Joint European Research Infrastructure network for Coastal Observatories

First FCT Activities Report

D#1.6

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1. Document description

REFERENCES

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2. Executive Summary

This report describes the different actions carried out within the Forum for Coastal Technology framework. FCT's actions were implemented to better encourage collaboration between public stakeholders (scientists, managers, executives, ..) and private companies to ensure a common and coherent approach of the technical developments for operational oceanographic systems.

In that sense, the two main FCT actions for this first JERICO's year were dedicated to (1) enquire about needs and expectations from companies manufacturing oceanographic instrumentations and sensors companies and (2) the organisation of the first FCT workshop at the Sea Tech Week event in Brest (France, october 2012).

3. Introduction

This forum is part of the JERICO project to link and encourage European companies to interact with public entities and European funded oceanographic research. Coastal oceanography is a new market that is expanding despite being mainly driven by regulation. The societal awareness and the anthropic pressure on coastal areas (land and water) will reinforce this regulation. In that context two kinds of market are emerging: the first one to address scientific issues and the second one to address coastal resources management and exploitation. Uncertainty and low visibility in this new market slows down involvement of private investments.

Bringing the industry and the research communities together should allow a substantial enhancement of capabilities at the research level in public and academic institutes in terms of products and services for this new and immature market.

The Terms of Reference (www.jerico-fp7.eu/coastal-technologies) describe the aims as well as the main content and strategic issues raised by the FCT.

The needs for better visibility have been highlighted. On one side, companies are not sufficiently aware of the requirements of the research and on the other side scientists are not really informed of the latest developments carried out by private companies.

These two "worlds" clearly need to work closer. This opinion is shared by both public research and private industry. The FCT should fill this gap.

Even if the objective seems clear, the way to fulfill it is still to be clarified.

In the past many attempts have been initiated in order to get some support from the European Community (EC). Despite no success some feasibility work was carried out and the JERICO project builds upon it. In the next four years, JERICO should be able to find and seed a permanent mechanism (including funding sources) to promote European coastal research and develop related businesses between the various coastal stakeholders.

To launch the FCT, two surveys were carried out aimed on the one hand at scientists (JERICO, project's partners) and on the other hand the private companies that are active in instrumentation or sensor development for coastal oceanography.

The result of the first survey (with a high ratio of answers) is available here: http://www.jerico-fp7.eu/coastal-technologies/survey-organisation. The aims were mainly to determine the FCT boundaries.

The second survey was thereafter designed considering the first survey's outcomes. It was sent to companies (major groups and SMEs) that either develop, use or supply sensors, instrumentation and platforms to monitor coastal oceanographic parameters and processes. The analysis of this survey allowed JERICO to better describe the latest company interests.

26 people attended the first FCT workshop scheduled during the SeaTechWeek in Brest in October 2012. Dissolved Oxygen and nutrients measurements were the main topics of this workshop.

Along with this workshop, IFREMER has carried out a calibration experiment in its metrology laboratory. The focus was mainly on temperature, conductivity and dissolved oxygen.

The FCT plans to conduct further experiments both in the laboratory and *in-situ* in late 2013 or early 2014. Multiple dissolved oxygen sensors will be assessed during initial experiments in France and further developed through the JERICO Trans-national Access (TNA) call in 2014.

The FCT will have a workshop focused on nutrient measurements in the coastal ocean during Oceanology International in March 2014 in London.

4. Second survey analysis

4.1. Objective

The main goal of this survey was to assess needs and expectations from companies manufacturing oceanographic instrumentations and sensors. Indeed companies need visibility to invest in the oceanographic market (which is a niche market). Looking outside the traditional technical and scientific environment, many technologies could be suitable to develop new sensors. On the other hand, many instrument's users do not have a sound knowledge of the available market. One of the main goals of the FCT is to involve the companies (major groups as well as SMEs) that either develop, use or supply sensors and instrumentation to monitor coastal oceanographic parameters and processes.

The aims of this second questionnaire are therefore to evaluate both:

- The industry knowledge of the oceanographic community needs,
- How the sensor users community is aware of the latest R&D developments and commercial offers.

4.2. Survey composition

From May 25th 2012 to October 31st, JERICO conducted a web-based survey within the 'FCT' framework. The FCT team used 'surveymonkey.com' as the web-based survey tool to carry this work out. The survey contained a total of 41 questions divided into 5 sections:

- General information
- Sensors for chemical / biogeochemical measurements
- Sensors for physical measurements
- Sensors for biological measurements
- View on the forum for coastal technologies (FCT)

4.3. Survey synyhesis

This survey was carried out with the help of sensor/instrument manufacturer companies. It has been done within the FCT framework in order to get a better grasp of their vision about sensor/instrument issues. Below are the major tendencies that emerged from this survey.

About 10 companies filled the survey. It can be seen as few, but it is actually a good implication given that oceanographic sensor/instrument companies are only few. It attests from their interest in the FCT. The main activities from these companies are manufacturing and selling instruments. Most of these companies deal with electronics and optical technologies. They also integrate their sensors on platforms, fixed platforms and buoys being the most common. These activities are done primarily for monitoring and observation before research. The environments where the companies are focused are coastal (including riverine and estuarine) and open ocean waters. Finally, almost all these

companies provide training for a better use of their instruments.

About chemical sensors, the main focus of these companies is dissolved oxygen and nutrients (mainly nitrite/nitrate and phosphate). Technology wise, dissolved oxygen measurements are based on optical and infrared technologies as nutrient measurements are based on wet chemistry, except for nitrate where UV spectrometry is available. Accuracy, reliability and biofouling were the most cited issues when it came to concern about the sensors/instruments. Range and detection limit were also highly cited. About sensors for measuring physical parameters, the main commercial offer is based on turbidity, salinity and temperature. The technologies used for these parameters are respectively optical technologies, inductive principle and resistance thermometers. Reliability is the main concern from the manufacturers, thereafter came accuracy, range precision and biofouling issues. Concerning sensors that are able to measure biological parameters, they are mainly focused (by far) on chlorophyll. Other pigments or primary production were much less cited. Fluorescence is of course the main technology used for these chlorophyll sensors. Accuracy and biofouling are still the main issues encountered for these sensors.

Overall, a large fraction of these companies (about 70%) provide solution to prevent from biofouling. These solutions are mainly based on wiper ad shutter and copper material. They also provide transmission capabilities, that are mainly based on GSM, cable or radio (HF, wifi…) technologies.

The survey also enquired about survey the view of companies about the next generation of sensors. The responses were diverse, but amongst the most cited were low cost sensors, end of wet systems, long-term stability sensors.

Only 60%of the companies that filled the survey knew about the JERICO project and its FCT initiative. But they see the FCT as an entity able to animate and coordinate all sorts of actions (eg workshops, information diffusion, field test…) between the scientific community and the companies. They recommend the FCT to be aware of initiatives from the ACT in USA, from the MCERTS (Environment Agency's Monitoring Certification Scheme) in UK and from the WOC (World Ocean Council). All the companies agree on the fact that an European equivalent of the ACT should be initiated, bringing mainly together academics and SMEs. Workshops and product demos are the most wanted initiatives for the FCT to carry out. Finally, about the input that the FCT could bring to companies, ‘user needs’ is the most voted in.

4.4. Detailed results

4.4.1. Figures and participants

The table 1 presents who did participate to the survey

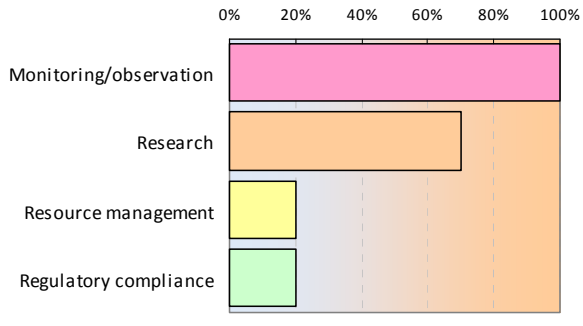
Table 1: Second FCT survey's participant details list

Part.	Company	Country	Contact person	Response Date
1	CHELSEA Instruments	UK	Mike Challiss	August 21st
2	SYSTEA Spa	Italy	Luca Sanfilippo	July 24th
3	CONTROS Systems	Germany	Melanie Herrmann	June 26th
4	Communication Technology srl	Italy	Gianni Biasini	June 20th
5	AANDERAA Data Instruments	Norway	Emilie Dorgeville	June 19th
6	SALTANTIC	USA	Geoff MacIntyre	June 12th
7	MacArtney A/S	Denmark	Mike Sawkins	June 8th
8	Ocean instruments Ltd	UK	Kelso Ridell	June 8th
9	HS Engineers	Germany	Helmut Schlueter	June 7th
10	SubCtech GmbH	Germany	Stefan Marx	June 7th

4.4.2. General information

Q1. What is your main target market when developing sensors / instruments?

