

Space Team Rocket 09 (Asimov)

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2019

The aim of our yearly Space Team Rocket Project is to build a rocket and fly it in France. The STR project consist of new members of the TU Vienna Space Team. This year's focus was to test and build a new recovery system for another Space Team Project. Additionally, we are trying to implement a steerable parachute however, we didn't finish it in time. Sadly, we went full ballistique and therefore couldn't test the recovery mechanism as the fault had nothing to do with it.



1 Introduction [7-8 lines]

In 2010 the Space Team launched its first ever rocket at C'Space, additionally this was the first ever rocket launch for the newly founded Space Team. Since then the so called STR-series has become an ongoing yearly project. Since some years the more experienced Team members of the Space Team have moved on to bigger projects, since then the STR project consist of mostly newer team members.

The number of participants has been fluctuating throughout the year of development. There are about nine people that contributed to the project. Florian Precht, Berhard Suppan and Benjamin Fillei have been responsible for recovery. Gabriel Winkler is responsible for the Electronics Mount. Patrick Enzenberger und Benjamin Heinrich are working on the implementation of the steerable parachute. Additionally, Noah Bruns and David Wagner helped with building the rocket-body. Fabian Kresse has been project and lead an has been organizing and been involved inbuilding the rocket.

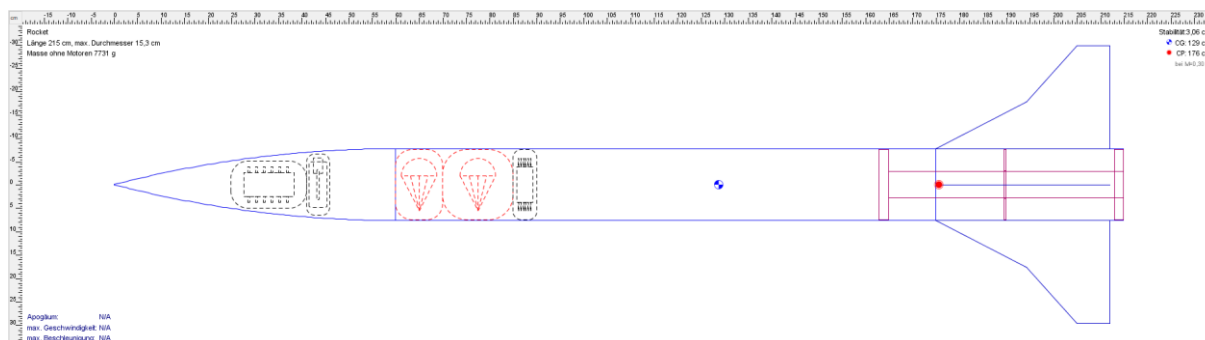
The project is split in several milestones. First, we needed to finish the airframe. Parallel to that the development of our recovery system was pursued. Those are the most flight critical systems and therefore had to be finished first. The development of our flight hardware has been an ongoing project since many years and is brought forward by an almost separate branch of the team. This means we only need to make minimal adjustments to already existing hardware.

The TU Vienna Space Team needed a new separation mechanism that is: reliable, simple and pyro less. Therefore, we adapted last years system and improved it considerably. The steerable parachute should allow us a more reliable recovery.

