

# Introducing the Ring-Moon Systems Node

## Data

Cassini → 2020  
derived  
 OCC support

## "Ring Moon Systems"

- Audio tracking?

PDART - HST → JWST **PDS4**

Specific ground-based

→ Mike, ... Keck

→ Help from SBN?

Centaur!

PDS4 migration  
 (on-the-fly)

## Services

OPUS  
 Indexing & Search

(Cassini)  
 JPL

## Data Pipelines

HST - JWST

CIRS reformatting.  
 Restorations ← Galileo, Pioneer <sup>-SSI</sup>

## Derived products

(PPAP) COISS calib  
 (CDAPS) VCOISS calib

(CDAPS) SPICE regeneration (Rdb)  
 Metadata - VSP, Galileo, IRIS, RSSOCCS

Viewer tools - upgrades

Movies

Mosaic

Auto-Mosaicking

OLAF support  
 & enhancement

## PDS4!

What do we suck at?

Web design!

- Content management

- Disaster Recovery  
 Amazon cloud?

- NSSDC

OPUS ↔ PDS4  
 updates  
 sharing

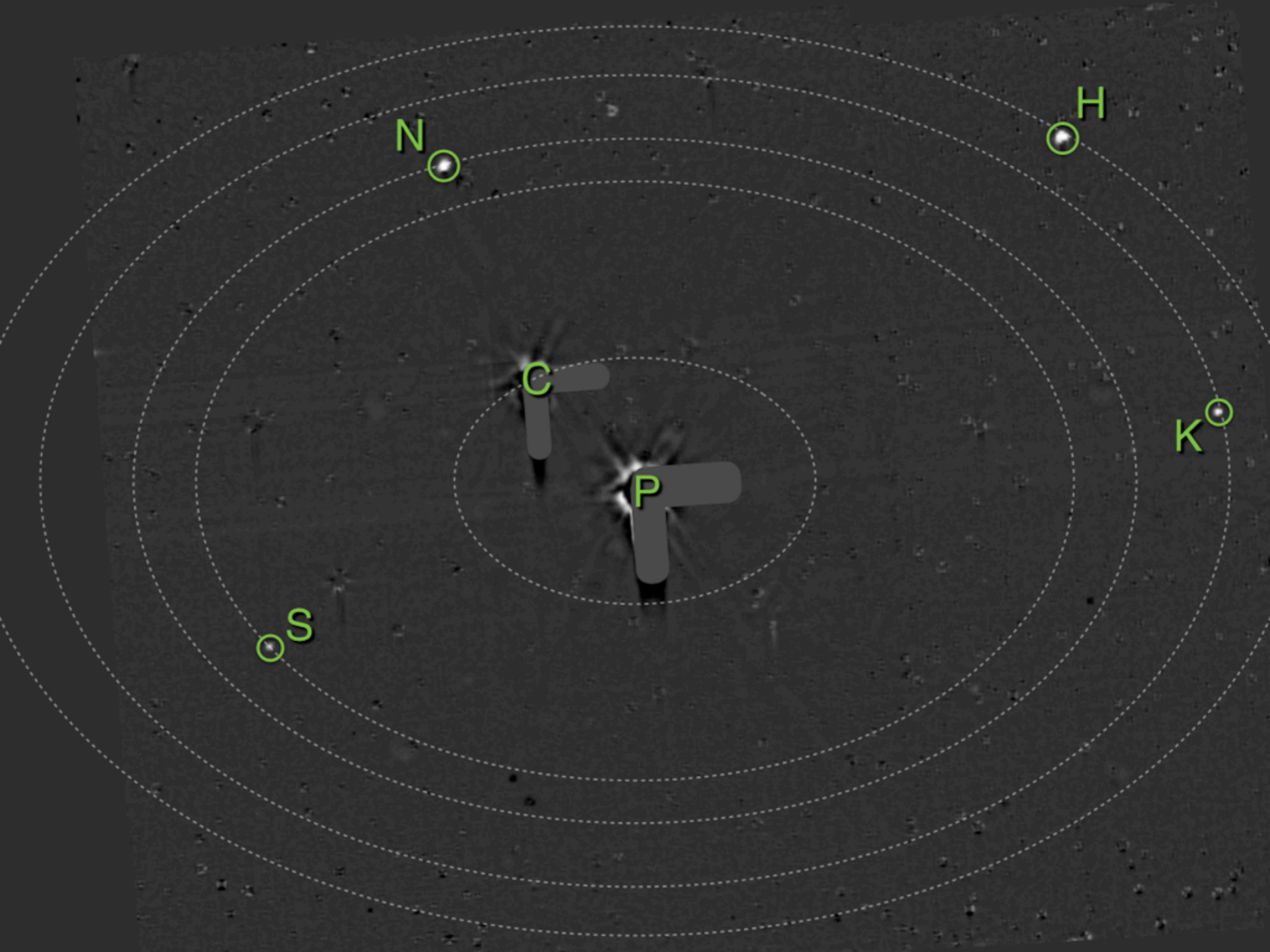
Self promotion

Tool maintenance

RESTFUL

API

# How I Spent My Summer Vacation



**N**



**H**



**C**



**P**



**K**



**S**

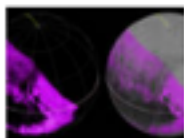






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16 days ago



Pluto's Incredible Diversity of Surface Reflectivities and...  
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Women Make Up Approximately 25 Percent of the New...  
2 months ago

