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D9.9 Interim Report on promoting the Marine Science Technology Synergies

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Introduction

Eurofleets+ plays a central role in provision of access to our Global Oceans and Seas. As a result, one of its key objectives is to ensure that it not only explores, develops but promotes Marine Science Synergies across all stakeholders to ensure that all vessels can respond to Users' needs.

Marine research infrastructure is advancing with new fixed ocean seafloor observation and mobile surface and subsea autonomous technologies presenting challenges to the existing fleet to deploy and maintain them. Technologies such as autonomous vehicles are advancing rapidly as well as the exploration of new and novel applications for existing equipment and machinery.

Research vessels are striving to move towards better interoperability, building a more flexible and responsive fleet across Europe which is being achieved by new state of the art vessel design or through modernization and modification of the existing fleet. The highly capable modern fleet is able to perform multidisciplinary research including deep ocean high resolution mapping, deep ocean seismic acquisition, full ocean depth oceanography, sampling and coring to 8,000m water depth, metal free CTD sampling ("clean CTD"), acquisition of 24 m long sediment cores and acting as platforms supporting modern marine equipment such as ROV's and AUV's.

Eurofleets+ continuously engages with stakeholders so that research vessels can respond to user needs and their needs in relation to evolving technologies. Eurofleets networking activities include work packages dedicated to stakeholder engagement and Innovation Management and Exploitation. Through questionnaires, interviews workshops and polls, users have been engaged to identify their needs the solutions to which is not available can be potentially solved through Marine Technology Synergies.

Synergies with other European funded projects have also been explored and developed, through engagement with workshop activities, platforms, ship time opportunities and validation of new service provision relevant to the Eurofleets+ project and its community.

Eurofleets+ Joint Research Actions focus areas were identified in the past projects Eurofleets and Eurofleets 2. Working closely with industry partners and SME's, Eurofleets+ focuses on three specific objectives including advancing the data management processes, investigating and developing equipment and rigs for deep sea operations from vessels, and developing innovative methods and strategies for intelligent exploration, mapping and control using cooperative navigation. Each of these focus areas are being developed through working together with researchers, industry and stakeholders to develop new or adapt existing technologies to further enhance the European Research Vessel Fleet operations and service provision.

Promotion of the possible synergies and potential JRA collaborations has continued since the beginning of the project. Activities including Eurofleets+ science sessions, presentations of the technologies developed, exploration of possible opportunities to collaborate with projects, RI's, networks and researchers have taken place with further activity planned into 2022.

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1. Marine Technology Synergies with Other Infrastructures

1.1 Drivers for developing Marine Technology Synergies

It is understood that there is positive synergy when *"the result is greater than the sum of the results of each element or each part acting in isolation*"; this can be summed up very simply with the aphorism" one and one makes three.

At its core Eurofleets+ sets out to identify, develop and implement Marine Technology Synergies across all activities to sustainably optimise coordinated approach in the provision of access to our seas and global oceans. Externally it generates synergies to exploit complementary observing systems and infrastructures and to set-up sustained integrated services to the user communities.

Synergies can occur in marine science technologies at different levels:

- in research and innovation for development, in the design of new equipment, using new technologies (3.1, 3.2, 3.3);
- in the implementation of these new technologies in infrastructures and projects (deployment and recovery of equipment: 3.2);
- in standardization of operations;
- in developing a coordination structure for the formation and training of technicians, as well as, the standards of calibration and operation of equipment including deployed equipment as rigs;
- in logistics and optimization of uses of new technologies;
- in the strategy for attracting resources for development;
- In identifying synergy actors in marine science technologies.

Recognizing the opportunity for development presented by Marine Technology Synergies, and building on the legacy of the previous Eurofleets and Eurofleets II projects, Eurofleets+ includes not just Joint Research Activities but also industry and research infrastructure partners to ensure delivery of synergistic tools and equipment to meet the evolving challenges of marine research, especially for deep ocean research and exploration, data management, and virtual access. Eurofleets+ JRA activities were defined by the user and stakeholder needs for the development of new tools established in the previous projects. These needs are related to the technological evolution of equipment but also to manoeuvres and operations, cable lengths, fiber ropes, data transmission or interoperability between different platforms. Collaborative industry partners across software, engineering and robotics play a key role in Eurofleets+ JRA, coupled with coordinated inputs from stakeholders such as Vessel Operators, other Research Infrastructures and integral stakeholder groups.

Eurofleets+ endeavours to engage collaboratively with complementary projects, observing systems and research Infrastructures as a core activity. Eurofleets+ are active members of the Board of European Environmental Research Infrastructures (BEERI), which is the decision-making body of the ENVRI community. In addition, the Eurofleets+ advisory board includes representatives from EuroGOOS, JCOMMOPS and the European Marine Board who provide feedback on activities and advice on future actions from their representative communities. Eurofleets+ Coordinator, Aodhán Fitzgerald, has joined the advisory board of European Facility for Airborne Research (EUFAR), a unique

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European research infrastructure dedicated to airborne research in the environmental and geo-sciences. Eurofleets+ and EUFAR have many synergies not only related to research, observation and validation applications in Marine Science but also in the future development of a Eurofleets RI. EUFAR have recently progressed on the Research Infrastructure lifecycle by establishing an AISBL, a model under consideration by Eurofleets+ for the long-term proposal to better coordinate and optimise the European research fleets.

Further Eurofleets+ stakeholder engagement is coordinated by Work Package 5 led by EMSO ERIC. Activities include engagement of key stakeholder groups through questionnaires and interviews (Deliverable 5.3 Map of User Needs) to identify and confirm user needs with regard to research vessels and through international stakeholder workshops (D5.2 Report and recommendations from International Workshop) focused on areas of extreme importance internationally. Additionally, cross cutting actions within Work Package 7 Innovation Management and Exploitation focused on identifying market needs and innovation potential have been identified and will be explored further for potential exploitation (D7.3 Industry Platform on Market Needs and Innovation Potential).

