مركز محمد بن راشد للفضاء

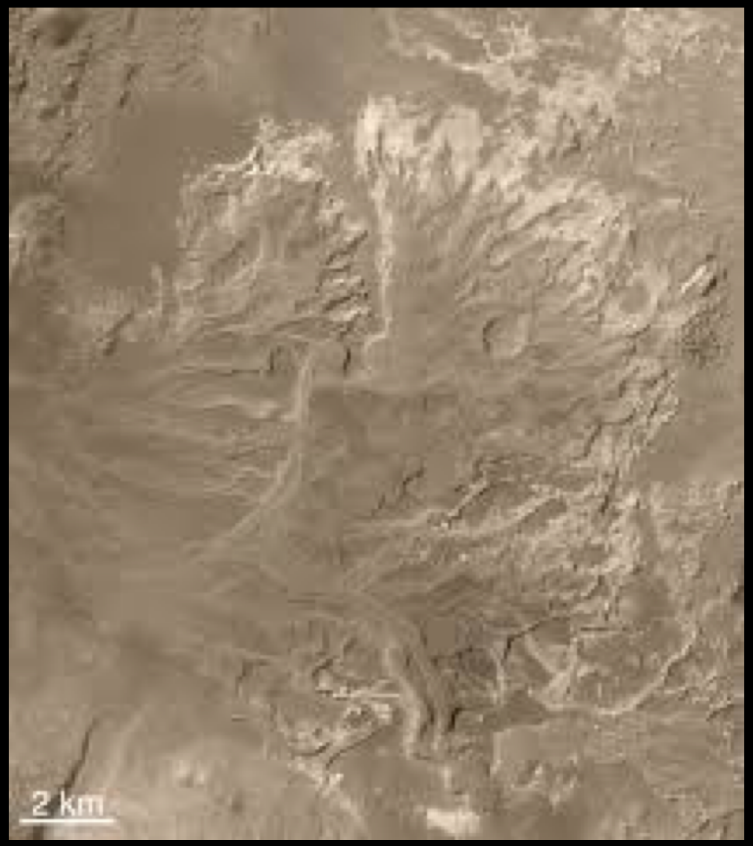
MOHAMMED BIN RASHID SPACE CENTRE

Improving MAVEN-IUVS Lyman-Alpha Apoapsis Images

Aisha Al Mannaei

Mentors: Mike Chaffin & Sonal Jain

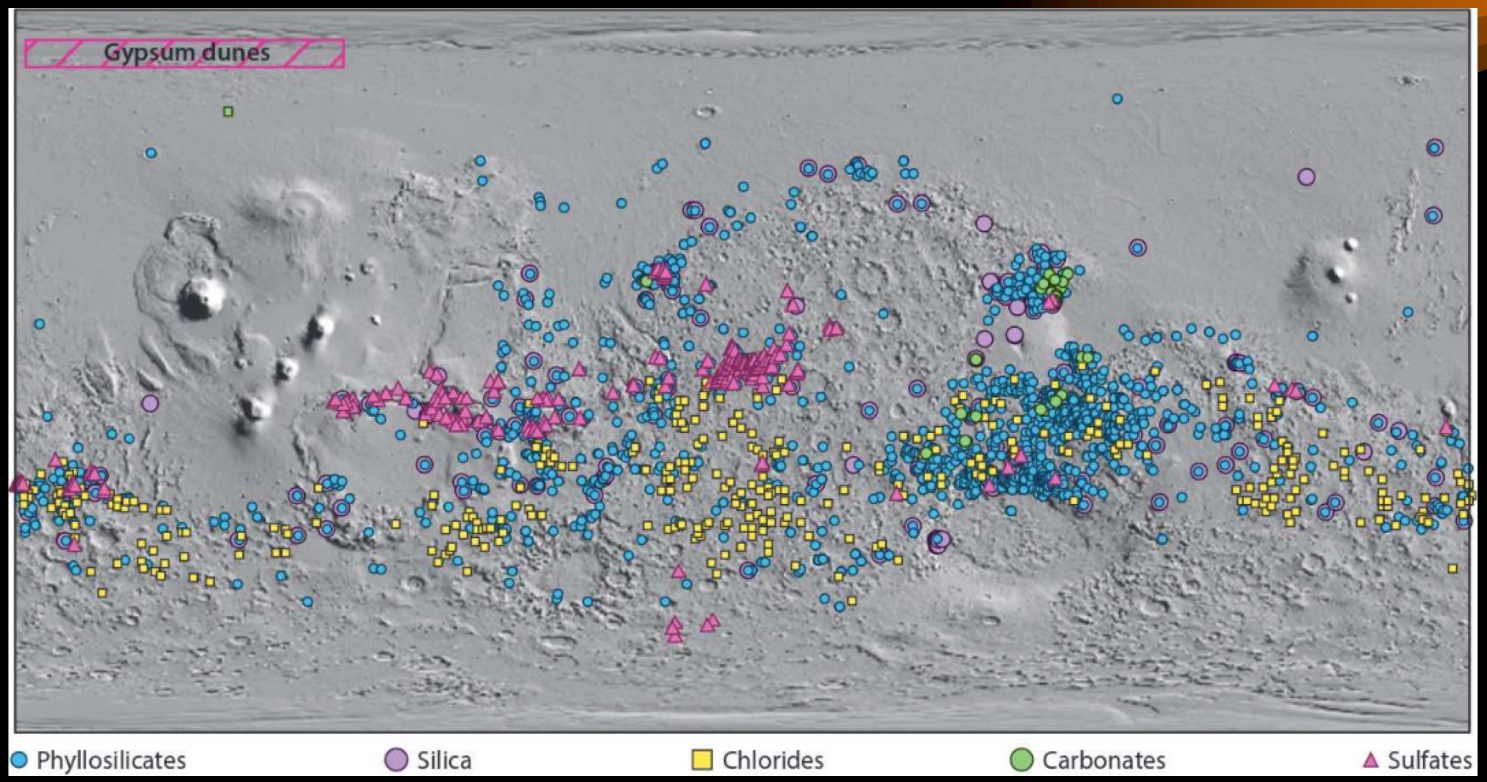
Mars in the Past



Eberswalde Crater, Mars, as imaged by Mars Global Surveyor.

- Liquid water
- Terrestrial rivers
- Fluvial activity[1]

Mars in the Past



Aqueous mineral locations on the surface of Mars, from the review by Ehlmann and Edwards (2014)

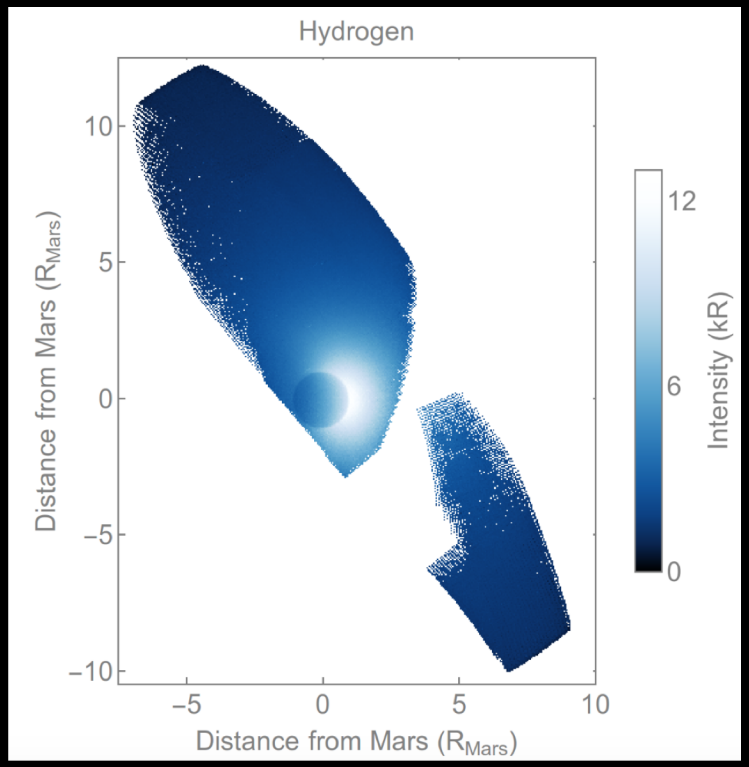
Present-day Mars

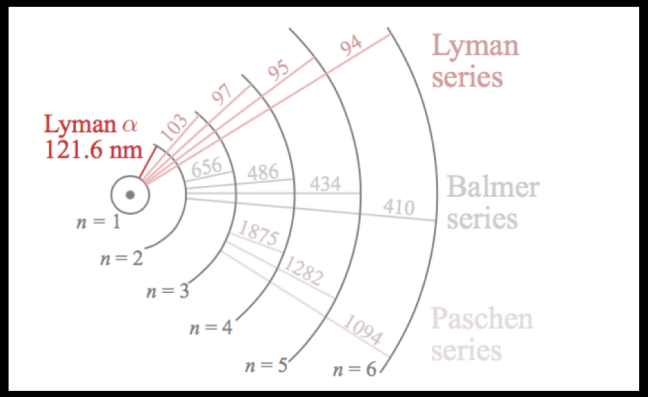
- H at Mars H Corona is moving fast due to its light mass, therefore, escaping its gravity.
- H is derived from lower atmospheric water.
- The loss of H from Mars is capable of drying and oxidizing the planet.

Credit: NASA's Goddard Space Flight Center

Background: H Corona

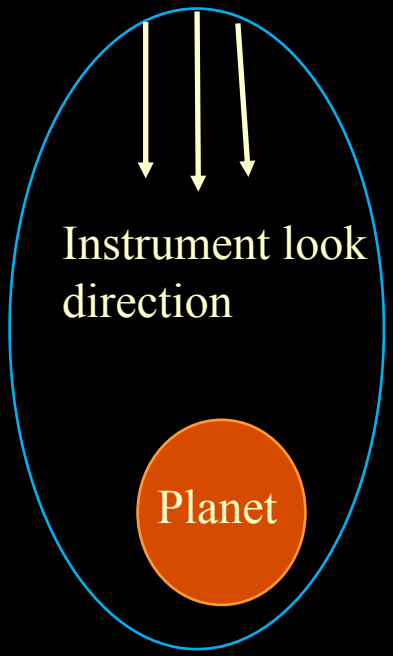
- UV light from sun is absorbed and re-emitted by the 2 → 1 jump of an electron in a hydrogen atom, releasing the Lyman-alpha glow.

