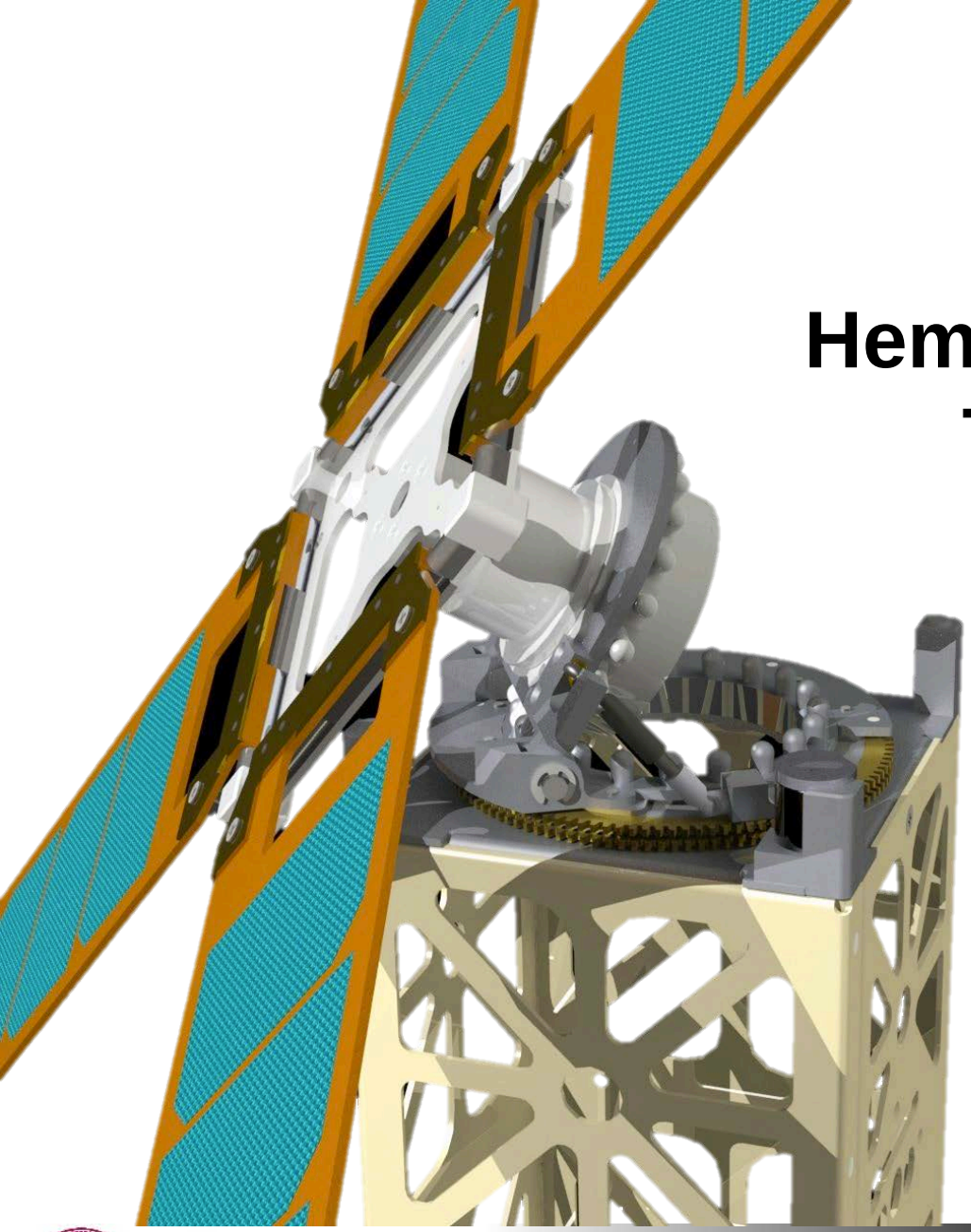

Hemispherical Anti-Twist Tracking System (HATTS)

