NET4mPLASTIC PROJECT

WP4 – Act. 4.1 Monitoring plastic and microplastic wastes on coastal and marine environments

D 4.1.3

On Field Test Procedure

June, 2022 - Version 1.1

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Acronyms / Abbreviations

ACRONYM	DEFINITION
EWS	Early Warning System
FPT	File Trasnfer Protocol
GNSS	Global Navigation Satellite System
MP	Microplastic
OBU	On board Unit
PP	Project Plan
PT	Project team
TC	Technical task coordinator
TGS-ML	Technical Subgroup on Marine litter, European Union expert group On marine litter
TM	Task Manager
UML	Unified Modelling Language
WP	Workpackage

1 Introduction

1.1 Background of the project

The main goal of the NET4mPLASTIC project is to achieve an efficient monitoring system for plastic and MP distribution along the Croatian and Italian coastal and marine areas in order to improve the environmental coastal and marine sea quality conditions.

According to doc R1, the WP4.1 Monitoring plastic and microplastic wastes on coastal and marine environments – have the goal to obtain physical, environmental, and plastic data for the 4 pilot sites identified in WP3, with the following activities:

- Topography and bathymetry monitoring with GPS, UAV based monitoring system and regional remote sensing (multispectral data reflecting information and land surface condition, ocean colour, phytoplankton, chemistry, atmospheric water vapour, temperature, etc.) (UNIFE, TIPH, UNISTFGAG)
- In-situ sampling activities, especially of the biota (IZSAM)
- Real-time recording of parameters relevant to MP: transparency, temperature, salinity, dissolved oxygen (% and mg/l), pH, pressure/depth, localization, flow, weather conditions (UNIST-FGAG)
- "on-fields" test procedure for all remote sources of data (maritime drone, instrumented package on board of ships, etc.) (HYDRA, PROSOFT)

The expected reports within WP4.1 are the following:

- D.4.1.1 - Sediments samplings, river and sea water samplings and biota sampling from the 4 macro-areas
- D.4.1.2 - Physical and remote sensing data and drone images
- D.4.1.3 - On Field Test Procedure
- D.4.1.4 - On Field Test Report

1.2 Purpose of the report

This document is the deliverable D.4.1.3 - On Field Test Procedure detailing all functional and non-functional requirements relevant to Drone / OBU component to be verified on field with related operative steps and expected successful results, within the activity WP4 act.4.1 Monitoring plastic and microplastic wastes on coastal and marine environments of the **Net4mPlastic project - New Technologies for Macro and Microplastic Detection and Analysis in the Adriatic Basin.**

The main goal of the field tests are to collect MP data using the drone and in parallel using the manta, and to check the realibility of data collected automatically by the drone thanks to the sensors installed, comparing the data with the ones processed in the lab using the manta.

The purpose of this document is summarized as follows:

- On field monitoring system description

- Boat and dafety requirements
- Description of the planned monitoring areas
- Description of pre-mission tasks and mission tasks
- Drone functional tests
  Description of data procedure

1.3 Reference documentation

No	Title	Rif/Report N.	Pubblished by
[R1]	**APPLICATION FORM - NET4mPLASTIC Project - New Technologies for macro and Microplastic Detection and Analysis in the Adriatic Basin** 2014 - 2020 Interreg V-A Italy - Croatia CBC Programme Call for proposal 2017 Standard - NET4mPLASTIC Priority Axis:Environment and cultural heritage	Application ID: 10046722, dated 30/06/2017	Lead applicant: UNIVERSITY OF FERRARA
[R2]	EWS requirements definition	HYD001-SPE-001.0	ACT3.3 – Net4Mplastic
[R3]	D 3.3.2 – EWS Hardware Architecture and network design	HYD002-SPE-001.0	ACT3.3 – Net4Mplastic
[R4]	D 3.3.3 – EWS Software Architecture design	HYD003-SPE-001.0	ACT3.3 – Net4Mplastic
[R5]	D 3.3.4 – EWS Hardware and other software Components	HYD004-SPE-001.0	ACT3.3 – Net4Mplastic
[R6]	D 3.3.5 - Report and database provision	HYD005-SPE-001.0	ACT3.3 – Net4Mplastic
[R7]	D.5.2.4 - Net4mPlastic project - Marine OBU _Drone test procedure and report	HYD006-SPE-001.0	ACT5.2 – Net4Mplastic

2 On field monitoring system description

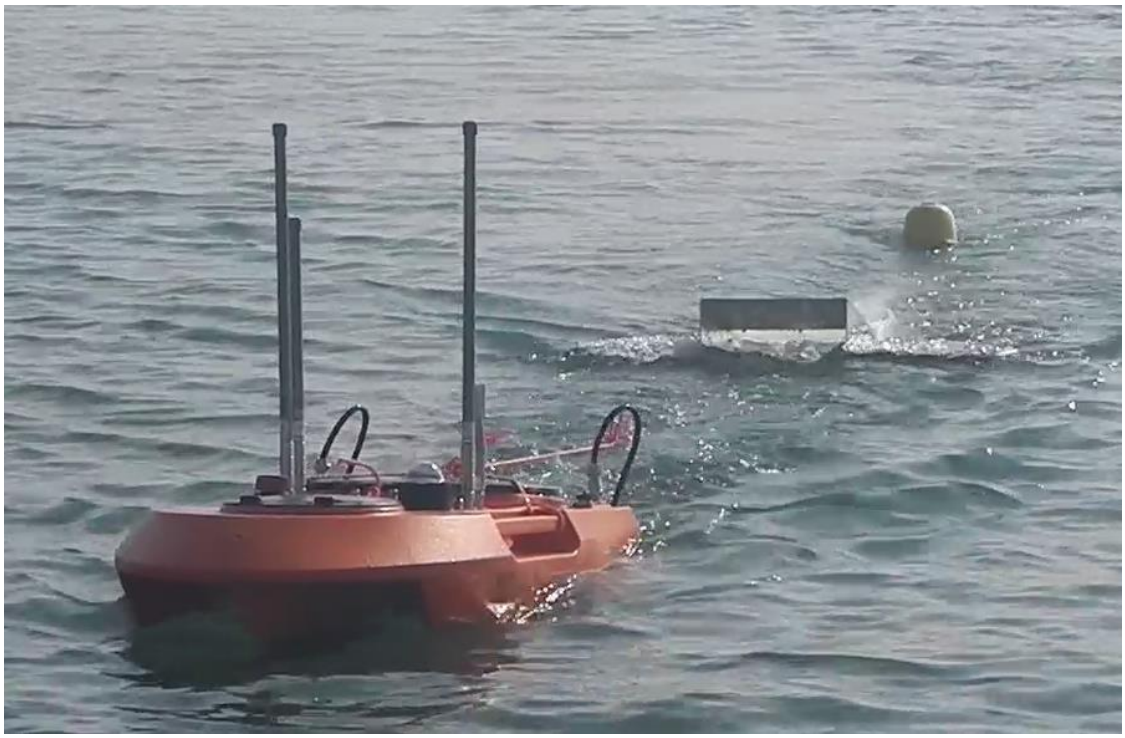
The purpose of this section is to describe the final configuration that will be adopted to carry out the monitoring campaign of MP in the pilot sites in Italy and Croatia.
For each site the following parts are requested:

