

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

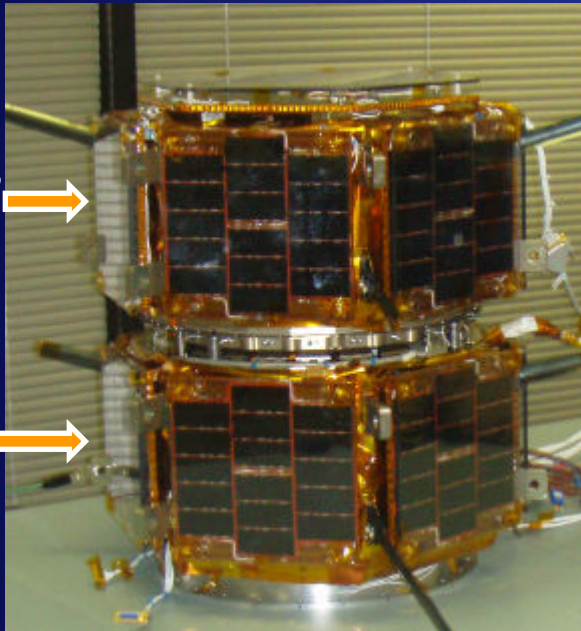
- The FASTRAC Project
- Program Status
- Mission Overview
- Mission Objectives
- Mission Highlights
- Concept of Operations
- FASTRAC Website & User Community
- UT Austin Ground Station

The FASTRAC Project

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

- 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

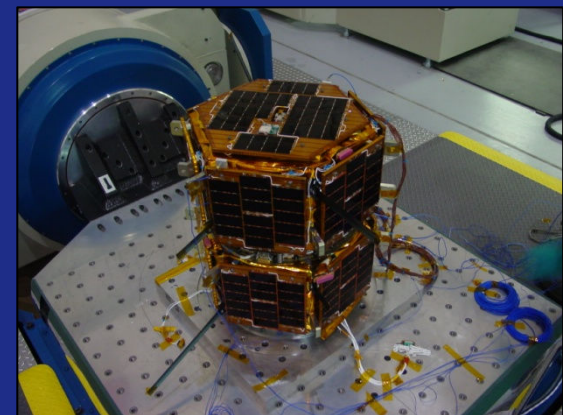
FASTRAC 1 “Sara Lily” →



FASTRAC 2 “Emma” →

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

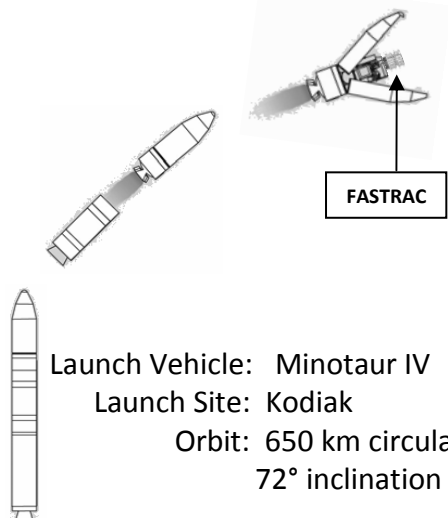


FASTRAC Mission Highlights

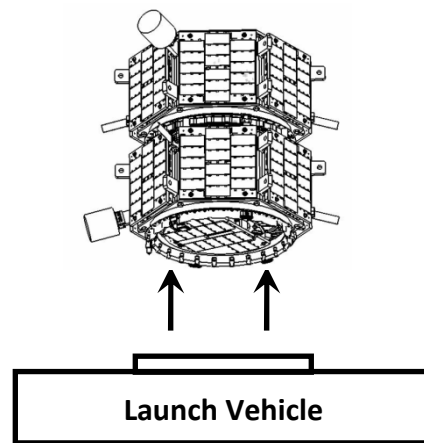
- FASTRAC will be the first ever to, or first nanosatellite class mission to:
 - Demonstrate on-orbit real-time GPS relative navigation between two spacecraft
 - Demonstrate on-orbit real-time attitude determination with a single GPS antenna
 - Demonstrate a micro-discharge plasma method of low-thrust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

FASTRAC: Concept of Operations

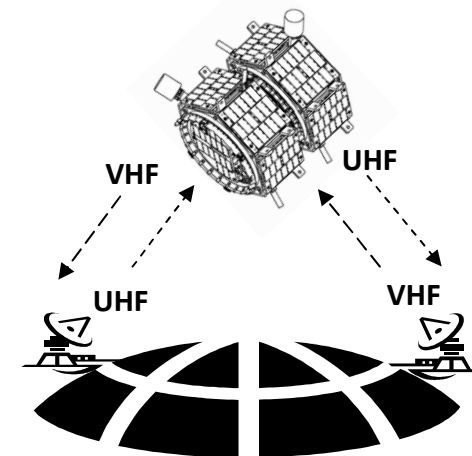
1 Launch & Early Operations: Launch



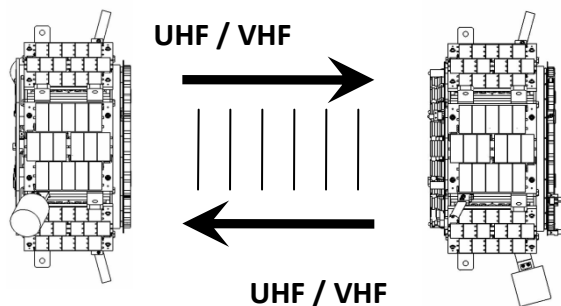
2 Launch & Early Operations: Launch Vehicle Separation



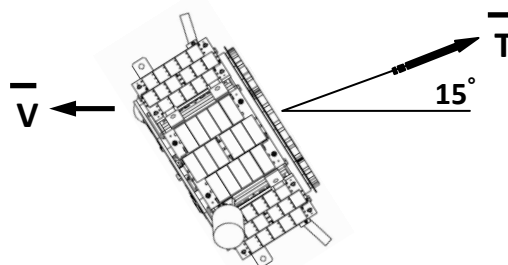
3 Launch & Early Operations: Initial Acquisition



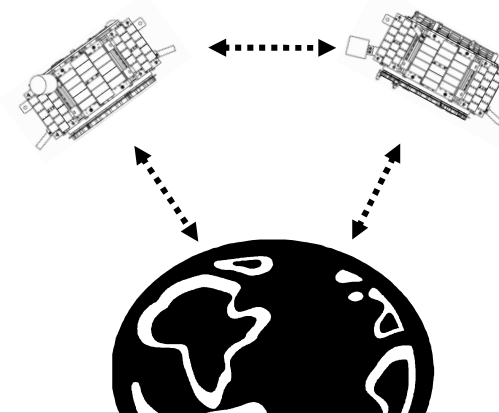
4 GPS Onboard Relative Navigation Using UHF/VHF Crosslink



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



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





Upload / View Data

Please register in the forums first.

