NASA PDS IMG: Accessing Your Planetary Image Data

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Jet Propulsion Laboratory
California Institute of Technology

Accessing Your Planetary Image Data

Overview

- What is PDS IMG?
- Image Atlas
  - Web interface – https://pds-imaging.jpl.nasa.gov/search
  - Search service – https://pds-imaging.jpl.nasa.gov/solr
- Questions
- References

Accessing Your Planetary Image Data

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- *Questions*
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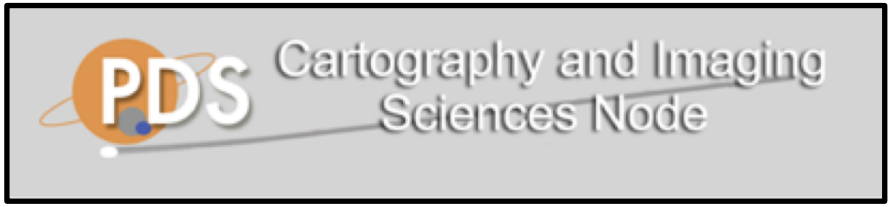
Overview



What is PDS IMG?

- Cartography and Imaging Sciences Node (IMG) of the NASA Planetary Data System (PDS)
- Home to over 700 TB of digital image archives
- Diverse collection of images
  - Orbital and landed missions
  - Original, raw experiment data and derived products
  - Differing coordinate systems
- Customers include both scientists and the space-enthusiast community
  - Cassini ISS team
  - Amateur image processing engineers

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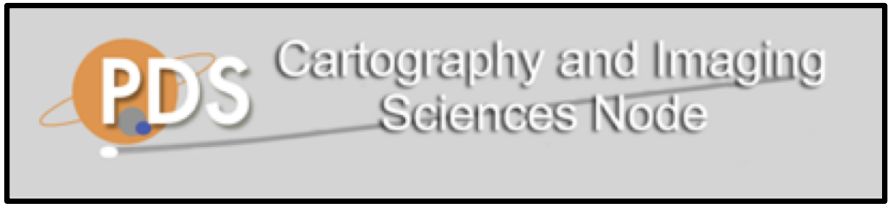

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Problem: how can we effectively and efficiently find the images we want?

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PDS Image Atlas

Perform a text search like "mars crater" or "cassini rings", or a more advanced search like "TARGET_NAME:enceladus"

Search

Show results for
(click to remove filter)

Share

Narrow your search by selecting a facet below

- Mission
  - 2001 mars odyssey (2649714)
  - cassini (903412)
  - chandrayaan-1 (21645)
  - clementine (1996197)
  - galileo (20123)
  - lcross (5308)
  - lunar orbiter (2991)
  - lunar reconnaissance orbiter (4120765)
  - magellan (72818)
  - mars exploration rover (6949475)
  - mars global surveyor (243227)
  - mars pathfinder (17899)
  - mars reconnaissance orbiter (1651653)
  - mars science laboratory (10461579)
  - messenger (1309800)
  - new horizons (15179)
  - phoenix (256433)
  - viking lander (6585)
  - viking orbiter (61693)
  - voyager (538538)
- Spacecraft
- Instrument
- Target
- Product Type
- Lighting Geometry
- Filters
- Lat/Lon Bounding Box
- Time Constraints
- Orbital Mission Constraints

Results: 24 Page:

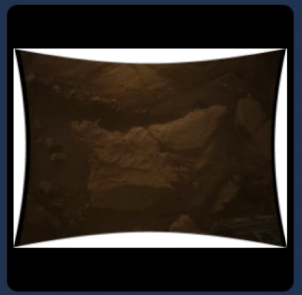
< 1 2 3 ... 1304376 1304377 > displaying 1 to 24 of 31305034

Grid View Sort View Add field to sort by: START_TIME Clear

Select All Images: On Page In Query

1869MD000754000020080OE01_DRCL

1869MD000754000020080OE01_DRCX



1869MD000754000020080OE01_DRLX

Image Atlas

Web Interface

- Intuitive user interface
- Autocomplete search bar
- Share your search
- Pop-up image viewer
- Interactive maps
- Download capability