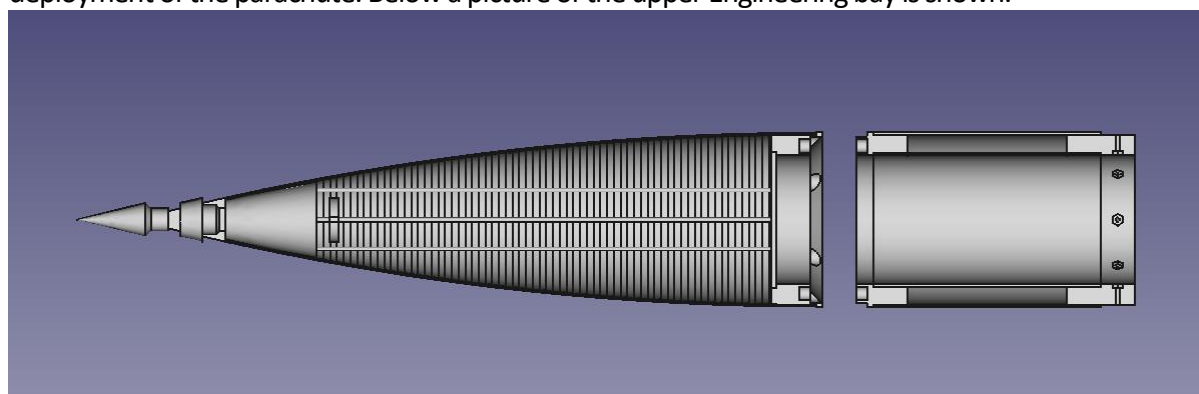
2 Mechanical description [*> 10 lines + plans + photos*]

The whole airframe is made from CFK except for the nosecone. It is made from GFK.

A general plan of the rocket can be seen below.

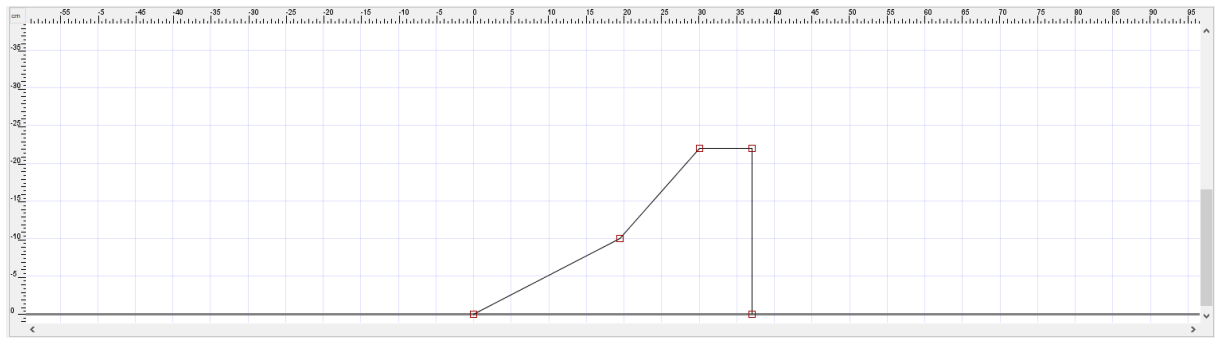


In the upper nosecone we have our upper-engineering bay. It is responsible for separation and deployment of the parachute. Below a picture of the upper Engineering bay is shown.



For recovery a line is fastened inside the nosecone. It is further fastened from the outside with the help of a screw. This line is burned through once apogee is detected. A parachute is deployed.

In the main tube we have the lower engineering bay. It is responsible for steering the parachute. At the bottom we have the engine mount. It holds the motor.



Above the finshape can be seen.



Above the picture of our electronics mount can be seen. Below you can see some pictures of the rocket.

