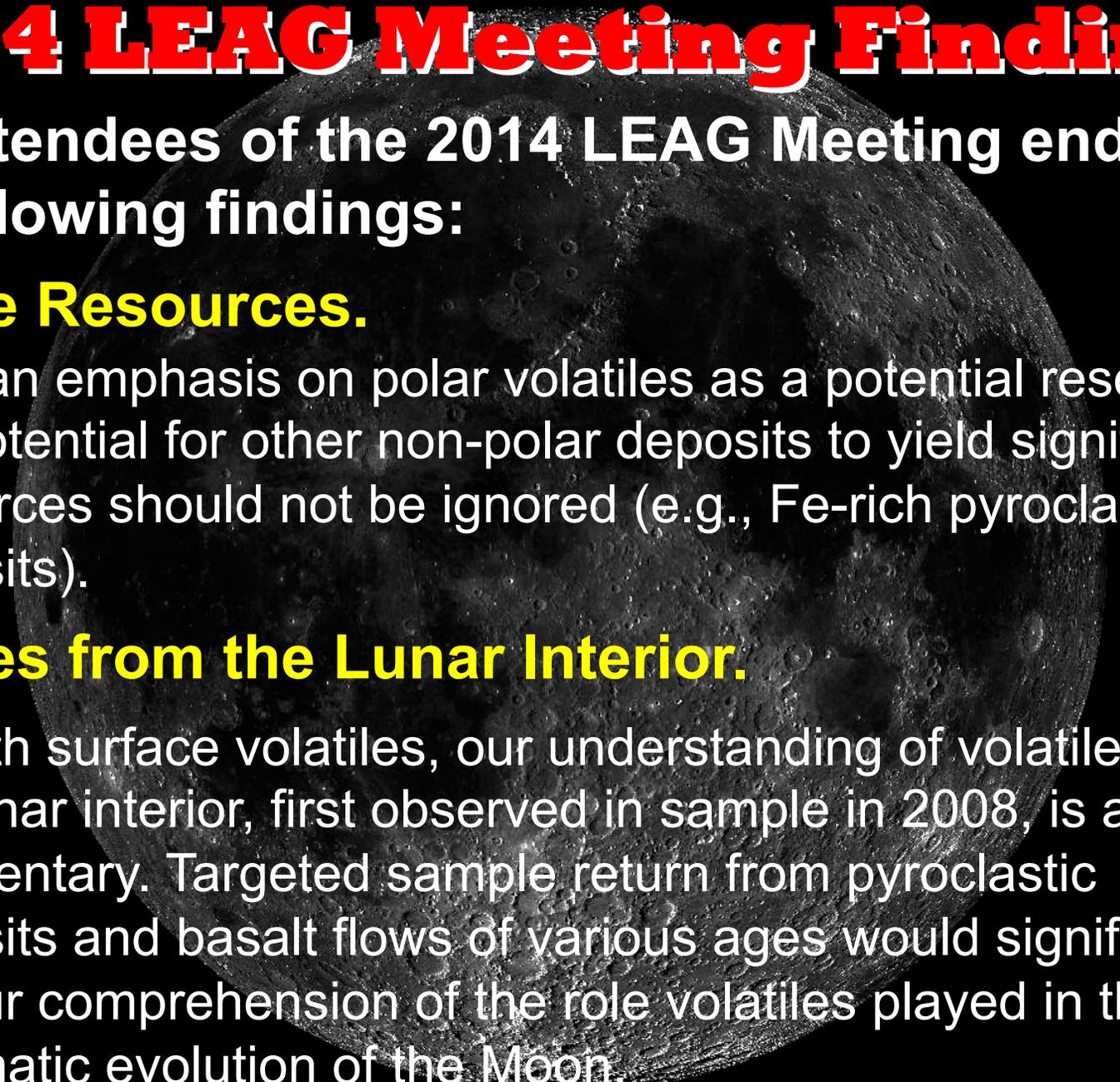


2014 LEAG Meeting Findings



The attendees of the 2014 LEAG Meeting endorse the following findings:

Volatile Resources.

- With an emphasis on polar volatiles as a potential resource, the potential for other non-polar deposits to yield significant resources should not be ignored (e.g., Fe-rich pyroclastic deposits).

Volatiles from the Lunar Interior.