Solar System and Beyond

July 1, 2015

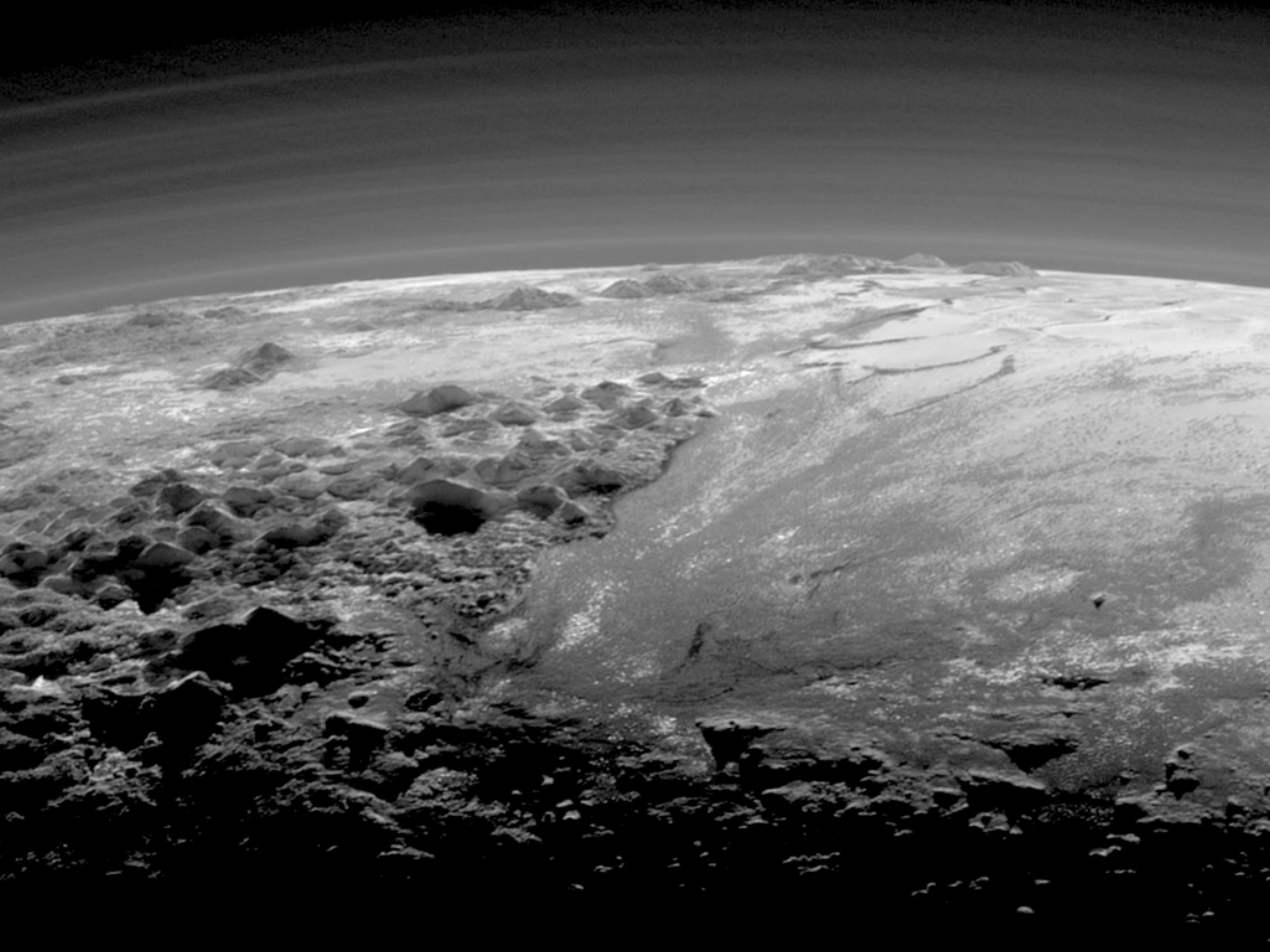
# Styx Meets Styx

Legendary Band Starstruck by NASA's New Horizons Team



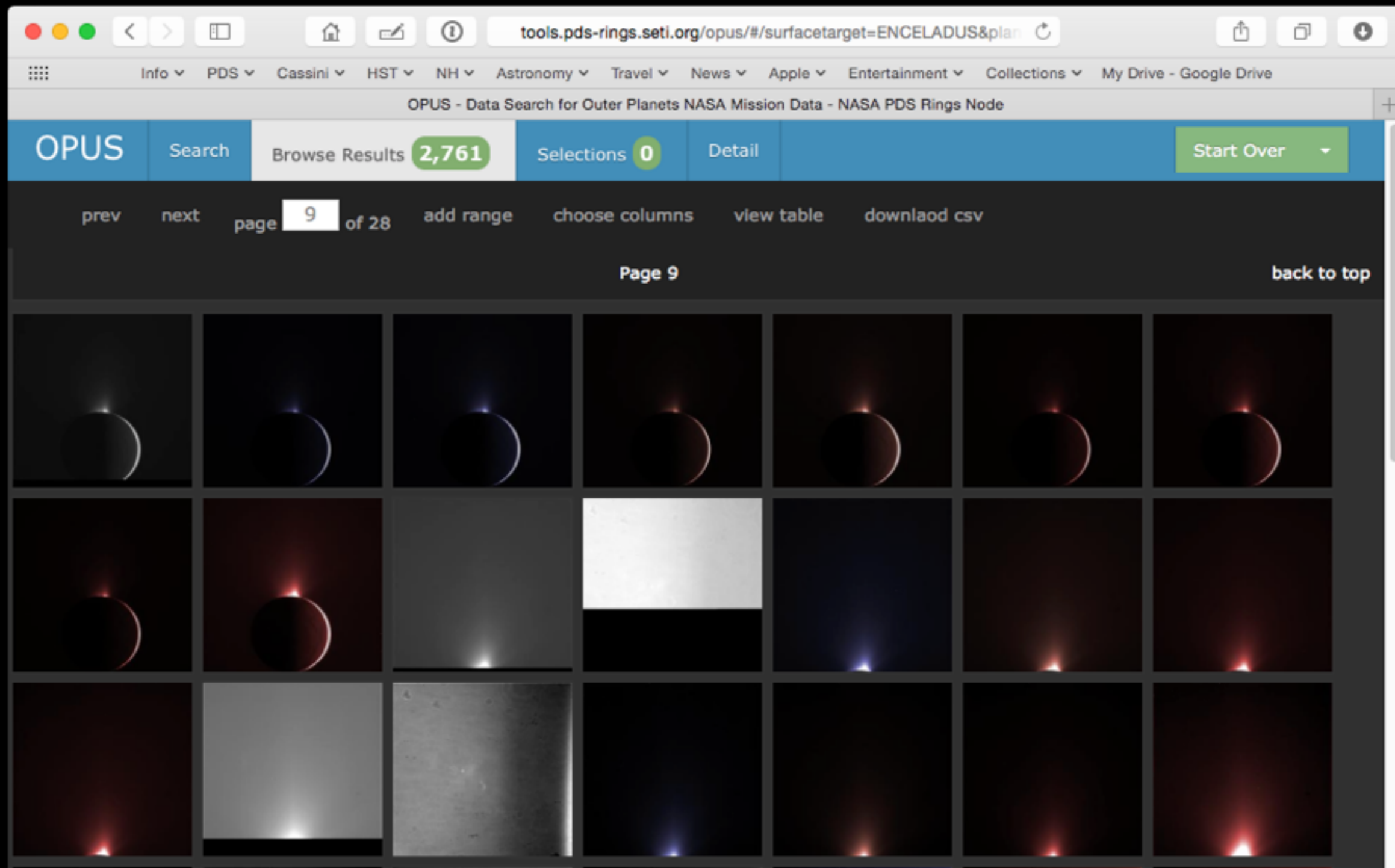
Styx band members share laughs with the scientist who discovered Styx, Pluto's moon. Left to right: Lawrence Gowan, Tommy Shaw, New Horizons' Mark Showalter, and Todd Sucherman  
Credits: NASA/Joel Kowsky

What do a classic rock band and Pluto's smallest moon have in common? Answer: they both share the same name.



# Why the Name Change?

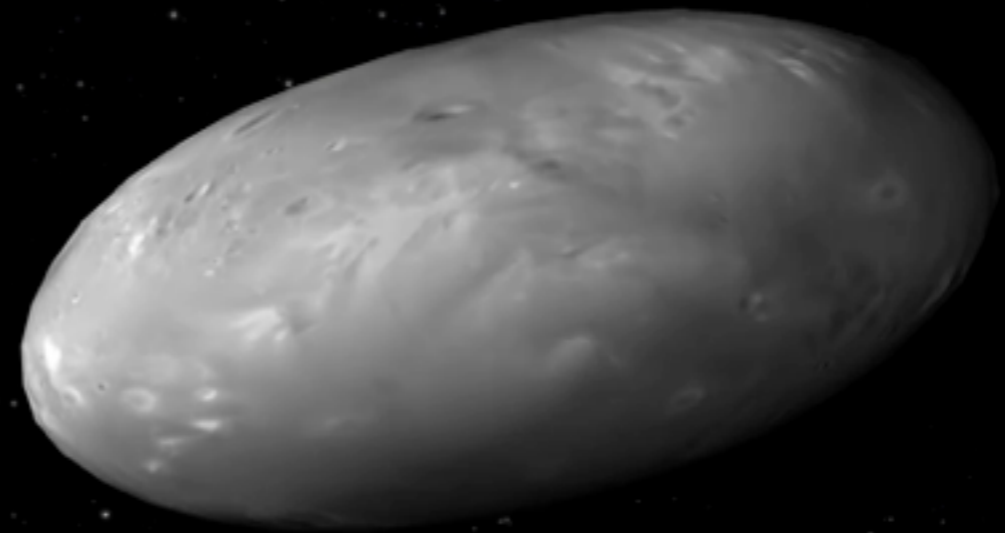
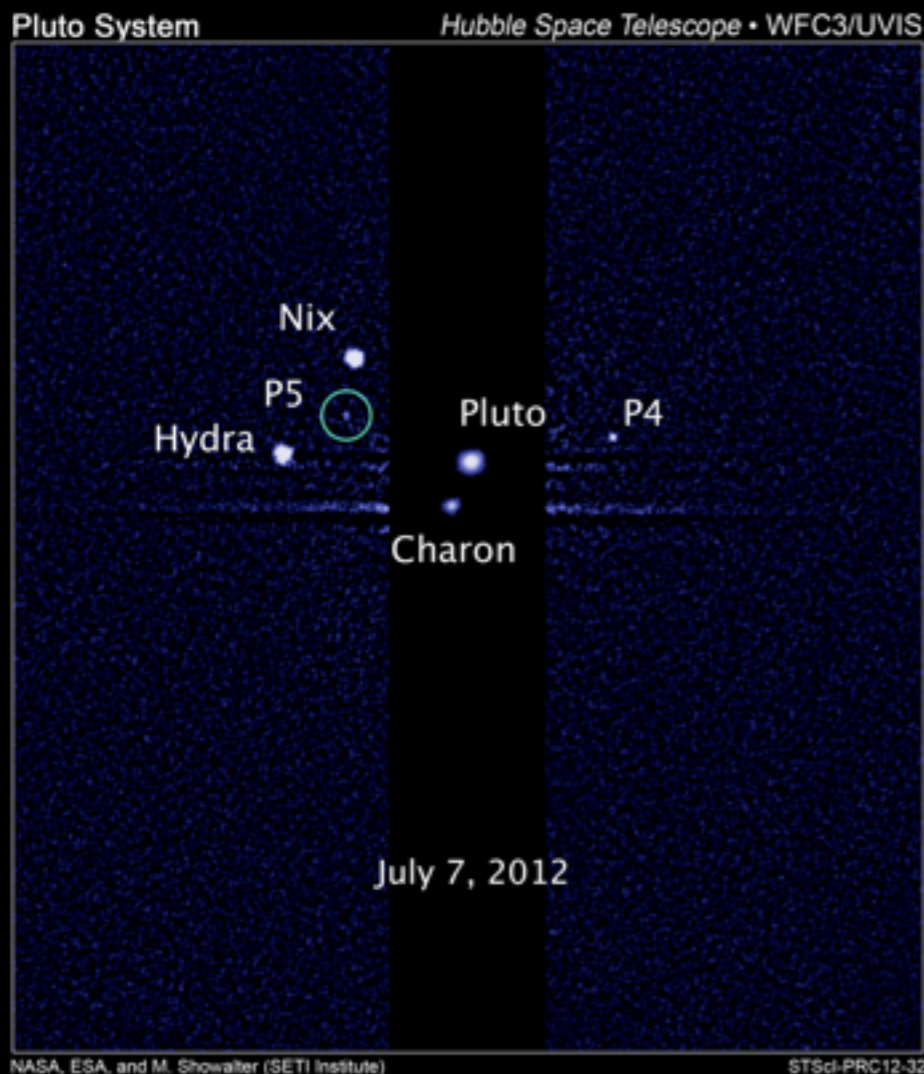
- So users understand why we can help them find images of Enceladus (for example).



The screenshot displays a web browser window with the URL `tools.pds-rings.seti.org/opus/#/surfacetarget=ENCELADUS&plan`. The page title is "OPUS - Data Search for Outer Planets NASA Mission Data - NASA PDS Rings Node". The interface includes a navigation bar with "OPUS", "Search", "Browse Results 2,761", "Selections 0", and "Detail". A "Start Over" button is visible in the top right. Below the navigation bar, there are controls for "prev", "next", "page 9 of 28", "add range", "choose columns", "view table", and "download csv". The main content area shows a grid of image thumbnails, with "Page 9" and a "back to top" link. The thumbnails consist of a 3x7 grid of small images, many of which show the crescent ring of Enceladus against a dark background, with some showing surface details.

# Why the Name Change?

- To provide a clear entry point to the PDS for planetary dynamicists.



## Planetary Rings Node

### Satellite Astrometry

The table below contains links to all of the available astrometric volumes and will be updated as new volumes are released. Satellites are identified by their NAIF IDs. A table of [NAIF IDs](#) for the inner Saturnian satellites is provided at the bottom of the page.

- Clicking on the VOLUME\_ID will allow you to browse the volume.
- To download an entire volume, right click on that volume's "Bundled" link in the second column.

The bundled volumes are provided in .tar.gz format. For information on opening files of this type, click [here](#).

### Saturn Satellite Astrometry

Volume	Bundle	Coverage Dates (UTC)	Satellites included (NAIF ID)
		1994-	



# How Will the Ring-Moons Systems Node Fit?

- Our work complements that of the other Discipline Nodes:
  - We focus on multi-target missions and instruments. (Generally not mappers, generally not *in situ* data.)
  - We care about where bodies are and how they move, but not so much what they look like.
  - We are beginning a PDART-supported effort to bring the HST archive of Solar System data into the PDS4 system.
    - In effect, we are becoming the “lead node” for HST.



