# MIRKA2-RX

A REXUS Flight Experiment in Preparation for the Atmospheric Entry CubeSat Mission CAPE



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# Overview

1. Introduction of KSat
2. CAPE, a Re-entry mission
3. The REXUS Project MIRKA2-RX
4. Results
5. Impact on CAPE
6. Conclusion
7. Outlook: MIRKA2-ICV/HyEnd

# Introduction of KSat e.V.

**Small Satellite Student Society at the University of Stuttgart**

- Founded: 08.04.2014
- Members: 40+

**Goals**:

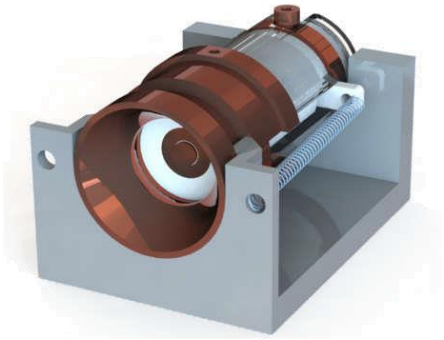
- Participation on space related projects
- Connection industry & science
- Hands-on Experience

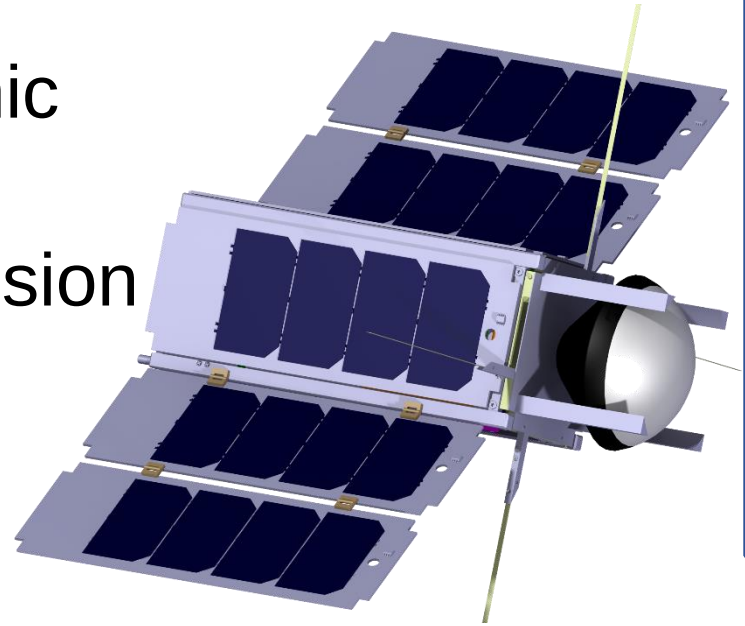
**Supporting Institute:**

- Institute of Space Systems (IRS), University of Stuttgart

# CAPE Cubesat Atmosphaeric Probe for Education

- Two unit CubeSat as service module
- One unit Re-Entry Capsule MIRKA 2
- FIPEX sensors for atomic oxygen
- PETRUS electric propulsion system, IRS developed

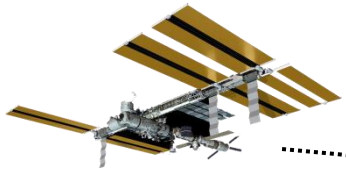


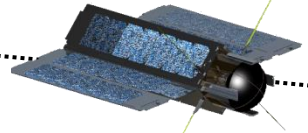


# Goals of CAPE

- Demonstration of PETRUS
- Atomic oxygen distribution in upper atmospheric layers
- Qualification of heat shield materials
- In-situ measurements of ablation materials
- Implementation of a technical platform for in-situ heat shield tests

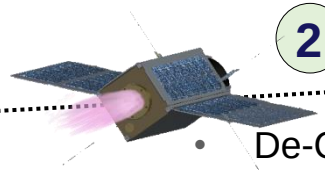
# CAPE Mission Overview





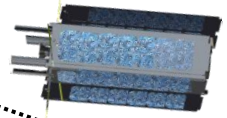
**1 Deployment**

From aprrox. 400 km
(e.g. from ISS)



