SMARTSat

Shape Memory Alloy Research Technology Satellite

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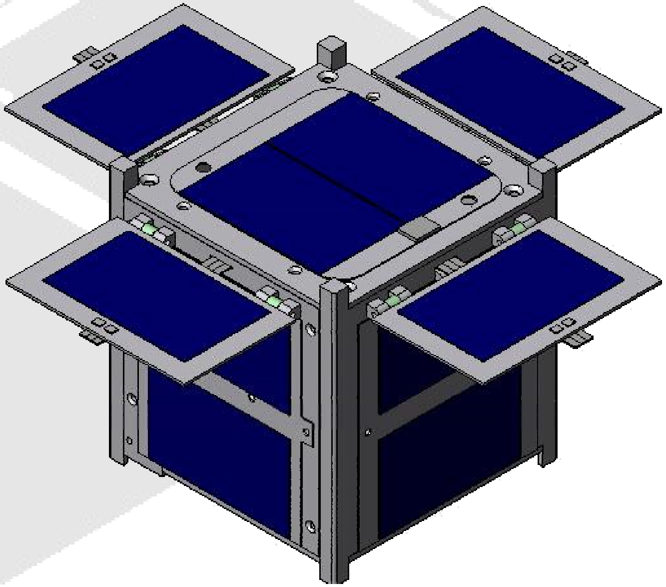
Outline

- Introduction / Mission Objectives
- Systems Overview
- Power Analysis
- Thermal Analysis
- Mass Budget
- Balloon Testing



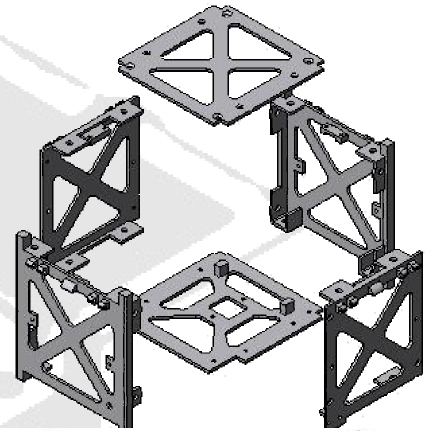
Introduction

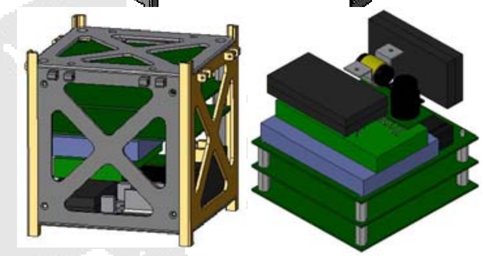
- The Space Engineering Institute program at Texas A&M's Spacecraft Technology Center is a partnership with NASA that is focused on providing an opportunity for undergraduate students to work in teams on projects directly related to the space industry.
- One team of 5 to 15 students has been designing a CubeSat for several semesters.

Mission Objectives

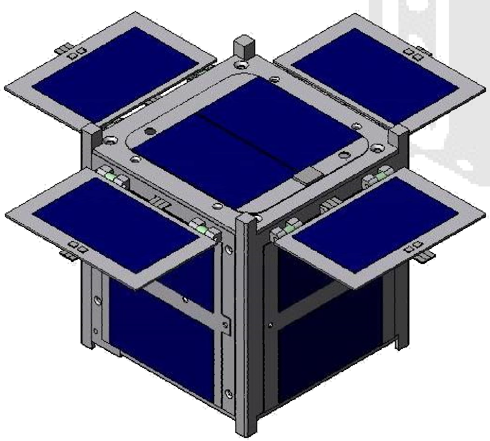
- Demonstrate the use of Shape Memory Alloys to deploy solar panels.
- Demonstrate an attitude determination algorithm using input from a magnetometer and sun sensors.
- Take and transmit pictures of Earth.

