



***Mars Atmosphere and Volatile Evolution  
(MAVEN) Mission***

***Supra-Thermal And Thermal Ion Composition  
(STATIC)***

**PDS Archive**

**Software Interface Specification**

Rev 1.0

STATIC Draft

5/30/2014

Prepared by

James P. McFadden

([mcfadden@ssl.berkeley.edu](mailto:mcfadden@ssl.berkeley.edu))

**MAVEN  
Supra-Thermal And Thermal Ion Composition (STATIC)**

**PDS Archive  
Software Interface Specification**

**Rev. 1.0 STATIC Draft  
May 30, 2014**

Custodian:




James P. McFadden  
STATIC Principal Investigator

6-2-14

Date

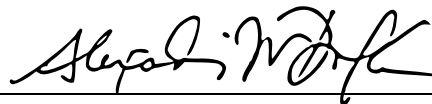
Approved:



Digitally signed by David L. Mitchell  
DN: cn=David L. Mitchell, o=UCB  
SSL, email=mitchell@ssl.berkeley.edu,  
c=US  
Date: 2014.06.02 13:31:42 -08'00'

David L. Mitchell  
MAVEN SDWG Lead

Date



Alexandria DeWolfe  
MAVEN Science Data Center

June 10, 2014

Date

Raymond J. Walker  
PDS PPI Node Manager

Date

---

Thomas H. Morgan  
PDS Project Manager

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Date

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static.c:data.c0\_64e2m,static.c:data.c2\_32e32m,static.c:data.c4\_4e64m,  
 static.c:data.c6\_32e64m,static.c:data.c8\_32e16d,static.c:data.ca\_16e4d16a,static.c:data.cc\_3  
 2e32m8d,static.c:data.cd\_32e32m8d,static.c:data.ce\_16e16m4d16a,static.c:data.cf\_16e16m  
 4d16a,static.c:data.d0\_32e8m4d16a,static.c:data.d1\_32e8m4d16a,static.c:data.d2\_32e8m16  
 a,static.c:data.d3\_32e8m16a,static.c:data.d4\_2m4d16a ..... 44

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static.c:data.c0\_64e2m,static.c:data.c2\_32e32m,static.c:data.c4\_4e64m,  
 static.c:data.c6\_32e64m,static.c:data.c8\_32e16d,static.c:data.ca\_16e4d16a,static.c:data.cc\_3  
 2e32m8d,static.c:data.cd\_32e32m8d,static.c:data.ce\_16e16m4d16a,static.c:data.cf\_16e16m  
 4d16a,static.c:data.d0\_32e8m4d16a,static.c:data.d1\_32e8m4d16a,static.c:data.d2\_32e8m16  
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## 1 Introduction

This software interface specification (SIS) describes the format and content of the Supra-Thermal And Thermal Ion Composition (STATIC) Planetary Data System (PDS) data archive. It includes descriptions of the data products and associated metadata, and the archive format, content, and generation pipeline.

### 1.1 Distribution List

Table 1: Distribution list

Name	Organization	Email
James P. McFadden	UCB/SSL	mcfadden@ssl.berkeley.edu
Dave Mitchell	UCB/SSL	mitchell@ssl.berkeley.edu
Alexandria DeWolfe	LASP/SDC	alex.dewolfe@lasp.colorado.edu
Steve Joy	UCLA/PDS/PPI	sjoy@igpp.ucla.edu
Ray Walker	UCLA/PDS/PPI	rwalker@igpp.ucla.edu
Joe Mafi	UCLA/PDS/PPI	jmafi@igpp.ucla.edu

### 1.2 Document Change Log

Table 2: Document change log

Version	Change	Date	Affected portion
0.0	Template	2012-Aug-24	
0.1	First STATIC attempt	2014 Feb 20	All
1.0	Signature Version	2014-May-30	All

### 1.3 TBD Items

Table 3 lists items that are not yet finalized.

Table 3: List of TBD items

Item	Section(s)	Page(s)
Full references for PDS4 Standards Reference, and Data Provider's Handbook documents (to be provided by PDS/PPI)	1.9	
Sample labels (to be provided by PDS/PPI)	Appendices C, D, and E	

### 1.4 Abbreviations

Table 4: Abbreviations and their meaning

Abbreviation	Meaning
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Abbreviation	Meaning
ASCII	American Standard Code for Information Interchange
Atmos	PDS Atmospheres Node (NMSU, Las Cruces, NM)
CCSDS	Consultative Committee for Space Data Systems
CDR	Calibrated Data Record
CFDP	CCSDS File Delivery Protocol
CK	C-matrix Kernel (NAIF orientation data)
CODMAC	Committee on Data Management, Archiving, and Computing
CRC	Cyclic Redundancy Check
CU	University of Colorado (Boulder, CO)
DAP	Data Analysis Product
DDR	Derived Data Record
DMAS	Data Management and Storage
DPF	Data Processing Facility
E&PO	Education and Public Outreach
EDR	Experiment Data Record
EUV	Extreme Ultraviolet; also used for the EUV Monitor, part of LPW (SSL)
FEI	File Exchange Interface
FOV	Field of View
FTP	File Transfer Protocol
GB	Gigabyte(s)
GSFC	Goddard Space Flight Center (Greenbelt, MD)
HK	Housekeeping
HTML	Hypertext Markup Language
ICD	Interface Control Document
IM	Information Model
ISO	International Standards Organization
ITF	Instrument Team Facility
IUVS	Imaging Ultraviolet Spectrograph (LASP)
JPL	Jet Propulsion Laboratory (Pasadena, CA)
LASP	Laboratory for Atmosphere and Space Physics (CU)

Abbreviation	Meaning
LID	Logical Identifier
LIDVID	Versioned Logical Identifier
LPW	Langmuir Probe and Waves instrument (SSL)
MAG	Magnetometer instrument (GSFC)
MAVEN	Mars Atmosphere and Volatile Evolution
MB	Megabyte(s)
MD5	Message-Digest Algorithm 5
MOI	Mars Orbit Insertion
MOS	Mission Operations System
MSA	Mission Support Area
MSE	Mars Solar Ecliptic Coordinate System
NAIF	Navigation and Ancillary Information Facility (JPL)
NASA	National Aeronautics and Space Administration
NGIMS	Neutral Gas and Ion Mass Spectrometer (GSFC)
NMSU	New Mexico State University (Las Cruces, NM)
NSSDC	National Space Science Data Center (GSFC)
PCK	Planetary Constants Kernel (NAIF)
PDS	Planetary Data System
PDS4	Planetary Data System Version 4
PF	Particles and Fields (instruments)
PPI	PDS Planetary Plasma Interactions Node (UCLA)
RS	Remote Sensing (instruments)
SCET	Spacecraft Event Time
SDC	Science Data Center (LASP)
SCLK	Spacecraft Clock
SEP	Solar Energetic Particle instrument (SSL)
SIS	Software Interface Specification
SOC	Science Operations Center (LASP)
SPE	Solar Particle Event
SPICE	Spacecraft, Planet, Instrument, C-matrix, and Events (NAIF data format)

Abbreviation	Meaning
SPK	Spacecraft and Planetary ephemeris Kernel (NAIF)
SSL	Space Sciences Laboratory (UCB)
STATIC	Supra-Thermal And Thermal Ion Composition instrument (SSL)
SWEA	Solar Wind Electron Analyzer (SSL)
SWIA	Solar Wind Ion Analyzer (SSL)
TBC	To Be Confirmed
TBD	To Be Determined
UCB	University of California, Berkeley
UCLA	University of California, Los Angeles
URN	Uniform Resource Name
UV	Ultraviolet
XML	eXtensible Markup Language

## 1.5 Glossary

**Archive** – A place in which public records or historical documents are preserved; also the material preserved – often used in plural. The term may be capitalized when referring to all of PDS holdings – the PDS Archive.

**Basic Product** – The simplest product in PDS4; one or more data objects (and their description objects), which constitute (typically) a single observation, document, etc. The only PDS4 products that are *not* basic products are collection and bundle products.

**Bundle Product** – A list of related collections. For example, a bundle could list a collection of raw data obtained by an instrument during its mission lifetime, a collection of the calibration products associated with the instrument, and a collection of all documentation relevant to the first two collections.

**Class** – The set of attributes (including a name and identifier) which describes an item defined in the PDS Information Model. A class is generic – a template from which individual items may be constructed.

**Collection Product** – A list of closely related basic products of a single type (e.g. observational data, browse, documents, etc.). A collection is itself a product (because it is simply a list, with its label), but it is not a *basic* product.

**Data Object** – A generic term for an object that is described by a description object. Data objects include both digital and non-digital objects.

**Description Object** – An object that describes another object. As appropriate, it will have structural and descriptive components. In PDS4 a ‘description object’ is a digital object – a string of bits with a predefined structure.

**Digital Object** – An object which consists of real electronically stored (digital) data.

**Identifier** – A unique character string by which a product, object, or other entity may be identified and located. Identifiers can be global, in which case they are unique across all of PDS (and its federation partners). A local identifier must be unique within a label.

**Label** – The aggregation of one or more description objects such that the aggregation describes a single PDS product. In the PDS4 implementation, labels are constructed using XML.

**Logical Identifier (LID)** – An identifier which identifies the set of all versions of a product.

**Versioned Logical Identifier (LIDVID)** – The concatenation of a logical identifier with a version identifier, providing a unique identifier for each version of product.

**Manifest** - A list of contents.

**Metadata** – Data about data – for example, a ‘description object’ contains information (metadata) about an ‘object.’

**Non-Digital Object** – An object which does not consist of digital data. Non-digital objects include both physical objects like instruments, spacecraft, and planets, and non-physical objects like missions, and institutions. Non-digital objects are labeled in PDS in order to define a unique identifier (LID) by which they may be referenced across the system.

**Object** – A single instance of a class defined in the PDS Information Model.

**PDS Information Model** – The set of rules governing the structure and content of PDS metadata. While the Information Model (IM) has been implemented in XML for PDS4, the model itself is implementation independent.

**Product** – One or more tagged objects (digital, non-digital, or both) grouped together and having a single PDS-unique identifier. In the PDS4 implementation, the descriptions are combined into a single XML label. Although it may be possible to locate individual objects within PDS (and to find specific bit strings within digital objects), PDS4 defines ‘products’ to be the smallest granular unit of addressable data within its complete holdings.

**Tagged Object** – An entity categorized by the PDS Information Model, and described by a PDS label.

**Registry** – A data base that provides services for sharing content and metadata.

**Repository** – A place, room, or container where something is deposited or stored (often for safety).

**XML** – eXtensible Markup Language.

**XML schema** – The definition of an XML document, specifying required and optional XML elements, their order, and parent-child relationships.

## 1.6 MAVEN Mission Overview

The MAVEN mission launched on an Atlas V on November 18. After a ten-month ballistic cruise phase, Mars orbit insertion will occur on or after September 22, 2014. Following a 5-week transition phase, the spacecraft will orbit Mars at a 75° inclination, with a 4.5 hour period and periapsis altitude of 140-170 km (density corridor of 0.05-0.15 kg/km<sup>3</sup>). Over a one-Earth-year period, periapsis will precess over a wide range of latitude and local time, while MAVEN obtains detailed measurements of the upper atmosphere, ionosphere, planetary corona, solar wind, interplanetary/Mars magnetic fields, solar EUV and solar energetic particles, thus defining the interactions between the Sun and Mars. MAVEN will explore down to the homopause during a series of five 5-day “deep dip” campaigns for which periapsis will be lowered to an atmospheric density of 2 kg/km<sup>3</sup> (~125 km altitude) in order to sample the transition from the collisional lower atmosphere to the collisionless upper atmosphere. These five campaigns will be interspersed though the mission to sample the subsolar region, the dawn and dusk terminators, the anti-solar region, and the north pole.

### 1.6.1 Mission Objectives

The primary science objectives of the MAVEN project will be to provide a comprehensive picture of the present state of the upper atmosphere and ionosphere of Mars and the processes controlling them and to determine how loss of volatiles to outer space in the present epoch varies with changing solar conditions. Knowing how these processes respond to the Sun’s energy inputs will enable scientists, for the first time, to reliably project processes backward in time to study atmosphere and volatile evolution. MAVEN will deliver definitive answers to high-priority science questions about atmospheric loss (including water) to space that will greatly enhance our understanding of the climate history of Mars. Measurements made by MAVEN will allow us to determine the role that escape to space has played in the evolution of the Mars atmosphere, an essential component of the quest to “follow the water” on Mars. MAVEN will accomplish this by achieving science objectives that answer three key science questions:

- What is the current state of the upper atmosphere and what processes control it?
- What is the escape rate at the present epoch and how does it relate to the controlling processes?
- What has the total loss to space been through time?

MAVEN will achieve these objectives by measuring the structure, composition, and variability of the Martian upper atmosphere, and it will separate the roles of different loss mechanisms for both neutrals and ions. MAVEN will sample all relevant regions of the Martian atmosphere/ionosphere system—from the termination of the well-mixed portion of the atmosphere (the “homopause”), through the diffusive region and main ionosphere layer, up into the collisionless exosphere, and through the magnetosphere and into the solar wind and

downstream tail of the planet where loss of neutrals and ionization occurs to space—at all relevant latitudes and local solar times. To allow a meaningful projection of escape back in time, measurements of escaping species will be made simultaneously with measurements of the energy drivers and the controlling magnetic field over a range of solar conditions. Together with measurements of the isotope ratios of major species, which constrain the net loss to space over time, this approach will allow thorough identification of the role that atmospheric escape plays today and to extrapolate to earlier epochs.

### **1.6.2 Payload**

MAVEN will use the following science instruments to measure the Martian upper atmospheric and ionospheric properties, the magnetic field environment, the solar wind, and solar radiation and particle inputs:

- NGIMS Package:
  - Neutral Gas and Ion Mass Spectrometer (NGIMS) measures the composition, isotope ratios, and scale heights of thermal ions and neutrals.
- RS Package:
  - Imaging Ultraviolet Spectrograph (IUVS) remotely measures UV spectra in four modes: limb scans, planetary mapping, coronal mapping and stellar occultations. These measurements provide the global composition, isotope ratios, and structure of the upper atmosphere, ionosphere, and corona.
- PF Package:
  - Supra-Thermal and Thermal Ion Composition (STATIC) instrument measures the velocity distributions and mass composition of thermal and suprathermal ions from below escape energy to pickup ion energies.
  - Solar Energetic Particle (SEP) instrument measures the energy spectrum and angular distribution of solar energetic electrons (30 keV – 1 MeV) and ions (30 keV – 12 MeV).
  - Solar Wind Ion Analyzer (SWIA) measures solar wind and magnetosheath ion density, temperature, and bulk flow velocity. These measurements are used to determine the charge exchange rate and the solar wind dynamic pressure.
  - Solar Wind Electron Analyzer (SWEA) measures energy and angular distributions of 5 eV to 5 keV solar wind, magnetosheath, and auroral electrons, as well as ionospheric photoelectrons. These measurements are used to constrain the plasma environment, magnetic field topology and electron impact ionization rate.
  - Langmuir Probe and Waves (LPW) instrument measures the electron density and temperature and electric field in the Mars environment. The instrument includes an EUV Monitor that measures the EUV input into Mars atmosphere in three broadband energy channels.
  - Magnetometer (MAG) measures the vector magnetic field in all regions traversed by MAVEN in its orbit.

## 1.7 **SIS Content Overview**

Section 2 describes the Supra-Thermal And Thermal Ion Composition (STATIC) sensor. Section 3 gives an overview of data organization and data flow. Section 4 describes data archive generation, delivery, and validation. Section 5 describes the archive structure and archive production responsibilities. Section 6 describes the file formats used in the archive, including the data product record structures. Individuals involved with generating the archive volumes are listed in Appendix A. Appendix B contains a description of the MAVEN science data file naming conventions. Appendix C, Appendix D, and Appendix E contain sample PDS product labels. Appendix F describes STATIC archive product PDS deliveries formats and conventions.

## 1.8 **Scope of this document**

The specifications in this SIS apply to all STATIC products submitted for archive to the Planetary Data System (PDS), for all phases of the MAVEN mission. This document includes descriptions of archive products that are produced by both the STATIC team and by PDS.

