

# The AEROS Mission: From concept to future operations



## AEROS Consortium

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**AEROS Mission:** AEROS is a 3U CubeSat pathfinder toward a future ocean-observing constellation, which will operate in a 500 km Sun-Synchronous orbit, targeting the Portuguese Atlantic region. The AEROS payloads include the miniaturized high-resolution Hyperspectral camera, the software defined radio to process data from ARGOS and LoRa devices and the 5MP RGB camera. The team is also developing a Control Centre for both Ground Stations and the Data Analysis Centre.

## I. AEROS Mission Concept

AEROS mission objectives and requirements

- **Climate Change**
  - Monitoring the near surface ocean and meteorological conditions
  - Develop, integrate and test payloads for small satellite: Hyperspectral Camera (HYC); Software Defined Radio (SDR) for biologging technology ARGOS tags, LoRa WAN; and an RGB camera for scene context.
- **Oceanography**
  - Monitor water quality and oceanographic features such as upwelling regions and mesoscale eddies
  - Support monitoring of Marine Protected Areas (MPAs) and the distribution of marine megafauna (whales, sharks, etc.)
  - Ocean Color, Sea Surface Salinity, Color Dissolved Organic Matter, Ocean Current/Front Locations and Fauna Location
- **Academic Advancement**
  - Advance the scientific knowledge, promote the dissemination to the public and raise awareness to the space industry
- **Communication**
  - Develop and test a communication system compatible with ocean deployed sensors
- **Hardware & Software**
  - Modular and versatile satellite platform
- **Big Data Analysis**
  - Data processing algorithms to gather, process and disseminate data in Data Analysis Center (DAC)

Figure 1: AEROS Spacecraft CAD Rendering

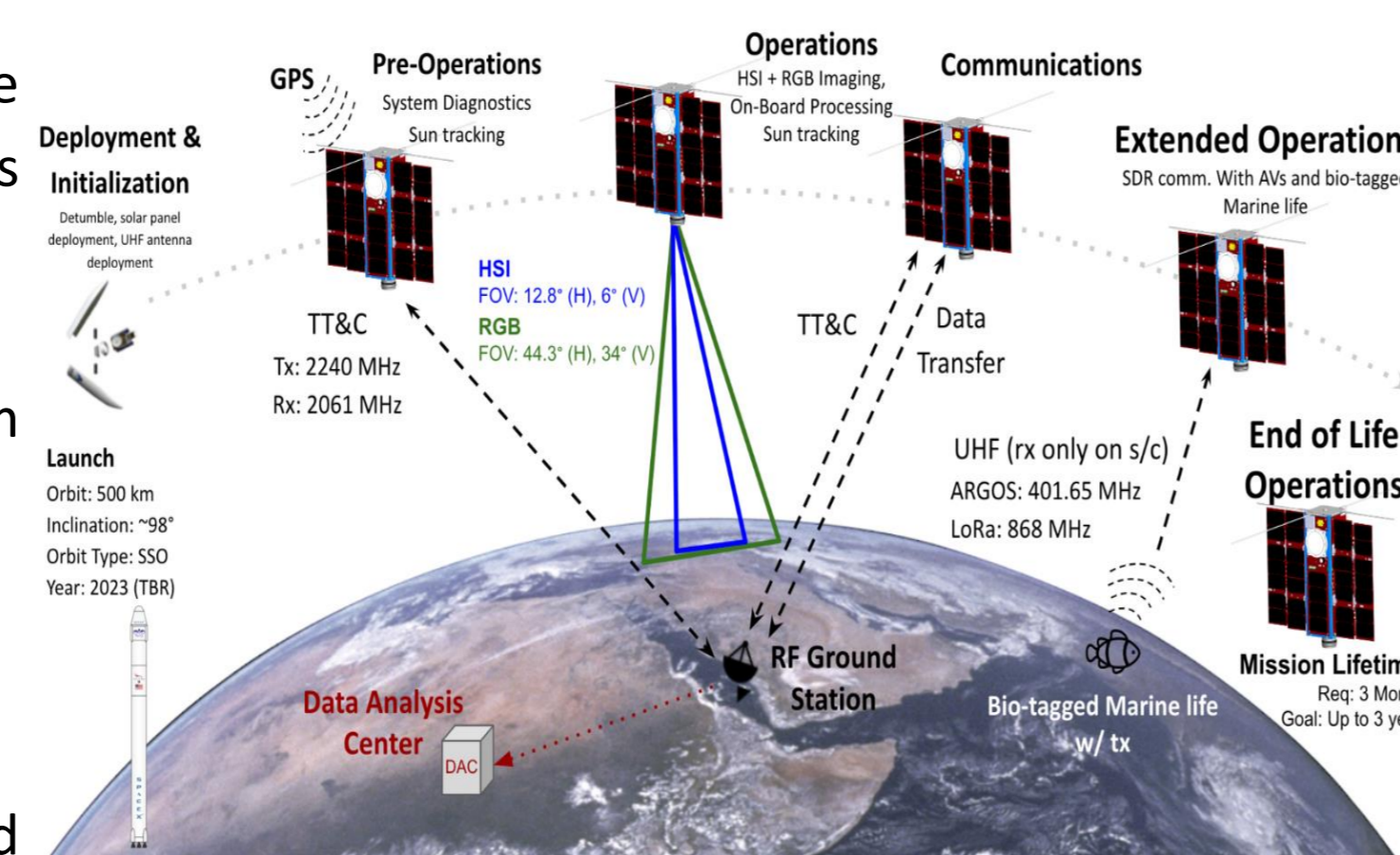
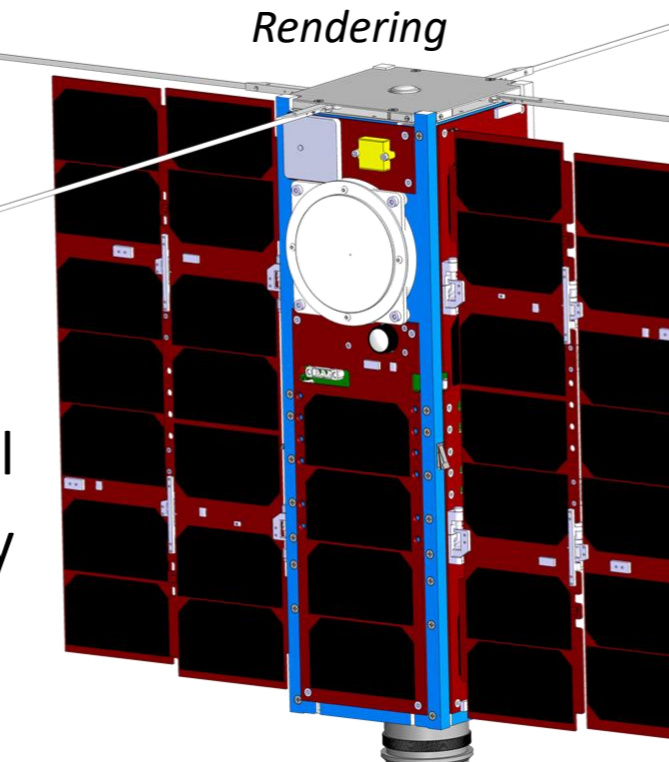


