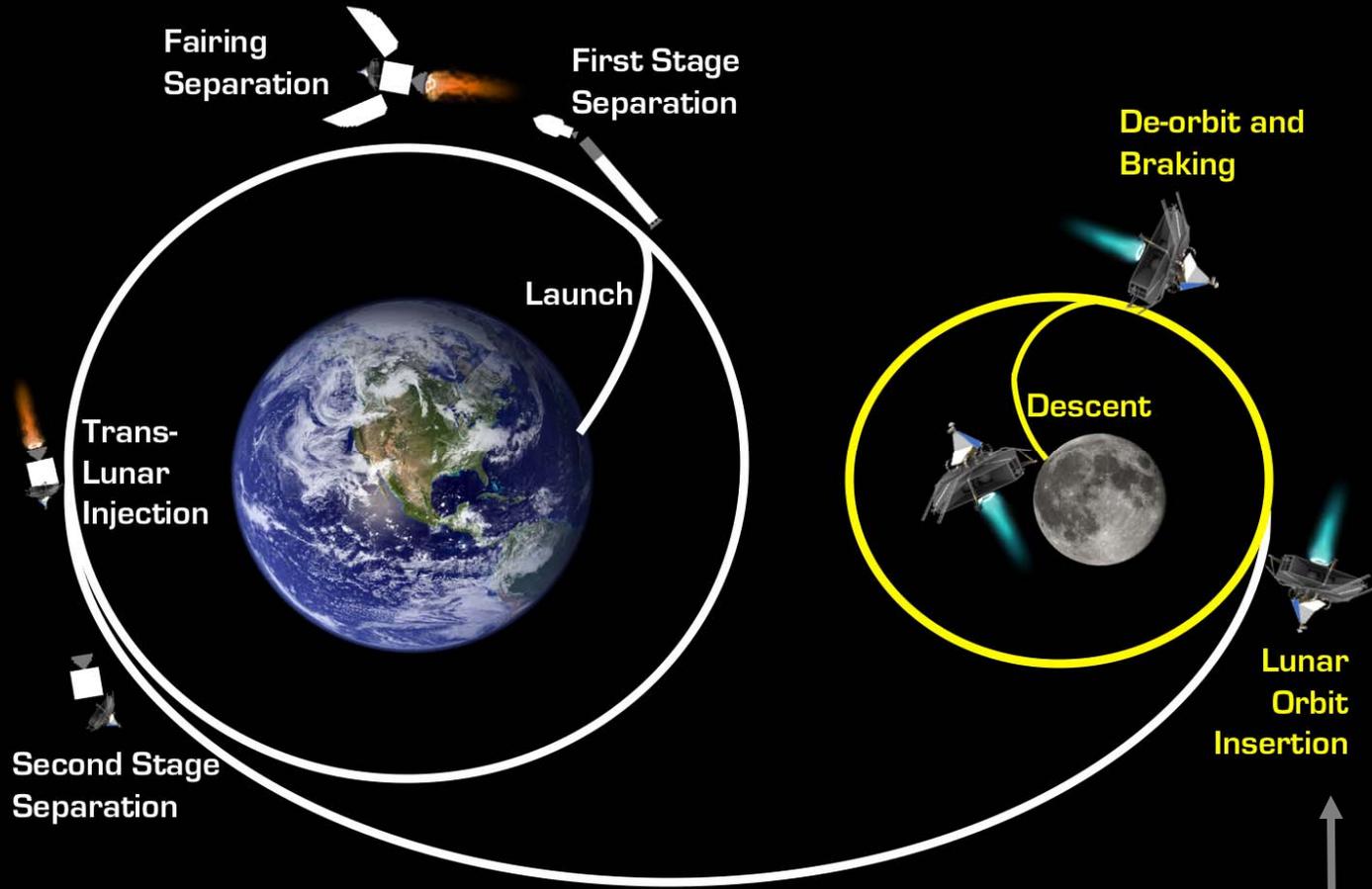


Astrobotic Technology Inc.

