



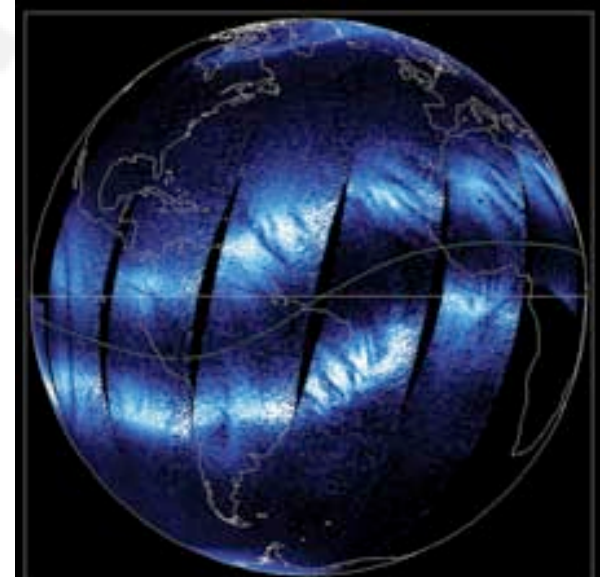
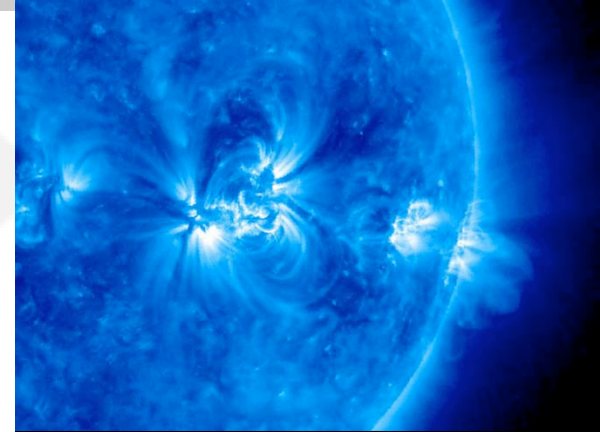
The NSF Cubesat Program

Therese Moretto Jorgensen

**Atmospheric and Geospace Science Division
The National Science Foundation**

Cubesat Science

- advance research in many science areas
- spur innovation, creativity and technology development
- space missions within the scope of traditional NSF grants
- enhance university participation in space activities



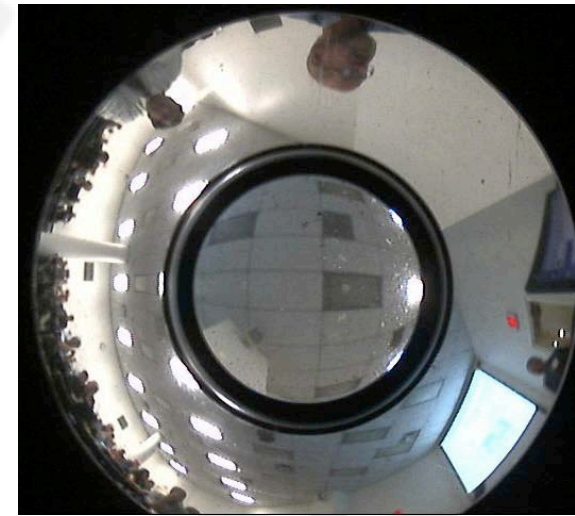
Education and Workforce

- train the next generation of scientists and engineers in space
- full, end-to-end mission experience
- spur new excitement for science & engineering



