



Jet Propulsion Laboratory
California Institute of Technology

Introduction to PDS Tools, Services, and Standards

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Overview

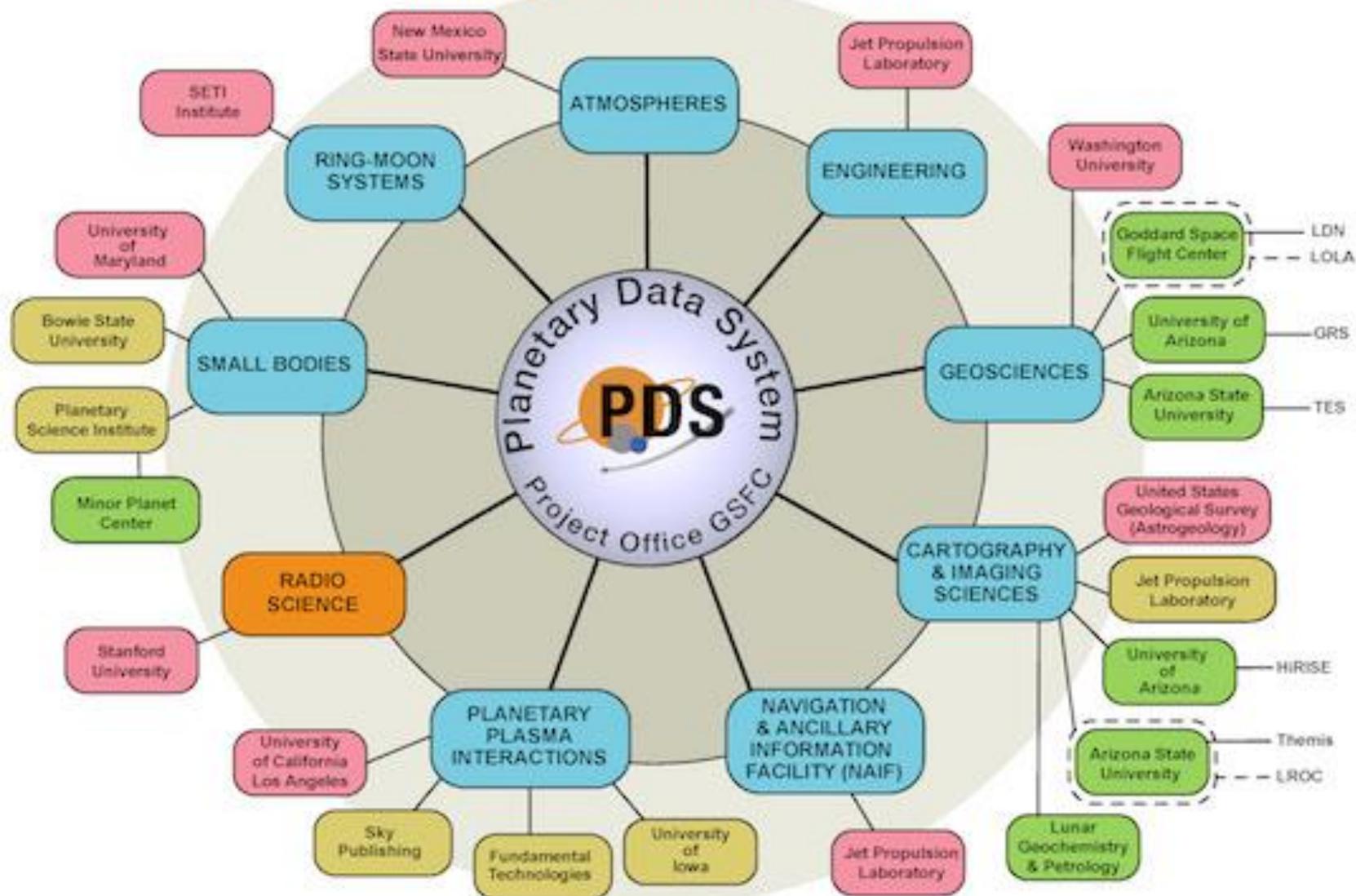
- What is the PDS?
- PDS4 Standard
- Tools

What is the PDS?