- a boat A with a standard size manta with a net of 300um;
- a boat B with onboard the OBU unit equipped with GNSS receiver, CT and autonomous datalogger;
- a marine drone equipped with mini-manta and HOLO2 sensor.

Boat A and boat B shall follow the same planned monitoring transepts. Boat B will follow the drone that will be controlled by a person on board equipped with dedicated drone remote consolle.
The measurement carried out by the drone equipped with HOLO2 and mini-manta can also be carried out adopting the following configuration:

A) mini-manta connected at stern of the boat B equipped with OBU and with the HOLO2 sensor at 50cm under the sea level and fixed to a side of boat B with a rope. The drone will be switched off on board of boat B.

The configuration A is suggested to speed up the monitoring mission in case of limited window of suitable wheather conditions to avoid the deployment and recovery of the drone that in this experimental missions is carried out by the boat B and can be considered the more “risky” task of the mission for people and instrumentation.
The following pictures show the drone equipped with mini-manta and HOLO2 sensor, related consolle for remote control and the OBU with CT and GPS.
It is necessary to have a notebook PC onboard of boat B to configure the HOLO2 sensor and to download data after the completion of some transepts as described in section 4 of the present document.



Drone and mini-manta at sea

Drone and mini-manta at sea and on land. Drone remote consolle

HOLO2 sensor mechanically fixed under the drone hull

OBU: datalogger box, CT and GNSS, battery charger

3 Boats and Safety Requirements

Boat A and B indicated in section 2 above shall satisfy the following minimum requirements

REQUIREMENT ID	Description
B01	motor boat capable to move at low speed (1knot)
B02	suitable to host at least 4 persons
B03	Availability of 230VAC on board for Laptop and OBU
B04	Availability of a flushing pump to clean the manta net
B05	If not equipped with small crane the boat shall have a flat area (platform) at stern very close to the sea surface that allows an easy deploy/recovery of drone

The operation shall be allowed with sea state condition less or equal to Beaufort 2 corresponding to a peak wave of 30cm and a maximum wind speed of 3.4m/s and no rain to operate in safe conditions to deploy/recover the drone. In case of worse weather condition, the operation with the manta and the navigation of the drone will be forbidden.

The more risky tasks during a mission are the deployment and recovery of the drone equipped with mini-manta at its stern and HOLO2 sensor fixed under its hull. The feasibility of this operation shall be accurately evaluated for each mission and for each boat available. In case of not availability of the minimal safety conditions the drone will stay on board and the same monitoring mission can be carried out with the configuration A described in section 2 of the present document.

The minimum persons on board of boat B are:

- 1 boat driver;
- 2 persons to deploy/recover the drone and manage it with mini-manta and to recover the mini-manta bottle;
- 1 spare person to get pictures and movies for communication activity WP2.