**2 De-orbit**

- De-Orbit down to separation attitude
- Atmospheric measurements
- PPT demonstration



**3 Separation**

At approx. 150 km altitude

**4 Re-entry of the capsule**

Measurements of the ambient conditions and the re-entry performance of the capsule

**5 Transfer of re-entry data via satellite**

Transmission of data through Iridium communication system

**6 Demise of SDM, impact of capsule**

Potential for monitoring of break-up and demise

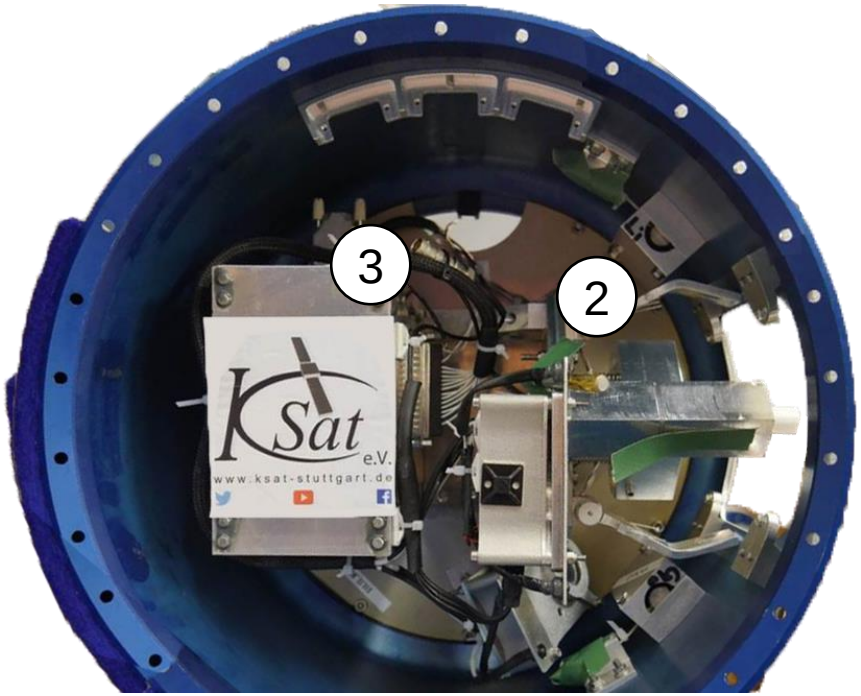
# REXUS Rocket EXperiments for University Students

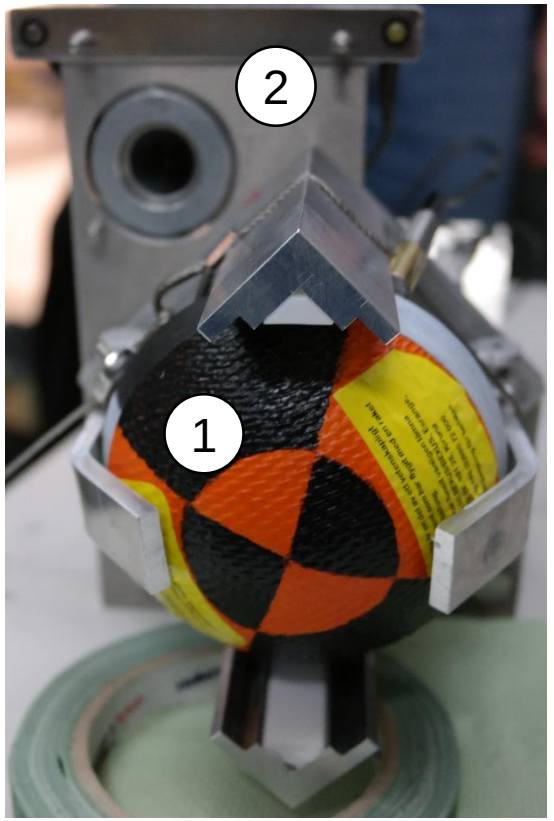
- REXUS/BEXUS Program from DLR and SNSB
- Unguided, spin-stabilised rocket
- Improved Orion motor
- 4 – 5 experiments per rocket
- Apogee at 90 km
- Perfect for CAPE subsystems qualification