- PDS = Planetary Data System
- Archives and distributes scientific data from planetary missions, astronomical observations, and laboratory measurements.
- All PDS-produced products are:
 - peer-reviewed
 - well-documented
 - easily accessible through various search tools depending on the discipline
 - meet the PDS data standard

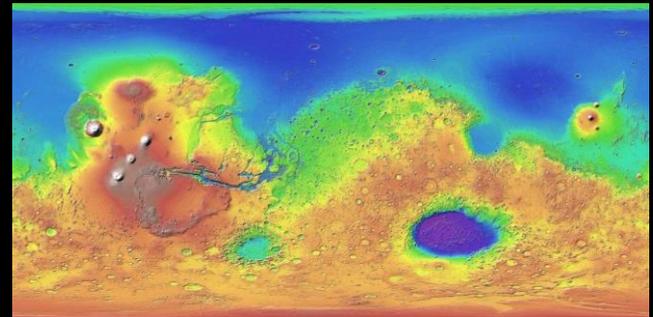
NODES/SUBNODES/DATA NODES

Function / Node Home Institution

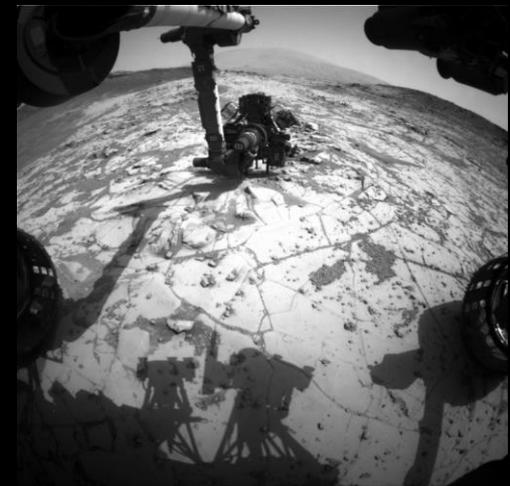


PDS Cartography and Imaging Sciences Node

- IMG is home to over 700 TB of digital image archives
- Partnership between JPL and USGS
- Wide variety of data
 - Orbital vs. landed missions
 - Original raw experiment data vs. derived products
 - Differing coordinate systems
- Varying data users
 - Scientists
 - Public
 - Developers
- Requires a wide range of tools and expertise to meet these customer needs



MGS Mola Global Colorized Hillshade 463M²



Curiosity Rover Hazcam Image of Drilling
On Jan. 13, 2015³

International Planetary Data Alliance (IPDA)

- Founded in 2006, is a closely cooperating partnership to maintain the quality and performance of data (including data formats) from planetary research using instruments in space.
- Promotes the international exchange of high-quality scientific data
- Adopted the PDS standard
- Includes, among others, NASA, ESA, and UKSA.
- <https://planetarydata.org/>



PDS4 Standard

- PDS4 replaces PDS3
 - A new revision to the PDS standards for archiving
- PDS4 is designed to produce higher quality, more accessible archives using modern software capabilities.
- Like PDS3, PDS4 specifies:
 - What can and should be in an archive: data, documentation, calibration information, etc.
 - What types of data are considered archive-quality
 - How data products should be labeled to be consistent across PDS

- PDS3 differs from PDS4 in terms of:
 - Data Types
 - Labels
 - Products
 - Data Processing Levels
 - Directory structure

Tools

Tools

- Data processing pipeline
- Label design
- Data validation
- Data access

- Data processing pipeline

AMMOS PDS Pipeline Service (APPS)

- Enables creation and validation of PDS4 labels and archive bundles by science data producers.
- Distributed processing system
- Attaches to the operational data pipeline
- Produces archive ready products on the fly
- *Soon-to-be open sourced on Github*
- <https://ammos.jpl.nasa.gov/toolsandservices/downlink/instrumentdataprocessing/appsammospdspipelineservice/>

- Label design

APPS Label Design Tool

- Web interface for creating PDS4 labels
- Do not need to know XML*
- Does require some knowledge of terminology
- Questions for users to select the attributes (aka keywords) they need
- Produces valid PDS4 label
- <https://pdsimg-services.jpl.nasa.gov/ldt/dashboard.php>

Label Design Tool

1. Product Type

2. Discipline Nodes

3. Mission Specifics

4. Export

What type of product would you like to create a label for?

