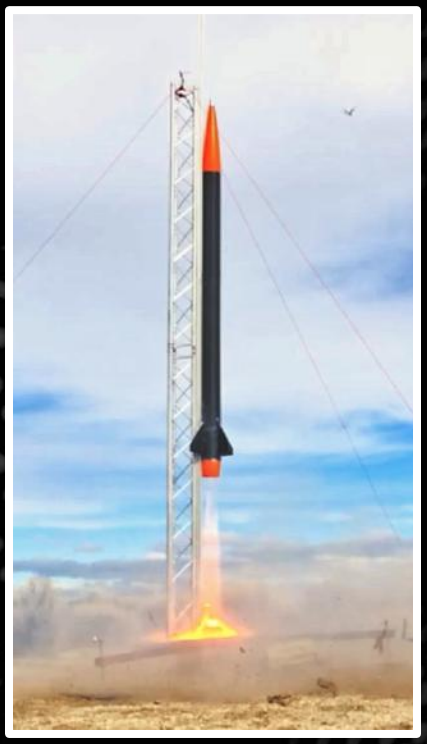
OSU AIAA

Oregon State University Chapter of the American Institute of Aeronautics and Astronautics

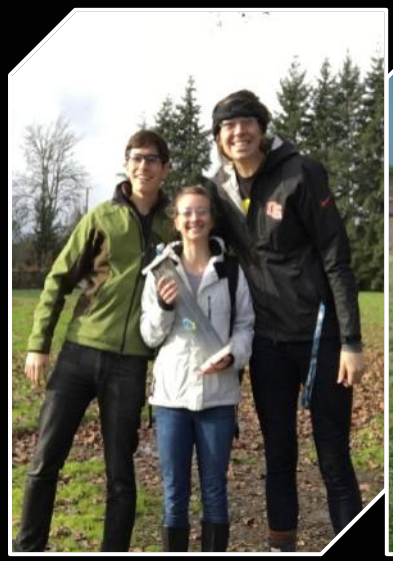


Oregon State Rocketry

Oregon State UNIVERSITY

Team Structure

Aero & Recovery

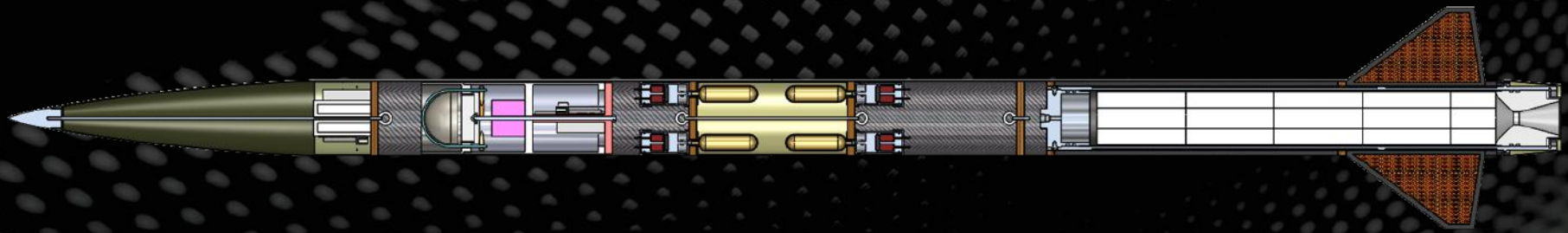


Avionics

Payload

Propulsion

Structures & Integration



Experimental Sounding Rocketry Association (ESRA)

Mission

- Hands-on technical experience for engineering and science students
- Heavy emphasis on student design
- Technical documentation also very important

Experimental Sounding Rocketry Association (ESRA)

History

- ESRA formed in 2003
- First IREC was near Green River, UT in 2006
- Two teams, approximately 20 students
- Grown steadily over 10 years to over 50 teams and 600 students
- Teams from all over the world
- Has gotten the attention of aerospace industry for recruiting and sponsorship

Experimental Sounding Rocketry Association (ESRA)

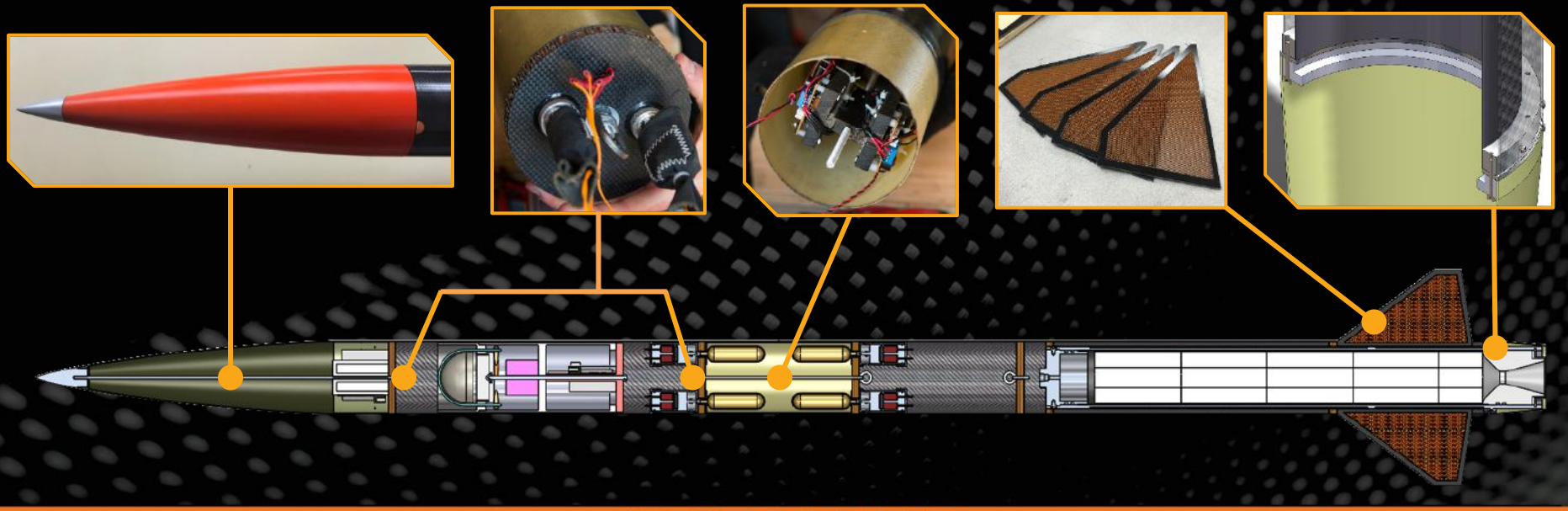
Future

- Planning to move to Spaceport America, NM in 2017
- Increased public involvement
- Considering unlimited altitude category and small launch conference

Structures & Integration

Nosecone	Airframe	Fin Can
Von Karman	Composite Bulkheads	Sandwich Structure Fins
Aluminum tip	Fiberglass Couplers	Motor Retainer
Fiberglass body	Carbon Body Tubes	Fiberglass Boat Tail

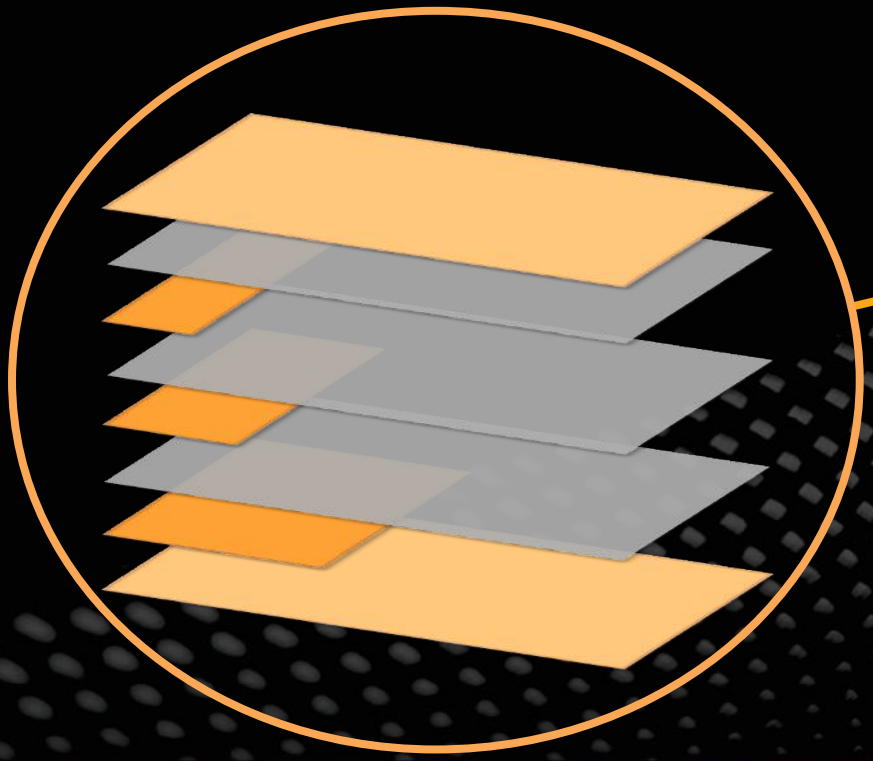
Total Structural Weight: 10.0 lbs **Structural Weight Reduction: 45%**

