Hopping and Rolling Locomotion with Spherical Tensegrity Robots

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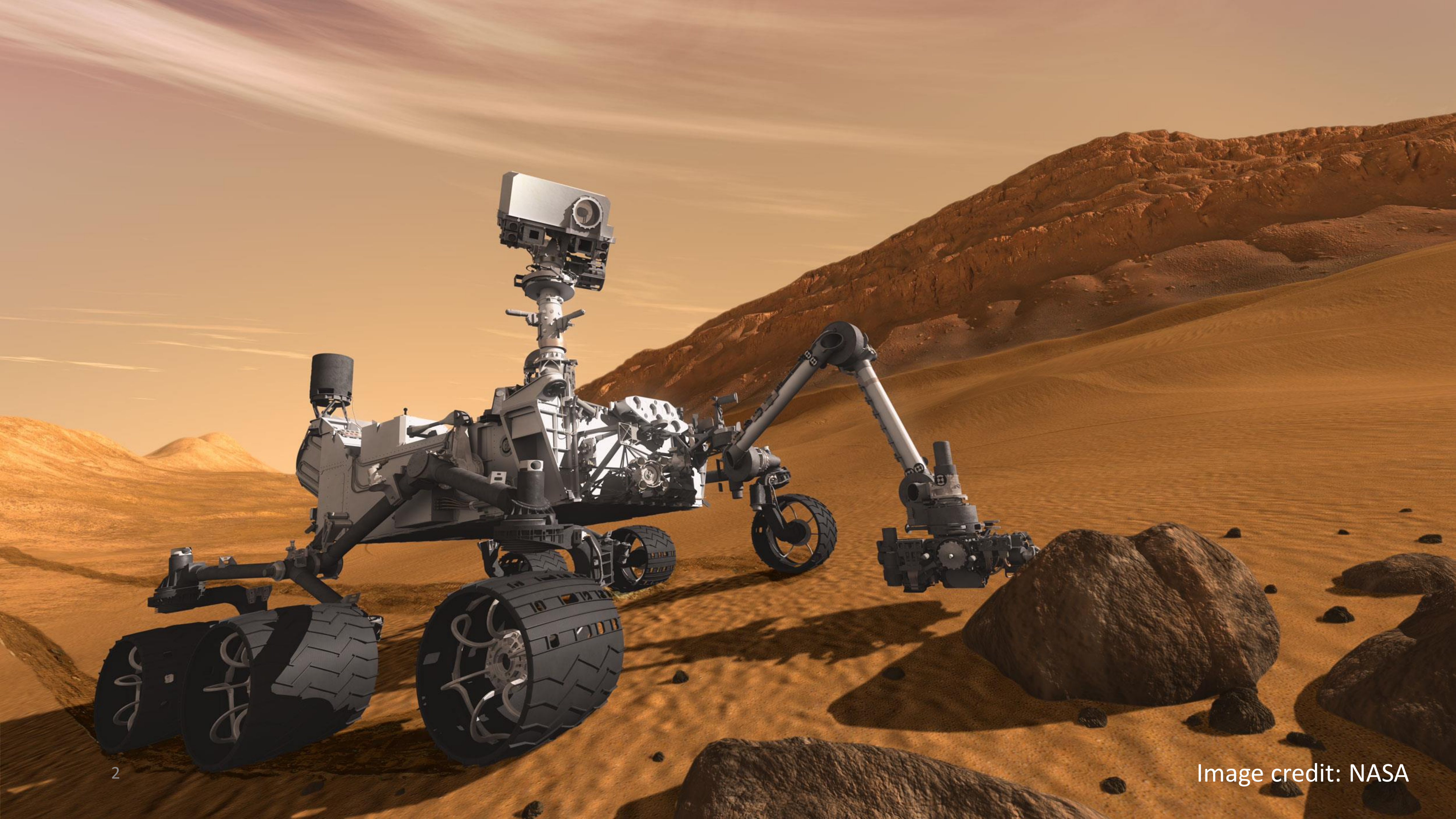
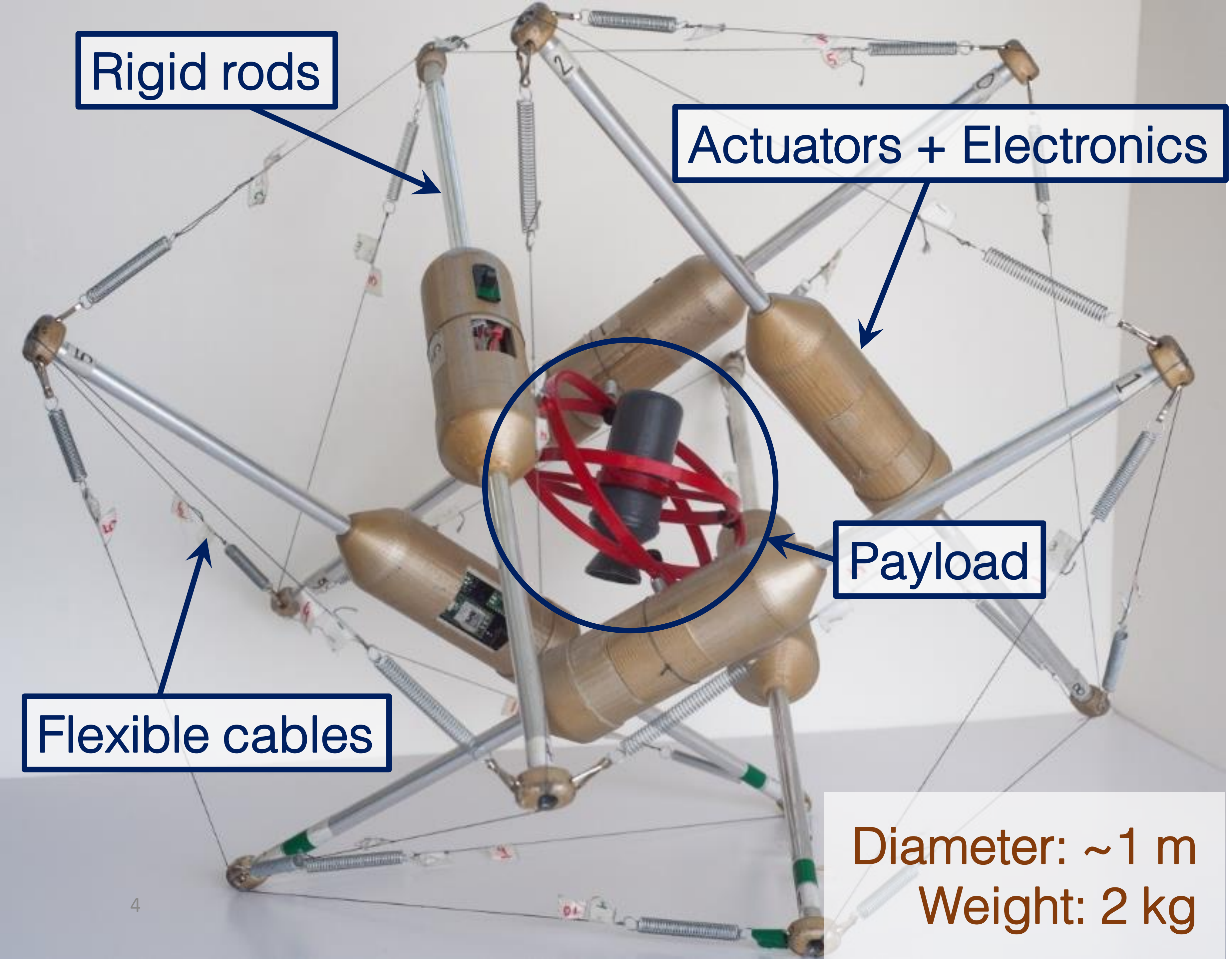