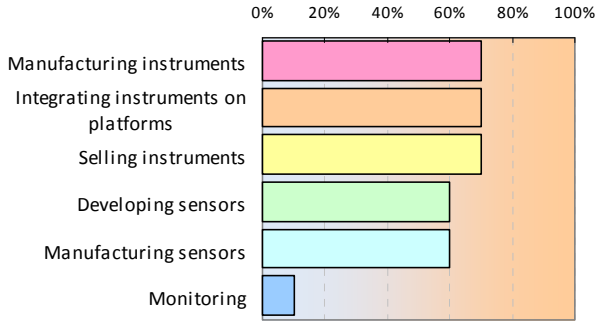
Answer Options	Response Percent	Response Count
Research	70,0%	7
Monitoring/observation	100,0%	10
Resource management	20,0%	2
Regulatory compliance	20,0%	2
Other, please specify		1
	answered question	**10**



Results show that the companies are mainly focused on monitoring and research activities when developing sensors. Resource management and regulatory purposes were cited but represent less interest.

Q2. What is your main activity?

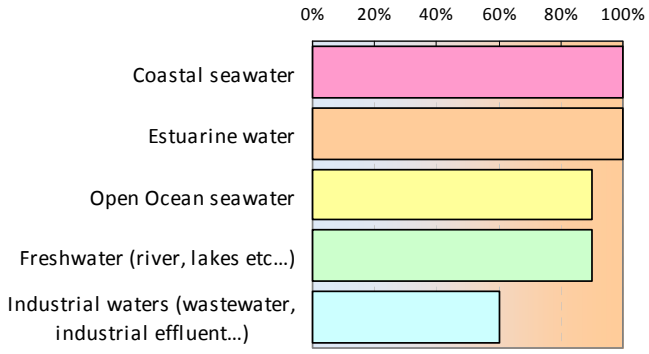
Answer Options	Response Percent	Response Count
Developing sensors	60,0%	6
Manufacturing sensors	60,0%	6
Manufacturing instruments	70,0%	7
Integrating instruments on platforms	70,0%	7
Selling instruments	70,0%	7
Monitoring	10,0%	1
Other, please specify		1
answered question		**10**



Results show that the most of the companies manufacture/develop sensors to integrate them on instruments. Obviously, they sell these instruments (even if the question was more to know if they were selling only – not developing). Only one company deals with monitoring activities.

Q3. What operating environment are your sensors and instruments developed for?

Answer Options	Response Percent	Response Count
Coastal seawater	100,0%	10
Estuarine water	100,0%	10
Open Ocean seawater	90,0%	9
Freshwater (river, lakes etc…)	90,0%	9
Industrial waters (wastewater, industrial effluent…)	60,0%	6
Other, please specify	1	1
answered question		**10**

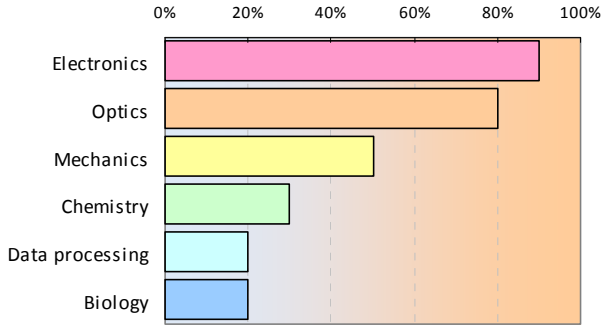


This question clearly shows that most of the instruments/sensors developed by the companies are available for a large range of aquatic medium from freshwater to seawater (coastal and oceanic). The activity of the companies, which have filled this survey, concerning sensors for industrial effluents and wastewaters seems to be less important.

Other environments were also mentioned i.e. esoteric applications such as inside offshore well waters re-injection pipelines and during commissioning of subsea pipelines.

Q4. Amongst the following technologies, which ones are the most representative of your activities?

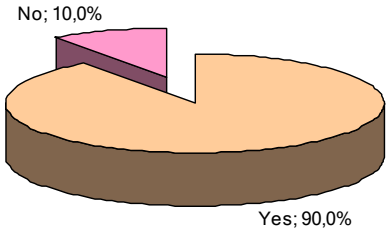
Answer Options	Response Percent	Response Count
Mechanics	50,0%	5
Electronics	90,0%	9
Data processing	20,0%	2
Optics	80,0%	8
Biology	20,0%	2
Chemistry	30,0%	3
Other, please specify		2
answered question		**10**



Electronics and optics are the most representative activities of the companies (90-80% of the answers), followed by mechanics with only 50%. Chemistry, data processing and biology are much less representative of the company's activities.

Q5. Do you integrate your sensors or instruments on platforms?

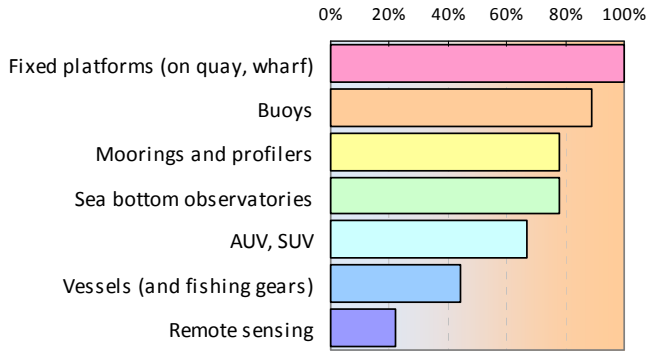
Answer Options	Response Percent	Response Count
Yes	90,0%	9
No	10,0%	1
answered question		**10**



Almost all the companies do integrate their sensors on platforms.

Q6. On what type of platforms are used to integrate your sensors / instruments?

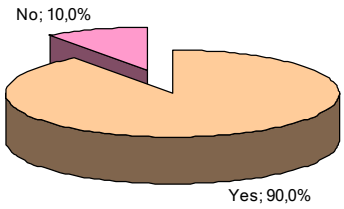
On what type of platforms are used to integrate your sensors / instruments?		
Answer Options	**Response Percent**	**Response Count**
Buoys	88,9%	8
Moorings and profilers	77,8%	7
Fixed platforms (on quay, wharf)	100,0%	9
Vessels (and fishing gears)	44,4%	4
AUV, SUV	66,7%	6
Remote sensing	22,2%	2
Sea bottom observatories	77,8%	7
Other, please specify		1
answered question		**9**



The most common platforms are 'fixed' platforms (such as peer, wharf), buoys as well as mooring and profilers. But the instruments/sensors are also used to be deployed on AUV and SUV (60% of the answers). Vessels and remote sensing does not seem to be often used as common platforms.

Q7. Do you provide training for a better use of your sensors / instruments?

Answer Options	**Response Percent**	**Response Count**
Yes	90,0%	9
No	10,0%	1
answered question		**10**



Almost all the companies provide training or specific courses for a better use of their instruments.

4.4.3. Sensors for chemical / biological measurements

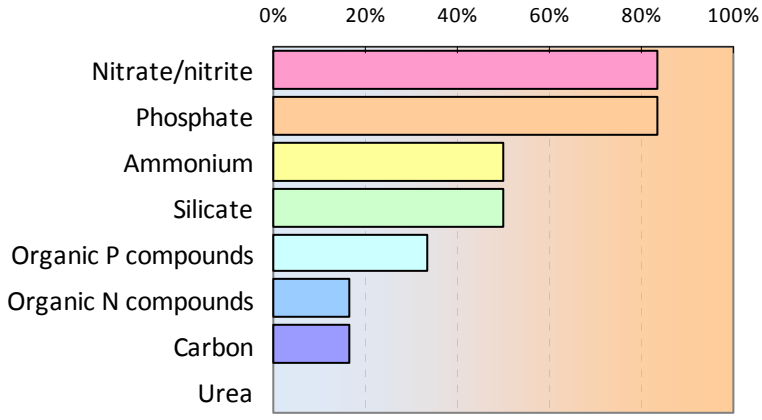
Q1. What kind of chemical / biogeochemical parameters are your sensors/instruments able to measure?

