

Planetary Science Big Data

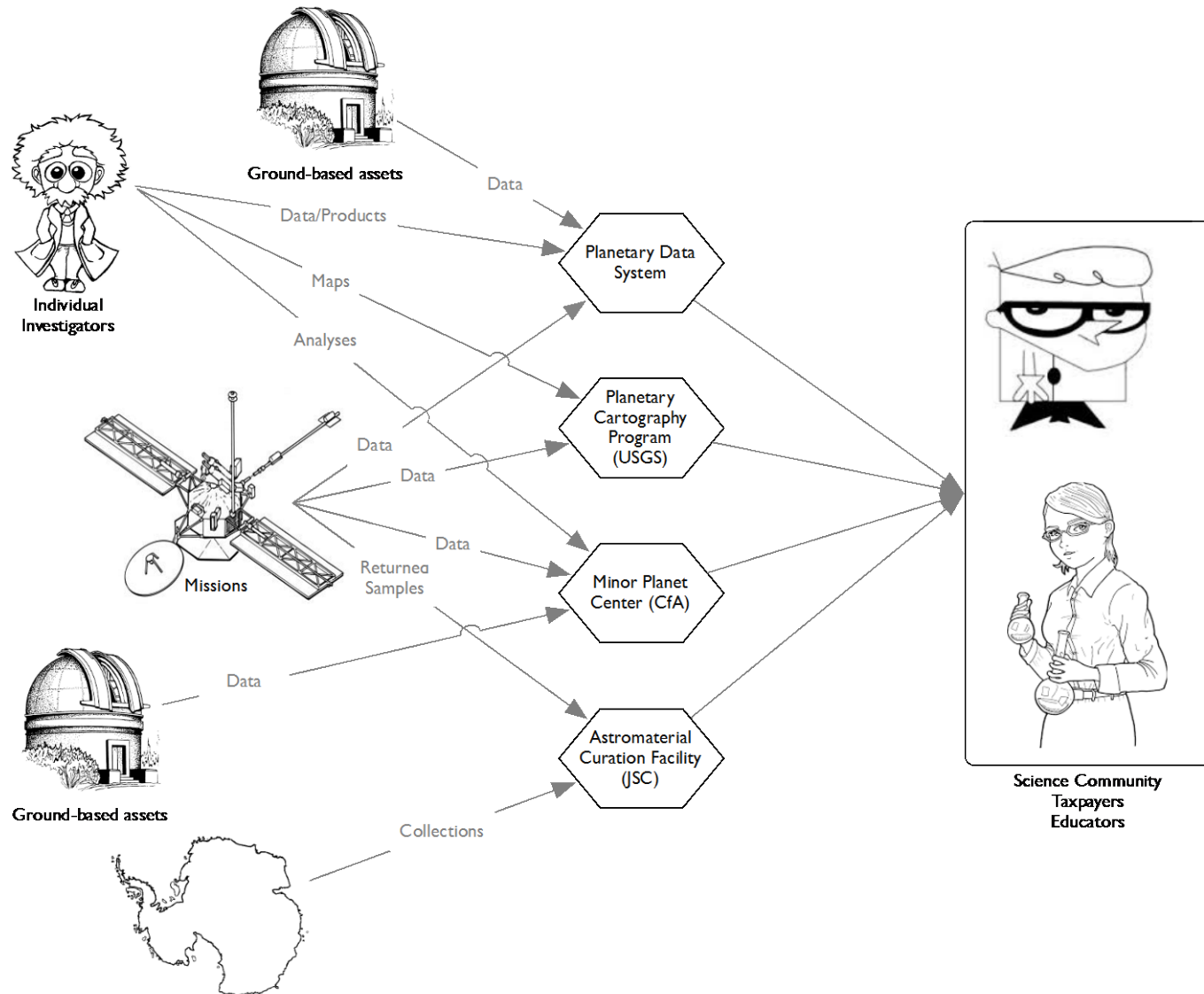
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Planetary Data System
Program Scientist

PSD Data Policies

- ◆ All science data returned from NASA missions are immediately in the public domain.
 - ✦ A short period of exclusive access may be proposed for data calibration and validation, but a compelling justification for it must be demonstrated.
 - ✦ Any period of exclusive access should be the minimum that is consistent with optimizing science return from the mission. Barring exceptional circumstances, it may not exceed six months.
- ◆ Keeping with the *NASA Plan for Increasing Access to the Results of Scientific Research**, data necessary to replicate published research results that are the product of a NASA award must be made available through an archive or a journal's supplemental material.

