Using the Moon to facilitate exploration of Near Earth Objects

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Three Themes:
- Science (Sci)
- Feed Forward (FF)
- Sustainability (Sust)

Sustainability is the key:
- Transition strategy outlined;
- Commercial “on ramps” are defined;
- International cooperation is critical.
Feed Forward Theme: Initial version Mars-centric;

Mars Risk Reduction Value:
How well do the candidates address the key risk reduction areas identified through NASA’s robotic and human Mars mission planning studies.

Lunar Platform Value:
Do candidates leverage the unique attributes of a lunar program to achieve success – or – would other platforms be more effective from a technical/cost perspective.
Lunar Exploration Roadmap

http://www.lpi.usra.edu/leag/ler_draft.shtml

Feed Forward Theme Expanded in 2010:

- **Goal FF-A**: Identify and test technologies on the Moon to enable robotic and human solar system science and exploration;

- **Goal FF-B**: Use the Moon as a test-bed for missions operations and exploration techniques to reduce the risks and increase the productivity of future missions to Mars and beyond;

- **Goal FF-C**: Use the Moon to prepare for future missions to Small Bodies.
Lunar Exploration to Enable NEO Exploration

Pros:
- Harsh space environment;
- Proximity;
- International cooperation is critical;
- Dust/regolith issues;
- ISRU;
- Similarity in (some) Technological Developments.

Con:
- Gravity.
Lunar Exploration Roadmap

Goal FF-C: Use the Moon to prepare for future missions to Small Bodies.

Evaluation Criteria:

**Small Body Mission Risk Reduction Value**: How well do the candidates address the key risk reduction areas identified through NASA’s Small Body robotic and human mission planning studies.

**Lunar Platform Value**: Do candidates leverage the unique attributes of a lunar program to achieve success – or – would other platforms be more effective from a technical/cost perspective.

**Overarching objectives for Goal FF-C:**

- Ability to operate on a Geologic Surface.
- Operations on Airless bodies.
- Operating in an extreme Radiation environment.
- Long duration mission activities.
Using the Moon to prepare for future missions to Small Bodies

Technology Developments

• Sampling & Preservation Technologies – volatiles, ices, regolith;
• Robotic Sample Return/Curation Technologies;
• Radiation protection technologies.
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Different lighting conditions – EVA light to dark transitions (perception under different shadow/lighting regimes).

Plasma-dust environment = Electrostatic issues.

Apollo 17 Dust Sketch
Using the Moon to prepare for future missions to Small Bodies

- Thermal regimes for equipment doing EVA. More constant on the Moon, but could test equipment on the Moon for NEO exploration.

- Robotic-human interactions (teleops, efficiency plans, etc.).

- Mitigation of suit/tool failures and wear-and-tear due to dust interaction. Airlock ports.
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- **Radiation Environment**: tissue equivalent dosimeters exposed for long periods, so applicable to any deep space mission. Testing on radiation shielding strategies and technologies.

- **ISRU**: initial emphasis on prospecting. Both volatiles and metals. Some business cases have been outlined, which need to be explored in detail.
Using the Moon to prepare for future missions to Small Bodies

The Moon is an Exploration Asset:

- Technology Development (robotic & human science and exploration);
- Protection technologies for human missions;
- Systems Integration for human missions.