

Towards radioactivity monitoring in confined environments

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Receives funding from European Union under Horizon 2020 FET Proactive Programme via grant agreement No. 101017808

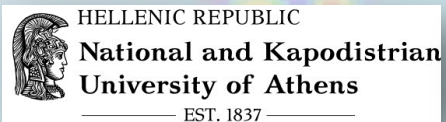
RAMONES



RAMONES – Radioactivity Monitoring in Ocean Ecosystems

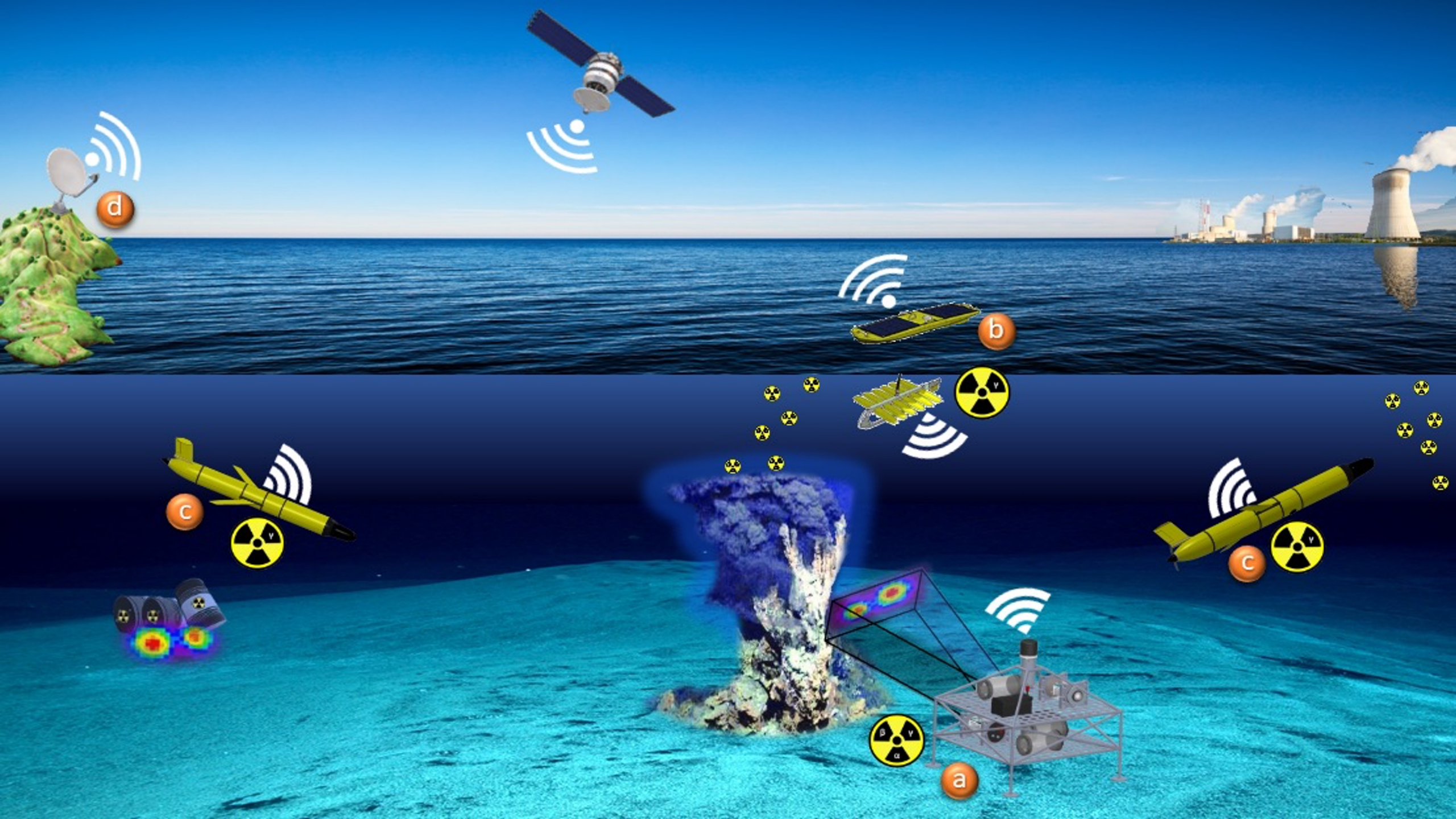
- Design, develop and validate for the first time, a broad set of novel instruments for measuring radioactivity in seabed and water column.
- Design, develop and validate novel adaptation, self-deployment and self-awareness collaborative marine robotics capabilities for the efficient operation and sensing with the new marine radiometry instrumentation.
- Design, develop and validate novel statistical, artificial intelligence and environmental modelling methodologies for processing and modelling marine radioactivity multi-modal data.