3 Electronic and computer description [*> 10 lines + plans + photos*]

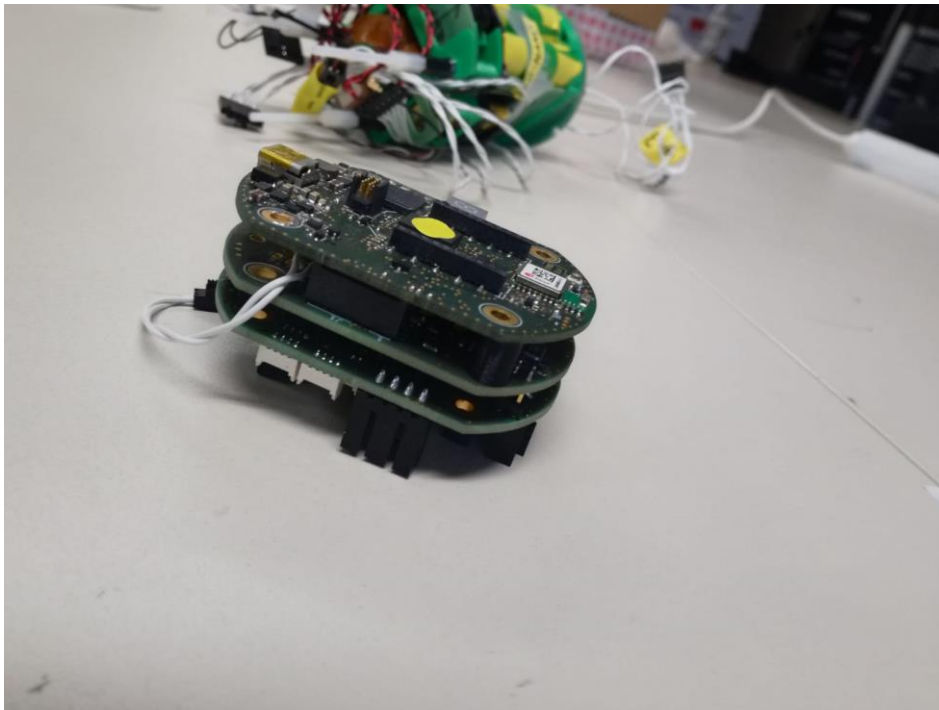
We are using 3 in-house PCB boards. They are connected via PCB-to-PCB Connectors. The visible, first board, (see picture) is the Flight Management System (FMS). This board is responsible for everything (initiate recovery, log flight data, start detection...).

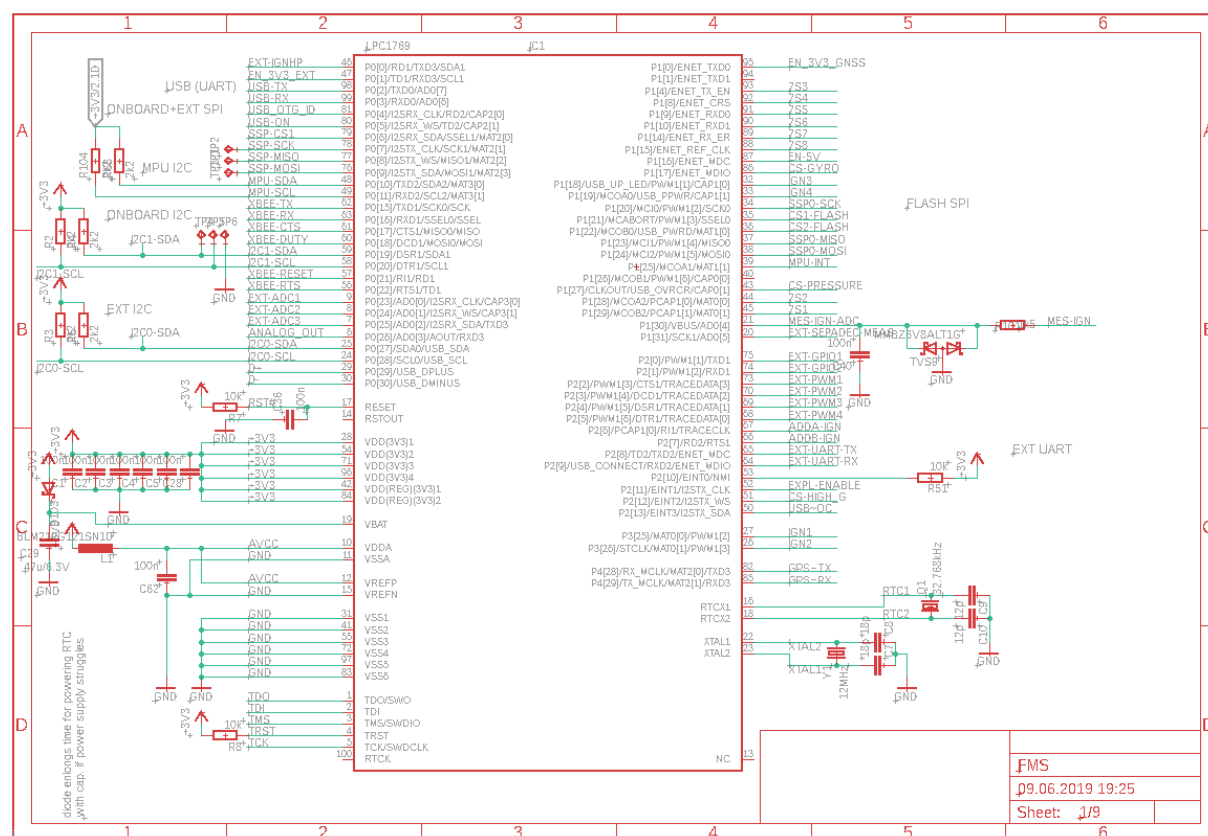
The FMS has a normal accelerometer, a high-G accelerometer, a 9-axis measurement system, a magnetometer, an additional independent gyroscope, and a barometer. Furthermore, a GPS is present on the board. The second and third board (not really visible on the picture) are only breakout boards for the igniter-channels and so on.

