

Precision Pointing Reconstruction and Geometric Metadata Generation for Cassini Images

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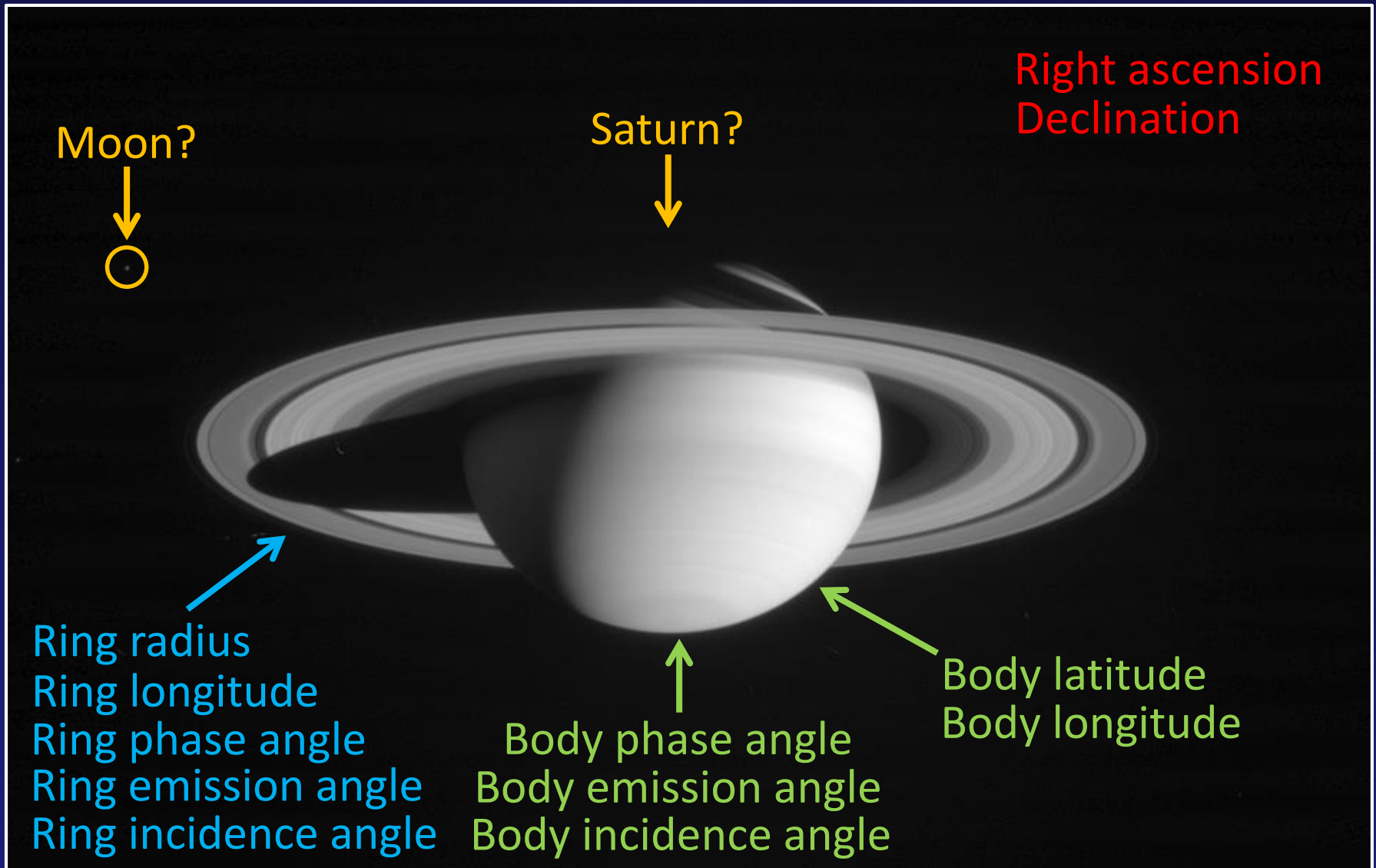
Mitch K. Gordon



3rd Planetary Data Workshop – Flagstaff, AZ

June 12, 2017

Big Question: What's at Each Pixel?