4 Planned Monitoring Sites

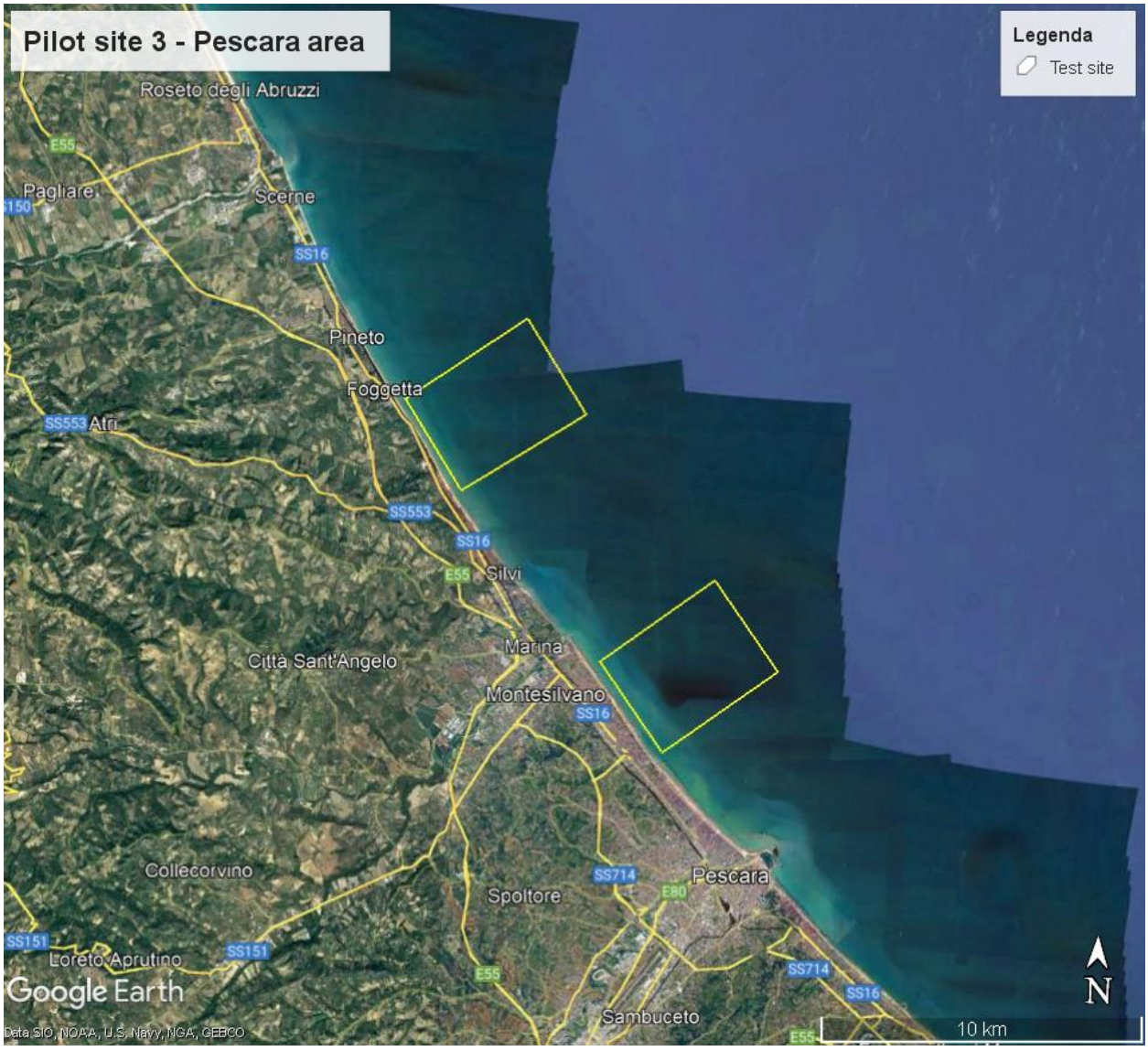
4.1 Sites in Italy

The selected sites in Italy are the following:

- Pilot site 1: Po Delta, located in the Adriatic Sea, North Italy, West coast; selected locations are Goro (in the South of Po mouth), and Boccasette (in the North of Po mouth);
- Pilot site 3: Pescara area, located in the center of the Adriatic Sea, West coast.

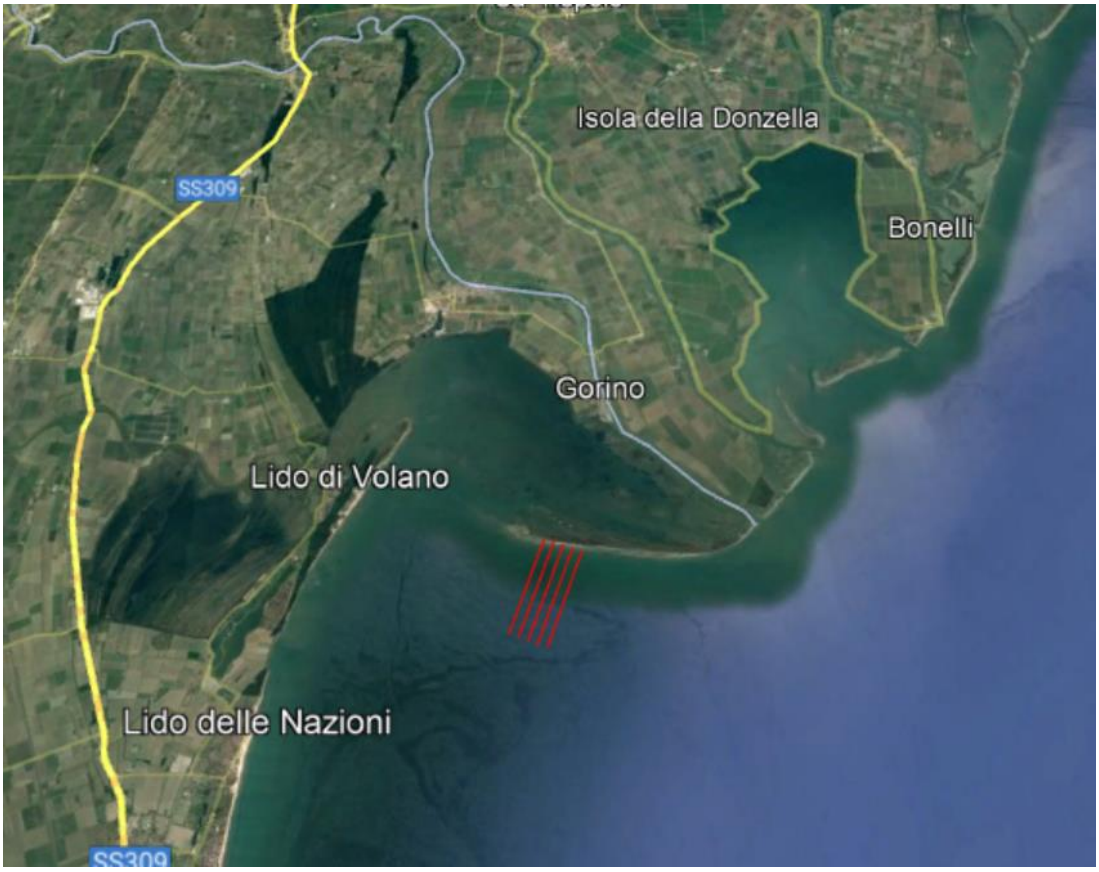
See enclosed an overview of the selected areas.

