First-Year Results from the LAMP Instrument on the LRO Mission

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& the LAMP Team

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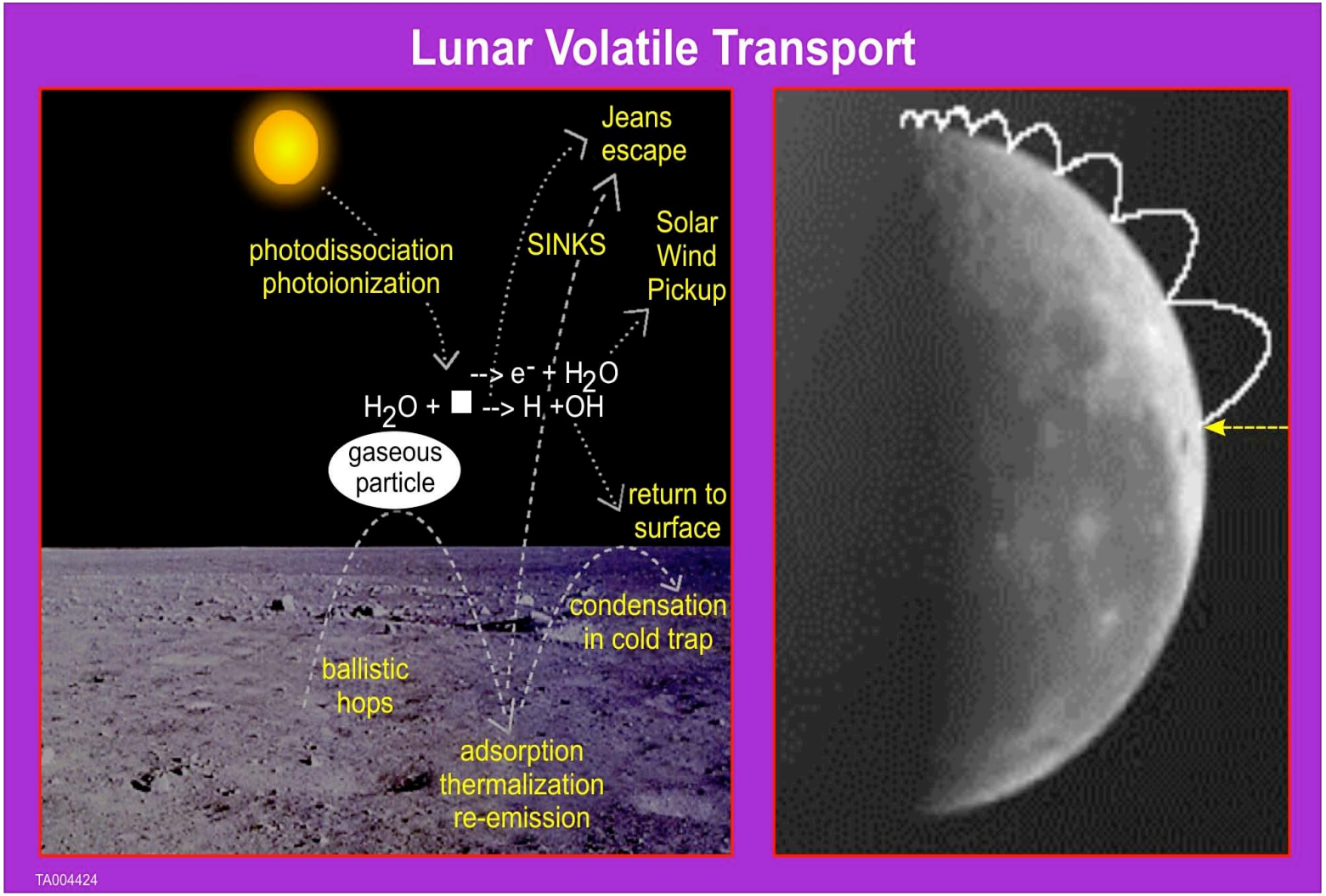
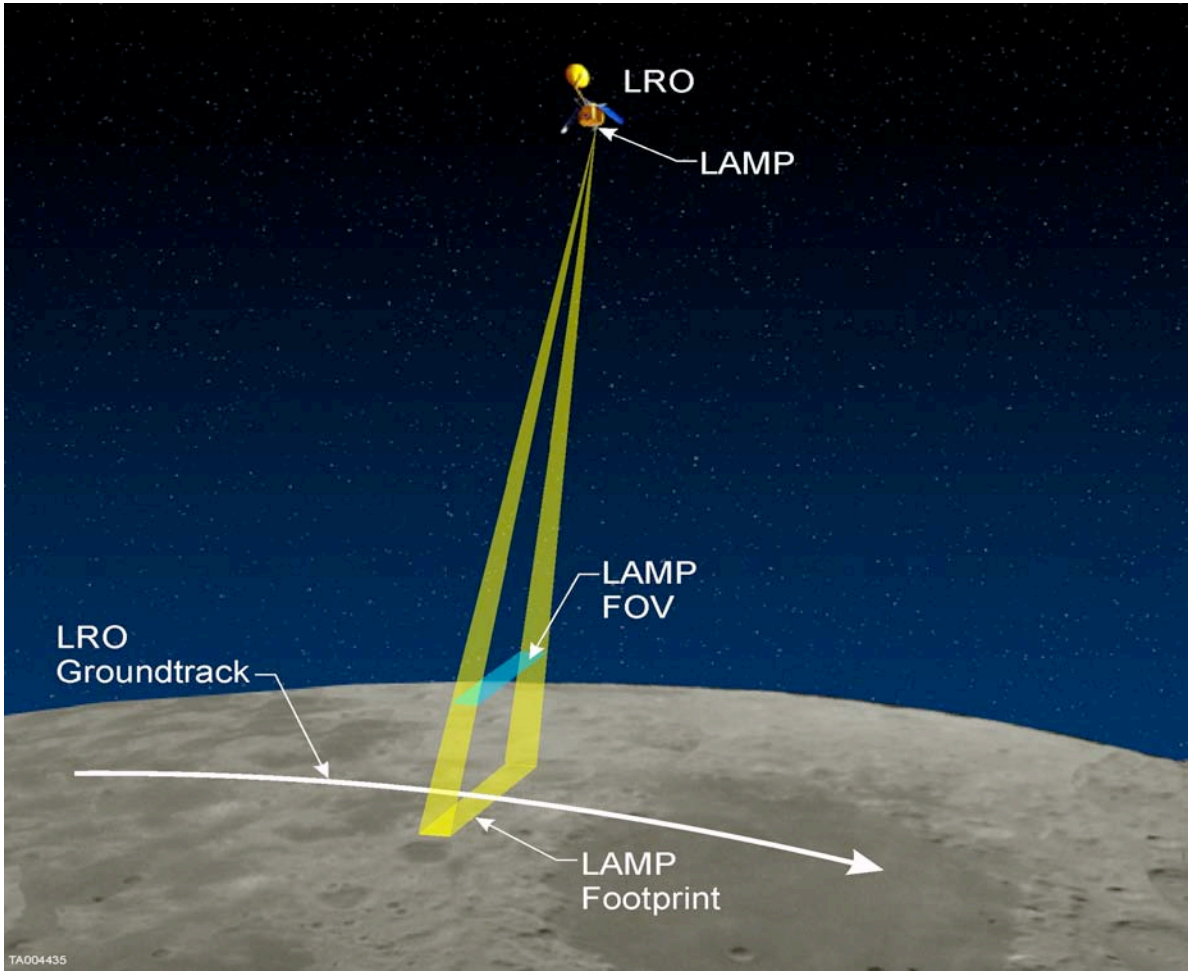


Why is LAMP on LRO?

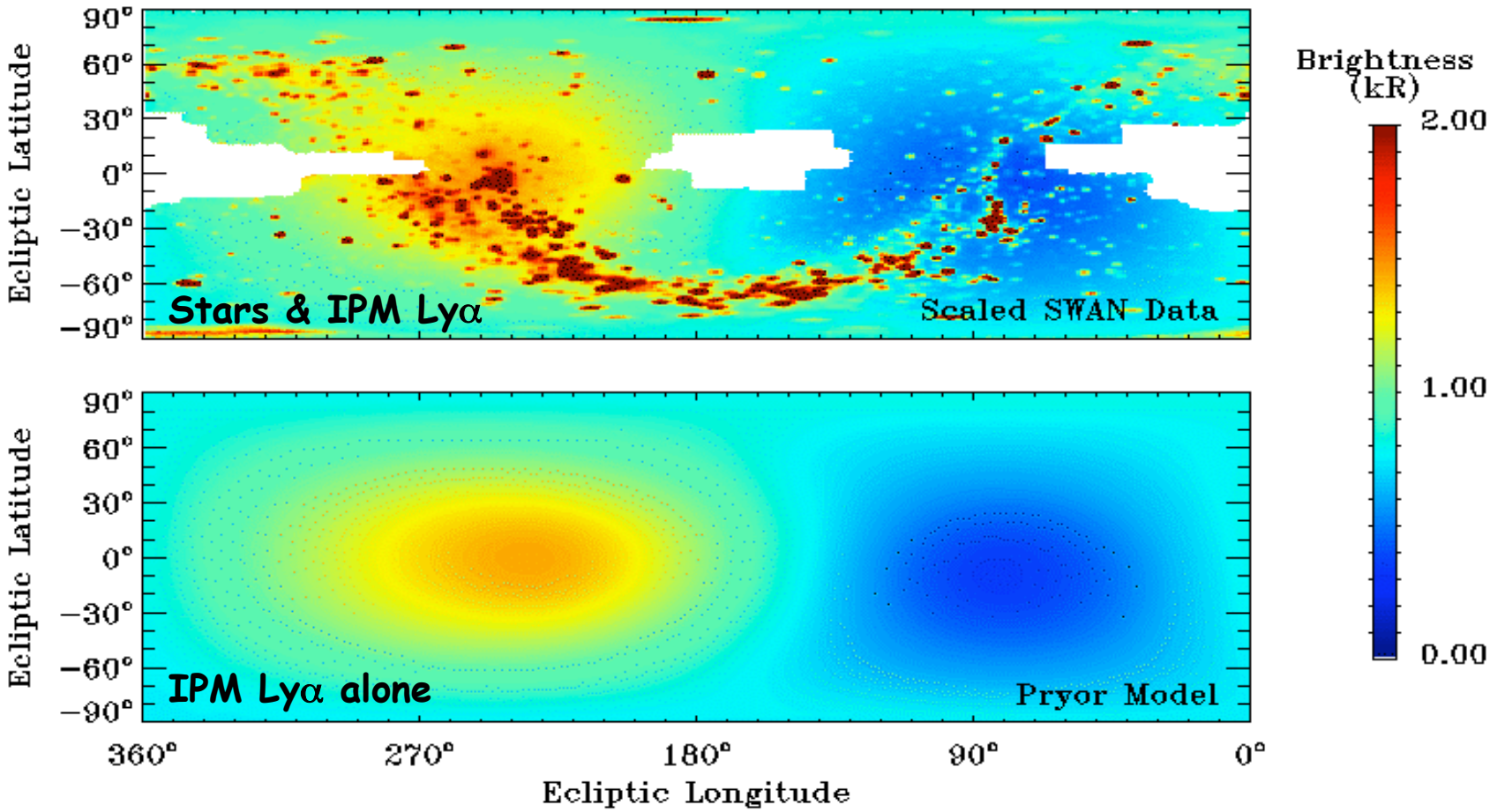
- Water and other volatiles collect in permanently shaded regions (PSRs) from solar wind & comet impacts [e.g., *Crider & Vondrak* 2000], but it's hard to see inside PSRs



