

Virginia Space Grant Consortium Support of Space @ Virginia Tech

Prof. Wayne Scales, Director
Center for Space Science and Engineering Research (Space@VT)
Virginia Tech

Mid-Atlantic Regional Space Grant Meeting
September 24-26 2014

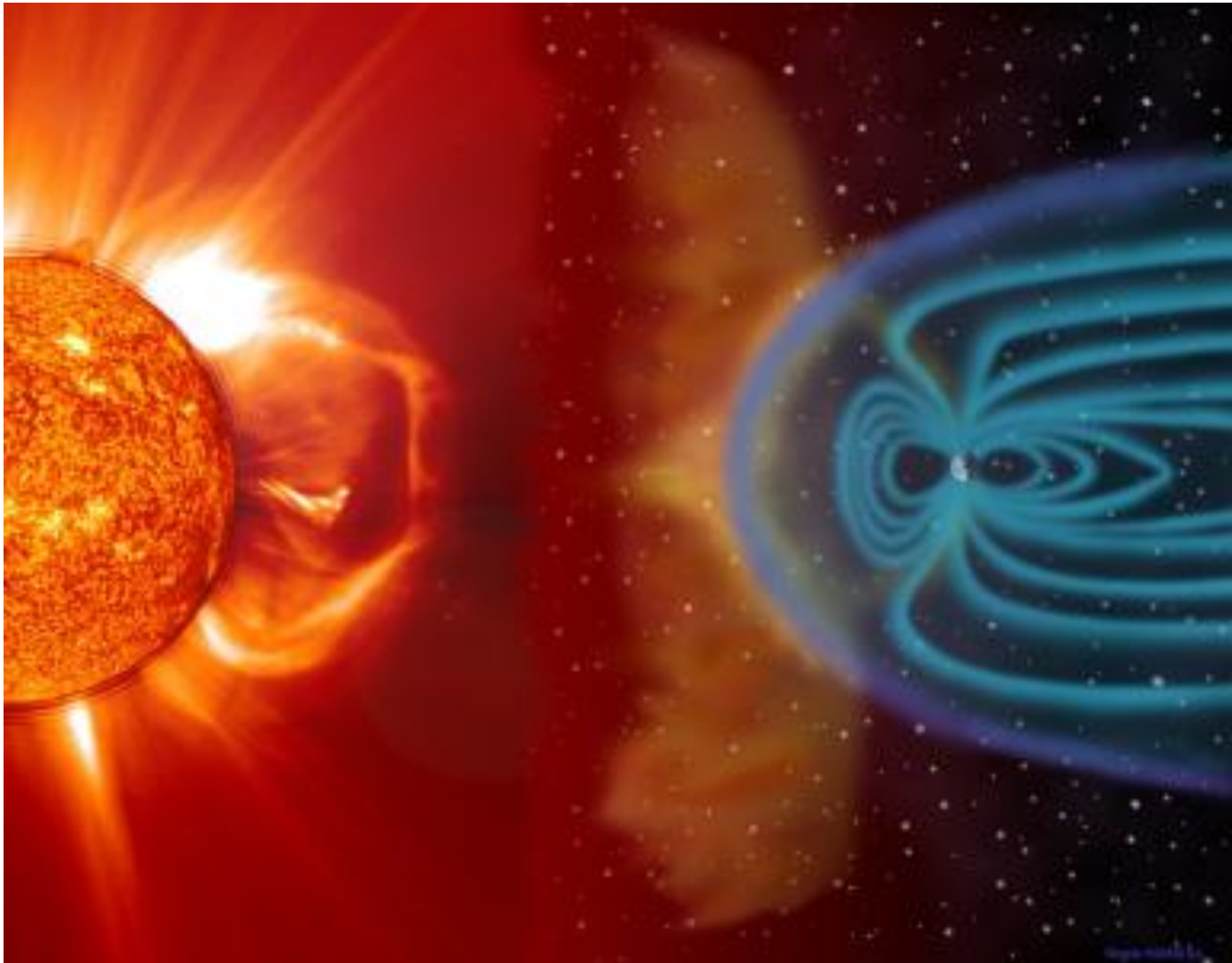
Space@VT at a Glance

- Organized in 2007 as a VT Engineering Research Center
- 9 tenure track, 4 research, faculty in ECE and AOE
- 4 Postdocs and approximately 30 graduate students
- Supports 2-3 times as many undergraduates involved in projects
- Substantial Outreach to K-12.
- Primary funding from NSF, NASA, DoD, DoE, Private Industry