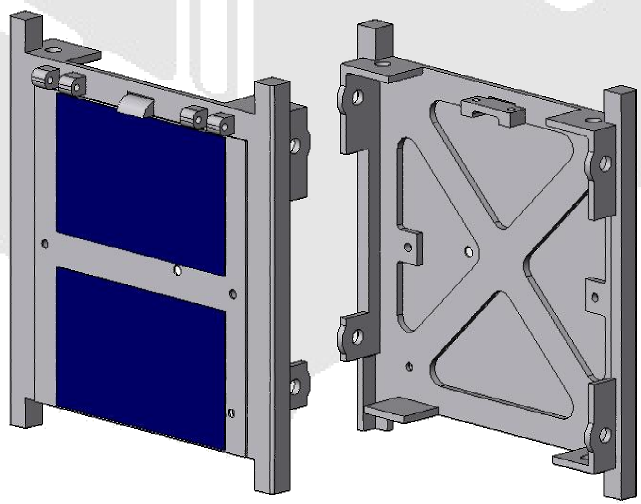
Structure

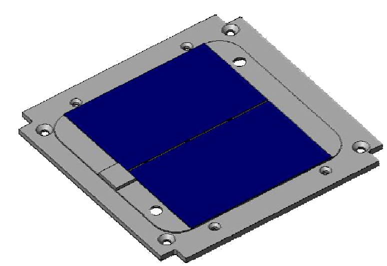




- Six panels of Aluminum 6061
  - Integrated side rails
- Cover panels on all sides
  - Ground plane for solar cells
  - Radiation shielding
- Integrated mounting brackets for components

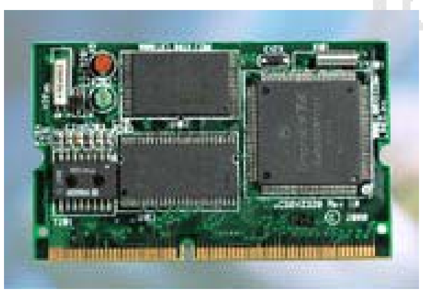






Command and Data Handling/ Communications

- Microprocessor
  - DragonBallVZ
  - Processing power for attitude determination
  - High radiation tolerance
  - Low power
- Microcontrollers for redundancy



- Radio
  - Yaesu VX-2R
  - Modified to reduce mass and space

- TNC
  - PicoPacket
  - 1200 Baud
  - Smallest complete TNC available
  - Modified to reduce power, mass, and space

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Attitude Determination and Control

Attitude Determination:

- **Magnetometer**
  - **Honeywell HMC 2003**
    - **Three-axis magnetic sensor**

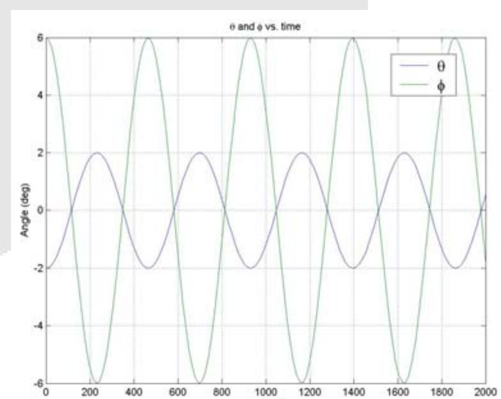
- **Sun Sensors**
  - **Hamamatsu position-sensitive detectors**

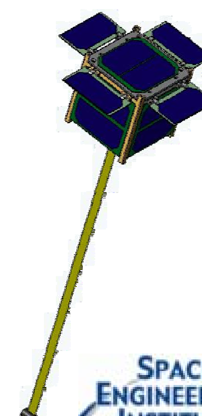
- **Kalman Filter**

Attitude Control

- **Magnetorquers (active)**

- **Gravity Gradient boom (passive)**
  - **Gravity holds the long axis perpendicular to earth's surface**