Answer Options	Response Percent	Response Count
Dissolved Oxygen	60,0%	6
Nutrients	50,0%	5
Hydrocarbon / Volatil Organic Compound (VOC)	40,0%	4
Dissolved gases (other than O2)	30,0%	3
Trace elements (eg trace metals…)	20,0%	2
Other, please specify		6
answered question		**10**
skipped question		**0**

Oxygen and nutrients were the most cited parameters for this question, followed by hydrocarbon and other dissolved gases. Trace elements were also cited but in a lesser extent.

Q2. In terms of nutrients, which of the following are of interest for you?

Answer Options	Response Percent	Response Count
Nitrate/nitrite	83,3%	5
Ammonium	50,0%	3
Urea	0,0%	0
Phosphate	83,3%	5
Silicate	50,0%	3
Organic N compounds	16,7%	1
Organic P compounds	33,3%	2
Carbon	16,7%	1
Other, please specify		0
answered question		**6**



Classical nutrients (mainly nitrate/nitrite and phosphate, but also silicate and ammonium) were the most cited with percentages above or equal to 50%. Organic compounds (N, P) and carbon seem also to be of interest but with percentages less than 20%.

Q3. Related to the above questions, what kind of technologies do you use for your sensors?

Answer	NO3	NO2	NH4	Urea	PO4	Silicate	Org. P	Org. N	Carbon	O2	Diss. gases	HydroC/VOC	Trace elements
1												Fluo	
2	WC	WC	WC		WC	WC	WC	CW					WC
3											NDIR	NDIR	
4										Optical/polaro.			
5										Optical	Optical		
6	UV												
7	WC	WC	WC		WC	WC	WC						
8										Optical		Optical	
9	WC	WC	WC		WC	WC	WC		NDIR	Optode	NDIR	NDIR	

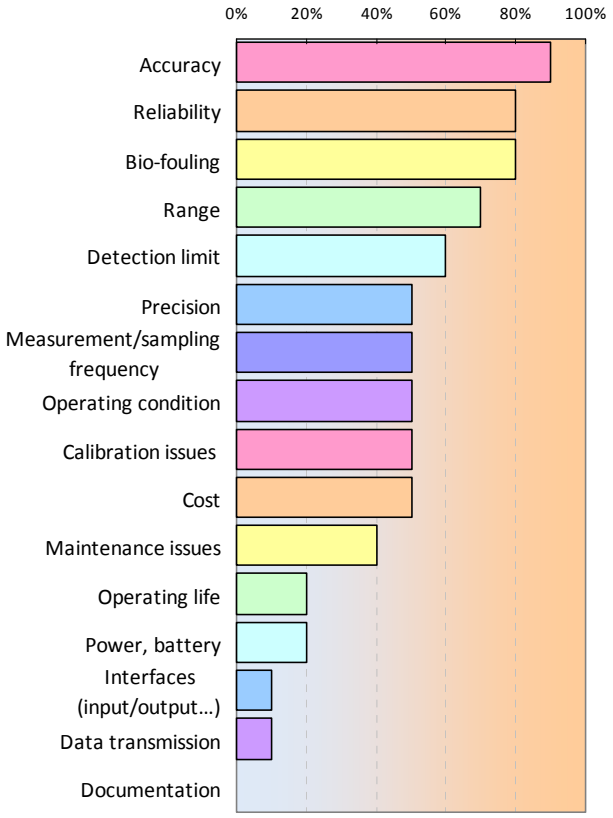
NO3=nitrate, NO2=nitrite, PO4=phosphate, NH4=ammonium, Org. P=organic P, Org. N=organic N, O2= Dissolved oxygen, HydroC/VOC= Hydrocarbon / Volatile Organic Compound (VOC)

WC=Wet chemistry, UV=Ultraviolet technology, NDIR / IR=Infrared technology, GTDs=Gas Tension Devices, OS=Optical Sensors, Fluo= Fluorescence

With regards to nutrients, most measurements are based on wet chemistry. Nitrate is also measured by UV spectrophotometry. Dissolved oxygen and other gases are measured by various technologies, but optical methods seem to be substantially utilized.

Q4. Which of the following areas are you really concerned about with regard to chemical sensors?

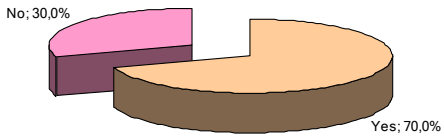
Answer Options	Response Percent	Response Count
Detection limit	60,0%	6
Range	70,0%	7
Accuracy	90,0%	9
Precision	50,0%	5
Measurement/sampling frequency	50,0%	5
Reliability	80,0%	8
Operating condition (pressure, corrosion etc…)	50,0%	5
Calibration issues (ease, time, frequency, automatic…)	50,0%	5
Interfaces (input/output…)	10,0%	1
Maintenance issues	40,0%	4
Cost	50,0%	5
Documentation	0,0%	0
Operating life	20,0%	2
Bio-fouling	80,0%	8
Power, battery	20,0%	2
Data transmission	10,0%	1
Other, please specify		0
answered question		**10**



The issues that emerged from this question were accuracy, reliability and bio-fouling that were above the 80% threshold. Thereafter came issues related range and detection limit (>60%). Precision, sampling frequency, operating condition, calibration and cost reach an answer rate of 50%. Finally companies seem a bit less concerned about issues related to maintenance issues, operating life, interface and data transmission.

Q5. Considering bio-fouling, do you provide anti-fouling technologies?

Answer Options	Response Percent	Response Count
Yes	70,0%	7
No	30,0%	3
If yes, please describe briefly		5
answered question		10
skipped question		0



About 70% of the survey participants provide anti fouling technologies.

The different technologies cited are:

- Coated lenses, wipers,

- In-situ self-priming 0.2 microns microfiltration unit with auto back-wash

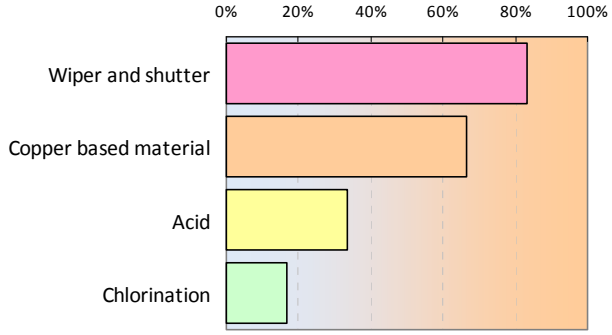
- Supply Hydro-Wiper to clean optical windows and shutters to cover membrane sensors.

- "Fully automatic self-cleaning filter for e.g. nutrient analyzer. Maintenance free tested for at least 6 months.

- Fully automatic water cleaning procedures for ""underway"" ship measuring systems consists of acid cleaning, pressured tap water and heating."

Q6. How do you protect your sensors?

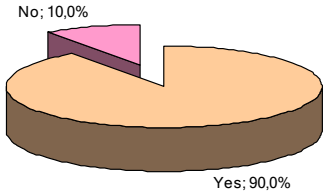
Answer Options	Response Percent	Response Count
Copper based material	66,7%	4
Chlorination	16,7%	1
Acid	33,3%	2
Wiper and shutter	83,3%	5
Other, please briefly describe		2
answered question		6
skipped question		4



Shutters and wipers mostly protect sensors. Copper based material is also a technological solution. Acid cleaning and chlorination were also cited.

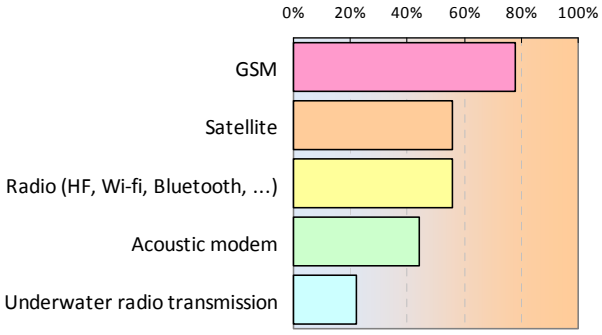
Q7. Do you include a data transmission technology with your sensors/instruments?

Answer Options	Response Percent	Response Count
Yes	90,0%	9
No	10,0%	1
answered question		**10**
skipped question		**0**



Q8. What are the transmission technologies implemented?

