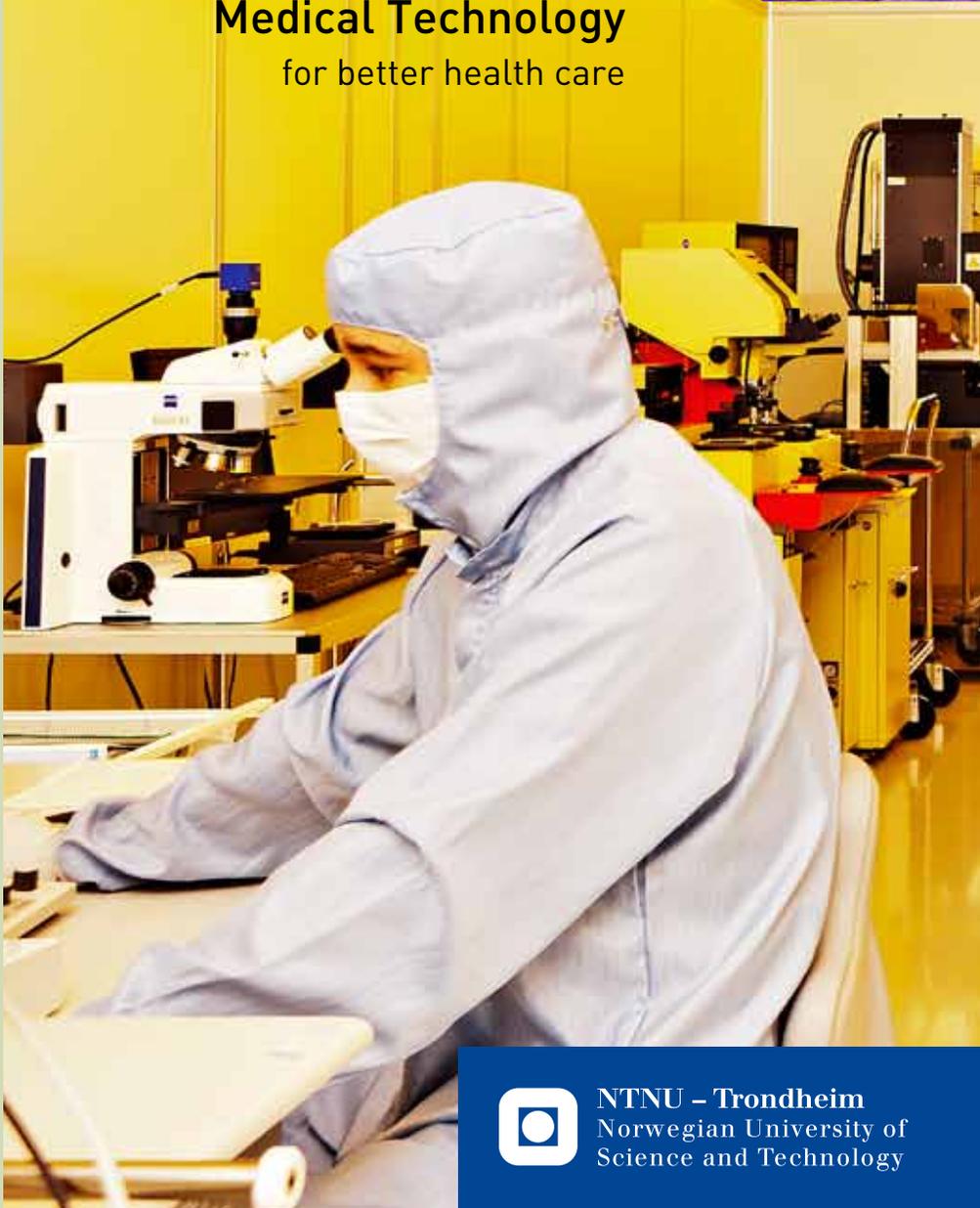


Medical Technology

Challenging the limits of
Medical Technology
for better health care

SEM micrograph of CaCO_3 crystals
Photo: Magnus Ø. Oldenby, NTNU





Strategic Area of Medical Technology 2011

The Strategic Area of Medical Technology was founded by the Board of NTNU in 1999. The aim is to develop unique interdisciplinary collaboration between research groups in medical technology, to contribute to excellent research and innovation in health care, and to improve patient outcomes.