*http://www.nasa.gov/sites/default/files/files/NASA_Data_Plan.pdf

What is the Planetary Data Environment Like?



Astromaterials Curation Facility

- ◆ The Astromaterials Curation Facility (ACF) at NASA's Johnson Space Center stores, curates, studies, and distributes all returned samples and some space-exposed hardware.
 - ✦ Lunar samples (Apollo & Luna)
 - ✦ Meteorites (ANSMET)
 - ✦ Genesis
 - ✦ Stardust
 - ✦ Cosmic Dust
 - ✦ Hayabusa
- ◆ ACF personnel working closely with missions that involve sample return to insure that return and recovery of samples meet mission requirements.
- ◆ Current project to re-engineer sample catalog(s), make them more available online, and link into the PDS.



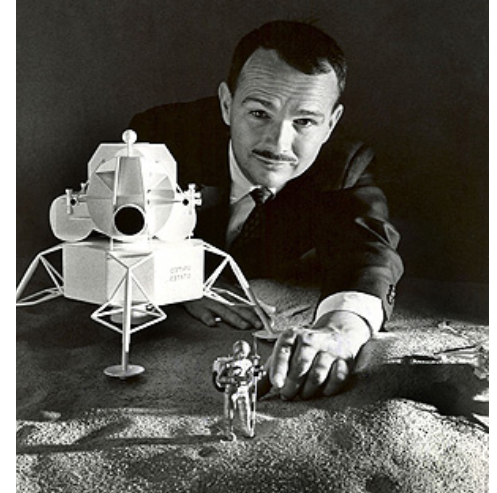
Minor Planet Center

- ◆ Responsible for the designation of minor bodies in the Solar System, in conjunction with the Central Bureau for Astronomical Telegrams (CBAT); and natural satellites (also in conjunction with CBAT).
- ◆ Also responsible for the efficient collection, computation, checking and dissemination of astrometric observations and orbits for minor planets and comets.
- ◆ Small Bodies Node currently pulls data from the MPC. JPL's HORIZONS system also pulls data from MPC and users can download these data in a number of formats, including SPICE.

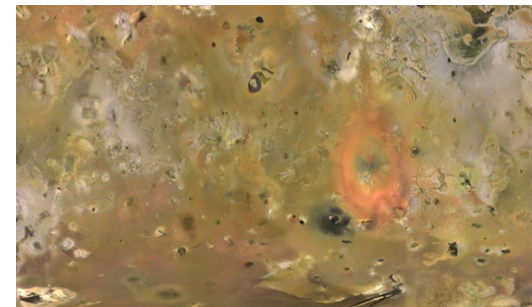


Planetary Cartography Program

- ◆ Managed for NASA by the USGS Astrogeology Science Center since early 1960's.
- ◆ Develops and maintains a cartographic capability in support of NASA's missions.
- ◆ Advises NASA on planetary mapping (technical) issues.
- ◆ Develops and maintains ISIS — Integrated System for Imagers and Spectrometers — a free, specialized, digital image processing software package providing the ability to place many types of data in the correct cartographic location, enabling disparate data to be co-analyzed.
- ◆ ISIS has long made use of PDS SPICE data, and is now about to incorporate the SPICE-based *Cosmographia* mission visualization tool. Still further interfaces with the PDS are under discussion.