Register

Username:
Password:

for RADIO OPERATORS

- Overview
- Upload/View Data
- Forums
- Follow Facebook
- Follow Twitter

Register & Upload Data to Our Website

Our Project - Our Satellites - For Educators - For Radio Operators - News - Documentation
Accessibility - Department of Aerospace Engineering and Engineering Mechanics - The University of Texas at Austin
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Friend Us on

The User Community will be able to see the data that has been uploaded to the website

<http://fastrac.ae.utexas.edu>

FASTRAC COMMUNITY

facebook Search

FASTRAC Satellites

Wall Info Photos Discussions +

What's on your mind?

Attach: [Icons] Everyone Share

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FASTRAC Satellites

25 new photos

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FASTRAC (Formation Autonomy Spacecraft with Thrust, ReInav, Attitude and Crosslink) is pair of student built satellites from UT Austin. Launching May 2010.

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

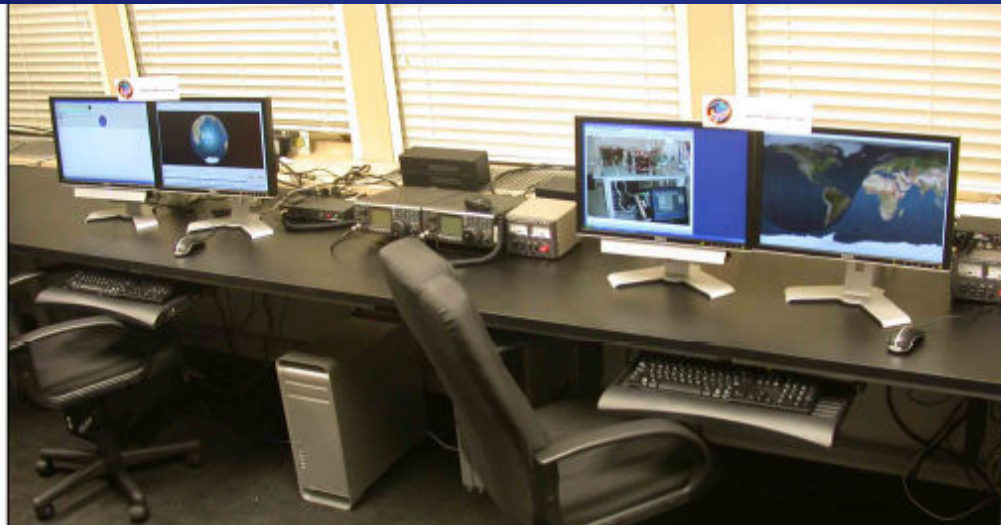
Follow us on Twitter: www.twitter.com/fastracsats →

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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!!!





UT Ground Station Software

The image shows two overlapping software windows. The background window is 'Satellite Tracker Client', which displays an Earth view with a satellite labeled 'CUBE-1-7+APD II'. The foreground window is also 'Satellite Tracker Client', but it is open to the 'Satellites' configuration page. It contains several sections: 'Satellites' with a list of satellite names and IDs; 'Orbital Parameters' with two rows of numerical data; 'Transponders' with fields for Downlink and Uplink frequencies and modes; and 'Stations' with fields for Hostname, Latitude, Longitude, and Altitude. To the right, the 'Antenna Client' window is open to the 'Rig' configuration page, showing 'Radio' and 'Rotator' settings. The 'Radio' section includes fields for Frequency (4372740), Mode, Strength (12%), and Squelch. The 'Rotator' section features two circular gauges for Azimuth (56) and Elevation (171). Below these are 'Set', 'Refresh', and 'Stop' buttons. At the bottom of the Antenna Client window is a 'TNC' section with a large empty text area and 'Send' and 'Ctrl+C' buttons.



Automation Scripts

Example of Script Downloading Data

```
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 SENT"  
      expect $prompt1 { exp_send "\r" }  
      set gpsData $expect_out(buffer)  
      makeFile $sat $prefix $gpsData $currentTime  
    }  
    if { [lindex $requestedData 1]==1 } {  
      set prefix "h"  
      expect $prompt1 { exp_send "$health\r\n";  
                        puts "HEALTH DATA REQUEST SENT"  
      expect $prompt1 { exp_send "\r" }  
      set healthData $expect_out(buffer)  
      makeFile $sat $prefix $healthData $currentTime  
    }  
    if { [lindex $requestedData 3]==1 } {  
      set prefix "t"  
      expect $prompt1 {exp_send "$thruster\r\n";  
                        puts "THRUSTER DATA REQUEST SENT"  
      expect $prompt1 { exp_send "\r" }  
      set thrusterData $expect_out(buffer)  
      makeFile $sat $prefix $thrusterData $currentTime  
    }  
  }  
}
```

```
CONNECTING TO FAST2...  
cmd:help co CONNECTION REQUEST TO FAST2 SENT  
nnnect  
c fast2  
CONNECT callsign [via calls] can be used to reconnect with different path  
cmd:cmd:KESDTW>FAST2/1: <<C>>:  
FAST2 Is Now Connected. GO HORNSCONNECTED to fast2  
DOWNLOADING DATA  
DOWNLOADING REQUESTED DATA  
fast2> HEALTH DATA REQUEST SENT  
  
gh 0  
P  
[0]00000000000000009215 010482F 024F23D 025AD95 021E0EB 0226BAF 021777B 0230000 0000000 0000000 00  
244244245246446A2442432440063E39007007007007325A00800700700701860050050050054FDD004004004004DA3A00500600  
GHCP  
fast2>  
fIMU DATA REQUEST SENT  
  
ast2>  
fast2> gi 0  
  
P  
[0]7250D13.4005993.6749993.7190990.9212001.8473001.68070052[0]  
ICP  
fast2ALL FILES SAVED.  
DATA SUCCESSFULLY DOWNLOADED=====  
  
fast2>  
fast2>  
fast2>  
fast2>  
fast2>  
fast2> disc  
  
P  
fast2> [0]NONE  
SCRIPT DONE
```

Based on Expect Scripting Language



QUESTIONS?

