

AEROS: Portuguese Cubesat for Ocean Monitoring (concept, testing and launch)

AEROS Consortium

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MIT Portugal 2023 Annual Conference

AEROS Mission: AEROS is a 3U scientific CubeSat, a precursor of a future ocean-observing constellation, that will operate a miniaturized high-resolution hyperspectral camera in the visible spectrum (470-900 nm), a Software Defined Radio for the ARGOS and LoRa protocols and a RGB camera for geolocation of the hyperspectral images. The AEROS will manoeuvre in a ~500 km Sun-Synchronous orbit, with 98 degrees of inclination and targeting the Portuguese Atlantic region and Exclusive Economic Zone. The project also developed the Ground Segment Command and Control Centre and the Data Analysis Centre for the image processing, display and access to the AEROS data. The launch of AEROS will be made in the SpaceX Falcon 9 Transporter 10, forecasted to February 2024.

I. AEROS Mission Concept

AEROS mission objectives and requirements

- **Climate Change & Communication**
 - Monitoring the ocean surface and meteorological conditions
 - Informing local climate models
 - Develop, integrate and test payloads: Hyperspectral Camera (HSI); Software Defined Radio (SDR) for biologging technology ARGOS tags, LoRaWAN; and an RGB camera for contextualizing HSI 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, Phytoplankton Pigment Detection, 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
- **Big Data Analysis**
 - Data processing algorithms to gather, process and disseminate data in Data Analysis Center (DAC)

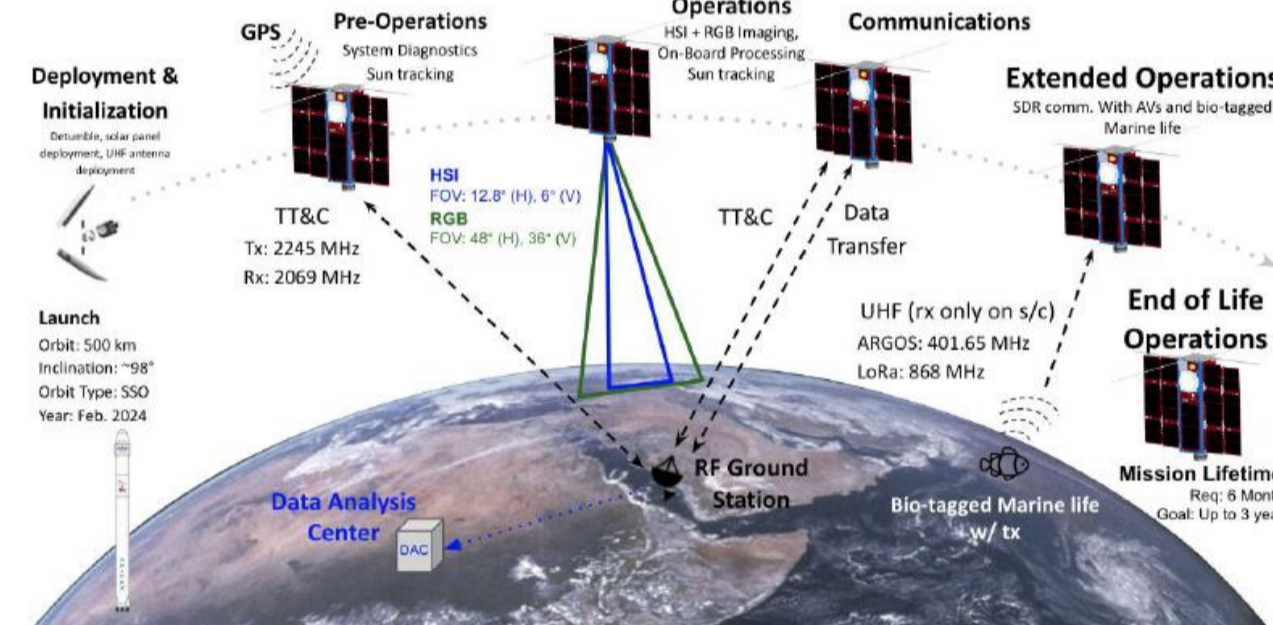


Figure 1: AEROS Concept of Operations

II. Hardware & Testing

Figure 2&3 displays both faces of the 3U AEROS satellite assembled and ready for final tests. HSI camera pointing up, solar panels deployed, 2 S-Band antennas, for telecommand and telemetry with the Ground Station, in both satellite faces of the satellite and umbilical cable to conduct the debugging and insertion of commands directly in the CAN Bus of the satellite, used in the final stages of the tests. Next steps will be the Thermal Vacuum tests and Random Vibration tests.

