MI Lab Annual Report 2012

Summary

Recruitment of clever and motivated researchers is MI Lab strongest asset, and in 2012 MI Lab financed a multi-disciplinary group of 23 PhD students and post-doctoral fellows; nine medical doctors, nine from physics and mathematics, and three from engineering and electronics. Inside this research environment there is a continuous generation of new ideas that have potential for fulfilling the MI Lab vision of innovation that may facilitate cost efficient health care and improved patient outcome. It is nice to see the competence and enthusiasm of this group of PhD and post doc students. They obtain experience in medical R&D in the crossroad between university, industry and hospital, and will be a future pool for recruitment of high-quality personnel for Norwegian industrial R&D, health care and academia.

The Centres for Research-based Innovation represent a new scheme in which several industrial partners, university and hospital work together in an open research environment. Our experience so far is that we in MI Lab are able to build an arena for open innovation and long-term industrial research with high scientific quality and commitment from the partners. In 2012 this resulted in publication of 43 refereed articles in international journals and one important invention that is in the patenting process.

MI Lab wants to be an integrated part of the total ultrasound and MR research environment in Trondheim, and the experience so far is that the interaction is excellent between the MI Lab hired PhD and post doc students and the rest of the medical imaging community in Trondheim. We like to call this the “MI Lab family”.

MI Lab has a broad range of research activities in ultrasound, MR and image-guided surgery. In 2012 we have (see Scientific activities and results subchapter below) chosen to high-light scientific results from the areas of:

- new ultrasound technology for increased imaging frame rate
- how the pocket-sized hand-held ultrasound scanner Vscan can change medical practice at the hospital emergency admittance and in the GP office
- how minimally invasive brain surgery combining MR imagingprior to operation and ultrasound imaging during operation can improve patient outcome
- functional MR imaging for early diagnosis of dementia
- basic research on application of new MR methods tailor-made to monitor stem cell treatment in the brain

Vision

To facilitate cost efficient health care and improved patient outcome through innovation in medical imaging, and to exploit the innovations to create industrial enterprise in Norway.

Research Plan

The MI Lab research plan is based on the understanding that the most important challenge for the future healthcare is how to exploit the great achievements in medical research in order to improve patient treatment and outcome while containing costs. Medical imaging is central to meeting this challenge, and new technology for improved cost efficacy should be a main focus for imaging research and industrial innovation. Innovation in medical imaging can contribute to improved cost-efficiency on several levels, and MI Lab has chosen to focus on three important areas:

- high quality medical imaging products and applications for non-expert users at the initial point of care
- less complications and more rapid patient rehabilitation with image-guided minimally invasive surgery
- more rapid and more precise choice of efficient treatment through decision-making based on advanced medical imaging.

As advised by the Scientific Advisory Board, MI Lab has chosen to have one “area of focus where it can be the synergistic agent for the creation of new program(s)”. That is basic ultrasound technology and integrating research on hardware, software and transducer arrays. In the coming years breakthroughs in ultrasound technology will cause major improvements of ultrasound image quality, and MI Lab wants to be one of the world leaders in this research area. Research on this next generation ultrasound technology will have long-term benefit for all the MI Lab ultrasound industrial partners as well as the university and hospital research groups involved in research on clinical applications of ultrasound. The MI Lab research on hardware, software and transducer arrays will be tailored to the specific challenges and goals for each industrial partner and research group. This activity is now organized in a new subproject 1.1 called “Ultrasound image improvement” which includes research on transducer arrays, ultrasound probe electronics, software beamforming, parallel imaging & compressed sensing, minimum diffractive wave imaging, model powered acquisition and new technology for flow imaging/quantification.

