Small Sat Conference 2012

Utah State University – Logan UT

CubeSat Subsystems

- Power
- Attitude Control
- Processors
- Communications
- Tech Development
- Using non-hardened or non-flight electronics
- Commercial products

Power Considerations

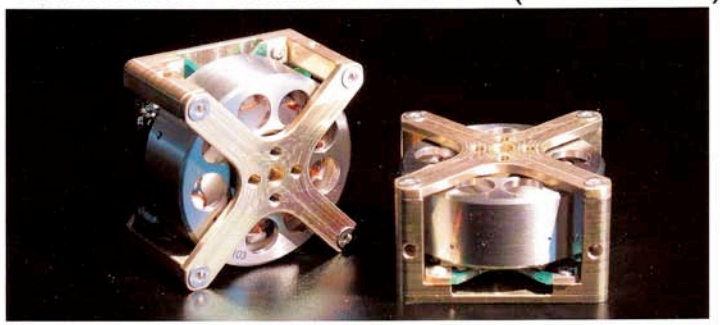
- Solar cell degradation due to radiation
- Avoid the need for trickle charging

Attitude Control & Deorbiting

- Reaction Wheels
- Torque Coils
- Electro-dynamic Tether
- Thrusters

Reaction Wheels

Picosatellite Reaction Wheels (RW-0.01-4)



Nominal Momentum	10 mNm-sec @ 3410 RPM
Nominal Torque	1 mNm
Control Mode	Speed or Torque, built-in control CPU
Command / Telemetry	UART or I^2C/SMBus
Mechanical	50 mm x 50 mm x 30 mm, 120 g mass
Supply Voltage	3.4 to 6.0 V nominal (8 V max)
Supply Power	0.7 W maximum under full torque 0.16 W @ 3410 RPM steady-state 0.1 W @ 2000 RPM steady-state
Environment	-40°C to +70°C operating temperature >12 g_{RMS} Vibration, >20 krad radiation dose
Reliability	Diamond coated hybrid ball bearings Redundant motor windings Radiation lot-screened parts
Heritage	Common design to RW-0.03-4, with >3 year on-orbit 9 Flight units delivered, awaiting launch

Sinclair Interplanetary

UTIAS SFL Space Flight Laboratory

+1-647-286-3761 dns@sinclairinterplanetary.com

Rev 2011a

Electro-dynamic Tether

TETHERS UNLIMITED

Advanced Technologies for Space, Sea, Earth, and Air

Electrodynamic Tethers

An **electrodynamic tether** is essentially a long conducting wire extended from a spacecraft. The gravity gradient field (also known as the "tidal force") will tend to orient the tether in a vertical position. If the tether is orbiting around the Earth, it will be crossing the Earth's magnetic field lines at orbital velocity (7-8 km/s!). The motion of the conductor across the magnetic field induces a voltage along the length of the tether. This voltage can be up to several hundred volts per kilometer.

In an "electrodynamic tether drag" system, such as the Terminator Tether, the tether can be used to reduce the orbit of the spacecraft to which it is attached. If the system has a means for collecting electrons from the ionospheric plasma at one end of the tether and expelling them back into the plasma at the other end of the tether, the voltage can drive a current along the tether. This current will, in turn, interact with the Earth's magnetic field to cause a Lorentz **JXB** force which will oppose the motion of the tether and whatever it is attached to. This "electrodynamic drag force" will decrease the orbit of the tether and its host spacecraft. Essentially, the tether converts the orbital energy of the host spacecraft into electrical power, which is dissipated as ohmic heating in the tether.

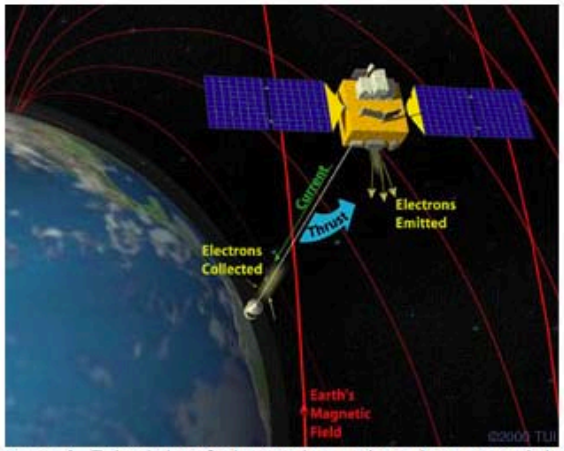
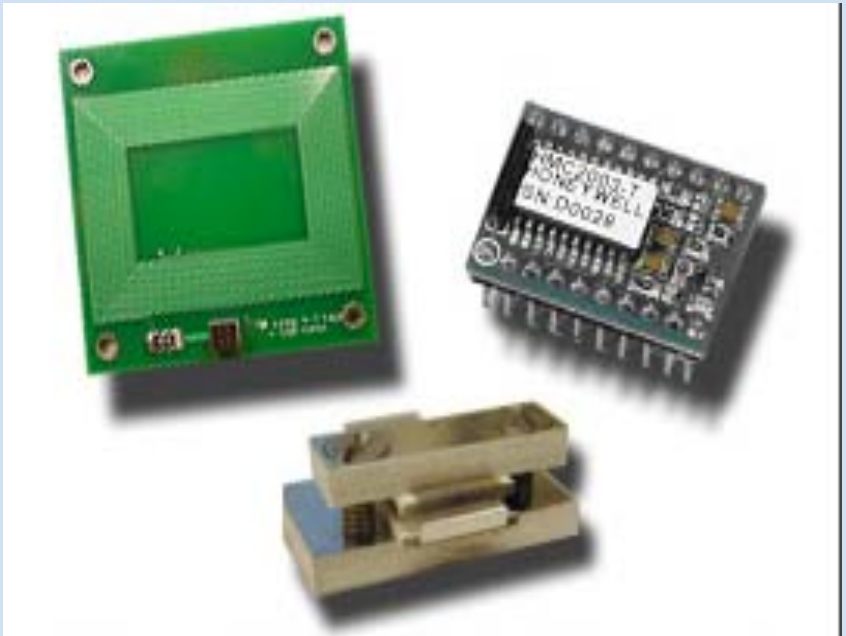


Figure 1. Principle of electrodynamic tether propulsion.

Torque Coils



Primary Attitude Control Components

Top: (Left) Magnetic Torque coil
(Right) Magnetometer

Bottom: (Center) Micro-Vaccum Arc Thruster

Thrusters

- Electrolysis Propulsion
- N2O/ABS Thruster
- Ion Thrusters

Electrolysis Propulsion

- Break down water to hydrogen and oxygen
- Eliminates risk of stored flammable fuels
- Provides for “do no harm” requirement.

N2O/ABS Thruster

- Nitrous oxide and nylon or ABS fuel
- Eliminates risk of stored flammable fuels
- Provides for “do no harm” requirement.

Ion Electrospray Propulsion System for CubeSats (iEPS)

SPL
space propulsion laboratory
massachusetts institute of technology

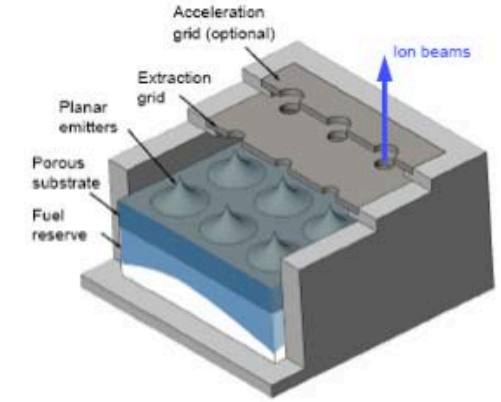


Fig 1. Conceptual view of an iEPS thruster module (Dan Courtney, courtesy)

Maximum compactness is achieved through the use of MEMS techniques, similar to those used in the fabrication of microchip components. A crucial part in the process is the monolithic integration of silicon with micro-fabricated porous metal substrates containing the ion emitting structures. Designing the new generation of compact ion thrusters is a challenging task. Essentially, we have a very small thruster (10x10x2.5 mm) which is literally soaked in a conductive liquid and includes all required elements to provide outstanding electrical and hydraulic isolation at voltages of about 1000 V when operating for long times at high performance.

