FASTRAC

The University of Texas Nanosatellite Program

The FASTRAC Satellites

Sebastián Muñoz

7th Annual CubeSat Developer's Workshop

Cal Poly San Luis Obispo

April 23, 2010

AGENDA

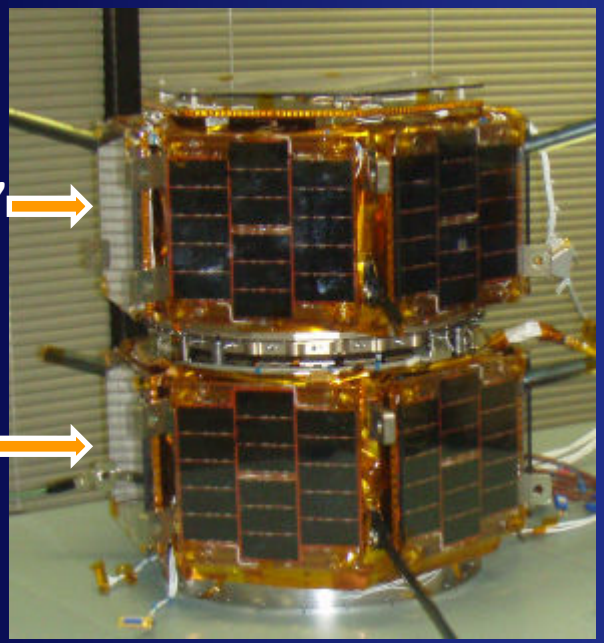
- The FASTRAC Project
- Program Status
- Mission Overview
- Mission Objectives
- Mission Highlights
- Concept of Operations
- FASTRAC Website & User Community
- UT Austin Ground Station

The FASTRAC Project

Formation
Autonomy
Spacecraft with
Thrust,
RelNav,
Attitude, and
Crosslink

FASTRAC 1 "Sara Lily"

FASTRAC 2 "Emma"

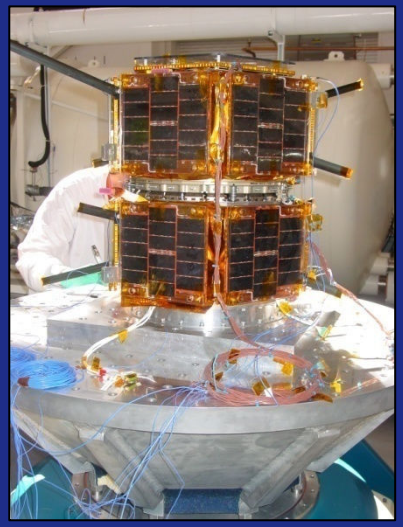


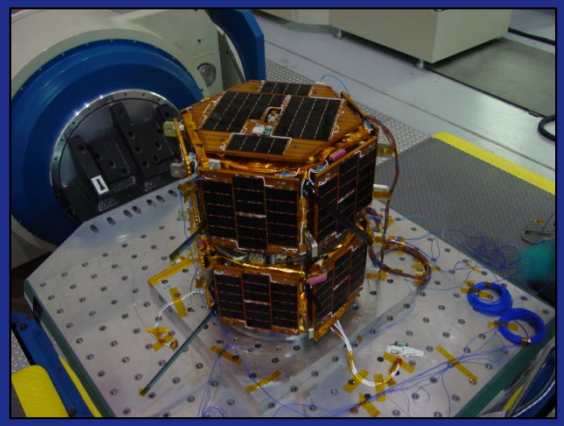
- 2003 – 2010
  - Nanosat Competition
  - Flight Redesign
  - Integration & Delivery
  - Acceptance Testing at AFRL
  - Software Development/Testing and Hardware Modifications
  - Environmental Testing at AFRL
  - Launch on STP-S26
- All-student team:
  - Management
  - Fabrication & Assembly
  - Software
- $ 200 K Budget

FASTRAC Program Status

- FASTRAC Satellites
  - Completed Flight Software Development
  - Completed Environmental Testing in February
  - Ready to be integrated to Launch Vehicle – awaiting shipment to Kodiak, AK
  - Launching in Summer 2010 from Kodiak, Alaska
- FASTRAC Amateur Radio Frequency Information
  - FASTRAC 1 or “Sara Lily”
    - Downlink: 437.345 MHz FM
    - Beacon: 437.345 MHz AX.25 1200 AFSK
  - FASTRAC 2 or “Emma”
    - Downlink: 145.825 MHz FM
    - Beacon: 145.825 MHz AX.25 1200 AFSK

Please HELP US TRACK OUR Satellites!!!





FASTRAC Mission

- The FASTRAC satellites will demonstrate the following enabling technologies for nanosatellites:
  (1) On-orbit real-time GPS relative navigation via real-time crosslink data exchange
  (2) On-orbit real-time attitude determination using a single frequency, C/A-code, reprogrammable GPS receiver
  (3) Micro-discharge plasma thruster
  (4) Distributed ground station network

FASTRAC Mission Objectives

The FASTRAC primary mission objectives are:

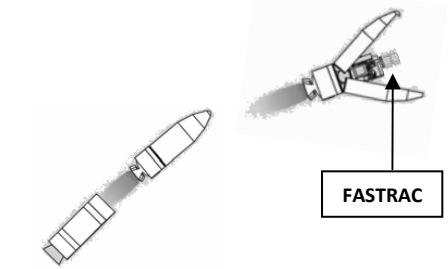
- Demonstrate two-way intersatellite crosslink with verified data exchange
- Perform on-orbit real-time GPS relative navigation to an accuracy matching ground simulations (compared to post-processed)
- Demonstrate autonomous thruster firing using accurate, single-antenna on-orbit real-time GPS attitude determination

FASTRAC Mission Highlights

- FASTRAC will be the first ever to, or first nanosatellite class mission to:
  - Demonstrate on-orbit real-time GPS relative navigation between two spacecraft
  - Demonstrate on-orbit real-time attitude determination with a single GPS antenna
  - Demonstrate a micro-discharge plasma method of low-thrust propulsion on a spacecraft
  - Fly a new composite propellant tank in space (developed by CTD and provided by AFRL)

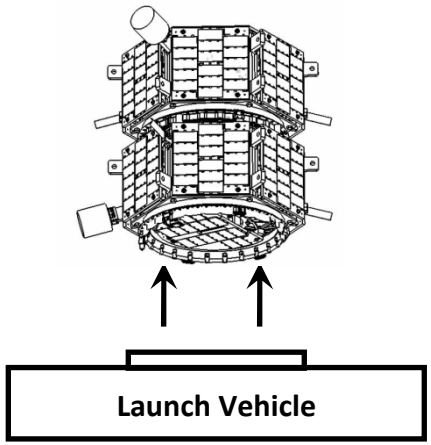
FASTRAC: Concept of Operations

1 Launch & Early Operations: Launch

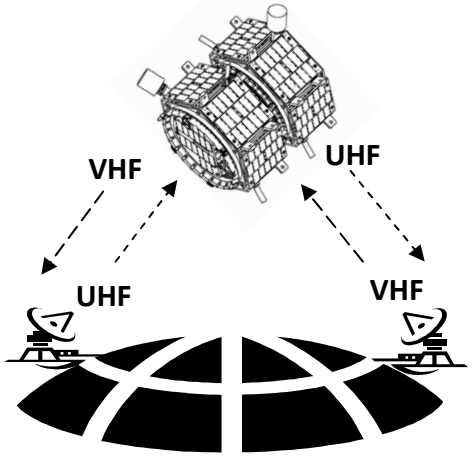


Launch Vehicle: Minotaur IV
Launch Site: Kodiak
Orbit: 650 km circular
72° inclination

