

BillikenSat-II

The First Bio-Fuel Cell Test Platform for Space

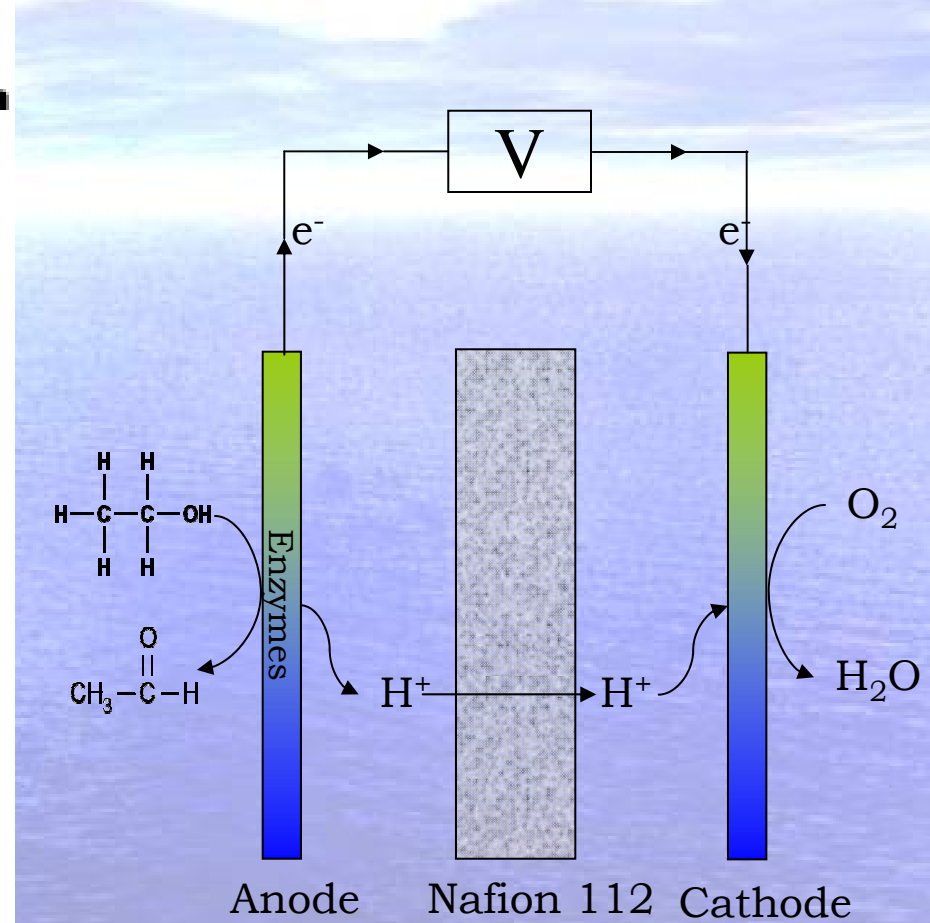
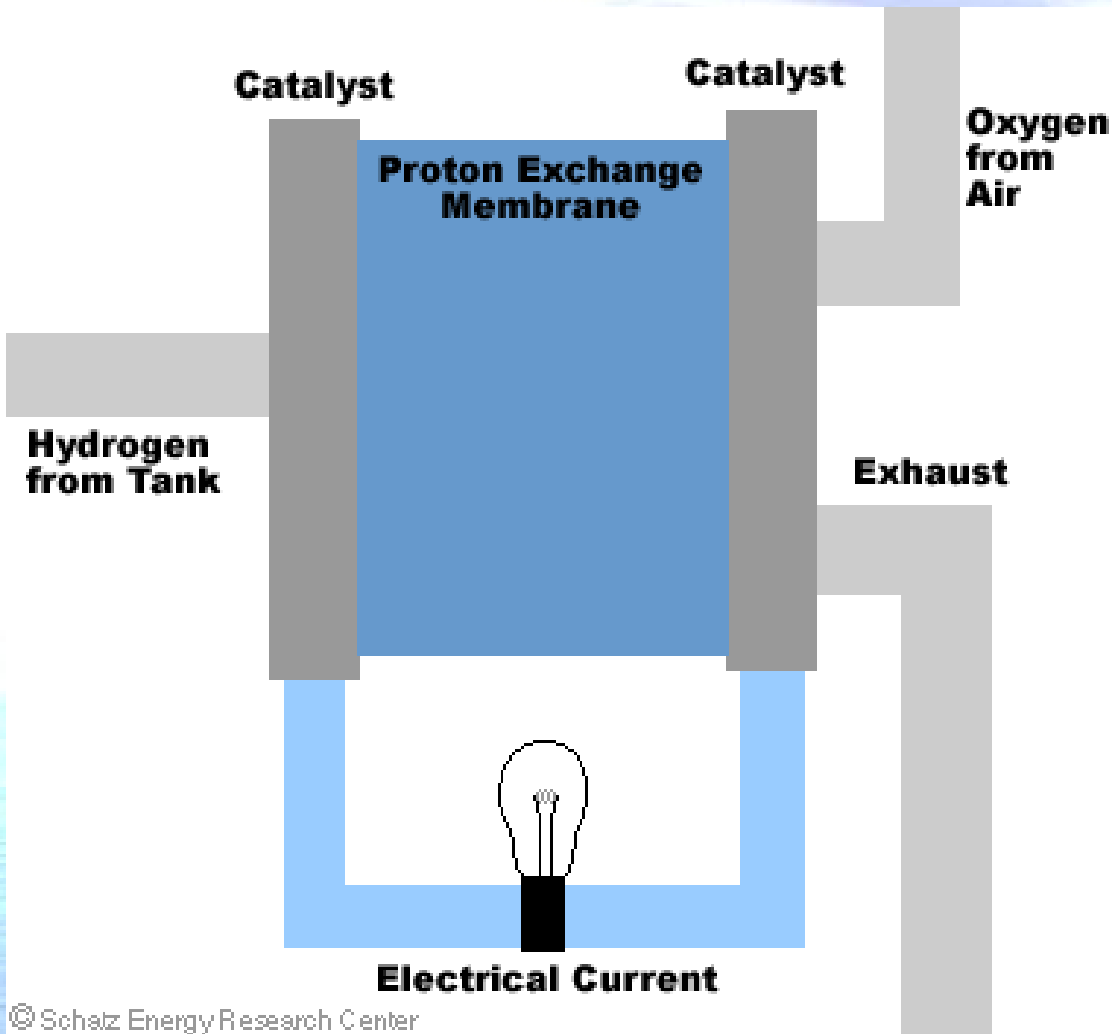
Dr. Sanjay Jayaram
Ben Corrado

SAINT LOUIS UNIVERSITY
SPACE SYSTEMS RESEARCH LAB
CUBESAT 2006-07



Presentation at the Cubesat Developers Workshop
The Boeing Company, Huntington Beach, CA
April 19, 2007

