



Space Solar Power Technology for Lunar Polar Applications

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Space Solar Power Technology

for Lunar Polar Applications



- Technology for Laser-Photo-Voltaic Wireless Power Transmission (Laser-PV WPT) is being developed for lunar polar applications by Boeing and NASA Marshall Space Flight Center
- A lunar polar mission could demonstrate and validate Laser-PV WPT and other SSP technologies, while enabling access to cold, permanently shadowed craters that are believed to contain ice
 - Craters may hold frozen water and other volatiles deposited over billions of years, recording prior impact events on the moon (and Earth)
 - A photo-voltaic-powered rover could use sunlight, when available, and laser light, when required, to explore a wide range of lunar polar terrain.
- The National Research Council recently found that a mission to the moon's South Pole-Aitkin Basin has high priority for Space Science

North Pole (SEE BELOW)

Moon's Orbit

Sun Rays are Horizontal
at North & South Poles
•NEVER shine into Craters
•ALWAYS shine on Mountain

South Pole (SEE BELOW)

Direct
Communication
Link

Solar Power
Generation on
Mountaintop

Wireless Power
Transmission
for Rover Operations
in Shadowed Craters

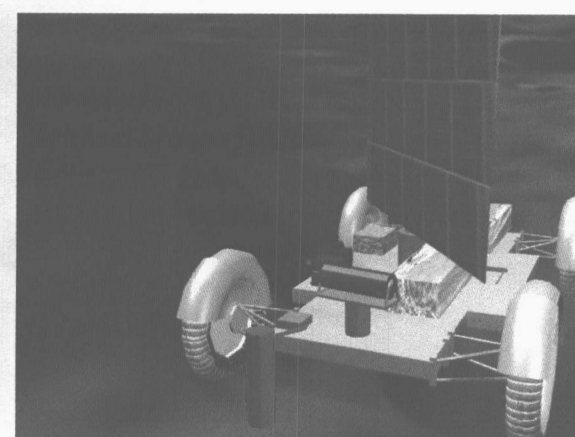
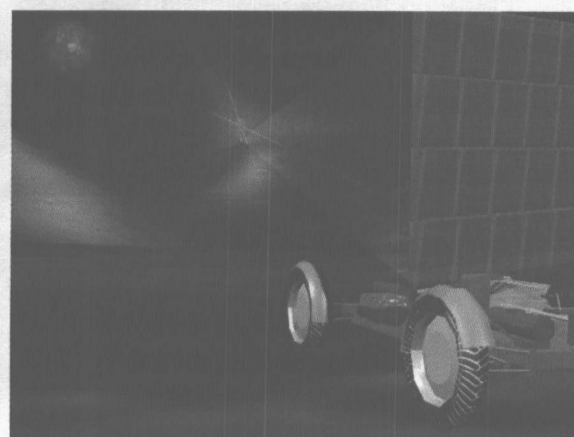
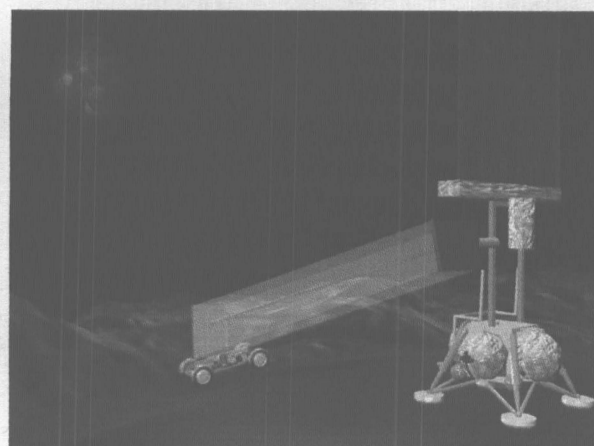
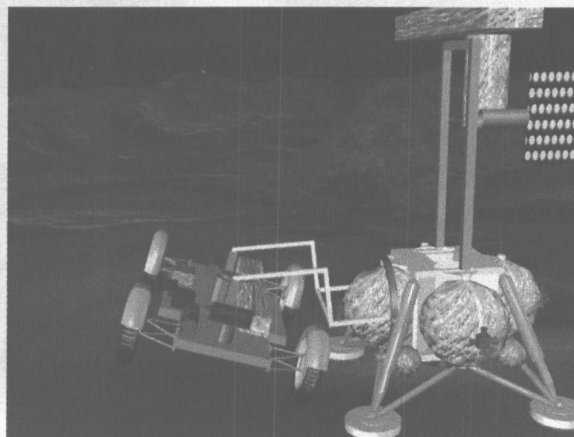
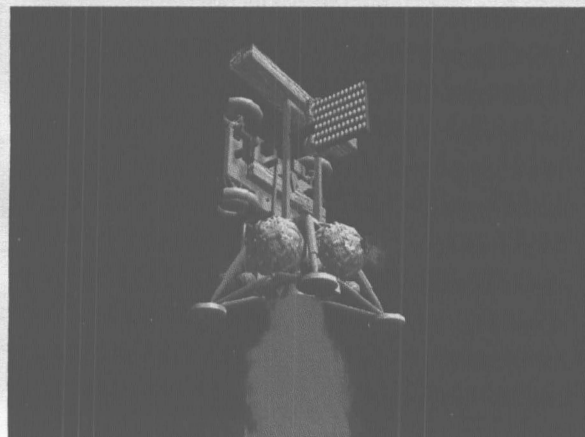
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POSSIBLE ICE DEPOSITS