Inside this framework, MI Lab has the following project structure:
Research Task 1: Ultrasound technology

- Ultrasound image improvement

Research Task 1: Advanced imaging applications for non-expert user

- Cardiac Ultrasound
- Pocket-sized Ultrasound

Research Task 3: Image guided minimally invasive surgery

- Neurosurgery
- Cardiac & Vascular surgery

Research Task 4: Imaging based information to support medical decision making

- Advanced MR methods in clinical diagnosis
- MR in regenerative medicine & nanoparticles for imaging

Strategy

The strategy is to establish a creative melting pot for medical imaging research through:

- bringing together on a daily basis researchers from university, hospital and industry
- establishing a large multi-disciplinary research environment including medicine, ICT, physics, mathematics, cybernetics, electronics, physiology, molecular biology, neuroscience, psychology etc.
- in the same projects combine curiosity driven research and relevance for industry and health care

And that successful innovation for next generation technology will emanate from this integration between research on new technology and research on new clinical practice.

MI Lab has focused on the following success criteria (taken from the RCN “official” list of success criteria for Centres for Research-based Innovation):

- The centre engages in long-term industrial research of a high international calibre, and demonstrates its high quality through its production of doctorates, scientific publications, papers for presentation at recognised international conferences and other forms of scientific merit.
- Researchers from the host institution and partners participate actively in the centre's research. The centre has achieved mutual mobility of personnel between the centre and the user partners.
- The centre attends to researcher training effectively, and helps to train highly skilled personnel in the centre's special fields.
- The centre's research has engendered or is expected to engender possibilities for innovation and enhanced competitiveness among user partners and expectations about social ramifications over and above the partners' direct participation in the centre's activities.

Organisation

The MI Lab board consistes from June 8, 2011 of:

Eva Nilsen, GE Vingmed Ultrasound, leader
Erik Swensen, MediStim
Atle Kleven, Sonowand
Audun Græsli, Aurotech Ultrasound
Sturla Eik-Nes, St. Olavs Hospital
Stig Slørdahl, NTNU
Asta Håberg, NTNU

There was one MI Lab board meeting in 2012: November 20.

MI Lab also has an “MI Lab leader group” consisting of the MI Lab leader and the senior NTNU personnel that are most involved in the MI Lab activities:

- Professor Olav Haraldseth, MD, PhD
- Professor Hans Torp, PhD

- Professor Asta Håberg, MD, PhD
- Professor Asbjørn Støylen, MD, PhD
- Professor Trond Ytterdal, PhD
- Research Scientist Lasse Løvstakken, PhD
- Research Scientist Bjørn Olav Haugen, MD, PhD

The MI Lab partners at the end of 2012 are:

- NTNU (Trondheim)
- St. Olavs Hospital HF (Trondheim)
- GE Vingmed Ultrasound AS (Horten, Oslo and Trondheim)
- MediStim ASA (Oslo)
- Sonowand AS (Trondheim)
- Aurotech Ultrasound AS (Tydal and Trondheim)
- Arctic Silicon Devices AS (Trondheim)
- NordicNeuroLab AS (Bergen)
- CorTechs Labs Inc (San Diego, California, USA)
- SINTEF (Trondheim)
- Helse Midt-Norge RHF (Stjørdal)

The Centres for Research-based Innovation represent a new scheme in which several industrial partners and the university work together in an open research environment. Our experience so far is that we in MI Lab are able to build an arena for open innovation and long-term industrial research with high scientific quality and commitment from the partners. In 2012 this resulted in publication of 43 refereed articles in international journals and one new invention that is in the patenting process.

In 2012 the MI Lab leadership vsitied the SME Ultrasound partners; visit to Sonowand in Trondheim on March 8, to Aurotech in Trondheim on March 9, and to MediStim in Oslo on September 12. MI Lab board leader Eva Nilsen, MI Lab leader Olav Haraldseth, professor Hans Torp and Eivind Andersen from NTNU Technology Transfer AS took part in these visits.

To foster integration between the partners MI Lab has arranged all-day seminars called MI Lab Day. In 2012 the MI Lab Day was combined with the the annual MedIm national PhD student meeting. It lasted for two days (November 28-29), and with a total of app. 120 attendees, of which app. 70 were PhD students. MedIm is the Norwegian Research School in Medical Imaging and is described more in detail in the Recruitment subchapter below. The main theme of this meeting was to focus on innovation in PhD projects, and the keynote speaker was Bjørn Olstad, CEO of Microsoft Development Center Norway. All the attending PhD students contributed with either an oral presentation or a poster, and a committee with representatives from the university Technology Transfer offices in Oslo, Bergen and Trondheim awarded a prize of 25.000 kroner for the student project with the best innovation potential.