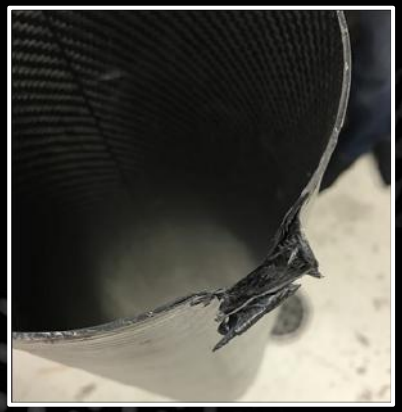


Structures & Integration

Body Tubes

- 12,000 lb. buckling test
- 45 J impact energy, zippering test

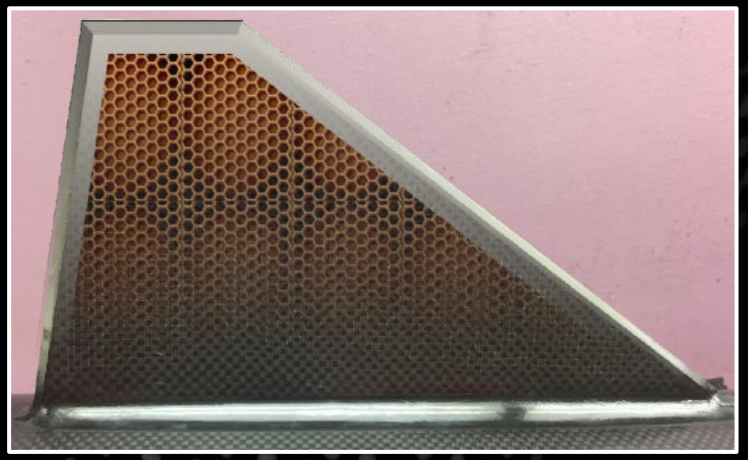




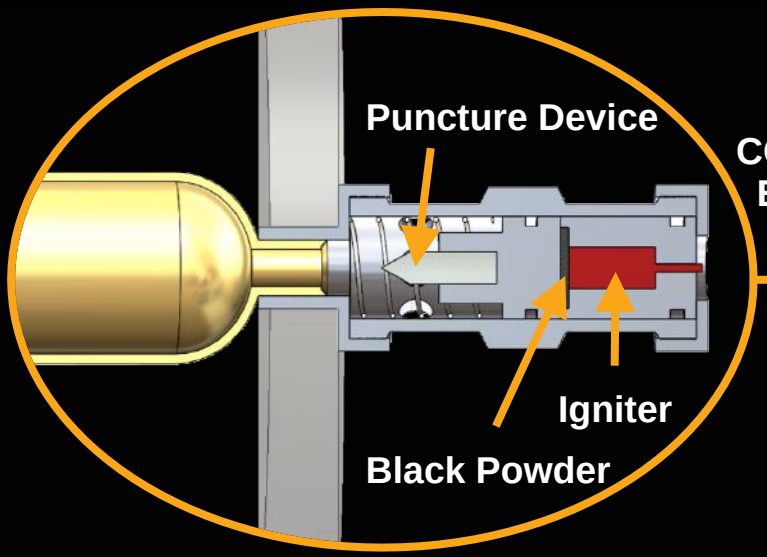
Structures & Integration

Fin Can

- Honeycomb core fins
- 5 plies carbon fiber weave
- G10 fiberglass fin edges
- Through-wall attachment
- Aluminum motor retaining assembly



Aero & Recovery: Design



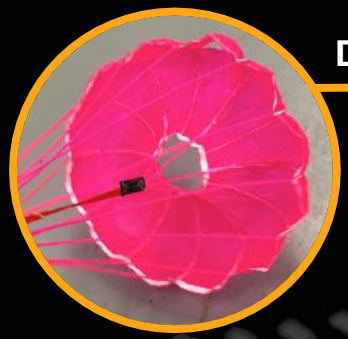
CO2 Ejection System

Main Chute

Diameter : 105”

$V_{descent}$: 14 ft/s

C_D : 3.1

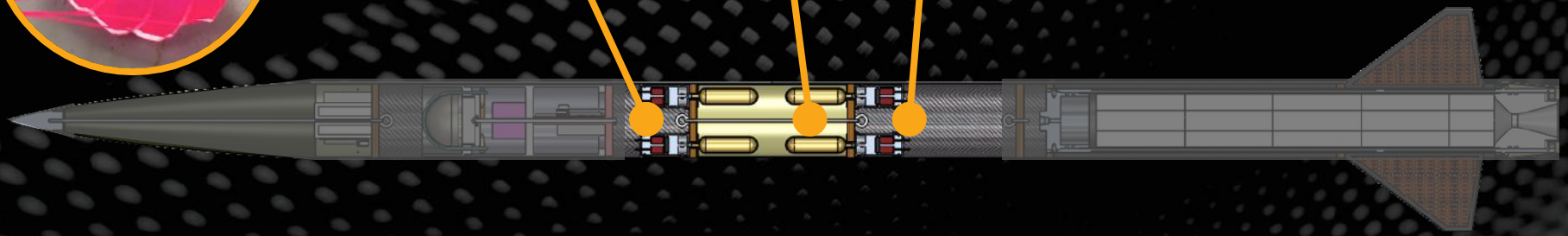


Drogue Chute

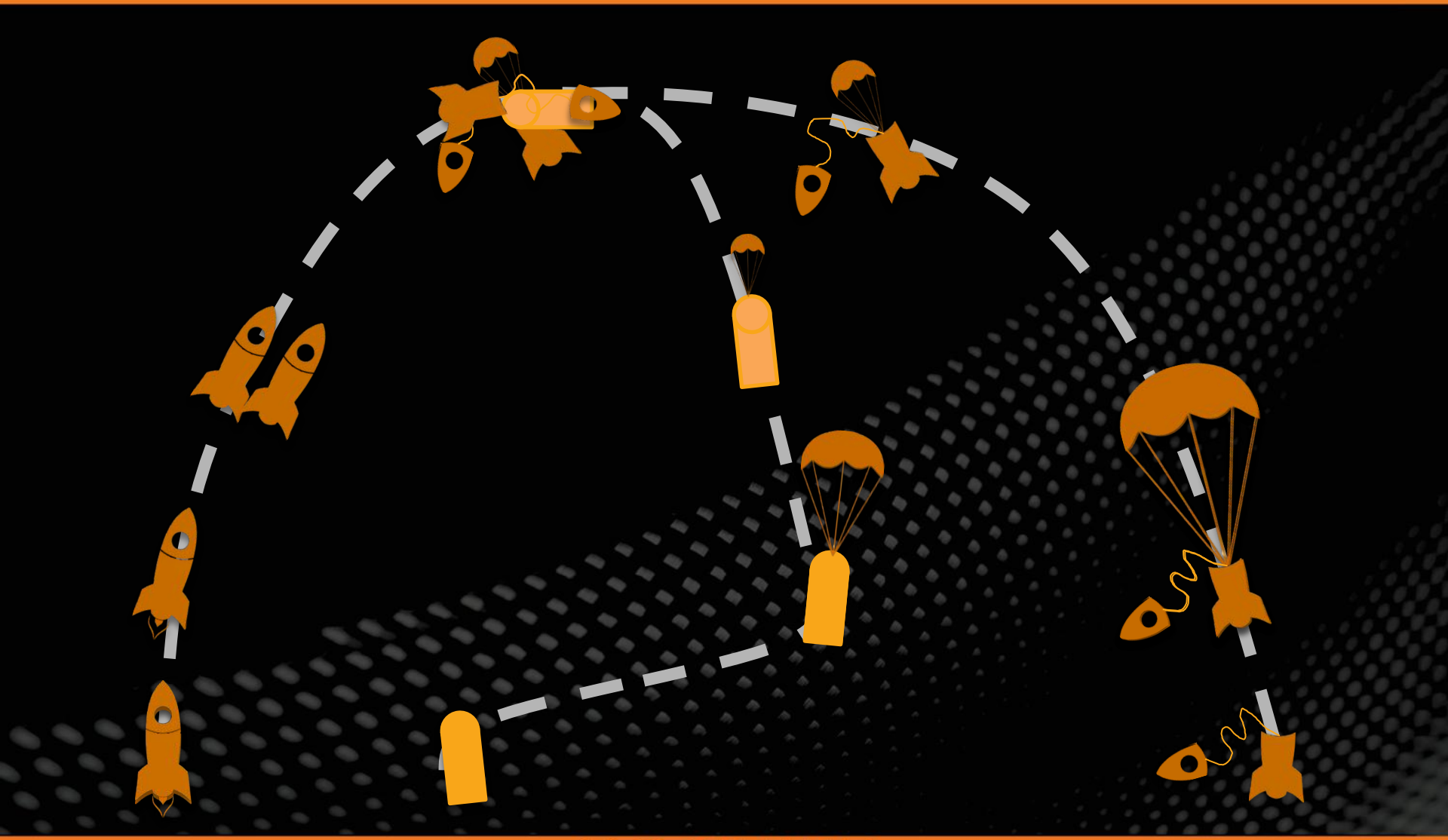
Diameter : 22”