We have a takeoff detection that inhibits the igniters. For detecting apogee, we employ a Kalman filter. Additionally, to our apogee detection a timer can be used separately. Both can be set, what ever event occurs first triggers the igniters. This leads to double redundancy. One 2S LI-Po akku is used.

The FMS does Power management, internally it uses 5V and 3,3Vs. One more LI-Po akku is present that is used for heating the heat element used by recovery. For recording, we log our data on a flash. It can be read out after flight over USB. A radio system using Lora modulation is present on the electronics stack, some data is sent in flight back to the ground station. The heart of the FMS is the MC LPC1796. Below you can see our architecture without the sensors. I will have the plans (and an electronics stack) with me for RCE3.

For recording a flight video we used a RunCam2.



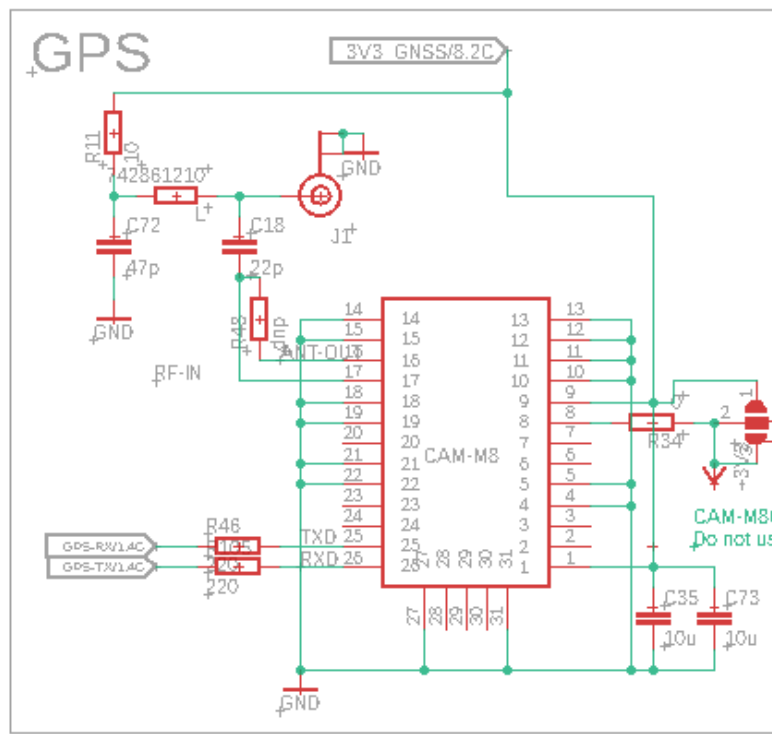


4 Experience [*> 10 lines + calibration curves + photos + plans of the sensors*]

We want to answer multiple questions. Is it possible to steer the rocket with a parachute? Is our new Hardware generation working properly? Does our logging work? Does our new recovery system work as anticipated? Sadly, we didn't finish the steerable parachute. Furthermore, we are always interested in our sensor and video data.

