

16 November 2017  
Biblioteca Almeida Garret  
Porto, Portugal



STRONG  
MAR

# 2017 STRONGMAR CONFERENCE

## A SEA OF TECHNOLOGY

ORGANIZER



[www.strongmar.eu](http://www.strongmar.eu)

THE STRONGMAR PROJECT IS FUNDED BY THE  
EUROPEAN COMMISSION UNDER THE H2020 EU  
FRAMEWORK PROGRAMME FOR RESEARCH AND  
INNOVATION (H2020-TWINN-2015, 692427)



# VENUE

The 2017 STRONGMAR conference will take place at the Biblioteca Municipal Almeida Garrett, Porto (floor -2, Main Auditorium).



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Rua de D. Manuel II Jardins do Palácio de Cristal 4050-239 Porto <a href="mailto:bib.agarrett@cm-porto.pt">bib.agarrett@cm-porto.pt</a>	+351 226081000	<a href="http://bmp.cm-porto.pt/bmag">http://bmp.cm-porto.pt/bmag</a>



Main auditorium (image credits: Biblioteca Municipal Almeida Garrett)

# WELCOME

The STRONGMAR project team would like to wish you all a warm welcome to the one-day 2017 STRONGMAR conference - A sea of Technology.

The STRONGMAR project is an EU H2020 project, worth around 1 M€, aiming at creating solid and productive links in the global field of marine science and technology between INESC TEC and established leading research European institutions, capable of enhancing the scientific and technological capacity of INESC TEC and linked institutions. It also seeks to help raise its staff's research profile and its recognition as a European maritime research center of excellence.

STRONGMAR is coordinated by INESC TEC and is partnered with CINTAL, Heriot-Watt University, NATO Science & Technology Organization, Universitat de Girona and the University of Aberdeen.

The project will perform a series of activities from summer schools, winter schools, short-term scientific meetings, long-term staff visits, networking meetings, workshops, conferences, technology transfer workshops with stakeholders, and other dissemination activities.

This year's conference is mainly devoted to the technology which has been developed and applied in sea and oceans engineering and science. The "Sea of Technology" conference brings together a collection of prestigious and experienced speakers from around the world. The talks will cover a wide range of subsea technology from developments in subsea communications cables to underwater mining and the technology being applied; from 3D laser imaging to submersible holography of marine organisms; and from remote sensing of the sea and current profiling through to emerging opportunities and challenges. It is hoped that the range and topicality of the talks will encourage spirited and lively discussion that will spawn new research co-operation between European nations and the rest of the world; and promote the application of new technologies.

On behalf of myself, the project partners, the organising committee and the invited speakers, we wish you all a captivating, productive and pleasant meeting.

John Watson  
Chair of the 2017 STRONGMAR conference

The investment of INESC TEC in the technical-scientific development in autonomous systems and related fields, aims at solving new problems of society on a European, national and regional scale, thus contributing to the promotion of a regional development perspective of reference in ocean management (related with areas like safety and security, energy, raw materials and environment).

It is universally accepted that humanity has made significant improvements in its condition and quality of life. However, despite these achievements, humanity has not yet been able to manage this progress in a 'healthy', respectful and harmonious relationship with planet Earth and all species that inhabit it.

The economic growth will be feasible and compatible with a robust public health, leisure activities evenly spread through the population, reduction of the impact of climate change adaptation and other large-scale accidents, and, balanced management of natural resources in a non-depleting mode.

Oceans cover more than 70% of the surface of the globe, consist of over 90% of the living space, and are at the core momentum of our planet's physical, chemical, and biological cycles. However, the seas and oceans that dominate the surface of our planet remain relatively unexplored and poorly understood.

In this context, it is crucial to have a profound and solid knowledge about the oceans and the relations established between the oceans, the shoreline, the air and the forests. Understanding and reacting accordingly with these interactions will have a strong impact on growth and sustainability of the current and future population.

The 2017 STRONGMAR conference is a small contribution for the oceans-related R&D performed at INESC TEC, so that it is established in deep knowledge and consistent with sustainable growth.

