# RFTSat: Backscatter Communication in Low Earth Orbit

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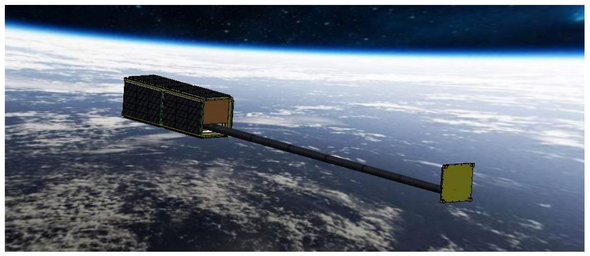
## Introduction

The NNU RFTSat is a 3U CubeSat that will perform a technology demonstration of wireless, radio frequency (RF) tags that harvest RF energy. These tags communicate data and commands with the spacecraft using backscatter technology. The RF tags can be configured to measure various occurrences such as radiation, temperature, acceleration, electric field strength, and magnetic field strength. During the mission, the RF tags will be deployed to demonstrate the range and effectiveness of the RF system in the environment of space. In the upcoming mission, RFTSat will focus measurements on space weather and radiation.



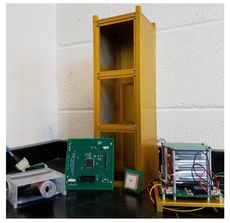
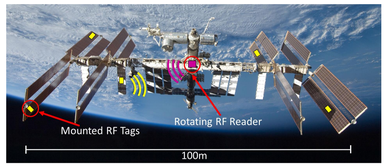


Figure 1: CAD mockup of RFTSAT in Orbit

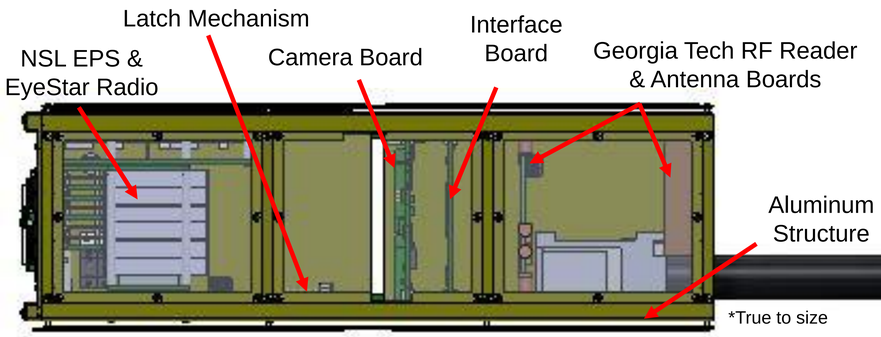
If proven successful and effective, this technology could be implemented on the International Space Station




## Flight Code and Interface Board

The Flight Code being written will be programmed on an MSP430 microcontroller mounted on the Interface Board and will act as the brain of RFTSat, responsible for:

- Latch and Boom deployment
- Controlling the collection and distribution of data
- Maintaining power levels
- Controlling Communication with Earth


*True to size

## Mission Objectives

NNU RFTSat expects to launch in 2018 with the objective of successfully measuring space weather using distributed, passive RF sensor tags. The objectives of the mission are:

- Collect space weather data wirelessly from an energy harvesting RF tag
- Demonstrate data collection at various distances of space between the RF reader and RF tag
- Provide sustained data throughout the satellite's life

### RFTSat Subsystems

The RFTSat subsystems will be built primarily using commercial off the shelf components. The frame, electrical power system (EPS), radio, batteries, and on-board computer (OBC) have and will be selected with the goal of conserving power for extended mission life. Figure 2 shows the top level diagram of the RFTSat subsystems.