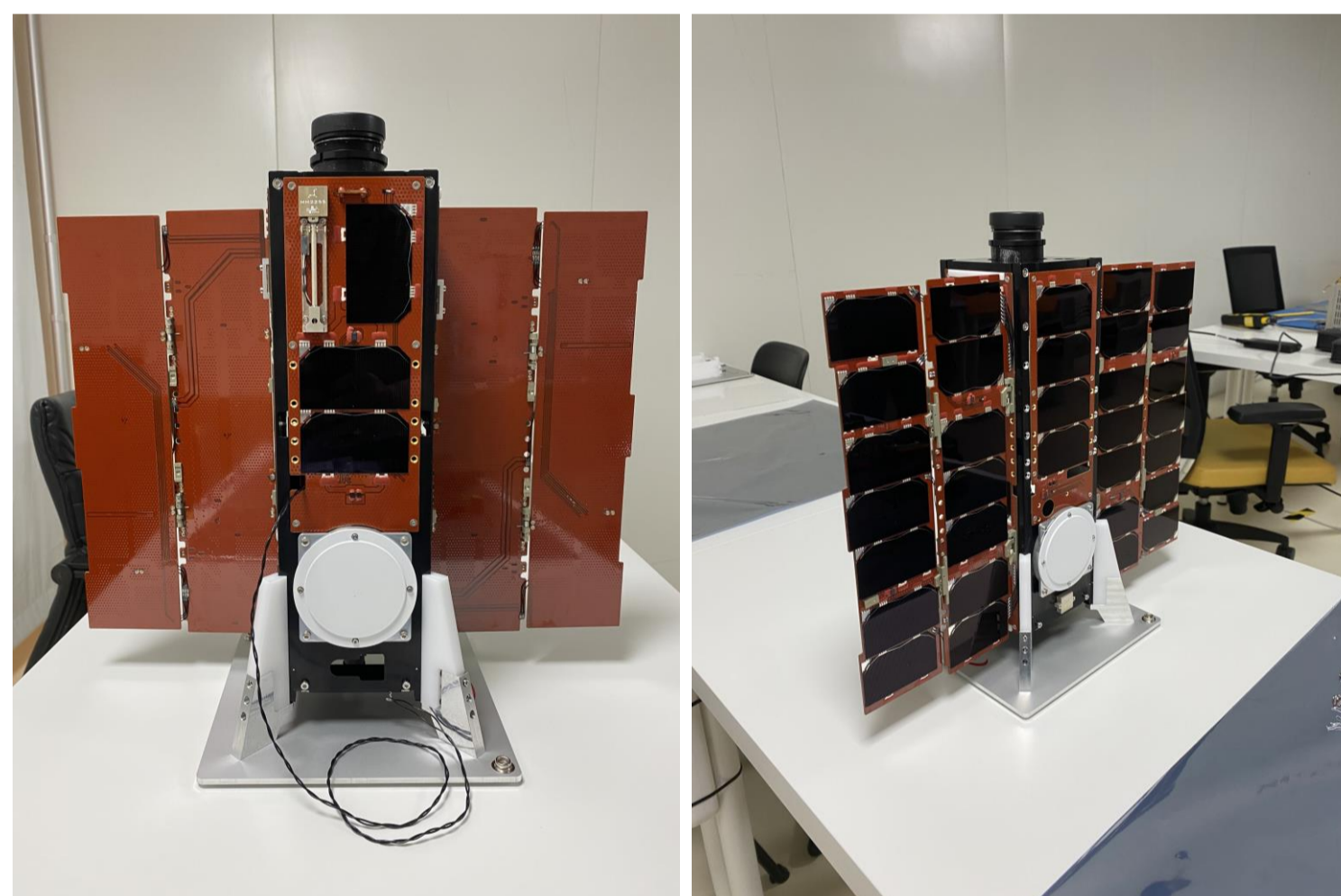


Figure 2: X- face of AEROS (with umbilical)

Figure 3: X+ face of AEROS

III. Software & Testing

Figure 4 displays the schematic of the complete validation facility (including software) of the AEROS. Figure 6 shows the real validation facility used in AEROS. It includes four different computers, PC1 for the Spectrum Analyser and CAN Xplained Ultra device for injecting CAN messages and sniffing both satellite CAN buses, PC2 to connect the Software Defined Radio payload, PC3 for the downlink processing chain and PC4 for Uplink data transmission. Figure 5 shows the successful FitCheck test campaign in the ExoPod, platform to be used in the launch of AEROS.

