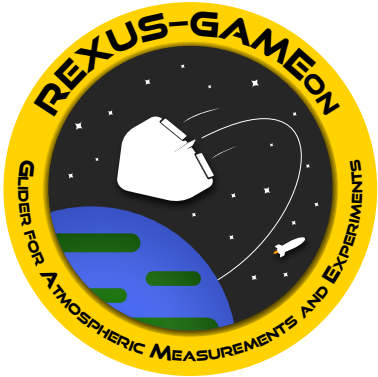


REXUS 32 GAMEON

Per Kopfsprung ins All: Glider for Atmospheric Measurements and Experiments

Overview

Overview

RX25 GAME

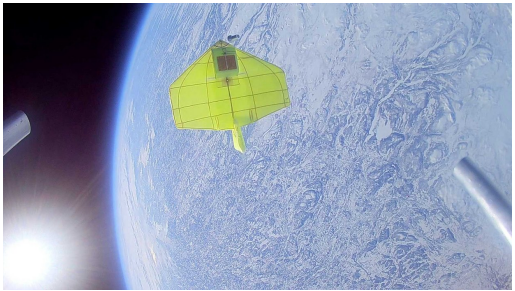


Figure: Ejection of RX25 GAME

- 3rd Rexus / Bexus mission at EAH Jena
- successfully developed a microglider platform and launched 2019
- Problem: not recovered, Depron foam melted

Experiment objectives

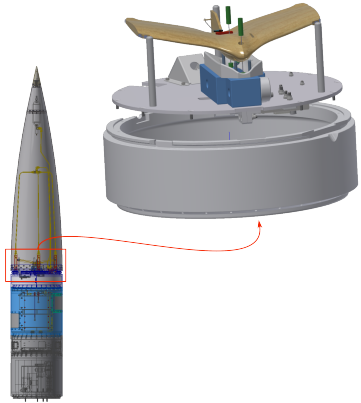


Figure: GAMEon module inside RX32

- Transport a glider with a sounding rocket to near space altitude
- Eject the Free Gliding Unit (FGU) from the REXUS rocket
- Transition from high speed vacuum ambient conditions to stable flight
- Establish radio transmission between glider and collect flight data
- Autonomous controlled flight towards a target coordinate
- Measure heading based on sun azimuth using photodiodes

Overview

Developed platform (Mechanics)

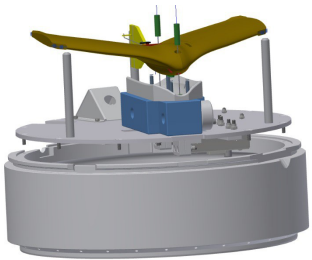
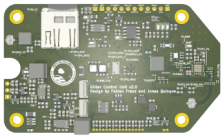


Figure: Module, consisting of Rocket Mounted Unit (RMU) and Free Gliding Unit (FGU)

- RMU: Ejection mechanism from RX25 GAME, new camera, new electronics (RCU)
- FGU mounted with steel wires and spring mechanism and ejected via pyro cutters
- Developed FGU made of balsa wood, weight 143 g, wingspan 262 mm

Developed platform (Electronics) [1/3]



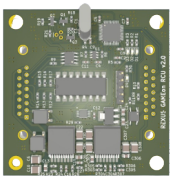
Glider Control Unit

- Electronics of the glider with microcontroller, sensors and antenna

UART

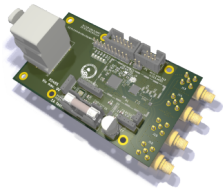
Rocket Control Unit

- Communication interface between rocket and GCU (while glider is onboard)
- Electrical interface between rocket and GCU



LoRa@886 MHz

MORABA TM (RF Link @S-band)



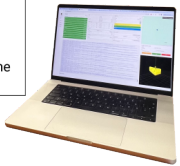
Groundstation Interface

- Communication interface between GCU and software ground station

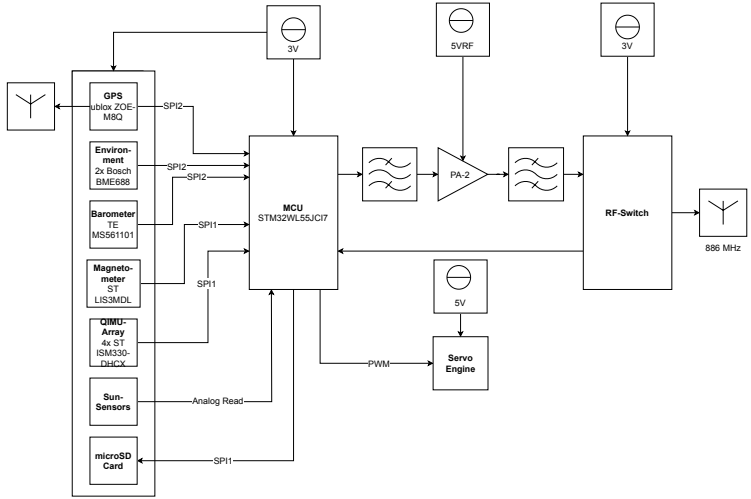
RS485/ Ethernet

Software Groundstation

- "Command station" for displaying (&save) all incoming information of the experiment



Developed platform (Electronics) [2/3]



Developed platform (Electronics) [3/3]