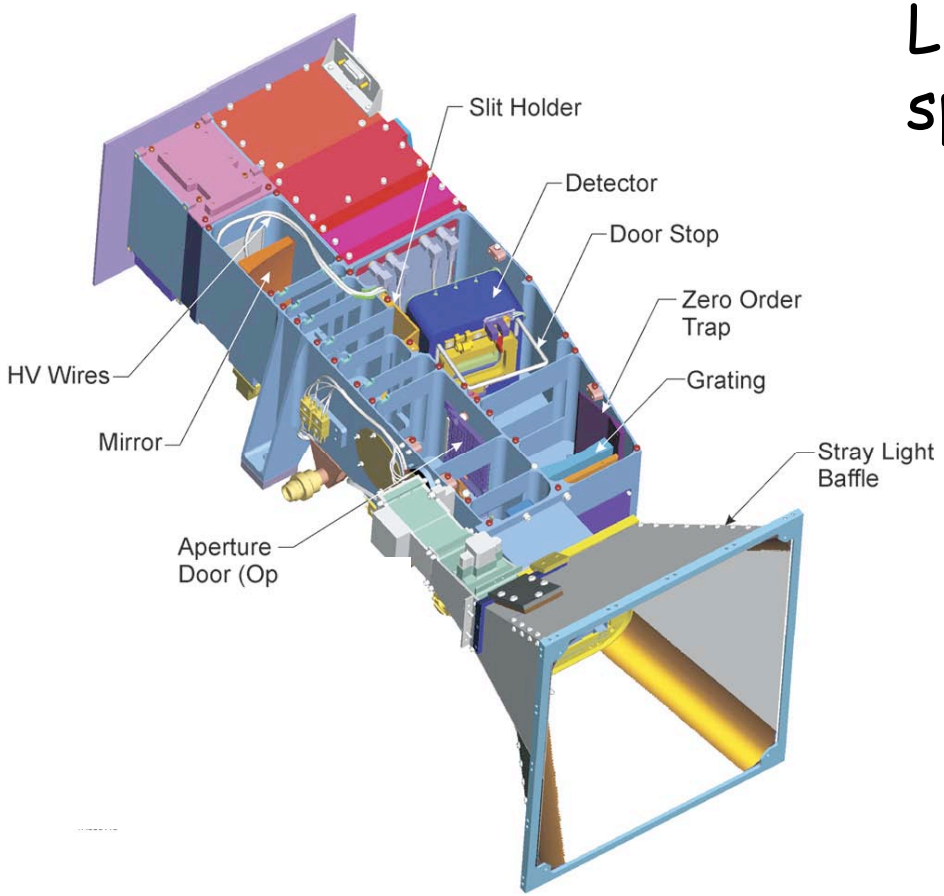
The LAMP concept:

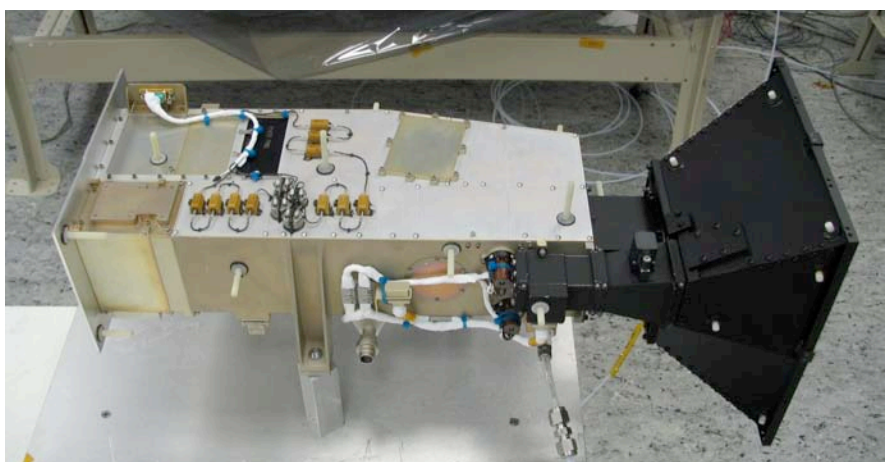
- Why not use IPM Lyα (along with UV starlight) as a source of illumination to look at the lunar nightside & permanently shadowed regions (PSRs)?
- The IPM illumination is the same inside & outside of PSRs

IPM Lyα Data & Model



- At 121.6 nm, the night sky is glows in Lyman-α light from H atoms passing through the solar system – the interplanetary medium (IPM)
- Compared to direct sunlight it would be like twilight on an overcast day
- Starlight is another (much fainter) illumination source we exploit





LAMP is an ultraviolet imaging spectrograph composed of:

- A 41 x 65 mm off-axis paraboloid primary telescope mirror
- A 50 x 50 mm toroidal holographic diffraction grating
- A 2-D imaging photon counting DDL microchannel plate (MCP) detector with a vacuum cover/window assembly
- A Lunar Terminator Sensor (LTS) with dual visible-light photodiodes
- A stray-light baffle at the entrance aperture
- An aperture door with a pinhole for dayside observations

LAMP Specs:
Mass: 6.06 kg
Power: 4.52 W
FOV: 0.3° × 6.0°
λ Range: 57-196 nm
λ Resolution: <4 nm (filled slit)

LAMP Science & Measurements

- LAMP will be used to identify and localize exposed water frost in permanently shadowed regions (PSRs)
- LAMP will provide landform mapping (using Lyα albedos) in and around the PSRs of the lunar surface
- LAMP will demonstrate the feasibility of using starlight and UV sky-glow for future night time and PSR surface mission applications
- LAMP will Assay the Lunar Atmosphere and Its Variability

THE LAMP TEAM:

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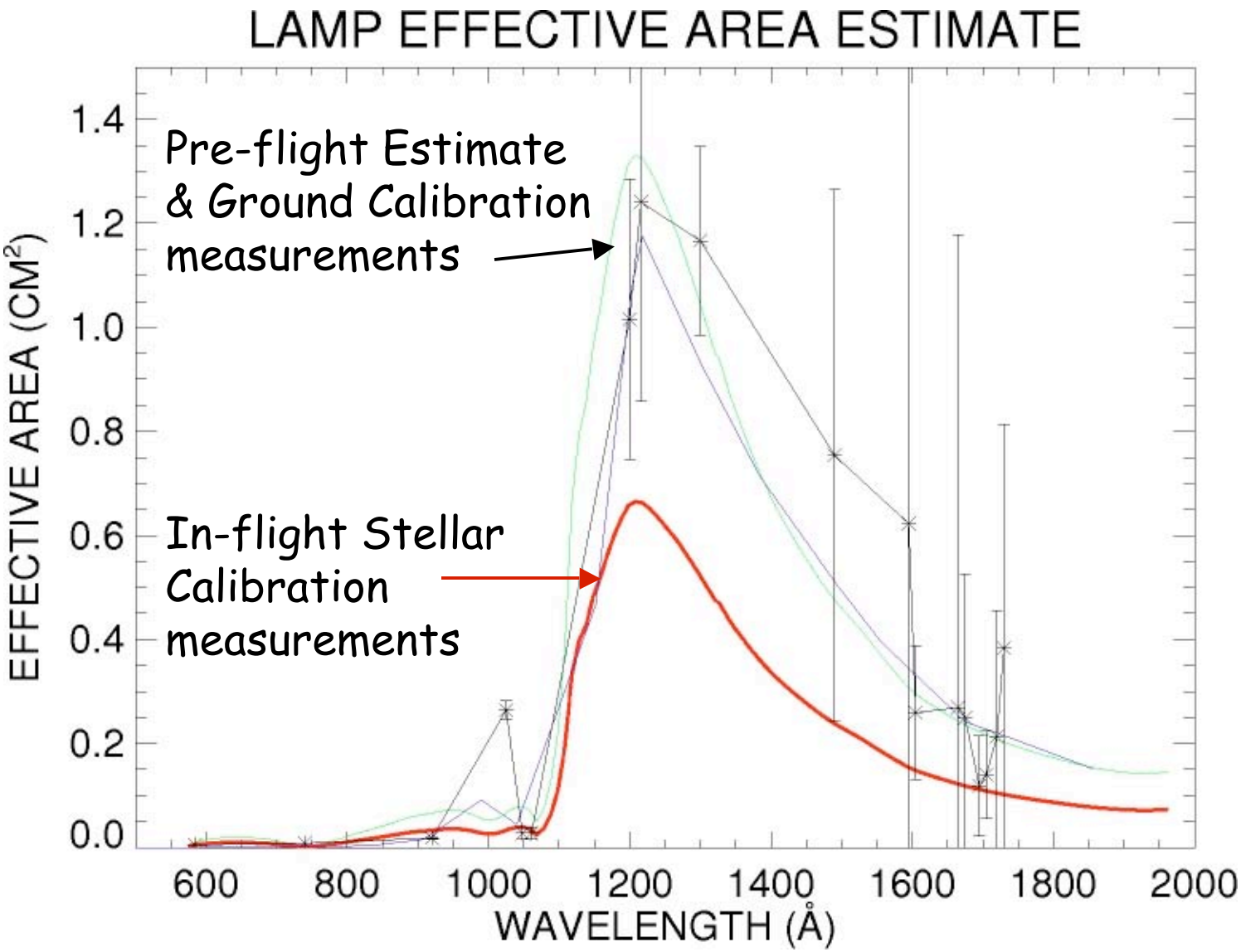
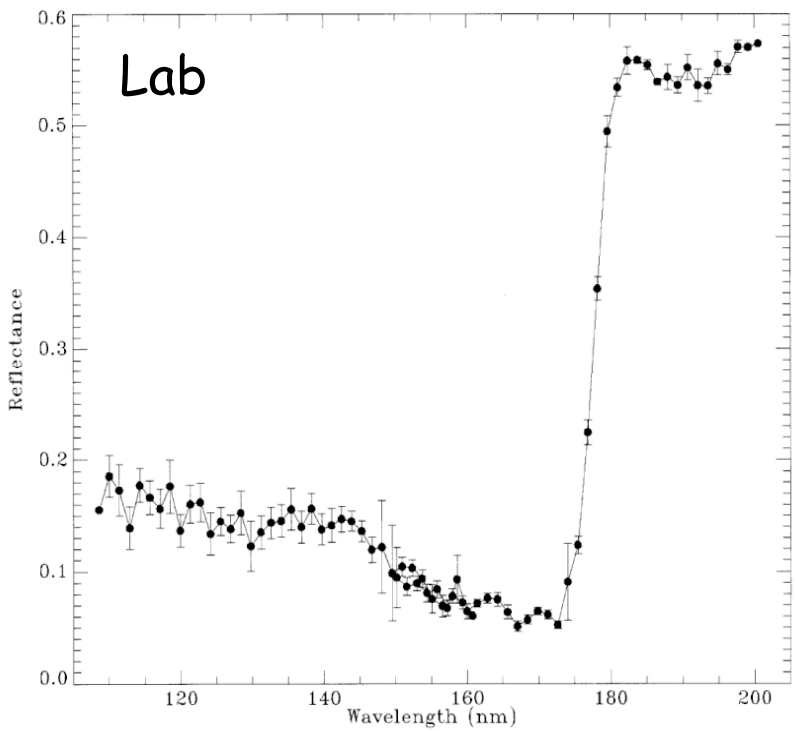
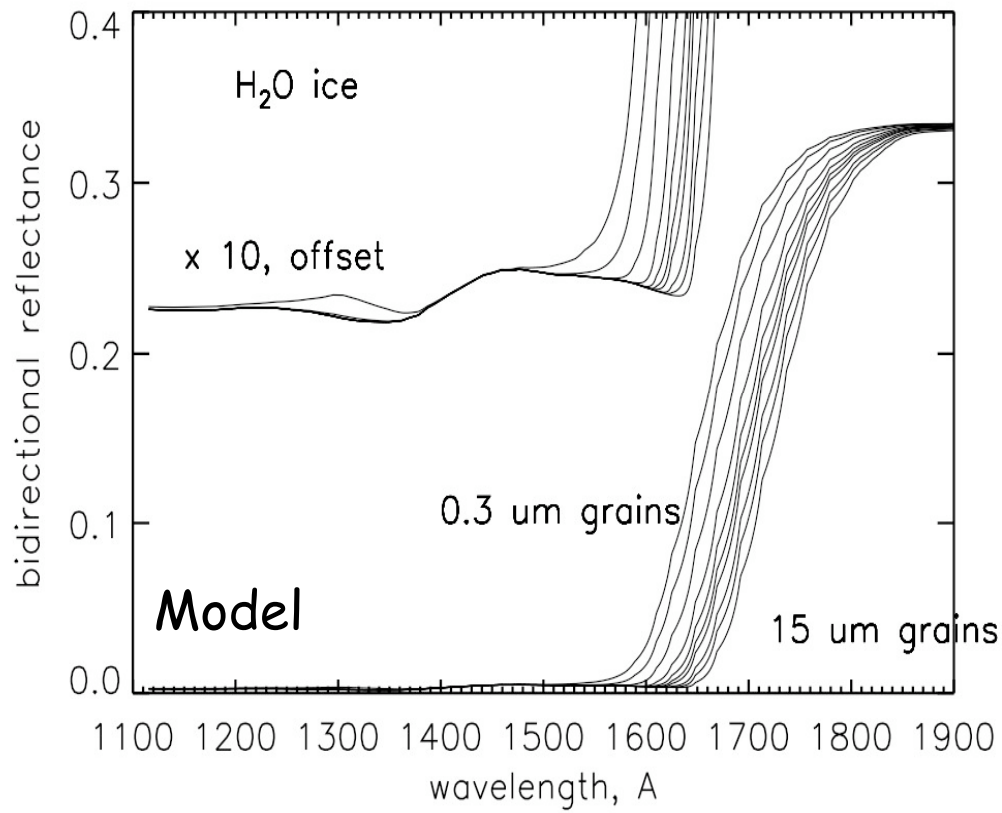


LAMP's effective area - the microchannel plate detector is coated with CsI and the optical elements are coated with Al/MgF_2 to provide peak sensitivity at Lyα

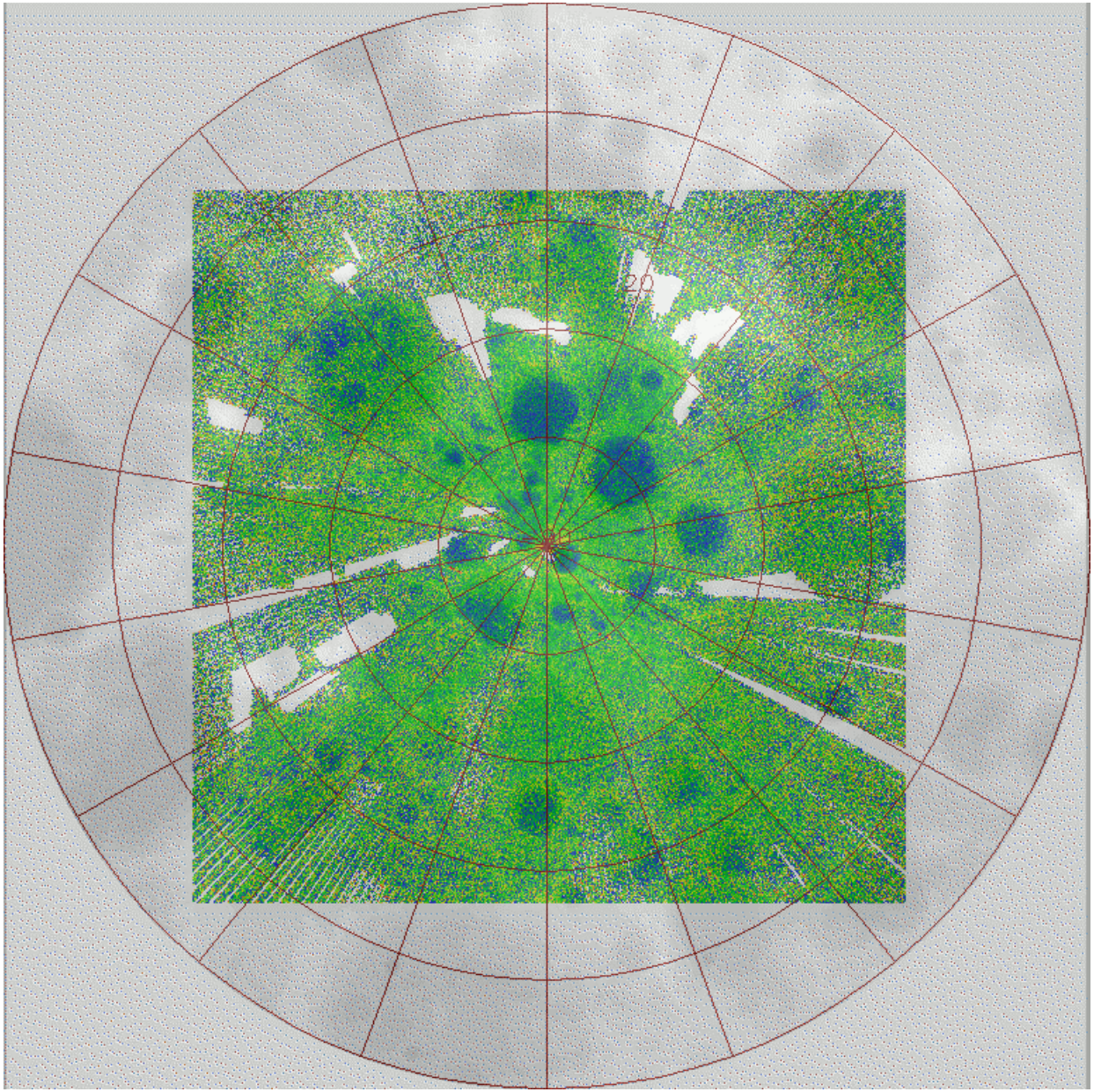
Water Ice Detection Technique

- Lab measured water frost reflectance shows a distinct broad UV absorption band or "cut off" in reflectivity at ~160-180 nm
- LAMP searches for this spectral signature of water ice in PSR albedo measurements