Contact Information

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<http://fastrac.ae.utexas.edu>

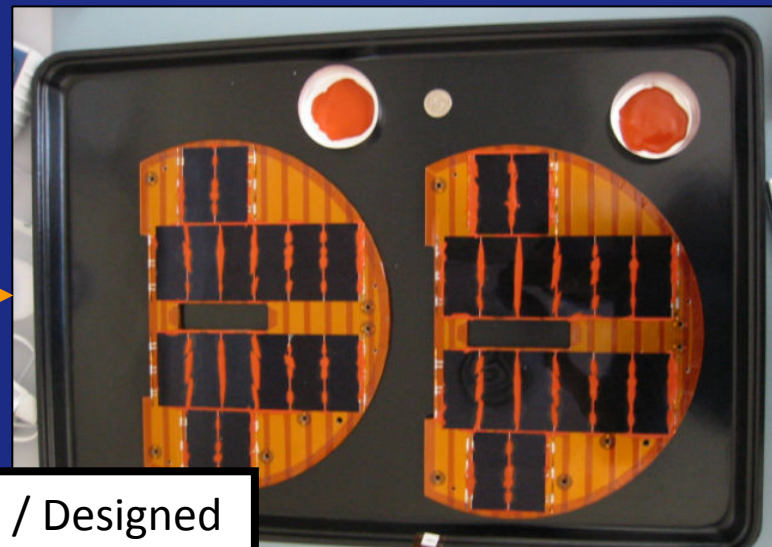
<http://www.facebook.com/fastracsats>

<http://www.twitter.com/fastracsats>

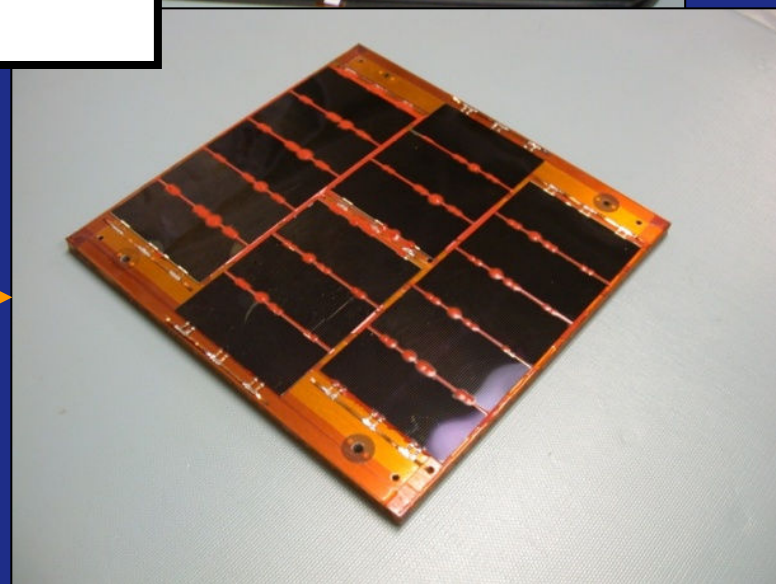
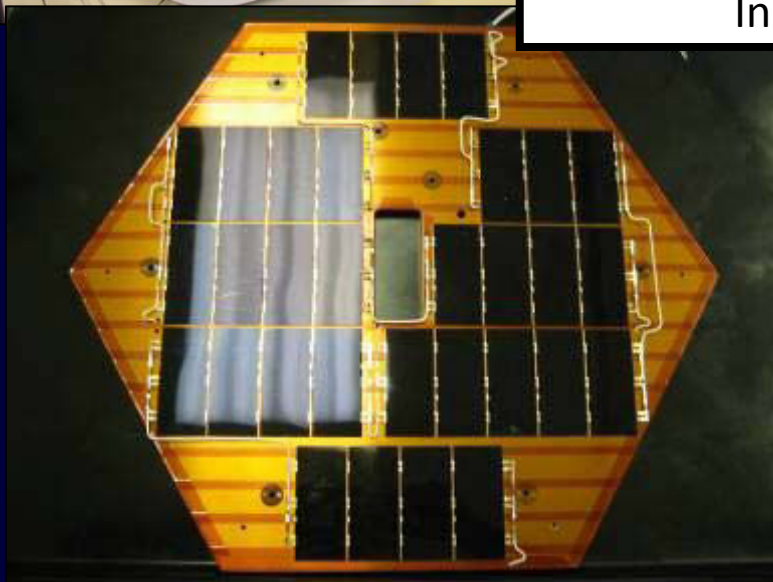