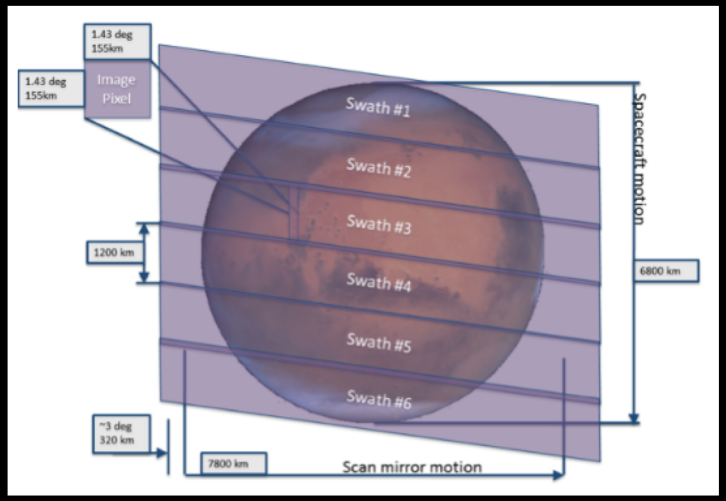


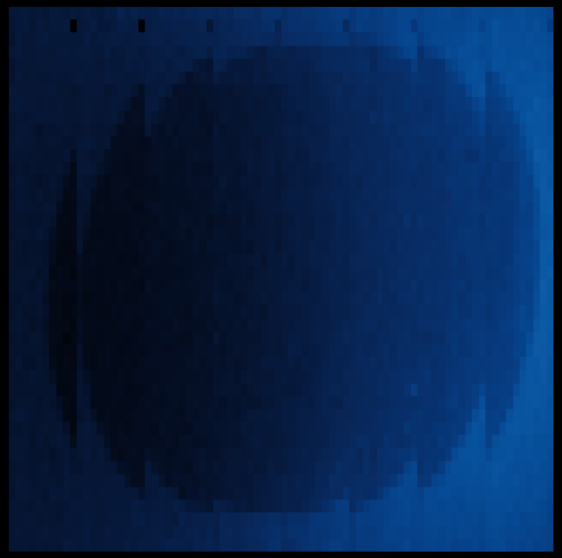


Background: Apoapsis Maps

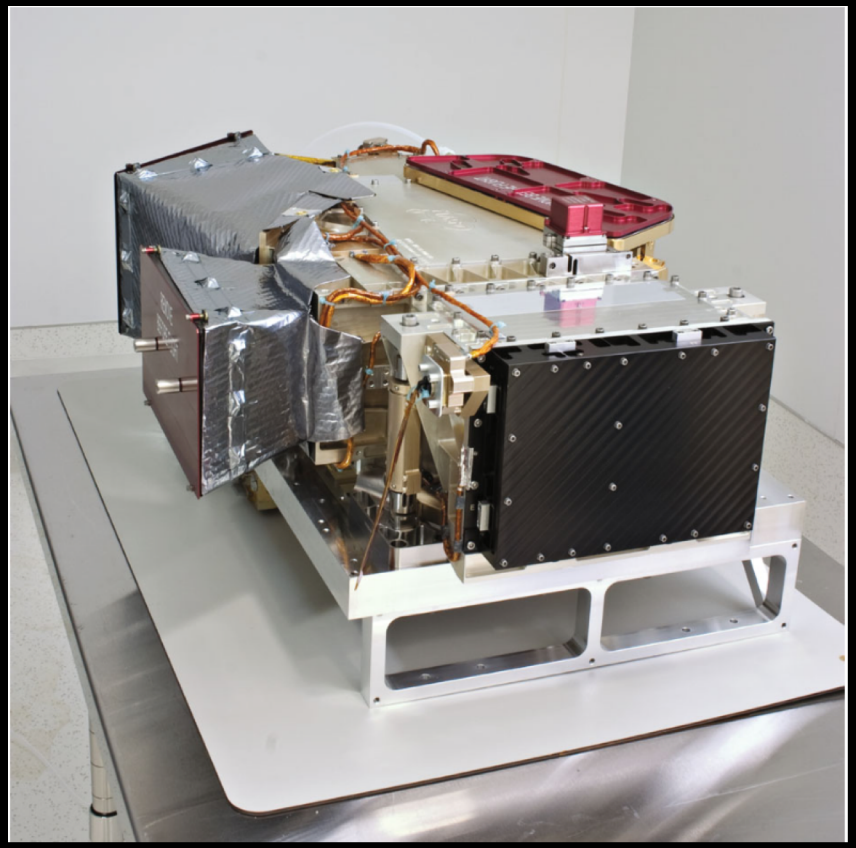
- IUV Spectograph
- Detect various wavelengths: second order FUV (110-190 nm) and first order MUV (180-340 nm).



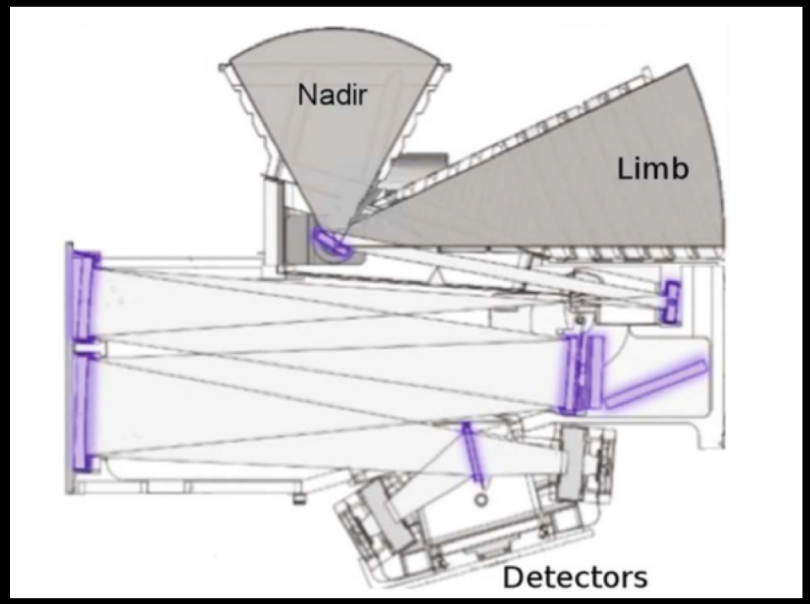




Instrument: IUVS Data Processing

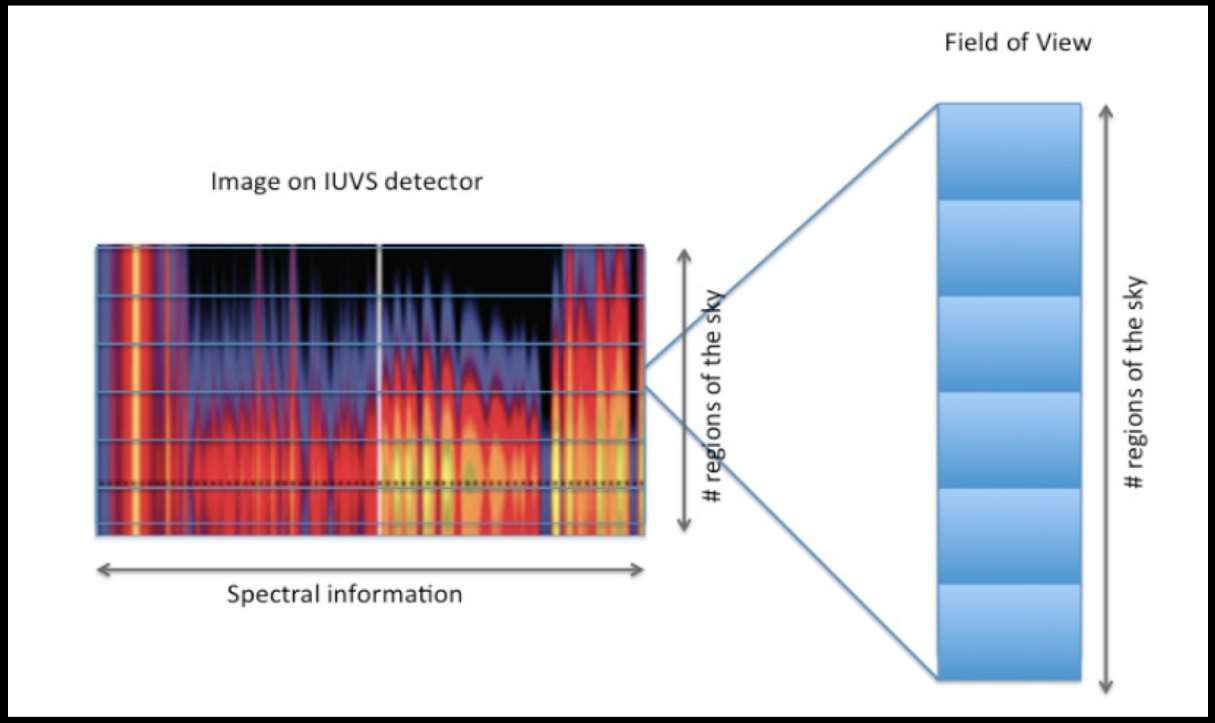


IUVS instrument image taken at LASP (McClintock et al.)



Instrument: Image on Detector

- Light in each of the imaging pixels is dispersed in wavelength to form a 2-D image on the detector.



Data Processing for H Corona

Raw Data Measure ments [DN]

→

Calibrated Spectra [kR/nm]

→

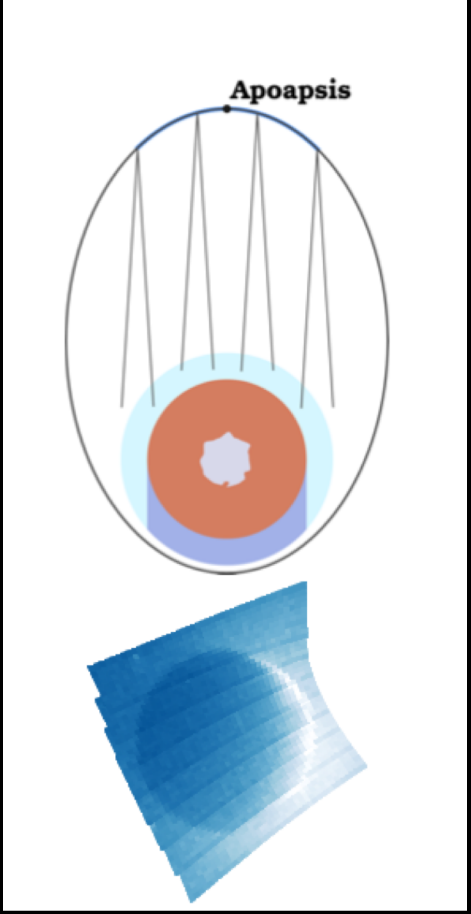
Summed into specific spectral features [kR]

→

Projected into H corona images

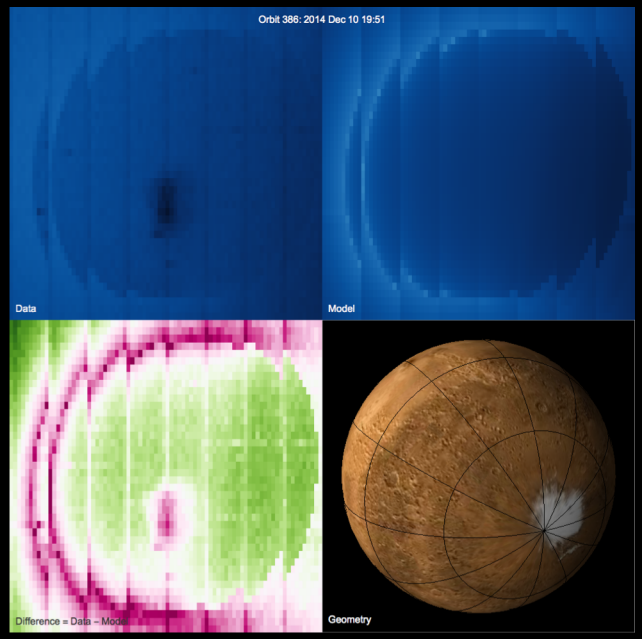
Research Focus: Apoapse Observations

- 2D images of the whole of Mars disk using the scan mirrors and motion of the spacecraft.