Figure 2: AEROS Concept of Operations

## II. Hardware

The images shown in Figure 3 capture the evolution of the AEROS scientific payloads to be compatible with the constraints of a 3U CubeSat. The images shown in Figure 4 relate to the Structural Design and Analysis. Procedures are being developed for Assembly and Integration and we have planned the Qualification. We have initiated the manufacturing of the structure.

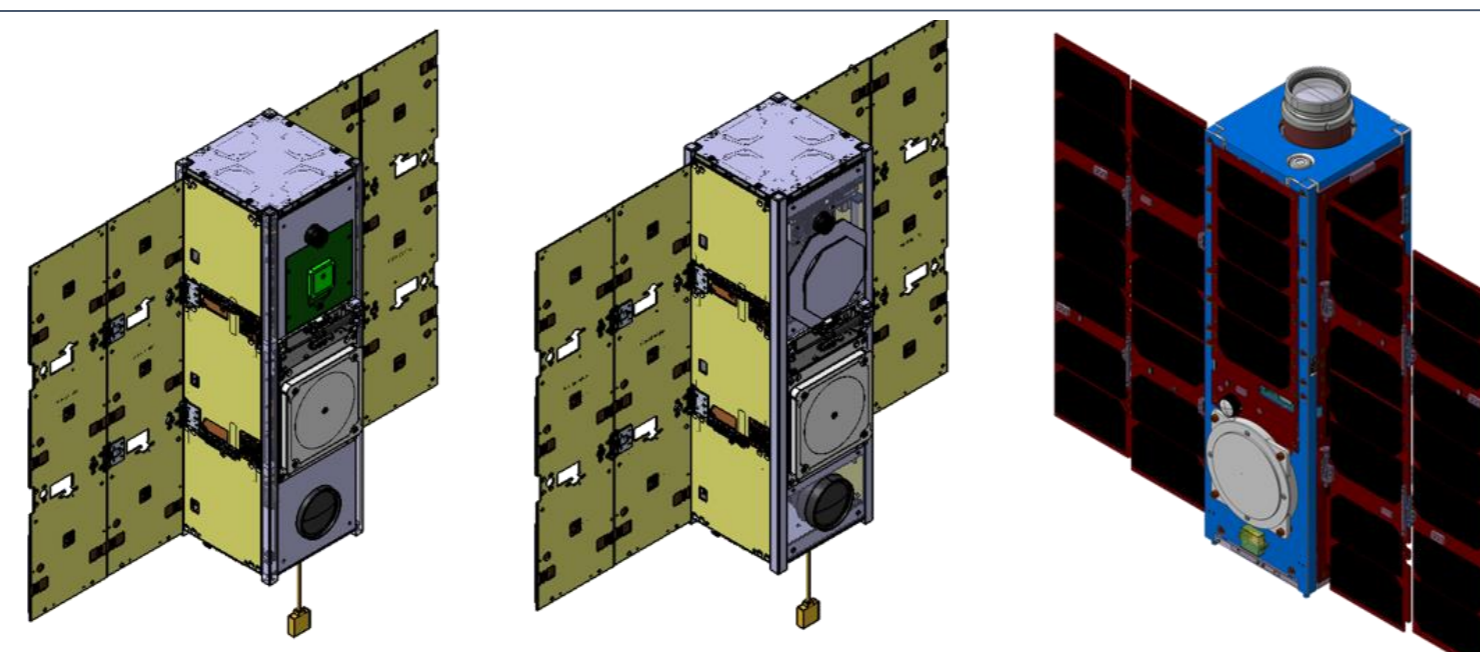


Figure 3: Design concepts and evolution