Scientific activities and results

MI Lab has during recent years had several new inventions in ultrasound technology that may significantly improve imaging of the heart and imaging of blood flow in big and small vessels. Several new inventions in soft-ware beamforming (how the

ultrasound signal is transmitted and received) has enabled significant increases in imaging frame rate sfor many applications (in the case of cardiac wall imaging from presently app. 50 images per second to close to 1000 per second for 2D imaging and 500 per second for 3D imaging). On-going clinical research projects evaluate to what extent this new technology may:

- enable real-time 3D ultrasound of the heart
- improve ultrasound based methods for quantification of the leakage in cardiac valve diseases (both in adults and congenital heart defects in the newborn)
- image how the electrical signal propagate through the heart muscle
- improve ultrasound imaging of blood flow in the brain arteries.

The two latter may have importance for diagnosis of cardiac arrhythmias and brain surgery respectively.

The pocket-sized hand-held ultrasound scanner Vscan has been a success for MI Lab, and activities in 2012 has been clinical research projects that evaluate how Vscan can change medical practice as it enables use of ultrasound imaging of high quality by non-expert users in the health care system. One example is a study published in 2012 in the Europeran Journal of Internal Medicine. The study was performed at the Levanger Hospital (90 km north of Trondheim). The consequences of systematic use of Vscan at the emergency admittance of 196 patients to the medical department were evaluated, and the main conclusion was: *" By adding a pocket-sized ultrasound examination of <10 min to usual care, we corrected the diagnosis in almost 1 of 5 patients admitted to a medical department, resulting in a completely different treatment strategy without delay in many of the patients. Routinely adding a cardiac and abdominal ultrasound screening has the potential to rearrange inpatients workflow and diagnosis."* Another example was a study published in 2012 in the journal Family Practice where seven General practitioners (GPs) in the Trondheim area examined 92 patients with risk factors for cardiac failure, and the conclusion was: *" In this study, we have shown that it is possible for GPs, after a limited period of focussed training, to use a pUS [pocket-sized Ultrsound] scanner to assess a surrogate marker for global LV function in 87% of the patients with or at risk of developing reduced LV function. The pUS examination could easily be performed in 5 minutes during a routine consultation in the GPs office."*

MI Lab has been involved in an extensive research activity on minimally invasive brain surgery combining functional MR imaging performed prior to operation and ultrasound imaging during operation. This setting reduces the risk for damage to healthy brain tissue and enables so-called "radical surgery", i.e. that the operation may be performed earlier in the case of slow-growing tumors and that the surgeon may remove more tissue close to the tumor. Both are expected to reduce the risk for relapse of the tumor. In a retrospective study published in the high impact journal JAMA (The Journal of the American Medical Association) the results of this radical surgery in Trondheim were compared to another hospital in Norway and the conclusion was:"*Treatment at a center that favored early surgical resection was associated with better overall survival than treatment at a center that favored biopsy and watchful waiting."*

There were also several interesting results from the MI Lab research activity with functional MR used to detect changes in the localization of the brain activities that cause the typical early symptoms of dementia: to recognize smells and to find your

way in a familiar environment. MI Lab has developed methods to test these functions while the patient is inside the MR system, and the goal is to try to develop methods that can detect dementia as early as possible. This is important as new treatments that may retard the disease process probably probably have significantly better effect the more early the treatment can start. A study published in the Journal of Neurophysiology in 2012 detected the difference in brain activity in cases of recognition and non-recognition of smells and also found evidence for a link between both episodic and semantic memory functions and smell recognition.

