# ANNUAL REPORT 2020
# SFI SMART OCEAN


Street-Address: Bjørn Trumpy´s hus, Allegt. 55, 5007 Bergen, Norway

## Contents

## Summary


Norway has very long and valuable experience within shipping and exploitation of sea resources. Over the past half century traditional fishing has been supplemented by fish farming/ aquaculture. In parallel, Norway has become one of the pioneers in offshore exploration of oil and gas on the Norwegian shelf. Further, over the past years there have been a considerable progress in technology for offshore wind energy. Currently this also includes methods for subsea energy conversion and storage. There are also other possibilities such as deep-sea mineral exploitation which is worthwhile pursuing.

The Government´s ocean strategy is clear: "*The Government will contribute to the greatest possible overall sustainable value creation and employment in the maritime industries*". SFI Smart Ocean is set up and organized to best possible contribute to sustainable exploitation of the sea resources. This implies:

- Systematic collection of high-quality data is a key to achieve well informed decisions and sustainable management of the marine resources.
- The prime objective of SFI Smart Ocean is thus to create a flexible, robust, energy efficient and cost-effective smart sensor network platform for marine measurements and data handling.
- This network may be used for condition monitoring of industrial installations and for environmental monitoring for instance for climate studies.

The operation of SFI Smart Ocean has been organized in four interlinked work packages: Autonomous sensors and measurement strategy, wireless network communication, software technology and big-data middleware and finally pilot demonstrators. In addition, there is an overarching activity taking care of administration and necessary functions such as education, data management, commercialization, and innovation.

The latter is utter importance to make innovation happen. Bringing together partners and people with different education and experience stimulates innovation. So does students on all levels (BSc, MSc and PhD). SFI Smart Ocean will also connect with miscellaneous network and clusters etc. to stimulate collaboration on student projects.


Geir Anton Johansen,
Centre director SFI Smart Ocean

## Vision and objectives

***The SFI Smart Ocean vision*** is realization of a generic autonomous and flexible wireless multi-parameter marine observation system for reliable management of a productive and healthy ocean.

SFI Smart Ocean will focus on enabling real-time high-quality data for increased autonomy, increased value of coastal and oceanic management models and systems. This will lead to sustainable and profitable ocean industry operations, and to fact-based ocean resource management.

The observation system key factors are highly cross-disciplinary:

- sensors and measurement parameters
- flexibility and adaptive sampling in time and space
- point measurement vs. monitoring over large areas
- distributed measurements
- measurement uncertainty and reliability
- time history as input to big-data analysis
- machine learning, prediction, and emergency response
- data format aggregation and safety
- low power consumption and local sensor intelligence

Organising this as a centre spanning multiple scientific disciplines and sectors will ensure a vendor neutral nature of the system and enable a diversity of applications.