High-quality research in medical technology is performed in the various research groups, which was reflected in the high score obtained for many of the applications to the Research Council of Norway for Centre of Excellence status. To strengthen the collaboration between disciplines in medicine and technology, new interdisciplinary projects between researchers at NTNU, SINTEF and St. Olavs Hospital were initiated.

To improve the master's degree programmes in medical technology and the opportunities to work on the master's thesis at research groups at various faculties, we have established a web page (www.ntnu.edu/medtech/masters) with information about possible research projects for master students. We hope that this will also inspire new interdisciplinary research projects.

Catharina de Lange Davies

Director of NTNU's Strategic Area of Medical Technology

Internationalization

To improve international collaboration, funding of half a million Norwegian kroner was provided for 11 research visits for PhD students, postdocs, and researchers. Two examples reflect the variety of the projects supported:

- A five-month stay for PhD student Sofia Hussain at Stanford University, which resulted in redesign and biomechanical improvement of the prosthetic leg produced by the International Red Cross for children in Cambodia.
- Sabbatical leave for Professor Marit Anthonsen at the University of California, San Diego, to study host restriction factors related to human immunodeficiency virus (HIV) infections. The project aims to identify novel regulators of innate immunity to HIV, aiding development of successful therapeutic and vaccine strategies for HIV infections.



Dissemination

The Operating Room of the Future (FOR) produced a video about its activity:

<http://youtu.be/wWZJQyEYriU>



The Human Motor Control network participated in NRK's television programme NEWTON, demonstrating methods for gait analysis:

<http://www.nrk.no/nett-tv/klipp/802479/> (In Norwegian)

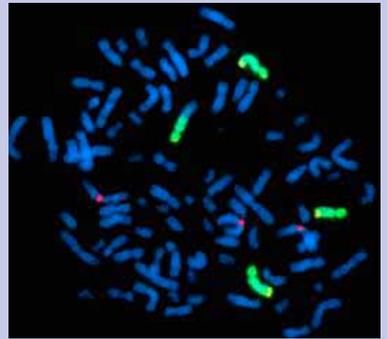
The Biomedical Optics network demonstrated use of lasers in investigation of bruises in NRK's television programme Schrödingers katt:

<http://www.nrk.no/nett-tv/indeks/283968/> (In Norwegian)



Medical Biotechnology

– aims to develop technology to diagnose, treat or prevent human diseases by applying basic science, medical expertise and advanced methods to living cells or part of cells. One highlight is that researchers working on multiple myeloma (cancer of plasma cells in the blood) recently have discovered an important mechanism for successful killing of myeloma cancer cells. They have shown that bone morphogenic protein (BMP)-induced programmed cell death in myeloma cells is dependent on downregulation of the protein MYC. This finding suggests that the MYC protein might be an important drug target in multiple myeloma patients (Holien et al. *Leukemia*, doi: 10.1038/leu.2011.263, Epub 2011). The figure shows myeloma cells with MYC-gene duplications in red.



Medical Imaging and Image-Guided Therapy

– focuses on the use of ultrasound and MR imaging for diagnosis, image-guided treatment and monitoring of intervention in various diseases. In 2011, the medical imaging environment at NTNU consolidated its position among the world's most innovative research groups in this field.

Medical imaging has become a key modality in medical research, and the groups at NTNU are attractive partners in national and international collaboration. The Medical Imaging Lab (MI Lab), which is a centre for research-driven innovation, is now involved in two K.G. Jebsen centres (Breast Cancer Research and Exercise in Medicine), and in the NORBRAIN neuroscience initiative, which is on the national roadmap for research infrastructure and this year received NOK 80 million from the Norwegian Research Council. The Operating Room of the Future is also on this national roadmap with the NorMIT initiative, together with the Intervention Centre at Oslo University Hospital.

