MIRKA2-RX

Micro Return Capsule 2 - REXUS

1st Symposium on Space Educational Activities

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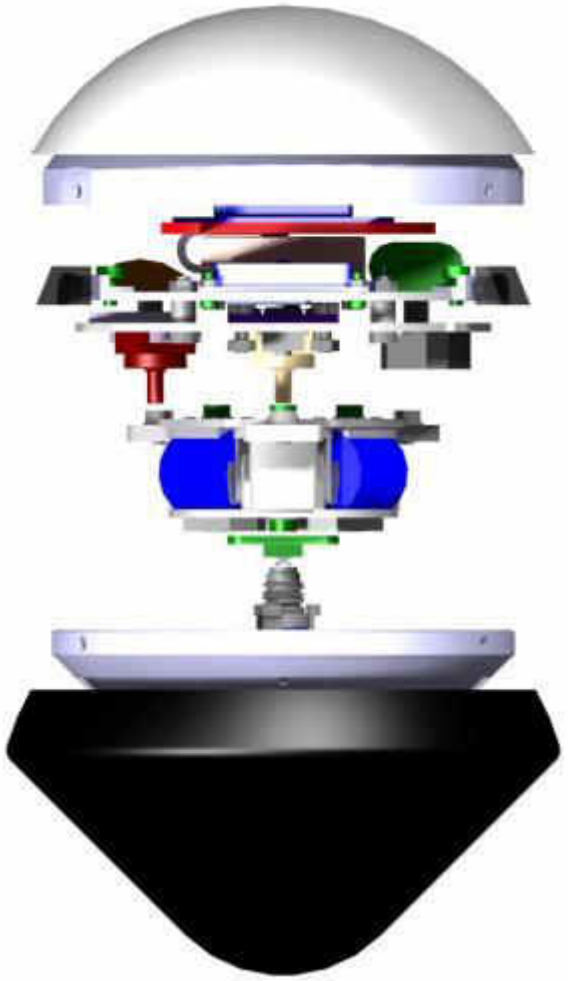
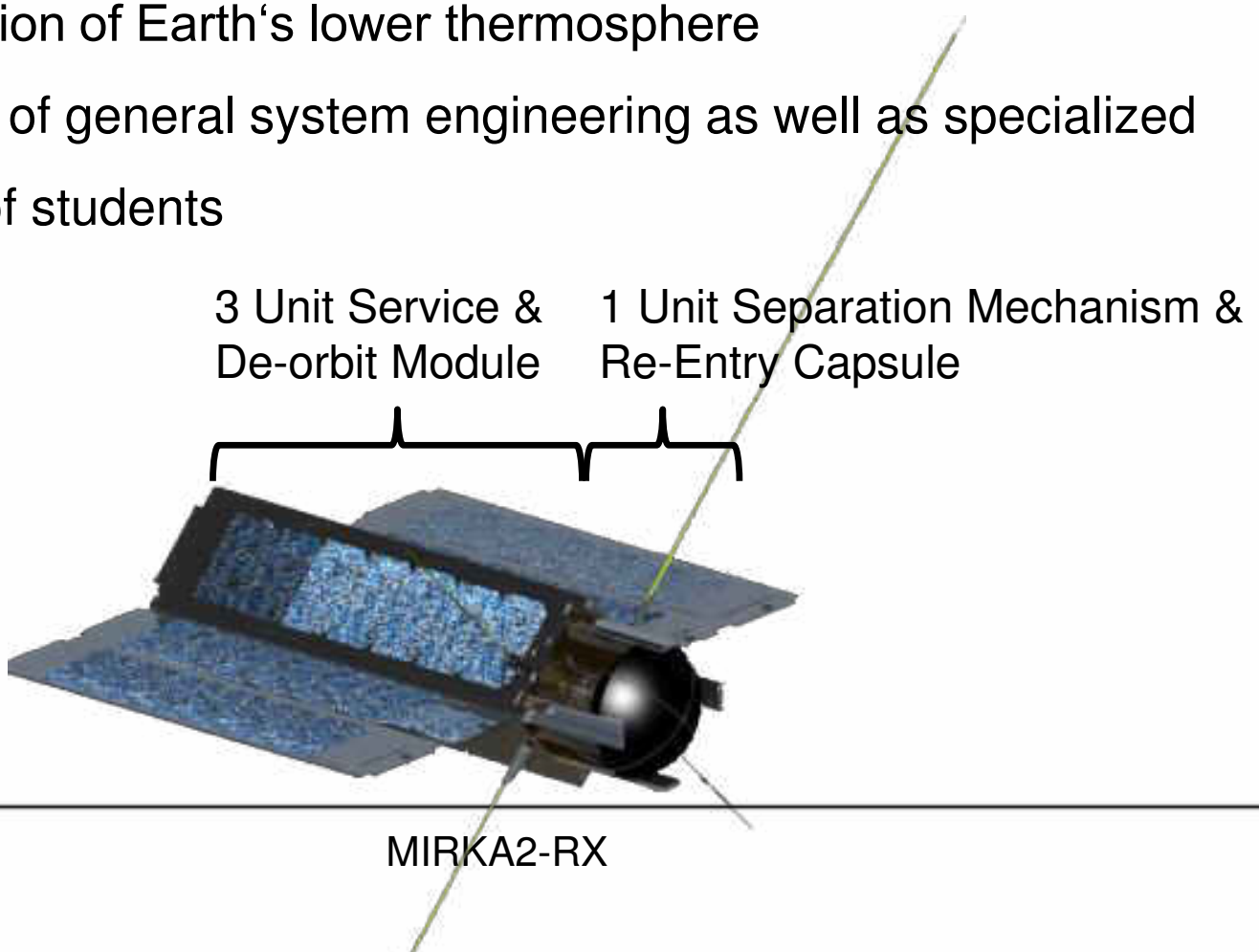
Overview

1. Introduction and Motivation
2. Experimental Set-up
3. Mission Scenario
4. Capsule MIRKA2-RX
5. Separation Mechanism LOTUS
6. Conclusion
7. Outlook



Introduction and Motivation

- Precursor project of CAPE (**C**ubeSat **A**tmospheric **P**robe for **E**ducation)
- CAPE serves as a demonstration and qualification platform for electric propulsion and atmospheric re-entry technology
- Characterization of Earth‘s lower thermosphere
- Development of general system engineering as well as specialized expert skills of students



