



LRO, LEND and the search for water on the moon

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About me

- Undergraduate physics major currently enrolled at NMSU; non-traditional student
- Summer intern at NASA under the MU-SPIN program
- Part-time rock star



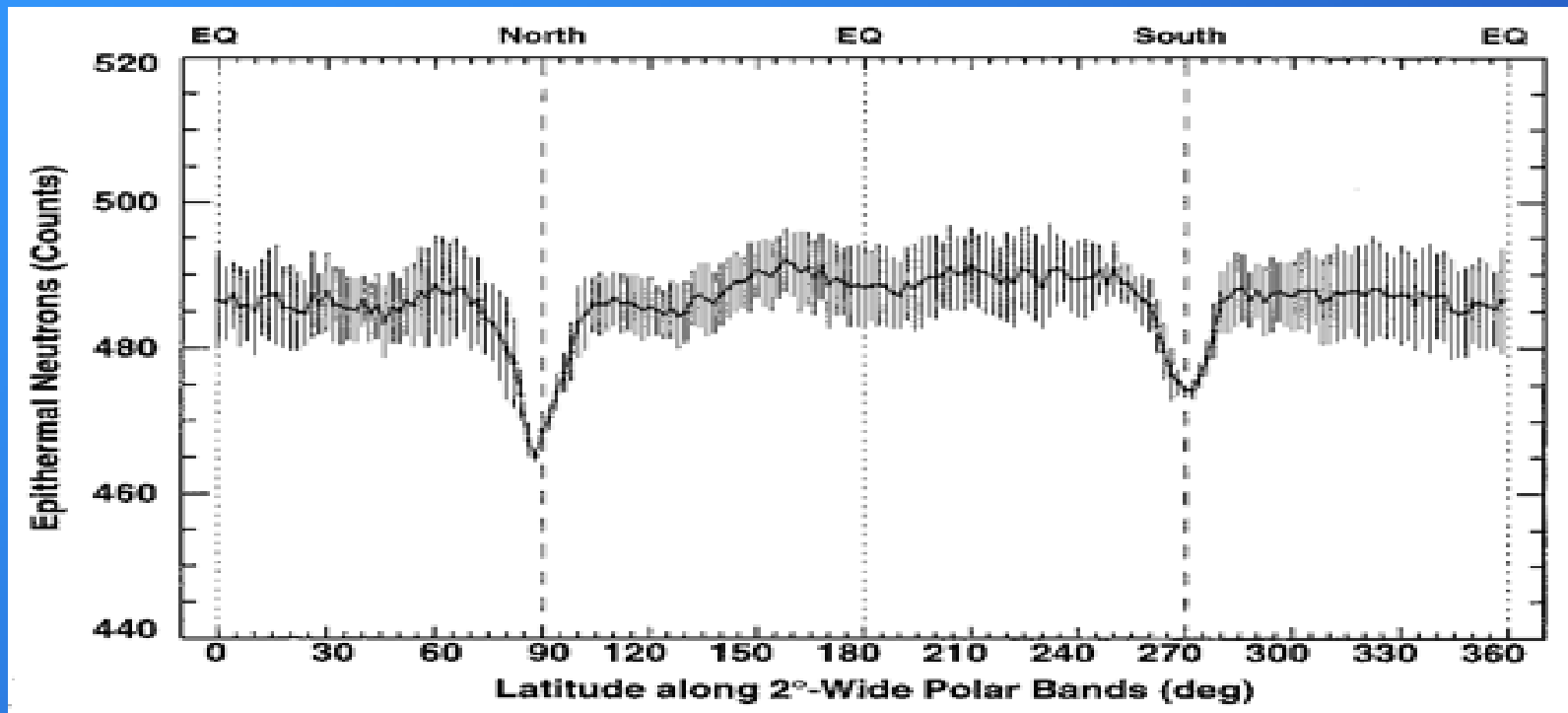
Outline

- The Moon
- Neutron Production
- Neutron Detection
- LRO
- LEND
- LCROSS
- Conclusion

Why Return to the moon?

- Permanent base on the moon.
- Could be used as starting point for Mars exploration.
- Data from Lunar Prospector and Clementine suggest the existence of permanently shadowed craters at lunar poles.