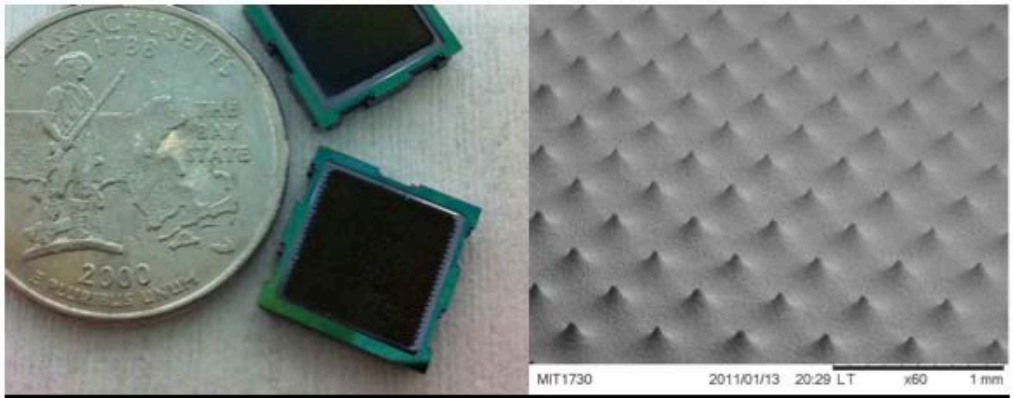


Fig 2. Left: iEPS modules fabricated in silicon (SPL). Right: Electron microscope images of ion emitting structures micro-fabricated in porous metal (Dan Courtney, courtesy)

Communications

communications
Communication Systems-West
640 North 2200 West P.O. Box 16850
Salt Lake City, UT 84116

DICE

Update on Cadet CubeSat Radio Programs

The L-3 Cadet radio is a compact, low-power, high data rate transceiver designed for small satellite applications. The dimensions of the Cadet radio, shown at right, are 7cm x 7cm x 1.3cm when assembled in its aluminum chassis. Cadet is capable of transmitting up to 24 Mbps.

October 2011 was an eventful month for Cadet programs, with the successful launch of the first Cadet- supported CubeSat mission, and the kickoff of a new Cadet contract to develop additional communication capabilities. These events are described below in greater detail.

DICE CubeSat Mission Launches with UHF Cadet Radio

In the early morning of Friday, October 28, 2011, a NASA Delta II rocket launched from Vandenberg Air Force Base in California. This rocket carried the NASA NPP* weather satellite plus six CubeSats built by the Space Dynamics Lab (SDL) / Utah State University, Auburn University, Montana State University, and the University of Michigan. All CubeSats were successfully deployed in their intended orbits.

The SDL mission consists of two CubeSats for the National Science Foundation-sponsored Dynamic Ionosphere CubeSat Experiment (DICE). DICE is an advanced space weather mission, designed to collect significant amounts of data on electrical phenomena that have a real impact on global communication and navigation infrastructures.

*NPP = National Polar-orbiting Operational Environmental Satellite System Preparatory Project

Processors

- Flight heritage & rad. hardened electronics
- Using non-flight, non-hardened electronics
  - Watchdogs and resets to prevent latch-ups.
- Cubesat Space Protocol (CSP) - a small network-layer delivery protocol
  - 32 Bit Header, protocol written in C.

Tech Development

- 3D Printing – Additive Manufacturing
  - Support Structure - MSU
  - N2O/ABS Thruster - USU
- CubeSat Kits

Commercial CubeSat Products

- Pumpkin
- Tyvek
- Armadillo
- KickSat Sprite
- Tiger Innovations

The Sprite Spacecraft

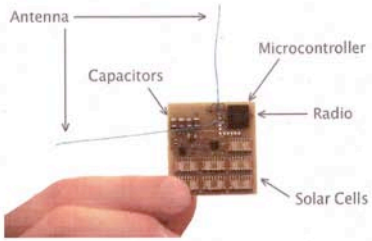
KickSat

A tiny open source/open hardware spacecraft project

The Big Picture:

Our goal is to dramatically lower the cost of spaceflight, making it easy enough and affordable enough for anyone, from hobbyists to high school students, to explore space. We can do this by shrinking the size and mass of the spacecraft, allowing many to be launched together.

The Sprite Spacecraft:



The Sprite is a tiny (3.5 by 3.5 centimeter) single-board spacecraft. It has a microcontroller, radio, and solar cells and is capable of carrying single-chip sensors, such as thermometers, magnetometers, gyroscopes, and accelerometers. To lower costs, Sprites are designed to be deployed hundreds at a time in low Earth orbit and to simultaneously communicate with a ground station receiver.

The KickSat Mission:

KickSat is being planned as a technology demonstration mission for the Sprite spacecraft. It is a 3U CubeSat that will house a 1U avionics bus and a 2U Sprite deployer. KickSat will be launched through NASA's ELaNa program and will carry approximately 200 Sprites into an orbit with an altitude of between 300 and 350 kilometers where they will be released as free-flying spacecraft.

Who We Are:

The KickSat project was founded in 2011 by members of the Space Systems Design Studio at Cornell University and crowd-funded by 315 individual backers on Kickstarter.com. It is an outgrowth of research on small spacecraft that has been conducted at Cornell since 2007.

For more information visit kicksat.net

Pumpkin Space Systems

PUMPKIN™
SPACE SYSTEMS

Update
Q3 2012

HATTS

- Pumpkin's Hemispherical Anti-Twist Tracking System (HATTS™) is a groundbreaking volume- and mass-efficient solution to the problem of uninterrupted 2DOF steering of solar arrays, high-gain antennas, and thrusters. Simple, strong, light, and fitting in just 1/4U, HATTS is a critical enabling technology for next-generation nanosatellites. HATTS can articulate propulsion / deorbit modules and high-power solar arrays simultaneously, as part of a 3U CubeSat that fits within a standard P-POD.

Pumpkin HATTS v1.4. Patent(s) pending

Missions

- Three more triple CubeSats employing Pumpkin technologies are manifested on an upcoming rocket. NROL-36 will carry USC-ISI's Aeneas, the third Pumpkin Colony I bus to be launched. Also aboard NROL-36 are UC Berkeley's CINEMA and CU-Boulder's CSSWE. All three spacecraft passed random vibe proto-qual at 15.9(X), 16.9(Y), 11.2(Z). These values exceed the Colony I design requirements, demonstrating the surety of Pumpkin's architectures and its users' implementations.

NROL-36 mission patch

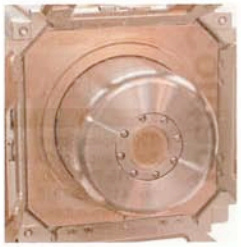
USC / ISI's Aeneas tracks shipping containers on the open seas

UC Berkeley's CINEMA with its MAGIC sensor deployed at the end of its boom

CU-Boulder's CSSWE utilizes a solid-wall 3U Chassis Walls to secure the REPTile scientific instrument

Propulsion

- A deorbit module from Pumpkin partner Digital Solid-State Propulsion (DSSP) is now available. At under 600g total mass and delivering over 47.5m/s deltaV to a 4kg 3U-size CubeSat, DSSP's deorbit thruster attaches directly to Pumpkin's Colony I / MISC 2 and newer MISC 3 busses. The deorbit module is one of a family of Pumpkin-compatible DSSP thrusters that use energetic material technology.



DSSP deorbit thruster on Pumpkin Colony I CubeSat

Pumpkin Kits

CUBE SAT KIT™
www.cubesatkit.com

Rev D skeletonized 1U CubeSat Kit structure with Solar Panel Clips, Rev C FM430 Flight Module and Microhard MHX transceiver installed. Shown approximately 88% size.

Profile

- The affordable, *space-proven* off-the-shelf professionally engineered CubeSat kit. Ready to turn your CubeSat mission into reality.
- Conforms fully to the CubeSat Design Specification.

Benefits

- 300g total mass[1] maximizes available user payload.
- Provides hardware solutions for structure, C&DH, RTC, mass storage, RBF and development / debug systems in a single commercial off-the-shelf (COTS) package.
- User-selectable Pluggable Processor Modules (PPMs) with powerful 8- and 16-bit microcontrollers can operate continuously in orbit due to low power requirements.
- Wiring-free interconnect scheme accepts user modules and/or PC/104 modules as payload on standardized stacking connectors, thereby increasing reliability.
- Directly compatible with many different transceivers.
- Included Salvo™ Pro multitasking RTOS, EFFS-THIN FAT-compatible SD Card software and CubeSat Kit software speed software development and reduce system complexity -- ideal for software design teams.[2]
- +5Vdc primary supply for all on-board electronics simplifies power supply design.

You

- Add radio, EPS, antenna(s), mission software and internal and/or external payloads.
- Transition seamlessly from development / debug / test environment to your launchable CubeSat with included Development Board and Flight Model.
- Meet your launch date on time and under budget.

