CanSat 2011
Post Flight Review

Team 513
Virginia Tech Team Rocket

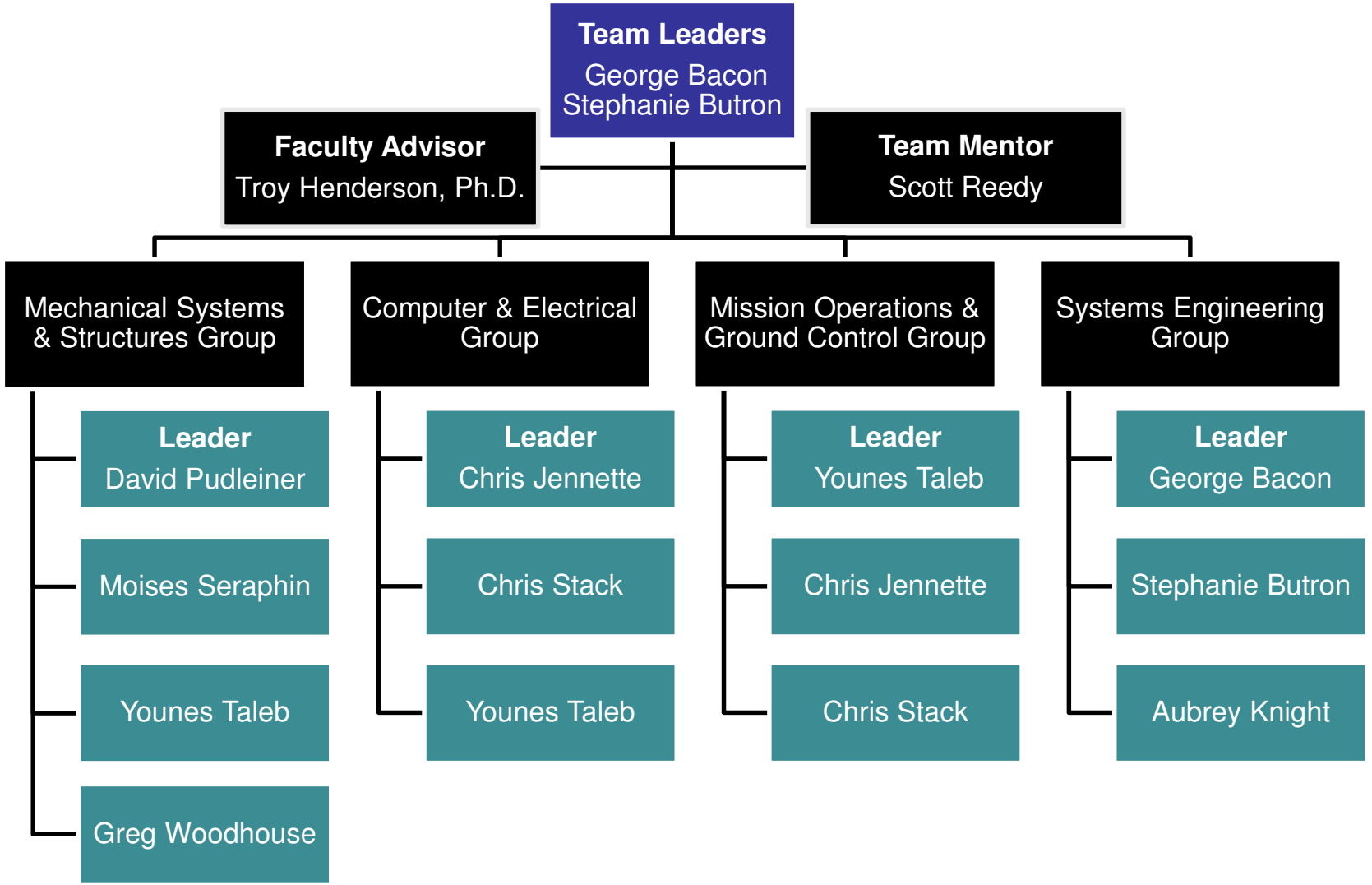
Presentation Outline

- **Systems Overview** – David Pudleiner
- **CONOPS and Sequence of Events** – Younes Taleb
- **Flight Data Analysis** – Chris Jennette
- **Failure Analysis** – Chris Jennette
- **Management** - George Bacon
- **Conclusion** – George Bacon

Team Overview

Name	Major	Year
George Bacon	Aerospace Engineering	Junior
Stephanie Butron	Aerospace Engineering	Junior
Chris Jennette	Electrical Engineering	Junior
Aubrey Knight	Aerospace Engineering	Junior
David Pudleiner	Mechanical Engineering	Junior
Moises Seraphin	Aerospace Engineering	Junior
Chris Stack	Computer Engineering	Junior
Younes Taleb	Aerospace Engineering	Junior
Greg Woodhouse	Aerospace Engineering	Junior

Team Organization



Acronyms

- **ADR** – Average Descent Rate
- **CDH** – Communication and Data Handling
- **CONOPS** – Concept of Operations
- **GCS** – Ground Control System
- **GPS** – Global Positioning System
- **S/H** – Shipping and Handling
- **SOE** – Sequence of Events

Systems Overview

David Pudleiner

Mission Summary

- Launch an autonomous CanSat with a deployable lander containing one large raw hen egg
- CanSat will be deployed from a rocket at an altitude around 1020 meters and start transmitting GPS telemetry
- At 500 meters, the carrier shall release the lander that contains one large raw hen egg
- After separation, the carrier shall have an Average Descent Rate (ADR) of 4 meters per second and the lander shall have an ADR or 5.5 meters per second
- The lander should land without damaging the egg and measure the force of impact with the ground

CanSat Overview

- **Key design decisions**
  - Used integrated antenna
  - Parachutes for decent control
  - Rod and disc frame
  - Electrical components located at the top section of both pieces
  - Egg compartment located at the bottom of the lander
  - Screw and nut separation mechanism

