inspireFly

Making Space Local

Presentation Overview

inspireFly

Section 1.0	Motivation & Background
Section 2.0	Mission Objective & Applications
Section 3.0	Technical Design
Section 4.0	Business Strategy & Funding
Section 5.0	Model-Based Systems Engineering
Section 6.0	Milestones & Future Applications

ASTRANIS

Space @ Virginia Tech
Center for Space Science and Engineering Research

VIRGINIA TECH

inspireFly

Mission Statement

inspireFly will design and develop novel CubeSats that present a unique style of access to space for the general public, while demonstrating new technologies for future satellite and space vehicle applications.

Core Values

Inspiration | Diversity | Effectiveness | Ambition | Sincerity

Futuristic Vision

We will present diverse, quickly-accessible, and affordable outer space opportunities to all individuals through CubeSats and other small satellites while expanding capabilities in the space environment through our commitment to inspire, pioneer, and diversify.

ASTRANIS

Space @ Virginia Tech
Center for Space Science and Engineering Research

VIRGINIA TECH

Competition Description

inspireFly

Astranis SEDS SAT-2 Competition

- Design a novel 1U CubeSat up to preliminary design for a chance to win fully-funded launch
- Conform to NanoRacks CubeSat Deployer for deployment via International Space Station

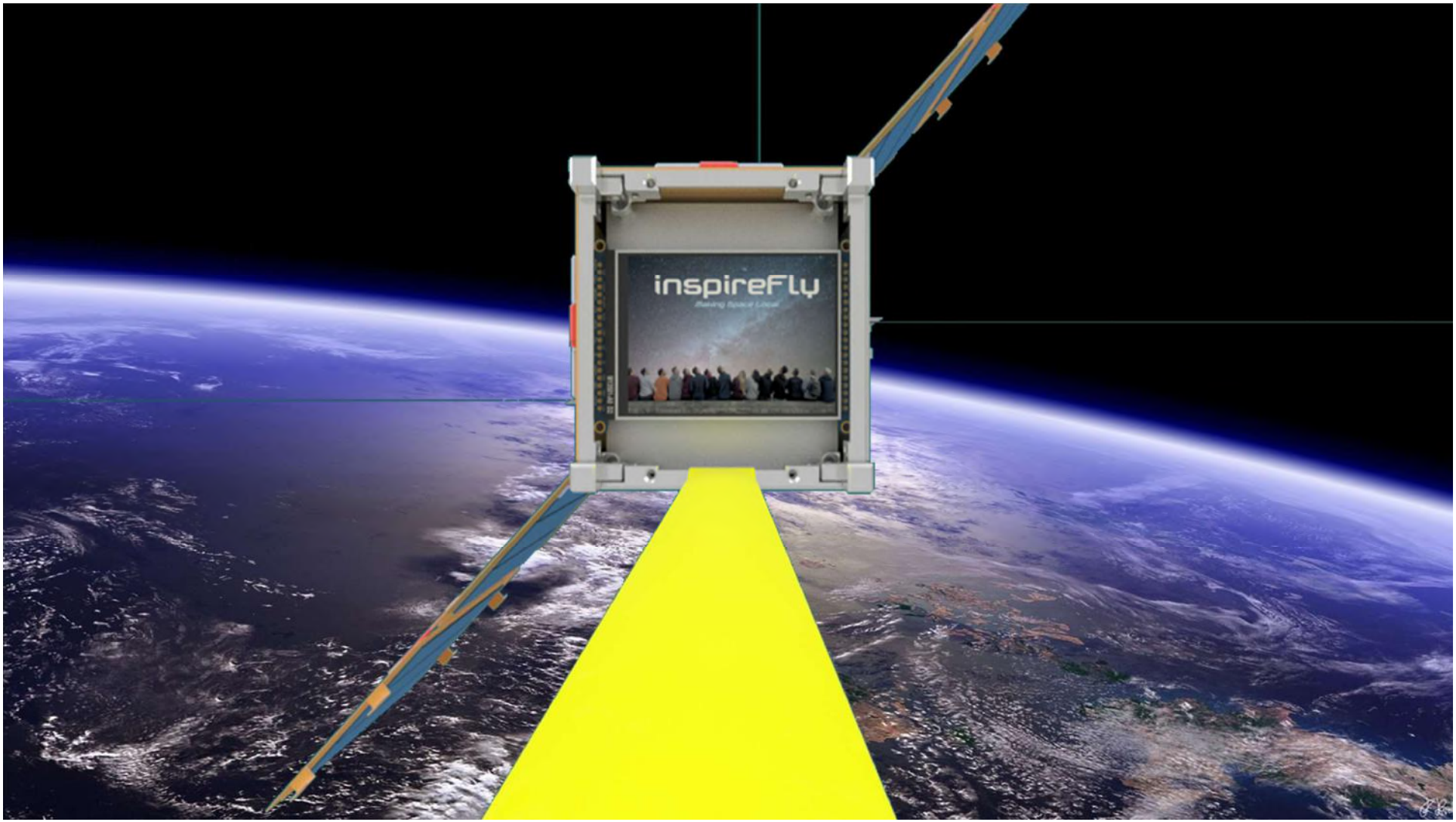
Competitors included:

