TECHNICAL DESCRIPTION CACTUS-1

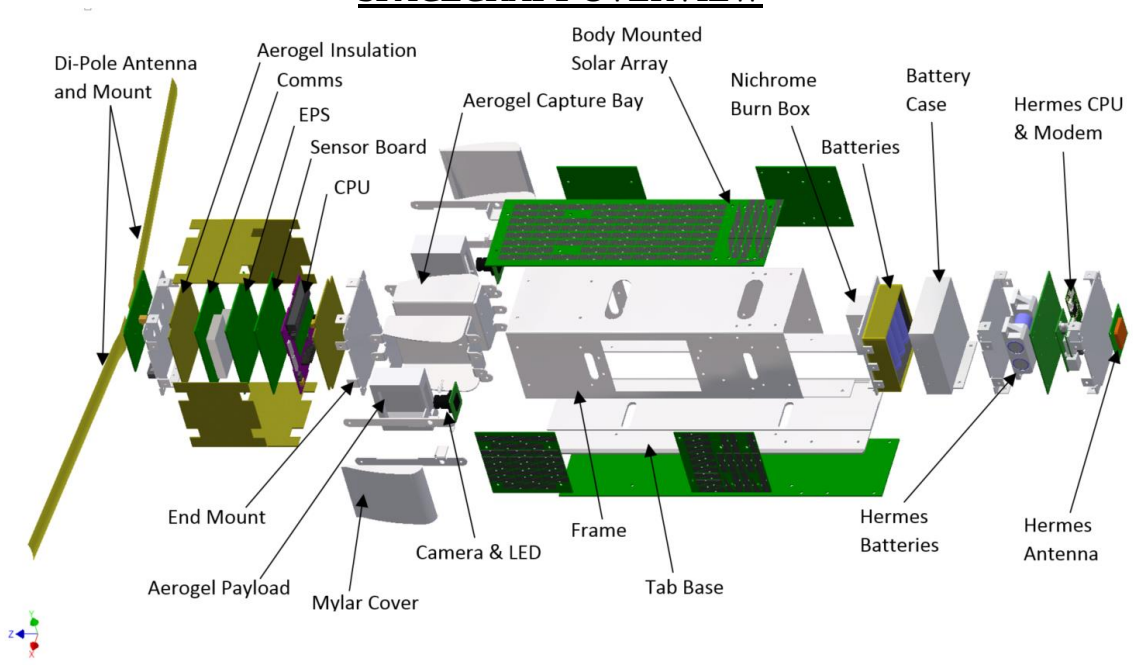
Capitol Technology University

The overall goal of the CACTUS-1 mission is to profile and capture micrometeorites and micro-debris, using aerogel. This will demonstrate technology for cleanup of LEO. It will also provide a technology demonstration for an Iridium communication and command subsystem, and verify our bus design (which is based on open hardware designs).

The satellite will be launched as a secondary payload aboard Virgin Galactic Launcher 1, from Mojave, California, USA, December 2017. It will be inserted into a near circular polar orbit at about 500 km altitude, on an inclination from the equator near 90 degrees. Cactus-1 will be able to communicate after a charging orbit following deployment. Transmission of health and safety telemetry and payload data occur when commanded by the ground; these transmissions are capped by the flight system at no more than 10 minutes duration (or when a turn-off command is received from the ground, whichever comes first). The satellite is also capable of short periodic health packet transmissions at scheduled intervals for monitoring purposes, the interval of which (e.g. every 10 minutes for the next 2 orbits) can be sent by ground commands; the default state is no periodic transmissions. Also, the satellite can be set by command from the ground, to respond to amateur user 'pings' with a short telemetry packet to support educational use.

Our minimum mission success criteria is two weeks of working operations; our nominal mission duration for scientific results is 3 months; our extended optional mission duration is 2 years. The time to deorbit is TBD; see the the ODAR (Orbital Debris Assessment Report) for details.

SPACECRAFT OVERVIEW



The spacecraft is a single 3U++ cubesat with the dimensions of approximately 36.6cm x 10.3cm x 11.0cm.The total mass is roughly 2.75 kg.

SUBSYSTEM DESCRIPTIONS:

Guidance, Navigation and Control (GNC) Subsystem:

The CACTUS-1 spacecraft will use Passive Magnetic Attitude Control or PMAC, comprised of a pointing magnet for attitude control, and hysteresis rods for angular momentum dampening.

Command and Data Handling (C&DH) Subsystem:

The C&DH for CACTUS-1 utilizes a main frequency 433.050-434.790Mhz. This is accomplished through using a Radiometrix TR2M-433-5 multi-channel transceiver with AFS2-433 RF power amplifier. The Antenna is a full wave dipole tape antenna. The system is controlled by a PiSat board running NASA's open source Core Flight Software (CFS).
The second or experimental Hermes comms system is comprised of an Iridium modem 9603 N transceiver and a helicoil 48mm antenna.

Electrical Power Subsystem (EPS):

The primary EPS is a direct energy transfer system using the solar array to produce 3.08W average. This is composed of (6) 1U and (2) 0.5U solar panels using Trisol 28% efficient GaAs triple junction solar cells, it utilizes (4) COTS 18650 3.7V 28090 mAhr Lithium ION battery cells. The EPS drives the primary PiSat board, which acts as the distribution hub for the sensors and payloads. Nominal power usage is 1.77W with an additional +1.1W when transmitting.

The Hermes payload EPS consists of (4) 0.5U solar panels using Trisol GaAs 28% efficiency solar cells, and (3) COTS 18650 battery cells. To turn on the entire CubeSat, there are two powered inhibit switches and 1 SW timer to ensure that the spacecraft is triggered on when launched from the launcher.

Thermal Control Subsystem (TCS):

The TCS insulates the card stack of the CubeSat with Aerogel blanketing insulation. Embedded sensors within all systems monitor temperatures. Onboard software system monitoring and procedures will maintain the temperature by deciding which sections to turn on or off, or speed up or slow down the processor or hibernate.

Structure Subsystem:

This structure is a 3U++ canisterized payload (based on 12/2016 IDD). The structure is fabricated with 7075 Aluminum for the outside structure.

Propulsion Subsystem:

There is no propulsion subsystem within the spacecraft.

Payload Subsystems:

The TRAPSat (TRapping with Aerogel Prototype Subsystem) payload on Cactus-I will be used to capture micro-meteorites and other various types of space debris. This system will include Silica Aerogel monolith as the main instrument for the capture and a camera to take a picture of the Aerogel. The Aerogel will be placed within a 3D printed RASC (Raised Aerogel Support Container) for secure placement. The data collection will be stored through the PiSat compute module.

The second payload, Hermes, will use a COTS Iridium 9603 Modem to serve as an experimental communications payload, with bidirectional communication to the ground station via the Iridium Constellation of satellites. This system will use a Raspberry Pi Zero as the compute module.