Biofuel Cell Technology

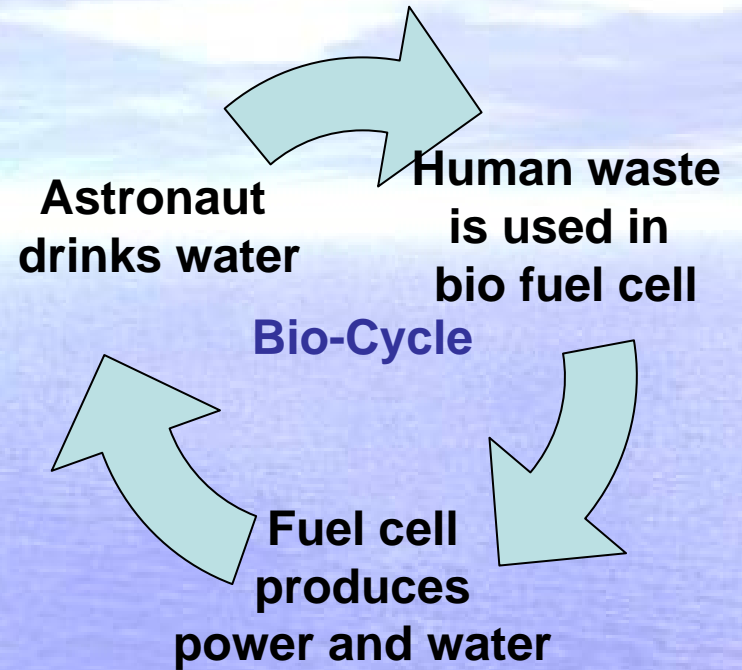
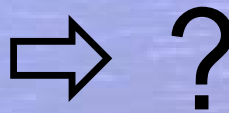
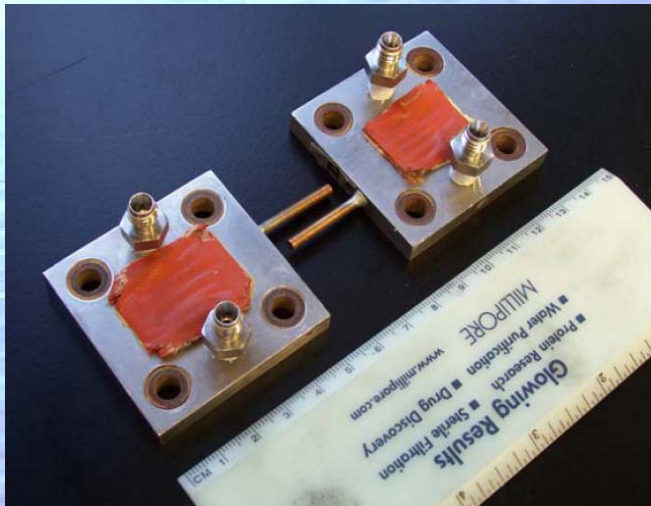


Enzyme catalyzed bio-reaction that produces power in a manner similar to a hydrogen fuel cell or an alkaline battery

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In space?



GOAL: Proof of concept

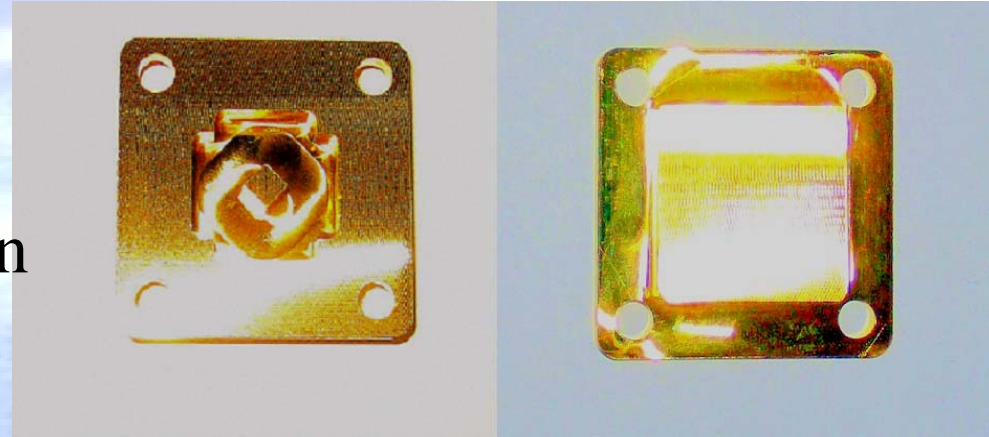
CHALLENGES:

- Sizing – Volume, mass
- Pressure Regulation
- Temperature Regulation
- Experimental Verification

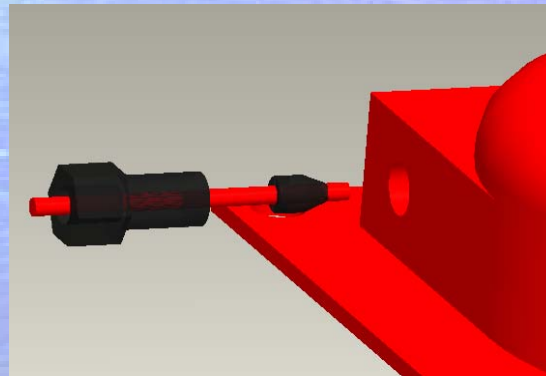
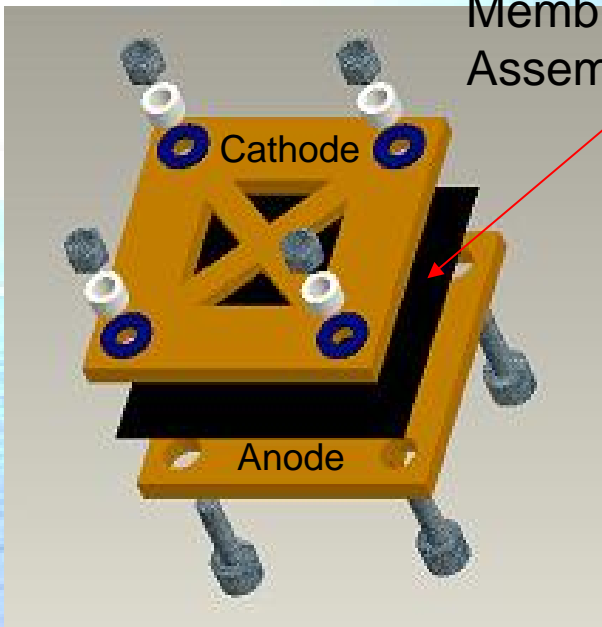


Payload

- Able to utilize variety of fuels
- **Smaller, lighter flight version**
- Large fuel reservoir, resists corrosion
- Good conduction between plates:
Gold plating, 4 bolts

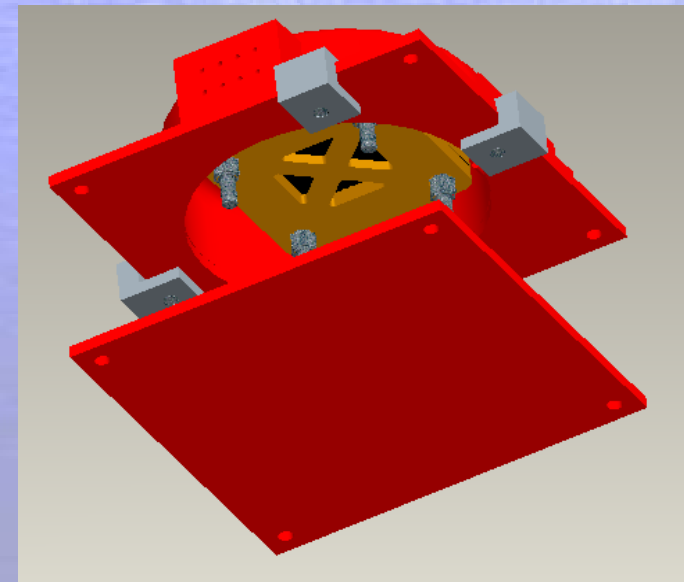


Membrane Electrode
Assembly (MEA)



