



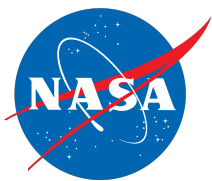
PDS4 Operational Readiness Review

Demonstration of PDS4 Applied to Mission Data

R. Beebe Atmospheres Node 

T. King— Planetary Plasma Interactions Node 

S. Hardman— Engineering Node 



End-to-End PDS4 Prototype

A prototype has been developed including:

MAVEN user access

MAVEN instrument team leaders have reviewed access pages and contributed input

LADEE user access

LADEE instrument team leaders have reviewed documents

The Documents area is partially populated

Migrated Phoenix Data (Martian Polar Lander)

Main page and data from the meteorological station are available as a demonstration

Search

User Access Pages are PDS4 products with XML labels

Are accessible via main PDS4 search

Can be assigned priority to assure they are listed first

Discovery

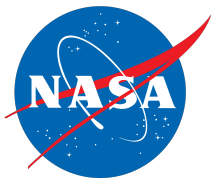
User Access Pages are designed to allow the user to access data and documentation without knowledge of the PDS4 data model and XML

Retrieval

A simple scheme has been developed to allow users to select products

Intent – to exercise PDS4 retrieval capability

Currently requires user interaction – automating software is still to be developed



The Phoenix Prototype Site

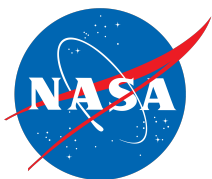


Sited at ATMOS & searchable

<http://atmos.nmsu.edu/PDS4BETA/phoenix/phoenix.html>

Based on migrated PDS3 Mars lander data

As PDS4 was developed Phoenix migrated data was used extensively to test model concepts by successive migrations and interaction with the development team



Go to Search- Enter Phoenix
<http://pds.nasa.gov/tools/data-search/>

Enter Phoenix

Data Search

Begin your search with one of the quick searches on the left, or try any of the following:

- A target name like **mars** or **eros**
- An instrument name or type like **spectrometer** or **laser altimeter** or **MOLA**
- A target body type like **asteroid**
- A word or phrase to find in the description of a data set or search tool

You can further refine your query by:

- Use quotation marks to bind words that occur together, e.g. "**mars express**"
- Specifying a search field before the word to search, e.g. **target:mars**
 - The legal search fields are **target:**, **instrument:**, **investigation:**, **instrument_type:**
- Inserting logical operator **OR** or **AND**, e.g. **target:uranus OR target:neptune**



Refine Your Search

Type

- [Data Set \(48\)](#)
- [Instrument \(16\)](#)
- [Investigation \(3\)](#)
- [Search Tool \(2\)](#)
- [Resource \(1\)](#)
- [Instrument Host \(1\)](#)

Investigation

- [Phoenix \(52\)](#)
- [2001 Mars Odyssey \(1\)](#)
- [Mars Reconnaissance Orbiter \(1\)](#)

Instrument

- [Camera \(1\)](#)
- [Radio Science \(1\)](#)

Search Results

[New Search](#)

1–50 of **71 results** (0.002 seconds)

Archive Information

These web pages provide detailed information for the matching investigations. If no page looks appropriate, you can browse the matching search tools and data sets, below.

Resource: [Phoenix Archive Information](#)
Information about Phoenix Archive Information

Search Tools

These tools let you search for data products matching your query. This is usually the best way to access the data. If no tool looks appropriate, you can browse the matching data sets, below.

Search Tool: [Phoenix Image Search](#)
Information about Phoenix Image Search

Search Tool: [Phoenix Analyst's Notebook](#)
Information about Phoenix Analyst's Notebook

Data Sets and Information

Data Set: [PHOENIX MARS TELLTALE WIND VELOCITY & DIRECTION V1.0](#)
Information about PHX-M-TT-5-WIND-VEL-DIR-V1.0
PHOENIX - PHX-M-TT-5-WIND-VEL-DIR-V1.0 - starting 2008-05-25T00:00:00Z

Data Set: [PHOENIX MARS ROBOTIC ARM 4 RDR DERIVED V1.0](#)
Information about PHX-M-RA-4-RDR-SCI-V1.0



Atmospheres data and related services

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Phoenix

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MET
LIDAR
ASE
AO
TT

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PDS4 Wide Search
PDS4 Label to Text
PDS4 Label to PDS3 Label
PDS3 Label to PDS4 Label
Data Format Translations



Welcome to the Phoenix Archive Page

Now in PDS4

Phoenix Mars Lander (PHX)

landed at 68.22oN latitude and 125.7oW longitude on May 5, 2008. It was equipped with a suite of instruments that included a meteorological package as well as a robotic arm to dig through the protective topsoil layer to study the soil and water-ice below.

Basic Mission Goals

Study the history of water in all its phases on Mars and how that pertains to the climatological, geological, and potentially biological record

Search for evidence of a habitable zone and assess the biological potential of the ice-soil boundary in the present martian climate.