Answer Options	Response Percent	Response Count
GSM	77,8%	7
Electrical or optical cable(ethernet etc.)	88,9%	8
Satellite	55,6%	5
Radio (HF, Wi-fi, Bluetooth, ...)	55,6%	5
Underwater radio transmission	22,2%	2
Acoustic modem	44,4%	4
Other, please specify		2
answered question		**9**
skipped question		**1**



GSM appears to be the most used technology to transfer data when using chemical sensors. However, the satellite and radio technologies seem to be also well implemented. In the 'other' section was specified the wireless technology.

Q9. What do you consider to be the next generation of chemical sensors / instruments to be developed in support of coastal oceanography?

Answer Options	Response Count
	7
answered question	7
skipped question	3

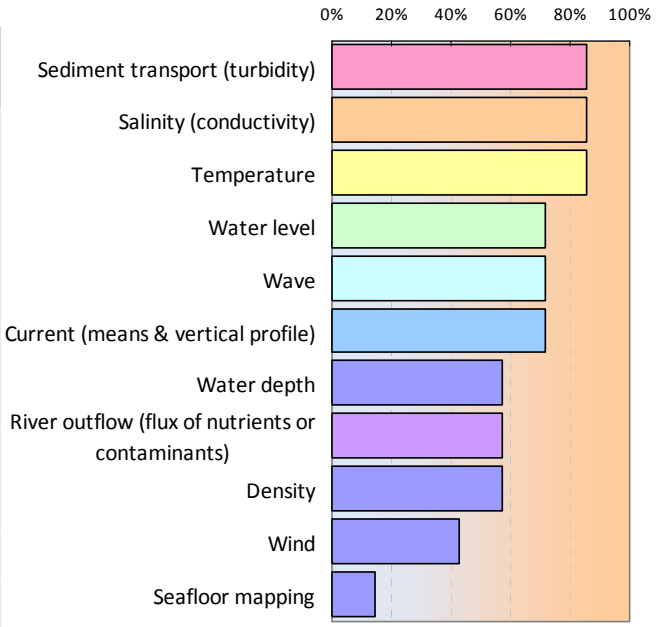
The different answers about the next generation of chemical sensors/instruments are listed below:

- low cost, high volume, disposable
- Looking forward to receive suggestions from our Customers
- Optical pH
- Micro Sensor - fluidity sensors, small.
- McLane ESP real-time analysis of DNA with real-time telemetry of results
- Micro-sensors (MOSFET technology) combined with micro pumps (MEMS based)
    - Low on service, long-term stable, e.g. for nutrients, pH (!), H2S

4.4.4. Sensors for physical measurements

Q1. What parameters are your instruments able to measure?

Answer Options	Response Percent	Response Count
Water depth	57,1%	4
Seafloor mapping	14,3%	1
River outflow (flux of nutrients or contaminants)	57,1%	4
Sediment transport (turbidity)	85,7%	6
Water level	71,4%	5
Wave	71,4%	5
Current (means & vertical profile)	71,4%	5
Wind	42,9%	3
Salinity (conductivity)	85,7%	6
Density	57,1%	4
Temperature	85,7%	6
Other, please specify		5
answered question		**7**
skipped question		**3**



The three answers that received most of the vote were Temperature, conductivity and turbidity. Thereafter came parameters like water level, wave and current. Water depth, river outflow density and wind were also cited within percentages ranging from 43 to 57. Finally, seafloor mapping was the less cited with only 14 %.

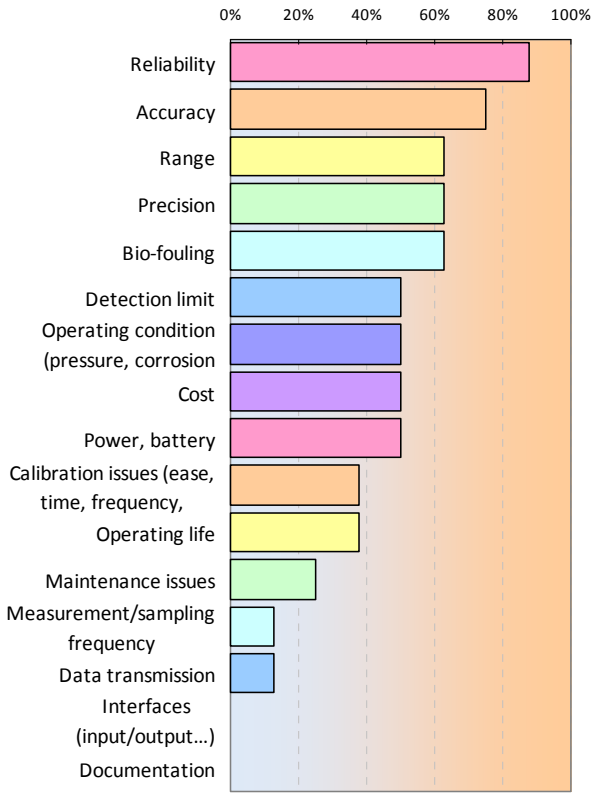
Q2. Related to the above questions, what kind of sensor technology do you use? (eg depth: sounder, lidar...)?

Part.	Temp.	Current	Wave	Water level	Depth	River Outflow	Turbidity	Seafloor mapping	Wind	Salinity	Density
1	PT 100				strain guage		optical			inductive	
2	Thermometers	Doppler Current Profilers	Doppler Current Profilers	Pressure	Sonar	ADCP	Laser Scatterometry - Doppler Current Profilers	SSS	Sonic	Electrode Cells	CTD
3	Thermistor bridge	Acoustic	Based on pressure measurement	Piezoresistive pressure element			Optical sensors		Mechanical sensors	Inductive principle	
4	PRT	ADCP	ADCP	Radar	Strain Sensor	Wet Chemistry	Optical		Anemometer	Pmped water system or Inductive	Calculated
5							Optical Turbidity sensor				
6	PT1000	inductive (electro-magnetic)	pressure; directional waves: pressure + current (PUV)	pressure sensor						4- ans 7-pole cells	
7	PT1000	ADCP	ADCP	pressure transducer	pressure transducer	ADCP, Velocity meter	Optical turbidity sensor		Anemometer	7-electrode cell	

TS= Thermosalinograph, T= thermistor, ADCP= Acoustic Doppler Current Profiler

Q3. Which of the following areas are you really concerned in terms of physical sensors?

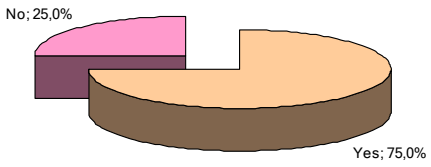
Answer Options	Response Percent	Response Count
Detection limit	50,0%	4
Range	62,5%	5
Accuracy	75,0%	6
Precision	62,5%	5
Measurement/sampling frequency	12,5%	1
Reliability	87,5%	7
Operating condition (pressure, corrosion etc…)	50,0%	4
Calibration issues (ease, time, frequency, automatic…)	37,5%	3
Interfaces (input/output…)	0,0%	0
Maintenance issues	25,0%	2
Cost	50,0%	4
Documentation	0,0%	0
Operating life	37,5%	3
Bio-fouling	62,5%	5
Power, battery	50,0%	4
Data transmission	12,5%	1
Other, please specify		0
answered question		**8**
skipped question		**2**



The first concern from the companies is reliability of their sensors/instruments. However, accuracy, range, precision and biofouling were also substantially cited (> 60%). Thereafter issues related to detection limit, operating condition, cost, power, calibration, and operating life were also largely mentioned at about 50%. Finally companies seem a bit less concerned about issues related to maintenance issues, sampling frequency, interface and data transmission.

Q4. Considering bio-fouling, do you provide anti-fouling technologies?

Answer Options	Response Percent	Response Count
Yes	75,0%	6
No	25,0%	2
If yes, please describe briefly		5
answered question		8
skipped question		2



About 75% of the survey participants provide anti fouling technologies.

The different technologies cited are:

- wipers

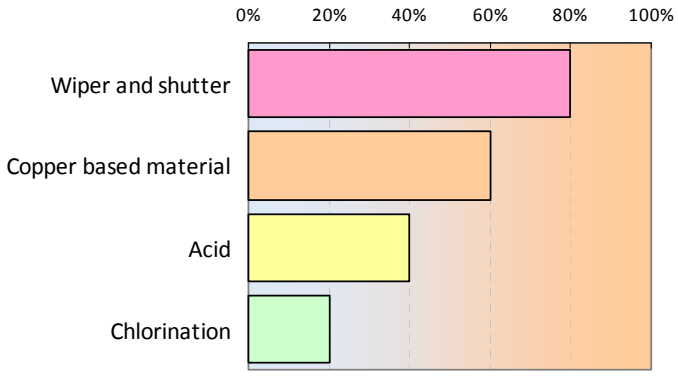
- Sensors for moorings are included in plastic tubing and the water is pumped within the tubing. Mechanical cleaning of the sensitive elements happens when water is pumped, when water is not pumped the TBTO anti-fouling dissolved in the water inside the tubing, preventing bio growth

- Wiper

- Use of materials/coating that contain copper ions.