- MIT/Tufts/Northeastern, UC San Diego, Embry Riddle, CU Boulder, Texas A&M, Purdue, Rice, etc.

ASTRANIS

Space @ Virginia Tech
Center for Space Science and Engineering Research

VIRGINIA TECH


inspireFly

Technical Design

Simran Singh & Richard Gibbons

Mission Objectives

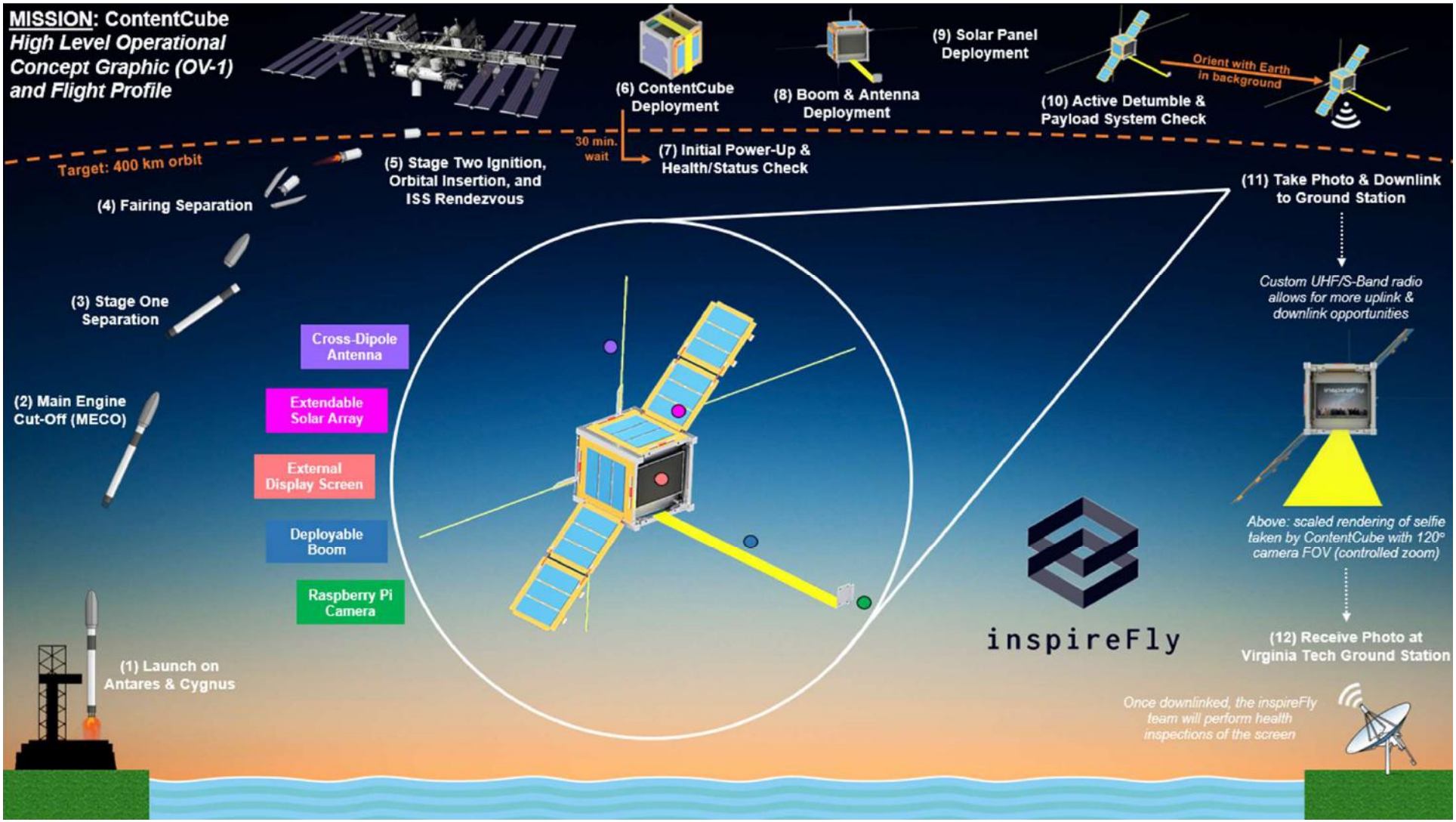
inspireFly

I. Develop 1U CubeSat with a unique and novel payload encompassing an external display screen and camera