- ***Core Research Expertise Includes:***
 - ***Ground-Based Space Weather Experiments:***
(HF Radar, Magnetometer, GPS, High Power HF Transmitters)
 - ***Space-Based Space Weather Experiments:***
(Sounding Rocket, Small Satellite, NASA Small Explorer (SMEX), etc.)
 - ***Space Plasma Modeling Using Advanced Computing:***
(Turbulence, Spacecraft Interactions, Space Propulsion, Space Debris)
 - ***Spacecraft Dynamics and Control***
 - ***Space Propulsion***

Mission of Space@VT:

- Physics and chemistry of the near-earth space environment
- Impact of this environment on modern technology
- Effective utilization of the environment



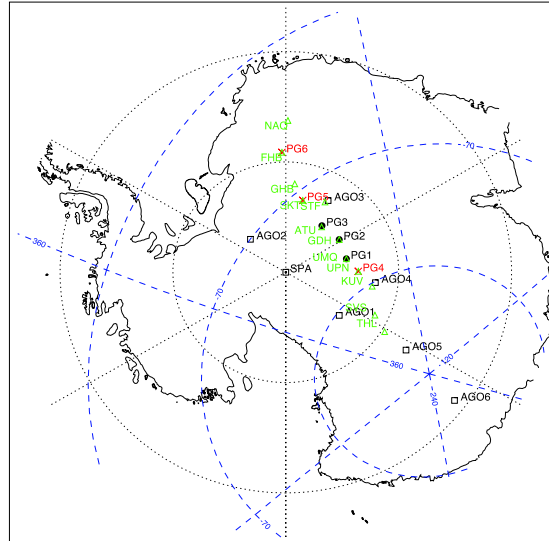
Some Ongoing Projects

Polar NOX



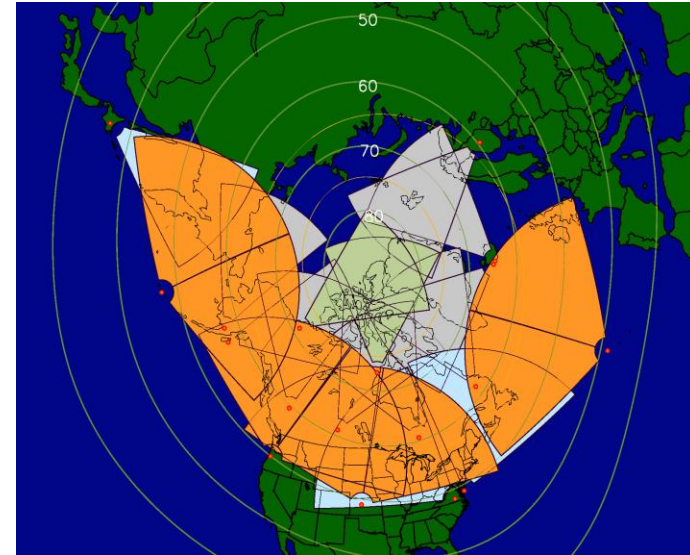
- VT lead NASA sounding rocket science mission
- Scheduled for launch in 2016 from Poker Flat, Alaska
- Stellar occultation studies of lower thermospheric Nitrous Oxide and relevance to Global Change.

PENGUIn



- VT lead development of magnetometer stations in Antarctica for space weather investigations
- First comprehensive investigations of GPS scintillations effects at high latitudes.
- NSF major space weather facility

SuperDARN Mid-Latitude



- VT lead build of HF radars across mid-latitudes to investigate effects of severe geomagnetic storm phenomena
- NSF sponsored major space weather facility
- Technology has numerous implications for remote sensing

VSGC Support/Collaboration

- VSGC has provided seed support that has served to initiate several major Space@VT agendas:
 1. Growth and development of the small satellite program
 2. NSF sponsored LAICE cube-sat mission
 3. New satellite ground station at Virginia Tech
 4. RockSat (NASA student sounding rocket instrument test-bed)
- VGSC fellowships, summer student, and travel support have enabled each of these to develop into highly successful agendas for Virginia Tech space research programs.

