Lunar CRater Observation and Sensing Satellite Project

A LCROSS Update

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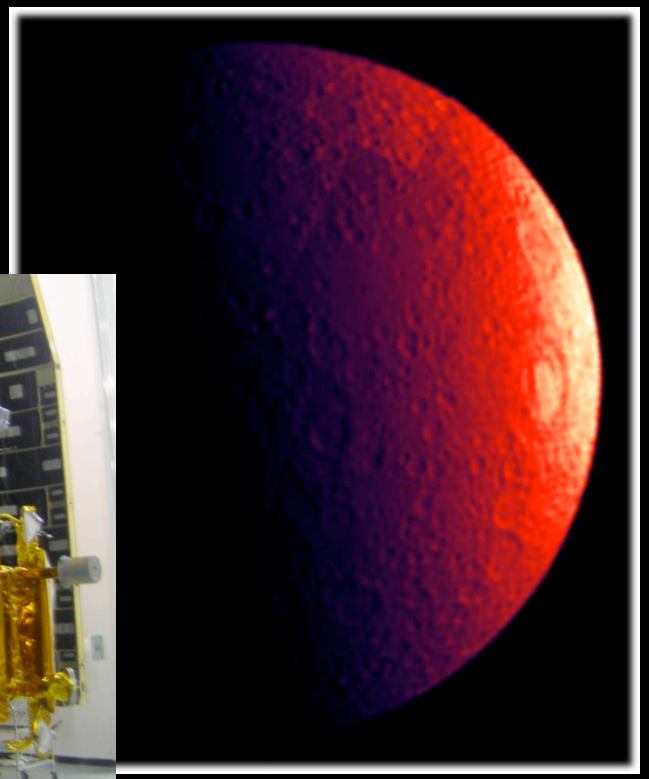
Payload Manager



LCROSS Background

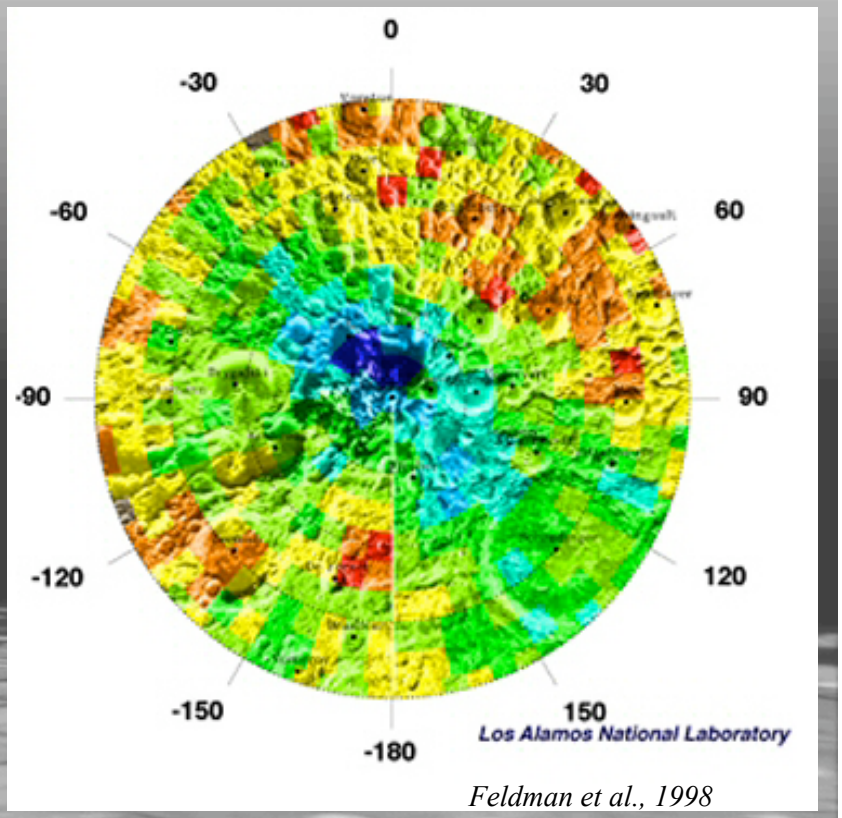
Lunar Prospector detected an increase in hydrogen concentration over the lunar poles.

The debate over the form, concentration and distribution has continued ever since.

If the hydrogen in an accessible and usable form, it could be a potential resource?

The form, distribution and concentration of [H] is relevant to inner solar system asteroid/comet fluxes, lunar volatiles and planetary evolution.

SP Hydrogen Abundance



Feldman et al., 1998

LCROSS will provide the most unambiguous data set to date as to the nature of lunar hydrogen

The LCROSS Experiment

What we know about the distribution of [H]:

- Accumulation/retention processes possibly differ at carter scales of ~50-100 km
- Possibly different at smaller scales, but currently have no evidence one way or another

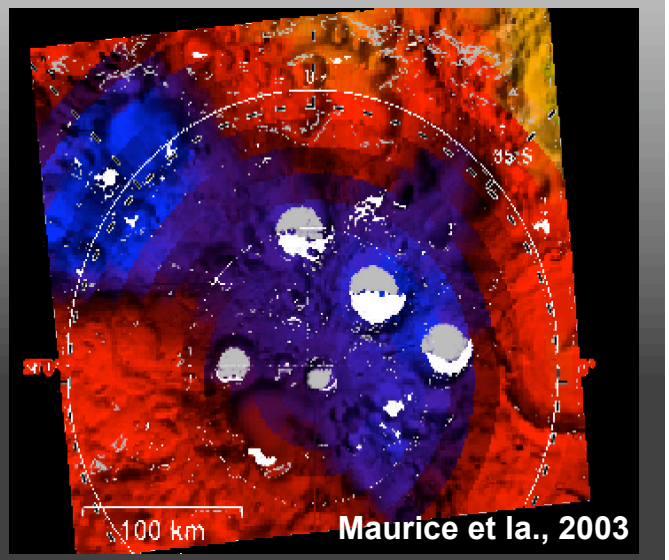
Two End-Member Models:

Smooth:

- Low-concentrations (~1%) evenly distributed
- Chances of a LCROSS detection is ~90%

Chunky:

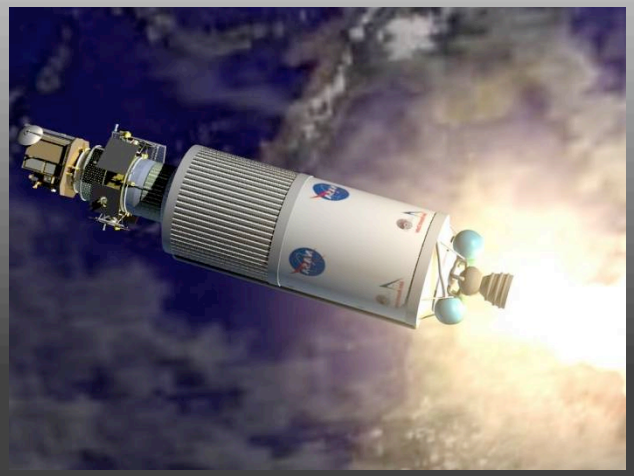
- Pockets of high concentrations (~10%)
- Chances of a LCROSS detection is ~10%



- A water detection < 2% supports the "Smooth" Model
- A water detection > 2% or no detection supports the "Chunky" model