Q5. Considering bio-fouling, how do you protect your sensors?

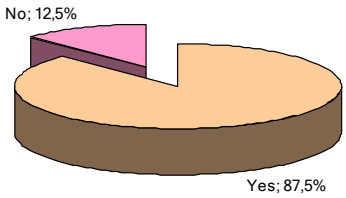
Answer Options	Response Percent	Response Count
Copper based material	60,0%	3
Chlorination	20,0%	1
Acid	40,0%	2
Wiper and shutter	80,0%	4
Other, please specify		2
answered question		5
skipped question		5



As for chemical sensors, sensors/instruments are mostly protected by shutters and wipers. Copper based material is also a technological solution. Acid cleaning and chlorination were also cited but to a less extent (< 40%).

Q6. Do you include a data transmission capability with your sensors / instruments?

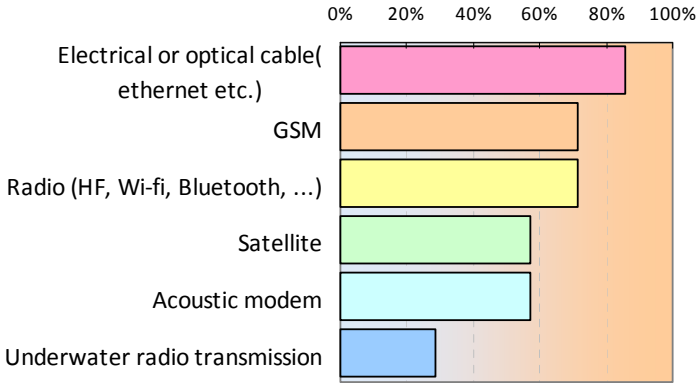
Answer Options	Response Percent	Response Count
Yes	87,5%	7
No	12,5%	1
answered question		**8**
skipped question		**2**



Most sensors/instruments are equipped with transmission capabilities (87,5%).

Q7. What are the transmission technologies implemented?

Answer Options	Response Percent	Response Count
GSM	71,4%	5
Electrical or optical cable (ethernet etc.)	85,7%	6
Satellite	57,1%	4
Radio (HF, Wi-fi, Bluetooth, ...)	71,4%	5
Underwater radio transmission	28,6%	2
Acoustic modem	57,1%	4
Other, please specify		1
answered question		**7**
skipped question		**3**



The most common answer for physical sensors/instruments was the electrical/optical cable with more than 80%. GSM and Radio were the second most cited transmission technology. In the 'other' section were also cited the wireless technology.

Q8. What do you consider to be the next generation of physical sensors/instruments in support of coastal oceanography?

Answer Options	Response Count
	4
answered question	**4**
skipped question	**6**

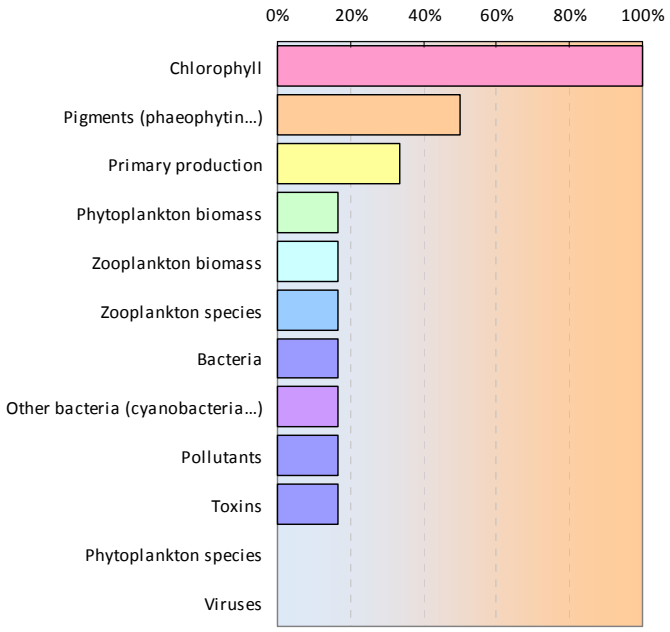
The different answers about the next generation of physical sensors are listed below:

- low cost, disposable
- Optical pH
- McLane ESP real-time analysis of DNA for specific toxins
- biofouling, long-term stability

4.4.5. .Sensors for biological measurements

Q1. What parameters are your sensors / instruments able to measure?

Answer Options	Response Percent	Response Count
Chlorophyll	100,0%	6
Pigments (phaeophytin, carotene…)	50,0%	3
Primary production	33,3%	2
Phytoplankton biomass	16,7%	1
Phytoplankton species	0,0%	0
Zooplankton biomass	16,7%	1
Zooplankton species	16,7%	1
Bacteria	16,7%	1
Other bacteria (cyanobacteria…)	16,7%	1
Viruses	0,0%	0
Pollutants	16,7%	1
Toxins	16,7%	1
Other, please specify		2
answered question		**6**
skipped question		**4**



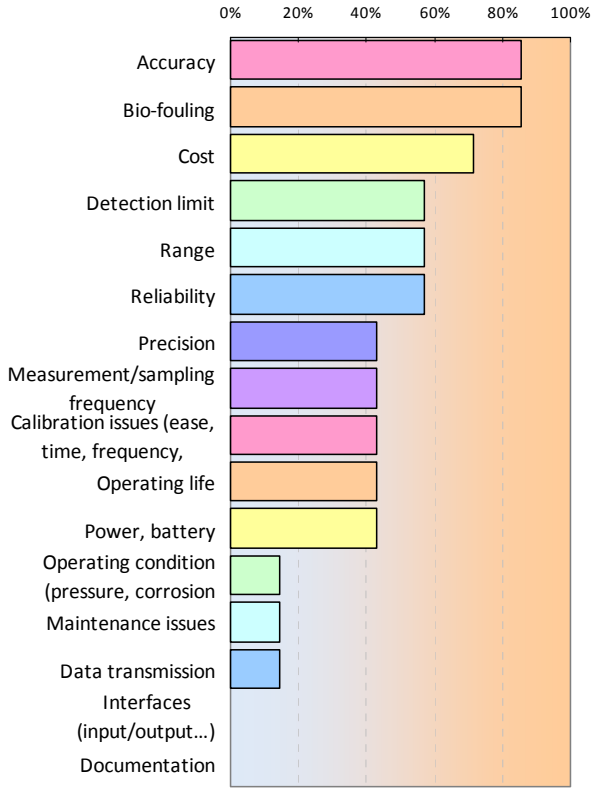
Chlorophyll is clearly the most measured biological parameter with biological sensors. Pigments and primary production came second and third. Finally the other parameters such as bacteria, phytoplankton biomass etc received a percentage less than 20 %.

Q2. Related to the above questions, what kind of technology do you use for your biological sensors / instruments? (e.g. Chlorophyll : fluorescence…)

Chlorophyll	Pigments	Primary production	Phytoplankton biomass	Phyto. species	Zoo. biomass	Zoo. species	Bacteria	Virus	Pollutant	Toxin
optical fluorescence	optical fluorescence	Fast repetition rate optical fluorescence	Fast repetition rate optical fluorescence							
in situ fluorescence induction and relaxation		in situ fluorescence induction and relaxation								
Optical fluoresence										
Fluorometer	Fluorometer				Sampler	Sampler				DNA assay
Fluorometer	Fluorometer									

Q3. Which of the following areas are you really concerned about with regard to biological sensors ?

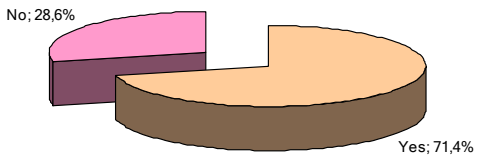
Answer Options	Response Percent	Response Count
Detection limit	57,1%	4
Range	57,1%	4
Accuracy	85,7%	6
Precision	42,9%	3
Measurement/sampling frequency	42,9%	3
Reliability	57,1%	4
Operating condition (pressure, corrosion etc…)	14,3%	1
Calibration issues (ease, time, frequency, automatic…)	42,9%	3
Interfaces (input/output…)	0,0%	0
Maintenance issues	14,3%	1
Cost	71,4%	5
Documentation	0,0%	0
Operating life	42,9%	3
Bio-fouling	85,7%	6
Power, battery	42,9%	3
Data transmission	14,3%	1
Other, please specify		0
answered question		**7**
skipped question		**3**



Accuracy and biofouling issues (> 80%) are the main concerns from the company, followed closely by cost (about 70%). Detection limit, range and reliability also received high percentages (> 50%).