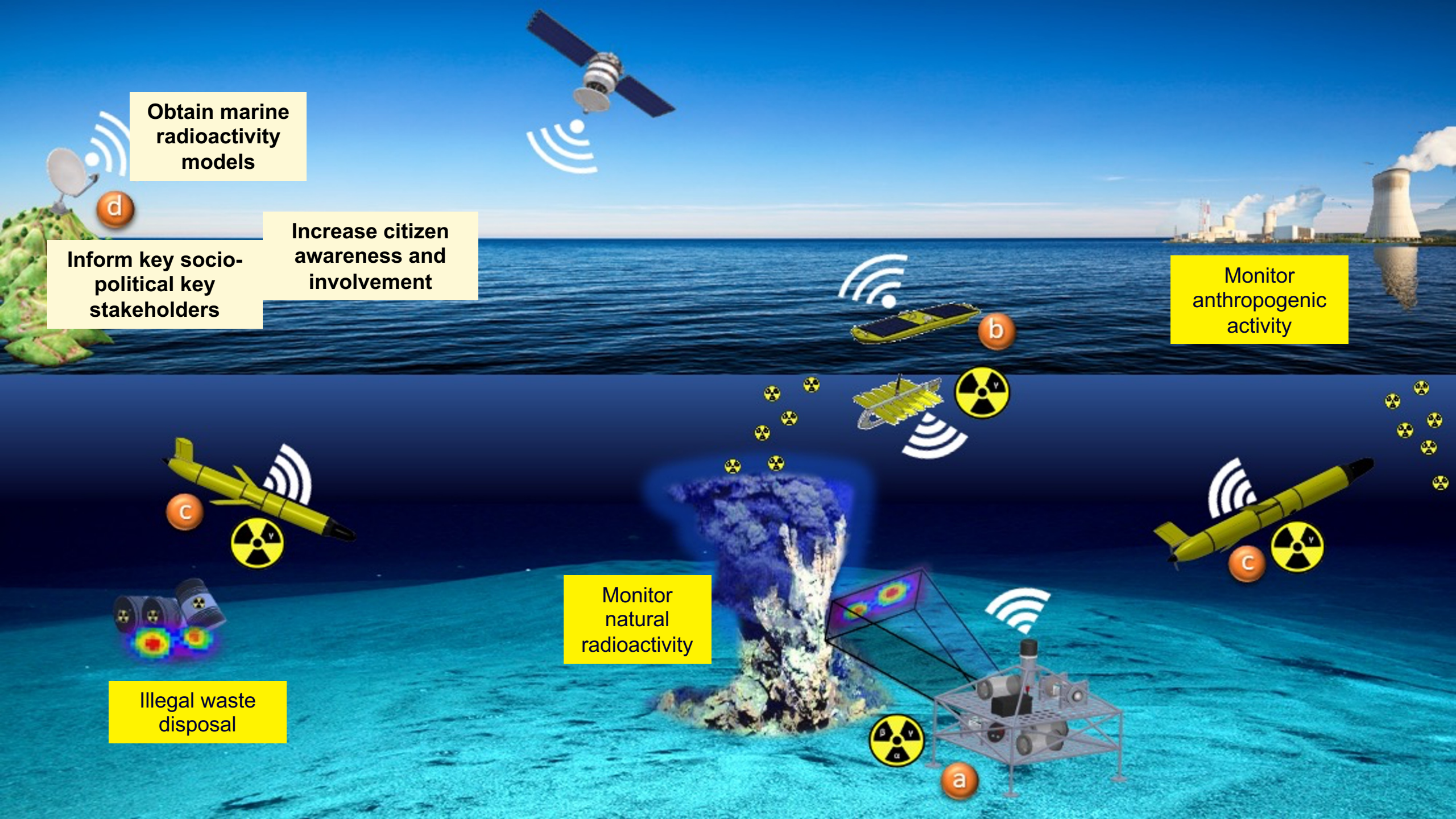
Consortium Partners



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www.ramones-project.eu





Obtain marine
radioactivity
models

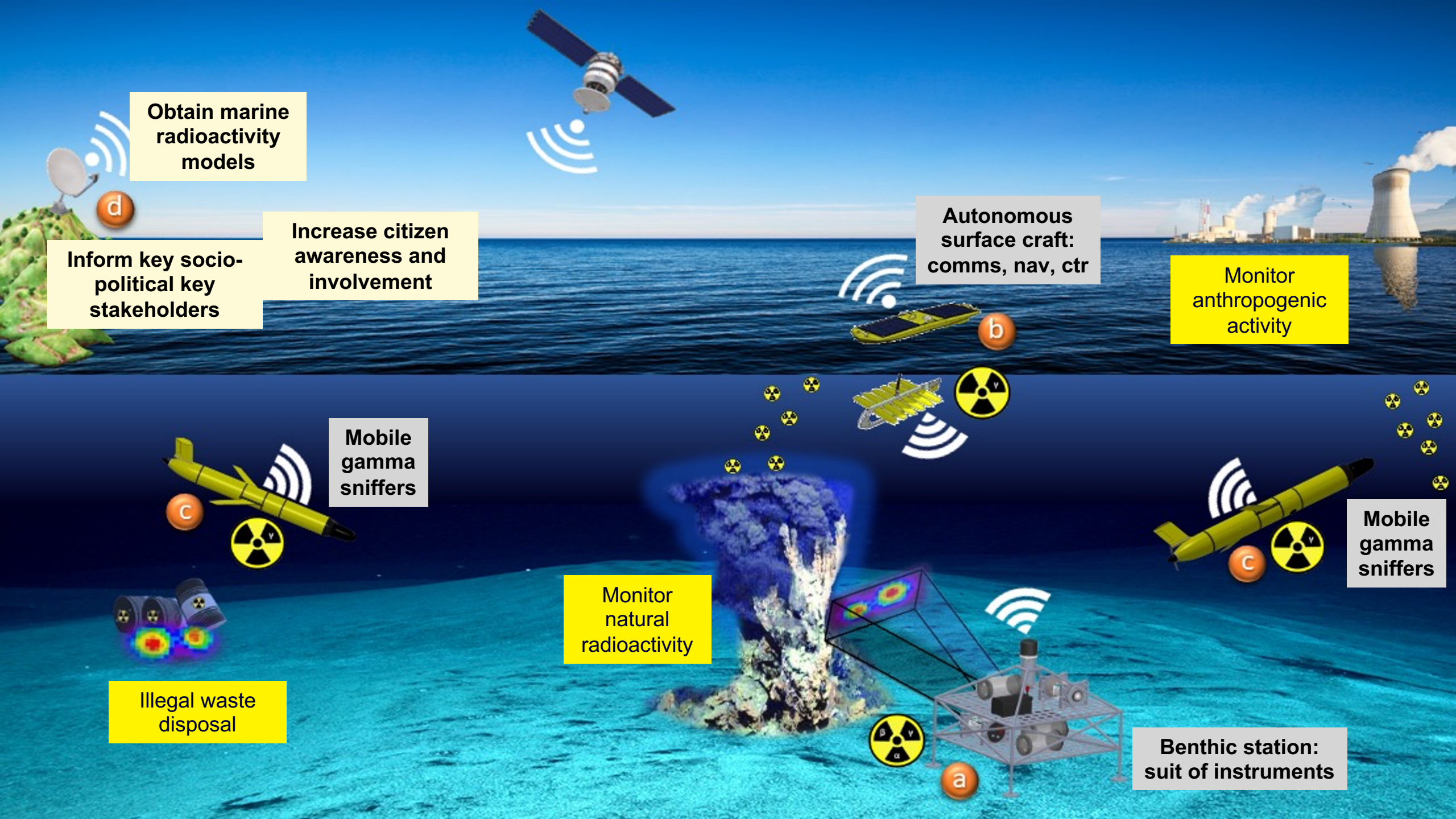
Inform key socio-
political key
stakeholders

Increase citizen
awareness and
involvement

Monitor
anthropogenic
activity

Monitor
natural
radioactivity

Illegal waste
disposal



Obtain marine radioactivity models

Inform key socio-political key stakeholders

Increase citizen awareness and involvement

Autonomous surface craft: comms, nav, ctr

Monitor anthropogenic activity

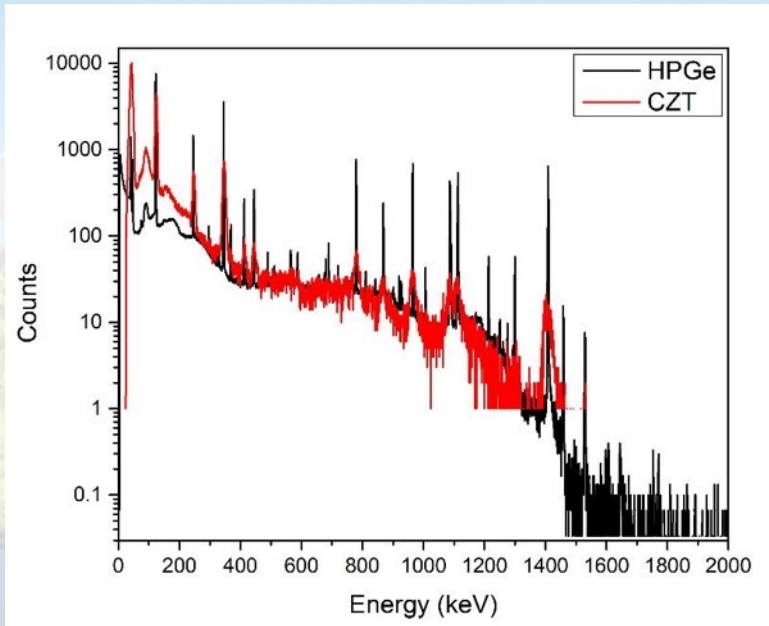
Mobile gamma sniffers

Illegal waste disposal

Monitor natural radioactivity

Mobile gamma sniffers

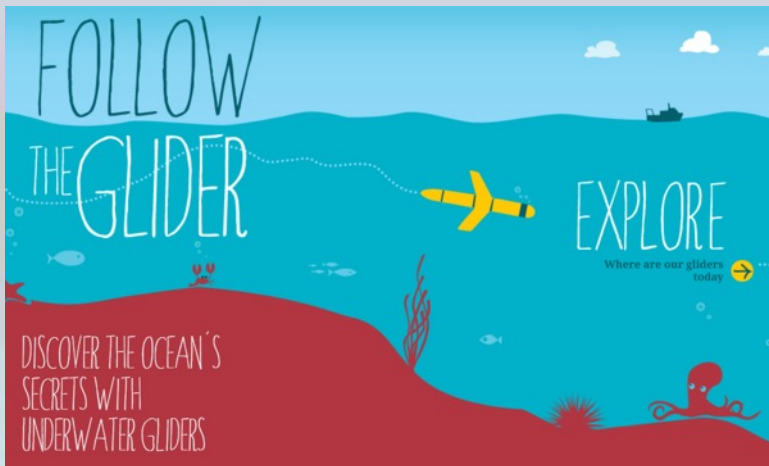
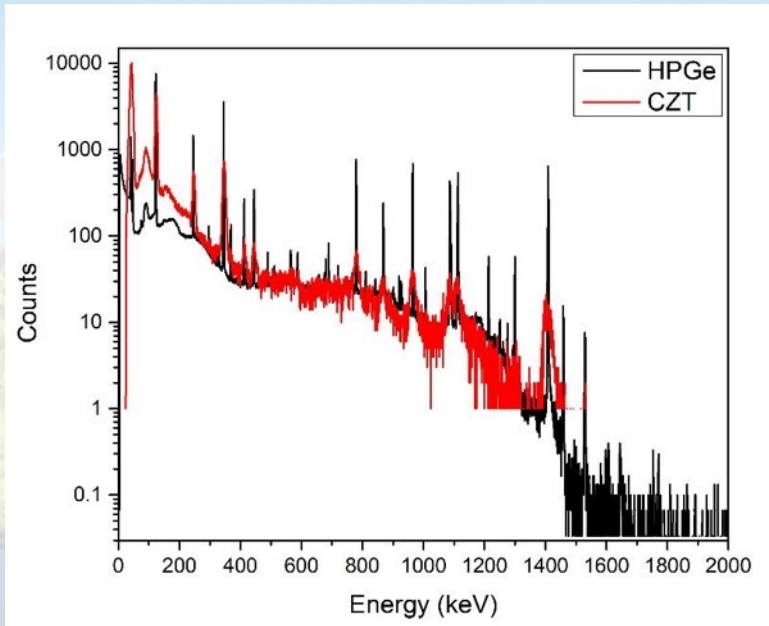
Benthic station: suit of instruments