MI Lab also has research activities that aim to develop MR methods to monitor stem cell treatment. The clinical relevance is based on the wide spread notion that clinical success of such therapy may be dependent on new imaging protocols that are tailor-made to detect stem cell migration after injection and monitor the anatomical and functional changes in the tissue during the treatment. MI Lab researchers had in 2012 two scientific publications where it was proved in animal models of white matter damage in the brain that it is possible with different MR methods first to ensure that the cells do not migrate away from the injection site and afterwards to detect early signs of reparation of the nerve damage.

International cooperation

A main strategy for strengthening international collaboration is to attach foreign professors and researchers in 20% positions as international guest professors and guest researchers, and by the end of 2012 there were four such positions:

- Guest professor Arend Heerschap, Department of Radiology, Radeboud University, Nijmegen, Netherlands
- Guest professor Anders M. Dale, Multimodal Imaging Laboratory, University of California San Diego, USA
- Guest professor Jan D'hooge, Department of Cardiovascular Imaging and Dynamics, Catholic University Leuven, Belgium
- Guest professor Henrik Larsson, Unit for Functional Image Diagnostics at Glostrup University Hospital, Copenhagen, Denmark

MI Lab also has had a wish to improve the collaboration with the ultrasound research environment in Oslo (both cardiology and technology), and at the end of 2011 MI Lab had attached two guest professors:

- Svend Aakhus, consultant in cardiology, Olso University Hospital (Rikshospitalet)
- Sverre Holm, Centre for Imaging at the Department of Informatics, University of Oslo

These guest professors and guest researchers are chosen because they have a competence and research experience that is of benefit for MI Lab, and, at the same time, look upon MI Lab as an important possibility for improving their own research activities through active participation in the research environment in Trondheim.

MI Lab also has an international Scientific Advisory Board (SAB) that consists of four foreign professors/researchers with expertise in the different areas of the MI Lab research plan:

- Professor Peter Burns, Department of Medical Biophysics, University of Toronto, Canada
- Professor Lars-Åke Brodin, The Royal Institute of Technology (KTH), Stockholm, Sweden
- Technology leader Jean-Francois Gelly, Parallel Design SA, Sofia Antipolis, France
- Professor Henrik Larsson, Unit for Functional Image Diagnostics at Glostrup University Hospital, Copenhagen, Denmark

MI Lab was in 2012 involved in the arranging of several seminars in Trondheim with international speakers:

- Nansen Neuroscience Trondheim Meeting, May 29: Fernando Lopez da Silva, University of Amsterdam; Derrek Paul Hibar, UCLA.
- Regenerative medicine – opportunities and challenges, October 3: Erik Shapiro, Michigan State University; Willem Mulder, Mount Sinai Hospital, New York; Mike Modo, University of Pittsburgh, USA; Sue Barnett, University of Glasgow; Eva Sykova, University of Prague; John Riddell, University of Glasgow; Chris McCabe, University of Glasgow; Tobias Nyberg, KTH, Stockholm; Hans Von Holst, Karolinska Hospital, Stockholm).
- The annual MedIm national PhD student meeting (combined with the MI Lab Day), November 28 – 29: Alan Koretsky, National Institute of Health, Bethesda, Maryland, USA; Lars Åke Brodin, KTH, Stockholm; Tom Scheenen, Radboud University Nijmengen Medical Centre, Nederland; Rainer Heintzmann, Institute of Physical Chemistry, Jena, Tyskland.

MI Lab is involved in two European ESFRI infrastructure initiatives, EATRIS (European Advanced Translational research Infrastructure in Medicine) and Euro-BioImaging. MI Lab leader Olav Haraldseth is member of the board of the Norwegian participant organisations for both, the Norwegian EATRIS Centre and Nor-BioImaging respectively, and he is also formally acting as the national contact person and co-ordinator for medical imaging in both infrastructures.