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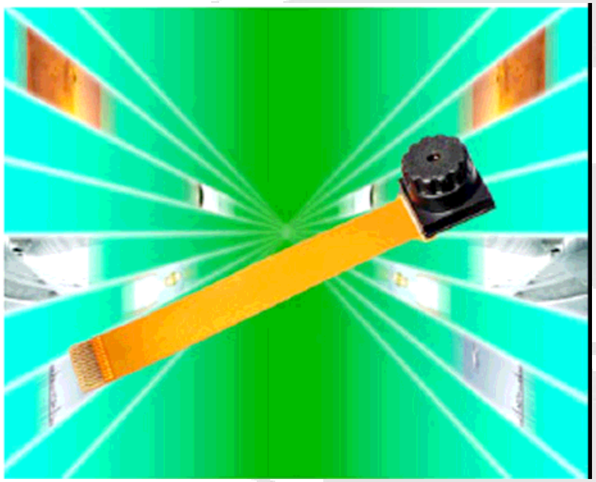
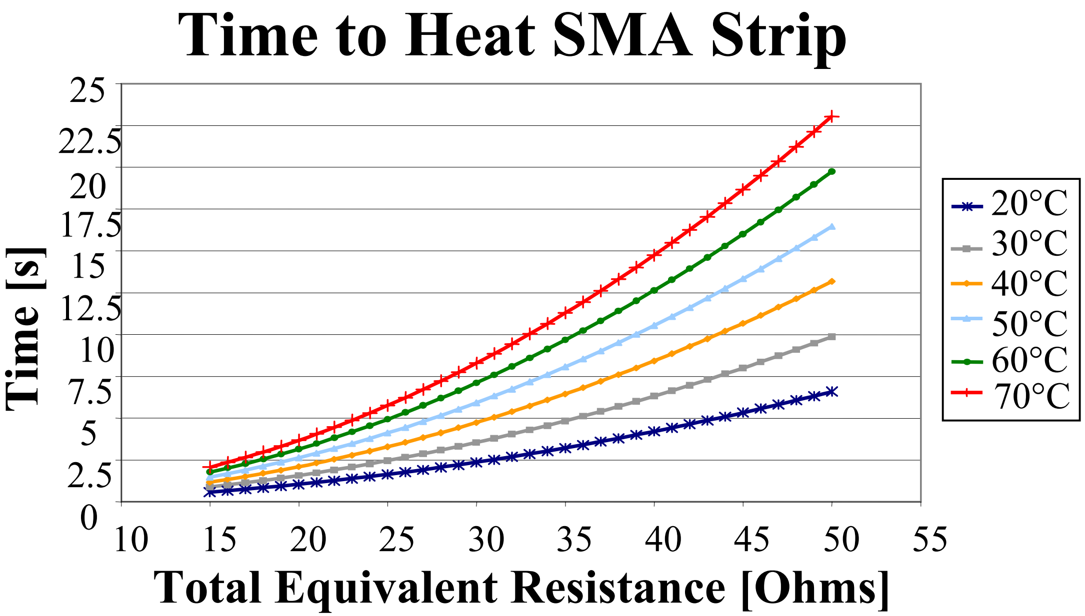
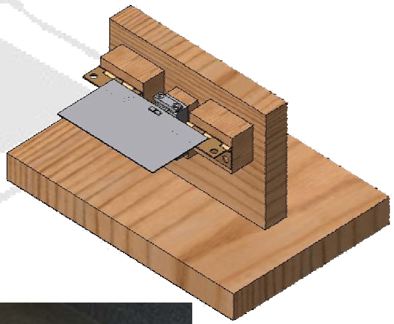
Camera

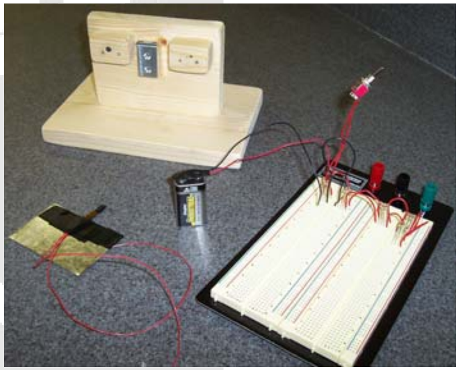


- SXGA Camera Module
  - Dialog Semiconductor
  - 1.3 Mega pixels
  - JPEG compression
  - Low power consumption

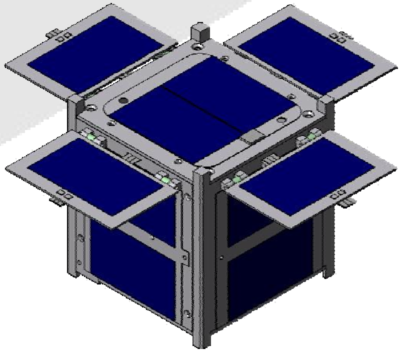
Shape Memory Alloy System







- Shape memory alloy (SMA) strips will deploy four panels each with an additional solar cell
  - Lightweight
  - Controlled deployment
  - Very simple system