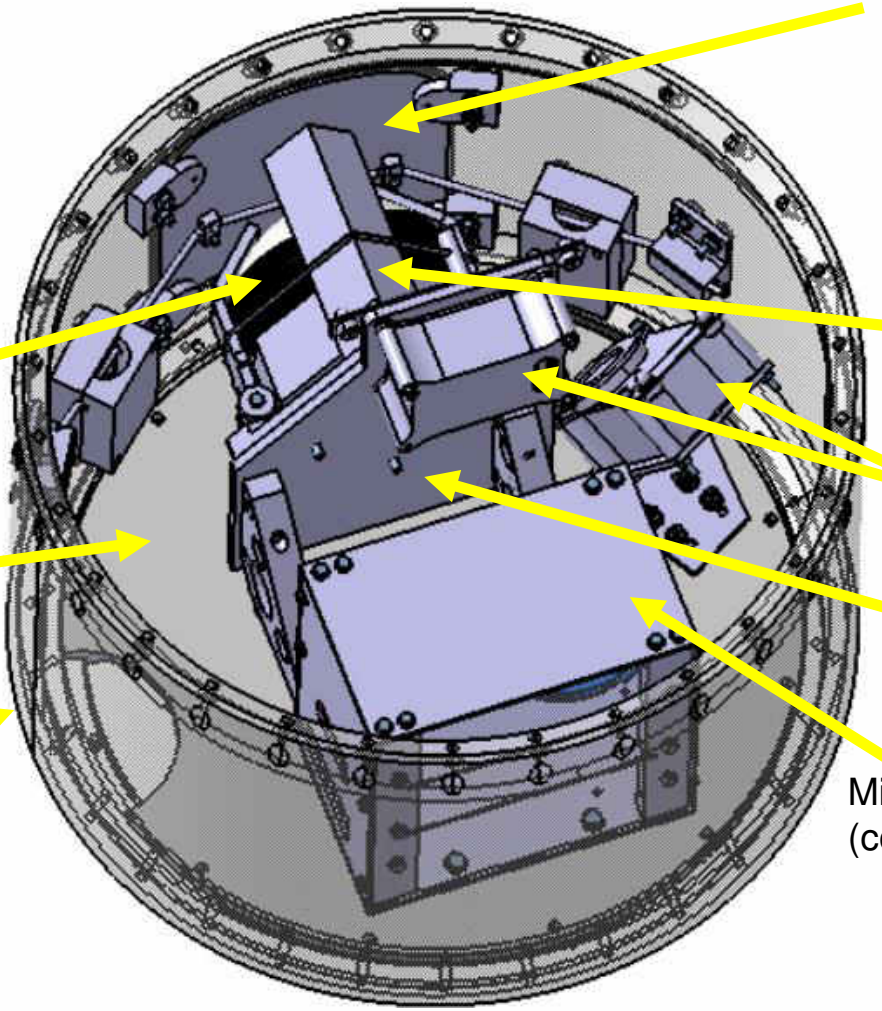
Introduction and Motivation

Experiment to validate:

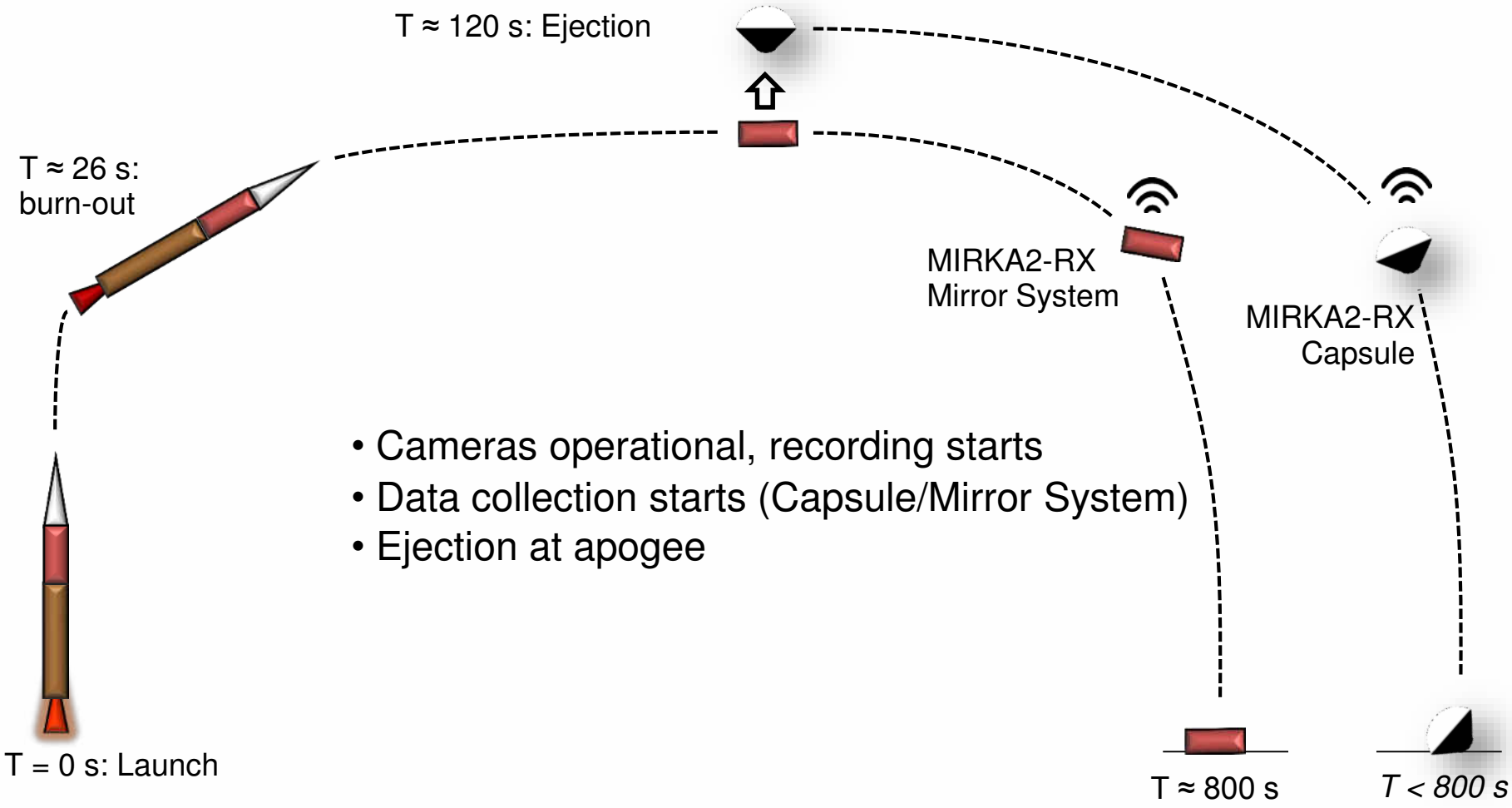
- Flight behavior, communication and electronic system of the MIRKA2 capsule
- Performance of the specially developed ejection-mechanism LOTUS (**L**ow **O**rbit **T**echnical **U**nit **S**eparator)
- Launch March 2016 on REXUS-19

(ESA 2007)