## 1.9 **Applicable Documents**

- [1] Planetary Data System Data Provider's Handbook, **TBD**.
- [2] Planetary Data System Standards Reference, Version 1.2.0, March 27, 2014.
- [3] Planetary Science Data Dictionary Document, **TBD**.
- [4] Planetary Data System (PDS) PDS4 Information Model Specification, Version 1.1.0.1.
- [5] Mars Atmosphere and Volatile Evolution (MAVEN) Science Data Management Plan, Rev. C, doc. no.MAVEN-SOPS-PLAN-0068
- [6] Archive of MAVEN CDF in PDS4, Version 3, T. King and J. Mafi, March 13, 2014.

## 1.10 **Audience**

This document describes the interactions between the MAVEN Project, STATIC instrument team, and PDS, defining the roles and responsibilities of each in producing STATIC PDS archive products. It is also useful to those wishing to understand the format and content of the STATIC PDS data product archive collection. Typically, these individuals would include scientists, data analysts, and software engineers.

## 2 STATIC Instrument Description

The Supra-Thermal And Thermal Ion Composition (STATIC) [See Figure 1] instrument is designed to measure the ion composition and distribution function of the cold Martian ionosphere, of the heated suprathermal tail of this plasma in the upper ionosphere, and the pickup ions accelerated by solar wind electric fields. STATIC operates over an energy range of 0.1 eV up to 30 keV, with a base time resolution of 4 seconds. The instrument consists of a toroidal “top hat” electrostatic analyzer with a  $360^\circ \times 90^\circ$  field-of-view, combined with a time-of-flight (TOF) velocity analyzer with  $22.5^\circ$  resolution in the detection plane. The TOF combines a -15 kV acceleration voltage with ultra-thin carbon foils to resolve  $\text{H}^+$ ,  $\text{He}^{++}$ ,  $\text{He}^+$ ,  $\text{O}^+$ ,  $\text{O}_2^+$ , and  $\text{CO}_2^+$  ions. Secondary electrons from carbon foils are detected by microchannel plate detectors and binned into a variety of data products with varying energy, mass, angle, and time resolution. To prevent detector saturation when measuring cold RAM ions at periapsis ( $\sim 10^{11}$  eV/cm<sup>2</sup>-s-sr-eV) while maintaining adequate sensitivity to resolve tenuous pickup ions at apoapsis ( $\sim 10^3$  eV/cm<sup>2</sup>-s-sr-eV), the sensor includes both mechanical and electrostatic attenuators that increase the dynamic range by a factor of  $10^3$ . The STATIC sensor is mounted on the APP boom, along with NGIMS and IUVS, so that it can be pointed in the ram direction during periapsis passes. During apoapsis, pointing of the APP is alternated between optimal viewing for IUVS and STATIC, both of which depend on orbit parameters and local time.

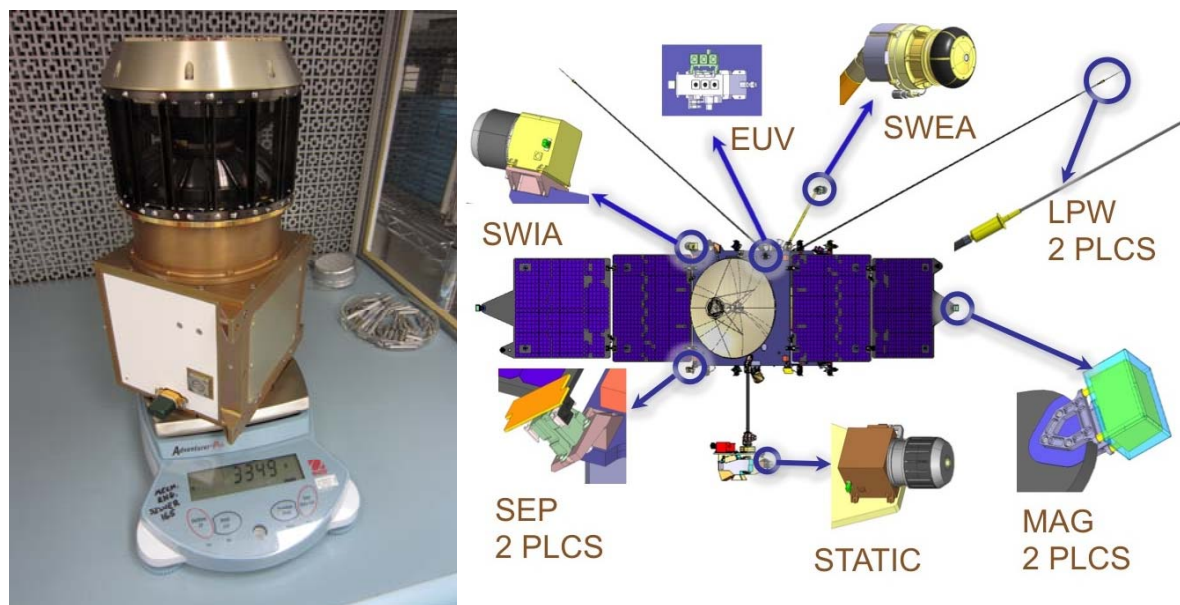


Figure 1: The STATIC instrument and its location on the spacecraft.

### 2.1 Science Objectives

STATIC provides measurements that satisfy the MAVEN level 1 requirement to determine mass, energy, flux and velocity distributions of ions ( $\text{H}^+$ ,  $\text{O}^+$ ,  $\text{O}_2^+$ ,  $\text{CO}_2^+$ ) above the exobase with velocities greater than 5 km/s ( $\sim$ escape speed) and energies extending up to 10 KeV (pick-up ion energies), with ability to resolve horizontal lengths of 100 km in magnetic cusp regions. STATIC requires mass resolution  $\Delta m/m$  of 0.5, sufficient to resolve the 4 major ion species, angular resolution better than  $30^\circ$ , temperature and velocity precision better than 25%. MAVEN carries a



suite of instruments that measure the significant energy inputs into the Martian system and the neutral and charged populations of escaping atmospheric gases, in order to determine how the former drives the latter, with the goal of characterizing the state of the upper atmosphere and its evolution over Mars' history. Within this framework, the main science objective for the STATIC sensor is to measure the composition of the thermal ion population at periapsis, its temperature and density changes with altitude, the formation of suprathermal ion tails with gravitational escape velocity, and the pickup ion population in the solar wind. With these measurements, STATIC can directly measure the atmospheric losses due to pickup ion processes, and measure the source population in the chemical reaction,  $O_2^+ + e^- \rightarrow O + O$ , which results in neutral atom losses.

In order to achieve these science goals, STATIC satisfies, and in most cases significantly exceeds, the following MAVEN Level 3 measurement requirements:

- STATIC shall measure energy fluxes from  $10^7$  to  $10^{10}$  eV/[cm<sup>2</sup> s sr eV] w/ 20 second resolution
- STATIC shall measure energy fluxes from  $10^4$  to  $10^8$  eV/[cm<sup>2</sup> s sr eV] w/ 30 minute resolution
- STATIC shall measure ions from at least 1-44 amu
- STATIC shall have mass resolution  $m/\Delta m$  of at least 2
- STATIC shall measure ions from 1 eV to 10,000 eV
- STATIC shall have energy resolution  $\Delta E/E$  at least 30%
- STATIC shall have angular resolution of at least 30 degrees
- STATIC shall have a field of view of at least 60 degrees by 180 degrees

## 2.2 Electrostatic Optics and Detectors

The STATIC instrument uses an electrostatic analyzer (ESA) and time-of-flight (TOF) velocity analyzer to resolve ion energy per charge, direction, and velocity per charge. When combined with knowledge of charge state (nearly all ions at Mars are singly charged except solar wind alphas), STATIC resolves the distribution function of all major ion species in the Martian plasma. As shown in the block diagram of Figure 2, ions are selected for energy/charge by a top-hat electrostatic analyzer, then accelerated by -15 kV into the TOF analyzer. Ions entering the TOF penetrate Start and Stop carbon foils, producing secondary electrons that are deflected and accelerated to microchannel plate (MCP) detectors. A complete event will produce signals on each preamplifier (labeled A, B, C, D in Figure 2), resulting in timing signals TA, TB, TC, and TD. The Time-to-Digital Converter (labeled TDC in the figure) calculates time between the signals (~1 ns resolution) and passes the information to the Ion Digital Interface Board for event processing. The short delay (10-100 ns) between Start and Stop signals as the ion transits the 2 cm TOF gap provides information on the accelerated ion's velocity. The detection electronics use discrete anode delay line techniques to determine both event location (TA-TB or TC-TD) and time-of-flight (TA-TC or TB-TD). The energy analyzer also includes electrostatic deflectors at the entrance which expand the nominal 360° x 6° field-of-view (FOV) to 360° x 90°. The 360° FOV is binned into sixteen 22.5° discrete anode look directions. The dynamic range of the instrument is expanded by both mechanical and electrostatic attenuators located near the ESA entrance aperture. Details of the instrument subsystems can be found in McFadden et al., 2014. Additional instrument parameters can be found in Table 5.

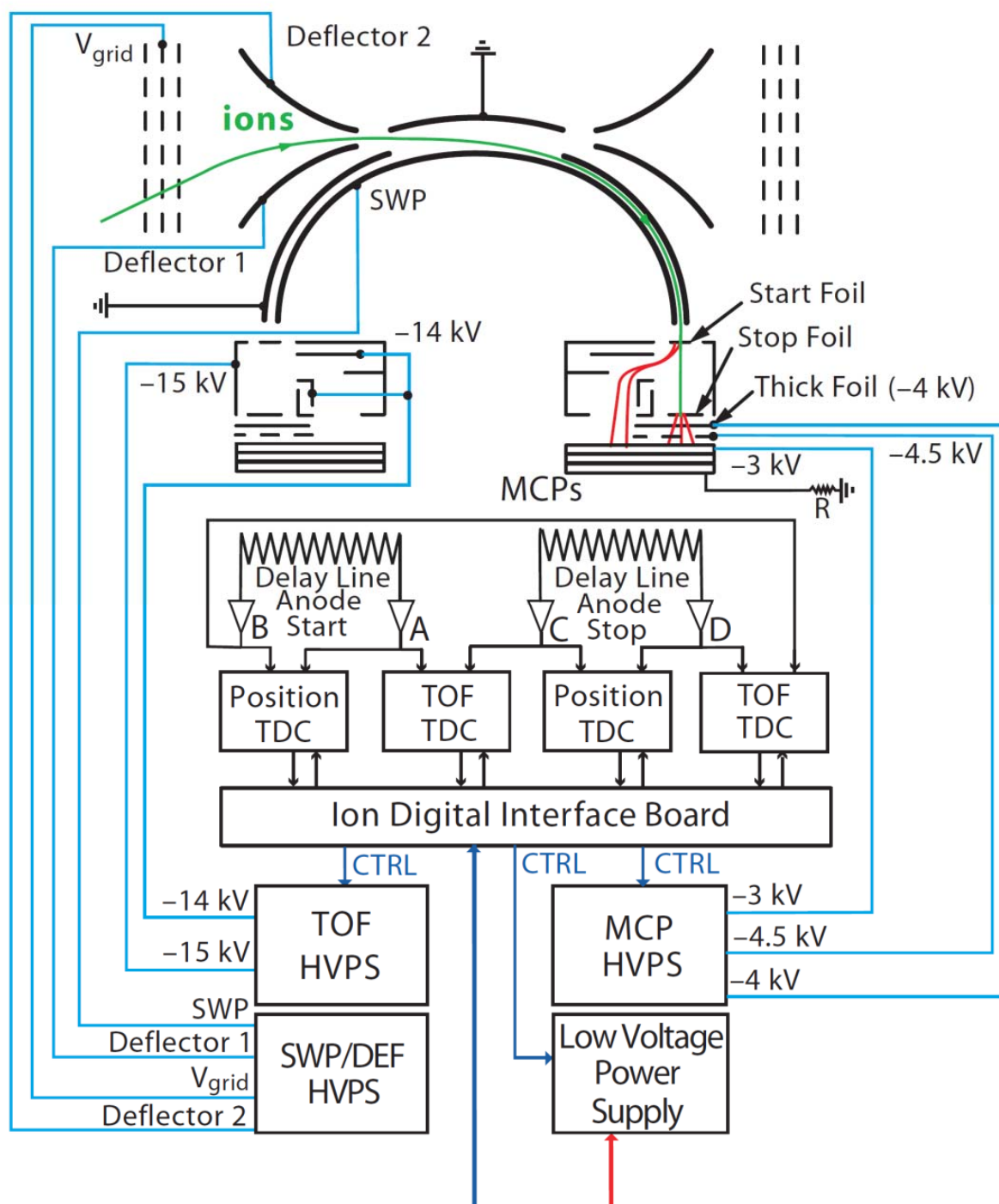


Figure 2: Block diagram of the STATIC sensor. Ions are selected for direction by deflectors, and for energy/charge by a toroidal top-hat electrostatic analyzer (ESA). The sensor includes an electrostatic attenuator ( $V_{grid}$ ) and a mechanical attenuator (not shown). After passing through the ESA, ions are accelerated by -15 kV into the time-of-flight velocity analyzer. Secondary electrons from Start and Stop ultra-thin carbon foils (red) are directed to microchannel plate detectors (MCPs). MCP charge pulses are split on discrete delay-line anode chains, amplified, and fed into four time-to-digital converters (TDC) which determine event position and time-of-flight in the 2 cm gap between Stop and Start carbon foils.

Table 5: *STATIC Instrument Specifications*

Parameter	Value	Comments
<b>Electrostatic Analyzer</b>		Toroidal top-hat
$\Delta R/R$	0.064	37.5 mm inner hemisphere radius
Analyzer constant	7.8	Energy/Voltage, 0 to 4 kV HV sweep
Deflector Constant	6.4	Deflector/(Inner Hemisphere) voltage ratio for
Energy Range	0.1 eV to 30 keV	
Analyzer Energy Resolution	16%	$\Delta E/E$ measured
Measurement Energy Resolution	11%-16%	Ram and Pickup Modes
Energy Sweep Rate	0.25 Hz	64 energies in 4 sec
Deflector Sweep Rate	16 Hz	16 deflection steps each 61 ms
Instantaneous Field of View	360° x 6° FWHM	Planar w/o deflection
Field of View with Deflection	360° x 90°	Conical
Simulation Geometric Factor	0.016 cm <sup>2</sup> -sr-E	Excluding grids/posts/efficiencies
ESA Geometric Factor	0.0031 cm <sup>2</sup> -sr-E	Including grids/posts at high energy
ESA-TOF Total Sensitivity	0.0015 cm <sup>2</sup> -sr-E	Highest for molecular H <sub>2</sub> <sup>+</sup>
Attenuation Factors	1,10,100,1000	Selectable attenuation of cold RAM ions
<b>Time-of-Flight Analyzer</b>		
Post Analyzer Acceleration	-15 kV	
Carbon Foil Thickness	<1.0 ug/cm <sup>2</sup>	Nominal, varies with anode
Carbon Foil grid frames	333 lines/inch	~62% transmission
TOF gap between Start/Stop	2 cm	
Proton time of flight	12 to 7 ns	0 to 30 keV initial energy
Anode detection resolution	22.5°	
Thick Foil	500 nm kapton	50 nm Al coatings
MCP Detectors	Z-stack	
Anode Rejection	~25%	Cross talk events rejected in electronics
Start Efficiency	60%-80%	Mass dependent, excludes grid frame losses
Stop Efficiency	20%-60%	Mass, molecular, & energy dependent
<b>Electronics</b>		
Preamp shaping	8 ns	
CFD timing jitter	<1 ns	
TDC resolution	<0.2 ns	
Accumulation time	3.8 msec	No accumulation during energy changes
Accumulation intervals per sweep	1024	64 energy x 16 deflection intervals
<b>Typical Data Products</b>		
P1 Energy spectra	64E x 2M	4 sec resolution
P1 Mass spectra	4E x 64M	4 sec resolution
P1 Energy-Mass spectra	32E x 32M	4 sec @ periapsis, 128 s @ apoapsis
P2 Energy-Deflection spectra	32E x 16D	4 sec @ periapsis
P3 Energy-SolidAngle spectra	32E x 64 $\Omega$	4 sec @ periapsis
P4 Energy-Mass-Deflector	32E x 32M x 8D	16 sec @ periapsis, Ram Mode
P4 Energy-Mass-SolidAngle	16E x 16M x 64 $\Omega$	32 sec @ periapsis, Conic Mode
P4 Energy-Mass-SolidAngle	32E x 8M x 64 $\Omega$	128 sec @ apoapsis, Pickup Mode
Mass Histogram Array	1024 TOF bins	4 to 256 sec resolution, 5.8 TOF bins per ns

## 2.3 Measured Parameters

STATIC cycles through its entire 64 energy step range once every four seconds. At each energy step, STATIC pauses and sweeps the deflectors over their full angular range (16 deflection steps). At each of the 1024 energy-deflector steps, particle events are decoded by their values of TA, TB, TC, TD, TA>TB, TC>TD, TA-TC, TB-TD, |TA-TB|, |TC-TD| and recorded in a set of intermediate arrays in the instrument (SRAM). The arrays are double-buffered allowing a complete 4 second measurement to be completed while the previous measurements are read out. The TOF timing circuits have 10-bit resolution (1024 TOF bins), event position is 4 bits (16 anodes), and there are 16 deflection steps at each of the 64 energy steps. This results in a measurement array that is 16 Mbytes – too large to transmit. Instead, the instrument sorts these data into smaller arrays by averaging in various dimensions before transmission to the PFDPU. This compression includes a mass look-up table (MLUT) which reduces the 1024 TOF bins to 64 mass bins. The result of this latter compression is “mass”, not TOF, since the MLUT accounts for the changes in ion transit time that vary with a particle’s initial energy. This allows the instrument to average over energy without blurring the mass resolution. Upon transmission to the PFDPU, these measurement arrays are further sorted and averaged before being packaged and transmitted to the spacecraft, or recorded in a PFDPU burst memory.