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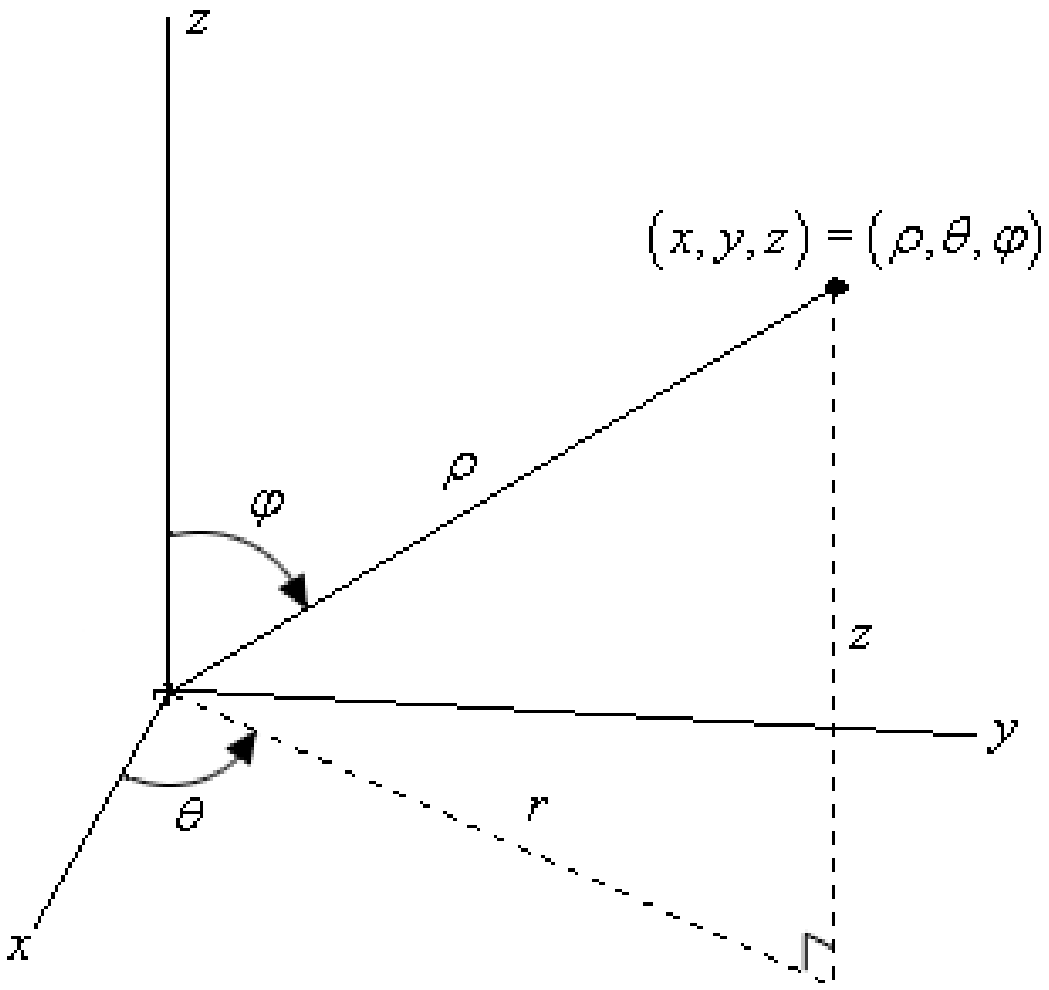
Problem Statement: Hemispherical Tracking Ability



