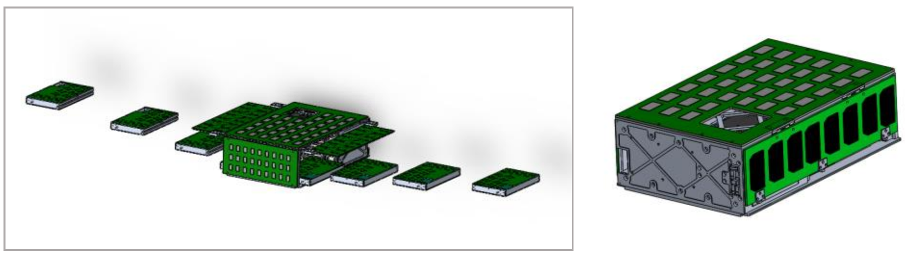
ANDESITE Satellite Technical Description

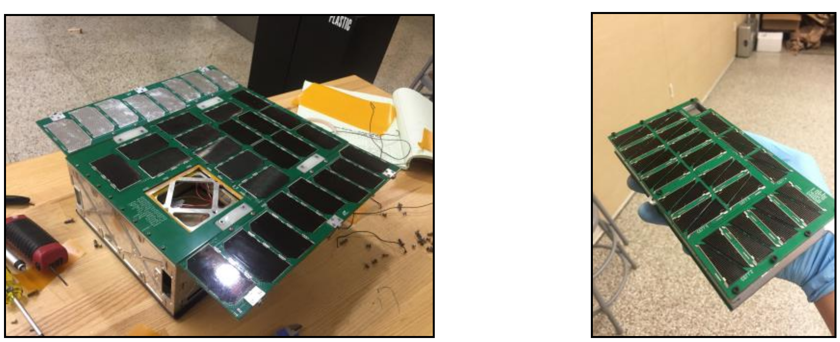
Mission and Satellite Description

Space weather arises from interactions between the Earth's plasma environment and the impinging solar wind. These interactions can damage satellites, harm astronauts in space, render GPS information erratic and unreliable, disrupt ground-space communications, and even cause electricity blackouts on Earth. ANDESITE is a small satellite swarm dispersed in orbit over tens of kilometers; it will measure relative variations of the Earth's magnetic field as it flies through the aurora. This will support mapping the current densities due to energetic charged particles moving into and out of the atmosphere, in the polar regions where the aurora occurs, to improve our understanding of space weather.

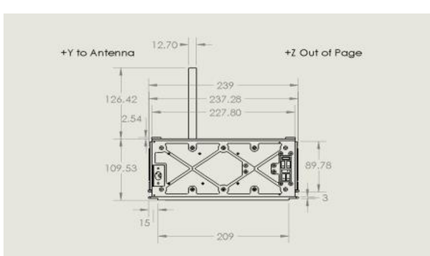
ANDESITE will be launched from the Rocket Labs New Zealand launch site, into a 500 km circular orbit at 85 degrees' inclination, in November of 2017.



(a)



(b)



(c)

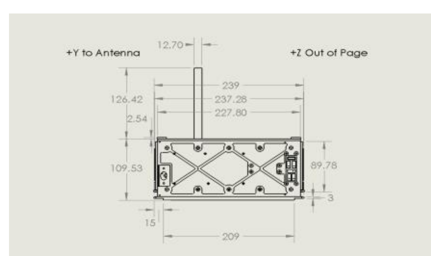


Figure 1: (a) Full satellite system with Mule and Sensor Nodes pulled out in direction of deployment and aggregate system as it will be deployed (b) Engineering models of 6U Mule and Sensor Node. (c) Schematic of Mule with dipole antenna deployed, each node has similar antenna (GlobalStar patch antenna is recessed in hole on top of the 6U bus)

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ANDESITE consists of 8 identical deployable Sensor Nodes, and a 6U “data Mule.” All 9 satellites deploy from the launch vehicle with the Sensor Nodes contained in the 6U Mule (see the above Figure 1a). At the time of deployment, the attitude control system stabilizes the aggregate satellite using magnetic torque coils. When stabilization is confirmed from mission control, Sensor Nodes will be ejected from the Mule, one pair per orbit. Drag will cause the ejected Sensor Nodes to lag behind the Mule along the orbit track. Each Sensor Node, 17.5 x10 x 1.75 cm, mass 380 g, contains its own electrical system, battery and solar panels.

Following the mission, the Sensor Nodes will lag out of radio contact and having no contact will shut down, while the main 6U will remain active to downlink data through the GlobalStar network. The Sensor Nodes will deorbit within a matter of months after launch, while the Mule will continue collecting and downloading single point magnetometer data for the remainder of the two year mission. The Mule will stay on orbit for about 4.2 years (see the Orbital Debris Assessment Report for details).

Communications Subsystem: The Mule communicates with ANDESITE mission operations via the Globalstar network, using a NearSpace Launch / GlobalStar Eyestar Duplex model duplex radio.

The Mule and each Sensor Node have a HOPERF Electronic model RFM22B short range duplex transceiver, operating with monopole measuring-tape antenna, ~6.5 inches in length (seen in Figure 1c). The Mule and the Sensor nodes communicate via a mesh topology, with Sensor Nodes relaying data to and from the Mule.

Guidance, Navigation and Control (GNC) Subsystem: The GNC on board the Mule is a simple feedback controller using magnetic torque coils, built by ISI Space, to cancel out environmental torques. It takes data from a set of gyros, sun sensors, GPS receiver and on-board magnetometers. The Sensor Nodes have no attitude control, but include a GPS receiver for localization of the science magnetometer data.

Command and Data Handling (CDH) Subsystem: The Mule CDH includes a flight computer based on an off-the-shelf Beagle Bone Black (BBB). The BBB operates regardless of the state of the rest of the subsystems. The BBB interfaces to the GlobalStar transceiver, and to the Sensor Node, and performs basic spacecraft state of health monitoring.

The Sensor Node CDH is a set of Arduino micro-controllers interfacing to the RFM22B transceiver.

Electrical Power Subsystem (EPS): The Mule EPS is a direct energy transfer system using a solar array producing approximately 16W of orbit average power to charge the 30 W-hr battery system. Solar panels and batteries are flight heritage models from Clyde Space. The solar arrays utilize standard Improved Triple Junction (ITJ) Solar Cells from Spectrolab. The EPS board communicates to the Power Switch Boards to control charging and load switching.

The Sensor Node EPS’ include solar panels producing approximately 5 W of orbit average power, to charge the 37 W-hr battery system. Solar panels use Spectrolab TASC cells and batteries are single cell Lithium Polymer pouches.

Thermal Control Subsystem (TCS): All elements are passively temperature controlled through coatings and hardware placement.

Structure Subsystem: The structure is fabricated of Aluminum 6061, and an anodized baseplate that conforms to the deployer specifications is made from Aluminum 7075. The Sensor Node is also Aluminum 6061.

Propulsion Subsystem: No propulsion subsystem is included.

Payload Subsystem: The payloads are off-the-shelf magnetometers from Honeywell, used to measure the magnetic field at each of the sensor nodes, to support the science mission described above.