For more information on the PHX mission see the following links:

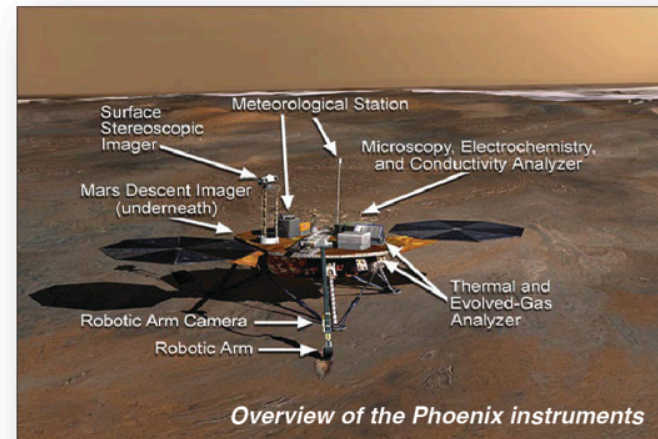
- [Science Goals](#)
- [Mission Description](#)
- [Spacecraft Description](#)

PDS4 Primer:

For information on the new standards associated with PDS4 please browse the following links.

- [Concepts Document](#)
- [Standards Reference](#)

Do you need to [update your browser to view XML?](#)



Overview of the Phoenix instruments

Do you need to [update your browser](#) to view XML?

Instrumentation and Access to Data:

The Atmospheric instrument complement consists of:

1. A meteorological station consisted of a pressure sensor and a mast that held 3 thermocouples and a wind speed indicator (Telltale).
2. A LIDAR designed to measure the vertical distribution of scattering particles (both dust and clouds) in the Martian atmosphere.
3. An atmospheric structure data was derived from output from the Inertial Measurement Unit during entry, descent and landing.
4. Derivation of atmospheric opacities based on data from the Surface Stereo Imager.

Archive Bundles

Phoenix Mission Bundle contains documents and files common to all the instruments describing the mission and spacecraft (In preparation).

Each of the following archive bundles contains data collections for system context, documentation for the data, individual data collections for raw, reduced, and/or derived data products complete with calibration information where applicable. Other products are available from the [Geosciences Node](#).

[Meteorological Station \(MET\)](#) data are stored as time ordered ASCII tables with supporting documentation for sols 1-150.

Light Detection and Ranging (LIDAR) data are stored as time ordered ASCII tables with supporting documentation for sols 1-150. (in preparation)

Atmospheric Structure Experiment (ASE) data are stored as time ordered ASCII tables with supporting documentation for Entry, Descent, and Landing. (in preparation)

Atmospheric Opacity (AO) data are stored as time-ordered ASCII tables with supporting documentation for sols 1-151, derived from images from the SSI. (in preparation)

Telltale Anemometer (TT) data are stored as time-ordered ASCII tables with supporting documentation for sols 1-151, derived from images from the SSI. (in preparation)



Atmospheres data and related services

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Phoenix

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MET
LIDAR
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PDS4 Tools

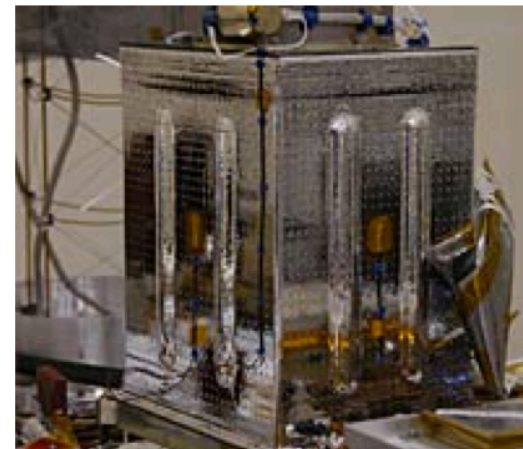
Minimal User's Tutorial
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PDS3 Label to PDS4 Label
Data Format Translations



Meteorological Station (MET)

Meteorological Station (MET)

Throughout the course of Phoenix surface operations, MET recorded the daily weather of the martian northern plains using temperature and pressure sensors. It was designed in Canada by Optech and MDA, supported by the Canadian Space Agency. A team headed by York University oversaw the science operations of the station. The York University team includes contributions from the University of Alberta, University of Aarhus (Denmark), Dalhousie University, Finnish Meteorological Institute, Optech, and the Geological Survey of Canada. Canadarm maker MacDonald Dettwiler and Associates (MDA) of Richmond, B.C. built the MET. <http://phoenix.jpl.arizona.edu/science05.php>

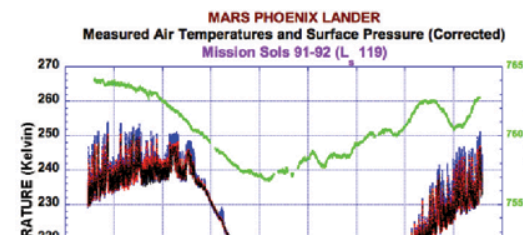


Useful Mission Documents

- [Mission Description](#) - Description of the instrument and data structures
- [Spacecraft Description](#) - Description of the instrument and data structures
- [Software Interface Specification \(SIS\)](#) - Description of the instrument and data structures
- [Calibration Document](#) - Description of the calibration methods

Archive Bundle Contents

[Document](#) - Directory containing the Document Collection, including references to refereed journals using this instrument.



Archive Bundle Contents

[Document](#) - Directory containing the Document Collection, including references to refereed journals using this instrument.

Raw Data

[Data Set description](#)

[Raw Data](#) - Directory containing the EDR data files for sols 1-150.

Reduced Data

[Data Set description](#)

[Reduced Data](#) - Directory containing the RDR data files for sols 1-150.

For the Experienced User

[Complete Bundle](#) - Zip file containing the entire MET Bundle.

[MET Bundle Root](#) - The root directory for the MET instrument bundle for experienced users including links to the context products.

