Technical Description - Virginia Tech (Ceres)

The Ceres mission goals are to:

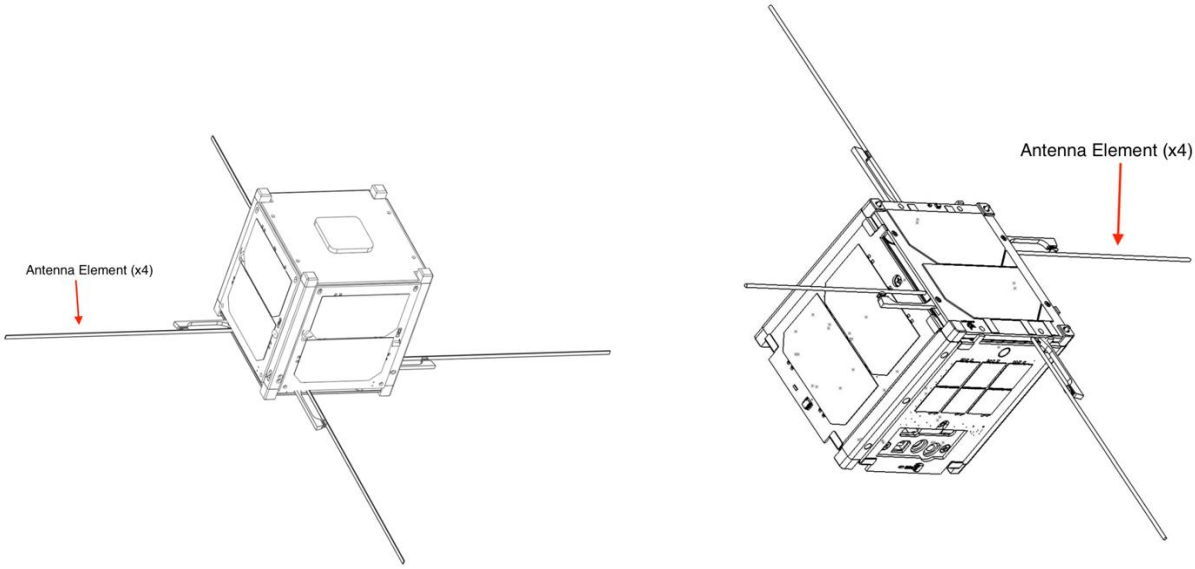
1. Provide a hands-on, student-led flight project experience for undergraduate students by designing, developing, integrating, testing and flying a 1U CubeSat.

2. Obtain measurements of the orbital decay of a constellation of satellites to develop a database of atmospheric drag and the variability of atmospheric properties.

The satellite will launch November 8, 2018, on an Orbital ATK Antares II Cygnus ISS resupply mission. It will be deployed from the International Space Station via the NanoRacks CubeSat Deployer January 8, 2019. It will be inserted into a 400 km circular orbit, at an inclination of 51.6 degrees. The orbital lifetime is estimated to be 2 years. See the mission ODAR for details.

The spacecraft, shown in Figure 1 below, is a 1U CubeSat with nominal dimensions of 105 mm X 105 mm X 113 mm, massing about 1.3 kg.

Figure 1: VT Satellite Overview



Ceres (VT)

Description of Subsystems

Communications Subsystem:
For communication with ground stations the satellite uses an AstroDev Li-2 Lithium radio using a nominal 2 W transmit power operating in the UHF frequency range. The data will be packaged in the AX.25 format and will use the GMSK modulation scheme. Uplink commands will be encrypted, and telemetry downlinks will be unencrypted. Telemetry downlinking is initiated based on receipt of a valid uplink command from the ground station.

Payload Subsystem:
The payload on the satellite, for investigating atmospheric density as it affects orbit decay, consists of a microelectromechanical systems (MEMS) three-axis magnetometer and MEMS three-axis gyroscope in an inertial measurement unit and external sun sensors to determine the spacecraft's attitude and a GPS receiver to determine spacecraft's position.

Software and Data Handling Subsystem:
The satellite records magnetometer, gyroscope, sun sensor, and GPS position versus time, and will store that data on SD cards for downlinking. Ceres uses a Texas Instruments MSP430 series microcontrollers, one for interfacing with the radio and one for flight operations, and will use Free RTOS (real time operating system).

Attitude Determination and Control Subsystem:
The satellite will use passive magnetic attitude control to align the satellite with earth's magnetic field using a combination of permanent magnets, and hysteresis material. Contingent upon software development, Ceres can also implement active pointing using magnetorquers. The satellite will use a combination of magnetometer, gyroscope, and sun sensor data to determine orientation.

Power Subsystem:
Ceres uses Clyde Space electrical power systems (EPS) with integrated 20 Wh batteries and a combination of Clyde Space and EnduroSat solar panels.

Structures Subsystem:
The side panels are constructed from a 3D printed material, Ultem thermoplastic substrate, with a carbon nanotube embedded matrix. The rails and the two end-plates are constructed from aluminum.