II. Use active ADCS to maintain Earth in the background when photographing external display screen
III. Downlink image taken of external display screen to Virginia Tech Ground Station
IV. Operate in orbit for at least six months
V. Verify functionality of external display screen in space environment

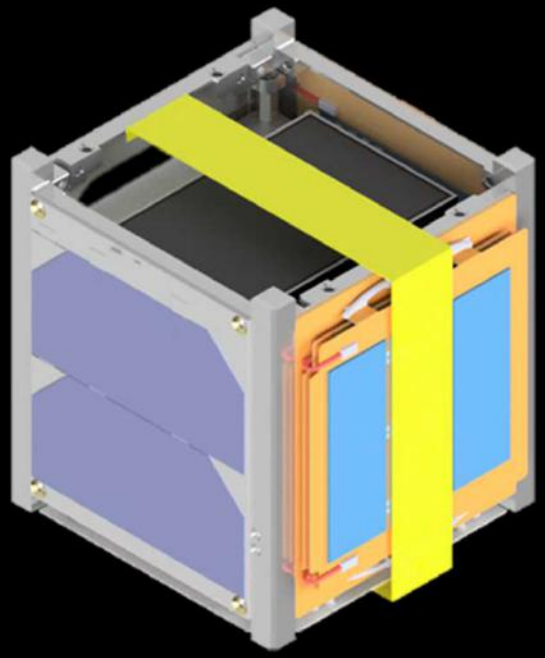
ASTRANIS

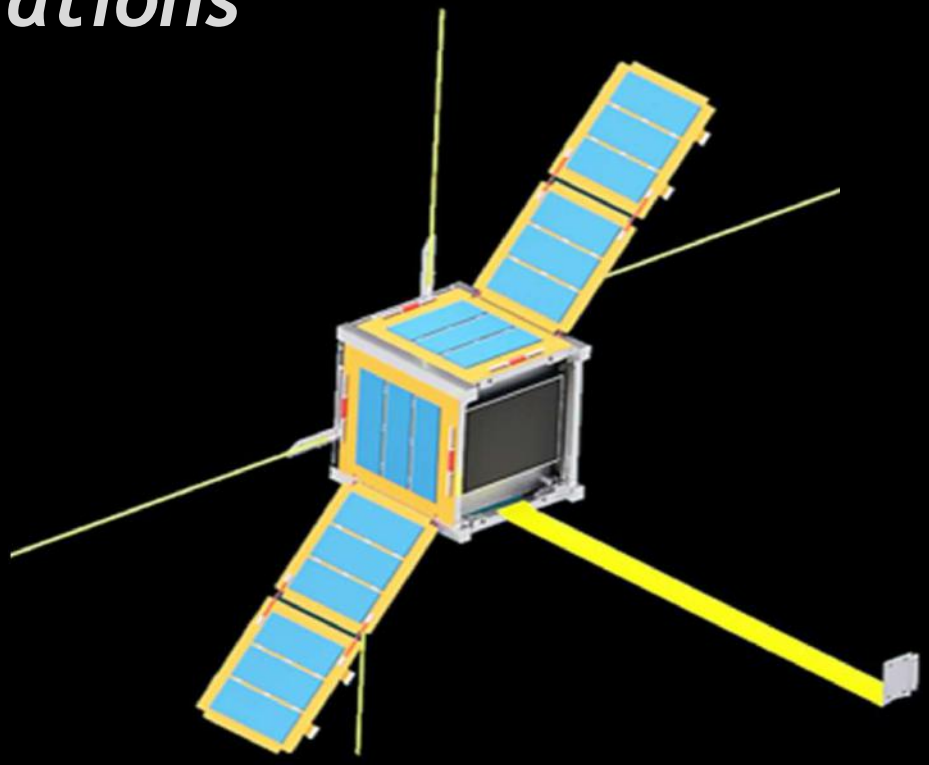
Space @ Virginia Tech
Center for Space Science and Engineering Research