- Craters are COLD: -300F (-200C)
- Frost/Snow after Lunar Impacts
- Good for Future Human Uses
- Good for Rocket Propellants



Lunar Polar Technology Flight Demonstration Overview of Mission Concept

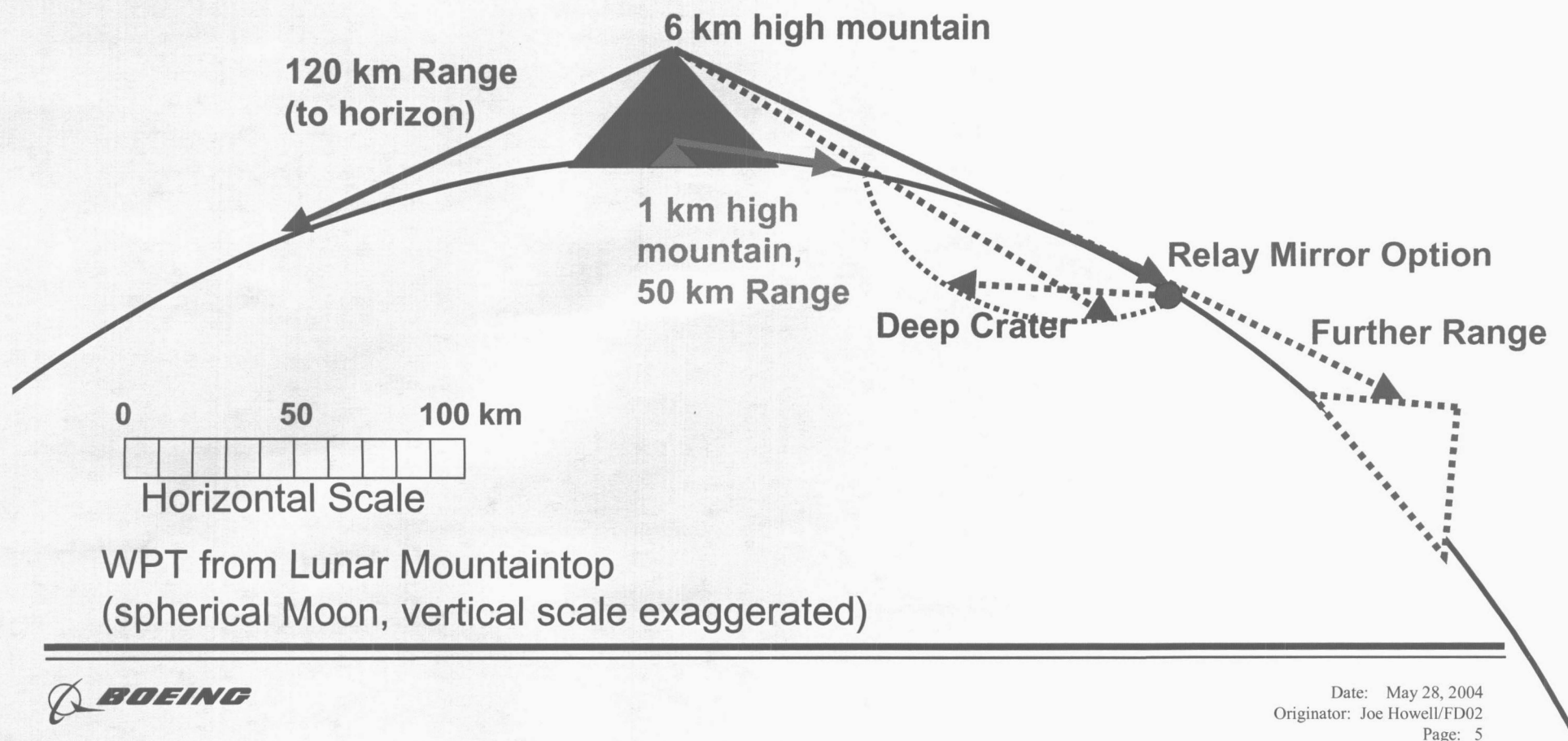




Laser Range Depends on Topography



Transmitter on lunar mountain could beam power > 100 km





Apollo Lunar Roving Vehicle (LRV): Candidate for Lunar Laser-PV WPT Mission