MI Lab is also involved in two national research infrastructure initiatives that are on the RCN roadmap for large-scale national research infrastructures, NORBRAIN and NorMIT. NORBRAIN (The Norwegian Brain Initiative) is a large-scale national research infrastructure in neuroscience that aims to achieve a vertical integration: from cellular biology, through systems neuroscience research in animal models, and to research on patients and human volunteers with advanced MR technology. MI Lab is one of three partners together with the Kavli Institute for Systems Neuroscience in Trondheim (headed by Professor Edvard Moser) and Centre of Molecular Biology and Neuroscience (CMBN) in Oslo. In 2011 The Research Council of Norway funded phase I of NORBRAIN with NOK 80 millions kroner (app. 10 millions Euro). NorMIT (The Norwegian centre for minimally invasive image guided therapy and medical technologies) is on the RCN roadmap as “investment ready”. NorMIT is a collaboration between the Operating Room of the Future (ORF) at St. Olavs Hospital and The Intervention Centre at Oslo University Hospital (Rikshospitalet).

Recruitment

MI Lab thinks that recruitment of the best students is the main success factor to obtain the scientific goals. The main criteria for candidates to MI Lab PhD and post doc positions are:

- High scientific quality
- Personal abilities for scientific work in a multi-disciplinary research environment and in the crossroad between university, hospital and industry and
- High motivation for work in the MI Lab research tasks and subproject

During 2012 MI Lab financed 23 PhD students/ post doc fellows (19,5 man-years since some of the medical doctors combine PhD/post doc with clinical positions in St. Olavs Hospital).

The balance between between PhD and post doc, between Norwegian and foreign recruitment and the multi-disciplinarity are according to plan:

PhD / post doc	19 / 4
Norwegian / foreign	20 / 3
Medicine / technology & other	9 / 14

The foreign recruitment was from: The Netherlands, France and China.
The non-medical students were from: engineering (1), electronics (2), physics (7), mathematics (3), and molecular biology (1).

However, there is a less than satisfactory balance between the sexes:

Male / female	18/ 5 (22 % female)

At NTNU (with Faculty of Medicine as host faculty) there is a PhD programme in medical technology headed by Professor Hans Torp, who is also one of the key professors in MI Lab (and part of MI Lab leader group).

To further improve the quality of the PhD training MI Lab leader Olav Haraldseth initiated and is the current leader of the Norwegian Research School in Medical Imaging (MedIm: www.ntnu.no/medicalimaging). The Research Council of Norway (RCN) had an open call for post graduate researcher training programmes [forskerskoler] in 2008, and the Norwegian Research School in Medical Imaging was one of the five appointed (the only in the area of medicine and health and the only at NTNU). It is a collaboration with the universities in Oslo, Bergen and Tromsø and has a total budget of 24 million NOK over 8 years. The researcher school is for all Norwegian PhD students in the area of medical imaging (including MR, ultrasound, PET, image guided surgery, optical imaging and bionanotechnology), and the main aim is to improve the quality of medical imaging research in Norway. This will be achieved through improving the national collaboration, the multi-disciplinarity of the research, the quality of the PhD training, and the recruitment of the best students (also foreign recruitment). MI Lab also thinks that the researcher school is an important tool for improved female recruitment to this research area.

Communication and dissemination activities

A main concept for MI lab is that all original and important scientific results shall be published as quickly as possible though presentation at international scientific meetings and as full scientific papers in international journals with referee. The 2011 publication list (see appendix 3 below) contains 43 refereed articles in international journals

MI Lab also has a focus on spreading knowledge about new technology and new methods to the relevant personnel in the Norwegian health care system. The MR, ultrasound and image-guided surgery research environment in Trondheim includes also three National Centres of Competence appointed by the Norwegian Ministry of Health.
They are National Centres of Competence in:

- Ultrasound- and image guided therpay
- Functional MRI
- Foetal ultrasound

One of the main tasks of these centres is to spread new knowledge of clinical relevance to the Norwegian health care system through hands-on training, courses and seminars, and they collaborate closely with MI Lab in this context.

APPENDIX 1 – MI Lab PERSONNEL 2012

The list includes all participants in research related to the MI Lab research subprojects.

