LINKÖPING UNIVERSITY

Welcome to the Exciting World of CMIV

Annual Scientific Report 2013

Project Leader, CMIV
Marie Waltersson

Production
Ariom Reklambyrå

Photography
CMIV
Oskar Lüren
Valentin Mellström

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Visiting adress
CMIV
Linköping University Hospital
Entrance 1, floor 11
Linköping, Sweden

Postal adress
CMIV
Linköping University
581 85 Linköping
Sweden

info@cmiv.liu.se
www.liu.se/cmiv

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4 PREFACE

"Multi-disciplinary collaboration and a strong link to the clinic is the key to our success in medical imaging research and contribution to improved patient care."

ANDERS PERSSON

SINCE THE START of CMIV in 2002, the main focus for our research has been to improve quality of care. Our strength is the dedicated researchers and staff working together towards the common goal; to gain patient benefit. Focus research and clinical areas have been brain disorders and heart disease.

During 2013 additional research areas have grown in importance in the CMIV portfolio; research linked to the metabolic syndrome, visualization and quantification of white and brown adipose tissue and digital pathology. The first publication describing the imaging technique and the discovery of a new type of fat in humans, BRITE/Beige fat, has been published in Nature Medicine May 2013.

CMIV heads a consortium developing new work processes and IT tools for digital pathology. This project aims to design novel workflows and adapted IT architecture, as well as a prioritized requirement set for corresponding IT tools. In October 2013 the first Nordic Symposium in Digital Pathology was arranged by CMIV in Linköping. Now the expectations of the second symposium in 2014 are high.

One example of the CMIV research's importance for clinical routine is quantitative MRI imaging of "neuro" examinations that has moved into the radiology department. It is now an important link in the daily clinical workflow.

The result from all on-going activities and the added focus areas have rapidly gained wide attention and the unique patient-oriented clinical research now attracts researchers and clinicians from around the world.

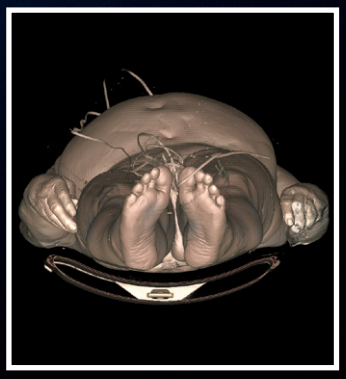
The growing number of researchers and projects and the inflow of grants challenge the human and technical infrastructure. The planning and building of CMIV 3.0 has started and moving into new premises in 2015 can be a stairway to heaven for CMIV.

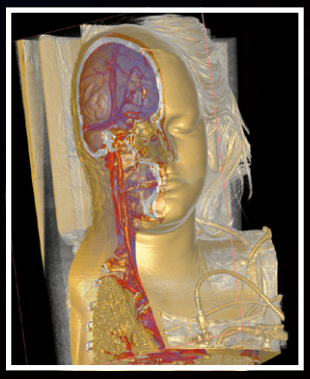
I am looking forward to the continued collaboration with the outstanding individuals at CMIV and the unique twinning of academic disciplines with great confidence.

ANDERS PERSSON, DIRECTOR OF CMIV

6 CMIV 2002 – 2012

When CMIV was initiated, the vision was to gather all the components of medical imaging and visualization in one place. And at the same time create a whole new type of research environment where scientists, technicians and medical doctors could work close together with immediate access to the patients. A place where there was no distance between research and clinical needs.

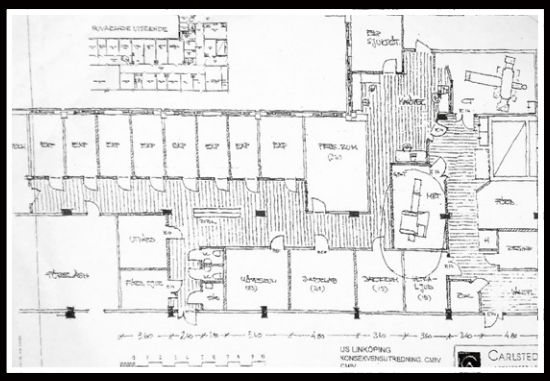


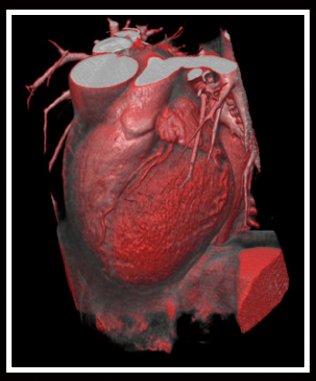


Enriching Life Through a Closer Look at Death

Launch of a new method for 3D virtual autopsies with a CT scan that only takes a few seconds – with no need to cut the body open. The method not only moves forensic science forward, the knowledge gained from working with high volume and high-resolution 3D images also benefits living patients. Plans for a new center start to take shape.

2003

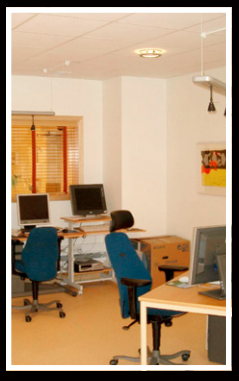




No Windows, an Amazing View

Four square meters and no windows, our first office was nothing to boast about. But when you are looking at CT images that in a short period of time will increase the number of coronary artery exams tenfold, the view is still pretty amazing.

2002



Building with No Walls

When you're first in the world to build a center that tears down traditional boundaries and allows people, ideas, creativity and production to flow freely, there are no blueprints or models to follow. Still progress is swift and the only thick walls in sight surround the CT and MRI scanners.

2004

Greatly Improving Patient Comfort

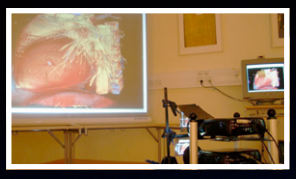
The new MRI scanner is in place and synthetic MR takes off. Synthetic MR is a software-based technology that reduces the examination time from one hour to a few minutes, greatly increasing patient comfort. Previously undetected conditions can also be visualized.

2005

Boosting Brainpower

Functional magnetic resonance imaging fMRI is becoming increasingly important in brain surgery and the fight against neurodegenerative disease. A new toolbox helps detect areas of neural activity in the brain. Professor Anders Ynnerman is awarded the Akzo Nobel Science Award for his epoch-making contributions to visualization. SCAAR, a national register for heart patients, is also founded.