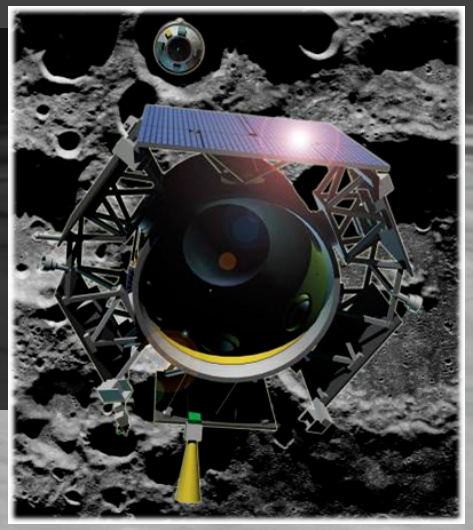
The LCROSS Mission

1. Launched stacked with LRO June 18, 2009

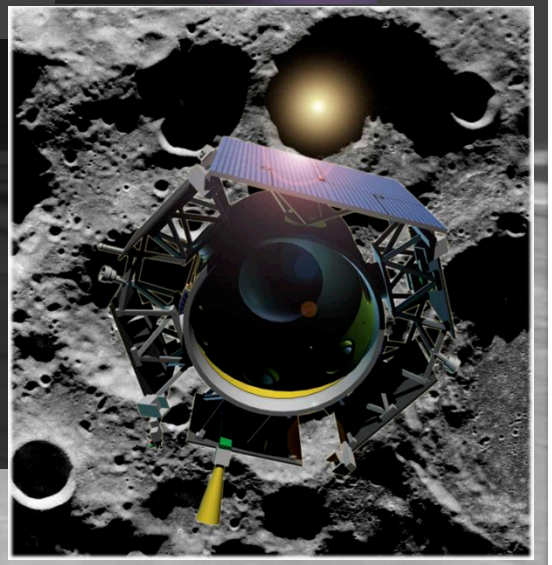


2. After Lunar swing-by, enter a 4 month cruise around Earth

3. October 9, 2009, target the Centaur Upper Stage and position S-S/C to fly 4 minutes behind

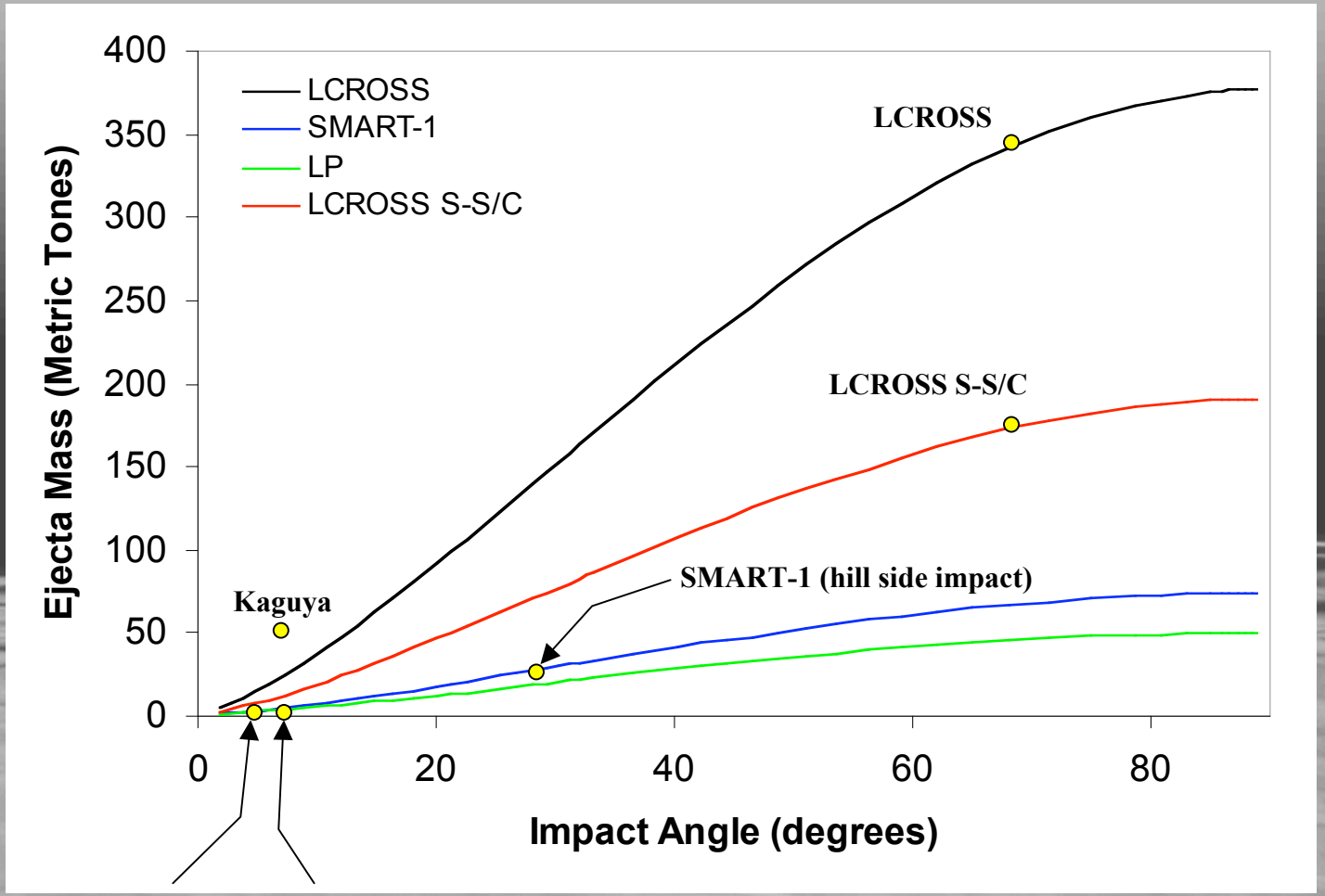


4. S-S/C observes impact, ejecta cloud and resulting crater, making measurements until impacting itself

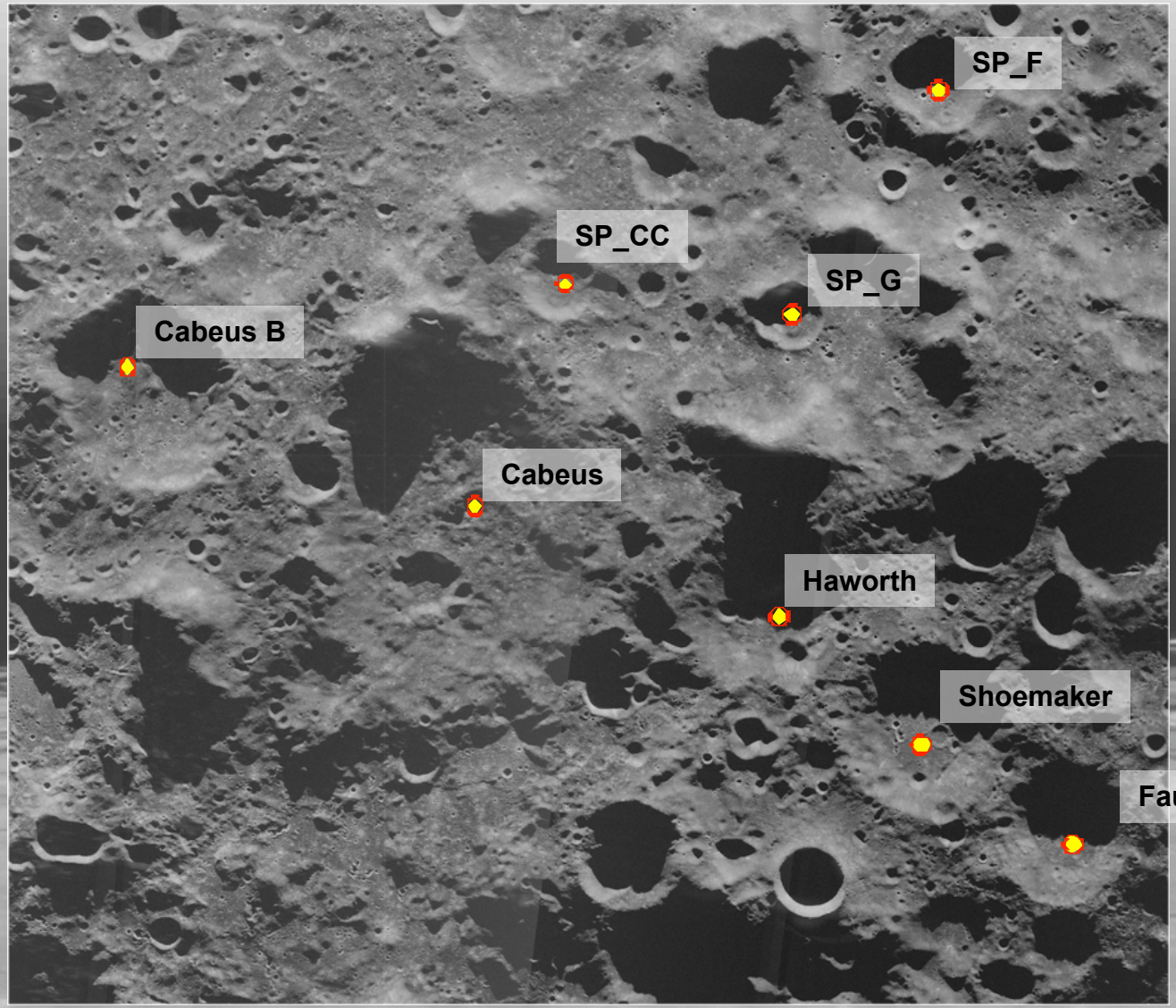


The Impact – How Does it Compare?

Estimates of the total ejecta mass as a function of impact angle for four impactors: LCROSS, LCROSS S-S/C, Lunar Prospector (LP), and SMART-1



The Impact – Where?



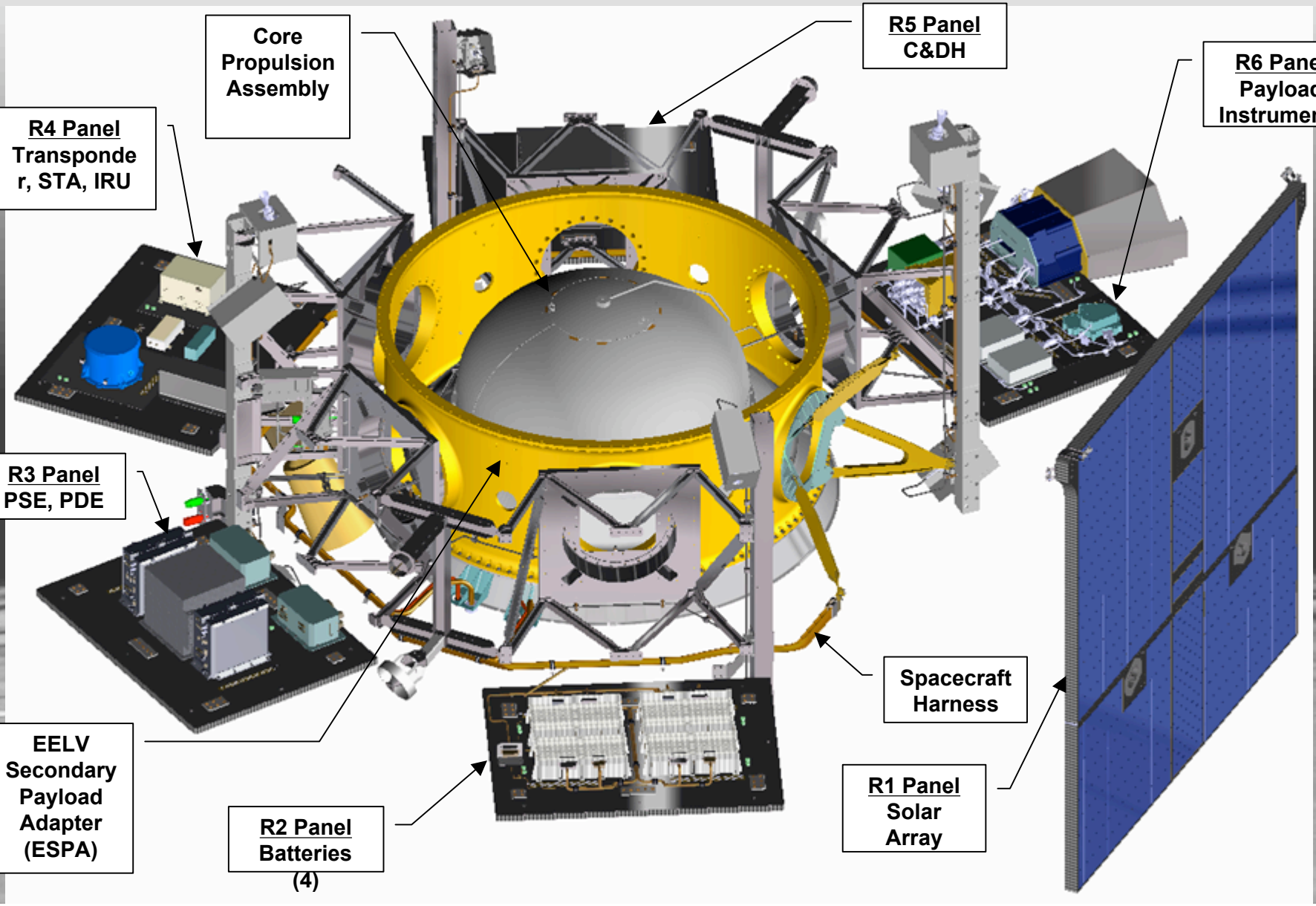
The Impact – Where?