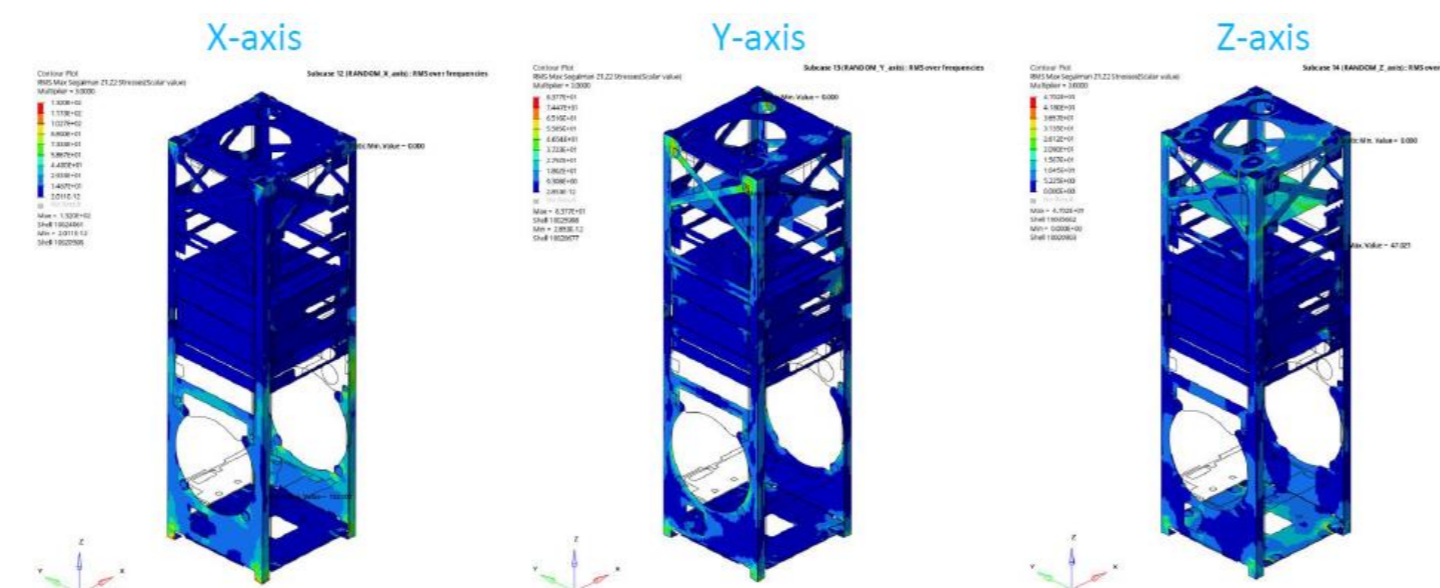


Figure 4: Structural Design

## III. Software

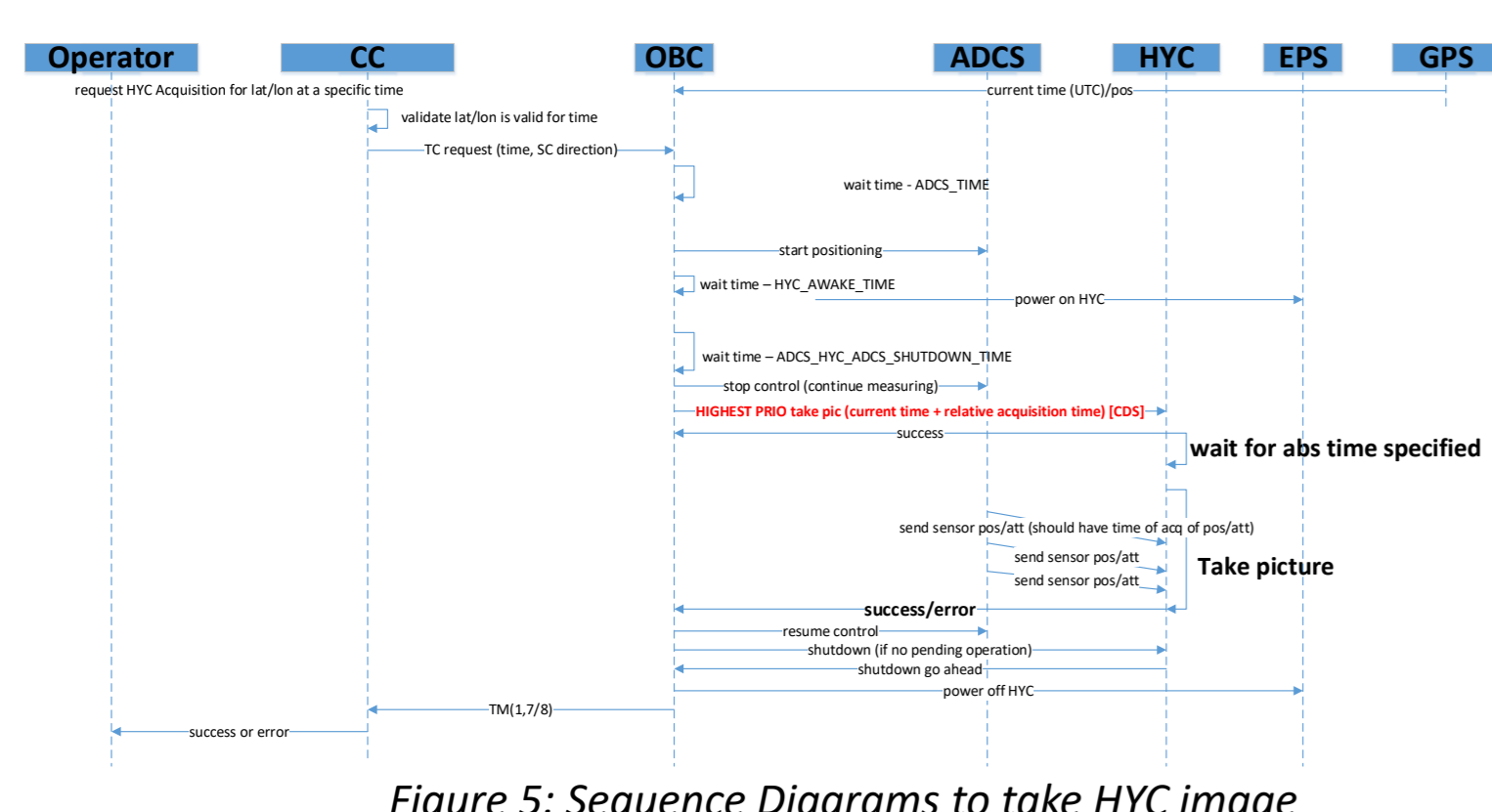


Figure 5: Sequence Diagrams to take HYC image

Static design components have been fixed and the detailed design stabilized, including all the interfaces between components. The internal protocols are being verified and developed. Figure 6 presents the internal architecture of the AEROS, including the component interfaces.

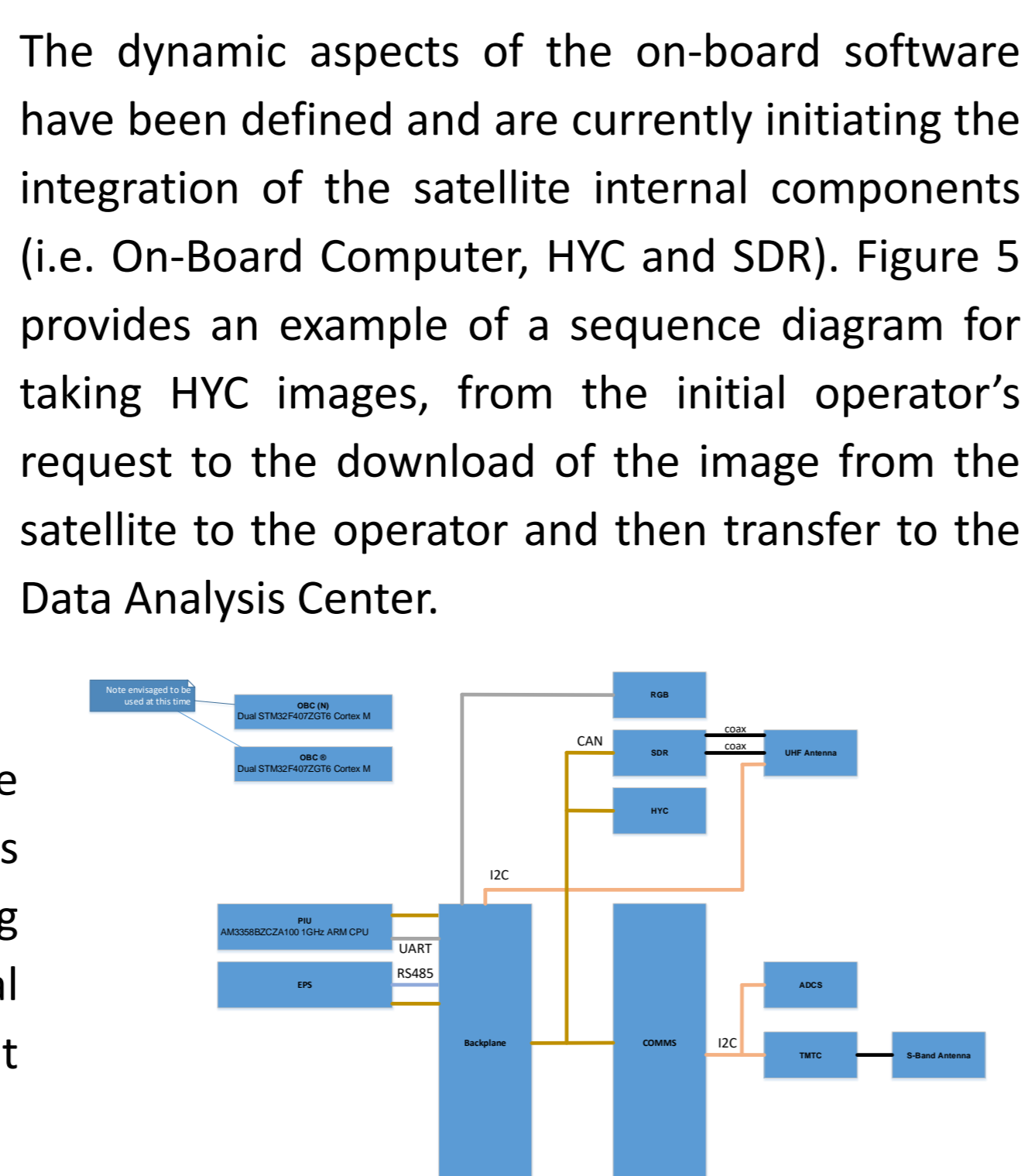


Figure 6: Design Components Diagram

## IV. Hyperspectral Camera & RGB Camera

AEROS' primary payload is a low-power (5W max), compact (70.8 x 70.8 x 105 mm<sup>3</sup>) hyperspectral imager. It uses a static spectral filter integrated on top of a CMOS detector to achieve 150 VIS/NIR measurement bands from 470 - 900 nm, each with 10 nm bandwidth. We have done the optical and mechanical design, Structural and Thermal Analysis, Vibration Testing, TVC Testing and Validation and Verification, as shown in Figures 7.