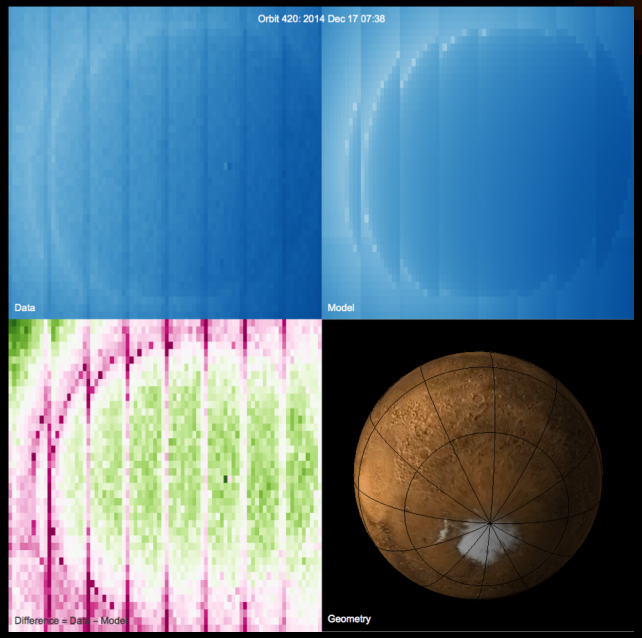
Research Focus: Apoapse Observations

Problem #1



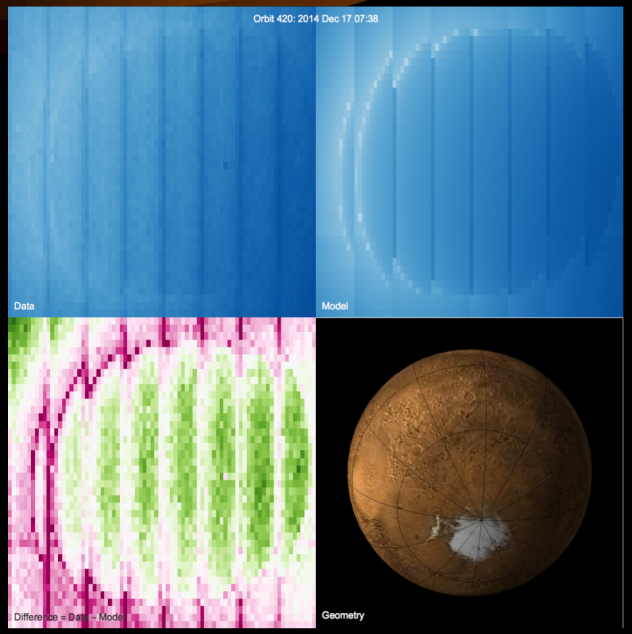
Appropriate detection of Lyman-alpha

Problem #2



Background Subtraction

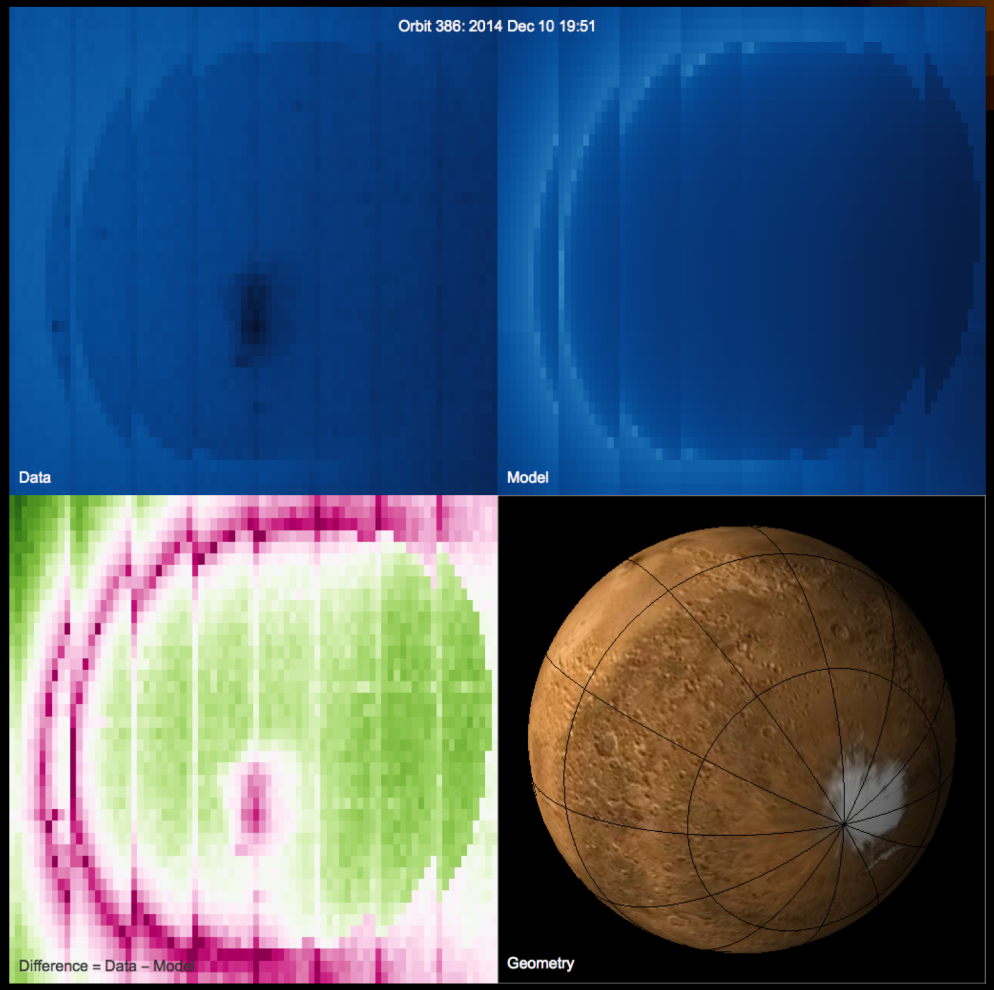
Problem #3



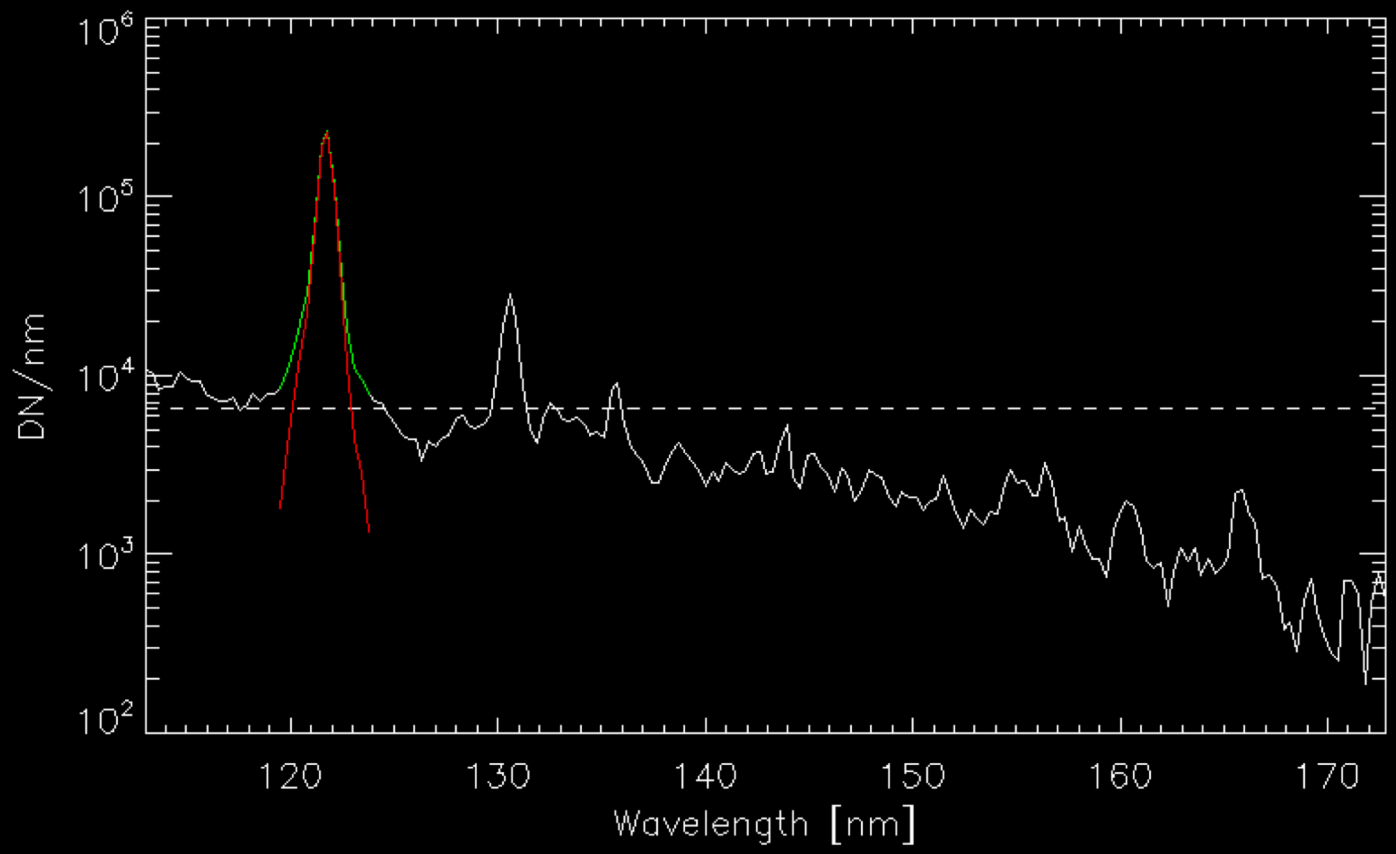
Correct for the lines

Step One: Detection of Lyman-Alpha