# Potential Overlaps and Synergies

- Mars: We might play a more active role in Phobos and Deimos data.
- Small Bodies:
  - We can point to the SBN for general information about asteroid dynamics.
    - This is not within our scope but dynamicists may expect otherwise.
  - Our users are interested in data related to the rings and moons of small bodies. This can also be accomplished by pointing to SBN holdings.
    - Metadata and OPUS support will be considered.
  - We are very interested in the Pluto system.
    - For our purposes, New Horizons is a Voyager-like data set.
    - The Pluto system serves as an archetype for circumbinary planets.
    - Numerous astrometric and ring/moon search data sets also exist.
- Everybody:
  - Our metadata initiative can support multiple disciplines, both imaging and non-imaging data sets.

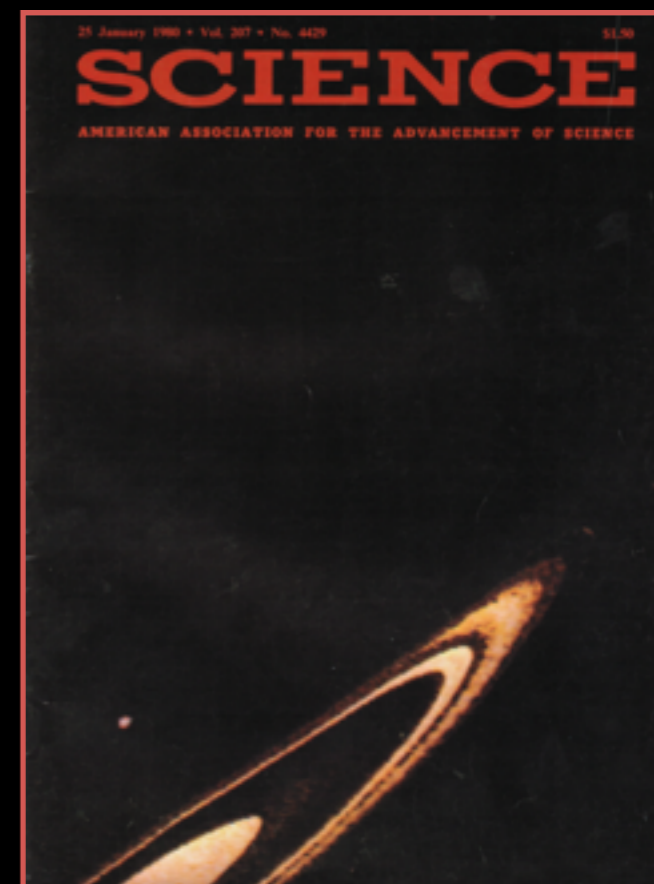
# Missions & Data Sets

## • Today

- Cassini
  - ISS raw & calibrated
  - UVIS
  - VIMS
  - Occultations
  - (CIRS)
- New Horizons LORRI
- Voyager ISS
- Galileo SSI
- HST outer planets
  - WFPC2, ACS, WFC3, NICMOS
- Astrometry

## • Planned

- Cassini
  - CIRS interferograms, derived maps
  - More occultations
- New Horizons MVIC/LEISA
- Voyager IRIS
- HST (everything in the solar system)
- Pioneer 10 & 11 IPP →
- Earth-based...
  - Images
  - Occultations
  - Astrometry
- On-the-fly migration!



# HST-PDS Interface Project

- “Integrating Hubble Data Sets into the Planetary Data System” was selected for PDART support
- PI: Showalter
- Co-Is: Gordon, Tiscareno, Kolokolova
- Collaborators: A’Hearn, Beebe, Chanover, Crichton, Gaddis, Jon Giorgini (for Hubble SPKs), Guinness, Hardman

# HST-PDS Interface Project

<b>Instrument</b>		<b>Image</b>	<b>Spectra</b>	<b>Other</b>
Advanced Camera for Surveys	ACS	3268	73	
Cosmic Origins Spectrograph	COS	65	97	
Fine Guidance Sensor	FGS			0*
Faint Object Camera	FOC	239	14	
Faint Object Spectrograph	FOS		1116	
Goddard High-Resolution Spectrograph	GHRS		873	
High-Speed Photometer	HSP			139*
Near Infrared Camera and Multi-Object	NICMOS	1475	79	
Space Telescope Imaging Spectrograph	STIS	1021	2941	
Wide Field Camera 3	WFC3	6388		
Wide-Field Planetary Camera 1	WF/	522		
Wide-Field Planetary Camera 2	WFPC2	11073		

# HST-PDS Interface Project

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Wide-Field Planetary Camera 2	WFPC2	11073		

# PDART Project Components

- Complete PDS4 integration including...
  - Raw & calibrated data.
  - Browse products.
  - Complete sets of SPICE kernels.
  - Target identifications.
  - Geometric metadata.
  - PDS-compliant versioning of products.
- Goal is to build an automated pipeline, which updates the PDS Registry with new MAST products nightly.
  - Work will be completed just in time for JWST!
- This effort will likely yield tools broadly useful across the PDS.
- The effort could become a significant driver behind PDS4 design and development.
- This is a holistic effort!

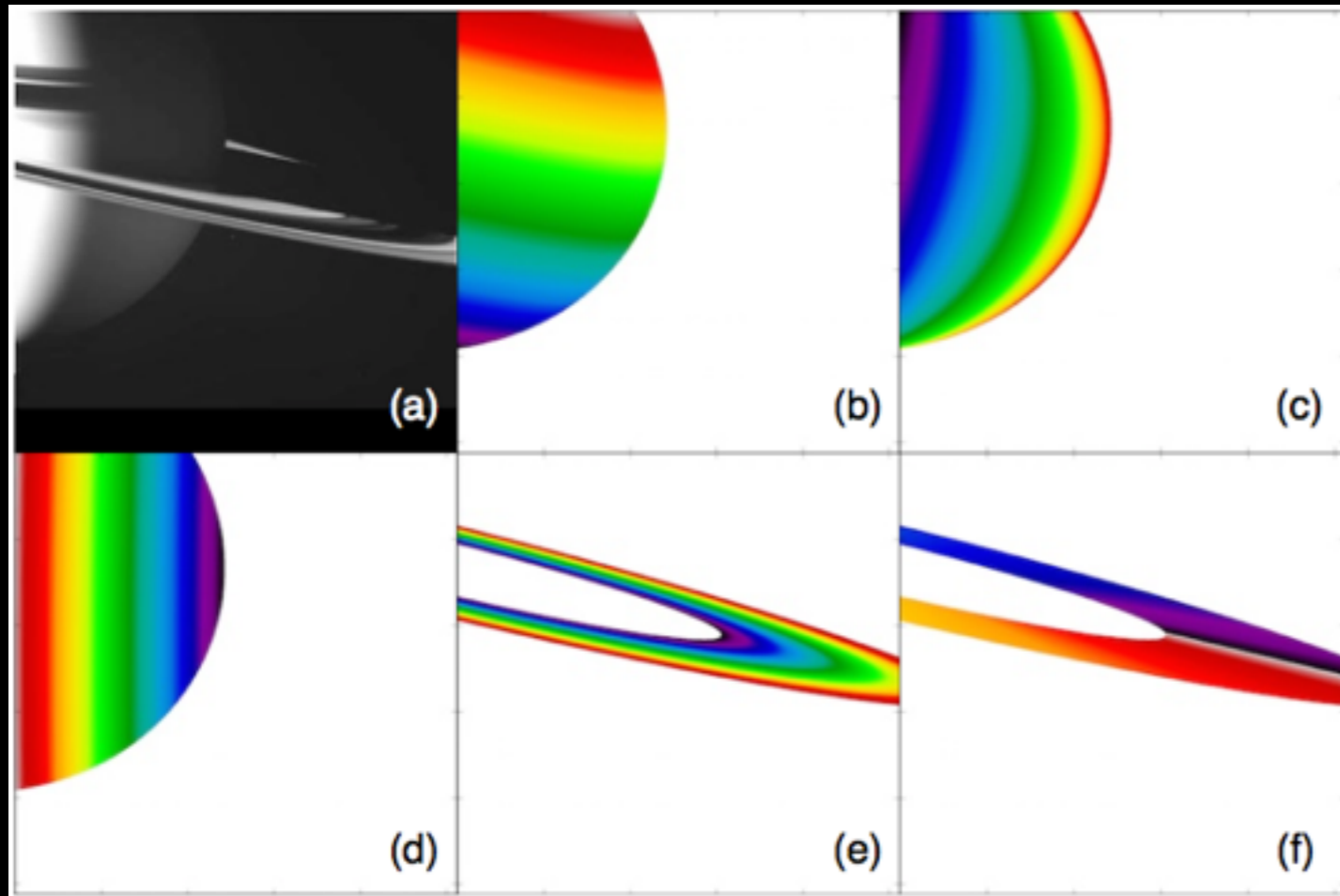
# Recent Experience with DAPs

- Our own HST effort is the of course the largest.
- One PI hired Mitch as a co-I.
- Others have received one-on-one tutorials.
  - These are relatively few in number so far.
  - Data sets are also relatively small so far.