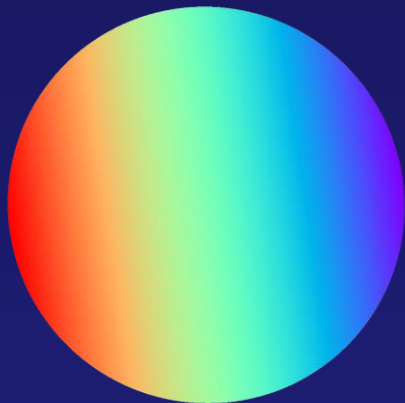
Our End Product (#1): Backplanes



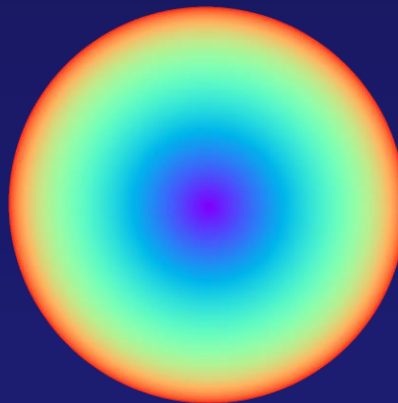
Longitude



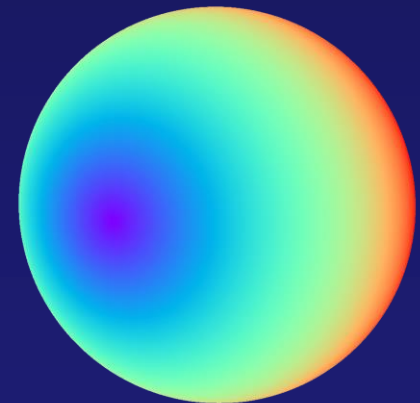
Latitude



Phase angle



Emission angle

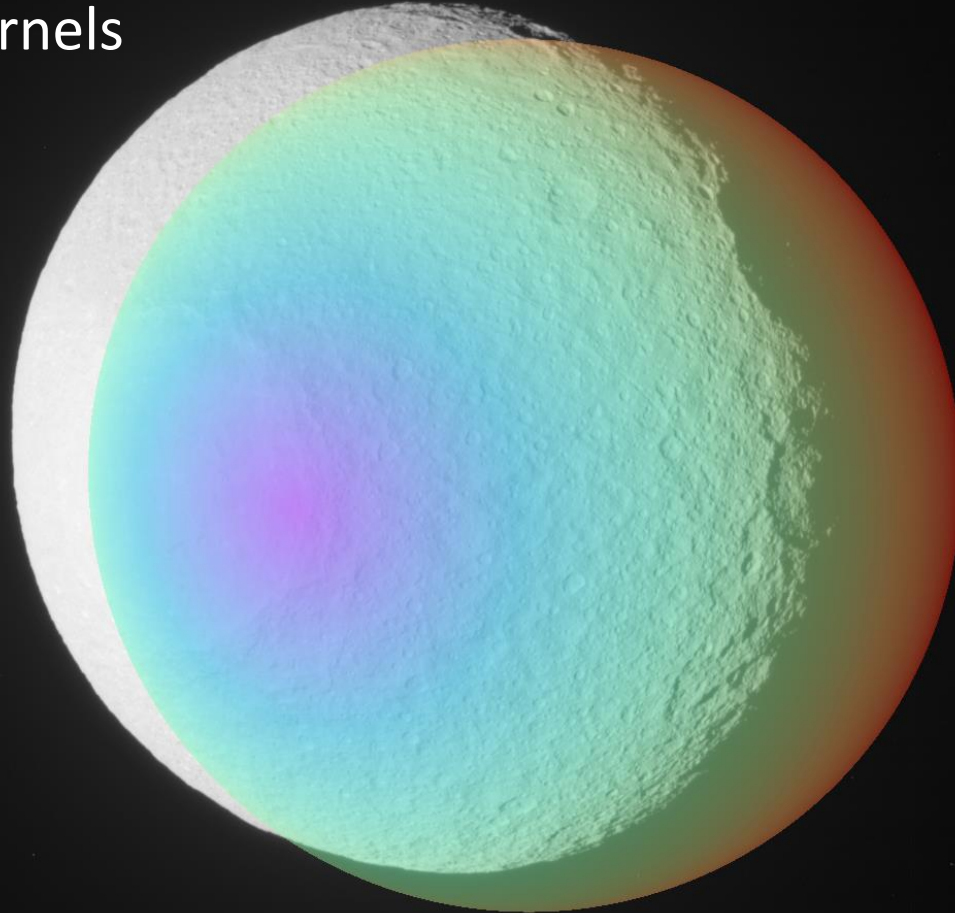


Incidence angle

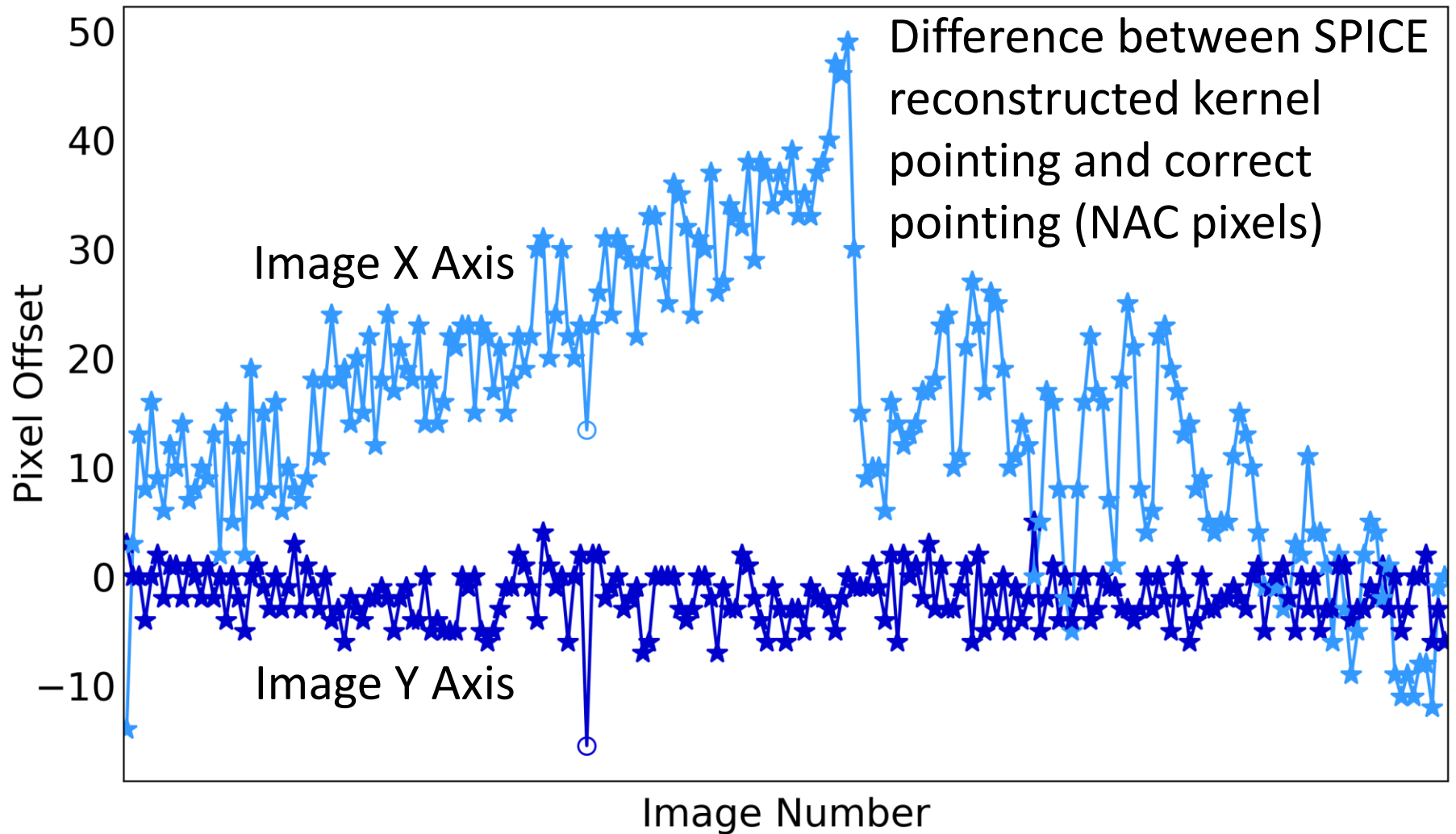
➔ Total of 120 Backplanes Available ←

One “Little” Problem...

Pointing from SPICE reconstructed kernels