Activity Area	Needs Identified			
Access	Interoperability of Equipment	Data Transmission/Telepresence	Access to the Artic and Deep Ocean	Access to vessel Schedules
JRA-Joint Research Activities	Real Time Data Transfer	Sensor Development	DPI on-board	Deep Sea Operations
Innovation Management and Exploitation	Access to Vessel Time for Testing	Sensor and Equipment Development	Develop Links with Industry	Real Time Access to Data

Table 1-1 Summary of user needs for Access, JRA and Innovation Management and Exploitation

1.2 Stakeholder Engagement & Collaboration- Identified potential research and observation synergies

As outlined above, one of the key aims of the Eurofleets+ is to involve relevant stakeholders to coordinate efforts for the use of technologies and platforms for marine research and to assess the progressing needs and perspectives of stakeholders and user communities.

Organised in April of 2021 and led by EMSO ERIC, the first Eurofleets International Stakeholder Workshop took place, virtually, titled *"Combining fixed and mobile ocean observing systems and their link with satellite observations",* and was attended by more than 140 participants. This workshop aimed at connecting fixed and mobile ocean observing system infrastructure operators and stakeholders for the benefit of greater coordination and integration, that will undoubtedly translate

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into efficiency and more and better data and connecting to better services to public/society concerning climate change for example.

The communities involved in this workshop were:

- vessels operators;
- fixed-point observatories (coastal and deep-ocean);
- mobile systems (unmanned vehicles, ARGO floats);
- remote sensing (airborne, satellite).

The event had five invited speakers. After a brief introduction on the EUROFLEETS+ project, its Objectives and future plans to evolve towards a long-term sustainable distributed Infrastructure for the coordination of Research Vessels (RVs) in Europe (EUROFLEETS-RI), were presented. The first two invited speakers were from the European Commission (EC) and the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT). The EC representative briefly outlined the strategy, trends, and priorities for Horizon Europe in the environmental-marine domain. The EUMETSAT representative briefly outlined the strategy, trends and priorities for Horizon Europe in the space domain in relation and synergies with marine infrastructures.

The workshop included presentations from fixed-point and mobile research infrastructures (EMSO ERIC and EuroARGO ERIC) and from a project dealing with gliders (GROOM-II). To stimulate discussion during the workshop, four key concepts, towards an interdisciplinary framework of excellent science with fit-for-purpose technology, were proposed in line with UN Decade and Horizon Europe objectives.

The full report on the workshop can be found in D5.2 - Report and recommendations from International Workshop.

Through small group discussions and interactive polls, the needs of the user communities were summarized as:

- **Improving collaboration with RVs, sharing of best practice, developing new tools and favouring integration of the operations at sea through a better interoperability of the equipment**.

Eurofleets+ Progress to date

Improving interoperability of ROV's and AUV's is a primary aim of Eurofleets+, especially in terms of improvement and standardisation of tools/rigging and more efficient operation. Reducing the number of tools/rigging on-board with the aim of achieving a polyvalence is also a challenge within the current fleet (mainly in medium and small vessels) and will be addressed as part of the research. JRA 3.2 specifically address this issue and is outlined in detail section 3.2 Joint Research Action 3.2 Equipment innovations for deep sea operations from vessels

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- **Improving coordination between RIs through joint training and testing**

Eurofleets+ Progress to date

The evolution of marine technologies requires technicians to operate and maintain the equipment. Technicians affiliation can be with the infrastructure (sometimes managed by a third party) or the research institution. The equipment used in marine research is more or less standarised, however the equipment and the rigs used for deployment are usually different. Greater interoperability between vessels offers more flexibility for all Marine Research Infrastructures for deployment and recovery of equipment. Common technical training and equipment calibration and test processes is a great opportunity for exploiting synergies within the European RI landscape and beyond. Therefore, a structure that can handle and coordinate the training of technicians and the calibration and test procedures as well as the standards used is necessary. Eurofleets+ initiatives being developed across work Package 3 Joint Research Activities (outlined in section 2 and Work Package 6 Education and Training, Marine Technician Exchange, Robotics Labs and Marine Infrastructure Management training are all working towards greater coordination of services to Marine RI's. Additionally, a cooperation with Euro Argo Eric to participate in the Eurofleets+ Floating University scheduled on the CNR RV Dallporta in September 2022 is being explored.

- **Simplifying the access system to RVs towards multi-mission approach with the purpose of optimizing the space-time use of the RVs**

Eurofleets+ Progress to date

Eurofleets+ participating research vessels schedules are published in the European Virtual Infrastructure in Ocean Research Portal where potential users can view the following:

- Research Vessel Cruise Programme database, containing planned cruises per research vessel and owner / operator;
- Research Vessel database, containing characteristics of each research vessel, owner / operator details and, if available, a link to the ship's web page;
- Cruise Summary Reports (CSR) database, containing details of completed cruises and providing a first level inventory of oceanographic measurements made and samples taken during the cruises;

In addition, Eurofleets+ has actively engaged in initiatives with other RI's in pursuit of better coordination for improved European Marine Science Research through interactive workshops, meetings and conferences. EuroArgo ERIC organized a workshop Cooperation Framework between Marine Research Infrastructures" was organized as a side event to the 9th EuroGOOS Conference on May 5th 2021. The event attended by 11 marine Research Infrastructures and representatives gathered to discuss future strategy under a co-designed collaborative plan within the landscape of the UN Decade of Ocean Science and the European Ocean Observing System, with the aim to address and plan the next steps on sharing of knowledge and expertise, strengthening cooperation on both field activities and new technologies, creating robust interactive data interfaces, promoting joint activities on marine research and services and raising public awareness on marine environmental issues. There were 11 collaborative actions identified of which many present opportunities for synergies with the

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Eurofleets community which will continue to explore and develop. The full report of the workshop can be accessed here. "Cooperation Framework between Marine RIs"