Eugene Shoemaker (1928-1997)

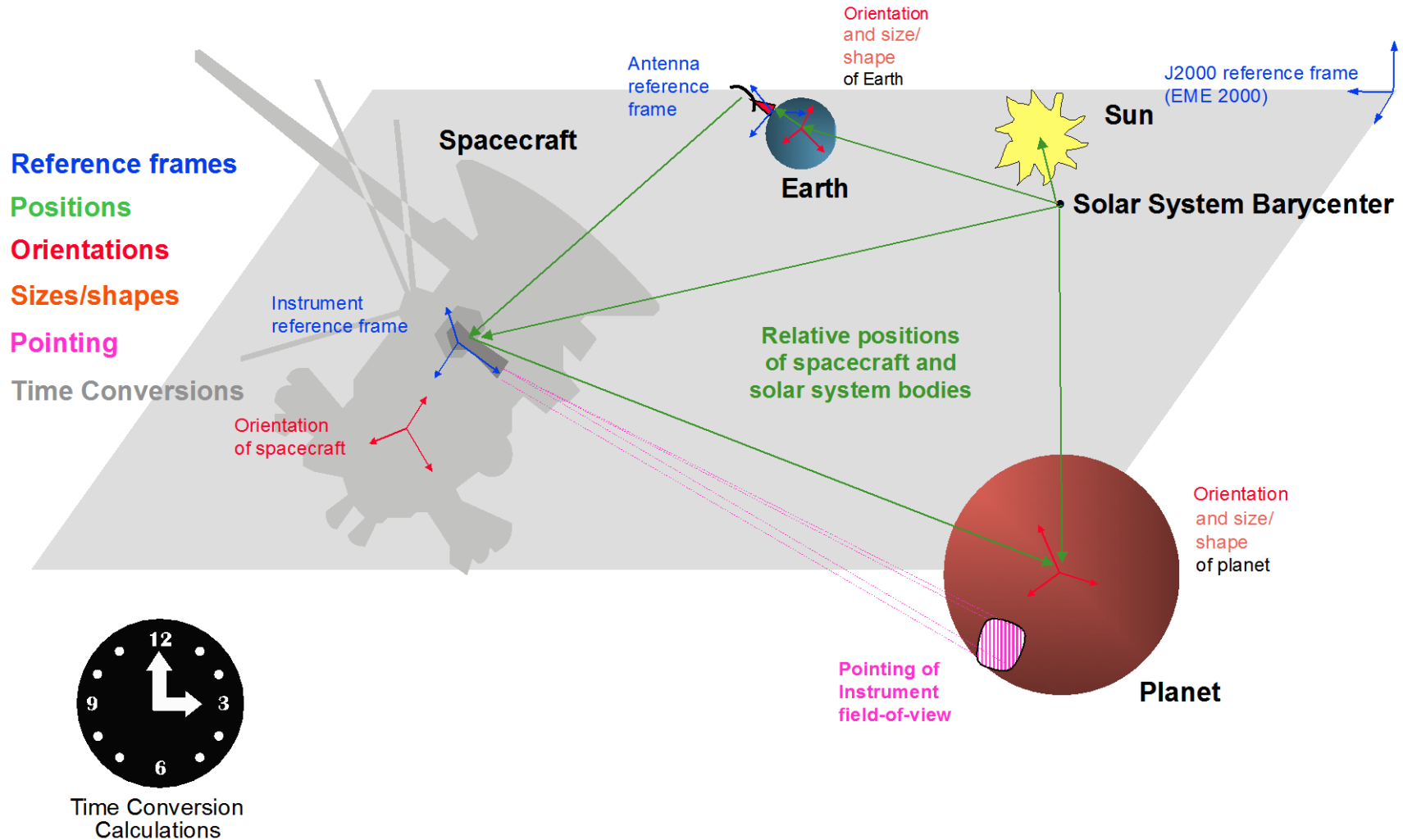


Mosaic of Io

The Planetary Data System

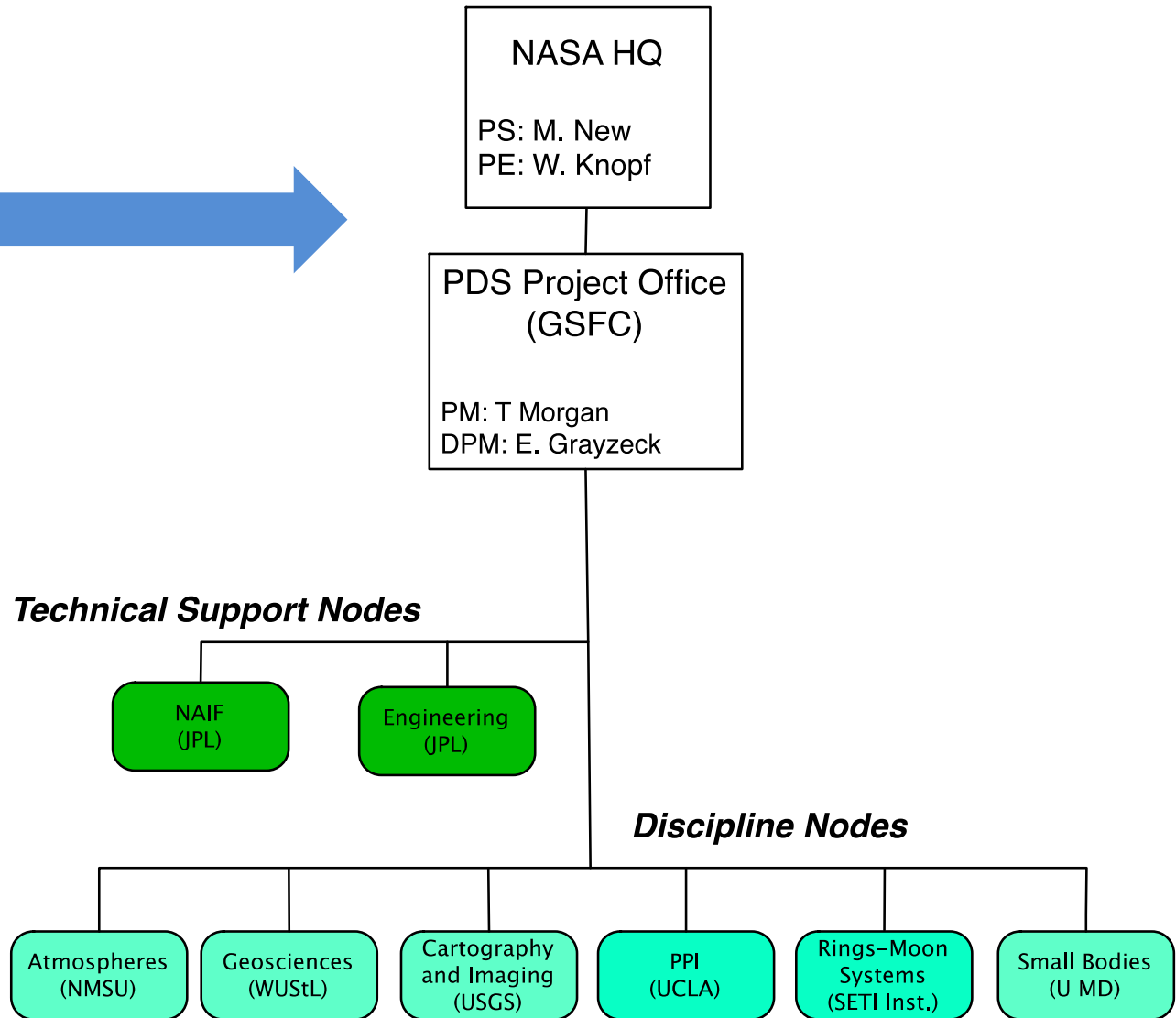
- ◆ A federated archive of planetary science data, curated by discipline experts.
- ◆ Arranged as a set of “Discipline Nodes” that were recently re-competed through a CAN.
 - ✦ Planetary science data physically stored at these nodes.
 - ✦ Deep archive at the NSSDCA.
- ◆ Two “Technical Support Nodes”
 - ✦ Engineering Node (EN) provides system engineering capabilities to the PDS as a whole
 - ✦ Navigation and Ancillary Information Facility (NAIF) implements standards and tools for recording and using **observation geometry** data and archives these for missions.

