Case Study of a Propulsion System for Cubesat

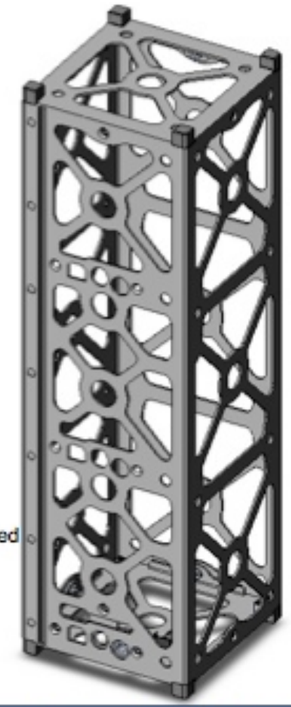
By: Vishal Doshi & Evan Olson

What is a Cubesat?

- A cubesat is a small satellite with a volume comparable to a liter of water for 1U
- Dimensions: 10cm X 10cm X 10cm (1U)
- Background
  - Started by California Polytechnic State University & Stanford University
    - Objective: Standardize satellite construction for universities worldwide to enable exploratory science

Courtesy of Pumpkin Incorporated

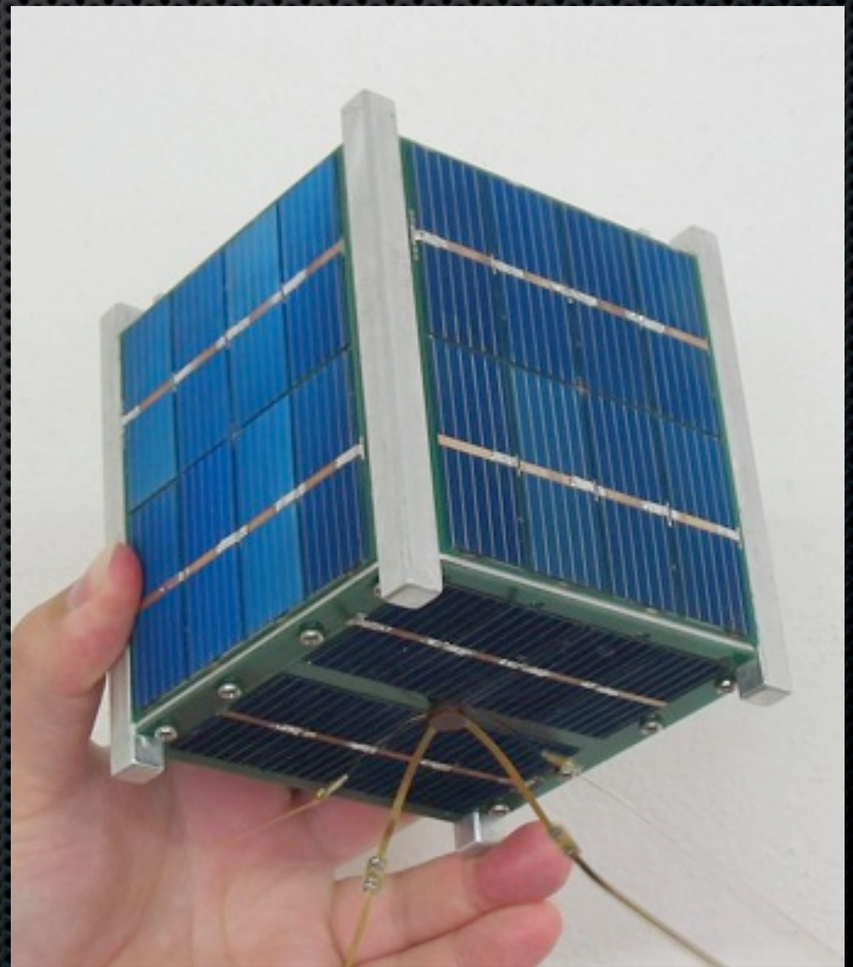
1U Configuration



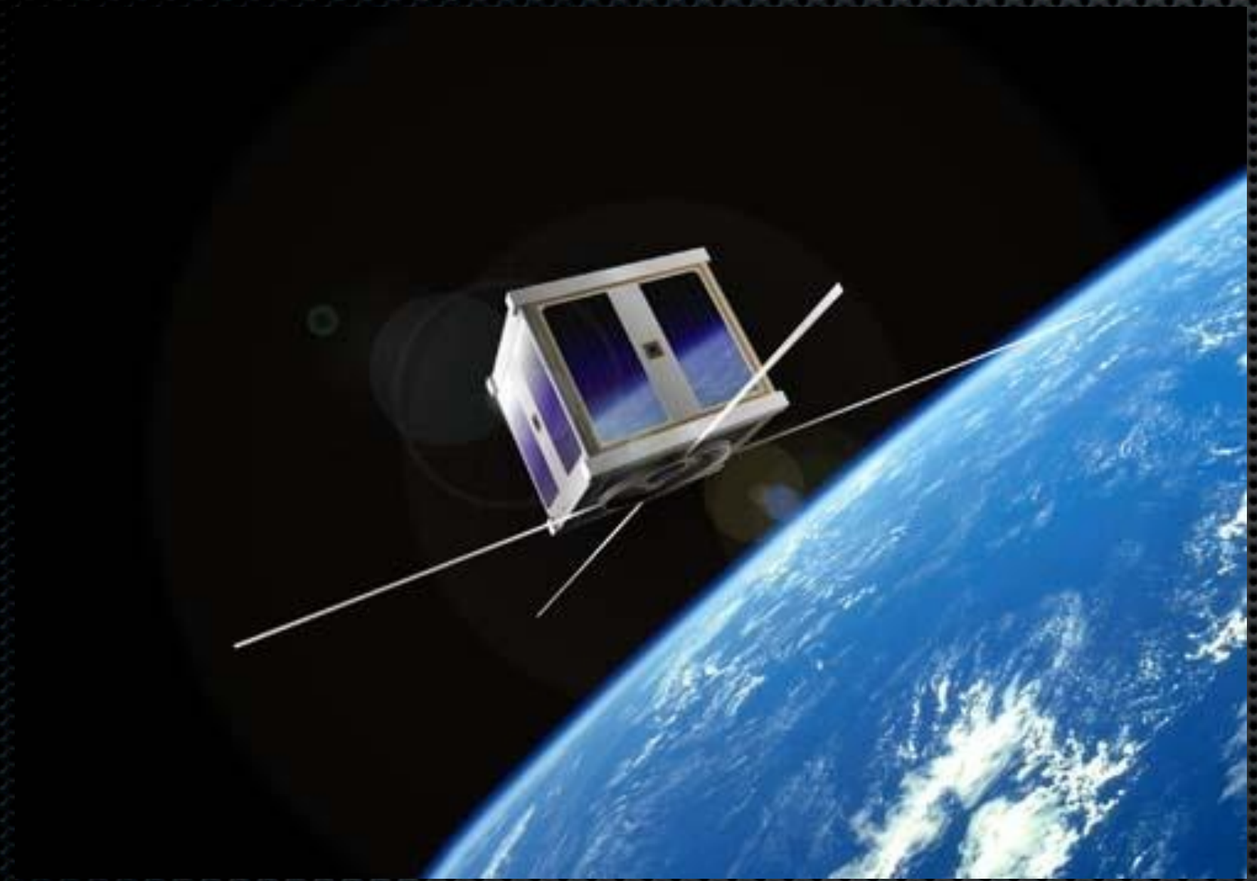
Chassis of a 3U cubesat

Why Use a Cubesat?

- Capabilities: Earth remote sensing (taking pictures, radiation measurements, earthquake detection), space science (van allen radiation belts, space weather), genetic experiments (growth of E coli bacteria in space), testing of various propulsion systems, etc.