Image Atlas

Web Interface

- **Intuitive user interface**
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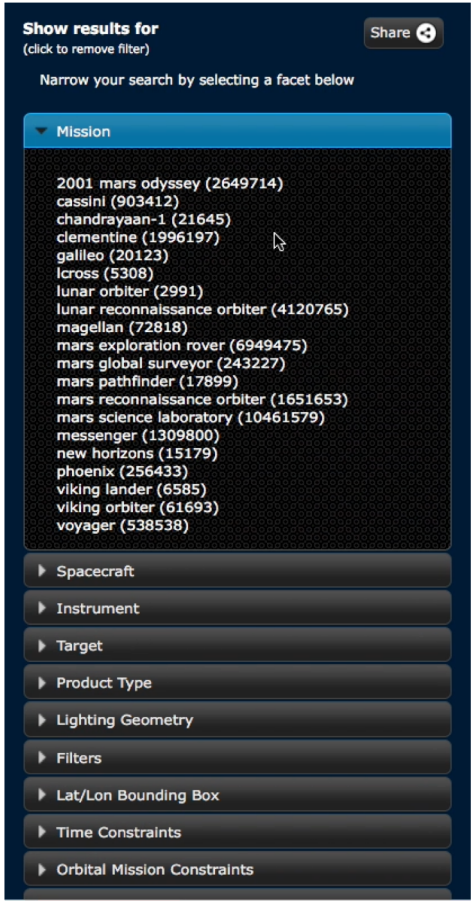
Image Atlas

Web Interface

- Intuitive user interface
  - Filter search results using PDS keyword constraints, including mission, instrument, target, product type
  - View image results as either grid or list with field values
  - Sort results by field values in either ascending or descending order



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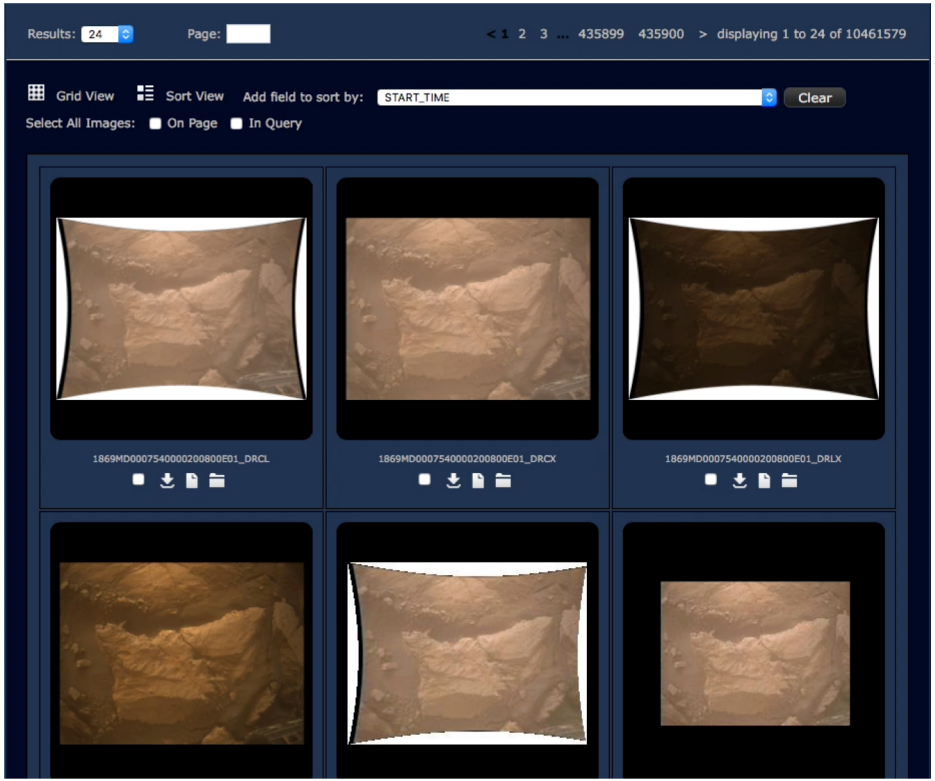

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Web Interface

- Intuitive search interface
- Autocomplete search bar
  - Supports free-text searching, such as “mars crater” or “cassini rings”
  - Also supports Lucene query syntax for more specific queries
    - `ATLAS_MISSION_NAME:“cassini” OR PRODUCT_TYPE:“edr” AND -TARGET:“mars”`
    - `START_TIME:[1999-02-14T00:00:00.000Z TO 2013-12-24T00:00:00.000Z}`