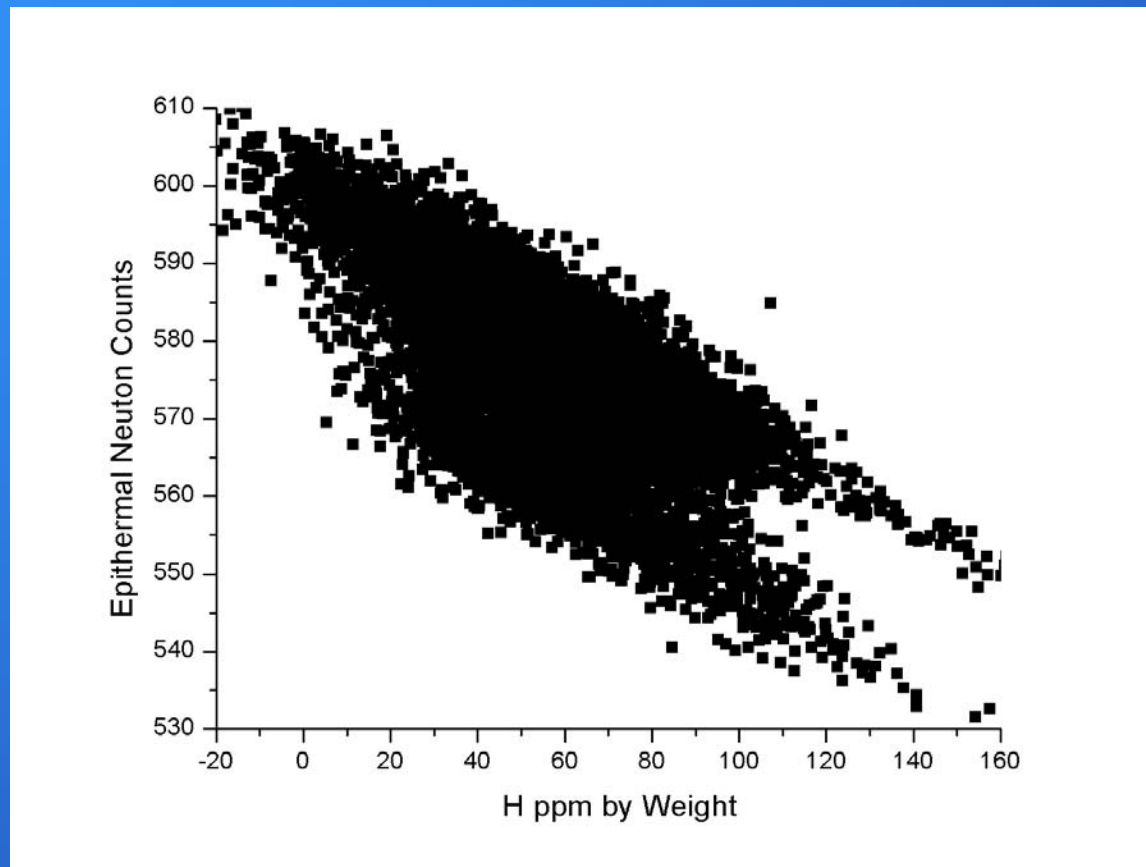
Evidence For H₂O



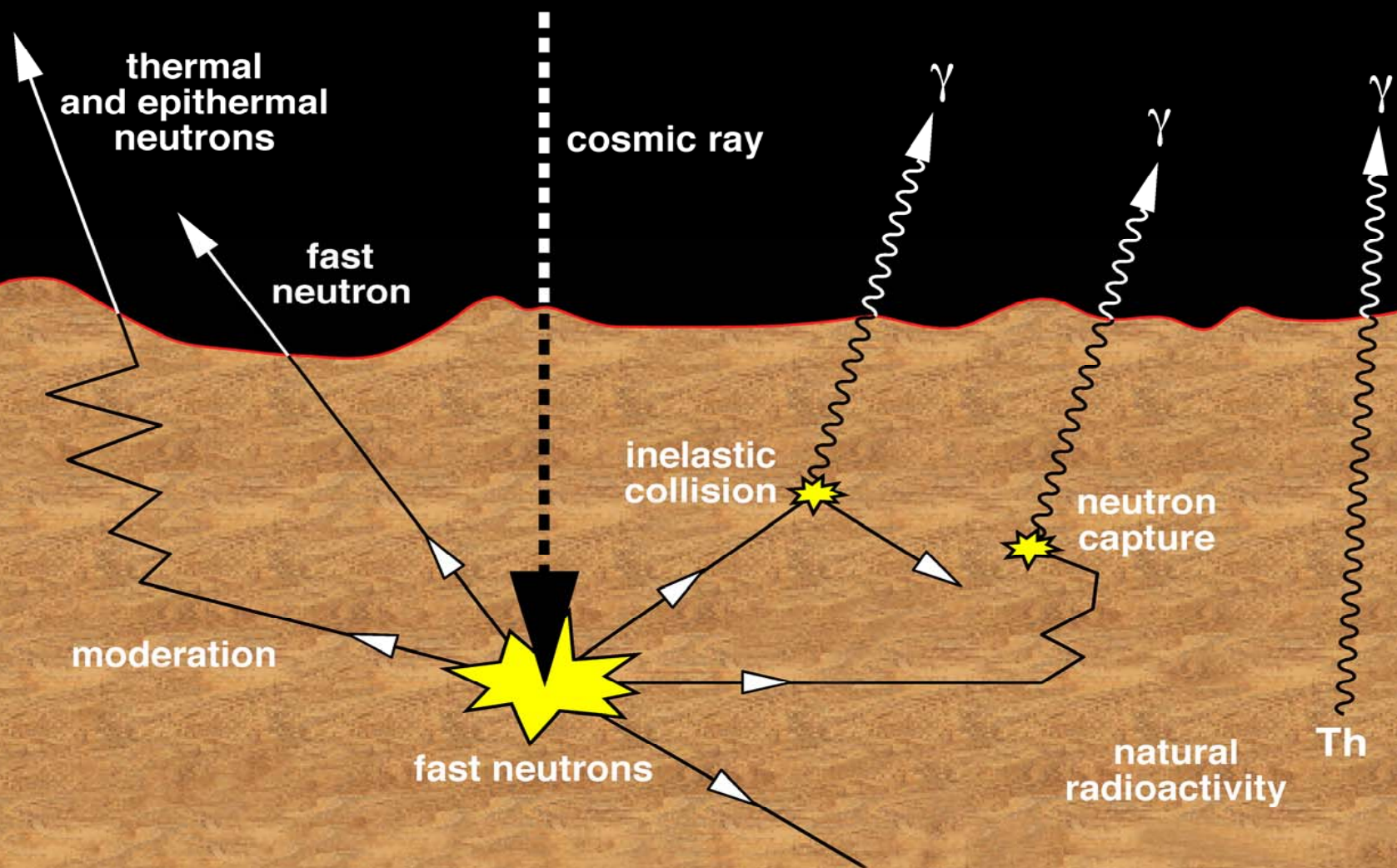
W. C. Feldman, * S. Maurice, A. B. Binder, B. L. Barraclough, R. C. Elphic, D. J. Lawrence, *Fluxes of Fast and Epithermal Neutrons from Lunar Prospector: Evidence for Water Ice at the Lunar Poles*, Science, Sept. 1998, Vol. 281. no. 5382, pp. 1496-