 Context

 Document

 File Text

 Observational

 Thumbnail

- ✓ Product Type
- ✓ Product
- ✓ Identification Area
- ✓ Observation Area
- 5. Time Coordinates**
- 6. Investigation Area
- 7. Observing System
- 8. Target Identification

What elements do you want to keep in 'Time Coordinates'?

local mean solar time	Enter value (optional)	-	0	+
local true solar time	Enter value (optional)	-	0	+
solar longitude	Enter value (optional)	-	1	+
start date time	Enter value (optional)	-	1	+
stop date time	Enter value (optional)	-	1	+



Please choose the appropriate elements for your product.

solar longitude (Optional)

Min Occurrences: 0
Max Occurrences: 1

The solar_longitude attribute provides the angle between the body-Sun line at the time of interest and the body-Sun line at its vernal equinox.

hover over any of the elements to see helpful descriptions to guide your decisions. These descriptions indicate whether the element is required or optional.

- Data validation

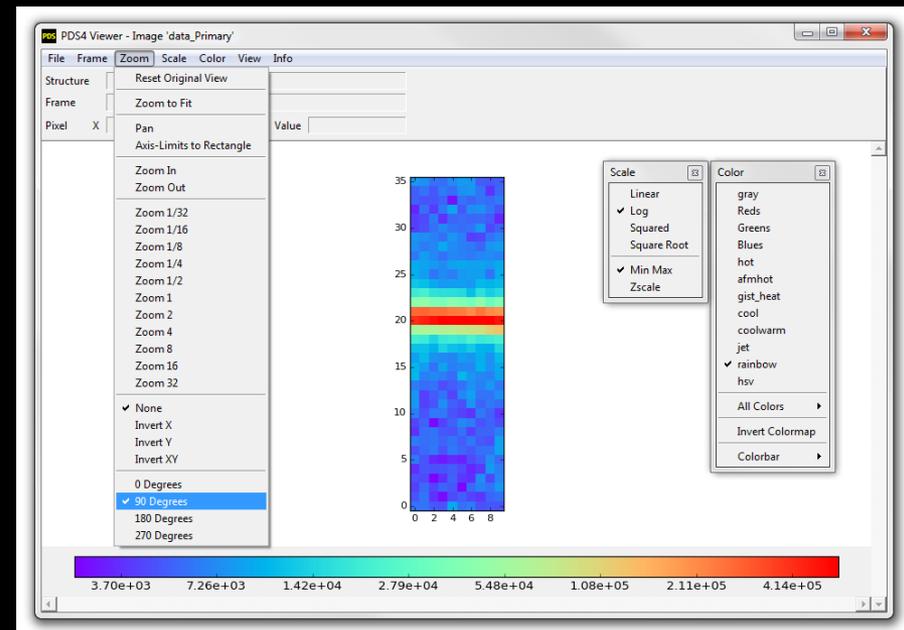
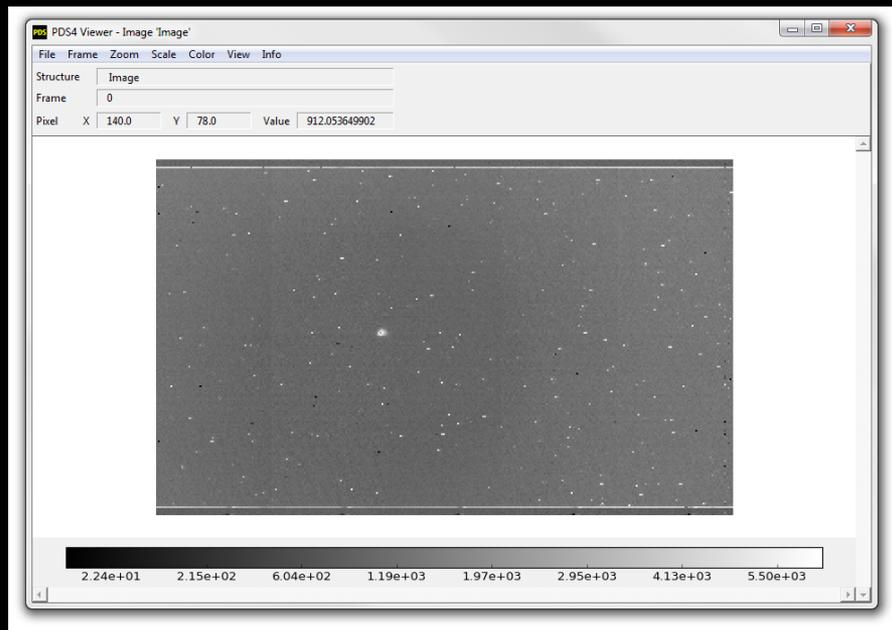
PDS4 Validation Tool