Pumpkin Development Kit

Features

- Rigid and lightweight aluminum construction with only three major assemblies and all-stainless fasteners.
- Structure is fully alodyned for electrical conductivity. Wear surfaces are hard-anodized.
- Available in standard 1U (10x10x10cm), 0.5U, 1.5U, 2U, 3U and custom configurations.
- All flight components rated for -40 to +85 °C.

- Available Flight MCUs include:
  - PPM A1/A2/A3, 7.3728-16MHz: TI's ultra-low-power 16-bit MSP430F1612/1611/2618 MCUs
  - PPM B1, 100MIPS@100MHz: Silicon Labs® 8-bit C8051F120 MCU
  - PPM D1, 16MIPS@32MHz: Microchip® 16-bit PIC24FJ256GA110 MCU
  - PPM D2, 40MIPS@80MHz: Microchip® dsPIC33FJ256GP710 DSC
  - PPM E1, 16MIPS@32MHz: Microchip® 16-bit PIC24FJ256GB210 MCU
- Each processor family provides a minimum of multiple timers, 2xUART, 2xSPI, 1xI2C, 8xADC, Flash, RAM, low-power modes and JTAG/debug interfaces. See individual PPM datasheets for more information.
- 104-pin stackable CubeSat Kit Bus connects user modules without wires. Supports multiple stacking heights.
- Accepts up to five PC/104-sized user modules. COTS +5V PC/104 modules supported on separate bus.
- Configurable Remove-Before-Flight (RBF) and single or dual Separation Switches rated at 10A each.[3]
- Kit can accommodate any +5V/+3.3V transceiver via adapters or as a user-designed module for COM. Drop-in compatibility with Microhard Systems MHX series OEM transceivers.[4]
- Bus-powered USB interface for on-the-launcher monitoring, firmware upgrades, etc. On-board electronics can be powered directly from USB interface.[5]
- Requires only a single +5Vdc power supply -- also has external +5Vdc bus power connector.
- Development Board (DB) is electrically identical to Motherboard+PPM, with additional features for debugging.
- Kit contents[6] are shown below. Requires only a CubeSat Kit-certified C compiler / toolset and a PC to begin development. Transceivers / modems / antennas / batteries / solar panels / flight software are **not** included.

Contact

CUBE SAT KIT™

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tel: 415-584-6360
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web: www.cubesatkit.com
email: info@cubesatkit.com

1. Figure for complete Rev D skeletonized chassis, MB +PPM, Microhard MHX-2420 transceiver and fastening hardware.
2. A C compiler compatible with the selected processor family and Pumpkin's Salvo RTOS, EFFS-THIN and CubeSat Kit software is required. See price list for details.
3. Each switch has C, NC and NO contacts available.
4. +5Vdc is available to power transceiver. User radios matching the MHX series' physical and electrical form factors can plug directly into the FM430 Flight Module. See http://www.microhardcorp.com for more information on the MHX series of spread-spectrum transceivers. User radios can also be implemented as PC/104-size modules that connect directly to the CubeSat Kit Bus.
5. 500mA max over USB. Multi-platform USB drivers included with kit.
6. Contents are subject to change without notice. Rev D CubeSat Kit /PIC24 shown with DB + PSPM D, skeletonized 1U structure containing MB + PPM D1, and additional Kit components. The appearance and specifications of some components shown may differ from current production.

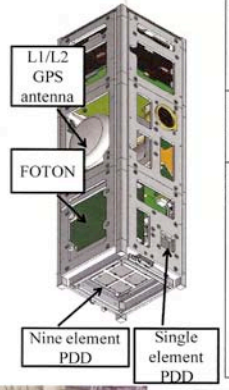
Specifications subject to change without notice. Made in USA.

707-00273-J 08/2012

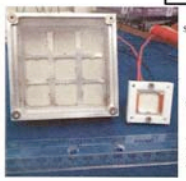
Armadillo

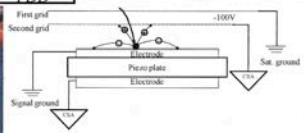
ARMADILLO

Atmosphere Related Measurements And Detection of submILLimeter Objects



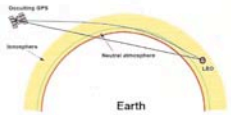
Who we are:	ARMADILLO is The University of Texas at Austin's entry into the University Nanosatellite Program competition run through the Air Force Research Lab. The team is student-run with a faculty principal investigator.
Mission Statement:	Enable students to measure the LEO sub-millimeter space debris environment and demonstrate space weather monitoring using low cost CubeSat technologies.
Mission Objectives:	1. Characterize in-situ sub-millimeter level dust and debris particles in LEO by sensing impacts at varying times, directions, and locations. 2. Demonstrate ionospheric radio-occultation within a single CubeSat volume (10 cm x 10 cm x 10 cm) using a software-defined dual frequency GPS receiver. 3. Train students in best systems engineering practices by executing a complete spacecraft life cycle from concept design to mission operations.





PDD Concept of Operations (top)
EDU PDD unit (left);

EDU FOTON unit (right); Radio occultation explanation (bottom)



Primary payload—Piezo-electric Dust Detector (PDD)	The PDD will detect sub-millimeter size space dust particles by studying impacts on piezo elements in order to update current space debris models.	PDD specifications: • Fits within 0.5U CubeSat form factor • Mass < 400 grams • Power < 3W • Provide secondary unit as reference in an orthogonal direction from main unit.	Current status: • EDU model on FlatSat • Protoflight unit on RockSat in August 2012 • Software interface with ARMADILLO in progress.
Secondary payload—FOTON GPS receiver:	The FOTON will gather radio occultation data from GPS satellites while on-orbit to help better understand space weather and the ionosphere.	FOTON specifications: • Fits within 0.5U CubeSat form factor • Mass approx. 365 grams • Power = 4.5 W instantaneous, <1 W OAP • Dual-frequency • Software-defined	Current status: • EDU model on FlatSat • Tested on sounding rocket in Spring 2012 • Software interface with ARMADILLO in progress.

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210 E. 24th St.
Austin TX 78712

Cockrell School Aerospace Engineering and Engineering Mechanics

Website: http://armadillo.ae.utexas.edu/
Facebook: fb.me/UTSatLab
Twitter: @UTSatLab
Email: UTSatLab@gmail.com

Tyvak

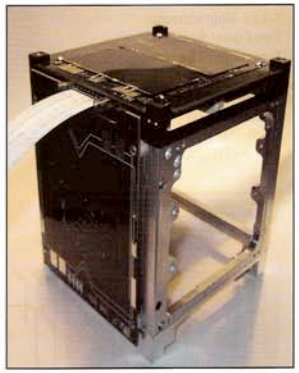
tyvak
NANO-SATELLITE SYSTEMS LLC

Your Experienced CubeSat Team

Intrepid Pico-Class CubeSat Suite

Overview

The ***Intrepid*** 1U CubeSat Suite represents the most compact and capable complete 1U system in the world. We've bundled the Tyvak™ ***Intrepid*** System Board with a custom UHF Communication System (70cm Amateur Band), Side Panels with Sensors, Torquers, Solar Cells, a Monopole Antenna, a Battery Module, and a structure that makes optimal use of limited volume. The highly integrated nature of the design enables mission concepts previously unfeasible in only a 1U volume, passing launch savings to the end user. With a custom Embedded Linux platform interfacing all the subsystem components, developers can hit the ground running from day one in a familiar development environment.