1. VT Small Satellite Research Program

Prof. Scott Bailey (Atmospheric Chemistry/Optical Remote Sensing)

Prof. Jonathan Black (Spacecraft Dynamics and Control)

Prof. Gregory Earle (Ionospheric Physics/Space Plasma Instrumentation)

Dr. Robert McGwier (Communication System Design)

(Some 40 students involved including graduate and undergraduate)

VGSC Support Through Small Satellite Working Group:

- **Virginia Tech has three cubesats that have launch opportunities 1 from Elana and 1 from NASA University SmallSat Program. VSGC is supporting in various ways.**
- **VSGC sponsored Alex Friedman (VT) as Wallops Intern in summer 2013 to help with development of the WFF small sat facility for use by universities.**
- **Virginia Tech used RockSat-X platform with VSGC support to advance a cubesat effort and flew IMU's for the September 2013 mission.**
- **VSGC is administrative lead to support a QB-50 cube-sat program with VT as technical lead. French institutions and other VA universities are involved.**

2. LAICE CubeSat Mission

(Prof. Gregory Earle, PI)

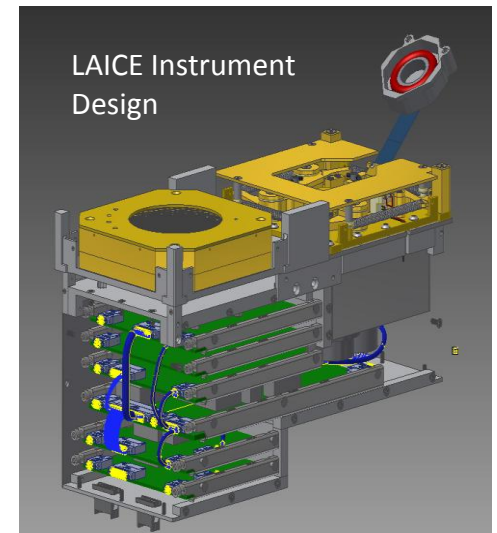
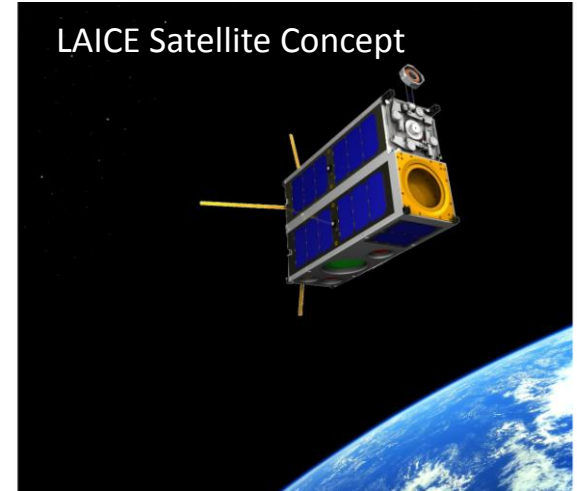
Personnel: GDE's research efforts have provided project experience and/or thesis topics for 17 students over the last 2 years. 6 of these are in ECE and 11 are in AOE. One post-doc and two systems engineers also contribute to these projects. Four summer REU students are also contributing to these efforts in summer 2014.

Project Highlights:

1. Lower Atmosphere/Ionosphere Coupling Experiment (LAICE) – This is an NSF-funded 6U CubeSat for which VT is the lead institution, with U of Illinois as a co-investigator. It is scheduled to launch from the ISS in January 2016. The VSGC was very supportive in providing bridge funding to cover three students on this project prior to receipt of NSF funds.
2. VSGC also provides fellowship support for four students who work either directly or indirectly on Prof. Earle's projects in the Space@VT group.

These projects include:

1. Mission management for the LAICE nanosat program;
 2. Development of a space-based capacitance manometer sensor for future nanosatellite missions.
 3. Design and fabrication of an air-bearing test stand for CubeSat attitude control and dynamics testing.
 4. Mechanical design of small satellite structures.
3. VSGC and VT have teamed to develop ground-station capabilities in support of a European nanosatellite swarm mission called QB-50. VT will develop and use its ground station to downlink data from one or more of these orbiting spacecraft in 2016 and beyond.