A Carnegie Mellon Spin-off Company

David Gump
President





SpaceX Falcon 9 sends lander/rover toward Moon

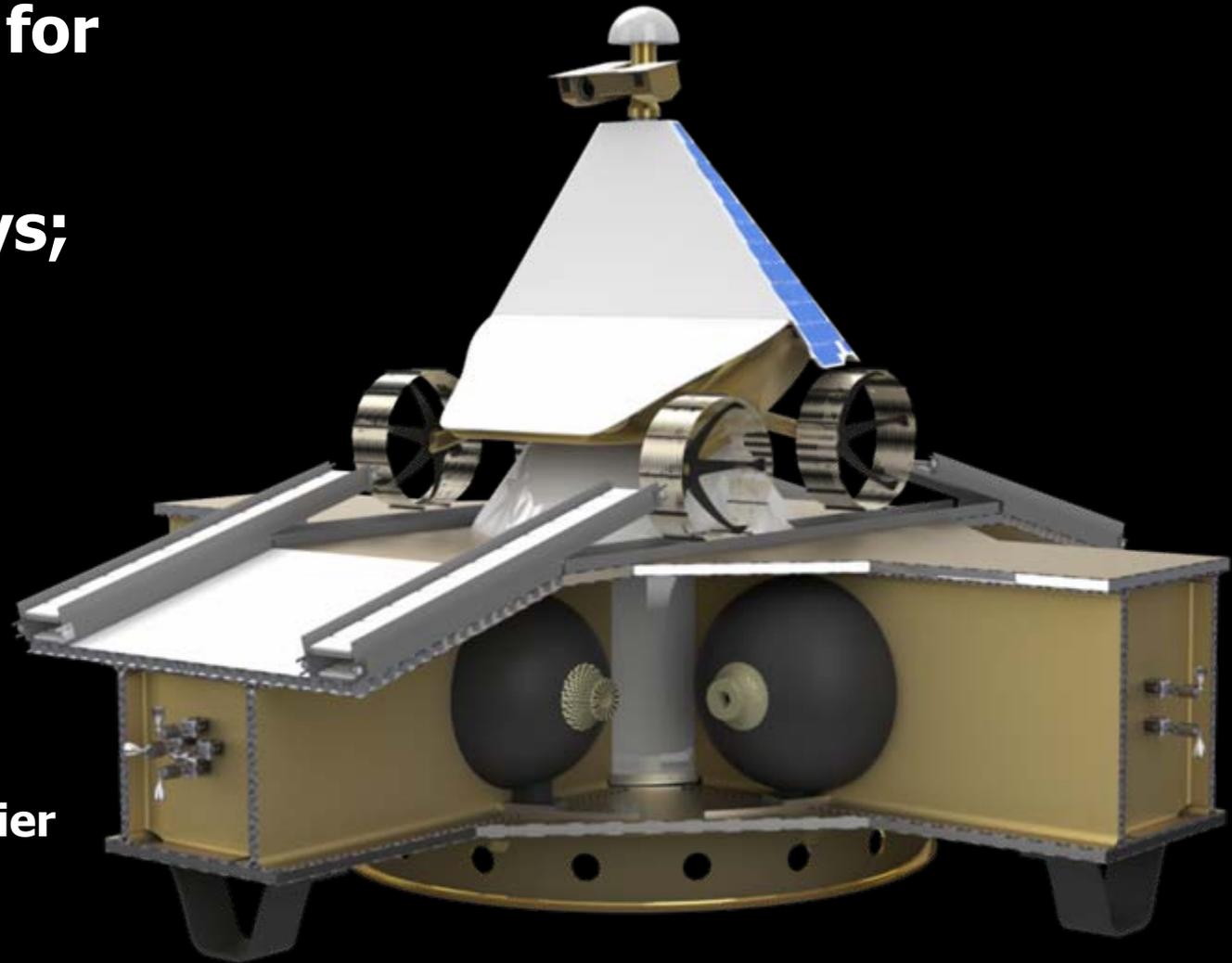
April 2013 to an Apollo site

**60 kg payload for
NASA, others**

**Explore 12 days;
hibernate;
resume trek**

Allies:

- Lockheed Martin
- Aerojet
- Scaled Composites
- International Rectifier
- Harmonic Drive
- Caterpillar

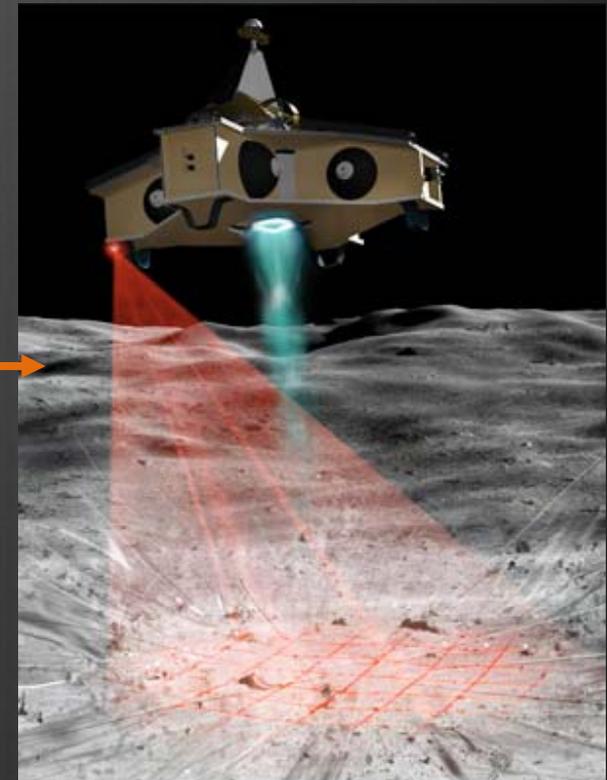
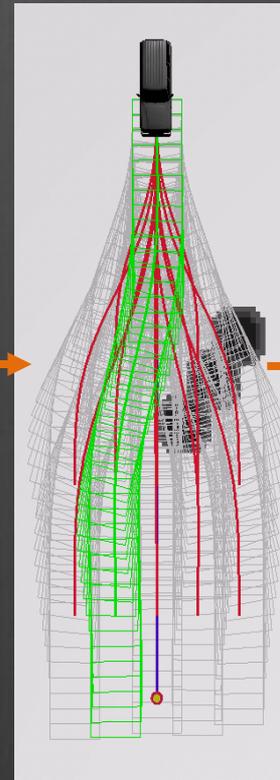
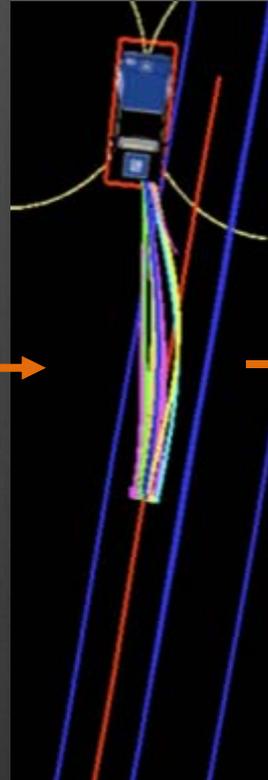