Image credit: NASA

Mission Goals

- Travel over a 1 km distance on the Moon’s surface
- Safely deliver a 1 kg payload
- Total weight of the rover is limited to 10 kg



Diameter: ~1 m
Weight: 2 kg

- Compliant
- Lightweight
- Compact
- Robust

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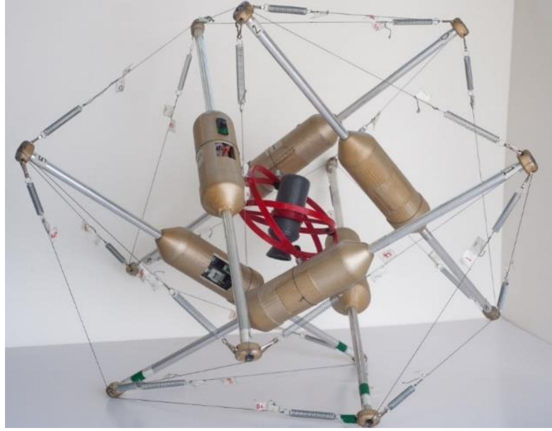
Mission Goals



- Travel over a 1 km distance on the Moon's surface

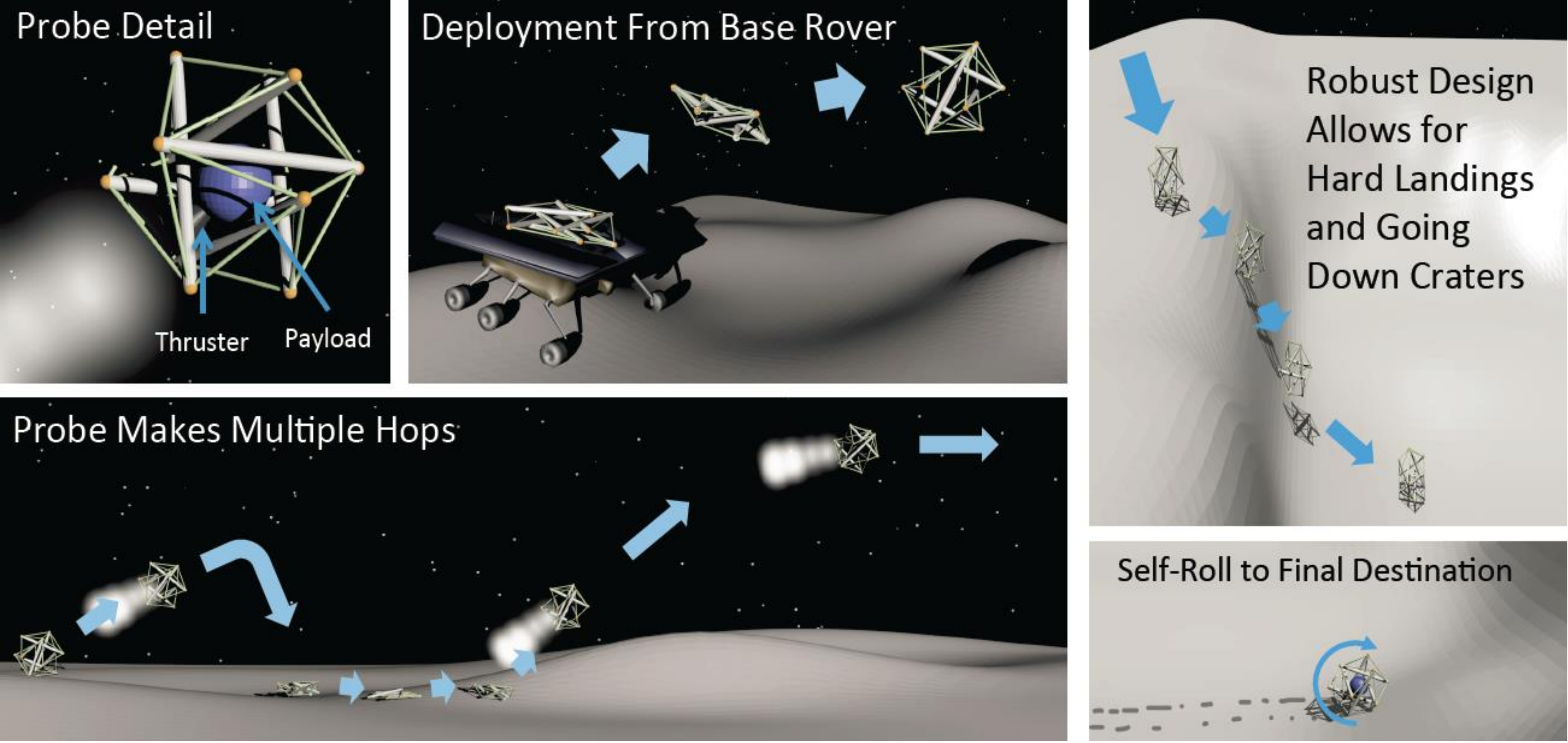
  → Tensegrity robots can travel by combining rolling and hopping