LCROSS Candidate Target List

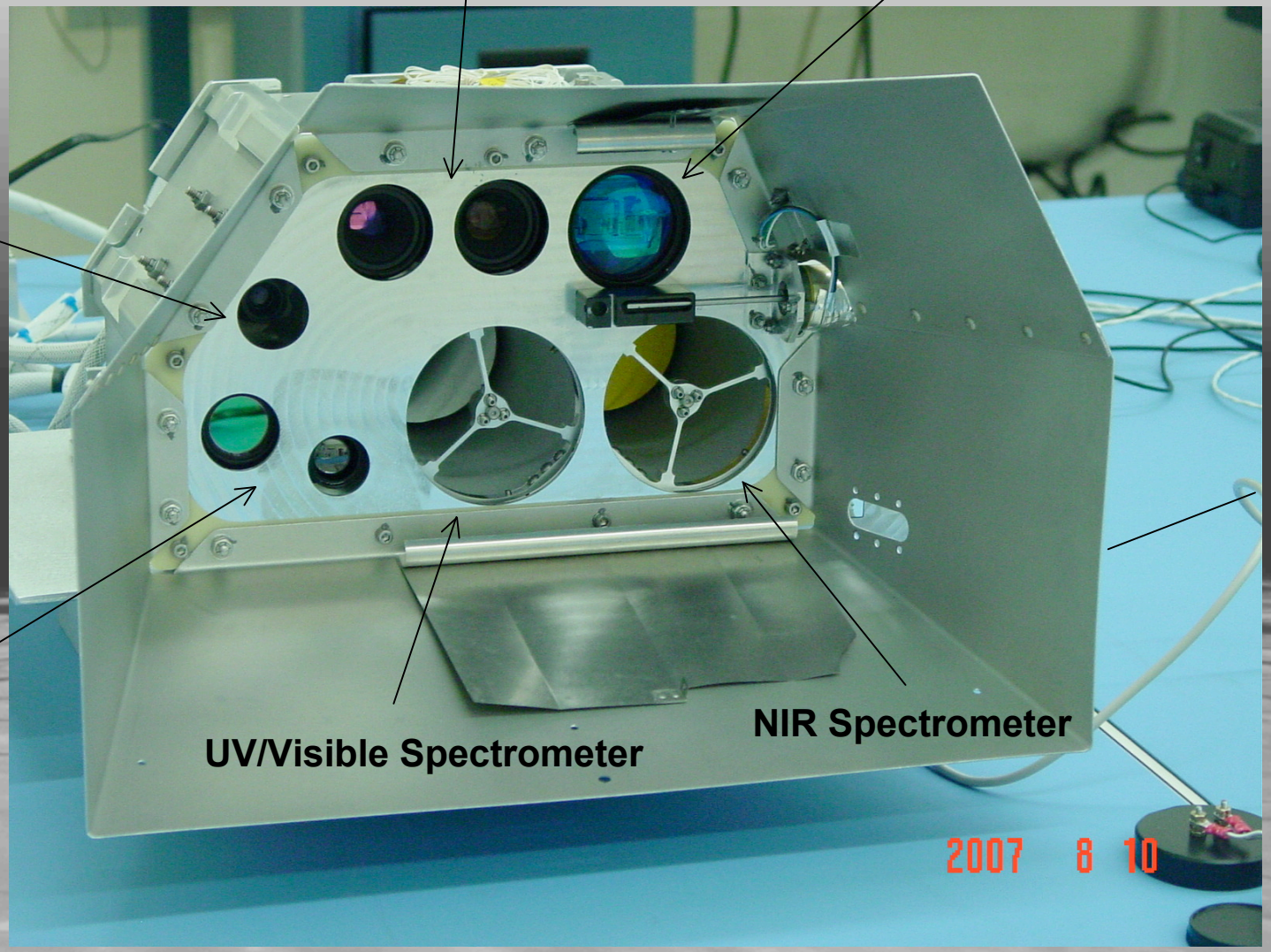
Target Designation	Pole	Crater Name	Slope (P/F)	Roughness (P/F)	Mean WEH (%)	Topo Mask (km)		Centaur Target Location	
						To Sun	To Earth	Lat	Lon (East)
SP_A	South	Faustini	P	P	<1	2.3	0.9	-87.2	89
SP_B	South	Shoemaker	P	P	<1	2.5	-0.6	-88.5	50
SP_C	South	Cabeus	P	P	>1	3	8.5	-85.6	308.9
SP_CB	South	Cabeus B	P	P	>1	0.9	-0.5	-81.9	305.3
SP_CC	South	<no-name>	P	P	>1	2.5	0.1	-83.9	338.9
SP_D	South	Haworth	P	P	<1	2.7	0.8	-87.4	355
SP_F	South	<no-name>	P	?	>1	1.8	0.5	-82.3	12
SP_G	South	<no-name>	P	?	>1	2.4	0.4	-84.3	1

The LCROSS Spacecraft

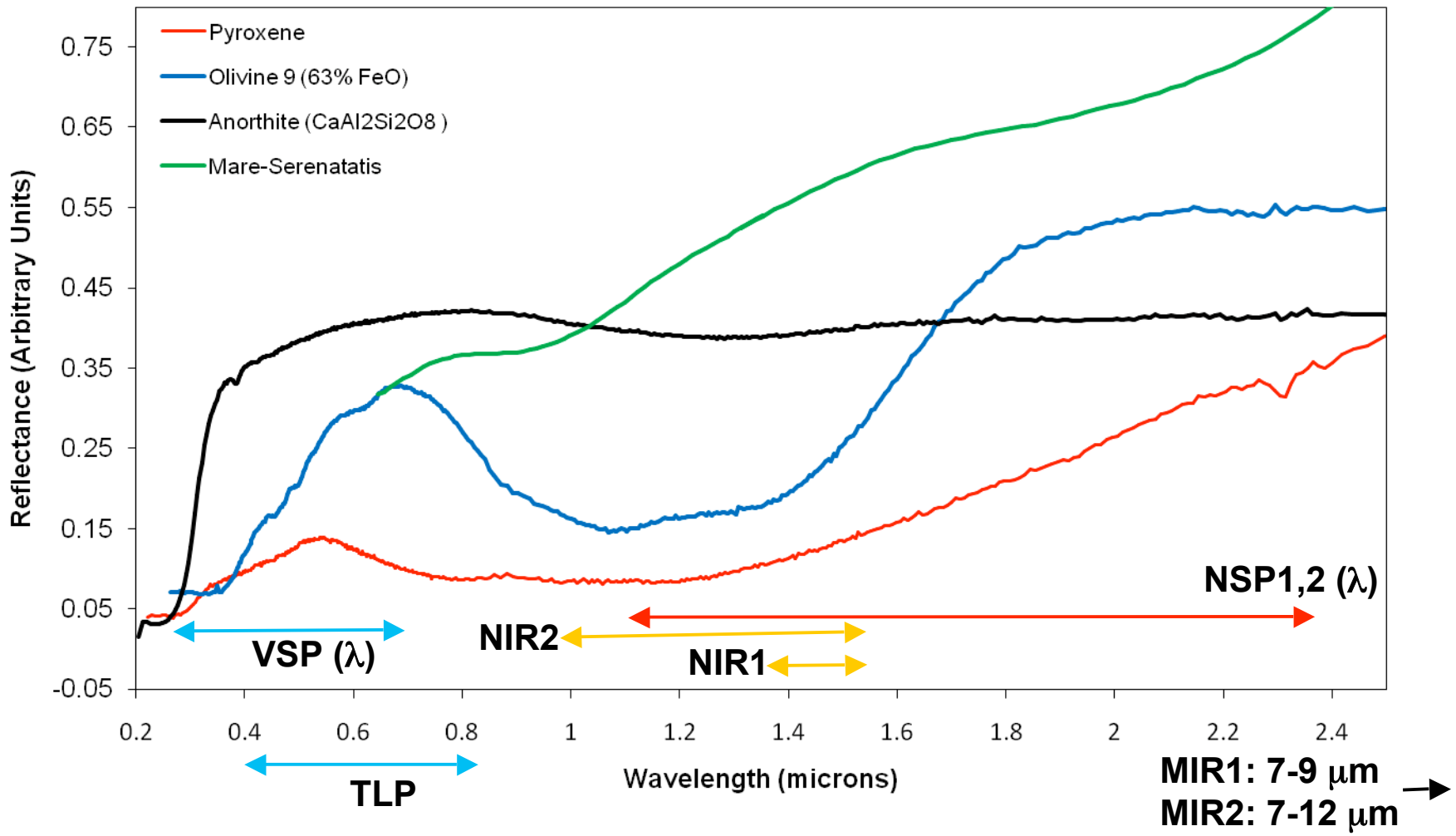
The LCROSS Spacecraft



The LCROSS Payload



LCROSS Wavelength Coverage



EBOC: Earth Based Observation Campaign

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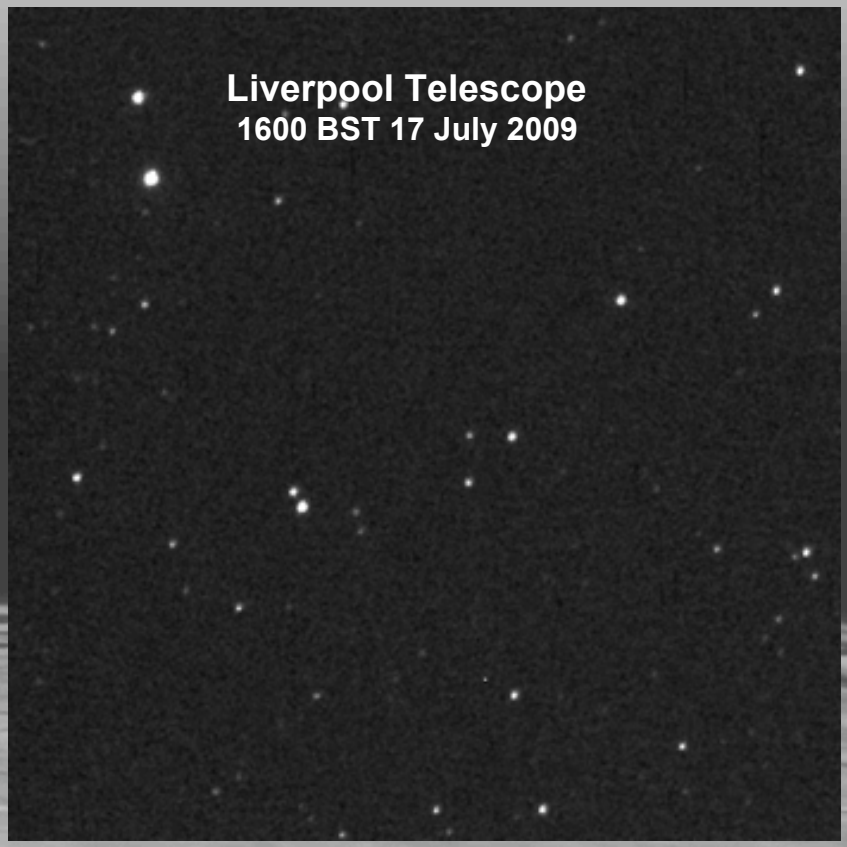
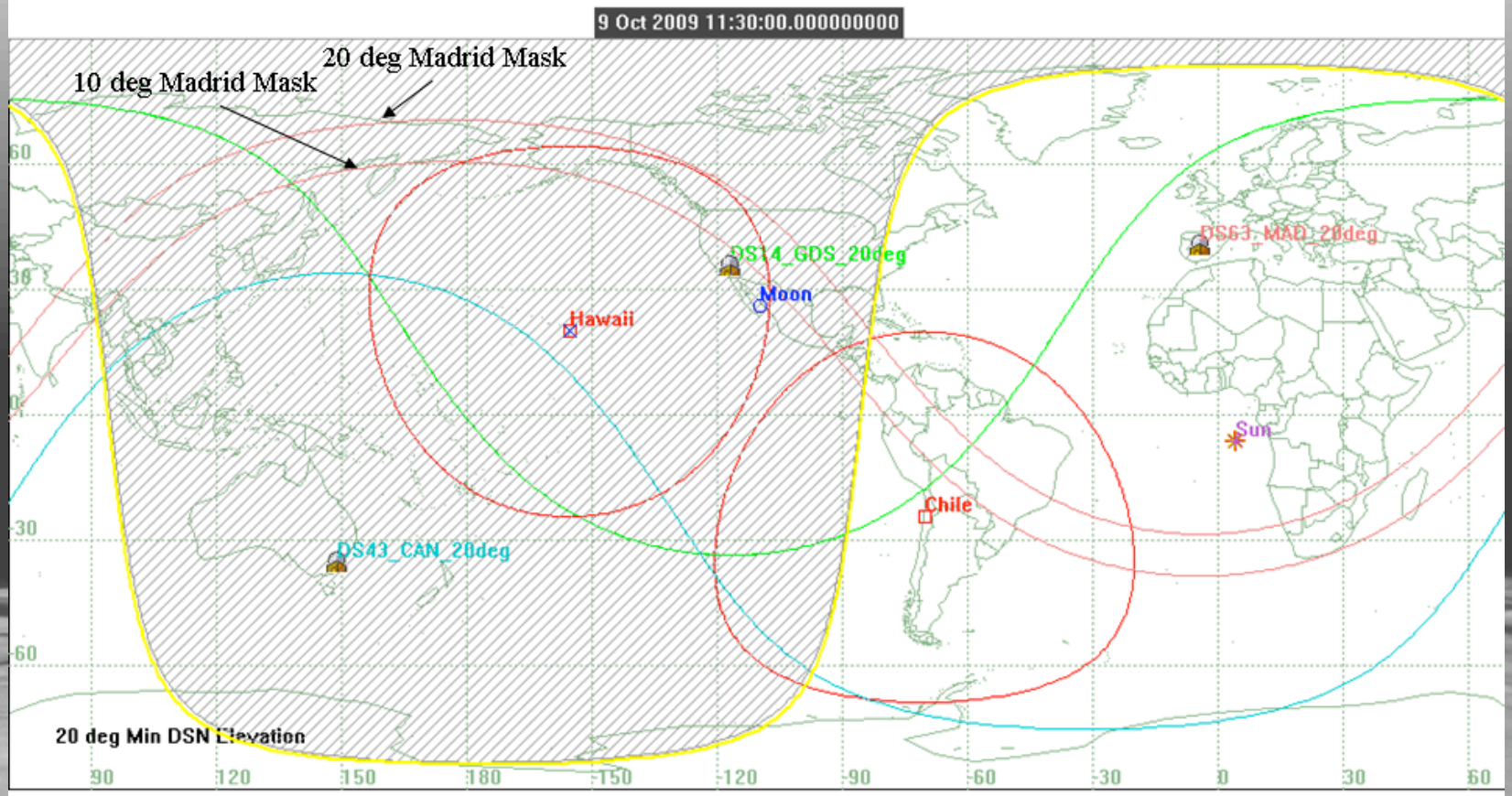
Observations of LCROSS/Centaur Spacecraft in Flight