Key Features:

Flight-proven on the Moon

2 flight-qualified units still exist

Long Distance Roving Capability Large Platform for
WPT Receiver

Potential LRV Modifications

Large Photo-Voltaic Panel

Revise Batteries (rechargeable)

Revise Deployment System

Revise Data / Comm. Interfaces

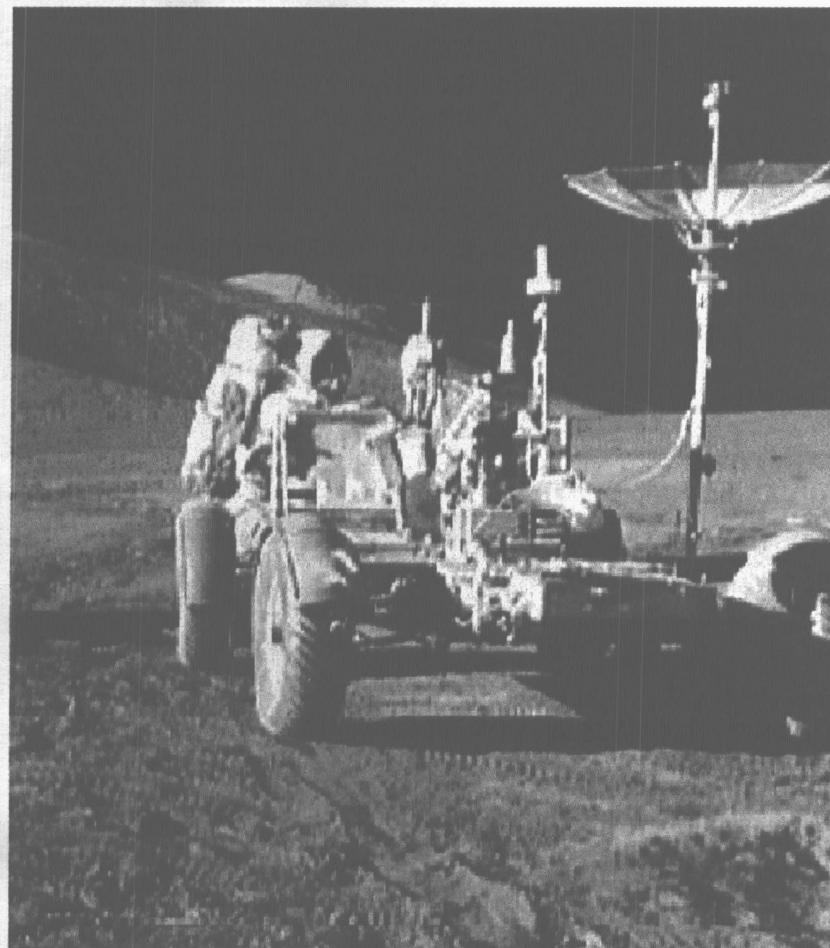
Delete Crew Interfaces (optional)

