4.5, 2.4.6, 2.4.9, 3.1.1, 3.1.2, 3.1.4, 3.2.3, 3.4.1, 3.4.2.5, 3.4.2.6, 3.4.2.8, 3.4.2.9, 3.4.2.10, 3.4.2.12, 4.1, 4.2, 4.3

Table 2: Document Change History

Change	**Date**	**Affected Portions**
Version 1.0 – "Signature Ready" Version; updates based on Review telecon, Independent Reviewers' comments, and ongoing discussions with PSA and PDS-PPI	January 17, 2005	TBD Items – Table 3; 2.4.3; 2.4.7; 2.4.9; 3.4.2.3; 3.4.2.4; 3.4.2.5; 3.4.2.6; 3.4.2.7; 4.3.2; 4.3.3; 4.3.4; Appendix A; Appendix B
Additional updates to Version 1.0 based on Data Review held at ESTEC January 26-27, 2005	February 2, 2005	TBD Items – Table 3; 1.9 Table 5 – added Leif Kalla, Data Manager; 2.4.7 – clarification concerning form of calibration reports; 2.4.9 – additional ancillary data; 3.4.2.5 – changed file naming scheme for calibration files; 3.4.2.12 – added ancillary data description; 4.2 Table 17 – updated delivery dates; 4.3.4.1 & Table 26 – added NPI MODE DATA description and information; Appendix B – Directory listing updated to reflect changed calibration files naming scheme
Version 1.1 – based on discussions with IRF concerning IMA data set changes and ongoing discussions with PSA	September 16, 2005	TBD Items – Table 3; 2.1 and Table 7 – IMA standard data products; 2.3.4 – Volume Identification; 2.4.5 – IMA data set description; 2.4.6 & 3.4.2.5 – deleted references to CalTab software; 2.4.9 – clarification of ancillary data usage; 3.4.2.12 – description of DATA directory; 4.1.2 – IMA DATA directory; 4.2 Table 17 – updated delivery dates and IMA standard data products; 4.3.3 – updated entire section of IMA Data Product Design

Table 2: Document Change History

Change	**Date**	**Affected Portions**
Version 1.2 – based on PSA ELS Data Set Review, PDS-PPI NPI/ELS Review, and ongoing discussions with IRF, PSA, and PDS-PPI	May 31, 2006	TBD Items – Table 3; 1.8.2 Glossary – added unit definitions; 2.1 ELS instrument description, NPI Data Products, and Tables 6-9; 2.4.5, 3.4.1, and 4.2 Table 17 – units updated; 4.3.1 Table 18 – clarification of data accuracy vs. instrument accuracy; 4.3.2 Table 19 – ELS units updated; 4.3.2.1 – ELS data formats updates, Table 20 – added MODE DATA rows; 4.3.2.2 Table 21 – updated ELS description in data label; 4.3.3.1 Table 23 – added MODE DATA rows; 4.3.4 Table 25 NPI units updated; 4.3.4.1 Table 26 – added MODE DATA rows.

TBD Items

Table 3: TBD Items

Item Description	Section	Pages
NPD Data Products and sizes	2.1 – Table 9	13
Delivery of PSA Level 2, CODMAC Level 3 data	3.1.1, 4.2	22, 36-37
NPD DATA Directory Structure	4.1.4	35
NPD Data Products and Delivery Schedule	4.2, 4.3.5	37, 60-66

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List of Tables:

1 Introduction

This document describes the contents and types of volumes belonging to all of the ASPERA-3 data sets.

1.1 Purpose and Scope

The purpose of this document is two-fold. First, it provides users of the ASPERA-3 instrument data with detailed descriptions of the data products and a description of how the products are generated, including data sources and destinations. Secondly, this EAICD document is the official interface between the ASPERA-3 instrument team and the archiving authorities, ESA Planetary Science Archive (PSA) and NASA Planetary Data System (PDS). This specification applies to all archive volumes containing ASPERA-3 data products for the mission duration.

1.2 Archiving Authorities

The Planetary Data System Standard is used as the 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

The PSA is the *official* Mars Express science data archive, and any data sets distributed to PDS must be identical copies of the PSA data sets.

1.2.1 ESA Planetary Science Archive (PSA)

ESA implements an online science archive, the PSA,

- To support and ease data ingestion.
- To offer additional services to the scientific user community and science operations teams such as search queries and several data delivery options.

The PSA aims for online ingestion of logical archive volumes and will offer the creation of physical archive volumes on request.

1.2.2 NASA Planetary Data System (PDS)

The PDS is the primary organization within NASA responsible for archiving planetary data. ASPERA-3 data products are to be archived at the Planetary Plasma Interactions (PPI) node located at the University of California, Los Angeles (UCLA).

1.3 Contents

This document describes the Mars Express ASPERA-3 data flow from the spacecraft to insertion into the PSA and the PDS. Information on how data are processed, formatted, labeled, and uniquely identified is included. General naming schemes for data volumes, data sets, data and label files are discussed. Standards used to generate the data products are explained. The design of the data set structure and data products is given.

1.4 Audience

This specification is useful to those who wish to understand the format and content of the ASPERA-3 PSA/PDS data product archive collection. Typically, these individuals would be planetary scientists, the staff of the PSA and PDS, software engineers, or data analysts.

1.5 Scientific Objectives

The general scientific objectives of the ASPERA-3 experiment are to study the solar wind and atmosphere interaction, and to characterize the plasma and neutral gas environment in the near-Mars space through energetic neutral atom (ENA) imaging and *in situ* plasma measurements. The investigations will address the fundamental question:

What is the long-term and short-term impact of the solar wind on Mars and its atmosphere?

The ASPERA-3 experiment is comprised of four sensors: two ENA sensors, an electron spectrometer, and an ion spectrometer. The following are the science goals of ASPERA-3:

1. Remote sensing of energetic neutral atoms (ENA):
    a. For remote mapping of the global solar wind interaction with the Martian atmosphere,
    b. To characterize quantitatively the effects of plasma interacting with the atmosphere,
    c. To determine the morphology of the global plasma and neutral gas outflow at Mars.
2. Provide *in situ* measurements of ions and electrons:
    a. To better understand the transfer of energy, mass and momentum of solar wind plasma to the Martian ionosphere and upper atmosphere,
    b. To provide adequate measurements of the plasma acceleration/outflow from the Martian ionosphere, part of the outflow charge-exchanging to ENAs,
    c. To provide undisturbed solar wind parameters required for interpretation of ENA images.

1.6 Applicable Documents

Planetary Science Data Dictionary Document, August 28, 2002, JPL D-7116, Rev. E

Planetary Data System Standards Reference, August 1, 2003, Version 3.6, JPL D-7669, Part 2

The Mars Express Archive Generation, Validation and Transfer Plan, June 21, 2001, Rev. 1.0, ESA-MEX-TN-4009

Planetary Science Archive Experiment Data Release Concept Technical Proposal, 22 October 2004, Issue 1.14, SOP-RSSD-TN-015

Planetary Science Archive Technical Note Geometry and Position Information, 08 October 2004, Issue 3, Revision 3, SOP-RSSD-TN-010

Program-Level Requirements for the ASPERA-3 Mission of Opportunity Project: approved November 1999

APAF Project Data Management Plan, July 10, 2003, Version 1.3, APAF-PDMP-15-03561

ASPERA-3 Main Unit Software User's Guide, June 21, 2003, Issue 3, ME-ASP-MA-0005

ICA-IMA-VIA TC/TM Data Formats and Related Software Aspects, Issue 1.7, 28 October 2004

ASPERA-3: Analyser of Space Plasmas and Energetic Ions for Mars Express, September 2004, ESA SP-1240

ASPERA-3 Flight Performance Report: submitted to ESA December 19, 2002

1.7 Relationships to Other Interfaces

Other interfaces that have an impact on ASPERA-3 data set generation, packaging, distribution, and documentation include:

1. ASPERA-3 IDFS Data: These data are produced from telemetry and are used to produce the PDS-compliant data and label files. If these data are reprocessed for any reason, there could be a direct impact on the generation of the PSA/PDS data sets.
2. IDFStoPDS Software: This software is used to produce the PDS-compliant data and label files from IDFS data. Any change in this software could impact the generation of the PSA/PDS data sets.
3. SPICE Data: These data are retrieved from the ESTEC or NAIF servers (mirrored sites) and are used to produce the GEOMETRY index table and label files for each data set release. Any change in these data could result in updates to the GEOMETRY files.
4. PSA geolib and NAIF SPICE Software Libraries: These software libraries are linked with SwRI software (GeoTab) to produce the GEOMETRY index table and label files for each data set release. Any change in these libraries could result in updates to the GeoTab software. Any GeoTab updates could result in reproduction of the GEOMETRY files.
5. PVV Software: This software is provided by PSA and used by the instrument teams to verify data set releases before delivery to PSA/PDS. Changes to this validation software could impact data set deliveries.
6. Data Release Concept: This PSA concept is used for ASPERA-3 data releases and revisions, and any changes to the concept could directly impact data set generation, packaging, distribution, and documentation.
7. PSA/PDS Archive Delivery Requirements: Any delivery requirement changes could result in changes to data set packaging, distribution, and documentation.

1.8 Acronyms, Abbreviations, and Glossary

1.8.1 Acronyms and Abbreviations

Table 4: Acronyms and Abbreviations

Acronym	Definition
APAF	ASPERA-3 Processing and Archiving Facility
ASCII	American Standard Code for Information Interchange
ASPERA-3	Analyzer of Space Plasma and Energetic Atoms (3rd Version)
CD-R	Compact Disc – Recordable Media
CD-ROM	Compact Disc – Read-Only Memory
CDT	Central Daylight Time
Co-I	Co-Investigator
Co-PI	Co-Principal Investigator
CODMAC	Committee on Data Management and Computation (of NRC)
CST	Central Standard Time
CSV	Comma Separated Values (PDS Spreadsheet Object ASCII format)
DDID	Data Delivery Interface Document
DDS	Data Disposition System
DOY	Day Of Year (Julian date, 3 digits)
DPU	Data Processing Unit (of the ASPERA-3 instrument package)
DSID	Data System Interface Document
DVD	Digital Versatile Disc
EAICD	Experimenter to Archive Interface Control Document
ECLIPJ	Ecliptic coordinates based upon the J2000 frame
EDR	Experiment Data Record
ELS	Electron Spectrometer (of the ASPERA-3 instrument package)
ENA	Energetic Neutral Atom
ESA	European Space Agency
ESOC	European Science Operations Center (Darmstadt, Germany)
ESTEC	European Space Research and Technology Center (Noordwijk, Holland)
GB	Gigabyte(s)
GIF	Graphics Interchange Format

Table 4: Acronyms and Abbreviations

Acronym	Definition
HTML	Hyper-Text Markup Language
IC	Interplanetary Cruise
ICD	Interface Control Document
IDFS™	Instrument Data File Set or Instrument Description File Set
IMA	Ion Mass Analyzer (of the ASPERA-3 instrument package)
IRF	Swedish Institute of Space Physics (Kiruna, Sweden)
ISO	International Standards Organization
J2000	Earth mean equator, dynamical equinox of J2000
JPL	Jet Propulsion Laboratory
MB	Megabyte(s)
MEX	Mars Express
MU	Main Unit – refers to ASPERA-3 Main Unit DPU (IMA has separate DPU)
NAIF	Navigation Ancillary Information Facility
NASA	National Aeronautics and Space Administration
NEV	Near Earth Verification
NPD	Neutral Particle Detector (of the ASPERA-3 instrument package)
NPI	Neutral Particle Imager (of the ASPERA-3 instrument package)
NRC	National Research Council
NSSDC	National Space Science Data Center
OA	Orbit/Attitude (of the Mars Express Spacecraft)
OBT	On-Board Time
PDF	Portable Document Format
PDMP	Project Data Management Plan
PDS	NASA Planetary Data System
PI	Principal Investigator
PM	Project Manager
PPI	Planetary Data System, Planetary Plasma Interactions Node
PSA	ESA Planetary Science Archive
PVV	PSA Validation and Verification tool

Table 4: Acronyms and Abbreviations

Acronym	**Definition**
RDR	Reduced Data Record
RSSD	Research and Scientific Support Department of ESA
SDDAS™	Southwest Data Display and Analysis System
SIS	Software Interface Specification
SPICE	Spacecraft, Planet, Instrument, C-matrix, Events files and software
SPM	Software Project Manager
SU	Scanning Unit (of the ASPERA-3 instrument package)
SwRI®	Southwest Research Institute®
TBC	To Be Confirmed
TBD	To Be Determined (or Defined)
TM	Telemetry
UCLA	University of California, Los Angeles
UTC	Universal Time Coordinated

1.8.2 Glossary

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

Archive Volume - An Archive Volume is a single physical media (CDROM, DVD, 9-track tape, etc.) used to permanently store files within the PDS archive. Archive Volumes may only be created on media approved by the PDS as meeting archive quality standards.

Archive Volume Set – A collection of one or more Archive Volumes used to store a single Data Set or collection of related Data Sets.

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

Counts / Accumulation – Refers to raw telemetry data in counts for particle data. The accumulation period is instrument dependent, so the raw data is referenced in this way to indicate raw counts as measured by the instrument.

Counts / Second – Count rate for particle data; science units for NPI and NPD PSA Level 2 data.

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

Data Set – The accumulation of data products, secondary data, software, and documentation that completely document and support the use of those data products. A data set can be part of a data set collection. (PDS Standards Reference, August 1, 2003)

Differential Number Flux – Science units for ELS and IMA PSA Level 2 data:

$$\frac{cnts}{cm^2 - sr - \sec - eV}$$

E-Volume – Electronic version of an archive volume, organized identically to the physical volume with the same requirements to meet PDS archive quality standards.

Standard Data Product – A Data Product generated in a predefined way using well-understood procedures, processed in "pipeline" fashion. Data Products that are generated in a non-standard way are sometimes called *special Data Products.*

1.9 Contact Names and Addresses

Table 5: ASPERA-3 Archive Collection Support Staff

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

The Analyzer of Space Plasma and Energetic Atoms, 3rd version (ASPERA-3), aboard the Mars Express spacecraft is an instrument comprised of four different sensors (or detectors): the Electron Spectrometer (ELS), the Ion Mass Analyzer (IMA), the Neutral Particle Detector (NPD), and the Neutral Particle Imager (NPI). The general scientific objective of the ASPERA-3 experiment is to study the solar wind–atmosphere interaction and characterize the plasma and neutral gas environment in the near-Mars space through energetic neutral atom (ENA) imaging and local charged particle measurements. The studies are to address the fundamental question: How strongly do the interplanetary plasma and electromagnetic fields affect the Martian atmosphere? This question is directly related to the problem of Martian dehydration.

The Neutral Particle Imager (NPI) provides measurements of the integral ENA flux (0.1 – 60 keV) with no mass and energy resolution but high angular resolution. The Neutral Particle Detector (NPD) provides measurements of the ENA flux, resolving velocity (0.1 – 10 keV) and mass (H and O) with a coarse angular resolution. The electron spectrometer (ELS) is a standard top-hat electrostatic analyzer in a very compact design. These three sensors are located on a scanning platform providing 4π coverage (maximum possible). The instrument also contains an ion mass composition sensor, IMA (Ion Mass Analyzer). Mechanically, IMA is a separate unit connected by a cable to the ASPERA-3 main unit. IMA provides ion measurements in the energy range 0.01 – 40 keV/q for the main ion components H^+, H_2^+, He^+, O^+, with 20-80 amu/q.

2.1 Scientific Measurements

The general scientific objectives of ASPERA-3 are to study the solar wind and atmosphere interaction, and to characterize the plasma and neutral gas environment in the near-Mars space through energetic neutral atom (ENA) imaging and in-situ plasma measurements. The specific science measurements to carry out these goals are:

1. Integral ENA fluxes in the energy range of 0.1 to 60 keV.
2. Mass/energy resolved neutral hydrogen and oxygen atom spectra in the energy range of 0.1 to 100 keV.
3. Ion energy/mass/angle resolved spectra in the energy range of 0.01 to 40 keV; 1-106 atomic mass units per unit charge (amu/q); with 4π steradian coverage.
4. Electron spectra in energy range of 0.05 eV to 20 keV, with up to 4π steradian coverage. However, due to spacecraft blockage, 4π steradian coverage is never really achieved.

The ASPERA-3 archived data sets contain data measurements necessary to satisfy the scientific goals and objectives. Each ASPERA-3 data set is given a unique alphanumeric identifier (Data Set ID) constructed according to PDS naming conventions (described in **section 3.1.2**). Within each data set, there are standard data products (collection of similar files). The Standard Data Product ID is used to link similar data products, and each data product (file) has a unique Data

Product ID (file name without extension). The Standard Data Product ID formation and the File Naming Convention for data products are given in **section 3.1.4**.

The following tables show the archived data sets and products of the scientific return.

The Standard Data Product IDs for ELS PSA Level 1b (EDR) products are:

1. ELSSCIL_C_ACC – ELectron Spectrometer SCIence Low energy range data in Counts / ACCumulation units. This is ELS raw counts for energy range 0.05 eV to 150 eV.
2. ELSSCIH_C_ACC – ELectron Spectrometer SCIence High energy range data in Counts / ACCumulation units. This is ELS raw counts for energy range 5 eV to 20 keV.

The Standard Data Product IDs for ELS PSA Level 2 (RDR) products are:

1. ELSSCIL_DNF – ELectron Spectrometer SCIence Low energy range (0.05 – 150 eV) data in Differential Number Flux units.
2. ELSSCIH_DNF – ELectron Spectrometer SCIence High energy range (5 eV – 20 keV) data in Differential Number Flux units.

Table 6: ASPERA-3 Electron Spectrometer (ELS) Data Sets

Scientific Objectives and Measurements	Data Set ID	Standard Data Product ID	Max. Mb/Day
Define local characteristics of the main plasma regions Electron spectra in energy range of 0.05 eV to 20 keV with a 360° field of view, ±2° deviation out of viewing plane (elevation). There are 16 sectors, each 22.5° wide.	MEX-M-ASPERA3-2-EDR-ELS-V1.0 PSA Level 1b CODMAC Level 2	ELSSCIL_C_ACC	130
		ELSSCIH_C_ACC	130
	MEX-M-ASPERA3-3-RDR-ELS-V1.0 PSA Level 2 CODMAC Level 3	ELSSCIL_DNF	130
		ELSSCIH_DNF	130

The Standard Data Product IDs for IMA PSA Level 1b (EDR) products are:

1. IMA_AZ0_C_ACC – IMA AZimuth anode 0 data in Counts / ACCumulation units.
2. IMA_AZ1_C_ACC – IMA AZimuth anode 1 data in Counts / ACCumulation units.
3. IMA_AZ2_C_ACC – IMA AZimuth anode 2 data in Counts / ACCumulation units.
4. IMA_AZ3_C_ACC – IMA AZimuth anode 3 data in Counts / ACCumulation units.
5. IMA_AZ4_C_ACC – IMA AZimuth anode 4 data in Counts / ACCumulation units.
6. IMA_AZ5_C_ACC – IMA AZimuth anode 5 data in Counts / ACCumulation units.
7. IMA_AZ6_C_ACC – IMA AZimuth anode 6 data in Counts / ACCumulation units.
8. IMA_AZ7_C_ACC – IMA AZimuth anode 7 data in Counts / ACCumulation units.
9. IMA_AZ8_C_ACC – IMA AZimuth anode 8 data in Counts / ACCumulation units.
10. IMA_AZ9_C_ACC – IMA AZimuth anode 9 data in Counts / ACCumulation units.
11. IMA_AZ10_C_ACC – IMA AZimuth anode 10 data in Counts / ACCumulation units.
12. IMA_AZ11_C_ACC – IMA AZimuth anode 11 data in Counts / ACCumulation units.
13. IMA_AZ12_C_ACC – IMA AZimuth anode 12 data in Counts / ACCumulation units.
14. IMA_AZ13_C_ACC – IMA AZimuth anode 13 data in Counts / ACCumulation units.
15. IMA_AZ14_C_ACC – IMA AZimuth anode 14 data in Counts / ACCumulation units.
16. IMA_AZ15_C_ACC – IMA AZimuth anode 15 data in Counts / ACCumulation units.