Cooperation with other European funded projects

Project Name	Activity	Potential Synergies	Current Status
EUMarine Robots	Transnational Access Programme	Strategy development for long lasting transnational access to European Robots	Active
CatRIs	Service	Eurofleets+ included in CatRI's platform	Active
EuroSea	Policy Brief	Recommendations for sustainable ocean observation and management.	Published
GROOM-II	Collaboration	Technology Deployment Synergies	Active
RITrainPlus	Collaboration (Associate partners)	RI Management Training design and development	Active
Mission Atlantic	Research Vessel Access	Access to Vessel schedules	Active
IAtlantic	Training and Shiptime Platform	Collaborative training through floating university and	Active
INTAROS	Roadmap for a future Sustainable Arctic Observing System	Eurofleets+ Research Vessel Artic Region capacity	Active
NAUTILOS	Vessel Access	Sensor Validation	Active

Table 1-2 Synergies with European Funded Projects

2 Eurofleets+ Joint Research Activity Marine Science Technologies Synergies

Eurofleets+, research activities are encompassed in a single WP including three Joint Research Activities (JRA). These activities address three important topics innovative areas of concern for oceanographic vessels, data management and data access, increasing interoperability of vessels, particularly regional vessels to expand capacity and finally the expansion of the role robotics can play in ocean exploration. Task 9.3 Promoting the science of Eurofleets focuses on disseminating the scientific activities and results of the three aspects of JRA. The aim is to achieve this through presentations at conferences, organisation of a special sessions or side events at relevant meeting, publication of articles in Journals and popular science magazines, and finally to ensure that there is a focus on JRA activities at the stakeholder engagement events. A summary of each of the specific JRA focus areas and their related synergies with external project partners are outlined below.

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2.1 JRA 3.1 Advancing shipboard data management and data access

Eurofleets+ data management aims ultimately at publishing the metadata and data sets as collected by scientific teams during all the Eurofleets+ TNA cruises. This publishing is done through the EVIOR portal (European Virtual Infrastructure in Ocean Research) – integrated into the Eurofleets+ Website, and towards the larger community through inclusion in SeaDataNet and EMODnet portals and in a F.A.I.R. way. Therefore, the data management (DM) is deployed in synergy with SeaDataNet and its European network of NODCs. Scientific cruise teams formulate cruise DM plans for review by SDN NODCs (HCMR, OGS, and RBINS), who coach each scientific team before, during, and after TA cruises. They arrange later validation and archival of cruise data sets by NODCs for long term stewardship, and publishing. Scientific teams can make use of EMODnet Ingestion for transfer of processed cruise data sets to the NODCs.

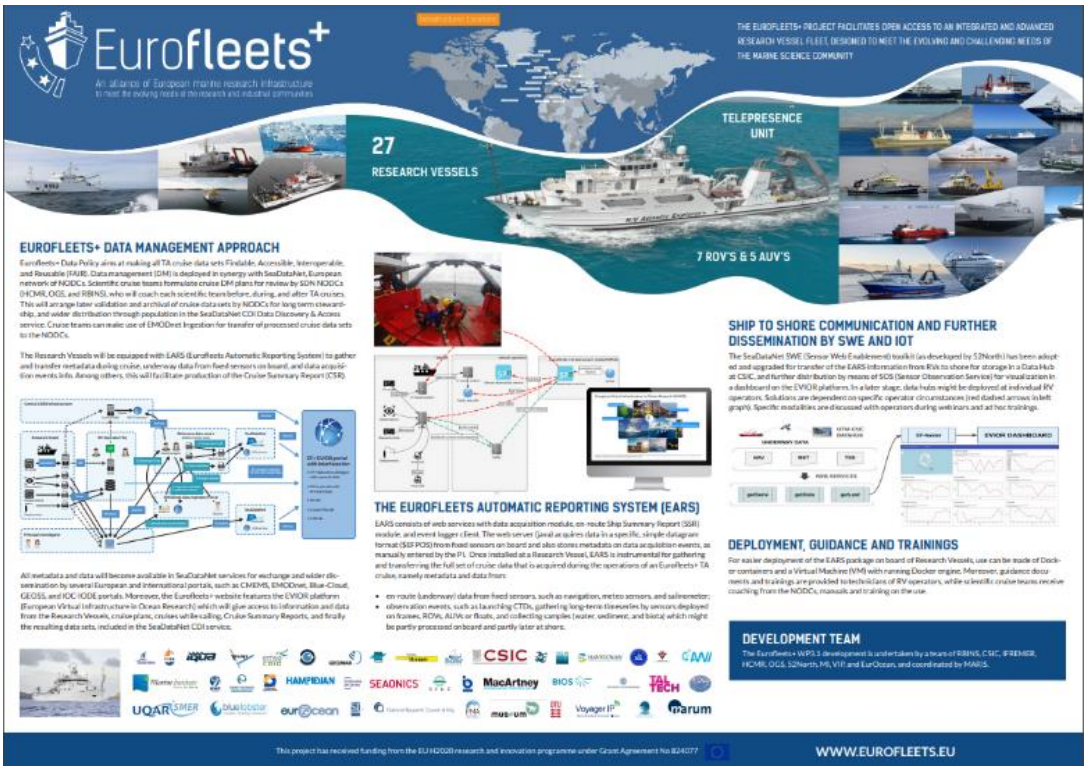

Figure 2-1Eurofleets+ JRA 3.1 ADVANCED SHIPBOARD DATA MANAGEMENT AND DATA ACCESS

The Research Vessels are being equipped with EARS (Eurofleets Automatic Reporting System) to gather and transfer metadata during cruise, underway data from fixed sensors on board, and data acquisition events info. Among others, this facilitates production of the Cruise Summary Reports (CSR) which are published and made available at EVIOR soon after the cruises. The advanced version of the shipboard data management system has successively been piloted on board selected research vessels, and rolled out across the fleet to supported Eurofleets+ funded TNA. The functionalities of the EVIOR portal continue to be reviewed, improved and expanded, including providing researchers in a later project stage with unique cloud computing and analytical technologies for interacting with the collected research vessel metadata and data.