STATIC can produce 22 different data products, or APIDs, with each product tailored to resolve a particular feature of the required measurement set. Column 2 of Table 6 lists the measurement arrays (E=energy, M=mass, D=deflection, and A=anode) that make up the various data products. Depending upon location in the orbit, and the data allocation given by the spacecraft, different combinations of data products and time resolutions can be selected. STATIC’s data allocation varies during the mission depending upon distance from Earth to Mars. Current data rates are characterized as multiples (x1, x1.5, x2, x3.25, x4.5) of STATICs baseline rate of 2.2 kbit/s uncompressed. Data compression of this “survey data” is expected to be about a factor of 2, which will provide bandwidth for the transmission an equal quantity of higher time resolution “burst data”. Even at the lowest data allocation rate (x1), STATIC will be able to transmit 2 dimensional energy-mass spectra and 3-dimensional energy-angle (22.5°) distributions at the highest cadence (4 seconds) during ionospheric encounters. At higher data allocations, STATIC’s 4 second resolution can be maintained for these products at all altitudes. Higher dimensional survey data products (APIDs CC, CE, D0, D2) are always averaged over time, and at any one time, only one of these products can be produced. The selected product is determined by optimizing the science return by the selected mode. Higher time resolution for these products is achieved with burst data (APIDs CD, CF, D1, D3), where only one of the four APIDs can be recorded at any one time.

Columns 3 to 8 in Table II list anticipated time resolution in seconds for STATIC data products during x1 and x4.5 data allocations rates. These are only preliminary time resolutions and data products selections, and will likely be varied during the mission to optimize science. Data product resolution is always 4 seconds x  $2^N$ , where N is a non-negative integer. A subset of data products are sent that depend on the operating mode (Ram, Conic, and Pickup) and modes are selected by altitude and/or location during the orbit. The software is flexible allowing new modes with different data product combinations and different time resolutions to be developed. Events packets (D6) contain a set of raw event data (event timing codes) used for diagnosing the sensor.

Fast housekeeping (D7) is used for diagnosing high voltage sweeps and offsets. Rate packets (D8, D9, D10) are used for dead time corrections and to determine TOF efficiency. Mass histograms (DB) are used for evaluating sensor operations and for high resolution TOF observations.

Table 6: Typical STATIC Data Products (APIDs)

APID	Description	x1			x4.5		
		Ram	Conic	Pickup	Ram	Conic	Pickup
2A	Housekeeping	32	32	32	32	32	32
C0	64Ex2M	4	4	16	4	4	4
C2	32Ex32M	#####	#####	#####	####	#####	#####
C4	4Ex64M	#####	#####	#####	####	#####	#####
C6	32Ex64M	4	4	64	4	4	4
C8	32Ex16D	4	4	#####	4	4	#####
CA	16Ex4Dx16A	4	4	#####	4	4	4
CC	32Ex32Mx8D	64	#####	#####	16	#####	#####
CD	32Ex32Mx8D	4	#####	#####	4	#####	#####
CE	16Ex16Mx4Dx16A	#####	64	#####	####	32	#####
CF	16Ex16Mx4Dx16A	#####	4	#####	####	4	#####
D0	32Ex8Mx4Dx16A	#####	#####	512	####	#####	64
D1	32Ex8Mx4Dx16A	#####	#####	16	####	#####	16
D2	32Ex8Mx16A	#####	#####	#####	####	#####	#####
D3	32Ex8Mx16A	#####	#####	#####	####	#####	#####
D4	2Mx4Dx16A	#####	#####	16	####	#####	4
D6	Events	2700	2700	2700	2700	2700	2700
D7	Fst Hkp	#####	#####	#####	####	#####	#####
D8	Rate1	4	4	4	4	4	4
D9	Rate2	128	128	128	128	128	128
DA	Rate3	4	4	4	4	4	4
DB	1024M	64	64	256	4	4	64

## 2.4 Operational Modes

Due to the flexibility built into STATIC's design, operational modes become a complex matrix that depend on spacecraft data allocation (x1, x1.5, x2, x3.25, x4.5), on data product selection (APIDs), on data product time resolutions, on energy sweep tables, on attenuator state, and on instrument pointing as determined by the APP. The data product arrays listed in Table II are independent of energy sweep and deflection sweep, which are programmed with Look Up Tables (LUTs) that are loaded into the instrument by the PFDPU. These LUTs vary with instrument mode (Ram, Conic, and Pickup) and will likely change over time as operations are refined. Preliminary energy sweep tables for Ram, Conic and Pickup modes have logarithmic sweeps spanning energy ranges of 0.1-50 eV, 0.1-500 eV, and 2.7-31000 eV, respectively. Preliminary deflection ranges are +/- 22.5° for Ram mode, and +/- 45° for Conic and Pickup modes. Other

modes are planned including a Scan mode, where the APP is rotated and STATIC's deflectors are off, and an Eclipse mode whose operation is TBD.

Data products are independent of the attenuator states of the sensor, which are used to reduce ion fluxes and prevent detector saturation as the spacecraft passes through periapsis. STATIC has a mechanical (M) and electrostatic (E) attenuator, which have factors of 100 and 10 for levels of attenuation, respectively. The mechanical attenuator extends over 180° centered on the ram direction, and the electrostatic attenuator only operates at low energies (<15 eV) and is controlled by a LUT. The four attenuator states ME = 00, 01, 10, & 11, produce four different levels of attenuation in the ram direction (1., 1/10, 1/100, 1/1000) at low energy and are expected to be primarily used during Ram and Conic modes. The attenuator is controlled by the PFDPU which monitors the count rate and increments the attenuation up or down by factors of 10 as peak count rate exceeds, or drop below, programmable thresholds. The nominal peak count rate for increasing attenuation is ~200 kHz, and attenuation is reduced when the peak rate drops below ~8.4 kHz. The attenuator algorithm in the PFDPU includes two parameters, an averaging parameter to add hysteresis, and a cadence parameter to determine how often to test against the thresholds. In addition, mechanical attenuator changes are limited to no more than once every 5 minutes.

Information about the energy and deflector sweeps, the attenuator state, and data product time resolution are encoded into the APID headers to allow proper decoding of data on the ground. The headers also include information to designate diagnostic mode operations, the state of the test pulser (on/off), and packet number when multiple packets are assembled to make a product.

Lastly, for data products that average over FOV (APIDs C0, C2, C4, C6, C8, CC, CD), assumptions must be made about the geometric factor used in calculating fluxes (physical units) from count rate. Since the attenuators are not uniform over look direction, and because the sensor FOV has time varying blockage by the spacecraft, assumptions must be made about the primary direction where the ions originate. For Ram mode, the assumption will be that events originate in anode 7 which looks in the spacecraft ram direction. For Conic mode, where ions are a bit hotter and where flows may be present, the assumption will be that events originate in anodes 6, 7 and 8, and within 23° of the ram direction. For Pickup mode, ground software will use the full FOV-averaged geometric factor. For data products that contain no mass information (APIDs C8, CA), the mass assumption will be protons for data collected in the solar wind or magnetosheath, and O<sub>2</sub><sup>+</sup> for ions below the ionopause. These assumptions will be the basis of automated ground data processing, at least at the beginning of the mission. However, it should always be possible for a data analyst to use measurements from another data product to refine or change the assumptions, if warranted.

## **2.5 Operational Considerations**

During normal operations, STATIC operates continuously throughout the orbit. The STATIC EM unit was demonstrated to operate properly, with full high voltage, at a pressure of  $5 \times 10^{-4}$  Torr during vacuum chamber tests. This provides an order of magnitude margin over the highest pressures anticipated during deep dips into the Martian ionosphere (120 km altitude). STATIC operates autonomously with a redundant 3 wire command-data-clock interface to the PFDPU, redundant power (+28V and 28Return), and mechanical actuator power. STATIC also contains heaters and thermistors which are controlled and monitored by the spacecraft, and a one-time cover opening circuit that was actuated a few months after launch.

STATIC is powered on by a command to the PFDPU, which provides low voltage (LV) regulated +28V to STATIC. The PFDPU then runs STATIC's "LV RTS" (relative time sequence, RTS\_STASTART) initialization that commands the experiment, loads tables, and leaves STATIC in a low data rate mode. The initialization sequence begins with a "disable STATIC HV RTS" command to prevent high voltage turn on while the LV initialization sequence is running, and ends the command sequence by enabling STATIC's HV RTS. The initialization sequence also arms the PFDPU logic that controls STATIC's attenuator. High voltage is turned on by sending a command to the PFDPU to arm STATIC's HV. This arming starts STATIC's HV RTS (RTS\_STAHVON), unless the LV RTS is running. The HV RTS consists of a command sequence that brings up the three HV supplies (Sweep-Deflector HV, MCP HV, 15kV ACC HV) to nominal voltage over a 3 minute sequence. STATIC is then commanded into a nominal mode (typically Pickup mode).

The various operational modes of STATIC are controlled by mode RTSs stored in the PFDPU. A mode RTS command will initiate a sequence of commands that configure STATIC and determine which data packets are sent, the time resolution of those data packets, the energy-deflector sweep table to be used, and the attenuator thresholds. During an orbit, the spacecraft will initiate mode RTS commands to configure STATIC to Ram, Conic and Pickup modes, with timing of the commands depending upon the phase of the orbit. During a mode command sequence, data products may be corrupted as the instrument configuration is changed. Mode RTS commands have been organized to minimize these problems, and should result in the loss of no more than a single 4 second measurement. Mode RTSs will be modified over the mission to account for changes in link margin data rates (x1, x1.5, x2, x3.25, x4.5) and to optimize science return as we learn more about the Martian environment.

For a complete summary of STATIC commanding, refer to the following documents:

McFadden et al., 2014

MAVEN\_PF\_FSW\_021\_CTM

MAVEN\_PF\_STATIC\_012\_FPGA\_Specification

MAVEN\_PF\_STATIC\_XXX\_Mode\_Data\_Rates

## **2.6 Ground Calibration**

For information on the STATIC Ground Calibration, see McFadden et al., 2014.

## **2.7 Inflight Calibration**

STATIC is required to have an in-flight calibration procedure to determine its absolute sensitivity to within 25%. The STATIC angular and energy responses and the geometric factor (minus detection efficiency) was determined on the ground to within ~15% by calibrations and electrostatic optics simulations. However, to obtain the absolute sensitivity, the detection efficiency must also be known. This efficiency depends on the microchannel plate (MCP) efficiency and carbon-foil secondary electron efficiency, which may vary during the mission. Thus, an in-flight calibration procedure is needed to measure and track this efficiency.

Detection efficiency can be directly measured by STATIC from the Rates data products (MAVEN\_PF\_STATIC\_012\_FPGA\_Specification). The total STATIC detection efficiency is given by the product of the START signal detection efficiency and STOP signal detection efficiency. START and STOP detection efficiencies are given by the ratios of ValidEvents/StopEvents and ValidEvents/StartEvents, respectively. Rate data products (APIDs D8, D9) contain ValidEvents, StopEvents, and StartEvents, along with 9 other diagnostics. Preliminary detection efficiencies were determined during ground calibrations using a single mass beam (McFadden et al., 2014) and shown to be roughly 25% for most masses, and demonstrating that efficiency differences were rather small except for the largest masses ( $\text{CO}_2^+$ ).

Inflight calibrations will also include a cross check between densities determined by STATIC and those determined by SWEA, SWIA, NGIMS, and LPW, and a cross-calibration of flux between STATIC and SWIA. All of these sensors can provide density information over limited altitude ranges. Therefore, STATIC can be the linchpin that provides cross-calibrations for all other instruments. Inflight calibrations will also look for unexpected variations in sensor response due to second order effects like leakage fields through grids, which were not included in the instrument simulations.



### 3 Data Overview

This section provides a high level description of archive organization under the PDS4 Information Model (IM) as well as the flow of the data from the spacecraft through delivery to PDS. Unless specified elsewhere in this document, the MAVEN **STATIC** archive conforms with version 1.1.0.1 of the PDS4 IM [4] and version 1.0 of the MAVEN mission schema. A list of the XML Schema and Schematron documents associated with this archive are provided in Table 8 below.

Table 7: MAVEN STATIC Archive Schema and Schematron

XML Document	Steward	Product LID
PDS Master Schema, v. 1.1.0.1	PDS	urn:nasa:pds:system_bundle:xml_schema:pds-xml_schema
PDS Master Schematron, v. 1.1.0.1	PDS	urn:nasa:pds:system_bundle:xml_schema:pds-xml_schema
MAVEN Mission Schema, v. 1.0	MAVEN	
MAVEN Mission Schematron, v. 1.0	MAVEN	

#### 3.1 Data Reduction Levels

A number of different systems may be used to describe data processing level. This document refers to data by their PDS4 reduction level. Table 8 provides a description of these levels along with the equivalent designations used in other systems.

Table 8: Data reduction level designations

PDS4 reduction level	PDS4 reduction level description	MAVEN Processing Level	CODMAC Level	NASA Level
Raw	Original data from an instrument. If compression, reformatting, packetization, or other translation has been applied to facilitate data transmission or storage, those processes are reversed so that the archived data are in a PDS approved archive format.	0	2	1A
Reduced	Data that have been processed beyond the raw stage but which are not yet entirely independent of the instrument.	1	2	1A
Calibrated	Data converted to physical units entirely independent of the instrument.	2	3	1B

<b>PDS4 reduction level</b>	<b>PDS4 reduction level description</b>	<b>MAVEN Processing Level</b>	<b>CODMAC Level</b>	<b>NASA Level</b>
Derived	Results that have been distilled from one or more calibrated data products (for example, maps, gravity or magnetic fields, or ring particle size distributions). Supplementary data, such as calibration tables or tables of viewing geometry, used to interpret observational data should also be classified as 'derived' data if not easily matched to one of the other three categories.	3+	4+	2+

### 3.2 Products

A PDS product consists of one or more digital and/or non-digital objects, and an accompanying PDS label file. Labeled digital objects are data products (i.e. electronically stored files). Labeled non-digital objects are physical and conceptual entities which have been described by a PDS label. PDS labels provide identification and description information for labeled objects. The PDS label defines a Logical Identifier (LID) by which any PDS labeled product is referenced throughout the system. In PDS4 labels are XML formatted ASCII files. More information on the formatting of PDS labels is provided in Section 6.3. More information on the usage of LIDs and the formation of MAVEN LIDs is provided in Section 5.1.

### 3.3 Product Organization

The highest level of organization for PDS archive is the bundle. A bundle is a list of one or more related collections of products, which may be of different types. A collection is a list of one or more related basic products, which are all of the same type. Figure 3 below illustrates these relationships.

