2017 ANNUAL REPORT

CIUS

Centre for Innovative Ultrasound Solutions

sfi Centre for Research-based Innovation

cius

NTNU
Norwegian University of Science and Technology

Academic Partners

NTNU
Norwegian University of Science and Technology

SINTEF

UiO : University of Oslo

HSN University College of Southeast Norway

Industry Partners

Statoil

Archer

AUROTECH ultrasound

GE Vingmed Ultrasound

InPhase Solutions

KONGSBERG

HALFWAVE

MEDISTIM

XFAB MIXED-SIGNAL FOUNDRY EXPERTS

PHOENIX SOLUTIONS

Sensorlink

Health Sector Partners

HELSE MIDT-NORGE

HELSE NORD-TRØNDELAG

ST. OLAVS HOSPITAL
TRONDHEIM UNIVERSITY HOSPITAL

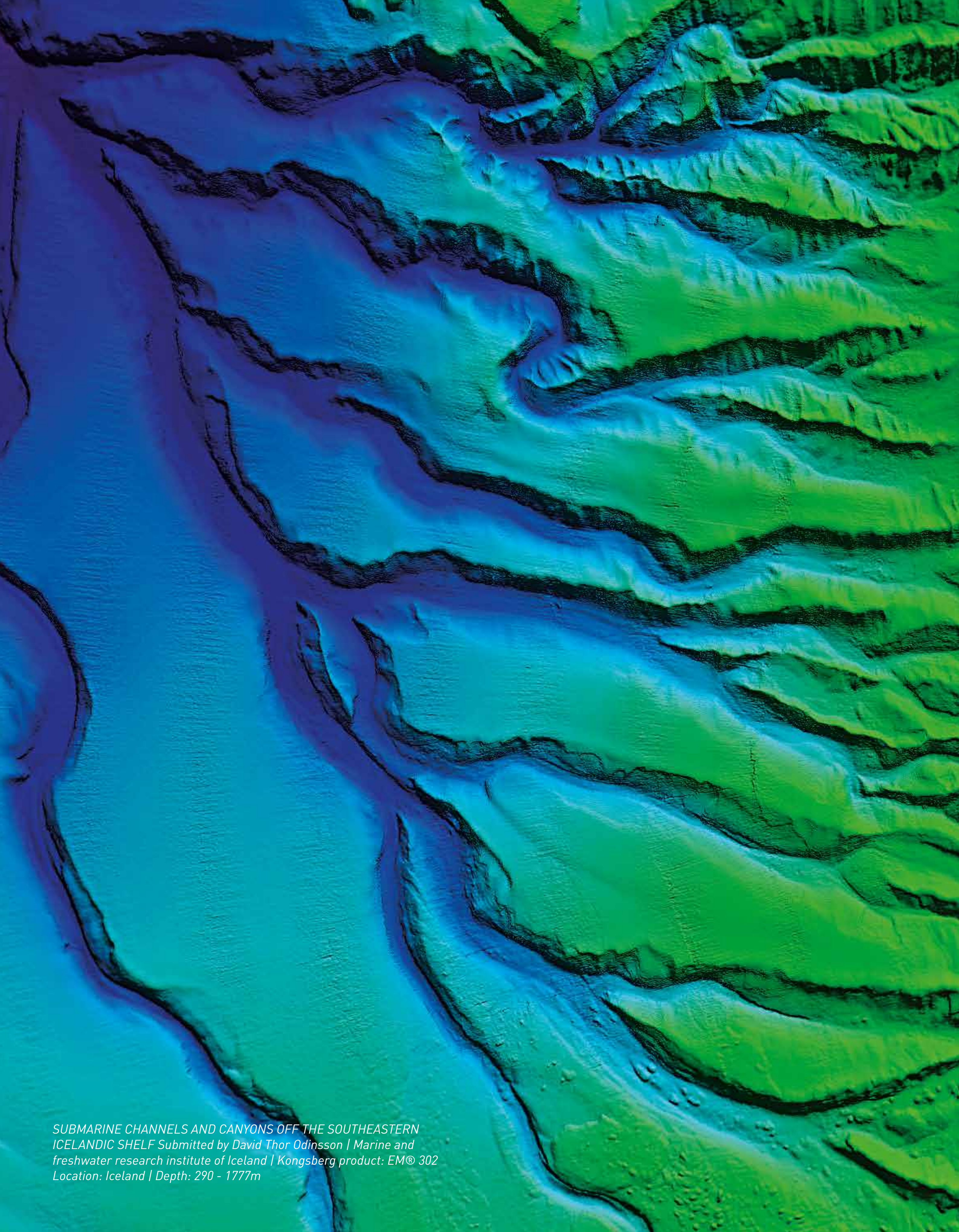
Levanger kommune

VERDAL KOMMUNE

Host

NTNU
Faculty of Medicine and Health Sciences
Department of Circulation and Medical Imaging

Contents



SUBMARINE CHANNELS AND CANYONS OFF THE SOUTHEASTERN ICELANDIC SHELF Submitted by David Thor Odinsson | Marine and freshwater research institute of Iceland | Kongsberg product: EM® 302 Location: Iceland | Depth: 290 - 1777m

Asta Håberg
Centre Director

In the CIUS annual report for 2017 you will find an overview of the tangible results we have obtained.

As you will see, the activity has increased in all areas since 2016. However, CIUS is so more than the number of PhD and Postdoc positions, papers accepted and IPR reported, which you can read up on in this report.

For instance, CIUS strengthens the bonds, intellectual exchanges and collaborations between academic partners in CIUS and their international colleagues. This is exemplified by the UltraSound ToolBox developed by the University of Oslo and NTNU, in collaboration with the University of Lyon and John Hopkins University. The toolbox facilitates the comparison of imaging techniques as well as dissemination of research results, thereby bringing CIUS members, partners, and the international ultrasound community closer together.

Further, an advantage of an SFI organization is the many formal and informal meetings in which the PhDs and Postdocs in CIUS get to present and discuss their work with CIUS partners in and outside their field of research. This stimulates transdisciplinary thinking and opens the mind to novel applications. Such exposure, together with CIUS specific training of our Candidates, are aimed at preparing them for tomorrow's job market.

In 2017, we have worked specifically on establishing the best methodology for identifying innovations in CIUS and bringing these to the attention of all CIUS members to fully realize the potential of the innovations across the health, maritime and oli&gas sectors. The addition of the industry liaison, Dr. ing. Svein-Erik Måsøy, in 2017 was a very important step in this work.

The talented and dedicated people in CIUS make it a great centre to run and the many different research areas ensure it is never dull. I want to thank everyone in CIUS for their efforts in 2017, and look forward to 2018 with new challenges and victories. I want to thank the Research Council of Norway for their economic support and helpful administrative staff.

A big thank you to our partners for their economic support, intellectual contributions and for sharing their experiences in how to get from an idea to a commercially successful product. They are providing the opportunity of rapidly assessing the feasibility of new technologies emerging from CIUS in patients.

Bjørn Gustafsson
Dean

The SFI CIUS encapsulates several of the strategic research goals of NTNU and the Faculty of Medicine and Health Sciences.

The research in CIUS reflects the span of activities at the Faculty, and includes technological development as well as clinical studies. CIUS current work builds on a longstanding tradition of close collaboration between academic research at NTNU and Norwegian ultrasound industry. In CIUS, new partners from the maritime and oil & gas industries have been brought in, setting an example for multi-disciplinary research and an inclusive culture which is needed to succeed in the future both as an academic institution and in creating value for the society.

Building and nurturing an innovation culture and honing entrepreneurial skills are important parts of NTNUs mission to meet future challenges. An SFI is a unique arena to expose and teach the next generation scientists and researchers these skills. As CIUS host, we are happy to see that the mechanisms implemented in CIUS for identification of innovation potential has led to four Disclosures of resulting IPR in 2017 alone, and that two of these are of commercialization value for CIUS corporate partners.

CIUS 2017 annual report demonstrates the range of activities in CIUS just during the last year and how they come together despite seemingly quite diverse. We are proud to present CIUS 2017 results, and look forward to the new developments and results in 2018.

Indeed, CIUS activity sums up the goal of the strategic research Area NTNU Health: Innovative solutions to complex (health) challenges.

Eva Nilssen
Board Leader

2017 has been an exciting year for the CIUS programme. This is our second full year and the projects are gaining momentum and results are produced.

One of our key goals with CIUS is to create innovations by synergies between the different partners; in Oil & Gas, Healthcare and Maritime business areas. This is already progressing quite well with collaboration research in both WP1 and WP2 for electronics, transducer and beamforming techniques with potential benefits for partners from all business areas.

Example: Common electronic components for Healthcare and Maritime, at NTNU. Common transducer technology for Healthcare, Maritime and Oil & Gas at USN. Common beamforming technology for Healthcare and Maritime at UiO.

Also, new research projects between CIUS partners together with new, smaller partners, were started last year.

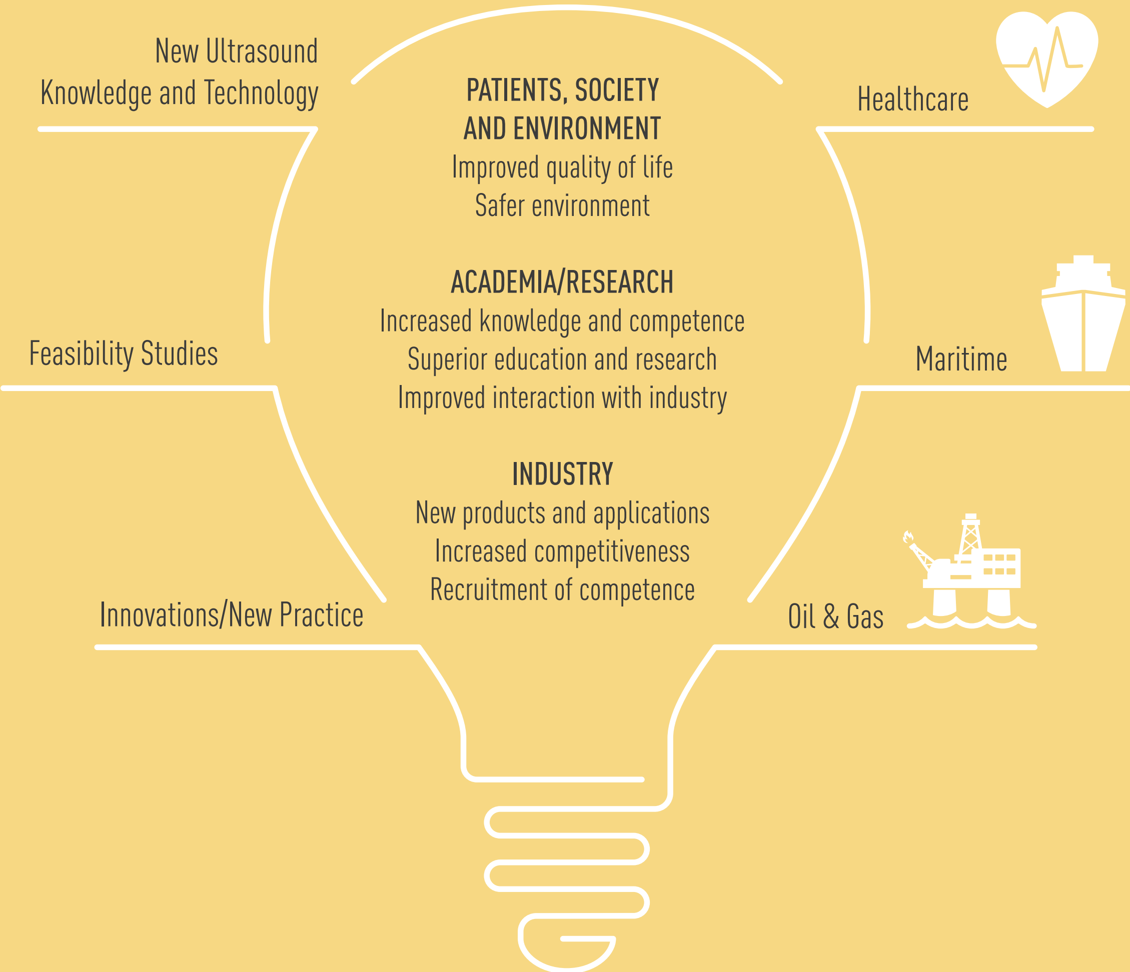
Example: Industry partners GE Vingmed Ultrasound, Sensocure og Medistim, with academic research partners SINTEF Raufoss Manufacturing, Norner Research AS and University College of Southeast Norway, were granted production technology research project from the Norwegian Research Council. The project, Advanced manufacturing technologies for high impact medical devices, is of a 3-year duration.

There is quite a few very exciting projects in CIUS and adjacent programmes, many of them with great potential. One of my favorites is nanotechnology combined with ultrasound for chemotherapy treatment. Microbubbles containing nanoparticles with chemotherapy are injected into the bloodstream. Ultrasound is then used to both deploy the particles into the cancer cells itself and then to activate the drug. This project has all the elements of a successful research collaboration: Nanotechnology from SINTEF and NTNU, microbubbles from Phoenix Solutions, state-of-the-art transducer technology from USN and NTNU, therapeutic and imaging ultrasound techniques from SINTEF, NTNU and USN, clinical testing with St.Olavs hospital and industry partnership with Phoenix Solutions for commercialization. And most important of all: If successful, this will both save lives and improve the quality of life for many cancer patients.

The development of competency and contacts between industry partners and academia by the CIUS research effort is important for the Norwegian ultrasound industry. There is great potential for innovative solutions securing continued activity in existing companies as well as the creation of new industry companies.

CIUS Idea

CIUS will deliver novel ultrasound technology solutions for the benefit of the involved partners, new diagnostic tools for the benefit of patients and the healthcare providers, important knowledge disseminated in highly recognized scientific journals, and skilled personnel to further exploit the future potential of ultrasound imaging in Norwegian industries, healthcare and academia.



The CIUS Concept

The Centre for Innovative Ultrasound Solutions (CIUS) combines frontier academic research in ultrasound technology development with innovation in leading Norwegian ultrasound companies working in medical, maritime, and oil & gas application areas.

In medicine, improved diagnosis of coronary heart disease, the leading cause of mortality worldwide, is strongly needed. In the maritime sector, long-term monitoring of subsea structures and organisms for safer and more efficient harvest of ocean resources is required. In oil & gas, there is a particular need for better monitoring of well integrity and of pipelines and risers for increased oil recovery and avoiding serious environmental incidents.

Ultrasound technology as used in the three sectors has a tremendous unexplored potential for meeting future challenges. In CIUS, industry, academia, public institutions, and private research foundations join forces and explore synergies across disciplines, leveraging next-generation ultrasound technology for a better world. Key ultrasound research tasks will be within transducer design, acoustics and image formation, Doppler and deformation imaging, as well as image analysis and visualization. By applying these technologies to specific innovation goals within each sector, significant business opportunities in the international market will be achieved. CIUS will by unique competence and innovations, secure long-term competitive advantage within areas where Norway is internationally recognized for excellent research, innovation, and product deliveries.

CIUS is hosted by the Department of Circulation and Medical Imaging, Faculty of Medicine and Health Sciences at the Norwegian University of Science and Technology (NTNU), Norway's largest university.
The ultrasound group at NTNU is known for their expertise within ultrasound research and innovation in healthcare through 40 years. Expertise and research facilities are joined in a virtual laboratory organization including selected Norwegian academic institutions and important cornerstone enterprises as well as several small-to-medium enterprises (SMEs) in Norway. CIUS encompasses 4 research partners, 11 industrial/corporate partners and 5 healthcare user partners.

Research Methodology

The research methodology in CIUS is an iterative process between curiosity-driven technological development and user-involved feasibility studies in laboratories in maritime and oil & gas settings, and in the clinic.

A close interaction with user partners will ensure that all projects initiated are based on the future needs in the different sectors. A large multidisciplinary research environment is now established across geographical locations (NTNU, Trondheim– UiO, Oslo – USN, Horten), which include scientists and engineers with backgrounds in acoustics, physics, mathematics, electronics, and computer science. Medical doctors and other healthcare personnel are included in clinical studies. Most of the budget is allocated to researcher training at the PhD and Postdoc level.

The aim of these activities is to identify new innovations that can be brought to the market by our corporate partners. The ultimate goal is that the new innovations created in CIUS will generate a large positive impact for Norwegian ultrasound research, the CIUS corporate partners and the healthcare sector.

Overarching Goals

1. To be a world-leading centre for research and innovation in next-generation ultrasound imaging, improving patient care, harvesting of ocean resources, and for environmental monitoring and safety.

2. To extend and strengthen the innovation culture with emphasis on rapid translation from idea to practical applications and solutions needed to facilitate new growth for the industries.

3. To be the main educational and knowledge centre for ultrasound technology to ensure sufficient competence and recruitment needed by Norwegian industries, academia, and the healthcare sector.

Organization and Location

SFI CIUS is hosted by the Faculty of Medicine and Health sciences (MH) at the Norwegian University of Science and Technology (NTNU), and localized to the Department of Circulation and Medical Imaging.

Physically the academic research activity is divided across four institutions: NTNU, University College of Southeast Norway (USN), University of Oslo (UiO), and SINTEF. SFI CIUS has 11 corporate partners; GE Vingmed Ultrasound, Medistim, Aurotech and Phoenix Solutions within the medical sector; and Statoil, Halfwave, Sensorlink, Inphase Solutions and Archer BTC within the oil & gas sector; Kongsberg Maritime within the martime sector and X-Fab for advanced analog and mixed-signal process technologies. In addition there are five user partners within the medical health provision sector; St. Olavs hospital, Mid-Norway Regional Health Authorities, Nord-Trøndelag Hospital Trust plus Levanger and Verdalen Community Health Services.

The research activity is divided into 9 work packages (WPs). USN is responsible for WP1, UiO for WP2 while WP3-7 are located to NTNU. WP8-9 are in collaboration with the industrial partners and headed by CIUS' industrial liaison. Activity connected to WP1 and WP2 is also localized to the CIUS host. There is extensive collaboration across WPs, and an iterative process between development of new technologies in WP1-4 and their validation and feasibility testing in WPs 5-9 is critical to SFI CIUS' success.

The daily activity of the centre is overseen by centre Director Professor Asta Håberg. Further, the CIUS administration includes Industry Liaison Svein-Erik Måsøy, the Project Coordinator and Administrator Christina Kildal, Communication and Web Officer Kari Williamson, Intranet responsible Sigrid Berg and Financial Advisor/Project Economist Vegard Nyhus.

Each WP has a primary investigator (PIs) who oversees the respective WP's research activity. All CIUS activities are supervised and directed by a working Board of Representatives consisting of nine members with a majority from the corporate partners. The Board Chair is Eva Nilssen, Director of R&D GE Vingmed Ultrasound.

Board Leader Eva Nilssen, GE Vingmed Ultrasound

Dean Bjørn Gustafsson, NTNU

Centre Director Asta Håberg, NTNU

Industry Liason Svein-Erik Måsøy, NTNU

MANAGEMENT

CIUS

BOARD

Appointed Board Representatives:
Fredrik Varpe, Statoil
Frank Tichy, Kongsberg Maritime
Petter Aadahl, St. Olavs hospital
Olav Haraldseth, NTNU
Berit L. Strand, NTNU

Elected Board Representatives among the Corporate Partners:
Erik Swensen, Medistim
Dag-Haakon Frantzen, BTC Archer

SCIENTIFIC ADVISORY BOARD

Dr. Iacob Mathiesen, CSO, Otivio, Oslo

Professor Jenny Dankelman, MISIT Group, Delft University of Technology

Dr. Philippe Blondel, Senior Lecturer, University of Bath

Anna Shaughnessy, previous Director of Earth Resources Laboratory, MIT

CIUS' Scientific Advisory Board was constituted in 2017 and includes academic and industry/corporate experts in the wide range of fields covered in CIUS.The Scientific Advisory Board will deliver their first evaluation in 2018 to ensure initiation of appropriate adjustments as early as possible.