Earth Ground Conditions at Impact

June 18 SP Impact Ground Track



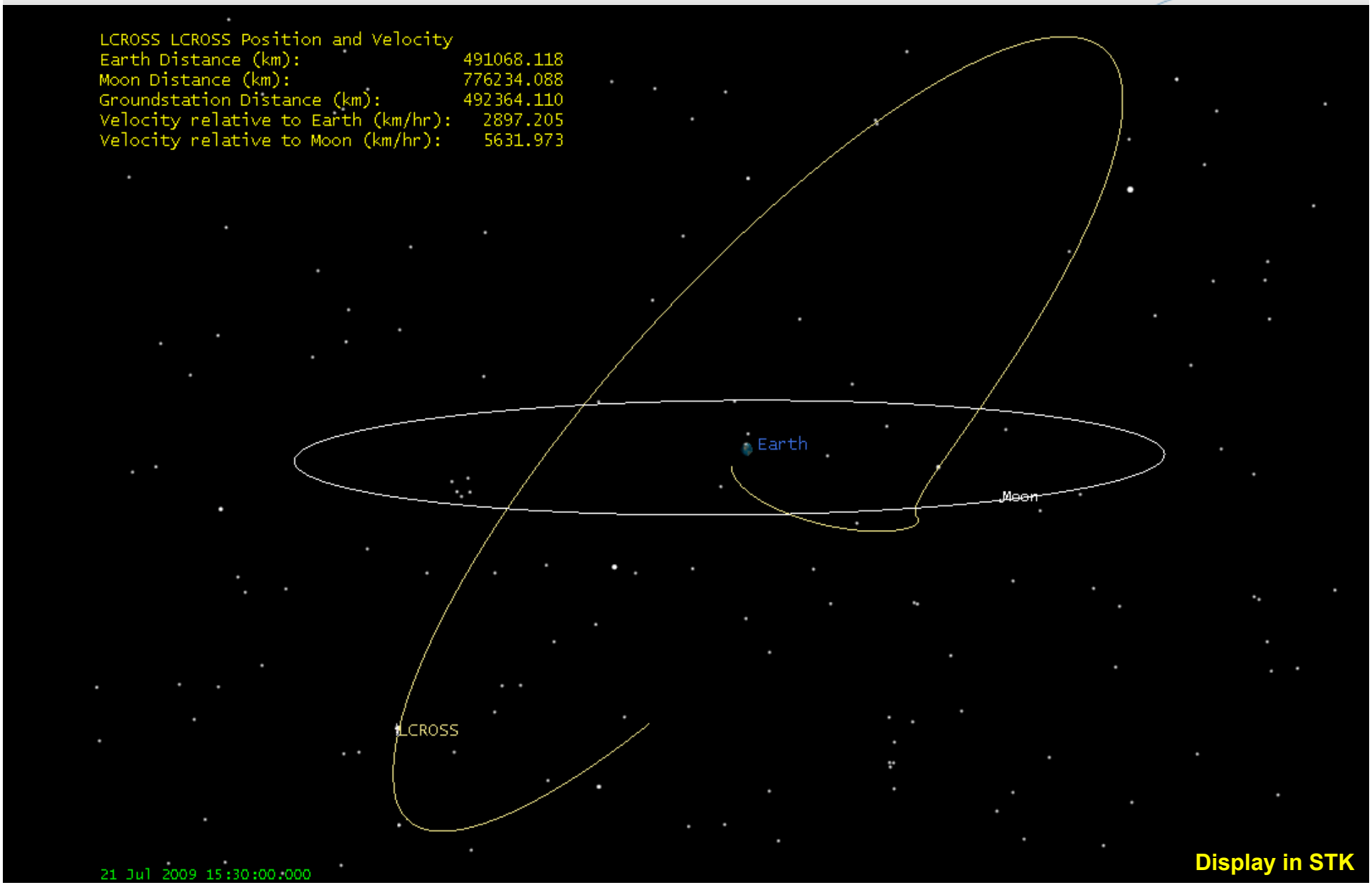
Hawaii lunar elevation
= 47 deg @ impact