Air Tight Fill Port

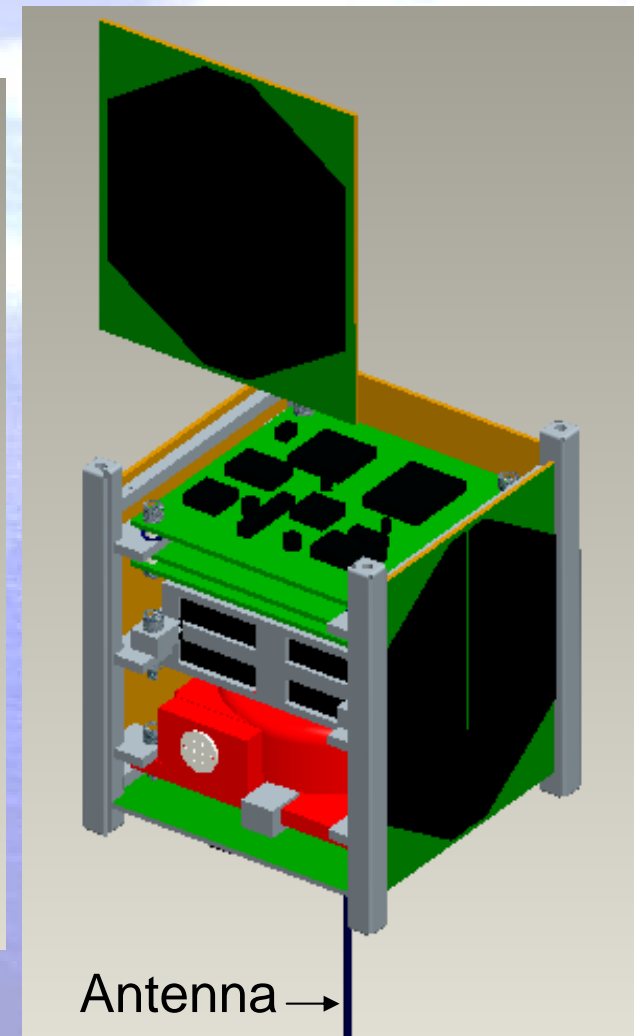
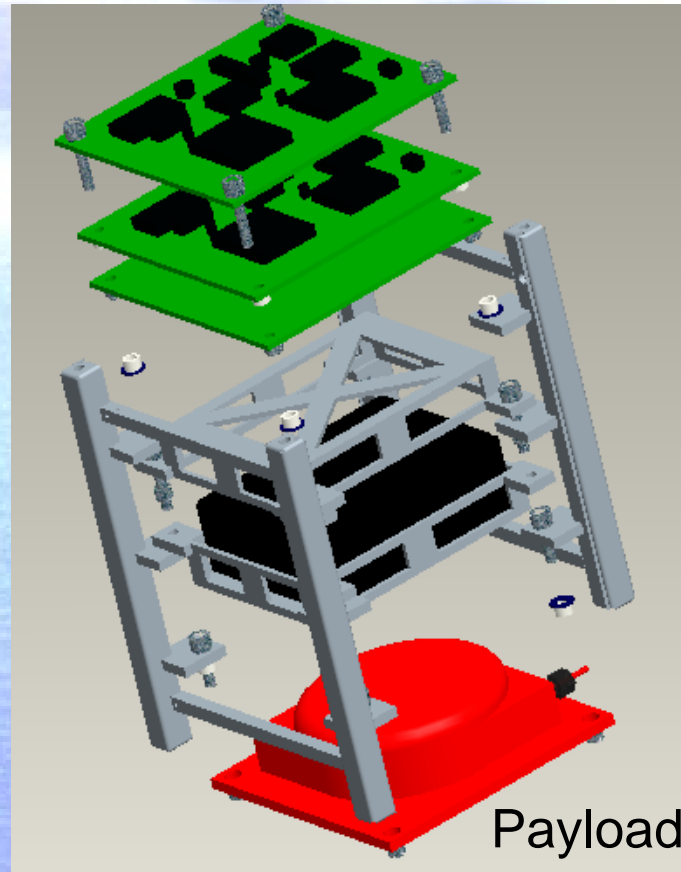
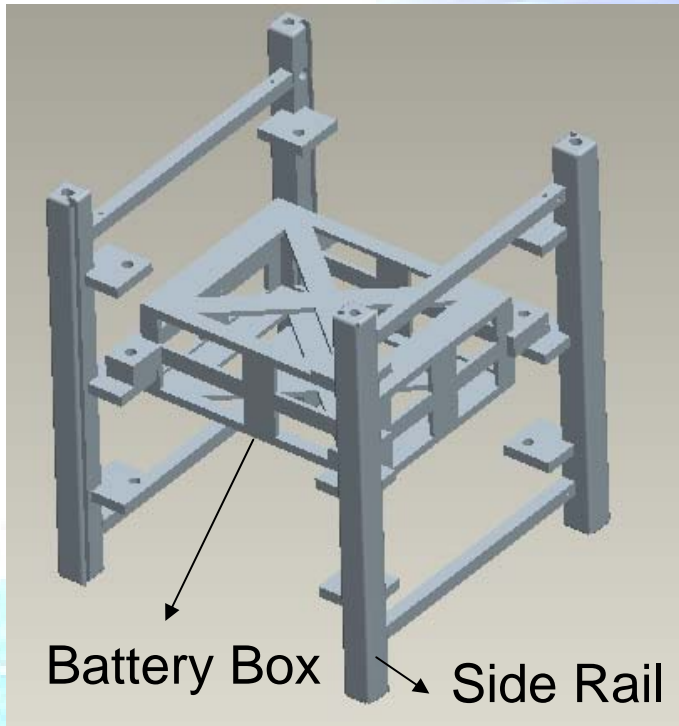
Finished Anode