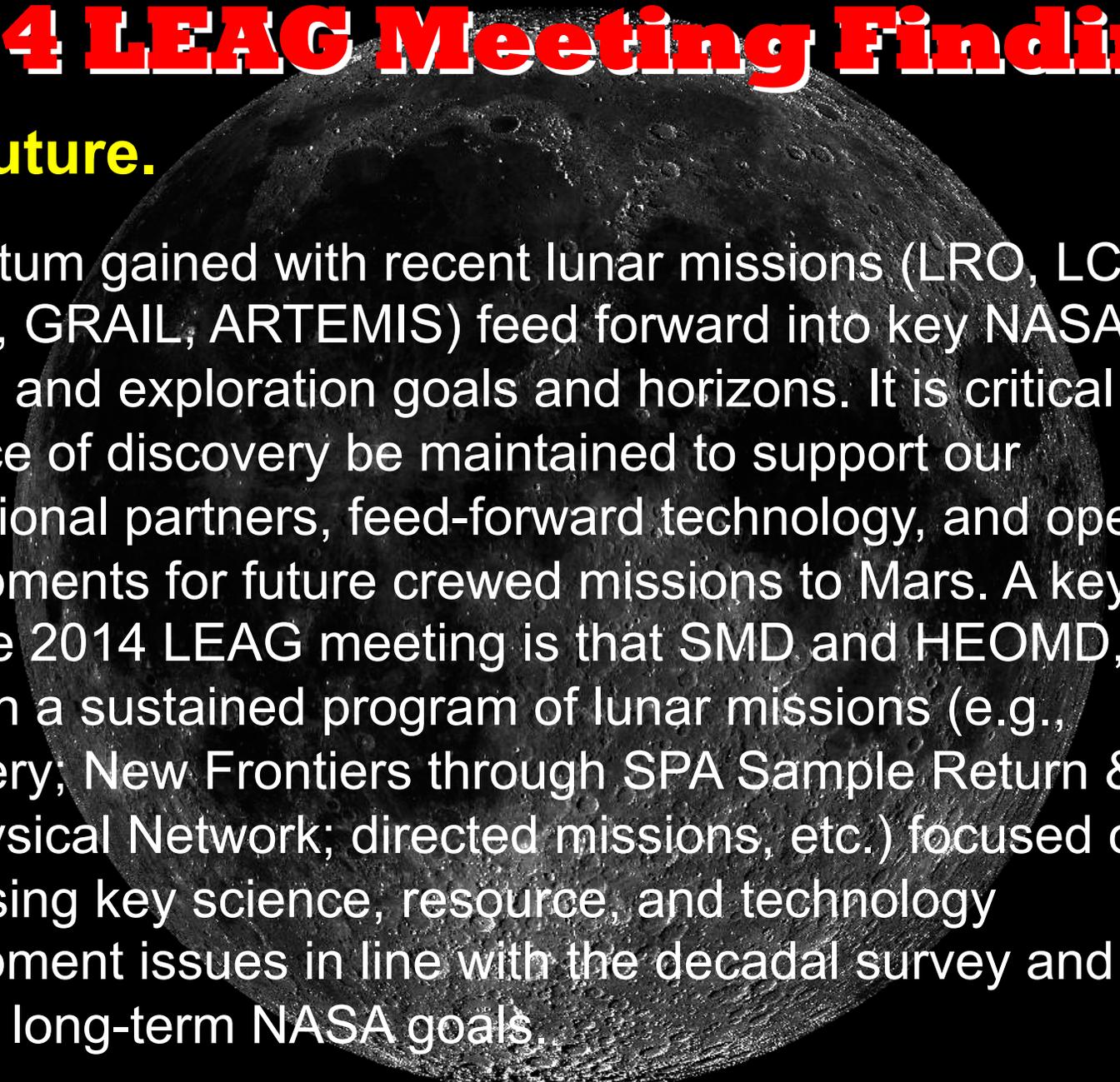
- As with surface volatiles, our understanding of volatiles in the lunar interior, first observed in sample in 2008, is also rudimentary. Targeted sample return from pyroclastic deposits and basalt flows of various ages would significantly aid our comprehension of the role volatiles played in the magmatic evolution of the Moon.

2014 LEAG Meeting Findings

Resource Prospecting.