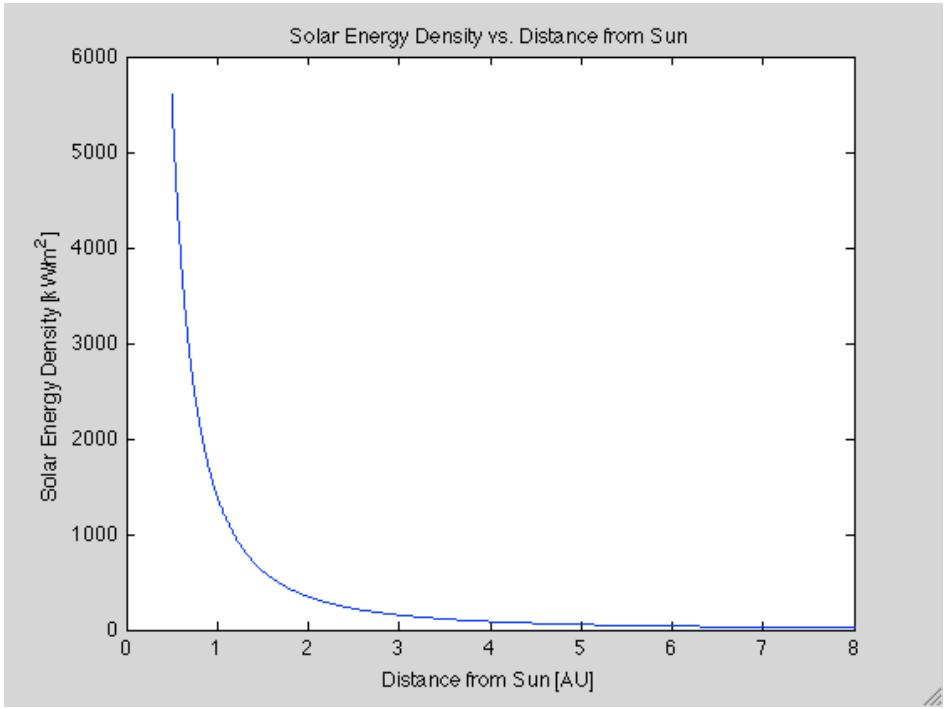
2 Degree of freedom hemispherical tracking

Continuous rotation w/o slip ring connectors

- No twisting of wires, hoses, etc.