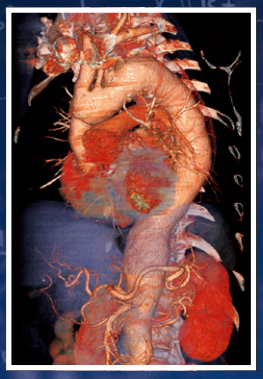
2007



A Big Leap for the Heart

With so many exciting research projects underway, there's been no time for the official opening of the center until now. The virtual theatre makes a grand entrance but it is the new Dual Source CT that steals the show. It can scan any beating heart, at any rate, allowing cardiovascular research to take a big leap forward.

2006



Hidden Mysteries Revealed

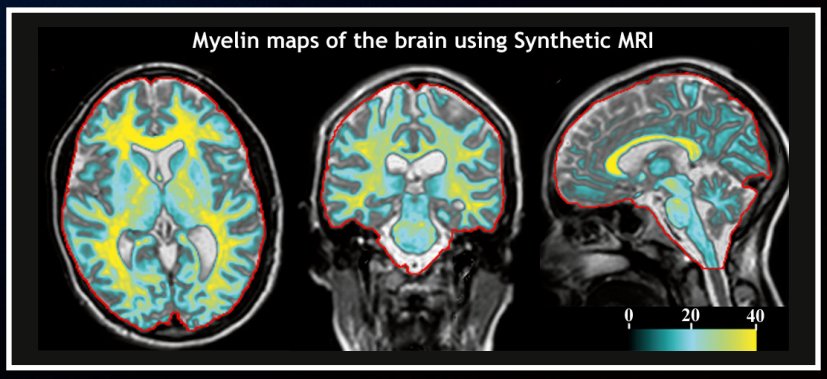
Breakthrough for a new method rendering extremely large data volumes that allow immediate display of high-resolution, full-body scans. Director Anders Persson receives the Lennart Nilsson Award for revealing the hidden mysteries of the body and producing images that can be understood and interpreted by laymen and experts alike.

2008

Surgical Knife Replaced by Fingertips

The Virtual Autopsy table is launched dispensing with the need for invasive surgical procedures. Explore the inside of the human body in 3D using only your fingertips. CMIV is also one of the first centers in the world to install the Somatom Definition Flash. This year CMIV also wins the Athena Award for best clinical medical research in Sweden.

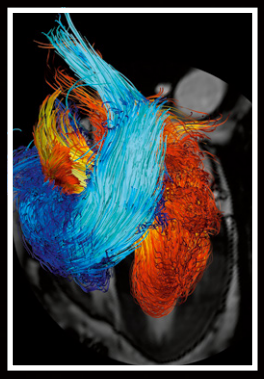
2009



Exposing the Culprit

An advanced method based on MR images shows the quantities and distribution of subcutaneous and visceral fat in the body – the latter responsible for many modern day illnesses. This can prove helpful in understanding and treating endocrine system disorders. Professor Anders Ynnerman is honored with IVA's gold medal. CMIV is first in Scandinavia to install a new type of 3 Tesla MR scanner.

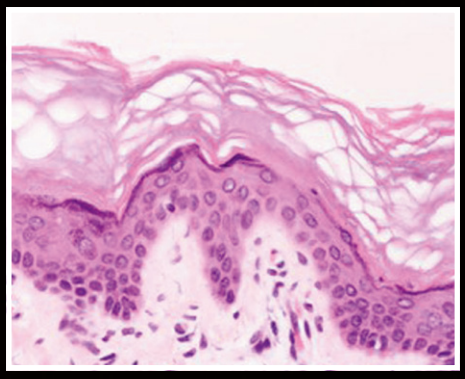
2011



The Bloodless Blood Trail

New method to measure and visualize blood flow with MR paves the way to replacing invasive methods. After more than ten years of continuous improvements, the CT radiation dosage is lowered by as much as 70%. Awards this year include the Knowledge Award, and the Thorax category in Siemens International CT Image Contest which is given to Petter Quick while ten out of the eleven Swedish papers accepted at the RSNA are submitted by CMIV.

2010



Branching Out to Pathology

Pathology is one of the most recent scientific fields being digitalized to further the delivery of personalized medicine. The CMIV article on Parametric fMRI Analysis is one of the most popular downloads from the high impact journal Neuroimage.

2012

12 HIGHLIGHTS 2013

2013 has been an eventful year at CMIV with many publications, awards and research grants. The research has blossomed and resulted in exciting meetings and conferences. Here you will find the highlights of the year.

Professor Anders Persson is Honored with the Combined Royal Colleges Award 2013

THE COMBINED ROYAL Colleges medal is awarded each year for an outstanding contribution to the advancement of medical photography or the wider field of medical imaging. This year Professor Anders Persson, head of CMIV, was honored with the award. He received the medal for pioneering work in medical imaging.

The medal was originally established in 1958 by the Royal Photographic Society in collaboration with the Royal College of Physicians of London, the Royal College of Surgeons of England and the Royal College of Obstetricians and Gynaecologists. The award ceremony was held at the Royal Society in London.

CMIV PhD Student Conference

THIS YEAR THE CMIV PhD conference was held at Storgården in Rimforsa. During the conference the PhD students presented their project in poster sessions, where projects and ideas were discussed with both other PhD students and senior researchers. The conference also included a workshop where mixed groups brainstormed about the future development of CMIV and ended with a valuable session on writing popular science with Monica Westman Svenselius, editor at Linköping University.

Nordic Symposium on Digital Pathology 2013

THE FIRST NORDIC Symposium on Digital Pathology attracted both national and international guests. The meeting was a great success for all participants as it presented a unique opportunity to discuss clinical experiences and state-of-the-art technology in the field of digital pathology. The speakers presented leading efforts in digital pathology, spanning from large-scale clinical implementations to exciting research outlooks.

The symposium was hosted by Linköping University and CMIV and was initiated by the consortium members of the Swedish research project "Optimized tools for digital pathology". The consortium consists of Linköping University, nine county councils/care providers (Gävleborg, Jönköping, Kalmar, Norrlandstingen, Sahlgrenska and Östergötland), the medical IT company Sectra and the industrial research institute Swerea IVF.