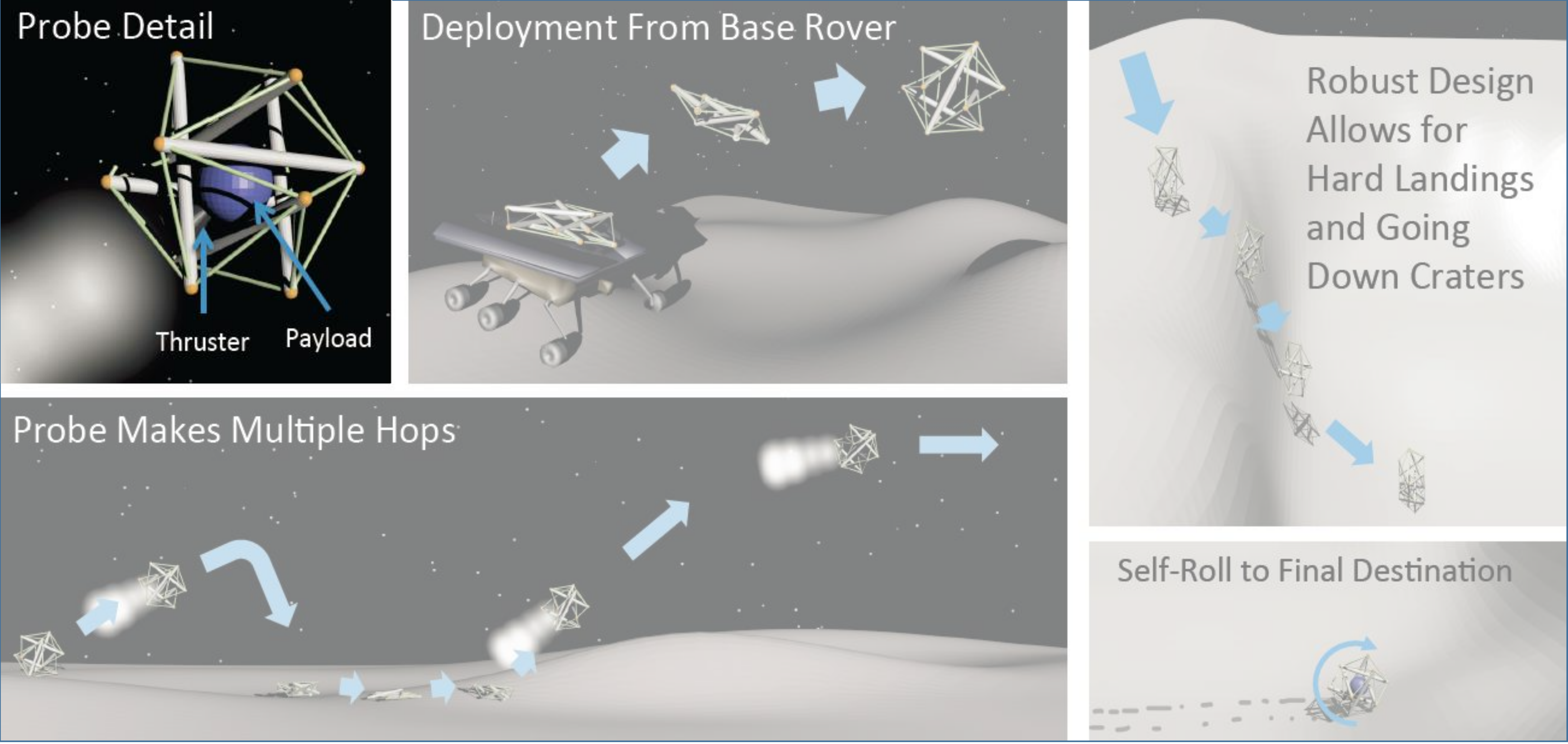
- Safely deliver a 1 kg payload

  → Tensegrity structure provides payload protection

- Total weight of the rover is limited to 10 kg

  → Tensegrity robots are lightweight


Probe Detail
Thruster
Payload
Deployment From Base Rover
