

Duke University AERO Devil's Advocate

2026 IREC - 30k SRAD Solid Propulsion

403

Duke AERO

- Began in 2017
- ~ 40 active members
- Major Projects in 26-27:
 - Liquid & Solid Prop.
 - Active Control Systems
 - Advanced In-House Manufacture Techniques
 - Energy Recycling Payload
 - Directional Recovery

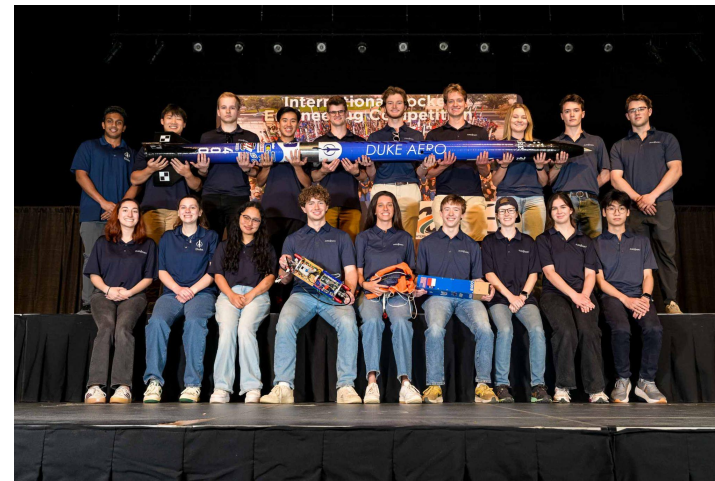


Fig. 1 Team Photo at 2025 IREC

Devil's Advocate Overview

- Third Duke AERO vehicle in the 30k-SRAD category
- Payload deployed at apogee; contains gimbal camera, directional recovery, and power recycling unit
- Second year flying full control stack with canards and airbrakes
- Descends under modular, fully-SRAD recovery system with directional recovery and separation-enhancing blast disk

SRAD Solid Motor

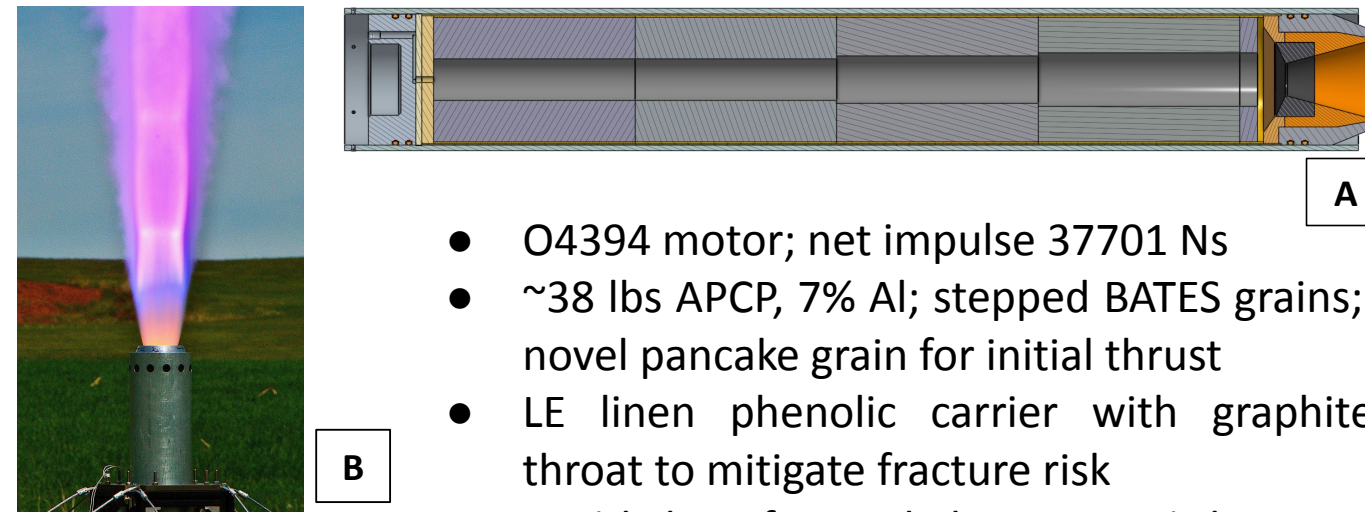


Fig. 2A Motor Cross-Section
Fig. 2B Static Hotfire

- O4394 motor; net impulse 37701 Ns
- ~38 lbs APCP, 7% Al; stepped BATES grains; novel pancake grain for initial thrust
- LE linen phenolic carrier with graphite throat to mitigate fracture risk
- 38% lighter forward closure, 19% dry mass reduction over prior design