# MIRKA2-RX Micro Return Capsule 2 on REXUS

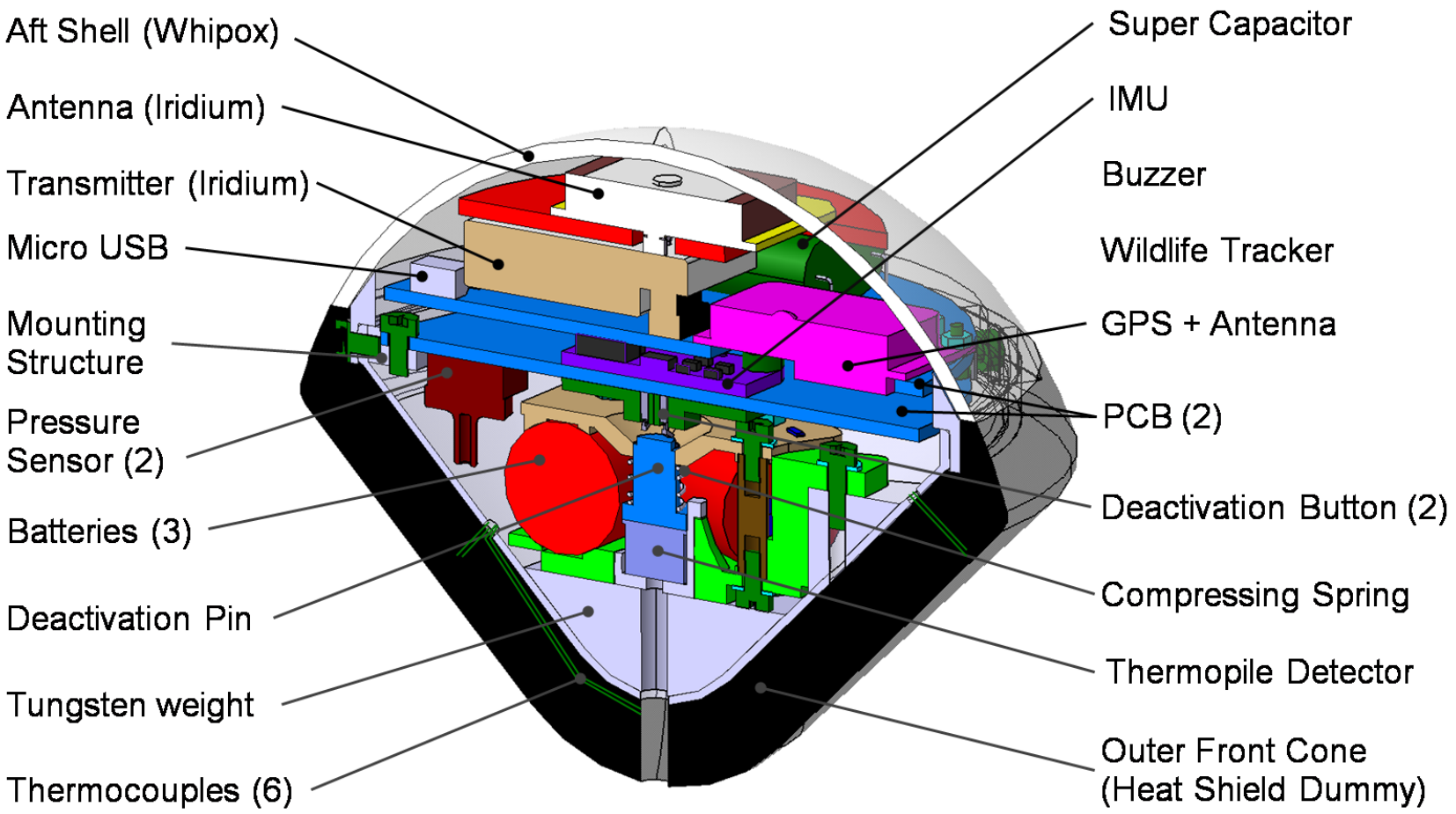
Experiment systems:

1. MIRKA2-RX capsule
2. Separation system
3. On-board electronics



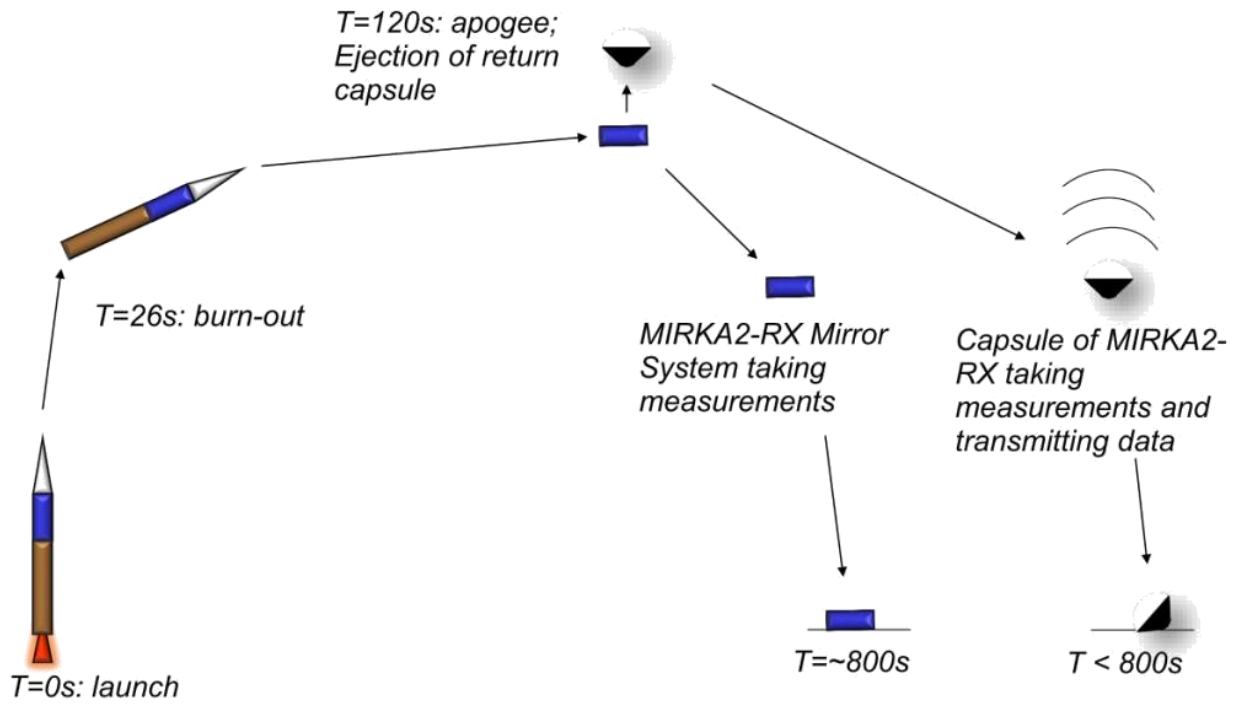
# Design of the Capsule



# MIRKA2-RX Mission Overview

Primary objectives:

- Qualification of the separation system for a miniaturized capsule in space
- Qualification of the electronic system of the capsule
- Establish an Iridium communication link



