MITSET

System Overview

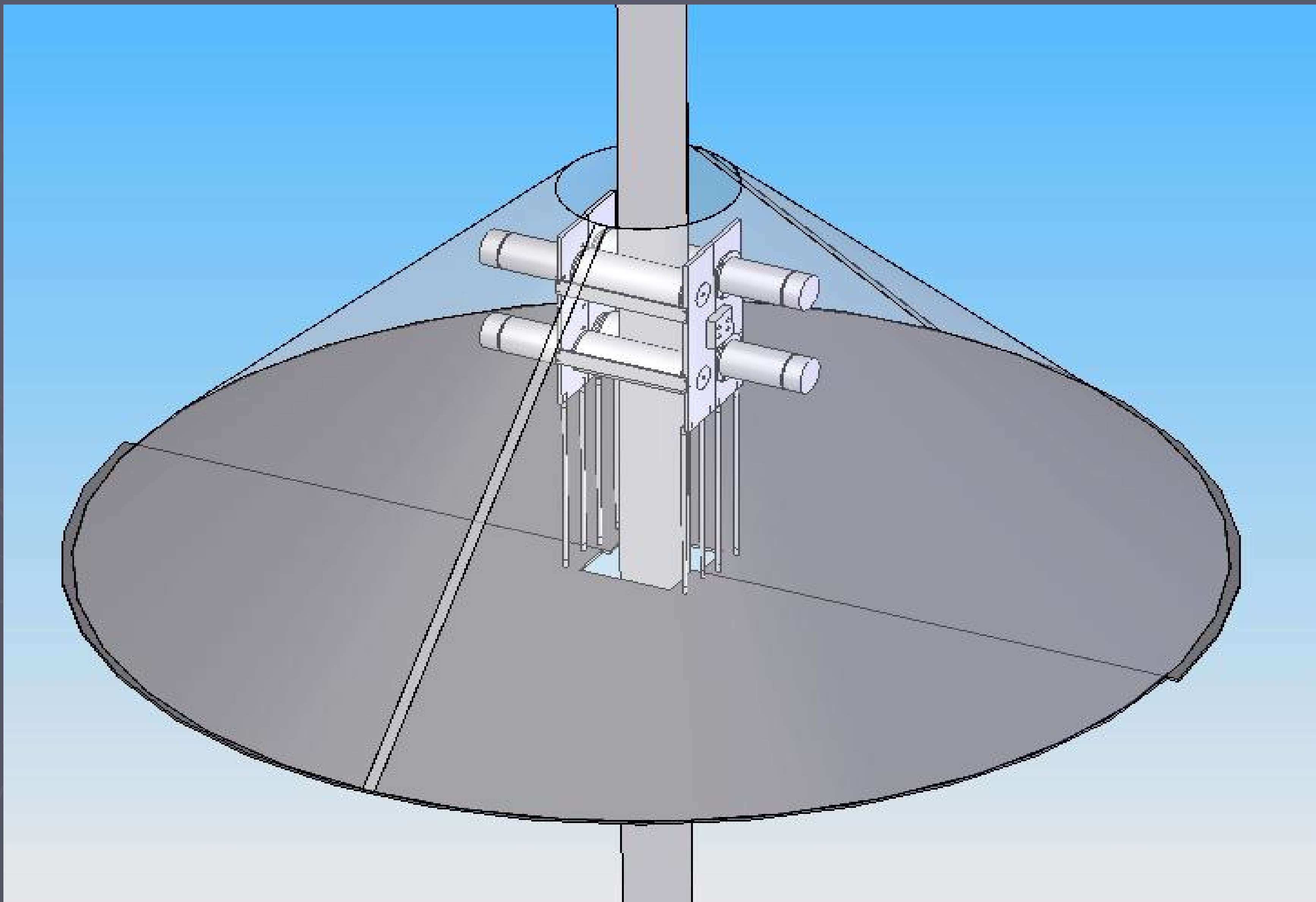
Climber Specs

- The scoring equation for last year's competition was
  - $m_{payload} * V_{avg} / m_{structural}$
- The climber had to be able to ascend a 50m ribbon at an average speed of 1m/s .
- Maximum beamed power of 100KVA.
- No previously stored energy.
- Maximum energy storage of 25% at any time.
- $10kg < m_{structural} < 25$ kg
- Fully autonomous
- Safety regulations must be met
- Power Transmission belt ribbon

Early Goals

- Based on the competition rules, the team delineated some goals concerning the climber, that were believed to maximize performance on competition day based on the scoring equation
  - It should travel at an average speed of 1m/s.
  - It should weigh about 25kg without payload
  - It should be able to carry 25kg of payload while maintaining its average speed.