Pilot site 1 – test sites in Po Delta – Italy



Pilot site 3 – test sites in Pescara– Italy

Overview of Transets in Delta Po – Italy



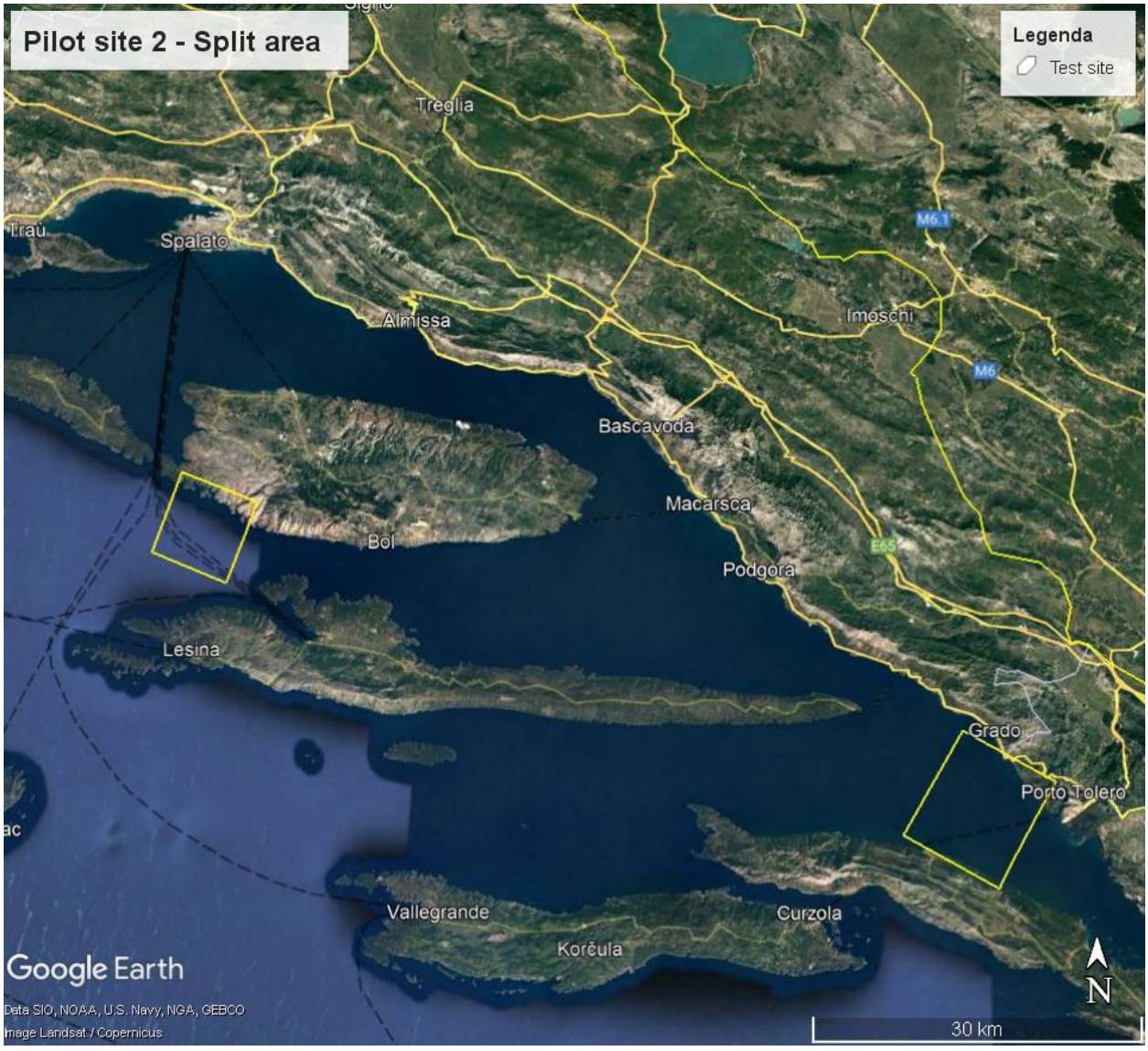
Detail of Transets in GORO – Italy

4.2 Sites in Croatia

The selected sites in Croatia are the following:

- Pilot site n.2: Split, located in the center of the Adriatic Sea, East coast.
- Pilot site n.4: Rijeka, located in the North Adriatic Sea, East coast;

See enclosed an overview of the areas.



Pilot site 2 – test sites in Split – Croatia


Treglia
E65
Salona
Castel Stafileo
Trau
Spalato
Stobreč
Okrug Gornji
Podstrana
70
Almissa
San Pietro della Brazza
Brač
Bol
Cittavecchia
Lesina
Zaraće


Drvenik
Zaostrog
San Giorgio
Podaca
Grado
8
Porto Tolero
Trappano
415
414
Donja Banda

Pilot site 4 – test sites in Rijeka – Croatia

An alternative site has been identified close to RAB island, as in teh figure below.


Fiume
E65
Cirquenizza
Malinska
Novi
Krk
Verbenico
E65
Vrataruša
Veglia
Ponte
Segna
23
E65
Bescanuova
Sveti Juraj
Otok Prvić
Lukovo
Loparo
Nacionalni Park Sjeverni Velebit
Kra
Donja Klada
E65
Rab
Arbe
Stinica
Image © 2021 CNES / Airbus
Image Landsat / Copernicus

5 Pre-Mission Tasks

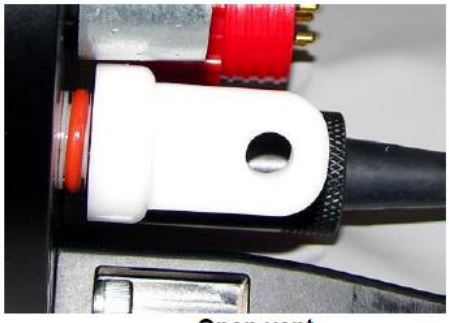
The day before the mission the following preparation tasks shall be carried out:

1) To recharge the drone battery using its battery charger. The drone integrates only one battery to assure navigation stability with the HOLO2 instrument connected under the hull. The second spare battery can be recharged outside the drone in order to have two fully charged battery packs for a mission.
   During the recharging phase of the drone battey, keep open the door of the battery compartment to allow heat dissipation. Pay attention to the cables and battery aligment closing the battery compartment door and verify it is properly closed to avoid water intrusion during the navigation.

2) To recharge the internal battery of the drone consolle using the USB cable inside the consolle case.

3) To charge the battery of the HOLO2 using dedicated battery charger with Subconn Micro 6 pins connectors. This operation shall be carried out in dry condition opening the white vent port manully (it is sufficient to see its o-ring). When the charger light is full green the battery is charged. Remove the charger connector and put the 6 pin dummy plug; close properly the vent port.

Battery charger



Open vent

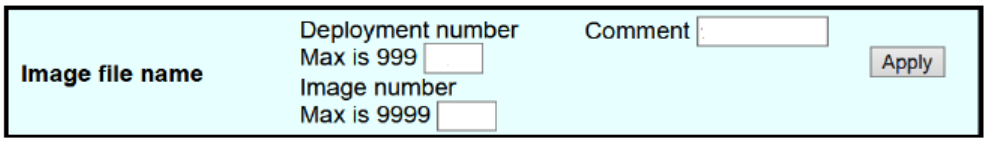
Red clip—a reminder to close the vent

4) To prepare the HOLO2 sensor by means of its web server interface. To activate the web server connection it is necessary to execute the following procedure:

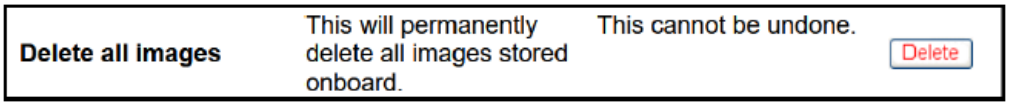
a. In a notebook equipped with ethernet interface to set the IP 192.168.0.1 with netmask 255.255.255.0.
b. Remove the red dummy plug from the HOLO2 and use the cable terminated on one side with RJ45 connector to connect HOLO2 and notebook.
c. Move the magnetic switch of HOLO2 from 0 to 1 and after 1 second back to 0 and wait about one minute to get connection with the HOLO2 web server by means of an internet browser editing as URL the address 192.168.0.150.
d. The following web page shall be displayed:

Verify that the Program 1 is set with 20 fps (0.05sec period). Anyway with transepts with duration of **15mins** it is possible also to set **10 fps (0.1sec period)** to speed up the data download and processing steps avoiding losing MP detection resolution.

e. In the following page insert Deployment Number = 1 and Image number max = 9999.



f. To delete all internal images (it is supposed they were already saved in external SSD) with the following command



g. To disconnect the Ethernet cable from the sensor and insert the red dummy plug.

h. To prepare a set of mechanical tools and consumables: spanner and screw drivers (to fix HOLO2 under the drone), ropes and plastic ties, etc. (see section 9).

5) To charge the battery of the OBU disconnecting it from the OBU. In case of availability of 230VAC on board it is possible to avoid using the battery. Anyway it is evidenced that the OBU battery has an autonomy of about 20 hours of operations thus probably it is not necessary to recharge it to execute all missions. It is undelined that the OBU shall remain with CT, GNSS and datalogger disconnected to save the battery. Connect them only after the OBU is fixed on board of the boat to start the mission. Adopt the following connection sequence: connect before the cable on GNSS and CT to the OBU box and after connect the green power connector to the datalogger Artila inside the OBU box and close the box. The GNSS shall see the sky and the CT shall be in water.

6) To verify that the mini-manta net and its bottle are clean.

At the arrival of person and instrumentation in the place of boat B, the following tasks shall be carried out on board of the boat B:

7) To verify that the HOLO2 has all dummy plugs on the electrical connectors and vent port propely closed; to fix HOLO2 under the drone with dedicated metal parts and a safery rope. The HOLO2 shall have the magnetic switch to 0 since the last deleting of internal images.

8) To connect the mini-manta to the drone with the ropes and related metal wires.

9) To fix the OBU on board on boat B; to connect GNSS and CT to the OBU box, connect power to the datalogger; remove the protective cap of the CT and fix it with plastic ties to a small pole fixed to the boat to keep the sensor in water.

After this task it is possible to navigate with the boat to the beginning of first transept to begin the mission.

6 Mission Tasks

During the execution of a mission the following information shall be logged manually by the people that execute the mission:

a) Take note of the counter in the flow sensor of the manta.
b) Move switch of the HOLO2 from 0 to 1. Take note of the time and GNSS position when the HOLO2 magnetic switch is moved to 1.
c) Switch ON the drone and related console and test correct pairing in air activating the thrusters. The drone is switched ON with related switch SW indicated in this picture whereas to switch ON the console it is necessary to push and release the button indicated with the arrow a first time and after to keep the same buttom pressed waiting for the 4 LEDs ON. **NOTE:** before to switch on the console check that the front selectors are set on Unlock (left) and Manual (right).

Joystick on the left allows to command the dorne to go forth and back whereas joystick on the righ allows the drone to turn. The person controlling the drone shall keep the console tied with a safety string to the pants or jacket.

d) Deploy the drone in water.
e) Move the boat B and with the console keep the drone parallel to the boat at about 5m from the boat avoiding collision
f) At the end of the transept recover the drone onboard and move the magnetic switch to 0 taking note of time of this event and related GNSS position. In order to avoid to recover and to deploy the drone it is possible to carry out consecutive transepts (maximum 3-4 transepts of 15-20min) recovering only the manta bottle but it is recommended to take note of the time of beginning and end of each transept.

NOTE: the OBU acquires autonomously CT data tagged with GMT time and GNSS position thus the user has only to download the data at the end of the mission.

The sheet in ***Appendix A*** shall be used for each mission to take note of essential information for data downloading and post processing.

7 Download Data Procedure

The data to download for each mission are the following:

- HOLO2 holograms
- OBU data

The following paragraphs describe the download procedures and type of data to be saved.

7.1 HOLO2 Data Download

To download the data from the HOLO2 sensor it is necessary

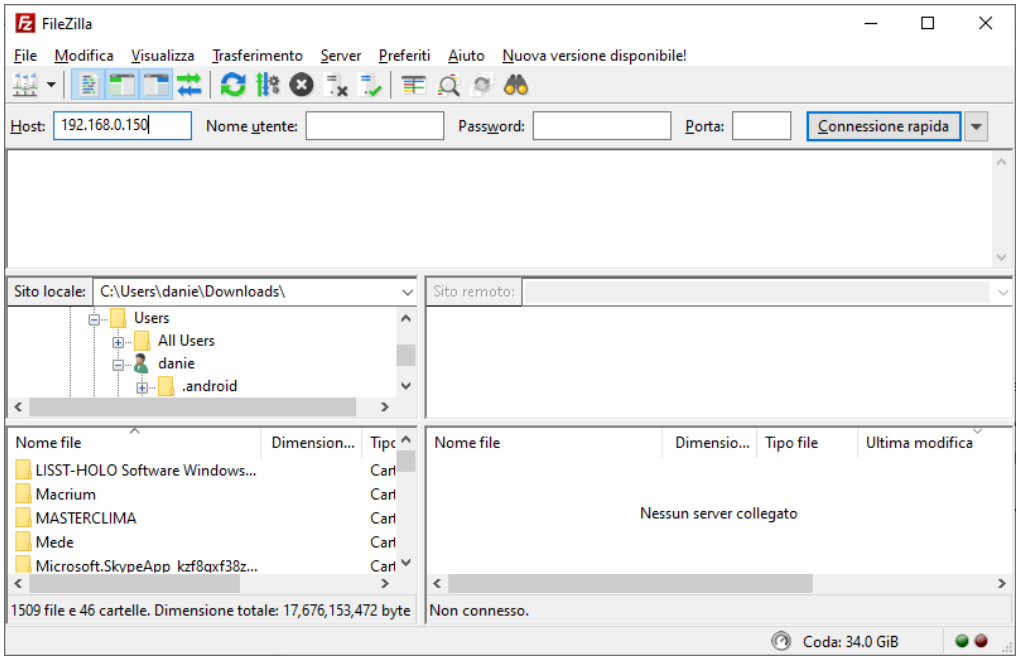
a. to connect the ethernet cable from the sensor to a notebook PC with ethenet interface (IP address 192.168.0.1/24) and with installed an FTP client (e.g. Filezilla).

b. Move the magnetic switch of HOLO2 from 0 to 1 for 1 second and immediately back to 0. After about 1 minute it is possible from the PC to get access to the web server interface of the sensor using a web borwser with URL 192.168.0.150. The following page is displayed

c. Go to the ***Tools*** page and disable the automatic sleep to keep the sensor awaken during the data transfer.