Component Summary

Carrier

Sensor Subsystem
-GPS
-Pressure sensor
-Accelerometer

Mechanical Subsystem
-Frame: Carbon Rods/Tube and Fiberglass Discs
-Bonding Materials: Electrical Tape, Epoxy, Zip Ties

CDH Subsystem
-Arduino Pro Mini
-EEPROM

GCS Subsystem
-Antenna
-Transceiver

Lander

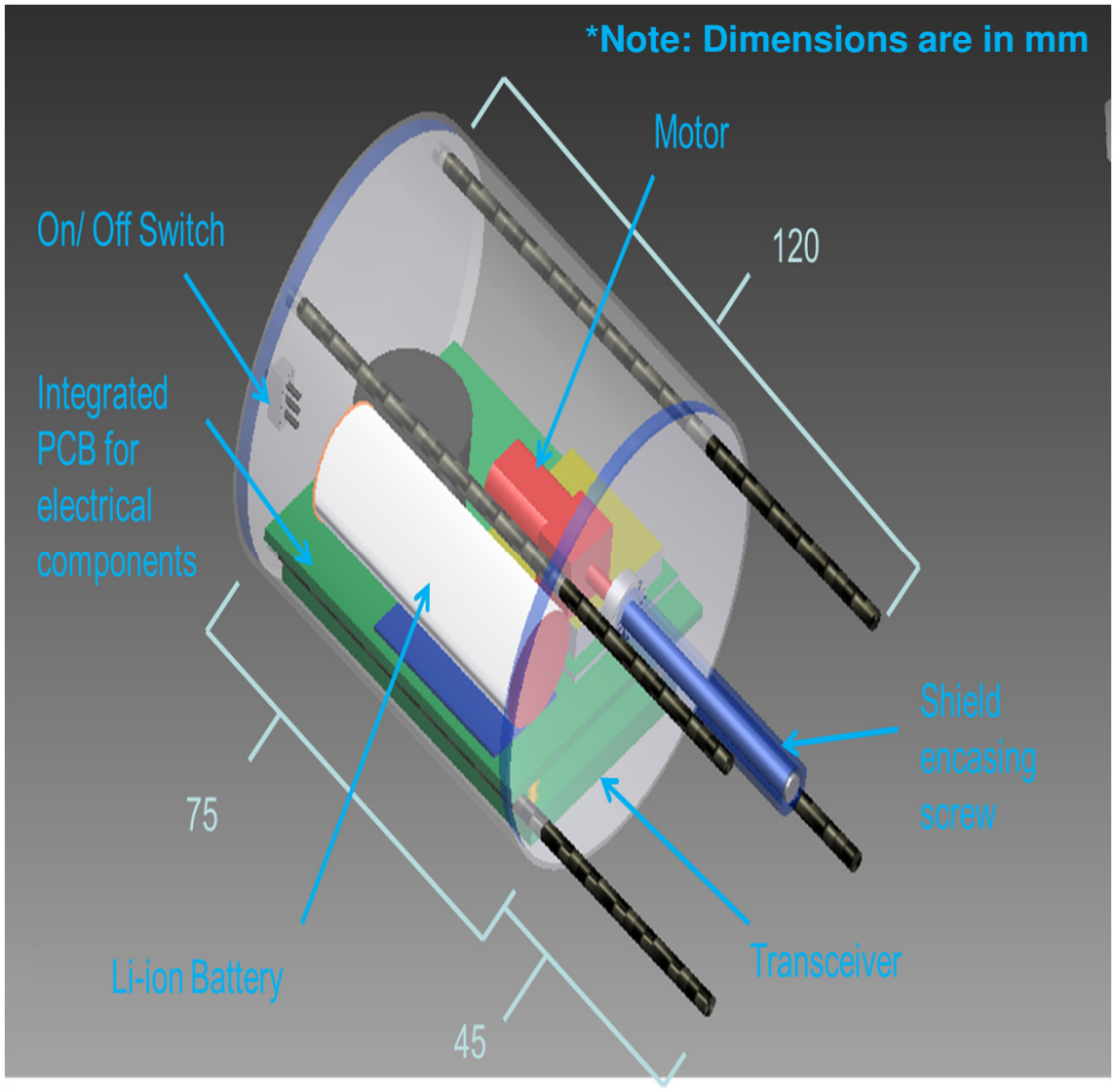
Sensor Subsystem
-Accelerometer
-Pressure Sensor

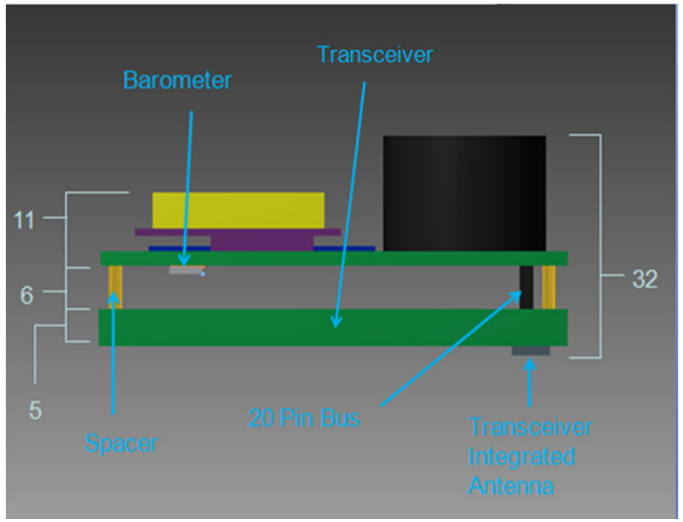
Mechanical Subsystem
-Frame: Carbon Rods/Tube, Fiberglass Discs, Tennis Ball Can
-Bonding: Electrical Tape, Epoxy, Zip Ties
Egg Protection: Pipe Foam