← 3.5 m →

Autonomous cars evolve to lunar landers

Uses radar, laser, and obeys the California traffic code

Uses radar, laser, and obeys gravity



Dr. Whittaker's winning car in DARPA Urban Challenge

Maps Terrain

Finds Safe Paths

Lunar Lander now being designed

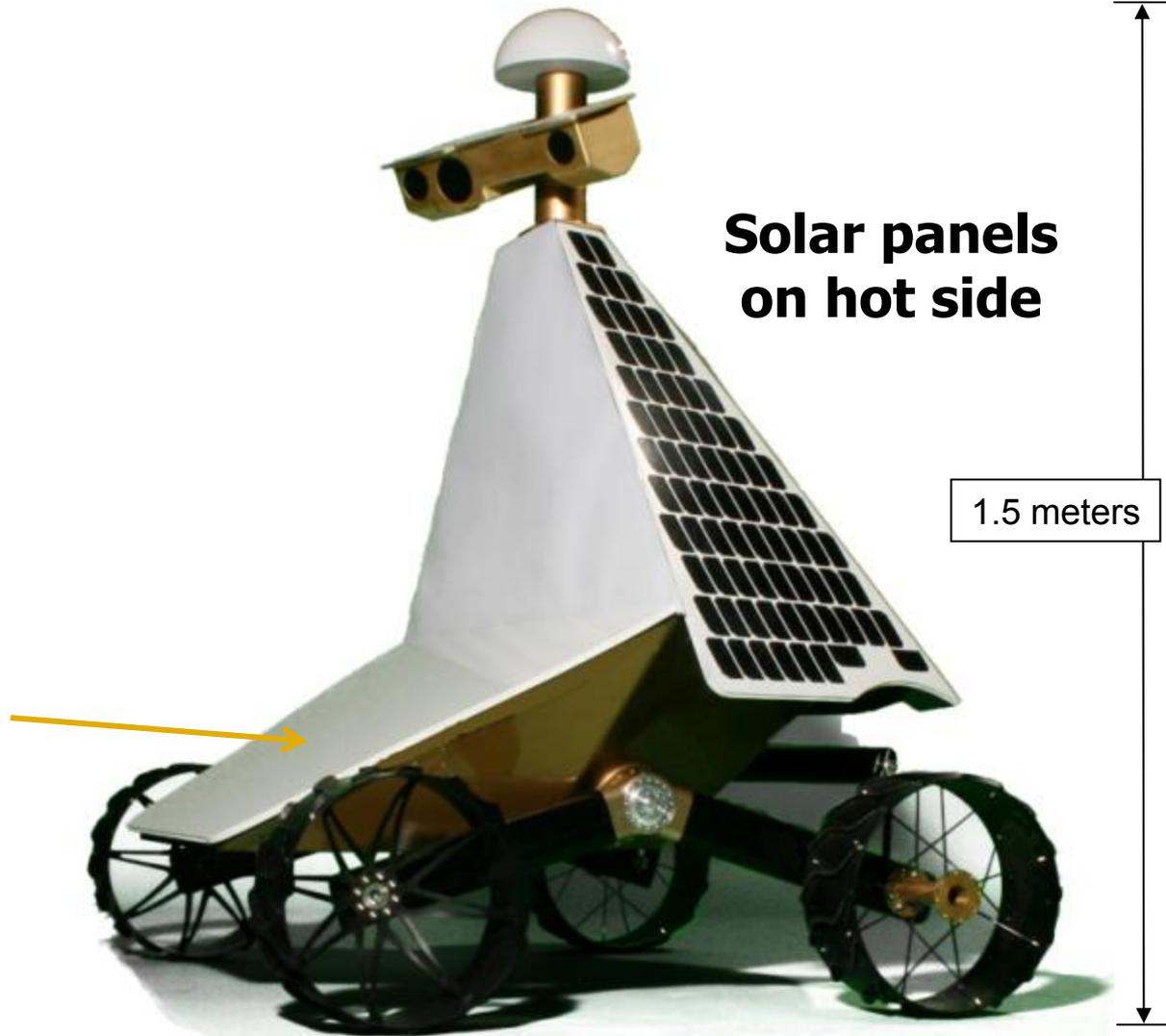
Rover design solves lunar heat challenge