Key Researchers

NAME	INSTITUTION	SEX	MAIN AREA
• Hans Torp	NTNU	M	Ultrasound technology
• Bjørn Angelsen	NTNU	M	Ultrasound technology
• Lasse Løvstakken	NTNU	M	Ultrasound technology
• Trond Ytterdal	NTNU	M	US probe electronics
• Asbjørn Støylen	NTNU & St. Olav	M	Cardiac ultrasound
• Asta Håberg	NTNU & St. Olav	F	Clinical MRI
• Olav Haraldseth	NTNU & St. Olav	M	Clinical MRI
• Tone F. Bathen	NTNU	F	Clinical MRI
• Ann-Mari Brubakk	NTNU	F	Clinical MRI
• Dag Ole Nordhaug	NTNU & St. Olav	M	Cardiac surgery
• Geirmund Unsgård	NTNU & St. Olav	M	Neurosurgery
• Ole Solheim	NTNU & St. Olav	M	Neurosurgery
• Sturla Eik-Nes	NTNU & St. Olav	M	Foetal ultrasound
• Kjell Arne Kvistad	NTNU & St. Olav	M	MR radiology
• Pål Erik Goa	St.Olavs Hospital	M	MR technology
• Anders Kristoffersen	St.Olavs Hospital	M	MR technology
• Toril A. Hernes	SINTEF & NTNU	F	Image guided surgery
• Tormod Selbekk	SINTEF	M	Neurosurgery
• Frank Lindseth	SINTEF	M	Neurosurgery
• Kjell Kristoffersen	GE Vingmed&NTNU	M	Ultrasound technology
• Eva Nilssen	GE Vingmed	F	Ultrasound technology
• Tore Bjåstad	GE Vingmed	M	Ultrasound technology
• Svein Arne Aase	GE Vingmed	M	Ultrasound technology
• Sten Roar Snare	GE Vingmed	M	Ultrasound technology
• Fredrik Orderud	GE Vingmed	M	Ultrasound technology
• Stein Inge Rabben	GE Vingmed	M	Ultrasound technology
• Erik Steen	GE Vingmed	M	Ultrasound technology
• Atle Kleven	Sonowand	M	Ultrasound technology
• Erik Swensen	MediStim	M	Ultrasound technology
• Jonas Crosby	MediStim	M	Ultrasound technology
• Tonni F. Johansen	SINTEF & NTNU	M	Ultrasound technology
• Atle Bjørnerud	Nordic NeuroLab	M	MR technology
• Audun Græsli	Aurotech	M	Ultrasound technology
• Torbjørn Hergum	Aurotech	M	Ultrasound technology
• Marco Voormolen	Aurotech	M	Ultrasound technology

Visiting Researchers (= guest professors/researchers in 20% position)

NAME	AFILIATION	SEX	MAIN AREA
• Jan D'hooge	Catholic University, Leuven, Belgium	M	Ultrasound technology
• Anders M. Dale	University of California, San Diego, USA	M	MR technology
• Arend Heerschap	Radeboud University, Nijmegen, Netherlands	M	MR technology
• Henrik Larsson	Glostrup Univ. Hospital, Copenhagen, Denmark	M	Clinical MRI
• Svend Aakhus	Oslo University Hospital, Norway	M	Cardiac ultrasound
• Sverre Holm	University of Oslo, Norway	M	Ultrasound technology

Postdoctoral researchers with financial support from the centre budget

NAME	NATIONALITY	SEX	SUBPROJECT
• Brage H. Amundsen	Norway	M	2.1
• Bjørn Olav Haugen	Norway	M	2.2
• Håvard Dalen	Norway	M	2.2
• Ingerid Reinertsen	Norway	F	3.1

Postdoctoral researchers involved in projects in the centre with financial support from other sources

NAME	FUNDING	NATIONALITY	SEX	
• Gabriel Kiss	GE Vingmed	Romania	M	2.1
• Live Eikenes	HMN	Norway	F	4.1
• Hanne Lehn	NTNU	Norway	F	4.1
• Toril E. Sjøbakk	St. Olavs Hospital	Norway	F	4.1
• Niels van Strien	RCN	Netherlands	M	4.1
• Siver Mostue	HMN	Norway	M	4.3
• Ioanna Sandvig	HMN	Greece	F	4.3
• Else Marie Huuse	NTNU	Norway	F	4.3
• Marius Widerøe	NTNU	Norway	M	4.3