What is “Observation Geometry”?



The Current PDS

The hierarchy shown is misleading; actual operations are collaborative, as befits a federation.



Performance reviewed this month by non-PDS peer reviewers.

Re-competed in August.

Data Format Standards

- ◆ PDS has just released a new data standard, PDS 4.
 - ✦ PDS 4 is model-driven, service-oriented, and XML-based.
 - ❖ Provides a comprehensive global information model and hence a unitary archive metadata architecture.
 - ❖ A modern technical foundation for planetary science data.
- ◆ Deployment has prioritized providing required capabilities to recent missions (LADEE, MAVEN, InSight, OSIRIS-REx) over the conversion of legacy data.
 - ❖ Conversion of existing PDS 3 products to PDS 4 to be done when practical and sensible.

Observation Geometry Standards

- ◆ SPICE is a NASA-developed format for recording observation geometry.
- ◆ Used by all NASA planetary missions for computing assorted geometry parameters needed to support mission operations, science data archiving and science data analysis.

Internationally Accepted Standards

- ◆ ESA's PSA and JAXA's DART are both adopting PDS 4. ESA, JAXA, RSA, & ISRO use SPICE.
- ◆ NASA is a founding member of the International Planetary Data Alliance which aims to ease discovery, access and use of planetary data by world-wide scientists regardless of which agency is collecting and distributing the data.
 - ★ IPDA's nascent standard is an internationalized version of PDS 4.
 - ★ IPDA recommends the use of SPICE.



16 Feb 2016



NASA Ad Hoc Big Data Task Force



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Scale of the PDS

Node	Data Volume (TB)
Atmospheres	3.0
Cartography and Imaging	825.0
Geosciences	165.0
NAIF	0.5
Planetary Plasma Interactions	7.5
Ring-Moon Systems	1.6
Small Bodies	3.1
TOTAL	1,000.7

- ◆ Total volume is currently ~1 PB.
- ◆ Note, though, that no user ever needs to access, search, download, or process the entirety of the PDS.
- ◆ Almost all computations on data are performed on individual workstations.

Future

- ◆ Just started a process to work with the community on developing the next ten-year Roadmap.
 - ✦ Opportunity for self-nominations to the Roadmap Team will be announced in March.
 - ✦ Issued an RFI to acquire community thoughts on PDS improvements.
- ◆ Some areas of improvement under current consideration:
 - ✦ Simplifying and improving pipelines between missions and the PDS.
 - ✦ Improving search capabilities (enabled by PDS 4).
 - ✦ Generating more useful metrics of node performance.
 - ✦ Improving tools for archiving of small data sets — the kind produced by individual researchers.
 - ✦ Improving archive preparation and documentation, especially for non-mission data providers.

NATIONAL AERONAUTICS
AND SPACE ADMINISTRATION

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SPICE

An Observation Geometry System for Planetary Science Missions

Click [here for announcements](#) regarding SPICE data, software, tutorials and training, last updated **Feb 4, 2016**.

NASA's Navigation and Ancillary Information Facility (NAIF) offers NASA flight projects and NASA funded researchers an observation geometry information system named "SPICE" to assist scientists in planning and interpreting scientific observations from space-based instruments aboard robotic planetary spacecraft. SPICE is also widely used in engineering tasks associated with these missions.

The SPICE system is also available to space scientists and engineers around the globe, subject to the provisions explained on the [Support](#) and [Rules](#) web pages. SPICE may also be used outside of the planetary science discipline, subject to those same provisions.

SPICE is widely used in the NASA and international planetary exploration communities, and even beyond. But use of SPICE is **not** a requirement of NASA's Planetary Science Division missions, nor of the Planetary Data System, nor of the International Planetary Data Alliance.