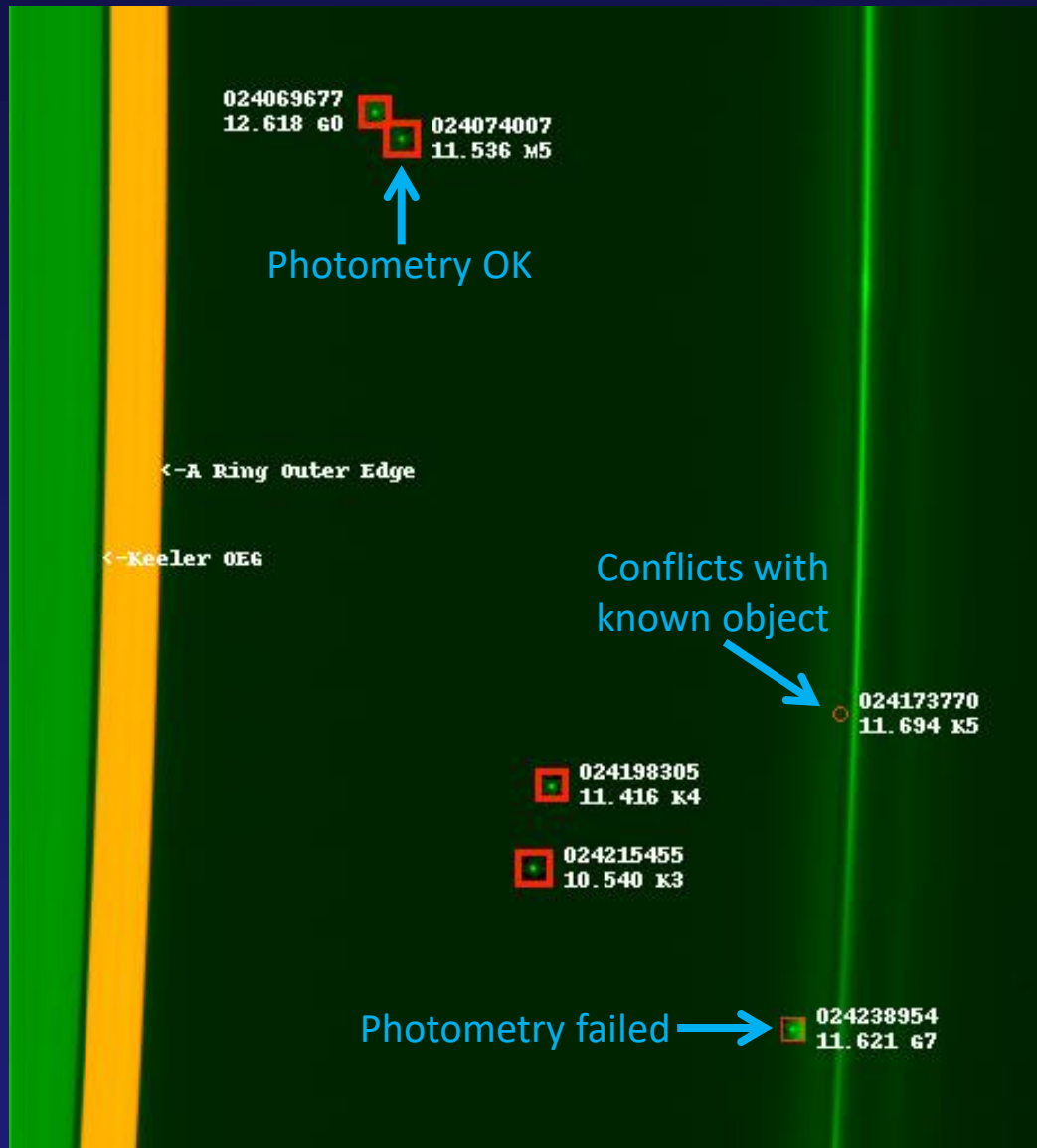
Navigation Errors



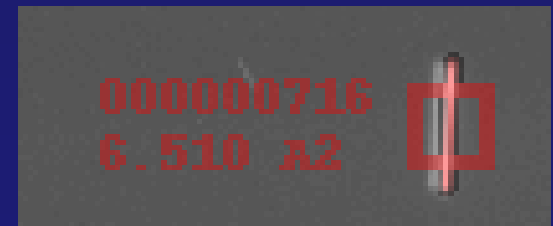
Re-Navigation of Cassini ISS Images

- Create a model of what should be there
- Perform a 2-D correlation between the image and model
- The peak correlation determines the offset
- Navigate using:
 - Stars
 - Bodies (Saturn and icy moons)
 - Rings
 - Titan (really hard – not in this talk)
- **Our End Product (#2): New SPICE kernels**

