Small Spinning Landers for Solar System Exploration Missions

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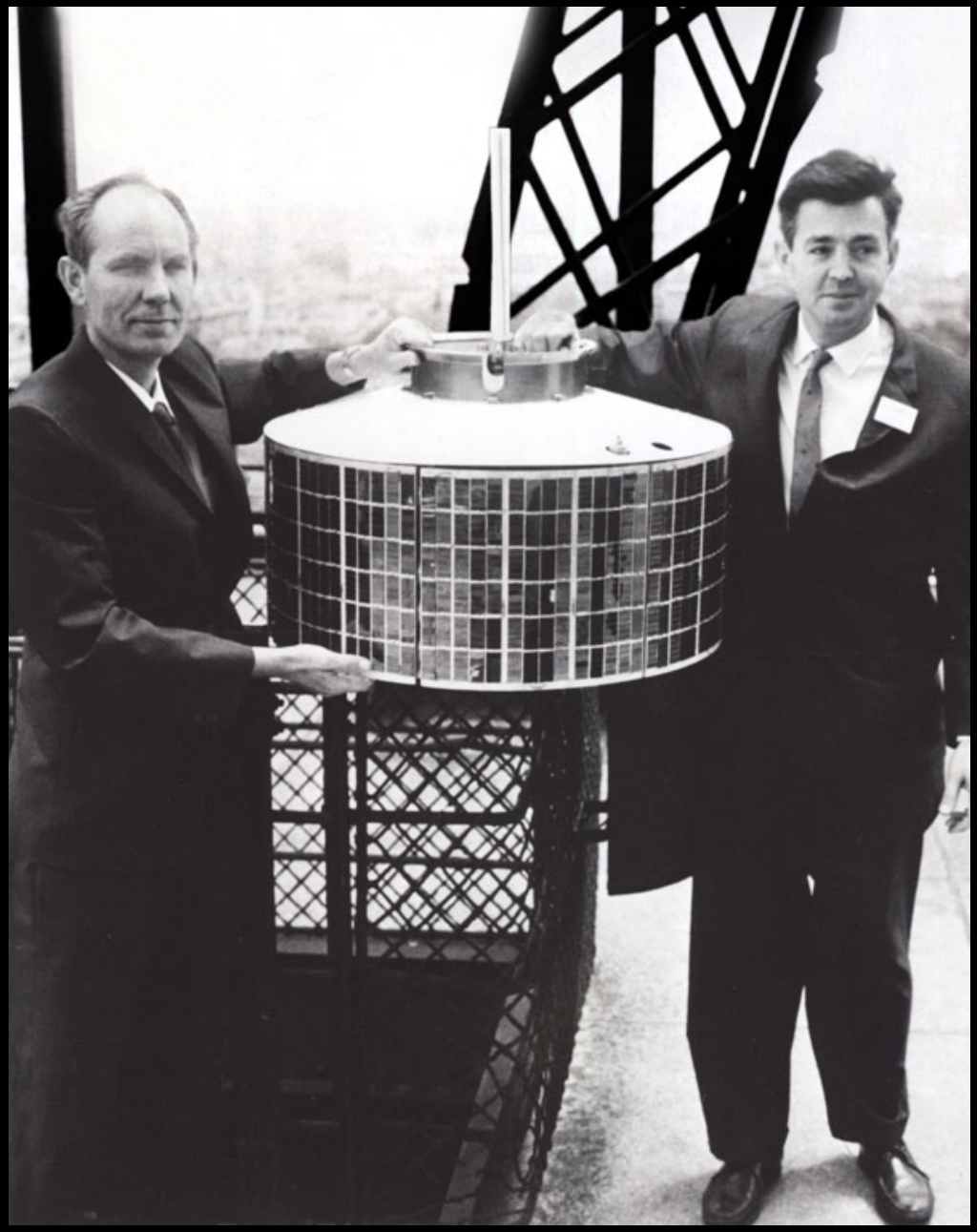
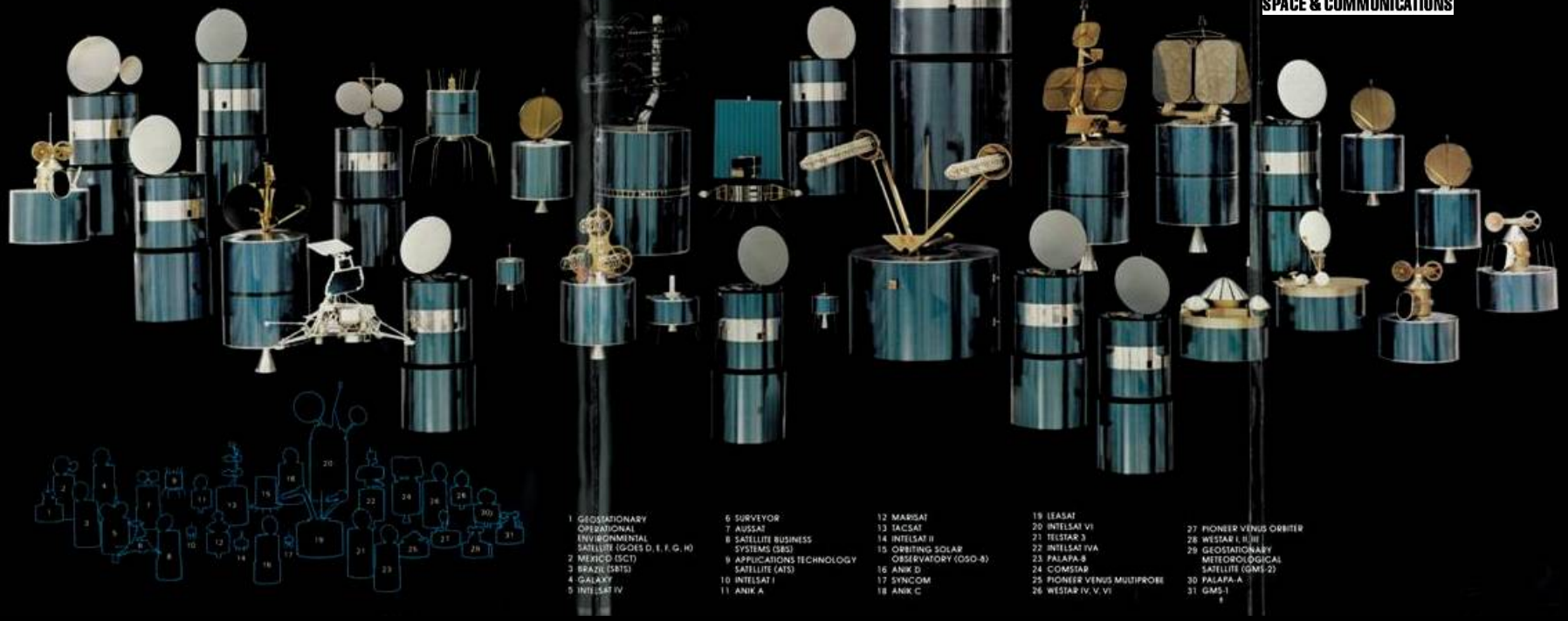
1961