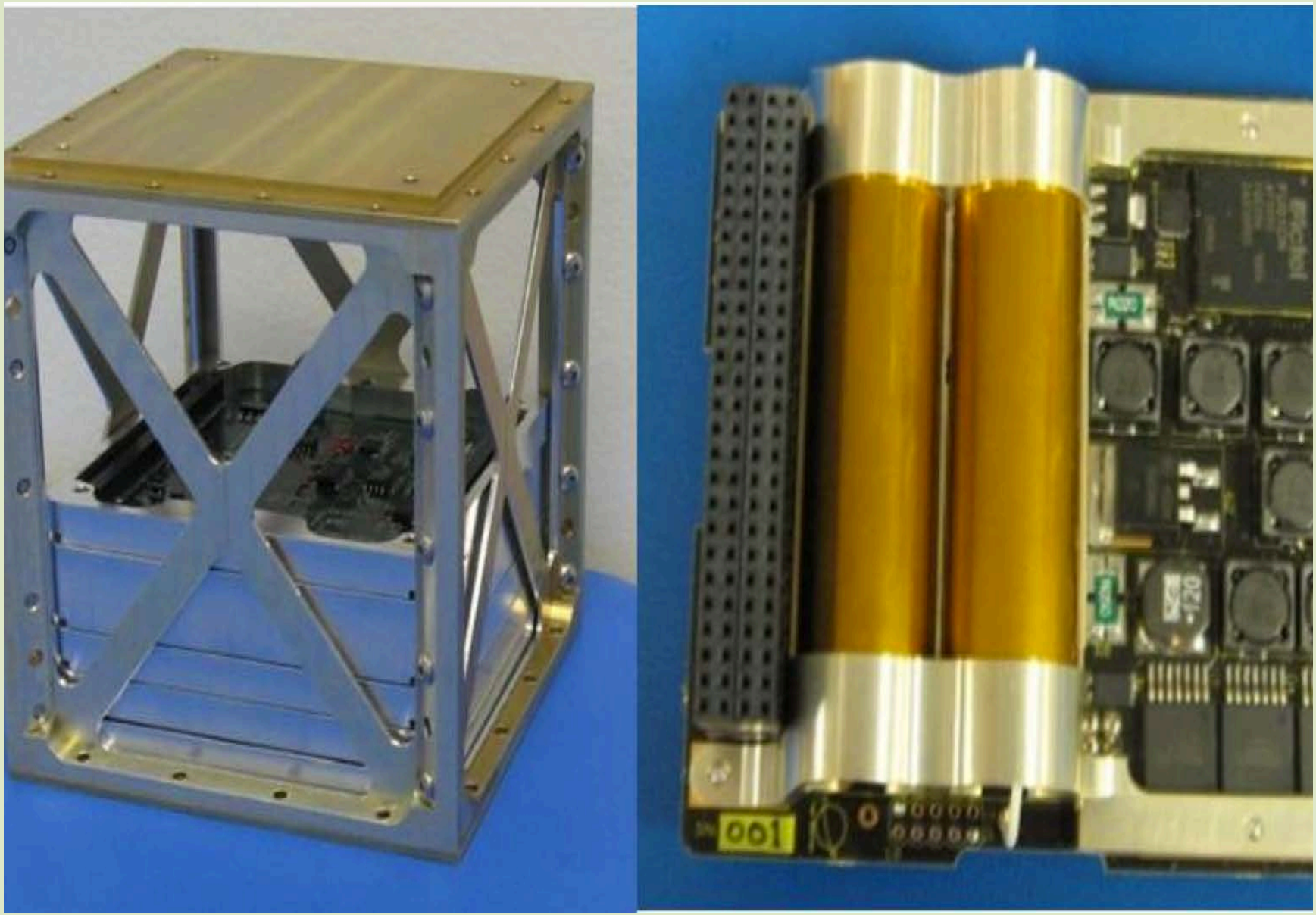
Features

- **System Power Requirements**
  - 100% CPU, UHF Receive Mode: < 400mW
  - 100% SDRAM Read / Write, UHF System in Receive Mode: < 450mW

- **UHF Daughterboard**
  - Operates on the 70cm Amateur Radio Band
  - Designed around the AX5042 Transceiver
  - Adjustable Transmit Power, greater than 1W
  - Software Agile Frequency, Modulation, Filtering, and Data Rates
  - Supports FSK, GFSK, MSK, GMSK, PSK, OQPSK
  - Data Rates from 1.2 to 250kbps
  - RX Sensitivity better than -112 dBm at 9.6kbps FSK (<0.5% Packet Error Rate)
  - RF Amplifier Efficiency >45%
  - Over-Temperature Protection

- **System Board**
  - AT91SAM9G20 Processor @400Mhz
  - 128MB 32bit SDRAM @133Mhz
  - 512MB 8bit NAND Flash
  - 32MB Serial Data Flash (Phase Change Memory)
  - MicroSD Card (HC Compatible)
  - Four High Efficiency Buck/Boost Regulators (Up to 95%)
  - Single Ground Point to Structure
  - Real Time Clock with Backup Battery
  - 3-Axis Gyro
  - 3-Axis Accelerometer
  - 3-Axis Magnetometer
  - Six Power Sensors
  - Three Temperature Sensors
  - Pressure Sensor
  - Latch-Up Protection for Memory and Processor
  - Low State of Charge Recovery System
  - Process Level Software Watchdog
  - Internal Atmel Hardware Watchdog
  - External Windowed Hardware Watchdog
  - Resistor Programmable Hard Reboot Timer (1 to 48 days, or disable)
  - Separate Ground allows chosen electronics to never hard reboot

Tiger Innovations



Examples

- MSU
- MIT
- USU
- Berkley
- University of Colorado – Lauren Blum
- Samson
- Deorbiting
- Swarms
- Arrays

MSU – Montana State University

SSEL – Space Science and Engineering Laboratory

- FIREBIRD - **F**ocused **I**nvestigations of **R**elativistic **E**lectron **B**urst, **I**ntensity, **R**ange, and **D**ynamics

- A constellation of three CubeSats developed by MSU and partners with UNH.

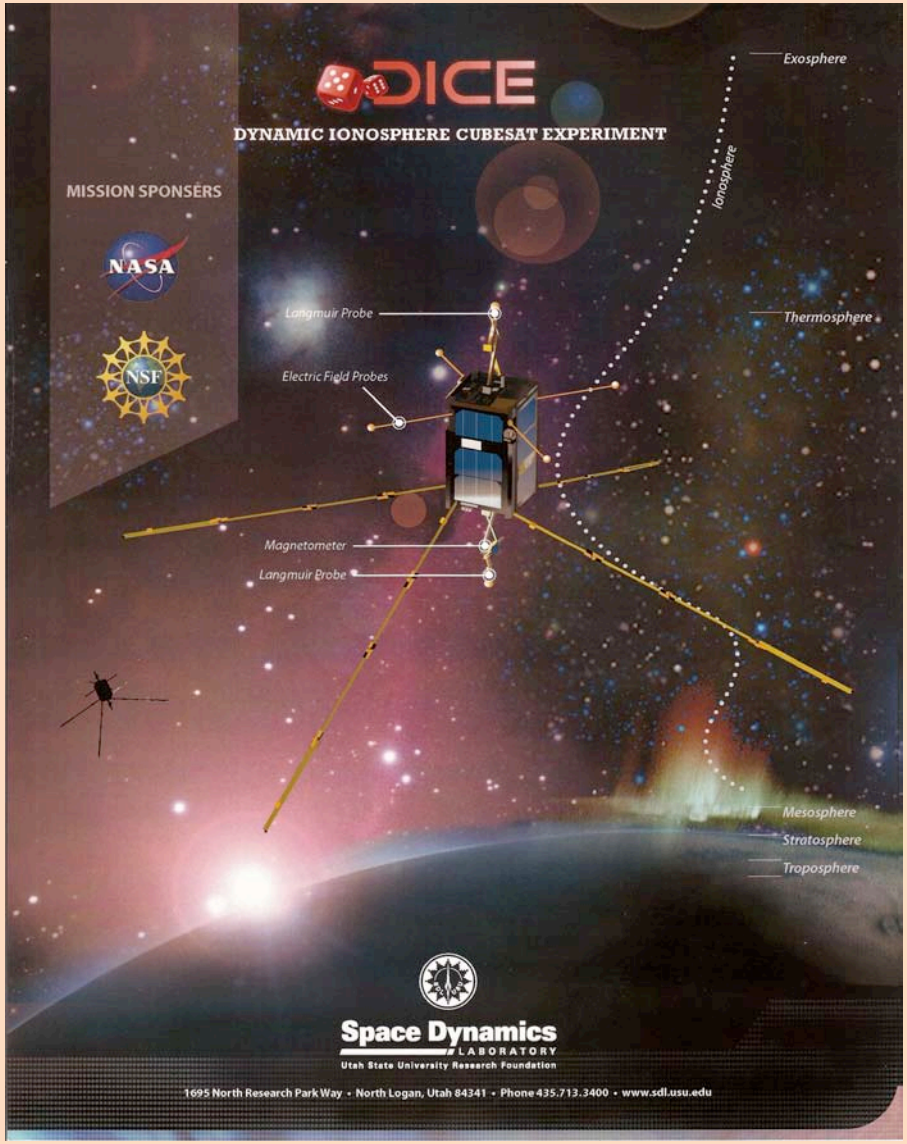
MSU - Explorer

Approximately 125 students designed, built and tested the satellite over the past five years

one of six university-built satellites onboard the Delta II rocket.

