MI Lab Annual Report 2010

Summary

In 2010 MI Lab succeeded in recruiting many high quality researchers and during 2010 MI Lab financed 34 PhD students/ post docs and 6 international guest professors. It is nice to see the competence and enthusiasm of the growing group of MI Lab hired 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 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 2010 this resulted in publication of 31 refereed articles in international journals and many important inventions that are in different phases of the patenting and licensing 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".

In 2010 MI Lab underwent two international expert evaluations (see details below). We are especially proud about the conclusion in the midway evaluation expert panel report from the Research Council of Norway:
"MI Lab started up rapidly and efficiently and now produces results of world class quality that are bound to result in important innovations in medical imaging."

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 / 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.

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's user partners have increased their research activities both through participation in the centre's activities and their own R&D activities on topics of relevance to the centre.
- 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.

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 (see details below), 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, and will also include a transducer workshop.

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
- Foetal Ultrasound
- MR in regenerative medicine & nanoparticles for imaging

Organisation

The MI Lab board consisted in 2010 of:

Kjell Arne Ingebrigtsen, leader
Eva Nilsen, GE Vingmed Ultrasound
Erik Swensen, MediStim
Bjørn Olstad, FAST
Atle Kleven, Sonowand
Sturla Eik-Nes, St. Olavs Hospital
Stig Slørdahl, NTNU
Asta Håberg, NTNU

There were two MI Lab board meetings in 2010: March 11 and November 10.

The interaction between the MI Lab board, the MI Lab leader and the organisation of the host institution, NTNU, has functioned excellently in 2010. The Faculty of Medicine is host faculty for MI Lab at NTNU, and the dean, Stig Slørdahl, is member

of the MI Lab board. MI Lab is co-localised with the Department of Circulation and Medical Imaging and most of the MI Lab hired PhD students, post docs and international guest professors/researchers are formally employed by this department. The head of the department, Øyvind Ellingsen, and MI Lab leader Olav Haraldseth have collaborated closely on a daily basis, and the interaction is also strengthened as the MI Lab board leader, Kjell Arne Ingebrigtsen, has been member of the Advisory Council of the Department of Circulation and Medical Imaging.

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 as subproject leaders and main supervisors for PhD students hired by MI Lab.

The MI Lab leader group consists of:

- Professor Olav Haraldseth, MD, PhD
- Professor Hans Torp, PhD
- Associate professor Asta Håberg, MD, PhD
- Associate professor Asbjørn Støylen, MD, PhD
- Professor Trond Ytterdal, PhD
- Research Scientist Lasse Løvstakken, PhD
- Research Scientist Bjørn Olav Haugen, MD, PhD

Interactions with the partners

The MI Lab partners in 2010 are:

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

FAST's engagement in MI Lab has been on hold from the company due to change of priorities following the acquisition by Microsoft in 2008, however, FAST is still partner in MI Lab.

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 2010 this resulted in publication of 31 refereed articles in international journals and many important inventions that are in different phases of the patenting and licensing process.

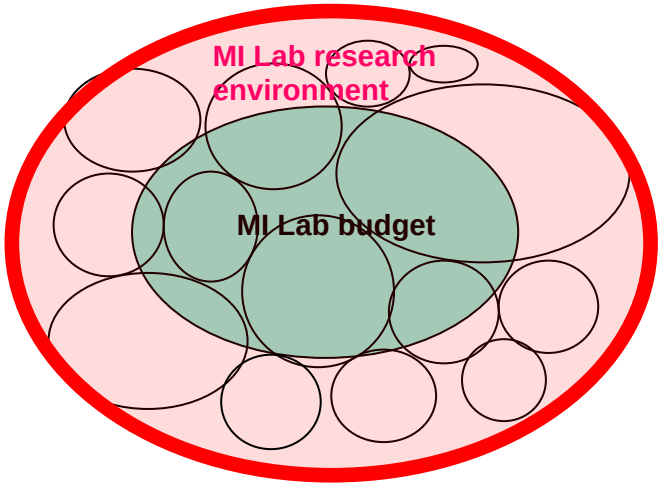
In 2010 the MI Lab Annual Partner Meeting was on March 11 and was attended by all partners with the exception of FAST, Sonowand, CorTechs Labs and Helse Midt-Norge.

To foster integration between the partners MI Lab arrange all-day seminars called MI lab Day twice every year. Tthe aim of this event is to bring together all the partners and all the researchers to a day of science and mingling:

- The MI Lab Day April 29, 2010 had the programme title “Advances in MRI”. The seminar had five international guest speakers: Erik Shapiro from the Yale University, USA; Willem Mulder from Mount Sinai Medical School in New York City, USA; Nicola Seiberlich from University Hospitals Cleveland, USA; Benedikt Poser from the Erwin-Hahn Institute in Essen, Germany; Tom Scheenen from the Radeboud University in Nijmegen, the Netherlands.
- The MI Lab Day November 18, 2010 had the programme title “Advances in Ultrasound and MRI”. The seminar had three invited guest speakers: Mike Modo from King’s college London United Kingdom; Jan D’hooge from Katholike Universiteit Leuven, Belgium; Sverre Holm from University of Oslo.