- Software for validating PDS4 product labels and product data
- The associated schema for the product label specifies syntactic and semantic constraints.
- The product label itself specifies the constraints for the data.
- <https://pds.nasa.gov/pds4/software/validate/>

- Data access

PDS4 Viewer

- Product and label visualization tool for PDS4 data
- Standalone software installable for Windows, Mac, Linux
- Supports most PDS4 data (images, spectra, arrays, tables)
- http://sbndev.astro.umd.edu/wiki/PDS4_Viewer



PDS Engineering Search

- Faceted search against all holdings of the PDS archive
- Results include
 - Archive information
 - Search Tools
 - Data Sets

Refine Your Search

Model Version
[PDS3](#) (2581)
[PDS4](#) (26)

Agency
[ESA](#) (2524)
[NASA](#) (83)

Type
[Data Set](#) (2557)
[Service](#) (23)
[Collection](#) (22)
[Search Tool](#) (19)
[Bundle](#) (2)
[Resource](#) (2)
[Target](#) (1)

Target
[Planet](#) (2626)
[Satellite](#) (25)
[Other](#) (23)
[Calibration](#) (15)
[Comet](#) (5)
[Asteroid](#) (2)

Investigation
[Mars Express](#) (2515)
[Mars Science Laboratory](#) (23)

Search Results

target:mars [New Search](#)

1–50 of **2626 results** (0.003 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](#)
 The Phoenix Archive Information page provides details on the investigation, instruments and targets associated with the archive as well as additional resources for discovering Phoenix data.

Resource: [MAVEN Archive Information](#)
 The MAVEN Archive Information page provides details on the investigation, instruments and targets associated with the archive as well as additional resources for discovering MAVEN data.

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: [2001 Mars Odyssey Image Search](#)
 Use the Planetary Image Atlas to search for images from the 2001 Mars Odyssey mission.

Search Tool: [Mars Exploration Rover Image Search](#)
 Use the Planetary Image Atlas to search for images from the Mars Exploration Rover mission.

[More...](#)

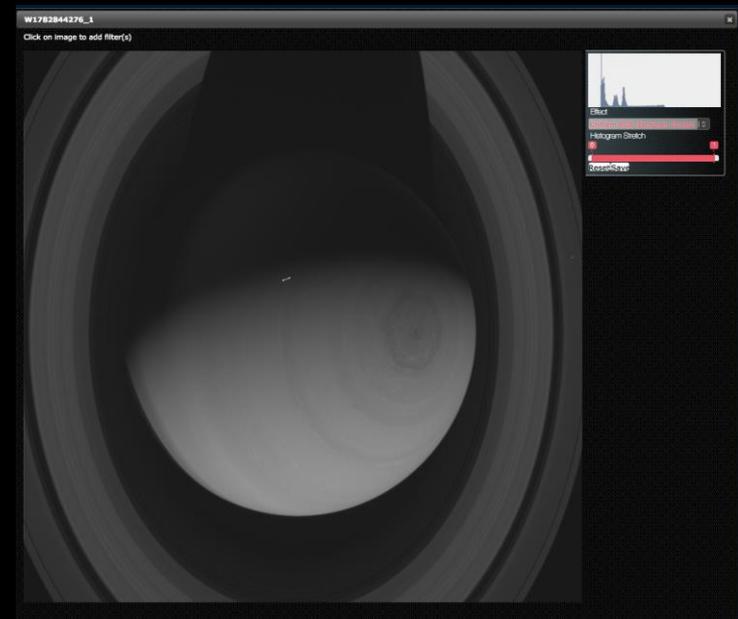
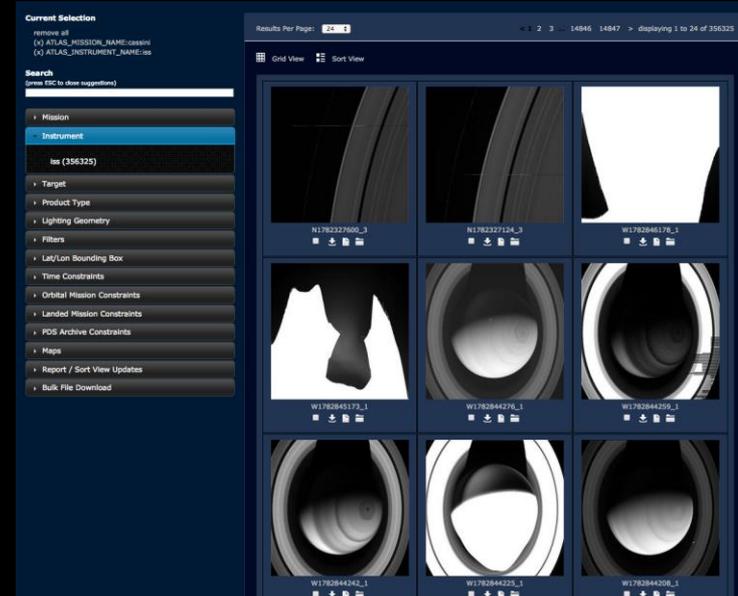
Data Sets and Information