Selecting and Requesting Data - The following approach can be used to obtain data that meets your specifications. Access to a time ordered list of the products allows you to understand the scope of the data set and to assure that you have received all the data that meets your requirements.

[Selecting Data](#) - This will allow you to access a time-ordered list of observations and to select products based on physical parameters of your choice. Completion of your product list results in an order returned below

Receiving Data

Citing Data Sets for Publications

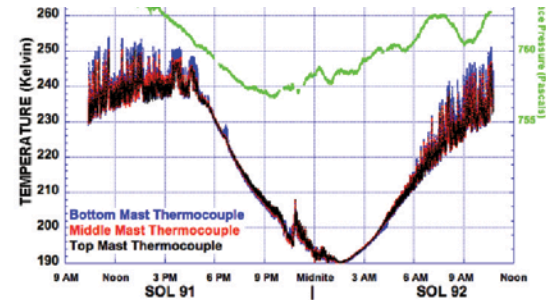
CITATION_DESC = Dickinson, C.D., PHX METEOROLOGICAL DATA V1.0, NASA Planetary Data System, 2008.

Other Useful Products for Interpreting the Data

[References](#) - Representative Publications using the data

[Other Potential Relevant Data](#) - Data that may be relevant from missions other than PHX

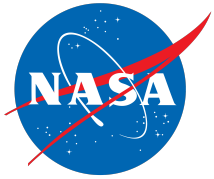
Archived PHX SPICE ancillary data providing observation geometry (positions, orientations, instrument pointing, time conversions, etc.) are available from the [PDS NAIF Node](#).



Above are shown derived near-surface atmospheric temperatures and corrected surface pressure values obtained during ~1 sol of the mission.

This session which began on Sol 91 of the mission was 90110 seconds in duration, starting at 11:25:27 LTST and continuing through to Sol 92, and obtaining measurements at 2 second intervals (0.5 Hz). Most Mars Phoenix Data collection sessions employed this same sequence, spanning slightly more than one sol.

The MET Instrument Package included three thermocouples attached near the Top, the Middle, and the Bottom of the MET Mast (the Telltale wind speed and direction mechanical device was located atop this Mast). The MET Package also included a Pressure Sensor.



Selecting and Requesting Data

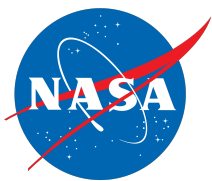
A time-ordered csv file containing a list of MET products consisting of product name and associated physical parameters is available.

The user encounters an interactive interface with the MET list to create a request for specific products.

A python script (`bulkdataloader.py`) receives the request, ingests the list of products from the csv file and generates the PDS4 LIDS and queries the Registry to find the products

Transport system within the Registry packages the selected files and returns a zip file with the requested products and associated labels

This constitutes a prototype of one type of retrieval that is possible using external code querying the Registry for specific products.



Data Access

We've demonstrated the following:

Search

User Access Pages are PDS4 products with XML labels

Are accessible via main PDS4 search

Can be assigned priority to assure they are listed first

Discovery

User Access Pages are designed to allow the user to access data and documentation without knowledge of the PDS4 data model and XML

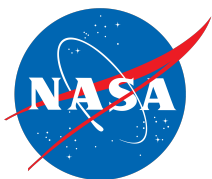
Retrieval

A simple scheme has been developed to allow users to select products

Intent – to exercise PDS4 retrieval capability

Currently requires user interaction – automating software is still to be developed

We move on to development for PDS4 Mission Pages for LADEE and MAVEN



Please go to the LADEE Site



Sited at ATMOS & accessible via EN PDS4 access page
<http://atmos.nmsu.edu/PDS4BETA/LADEE/mainr.html>

Atmospheres data and related services

- Atmospheres data
- Software
- Document submission
- Abstracts of funded NASA proposals
- Sphere

PDS Web Sites

- PDS
- Atmospheres
- Geosciences
- Imaging
- Navigational & Ancillary Information (NAIF)
- Planetary Plasma Interactions (PPI)
- Planetary Rings
- Small Bodies

LADEE

- Main
- NMS
- UVS
- LDEX

PDS4 Tools

- Minimal User's Tutorial
- PDS4 Wide Search
- PDS4 Label to Text
- PDS4 Label to PDS3 Label
- PDS3 Label to PDS4 Label
- Data Format Translations



Welcome to the LADEE Archive Page

Now in PDS4

Lunar Atmosphere & Dust Environment Explorer (LADEE) is a robotic mission that will orbit the moon to gather detailed information about the lunar atmosphere, conditions near the surface and environmental influences on lunar dust.

Basic Mission Goals

Determine the composition of the lunar atmosphere and investigate the processes that control its distribution and variability, including sources, sinks and surface interactions.

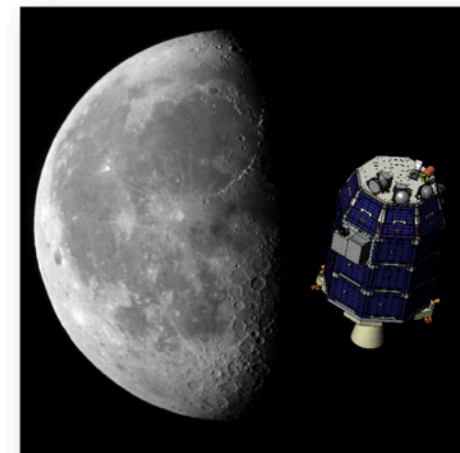
Characterize the lunar exospheric dust environment and measure any spatial and temporal variability and impacts on the lunar atmosphere. For more information on the LADEE mission see the following links:

- [Science Goals](#)
- [Mission Description](#)
- [Spacecraft Description](#)
- [Master Mission Schedule](#)

PDS4 Primer:

For information on the new standards associated with PDS4 please browse the following links.