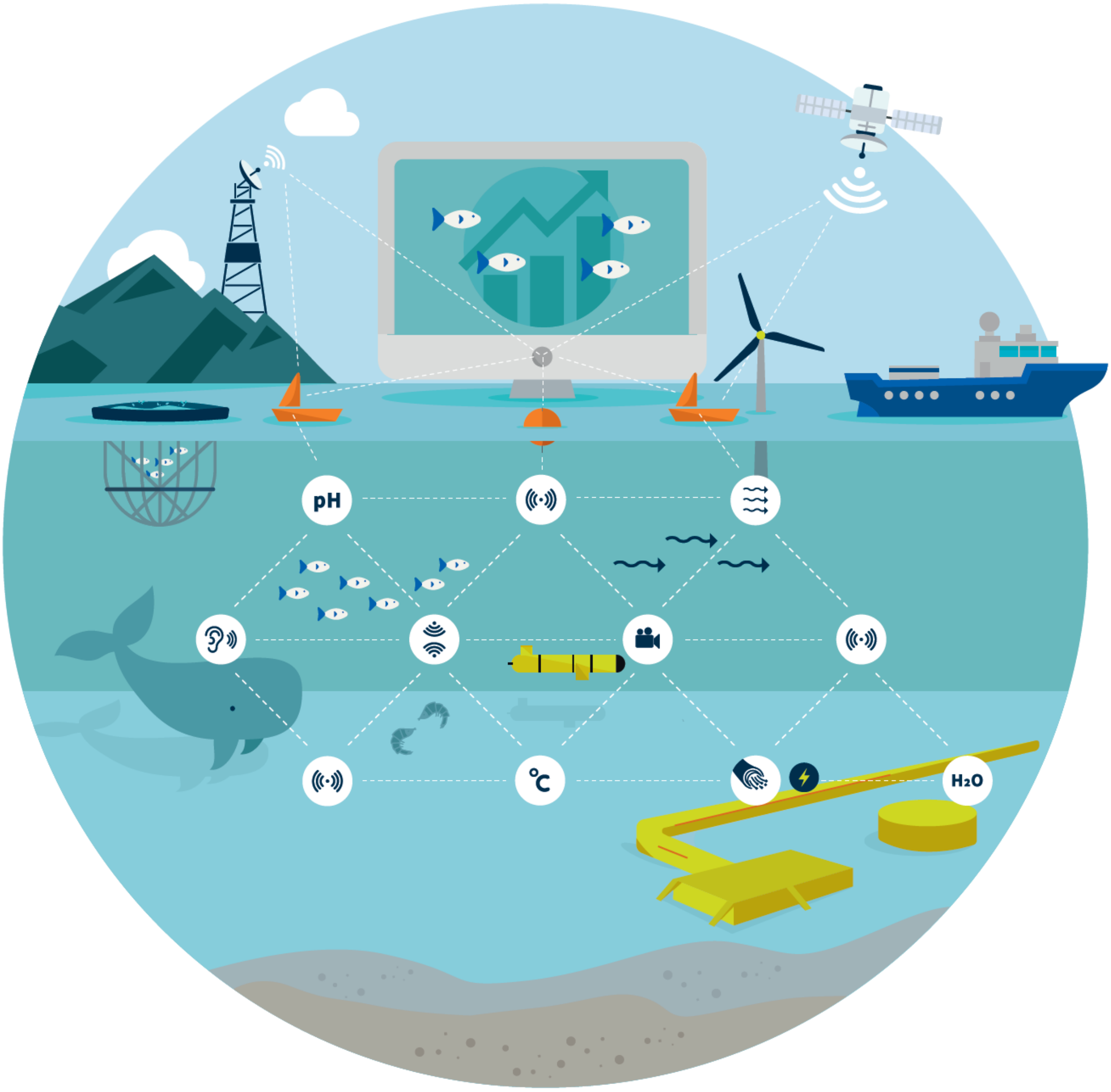
Standardized interfaces will enable integration of a diversity of sensor types, during and after the Centre's lifetime. As examples, it will be possible to implement sensors for monitoring of e.g.

***(i) Environmental parameters:*** pressure, temperature, salinity, ocean currents, waves, $CO_2$ and $O_2$, pH, chemical substances, oil-in-water, turbidity, seabed ecosystem, seabed gas leakage, $CO_2$ capture and storage (CCS) consequences, subsurface and reservoir monitoring.

***(ii) Structural parameters:*** flow-induced vibrations, fatigue evaluation, safety valve event detection, pipe leakage, pipe integrity, process integrity, mooring and power cable stress, wind turbine structure integrity.

***(iii) Marine life parameters:*** biomass, species, animal sound and communication, noise level and its consequences, salmon lice spreading.

These are all parameter values needed for well-founded decisions by industry and authorities, in optimization of operations or maintenance, and evaluations of license to operate. They are building blocks for filling the knowledge needs and societal challenges.




***Primary objective:***
The centre objective is to create a wireless observation system for multi-parameter monitoring of underwater environments and installations.