Stars-Based Navigation



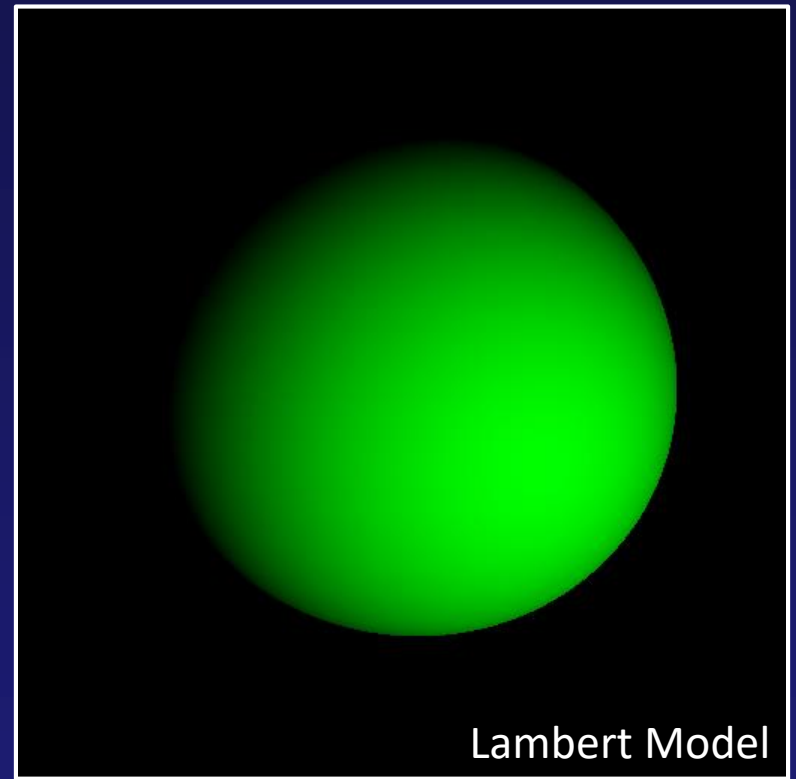
- UCAC4 and YBSC catalogs (113M+ stars)
- More complicated than you would think!
- Use photometry to validate offset, including star color and ISS filters
- Handle streaking due to spacecraft rotation



Body-Based Navigation (Lambert)