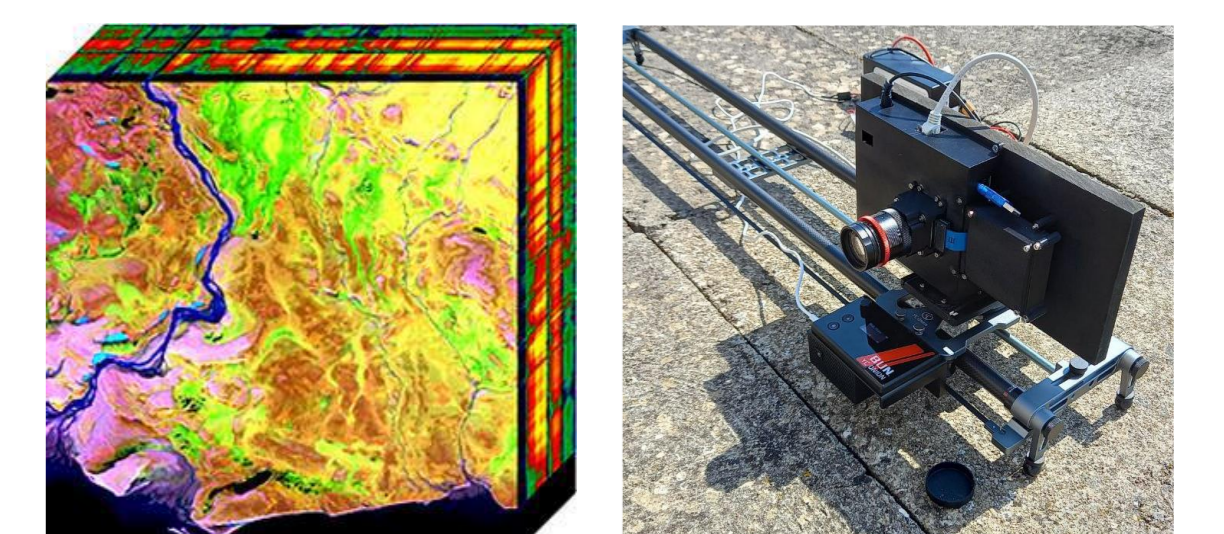


Figure 7: HYC hypercube (left) and test validation facility (right)

A RGB imager will provide contextual imagery of overlapping ground scenes for the HYC. A study was performed to select the correct Focal Length considering the region of interest (Figure 8). The 6mm Focal Length (green) was selected.