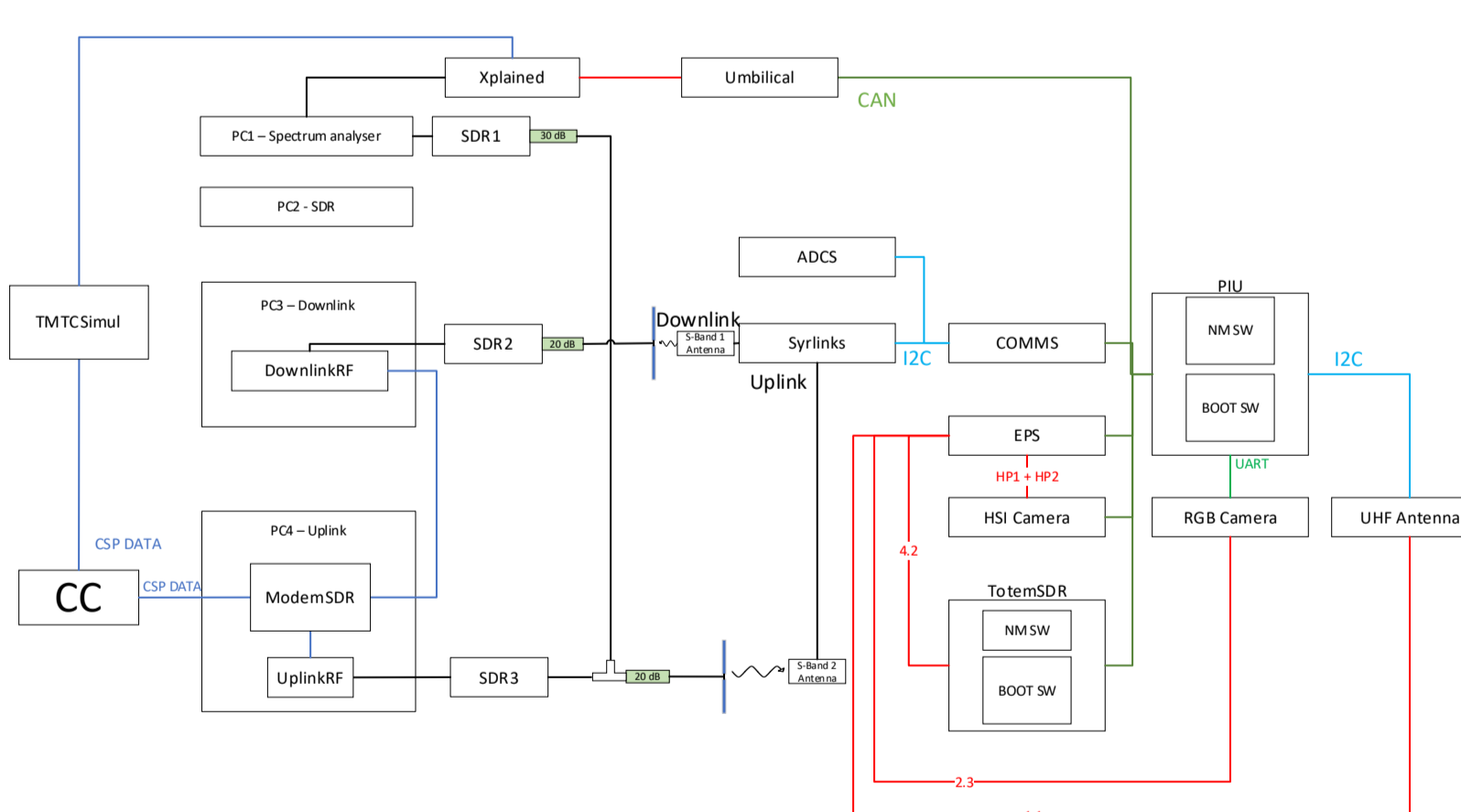


Figure 4: Validation Facility Schematic



Figure 5 (left): Exopod Testing

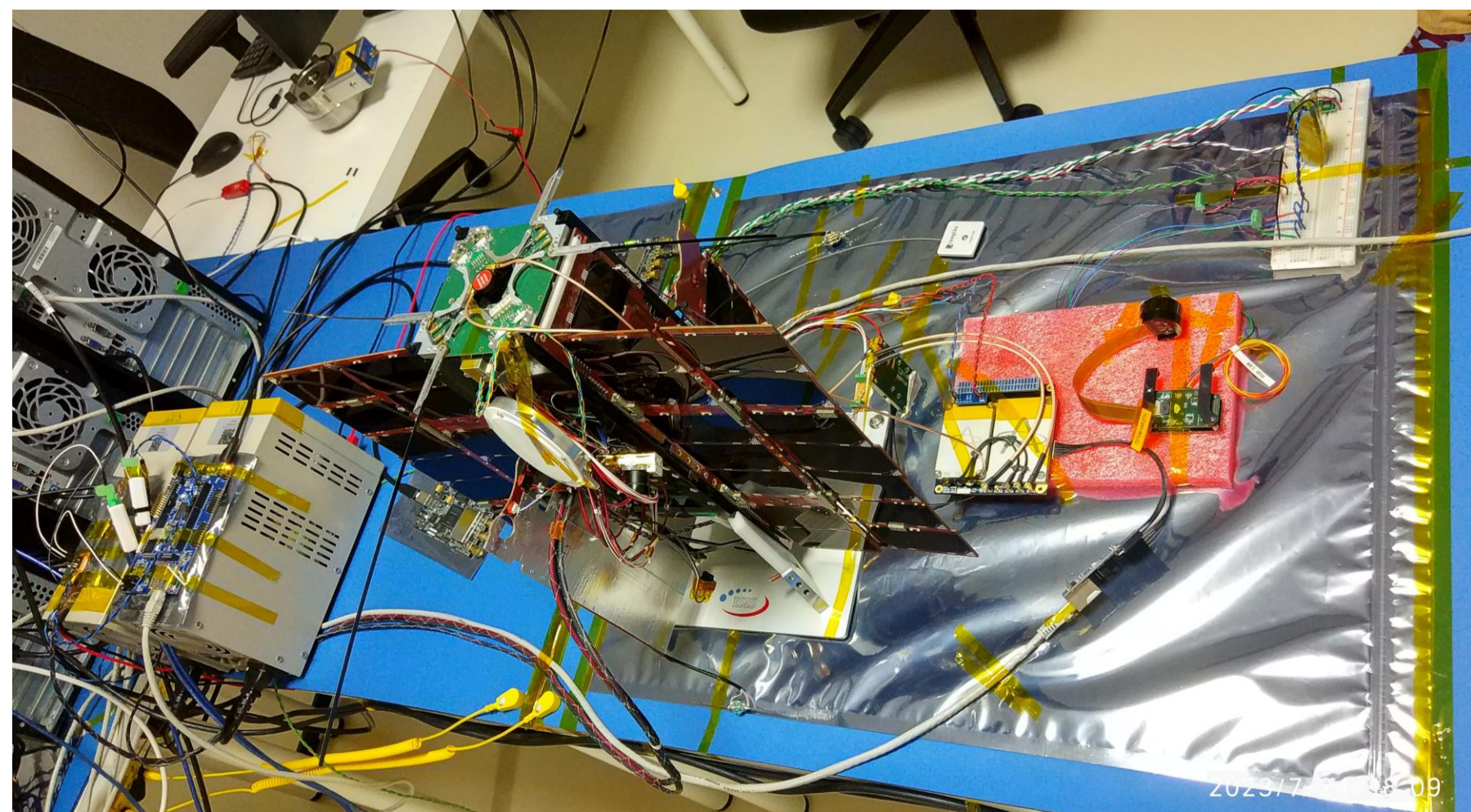


Figure 6 (right): Validation Facility

IV. Hyperspectral Camera & RGB Camera

AEROS' primary payload is a low-power (5W max), compact (70.8 x 70.8 x 105 mm³) 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. Optical and mechanical design, Structural, Thermal Analysis and Vibration Testing was performed in the engineering model.