Q4. Considering bio-fouling, do you protect your sensors?

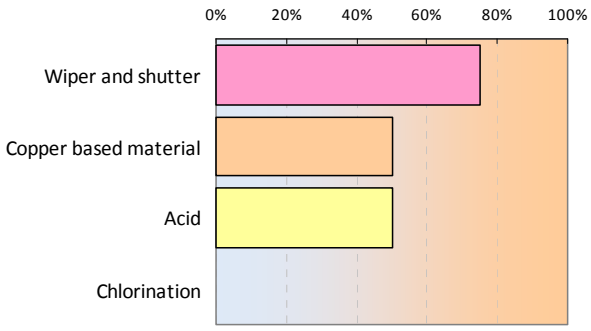
Answer Options	Response Percent	Response Count
Yes	71,4%	5
No	28,6%	2
answered question		**7**
skipped question		**3**



About 70% of the companies that have answered the survey state that they protect the ‘biological sensors’ from biofouling.

Q5. Considering bio-fouling, how do you protect your sensors?

Answer Options	Response Percent	Response Count
Copper based material	50,0%	2
Chlorination	0,0%	0
Acid	50,0%	2
Wiper and shutter	75,0%	3
Other, please specify		2
answered question		4
skipped question		6



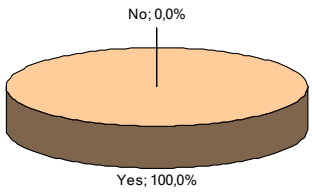
As for chemical sensors, sensors/instruments are mostly protected by shutters and wipers. Copper based material is also another technological solution. Acid cleaning was also cited but to a less extent. Chlorination has not been cited.

Another solution mentioned was:

- titanium housing

Q6. Do you include a data transmission capability with your sensors / instruments?

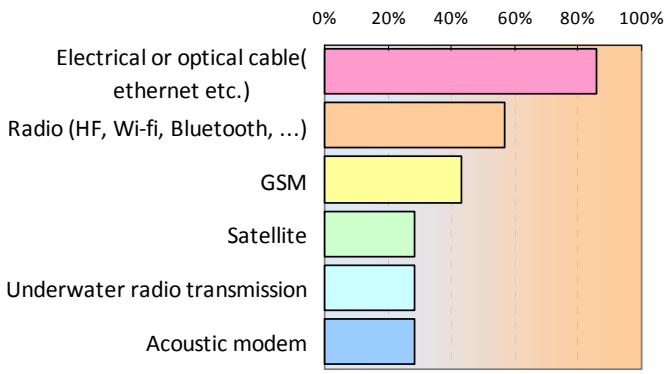
Answer Options	Response Percent	Response Count
Yes	100,0%	7
No	0,0%	0
answered question		7
skipped question		3



All the sensors provided by the companies that has answered this question are equipped with transmission capabilities.

Q7. What are the transmission technologies implemented?

Answer Options	Response Percent	Response Count
GSM	42,9%	3
Electrical or optical cable(ethernet etc.)	85,7%	6
Satellite	28,6%	2
Radio (HF, Wi-fi, Bluetooth, ...)	57,1%	4
Underwater radio transmission	28,6%	2
Acoustic modem	28,6%	2
Other, please specify		1
answered question		**7**
skipped question		**3**



The survey shows that electrical/optical cable is the most common used technology to transfer data from the sensors. Radio and GSM were also frequently cited.

In the 'other' section was specified technology like:

- wifi

Q8. What do you consider to be the next generation of biological sensors/instruments to be developed in support of coastal oceanography?

Answer Options	Response Count
	4
answered question	**4**
skipped question	**6**

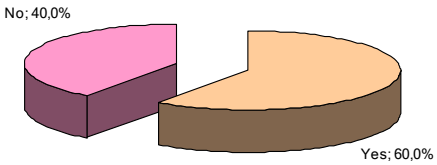
The different answers to this question are listed below:

- low cost, low power and high end evolution of sensors for primary production
- Remove Wet based Systems - Small, easy to change, reliable
- McLane ESP DNA array with real-time telemetry

4.4.6. View on the Forum for Coastal Technologies

Q1. Do you know the JERICO project (www.jerico-fp7.eu)?

Answer Options	Response Percent	Response Count
Yes	60,0%	6
No	40,0%	4
answered question		**10**
skipped question		**0**



More than half of the companies that filled the survey knew about the JERICO project.

Q2. How can we use the FCT to create a better link between sensor users (scientific community) and providers (companies)? Please briefly describe

Answer Options	Response Count
	6
answered question	**6**
skipped question	**4**

The different answers to this question are listed below:

- Learn from experiences of ACT and build on these. Compliments not duplicate. Think Global.
- Supporting field tests in real environment conditions with some financial contribution
- Arrange workshops to improve communications
- A workshop is a great introduction to a new organization
- Keep information freely available, sometimes difficult in a commercial world.
- Company and product presentation at your homepage, in papers / brochures, conferences

Q3. Do you know interesting initiatives that you think we should be aware of or linked to? Please briefly describe

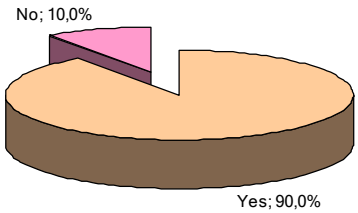
Answer Options	Response Count
	3
answered question	**3**
skipped question	**7**

To this question companies gave the following answers:

- NOAA Alliance for Coastal Technologies
- MCERTS running in UK
- WOC should be important

Q4. Do you know the 'Alliance for Coastal Technology' (ACT: http://www.act-us.info/)?

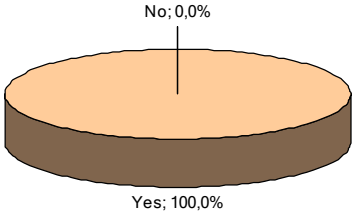
Answer Options	Response Percent	Response Count
Yes	90,0%	9
No	10,0%	1
answered question		**10**
skipped question		**0**



Almost all the companies were aware about the ACT initiative

Q5. If such an initiative would be developed at the European level, would you like to be involved?

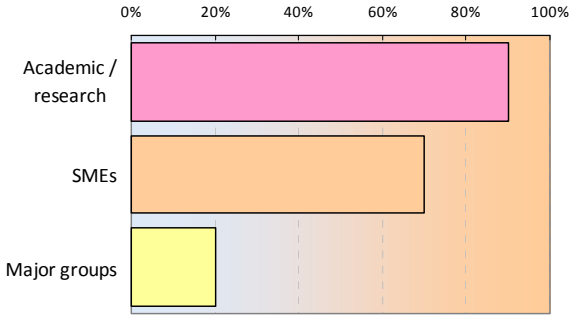
Answer Options	Response Percent	Response Count
Yes	100,0%	10
No	0,0%	0
answered question		**10**
skipped question		**0**



All the companies would like to be involved in a similar European initiative such as the ACT

Q6. Who in your opinion should be invited to participate in the FCT?

Answer Options	Response Percent	Response Count
Academic / research	90,0%	9
SMEs	70,0%	7
Major groups	20,0%	2
Other, please specify		1
answered question		10
skipped question		0



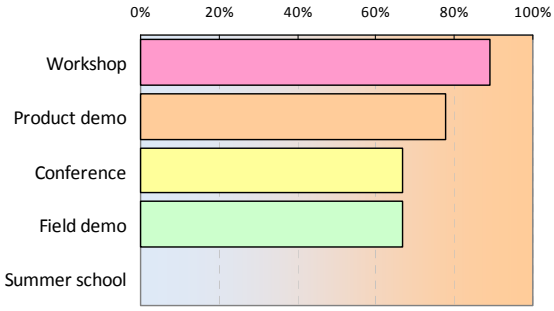
From the company point of view, academics and SMEs are the most voted in partners for the FCT

Another suggestion was formulated:

- users of oceanographic data from private industry

Q7. Amongst the following FCT initiatives which one(s) would you like participate in?