# Metadata Initiative

## 1. Backplanes



ISS Image of Saturn  
and its rings

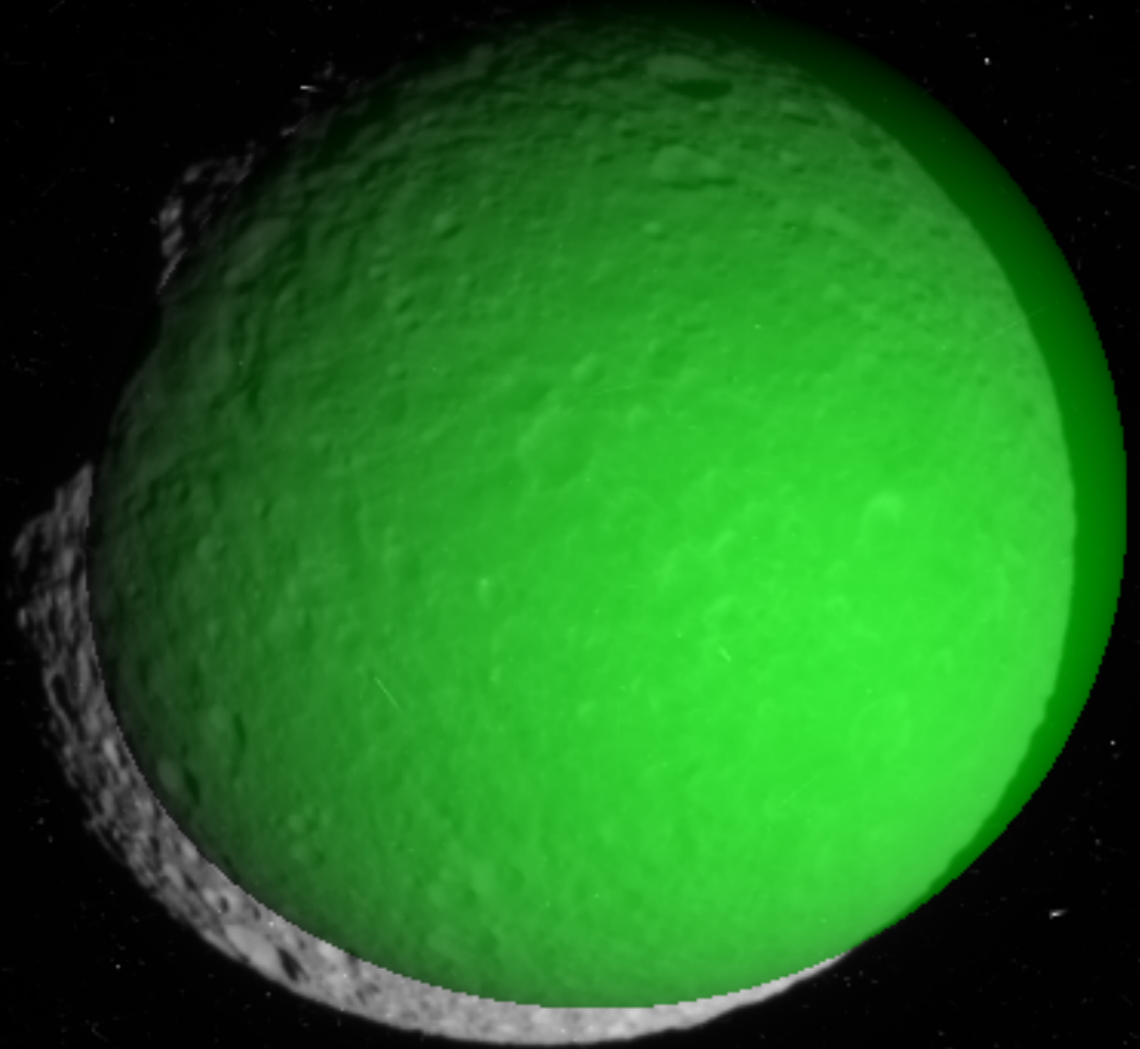
North-south UVIS  
scans across Saturn



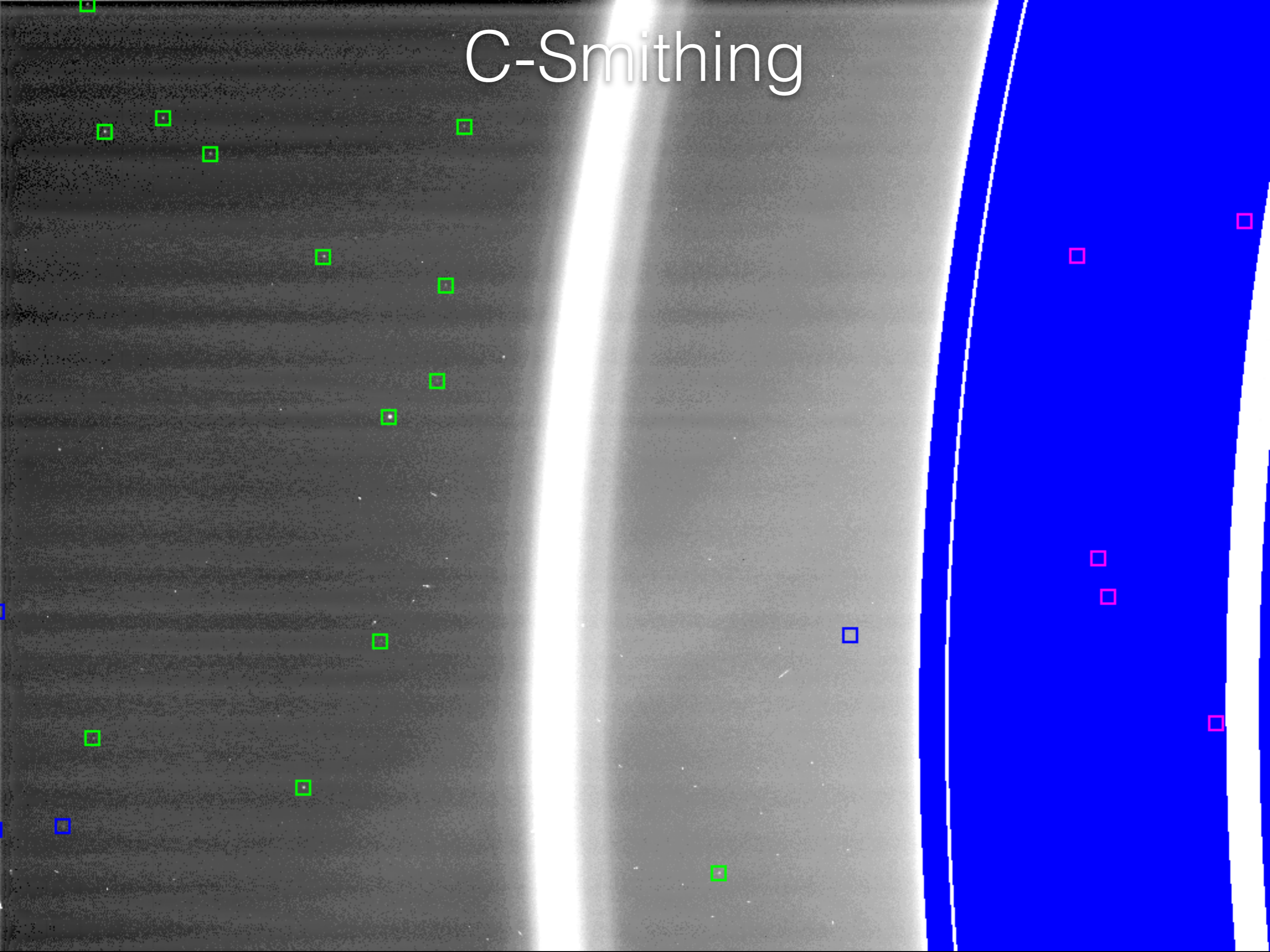
# Metadata Initiative

## 2. C-Smithing

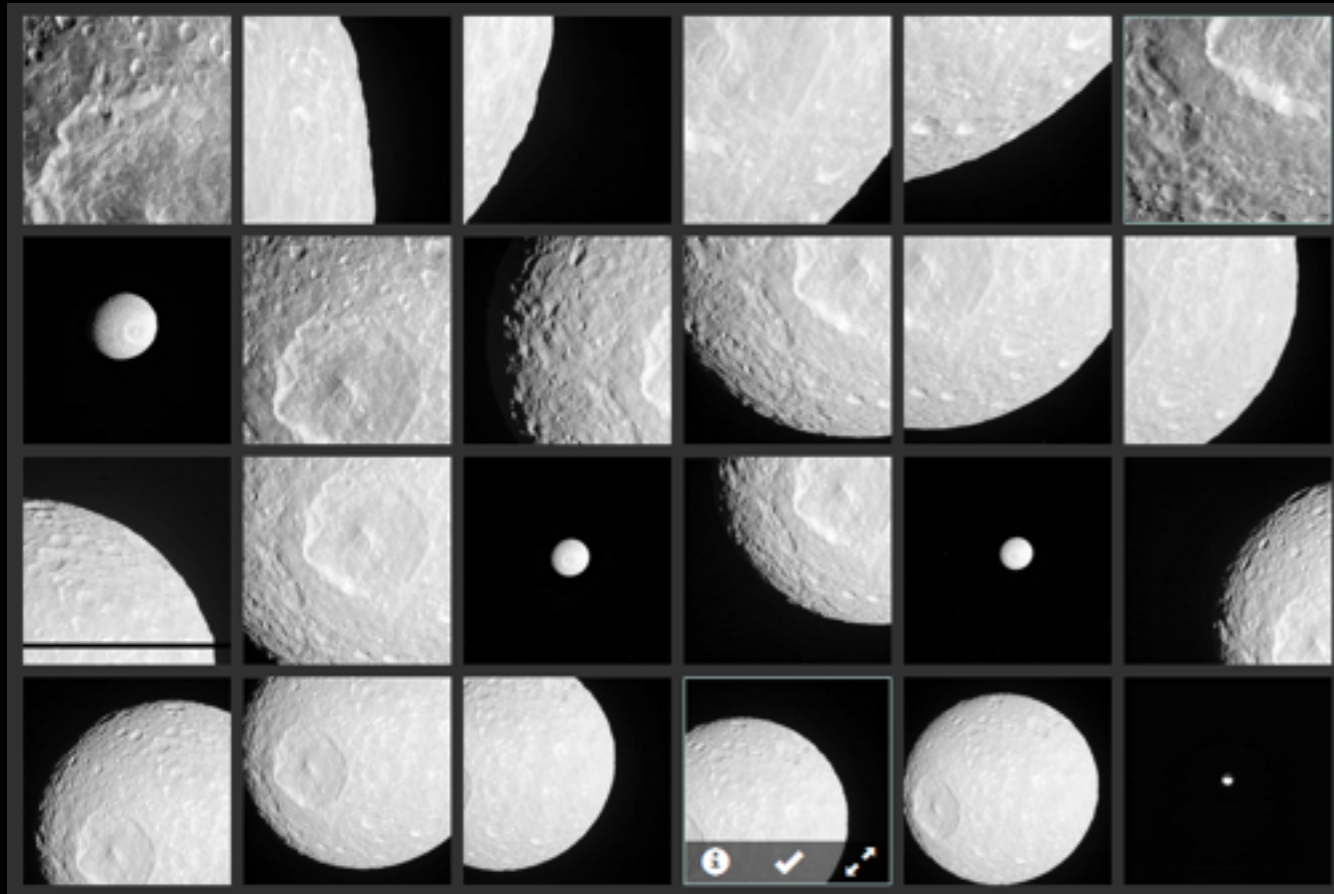
- Automated C-smithing
  - Currently in development under a CDAPS grant.
  - Could be extended to Voyager, Galileo, New Horizons, etc. upon completion.
  - Other Nodes may have additional applications.