$V_{descent}$: 89 ft/s

C_D : 3.0

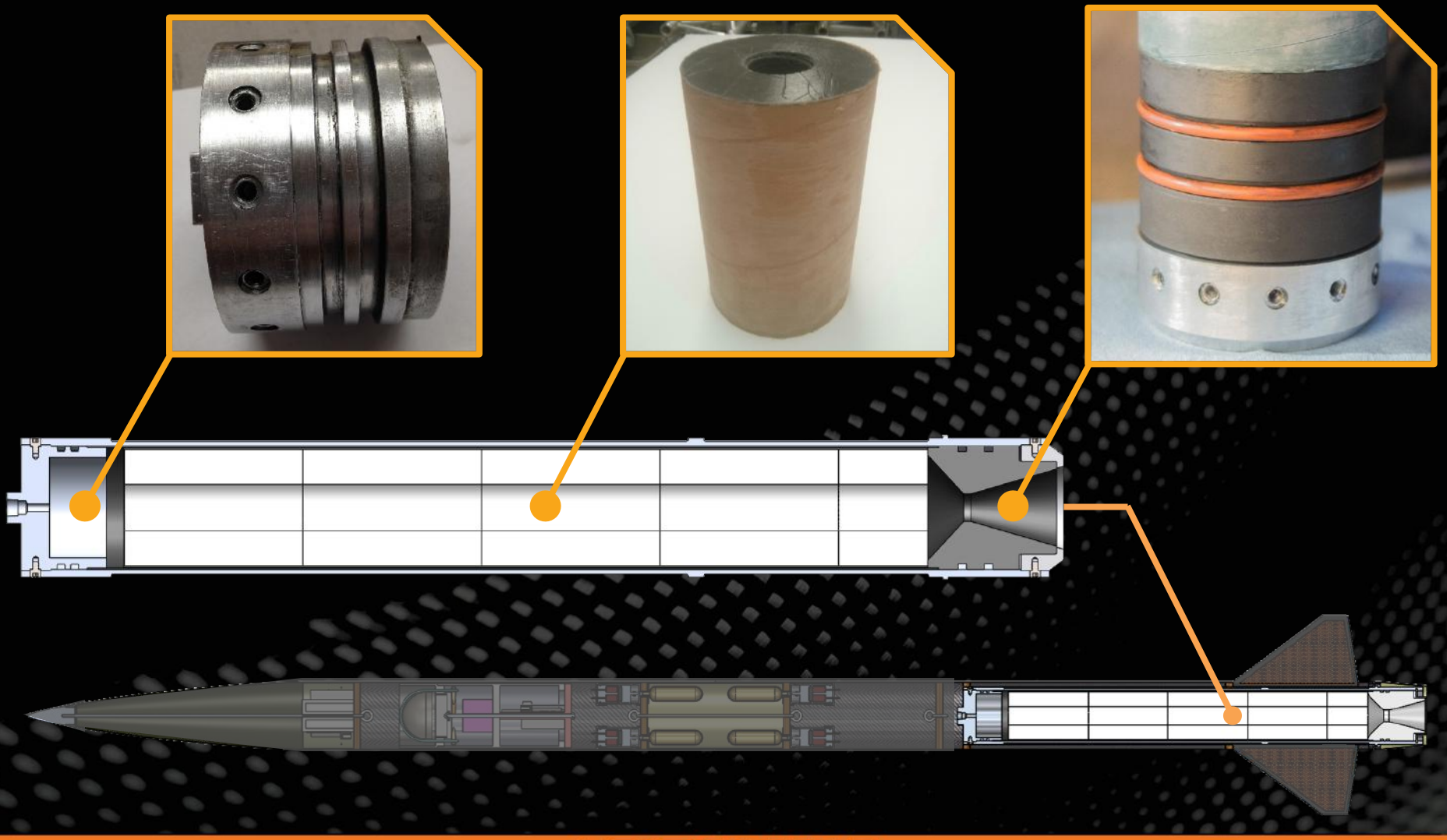


Aero & Recovery: Trajectory

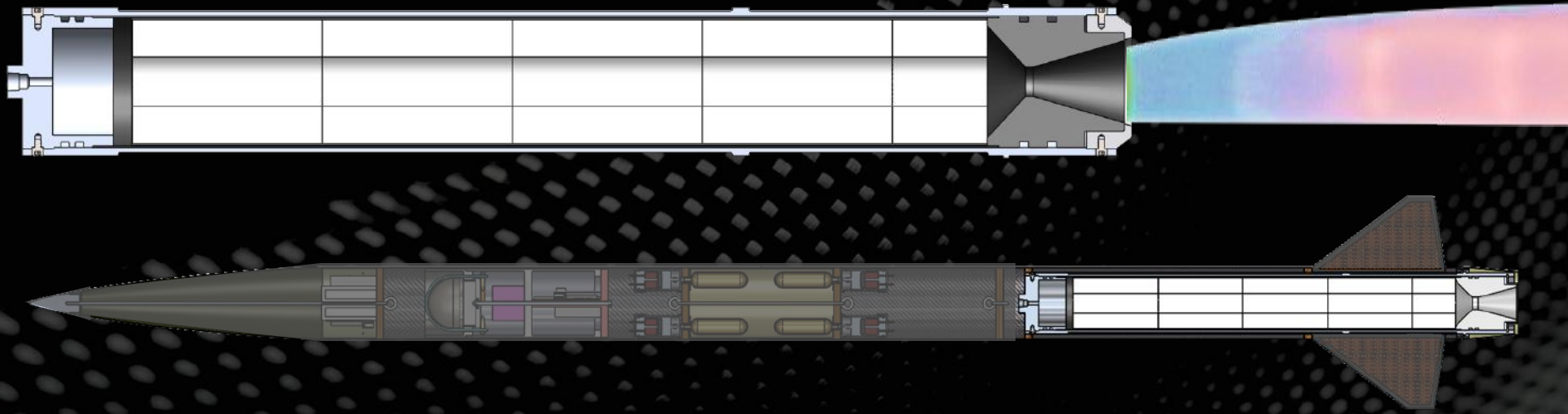


OSU AIAA

Propulsion: Design



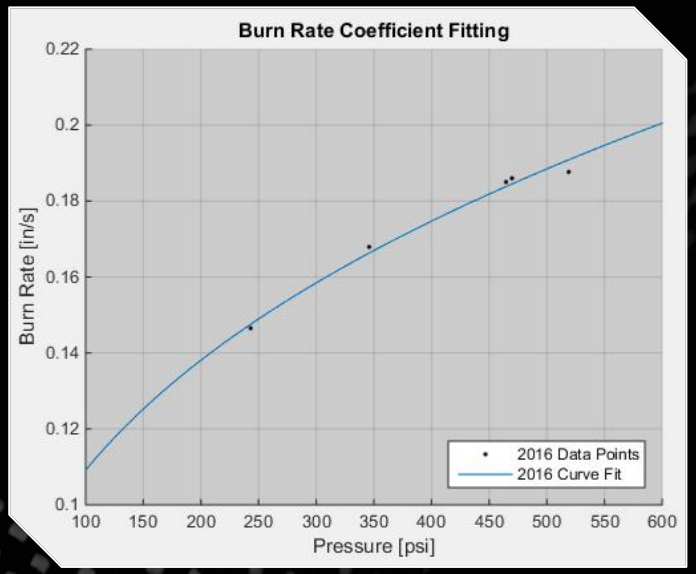
Propulsion: Design



Propulsion: Propellant

Ammonium Perchlorate Composite Propellant

Role	Ingredient	Mass Fraction
Binder	HTPB	12%
Fuel	Al and Zn	1.5%
Oxidizer	AP	80%