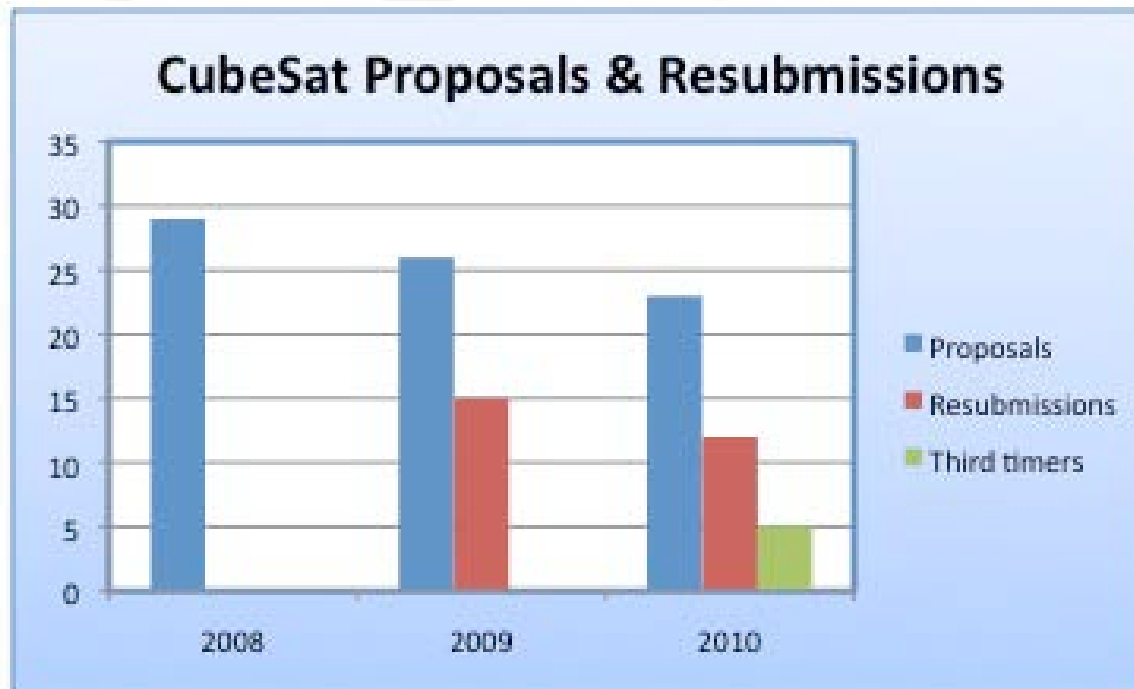
A New NSF Program

- Program conceived 2007; first solicitation 2008
- Utilize CubeSat and P-POD technology development
- Space weather & atmospheric research and education



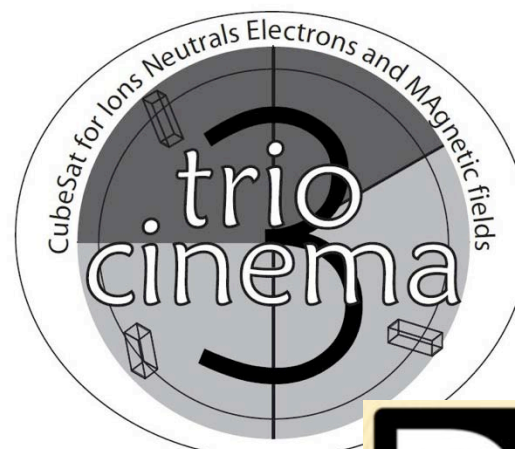
Cubesat Competitions 2008-2012

FY	Projects	Selected	Panel
2008	29	2	21
2009	26	4	20
2010	23	2	19
2012	23	1	19

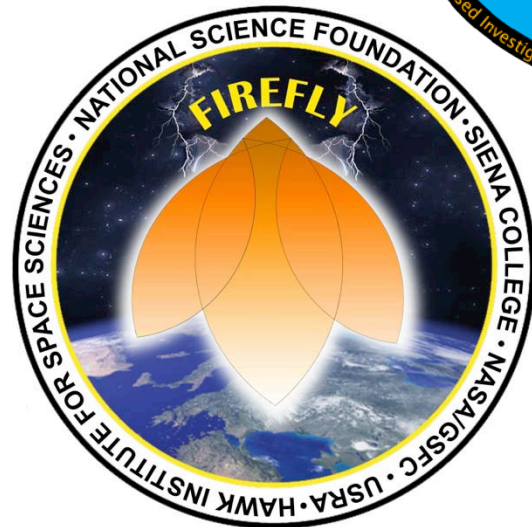
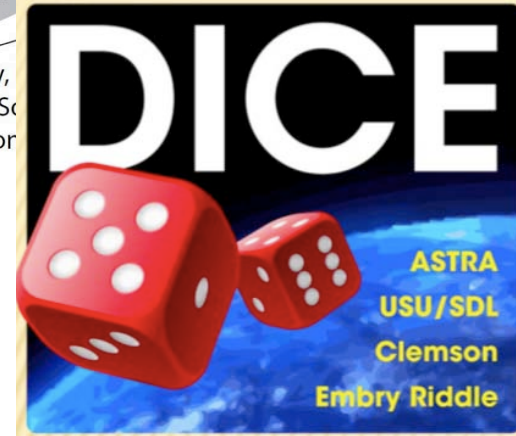