Hawaii Sunset @ 04:01 UTC

Sunrise @ 16:17 UTC

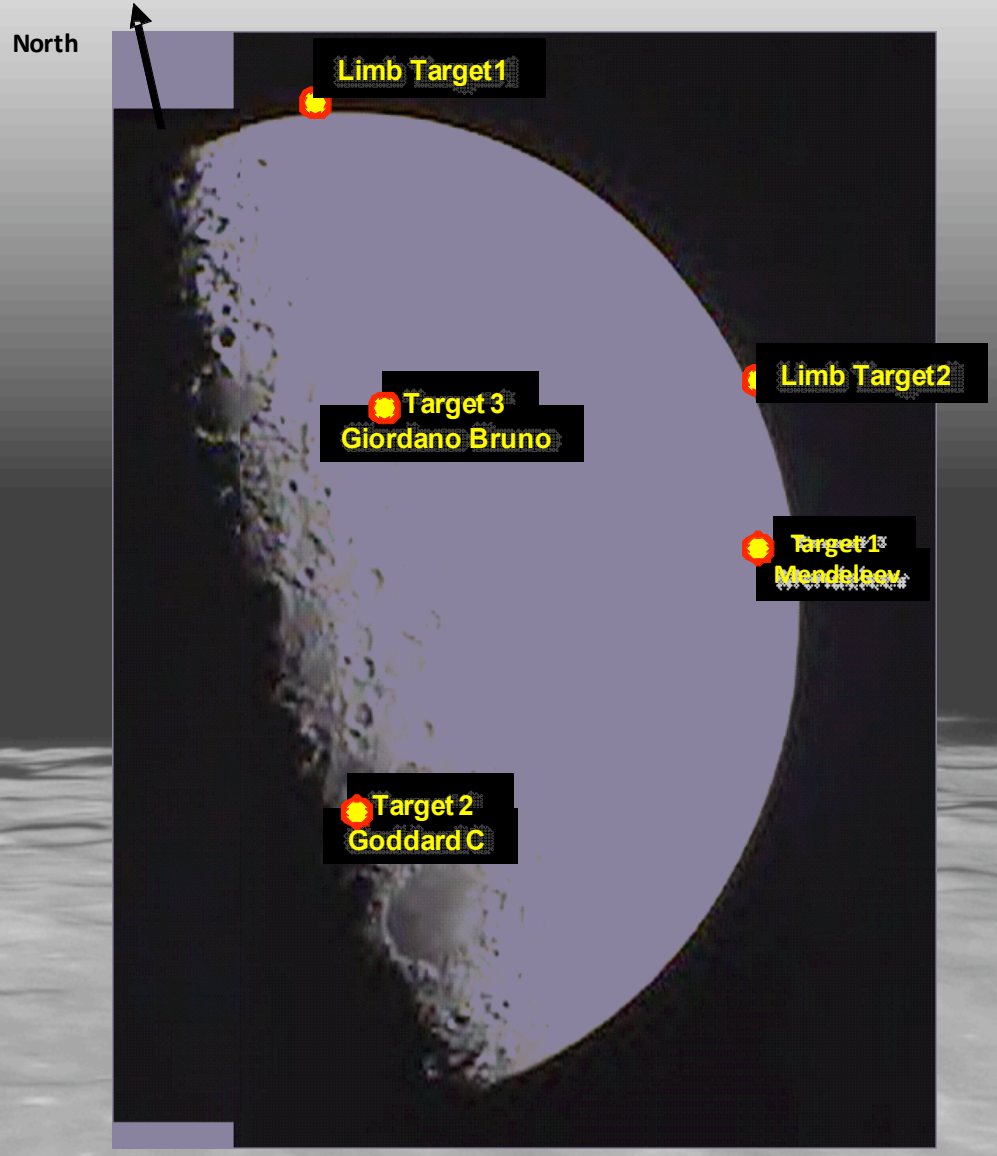
LCROSS Current Position

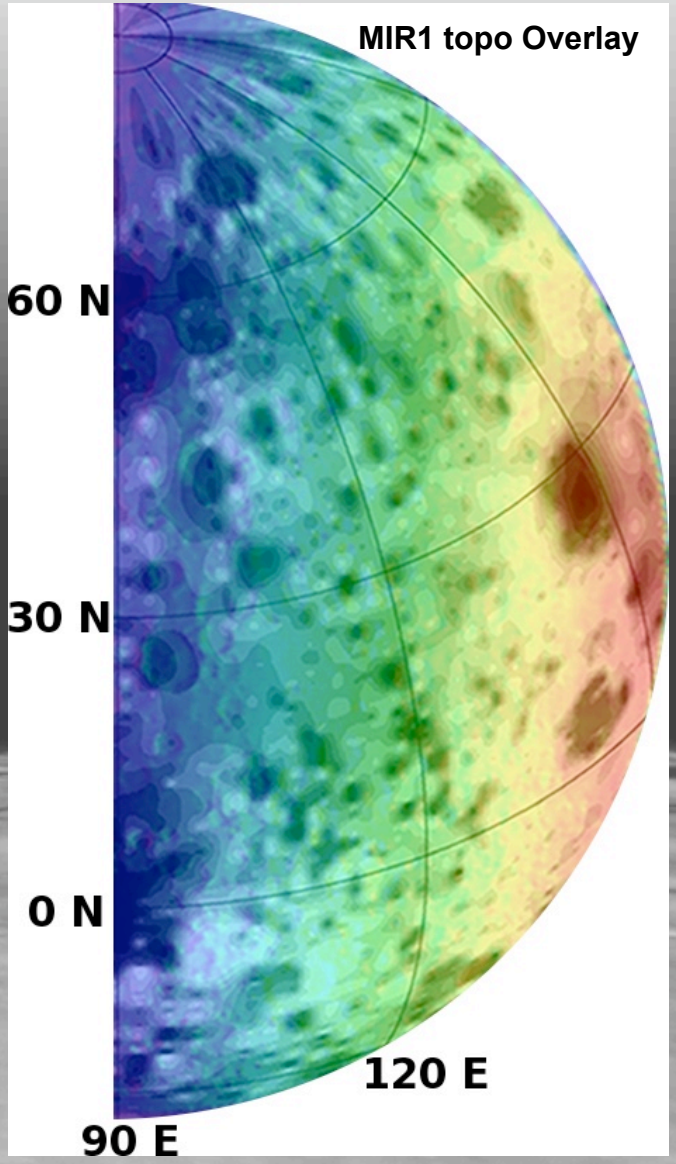
Current as of UTC: 2009-199-15:30:00



Lunar Swingby Images

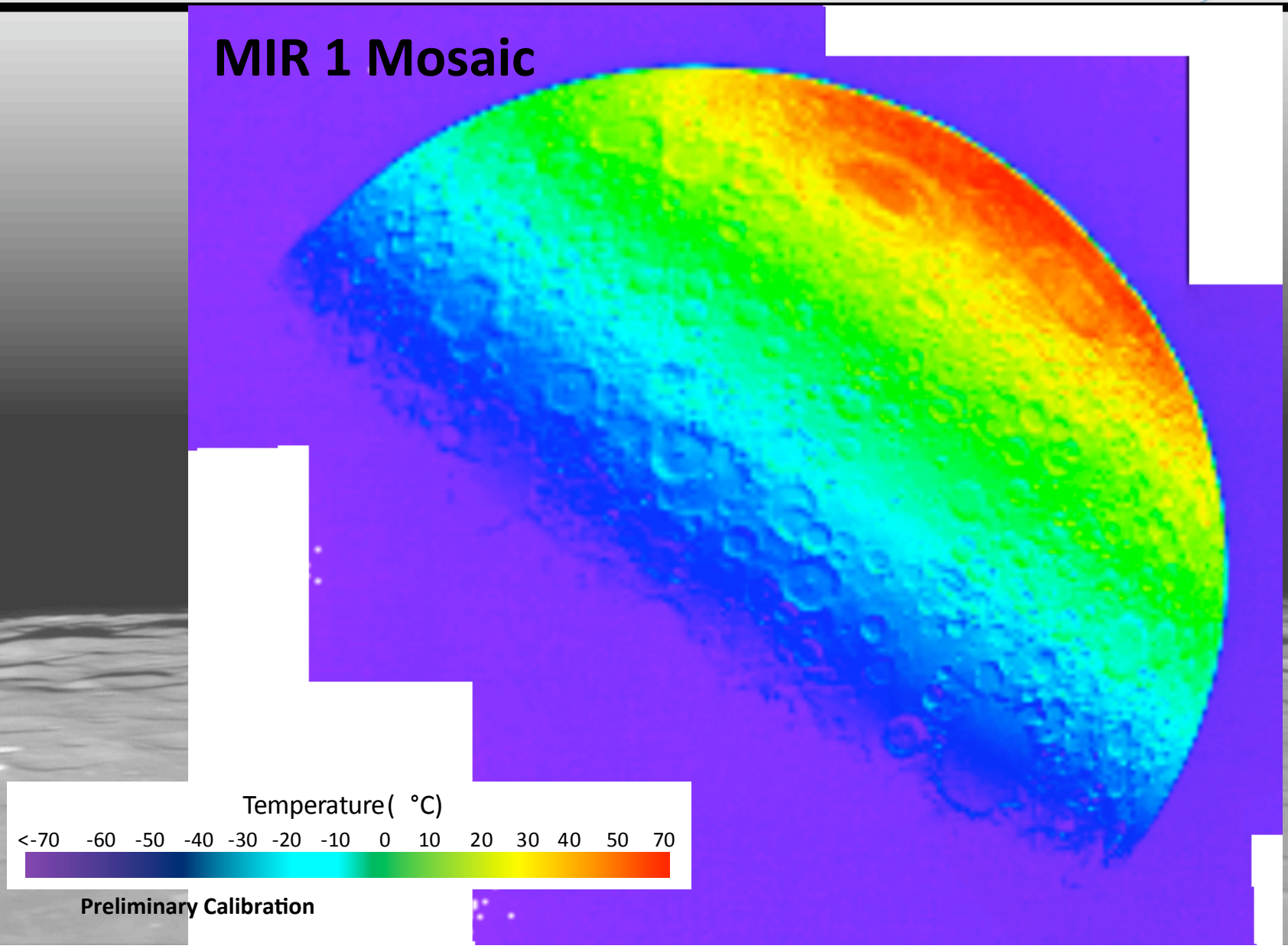
Visible Context Camera Mosaic





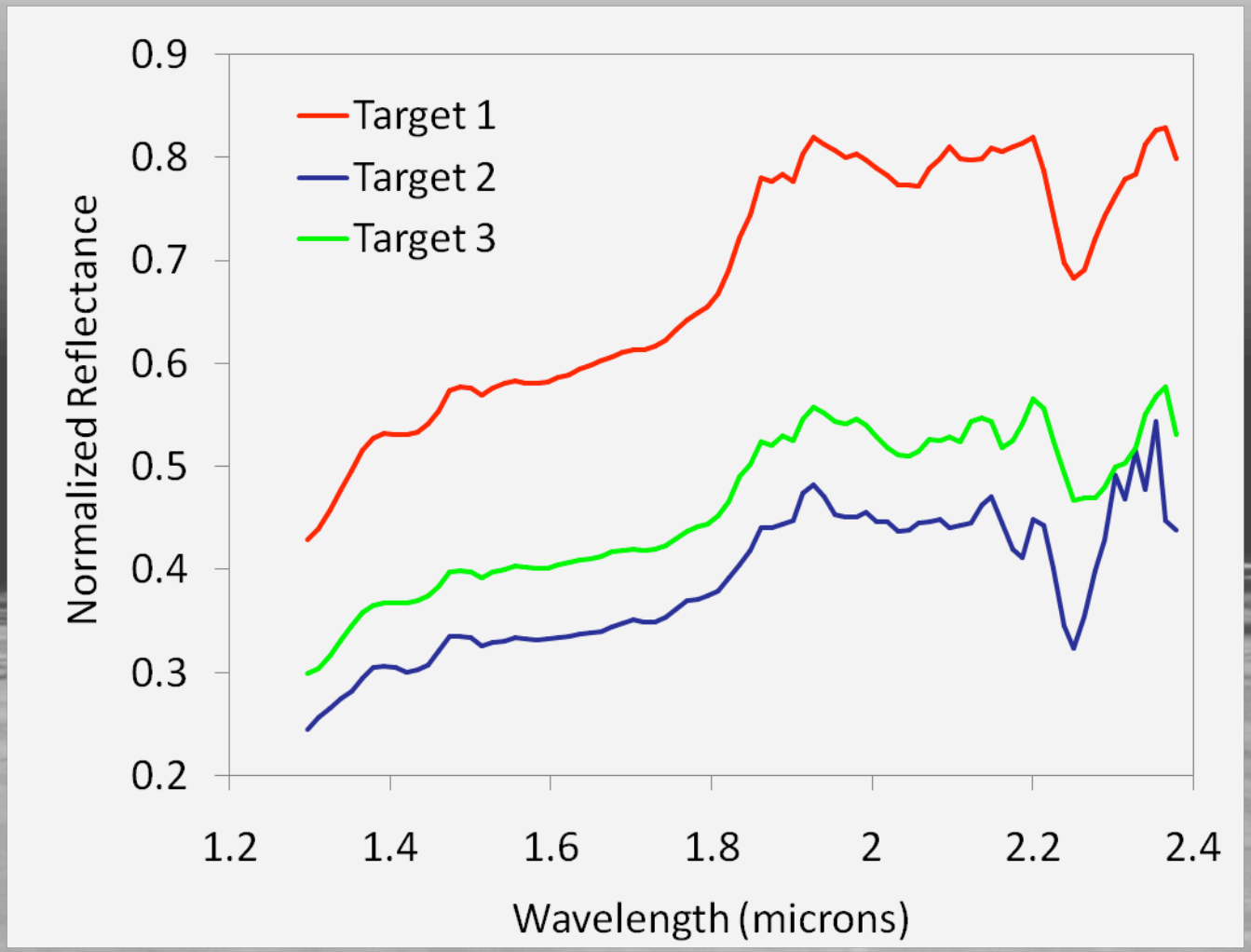
Lunar Swingby Images

MIR 1 Mosaic



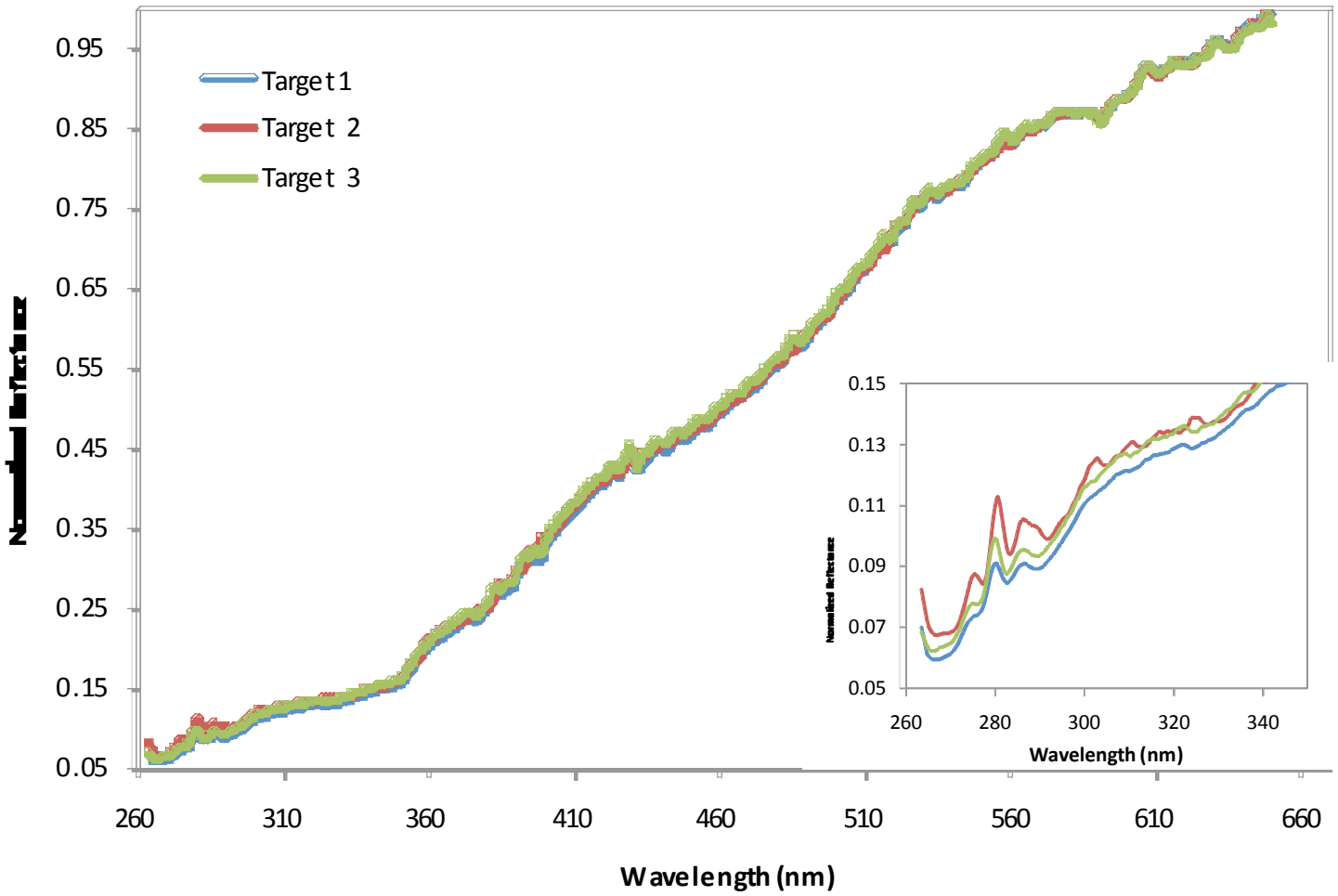
Lunar Swingby Spectra

Nadir NIR Spectrometer



Lunar Swingby Spectra

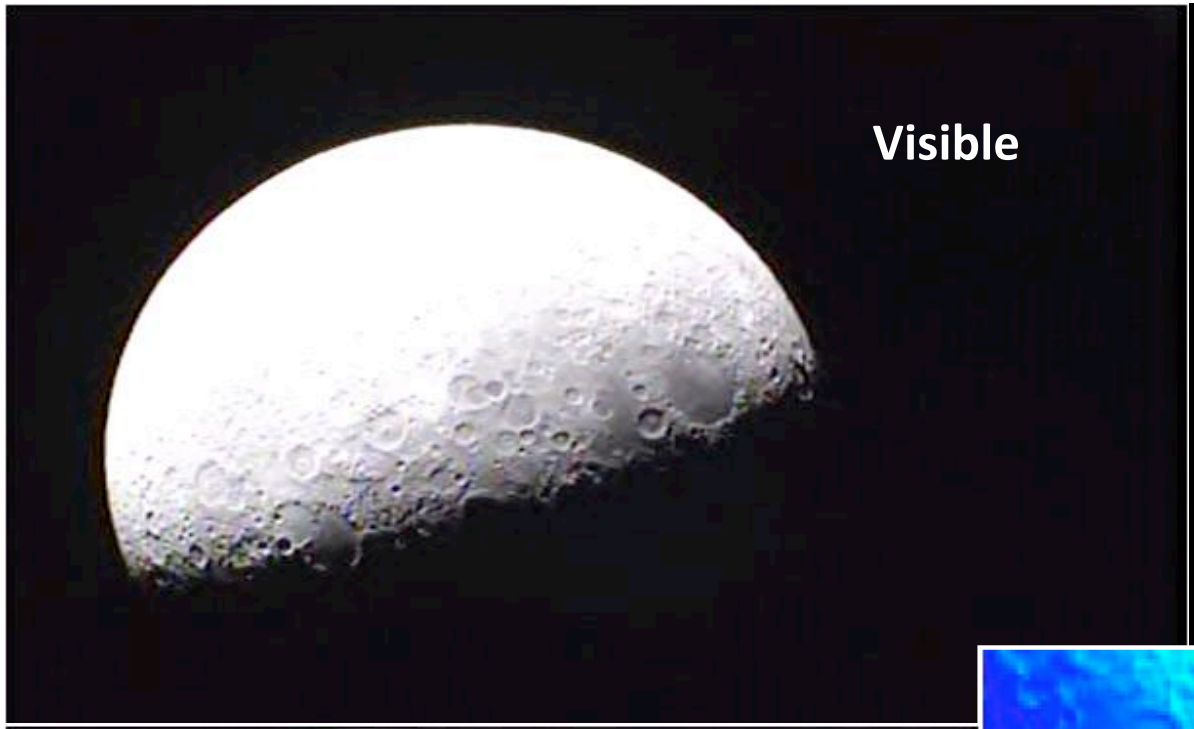
UV/Visible Spectrometer



Summary