ATM

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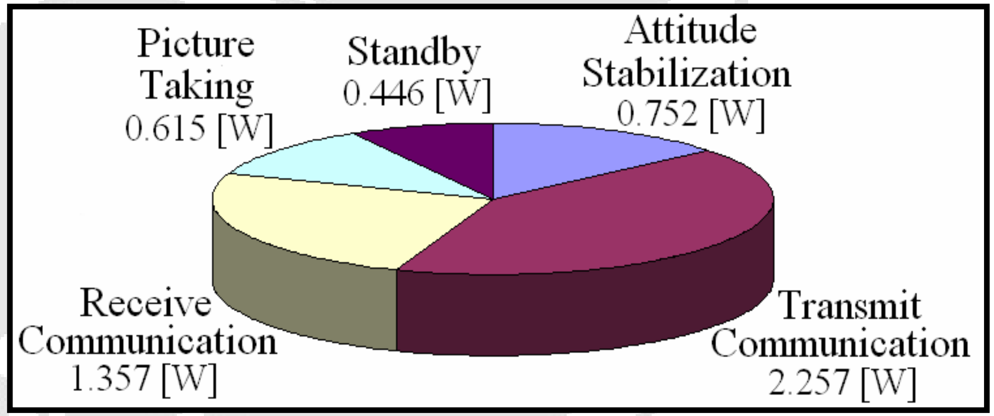
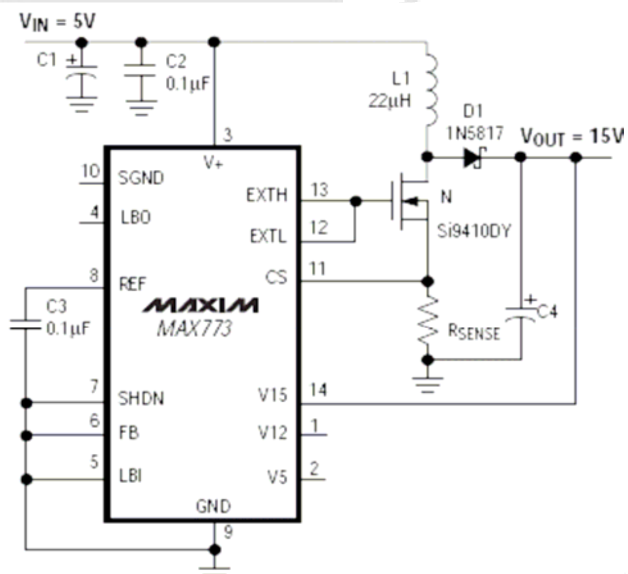
Power Subsystem

- Power Storage
  - 3.7V Lithium Ion Batteries
    - Two in series, 1950 mAh
  - MAX 1737 Charger
    - 300kHz
    - 90% Conversion Efficiency
- Power Converters
  - Buck
    - MAX 758A (+5V)
    - MAX 649 (+5V/+3.3V/+3V/adj.)
  - Boost
    - MAX 770 (+5V/adj.)
    - MAX 773 (+15V/adj.)
  - Buck/Boost
    - Max 743 (+5V/+-15V/+-12V)
- Super Capacitors
  - Capacitance: 2F
  - Voltage Rating: 5V

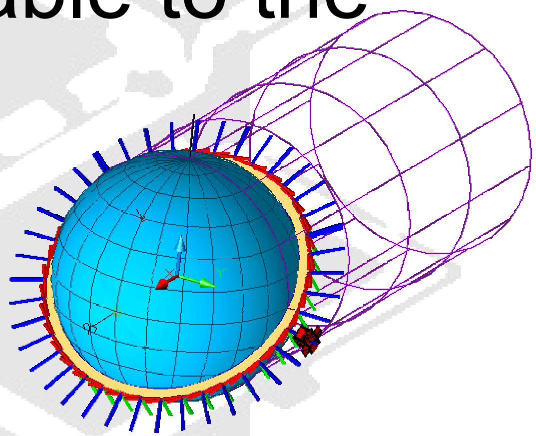
Power Modes





Power Analysis

- Used Thermal Desktop and RadCad to analyze solar power available to the satellite during its orbit.
- Satellite was simulated to remain stable on its axes during orbit, approximating the attitude control system.