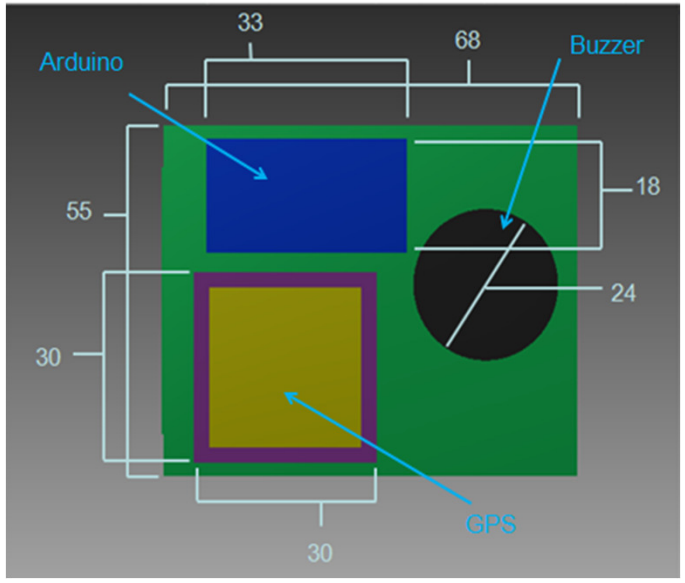
CDH Subsystem
-Arduino Pro Mini
-EEPROM

GCS Subsystem
-Antenna
-Transceiver

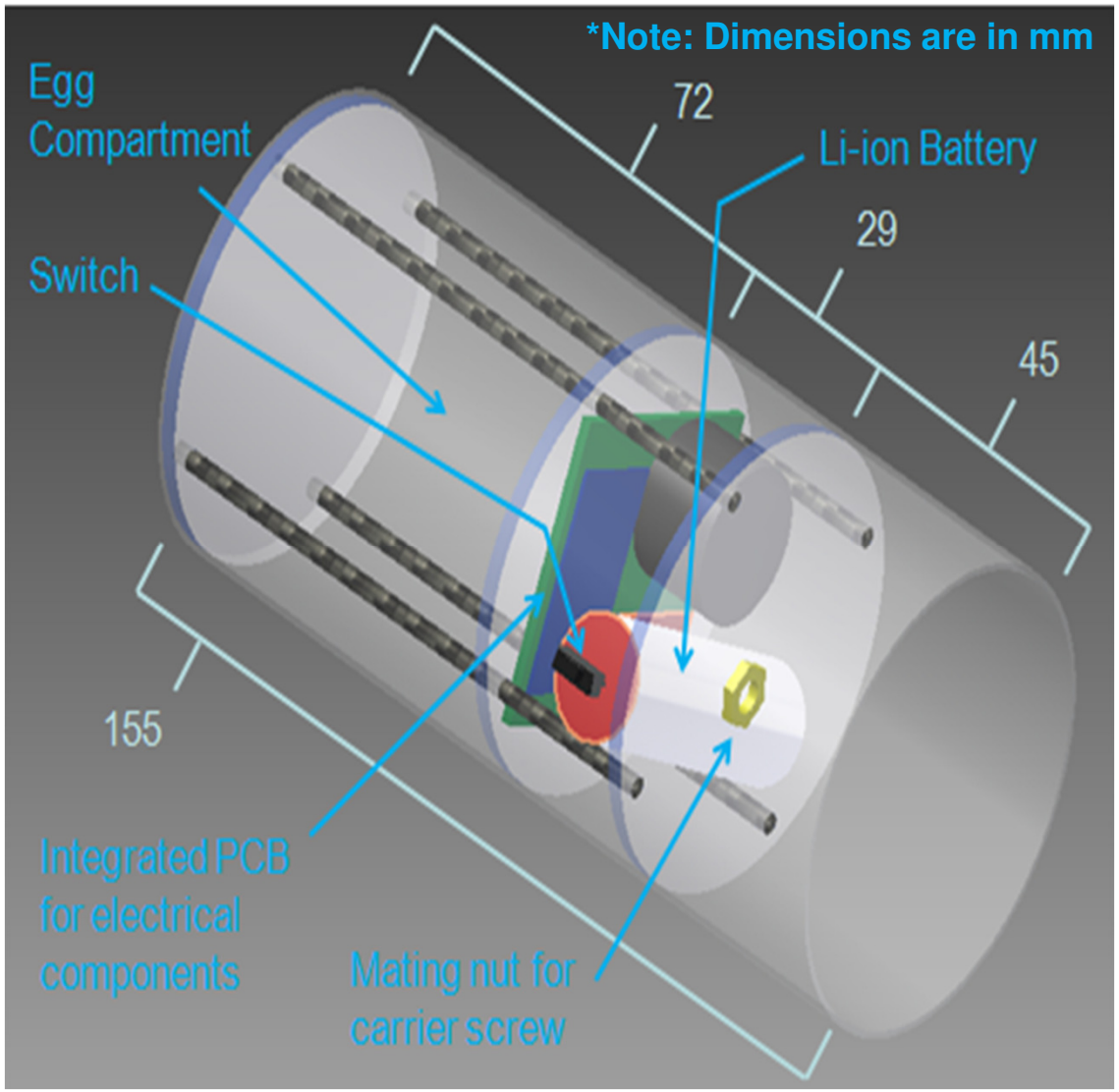
Physical Layout - Carrier

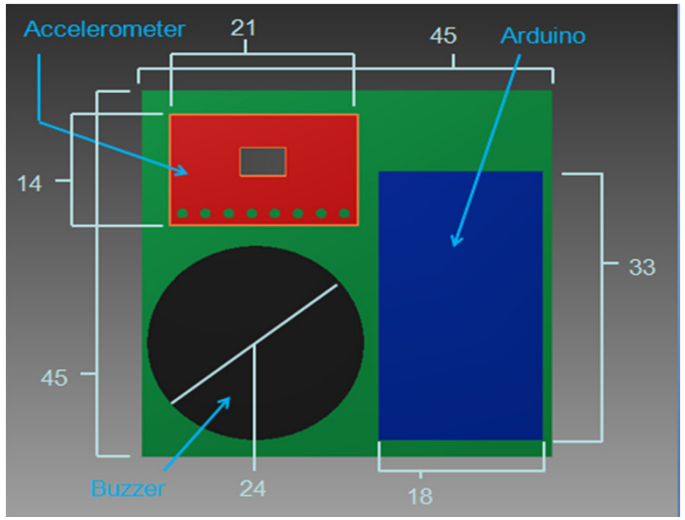


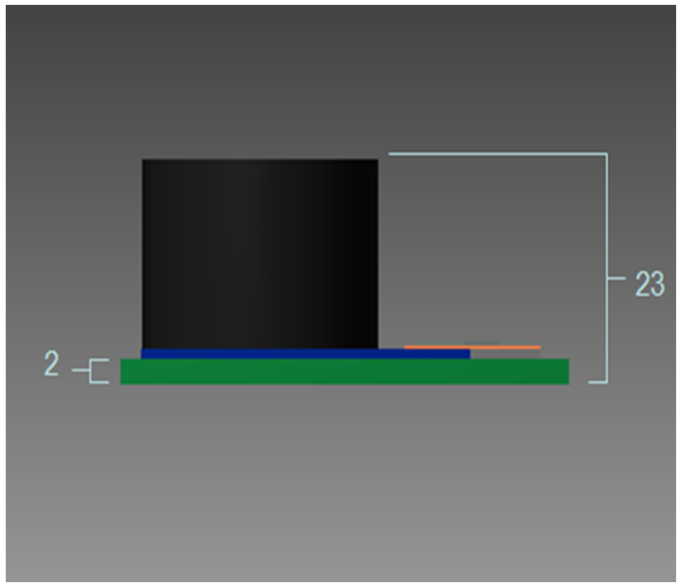