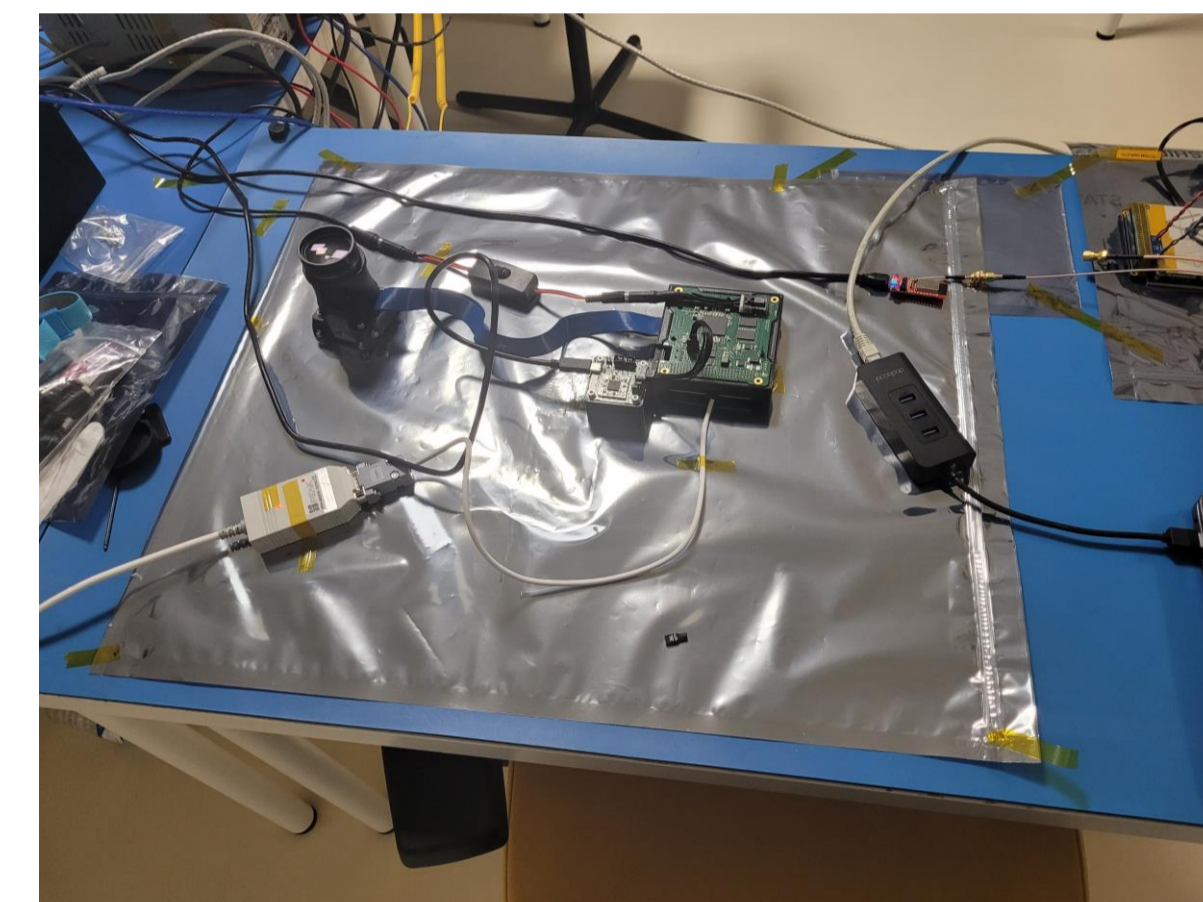


Figure 7 (left): HSI flight model

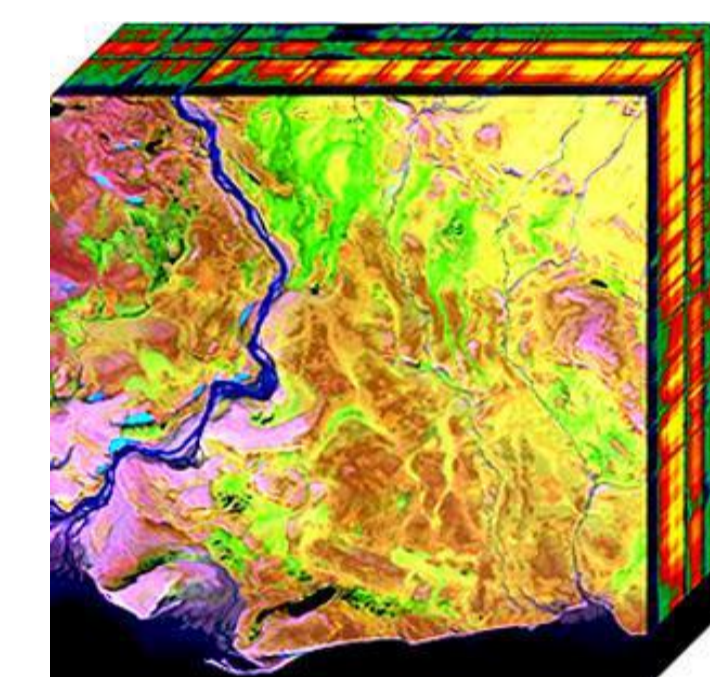


Figure 8: HSI Hypercube example



Figure 9: Test validation facility

A RGB imager will provide contextual imagery of overlapping ground scenes for the HSI. A study was performed to select the correct Focal Length considering the region of interest (Figure 11). The 6mm Focal Length (green) was selected.