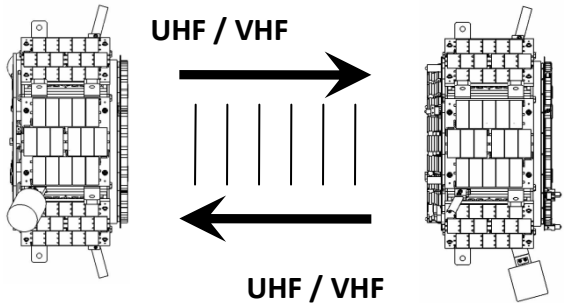
2 Launch & Early Operations: Launch Vehicle Separation



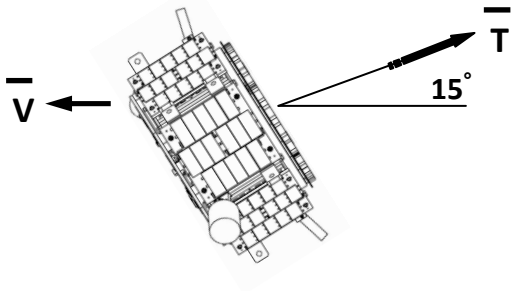
3 Launch & Early Operations: Initial Acqusition



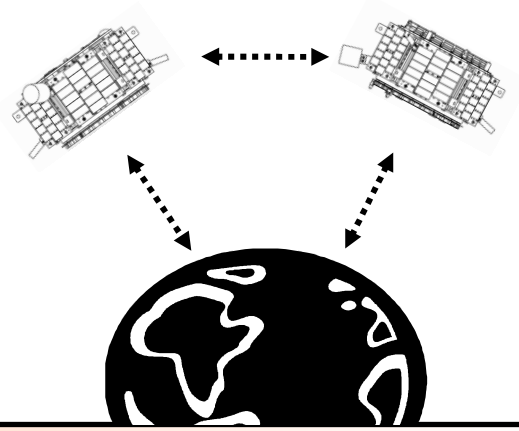
4 GPS Onboard Relative Navigation Using UHF/VHF Crosslink