**Daytime
temperatures
reach 224°F**

**Solar panels
on hot side**

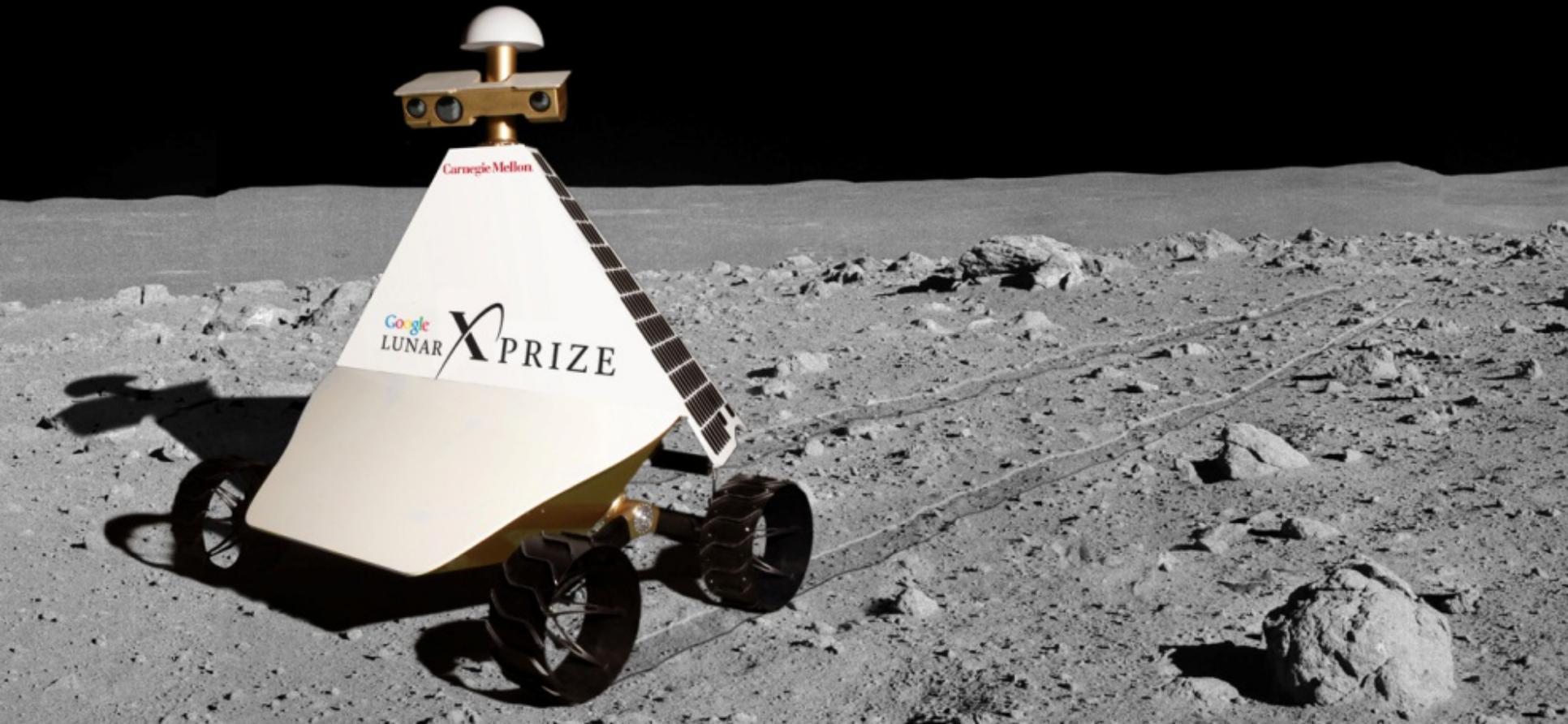
**Radiator on
shadowed side
dumps heat**



Only two drive actuators – internal, chain drive to wheels

Extending the Internet to the Moon

- ▶ Rover sends 3D HD video as it explores
- ▶ Live on the Web – citizen explorers participate
- ▶ A social robot – blogs and chats individually