BACK UP SLIDES

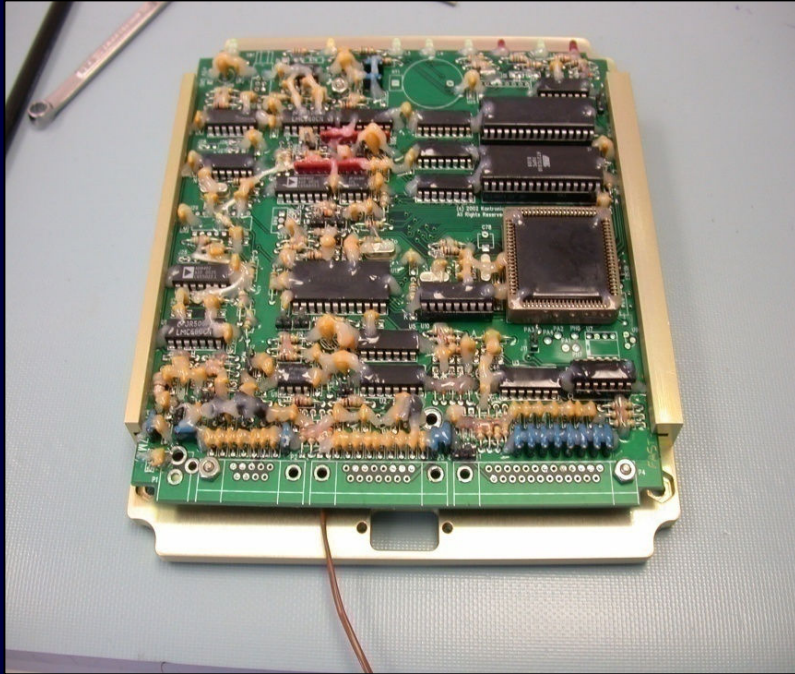
FASTRAC Subsystems Overview



Solar Panels Built / Designed
In House

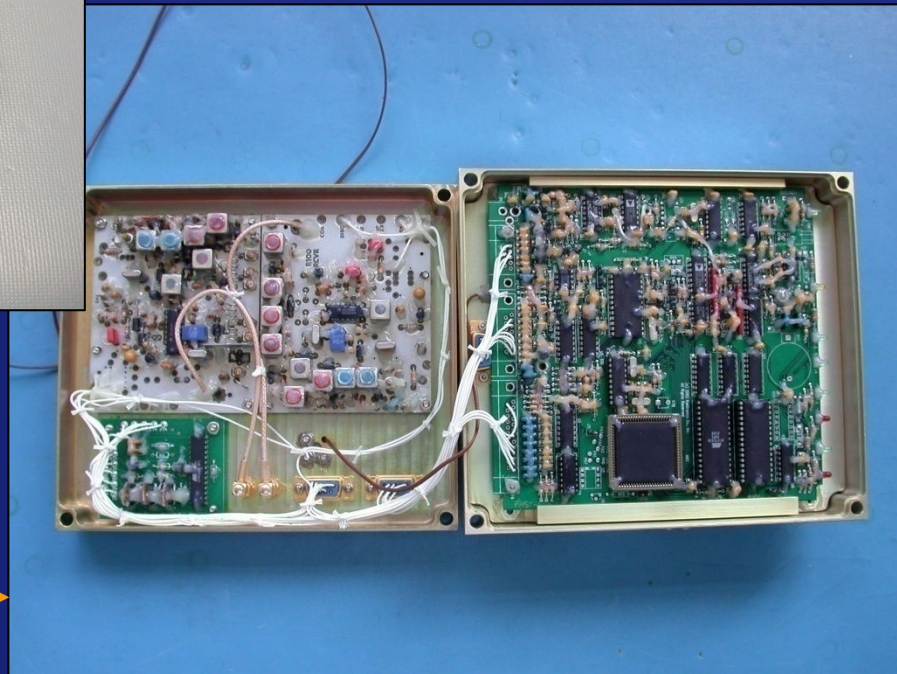


FASTRAC Subsystems Overview



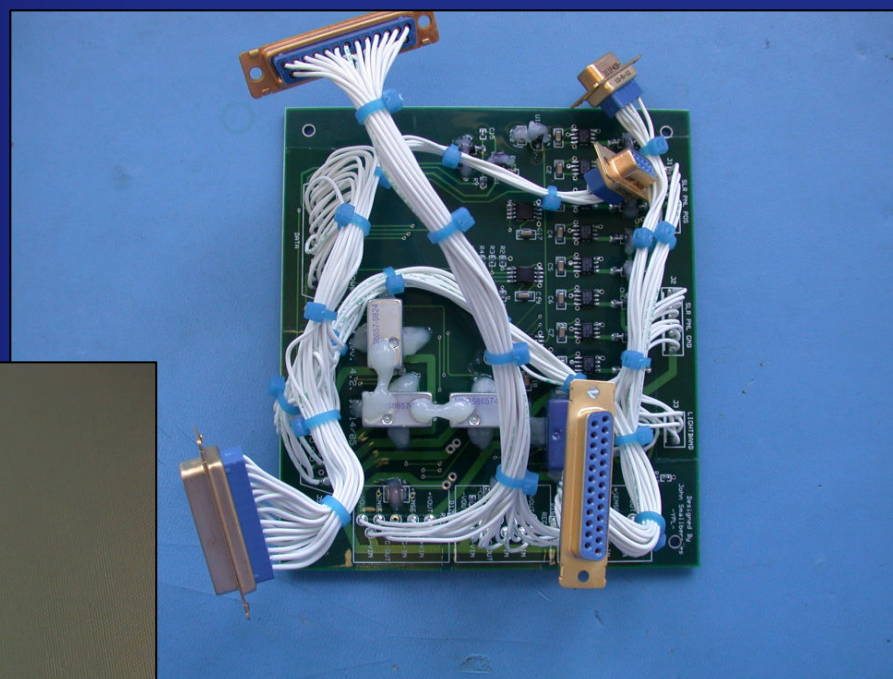
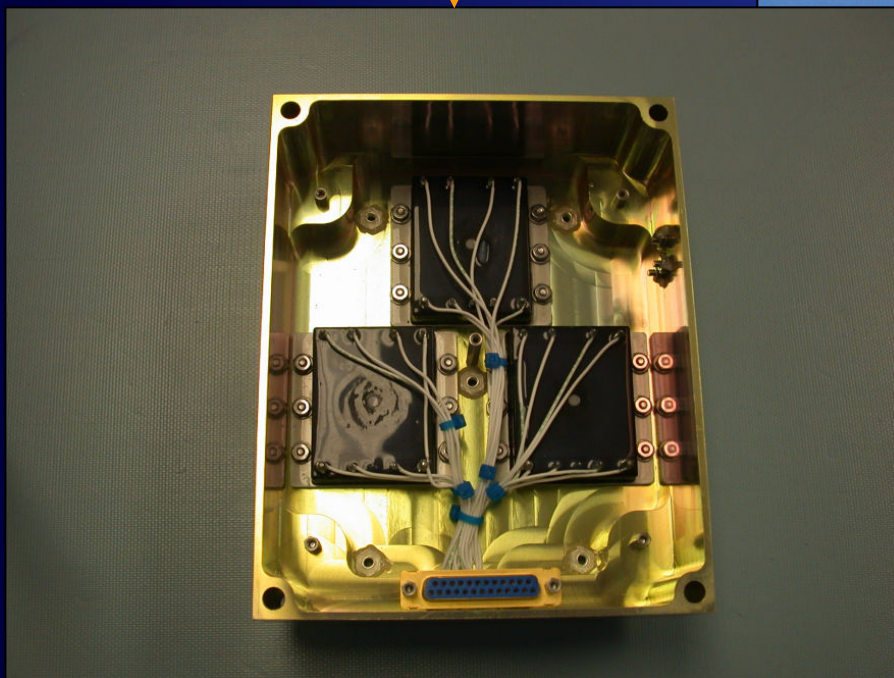
Kantronics KPC-9612+ TNC