Airframe

- 139" long & 6" internal diameter
- 124 lbs wet weight; 86 lbs dry weight
- 6061 aluminum internal structures; fiberglass tubes
- Forged carbon airbrake petals & canard fins
- Carbon fiber-core fins with carbon fiber tip-to-tip & epoxy fillets

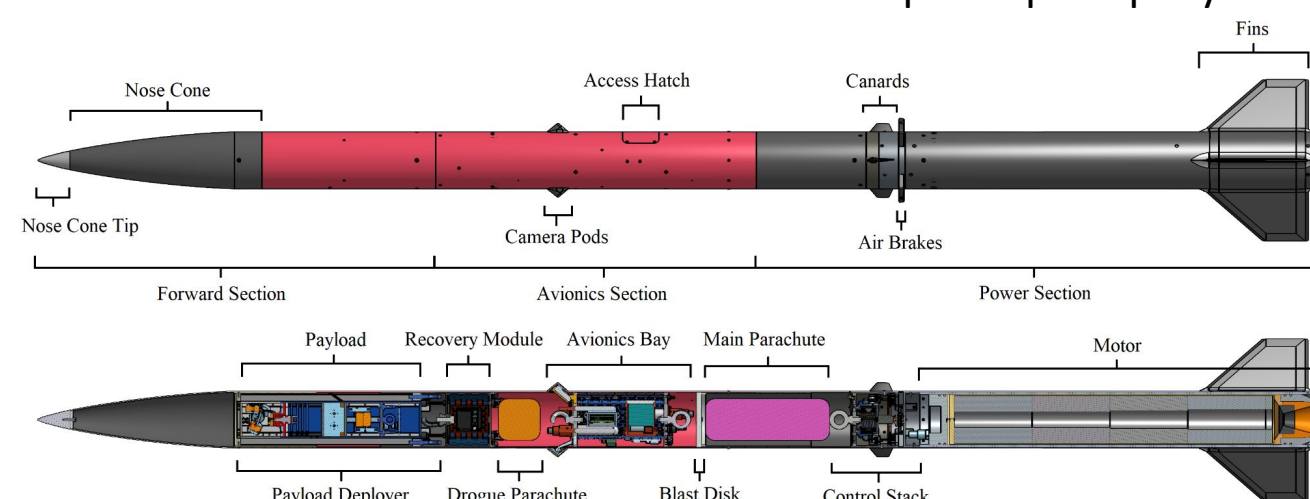


Fig. 3 Devil's Advocate CAD, internal & external views

Control Stackup

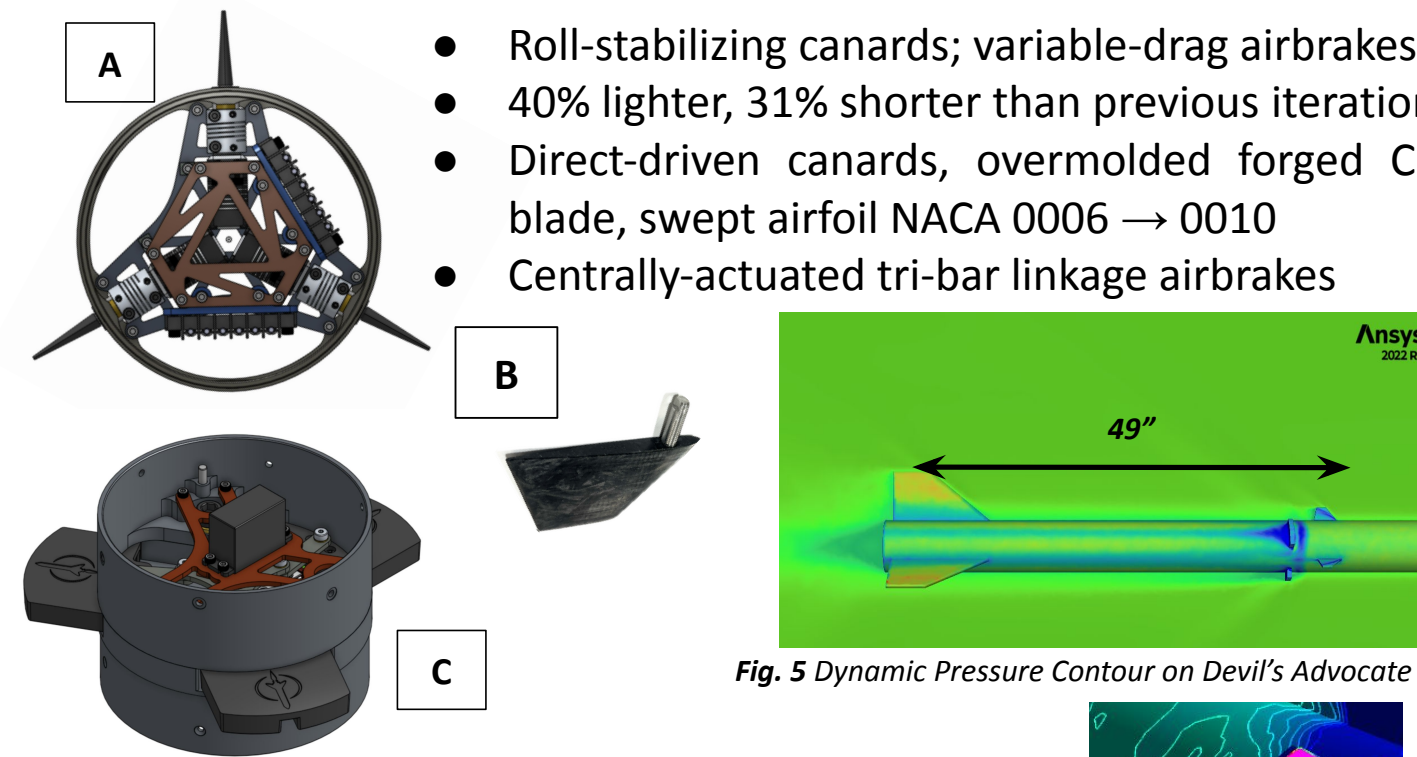


Fig. 4a Canards internal mechanism
Fig. 4b Overmolded blade on steel shaft
Fig. 4c Airbrakes system CAD

Avionics System