Integration with the medical imaging community in Trondheim

MI Lab wants to be an integrated part of the total Ultrasound and MR research environment in Trondheim, and the MI Lab subprojects collaborate with related research activities financed from other sources, visualised in this sketch (each circle represents a research activity that may be funded from several sources):



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”.

All the participants in this integrated research environment have a continuous focus on obtaining new funding for ongoing and new projects. In this context some of the

PhD students and post docs change funding over time depending on which financing sources that fits their activity and profile, and parts of their project period will be financed from MI Lab and parts from other sources.

International collaboration and EU projects

A main strategy for strengthening international collaboration is to attach foreign professors and researchers in 20% positions as international guest professors and guest researchers. MI Lab has planned for eight such positions, and by the end of 2009 there are six:

- 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
- Guest researcher Kim Mouridsen, Center of Functionally Integrative Neuroscience, Århus, Denmark
- Guest researcher Jean-Francois Gelly, Parallel Design SA, Sofia Antipolis, France

There has also been a wish to improve the collaboration with the ultrasound technology research at the University of Oslo, and professor Sverre Holm from the Centre for Imaging at the Department of Informatics at UiO has been hired as MI Lab guest professor.

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 has an extensive international network and collaborates with researchers at foreign universities on many different levels. The MI Lab publications 2008-2010 include 64 full scientific papers in international journals with referee. In 22 of these (34%) there is co-publication with foreign professors and researchers coming from 15 universities in 9 countries (USA, UK, Australia, China, Belgium, Netherlands, Italy, Belarus and Denmark), and we we have also ongoing collaboration with 14 other foreign universities and hospitals (not counting the EU project partners). Currently two MI Lab financed PhD students/post docs are on research stays, one at the Martinos Centre for Biomedical Imaging at Harvard/MIT/MGH in Boston USA (main contact Bruce Fischl), and one at the Department of Cardiovascular Medicine, Cleveland Clinic, USA (main contact Tom Marwick). In 2010 professor Asta Håberg is in invited speaker at University College of London and University of Arizona, professor Hans Torp at University of Sendai, Japan, and professor Trond Ytterdal at International Conference on Solid-State and Integrated Circuit Technology in Shanghai.

MI Lab partners have during 2010 been involved in the following EU 7th Framework Programme with research activities closely related to MI Lab:
- "Smart PM, Smart Power Management in Home and Health" ENIAC Joint Undertaking project since 2008. GE Vingmed Ultrasound is partner in the European consortium.
- NEXES - Living Healthily at Home. FP 7 project since 2008, St. Olavs Hospital is partner.
- LUPAS, Luminiscent Polymers for the Ageing Society. New FP 7 project in 2009. NTNU is partner.
- 3MICRON, Three modality contrast imaging using multi-functionalised microballoons, new FP 7 project in 2009, SINTEF is partner.
- 3D Visualisation for Neurosurgery. Nordic NeuroLab is partner.
- NeuroImaging Genetics Biomarkers in Brain Disorders ("S-GeneBrain"). FP7-HEALTH-2010-two-stage. NTNU is partner.
- IIIOS, Integrated Interventional Imaging Operating System, Marie Curie Training Site. NTNU is one of 10 partners.
- COST Action BM0601: Advanced Methods for the Estimation of Human Brain Activity and Connectivity (NEUROMATH). NTNU is partner in this network with participants from14 countries.

MI Lab was co-organizer when SMIT (Society for Medical Innovation and Technology) had their 22. annual conference in Trondheim September 2-4, 2010 (see: www.smit2010.com).

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 relevant MI Lab research tasks and subproject

In 2010 MI Lab succeeded in recruiting many high quality researchers and during 2010 MI Lab financed 34 PhD students/ post docs.

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

PhD / post doc	22 / 12
Norwegian / foreign	24 / 10
Medicine / technology & other	9 / 25

The foreign recruitment was from: Sweden, UK, The Netherlands (2), France, Spain, Greece, Rumania, Turkey and China.
The non-medical students were from: engineering (7), electronics (3), physics (7), mathematics (4), physiology (1), molecular biology (2), and psychology (1)

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

Male / female	25 / 9 (27 % 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 (see: 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 national collaboration, multi-disciplinary research, quality of PhD training, and 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

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 papers in international scientific journals with review. The 2010 publication list (see appendix 3 below) contains 31 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 several National centres of competence appointed by the Norwegian Ministry of Health (Helse- og omsorgsdepartementet, HOD).
They are National Centres of Competence in:

- Foetal ultrasound
- 3D ultrasound in surgery
- Functional MRI
- In-vivo MR spectroscopy

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.