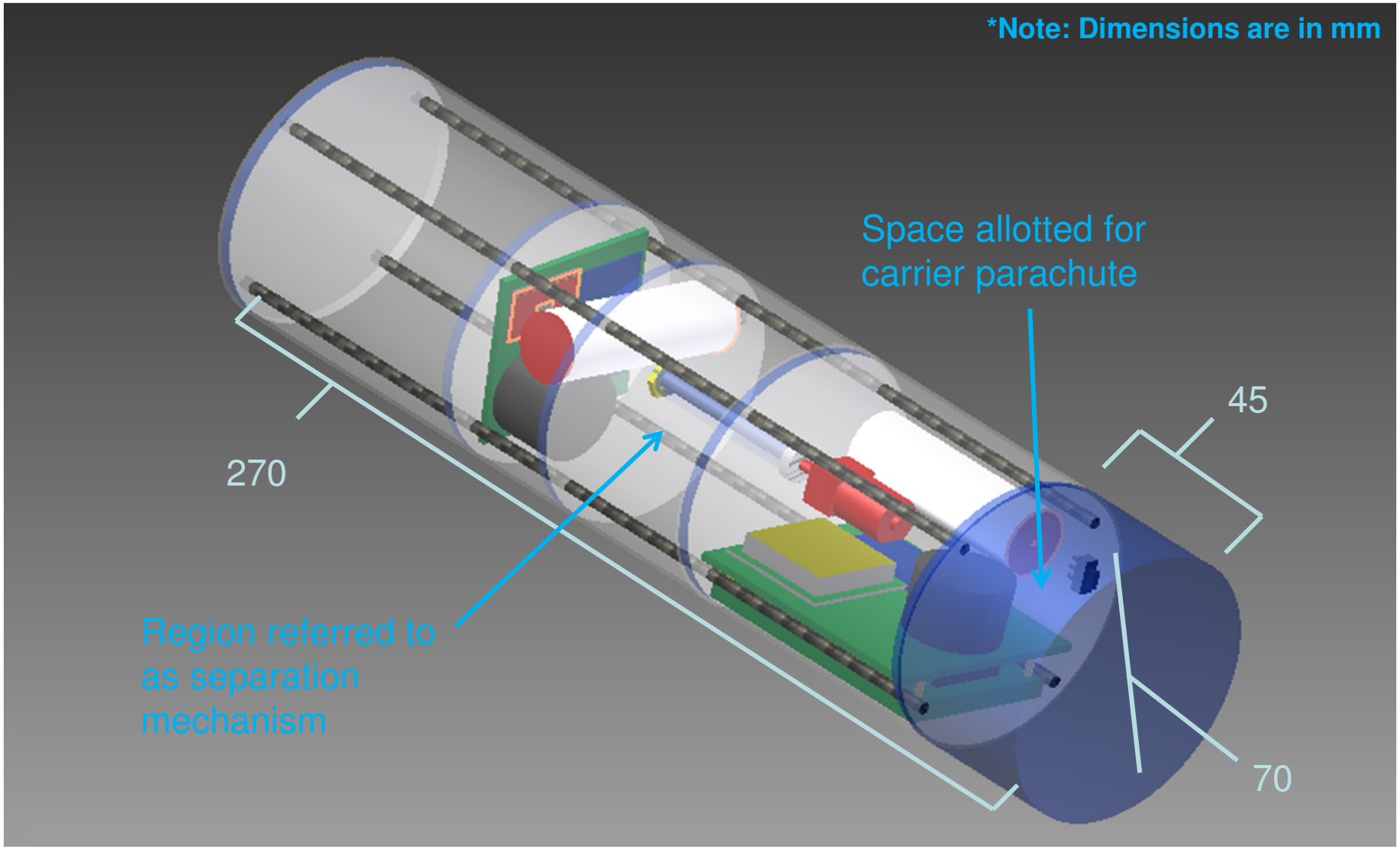
Physical Layout - Lander







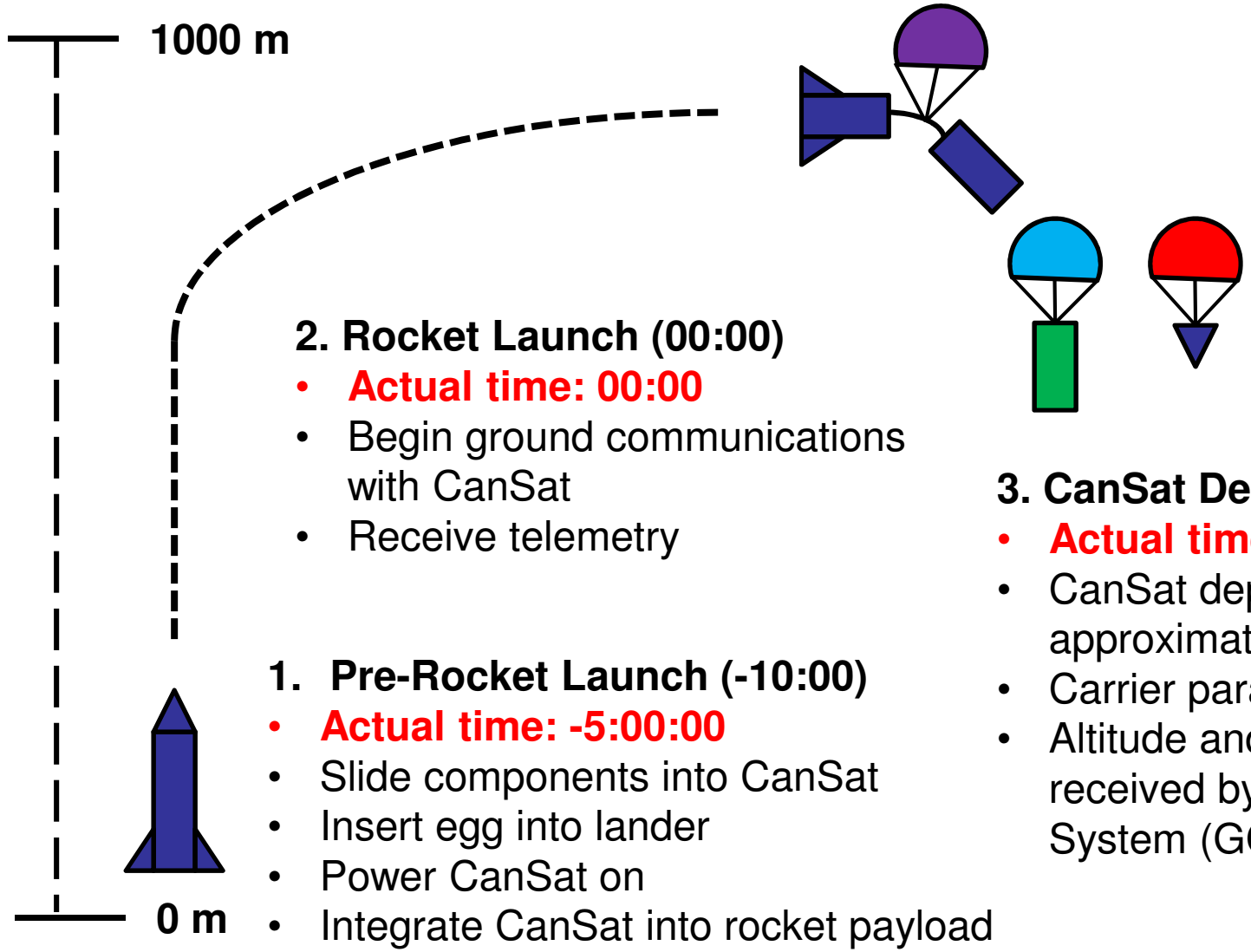
Physical Layout – Entire CanSat



Concept of Operations and Sequence of Events

Younes Taleb

Concept of Operations – Planned vs. Actual

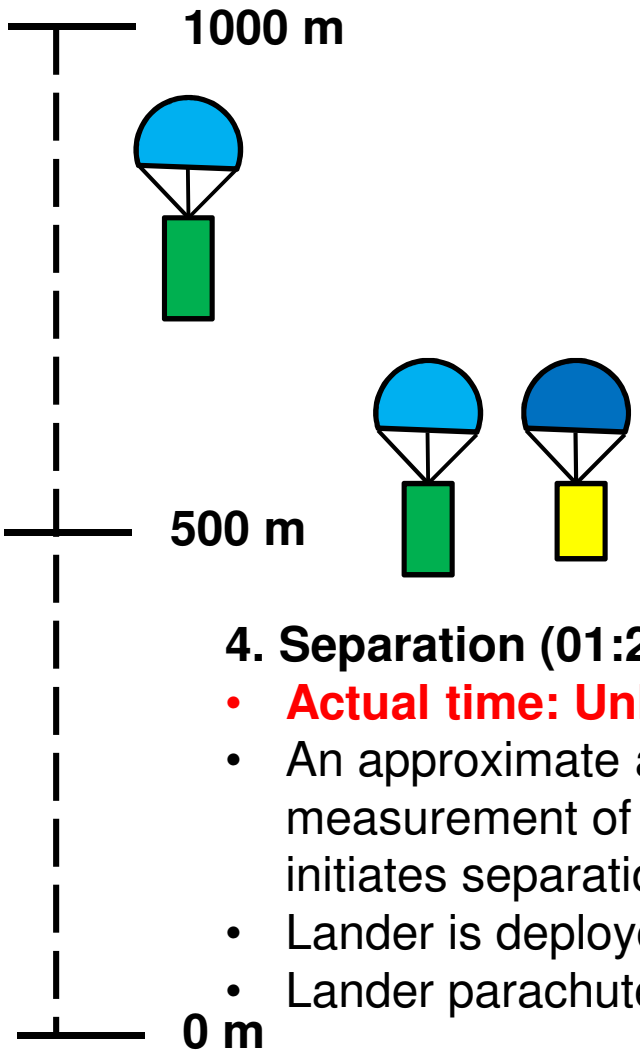


2. Rocket Launch (00:00)
- **Actual time: 00:00**
- Begin ground communications with CanSat
- Receive telemetry

1. Pre-Rocket Launch (-10:00)
- **Actual time: -5:00:00**
- Slide components into CanSat
- Insert egg into lander
- Power CanSat on
- Integrate CanSat into rocket payload