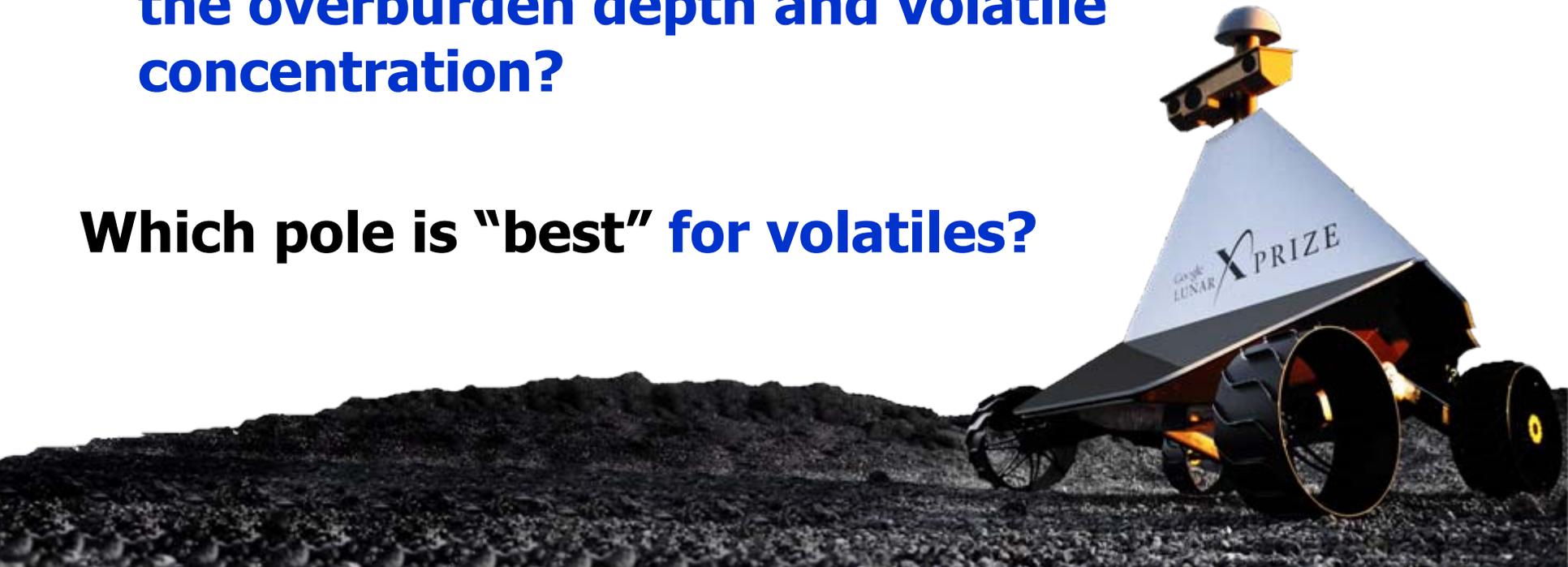


The Three Top Resource Questions

Are volatiles locally concentrated within the broad regions sensed from orbit?

In partially shadowed regions, what's the overburden depth and volatile concentration?

Which pole is "best" for volatiles?



Are Volatiles Locally Concentrated?

Orbital resolution for hydrogen is multi-kilometer

Do local variations (10-100m) produce significantly higher/lower richness?

Variations might stem from topography, age or mineral composition

A 2X variation has enormous impact on economic value of lunar volatiles



Are Partially Shadowed Regions Viable?