Automatic sleep	☑ Check here to disable sleep. The instrument will remain awake indefinately.	This will allow continuous web access but consumes power.	Apply

d. Open Filezilla ftp client, insert the IP 192.168.0.150 and no need to specify a host thus you can push directly the button “Quick Connection”



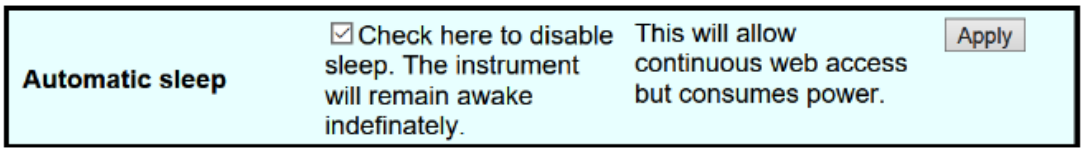
e. On the right side of the window above there will be the folder ***images***: drag and drop it to the left side. It is suggested to select as destination folder on the left side an external SSD in order to allow an easy data transfer among the project partners.
With an acquisition rate of 20fps the time to transfer the holograms collected in 15mins is about 30-40mins. At the end of the transfer rename the folder images on the left side with a name associated to the transept: e.g. Rijeka_Transept_1 and inside the folder create a ***readme.txt*** file where to write date and time of begin and end of the transept:

```
BEGIN 25/10/21 09:23:12
END   25/10/21 09:52:24
```

f. At the end of the data transfer you can delete all the HOLO2 internal images with the following command

Delete all images	This will permanently delete all images stored onboard.	This cannot be undone.	Delete

g. Before disconnecting PC from HOLO2 you can put the HOLO2 to sleep after 10min as indicated in this picture



The processing of the holograms will be done in the office in the afternoon/evening at the end of the mission. It consists of the following step:

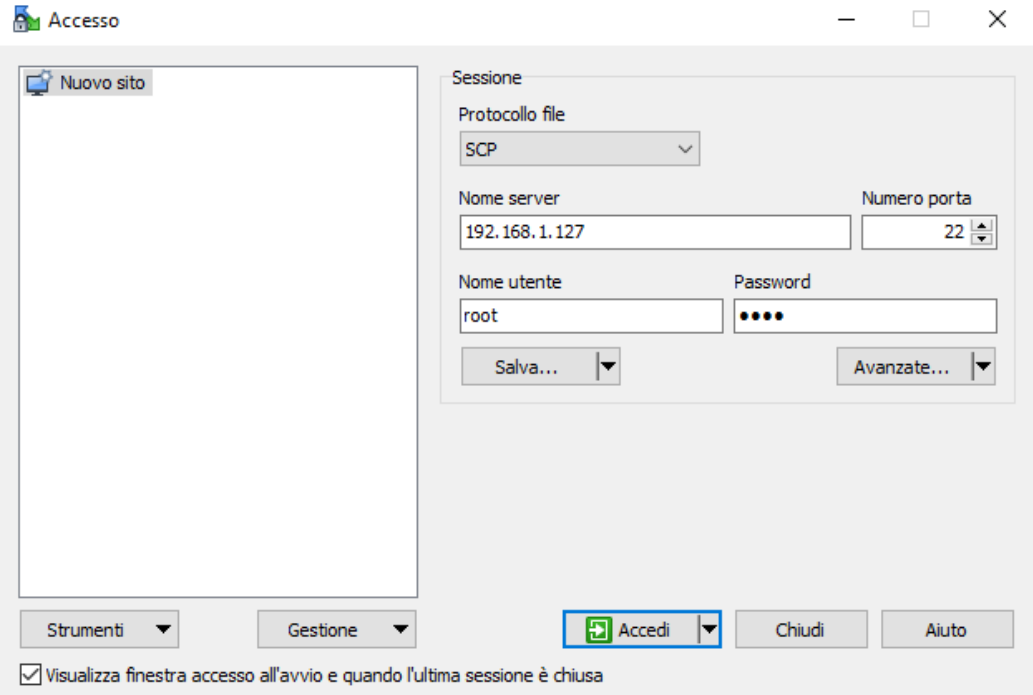
STEP1 – To see rapidly with the application ***OpenSeeIt_v0.47.16.4*** in browse modality all acquired holograms and take note only of the ones with presence of particles. In particular select a clean holograms without particles to be used as background during the batch processing.

STEP2 – To start the batch processing and wait for result generation only for the subset of holograms selected in STEP1.