The SeaDataNet SWE (Sensor Web Enablement) toolkit (as developed by 52North) has been adopted and upgraded for transfer of the EARS information from RVs to shore for storage in a Data Hub at CSIC,

and further distribution by means of SOS (Sensor Observation Service) for visualization in a dashboard on the EVIOR platform. This facilitates the transfer of cruise metadata and underway observation data from the EARS equipped research vessels to the shore while sailing. The dashboard (http://eurofleets.utm.csic.es/) is integrated in EVIOR and running with data streams from several research vessels. The following image gives an illustration.

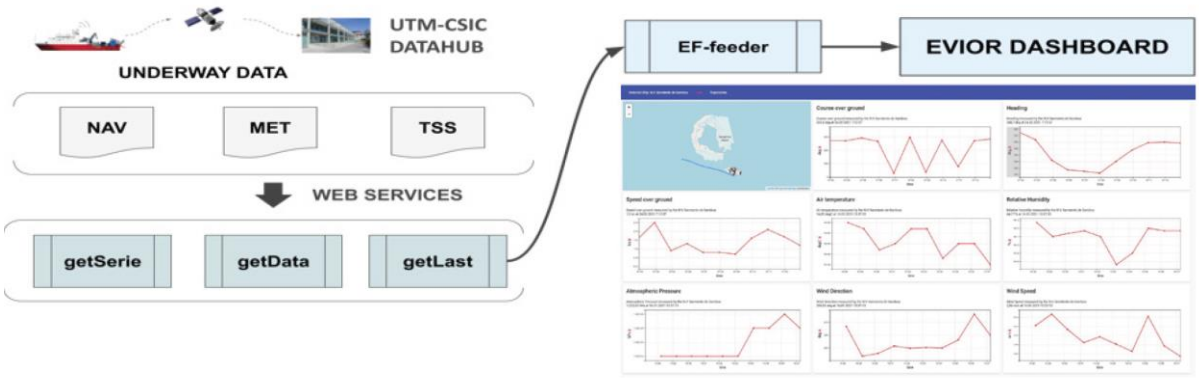

Figure 2-2 Eurofleets+ Underway Data

To date, the SeaDataNet CDI metadata format for describing observation data sets use was made of the L05 vocabulary to indicate the device categories (class of instruments) used for acquiring the observations. As part of the ENVRI-FAIR project, aiming at making data management services more FAIR, an expansion was made to be able to include also the specific type of instruments, such as e.g. Sea-Bird SBE 21. In this way, there is additional information available for making a better judgement on the quality of the data, useful for data centres performing QA-QC on the data, and for end-users. This expansion is done by adding the option for terms from the L22 vocabulary (Device Catalogue). The information for the CDI can be retrieved from the SensorML records that are being used as part of the SWE toolkit and this opens opportunities for Eurofleets+ as part of the EARS module to carry also the types of instruments as used on the research vessels.

There is a requirement to shorten the time period between data acquisition and data access for users on research vessels and on shore, as well as for interacting with crew and vessels from the shore. The ability to directly communicate from the shore with the ship, its crew, and its data acquisition operations, while sometimes at the other end of the world, will facilitate optimising the scientific output of these costly operations and the logistic support, where needed. Industry partner Voyager IP, specialists in maritime satellite and communications technologies have developed Guidelines for control and optimisation of hard/software which leverages existing technology to deliver a pooled solution for flexible data communications in a more effective and efficient manner. This system is currently implemented by some European Vessel operators within their own fleet. However, work is ongoing to implement this solution across multiple operators to further increase communications capacity across Europe. Solutions were presented to vessel operators during the Eurofleets+ Science Session at the 23rd European Research Vessel Operators meeting, June 2021 (Section 4.1).

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2.2 Joint Research Action 3.2 Equipment innovations for deep sea operations from vessels

Joint Research Action 3.2 Equipment innovations for deep sea operations from vessels focuses on improved capability for regional vessels and improving sustainability. Exploration of the deep sea is a major challenge and opportunity in marine research. Rigs and related technologies are fundamental to the study of the sea as they are needed to deploy equipment. Therefore, Eurofleets+ is conducting investigations concerning deep sea research from vessels aiming at achieving interoperability of rigs to be able to deploy different equipment, enabling installation of mobile equipment when needed, and facilitating sharing and installation of equipment across different ships. Two specific areas of research aim at increasing the capacity and interoperability for regional vessels and the third a dual mode handling system will be designed for the deployment and recovery of research tools and equipment such as ROV's, Grabs, Drop cameras and observatory components to seabed through moon-pools or/and over the side. Limited examples of dual handling systems for deployment through moon pool/ over the side are in existence and this task seeks to develop a concept design and simulation of operation will be conducted to demonstrate the design and prove its fitness for purpose.