First Recursion



Lessons from First Recursion

- 1st recursion was a crash course in climber design in which the team mostly experimented brainstormed ideas.
- Construction and machining mandated that several aspects of the initial design be modified.
- After testing the first recursion, the team discovered that the roller configuration was flawed for it could not generate enough torque.
- The team also discovered that the climber was too heavy and flimsy.

CURRENT DESIGN

Modifications

- The team applied the lessons from the first recursion to create a better climber.
- The team decided to switch to a two motor configuration with 50:1 gear ratio which provides substantially greater torque and weighs as much as the earlier recursion.
- Polycarbonate is the primary material instead of aluminium.
- Changed overall design layout to increase stiffness.
- Included additional design for a more complete climber setup that included mount points for failsafe brakes, guide rollers, belay hooks, payload and electronics.

Current Design Components

- Motor-roller module
- Payload module
- Electronics module
- Power module
- All modules except electronics module have been modified

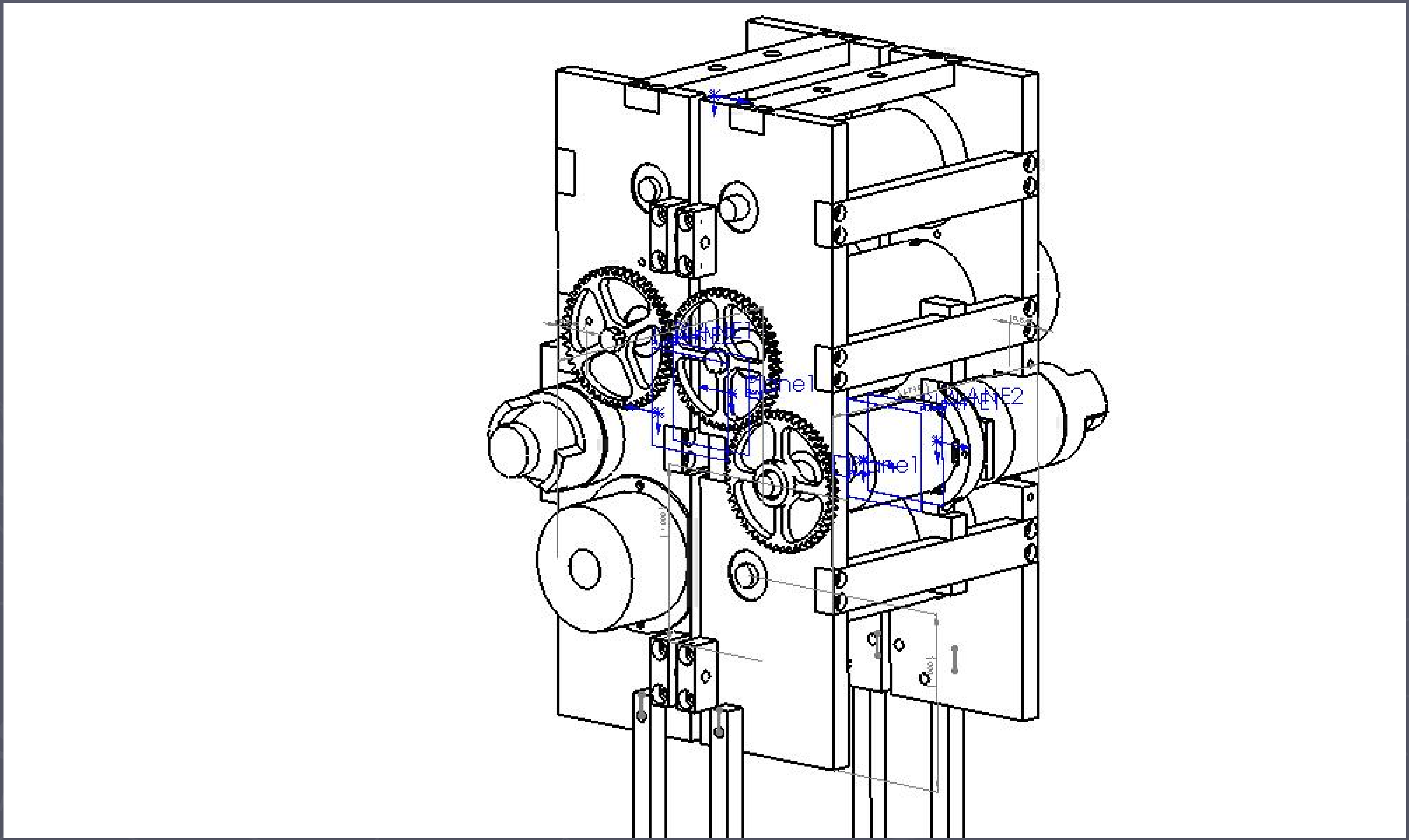
Motor-Roller Module

- Powered by 2 DeWalt power drill motors.
- Structure made of polycarbonate (including the roller) which provides greater strength compared to aluminum.
- Motors are geared to generate necessary torque.