Our Objective



- Manufacture a 3U cubesat
  - Demonstrating the use of micro pulsed plasma thrusters (μPPT) for passive attitude control
  - Cost effective
  - Software compatibility

Why Use a Propulsion System?

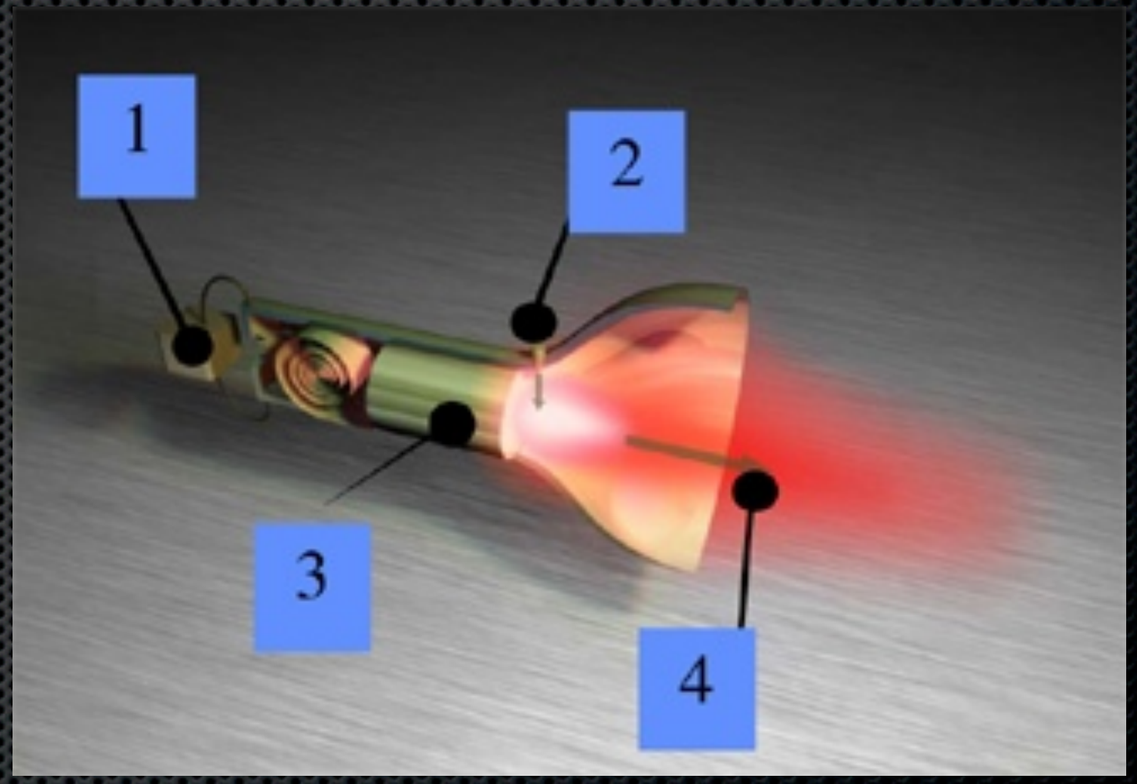
- Provides compensation for disturbance torques
  - Such as drag, gravity gradient, solar pressure, and magnetic forces
- Attitude control
  - Communication improvement
    - Power generation (solar panels)
    - Improved scientific missions
- Orbit Control
  - Improved mission autonomy
- Very few cubesats have propulsion systems for means of attitude control

Various Propulsion Systems

- Electric Propulsion
  - μPPT
  - FEEP (Field Emission Electric Propulsion)
  - Ion guns
- Chemical Propulsion
  - Bi-Propellant micro rocket engine
  - Monopropellant micro rocket engine
- Reaction wheels
- Magnetic torque coils
- Cold gas thrusters