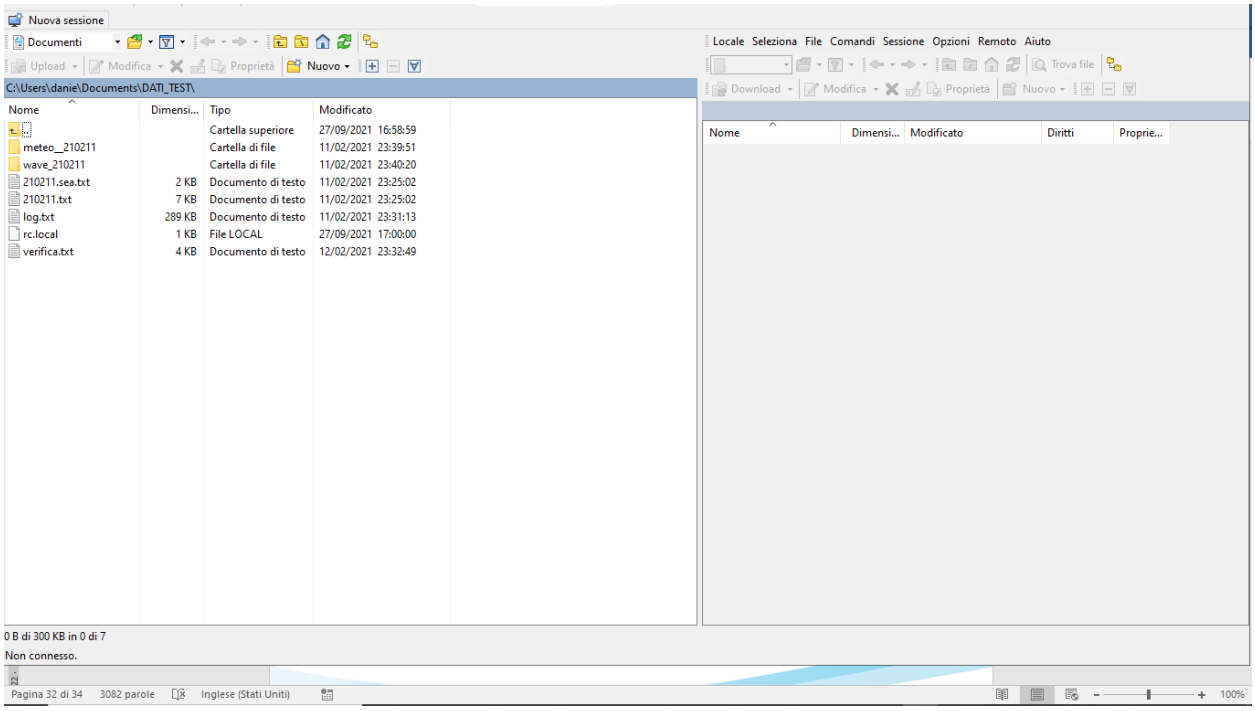
For a transept of 15-20min at 20fps, STEP1 takes about 1-1.5hours and STEP2 another hour for a total processing time of about 2-3 hours to get MP concentration results and image of detected partcles with size classification.

7.2 OBU Data Download

All CT data logged inside the OBU are GMT time and GNSS position tagged thus they can be downloaded at the end of the mission in office. Anyway it is suggested to get a look at the data also during the mission. The OBU datalogger has IP address 192.168.1.127 thus it is necessary to set the notebook PC with the IP 192.168.1.100 (netmask 255.255.255.0) to get access to the data using WINSCP application (https://winscp.net/eng/download.php) in modality SCP. As indicated in the following picture set the server **IP 192.168.1.127** and insert the username and password **root, root** to get access to the OBU datalogger as shown in this picture.



In the following window on the right side move from the root to the folder /media/mmc/datames to see the files ***YYMMDDhhmmss.dat*** and ***YYMMDDhhmmss.gps*** and drag and drop them on the left side in the PC hard drive. They are small files easy to be trasnsferred also via email. The name of the files is the GMT date and time of switch on of the OBU on board of boat B. No necessary to delete the files from the OBU datalogger as the storage autonomy is very big compared with the files sizes. .DAT and .GPS files can be open with EXCEL as they are CSV test files.


Nuova sessione
Documenti
Upload
Modifica
Proprietà
Nuovo
C:\Users\danie\Documents\DATI_TEST\
Nome
Dimensi...
Tipo
Modificato
Cartella superiore 27/09/2021 16:58:59
meteo__210211 Cartella di file 11/02/2021 23:39:51
wave_210211 Cartella di file 11/02/2021 23:40:20
210211.sea.txt 2 KB Documento di testo 11/02/2021 23:25:02
210211.txt 7 KB Documento di testo 11/02/2021 23:25:02
log.txt 289 KB Documento di testo 11/02/2021 23:31:13
rc.local 1 KB File LOCAL 27/09/2021 17:00:00
verifica.txt 4 KB Documento di testo 12/02/2021 23:32:49
Locale Seleziona File Comandi Sessione Opzioni Remoto Aiuto
Trova file
Download
Modifica
Proprietà
Nuovo
Nome
Dimensi...
Modificato
Diritti
Proprie...
0 B di 300 KB in 0 di 7
Non connesso.
Pagina 32 di 34
3082 parole
Inglese (Stati Uniti)
100%

8 NOTES FOR THE MISSION

It is recommended to have on board a set of mechanical tools and consumables parts as shown in this table.

Spanner sets	
Screw drivers set	
Scissors	
Plastic ties (length of 30-40cm)	
Small ropes (10m with working strength of at least 100kg).	
Adhesive tape	
Neoprene film (2mm thickness)	

At the end of each mission remember to execute the following maintenance tasks:

- Clean the HOLO2 sensor with clean drink water and dry it.
- Clean the CT sensor with drink water dry it and protect its head with the cap.

9 APPENDIX A – Mission Log Data

Mission Location				**Mission Persons**
Mission Date				*(Head)*
Notes				
TRANSEPT		**TIME [hh:mm:ss]**	**POSITION [LAT LON]**	**MANTA FLOW COUNTER**
#1	**BEGIN**			
	END			
#2	**BEGIN**			
	END			
#3	**BEGIN**			
	END			
#4	**BEGIN**			
	END			
#5	**BEGIN**			
	END			
#6	**BEGIN**			
	END			

The Time of BEGIN and END are respectively the time of moving the magnetic switch of HOLO2 from 0 to 1 and viceversa. The position can be read from the GNSS receiver of a normal smart-phone (many free APP are available in the App-Store).

10 APPENDIX B – Tethered Drone For Macroplastic

Scope of the present Appendix is to provide the procedure to use an underwater tethered drone equipped with camera procured for the monitoring of Macroplastic at the sea bottom.

10.1 Underwater Drone System Overview

The Navatics MITO System consist of an underwater drone able to dive up to 40m water depth thru a control data cable hosted by a wireless, sea-surface relay buoy. The operator, using a dedicated remote controller hosting a common Android/iOS device, will be able to drive the drone from the boat via wifi link with the surface relay buoy. Herebelow is depicted the Navatics MITO at sea and the Navatics MITO major components breakdown.