The system based on autonomous smart sensors will serve as an enabling fundament to realize flexible, distributed, robust, energy efficient, cost-effective, and safe marine measurements and big-data handling, to support the Centre’s vision in respect to societal and industrial challenges.

***Secondary objectives** include**:***

- Develop methodologies for self-diagnostics and self-validation of underwater sensors, and optimization of sensor network lay-out for higher reliability of sensor data.
- Develop new measurement technologies, and sensors for distributed monitoring,
- Develop a smart sensor platform for pre-processing, embedded data compression, and communication using autonomous, battery-operated sensors for marine measurements.
- Establish energy-efficient and robust wireless communication from underwater sensors to control room,
- based on underwater acoustic data transmission and mobile (4G/5G) or satellite networks in air.
- Develop software technology and systems for big-data analysis, with focus on embedded data compression, data aggregation, storing, safety, reliability, analysis, machine learning, and prediction.
- Construct four complementary pilot demonstrators for testing of system components and the potentials of the integrated system: two for environmental monitoring, and two for structural integrity.
- A minimum of 10 spin-off innovation or commercialization projects during the Centre period.
- Internationalization for cooperation with world leading researchers within the field. Use of secondments (adjunct professor); mobility of PhDs, Postdocs, and researchers (staff exchange, workshops, short visits).
- We expect to publish up to 150 articles in scientific peer-reviewed journals, up to 200 papers in international conference proceedings, and submit up to 10 patents, over the Centre’s 8-year lifetime.
- Training of up to 15 PhD &1 PostDoc financed directly under the Centre, and more than 60 MSc candidates, as well as BSc candidates.
- Establish large collaborations (e.g., EU-projects) as spin-offs during the Centre’s lifetime, and as part of the phasing-out strategy from the Centre, to maximise impact of the Centre results.

## Research plan/strategy

SFI Smart Ocean has an important focus on innovation for the industry sector and society, but equally important focus is the long-time scientific research in the Centre within fields necessary to fulfil the Centre's objectives. The research activity in the Centre is still in a preparatory phase where the strategy is to connect research and development by the different partners. This will take place within and across the different work packages as described in the he application. Kick-off meetings will be arranged to facilitate this, and the strategy will then be to identify and fill gaps by allocate and bring together competence and experience of the partners. Recruitment of PhD-students will be an important part of this.

Scientific research topics focused in the Centre are:

***Measurement strategy and uncertainty:***
Optimization of sensor network lay-out and associated measurement uncertainty is essential for robust long-term measurement solutions. The major research questions are:
(i) can we develop generic sensor self-validation and self-diagnostic properties for uncertainty reduction in long term subsea operations, and
(ii) can we develop a generic methodology for optimization of measurement lay-out with respect to low uncertainty of selected output measurement parameter?

***Anti-biofouling nanostructured surfaces for sensor signal quality and increased lifetime at sea:***
The major research question to be addressed related to biofouling, is: can we with detailed knowledge about the water flow and micro-fauna at typical sensor locations, design effective self-cleaning (anti-biofouling) surfaces targeted for these locations? First phase of this project will also include novel accurate pH point sensor for marine environment.

***Distributed fibre optic sensing for environmental and integrity monitoring:***
Main focus areas are:

*i) Novel design and advanced signal processing for Distributed Acoustic Sensing (DAS):* Commercial DAS systems are quite complex and provides qualitative results. Key research topics in the Centre are advanced signal processing and development of machine learning algorithms to enable quantification of various exposures in real time.

ii) *Distributed Chemical Sensing (DCS)* - Developing new monitoring platforms and methodologies: distributed sensing platform of the following key parameters: pH, $CO_2$, $H_2S$ and hydrocarbons. Key research questions include the type of sensor material to be used on the optical fibre, the coating thickness and methodology.

***Guided ultrasonic wave (GUW) technology for subsea integrity monitoring:***

Main focus areas are:

(i) *Development of GUW methodology for distributed monitoring of offshore wind turbine structures*.