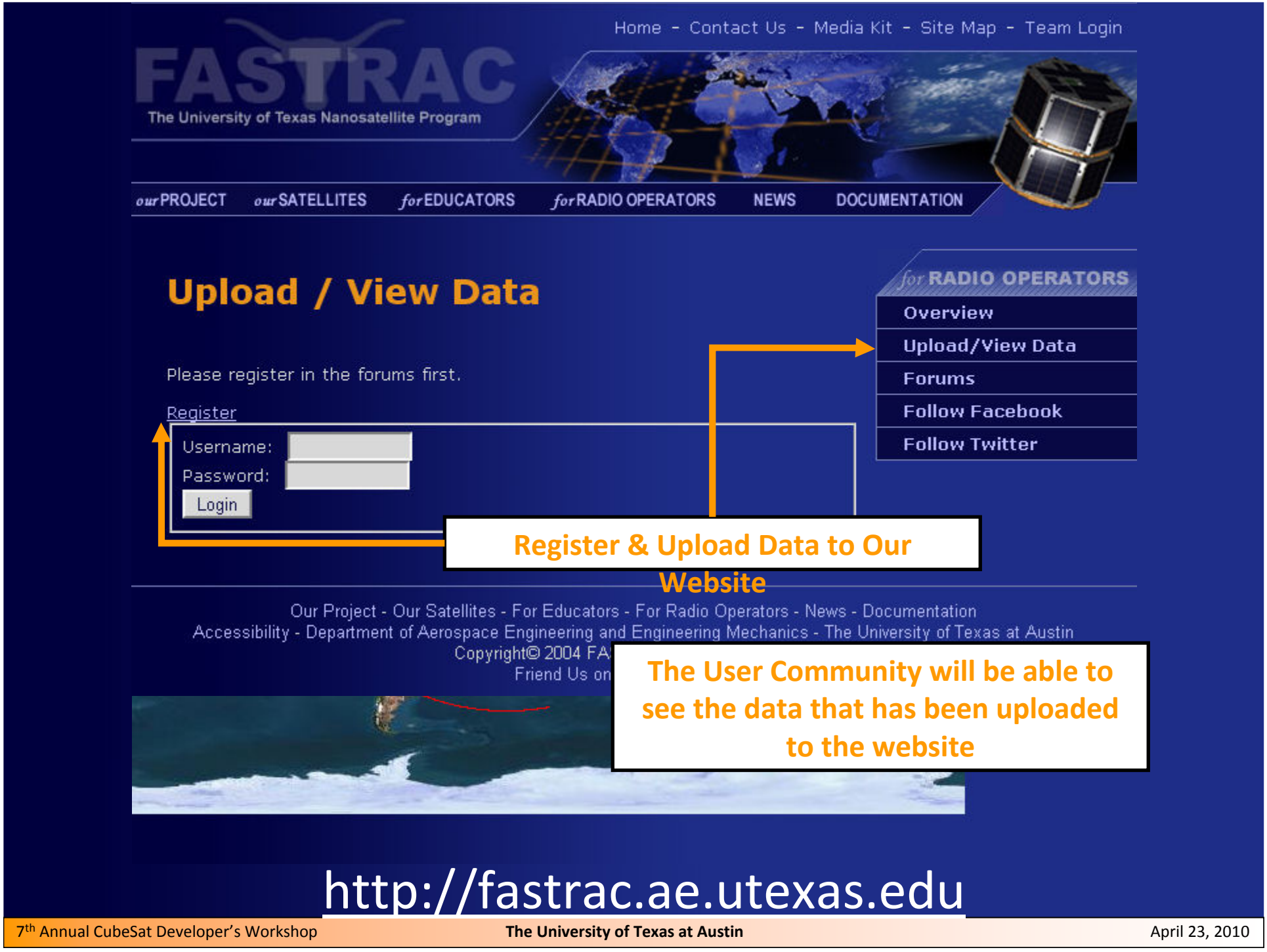


5 Onboard, Single-Antenna GPS Attitude Microdischarge-Plasma Thruster



6 Amateur Radio Operations: APRS, Digipeat, and Store-and-Forward





http://fastrac.ae.utexas.edu

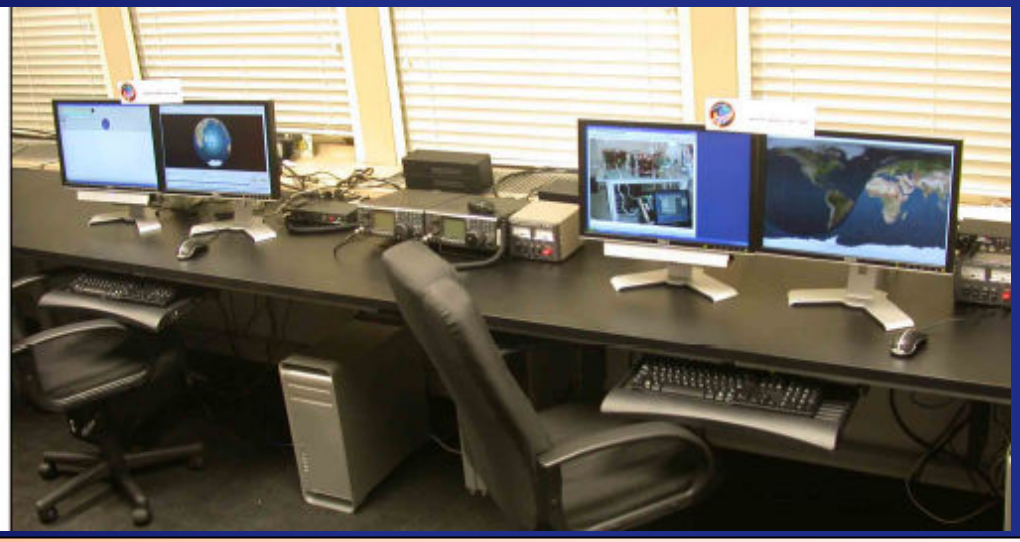
FASTRAC COMMUNITY

Fan us on Facebook: www.facebook.com/fastracsats

Follow us on Twitter: www.twitter.com/fastracsats

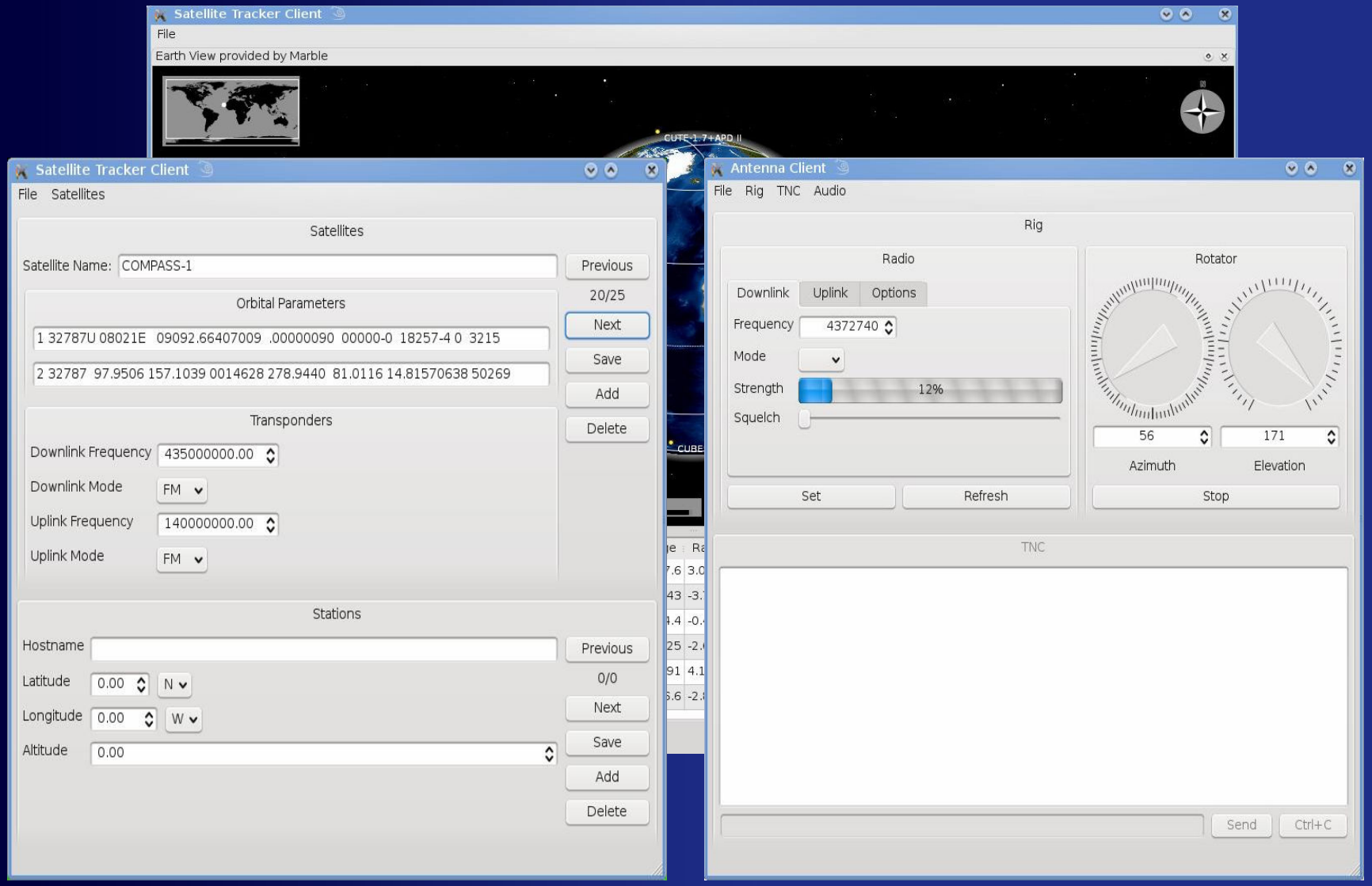
UT Austin Ground Station

- Two independent ground stations
  - Capable of tracking two different satellites at any time
  - Hardware for each station:
    - 16.8 dB Yagi UHF Antenna, 12.25 dB Yagi VHF Antenna
    - ICOM 910 Radio, Kantronics TNC KPC 9612+, and Yaesu G5500 Rotor
- If you want us track your satellite, let us know!!!



FASTRAC

UT Ground Station Software



Automation Scripts

```
proc download_data { sat requestedData currentTime } {
        set prompt1 "fast1>"
        set prompt2 "fast2>"
        set gps "f77 0"
        set health "gh 0"
        set thruster "gt 0"
        set imu "gi 0"
        puts "DOWNLOADING REQUESTED DATA"
        #puts "GIVEN List: $requestedData"
        if { $sat==1 } {
                if { [lindex $requestedData 0]==1 } {
                        set prefix "g"
                        expect $prompt1 { exp_send "$gps\r";
                                          puts "GPS DATA REQUEST S
                        expect $prompt1 { exp_send "\r" }
                        set gpsData $expect_out(buffer)
                        makeFile $sat $prefix $gpsData $currentTim
                }
                if { [lindex $requestedData 1]==1 } {
                        set prefix "h"
                        expect $prompt1 { exp_send "$health\r\n";
                                          puts "HEALTH DATA REQUES
                        expect $prompt1 { exp_send "\r" }
                        set healthData $expect_out(buffer)
                        makeFile $sat $prefix $healthData $current
                }
                if { [lindex $requestedData 3]==1 } {
                        set prefix "t"
                        expect $prompt1 {exp_send "$thruster\r\n";
                                         puts "THRUSTER DATA REQUE
                        expect $prompt1 { exp_send "\r" }
                        set thrusterData $expect_out(buffer)
                        makeFile $sat $prefix $thrusterData $curre
                }

        }
```