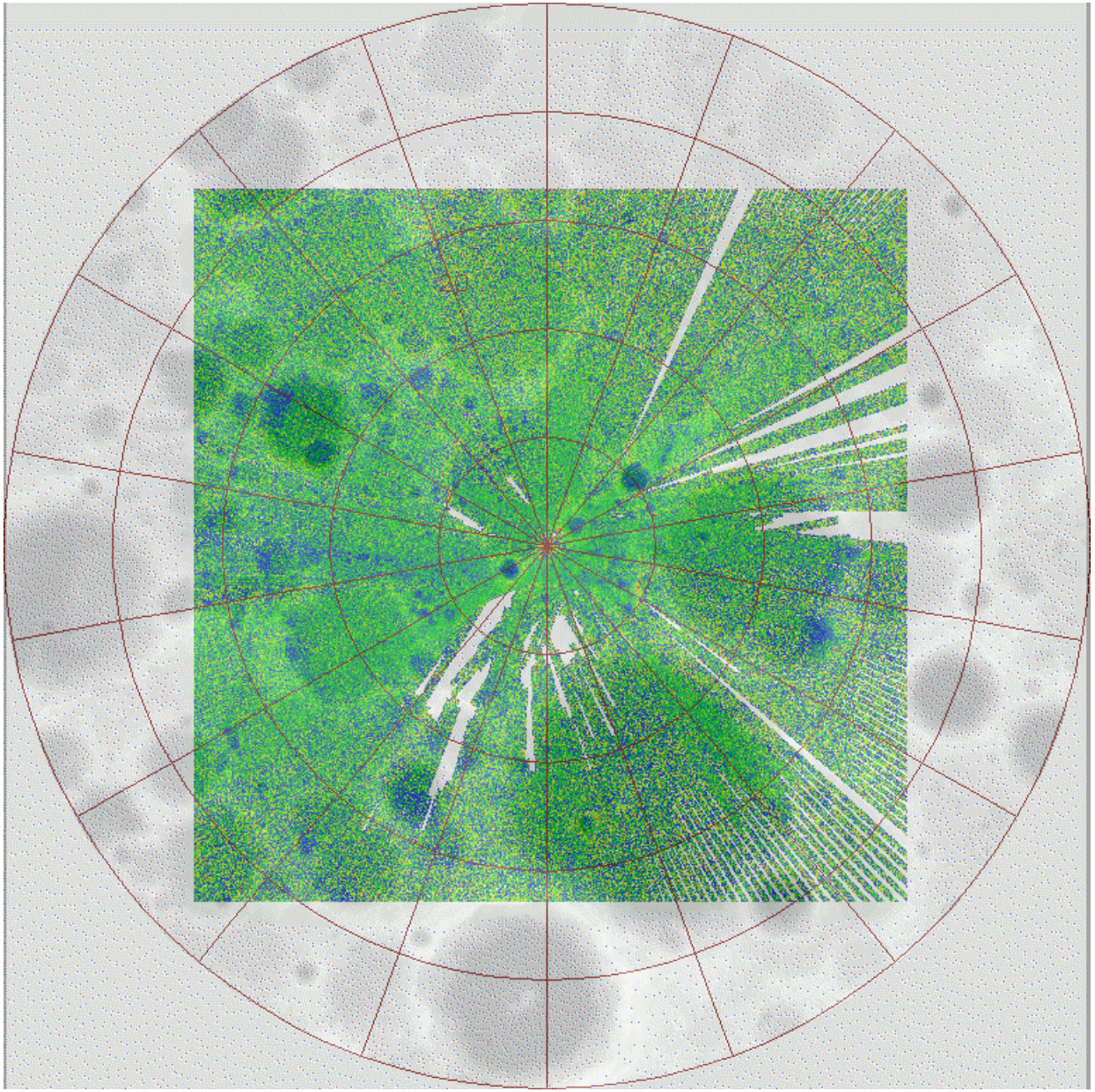


LAMP South Pole Brightness Map



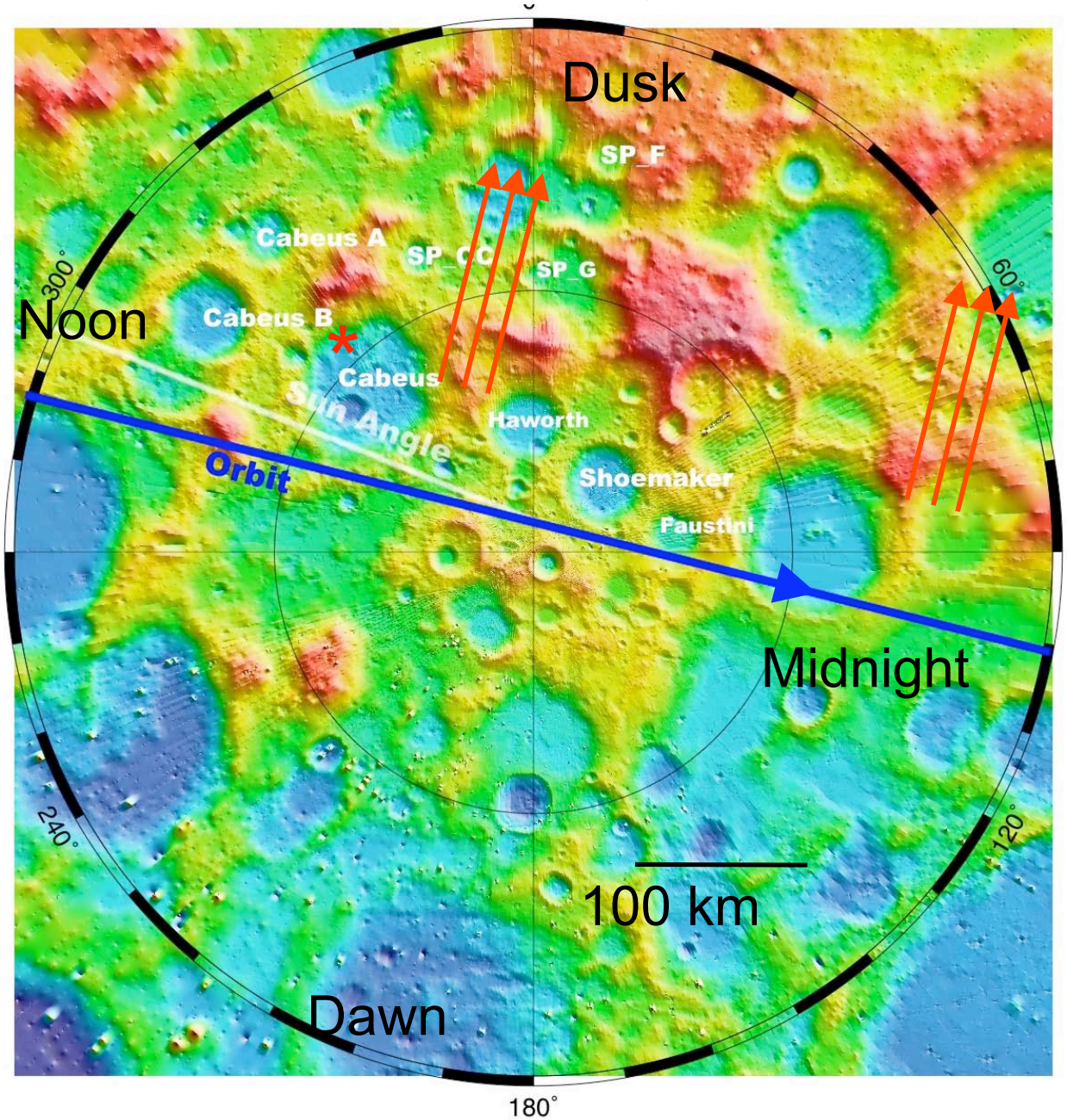
PSRs are darker than surrounding areas at far-ultraviolet wavelengths