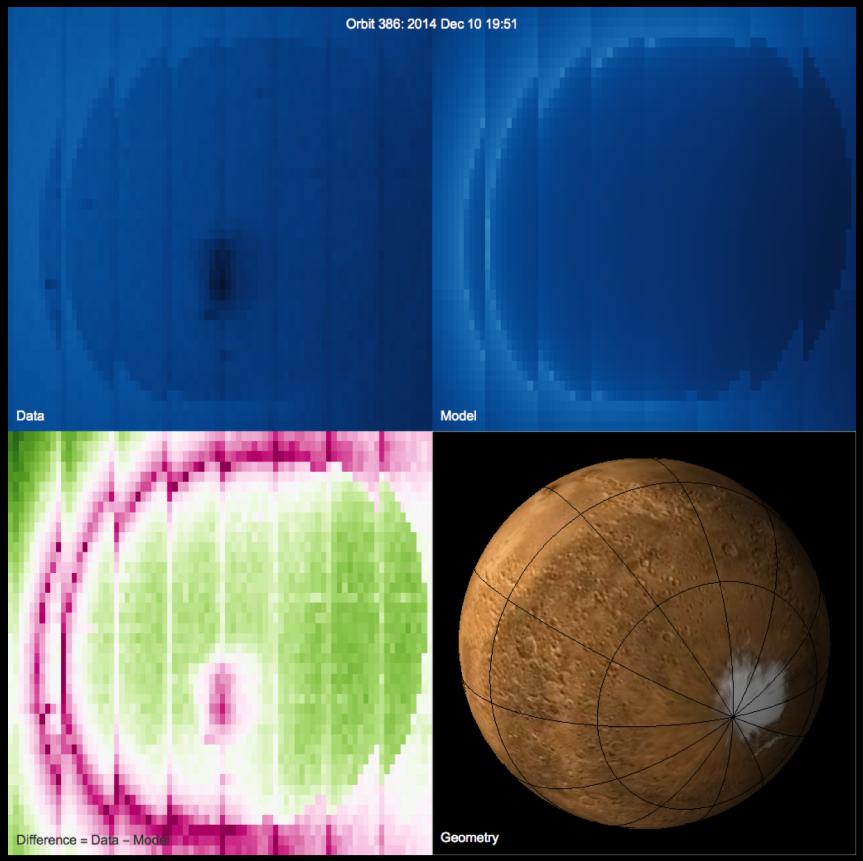
Problem #1



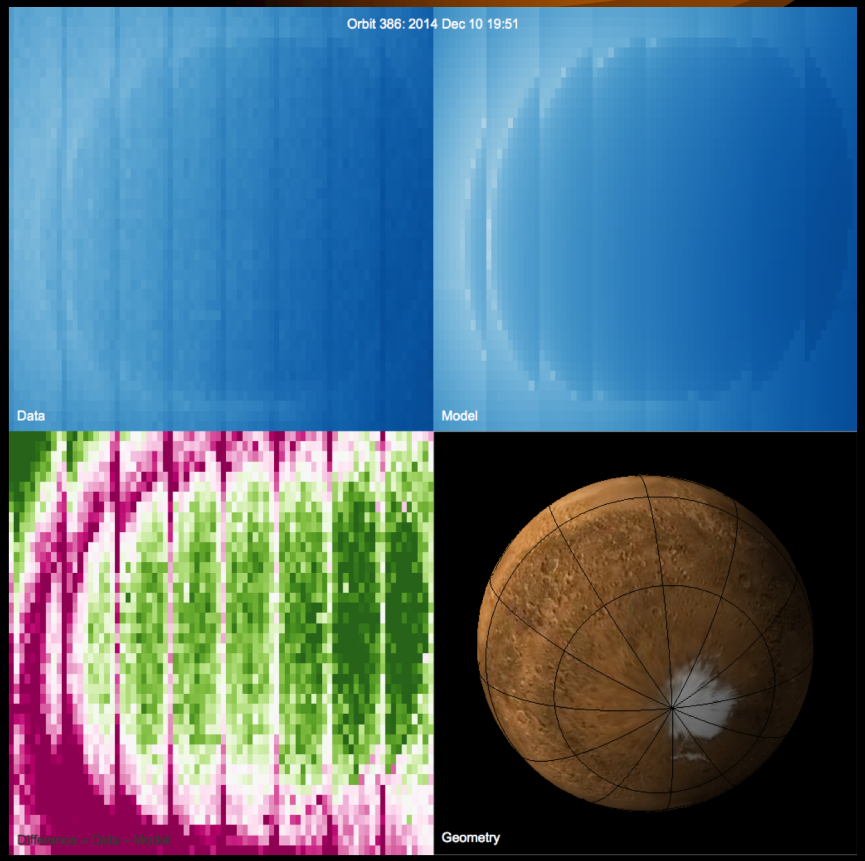
First Step of Data Processing



First Step to Data Improvement

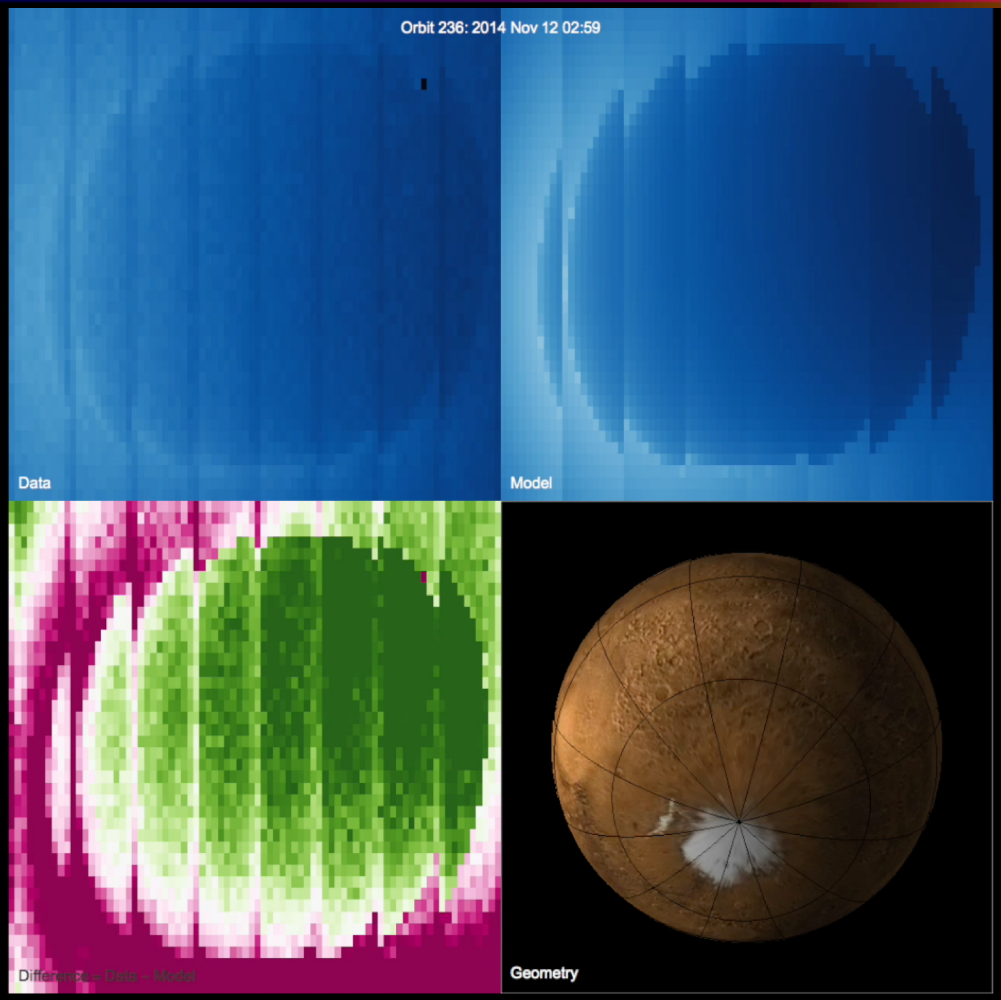


Before

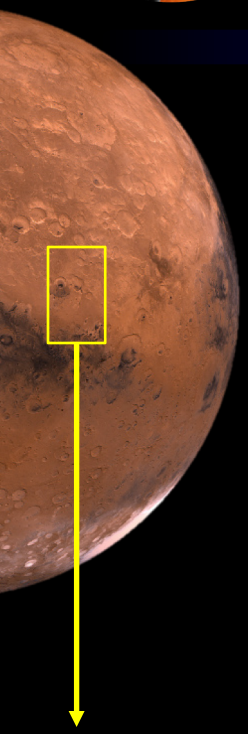


After

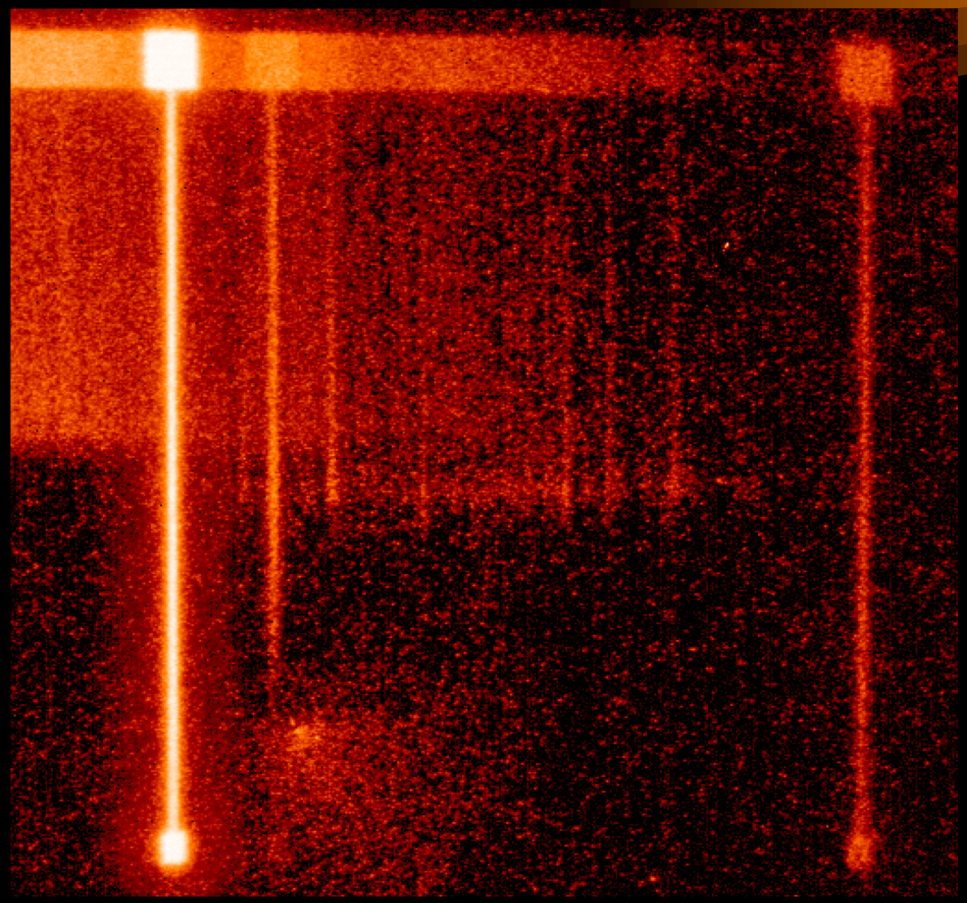
Results: First Step



Second Step: Background Subtraction



Observational Geometry
(6500 km)