There is a technology gap to confirm presence and integrity of cement grouting used in wind turbines. Cable free (wireless) monitoring solution is highly preferred. Key research questions include how to optimize and exploit the elastic waveguide for interrogation and evaluation of the grouting material used behind steel structure.

(ii) *Development of GUW methodology for distributed pipeline integrity and fatigue*. The potentials of GUW for detection and evaluation of material integrity and fatigue as input to online lifetime prediction of subsea pipelines will be explored. The propagation velocity of different leaky elastic guided wave modes over large portions of the pipe are to be investigated, as a function of pipe material fatigue. Key challenges include optimized use of waveguide modes, signal dispersion, and handling of pipe welds, flanges, and coating materials.

***Acoustic tomography for mesoscale marine environmental monitoring:***

The Centre will demonstrate how acoustic tomography can contribute to increased data coverage and cost-efficiency, by increasing the area representativity of measurement, and with a high time resolution with minimal need for manual intervention during operation.

*Research questions* include:

(i) How representative are point measurements (in space) with respect to monitoring the average volumetric state (in a region) of the coastal or fjord environment;

(ii) How can estimates of environmental parameters on the mesoscale be improved with a multipurpose observing system including acoustic tomography;

(iii) What is the impact of acoustic tomography on the quality of state estimates when combined with other existing data sources.

***Underwater wireless network communication:***

An innovative solution that will fill current technology gaps is development of Underwater Wireless Sensor Networks (UWSNs) for short-range communication between nodes, focusing on;

(i) development and implementation of methods for increasing underwater data rate per communication range;
(ii) energy-optimized operation for extended battery lifetime;
(iii) solutions constraining hardware size and cost; and
(iv) a network of sensors to increase spatial resolution and coverage.

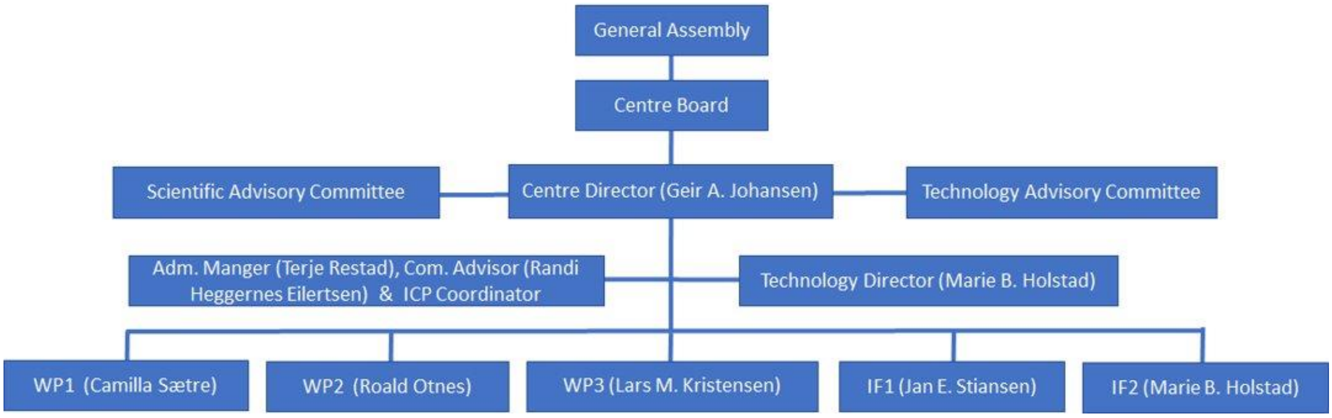
Standardized interfaces and protocols are important to enable interoperability and flexibility.
***Software technology and big-data middleware:***
The overarching *research question* is how to provide an adaptable architectural framework supporting smart ocean requirements. The *hypothesis* is that extending the emerging web-of-things architecture can provide an architectural framework and support software platform implementation that enables systems-of-smart systems. This will be *experimentally investigated* by software implementations integrated into the platforms of user partners and pilot demonstrators.