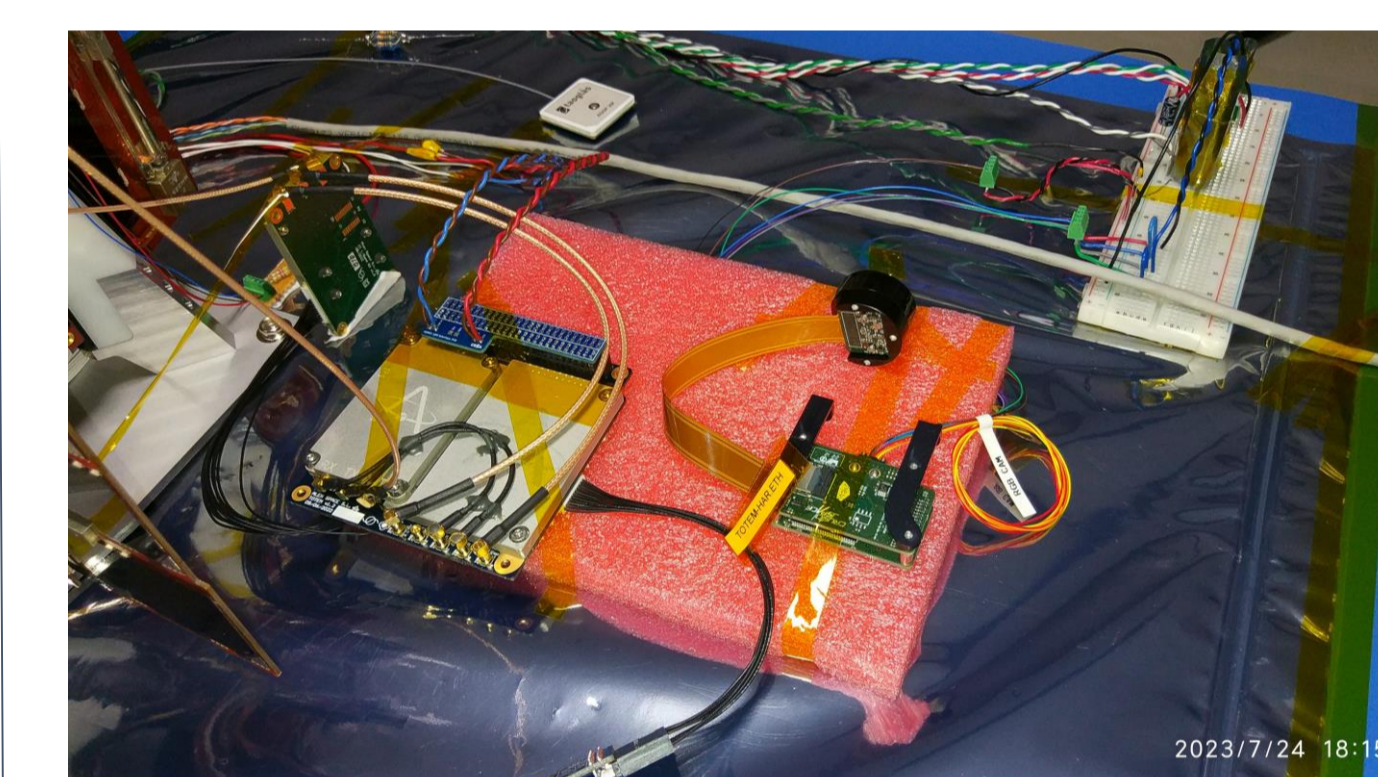


Figure 10: RGB Camera & SDR Flight Model

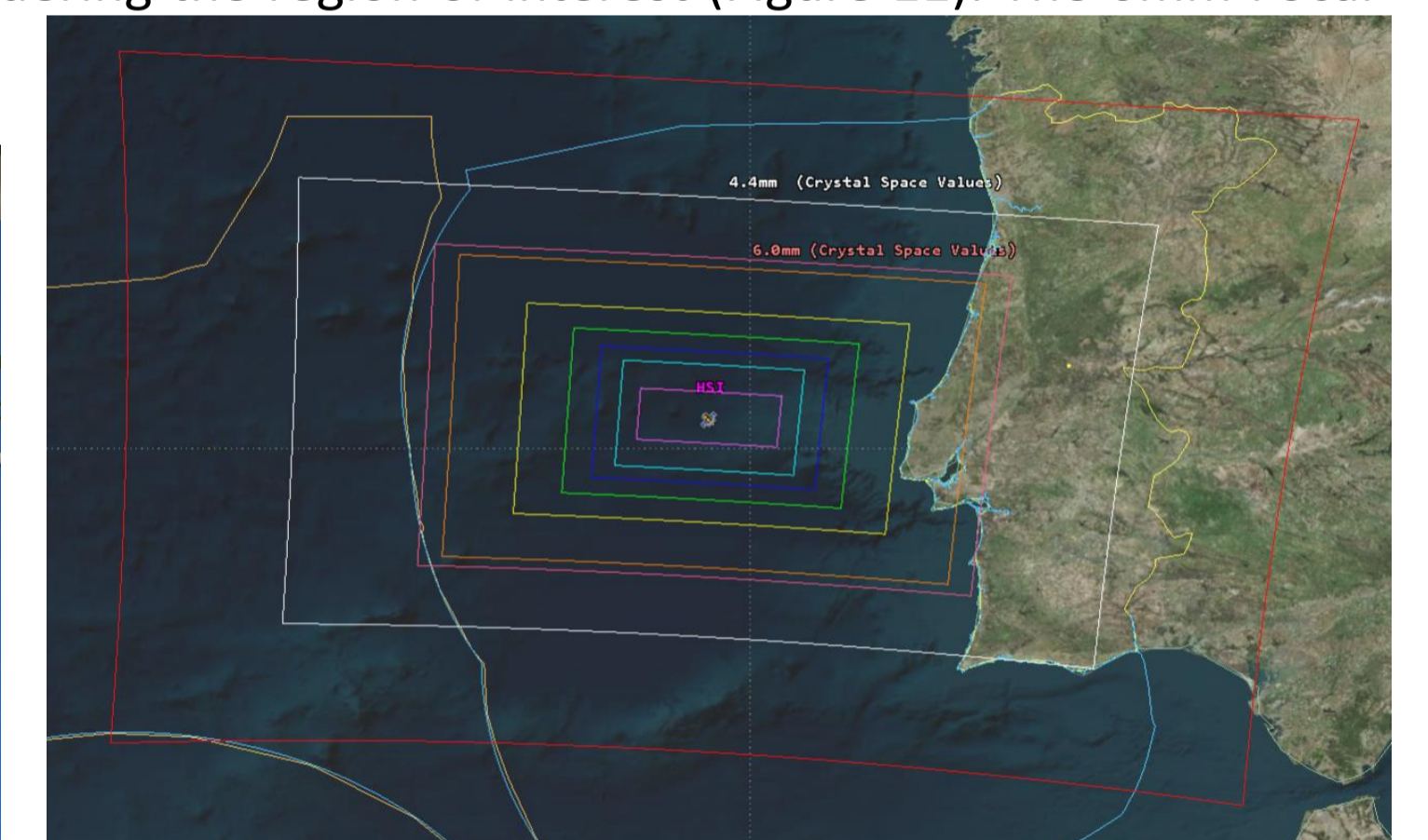


Figure 11: RGB Camera Focal Length selection

V. Software Defined Radio

AEROS hosts a software defined radio (figure 10) based on a Zynq-7000 system-on-a-chip that uses the GNU Radio software. The SDR supports the ARGOS protocol and the LoRaWAN implementation. Both implementations will allow AEROS' objectives to connect with autonomous vehicles and biologging tagged marine life (e.g., sharks and mantas). Figure 12 shows the implementation for demodulating the ARGOS.