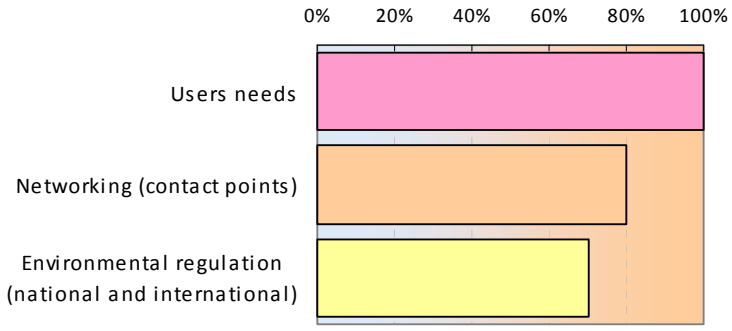
Answer Options	Response Percent	Response Count
Conference	66,7%	6
Workshop	88,9%	8
Summer school	0,0%	0
Product demo	77,8%	7
Field demo	66,7%	6
Other, please specify		1
answered question		9
skipped question		1



Most of the FCT initiatives such as workshop, product demo, conferences and field demo received high answer's percentages. Only summer school does not seem to convince the companies

Q8. What kind of inputs could the FCT provide to your company?

Answer Options	Response Percent	Response Count
Users needs	100,0%	10
Environmental regulation (national and international)	70,0%	7
Networking (contact points)	80,0%	8
Other, please specify		1
answered question		**10**
skipped question		**0**



The companies that filled the survey voted substantially for the three proposed inputs. However, 'User needs' was the most voted in.

Q9. If you have any suggestion, or action you would like the FCT to carry out, please describe:

Answer Options	Response Count
	3
answered question	**3**
skipped question	**7**

The suggestions made were:

- An initial joint meeting with ACT to assess activities to date and produce a joint plan to meet global requirements

- This is a very good initiative and we look forward to its success

- To detect users (academic or official) who are willing to act as first user, sharing the development risk with SME.

5. First FCT workshop

5.1. Workshop goals

If the scientific institutes in Europe are well identified, and in particular the contact details for the expert fellows, this remains unclear for the private companies. These latter are spread all over Europe and no exhaustive list exists so the proper diffusion of information toward them remains an issue.

This is clearly needed to be able to exchange on regular basis information about user requirements and technological developments.

The main task, identified in the FCT's ToR (Terms of Reference) was to organize workshops that should (1) help the industry to get a better idea of requirements for research and monitoring and (2) allow the scientific community to be aware of the latest sensor/instrument developments.

Two workshops were therefore scheduled within JERICO with the aim to gather private companies and scientific users with the main objective to foster interaction between scientists and instruments and services suppliers, which are mainly private small companies. With no specific format, the first workshop can be considered as a pilot. The conclusion of this first meeting and the feedback from the attendees will help to setup the second FCT meeting in term of new format (if necessary) and content.

5.2. Organization of the workshop

Every two years, the Sea Tech Week event in Brest attracts many stakeholders of the marine sciences and maritime industry. JERICO decided to join this event that offered the opportunity to attend parallel conferences and workshops on oceanographic topics. An instrumentation and sensors exhibition and demonstration attracted companies, which could then be interested in the FCT and its workshop. Many managers and public deciders did also attend the STW.

This 1-day workshop focused on oxygen and nutrients measurements: calibration procedures, deployments, maintenance, and robustness.

The workshop was separated in two main parts: (agenda attached on annex)

During the morning session, after a short introduction done by the JERICO's coordinator, invited scientists gave presentations about their work (with an overview of the state of art on their subject)

Through the afternoon session, representatives of companies delivered talks on their developments and products.

A general and constructive discussion between scientists and representatives of private companies wrapped up the workshop.

26 people attended the workshop, allowing animated discussions. We didn't follow the classical scheme with a debate reserved to a panel. The discussion was comprehensive and animated. People were particularly interested in getting more insight from the American organization ACT. Mario Tamburri, currently director of the US-ACT presented this initiative and gave perspectives and advices about what could be the European counterpart.

Despite the successful participation of the workshop, the proportion of private companies that attended was limited (20%). This is a concern, and a lot of work has still to be carried out to be able to durably implicate more SMEs within the FCT.

During all the day, lunch and coffee breaks provided full opportunities of networking with people attending other conferences and exhibition in the SeaTechWeek.

5.3. Presentations

The presentations given during the workshop are available on the JERICO's Website.

http://www.jerico-fp7.eu/coastal-technologies/workshop-organisation

5.3.1. Welcome and *general introduction*

Patrick Farcy (Senior Research Fellow, Ifremer), JERICO's project coordinator, gave a detailed presentation of the project, explaining the main purpose of this meeting. He put emphasis on the importance of the involvement of industry in the project.

JERICO aims at sustaining the long term European network of coastal observatories. To initiate the infrastructure sharing process, JERICO is funding a Trans National Access (TNA) giving an opportunity to all institutes to use infrastructures available in other countries.

5.3.2. FCT presentation

Glenn Nolan (WP10 leader) explained in detail how the FCT was born. Different institutes have attempted to find a mechanism to fill the gap between scientists and industry for more than a decade. JERICO represents the opportunity to seed this forum in close cooperation with other bodies like EuroGOOS.

5.3.3. First survey results

Yannick Aoustin (research fellow, Ifremer) presented a concise summary of the first survey. (Analysis and synthesis are available on the JERICO web site). Most of the Jerico partners answered the survey. It provides an overview of the coastal monitoring activities in Europe. Scientists gave information on their sensor needs. They are all concerned with calibration, reliability, maintenance and biofouling.

The analysis of the survey shows that all partners share the aims and scope of the FCT. Among others, the main actions that should be done in the next years are:

Encourage regular exchange of information to bring users requirement and technological developments closer together.

Set up performance demonstrations,

Establish recommended standards or best practices

Invite SMEs and environmental stakeholders to join FCT

5.3.4. Calibration experiment

Florence Salvetat (research fellow, Ifremer) hosted the first JERICO calibration experiment within the Ifremer metrology laboratory.

The experimental method was clearly detailed. Due to the physical size of the thermo-regulated

seawater bath only a small number of multi-parameter probes can be calibrated at the same time.

Three laboratories participated to this first inter-calibration experiment. The calibration focused on temperature / conductivity and dissolved oxygen.

The perspectives are to extend this experiment to other parameters such as turbidity and fluorescence. Other issues to investigate could be a comparison between different sensor technologies and different calibration protocols.

5.3.5. Oxygen measurement, state of the art

Laurent Coppola, (CNRS – INSU) on behalf of a group of scientists, gave a concise but comprehensive white paper on O2 measurements.

O2 measurement is one of the most important parameters giving information on the environmental and biological conditions of the oceans.

There are different methods (lab and in situ) to sample dissolved oxygen from Winkler titration to optical sensors. Accuracy is very critical for deep-water processes.

Accuracy can be reached by calibration in lab (recalibration) before and after experiment. Significant drift is a concern.

Scientists need sensors with short response time, better accuracy and long-term stability.

A short discussion followed the presentation:

It seems that the difference between optode and winkler can be explained by the sampling method.

The long response time of the optode could give underestimated measurements particularly when this sensor is used on Pagode float or on Ferrybox, where the optode is often in contact with air.

Scientists want to go further with SMEs on this subject; for example, record the behavior of a batch of membranes (diffusion time). The technology inside sensors is confidential so scientists or users cannot investigate the problem.

5.3.6. In situ nutrient measurement, state of the art

Agathe Laes (research fellow, Ifremer) presented a synthesis of in situ nutrient measurements with the important key words, high frequency, robust, accurate, biofouling protection.

Long term monitoring of nutrient concentrations are essential to discern the natural signal from anthropogenic perturbation and to contribute to the Marine Strategy Framework Directive.

The talk focuses on the developments made at Ifremer:

Chemini (a wet chemistry system deployed on buoys)

Integration of an Isus probe (optical sensor) on an Argo profiling float.

Some remarks from the attendees.

Intercalibration from different systems is clearly needed.

What is the next step after Baie de Vilaine ? Chemini on FerryBox.

5.3.7. ACT presentation

Mario Tamburri (ACT executive director) introduced ACT (Alliance for Coastal Technologies) to the audience.

Changing ocean requires innovation and new technologies. The transition from emerging technologies to operational instrumentation must be done rapidly and efficiently. The dialogue between all the actors, from the developers to the users, must be continuous. The ACT organization maintains this permanent link.