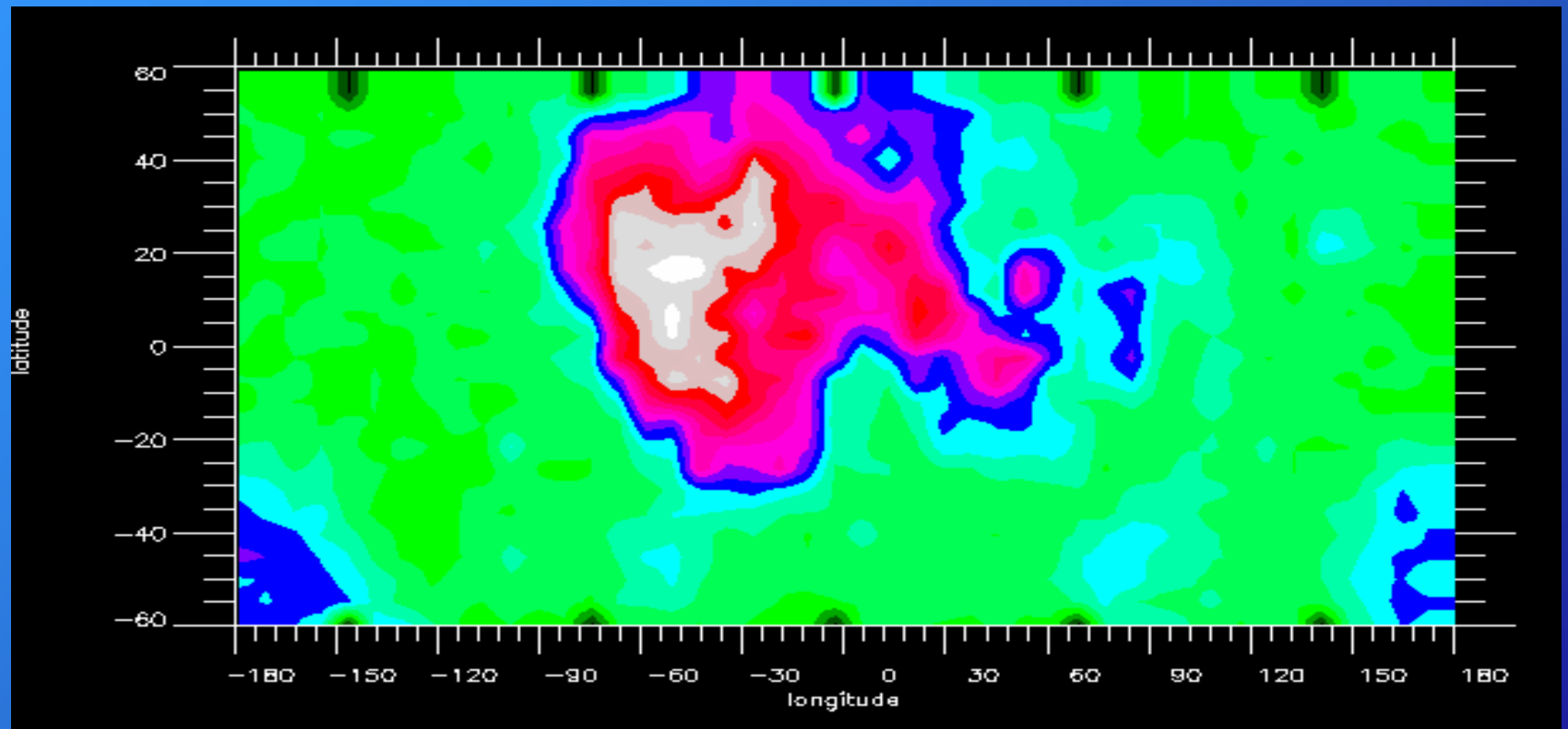
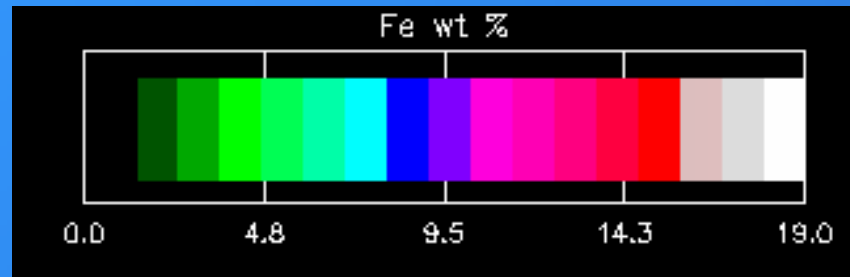
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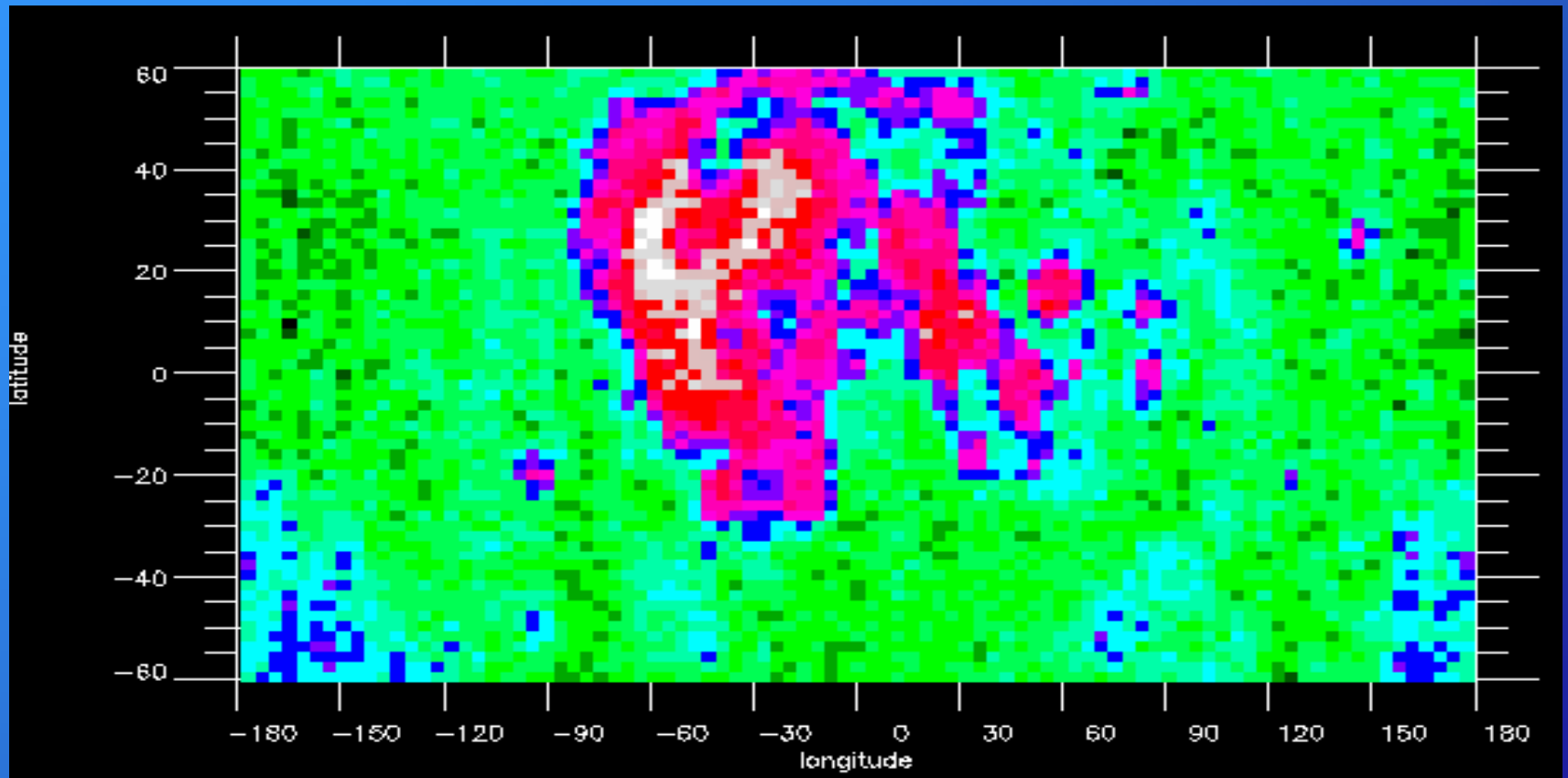
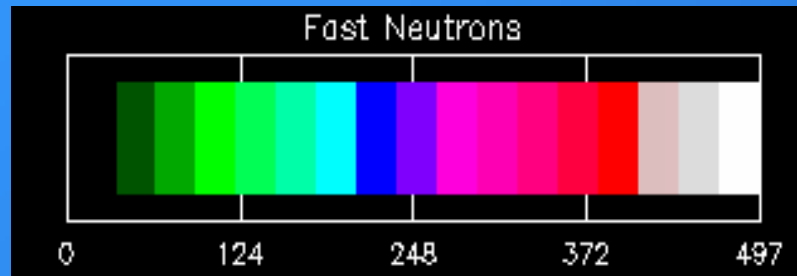
Lunar Prospector Data