1985 Hughes Family of Spacecraft

HUGHES
SPACE & COMMUNICATIONS

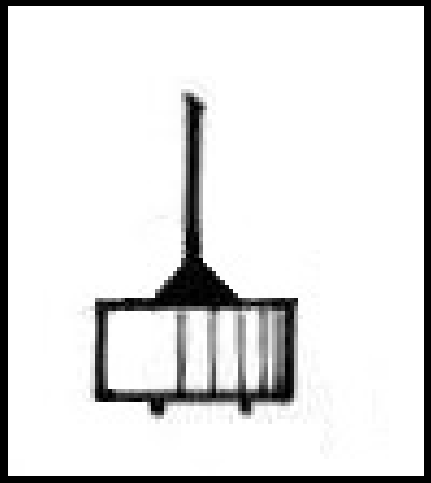


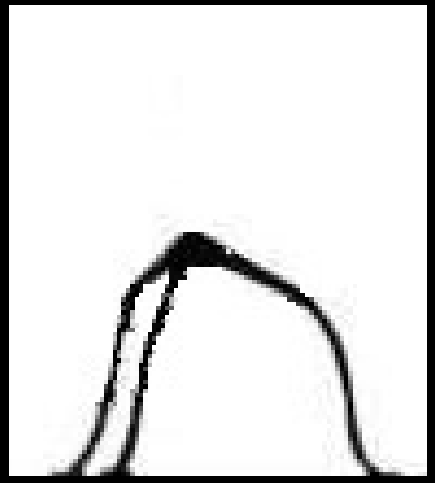
1 GEOSTATIONARY OPERATIONAL ENVIRONMENTAL SATELLITE (GOES D, E, F, G, H)
2 MEXICO (SCT)
3 BRAZIL (SBTS)
4 GALAXY
5 INTELSAT IV
6 SURVEYOR
7 AUSSAT
8 SATELLITE BUSINESS SYSTEMS (SBS)
9 APPLICATIONS TECHNOLOGY SATELLITE (ATS)
10 INTELSAT I
11 ANIK A
12 MARISAT
13 TACSAT
14 INTELSAT II
15 ORBITING SOLAR OBSERVATORY (OSO-8)
16 ANIK D
17 SYNCOM
18 ANIK C
19 LEASAT
20 INTELSAT VI
21 TELSTAR 3
22 INTELSAT IVA
23 PALAPA-B
24 COMSTAR
25 PIONEER VENUS MULTIPROBE
26 WESTAR IV, V, VI
27 PIONEER VENUS ORBITER
28 WESTAR I, II, III
29 GEOSTATIONARY METEOROLOGICAL SATELLITE (GMS-2)
30 PALAPA-A
31 GMS-1