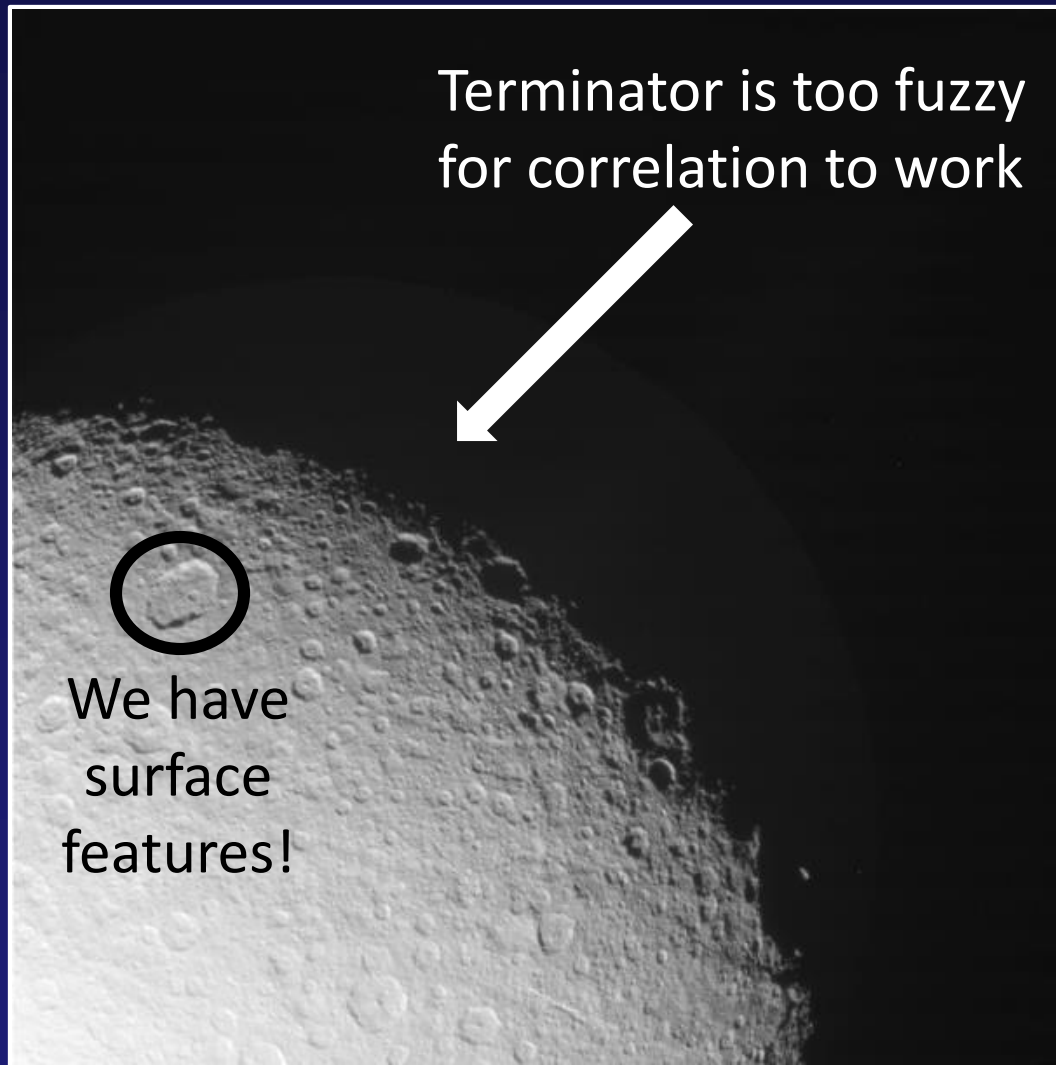
+



Body-Based Navigation (Lambert)



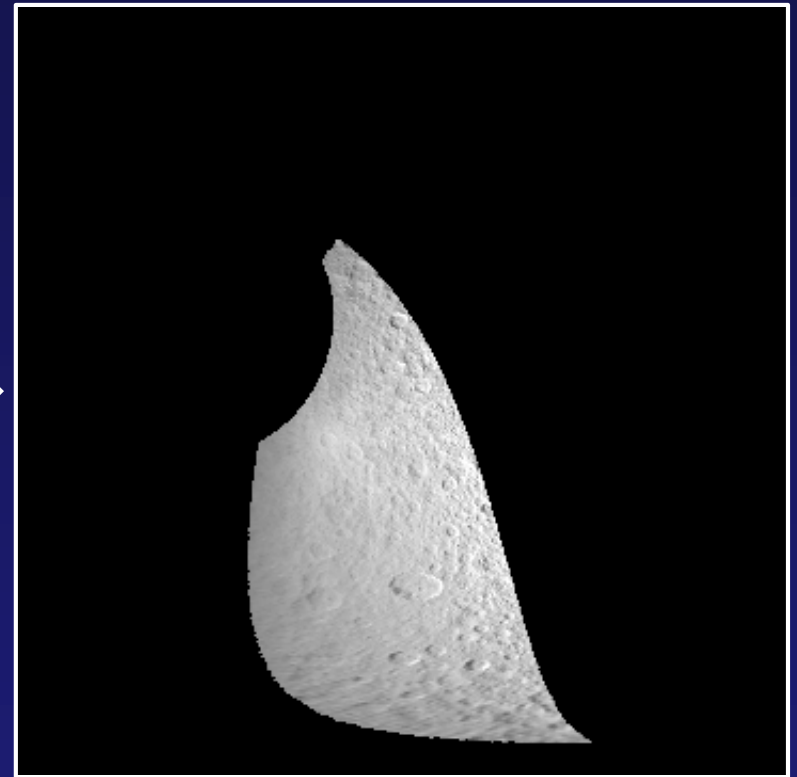
Unnavigable Body Image



Body-Based Navigation (Cartographic)



Navigable Image

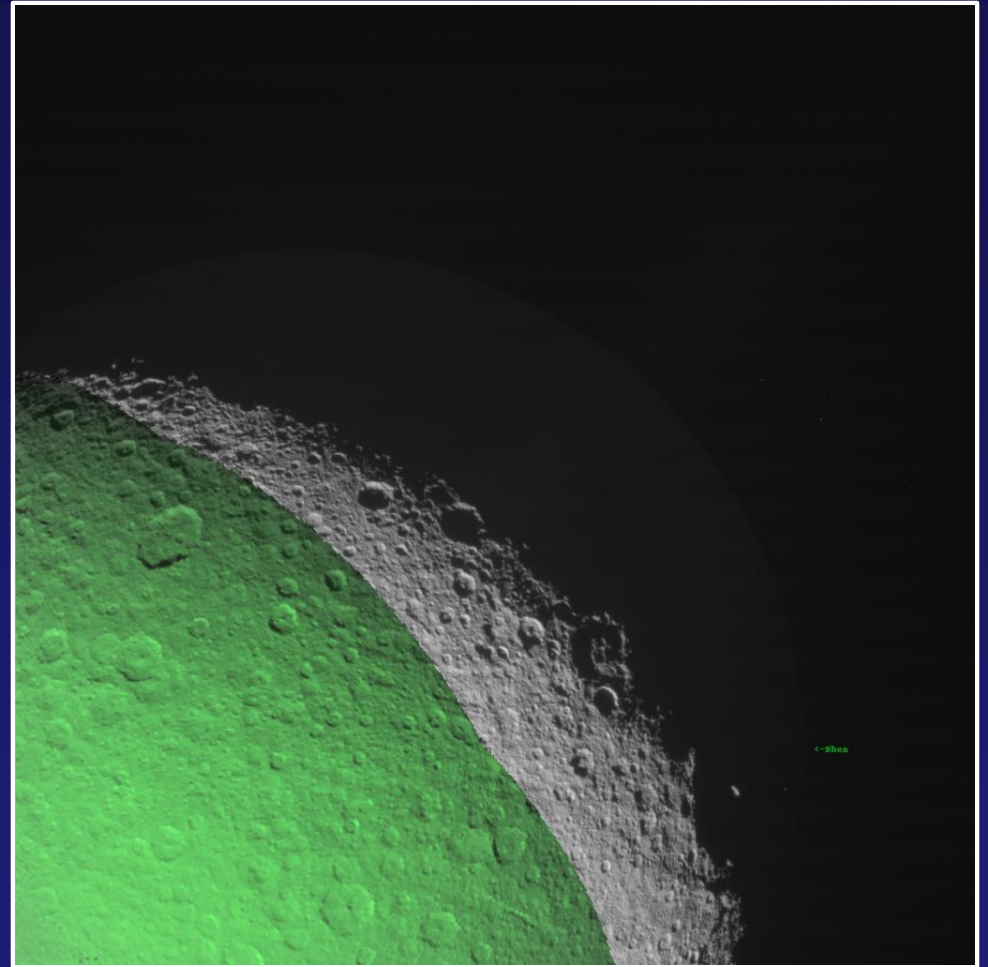
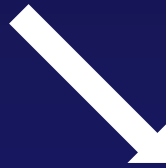
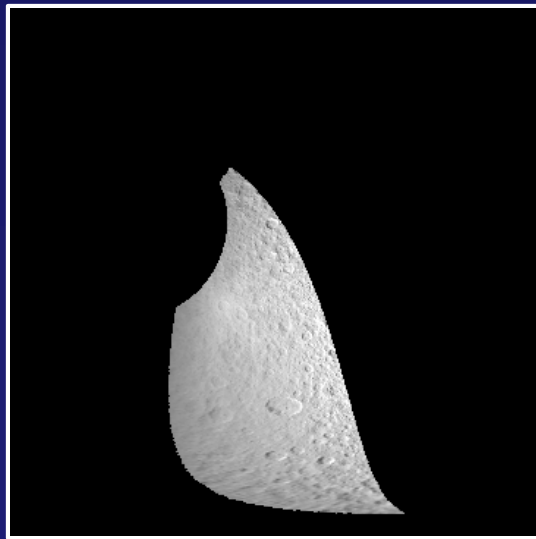