Example of Script Downloading Data

```
CONNECTING TO FAST2...

cmd:help co CONNECTION REQUEST TO FAST2 SENT

nnect
c fast2
CONNECT  callsign [via calls]  can be used to reconnect with different path
cmd:cmd:KE5DTW>FAST2/1: <<C>>:
FAST2 Is Now Connected. GO HORNSConnected to fast2
DOWNLOADING DATA

DOWNLOADING REQUESTED DATA
fast2> HEALTH DATA REQUEST SENT

gh 0

P
[illegible]000000000000009215 010482F 024F23D 025AD95 021E0EB 0226BAF 021777B 0230000 0000000 0000000 0000000 00
2442442452464 46A2442432440063E39007007007007325A008007007007018600500500500 54FDD004004004004DA3A00500600
GHCP
fast2>
fIMU DATA REQUEST SENT

ast2>
fast2> gi 0

P
[illegible]72S0D13.4005993.6749993.7190990.9212001.8473001.68070052[illegible]
ICP
fast2ALL FILES SAVED.
DATA SUCCESSFULLY DOWNLOADED==========

>
fast2>
fast2>
fast2>
fast2>
fast2>
fast2> disc

P
fast2> [illegible]ONE
SCRIPT DONE
```

Based on Expect Scripting Language

QUESTIONS?

Contact Information

Dr. E. Glenn Lightsey
FASTRAC Principal Investigator
lightsey@mail.utexas.edu
+1 (512) 471-5322

Sebastián Muñoz
FASTRAC Student Project Manager
smunoztoro@gmail.com
+1 (512) 471-5144

