Integrated X-band Communication Antenna and Solar Array for Interplanetary CubeSats

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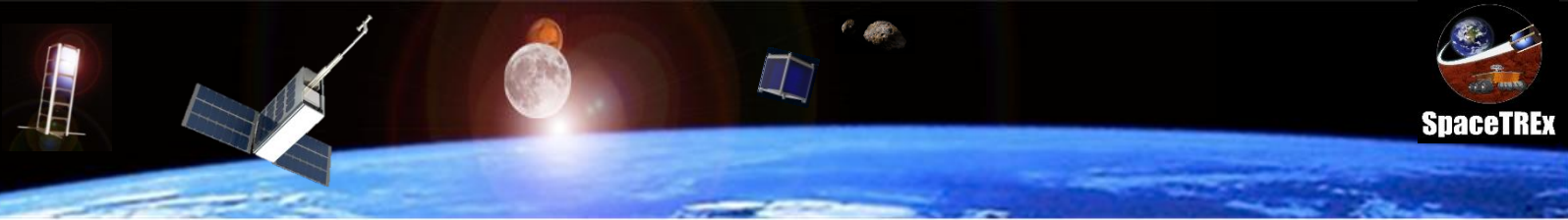akshay.choudhari@asu.edu

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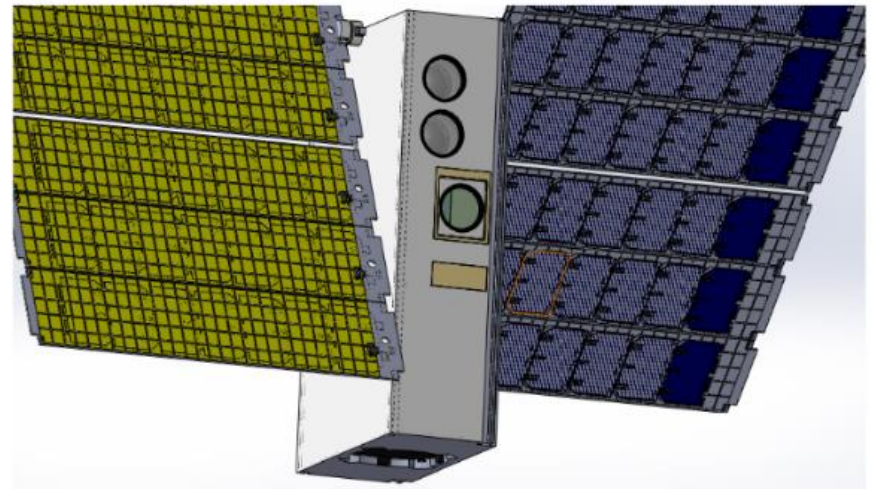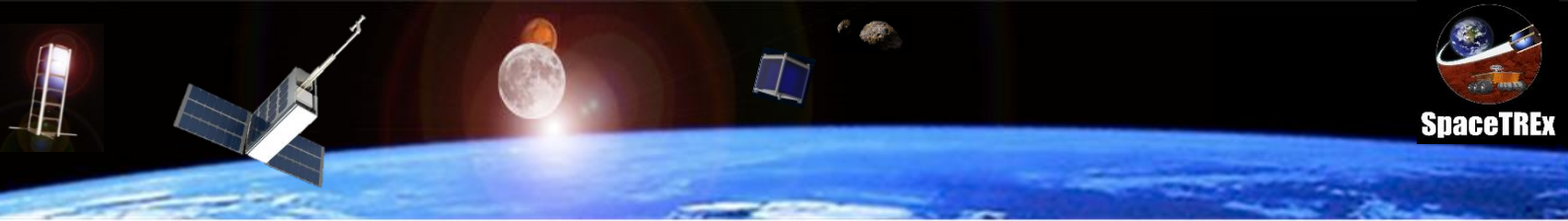Arizona State University

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Hybrid solar array and reflectarray

- HaWK Solar Arrays
  - Dual Gimbals
    - Reaction wheel solar desaturation
    - Variable modes

- X-Band Reflect Array
  - Hybrid on back of HaWK array

- Similar concept – ISARA (Ka-band)

ISARA REFLECT ARRAY

HAWK GIMBALLED SOLAR ARRAY

Pros and Cons

Pros

- Reduced mass and after deployment volume
- Reduced number of deployments
- Reduced effective surface area
- Simultaneous operation of solar array and antenna
- Redundancy
- Reduced Comms link limitations during tumbling
- Improvement in antenna gain*