Scientific Advisory Board

The MI Lab Scientific Advisory Board (SAB) had its first meeting on January 18, 2010. The board consists of four foreign professors/researchers with expertise in the different areas of the MI Lab research plan.

Two of them have no scientific collaboration with MI Lab:

- Professor Peter Burns, Department of Medical Biophysics, University of Toronto, Canada
- Professor Lars-Åke Brodin, The Royal Institute of Technology (KTH), Stockholm, Sweden

The two others are attached to MI Lab as guest professor/researcher:

- Guest researcher Jean-Francois Gelly, Parallel Design SA, Sofia Antipolis, France
- Guest professor Henrik Larsson, Unit for Functional Image Diagnostics at Glostrup University Hospital, Copenhagen, Denmark

The mandate of the MI Lab Scientific Advisory Board at the first meeting was to:

- Evaluate the scientific quality and scientific originality of the on-going research and future research plans
- Evaluate if the research is according to international trends
- Discuss the research activities with some of the key professors and post docs
- Advice on changes to the research plans and/or suggest other research activities and new research ideas
- Make a written report on the evaluation and recommendations

Some of the main conclusions from the Scientific Advisory Board were (citations from the writtenreport):

“The reviewers were uniformly impressed with the research environment at NTNU. Medical technology researchers have built an enviable network that reaches on the one hand into strong collaborations with commercial partners, both local, national and - in the case of GE - multinational; and on the other hand into clinical care in interventional medicine, fetal maternal health, radiology, cardiology, neurology and neurosurgery. The seamless discussion of projects between scientists, engineers and clinicians we met reflected the high level of integration of basic science and engineering and clinical research that has become part of the culture of NTNU in medicine. Indeed NTNU’s international reputation is founded on a strong record of success in the translation of ideas into both clinical care and commercial innovation. No amount of planning can create a culture of this quality: it has arisen out of the work of several generations of visionary researchers at NTNU, and represents the fundamental asset upon which MI Lab is designed to build. We regard this as representing excellence at an international level.”

“MI Lab is composed of world-class investigators working in a uniquely collaborative environment with clinicians and industry. It is to be congratulated on its culture for multidisciplinary research and training: it is a clear leader in its field.”

“The expertise of the investigators participating in MI Lab is dominated by the extremely strong ultrasound group (~70%), with MR research occupying most of the

remaining researchers. The ultrasound scientists form one of the leading research groups worldwide, with very strong expertise in cardiac imaging, Doppler, fetal-maternal imaging and technology development. They have led innovations that created and sustained Vingmed - and later GE echocardiography - as a global commercial force. Their pace of innovation never seems to slacken, as evidenced by the success of their most recent foray into miniaturized ultrasound, now marketed strongly by GE as the VScan, as well as work in new methods of blood flow imaging. The MR group is perhaps less mature as investigators but is focusing on neuroimaging and intervention with excellent progress. MI Lab is exploiting the opportunity to bring in smaller, more local companies involved in processing and microfabrication, for example. This is clearly beneficial to both NTNU researchers and the local commercial sector."

"It is fair to say, however, that the structure that MI Lab has arrived at, while understandable and clearly well-functioning, presents possibly the greatest challenge to its review and scientific assessment. While there are laudable aims to stimulate training, clinical and commercial translation; by definition, MI Lab does not appear to have a scientific goal, or even agenda. It seems to serve more the function of an umbrella, under which investigators bring their own projects, collaborations and funding. This is the 'bottom up' approach that professor Haraldseth described as a principle of MI Lab's governance, which is based on realistic and pragmatic considerations: the well-established research programs of the investigators, the business plans of the various partner companies, and so on. MI Lab does not call the scientific and commercial tune of these projects, but accepts them into its fold."
"Thus strategic thinking, in science and in long term planning, should be brought to the second-term plan. We do not see this as excluding the existing structure; indeed, a blend of 'bottom-up' projects in an umbrella with its own intramural program opens up a new type of collaborative interaction."

"Conclusion Transducers (Gelly):
As a representative of industry in Medical Ultrasound Transducer linked to Cardiac application, I am a strong believer in MiLab structure and plans. As quite important spin off for industry are expected and given the high level of ambition of the projects, I would encourage MiLab team, industrial partners, and medical expert stakeholders to pursue effort in identifying key deliverables and associated risks (with back up solutions for instance) to facilitate "consortium" management. Also given the long-term profile of backbone road map, it seems to me important to imagine a resource plan supporting it beyond the identified projects reviewed so far.
It is also obvious that this structure will generate highly skilled and with unique training engineers for industry."

"Conclusion on cardiology (Brodin)
One of the most important key´s to the scientific success and high quality of the scientific work at NTNU concerning image related research are the close integration, between basic technical applied research and its connection to the clinic. The research environment with the technical development working with the testing facility situated just around the corner. This communication is also for taking clinical needs to technical solutions. These research areas are of great interest with studies both working with high end machines for improved diagnosis but also working with small ultrasound machines for finding there usability in general health care."