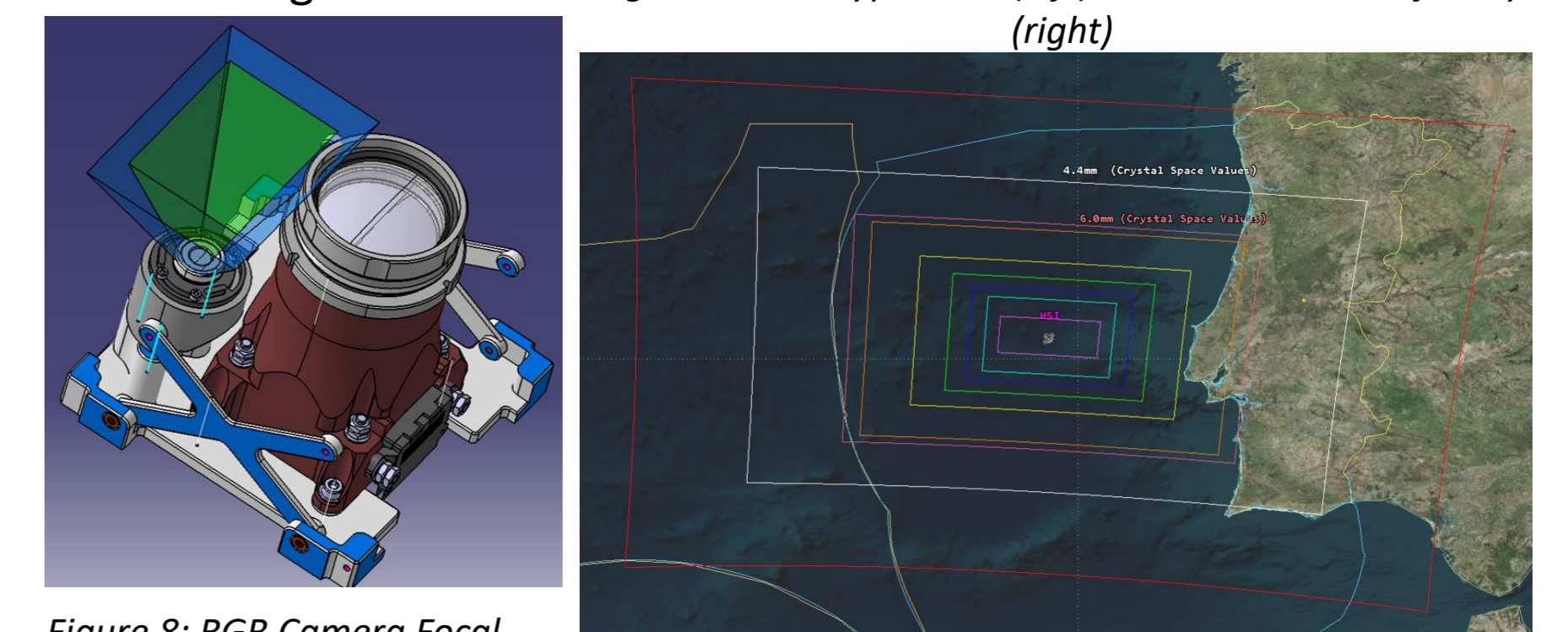


Figure 8: RGB Camera Focal Length selection (up and right)

## V. Software Defined Radio

AEROS hosts a software defined radio based on a Zynq-7000 system-on-a-chip that uses the GNU Radio software. The SDR supports the ARGOS protocol and the LoRa WAN implementation. Both implementations will allow AEROS' objectives to connect with autonomous vehicles and biologging tagged marine life (e.g., sharks and mantas). Figure 9 shows schematics of the SDR/ARGOS/LoRa Concept. Figure 10 shows the implementation for demodulating the ARGOS signal of a sample tag already present in the animals in the Azores seas. It includes several characteristics analysed in the development, the spectral analysis, phase modulation, bandwidth and signal spectrum (using two different technologies).