PartSRs don't require isotope power

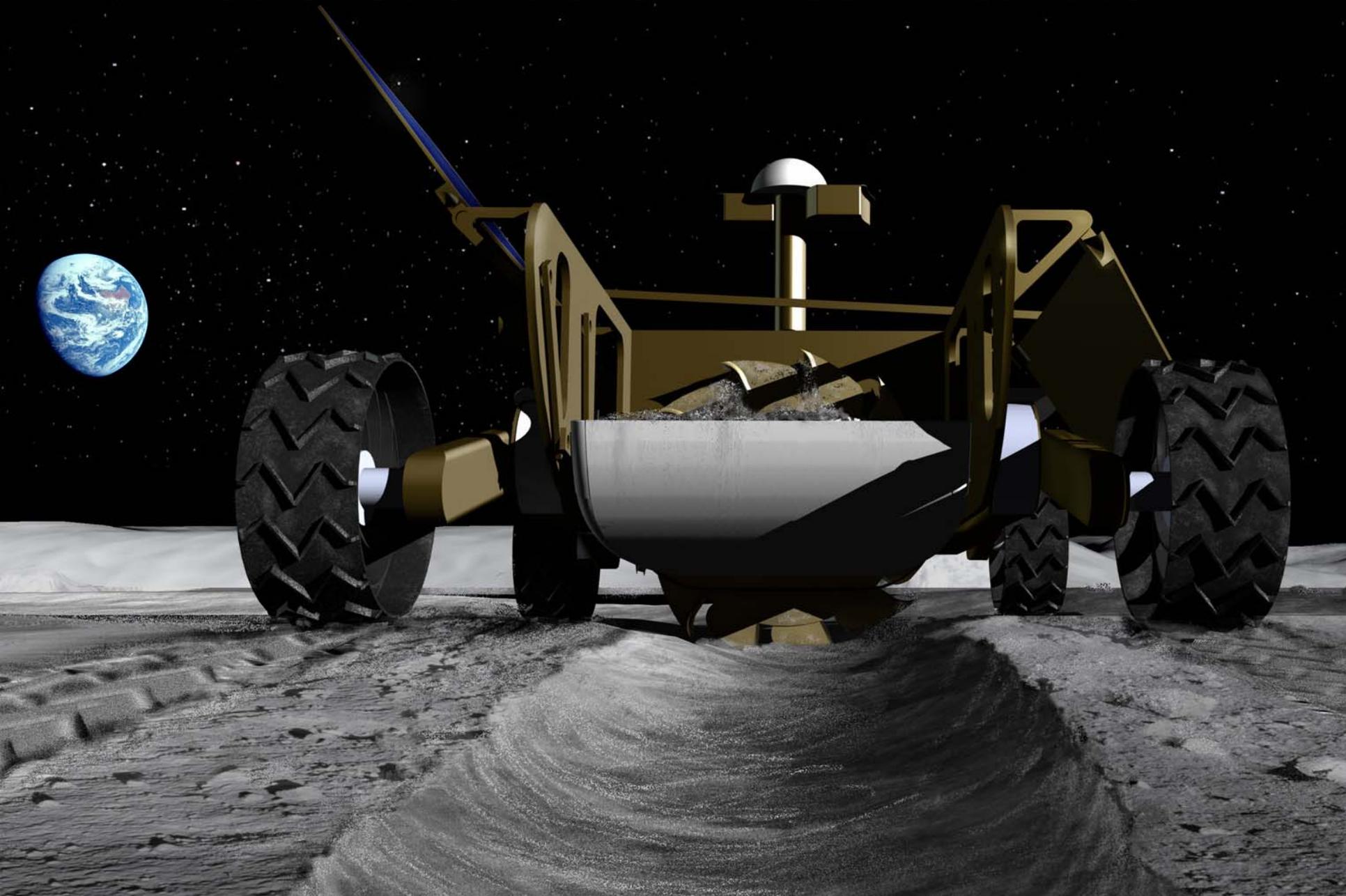
- Solar machines are lower cost
- Presidential launch approval not required
- Commercial sector can lead operations

How deep / variable is the overburden?