## Organisation

University of Bergen (UiB), represented by Department of Physics and Technology, is the Centre Owner, and the Centre administration will be hosted at the Department in “Bjørn Trumpy´s hus”.

## Organisational structure

The organisation-chart for SFI Smart Ocean is illustrated below:




The General Assembly is the body responsible for the major decisions regarding the Centre. The General Assembly shall follow up that the plans and intentions underlying the Project and the Consortium Agreement are fulfilled, and that Centre's activity is realised within the approved time and cost frameworks. All partners are represented in the General Assembly, and UiB as Host Institution chairs the General Assembly.

The Centre Board is the executive body of the Centre, with collective operational responsibility of the Centre. The Centre Board makes ordinary, operational decisions on the Centre. The main responsibility of the Centre Board is to ensure that the intentions and plans underlying the Centre are fulfilled.

The Centre Board are to be appointed by the General Assembly in the beginning of 2021, and will consists of 7 members: one member from the Host Institution, two members from the research partners, three members from the industry user partners, and one member from the industry clusters in the Centre.

As the host of SFI Smart Ocean, UiB is responsible for the coordination of all activities in the centre. The day-to-day management is carried out by the Centre Director Geir Anton Johansen, Technology Director/Deputy Director Marie Bueie Holstad (NORCE) and the administrative coordinator (Terje Restad from 1. March 2021).

A Scientific Advisory Committee (SAC) consisting of 4 international and independent experts will give advice to the Centre Board via the Centre Director on scientific issues and priorities, to ensure high-quality scientific impact. SAC will be appointed in 2021.

A Technology Advisory Committee (TAC) consists of one representative of all Consortium Participants each, and gives advice to the Centre Board via the Centre Director on technical issues and priorities, including ICP, to ensure industrial, innovation, research and value creation impact.

The Technology Advisory Committee is chaired by the member from the Host Institution. TAC will be appointed in 2021.

## Partners

The consortium consists of research partners, user partners from industry and industry clusters, and national authority observers.

**RESEARCH PARTNERS:**

Western Norway University of Applied Sciences

NORCE

NERSC

FFI Norwegian Defence Research Establishment

**USER PARTNERS – INDUSTRY:**

AANDERAA

xylem Let's Solve Water

tampnet

KONGSBERG

bouvet

TSC | SUBSEA

OCTIO Environmental

METAS

Lundin Energy

**USER PARTNERS/ INDUSTRY CLUSTERS:**

GCE Ocean Technology

GCE | NODE | AN INDUSTRY-DRIVEN CLUSTER FOR OCEAN TECHNOLOGIES

**NATIONAL AUTHORITY OBSERVERS:**

DIRECTORATE OF FISHERIES

PETROLEUM SAFETY AUTHORITY NORWAY

## Cooperation between the Centre's partners

Scientific cooperation between partners has been in a planning-phase, with emphasis on the work-plan for 2021. The main scientific cooperation will start in 2021 when the research activity increases, and new personnel are hired.

Future plans for mobility and network activities will be essential for cooperation between the partners.

# Scientific activities and results

The activity in SFI Smart Ocean is divided into three work packages (WP) and two integrating functions (IF).

The three WPs are edge-cutting disciplinary activities, however with necessary and strong mutual interaction. The IFs are cross-cutting interdisciplinary activities, integrating the three WPs, cf. Fig. 2.

| Work Packages (WP) and Integrating Functions (IF) | | IF1 | | | | IF2 |
|---|---|---|---|---|---|---|
| | | Pilot demonstrators | | | | Overarching activities |
| | | Environment | | Integrity | | |
| WP1 | Autonomous sensors and measurement strategy | PD1 - Local scale environmental monitoring | PD2 - Mesoscale environmental monitoring | PD3 - Integrity measurements offshore wind | PD4 - Integrity measurements oil and gas | • Administration<br>• Education<br>• Data management<br>• Commmunication<br>• Commercialisation, Innovation & IPR [ICP] |
| WP2 | Wireless network communication | | | | | |
| WP3 | Software technology and big-data middleware | | | | | |