Wrist joint

Tracking for Interplanetary Missions



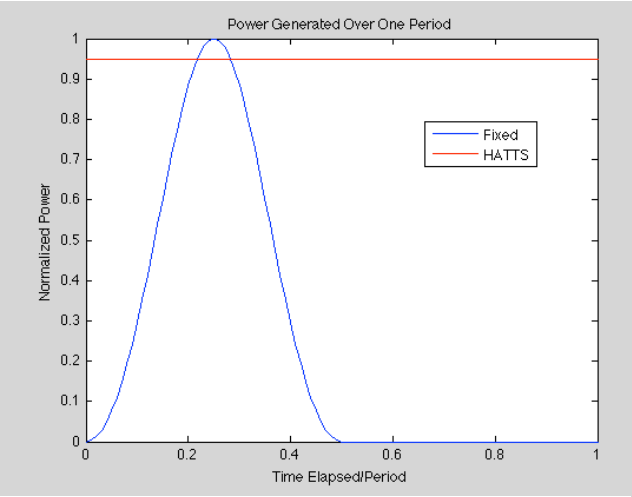
Voyager Image courtesy of NASA

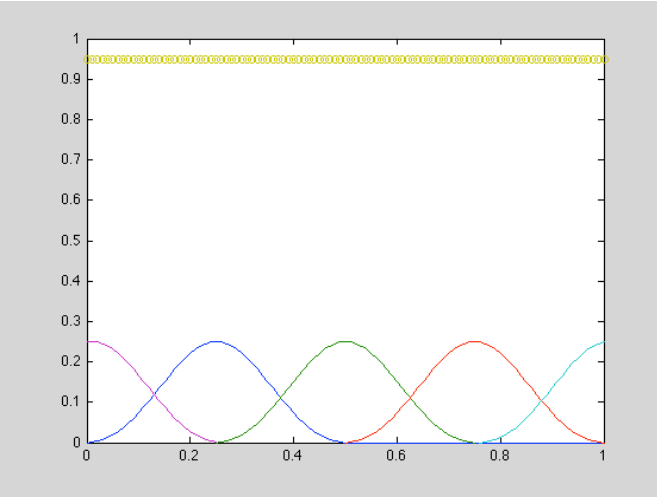
Earth ≅ 1400 kW/m^2 Mars ≅ 600 kW/m^2

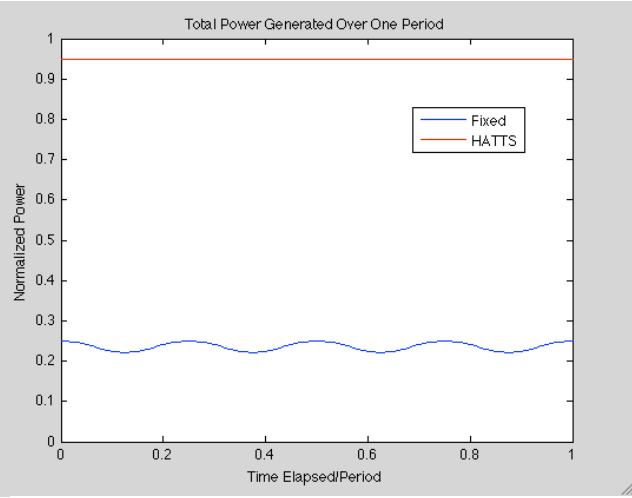
- Transmission Losses
  - Ability to use highly focused antenna improves data collection abilities and performance

Solar Power Generation

Relative Power Generation During Passive Thermal Control (aka Barbecue Roll)







Note: Fixed panels generate no power while shaded. Roll rate assumed constant.
Control power used shown relative to full twelve panel array used in 3U CubeSats.

Requirements for CubeSat Tracking System

- Stowed Volume < ½ U
- Mass < 300 grams
  - CubeSat < 1330 grams per U
- Minimal obstruction of surface
- High reliability
  - Minimal deployment events
  - Avoid slip rings