PhD students with financial support from the centre budget

NAME	NATIONALITY	SEX	SUBPROJECT
• Tonje Fredriksen	Norway	F	1.1
• Bastien Denarie	France	M	1.1
• Birger Brekke	Norway	M	1.1
• Solveig S. Alnes	Norway	F	1.1
• Jørgen Avdal	Norway	M	1.1
• Hans H. Hansen	Norway	M	1.1
• Pang Weng	China	M	1.1
• Jon Petter Aasen	Norway	M	2.1
• Joakim Schistad Lund	Norway	M	2.1

• Lars Chr. Lervik Nilsen	Norway	M	2.1
• Ole Chr. Mjølstad	Norway	M	2.2
• Garrett N. Anderson	Norway	M	2.2
• Asgeir Jakola	Norway	M	3.1
• Daniel Høyer Iversen	Norway	M	3.1
• Ingvild K. Ekroll	Norway	F	3.2
• Øystein Pettersen	Norway	M	3.3
• Jarle Ladstein	Norway	M	4.1
• Tuva Roldsdatter Hope	Norway	F	4.1
• Sjoerd Hak	Netherlands	M	4.3

PhD students involved in projects in the centre with financial support from other sources

NAME	FUNDING	NATIONALITY	SEX	SUBP
• Siri-Ann Nyrnes	HMN	Norway	F	1.1
• Thomas Skaug	HMN	Norway	M	1.1
• Zhao Kangqiao	NTNU	China	M	1.1
• Sasha Gulati	St.Olavs Hospital	Norway	M	3.1
• Frode Manstad-Hulaas	St.Olavs Hospital	Norway	M	3.2
• Reidar Brekken	SINTEF & HMN	Norway	M	3.2
• Ole Vegard Solberg	SINTEF	Norway	M	3.2
• Lars Erik Bø	SINTEF	Norway	M	3.2
• Veronica Berezova	RCN	Czech Rep.	F	4.1
• Emilie Vallee	RCN	France	F	4.1
• Hallvard R. Evensmo	NTNU	Norway	M	4.1
• Ida Antonsen	NTNU	Norway	F	4.1
• Grete Kjelvik	HMN	Norway	F	4.1
• Tor Ivar Hansen	NTNU	Norway	M	4.1
• Nicolas Elvemo	NTNU (forskerlinje)	Norway	M	4.1
• Carl Pintzka	NTNU (forskerlinje)	Norway	M	4.1
• Jarle Alexander Møller	NTNU (forskerlinje)	Norway	M	4.1
• Tora Morken	HMN	Norway	F	4.3
• Jana Cebulla	NTNU	Norway	F	4.3
• Axel Nyman	NTNU (forskerlinje)	Norway	M	4.3

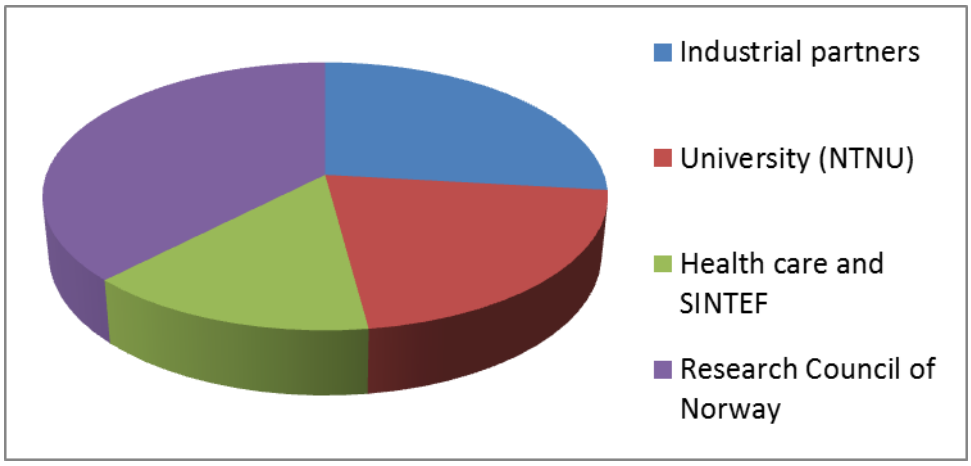
RCN = The Research Council of Norway
HMN = Helse Midt-Norge (the Regional Health Authority of Middle Norway)
HiST = Høgskolen i Sør-Trøndelag