Nuclear Radiation from a Planetary Surface







Detection Of Lunar Neutrons

- Neutrons will be detected by LEND primarily with ^3He detectors as well as one anti-coincidence scintillator detector.
- $n + ^3\text{He} = ^3\text{H} + p + 764 \text{ keV}$

LRO, LEND and LCROSS



LRO

- Scheduled for launch Oct. 2008
- 4 day journey to moon
- 2 month commissioning orbit
- 1 year polar mapping orbit



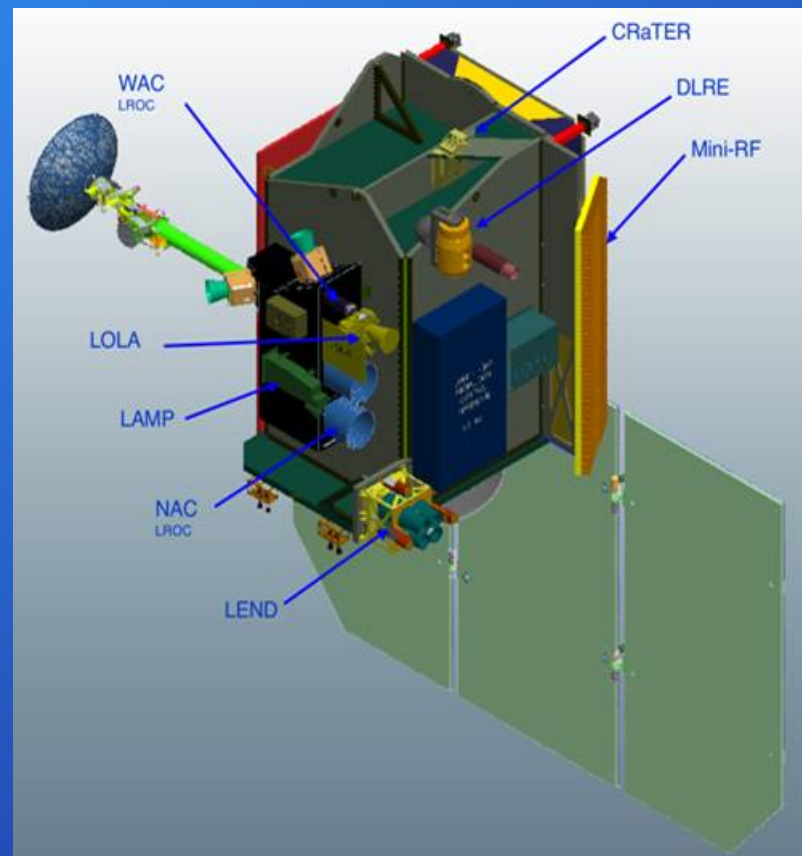
LRO Objectives

- Characterization of lunar radiation environment
- Assessment of possible landing sights - up to 1m resolution
- Imaging of permanently shadowed regions
- Temperature mapping of lunar surface
- Characterization of lunar topography
- Identification of possible water ice deposits
- Improved spatial resolution mapping of hydrogen
- Examine the variation of hydrogen content at moderate latitudes in comparison with surface variations of minerals, thermal conductivity, and maturity