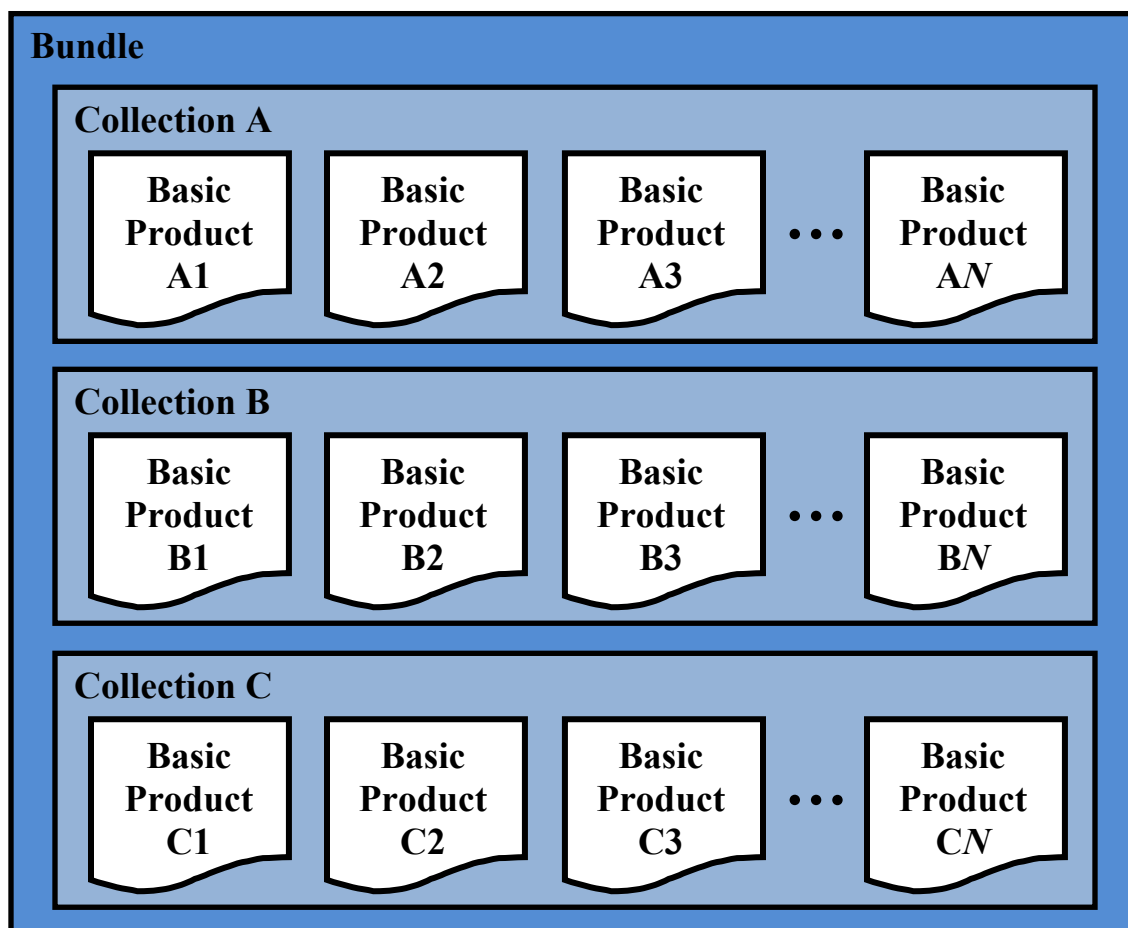


Figure 3: A graphical depiction of the relationship among bundles, collections, and basic products.

Bundles and collections are logical structures, not necessarily tied to any physical directory structure or organization. Bundle and collection membership is established by a member inventory list. Bundle member inventory lists are provided in the bundle product labels themselves. Collection member inventory lists are provided in separate collection inventory table files. Sample bundle and collection labels are provided in Appendix C and Appendix D, respectively.

### 3.3.1 Collection and Basic Product Types

Collections are limited to a single type of basic products. The types of archive collections that are defined in PDS4 are listed in Table 9.

Table 9: Collection product types

Collection Type	Description
Browse	Contains products intended for data characterization, search, and viewing, and not for scientific research or publication.

Context	Contains products which provide for the unique identification of objects which form the context for scientific observations (e.g. spacecraft, observatories, instruments, targets, etc.).
Document	Contains electronic document products which are part of the PDS Archive.
Data	Contains scientific data products intended for research and publication.
SPICE	Contains NAIF SPICE kernels.
XML_Schema	Contains XML schemas and related products which may be used for generating and validating PDS4 labels.

### 3.4 Bundle Products

The STATIC data archive is organized into 1 bundle. A description of the bundle is provided in Table 10, and a more detailed description of the contents and format is provided in Section 5.2.

Table 10: STATIC Bundles

Bundle Logical Identifier	PDS4 Reduction Level	Description	Data Provider
urn:nasa:pds:maven.static.c	Calibrated	Fully calibrated ion velocity distributions, energy spectra, mass spectra, event rates, housekeeping and ground computed physical quantities such as density and temperature. Tables of sensitivity and energy/angle maps included as needed.	ITF

### 3.5 Data Flow

This section describes only those portions of the MAVEN data flow that are directly connected to archiving. A full description of MAVEN data flow is provided in the MAVEN Science Data Management Plan [5]. A graphical representation of the full MAVEN data flow is provided in Figure 4 below.

All ITFs will produce calibrated products. Following an initial 2-month period at the beginning of the mapping phase, the ITFs will routinely deliver preliminary calibrated data products to the SDC for use by the entire MAVEN team within two weeks of ITF receipt of all data needed to generate those products. The SOC will maintain an active archive of all MAVEN science data, and will provide the MAVEN science team with direct access through the life of the MAVEN mission. After the end of the MAVEN project, PDS will be the sole long-term archive for all public MAVEN data.

Updates to calibrations, algorithms, and/or processing software are expected to occur regularly, resulting in appropriate production system updates followed by reprocessing of science data

products by ITFs for delivery to SDC. Systems at the SOC, ITFs and PDS are designed to handle these periodic version changes.

Data bundles intended for the archive are identified in Table 10.

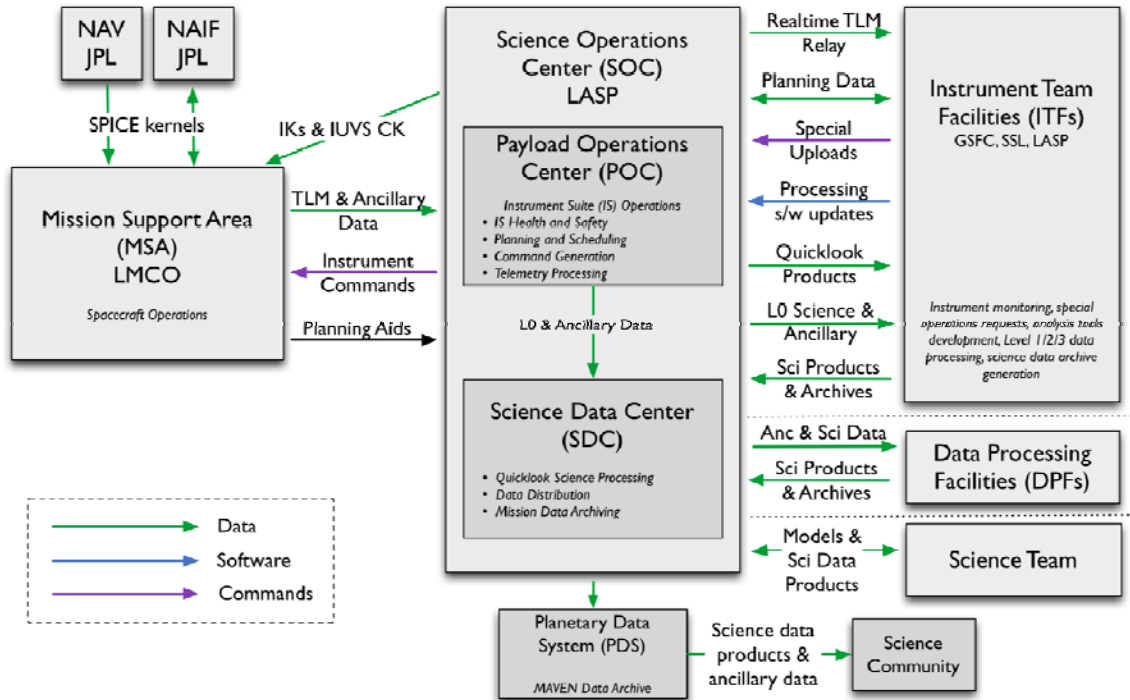


Figure 4: MAVEN Ground Data System responsibilities and data flow. Note that this figure includes portions of the MAVEN GDS which are not directly connected with archiving, and are therefore not described in Section 3.5 above.

## **4 Archive Generation**

The STATIC archive products are produced by the STATIC team in cooperation with the SDC, and with the support of the PDS Planetary Plasma Interactions (PPI) Node at the University of California, Los Angeles (UCLA). The archive volume creation process described in this section sets out the roles and responsibilities of each of these groups. The assignment of tasks has been agreed upon by all parties. Archived data received by the PPI Node from the STATIC team are made available to PDS users electronically as soon as practicable but no later two weeks after the delivery and validation of the data.

### **4.1 Data Processing and Production Pipeline**

The following sections describe the process by which data products in each of the STATIC bundles listed in Table 10 are produced.

#### **4.1.1 Raw Data Production Pipeline**

After receiving MAVEN processing Level 0 data from the POC, the SDC will process the Level 0 into Quicklook science products using software provided by the STATIC ITF. The SDC will provide the STATIC ITF with Level 0 data files (consisting of compressed PF packets in their native format, one file per UT day for all PF Survey data, and one file per UT day for all PF Archive data), Quicklook science data and all ancillary data required for science processing. From this data, the STATIC ITF will generate Level 2 calibrated science data products. The science data products that the STATIC ITF delivers to the SDC will be stored by the SDC for the duration of the project, and will be made available to the MAVEN team. The SDC will deliver archival-quality science data products to the PDS for distribution to the public and long-term archiving in accordance with the STATIC-PDS SIS (this document) and the SOC-PDS SIS. The SDC will also be responsible for delivering Level 0 archives and non-SPICE ancillary data to the PDS for long-term archiving, in accordance with the SOC-PDS SIS and the Export Control Checklist.

#### **4.1.2 Calibrated Data Production Pipeline**

Calibrated STATIC Level 2 data will be produced from the raw level 0 PF data files by the STATIC ITF using IDL software, and provided for archiving in the PDS in CDF format. The data production pipeline will be run in an automated fashion to produce archival-ready files from the raw level 0 data.

Beginning as soon as possible but no later than 2 months after the start of science operations, the STATIC ITF will routinely generate Level 2 science data products and deliver them to the SOC. After the initial 2-month calibration period, the STATIC ITF will deliver preliminary Level 2 products to the SDC for distribution to the MAVEN team within two weeks of receiving all data required for science processing (including all SPICE kernels and other ancillary data required for processing) by the ITFs. Final Level 2 STATIC products will be delivered to the SDC as soon as they are complete, no later than needed to meet the PDS delivery schedule in Table 12.

The STATIC ITF does not plan to produce Level 3 products, instead using Level 2 as the final science products.

The STATIC ITF will deliver validated science data products and associated metadata for PDS archiving to the SOC two weeks prior to every PDS delivery deadline. The first PDS delivery will occur no later than 6 months after the start of science operations, and subsequent deliveries will take place every 3 months after the first delivery. The first delivery will include data collected during the cruise and transition phases in addition to the science data from the first 3 months of the mapping phase. Each subsequent delivery will contain data from the 3 months following the previous delivery. The final delivery may contain products involving data from the entire mission.

The STATIC ITF will also provide the SDC with data product descriptions, appropriate for use by the MAVEN science team in using MAVEN science data products and consistent with PDS metadata standards.

## **4.2 Data Validation**

### **4.2.1 Instrument Team Validation**

All STATIC data will be calibrated and converted to physical units by the STATIC ITF, then spot-checked by the instrument lead and his designees for accuracy and integrity.

### **4.2.2 MAVEN Science Team Validation**

The MAVEN science team will work with the same STATIC products that will be archived in the PDS. If any calibration issues or other anomalies are noted, they will be addressed at the STATIC ITF by the instrument lead or his designees.

### **4.2.3 PDS Peer Review**

The PPI node will conduct a full peer review of all of the data types that the STATIC team intends to archive. The review data will consist of fully formed bundles populated with candidate final versions of the data and other products and the associated metadata.

*Table 11: MAVEN PDS review schedule*

<b>Date</b>	<b>Activity</b>	<b>Responsible Team</b>
2014-Mar-24	Signed SIS deadline	ITF
2014-Apr-18	Sample data products due	ITF
2014-May to 2014-Aug	Preliminary PDS peer review (SIS, sample data files)	PDS
2015-Mar-02	Release #1: Data due to PDS	ITF/SDC
2015-Mar to 2015-Apr	Release #1: Data PDS peer review	PDS
2015-May-01	Release #1: Public release	PDS

Reviews will include a preliminary delivery of sample products for validation and comment by PDS PPI and Engineering node personnel. The data provider will then address the comments coming out of the preliminary review, and generate a full archive delivery to be used for the peer review.

Reviewers will include MAVEN Project and STATIC team representatives, researchers from outside of the MAVEN project, and PDS personnel from the Engineering and PPI nodes. Reviewers will examine the sample data products to determine whether the data meet the stated science objectives of the instrument and the needs of the scientific community and to verify that the accompanying metadata are accurate and complete. The peer review committee will identify any liens on the data that must be resolved before the data can be ‘certified’ by PDS, a process by which data are made public as minor errors are corrected.

In addition to verifying the validity of the review data, this review will be used to verify that the data production pipeline by which the archive products are generated is robust. Additional deliveries made using this same pipeline will be validated at the PPI node, but will not require additional external review.

As expertise with the instrument and data develops the STATIC team may decide that changes to the structure or content of its archive products are warranted. Any changes to the archive products or to the data production pipeline will require an additional round of review to verify that the revised products still meet the original scientific and archival requirements or whether those criteria have been appropriately modified. Whether subsequent reviews require external reviewers will be decided on a case-by-case basis and will depend upon the nature of the changes. A comprehensive record of modifications to the archive structure and content is kept in the Modification\_History element of the collection and bundle products.



The instrument team and other researchers are encouraged to archive additional STATIC products that cover specific observations or data-taking activities. The schedule and structure of any additional archives are not covered by this document and should be worked out with the PPI node.

### 4.3 Data Transfer Methods and Delivery Schedule

The SOC is responsible for delivering data products to the PDS for long-term archiving. While ITFs are primarily responsible for the design and generation of calibrated and derived data archives, the archival process is managed by the SOC. The SOC (in coordination with the ITFs) will also be primarily responsible for the design and generation of the raw data archive. The first PDS delivery will take place within 6 months of the start of science operations. Additional deliveries will occur every following 3 months and one final delivery will be made after the end of the mission. Science data are delivered to the PDS within 6 months of its collection. If it becomes necessary to reprocess data which have already been delivered to the archive, the ITFs will reprocess the data and deliver them to the SDC for inclusion in the next archive delivery. A summary of this schedule is provided in Table 12 below.

Table 12: Archive bundle delivery schedule

Bundle Logical Identifier	First Delivery to PDS	Delivery Schedule	Estimated Delivery Size
urn:nasa:pds:maven.static.c	No later than 6 months after the start of science operations	Every 3 months	TBR

Each delivery will comprise both data and ancillary data files organized into directory structures consistent with the archive design described in Section 5, and combined into a deliverable file(s) using file archive and compression software. When these files are unpacked at the PPI Node in the appropriate location, the constituent files will be organized into the archive structure.

Archive deliveries are made in the form of a “delivery package”. Delivery packages include all of the data being transferred along with a transfer manifest, which helps to identify all of the products included in the delivery, and a checksum manifest which helps to insure that integrity of the data is maintained through the delivery. The format of these files is described in Section 6.4.

Data are transferred electronically (using the *ssh* protocol) from the SOC to an agreed upon location within the PPI file system. PPI will provide the SOC a user account for this purpose. Each delivery package is made in the form of a compressed *tar* or *zip* archive. Only those files that have changed since the last delivery are included. The PPI operator will decompress the data, and verify that the archive is complete using the transfer and MD5 checksum manifests that were included in the delivery package. Archive delivery status will be tracked using a system defined by the PPI node.

Following receipt of a data delivery, PPI will reorganize the data into its PDS archive structure within its online data system. PPI will also update any of the required files associated with a PDS

archive as necessitated by the data reorganization. Newly delivered data are made available publicly through the PPI online system once accompanying labels and other documentation have been validated. It is anticipated that this validation process will require no more than fourteen working days from receipt of the data by PPI. However, the first few data deliveries may require more time for the PPI Node to process before the data are made publicly available.

The MAVEN prime mission begins approximately 5 weeks following MOI and lasts for 1 Earth-year. **Error! Reference source not found.** shows the data delivery schedule for the entire mission.