Large Keyhole

Air-glow slit

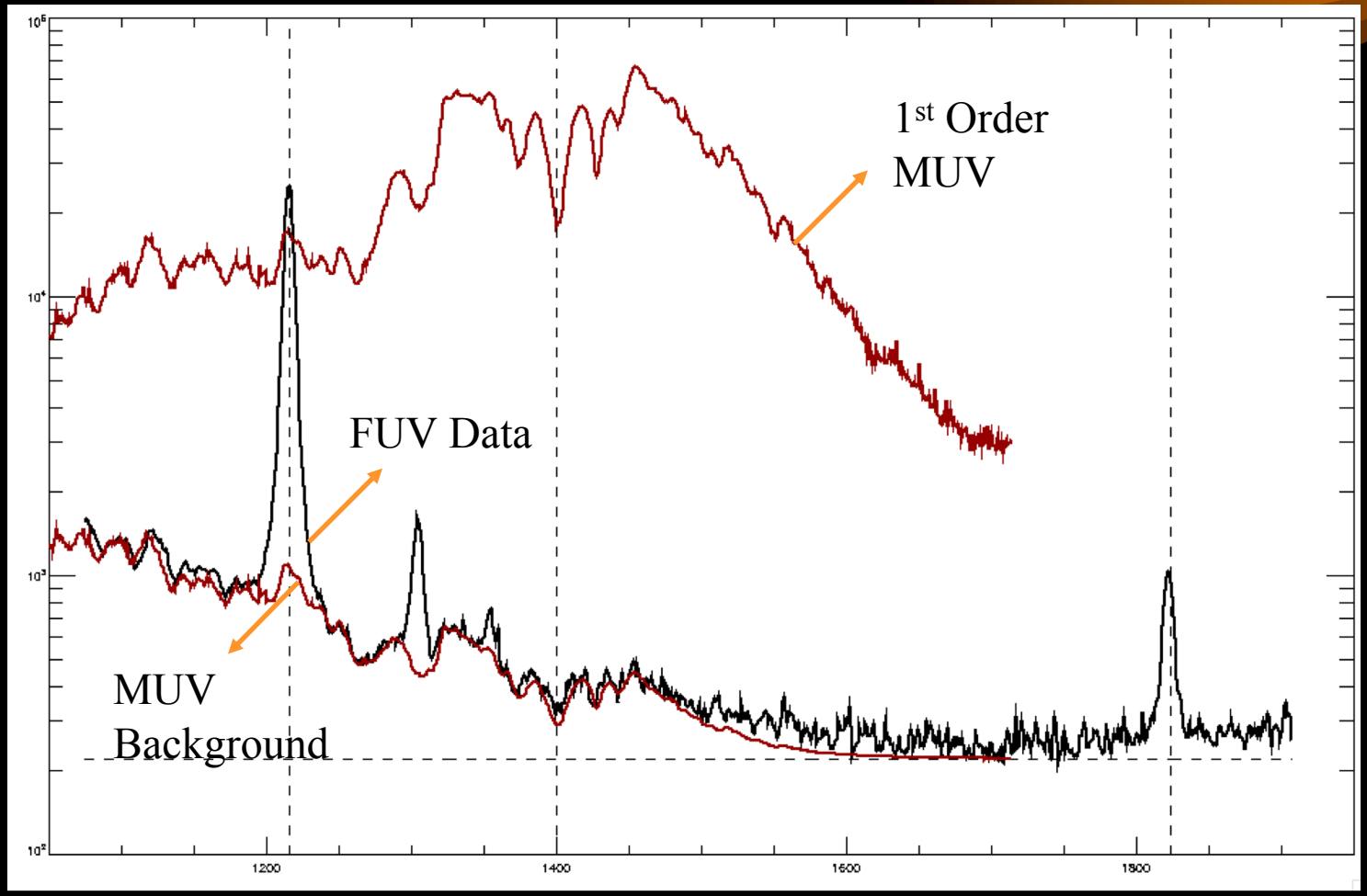
Small Keyhole

Spatial Dimension

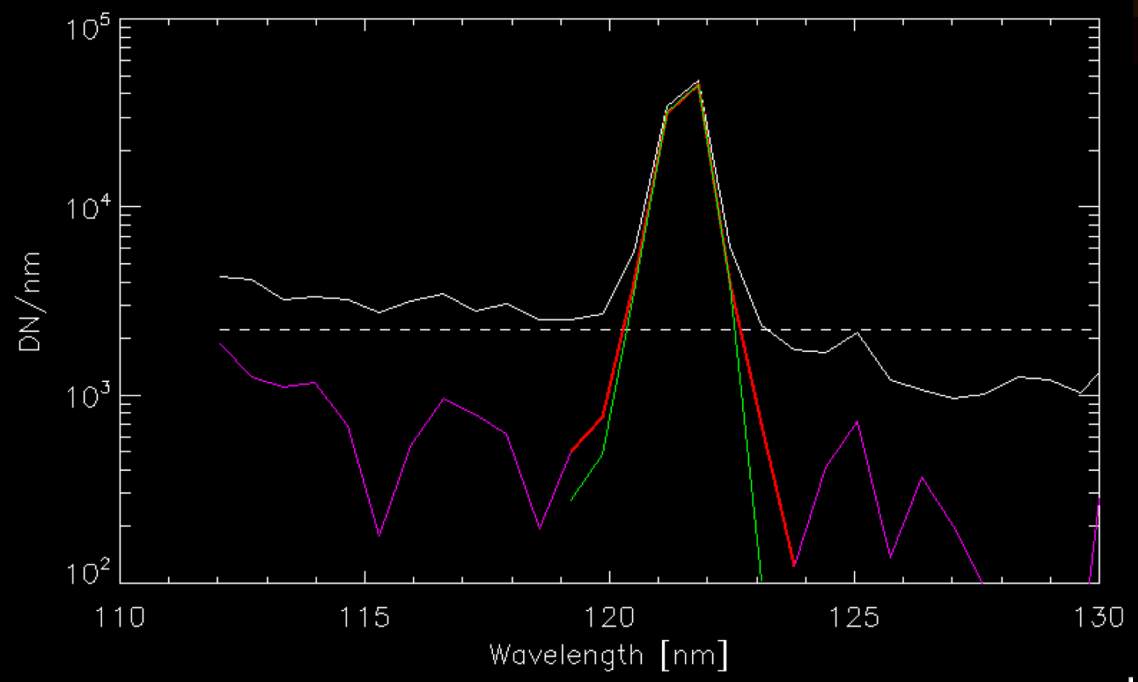
Spectral Dimension

Credit: Justin Deighen

Second Step of Data Processing



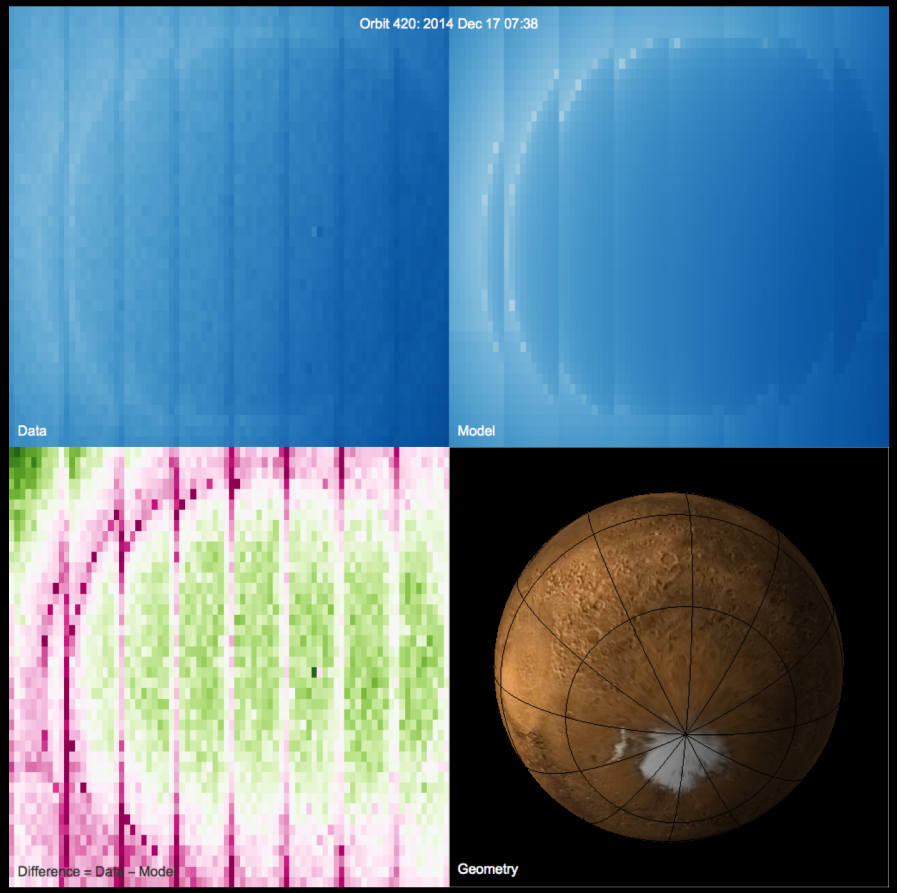
Second Step of Data Processing

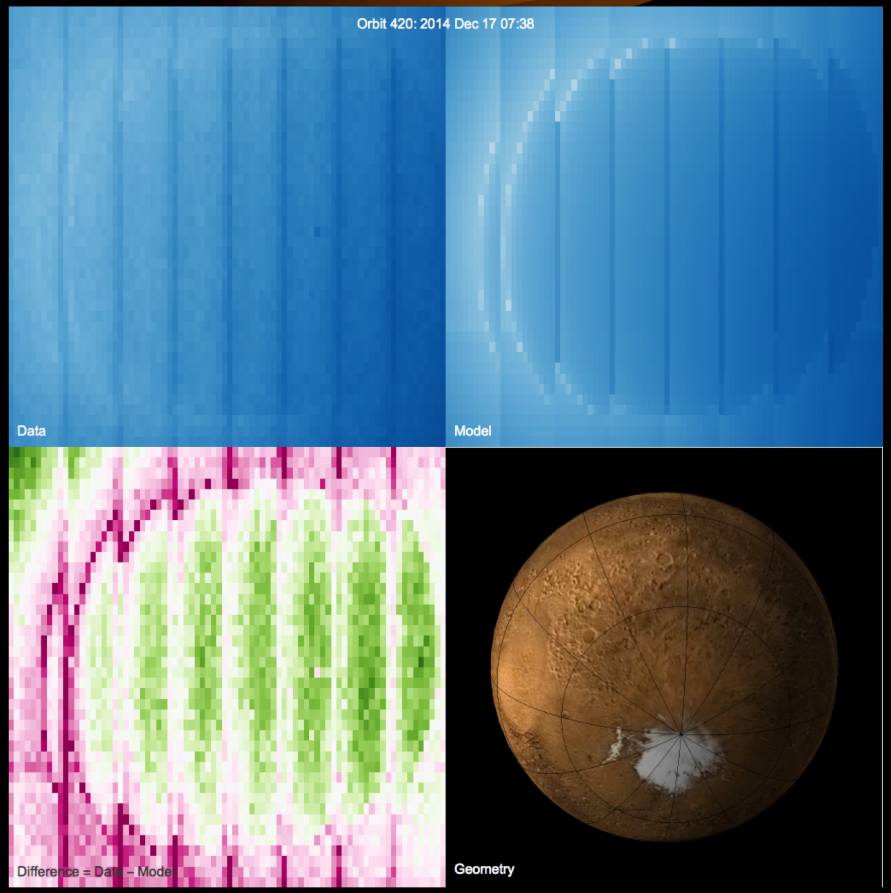


Red: Lyman-Alpha first step background subtraction.
Green: Lyman-alpha second-step background subtraction.
Purple: Subtracted Background

- Used 1st order MUV (180-340 nm) data.
- Ran a MLR routine on 1st order MUV and included it for background subtraction.