The Knut and Alice Wallenberg Foundation has Granted a CMIV Project With Four Year Funding

Knut och Alice Wallenbergs Stiftelse

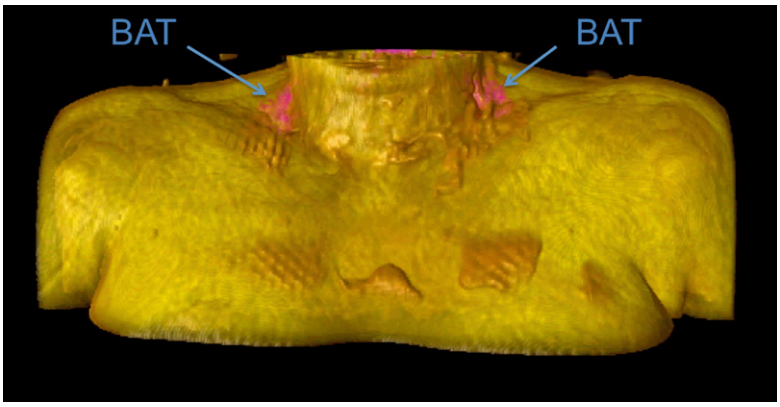
THE CMIV PROJECT "Seeing organ function – patient specific image data", is one of 27 Swedish research projects with potential of new scientific breakthroughs, which together are granted over 770 million SEK by Knut and Alice Wallenberg Foundation. The CMIV project, with professor Anders Ynnerman as principal applicant has been granted with four year funding of 24.5 million SEK. Co-applicants are Örjan Smedby, Timo Ropinski, Magnus Borga, Tino Ebbers, Maria Engström, Markus Heilig, Matts Karlsson, Hans Knutsson, Peter Lundberg, Claes Lundström, Anders Persson and Karin Wårdell.

3D Technologies Reveal Hidden Egyptian Treasures

DURING 2013 CMIV participated in a project together with the Interactive Institute Swedish ICT at Visualization Center C in Norrköping and Autodesk to create a digital copy of the mummy Neswaiu from Medelhavsmuseet in Stockholm. The result is now presented in a new exhibition where the visitors can unwrap and explore the mummy using an interactive touch table.

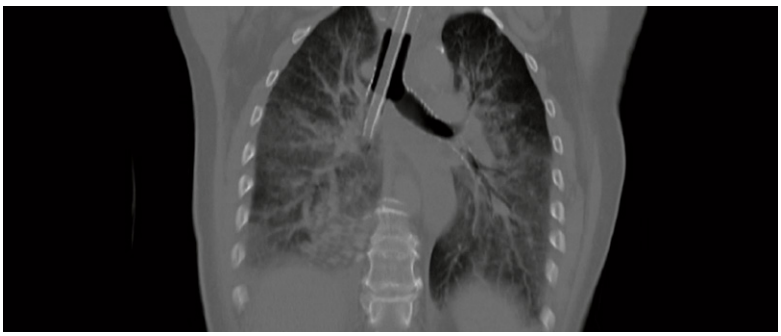
The mummy has been captured digitally in 3D using a combination of dual energy computed tomography (CT) and 3D photogrammetry using the Autodesk ReCap solution, resulting in a complete 3D model of the mummy, not just for the outside but also on the inside.

Apart from Neswaiu also the rest of the mummies at Medelhavsmuséet were scanned at CMIV. The novel CT methods developed at CMIV allowed a more detailed scanning of the mummies than has ever been possible before and therefore revealed details that were not previously known. The images present a unique possibility for the historians to explore the Egyptian culture without disturbing the mummies.



Nature Publication

DURING SPRING 2013 a CMIV research group, published a study in Nature Medicine. The aim of the study was to investigate which types of brown fat there are in humans. The results show, unlike earlier studies, that there are two types of brown fat in humans. Evidence for the existence of beige brown fat has been presented in earlier studies. However, this study also found evidence of classical brown fat, a type of brown fat that until now only was believed to be present in rodents. The research is a collaboration between scientists from Sahlgrenska Academy in Gothenburg and from CMIV in Linköping. At CMIV a magnetic resonance camera is used to localize the brown fat. The image is used as guidance when extracting the tissue samples, which are then analyzed on a molecular level in Gothenburg.



Anders Persson Receives Award at Röntgenveckan 2013

ANDERS PERSSON RECEIVED the second place award for best independent presentation at Röntgenveckan 2013. The subject of his presentation was "High frequency of misplaced catheters in the thoracic region of patients treated and deceased in hospital care".

Dagens Medicin attended Röntgenveckan and published an article about Anders study (Dagens medicin 36/13 onsdag 4 september).

Swedish Research Council Grant to CMIV Researcher

THE SWEDISH RESEARCH COUNCIL grants CMIV researcher Petter Dyverfelt four million SEK during four years for his project "A paradigm shift in the evaluation of vascular disease: Quantification of hemodynamic markers with novel 4D magnetic resonance flow imaging".

This project will develop new techniques for measuring blood flow properties using 4D magnetic resonance flow imaging. Most vascular diseases are related to atherosclerosis. Atherosclerosis alters the blood flow mechanics which in turn damages the vessels and worsens the vascular disease. Finding new ways to monitor the blood flow will increase the understanding of the relation between blood flow and vascular disease and open up for new diagnostic possibilities.

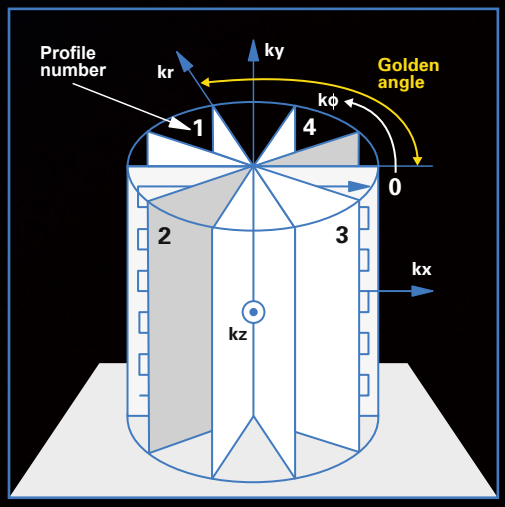
16 CMIV IMAGING CHAIN

CMIV conducts focused front-line research within multidisciplinary projects providing solutions to tomorrow's clinical issues. The mission is to develop future methods and tools for image analysis and visualization for applications within health care and medical research.

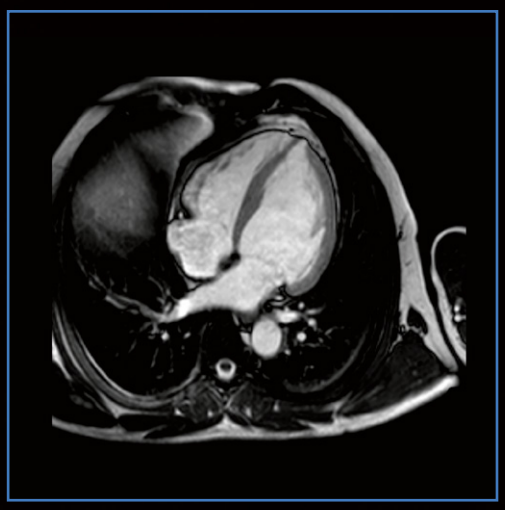
CMIV HAS A unique constellation in which research in the university provides the opportunity for clinical benefit in the county council while the industry benefits nationally and internationally. The activities aim to combine different demands were the university seeks publications in high quality journals and the county council wishes that the research and development comes to patient benefit. CMIVs organization centrally located within the university hospital creates conditions that combine these requirements. Results from basic research in universities can be utilized in clinical research which can then result in scientific publications, and patient cure.