For our measured parameters refer to section 3. Our accelerometers are MEMS. All our hardware is of the shelf. For our experiment we mainly rely on our GPS. It is a CAM-M8Q. The GPS should be providing us with a range of values that are over the flight area. It is already calibrated. However, it cannot be more accurate than a couple of meters. This won't be a problem. Plans can be seen below.

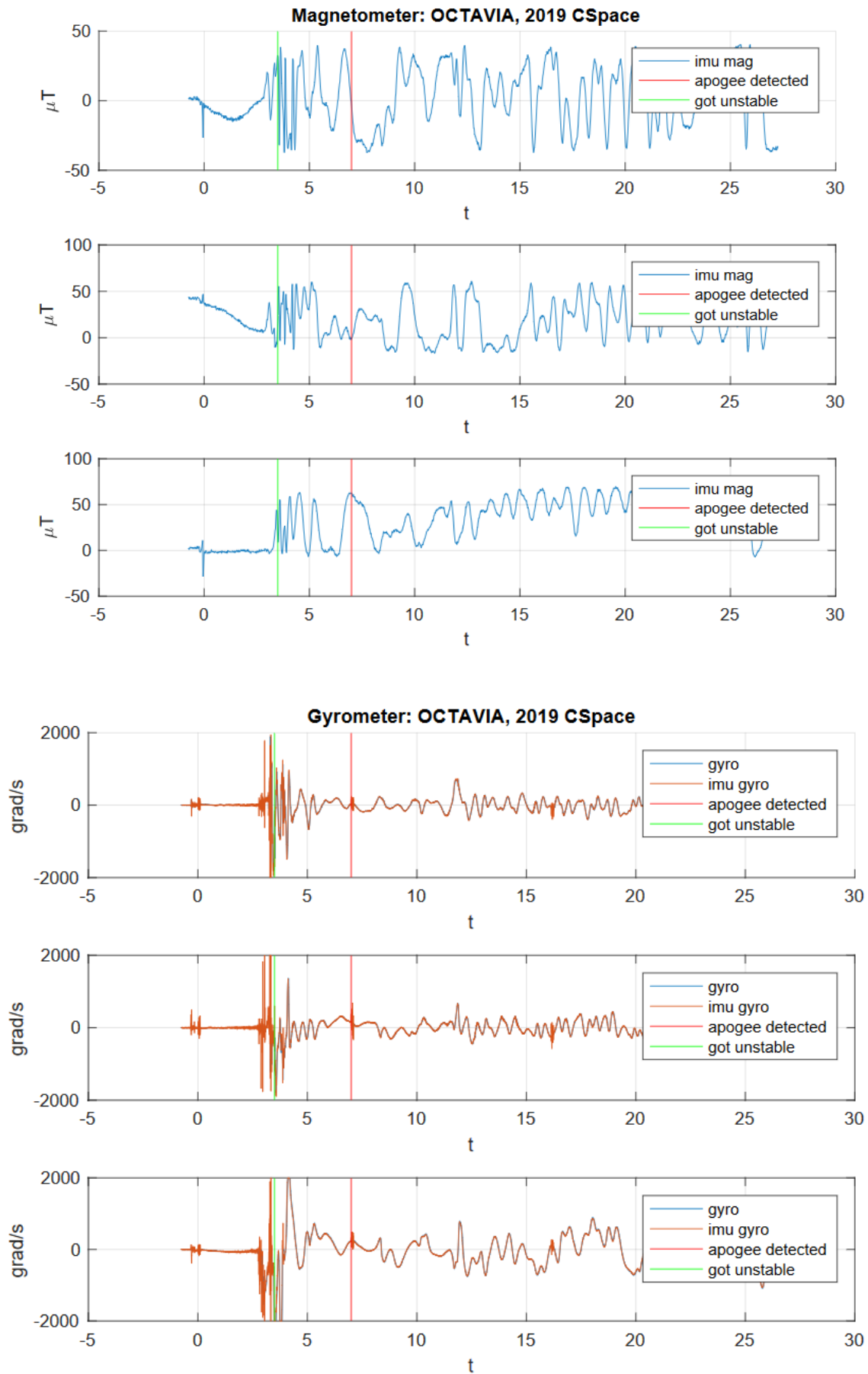
We sewed a parachute that is steerable. It is based on a NASA-Parawing. It will be interesting to see how it performs under real conditions. We are still working on a good method to pack it and reduce the impact shock more. If we can't up with a really good design that we are confident in, we will only fly with a backup chute and test the rocket and its sensors, especially our new recovery system.