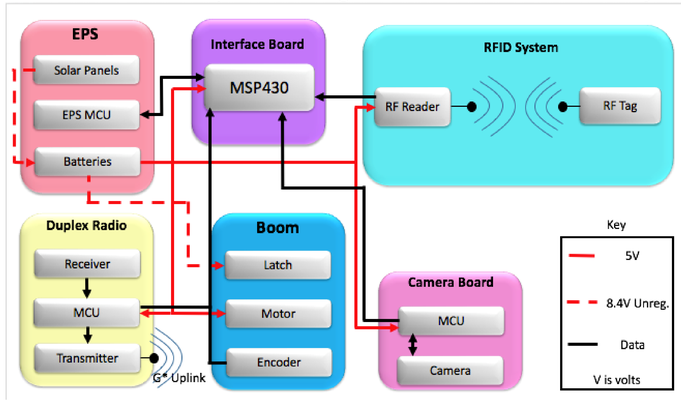


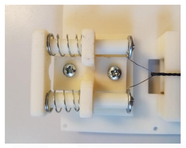

Figure 2: RFTSAT Systems Functional Block Diagram

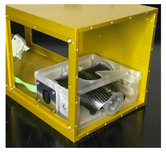
## Boom and Latching System

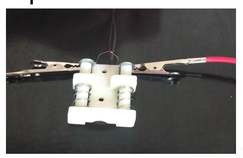
RFTSat has a unique design, in which the endplate will be detached from the frame of the satellite once launched. The endplate, which houses the RF tag, will be extended out one meter via the carbon fiber boom.

A "latch system" will be used to secure the endplate until the satellite is deployed in space.
The latch system must:

- Secure the endplate to withstand launch vibrations
- Release the endplate without impeding later boom deployment
- Withstand extreme temperatures found in space







## RF Backscatter Technology

The RF tag system being used is a wireless system based on the designs of backscatter tags that are already implemented on earth. The RF system consists of a reader, which broadcasts electromagnetic radiation, and a tag which harvests that radiated energy to perform sensor measurements. The tag communicates information back to the reader by modulating the RF signal scattered from the tag antenna. This technology presents the ability to communicate with simplified design, and eliminates the need for batteries and wiring to the tag. This eliminates various risks of noise and interference when transferring data.

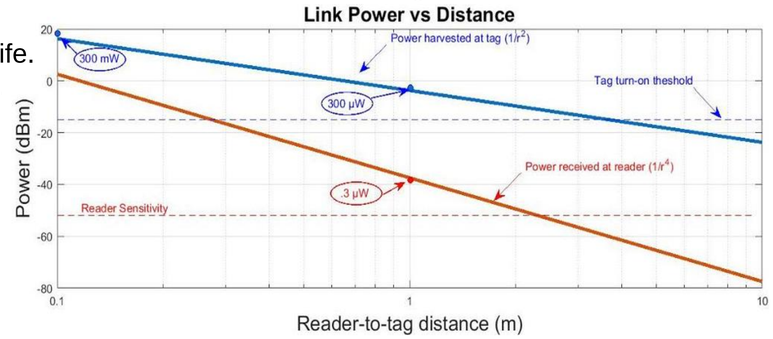



Figure 3: Link Budgets for RF Reader and RF Tag (r is Radius)

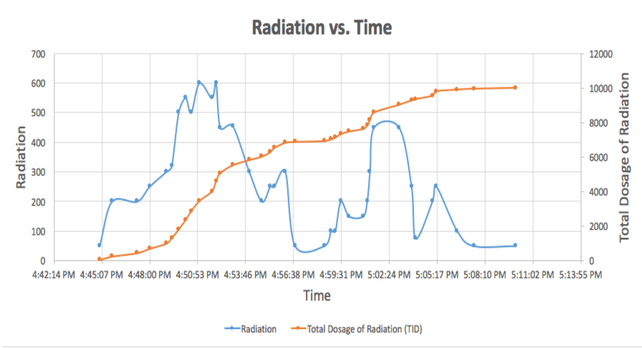


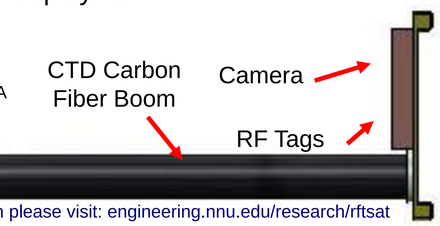

Figure 4: Model of Data Expected from Radfet on the RF Tag Board

## Caldwell High School

RFTSat will partner with CHS as they look to put a camera on the satellite to visually document mission success; primarily boom deployment.

### Acknowledgements

- Greg Durgin, Georgia Tech
- NASA USIP Grant NNX16AI77A




For more information please visit: engineering.nnu.edu/research/rftsat