

DELLINGR



Dellingr: Developing a 6U CubeSat Platform

Behnam Azimi

bazimi@uwm.edu

Luigi Balarinni

luigi.balarinni@gmail.com

James Marshall

jcmars@gwmail.gwu.edu

Electrical Engineering PhD Student
University of Wisconsin–Milwaukee, Milwaukee WI

Mechanical Engineering PhD Student
Stevens Institute of Technology, Hoboken NJ

Computer Science PhD Student
George Washington University, Washington DC

Mission

Dellingr is a 6U CubeSat being developed by GSFC to fulfill two science objectives, validate new hardware, develop new construction processes, and to expand CubeSat capabilities at Goddard. Dellingr will demonstrate a path forward in accomplishing more challenging scientific objectives with CubeSats. The project timeline is one year, with launch slated for summer 2015. We are currently in the build and test phase.

Science Payload

The scientific payload includes a magnetometer deployed on a boom and a set of two internal magnetometers. In addition to collecting data about the magnetic field, the boom mounted magnetometer will validate the use of the two internal magnetometers for future missions.

An Ion Neutral Mass Spectrometer will collect data about the ionosphere-thermosphere-mesosphere system.

In addition to the volume and power constraints imposed, the instruments require pointing (+/- 5 degrees) with knowledge (+/- 0.1 degrees).

Fine Sun Sensor

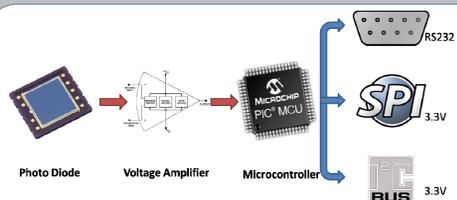
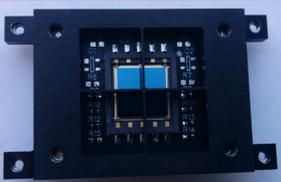
Behnam Azimi -

The Fine sun sensor determines the spacecraft body's angles with respect to the sun. This information is used for rotating the spacecraft and therefore applied in earth pointing devices and solar array orientation.

Number of FSS in spacecraft: 3

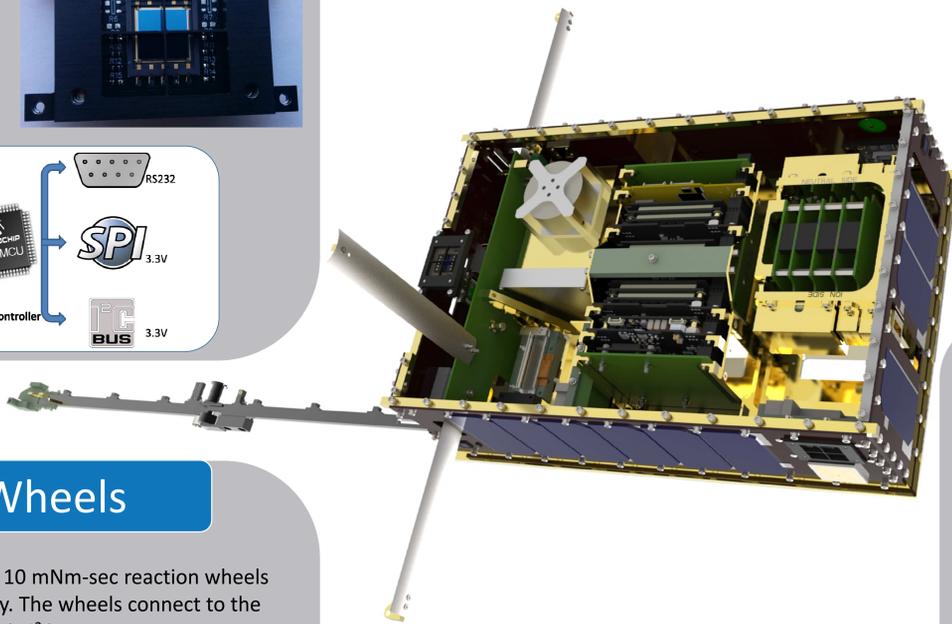
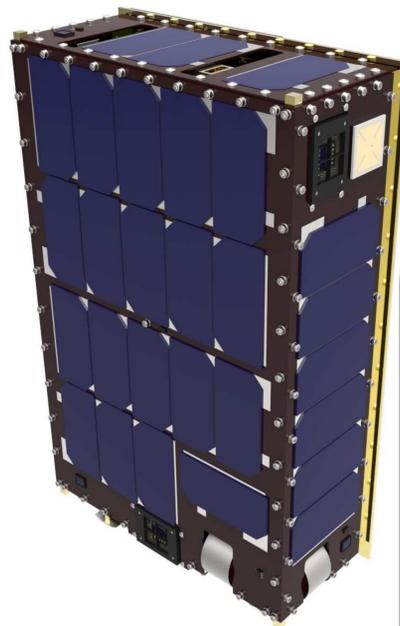
Communication protocol: SPI

Responsible for writing the microcontroller code in FSS board and modify the design of hardware for supporting SPI.