3. CanSat Deployed (00:30)
- **Actual time: 00:16**
- CanSat deployed at approximately 1000 m
- Carrier parachute opens
- Altitude and pressure data is received by the Ground Control System (GCS)

Concept of Operations – Planned vs. Actual



5. Landing (03:28)

- **Actual time: Unknown**
- Audible beacons activate on both the carrier and lander upon landing
- Impact force recorded by the lander

4. Separation (01:20)

- **Actual time: Unknown**
- An approximate altitude measurement of 500 meters initiates separation
- Lander is deployed
- Lander parachute opens

6. Recovery (13:28)

- **Actual time: 4:20:00**
- Carrier and lander are retrieved
- Telemetry data is retrieved from the lander via a USB connection

Mission Sequence of Events – Planned vs. Actual

Arrival at Launch Site

- Planned: 8:00AM
- Actual: 8:25AM

Check-in with Flight Judge

- Weight CanSat assembly (Planned: 1:15PM, Actual 2:11PM)
- Perform fit-check (Planned: 1:16PM, Actual 2:11PM)
- Measured antenna height (Planned: 1:17PM, Actual 9:40AM)
- Assigned egg (Planned: 8:00AM, Actual 8:45AM)
- Assigned rocket payload (Planned: 1:20PM, Actual 2:17PM)

Prep and Test CanSat

- Check subsystems (Planned: 11:00AM, Actual 12:00PM)
- Fit egg into lander (Planned: 9:00AM, Actual 9:15AM)
- Power CanSat online (Planned: 1:20PM, Actual 2:17PM)
- Integrate CanSat into rocket payload (Planned: 1:20PM, Actual 2:17PM)

Launch CanSat

- Panned: 1:00PM
- Actual: 2:20PM

Mission Sequence of Events – Planned vs. Actual

Landing Prediction
- Planned: 1:45PM
- Actual: 2:00PM

Recovery
- Egg is checked for damage (Planned: 2:00PM, Actual 6:00PM)
- Carrier and lander are retrieved (Planned: 2:00PM, Actual 6:00PM)

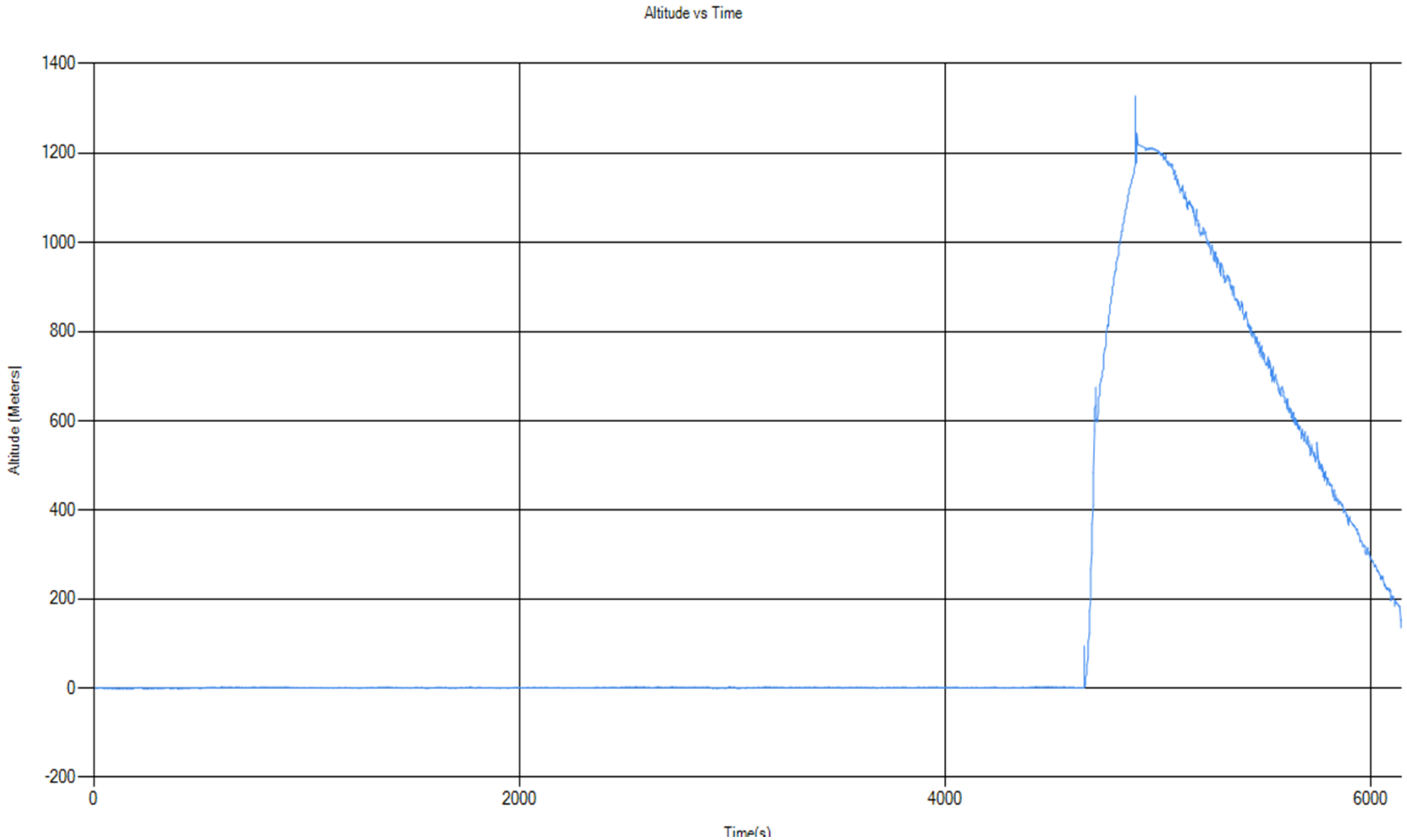
Analysis
- Data is retrieved from the lander via USB cable (Planned: 2:30PM, Actual 7:30PM)
- Telemetered data is analyzed (Planned: 4:00PM, Actual 9:00PM)