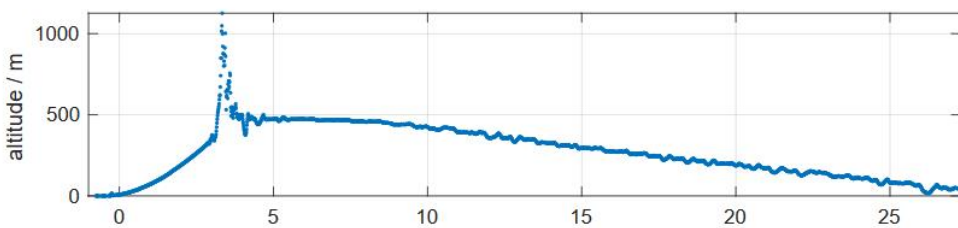
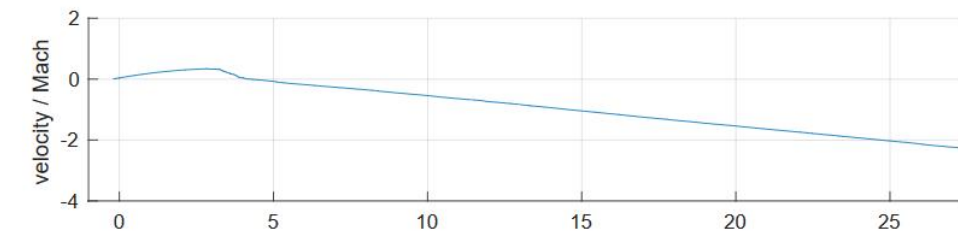
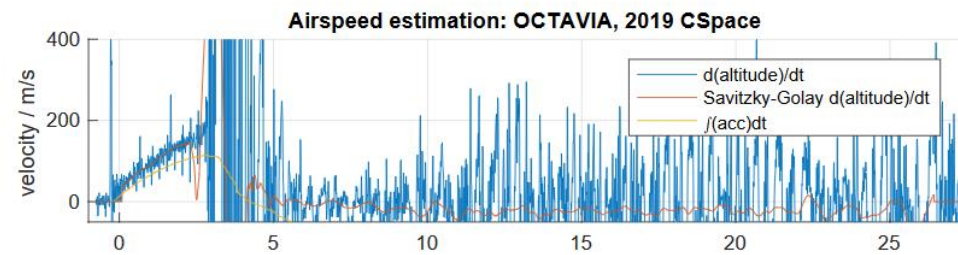
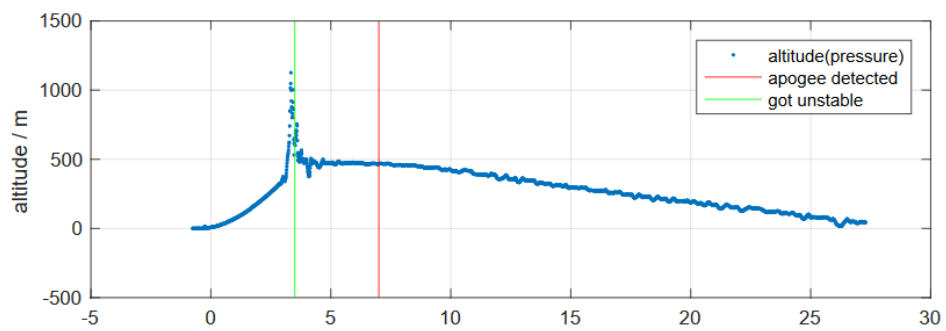
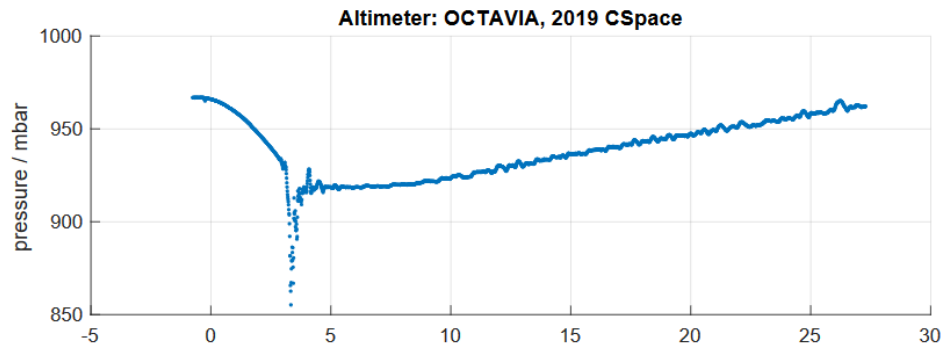