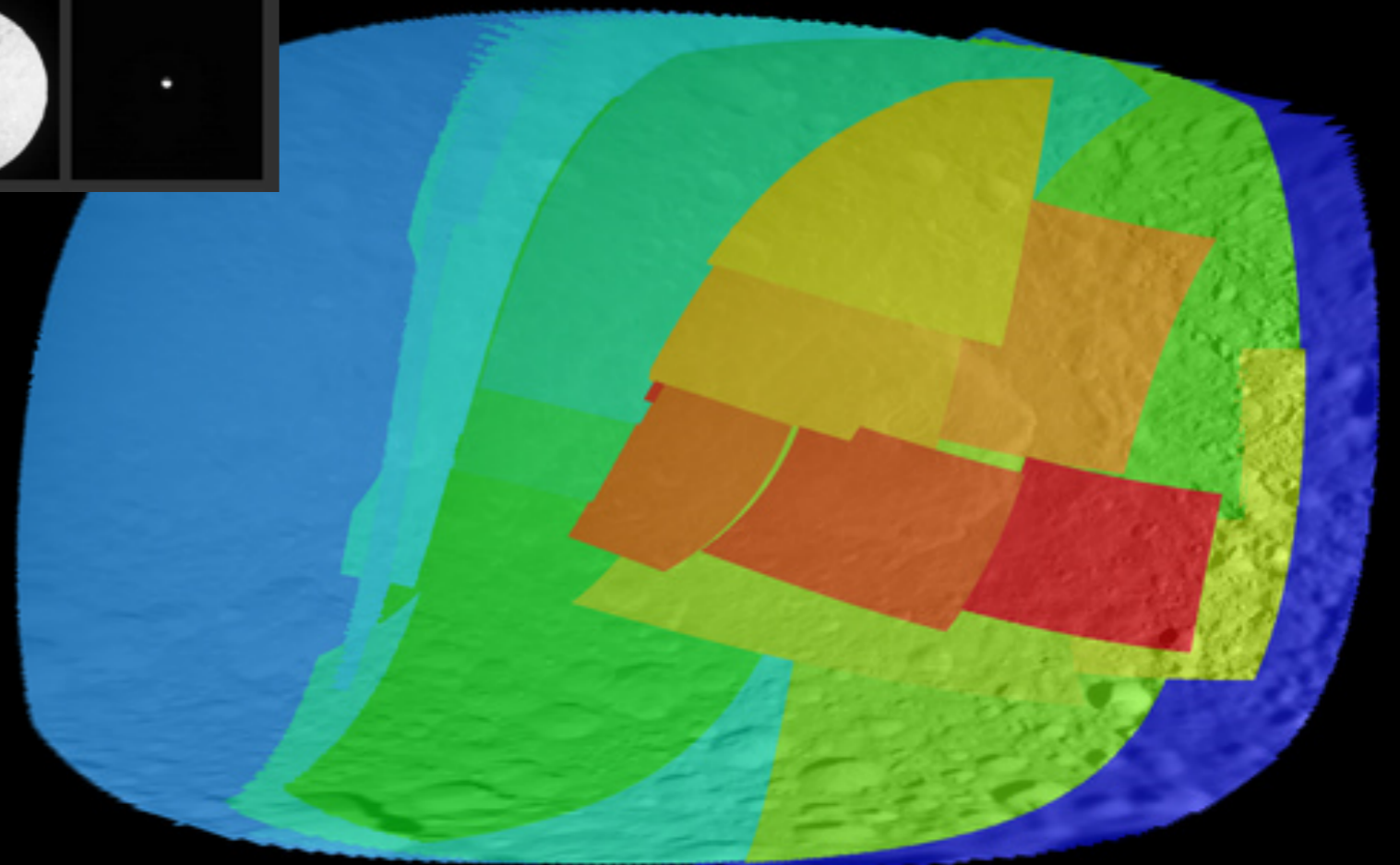
# C-Smithing



# C-Smithing



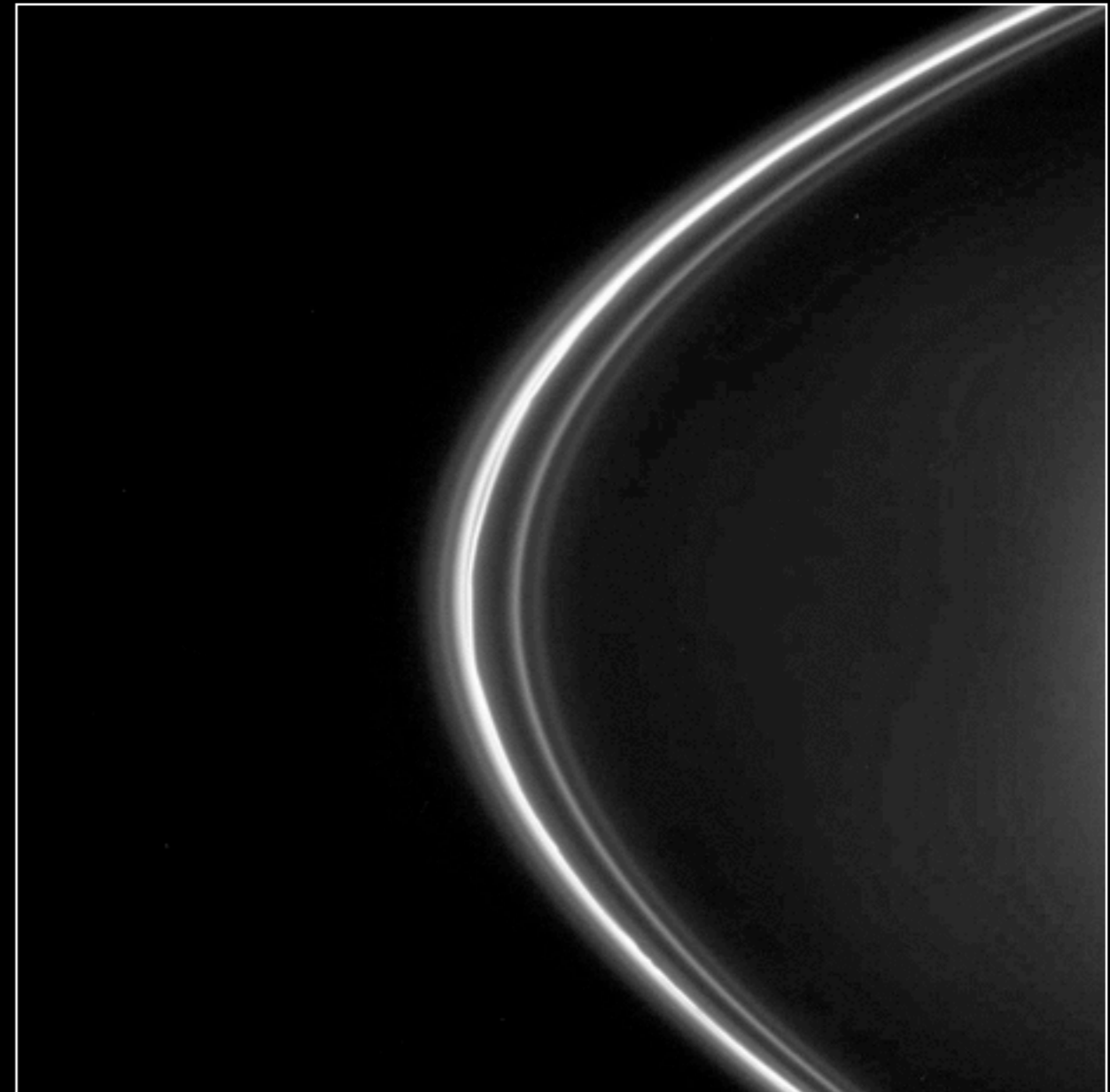
Mimas map and alignments  
constructed on-the-fly via  
“bootstrapping”



# Metadata Initiative

## 3. Composite Products

- Allow searches defined by relationships between products.
  - Movie sequences.



# Metadata Initiative

## 3. Composite Products

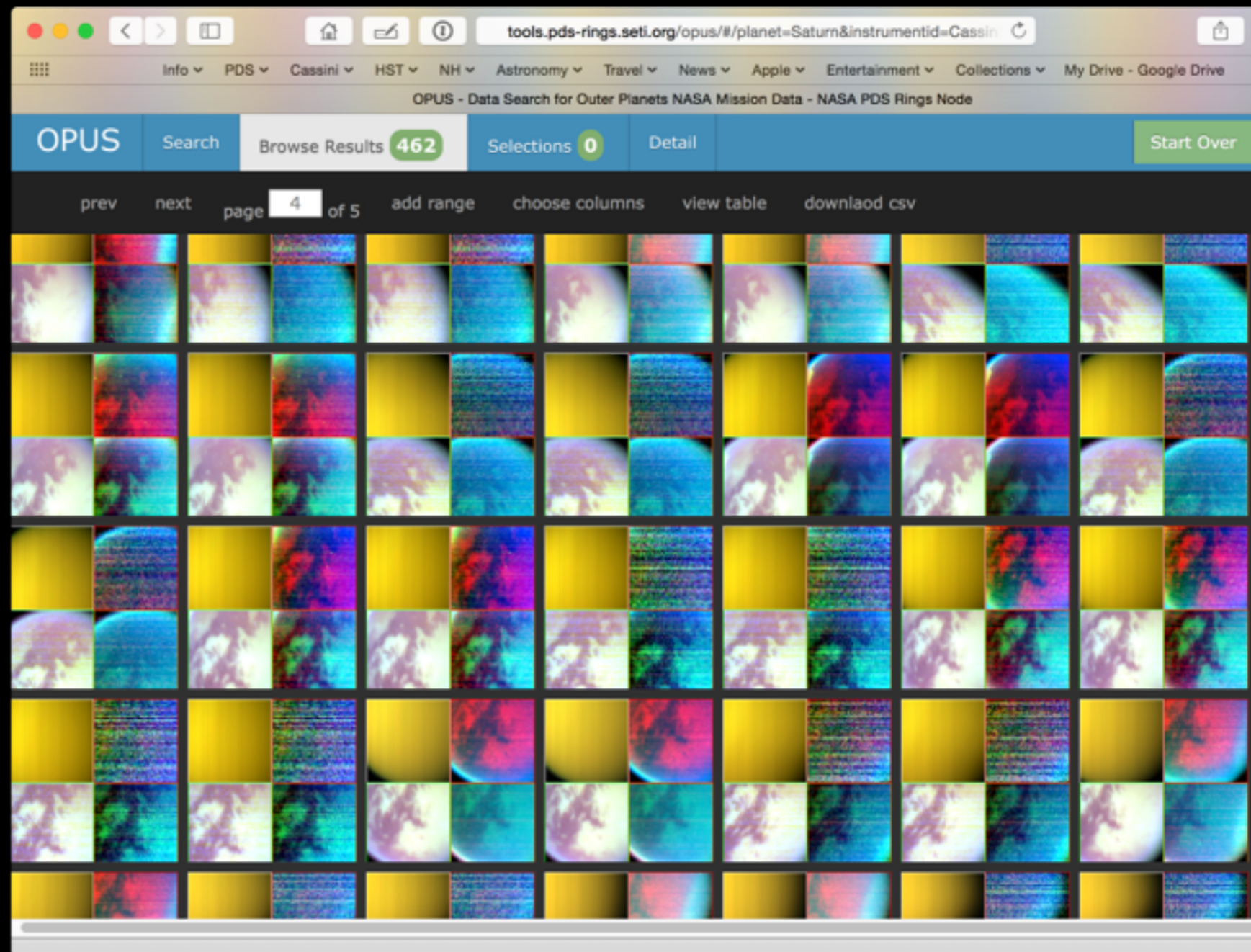
- Allow searches defined by relationships between products.
- Movie sequences.
- Color sets.