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Image Atlas: Web Interface

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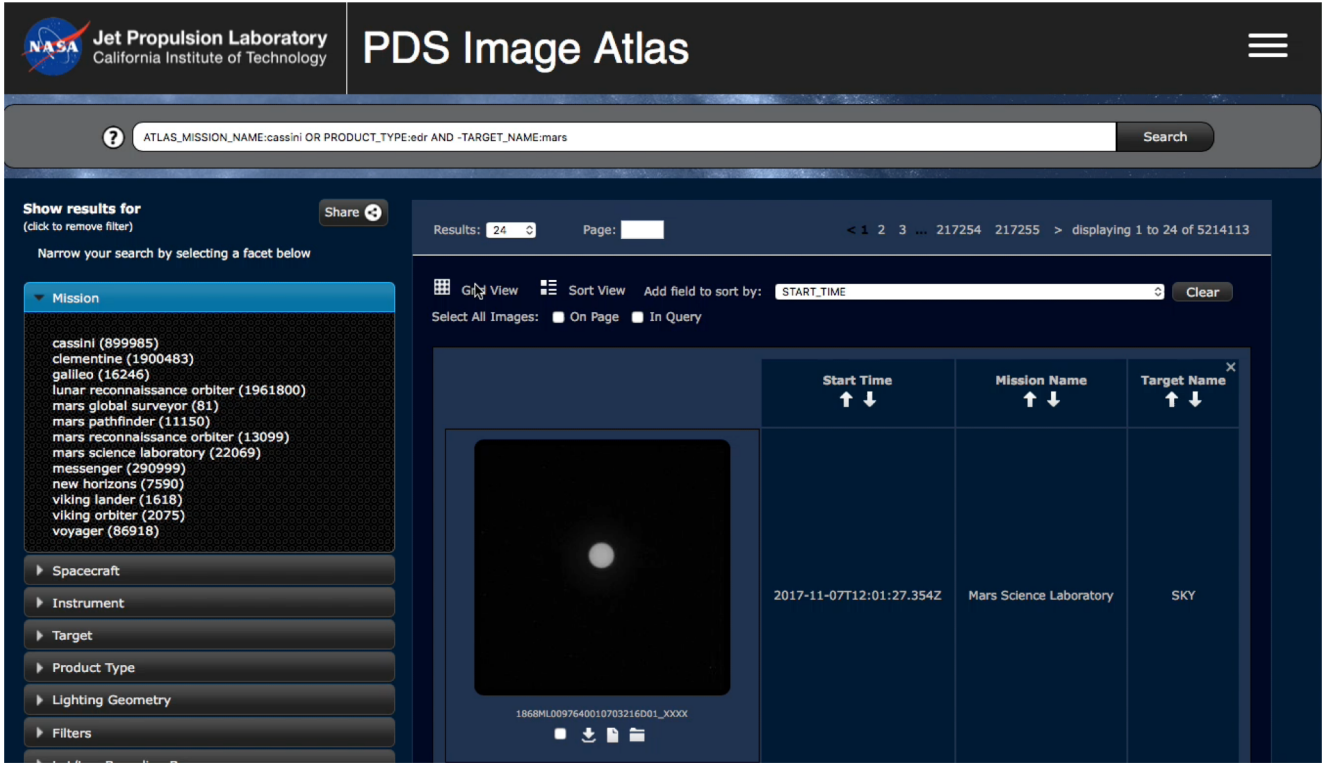