Propulsion: Testing

Static Test Fire Results

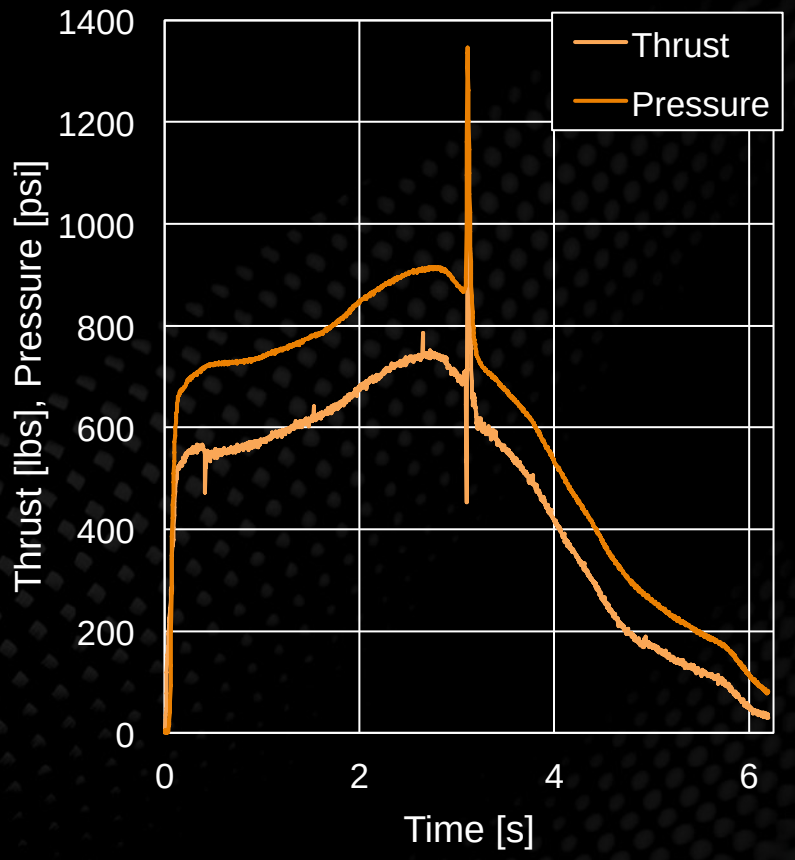
Burn Time
5.8 s

Thrust
650 lb

Pressure
917 psi

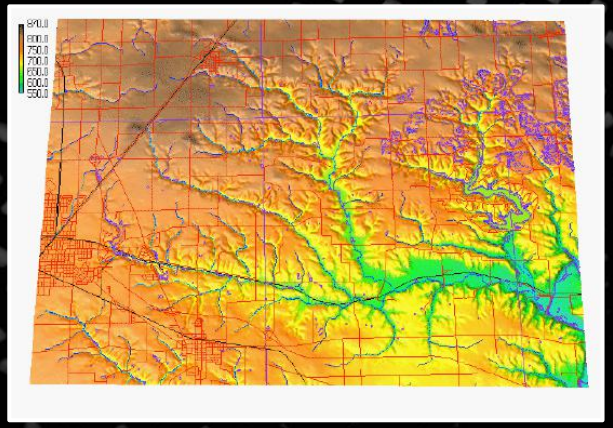
Impulse
12.6 kN*s

Specific Impulse
190 s

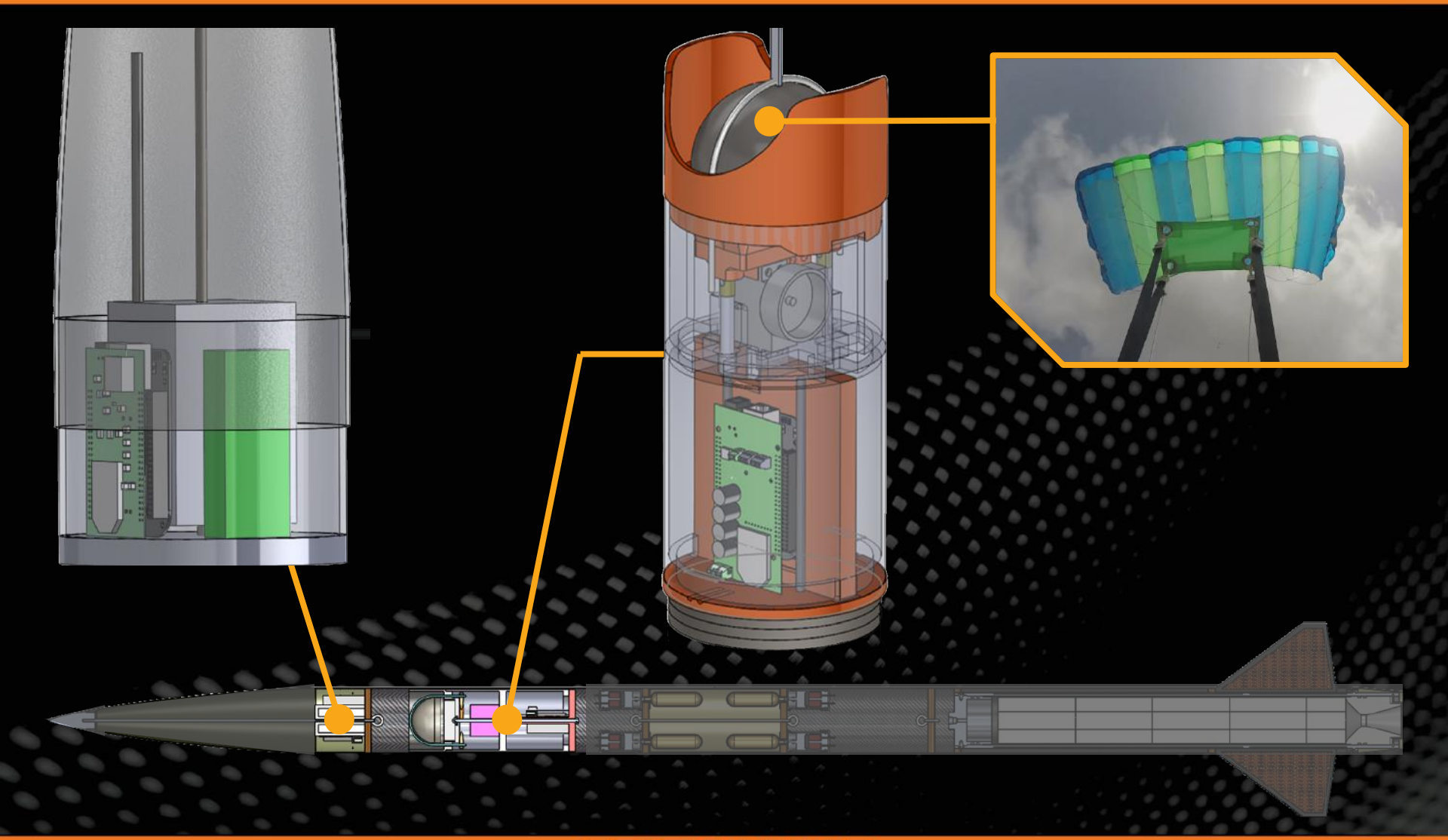


Payload: Motivation

Launch Vehicle Component Recovery



Payload: Design



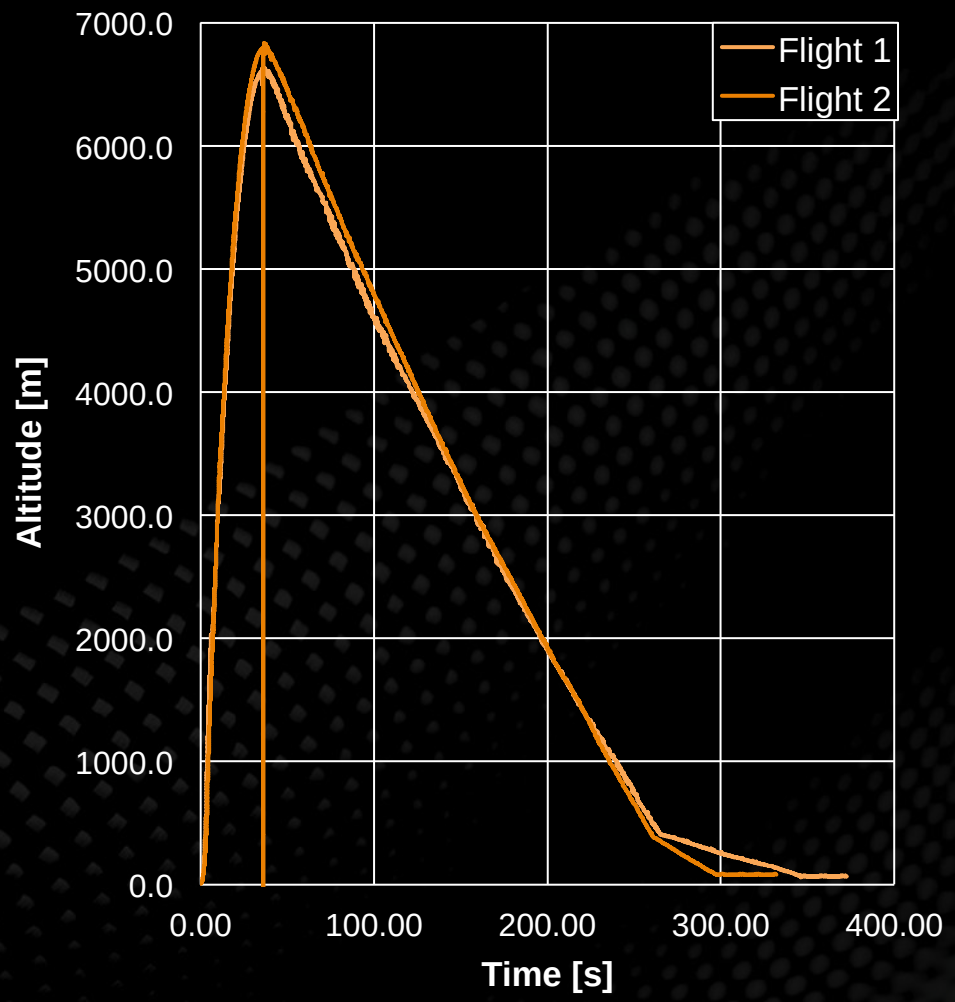
Payload: Operation

Testing	Capsule	Electronics

Competition Results

Two Successful Test Flights

Test Flight	1	2
Apogee	21,758 ft	22,428 ft
Max Speed	1002 mph	1020 mph
Max Acceleration	11.6 g	10.1 g
Max Roll Rate	790°/s	815°/s
Recovery Distance	2.1 mi	2.6 mi



Oregon State Rocketry

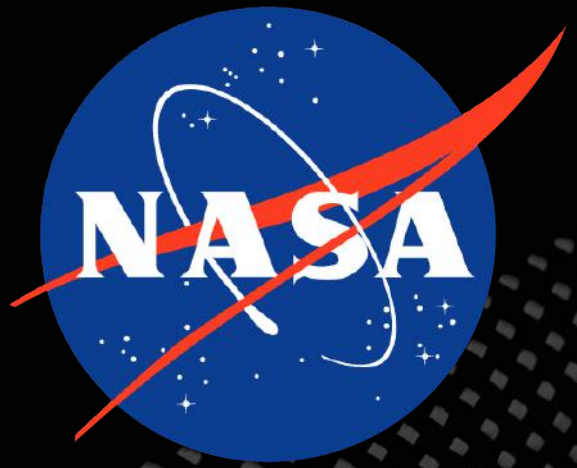
Past Successes

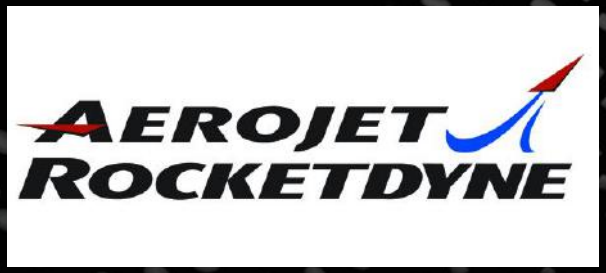
- 2014 1st Place in Basic Category
- 2014 1st place in payload competition
- 2015 3rd place in advanced category
- 2015 1st place in payload completion
- 2016 1st place in advanced category

Future Goals

- ESRA advanced category team
- ESRA hybrid team
- Space shot rocket

Where we have gone



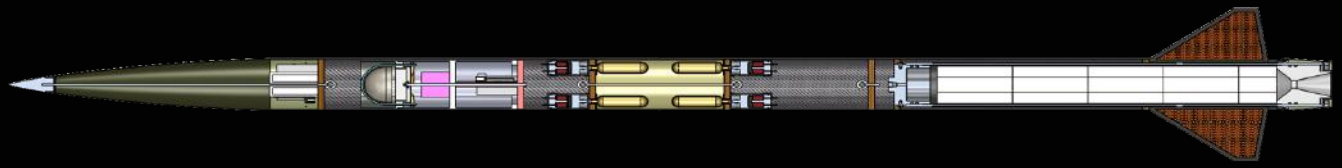


Thank You!

Thank you Space Grant and ESRA for helping make Oregon State Rocketry a reality

OSU AIAA

Oregon State University Chapter of the American Institute of Aeronautics and Astronautics



Oregon State University

Questions?