*Figure 2: Work packages (WP) and Integrating Functions (IF).*

**WP1 - Autonomous sensors and measurement strategies** will develop autonomous sensor technologies, new measurement methods, and strategies for improved monitoring of underwater environments and structures. Technology providers will develop/adapt autonomous capabilities in own sensors, such as implementing embedded sensor data pre-processing, compression, safety and low bandwidth communication; energy-optimized and intelligent sensor operation for extended battery lifetime; acoustic modem compatibility with standardized communication protocols; and commercially available battery packages and recharging solutions. Sensors for environment (ocean current, acidity/$CO_2$), gas leakage (pipeline, CCS), and gravimetry, will be addressed initially. Additional sensor types will be addressed over the Centre's lifetime.

Research tasks include development of new sensor and measurement technologies for selected cases for which solutions are not available, such as anti-biofouling nano-treatment of sensing surfaces; DAS for integrity and structural vibration analysis; DCS for environmental monitoring; GUW for pipeline fatigue monitoring, ART and GUW for local and distributed grout integrity measurement at offshore wind turbines; and methodologies for systematic quality analysis of marine observation systems with respect to uncertainty, self diagnostics and compensation, on-site calibration and verification techniques.

**WP2 - Wireless network communication** will develop a low-cost, miniaturized, and short-range acoustic underwater wireless technology platform assembled to an energy-efficient underwater wireless sensor network (UWSN), for dense and long-term marine monitoring. The network gateway will be interoperable with IoT-standards and telecom operators' infrastructure and adapt both to sensor data and the significant challenges related to the underwater transmission medium. Hardware and software must be optimized with respect to limited battery capacity, efficiency, and reliability. WP2 and WP3 are thus closely linked with respect to embedded and centralized processing. Standardized and non-proprietary communication solutions are essential. Acoustic modem and communication protocols shall build on state-of-the-art within underwater acoustic communication technology. The system will be interfaced towards mobile networks (4G, 5G), satellite communication, fibre optic "backbone" network (where available), and ASVs.
Research tasks include low-cost hardware, energy-efficiency, reliable communication, relative high transmission rate and long-term monitoring. This includes acoustic modem optimization and development; embedded signal processing and edge computing, adaptive and cognitive communication techniques; network protocol development; and advanced power control.

**WP3 - Software technology and big-data middleware** will develop a validated multi-tiered architectural software systems framework enabling innovation and cost-effective development of robust applications and data services. It will be based on internet-of-things and the emerging web-of-things paradigms and span software technology for sensor data collection (WP1) through communication, aggregation, local processing (WP2) to data storage and analytics. The data management system will emphasize interoperability, data quality- and integrity, security and reliability. The joint expertise of the WP3 partners covers the complete software technology stack, including cloud-based software platforms (e.g., KM's Kognifai Ecosystem, AADI's xCloud), communication and distributed systems middleware (NORCE, HVL), software architectural frameworks for smart systems and big data services (Bouvet, HVL, NORCE), visual analytics and machine learning (NORCE; EPOS, Glider, and Enlighten projects). HI and NERSC as end-users will play an important

role for evaluation on the pilot demonstrators, and ensuring that the data streams will interface to scientific data infrastructures (e.g., NMDC) for research purposes in addition to commercial systems of the involved partners. WP3 will to a substantial degree leverage the experience from infrastructure projects, and competence and software implementations of the partners for integration of sensors, data sources, and data services. This will also mitigate the risks involved in the development of the smart ocean framework and software platform.
Research tasks include adaptable software architectures, advanced sensor-cloud integration protocols, standardized semantic data location and sharing, interoperable composite data services, machine learning algorithms for environmental monitoring and integrity measurements, experimental evaluation and *prototyping* through PD1-4, and by integration with existing commercial systems (e.g., Kognifai and xCloud).