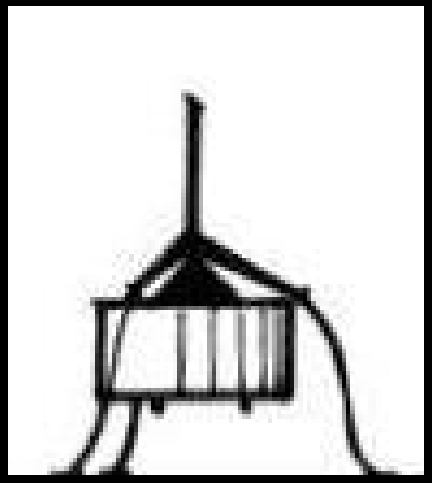
2007


2007-2008
Google
LUNAR
PRIZE
OFFICIAL TEAM
SCSG

From Dual-Spin Spinning Spacecraft to Spinning Lander







Despun Section + Leg System

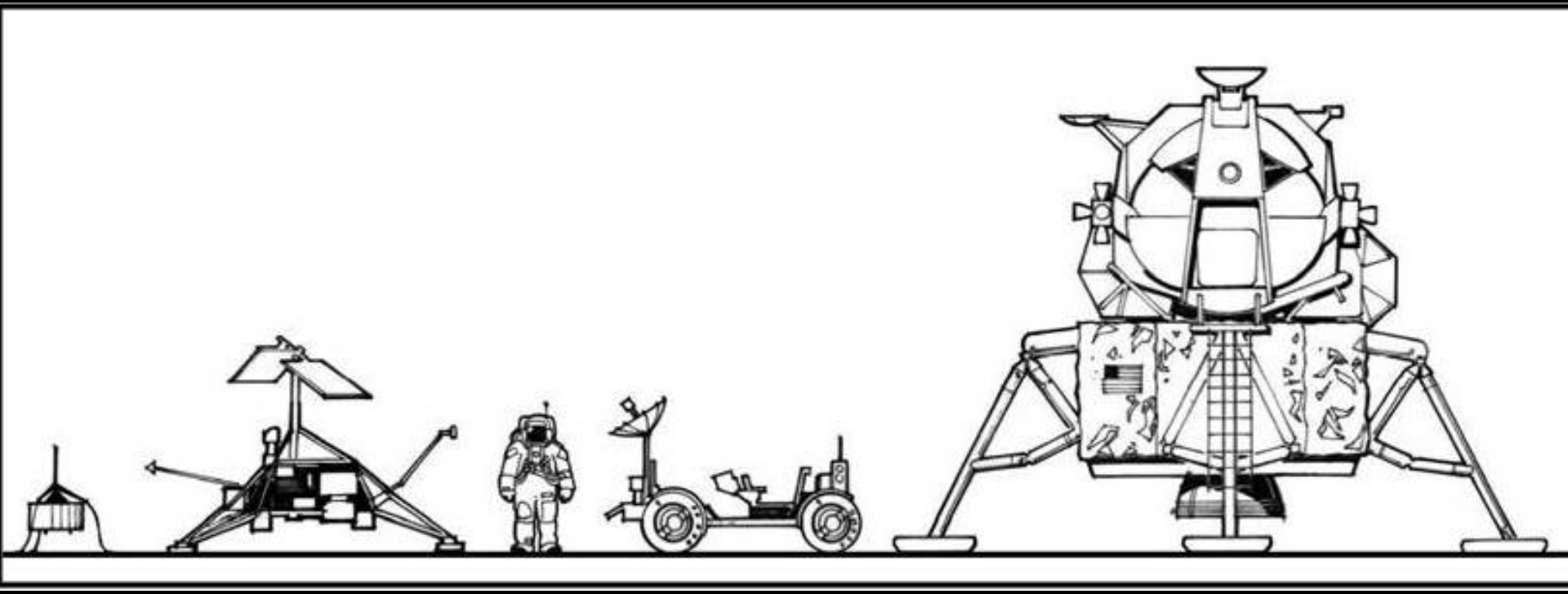
Spun Section + Landing Radar

= Spinning Lander*

* U.S. patent #20090206204; foreign patents pending


2008

Size Comparison for GLXP Win



Why Consider Spinning vs. 3-Axis Landers?