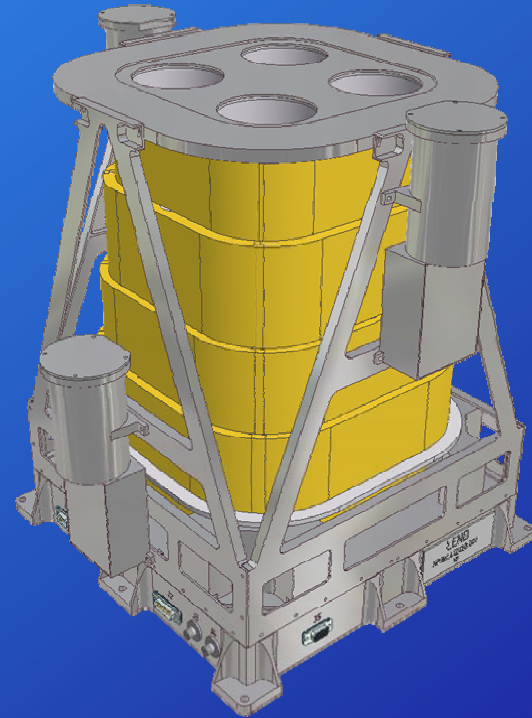
LRO Instrument Suite

- **LEND, Lunar Exploration Neutron Detector**
- LROC, Lunar Reconnaissance Orbiter Camera; WAC, NAC
- LAMP, Lyman Alpha Mapping Project
- DLRE, Diviner Lunar Radiation Experiment
- LOLA, Lunar Orbiter Laser Altimeter
- CRaTER, Cosmic Ray Telescope for the Effects of Radiation
- Mini-RF, Synthetic Aperture Radar



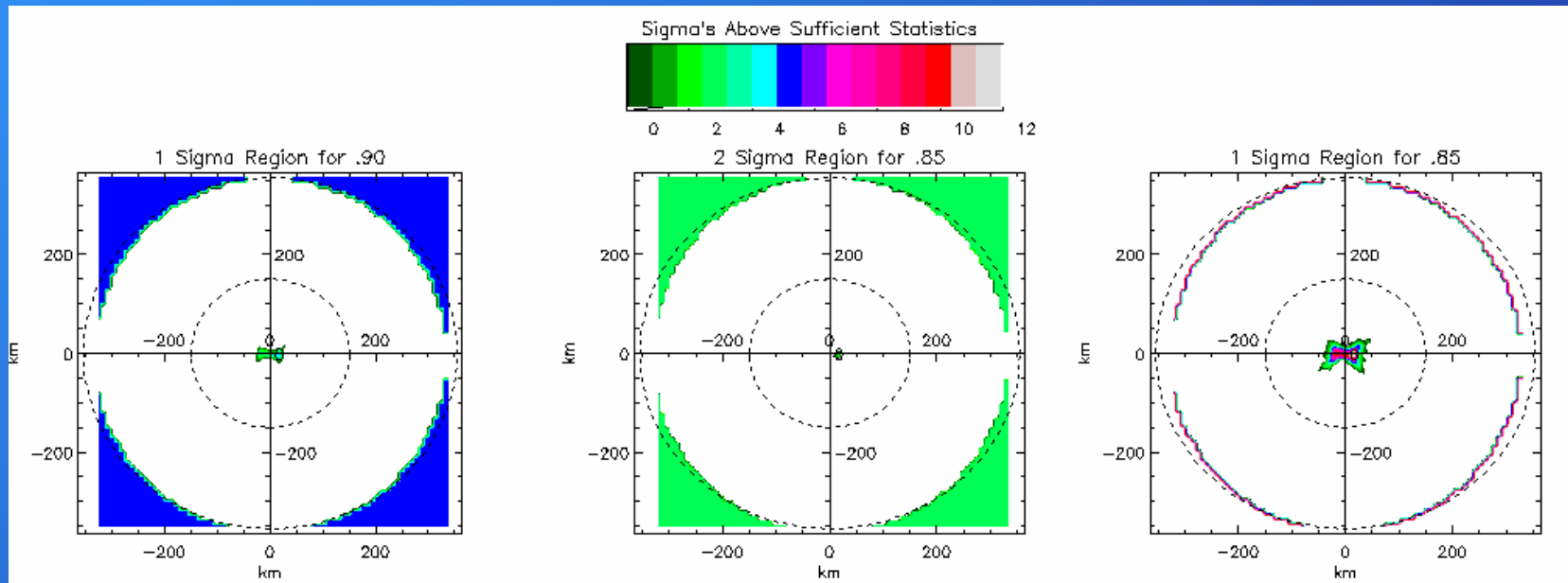
LEND

- 4 collimated ^3He detectors for epithermal neutrons (5 km resolution)
- 2 “Doppler” ^3He detectors for thermal neutrons
- 1 ^3He for thermal neutrons
- 1 ^3He for epithermal neutrons
- 1 scintillation sensor for high energy neutrons (300 keV- 15 MeV)



Expected Counts from LEND

The figure below shows the expected counts above statistical variation from LEND after 50 days of orbit