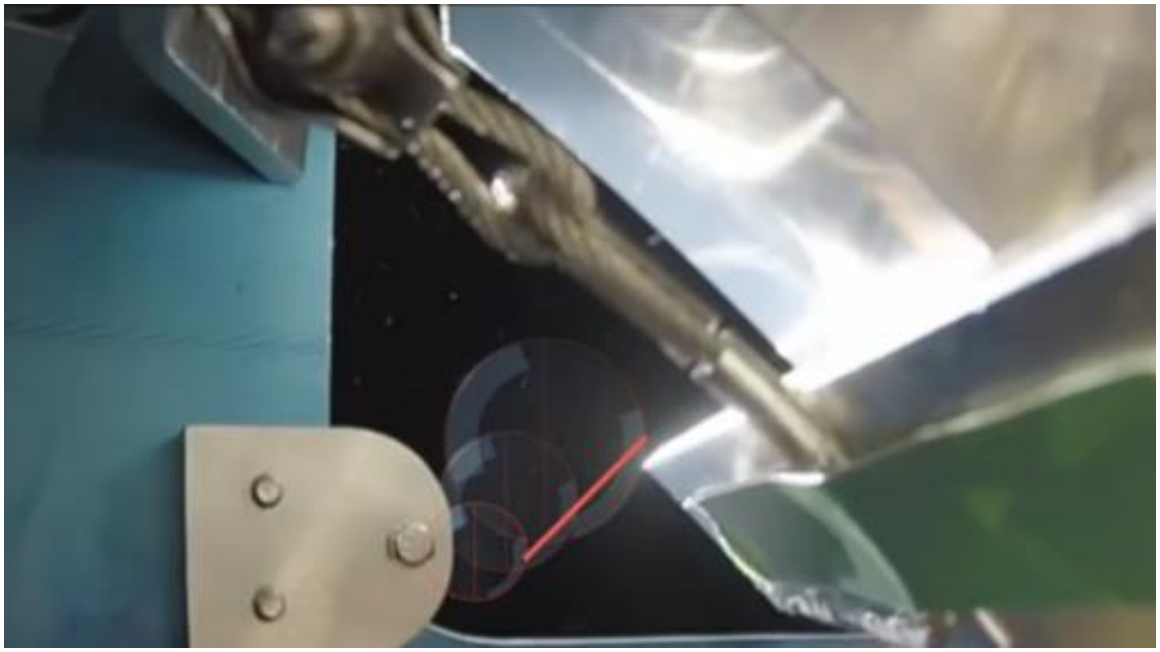
# MIRKA2-RX, Launch Campaign

# Results

- All primary mission objectives completed
- Capsule didn’t activate during separation
  - Reason: jamming of activation mechanism
- Recovery enabled valuable post flight analysis