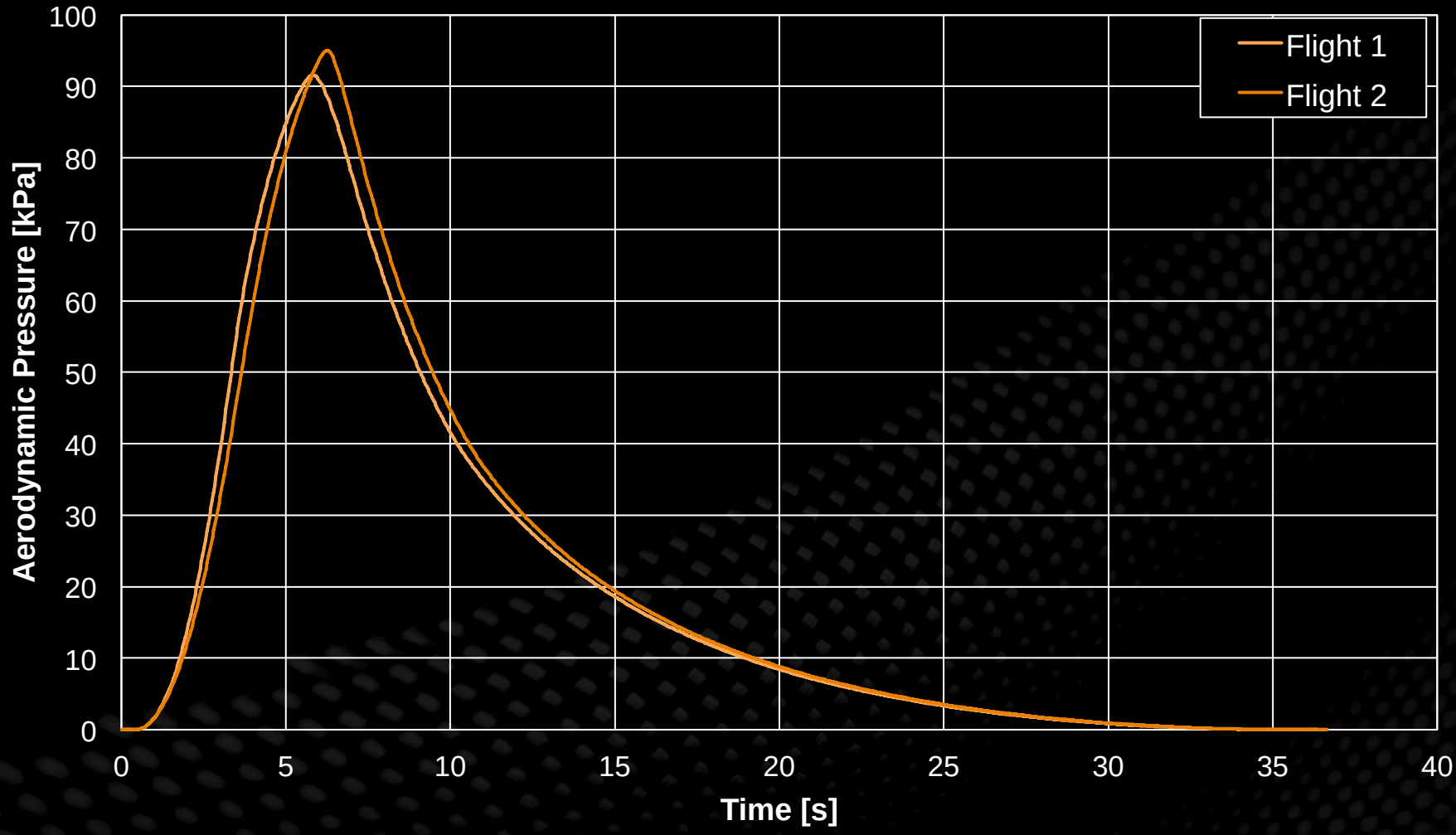
OSU AIAA

Oregon State University Chapter of the American Institute of Aeronautics and Astronautics