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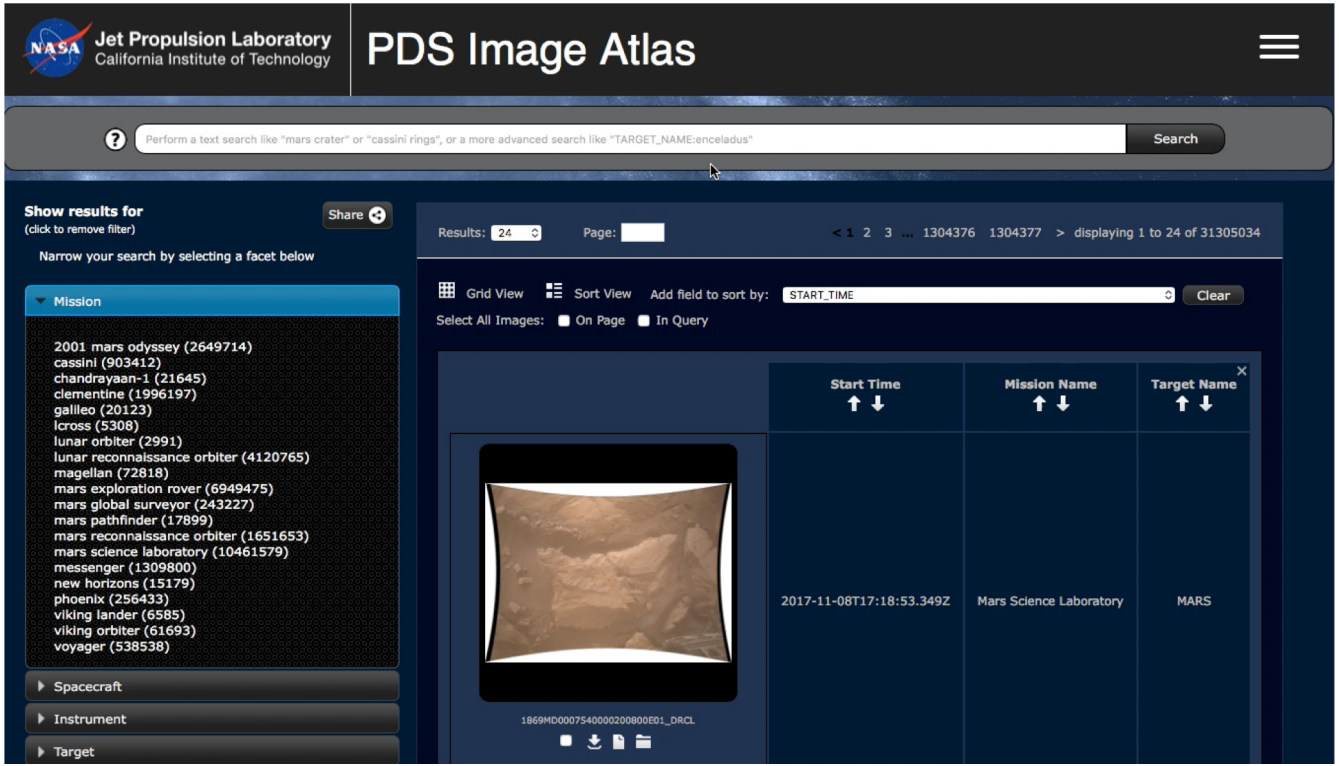

Image Atlas

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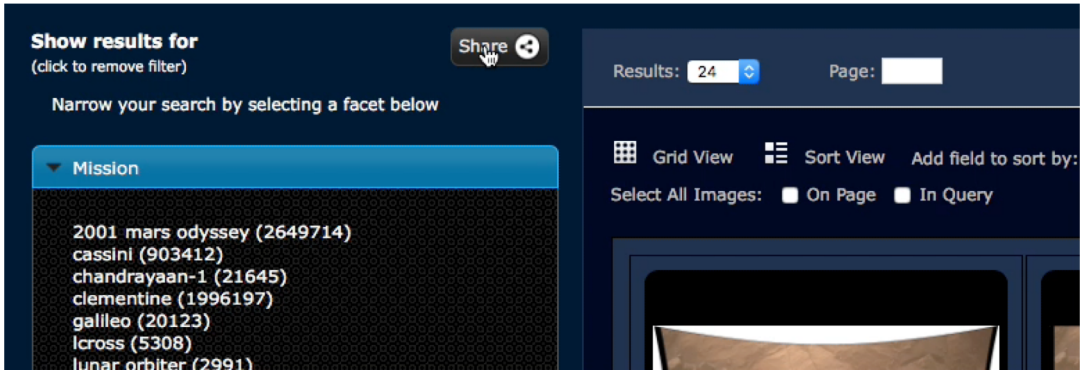

Image Atlas

Web Interface

- *Intuitive search interface*
- *Autocomplete search bar*
- *Share your search*
- **Pop-up image viewer**
  - **Dynamic range/histogram/stretch**
  - **Supplementary images**
  - **Downloading**
  - **Machine learning-enabled overlays**
- *Interactive maps*
- *Download capability*

Image Atlas

Web Interface

- Pop-up image viewer
  - Dynamic range/histogram/stretch
  - Supplementary images
  - Downloading