Experimental Set-up

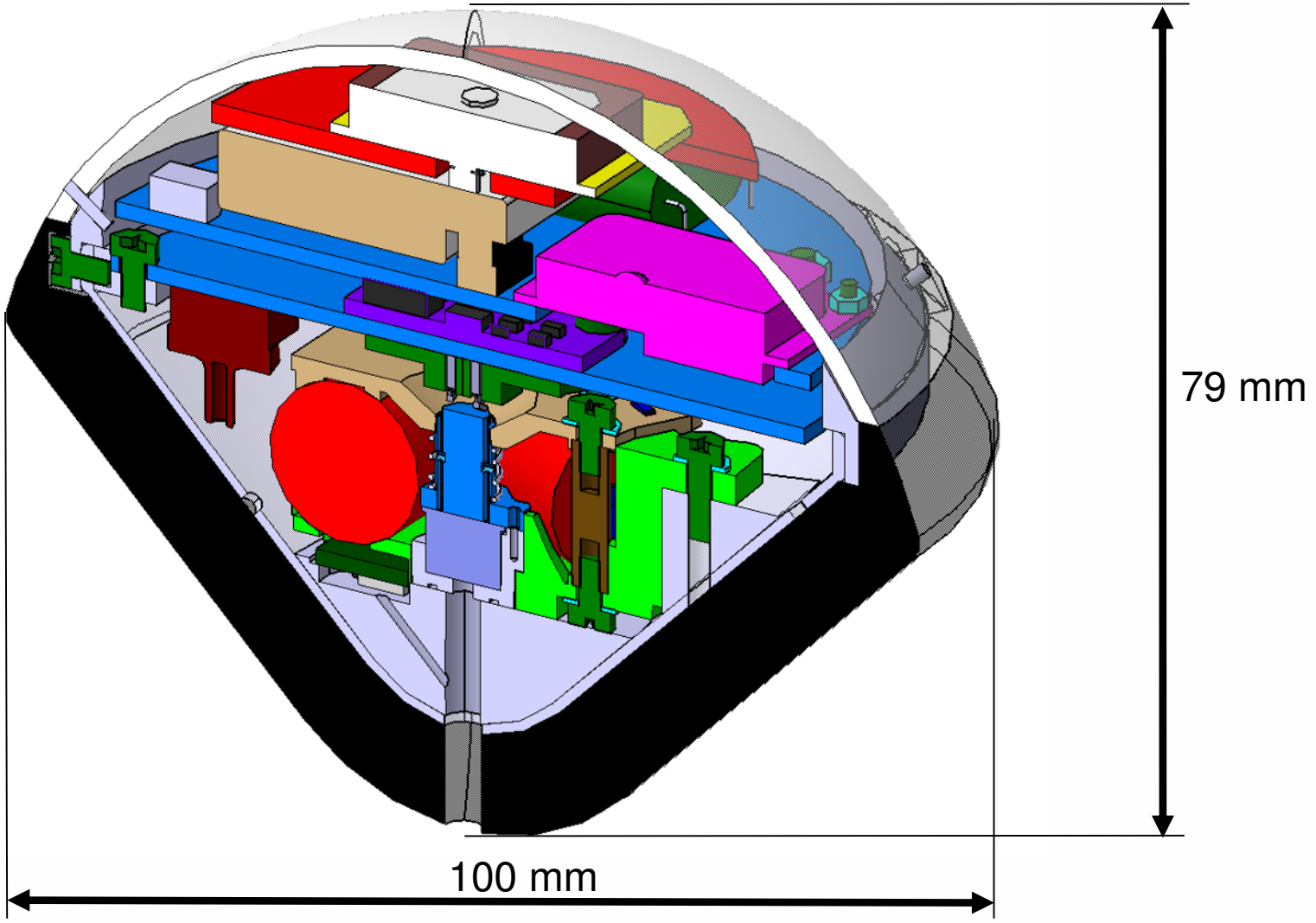


Mission Scenario

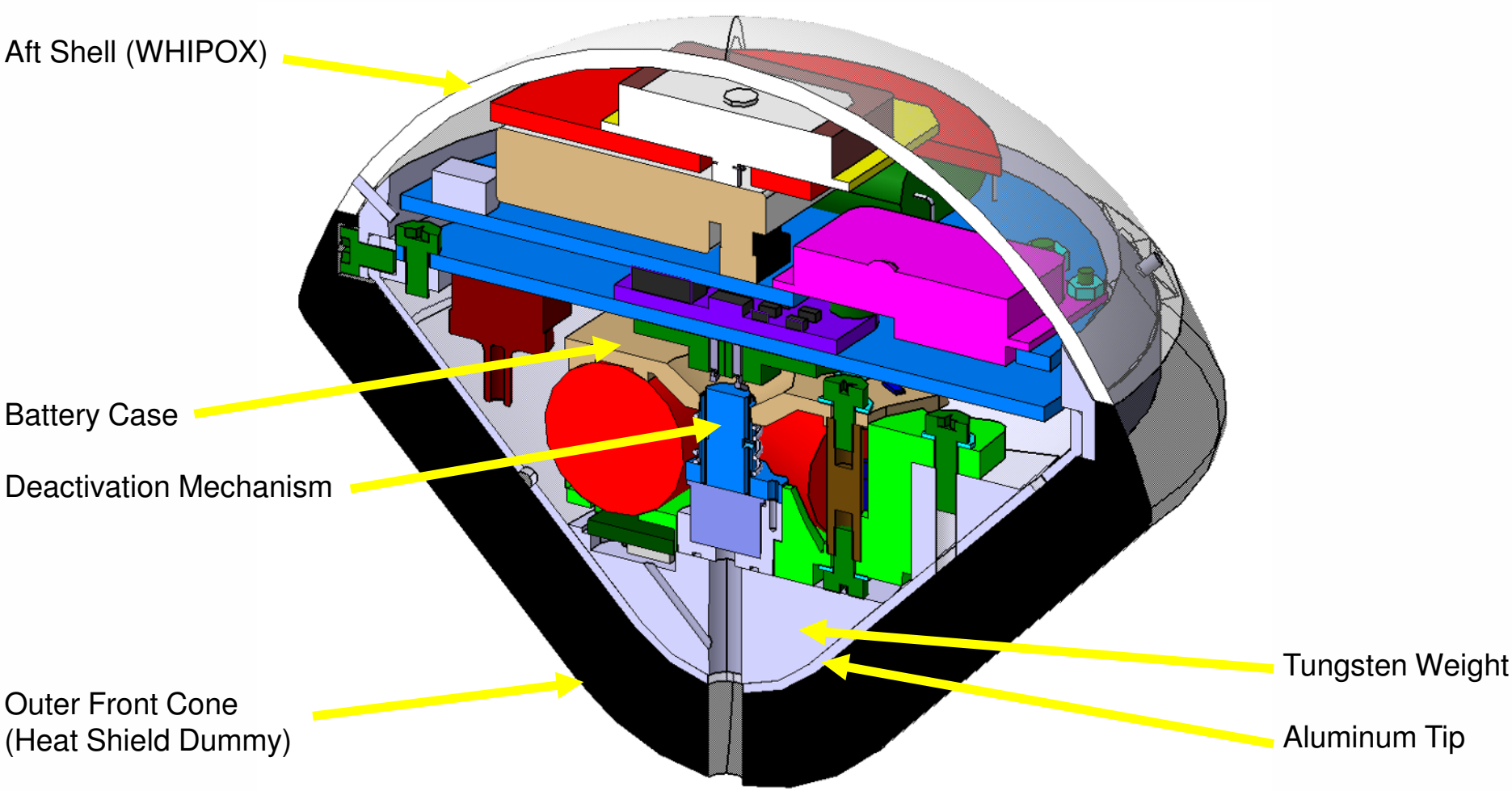


- Cameras operational, recording starts
- Data collection starts (Capsule/Mirror System)
- Ejection at apogee