Challenges

Radioactivity survey and mapping

- Radioactivity measurement is a stochastic process
- Very low propagation in the water
- Lack of off-the-shelf underwater instruments



SOCIB: ICTS SOCIB

<https://followthegliders.socib.es/>

Challenges

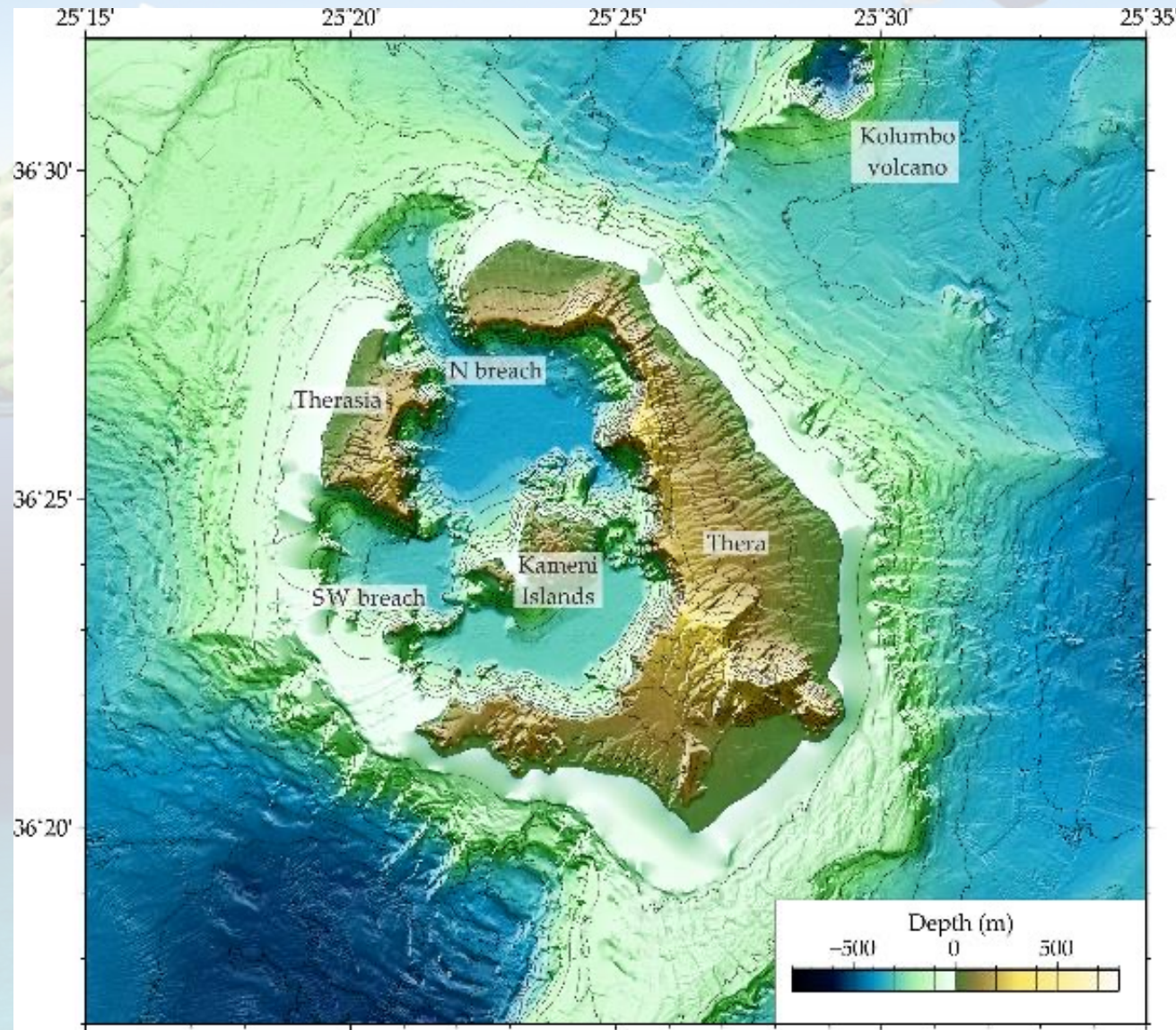
Radioactivity survey and mapping

- Radioactivity measurement is a stochastic process
- Very low propagation in the water
- Lack of off-the-shelf underwater instruments

Glider platforms

- Limited payload and energy capacity
- Low navigational accuracy
- Complex motion planning
- Slow internal update rate and processing power

Field demonstration – Kolumbo underwater volcano, Santorini, Greece



Nomikou, P., Druitt, T., Hübscher, C. et al.