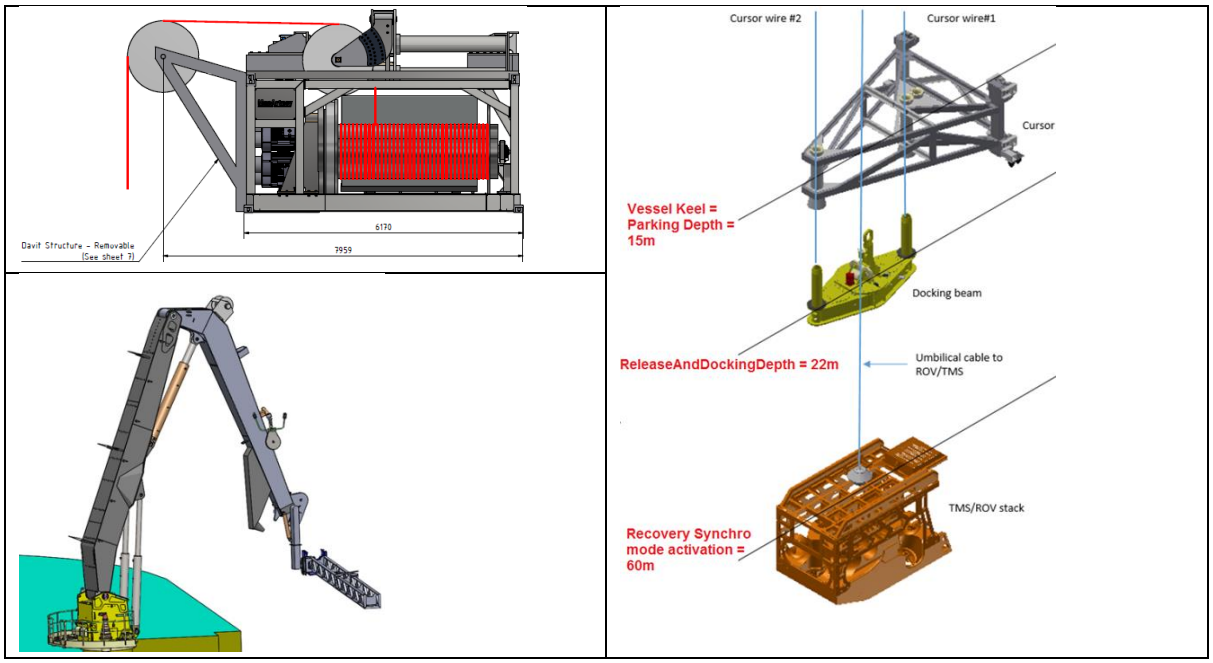

Figure 2-3 JRA Equipment innovations for deep sea operations from vessels

A detailed review of requirements of deep water observatories, deep water moorings and deep-water research in use currently and their future requirements including size and weights of deployed equipment, cables and landers and length and complexity of design of deep water moorings was conducted, which are presented in D3.5 - Review of current and future deep water requirements. European and international cooperation inputs were secured including EMSO ERIC, Ocean Networks Canada and S-NET project in Japan. Information on the current and future technical requirements of the deep-sea research communities in terms of deployment, maintenance and recovery of equipment informed the development and design of equipment to accomplish the Equipment innovations for deep sea operations from vessels.

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Eurofleets+ includes key synergistic industry partners, Hampidjan, MacArtney and SEAONICS to enable the exploration of synergies that can be achieved through the developments in the JRA tasks related to equipment innovations for deep sea operations from vessels. Working together with research vessel operators and other Marine Technology Research Infrastructures to develop detailed requirements analysis in order to identify key considerations for the design of each new solution.
The first of these (3.2.2), a New deep-sea winch design, an electric, heave compensated portable (ISO 20') winch from MacArtney to be utilized on Ocean, Global, Regional and vessels of opportunity (OSV) development implements, on the one hand, the ability to work in the deep-sea, and on the other, its portability. A portable winch such as this would allow Research Vessel Operators to expand the tools used on their vessels for the deployment of instrumentation and in turn research teams extend their studies in the deep sea using medium-sized vessels. Consultation with industry partner Hampidjan (key supplier of fiber ropes) played a key role in reduced weight of the design through expert advice on the conversion to the use of fiber ropes which allows access to greater depths and less load on the deck layout. The introduction of fiber ropes causes an adaptation of the rigs and an adaptation of the operations and performance of the deployed equipment.

Limited examples of dual handling systems for deployment through moon pool/over the side are in existence. Task 3.4 Moon-pool use for deployment and recovery of research tools seeks to develop a concept design and a simulation of operation to demonstrate the design and prove its fitness for purpose. The draft design which incorporates the scope of supply for a dual multipurpose launch and recovery system for oceanographic research tools and equipment such as (but not limited to) ROV's, grabs, drop cameras and observatory components to seabed through moonpool and/or over the side was presented to the European Research Vessel Operators for feedback ahead of progressing to concept design and 3d mapping. Observatories such as the SmartBay Test Site provided detailed drawings and specifications of observatory equipment and instrument frames as use cases for the new moonpool system. The design of both above technologies were presented to potential operators and users for feedback at the Eurogoos Conference - Ocean Observing Technologies, May 2021 and 23rd European Vessel Operators meeting, June 2021 (Section 4.1). In development of the functional system specification SEAONICS worked with the Vard Group (one of the world leaders in specialized shipbuilding for the offshore market) in developing detailed drawings including new Ice breaker vessel design incorporating the moon-pool and over-side operations concept system design

Progress has also been made on task 3.2.3 - Multipurpose crane/handling system for deep water operations (Outline design). In this case, the feedback until now is done with the company that carries out this feasibility study (Ferri) and EF+. A ship model is necessary to be able to frame this design and it was obtained from an engineering company. It is on this model that a first design was started and from here, again, the feed backs with EF+ and operators were produced. Cooperation with the fiber rope manufacturer (Hampidjan) is also required in this case. This factor imposes new performance but also a specific design due to the characteristics of fiber ropes compared to steel cables, especially in weight.

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2.3 Joint Research Action 3.3 Intelligent robot exploration

JRA 3.3 Intelligent robot exploration explores innovative methods and strategies for intelligent exploration, mapping and control using cooperative navigation. New technologies for Autonomous Surface Vehicles (AUVs) and Autonomous Underwater Vehicles (ASVs) are being developed and the innovations will be validated prior to field testing during operational cruises. These activities involve researchers from academia and industry working closely together and interaction with innovation and exploitation activities, and remote access.