Professor Lars Hoff (USN)


Professor Sverre Holm (UiO)


Professor Hans Torp (NTNU)


Professor Lasse Løvstakken (NTNU)


Professor Asta Håberg (NTNU)


Professor Bjørn Olav Hauge (NTNU)


Professor Asbjørn Støylen (NTNU)


Industry Liason
Svein-Erik Måsøy (NTNU)

WORK PACKAGE LEADERS


Christina Kildal


Sigrid Berg


Vegard Nyhus


Kari Williamson

ADMINISTRATION

Partners and Collaborations

CIUS has partnered with important cornerstone enterprises, SMEs, academic institutions, and the healthcare sector.

Industry partners

Archer - Bergen Technology Center
AUROTECH ultrasound
GE Vingmed Ultrasound
HalfWave
InPhase Solutions
Kongsberg Maritime Subsea
Medistim
Phoenix Solutions
Sensorlink
Statoil
X-FAB

Health sector partners

Helse Midt-Norge
Helse Nord-Trøndelag
Levanger Municipality
St. Olavs hospital
Verdal Municipality

Academic partners

SINTEF
Norwegian University of Science and Technology (NTNU)
University College of Southeast Norway (USN)
University of Oslo (UIO)

Centre for
Innovative
Ultrasound
Solutions

CIUS 2017

INNOVATION STATISTICS

METHODS/MODELS/
PROTOTYPES

PRODUCTS

SERVICES

95%

UNEXPLORED OCEANS
(SEABED MAPPING)

PhD

Ultrasound dates back to

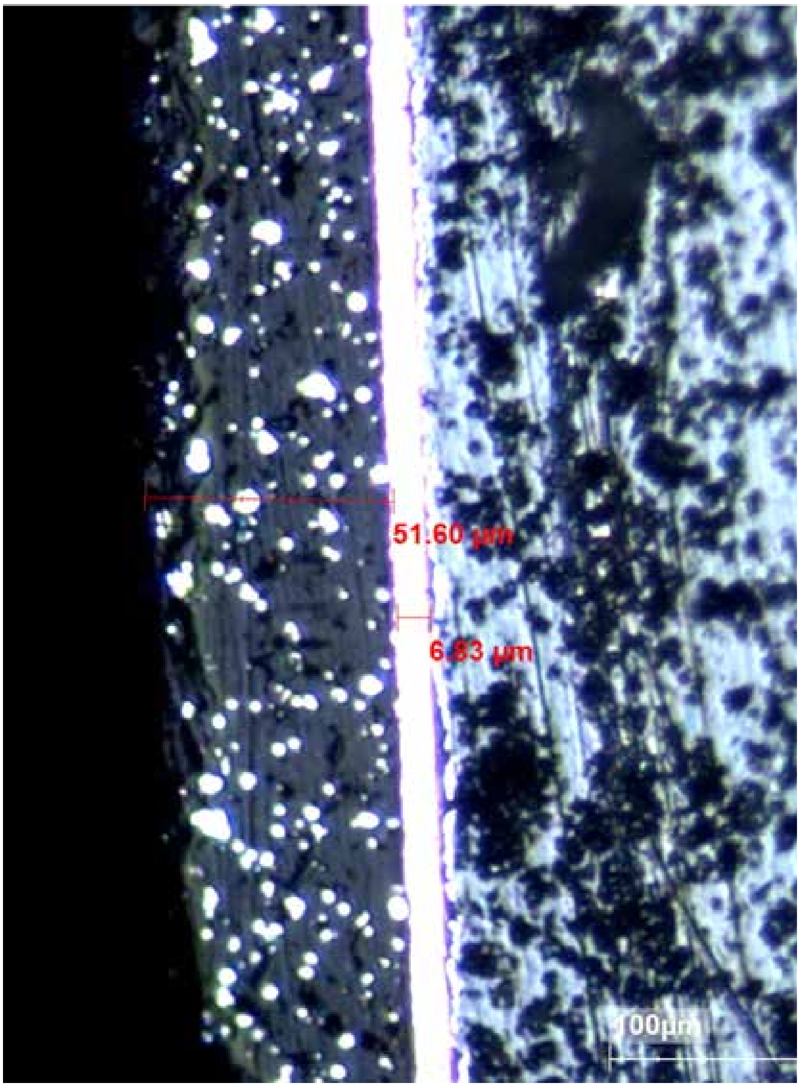
1794

1

Transducer and Electronics

Lars Hoff, Professor, University College of Southeast Norway (USN)
WP leader

▼ *Cutting through a transducer acoustic stack. Materials with different acoustic properties to the right and to the left. The middle bright structure is the adhesion layer, its thickness is important for the transducer acoustic performance.*



Our main goal for 2017 has been to consolidate our existing methods, that are getting the fabrication and characterization procedures more firmly established.

WP1-1: Acoustic source characterization and optimization

WP1-2: Integrated high-performance transducer array electronics

WP1-3: Embedded ultrasonic sensors

WP1-4: Dedicated high-frequency and multi-bandwidth transducers

Improved transducer lab

The transducer lab is improving steadily. Our main new equipment is the Onda AIMS III scanning tank for calibrated sound field measurements. This has proven to be an invaluable addition to the lab. It is used extensively to characterize transducers from the CIUS partners, and to investigate our own developments. During 2017, we have also acquired a Speedmixer to make our own composite materials for acoustic matching layers and fine-mechanical tools for fabricating transducer housing, acoustic lenses etc. This will increase our flexibility, speed up production time, and allow us to make more product-like transducer prototypes.

Challenges

We have expanded rapidly and have had to involve external competence, notably CIUS-funded Associate Professor Martijn Frijlink, who contributes by supervising students and sharing from his expertise and vast practical experience in transducer design, and Tonni Johansen, a researcher at NTNU/SINTEF. We also receive valuable contributions from the industrial partners.

Our work is laboratory-intensive, and we have a constant need for new equipment. The microtechnology laboratory at USN is well equipped, and the dedicated transducer laboratory is becoming well established. However, to reach the level where we want to be requires continuous investments in equipment, and achieving funding for this is a constant process.

2018

We have a new multi-frequency band transducer concept and going forward we wish to compare measured and modelled temperature in underwater transducers.

Two new PhD projects will start during 2018, and topics for both of these projects are robust transducers, including longevity in normal use and behaviour in harsh environments, e.g. high pressure and temperatures.

2

Acoustics and Beamforming

Sverre Holm, Professor, University of Oslo
WP leader

▼ *PhD Candidate Ali Fatemi carrying out experiments in the lab*

WP2's six subprojects are all within fundamental research on acoustic wave propagation and image formation common to applications in oil & gas, maritime and medicine. We will develop knowledge and simulation tools for improved algorithms in all applications to achieve improved image resolution and contrast, higher frame rates, and improved measurement accuracy (e.g. in Doppler imaging). We are using research systems at academic laboratories as well as computer simulations to investigate next-generation imaging based on channel data processing that will provide a strong basis for innovation for the user partners.

WP2-1: Simulation of acoustic and elastic wave propagation in heterogeneous and layered media

To address artifacts such as specular reflection, second order scattering, and reverberation, we have developed tools to enable the comparison of beamforming techniques: The UltraSound ToolBox (www.ustb.no).
In 2018, there will be simulation and modelling activities in most of the work packages. In addition, modelling of propagation of elastic waves in muscle will be undertaken in a collaboration with The Norwegian School of Sports Sciences.

WP2-2: Guided waves in steel plates and pipes

The focus of the research in this group has been to conduct simulations using COMSOL and SimSonic to get more insight on acoustic wave propagation in plates and pipes. A project was initiated together with WP3 to see if it is possible to introduce their ultrasonic Doppler-knowledge to the field of non-destructive testing. Going forward, we will establish and develop the simulation framework.

WP2-3: Non-linear SONAR imaging

A collaboration between UiO and KM, where measurements show very promising results for improving image quality in bathymetry. Simulations tools for non-linear imaging have been further developed and made available to KM.
Next, we will follow up the simulator, and assist in its use and on implementation and testing in their multibeam echosounder product.

WP2-4: Elastography in cardiac imaging

In collaboration with the Medima project at UiO we have established two different methods for ultrasound elastography: Acoustic radiation force imaging and elastography with an external vibrator. Of the two, the latter is probably the method with the largest potential for cardiology. In 2018 we plan to perform the first tests on cardiac elastography in collaboration with GE Vingmed Ultrasound.

WP2-5: Advanced SONAR Array Design in Underwater Mapping and Imaging

The project started by establishing a SONAR simulator which is based on a reference simulation package in medical ultrasound, where the user has control over the SONAR array geometry and the transmitted signal of each elements, thanks to a pulse design module. It is also possible to define the seabed model and acquisition geometry. Going forward, emphasis will be on the selection of suitable waveforms with good orthogonal properties. This could lead to improvement in the mapping rate.

WP2-6: Suppression of reverberation artifacts in ultrasound imaging

We study the redirection phenomenon where energy in the probe's elevation plane bounces off ribs and interact with e.g. lungs, continuing to improve the performance and accuracy of the simulation code, aiming to include the numerical evidence in upcoming publications. We have started developing techniques to detect and eliminate reverberant noise in cardiac ultrasound imaging, and are working on an adaptive beamforming method that is able to distinguish between speckle signal and reverberant noise.

3

Doppler and Deformation Imaging

Hans Torp, Professor, NTNU
WP leader

▼ *A laboratory sheep is being prepared by a surgeon before insertion of artificial mitral valve.*

WP3 covers continuous developments of Doppler based methods for velocity and deformation measurements and -imaging in 2D and 3D. Enabling technology includes ultrahigh frame-rate data acquisition and real-time processing of data from 1D and 2D matrix array transducers, as well as novel approaches for random signal models and parameter estimation.

WP3-1: Vector-flow imaging

In collaboration with SickKids Hospital in Toronto, we work towards increasing activity vector flow imaging in paediatric cardiology. GE-Vingmed has implemented this technology on the scanner Vivid E95, which has recently been released for clinical use.

We have developed the intracardiac 3D vector flow imaging further, using a combination of Doppler and speckle tracking, and in vivo results have been presented for the first time at the IEEE International Ultrasonic symposium. A new combination of vector flow imaging and tracking Doppler for quantitative analysis has been developed by Postdoc Jørgen Avdal and his colleagues, and published in IEEE TUFFC.

WP3-2: Flow measurement in non-stationary and noisy surroundings

High framerate 3D data acquisition, adapted to coronary flow imaging, is now implemented as a prototype, and several in vivo recordings has been performed. These datasets are used for 3D imaging as well as quantitative Doppler spectrum analysis, and results have been presented at international conferences. One special challenge is the clutter filtering, which must be adapted to the rapid motion of the myocardium. Results using a singular value decomposition has been implemented, and recently, an alternative, non-paramtric method based on classical detection theory has been developed.

WP3-3: High frame rate tissue deformation imaging

Several new data have been setup for high frame rate 2D and 3D cardiac data have been tested in vitro and in vivo, as well as processing methods for vector Doppler and shear wave imaging.

A new method for quantitative shear wave imaging, "clutter wave imaging"has been further developed and tested for normal volunteers. The method gives reasonable values for wave propagation speed for normal myocardium. Next step is to test the method in patients with myocardial fibrosis

WP3-4: Doppler imaging of flow in cement behind steel casing

This subproject is a combination of beamforming strategies to optimize SNR for fluid flow in cement behind steel casing, and clutter suppression techniques developed in WP3-2.

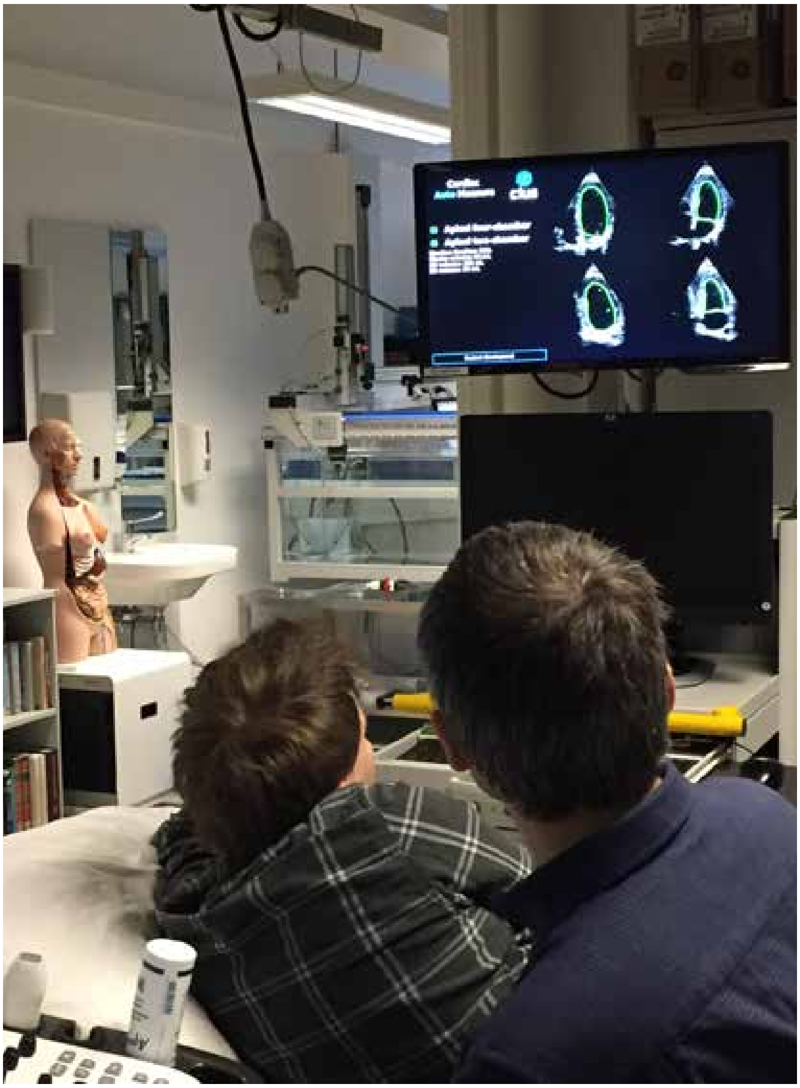
Two PhD Candidates are working on this project. Experimental setup is under development at the ultrasound lab, NTNU, and will be ready for testing by April 2018.

4

Image Analysis and Visualization

Lasse Løvstakken, Professor, NTNU
WP leader

▼ *Testing of our real-time method for automatic measurement of ejection fraction in the laboratory.*



This work package covers the development of image processing and analysis methods to extract relevant and contextual information from ultrasound image data, to improve measurement quality and to provide an improved workflow to reduce the time to decision or diagnosis.

Addressing challenges

We are addressing challenges in medical, maritime and industrial applications, using modern approaches in signal and image processing, as well as recent machine learning algorithms for classification and extraction of data and image features. The work package outcome will provide a basis for improved extraction of relevant high-level image information, and a basis for improved data acquisition and processing at lower levels.

The current work package tasks are as follows:

WP4-1: Real-time 3D image segmentation of all heart chambers

WP4-2: Patient and image registration for improved workflow and ease-of-use

WP4-3: Improved processing of corrosion pittings in external pipe inspection

WP4-4: Improved detection of pores and cracks in downhole logging

WP4-5: Model-based acquisition for high frame rate medical ultrasound imaging

These tasks share common challenges and can be addressed by common data and image processing approaches.

An initial aim for WP4 will be to establish a state-of-the-art framework and expertise in machine learning algorithms, trained to recognize and segment relevant image or data features. Further, we want to develop a model-based estimation framework for regularization and reconstruction of noisy and potentially missing image information based on physical models, a pathway towards more robust measurements. Finally, to explore how these methods can provide a context for improved data acquisition and measurements.

2018

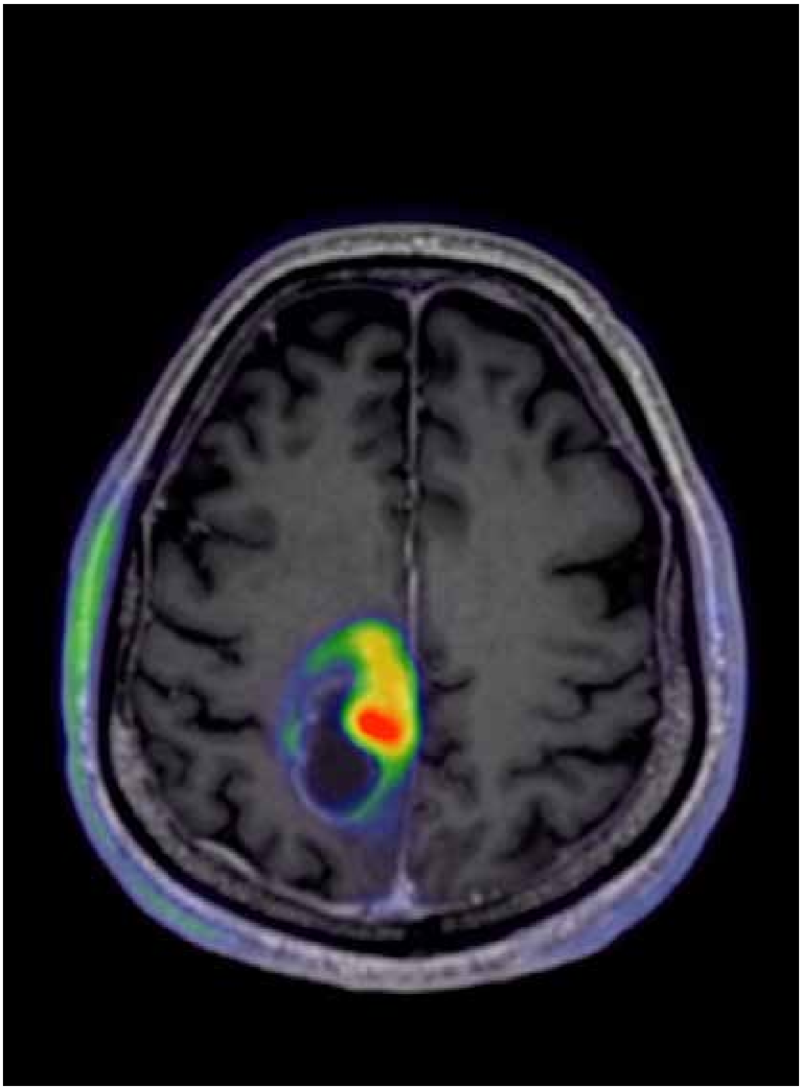
A framework for automatic anatomical cardiac measurements based on deep learning has been developed, and initial results have been shown at the Myocardial function imaging meeting in Belgium this year. Another PhD Candidate will join the team from WP6 to further investigate the potential for automation and simplification of cardiac ultrasound imaging. Discussions are ongoing regarding machine learning projects with Statoil and Konsberg Maritime, respectively. A Postdoc will join to investigate the potential and synergies for machine learning in well logging and sea bed classification.