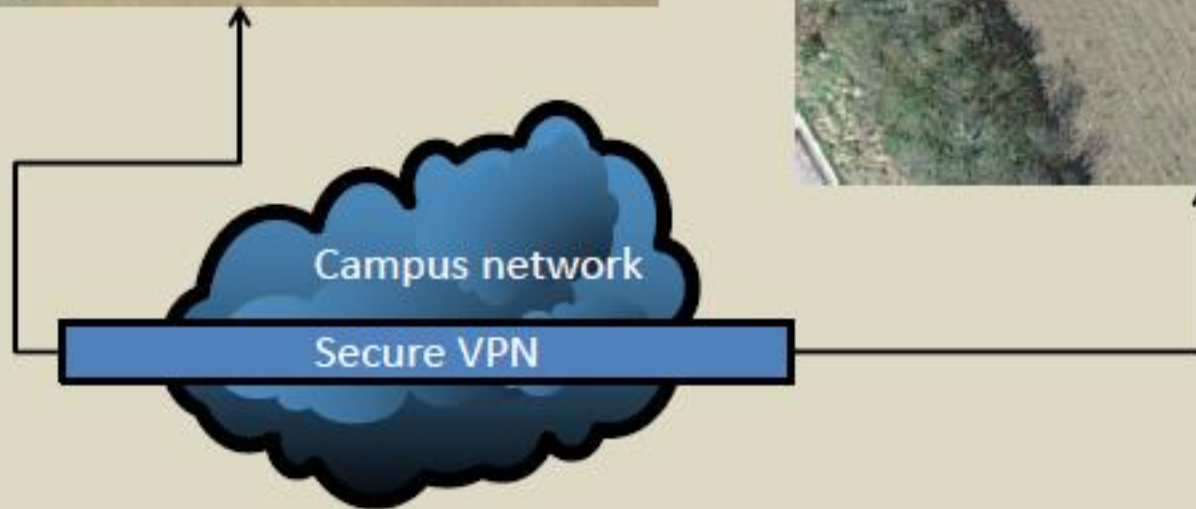


3. Satellite Ground Station

(Dr. Robert McGwier*, Technical Lead)

(* Also, Director of Research, Hume Center for National Security and Technology)

Operations Room, Space@VT



Ground Station

Amateur VHF / UHF:

- Command and Control of VT Spacecraft
- Command and Control of Third Party Spacecraft
- Telemetry Monitoring of active cubesats (FunCube, etc.)



3.0 meter dish + L-Band uplink

- S-Band Downlink (ISS HAMTV, high rate telemetry, etc.)
- L-Band Uplink (Amateur Satellite Service)



4.5 meter dish

- Earth Moon Earth (1296 MHz / 2304 MHz / 10.368 GHz)
- Radio Astronomy (Hydrogen Lines @ 1420 MHz)



Weather (Image) Systems

- GOES Geosynchronous (WEFAX, 1691 MHz)
- NOAA LEO (APT, 137 MHz)
- Tracking and fixed antenna systems

Commercial Systems

- Earth Sensing Spacecraft with S-Band up/down and X-Band down

Ground Station

Education (NUMBER 1 PRIORITY)

- **Hands On Training/Experience**
Students will be *BUILDING* the facility
- **Course Work**
Opportunities to include the facility in coursework; to include labs, semester projects, independent study, undergraduate research, etc.
- **Research Experience for Undergraduates (REUs)**
- **Operational Experience**
Students will be part of spacecraft command and *control* operations, giving them an edge when applying for jobs after VT.
- **Trained Corps of Student Volunteer Operators**

Potential Curriculum Involvement

- Digital Communications
- Satellite Communications
- Intro to Space Sciences
- Astrodynamics
- Software Defined Radio
- And probably more...