Acknowledgements

We would like to thank our mentor, Charles Clagett, the Dellingr Team, and everyone at NASA for their support and guidance. This has been a memorable and valuable internship.



GPS / Antenna

Behnam Azimi -

Dellingr uses Novatel OEMV-1G for GPS. GPS will provide an independent time source, plus eliminate the need for an accurate onboard ephemeris.

Responsible for testing of GPS and writing the code for retrieving position and time from the GPS. Also modified the PCB for the GPS Antenna from the Firefly GPS Antenna.



Solar Panel

Luigi Balarinni -

Dellingr uses in-house developed solar panels to reduce costs, increase functionality, and allow custom geometry.

Additional functionality:

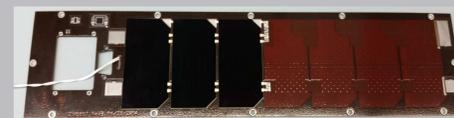
- Mounting for Custom Solar Cells
- Magnetorquers for Spacecraft Orientation
- Temperature Sensor for Cell Monitoring
- Fine / Coarse Sun Sensor for Navigation
- GPS antenna / Camera

Dellingr's Solar Panel boards will use Pressure Sensitive Adhesive Tape, shown here, to adhere the solar cells.

Manufacturer: Caplinq PIT2SD/38.1

Tape > RTV Silicon due to:

- Simplicity
- No Equipment Required
- Quick Turnaround

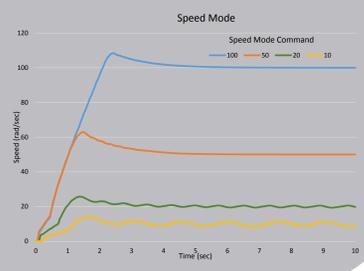
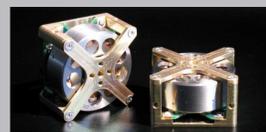


Reaction Wheels

James Marshall -

Dellingr uses 3 Sinclair Interplanetary 10 mNm-sec reaction wheels to provide +/-5 degree pointing accuracy. The wheels connect to the special services card and communicate via I²C.

Responsible for testing / validation, providing communication with the wheels, and deriving a model of the wheels for using in the Attitude Control System. Communication software is complete, and I am currently employing a "grey"-box system identification approach to modeling the wheels.

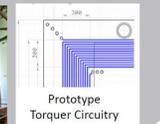


Magnetorquers

Luigi Balarinni -

The Attitude Control System uses Reaction Wheels and Magnetorquers for quick and gradual orientation, respectively. Magnetorquers are made from loops of copper wire. When electrical current runs through the Magnetorquer, the electricity creates a magnetic field. This magnetic field will interact with the Earth's field and change the orientation of the CubeSat.

The Magnetorquer is integrated within the Solar Panel PCB Board. 19 loops x 15 mm wide x 10 mm space x 6 layers 114 loops => 0.215 A-m² theoretical torque.



Run	milliAmps	Mag Moment, A*m ²
1	75	0.1748
2	65	0.1522
3	55	0.1389
4	45	0.1072
5	35	0.0831

Power System

James Marshall -

The Electrical Power System (EPS) and batteries are both 3rd generation Clyde Space products. The EPS has six 12W battery charge regulators, has ten controllable switches, and outputs power at 3.3V, 5V, and 12V. The batteries are three 30Wh modules, each with built in heaters. All connect via the CubeSat Kit Bus.

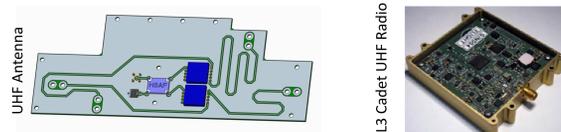
Responsible for basic testing and validation, implementing communication routines over I²C, and providing a library of functions to access telemetry and command the components.

Radio / UHF Antenna

Behnam Azimi -

Dellingr uses L3 Cadet UHF Radio, which is a Half duplex UHF CubeSat radio with 9600 bps GFSK modulation for uplink and 3.0 Mbps OQPSK modulation for downlink. The Radio connects to main processor via serial port with a baud rate of 57600.

Responsible for testing the radio and writing the code for the main processor to communicate with the radio as well as the design of the PCB for the UHF antenna.



Future Work

The next major steps will involve software development, integration, and full system testing. Our internships have been extended so that we may learn more about this process.

Software development will consist of porting NASA's core Flight Executive (cFE) to FreeRTOS, the OS running on the main flight computer, a GomSpace NanoMind. Applications and libraries will then be developed for each component.

While some component level testing has been completed, most testing will be done on the system as a whole. This approach is appropriate given the large number of COTS components and extremely limited schedule.

Coarse Sun Sensor / MEMS Gyro

Behnam Azimi -

Dellingr uses 6 Coarse Sun Sensors. Each Coarse Sun Sensor (CSS) delivers coarse information about the position of the sun relative to the spacecraft. This information is used for coarse maneuvering of the spacecraft and to inform the spacecraft about the position of the sun when it is in a safe mode of operation. Each CSS directly connects to an ADC on the main computer board. The MEMS Gyros also provide information for determining attitude.

Responsible for testing the CSS and MEMS gyro as well as writing the code to communicate between Gyro and main processor.