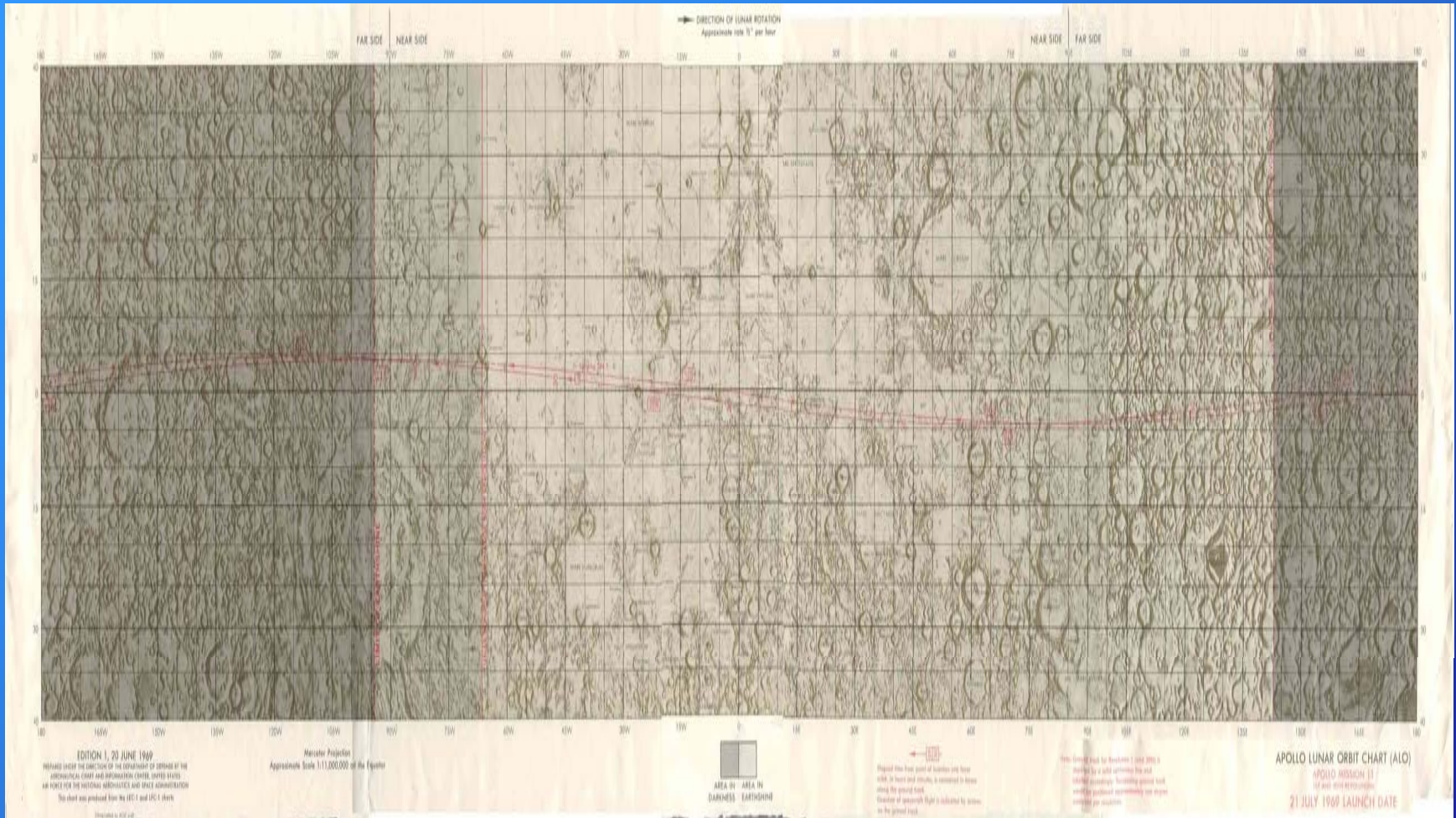


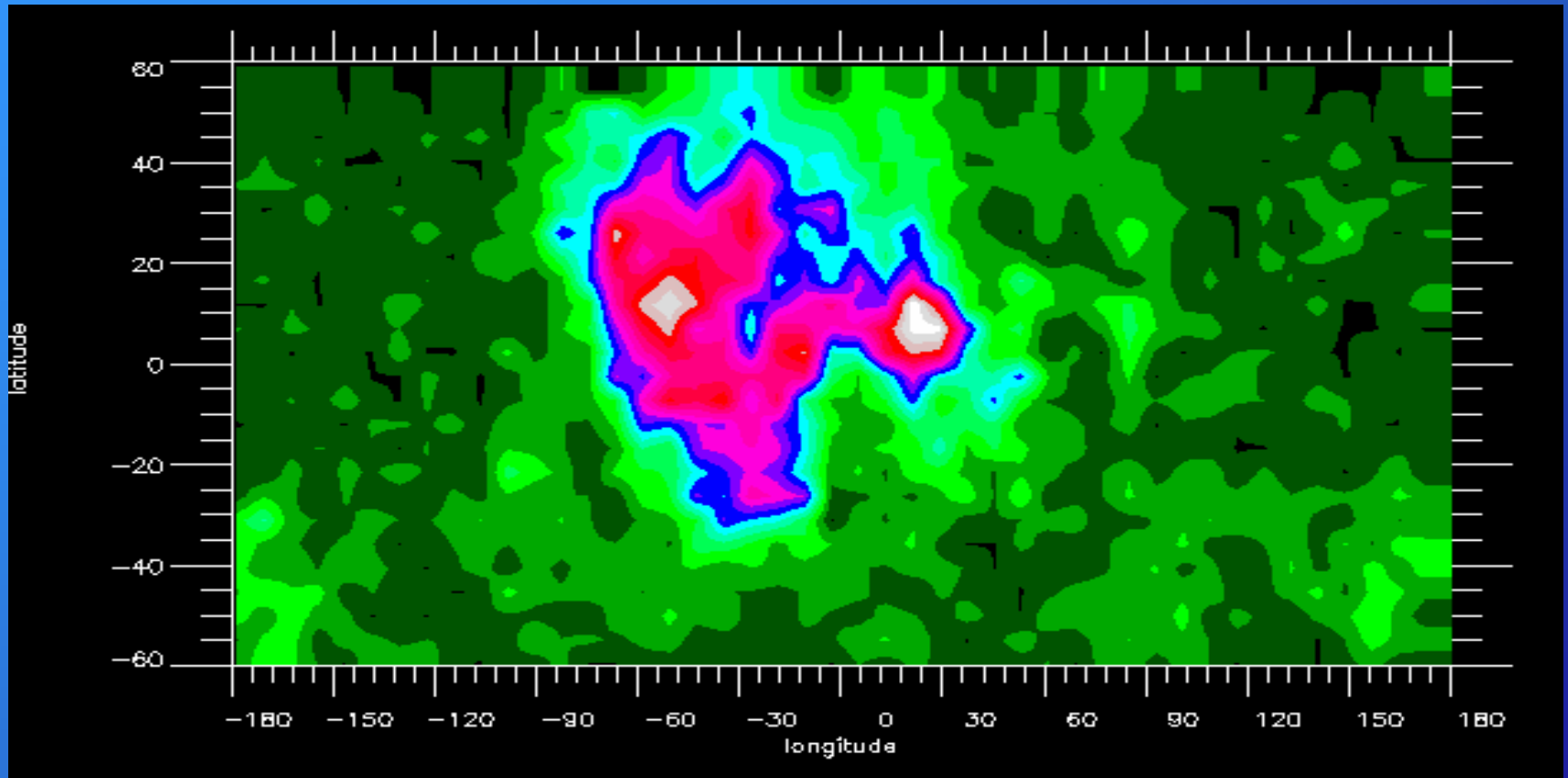
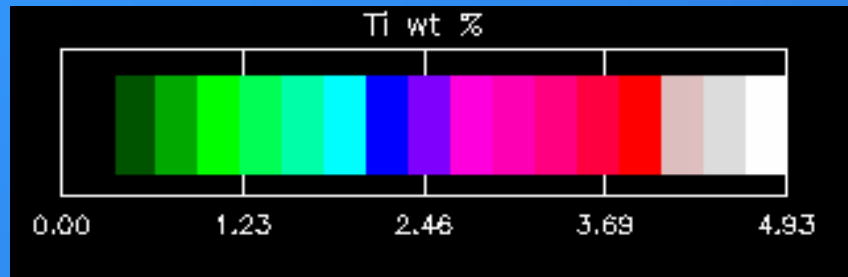
LCROSS