Eduardo Silva  
Principal Investigator of the STRONGMAR project

# PROGRAMME

## SCHEDULE

Start	End	Session	Speaker	Title
09:30	10:00	Registration and welcome coffee		
10:00	10:30	Welcome session	John Watson Aberdeen University Scotland, UK	NA
10:30	11:00	Session 1	David Meldrum SAMS Scotland, UK	<i>The SMART cables initiative: equipping sub-sea communications cables with new capabilities for tsunami warning and climate change monitoring.</i>
11:00	11:30	Session 2	Luigi De Dominicis ENEA Rome, Italy	<i>Subsea 3D laser imaging: new developments.</i>
11:30	12:00	Coffee break		
12:00	12:30	Session 3	Stef Kapusniak Soil Machine Dynamics England, United Kingdom	<i>Underwater mining.</i>
12:30	13:00	Session 4	Archie Todd Morrison III Woods Hole Group, Inc. East Falmouth, USA	<i>Real-Time Current Profiles in Support of Offshore Oil and Gas Operations.</i>
13:00	15:00	Lunch		
15:00	15:30	Session 5	Pedro Jorge INESC TEC Porto, Portugal	<i>GeoLIBS: Towards real-time identification, classification and quantification of complex minerals in underwater mining applications.</i>
15:30	16:00	Session 6	Nick Burns Aberdeen University Scotland, UK	<i>Development of Subsea Digital Holographic Camera for Imaging of Marine Organisms</i>
16:00	16:30	Coffee break		
16:30	17:00	Session 7	Philippe Courmontagne Aix-Marseille Université Marseille, France	<i>Noise-reduction process and useful signal interpretation on recorded passive acoustic signals using time-frequency representations.</i>
17:00	17:30	Session 8	José Miguel Almeida INESC TEC Porto, Portugal	<i>EVA - Exploration VAMOS AUV.</i>
17:30	18:00	Session 9	Rick Spinrad Marine Technology Society Bend, Oregon	<i>Emerging Opportunities and Challenges in Ocean Technology.</i>
18:00	18:30	Closing session	Eduardo Silva INESC TEC and ISEP, Portugal	NA

# SESSIONS

S1

## ***The SMART cables initiative: equipping sub-sea communications cables with new capabilities for tsunami warning and climate change monitoring***

A joint initiative between the International Telecommunication Union (ITU), the World Meteorological Organization (WMO) and the Intergovernmental Oceanographic Commission (IOC) of UNESCO is examining novel uses for submarine telecommunication cables. The initiative addresses two main issues: the need for sustained climate-quality data from the sparsely observed deep oceans, and the desire to increase the reliability and integrity of the global tsunami warning networks. In the latter case, a significant proportion of the network suffers from failure and vandalism of the sea-surface telemetry buoys that relay the tsunami signals from the sea-bed sensor package. Incorporating the sensors within a submarine cable repeater is an obvious way of increasing system reliability and delivering important societal benefit. At the present time, plans are well advanced to launch a pilot project with the active involvement of cable industry players. This paper sets out the background to the initiative and describes its current status.

S2

## ***Subsea 3D laser imaging: new developments***

An impressive number of laser-based sensors for 3D vision for terrestrial applications have been developed so far, making it a mature and expanding market worth billions of euros. When it comes to the subsea environment the presence of water, combined with the demand to operate at depth, acts as game changing factor and considerable scientific and technological challenges arise. Nevertheless the last five years have witnessed remarkable progresses, with some devices developed by SMEs successfully deployed in subsea environment.

At ENEA are under investigation new technological solutions to further improving the performances of subsea 3D laser imaging systems. Our efforts are focused on the adoption of amplitude modulated laser beams to exploit their peculiar features of collective water backscattering to extend the operative range. In addition, we are working on the first subsea 3D laser imaging devices capable to record at the same time the 3D shape and colours of the submersed target. Finally It will be shown the test of a 3D laser imaging system qualified to operate in radioactively contaminated waters and suitable for operation at sea in the aftermath of severe nuclear incidents.

S3

## ***Underwater mining***

The talk covers the current status of the emerging underwater mining market from an exploration and mining perspective. With respect to offshore mining, the presentation will describe who is mining and exploring what and where they are doing it – focussing on the technology being deployed. Inland underwater mining developments will also be described.