Eurofleets+ is generating synergies with EUMarineRobots (EUMR) at a number of levels. Several surveys have been carried out within Eurofleets+ using the Sparus AUV owned by UdG to test the intelligent navigation strategy of JRA3.3 Intelligent robot exploration. One of the tasks of JRA3.3 requires extensive data gathering, using a downward looking high-resolution camera, to develop a machine learning system for the identification of seagrass. In 2021 the University of Southampton carried out a survey using the Sparus AUV in the framework of TNA experiments that are part of the EUMarineRobots project. This TNA also included gathering image data from different habitats with Sparus II AUV with a down-looking high-resolution camera. The data gathering locations were a posidonia site south of Sant Feliu de Guixols' harbor and a Maërl site in front of Lloret de Mar. The TNA was executed remotely and the University of Southampton processed the data to obtain image mosaics to characterize the local distribution and state of conservation of vulnerable habitats in complex terrains and will help establish reference sites for future monitoring. At the same time, the dataset of Sant Feliu de Guixols was shared with two of the partners of Eurofleets+, University of Girona and Coronis Computing, Eurofleets+ industry partner, and the gathered data is being integrated into the datasets which will be used for the development of Posidonia classifier of JRA3.3.

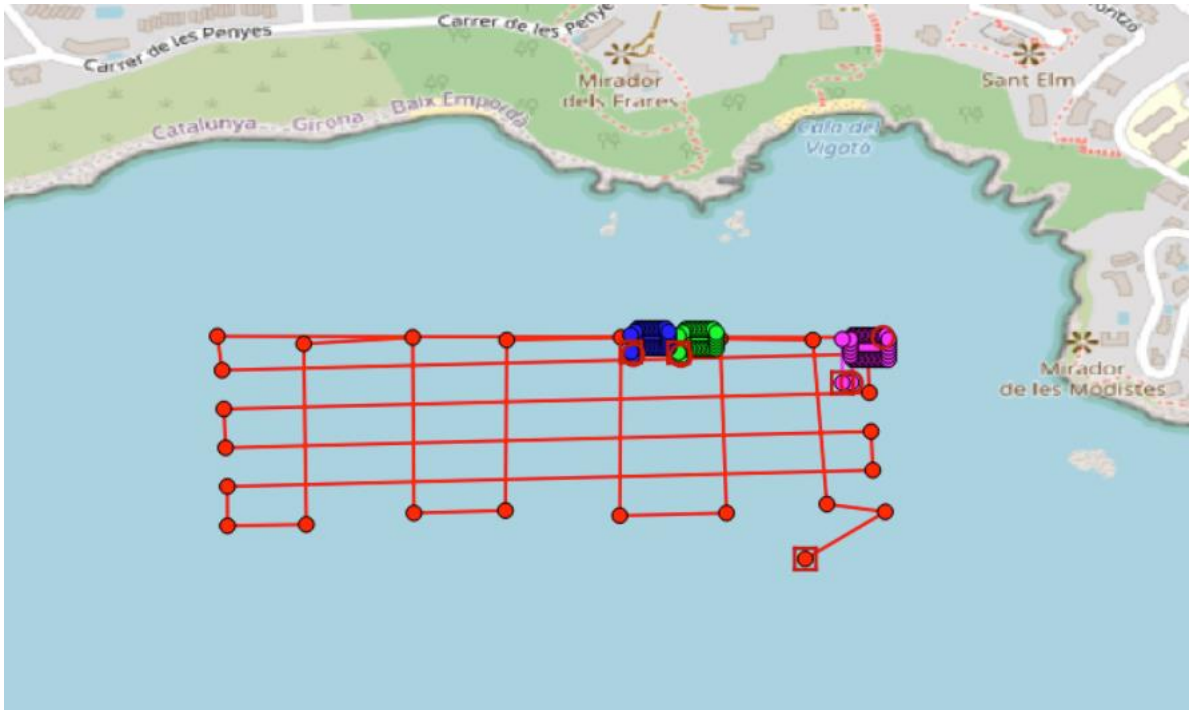

Figure 2-4Mission site and mission plans at Cala Vigatà in Sant Feliu de Guixols. Four datasets were collected: one sparse dataset and 3 dense ones. Missions were overlapped to compare Posidonia oceanica seagrass cover over a large extension

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Additionally, as outlined in Table 1, 2 Synergies with European Funded Projects Eurofleets+ and EUMR were actively involved in the virtual plenary session entitled "Marine Robotics in the Framework of European Research Infrastructure Programs" as part of the Porto virtual component of the international OCEANS 2021 San Diego-Porto conference. Both marine infrastructure projects presented several initiatives, including the participation of Jan Opderbecke (Head of the Unit for Underwater Systems at Ifremer, Toulon, France), Joao Sousa (Head of the Underwater Systems and Technologies Laboratory – LSTS, Porto, Portugal), Pere Ridao (Head of the Underwater Robotics Research Center - CIRS, Girona, Spain), Antonio Pascoal (Coordinator of the Oceans Thematic Area of the Laboratory of Robotics and Systems in Engineering and Science - LARSyS, IST, Lisbon, Portugal), Niamh Flavin (Project Management for Eurofleets+ within the Research Vessel Operations section of the Marine Institute, Galway, Ireland), and Rafael Garcia (Director of the Underwater Vision Lab, at the Computer Vision and Robotics Institute of University of Girona, Spain).

3 Promoting the Marine Science Technology Synergies

Since the beginning of the project in February 2019, development of activities in Work Package 3 and the subsequent Marine Science Technology Synergies have been actively promoted across conferences, events and through the publication of papers and posters. Many activities also focused on engagement with stakeholders and research vessel users to further build awareness of the solutions being delivered. As outlined previously, developments under JRA activity were impacted by COVID in some instances as there was limited access to vessels, labs and workshops. This coincided with a sharp reduction in opportunities for promotion in 2020 as events adapted to virtual solutions. Opportunities in 2021 increased as is evident from the level of activity below. All activity related to the project is summarised in Table in Annex I.

3.1 First EUROFLEETS "Science Session

To meet the expected challenges of research vessels, Eurofleets+ project is undertaking Joint Research Activities (JRA) with key industry partners. These JRAs focus on three topics of interest to marine science and marine exploration in general, with all three focusing directly on equipment and software used in research but also in other marine fields.