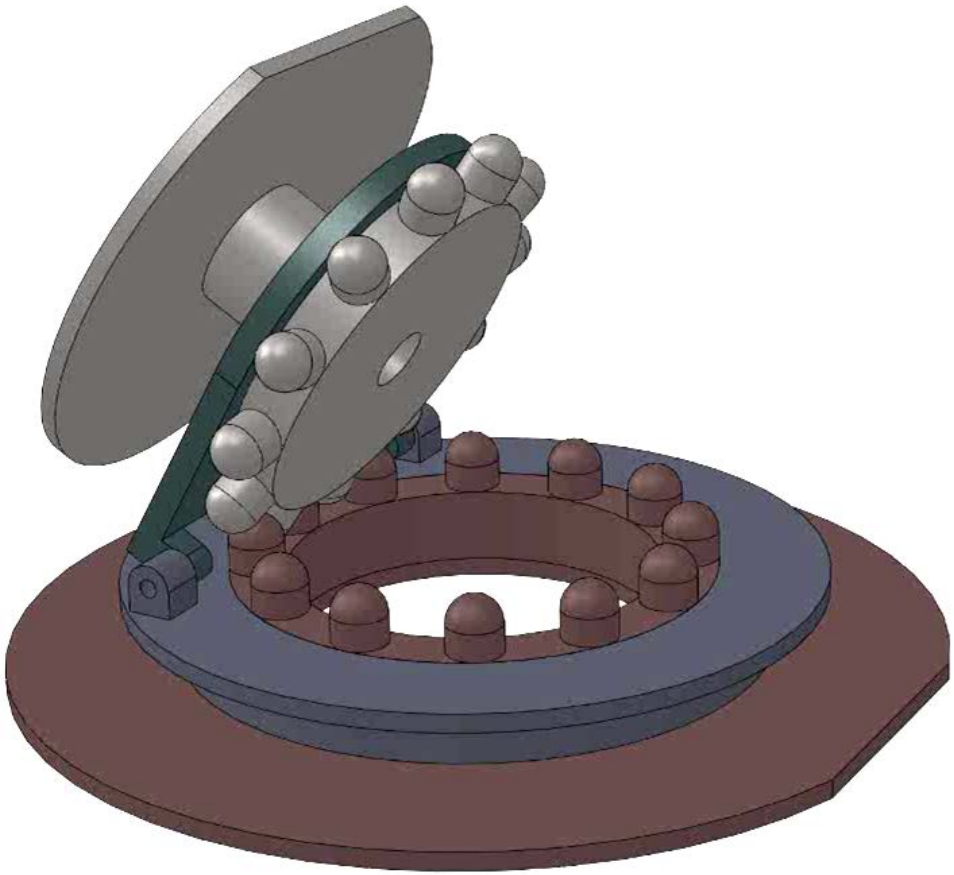
Existing Solutions

Slip Rings

Canfield Joint

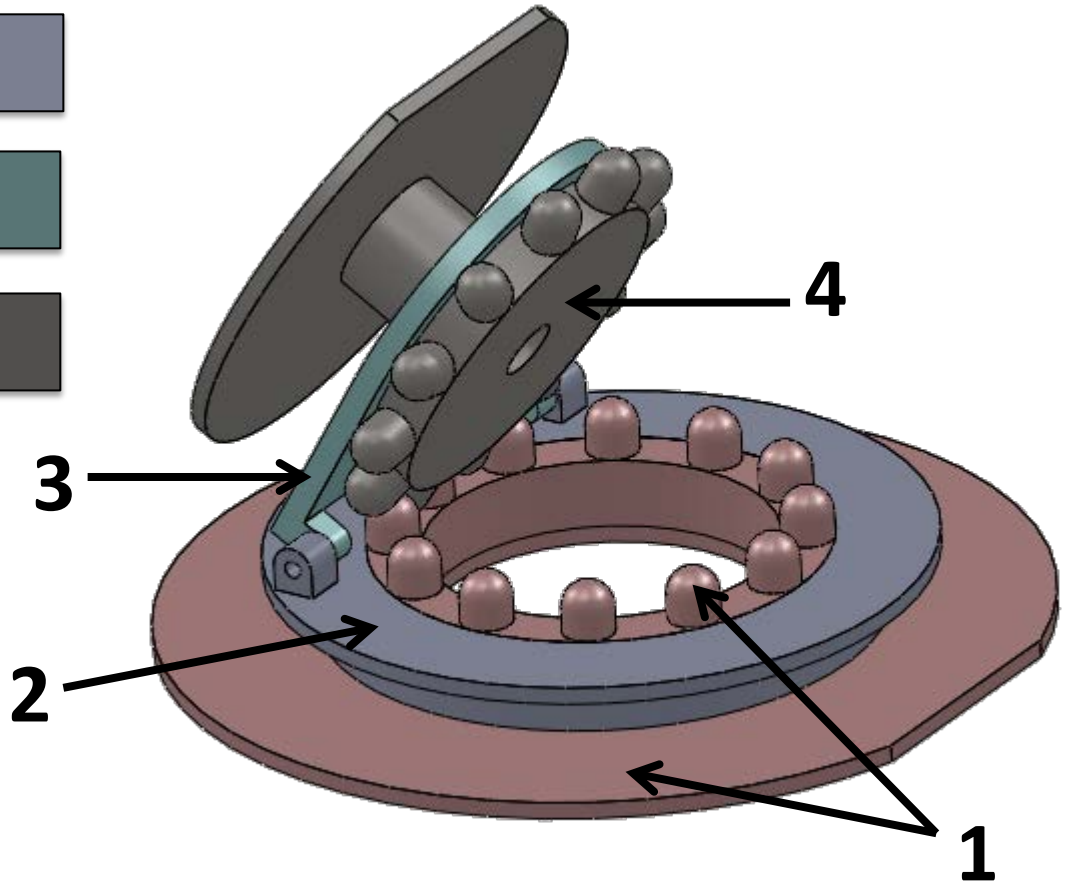
Untwist

The HATTS Solution