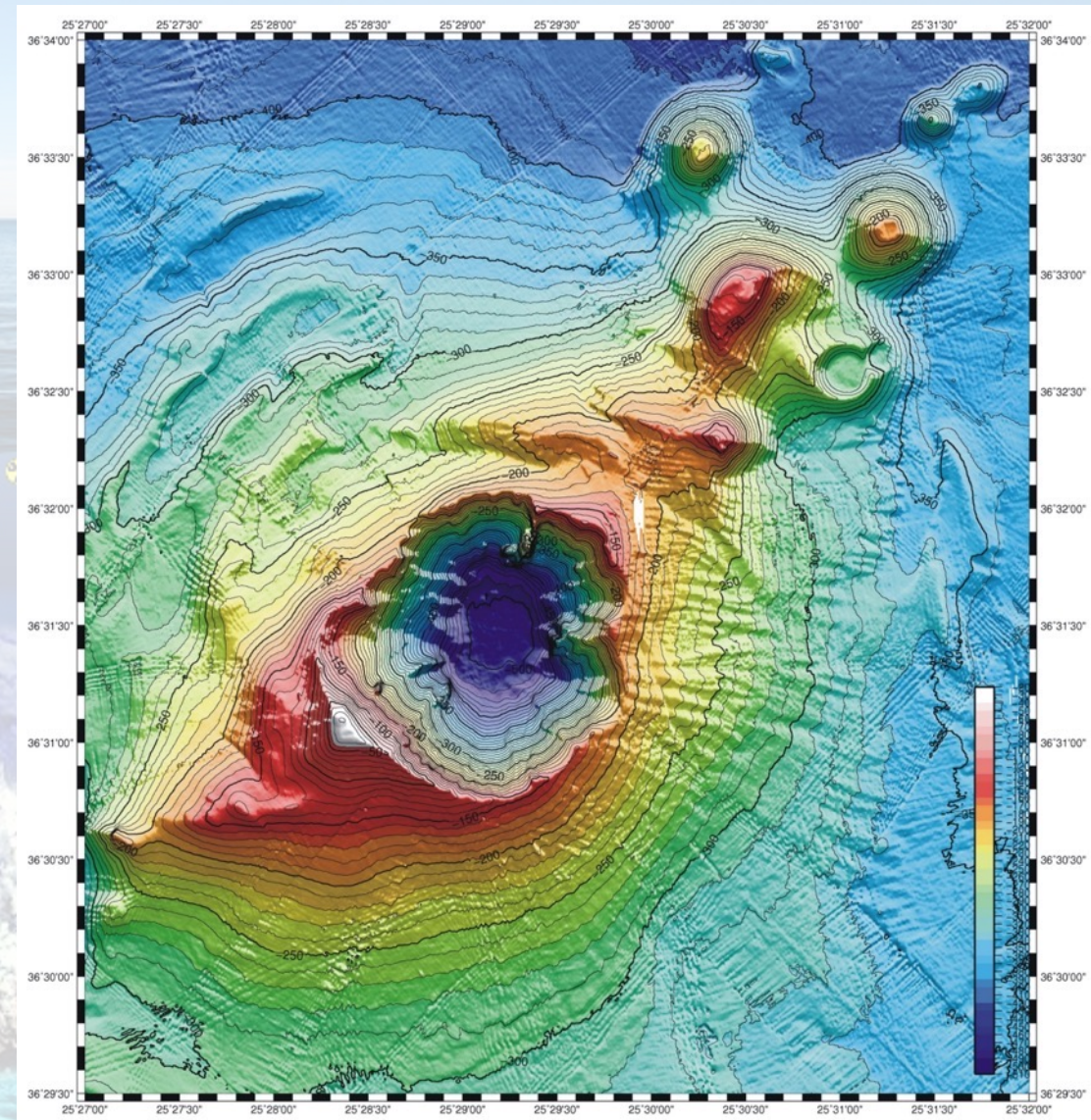


Figure courtesy of Haraldur Sigurdsson, Steven Carey, Matina Alexandri and Katy Croff.

Instruments & Vehicles – Radiation Measurement Instruments

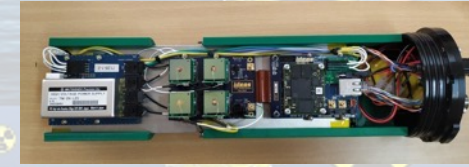
γ -Sniffer

CZT Gamma Spectrometer for autonomous vehicles
resolution: FWHM $\sim 3\%$ at 662 keV (Cs-137)
energy ranges: 40-1600 keV (operational)



SUGI

Submarine Gamma Imager



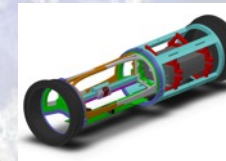
CHERI

Cherenkov Imager



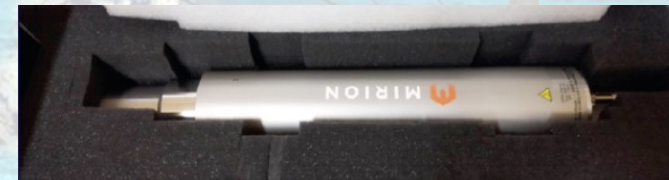
α SPECT

Underwater Alpha Spectrometer



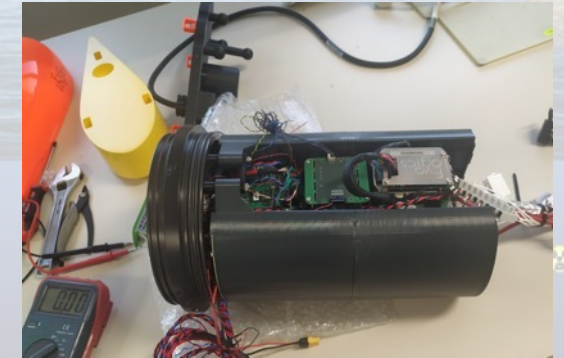
GASPAR

Gamma Spectrometer for
Marine Radioactivity Studies



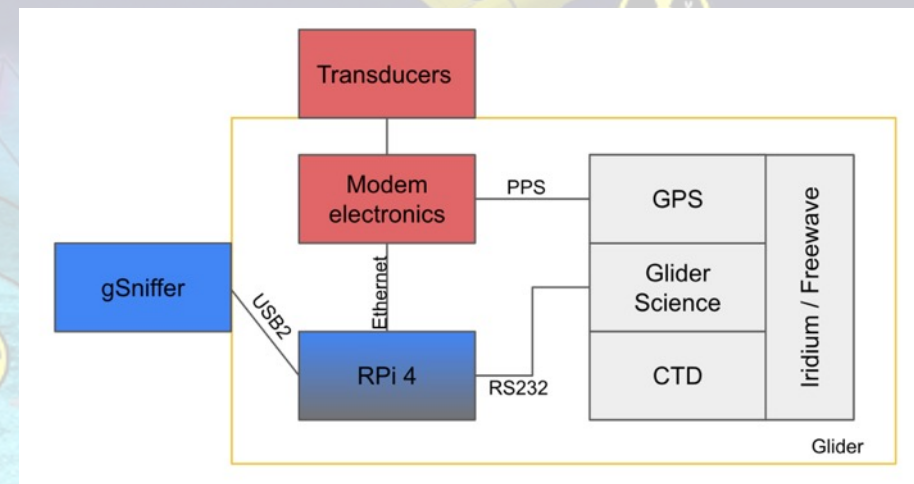
Instruments & Vehicles – Autonomous Underwater Glider