  * – assuming both arrays can be synchronized

Cons

- Solar array and Reflectarray integration process complexity
- Two feeds required
- Complexity of synchronizing two Reflectarray signals (and feeds)

❖ Longer communication link time with CubeSat
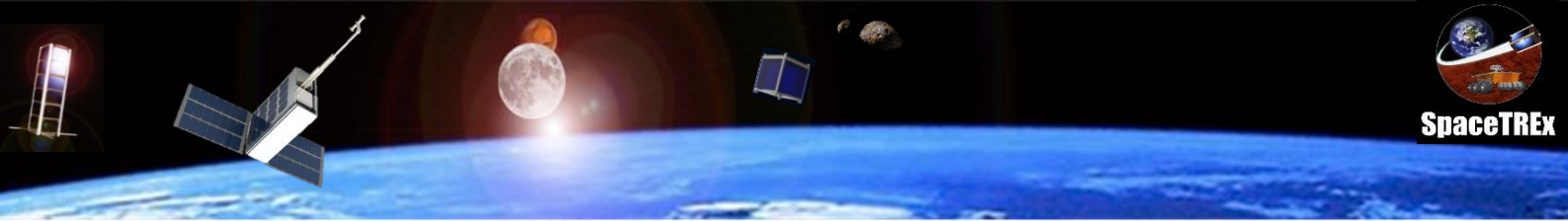
Properties

Specification	X-band reflectarray
Mass	0.5 kg
Gain	31.69 dB (single array) 34.7 dB (double array)

Specification	MMA E-HaWK (3 panels/ wing)
Mass	0.85 kg
Power	44 W OAP

1 – estimated mass of only electronics (no chassis)
2 – assuming both arrays can be synchronized

High gain X-band Reflectarray
NASA JPL (MarCO)

Change in Gain of reflectarray with antenna area
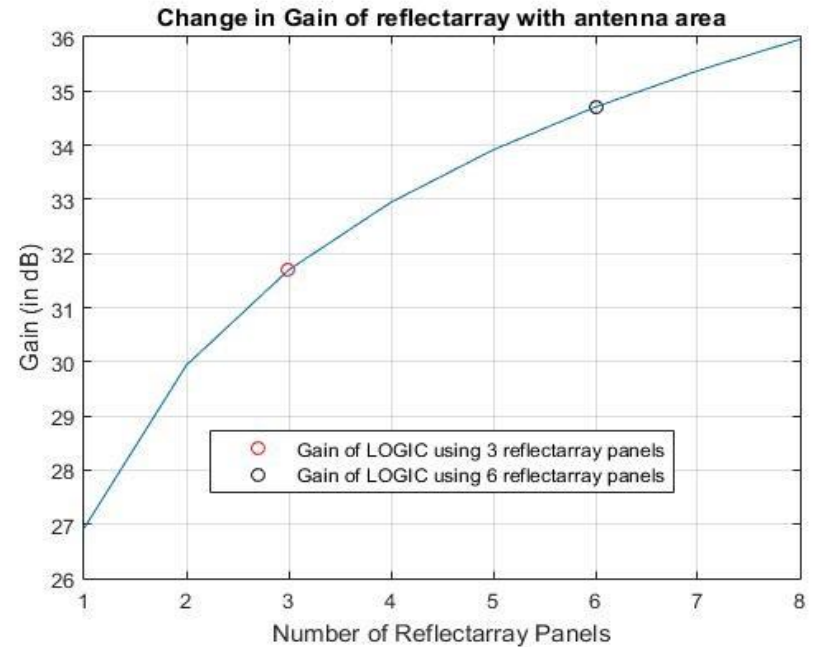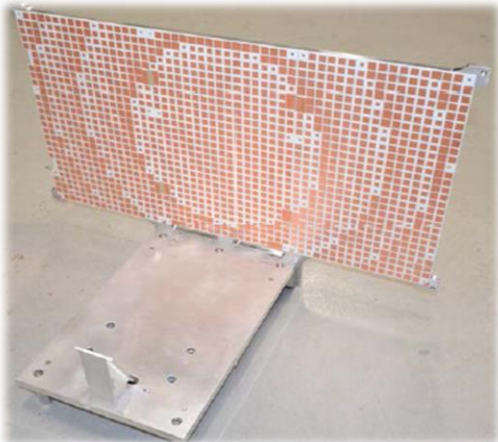
❖ Total area of 12U x 2U shared by Reflectarray and solar panels
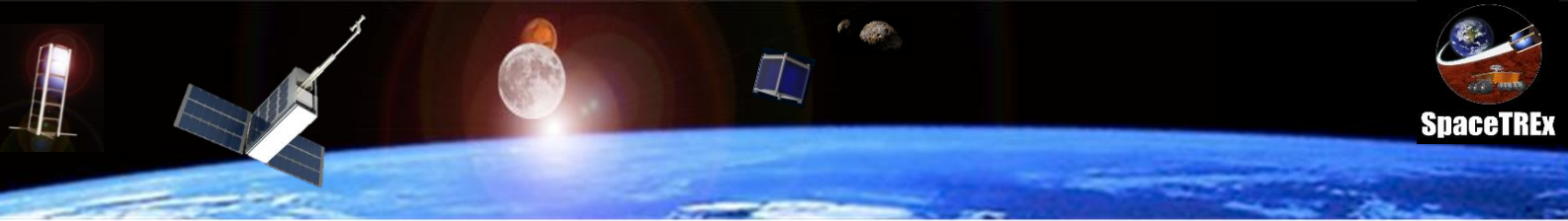
Devils LOGIC: Low Orbit Geothermal Imaging CubeSat