5

Asta Håberg, Professor, NTNU
WP leader

▼ *Brain cancer imaged with PET-MRI and 18F- FACBC (Fluciclovine) tracer to pinpoint tumor hotspots used to plan ultrasound navigated neurosurgery from work in WP5-3.*

Multimodality and Interventional Imaging



This work package covers development and application of multimodal and interventional imaging to improve diagnostic precision, treatment and follow-up of patients with cardiac disease and cancer.

WP5-1: Multimodal imaging and 3D volume registration in cardiology

A major goal for CIUS is to develop ultrasound-based methods for visualizing coronary artery flow in patients with possible coronary artery disease. Such methodology will minimize patient and staff exposure to radiation, which is currently a major health concern. The initial validation of coronary artery flow estimated with ultrasound technology started in patients with and without coronary artery stenosis on CT in 2017. It also includes the development of a navigation system to provide real-time registration between the ultrasound data obtained during the intervention and the preoperative CT data. The navigational method will be further refined in 2018, in collaboration with GE and SINTEF. Furthermore, a study of the quality and feasibility of 3D visualization of the aortic root with ultrasound compared to CT for use in different cardiac interventional scenarios was launched.

WP5-2: Multimodal imaging for image guided surgery

To select the best treatment for lung cancer patients, it is of utmost importance to identify whether the cancer has spread to the lymph nodes and which lymph nodes are affected. This requires expert radiological reading. In CIUS, an automated method for lymph node detection and anatomical location assignment in lung cancer was developed in 2017, which will be further improved upon in 2018. Moreover, the applicability of the method for other types of tissue classification will be assessed.

WP5-3: Multimodal US and PET-MRI for improved diagnosis

Primary brain cancer has a poor prognosis, but radical surgery removing as much tumour tissue as possible without compromising function improves life expectancy and quality. PET-MRI may have added value in brain cancer treatment: PET can depict tumour tissue with higher specificity than MRI while the relationship between the tumour and important functional brain areas can be obtained with a combination of different MRI methods. With PET-MRI both can be obtained at the same time. The resulting multimodal preoperative PET-MRI images can be used in the neuro-navigation system. Combining these images with preoperative ultrasound images, the neurosurgeon can remove tumour tissue in a highly targeted fashion. The feasibility of the PET tracer 18F-FACBC, which is specific with regard to binding to tumor tissue for brain cancer detection and classification, its value in surgical planning and effects on outcome is currently being studied.

WP5-4: Ultrasound imaging and manipulation in targeted drug delivery

A major problem with chemotherapy is the low uptake of drugs in tumors. Focused ultrasound combined with microbubbles has been reported to improve the delivery of nanoparticles in tumor tissue and the therapeutic effects are improved. Professor Davies and collaborators aim to improve uptake of drugs in tumors using focused ultrasound and microbubbles, and to open the blood-brain barrier and increase the amount of drugs and nanoparticles in brain tissue. Studies to understanding the mechanism of ultrasound-enhanced delivery with microbubbles are also ongoing. In collaboration with Phoenix Solutions, Davies have taken Acoustic Cluster Therapy (ACT) closer to the clinic by modifying a clinical GE Vivid E9 scanner. They show that ACT safely and temporarily increased uptake of a drug. In mice with breast cancer, complete regression of the tumors was observed when drug loaded nanoparticles-microbubbles developed at SINTEF were combined with focused ultrasound. The effect of focused ultrasound and drug loaded nanoparticles-microbubbles versus free drug for the treatment of glioma, demonstrated that both drug delivery methods were equally effective when combined with focused ultrasound. In 2018, a clinical study is planned in colorectal and breast cancer patients with liver metastases.

6 Ubiquitous Ultrasound

Bjørn Olav Haugen, Professor, NTNU
WP leader

Pocket-sized ultrasound devices are extremely portable, and can increase the use of ultrasound imaging as part of the diagnostics of patients - from rural district hospitals to nursing homes in the Western world. Development of easy-to-use ultrasound technology has significant innovation potential and can be paradigm altering for practices in the healthcare sector, where the goal is to offer patients quicker diagnosis outside hospitals as well as to avoid unnecessary hospital admissions.

Work package 6 covers research needed to test ultrasound technology for imaging of multiple organs to increase the usefulness in different clinical scenarios, and automatic measurements of relevant physiological parameters to aid non-expert users.

WP6-1: Multipurpose ultrasound imaging for non-experts
WP6-2: Clinical benefit of use of pocket-sized ultrasound imaging in nursing homes.
WP6-3: Automatic detection of signs of heart disease

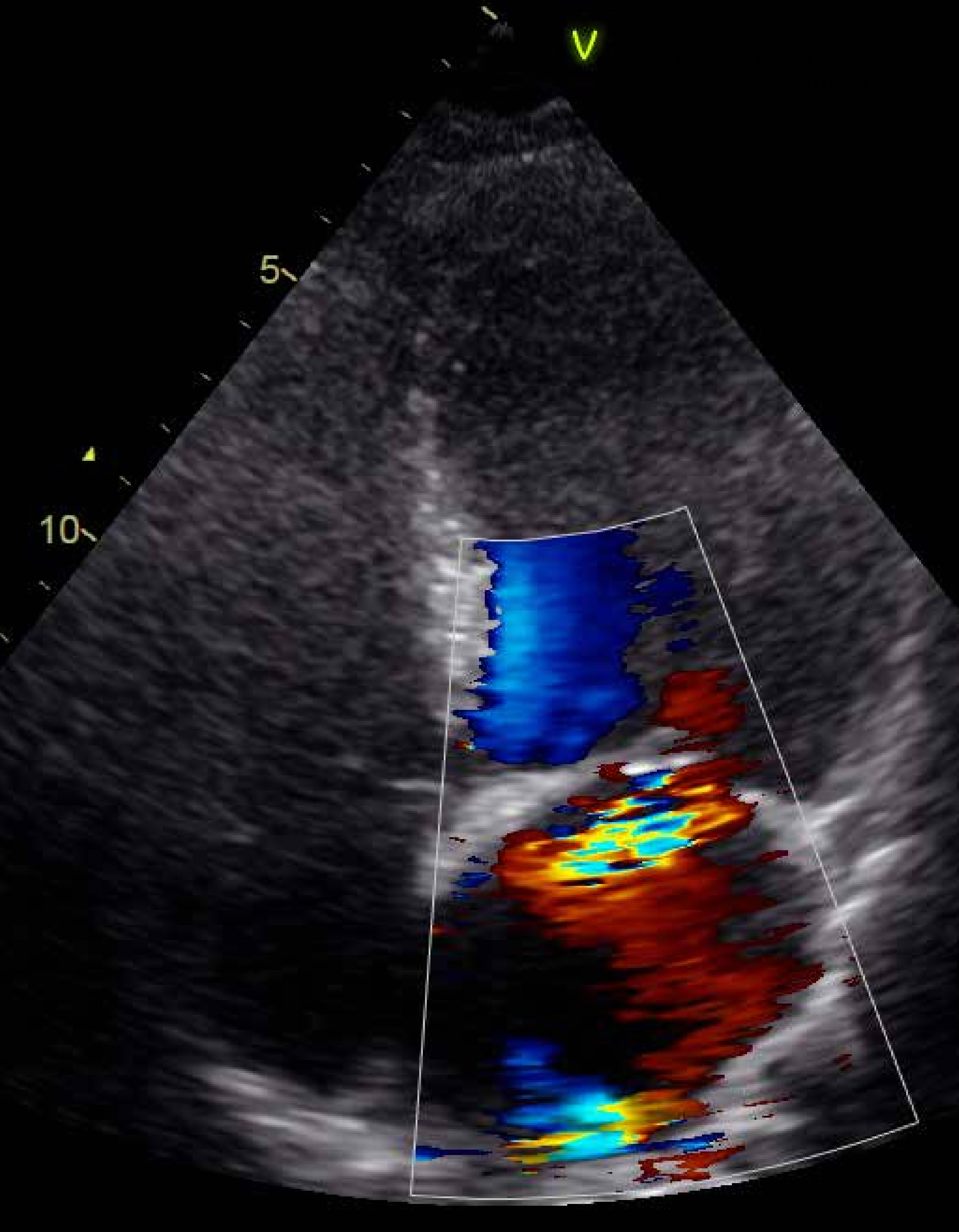
Promising results

CIUS intern Jahn Frederik Grue and Sigurd Storve from GE Vingmed have developed and evaluated an algorithm for the detection of heart failure using Automatic measurements of left ventricular long-axis indices. Grue was awarded with best scientific contribution at the national meeting of the Norwegian Society of Cardiology, and Professor Løvstakken and his team has used Grue's data set for machine learning. The results are very promising and this work is important for WP6-1.

2018

Next, we want to compare images interpreted by the trained non-expert to that of an experienced cardiologist, study the feasibility of physicians identifying cause of distress in nursing home patients using handheld US technology, and develop new automated methods for navigational aid and (semi)automatic measurements. Three PhD Candidates will start their work in 2018, and we will train nursing home physicians and general practitioners in the use of handheld US devices.

▶ *High frame rate blood flow specle tracking echocardiography: Blood floow patterns and enery loss maps, using in-house developed software, 2D blood velocity fields were processed without in-plane flow assumptions. Energy losses were calculated within a region encompassing the RV, using a spline-based segmentation and reconstruction approach.*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7

Clinical Feasibility

Bjørn Olav Haugen, Professor, NTNU
WP leader

WP7 will establish clinical feasibility of new ultrasound imaging methods developed in CIUS, with focus on ischemic heart disease. The overarching aim is safer, more accurate and efficient diagnostic tools for early detection and patient selection for immediate intervention in patients with ischemic cardiac disease. We are developing new techniques to visualize coronary stenosis, quantify them and assess viability of the myocardium to predict whom will benefit from medical treatment and revascularization.
We also work on developing accurate 3D quantification of flow for improved diagnosis, planning and treatment of heart valve disease and shunts in heart disease. Our main objective is clinical implementation and proof of principle for new ultrasound based methods for better diagnosis and treatment of ischemic heart disease, valvular and congenital heart disease. WP7 is heavily dependent on the technological solutions developed in the other WPs in CIUS before clinical validation is possible.

WP 7-1: Ultrasound coronary angiography
The main aim of this project is to assess the feasibility of new 3D methods for visualizing coronary arteries and quantification of coronary stenosis with Doppler. The method is ready for pilot testing.
WP 7-2: Ultrasound imaging and quantification of tissue at risk
We want to assess the feasibility of new US methods to detect and quantify tissue at risk, i.e. ischemic myocardial tissue that with high probability can be normalized with revascularization.
WP7-3: Ultrasound imaging of myocardial viability
In this project, tissue Doppler recordings of patients after myocardial infarction will be compared to MRI, in order to identify the best ultrasound markers of non-viable fibrotic tissue.

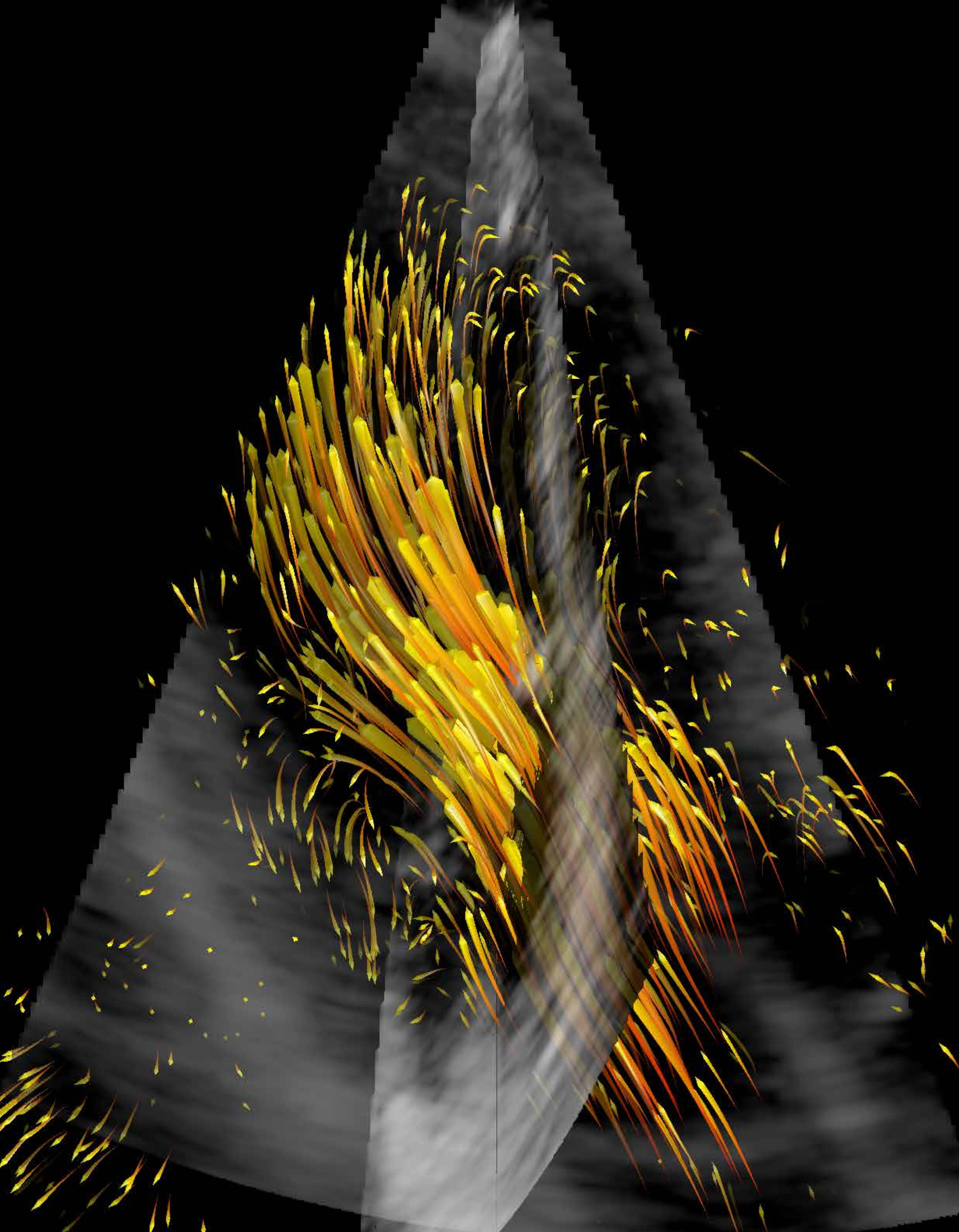
Blood flow imaging in heart disease

CIUS PhD Candidate Wadi Mawad has developed a method that may become a valuable tool in developing an approach based on blood flow patterns and energy-loss calculations to select a more optimal time for intervention in young patients with a severe leak of the lung artery valve.

2018

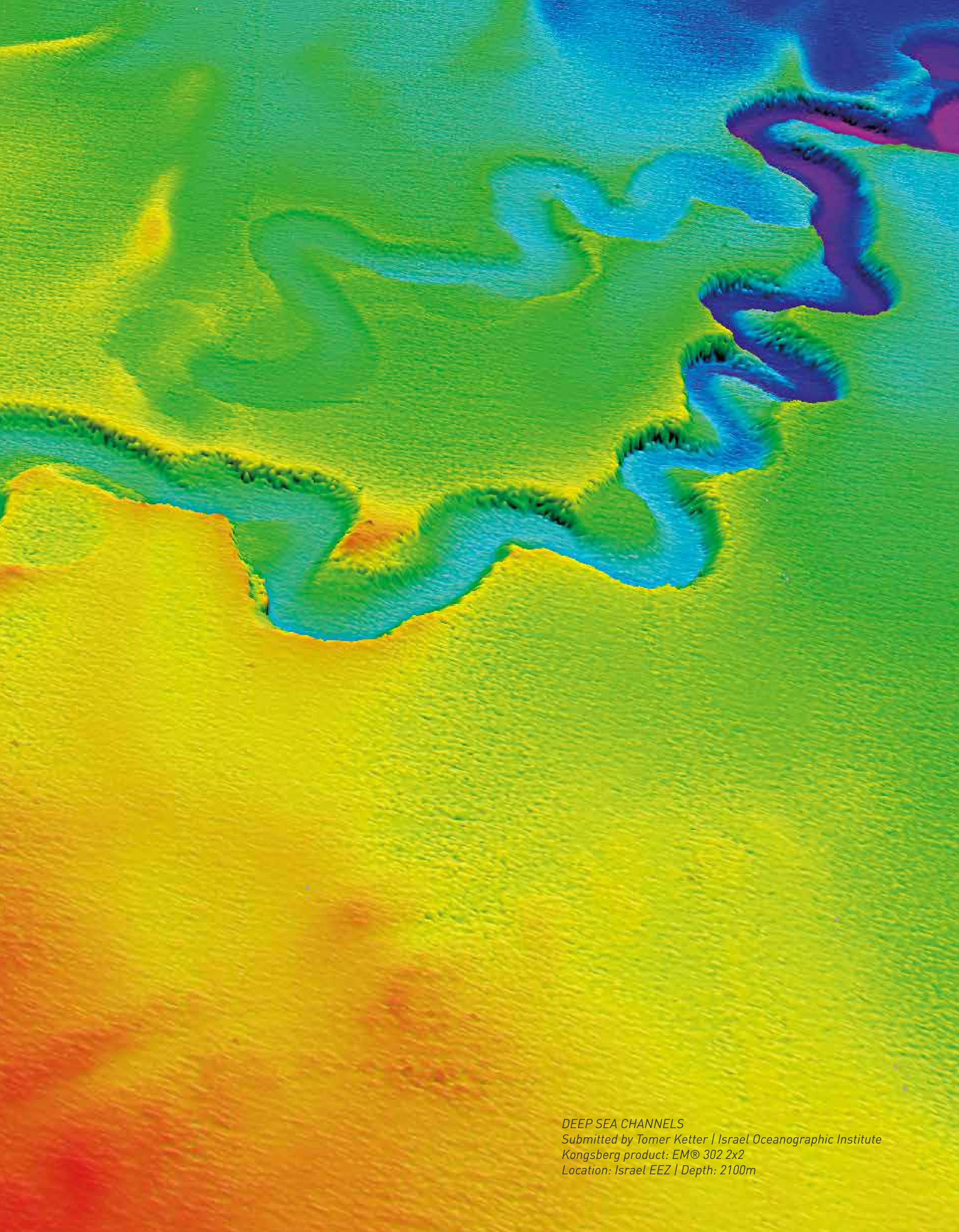
We have several papers due in 2018, and two PhD Candidates will start their projects. We are also preparing joint studies at SickKids Hospital and St. Olavs hospital.

▶ 3D visualization of blood flowing through a cardiac cycle in a healthy volunteer. The black and white slices, are called bmode and shows anatomy, while the blood´s movement is visualized as synthetic particles in orange.



The development of competency and contact between industry partners and academia by the CIUS research effort is important to the Norwegian ultrasound industry.

- Eva Nilssen, Board Leader



DEEP SEA CHANNELS
Submitted by Tomer Ketter | Israel Oceanographic Institute
Kongsberg product: EM® 302 2x2
Location: Israel EEZ | Depth: 2100m

Medical doctors Martin Altrehuther, Torbjørn Dahl, Hanne Ellekjær, Bernt Harald Helleberg, and Arne Seternes (lying down) testing new concepts.

