

# Parachute Reefing System for Sounding Rockets

## Graduate



Luca Jost

**Introduction:** The association Akademische Raumfahrt Initiative Schweiz (ARIS) brings together students from Swiss universities interested in space exploration. Several rockets have been built over the years for student competitions and research. The rockets built by ARIS are fully reusable, as they are recovered by parachute. With the rockets getting larger and heavier with each passing year, a solution to reduce the shock loads at parachute opening is needed. Consequently, the development of an active parachute reefing system was proposed.

**Approach / Technology:** After evaluating a large number of line cutting methods, it was decided that a thermal solution would provide the best results. The reefing line is guided through a ceramic heating element and gets burned through at a target altitude. Once the reefing line is cut, the parachute can fully open.

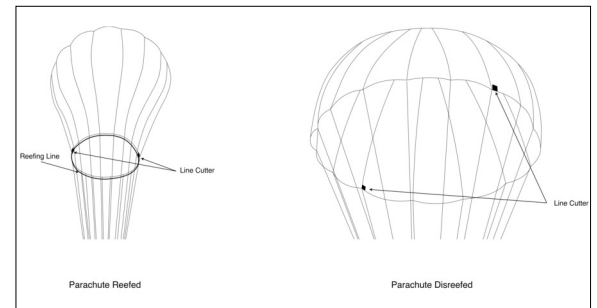
A custom hardware was developed to drive the heating element, receive data over a telemetry link and process sensor data. The system is based around a STM32 microcontroller. Through the telemetry link, the reefing computer can receive commands to initiate the cut of the reefing line. In addition, a Kalman filter was developed to estimate the velocity and altitude of the rocket, allowing the reefing computer to also work fully autonomously. All relevant system settings can be changed through the USB interface. An enclosure was designed and manufactured using a 3D printer.

**Result:** A comprehensive testing campaign was carried out to assess the system's functionality. Many cutting tests were conducted to determine the effectiveness and repeatability. To validate the state estimation, multiple drone flights were performed. In these field tests, a FPV drone was used to accelerate

upwards with up to 4 g and reach altitudes of around 100 meters. Finally, a full-scale rocket flight of the whole system was conducted. The reefing system cut the line at parachute opening, proving its effectiveness.

## Illustration of the implemented parachute skirt reefing

Own presentation



## Test flight of the Reefing System with a sounding rocket

Own presentation



## Reefing Line Cutter PCB, mounted heating element and enclosure

Own presentation



## Advisor

Prof. Dr. Andreas Breitenmoser

## Co-Examiner

Theo Scheidegger,  
Swens GmbH, Schänis,  
SG

## Subject Area

Embedded Systems

## Project Partner

ARIS Akademische  
Raumfahrt Initiative  
Schweiz, Dübendorf,  
ZH