Post Flight Review
- Planned: 12:10PM

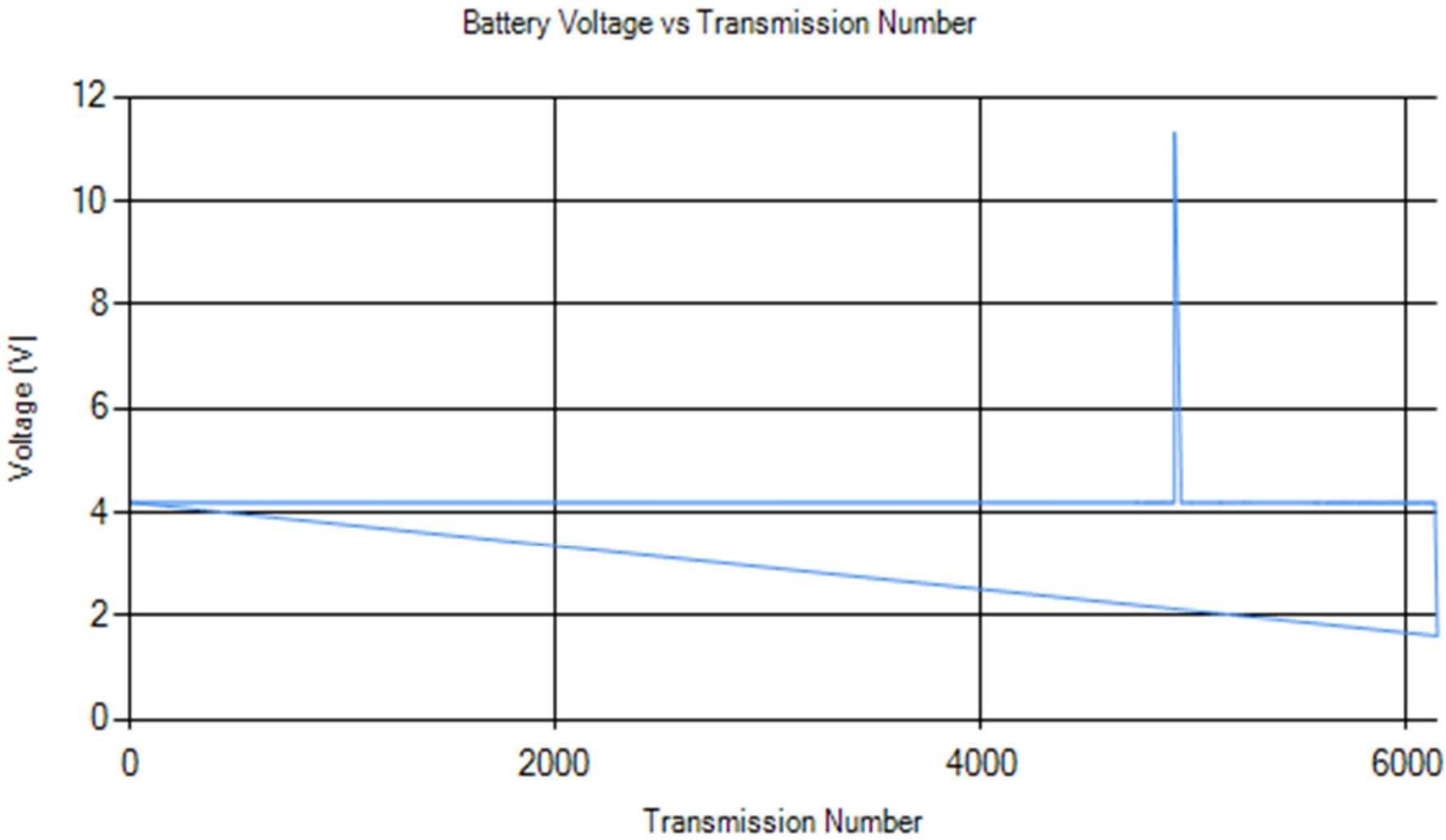
Flight Data Analysis

Chris Jennette

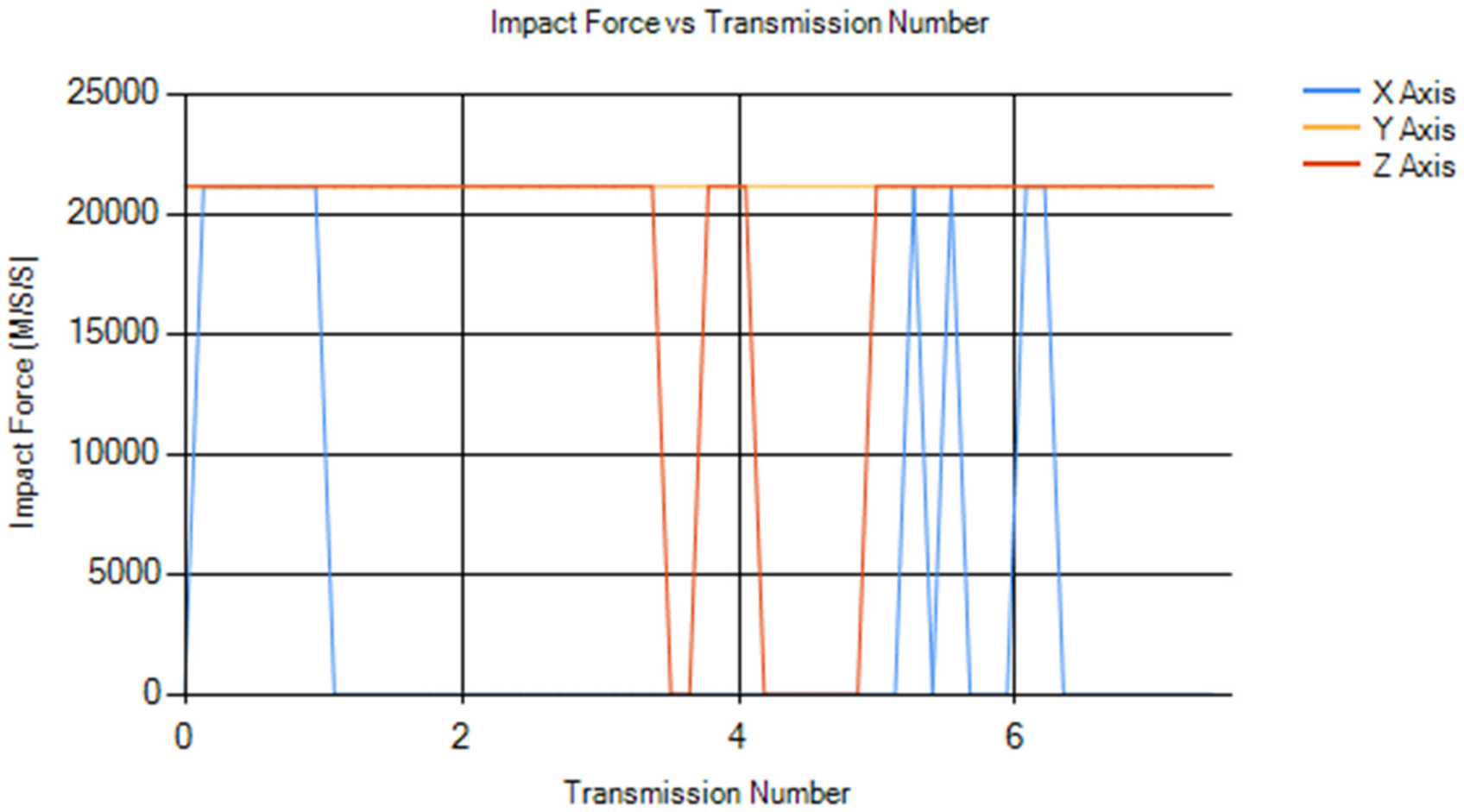
Lander Altitude



Lander Battery



Lander Impact



Failure Analysis

Chris Jennette

Failure Analysis

- **Identification of failures**
  - Carrier parachute harness detached during deployment
  - Transmission of data not consistent
  - Storage of data from accelerometer
- **Root causes**
  - Force of deployment on parachute was underestimated
  - Antenna on-board the carrier too weak
  - Range of accelerometer too small
- **Corrective actions**
  - Secure parachute harness with more than epoxy
  - Use a higher gain antenna for the carrier

Management

George Bacon

CanSat Budget – Hardware

Component	Model Name	Quantity	Total Cost	S/H	Price Definition
Battery	Li-Ion 14500 Battery	2	$19.90	$10.35	Actual
Battery Charger	Smart Charger for 3.7 V Li-ion Battery	1	$4.28		Actual
Transceiver	20CIR VERT RECPT	2	$3.76	$7.52	Actual
Break Away Headers	Break Away Headers-Right Angle	2	$1.95	$7.51	Actual
Buzzer	668-1028-ND	2	$4.51		Actual
Accelerometer	Triple Axis Accelerometer Breakout - ADXL345	1	$27.95	$9.28	Actual
Switch	SWITCH SLIDE SPDT 2POS SSA SER	2	$1.85		Actual
EEPROM	Microchip 24AA1025	1	$4.28	$1.28	Actual
Fiberglass Plates	Fiberglass Sheet	1	$21.49		Actual
Structural Rods	Midwest 5803 Carbon Fiber .125 40" Rod	2	$6.69		Actual

CanSat Budget – Hardware

Component	Model Name	Quantity	Unit Cost	S/H	Price Definition
Microcontroller	Arduino Pro Mini 328 - 3.3V/8MHz	2	$18.95	$28.03	Actual
Barometric Pressure Sensor	BMP085 Breakout	2	$19.95		Actual
Motor	56:1 Micro Geared Motor	1	$18.99	$5.60	Actual
Parachute	20" Sky Angle Parachute	2	$63.90	$11.00	Actual