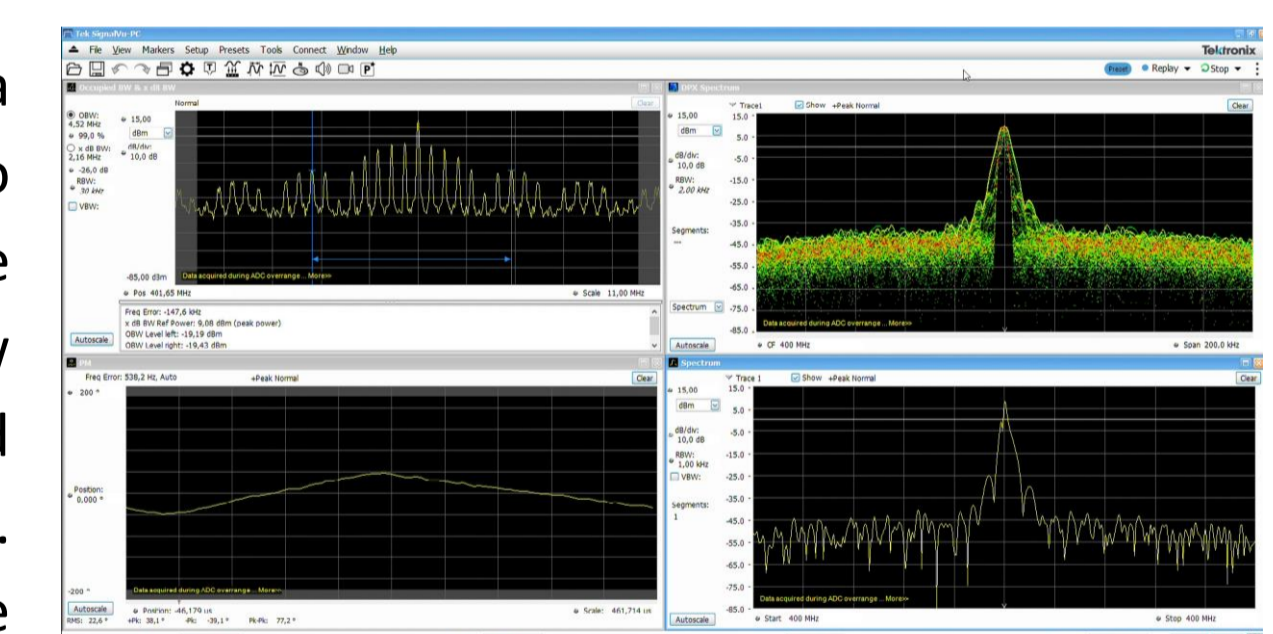


Figure 12: ARGOS Signal Demodulation

VII. Data Analysis Centre

The Data Analysis Centre (DAC) was developed using a service-oriented architecture and microservices-based. It receives the information from both bus and payload data and provide products and services to the different users, augmenting the data received with additional insights and value (<https://aiops.ceiiia.com/Map>). The DAC processes the raw data received from the satellite. The data is received from different data sources, including the AEROS satellite. Information includes the Copernicus, AIS, AUVs, ARGOS and LoRa Telemetry. It is also the responsibility to validate the data received.

Figure 13 and 14 show the mockup of the DAC and the DAC HMI displaying the SAT-AIS information and highlighting the information received for each area of interest in the Portuguese coast.