“Conclusion MR (Larsson)
In conclusion, the MR projects to a large extent comply with the success criteria defined by RCN. The MR projects are in accordance with the international trend, some projects are very innovative and some are very ambitious with a great clinical potential. I find the broadness of the MR projects is strength, especially because the overall focus is coherent and the projects mutually benefit from each other. Finally, I see a possible value of a more direct integration between MR and US. Overall I am impressed and strongly recommend continued financial support.”

Midway evaluation from RCN

In 2010 the Research Council of Norway’s organized a midway evaluation of all the 14 Centres for Research-based Innovation. We are happy about the final report on MI Lab from the international expert panel; some citations:

“MI Lab started up rapidly and efficiently and now produces results of world class quality that are bound to result in important innovations in medical imaging.”

“The current and proposed research activities of the MI Lab are excellent and cover very well the current medical needs of improve- ment in ultrasound imaging, MRI and image guided therapy”
“Novel opportunities are being picked up, such as nano-particle based imaging and drug delivery”
“The headline research plan for the Centre’s final three-year period is well laid out and based on the high competence established and the great achievements so far in the field of MRI, ultrasound and image guided therapy.”

“MI Lab has an excellent publication profile.”

“The competence of the involved partners is at a very high profile and suitable for the research tasks.”
“MI lab has decided to use as much possible of the available funding to finance PhD students. This has resulted in an impressive total number of 34 PhD students and post docs. The students constitute an interesting interdisciplinary mix of engineers, physicists, mathematicians and physicians that has the potential to lead to a very fruitful innovative environment.”
“The Centre aims to act as a melting pot that is both multidisciplinary and, importantly, bridges academia, the clinic and business. This approach is critical to product innovation in the medical technology area – co-location of the three in a single facility is distinctive.”
“MI Lab has during its rather short lifetime obtained an impressive international network that includes several prominent individual scientific partners”

“The Centre is hosted within a “showpiece” facility within St Olav’s Hospital. NTNU is the host institution with excellent facilities concentrated to one floor at St Olav”
“The Centre is a key component of St Olav’s strategy as a healthcare provider. This is reflected in the decision to site it in the hospital. The importance of the interactions of the Centre with the hospital cannot be over- emphasised. The industrial partners

recognise these as the key advantage that the Centre has when compared with its international competition."
"The University has taken the strategic approach of creating an integrated facility – this is to be applauded and should be recognised as a benchmark for others."

The report also contained a list of recommendations, and MI Lab is now in the process of following-up this valuable advice from the expert panel.

Infrastructure

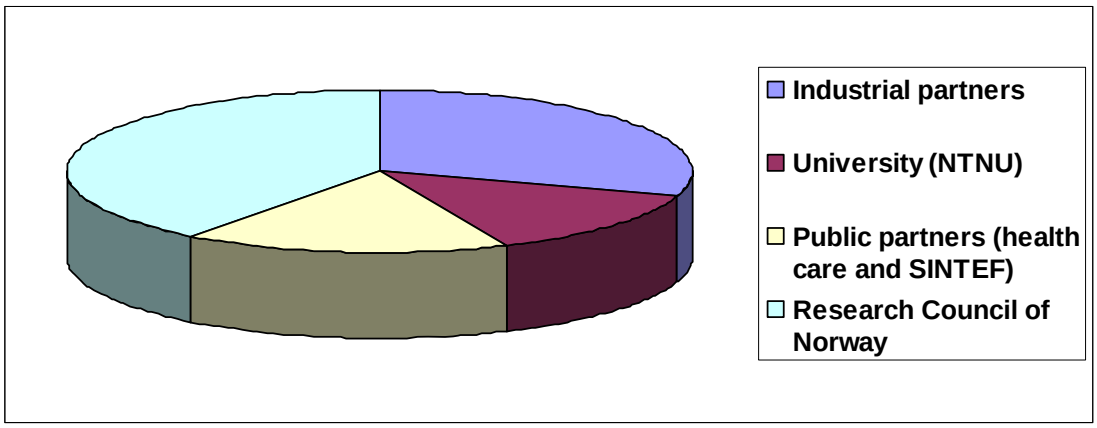
The Kavli Institute for Systems Neuroscience in Trondheim (headed by Professor Edvard Moser), MI Lab and Centre of Molecular Biology and Neuroscience (CMBN) in Oslo, have in 2009 initiated the establishment of a national research infrastructure in neuroscience called **NORBRAIN**. The aim is to achieve a vertical integration from cellular biology (main focus of CMBN) through systems neuroscience research in animal models (main focus of the Kavli Institute) to research on patients and human volunteers with advanced MR technology (MI Lab). NORBRAIN is on the RCN roadmap for large-scale national research infrastructures, and the MI Lab part of this NORBRAIN application is funding of a clinical 7 Tesla MR system for human research. With this new technology the spatial resolution of 0,1 mm for anatomy and 0,5 mm for functional studies will be possible. Similarly, NorMIT (Norwegian centre for minimally invasive image guided therapy and medical technologies) is on the same RCN roadmap. **NorMIT** is a collaboration between the Operating Room of the Future (ORF) at St. Olavs Hospital and The Intervention Centre at Oslo University Hospital. Both NORBRAIN and NorMIT are on the Research Council of Norway "Norwegian Roadmap for Research Infrastructure" as "investment ready".