VIRGINIA TECH


MISSION: ContentCube
High Level Operational Concept Graphic (OV-1) and Flight Profile
(6) ContentCube Deployment
(8) Boom & Antenna Deployment
(9) Solar Panel Deployment
Orient with Earth in background
(10) Active Detumble & Payload System Check
Target: 400 km orbit
30 min. wait
(7) Initial Power-Up & Health/Status Check
(5) Stage Two Ignition, Orbital Insertion, and ISS Rendezvous
(4) Fairing Separation
(3) Stage One Separation
(2) Main Engine Cut-Off (MECO)
(1) Launch on Antares & Cygnus
Cross-Dipole Antenna
Extendable Solar Array
External Display Screen
Deployable Boom
Raspberry Pi Camera
(11) Take Photo & Downlink to Ground Station
Custom UHF/S-Band radio allows for more uplink & downlink opportunities
Above: scaled rendering of selfie taken by ContentCube with 120° camera FOV (controlled zoom)
inspireFly
(12) Receive Photo at Virginia Tech Ground Station
Once downlinked, the inspireFly team will perform health inspections of the screen

ContentCube Configurations





inspireFly

ASTRANIS

Space @ Virginia Tech
Center for Space Science and Engineering Research

VIRGINIA TECH

Payload Components

inspireFly

External display screen options

- Adafruit
- Smraza
- Waveshare (tri-color)
- Displaytech

Camera

- Ximea 5 MP
  - 2592 x 1944 pixels
  - Little/no compression
  - Flexible FOV
  - Flight heritage

ASTRANIS

Space @ Virginia Tech
Center for Space Science and Engineering Research

VIRGINIA TECH

Payload Testing

inspireFly

Planned Testing

- Thermal-vacuum
- Black-box glare
- Low-velocity impact
- Cyclic vibration
- NASA gondola
- OLVT launch vehicle

In-Progress Testing

- High-vacuum
- Residual gas analyzer (RGA)

ASTRANIS

Space @ Virginia Tech
Center for Space Science and Engineering Research

VIRGINIA TECH

Mechanical & Structural Components

inspireFly

Chassis

- ISIS 1U CubeSat structure
  - Meets requirements
  - Flight heritage (ISS)

Deployable boom options

- Tape-spring
- Composite
- NASA solar sail roll-up
- Artificial muscle technology
- Inflatable