## S4

### **Real-Time Current Profiles in Support of Offshore Oil and Gas Operations**

Oil and gas operators in the US Gulf of Mexico have, since 2005, been required to acquire real-time current profiles as a condition of their leases. The measurements must cover the near-surface down to the near-bottom or to 1000 meters depth during any operation in waters deeper than 400 meters. In waters deeper than 1100 meters or near steep bathymetry, additional near-bottom measurements may also be required, but not necessarily in real-time. The profiles are nominally 20-minute averages and must be delivered at least daily to a public database maintained by the National Data Buoy Center (NDBC).

Woods Hole Group has designed, installed, operated, and maintained real-time current profiling systems, both rig-based and moored, for operators in the Gulf of Mexico and elsewhere in the world for approximately two decades. Woods Hole Group systems have evolved considerably in that period, emphasizing personnel safety, convenience and reliability of operation, and more useful and readily accessible data products. These improvements have been achieved through modifications to the electrical and mechanical design of the launch and recovery systems, enhancement of the electronics, and custom built, in-house firmware and software. While systems are often installed to satisfy the regulatory requirements, they commonly become an essential support for daily operations, are used by metocean personnel to improve the reliability of forecasts, feed into the work of naval architects for rig design and fatigue analysis, and contribute to a greater understanding of the physical oceanography of the Gulf of Mexico and other locations.

In support of these latter goals, Woods Hole Group has conducted an in depth analysis of the first six years of the database hosted by NDBC. The talk will focus primarily on the current state of Woods Hole Group rig-based and moored current profiling systems, but will also touch on some of the results of that analysis.

## S5

### **GeoLIBS: Towards real-time identification, classification and quantification of complex minerals in underwater mining applications.**

A real time ore grading system, based on LIBS technology was developed in the scope of project VAMOS. Results obtained at the Imerys Minerals Ltd. test site in Lee Moor, Devon, UK, will be presented, showing the viability of the technology for real time grade control in underwater mining applications.

## S6

### **Development of Subsea Digital Holographic Camera for Imaging of Marine Organisms**

This talk describes the concept of holography and the application of its digital counterpart in underwater imaging of marine organisms. The major components of an underwater digital holographic camera are considered and the selection criteria of each explored. The integration of these components is then discussed in conjunction with the requirements for control of a complete digital holographic camera. Finally, data storage, download and analysis are illustrated with examples of data collected using the eHoloCam system.

S7

## ***Noise-reduction process and useful signal interpretation on recorded passive acoustic signals using time-frequency representations***

In this presentation, a blind de-noising process will be proposed, allowing to obtain a strong signal to noise ratio enhancement without knowledge about the useful signal and the disturbing terms. In order to take into account the non stationary properties of the useful signal, the de-noising process will be performed using time-frequency representations. A theoretical application in a context of underwater acoustic communications will be proposed, showing that the use of such a process could be of great interest when it is question of underwater acoustic repeater.

S8

## ***EVA - Exploration VAMOS AUV***

EVA is an Autonomous Underwater Vehicle developed for mining exploration assistance. It has two main tasks: performing accurate realtime 3D mapping of the environment and mining operation assistance allowing the perception of occluded mine areas and the observation and navigation of the mining machine. This AUV was developed under the scope of the European project iVAMOS!.

iVAMOS! will enable access to high grade EU reserves of deeper seated minerals by providing a new Safe, Clean and Low Visibility Mining Technique and will prove the Environmental and Economic Viability of extracting currently unreachable mineral deposits, thus encouraging investment and helping to safeguard the EU access to strategically important minerals. The iVAMOS! mining technique will enable: Re-opening abandoned mines; Extensions of opencut mines which are limited by stripping ratio, hydrological or geotechnical problems; and opening of new mines with limited environmental impacts in the EU.

S9

## ***Emerging Opportunities and Challenges in Ocean Technology***

An assessment of the trends we can expect in sensors, platforms, data, etc. as applied to ocean technological solutions. Particular attention will be paid to those emerging capabilities we can expect in the next 5-10 years, including developments from some seemingly disparate technological fields. Examples of specific applications will be included.