#### **4.4 Data Product and Archive Volume Size Estimates**

STATIC data products consist of files that span one UT day, breaking at 0h UTC SCET. Files vary in size depending on the telemetry rate and allocation.

#### **4.5 Data Validation**

Routine data deliveries to the PDS are validated at the PPI node to insure that the delivery meets PDS standards, and that the data conform to the standards defined in the SIS, and set in the peer review. As long as there are no changes to the data product formats, or data production pipeline no additional external review will be conducted.

#### **4.6 Backups and duplicates**

The PPI Node keeps three copies of each archive product. One copy is the primary online archive copy, another is an onsite backup copy, and the final copy is an off-site backup copy. Once the archive products are fully validated and approved for inclusion in the archive, copies of the products are sent to the National Space Science Data Center (NSSDC) for long-term archive in a NASA-approved deep-storage facility. The PPI Node may maintain additional copies of the archive products, either on or off-site as deemed necessary. The process for the dissemination and preservation of STATIC data is illustrated in Figure 5.

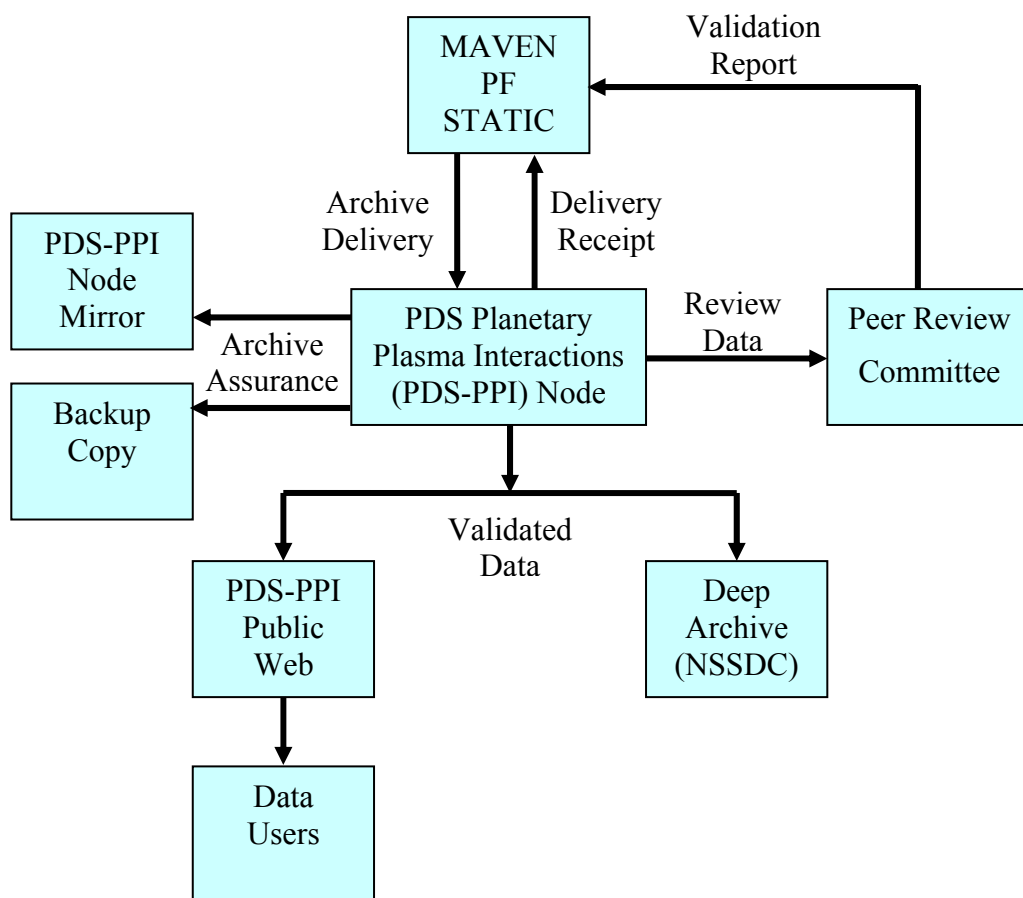


Figure 5: Duplication and dissemination of STATIC archive products at PDS/PPI.

## 5 Archive organization and naming

This section describes the basic organization of an STATIC bundle, and the naming conventions used for the product logical identifiers, and bundle, collection, and basic product filenames.

### 5.1 Logical Identifiers

Every product in PDS is assigned an identifier which allows it to be uniquely identified across the system. This identifier is referred to as a Logical Identifier or LID. A LIDVID (Versioned Logical Identifier) includes product version information, and allows different versions of a specific product to be referenced uniquely. A product's LID and VID are defined as separate attributes in the product label. LIDs and VIDs are assigned by the entity generating the labels and are formed according to the conventions described in sections 5.1.1 and 5.1.2 below. The uniqueness of a product's LIDVID may be verified using the PDS Registry and Harvest tools.

#### 5.1.1 LID Formation

LIDs take the form of a Uniform Resource Name (URN). LIDs are restricted to ASCII lower case letters, digits, dash, underscore, and period. Colons are also used, but only to separate prescribed components of the LID. Within one of these prescribed components dash, underscore, or period are used as separators. LIDs are limited in length to 255 characters.

MAVEN STATIC LIDs are formed according to the following conventions:

- Bundle LIDs are formed by appending a bundle specific ID to the MAVEN STATIC base ID:

urn:nasa:pds:maven.static.<bundle ID>

Since all PDS bundle LIDs are constructed this way, the combination of maven.static.bundle must be unique across all products archived with the PDS.

- Collection LIDs are formed by appending a collection specific ID to the collection's parent bundle LID:

urn:nasa:pds:maven.static.<bundle ID>:<collection ID>

Since the collection LID is based on the bundle LID, which is unique across PDS, the only additional condition is that the collection ID must be unique across the bundle. Collection IDs correspond to the collection type (e.g. "browse", "data", "document", etc.). Additional descriptive information may be appended to the collection type (e.g. "data-raw", "data-calibrated", etc.) to insure that multiple collections of the same type within a single bundle have unique LIDs.

- Basic product LIDs are formed by appending a product specific ID to the product's parent collection LID:

urn:nasa:pds:maven.static.<bundle ID>:<collection ID>:<product ID>

Since the product LID is based on the collection LID, which is unique across PDS, the only additional condition is that the product ID must be unique across the collection.

A list of STATIC bundle LIDs is provided in Table 10. Collection LIDs are listed in Table 13.

### 5.1.2 VID Formation

Product version ID's consist of major and minor components separated by a "." (M.n). Both components of the VID are integer values. The major component is initialized to a value of "1", and the minor component is initialized to a value of "0". The minor component resets to "0" when the major component is incremented.

## 5.2 STATIC Archive Contents

The STATIC archive includes the calibrated (MAVEN level 2) bundle listed in Table 10. The following section describes the contents of this bundle in greater detail.

### 5.2.1 STATIC Calibrated (MAVEN Level 2) Science Data Bundle

The STATIC.calibrated Level 2 Science Data Bundle contains fully calibrated data in physical units, consisting of Coarse and Fine resolution 3d distributions and energy spectra and moments from onboard computations.

Table 13: static.c Level 2 Science Data Collections

Collection LID	Description
urn:nasa:pds:maven.static.c:data.2a_hkp	housekeeping data
urn:nasa:pds:maven.static.c:data.c0_64e2m	64 energy x 2 mass ion distributions in units of differential energy flux
urn:nasa:pds:maven.static.c:data.c2_32e32m	32 energy x 32 mass ion distributions in units of differential energy flux
urn:nasa:pds:maven.static.c:data.c4_4e64m	4 energy x 64 mass ion distributions in units of differential energy flux
urn:nasa:pds:maven.static.c:data.c6_32e64m	32 energy x 64 mass ion distributions in units of differential energy flux
urn:nasa:pds:maven.static.c:data.c8_32e16d	32 energy x 16 deflection ion distributions in units of differential energy flux
urn:nasa:pds:maven.static.c:data.ca_16e4d16a	16 energy x 4 deflection x 16 anode ion distributions in units of differential energy flux
urn:nasa:pds:maven.static.c:data.cc_32e8d32m	32 energy x 8 deflection x 32 mass ion distributions in units of differential energy flux
urn:nasa:pds:maven.static.c:data.cd_32e8d32m	32 energy x 8 deflection x 32 mass ion distributions in units of differential energy flux
urn:nasa:pds:maven.static.c:data.ce_16e4d16a16m	16 energy x 4 deflection x 16 anode x 16 mass ion distributions in units of differential energy flux
urn:nasa:pds:maven.static.c:data.cf_16e4d16a16m	16 energy x 4 deflection x 16 anode x 16 mass ion distributions in units of differential energy flux
urn:nasa:pds:maven.static.c:data.d0_32e4d16a8m	32 energy x 4 deflection x 16 anode x 8 mass ion distributions in units of differential energy flux
urn:nasa:pds:maven.static.c:data.d1_32e4d16a8m	32 energy x 4 deflection x 16 anode x 8 mass ion distributions in units of differential energy flux

Collection LID	Description
urn:nasa:pds:maven.static.c:data.d2_32e16a8m	32 energy x 16 anode x 8 mass ion distributions in units of differential energy flux
urn:nasa:pds:maven.static.c:data.d3_32e16a8m	32 energy x 16 anode x 8 mass ion distributions in units of differential energy flux
urn:nasa:pds:maven.static.c:data.d4_4d16a2m	4 deflection x16 anode x 2 mass ion distributions in units of differential energy flux
urn:nasa:pds:maven.static.c:data.d6_events	Raw event data
urn:nasa:pds:maven.static.c:data.d7_fsthkp	Fast housekeeping
urn:nasa:pds:maven.static.c:data.d8_12r	12 event rates averaged over energy
urn:nasa:pds:maven.static.c:data.d9_12r64e	12 event rates x 64 energy
urn:nasa:pds:maven.static.c:data.da_1r	1 selected event rate at high resolution
urn:nasa:pds:maven.static.c:data.db_1024tof	1024 bin mass histogram in counts
urn:nasa:pds:maven.static.c:document	Documents related to the static.c bundle.

### 5.2.1.1 maven.static.c:data.2a\_hkp

maven.static.c:data.2a\_hkp contains files with time-ordered fully calibrated housekeeping data, derived from APID 2a. The 99 different housekeeping data include instrument voltages and currents, configuration bytes, table check sums, etc. Data files will also contain the raw housekeeping data.

The data files contain a time-ordered array with time in Epoch time, Mission-Elapsed-Time (MET), Time\_TT200 (UTC time from 1-1-2000 12:00, including leap seconds), Ephemeris time (used by SPICE), and Unix time (Seconds since 1970-01-01/00:00).

The STATIC ITF will produce these products, with one file per UT day, with the naming convention mvn\_sta\_l2\_2a\_hkp\_<yyyy><mm><dd>T<hh><mm><ss>\_v<xx>\_r<yy>.cdf when data are available.

Data files will also contain non-record-varying (NRV) “support data” with the calibration parameters.

### 5.2.1.2 maven.static.c:data.c0\_64e2m

maven.static.c:data.c0\_64e2m contains files with time-ordered fully calibrated differential energy flux in 64 energy bin x 2 mass bin arrays, averaged over look direction. Data are derived from APID c0. Data files will also contain the raw counts data, and calibrated array descriptions.

The data files contain a time-ordered array with time in Epoch time, Mission-Elapsed-Time (MET), Time\_TT200 (UTC time from 1-1-2000 12:00, including leap seconds), Ephemeris time (used by SPICE), and Unix time (Seconds since 1970-01-01/00:00).

The STATIC ITF will produce these products, with one file per UT day, with the naming convention mvn\_sta\_l2\_c0\_64e2m\_<yyyy><mm><dd>T<hh><mm><ss>\_v<xx>\_r<yy>.cdf when data are available.

Data files will also contain non-record-varying (NRV) “support data” that contain calibration parameters for full data reconstruction of differential energy flux from the raw counts.

#### **5.2.1.3 maven.static.c:data.c2\_32e32m**

maven.static.c:data.c2\_32e32m contains files with time-ordered fully calibrated differential energy flux in 32 energy bin x 32 mass bin arrays, averaged over look direction. Data are derived from APID c2. Data files will also contain the raw counts data, and calibrated array descriptions.

The data files contain a time-ordered array with time in Epoch time, Mission-Elapsed-Time (MET), Time\_TT200 (UTC time from 1-1-2000 12:00, including leap seconds), Ephemeris time (used by SPICE), and Unix time (Seconds since 1970-01-01/00:00).

The STATIC ITF will produce these products, with one file per UT day, with the naming convention mvn\_sta\_l2\_c2\_32e32m\_<yyyy><mm><dd>T<hh><mm><ss>\_v<xx>\_r<yy>.cdf when data are available.

Data files will also contain non-record-varying (NRV) “support data” that contain calibration parameters for full data reconstruction of differential energy flux from the raw counts.

#### **5.2.1.4 maven.static.c:data.c4\_4e64m**

maven.static.c:data.c4\_4e64m contains files with time-ordered fully calibrated differential energy flux in 4 energy bin x 64 mass bin arrays, averaged over look direction. Data are derived from APID c4. Data files will also contain the raw counts data, and calibrated array descriptions.

The data files contain a time-ordered array with time in Epoch time, Mission-Elapsed-Time (MET), Time\_TT200 (UTC time from 1-1-2000 12:00, including leap seconds), Ephemeris time (used by SPICE), and Unix time (Seconds since 1970-01-01/00:00).

The STATIC ITF will produce these products, with one file per UT day, with the naming convention mvn\_sta\_l2\_c4\_4e64m\_<yyyy><mm><dd>T<hh><mm><ss>\_v<xx>\_r<yy>.cdf when data are available.

Data files will also contain non-record-varying (NRV) “support data” that contain calibration parameters for full data reconstruction of differential energy flux from the raw counts.

#### **5.2.1.5 maven.static.c:data.c6\_32e64m**

maven.static.c:data.c6\_32e64m contains files with time-ordered fully calibrated differential energy flux in 32 energy bin x 64 mass bin arrays, averaged over look direction. Data are derived from APID c6. Data files will also contain the raw counts data, and calibrated array descriptions.

The data files contain a time-ordered array with time in Epoch time, Mission-Elapsed-Time (MET), Time\_TT200 (UTC time from 1-1-2000 12:00, including leap seconds), Ephemeris time (used by SPICE), and Unix time (Seconds since 1970-01-01/00:00).

The STATIC ITF will produce these products, with one file per UT day, with the naming convention mvn\_sta\_l2\_c6\_32e64m\_<yyyy><mm><dd>T<hh><mm><ss>\_v<xx>\_r<yy>.cdf when data are available.

Data files will also contain non-record-varying (NRV) “support data” that contain calibration parameters for full data reconstruction of differential energy flux from the raw counts.

#### **5.2.1.6 maven.static.c:data.c8\_32e16d**

maven.static.c:data.c8\_32e16d contains files with time-ordered fully calibrated differential energy flux in 32 energy bin x 16 solid angle bin arrays (16 deflection angles and summed over anodes, but assumed that counts are from anode 7 in the ram direction), averaged over mass assuming  $O_2^+$ . Data are derived from APID c8. Data files will also contain the raw counts data, and calibrated array descriptions.

The data files contain a time-ordered array with time in Epoch time, Mission-Elapsed-Time (MET), Time\_TT200 (UTC time from 1-1-2000 12:00, including leap seconds), Ephemeris time (used by SPICE), and Unix time (Seconds since 1970-01-01/00:00).

The STATIC ITF will produce these products, with one file per UT day, with the naming convention `mvn_sta_l2_c8_32e16d_<yyyy><mm><dd>T<hh><mm><ss>_v<xx>_r<yy>.cdf` when data are available.

Data files will also contain non-record-varying (NRV) “support data” that contain calibration parameters for full data reconstruction of differential energy flux from the raw counts.

#### **5.2.1.7 maven.static.c:data.ca\_16e4d16a**

maven.static.c:data.ca\_16e4d16a contains files with time-ordered fully calibrated differential energy flux in 16 energy bin x 64 solid angle bin arrays (4 deflection angles x 16 anodes), averaged over mass assuming  $O_2^+$ . Data are derived from APID ca. Data files will also contain the raw counts data, and calibrated array descriptions.

The data files contain a time-ordered array with time in Epoch time, Mission-Elapsed-Time (MET), Time\_TT200 (UTC time from 1-1-2000 12:00, including leap seconds), Ephemeris time (used by SPICE), and Unix time (Seconds since 1970-01-01/00:00).