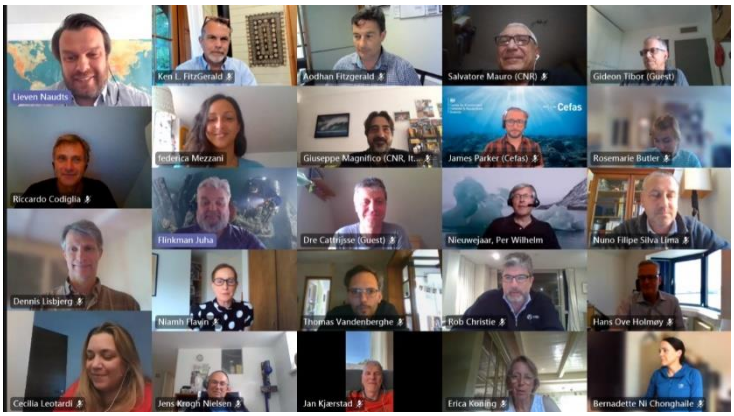

Figure 3-1 Eurofleets+ Science Session 2021

Eurofleets+ held the first of its "Science Sessions" during the 23rd European Research Vessel Operators (ERVO) Annual meeting in June 2021, highlighting the innovative product solutions being developed by the project Joint Research Actions. In collaboration with Work Package 7 Industry Platform, the one-hour "Science Session" took place on day two of the ERVO meeting and was moderated by Colm Mulcahy, CEO of Voyager IP (Eurofleets+ beneficiary) and chair of the Eurofleets+

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Industry Platform. A number of the project initiatives being developed have now reached a design, implementation or deployment phase and were presented to the wider ERVO group as key stakeholders and for feedback.

Presentations included:

- Eurofleets Automatic Reporting System (EARS) Eurofleets+ Data Management System (JRA 3.1)
- Optimizing solutions for telepresence and real-time data transfer. (JRA 3.1)
- EFs+ Portable Electric Deep Sea Winch Design. (JRA 3.2)
- Dual Mode Handling System (DMHS) designed by SEAONICS (JRA 3.2)

The presentations include live polls and question and answers after each presentation, with the audience reaching 55 attendees during the session. The live polls provided direct feedback on the JRA develop presented providing key feedback to the task leaders to inform further iterations of the developed technologies.

The presentations are available at the ERVO website here: https://www.ervo-group.eu/np4/np4/np4/46.html

3.2 Presentations at Other Workshops, Conferences and Expeditions

2019

- ERVO June 2019 (Presentation)
- IRSO Meeting (Presentation) (JRA 3.1) September 2019
- Marine Autonomous Technology Showcase Conference and Exhibition Southampton (Exhibition) (All JRA) November 2019

2020

- Data management for European fleet of research vessels in EUROFLEETS+" to both Sea Tech Week and Eurogoos Ocean Technology Forum being held in parallel which will be held virtually in October 2020 (JRA3.1)
- IRSO Online Presentation October 2020

2021

- European research infrastructure synergies EUMR (Workshop) (JRA3.3) April 2021
- International Conference on Marine Data and Information Systems (IMDIS) (Poster) April 2021
- Eurogoos Conference – Ocean Observing Technologies (Paper and Presentation JRA3.2) May 2021
- EMODnet Open Conference (Poster) (JRA3.1) June 2021
- EMRA(Presentation) JRA3.3 July 2021
- Oceans 21(Presentation) JRA3.3 September 2021

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3.3 Eurofleets+ Papers, posters and articles

Two Journal articles have been published in the period in Remote Sensing and ISPRS Journal of Photogrammetry and Remote Sensing focused on the work of advances in underwater autonomous vehicles.

- Scale Accuracy Evaluation of Image-Based 3D Reconstruction Strategies Using Laser Photogrammetry, Isteni, Klemen; Gracias, Nuno; Arnaubec, Aurélien; Escartín, Javier; Garcia, Rafael.(JRA3.3)
- Automatic scale estimation of structure from motion based 3D models using laser scalers in underwater scenarios, Isteni, Klemen; Gracias, Nuno; Arnaubec, Aurélien; Escartín, Javier; Garcia, Rafael. (JRA3.3)

Papers

9th Eurogoos International Conference: Advances in Operational Oceanography: Expanding Europe's Ocean Observing and forecasting capacity

Topic: Ocean Observing Technologies. (

Eurofleets: fostering links to industry in the advancement of equipment innovations for deep sea operations from research vessels

Niamh Flavin MI, Aodhán Fitzgerald MI, Arturo Castellon Masalles CSIC, David Waage Hampidjan, Lars Jørgensen MacArtney ASJan Kjærstad &Jarle Sigurd Ødegård Seaonics. JRA3.2)

Poster Presentations

International Conference on Marine Data and Information Systems (IMDIS)

- UTM-CSIC Data Service Architecture: from acquisition on-board to final dissemination EARS, Juan Luis Ruiz, UTM-CSIC, Susana Diez, UTM-CSIC, Xavier Rayo, UTM-CSIC, Guillermo Garriga, UTM (JRA3.1)
- CSIC Data management in Eurofleets+: the whole picture Thomas Vandenberghe, RBINS, Sciences Susana Diez Tagarro, CSIC, Dick Schaap, MARIS B.V., Guillaume Clodic, IFREMER Juan Luis Ruiz, CSIC, Hong Minh Le, RBINS, Yvan Stojanov, RBINS, Christian Autermann, 52°North Simon Jirka , 52°North (JRA3.1)

EMODnet Open Conference 2021

- Adoption of SWE toolkit by EU Eurofleets+ project in synergy with EMODnet Ingestion (JRA3.1) Dick Schaap MARIS, Thomas Vandenberghe RBINS, Susana Diez Tagarro CSIC

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Annex I

The table below summarises all Eurofleets+ communication activity from February 2019 to January 2022.