ASTRANIS

Space @ Virginia Tech
Center for Space Science and Engineering Research

VIRGINIA TECH

Thermal Components

inspireFly

Polyimide thermofoil heater

- TRL 9
- Wide operational range
- Small size

Strip-sensing RTD

- Low power draw
- Wide operational range
- Small size

ASTRANIS

Space @ Virginia Tech
Center for Space Science and Engineering Research

VIRGINIA TECH

Mechanical, Structural, Thermal Testing

inspireFly

Mechanical & Structural

- Vibration
- Deformation
- Boom deployment
  - Temperature
  - Force

Thermal

- Sensor calibration
- Radiative output & control

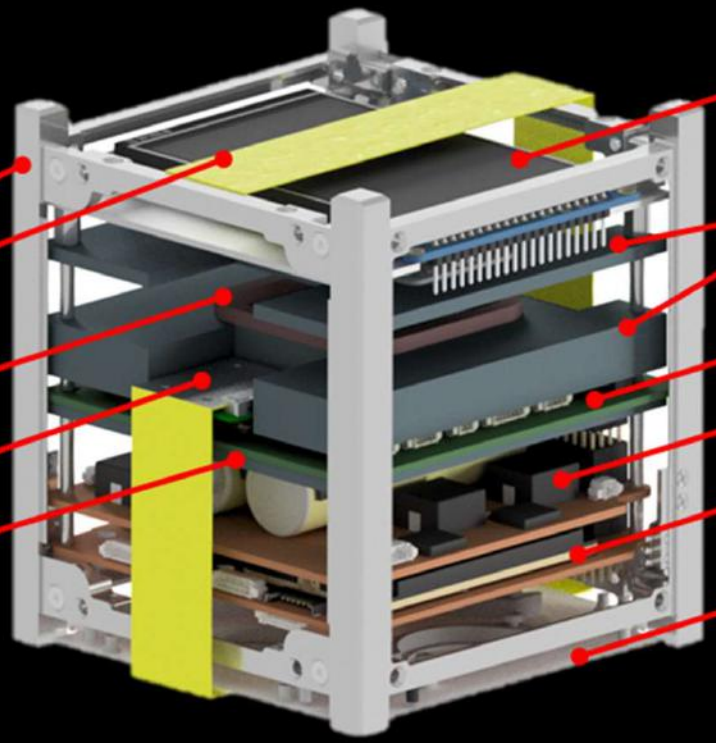
ASTRANIS

Space @ Virginia Tech
Center for Space Science and Engineering Research

VIRGINIA TECH

ContentCube Baseline Design Layout

inspireFly



ASTRANIS

Space @ Virginia Tech
Center for Space Science and Engineering Research

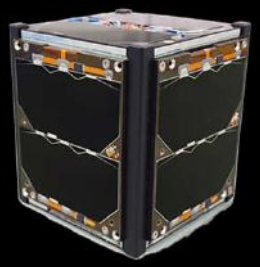
VIRGINIA TECH

Current Bus Options

inspireFly

In-house

- Custom OBC
- Tailored to our mission
- Student experience



ISIS 1U

NGcore

- Research group
- Goal to design reliable bus for future VT payloads

EnduroSat 1U

COTS bus

- EXA, ISIS, EnduroSat, AAC Clyde Space
- Most reliable
- Flight heritage

ASTRANIS

Space @ Virginia Tech
Center for Space Science and Engineering Research

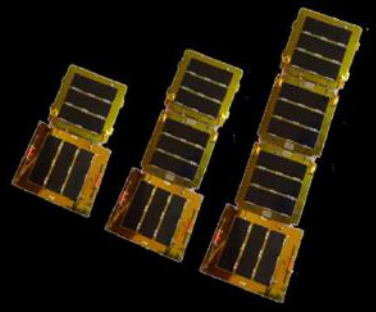
VIRGINIA TECH

Power Systems

inspireFly

Power Generation

- Deployable solar array (DSA) 2-A configuration (integrated magnetorquers)



Power Storage

- GomSpace P31u Electrical Power System (EPS)

ASTRANIS

Space @ Virginia Tech
Center for Space Science and Engineering Research

VIRGINIA TECH

Telecommunications

inspireFly

Gomspace Nanocom AX100 UHF radio for uplink/downlink

- Proper size
- Low weight
- Low power draw
- Relatively high transmission/receive rate

ASTRANIS

Space @ Virginia Tech
Center for Space Science and Engineering Research

VIRGINIA TECH

Attitude Determination & Control System

inspireFly

Inertial Measurement Units

- Vector Nav 100
  - 3-axis magnetometer, 3-axis accelerometer, 3-axis gyroscope
  - Single-fault tolerance
  - Flight heritage
  - ITAR-free

Magnetorquers

- MT-1 Compact
  - Integrated into base of deployable solar panels
  - High lifetime
  - Extensive testing
  - Flight heritage

ASTRANIS

Space @ Virginia Tech
Center for Space Science and Engineering Research

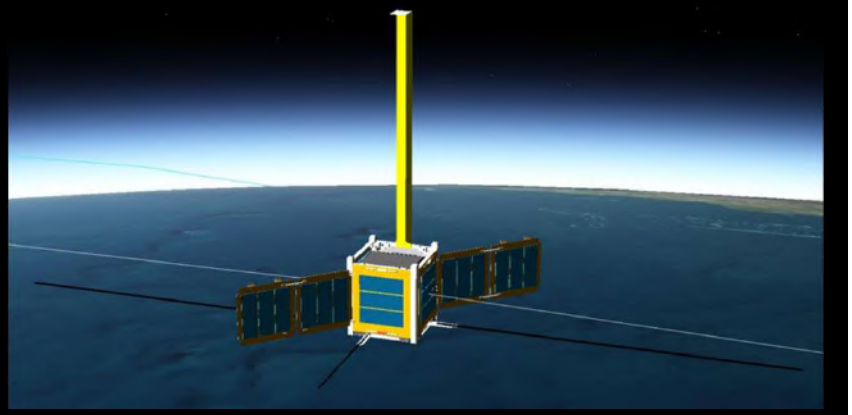
VIRGINIA TECH

Lifetime Analysis

Using STK's lifetime analysis tool with:

- The DTM 2012 drag model
- C_d of 2.0 and 2.2
- Threshold altitude of 65 km
- Mass of 2.3 kg

The CubeSat is estimated to have a lifetime of 1-2 years



inspireFly

ASTRANIS

Space @ Virginia Tech
Center for Space Science and Engineering Research

VIRGINIA TECH

Business Development

Matt Krivansky

Business Strategy & Funding

inspireFly

- High caliber engineering is usually ever-present in most CubeSat mission designs, however what lacks is sufficient funding
- inspireFly's Business Development team has proven success with fundraising from former organizations
- We have explored, implemented, and secured funding:
  - Communicating with potential angel investors
  - Virginia Tech's Student Engineering Council
  - Information and Corporate Sponsorship Packages

ASTRANIS

Space @ Virginia Tech
Center for Space Science and Engineering Research

VIRGINIA TECH

Preliminary Cost: ContentCube Mission

CC Flight Model	CC Engineering Model	Subsystem Testing	Outsourced Production	Margin (20%)	
Flight-ready mission model	Identical to flight model	Payload, ADCS, Structures, Deployables	PCB population, custom flight board manufacturing	Unexpected or emergency expenses	**Total**
$36,540	**$36,540**	**$10,000**	**$5,000**	**$17,616**	**$105,696**

inspireFly

ASTRANIS

Space @ Virginia Tech
Center for Space Science and Engineering Research

VIRGINIA TECH

Model-Based Systems Engineering

Simran Singh

What is MBSE?

- Create & leverage domain models
  - Avoids document-based information exchange
- Focus on relationships between concepts, individuals, roles, etc.
- Increase coordination & productivity of large teams

inspireFly

ASTRANIS

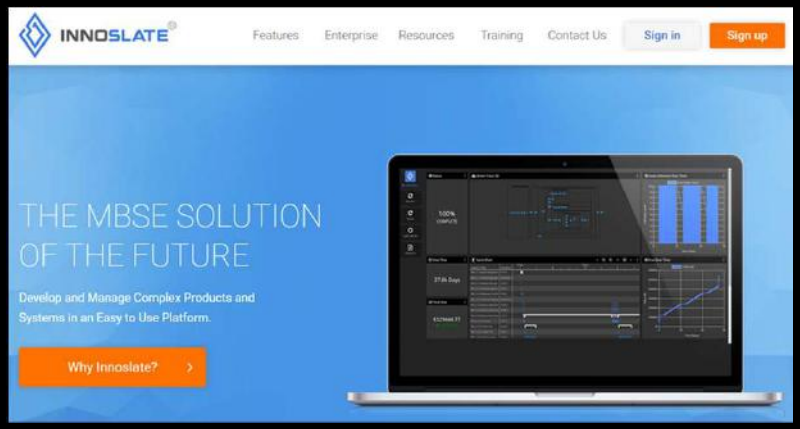
Space @ Virginia Tech
Center for Space Science and Engineering Research

VIRGINIA TECH

Innoslate: Cloud-Based MBSE Tool

inspireFly

- Requirements management
  - Documentation & analysis
- Test plans
  - Verification & traceability
- Workflow, data, hierarchies
  - Transitions & version control
- Simulations
  - Cost, schedule, performance
- Design architectures & processes



ASTRANIS

Space @ Virginia Tech
Center for Space Science and Engineering Research

VIRGINIA TECH

Milestones & Future Applications

Ben Strickler

Upcoming Milestones

inspireFly

- Feb. 2020 — *inspireFly Presenting at Paris Space Week*
- Feb. 2020 - Mar. 2021 — *Design, Development, Testing, Integration*
  CDR in May 2020
- Apr. - Jun. 2021 — *Flight Readiness Review (FRR)*
- Jul. - Sep. 2021 — *ContentCube Launch*
- Oct. 2021 - Dec. 2022 — *Mission Operations*