- Data output provided solar energy input in W/m^2 for each cell at 39 positions during one orbit. Each TecStar solar cell has a 22% beginning of life efficiency.

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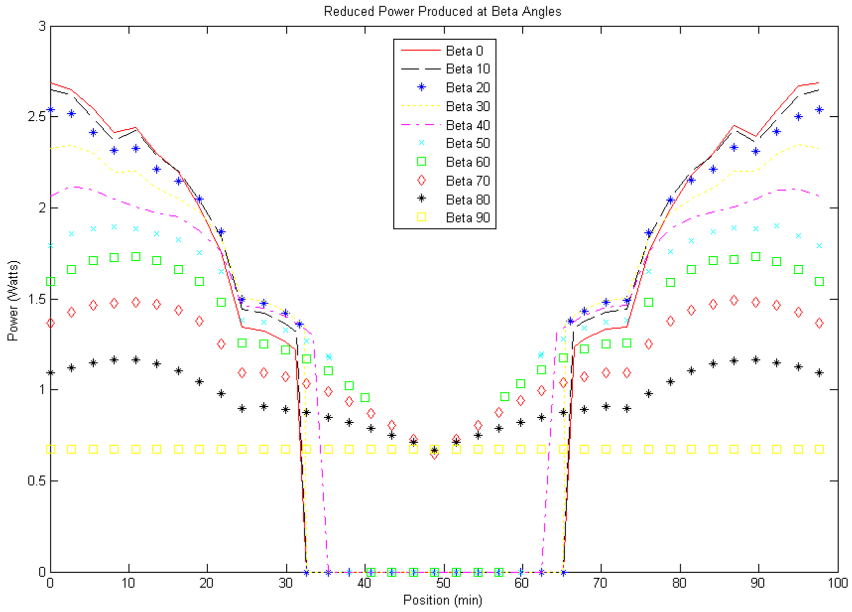
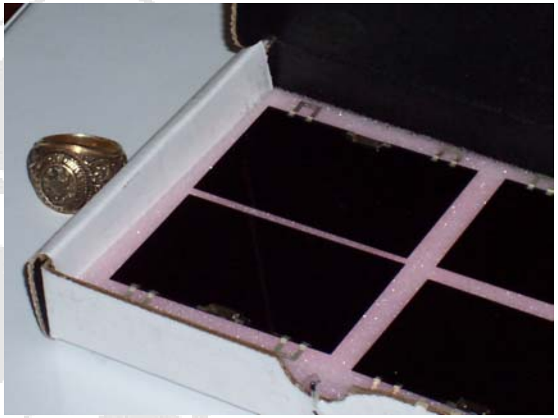
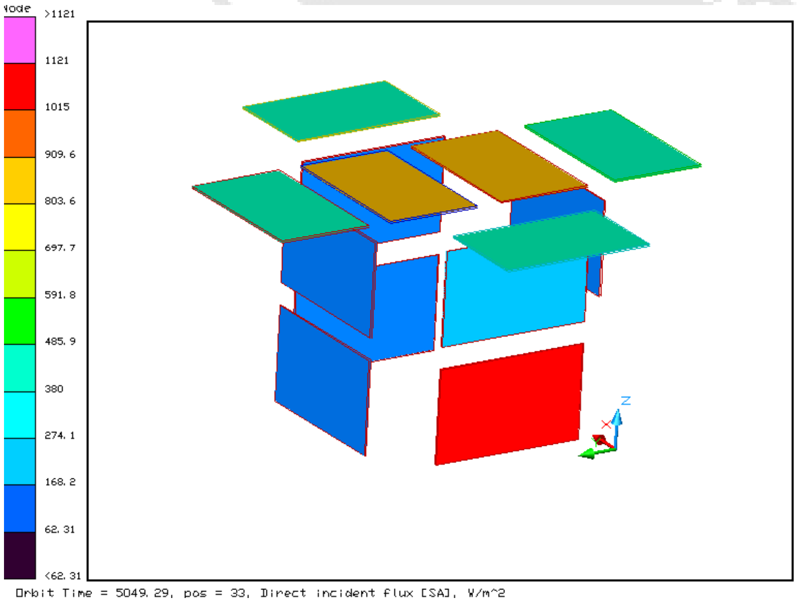
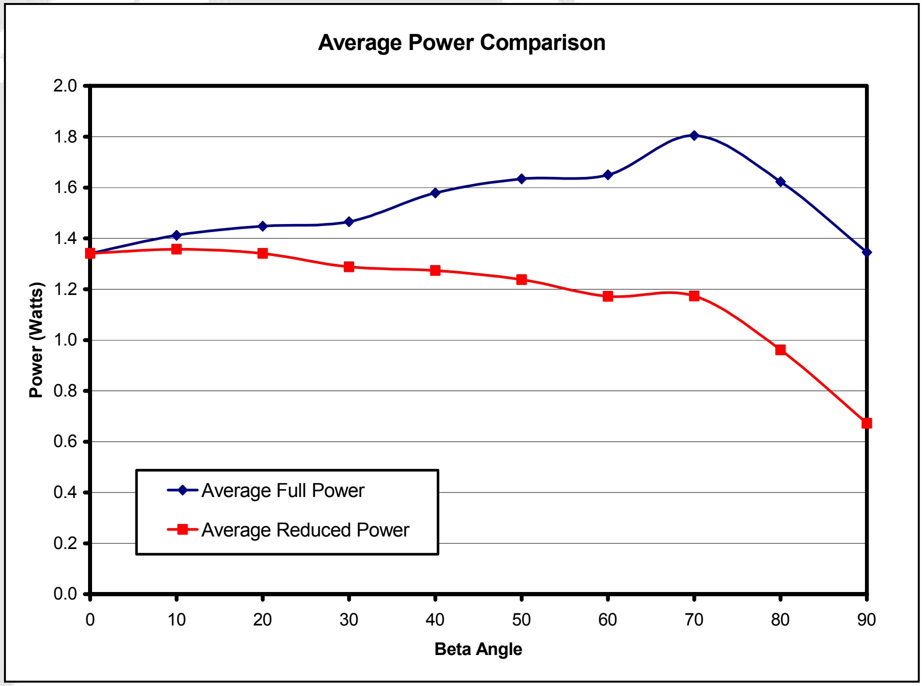

