



# Prioritized Technology: Small Satellites – Electric Propulsion

## Technical Goal

- (1) Long-duration thruster firings are required to generate high delta-V, therefore high Isp is needed to reduce the propellant mass and volume to fit within a SmallSat. Rad-tolerant to survive long-duration flight in deep space. Requires high power solar arrays.
  - a. Packages to 3U-4U. 150-300 W ( $I_2$  or Xe) (1300 – 1500 sec, 2,000 to 10,000 hours) Requires high power solar arrays. Typically HET
  - b. ESPA-class. 300-600 W (Xe or  $I_2$ ) (1300 – 1500 sec, 6,000 to 10,000 hours. Typically HET
- (2) System packages to <1U. Rad-tolerant to survive long-duration flight in deep space. <100 W, 0.1 to 1.2 mN, 2000-5000 sec Isp, 5,000 to 15,000 hours. Typically BIT (Xe or  $I_2$ ), or electro spray (ionic liquids).

## Mission Applications

- (1) Direct transportation to the moon, Mars, Venus, and main asteroid belt from GTO; higher power missions e.g. to Europa.
  - a. CubeSat missions \$20-\$50M
  - b. ESPA-class missions, enables larger science payload. \$100M
- (2) Enables low power, rideshare missions <12U (~\$10M missions). Missions like LunaH-Map, Lunar IceCube, and DAVID. No new power system requirements.

## Technical Status

*The gap is lifetime.*

- 1) 100 to 600 W electric thrusters performance has been demonstrated with the required Isp and thrust. Flight-like power processing units have not been developed (compact, high power density, rad hard). Iodine cathodes have not yet been developed.
  - a. 200 W Xe thrusters have demonstrated 1800 hours of operation (then soft failure), and 80 hours using iodine propellant (test ended before failure). 200 W, 30 krad iSat flight PPU being built.
  - b. 600 W  $I_2$  thrusters have demonstrated 80 hours of operation (test ended before failure). 600 W brassboard PPU being built
- (2) 100 microNewton thruster performance demonstrated to 200 hours until failure (MIT). In-space demo with limited operability (MIT 2015 and 2016, Busek 2018). BIT thruster 500 hour life test. MicroNewton thrusters flew on LISA Pathfinder.

## Development Cost and Schedule