γ -Sniffer payload

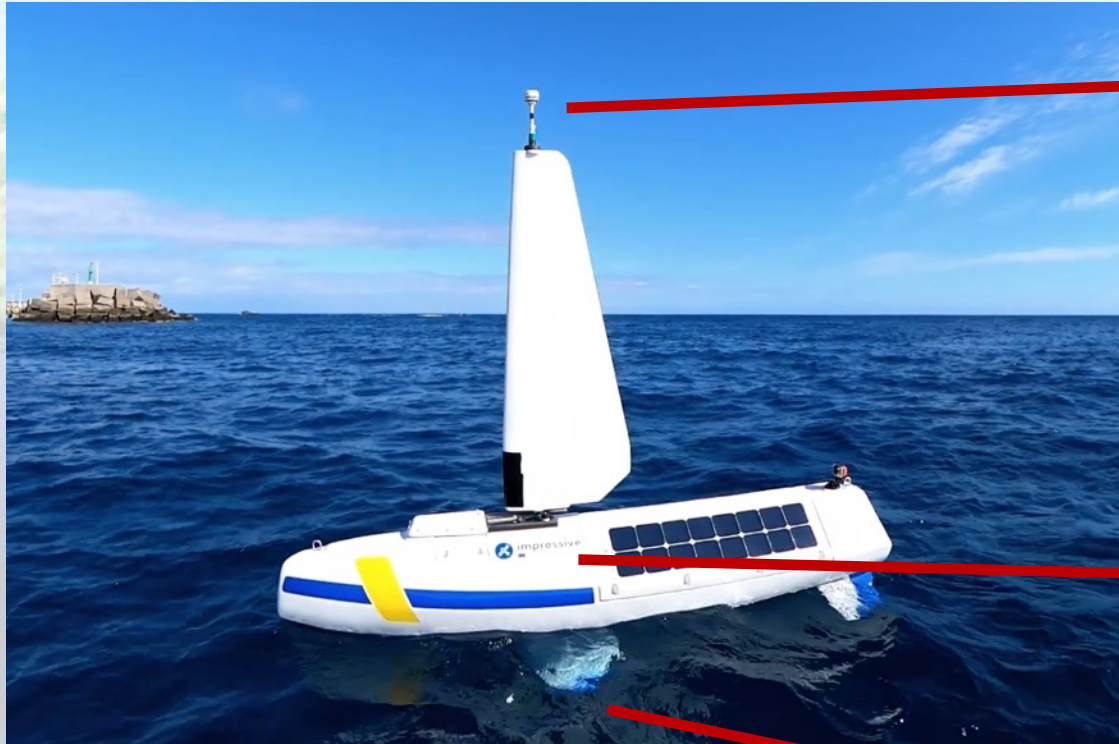


USB/Modem payload

Control module



Instruments & Vehicles – Autonomous Surface Craft



A-Tirma Sail ASV



GPS/4G/Sat



Control SBC



Dpto. de Informática y Sistemas
Instituto Universitario SIANI



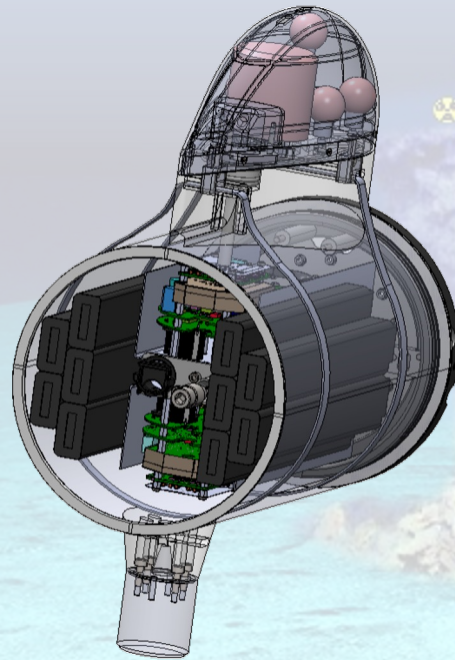
ULPGC
Universidad de
Las Palmas de
Gran Canaria



USB/L / modem

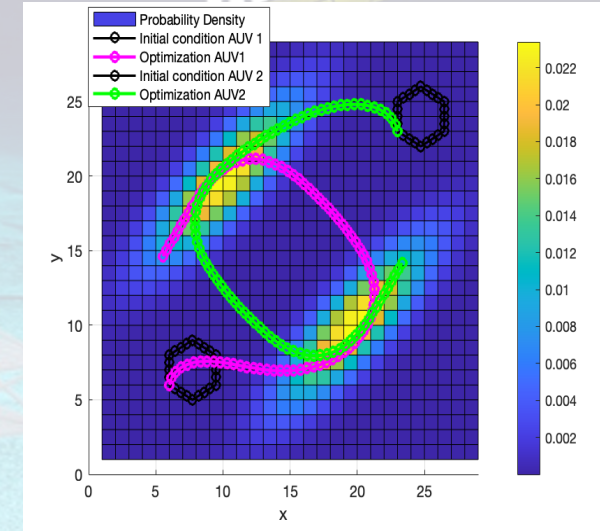
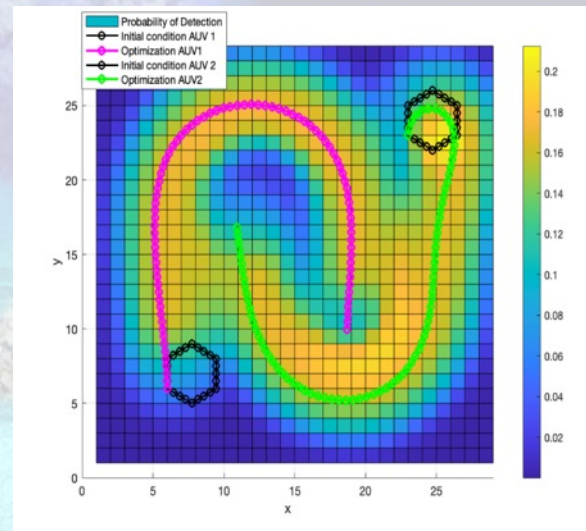
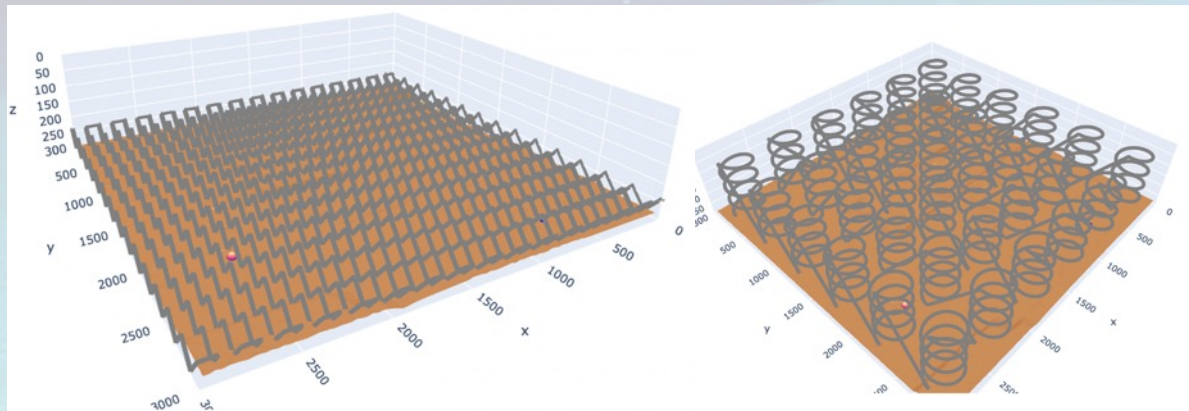
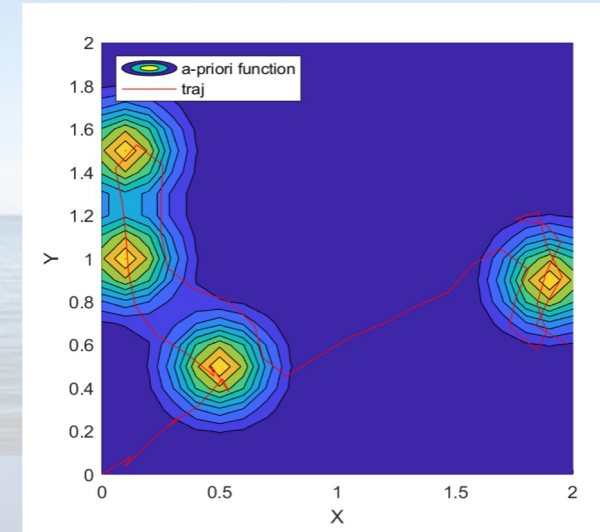
Instruments & Vehicles – Positioning and Communications

- EvoLogics USBL/Modems
- Equipped with chip level atomic clocks
- Silent USBL mode
 - inverted USBL
 - one way travel time
 - timeslots interrogation
- Optional second transducer
- Independent power bank



Instruments & Vehicles – Adaptive Motion Planning and Cooperative Control

- Goal: Radioactive source and plume detection
- Adaptive motion planning strategy
 - Off-line cooperative motion planning
 - use prior information (expected to be uncertain)
 - Online adaptation
 - probabilistic framework
 - optimal search theory
 - never been used for underwater radioactivity mapping
- Glider Backseat driver
 - navigation correction (on-line steering & waypoints update)
 - behaviors change based on onboard or ASV data processing