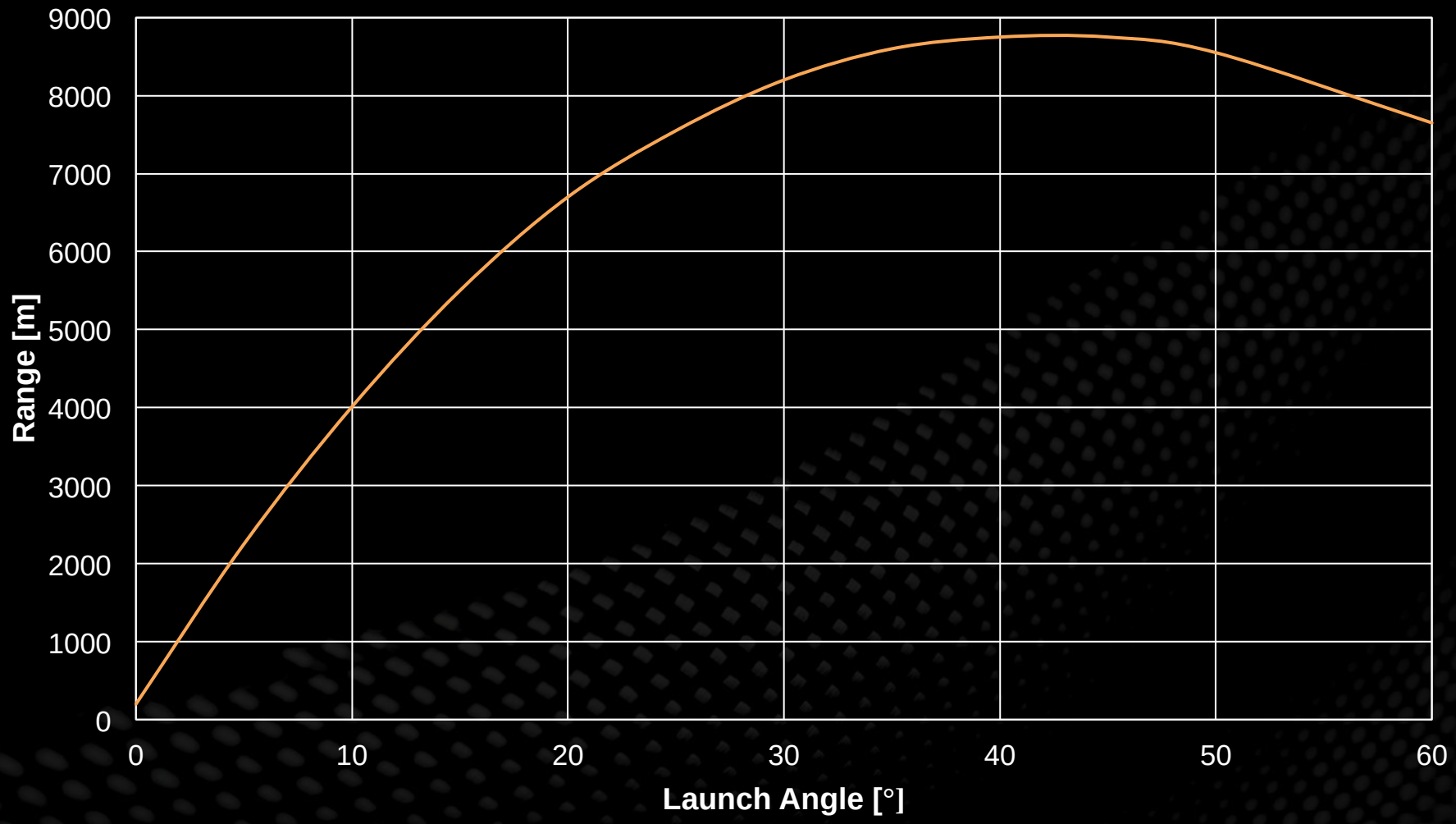
Backup Slides

Oregon State UNIVERSITY

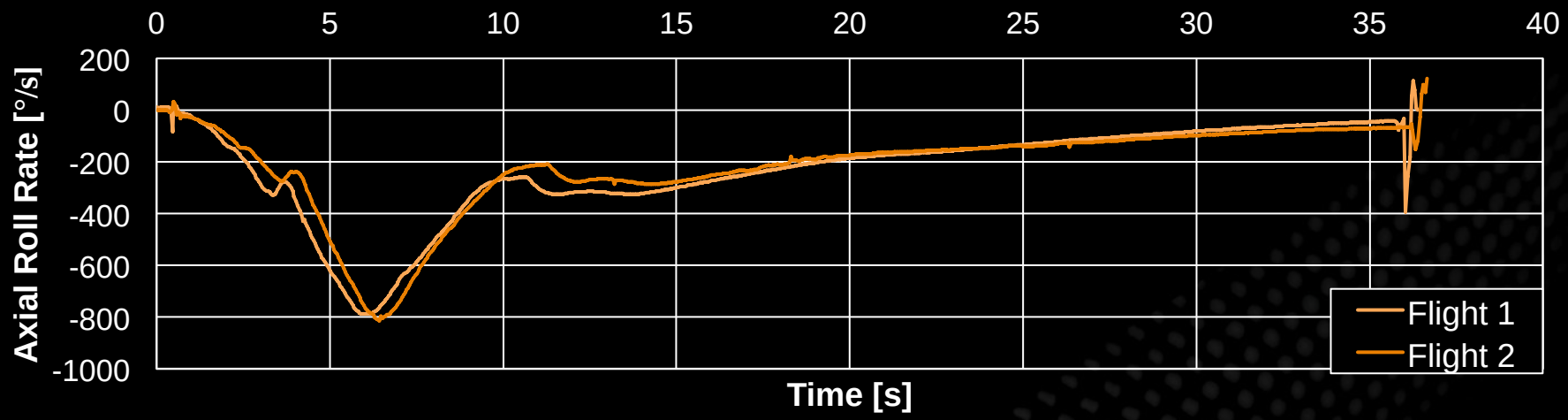
Aerodynamic Pressure

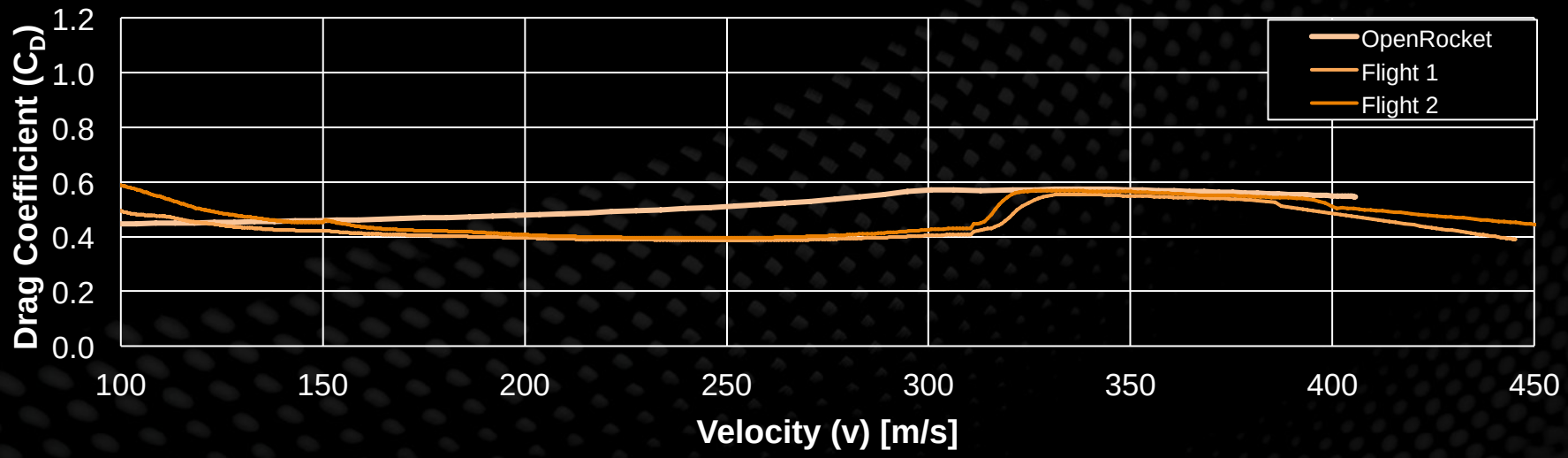


Ballistic Trajectories



Additional Flight Data

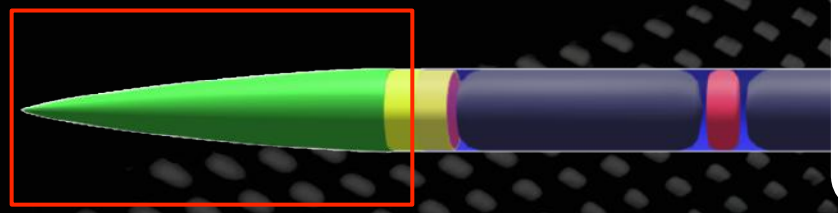


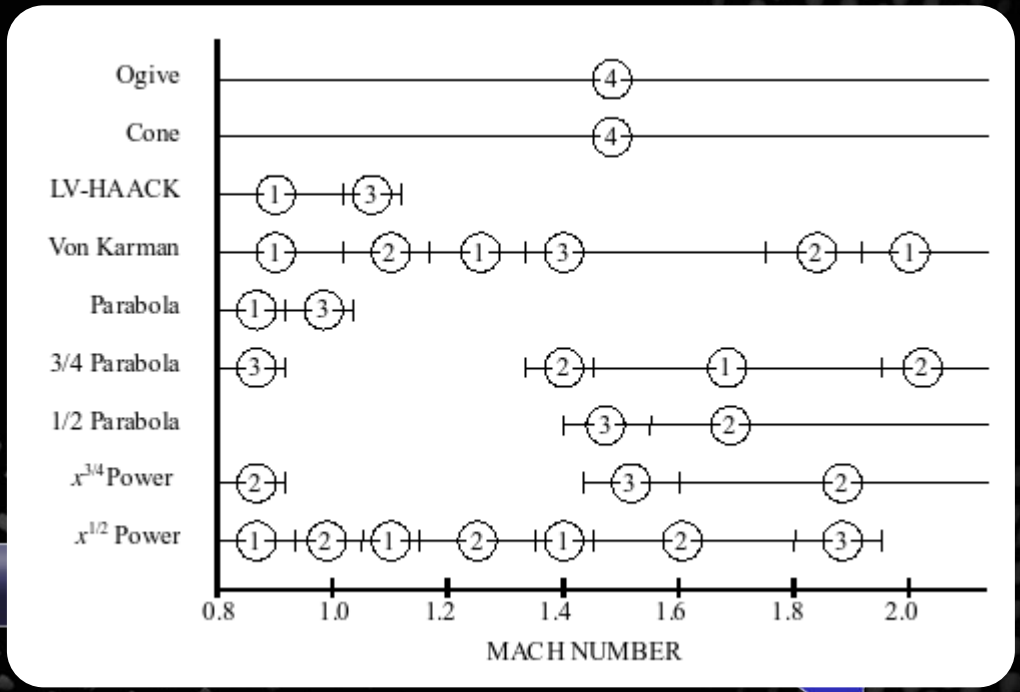


Aero & Recovery

Aerodynamic Profile: Nose Cone

- Von Kármán Profile
- Worked very well

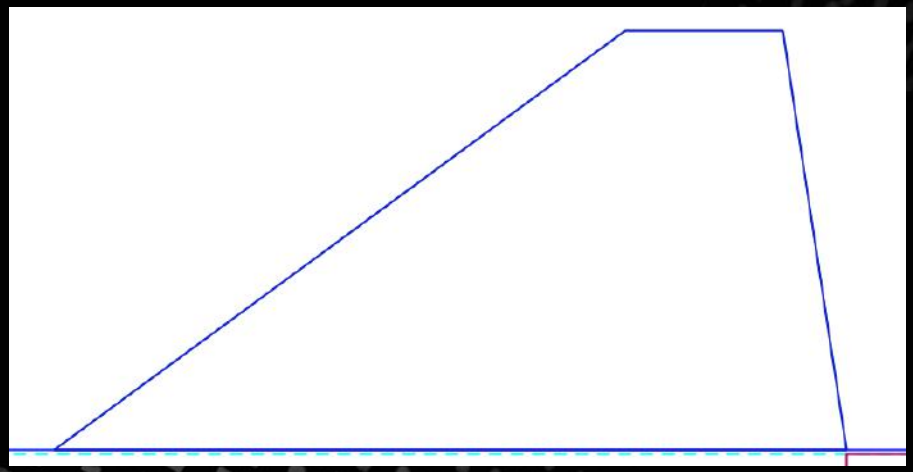




Aero & Recovery

Aerodynamic Profile: Fins

- Trapezoidal shape
- Ease of manufacturing
- Good subsonic performance
- Reduce flutter risk