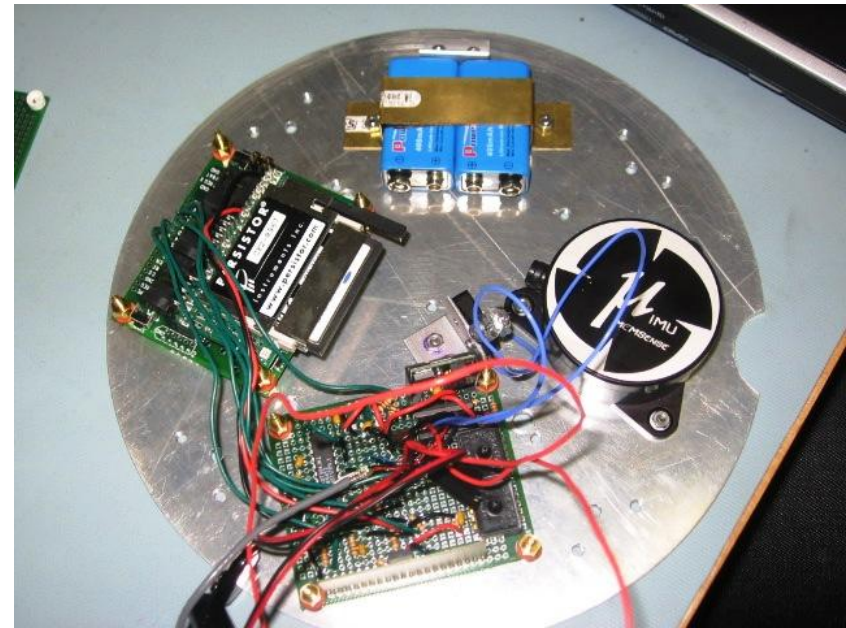
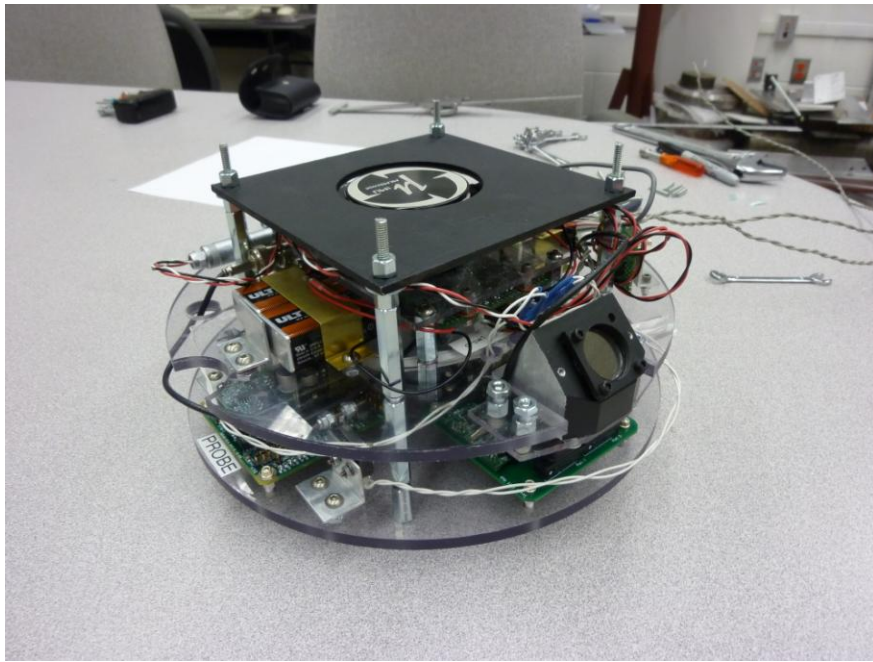
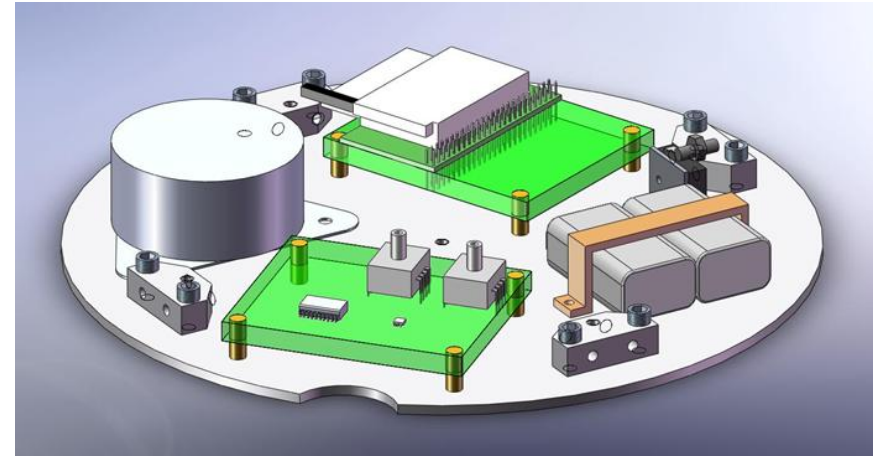
Research

