The TEXAS Satellite Design Laboratory: An Overview of Our Current Projects

FASTRAC, BEVO-2, & ARMADILLO

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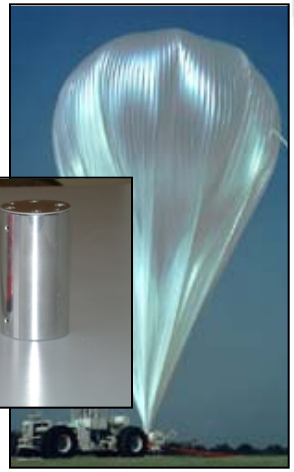
CubeSat Developers' Workshop
April 20-22, 2011

Cockrell School
THE UNIVERSITY OF TEXAS AT AUSTIN
Aerospace Engineering and Engineering Mechanics

UT Austin's Satellite Design Laboratory (SDL)
Founded 2002

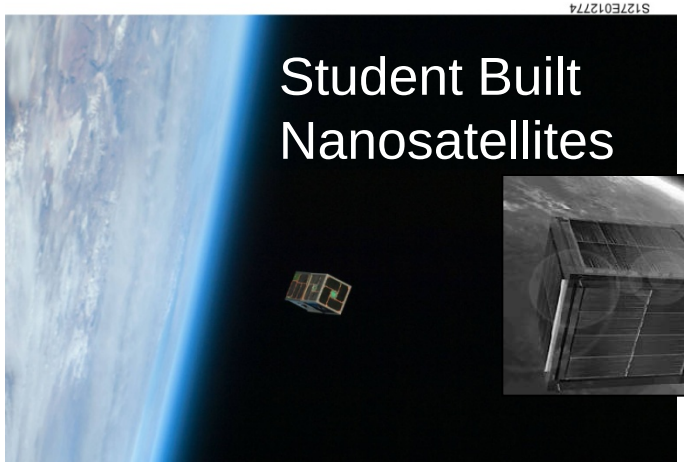
Sounding Rockets

CanSats



High Altitude Balloons

Satellite Ground Station



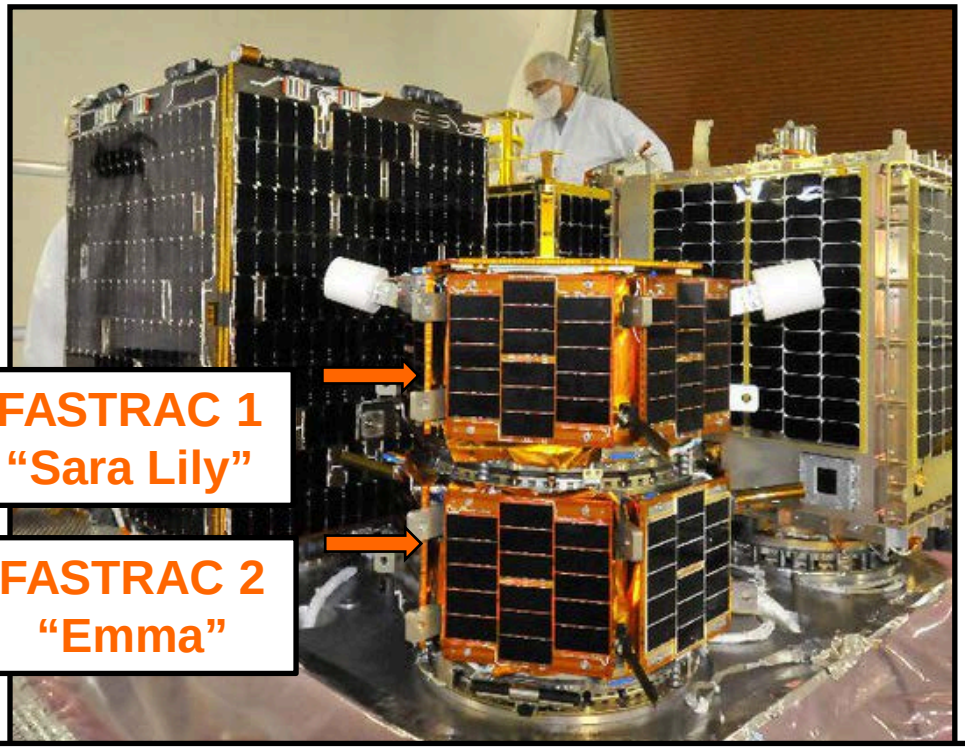
Nanosat Groups

KC-135/C-9

Space Shuttle Deployed Payloads

The FASTRAC Project:

Formation Autonomy Spacecraft with Thrust, RelNav, Attitude & Crosslink

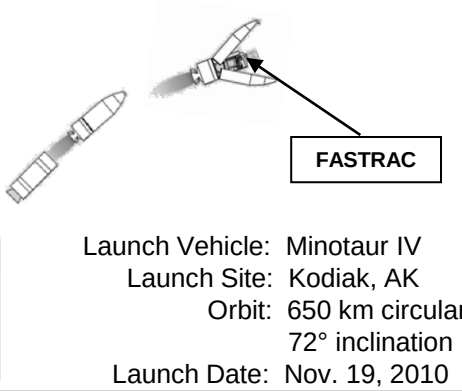


FASTRAC Satellites Mated on STP-S26.
Credit: U.S. Air Force photo by Lou Hernandez

- **Mission Objectives:**
  - **Demonstrate two-way inter-satellite 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 operation using accurate, **single-antenna on-orbit real-time GPS attitude determination**
- **Project Duration:** 2003 – 2011
  - **January 2005 Nanosat Competition**
  - Flight Redesign
  - Integration & Delivery
  - Acceptance Testing at AFRL
  - Software Development/Testing and Hardware Modifications
  - Environmental Testing at AFRL
  - **Launched on STP-S26 on Nov 19, 2010**
- **$ 230K Total Budget For Two Flight Tested Satellites**

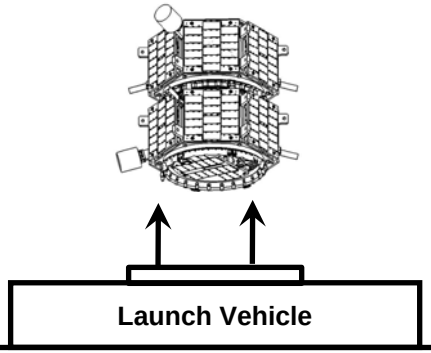
FASTRAC: Concept of Operations & Status

1 Launch & Early Operations: Launch

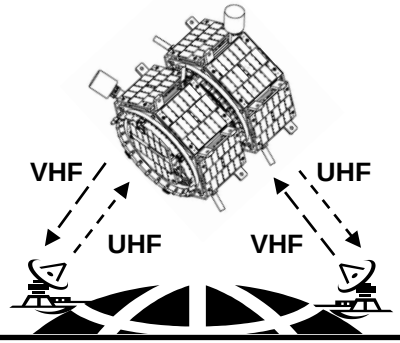


Launch Vehicle: Minotaur IV
Launch Site: Kodiak, AK
Orbit: 650 km circular
72° inclination
Launch Date: Nov. 19, 2010

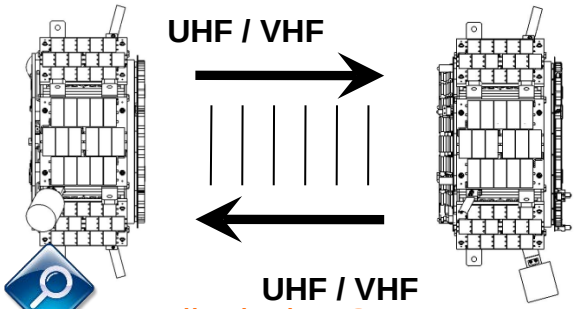
2 Launch & Early Operations: Launch Vehicle Separation