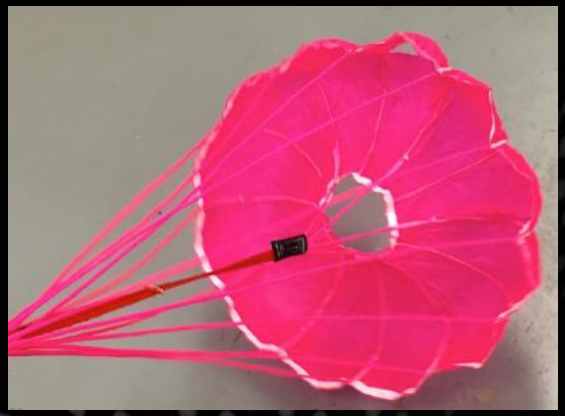


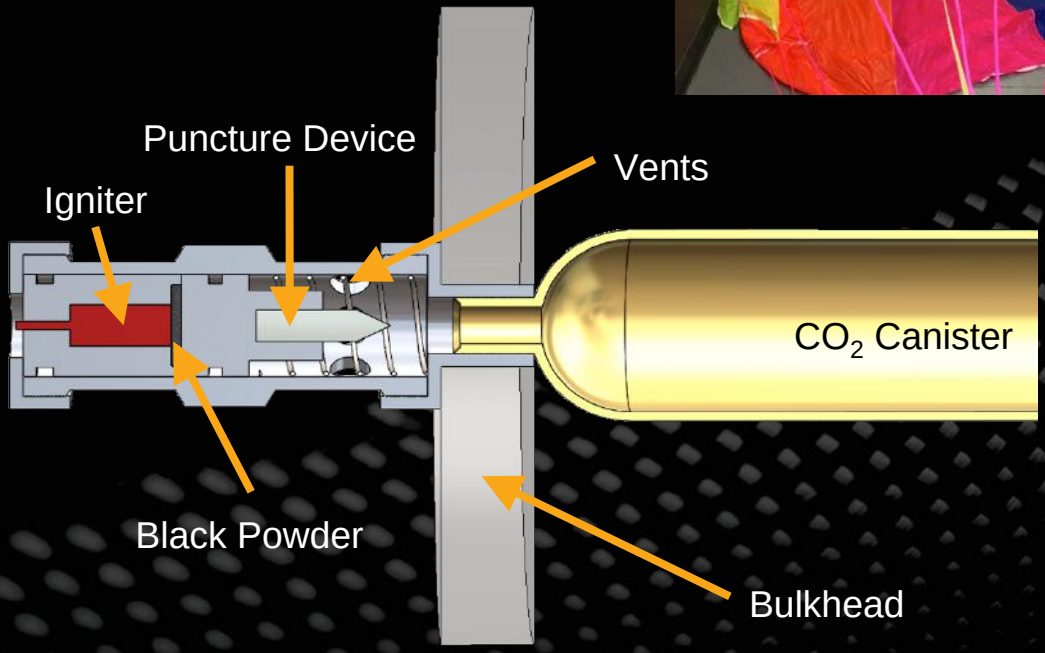
Aero & Recovery

Parachutes

- Toroidal canopies

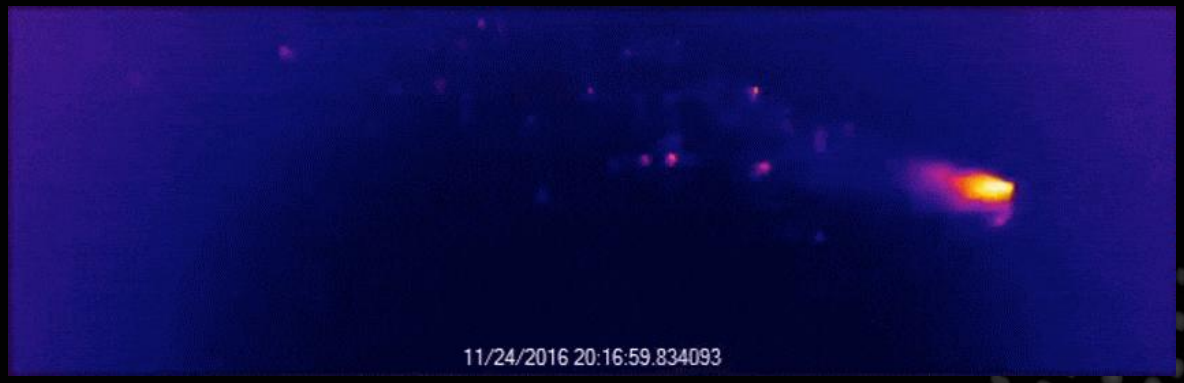
CO_2 Ejection

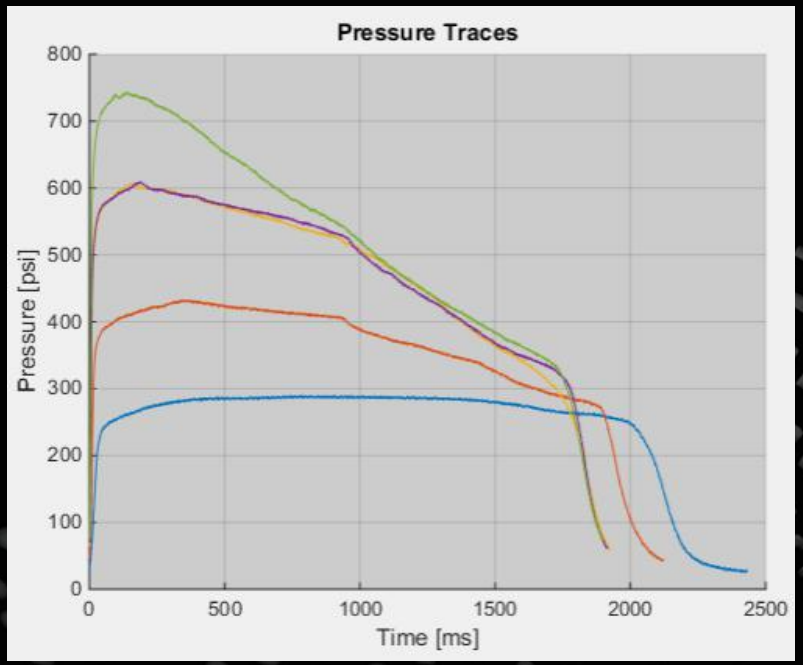




Parachute	Drogue	Main
Diameter	22 in	105 in
Descent Speed	88.5 ft/s	13.7 ft/s
Drag Coefficient	3.0	3.1

Propulsion: Subscale Testing

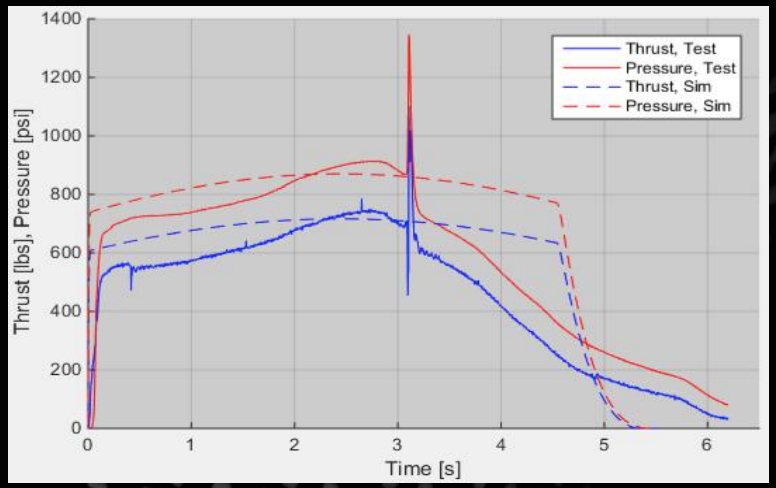


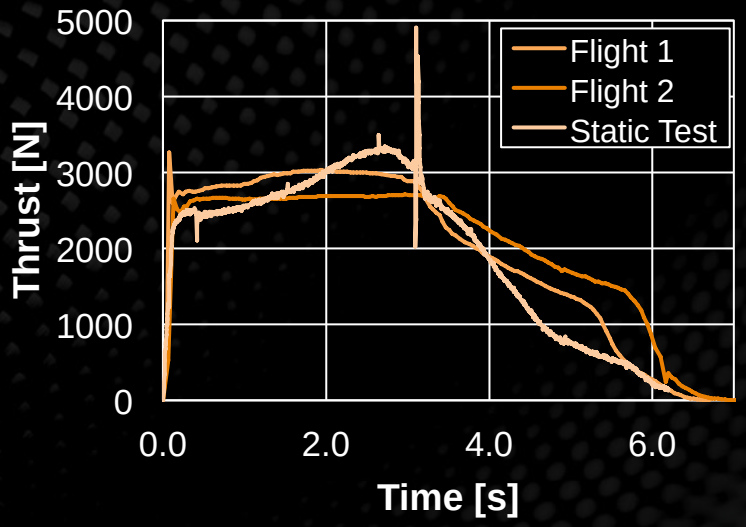


Burn Rate Coefficient Data	
a	.0228 in/s
n	.3396
R^2	.9858

Propulsion: Fullscale Test Data

Test Condition	Sim	Static Test	Test Flight 1	Test Flight 2
Burn Time [s]	5	5.8	5.8	6.2
Thrust [lb]	700	650	660	600
Pressure [psi]	870	917	Not Collected	
Impulse [kN*s]	15	12.6	13.4	13.9
Specific Impulse [s]	250	190	210	210





Old Payload Slides

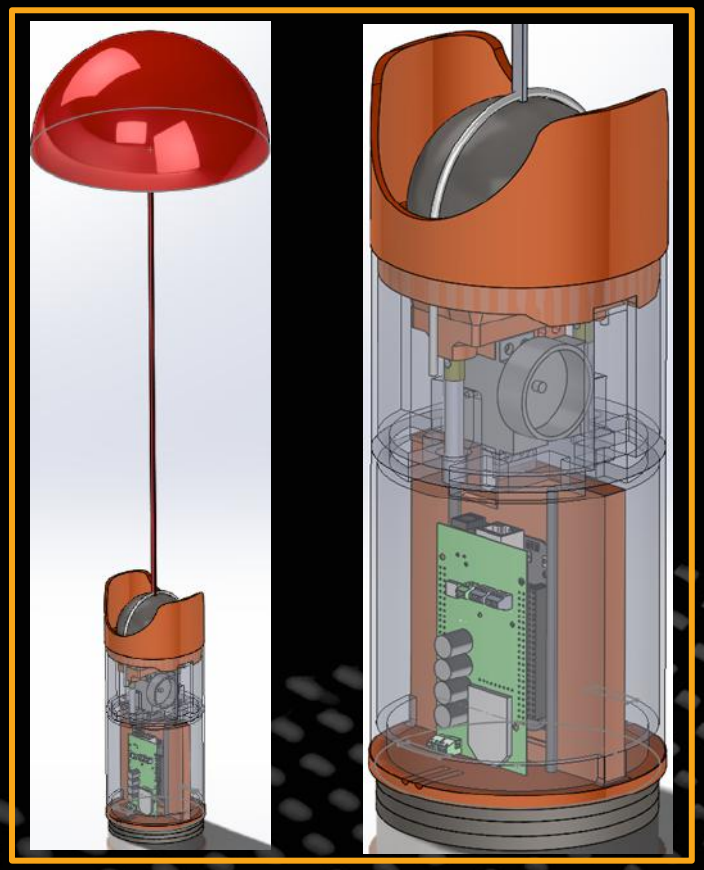
Payload

Autonomously Guided Ram-Air Parachute

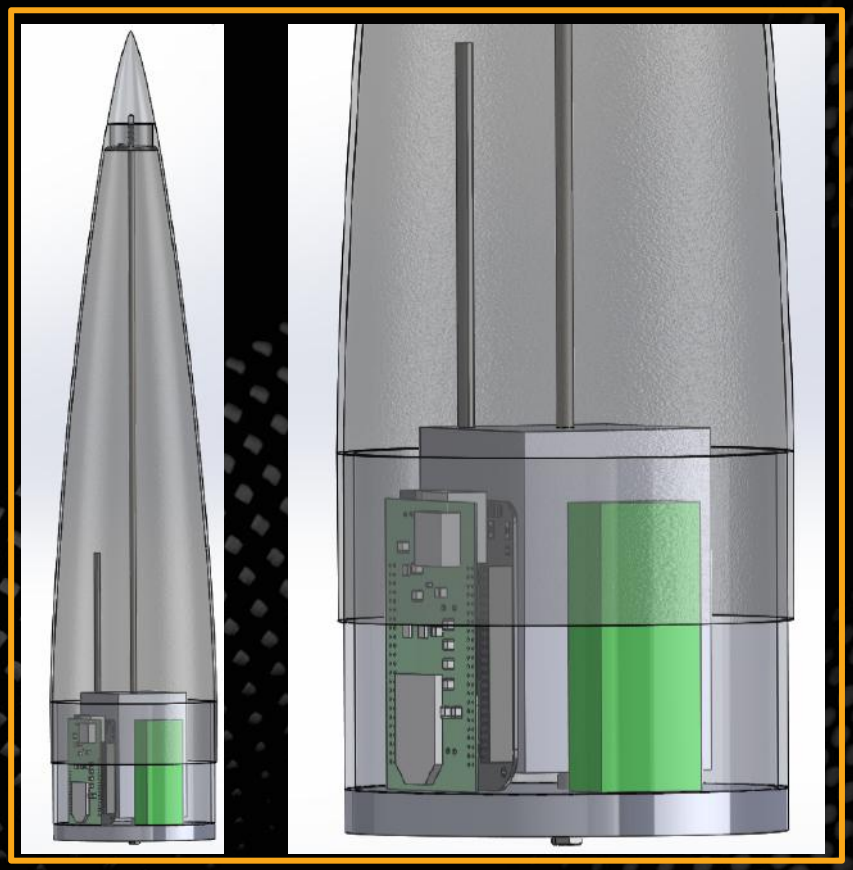
1. Eject from rocket at 23,000 ft
2. Fall under drogue to 3,000 ft
3. Deploy maneuverable ram-air parachute
4. Maneuver to preprogrammed GPS location