Lat/Lon Reprojection

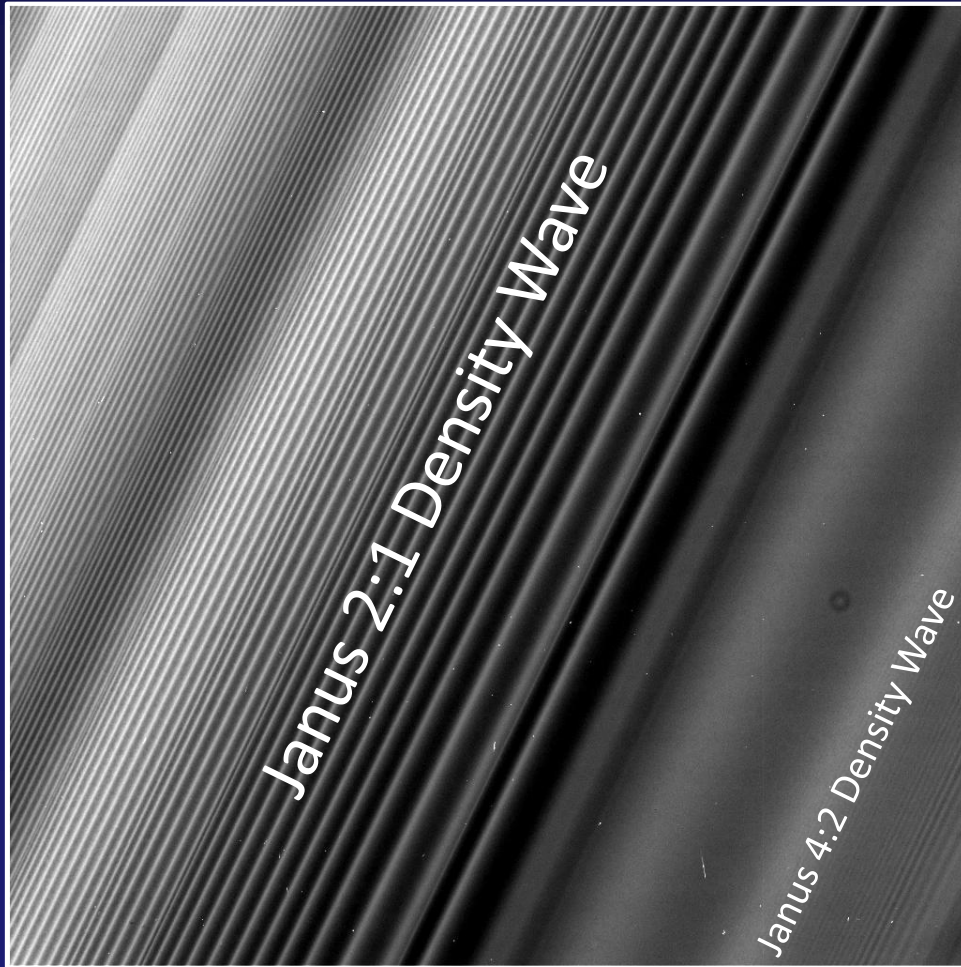
Body-Based Navigation (Cartographic)