- [Concepts Document](#)
- [Standards](#)



Instrumentation and Access to Data

The instrument complement consists of:

1. A neutral mass spectrometer that measures the mass distribution of neutral species over a mass-to-charge (m/z) range between 2-150,
2. An ultraviolet/visible spectrometer spanning 250-800 nm wavelength, with high (<1 nm) spectral resolution,
3. A lunar dust experiment that is sensitive to a particle size range of between 100 nm and 5 μ .

Archive Bundles

[LADEE Mission Bundle](#) contains documents and files common to all the instruments describing the mission and spacecraft.

Each of the following archive bundles contain data collections for system context, documentation for the data, individual data collections for raw, reduced, and/or derived data products complete with calibration information where applicable.

[Neutral Mass Spectrometer \(NMS\)](#) data are stored as time ordered ASCII tables with supporting documentation.

[Ultraviolet/Visible Spectrometer \(UVS\)](#) data are stored as time ordered ASCII tables with supporting documentation.

[Lunar Dust Experiment \(LDEX\)](#) data are stored as time ordered ASCII tables with supporting documentation.

Lunar Laser Communications Demo (LLCD) NASA's first space-laser communications experiment was a technology payload and was not archived.



Search for:

Atmospheres data and related services

- Atmospheres data
- Software
- Document submission
- Abstracts of funded NASA proposals
- Sphere

PDS Web Sites

- PDS
- Atmospheres
- Geosciences
- Imaging
- Navigational & Ancillary Information (NAIF)
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- Planetary Rings
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LADEE

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PDS4 Tools

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- PDS4 Wide Search
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- PDS4 Label to PDS3 Label
- PDS3 Label to PDS4 Label
- Data Format Translations



Neutral Mass Spectrometer (NMS)

The Neutral Mass Spectrometer (NMS) is a high sensitivity quadrupole mass spectrometer with a mass range to 150 Dalton and unit mass resolution. The NMS "adaptive" scan mode allows bands of mass values to be selected to search for unexpected species. NMS has two instrument modes of operation: (1) open source (Tilt or survey mode and ion mode) (2) closed source (Ram Mode).

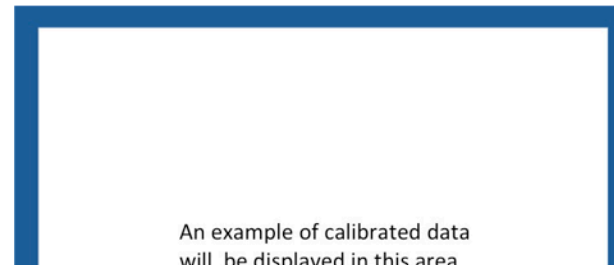
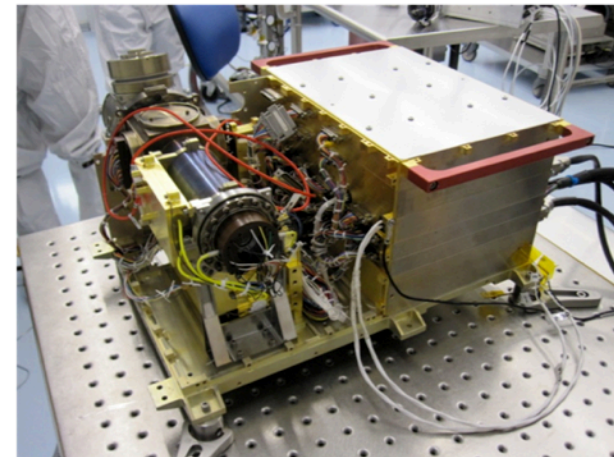
Useful Mission Documents

- [Mission Description](#)
- [Spacecraft Description](#)
- [Software Interface Specification \(SIS\)](#) - Description of the instrument and data structures
- [Calibration Document](#) - Description of the calibration methods

Archive Bundle Contents

- [Document](#) - Directory containing the document collection, which includes references to refereed journals using this instrument, and information about calibration and explanation of data structures.
- [Raw Data](#) - Directory containing the raw data files.
- [Calibrated Data](#) - Directory containing the calibrated data files.

Selecting and Requesting Data - Each of the following indices can be downloaded and edited to contain data that conforms to your needs. This allows you to understand the scope of the data set and to tailor your request for specific products.