Profiles and Stories

A new generation of researchers

CIUS is affiliated to some of the best ultrasound researchers in the world. Meet three of our up-and-coming talents:
Solveig Fadnes works with fetal heart imaging, and her techniques can be the solution to saving children born with cardiac disease. Marcus Wild is trying to understand how and where heat is generated in piezoelectric material to solve the challenge of overheating SONARs and ultrasound sensors. Antoine Blachet wants to make seabed mapping more effective by designing new and improved SONAR designs.

Stories

Like CIUS Director Asta Håberg said in the introduction: CIUS is more than the numbers we report and present in different forums. CIUS is what it is because of dedicated people, a lot of hard work and valuable collaborative partners. Let us tell you some of their stories.

Partners

Our partners are important to us in many ways, not just for their economic and intellectual support. They are significant in the process of taking an idea and transforming it into a product.

Halfwave and InPhase Solutions are working together on a Crack Detection technology for inspection of gas pipes. Medistim and GE Vingmed Ultrasound just received a large grant from the Norwegian Research Council for their work on developing new production technology for the health sector. ReLab is the first start-up coming out of CIUS, and will design and produce ultrasound transducers - from the drawing board to the fully developed system.

Postdoc

Solveig Fadnes

Capturing the Blood Flow with Ultrafast Imaging

Recent technological advances have given us new possibilities in ultrasound blood flow imaging, and may help clinicians when diagnosing cardiac diseases to give patients the best possible treatment and follow-up. Solveig Fadnes, a Postdoc at CIUS, is working with fetal heart imaging. - I found the possibility to work with medical technology intriguing. The idea of working towards improved diagnostic tools, ultimately help doctors save lives, sounded like a dream job, she says.

Detection is crucial

In Norway, over 500 children are each year born with cardiac disease. To ensure the best outcome of the newborn child, clinicians need to detect these diseases before birth. They can then follow up the pregnancy and make sure the birth happens in a hospital with the knowledge and equipment needed.
- The blood circulation in the fetus is complex, and anytime during the development of the circulatory system, cardiac malformations or diseases may develop. The malformations may not be critical in fetal life, but when the child is born and starts to breathe, the circulatory system undergoes large changes and these malformations may become fatal, says Fadnes. - The blood flow is closely connected to the development of the heart. If we can learn more about the physiology and map the normal blood flow pattern in the developing heart, we think we will be able to detect whether or not there is abnormal flow patterns and a developing cardiac disease.

Motivating teamwork

Fadnes uses the word "we" a lot, and she is clear about the importance of working together. - I love teamwork, both discussing problems with the other technical researchers, but also working with the medical doctors, and get a peek into their daily life and the challenges they meet. Together we can discuss how to move forward and how to improve the diagnostic tools for the benefit of the patients.

Ultrafast imaging

So how does Fadnes and her colleagues use ultrasound technology in their work? – We are using a new technique called ultrafast imaging, where broad ultrasound beams like diverging beams are utilized instead of focused ultrasound beams. One diverging beam covers the whole imaging sector, which means that we get one full image per transmitted ultrasound wave, unlike in conventional imaging where you may need to transmit 100 focused beams to build one image. With ultrafast imaging we acquire several thousand images per second making it possible to capture the rapid changes in the blood flow and extract the blood direction and velocity to see details we could not see with conventional imaging.

Goal: Implementation

Next, Fadnes wants to include fetuses with cardiac diseases in her study, to see how and if the details they observe with the new blood flow imaging technique can be useful when diagnosing cardiac disease before birth.
- We also want to look into the estimation of cardiac wall stiffness, and how this parameter can relate to the blood flow patterns and the cardiac disease.
- Hopefully, new clinical parameters will emerge from my research, describing details in the blood flow of diagnostic importance not available today, helping the clinicians in their daily practice to the benefit of the patients. The ultimate goal is to see my research implemented on a clinical scanner and being used in daily practice.

PhD Candidate

Marcus Wild

Predicting Heat

Within the maritime industry, ships use SONAR systems in order to make maps of the seabed, or find and catch fish. The challenge with SONARs is that they have a tendency to overheat, and Marcus Wild, a PhD Candidate at CIUS, is trying to make the temperature rise more predictably to prevent this.

Understanding SONARs

- SONARs emit sound waves, which then bounce off the seabed and return to the ship, in the same way that a bat or a dolphin uses sound to find its prey, Wild explains. - Understanding the behaviour of SONAR systems requires working with a variety of scientific fields: Thermal, mechanical, electrical and piezoelectric and this is what initially drew me to this field.

SONARs are made of many components, but one of the most important components is the piezoelectric (piezo means squeeze) material. When pressure is applied, an electric current field is produced and reversely; when an electric field is applied it generates a sound wave. This material is the driving mechanism behind the sound wave generated by SONAR and acts both as a speaker and a microphone simultaneously. However, some of this energy is also converted into heat, and excessive temperatures will damage the SONAR.

Material properties

In order to predict the heating in the piezoelectric material, the material properties need to be characterized accurately. - First, we developed a fast and accurate method to characterize the piezoelectric material. This method uses a 1D analytical model of a piezoelectric material, which predicts the material's electrical admittance as a function of frequency for a given set of material parameters. The electric admittance is the ease that a material has to allow an electrical current to flow through it for a given voltage. This property is frequency dependent for a piezoelectric material. The shape of the electrical admittance as a function of frequency can give us a lot of information about the material properties such as the resonance frequency or the energy loss mechanisms. The electrical admittance can also be measured quite easily in our case, says Wild.

Kongsberg Maritime

Wild has been working closely with CIUS partner Kongsberg Maritime during his research: - Seeing the innovations that I come up with being put to use is exiting, and it shows me that my work is making a tangible difference.
Martin Bring, Wild's supervisor at Kongsberg Maritime, highlights Wild's intelligence and positivity. - It is inspiring to work with him, and to get his ideas and perspectives on what we are working on, he says. - It is important for us to collaborate with colleges and involve students. They often have a different point of view, which again can trigger our own thoughts and ideas.

Predicting the heat

Now that Wild and his team have developed a method to characterize the piezoelectric material, they will apply it to the piezoelectric material at various temperatures.
- Indeed, the material parameters tend to change with temperature, and this is important for us to capture if we are to predict the heat rise within this material. Once we have these material parameters, we will be able to predict the frequency and spatially dependent energy loss in the material. This will bring us a step closer to understanding how and where the heat is generated in these materials.

Transmissible research

While Wild's research directly benefits underwater transducer manufacturers, his findings can also be transferred to transducers in the medical, oil & gas industry. - As a result of the research I am conducting, I hope to give ultrasound transducer manufacturers a tool to predict the self-heating for a particular transducer design. This is important as this kind of tool would allow manufacturers to optimize their design and thus produce more stable and more efficient transducers.

PhD Candidate

Antoine Blachet

More Effective Seabed Mapping

Today, a significant part of the oceans remains coarsely mapped. Some specific areas, like the continental shelves, will require high-resolution surveys and keep scientist busy for decades. But what if we could improve the efficiency of current surveys?
That is the question Antoine Blachet, a CIUS PhD Candidate, asked himself.

Efficient tool

The Multi-beam echo sounder is one of the most efficient and reliable tools for seabed mapping, whether it is for geological surveys or inspection of man-made objects such as pipelines or ship wrecks. - Since its introduction in the 1980s the improvements in transducer technology and processing power has been significant, but the fundamental design has not really changed for 40 years, says Blachet.

Motivating environment

Blachet has a background in Applied Geophysics, a multidisciplinary field, and he wanted to explore the signal processing side. He is now a part of the Digital Signal Processing and Image Analysis Group group at UiO. - The research environment here is probably what motivates me every day. There is always something new to learn.

He also points to the Centre for Innovative Ultrasound Solutions: - They connect ultrasound researchers into the same community, and thanks to CIUS I can work on real life problems that are relevant for our industrial partners. It is a great source of motivation, he says.

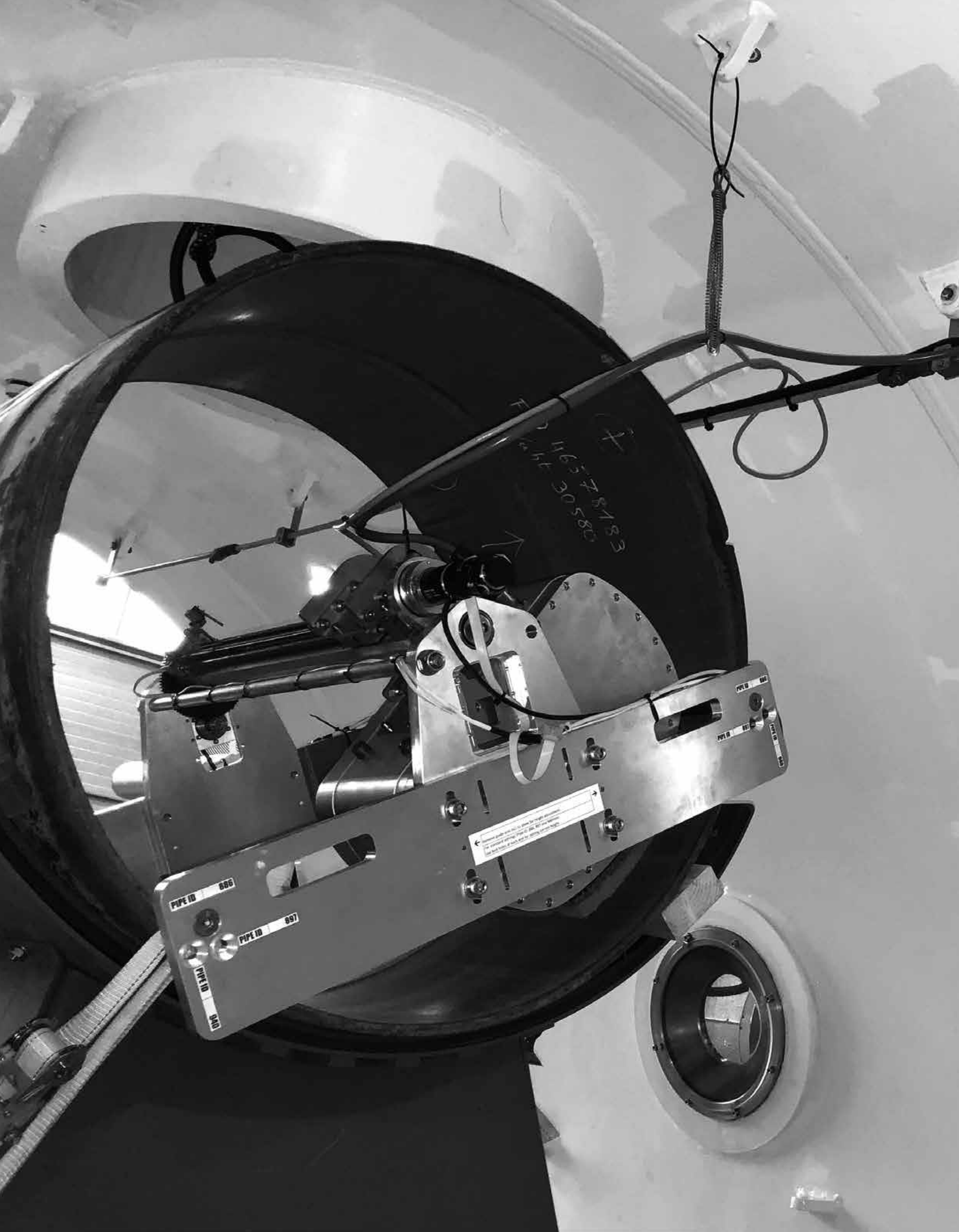
New SONAR designs

Collaborating with Kongsberg Maritime, a CIUS industrial partner, he is now exploring new SONAR designs that could lead to improved performance in some particular applications. One possibility is to transmit advanced coded waveforms, inspired from modern techniques used in radar and wireless communication. - The prosperity of future generations is undoubtedly linked to a sustainable use of ocean resources. I strongly believe that marine technologies such as SONAR will play an increasingly important role in this direction, Blachet says eagerly.
- By carefully choosing specific codes, we are trying to mitigate interferences between signals transmitted at the same time. This will make it possible to map multiple parts of the seabed at the same time. It may also increase the sounding density, and make the survey more efficient.

The future

Blachet and his team will continue to explore the benefits of advanced signal modulation for seabed mapping. New SONAR geometries might be considered at a later stage, along with experimental measurements.

- My hopes are that this research project will open new possibilities for ocean mapping. The goal is to develop ideas that can be used for the next generation of products.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PIPE ID 897
PIPE ID 940

Halfwave and InPhase Solutions

Crack Detection Technology

Halfwave and InPhase Solutions, both industry partners of CIUS, have a long-standing relationship. First collaboration dates back to more than five years ago, when InPhase Solutions contributed to relevant research and development tasks to improve Halfwave's successful Acoustic Resonance Technology (ART) as pipeline inspection technology. Since consultants from InPhase Solutions have specific competence in the fields of ultrasound and signal processing, they can temporary support related technology development in times where more resources are needed.

The solution to pipe wall cracks?

Currently, InPhase is involved in Halfwave's pursuit to develop a Crack Detection technology for in-line inspection of gas pipes, based on Halfwave's ART scan tool. This intriguing project was initiated based on observations of propagating acoustic modes that were detected with ART hardware and that can be dependent on defects in the gas pipe wall. One of the more relevant defects is stress corrosion cracking (SCC), which poses a serious risk to pipeline integrity. Cracks in the pipe wall can change the signature of propagating acoustic waves. These acoustic signal changes can be detected and subsequently be used to potentially size and locate the cracks.
However, due to the small size of typical stress corrosion cracks, they appear to be very difficult to detect with existing in-line inspection technologies.

Promising results

Results from the first development phases in the past two years at Halfwave have all been successful. In controlled experiments in water, both artificially machined notches in steel plates and real cracks in real pipe samples, could be clearly discriminated from undamaged areas.

Dedicated signal processing results even showed ways to discriminate cracks from other defect types. These very promising in the pursuit led to the current development phase, where water is replaced by pressurized gas as the propagation medium; like in a real gas pipeline.
The complicated test set-up contains many transducers with programmable transmit and receive channels, that can record on all transducers simultaneously. Initial processed results show many different aspects of the acoustic waves and are extremely promising in the pursue to detect SCC based on Halfwave's ART tool.

Continued research in CIUS

HalfWave will continue research on the crack detection challenge within CIUS, and plan to start a PhD project in 2018. Dr. Petter Norli, R&D Director of HalfWave states: - We are looking forward to continuing this exciting project in CIUS with more in-depth research in the years to come, and we are currently building a strong team within CIUS on understanding the basis of ultrasound propagation in steel layers among all the oil & gas partners.

◄ High-pressure test set-up consisting of a test scanner head with many transducers inside a pipe sample with real cracks. The test scanner head can mechanically translate and rotate to make circumferential scans of part of the pipe sample. The set-up is placed inside a pressure vessel at NUI (Bergen) that allows pressures up to 65 bar.

Medistim and GE Vingmed Ultrasound

CIUS Partners Deepens their Collaboration with New Grant

Together with Sensocure, CIUS partners Medistim and GE Vingmed Ultrasound has been granted 14.4 million NOK from the Research Council of Norway. With their project "Advanced Manufacturing Technologies for High Impact Medical Devices", they will be developing new production technology for the health sector. The collaboration will enable cost-effective production of advanced medical equipment in the future.

Valuable collaboration

GE Vingmed Ultrasound is the world leading producer of ultrasound equipment for heart imaging. Medistim supplies medical equipment for quality assurance of cardiovascular surgery, while Sensocure's sensors measure effective blood supply to organs in the body.
– After some conversation, we quickly found common challenges, says Christian Holm Edvardsen, Project Manager in GE Vingmed Ultrasound.
- Our participation in CIUS makes it easy to find collaborative partners. For us it was quite natural to enter into a partnership with GE since we knew each other through CIUS, adds Erik Swensen, VP R&D in Medistim.

Aiming high

The aim is to develop new and smart production technologies to enable continued cost-effective production of advanced medical devices in Norway, building on former successes of developing globally competitive manufacturers of complex medical equipment within areas where design, development and manufacturing are based on advanced know-how, competencies and skills. Manual operations today are executed in clean zones with extreme hygiene requirements. With new technology, the goal is to lower production costs by, for example, increasing efficiency and reducing freight costs on expensive components.

Bringing todays production to the next level

Swensen states that: - Medistim sees the funding of this project as a unique opportunity to develop new production technology that may bring today's production of ultrasound probes to the next level in terms of effectiveness and quality. For a company with labor-intensive manufacturing in Norway, this can mean a significant strengthening of our competitive edge in a global market.

The collaboration established through the pre-project and the application process has been a great platform to strengthen the medical production technology environment in Norway going forward. - The health industry has a significant potential as a value creator and employer," said former Minister of Trade and Industry, Monica Mæland, in a press release. She points to how projects like this connects young healthcare companies and research environments, which together can contribute to the health industry.

- We are good at radio pharmacology, cancer treatment and sensor technology in Norway, but we are just in the starting block of converting this into an industry - so these research funds are very important, said Bent Høie, Norwegian Minister of Health.


First start-up coming out of CIUS

ReLab

> ReLab plans to be Europe's leading manufacturer of single element transducers, and aims at low-cost robotized production of high quality ultrasound transducers.

First CIUS spin-off is up and running

ReLab is a newly established design and production company for ultrasound transducers that springs out from the CIUS consortium. ReLab was founded in January 2018 by Kristoffer Johansen and Kenneth K. Andersen, two PhD Candidates specializing in respectively stable-inertial cavitation and unconventional transducer design.

As entrepreneurs, they have come in contact with Norway's leading ultrasound actors. These have directly and indirectly contributed to the shaping of ReLab, a motivating factor for the two. - It's both exciting and challenging, and it's important to be aware that the qualities you need to succeed as an entrepreneur do not necessarily match the challenges you face as a researcher, says Kenneth K. Andersen.

Rapid prototyping is a key service the company will provide customers with, and this will incentivize them to initiate and accomplish innovation that creates benefit for their core businesses. Moreover, ReLab's overall objective is to provide ultrasound transducer solutions for Norwegian and international customers - from idea to fully developed systems.

Gamechanger

The motivation behind establishing a design and production company for ultrasound transducers in Norway arose from discussions with several of CIUS's partners. They characterized the international transducer market as high-priced, monopolized, and associated with long production processes, which ultimately may both negatively affect the ability to deliver services in an expanding market, and successfully initiate and complete innovative projects.

Furthermore, Norwegian ultrasound companies have also expressed interest in more rapid prototyping, better insight into the manufactured transducers, and a closer dialog between the design and production facilities. All of the above to strengthen their position in a demanding international market.

A range of services already available

ReLab is currently located at the research park of the University College of Southeast Norway, and works out of the NorFab laboratory collaboration with access to state-of-the art cleanroom and conventional laboratory facilities.