The STATIC ITF will produce these products, with one file per UT day, with the naming convention `mvn_sta_l2_ca_16e4d16a_<yyyy><mm><dd>T<hh><mm><ss>_v<xx>_r<yy>.cdf` when data are available.

Data files will also contain non-record-varying (NRV) “support data” that contain calibration parameters for full data reconstruction of differential energy flux from the raw counts.

#### **5.2.1.8 maven.static.c:data.cc\_32e8d32m**

maven.static.c:data.cc\_32e8d32m contains files with time-ordered fully calibrated differential energy flux in 32 energy bin x 8 solid angle bin (8 deflection angles and summed over anodes, but assumed that counts are from anode 7 in the ram direction) x 32 mass bin arrays. Data are derived from APID cc. Data files will also contain the raw counts data, and calibrated array descriptions.



The data files contain a time-ordered array with time in Epoch time, Mission-Elapsed-Time (MET), Time\_TT200 (UTC time from 1-1-2000 12:00, including leap seconds), Ephemeris time (used by SPICE), and Unix time (Seconds since 1970-01-01/00:00).

The STATIC ITF will produce these products, with one file per UT day, with the naming convention `mvn_sta_l2_cc_32e8d32m_<yyyy><mm><dd>T<hh><mm><ss>_v<xx>_r<yy>.cdf` when data are available.

Data files will also contain non-record-varying (NRV) “support data” that contain calibration parameters for full data reconstruction of differential energy flux from the raw counts.

#### **5.2.1.9 maven.static.c:data.cd\_32e8d32m**

`maven.static.c:data.cd_32e8d32m` contains files with time-ordered fully calibrated differential energy flux in 32 energy bin x 8 solid angle bin (8 deflection angles and summed over anodes, but assumed that counts are from anode 7 in the ram direction) x 32 mass bin arrays. Data are derived from APID cd. Data files will also contain the raw counts data, and calibrated array descriptions.

The data files contain a time-ordered array with time in Epoch time, Mission-Elapsed-Time (MET), Time\_TT200 (UTC time from 1-1-2000 12:00, including leap seconds), Ephemeris time (used by SPICE), and Unix time (Seconds since 1970-01-01/00:00).

The STATIC ITF will produce these products, with one file per UT day, with the naming convention `mvn_sta_l2_cd_32e8d32m_<yyyy><mm><dd>T<hh><mm><ss>_v<xx>_r<yy>.cdf` when data are available.

Data files will also contain non-record-varying (NRV) “support data” that contain calibration parameters for full data reconstruction of differential energy flux from the raw counts.

#### **5.2.1.10 maven.static.c:data.ce\_16e4d16a16m**

`maven.static.c:data.ce_16e4d16a16m` contains files with time-ordered fully calibrated differential energy flux in 16 energy bin x 64 solid angle bin (4 deflection angles x 16 anodes) x 16 mass bin arrays. Data are derived from APID ce. Data files will also contain the raw counts data, and calibrated array descriptions.

The data files contain a time-ordered array with time in Epoch time, Mission-Elapsed-Time (MET), Time\_TT200 (UTC time from 1-1-2000 12:00, including leap seconds), Ephemeris time (used by SPICE), and Unix time (Seconds since 1970-01-01/00:00).

The STATIC ITF will produce these products, with one file per UT day, with the naming convention

`mvn_sta_l2_ce_16e4d16a16m_<yyyy><mm><dd>T<hh><mm><ss>_v<xx>_r<yy>.cdf` when data are available.

Data files will also contain non-record-varying (NRV) “support data” that contain calibration parameters for full data reconstruction of differential energy flux from the raw counts.

### **5.2.1.11      maven.static.c:data.cf\_16e4d16a16m**

maven.static.c:data.cf\_16e4d16a16m contains files with time-ordered fully calibrated differential energy flux in 16 energy bin x 64 solid angle bin (4 deflection angles x 16 anodes) x 16 mass bin arrays. Data are derived from APID cf. Data files will also contain the raw counts data, and calibrated array descriptions.

The data files contain a time-ordered array with time in Epoch time, Mission-Elapsed-Time (MET), Time\_TT200 (UTC time from 1-1-2000 12:00, including leap seconds), Ephemeris time (used by SPICE), and Unix time (Seconds since 1970-01-01/00:00).

The STATIC ITF will produce these products, with one file per UT day, with the naming convention

mvn\_sta\_l2\_cf\_16e4d16a16m\_<yyyy><mm><dd>T<hh><mm><ss>\_v<xx>\_r<yy>.cdf    when data are available.

Data files will also contain non-record-varying (NRV) “support data” that contain calibration parameters for full data reconstruction of differential energy flux from the raw counts.

### **5.2.1.12      maven.static.c:data.d0\_32e4d16a8m**

maven.static.c:data.d0\_16e4d16a8m contains files with time-ordered fully calibrated differential energy flux in 16 energy bin x 64 solid angle bin (4 deflection angles x 16 anodes) x 8 mass bin arrays. Data are derived from APID d0. Data files will also contain the raw counts data, and calibrated array descriptions.

The data files contain a time-ordered array with time in Epoch time, Mission-Elapsed-Time (MET), Time\_TT200 (UTC time from 1-1-2000 12:00, including leap seconds), Ephemeris time (used by SPICE), and Unix time (Seconds since 1970-01-01/00:00).

The STATIC ITF will produce these products, with one file per UT day, with the naming convention

mvn\_sta\_l2\_d0\_16e4d16a8m\_<yyyy><mm><dd>T<hh><mm><ss>\_v<xx>\_r<yy>.cdf    when data are available.

Data files will also contain non-record-varying (NRV) “support data” that contain calibration parameters for full data reconstruction of differential energy flux from the raw counts.

### **5.2.1.13      maven.static.c:data.d1\_32e4d16a8m**

maven.static.c:data.d1\_16e4d16a8m contains files with time-ordered fully calibrated differential energy flux in 16 energy bin x 64 solid angle bin (4 deflection angles x 16 anodes) x 8 mass bin arrays. Data are derived from APID d1. Data files will also contain the raw counts data, and calibrated array descriptions.

The data files contain a time-ordered array with time in Epoch time, Mission-Elapsed-Time (MET), Time\_TT200 (UTC time from 1-1-2000 12:00, including leap seconds), Ephemeris time (used by SPICE), and Unix time (Seconds since 1970-01-01/00:00).

The STATIC ITF will produce these products, with one file per UT day, with the naming convention

mvn\_sta\_l2\_d1\_16e4d16a8m\_<yyyy><mm><dd>T<hh><mm><ss>\_v<xx>\_r<yy>.cdf when data are available.

Data files will also contain non-record-varying (NRV) “support data” that contain calibration parameters for full data reconstruction of differential energy flux from the raw counts.

#### **5.2.1.14 maven.static.c:data.d2\_32e16a8m**

maven.static.c:data.d2\_16e16a8m contains files with time-ordered fully calibrated differential energy flux in 16 energy bin x 16 solid angle bin (no deflection, 16 anodes) x 8 mass bin arrays. Data are derived from APID d2. Data files will also contain the raw counts data, and calibrated array descriptions.

The data files contain a time-ordered array with time in Epoch time, Mission-Elapsed-Time (MET), Time\_TT200 (UTC time from 1-1-2000 12:00, including leap seconds), Ephemeris time (used by SPICE), and Unix time (Seconds since 1970-01-01/00:00).

The STATIC ITF will produce these products, with one file per UT day, with the naming convention mvn\_sta\_l2\_d2\_16e16a8m\_<yyyy><mm><dd>T<hh><mm><ss>\_v<xx>\_r<yy>.cdf when data are available.

Data files will also contain non-record-varying (NRV) “support data” that contain calibration parameters for full data reconstruction of differential energy flux from the raw counts.

#### **5.2.1.15 maven.static.c:data.d3\_32e16a8m**

maven.static.c:data.d3\_16e16a8m contains files with time-ordered fully calibrated differential energy flux in 16 energy bin x 16 solid angle bin (no deflection, 16 anodes) x 8 mass bin arrays. Data are derived from APID d3. Data files will also contain the raw counts data, and calibrated array descriptions.

The data files contain a time-ordered array with time in Epoch time, Mission-Elapsed-Time (MET), Time\_TT200 (UTC time from 1-1-2000 12:00, including leap seconds), Ephemeris time (used by SPICE), and Unix time (Seconds since 1970-01-01/00:00).

The STATIC ITF will produce these products, with one file per UT day, with the naming convention mvn\_sta\_l2\_d3\_16e16a8m\_<yyyy><mm><dd>T<hh><mm><ss>\_v<xx>\_r<yy>.cdf when data are available.

Data files will also contain non-record-varying (NRV) “support data” that contain calibration parameters for full data reconstruction of differential energy flux from the raw counts.

#### **5.2.1.16 maven.static.c:data.d4\_4d16a2m**

maven.static.c:data.d4\_4d16a2m contains files with time-ordered fully calibrated differential energy flux in 64 solid angle bin (4 deflection x 16 anodes) x 2 mass bin arrays. Data are derived from APID d4. Data files will also contain the raw counts data, and calibrated array descriptions.

The data files contain a time-ordered array with time in Epoch time, Mission-Elapsed-Time (MET), Time\_TT200 (UTC time from 1-1-2000 12:00, including leap seconds), Ephemeris time (used by SPICE), and Unix time (Seconds since 1970-01-01/00:00).

The STATIC ITF will produce these products, with one file per UT day, with the naming convention `mvn_sta_l2_d4_4d16a2m_<yyyy><mm><dd>T<hh><mm><ss>_v<xx>_r<yy>.cdf` when data are available.

Data files will also contain non-record-varying (NRV) “support data” that contain calibration parameters for full data reconstruction of differential energy flux from the raw counts.

#### **5.2.1.17 maven.static.c:data.d6\_events**

`maven.static.c:data.d6_events` contains files with time-ordered raw event data. Data are derived from APID d6.

The data files contain a time-ordered array with time in Epoch time, Mission-Elapsed-Time (MET), Time\_TT200 (UTC time from 1-1-2000 12:00, including leap seconds), Ephemeris time (used by SPICE), and Unix time (Seconds since 1970-01-01/00:00).

The STATIC ITF will produce these products, with one file per UT day, with the naming convention `mvn_sta_l2_d6_events_<yyyy><mm><dd>T<hh><mm><ss>_v<xx>_r<yy>.cdf` when data are available.

Data files will also contain non-record-varying (NRV) “support data” that contain information to reconstruct sensor state.

#### **5.2.1.18 maven.static.c:data.d7\_fsthkp**

`maven.static.c:data.d7_fsthkp` contains files with time-ordered fully calibrated fast housekeeping data. Data are derived from APID d7. Only one housekeeping channel is recorded at a time.

The data files contain a time-ordered array with time in Epoch time, Mission-Elapsed-Time (MET), Time\_TT200 (UTC time from 1-1-2000 12:00, including leap seconds), Ephemeris time (used by SPICE), and Unix time (Seconds since 1970-01-01/00:00).

The STATIC ITF will produce these products, with one file per UT day, with the naming convention `mvn_sta_l2_d7_fsthkp_<yyyy><mm><dd>T<hh><mm><ss>_v<xx>_r<yy>.cdf` when data are available.

Data files will also contain non-record-varying (NRV) “support data” with the calibration parameters.

#### **5.2.1.19 maven.static.c:data.d8\_12r**

`maven.static.c:data.d8_12r` contains files with time-ordered event rate data averaged over a spin. Data are derived from APID d8. The twelve event rates are documented in MAVEN\_PF\_STATIC\_012\_FPGA\_Specification. Event rates can be used to calculate efficiencies and correct for dead time.

The data files contain a time-ordered array with time in Epoch time, Mission-Elapsed-Time (MET), Time\_TT200 (UTC time from 1-1-2000 12:00, including leap seconds), Ephemeris time (used by SPICE), and Unix time (Seconds since 1970-01-01/00:00).

The STATIC ITF will produce these products, with one file per UT day, with the naming convention `mvn_sta_l2_d8_12r_<yyyy><mm><dd>T<hh><mm><ss>_v<xx>_r<yy>.cdf` when data are available.

Data files will also contain non-record-varying (NRV) “support data” with the 12 event rates identified.

#### **5.2.1.20 maven.static.c:data.d9\_12r64e**

`maven.static.c:data.d9_12r64e` contains files with time-ordered event rate data sorted into 12 rates x 64 energy bin arrays that are averaged over multiple spins. Data are derived from APID d9. The twelve event rates are documented in MAVEN\_PF\_STATIC\_012\_FPGA\_Specification. Event rates can be used to calculate efficiencies and correct for dead time.

The data files contain a time-ordered array with time in Epoch time, Mission-Elapsed-Time (MET), Time\_TT200 (UTC time from 1-1-2000 12:00, including leap seconds), Ephemeris time (used by SPICE), and Unix time (Seconds since 1970-01-01/00:00).

The STATIC ITF will produce these products, with one file per UT day, with the naming convention `mvn_sta_l2_d9_12r64e_<yyyy><mm><dd>T<hh><mm><ss>_v<xx>_r<yy>.cdf` when data are available.

Data files will also contain non-record-varying (NRV) “support data” with the 12 event rates identified.

#### **5.2.1.21 maven.static.c:data.da\_1r**

`maven.static.c:data.da_1r` contains files with time-ordered event rate data from a selected rate channel. Data are derived from APID da. Event rates are documented in MAVEN\_PF\_STATIC\_012\_FPGA\_Specification. Event rates can be used to calculate efficiencies and correct for dead time.

The data files contain a time-ordered array with time in Epoch time, Mission-Elapsed-Time (MET), Time\_TT200 (UTC time from 1-1-2000 12:00, including leap seconds), Ephemeris time (used by SPICE), and Unix time (Seconds since 1970-01-01/00:00).

The STATIC ITF will produce these products, with one file per UT day, with the naming convention `mvn_sta_l2_da_1r_<yyyy><mm><dd>T<hh><mm><ss>_v<xx>_r<yy>.cdf` when data are available.

Data files will also contain non-record-varying (NRV) “support data”.

#### **5.2.1.22 maven.static.c:data.db\_1024tof**

`maven.static.c:data.db_1024m` contains files with time-ordered time-of-flight (TOF) raw data. Data are derived from APID db. Data allows detailed examination of mass resolution and electronic drift of the TOF circuits. Data are averaged over energy so mass blurring can occur if mass peaks appear at different energies.

The data files contain a time-ordered array with time in Epoch time, Mission-Elapsed-Time (MET), Time\_TT200 (UTC time from 1-1-2000 12:00, including leap seconds), Ephemeris time (used by SPICE), and Unix time (Seconds since 1970-01-01/00:00).

The STATIC ITF will produce these products, with one file per UT day, with the naming convention `mvn_sta_l2_db_1024tof_<yyyy><mm><dd>T<hh><mm><ss>_v<xx>_r<yy>.cdf` when data are available.

Data files will also contain non-record-varying (NRV) “support data” to convert TOF bin to actual time.

### 5.2.1.23 STATIC.calibrated Document Collection

The STATIC calibrated data document collection contains documents which are useful for understanding and using the STATIC Calibrated (MAVEN Level 2) Science Data bundle. Table 14 contains a list of the documents included in this collection, along with the LID, and responsible group. Following this a brief description of each document is also provided.

Table 14: STATIC Calibrated Science Data Documents

Document Name	LID	Responsibility
MAVEN Science Data Management Plan	urn:nasa:pds:MAVEN:document:SDMP	MAVEN Project
MAVEN STATIC Archive SIS	urn:nasa:pds:maven.static:document:SIS	STATIC Team
MAVEN Mission Description	urn:nasa:pds:MAVEN:document:MissionDescription	MAVEN Project
MAVEN Spacecraft Description	urn:nasa:pds:MAVEN:document:SpacecraftDescription	MAVEN Project
STATIC Instrument Paper	urn:nasa:pds:maven.static:document:STATIC_instrument_paper	STATIC Team
MAVEN_PF_FSW_021_CTM	urn:nasa:pds:maven.static.calibrated:document:PF_FSW_021_CTM	MAVEN PF PM
MAVEN_PF_STATIC_012_FPGA_Specification	urn:nasa:pds:maven.static:document:STATIC_012_FPGA_Specification	STATIC Team
MAVEN_PF_STATIC_XXX_Mode_Data_Rates	urn:nasa:pds:maven.static:document:STATIC_XXX_Mode_Data_Rates	STATIC Team

**MAVEN Science Data Management Plan** – describes the data requirements for the MAVEN mission and the plan by which the MAVEN data system will meet those requirements

**MAVEN STATIC Archive SIS** – describes the format and content of the STATIC PDS data archive, including descriptions of the data products and associated metadata, and the archive format, content, and generation pipeline (this document)

**MAVEN Mission Description** – describes the MAVEN mission.

**MAVEN Spacecraft Description** – describes the MAVEN spacecraft.

**STATIC Instrument Paper** – describes the MAVEN STATIC instrument.

**MAVEN\_PF\_FSW\_021\_CTM** – describes the flight software and data packet format.

**MAVEN\_PF\_STATIC\_012\_FPGA\_Specification** – describes the STATIC FPGA hardware and onboard data sorting.

**MAVEN\_PF\_STATIC\_XXX\_Mode\_Data\_Rates** – describes STATIC data rates and APID selection for different instrument modes. .