MI Lab is also partner in the "Norwegian EATRIS Centre" established in 2010 as the Norwegian node in the construction phase of the ESFRI European research infrastructure **EATRIS** (European Advanced Translational research Infrastructure in Medicine). MI Lab is also involved in Nor-BioImaging which is the Norwegian participant in the preparatory phase of the ESFRI infrastrcucture Euro-BioImaging. Nor-BioImaging is headed by professor Ole Sejersted from Oslo University Hospital, and MI Lab director Olav Haraldseth is official Norwegain contact person for medical imaging in Euro-BioImaging.

APPENDIX 1 - Annual accounts 2010

The total costs of NOK 32.2 million (approximately EUR 4.1 million) in 2010 were divided between cash contributions of NOK 18.3 million and contributions from the partners (including the host, NTNU) of NOK 13.9 million.
The financing split on type of source were:

Industrial partners	30 %
NTNU	14 %
Health care and SINTEF	17 %
RCN	39 %



APPENDIX 2 – MI Lab PERSONNEL 2010

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
• Asbjørn Støylen	NTNU & St. Olav	M	Cardiac ultrasound
• Trond Ytterdal	NTNU	M	US probe electronics
• Lasse Løvstakken	NTNU	M	Ultrasound technology
• Asta Håberg	NTNU & St. Olav	F	Clinical MRI
• Olav Haraldseth	NTNU & St. Olav	M	Clinical MRI
• Ingrid Gribbestad	NTNU	F	Clinical MRI
• Ann-Mari Brubakk	NTNU	F	Clinical MRI
• Marte Thuen	NTNU	F	MR technology
• Dag Ole Nordhaug	NTNU & St. Olav	M	Cardiac surgery
• Geirmund Unsgård	NTNU & St. Olav	M	Neurosurgery
• Sturla Eik-Nes	NTNU & St. Olav	M	Foetal ultrasound
• Hans Olav Myhre	NTNU & St. Olav	M	Vascular surgery
• 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 Nilsen	GE Vingmed	F	Ultrasound technology
• Fredrik Orderud	GE Vingmed	M	Ultrasound technology
• Stein Inge Rabben	GE Vingmed	M	Ultrasound technology
• Olivier Gerard	GE Vingmed	M	Ultrasound technology
• Stian Langeland	GE Vingmed	M	Ultrasound technology
• Erik Steen	GE Vingmed	M	Ultrasound technology
• Atle Kleven	Sonowand	M	Ultrasound technology
• Erik Swensen	MediStim	M	Ultrasound technology
• Bill Glenn	MediStim	M	Ultrasound technology
• Jonas Crosby	MediStim	M	Ultrasound technology
• Atle Bjørnerud	Nordic NeuroLab	M	MR technology
• Yngve Kvinnsland	Nordic NeuroLab	M	MR technology
• Øystein Moldsvor	ASD	M	US probe electronics
• Audun Græsli	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,	M	Clinical MRI

		Copenhagen, Denmark		
•	Kim Mouridsen	CFIN Århus, Denmark	M	Image analysis
•	Jean-Francois Gelly	Parallel Design SA, Sofia Antipolis, France	M	MR technology
•	Sverre Holm	University of Oslo, Norway	M	Ultrasound technology

Postdoctoral researchers with financial support from the centre budget

	NAME	NATIONALITY	SEX	SUBPROJECT
•	Torbjørn Hergum	Norway	M	1.1
•	Svein Arne Aase	Norway	M	1.1
•	Brage H. Amundsen	Norway	M	2.1
•	Gabriel Kiss	Rumania	M	2.1
•	Charlotte B. Ingul	Sweden	F	2.1
•	Bjørn Olav Haugen	Norway	M	2.2
•	Ingerid Reinertsen	Norway	F	3.1
•	Håvard B. Nordgård	Norway	M	3.2
•	Marco Voormolen	Netherlands	M	3.2
•	Helen Palmer	UK |	F	4.1
•	Live Eikenes	Norway	F	4.1
•	Tore Bjåstad	Norway	M	4.2

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

	NAME	FUNDING	NATIONALITY	SEX
•	Niels van Strien	NFR	Netherlands	M
•	Svein-Erik Måsøy	HMN	Norway	M
•	Hanne Lehn	NTNU	Norway	F
•	Else Marie Huuse	NTNU	Norway	F
•	Toril E. Sjøbakk	St. Olavs Hospital	Norway	F
•	Ole Chr. Eidheim	NTNU	Norway	M