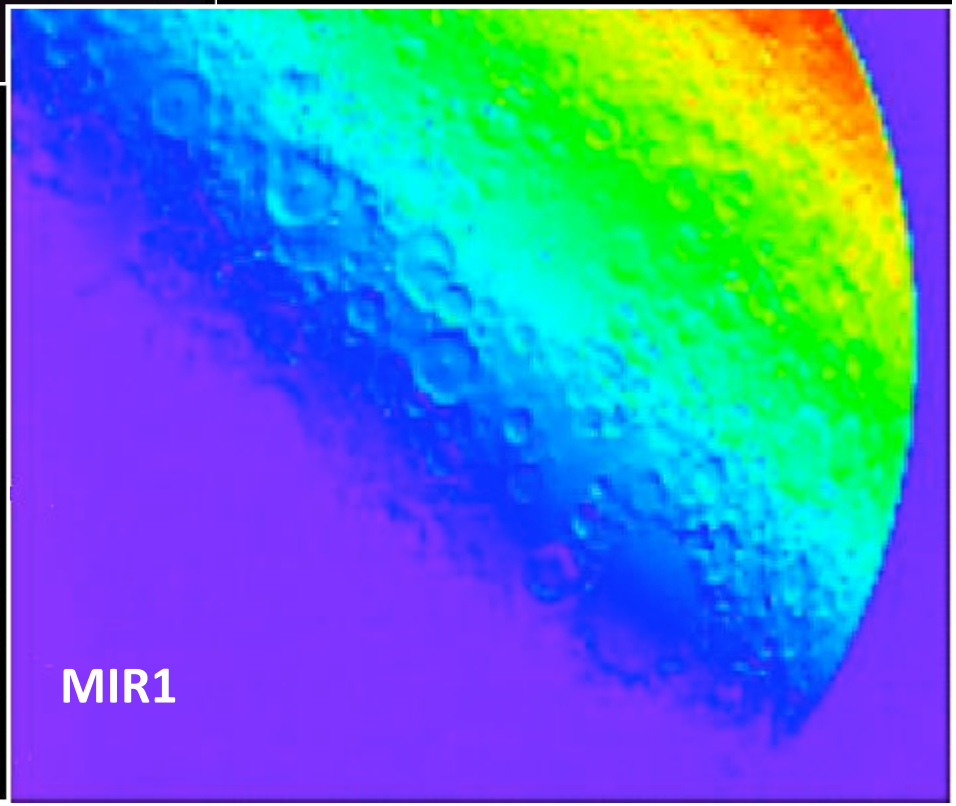
We'll know in about 79 days!

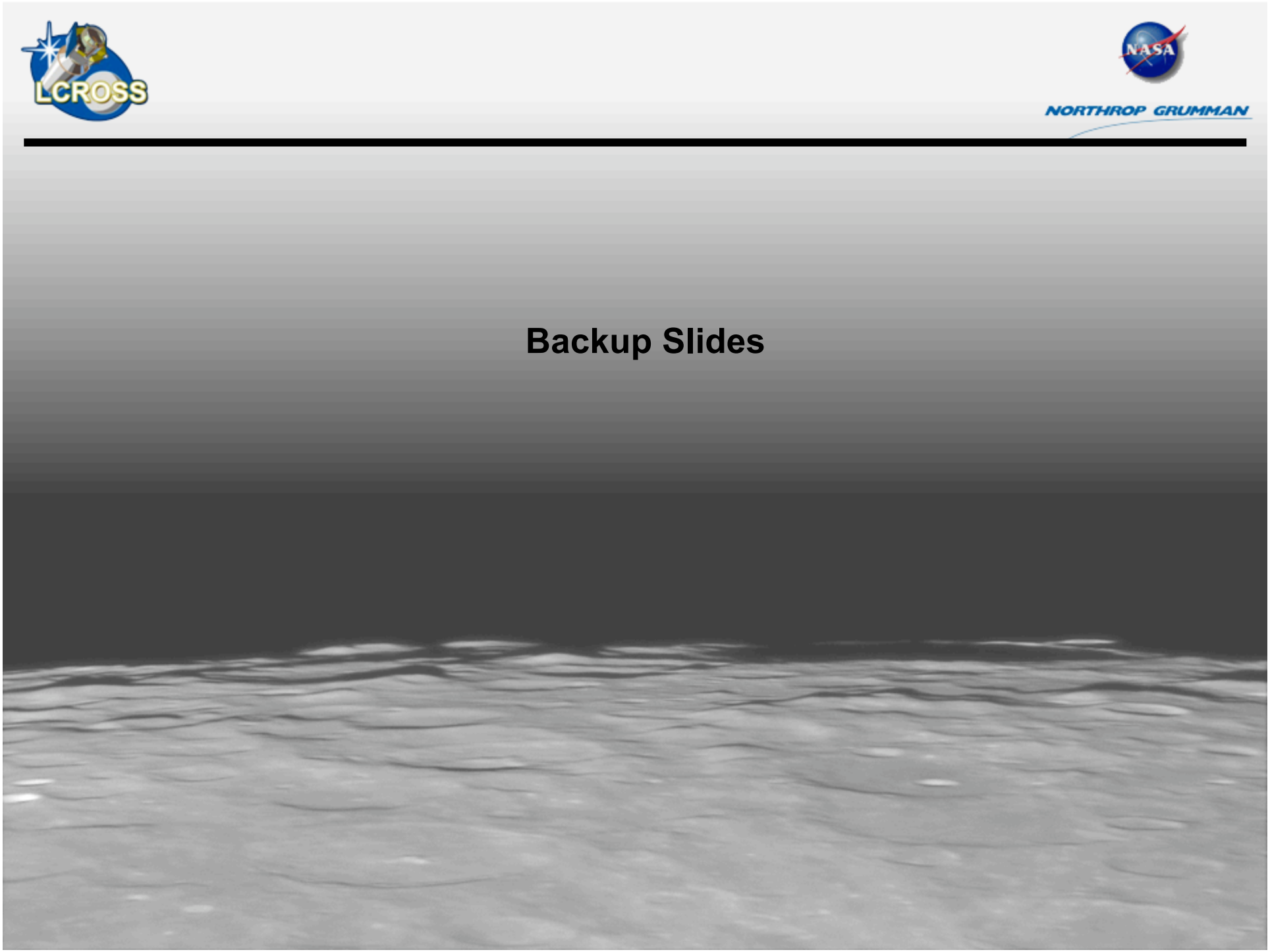
- Swingby was very successful: Instruments and Spacecraft all doing well.
- Impact 11:30 UTC, October 9, 2009
- Should be visible from Earth from Hawaii to as far east as the Mississippi
- South Pole Impact: Impact target selection an on-going process with final decision first week of September
- LCROSS SC and Instrument development demonstrated a novel approach: High scientific return per dollar spent



Swung by the moon.
Headed for impact.
Having a great time!