## 6 Archive products formats

Data that comprise the STATIC archives are formatted in accordance with PDS specifications [see *Planetary Science Data Dictionary* [4], *PDS Data Provider's Handbook* [2], and *PDS Standards Reference* [3]. This section provides details on the formats used for each of the products included in the archive.

### 6.1 Data File Formats

This section describes the format and record structure of each of the data file types.

#### 6.1.1 Calibrated data file structure

STATIC calibrated data files will be archived with PDS as Common Data Format (CDF). In order to allow the archival CDF files to be described by PDS metadata a number of requirements have been agreed to between the STATIC ITF and the PDS-PPI node. These requirements are detailed in the document *Archive of MAVEN CDF in PDS4* (T. King and J. Mafi, July 16, 2013). General attributes listed in this document are not included below. Only STATIC specific “time varying data” and “support data” are listed in the following tables. These CDF files will be the same one’s used and distributed by the STATIC ITF internally. The contents of the STATIC CDF files are described in the tables below.

Table 15: Contents for “vary data” in *static.c:data.2a\_hkp* housekeeping files

Field Name	Data Type	Description
EPOCH	EPOCH	Spacecraft event time for this data record (UTC Epoch time from 01-Jan-0000 00:00:00.000 without leap seconds), one element per ion distribution (NUM_DISTs elements)
TIME_TT2000	TT2000	UTC time from 01-Jan-2000 12:00:00.000 including leap seconds), one element per ion distribution (NUM_DISTs elements)
TIME_MET	DOUBLE	Mission elapsed time for this data record, one element per ion distribution (NUM_DISTs elements)
TIME_EPHEMERIS	DOUBLE	Time used by SPICE program (NUM_DISTs elements)
TIME_UNIX	DOUBLE	Unix time (elapsed seconds since 1970-01-01/00:00 without leap seconds) for this data record, one element per ion distribution. This time is the center time of data collection. (NUM_DISTs elements)
HKP_RAW	INTEGER	Housekeeping array of dimension (NUM_DISTs,NHKP) of raw housekeeping values
HKP_CALIB	FLOAT	Housekeeping array of dimension (NUM_DISTs,NHKP) of calibrated housekeeping values
QUALITY_FLAG	INTEGER	Quality flag (NUM_DISTs elements)



Table 16: Contents for “support data” in static.c:data.2a\_hkp housekeeping files

Field Name	Data Type	Description
PROJECT_NAME	STRING	‘MAVEN’
SPACECRAFT	STRING	‘0’
DATA_NAME	STRING	‘Housekeeping’
APID	STRING	‘2a’
NUM_DISTS	INTEGER	Number of measurements or times in the file
NHKP	INTEGER	Number of housekeeping channels Value=99
HKP_CALIB	INTEGER	Calibration parameters to convert raw housekeeping value to calibrated housekeeping with dimension (8,NHKP)
HKP_LABELS	STRING	Housekeeping label string array with dimension NHKP

Table 17: Contents for “vary data” in the files:

static.c:data.c0\_64e2m,static.c:data.c2\_32e32m,static.c:data.c4\_4e64m,  
static.c:data.c6\_32e64m,static.c:data.c8\_32e16d,static.c:data.ca\_16e4d16a,static.c:data.cc\_32e  
32m8d,static.c:data.cd\_32e32m8d,static.c:data.ce\_16e16m4d16a,static.c:data.cf\_16e16m4d16a,  
static.c:data.d0\_32e8m4d16a,static.c:data.d1\_32e8m4d16a,static.c:data.d2\_32e8m16a,static.c:  
data.d3\_32e8m16a,static.c:data.d4\_2m4d16a

Field Name	Data Type	Description
EPOCH	EPOCH	Spacecraft event time for this data record (UTC Epoch time from 01-Jan-0000 00:00:00.000 without leap seconds), one element per ion distribution (NUM_DISTS elements)
TIME_TT2000	TT2000	UTC time from 01-Jan-2000 12:00:00.000 including leap seconds), one element per ion distribution (NUM_DISTS elements)
TIME_MET	DOUBLE	Mission elapsed time for this data record, one element per ion distribution (NUM_DISTS elements)
TIME_EPHEMERIS	DOUBLE	Time used by SPICE program (NUM_DISTS elements)
TIME_UNIX	DOUBLE	Unix time (elapsed seconds since 1970-01-01/00:00 without leap seconds) for this data record, one element per ion distribution. This time is the center time of data collection. (NUM_DISTS elements)
TIME_START	DOUBLE	Unix time at the start of data collection. (NUM_DISTS elements)
TIME_END	DOUBLE	Unix time at the end of data collection. (NUM_DISTS elements)

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TIME_DELTA	DOUBLE	Averaging time. (TIME_DELTA = TIME_END – TIME_START). (NUM_DISTs elements).
TIME_INTEG	DOUBLE	Integration time. (TIME_DELTA / N_ENERGY). (NUM_DISTs elements).
VALID	INTEGER	Validity flag codes valid data (bit 0), test pulser on (bit 1), diagnostic mode (bit 2), data compression type (bit 3-4), packet compression (bit 5) (NUM_DISTs elements)
MD	INTEGER	Mode byte in packet header. (NUM_DISTs elements)
MODE	INTEGER	Decoded mode number. (NUM_DISTs elements)
RATE	INTEGER	Decoded telemetry rate number. (NUM_DISTs elements)
SWP_IND	INTEGER	Index that identifies the energy and deflector sweep look up tables (LUT) for the sensor. SWP_IND is an index that selects the following support data arrays: ENERGY, DENENERGY, THETA, DTHETA, PHI, DPHI, DOMEGA, GF and MASS_ARR. (NUM_DISTs elements) EN_IND ≤ NSWP
MLUT_IND	INTEGER	Index that identifies the onboard mass look up table (MLUT). MLUT_IND is an index that selects the following support data: TOF_ARR. (NUM_DISTs elements) MLUT ≤ NMLUT
EFF_IND	INTEGER	Index that identifies the efficiency calibration table to be used. EFF_IND is an index that selects the following support data: EFF. (NUM_DISTs elements) EFF_IND ≤ NEFF
ATT_IND	INTEGER	Index that identifies the attenuator state (0 = no attenuation, 1 = electrostatic attenuation, 2 = mechanical attenuation, 3 = mechanical and electrostatic attenuation). (NUM_DISTs elements)
SC_POT	FLOAT	Spacecraft potential (NUM_DISTs elements)
MAGF	FLOAT	Magnetic field vector with dimension (NUM_DISTs, 3)
QUAT_SC	FLOAT	Quaternion elements to rotate from STATIC coordinates to Spacecraft coordinates (NUM_DISTs, 4)
QUAT_MSO	FLOAT	Quaternion elements to rotate from STATIC coordinates to MSO coordinates (NUM_DISTs, 4)

BINS_SC	INTEGER	Integer array of 1s and 0s with dimension (NUM_DISTS, NBINS) with 0s used to identify angle bins that include spacecraft surfaces. If NBINS=1, then BINS_SC is used to identify those times, value=0, when the spacecraft is in STATIC's FOV.
POS_SC_MSO	FLOAT	Spacecraft position in MSO coordinates with dimension (NUM_DISTS, 3)
BKG	FLOAT	Background counts array with dimensions (NUM_DISTS, NENERGY, NBINS, NMASS)
DEAD	FLOAT	Dead-time correction array with dimensions (NUM_DISTS, NENERGY, NBINS, NMASS)
DATA	FLOAT	Counts array with dimensions (NUM_DISTS, NENERGY, NBINS, NMASS)
EFLUX	FLOAT	Differential energy flux array with dimensions (NUM_DISTS, NENERGY, NBINS, NMASS) EFLUX = (DATA-BKG)*DEAD*/(TIME_INTEG*G) G = GEOM_FACTOR*GF*EFF
QUALITY_FLAG	INTEGER	Quality flag (NUM_DISTS elements)

Table 18: Contents for “support data” in the files:

*static.c:data.c0\_64e2m,static.c:data.c2\_32e32m,static.c:data.c4\_4e64m,static.c:data.c6\_32e64m,static.c:data.c8\_32e16d,static.c:data.ca\_16e4d16a,static.c:data.cc\_32e32m8d,static.c:data.cd\_32e32m8d,static.c:data.ce\_16e16m4d16a,static.c:data.cf\_16e16m4d16a,static.c:data.d0\_32e8m4d16a,static.c:data.d1\_32e8m4d16a,static.c:data.d2\_32e8m16a,static.c:data.d3\_32e8m16a,static.c:data.d4\_2m4d16a*

Field Name	Data Type	Description
PROJECT_NAME	STRING	'MAVEN'
SPACECRAFT	STRING	'0'
DATA_NAME	STRING	'XX YYY', where XX is the APID and YYY is the array abbreviation (64e2m, 32e32m,... etc.)
APID	STRING	'XX', where XX is the APID
UNITS_NAME	STRING	'eflux'
UNITS_PROCEDURE	STRING	'mvn_convert_sta_units' name of IDL routine used for units conversion
NUM_DISTS	INTEGER	Number of measurements or times in the file
NENERGY	INTEGER	Number of energy bins
NBINS	INTEGER	Number of solid angle bins
NMASS	INTEGER	Number of mass bins
NDEF	INTEGER	Number of deflector angle bins
NANODE	INTEGER	Number of anode bins
NATT	INTEGER	Number of attenuator states -4

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NSWP	INTEGER	Number of sweep tables – will increase over mission as new sweep modes are added
NEFF	INTEGER	Number of efficiency arrays – will increase over mission as sensor degrades
NMLUT	INTEGER	Number of MLUT tables – will increase over mission as new modes are developed
BINS	INTEGER	Array with dimension NBINS containing 1 OR 0 used to flag bad solid angle bins
ENERGY	FLOAT	Energy array with dimension (NSWP, NENERGY, NBINS, NMASS)
DENERGY	FLOAT	Delta Energy array with dimension (NSWP, NENERGY, NBINS, NMASS)
THETA	FLOAT	Angle array with with dimension (NSWP, NENERGY, NBINS, NMASS)
DTHETA	FLOAT	Delta Angle array with dimension (NSWP, NENERGY, NBINS, NMASS)
PHI	FLOAT	Angle array with dimension (NSWP, NENERGY, NBINS, NMASS)
DPHI	FLOAT	Delta Angle array with dimension (NSWP, NENERGY, NBINS, NMASS)
DOMEGA	FLOAT	Delta Solid Angle array with dimension (NSWP, NENERGY, NBINS, NMASS)
GF	FLOAT	Geometric Factor array with dimension (NSWP, NENERGY, NBINS, NMASS)
EFF	FLOAT	Efficiency array with dimension (NEFF, NENERGY, NBINS, NMASS)
MASS_ARR	FLOAT	Mass array with dimension (NSWP, NENERGY, NBINS, NMASS). Nominal mass of a mass bin in units of AMUs based on TOF. This array is not integer AMU.
TOF_ARR	FLOAT	Time-of-flight (TOF) array with dimension (NMLUT, NENERGY, NBINS, NMASS). Gives average TOF value for mass bins.
TWT_ARR	FLOAT	Time-of-flight Weight (TWT) array with dimension (NMLUT, NENERGY, NBINS, NMASS). Gives number of TOF bins in a given mass bin. Used for normalizing a mass spectra.
GEOM_FACTOR	FLOAT	Geometric factor of a single 22.5 degree sector
MASS	FLOAT	Proton mass (0.01044) in units of MeV/c <sup>2</sup>
CHARGE	FLOAT	Proton charge (1)
DEAD_TIME_1	FLOAT	Dead time for processed events. Dead time corrections are generally not necessary. Corrections require use of STATIC APID DA rate packets.

DEAD_TIME_2	FLOAT	Dead time for rejected events. Dead time corrections are generally not necessary. Corrections require use of STATIC APID DA rate packets.
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Table 19: Contents for “vary data” in the files: static.c:data.d6\_events

Field Name	Data Type	Description
EPOCH	EPOCH	Spacecraft event time for this data record (UTC Epoch time from 01-Jan-0000 00:00:00.000 without leap seconds), one element per ion distribution (NUM_DISTs elements)
TIME_TT2000	TT2000	UTC time from 01-Jan-2000 12:00:00.000 including leap seconds), one element per ion distribution (NUM_DISTs elements)
TIME_MET	DOUBLE	Mission elapsed time for this data record, one element per ion distribution (NUM_DISTs elements)
TIME_EPHEMERIS	DOUBLE	Time used by SPICE program (NUM_DISTs elements)
TIME_UNIX	DOUBLE	Unix time (elapsed seconds since 1970-01-01/00:00 without leap seconds) for this data record, one element per ion distribution. This time is the center time of data collection. (NUM_DISTs elements)
VALID	INTEGER	Validity flag codes valid data (bit 0), test pulser on (bit 1), diagnostic mode (bit 2), data compression type (bit 3-4), packet compression (bit 5) (NUM_DISTs elements)
TDC_1	INTEGER	Time-to-Digital Converter (TDC) 1, time of flight from TA-TC.
TDC_2	INTEGER	Time-to-Digital Converter (TDC) 2, time of flight from TB-TD.
TDC_3	INTEGER	Time-to-Digital Converter (TDC) 3, position from TA-TB.
TDC_4	INTEGER	Time-to-Digital Converter (TDC) 4, position from TC-TD.
EVENT_CODE	INTEGER	Event code: bit0-5: A-first, B-first, A-pulse valid, B-pulse valid, C-pulse valid, D-pulse valid
CYCLESTEP	INTEGER	Cycle step (0-1023) during a data accumulation that the event happened
ENERGY	FLOAT	Sensor energy during the event
QUALITY_FLAG	INTEGER	Quality flag (NUM_DISTs elements)

Table 20: Contents for “support data” in files: static.c:data.d6\_events

Field Name	Data Type	Description
PROJECT_NAME	STRING	'MAVEN'
SPACECRAFT	STRING	'0'
DATA_NAME	STRING	'db_1024m'
APID	STRING	'db'
NUM_DISTs	INTEGER	Number of measurement times in the file
TDC1_CONV	FLOAT	Conversion factor for TDC1
TDC2_CONV	FLOAT	Conversion factor for TDC2
TDC3_CONV	FLOAT	Conversion factor for TDC3
TDC4_CONV	FLOAT	Conversion factor for TDC4
TDC1_OFFSET	FLOAT	Offset to subtract from TDC1 before multiplying by TDC1_CONV to get TOF in nanoseconds
TDC2_OFFSET	FLOAT	Offset to subtract from TDC2 before multiplying by TDC1_CONV to get TOF in nanoseconds
TDC3_OFFSET	FLOAT	Offset to subtract from TDC3 before multiplying by TDC1_CONV to get POS in nanoseconds
TDC4_OFFSET	FLOAT	Offset to subtract from TDC4 before multiplying by TDC1_CONV to get POS in nanoseconds
AN_BIN_TDC3	INTEGER	Onboard anode bin rejection boundaries used to filter TDC3 event position with dimension 16 anodes x 2 limits (16, 2). (upper/lower limits)
AN_BIN_TDC4	INTEGER	Onboard anode bin rejection boundaries used to filter TDC4 event position with dimension 16 anodes x 2 limits (16, 2). (upper/lower limits)
MS_BIN_OFFSET	INTEGER	Onboard mass bias offset array for correcting TDC1 and TDC2 prior to mass bin validation.
EVCONVLUT	INTEGER	Look up table code for valid events addressed by the TDC pulses (see cmd 0x41 in MAVEN_PF_STATIC_012_FPGA_Specificatio n)
TIMERST	INTEGER	Sets dead time for rejected events. Used to assure TDC is completely reset. (see cmd 0x46 in MAVEN_PF_STATIC_012_FPGA_Specificatio n)