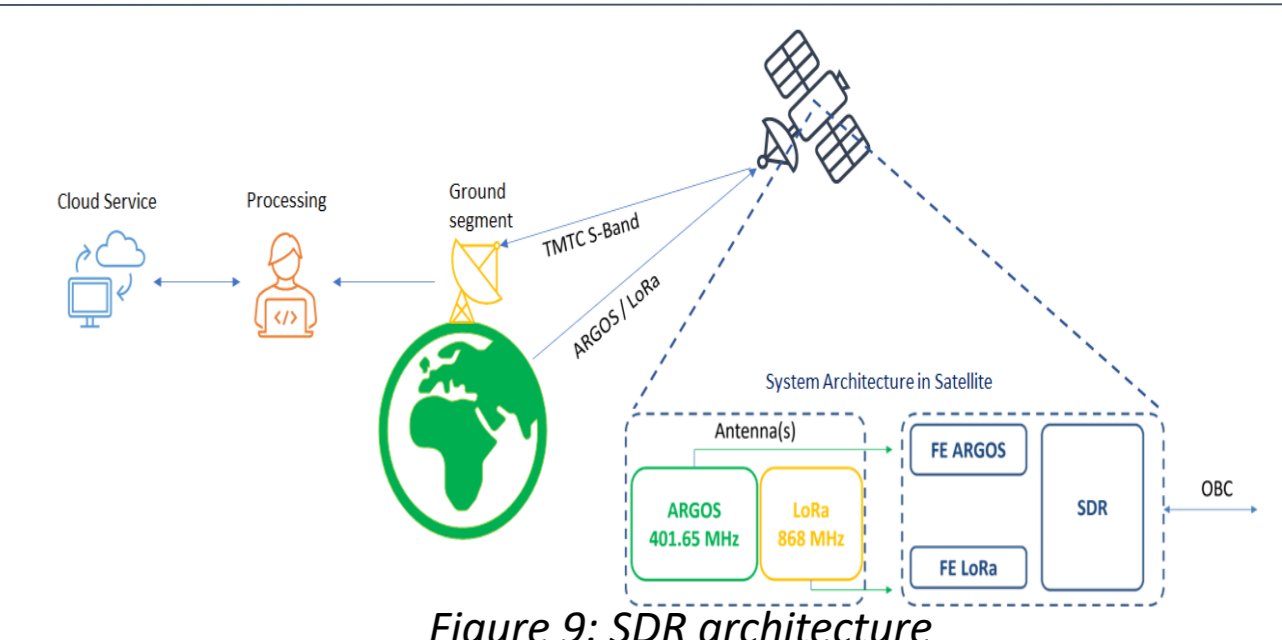


Figure 9: SDR architecture

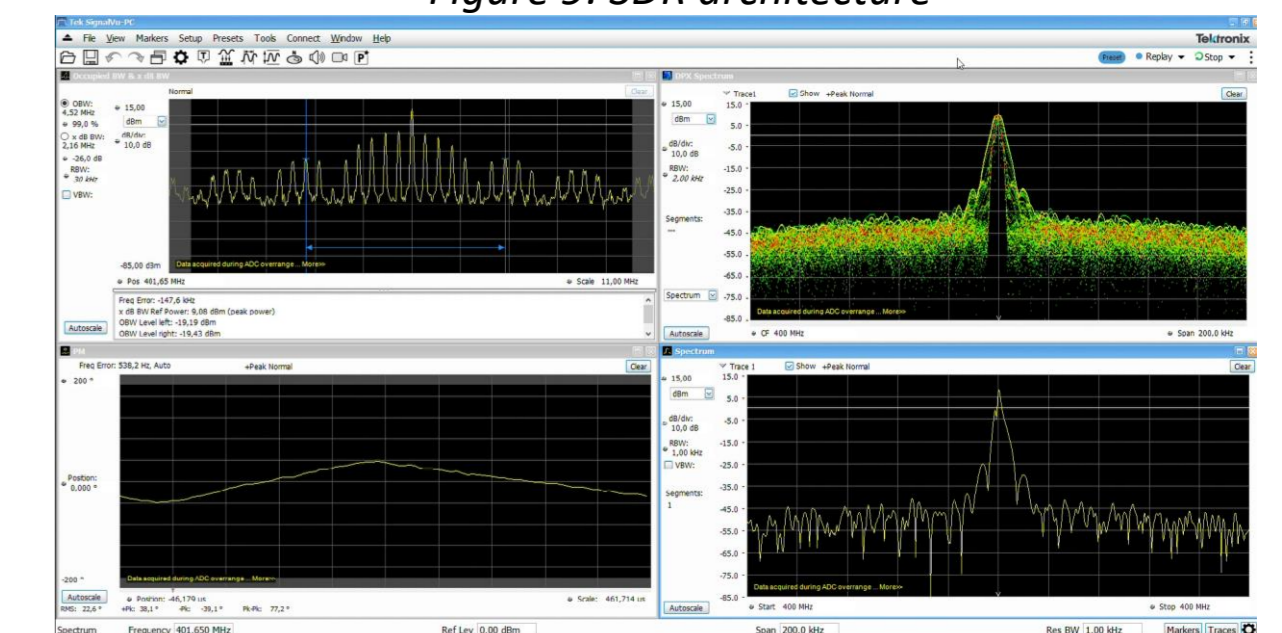


Figure 10: ARGOS signal demodulation

## VI. Command Center

The AEROS satellite will be controlled by two ground stations and a single Command Center (CC). The Command Center operator will be able to send Telecommands to the satellite and receive the telemetry from the satellite. The Packet Utilization Standard is being used in the development and formatting of the TC/TM messages. The communication is made using S-Band to both uplink and downlink with a frequency ~2GHz. The CC interfaces with the Data Analysis Centre to provide the information received from the satellite. Figure 11 shows a high level architecture of the CC connecting both ground stations.

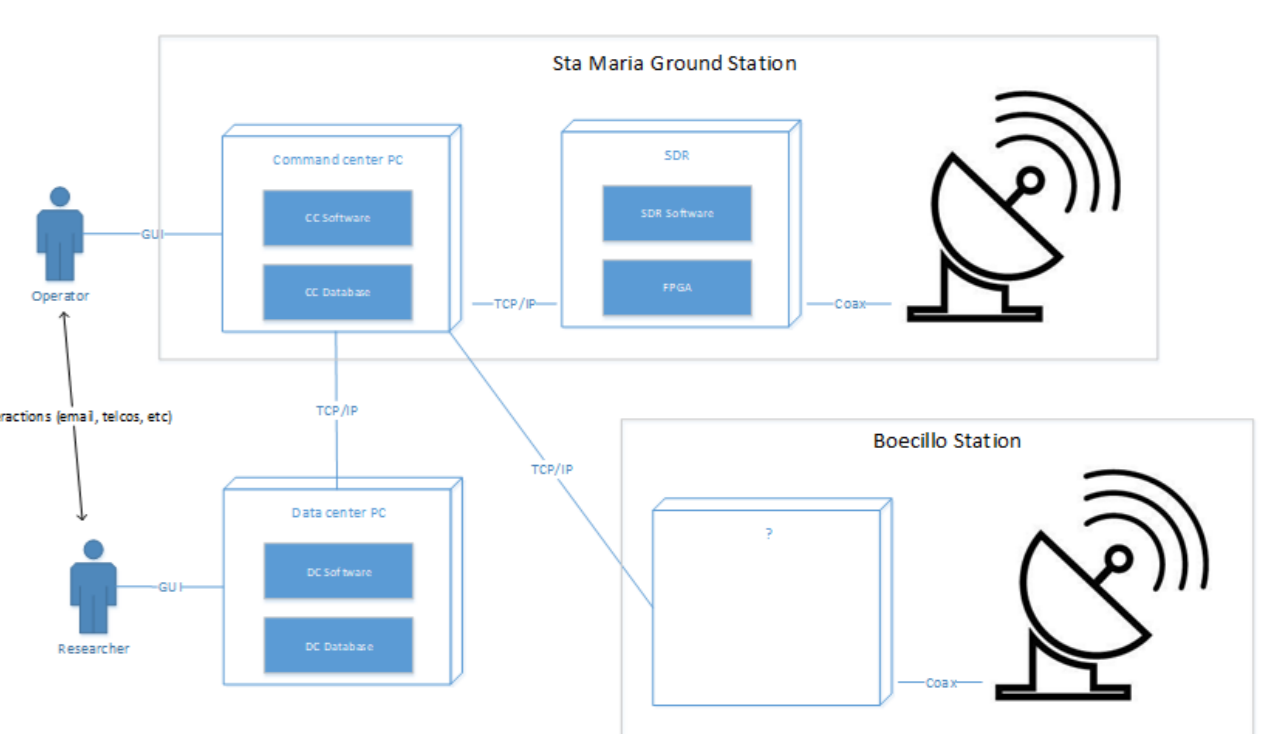


Figure 11: Command Center and Data Analysis Centre architecture

## VII. Data Analysis Centre

The Data Analysis Centre is being developed in a service-oriented architecture and microservices-based development. The objective is to receive information from both bus and payload data and provide products and services to the different customers and stakeholders, augmenting the data received with additional insights and value. The DAC will process the raw data received from the satellite. The data will be received from different data sources including the AEROS satellite. It is also the responsibility of the DAC to validate the data received. Figure 12 and 13 show the simplified architecture of the DAC and the mockup of the HMI of the DAC.