In contact with scientists on one side and with the industry on the other side ACT is able to identify user needs and new technologies available.

Lab and field demos enable unbiased performance verifications and training.

Information is gathered and dispatched through technology workshops on specific subjects.

A short discussion followed the presentation:

How to attract people to the workshops? ACT can fund the participation. NOAA give a financial support of 3M$ by year (1 M$ is an estimated minimum to keep ACT going on).

There is not any other initiative like ACT in the world.
ACT looks forward to partnering with FCT.

Question on CO2 determination, pCO2 and dissolved inorganic carbon

Fouling is a big factor for pCO2

Metrology ; Dynamic behavior of sensor

Real success of field tests and web site

5.3.8. Company presentation 1, O2

Emilie Guidicelli (HOCER) oxygen optode from Aaderaa

Overview of improvements in new optodes, calibration and validation

5.3.9. Company presentation 2, O2

Miguel Moll: (EMS Environmental Monitoring Systems)

Presentation of the new SBE43 dissolved oxygen probe.

5.3.10. Institute presentation 3, O2

Maik Grunwald (Helmholtz Zentrum Geesthacht) O2 measurement, calibration and validation

Many in situ platforms (fixed or on vessels, ferrybox) are operational along the German coast.

Different sensors (AMT, RINKO, AANDERAA) are under test.

Two years of tests under quality assurance have shown an underestimation of the optode measurements. Drifting is also observed, possibly due to biofouling. Calibration must be done over the full range before and after a change in FerryBox.

Bubbles are a challenge in a FerryBox (and other systems with pump).

5.3.11. Company presentation 4, Nutrient

Luca Sanfilippo (AMS SYSTEA)

Systea presented the new WIZ *in-situ* multi-parametric nutrients probe (up to 4 parameters).

This probe uses the micro loop flow reactor technology. The main features are an automatic sample blank correction, a biofouling protection, an automatic washing and a 0.2 microns filtration unit.

5.3.12. Company presentation 5, nutrient

Miguel Moll: (EMS)

EMS made a presentation of the Satlantic nutrient sensor SUNA

This sensor measures only nitrate.

Usable in coastal waters but with some high interferences due to bromide ions.

5.3.13. Institute presentation 6, nutrient

Maik Grunwald: (HZG)

HZG delivered information of operation of chemical nutrient analyzers installed on fixed platforms.

The commercially available instruments do not feature long-term stability for unattended operation. There is still a demand on more robust and reliable instruments with high sensitivity

5.3.14. Round table and discussion

Glenn Nolan & Mario Tamburri: moderated this discussion with and between the attendees.

The whole attendance agreed that a strong partnership between sensors users and industry (mainly SME) is mandatory. We need a roadmap to reach this objective; how to proceed now?

The foremost question is "how to involve private companies?". This issue was the matter of the discussions throughout the workshop. Everyone agrees that the forum cannot be productive without a strong and long-term contribution from industry.

We urgently need to find an answer to another concern that is "How companies can gain from the process?" Participation must be a win-win "game". Attending workshops or taking part in verification in-situ trials costs time and money.

Scientific institutes have gathered a large amount of sensor best practices. This experience and the user knowledge are useful for SMEs. Companies are keen to get user feedback on a regular basis; continuous information exchange is required.

ACT organizes regular activities, like workshops where users and manufacturers can exchange information and data. The minutes of these workshops are available to all members. Sensor suppliers join in-situ experiments where instruments are tested in the real environment. The results of these tests are useful to issue recommendations and harmonization of measurement protocols.

ACT suggests organizing annual workshops, focusing on particular technologies, water parameters or specific measurement method. Questionnaires sent to users and sensors suppliers to sort out specific problems are useful to the whole oceanographic community.

Calibration and maintenance are key issues that scientists want to see improvements in. Indeed, scientists often get the funding to buy instruments which subsequently require a large budget for the maintenance. They don't want to send their equipment to the other side of the world. Help from the manufacturer is welcome. This can be done through calibration workshops, which give also the opportunity for exchange of know-how.

There is a group in the US that organizes calibration. There is no similar initiative in Europe. Some companies state that they don’t want to have all the equipment coming back to their labs for calibration. It is also hard to evaluate the cost of calibration. Harmonization of calibration procedures is needed (JERICO might initiate that). Some recommend that the calibration should be done under the responsibility of independent laboratories.

Companies understand the difficulties of their users; they can teach how to use the instruments.

5.3.15. Closure

Parick Farcy

The FCT must open up JERICO to companies, mainly sensor manufacturers as a first step. A list of relevant companies should be circulated.

JERICO offers Transnational Access to European Coastal Observatories and Calibration Facilities to facilitate innovation through collaboration between users. TNA information should be communicated to the companies, so they can benefit from this initiative. The next call in January will be open to new partners.

5.4. Recommendations

The workshop has left many questions unanswered. The main objective of the FCT in the project JERICO, is to seed a mechanism (including organization and funding) to establish a permanent and lively communication between sensor and service companies on one side and users, scientists or managers, on the other side.

Going to an operational status for new sensors or monitoring systems, which is the last step in the technology readiness level (TRL) scale , is a long and costly process, most of the time supported solely by companies. FCT must carry out or support activities to verify and promote technologies that are ready for commercialization. Unbiased verification reports written by third parties, fully transparent and available to all parties will help marine companies and vendors in the oceanographic market.

To achieve these objectives some recommendations were suggested during the workshop:

- Keep the FCT active through events or newsletters: FCT will promote activities through the JERICO Newsletter periodically,
- Distribute and maintain on line an up to date relevant list of sensors manufacturers, vendors and services companies,
- Following the work done within the ESONET project, develop the "yellow pages" concept for getting an overview of all relevant sensors and products commercially available,
- Propose verification activities on a voluntary basis focus on one technology, parameter or platform,
- Keep close relationship with the Alliance for Coastal Technologies (ACT) in the US.
- Organize a yearly forum,
- Write a quality guide for all FCT activities,
- Propose a structure for the future FCT.

It should be emphasized that while FCT is making good initial progress through the JERICO project at present, it is comparatively under-resourced (compared with ACT-US) and FCT sits within a short-term project structure. In order to ensure continuity of the activity in the post-JERICO era consideration should be given to establishing a modest secretariat to continue the work initiated in JERICO.

Annex 1 Workshop agenda

	Item	**Speaker**
8 45	Welcome and Introductions	Patrick Farcy Project Coordinator, IFREMER Brest, France
9 00 – 1200	**Morning session**	
9 00	FCT Presentation	Glenn Nolan Section manager, Marine Institute, Galway, Ireland
9 20	FCT results: first survey review, experimentations and perspectives	Yannick Aoustin Research fellow, IFREMER Brest, France
9 40	FCT actions: first experimentation and perspectives	Florence Salvetat Research fellow, IFREMER Brest, France
10 00	**Coffee Break**	
10 20	FCT focus 1// Oxygen: - State of the art (technology wise) - Needs for coastal observations - Challenges to address	Laurent Coppola Research Fellow, CNRS Lab. d'Océanographie de Villefrance
11 20	FCT focus 2// Nutrient (NO_3 mainly): - State of the art (technology wise) - Needs for coastal observations - Challenges to address	Agathe LAES (TBC) Research fellow, IFREMER Brest, France
1230	**Lunch**	
1400 – 1800	**Afternoon session**	
1400	An example to be inspired of: The US-ACT // Alliance for Coastal Technologies -	Dr. Mario Tamburri Executive Director, US ACT Solomons, USA
15 00	Company presentation Oxygen #1	Emilie Giudicelli Oceanography section Manager HOCER / Aanderaa, France
15 10	The new SBE63 dissolved oxygen optode (SBE)	Audrey Malarin EMS Systèmes de Monitorage, France

15 20	Calibration of an oxygen optode: a feedback	Maik Grunwald Research fellow, Inst. for Coastal Research, Germany
15 30	Nutrient in-situ-probe WIZ product	Luca Sanfilippo SYSTEA SpA, Italy
15 40	The SUNA Nutrient sensor from Satlantic	Audrey Malarin EMS Systèmes de Monitorage, France
15 50	Results from chemical nutrient analysers	Maik Grunwald Research fellow, Inst. for Coastal Research, Germany
16 00	**Coffee Break**	
16 20	Round table and discussion	All – Moderators: Glenn Nolan – Marine Institute Mario Tamburri – US-ACT
17 30	Summary & close	Patrick Farcy Project Coordinator, IFREMER Brest, France

Annex 2 List of attendees

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