The Standard Data Product IDs for IMA PSA Level 2 (RDR) products are:

1. IMA_AZ0_DNF – IMA AZimuth anode 0 data in Differential Number Flux units.
2. IMA_AZ1_DNF – IMA AZimuth anode 1 data in Differential Number Flux units.
3. IMA_AZ2_DNF – IMA AZimuth anode 2 data in Differential Number Flux units.
4. IMA_AZ3_DNF – IMA AZimuth anode 3 data in Differential Number Flux units.
5. IMA_AZ4_DNF – IMA AZimuth anode 4 data in Differential Number Flux units.
6. IMA_AZ5_DNF – IMA AZimuth anode 5 data in Differential Number Flux units.
7. IMA_AZ6_DNF – IMA AZimuth anode 6 data in Differential Number Flux units.
8. IMA_AZ7_DNF – IMA AZimuth anode 7 data in Differential Number Flux units.
9. IMA_AZ8_DNF – IMA AZimuth anode 8 data in Differential Number Flux units.
10. IMA_AZ9_DNF – IMA AZimuth anode 9 data in Differential Number Flux units.
11. IMA_AZ10_DNF – IMA AZimuth anode 10 data in Differential Number Flux units.
12. IMA_AZ11_DNF – IMA AZimuth anode 11 data in Differential Number Flux units.
13. IMA_AZ12_DNF – IMA AZimuth anode 12 data in Differential Number Flux units.
14. IMA_AZ13_DNF – IMA AZimuth anode 13 data in Differential Number Flux units.
15. IMA_AZ14_DNF – IMA AZimuth anode 14 data in Differential Number Flux units.
16. IMA_AZ15_DNF – IMA AZimuth anode 15 data in Differential Number Flux units.

Table 7: ASPERA-3 Ion Mass Analyzer (IMA) Data Sets

Scientific Objectives and Measurements	Data Set ID	Standard Data Product ID	Max. Mb/Day
Define local characteristics of the main plasma regions Ion energy/mass/angle resolved spectra in energy range 0.01 to 40 keV, 1-106 atomic mass units per charge with 4π steradian coverage	MEX-M-ASPERA3-2-EDR-IMA-V1.0 PSA Level 1b CODMAC Level 2	IMA_AZ0_C_ACC	116
		IMA_AZ1_C_ACC	116
		IMA_AZ2_C_ACC	116
		IMA_AZ3_C_ACC	116
		IMA_AZ4_C_ACC	116
		IMA_AZ5_C_ACC	116
		IMA_AZ6_C_ACC	116
		IMA_AZ7_C_ACC	116
		IMA_AZ8_C_ACC	116
		IMA_AZ9_C_ACC	116
		IMA_AZ10_C_ACC	116
		IMA_AZ11_C_ACC	116
		IMA_AZ12_C_ACC	116
		IMA_AZ13_C_ACC	116
		IMA_AZ14_C_ACC	116
		IMA_AZ15_C_ACC	116
	MEX-M-ASPERA3-3-RDR-IMA-V1.0 PSA Level 2 CODMAC Level 3	IMA_AZ0_DNF	116
		IMA_AZ1_DNF	116
		IMA_AZ2_DNF	116
		IMA_AZ3_DNF	116
		IMA_AZ4_DNF	116
		IMA_AZ5_DNF	116
		IMA_AZ6_DNF	116
		IMA_AZ7_DNF	116
		IMA_AZ8_DNF	116
		IMA_AZ9_DNF	116
		IMA_AZ10_DNF	116
		IMA_AZ11_DNF	116
		IMA_AZ12_DNF	116
		IMA_AZ13_DNF	116
		IMA_AZ14_DNF	116
		IMA_AZ15_DNF	116

The Standard Data Product ID for NPI PSA Level 1b (EDR) product is:

1. NPINORM_C_ACC – Neutral Particle Imager NORMal mode data in Counts / ACCumulation units (raw telemetry counts).

The Standard Data Product ID for NPI PSA Level 2 (RDR) product is:

1. NPINORM_C_SEC – Neutral Particle Imager NORMal mode data in Counts / SECond units (count rate).

Table 8: ASPERA-3 Neutral Particle Imager (NPI) Data Sets

Scientific Objectives and Measurements	Data Set ID	Standard Data Product ID	Max. Mb/Day
Determine the instantaneous global distributions of plasma and neutral gas near Mars; energy deposition from the solar wind to the ionosphere; search for the solar wind-Phobos interactions Integral ENA fluxes in the energy range 0.1 to 60 keV	MEX-M-ASPERA3-2-EDR-NPI-V1.0 PSA Level 1b CODMAC Level 2	NPINORM_C_ACC	78
	MEX-M-ASPERA3-3-RDR-NPI-V1.0 PSA Level 2 CODMAC Level 3	NPINORM_C_SEC	78

NOTE on NPI PSA Level 2 Data:

The signals produced by NPI contain both an ENA component and a UV component as expected for all types of ENA instruments. The signals from each component are intermixed and there is no prescribed way to separate each component. Extraction is complicated because both components are model dependent. In some cases, even the type of model to use is still not identified and, definitely, there is no and will be no standard approach to separate the two signals. Another aspect is that NPI is very useful as a UV detector. Thus, the UV component has become as important as the ENA component.

Therefore, in order to have useful scientific products into the public archive for NPI, the data are provided in terms of count rates instead of fluxes. The count rate signal contains the corrected data from NPI to that stage. The count rate unit allows future investigations to mine the NPI data for both ENA and UV signals using the most appropriate models for their particular studies. Thus, NPI count rates are the correct data unit to be stored in the public archive for science validity and usefulness.

The Standard Data Products and IDs for NPD continue to be under discussion and TBD. The table below reflects what is known at the time of this writing.

Table 9: ASPERA-3 Neutral Particle Detector (NPD) Data Sets

Scientific Objectives and Measurements	Data Set ID	Standard Data Product ID	Max. Mb/Day
Study plasma induced atmospheric escape; modification of atmosphere by ion bombardment Mass/energy resolved neutral hydrogen and oxygen atom spectra in the energy range of 0.1 to 100 keV	MEX-M-ASPERA3-2-EDR-NPD-V1.0 PSA Level 1b CODMAC Level 2	NPD1RAW_C_ACC	TBD
		NPD2RAW_C_ACC	TBD
		NPD1TOF_C_ACC	TBD
		NPD2TOF_C_ACC	TBD
		NPD1BM1_C_ACC	TBD
		NPD2BM1_C_ACC	TBD
	MEX-M-ASPERA3-3-RDR-NPD-V1.0 PSA Level 2 CODMAC Level 3	NPD1RAW_C_SEC	TBD
		NPD2RAW_C_SEC	TBD
		NPD1TOF_C_SEC	TBD
		NPD2TOF_C_SEC	TBD
		NPD1BM1_C_SEC	TBD
		NPD2BM1_C_SEC	TBD
		NPD1 TBD	TBD
		NPD2 TBD	TBD

* NOTE: There are ongoing discussions among the ASPERA-3 team member to define and finalize the NPD products to deliver.

2.2 Data Handling Process

Southwest Research Institute is responsible for the production and delivery of PDS-compliant ASPERA-3 data archives to PSA and PDS. For ASPERA-3 data products, the relevant PDS personnel are within the Planetary Plasma Interactions (PPI) Node. The personnel at PDS-PPI are responsible for participating in the archive planning efforts and for producing ancillary data (e.g. geometry information, indexes, etc.) for the final data labels and archive volumes. Since IRF is the ASPERA-3 leading PI institution, it is their responsibility to ensure that proper information is disseminated for the development and operation of the data system, and the ASPERA-3 PI has the final say on what data are included in the archive.

ASPERA-3 data are archived at SwRI in the Instrument Data File Set (IDFS) format. The IDFS format is described at http://www.idfs.org. The IDFS is a collection of files written in a prescribed format that contain data, timing information, and meta-data. The impetus behind the IDFS is the need to maintain certain meta-data parameters with the data in order to correctly interpret the data. The two key tasks supported by the IDFS are the conversion of telemetry values to physical units and the registration of each data sample to a given point in time. One goal (and a very important one) of IDFS is to preserve the raw high-resolution data in an organized way that requires no reprocessing. This approach automatically does the archiving of the total telemetry base in an organized, reversible fashion.

The data in IDFS format are archived at SwRI and accessed by the ASPERA-3 team for science data analysis. A software tool that can be executed both interactively and in batch mode has been developed to process IDFS data to the PDS spreadsheet object form. The interactive mode of the IDFStoPDS software tool allows the user to select the data set, input PDS keyword values, and save the information in a template for later use. The batch mode of IDFStoPDS uses the template and optional input time range to process IDFS data to the PDS form in bulk. Each execution of IDFStoPDS generates the PDS-compliant spreadsheet/field object Comma Separated Values (CSV) data file and the associated PDS label file (LBL) for the time range specified (either input or as saved in the template). IDFStoPDS was designed to be flexible so that it can be used to process all levels (from raw to derived) of IDFS data to CSV format for archival.

2.3 Product Generation

2.3.1 Data Production and Transfer Methods

The SwRI ASPERA-3 software team produces the ASPERA-3 standard product archive collection in cooperation with the PDS Planetary Plasma Interactions (PPI) Node at the University of California, Los Angeles (UCLA). The NASA Discovery Office funds the SwRI ASPERA-3 activities and the NASA Planetary Data System funds the PPI activities.

Using the IDFStoPDS software tool, the SwRI team produces the individual data files and the associated detached PDS labels for each of the standard data products defined in **section 2.1** above. Data files are all comma-separated values (CSV), ASCII files containing all data of the appropriate type for the time interval contained in the data product. The IDFStoPDS tool assigns interim values to the following keywords in the detached labels:

1. SPACECRAFT_CLOCK_START_COUNT = "$BSCLK"
2. SPACECRAFT_CLOCK_STOP_COUNT = "$ESCLK"
3. MISSION_PHASE_NAME = "$PHASE"
4. ORBIT_NUMBER = $ORB_NO

These keyword values are preceded by a '$' in order that post-processing software can easily and efficiently parse them to replace with appropriate values. The SwRI customized GeoTab software parses the data labels and properly replaces these keyword values. This completes the generation of fully PDS-compliant detached labels.

2.3.2 Volume Creation

SwRI collects the PDS CSV data files and labels onto logical archive e-volumes (electronic volumes). A single ASPERA-3 data set (e.g., ELS EDR, NPI EDR, etc.) for a specified time interval is organized as a single archive e-volume. Once all of the data files, labels, and ancillary data files are organized onto an archive e-volume, all of the PDS required files (AAREADME, INDEX, ERRATA, etc.) are generated. The PSA release object/mechanism will be used for archive e-volume generation and submission. This means that each logical e-volume is a data release since they are for specific time periods. In other words, a logical archive e-volume is identical to a data set release. The collection of data set releases comprises the entire data set (all data for the whole mission). Once the data and files are generated and organized for a data release, the archive e-volume (or data set release) is ready for validation. The SwRI staff runs the PSA-provided validation software tool (PVV, described in the next section) to ensure all files are present and conform to PDS standards. Any errors are corrected and the archive e-volumes are submitted to PSA for ingestion to the *official* public archive. SwRI will simultaneously submit the same archive e-volumes to IRF and PDS-PPI. PDS-PPI agrees to only release ASPERA-3 data to the public *after* the PSA *official* archive has released the data. It is expected at this time to produce several archive e-volumes every six months for the ASPERA-3 sensor (ELS, IMA, NPI, and NPD) data that have been reviewed and are ready for ingestion. Thus, several data set releases (archive e-volumes) will be produced and delivered at one time.

PSA and PDS do not require data to be written on physical media, so only e-volumes are organized and delivered by SwRI to the PSA and PDS. However, at the end of the mission, the PDS PPI Node will produce physical archive volumes on DVD media and deliver these to the NSSDC for deep archive.

2.3.3 Volume Validation

The ASPERA-3 team, PSA team, and PPI node validate volumes in two ways. Before any volumes are produced, a peer review panel validates the structure and content of the archive volumes. PSA has provided a volume validation tool (PVV) that is to be used by the SwRI team to check each volume before sending to PSA for public release. Once volume production begins, the peer review panel may spot check volumes as deemed necessary by the PSA team.

The official ESA peer review panel consists of members of the instrument team, the PSA team, the Mars Express representative from the PDS Geosciences Node, and scientists selected by the PSA team. In addition, the PDS PPI Node staff reviews the ASPERA-3 data sets. The PSA and PDS personnel are responsible for validating that the volume(s) are fully compliant with PDS standards. The instrument team and chosen science reviewers are responsible for verifying the content of the data set, the completeness of the documentation, and the usability of the data in its archive format. The peer review process is a two-part process. First, the panel reviews this document and verifies that a volume produced to this specification will be useful. Next, the panel reviews a specimen volume to verify that the volume meets this specification and is indeed acceptable.

2.3.4 Volume Identification

Each ASPERA-3 archive e-volume bears a unique volume identifier (VOLUME_ID keyword in the VOLDESC.CAT file) of the form: MEXASP_XY00, where MEX identifies the spacecraft (Mars Express), ASP identifies the experiment (ASPERA), X identifies the data set instrument, and Y identifies the data type of the data set. The data set instrument identifier, X, in the Volume ID is defined as: 1 = ELS, 2 = IMA, 3 = NPI, and 4 = NPD. The data type identifier, Y, in the Volume ID is defined as: 1 = PSA Level 1b (raw), and 2 = PSA Level 2 (flux or other science unit). There are eight (8) possibilities:

1. MEXASP_1100 = Volume ID for ELS PSA Level 1b data set
2. MEXASP_1200 = Volume ID for ELS PSA Level 2 data set
3. MEXASP_2100 = Volume ID for IMA PSA Level 1b data set
4. MEXASP_2200 = Volume ID for IMA PSA Level 2 data set
5. MEXASP_3100 = Volume ID for NPI PSA Level 1b data set
6. MEXASP_3200 = Volume ID for NPI PSA Level 2 data set
7. MEXASP_4100 = Volume ID for NPD PSA Level 1b data set
8. MEXASP_4200 = Volume ID for NPD PSA Level 2 data set

For example, all ELS raw data set releases will have a Volume ID of “MEXASP_1100”, all IMA raw data set releases will have a Volume ID of “MEXASP_2100”, all ELS flux data set releases will have a Volume ID of “MEXASP_1200”, and so on. The VOLUME_ID value can be used as the label for any physical medium on which the data are stored.

2.4 Overview of Data Products

2.4.1 Pre-Flight Data Products

No pre-flight data products are planned for archival at this time.

2.4.2 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 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 where available, will be provided in any archived calibration data and ancillary data.

2.4.3 Instrument Calibrations

The raw ground calibration data are not archived, but the calibration data derived from these tests are included as a set of tables. The structure and content of the calibration tables are described in **section 3.4.2.5**. The calibration reports and any other calibration documentation are in the DOCUMENT directory.

2.4.4 Other Files Written During Calibration

No other calibration information is available for archive.

2.4.5 In-Flight Data Products

There are two main divisions of the ASPERA-3 in-flight data products:

1. Near Earth Verification (NEV) and Interplanetary Cruise (IC) data
    a. TARGET_NAME = “SOLAR WIND”
    b. TARGET_TYPE = “PLASMA CLOUD”
2. Mars orbit data
    a. TARGET_NAME = “MARS”
    b. TARGET_TYPE = “PLANET”

There are four PSA Level 1b (CODMAC Level 2, PDS EDR) data sets, and four PSA Level 2 (CODMAC Level 3, PDS RDR) data sets for the entire mission (both in-flight divisions). However, the data products included may differ depending on the instrument (ELS, IMA, NPI, and NPD) modes and operations during NEV/IC and Mars orbit. See tables 6, 7, 8, and 9 in section 2.1 for scientific measurements of the data sets.

The PSA Level 1b, CODMAC Level 2, Experiment Data Record (EDR) data sets are:

1. MEX-M-ASPERA3-2-EDR-ELS – Electron Spectrometer data (counts/accumulation) with up to 128 energy steps (center eV) ranging from 0.01 to 20 keV.
2. MEX-M-ASPERA3-2-EDR-IMA – Ion Mass Analyzer data (counts/accumulation) in the energy range 0.01 to 40 keV for all mass channels and azimuth anodes.
3. MEX-M-ASPERA3-2-EDR-NPI – Neutral Particle Imager data (counts/accumulation) of integral ENA fluxes in the energy range 0.1 to 60 keV.

4. MEX-M-ASPERA3-2-EDR-NPD – Neutral Particle Detector data (counts/accumulation) of atom spectra in the energy range 0.1 to 100 keV.

The PSA Level 2, CODMAC Level 3, Reduced Data Record (RDR) data sets are:

1. MEX-M-ASPERA3-3-RDR-ELS – Electron Spectrometer data (differential number flux) with up to 128 energy steps (center eV) ranging from 0.01 to 20 keV.
2. MEX-M-ASPERA3-3-RDR-IMA – Ion Mass Analyzer data (differential number flux) in the energy range 0.01 to 40 keV for all mass channels and azimuth anodes.
3. MEX-M-ASPERA3-3-RDR-NPI – Neutral Particle Imager data (counts/second) of integral ENA fluxes in the energy range 0.1 to 60 keV.
4. MEX-M-ASPERA3-3-RDR-NPD – Neutral Particle Detector data (counts/second) of atom spectra in the energy range 0.1 to 100 keV.

Each data set will be organized as a logical volume with ancillary data (geometry and calibration tables) included specific to the data set where applicable.

2.4.6 Software

The software used to process the data from the IDFS form to the PDS-compliant form is included in the SOFTWARE directory. Also, the software to generate the Geometry and Position index table and label files from the data labels and SPICE kernels is located in this directory. The input files for this software are not for archival, so they are found in the EXTRAS/IDFS_DATA and EXTRAS/SPICE_DATA subdirectories. There are three programs:

1. IDFStoPDS – Software tool to process IDFS data to the PDS-compliant spreadsheet form (CSV) and generate associated PDS labels (LBL), written by SwRI.
2. GeoTab – Software tool to read SPICE kernels and generate the geometry table and associated label, written by PSA team, customized by SwRI. GeoTab must parse the data labels for creating the geometry index table, so SwRI added functionality to GeoTab to also replace keyword values (start with '$' to indicate placeholder) in the data labels.

There are two possible executables in the ASPERA3_SW_BIN subdirectory for each software tool/program – Solaris version (Sun) and Linux version (Lin). The software guide for each includes the version description for each executable (compiler used, platform used, etc.), how to run the software, and sample inputs and outputs for comparison purposes. The configuration files necessary to run the programs for a particular release are in the ASPERA3_SW_CONFIG_* subdirectory. To generate a data set release, a unique set of configuration files is needed. Thus, a new ASPERA3_SW_CONFIG_* subdirectory is added for each release. The naming convention for these subdirectories is:

ASPERA3_SW_CONFIG_<time period>, where

<time period> = 'NEV', 'IC', or MMMYYYY

MMMYYYY is 3-character month and 4-digit year

The contents of the SOFTWARE subdirectories are packaged and delivered in .ZIP files with associated detached .LBL files that describe the contents of the .ZIP files.