In 2011, the Ministry of Health and Care Services approved parts of our network as a new national centre of competence for ultrasound and image-guided intervention. The national centre of competence in Functional MR Imaging has continued its activities. Both centres are hosted by St. Olavs Hospital.

BIOINFORMATICS – is part of the national FUGE Bioinformatics technology platform, providing expertise and research to Norwegian research groups through the national programme for functional genomics. Through funding from the Research Council of Norway, this national platform will be continued as a Norwegian node in the European ELIXIR bioscience data infrastructure (www.elixir-europe.org). The bioinformatics network held a national hands-on course in data analysis for next generation sequencing. The participants analysed sequence data from microRNA expression and transcription factor ChIP-seq experiments.



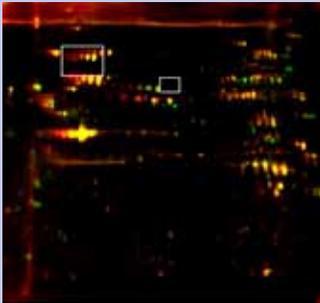
Biomechanics

– focuses on mathematical modelling and biomechanical analysis of tissues and organs. A high-priority activity is modelling of the mitral valve. To improve mathematical modelling, it is important to know the microstructural organization of the different materials constituting the valve. An important issue is the presence, phenotype, and extent of muscle fibres. A study was conducted to determine whether there is smooth muscle in the valve (Nordrum and Skallerud, "Smooth muscle in the human mitral valve: extent and implications for dynamic modelling", APMIS, DOI: 10.1111/j.1600-0463.2011.02860.x). A significant amount of smooth muscle was found in the anterior leaflet (figures). Muscle activation helps in maintaining an optimal shape for haemodynamics during systole.



Biomedical optics

– comprises groups spanning a wide array of research fields from hardware development, through biologically driven microscopy and spectroscopy, to clinical applications. An example of the cross-disciplinary research is described in the publication by Baglo et al. (Photochem. Photobiol. Sci. 2011;10:1137-45). Here, cancer cells are treated with photodynamic therapy (PDT) and changes in protein expression (upregulation red/downregulation green, figure) are recorded using advanced proteomic techniques.

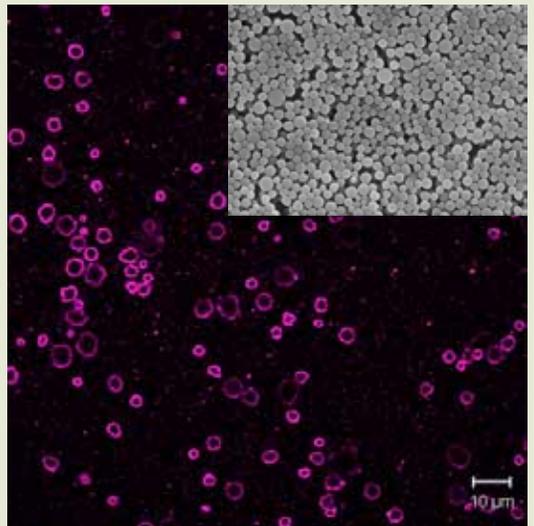


HEALTH INFORMATICS

The Norwegian Centre for Electronic Health Records Research (NSEP) is a multidisciplinary research centre and NTNU's programme for health informatics. NSEP continuously works on information systems for workflow support, and on technologies for automated collection of data about delivered healthcare. In 2011, welfare technology emerged as a major trend in health informatics. Welfare technology relates to delivering health information system services in the patient's home, aiding the patient, and with the patient as a primary user.