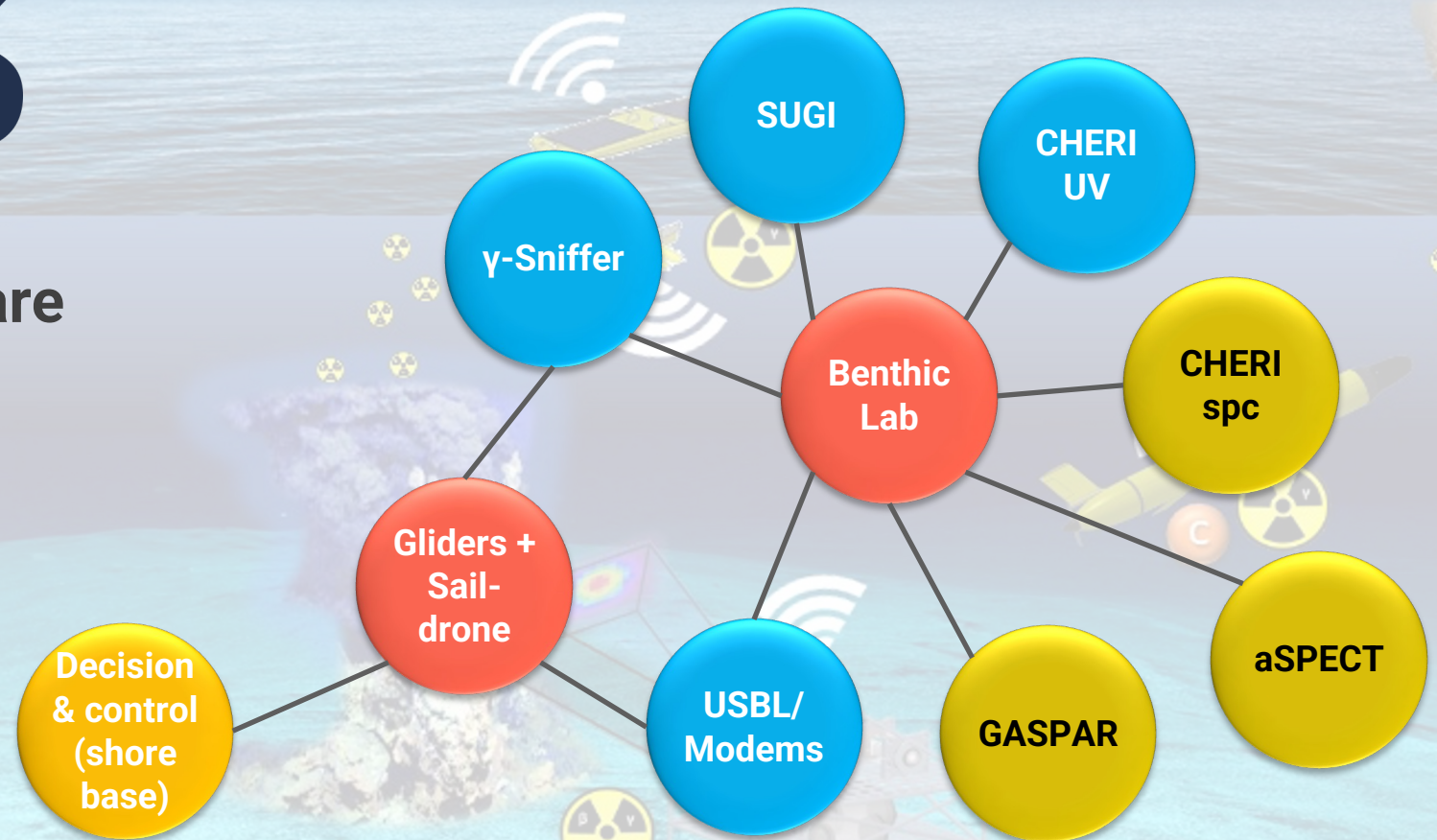


Instruments & Vehicles – Software

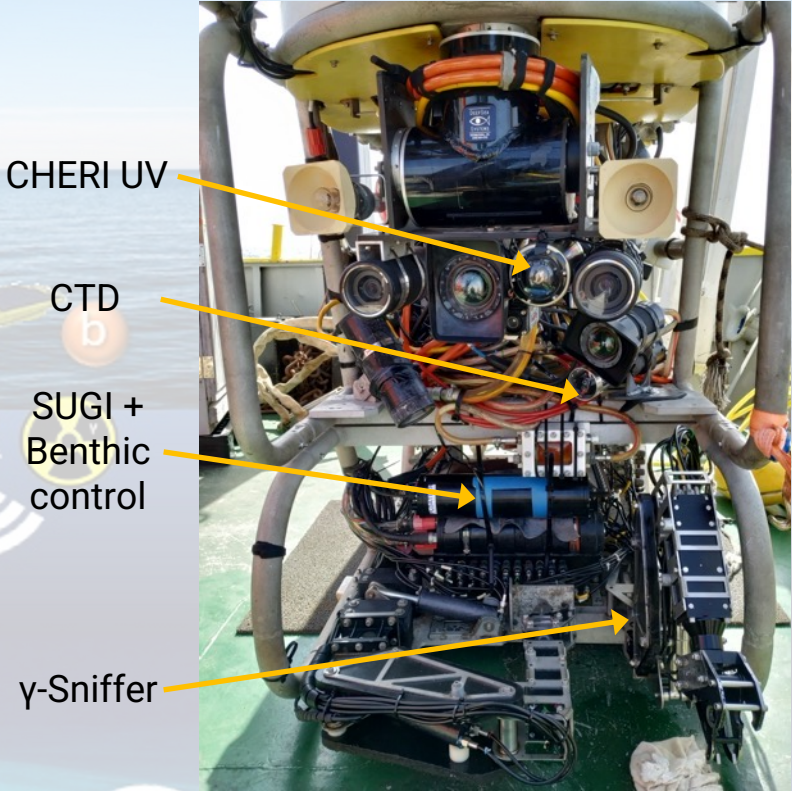
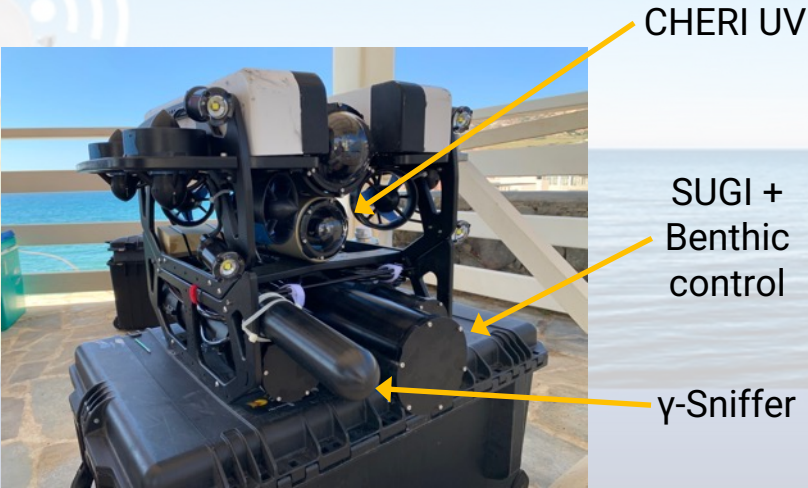
 **ROS**™