PhD students with financial support from the centre budget

	NAME	NATIONALITY	SEX	SUBPROJECT
•	Zhao Kangqiao	China	M	1.1
•	Tonje Fredriksen	Norway	F	1.1
•	Bastien Denarie	France	M	1.1
•	Eivind Sjøtun	Norway	M	1.1
•	Birger Brekke	Norway	M	1.1
•	Halvard Kaupang	Norway	M	1.1
•	Solveig S. Alnes	Norway	F	1.1
•	Hans H. Hansen	Norway	M	1.1
•	Engin Dikici	Turkey	M	2.1
•	Jon Petter Aasen	Norway	M	2.1
•	Anders Thorstensen	Norway	M	2.1
•	Ole Chr. Mjølstad	Norway	M	2.2
•	Garrett N. Anderson	Norway	M	2.2
•	Asgeir Jakola	Norway	M	3.1
•	Vigdis Holom	Norway	F	3.2

• Ingvild K. Ekroll	Norway	F	3.2
• Benjamin Garzon	Spain	M	4.1
• Alexander Olsen	Norway	M	4.1
• Jarle Ladstein	Norway	M	4.1
• Jørgen Avdal	Norway	M	4.1
• Ioanna Sandvig	Greece	F	4.3
• Sjoerd Hak	Netherlands	M	4.3

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

NAME	FUNDING	NATIONALITY	SEX
• Håvard Dalen	NTNU	Norway	M
• Siri-Ann Nyrnes	HMN	Norway	F
• Thomas Skaug	HMN	Norway	M
• Reidar Brekken	SINTEF & HMN	Norway	M
• Ole Vegard Solberg	SINTEF	Norway	M
• Lars Erik Bø	SINTEF	Norway	M
• Veronica Berezova	St.Olavs Hospital	Czech Rep.	F
• Emilie Vallee	NFR	France	F
• Dag-Håkon Frantzen	NFR	Norway	M
• Sten Roar Snare	NFR	Norway	M
• Jochen Deibele	NFR	Norway	M
• Xu Ye	NFR	China	F
• Nitin Goyal	NFR	India	M
• Sigrid Berg	NFR	Norway	F
• Linga Cenkeramaddi	NFR	India	M
• Kamal Raj Chapagain	NFR	Nepal	M
• Kjersti Midtbø	NFR	Norway	F
• Kjetil Dale	NTNU	Norway	M
• Lene Annette Rustad	NTNU	Norway	F
• Sasha Gulati	St.Olavs Hospital	Norway	M
• Frode Manstad-Hulaas	HMN	Norway	M
• Hallvard R. Evensmo	NTNU	Norway	M
• Ida Antonsen	NTNU	Norway	F
• Grete Kjelvik	HMN	Norway	F
• Marius Widerø	NTNU	Norway	M
• Tora Morken	HMN	Norway	F
• Kristine Skårdal	RCN	Norway	F
• Hilde Kjeldstad Berg	HiST	Norway	F
• Kari Ravn Eide	HiST	Norway	F
• Marianne G. Heldahl	Sanitetskvinnene	Norway	F
• Guro Giskeødegård	NFR	Norway	F
• Siver Andreas Mostue	NFR	Norway	M
• Roar Johansen	HMN	Norway	M
• Nicolas Elvemo	NTNU (forskerlinje)	Norway	M
• Carl Pintzka	NTNU (forskerlinje)	Norway	M

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

APPENDIX 3 – MI Lab Publications and PhD dissertations 2010

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 2010

Medical doctors

1. Håvard Bersås Nordgaard. Tranist-time flowmetry and wall shear stress analysis of coronary artery bypass grafts – A clinical and experimental study.
2. Jian Xu. Blood oxygen level dependent functional magnetic resonance imaging and diffusion tensor imaging in traumatic brain injury research.
3. Håvard Dalen. Echocardiographic indices of cardiac function – Normal values and association with risk factors in a population free from cardiovascular disease, hypertension and diabetes.
4. Toril Skandsen. Moderate and severe traumatic brain injury. Magnetic resonance imaging findings, cognition and risk factors for disability.
5. Roar Johansen. MR techniques in evaluation of breast cancer patients with poor prognosis.
6. Khalid Shaker Ibrahim. Intraoperative ultrasound assessment in coronary artery bypass surgery – with special reference to coronary anastomoses and the ascending aorta.

Technologists

7. Fredrik Orderud. Real-time segmentation of 3D echocardiograms using a state estimation approach with deformable models.
8. Thomas Moe Halvorsrød. On Low Power, Analog Modules for Medical Ultrasound Imaging Systems.
9. Øystein Olsen. Analysis of manganese enhanced MRI of the normal and injured rat central nervous system.
10. Line Rørstad Jensen. Evaluation of treatment effects in cancer by MR imaging and spectroscopy.