**IF1 – Pilot demonstrators:** Pilot demonstrators (PD) will be developed and used for demonstration of components and the integrated system. The tests will be designed flexible and generic with detailed monitoring of influencing parameters, and in close cooperation with the industry partners providing specifications and priorities through their contribution to the Technical Advisory Committee. The objective is to (i) establish insea facilities and environments for research and testing of Smart Ocean system components developed under WP1-WP3; and (ii) demonstrate these system components and the total system under realistic operational conditions, as pilots for *example applications*. Four pilot demonstrators will be enabled, two for environmental monitoring (PD1 and PD2); and two for structural monitoring of marine installations (PD3 and PD4).
Important infrastructure for the Centre will include: (i) large-scale test facilities at Austevoll, operated by IMR (part of the Ocean Innovation Norwegian Catapult); (ii) Unitech's Zephyros floating offshore wind turbine (formerly Hywind; now part of the Sustainable Energy Norwegian Catapult Centre); (iii) marine test facilities for medium scale testing at Industrilaboratoriet (ILAB); (iv) ROVs, AUVs and gliders, as part of the Norwegian Ocean Observation Laboratory; (v) various subsea test sites and pits; and (vi) additive manufacturing/3D printing of metal and composites for rapid protyping.

***Pilot demonstrator PD1 - Local scale environmental monitoring:***
A multipurpose local-scale wireless network of autonomous sensors for monitoring of oceanographic and seabed environmental parameters will be established around an aquaculture plant. Candidate measurement parameters include current profiling, $O_2$ and $CO_2$ concentrations, gravity, gas leakage, pH, pressure, temperature, salinity, turbidity. This includes development/testing of distributed autonomous multi-sensor wireless communication, embedded processing, distributed systems middleware algorithms, machine learning, etc., in close interaction with WP1-WP3. PD1 will contain and demonstrate all major Smart Ocean monitoring system components and functionalities.

***Pilot demonstrator PD2 - Mesoscale environmental monitoring:*** A real time, integrated and scalable ocean multipurpose observing system will be developed and demonstrated using acoustic technologies, for (1) acoustic tomography to observe mean ocean temperature and water circulation; (2) geo-positioning observations from underwater autonomous sensors (WP1); and (3) monitoring the underwater acoustic environment. Time series of three-dimensional ocean parameters will be provided and combined with oceanographic point or profiling measurements and high-resolution dynamical ocean models through assimilation. Data processing will involve 3D visualization as well as machine learning to handle complex data streams and for automatic optimising of sampling properties (cf. WP3). Wireless communication relevant to such measurements are handled primarily under WP2 and PD1, to be implemented and used under PD2 when relevant. Test site will be covering ca. 5 km x 5 km.

***Pilot demonstrator PD3 - Integrity measurements offshore wind:*** PD3 will be established and used for research, development, testing, and demonstration of sensors for integrity monitoring of (bottom-mounted) and floating wind turbine structures, addressed under WP1 and WP3. Sensors for inspection and evaluation of cement grouting integrity will involve local acoustic resonance ("point") methods (ART), and development of distributed GUW measurement methods for wide spatial coverage.

***Pilot demonstrator PD4 - Integrity measurements oil and gas:*** PD4 will be established and used for research, development, testing, and demonstration of sensors for integrity monitoring of oil and gas installations. Flow induced pipeline vibrations may be monitored using DAS. Pipeline fatigue will be investigated using GUW. Autonomous gas leakage detection systems will involve acoustic methods. For PD3 and PD4 wireless communication relevant to such autonomous sensors are handled under WP2 and PD1.

**IF2 - Overarching activities:** Centre administration; commercialisation, innovation and IPR aspects; internal and external communication (dissemination and outreach); data management plan; and education of Master and PhD students.

## International cooperation

There have been no international activities at SFI smart Ocean in 2020, due to both starting the centre on 1 December 2020 and the restrictions from the Covid19-situation. In 2021 however, the centre plans to recruit mainly international both adjunct professors II and members of the Scientific Advisory Committee.