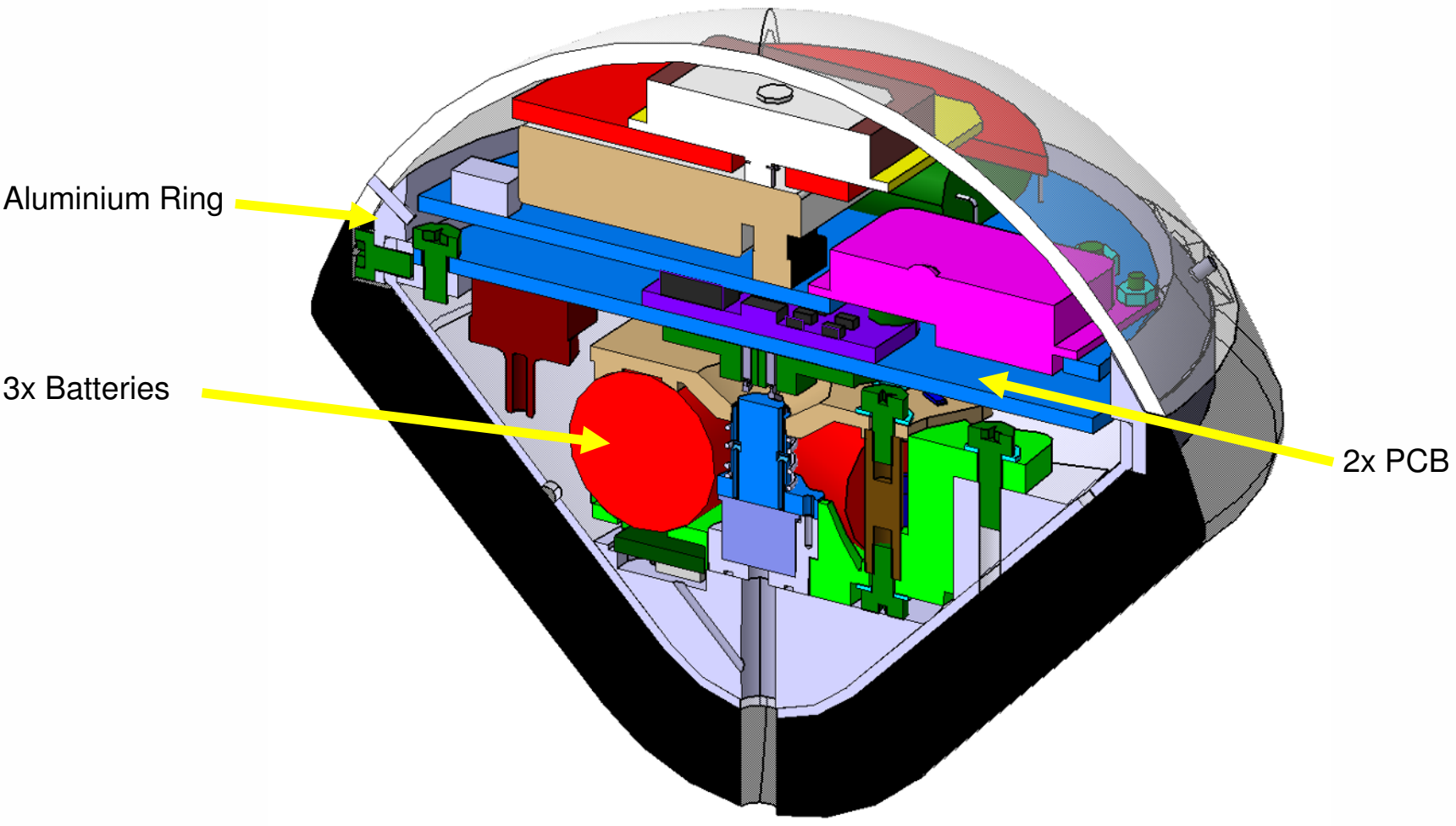
Capsule MIRKA2-RX



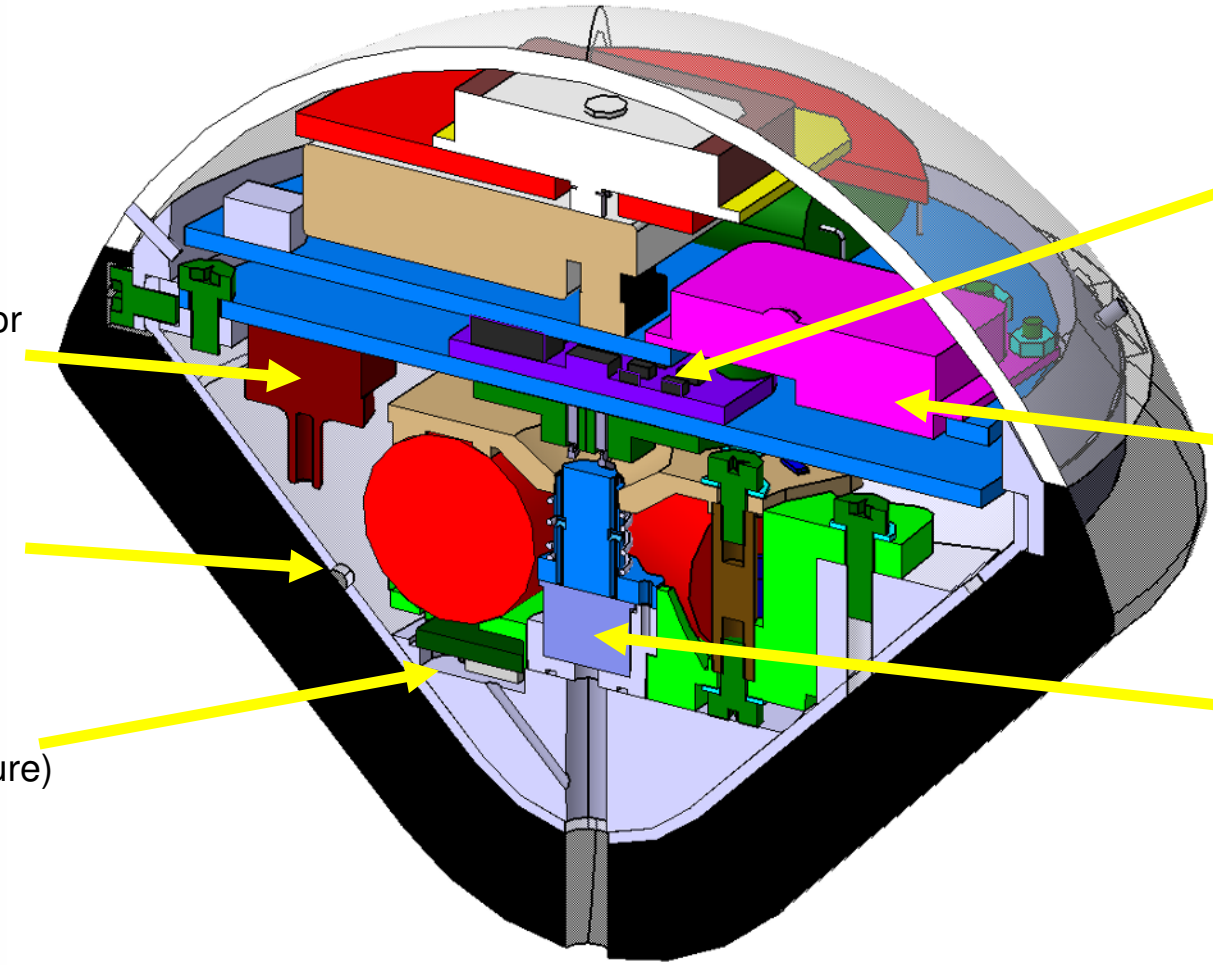
Capsule MIRKA2-RX



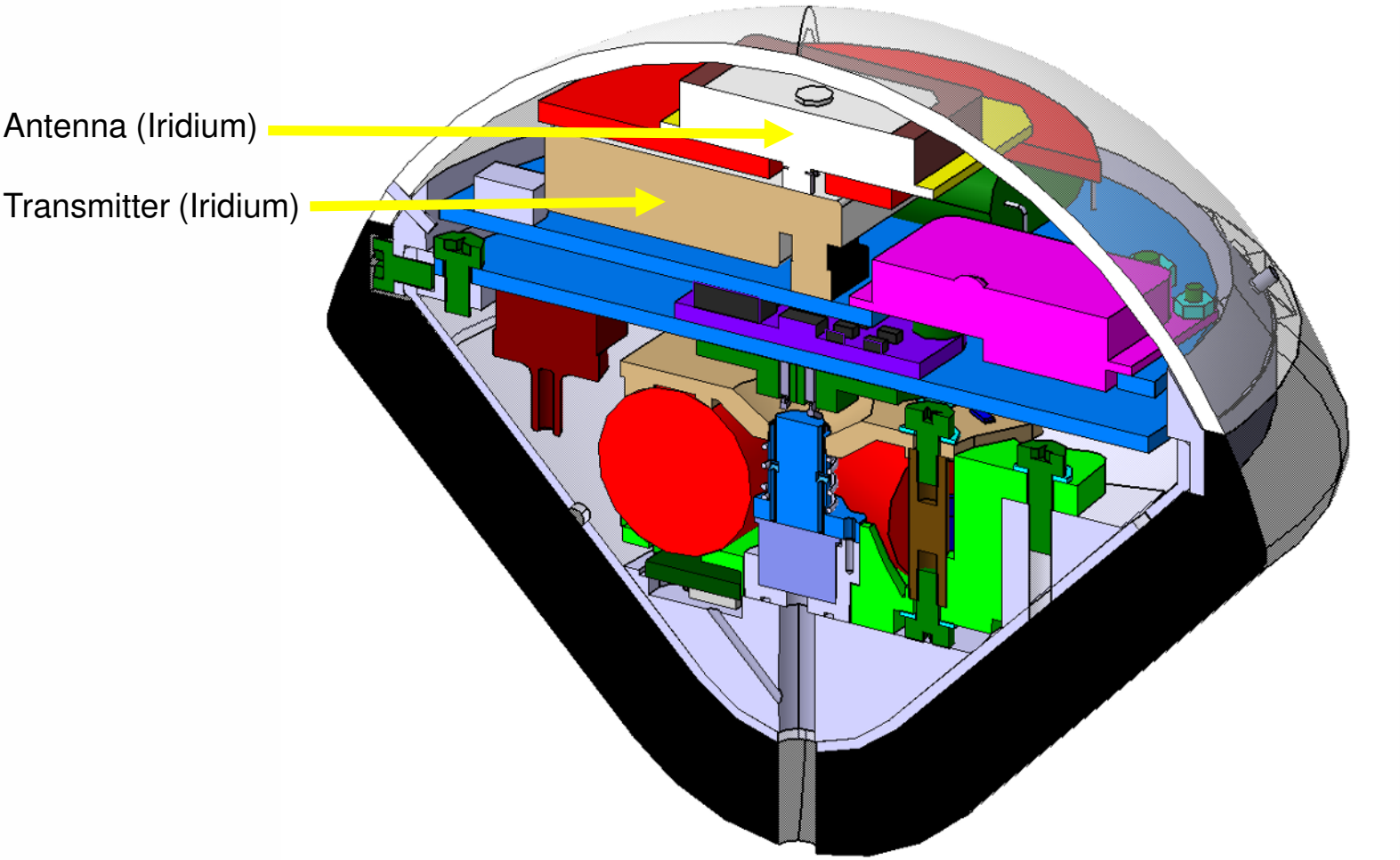
Capsule MIRKA2-RX



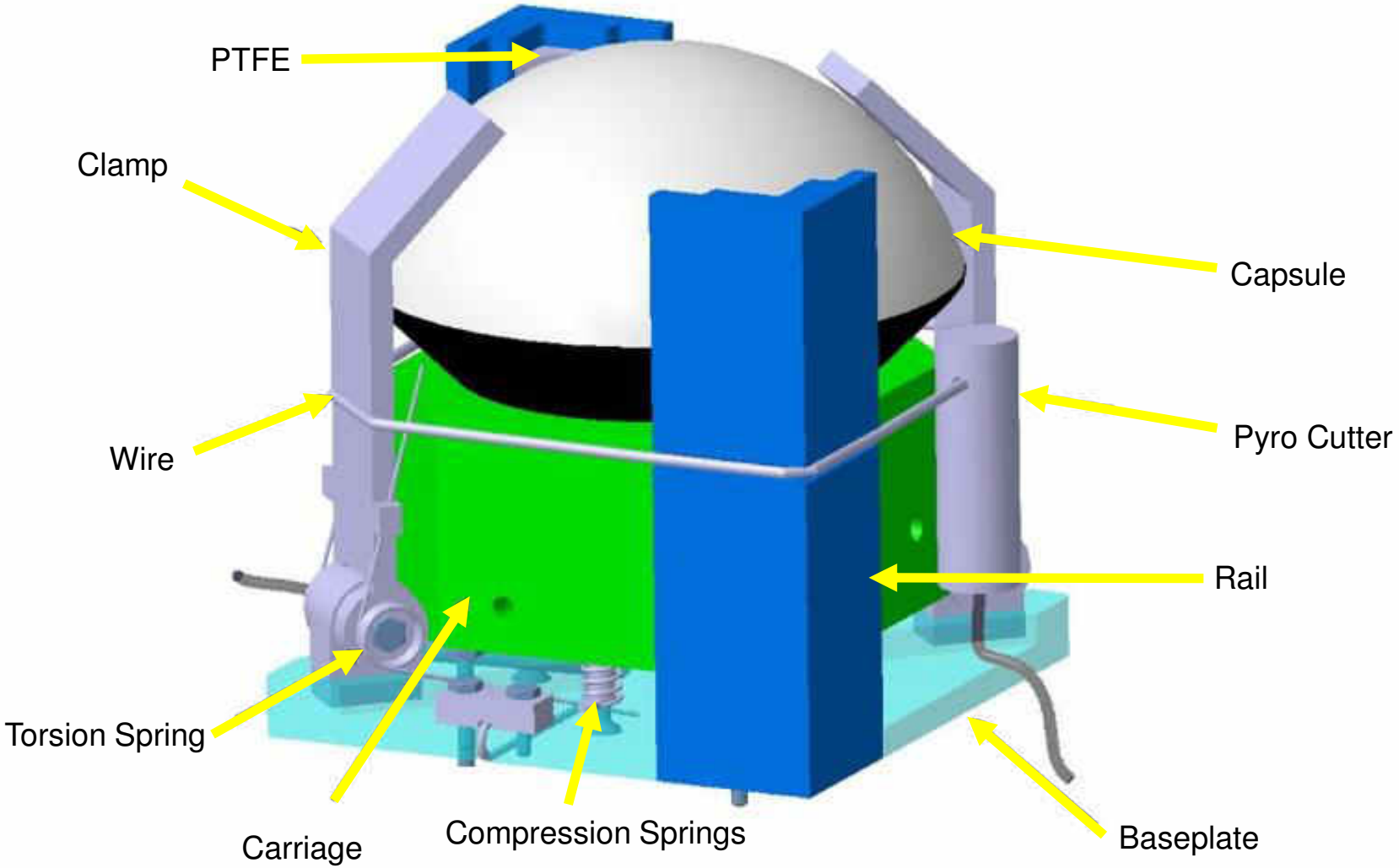
Capsule MIRKA2-RX



Capsule MIRKA2-RX



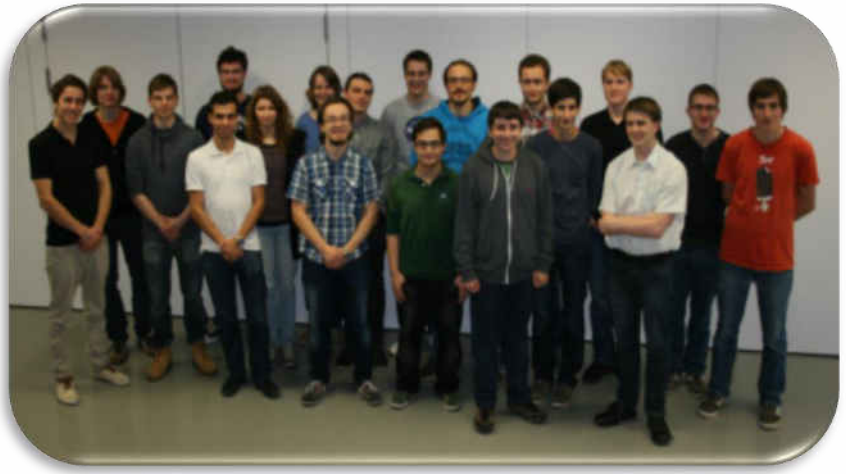
LOTUS
Low Orbit Technical Unit Separator



Separation Test

Conclusion

- Development of the following subsystems of CAPE:
  - Capsule MIRKA2: electronics, communication, software, structure
  - Separation Mechanism LOTUS
- Measurement of the flight stability and the stagnation pressure to improve simulations
- Opportunities for students
  - Application of knowledge
  - Improvment of project managemnt skills
  - Better understanding of space systems



Team (2014)

Outlook

- Analyzation of the experimental data
- Improvement of the performance of the capsule and the Separation Mechanism and further experiments to rise the TRL
- Designing, building and testing of the Service and De-Orbit Module

Thank you for your attention!