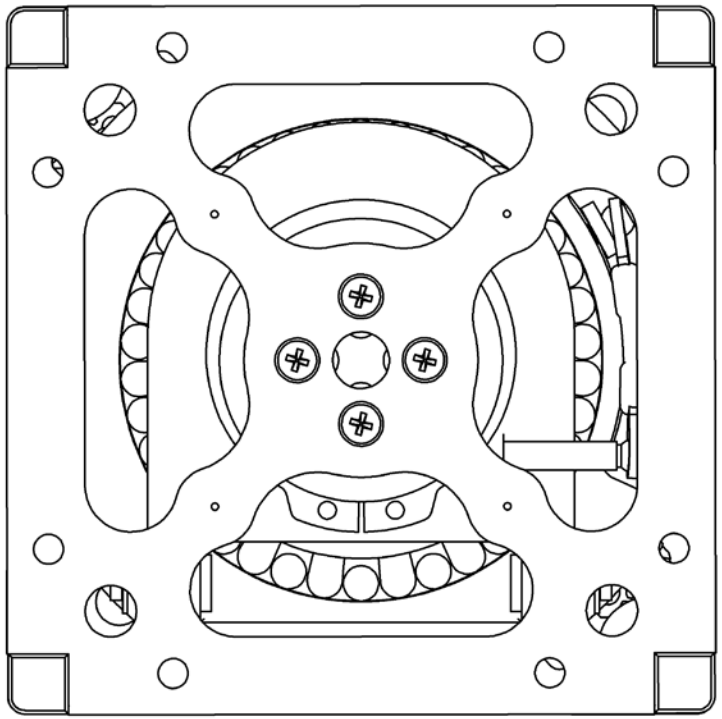
HATTS Components

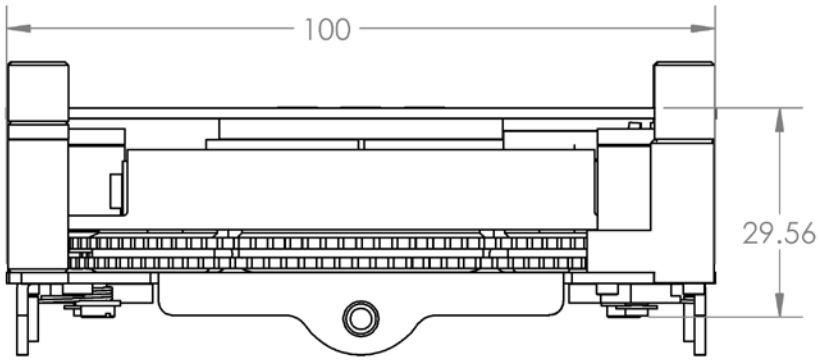
1. Fixed base with gear
2. Rotating platform
3. Elevation platform
4. Anti-Twist Gear