Pressurized Chamber



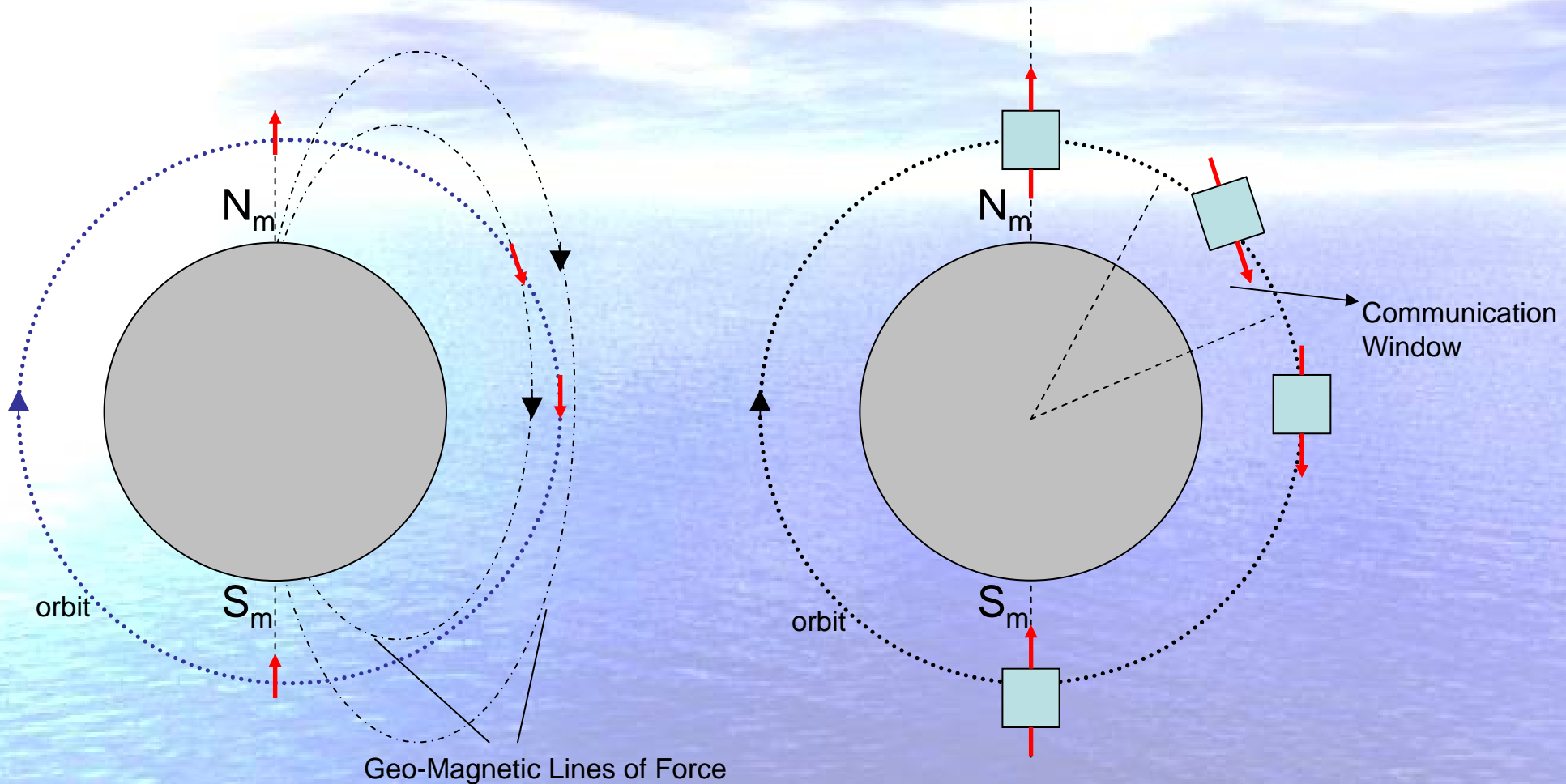
Structure



- **Common fasteners** used throughout
- Component **positions interchangeable**



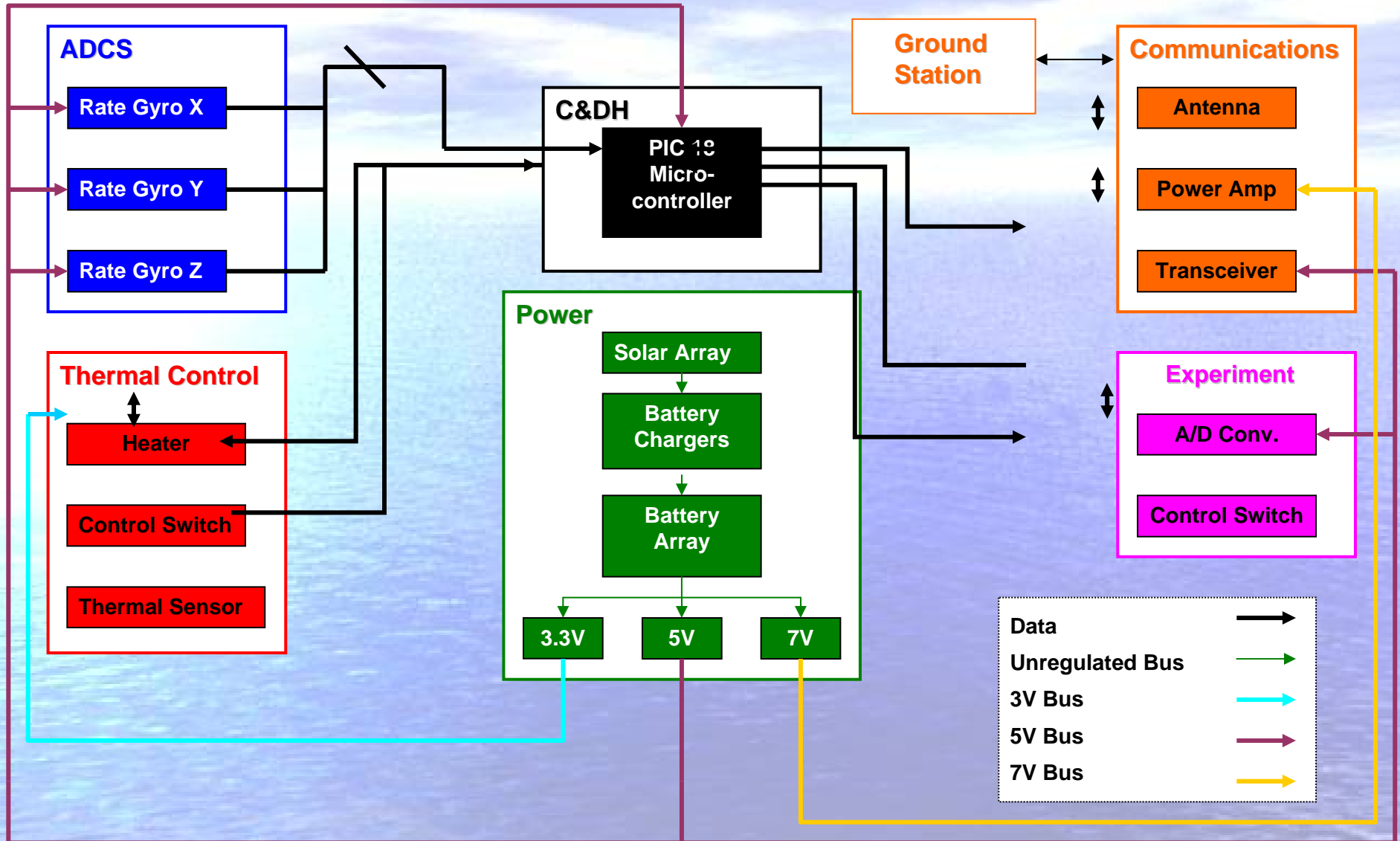
Attitude Control



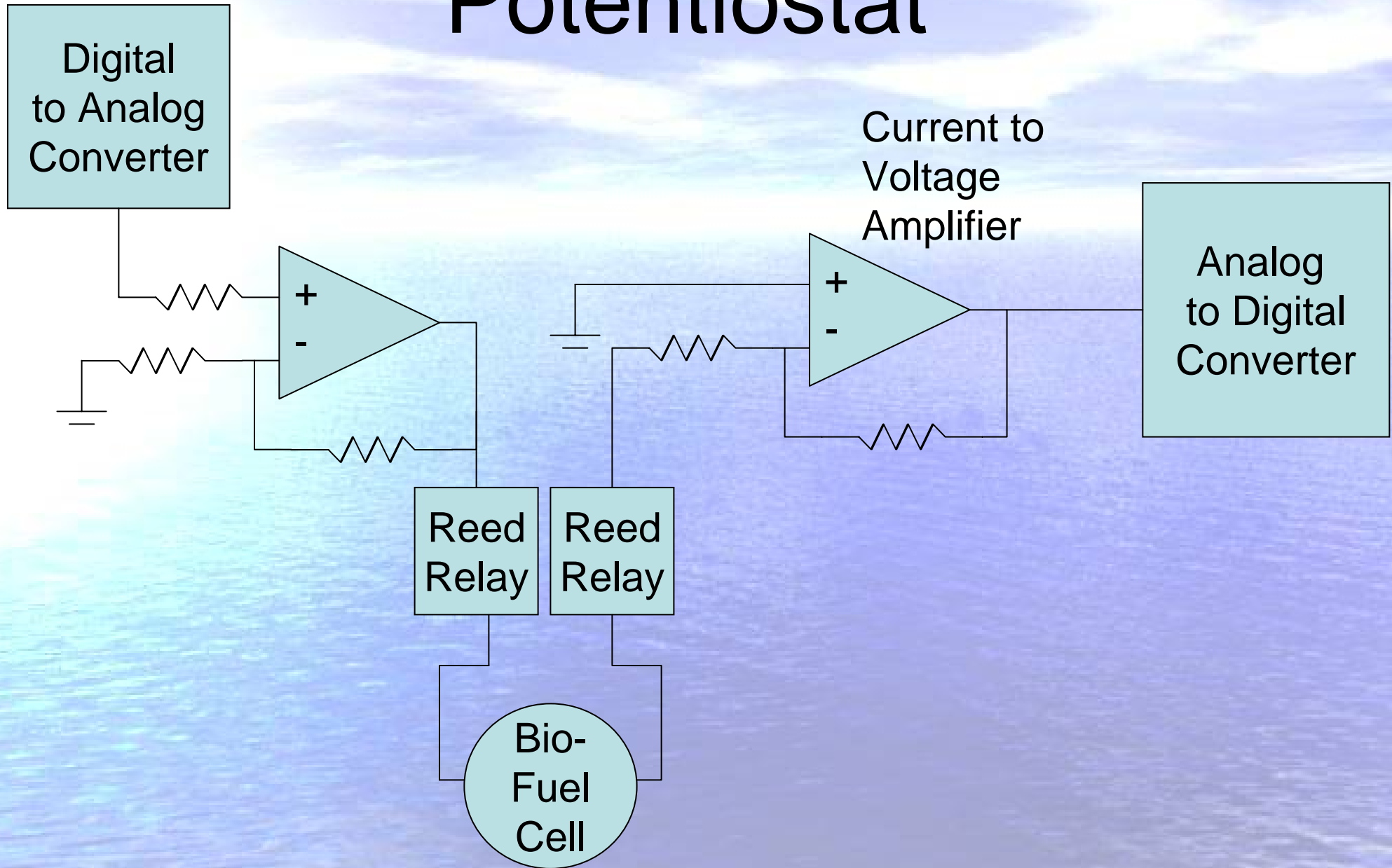
Passive Control using Permanent Magnets and Hysteresis Dampers