USU – Utah State University

- DICE – Dynamic Ionosphere CubeSat Experiment



USU-Space Dynamics Laboratory

SDL/10-306

Space Dynamics LABORATORY
Utah State University Research Foundation

ABOUT SDL

The Space Dynamics Laboratory (SDL) has a five-decade legacy of providing innovative solutions to critical challenges faced in the defense, national security, academic, civil, and commercial arenas. SDL leads the way in electro-optical remote sensing systems, atmospheric and environmental research instrumentation, groundbreaking small satellite technologies, sensor calibration and test capabilities and facilities, data exploitation products, and intelligence, surveillance and reconnaissance solutions.

From concept to development, SDL scientists and engineers have improved, and often defined, the state of the art in optical design, stability control, thermal management, data analysis and management, and mission planning. SDL has unique capabilities to quickly develop prototype and one-of-a-kind remote sensing systems for ground, air, and space-based platforms. We continuously renew our capabilities and grow our business through technology innovation and by expanding our presence in the full lifecycle of our customers' programs.

SDL is a nonprofit research corporation and a unit of the Utah State University Research Foundation (USURF), owned by Utah State University. SDL is one of only 14 University Affiliated Research Centers (UARCs) in the nation. As such, SDL maintains a strategic relationship with the Department of Defense (DoD) in the development of key defense technologies.

Headquartered in North Logan, UT, SDL employs more than 450 dedicated professionals, including university-level student staff, at facilities in Albuquerque, NM; Colorado Springs, CO; Los Angeles, CA; Washington, DC; Huntsville, AL; Bedford, MA; and Houston, TX.

www.spacedynamics.org

HAPPENING NOW

WISE *(Wide-field Infrared Survey Explorer)* - With over 500 times the IR sensitivity of previous survey missions, WISE scanned the entire celestial sky over 1.5 times, capturing more than 2.7 million pictures in four IR bands (over 9 million images) of astral objects. Launched in December 2009, WISE discovered 19 new comets, over 40 ultra-luminous IR galaxies, almost 100 confirmed new brown dwarfs, and more than 33,500 asteroids, including 132 near-Earth objects (NEO). SDL developed the WISE science instrument, which also performed an extended mission, NEOWISE, to hunt for more asteroids and comets during a full sweep of the asteroid belt.

OCO-2 *(Orbiting Carbon Observer-2)* is NASA's mission dedicated to studying atmospheric carbon dioxide. SDL is providing the OCO-2 cryogenic subsystem and a flight spare. OCO-2 will provide the first complete picture of human and natural carbon dioxide sources and sinks, mapping their global geographic distribution and studying their changes over time. OCO-2 replaces OCO-1, which was lost during a launch vehicle failure in 2009.

DICE *(Dynamic Ionosphere CubeSat Experiment)* - With the simultaneous launch and deployment of two identical CubeSats, DICE will measure ionospheric gradients on the edges of Storm Enhanced Density (SED) features. The DICE mission will further understanding of the formation, evolution, and decay of SEDs and their related impact on space weather forecasting.

EMAS *(Enhanced MODIS Airborne Simulator)* - SDL is providing a cooled optical bench assembly (COB) to enhance the MODIS Airborne Simulator (MAS), a wide-band, multispectral, whiskbroom scanner operated by the NASA Airborne Sensor Facility for Earth-observing campaigns aboard high-altitude NASA platforms. The COB contains instrumentation for 12 LWIR bands and one MWIR band, with accommodation for 12 MWIR bands. The MAS spectral bands span from 0.45 to 14.0 μm and are similar to those of the MODIS (Moderate Resolution Imaging Spectroradiometer) instrument aboard the AQUA and TERRA satellites.

NOVA - SDL's *Nano-Satellite Operation Verification and Assessment* test facility enables pre-launch testing. Its unique capabilities include mass properties testing, magnetic field generation, solar simulation, and the measurement of speed, jitter, and torque for small satellites that weigh less than 10 kilograms.

2009 - 2010

PEARL *(Pico-satellite Exo-Atmospheric Research Laboratory)* is a spacecraft platform designed from the ground up to provide high capability in a CubeSat form factor. The initial 3U version is a highly capable bus. Increased control of processing and pointing provides the utility necessary for relevant scientific or military missions. The PEARL platform is a set of standard and customizable components that can be assembled into mission-specific configurations while minimizing engineering costs and development schedules.

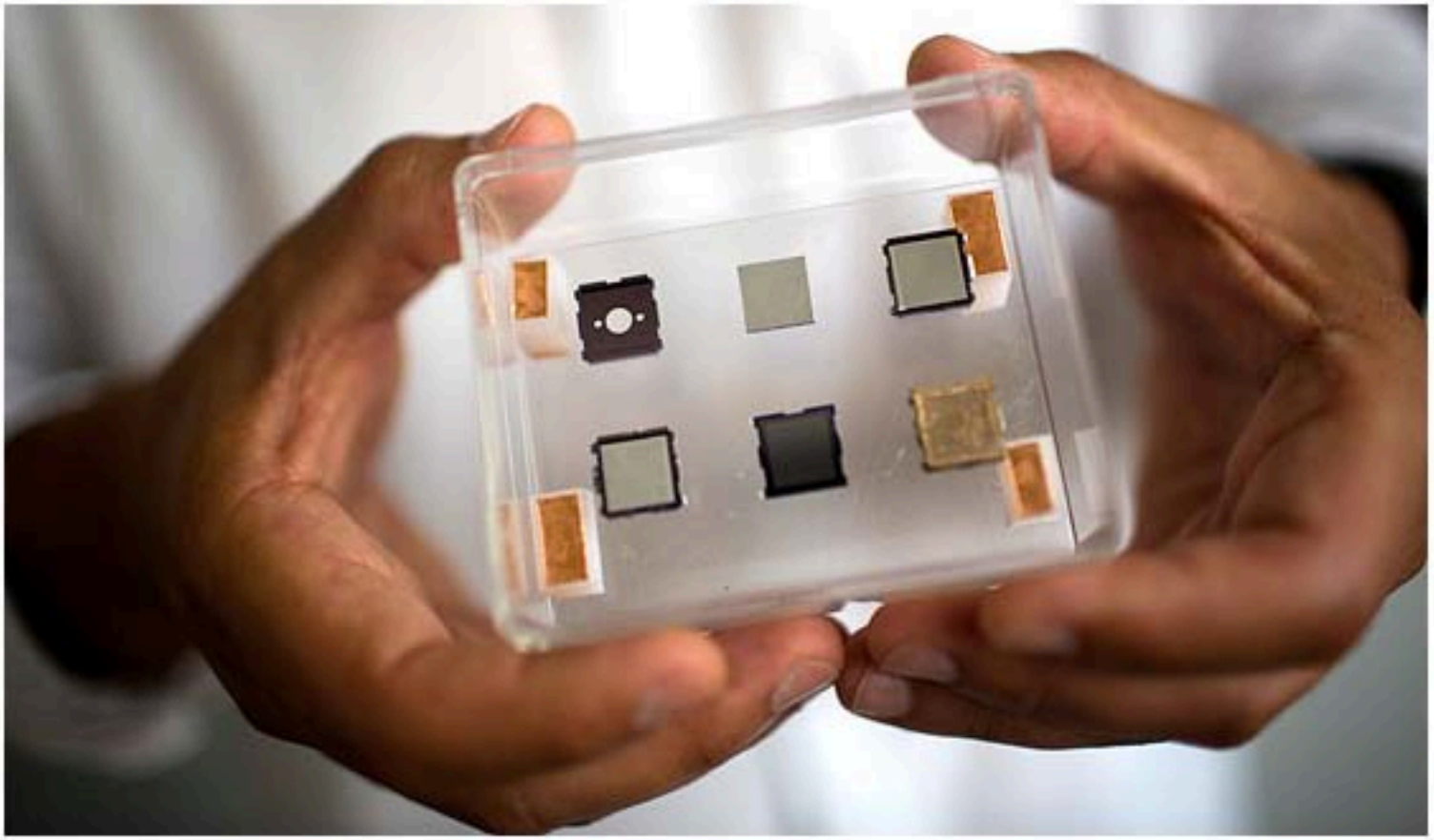
EyePod is an intelligent, geo-aware, day/night imaging sensor system for deployment aboard Class 3 UAVs. EyePod's jitter-stabilized, dual sensor, dual focal length system allows operators to conduct both wide-area survey and high-resolution inspection missions from a single flight pass. Its innovative design solves the challenges of excessive image smear from aircraft jitter, while providing geo-registered, high-quality images for immediate exploitation.