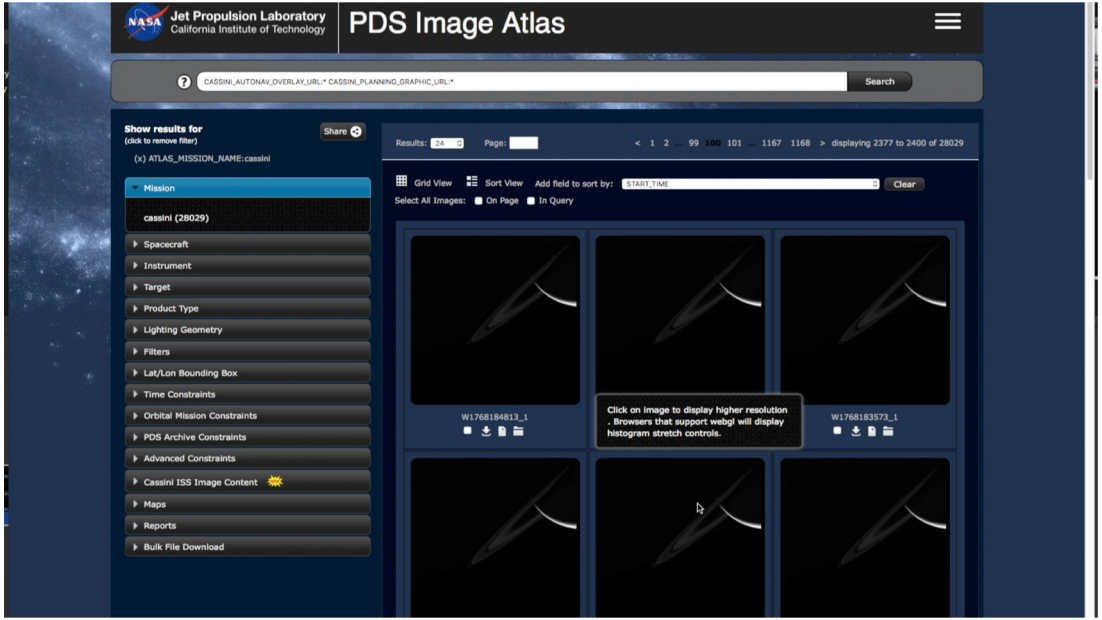

Image Atlas

Web Interface

- Pop-up image viewer
  - Machine learning-enabled overlays

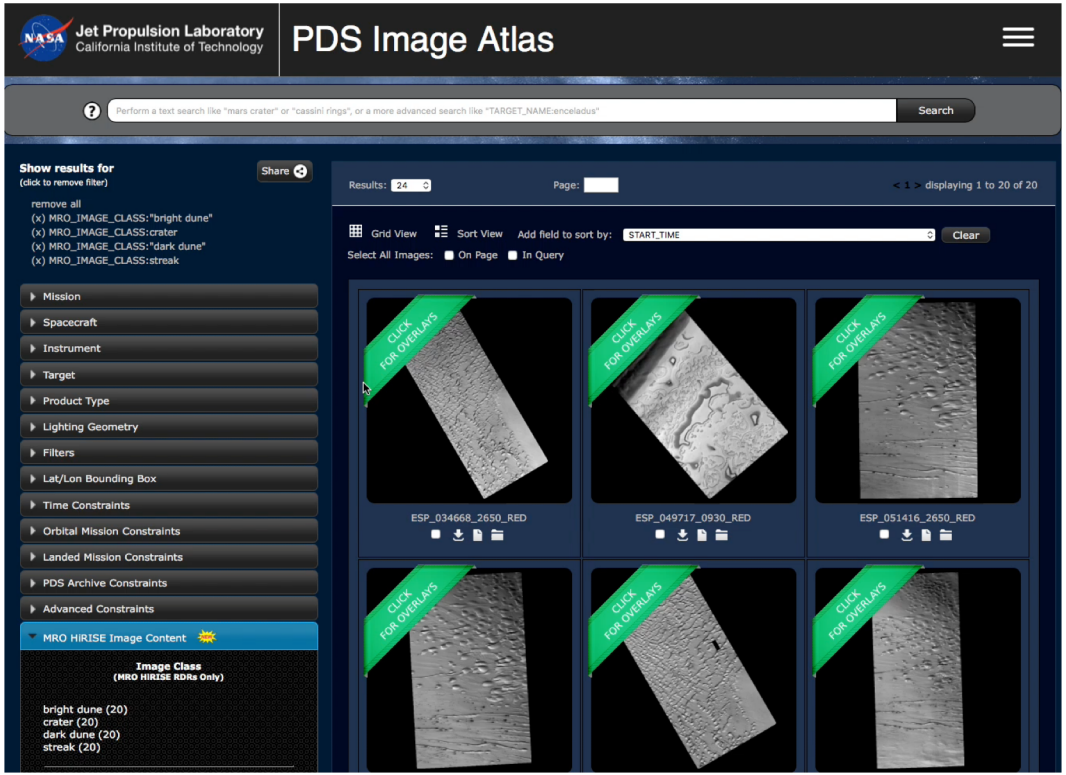

Image Atlas

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Image Atlas

Web Interface

- Interactive maps
  - Selection of latitude and longitude ranges
  - Available maps: Saturn's moons, Mars, Earth's moon