LAMP North Pole Brightness Map

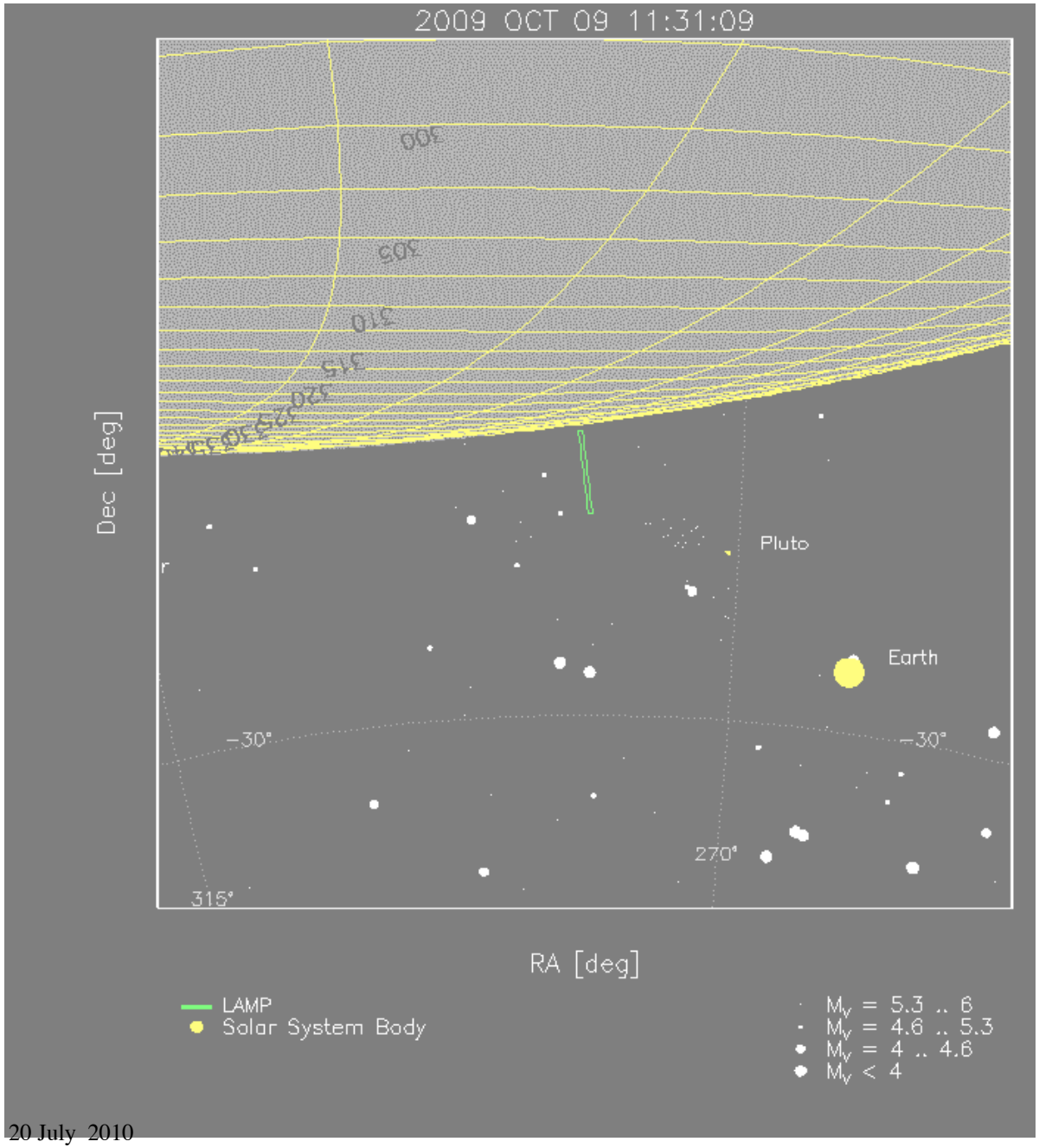


LRO/LAMP's View of LCROSS Impact

- During the impact, LRO flew from ~noon to ~midnight over the south pole
- LRO closest approach was offset from Centaur impact time by ~90 seconds



LAMP/LCROSS Animation



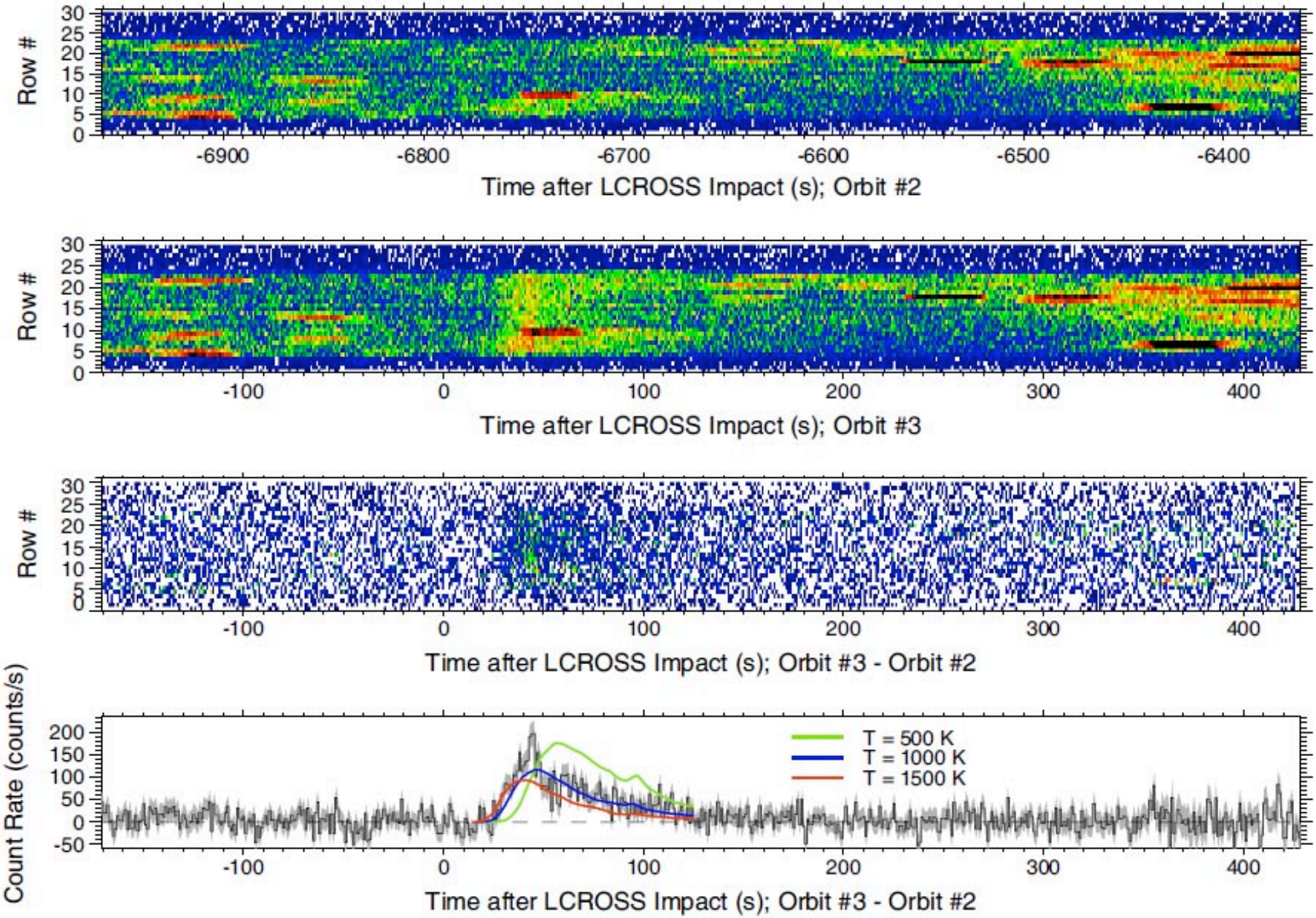
- LAMP slit indicated by the green line near the limb (roll angle ~80.3°)
- Plume visible above limb (seen from LRO) at altitudes z>35 km
- 8 consecutive orbits: 2 before, 1 during, & 5 after
- LCROSS Centaur target in Cabeus crater:

  lat = -84.675°

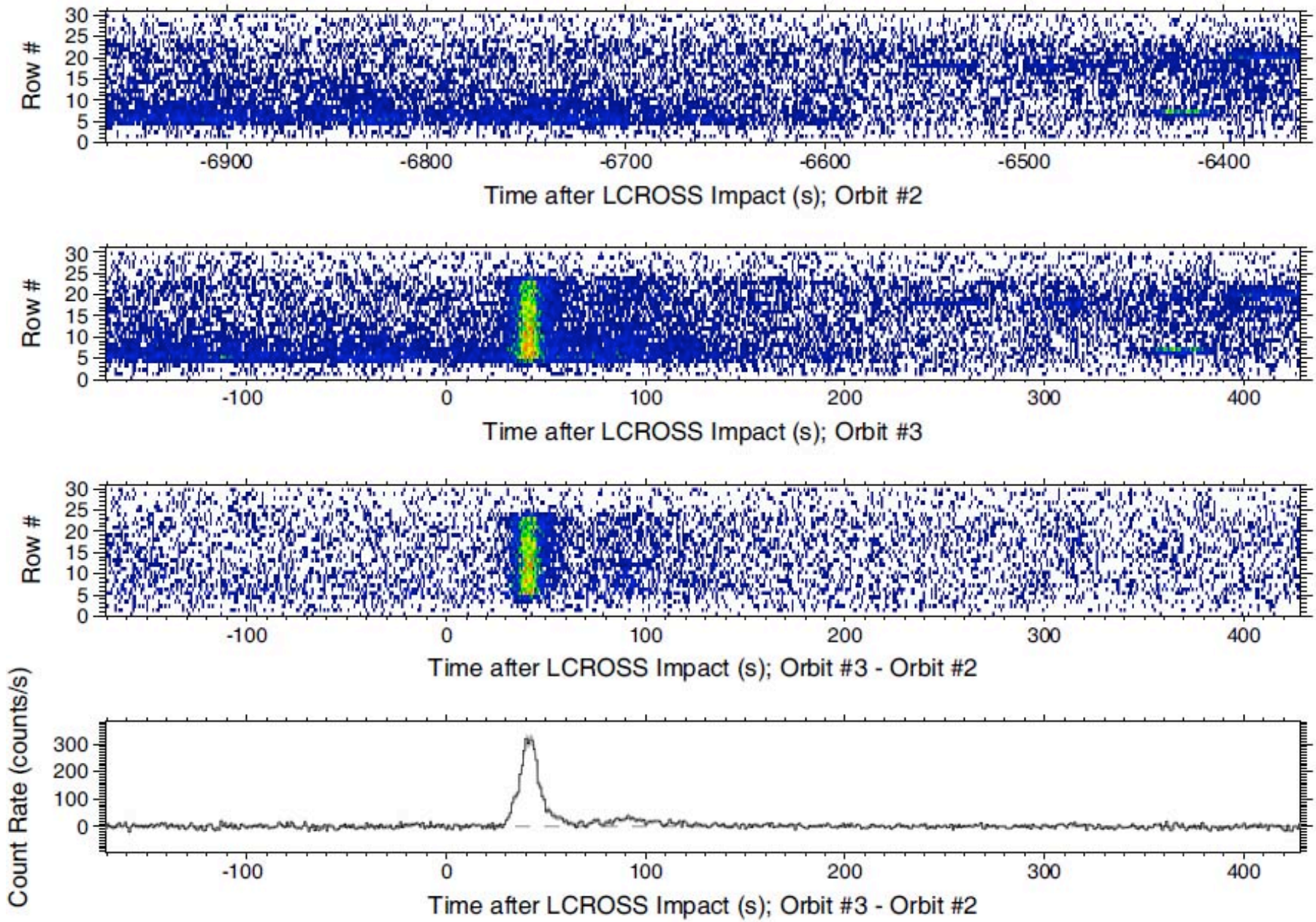
  lon = 311.275°

  UT = 11:31:19

Plume Light Curves – H_2

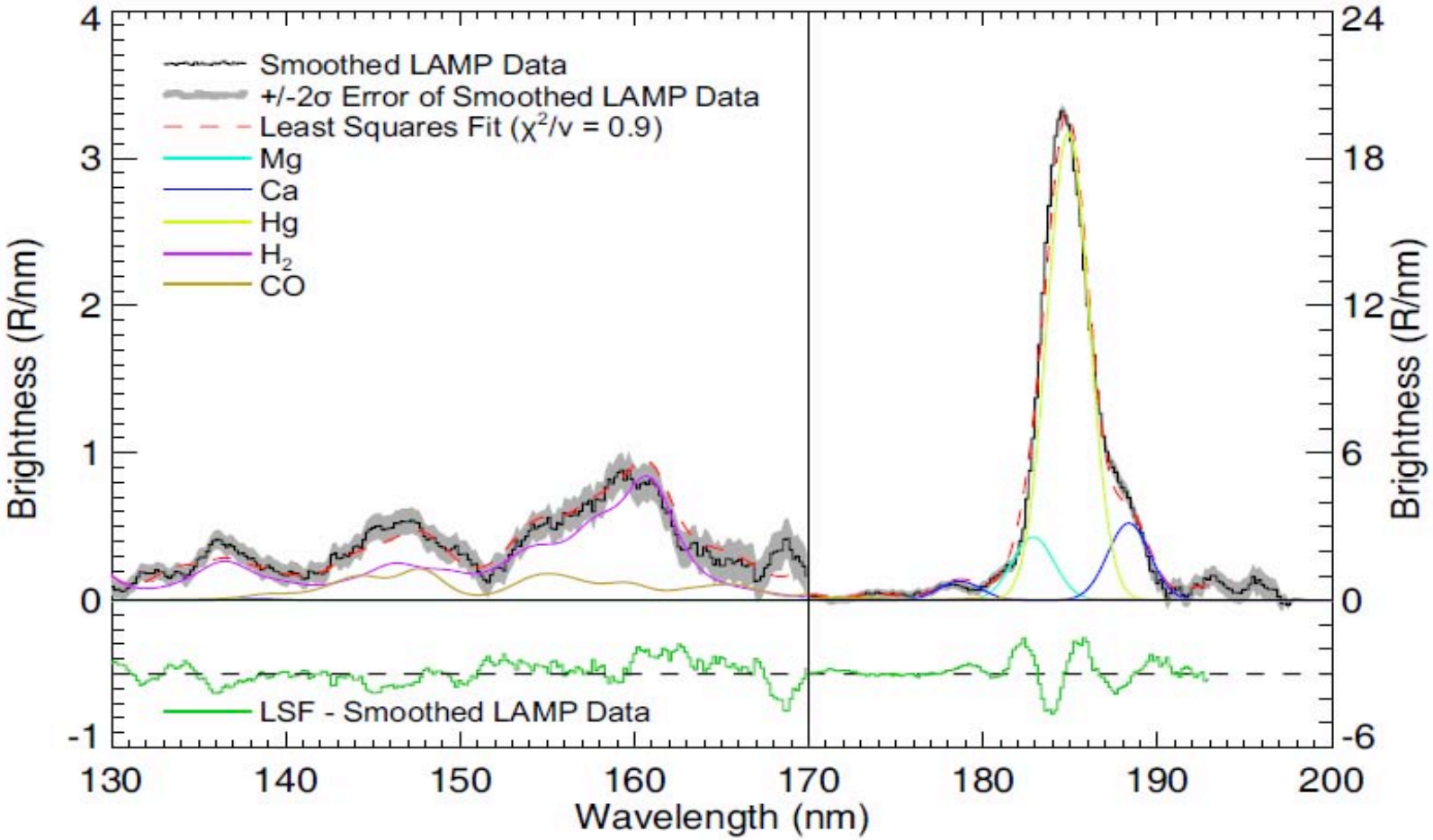


Plume Light Curves – Hg

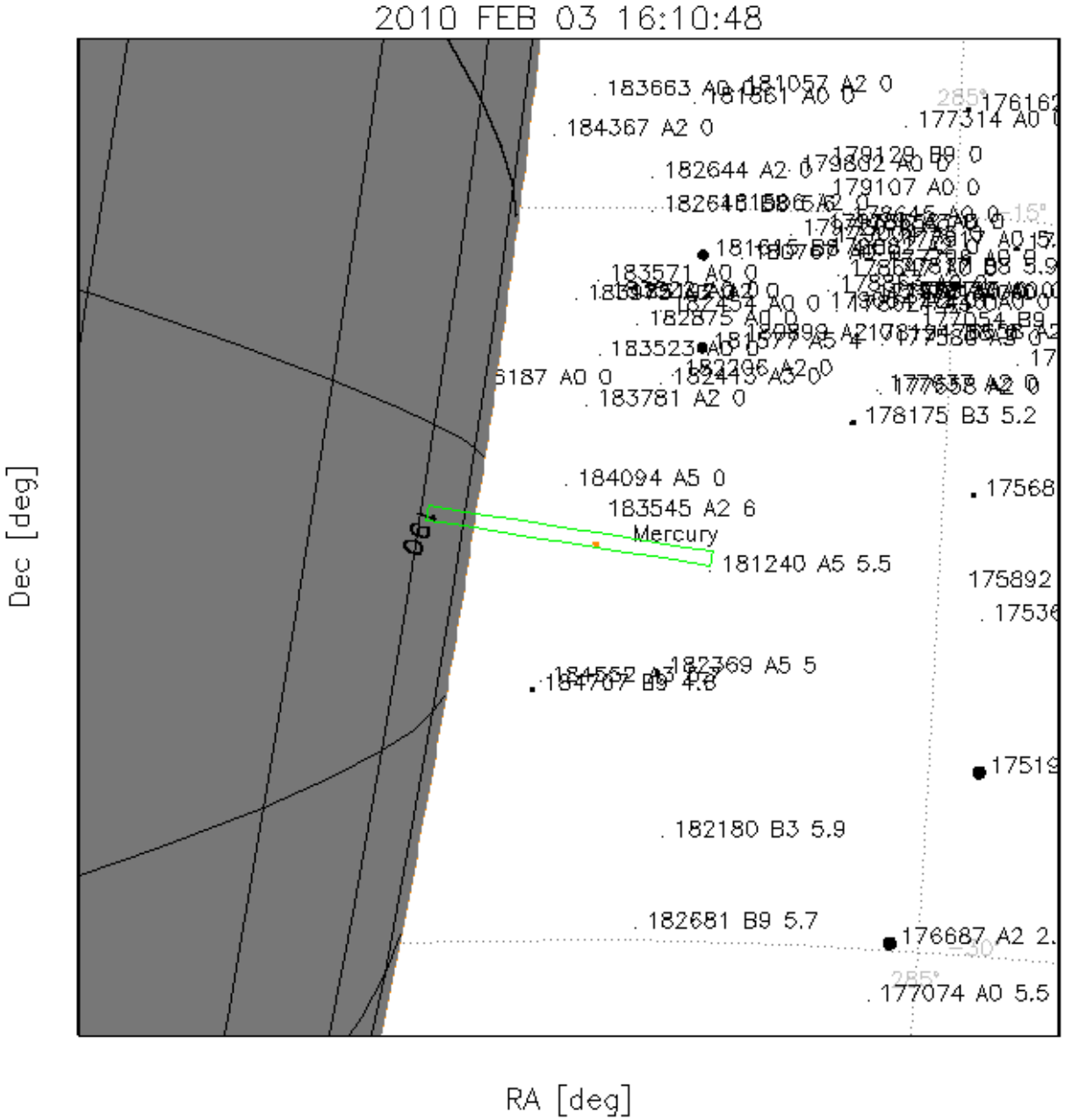


LAMP Spectral Detections

- LAMP observed a plume raised by the LCROSS impact
- Observed emissions include
  - H_2 & CO fluorescence emissions from 105-165 nm (T=1000 K)
  - Neutral atomic Hg at 185 nm (with contributions from Ca and Mg)
- Many useful upper limits were obtained

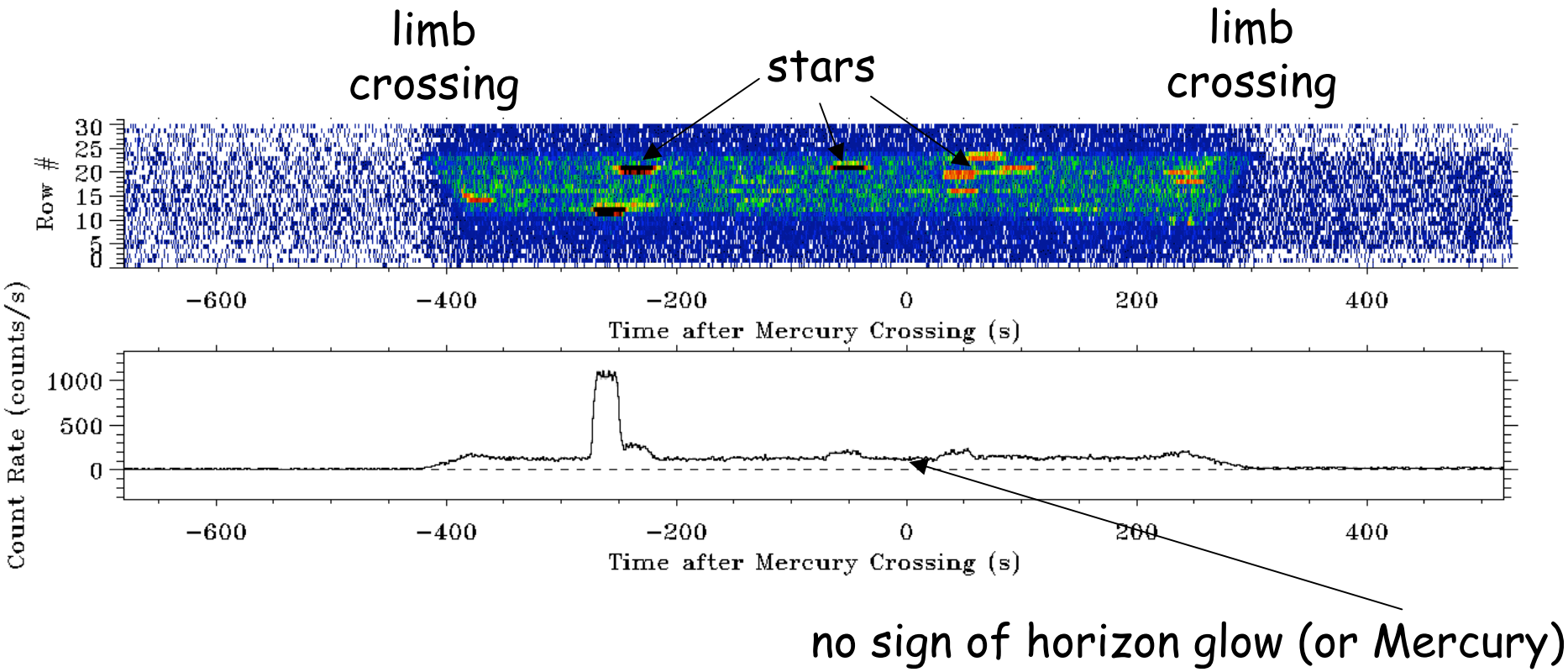


Horizon Glow Roll (February 3, 2010)