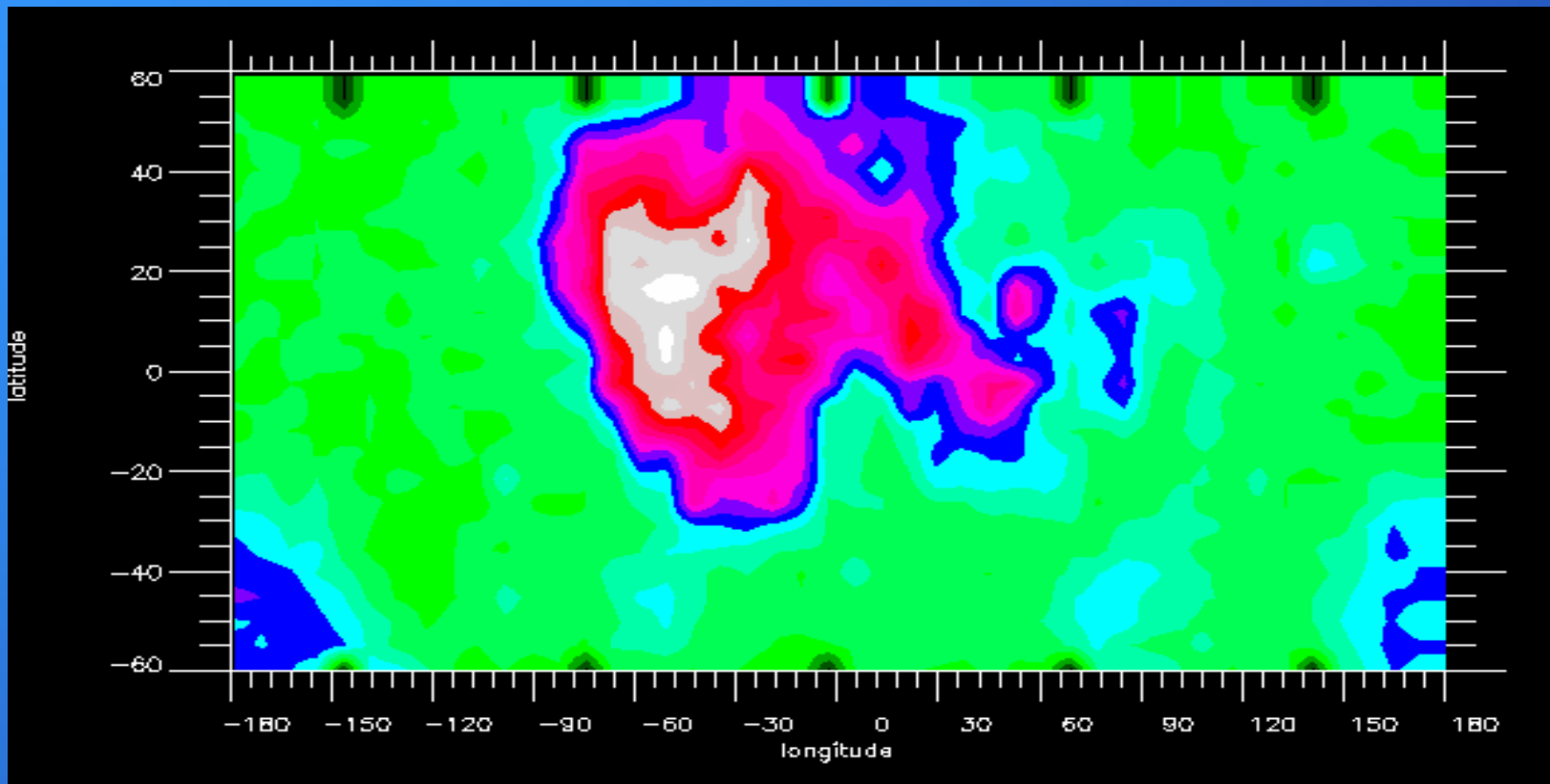
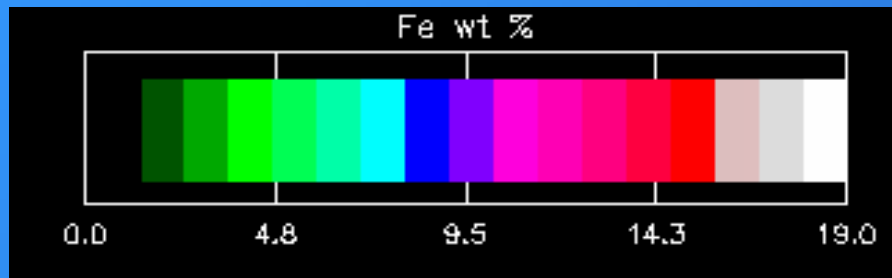
Lunar CRater Observation and Sensing Satellite