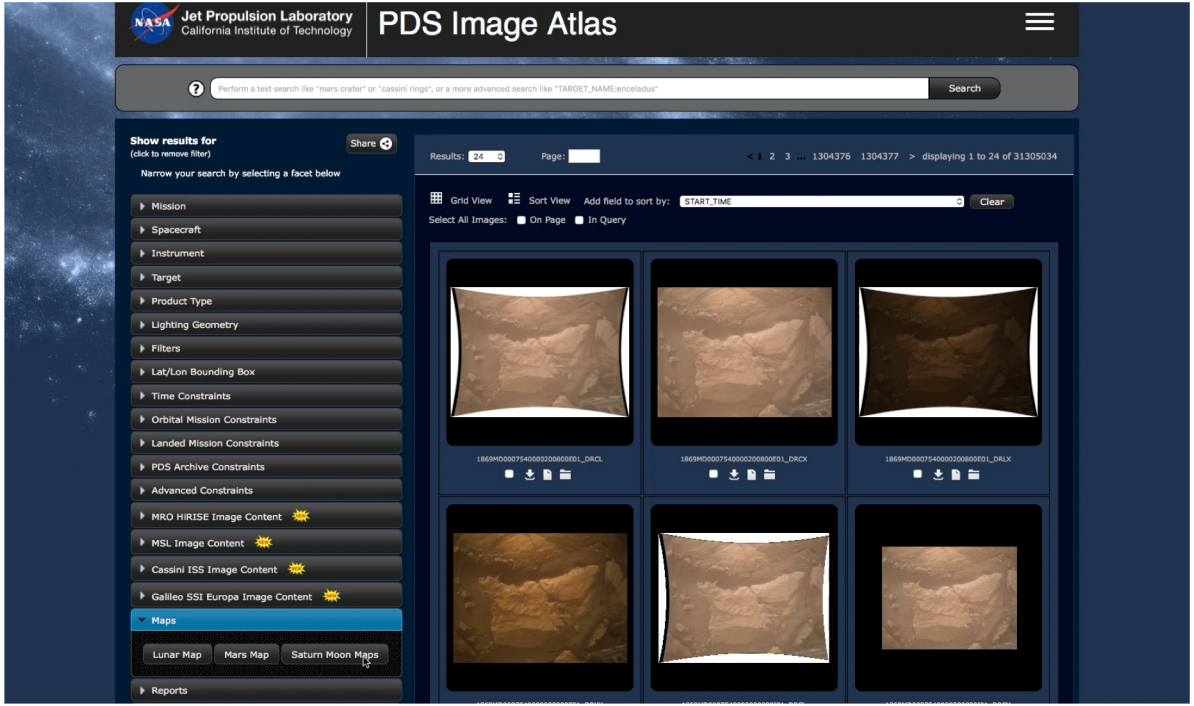

Image Atlas

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Image Atlas

Web Interface

- Download capability
  - Select individual images on page or all in query
  - Generates download script that can be run on macOS, Windows, and Linux
  - Downloaded products include the image and its PDS label
  - Other images may be downloaded as well for some products

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Image Atlas

Search Service

- Apache Solr Overview
- Configuration
- Sample Queries

Image Atlas

Search Service

- **Apache Solr Overview**
- *Configuration*
- *Sample Queries*

Image Atlas

Search Service

- Apache Solr Overview
  - Open source enterprise search platform
  - Requires a *schema* in which *fields* are defined of various *types*, such as *strings*, *multi-values* (arrays), and *floats*
  - A *data import* file maps data from an external source to fields in the schema
  - Powerful *faceting* functionality
  - Queries are made to Solr via its RESTful API
- Configuration
- Sample Queries

Image Atlas

Search Service

- *Apache Solr Overview*
- Configuration
  - Ingestion scripts
  - MySQL databases
  - Managed schema
  - Data Import files
  - Update processors
- *Sample Queries*

Image Atlas

Search Service

- *Apache Solr Overview*
- Configuration
  - **Ingestion scripts**
  - *MySQL databases*
  - *Managed schema*
  - *Data Import files*
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- *Sample Queries*