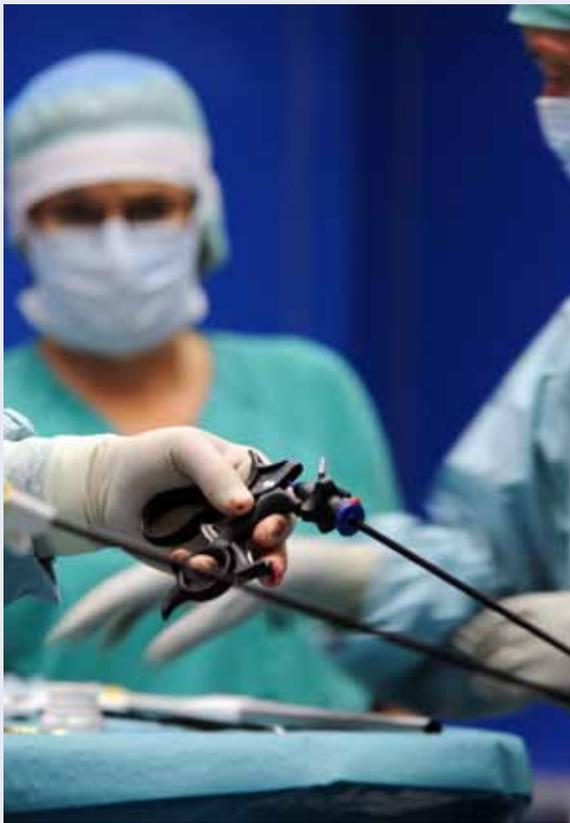
Bionanotechnology

– is a growing field at NTNU. Current research activities include inducing partly disordered protein structure through incorporation of nanogold particles, multitool labels for amyloid strain identification for characterization at different length scales, and use of nanoparticles for drug delivery including ultrasound-stimulated induced localized release. This research is complemented by activities such as cleanroom-based nanofabrication, nanowires used for cell impalement, and characterization exploring the focused ion beam and determination of nanoscale interactions. One highlight in 2011 was the project activity on mineralization of polysaccharide hydrogels, from which an artificially coloured electron micrograph (front page) captured in the NTNU NanoLab won the national competition for a graphical illustration to be used as the symbol for the new large-scale research programme Nano2021 by the Norwegian Research Council. The image below shows nanoparticles visualized by electron microscopy (inserted) and fluorescently labelled nanoparticles stabilizing gas bubbles made by SINTEF Material and Chemistry.



HUMAN MOTOR CONTROL

– ongoing research projects range from method development and mechanism studies to clinical trials. The annual autumn seminar was on “Modern Technology and Human Motor Control”, where two renowned international keynote speakers as well as researchers and PhD students from Human Motor Control presented their work to researchers, students, and clinicians. The network is part of a European consortium that received 3-year funding from the EU ICT programme under 7FP with the project “FALL Repository for the design of Smart and sElf-adaptive Environments prolonging INdependent livinG” (FARSEEING).



Operating Room of the Future

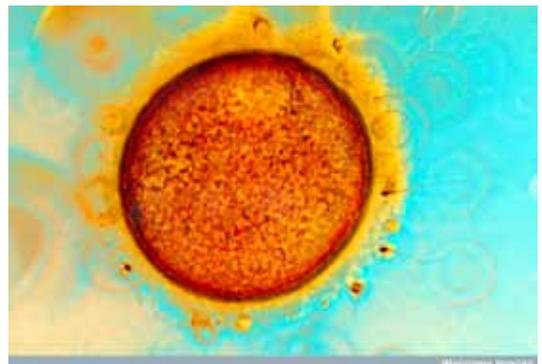
In 2011, the importance of the Operating Room of the Future (FOR) as a research platform has been further consolidated. The activity in our six operating rooms is concentrated on minimally invasive image guided therapy. This scientific work is now expanding into new areas. Larger multi-centre studies on the clinical application of new technology are in the planning stage, and 14 PhD candidates are now using FOR as the basis for their scientific work.

FOR is responsible for the training programme and certification in electromedical equipment for all operating clinics at St. Olavs Hospital, as well as for organizing experimental surgery.

During the last year, FOR has strengthened its focus on the use of new digital media technology, decision support, and effective workflow. Projects with the petroleum industry as well as with local and national authorities and other research facilities are carried out in this context.