- 5th gen FC: ERS Epsilon
- SRAD Digital Live video system
- Quad-redundant tracking
- Impact-resistant blackbox
- Isogrid avionics bay structure
- CF strut reinforced forged FG battery access hatch
- Integrated ground station with multi-user support

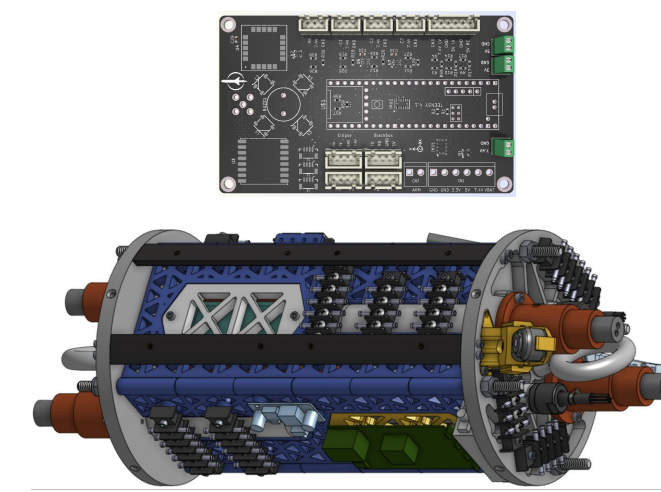


Fig. 7 ERS Epsilon & Avionics Bay

Modular SRAD Recovery

- SRAD drogue and main parachutes
- Controlled descent under cruciform drogue via dynamic line actuation
- Separation-enhancing blast disk
- Car-pull tests to verify inflation and calculate snatch forces