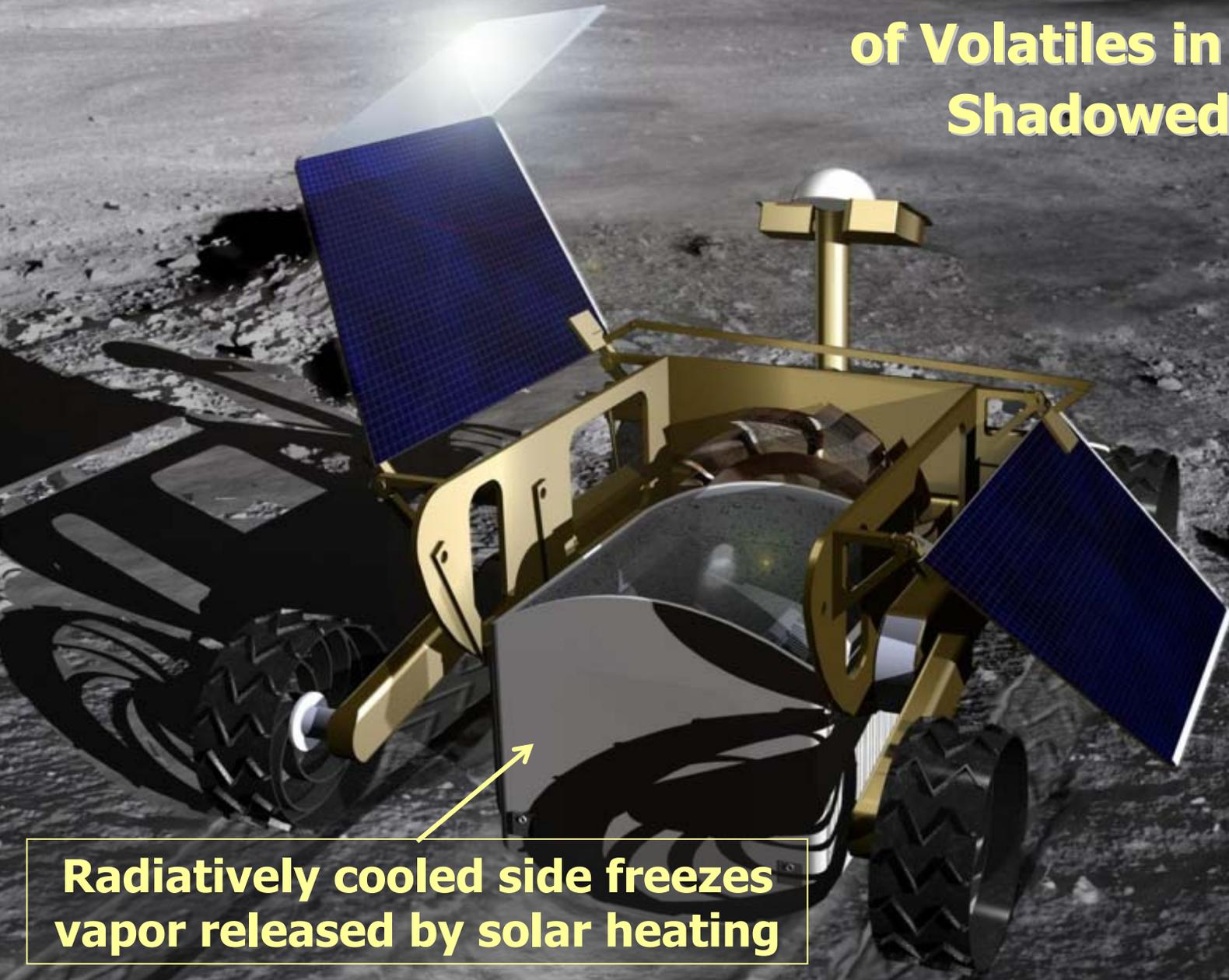
How rich are the volatiles in PartSRs?



Astrobotic Bucket-Wheel Excavator



Mobile Continuous Recovery of Volatiles in Partially Shadowed Regions



Radiatively cooled side freezes
vapor released by solar heating

Best pole \neq largest total volatile amount

“Best” is combination of:

- Highest local concentrations
- Easiest terrain (slopes, overburden, PartSRs)

Picking the right pole matters over time

- Increasingly specialized machinery produces more fuel per kg from Earth
- Spare & repurposed machinery enables continued production after breakdowns
- Larger operations likely can support humans for repairs and creating process improvements

The Three Top Resource Questions

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