The research projects at CMIV are all part of the imaging chain. Projects move dynamically through the chain and researchers from different disciplines work together to reach the goal of patient benefit. Focused research and development in all steps of the chain is important to continue to improve quality of care.

Information is gathered using novel imaging equipment



Raw data is processed using complex calculations and algorithms



Important findings are visualized in a comprehensive way

Images and findings are used in patient care

18 FLAGSHIP PROJECTS

During 2013 the CMIV scientific council decided to identify the three CMIV projects together best representing the broad and multi-disciplinary research at CMIV. The flagship projects were chosen through a nomination procedure and the resulting projects complement each other in modalities, project stage and medical area.

PROJECT NAME
Assessment of cardiovascular blood flow using 4D flow MRI

PROJECT LEADER
Tino Ebbers, Department of Medical and Health Sciences, Division of Cardiovascular Medicine & Department of Science and Technology, Division of Media and Information Technology

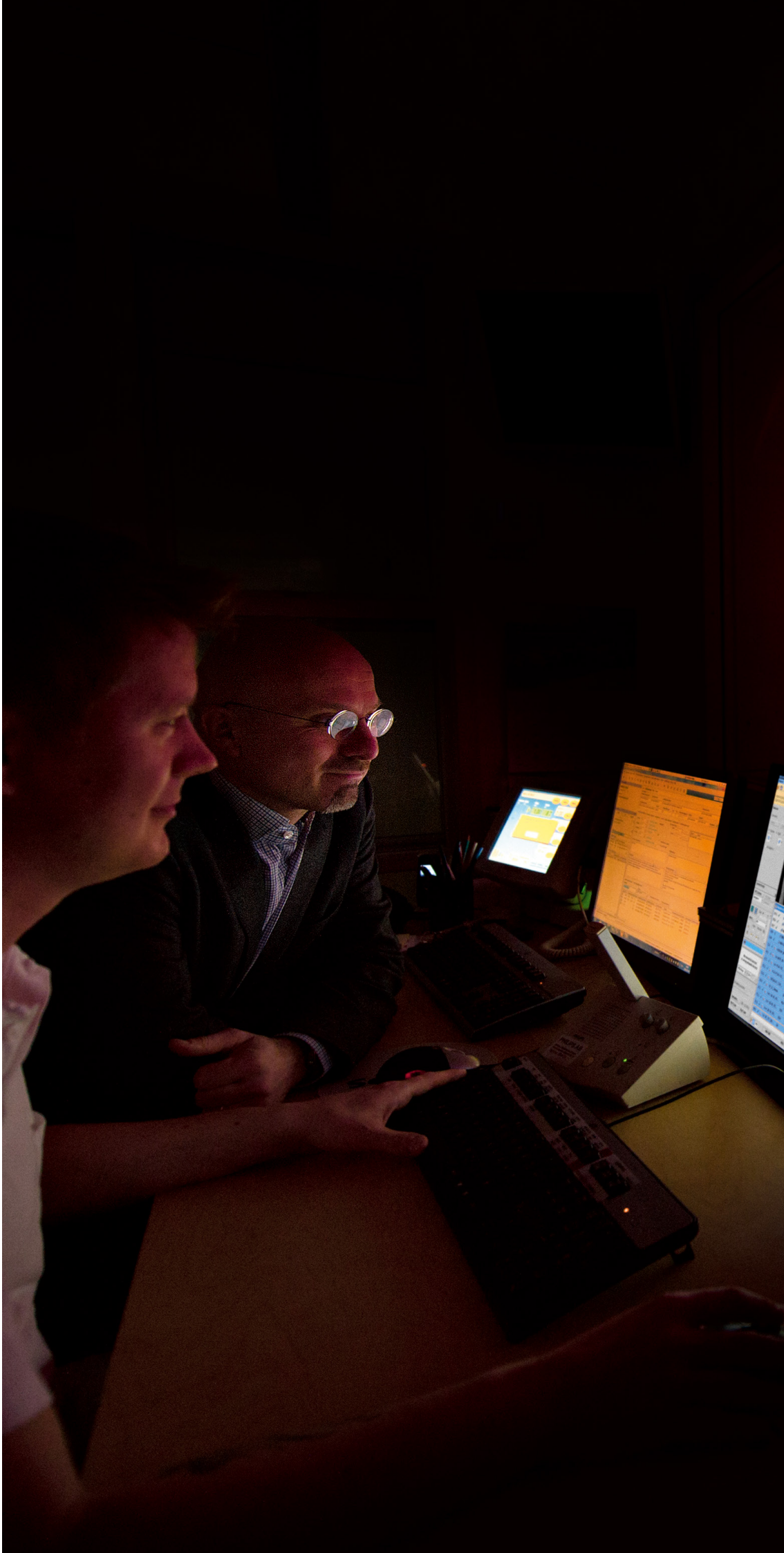
MAIN PROJECT PARTICIPANTS
Senior research leaders: Tino Ebbers, Carl-Johan Carlhäll, Jan Engvall, Petter Dyverfeldt
Post Doc: Jonas Lantz
PhD students: Sven Petersson, Jonatan Eriksson, Belén Casas Garcia, Mariana Bustamante