+

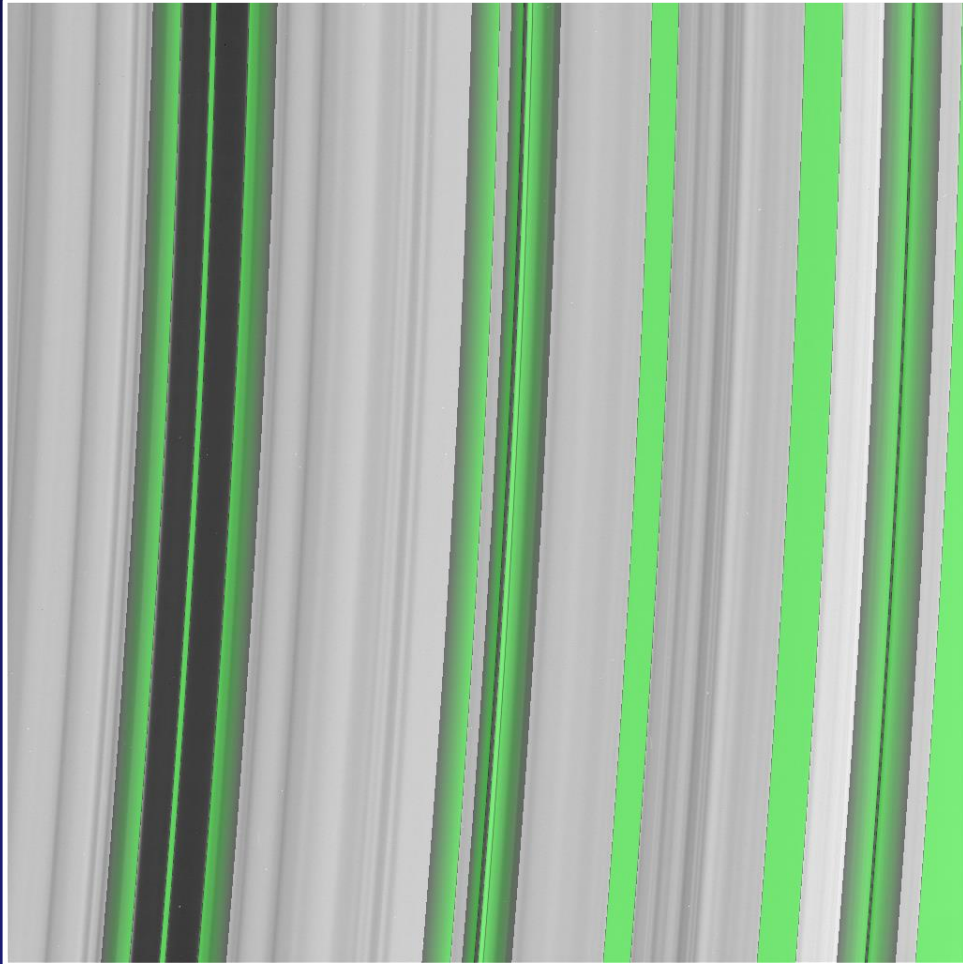


Rings are Really Complicated



- Rings vary with
 - Radius
 - Longitude
 - Time
 - Lit/Unlit Side
 - Lighting geometry
 - Viewing geometry
- Rings contain
 - Density waves
 - Bending waves
 - Embedded moonlets

Rings – There is (Some) Hope

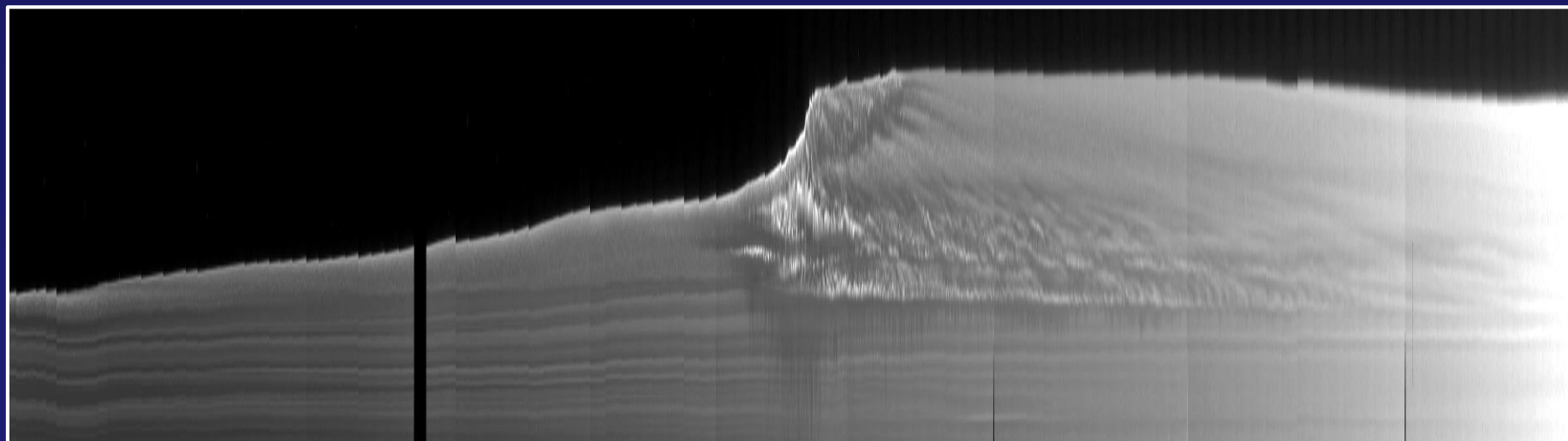
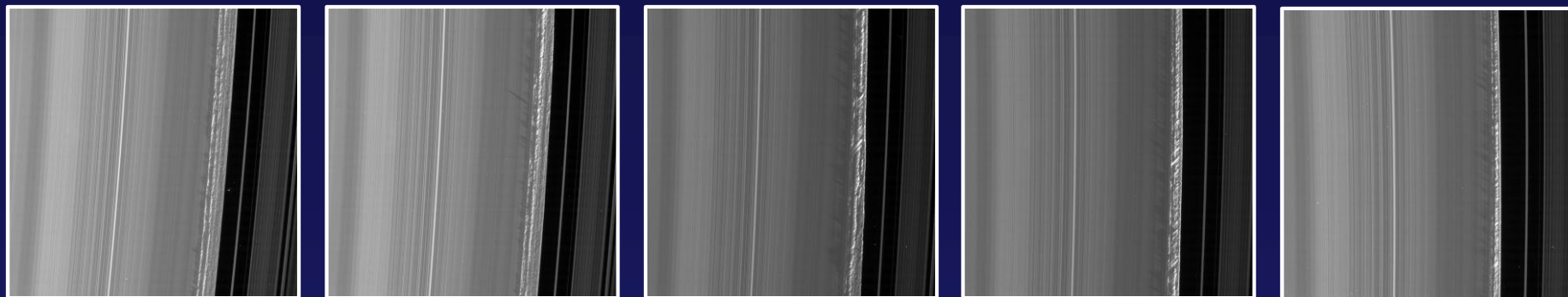