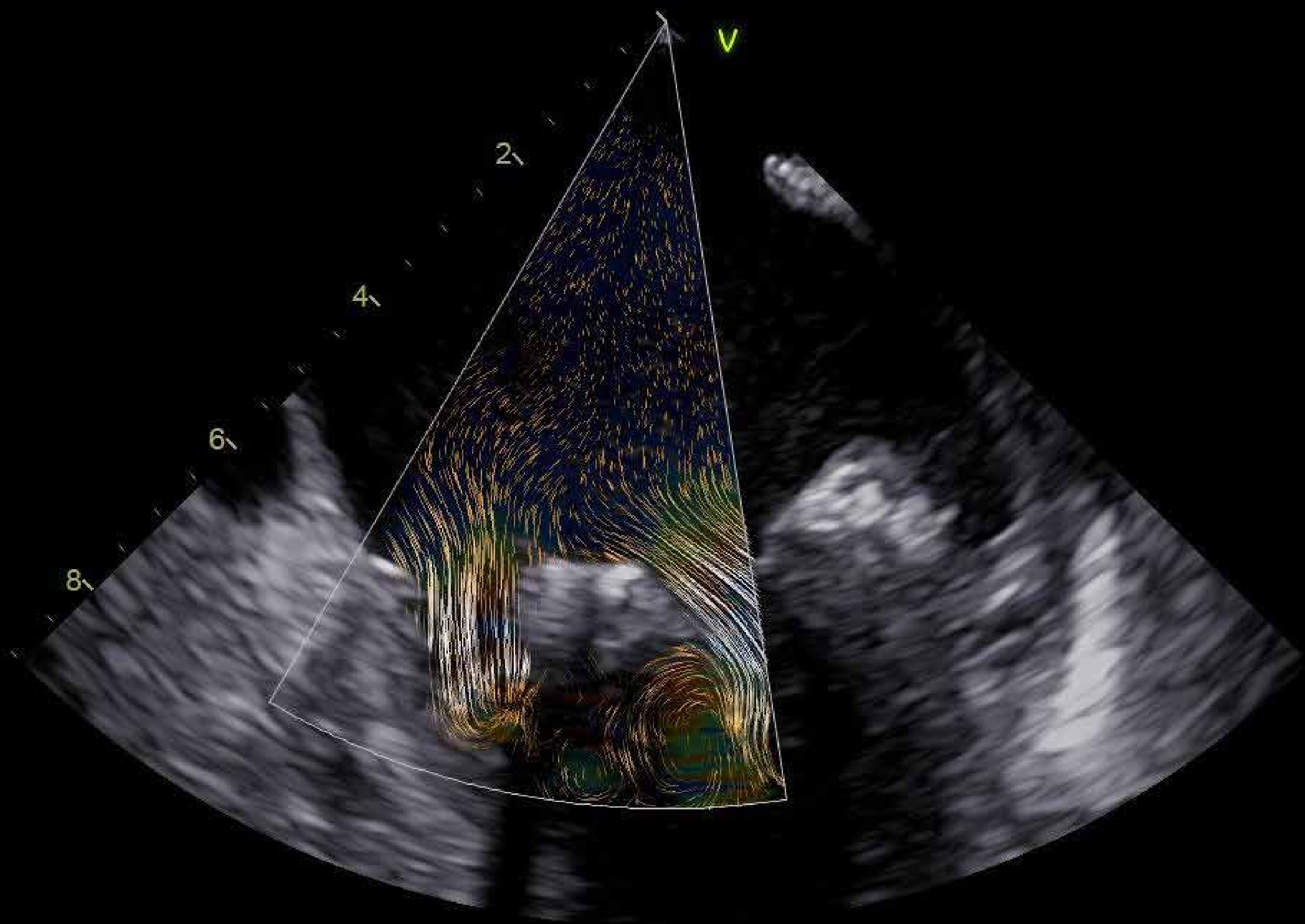
Today, ReLab has the capacity to offer a range of services, such as design, prototyping and small-scale production of ultrasound transducers. In addition, ReLab is also capable of testing existing ultrasound transducers and transducer systems. They are, for example, capable of performing sound-field and pulse-echo characterization, measuring electrical properties, as well as taking SEM images of transducer structures. - We are aiming for ReLab to be one of Europe's leading suppliers of design and production of ultrasound transducers, Kenneth K. Andersen says.

Innovation

Innovations are crucial for every successful research environment, and we are doing our best to make sure everyone connected to CIUS gets the support they need when coming up with an idea. We have created a formal process for researchers to report inventions, and in 2017, an Industry Liaison position was created. Svein-Erik Måsøy describes his new role as an "innovation manager". - This is the main goal of CIUS: Taking research from an idea to something that can benefit society as a whole through commercially available products, he says.

In 2014, Lasse Løvstakken and his team showed promising technical results tracking the flow and direction of blood. Today, Blood Speckle Imaging (BSI) has been implemented in the Vivid E95 scanner from GE as a new product, and the feedback is overwhelmingly positive.

▼ *Blood Speckle Imaging example from GE Vingmed Ultrasound e95 system; after Mitral Valve correction with the Mitra-Clip procedure.*



Innovation work in CIUS

Svein-Erik Måsøy

CIUS Industry Liaison

> Hi, my name is Svein-Erik Måsøy and in May 2017 I started working as the Industry Liaison in CIUS.

What is my role?

The Industry Liaison position probably best translates into an innovation manager; someone who is responsible for making sure all the great ideas that daily are thought of by the CIUS research teams are collected and evaluated for their potential use as products or services. This must of course happen in close collaboration with our industrial partners. This is the main goal of CIUS: Taking research from an idea to something that can benefit society as a whole through commercially available products.
My role is to have an overview of all projects that are going on within CIUS and to make sure relevant information are distributed to the right people. This could for example be to inform an industrial partner within the oil & gas domain about an exciting project in medicine that could be used for oil & gas applications. It could also be to connect people inside CIUS who should know about each other's projects, or to connect academic researchers with partners.
CIUS involves more than 100 people and have a lot of ongoing projects and activities at all times, so this keeps me occupied.

How do I work?

My main mode of operation is to talk to people. I continuously throughout the year try to visit all our industrial and academic partners, understand their needs, discuss projects, get to know everybody, and communicate my findings. Having the CIUS seminars twice a year, where we gather all partners and researchers, also helps to strengthen knowledge about everything that goes on, and to facilitate communication. As an example, in 2018 we have set up an oil & gas team with a clear research strategy and regular update meetings across all relevant partners. We already have several very interesting cross-disciplinary projects going on here.

As a formal step to collect innovations, we have created a process for researchers to report inventions through a Declaration OF Invention (DOFI) process. Each year (at the CIUS spring meeting) we have a yearly sum-up DOFI competition and the winning team, or researcher, receives a cash price. To make sure this process is continuous, I visit all academic teams regularly and arrange meetings were the goal is to discuss potential new innovations from the team since the last time we met. All reported DOFI's are distributed to our industrial partners as soon as they are formally registered, and they report back their potential interest in the concepts. This is a great way of working and allows for great transparency. It also forces everyone to think hard about their work and its relevance to our partners.

My background

As CIUS revolves around new ultrasound solutions within oil & gas, maritime, and the medical business area, it is important for me to have a broad understanding of the different challenges within these industries. In my 18 years in the ultrasound industry, starting with a PhD in medical ultrasound, I have worked within all these areas, and I find this to be very rewarding and important for the work I do today. Still, my main source of knowledge for what is important within CIUS is of course our partners and researchers. They have all the cutting-edge knowledge for us to really be at the forefront of ultrasound technology and application opportunities.

The Norwegian ultrasound community is world leading within its fields, both from an industrial and academic perspective, and this is what makes CIUS such a fantastic, interesting journey!

Blood Speckle Imaging (BSI)

New product: Blood Speckle Imaging - A New Way to Visualize Blood Flow in the Heart

In 2017, GE Vingmed Ultrasound AS launched a new product based partially on research carried out in CIUS. Further research to improve the technology will be pursued in CIUS.

The manifestation of cardiac diseases can be seen as changes in tissue and blood motion patterns. Professor Lasse Løvstakken and his team have developed a new way to measure and visualize blood flow patterns, with particular application for studying the paediatric population with congenital heart diseases which are very often linked to abnormal blood flow patterns. - Our hope is that this new approach can bring about a more detailed understanding of cardiac disease as well as a tool for more accurate diagnosis.

Blood speckle tracking

- The technology and application has developed over many years, starting mainly in my PhD work and through the collaboration with paediatric cardiologist Siri Ann Nyrnes. Initially this was a qualitative approach, but as technology matured we saw the potential for improved quantification of blood flow patterns using an image tracking approach. Central to this technique is also a new and more intuitive visualization of the blood motion, Løvstakken says.

Utilizing plane wave techniques

- During 2014, Lasse Løvstakken and his team showed promising technical results tracking speckle pattern from blood flow. This was based on utilizing plane wave techniques in order to acquire the data with high enough temporal resolution to be able to track the fast moving blood speckles, says Gunnar Hansen, Global Research Account Manager at GE Healthcare.

This had the potential to give researchers a completely new way to visualize blood flow in the heart and could overcome the limitation with Doppler (by tracking any blood motion in a 2D plane). - GE was very interested in exploring this opportunity further as we are leading in speckle tracking of tissue mainly applied to quantify contraction of the heart, Hansen adds.

GE Vingmed collaboration

The collaboration with GE Vingmed goes back to the founding and development of the Norwegian company named Vingmed Sound in the 1970-80s, initially a spin-off company for the ultrasound Doppler activity in Trondheim, according to Løvstakken. - Since then we have worked closely together in a highly synergetic fashion. The academic side is provided with special access to hardware and in-house expertise, as well as opportunities for bringing new methods to patients. On the other side the industry gets access to new competent people and projects pushing their ultrasound technology and clinical application further.

Clinical data acquired from Norway and Canada

To explore the clinical potential of the BSI it was very important to collect clinical data. Focus was to start looking into children with congenital heart diseases (CHD) where the blood flow can be very complex and difficult to interpret correctly.

GE built two Vivid E9 systems with the plane wave technology. With the Ethical Committee approval, the systems were installed at St. Olavs Paediatric Department in 2015, where Dr. Siri Ann Nyrnes started to acquire clinical data. To gain more cases with CHD, an identical system was installed at the SickKids Hospital in Toronto, with Dr. Luc Mertens team. This is one of the largest paediatric hospitals in North America and they had an extensive amount of newborn and paediatric patients. Both systems only acquired the data, so these needed to be processed by Løvstakken's team to perform tracking and display the results.

Implementation

After a lot of work to optimize tracking and visualization the results were so promising that GE decided to implement this in the Vivid E95 scanner.

In addition to covering neonatal and paediatric applications, it was also implemented for interventional imaging to support planning and evaluation of interventional procedures for valve repair and replacement.

Overwhelming feedback

- BSI was introduced to the market during the American Society of Echocardiography conference in 2017, and feedback from customers have been overwhelmingly positive, says Hansen. This work will continue in the CIUS programme to further develop the method for additional application including 3D and to add quantitative analysis of the flow pattern. - Clinical studies and use will reveal the potential for the approach for improving the understanding of pathophysiology and with regards to direct clinical application. This is done in collaboration with larger hospitals around the world, and in our case in particular with the SickKids Hospital in Toronto. The method is further continuously improved in terms of accuracy and robustness, Løvstakken adds.

Innovation Statistics 2017

New methods/models/prototypes = 7
New products = 1
New services = 2

CIUS researchers have delivered four Declaration OF Inventions (DOFI) to the CIUS consortium in 2017: Three regarding new machine learning methods developed for cardiac ultrasound, and a new method for imaging mechanical waves inside the human heart.

The University College of Southeast Norway (USN) has together with CIUS industry partner Phoenix Solutions developed a new dual-frequency ultrasound transducer to be used in animal experiments. Also, GE Vingmed Ultrasound (GEVU) has implemented a new automatic AV plane detection method which is currently under evaluation in Brisbane in collaboration with CIUS researchers.

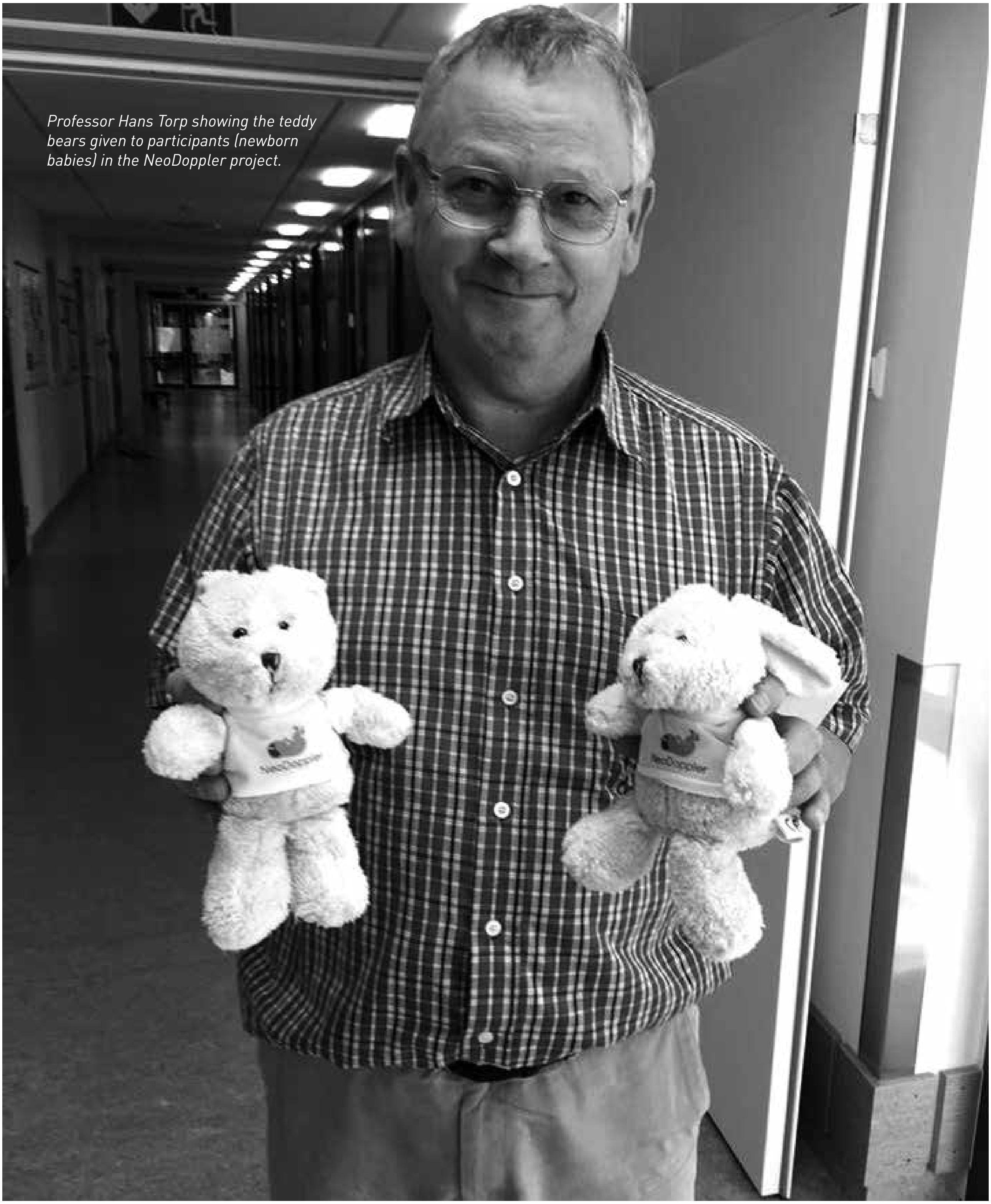
GEVU has also launched a new product, the Blood Speckle Imaging method.

Public partners Innherred Samkommune and Levanger Sykehus have started using new services; pocket-sized ultrasound diagnostics among inexperienced users and solutions for telemedicine support to inexperienced users or users at remote locations. This has happened in collaboration with a research and development team from CIUS, improving diagnostic precision and diagnostic workflow in their hospitals and general practice.

The industry partners in CIUS have been awarded new contracts, both inside and outside of CIUS, which are very rewarding for the CIUS family.

International Collaboration


MISIT, Delft University of Technology, Delft, Netherlands
University of Bath, Bath, UK
Otivio, Oslo
Interreg Norway-Sweden
Linköping University, Linköping, Sverige
Technical University of Denmark, Lyngby, Denmark
Charité Hospital, Berlin, Tyskland
Medical University of Vienna, Vienna, Austria
CREATIS, INSA Lyon/ University of Lyon/ ENS de Lyon, Lyon, France
GE Parallell Design, Nice, France
Aculab, University of Rome, Rome, Italy
Institute of Soft Matter Mechanics, College of Mechanics and Materials, Hohai University, Nanjing People's Republic of China, Hohai, China
KU Leuven, Leuven, Belgium
University of Queensland and the Indigenous Cardiac Outreach Program, Queensland, Australia



Professor Hans Torp showing the teddy bears given to participants (newborn babies) in the NeoDoppler project.

PhD Candidates

Kenneth K. Andersen (WP1)
Unconventional ultrasound transducer design
New ultrasound imaging and therapeutic modalities may require or benefit from ultrasound transducer that can operate at significantly different frequencies. To handle the complexity of these dual-frequency transducers, we have developed a numerical optimization method based on linearizing the phase spectrum. Using this method, a dual-frequency transducer has been designed and optimized for Phoenix Solutions AS. The transducer has been prototyped and tested, and is expected to be used in pre-clinical trials in 2018.

Erik Andreas Berg (WP5)
Multimodality and interventional imaging
We refine and validate a computerized algorithm for 3D transthoracic and transesophageal echocardiographic measures for reconstruction of aortic root morphology. We also work on a semi-automatic computerized algorithm for semi-quantification of aortic and mitral valve regurgitations based on ultrasound data, the clinical value of an algorithm for continuous ultrasound monitoring of LV function during major surgery, and an application for 3D echocardiography of coronary arteries.

Antoine Blachet (WP2)
SONAR seabed mapping
Together with Kongsberg Maritime, I am exploring new SONAR designs that could lead to improved performance in some particular applications. One possibility is to transmit advanced coded waveforms, inspired from modern techniques used in radar and wireless communication. We are trying to mitigate interferences between signals transmitted at the same time. This will make it possible to map multiple parts of the seabed at the same time. It may also increase the sounding density, and make the survey more efficient.

Seyed Ali Fatemi (WP2)
Acoustics and beamforming
State-of-the-art echocardiography allows to correctly diagnose most of cardiovascular diseases. An unknown source of clutter, however, hinders the visualization of the heart in some cases. The aim of this project is to study the cause of this clutter noise in the current echocardiograms and to propose new processing methods to improve the image quality.

Cristiana Golfetto (WP3)
Doppler and deformation imaging
Doppler measurements in coronary arteries are difficult due to rapid motion of the myocardium and small vessel dimensions. High frame rate 3D Doppler imaging with retrospective spectral Doppler processing could potentially solve this. However, the combination of low blood flow velocities and excessive tissue motion in parts of the cardiac cycle makes clutter suppression challenging. I am working on finding an adaptive clutter filter able to reduce power Doppler artefacts such as flashing and dropouts. The project focuses on flow velocity measurements in non-stationary and noisy surroundings.

Thomas Grønli (WP4)
Model-based flow estimation methods
Ultrasound vector-flow measurements are hampered by noise, dropouts and erroneous outliers, thus the need for robust filtering and reconstruction is imperative to its continued adoption in clinical settings. This project focuses on the development of model-based regularization and robust Bayesian inference methods for fluid estimation in the context of intracardiac blood flow using ultrasound measurements. The overall aim is to improve ultrasound estimation of clinical flow properties.

Aslak Lykre Holen (WP1)
Transmitters and receivers for ultrasound systems
This project is developing transmitter and receive hardware for low power and high integration targeting medical ultrasound. The aim of this project is to study low power adaptive solutions for integrated high voltage ultrasound pulse generators with harmonic suppression, and low power digital hardware beam formers for ultrasound receivers.