Event/Activity Name	Date	Location	Dissemination Type (Poster, exhibition, presentation etc.)
IODE Scientific Conference	18-19/02/2019	Tokyo (Japan)	Poster: The Spanish Institute of Oceanography recent updates of data sharing within the framework of international marine data management initiatives
Eurofleets+ (alliance of European marine research infrastructure) kick off meeting takes place at the Marine Institute.	March 2019	Internet	Press Release
Master's class at Valencia Politechnical Univ (UPV)	11/03/2019	Gandia (Spain)	Master's class
EGU General Assembly 2019	8 – 12 April 2019	Vienna	Information booth
EGU General Assembly 2019	09-Apr-19	Vienna	Townhall meeting
Norway-US Workshop on Machine Learning to Improve Science for the Sustainability of Living Ocean Resources	23-25 April 2019	Bergen, Norway	Presentation
III RICH Symposium	14/05/2018	Brussels	Presentation
European Maritime Day	16-17 May 2019	Lisbon	Exhibition
Atlantic Fair	23-May-19		Public lecture
Science Fair BERRI/ENvriPlus	04/06/2019	Brussels	Exhibition
EUROFLEETS+ Access Programmes- SEA Programme	07-Jun-19	Cork Ireland	Presentation

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Official Launch of EF+ project	7th June 2019	Cork (Ireland)	Presentation
Eurofleets+ is officially launched at SeaFest in Cork	June 2019	Internet	Press Release
Eurofleets+ is officially launched at SeaFest in Cork	June 2019	Print Media	Inshore Ireland Vol 15 Issue 2 Pg 23.
EUROFLEETS+ Ship-time and marine Equipment Application (SEA-Programme) Call "OCEANS"	June 2019	Internet	Press Release
2019 ERVO Meeting	11-13 June 2019	Hamburg (Germany)	Presentation
2019 ERVO Meeting	11-13 June 2019	Hamburg (Germany)	Presentation via Skype
21th ERVO Annual Meeting' The European Research Vessels Operators Group	11-13/06/2019	Hamburg (Germany)	Poster: 2018 Cruise Activities of the Inst. Esp. Oceanografia (IEO)
ERVO	11-13 June 2019	Hamburg	Presentation
IUGG/IAPSO Conference	8-18/07/2019	Montreal (Canada)	Poster: Sharing Data of the Spanish Oceanographic Institute Observing System (IEOOS) in the Framework of International Initiatives.)
EMSO ERIC 4th Engineering and Logistics Service Group (ELSG) Meeting	12-Jun-19	Virtual Meeting	Presentation via Skype
Post at AWI Intranet: "EUROFLEETS + SEA Call OCEANS – APPLY NOW"	July – Sept 19	AWI Intranet	Post at AWI Intranet & Email distribution lists
All Atlantic Young Researchers Summer School	24/08/2019	Galway	Exhibition
EMSO-ERIC Workshop on Sea Operations for Ocean Observatories	25-26 Sept 19	Toulon (France)	Presentation
2019 IRSO Meeting	10 October 2019	Hobart (Tasmania)	Presentation
2019 IRSO Meeting	10 October 2019	Hobart (Tasmania)	Poster
Applications open for EuroFleets+ Floating University	Oct 2019	Internet	Press Release
EMB / EurOcean Joint Open Event	6 November 2019	Berlin (Germany)	Presentation

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Marine Autonomous Technology Showcase	15/11/2019	NOC, Southampton	Exhibition
RV Celtic Explorers Users Workshop	22/11/2019	Marine Institute,	Presentation
Researchers invited to apply for three Eurofleets+ Programmes	Nov 2019	Internet	Press Release
EFs+ Working Meeting	17 December 2019	Milan (Italy)	Presentation
STRATEGIC DEVELOPMENT PROGRAMME FOR EUROFLEETS+	30-31/1/2020	Milan (Italy)	Presentation
Policy Makers Newsletter	09/01/2020	Direct Mail	Newsletter
iAtlantic Kick Off Meeting	12/05/2020	Virtual Meeting	Presentation
Project Newsletter	02/06/2020	Direct Mail	Newsletter
Mission Atlantic Kick Off Meeting	30th September 2020 – 2nd October 2020	Online	Oral presentation
IRSO	November 2020	Virtual Exhibition	Presentation
Long-term vision for the European Research Fleet ERVO Webinar	October 19, 2020	Virtual	Oral presentation
Marine Institute Research Symposium	9th and 10th December	Virtual	Oral presentation
EuroSEA General Assembly	20th January 2021	Virtual	Oral presentation
INTAROS Workshop	4/02/2021	Virtual	Oral Presentation
GROOM II	4/02/2021	Virtual	Oral Presentation
Distributed RIs workshop	17/03/2021	Virtual	Oral Presentation
Eurofleets Int Workshop	13/04/2021	Virtual	Oral Presentation
European research infrastructure synergies EUMR	15/04/2021	Virtual	Oral Presentation

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International Conference on Marine Data and Information Systems (IMDIS)		Virtual	Poster x 2
Eurogoos Conference – Ocean Observing Technologies	04/05/21	Virtual	Oral Presentation, Abstract
Eurogoos Conference - European Research Infrastructures	05/05/21	Virtual	Oral Presentation, Abstract
Cooperation Framework Between Marine RIs ARGO Event	05/05/21	Virtual	Presentation
ERVO	01/06/2021	Virtual	Presentation
ERVO	02/06/2021	Virtual	Special Science Session
EUMR All Atlantic Workshop	02/06/2021	Virtual	Presentation and Panel Moderator
AANCHOR All Atlantic Floating University Workshop	02/06/2021	Virtual	Presentation
Aix-Marseille University Protect Our Oceans	16/06/2021	Virtual	Presentation and Panel & Poster
EMODnet Open Conference	14/06/2021 to 16/06/2021	Virtual	Poster Presentation
EMRA	08/07/2021	Virtual	Oral Presentation
Oceans 21	23/07/2021	Virtual	Oral Presentation
Oceans 21	23/07/2021	Virtual	Oral Presentation
EMSO JRU Workshop	7/10/2021	Napoli	Oral Presentation
NAUTILOS Project Meeting	20/10/2021	Virtual	Oral Presentation

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