Robust Design Allows for Hard Landings and Going Down Craters
Probe Makes Multiple Hops
Self-Roll to Final Destination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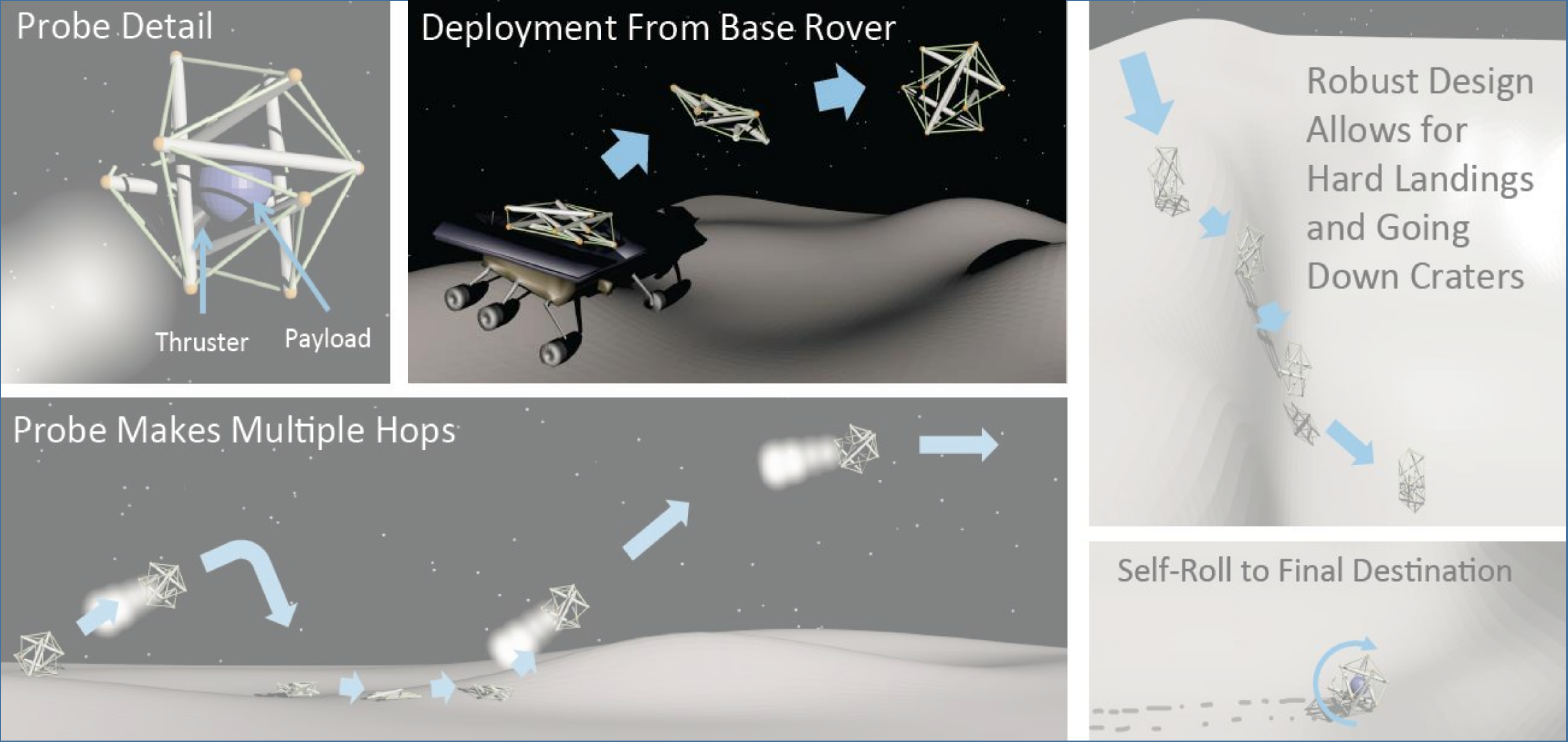
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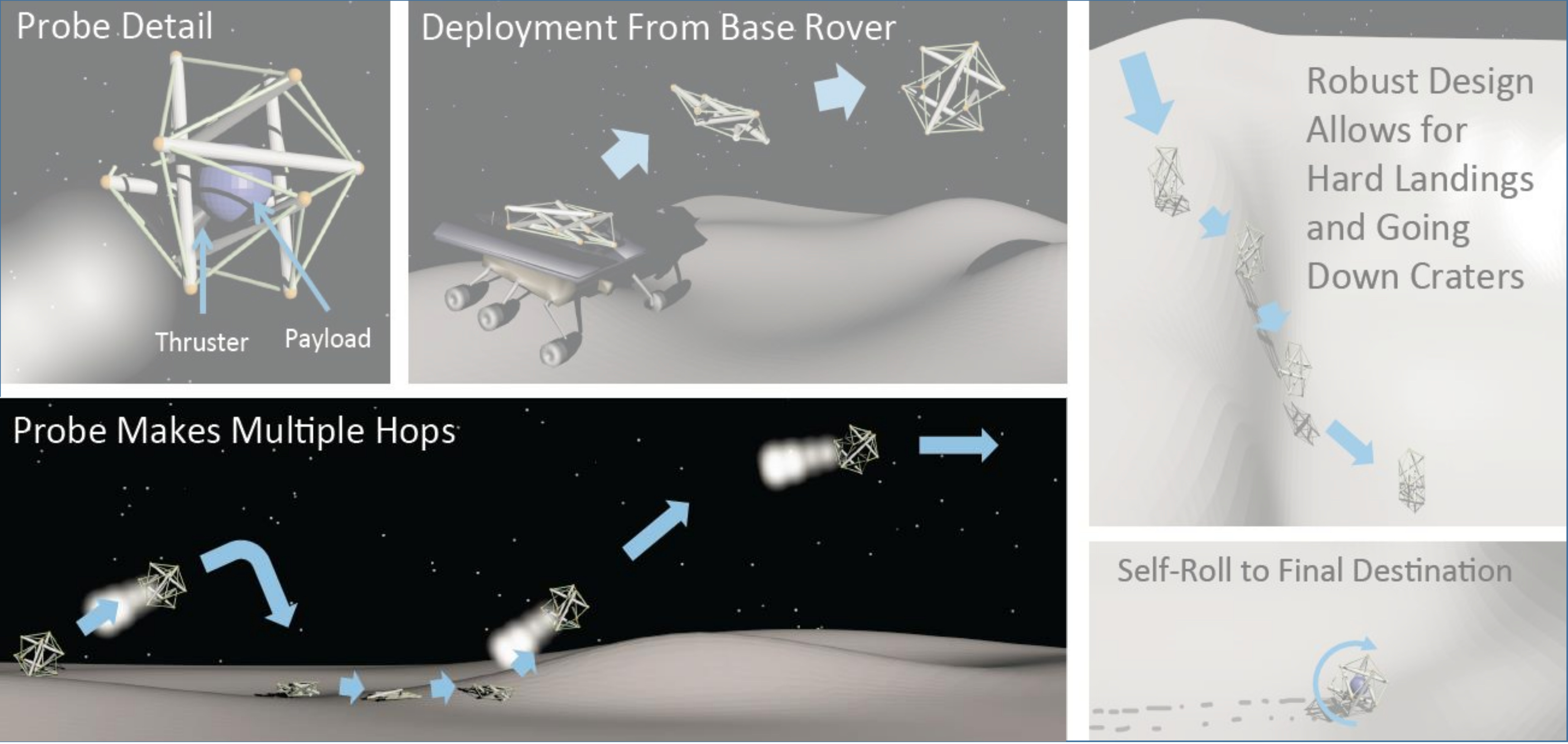