Add Teleoperation Capability

Extend Range of Ops (TBD x 100 km)

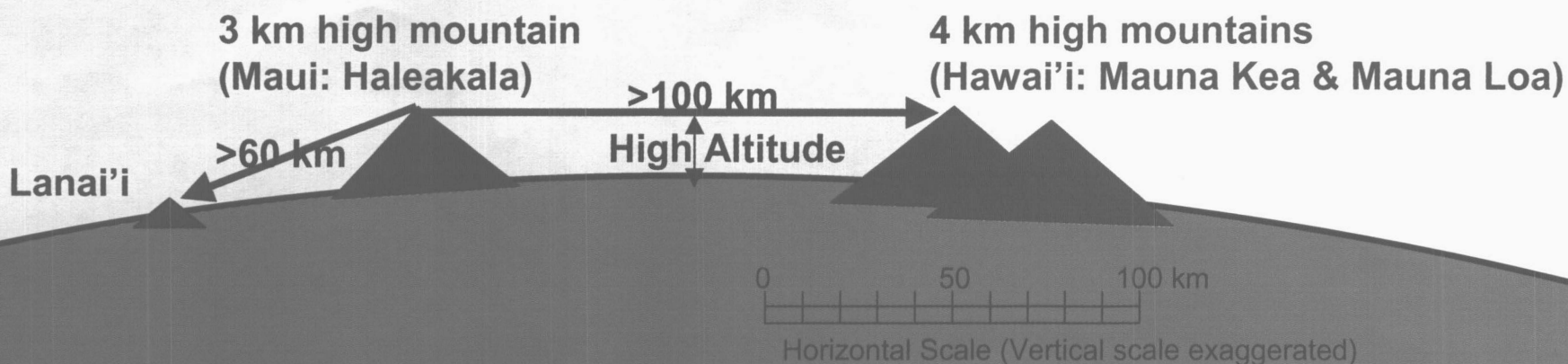
Requalify for Low T Ops (~100 Kelvin)

Add Scientific Payload Interfaces





Wireless Optical Near-field Directed Energy Relay for Technology Demonstration and Lunar Mission Simulation



Laser Power Transmission from established site(s) on Maui

- Air Force Maui Optical and Supercomputing (AMOS) Site
 - World-class laser facilities with large, high quality optics
- NASA Lunar Ranging Experiment (LURE) Observatory
 - Laser telescope operated by the University of Hawaii

Photo-Voltaic Power Reception at site(s) on Maui, Lanai, or Hawaii

- Barren terrain, similar to moonscape, can simulate mission operations
 - Large areas have fine volcanic ash soils (similar to lunar regolith)
 - Small craters exist at volcanic vents
 - Candidate site on Hawaii was used to test Apollo rover)
- Similar to lunar polar geometry, laser beams down from mountaintop
- Relatively low humidity; Excellent night-time visibility
- Potential for End-to End technology demonstration / validation



Conclusions



- Laser-Photo-Voltaic Wireless Power Transmission can enable access to permanently shadowed craters near the moon's North and South Poles
 - Lunar application can mature Laser-PV WPT technology while investigating ice deposits with high value for Space Science and Human Exploration and Development of Space
- Ground demonstration is prerequisite for Flight demo
 - Current Status: Small scale benchtop tests initiated at AMOS
 - Next Step: Initiate power beaming over modest distances
 - Potential Future Steps:
 - Increase range, efficiency, apertures and power levels
 - End-to-end technology demonstration (power from sunlight)
 - Test prototype flight hardware in simulated mission operations
 - Perform lunar mission (technology flight demonstration)