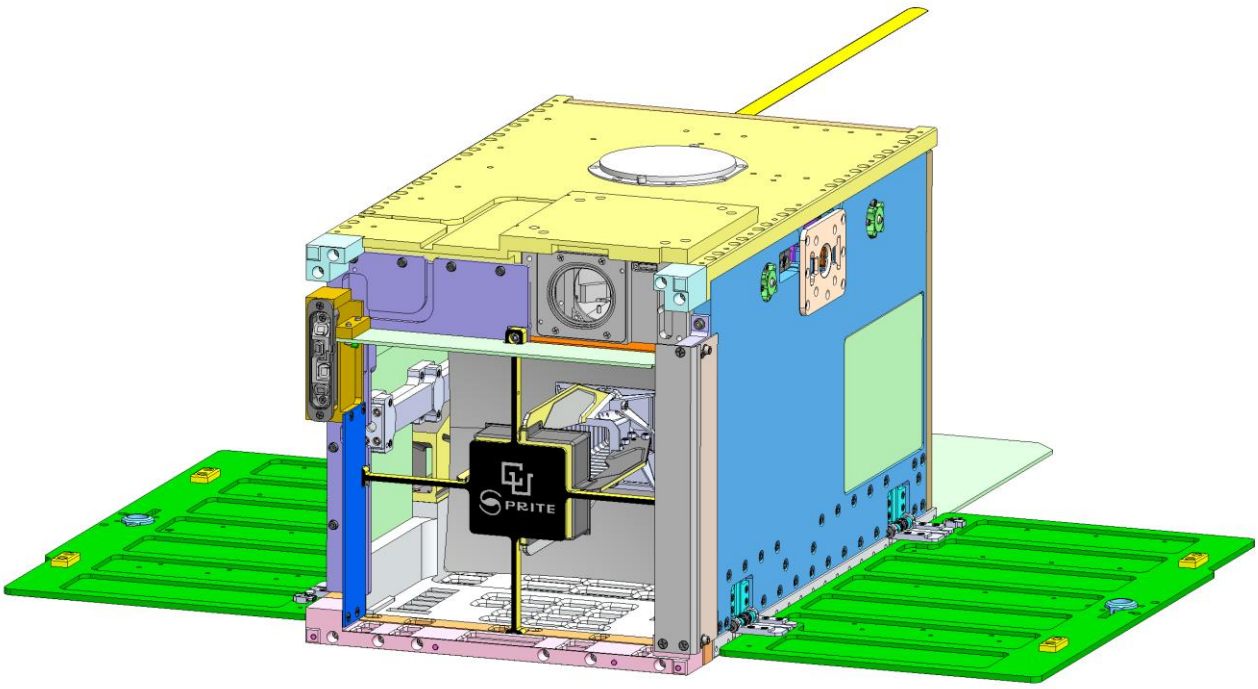
SPRITE Satellite – Technical Description

The overall goal of the Supernova Remnants and Proxies for ReIonization Testbed Experiment (SPRITE) is to measure the ionizing radiation that leaks from nearby galaxies in the Far-Ultraviolet (100 – 175 nm) in order to assess how such radiation is transported from deep within neutral gas clouds to the ionized intergalactic medium. This measurement will help us understand how mass and energy flows within galaxies, and how massive stars impact their surroundings and drive galactic winds. In tandem, SPRITE will test several new technologies for astronomy, including advanced mirror coatings for the deep ultraviolet that have enhanced reflectance and environmental stability. SPRITE will also carry a compact, high efficiency telescope for a CubeSat, maximizing the potential of this small craft for exploring deep space phenomena.

The satellite will be launched as a secondary payload aboard a Space-X Falcon 9, with the primary payload the TRACERS mission, No Earlier Than April 13, 2025. It will be inserted into an orbit at 510 km apogee and 510 km perigee, on an inclination from the equator of 97.4 degrees. Transmission will begin 30 minutes after deployment, and cease at the end of the mission (nominally 2 years after launch). Atmospheric friction will slow the satellite and reduce the altitude of the orbit, until de-orbiting occurs approximately 2.5 years after the end of the nominal mission. See the Orbital Debris Assessment Report for details.

The spacecraft is a single unit with the dimensions of 12x ~ 10 cm X 10 cm X 10 cm CubeSat modules (giving an overall dimension of 22.6 cm X 22.6 cm X 39 cm.) The total mass is about 19.5 Kg.

Figure 1 SPRITE Overview with the S-band patch antenna and UHF antenna shown.



SPRITE contains the following systems:

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Attitude Determination and Control (ADCS) Subsystem: The SPRITE ADCS is a Blue Canyon Technologies (BCT) XACT-15 module consisting of three reaction wheels to control the spacecraft pointing, and torque rods to offload momentum. The system pointing is determined by a star tracker, which will direct the SPRITE spectrograph to observe stellar and extragalactic sources. This unit is critical to the SPRITE mission.

Spacecraft Avionics Subsystem: The SPRITE avionics stack consists of four interconnected custom circuit boards, including a command and data handling (C&DH) system with FPGA and flash storage, an electrical power systems (EPS) board that regulates power to other subsystems and facilitates battery charging (see separate subsection for more detail), a generic interface board (GIFB) that interfaces with spacecraft systems, including the ADCS, UHF and S-band radios, and thermal subsystems, and a SPRITE-specific interface board (SPIFFY) that interfaces with the SPRITE science instrument.

Electrical Power Subsystem (EPS) – (part of the Avionics Stack): The EPS subsystem regulates power to the spacecraft and science instrument, taking power from the solar arrays at approximately 36W of orbit average power to charge the 6.4 A-hr Space Inventor BAT-P3 battery system. The solar arrays utilize standard AzureSpace 3G30A photovoltaic cells; the BAT-P3 employs COTS Panasonic 18650B cells. The EPS board controls charging and load switching based on signals from the C&DH. At the end of the mission, a series of LS-9505M MilSpec latching relays will disconnect the SPRITE solar panels from the battery permanently, while a load resistor drains the remaining battery charge, satisfying the requirement for safe decommissioning.

Communications Subsystem (COMMS):

The COMMS includes both UHF (SpaceQuest TRX-U) and S-band (Clyde Space STX) transceivers. The UHF antenna is a custom fabrication consisting of a deployable gold coated copper rod mounted to the spacecraft chassis. The S-band antenna is a Clyde Space patch antenna. The primary ground station is located in Boulder, Colorado at the University of Colorado, with both UHF and S-band receivers, and UHF uplink capability. A similar ground station in Alaska owned by the University of Colorado Boulder, will be available also.

In conformance with § 5.107 Transmitter control requirements, all transmission from the satellite can be terminated by sending the proper command to the spacecraft over UHF.

Thermal Control Subsystem (TCS): The TCS warm-biases the temperature of the SPRITE telescope and detector system by utilizing Birk 2.5W and 5W patch heaters, with feedback from mounted thermistors. Thermistors are wired to the C&DH through the GIFB for control of the heaters.

Structure Subsystem: The SPRITE chassis is fabricated from aluminum and light-weighted where appropriate.

Propulsion Subsystem: No propulsion subsystem is included.

Payload Subsystem: The SPRITE science instrument consists of a telescope feeding a compact spectrograph system. The payload records spectra in the far-ultraviolet, which is only accessible from space, on a microchannel plate detector system.