Fig. 8 Controlled Recovery Module

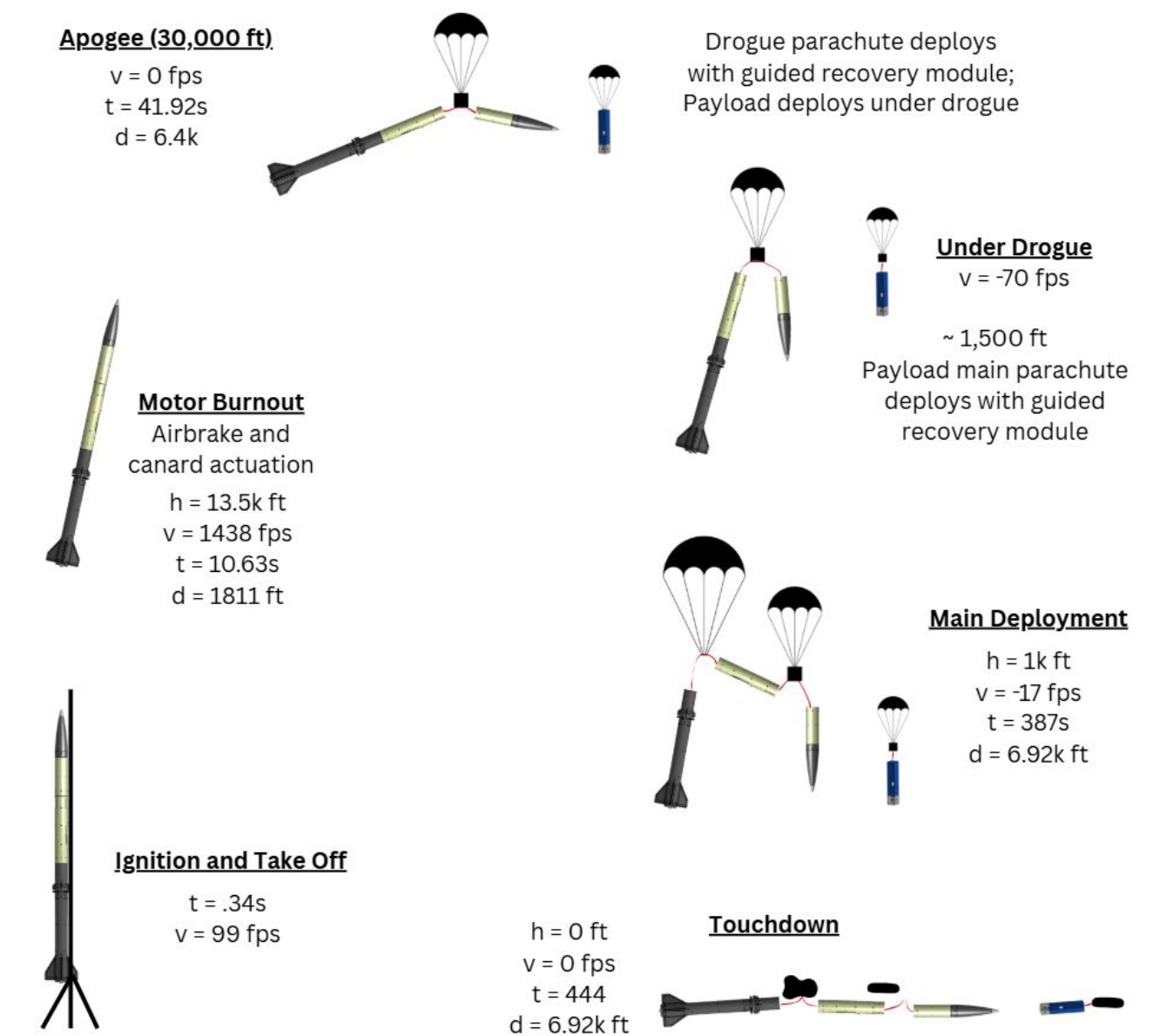


Fig. 9 Blast Disk



Fig. 10 Main Parachute

Concept of Operations (CONOPS)



Kratos (5U CubeSat)

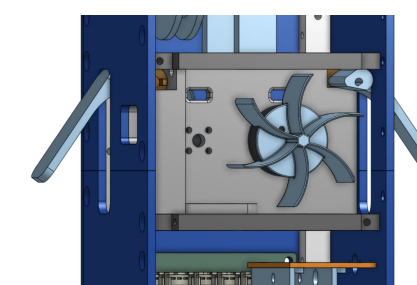


Fig. 11 Energy Recycling

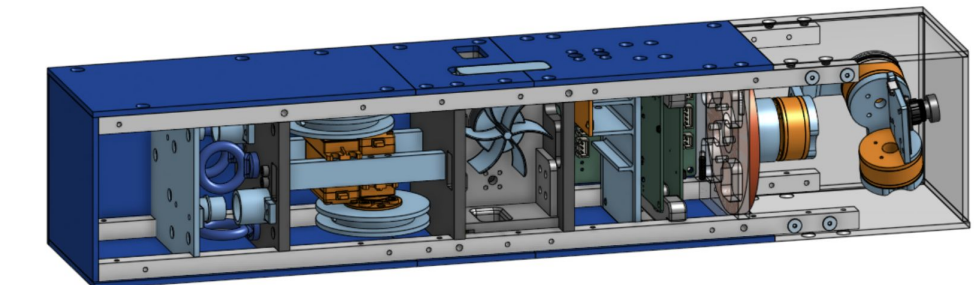


Fig. 12 5U CubeSat Payload

- SRAD 4.5 ft cruciform parachute deployed reefed at apogee
- Autonomous **controlled recovery** with magnetometer guidance
- New energy recycling unit verified through wind tunnel testing
- SRAD flight computer stack (Atreus) for control & telemetry
- 3-DOF **gimbal camera** encased in acrylic frame for stable video
- Live video transmission to ground station during descent
- Onboard data logging and post-flight analysis capabilities

AERO Sponsors