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References

[1] M. Ehresmann, A. Behnke, J.-P. Baumann, J. Franz, D. Galla, B. Gäßler, F. Grabi, F. Hießl, M. Koller, G. Kuhn, N. Müller, R. Müller, A. Papanikoloau, J. Rieser, V. Schöneich, H. Seiler, M. Siedorf, V. Starlinger, A. Stier, A. Tabelander, F. Vardar, S. Wizemann, A. S. Pagan, G. Herdrich, and R. Laufer: *CubSat-sized Re-entry Capsule MIRKA2.* 10th IAA Symposium on Small Satellites for Earth Observation, Berlin, 2015

[2] A.S. Pagan, G. Herdrich, R. Laufer, and the KSat Team: *CubeSat Atmospheric Probe for Education (CAPE)*. 10th IAA Symposium on Small Satellites for Earth Observation, Berlin, 2015.

[3] G. Herdrich, R. Laufer, A. S. Pagan, et al: *Planetary Probe Design Workshop: Collaborative Hands-On Small Satellite Training for Engineering Students*, 10th IAA Symposium on Small Satellites for Earth Observation, Berlin, 2015

[4] V. Schöneich, F.Grabi, H.Seiler, J.-P. Baumann, A. Behnke, M. Ehresmann, J. Franz, D. Galla, M. Koller, J. Rieser, M. Siedorf, R. Tietz, A.S. Pagan, G Herdrich, and R. Laufer: *A Service and Deorbit Module for CubeSat Applications*. 10th IAA Symposium on Small Satellites for Earth Observation, Berlin, 2015

[5] A. Sidor, R. Braun, and D. DePasquale: *RED-Data2 Commercial Reentry Recorder: Size Reduction and Improved Electronics Design.* AIAA Atmospheric Flight Mechanics Conference, 2014 [Online] http://www.ssdl.gatech.edu/papers/conferencePapers/AIAA-2014-1231.pdf (accessed November 2015)

[6] J.-P. Baumann, A. Pagan, and G. Herdrich: *Aerothermodynamik re-entry analaysis of the cubesat-sized entry vehicle MIRKA2*

[7] J. Göhring, S. Hackemann, and B. Kanka: *Whipox®: Ein faserverstärkter oxidkeramischer Werkstoff für Hochtemperatur- Langzeitanwendungen. Mat.-wiss. U. Werkstofftech. (2007), 38: 766-772.doi: 10.1002/mawe.200700191*

[8] LOCOSYS Technology Inc.: GPS_LS20031_datasheet_v1.3. Available online at: http://www.locosystech.com/product.php?zln=en&id=20# (accessed November 2015)

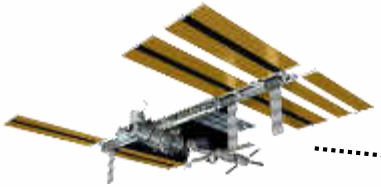
[10] Quake Global, Inc.: Quake Q9602 datasheet. Available online at: http://www.m2mconnectivity.com.au/sites/default/files/brochures/9602_Marketing_Datasheet.pdf (accessed November 2015)

References

[11] Arduino, LCC: Arduino Nano Data Sheet. Available online at: https://www.arduino.cc/en/uploads/Main/ArduinoNanoManual23.pdf (accessed November 2015)
[12] Arduino, LCC: Arduino Mega Documentation. Available online at: https://www.arduino.cc/en/Main/ArduinoBoardMega2560#documentation (accessed November 2015)
[13] S. Lee: The CubSat Program: *CubeSat Design Specification.* California Polytechnic State University, San Luis Obispo, CA 93407, USA. Technical note - Revision 13 (2014)

APPENDIX

CAPE Mission Scenario



1 Deployment
e.g. from ISS

2 De-orbit

- De-orbit down to separation altitude
- Atmospheric measurements
- PPT demonstration