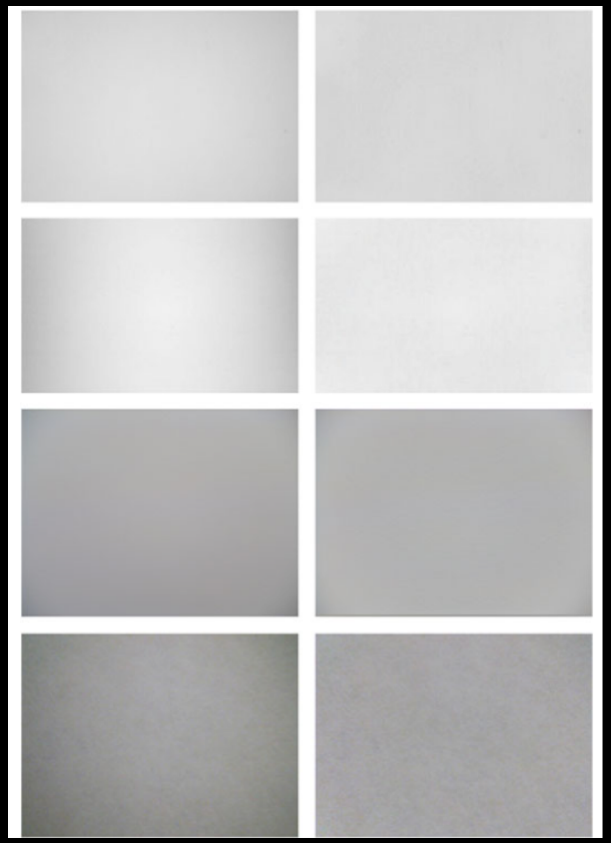
Results: Improvement of Second Step Data Processing





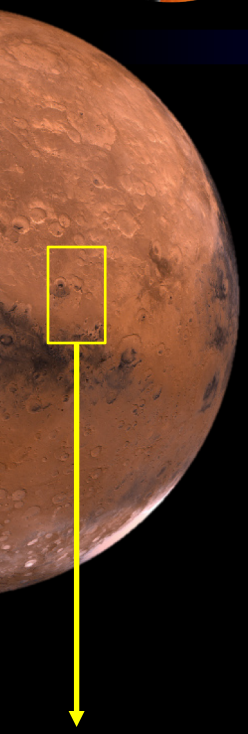
Third Step: Flatfield Correction

- Technique used to improve the quality of digital imaging caused by the variations of pixel-to-pixel sensitivity in the detector.

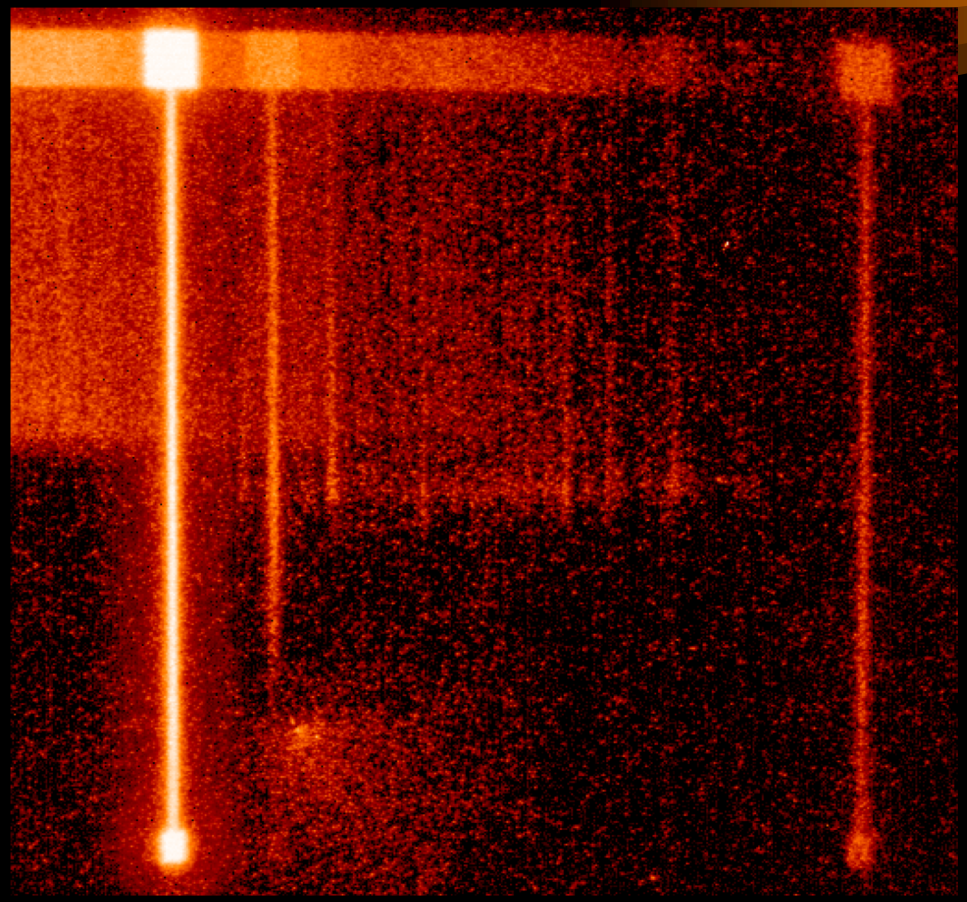


Before After

Third Step: Flatfield Correction



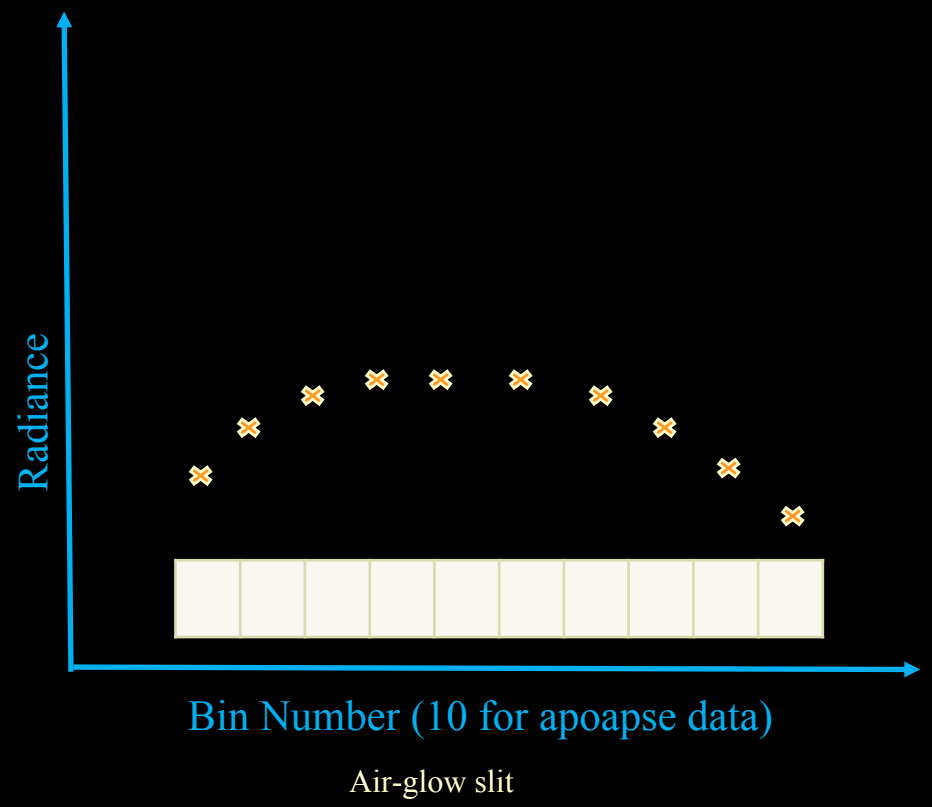
Observational Geometry
(6500 km)

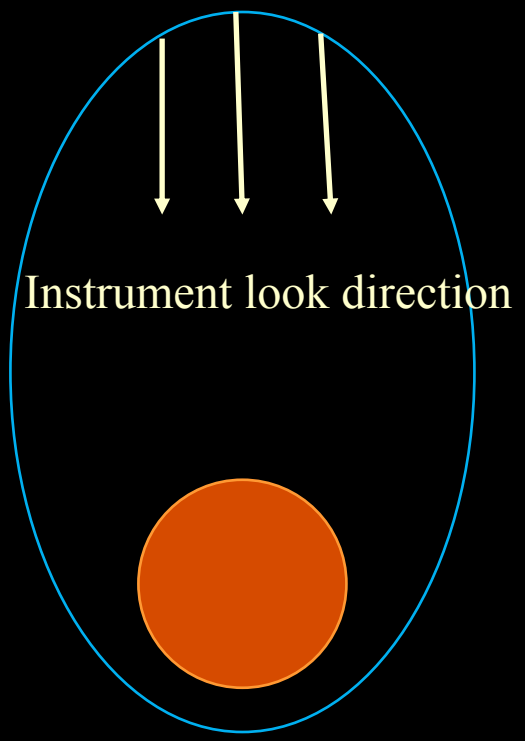


Credit: Justin Deighen

Third Step: Flatfield Correction

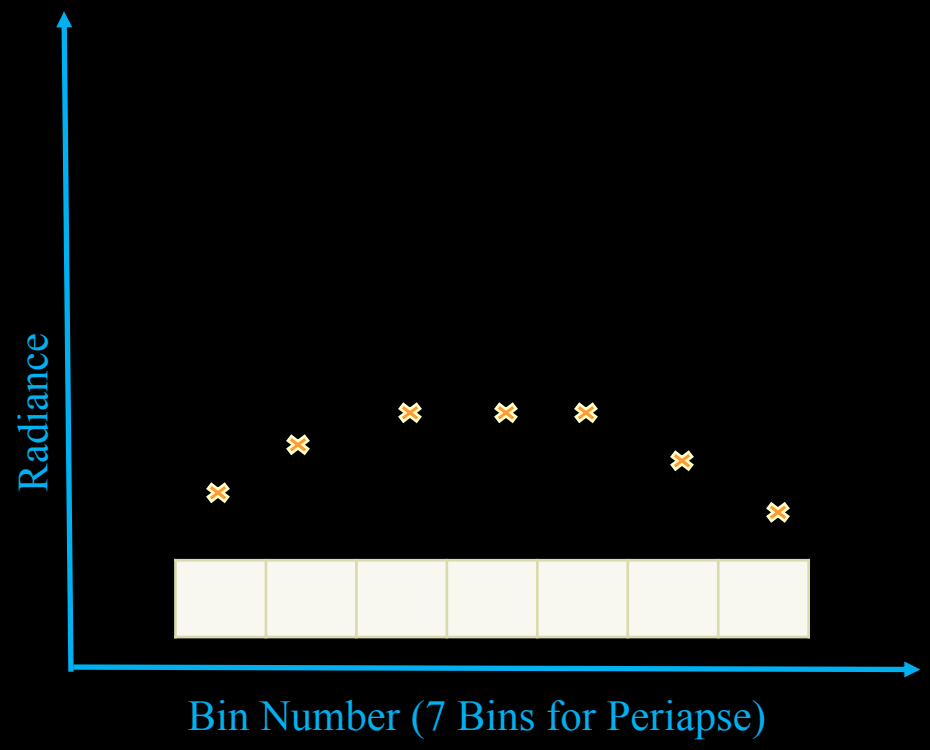
- Apoapse Data (10 Bins)