Antenna	Antenna OUTDR OMNIDIR 915MHZ STR	1	$52.50	$8.86	Actual
GPS	32 Channel LS20031 GPS 5Hz Receiver	1	$59.95	$8.44	Actual
Casing	Wilson T1003 3pak YEL TEN/BALL	2	$7.26		Actual
Miscellaneous			$98.29		Actual
Cost of Components			$595.17		
S/H			$97.87		
Total Cost of Components			$693.04		

CanSat Budget – Other Costs

Transportation/Hotel/Food Costs

Description	Cost	Price Definition
Van Rental: Virginia Tech Fleet Services (12 Passenger Van)	$520	Estimate
Airfare	$2,500	Estimated
Hotel	$240	Estimated
Food	$750	Estimated
Subtotal	**$4,010**	

Note: Transportation cost covers all three Virginia Tech CanSat Teams

Ground Control Station Costs

Description	Cost	Price Definition
Laptop Computer	$0	Estimated
Arduino Software	$0	Estimated
GCS Software	$0	Estimated
Transceiver Software	$0	Estimated
Subtotal	**$0**	

CanSat Budget – Income & Total Costs

Total Cost

Description	Price
Hardware	$693.04
Transportation/Hotel/Food Costs	$4,010
Ground Control Station Costs	$0
Total Cost Overall	**$4,703.04**

Income

Income Source	Date	Amount
VT SEC	Fall 2010	$400
VT SEC	Spring 2011	$350
VT Student Affairs	Spring 2011	$933
VT ECE Department	Spring 2011	$200
Total Income		**$1,883**

Conclusions

George Bacon

What Worked / What Didn't

- **Successful**
  - Separation mechanism
  - Ground station software/hardware
  - Flight software

- **Possible Failures**
  - Egg containment

- **Failure**
  - Carrier parachute harness to CanSat
  - Carrier on-board antenna
  - Accelerometer

Lessons Learned

- Allow more time for testing (3 months minimum)
- Start build the night before launch day
- Don't use epoxy when not necessarily needed
- Have more electrical and computer engineers
- Schedule more proofreading/reviewing time for control gates
- Get organized earlier in competition