NuSAR is a small, high-bandwidth, synthetic aperture radar (SAR) system that provides large-area surveillance and reconnaissance for small manned and unmanned aircraft. Independent of weather and lighting conditions, NuSAR can detect manmade or metal objects with clarity, even through foliage and topsoil. Its dual-frequency (L- and X-band) design features onboard GPS/INS and embedded real-time image formation.

MIT – Massachusetts Institute of Technology

MIT 'microthrusters' are the size of a penny, could reposition tiny satellites

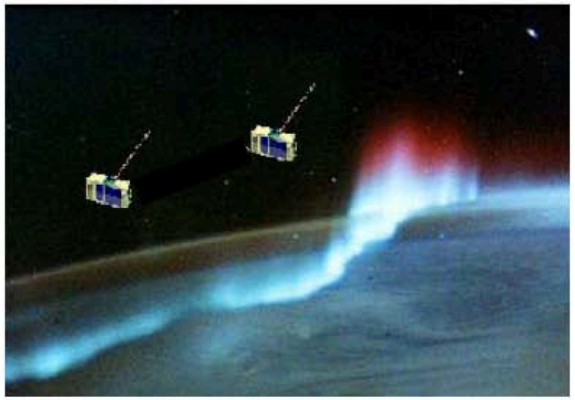
By Zach Honig posted Aug 18th 2012 9:06AM



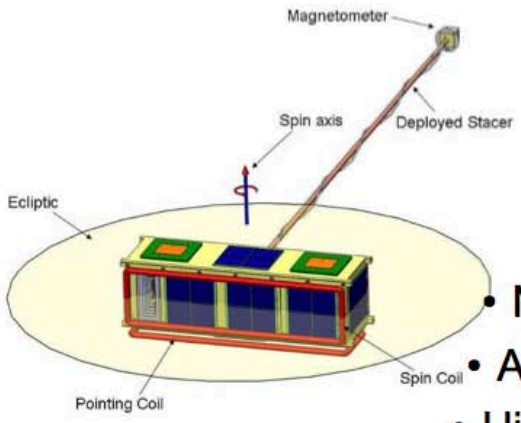
University of California, Berkley

CINEMA (CubeSat for Ions, Neutrals, Electrons, & MAgnetic fields)

Mission Highlights



- 3U CubeSat (2008-9 NSF Proposal)
- 1 Additional CubeSat (Kyung Hee U.)
- Balance of Heritage and Innovation
- Mix of Student and Professional Labor
- Purpose: Space Weather Research
  - SupraThermal Particle Detector
  - Boom-mounted 3-Axis Magnetometer
- Spinning Ecliptic-Normal Attitude
- High Inclination Orbit
- ~1 Year Mission Duration



Technological Impacts

- New Sensors and Spacecraft Systems
- Active ACS
- High Data Throughput (~900 Mbit/day)

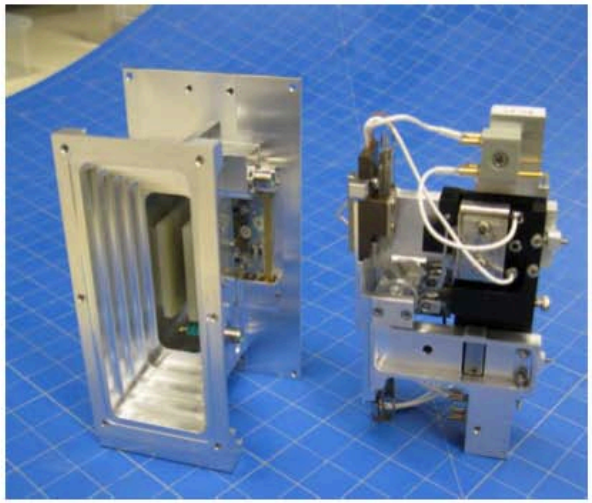
University of California, Berkley

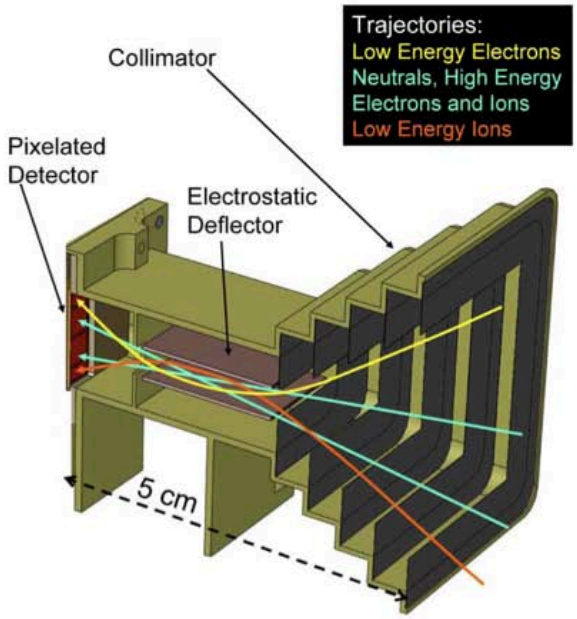
CINEMA (CubeSat for Ions, Neutrals, Electrons, & MAgnetic fields)

STEIN Instrument

SupraThermal Electrons Ions & Neutrals

- Heritage: STEREO STE Sensor
- with Electrostatic Deflection
- Heritage: Mechanical Attenuator Reduces Particle Count by 10^2
- Prototype Built and Being Tested





Resolution: ~1KeV FWHM
Range: few to 100KeV

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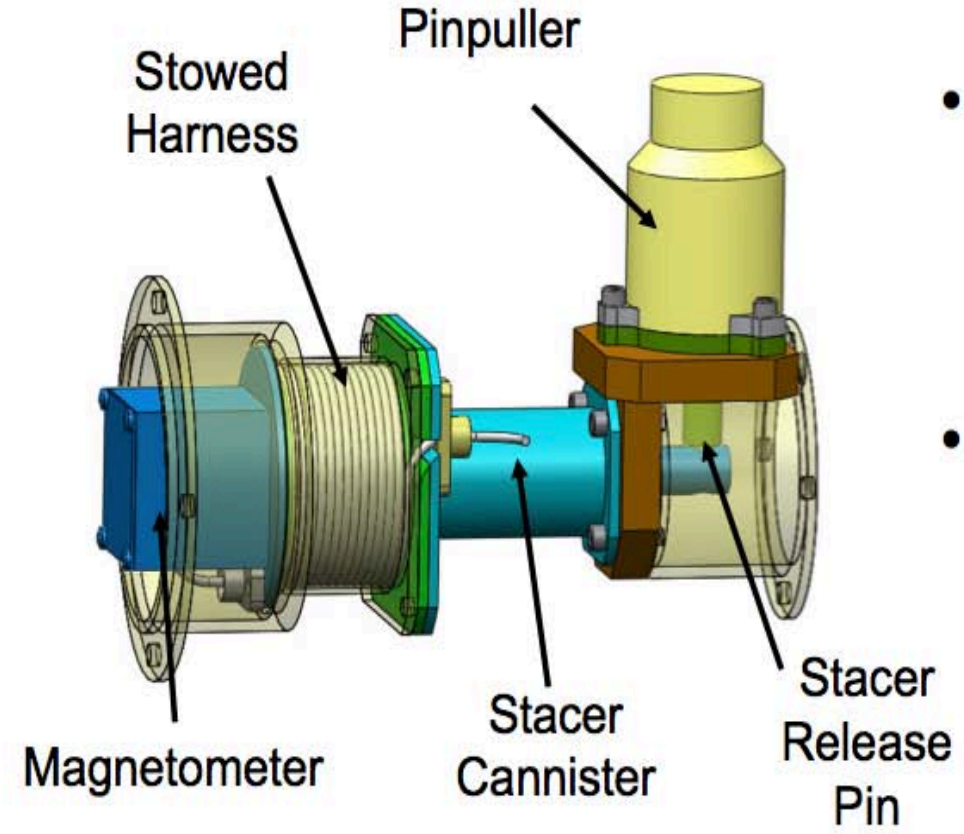
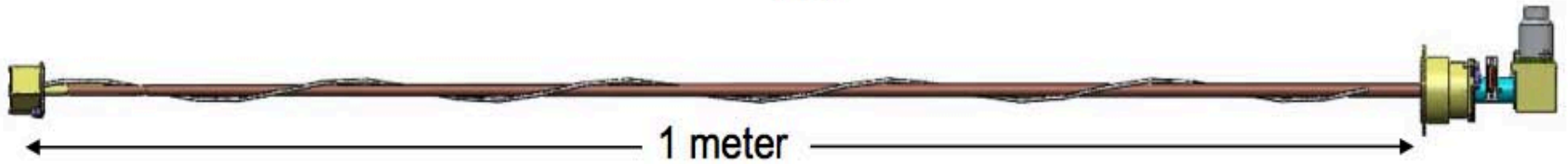
CINEMA (CubeSat for Ions, Neutrals, Electrons, & MAgnetic fields)