- The attendees of the LEAG meeting support the HEOMD **Resource Prospector Mission** concept as a good start in the “prospecting phase” for lunar resources. NASA’s Planetary Science Mission Division (PSD) is encouraged to explore avenues for community participation in this mission (e.g., guest scientist program);
- Additional missions (that include competed payloads and payloads on missions of opportunity) to expand our understanding of the form, mobility, and resource potential of lunar volatiles would be the next logical step. These would include focused orbital, surface, and sample return missions.

2014 LEAG Meeting Findings



The Future.

Momentum gained with recent lunar missions (LRO, LCROSS, LADEE, GRAIL, ARTEMIS) feed forward into key NASA science and exploration goals and horizons. It is critical that this pace of discovery be maintained to support our international partners, feed-forward technology, and operational developments for future crewed missions to Mars. A key finding from the 2014 LEAG meeting is that SMD and HEOMD, maintain a sustained program of lunar missions (e.g., Discovery; New Frontiers through SPA Sample Return & Lunar Geophysical Network; directed missions, etc.) focused on addressing key science, resource, and technology development issues in line with the decadal survey and to support long-term NASA goals.

2014 LEAG Meeting Findings

LRO - Mini-RF.

- LEAG and the lunar community are concerned that the Mini-RF instrument is being terminated as part of the active payload for the LRO Extend Mission 2.
- Mini-RF in the Earth-based bistatic mode is the only instrument on the LRO payload that is capable of detecting the presence subsurface ice deposits, which are of extreme interest both scientifically and for exploitation as a potential resource. Data presented at the 2014 LEAG meeting highlighted this and these data demonstrate the programmatic importance of Mini-RF for identifying water ice deposits in permanently shadowed craters.
- We believe the termination of the Mini-RF experiment will result in a significant degradation of the potential to understand lunar polar volatiles.
- The SMD/PSD and HEOMD are encouraged to explore options to continue funding such targeted Mini-RF bistatic measurements during the second extended mission period or provide an opportunity to do so during the third LRO extended mission.

2014 LEAG Meeting Findings

International Cooperation.

- The creation of the Science White paper for ISECG Science Working Group, while coordinated by SSERVI, should have input from the broad lunar, small bodies and Mars communities in addition to the SSERVI nodes. The Analysis Groups can facilitate such input through coordination with SSERVI central.
- Comprehensive investigations of lunar volatiles for both science and exploration could be a rallying point for future international cooperation in lunar science and exploration.

2014 LEAG Meeting Findings

Astronaut Training.

The current program of geologic training for NASA astronauts, engineering, operations and management personnel is extremely valuable because it supports the development of a "exploration mindset" that will be essential to all future planetary exploration by:

- Providing a context for understanding planetary surface hardware design requirements should be designed and developed;
- Providing examples of the operations principles and practices that will be necessary for planetary surface exploration;
- Giving management experience in the astronaut training and hardware development necessary to produce significant returns from future planetary exploration.

Continuing the current management structure (NASA personnel) and training program (joint effort by NASA-USGS-academic institution), funded jointly by HEOMD and SMD, is strongly supported and endorsed by the 2014 LEAG meeting.

2014 LEAG Meeting Findings

Planetary Cartography*.

- An oversight body for Planetary Cartography needs to be created that has the status of an Analysis Group (AG) and has representation on the Planetary Science Subcommittee of the NASA Advisory Council. This is needed in order to address cartographic planning and requirements and to enable consistent standards to be applied to various planetary datasets. The need for the establishment of such an AG is recognized and supported by the LEAG community in order to continue NASA's excellence in Planetary Cartography.

* follow up to Planetary Science Subcommittee finding, September 2014

2014 LEAG Meeting Findings

Surface Volatiles.