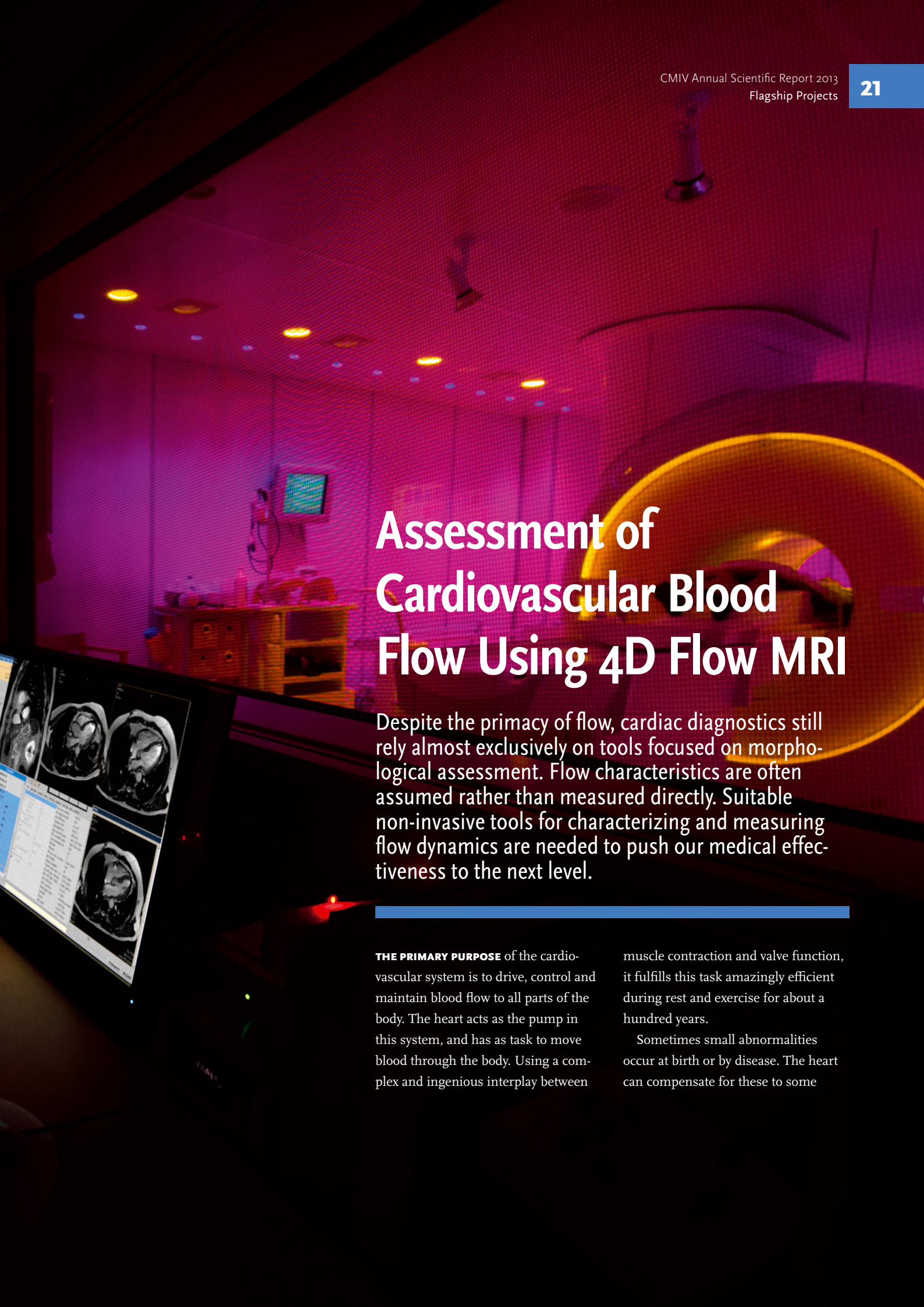
GRANTS
Swedish Research Council 2011-2013
European Research Council 2013-2017

KEY PUBLICATIONS
Sigfridsson A, Petersson S, Carlhäll CJ, Ebbers T. 4D flow MRI using spiral acquisition. Magn Res in Med. 2012;68:1065-1073.

Dyverfeldt P, Sigfridsson A, Knutsson H, Ebbers T. A Novel MRI Framework for the Quantification of Any Moment of Arbitrary Velocity Distributions. Magnetic Resonance in Medicine 2011;65:725-731.

Markl M, Kilner PJ, and Ebbers T. Comprehensive 4D velocity mapping of the heart and great vessels by cardiovascular magnetic resonance. J Cardiovasc Magn Reson. 2011; 13(1): 7.





Assessment of Cardiovascular Blood Flow Using 4D Flow MRI

Despite the primacy of flow, cardiac diagnostics still rely almost exclusively on tools focused on morphological assessment. Flow characteristics are often assumed rather than measured directly. Suitable non-invasive tools for characterizing and measuring flow dynamics are needed to push our medical effectiveness to the next level.

THE PRIMARY PURPOSE of the cardiovascular system is to drive, control and maintain blood flow to all parts of the body. The heart acts as the pump in this system, and has as task to move blood through the body. Using a complex and ingenious interplay between muscle contraction and valve function, it fulfills this task amazingly efficient during rest and exercise for about a hundred years.

Sometimes small abnormalities occur at birth or by disease. The heart can compensate for these to some

extent, but they can also lead to inefficient pump function and sometimes to a cascade of more severe abnormalities.

–We continue to lose ground against cardiovascular diseases. They are driven by obesity, diabetes and an aging population, says Tino Ebbers, Professor in Cardiovascular Physiology and project leader of "Assessment of cardiovascular blood flow using 4D flow MRI". Imaging that is focused on answering the most relevant questions, with an eye towards tangible improvements in diagnosis, therapy and outcomes can facilitate treatment of cardiac patients with higher quality and lower costs. Despite the primacy of flow, cardiac diagnostics still rely almost exclusively on tools focused on morphological assessment. Flow characteristics are often assumed rather than measured directly. Suitable non-invasive tools for characterizing and measuring flow dynamics are needed to push our medical effectiveness to the next level.

Tino has studied blood flow with magnetic resonance imaging (MRI) for many years. In the beginning the analysis was time-consuming with low quality images and not suitable for a clinical setting.

–The magnetic resonance technique has advanced in recent years and it is now possible to analyse blood flow with high quality images fast enough for clinical purposes, continues Tino.
–At CMIV, we are one of the leading centres in the world when it comes to imaging blood flow dynamics in the heart.

Analysing the heart ads an extra dimension to the imaging since it is in constant motion.