# Metadata Initiative

## 3. Composite Products

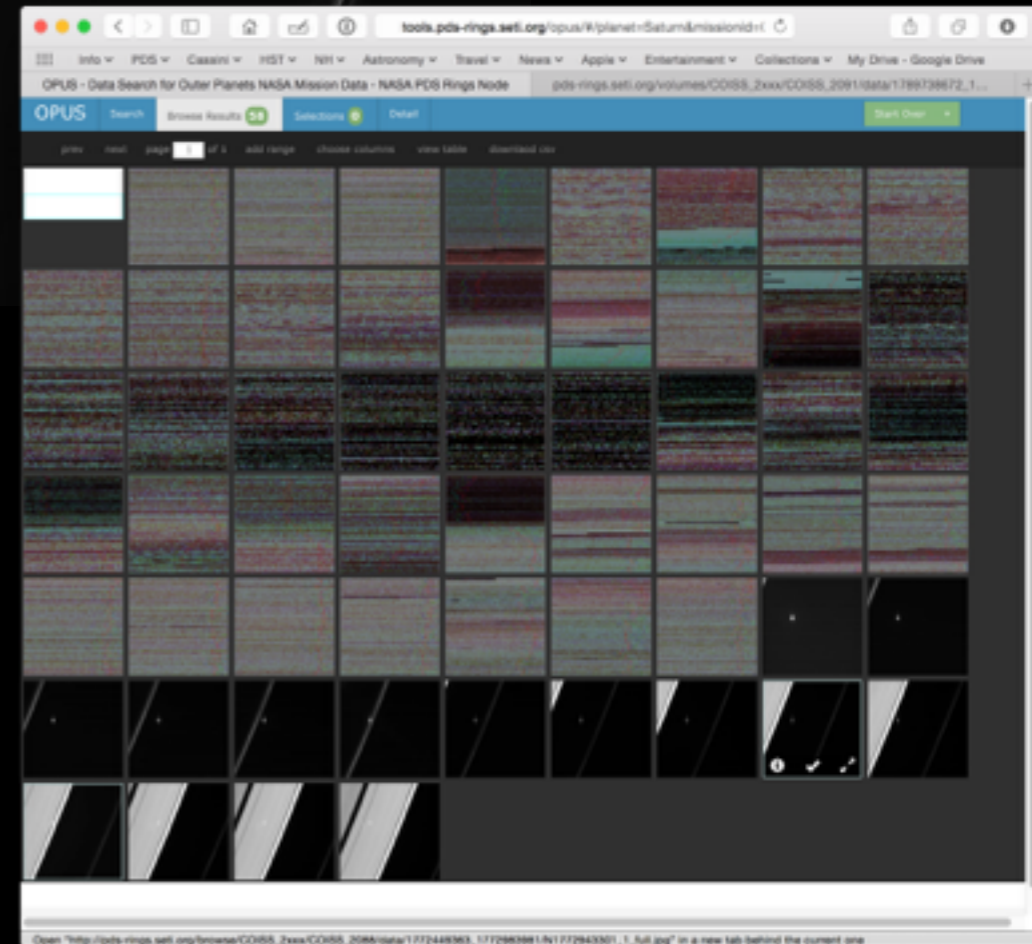
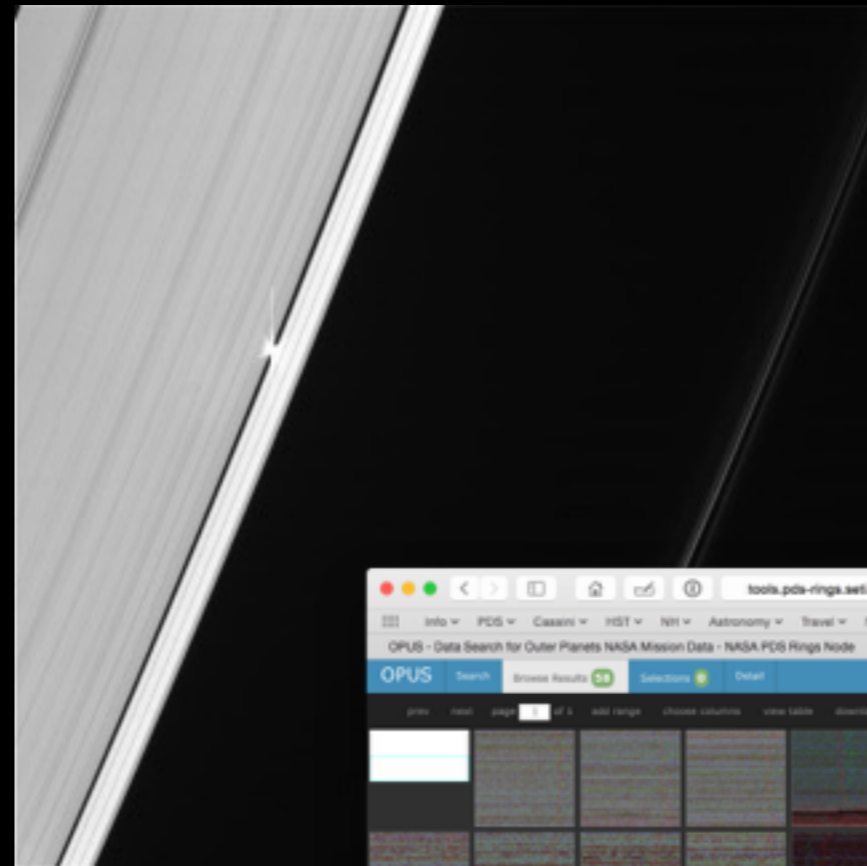
- Allow searches defined by relationships between products.
- Movie sequences.
- Color sets.
- Mosaics.



# Metadata Initiative

## 3. Composite Products

- Allow searches defined by relationships between products.
  - Movie sequences.
  - Color sets.
  - Mosaics.
  - Planning sequences.