An example of calibrated data will be displayed in this area

LADEE

Main
NMS
UVS
LDEX

PDS4 Tools

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PDS4 Label to PDS3 Label
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Data Format Translations

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As-Flown Index

[Calibrated Data \(txt\)](#) - List of observations in order of acquisition

[Requesting Data](#) - You will need to upload your edited file

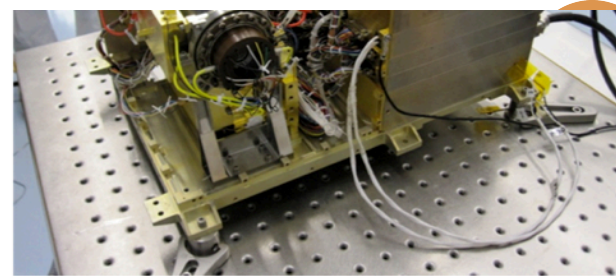
Citing Data Sets for Publications (to be developed)

Other Useful Products for Interpreting the Data

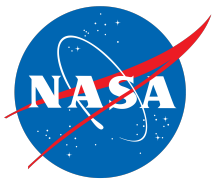
[References](#) - Publications by team members (also found in [Document](#))

[Other Potential Relevant Data](#) - Data that may be relevant from missions other than LADEE

[SPICE](#) - Archived LADEE SPICE ancillary data providing observation geometry (positions, orientations, instrument pointing, time conversions, etc.) are available from the PDS NAIF Node



An example of calibrated data
will be displayed in this area



Please go to the MAVEN Site



Sited at PPI and ATMOS & accessible via EN PDS4 access page
<http://ppi.pds.nasa.gov/project/maven/>





- [Nasa Portal](#)
- [Site Help](#)
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MAVEN

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- [SEP](#)
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- [SWIA](#)
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- [LPW-EUV](#)
- [MAG](#)
- [ACC](#)

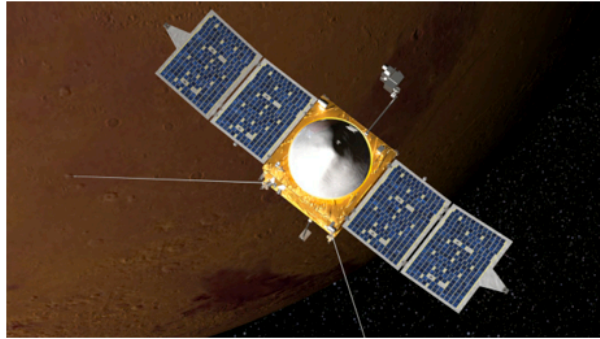


Welcome to the MAVEN Archive Page

Now in PDS4

Mars Atmosphere & Volatile Evolution Mission (MAVEN)

The Mars Atmosphere and Volatile Evolution Mission (MAVEN) was launched Nov XX, 2013, to explore the planet's upper atmosphere, ionosphere and interactions with the sun and solar wind. After a 10 month ballistic cruise the craft went into orbit XX Sept 2014. The primary mission was planned to last for one earth year. To obtain coverage of near Mars space the mission was designed with an elliptical orbit that precessed in latitude and local solar time. The mission plan included nominal orbits that have periapsis near 150 km, with 5 "deep dip" campaigns with periapsis near 125 km.



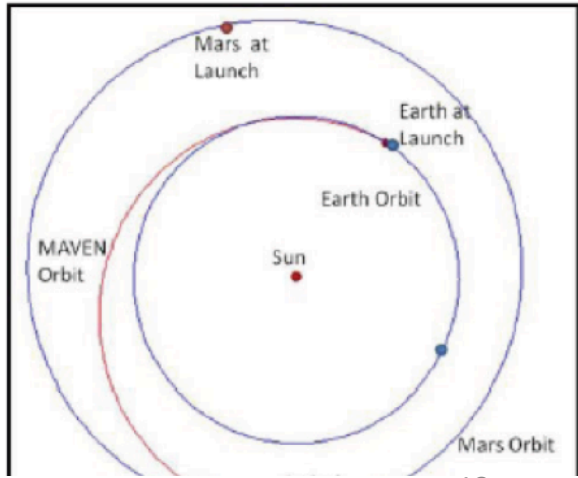
QUICK LINKS

- [FAQ](#)
- [Citation Policy](#)
- [Data Producer](#)
- [Data Supplier](#)
- [Errata for all volumes](#)
- [Help for Data Users](#)
- [Help for Data Reviewers](#)
- [Help for Data Providers](#)

Basic Mission Goals

- Determine the role that loss of volatiles from the Mars atmosphere to space has played through time
- Determine the current state of the upper atmosphere, ionosphere, and interactions with the solar wind
- Determine the current rates of escape of neutral gases and ions to space and the processes controlling them
- Determine the ratios of stable isotopes that will tell Mars' history of loss through time

For more information on the MAVEN mission see the following links:



PDS NODES

- [PDS Home](#)
- [Atmospheres](#)
- [Geosciences](#)
- [Imaging](#)
- [NAIF - SPICE](#)



PDS4 Primer:

For information on the new standards associated with PDS4 please browse the following links

- [PDS4 Concept Document](#)
[PDS4 Standards](#)

Instrumentation and Access to Data:

The instrument complement consists of:

1. A mass spectrometer to determine global characteristics of the upper atmosphere and ionosphere,
2. An ultraviolet spectrometer to characterize the upper atmosphere and ionosphere,
3. A solar EUV irradiance monitor and
4. A fields and particles integrated package for *in situ* measurements. Included in the package are: LPW, SWEA and SEP to measure electrons and SWIA and STATIC to detect ions, while magnetic fields and electric fields are recorded by MAG and LPW respectively.
5. In addition, accelerometer data is acquired in the 5 "deep-dip" campaigns to sample the lower atmosphere

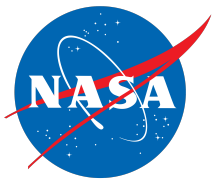
Available Data

[MAVEN Mission Bundle](#) contains documents and files that are common to all the instruments describing the mission and spacecraft

Each of the following archive bundles contain collections for system context, documentation of the data, individual data collections of raw, reduced and/or derived complete with calibration information where applicable.