Publication list 2010

(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. Nyrnes SA, Lovstakken L, Skogvoll E, Torp H, Haugen BO. Does a new ultrasound flow modality improve visualization of neonatal pulmonary veins? Echocardiography. 2010 Oct;27(9):1113-9. PMID: 21039814
2. Hergum T, Bjastad T, Lovstakken L, Kristoffersen K, Torp H. Reducing color flow artifacts caused by parallel beamforming. IEEE Trans Ultrason Ferroelectr Freq Control. 2010;57(4):830-8. PMID: 20378446

3. Swillens A, Degroote J, Vierendeels J, Lovstakken L, Segers P. A simulation environment for validating ultrasonic blood flow and vessel wall imaging based on fluid-structure interaction simulations: ultrasonic assessment of arterial distension and wall shear rate. Med Phys. 2010 Aug;37(8):4318-30. PMID: 20879592
4. Swillens A, Segers P, Lovstakken L. Two-dimensional flow imaging in the carotid bifurcation using a combined speckle tracking and phase-shift estimator: a study based on ultrasound simulations and in vivo analysis. Ultrasound Med Biol. 2010 Oct;36(10):1722-35. PMID: 20800949
5. Swillens A, Segers P, Torp H, Løvstakken L. Two-dimensional blood velocity estimation with ultrasound: speckle tracking versus crossed-beam vector Doppler based on flow simulations in a carotid bifurcation model. IEEE Trans Ultrason Ferroelectr Freq Control. 2010;57(2):327-39. PMID: 20178899
6. Skaug TR, Hergum T, Amundsen BH, Skjaerpe T, Torp H, Haugen BO. Quantification of mitral regurgitation using high pulse repetition frequency three-dimensional color Doppler. J Am Soc Echocardiogr. 2010;23(1):1-8. PMID: 19914037
7. Yu A, Lovstakken L. Eigen-based clutter filter design for ultrasound color flow imaging: a review. IEEE Trans Ultrason Ferroelectr Freq Control. 2010;57(5):1096-111. PMID: 20442020

2.1 Cardiac ultrasound

8. Dalen H, Thorstensen A, Vatten LJ, Aase SA, Stoylen A. Reference Values and Distribution of Conventional Echocardiographic Doppler Measures and Longitudinal Tissue Doppler Velocities in a Population Free from Cardiovascular Disease. Circ Cardiovasc Imaging. 2010 Sep 1;3(5):614-22. PMID: 20581050
9. Aase SA, Björk-Ingul C, Thorstensen A, Torp H, Støylen A. Aortic Valve Closure: Relation to Tissue Velocities by Doppler and Speckle Tracking in Patients with Infarction and at High Heart Rates. Echocardiography. 2010;27(4):363-9.PMID: 20331696
10. Thorstensen A, Dalen H, Amundsen BH, Aase SA, Stoylen A. Reproducibility in echocardiographic assessment of the left ventricular global and regional function, the HUNT study. Eur J Echocardiogr. 2010;11(2):149-56. PMID: 19959533
11. Dalen H, Thorstensen A, Aase SA, Ingul CB, Torp H, Vatten LJ, Stoylen A. Segmental and global longitudinal strain and strain rate based on echocardiography of 1266 healthy individuals: the HUNT study in Norway. Eur J Echocardiogr. 2010;11(2):176-83. PMID: 19946115
12. Ingul CB, Malm S, Refsdal E, Hegbom K, Amundsen BH, Støylen A. Recovery of function after acute myocardial infarction evaluated by tissue Doppler strain and strain rate. J Am Soc Echocardiogr. 2010;23(4):432-8. PMID: 20202790
13. Hovland A, Staub UH, Bjørnstad H, Prytz J, Sexton J, Støylen A, Vik-Mo H. Gated SPECT offers improved interobserver agreement compared with echocardiography. Clin Nucl Med. 2010 Dec;35(12):927-30. PMID: 21206222
14. Nestaas E, Støylen A, Brunvand L, Fugelseth D. Longitudinal strain and strain rate by tissue Doppler are more sensitive indices than fractional shortening for assessing the reduced myocardial function in asphyxiated neonates. Cardiol Young. 2011 Feb;21(1):1-7. Epub 2010 Oct 6. PMID: 20923594
15. Ericsson M, Andersson KB, Amundsen BH, Torp SH, Sjaastad I, Christensen G, Sejersted OM, Ellingsen O. High-intensity exercise training in mice with cardiomyocyte-specific disruption of Serca2. J Appl Physiol. 2010;108(5):1311-20. PMID: 20167673
16. Aamot IL, Moholdt T, Amundsen BH, Solberg HS, Mørkved S, Støylen A. Onset of exercise training 14 days after uncomplicated myocardial infarction: a randomized controlled trial. Eur J Cardiovasc Prev Rehabil. 2010;17(4):387-92. PMID: 19940774