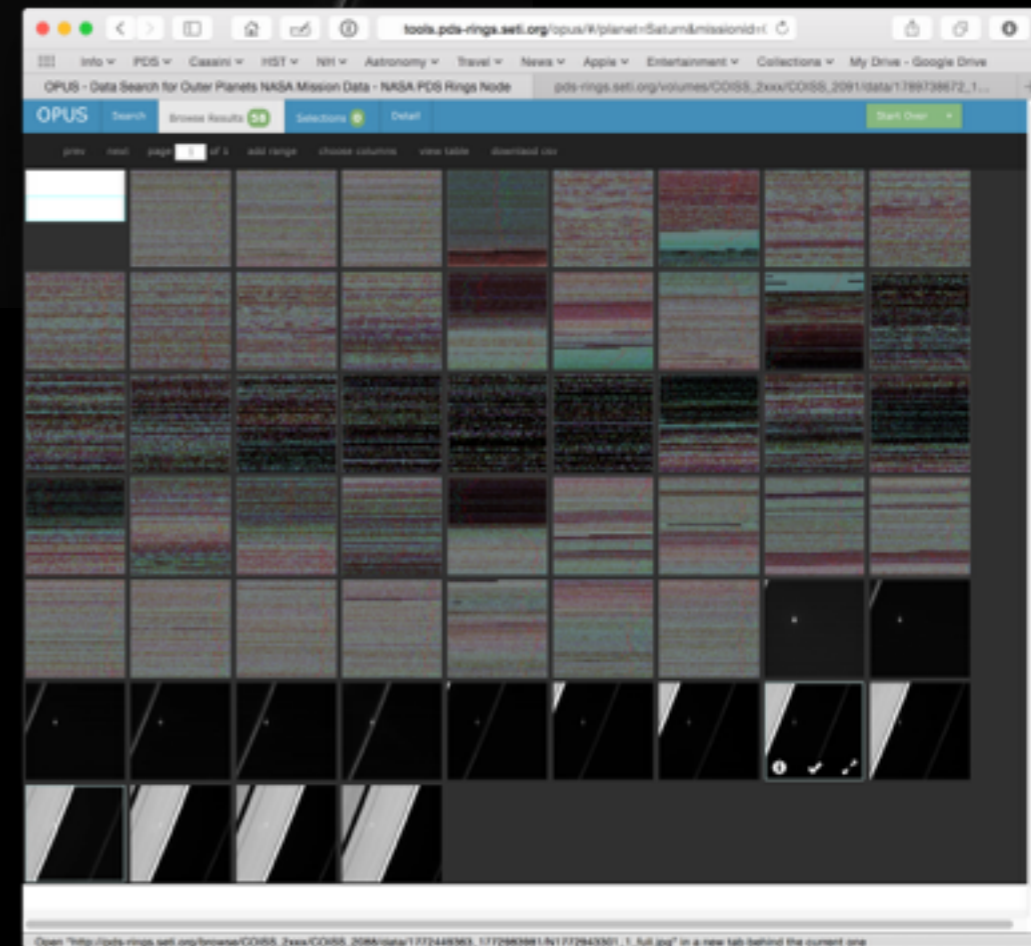
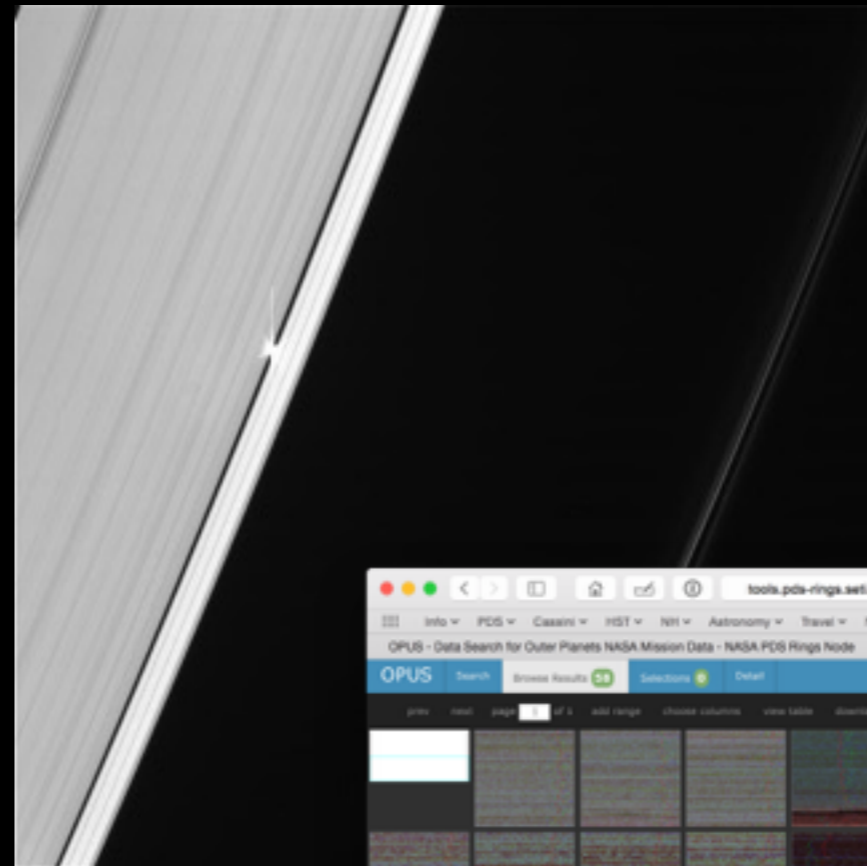




# Metadata Initiative

## 3. Composite Products

- Allow searches defined by relationships between products.
  - Movie sequences.
  - Color sets.
  - Mosaics.
  - Planning sequences.
- Some PDS4 design work will be required so that a product can be defined in terms of other products.



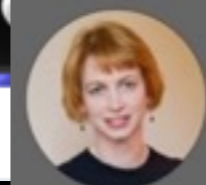
# OPUS News

PDS OPUS retweeted

 **Emily Lakdawalla** @elakdawalla · Jul 18  
It's amazing how often I turn a blog post into an excuse to dig through @pdsopus for Voyager data



← ↻ 21 ★ 66 ⋮



**Emily Lakdawalla** @elakdawalla  
@pdsopus y u no have New Horizons MVIC pictures in your database? :(

1 Fave

0 Retweets

Sep 17, 20...t 10:22 AM

via **TweetDeck**



# OPUS News



## Use case 1: Downloading

- Read about image number N1695760475\_1 in paper
- Cassini images are available at <http://tools.pds-rings.seti.org/opus/>
- Would need to learn how interface works
  - not too hard, but want automation

```
In [4]: myiframe('http://tools.pds-rings.seti.org/opus')
```

Out[4]:

The screenshot shows the OPUS web interface. At the top, there is a search bar with a 'Search' button and a 'Start Over' button. Below the search bar, there is a 'General Constraints' section with a dropdown arrow. The constraints listed are: Planet ( ), Intended Target Name ( ), Mission ( ), Instrument Host Name ( ), Instrument Name ( ), Observation Time ( ), and Nominal Target. At the bottom of the page, there is a footer with the text: 'OPUS is project of the Planetary Rings Node • About • Datasets • API • Blog • Questions and Comments'. There is also a question mark icon in the bottom left corner and a navigation icon in the bottom right corner.



# OPUS News

A FILM FOR IMAX® AND GIANT SCREEN THEATERS IN MUSEUMS, ATTRACTIONS AND PLANETARIUMS

## IN SATURN'S RINGS TAKE THE JOURNEY

In Saturn's Rings Late Summer Teaser (4K)

## IN SATURN'S RINGS



Big & Digital presents SV2 STUDIOS PRODUCTION  
BY STEPHEN VAN VOUREN MUSIC BY GREENSBORO SYMPHONY ORCHESTRA CONDUCTED BY DMITRY SITKOVETSKY  
EDITED BY JAMES TOH PRODUCTION DESIGNER DON CLINE COSTUME DESIGNER NATHALIE A. CARROL EXECUTIVE PRODUCERS EDMOND A. GRIN  
PRODUCED BY MICHAEL MALASKA, DAVID & LAURA VAN VOUREN, KEITH HAVILAND, KEVIN MCABEE, ANTHONY BIELLO, VAL KLEAVANS  
EXECUTIVE PRODUCERS LAMY VINEYARD, ERK RANKING, CHARLES W. CLARK, STEPHEN KEEN, TOM MATSON, BERNIE M. BOHIGAS, CLAUDIO BOTTACCINI  
PRODUCED BY SV2 STUDIOS DIRECTED BY STEPHEN VAN VOUREN