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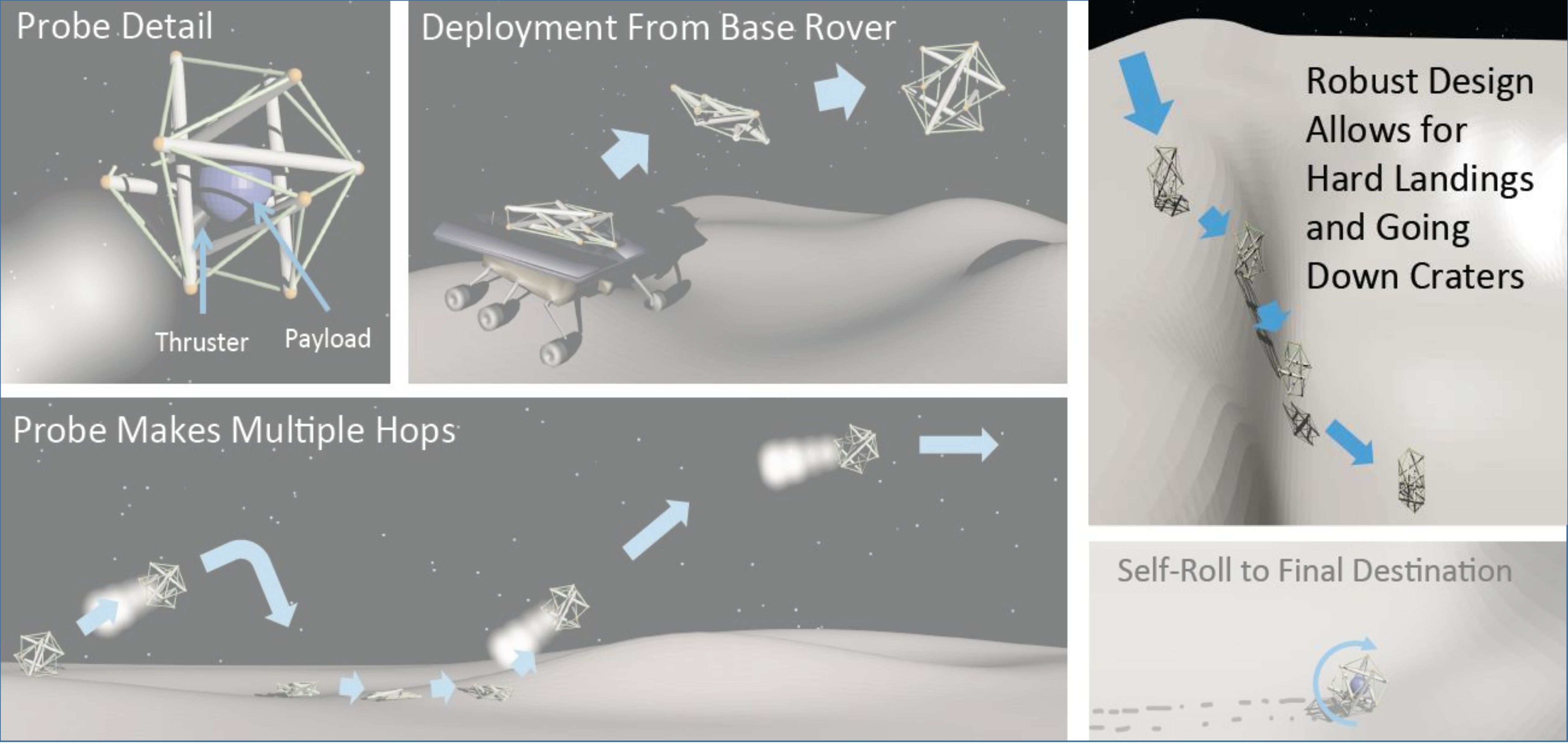
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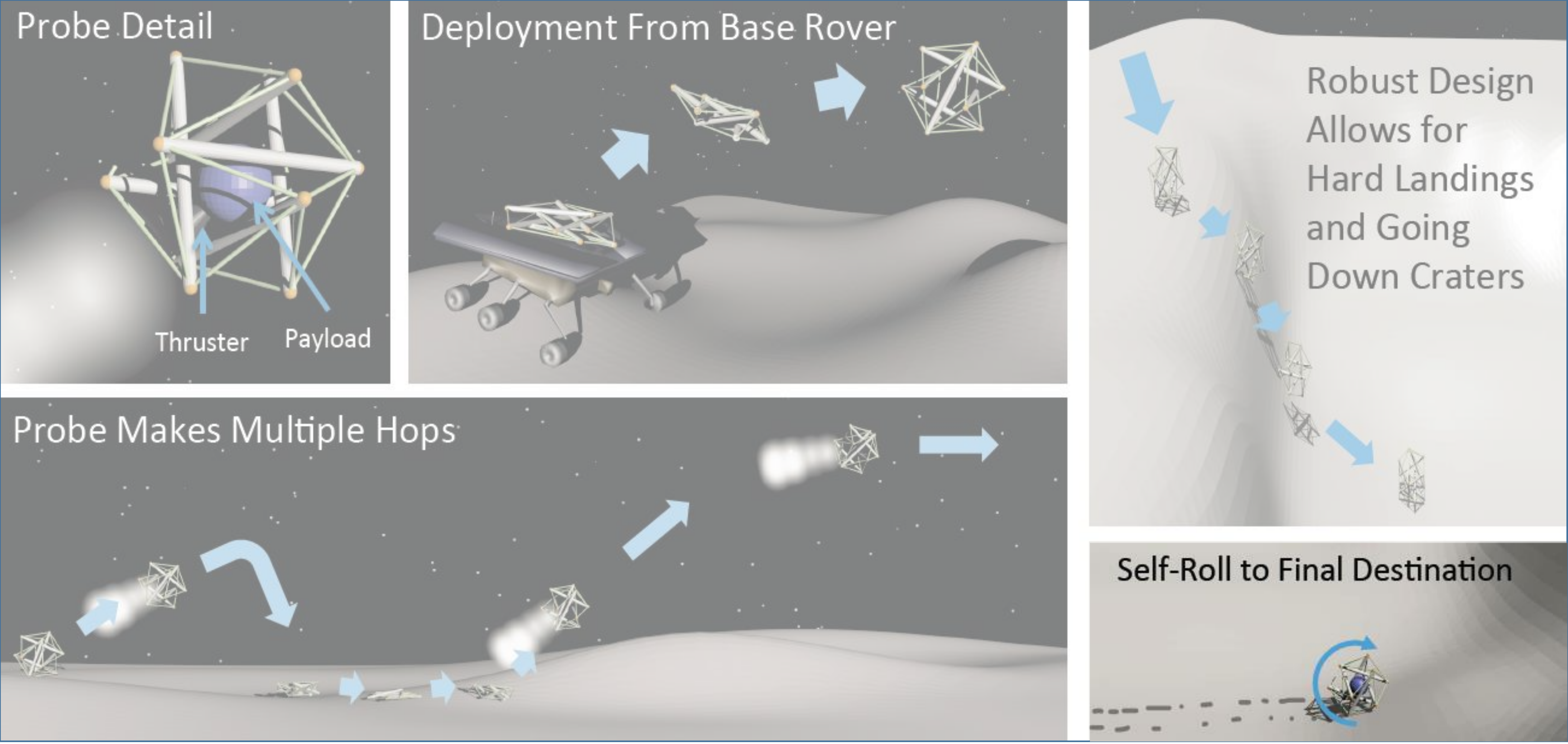
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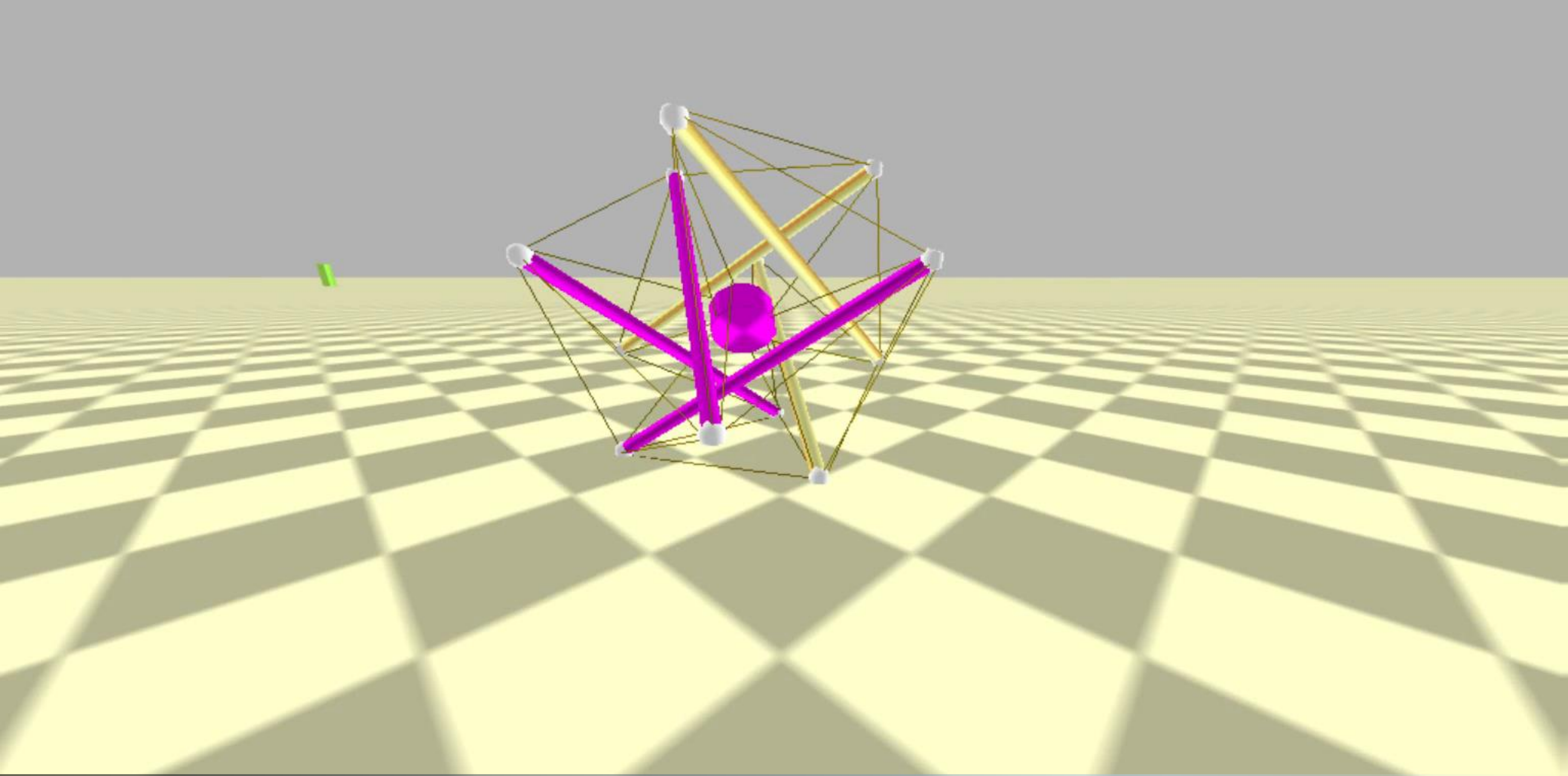
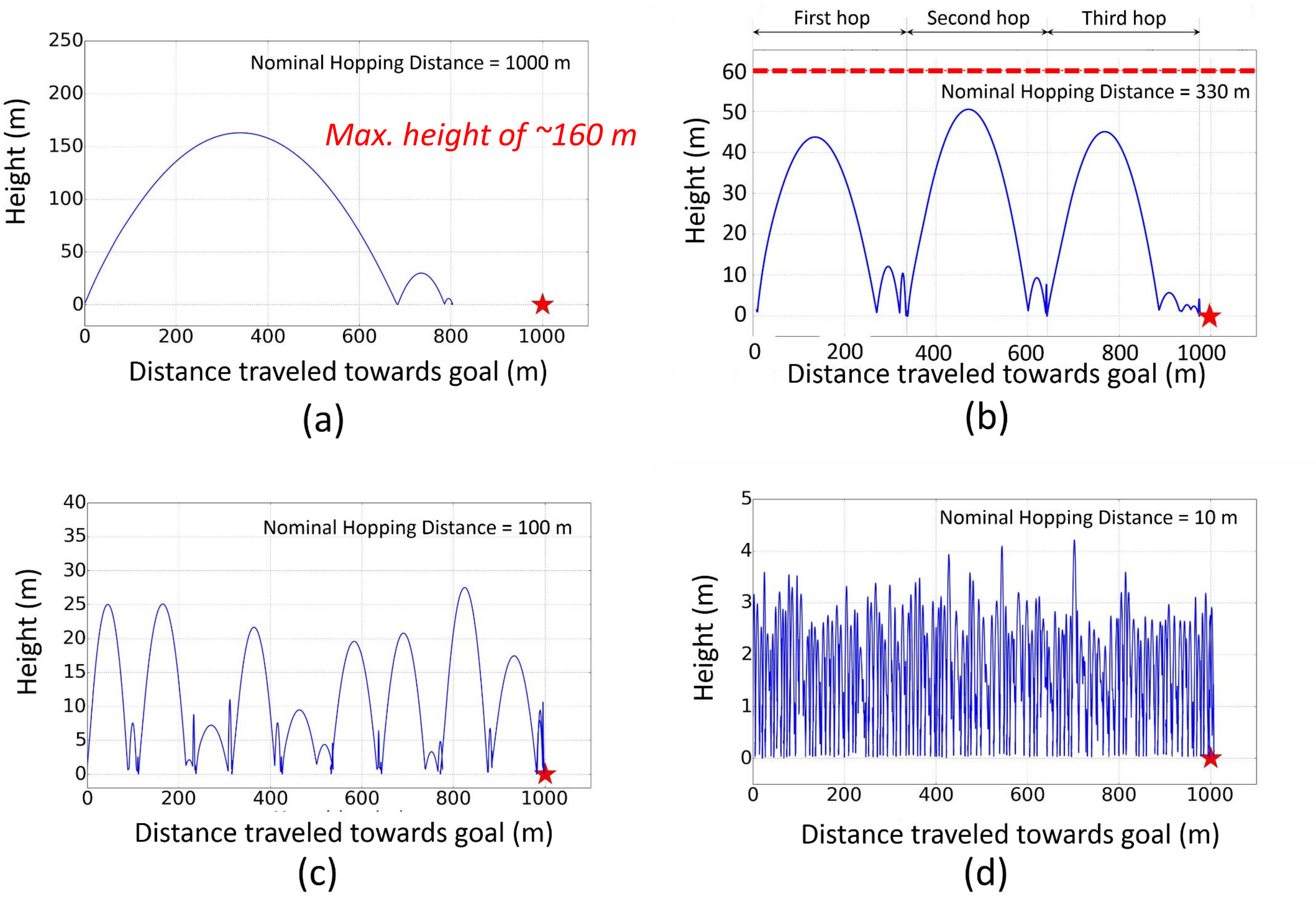