- Catalog of 67 near-circular features
- Must ignore the rest of the rings
- There are many up-close rings images we can't navigate

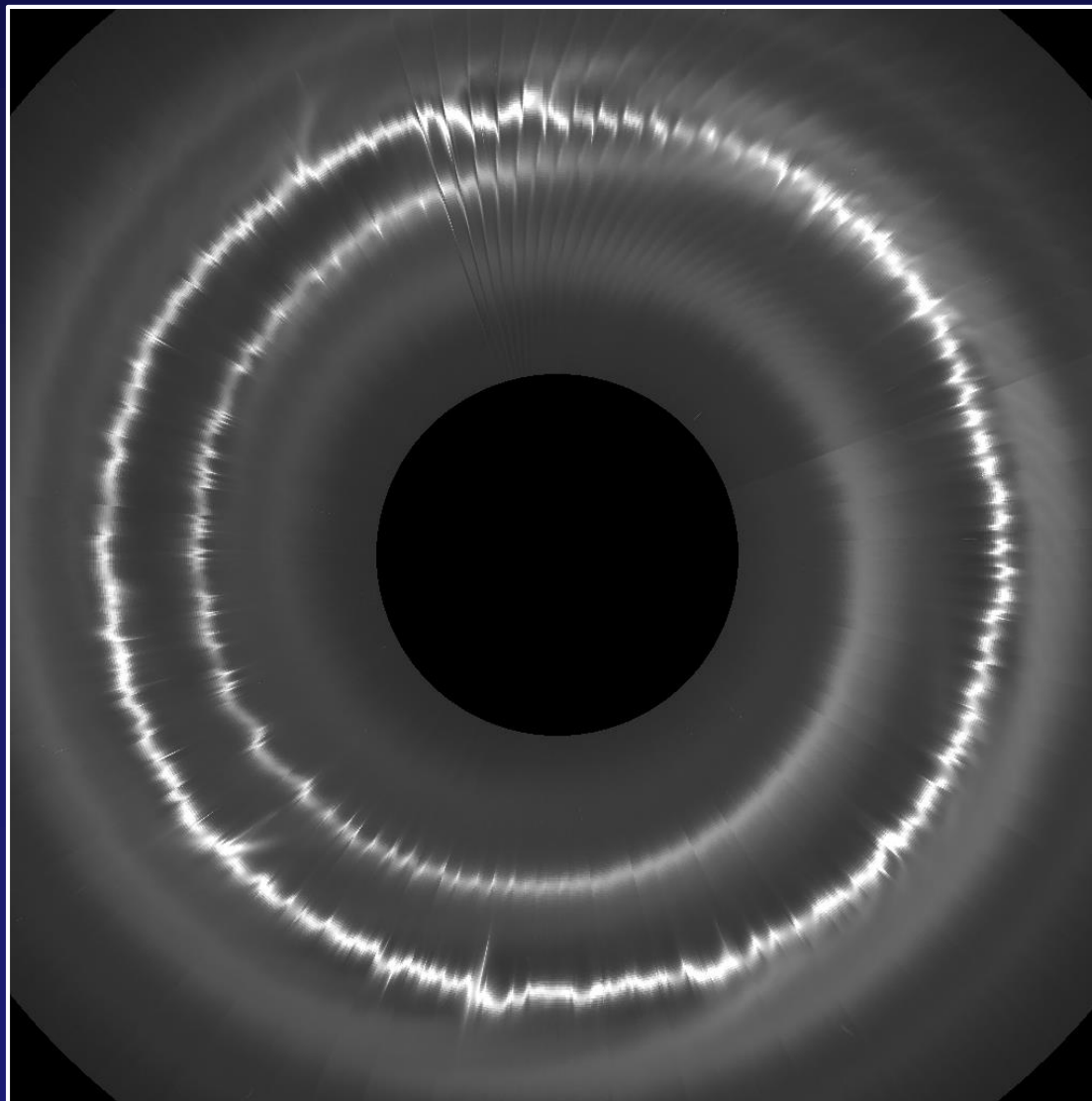
Current Status

- 100,000 lines of Python
- Processed all 357,108 images through COISS_2101
 - 4,800 CPU-hours on Amazon EC2
- 75% of images navigated successfully
- Of the rest:
 - 11% – Closeups of Saturn
 - 7% – Closeups of the rings
 - 6% – Problematic images of Titan
 - 1% – Other causes

Derived Product: Ring Linear Mosaic



Derived Product: Ring Polar Mosaic



Derived Product: Moon Surface Map