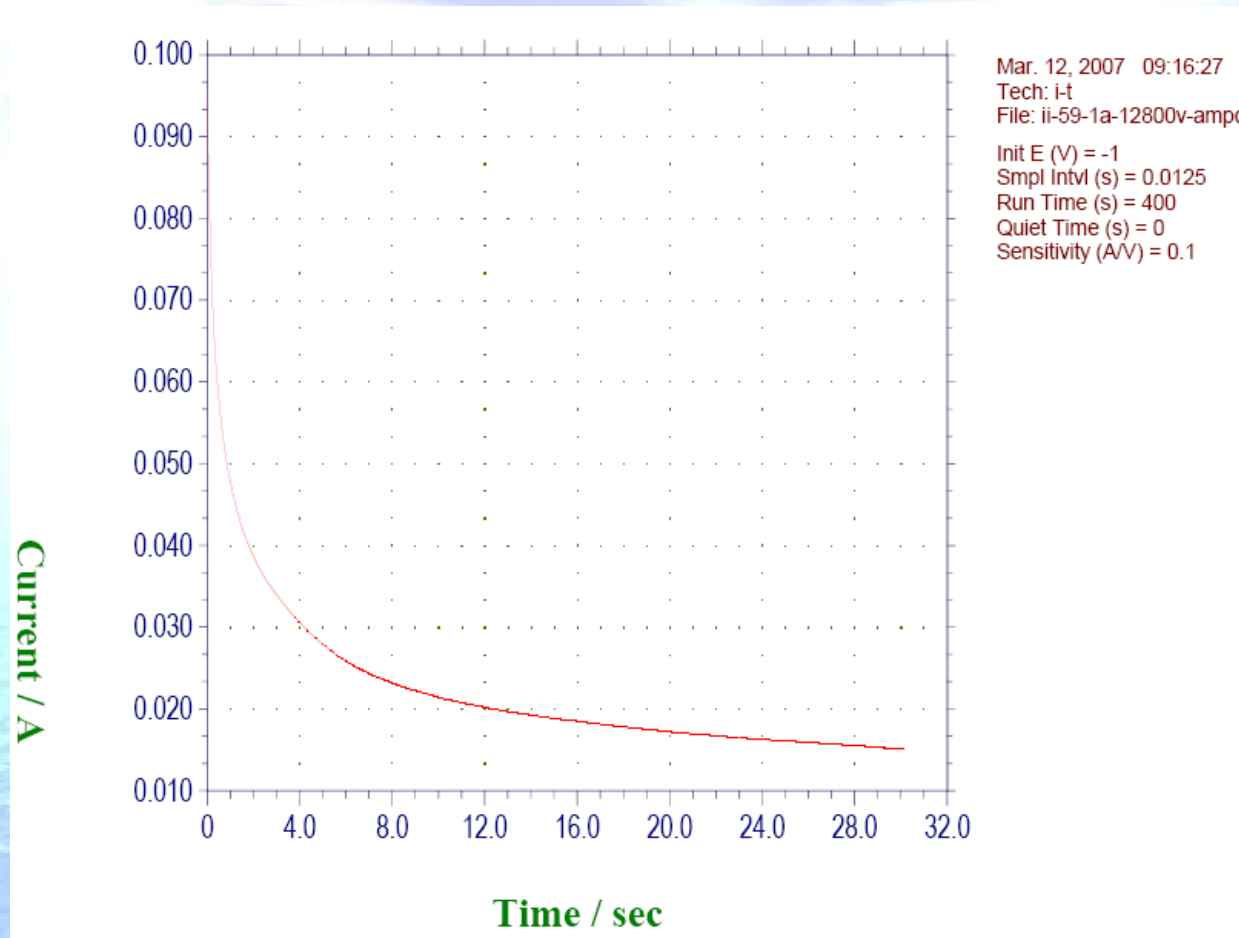
Electronic Interfaces



Potentiostat



Fuel Cell Output



BillikenSat-II: 20 mW

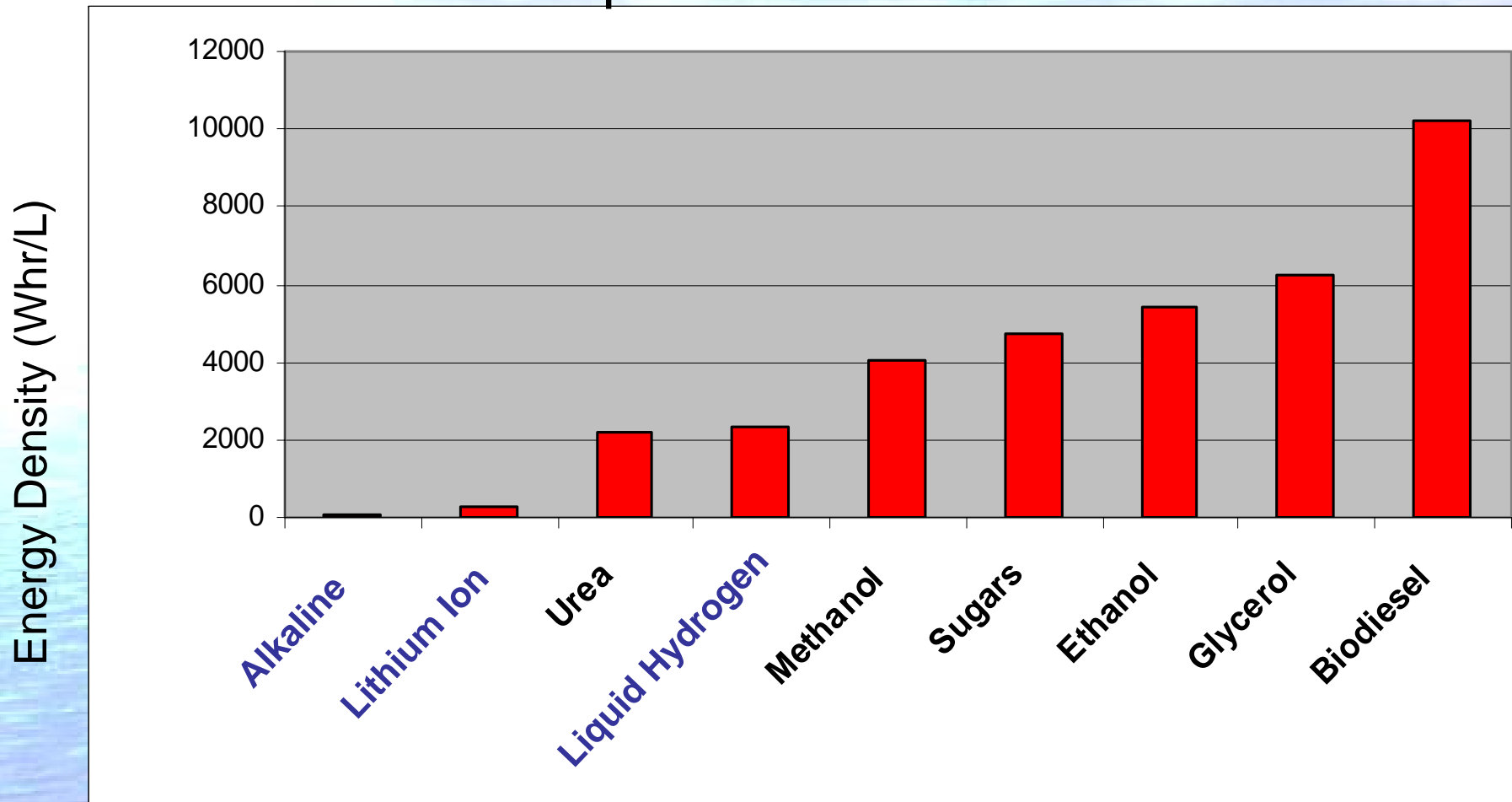
Comparison: A cell phone on average draws 200 mW