ASTRANIS

Space @ Virginia Tech
Center for Space Science and Engineering Research

VIRGINIA TECH

Future Applications

- External screen devices for space tourism
- Media
  - Live-streaming (e.g. YouTube, Twitch, music videos, concerts)
  - Broadcasting (e.g. sports, news)
- Science/technology
  - Planetary rovers
  - Extraterrestrial habitats
  - Astronaut suit integration

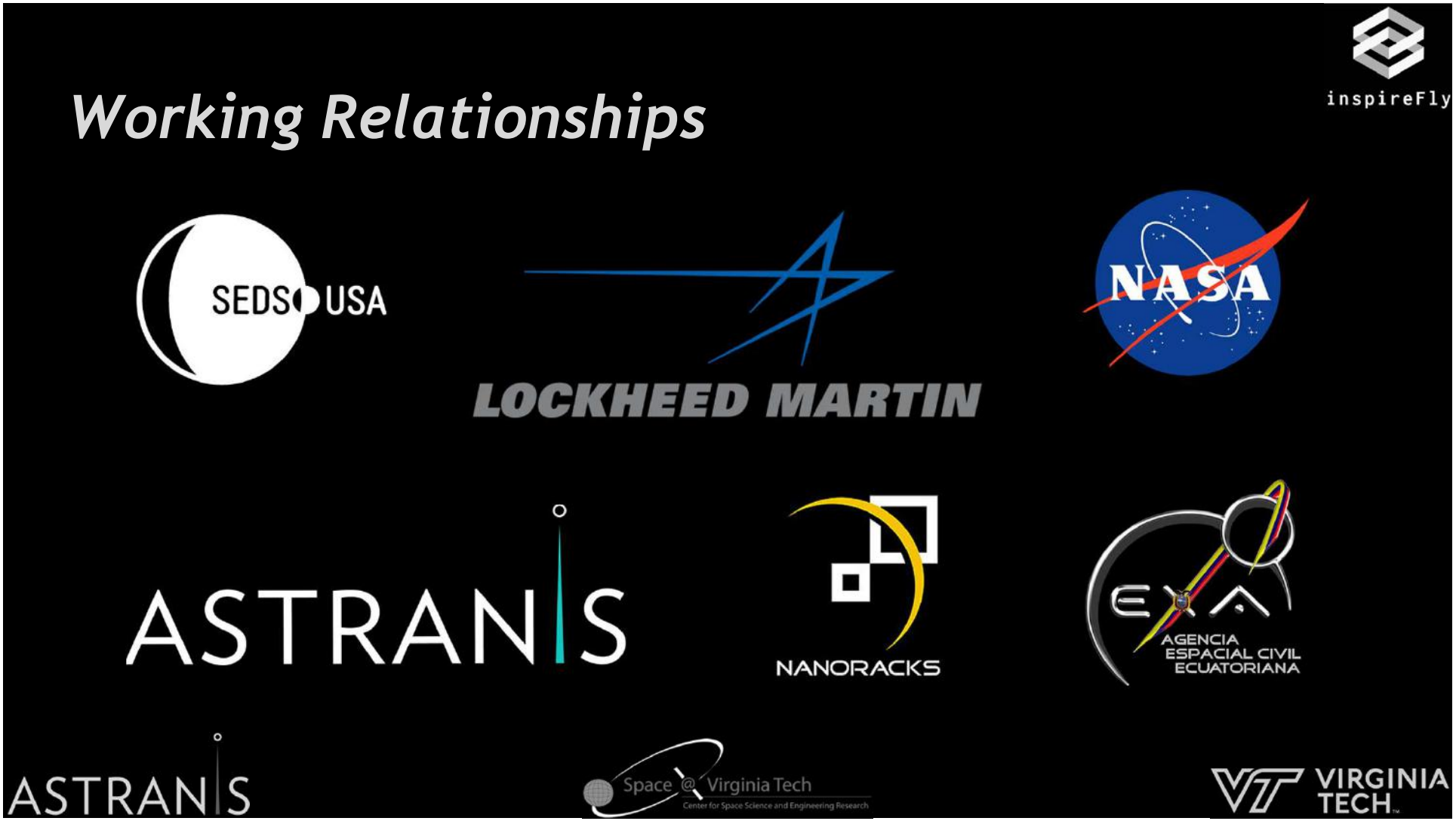
inspireFly

ASTRANIS

Space @ Virginia Tech
Center for Space Science and Engineering Research

VIRGINIA TECH

Working Relationships



inspireFly

www.inspirefly.space