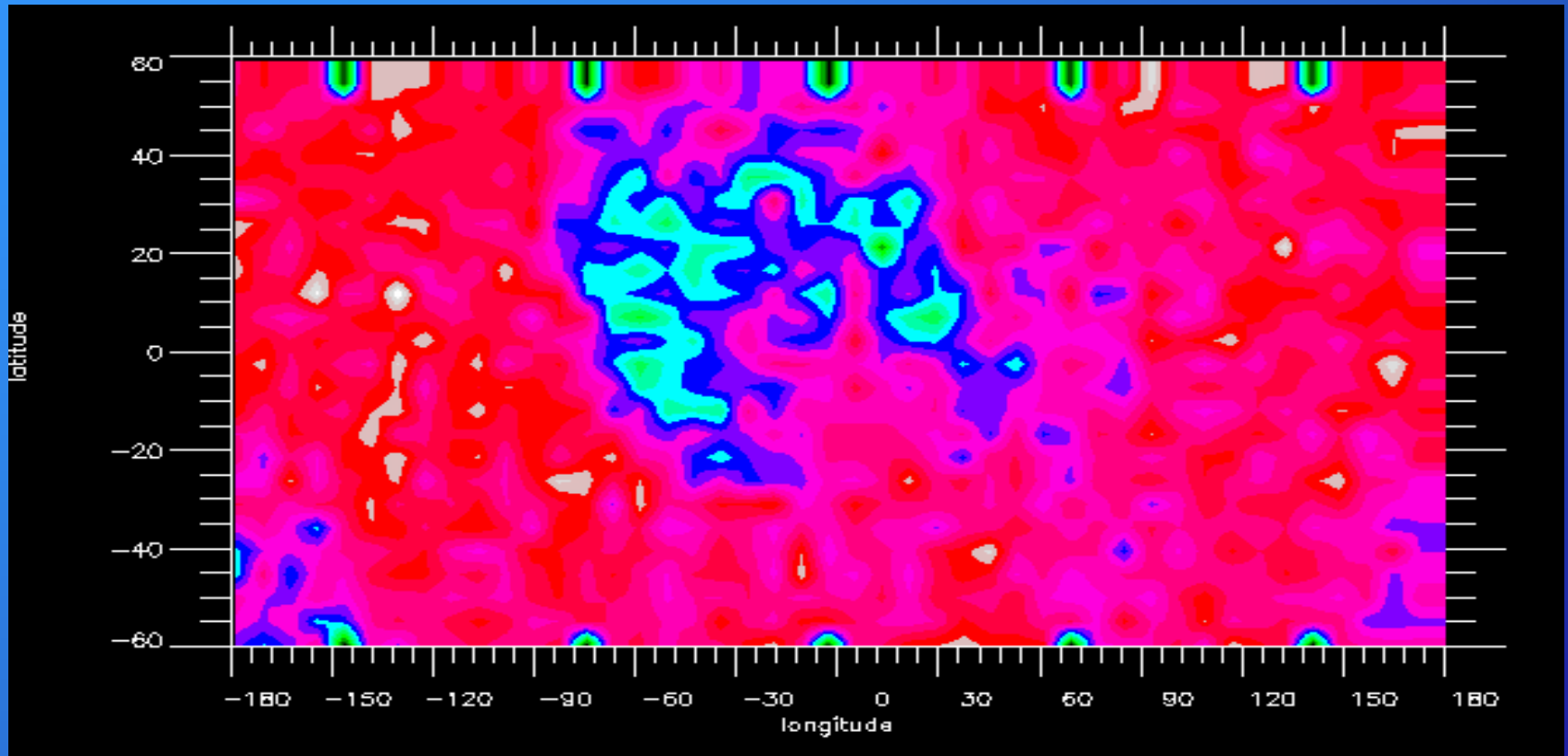
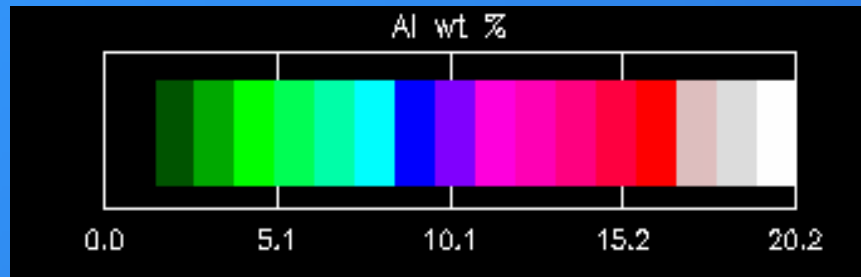


- LCROSS is the secondary payload associated with LRO.
- LCROSS mission : impact the lunar surface and analyze the debris plume for evidence of H₂O.
- Data from LEND and other instruments aboard LRO will be used to determine the best impact site.









Conclusion

- There is currently substantial evidence for water ice in permanently shadowed craters in polar regions on the moon.
- Knowledge gained from LRO can be used for further extraterrestrial human exploration of the solar system

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