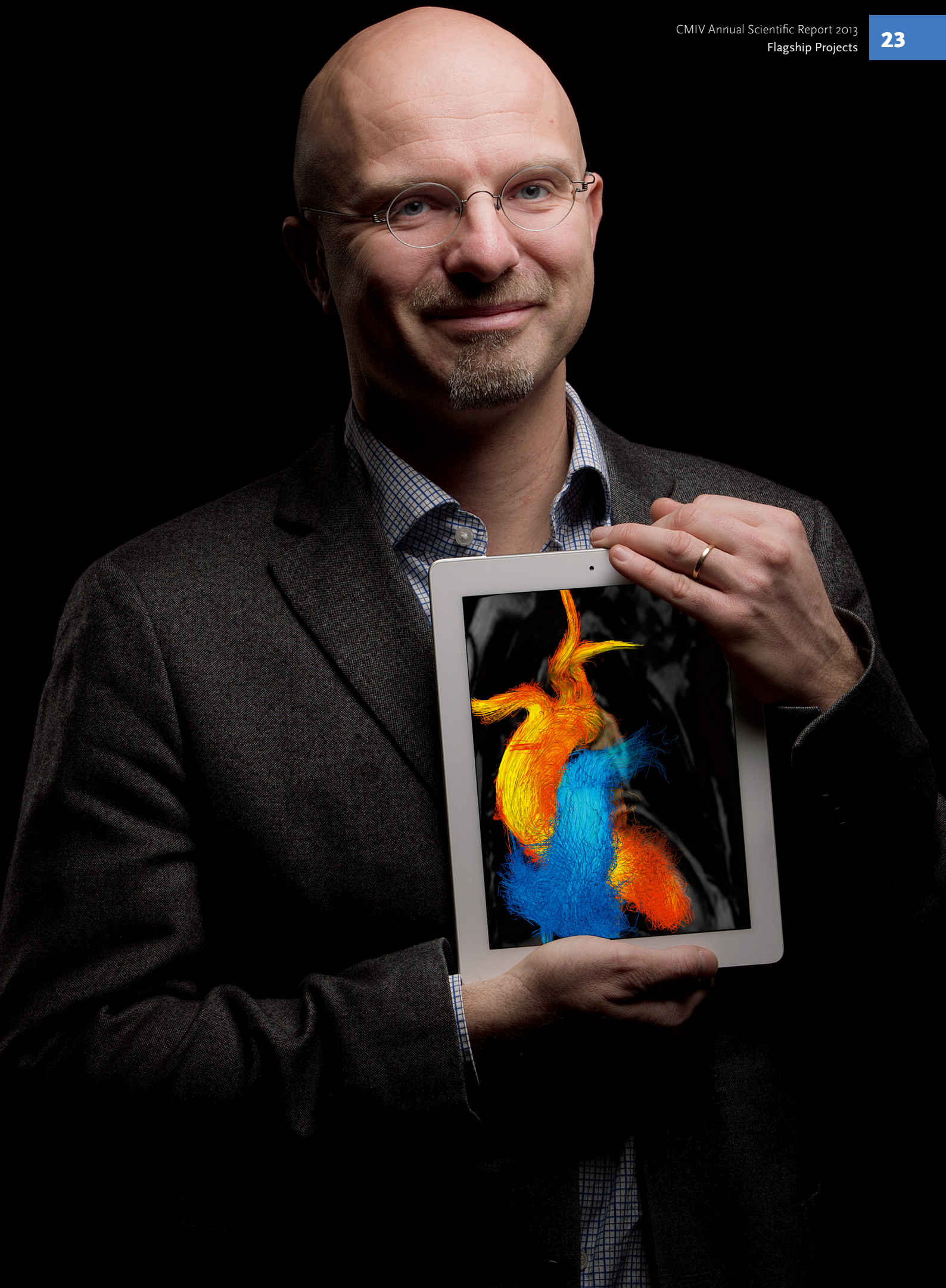
The objective of this project is to develop the next generation of methods for the non-invasive quantitative assessment of cardiac diseases and therapies by focusing on blood flow dynamics, with the goals of earlier and more accurate detection and improved management of cardiac diseases.
The project has developed a method for flow quantification using MRI which allows for simultaneous measurement of time-resolved, three-dimensional (time + 3D = 4D) blood flow velocity and turbulence intensity. This method reveals blood flow patterns in the heart and the large vessels.

–We are now working on optimizing the accuracy, measurement time, and robustness of 4D flow MRI and have good hope of bringing the technique to clinical use in the near future.
Cardiovascular blood flow is still to a large extent unknown. In order to define relevant parameters, development of analysis and visualization approaches and studies of normal and abnormal blood flow have to be performed in chorus.

Studying cardiovascular blood flow dynamics in patients and healthy subjects will improve our understanding of the roles of flow dynamics in health and disease, leading to improved cardiac diagnostics, novel assessments of pharmaceutical, interventional, and surgical therapies, and promoting exploration of new avenues for management of cardiac disorders.

"At CMIV, we are one of the leading centers in the world when it comes to imaging blood flow dynamics in the heart."

PROFESSOR TINO EBBERS



PROJECT NAME
Imaging of Brown Adipose Tissue

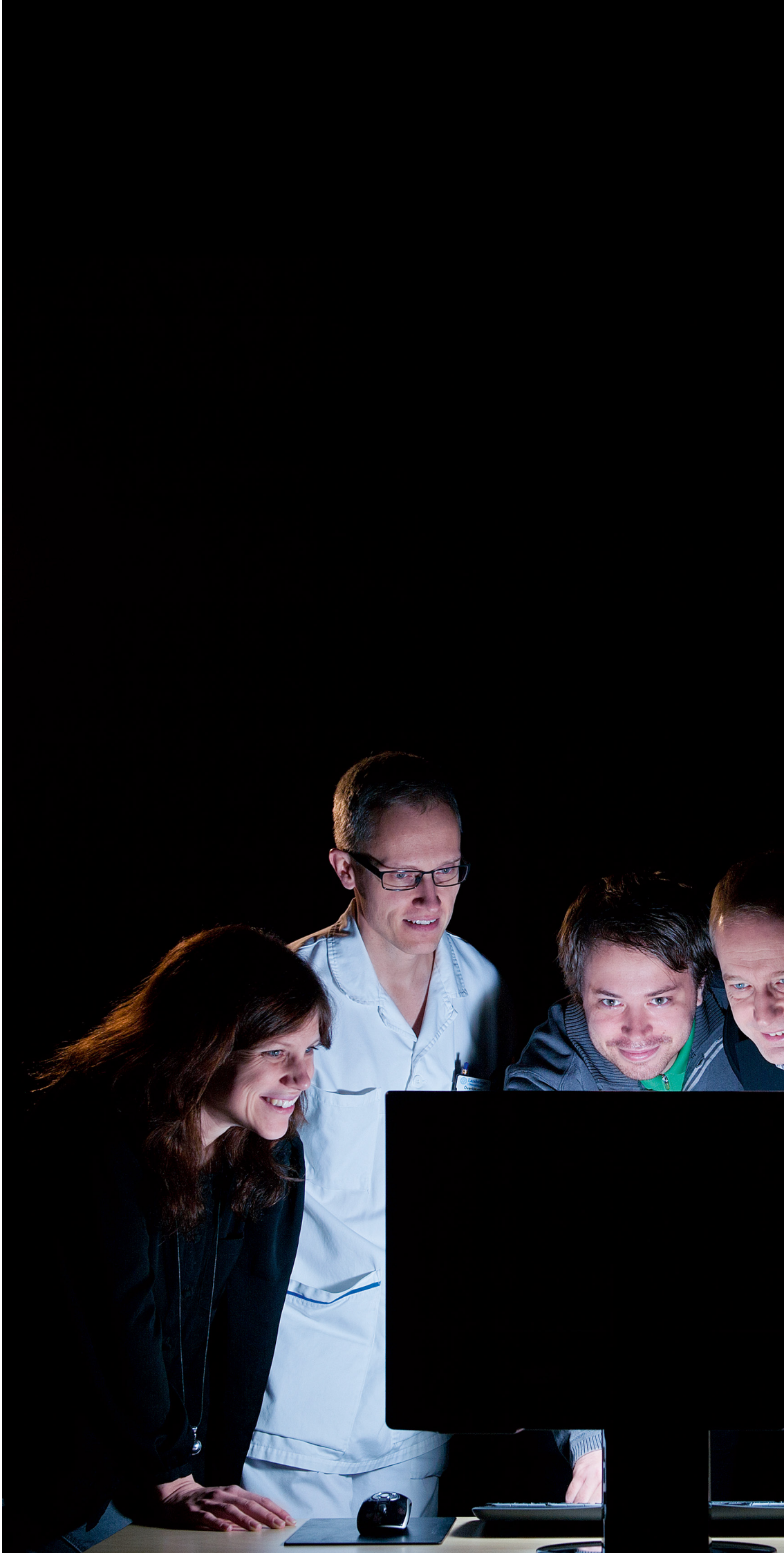
PROJECT LEADER
Magnus Borga, Department of Biomedical Engineering, Division of Medical Informatics