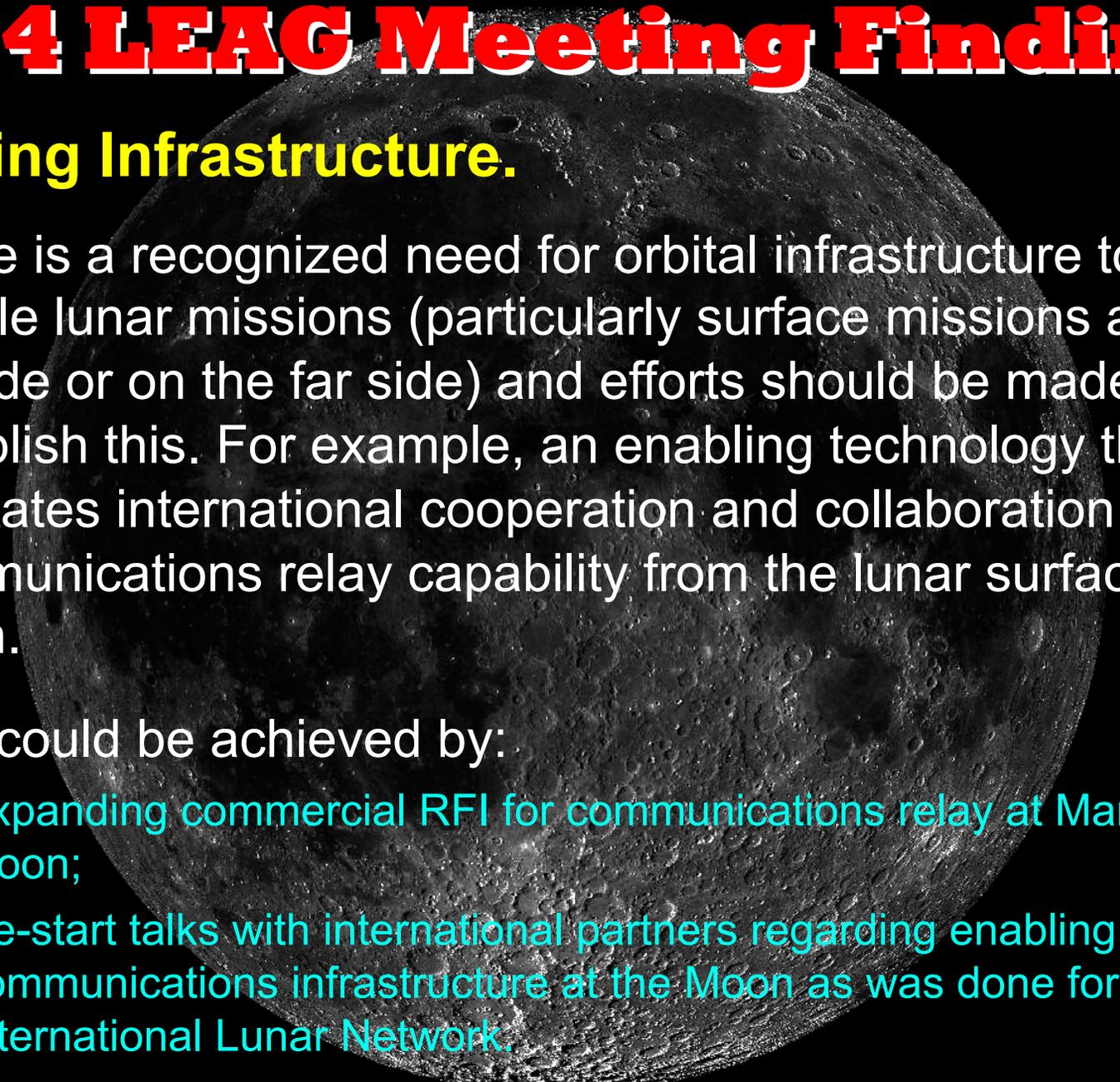
- Our understanding of the surface OH/H₂O first observed in 2009, is rudimentary at best and several “strategic science knowledge gaps” exist. These include:
 - What is the distribution, abundance, and variability of OH/H₂O and other volatiles across the lunar surface?
 - What are the processes responsible for formation and mobility of surficial OH/H₂O on the Moon?
 - What is the resource potential of the surficial OH/H₂O and is it renewable?

2014 LEAG Meeting Findings

Cube-Sats.

- The creation of opportunities for small (cube-sat) scale missions / experiments for the Space Launch System (SLS) and other launch opportunities is encouraged and should be widely advertised.
- The selection of [Lunar Flashlight](#) as a SLS-EM1 cube-sat payload through HEOMD is an excellent demonstration of the value of such a program. PSD is encouraged to explore avenues for community participation in this mission.