3 Launch & Early Operations: Initial Acqusition & Checkout

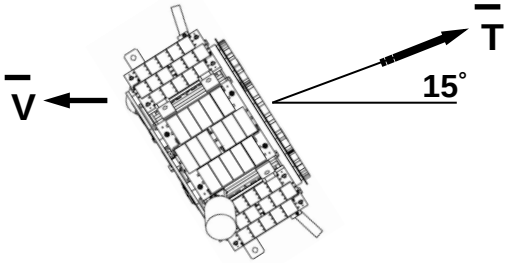


4 GPS Onboard Relative Navigation Using UHF/VHF Crosslink



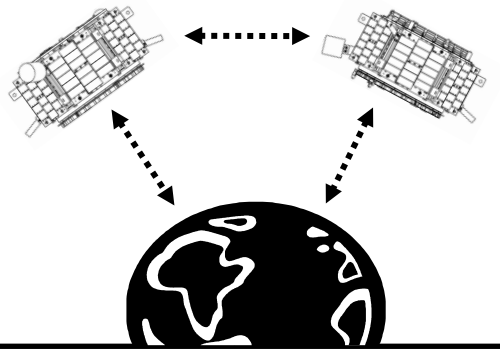
* Full Mission Success

5 Onboard, Single-Antenna GPS Attitude Autonomous Thruster Operation



* Attitude Determination and Thruster Logic Demonstrated

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



Currently Undergoing This Phase

Expected >Summer 2011

FASTRAC: Initial 4 months of Operations

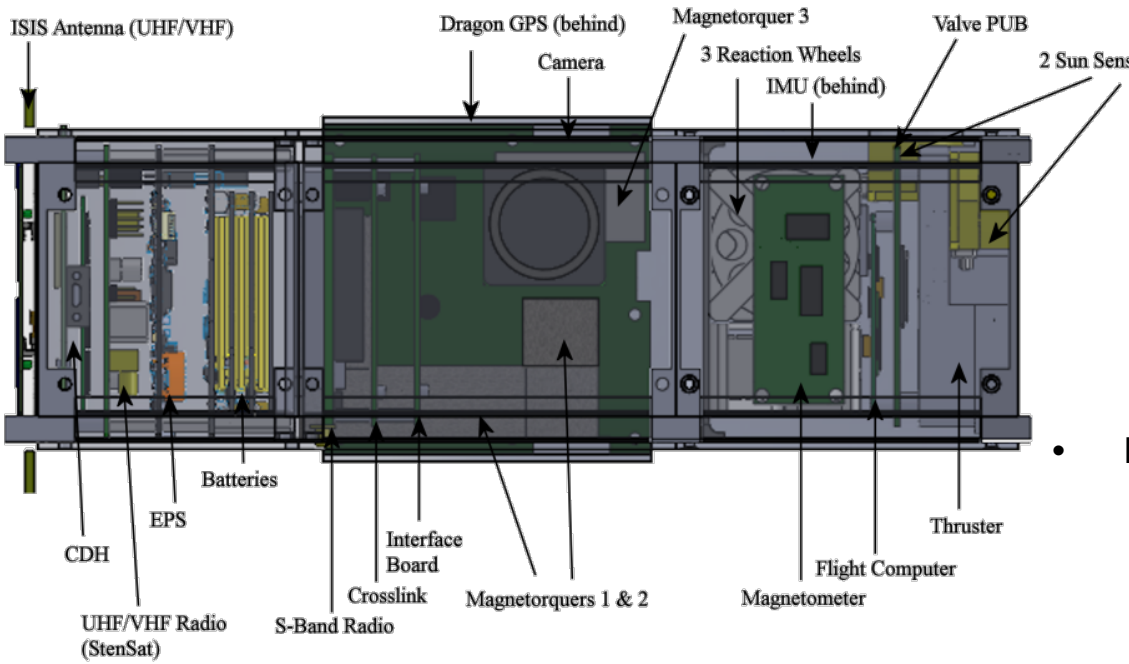
FASTRAC Team awaiting first contact. Nov 20, 2010 @ 6:22 AM CST

Incredible Support from the HAM Community: Uploaded more than 4500 beacon messages from the satellites as of April 18, 2011!