Societal aspects

Several of the research projects in the societal aspects network concern the impact of cultural values on science and technology, and vice versa. Other research projects concern the interaction between politics and ethics in the field of medical technology, discuss the ethical consequences of medical technology, or explore the field of health communication. Research projects of the societal aspects network in 2011 included: *Reproductive relations: Production of gendered meanings in the field of reproduction, In genes we trust? Biobanks, commercialization and everyday life, Picturing the Brain: Perspectives on Neuroimaging, and Crossover Research: Well-constructed systems biology.* The NTNU project *Inside out* studies how new imaging technologies redefine the body (figure).



Education:

Master's and PhD education offered in medical technology

In 2011, the Strategic Area of Medical Technology organized a web page with an overview of available master's projects in medical technology in order to facilitate interdisciplinary collaboration and research projects. www.ntnu.edu/medtech/masters

NTNU also offers an international master's degree in medical technology. www.ntnu.edu/studies/msmedtek

There is a PhD programme in medical technology: www.ntnu.no/studier/phmedt. The Strategic Area is working together with the Norwegian Research School in Medical Imaging (MedIm) to organize new courses and seminars for PhD students on a national basis: www.ntnu.edu/medtech/studies. MedIm's main goal is to improve future research on medical imaging through the strengthening of PhD training in the field: www.ntnu.edu/medicalimaging/

Seminars

Health Informatics – In August, NTNU hosted the fifth international symposium on Human Factors Engineering in Health Informatics, where one session was dedicated to patient-centred information systems.

HelsIT 2011 – the annual one-week conference "HelseInformatikkuka i Trondheim" (Health Informatics Week in Trondheim – HelsIT) was arranged in September by KITH (www.kith.no) in collaboration with the Norwegian Research Centre for Electronic Patient Records (NSEP, www.ntnu.edu/nsep) and the programme for health informatics at NTNU.

"Velferdsteknologikonferansen 2011" – NTNU participated in the welfare technology conference in Trondheim, both as organizers and as presenters. More than 300 people attended the conference.

"Kroppstokt 2011" – a photo exhibition where pictures from inside the body using various biotechnological and medical imaging techniques were presented.



PhD candidate seminar on Medical Technology focusing on research dissemination and innovation was organized by NTNU's Strategic area of medical technology. Approximately fifty PhD and master's student's as well as post-docs attended the seminar.

The Bioinformatics annual network meeting – this year titled "Surfing the genome tsunami?" – featured talks on topics including oil reservoir metagenomics, diatom and coral genome sequencing, sequencing technologies, data analysis, and ethical challenges of human genome sequencing. The talks illustrated some of the breadth in how high-throughput sequencing can be applied to biological problems, but also highlighted challenges in data handling and analysis.

The 6th annual NanoLab meeting was organized in close proximity to research groups in medicine to stimulate the participation of these research groups. A large part of the presentation focused on research activity or clean-room opportunities related to bionanotechnology.

MedIm – the Norwegian Research School in Medical Imaging has organized two National PhD Conferences in Medical Imaging during 2011. The first took place in Bergen in January, and was a joint event with the annual MedViz day. In November, a similar event was held in Oslo, this time in cooperation with the Intervention Centre (Oslo University Hospital and the University of Oslo). The events attracted 145 and 130 participants respectively.

MI Lab Day – In November 2011, the MI Lab organized an all-day seminar, with the keynote lecture given by Professor Kevin M. Brindle, University of Cambridge. The seminar provided an excellent opportunity for updates and networking within the ultrasound and MR research groups.



Kjell Kristoffersen, Bjørn Angelsen, Kjell Arne Ingebrigtsen



Pro-Rector Kari Melby, Marie H. Aune og Jørgen Stenvik

Awards

The Norwegian Academy of Technological Sciences (NTVA) Prize of Honour 2011 was awarded to Kjell Kristoffersen, Bjørn Angelsen and Kjell Arne Ingebrigtsen for their outstanding contribution to the development and commercialization of ultrasound for medical imaging.