Image Atlas

Search Service Configuration

- Ingestion pipeline
  - Data is stored on disk at PDS IMG and elsewhere
  - The PDS labels of each image are parsed for image metadata
  - If applicable, raw images are converted to browser-friendly formats
  - Neural networks are run on some datasets, including MSL and Europa

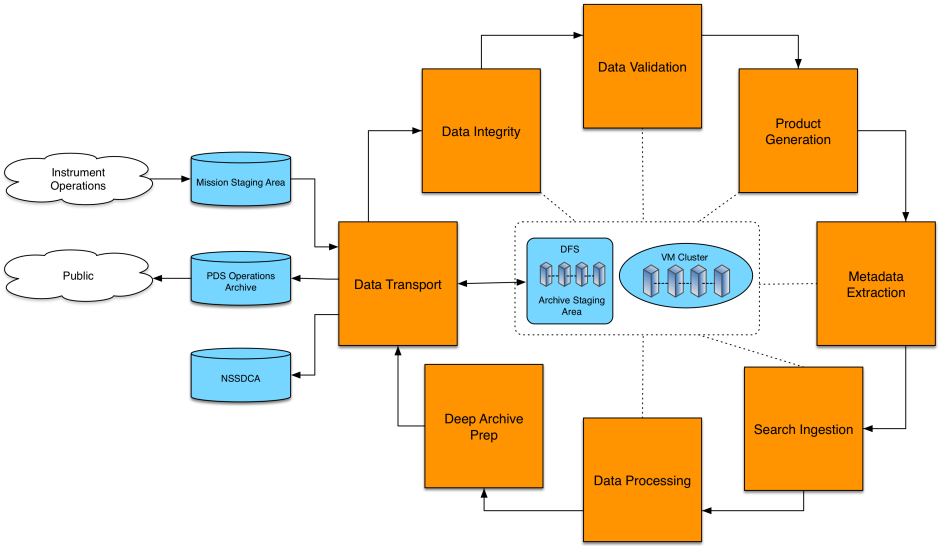

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Image Atlas

Search Service Configuration

- MySQL databases
  - Each data set is given its own database
  - Data within databases are broken into tables by instrument, product type, etc.
  - Additional neural network classification information is appended to tables as relevant

Image Atlas

Search Service

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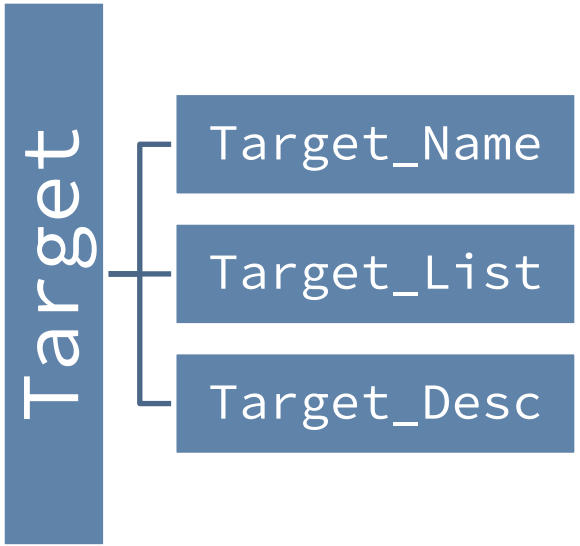
Image Atlas

Search Service Configuration

- Managed schema
  - XML file listing PDS keywords as *fields*
  - *Copy fields* allow individual fields to represent multiple fields



Example. A query for field `Target` *will search the* `Target_Name`, `Target_List`, *and* `Target_Desc` *fields of image metadata.*

Image Atlas

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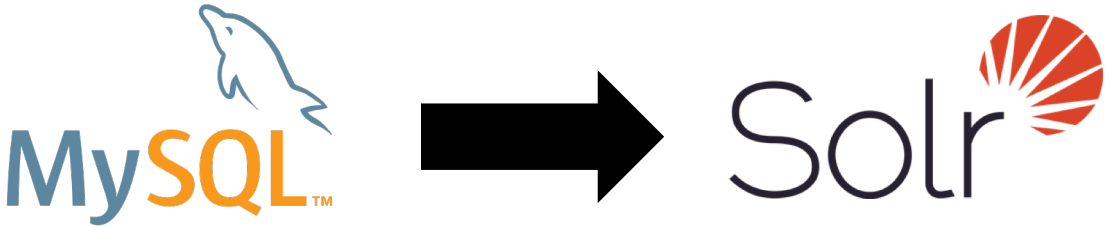
Image Atlas