Data Set: [MARS EXPRESS MARS MRS 1/2/3 EXTENDED MISSION 2 2672 V1.0](#) (from ESA)
 This is a Mars Express Radio Science data set, collected during the extended mission phase 2007-11-01 to tbd. It is a Global Gravity measurement and covers the time 2010-12-10T00:33:09.500 to 2010-12-10T04:52:23.500.

[MARS EXPRESS - MEX-M-MRS-1/2/3-EXT2-2672-V1.0 - starting 2010-12-10T00:33:09.5Z](#)
[MARS EXPRESS - MEX-M-MRS-1/2/3-EXT2-2672-V1.0 - \(from ESA\)](#)

PDS Image Atlas

- Provides access to entire IMG archive
- Faceted searches based on common search criteria
- Bulk downloads of resulting images
- Bounding box searches through map interfaces:
 - Saturnian moons, Earth's moon, and Mars
- Leverages W10N to provide on-the-fly image transformations



- Image content search for MSL, MRO, Cassini data (more coming)
 - Uses trained neural networks to classify images that contain specific ‘content’
- <http://pds-imaging.jpl.nasa.gov/search/>

Current Selection

remove all
 (x) ATLAS_MISSION_NAME:"mars science laboratory"
 (x) MSL_IMAGE_CLASS:wheel

Search
 (press ESC to close suggestions)

- › Mission
- › Spacecraft
- › Instrument
- › Target
- › Product Type
- › Lighting Geometry
- › Filters
- › Lat/Lon Bounding Box
- › Time Constraints
- › Orbital Mission Constraints
- › Landed Mission Constraints
- › PDS Archive Constraints
- › Landmarks
- › MSL Image Content**

Image Class

Results Per Page: 24 < 1 2 3 ... 2910 2911 > displaying 1 to 24 of 69859

Grid View Sort View Sort By: BANDS Clear

MRO 'bright dune'

MSL 'wheel'

- › Mission
- › Spacecraft
- › Instrument
- › Target
- › Product Type
- › Lighting Geometry
- › Filters
- › Lat/Lon Bounding Box
- › Time Constraints
- › Orbital Mission Constraints
- › Landed Mission Constraints
- › PDS Archive Constraints
- › Landmarks**

Landmark Class
 (MRO HiRISE RDRs Only)

bright dune (1304)
 crater (857)
 dark dune (332)
 impact (43)
 streak (235)