The SOFTWARE directory of the ASPERA-3 data set deliveries contains:

```
                 |-- SOFTINFO.TXT (Describes directory contents)
                 |
                 |-- ASPERA3_SW_BIN.ZIP (Contents of the
                 |                ASPERA3_SW_BIN subdirectory)
                 |
                 |-- ASPERA3_SW_BIN.LBL (PDS Label describing the
                 |              contents of ASPERA3_SW_BIN.ZIP)
                 |
                 |-- ASPERA3_SW_CONFIG_*.ZIP (Contents of the
                 |                      ASPERA3_SW_CONFIG_*
 -|-- SOFTWARE -|                      subdirectory for the
                 |                      time period/release '*'
                 |                      as described above)
                 |
                 |-- ASPERA3_SW_CONFIG_*.LBL (Detached PDS Labels
                 |                  describing the contents of
                 |                    ASPERA3_SW_CONFIG_*.ZIP)
                 |
                 |-- ASPERA3_SW_DOC.ZIP (Contents of the
                 |                 ASPERA3_SW_DOC subdirectory)
                 |
                 |-- ASPERA3_SW_DOC.LBL (PDS Label describing
                            the contents of ASPERA3_SW_DOC.ZIP)
```

The organization and contents of the SOFTWARE directory and subdirectories when the zip files ASPERA3_SW_BIN.ZIP, ASPERA3_SW_CONFIG_*.ZIP, and ASPERA3_SW_DOC.ZIP are unzipped is:

```
                         |- IDFStoPDS.[Sun,Lin]
    |-- ASPERA3_SW_BIN -|- GeoTab.[Sun,Lin]
    |
    |
    |      |                 |-- IDFStoPDS Set up files (*.cfg)
SW--|-- ASPERA3_SW_CONFIG_* -|-- IDFStoPDS templates (*.I2P)
    |                        |-- GeoTab input files
    |
    |
    |-- ASPERA3_SW_DOC -|-- IDFStoPDS Guide
                         |-- GeoTab Guide
```

2.4.7 Documentation

Most of the documentation provided in the archive volumes is either in the form of PDS catalog (.CAT) files in the CATALOG directory or are in the DOCUMENT directory. The documents provided in the DOCUMENT directory are:

1. This EAICD document in MS Word, PDF, and HTML.
2. ASPERA-3: Analyser of Space Plasmas and Energetic Ions for Mars Express in PDF – Instrument paper published by ESA.
3. ASPERA-3 Flight Performance Report in PDF – submitted to ESA December 19, 2002.
4. ASPERA-3 Sensor Frames and Geometry Information Text file – generated from the SPICE Mars Express Frames Kernel and ASPERA-3 Instrument Kernel files.
5. ASPERA-3 Sensor Numbering document in PDF – supporting document illustrating ASPERA-3 geometry and frames provided by IRF.
6. ASPERA-3 Design Description document in PDF – provided by IRF.
7. ASPERA-3 Flight Operation Manual in PDF – provided by IRF.
8. Calibration Reports in PDF.

This EAICD document and the ASPERA-3 Sensor Frames and Geometry Information are the only documents that are considered critical documentation for the understanding of the contents and usage of the ASPERA-3 archived data sets. The calibration reports are provided in PDF and in ASCII when available. All critical calibration information is included in ASCII form in the calibration tables and associated labels. The other documents add to the understanding of the ASPERA-3 experiment, but are considered non-critical documentation for the archive. Thus, these documents will be delivered to PSA and PDS in PDF form only. PSA and PDS-PPI will take it upon themselves to translate these documents to an ASCII form at the end of the mission as required.

2.4.8 Derived and Other Data Products

Many ASPERA-3 data products are provided through the SDDAS suite of software tools that support space physics data analysis. Through this system, many derived data products are developed. It is the intention to define and deliver to PSA and PDS any derived data products that the ASPERA-3 team deem useful to the public. This is to be decided well into the mission and delivered after mission end.

2.4.9 Ancillary Data Usage

The Mars Express SPICE kernels and software are used to generate Orbit and Attitude data for use in conjunction with the ASPERA-3 data. It is important for ASPERA-3 science studies to know where in space and time the Mars Express spacecraft and ASPERA-3 instruments are located and what objects (Sun, Mars, Earth, Phobos, Deimos) are in the fields of views. The archived GEOMETRY index table for each data set is generated from the Mars Express spacecraft general orbit data using the GeoTab software and SPICE kernels. The ASPERA-3 view directions for each sensor can be derived using the SPICE kernels and software. The ASPERA-3 Sensor Frames and Geometry Information document (in DOCUMENT directory) provides a code example (in C and FORTRAN) for determining the view directions of the ASPERA-3 sensors.

3 Archive Format and Contents

3.1 Format and Conventions

3.1.1 Deliveries and Archive Volume Format

During the nominal mission, the PSA Level 1b data sets for each ASPERA-3 instrument (ELS, IMA, NPI, and NPD) are to be delivered once a month. Thus, four logical archive volumes are delivered monthly where each volume contains a single data set. The PSA Release object concept is used where updates (new or changed data) to the data sets are delivered. The archive volumes have the following naming convention:

MEXASP_<sensor name>_<sequence no. XY00>

where <sensor name> = {ELS, IMA, NPI, or NPD}
<sequence no. XY00> = X identifies the data set:
1 = ELS 3 = NPI
2 = IMA 4 = NPD
Y identifies the data type of the data set:
1 = PSA Level 1b 2 = PSA Level 2

For example, the raw data ELS archive volume is: MEXASP_ELS_1100
the flux data ELS archive volume is: MEXASP_ELS_1200
the raw data IMA archive volume is: MEXASP_IMA_2100
the PSA L2 data NPI archive volume is: MEXASP_NPI_3200
etc.

These are the names of the packaged (zipped, tar'd, etc.) directories and files that make up the archive e-volumes. The PSA Level 2 data sets (flux or other units) are to be delivered well into the mission or beginning at mission end (TBD).

3.1.2 Data Set ID Formation

PDS data set identifiers (DATA_SET_ID) conform to the following format:

MEX-M-ASPERA3-<processing level>-<data type>-<sensor name>-V<version number x.y>

where <processing level> = CODMAC Levels: 2 or 3
CODMAC Level 2 ≡ PSA Level 1b
CODMAC Level 3 ≡ PSA Level 2
<data set type> = EDR or RDR
<sensor name> = {ELS, IMA, NPI, or NPD}
<version number x.y> = x starts at 1, y starts at 0

For example, version one of the ELS raw data set has ID: MEX-M-ASPERA3-2-EDR-ELS-V1.0

3.1.3 Data Directory Naming Convention

The naming convention used below the DATA directory is:
<sensor name>_<data set type>_<processing level>_<time period>

where <sensor name> = {ELS, IMA, NPI, or NPD}
<data set type> = EDR or RDR
<processing level> = PSA levels: L1B or L2
<time period> = NEV, IC, or MMMYYYY for Month and Year

For example, the ELS NEV raw data will be in the DATA subdirectory: ELS_EDR_L1B_NEV

and the first Mars ELS raw data will be in the DATA subdirectory: ELS_EDR_L1B_JAN2004

If a revision is delivered for the same ELS raw data, it will be in the same DATA subdirectory, but the data labels will have updated REVISION_ID keyword values.

All data sets can be linked even though they are delivered separately through the release ID values. A given release ID corresponds to the same specific time period, and this time period is the same for all the data sets (ELS, IMA, NPI, and NPD).

3.1.4 File Naming Convention

Data products have names of the following form:

<IDFS name>YYYYDDDHHMMXXXXX<S>VV.CSV

where

<IDFS name> is up to 8 characters briefly describing the data product
(e.g., ELSSCIL, ELSSCIH, IMA_AZ0, NPINORM, NPD1TOF, etc.),

YYYYDDDHHMM is the start year, day, hour, and minute of the data product,

XXXXX is the short units label of the data product
(e.g., C_ACC is for counts/accumulation, C_SEC is for counts/second, DNF is for Differential Number Flux),

S is optional and if present indicates that it is a scanning or sweeping data product
(scanning/sweeping: instrument cycles through steps and data are sampled per step), and

VV is a version number with range 01-99. It is expected that the file version number will remain 01 and that any data file updates will be managed using the REVISION_ID in the labels. If any extreme cases occur where the data file versions must be updated due to major changes and the files must be completely reprocessed to replace older files, these will be handled between the ASPERA-3 team, PSA, and PDS on a case-by-case basis.

CSV extension indicates Comma Separated Values (PDS spreadsheet object).

The associated label files have the exact names as their data products with the .LBL extension.

The PRODUCT_ID values are the exact names as the data products with no extension.

The STANDARD_DATA_PRODUCT_ID values are shortened names of the data products with the date/time and version information removed:

<IDFS name>_XXXXX

where

<IDFS name> and XXXXX are as described above.

3.2 Standards Used in Data Product Generation

3.2.1 PDS Standards

The 3.6 PDS standards are used, dated August 1, 2003.

3.2.2 Time Standards

3.2.2.1 Date and Time Formats

The dates and times used within ASPERA-3 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 (OBT) counters of the spacecraft and instrument computers. The OBT counter is given in the headers of the experiment telemetry source packets. It contains the data acquisition start time as 32 bits of unit seconds followed by 16 bits of fractional seconds. The OBT is 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 Mars Express SCLK files.

3.2.2.3 OBT to UTC Time Conversion

UTC time is a function of the time correlation packages and the on-board time. The time correlation packages are archived and distributed in the SPICE auxiliary data set and contain linear segments that map the on-board time to UTC time. The linear segment is represented by a time offset and a time gradient. The conversion function is:

$$\text{Time in UTC} = \text{offset} + (\text{OBT(seconds)} + (\text{OBT(fractional part)} * 2^{-16})) * \text{gradient}$$

3.2.3 Reference Systems

The ASPERA-3 data are always in the instrument reference frame since data are sampled *in situ*. The GEOMETRY table contains spacecraft related parameters expressed in the J2000 reference frame. Any ASPERA-3 instrument specific ancillary data provided will be in the J2000 (equatorial) reference frame.

3.2.4 Other Applicable Standards

None.

3.3 Data Validation

The ASPERA-3 team, PSA team, and PPI node validate data product contents and formats in two ways. Before any data sets are produced and delivered, a peer review panel validates the structure and content of the data sets. PSA has provided a volume validation tool (PVV) that is to be used by the SwRI team to check each data set volume before sending to PSA for public release. Once data set production begins, the peer review panel may spot check data sets as deemed necessary by the PSA team.

The peer review panel consists of members of the instrument team, the PSA team, the PPI and Central Nodes of the PDS, and scientists chosen by the PSA team. The PSA and PDS personnel are responsible for validating that the data sets are fully compliant with PDS standards. The instrument team and chosen science reviewers are responsible for verifying the content of the data set, the completeness of the documentation, and the usability of the data in its archive format. The peer review process is a two-part process. First, the panel reviews this document and verifies that data sets produced to this specification will be useful. Next, the panel reviews specimen data sets to verify that they meet this specification and is indeed acceptable.

3.4 Content

3.4.1 Volume Sets and Data Sets

For Mars Express ASPERA-3 data set deliveries to PSA and PDS, a volume set is equivalent to a data set. So, for Volume ID MEXASP_XY00, the following data sets/volumes are delivered:

1. MEXASP_ELS_1100 (name of the bundled delivery e-volume)
   This data set/volume contains the ELS PSA Level 1b (raw) data.
2. MEXASP_IMA_2100 (name of the bundled delivery e-volume)
   This data set/volume contains the IMA PSA Level 1b (raw) data.

3. MEXASP_NPI_3100 (name of the bundled delivery e-volume)
   This data set/volume contains the NPI PSA Level 1b (raw) data.
4. MEXASP_NPD_4100 (name of the bundled delivery e-volume)
   This data set/volume contains the NPD PSA Level 1b (raw) data.
5. MEXASP_ELS_1200 (name of the bundled delivery e-volume)
   This data set/volume contains the ELS PSA Level 2 (differential number flux) data.
6. MEXASP_IMA_2200 (name of the bundled delivery e-volume)
   This data set/volume contains the IMA PSA Level 2 (differential number flux) data.
7. MEXASP_NPI_3200 (name of the bundled delivery e-volume)
   This data set/volume contains the NPI PSA Level 2 (counts/second) data.
8. MEXASP_NPD_4200 (name of the bundled delivery volume)
   This data set/volume contains the NPD PSA Level 2 (counts/second) data.

3.4.2 Directories

3.4.2.1 Root Directory

The following files are contained in the root directory, and are produced by SwRI with the assistance of the PPI node at UCLA. These two files are required by the PDS Archive Volume organization standards.

Table 10: Root Directory Contents

File Name	File Contents
AAREADME.TXT	This file completely describes the Volume organization and contents (PDS label attached).
ERRATA.TXT	A cumulative listing of all known errors, omissions, and areas of non-conformance with PDS standards on this and all previous volumes in the volume set.
VOLDESC.CAT	A description of the contents of the Volume in a PDS format readable by both humans and computers.

3.4.2.2 INDEX Directory

The following files are contained in the INDEX directory and are produced by SwRI. The INDEX files are generated using the PSA PVV tool, the GEO files are generated using SwRI software linked with the PSA geolib library, and the DOC_INDX files are generated manually using a local system editor.

Table 11: Index Directory Contents	
File Name	**File Contents**
INDXINFO.TXT	A description of the contents of the INDEX directory
INDEX.TAB	A table listing the ASPERA-3 Data Products for the data set
INDEX.LBL	A PDS detached label that describes INDEX.TAB
GEO_EARTH.TAB	A table of the Geometry and position descriptions for the data products in the data set with a reference target of Earth
GEO_EARTH.LBL	A PDS detached label that describes GEO_EARTH.TAB
GEO_MARS.TAB	A table of the Geometry and position descriptions for the data products in the data set with a reference target of Mars
GEO_MARS.LBL	A PDS detached label that describes GEO_MARS.TAB
DOC_INDX.TAB	A table listing the DOCUMENT files for the data set
DOC_INDX.LBL	A PDS detached label that describes DOC_INDX.TAB

3.4.2.3 DOCUMENT Directory

The document directory contains this EAICD document in MS Word, PDF, and HTML. Since this document is required for use of the archive data set, PDS standards require that it be available in some ASCII format, and HTML is an acceptable ASCII format. The following files are contained in the DOCUMENT directory.

Table 12: Document Directory Contents	
File Name	**File Contents**
DOCINFO.TXT	A description of the contents of the DOCUMENT directory
MEX_ASPERA3_PSA_ICD_Vxx_yy.HTM	The ASPERA-3 Experiment to Archive Interface Control Document (this EAICD document) as hypertext, where xx_yy is the version number (e.g., V01_00 is first version – same as V1.0)
MEX_ASPERA3_PSA_ICD_Vxx_yy.DOC	The ASPERA-3 Experiment to Archive Interface Control Document (this EAICD document) in Microsoft Word format, where xx_yy is the version number (e.g., V01_00 is same as V1.0)
MEX_ASPERA3_PSA_ICD_Vxx_yy.PDF	The ASPERA-3 Experiment to Archive Interface Control Document (this EAICD document) in PDF format, where xx_yy is the version number (e.g., V01_00 is first version – same as V1.0)
MEX_ASPERA3_PSA_ICD_Vxx_yy.LBL	The PDS detached label that describes the ASPERA-3 Experiment to Archive Interface Control Document (this EAICD) for each of its formats: hypertext, MS Word, PDF
ASPERA3_MEX_EXP.PDF	The Analyzer of Space Plasmas and Energetic Atoms (ASPERA-3) for the Mars Express Mission (submitted to ESA) in PDF format
ASPERA3_MEX_EXP.LBL	The PDS detached label that describes the ASPERA3_MEX_EXP.PDF document
ASPERA3_FLIGHT_PERF.PDF	The ASPERA-3 Flight Performance Report Document (submitted to ESA) in PDF format

Table 12: Document Directory Contents	
File Name	**File Contents**
ASPERA3_FLIGHT_PERF.LBL	The PDS detached label that describes the ASPERA3_FLIGHT_PERF.PDF document
ASPERA3_SENSOR_FRAMES.PDF	The ASPERA-3 Sensor Numbering and frames support document (provided by IRF) in PDF format
ASPERA3_SENSOR_FRAMES.LBL	The PDS detached label that describes the ASPERA3_SENSOR_FRAMES.PDF document
ASPERA3_SENSOR_GEOMETRY.TXT	The ASPERA-3 Sensor Frames and Geometry Information Text file with attached PDS label
ME_ASP_DS_0002.PDF	The ASPERA-3 Design Description document in PDF format
ME_ASP_DS_0002.LBL	The PDS detached label that describes the ME_ASP_DS_0002.PDF document
ME_ASP_MA_0003_V3_0.PDF	The ASPERA-3 Flight Operation Manual in PDF format
ME_ASP_MA_0003_V3_0.LBL	The PDS detached label that describes the ME_ASP_MA_0003_V3_0.PDF document
XXX_CALIBRATION_REPORT.PDF	ASPERA-3 Instrument XXX Calibration Report (where XXX is ELS, IMA, NPI, or NPD) in PDF format
XXX_CALIBRATION_REPORT.LBL	The PDS detached label that describes the XXX_CALIBRATION_REPORT.PDF document

3.4.2.4 CATALOG Directory

The files in the CATALOG directory provide a top-level understanding of the Mars Express ASPERA-3 Experiment and its data products. The ESA Mars Express Project team provided the mission and spacecraft files. The ASPERA-3 team provided information for the instrument and data set files, and SwRI formatted these files into PDS standard form. All catalog files are ASCII text files with <CR><LF> line termination and line lengths are no longer than 78 characters.

Table 13: Catalog Directory Contents	
File Name	**File Contents**
CATINFO.TXT	A description of the contents of the CATALOG directory
MISSION.CAT	PDS mission catalog description of the Mars Express mission
INSTHOST.CAT	PDS instrument host (spacecraft) catalog description of the Mars Express spacecraft
ASPERA3_INST.CAT	PDS instrument catalog description of the ASPERA-3 instrument
ASPERA3_XXX_RELEASE.CAT	PSA Release catalog description of the data set release, where XXX is ELS, IMA, NPI, or NPD; Each data set release and/or revision has updated release and revision objects contained
ASPERA3_XXX_EDR_DS.CAT	PDS Data Set catalog description of the XXX PSA Level 1b data set, where XXX is ELS, IMA, NPI, or NPD

Table 13: Catalog Directory Contents

File Name	File Contents
ASPERA3_XXX_RDR_DS.CAT	PDS Data Set catalog description of the XXX PSA Level 2 data set, where XXX is ELS, IMA, NPI, or NPD
ASPERA3_SOFTWARE.CAT	PDS Software catalog description of the ASPERA-3 software included in the SOFTWARE directory
PERSON.CAT	PDS personnel catalog description of ASPERA-3 Team members and other persons involved with the generation of Data Products
REF.CAT	ASPERA-3 references mentioned in other *.CAT files

3.4.2.5 CALIBRATION Directory

The calibration directory contains the calibration tables (.TAB files) and associated labels (.LBL files) necessary to convert or process the raw data (PSA Level 1b) to calibrated science units (PSA Level 2). These files are generated manually by SwRI using a local system editor. The CALINFO.TXT file describes the contents of the directory and how to use the calibration tables in the directory.

Table 14: Calibration Directory Contents

File Name	File Contents
CALINFO.TXT	A description of the contents of the CALIB directory
<IDFS name>_CAL<_Type>.TAB	A calibration data table for data products beginning with <IDFS name> as described in **section 3.1.4**. If more than one table is needed, then a table type <_Type> is appended to the name. For example, if NPINORM data products need only one table, then the name is NPINORM_CAL.TAB, but if separate tables are needed, then the name for geometry factors could be something like NPINORM_CAL_GF.TAB
<IDFS name>_CAL<_Type>.LBL	A PDS detached label that describes <IDFS name>_CAL<_Type>.TAB

3.4.2.6 GEOMETRY Directory

The Geometry and Position index table (in the INDEX directory) contains the geometry data for the ASPERA-3 data sets. Any additional geometry information, such as the ASPERA-3 view directions for each sensor, can be derived using the SPICE kernels and software. The ASPERA-3 Sensor Frames and Geometry Information document (in DOCUMENT directory) provides a code example (in C and FORTRAN) for determining the view directions for the ASPERA-3 sensors. There are no data files to put in a GEOMETRY directory, so the ASPERA-3 data sets do not have a GEOMETRY directory.

3.4.2.7 BROWSE Directory

ASPERA-3 data sets do not have browse products, thus a BROWSE directory does not exist.