Search Service Configuration

- Data import files



Provide mapping from PDS keywords in MySQL data source to fields in Solr schema

Image Atlas

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- *Sample Queries*

Image Atlas

Search Service Configuration

- Update processors
  - Run code before modifications are made to the index
  - Can be implemented in Java, Python (via Jython), and many other languages
  - Useful for sanitizing/amending documents before they are added to the index, e.g.:
    - Converting all times to conform to ISO-8601
    - Removing quotation marks around values
    - Removing trailing/leading whitespace

Image Atlas

Search Service

- *Apache Solr Overview*
- *Configuration*
- **Sample Queries**

Image Atlas

Search Service Sample queries

- Request 100 images in JSON format
  - `https://pds-imaging.jpl.nasa.gov/solr/pds_archives/select?q=*:*&rows=100&wt=json`
  - `q=*:*`, queries for all data
  - `rows=100`, limits the number of images returned to 100
  - `wt=json`, requests response in JSON

Image Atlas

Search Service Sample queries

- Request all the different product types for Cassini mission data
  - `https://pds-imaging.jpl.nasa.gov/solr/pds_archives/select?q=ATLAS_MISSION_NAME:cassini&facet=true&facet.field=PRODUCT_TYPE&wt=json`
  - `q=ATLAS_MISSION_NAME:cassini`, queries for only Cassini mission data
  - `facet=true`, turns on faceting
  - `facet.field=PRODUCT_TYPE`, requests all the different values (“constraints”) for `PRODUCT_TYPE` among Cassini mission data

Image Atlas

Search Service Sample queries

- Request all images taken during the Mars Science Laboratory mission from spacecraft clock counts greater than or equal to 397,000,000 that contain wheels in them
  - `https://pds-imaging.jpl.nasa.gov/solr/pds_archives/select?q=ATLAS_MISSION_NAME:“mars science laboratory” AND SPACECRAFT_CLOCK:[397000000 TO *] AND MSL_IMAGE_CLASS:wheel`
  - `q=ATLAS_MISSION_NAME:“mars science laboratory” AND SPACECRAFT_CLOCK:[397000000 TO *]`, queries for all data taken by MSL in the specified timeframe with wheels in the frame

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References

Content

- NASA Planetary Data System: https://pds.nasa.gov/
- PDS Imaging Node: https://pds-imaging.jpl.nasa.gov/
- NASA: https://nasa.gov/
- Apache Solr: http://lucene.apache.org/solr/
- Image Atlas: https://pds-imaging.jpl.nasa.gov/search/

Image Credits

- Slides 4, 5: “NASA Planetary Data System”. https://pds-imaging.jpl.nasa.gov/
- Slide 29, 38: “Apache Solr”. http://lucene.apache.org/solr/
- Slide 32: ”PDS Archiving Pipeline” – JPL proprietary. https://jpl.nasa.gov/
- Slides 34, 38: “MySQL”. https://oracle.com/mysql/

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Backup

- Webification (w10n)
- Servicification (serv10n)

Backup

- **Webification (w10n)**
- *Servicification (serv10n)*

Webification (w10n)

https://ammos.jpl.nasa.gov

- Multi-mission technology that enables piecewise retrieval of components of data products via a RESTful API
- Subsets of raw raster data can retrieved directly from the source, eliminating the need to download the entire original product
  - Saves bandwidth
  - Reduces download time
- Additional server-side operations are supported
  - PDS/VICAR to GIF conversion
  - Cropping and resizing
- No software for clients to install

Backup

- *Webification (w10n)*
- **Servicification (serv10n)**

Servicification (serv10n)

https://ammos.jpl.nasa.gov

- Multi-mission technology that allows applications (“tools”) installed on remote hosts to be executed over a network via a RESTful API
- “REST API wrapper”
- Implementation exists in Tools Service
- Tool support
  - Command line executables
    - systemctl
    - apt-get
  - Java classes
    - ImageIO
- A&A
- No software for clients to install

Webification (w10n) & Servicification (serv10n)

https://ammos.jpl.nasa.gov

- PDS IMG usage
  - Perform run-time conversion of raw image files to browser-friendly equivalents in different formats (e.g. GIF)
  - GIFs are used by image stretching/filtering/histogram software (JPLFX)
- For more information
  - Visit: https://ammos.jpl.nasa.gov
  - E-mail: ammos_info@jpl.nasa.gov
  - Phone: 818-393-0686

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