Number of Bright Dunes

0 to 1498

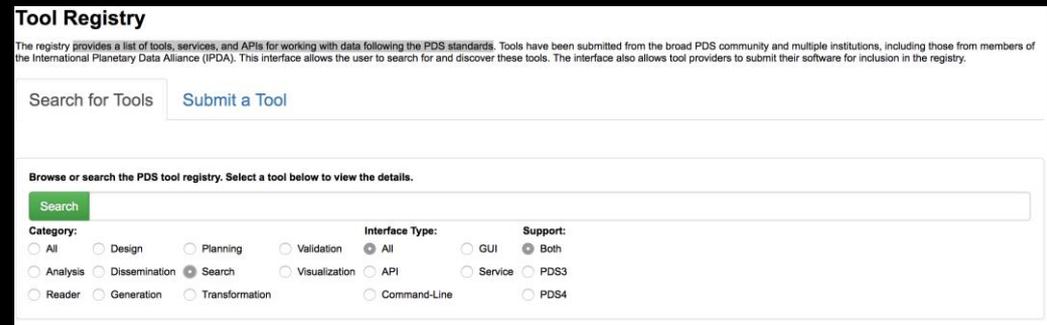
Other PDS IMG Tools

- Webification
 - <http://pds-imaging.jpl.nasa.gov/w10n>
- PDS Marsviewer
 - <http://pds-imaging.jpl.nasa.gov/tools/marsviewer>
- Photojournal
 - <http://photojournal.jpl.nasa.gov/index.html>
- UPC/PILOT
 - <http://pilot.wr.usgs.gov/>
- POW
 - <https://astrocloud.wr.usgs.gov/>
- Map-A-Planet 2
 - <https://astrogeology.usgs.gov/tools/map-a-planet-2>
- PDS Annex
 - <https://astrogeology.usgs.gov/pds/annex>

Other Tools

PDS Tool Registry

- Provides a list of tools, services, and APIs for working with data following the PDS standards
- Tools have been submitted by:
 - PDS community
 - Institutions
 - IPDA



The screenshot shows the 'Tool Registry' page. At the top, there is a title 'Tool Registry' and a brief description: 'The registry provides a list of tools, services, and APIs for working with data following the PDS standards. Tools have been submitted from the broad PDS community and multiple institutions, including those from members of the International Planetary Data Alliance (IPDA). This interface allows the user to search for and discover these tools. The interface also allows tool providers to submit their software for inclusion in the registry.' Below this, there are two buttons: 'Search for Tools' and 'Submit a Tool'. A search bar is present with a green 'Search' button. Underneath, there are three filter sections: 'Category', 'Interface Type', and 'Support'. The 'Category' section has radio buttons for All, Design, Planning, Validation, Analysis, Dissemination, Search (selected), Visualization, API, Reader, Generation, and Transformation. The 'Interface Type' section has radio buttons for All (selected), GUI, Service, Command-Line, and PDS3. The 'Support' section has radio buttons for Both (selected), PDS3, and PDS4.

- <https://pds.nasa.gov/tools/tool-registry/>



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- PDS Engineering Node Home Page
 - <https://pds.nasa.gov/>
- About the PDS
 - <https://pds.nasa.gov/about/about.shtml>
- PDS Organization
 - <https://pds.nasa.gov/about/organization.shtml>
- PDS Frequently Asked Questions
 - <https://pds.nasa.gov/about/faq.shtml>

- **PDS Concepts Document.** the view from 10,000 feet. Read this first.
 - <https://pds.nasa.gov/pds4/doc/concepts>
- **Information for Data Providers.**
 - <https://pds.nasa.gov/pds4/about/portal.shtml>
- **PDS Small Bodies Node Wiki for PDS4.** The hand-holding guide to PDS4 and XML labels.
 - http://sbndev.astro.umd.edu/wiki/SBN_PDS4_Wiki
- **PDS4 Documentation.**
 - <https://pds.nasa.gov/pds4/doc/index.shtml>

- PDS IMG Home Page
 - <http://pds-imaging.jpl.nasa.gov/>
- PDS IMG Help Page
 - <http://pds-imaging.jpl.nasa.gov/help/help.html>
- PDS IMG Data Archives
 - <http://pds-imaging.jpl.nasa.gov/volumes/>

Backup

More PDS4 Documentation Links

- **PDS4 Documents:** <https://pds.jpl.nasa.gov/pds4/doc/index.shtml>
- **IM Spec:** https://pds.jpl.nasa.gov/pds4/doc/im/v1/index_1700.html
-
- **DD (html):** https://pds.jpl.nasa.gov/pds4/doc/dd/v1/PDS4_PDS_DD_1700.html
- **DD (pdf):** https://pds.jpl.nasa.gov/pds4/doc/dd/v1/PDS4_PDS_DD_1700.pdf
- **Release Notes:**
https://pds.jpl.nasa.gov/pds4/doc/im/v1/PDS4Build7a_Release_1700_160928.pdf
-
- **XSD:** https://pds.jpl.nasa.gov/pds4/schema/released/pds/v1/PDS4_PDS_1700.xsd
- **SCH:** https://pds.jpl.nasa.gov/pds4/schema/released/pds/v1/PDS4_PDS_1700.sch
- **XML:** https://pds.jpl.nasa.gov/pds4/schema/released/pds/v1/PDS4_PDS_1700.xml
- **JSON:**
https://pds.jpl.nasa.gov/pds4/schema/released/pds/v1/PDS4_PDS_JSON_1700.JSON
- **OWL/RDF:**
https://pds.jpl.nasa.gov/pds4/schema/released/pds/v1/PDS4_PDS_OWL_1700.rdf