The centre also aims to start establishing an international network.

## Recruitment

In 2020 the focus has been on establishing the centre administration, and so far, the recruitment for the following positions are completed:

- Centre Director – Professor Geir Anton Johansen (starting 16 October 2020), UiB
- Administrative Manager – Terje Restad (starting 1 March 2021), UiB
- Communication Advisor – Randi Heggernes Eilertsen, UiB

These positions are in addition to persons already employed at the partners.

The recruitment plan for 2021 is as follows:

- Document handling person (20%), UiB
- ICP coordinator (20%), UiB
- 3 Prof. II positions (10% each), UiB
- PhD WP1 (GUW Grouting), UiB
- PhD WP1 (DAS), UiB
- PhD WP1 (pH and anti-biofouling surface), UiB
- PhD WP1 (Self-diagnostics smart sensor system), UiB
- PhD WP2 (Smart sensor communication and integration), HVL
- PHD WP3 (Software- and system architecture), HVL

## Communication and dissemination activities

Some presentations of SFI Smart Ocean have been made since the centre was founded. However, due to the short period the centre existed in 2020 and the Covid19-situation there has not been an extensive outreach activity in 2020.

The centre plans were however presented for the University board in August 2020.

As the research activities starts to give result, the management of the centre will make plans for further communication trough different media to both the scientific environment, users and general public.

# Attachments to the report

## Personnel

**Key Researchers in 2020**

| Name | Institution | Main research area |
|---|---|---|
| Geir Anton Johansen | UiB | IF2 |
| Camilla Sætre | UiB | WP1 |
| Bjørn Tore Hjertaker | UiB | WP1 |
| Bodil Holst | UiB | WP1 |
| Per Lunde | UiB | WP1 |
| Marie Bueie Holstad | NORCE | WP1, IF2 |
| Ingvar Henne | NORCE | WP1, WP2 |
| Tor Langeland | NORCE | WP3 |
| Junyong You | NORCE | WP3 |
| Jeremy Cook | NORCE | WP3 |
| Roald Otnes | FFI | WP2 |
| Kristin Mikkelsen | FFI | WP1, WP2 |
| Joachim Eastwood | FFI | WP3 |
| Lars M. Kristensen | HVL | WP3 |
| Kjell Eivind Frøysa | HVL | WP1 |
| Øyvind Bergh | IMR | IF1 |
| Jan Erik Stiansen | IMR | IF1 |
| Kjetil Lygre | NERSC | WP1 |
| Toril Hamre | NERSC | WP3 |
| Geir-Olav Fjeldheim | Lundin Energy | WP1 |
| Ragnar Heksem | Lundin Energy | WP3 |
| Jan Erik Faugstadmo | Kongsberg | WP2 |
| Inger Graves | AADI | WP1 |
| Martha Lien | Octio | WP3 |
| Frank Hauge | Octio | WP3 |
| Steinar Bjørnset | Tampnet | WP1, WP2 |
| Renate Grindheim | TSC Subsea | WP1 |
| Michael T. Smith | Metas | WP1 |
| Pål Reiersgaard | Bouvet AS | WP3 |
| Yngve Kvinnsland | Bouvet AS | WP3 |
| Gisle Nondal | GCE Ocean Technology | IF1 |

Due to the start-up 1. December 2020, there have been no activity on visiting researchers and PhD students/postdocs in 2020

## Accounts

**Funding**

| | Amount | Amount |
|---|---|---|
| The Research Council | 47 000 | |
| UiB | 194 576 | |
| Research Partners* | | |
| Enterprise partners* | | |
| Public partners* | | |

**Costs**

| | | |
|---|---|---|
| UiB | 241 576 | |
| Research Partners | | |
| Enterprise partners | | |
| Public partners | | |
| Equipment | | |

## Publications

The centre started 1 December 2020, therefore there have been no publications from the centre in 2020.