With flow: 20 mW/cm² is possible ⇒ Cell the size of a small book can power a laptop

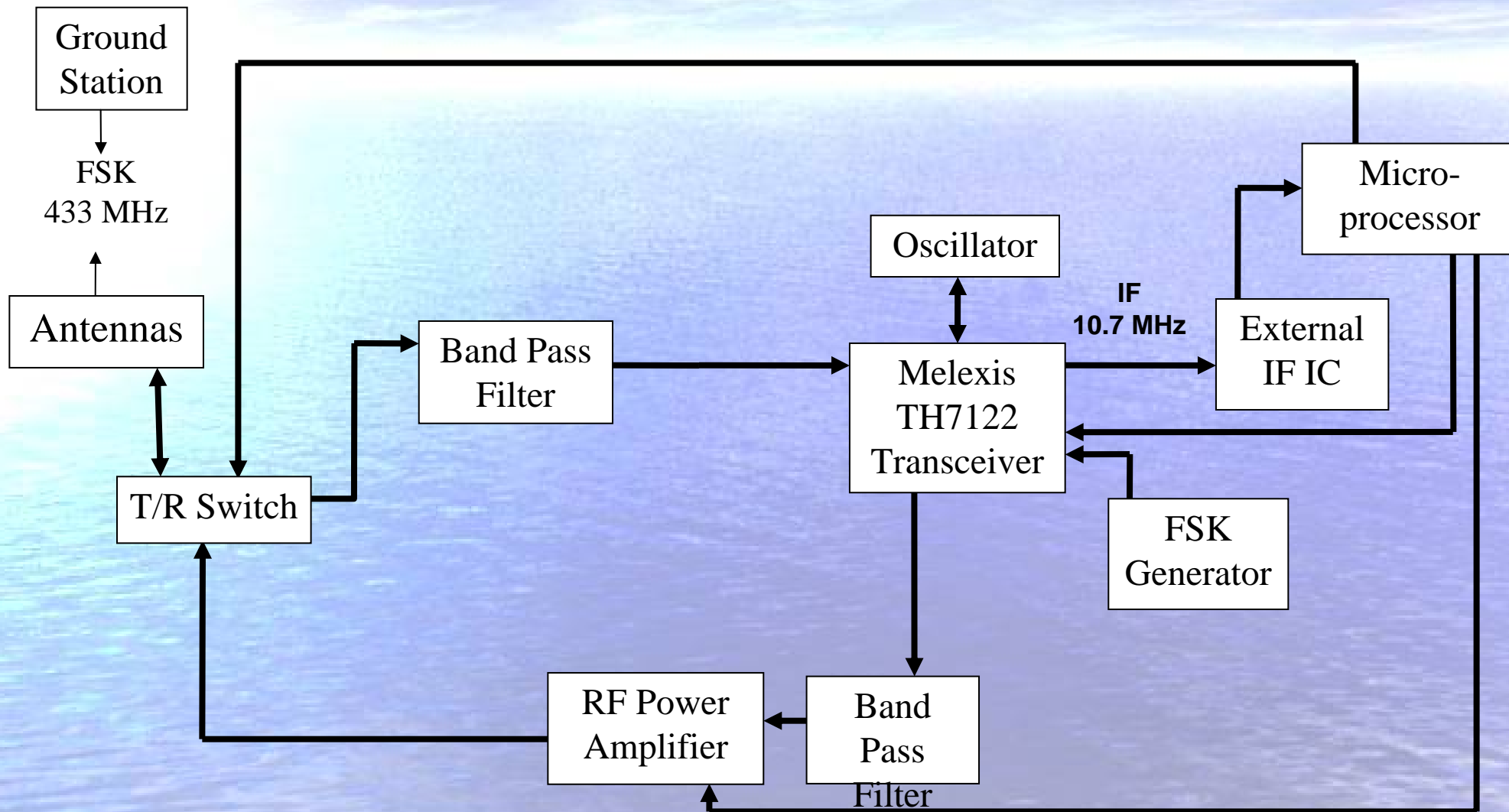


Fuel Versatility

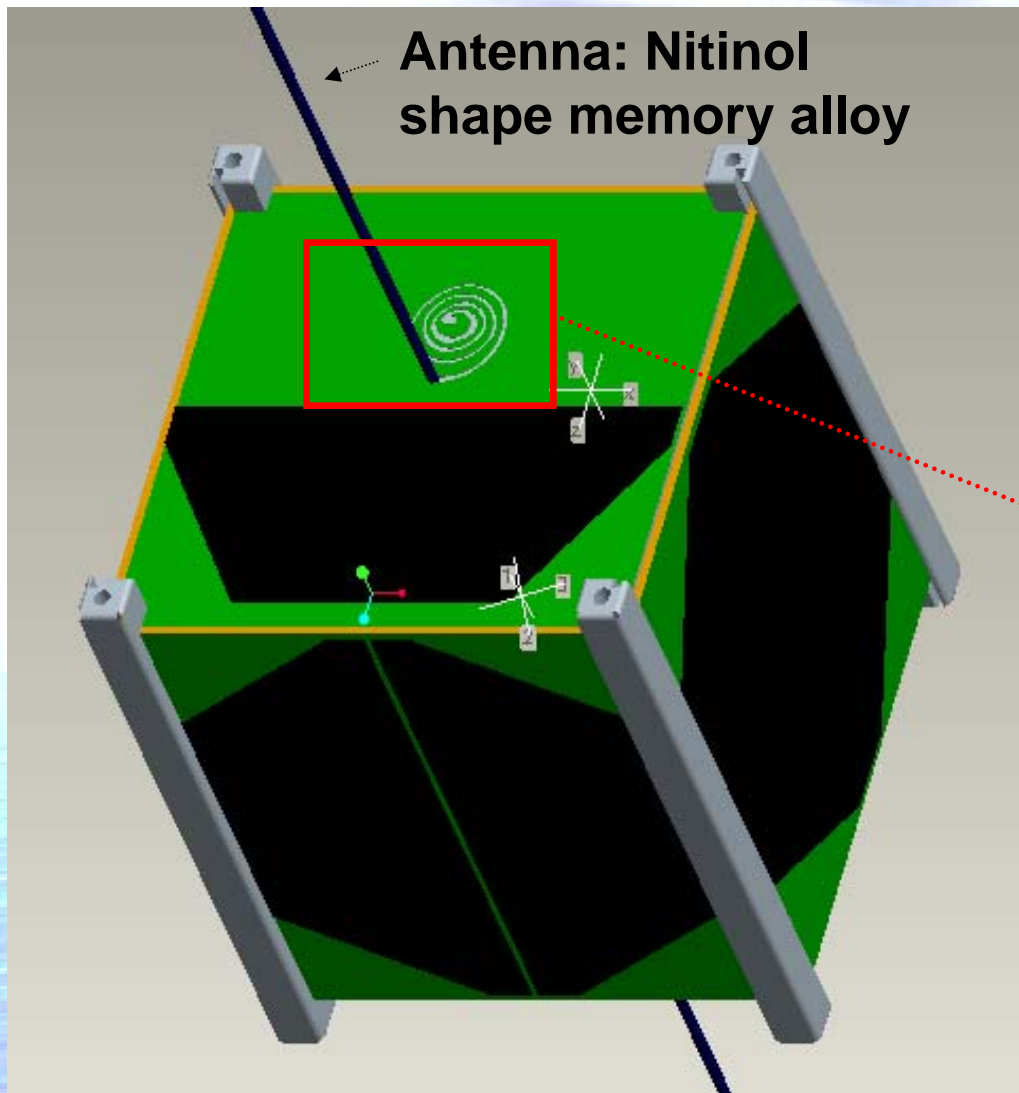
Components of Bio-Fuels



Communications

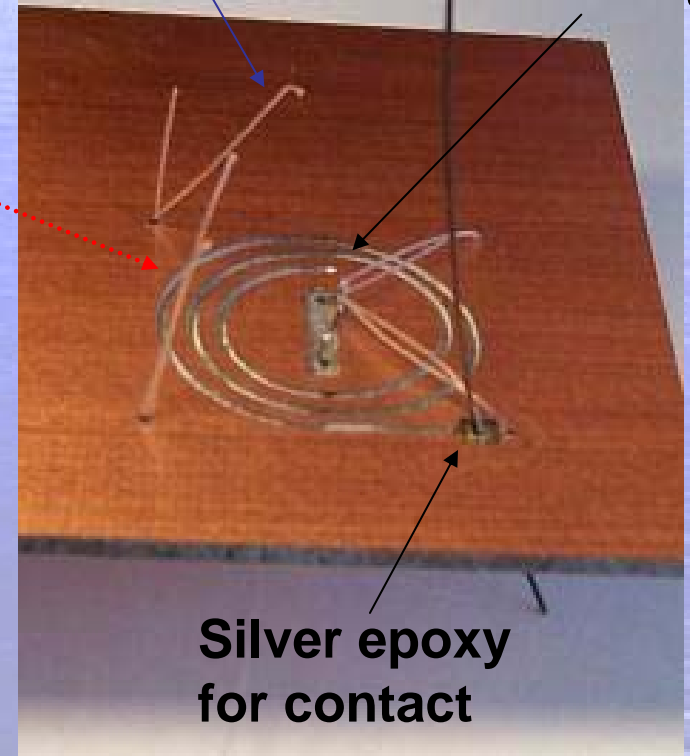


Antenna



Nylon & Nichrome for deployment

Spiral etching



Facilities

1. Ground Station



- **Software:** NOVA

- **Antenna:**

Model 436CP42 U/G Yagi

Beam-width 21° circular

2. Clean Room

- Vertical Flow
- Soft Wall



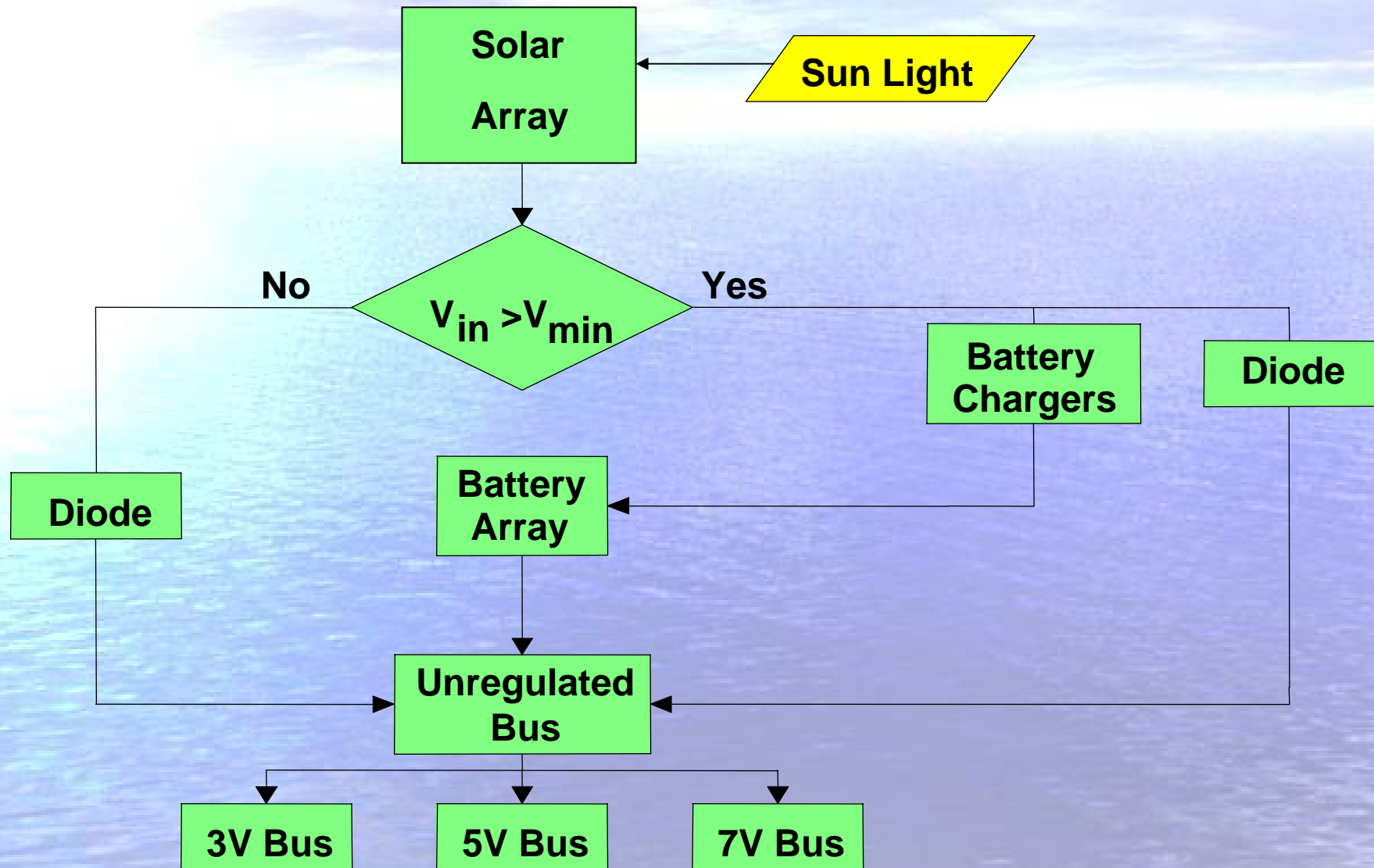
Students Involved

- **AEROSPACE SENIORS:**
 - Nathaniel Clark
 - Sonia Hernandez
 - Paul Lemon
 - Darren Pais
- **ELECTRICAL SENIORS:**
 - Thamer Bahassan
 - Mac Mills
 - Brian M. Vitale
- **COMPUTER ENGINEERING SENIORS:**
 - Justin Kerber
 - Jorge Moya
 - Elena Nogales
- **DEPT. OF CHEMISTRY GRADUATE STUDENT (PAYLOAD):**
 - Robert L Arechederra
- **JUNIORS:**
 - Ben Corrado (EE)
 - Yusshy Mendoza (ME)
- **SOPHOMORES & FRESHMEN:**
 - Rehan Refai (ME/AE)
 - Daniel Rooney (AE)
 - Nicholas Reder (AE)
 - Brandon Smith (AE)
 - Morgan Quinley (AE)
 - John Woodman (AE)

Questions?