CSSWE



Space Sciences Laboratory,
Kyung Hee University of Science and Technology
Imperial College London



Name	Start	Status	Sponsor	Investigators	Science Target	Technique
RAX	3Q 2008	2010 Launch	NSF	SRI U Michigan	Auroral turbulence	Bistatic UHF radar - ISR measured E-Field
		2011 Launch				
DICE	4Q 2009	2011 Launch		ASTRA Utah State U	Stormtime E-fields and Plasma Density	E-field, langmuir probe, magnetometer
E1P HRBE	3Q 2006	2011a Launch	NASA MSGC	Montana State University	Radiation Belt Structure & Dynamics	Geiger-Mueller Tube
		2011b Launch				
CINEMA	4Q 2009	2012 Launch	NSF	U Cal Berkeley	Energetic Ion, e ⁻ & Neutral Drivers	Multi-particle telescope & magnetometer
CSSWE	1Q 2010	2012 Launch		U Colorado	Outer Belt & Solar Energetic e ⁻ & H ⁺	Electron/proton telescope
SENSE	1Q 2011	2013 Manifest	AF/SM C	NRL, SRI, Aero Corp, ASTRA, AFRL	Iono Structure, Comp/Fields/Winds	WINCS, GPS RO UV Photometry
FIRE BIRD	3Q 2009	2013 Manifest	NSF	U New Hampshire Montana State U	Relativistic electron microbursts	Ion implanted solid- state detectors
FIREFLY	4Q 2008	In Design		Siena College GSFC	Terrestrial gamma ray flashes	RF, gamma-ray, and optical detectors
CADRE	3Q 2011	In Design		U Michigan	Thermosphere Comp/Dynamics	Wind, temp & mass spectrometer (WINCS)
EXO CUBE	4Q 2011	In Design		Scientific Solutions U Wisc, Cal Poly	Exosphere Structure & Dynamics	WINCS tuned for light Ions and neutrals

Space Weather CubeSats December 2012

■ Operational ■ Not Operational
■ A&T Phase ■ PDR/CDR Phase

Current Missions

Radio Aurora Explorer (RAX-2) – U. of Michigan, SRI International,
see <http://rax.engin.umich.edu/>

Dynamic Ionosphere CubeSat Experiment (DICE) –Utah State U., Embry-Riddle, Clemson,
see <http://www.sdl.usu.edu/programs/dice>

Colorado Student Space Weather Experiment (CSSWE) - U. of Co.,
see <http://lasp.colorado.edu/home/csswe>

Cubesat for Ions, Neutrals, Electrons, MAgnetic fields – U. of Cal. Berkley, Kyung-Hee U.,
Imperial College, Applied Physics Lab, Inter-American U. of Puerto Rico,
see <http://sprg.ssl.berkeley.edu/cinema/>

Firefly – GSFC, Hawk, Siena College, manifested to launch Sep. 2013, see
<http://www.nasa.gov/topics/universe/features/firefly.html>

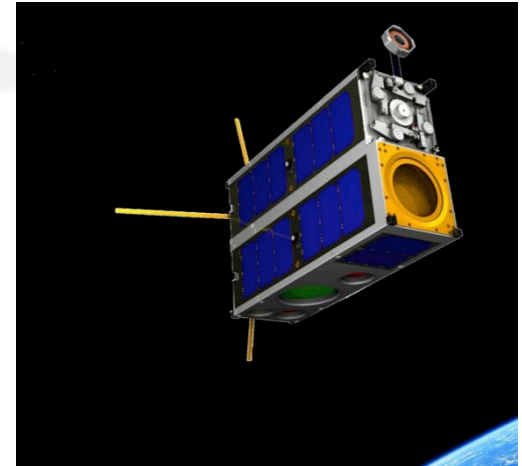
Firebird – Montana State U., U. of New Hampshire, Aerospace Corporation, manifested to
launch in Dec. 2013,
see <https://ssel.montana.edu/category/cubesat/>