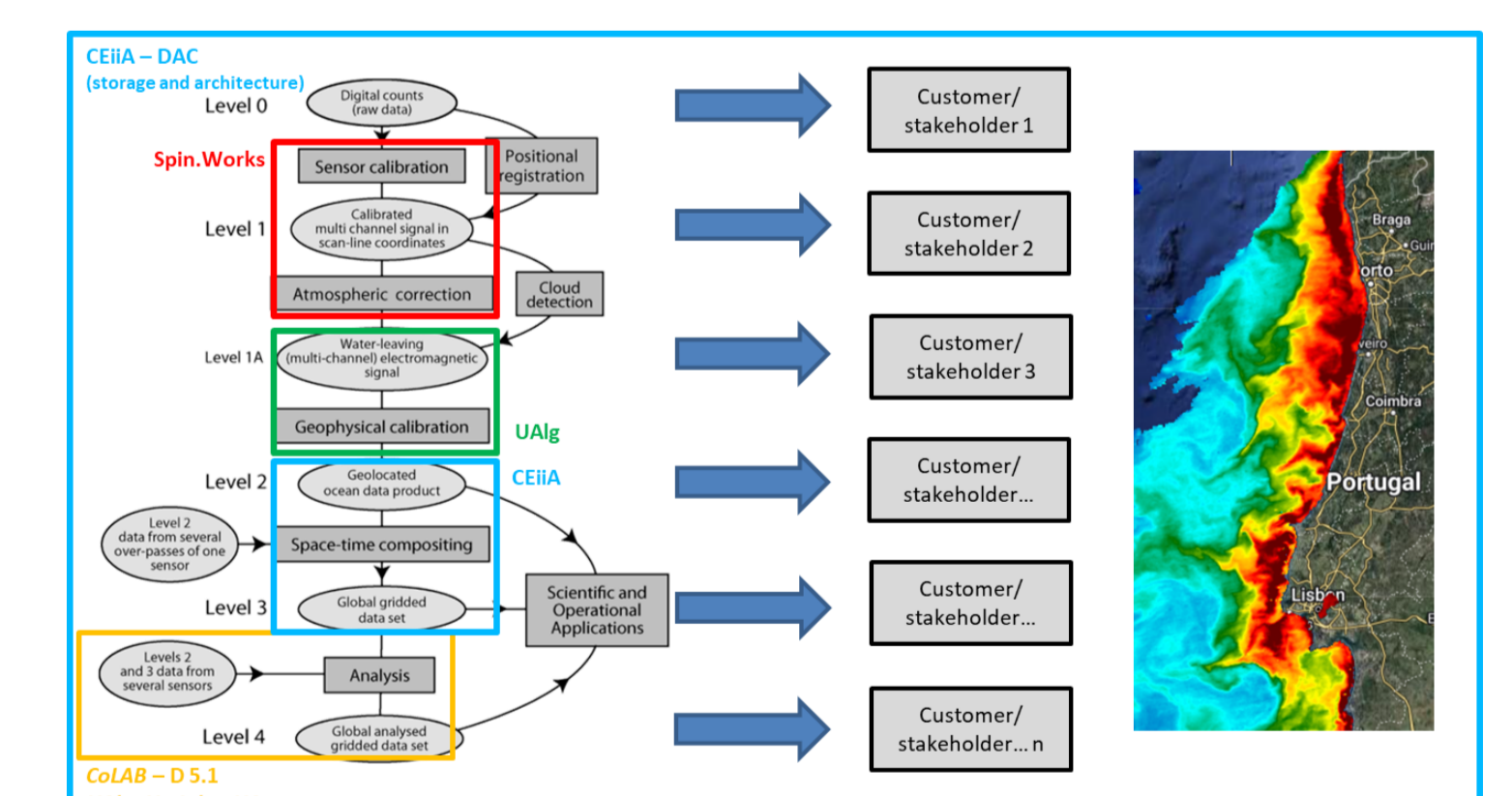


Figure 13: DAC mockup

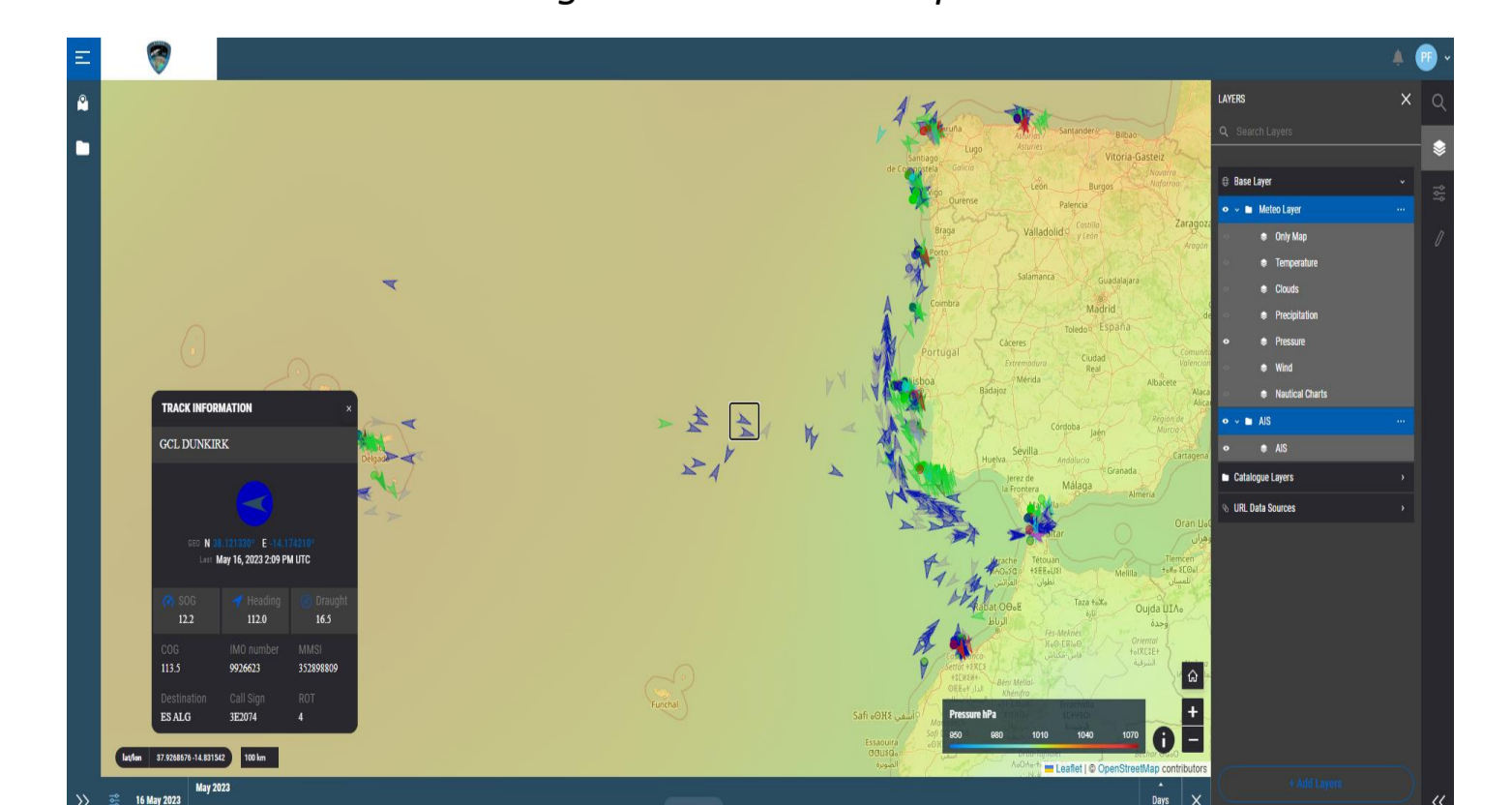


Figure 14: DAC HMI

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