http://fastrac.ae.utexas.edu

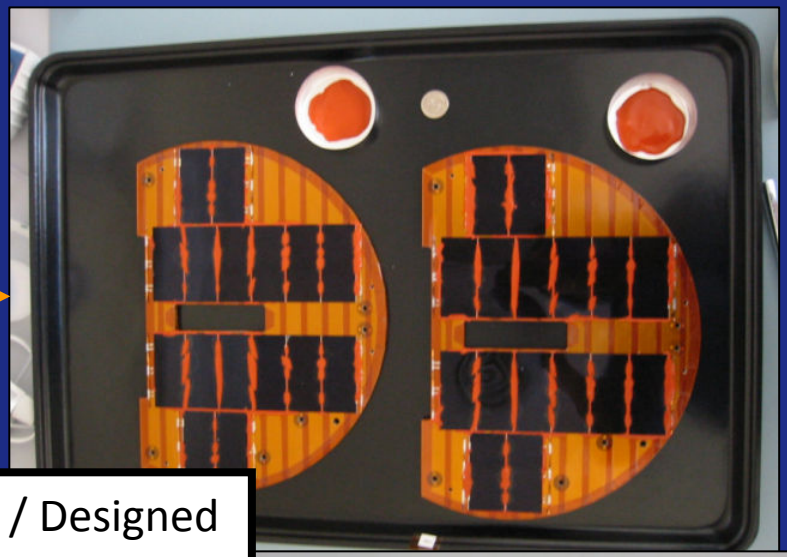
http://www.facebook.com/fastracsats

http://www.twitter.com/fastracsats

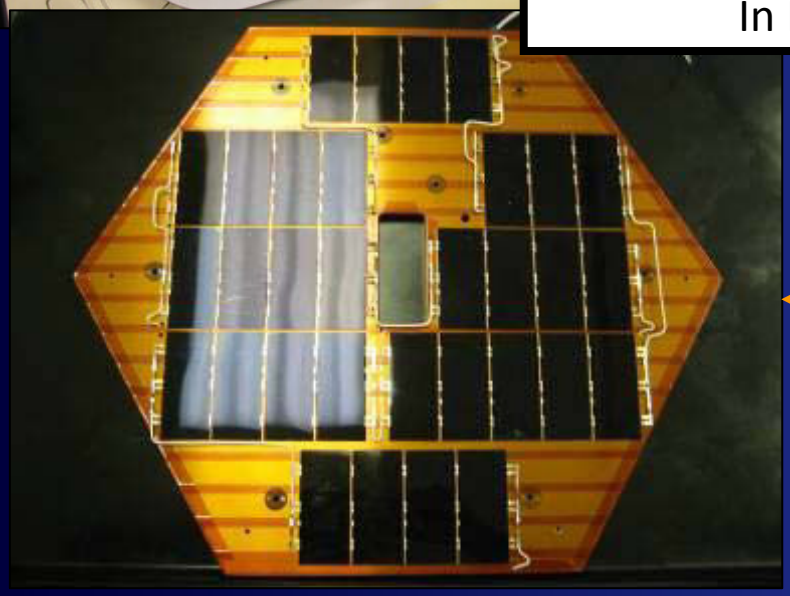
FASTRAC

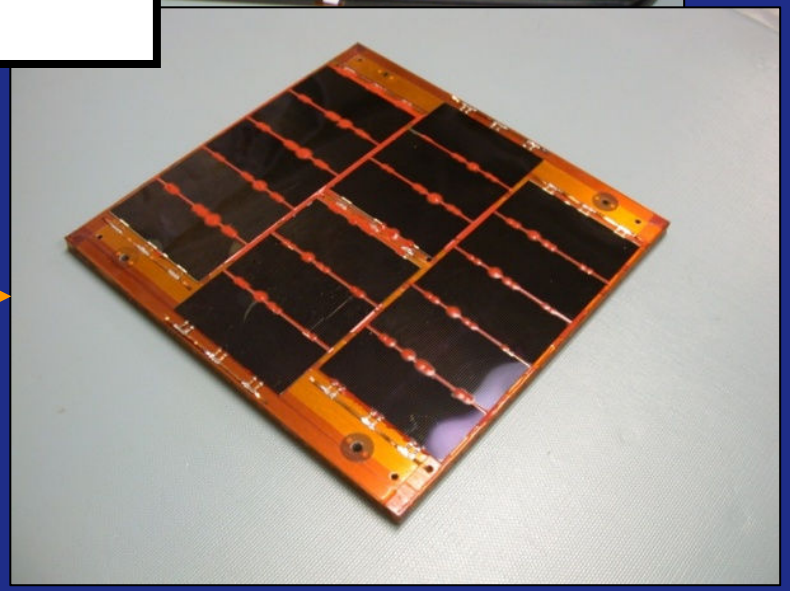
BACK UP SLIDES

FASTRAC Subsystems Overview

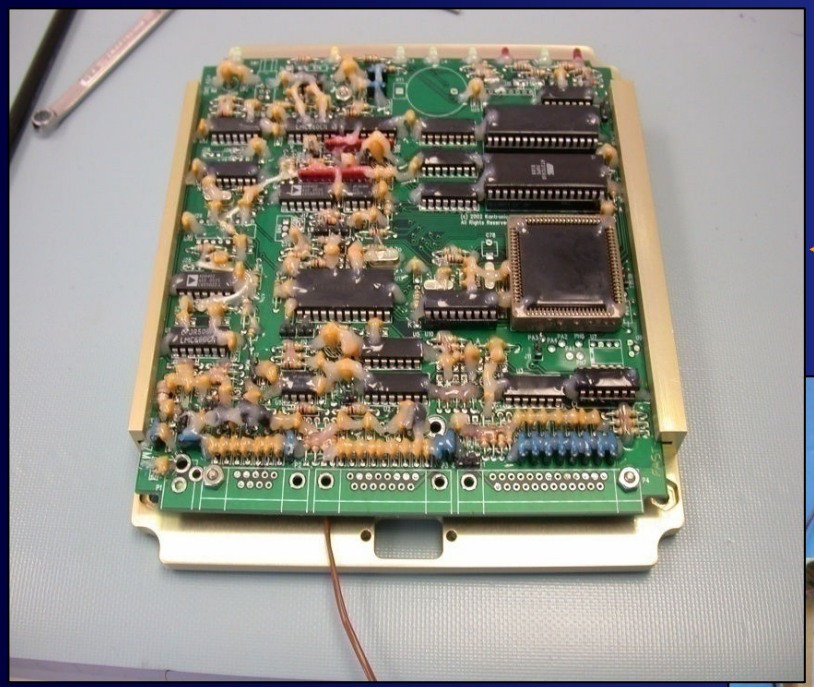


Solar Panels Built / Designed In House

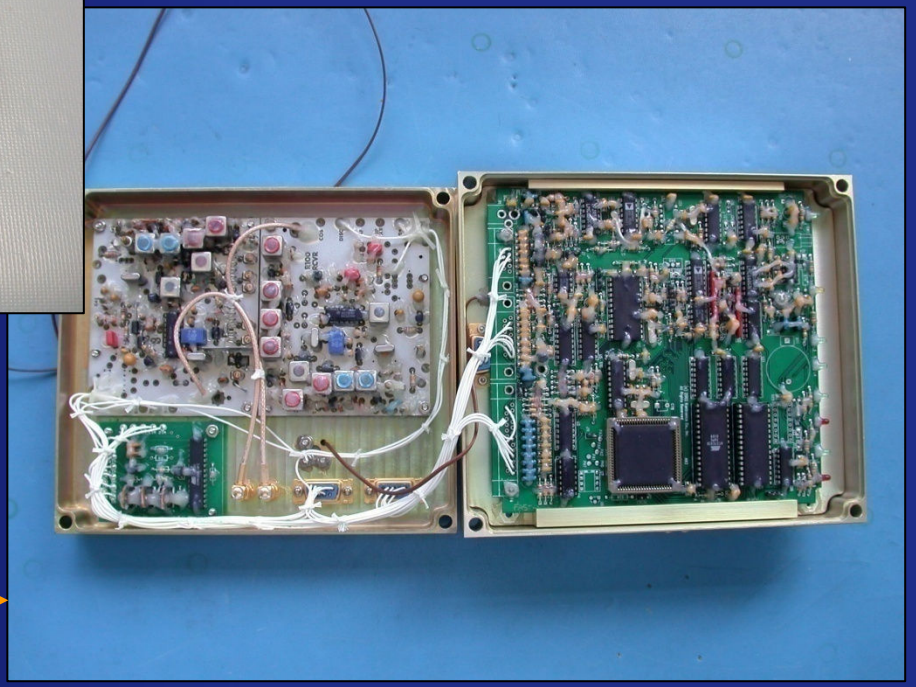




FASTRAC Subsystems Overview



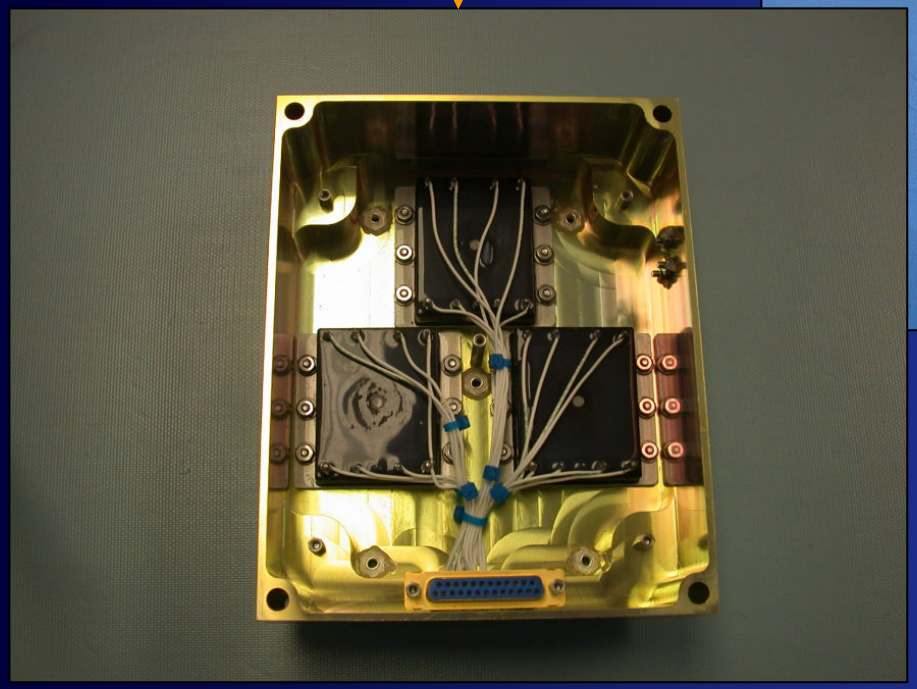
Kantronics KPC-9612+ TNC

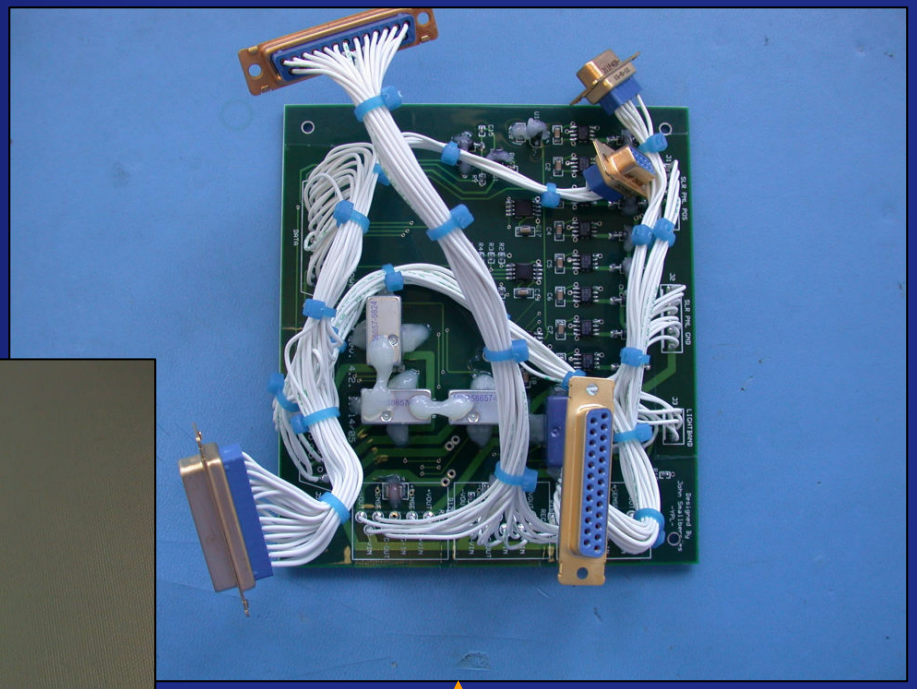


- Hamtronics Transmitters & Receivers
- Transmitter Relay Board
- Receiver Relay Board