[Neutral Gas and Ion Mass Spectrometer](#) (NGIMS) data are stored in time ordered ASCII tables with supporting documentation

[Imaging Ultraviolet Spectrometer](#) (IUVS) data are stored in time ordered FITS files with supporting documentation -higher order products are in FITS.



Use the sidebar to go to NGIMS



Atmospheres data and related services

- Atmospheres data
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- Abstracts of funded NASA proposals
- Sphere

PDS Web Sites

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- Small Bodies

MAVEN

- Main
- NGIMS
- IUVS
- STATIC
- SEP
- SWEA
- SWIA
- LPW
- LPW-EUV
- MAG
- ACC

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Neutral Gas & Ion Spectrometer

NGIMS

The Neutral Gas and Ion Mass Spectrometer (NGIMS) is a quadrupole mass spectrometer with open and closed sources. The open ion source mode is used to measure reactive neutral gas species and to sample ambient thermal and suprathermal ions while the closed source samples non-reactive neutrals. The mass range is 2 - 150 Da.

Measurement Objectives

NGIMS will measure the neutral composition, isotopic ratios and scale height temperature of the major gas species (He, N, O, CO, N₂, NO, O₂, Ar, and CO₂) in the upper atmosphere. It will:

- Determine variation of the neutral composition with altitude, local solar time, longitude and season from the homopause to the exobase where neutral gas can escape.
- Derive stable isotope ratios and variations.
- Provide a basis for the study of thermospheric energetics, transport, circulation, and formation of the ionosphere.
- Reveal the effects of lower atmosphere meteorological effects, such as dust storms, on the composition of the upper atmosphere and exobase.

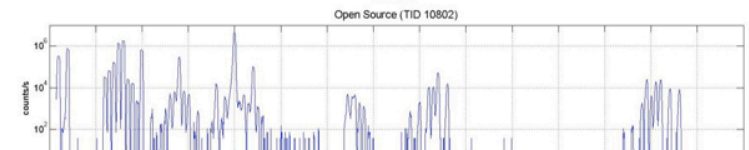
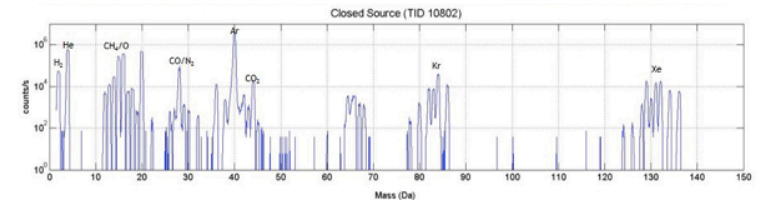
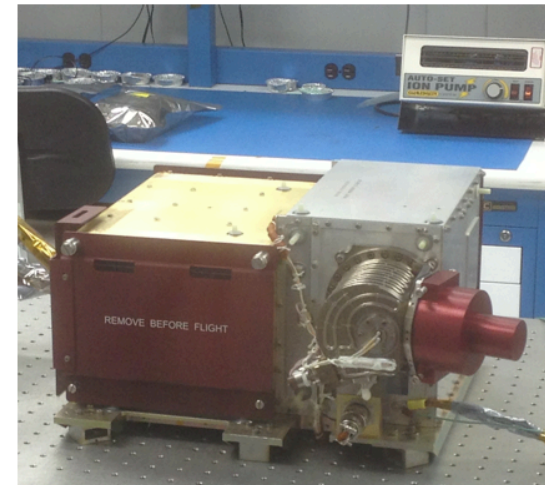
Useful Mission Documents

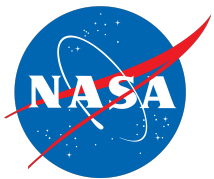
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SupraThermal & Thermal Ion Composition

STATIC

The Supra-Thermal And Thermal Ion Composition (STATIC) instrument utilizes a toroidal electrostatic analyzer with time of flight section mass range 1-70 AMU, $\Delta M/M > 4$ and an energy range ~ 1 eV to 30 keV, $\Delta E/E \sim 15\%$ with a field of view $360^\circ \times 90^\circ$.

Measurement Objectives

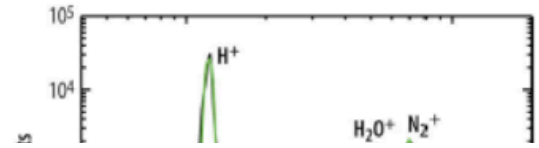
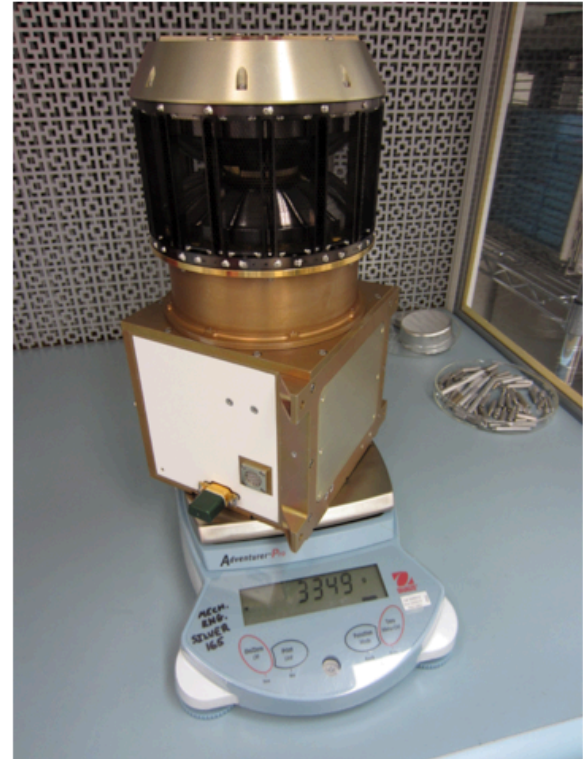
STATIC measures the velocity distributions and mass composition of suprathermal and thermal ions. It obtains density profiles of H^+ , He^{++} , He^+ , O^+ , O_2^+ and CO_2^+ . Measurements include the composition of thermal to energetic ions, energy distributions and pitch angle variations, including Ionospheric ions (0.1 - 10 eV), Tail superthermal ions (5-100eV), Pick-up ions (100-20,000 eV) and Key ions (H^+ , O^+ , O_2^+ and CO_2^+).