# SPEAKERS



**Archie Todd  
Morrison**

Todd Morrison is a Senior Ocean Engineer at the Woods Hole Group. He graduated from Harvard University in 1981 with a B.A., cum laude, in Engineering and Applied Science / Electrical Engineering. He earned an M.S. in Ocean Engineering and an O.E. in Oceanographic Engineering from the Massachusetts Institute of Technology and Woods Hole Oceanographic Institution, both in 1994. In 1997 he was awarded a Ph. D. in Oceanographic Engineering by the Massachusetts Institute of Technology and the Woods Hole Oceanographic Institution.

Dr. Morrison joined the Woods Hole Group in the summer of 2009. Before joining Woods Hole Group he developed instrument systems and software for biogeochemical and physical oceanographic investigations and fisheries and medical research for the Woods Hole Oceanographic Institution, several private oceanographic instrumentation companies, and as an independent consultant. His degrees and experience have focused on instrument development, the design of oceanographic systems, and underwater vehicle control. At Woods Hole Group he applies over 35 years of experience with electrical and electronic systems and design, mechanical systems, materials science, and software development to the design, fabrication, and installation of complex oceanographic instrument systems to address the needs of our clients. Projects include metocean measurement systems on buoys, moorings, and installed on offshore drill ships. His experience also includes design, deployment and recovery of data collection systems in support of proposed offshore wind energy projects.



## David Meldrum

David Meldrum studied physics and mathematics at St Andrews and Cambridge, subsequently becoming physicist in charge of the ice-penetrating radar programme at the Scott Polar Research Institute, and a physics tutor at Churchill College, Cambridge. He moved back to Scotland in 1978 to join the marine physics group at the Scottish Association for Marine Science and in 1989 became head of the technology development section. Two years were spent on secondment as technical co-ordinator of the IOC/WMO Data Buoy Co-operation Panel, a group of which he became chair from 2004 until 2009. He has recently served as co-chair of the IOC/WMO JCOMM Observations Programme Area, with special responsibility for marine meteorology and satellite communications, and as an ocean consultant based at the IOC/UNESCO in Paris. While in Paris, he served as vice chair of the ITU/WMO/IOC Joint Task Force promoting the use of future-generation commercial sub-sea cables for tsunami warning and climate change monitoring. As an independent consultant, he is currently engaged by the European Space Agency to develop best practice in data buoy observations for improved cal/val of satellite-derived marine meteorological products. Current research interests include satellite communication and positioning systems, autonomous systems and data buoys, and the development of smart sensors and intelligent instruments in support of polar science, ocean observation and marine meteorology. He is the author or co-author of more than 100 papers and reports in glaciology, oceanography, marine meteorology, satellite communications and technology development. He was elected as a Fellow of the Institute of Physics in 2012 in recognition of his achievements in the development of sensors and systems for ocean observation. He was awarded the UK Polar Medal by the Queen for his longstanding contributions to polar exploration and observation, and was elected to a personal chair at the University of the Highland and Islands in 2013.



Eduardo Silva is the Coordinator of the Centre for Robotics and Autonomous Systems (CRAS) at INESC TEC and Professor at the School of Engineering (ISEP) of the Porto Polytechnic Institute (IPP). He has a PhD in Electrical and Computer Engineering from the University of Porto. His main research areas are marine robotics, control architectures, perception and navigation for autonomous robots. He has participated in more than 14 research projects. He has more than 60 publications in the area of the Field Robotics.

## **Eduardo Silva**

Eduardo Silva is the Principal Investigator of the STRONGMAR project.



John Watson is Emeritus Professor of Optical Engineering at the University of Aberdeen. He has been researching and teaching in optics, optoelectronics, optical engineering and electronics for nearly forty years. His main areas of activity include holography, laser induced spectral analysis and optical image processing. In particular much of his work has centred around the application of holography for subsea imaging of marine plankton. He has published several hundred peer-reviewed papers and three books in related areas. He is a Fellow of the Inst of Physics (UK) and the Institute of Engineering Technology and is also a Senior Member of IEEE.

## **John Watson**



José Miguel Almeida is a professor at the School of Engineering (ISEP) of the Porto Polytechnic Institute (IPP). His main research area is sensing, perception and navigation in mobile multi-robot systems. He is a principal investigator or researcher in several research projects funded by entities such as Portuguese Science and Technology Foundation (FCT), Portuguese Innovation Agency (Adi/ANI) or NATO SfS programme. In particular, he is the INESC TEC responsible for the Navigation task in the iVAMOS! project (H2020).