- Hamtronics Transmitters & Receivers
 - Transmitter Relay Board
 - Receiver Relay Board
- An orange arrow points from this list to the photograph of the open hardware enclosure below.



FASTRAC Subsystems Overview

VICOR VI-J00 DC-DC Regulators

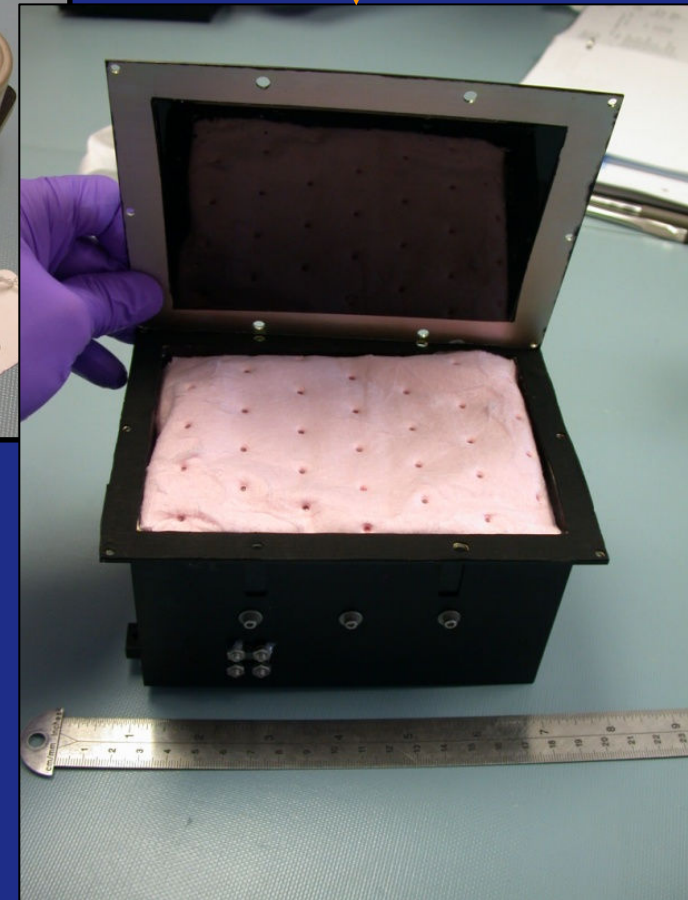
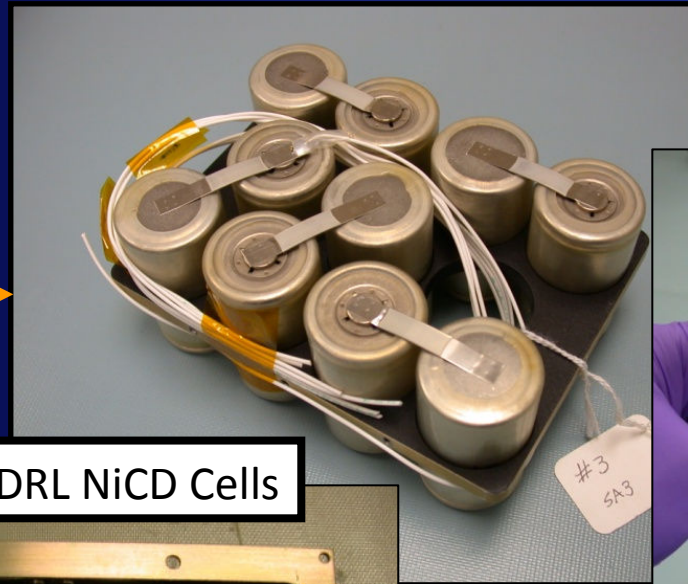


- Custom Designed VREG Board
 - Leach Relays (4 Inhibits)
 - Dallas Sensor Network