MAIN PROJECT PARTICIPANTS
Anders Persson, Olof Dahlqvist Leinhard, Thobias Romu, Nils Dahlström

GRANTS
KAW 2012-2017

KEY PUBLICATIONS
Martin E. Lidell, Matthias J. Betz, Olof Dahlqvist Leinhard, Mikael Heglind, Louise Elander, Marc Slawik, Thomas Mussack, Daniel Nilsson, Thobias Romu, Pirjo Nuutila, Kirsi A. Virtanen, Felix Beuschlein, Anders Persson, Magnus Borga, Sven Enerbäck, "Evidence for two types of brown adipose tissue in humans", Nature Medicine, 19(5): 631-634, 2013.

Magnus Borga, Kirsi A. Virtanen, Thobias Romu, Olof Dahlqvist Leinhard, Anders Persson, Pirjo Nuutila, Sven Enerbäck, "Brown adipose tissue in humans: detection and functional analysis using PET (Positron Emission Tomography), MRI (Magnetic Resonance Imaging), and DECT (Dual Energy Computed Tomography)", Methods of Adipose Tissue Biology, Methods in Enzymology, No. 537, 2014.



Imaging of Brown Adipose Tissue

Through a unique collaboration between researchers at CMIV and Sahlgrenska University Hospital the role of brown fat is unraveled. The vision is to find a way to reduce obesity related health problems.

THE GENETIC COMPOSITION of brown fat has been studied for several years at Sahlgrenska University Hospital. But it was not until the Sahlgrenska research group met the CMIV researchers Magnus Borga and Olof Dahlqvist Leinhard that the project reached new levels. Magnus and Olof have developed a method to distinguish fat from water in magnetic resonance imaging (MRI) a method applicable on localizing brown fat deposits in the body. The two research groups complement each other in a unique manner.

–We both bring competences to the project that the other group lack. The result is a fruitful collaboration for both groups, says Magnus Borga, Professor

in Medical Informatics and project leader of "Imaging of Brown Adipose Tissue".

The human body contains different types of adipose (fat) tissue that play different roles in the metabolism. While white adipose tissue (WAT) act as energy buffer, brown adipose tissue (BAT) converts stored energy (WAT) directly into heat that keeps us warm at least as infants and is also most likely of importance to us for longer than that.

Today's sedentary life style has generated a cluster of obesity related health problems commonly referred to as the metabolic syndrome. A positive energy balance will eventually lead to insulin resistance and ultimately type 2-diabetes, which in turn may cause e.g. heart attacks, stroke, kidney problems and also many types of cancers.

–The way we eat, we supply more energy than the body can use. If there was a way to increase the energy consumption without work it would revolutionize health care, continues Magnus.
In recent years, Brown Adipose Tissue (BAT) has emerged as a highly interesting object of study in the search for future solutions to many of the major health care challenges related to the metabolic syndrome. Also, recent publications have shown relations between BAT and osteoporosis and sarcopenia (age related loss of muscle mass).
The lack of efficient tools for studying BAT in vivo, however, is a serious limitation hindering large clinical studies related to BAT. Until recently the only available method for in vivo imaging of BAT was positron emission tomography, which requires injection of a radioactive substance in the subjects, clearly limiting its use in large prospective studies.

The overall aim of this project is therefore to develop and evaluate accurate automatic methods for high-resolution in vivo imaging, classification and quantification of BAT using quantitative magnetic resonance imaging and dual energy computed tomography.