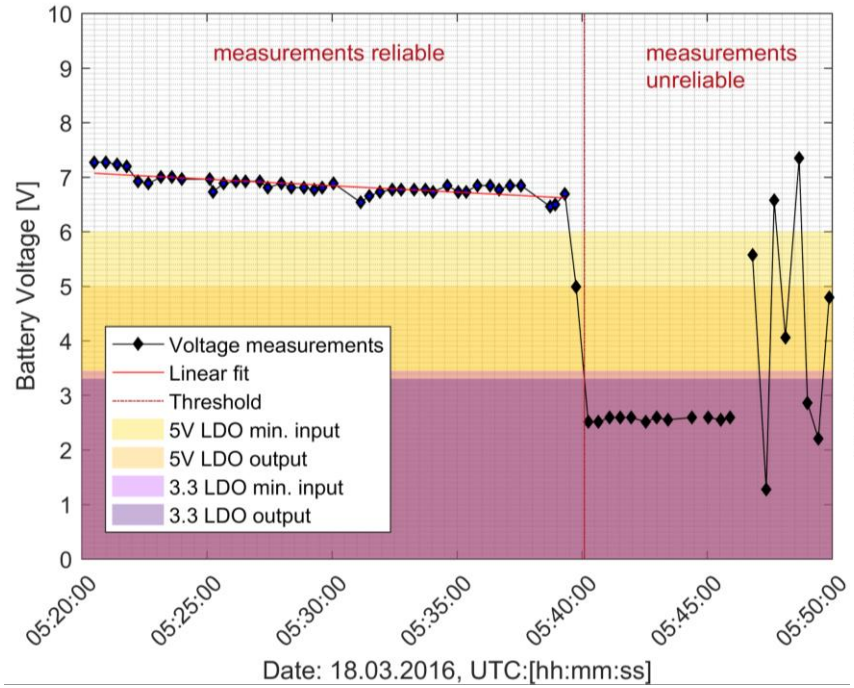
# Results Separation Mechanism

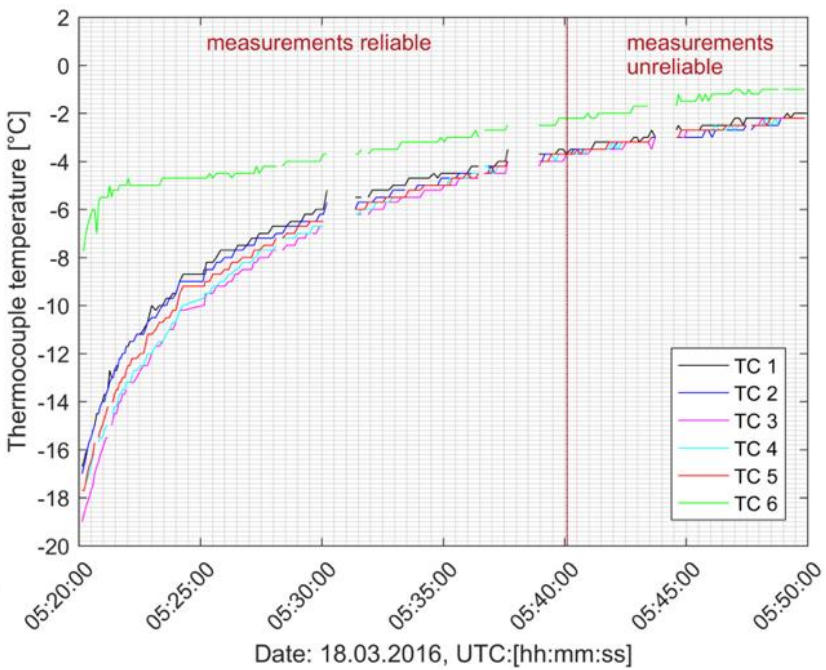
- Ejection time T+80s
- Ejection of Hatch and Capsule successful
- Ejection speed approx. 0.8 m/s



# Results Capsule

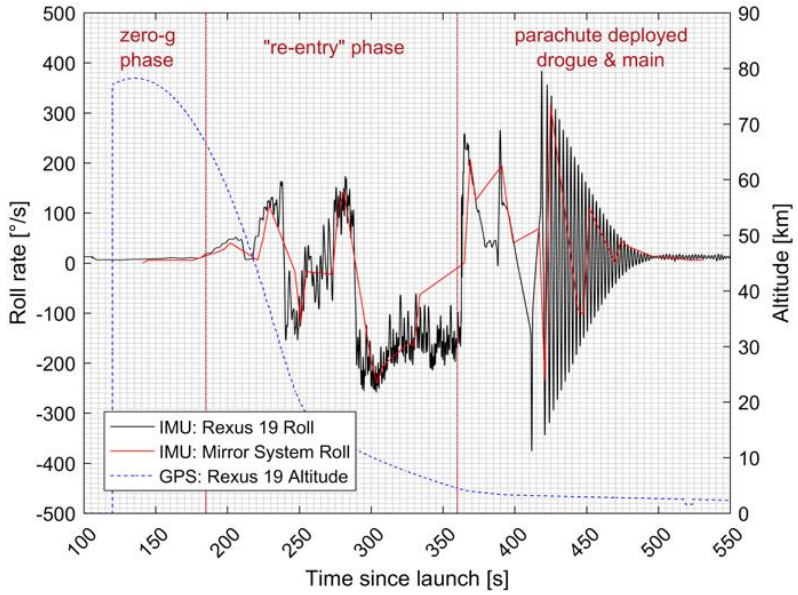
- Sensors worked reliably after impact
- Capsule runtime 29.7 min, 64 messages
- Avg. datarate 14b/s