- 6U CubeSat
- Hosted payload science mission to Phobos
  - Nominal Launch: Mars 2020
- 2 year mission life
  - Potential for extended mission (3 years)
- Thermal and visible camera payload
- Impulsive maneuver for Mars capture
  - 15+ flyby's achievable within 7 months
- 7 month science mission
  - Minimum of 5 flyby's science mission
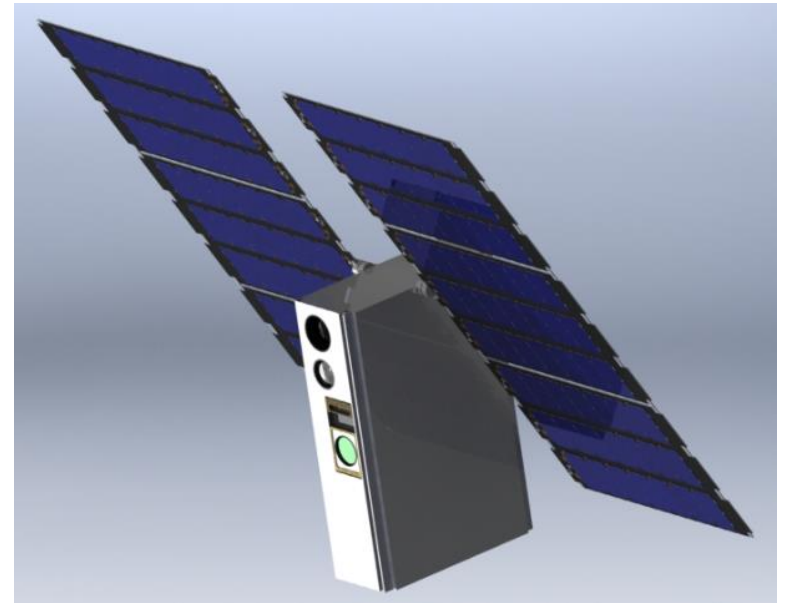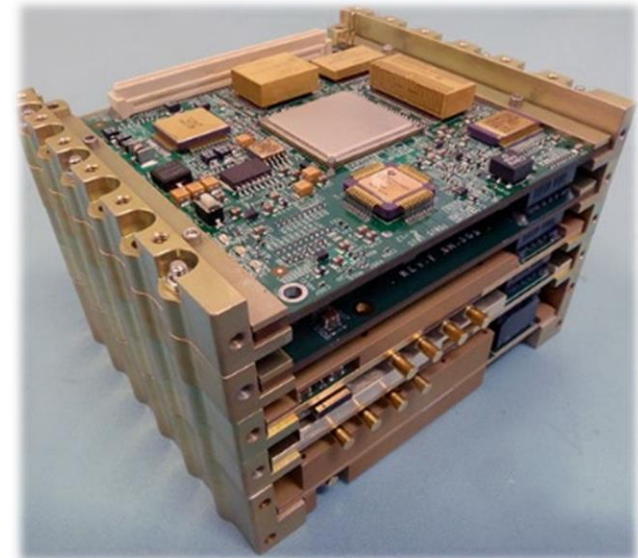