3 Separation
at approx. 150 km altitude

4 Re-entry of the capsule

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

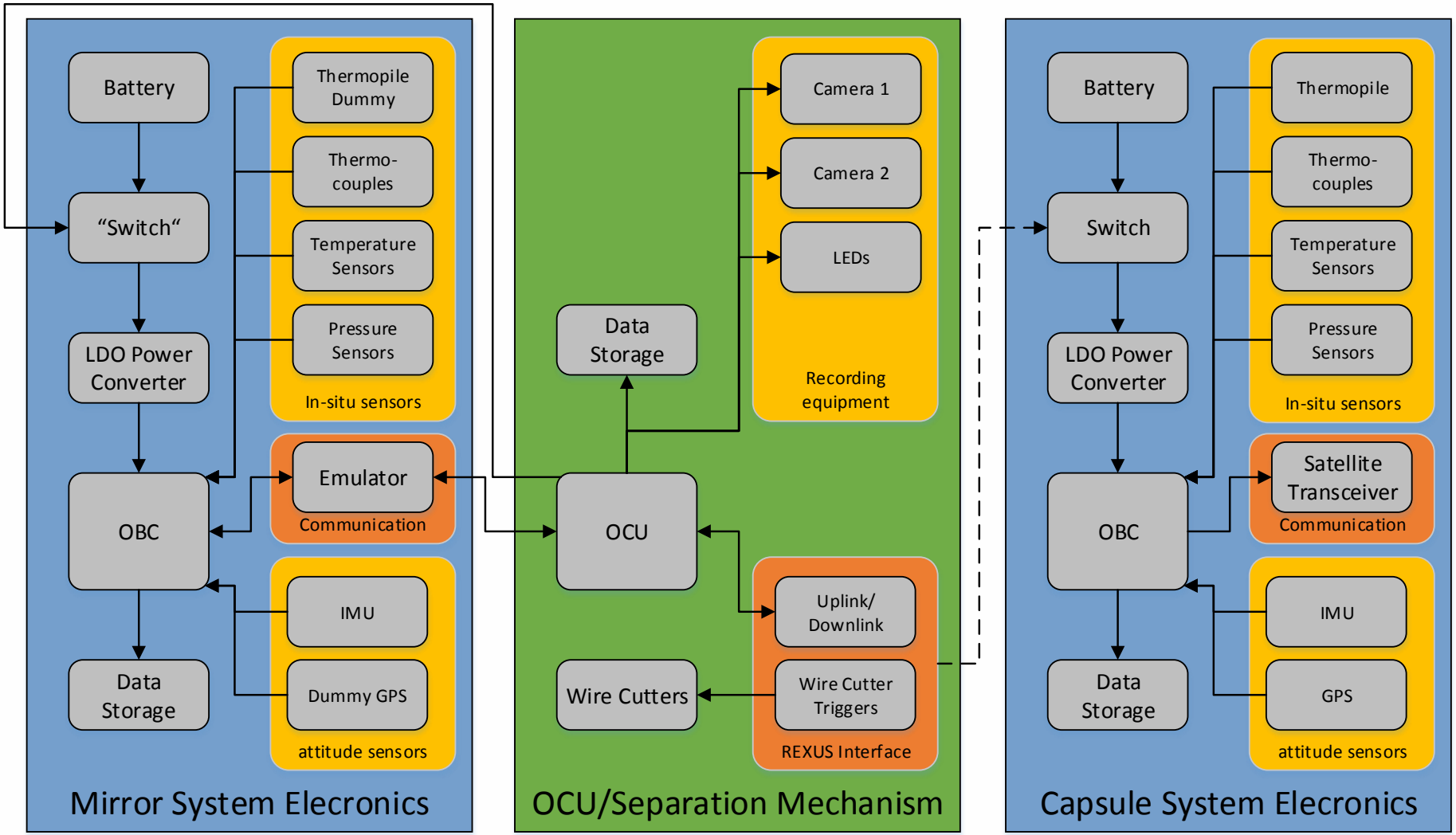
6 Demise of SDM, impact of capsule

Potential for monitoring of break-up and demise

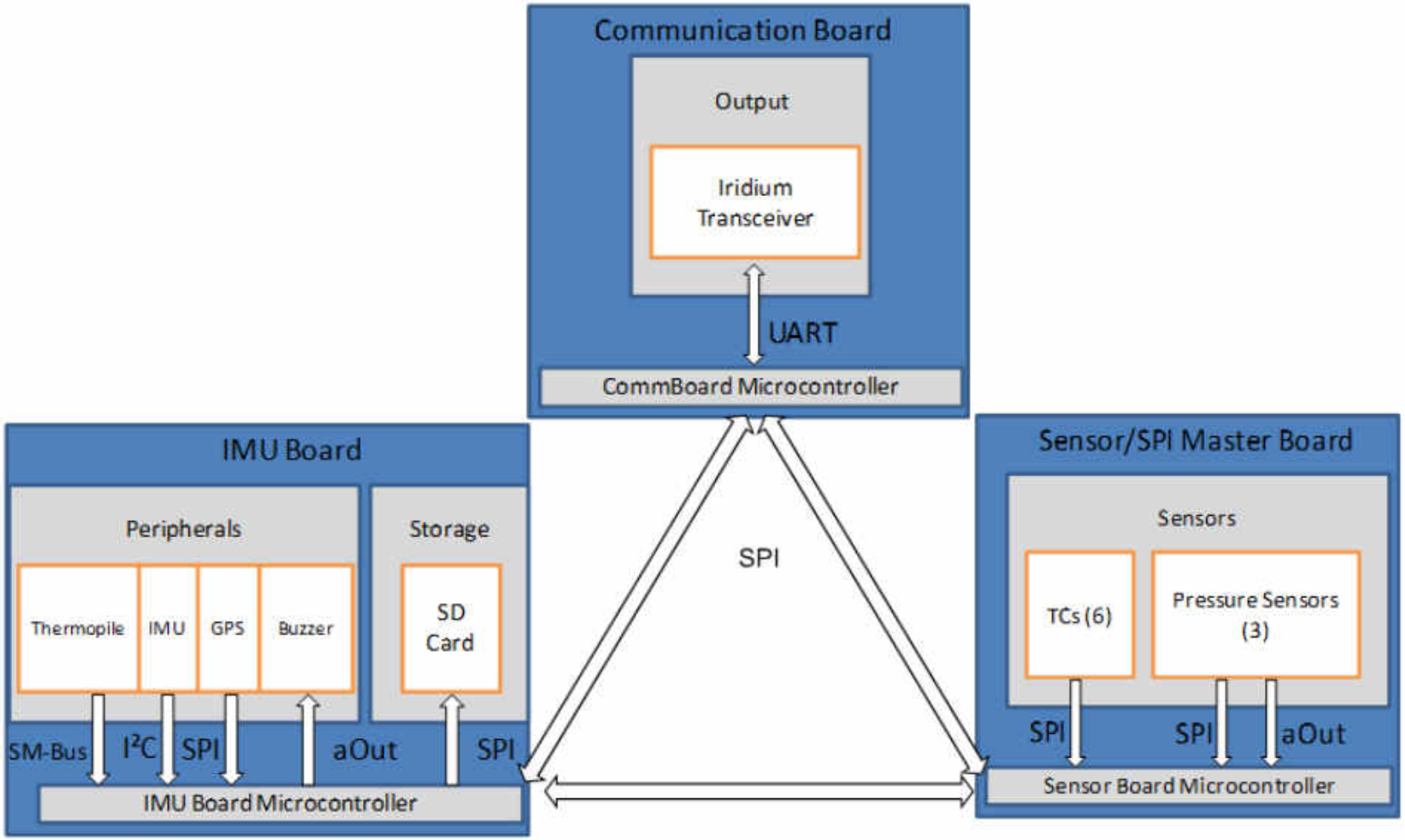
5 Transfer of re-entry data via satellite