3.4.2.8 SOFTWARE Directory

The software tools used to generate the PDS-compliant archive e-volumes from the IDFS data and SPICE kernels are provided in the SOFTWARE directory. The IDFS data and SPICE kernels used for input to generate the PDS-compliant data files are found in the EXTRAS directory. See **section 3.4.2.10** for the EXTRAS directory information and structure. Refer to **section 2.4.6** for additional SOFTWARE directory information and structure. The following files are contained in the SOFTWARE directory and are produced by SwRI.

Table 15: Software Directory Contents

File Name	File Contents
SOFTINFO.TXT	A description of the contents of the SOFTWARE directory
ASPERA3_SW_BIN.ZIP	A zip file containing the ASPERA3_SW_BIN subdirectory contents
ASPERA3_SW_BIN.LBL	A PDS detached label that describes ASPERA3_SW_BIN.ZIP
ASPERA3_SW_CONFIG_*.ZIP	Zip files containing the contents of the ASPERA3_SW_CONFIG_* subdirectories, where '*' refers to a time period/data release ('NEV', 'IC', or MMMYYYY)
ASPERA3_SW_CONFIG_*.LBL	PDS detached labels that describe ASPERA3_SW_CONFIG_*.ZIP
ASPERA3_SW_DOC.ZIP	A zip file containing the ASPERA3_SW_DOC subdirectory contents
ASPERA3_SW_DOC.LBL	A PDS detached label that describes ASPERA3_SW_DOC.ZIP

3.4.2.9 GAZETTER Directory

There are no plans to include a GAZETTER directory for ASPERA data set deliveries.

3.4.2.10 EXTRAS Directory

The EXTRAS directory contains additional items that may be useful to the users, but are non-essential for PDS archival. The contents of the EXTRAS directory and its subdirectories have no PDS restrictions or requirements (i.e., do not need to conform to PDS standards). These items include the IDFS data used for input to process the PDS CSV files, and the SPICE kernels used for generating the geometry table. The IDFS_DATA_* subdirectories are contained in zip files and have associated PDS labels to describe the contents. For each data set delivery (or release), a new IDFS_DATA_* subdirectory is created containing the IDFS data used as input for the data set delivery time period. The IDFS data used in previous data set releases remain in the EXTRAS directory in .ZIP files, and new releases add new IDFS data in newly created .ZIP files.

The naming convention for these subdirectories is:

IDFS_DATA_<time period>, where

<time period> = 'NEV', 'IC', or MMMYYYY

MMMYYYY is 3-character month and 4-digit year

Table 16: Extras Directory Contents

File Name	File Contents
EXTRINFO.TXT	Description of the contents of the EXTRAS directory and usage notes
IDFS_DATA_*.ZIP	Zip files containing the IDFS database and data files used in generating the data set releases, where '*' is 'NEV', 'IC', or MMMYYYY
IDFS_DATA_*.LBL	PDS detached labels that describe the associated IDFS_DATA_*.ZIP
MEX_SCIENCE_SUBPHASE_DEFS.TAB	A table listing of the Mars Express science mission phases used for determining the MISSION_PHASE_NAME values in the data labels
MEX_SCIENCE_SUBPHASE_DEFS.LBL	PDS detached label for MEX_SCIENCE_SUBPHASE_DEFS.TAB
SPICE_DATA subdirectory	SPICE kernels used in generating the entries in the geometry index table and label for this data set release

Organization of the EXTRAS directory is:

```
             |-- EXTRINFO.TXT (Describes directory contents)
             |
             |-- IDFS_DATA_*.ZIP (IDFS_DATA subdirectory
             |                     contents for '*' time period)
             |
             |-- IDFS_DATA_*.LBL (PDS Label describing the
             |                     contents of IDFS_DATA_*.ZIP)
             |
 |           |-- MEX_SCIENCE_SUBPHASE_DEFS.TAB (Table of Mission
-|- EXTRAS --|                   sub-phases used for data labels)
 |           |
             |-- MEX_SCIENCE_SUBPHASE_DEFS.LBL (PDS Label
             |          describing the Mission sub-phases Table)
             |
             |                |-- CK (C kernels used)
             |                |-- FK (Frames kernels used)
             |                |-- IK (ASPERA-3 Instrument kernel)
             |-- SPICE_DATA -|-- LSK (Leap Seconds kernel)
                              |-- ORBNUM (Orbit number kernels)
                              |-- PCK (Planets/Bodies kernels)
                              |-- SCLK (Spacecraft clock kernels)
                              |-- SPK (Spacecraft kernels used)
```

The organization and contents of IDFS_DATA_*.ZIP when unzipped is:

```
                  |-- Database (subdirectory of
  |               |               IDFS database files)
 -|-- IDFS_DATA_* -|
  |               |-- XXX (subdirectory of XXX
                              IDFS files, where XXX
                              is ELS, IMA, NPI, or NPD)
```

3.4.2.11 LABEL Directory

There are no referenced files to be included.

3.4.2.12 DATA (Standard Products) Directory

The DATA directory contains the actual Data Products for ASPERA-3. Each archive volume contains a single data set and uses the PSA Release concept for delivery. The DATA directory has subdirectories using the naming conventions described in **section 3.1.3**. These subdirectories contain the actual data files in CSV format with associated LBL files. Refer to **Section 4** for the subdirectory contents, data product descriptions, data file contents and structures, and sample labels for each data set.

4 Detailed Interface Specifications

This section describes the contents of the ASPERA-3 standard product archive e-volumes (or data sets). Appendix A contains information about the PDS software to read and validate the data products. The complete directory structure is shown in Appendix B.

4.1 Structure and Organization Overview

For each data set release, a DATA subdirectory is added based on time period, so the DATA directory grows with each release. For all ASPERA-3 data products, the CSV and associated LBL files have the same names. The names, without the extensions, are the Data Product IDs and are unique for each data product. The collection of similar data products comprises the Standard Data Product, and the Standard Data Product IDs are formed using two components of the Data Product ID, '<IDFS name>_XXXXX' (see **section 3.1.4**, File Naming Convention). Descriptions of the Standard Data Product IDs are given in **section 2.1**. The following sections give the structure and contents of the DATA directories for each ASPERA-3 instrument. There are two data sets per instrument – one for EDR (PSA Level 1B, CODMAC Level 2) data, and one for RDR (PSA Level 2, CODMAC Level 3) data.

4.1.1 ELS DATA Directory Structure

The following is the organization and contents of the DATA directories for the ELS data sets.

```
                                 |-- ELSSCIH*.CSV
                                 |-- ELSSCIH*.LBL  ELS Data
            |-- ELS_TTT_LLL_NEV --|-- ELSSCIL*.CSV  Release 1
            |                    |-- ELSSCIL*.LBL
            |
            |                   |-- ELSSCIH*.CSV
            |-- ELS_TTT_LLL_IC --|-- ELSSCIH*.LBL   ELS Data
            |                   |-- ELSSCIL*.CSV   Release 2
  |         |                   |-- ELSSCIL*.LBL
 -|- DATA --|
  |         |                        |-- ELSSCIH*.CSV
            |-- ELS_TTT_LLL_JAN2004 --|-- ELSSCIH*.LBL  ELS Data
            |                        |-- ELSSCIL*.CSV  Release 3
            |                        |-- ELSSCIL*.LBL
            |
            |                        |-- ELSSCIH*.CSV
            |-- ELS_TTT_LLL_FEB2004 --|-- ELSSCIH*.LBL  ELS Data
            |                        |-- ELSSCIL*.CSV  Release 4
            .                        |-- ELSSCIL*.LBL
            .
           etc.
               where TTT = EDR or RDR (Data Type)
                     LLL = L1B or L2 (PSA Data Level)
                     When TTT = EDR, LLL = L1B, and
                     When TTT = RDR, LLL = L2
```

4.1.2 IMA DATA Directory Structure

The following is the organization and contents of the DATA directories for the IMA data sets.

```
                                  |-- IMA_AZ0*.CSV
                                  |-- IMA_AZ0*.LBL
                                  |-- IMA_AZ1*.CSV
                                  |-- IMA_AZ1*.LBL
                                  |        .         IMA Data
           |-- IMA_TTT_LLL_NEV --|        .         Release 1
           |                      |        .
           |                      |-- IMA_AZ14*.CSV
           |                      |-- IMA_AZ14*.LBL
           |                      |-- IMA_AZ15*.CSV
           |                      |-- IMA_AZ15*.LBL
           |
           |                     |-- IMA_AZ0*.CSV
           |                     |-- IMA_AZ0*.LBL
           |                     |-- IMA_AZ1*.CSV
           |                     |-- IMA_AZ1.LBL
           |                     |        .          IMA Data
           |-- IMA_TTT_LLL_IC --|        .          Release 2
           |                     |        .
   |       |                     |-- IMA_AZ14.CSV
  -|- DATA --|                   |-- IMA_AZ14.LBL
   |       |                     |-- IMA_AZ15*.CSV
           |                     |-- IMA_AZ15*.LBL
           |
           |                          |-- IMA_AZ0*.CSV
           |                          |-- IMA_AZ0*.LBL
           |                          |-- IMA_AZ1*.CSV
           |                          |-- IMA_AZ1*.LBL
           |                          |        .        IMA Data
           |-- IMA_TTT_LLL_JAN2004 --|        .        Release 3
           |                          |        .
           |                          |-- IMA_AZ14*.CSV
           |                          |-- IMA_AZ14*.LBL
           |                          |-- IMA_AZ15*.CSV
           |                          |-- IMA_AZ15*.LBL
           .
           .
           .
          etc.
              where TTT = EDR or RDR (Data Type)
                    LLL = L1B or L2 (PSA Data Level)
                    When TTT = EDR, LLL = L1B, and
                    When TTT = RDR, LLL = L2
                    AZn,   n= 0-9  for Azimuth Anodes 0-9
                    AZnn, nn=10-15 for Azimuth Anodes 10-15
```

4.1.3 NPI DATA Directory Structure

The following is the organization and contents of the DATA directories for the NPI data sets.

```
                |-- NPI_TTT_LLL_NEV --|-- NPINORM*.CSV   NPI Data
                |                     |-- NPINORM*.LBL   Release 1
                |
                |-- NPI_TTT_LLL_IC --|-- NPINORM*.CSV   NPI Data
      |         |                    |-- NPINORM*.LBL   Release 2
     -|- DATA --|
      |         |-- NPI_TTT_LLL_JAN2004 --|-- NPINORM*.CSV  NPI Data
                |                         |-- NPINORM*.LBL  Release 3
                |
                |-- NPI_TTT_LLL_FEB2004 --|-- NPINORM*.CSV  NPI Data
                |                         |-- NPINORM*.LBL  Release 4
                |
                .
                .
               etc.
                   where TTT = EDR or RDR (Data Type)
                         LLL = L1B or L2 (PSA Data Level)
                         When TTT = EDR, LLL = L1B, and
                         When TTT = RDR, LLL = L2
```

4.1.4 NPD DATA Directory Structure

NPD data sets are under discussion, so this section is TBD.

4.2 Data Sets, Definition and Content

The following table provides information concerning the data types, standard products, delivery volumes, and delivery schedules for the data set releases.

Table 17: Delivery of ASPERA-3 Data Sets

Data Set ID	Standard Data Product IDs	E-Volume Size	Data Release Delivery Schedule
MEX-M-ASPERA3-2-EDR-ELS-V1.0 PSA Level 1b CODMAC Level 2 Raw counts (cnts/accum)	ELSSCIH_C_ACC ELSSCIL_C_ACC	~ 6.0 Gb	Several Data Set Releases are to be delivered every six months starting Sept. 2005. The first delivery is 8 releases containing data from launch through June 2004. The next deliveries contain six months of data each and are to be delivered as soon as possible in order to catch up to a 6-month lag. The amount of time between the 'catch-up' deliveries depends on the review cycle and will be worked out with PSA and PDS.
MEX-M-ASPERA3-3-RDR-ELS-V1.0 PSA Level 2 CODMAC Level 3 (differential number flux)	ELSSCIH_DNF ELSSCIL_DNF	~ 6.0 Gb	It is expected to begin delivering this data set in July, 2006 - TBD
MEX-M-ASPERA3-2-EDR-NPI-V1.0 PSA Level 1b CODMAC Level 2 Raw counts (cnts/accum)	NPINORM_C_ACC	~ 1.2 Gb	Several Data Set Releases are to be delivered every six months starting Feb. 2005. The first delivery is 8 releases containing data from launch through June 2004. The next deliveries contain six months of data each and are to be delivered as soon as possible in order to catch up to a 6-month lag. The amount of time between the 'catch-up' deliveries depends on the review cycle and will be worked out with PSA and PDS.
MEX-M-ASPERA3-3-RDR-NPI-V1.0 PSA Level 2 CODMAC Level 3 (counts/second)	NPINORM_C_SEC	~ 1.2 Gb	TBD

Table 17: Delivery of ASPERA-3 Data Sets

Data Set ID	Standard Data Product IDs	E-Volume Size	Data Release Delivery Schedule
MEX-M-ASPERA3-2-EDR-IMA-V1.0 PSA Level 1b CODMAC Level 2 Raw counts (cnts/accum)	IMA_AZ0_C_ACC IMA_AZ1_C_ACC IMA_AZ2_C_ACC IMA_AZ3_C_ACC IMA_AZ4_C_ACC IMA_AZ5_C_ACC IMA_AZ6_C_ACC IMA_AZ7_C_ACC IMA_AZ8_C_ACC IMA_AZ9_C_ACC IMA_AZ10_C_ACC IMA_AZ11_C_ACC IMA_AZ12_C_ACC IMA_AZ13_C_ACC IMA_AZ14_C_ACC IMA_AZ15_C_ACC	~ 6.5 Gb	Several Data Set Releases are to be delivered every six months starting early 2006. The first delivery is 8 releases containing data from launch through June 2004. The next deliveries contain six months of data each and are to be delivered as soon as possible in order to catch up to a 6-month lag. The amount of time between the 'catch-up' deliveries depends on the review cycle and will be worked out with PSA and PDS.
MEX-M-ASPERA3-3-RDR-IMA-V1.0 PSA Level 2 CODMAC Level 3 (differential number flux)	IMA_AZ0_DNF IMA_AZ1_DNF IMA_AZ2_DNF IMA_AZ3_DNF IMA_AZ4_DNF IMA_AZ5_DNF IMA_AZ6_DNF IMA_AZ7_DNF IMA_AZ8_DNF IMA_AZ9_DNF IMA_AZ10_DNF IMA_AZ11_DNF IMA_AZ12_DNF IMA_AZ13_DNF IMA_AZ14_DNF IMA_AZ15_DNF	~ 6.5 Gb	TBD
MEX-M-ASPERA3-2-EDR-NPD-V1.0 PSA Level 1b CODMAC Level 2 Raw counts (cnts/accum)	TBD	TBD	TBD
MEX-M-ASPERA3-3-RDR-NPD-V1.0 PSA Level 2 CODMAC Level 3 (counts/second)	TBD	TBD	TBD

4.3 Data Product Design

4.3.1 General Data Product Format

Since the ASPERA-3 data products tend to have sparsely populated data rows and variable length field values, the PDS SPREADSHEET is the chosen storage format for archival of these data. The SPREADSHEET is an ASCII data object containing logically uniform rows with fixed numbers of variable-length fields separated by field delimiters. For ASPERA-3 data products, the field delimiters are always commas. The SPREADSHEET object row delimiters are always carriage-return line-feed (<CR><LF>) ASCII line termination characters. The format for the SPREADSHEET objects is a comma-separated value format in which string fields are enclosed in double quotes and the extension for the data files is CSV. This format can be imported directly into many commercial data management systems and spreadsheet applications.

The ASPERA-3 SPREADSHEET objects for each data set describe rows of data with eight (8) FIELDS (columns) that are always delimited with COMMAs. The VALUES field can contain several items each also delimited with COMMAs. If the data are NOT from a 'scanning' instrument, then ITEMS = 1 for the VALUES FIELD object; otherwise, ITEMS > 1, where each item is a data value corresponding to a 'scan' parameter (such as center energy). Since each row can (and does for ASPERA-3) contain values from different data types and sensors, each row has fields to describe the data in that row.

The general ASPERA-3 data product format is given in the following table.

Table 18: ASPERA-3 Data Product Format

Object Field Name	Type	# Bytes / Format	Description
START TIME	TIME	21 yyyy-dddThh:mm:ss.sss	The start time in UTC 'Day Of Year' (DOY) format of the data sample(s) in the current row.
STOP TIME	TIME	21 yyyy-dddThh:mm:ss.sss	The stop time in UTC 'Day Of Year (DOY) format of the data sample(s) in the current row.
DATA TYPE NAME	CHAR	11 / A11	Identifies the type of data sampled in the current row.
DATA TYPE ID	INT	1 / I1	Identifies the type of data sampled in the current row.
DATA NAME	CHAR	50 / A50	The name of the data parameter in the current row.
DATA UNIT	CHAR	50 / A50	The units of the data value(s) in the current row.
VALUES	REAL	13 per ITEM E13.6	Data value for each data item in the current row. Data items can be variable for each row.
DATA QUALITY VALUE	REAL	13 E13.6	The data quality value associated with all the data items in the current row.

TIME fields are PDS Date/Time format described in section 3.2.2.1
CHAR fields are maximum values and not padded, so only what is needed is what is used.
REAL fields for data values are formatted for greatest possible accuracy and DO NOT reflect accuracy of the instrumentation measurement capability.

4.3.2 ELS Data Product Design

All ELS data on an archive volume are in the DATA directory. Each data set delivery release adds a new subdirectory of data to the DATA directory. All ELS data are in .CSV format with associated detached PDS .LBL files. The following table indicates the DATA subdirectories and contents of the ELS data sets.

Table 19: ELS Data Directory Contents

Data Set Release Time Period	Data Set ID Subdirectory / File Name	File Contents
Data Set Release 1 Near Earth Verification (NEV) Data Data taken during the cruise phase when Mars Express is closer to Earth than to Mars. This is mostly the NEV data but includes all data for time period June 2003 through September 2003.	MEX-M-ASPERA3-2-EDR-ELS-V1.0 ELS_EDR_L1B_NEV / ELSSCIL*.CSV ELS_EDR_L1B_NEV / ELSSCIL*.LBL ELS_EDR_L1B_NEV / ELSSCIH*.CSV ELS_EDR_L1B_NEV / ELSSCIH*.LBL	These ELS files contain the PSA level 1b, CODMAC level 2 science low (ELSSCIL*) and science high (ELSSCIH*) energy range data in counts/accumulation.
	MEX-M-ASPERA3-3-RDR-ELS-V1.0 ELS_RDR_L2_NEV / ELSSCIL*.CSV ELS_RDR_L2_NEV / ELSSCIL*.LBL ELS_RDR_L2_NEV / ELSSCIH*.CSV ELS_RDR_L2_NEV / ELSSCIH*.LBL	These ELS files contain the PSA level 2, CODMAC level 3 science low (ELSSCIL*) and science high (ELSSCIH*) energy range data in differential number flux units.
Data Set Release 2 Inter-Cruise (IC) Data Data taken during the cruise phase when Mars Express is closer to Mars than to Earth but before Mars Orbit Insertion. This includes all data for time period October 2003 through December 2003.	MEX-M-ASPERA3-2-EDR-ELS-V1.0 ELS_EDR_L1B_IC / ELSSCIL*.CSV ELS_EDR_L1B_IC / ELSSCIL*.LBL ELS_EDR_L1B_IC / ELSSCIH*.CSV ELS_EDR_L1B_IC / ELSSCIH*.LBL	These ELS files contain the PSA level 1b, CODMAC level 2 science low (ELSSCIL*) and science high (ELSSCIH*) energy range data in counts/accumulation.
	MEX-M-ASPERA3-3-RDR-ELS-V1.0 ELS_RDR_L2_IC / ELSSCIL*.CSV ELS_RDR_L2_IC / ELSSCIL*.LBL ELS_RDR_L2_IC / ELSSCIH*.CSV ELS_RDR_L2_IC / ELSSCIH*.LBL	These ELS files contain the PSA level 2, CODMAC level 3 science low (ELSSCIL*) and science high (ELSSCIH*) energy range data in differential number flux units.
Data Set Release 3 January 2004 Data (JAN2004) Data taken during January 2004 – first Mars orbits.	MEX-M-ASPERA3-2-EDR-ELS-V1.0 ELS_EDR_L1B_JAN2004 / ELSSCIL*.CSV ELS_EDR_L1B_JAN2004 / ELSSCIL*.LBL ELS_EDR_L1B_JAN2004 / ELSSCIH*.CSV ELS_EDR_L1B_JAN2004 / ELSSCIH*.LBL	These ELS files contain the PSA level 1b, CODMAC 2 science low (ELSSCIL*) and science high (ELSSCIH*) energy range data in counts/accumulation.
	MEX-M-ASPERA3-3-RDR-ELS-V1.0 ELS_RDR_L2_JAN2004 / ELSSCIL*.CSV ELS_RDR_L2_JAN2004 / ELSSCIL*.LBL ELS_RDR_L2_JAN2004 / ELSSCIH*.CSV ELS_RDR_L2_JAN2004 / ELSSCIH*.LBL	These ELS files contain the PSA level 2, CODMAC level 3 science low (ELSSCIL*) and science high (ELSSCIH*) energy range data in differential number flux units.