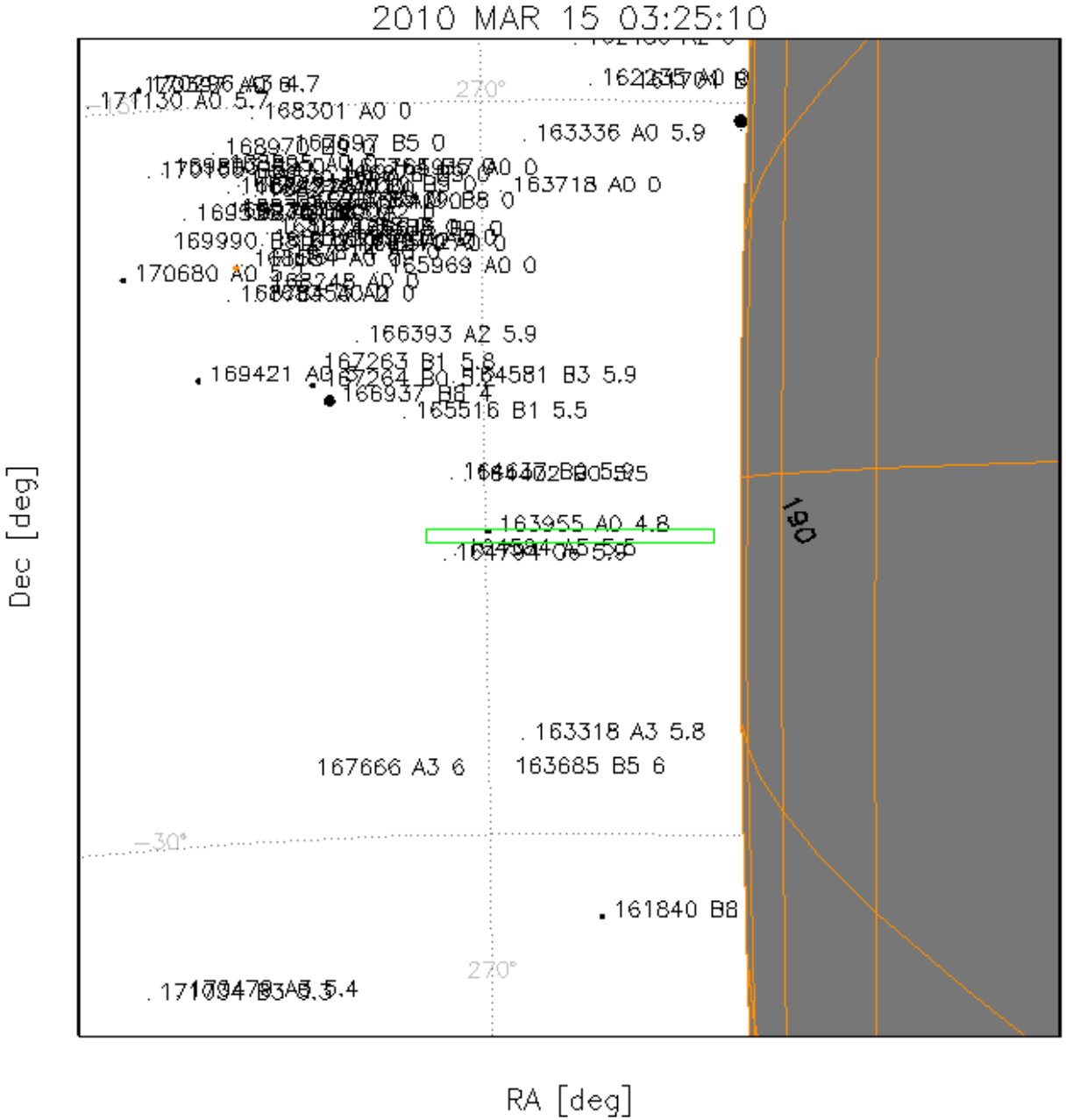


- Joint LROC & LAMP test observation of the pre-dawn limb
- LAMP slit indicated by the green line near the limb
- The Sun was ~23° below the horizon, so the shadow height was ~150 km (far above the LAMP slit)
- Due to the 60° solar keep-out zone and a slew rate of 6°/minute, the available observing time is very short

Horizon Glow Roll (February 3, 2010)

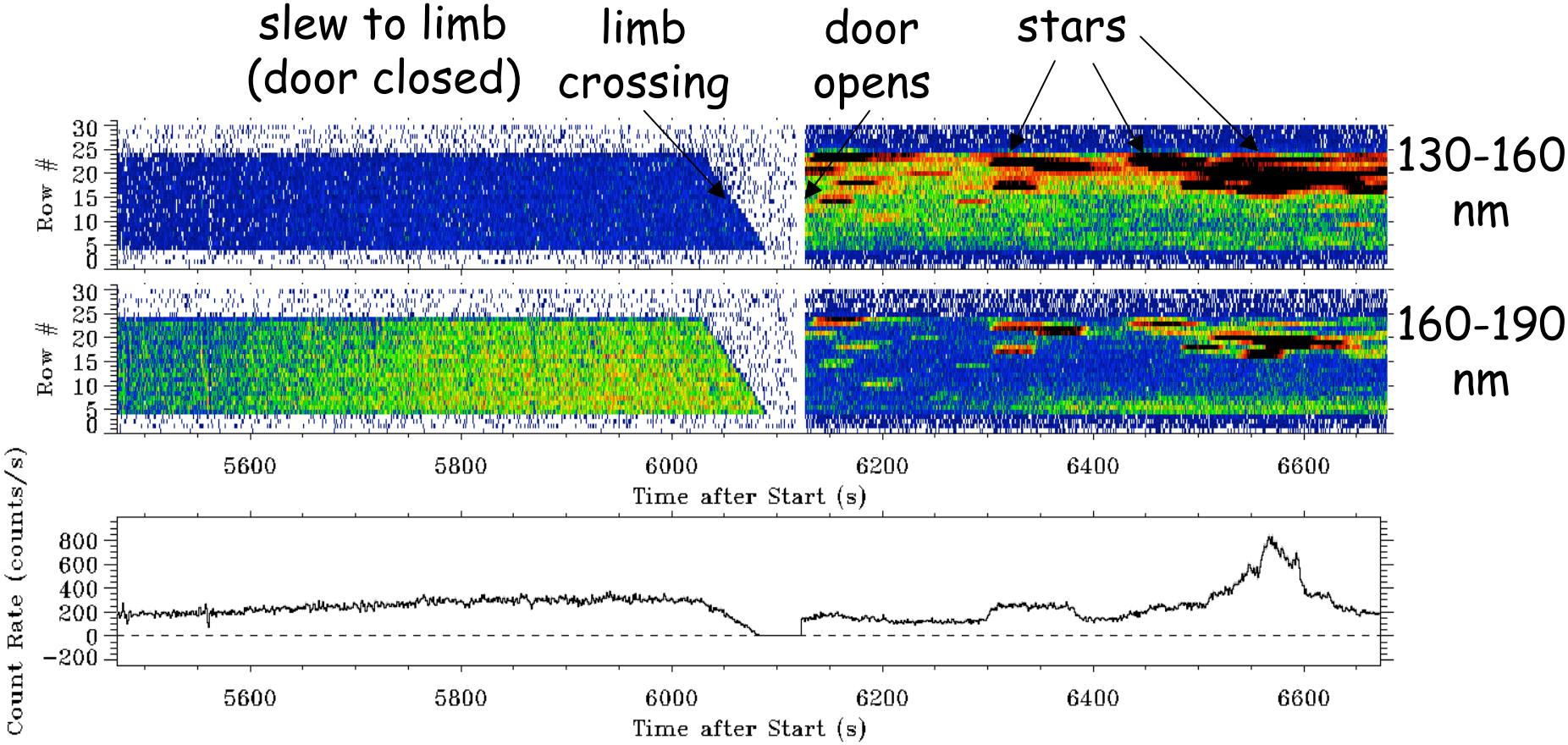


Sub-Solar Roll (March 15, 2010)



- Regular monthly limb observation, this time at low latitudes toward the sub-solar region
- LAMP slit indicated by the green line near the limb (roll angle ~80.9°)
- Slit projects at limb to altitude range of 7-52 km