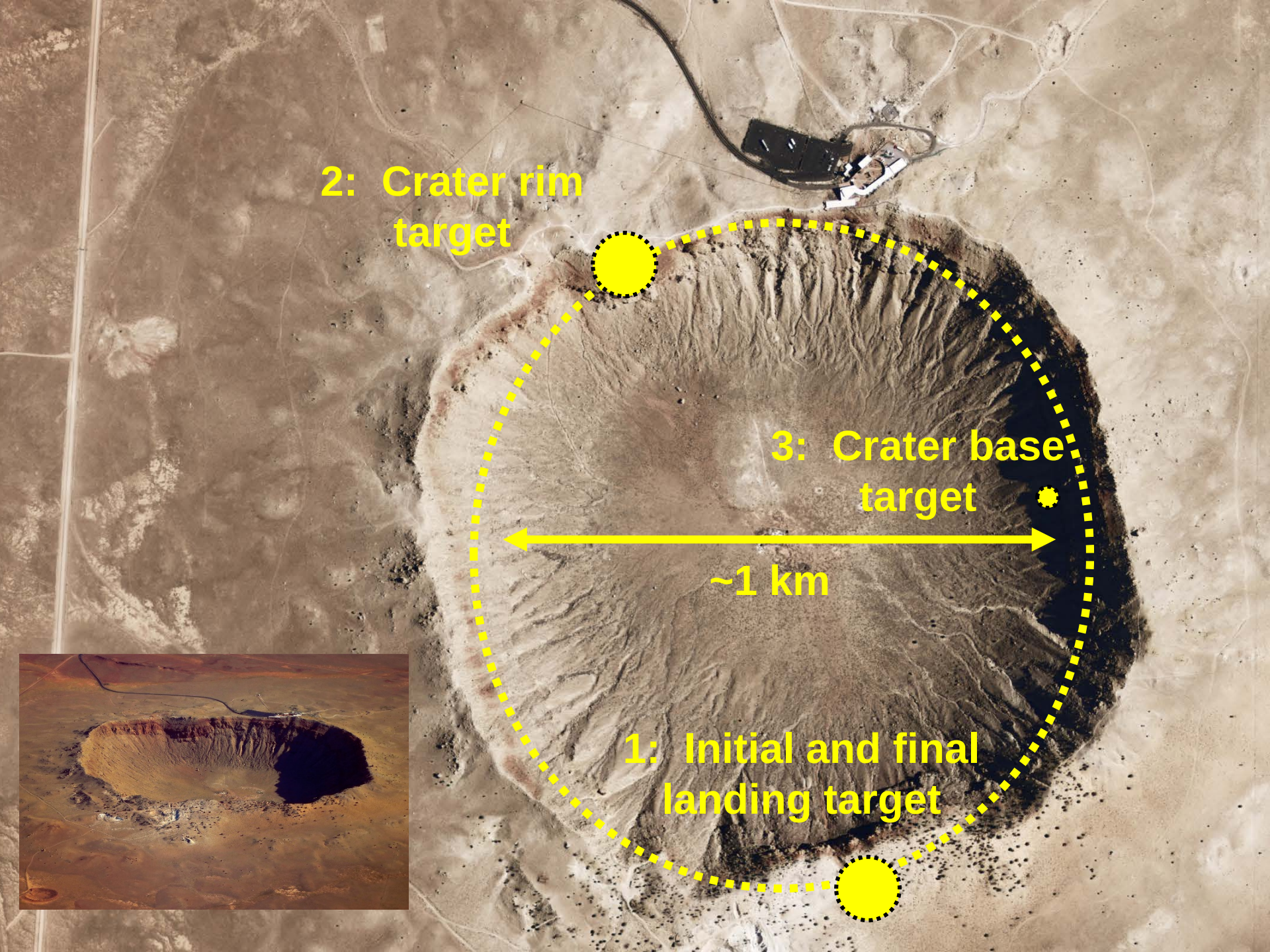
- Proven dual-spin system robustness and scalability
- Avionics and flight software ~1/3 as complex
- Propulsion ~1/2 as complex
- Single landing radar vs. 3
- No chance of tip-over at landing
- Excellent hopping capability (mobility)
- Overall development and I&T ~1/2 as complex
- Potential for significantly lower total mission cost