FASTRAC Subsystems Overview

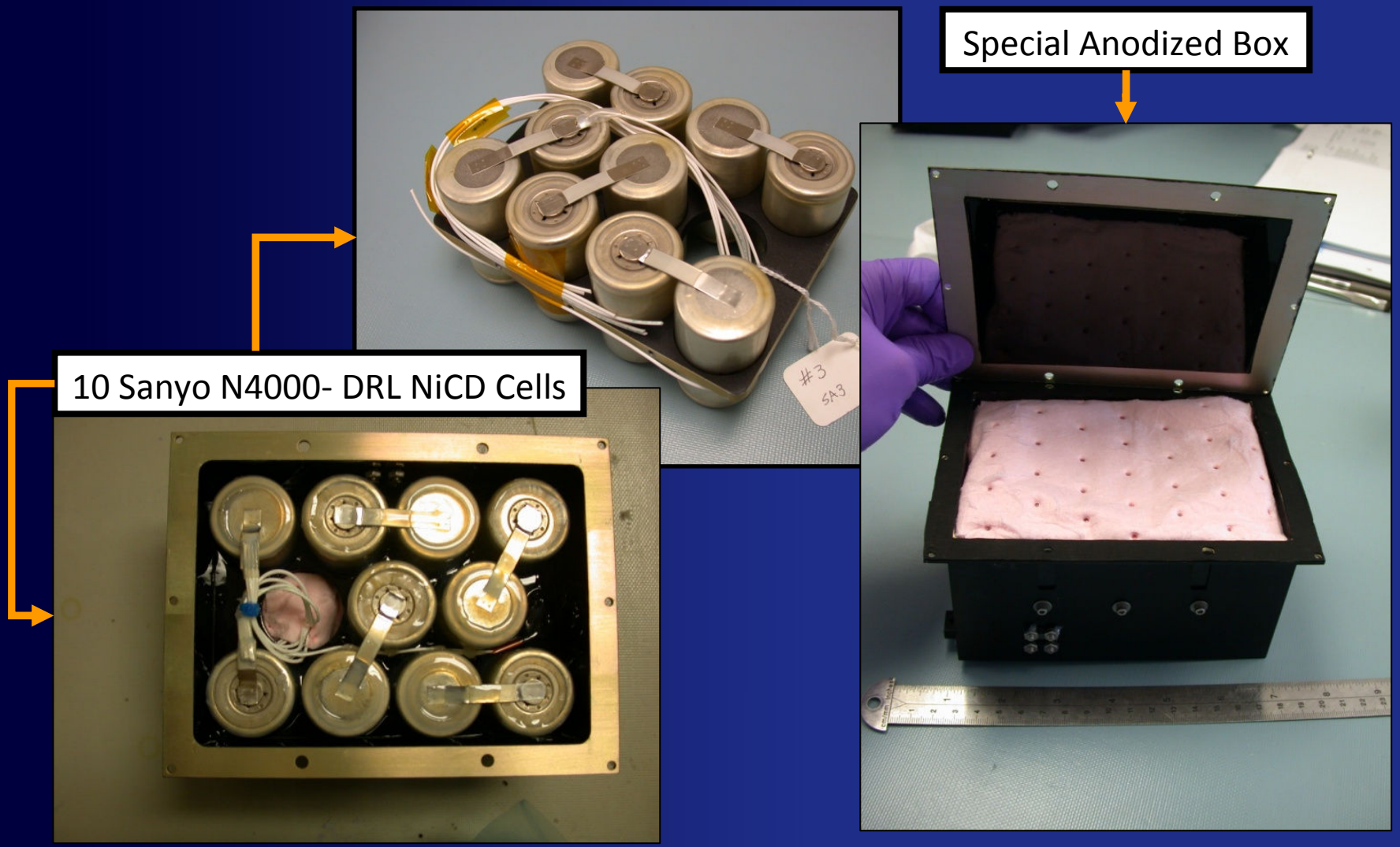
VICOR VI-J00 DC-DC Regulators



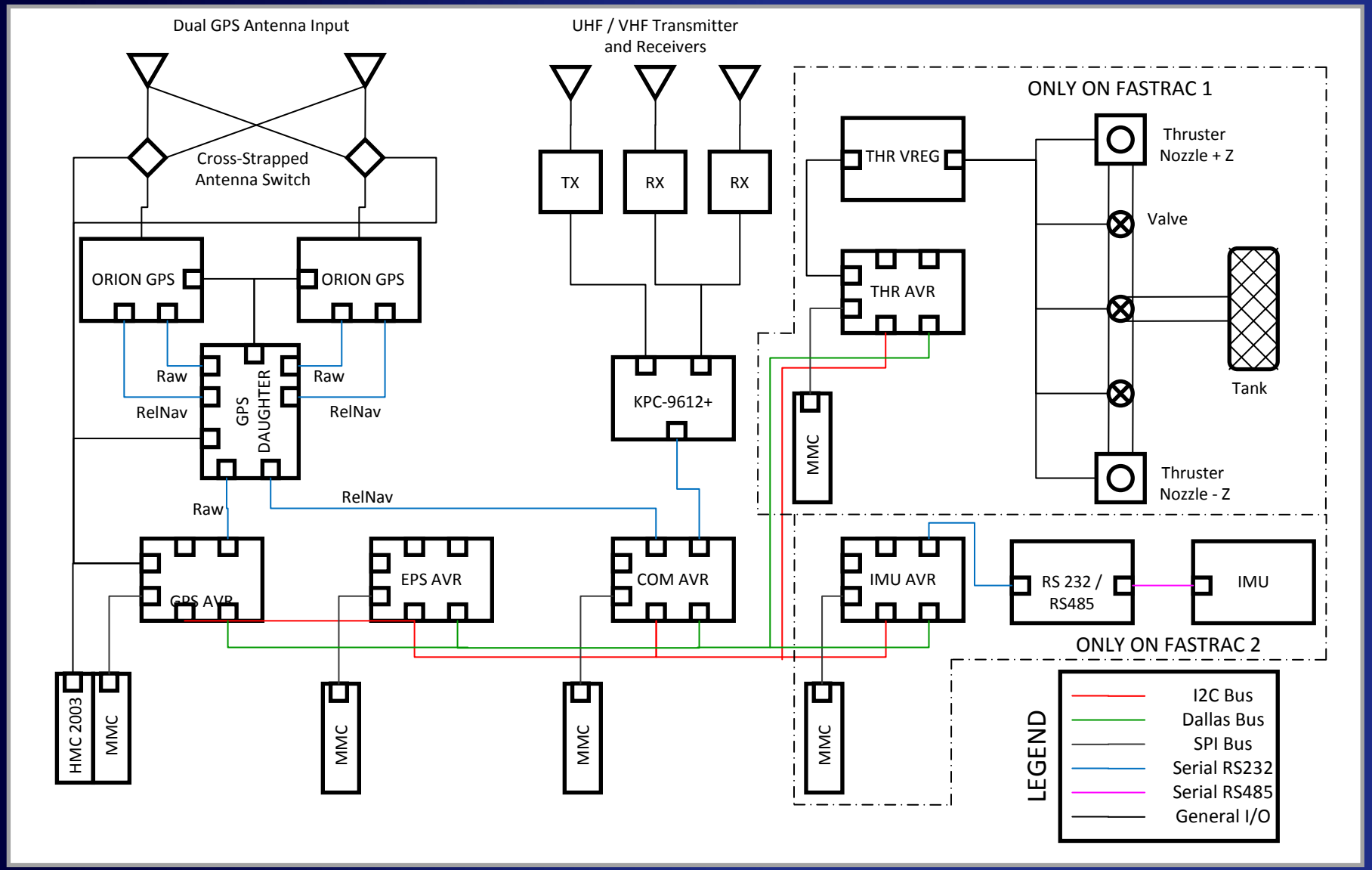


- Custom Designed VREG Board
  - Leach Relays (4 Inhibits)
  - Dallas Sensor Network