Reduced Power Produced at Beta Angles
Beta 0
Beta 10
Beta 20
Beta 30
Beta 40
Beta 50
Beta 60
Beta 70
Beta 80
Beta 90
Power (Watts)
Position (min)

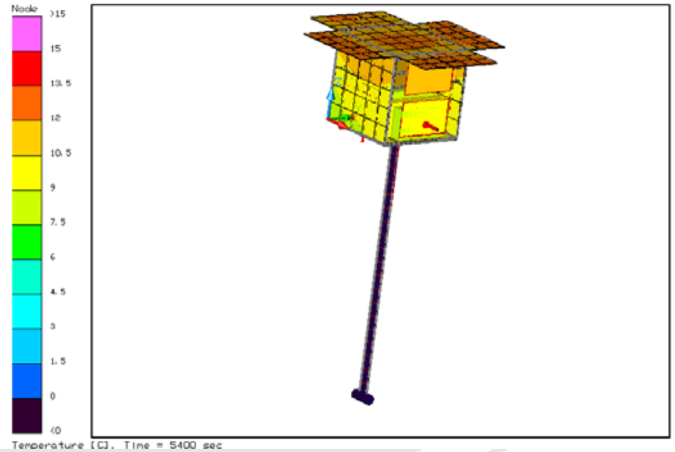


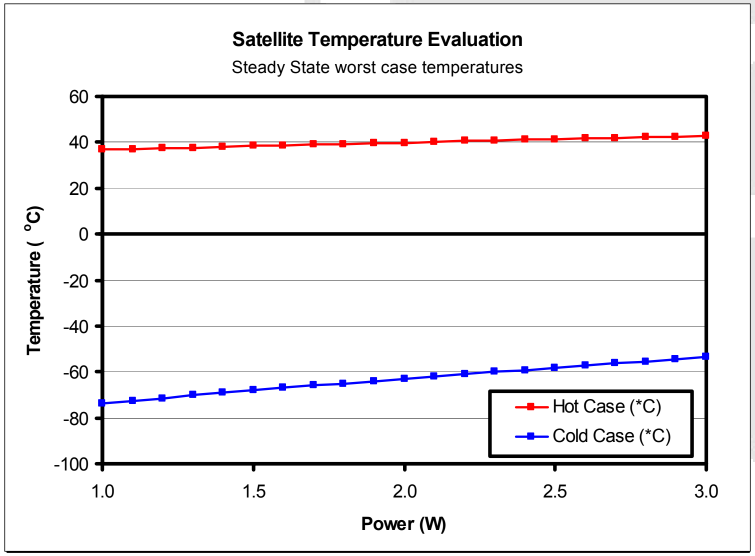

>1121
1121
1015
909.6
803.6
697.7
591.8
485.9
380
274.1
168.2
62.31
<62.31
Orbit Time = 5049.29, pos = 33, Direct incident flux [SA], W/m^2

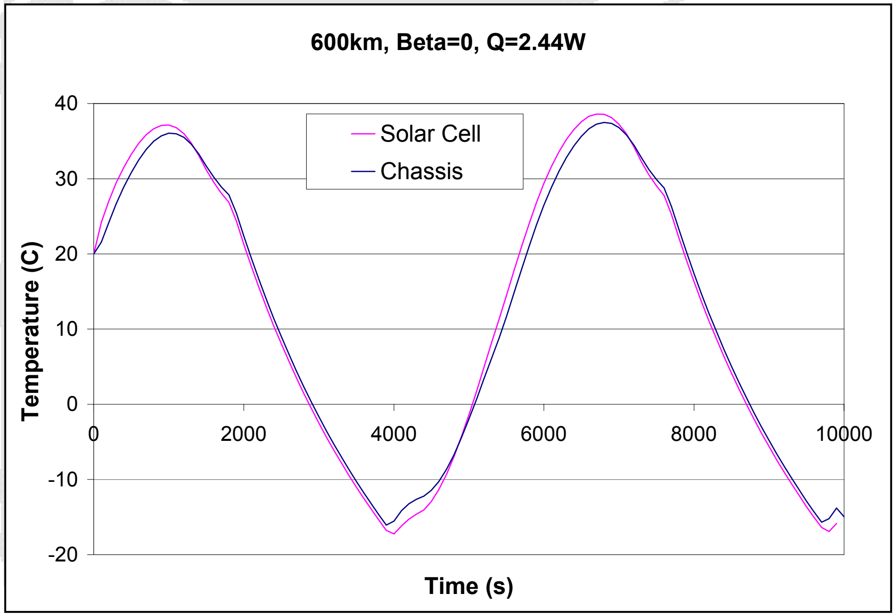

Average Power Comparison
Power (Watts)
Beta Angle
Average Full Power
Average Reduced Power

Thermal Analysis

- **Single-node analysis**
  - **sphere used in place of the satellite, with equivalent surface area**
- **Hot and cold case analyzed**
- **Thermal Desktop model being developed**