Composition Variations in the Exosphere, Thermosphere, and Topside Ionosphere
(EXOCUBE) – Scientific Solutions Inc., Cal Poly, U. of Wisconsin, and GSFC, not yet
manifested,
see <http://www.sci-sol.com/Exocube-Oct2011.pdf>

CubeSat investigating Atmospheric Density Response to Extreme driving (CADRE) – U. of
Michigan, Naval Research Labs, not yet manifested,
see http://exploration.engin.umich.edu/blog/?page_id=961

LAICE 2013

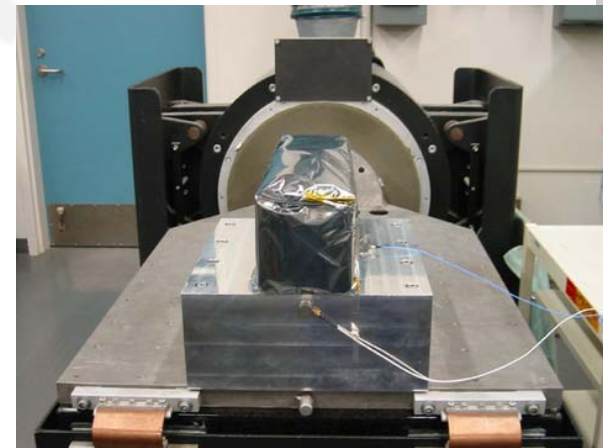
- Virginia Tech; U. Illinois; Aerospace Corp.; NWRA, Inc.
- Atmospheric gravity waves
- 6U cubesat; in-situ and remote sensing
- Award pending



Mission Support at NASA Wallops Flight Facility

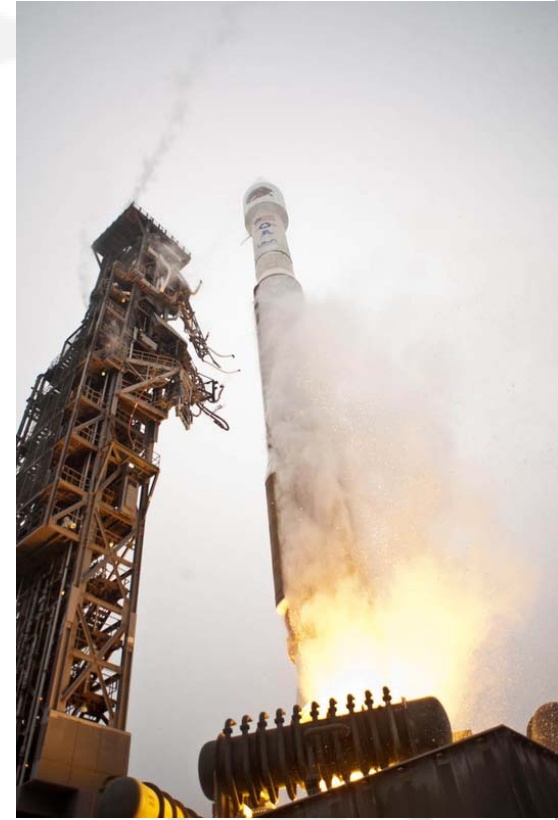


- Integration, testing, documentation
- Technical POC for satellite developer and launch provider
- Other technical and management support
- UHF and S-Band CubeSat Groundstation support



Launch Support

- DOD STP, S26, Nov 2010, Minotaur IV, Kodiak
- NASA ELaNa, NPP, Oct 2011, Delta II, Vandenberg
- NRO/NASA ELaNa NROL-36/ OutSat, Sep 2012, Atlas V, Vandenberg
- Future manifests with NASA ELaNa and NRO