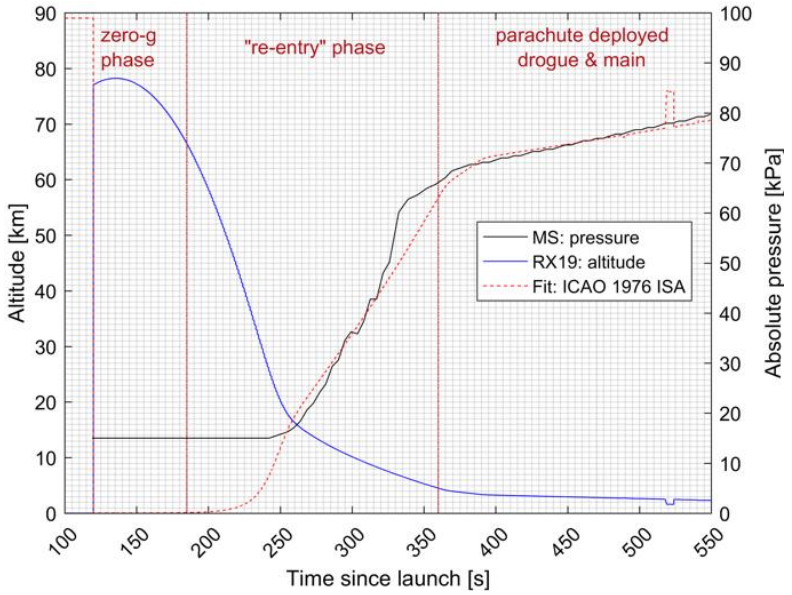


# Results Mirror System

- Verified electronics to work in vacuum and micro-g environment
- Demand for higher data rate/compression



# Impact on CAPE

- Separation mechanism performed under expectations
  - Ejection speed too low
  - Problem → integral heat load
- Pyrocutter board and separation electronics work
- Data Transmission rate needs to be increased
- Battery life sufficient

# Impact on CAPE

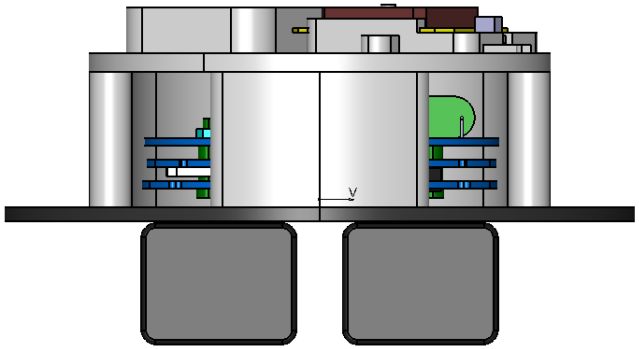
- First functional capsule iteration
- IMU: Worked, but insufficient data for flight qualification
- Activation mechanism: Needs redesign
- Thermopile: Not implemented
- Flight stability: Indirect evidence, follow-up projects necessary
- GPS: No flight qualification, hardware upgrade for follow-up projects