FASTRAC Subsystems Overview

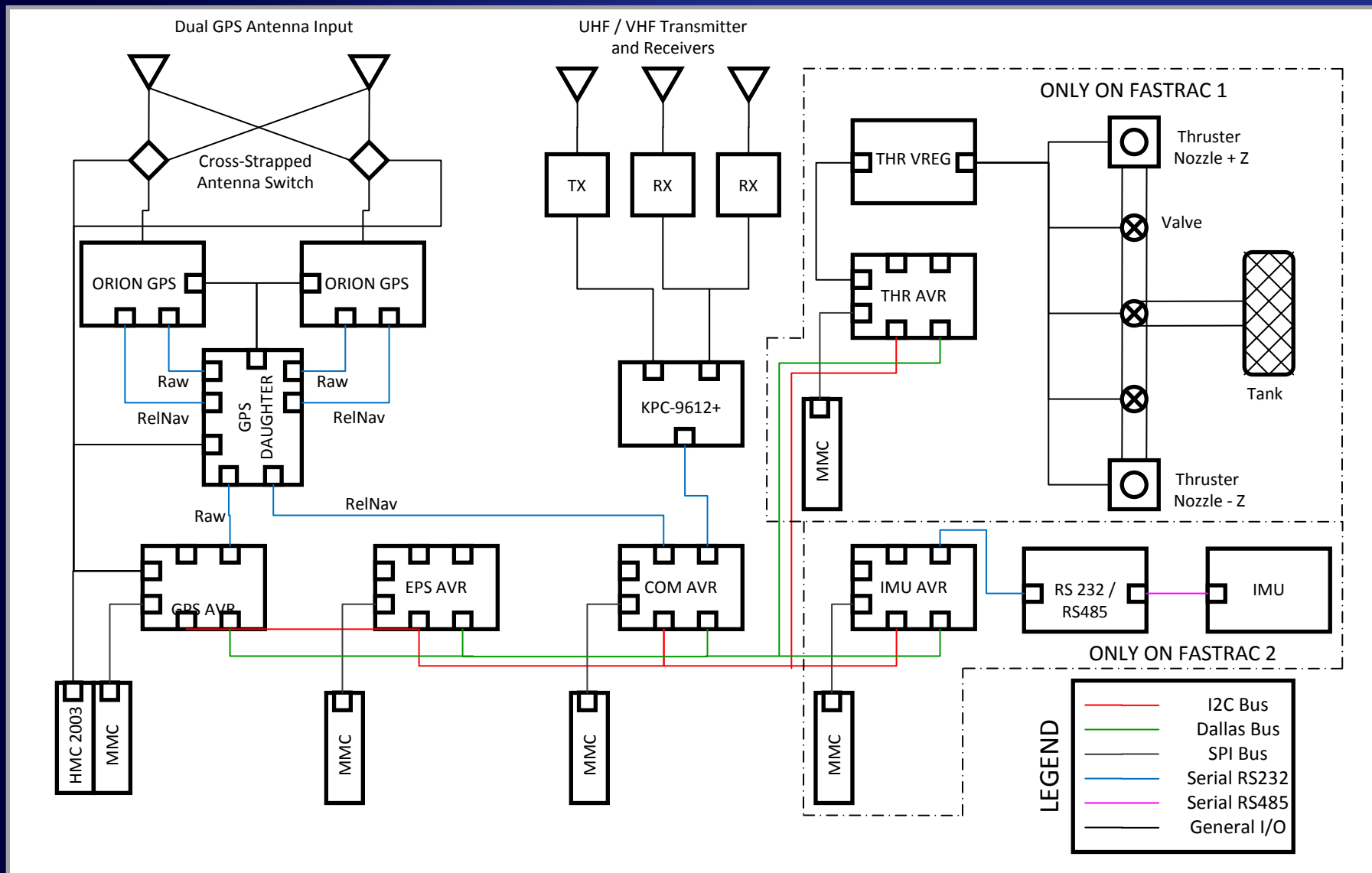
Special Anodized Box

10 Sanyo N4000- DRL NiCD Cells



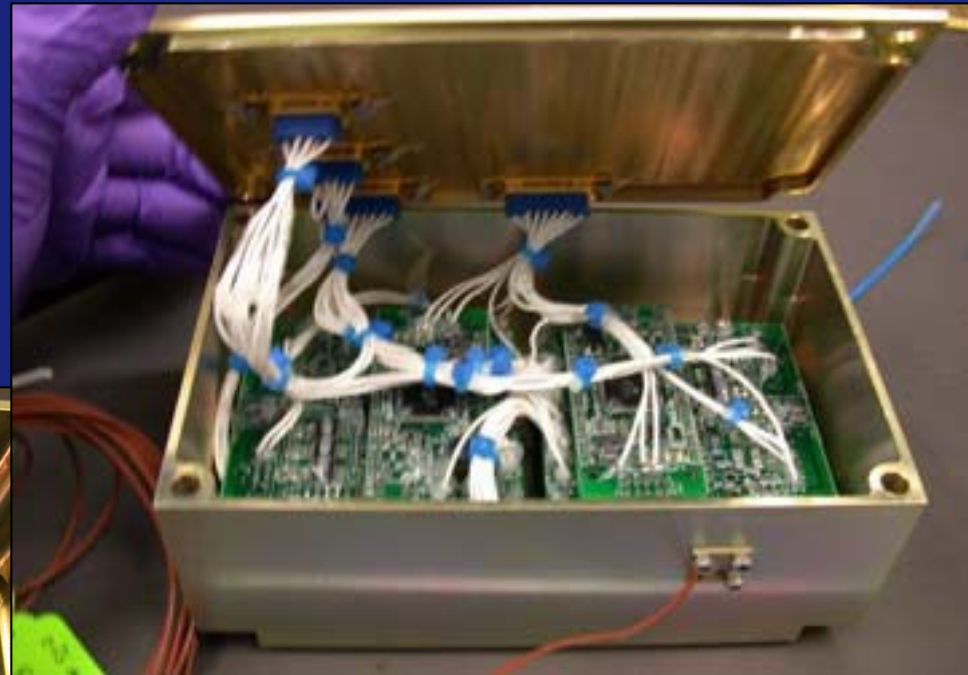
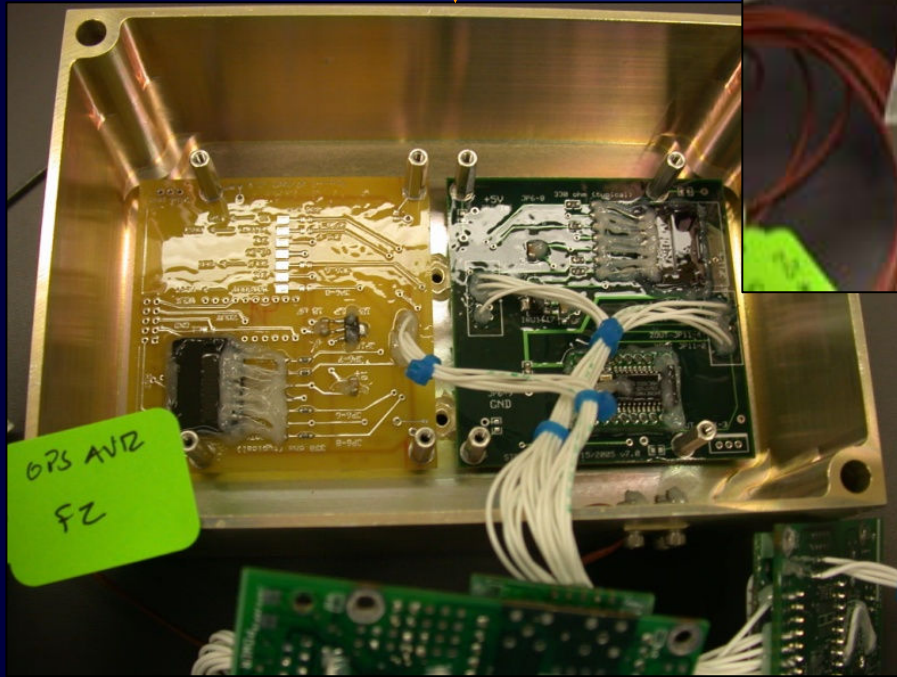