PDS3 versus PDS4

- Data Types
- Labels
- Products
- Data Processing Levels
- Archive Development

- Data Types

- Data types are fewer, simpler, and more rigorously defined
 - Four basic underlying types:
 - Array
 - Table
 - Parseable byte stream (e.g. text file)
 - Encoded byte stream (e.g. PDF, JPEG; need special software to read it)
 - Primary science data products are restricted to arrays and tables, or types derived from them.
 - For example, 2D and 3D images are derived from the array data type.
 - Tables may be text or binary, with fixed-width columns or CSV-style.
- [Policy on PDS4 Formats](#)

- Labels

PDS3 labels used a keyword = value syntax, with keywords and values defined in the PDS data dictionary.

PDS4 labels are written using XML, a standard widely used for information exchange.

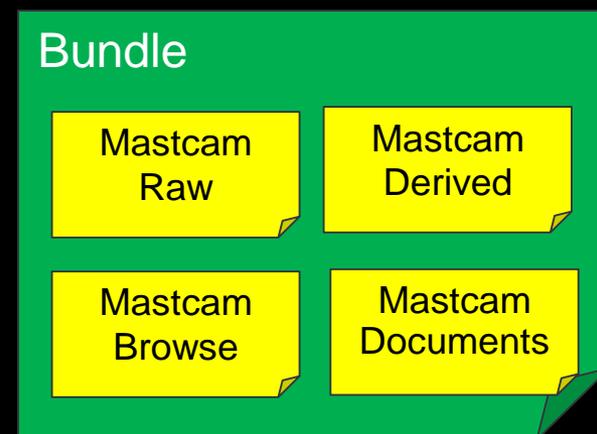
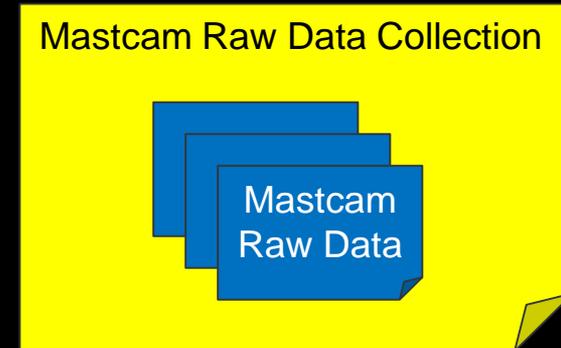
- Allows for more rigorous definition and validation of labels

If you are used to reading PDS3 labels, PDS4 labels will (at first) look hard to decipher, but there are tools for that.

And always looking for newer/better ones.

- Products

- What is a 'product' in PDS4?
 - Everything!
 - Every product has a unique ID (LIDVID).
 - Includes documents, browse images, calibration data, etc.
 - Products are grouped into collections
 - Similar to PDS3 data sets
 - Collections are grouped into bundles
 - Having unique IDs means every product is searchable and can be cited in publications.



- Data Processing Levels

In PDS4 they have names, not numbers

PDS4 processing level	PDS4 processing level description	NASA Level (used in PDS3)
Telemetry	Telemetry data with instrument data embedded. PDS does not archive telemetry data.	
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. Often called EDRs (Experimental Data Records).	0
Partially Processed	Data that have been processed beyond the raw stage but which have not yet reached calibrated status. These and more highly processed products are often called RDRs (Reduced Data Records).	1A
Calibrated	Data converted to physical units, which makes values independent of the instrument. Often called RDRs.	1B
Derived	Results that have been distilled from one or more calibrated 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. Often called RDRs.	2+

- Archive Development

- Generally similar to PDS3 for archive development
 - Milestones, deliverables, peer review procedures are all the same as before.
 - Pipeline processing software will output PDS4 labels instead of PDS3.
 - Few examples of PDS4 implementations to work from
 - Increased time for label and data product design
- Validation of products for delivery to your PDS node should be easier.
- Tools being developed to help processing (APPS)