Thong Tuan Huyhn (WP1)
Non-ideal effects in transducers
Novel medical ultrasound imaging utilize the nonlinear properties of the tissue. This requires a good control of the nonlinear behaviour of the transmit system. The aim of this project is to develop methods to explore and model the non-ideal effects in this system, defined as any effect that can not be described by an impulse response. The ultimate goal is to develop methods to compensate for such effects by shaping the transmit pulses. The project uses our 3D scanning hydrophone measurement tank, connected to a GE Vingmed Ultrasound scanner.

Wadi Mawad (WP7)
Cardiac blood flow and blood speckle tracking
The use of high-frame rate ultrasound and blood speckle tracking allows the visualization of cardiac blood flow patterns and quantification of flow characteristics such as vorticity and energy losses. Changes in flow characteristics are thought to precede overt cardiac remodeling which makes them potential early biomakers of adverse cardiac remodeling. This project focuses on the application of this imaging technology to multiple congenital cardiac conditions in children to assess its feasibility, reproducibility and to demonstrate differences in flow characteristics.

Cameron Lowell Palmer (WP6)
User guidance tools and analysis tools for handheld cardiac ultrasound
I work with augmented reality tool using a dynamic cardiac anatomical model adapted in real-time during scanning. Implementation of fully automatic mitral annulus motion measurements on GE Vingmed's new Vscan.

Andreas Sørbrøden Talberg (WP2)
Acoustics and beamforming
The focus is on using ultrasonic non-destructive testing methods in applications related to the oil & gas industry. Current work is being conducted with WP3 to combine the knowledge related to the propagation of waves in solids and the use of Doppler methods to inspect flow behind a solid layer through numerical and experimental work.

Morten Wigen (WP3)
3D Vector Flow Imaging
We are developing methods to image complex blood flow inside the heart in 3D using ultrasound. Comparable methods are currently only available using Phase-Contrast MRI, which is cumbersome and time consuming. Using ultrasound this method can be available bedside, and hence increase the clinical accessibility. The project is dependent on state-of-the-art 3D ultrasound equipment and involves development of methods for data acquisition and 3D vector flow estimation.

Marcus Wild (WP1)
Transdusers & Electronics
I investigate the heat generation and transfer within ultrasound transducers. Heating can cause performance and efficiency issues in modern transducers so it would therefore be of interest to be able to accurately model the temperature rise for a given design before prototyping. The initial part of my PhD consists of characterising the loss mechanisms in the piezoelectric component accurately for various external conditions such as driving voltage or temperature. I will then be using the determined losses to predict the temperature rise in a piezoelectric component.

Andreas Østvik (WP4)
Image processing, analyzis and visualization
The goal of my PhD project is to utilize and further develop machine learning methods to improve state-of-the-art solutions in the field of ultrasound image analysis and visualization. More specifically, research will be conducted on tasks such as classification of standard plane views in echocardiography, cardiac landmark detection and heart chamber segmentation in ultrasound images.

Postdocs

David Bouget (WP5)
Multimodiality and interventional imaging
In order to measure blood pressure and flow through a specific coronary artery, catheter insertion in the body is the current diagnosis approach. In order to perform the same measurement in a non-invasive manner, a solution is to use a US probe to image the flow inside the coronaries. One critical drawback is then the difficulty for the surgeon to properly target a specific coronary using only the US data. We are developing a system able to perform automatic registration between a pre-recorded CT with segmented coronaries and intra-diagnosis US data. In addition, the system is planned to be able to track the US probe motion in time in order to provide an accurate guidance map to the surgeon for reaching more easily regions of interest.

Fabrice Prieur (WP2)
Acoustics and beamforming
My contributions to the CIUS project deals with three main areas: First, the use of nonlinear propagation in underwater acoustics and exploring how the nonlinear effects of sound propagation in water can contribute to improve image quality in SONARs. Secondly, acoustic waves are often used to inspect tank walls, pipe surface, or boreholes for weakness signs such as corrosion, cracks, or bonding faults. Acoustic waves travelling along this structure can be analyzed to discover and position these weaknesses. Finally, I will use my experience in simulations both using finite element modelling method and finite time difference methods to improve our understanding of the propagation of elastic waves.

Sebstien Salles (WP3)
Doppler and deformation imaging
I work with the development of acquisition strategies and processing algorithms for high frame rate 3D tissue deformation imaging, utilizing the increased data information available using parallel acquisition techniques. The overall aim is to evaluate regions with specific properties such as increased stiffness or reduced muscle contraction. Methods will be based on Doppler, speckle tracking, and acoustic radiation force principles.

Erik Smistad (WP4 and WP5)
Image processing, analyzis and visualization
I am primarily working on image segmentation, and exploring new developments in the field of machine learning and neural networks. The work has so far been on classification of images as well as identifying structures, such as blood vessels and the left ventricle. I have also developed software tools for easy annotation of ultrasound image data (Annotationweb), and tools for processing ultrasound images with a trained neural network in real-time.

Researchers with External Financing in CIUS-projects

Postdoctoral Researchers

Jørgen Avdal, NTNU
Ingvild Kinn Ekroll, NTNU
Solveig Fadnes, NTNU
Daniel Iversen, NTNU

PhD Candidates

Lars Eirik Bø, NTNU/SINTEF
Torvald Espeland, NTNU
Stefano Fiorentini, NTNU
Harald Garvik, NTNU
Jahn Fredrik Grue, NTNU
Trine Husby, NTNU
Stine Hverven, UiO
Anna Karlberg, NTNU
Lars Kristian Lervik, NTNU
Elisabeth Grønn Ramsdal, UiO
Ole Marius Rindal, UiO
Lars Saxhaug, NTNU
Sofie Snipstad, NTNU
Silje Kjærnes Øen, NTNU

Scientific Personnel

Tore Bjåstad
Scientific Programmer
The main purpose of Bjåstad's work is to accelerate the process of getting new methods and algorithms into a product. Primarily, the product will be a GE Vingmed ultrasound scanner intended for cardio vascular imaging. This work will typically involve further development of scanner code to make it capable of executing new methods in real time, or to collect data for offline processing, or in some cases just assistance in how to set up and use existing functionality of the scanner.

Jan D'hooge
Professor
Professor Jan D'hooge of the University of Leuven in Belgium visited NTNU as a guest researcher of CIUS in 2017. Although D'hooge has long-standing relations with some of the CUIS investigators, the main purpose of his stay was to optimize the collaboration between his lab in Leuven and CIUS' in Trondheim, in order to maximally exploit potential synergies and avoid redundancy where possible.

Martijn Frijlink
Associate Professor
The Department of Micro- and Nanosystem Technology (USN) are developing and investigating different aspects of ultrasound transducers for applications in both medical, maritime, and industrial fields. With Frijlink's background in different medical and nonmedical ultrasound applications, and having experience from the field of medical transducer design and manufacturing, his contribution mainly consists of supporting different ultrasound transducer related projects.

Bjørnar Grenne
Researcher
Grenne is a researcher at NTNU and a cardiologist at St. Olavs hospital. His main research areas are advanced echocardiography, valvular disease, coronary artery disease and echocardiography in valve interventions.

Bjørn Olav Haugen
Professor
Haugen is a professor at NTNU and consultant cardiologist at Trondheim Hjertesenter. He has been involved in ultrasound technology research since 1998, and is the leader of WP 6 and 7 in CIUS.

Alan Hunter
Associate professor
Dr. Alan Hunter is a researcher and engineering lecturer at the University of Bath, UK. His research interests are in underwater remote-sensing using acoustics and autonomous systems, and he is a specialist in high-resolution synthetic aperture SONAR imaging. Dr. Hunter has been an Adjunct Associate Professor in the Department of Informatics at the University of Oslo (UiO) since 2017.

Tonni Franke Johansen
Researcher
Tonni Franke Johansen is a researcher at SINTEF and NTNU. His research interests are simulation and instrumentation for ultrasonic measurements systems. He contributes in research and supervision at USN with piezoelectric transducers, and at NTNU with wave propagation in layered media.

Yucel Karabiyik
Researcher
Karabiyik works on developing algorithms for optimization and automation of ultrasound Doppler imaging in fetal medicine. His aim is to reduce the cost of an ultrasound system while keeping the image quality sufficient, and the ultimate goal is to provide easy-to-use Doppler imaging on a portable cost effective ultrasound system that will be used in fetal medicine.

Gabriel Hanssen Kiss
Researcher
Hanssen Kiss works on fast registration and fusion tools for cardiac applications in order to identify and characterize the dynamics and function of cardiac structures based on multi-modal image data.
In addiotion, he is also involved with augmented reality visualization techniques to be used in the echocardiographic lab under image acquisition.

Luc Mertens
Professor
Luc Mertens is Section Head, Echocardiography at the Labatt Family Heart Centre, Hospital for Sick Children in Toronto, Canada.
Dr. Mertens' research interests focus on using new echocardiographic techniques to study the heart function in children.
He was recently appointed as a guest scientist at CIUS, collaborating on applications of high-frame rate ultrasound in children with heart disease.

Alfonso Rodriguez Molares
Senior Engineer
Molares' fields of research are acoustics and ultrasonics. He is currently developing new beamforming techniques to improve the ultrasound imaging of acoustically hard surfaces, aiming to improve the visualization of bone tissue in ultrasound images to support intraoperative monitoring of spinal surgery.

Ole Christian Mjølstad
Researcher
Mjølstad has worked with the development of pocketsize ultrasound technology since 2009, trying to improve physical examination and to increase diagnostic precision. Mjølstad and his colleagues continuously work to establish the position of pocketsize ultrasound in daily clinical care. An important part is the development and clinical evaluation of applications that increase the usability among non-experts.

Anders Thorstensen
Researcher
Thorstensen and his colleagues aim to evaluate the diagnostic accuracy of post systolic foreshortening for direct echocardiographic quantification of myocardial infarct size, using LE-MRI as reference method. The areas of post systolic of foreshortening are likely to benefit from early revascularization in patients with acute myocardial infarction.

CIUS Faculty

Svend Aakhus, Professor, NTNU
Knut E. Aasmundtveit, Professor, USN
Andreas Austeng, Professor, UiO
Håvard Dalen, Associate Professor, NTNU
Catharina Davies, Professor NTNU
Hefeng Dong, Professor, NTNU
Live Eikenes, Associate Professor, NTNU
Roy Hansen, Professor II, FFI/UiO
Espen Holte, Assistant Professor, St. Olav/NTNU
Tung Manh, Associate Professor, USN
Siri Ann Nyrnes, Researcher, NTNU
Tormod Selbekk, Research Manager, SINTEF
Annemieke van Wamel, Researcher, NTNU
Rune Wiseth, Professor, St. Olav/NTNU
Trond Ytterdal, Professor, NTNU
Andreas Åslund, Researcher, NTNU

Dissemination, Media Coverage and Outreach

CIUS acknowledges the importance of communicating our research to the public, and in 2017, CIUS projects has been featured in local, national and international press.

Ranging from touching patient stories to new scientific findings and tools, we will continue to use different media platforms to spread our research as widely as possible.

Different platforms calls for different ways of communication, and one channel of information is the NTNU Medicine and Health blog. This is a well-visited site where CIUS-affiliated researchers published 14 posts in 2017. The post "Microbubbles and focused ultrasound cure tumors in mice" was read more than 2000 times and reached over 7000 people in social media.

We will continue to make our researchers aware of their responsibility to inform the public of important findings, and support them in taking time to do so.

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Samarbeid: Ultralydapparatet som nå er utviklet i Trondheim, er et resultat av mange års forskning og samarbeid mellom ultralydmiljøet ved ved NTNU og leger ved St. Olav. Foto: RUNE PETTER NESS

Mirakel: – Hun er et mirakel, sier mamma Justyna Wojsyk om sin lille datter. Hun ble født 16 uker for tidlig, men har vist en ukuelig livsvilje.
Foto: RUNE PETTER NESS

Først ut: Ultralydmiljøet ved NTNU og det medisinske miljøet ved St. Olav er først ut med ultralydapparatet som kan måle blodstrømmen over tid. Fra venstre overlege Sigrid Vik, overlege Siri Ann Nyrnes og prosjektleder ved NTNU Technology Transfer, Siri Ann Mauseth. Helt til venstre mamma Justyna sammen med datteren Nina, som sover i kuvøsen. Foto: RUNE PETTER NESS

Tøff jente: Nina har vist seg å være en tøff jente. Nå har hun snart doblet fødselsvekten sin. Foto: RUNE PETTER NESS

Tobarnsforeldre: For sju år siden ble de foreldre til Stanislaw. I februar skulle han bli storebror. Men Nina kom så alt for tidlig. Foreldrene Justyna og Jakub er spent på hvordan det vil gå med lillesøster.
Foto: RUNE PETTER NESS

Tøff start på livet for Nina Alicja

Hun skulle ha vokst seg sterk og stor i mammas lune mage, men fire måneder for tidlig kom Nina Alicja til verden ved St. Olav. Da veide hun bare 615 gram.

»Trondheim

Livet på St. Olav

Like etter at hun ble født 7. november ble hun koblet til en Neodoppler, et ultralydapparat som er utviklet ved NTNU og St. Olav.

Da kunne legene for første gang i flere timer følge blodsirkulasjonen i hjernen til en så liten baby.

– Alt så helt fint ut, forteller Sigrid Vik, overlege ved nyfødt intensiv.

– Hun var så liten da hun ble født, men hun var veldig sterk. Hun er et mirakel, sier mamma Justyna Wojsyk.

Flagget til topps

Tidlig i desember heises flagget inne på et av pasientrommene på nyfødt intensiv.

Slik er det alltid når de bitte små babyene har kjempet seg gjennom sin første levemåned.

– I dag tidlig løp jeg ut på butikken for å kjøpe ballonger, smiler Justyna og peker mot vinduet. Der henger fargerike ballonger i en snor over adventsstaken.

Etter at hun ble tobarnsmor har hun lært seg å ta en dag av gangen, glede seg over små skritt og feire hvert gram som legger seg på den lille kroppen i kuvøsen. Etter en måned har Nina vokst fra 615 gram til 890 gram.

– Hun er blitt så stor, hun er rund ansiktet, sånn som meg, sier Justyna og smiler igjen.

Hver dag løfter hun sin lille datter varsomt opp av kuvøsen og legger henne hud mot hud på brystet. Slik sitter mor og barn i flere timer. Kengurumetoden, som de kaller det, har vist seg å være viktig også for de aller minste barna. Mens Nina sover, kjenner mamma på gleden over det lille hjertet som banker, beina som sparker og de ørsmå fingrene som knytter seg rundt hennes pekefinger.

– Jeg synger vuggesanger for henne, da blir hun så rolig, sier Justyna.

Nybrottsarbeid

Nå er Nina blitt en del av et forskningsdrevet innovasjonsprosjekt ved St. Olav. Et fremadstormende ultralydmiljø ved Institutt for sirkulasjons- og bildediagnostikk ved NTNU har i samarbeid med det medisinske miljøet ved St. Olav utviklet en helt ny ultralydteknologi som kan bidra til at færre premature barn får hjerneskade.

– Vi har i lang tid hatt mulighet til å ta øyeblikksbilder av hjernen med ultralyd. Men et slikt bilde forteller ikke noe om hva som har skjedd før og etter. Derfor har vi ønsket å gjennomføre ultralyd over tid, og følge blodstrømmen til hjernen. Det vil gi oss ny kunnskap, og en mulighet til å forebygge og bedre behandlingen av de mest sårbare barna, sier Siri Ann Nyrnes, overlege i barnekardiologi ved St. Olav.

Teknologien kan benyttes både overfor premature barn, men også for andre syke nyfødte som barn med hjertefeil og barn med infeksjoner. Så lenge babyen har et mykt område på hodet, der hvor skallebeinet ikke er vokst sammen, er det mulig å gjennomføre en slik monitorering.

– For noen år siden ble det forsøkt å utvikle en teknologi for å måle blodsirkulasjonen over tid, men den gang var teknologien veldig komplisert. Denne løsningen er forholdsvis enkel, og det ser veldig lovende ut, sier NTNU-professor Hans Torp som er en av dem som står bak Neodoppleren. Han leder en ultralydgruppe ved NTNU på rundt 50 forskere, og synes dette er svært spennende.

– Og så er det veldig artig å jobbe med leger som er så dedikerte, sier han.

Forebygge hjerneskade

7,5 prosent av barna i Norge fødes før uke 37, og regnes som premature. Enkelte blir født før uke 28 og betraktes dermed som ekstremt premature. De er svært sårbare, og tre av fire av de aller minste får en form for hjerneskade.

– De fleste får mindre skader, slik som lese- og skrivevansker eller konsentrasjonsvansker, sier Nyrnes.

Det er de første timene og dagene etter fødselen det er størst fare for at en hjerneskade kan oppstå. Nyrnes sier at de lenge har hatt et ønske om å bedre behandlingen av barna som er ekstremt premature. Nå ser det ut til at de kan være på vei til å lykkes. Med den nye ultralydteknologien kan de overvåke blodets aktivitet i hjernen over lengre tid, opptil flere døgn om nødvendig. Dermed kan en få et forvarsel hvis barnet er i ferd med å bli syk. Målet er å oppdage endringer slik at det kan gjøres tiltak for å stabilisere blodstrømmen og hindre hjerneskade.

– Dette er noe som ikke er gjort ved noe sykehus i verden tidligere. Det er nybrottsarbeid, sier Siri Ann Mauseth, prosjektleder ved NTNU Tecnhology transfer. Hun skal bidra til å løfte frem produktet, patentere det og kommersialisere det. Så langt er prosjektet finansiert med 16 millioner kroner fra ulikt hold, blant annet Forskningsrådet.

– Dette er et produkt som har et stort potensial. Hvis vi lykkes, kan dette bli benyttet ved alle nyfødt intensivavdelinger i verden, sier Mauseth.

Hasteinnlagt

Årlig fødes det rundt 16 ekstremt premature barn ved St. Olav. Noen av dem kan veie ned mot 500 gram.

Justyna hadde termin 28. februar, men da svangerskapet hadde vart i bare 24 uker og to dager, ble Nina født. Fødselen skjedde etter at Justyna ble hasteinnlagt ved St. Olav en uke tidligere da det ble oppdaget at hun mistet fostervannet.

– Det var så viktig at hun fikk lengst mulig tid i magen, for det betyr at sjansen for å overleve øker, forteller Justyna.

Rett etter at Nina var forløst med keisersnitt, festet legene en probe, som er som en liten knapp, til hodet. Slik kunne de overvåke blodsirkulasjonen i hjernen.

– Vi har testet denne proben på friske babyer tidligere. Nina var den tredje premature babyen og den aller minste vi har prøvd dette på, sier Vik.

«Mini-mini»

Nina trenger fortsatt hjelp til å puste, og mammas morsmelk får hun gjennom en sonde. Det meste av dagen sover hun, men av og til høres sped babygråt. Og noen ganger gløtter hun opp fra sin lille hule i kuvøsen. Trolig blir hun på sykehus frem til hun egentlig skulle kommet til verden, i slutten av februar. Like før jul ble hun flyttet til Ålesund sykehus, nærmere hjembyen Molde. Da blir det også lettere for pappa Jakub og storebror Stanislaw (7) å komme på besøk.

– Stanislaw har vært her en gang og besøkt lillesøsteren. Han så på henne, og sa «hun ser jo ut som en vanlig baby, hun er bare mini-mini».