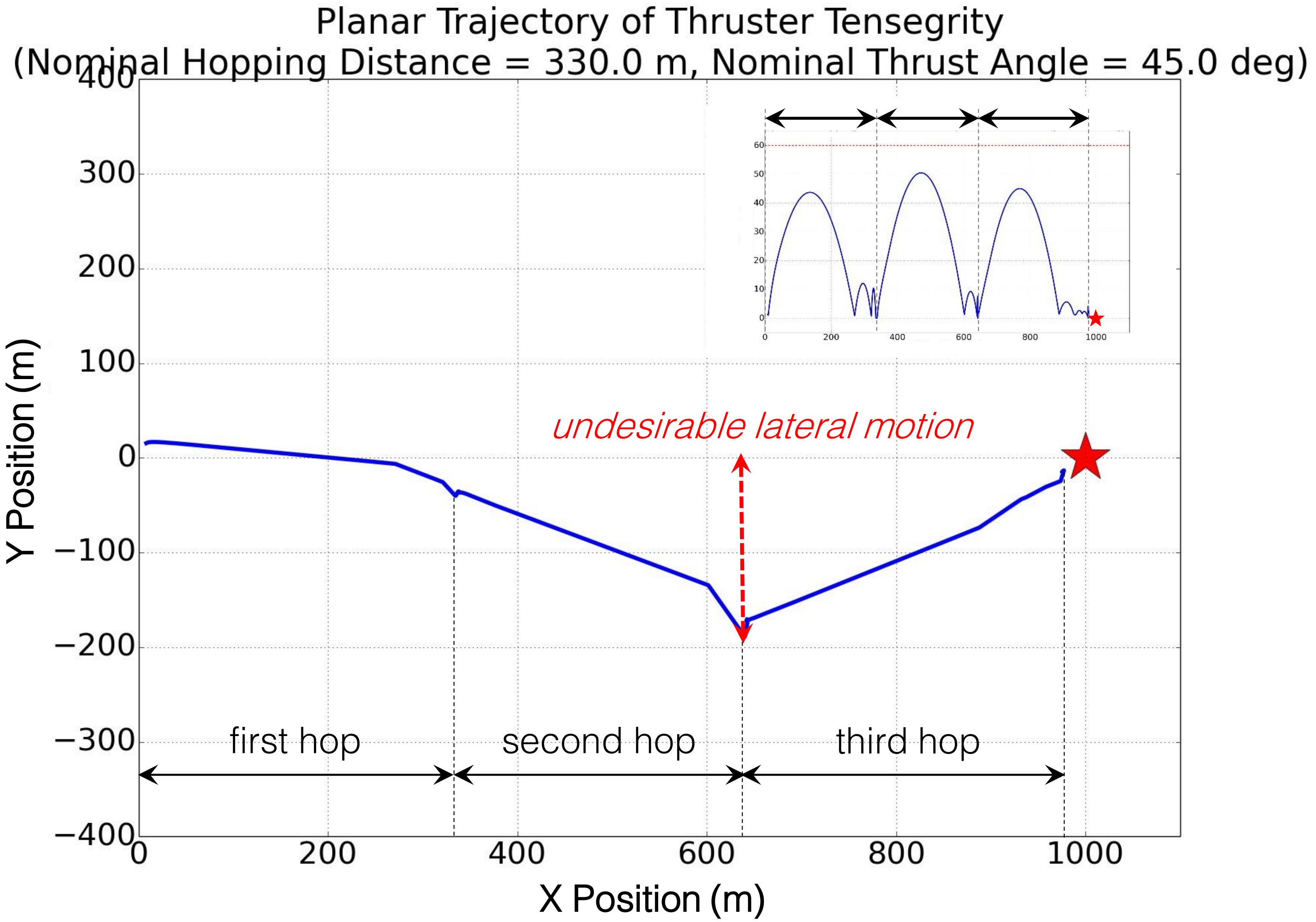
Simplified mission profile of a thruster-based tensegrity probe