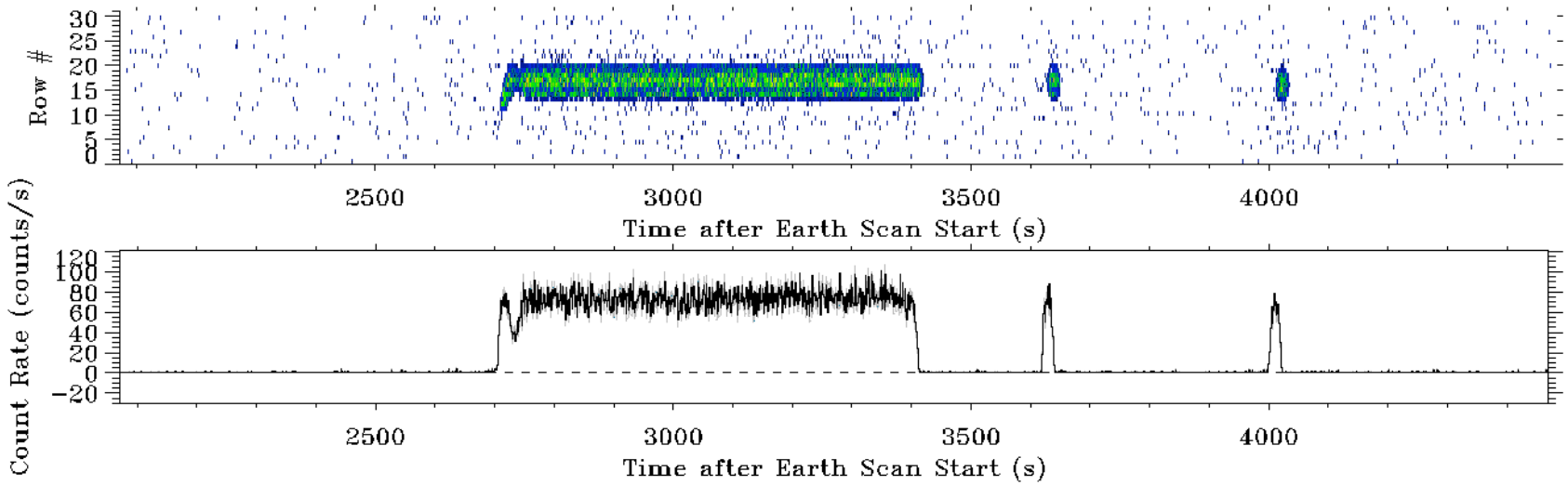
Sub-Solar Roll (March 15, 2010)



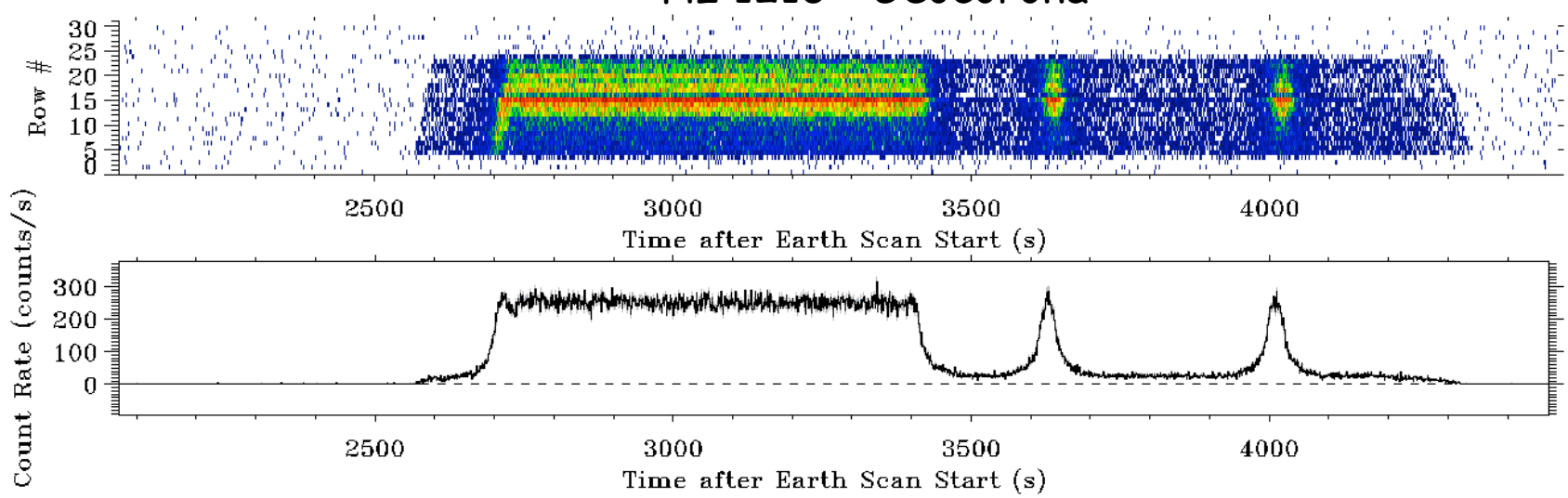
sunlight scattered by atmosphere dust?

Earth Ride-along (July 11, 2010)

OI 1304 - Dayglow



HI 1216 - Geocorona



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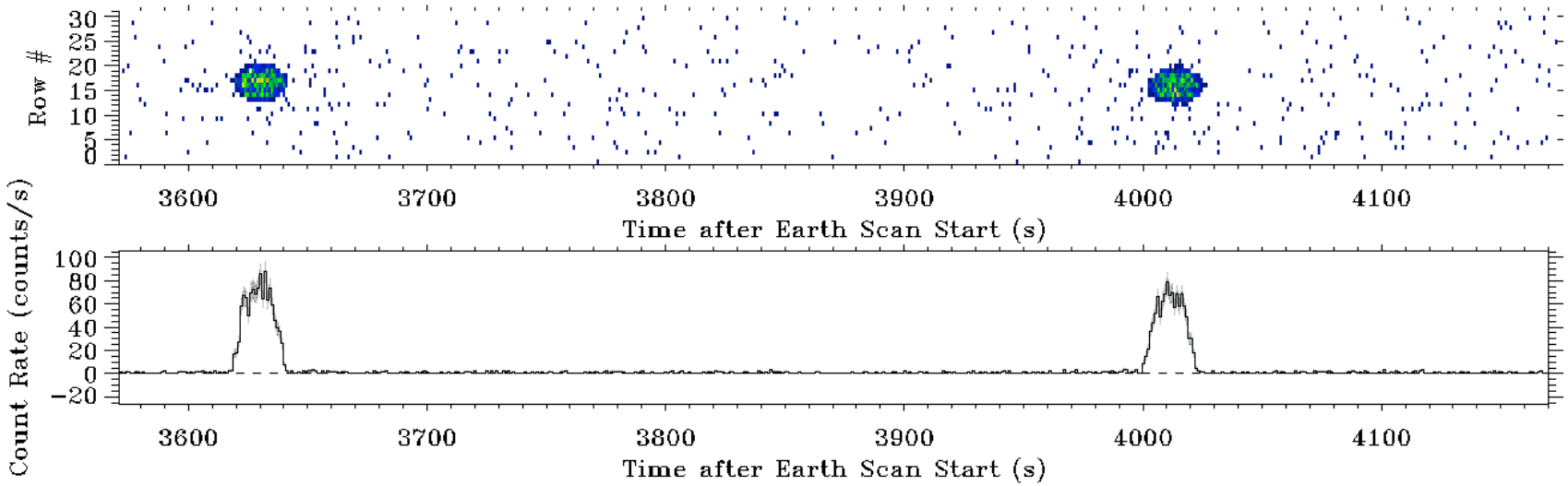

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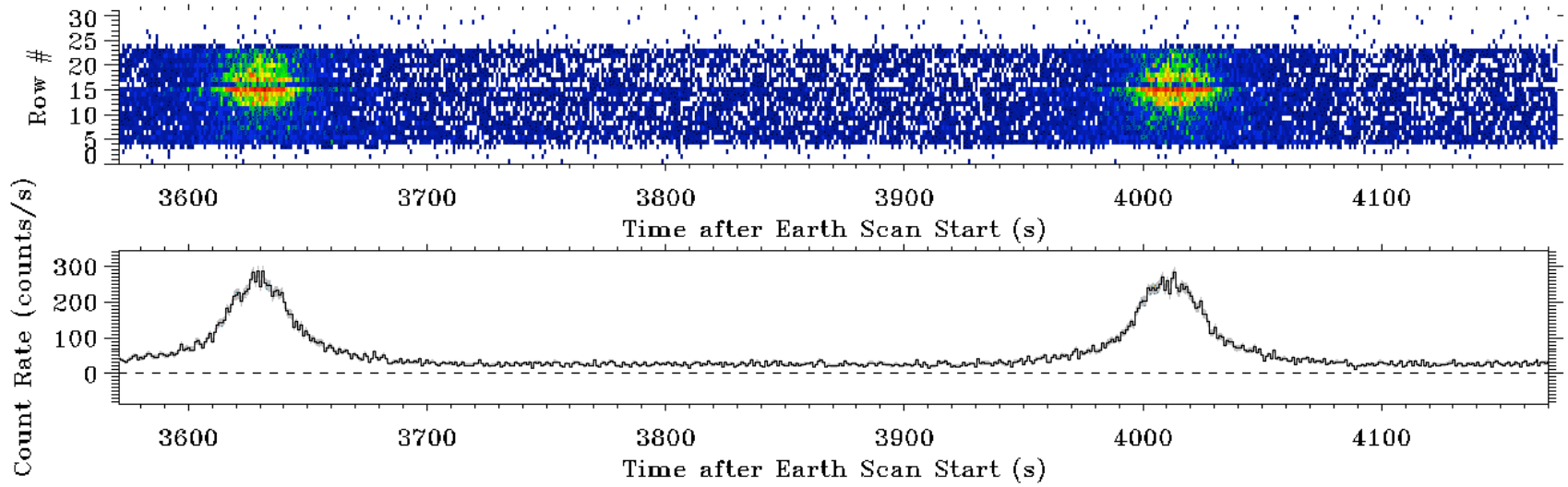

Summary

- LAMP detected a response to the LCROSS impact that we identify as fluorescence of sunlight by H_2 & CO and resonantly scattered sunlight by Hg in the plume
- LAMP is mapping out and searching for exposed water ice in permanently shadowed regions at the poles
- LAMP uses a spectral "fingerprint" for water ice that has the potential to definitively identify exposed water ice on the surface
- LAMP will continue to study how water and other volatiles are formed and are transported through the lunar atmosphere