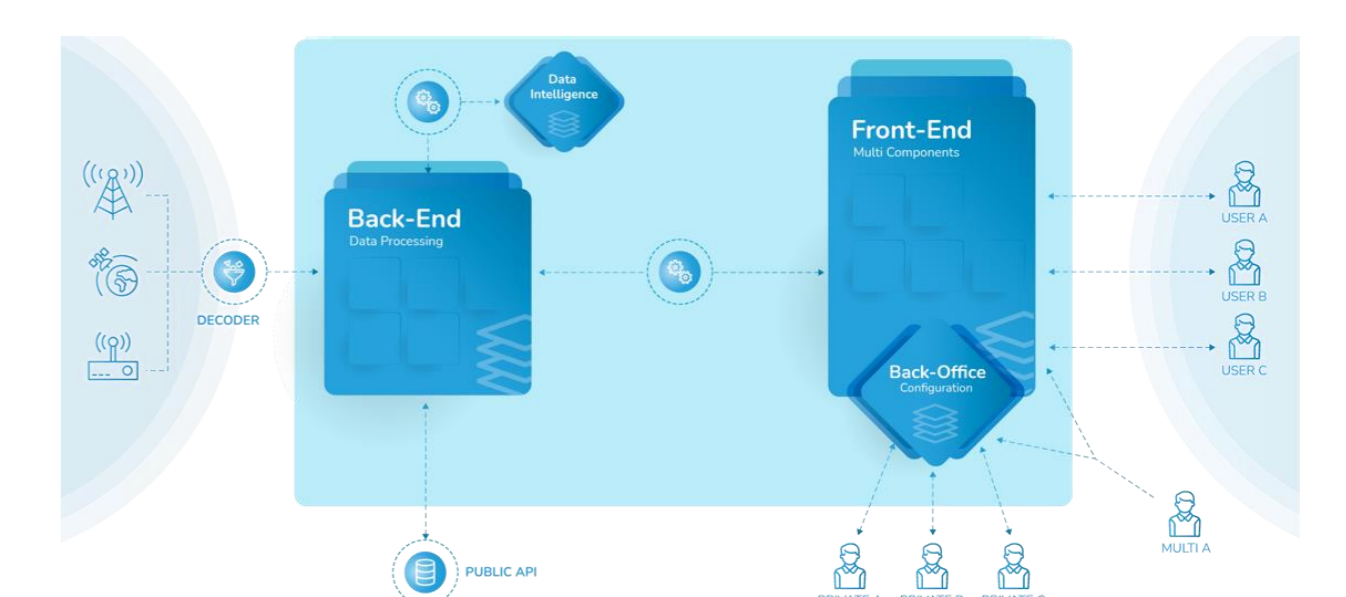


Figure 12: Command Center and Data Analysis Centre architecture

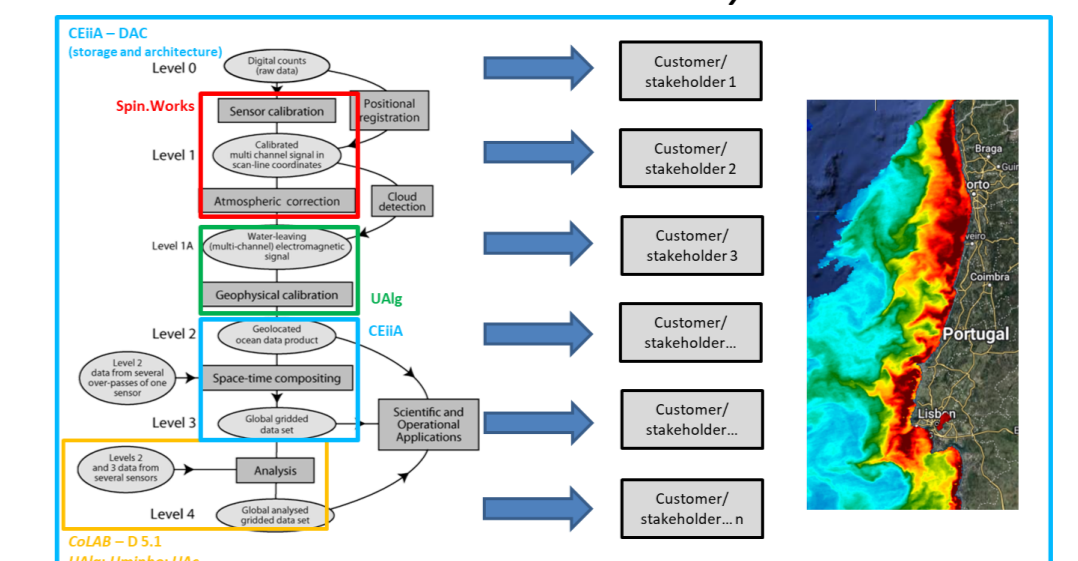


Figure 13: DAC HMI Mockup

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