FASTRAC Subsystems Overview

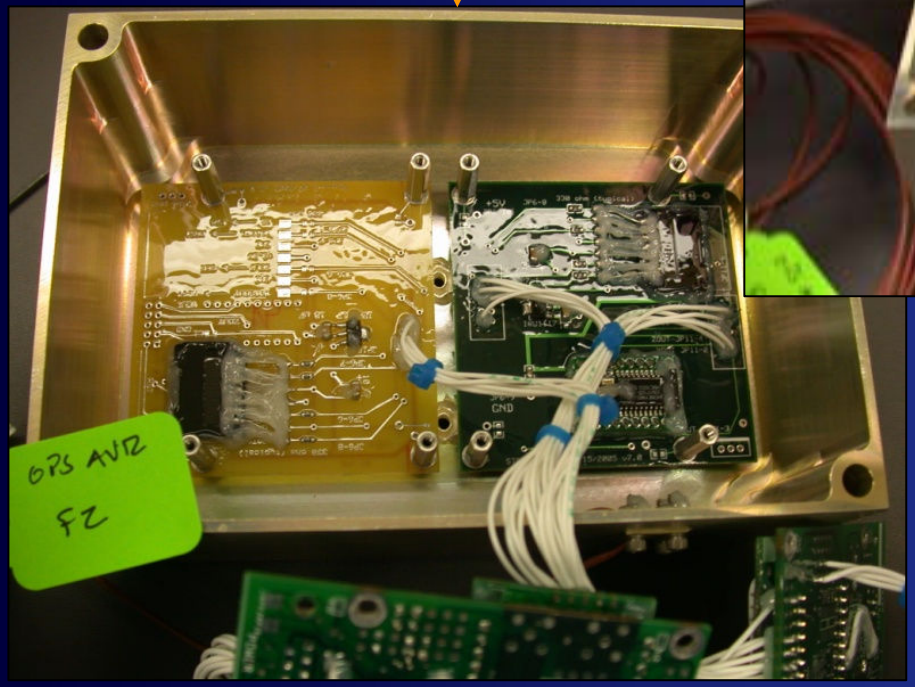


FASTRAC Subsystems Overview



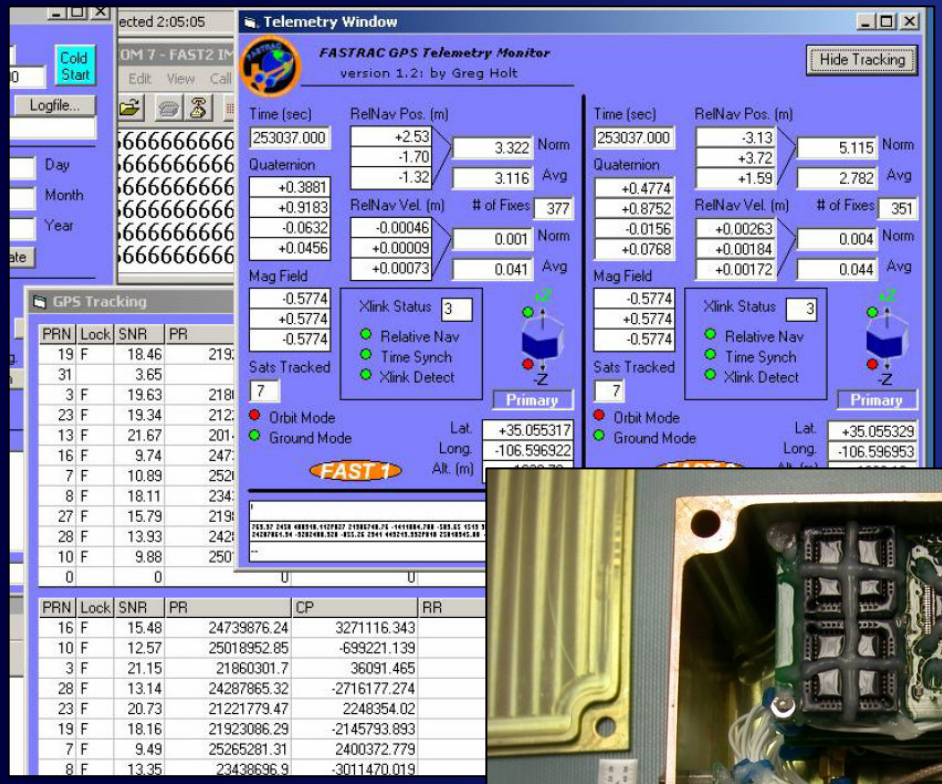
FASTRAC Subsystems Overview

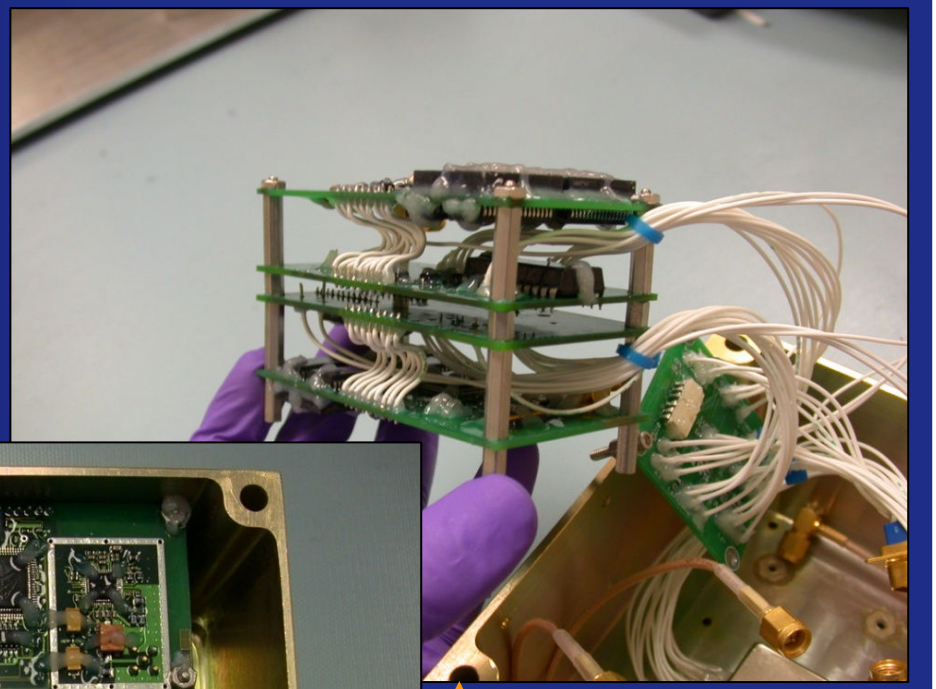
Custom Designed MMC / Magnetometer Boards