**Total 2008-2012:
\$9.8M**

CubeSat Funding FY 2008-2012

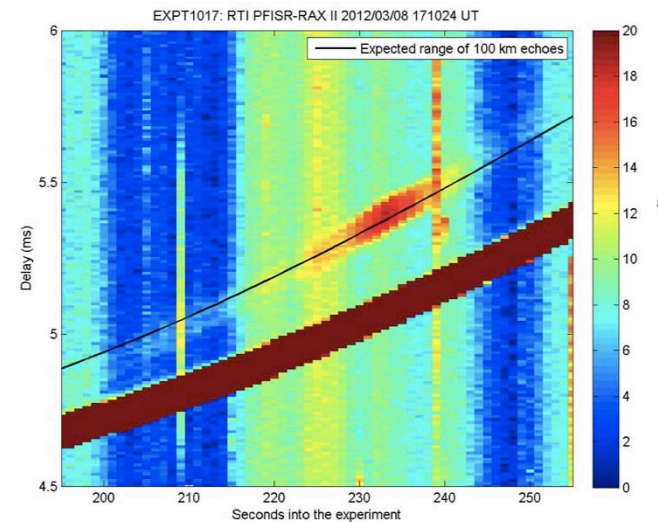


Average (excl ARRA)
over 5 years: \$1.4M

ARRA provided 2
satellite projects and
a REU site

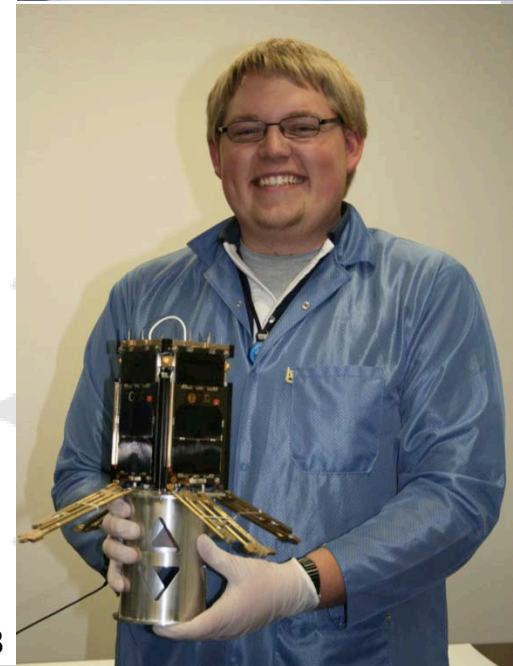
Accomplishments

- Scientific value of CubeSat missions confirmed
- Creative mission ideas and successful implementations
- Scientific papers and data
- Big educational impact
- Increased recognition of cubesats as a viable alternative for space



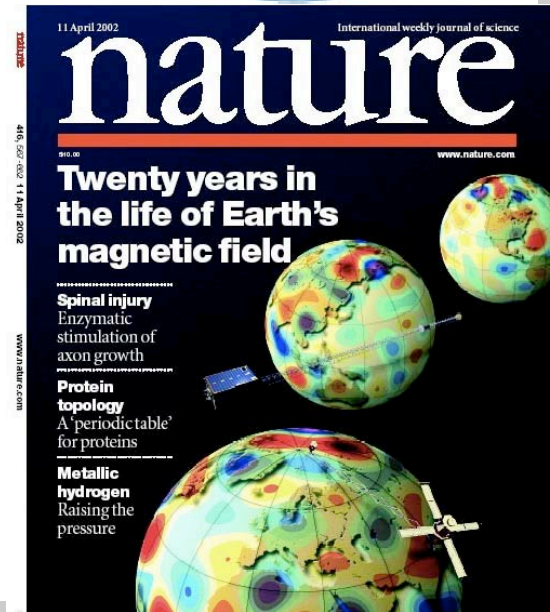
Essential Elements

- Strong science and engineering collaborations
- Thorough proposal review and selection as guarantee for success
- Requirements dictated solely by launch acceptance
- Minimal prescriptions for project management (testing, review, and documentation)
- Open inter-team discussions
- Funding for students



MAIN CHALLENGES

- Expansion to other science areas
- Larger constellations (European QB50 project)
- Frequency allocation & space debris concerns
- Barriers to space-based activities & aerospace engineering at NSF
- Metrics for success





Thank You All For 5 Amazing Years!