SCSG GLXP Concept

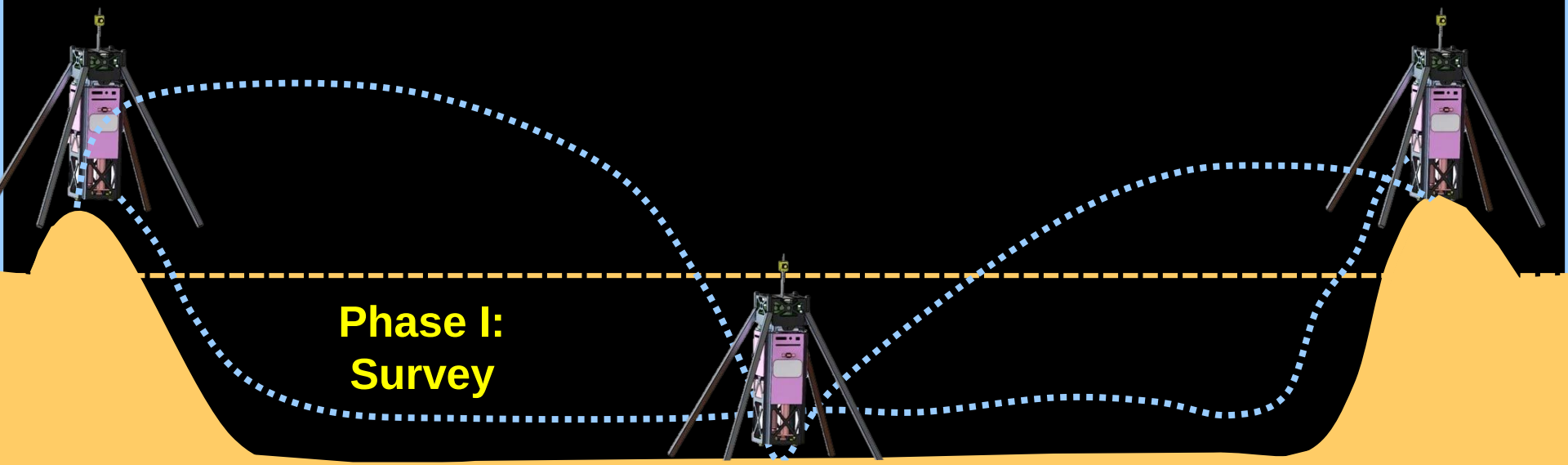
- **~240 kg wet; ~50 kg dry**
- **Falcon 1e / Star 30 TLI**
- **Solar panels + batteries**
- **Direct comm to Earth**
- **HD camera**
- **Biprop for all other maneuvers**
  - -- ~4.5 km/s ΔV capability
  - -- Full thruster complement
  - -- ~5 km hopping capability
- **~$20 million total mission cost**

~3U CubeSat Concept
(Lunar Polar Crater Surveyor)

- **~5 kg wet; ~4.4 kg dry**
- **Carried to surface by ‘Mothership’**
- **Batteries only**
- **Comm to Mothership or orbiter**
- **TBD science or tech payloads**
- **Hydrazine prop module**
  - -- Hover & translate thrusters
  - -- ~2-minute hovering capability
  - -- ~6 km hopping capability
- **Single-digit $ millions for several**


2: Crater rim target
3: Crater base target
~1 km
1: Initial and final landing target