Transmission of data through Iridium communication system

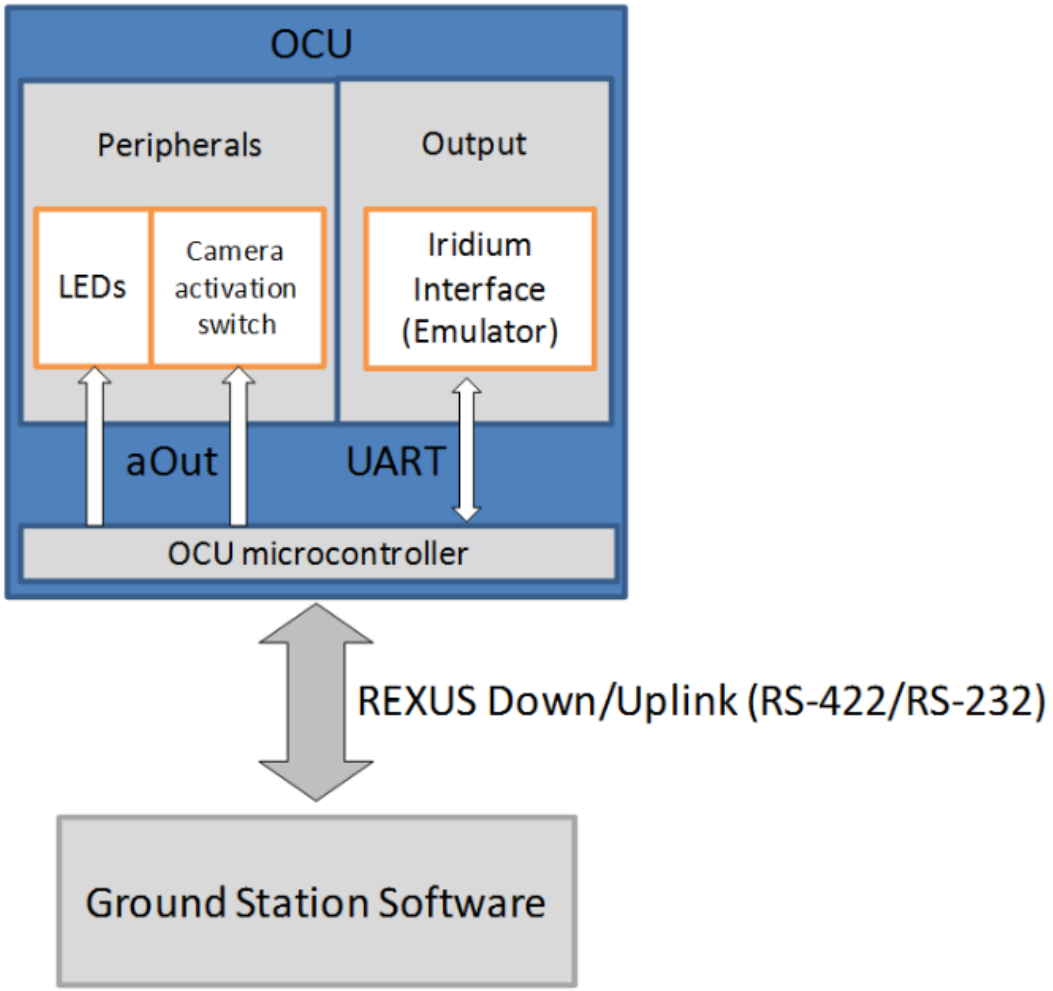
Electronic Design



On-Board Computer

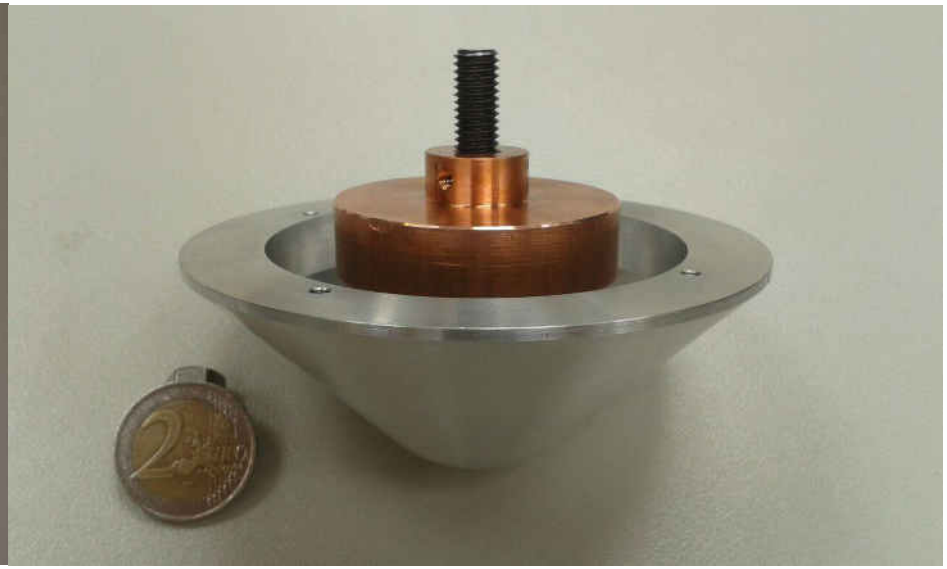


On-Board Control Unit



Qualification Tests

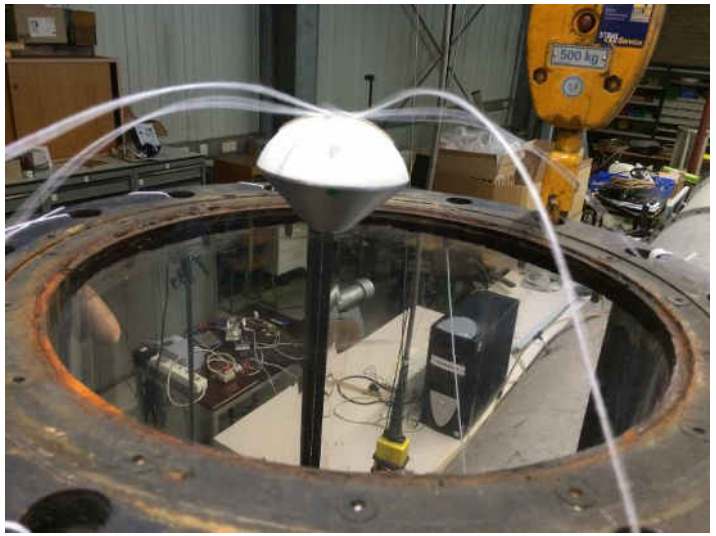
- Mock-Up capsule with adjustable center of mass to analyze the flight stability of the different configurations



Qualification Tests

- Drop test from a crane with a height of 20m

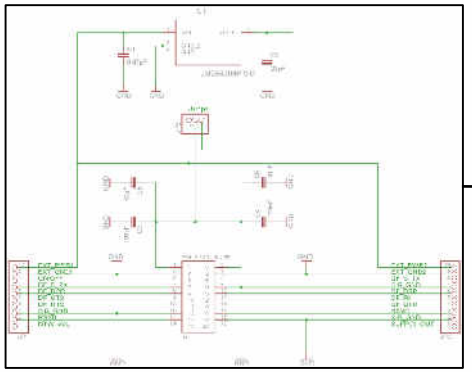
- Vertical Wind tunnel test



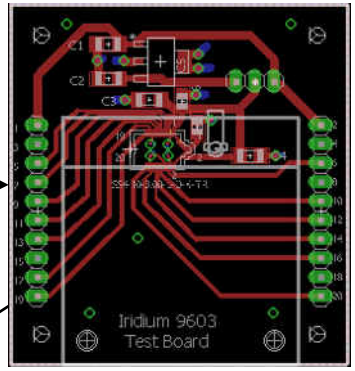
Qualification Tests

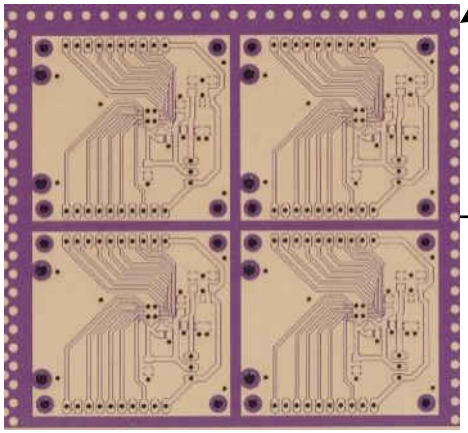
- Iridium test board

Schematics

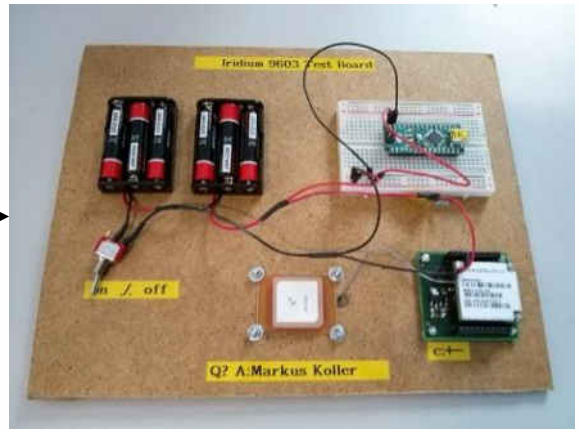


Board layout





Production



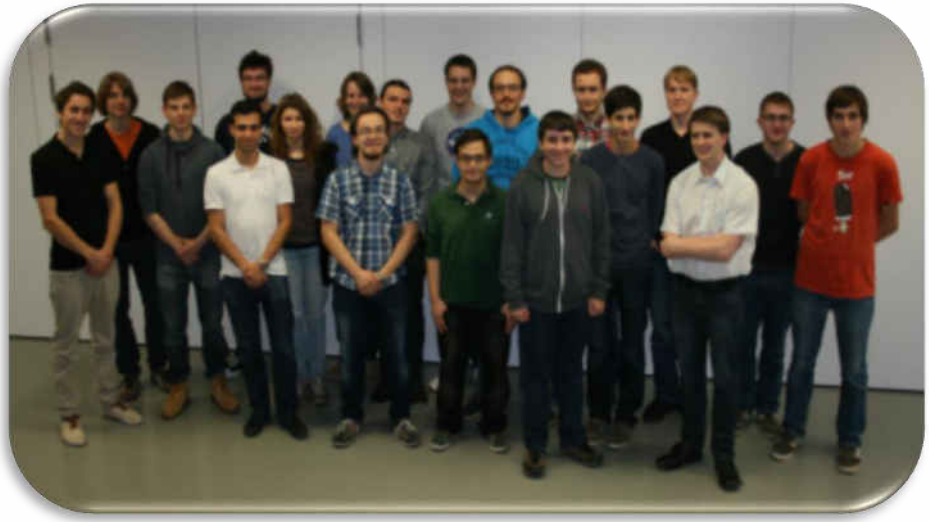
Testing

Small Satellite Student Group University of Stuttgart

nonprofit student association for education and development within space engineering

Founded: 08.04.2014
Members: 25+

Objectives:
Participation in space projects, collect practical experience, interface industry & research



Team (2014)