LOGIC Deployed View
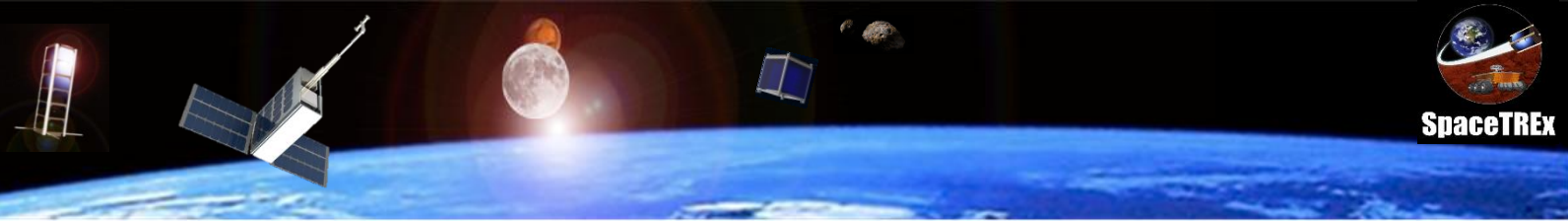
LOGIC - Communications Subsystem

- DSN compatibility
- EIRP - 35 dB
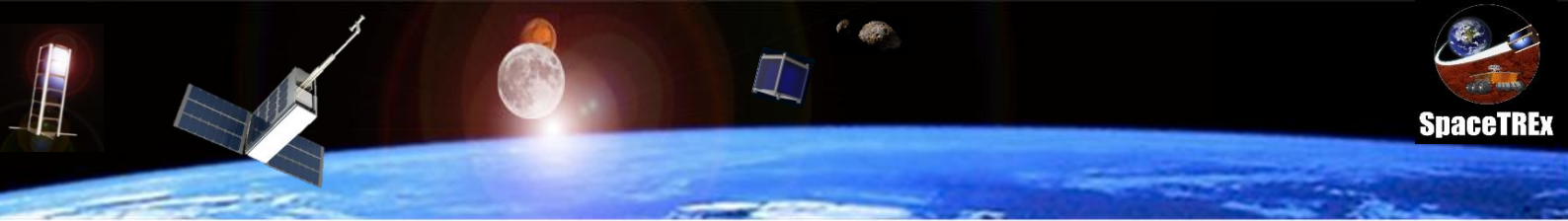- UHF relay (investigation in progress)

Iris V2 X band Transponder


NASA JPL (MarCO)

Link budget to Earth (X band)

Scenario (Date rate)	Distance (million km)	Downlink
Worst	300	6.4 kbps
Nominal	250	9.3 kbps
Best	200	14.5 kbps

❖ Integrated (solar array and) X-band Reflectarray with Iris v2 for Interplanetary missions

Summary

- Reduced risk during complex maneuvers (aerobraking)

- Simultaneous solar array and comms operation -> Reduced comms blackout

- CubeSat Electra (UHF) payload -> proximity comms to existing Mars orbiter assets
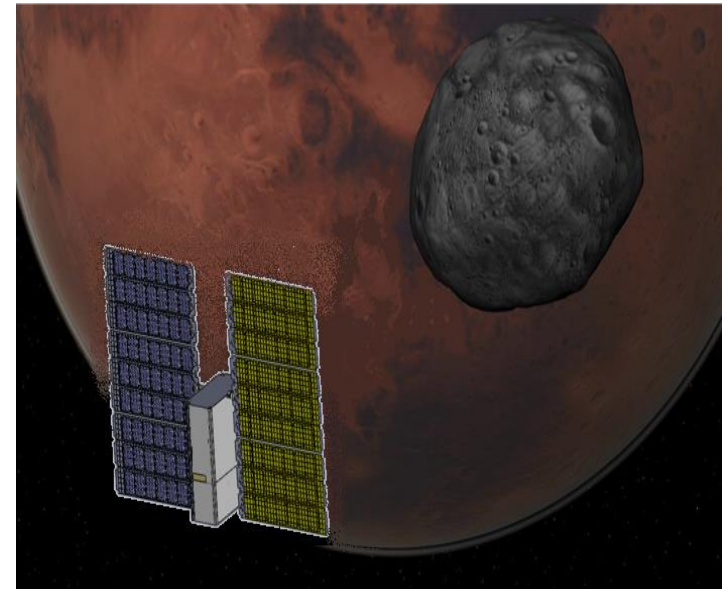
LOGIC spacecraft with Phobos and Mars