Project Eiger

EPFL ROCKET TEAM

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Spaceport America Cup 2019

SPACEPORT AMERICA® CUP

Flight data

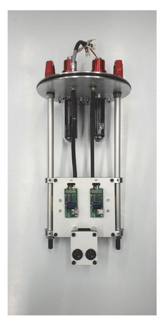
	End of rail	At maximum velocity
Speed [m/s]	*23.0*	*248.5*
Stability Margin [calibers]	*2.31*	*4.21*
Damping ratio [-]	*0.113*	*0.069*

	Value	Time
Apogee (without altitude correction)	*3'198 m*	*26.8 s*
Maximum acceleration [g]	*5.75*	*1.78 s*
Touchdown	*-*	*2 min 41 s*

Length : **3060 mm**
Characteristic diameter : **155.6 mm**
Launch mass : **31.582 kg**

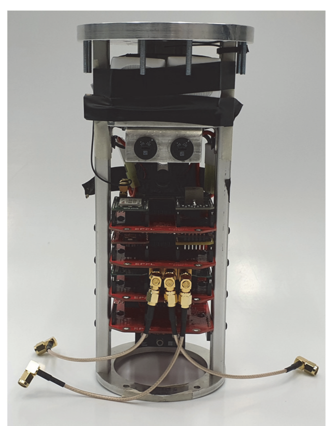
Features

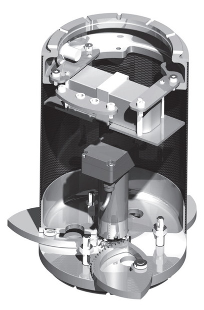
Payload
Damping experiment using a silicon oil based non-Newtonian fluid. The payload is made of a fly mass, the damping system itself and the avionics which includes all the sensors. The aim is to determine if a non-Newtonian fluid based damper can replace traditional dampers using springs or viscous friction on heavy launcher payload adapters.



Recovery
The parachute was completely researched, developed, tested and built by students. It aims to answer to both primary and secondary recovery phase requirements by implementing a reefing system.

Avionics
Located at the center of the rocket, it has a modular and distributed architecture. Four interconnected STM32 microcontrollers each control their own set of peripherals. These include two IMUs, barometers and GPS, as well as a 900 MHz RF transceiver connected to the 3-element conformal patch antenna array. The sensor data is logged on a SD card and processed by a dedicated microcontroller to control the airbrakes.



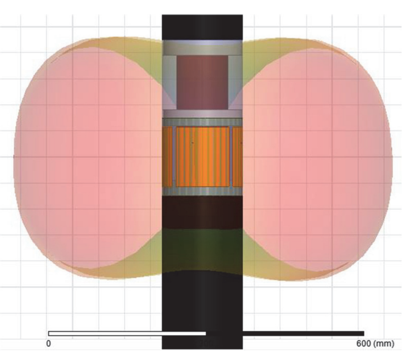


Shuriken airbrakes
Called shuriken, the module can control three small aerodynamic surfaces by means of a high quality servo motor.
A feedback loop controls the airbrakes based on altitude and velocity. The design is safe in case the motor fails. The braking surfaces are always deployed symmetrically, therefore the rocket doesn't become unstable. The module was designed by students. It can reduce our apogee by 300 m to achieve the predicted altitude.

Fins module
The rear of the rocket is composed of 68 parts totally designed and machined by students. The fins are interchangeable to adapt stability and ease repair. The bottom of the rocket is then protected by a thin boat tail which deforms at impact. The part is then unscrewed and replaced for the next launch.

Avionics bay

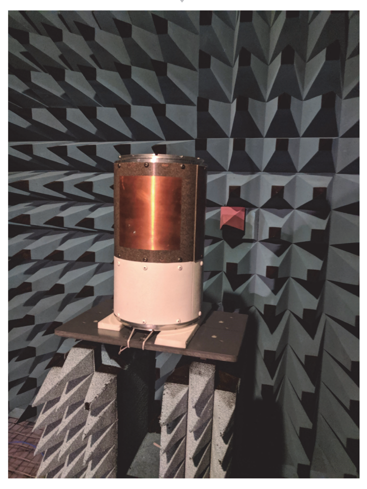
Design
The avionics bay is made of two parts



The conformal patch antennas and glass fiber panels are on the outside of the avionics bay. The antennas are curved to efficiently transmit data regardless of the rocket's roll.

The structural integrity is guaranteed by a beam structure composed of carbon beams clamped in aluminum rings.

Test
All parts are validated by tests or analysis

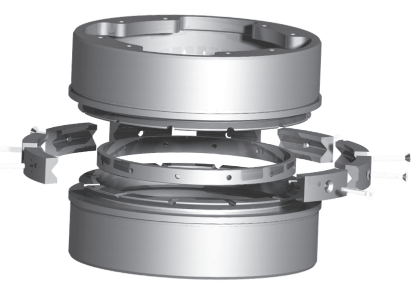


The antennas are tested in an anechoic chamber.

The beams are tested in a non-destructive traction test to ensure they have a margin of safety of at least 1.5 with regards to required values.

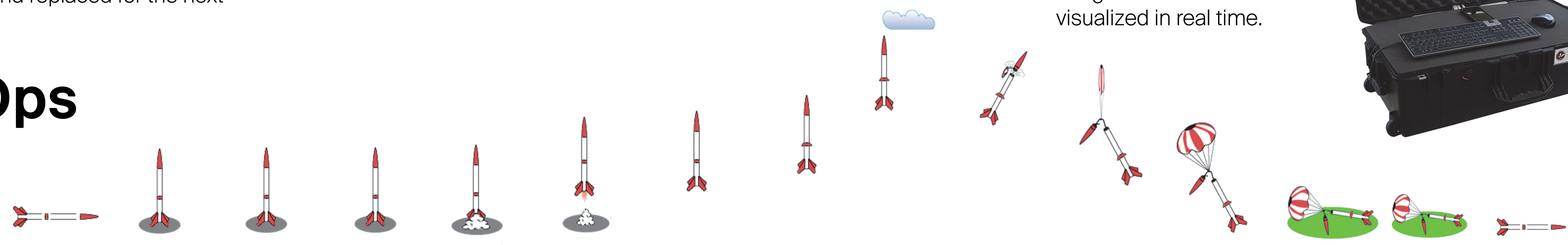
Final Module
Lake Geneva, Switzerland

Coupler
A coupling system inspired by the Marman clamp principle was developed for the launcher. It allows quick access to the inner systems and provides practical fastening points to transmit motor force or parachute shock to the structure.
It is also how we make our rocket modular.



Ground Station
Telemetry data from the rocket is sent back to the ground station and visualized in real time.

ConOps



	t - 2h	t - 5min	t - 4min	t - 2min 30s	t = 0s	t = 0.4s	t = 5.6 s	5.6s < t < 27s	t + 27s	t + 28s	t + 30s	t + 2min	t + 2min 41s	t + 30min	t + 60min
Phase	Assembling	Launch pad setup	Procedures check	Arming	Firing	Take off	Motor burnout	Ballistic flight	Apogee	Separation	Primary Recovery	Secondary Recovery	Ground arrival	Recovery	Dis-assembling
Passing criteria	Complete "Assembly procedure"	Rocket on pad with right launch angle	Complete "Rocket preparation"	Complete "Arming checklist"	Motor ignites	Rocket leaves rail	Motor has finished burning	Altitude control to reach predicted apogee	Rocket velocity reaches 0	Rocket starts descent	Reefed main deployed	Main unreefed	Rocket lies static on the ground	All rocket parts are recovered	All rocket parts are stored for shipping