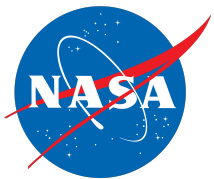
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Imaging Ultraviolet Spectrometer

IUVS

IUVS is an Imaging UltraViolet Spectrograph Spanning 110-340 nm with two spectral resolution modes with low resolution ($N\Delta\lambda=400$) and high resolution ($N\Delta\lambda=13,800$) to measure the D/H ratio.

Measurement Objectives

IUVS measures vertical profiles of neutrals and ions through limb emissions and provides information on the lower atmospheric properties from stellar occultations. In addition, it provides full disk maps obtained near apoapsis as well as D/H ratios and hot coronal mapping.

Useful Mission Documents

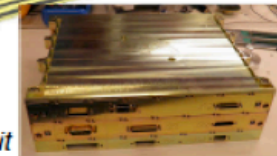
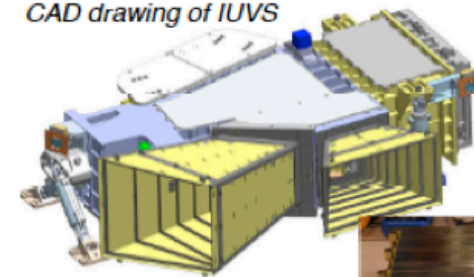
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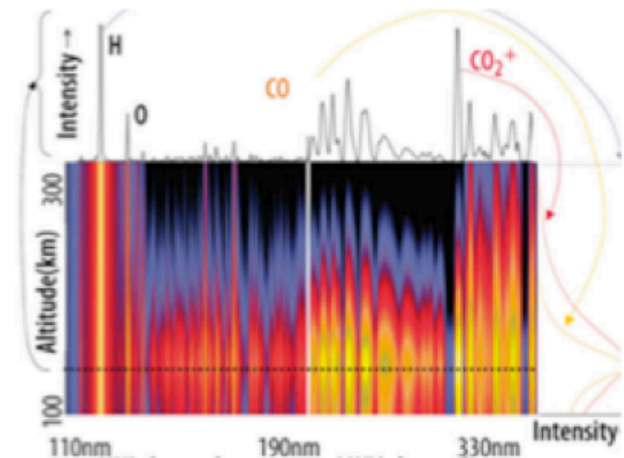
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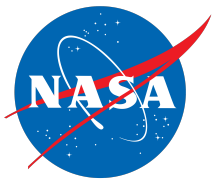
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CAD drawing of IUVS



Flight Data Processing Unit





Suppose you want information concerning Solar UV

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Seek the data set for a solar UV monitor

Use the sidebar to go to LPW-EUV



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LPW - EUV Monitor

The Extreme UltraViolet Monitor (EUV) uses three stable photometers at key wavelengths (0.1-7, 17-22, and 121.6 nm) representing different temperature solar emissions from different sources: chromospheric, transition region and coronal regions. This data is interpreted to characterize the solar EUV solar radiance.

Measurement Objectives

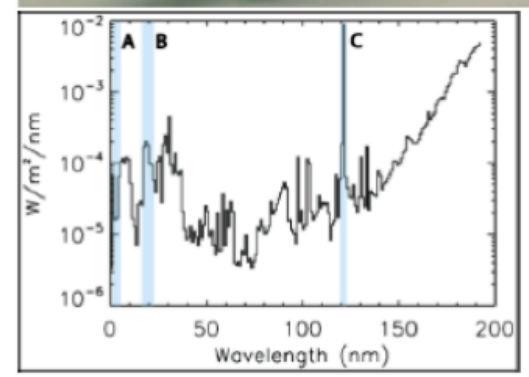
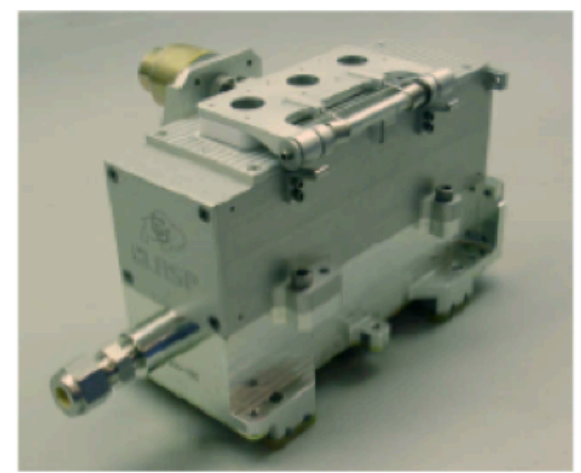
EUV will measure solar EUV irradiance shortward of 122 nm, which can vary from a few percent to more than a thousand times depending on the state of solar flares, etc. EUV measurements will provide solar EUV energy input to understand photoionization, photodissociation, and heating rates due to solar variability.

