

NARRATIVE QUARTERLY REPORT

(JULY–SEPTEMBER) 2024

Project — In situ monitoring of water quality in Cuban bays: creating and promoting the use of scientific tools

Participating institutions

- University of Havana (UH)
- Université Libre de Bruxelles (Belgium)

Cooperating institutions

- Center for Environmental Research and Transport Management (CIMAB)
- ESPOLETA Tecnologías (SME)

Other collaborating institutions

- José Antonio Echeverría Technological University of Havana (Cujae)
- Havana Bay State Management Group
- Université Catholique de Louvain

Project coordinators

Cuban side: Dr. C. Ernesto Altshuler Álvarez

Foreign side: Dr. Denis Terwagne

Participants — Dr. Geydis Fundora Nevot, Dr. Florence Degavre, Dr. Stamatios Nicolis, Dr. Alexandre Campo, MSc. Lázaro Martínez Ortiz, Eng. Alex Rivera Rivera, MSc. Luis Abel Rodríguez de Torner, Dr. Aramis Rivera Denis, Eng. Orestes Chávez Linares.

Duration — Five years

General objective — To provide the Cuban scientific-social ecosystem with a set of tools that enables in situ monitoring of water-quality parameters in Cuban bays, in a sustainable way and connected to local communities.

Specific objectives

- Design and build a wave channel at the Faculty of Physics, UH
- Design and build a buoy prototype
- Set up a server with a website to receive data from the buoys and from the community
- Establish a methodology for using the buoys
- Train the corresponding human resources

Fulfillment of the quarterly objectives

Objective 1. Completion of the purchase list for setting up a digital fabrication laboratory

During the last quarter, constant negotiation was carried out with suppliers of digital fabrication tools and machines. This process was essential for planning and developing a digital fabrication laboratory, known as a FabLab, at the Faculty of Physics of the University of Havana. By the end of August, the list of equipment needed for this facility was finalized, marking a significant milestone in creating this innovative space. Negotiation with suppliers has been a crucial aspect of this project: continuous dialogue was maintained throughout the period to ensure the selected tools and

machines met the standards required for a FabLab. This kind of laboratory not only provides access to advanced technology but also fosters creativity and hands-on learning among students. The final equipment list includes a variety of essential tools for digital fabrication, such as 3D printers, CNC machines, and electronics equipment. Each item was chosen carefully to ensure students can carry out innovative projects and develop technical skills that are increasingly in demand in the job market. The creation of the FabLab at the Faculty of Physics represents a unique opportunity for students and researchers: this space will not only serve as a hands-on learning center but will also facilitate interdisciplinary collaboration between different areas of knowledge. Students will be able to experiment with advanced technology, work on joint projects, and apply theoretical concepts in a real-world environment. With the equipment list finalized and negotiations advancing, the FabLab is expected to be operational in the near future — benefiting current students and attracting future ones interested in Physics and related disciplines, and representing a step forward in modernizing the academic curriculum and preparing students to face the technological challenges of the 21st century.

Objective 2. Training of PhD candidates at the FabAcademy



PhD students Alex Manuel Rivera Rivera and Luis Abel Rodríguez de Torner during their FabAcademy stay at the Université Libre de Bruxelles.

PhD students Eng. Alex Manuel Rivera Rivera and MSc. Luis Abel Rodríguez De Torner had the opportunity to take part in their first academic stay at the Université Libre de Bruxelles, where they attended the FabAcademy course. This program focuses on digital fabrication and prototype design, giving students the tools needed to carry out innovative projects. As a result of their training, both students developed and defended their first final-project prototypes. Eng. Alex Manuel Rivera Rivera presented a weather buoy, a device designed to measure and record meteorological data in real time, contributing to the collection of information crucial for bay studies. MSc. Luis Abel Rodríguez De Torner, meanwhile, worked on building a wave channel, a system that simulates sea conditions and allows the study of wave behavior. The experience in Brussels gave them a solid foundation to continue their studies and contribute to advancing knowledge in engineering and meteorology.

Objective 3. Continued development of the buoy



3D-printed prototype of the buoy hull.

After Eng. Alex Manuel Rivera Rivera and MSc. Luis Abel Rodríguez De Torner returned from the FabAcademy last July, intensive work continued on developing the buoy. This effort has included running a variety of tests focused on improving the device's technical performance — specifically on optimizing the stability and reliability of the wireless communication link, and on improving the buoy's energy efficiency to gain greater autonomy. Stability is a critical aspect for any device operating in aquatic environments, since it directly affects the ability to take precise measurements and remain functional under changing conditions; to address this, several strategies have been implemented, such as adjustments to the buoy's physical design to improve its flotation system, aiming to minimize unwanted movement that could affect data collection. On the wireless-communication side, extensive tests have been run to ensure data transmission is constant and secure — essential not only for real-time monitoring but also to ensure the collected data remains accessible without interruption; different libraries and manufacturers are being explored that could offer greater resistance to external interference and a stable connection even under adverse conditions. Energy efficiency is another fundamental pillar in the buoy's development: to maximize autonomy, different energy sources are being evaluated, including renewable options such as solar panels, and implementing energy-management systems will optimize consumption and extend the device's operating time without frequent recharging — beneficial not only operationally but also as a more sustainable approach to marine research.