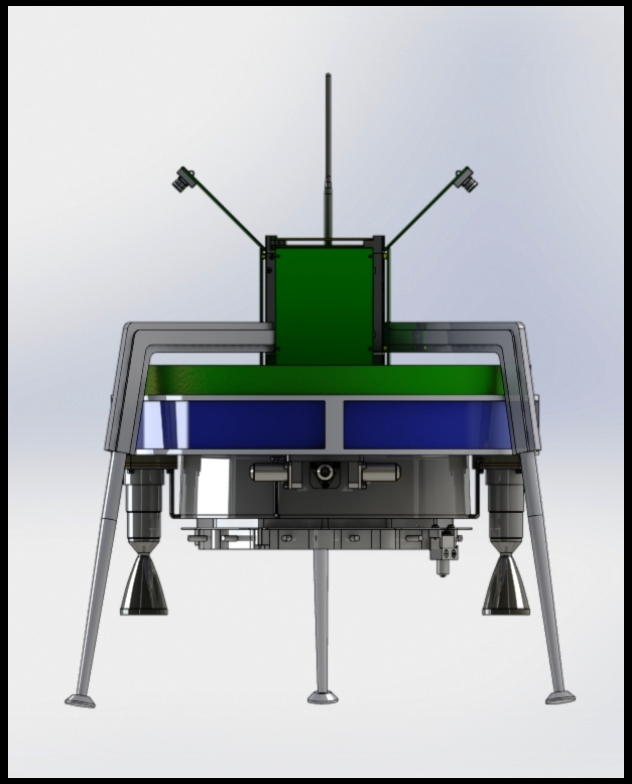
Meteor Crater Example



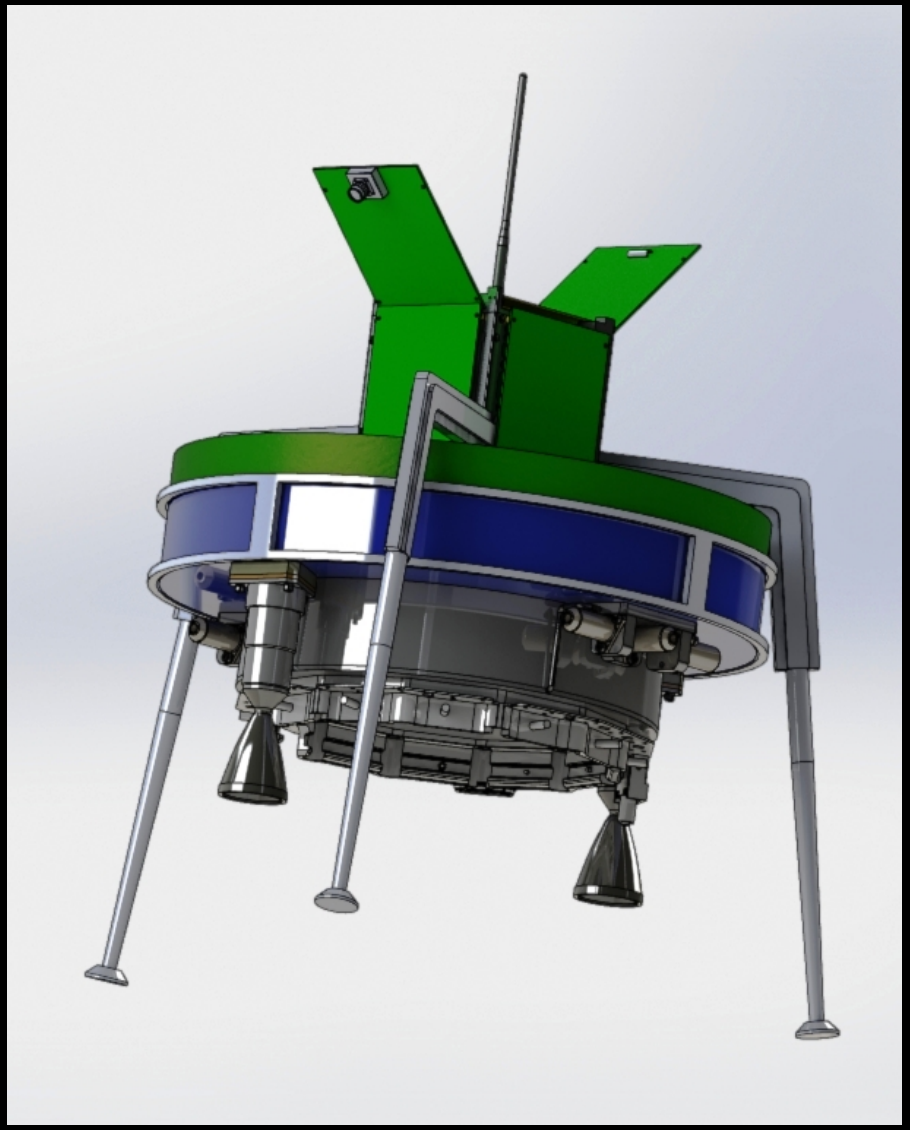
Issues With 3U Concept