Table 19: ELS Data Directory Contents

Data Set Release Time Period	Data Set ID Subdirectory / File Name	File Contents
Data Set Release N, N > 3 Mars Data (MMMYYYY) Data taken during month MMM and year YYYY while orbiting Mars.	MEX-M-ASPERA3-2-EDR-ELS-V1.0 ELS_EDR_L1B_MMMYYYY / ELSSCIL*.CSV ELS_EDR_L1B_MMMYYYY / ELSSCIL*.LBL ELS_EDR_L1B_MMMYYYY / ELSSCIH*.CSV ELS_EDR_L1B_MMMYYYY / ELSSCIH*.LBL	These ELS files contain the PSA level 1b, CODMAC level 2 science low (ELSSCIL*) and science high (ELSSCIH*) energy range data in counts/accumulation.
	MEX-M-ASPERA3-3-RDR-ELS-V1.0 ELS_RDR_L2_MMMYYYY / ELSSCIL*.CSV ELS_RDR_L2_MMMYYYY / ELSSCIL*.LBL ELS_RDR_L2_MMMYYYY / ELSSCIH*.CSV ELS_RDR_L2_MMMYYYY / ELSSCIH*.LBL	These ELS files contain the PSA level 2, CODMAC level 3 science low (ELSSCIL*) and science high (ELSSCIH*) energy range data in differential number flux units.

4.3.2.1 ASPERA-3 ELS Data Product Formats

All ELS data products have the same format, and each row (data file record) in the ELS SPREADSHEET data products has eight (8) COLUMN objects. The VALUES COLUMN object has an ITEMS element, where $0 < \text{ITEMS} \leq 128$ for ELS. The number of ITEMS in the VALUES object is the same for each data product, but will vary between data products. There are 16 SENSOR DATA TYPE NAME rows (records), one for each of the 16 ELS sectors, followed by a corresponding SCAN DATA TYPE NAME row. Each SCAN VALUE (Deflection Potential in volts) corresponds to the same ITEM element of the previous 16 SENSOR rows. Thus, the START TIME and STOP TIME are the same for the SENSOR records and corresponding SCAN record. The DATA QUALITY VALUE is only applicable for the SENSOR data. The 16 SENSOR rows and one SCAN row are followed by 23 rows (records) of mode data. All 23 rows of MODE DATA cover the same time period and correspond to the previous 16 SENSOR DATA TYPE NAME rows. The following table shows the contents of the columns for the different rows of the ELS data products.

Table 20: ELS Science Data File Contents and Structure

START TIME	STOP TIME	DATA TYPE NAME	DATA TYPE ID	DATA NAME	DATA UNIT	VALUES	DATA QUALITY VALUE
Sensor 0 Start Time	Sensor 0 Stop Time	SENSOR	1	ELS Sector 0 XR, where X = L for Low range data and H for High range data	c/acc (raw, EDR) or cnts/(cm^2-sr-sec-eV) (diff. number flux, RDR)	ITEMS # of data values, Comma delimited	0 – 4 and fill value, .LBL file has descriptions

Table 20: ELS Science Data File Contents and Structure

START TIME	STOP TIME	DATA TYPE NAME	DATA TYPE ID	DATA NAME	DATA UNIT	VALUES	DATA QUALITY VALUE
Sensor 1 Start Time	Sensor 1 Stop Time	SENSOR	1	ELS Sector 1 XR, where X = L for Low range data and H for High range data	c/acc (raw, EDR) or cnts/(cm^2-sr-sec-eV) (diff. number flux, RDR)	ITEMS # of data values, Comma delimited	0 – 4 and fill value, .LBL file has descriptions
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Sensor 15 Start Time	Sensor 15 Stop Time	SENSOR	1	ELS Sector 15 XR, where X = L for Low range data and H for High range data	c/acc (raw, EDR) or cnts/(cm^2-sr-sec-eV) (diff. number flux, RDR)	ITEMS # of data values, Comma delimited	0 – 4 and fill value, .LBL file has descriptions
Start Time for previous 16 sensors	Stop Time for previous 16 sensors	SCAN	2	Deflection Potential	Volts	ITEMS # of data values, Comma delimited	N/A
Start Time for previous sensor data	Stop Time for previous sensor data	MODE DATA	4	Software Version – Upper Byte	Unitless	Upper byte of flight s/w version	N/A
Start Time for previous sensor data	Stop Time for previous sensor data	MODE DATA	4	Software Version – Lower Byte	Unitless	Lower byte of flight s/w version	N/A
Start Time for previous sensor data	Stop Time for previous sensor data	MODE DATA	4	Software Mode	Unitless	0 – off 1 – booting 2 – safe 3 – PROM 4 - normal	N/A
Start Time for previous sensor data	Stop Time for previous sensor data	MODE DATA	4	Time Summation	Unitless	Number of sweeps summed in telemetry	N/A
Start Time for previous sensor data	Stop Time for previous sensor data	MODE DATA	4	Step Summation	Unitless	0 – no sums 1 – every 2 2 – every 4	N/A
Start Time for previous sensor data	Stop Time for previous sensor data	MODE DATA	4	Log Compression	Unitless	0 – off 1 – on	N/A
Start Time for previous sensor data	Stop Time for previous sensor data	MODE DATA	4	Sector 0 Enable	Unitless	0 – disabled 1 – enabled	N/A

Table 20: ELS Science Data File Contents and Structure							
START TIME	**STOP TIME**	**DATA TYPE NAME**	**DATA TYPE ID**	**DATA NAME**	**DATA UNIT**	**VALUES**	**DATA QUALITY VALUE**
Start Time for previous sensor data	Stop Time for previous sensor data	MODE DATA	4	Sector 1 Enable	Unitless	0 – disabled 1 – enabled	N/A
Start Time for previous sensor data	Stop Time for previous sensor data	MODE DATA	4	Sector 2 Enable	Unitless	0 – disabled 1 – enabled	N/A
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Start Time for previous sensor data	Stop Time for previous sensor data	MODE DATA	4	Sector 15 Enable	Unitless	0 – disabled 1 – enabled	N/A
Start Time for previous sensor data	Stop Time for previous sensor data	MODE DATA	4	Number of Active Anodes	Unitless	0 – 16; number of enabled sectors	N/A

SCAN data: During the PSA conducted independent review of the ELS data set, it was suggested, and approved by IRF, PSA and PDS-PPI, to provide the deflection potential (voltages) instead of the center electron energies in the data files. This reduces the data files by ~40% because the center energies vary slightly between ELS sectors, and thus a SCAN row would have to be written per SENSOR row. By providing the deflection potential, only one SCAN row per 16 sensor rows is written. The center electron energies are calculated by multiplying the K_FACTOR (eV/volt) for each sector with the deflection voltages in the SCAN row. The K_FACTORs are found in the calibration tables in the CALIB directory.

MODE DATA: The mode data give the state of the instrumentation as received in telemetry during the data sampling. These data are beneficial for data processing, and are included only for informational purposes in the archive.

4.3.2.2 ELS Sample Data Product Labels

Table 21: ELS Science Sample Label

```
PDS_VERSION_ID                = PDS3
RECORD_TYPE                   = STREAM
FILE_RECORDS                  = 40425

DATA_SET_ID                   = "MEX-M-ASPERA3-2-EDR-ELS-V1.0"
STANDARD_DATA_PRODUCT_ID      = "ELSSCIL_C_ACC"
PRODUCT_ID                    = "ELSSCIL20031741842C_ACCS01"
PRODUCT_TYPE                  = "DATA"
PRODUCT_CREATION_TIME         = 2004-11-29T18:02:33
RELEASE_ID                    = 0001
REVISION_ID                   = 0000

START_TIME                    = 2003-174T18:42:52.830
STOP_TIME                     = 2003-174T19:38:55.221
SPACECRAFT_CLOCK_START_COUNT = "1/0004473766.09844"
SPACECRAFT_CLOCK_STOP_COUNT  = "1/0004477128.35439"

INSTRUMENT_HOST_NAME          = "MARS EXPRESS"
INSTRUMENT_HOST_ID            = "MEX"
MISSION_PHASE_NAME            = "EV"
MISSION_NAME                  = "MARS EXPRESS"
TARGET_NAME                   = "SOLAR WIND"
TARGET_TYPE                   = "PLASMA CLOUD"
ORBIT_NUMBER                  = "N/A"
INSTRUMENT_NAME               = "
        ANALYZER OF SPACE PLASMA AND ENERGETIC ATOMS (3RD VERSION)"
INSTRUMENT_ID                 = "ASPERA-3"
PRODUCER_ID                   = "SJEFFERS"
PRODUCER_FULL_NAME            = "SANDEE JEFFERS"

NOTE                          = "
    ELSSCIL20031741842C_ACCS01.CSV contains Mars Express ASPERA-3 data
    from the Electron Spectrometer (ELS) low range (0.05 eV - 150 eV).
    The file covers the time period 2003-174 18:42:52.830 to
    2003-174 19:38:55.221 (orbit(s) N/A)."

DESCRIPTION                   = "
    This file contains data from ELSSCIL:  Electron Spectrometer (ELS)
    science data (SCI) from the low range (L) of the ELS power supply
    with up to 128 steps returned in telemetry.  These step values are
    in the SCAN rows of the data files in the form of deflection
    potential (volts).  To convert each step per sector to center
    electron energies (eV), use the K_FACTORS in the calibration
    tables.  Each SCAN row directly corresponds to the previous 16
    SENSOR rows where the SENSOR value (c/acc) in a given column is
    the data sampled at the SCAN value (deflection voltage) in that
    same column.  The SENSOR rows have one more column than the SCAN
    rows.  The additional column is the data quality indicator (last
    column) for that sensor data.  The data values are formatted for
    a high level of accuracy and DO NOT reflect the accuracy of the
    instrumentation.  Please refer to the Data Set Catalog,
    ASPERA3_EDR_ELS_DS.CAT, for detailed information about the data
    organization, science meaning, data quality determination, data
    modes, etc."

^SPREADSHEET             = "ELSSCIL20031741842C_ACCS01.CSV"
OBJECT                        = SPREADSHEET
  INTERCHANGE_FORMAT          = ASCII
  ROWS                        = 40425
  FIELDS                      = 8
```

```
ROW_BYTES                   = 1917 /* longest row, <CR><LF> too.*/
FIELD_DELIMITER             = "COMMA"

OBJECT                      = FIELD
  NAME                      = "START TIME"
  FIELD_NUMBER              = 1
  DATA_TYPE                 = TIME
  BYTES                     = 21
  DESCRIPTION               = "
    The START TIME field specifies the start time of the data
    sample(s) being returned in the current row in UTC.  The fields
    START TIME and STOP TIME define the time range covered by the
    samples contained on the current row."
END_OBJECT                  = FIELD

OBJECT                      = FIELD
  NAME                      = "STOP TIME"
  FIELD_NUMBER              = 2
  DATA_TYPE                 = TIME
  BYTES                     = 21
  DESCRIPTION               = "
    The STOP TIME field specifies the stop time of the data
    sample(s) being returned in the current row in UTC.  The fields
    START TIME and STOP TIME define the time range covered by the
    samples contained on the current row."
END_OBJECT                  = FIELD

OBJECT                      = FIELD
  NAME                      = "DATA TYPE NAME"
  FIELD_NUMBER              = 3
  DATA_TYPE                 = CHARACTER
  BYTES                     = 11 /* does not include double quotes */
  FORMAT                    = "A11"
  DESCRIPTION               = "
    The DATA TYPE NAME field identifies the type of data sample(s)
    being returned in the current row.  Valid entries include:
         SENSOR       - primary data
         SCAN         - center scan data associated with the primary data
         CALIBRATION  - calibration data associated with the primary data
         MODE DATA    - instrument status (mode) data
         PITCH ANGLE  - pitch angle data associated with the primary data
         START AZ     - start azimuthal angle data associated with the
                        primary data.  The values are always between
                        0 and 360 degrees.
         STOP AZ      - stop azimuthal angle data associated with the
                        primary data.  The values could be negative or
                        could be greater than 360 degrees.
    For example, if the data type name of the row is SENSOR, then the data
    within that row contains the primary sensor data being returned."
END_OBJECT                  = FIELD

OBJECT                      = FIELD
  NAME                      = "DATA TYPE ID"
  FIELD_NUMBER              = 4
  DATA_TYPE                 = ASCII_INTEGER
  BYTES                     = 1
  FORMAT                    = "I1"
  DESCRIPTION               = "
    The DATA TYPE ID field identifies the type of data sample(s)
    being returned in the current row.  It is equivalent to the
    DATA TYPE NAME field, except expressed as an integer instead
    of a string.  Valid entries include:
         1 - primary data
         2 - center scan data associated with the primary data
         3 - calibration data associated with the primary data
         4 - instrument status (mode) data
         6 - pitch angle data associated with the primary data
```

```
          7 - start azimuthal angle data associated with the primary
              data.  The values are always between 0 and 360 degrees.
          8 - stop azimuthal angle data associated with the primary
              data.  The values could be negative or could be greater
              than 360 degrees.
      For example, if the data type id of the row is 1, then the data
      within that row contains the primary sensor data being returned."
  END_OBJECT                  = FIELD

  OBJECT                      = FIELD
    NAME                      = "DATA NAME"
    FIELD_NUMBER              = 5
    DATA_TYPE                 = CHARACTER
    BYTES                     = 50 /* does not include double quotes */
    FORMAT                    = "A50"
    DESCRIPTION               = "
      The DATA NAME field identifies the name of the data
      parameter being returned in the current row."
  END_OBJECT                  = FIELD

  OBJECT                      = FIELD
    NAME                      = "DATA UNIT"
    FIELD_NUMBER              = 6
    DATA_TYPE                 = CHARACTER
    BYTES                     = 50 /* double quotes not included */
    FORMAT                    = "A50"
    DESCRIPTION               = "
      The DATA UNIT field identifies the units that the data
      values are expressed in for the current row."
  END_OBJECT                  = FIELD

  OBJECT                      = FIELD
    NAME                      = "VALUES"
    FIELD_NUMBER              = 7
    DATA_TYPE                 = ASCII_REAL
    BYTES                     = 1735 /* including delimiters */
    ITEMS                     = 124
    ITEM_BYTES                = 13
    FORMAT                    = "E13.6"
    DESCRIPTION               = "
      This field contains the data values associated with the data items
      being returned.  The field DATA TYPE NAME identifies the type of data
      being returned."
  END_OBJECT                  = FIELD

  OBJECT                      = FIELD
    NAME                      = "DATA QUALITY VALUE"
    FIELD_NUMBER              = 8
    DATA_TYPE                 = ASCII_REAL
    BYTES                     = 13
    FORMAT                    = "E13.6"
    DESCRIPTION               = "
      This field contains the data quality value associated with the data
      being returned.  Valid values include:
              0 - Good Data
              1 - Questionable Data
              2 - Invalid Data
              3 - Bad Data
              4 - Unknown State
      -3.40e+38 – Data Is Not Available
      Refer to the data set catalog file for a more in-depth explanation
      of how the setting of these values are determined."
  END_OBJECT                  = FIELD
END_OBJECT                    = SPREADSHEET

END
```

4.3.3 Data Product IMA Design

All IMA data on an archive volume are in the DATA directory. Each data set delivery release adds a new subdirectory of data to the DATA directory. All IMA data are in .CSV format with associated detached PDS .LBL files. The following table indicates the DATA subdirectories and contents of the IMA data sets.

Table 22: IMA Data Directory Contents

Data Set Release Time Period	Data Set ID Subdirectory / File Name	File Contents
Data Set Release 1 Near Earth Verification (NEV) Data Data taken during the cruise phase when Mars Express is closer to Earth than to Mars. This is mostly the NEV data but includes all data for time period June 2003 through September 2003.	MEX-M-ASPERA3-2-EDR-IMA-V1.0 IMA_EDR_L1B_NEV / IMA_AZ0*.CSV IMA_EDR_L1B_NEV / IMA_AZ0*.LBL IMA_EDR_L1B_NEV / IMA_AZ1*.CSV IMA_EDR_L1B_NEV / IMA_AZ1*.LBL : IMA_EDR_L1B_NEV / IMA_AZ9*.CSV IMA_EDR_L1B_NEV / IMA_AZ9*.LBL IMA_EDR_L1B_NEV / IMA_AZ10*.CSV IMA_EDR_L1B_NEV / IMA_AZ10*.LBL : IMA_EDR_L1B_NEV / IMA_AZ15*.CSV IMA_EDR_L1B_NEV / IMA_AZ15*.LBL	These IMA files contain the PSA level 1b, CODMAC level 2, IMA Azimuth anodes 0-15 energy x mass channel data in raw counts.
	MEX-M-ASPERA3-3-RDR-IMA-V1.0 IMA_RDR_L2_NEV / IMA_AZ0*.CSV IMA_RDR_L2_NEV / IMA_AZ0*.LBL IMA_RDR_L2_NEV / IMA_AZ1*.CSV IMA_RDR_L2_NEV / IMA_AZ1*.LBL : IMA_RDR_L2_NEV / IMA_AZ9*.CSV IMA_RDR_L2_NEV / IMA_AZ9*.LBL IMA_RDR_L2_NEV / IMA_AZ10*.CSV IMA_RDR_L2_NEV / IMA_AZ10*.LBL : IMA_RDR_L2_NEV / IMA_AZ15*.CSV IMA_RDR_L2_NEV / IMA_AZ15*.LBL	These IMA files contain the PSA level 2, CODMAC level 3, IMA Azimuth anodes 0-15 energy x mass channel data in differential number flux units.
Data Set Release 2 Inter-Cruise (IC) Data Data taken during the cruise phase when Mars Express is closer to Mars than to Earth but before Mars Orbit Insertion. This includes all data for time period October 2003 through December 2003.	MEX-M-ASPERA3-2-EDR-IMA-V1.0 IMA_EDR_L1B_IC / IMA_AZ0*.CSV IMA_EDR_L1B_IC / IMA_AZ0*.LBL IMA_EDR_L1B_IC / IMA_AZ1*.CSV IMA_EDR_L1B_IC / IMA_AZ1*.LBL : IMA_EDR_L1B_IC / IMA_AZ9*.CSV IMA_EDR_L1B_IC / IMA_AZ9*.LBL IMA_EDR_L1B_IC / IMA_AZ10*.CSV IMA_EDR_L1B_IC / IMA_AZ10*.LBL : IMA_EDR_L1B_IC / IMA_AZ15*.CSV IMA_EDR_L1B_IC / IMA_AZ15*.LBL	These IMA files contain the PSA level 1b, CODMAC level 2, IMA Azimuth anodes 0-15 energy x mass channel data in raw counts.