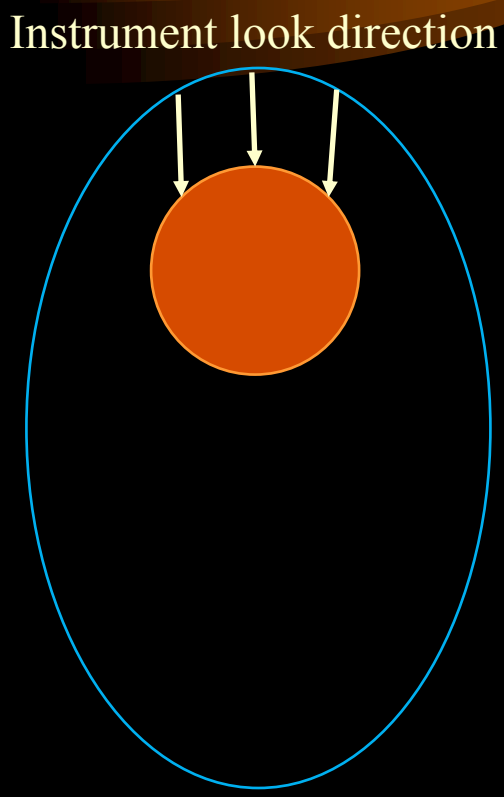


Flatfield Correction

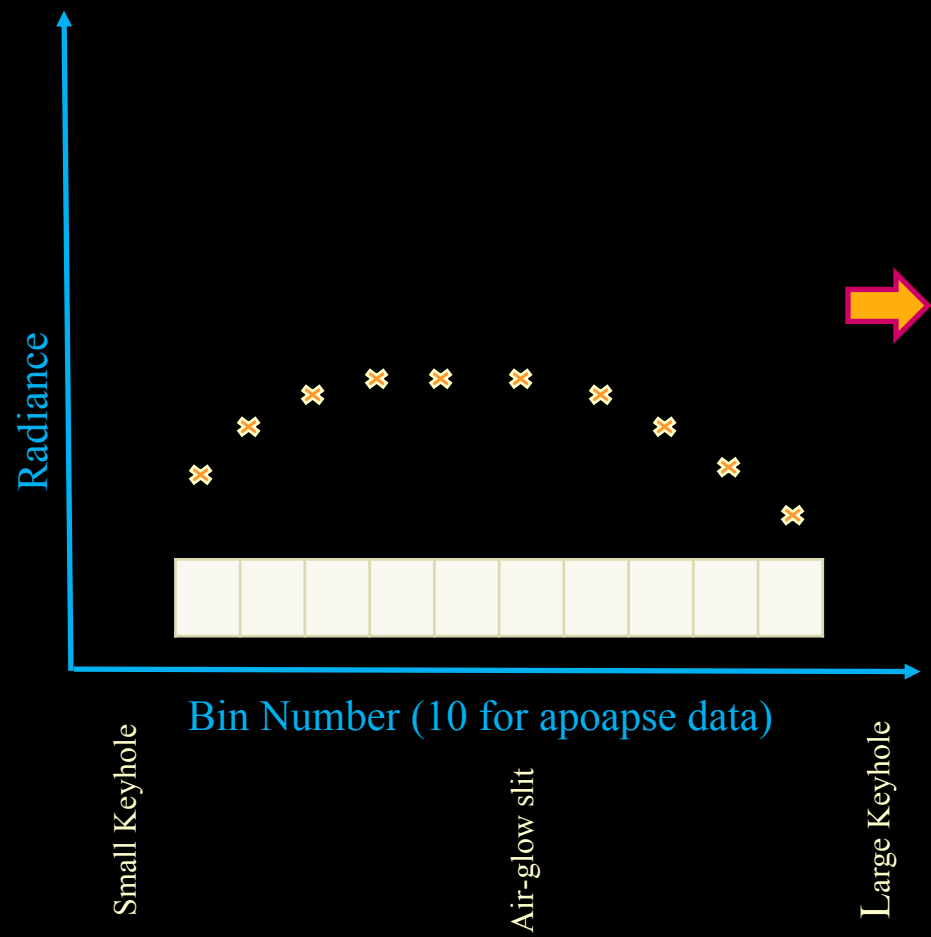
- Periapse Data (7 Bins)