Six-bar tensegrity robot “rolling” on uneven terrain

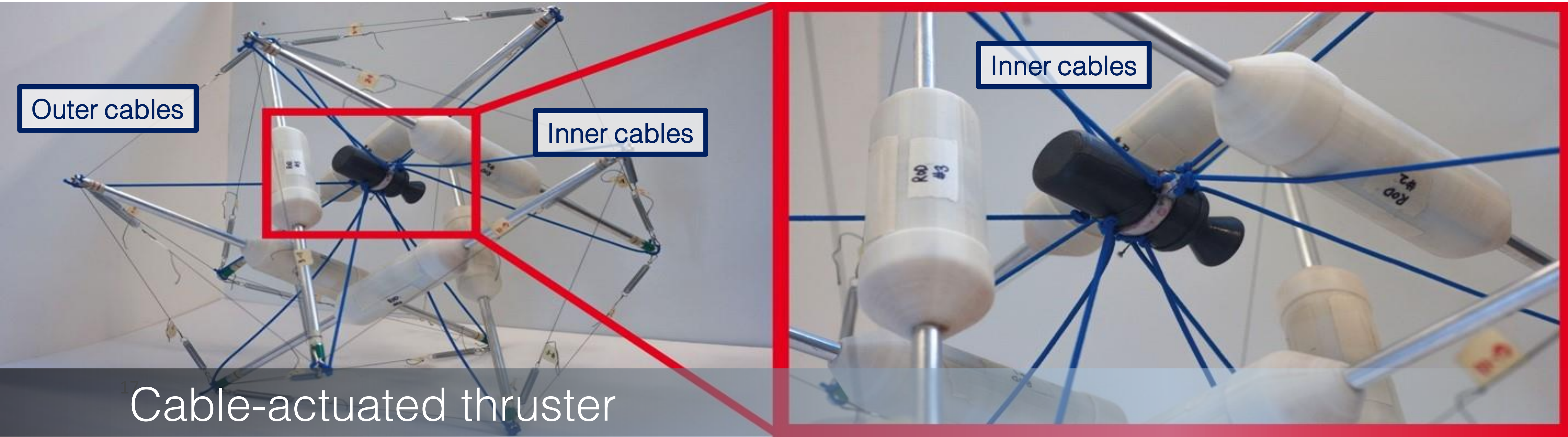

Drop Height: 48 inches (122 cm)

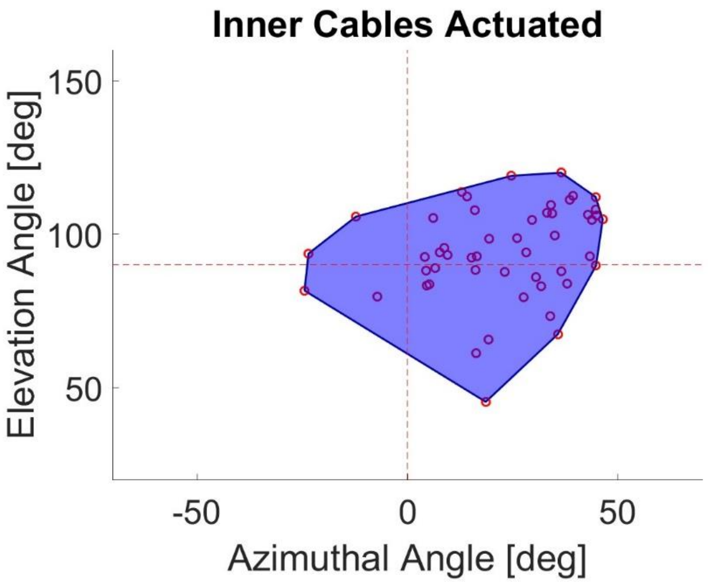


Nominal flight distance per hop	Estimated consumed propellant mass
1000 m	1.23 kg
330 m	2.65 kg
100 m	3.88 kg
10 m	13.68 kg

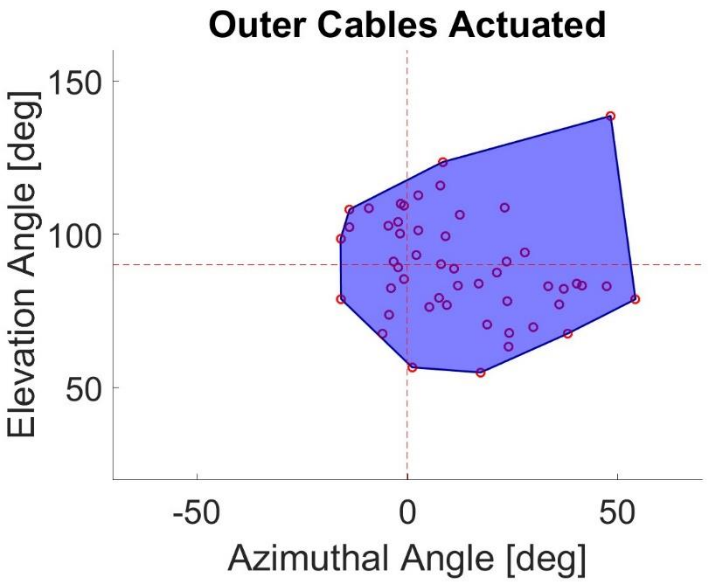

Planar Trajectory of Thruster Tensegrity
(Nominal Hopping Distance = 330.0 m, Nominal Thrust Angle = 45.0 deg)
undesirable lateral motion
first hop
second hop
third hop
Y Position (m)
X Position (m)