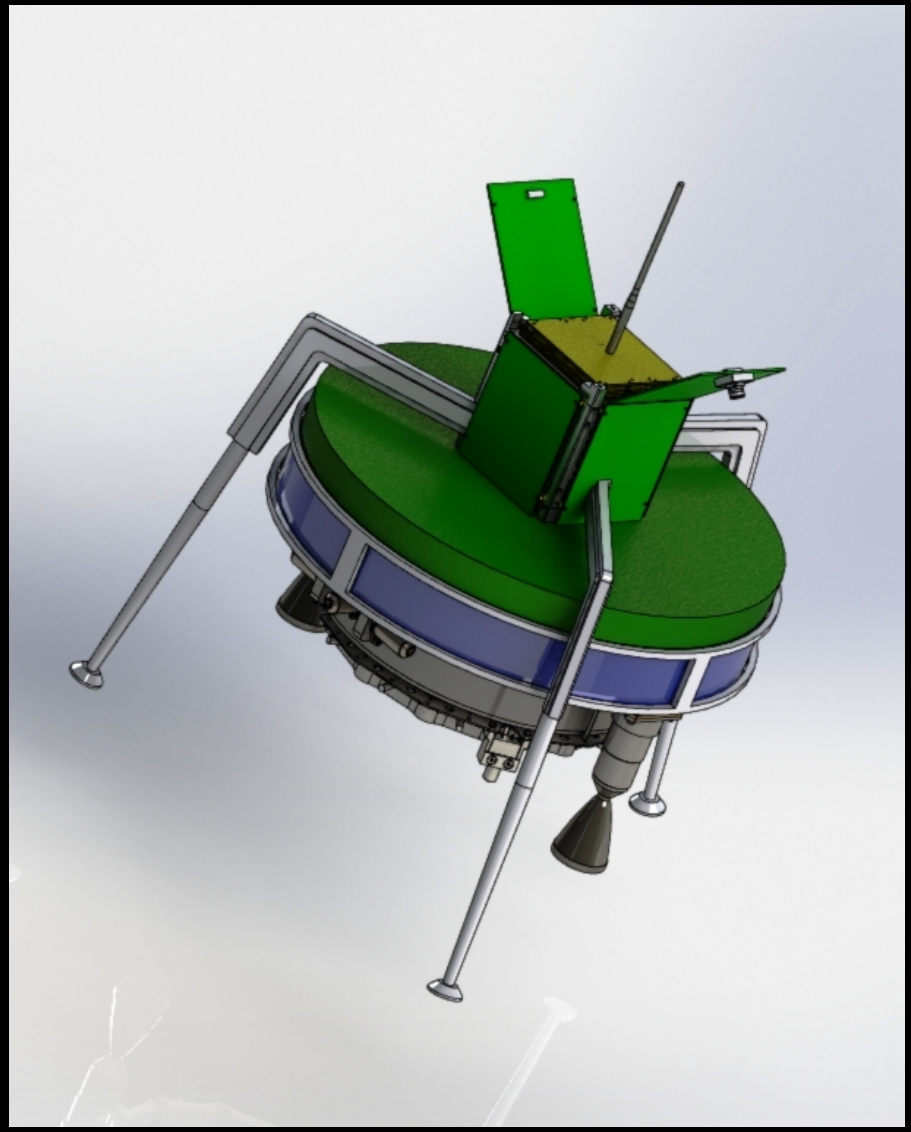
- May not be stable spinner
- Potentially limiting propulsion
- Toxic propellant
- Limited power capability