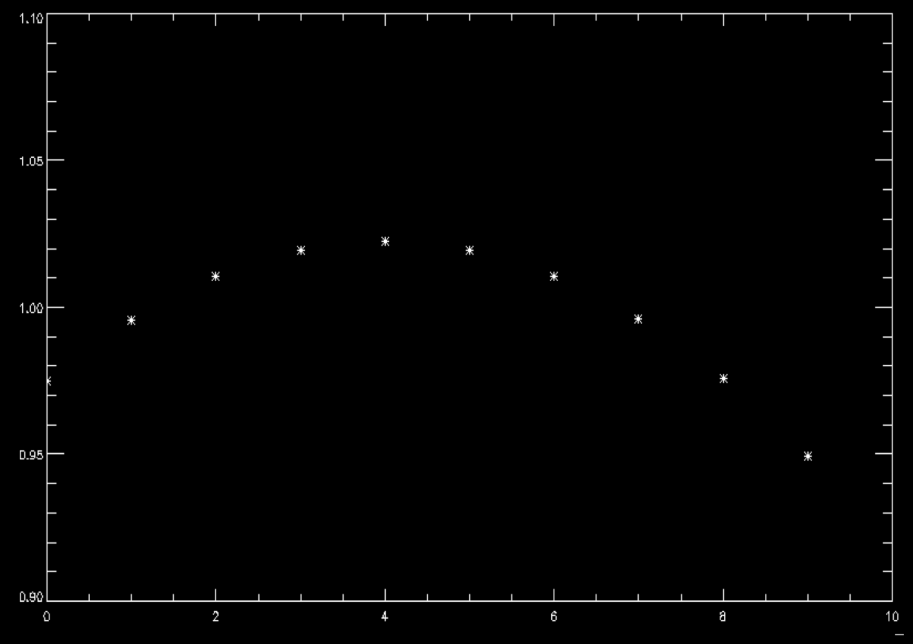


Air-glow slit

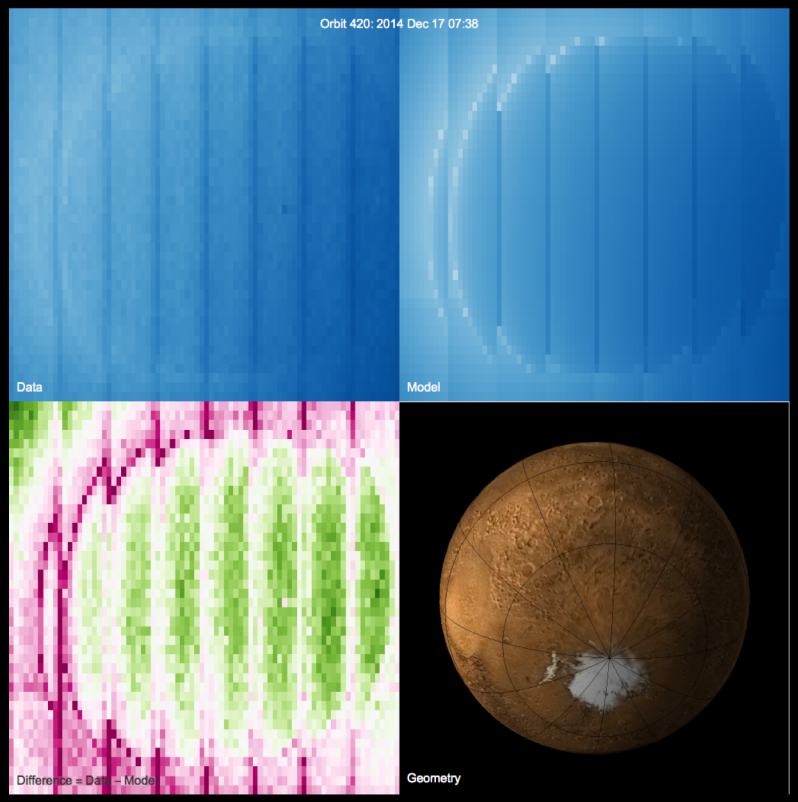


Third Step: Flatfield Correction

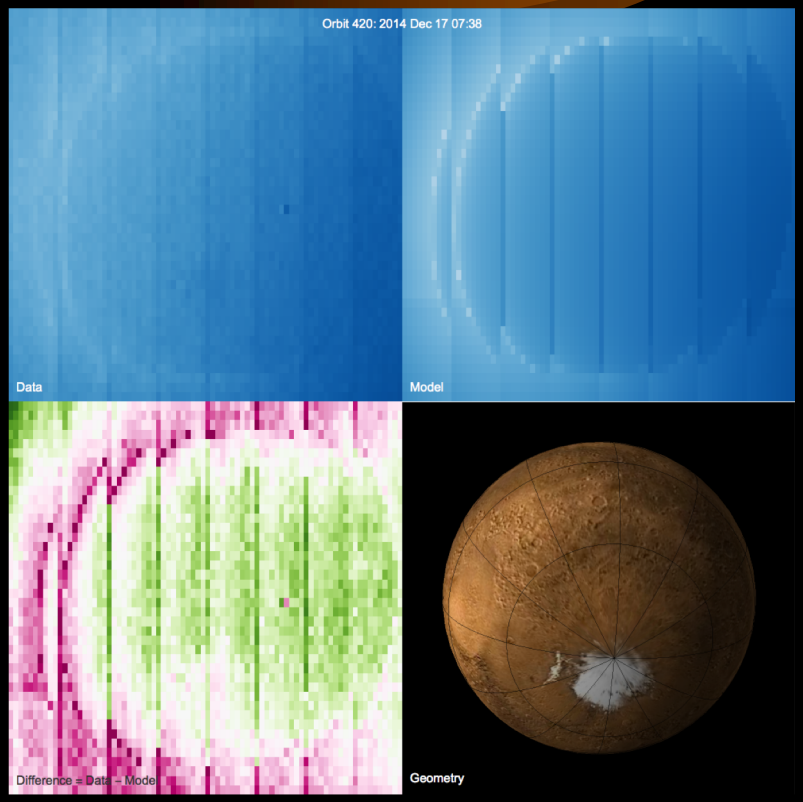




Third Step: Flatfield Correction

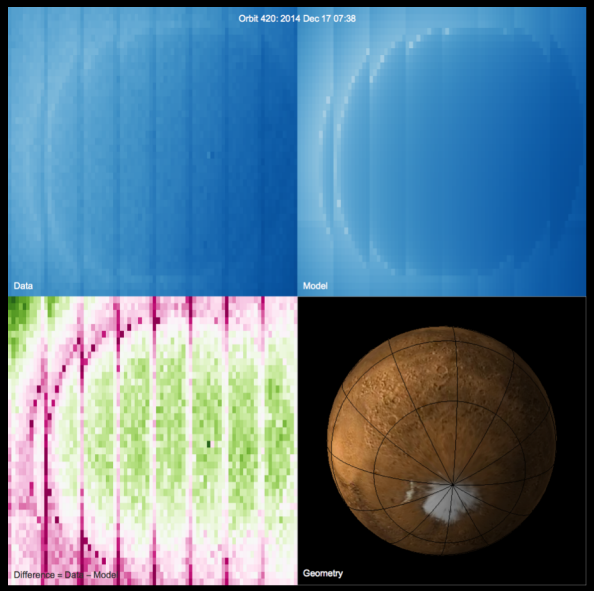


MUV Background Subtraction

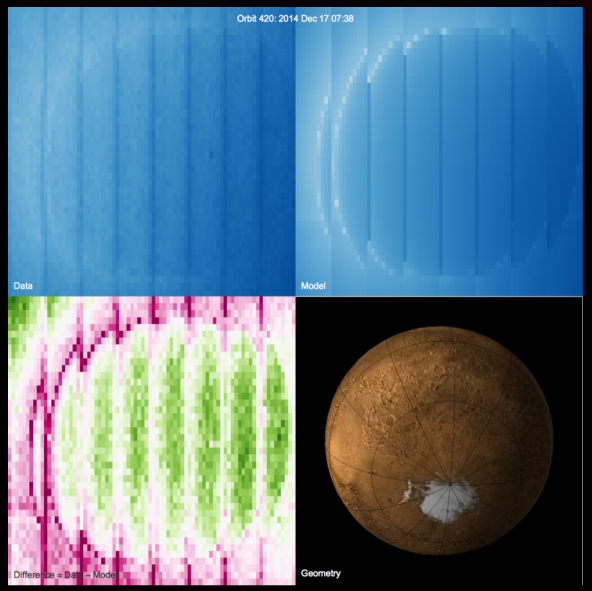


MUV Background Subtraction & Flatfield Correction

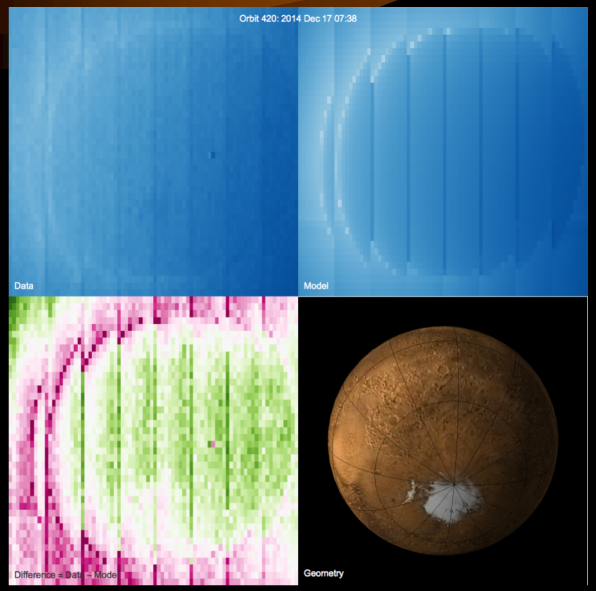
Procedure Summary



1. Background Subtraction

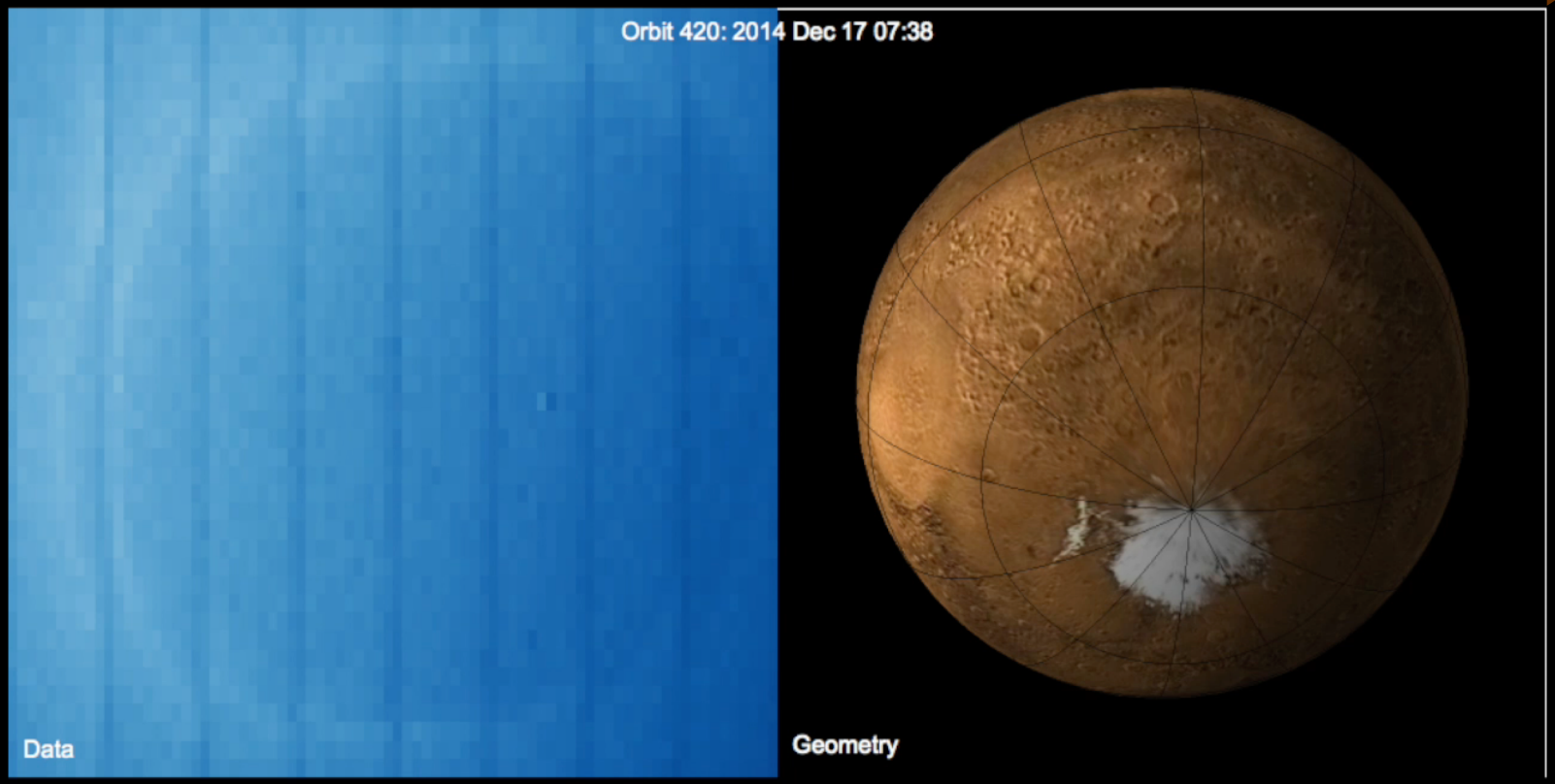


2. MUV Background Subtraction



3. MUV Background Subtraction & Flatfield Correction.

Final Results



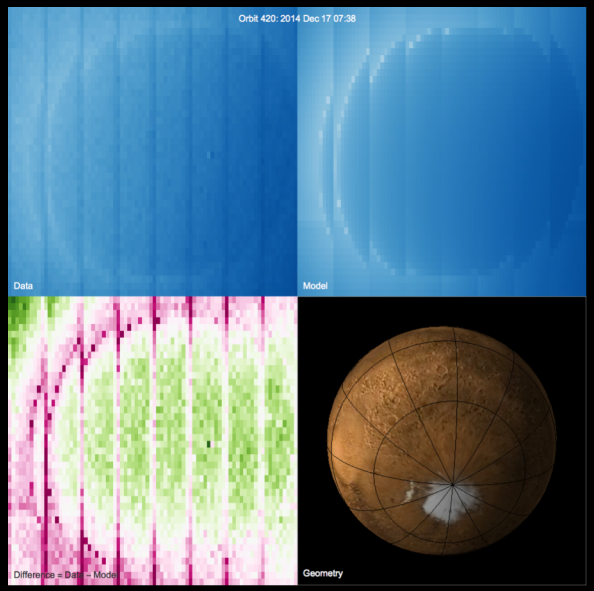
Next Steps

- Background code improvements, takes ~45 minutes to run one orbit.
- Improve the model for the new procedure.

Implications

- Seasonal variability of H loss
- Identify proton aurora from the data.

Procedure Summary



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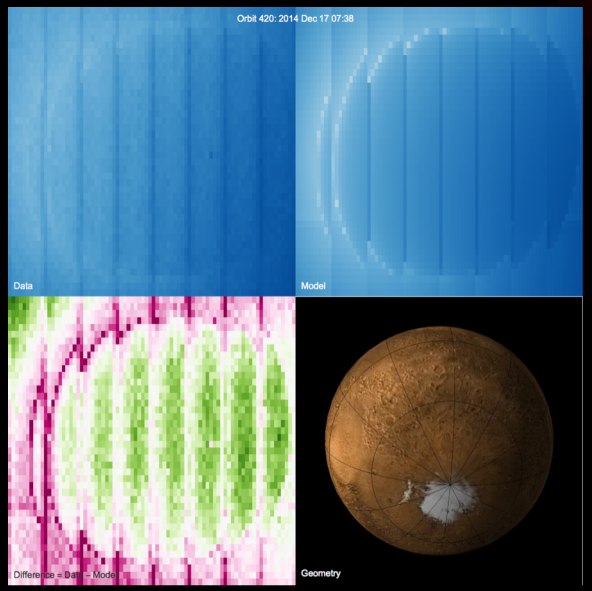
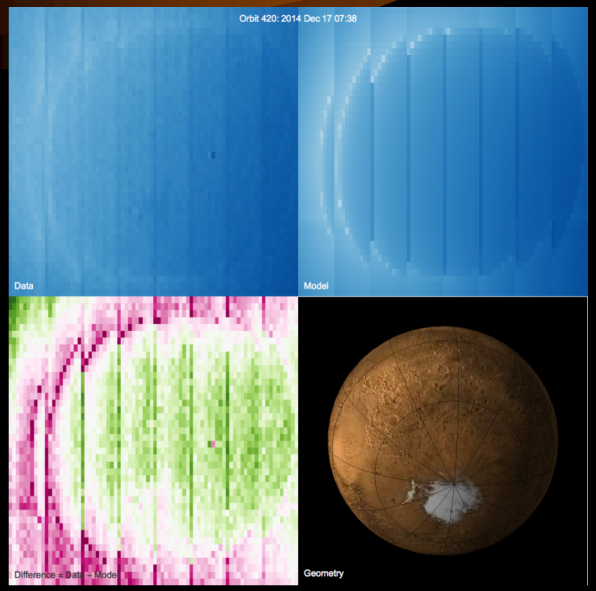


2. MUV Background Subtraction



3. MUV Background Subtraction & Flatfield Correction.