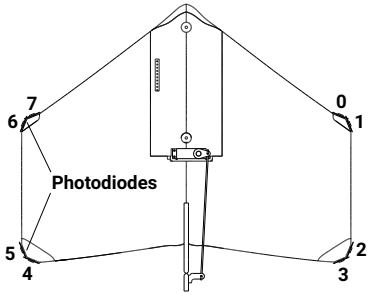


Figure: Photodiode orientation on glider

- Autonomous flight based on GPS coordinates + IMU or Sun Angle + IMU
- Generated current of 8 photodiodes, converted to voltage, filtered and amplified
- Based on known characteristics of the photodiodes, a resulting sun-angle can be calculated
- With known time and location: heading can be calculated

Overview

Ejection and rocket start

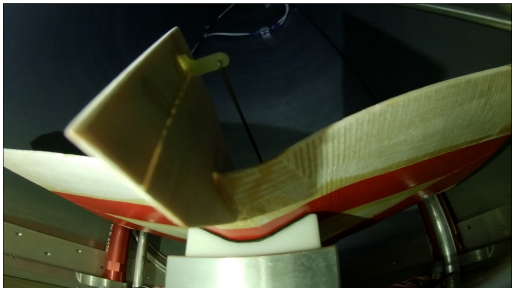
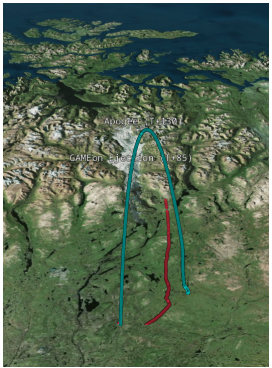


Figure: Glider inside RX32 nosecone

Figure: Ejected glider next to RX32 nosecone and motor

Glider trajectory and flight phases [1/2]



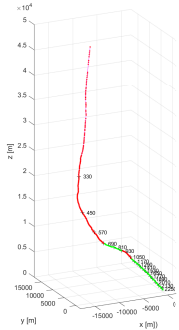


Figure: 3D path of the glider/RX32 calculated from GPS data

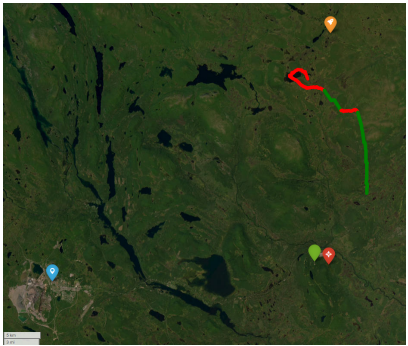


Figure: 2D path

Glider trajectory and flight phases [2/2]

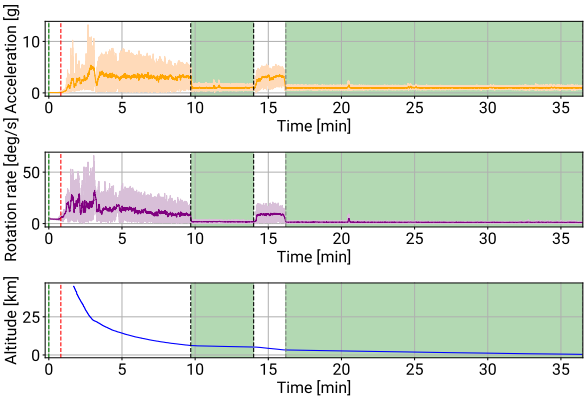


Figure: Total absolute acceleration and angular velocity over time and altitude with marked flight phases: ejection, apogee, between stable flight phase 1 and stable flight phase 2.

Heading calculated from photodiode data

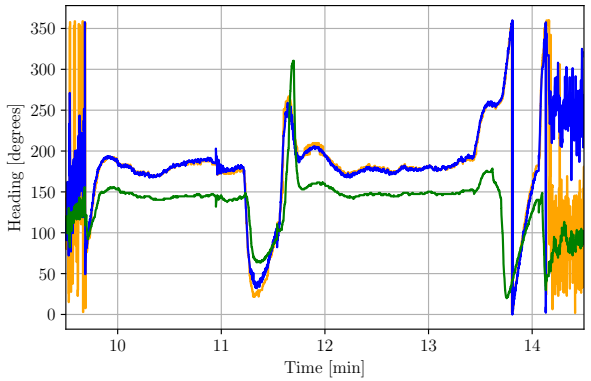


Figure: Comparison of sun-heading, gps-heading and drift compensated yaw angle

- Comparison of calculated heading with GPS heading and yaw angle (drift compensated)
- Sun-heading of the glider deviates from the direction of movement (GPS-heading) by approx. 20-25 degrees - wind came from the west
- Conclusion: detecting the heading of a glider, using 8 photodiodes, is possible
- Future work: improve calculation and find out how many photodiodes are needed (on balloon missions)

Overall results of RX32 GAMEon

Figure: Recovered glider

- Glider was successfully ejected from RX32 rocket (65 km altitude, Apogee: 76 km)
- Went into spiral dive, went into stable, autonomously controlled flight at 6.2 km altitude
- Data was transmitted to GSI from ejection to landing
- Glider was recovered without any noticeable mechanical or electronical damage
- Concept of measuring the heading using photodiodes was proven

Thank you for your attention!