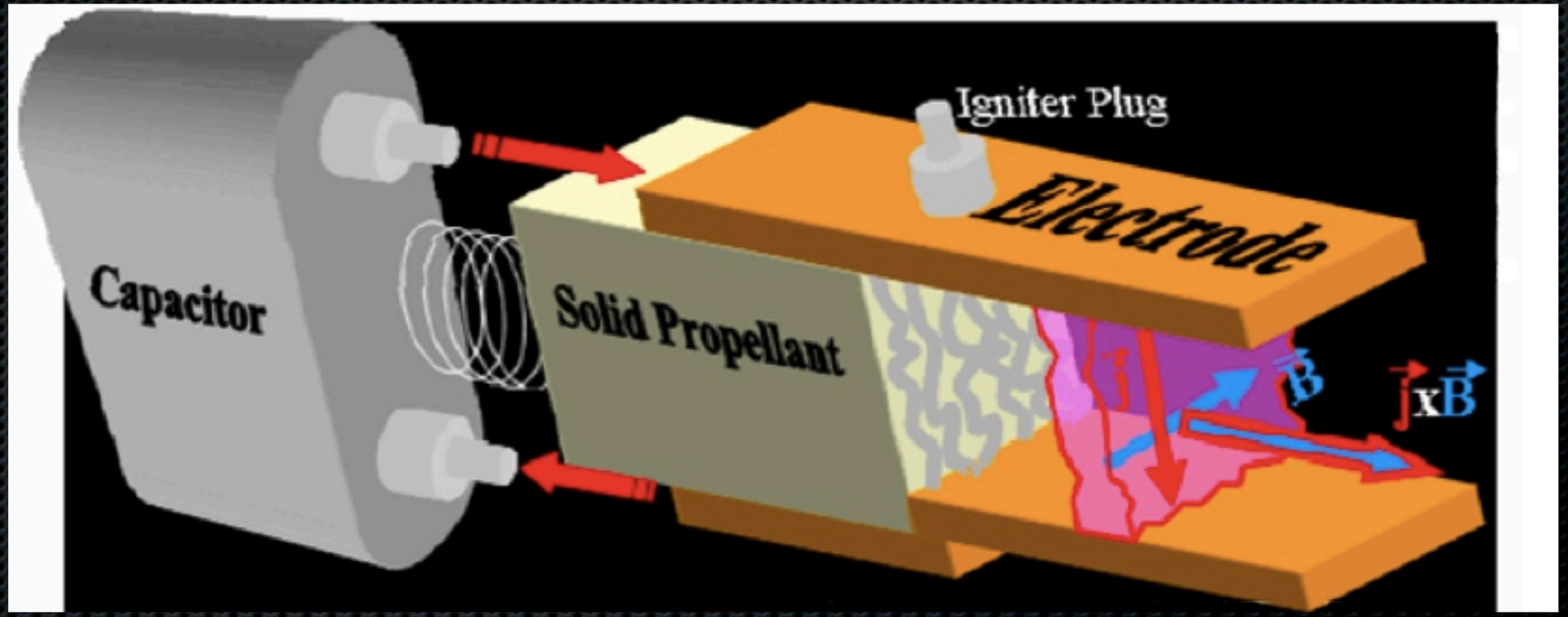
Why μPPT?

- Pros
  - Simple mechanical design
  - Storage
  - no moving parts
  - Low power consumption
  - No cubesat has demonstrated use of μPPT
- Cons
  - Custom made components
  - Expensive
  - Requires extensive knowledge of electricity and magnetism
  - Low thrust
  - Needs more research



What is μPPT?

- Electromagnetic micro propulsion system
- Components: 2 electrodes, high voltage capacitor (power storage system), solid teflon (propellant), and igniter plug



What Did We Do?

- Extensive background research on existing cubesat technology and missions
- Contacted many manufacturing companies for required custom made components
- Contacted Austrian research scientist Carsten Scharlemann
  - C. Scharlemann has a working model of μPPT
- Made a Rogowski coil to measure AC current