## **José Miguel Almeida**



## **Luigi De Dominicis**

Dr Luigi De Dominicis is a Physicist who has over 24 years of experience in innovation and carrying out and managing research and development at ENEA (Italy). This has included the coordination of European funded large-scale projects, activities devoted to sensor developments for industrial applications and the commercialisation of research. He is project reviewer for many national and international funding boards. He also holds a position at LUMSA University of Rome and is a Member of the Founders Committee of the British University in Baghdad.



## **Nick Burns**

Nick graduated from the University of Aberdeen with a BEng in Electronic and Computer Engineering in July 2005. He followed that with a PhD titled "Automated Analysis System for the Study of Digital Inline Holograms of Aquatic Particles". Nick work in the Engineering department of the University of Aberdeen and undertake course development and course delivery for the Electronics degree programmes. He has also had involvement in various research projects where his role has been in development of holographic systems, optical measurement techniques and digital control system design. Nick is the principal operator of the eHoloCam underwater holographic camera, which he has redeveloped to be deployed in ocean trenches to a depth of 10 km.



## **Pedro Jorge**

Pedro Alberto da Silva Jorge graduated in Applied Physics (Optics and Lasers) at the Univ. of Minho (1996), MSc in Optoelectronics and Lasers at the Physics Depart. of Univ. of Porto (2000); in 2006 concluded his PhD program at Porto Univ. in collaboration with the Depart. of Physics and Optical Sciences at the Univ. of Charlotte, North Carolina, USA, with work in luminescence based optical fibre systems for biochemical sensing applications. Since 1997 Pedro Jorge has been involved in several research and technology transfer projects related to optical fibre sensing technology, developing new sensing configurations and interrogation techniques for optical sensors. Pedro Jorge is a Senior researcher at INESC TEC where he leads the Biochemical Sensors team exploring the potential of optical fibre and integrated optics technologies in environmental and medical applications coordinating several projects. He has more than 200 publications in the fields of sensors in national and international conferences and peer reviewed journals, is author of 3 book chapters and also holds one patent. He is a member of SPIE and SPOF.



**Philippe  
Courmontagne**

Philippe Courmontagne was born in 1970. He received the Ph. D. degree in Physics at the University of Toulon (France) in 1997. In 1999, he became a Professor at a French electronic engineering school: the Institut Supérieur de l'Électronique et du Numérique (ISEN Toulon, France), in the field of signal and image processing. In 2001 he joined the Provence Materials and Microelectronics Laboratory (L2MP UMR CNRS 6137), which is a unit of the French national research center (CNRS). In 2005, he obtained his Habilitation (HDR - Habilitation as Research Supervisor) for his works in the field of noisy signal expansion. In 2007, he has been elected to the degree of IEEE Senior Member in recognition of professional standing for his works in the field of signal de-noising (SAR, SAS images), signal detection in noisy environment and signal transmission. In 2008, he has been elected as a member of the IEEE OES French chapter board and became in 2013 the IEEE OES French Chapter chair. Since that time, he actively participates in the development of the IEEE OES activities by means of student actions and workshop's organization. As recognition for his involvement in the OCEANS Student Poster Competition, in 2014, he has been appointed as Student Poster Competition chair. In 2016, he has been elected as member of the IEEE OES Administrative Committee. In September 2017, he has been elected as IEEE OES Vice-President Workshops And Symposia. In June 2019, he will be the general chair of the conference MTS/IEEE Oceans'19 Marseille. His field of interest concerns de-noising, detection and classification of underwater signatures, with applications to sonar signal analysis, SAS images and communications in shallow water.



**Stef Kapusniak**

Prior to joining SMD, Stef worked in the surface and underground mining industry, mainly in Australia. He has previously held roles in Australia as Mine Manager, Technical Services Manager, Preparation Plant Manager, Principal Mining Engineer, Senior Mining Engineer and Senior Geotechnical Engineer for a variety of companies. During his Australian career he received a ministerial appointment to the West Australian Coal Mines Examination Board. He gained a BSc in Mining Engineering and a PhD in Rock Mechanics from the University of Nottingham in the early eighties and holds both underground and opencut Mine Manager's tickets. He has also managed large construction Joint Ventures in the transport sector in the UK. Stef is the Technical Manager for the iVAMOS! project.