+

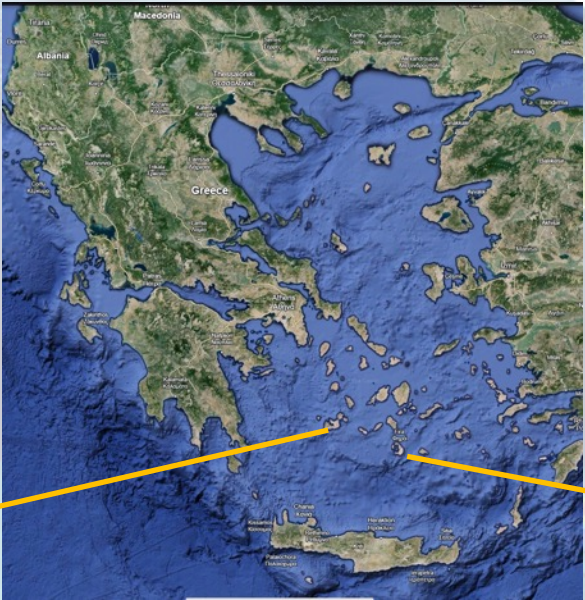
Partners' custom software



Initial field tests – Milos & Kolumbo hydrothermal vent fields, Greece



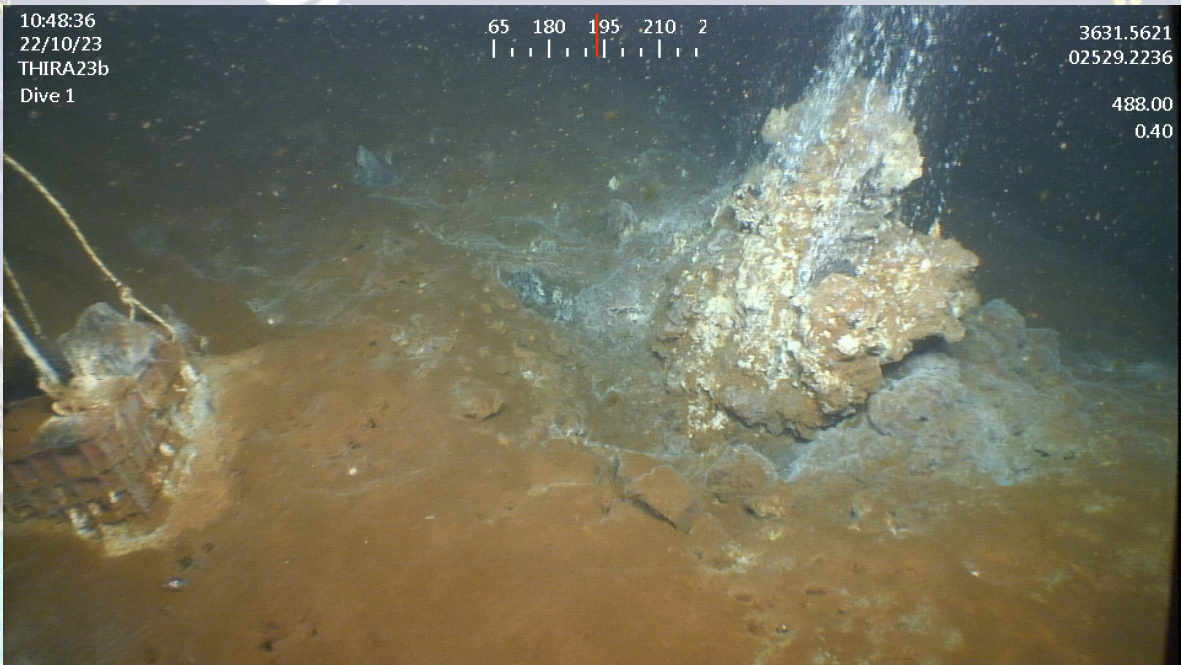
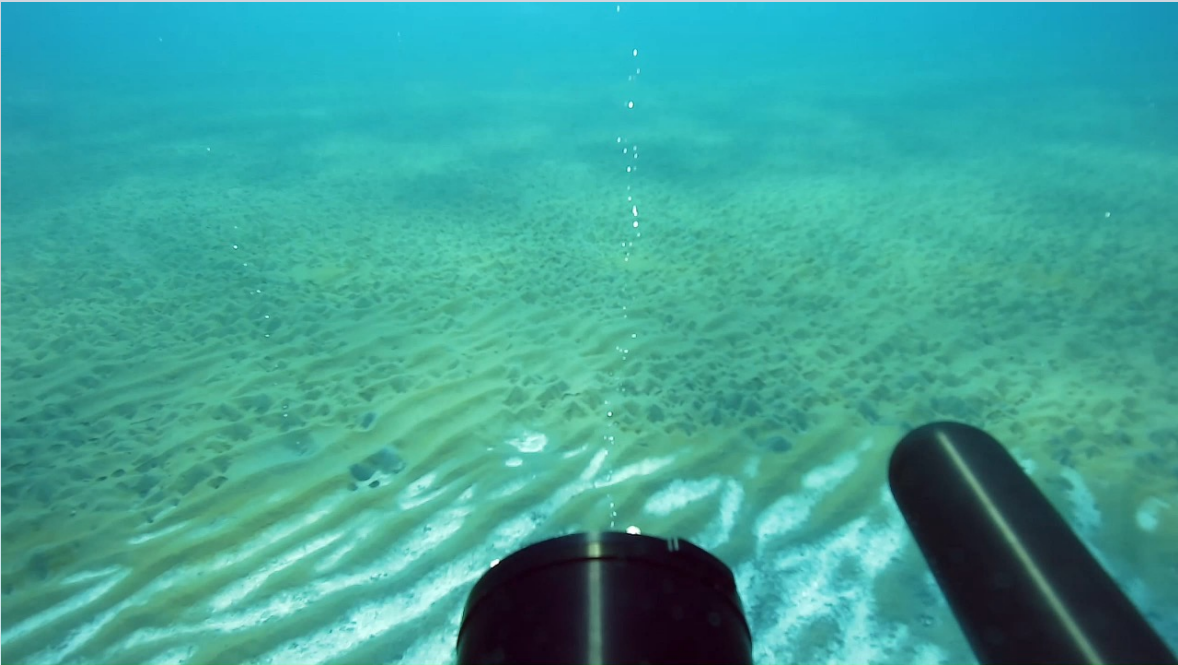
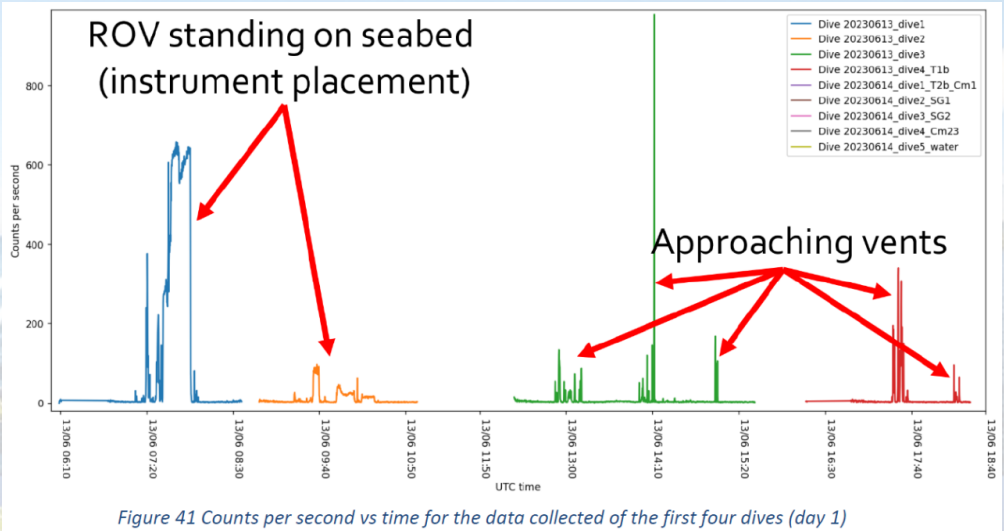
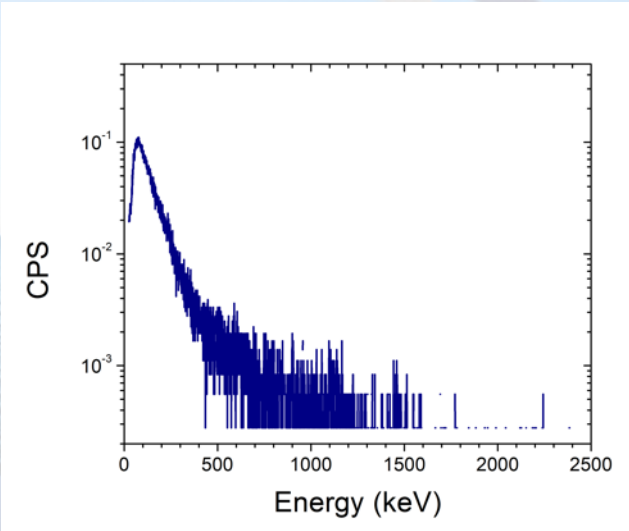
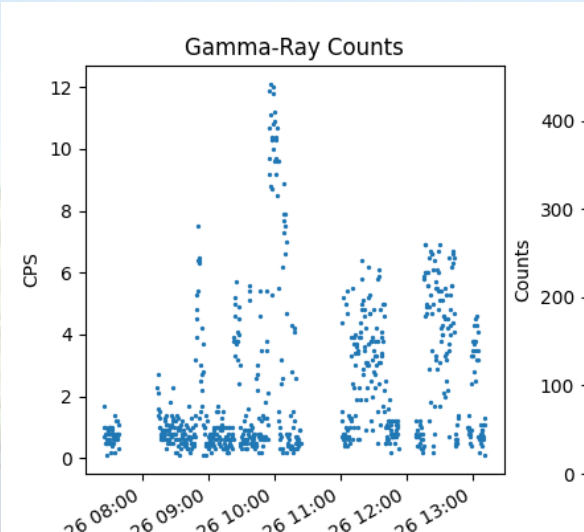
Milos