- Heritage: Self-deploying Stacer Element
  - 50 mm stowed length
  - 1 m deployed length
- Heritage: TiNi Aerospace SMA Pinpuller



University of Colorado, Boulder

CSSWE Colorado Student Space Weather Experiment

Lauren Blum
Project Manager
PhD student
Aerospace Engineering Sciences
and Laboratory for Atmospheric and Space Physics (LASP)
University of Colorado Boulder
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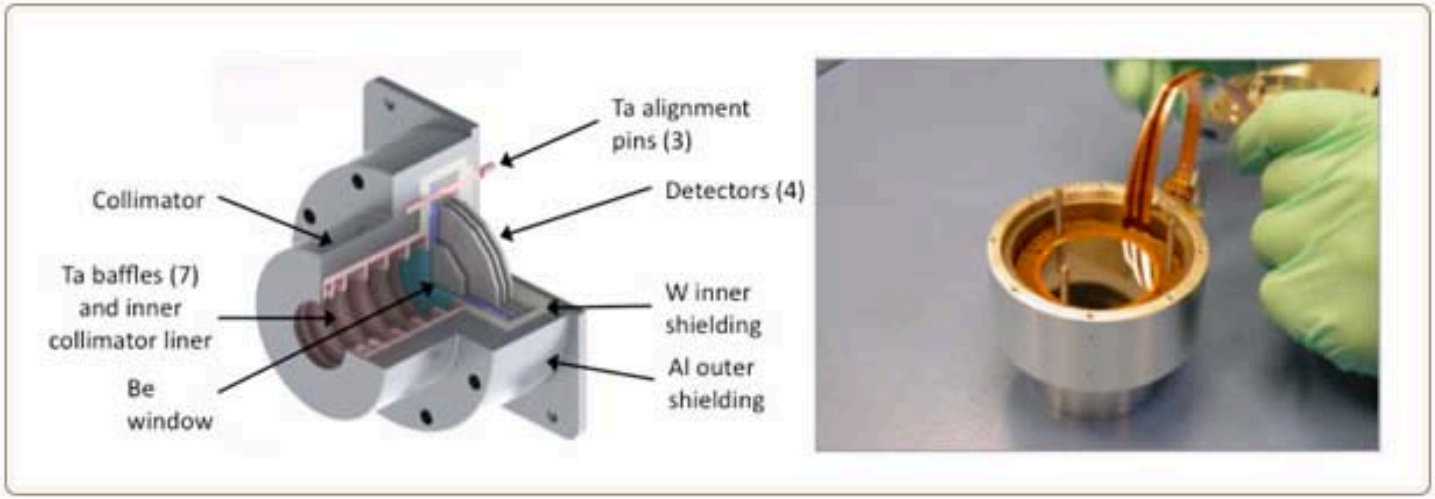
University of Colorado, Boulder

CSSWE Colorado Student Space Weather Experiment

REPTile Instrument Design

The REPTile instrument is a loaded-disc collimated telescope designed to measure energetic electrons and protons with a signal to noise ratio of two or greater. The instrument consists of a stack of four solid-state doped silicon detectors manufactured by Micron Semiconductor. Higher energy particles penetrate deeper into the detector stack and, as they do, they generate electron-hole pairs in the doped silicon. A bias voltage is applied across each detector to accelerate the loosened electrons to an anode, where they are collected and measured by instrument electronics. Using coincidence logic, the electronics determine which detectors the particle impacted, and thus the energy range of the particle.



Samson

Space Autonomous Mission for Swarming and Geolocation with Nanosatellites

Asher Space Research Institute

Technion – Israel Institute Of Technology

Demonstrate long-term autonomous cluster flight of multiple satellites, with algorithms based on DSSL's ERC-funded FADER study; and

Determine the position of a radiating electromagnetic terrestrial source based on time difference of arrival (TDOA) and/or frequency difference of arrival (FDOA).

CubeSat Rides

- ISS – International Space Station Deployments
- Wallops – 6 U CubeSat Deployer
- Orbital
- ELaNa – Educational Launch of Nanosatellites
- NASA's CubeSat Launch initiative (CSLI)
- ISIS – Innovative Solutions in Space
- NASA Flight Opportunities Program
- Space X

ISS – International Space Station

NASA Small Spacecraft Technology Program

National Aeronautics and Space Administration

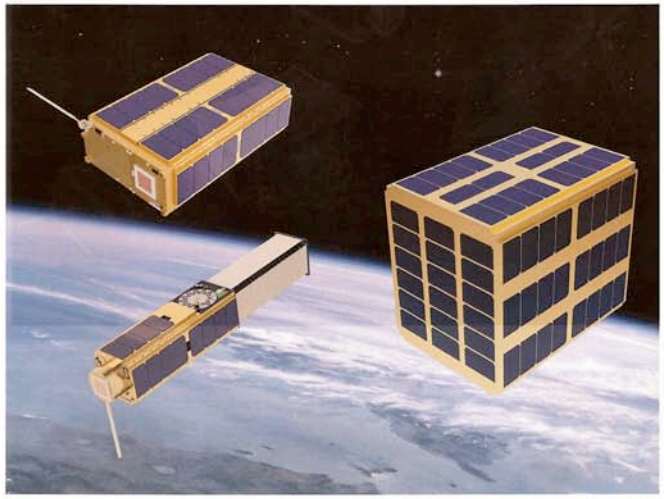
NASA

NASAfacts

NASA Small Spacecraft Technology Program

The NASA Office of the Chief Technologist (OCT) created the Small Spacecraft Technology Program (SSTP) to advance the utility and applicability of small spacecraft in support of NASA's exploration and discovery missions. Small spacecraft represent an emerging class of satellites, robots and systems that exploit their small size to take advantage of rideshare launch opportunities at reduced cost. Small spacecraft also exploit the growing amount of technical capabilities that we are witnessing in the high technology and electronics industries. As a result, small spacecraft and platforms are becoming more and more capable as their overall size continues to decrease.

The SSTP is one of nine major programs managed within the OCT, and one of three flight programs. SSTP is designed to demonstrate technologies bringing them from a Technology Readiness Level (TRL) of 3 to 5 to a TRL of 5 to 7 through ground development and eventual demonstration in the relevant environment of space. SSTP achieves this goal via the funding of the development, test, launch and operation of small spacecraft



CubeStack Deployer

NASA Flight Opportunities Program

"Fly Technologies in Space for FREE through the NASA Flight Opportunities Program"

Date/Time/Location
Thursday, August 16th, 1:00–2:00 PM
Utah State University Campus—Eccles Science Learning Center, Room 046

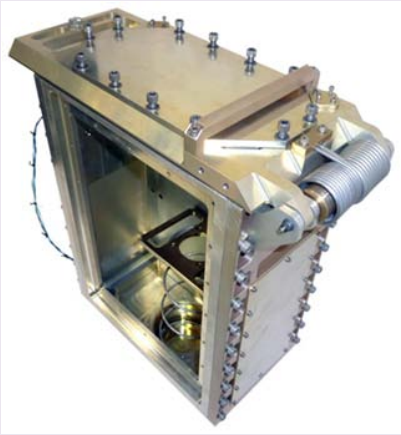
Agenda
The NASA Flight Opportunities Program is soliciting to fly small satellites and small satellite technologies on suborbital space vehicles at no expense to the researcher (free rides for research). The Program is purchasing suborbital flights from Virgin Galactic, Armadillo Aerospace, Masten Space Systems, UP Aerospace, XCOR Aerospace, and Whittinghill Aerospace and there is currently payload space available. The Program is also purchasing balloon flights from Near Space Corporation and parabolic aircraft flights from Zero-G Corporation. For any proposals that pass the peer review process, NASA will provide a free flight (or multiple flights) for the satellite or technology payload. The website for the program is https://flightopportunities.nasa.gov/ and the video is at http://www.youtube.com/watch?v=3pt8n_FcLRY.