FASTRAC Subsystems Overview



FASTRAC Subsystems Overview

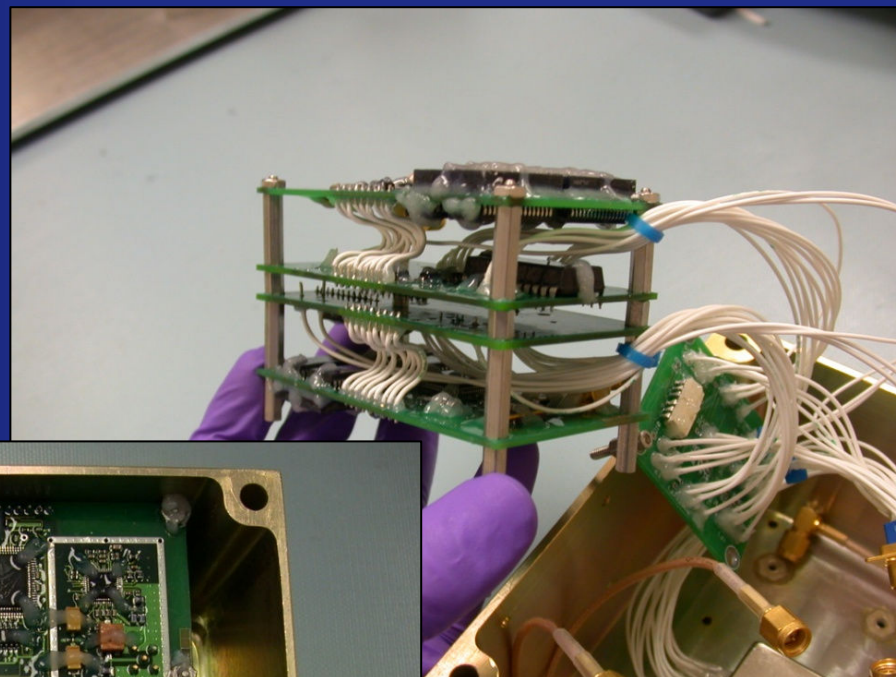
Custom Designed
MMC / Magnetometer
Boards



AVR Microcontrollers
developed by SCU

FASTRAC Subsystems Overview

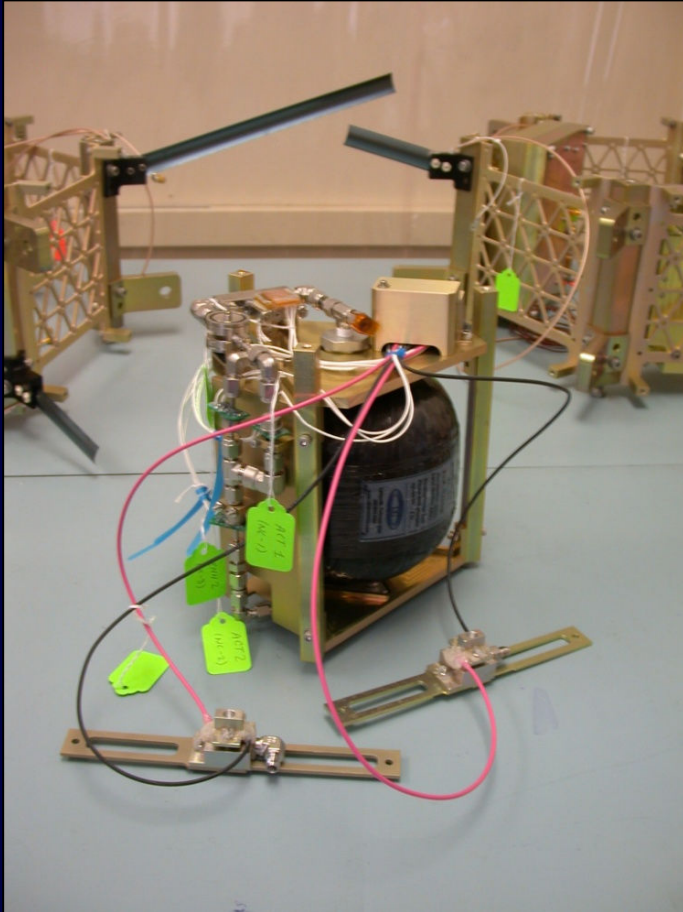
PRN	Lock	SNR	PR	CP	RR
19	F	18.46	219		
31		3.65			
3	F	19.63	218		
23	F	19.34	212		
13	F	21.67	201		
16	F	9.74	247		
7	F	10.89	252		
8	F	18.11	234		
27	F	15.79	219		
28	F	13.93	242		
10	F	9.88	250		
0		0			