Payload

CAD Model:



Payload Capsule



Nose cone assembly

Payload

Parachute:

- 15 ft^2 ram-air canopy
- Made of non-ZP F-111 nylon
- Deployed using Cypres 2 cutters

Parachute Testing:

- Dropped from 2,500 ft above target location
- The parachute deployed as expected at ~1,000 ft
- Drogue fall 65 mph

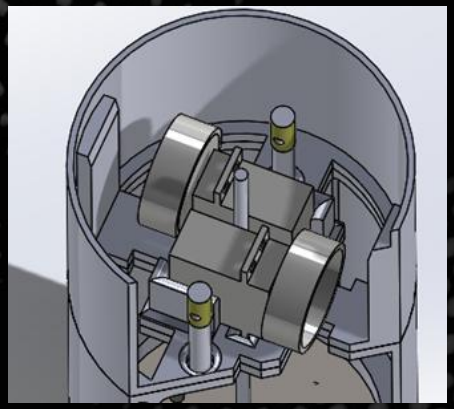
Payload

Steering:

- Winch servo motors
- Servo rotation depends on wind and present turning conditions

Steering Testing:

- Deployed parachute manually at 2,800 ft
- Followed preprogrammed left hand box pattern
- Glide ratio = 0.6



Payload

Capsule:

- 3D printed with ABS plastic
- Printed in 4 sections for ease of assembly and printing.
- Added 2 layers of fiberglass to motor housing
- Steel disks added to increase weight and lower C.G.

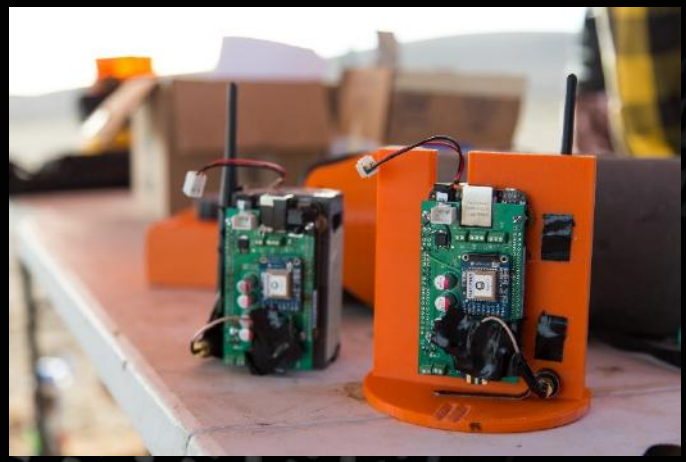
Capsule Testing:

- Survived 90 mph impact test

Payload

Custom avionics package:

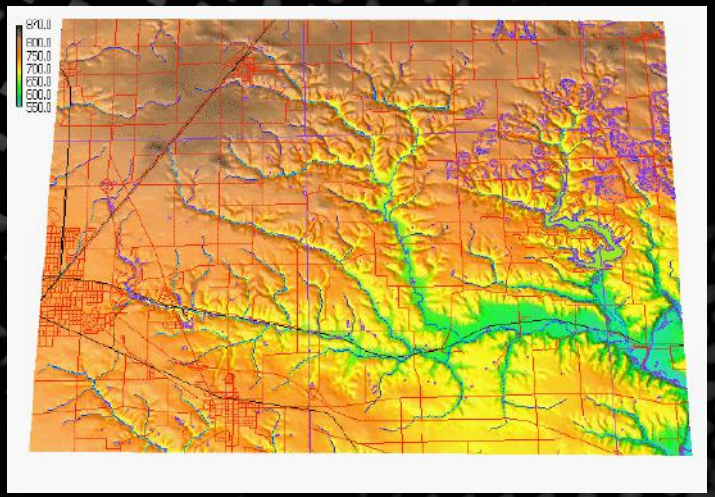
- GPS
- 3D Accelerometer
  - ± 16g sensitivity
- Magnetometer
  - ± 2 gauss sensitivity
- Gyroscope
  - ± 2000 degree/second sensitivity
- Altimeter
  - ± .12 hPa relative accuracy
- Live data transmission during flight and recovery



Payload

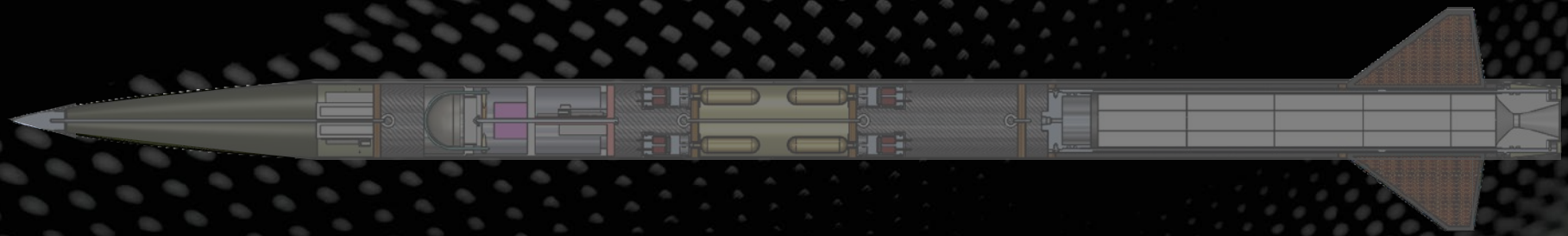
Applications of system:

- Surveying
- Rapid Delivery
- Targeted rocket recovery
- Atmospheric investigation

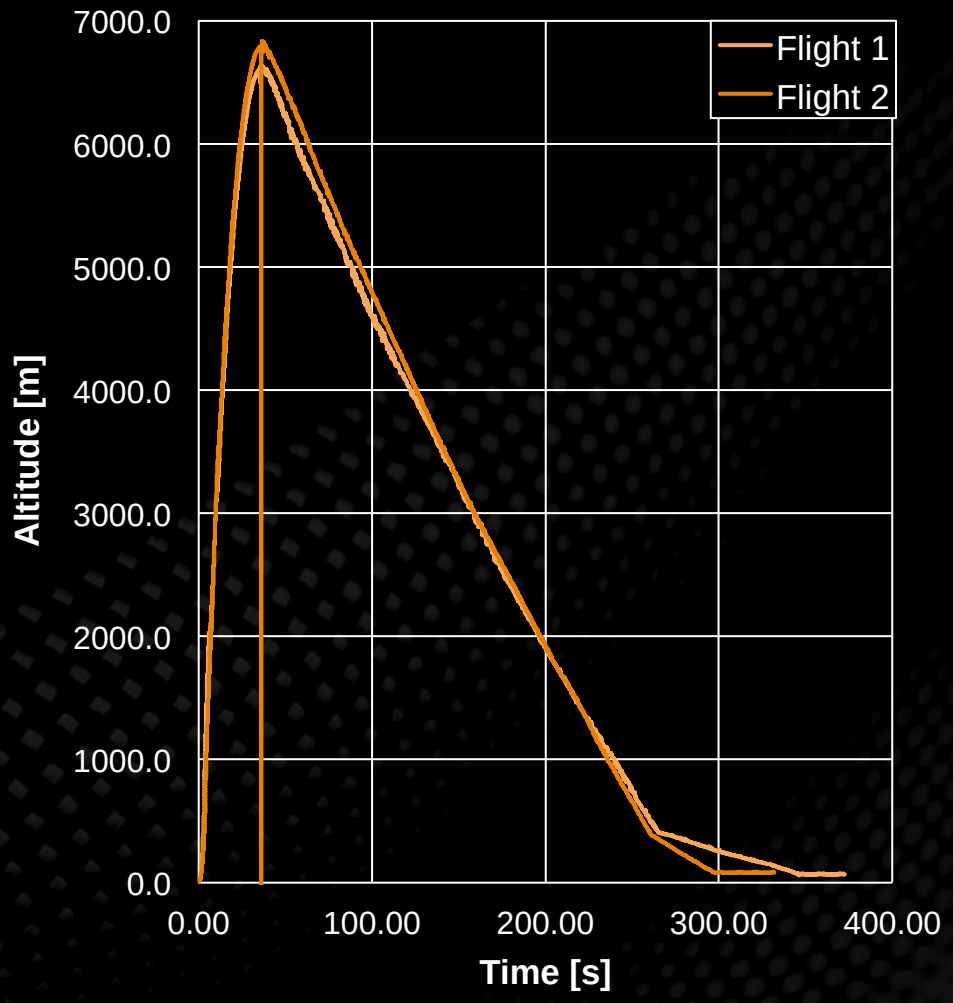


Payload Deployment Test

Payload Navigation Test



Test Flight Results

Two Successful Test Flights

Test Flight	1	2
Apogee	21,758 ft	22,428 ft
Max Speed	1002 mph	1020 mph
Max Acceleration	11.6 g	10.1 g
Max Roll Rate	790°/s	815°/s
Recovery Distance	2.1 mi	2.6 mi