Conference Contact
John Kelly, Program Mgr.
john.w.kelly@nasa.gov

Post-Conference Contact
Richard Mains, Technology Liaison
richard.c.mains@nasa.gov

Wallops Flight Facility

- *Wallops history with CubeSats and small satellites*
- *6U CubeSat deployer*
- *UHF CubeSat Groundstation*
- *Mission Planning Lab (MPL) for suborbital, CubeSat and small satellite missions*
- *CubeSat and small satellite integration and test facilities*
- *CubeSat and small satellite S-Band antenna*
- *Generic Reusable Aerospace Software Platform (GRASP) software for small satellites and CubeSats*
- *GSFC Lunar CubeSat studies*
- *GSFC SpaceCube 2.0 Mini CubeSat Processor*
- *Other advanced CubeSat and small satellite*



Wallops 6U Deployer

Arianespace

Utah State University Small Satellite Conference

arianespace
service & solutions

Small Satellite Launch Services

Thursday, August 16
1:00 – 2:00 PM
Eccles Science Learning Center
Room 053

- **The world's leading launch services provider will present an update on the new Vega and legendary Soyuz launch systems, now fully operational at the Guiana Space Center. The meeting is open to satellite manufacturers, operators & universities interested in flying payloads as primary or secondary passengers on two flight proven launch systems.**
  - **Scientific Missions**
  - **Earth Observation Satellites**
  - **Communications Satellites**

Contacts:

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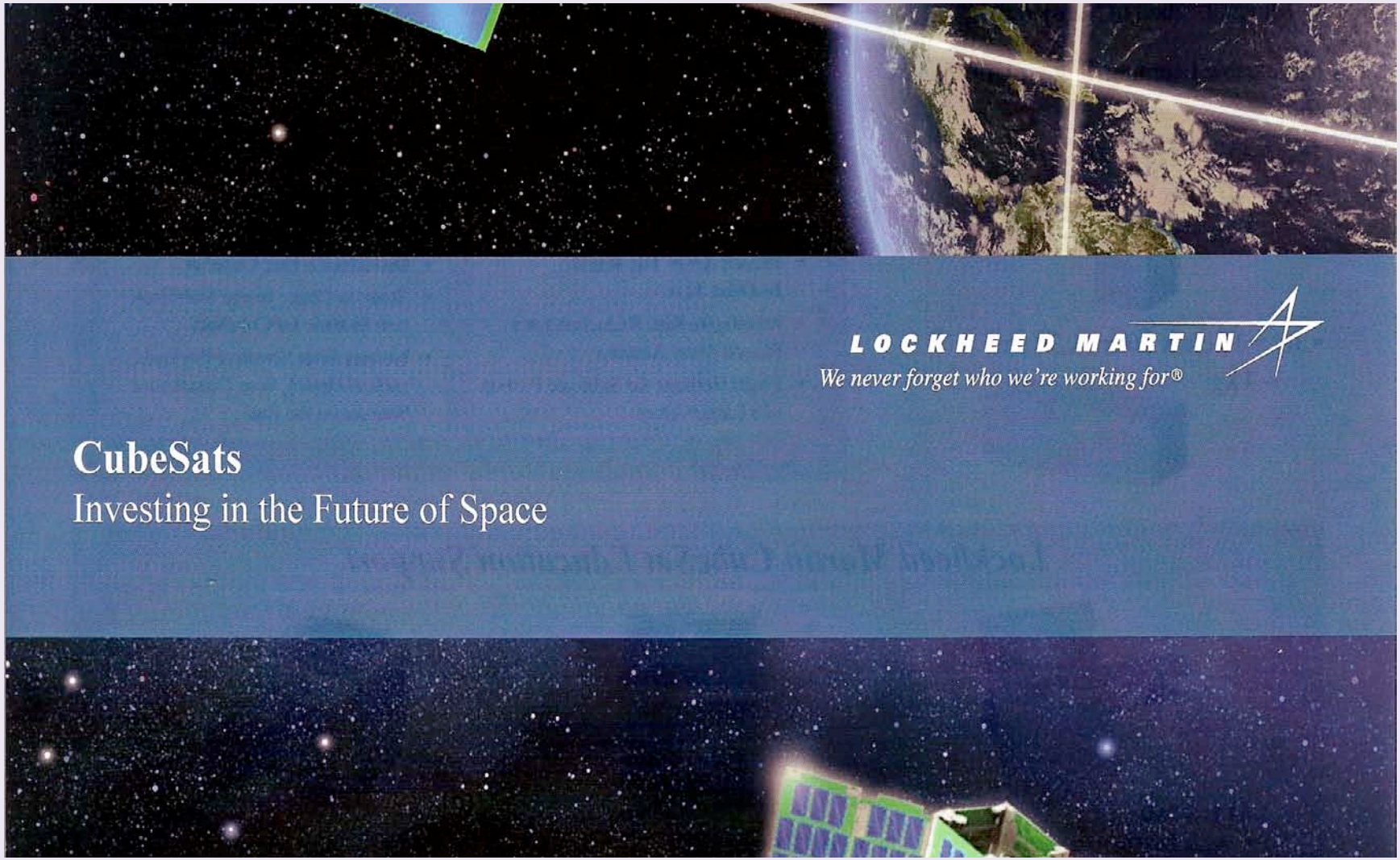
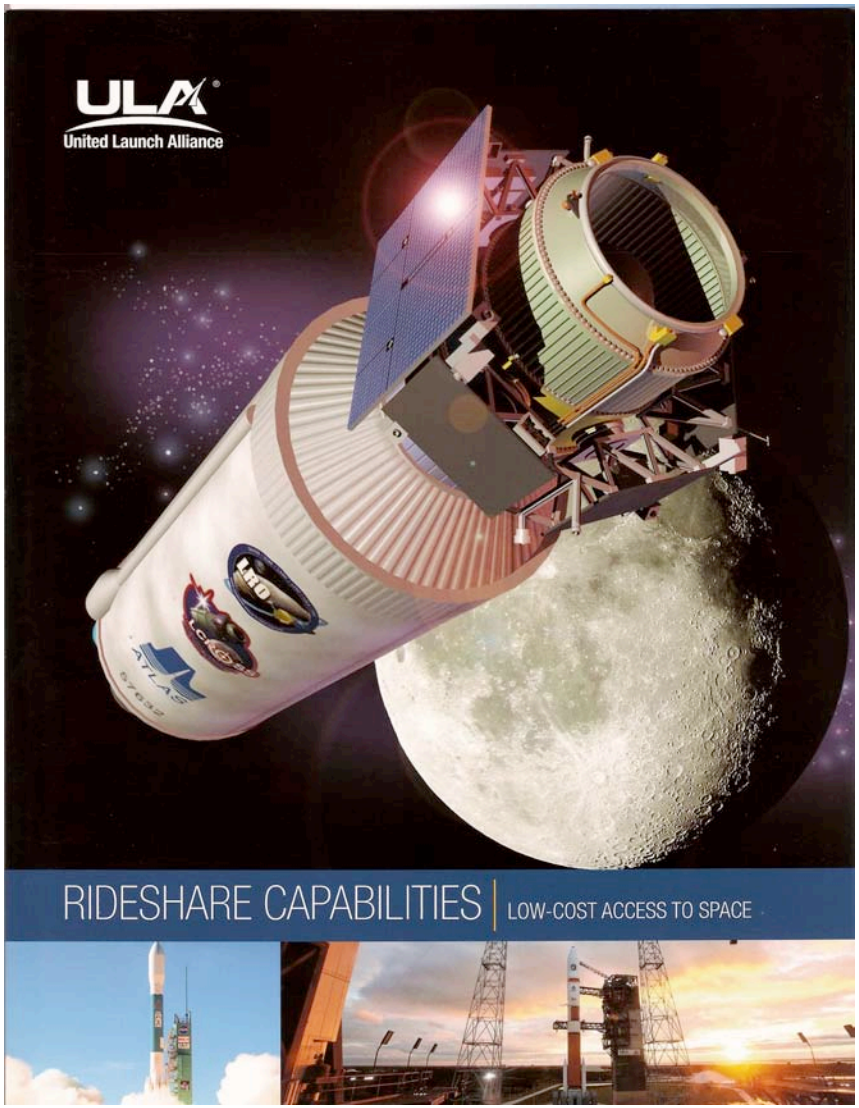
Serge Chartoire s.chartoire@arianespace.com

Lockheed Martin



United Launch Alliance



Ride Share Considerations

- “Do No Harm”
- No trickle charging of CubeSat
- Work to standards