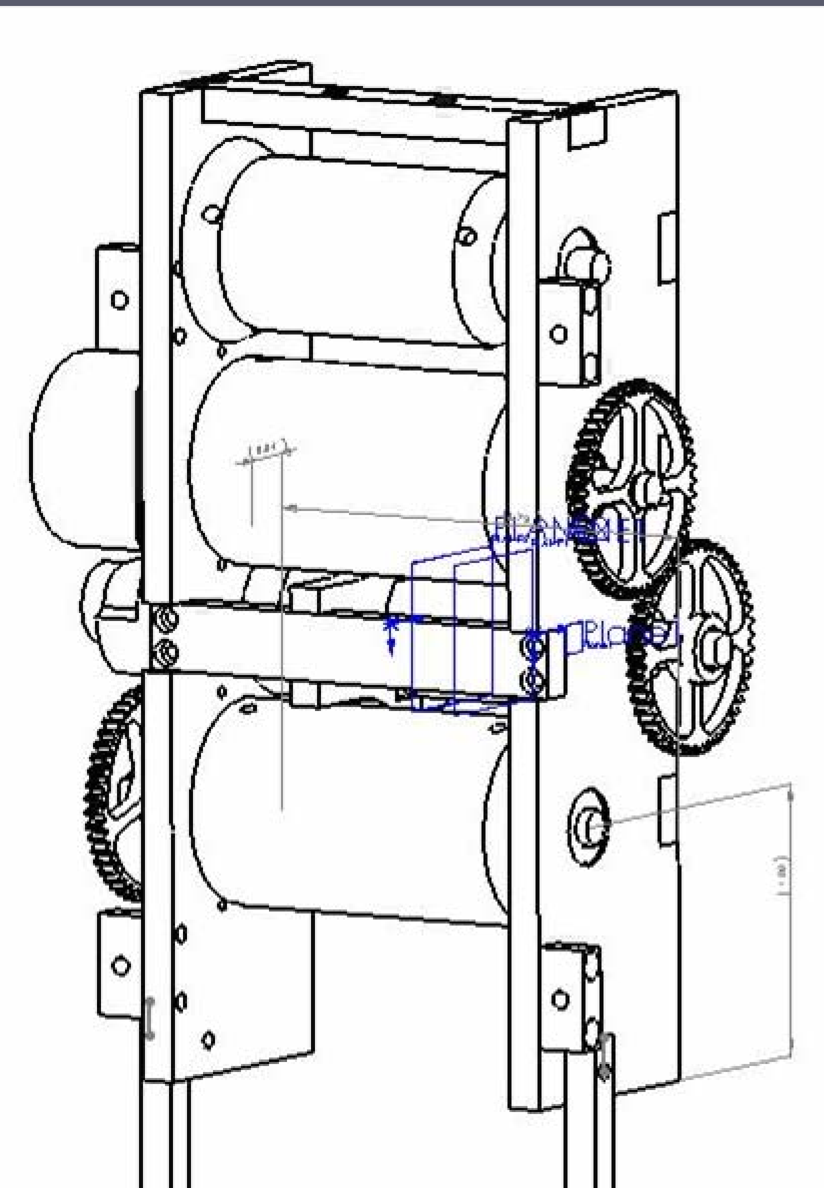
Payload and Power Modules

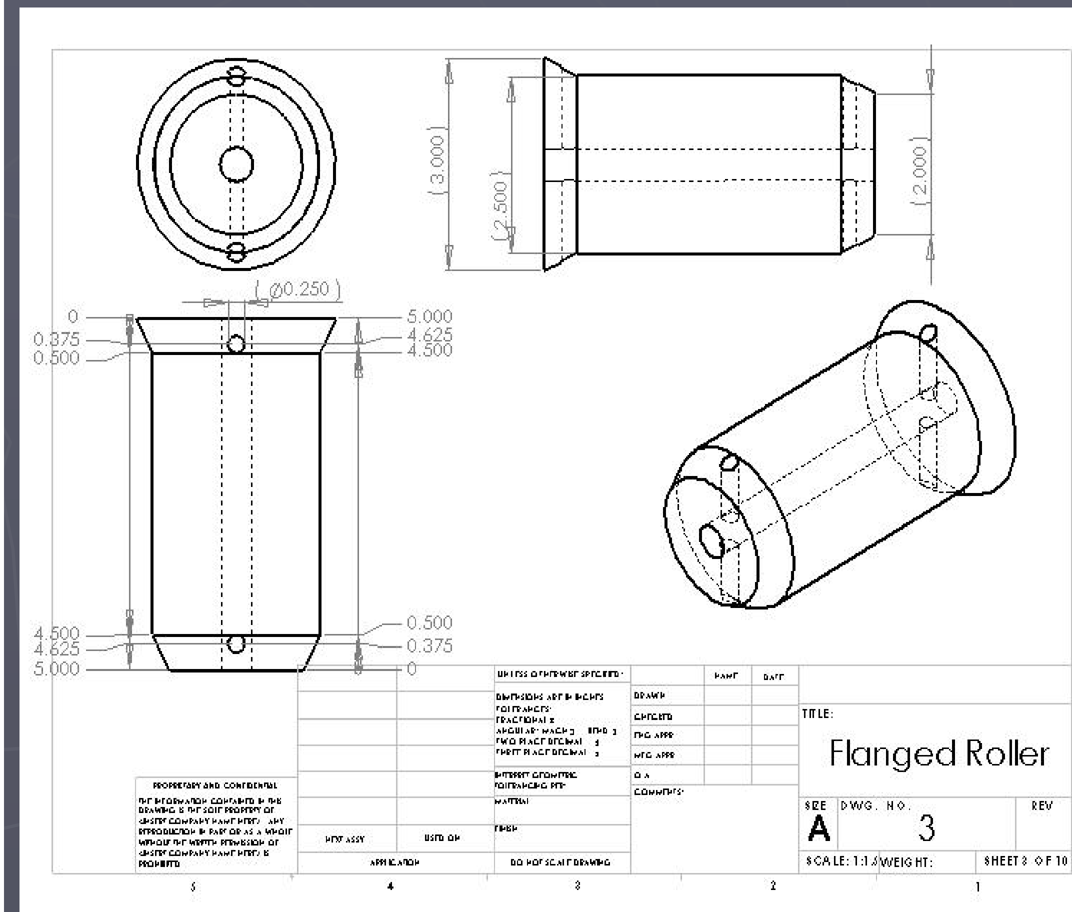
- Solar panels have been replaced by rectanna array so the payload bucket's status is currently unknown.
- Rectanna array will be attached to bottom of climber via kevlar or wood attachment.