CubeHATTS Specifications

- Mass: ~ 250 grams
- Stowed Volume:
  10cm x 10cm x 2.9 cm



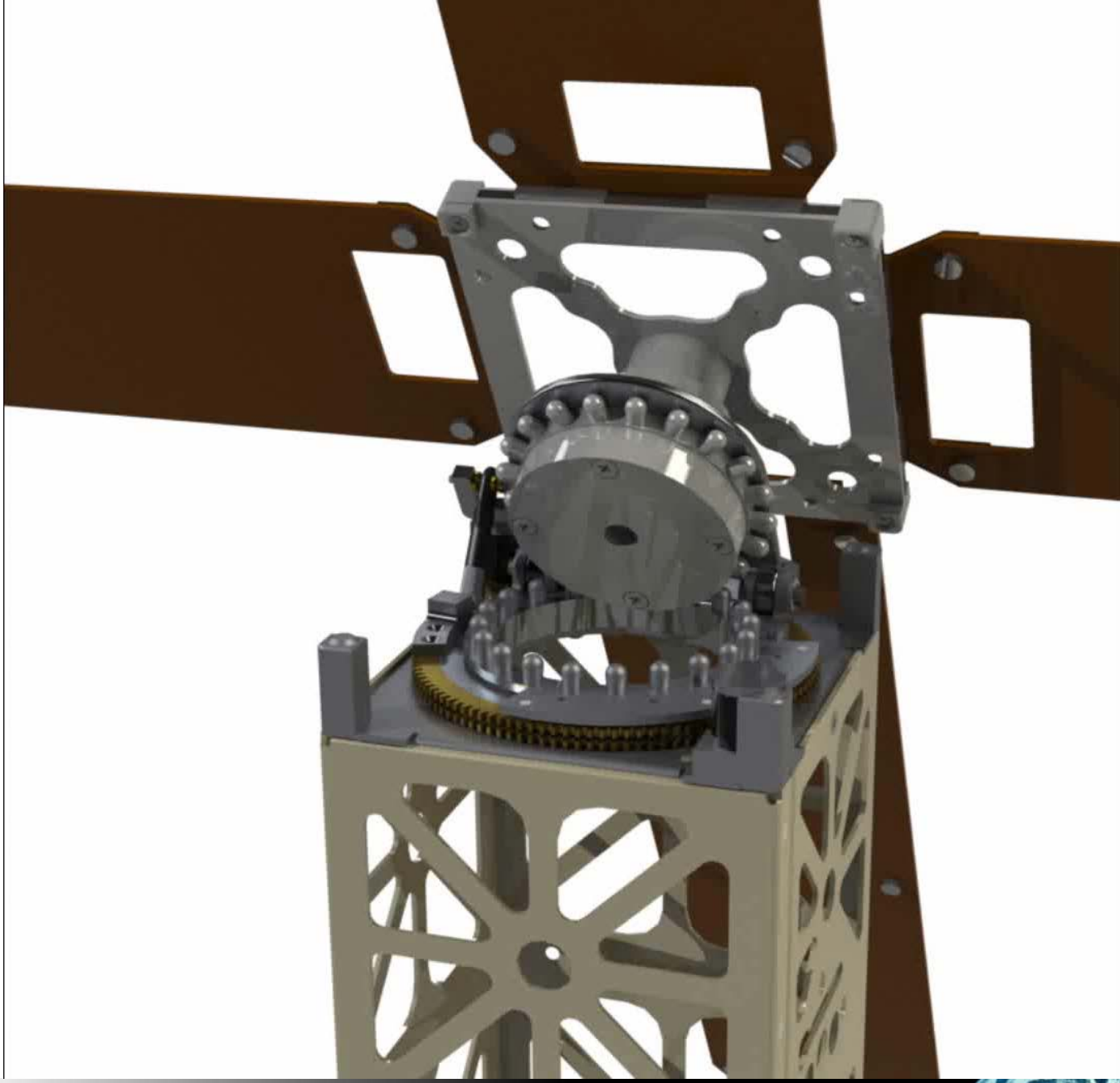


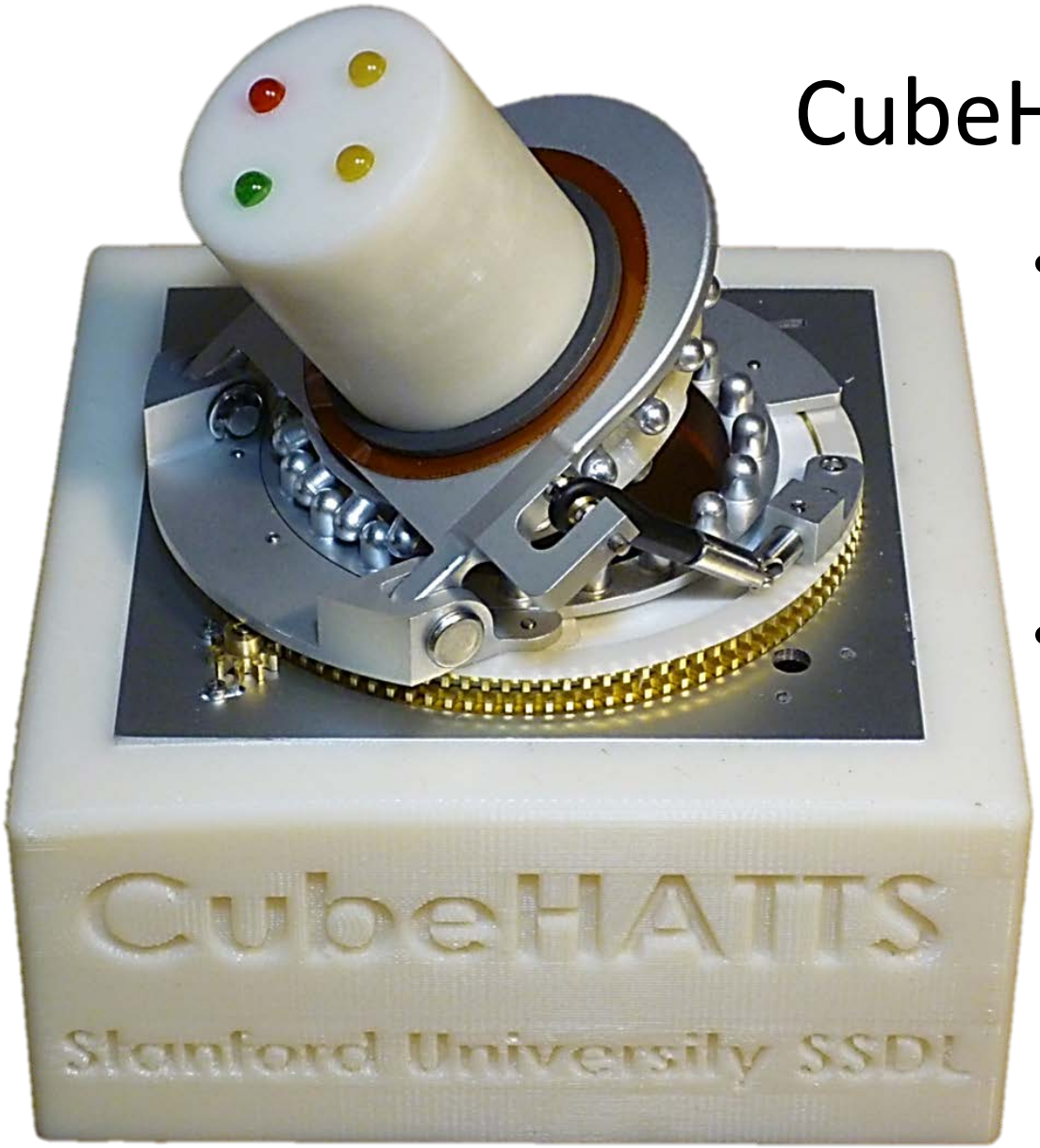
CubeSat Implementation Details

- Dual coaxial gears to control phi & theta
- Identical and rigidly mounted driving motors
- Telescoping arm for single action deployment
- Ball gears allow engagement through full range of elevation angles

CubeHATTS Status

- Work Completed:
  - CubeHATTS v1.1 design
  - Test unit
- Further Work
  - Lifetime analysis
  - Weight reduction





CubeHATTS Prototype

- Prove out high risk items
  - Ball Gears
  - Coaxial Gears
  - Elevation Arm
  - Bearings
- Fast time-to-test