APPENDIX 2 - Annual accounts 2012

The total costs in 2012 of 32,6 million NOK (app. 4,4 million Euro) were split between cash contributions of 17,7 MNOK and own effort contributions from the partners (including the host NTNU) of 14,9 MNOK.

The financing split on type of source was:

Industrial partners	27 %
NTNU	21 %
Health care and SINTEF	14 %
RCN	38 %



APPENDIX 3 – MI Lab Publications and PhD dissertations 2012

The listed PhD dissertations and full scientific papers cover scientific results from the MI Lab subproject activities. Some of the projects and involved persons are fully financed from MI lab, some are mainly financed from other sources than MI Lab, and some are partly financed from MI Lab and partly financed from other sources.

PhD dissertations 2012

Medical doctors

1. **Anders Thorstensen.** 2D and 3D echocardiography during inotropic alterations and after recent myocardial infarct.
2. **Marius Widerøe.** Magnetic resonance imaging of hypoxic-ischemic brain injury development in the newborn rat – manganese and diffusion contrasts.
3. **Helena Bertilsson.** Prostate cancer – Translational research. Optimizing tissue sampling suitable for histopathologic, transcriptomic and metabolic profiling.

Technologists

4. **Sjur Urdson Gjerald.** A fast ultrasound simulator.
5. **Grete Kjelvik.** Human odor identification studies in healthy individuals, mild cognitive impairment and Alzheimer's disease.
6. **Siver Andreas Moestue.** Molecular and functional characterization of breast cancer through a combination of MR imaging, transcriptomics and metabolomics.
7. **Maria Dung Cao.** MR metabolic characterization of locally advanced breast cancer – treatment effects and prognosis.
8. **Kirsten M. Selnæs.** MR imaging and spectroscopy in prostate and colon cancer diagnostics.
9. **Maria Tunset Grinde.** Characterization of breast cancer using MR metabolomics and gene expression analysis.

Publication list 2012

(only full scientific papers in international journals with referee,
and all are registered in the PubMed database at The National Institute of Health, NIH, USA)

1.1 Ultrasound image improvement

1. Prieur F, Johansen TF, Holm S, Torp H. Fast simulation of second harmonic ultrasound field using a quasi-linear method. J Acoust Soc Am. 2012 Jun;131(6):4365-75. PMID:22712911
2. Ekroll IK, Torp H, Løvstakken L. Spectral Doppler estimation utilizing 2-D spatial information and adaptive signal processing. IEEE Trans Ultrason Ferroelectr Freq Control. 2012 Jun;59(6):1182-92. PMID:22711413
3. Gao H, Hergum T, Torp H, D'hooge J. Comparison of the performance of different tools for fast simulation of ultrasound data. Ultrasonics. 2012 Jul;52(5):573-7. PMID:22348943

4. Gjerald SU, Brekken R, Hergum T, D'hooge J. Real-time ultrasound simulation using the GPU. IEEE Trans Ultrason Ferroelectr Freq Control. 2012 May;59(5):885-92. PMID: 22622973
5. Gjerald SU, Brekken R, Bø LE, Hergum T, Nagelhus Hernes TA. Interactive development of a CT-based tissue model for ultrasound simulation. Comput Biol Med. 2012 May;42(5):607-13. PMID: 22424668
6. Mehdizadeh S, Austeng A, Johansen TF, Holm S. Minimum variance beamforming applied to ultrasound imaging with a partially shaded aperture. IEEE Trans Ultrason Ferroelectr Freq Control. 2012 Apr;59(4):683-93. PMID: 22547279

2.1 Cardiac ultrasound

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