Table 22: IMA Data Directory Contents

Data Set Release Time Period	Data Set ID Subdirectory / File Name	File Contents
	MEX-M-ASPERA3-3-RDR-IMA-V1.0 IMA_RDR_L2_IC / IMA_AZ0*.CSV IMA_RDR_L2_IC / IMA_AZ0*.LBL IMA_RDR_L2_IC / IMA_AZ1*.CSV IMA_RDR_L2_IC / IMA_AZ1*.LBL : IMA_RDR_L2_IC / IMA_AZ9*.CSV IMA_RDR_L2_IC / IMA_AZ9*.LBL IMA_RDR_L2_IC / IMA_AZ10*.CSV IMA_RDR_L2_IC / IMA_AZ10*.LBL : IMA_RDR_L2_IC / IMA_AZ15*.CSV IMA_RDR_L2_IC / IMA_AZ15*.LBL	These IMA files contain the PSA level 2, CODMAC level 3, IMA Azimuth anodes 0-15 energy x mass channel data in differential number flux units.
Data Set Release 3 January 2004 Data (JAN2004) Data taken during January 2004 – first Mars orbits.	MEX-M-ASPERA3-2-EDR-IMA-V1.0 IMA_EDR_L1B_JAN2004 / IMA_AZ0*.CSV IMA_EDR_L1B_JAN2004 / IMA_AZ0*.LBL IMA_EDR_L1B_JAN2004 / IMA_AZ1*.CSV IMA_EDR_L1B_JAN2004 / IMA_AZ1*.LBL : IMA_EDR_L1B_JAN2004 / IMA_AZ9*.CSV IMA_EDR_L1B_JAN2004 / IMA_AZ9*.LBL IMA_EDR_L1B_JAN2004 / IMA_AZ10*.CSV IMA_EDR_L1B_JAN2004 / IMA_AZ10*.LBL : IMA_EDR_L1B_JAN2004 / IMA_AZ15*.CSV IMA_EDR_L1B_JAN2004 / IMA_AZ15*.LB	These IMA files contain the PSA level 1b, CODMAC level 2, IMA Azimuth anodes 0-15 energy x mass channel data in raw counts.
	MEX-M-ASPERA3-3-RDR-IMA-V1.0 IMA_RDR_L2_JAN2004 / IMA_AZ0*.CSV IMA_RDR_L2_JAN2004 / IMA_AZ0*.LBL IMA_RDR_L2_JAN2004 / IMA_AZ1*.CSV IMA_RDR_L2_JAN2004 / IMA_AZ1*.LBL : IMA_RDR_L2_JAN2004 / IMA_AZ9*.CSV IMA_RDR_L2_JAN2004 / IMA_AZ9*.LBL IMA_RDR_L2_JAN2004 / IMA_AZ10*.CSV IMA_RDR_L2_JAN2004 / IMA_AZ10*.LBL : IMA_RDR_L2_JAN2004 / IMA_AZ15*.CSV IMA_RDR_L2_JAN2004 / IMA_AZ15*.LBL	These IMA files contain the PSA level 2, CODMAC level 3, IMA Azimuth anodes 0-15 energy x mass channel data in differential number flux units.

Table 22: IMA Data Directory Contents

Data Set Release Time Period	Data Set ID Subdirectory / File Name	File Contents
Data Set Release N, N > 3 Mars Data (MMMYYYY) Data taken during month MMM and year YYYY while orbiting Mars.	MEX-M-ASPERA3-2-EDR-IMA-V1.0 IMA_EDR_L1B_MMMYYYY / IMA_AZ0*.CSV IMA_EDR_L1B_MMMYYYY / IMA_AZ0*.LBL IMA_EDR_L1B_MMMYYYY / IMA_AZ1*.CSV IMA_EDR_L1B_MMMYYYY / IMA_AZ1*.LBL : IMA_EDR_L1B_MMMYYYY / IMA_AZ9*.CSV IMA_EDR_L1B_MMMYYYY / IMA_AZ9*.LBL IMA_EDR_L1B_MMMYYYY / IMA_AZ10*.CSV IMA_EDR_L1B_MMMYYYY / IMA_AZ10*.LBL : IMA_EDR_L1B_MMMYYYY / IMA_AZ15*.CSV IMA_EDR_L1B_MMMYYYY / IMA_AZ15*.LB	These IMA files contain the PSA level 1b, CODMAC level 2, IMA Azimuth anodes 0-15 energy x mass channel data in raw counts.
	MEX-M-ASPERA3-3-RDR-IMA-V1.0 IMA_RDR_L2_MMMYYYY / IMA_AZ0*.CSV IMA_RDR_L2_MMMYYYY / IMA_AZ0*.LBL IMA_RDR_L2_MMMYYYY / IMA_AZ1*.CSV IMA_RDR_L2_MMMYYYY / IMA_AZ1*.LBL : IMA_RDR_L2_MMMYYYY / IMA_AZ9*.CSV IMA_RDR_L2_MMMYYYY / IMA_AZ9*.LBL IMA_RDR_L2_MMMYYYY / IMA_AZ10*.CSV IMA_RDR_L2_MMMYYYY / IMA_AZ10*.LBL : IMA_RDR_L2_MMMYYYY / IMA_AZ15*.CSV IMA_RDR_L2_MMMYYYY / IMA_AZ15*.LBL	These IMA files contain the PSA level 2, CODMAC level 3, IMA Azimuth anodes 0-15 energy x mass channel data in differential number flux units.

4.3.3.1 ASPERA-3 IMA Data Product Formats

All IMA data products have the same format, and each row (data file record) in the IMA SPREADSHEET data products has eight (8) COLUMN objects. The VALUES COLUMN object has an ITEMS element, where ITEMS = 96 or 32 for IMA. The number of ITEMS in the VALUES object is the same for each data product, but can vary between data products. There are 32 SENSOR DATA TYPE NAME rows (records), one for each of the 32 mass channels, followed by a corresponding SCAN DATA TYPE NAME row. Each SCAN VALUE (center electron energy in eV) corresponds to the same ITEM element of the previous 32 SENSOR rows. Thus, the START TIME and STOP TIME are the same for the SENSOR records and corresponding SCAN record. The DATA QUALITY VALUE is only applicable for the SENSOR data. The 32 SENSOR rows and one SCAN row are followed by 9 rows (records) of mode data. All 9 rows of MODE DATA cover the same time period and correspond to the previous 32 SENSOR DATA TYPE NAME rows. The following table shows the contents of the columns for the different rows of the IMA data products.

Table 23: IMA Science Data File Contents and Structure

START TIME	STOP TIME	DATA TYPE NAME	DATA TYPE ID	DATA NAME	DATA UNIT	VALUES	DATA QUALITY VALUE
Sensor 0 Start Time	Sensor 0 Stop Time	SENSOR	1	Mass Channel 0	c/acc (raw, EDR) or cnts/(cm^2-sr-sec-eV) (diff. number flux, RDR)	ITEMS # of data values, Comma delimited	0, 1 or fill value, .LBL file has descriptions
Sensor 1 Start Time	Sensor 1 Stop Time	SENSOR	1	Mass Channel 1	c/acc (raw, EDR) or cnts/(cm^2-sr-sec-eV) (diff. number flux, RDR)	ITEMS # of data values, Comma delimited	0, 1, or fill value, .LBL file has descriptions
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Sensor 31 Start Time	Sensor 31 Stop Time	SENSOR	1	Mass Channel 31	c/acc (raw, EDR) or cnts/(cm^2-sr-sec-eV) (diff. number flux, RDR)	ITEMS # of data values, Comma delimited	0, 1, or fill value, .LBL file has descriptions
Start Time for previous 32 sensors	Stop Time for previous 32 sensors	SCAN	2	Electron Energy	Center energy in eV (Electron Volts)	ITEMS # of data values, Comma delimited	N/A
Start Time for previous sensor data	Stop Time for previous sensor data	MODE DATA	4	Shadow Mask	Unitless	0 – disabled 1 – enabled	N/A
Start Time for previous sensor data	Stop Time for previous sensor data	MODE DATA	4	High Voltage Mask	Unitless	0 – disabled 1 – enabled	N/A
Start Time for previous sensor data	Stop Time for previous sensor data	MODE DATA	4	Operational Index	Unitless	Indicates data mode	N/A
Start Time for previous sensor data	Stop Time for previous sensor data	MODE DATA	4	Solar Wind Start Index	Unitless	Starting index for 32-step mode	N/A
Start Time for previous sensor data	Stop Time for previous sensor data	MODE DATA	4	Polar Angle Index	Unitless	Polar angle step level (0-15)	N/A

Table 23: IMA Science Data File Contents and Structure

START TIME	STOP TIME	DATA TYPE NAME	DATA TYPE ID	DATA NAME	DATA UNIT	VALUES	DATA QUALITY VALUE
Start Time for previous sensor data	Stop Time for previous sensor data	MODE DATA	4	Azimuth Sum Mode	Unitless	0 – no sums 1 – every 2 2 – every 4 3 – every 8 4 – all 16	N/A
Start Time for previous sensor data	Stop Time for previous sensor data	MODE DATA	4	Polar Angle Sum Mode	Unitless	0 – no sums 1 – every 2 2 – every 4 3 – every 8 4 – all 16	N/A
Start Time for previous sensor data	Stop Time for previous sensor data	MODE DATA	4	Energy Cycle Mode	Unitless	0 – 96 steps 1 – 32 steps	N/A
Start Time for previous sensor data	Stop Time for previous sensor data	MODE DATA	4	Mass Channel Sum Mode	Unitless	0 – no sums 1 – every 2 2 – every 4	N/A

MODE DATA: The mode data give the state of the instrumentation as received in telemetry during the data sampling. These data are beneficial for data processing, and are included only for informational purposes in the archive.

4.3.3.2 IMA Sample Data Product Labels

Table 24: IMA Science Sample Label

```
PDS_VERSION_ID                = PDS3
RECORD_TYPE                   = STREAM
FILE_RECORDS                  = 11904

DATA_SET_ID                   = "MEX-M-ASPERA3-2-EDR-IMA-V1.0"
STANDARD_DATA_PRODUCT_ID      = "IMA_AZ0_C_ACC"
PRODUCT_ID                    = "IMA_AZ020032870902C_ACCS01"
PRODUCT_TYPE                  = "DATA"
PRODUCT_CREATION_TIME         = 2004-11-23T17:06:19
RELEASE_ID                    = 0002
REVISION_ID                   = 0000

START_TIME                    = 2003-287T09:02:50.420
STOP_TIME                     = 2003-287T10:42:02.344
SPACECRAFT_CLOCK_START_COUNT = "1/0014202163.26623"
SPACECRAFT_CLOCK_STOP_COUNT  = "1/0014208115.21634"

INSTRUMENT_HOST_NAME          = "MARS EXPRESS"
INSTRUMENT_HOST_ID            = "MEX"
MISSION_PHASE_NAME            = "IC"
MISSION_NAME                  = "MARS EXPRESS"
TARGET_NAME                   = "SOLAR WIND"
TARGET_TYPE                   = "PLASMA CLOUD"
ORBIT_NUMBER                  = "N/A"
INSTRUMENT_NAME               = "
        ANALYZER OF SPACE PLASMA AND ENERGETIC ATOMS (3RD VERSION)"
INSTRUMENT_ID                 = "ASPERA-3"
PRODUCER_ID                   = "SJEFFERS"
PRODUCER_FULL_NAME            = "SANDEE JEFFERS"

NOTE                          = "
    IMA_AZ020032870902C_ACCS01.CSV contains Mars Express ASPERA-3 data
    from the Ion Mass Analyzer (IMA) for azimuth anode 0 (c/acc) in all
    mass channels (0-31) in energy range (1 eV - 40 keV).
    The file covers the time period 2003-287 09:02:50.420 to
    2003-287 10:42:02.344 (orbit(s) N/A)."

DESCRIPTION                   = "
    This file contains data from IMA_AZ0:  Ion Mass Analyzer (IMA)
    azimuth anode 0 (AZ0) data from all mass channels (0-31) with energy
    range of 1 eV to 40 keV.  The center energies (eV) of the energy range
    are the SCAN values determined for all the SENSORs (Mass channels).
    The SCAN row directly corresponds to the previous SENSOR rows where
    the SENSOR value (c/acc) in a given column is the data sampled at
    the SCAN value (center eV) in that same column.  The SENSOR rows
    have one more column than the SCAN row.  The additional column is
    the data quality indicator (last column) for that sensor data.
    Please refer to the Data Set Catalog, ASPERA3_EDR_IMA_DS.CAT, for
    detailed information about the data organization, science meaning,
    data quality determination, data modes, etc."

^SPREADSHEET             = "IMA_AZ020032870902C_ACCS01.CSV"
OBJECT                        = SPREADSHEET
  INTERCHANGE_FORMAT          = ASCII
  ROWS                        = 11904
  FIELDS                      = 8
  ROW_BYTES                   = 1525 /* longest row, <CR><LF> too.*/
  FIELD_DELIMITER             = "COMMA"

  OBJECT                      = FIELD
```

```
    NAME                     = "START TIME"
    FIELD_NUMBER             = 1
    DATA_TYPE                = TIME
    BYTES                    = 21
    DESCRIPTION              = "
      The START TIME field specifies the start time of the data
      sample(s) being returned in the current row in UTC.  The fields
      START TIME and STOP TIME define the time range covered by the
      samples contained on the current row."
  END_OBJECT                 = FIELD

  OBJECT                     = FIELD
    NAME                     = "STOP TIME"
    FIELD_NUMBER             = 2
    DATA_TYPE                = TIME
    BYTES                    = 21
    DESCRIPTION              = "
      The STOP TIME field specifies the stop time of the data
      sample(s) being returned in the current row in UTC.  The fields
      START TIME and STOP TIME define the time range covered by the
      samples contained on the current row."
  END_OBJECT                 = FIELD

  OBJECT                     = FIELD
    NAME                     = "DATA TYPE NAME"
    FIELD_NUMBER             = 3
    DATA_TYPE                = CHARACTER
    BYTES                    = 11 /* does not include double quotes */
    FORMAT                   = "A11"
    DESCRIPTION              = "
      The DATA TYPE NAME field identifies the type of data sample(s)
      being returned in the current row.  Valid entries include:
           SENSOR       - primary data
           SCAN         - center scan data associated with the primary data
           CALIBRATION  - calibration data associated with the primary data
           MODE DATA    - instrument status (mode) data
           PITCH ANGLE  - pitch angle data associated with the primary data
           START AZ     - start azimuthal angle data associated with the
                          primary data.  The values are always between
                          0 and 360 degrees.
           STOP AZ      - stop azimuthal angle data associated with the
                          primary data.  The values could be negative or
                          could be greater than 360 degrees.
      For example, if the data type name of the row is SENSOR, then the data
      within that row contains the primary sensor data being returned."
  END_OBJECT                 = FIELD

  OBJECT                     = FIELD
    NAME                     = "DATA TYPE ID"
    FIELD_NUMBER             = 4
    DATA_TYPE                = ASCII_INTEGER
    BYTES                    = 1
    FORMAT                   = "I1"
    DESCRIPTION              = "
      The DATA TYPE ID field identifies the type of data sample(s)
      being returned in the current row.  It is equivalent to the
      DATA TYPE NAME field, except expressed as an integer instead
      of a string.  Valid entries include:
           1 - primary data
           2 - center scan data associated with the primary data
           3 - calibration data associated with the primary data
           4 - instrument status (mode) data
           6 - pitch angle data associated with the primary data
           7 - start azimuthal angle data associated with the primary
               data.  The values are always between 0 and 360 degrees.
           8 - stop azimuthal angle data associated with the primary
               data.  The values could be negative or could be greater
```

```
              than 360 degrees.
      For example, if the data type id of the row is 1, then the data
      within that row contains the primary sensor data being returned."
  END_OBJECT                 = FIELD

  OBJECT                     = FIELD
    NAME                     = "DATA NAME"
    FIELD_NUMBER             = 5
    DATA_TYPE                = CHARACTER
    BYTES                    = 50 /* does not include double quotes */
    FORMAT                   = "A50"
    DESCRIPTION              = "
      The DATA NAME field identifies the name of the data
      parameter being returned in the current row."
  END_OBJECT                 = FIELD

  OBJECT                     = FIELD
    NAME                     = "DATA UNIT"
    FIELD_NUMBER             = 6
    DATA_TYPE                = CHARACTER
    BYTES                    = 50 /* double quotes not included */
    FORMAT                   = "A50"
    DESCRIPTION              = "
      The DATA UNIT field identifies the units that the data
      values are expressed in for the current row."
  END_OBJECT                 = FIELD

  OBJECT                     = FIELD
    NAME                     = "VALUES"
    FIELD_NUMBER             = 7
    DATA_TYPE                = ASCII_REAL
    BYTES                    = 1343 /* including delimiters */
    ITEMS                    = 96
    ITEM_BYTES               = 13
    FORMAT                   = "E13.6"
    DESCRIPTION              = "
      This field contains the data values associated with the data items
      being returned.  The field DATA TYPE NAME identifies the type of data
      being returned."
  END_OBJECT                 = FIELD

  OBJECT                     = FIELD
    NAME                     = "DATA QUALITY VALUE"
    FIELD_NUMBER             = 8
    DATA_TYPE                = ASCII_REAL
    BYTES                    = 13
    FORMAT                   = "E13.6"
    DESCRIPTION              = "
      This field contains the data quality value associated with the data
      being returned.  Valid values include:
              0 - Good Data
              1 - Bad Data
      Refer to the data set catalog file for a more in-depth explanation
      of how the setting of these values are determined."
  END_OBJECT                 = FIELD
END_OBJECT                   = SPREADSHEET

END
```

4.3.4 Data Product NPI Design

All NPI data on an archive volume are in the DATA directory. Each data set delivery release adds a new subdirectory of data to the DATA directory. All NPI data are in .CSV format with associated detached PDS .LBL files. The following table indicates the DATA subdirectories and contents of the NPI data sets.

Table 25: NPI Data Directory Contents

Data Set Release Time Period	Data Set ID Subdirectory / File Name	File Contents
Data Set Release 1 Near Earth Verification (NEV) Data Data taken during the cruise phase when Mars Express is closer to Earth than to Mars. This is mostly the NEV data but includes all data for time period June 2003 through September 2003.	MEX-M-ASPERA3-2-EDR-NPI-V1.0 NPI_EDR_L1B_NEV / NPINORM*.CSV NPI_EDR_L1B_NEV / NPINORM*.LBL	These NPI files contain the PSA level 1b, CODMAC level 2 normal mode data in counts/accumulation.
	MEX-M-ASPERA3-3-RDR-NPI-V1.0 NPI_RDR_L2_NEV / NPINORM*.CSV NPI_RDR_L2_NEV / NPINORM*.LBL	These NPI files contain the PSA level 2, CODMAC level 3 normal mode data in counts/second (count rate).
Data Set Release 2 Inter-Cruise (IC) Data Data taken during the cruise phase when Mars Express is closer to Mars than to Earth but before Mars Orbit Insertion. This includes all data for time period October 2003 through December 2003.	MEX-M-ASPERA3-2-EDR-NPI-V1.0 NPI_EDR_L1B_IC / NPINROM*.CSV NPI_EDR_L1B_IC / NPINORM*.LBL	These NPI files contain the PSA level 1b, CODMAC level 2 normal mode data in counts/accumulation.
	MEX-M-ASPERA3-3-RDR-NPI-V1.0 NPI_RDR_L2_IC / NPINORM*.CSV NPI_RDR_L2_IC / NPINORM*.LBL	These NPI files contain the PSA level 2, CODMAC level 3 normal mode data in counts/second (count rate).
Data Set Release 3 January 2004 Data (JAN2004) Data taken during January 2004 – first Mars orbits.	MEX-M-ASPERA3-2-EDR-NPI-V1.0 NPI_EDR_L1B_JAN2004 / NPINORM*.CSV NPI_EDR_L1B_JAN2004 / NPINORM*.LBL	These NPI files contain the PSA level 1b, CODMAC level 2 normal mode data in counts/accumulation.
	MEX-M-ASPERA3-3-RDR-NPI-V1.0 NPI_RDR_L2_JAN2004 / NPINORM*.CSV NPI_RDR_L2_JAN2004 / NPINORM*.LBL	These NPI files contain the PSA level 2, CODMAC level 3 normal mode data in counts/second (count rate).
Data Set Release N, N > 3 Mars Data (MMMYYYY) Data taken during month MMM and year YYYY while orbiting Mars.	MEX-M-ASPERA3-2-EDR-NPI-V1.0 NPI_EDR_L1B_MMMYYYY / NPINORM*.CSV NPI_EDR_L1B_MMMYYYY / NPINORM*.LBL	These NPI files contain the PSA level 1b, CODMAC level 2 normal mode data in counts/accumulation.
	MEX-M-ASPERA3-3-RDR-NPI-V1.0 NPI_RDR_L2_MMMYYYY / NPINORM*.CSV NPI_RDR_L2_MMMYYYY / NPINORM*.LBL	These NPI files contain the PSA level 2, CODMAC level 3 normal mode data in counts/second (count rate).