## Rick Spinrad

Dr. Richard W. (Rick) Spinrad recently retired from the position of Chief Scientist, at the National Oceanic and Atmospheric Administration (NOAA), where he had been appointed by President Barack Obama in 2014. He is currently a Professor of Oceanography at Oregon State University. An internationally recognized scientist and executive with more than 30 years of experience, Dr. Spinrad was the senior scientist for NOAA, driving policy and program direction for science and technology priorities. Prior to serving as Chief Scientist at NOAA, Rick was the Vice President for research at Oregon State University (OSU) in Corvallis, Oregon, and from 2003 until 2010 was the head of NOAA's Office of Oceanic and Atmospheric Research and the head of the National Ocean Service. As assistant administrator for research for NOAA, Dr. Spinrad directed the agency's programs in oceanography, atmospheric science, and climate. He directly supervised several of NOAA's high-profile research efforts, including ocean exploration, the National Sea Grant College Program, and the Climate Program Office, as well as seven NOAA laboratories around the United States.

Among his accomplishments, Dr. Spinrad was a co-lead of the White House Committee that developed the nation's first set of ocean research priorities and oversaw the revamping of NOAA's research enterprise. He also served as the Department of Commerce representative to the Office of Science and Technology Policy committee addressing scientific integrity. Dr. Spinrad spent two years as NOAA's assistant administrator for oceanic services and coastal zone management, directing the agency's navigation and coastal services, including the National Geodetic Survey, the Office of National Marine Sanctuaries, and the Office of Coastal Resource Management. As part of his duties, he represented U.S. interests in the establishment of a global tsunami warning system. Prior to joining NOAA, Dr. Spinrad served as a research director with the U.S. Navy (Office of Naval Research and Oceanographer of the Navy), where he was awarded the U.S. Navy Distinguished Civilian Service Award (highest award given by the U.S. Navy to a civilian). He has held faculty appointments at three universities (OSU, US Naval Academy, and George Mason University), served as Executive Director at a major national non-profit organization (Consortium for Oceanographic Research and Education, CORE), was President of a private company (Sea Tech, Inc.), and worked as a research scientist (at OSU and Bigelow Lab). He also developed the National Ocean Sciences Bowl for high school students. Dr. Spinrad served as the U.S. permanent representative to the United Nations' Intergovernmental Oceanographic Commission. He is the recipient of Presidential Rank Awards from Presidents George W. Bush and Barack H. Obama. Dr. Spinrad is past president of The Oceanography Society. He is a fellow of the American Meteorological Society, the Marine Technology Society, and the Institute of Marine Engineering, Science and Technology (IMarEST), and an IMarEST Chartered Marine Scientist. Dr. Spinrad received his bachelor of arts degree in earth and planetary sciences from The Johns Hopkins University in Baltimore, Maryland. He received his master of science and doctoral degrees in oceanography from Oregon