The Research Prize in Medical Technology 2011 was awarded to Husebye, Hjelmseth Aune and Stenvik for identification and intracellular localization of molecules involved in control and regulation of toll-like receptor 4. This receptor is involved in the recognition of gram-negative bacteria and is crucial for the first line defence against bacterial infections. Husebye H et al. The Rab11a GTPase Controls Toll-like Receptor 4-Induced Activation of Interferon Regulatory Factor-3 on Phagosomes. *Immunity* 2010;33:583-96. The award was funded by Vangslund AS.

Innovation

ULTRASOUND TECHNOLOGY

Scientific evidence for clinical benefits of the pocket-sized ultrasound scanner Vscan:

Three scientific papers published and/or in press in 2011 demonstrate the clinical benefits of using Vscan on new patients admitted to hospital.

<http://www.ntnu.edu/milab>

Three new patent applications within ultrasound technology were submitted:

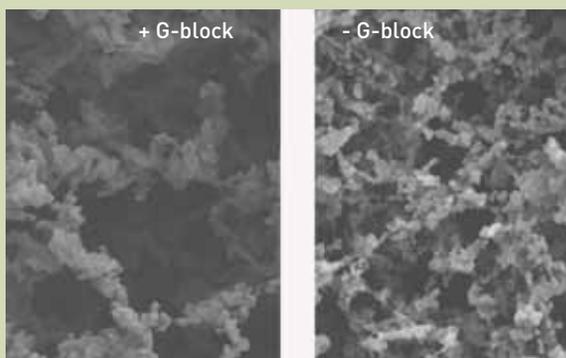
Thin Shell – speeds up cardiac ultrasound to 1000 image updates per second

Colour Pulsed Wave Doppler and *Velocity Matched Spectrum* – improved ultrasound-based grading of heart valve leakage

MEDICAL BIOTECHNOLOGY

G-block technology

– is based on specific alginate oligomers (G-blocks) and exploits their ability to modify the structural, functional, and barrier properties of mucus for use in medical applications such as lung diseases (for example cystic fibrosis) and mucosal drug delivery.



Opening of mucin matrix structures by G-blocks

The G-blocks project entered into a licensing agreement at the end of 2011.

NEW TECHNOLOGY FOR PAIN PROFILE REGISTRATION

– was developed in collaboration between St. Olavs Hospital, NTNU, and NTNU Technology Transfer AS. People with cancer report their pain profile themselves using a Combat tablet PC, which creates a better basis for doctors to provide precisely targeted pain relief.



This innovation was also demonstrated in a news broadcast from TV 2, Norway's largest commercial television station:



<http://tinyurl.com/cuue9vc>
(In Norwegian)

The Strategic Area of Medical Technology at NTNU includes:

Medical Biotechnology, Professor Berit Johansen, (berit.johansen@bio.ntnu.no)
Medical Imaging and Image-Guided Therapy, Post-doc Siver Moestue (siver.a.moestue@ntnu.no)
Bioinformatics, Professor Finn Drablos, (finn.drablos@ntnu.no)
Biomechanics, Professor Bjørn Skallerud, (bjorn.skallerud@ntnu.no)
Biomedical Optics, Associate Professor Magnus Lilledahl, (magnus.lilledahl@ntnu.no)
Bionanotechnology, Professor Bjørn Torger Stokke, (bjorn.stokke@ntnu.no)
Health Informatics, Associate Professor Arild Faxvaag, (arild.faxvaag@ntnu.no)
Human Motor Control, Associate Professor Jorunn Lægdheim Helbostad, (jorunn.helbostad@ntnu.no)
National Centre of Advanced Laparoscopic Surgery, Associate Professor Ronald Mårvik (ronald.marvik@stolav.no)
National Centre of Clinical MR Spectroscopy, Professor Ingrid Gribbestad (ingrid.s.gribbestad@ntnu.no)
National Centre of Expertise in 3D Ultrasound, Professor Toril N. Hernes (toril.n.hernes@sintef.no)
Societal Aspects, Researcher Lars Ursin (lars.ursin@ntnu.no)
The Operating Room of the Future, Professor Hans Olav Myhre (hans.myhre@ntnu.no)

Research Management Team:

Host Dean, Professor Stig Slørdahl (stig.slordahl@ntnu.no),
Director, Professor Catharina de Lange Davies (catharina.davies@ntnu.no), Faculty of Natural Sciences and Technology
Co-Director, Professor Olav Haraldseth (olav.haraldseth@ntnu.no), Faculty of Medicine
Professor Kjell Bratbergsengen (kjellb@idi.ntnu.no), Faculty of Information Technology, Mathematics, and Electrical Engineering
Professor Toril N. Hernes (toril.n.hernes@sintef.no), SINTEF Health Research
Associate Professor Bjørn Myskja (bjorn.myskja@hf.ntnu.no), Faculty of Humanities
Professor Siv Mørkved (siv.morkved@ntnu.no), Head of Research, St. Olavs Hospital, Trondheim University Hospital
Professor Bjørn Skallerud (bjorn.skallerud@ntnu.no), Faculty of Engineering, Science and Technology

Coordinator Medical Biotechnology, Tonje Strømme Steigedal, PhD (tonje.strommen@ntnu.no)

Coordinator Medical Imaging, Siver Moestue, PhD (siver.a.moestue@ntnu.no)

Adviser & Coordinator, Karin Tømmerås, PhD (karin.tommeras@ntnu.no)

PHDS IN MEDICAL TECHNOLOGY 2011

Ole Andreas Alsos, Ph.D. Mobile point-of-care systems in hospitals: Designing for the doctor-patient dialogue.

Silje Alvestad, Ph.D. Astrocyte-neuron interactions in experimental mesial temporal lobe epilepsy – A study of underlying mechanisms and possible biomarkers of epileptogenesis.

Eiliv Brenner, Ph.D. Glutamate related metabolism in animal models of schizophrenia.

Linga Reddy Cenkeramaddi, Ph.D. Nanoscale analog front-end amplifiers for medical ultrasound imaging.

Yunhan Chu, Ph.D. Development of methods for de novo design of functional drugs and catalyst compounds.

Benjamin Garzón Jiménez de Cisneros, Ph.D. Clinical applications of multimodal magnetic resonance imaging.

Tor Erik Evjemo, Ph.D. The details of reliability: Complexity, interaction and technologies in the operating theatre.

Guro Fanneløb Giskeødegård, Ph.D. Identification and characterization of prognostic factors in breast cancer using MR metabolomics.

Christian Ragnar Gutvik, Ph.D. A physiological approach to a new decompression algorithm using nonlinear model predictive control.

Mariann Gjervik Heldahl, Ph.D. Evaluation of neoadjuvant chemotherapy in locally advanced breast cancer based on MR methodology.

Sofia Hussain, Ph.D. Designing for and with marginalized people in developing countries: efforts to undertake a participatory design project with children using prosthetic legs in Cambodia.

Halvard Høiland-Kaupang, Ph.D. Models and methods for investigation of reverberations in nonlinear imaging techniques.

Anne Kathrine Larssen, Ph.D. Bygg og eiendoms betydning for effektiv sykehusdrift. [In Norwegian] [The significance of buildings and property for effective operation of hospitals.]

Magnus Østgård Olderøy, Ph.D. Bioinspired mineralization of alginate hydrogels.

Henrik Sahlin Pettersen, Ph.D. Cytotoxicity and repair of uracil and 5-fluorouracil in DNA.

Takaya Saito, Ph.D. Computational analysis of regulatory mechanism and interactions of microRNAs.

Ioanna Sandvig, Ph.D. The role of olfactory ensheathing cells, MRI, and biomaterials in transplant-mediated CNS repair.

Sten Roar Snare, Ph.D. Quantitative cardiac analysis algorithms for pocket-sized ultrasound devices.

Ole Vegard Solberg, Ph.D. 3D ultrasound and navigation – Applications in laparoscopic surgery.

Ole Solheim, Ph.D. Ultrasound guided surgery in patients with intracranial tumours.

Eva Veslemøy Tyldum, Ph.D. Cardiovascular function in preeclampsia – With reference to endothelial function, left ventricular function and pre-pregnancy physical activity.

Annual PhD degrees in medical technology at NTNU