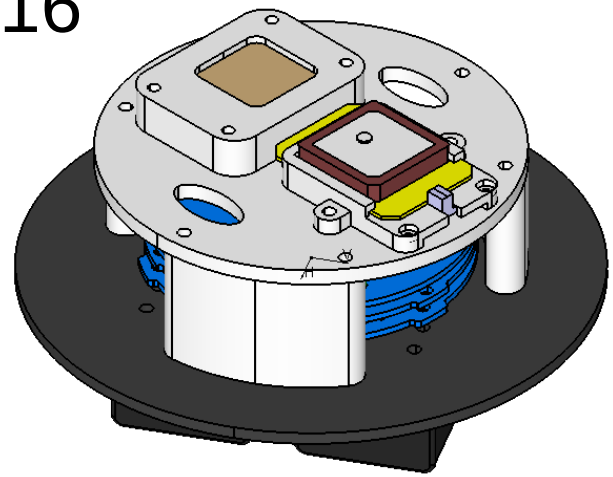
# Conclusion

- TRL increased for multiple CAPE components
- Critical design aspects shown (activation)
- Valuable educational experience for students
- Two follow up projects planned

# Outlook MIRKA2 - HyEnD

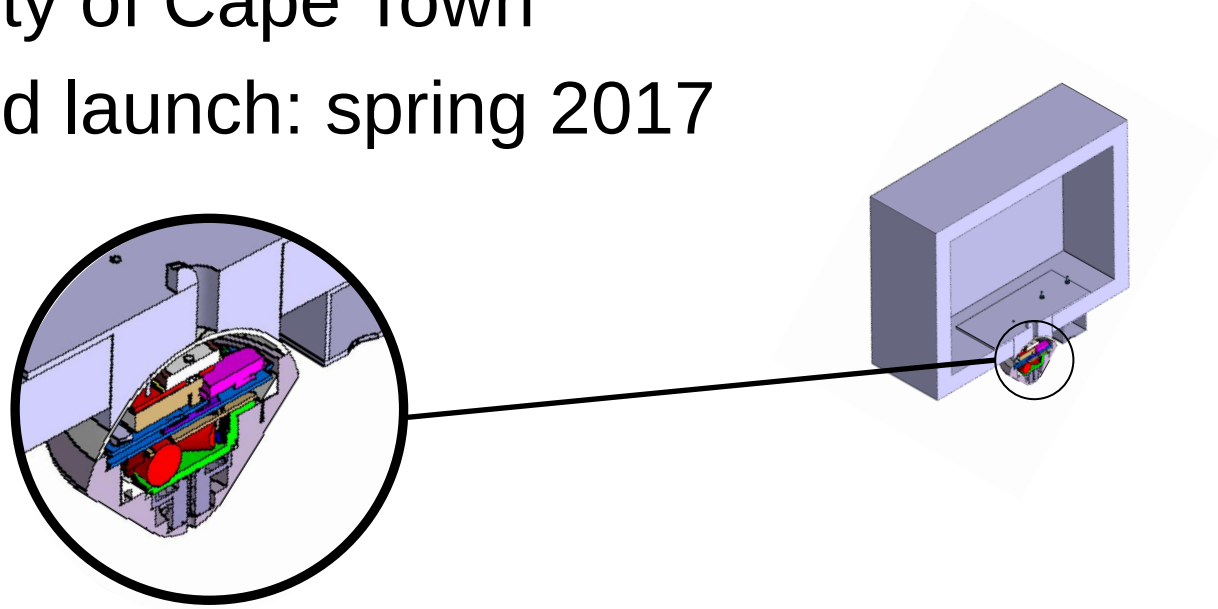
- Testing improved MIRKA2 – RX electronics on ultrasonic flight
- Cooperation with the Hybrid Engine Development (HyEnD) student team at the University of Stuttgart
- Launch in late October 2016





# Outlook MIRKA2 - ICV

- Inflight Communication Verification (ICV) of the Iridium data link
- High altitude balloon experiment
- In cooperation with SpaceLab of the University of Cape Town
- Expected launch: spring 2017



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# APPENDIX

# Results Capsule

- 67 messages sent
- 340 b/message
- Avg. datarate 14b/s