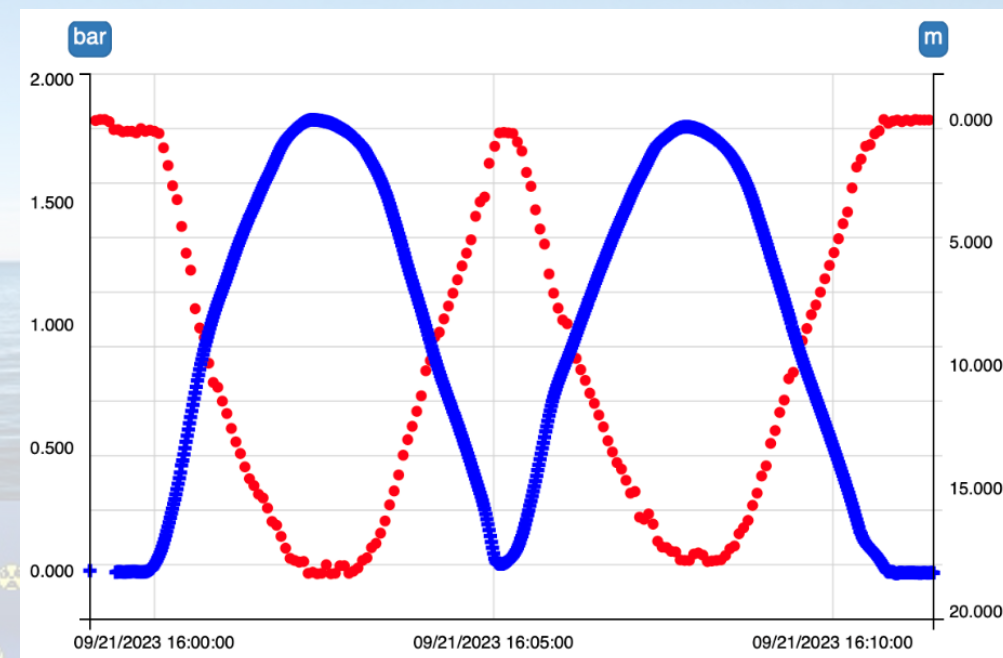
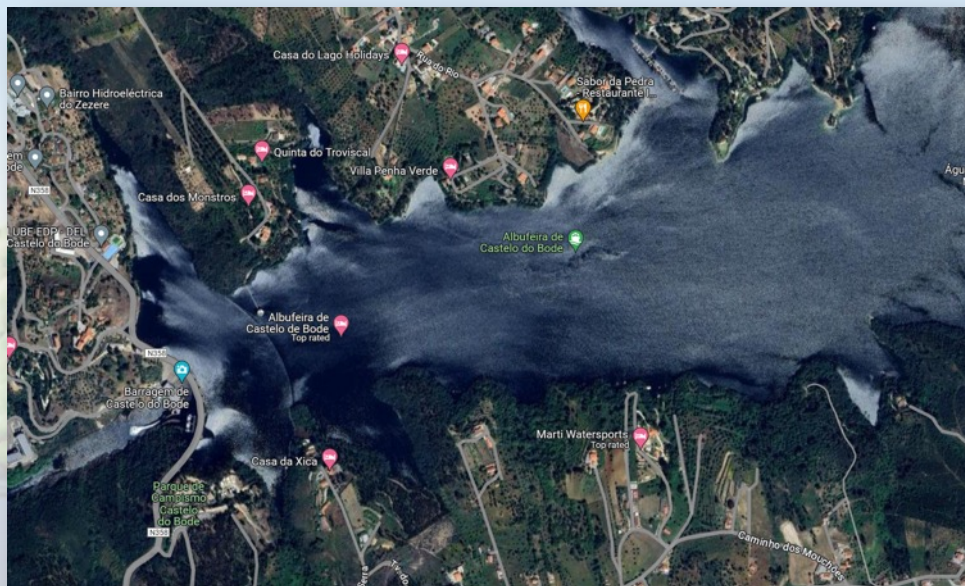
Kolumbo, Santorini



Initial field tests – Milos & Kolumbo hydrothermal vent fields, Greece



Initial field tests – Castelo de Bode, Portugal



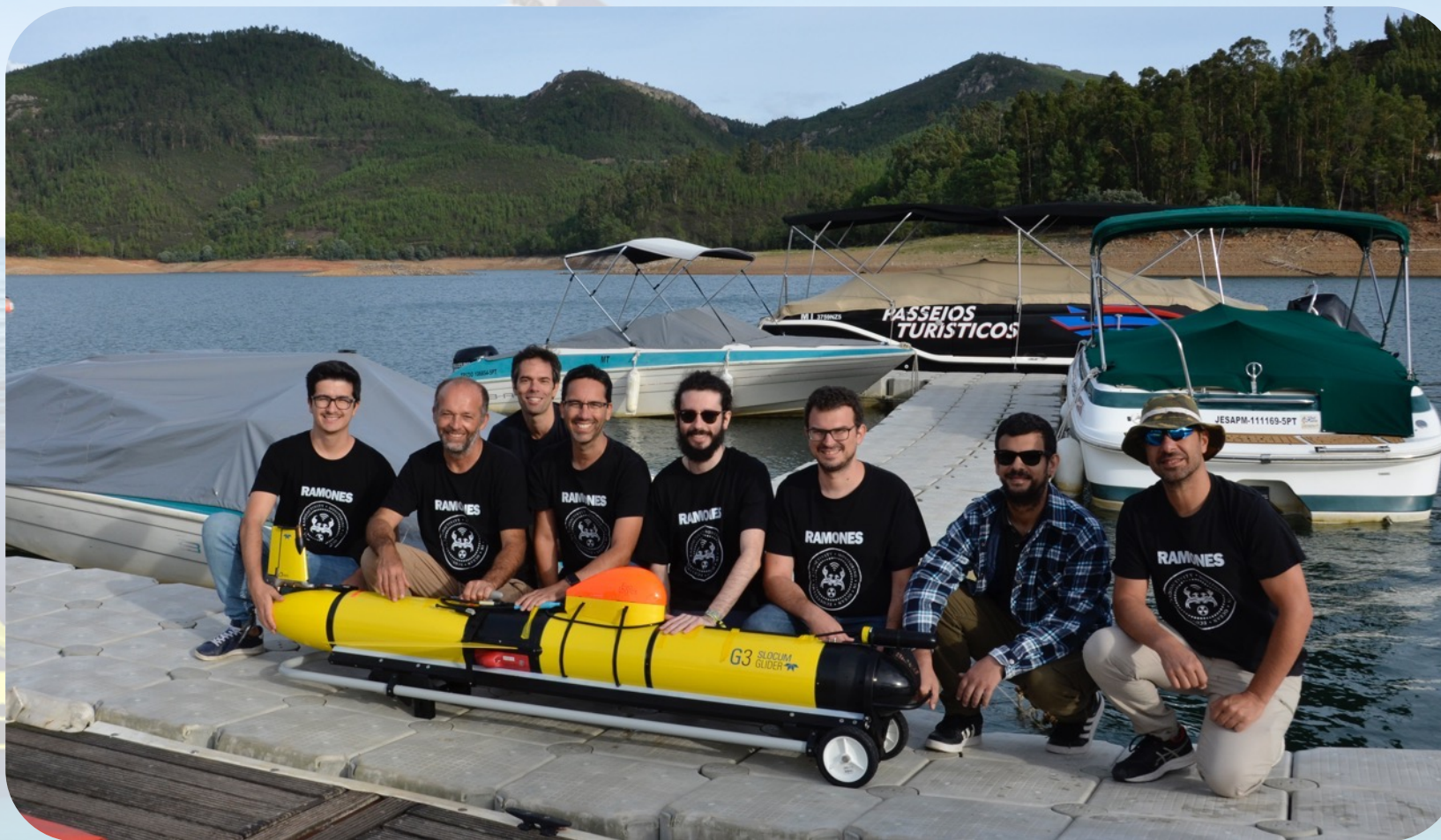
Glider depth and pressure

Full deployment demonstration at Kolumbo underwater volcano: October 2024

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