Current Design



Current Design





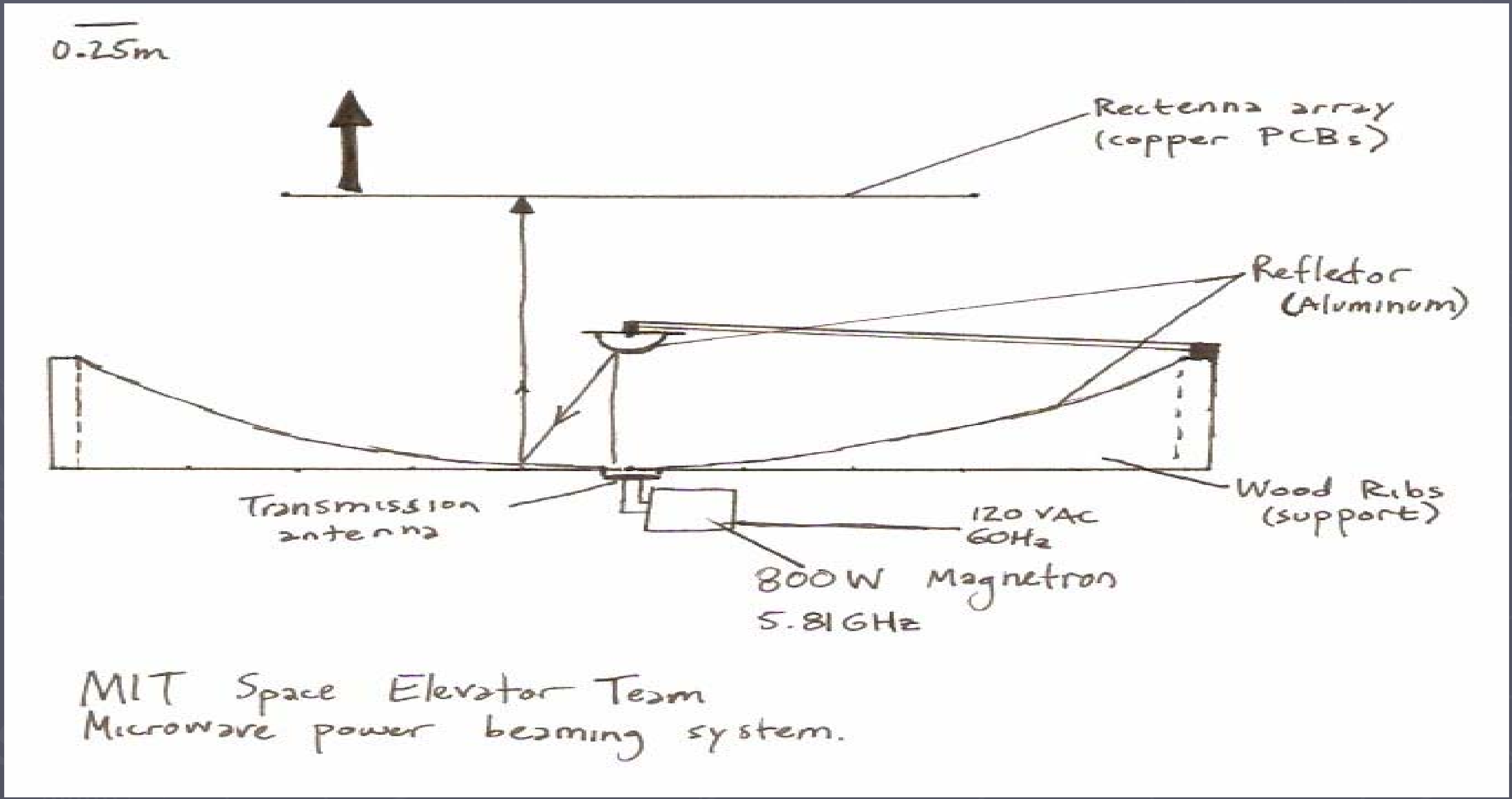
Power System

- Climber powered by beam source
- Beam source must direct most of its energy at climber
- Turn on/off at a command
- Only a quarter of the total energy can be stored

Microwave System

- Microwave
  - Efficient
  - Need magnetron, rectennas
  - Developing field
- 800 W Magnetron
  - 5.81 GHz
  - Diode Vacuum Tube-Oscillates to create microwave

Microwave System



Microwave System

- Waveguide
- Directs the extracted RF energy to the antenna
- Antenna
  - Circularly polarized
  - Helical Antenna
  - Out-of-phase microwaves

Microwave System

- Dish/Reflector
  - 14 foot satellite dish
  - Collimates beam
- Rectennas
  - Rectifiers and Antennas
  - Receives microwaves energy and converts oscillating current to DC

Control & Logic

- Controlled by Bitsy
  - Single Board Computer
  - Runs Linux
  - 802.11
  - Runs logic
- Stop/Start
- Reverse
- Speed Regulation

Power Transmission

- Design a better, more efficient transmission system.
  - Fixed Input - 750W, 5.801GHz signal via waveguide or coax
  - Fixed Output - circularly polarized microwaves at same frequency
  - Current design uses waveguides to transmit signal up to a hemispherical reflector and back to a parabolic dish, before traveling in a beam up to the rectenna array.
  - Goal - to transmit 400W of power to the rectenna array

Rectenna Design

- Current Design - based on a Texas A&M design which transmitted power on small scales (10W)
- Patch Antennas and rectifying circuitry
- Primary Goals - cheaper and more efficient (60-65%)
- Secondary Goals - Lighter and stronger (self supporting)

Control System Design

- Current control system is an analog control system supported by an onboard computer
- Requires finding many optimal parameters within the circuit.
- Many of the issues involved are pretty complicated and require us to find a delicate balance
  - Varying-voltage power supply
  - 15kF of capacitors that are restricted to 2.5V
  - Motors that can act with or against our power circuitry depending on operating levels

Gear Ratios

- Current design - Two DeWalt drill motors
  - .667 N/m of torque @ 21000 rpm
- Gear Ratio - 46.7:1
  - 1.4 N/m torque @ at rollers
- Second “Hi Speed” configuration - 10.5:1 gear ratio
- Goals - optimize combination of torque and speed supplied the rollers.

Weight Minimization

- Allowed weight - 10 to 25kg
- Current Design
  - Polycarbonate is used instead of aluminum or steel to cut mass
  - Hollowed out gears
  - Weight saving roller design
- Goal – Maximize payload to weight ratio without sacrificing performance.