SPICE is focused on [solar system geometry \(pdf\)](#). The SPICE system includes a suite of software, mostly in the form of application program interfaces (APIs), that customers incorporate in their own application programs to read SPICE data files and, using those data, compute derived observation geometry such as altitude, latitude/longitude and lighting angles. SPICE data and software may be used within many popular computing environments. The software is offered in FORTRAN 77, ANSI C, IDL® and MATLAB®, with versions for Java Native Interface and Python planned for the future.

NAIF serves as the "Navigation Node" of NASA's [Planetary Data System](#), archiving and providing the science community access to SPICE data from NASA's planetary exploration missions. Archived SPICE data from non-NASA missions is sometimes available at other national archives, and in some cases it is also available at the NAIF Node.

The current version of the SPICE Toolkit, Version N65, was released July 23, 2014. To see what's been added, fixed and changed relative to the previous release read the "whats.new" file available on this website under the Toolkit link for the language of interest to you, or see this same file in a Toolkit package you have downloaded.

Some customers find that using the Safari browser in association with some of these web pages yields unfamiliar results; consider trying a different browser.

Occasionally a customer is inside a local firewall having settings that prevent

PDS: The Planetary Data System

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New Releases

January 20, 2016
PDS Data Dictionary 1R07 Release

January 19, 2016
Odyssey Data Release 54b

January 6, 2016
Cassini Data Release 44

January 4, 2016
Odyssey Data Release 54

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Navigation & Ancillary Information (NAIF)

Planetary Plasma Interactions (PPI)

Ring-Moon Systems

Small Bodies

PDS Support

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Engineering

Data Analysis

Proposals Support

- NASA's Current Research Solicitations

Community Announcement:

NASA's Science Mission Directorate is seeking input for development of the 2017-2026 POS Roadmap. For more information, please see NSPIRES solicitation NNA15ZDA012L and this RFI Overview (PDF).

Welcome to the PDS

The PDS archives and distributes scientific data from NASA planetary missions, astronomical observations, and laboratory measurements. The PDS is sponsored by NASA's Science Mission Directorate. Its purpose is to ensure the long-term usability of NASA data and to stimulate advanced research. All PDS data are publicly available and may be exported outside of United States under "Technology and Software Publicly Available" (TSPA) classification. [Learn more about PDS.](#)

If you're beginning a new archiving project, you must use PDS4 and you can start from [here](#).

If you're developing a dataset in response to Planetary Data Archiving, Restoration and Tools (PDART), you can start from [here](#).

If you're developing a dataset in response to SMALL INNOVATIVE MISSIONS FOR PLANETARY EXPLORATION (SIMPLEX), you can start from [here](#).

Researchers	Data Providers	Data Reviewers	Proposers
Search or browse for data sets	PDS3 Archiving Standards	The peer review process	Information for PDS3 proposers
Get notified (subscribe) when new data becomes available	PDS4 Archiving Standards and Documents	PDS Node Contacts	Information for PDS4 proposers
Find images from planetary missions	PDS Node Contacts		Response to PDART
Find tools for viewing and working with PDS data			Response to Discovery AO
Learn about PDS data format and structure			Response to SALMON-2 AO
			Response to SIMPLEX
			ROSES 2008-2015 support in the PDS
			Archiving Check-list for PI-Led Proposals

Students & Educators

The PDS is mainly designed for scientists researching the planets. While you may find what you are looking for here, you are usually better off visiting one of the sites below, or another of the related sites.

Planetary Photojournal	A searchable collection of press release images from NASA planetary missions.
Map a Planet	Create maps of many of the planets of our solar system, with customizable locations and scale.
Cassini Rings Images	A Month-By-Month Gallery of Cassini images of Saturn's Ring System.

International Planetary Science Data Archives

Planetary Science Archive	An archive containing planetary science data results from ESA missions.
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Freedom of Information Act

naif.jpl.nasa.gov

pds.nasa.gov