For Justyna og ektemannen Jakub, har det vært krevende å følge Ninas tøffe start på livet. Men foreldrene tenker at de må være sterk i denne tiden, det hjelper ikke at de tynges ned av bekymringer.

– Jeg vet ikke hvordan Ninas liv blir, og hvordan situasjonen er om tre eller fem år. Men jeg er positiv og tenker at det skal gå bra. Hun har vist at hun er sterk, sier Justyna.

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Fakta

Under 1000 gram

Barn som fødes før utgangen av 37. svangerskapsuke, kalles premature barn.

Hvert år er i underkant av 3500 fødsler i Norge premature. Rundt 300 barn fødes før uke 28 og er ekstremt premature. Drøyt 200 av barna er under 1000 gram.

Barn født i uke 23, har 50 prosent sjanse for å overleve, for barn født i uke 24 er overlevelsen 70 prosent, mens barn født i uke 25 har 85 prosent sjanse for å overleve.

De minste kan ha en fødselsvekt ned mot 500 gram.

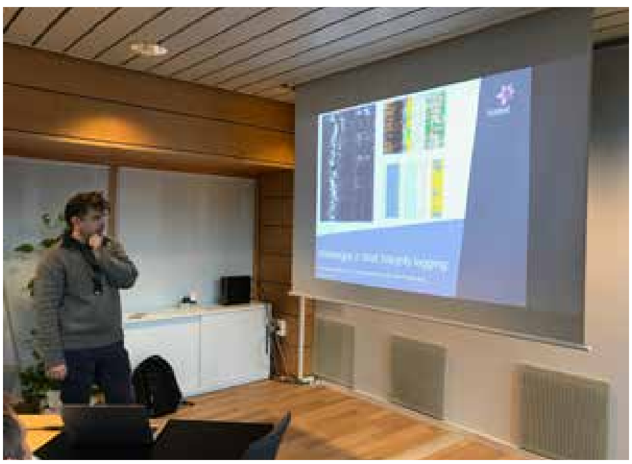
Ekstremt premature barn har økt risiko for funksjonsnedsettelser som cerebral parese, nedsatt syn og hørsel, lærevansker og psykiske vansker.

Kilde: St. Olavs hospital/ Medisinsk fødselsregister

Media Overview

Tøff start på livet for Nina Alicja - Livet på St. Olav	Adresseavisen
Enhancing marine sonar and medical ultrasound imagery using wave coherence	NTNU medicine -blog
Automatic lung cancer staging using CT data	NTNU Medicine - blog
Blood flow secrets in small hearts	NTNU medicine - blog
Reducing SONAR overheating	NTNU medicine - blog
Skal forske på kondisjon og hjerteflimmer	NRK Midtnytt
Leaky heart valves – new method for quantification by ultrasound	NTNU medicine - blog
Pocket-sized ultrasound helps screen stroke patients	NTNU medicine - blog
Dette norske gjennombruddet kan hjelpe millioner av diabetikere	Teknisk Ukeblad
Ultrasound automation simplifies detection of heart failure	NTNU medicine - blog
Forskning taler for bruk av lommeultralyd på slagpasienter	Dagens Medisin
Nanotechnology combined with ultrasound advances chemotherapy treatment in recent lab experiments	Azonano.com
Bringer medisin rett til kreftcellene og sparer friske celler	ABC Nyheter
Nanotech delivers chemo medicine to cancer cells while protecting healthy cells	Beforeitsnews.com
Bringer medisin rett til kreftcellene og sparer friske celler	Gemini
Nanotechnology delivers medicine to cancer cells while protecting healthy cells	Nanowerk.com
Ny forskning gir bedre kreftbehandling	Dagens Næringsliv
Ultrasonic cement evaluation in oil and gas wells	NTNU medicine blog
One-probe-two-frequencies-numerical-optimization-of-dual-frequency-transducers	NTNU medicine - blog
Det håndholdte ultralydapparatet blir kalt legenes nye stetoskop	A-magasinet (online)
Det nye stetoskopet	A-magasinet (print)
Ultrasound – a cross-sector solution	NTNU medicine - blog
Microbubbles and ultrasound cure tumours in mice	NTNU Medicine - blog
Can the growth rate of brain tumours help predict survival?	NTNU Medicine - blog
SFI-en CIUS på Akustikksymposium	Sverre Holm's blog
Universitetssykehuset St. Olavs Hospital	Facebook video- St. Olavs
Beamforming – An international challenge	NTNU Medicine - blog
Dette er NTNU!	Facebook video - NTNU
Improvements in ultrasound transducer design and manufacturing	NTNU Medicine - blog

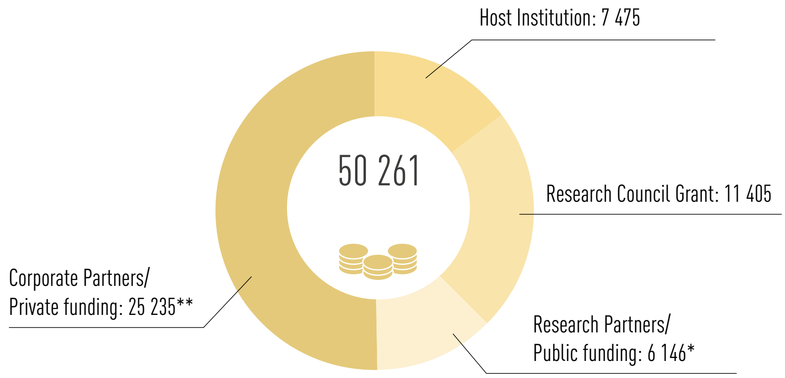
▼ *From top left: Professor Hans Torp at Forskningsdagene; Cristiana Golfetto speed updating on CIUS spring seminar; Statoil visit to Department of Circulation and Medical Imaging; Mingling at CIUS fall seminar; Ioan-Alexandru Merciu presenting during oil & gas seminar; Svein-Erik Måsøy presenting CIUS on Researchers Night.*



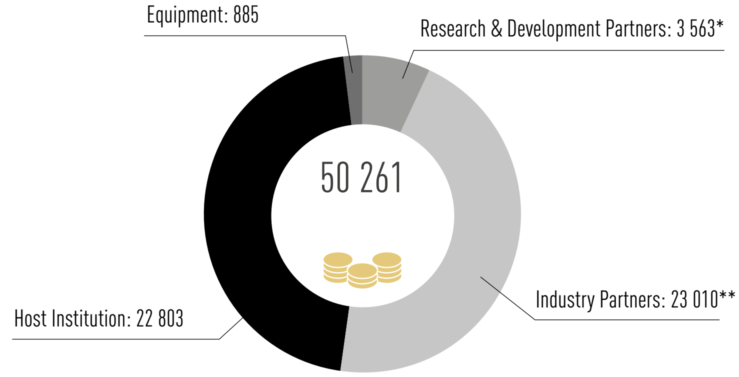
Annual Accounts for 2017

The annual account for 2017 deviated from the original budget, which can be attributed to slower start-up and less in-kind contributions from of the corporate partners.

FUNDING
(in 1000 NOK)



COSTS
(in 1000 NOK)



*SINTEF, University of Oslo, University College of Southeast Norway, Helse Midt Norge RHF, St. Olavs University Hospital HF, Nord-Trøndelag Hospital Trust.

**Statoil Petroleum AS, GE Vingmed Ultrasound AS, Archer-Berfen Technology Center AS, Sensorlink AS, Phoenix Solutions AS, InPhase Solutions AS, Kongsberg Maritime as, Halfwave AS, Aurotech Ultrasound AS, X-Fab Semiconductor Foundries AS, Medistim ASA

Journal Articles

AUTHOR/AUTHORS	TITLE	JOURNAL
Smistad,E, Østvik,A, Haugen,BO, Løvstakken,L	2D Left ventricle segmentation using deep learning	Proceedings - IEEE Ultrasonics Symposium (ISSN 1948-5719)
Bergh,T, Hafizovic,I, Holm,S	Acoustic imaging of sparse Sources with Orthogonal Matching Pursuit and clustering of basis vectors	Proceedings of the IEEE International Conference og Acoustics, Speech and Signal Processing (ISSN 1520-6149)
Ekroll, IK, Avdal,J	Adaptive clutter filtering based on tissue vector velocities	Proceedings-IEEE Ultrasonics Symposium(ISSN 1948-5719)
Atarzadeh,H, Xu,Y, Ytterdal,T	A Low-Power High-Dynamic-Range Reciever system for In-Probe 3-D Ultrasonic Imaging	IEEE Transactions on Biomedical Circuits and systems
Garvik,H, Wulff,C, Ytterdal,T	An 11.0 bit ENOB, 9.8 fJ/conv.-step noise-shaping SAR ADC calibrated by least squares estimation	Proceedings IEEE Custom Integrated Circuits Conference(ISSN 0886-5930)
Atarzadeh,H, Ytterdal,T	An in-probe low-noise low-power variable-gain receive amplifier for medical ultrasound imaging using CMUT transducers	Analog Integrated Circuits and Signal Processing(ISSN 0925-1030)
Myhre,O F, Johansen,T F, Angelsen,B	Analysis of acoustic impedance matching in dual-band ultrasound transducers	Journal of the Acoustical Society of America(ISSN 0001-4966) issue 141 2, pages 1170-1179
Khan,NH, Tegnander,E, Dreier,JM, Eik-Nes,S, Torp,H, Kiss,G	Automatic Detection and Measurement of Fetal Biparietal Diameter and Femur Length — Feasibility on a Portable Ultrasound Device	Open Journal of Obstetrics and Gynecology(ISSN 2160-8806)
Khan,NH, Tegnander,E, Storve,S, Dreier,JM, Eik-Nes,S, Torp,H, Kiss,G	Automatic Measurement of Fetal Abdominal Biometric Parameters —Feasibility on a Portable Ultrasound Device	Open Journal of Obstetrics and Gynecology(ISSN 2160-8806)
Grue,JF, Storve,S, Dalen,H,, Salvesen,Ø, Mjølstad,OC, Samstad,S, Torp,H, Haugen,BO	Automatic measurements of mitral annular plane systolic excursion and velocities to detect left ventricular dysfunction	Ultrasound in Medicine and Biology(ISSN 0301-5629)
Smistad,E, Iversen,DH, Leidig,L, Bakeng,JBL, Johansen,KF, Lindseth,F	Automatic Segmentation and Probe Guidance for Real-Time Assistance of Ultrasound-Guided Femoral Nerve Blocks	Ultrasound in Medicine and Biology(ISSN 0301-5629)
Arneberg,HC Andersen,TA Lorås,L Torp,H Scholbach,TE, Moe,T	Blood flow calculated in the uterine arteries based on the PixelFlux technique	Ultrasound in Obstetrics and Gynecology (ISSN 0960-7692)
Wild,MS, Hjelmervik,KB, Hoff,L, Bring,M	Characterising piezoelectric material parameters through a 3D FEM and optimisation algorithm	IEEE Oceans 2017,Aberdeen
Avdal,J, Løvstakken,L, Torp,H, Ekroll,IK	Characterising piezoelectric material parameters through a 3D FEM and optimisation algorithm	IEEE Transactions on Ultrasonics, Ferroeletrics and Frequency Control(ISSN 0885-3010)
Selmeryd,J, Henriksen,E, Dalen,H, Hedberg,P	Derivation and evaluation of Age-Spesific Multivariante reference regions to aid in Identification of Abdominal Filling Patterns: The HUNT and VaMIS Studies	JACC Cardiovasc Imaging
Ryspayeva,A, Andersen,KK, Hoff,L, Imenes,K	Design of an ultrasound transducer for continuous fetal heartbeat monitoring	Proceedings-IEEE Ultrasonics Symposium(ISSN 1948-5719)
Åslund,K O A, Snipstad,S, Healey,A, Kvåle,S, Torp,S H, Sontum,P C, Davies,C, van Wamel,A	Efficient Enhancement of Blood–Brain Barrier Permeability Using Acoustic Cluster Therapy (ACT)	Theranostics (ISSN 1838-7640) issue 7,1 pages 23-30
Storve,S, Torp,H	Fast simulation of dynamic ultrasound images using the GPU	IEEE Transactions on Ultrasonics, Ferroeletrics and Frequency Control(ISSN 0885-3010)
Kjesbu,I, Laursen,CB, Graven,T, Holden,HM, Rømo,B, Andersen,GN, Mjølstad,OC, Lassen,A, Dalen,H	Feasibility and Diagnostic Accuracy of Point-of-Care Abdominal Sonography by Pocket-Sized Imaging Devices, Performed by Medical Residents	Journal of Ultrasound in medicine(ISSN 0278-4297)
Chen,W, Fang,J, Pang,G, Holm,S	Fractional biharmonic operator equation model for arbitrary frequency-dependent scattering attenuation in acoustic wave propagation	Journal of the Acoustical Society of America(ISSN 0001-4966)
Rindal,OMH, Aakhus,S, Holm,S, Austeng,A	Hypothesis of Improved Visualization of Microstructures in the Interventricular Septum with Ultrasound and Adaptive Beamforming	Ultrasound in Medicine and Biology(ISSN 0301-5629)
Fadnes,S, Wigen,MS, Nyrnes,SA, Løvstakken,L	In vivo intracardiac vector flow imaging using phased array transducers for pediatric cardiology	IEEE Transactions on Ultrasonics, Ferroeletrics and Frequency Control(ISSN 0885-3010)
Fatemi, A, Torp, H, Aakhus,S, Rodriguez-Molares, A	Increased clutter level in echocardiography due to specular reflection	Proceedings of SPIE, the International Society for Optical Engineering(ISSN 0277-786X)

AUTHOR/AUTHORS	TITLE	JOURNAL
Fatemi,A, Torp,H, Aakhus,S, Rodriguez-Molares,A	Increased clutter level in echocardiography due to specular reflection	Progress in biomedical optics and imaging(ISSN 1605-7422)
Våpenstad,C, Hofstad,E F, Bø,L E, Kuhry,E, Johnsen,G, Mårvik,R, Langø,T, Hernes,T N	Lack of transfer of skills after virtual reality simulator training with haptic feedback	Minimally invasive Therapy and Allied Technologies,issue 6,26
Lindseth,F, Hallan,MN, Tønnesen,MS, Smistad,E, Våpenstad,C	MIIP: A web-based platform for medical image interpretation training and evaluation focusing on ultrasound	Progress in biomedical optics and imaging(ISSN 1605-7422)
Prieur,F, Sapozhnikov,O	Modelling of the Acoustic Radiation Force in elastography	Journal of the Acoustical Society of America(ISSN 0001-4966)
Lebedeva,A, Westman,E, Borza,T, Beyer,MK, Engedal,K, Aarsland,D, Selbæk,G, Håberg,A	MRI-based classification models in prediction of mild cognitive impairment and dementia in late-life depression	Frontiers in Aging Neuroscience (ISSN 1663-4365)
Karlberg,A, Berntsen,E M, Johansen,H, Myrthue,M O, Skjulsvik,A J, Reinertsen,I, E,Morteza, Hong,Y D, Xiao,Y, Rivaz,H, Borghammer,P, Solheim,O, Eikenes,L	Multimodal 18F-fluciclovine PET/MRI and ultrasound-guided neurosurgery of an anaplastic oligodendroglioma	World Neurosurgery (ISSN 1878-8750) issue 108, pages 989.e1-989.e8
Lervik,LCN, Brekke,B, Aase,SA, Lønnebakken, MT, Stensvåg,D, Amundsen,BH, Torp,H, Støylen,A	Myocardial Strain Rate by Anatomic Doppler Spectrum: First Clinical Experience Using Retrospective Spectral Tissue Doppler from Ultra-High Frame Rate Imaging	Ultrasound in Medicine and Biology(ISSN 0301-5629)
Xiao,Y, Eikenes,L, Reinertsen,I, Rivaz,H	Nonlinear deformation of tractography in ultrasoundguided low-grade gliomas resection	International Journal of Computer Assisted Radiology and Surgery(ISSN 1861-6410)
Andersen, KK, Frijlink, ME, Hoff, L	Numerical optimization of ultrasound transducers by the linearity of the phase spectrum	Proceedings-IEEE Ultrasonics Symposium(ISSN 1948-5719)
Snipstad,S	Omtale av doktorgradsavhandling: Ultrasound-mediated delivery of nanomedicine across biological barriers - for improved treatment of cancer and diseases in the brain	Fra Fysikkens Verden (ISSN 0015-9247)
Gundersen,GH, Norekvål,TM, Graven,T, Haug,HH, Skjetne,K, Kleinau,JO, Gustad,L, Dalen,H	Patient-reported outcomes and associations with pleural effusion in outpatients with heart failure: an observational cohort study	BMJ Open(ISSN 2044-6055)
Hverven,S, Rindal,OMH, Hunter,AJ, Austeng,A	Point scatterer enhancement in ultrasound by wavelet coefficient shrinkage	Proceedings-IEEE Ultrasonics Symposium(ISSN 1948-5719)
Huynh,TT, Haugen,GU, Hoff,L	Reduction of transmitted 2nd harmonics using an adaptive method by simulated annealing	Proceedings-IEEE Ultrasonics Symposium(ISSN 1948-5719)
Holm,S, Holm,MB	Restrictions on wave equations for passive media	Journal of the Acoustical Society of America(ISSN 0001-4966)
Mawad,W, Løvstakken,L, Fadnes,S, Mertens,L, Nyrnes,SA	Right ventricular flow dynamics in dilated right ventricles. Energy loss estimation based on blood speckle tracking echocardiography in children	Journal of the American Society of Echocardiography(ISSN 0894-7317)
Arneberg,HC, Andersen,TA, Lorås,L, Torp,H, Scholbach,T, Eggebø,TM	Sammenheng mellom blodstrøm i urinarteriene og fostervekst	Gynekologen(ISSN 0805-2158)
Rodriguez-Molares,A, Torp,H, Lippe,B, Løvstakken,L	Sequential CPWC: from ultrafast to ultralight	Proceedings of SPIE, the international Society for Optical Engineering (ISSN- 0277-786X)
Viggen,E M, Johanse,T F, Merciu,I A	Simulation and inversion of ultrasonic pitch-catch through-tubing well logging with an array of receivers	NDT & E international (ISSN 0963-8695) issie 85, pages 72-75
Rodriguez-Molares, A, Fatemi,Ali, Løvstakken,L, Torp,H	Specular Beamforming	IEEE Transactions on Ultrasonics, Ferroeletrics and Frequency Control(ISSN 0885-3010)
Rindal,O M H, Rodriguez-Molares,A, Austeng,A	The dark region artifact in adaptive ultrasound beamforming	Proceedings-IEEE Ultrasonics Symposium(ISSN 1948-5719)
Hverven,S, Rindal,OMH, Rodriguez-Molares,A, Austeng,A	The influence of speckle statistics on contrast metrics in ultrasound imaging	Proceedings-IEEE Ultrasonics Symposium(ISSN 1948-5719)
Rodriguez-Molares,A, Rindal,OMH, Bernard,O, Nair,A, Bell,MAL, Liebgott,H, Austeng,A, Løvstakken,L	The UltraSound ToolBox	Proceedings - IEEE Ultrasonics Symposium (ISSN 1948-5719)
Snipstad,S, Berg,S, Mørch,Y A, Bjørkøy,A, Sulheim,E, Hansen,R, Grimstad,I, Van Wamel, A, Maaland,A F, Torp,S H, Davies, C	Ultrasound Improves the Delivery and Therapeutic Effect of Nanoparticle-Stabilized Microbubbles in Breast Cancer Xenografts	Ultrasound in Medicine and Biology(ISSN 0301-5629)issue 43,11 pages 2651-2669
Nguyen,TT, Espinoza, AW, Hyler,S, Remme,EW, D´Hooge,J, Hoff,L	Velocity resolution improvement for high temporal resolution ultrasonic transducer	Proceedings-IEEE Ultrasonics Symposium(ISSN 1948-5719)