5 Flight sequence

We launched on July 17 at approximately 17:45. It was a clear and sunny day. The rocket had a stable trajectory until our fins broke off at approximately 2.7 seconds. This resulted in an unstable flight and an early deployment of the parachute that couldn't deal with the non-nominal force applied on it. All except the parachute were recovered on the following day: Everything was still in a nominal state except the fins that broke off during flight.

6 Results [>10 lines + curves]





From the Gyrometer data it can be seen that the rocket got unstable at around 2.8 seconds. At this point a max altitude of around 500 meters had been reached. The further dotted points that say we reached an attitude of 1000 meters are just measurement errors. Afterwards we descended with an approximate speed of 25m/s. Since we didn't manage to implement the steerable parachute, we cannot answer any question about it.

Since we didn't really get to test the deployment mechanism either we cannot fully say if it would have worked. However, some key parts appeared to have worked nominally. First, apogee was detected after the minimum set time, which indicates that it worked to our satisfaction. Furthermore, the nosecone mechanism stayed on the rocket and worked like it should work until we encountered the non-nominal flight state. However, once we entered this flight state, to high of a force acted on it and it separated it from the rocket.

The cause that for the unstable flight was that our fins separated from the rocket. We didn't sand the PLA on that the CFK was applied enough. Therefore, the CFK separated from the PLA and the fins broke off.

7 Conclusions [7-8 lines]

We had a ballistique flight because our fins disintegrated. This disintegration was do to a not good enough hold between our CFK and our PLA body. However, the recovery system worked nominally up until this point. The whole team has learned a lot during the project. First, that some project goals are just not viable to be achieved within one year. We learned this during the implementation of the steerable parachute. Furthermore, we will hopefully never again sand something not enough. Apart from the fins the rest of the airframe was sturdy and well-constructed, nothing except the fins was broken or damaged. We want to improve on the current recovery mechanism. We want to apply no more forces to a single rope. Furthermore, we want to simplify our recovery mechanism, because it was a real hassle to prepare it each time.

I personally wouldn't recommend trying for the steerable parachute on a STR rocket again because building the rocket from scratch is much to do as it is. Instead a cool experiment might be two cameras on the rocket. With those cameras and a CV-algorithm height and speed of the correct could be estimated and compared with our sensor data.

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