# STRONGMAR PROJECT

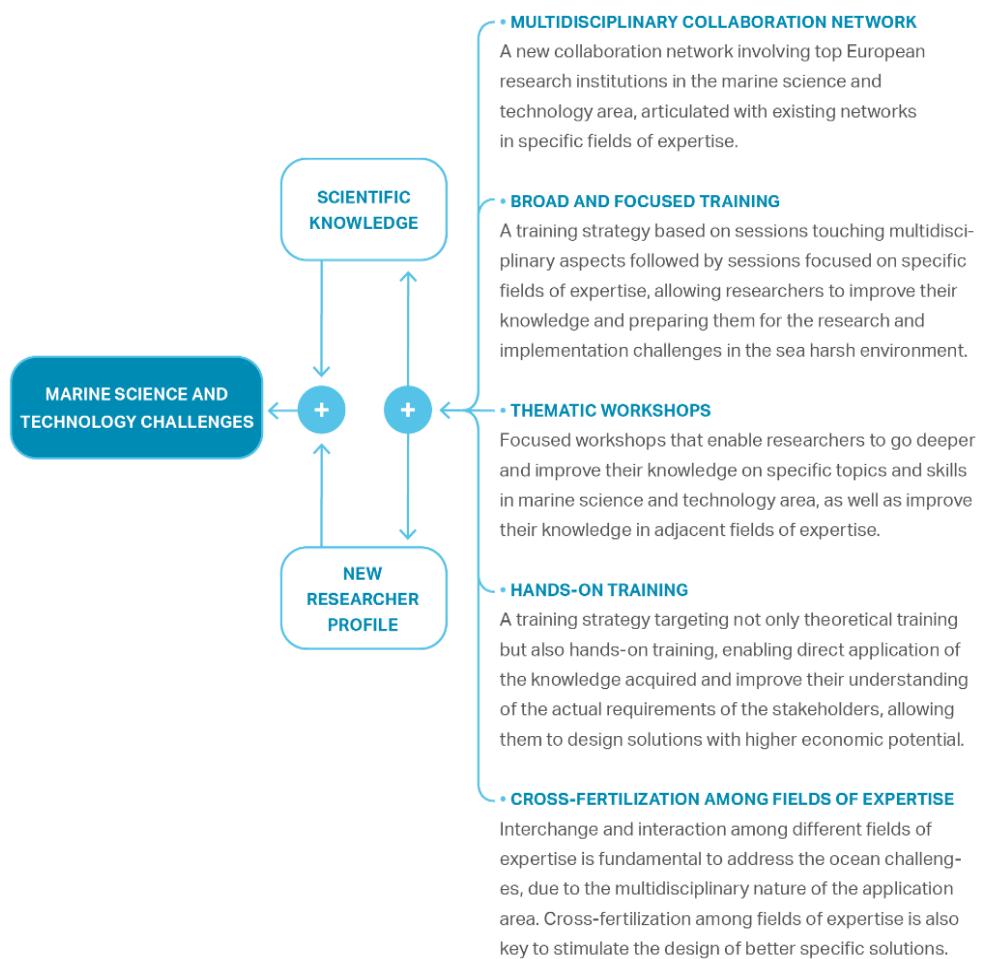
INESC TEC is strongly committed to become a center of excellence in maritime technology and, in particular, deep sea technology. It is strategically located, with fast access to deep sea, it has been steadily building up its skills, capabilities and resources, and is presently in the process of implementing an open research infrastructure, thus preparing itself to become capable of providing services and open access to the European academic and industrial communities and, thus, become a recognized European maritime research asset.

The STRONGMAR project thus aims at creating solid and productive links in the global field of marine science and technology between INESC TEC and established leading research European institutions, capable of enhancing the scientific and technological capacity of INESC TEC and linked institutions (as well as the capacity of partnering institutions involved in the twinning action), helping raising its staff's research profile and its recognition as a European maritime research center of excellence.

These objectives will be fulfilled through a set of measures: summer schools, winter schools, short-term scientific meetings, long-term staff visits, networking meetings, workshops, conferences, technology transfer workshops with stakeholders, and other dissemination activities. Therefore, the STRONGMAR project places INESC TEC as the pivot of a network of excellence, involving four European partners which are international leaders in deep sea technology.

## CONCEPT

Five main pillars support the project's concept:



# CONSORTIUM



## DATA

### Name

Strengthening Maritime Technology Research Center

### Acronym

STRONGMAR

### Reference

692427

### Duration

01/01/2016 to 31/12/2018 (36 months)

### Type of Action

Coordination & Support Action (CSA)

### Topic

Twinning

### Call for proposal

H2020-TWINN-2015

### EU contribution

999.203,75 €

### Project Officer

Agne Dobranskyte-Niskota

### Coordinator

INESC TEC (Portugal)

### Partners

CINTAL (Portugal), Heriot-Watt University (United Kingdom), NATO Science & Technology Organization (Belgium), Universitat de Girona (Spain) and University of Aberdeen (United Kingdom)

### CORDIS

[www.cordis.europa.eu/project/rcn/199452\\_en.html](http://www.cordis.europa.eu/project/rcn/199452_en.html)

### Website

[www.strongmar.eu](http://www.strongmar.eu)



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Go deeper into the Strongmar Project  
[www.strongmar.eu](http://www.strongmar.eu)

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