- **First Contact, Launch + 5 hours**
  - HAM Operators from Europe confirmed the satellites were beaconing and alive!
- **First UT-Austin Contact, Launch + 11 hours**
  - Confirmed Receipt of Satellite Beacons
- **First Successful Command of "Sara Lily" from UT-Austin and NASA JSC Ground Stations, Launch + 1 Week**
  - TLE confusion with other satellites on STP-S26
- **First Successful Command of "Emma" from UT-Austin, Launch + 2 Weeks**
  - Used digipeating capabilities designed into the system to control Emma through Sara Lily
- **Separated Satellites, Launch + 4 Months**
  - Confirmed satellites separated and crosslinked
- **Routinely downloading data from both satellites**
  - Both satellites' GPS receivers are obtaining position fixes on-orbit
  - Both satellites' GPS receivers are computing real-time on-orbit attitude solutions
  - Both satellites are healthy
  - Both satellites have crosslinked and exchanged GPS data
- **Ground Station has been operating semi-autonomously**
  - Records all the passes autonomously

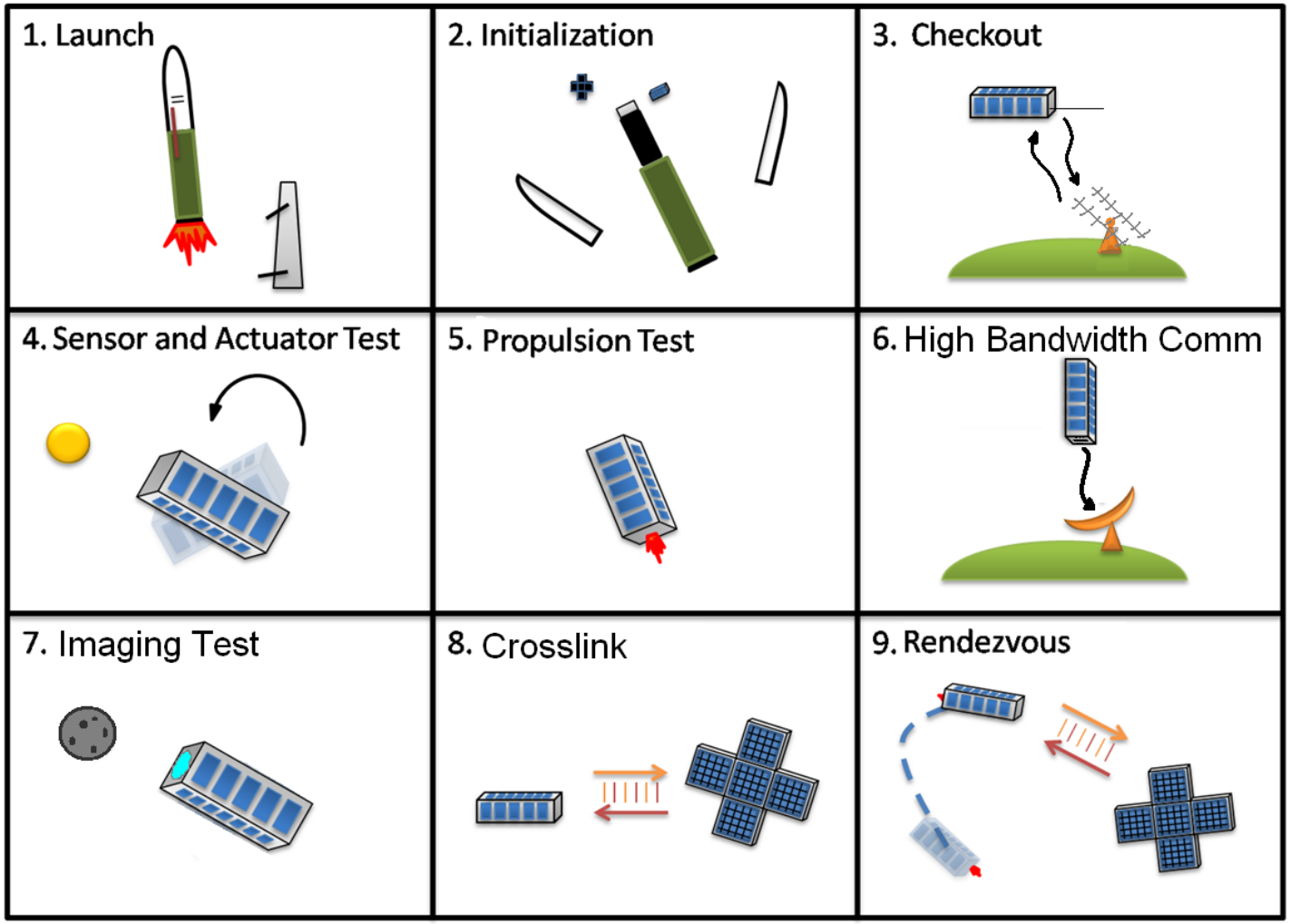
BEVO-2

Part of LONESTAR project: NASA-JSC, Texas A&M, UT-Austin



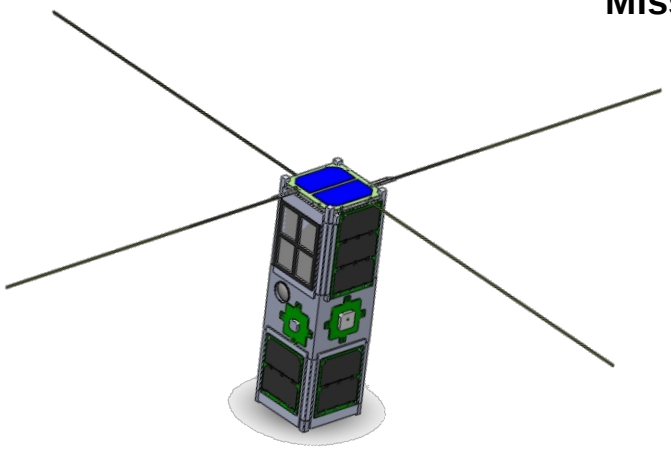
- **Mission 2 Objectives:**
  - Evaluate GN&C sensor and actuator suite performance
  - Evaluate a high band-width communications ground link
  - Evaluate GN&C capability to perform a rendezvous
  - Establish a communication crosslink between two satellites
  - Evaluate imaging capability
- **Mission 3 Objectives:**
  - Evaluate Gen 2 RCS and Gen 2 IMU
  - Demonstrate relative velocity and attitude within TBD requirements
  - Evaluate Gen 1 autonomous flight manager–activity sequencer
  - Demonstrate Gen 1 docking system
- **Mission 4 Objectives:**
  - Autonomous Rendezvous and Docking between 2 University class small satellites