IN MEMORY OF  
CARL SAGAN & STANLEY KUBRICK  
WWW.ISSATURNRINGS.COM

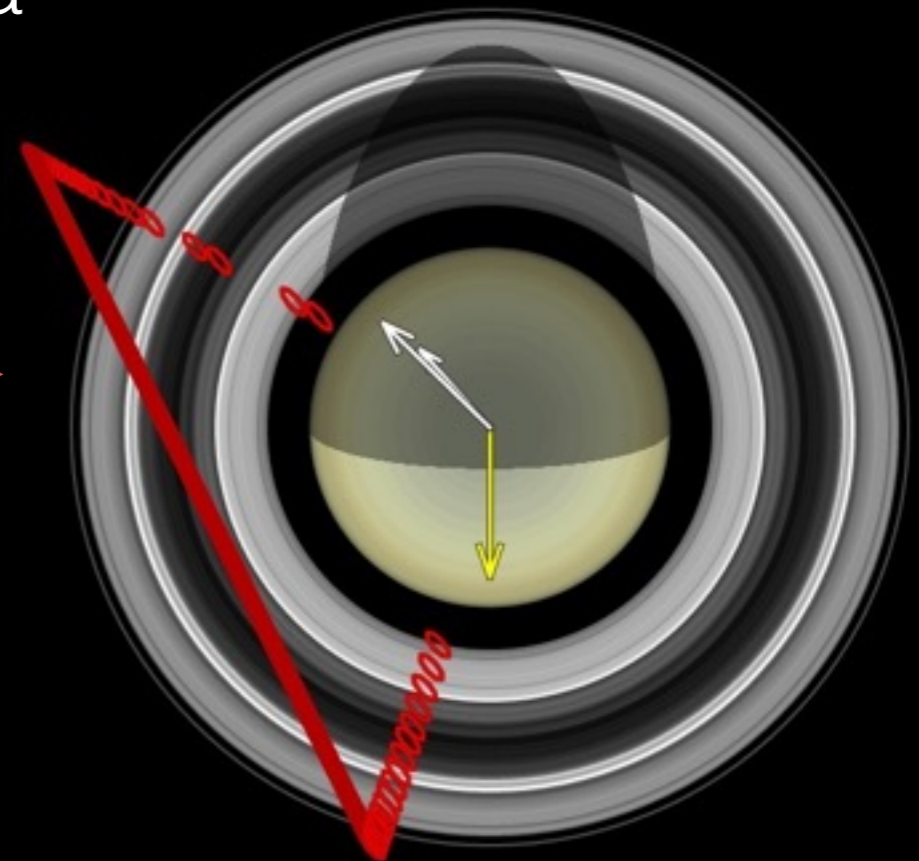
SV2

*"The result can only be described as spectacular."*

George Dvorsky, io9.com

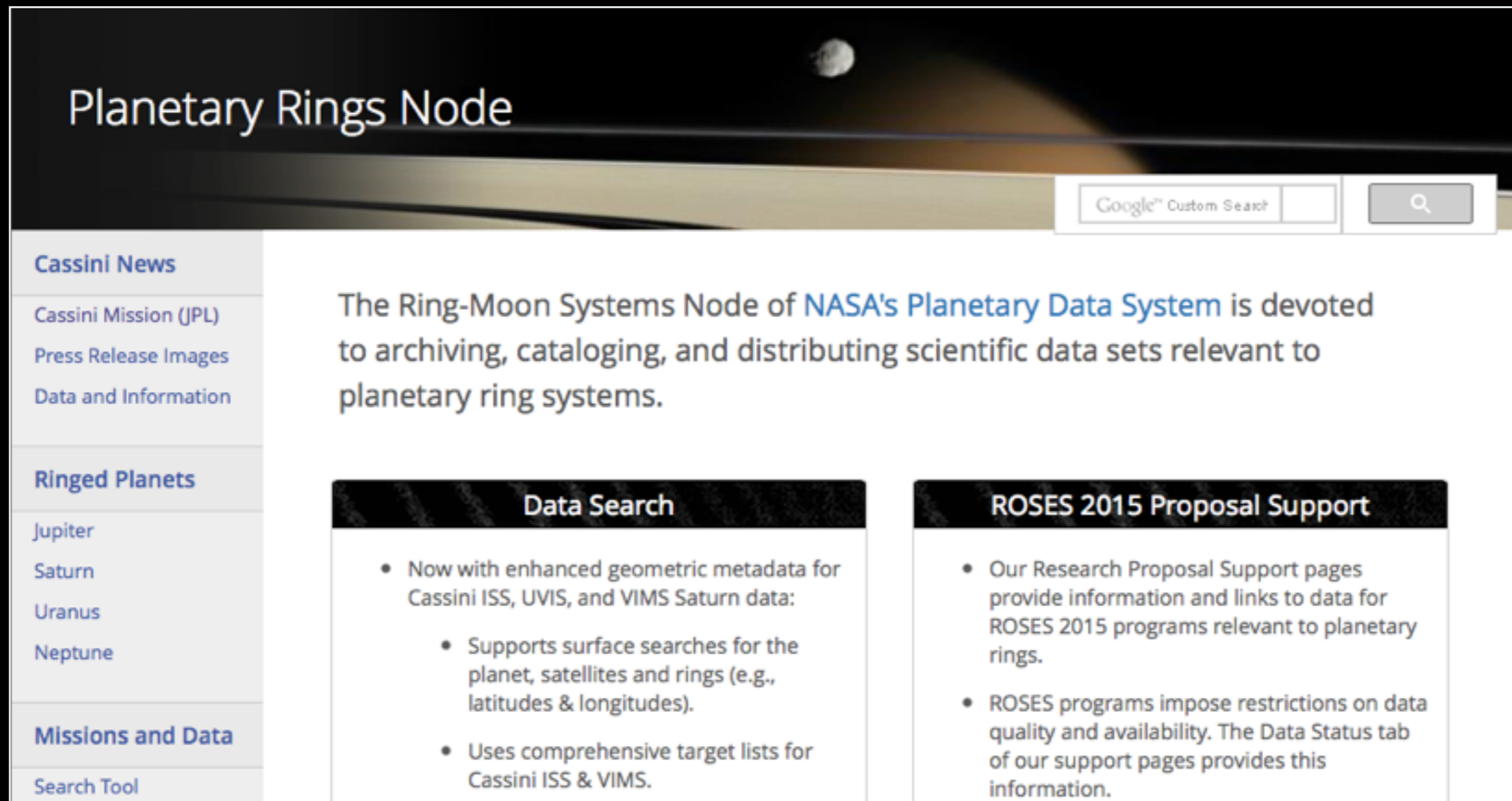
# OPUS Development Plans

- OPUS is not currently configured for frequent updates.
  - Integrating it into the PDS Registry concept will take some design effort.
- Moving target search.
- Non-local data (e.g. external archives of astrometric data).
- Enhanced capabilities for examining data products prior to downloading.
  - Interactive image views, line plots, etc.
  - Observation footprint diagrams. →
- API enhancements.
- More data and metadata!



# Web Site Design Approach

- Jekyll
  - Content Management System
  - Fully decouples site design from content
  - Content is managed by editing simple markup files.
  - Mock-ups are in progress.



The screenshot displays a web page titled "Planetary Rings Node" with a background image of a planet's horizon and a ringed planet. The page features a navigation sidebar on the left with sections: "Cassini News" (including links for Mission, Press Release Images, and Data and Information), "Ringed Planets" (listing Jupiter, Saturn, Uranus, and Neptune), "Missions and Data", and "Search Tool". A search bar with "Google™ Custom Search" is located in the top right. The main content area includes a descriptive paragraph about the Ring-Moon Systems Node of NASA's Planetary Data System. Below this are two highlighted boxes: "Data Search" and "ROSES 2015 Proposal Support", each containing a list of bullet points detailing their features and capabilities.

## Planetary Rings Node

Google™ Custom Search

### Cassini News

- Cassini Mission (JPL)
- Press Release Images
- Data and Information

### Ringed Planets

- Jupiter
- Saturn
- Uranus
- Neptune

### Missions and Data

Search Tool

The Ring-Moon Systems Node of [NASA's Planetary Data System](#) is devoted to archiving, cataloging, and distributing scientific data sets relevant to planetary ring systems.

#### Data Search

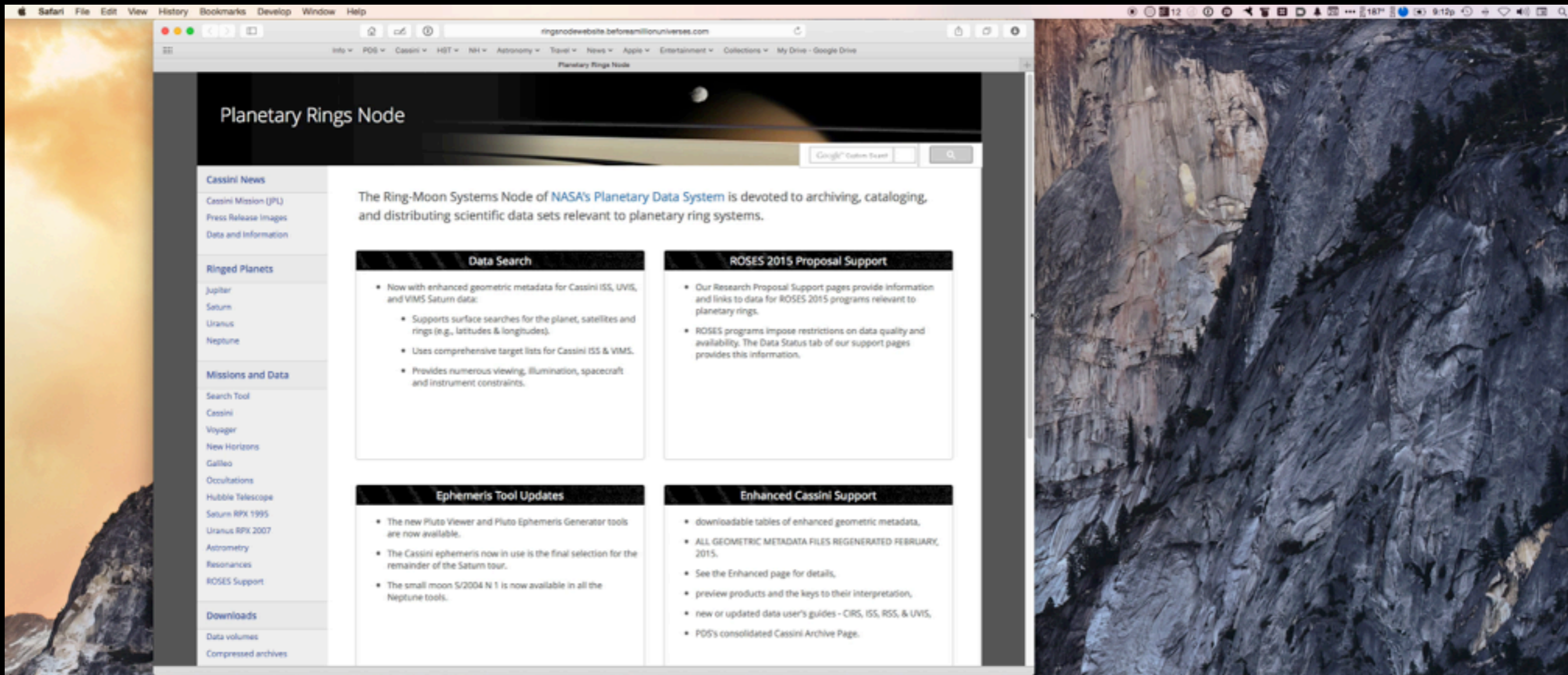
- Now with enhanced geometric metadata for Cassini ISS, UVIS, and VIMS Saturn data:
  - Supports surface searches for the planet, satellites and rings (e.g., latitudes & longitudes).
  - Uses comprehensive target lists for Cassini ISS & VIMS.

#### ROSES 2015 Proposal Support

- Our Research Proposal Support pages provide information and links to data for ROSES 2015 programs relevant to planetary rings.
- ROSES programs impose restrictions on data quality and availability. The Data Status tab of our support pages provides this information.

# Web Site Design Approach

- Bootstrap Framework
  - Dynamic re-sizing of layout, down to phone screen sizes.
  - Google is now giving higher rankings to phone-optimized sites.
  - The primary value to us is that it makes more effective use of large screens.



# Open Source

github.com/SETI/pds-tools

- We have released a few toolkits on GitHub.
- All are in Python.
- Our Python-CSPICE interface is receiving attention.
- Long-term goal: Make everything open source.
- Possible concern: Users requesting support.

GitHub This repository Search Explore Features Enterprise Pricing

SETI / pds-tools Watch 6

90 commits 1 branch 0 releases 3 contributors

Branch: master pds-tools / +

Fix ilr\_pattern() and olr\_pattern() in gravity.py.

markshowalter authored 7 hours ago latest commit f42996b97b

cspice	Merge	12 days ago
.gitignore	Move all cspice files into the cspice directory and make minor cosmet...	2 years ago
README.txt	Fixed README.txt, other cosmetic changes.	11 months ago
gravity.py	Fix ilr_pattern() and olr_pattern() in gravity.py.	7 hours ago
interval.py	Cleaned up a few unit tests to point to the correct file locations	2 years ago
julian.py	Minor syntax revisions, added vax.py	7 hours ago
julian_dateparser.py	initial import of second version of directory structure for pds-tools	2 years ago
pdsparser.py	Minor syntax revisions, added vax.py	7 hours ago
pdstable.py	Minor syntax revisions, added vax.py	7 hours ago
requirements.txt	adds requirements file	6 months ago
solar.py	Further debugging, mostly HST stuff. All unit tests still pass.	2 years ago
tabulation.py	See notes in revised files.	2 years ago
textkernel.py	Update pdstable.py and textkernel.py to use os.path.join and the OOPS...	2 years ago
vax.py	Minor syntax revisions, added vax.py	7 hours ago
vicar.py	Handle longs as valid data types.	10 months ago



# Updated Backup Procedures

- The review panel regarded our current backup plan as a major weakness.
  - The remote backup site is 20 miles away but therefore potentially susceptible to a single natural disaster.
- We have created an additional backup using Google Cloud Services.
  - Cost is \$10/TB/month for “nearline” storage.
  - Our holdings not (yet) at NSSDC amount to ~ 5 TB, so the cost is modest.
  - Uploads are free, downloads are not. Cost to recover holdings would be a few \$K if ever needed.
- Cloud storage also opens up the possibility of implementing cloud-based data processing services.
- HOWEVER, costs could become significant as our holdings grow.