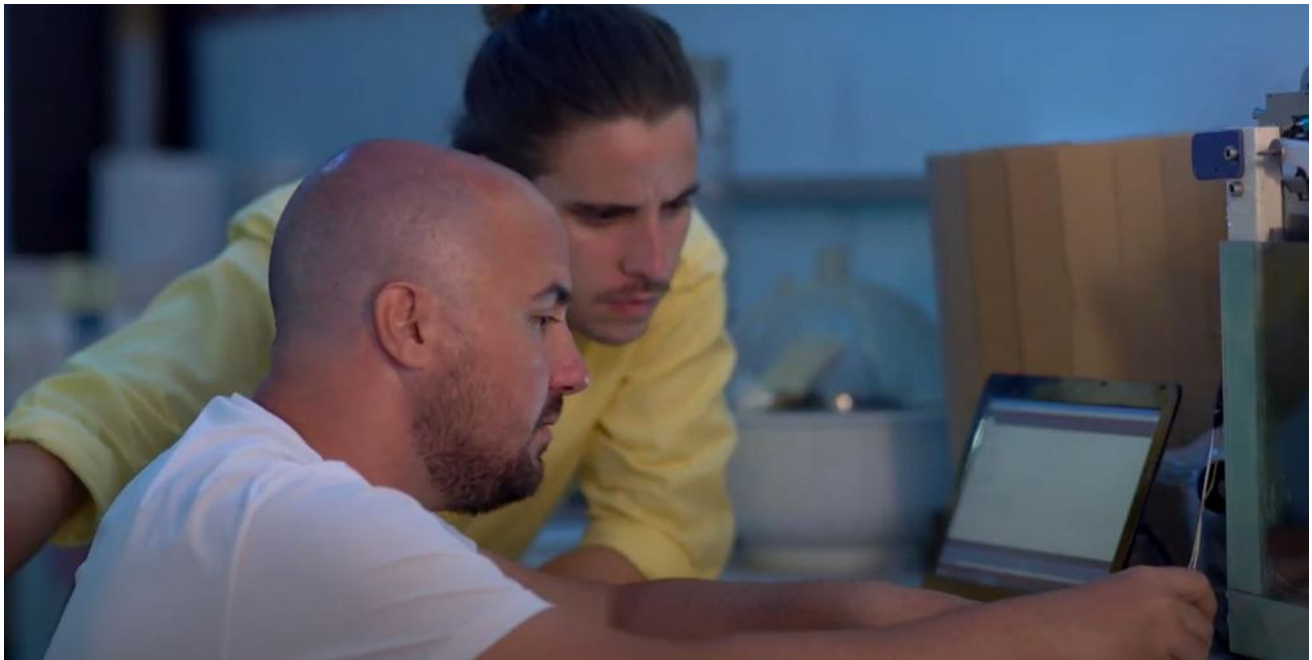
Objective 4. University outreach



Pre-university students working on electronics during the 2024 Physics Summer School.

From July 15 to 20, 2024, the Faculty of Physics of the University of Havana hosted the "2024 Physics Summer School," whose main goal was to introduce the Physics degree program to prospective students through intensive workshops for pre-university youth. During this week, participants engaged in practical and theoretical activities on fundamental topics in physics and technology. The workshops, designed to spark interest in science, offered a clear view of the practical applications of physics. Instructors Eng. Alex Manuel Rivera Rivera and MSc. Luis Abel Rodríguez De Torner guided the students through:

- Basic electronics: fundamental principles and simple circuits
- Small motors: operation and practical applications
- Arduino programming: getting familiar with this platform for electronics projects



The two instructors on the program "Observatorio Científico," Cuban National Television, August 17, 2024.

On August 17, 2024, both instructors took part in the program "Observatorio Científico," broadcast by Cuban National Television, where they reported on the FabLab Academy's activities and their importance for water-quality monitoring. The FabLab Academy has emerged as an innovative space that promotes hands-on learning and the development of technology projects focused on environmental issues. During the program, methodologies for assessing parameters affecting water potability were discussed, highlighting their importance for public health and aquatic ecosystems. The positive impact on the local community was another central theme, emphasizing how the workshops aim to raise young people's awareness about environmental care and encourage their active participation in technological solutions. The participation of Eng. Alex Manuel Rivera Rivera and MSc. Luis Abel Rodríguez De Torner underscored the importance of interdisciplinary work in applied science, inspiring new generations to get involved in scientific and technological fields that contribute to the country's sustainable development.

Sincerely,

Dr. C. Ernesto Altshuler

Head of the Complex Systems Laboratory, Center for Complex Systems, Faculty of Physics
University of Havana.