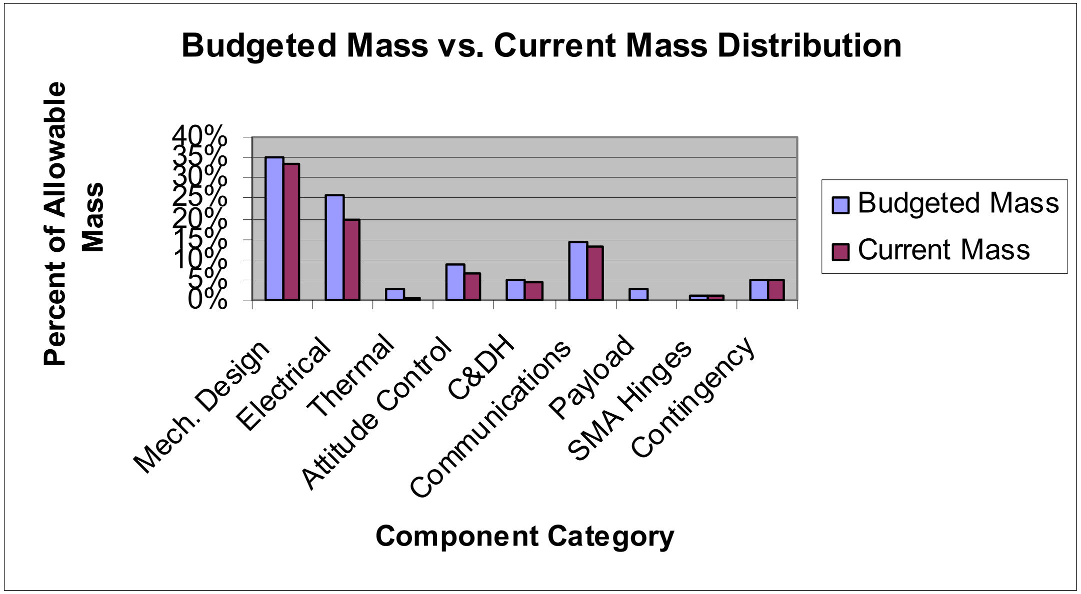






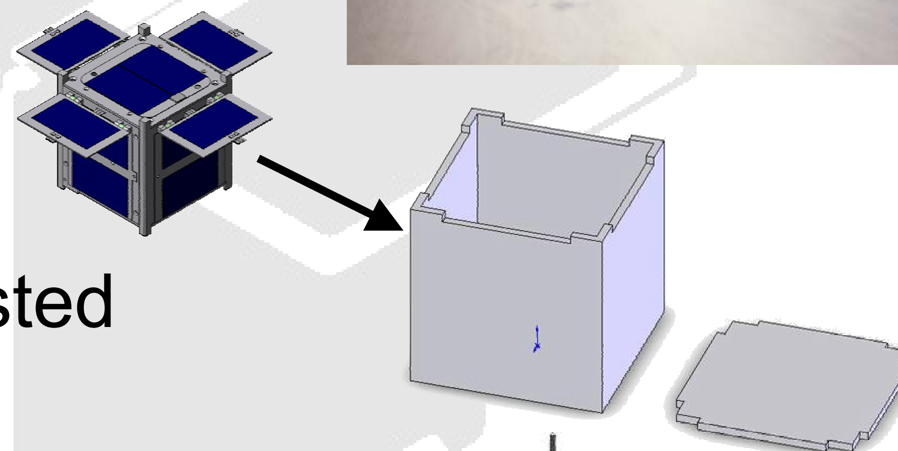
Mass Budget

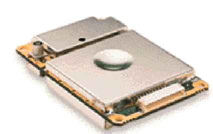
Component Category	Budgeted Mass	Current Mass
Mech. Design	35.00%	33.60%
Electrical	26.00%	19.80%
Thermal	2.50%	0.50%
Attitude Control	8.50%	6.50%
C&DH	5.00%	4.20%
Communications	14.50%	13.00%
Payload	2.50%	0.16%
SMA Hinges	1.00%	0.92%
Contingency	5.00%	5.00%



Balloon Testing

- SMARTBox is the high altitude balloon platform for testing SMARTSat components in a near space environment.
- Components and subsystems can be tested at altitudes around 100,000 feet, and recovered after testing using the tracking system.





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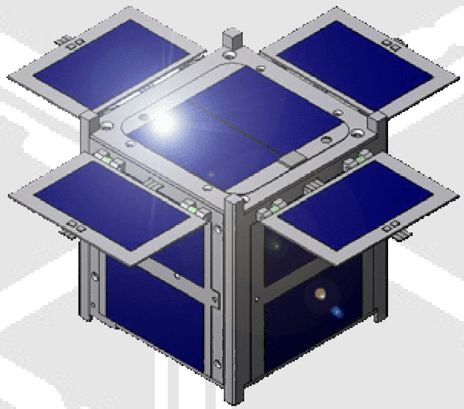
Conclusions

- Teamwork and communication is extremely important, especially with such a large team with different skill and experience levels, working on different schedules.
- Initial design phase has been completed. Subsystems are moving into the prototyping and testing stages.
- Prototypes will be tested on balloon launches beginning in the fall of 2006.



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