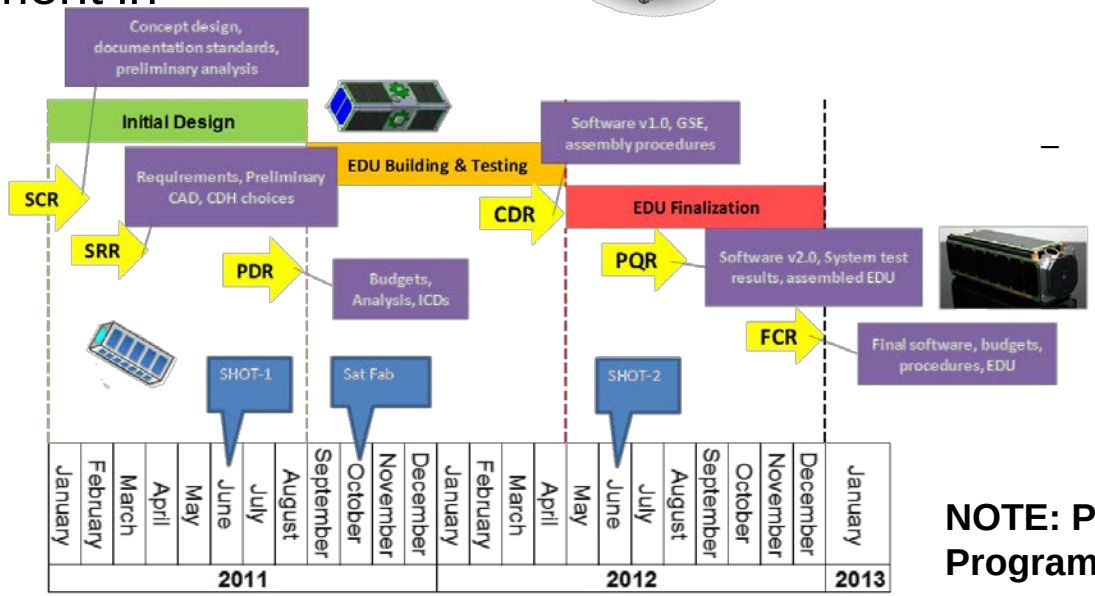
BEVO-2: Concept of Operations



ARMADILLO
A Collaboration Between UT-Austin and Baylor University

Attitude
Related
Maneuvers
And
Debris
Instrument in
Low
(**L**)
Orbit





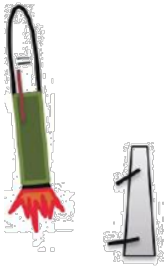
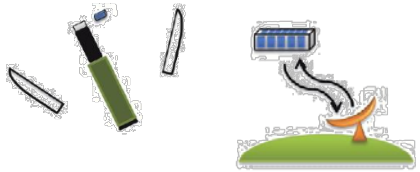
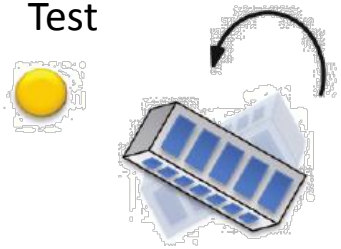
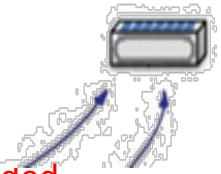
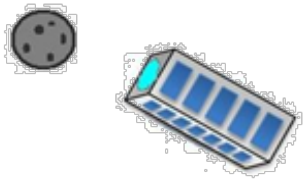
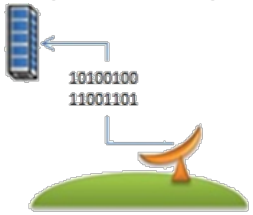
Mission Objectives:

- Characterize the **low altitude space dust** environment and the **orbit effects** of this space dust as potential threats to military satellites.
- Operate a **cold-gas thruster** to **extend mission lifetime** and perform a **controlled de-orbit maneuver** in order to gather more scientific data at different altitudes.
- Establish **optical navigation** by taking and downloading a celestial image to obtain an independent verification of satellite position and attitude.
- Demonstrate **on-orbit reprogrammable software** so the satellite may use updated commands and algorithms.

Develop a **reusable 3U picosatellite bus** for potential use on future missions in an effort to cut design and fabrication costs.

NOTE: Part of University Nanosatellite Program (7)

ARMADILLO: Concept of Operations

1. Launch 	2. Initialization & Checkout 	3. Sensor and Actuator Test 
4. Debris Detection Experiment  *Baylor provided	5. Propulsion Test  **minimum mission success	6. High Bandwidth Communications 
7. Imaging Test 	8. Satellite reprogramming 	9. De-Orbit Maneuver 

Student Involvement

- **All Student Teams**
  - >250 Students Overall Since 2002
- **Range of Disciplines**
  - Aerospace Engineering
  - Mechanical Engineering
  - Electrical & Computer Engineering
  - Information Technology
  - Physics
  - Computer Science
  - Journalism
  - Business
- **Student Engineering, Testing, and Assembly**
  - Spacecraft Technician Training
- **All Student Management**
  - Project Manager & Systems Engineering
  - Students Mentoring Other Students
- **Educational Curriculum Tie-Ins**
  - Labs and Design Courses
  - Student Projects
  - Independent research
- **K-12 Outreach**

Let the Fun Continue for Many More Projects!

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