3.1 Neurosurgery

17. Solheim O, Selbekk T, Jakola AS, Unsgård G. Ultrasound-guided operations in unselected high-grade gliomas-overall results, impact of image quality and patient selection. Acta Neurochir (Wien). 2010 Nov;152(11):1873-86. PMID: 20652608
18. Jakola AS, Sørlie A, Gulati S, Nygaard OP, Lydersen S, Solberg T. Clinical outcomes and safety assessment in elderly patients undergoing decompressive laminectomy for lumbar spinal stenosis: a prospective study. BMC Surg. 2010 Nov 22;10:34. PMID: 21092227
19. Berntsen EM, Gulati S, Solheim O, Kvistad KA, Torp SH, Selbekk T, Unsgård G, Håberg AK. Functional magnetic resonance imaging and diffusion tensor tractography incorporated into an intraoperative 3-dimensional ultrasound-based neuronavigation system: impact on therapeutic strategies, extent of resection, and clinical outcome. Neurosurgery. 2010;67(2):251-64. PMID: 20644410
20. Solheim O, Selbekk T, Løvstakken L, Tangen GA, Solberg OV, Johansen TF, Cappelen J, Unsgård G. Intrasellar ultrasound in transsphenoidal surgery: a novel technique. Neurosurgery. 2010;66(1):173-85. PMID: 20023548
21. Selbekk T, Brekken R, Solheim O, Lydersen S, Hernes TA, Unsgaard G. Tissue motion and strain in the human brain assessed by intraoperative ultrasound in glioma patients. Ultrasound Med Biol. 2010;36(1):2-10. PMID: 19854562

3.2 Cardiac & Vascular surgery

22. Nordgaard H, Swillens A, Nordhaug D, Kirkeby-Garstad I, Van Loo D, Vitale N, Segers P, Haaverstad R, Lovstakken L. Impact of competitive flow on wall shear stress in coronary surgery: computational fluid dynamics of a LIMA-LAD model. Cardiovasc Res. 2010 Dec 1;88(3):512-9.. PMID: 20581004
23. Nordgaard HB, Vitale N, Astudillo R, Renzulli A, Romundstad P, Haaverstad R. Pulsatility index variations using two different transit-time flowmeters in coronary artery bypass surgery. Eur J Cardiothorac Surg. 2010;37(5):1063-7. PMID: 20031439

4.1 Advanced MR methods in clinical diagnosis

24. Xu J, Evensmoen HR, Lehn H, Pintzka CW, Håberg AK. Persistent posterior and transient anterior medial temporal lobe activity during navigation. Neuroimage. 2010;52(4):1654-66. PMID: 20677377
25. Palmer HS, Garzon B, Xu J, Berntsen EM, Skandsen T, Håberg AK. Reduced fractional anisotropy does not change the shape of the hemodynamic response in survivors of severe traumatic brain injury. J Neurotrauma. 2010;27(5):853-62. PMID: 20199173
26. Heldahl MG, Bathen TF, Rydland J, Kvistad KA, Lundgren S, Gribbestad IS, Goa PE. Prognostic value of pretreatment dynamic contrast-enhanced MR imaging in breast cancer patients receiving neoadjuvant chemotherapy: overall survival predicted from combined time course and volume analysis. Acta Radiol. 2010;51(6):604-12. PMID: 20429756
27. Jensen LR, Huuse EM, Bathen TF, Goa PE, Bofin AM, Pedersen TB, Lundgren S, Gribbestad IS. Assessment of early docetaxel response in an experimental model of human breast cancer using DCE-MRI, ex vivo HR MAS, and in vivo 1H MRS. NMR Biomed. 2010;23(1):56-65. PMID: 19650073
28. Askim T, Indredavik B, Håberg A. Internally and externally paced finger movements differ in reorganization after acute ischemic stroke. Arch Phys Med Rehabil. 2010 Oct;91(10):1529-36. PMID: 20875510

4.3 MR in regenerative medicine & MR nanoparticles for imaging

29. Hak S, Reitan NK, Haraldseth O, de Lange Davies C. Intravital microscopy in window chambers: a unique tool to study tumor angiogenesis and delivery of nanoparticles. Angiogenesis. 2010;13(2):113-30. PMID: 20623252
30. Reitan NK, Thuen M, Goa PE, de Lange Davies C. Characterization of tumor microvascular structure and permeability: comparison between magnetic resonance imaging and intravital confocal imaging. J Biomed Opt. 2010;15(3):036004. PMID: 20615006
31. Olsen Ø, Kristoffersen A, Thuen M, Sandvig A, Brekken C, Haraldseth O, Goa PE. Manganese transport in the rat optic nerve evaluated with spatial- and time-resolved magnetic resonance imaging. J Magn Reson Imaging. 2010 Sep;32(3):551-60. Epub 2010 Jun 10. PMID: 20815052