4.3.4.1 ASPERA-3 NPI Data Product Formats

All NPI data products have the same format, and each row (data file record) in the NPI SPREADSHEET data products has eight (8) COLUMN objects. The VALUES COLUMN object has an ITEMS element, where ITEMS = 1 for NPI. There are 32 SENSOR rows, one for each NPI sector, followed by 40 rows (records) of mode data. All 40 rows of MODE DATA cover the same time period and correspond to the previous 32 SENSOR DATA TYPE NAME rows. The following table shows the contents of the columns for the NPI data product rows.

Table 26: NPI Science Data File Contents and Structure

START TIME	STOP TIME	DATA TYPE NAME	DATA TYPE ID	DATA NAME	DATA UNIT	VALUES	DATA QUALITY VALUE
Sensor 0 Start Time	Sensor 0 Stop Time	SENSOR	1	NPI Sector 0	cnts/acc (EDR) or cnts/sec (RDR)	1 Value per sector (row)	0 – 4 and fill value, .LBL file has descriptions
Sensor 1 Start Time	Sensor 1 Stop Time	SENSOR	1	NPI Sector 1	cnts/acc (EDR) or cnts/sec (RDR)	1 Value per sector (row)	0 – 4 and fill value, .LBL file has descriptions
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Sensor 31 Start Time	Sensor 31 Stop Time	SENSOR	1	NPI Sector 31	cnts/acc (EDR) or cnts/sec (RDR)	1 Value per sector (row)	0 – 4 and fill value, .LBL file has descriptions
Start Time for previous sensor data	Stop Time for previous sensor data	MODE DATA	4	Software Version – Upper Byte	Unitless	Upper byte of flight s/w version	N/A
Start Time for previous sensor data	Stop Time for previous sensor data	MODE DATA	4	Software Version – Lower Byte	Unitless	Lower byte of flight s/w version	N/A
Start Time for previous sensor data	Stop Time for previous sensor data	MODE DATA	4	Software Mode	Unitless	0 – off 1 – booting 2 – safe 3 – PROM 4 - normal	N/A
Start Time for previous sensor data	Stop Time for previous sensor data	MODE DATA	4	Log Compression Enabled	Unitless	0 – disabled 1 – enabled	N/A

Table 26: NPI Science Data File Contents and Structure

START TIME	STOP TIME	DATA TYPE NAME	DATA TYPE ID	DATA NAME	DATA UNIT	VALUES	DATA QUALITY VALUE
Start Time for previous sensor data	Stop Time for previous sensor data	MODE DATA	4	RICE Compression Enabled	Unitless	0 – disabled 1 – enabled	N/A
Start Time for previous sensor data	Stop Time for previous sensor data	MODE DATA	4	Accumulation Time	Unitless	N = 0-15, power of 2 to calculate data accumulation time in secs: $2^N * 0.03125$	N/A
Start Time for previous sensor data	Stop Time for previous sensor data	MODE DATA	4	Sector 0 Enable	Unitless	0 – disabled 1 – enabled	N/A
Start Time for previous sensor data	Stop Time for previous sensor data	MODE DATA	4	Sector 1 Enable	Unitless	0 – disabled 1 – enabled	N/A
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Start Time for previous sensor data	Stop Time for previous sensor data	MODE DATA	4	Sector 31 Enable	Unitless	0 – disabled 1 – enabled	N/A
Start Time for previous sensor data	Stop Time for previous sensor data	MODE DATA	4	Number of Active Anodes	Unitless	0 – 32; number of enabled sectors	N/A
Start Time for previous sensor data	Stop Time for previous sensor data	MODE DATA	4	NPI MCP Mode	Unitless	0 – > -2350V 1 – -2350V to -2450V 2 – -2450V to -2550V 3 – -2550V to -2650V	N/A

MODE DATA: The mode data give the state of the instrumentation as received in telemetry during the data sampling. These data are beneficial for data processing, and are included only for informational purposes in the archive.

4.3.4.2 NPI Sample Data Product Labels

Table 27: NPI Science Sample Label

```
PDS_VERSION_ID                = PDS3
RECORD_TYPE                   = STREAM
FILE_RECORDS                  = 1064

DATA_SET_ID                   = "MEX-M-ASPERA3-2-EDR-NPI-V1.0"
STANDARD_DATA_PRODUCT_ID      = "NPINORM_C_ACC"
PRODUCT_ID                    = "NPINORM20040212052C_ACC01"
PRODUCT_TYPE                  = "DATA"
PRODUCT_CREATION_TIME         = 2004-11-30T20:37:17
RELEASE_ID                    = 0003
REVISION_ID                   = 0000

START_TIME                    = 2004-021T20:52:26.985
STOP_TIME                     = 2004-021T20:52:58.985
SPACECRAFT_CLOCK_START_COUNT = "1/0022798340.01504"
SPACECRAFT_CLOCK_STOP_COUNT  = "1/0022798372.01504"

INSTRUMENT_HOST_NAME          = "MARS EXPRESS"
INSTRUMENT_HOST_ID            = "MEX"
MISSION_PHASE_NAME            = "MC Phase 1"
MISSION_NAME                  = "MARS EXPRESS"
TARGET_NAME                   = "MARS"
TARGET_TYPE                   = "PLANET"
ORBIT_NUMBER                  = 38
INSTRUMENT_NAME               = "
        ANALYZER OF SPACE PLASMA AND ENERGETIC ATOMS (3RD VERSION)"
INSTRUMENT_ID                 = "ASPERA-3"
PRODUCER_ID                   = "SJEFFERS"
PRODUCER_FULL_NAME            = "SANDEE JEFFERS"

NOTE                          = "
    NPINORM20040212052C_ACC01.CSV contains Mars Express ASPERA-3 data
    from the Neutral Particle Imager (NPI) in c/acc sampled in the
    energy range of 0.1 keV to 60 keV.
    The file covers the time period 2004-021 20:52:26.985 to
    2004-021 20:52:58.985 (orbit(s) 38)."

DESCRIPTION                   = "
    This file contains data for NPINORM: Neutral Particle Imager (NPI)
    normal instrument mode (NORM).  There are 32 azimuthal sectors and
    data are sampled in the energy range of 0.1 keV to 60 keV. Each row
    contains a single data value (SENSOR) in c/acc corresponding to one
    of the 32 azimuthal sectors, followed by a data quality indicator.
    The NPI Instrument is stationary (not rotating) for this data – the
    ASPERA-3 scanning unit is parked and has not yet been turned on.
    Please refer to the Data Set Catalog, ASPERA3_EDR_NPI_DS.CAT, for
    detailed information about data organization, science meaning, data
    quality determination, data modes, etc."

^SPREADSHEET             = "NPINORM20040212052C_ACC01.CSV"
OBJECT                        = SPREADSHEET
  INTERCHANGE_FORMAT          = ASCII
  ROWS                        = 1064
  FIELDS                      = 8
  ROW_BYTES                   = 195 /* longest row, <CR><LF> too.*/
  FIELD_DELIMITER             = "COMMA"

  OBJECT                      = FIELD
    NAME                      = "START TIME"
    FIELD_NUMBER              = 1
```

```
    DATA_TYPE                 = TIME
    BYTES                     = 21
    DESCRIPTION               = "
      The START TIME field specifies the start time of the data
      sample(s) being returned in the current row in UTC.  The fields
      START TIME and STOP TIME define the time range covered by the
      samples contained on the current row."
  END_OBJECT                  = FIELD

  OBJECT                      = FIELD
    NAME                      = "STOP TIME"
    FIELD_NUMBER              = 2
    DATA_TYPE                 = TIME
    BYTES                     = 21
    DESCRIPTION               = "
      The STOP TIME field specifies the stop time of the data
      sample(s) being returned in the current row in UTC.  The fields
      START TIME and STOP TIME define the time range covered by the
      samples contained on the current row."
  END_OBJECT                  = FIELD

  OBJECT                      = FIELD
    NAME                      = "DATA TYPE NAME"
    FIELD_NUMBER              = 3
    DATA_TYPE                 = CHARACTER
    BYTES                     = 11 /* does not include double quotes */
    FORMAT                    = "A11"
    DESCRIPTION               = "
      The DATA TYPE NAME field identifies the type of data sample(s)
      being returned in the current row.  Valid entries include:
           SENSOR       - primary data
           SCAN         - center scan data associated with the primary data
           CALIBRATION  - calibration data associated with the primary data
           MODE DATA    - instrument status (mode) data
           PITCH ANGLE  - pitch angle data associated with the primary data
           START AZ     - start azimuthal angle data associated with the
                          primary data.  The values are always between
                          0 and 360 degrees.
           STOP AZ      - stop azimuthal angle data associated with the
                          primary data.  The values could be negative or
                          could be greater than 360 degrees.
      For example, if the data type name of the row is SENSOR, then the data
      within that row contains the primary sensor data being returned."
  END_OBJECT                  = FIELD

  OBJECT                      = FIELD
    NAME                      = "DATA TYPE ID"
    FIELD_NUMBER              = 4
    DATA_TYPE                 = ASCII_INTEGER
    BYTES                     = 1
    FORMAT                    = "I1"
    DESCRIPTION               = "
      The DATA TYPE ID field identifies the type of data sample(s)
      being returned in the current row.  It is equivalent to the
      DATA TYPE NAME field, except expressed as an integer instead
      of a string.  Valid entries include:
           1 - primary data
           2 - center scan data associated with the primary data
           3 - calibration data associated with the primary data
           4 - instrument status (mode) data
           6 - pitch angle data associated with the primary data
           7 - start azimuthal angle data associated with the primary
               data.  The values are always between 0 and 360 degrees.
           8 - stop azimuthal angle data associated with the primary
               data.  The values could be negative or could be greater
               than 360 degrees.
      For example, if the data type id of the row is 1, then the data
```

```
      within that row contains the primary sensor data being returned."
  END_OBJECT                  = FIELD

  OBJECT                      = FIELD
    NAME                      = "DATA NAME"
    FIELD_NUMBER              = 5
    DATA_TYPE                 = CHARACTER
    BYTES                     = 50 /* does not include double quotes */
    FORMAT                    = "A50"
    DESCRIPTION               = "
      The DATA NAME field identifies the name of the data
      parameter being returned in the current row."
  END_OBJECT                  = FIELD

  OBJECT                      = FIELD
    NAME                      = "DATA UNIT"
    FIELD_NUMBER              = 6
    DATA_TYPE                 = CHARACTER
    BYTES                     = 50 /* double quotes not included */
    FORMAT                    = "A50"
    DESCRIPTION               = "
      The DATA UNIT field identifies the units that the data
      values are expressed in for the current row."
  END_OBJECT                  = FIELD

  OBJECT                      = FIELD
    NAME                      = "VALUES"
    FIELD_NUMBER              = 7
    DATA_TYPE                 = ASCII_REAL
    BYTES                     = 13 /* including delimiters */
    ITEMS                     = 1
    ITEM_BYTES                = 13
    FORMAT                    = "E13.6"
    DESCRIPTION               = "
      This field contains the data values associated with the data items
      being returned.  The field DATA TYPE NAME identifies the type of data
      being returned."
  END_OBJECT                  = FIELD

  OBJECT                      = FIELD
    NAME                      = "DATA QUALITY VALUE"
    FIELD_NUMBER              = 8
    DATA_TYPE                 = ASCII_REAL
    BYTES                     = 13
    FORMAT                    = "E13.6"
    DESCRIPTION               = "
      This field contains the data quality value associated with the data
      being returned.  Valid values include:
              0 - Good Data
              1 - Questionable Data
              2 - Invalid Data
              3 - Bad Data
              4 - Unknown State
      -3.40e+38 – Data Is Not Available
      Refer to the data set catalog file for a more in-depth explanation
      of how the setting of these values are determined."
  END_OBJECT                  = FIELD
END_OBJECT                    = SPREADSHEET

END
```

4.3.5 Data Product NPD Design

All NPD data on an archive volume are in the DATA directory. Each data set delivery release adds a new subdirectory of data to the DATA directory. All NPD data are in .CSV format with associated detached PDS .LBL files. The following table indicates the DATA subdirectories and contents of the NPD data sets.

Table 28: NPD Data Directory Contents: TBD

Data Set Release Time Period	Data Set ID Subdirectory / File Name	File Contents
Data Set Release 1 Near Earth Verification (NEV) Data Data taken during the cruise phase when Mars Express is closer to Earth than to Mars. This is mostly the NEV data but includes all data for time period June 2003 through September 2003.	MEX-M-ASPERA3-2-EDR-NPD-V1.0 NPD_EDR_L1B_NEV / NPD1RAW*.CSV NPD_EDR_L1B_NEV / NPD1RAW*.LBL NPD_EDR_L1B_NEV / NPD1TOF*.CSV NPD_EDR_L1B_NEV / NPD1TOF*.LBL NPD_EDR_L1B_NEV / NPD1BM1*.CSV NPD_EDR_L1B_NEV / NPD1BM1*.LBL NPD_EDR_L1B_NEV / NPD2RAW*.CSV NPD_EDR_L1B_NEV / NPD2RAW*.LBL NPD_EDR_L1B_NEV / NPD2TOF*.CSV NPD_EDR_L1B_NEV / NPD2TOF*.LBL NPD_EDR_L1B_NEV / NPD2BM1*.CSV NPD_EDR_L1B_NEV / NPD2BM1*.LBL	These NPD files contain the PSA level 1b, CODMAC level 2 RAW, TOF, and Bin Matrix mode data in counts/accumulation for NPD1 and NPD2.
	MEX-M-ASPERA3-3-RDR-NPD-V1.0 NPD_RDR_L2_NEV / NPD1RAW*.CSV NPD_RDR_L2_NEV / NPD1RAW*.LBL NPD_RDR_L2_NEV / NPD1TOF*.CSV NPD_RDR_L2_NEV / NPD1TOF*.LBL NPD_RDR_L2_NEV / NPD1BM1*.CSV NPD_RDR_L2_NEV / NPD1BM1*.LBL NPD_RDR_L2_NEV / NPD2RAW*.CSV NPD_RDR_L2_NEV / NPD2RAW*.LBL NPD_RDR_L2_NEV / NPD2TOF*.CSV NPD_RDR_L2_NEV / NPD2TOF*.LBL NPD_RDR_L2_NEV / NPD2BM1*.CSV NPD_RDR_L2_NEV / NPD2BM1*.LBL NPD_RDR_L2_NEV / TBD*.CSV NPD_RDR_L2_NEV / TBD*.LBL	These NPD files contain the PSA level 2, CODMAC level 3 RAW, TOF, and Bin Matrix mode data in counts/second (count rate) for NPD1 and NPD2. NPD re-binned RAW mode spectra data TBD

Table 28: NPD Data Directory Contents: TBD

Data Set Release Time Period	Data Set ID Subdirectory / File Name	File Contents
Data Set Release 2 Inter-Cruise (IC) Data Data taken during the cruise phase when Mars Express is closer to Mars than to Earth but before Mars Orbit Insertion. This includes all data for time period October 2003 through December 2003.	MEX-M-ASPERA3-2-EDR-NPD-V1.0 NPD_EDR_L1B_IC / NPD1RAW*.CSV NPD_EDR_L1B_IC / NPD1RAW*.LBL NPD_EDR_L1B_IC / NPD1TOF*.CSV NPD_EDR_L1B_IC / NPD1TOF*.LBL NPD_EDR_L1B_IC / NPD1BM1*.CSV NPD_EDR_L1B_IC / NPD1BM1*.LBL NPD_EDR_L1B_IC / NPD2RAW*.CSV NPD_EDR_L1B_IC / NPD2RAW*.LBL NPD_EDR_L1B_IC / NPD2TOF*.CSV NPD_EDR_L1B_IC / NPD2TOF*.LBL NPD_EDR_L1B_IC / NPD2BM1*.CSV NPD_EDR_L1B_IC / NPD2BM1*.LBL	These NPD files contain the PSA level 1b, CODMAC level 2 RAW, TOF, and Bin Matrix mode data in counts/accumulation for NPD1 and NPD2.
	MEX-M-ASPERA3-3-RDR-NPD-V1.0 NPD_RDR_L2_IC / NPD1RAW*.CSV NPD_RDR_L2_IC / NPD1RAW*.LBL NPD_RDR_L2_IC / NPD1TOF*.CSV NPD_RDR_L2_IC / NPD1TOF*.LBL NPD_RDR_L2_IC / NPD1BM1*.CSV NPD_RDR_L2_IC / NPD1BM1*.LBL NPD_RDR_L2_IC / NPD2RAW*.CSV NPD_RDR_L2_IC / NPD2RAW*.LBL NPD_RDR_L2_IC / NPD2TOF*.CSV NPD_RDR_L2_IC / NPD2TOF*.LBL NPD_RDR_L2_IC / NPD2BM1*.CSV NPD_RDR_L2_IC / NPD2BM1*.LBL NPD_RDR_L2_IC / TBD*.CSV NPD_RDR_L2_IC / TBD*.LBL	These NPD files contain the PSA level 2, CODMAC level 3 RAW, TOF, and Bin Matrix mode data in counts/second (count rate) for NPD1 and NPD2. NPD re-binned RAW mode spectra data TBD
Data Set Release 3 January 2004 Data (JAN2004) Data taken during January 2004 – first Mars orbits.	MEX-M-ASPERA3-2-EDR-NPD-V1.0 NPD_EDR_L1B_JAN2004 / NPD1RAW*.CSV NPD_EDR_L1B_JAN2004 / NPD1RAW*.LBL NPD_EDR_L1B_JAN2004 / NPD1TOF*.CSV NPD_EDR_L1B_JAN2004 / NPD1TOF*.LBL NPD_EDR_L1B_JAN2004 / NPD1BM1*.CSV NPD_EDR_L1B_JAN2004 / NPD1BM1*.LBL NPD_EDR_L1B_JAN2004 / NPD2RAW*.CSV NPD_EDR_L1B_JAN2004 / NPD2RAW*.LBL NPD_EDR_L1B_JAN2004 / NPD2TOF*.CSV NPD_EDR_L1B_JAN2004 / NPD2TOF*.LBL NPD_EDR_L1B_JAN2004 / NPD2BM1*.CSV NPD_EDR_L1B_JAN2004 / NPD2BM1*.LBL	These NPD files contain the PSA level 1b, CODMAC level 2 RAW, TOF, and Bin Matrix mode data in counts/accumulation for NPD1 and NPD2.