Useful Mission Documents

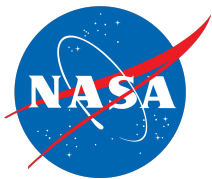
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EUV detector bandpasses



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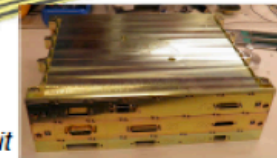
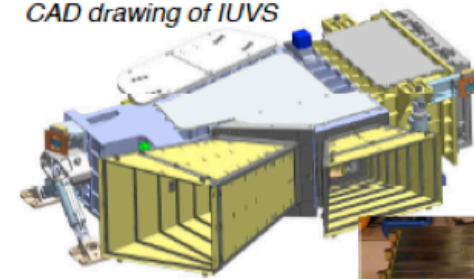
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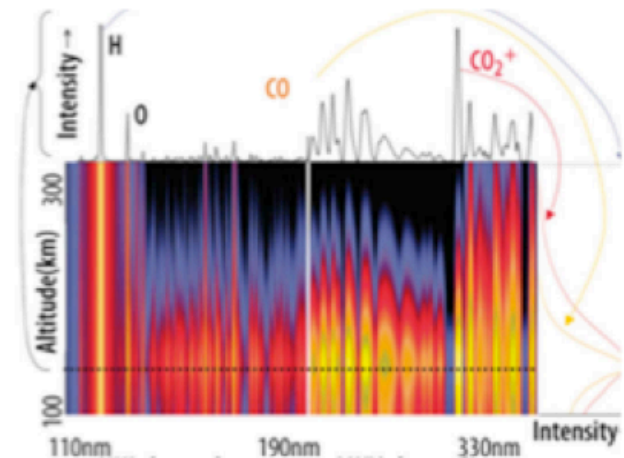
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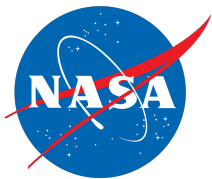
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CAD drawing of IUVS



Flight Data Processing Unit





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This approach provides transparency of location of data while allowing the data to be archived by discipline experts.





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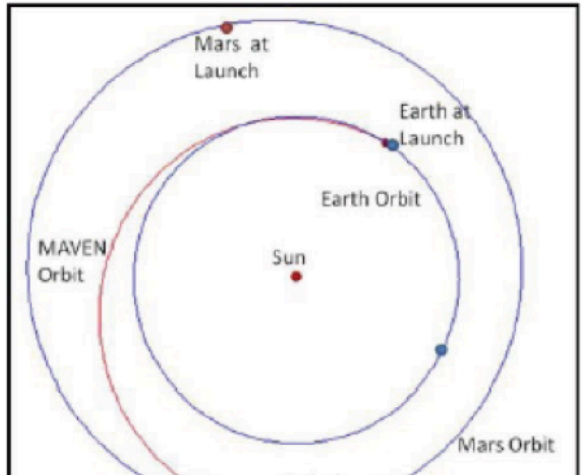
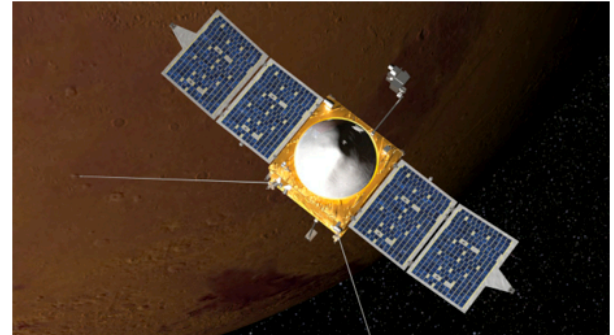
Now in PDS4

Mars Atmosphere & Volatile Evolution Mission (MAVEN)

The Mars Atmosphere and Volatile Evolution Mission (MAVEN) was launched Nov XX, 2013, to explore the planet's upper atmosphere, ionosphere and interactions with the sun and solar wind. After a 10 month ballistic cruise the craft went into orbit XX Sept 2014. The primary mission was planned to last for one earth year. To obtain coverage of near Mars space the mission was designed with an elliptical orbit that precessed in latitude and local solar time. The mission plan included nominal orbits that have periapsis near 150 km, with 5 "deep dip" campaigns with periapsis near 125 km.

Basic Mission Goals

- Determine the role that loss of volatiles from the Mars atmosphere to space has played through time
 - Determine the current state of the upper atmosphere, ionosphere, and interactions with the solar wind
 - Determine the current rates of escape of neutral gases and ions to space and the processes controlling them
 - Determine the ratios of stable isotopes that will tell Mars' history of loss through time
- For more information on the MAVEN mission see the following links:



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LADEE Site <http://atmos.nmsu.edu/PDS4BETA/LADEE/mainr.html>

MAVEN Site <http://ppi.pds.nasa.gov/project/maven/>

Phoenix Prototype

<http://atmos.nmsu.edu/PDS4BETA/phoenix/phoenix.html>

We've shown you one approach to providing user's access.

Sean Hardman will follow up on the system capabilities tomorrow