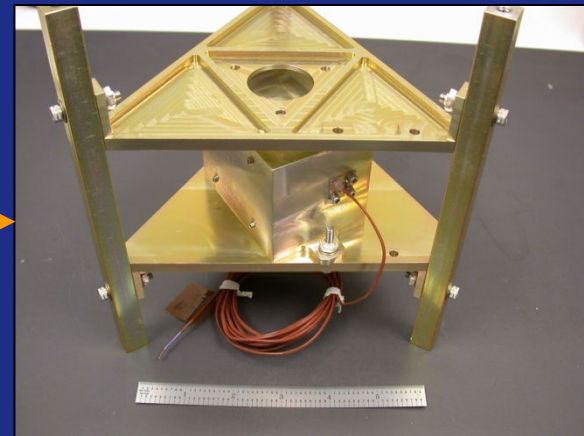
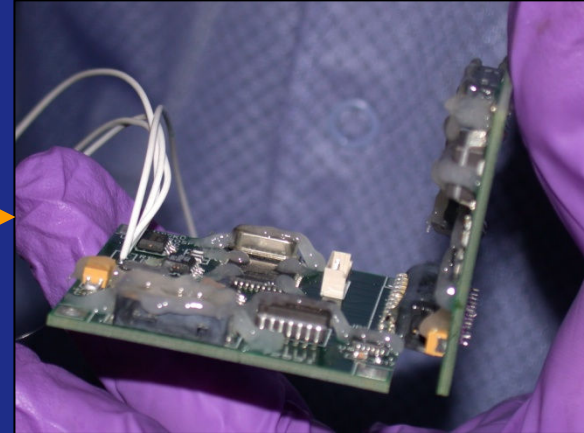
- Custom Designed Daughter Board
- Two Dow-key RF Switches
- Two Meca RF Splitters

Two Modified Orion GPS Receivers

FASTRAC Subsystems Overview



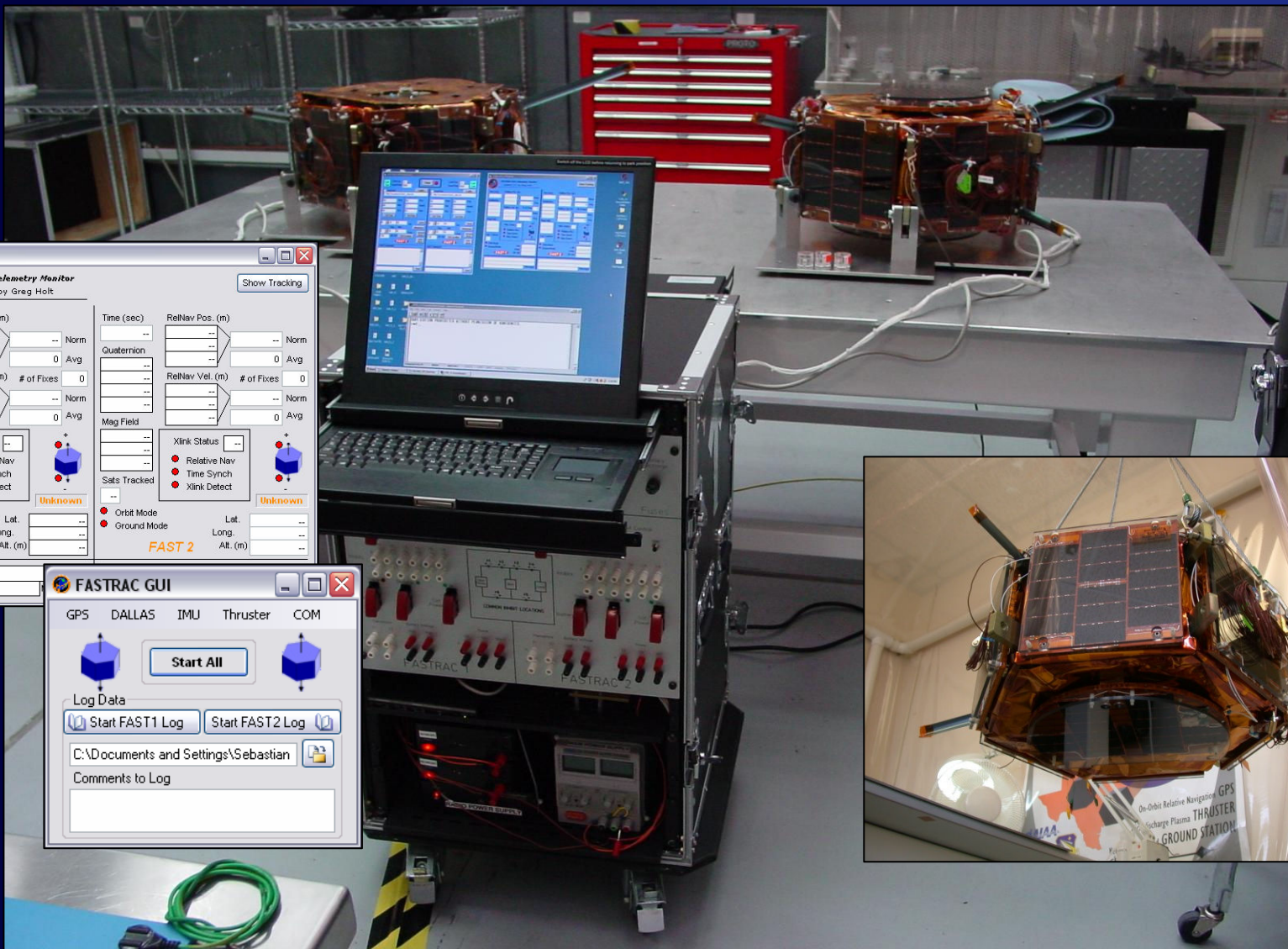
Micro Discharge Plasma Thruster
developed at UT Austin



Micro Aerospace Solutions IMU



FASTRAC Subsystems Overview



Telemetry Window
FASTRAC GPS Telemetry Monitor
version 1.2: by Greg Holt

Time (sec) RelNav Pos. (m) Quaternion RelNav Vel. (m) # of Fixes Mag Field Xlink Status Sats Tracked Orbit Mode Ground Mode Lat. Long. Alt. (m)

FAST 1

Time (sec) RelNav Pos. (m) Quaternion RelNav Vel. (m) # of Fixes Mag Field Xlink Status Sats Tracked Orbit Mode Ground Mode Lat. Long. Alt. (m)

FAST 2

FASTRAC GUI

GPS DALLAS IMU Thruster COM

Start All

Log Data

Start FAST1 Log Start FAST2 Log

C:\Documents and Settings\Sebastian

Comments to Log