<table>
<tr><th colspan="3">Table 28: NPD Data Directory Contents: TBD</th></tr>
<tr><th>Data Set Release
Time Period</th><th>Data Set ID
Subdirectory / File Name</th><th>File Contents</th></tr>
<tr><td></td><td>MEX-M-ASPERA3-3-RDR-NPD-V1.0
NPD_RDR_L2_JAN2004 / NPD1RAW*.CSV
NPD_RDR_L2_JAN2004 / NPD1RAW*.LBL
NPD_RDR_L2_JAN2004 / NPD1TOF*.CSV
NPD_RDR_L2_JAN2004 / NPD1TOF*.LBL
NPD_RDR_L2_JAN2004 / NPD1BM1*.CSV
NPD_RDR_L2_JAN2004 / NPD1BM1*.LBL
NPD_RDR_L2_JAN2004 / NPD2RAW*.CSV
NPD_RDR_L2_JAN2004 / NPD2RAW*.LBL
NPD_RDR_L2_JAN2004 / NPD2TOF*.CSV
NPD_RDR_L2_JAN2004 / NPD2TOF*.LBL
NPD_RDR_L2_JAN2004 / NPD2BM1*.CSV
NPD_RDR_L2_JAN2004 / NPD2BM1*.LBL
NPD_RDR_L2_JAN2004 / TBD*.CSV
NPD_RDR_L2_JAN2004 / TBD*.LBL</td><td>These NPD files contain the PSA level 2, CODMAC level 3 RAW, TOF, and Bin Matrix mode data in counts/second (count rate) for NPD1 and NPD2.
NPD re-binned RAW mode spectra data TBD</td></tr>
<tr><td rowspan="2">Data Set Release N, N > 3
Mars Data (MMMYYYY)
Data taken during month MMM and year YYYY while orbiting Mars.</td><td>MEX-M-ASPERA3-2-EDR-NPD-V1.0
NPD_EDR_L1B_MMMYYYY / NPD1RAW*.CSV
NPD_EDR_L1B_MMMYYYY / NPD1RAW*.LBL
NPD_EDR_L1B_MMMYYYY / NPD1TOF*.CSV
NPD_EDR_L1B_MMMYYYY / NPD1TOF*.LBL
NPD_EDR_L1B_MMMYYYY / NPD1BM1*.CSV
NPD_EDR_L1B_MMMYYYY / NPD1BM1*.LBL
NPD_EDR_L1B_MMMYYYY / NPD2RAW*.CSV
NPD_EDR_L1B_MMMYYYY / NPD2RAW*.LBL
NPD_EDR_L1B_MMMYYYY / NPD2TOF*.CSV
NPD_EDR_L1B_MMMYYYY / NPD2TOF*.LBL
NPD_EDR_L1B_MMMYYYY / NPD2BM1*.CSV
NPD_EDR_L1B_MMMYYYY / NPD2BM1*.LBL</td><td>These NPD files contain the PSA level 1b, CODMAC level 2 RAW, TOF, and Bin Matrix mode data in counts/accumulation for NPD1 and NPD2.</td></tr>
<tr><td>MEX-M-ASPERA3-3-RDR-NPD-V1.0
NPD_RDR_L2_MMMYYYY / NPD1RAW*.CSV
NPD_RDR_L2_MMMYYYY / NPD1RAW*.LBL
NPD_RDR_L2_MMMYYYY / NPD1TOF*.CSV
NPD_RDR_L2_MMMYYYY / NPD1TOF*.LBL
NPD_RDR_L2_MMMYYYY / NPD1BM1*.CSV
NPD_RDR_L2_MMMYYYY / NPD1BM1*.LBL
NPD_RDR_L2_MMMYYYY / NPD2RAW*.CSV
NPD_RDR_L2_MMMYYYY / NPD2RAW*.LBL
NPD_RDR_L2_MMMYYYY / NPD2TOF*.CSV
NPD_RDR_L2_MMMYYYY / NPD2TOF*.LBL
NPD_RDR_L2_MMMYYYY / NPD2BM1*.CSV
NPD_RDR_L2_MMMYYYY / NPD2BM1*.LBL
NPD_RDR_L2_MMMYYYY / TBD*.CSV
NPD_RDR_L2_MMMYYYY / TBD*.LBL</td><td>These NPD files contain the PSA level 2, CODMAC level 3 RAW, TOF, and Bin Matrix mode data in counts/second (count rate) for NPD1 and NPD2.
NPD re-binned RAW mode spectra data TBD</td></tr>
</table>

4.3.5.1 ASPERA-3 NPD Data Product Formats

All NPD data products have the same format, and each row (data file record) in the NPD SPREADSHEET data products has eight (8) COLUMN objects.

TBD

Table 29: NPD Science Data File Contents and Structure TBD

START TIME	STOP TIME	DATA TYPE NAME	DATA TYPE ID	DATA NAME	DATA UNIT	VALUES	DATA QUALITY VALUE

4.3.5.2 NPD Sample Data Product Labels

Table 30: NPD Science Sample Label: TBD

```
PDS_VERSION_ID                = PDS3
RECORD_TYPE                   = STREAM
FILE_RECORDS                  = 15183168

DATA_SET_ID                   = "MEX-M-ASPERA3-2-EDR-NPD-V1.0"
STANDARD_DATA_PRODUCT_ID      = "NPD1RAW_RAW"
PRODUCT_ID                    = "NPD1RAW20031902308RAW01"
PRODUCT_TYPE                  = "DATA"
PRODUCT_CREATION_TIME         = 2004-11-30T17:12:20
RELEASE_ID                    = 0001
REVISION_ID                   = 0000

START_TIME                    = 2003-190T23:08:36.307
STOP_TIME                     = 2003-191T01:12:25.215
SPACECRAFT_CLOCK_START_COUNT = "1/0005872109.28972"
SPACECRAFT_CLOCK_STOP_COUNT  = "1/0005879538.22878"

INSTRUMENT_HOST_NAME          = "MARS EXPRESS"
INSTRUMENT_HOST_ID            = "MEX"
MISSION_PHASE_NAME            = "IC"
MISSION_NAME                  = "MARS EXPRESS"
TARGET_NAME                   = "SOLAR WIND"
TARGET_TYPE                   = "PLASMA CLOUD"
ORBIT_NUMBER                  = "N/A"
INSTRUMENT_NAME               = "
        ANALYZER OF SPACE PLASMA AND ENERGETIC ATOMS (3RD VERSION)"
INSTRUMENT_ID                 = "ASPERA-3"
PRODUCER_ID                   = "SJEFFERS"
PRODUCER_FULL_NAME            = "SANDEE JEFFERS"

NOTE                          = "
    NPD1RAW20031902308RAW01.CSV contains Mars Express ASPERA-3 data
    from the Neutral Particle Detector 1 (NPD1) taken in RAW event
    mode and represented in raw units. There are four data values:
    Time Of Flight, Direction, Coincidence, and Stop Pulse Height.
    The file covers the time period 2003-190 23:08:36.307 to
    2003-191 01:12:25.215 (orbit(s) N/A)."

DESCRIPTION                   = "
    This file contains data from NPD1RAW:  Neutral Particle Detector 1
    (NPD1) RAW event mode. There are four data values:  Time of Flight,
    Direction, Coincidence, and Stop Pulse Height.  Each row contains
    a single data value (SENSOR) in raw units corresponding to one of
    the four data values, followed by a data quality indicator.  Please
    refer to the Data Set Catalog, ASPERA3_EDR_NPD_DS.CAT, for detailed
    information about the data organization, science meaning, data
    quality determination, data modes, etc."

^SPREADSHEET             = "NPD1RAW20031902308RAW01.CSV"
OBJECT                        = SPREADSHEET
  INTERCHANGE_FORMAT          = ASCII
  ROWS                        = 15183168
  FIELDS                      = 8
  ROW_BYTES                   = 195 /* longest row, <CR><LF> too.*/
  FIELD_DELIMITER             = "COMMA"

  OBJECT                      = FIELD
    NAME                      = "START TIME"
    FIELD_NUMBER              = 1
    DATA_TYPE                 = TIME
```

```
    BYTES                    = 21
    DESCRIPTION              = "
      The START TIME field specifies the start time of the data
      sample(s) being returned in the current row in UTC.  The fields
      START TIME and STOP TIME define the time range covered by the
      samples contained on the current row."
  END_OBJECT                 = FIELD

  OBJECT                     = FIELD
    NAME                     = "STOP TIME"
    FIELD_NUMBER             = 2
    DATA_TYPE                = TIME
    BYTES                    = 21
    DESCRIPTION              = "
      The STOP TIME field specifies the stop time of the data
      sample(s) being returned in the current row in UTC.  The fields
      START TIME and STOP TIME define the time range covered by the
      samples contained on the current row."
  END_OBJECT                 = FIELD

  OBJECT                     = FIELD
    NAME                     = "DATA TYPE NAME"
    FIELD_NUMBER             = 3
    DATA_TYPE                = CHARACTER
    BYTES                    = 11 /* does not include double quotes */
    FORMAT                   = "A11"
    DESCRIPTION              = "
      The DATA TYPE NAME field identifies the type of data sample(s)
      being returned in the current row.  Valid entries include:
           SENSOR       - primary data
           SCAN         - center scan data associated with the primary data
           CALIBRATION  - calibration data associated with the primary data
           MODE DATA    - instrument status (mode) data
           PITCH ANGLE  - pitch angle data associated with the primary data
           START AZ     - start azimuthal angle data associated with the
                          primary data.  The values are always between
                          0 and 360 degrees.
           STOP AZ      - stop azimuthal angle data associated with the
                          primary data.  The values could be negative or
                          could be greater than 360 degrees.
      For example, if the data type name of the row is SENSOR, then the data
      within that row contains the primary sensor data being returned."
  END_OBJECT                 = FIELD

  OBJECT                     = FIELD
    NAME                     = "DATA TYPE ID"
    FIELD_NUMBER             = 4
    DATA_TYPE                = ASCII_INTEGER
    BYTES                    = 1
    FORMAT                   = "I1"
    DESCRIPTION              = "
      The DATA TYPE ID field identifies the type of data sample(s)
      being returned in the current row.  It is equivalent to the
      DATA TYPE NAME field, except expressed as an integer instead
      of a string.  Valid entries include:
           1 - primary data
           2 - center scan data associated with the primary data
           3 - calibration data associated with the primary data
           4 - instrument status (mode) data
           6 - pitch angle data associated with the primary data
           7 - start azimuthal angle data associated with the primary
               data.  The values are always between 0 and 360 degrees.
           8 - stop azimuthal angle data associated with the primary
               data.  The values could be negative or could be greater
               than 360 degrees.
      For example, if the data type id of the row is 1, then the data
      within that row contains the primary sensor data being returned."
```

```
  END_OBJECT                   = FIELD

  OBJECT                       = FIELD
    NAME                       = "DATA NAME"
    FIELD_NUMBER               = 5
    DATA_TYPE                  = CHARACTER
    BYTES                      = 50 /* does not include double quotes */
    FORMAT                     = "A50"
    DESCRIPTION                = "
      The DATA NAME field identifies the name of the data
      parameter being returned in the current row."
  END_OBJECT                   = FIELD

  OBJECT                       = FIELD
    NAME                       = "DATA UNIT"
    FIELD_NUMBER               = 6
    DATA_TYPE                  = CHARACTER
    BYTES                      = 50 /* double quotes not included */
    FORMAT                     = "A50"
    DESCRIPTION                = "
      The DATA UNIT field identifies the units that the data
      values are expressed in for the current row."
  END_OBJECT                   = FIELD

  OBJECT                       = FIELD
    NAME                       = "VALUES"
    FIELD_NUMBER               = 7
    DATA_TYPE                  = ASCII_REAL
    BYTES                      = 13 /* including delimiters */
    ITEMS                      = 1
    ITEM_BYTES                 = 13
    FORMAT                     = "E13.6"
    DESCRIPTION                = "
      This field contains the data values associated with the data items
      being returned.  The field DATA TYPE NAME identifies the type of data
      being returned."
  END_OBJECT                   = FIELD

  OBJECT                       = FIELD
    NAME                       = "DATA QUALITY VALUE"
    FIELD_NUMBER               = 8
    DATA_TYPE                  = ASCII_REAL
    BYTES                      = 13
    FORMAT                     = "E13.6"
    DESCRIPTION                = "
      This field contains the data quality value associated with the data
      being returned.  Valid values include:
              0 - Good Data
              1 - Questionable Data
              2 - Invalid Data
              3 - Bad Data
              4 - Unknown State
      Refer to the data set catalog file for a more in-depth explanation
      of how the setting of these values are determined."
  END_OBJECT                   = FIELD
END_OBJECT                     = SPREADSHEET

END
```

Appendix A. Available Software to Read PDS Files

The latest version of the NASA PDS 'NASAView' tool can display spreadsheet objects and CSV files. The latest 'NASAView' can be obtained from the PDS software download page:

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

There are some non-PDS generic tools that can be used as well. The CSV format is fairly common and can be loadable into Microsoft Excel or other spreadsheet software. However, Microsoft Excel is limited to 65,536 rows, and most of ASPERA-3 CSV files contain more than 65,536 rows so Microsoft Excel will truncate them. Since the ASPERA-3 CSV files are in ASCII format, it is recommended to use a text editor to read and format the data for input to other tools.

Appendix B. Example of Data Set Directory Listing

```
Files in Root Directory MEXASP_NPI_3100:

AAREADME.TXT
ERRATA.TXT
VOLDESC.CAT

Subdirectories in Root Directory MEXASP_NPI_3100:

CALIB
CATALOG
DATA
DOCUMENT
EXTRAS
INDEX
SOFTWARE


MEXASP_NPI_3100/CALIB:

CALINFO.TXT
NPINORM_CAL.LBL
NPINORM_CAL.TAB


MEXASP_NPI_3100/CATALOG:

ASPERA3_INST.CAT
ASPERA3_NPI_EDR_DS.CAT
ASPERA3_NPI_RELEASE.CAT
ASPERA3_SOFTWARE.CAT
CATINFO.TXT
INSTHOST.CAT
MISSION.CAT
PERSON.CAT
REF.CAT


MEXASP_NPI_3100/DATA:

NPI_EDR_L1B_IC
NPI_EDR_L1B_JAN2004
NPI_EDR_L1B_NEV

MEXASP_NPI_3100/DATA/NPI_EDR_L1B_IC:
NPINORM20032870902C_ACC01.CSV
NPINORM20032870902C_ACC01.LBL
```

NPINORM20033650932C_ACC01.CSV
NPINORM20033650932C_ACC01.LBL

MEXASP_NPI_3100/DATA/NPI_EDR_L1B_JAN2004:
NPINORM20040050603C_ACC01.CSV
NPINORM20040050603C_ACC01.LBL
NPINORM20040121133C_ACC01.CSV
NPINORM20040121133C_ACC01.LBL
NPINORM20040141547C_ACC01.CSV
NPINORM20040141547C_ACC01.LBL
NPINORM20040212052C_ACC01.CSV
NPINORM20040212052C_ACC01.LBL
NPINORM20040230605C_ACC01.CSV
NPINORM20040230605C_ACC01.LBL
NPINORM20040232208C_ACC01.CSV
NPINORM20040232208C_ACC01.LBL
NPINORM20040242341C_ACC01.CSV
NPINORM20040242341C_ACC01.LBL
NPINORM20040251414C_ACC01.CSV
NPINORM20040251414C_ACC01.LBL

MEXASP_NPI_3100/DATA/NPI_EDR_L1B_NEV:
NPINORM20031741842C_ACC01.CSV
NPINORM20031741842C_ACC01.LBL
NPINORM20031752233C_ACC01.CSV
NPINORM20031752233C_ACC01.LBL
NPINORM20031752338C_ACC01.CSV
NPINORM20031752338C_ACC01.LBL
NPINORM20031760127C_ACC01.CSV
NPINORM20031760127C_ACC01.LBL
NPINORM20031762025C_ACC01.CSV
NPINORM20031762025C_ACC01.LBL
NPINORM20031811922C_ACC01.CSV
NPINORM20031811922C_ACC01.LBL
NPINORM20031842309C_ACC01.CSV
NPINORM20031842309C_ACC01.LBL
NPINORM20031872207C_ACC01.CSV
NPINORM20031872207C_ACC01.LBL
NPINORM20031881807C_ACC01.CSV
NPINORM20031881807C_ACC01.LBL
NPINORM20031891637C_ACC01.CSV
NPINORM20031891637C_ACC01.LBL
NPINORM20031892324C_ACC01.CSV
NPINORM20031892324C_ACC01.LBL
NPINORM20031901858C_ACC01.CSV
NPINORM20031901858C_ACC01.LBL
NPINORM20031902308C_ACC01.CSV
NPINORM20031902308C_ACC01.LBL
NPINORM20031912147C_ACC01.CSV
NPINORM20031912147C_ACC01.LBL
NPINORM20031922332C_ACC01.CSV
NPINORM20031922332C_ACC01.LBL

```
NPINORM20031942005C_ACC01.CSV
NPINORM20031942005C_ACC01.LBL
NPINORM20032061754C_ACC01.CSV
NPINORM20032061754C_ACC01.LBL


MEXASP_NPI_3100/DOCUMENT:

ASPERA3_FLIGHT_PERF.LBL
ASPERA3_FLIGHT_PERF.PDF
ASPERA3_MEX_EXP.LBL
ASPERA3_MEX_EXP.PDF
ASPERA3_SENSOR_FRAMES.LBL
ASPERA3_SENSOR_FRAMES.PDF
ASPERA3_SENSOR_GEOMETRY.TXT
DOCINFO.TXT
ME_ASP_DS_0002.LBL
ME_ASP_DS_0002.PDF
ME_ASP_MA_0003_V3_0.LBL
ME_ASP_MA_0003_V3_0.PDF
MEX_ASPERA3_PSA_ICD_V01_00.DOC
MEX_ASPERA3_PSA_ICD_V01_00.HTM
MEX_ASPERA3_PSA_ICD_V01_00.LBL
MEX_ASPERA3_PSA_ICD_V01_00.PDF
NPI_CALIBRATION_REPORT.LBL
NPI_CALIBRATION_REPORT.PDF


MEXASP_NPI_3100/EXTRAS:

EXTRINFO.TXT
IDFS_DATA_IC.LBL
IDFS_DATA_IC.ZIP
IDFS_DATA_JAN2004.LBL
IDFS_DATA_JAN2004.ZIP
IDFS_DATA_NEV.LBL
IDFS_DATA_NEV.ZIP
MEX_SCIENCE_SUBPHASE_DEFS.LBL
MEX_SCIENCE_SUBPHASE_DEFS.TAB
SPICE_DATA

MEXASP_NPI_3100/EXTRAS/SPICE_DATA:
FK
LSK
ORBNUM
PCK
SCLK
SPK

MEXASP_NPI_3100/EXTRAS/SPICE_DATA/FK:
MEX_V06.TF
```

```
MEXASP_NPI_3100/EXTRAS/SPICE_DATA/LSK:
NAIF0007.TLS

MEXASP_NPI_3100/EXTRAS/SPICE_DATA/ORBNUM:
ORMM_MERGED_00090.ORB

MEXASP_NPI_3100/EXTRAS/SPICE_DATA/PCK:
DE403-MASSES.TPC
EARTH_030531_040531_040309.BPC
MARS_IAU2000_V0.TPC
PCK00007.TPC
PCK00008.TPC

MEXASP_NPI_3100/EXTRAS/SPICE_DATA/SCLK:
MEX_040930_STEP.TSC

MEXASP_NPI_3100/EXTRAS/SPICE_DATA/SPK:
DE405S.BSP
ORHM_______________00038.BSP
ORMM__031222180906_00052.BSP
ORMM__040201000000_00060.BSP


MEXASP_NPI_3100/INDEX:

DOC_INDX.LBL
DOC_INDX.TAB
GEO_EARTH.LBL
GEO_EARTH.TAB
GEO_MARS.LBL
GEO_MARS.TAB
INDEX.LBL
INDEX.TAB
INDXINFO.TXT


MEXASP_NPI_3100/SOFTWARE:

ASPERA3_SW_BIN.LBL
ASPERA3_SW_BIN.ZIP
ASPERA3_SW_CONFIG_IC.LBL
ASPERA3_SW_CONFIG_IC.ZIP
ASPERA3_SW_CONFIG_JAN2004.LBL
ASPERA3_SW_CONFIG_JAN2004.ZIP
ASPERA3_SW_CONFIG_NEV.LBL
ASPERA3_SW_CONFIG_NEV.ZIP
ASPERA3_SW_DOC.LBL
ASPERA3_SW_DOC.ZIP
SOFTINFO.TXT
```