Gimbal-enclosed thruster

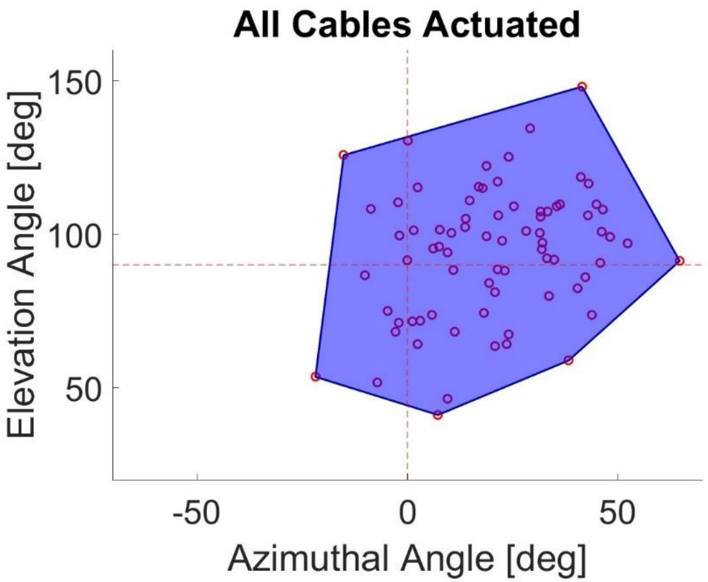

Outer cables
Inner cables
Inner cables
Cable-actuated thruster



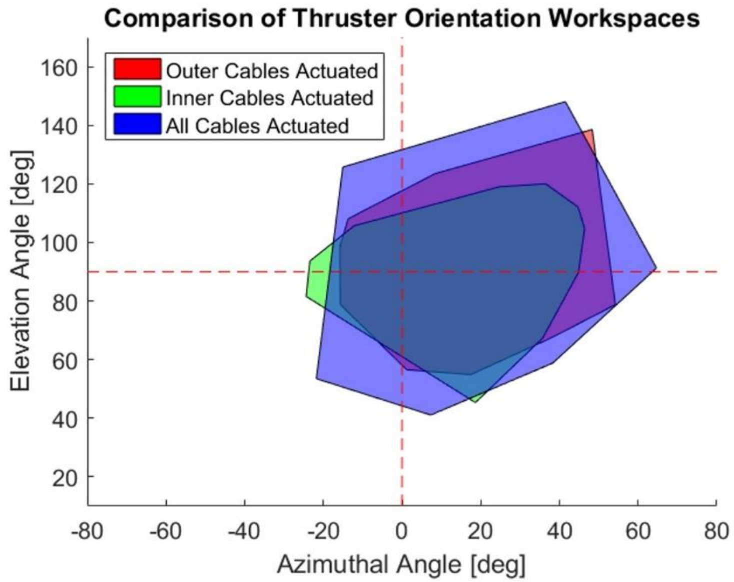
(a)



(b)



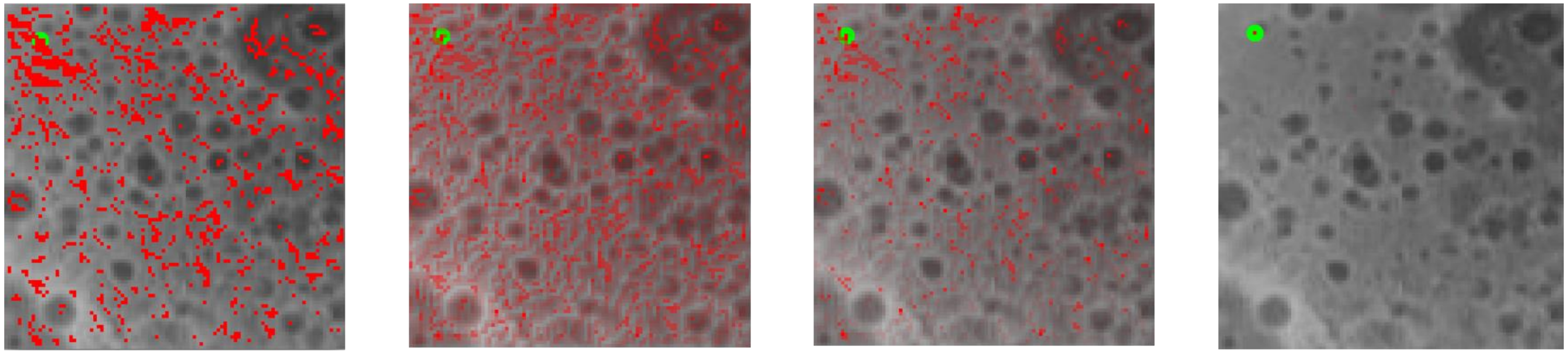
(c)



(d)

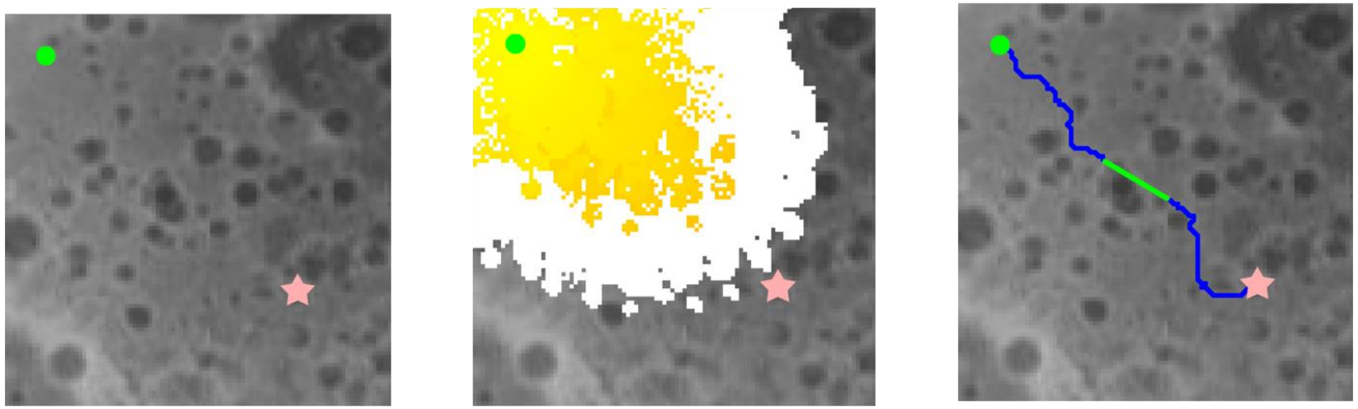
Actuation location	Inner cables	Outer cables	All cables
Min. azimuthal	-27	-17	-22
Max. azimuthal	46	55	63
Azimuthal difference	**73**	**72**	**85**
Min. elevation	44	54	42
Max. elevation	120	140	147
Elevation difference	**76**	**86**	**105**

Localization



(a) (b) (c) (d)

Path planning



(a) (b) (c)

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Thank you!

- Contact
  - E-mail: knkim@berkeley.edu
  - Website: http://best.berkeley.edu/best-research/best-berkeley-emergent-space-tensegrities-robotics/

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