Presentations

AUTHOR/AUTHORS	PRESENTATION	LOCATION
Salles,S, Løvstakken,L	3D myocardial mechanical wave measurements using high frame rate ultrasound imaging and Clutter filter wave imaging: towards a 3D myocardial elasticity mapping	IEEE Ultrasonics Symposium 2017
Fiorentini,S, Saxhaug,LM, Bjåstad,TG, Holte,E, Torp,H, Avdal,J	3D tracking Doppler for quantitative blood flow assessment of coronary arteries	2017 IEEE International Ultrasound Symposium (ius) in Washington D.C
Støylen,A	3D vs 2D echo strain: promise and reality	Eoroecho 2017, Lisboa
Wigen,MS, Løvstakken,L	4D cardiac vector flow imaging	The Artimino Conference on Medical Ultrasound Technology
van Wamel,A, Åslund,A, Sontum,PC, Healey,AJ, Snipstad,S, Kvåle,S, Bush,N, Bamber,Jeffrey, Davies,C	Acoustic cluster therapy boosts delivery of drugs in brains and tumors	Acoustic bubbles in therapy; Tours, France
van Wamel,A	Acoustic cluster therapy improves drug delivery	3rd International Nanomedicines Symposium on "Nanotheranostics: The power of nanomedicone, Islamabad
Golfetto C, Torp,H, Ekroll,I	Adaptive Clutter Filtering in Coronary Arteries	The Artimino Conference on medical Ultrasound Technology, 2017
Golfetto C, Torp,H, Ekroll,I	Adaptive Clutter Filtering in High Frame Rate 3D Coronary Imaging	IEEE Ultrasonics Symposium 2017
Garvik,H, Wulff,C, Ytterdal,T	An 11.0 bit ENOB, 9.8 fJ/conv.-step noise-shaping SAR ADC calibrated by least squares estimation	IEEE Custim Integrated Circuits Conference
Grue,J F, Storve,S, Dalen,H, Mjølstad,O C, Salvesen,Ø, Samstad,S, Torp,H, Haugen,B O	Automatic measurements of tissue doppler indices to detect left ventricular dysfunction	NCS Vårmøte 2017, Trondheim
Berg,S, Snipstad,S, Mørch YA, Hansen,R, Torp,SH, Davies,C	Bedre kreftbehandling med ultralyd, mikrobobler og nanopartikler	NFUD Symposium 2017, Tønsberg
Berg,S, Snipstad,S, Mørch YA, Hansen,R, Torp,SH, Davies,C	Bedre kreftbehandling med ultralyd, mikrobobler og nanopartikler	Regional Forskningskonferanse 2017, Trondheim
Arneberg,HC, Andersen,TA, Lorås,L, Torp,H, Scholbach,T, Eggebø,TM	Blood flow calculated in the uterine arteries based on the PixelFlux technique	NFUD Symposium,Tønsberg
Mertens,L, Nyrnes,SA, Løvstakken,L	Blood Speckle Imaging - Initial experience in children	ASE 2017, Baltimore
Nyrnes,SA, Fadnes,S, Mertens,L, Løvstakken,L	Blood Speckle Tracking - New insight to Pediatric Cardiology?	ASE 2017, Baltimore
Snipstad,S	Boblende nanomedisin mot kreft	Nettverssamling for realfagslærere i Sør-Trøndelag
Snipstad,S	Boblende nanomedisin mot kreft	Gjesteforelesning, Lillehammer Pensjonistuniversitet
Snipstad,S	Boblende nanomedisin mot kreft	Researchers Night 2017, Trondheim
Snipstad,S	Boblende nanomedisin mot kreft	Fagsnakk, Bibliotek for medisin og helse, NTNU/St.Olavs Hospital
Fadnes,S, Wigen,MS, Grønli,T, Nyrnes,SA, Løvstakken,L	Cardiac vector flow imaging	Myocardial Velocity & Deformation Imaging, Leuven
Larsen,I, Johansen,T F, Talberg,A S	Cement bond log interpretation in shale formations	SINTEF petroleum Conference 2017
Talberg, A S, Johansen,T F	Experimental evaluation of Lamb wave propagation in plates	Scandinavian Symposium on Physical Acoustics, Geilo
Chandrasekaran,SN, Holm,S, Prieur,F	Focused ultrasound setup for the study of acoustic radiation force induced biological effects in cells	Ultrasonics Symposium (IUS), 2017 IEEE International
Haugen,B O	Håndholdt ultralyd-legens universalverktøy	Norsk Forening for ultralyddiagnostikk Symposium 2017,Tønsberg
Lønmo,T I B, Weber,T C	Improving seep detection by swath sonars with adaptive beamforming	Acoustics ´17 Boston
Prieur,F, Rindal,O M, Holm,S, Austeng A	Influence of the Delay-Multiply-And-Sum beamformer on the ultrasound image amplitude	IEEE Ultrasonics conference 2017, Washington D.C.
Wigen,MS, Rodriguez-Molares,A, Bjåstad,TG, Eriksen,M, Stensæth,KH, Løvstakken,L	In-Vivo 3D Cardiac Vector Flow Imaging – a Comparison Between Ultrasound and Phase-Contrast MRI	2017 IEEE International Ultrasonics Symposium, Washington D.C

AUTHOR/AUTHORS	PRESENTATION	LOCATION
Mjølstad,O C	Klinisk Ultralyd	Oppdalsuka 2017
Grønli,T, Løvstakken,L	Modeling and data assimilation for improved blood velocity estimates	The Artimino Conference on Medical Ultrasound Technology
Prieur,F, Sapozhnikov,O	Modeling of the acoustic radiation force in elastography	174th Meeting Acoustical Soceity of America,New Orleans
Prieur,F, Sapozhnikov,O	Modeling of the acoustic radiation force in elastography	Scandinavian Symposium on Physical Acoustics, Geilo
Salles,S, Torp,H	Motion Tracking by Transverse Oscilliatins in 3D Cardiac Ultrasound Imaging	IEEE Ultrasonics Symposium 2017
Berg,S, Snipstad,S, Åslund,A, Mørch,Yrr A, Sulheim,E, Davies,C, Hansen,R	Nanoparticle-stabilized microbubbles and ultrasound for enhanced drug delivery	Acoustic bubbles in therapy: recent advances with medical microbubbles, clouds and harmonic antibubbles, ; Tours, France
Snipstad,S, Berg,S, Mørch,YA, Sulheim,E, Hansen,R, Davies,C	Nanoparticle-stabilized microbubbles for ultrasound-mediated drug delivery to tumors and the brain	The 22nd European Symposium on Ultrasound Contrast Imaging; Rotterdam, The Netherlands
Vik,SD, Torp,Hans, Støen,R, Nyrnes,SA	NeoDoppler- Ny ultralydteknologi for kontinuerlig måling av cerebral blodstrøm hos nyfødte	Pediaterdagene 2017,Ålesund
Holm,S	New insights from applying linear viscoelasticity to acoustics	40th Scandinavian Symposium on Physical Acoustics
Austeng,A, Rodriguez-Molares,A, Hansen,R E	Performance of coherence based adaptive sonar beamformers	Acoustics ´17 Boston
Lønmo,Tor I B, Austeng,A, Hansen,R E	Phase Detections with Low Complexity Adaptive Beamforming on Swath Sonars	2017 Underwater Acoustic Signal Processing Workshop
Ekroll,I, Avdal,J, Salles,S, Fadnes,S, Rodrigues-Molares,A, Løvstakken,L	Quantitative ultrasound imaging (at NTNU) - cardiovascular applications.	2017 Workshop on cardiovascular applications of medical ultrasound imaging
Mawad,W, Løvstakken,L, Fadnes,S, Mertens,L, Nyrnes,SA	Right ventricular flow dynamics in dilated right ventricles. Energy loss estimation based on blood speckle tracking echocardiography in children	American Society of Echocardiography,Baltimore
Rindal,O M H, Bell, M A. L	Short Lag Spatial Coherence beamforming in ultrasound imaging	40th Scandinavian Symposium on Pysical Acoustics, Geilo
Blachet,A, Lønmo,TIB, Austeng,A, Prieur,F, Hunter,A, Hansen,RE	Sonar data simulation with application to multibeam echo sounders	UACE2017-4th Underwater Acoustics Conference and Exhibition, Skiathos
Blachet,A	The effect of the source variations on 4D seismic surveys.	40th Scandinavian Symposium on Pysical Acoustics, Geilo
Holm,S	Thermodynamically viable fractional wave equations for power law attenuation in viscoelastic media	SIAM Conference on Computational Science and Engineering (CSE17)
Holm,S	Thermodynamically viable wave equations for power law attenuation in viscoelastic media	173rd Meeting of the Acoustical Society of America and the 8th Forum Acusticum
Løvstakken,L	Ultrafast ultrasound blood flow imaging - current and future perspectives	SPIE medical imaging
Dalen,H	Ultralyd- og hjerteforskning fra Trøndelag	Kardiologisk Høstmøte,Oslo
Snipstad,S	Ultralyd-mediert levering av nanomedisin – for bedre behandling av kreft og sykdommer i hjernen	Gjesteforelesning, Avdeling for komparativ medisin,Trondheim
van Wamel,A	Ultrasound and drug delivery	2nd International Workshop on Experimental Biology Nanotheranostics: From Bench to Bedside and Beyond", Islamabad
Fadnes,S, Tegnander,E, Nyrnes,SA, Løvstakken,L	Vector flow imaging of fetal circulation - an in vivo study	The Artimino Conference on Medical Ultrasound Technology
Fadnes,S, Tegnander,E, Nyrnes,SA, Løvstakken,L	Vector flow imaging of fetal circulation using diverging waves	IEEE International Ultrasonics Symposium
Måsøy,S-E	Verdens beste i ultralyd	Forskerfredag,Kunnskap for fremtiden, Byscenen,Trondheim
Golfetto,C	VScan	Starmus 2017, Trondheim

Book/Posters

AUTHOR/AUTHORS	BOOK CHAPTER	LOCATION
Talberg, A S, Johanse, T F, Larsen,I	Laboratory experiments on ultrasonic logging through casing for barrier integrity validation	ASME 2017 36th International Conference on Ocean, Offshore and Arctic Engineering - Volume 8: Polar and Arctic Sciences and Technology; Petroleum Teechnology, Trondheim,Norway, June 25-30,2017

AUTHOR/AUTHORS	POSTER	LOCATION
Smistad,E, Østvik,A, Haugen,BO, Løvstakken,L	2D Left Ventricle segmentation using deep learning	International Ultrasonics Symposium
Bush,N, Box,G, Healey,AJ, Sontum,P, Kvåle,S, van Wamel,A, Davies,C, Eccles,S, Bamber,J	Acoustic Cluster Therapy (ACT) enhances the therapeutic efficacy of Doxil™ for treatment of triple negative human breast cancer in mice	Acoustic bubbles in therapy recent advances with medical microbubbles,clouds and harmonic antibubbles,Tours
Mühlenpfordt,M, van Wamel,A, Åslund,A, Snipstad,S, Li,RG, Helgeland,EN, Salomonsen,ML, Healey,AJ, Sontum,PC, Kvåle,S, Davies,C	Acoustic Cluster Therapy (ACT) for improved treatment of cancer and brain diseases	The Nano@NTNU Symposium 2017 Highlighting nanoscience, nanotechnology and functional materials,Tromdheim
van Wamel,A, Åslund,A, Sontum,PC, Healey,AJ, Snipstad,S, Kvåle,S, Bush,N, Bamber,Jeffrey, Davies,C	Acoustic cluster therapy boosts delivery of drugs in brains and tumors	Acoustic bubbles in therapy recent advances with medical microbubbles,clouds and harmonic antibubbles,Tours
Ekroll, IK, Avdal,J	Adaptive clutter filtering based on tissue vector velocities	IEEE Ultrasonics Symposium 2017
Golfetto C, Torp,H, Ekroll,I	Adaptive Clutter Filtering in High Frame Rate 3D Coronary Imaging	2017 IEEE International Ultrasonics Symposium
Grue,JF, Storve,S, Mjølstad,OC, Eriksen-Volnes,T, Samstad,S, Torp,H, Dalen,H, Haugen,BO	Automatic measurements of left ventricular longitudinal function for inexperienced users	EuroEcho-Imaging,Lisboa
Grue,JF, Storve, S, Dalen,H, Mjølstad,OC, Salvesen,Ø, Samstad,S, Torp, H, Haugen,BO	Automatic measurements of tissue doppler indices to detect left ventricular dysfunction	ESC Congress 2017
Andersen,TA, Arneberg,HC, Scholbach,T, Torp,H, Lorås,L, Eggebø,TM,	Blood flow calculated in the uterine arteries based on the PixelFlux technique	27th World Congress on Ultrasound in Obstetrics and Gynecology, Wien
Garvik,H, Wulff,C, Ytterdal,T	Calibration of CDAC Weights in Noise-Shaping SAR ADCs	IEEE ISSCC 2017
Salles,S, Torp,H, Løvstakken,L	Clutter filter wave imaging (CFWI): a new way to visualize and detect mechanical waves propagation.	IEEE Ultrasonics Symposium 2017
Hjorth-Hansen, A, Graven,T, Gundersen, GH, Skjetne,K, Stølen, Kleinau,JO, Torp,H, Dalen,H	Feasibility and reliability of echocardiographic recording by nurses supported by interpretation via telemedicine	ESC EuroEcho-Imaging 2017,Barcelona
Saxhaug,LM, Graven,T, Olsen,Ø, Kleinau,JO, Skjetne,K, Dalen,H	Feasibility, accuracy and clinical influence of pocket-sized imaging by experts of the carotid arteries in patients with stroke and transitory ischemic attack	ESC Congress 2017, Barcelona
Snipstad,S, Berg,S, Mørch,YA, Bjørkøy,A, Sulheim,E, Hansen,R, Grimstad,I, Van Wamel,A, Maaland,AF, Torp,SH, Davies,C	Nanoparticle-stabilized microbubbles for ultrasound-mediated drug delivery and treatment of human breast adenocarcinoma in mice	The 22 European Symposium on Ultrasound Contrast Imaging,Rotterdam
Snipstad,S, Berg,S, Mørch,YA, Bjørkøy,A, Sulheim,E, Hansen,R, Grimstad,I, Van Wamel,A, Maaland,AF, Torp,SH, Davies,C	Nanoparticle-stabilized microbubbles for ultrasound-mediated drug delivery and treatment of human breast adenocarcinoma in mice	The Nano@NTNU Symposium 2017 Highlighting nanoscience, nanotechnology and functional materials,Tromdheim
Grønli,T, Swilens,A, Segers,P, Løvstakken,L	Real-time Assimilation and Regularization of Ultrasound Blood Velocity Measurements Using Smoothed Particle Hydrodynamics	2017 IEEE International Ultrasonics Symposium
Østvik,A, Smistad,E, Aase,SA, Haugen,BO, Løvstakken,L	Real-Time Classification of Standard Cardiac Views in Echocardiography using Neural Networks	IEEE International Ultrasonics Symposium
Åslund,A, Snipstad,S, Healey,AJ, Kvåle,S, Torp,SH, Sontum,PC, Davies,C, van Wamel,A	Safe and temporal opening of the blood brain barrier using Acoustic Cluster Therapy	The 22 European Symposium on Ultrasound Contrast Imaging,Rotterdam
Arneberg,HC, Andersen,TA, Lorås,L, Torp,H, Scholbach,T, Eggebø,TM	Sammenheng mellom blodstrøm i urinarteriene og fostervekst	Norks Gynekologisk Forening Årsmøte,Stavanger
Schmid,R, Snipstad,S, Mørch,YA	Ultrasound-enhanced drug delivery using nanoparticle-stabilized microbubbles	EuroNanoForum 2017, Valetta,Malta
Baghirov,H, Snipstad,S, Sulheim,E, Berg,S, Afadzi,M, Hansen,R, Thorsen,F, Mørch,YA, Davies,C, Åslund,A	Ultrasound-mediated delivery and distribution of polymeric nanoparticles in the normal brain parenchyma and melanoma metastases	The 22 European Symposium on Ultrasound Contrast Imaging,Rotterdam

Degrees 2017

MASTER/MEDICAL RESEARCH STUDENTS

PHD CANDIDATES

MEDICAL RESEARCH PROJECT

MASTER/MEDICAL RESEARCH STUDENTS	
Dual frequency ultrasound transducer array	Chauddary,BK (Supervisors: Hoff,L, Andersen,KK, Mahn,T, Chen,R)
Fast Non-Rigid Registration Using Polynomial Expansion with Diffeomorphic Constraints Applied to Cardiac Ultrasound Volumes	Ranestad,MH (Supervisors: Balasingham,I, Kiss,G)
Miniature Highly Sensitive Ultrasound Doppler Transducers	Bolstad,PK (Supervisor: Hoff,L)
Modeling and data assimilation for improved ultrasound measurement of blood velocity fields	Grønli,T (Supervisors: Davies,C, Løvstakken,L)
Vascular characterization of tumors growing in the chorioallantoic membrane	Bye,I (Supervisor: Davies,C)
Automatic measurements of left ventricular long-axis indicies	Grue,JF (Supervisor: Haugen,BO)
Cellular uptake of Nanoparticles by Sonoporation	Hanstad,S (Supervisor: Davies,C)
Air-coupled Ultrasound for Plate Thickness Measurements	Waag,G (Supervisors: Hoff,L, Hjelmervik,K, Tangen,TA, Norli,P)
Motion Tracking by Transverse Oscillations in 3D Cardiac Ultrasound Imaging	Bech,S (Supervisors: Torp,H, Salles,S)
Robust Landmark Detection of the Left Ventricle Based on 2D Ultrasound Image Data	Selle,A (Supervisor: Kiss,G, Torp,H)
Ultra-low power Design of DSRC modulator/demodulator in 28nm FD_SOI	Lid,G (Supervisors: Hagen,A, Blekken,B, Ytterdal,T, Aunet,S)
PHD CANDIDATES	
Quantitative Doppler analysis using color flow imaging and adaptive signal processing	Karabiyik,Y (Supervisors: Løvstakken,L, Ekroll,I, Torp,H, Eik-Nes, S)
Ultra-high frame rate tissue Doppler imaging, technical feasibility and first clinical experiences	Lars C.Lervik,LC (Supervisor: Støylen,A)
Transthoratic Doppler echocardiography for the detection of coronary artery senoses and microcascular coronary dysfunction	Holte,E (Supervisor: Rune Wiseth)
Ultrasound-mediated delivery of nanomedicine across biological barriers- for improved treatment of cancer and diseases in the brain	Snipstad,S (Supervisor: Davies,C)
MEDICAL RESEARCH PROJECT	
Blood flow calculated in the uterine arteries based on the PixelFlux technique	Andersen,TA, Arneberg,HC (Supervisors: Eggebø,TM, Torp,H, Scholbach,T, Lorås,L)

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Location
NTNU MTFS and ISB, located at Øya, St. Olavs hospital in Trondheim

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