- Command and Control of spacecraft VT is involved with (i.e. LAICE, DUSTIE, Fox-1 series, etc.)
- Command and Control of third party spacecraft (i.e. QB50, Commercial Contracts, etc.)
- Support of Hume/ECE/AoE/Space@VT Research contracts as appropriate
- Increase VT's (and thus VA's) Presence in Space Operations

4. RockSat

(Student sounding rocket instrument test-bed)

- Hy-V – Scramjet Testing
 - RockSat 2008/2009
- Nitrous Oxide Sensor
 - RockSat 2010/2011



RockSat 2014

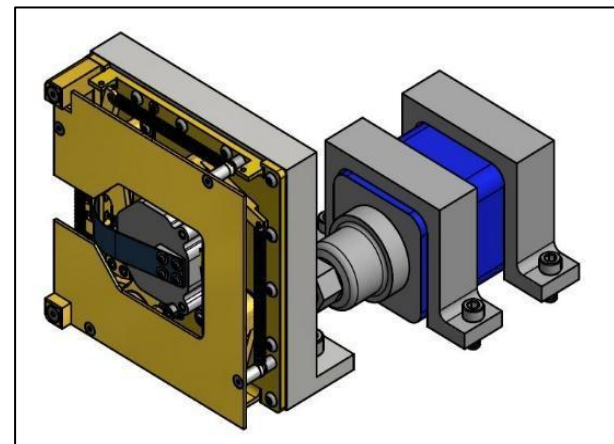
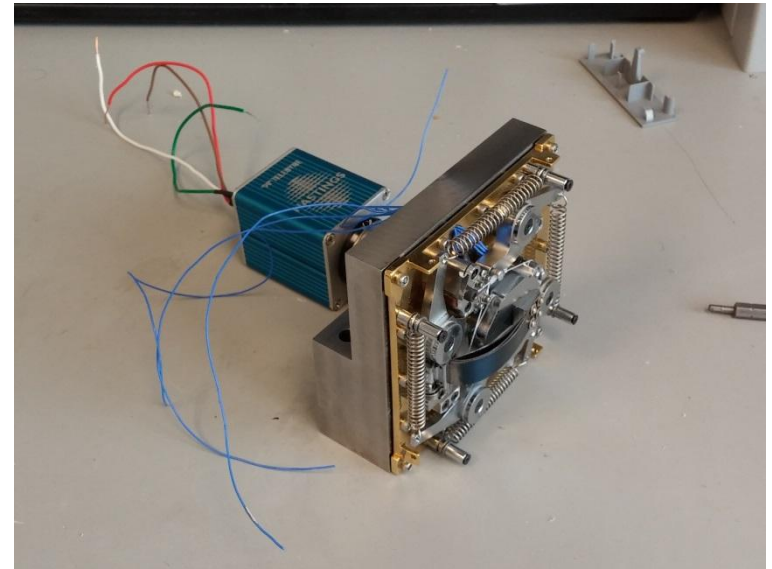
Aperture Cover Release Mechanism (ACRM)

Objective

- Test deployment of instrument cover release mechanism for LAICE Cubesat

Operation

- On-board timer signals thermal knife fire at T+3:00 to begin cap deployment
- Spring-loaded release of cap
- Arduino records cap deployment state



The Future

- Significant collaboration between VT and VSGC is expected into the future:
 - Prof. Gregory Earle, ECE, on VSGC Advisory Council
 - Prof Jonathan Black, new faculty member in AOE, brings extensive space hardware and cube-sat expertise and DoD connections
 - Substantial investment in ground station by the VT College of Engineering will allow further collaborative opportunities such as the QB-50 project
 - Rapidly developing collaboration with the Hume Center for National Security and Technology will open up new student populations and project opportunities
- VSGC is expected to be an important contributor to continued growth of the Space@VT research and education agenda.