Wish you were here!





Backup Slides

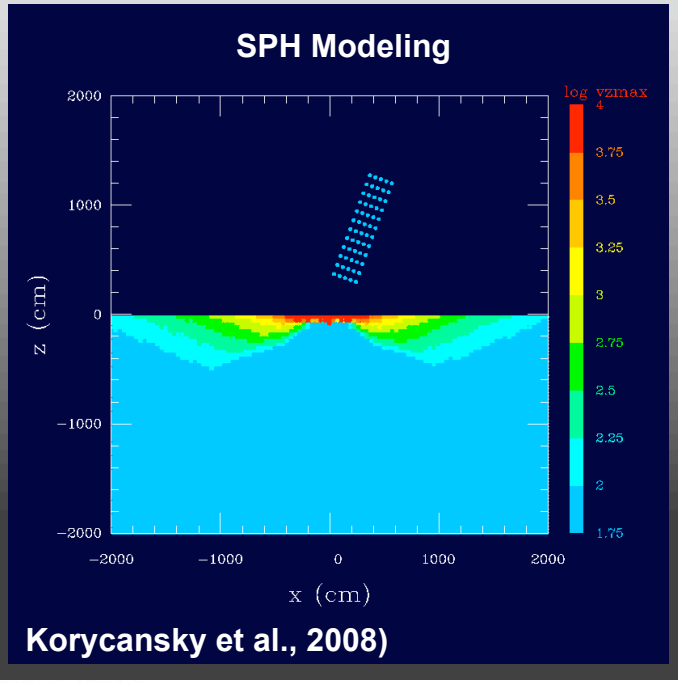
Question Addressed by LCROSS

Nature and form of the hydrogen?
- Water, hydrated minerals, hydrocarbons?
- Grain size?
- Distribution within regolith?

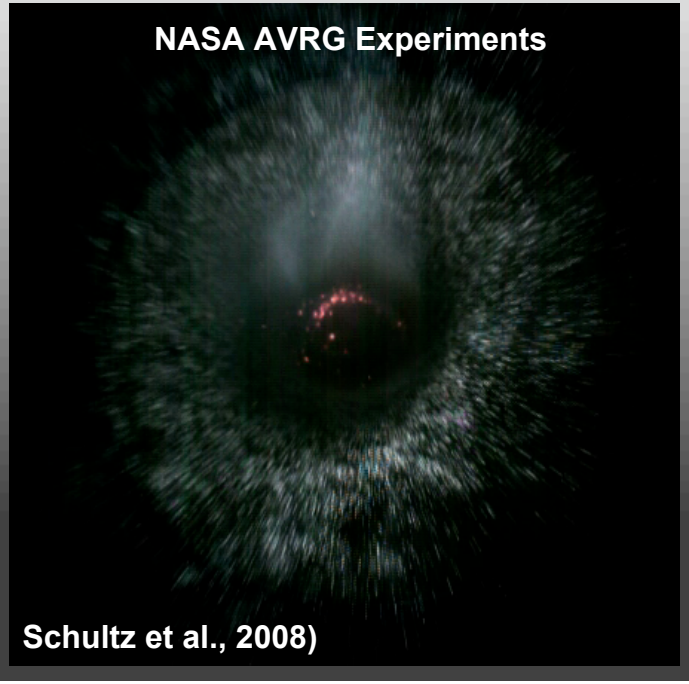
Nature of PSR regolith?
- Strength? Depth?
- Grain size?
- Composition?
- Is it similar to Apollo sites?

The Lunar Atmosphere / Volatile Processes?
- How does the Lunar atmosphere respond?
- What are the times scales for recovery?
- How do volatiles/dust migrate?

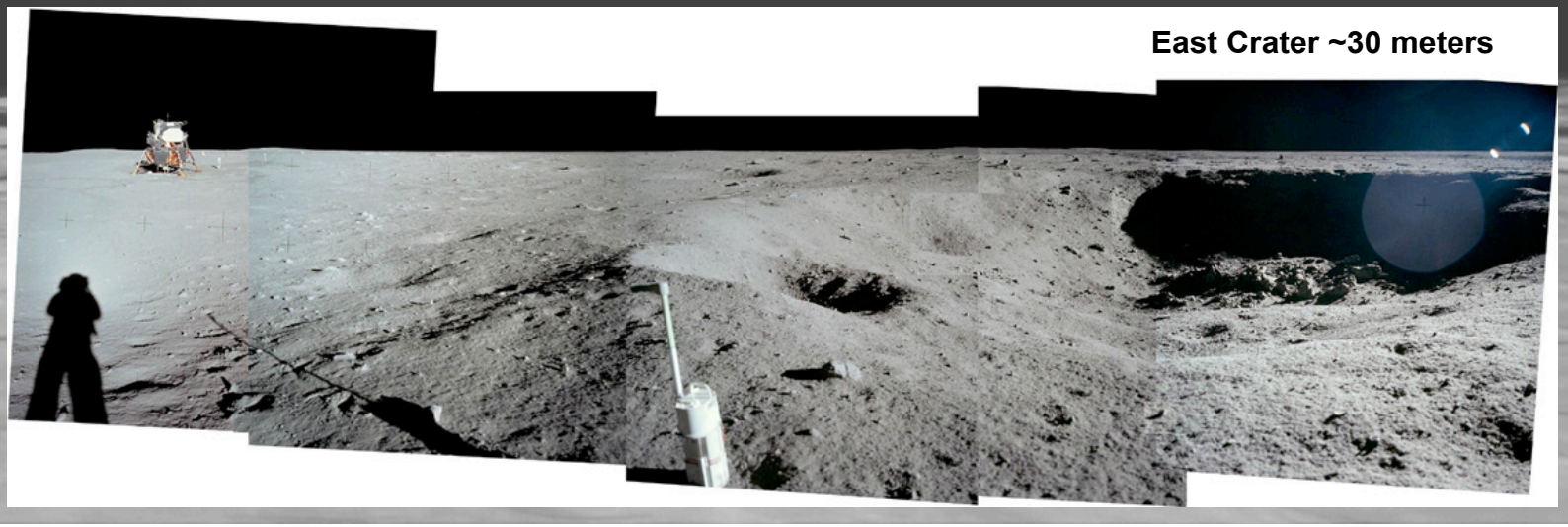
Predicted Centaur Crater Size



Korycansky et al., 2008)

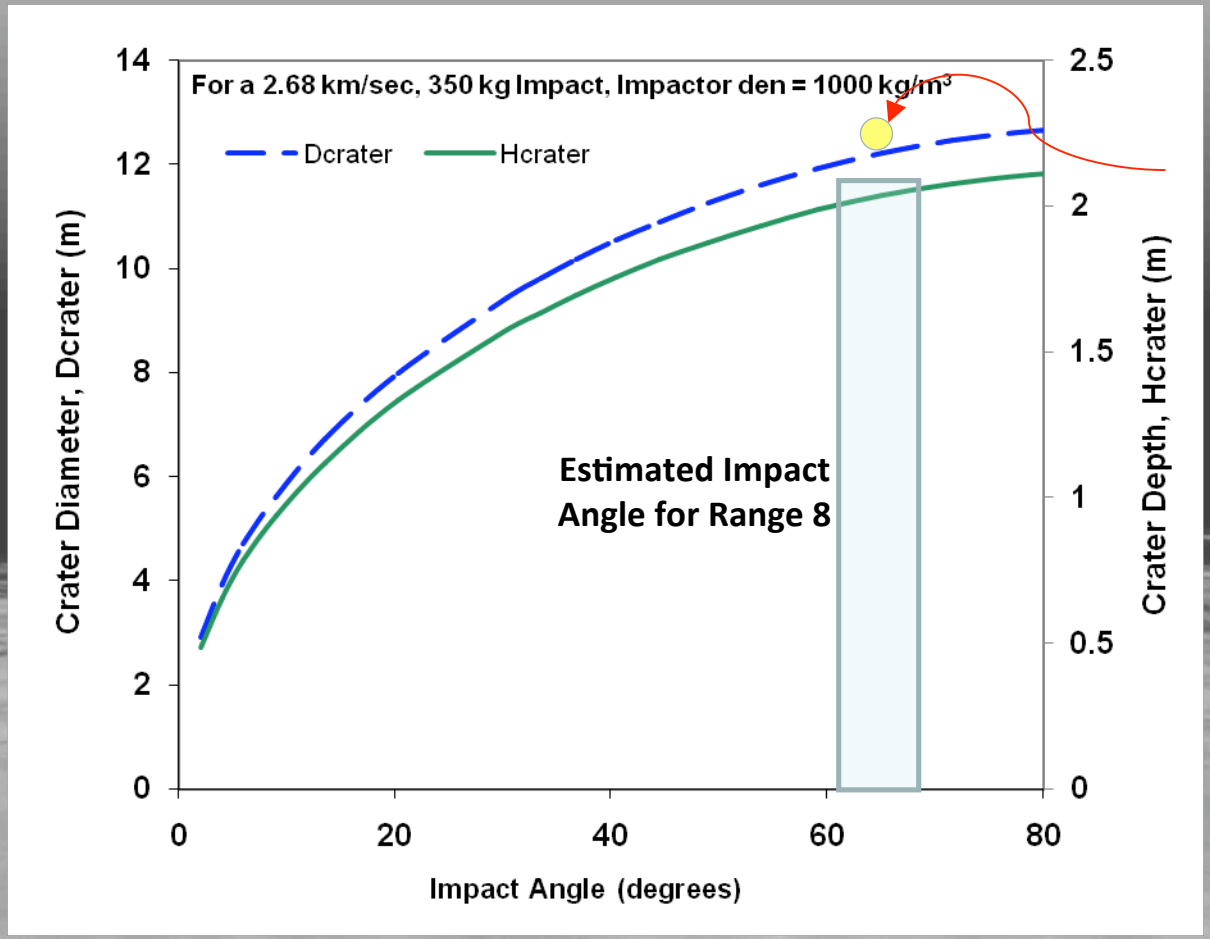


Schultz et al., 2008)