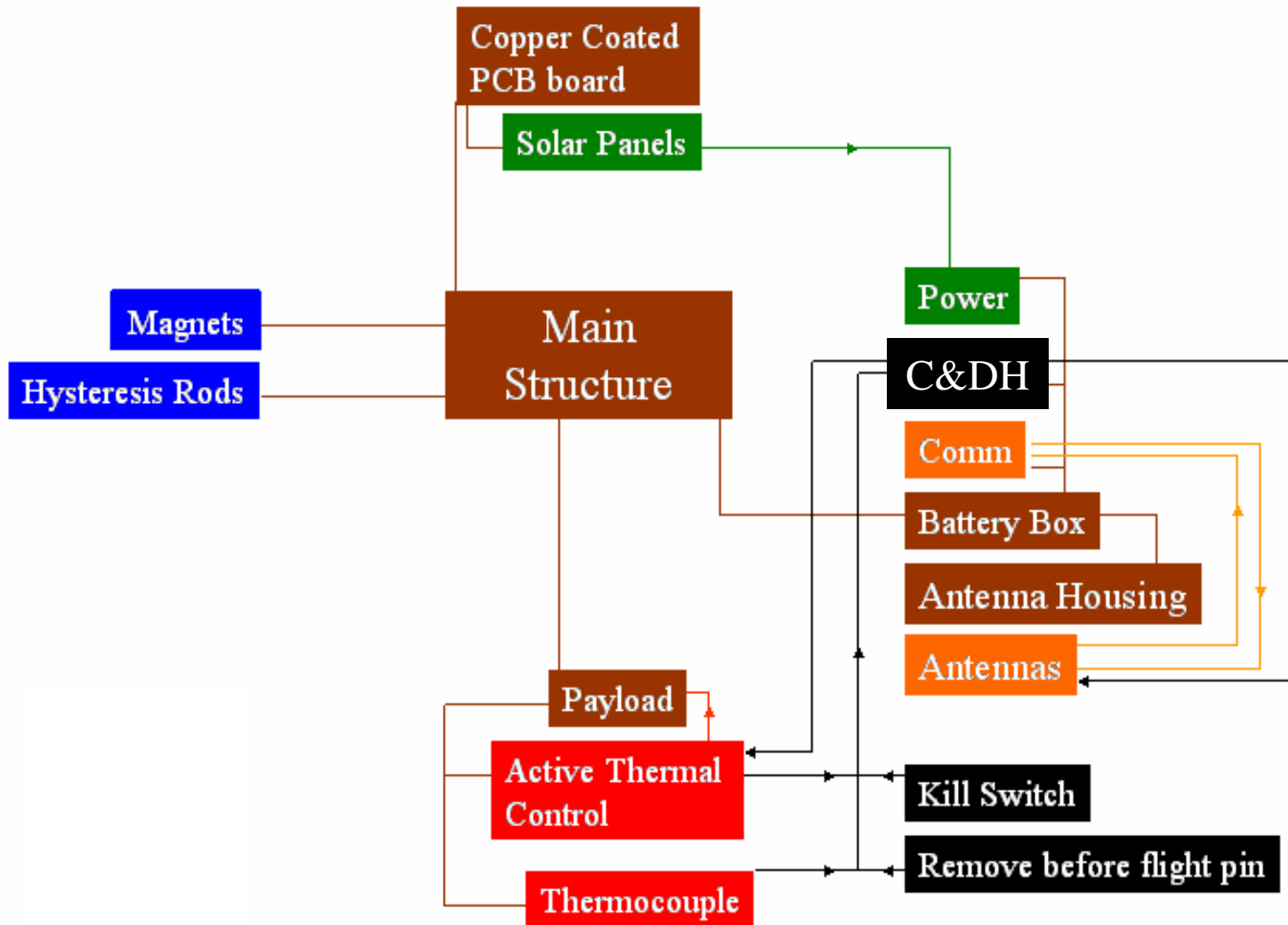



Power



System Interfaces

Legend



 Structures

 ADCS

 Power

 Comm.

 C&DH

 Thermal

Electrical Engineers: 3

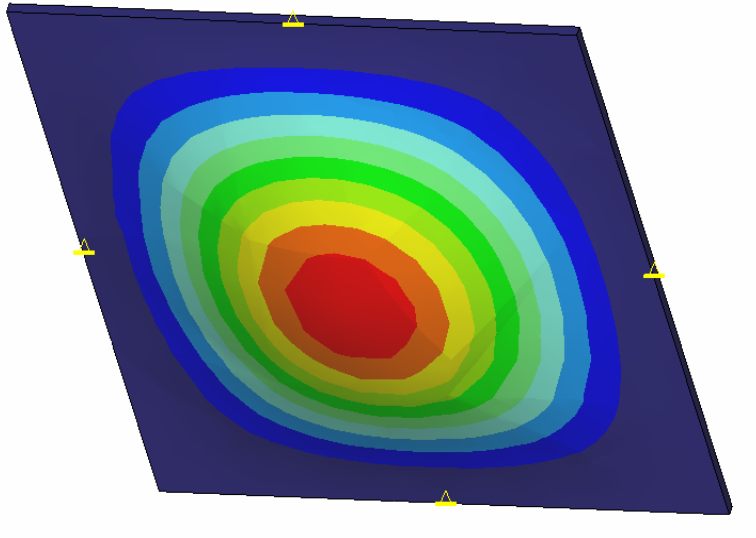
Computer Engineers: 2

Aerospace Engineers: 4

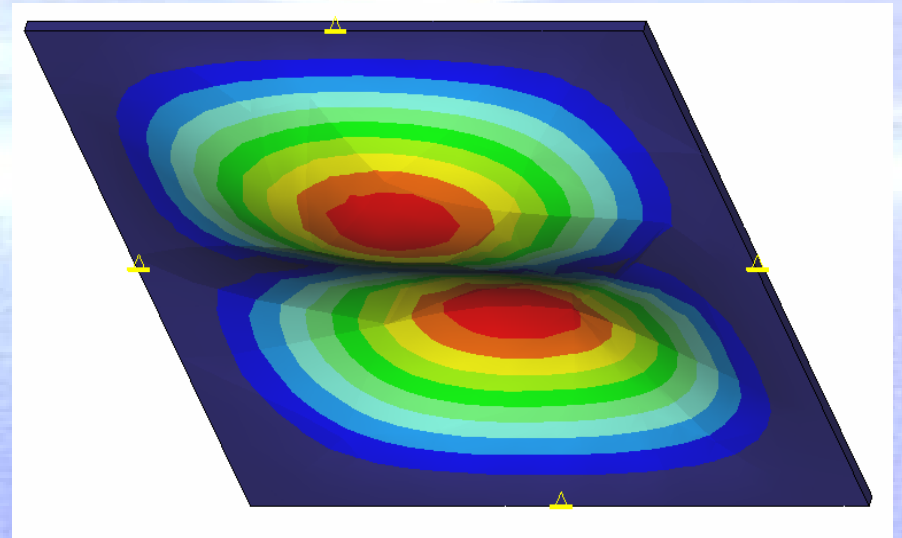
Chemistry: 1



Vibrations



Mode 1 Shape



Mode 2 Shape

- First natural frequency falls within range of frequencies expected on launch
- Deflections are 0.00116 mm