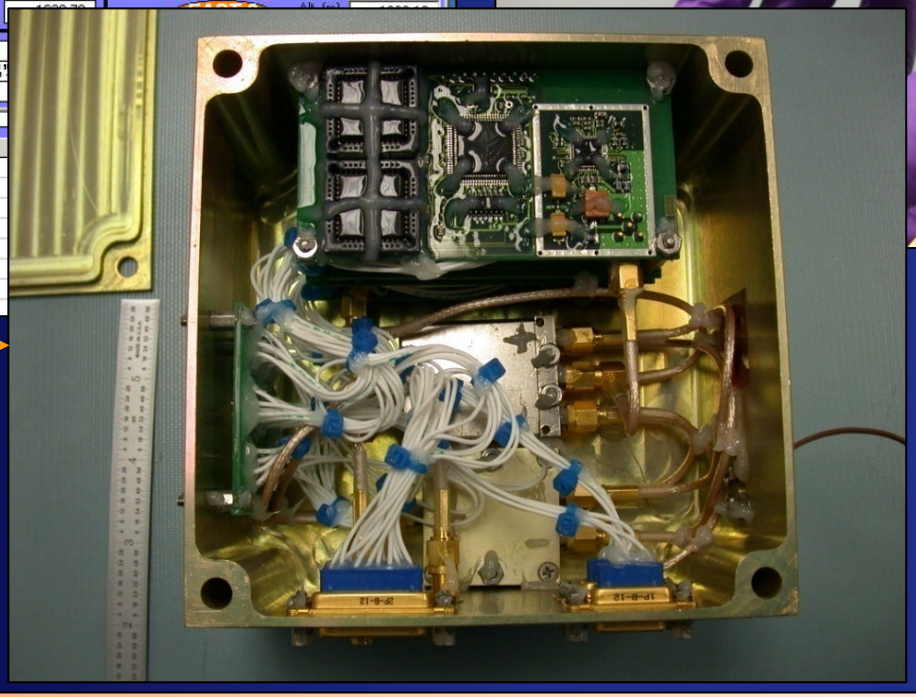


AVR Microcontrollers developed by SCU

FASTRAC Subsystems Overview



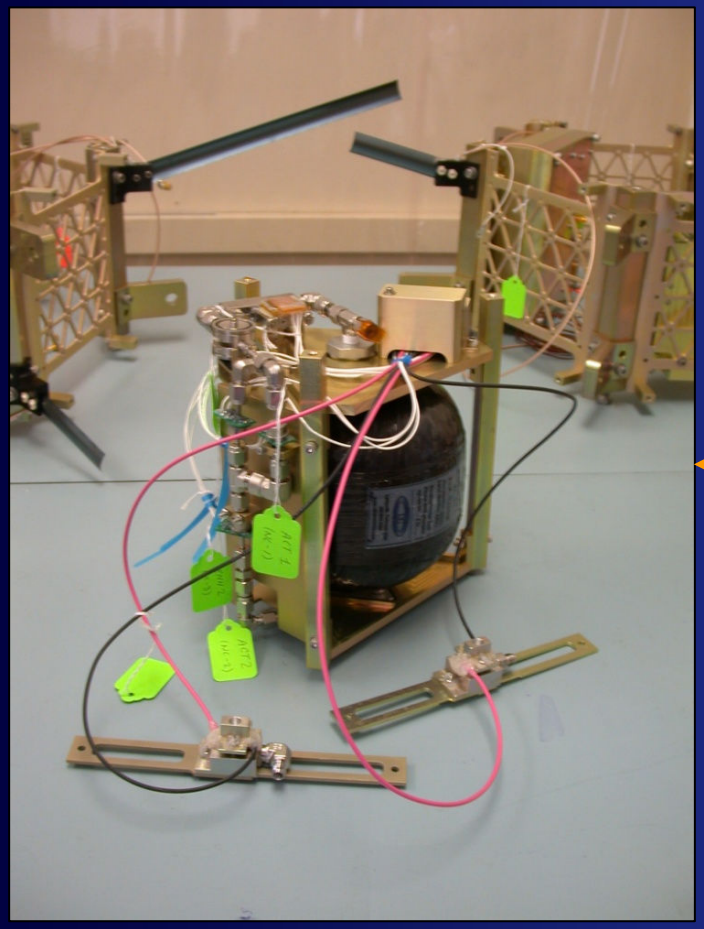




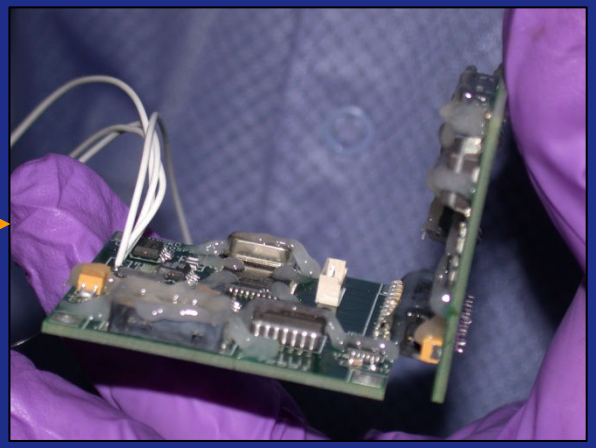
- Custom Designed Daughter Board
- Two Dow-key RF Switches
- Two Meca RF Splitters

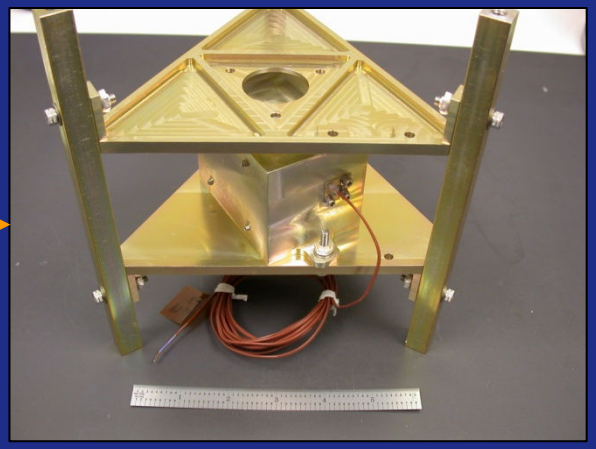
Two Modified Orion GPS Receivers

FASTRAC Subsystems Overview



Micro Discharge Plasma Thruster developed at UT Austin





Micro Aerospace Solutions IMU

FASTRAC Subsystems Overview