East Crater ~30 meters

Predicted Ranger 8 Crater Size

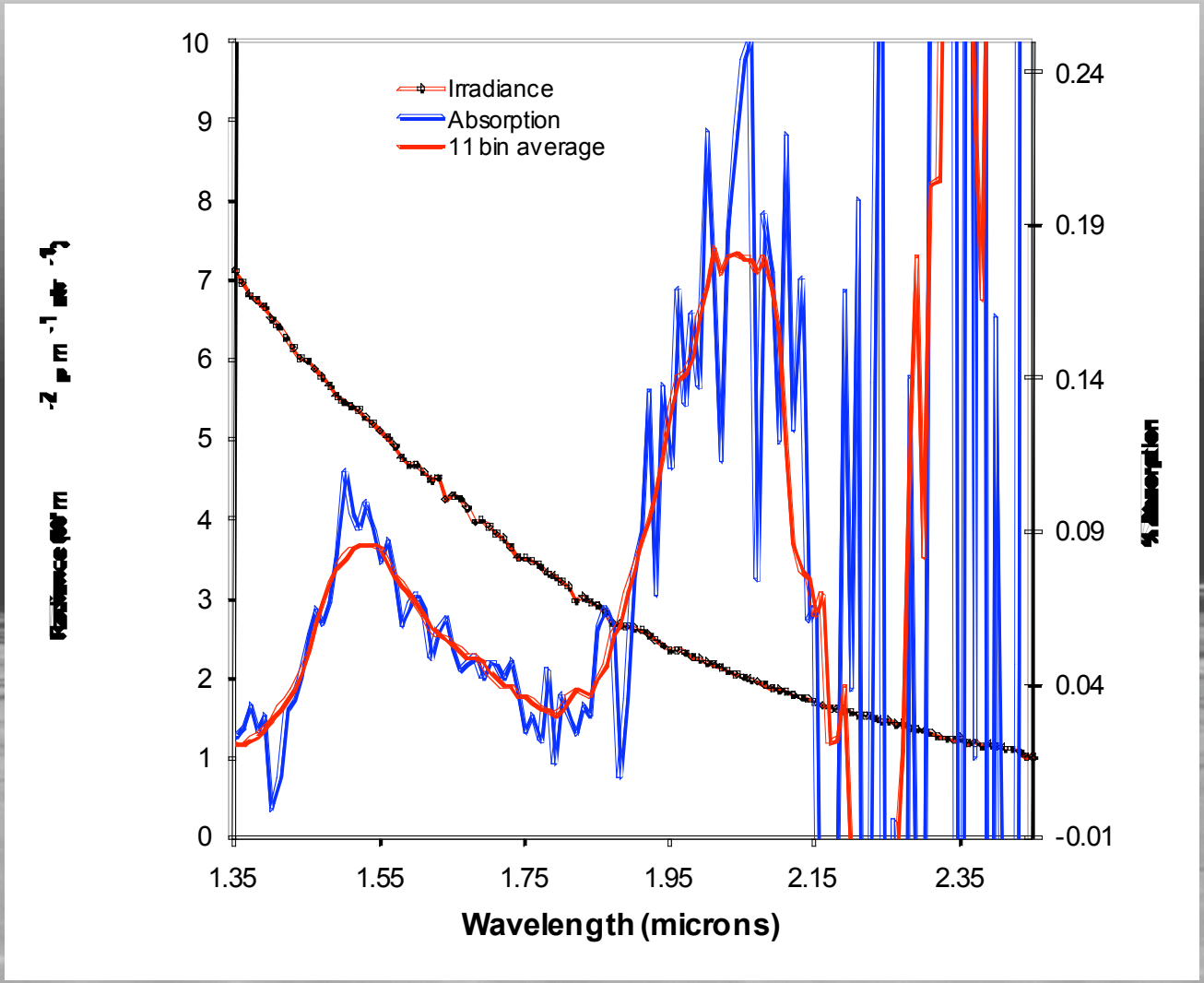
Estimated Crater Size and Depth for Ranger 8 Impact
Using one of the LCROSS Impact Estimate Tools



Measured Range 8 Impact Crater Diameter (12.5 m) from LO imaging

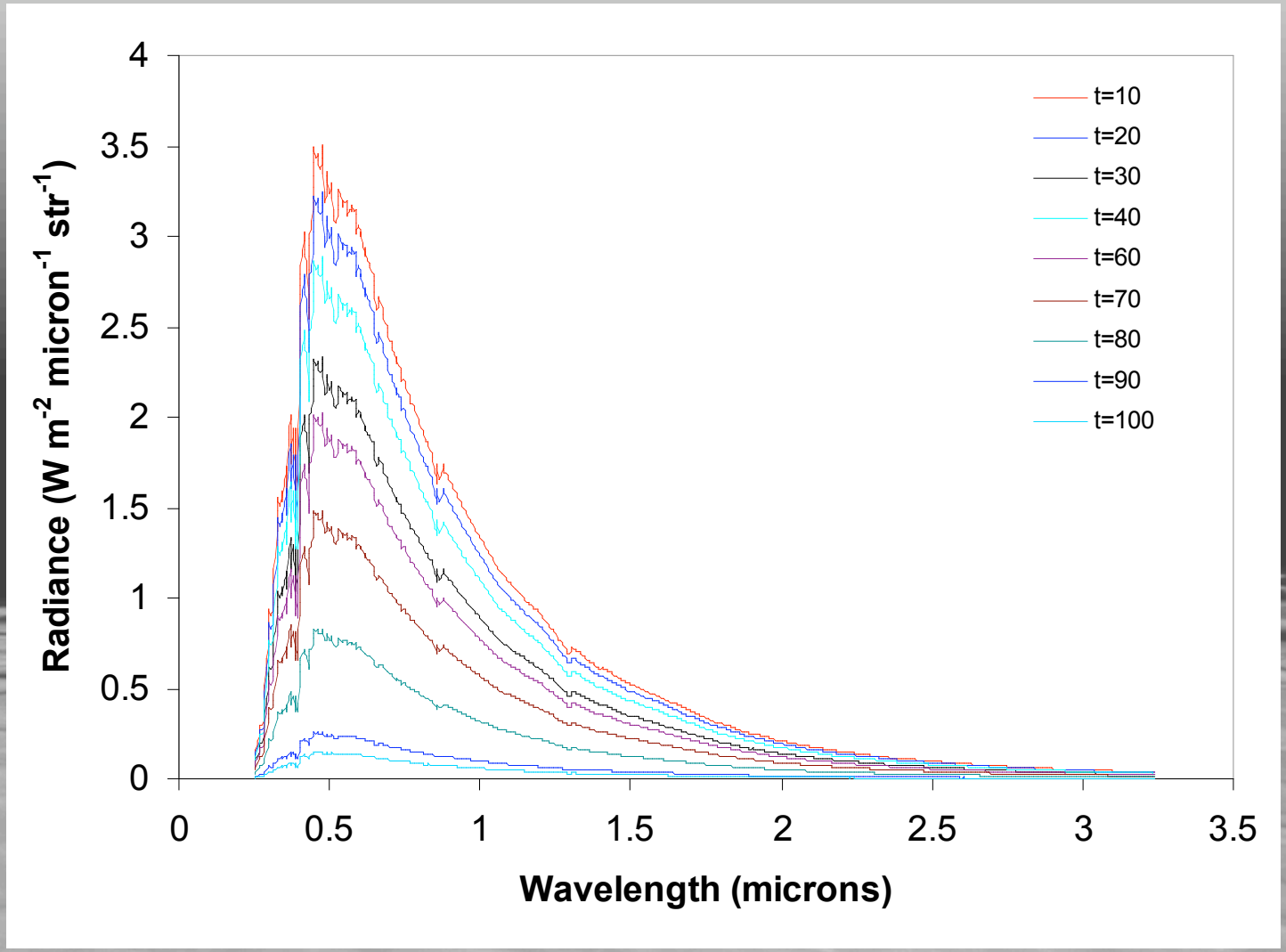
Expectations: LCROSS Water Detection

Calculated ejecta cloud radiance (left axis) and synthetic NIR spectrometer data for 1% water content

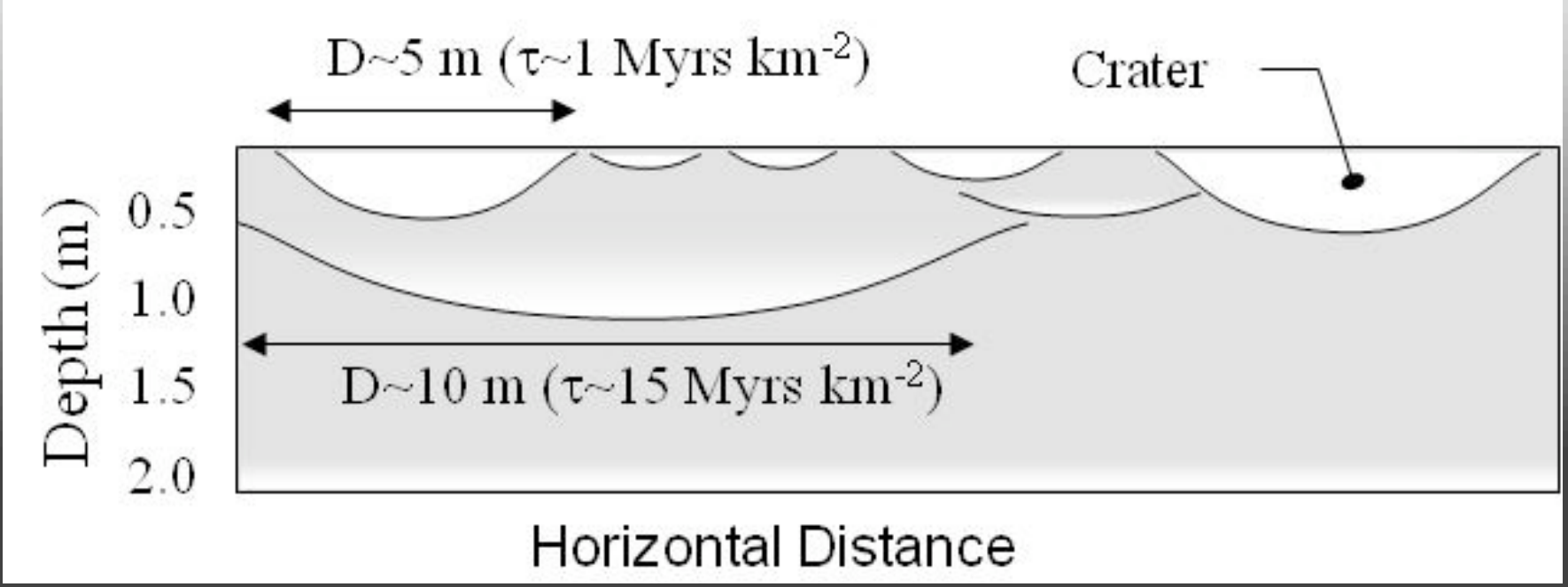


Expectations: Curtain Brightness

The radiance for the ejecta cloud only (derived be subtracting off the spectra from the lunar surface) for several times after Centaur impact.



The LCROSS Experiment: Smooth or Chunky?



Aerial fraction for 10 m craters that is in equilibrium, i.e., "wet", is:

~1 – Crater Diameter^2/Crater Spacing^2 = 1.-10^2/100^2 = **99%**

⇒Top meter sensed by LP is near the derived value: high concentration pockets (water greater than few %) in the top meter *not* likely….the *Smooth* model is predicted.

Impact Expectations: Earth Brightness (per 1 sqr arc sec)

Calculated Curtain Area Average Brightness