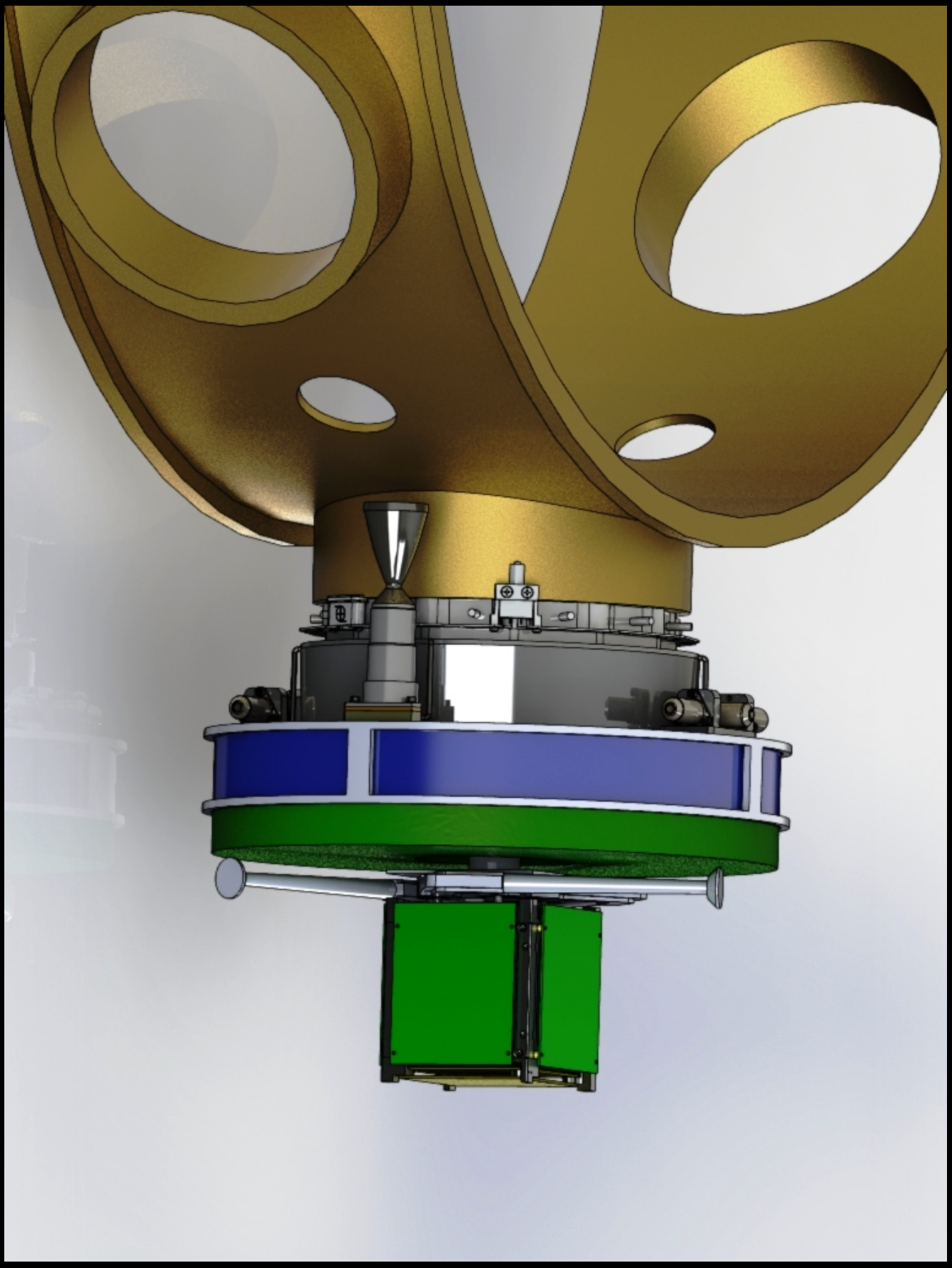
CubeSat ‘Grande’ Concept
(Lunar Polar Crater Surveyor)



- **~11-14 kg wet; ~7-10 kg dry**
- **Carried to surface by ‘Mothership’**
- **Batteries; optional solar panels**
- **Comm to Mothership or orbiter**
- **TBD science or tech payloads**
- **ADN + isobutane prop module**
  - -- Full thruster complement
  - -- ~0.8 to 1.0 km/s ΔV capability
  - -- ~10-minute hovering capability
  - -- ~15-20 km hopping capability
- **Single-digit $ millions for a few**







Next Steps

- **Cal Poly MS thesis**
  - Configuration and layout options
  - Leg system design and assessment
  - Mission performance assessments
  - Host platform(s) integration options
- **Partnering!**

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See me at booth #32!