Table 21: Contents for “vary data” in static.c:data.d7\_fsthrp fast housekeeping files

Field Name	Data Type	Description
EPOCH	EPOCH	Spacecraft event time for this data record (UTC Epoch time from 01-Jan-0000 00:00:00.000 without leap seconds), one element per ion distribution (NUM_DISTs elements)
TIME_TT2000	TT2000	UTC time from 01-Jan-2000 12:00:00.000 including leap seconds), one element per ion distribution (NUM_DISTs elements)
TIME_MET	DOUBLE	Mission elapsed time for this data record, one element per ion distribution (NUM_DISTs elements)
TIME_EPHEMERIS	DOUBLE	Time used by SPICE program (NUM_DISTs elements)
TIME_UNIX	DOUBLE	Unix time (elapsed seconds since 1970-01-01/00:00 without leap seconds) for this data record, one element per ion distribution. This time is the center time of data collection. (NUM_DISTs elements)
HKP_RAW	INTEGER	Housekeeping array of dimension (NUM_DISTs) of raw housekeeping values
HKP_CALIB	FLOAT	Housekeeping array of dimension (NUM_DISTs) of calibrated housekeeping values
HKP_IND	INTEGER	Index defines the selected fast housekeeping channel (NUM_DISTs elements). HKP_IND can be used to select support data.
QUALITY_FLAG	INTEGER	Quality flag (NUM_DISTs elements)

Table 22: Contents for “support data” in static.c:data.d7\_fsthrp housekeeping files

Field Name	Data Type	Description
PROJECT_NAME	STRING	‘MAVEN’
SPACECRAFT	STRING	‘0’
DATA_NAME	STRING	‘d7_fsthrp’
APID	STRING	‘d7’
NUM_DISTs	INTEGER	Number of measurements or times in the file
NHKP	INTEGER	Number of housekeeping channels - 99
HKP_CALIB	INTEGER	Calibration parameters to convert raw housekeeping value to calibrated housekeeping with dimension (8,NHKP)
HKP_LABELS	STRING	Housekeeping label string array with dimension NHKP

Table 23: Contents for “vary data” in the files: static.c:data.d8\_12r

Field Name	Data Type	Description
EPOCH	EPOCH	Spacecraft event time for this data record (UTC Epoch time from 01-Jan-0000 00:00:00.000 without leap seconds), one element per ion distribution (NUM_DISTS elements)
TIME_TT2000	TT2000	UTC time from 01-Jan-2000 12:00:00.000 including leap seconds), one element per ion distribution (NUM_DISTS elements)
TIME_MET	DOUBLE	Mission elapsed time for this data record, one element per ion distribution (NUM_DISTS elements)
TIME_EPHEMERIS	DOUBLE	Time used by SPICE program (NUM_DISTS elements)
TIME_UNIX	DOUBLE	Unix time (elapsed seconds since 1970-01-01/00:00 without leap seconds) for this data record, one element per ion distribution. This time is the center time of data collection. (NUM_DISTS elements)
INTEG_TIME	DOUBLE	Integration time for rate in seconds
VALID	INTEGER	Validity flag codes valid data (bit 0), test pulser on (bit 1), diagnostic mode (bit 2), data compression type (bit 3-4), packet compression (bit 5) (NUM_DISTS elements)
MD	INTEGER	Mode byte in packet header. (NUM_DISTS elements)
MODE	INTEGER	Decoded mode number. (NUM_DISTS elements)
RATE	INTEGER	Decoded telemetry rate number. (NUM_DISTS elements)
SWP_IND	INTEGER	Index that identifies the energy sweep table (ENERGY) in the support data. (NUM_DISTS elements) EN_IND < NSWP
RATES	FLOAT	Rate data for the 12 rate channels with dimension (NUM_DISTS, 12) units=counts/s
QUALITY_FLAG	INTEGER	Quality flag (NUM_DISTS elements)



Table 24: Contents for “vary data” in the files: static.c:data.d9\_12r64e

Field Name	Data Type	Description
EPOCH	EPOCH	Spacecraft event time for this data record (UTC Epoch time from 01-Jan-0000 00:00:00.000 without leap seconds), one element per ion distribution (NUM_DISTs elements)
TIME_TT2000	TT2000	UTC time from 01-Jan-2000 12:00:00.000 including leap seconds), one element per ion distribution (NUM_DISTs elements)
TIME_MET	DOUBLE	Mission elapsed time for this data record, one element per ion distribution (NUM_DISTs elements)
TIME_EPHEMERIS	DOUBLE	Time used by SPICE program (NUM_DISTs elements)
TIME_UNIX	DOUBLE	Unix time (elapsed seconds since 1970-01-01/00:00 without leap seconds) for this data record, one element per ion distribution. This time is the center time of data collection. (NUM_DISTs elements)
INTEG_TIME	DOUBLE	Integration time for rate in seconds
VALID	INTEGER	Validity flag codes valid data (bit 0), test pulser on (bit 1), diagnostic mode (bit 2), data compression type (bit 3-4), packet compression (bit 5) (NUM_DISTs elements)
MD	INTEGER	Mode byte in packet header. (NUM_DISTs elements)
MODE	INTEGER	Decoded mode number. (NUM_DISTs elements)
RATE	INTEGER	Decoded telemetry rate number. (NUM_DISTs elements)
SWP_IND	INTEGER	Index that identifies the energy sweep table (ENERGY) in the support data. (NUM_DISTs elements) EN_IND < NSWP
RATES	FLOAT	Rate data for the 12 rate channels sorted by energy step with dimension (NUM_DISTs, 12, 64) units=counts/s
QUALITY_FLAG	INTEGER	Quality flag (NUM_DISTs elements)

Table 25: Contents for “vary data” in the files: static.c:data.da\_1r

Field Name	Data Type	Description
EPOCH	EPOCH	Spacecraft event time for this data record (UTC Epoch time from 01-Jan-0000 00:00:00.000 without leap seconds), one element per ion distribution (NUM_DISTS elements)
TIME_TT2000	TT2000	UTC time from 01-Jan-2000 12:00:00.000 including leap seconds), one element per ion distribution (NUM_DISTS elements)
TIME_MET	DOUBLE	Mission elapsed time for this data record, one element per ion distribution (NUM_DISTS elements)
TIME_EPHEMERIS	DOUBLE	Time used by SPICE program (NUM_DISTS elements)
TIME_UNIX	DOUBLE	Unix time (elapsed seconds since 1970-01-01/00:00 without leap seconds) for this data record, one element per ion distribution. This time is the center time of data collection. (NUM_DISTS elements)
INTEG_TIME	DOUBLE	Integration time for rate in seconds
VALID	INTEGER	Validity flag codes valid data (bit 0), test pulser on (bit 1), diagnostic mode (bit 2), data compression type (bit 3-4), packet compression (bit 5) (NUM_DISTS elements)
MD	INTEGER	Mode byte in packet header. (NUM_DISTS elements)
MODE	INTEGER	Decoded mode number. (NUM_DISTS elements)
RATE	INTEGER	Decoded telemetry rate number. (NUM_DISTS elements)
SWP_IND	INTEGER	Index that identifies the energy sweep table (ENERGY) in the support data. (NUM_DISTS elements) EN_IND < NSWP
RATES	FLOAT	Rate data for 1 selected rate channel (NUM_DISTS elements) units=counts/s
RATE_CHANNEL	INTEGER	Rate channel selected (0-11)
QUALITY_FLAG	INTEGER	Quality flag (NUM_DISTS elements)

Table 26: Contents for “support data” in files: *static.c:data.d8\_12r*, *static.c:data.d9\_12r64e*, *static.c:data.da\_1r*

Field Name	Data Type	Description
PROJECT_NAME	STRING	'MAVEN'
SPACECRAFT	STRING	'0'
DATA_NAME	STRING	'd8_12r' or 'd9_12r64' or 'da_1r'
APID	STRING	'd8' or 'd9' or 'da'
NUM_DISTS	INTEGER	Number of measurements or times in the file
NSWP	INTEGER	Number of energy sweep tables.
ENERGY	FLOAT	Energy array with dimension (NSWP, 64) which can be indexed with SWP_IND
NRATE	INTEGER	Number of rate channels - 12
RATE_LABELS	STRING	Rate label string array with dimension NRATE

Table 27: Contents for “vary data” in the files: *static.c:data.db\_1024m*

Field Name	Data Type	Description
EPOCH	EPOCH	Spacecraft event time for this data record (UTC Epoch time from 01-Jan-0000 00:00:00.000 without leap seconds), one element per ion distribution (NUM_DISTS elements)
TIME_TT2000	TT2000	UTC time from 01-Jan-2000 12:00:00.000 including leap seconds), one element per ion distribution (NUM_DISTS elements)
TIME_MET	DOUBLE	Mission elapsed time for this data record, one element per ion distribution (NUM_DISTS elements)
TIME_EPHEMERIS	DOUBLE	Time used by SPICE program (NUM_DISTS elements)
TIME_UNIX	DOUBLE	Unix time (elapsed seconds since 1970-01-01/00:00 without leap seconds) for this data record, one element per ion distribution. This time is the center time of data collection. (NUM_DISTS elements)
INTEG_TIME	DOUBLE	Integration time for TOF accumulation (sec)
VALID	INTEGER	Validity flag codes valid data (bit 0), test pulser on (bit 1), diagnostic mode (bit 2), data compression type (bit 3-4), packet compression (bit 5) (NUM_DISTS elements)
MD	INTEGER	Mode byte in packet header. (NUM_DISTS elements)
MODE	INTEGER	Decoded mode number. (NUM_DISTS elements)

RATE	INTEGER	Decoded telemetry rate number. (NUM_DISTS elements)
SWP_IND	INTEGER	Index that identifies the energy sweep table (ENERGY) in the support data. (NUM_DISTS elements) EN_IND < NSWP
DATA	FLOAT	Accumulated events binned into 1024 time-of-flight channels with dimension (NUM_DISTS, 1024) units=counts
QUALITY_FLAG	INTEGER	Quality flag (NUM_DISTS elements)

Table 28: Contents for “support data” in files: static.c:data.da\_1024m

Field Name	Data Type	Description
PROJECT_NAME	STRING	‘MAVEN’
SPACECRAFT	STRING	‘0’
DATA_NAME	STRING	'db_1024m'
APID	STRING	'db'
NUM_DISTS	INTEGER	Number of measurement times in the file
NSWP	INTEGER	Number of energy sweep tables.
ENERGY	FLOAT	Energy array with dimension (NSWP, 64) which can be indexed with SWP_IND
NTOF	INTEGER	Number of TOF channels - 1024
TOF	FLOAT	Time of flight value for each TOF bin in nanoseconds. (1024 elements)

## 6.2 Document Product File Formats

Documents are provided in either Adobe Acrobat PDF/A or plain ASCII text format. Other versions of the document (including HTML, Microsoft Word, etc.) may be included as well.

## 6.3 PDS Labels

PDS labels are ASCII text files written, in the eXtensible Markup Language (XML). All product labels are detached from the digital files (if any) containing the data objects they describe (except Product\_Bundle). There is one label for every product. Each product, however, may contain one or more data objects. The data objects of a given product may all reside in a single file, or they may be stored in multiple separate files. PDS4 label files must end with the file extension “.xml”.

The structure of PDS label files is governed by the XML documents described in Section 6.3.1.

### **6.3.1 XML Documents**

For the MAVEN mission PDS labels will conform to the PDS master schema based upon the 1.1.0.1 version of the PDS Information Model for structure, and the 1.1.0.1 version of the PDS Schematron for content. By use of an XML editor these documents may be used to validate the structure and content of the product labels.

Examples of PDS labels required for the STATIC archive are shown in Appendix C (bundle products), Appendix D (collection products), and Appendix E (basic products).

## **6.4 Delivery Package**

Data transfers, whether from data providers to PDS or from PDS to data users or to the deep archive, are accomplished using delivery packages. Delivery packages include the following required elements:

1. The package which consists of a compressed bundle of the products being transferred.
2. A transfer manifest which maps each product's LIDVID to the physical location of the product label in the package after uncompression.
3. A checksum manifest which lists the MD5 checksum of each file included in the package after uncompression.

STATIC archive delivery packages (including the transfer and checksum manifests) for delivery to PDS are produced at the MAVEN SDC.

### **6.4.1 The Package**

The directory structure used in for the delivery package is described in the Appendix in Section F.1. Delivery packages are compressed using either [\[zip, or tar/gzip\]](#) and are transferred electronically using the ssh protocol.

### **6.4.2 Transfer Manifest**

The “transfer manifest” is a file provided with each transfer to, from, or within PDS. The transfer manifest is external to the delivery package. It contains an entry for each label file in the package, and maps the product LIDVID to the file specification name for the associated product's label file. Details of the structure of the transfer manifest are provided in Section F.2.

The transfer manifest is external to the delivery package, and is not an archive product. As a result, it does not require a PDS label.

### **6.4.3 Checksum Manifest**

The checksum manifest contains an MD5 checksum for every file included as part of the delivery package. This includes both the PDS product labels and the files containing the digital objects which they describe. The format used for a checksum manifest is the standard output generated by the md5deep utility. Details of the structure of the checksum manifest are provided in section F.3.

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The checksum manifest is external to the delivery package, and is not an archive product. As a result, it does not require a PDS label.

## Appendix A Support staff and cognizant persons

Table 28: Archive support staff

STATIC team			
Name	Address	Phone	Email
James P. McFadden	Space Sciences Laboratory, 7 Gauss Way, University of California, Berkeley, CA 94720	510-642-9918	mcfadden@ssl.berkeley.edu

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

## Appendix B Naming conventions for MAVEN science data files

This section describes the naming convention used for science data files for the MAVEN mission.

### Raw (MAVEN Level 0):

mvn\_<inst>\_<grouping>\_l0\_<yyyy><mm><dd>\_v<xx>.dat

### Level 1, 2, 3+:

mvn\_<inst>\_<level>\_<descriptor>\_<yyyy><mm><dd>T<hh><mm><ss>\_v<xx>\_r<yy>.<ext>

Code	Description
<inst>	3-letter instrument ID
<grouping>	Three-letter code: options are all, svy, arc for all data, survey data, archive data. Primarily for P&F to divide their survey & archive data at Level 0.
<yyyy>	4-digit year
<mm>	2-digit month, e.g. 01, 12
<dd>	2-digit day of month, e.g. 02, 31
<hh>	2-digit hour, separated from the date by T. OPTIONAL.
<mm>	2-digit minute. OPTIONAL.
<ss>	2-digit second. OPTIONAL.
v<xx>	2-digit data version: is this a new version of a previous file, though the same software version was used for both? (Likely to be used in the case of retransmits to fill in data gaps)
r<yy>	2-digit software version: which version of the software was used to create this data product?
<descriptor>	A description of the data. Defined by the creator of the dataset. There are no underscores in the value.
.<ext>	File type extension: .fits, .txt, .cdf, .png
<level>	A code indicating the MAVEN processing level of the data (valid values: 11, 12, 13)

Instrument name	<instrument>
IUVS	iuv
NGIMS	ngi
LPW	lpw
MAG	mag
SEP	sep
STATIC	swi
SWEA	swe
STATIC	sta
P&F package	pfp



## **Appendix C Sample Bundle Product Label**

This section provides a sample bundle product label.

## **Appendix D Sample Collection Product Label**

This section provides a sample collection product label.

## **Appendix E Sample Data Product Labels**

This section provides sample product labels for the various data types described in this document.

## **Appendix F PDS Delivery Package Manifest File Record Structures**

The delivery package includes two manifest files: a transfer manifest, and MD5 checksum manifest. When delivered as part of a data delivery, these two files are not PDS archive products, and do not require PDS labels files. The format of each of these files is described below.

### **F.1 Transfer Package Directory Structure**

[Insert a description of the directory structure contained in the delivery package.]

### **F.2 Transfer Manifest Record Structure**

The transfer manifest is defined as a two field fixed-width table where each row of the table describes one of the products in the package. The first field defines the LIDVID of each product in the package. The second field defines the file specification name of the corresponding product label in the package. The file specification name defines the name and location of the product relative to the location of the bundle product.

### **F.3 Checksum Manifest Record Structure**

The checksum manifest consists of two fields: a 32 character hexadecimal (using lowercase letters) MD5, and a file specification from the root directory of the unzipped delivery package to every file included in the package. The file specification uses forward slashes (“/”) as path delimiters. The two fields are separated by two spaces. Manifest records may be of variable length. This is the standard output format for a variety of MD5 checksum tools (*e.g.* md5deep, etc.).