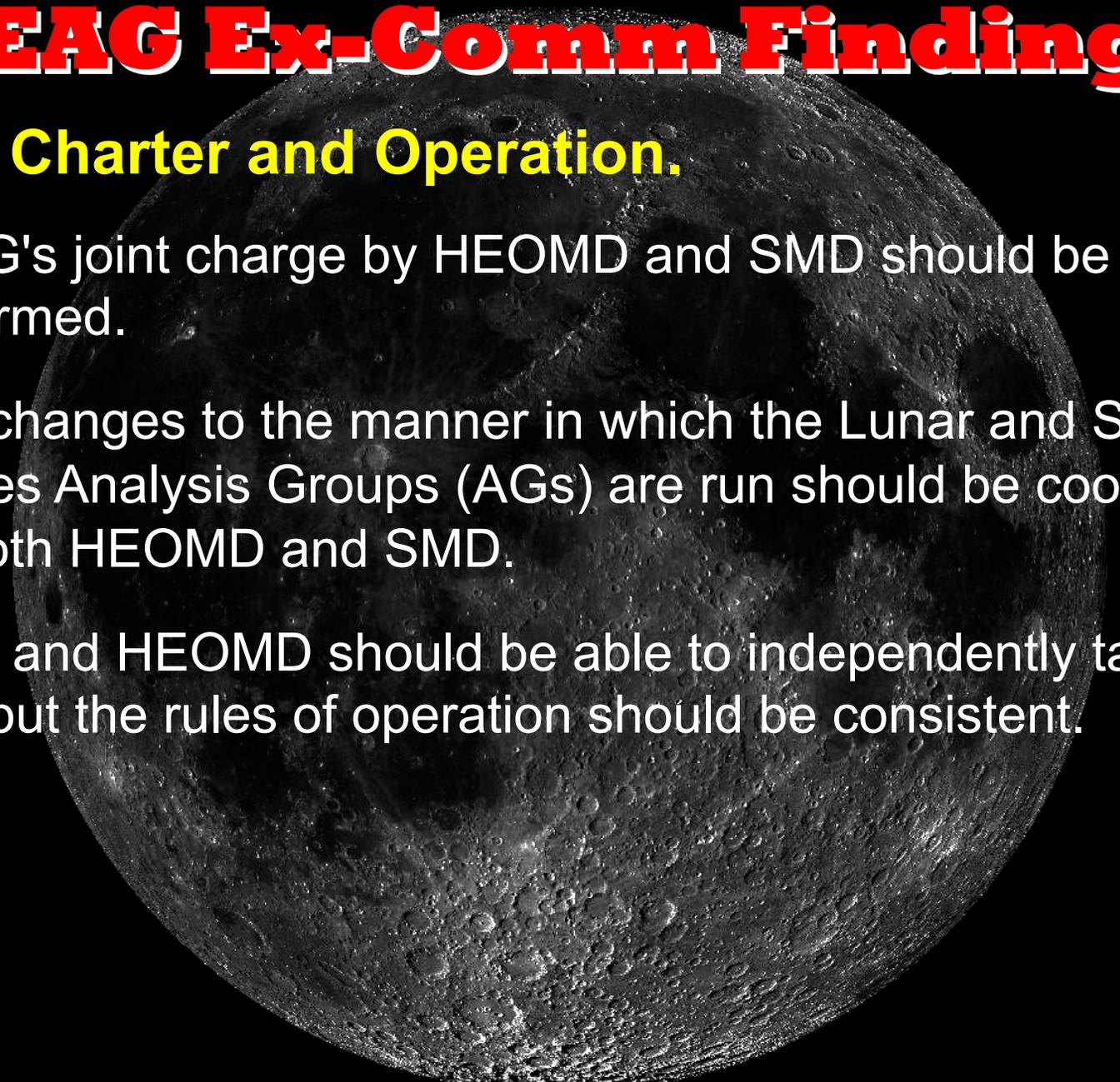
2014 LEAG Meeting Findings



Enabling Infrastructure.

- There is a recognized need for orbital infrastructure to enable lunar missions (particularly surface missions at high latitude or on the far side) and efforts should be made to establish this. For example, an enabling technology that facilitates international cooperation and collaboration is communications relay capability from the lunar surface to Earth.
- This could be achieved by:
 - Expanding commercial RFI for communications relay at Mars to the Moon;
 - Re-start talks with international partners regarding enabling communications infrastructure at the Moon as was done for the International Lunar Network.

LEAG Ex-Comm Findings



LEAG Charter and Operation.

- LEAG's joint charge by HEOMD and SMD should be confirmed.
- Any changes to the manner in which the Lunar and Small Bodies Analysis Groups (AGs) are run should be coordinated by both HEOMD and SMD.
- SMD and HEOMD should be able to independently task an AG, but the rules of operation should be consistent.