Navatics MITO

NAVATICS MITO Main Components

10.1.1 Specification

The specifications of the Underwater Drone System are the following:

- Dimensions: 360mm x 300mm x 135 mm
- Weight: 3 Kg
- Capacity: 80Wh 14.8V@5400mAh
- Operating Time: 2-4 hours
- CMOS Size: 1/1.7 inch
- Video Recording Resolution: 3840x2160@30/25 fps, 2048x1536@30/25 fps, 1920x1080@30/25 fps
- Live Stream Resolution: 1920x1080@30 fps
- Maximum Speed: 2 m/s
- Maximum Depth: 40m
- Tether Cable Length: 50m
- Wireless Range to Remote: 500m

Herebelow is depicted a breakdown of the drone.

Underwater Drone Breakdown

10.1.2 Quick Start Guide

The pre-deployment steps to prepare the drone for the mission are quick and easy and consists mainly of:

- Prepare the underwater drone;
- Prepare the wireless surface relay buoy;
- Prepare the iOS/Android device with the remote controller.
-

In the following paragraphs the main necessary steps are illustrated for a quick deploy. For detailed instructions please see the annexed user manual.

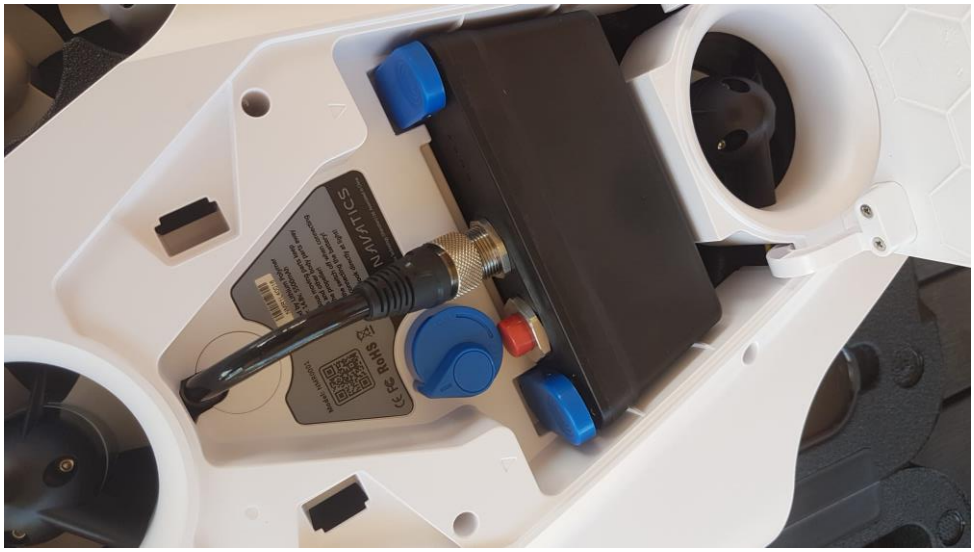
10.1.2.1 Drone Preparation

To prepare the drone for the mission is necessary to open the foam box on the drone side, recover the battery, flip the drone bottom up and insert the battery in the apposite housing, connecting it via the

dedicate connector and then switch on the instrument with the rotative swith located inside the battery housing.

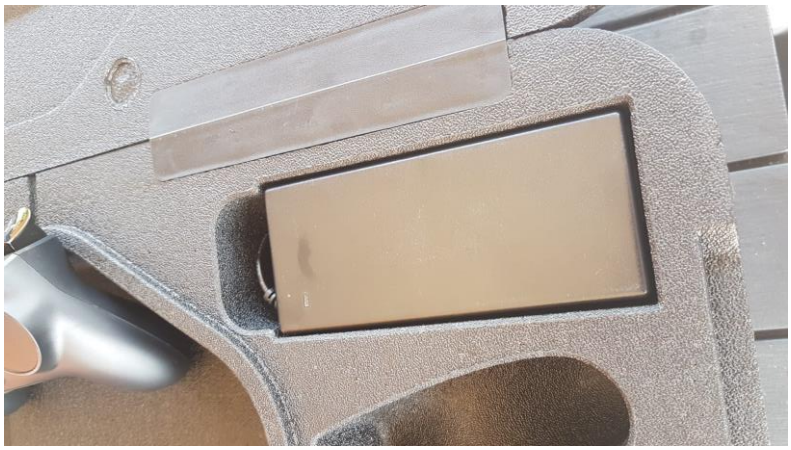
Drone with spare trusters and battery

Flipped up drone with opened battery housing



Battery inserted in the drone housing, ready to be switched on with the apposite rotative-blu switch

The battery of the drone can be charged with the apposite battery charger, illustrated in the picture below.



Drone Battery Charger

10.1.2.2 Wireless Surface Relay Buoy Preparation

To prepare the Wireless Surface Relay Buoy, it is necessary to open the box on the buoy side, take out the buoy and raise up the yellow antenna laying on the solar panel and the buoy will automatically switch on and it will be ready to be paired thru WiFi link with the iOS/Android device hosted by the remote controller.

Wireless Surface Relay Buoy – Controller – Buoy Charging Cables

Wireless Surface Relay Buoy Switched On (Antenna up)

On the antenna side, the buoy hosts an USB-C connector protected by a rubber enclosure. In case the buoy is discharged, charge it with the cables illustrated in the picture below.

Buoy Charging Cables

10.1.2.3 Remote Controller And System Connection

The remote controller needs to be assembled as shown in the picture below.

Remote Controller ready to host the phone

With an iOS or Android Device (and by selecting it on the physical switch on the front side of the controller, behind the phone holder), the following operations have to be performed:

- Install the NAVATICS MITO Application from the iOS/Android Store;
- Create an online account as requested by the application;
- Enable the OTG option (if not already enabled) on the device to be able to link the device with the controller;
- Connect with the appropriate USB-C or MicroUSB to USB cable the device with the controller;
- Place the device orizontally on the holder hosted by the controller.

At this point it is necessary to connect the prepared buoy and the prepared drone like illustrated in the picture below.

Drone – Buoy Tether Connection

The iOS/Android Device is ready now to connect via WiFi link to the prepared system consisting of underwater drone and wireless surface relay buoy. The application loaded on the device will prompt out all the necessary easy steps to be performed to have the uplink.
Once the wireless link is established, the drone and the surface buoy are ready to be deployed on the sea surface. The operator can then start to control the drone.

11 ANNEXES

Drone User Manual

HOLO2 User Manual

Mini-Manta Technical Sheet

MITO OWNER'S GUIDE