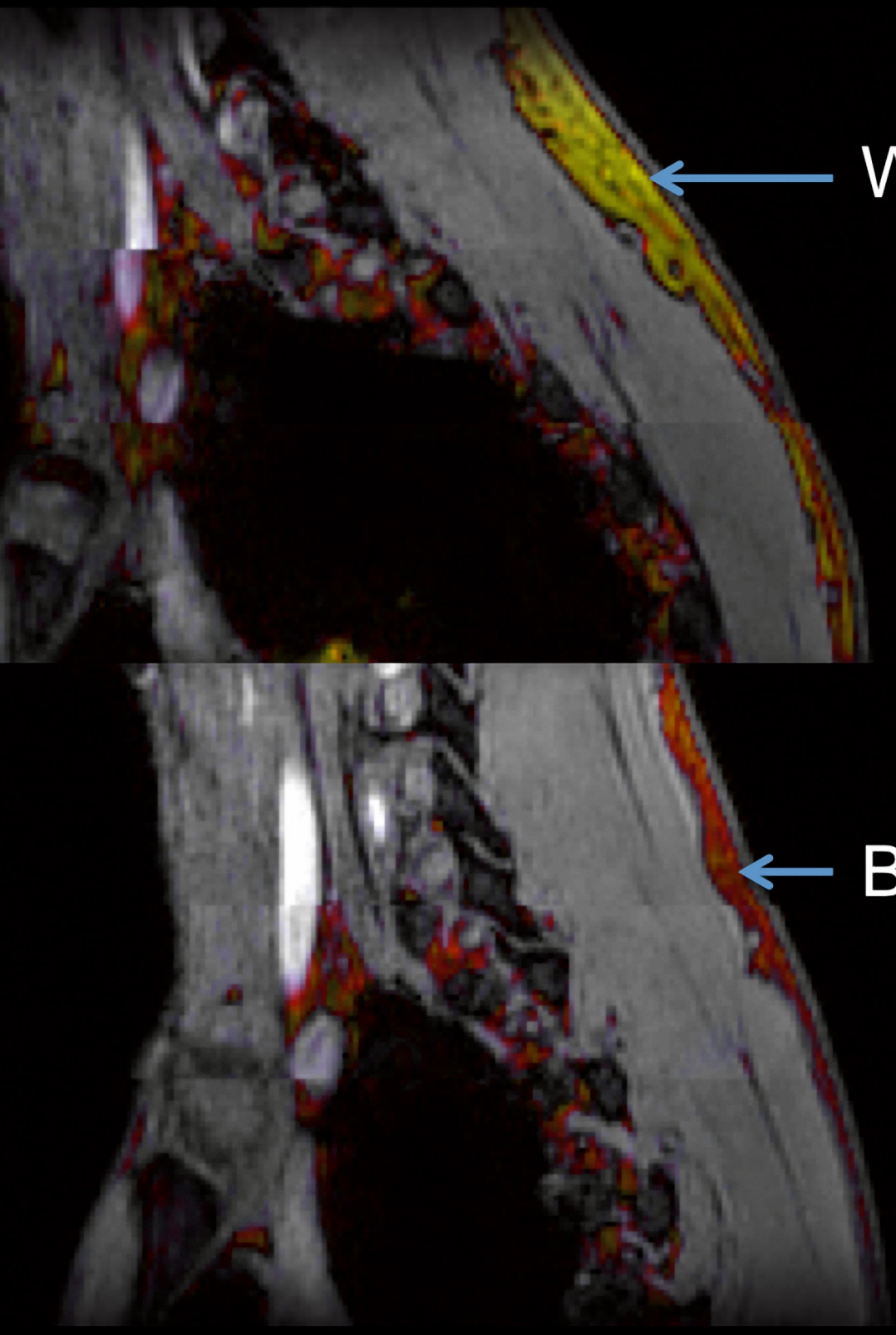
–Manual assessment of the BAT images is extremely time consuming, making larger studies impossible. Also, the reproducibility is limited in manual work. Computers on the other hand are very useful when it comes to reproducibility and speed, says Magnus.
In parallel with the method development the project also studies the properties of brown fat and the possibilities to activate and even increase the amount of brown fat.

–We have shown that it is possible to alter the constitution and amount of brown fat in rats by exposure to low temperatures. We are now proceeding with studies on humans and the results look promising, Magnus explains.

The studies of brown fat involve professionals from multiple disciplines, patient recruitment and advanced equipment. Without a center as CMIV the project would be impossible to realize.

"If there was a way to increase the energy consumption without work it would revolutionize health care."

PROFESSOR MAGNUS BORGA



The image illustrates how BAT can be detected in the neck and shoulders using MRI that can quantify the amount of fat and water in the tissue. WAT contains almost 100% fat and is indicated in yellow. BAT contains approximately 50% water and is indicated in red.

PROJECT NAME
Optimized flows and IT tools for digital pathology

PROJECT LEADER
Claes Lundström, Department of Science and Technology, Division for Media and Information Technology

MAIN PROJECT PARTICIPANTS
Senior research leaders: Claes Lundström, Peter Lundberg, Stergios Kechagias, Karin Wårdell, Daniel Forsberg, Nastaran Monsef, Ebo de Muinck, Per Carlsson, Lars-Åke Levin, Martin Hallbeck
PhD students: Kavitha Shaga Devan, Jesper Molin, Mattias Aronsson
Main clinical leads: Sten Torstenson, Janos Vasko, Lars Lundgren, Helen Richard, Edyta Johansson

GRANTS
VINNOVA 2012-2014

KEY PUBLICATIONS
Feature-enhancing zoom to facilitate Ki-67 hot spot detection,
Jesper Molin, Kavitha Shaga Devan, Karin Wårdell, Claes Lundström,
Proceedings SPIE Medical Imaging 2014.

Optimized Flows and IT Tools for Digital Pathology

In digital pathology the histology samples are scanned to create digital images of the tissue, which can be analyzed on a computer screen. While the pathologist is still responsible for the evaluation and diagnosis, the digital environment is a valuable tool for image analysis to detect, measure and grade diagnostic findings.

DIAGNOSTIC PATHOLOGY IS of crucial importance for health care, especially cancer care. Pathologists analyze tissue from the patient to determine its characteristics (histology). This knowledge is used to find the correct diagnosis and therapy. Due to lack of pathologists the waiting time for the pathology report is often long, with an anxious wait and delayed therapy for the patient as a result.

Linköping and Kalmar are world pioneers in digitization of the histology samples. The work was initiated by pathologist Sten Thorstenson as a way to deal with neck problems caused by

hours in the microscope. Now digitization entails wider advantages.

– We believe that digitization of the pathology workflow has the potential to increase both efficiency and quality of care, says Claes Lundström assistant professor at Linköping University.

In order to realize this potential, cross-disciplinary research efforts are needed that can combine clinical expertise with knowledge in image analysis and human-computer interaction.
– To digitize medical images is nothing new, continues Claes. The radiology department went through a similar revolution 15 years ago and now no one looks back.

Claes Lundström is the project leader of the CMIV project "Optimized flows and IT tools for digital pathology". The project aims to design an optimal workflow for digitized pathology, to develop a prototype of the pathologist's workstation and to create a platform for research and education within the field of digital pathology. CMIV heads the project consortium, which consists of nine county councils/care providers, the medical IT company Sectra and the industrial research institute Swerea IVF. The main funding source is VINNOVA (the Swedish Innovation Agency). CMIV efforts within the project are primarily focused on a number of research initiatives.

Today, most pathologists analyze histology samples in a microscope. In digital pathology the histology samples are instead scanned to create digital images of the tissue, which can be analyzed on a computer screen.

– A common delusion is that digitization means replacing the pathologists with computers. This is not an option, a machine can never have the diagnostic responsibility, explains Claes.

While the pathologist is still responsible for the evaluation and diagnosis, the digital environment is a valuable tool for image analysis to detect, measure and grade diagnostic findings. This possibility is an advantage that is expected to have enormous impact. The CMIV research agenda in digital pathology tackles image analysis challenges such as correlating findings between radiology and histology in liver biopsies and carotid artery plaques, as well as breast cancer histological grading and lung cancer cytology screening. Furthermore, health economic effects are investigated and human-computer interaction aspects are explored.

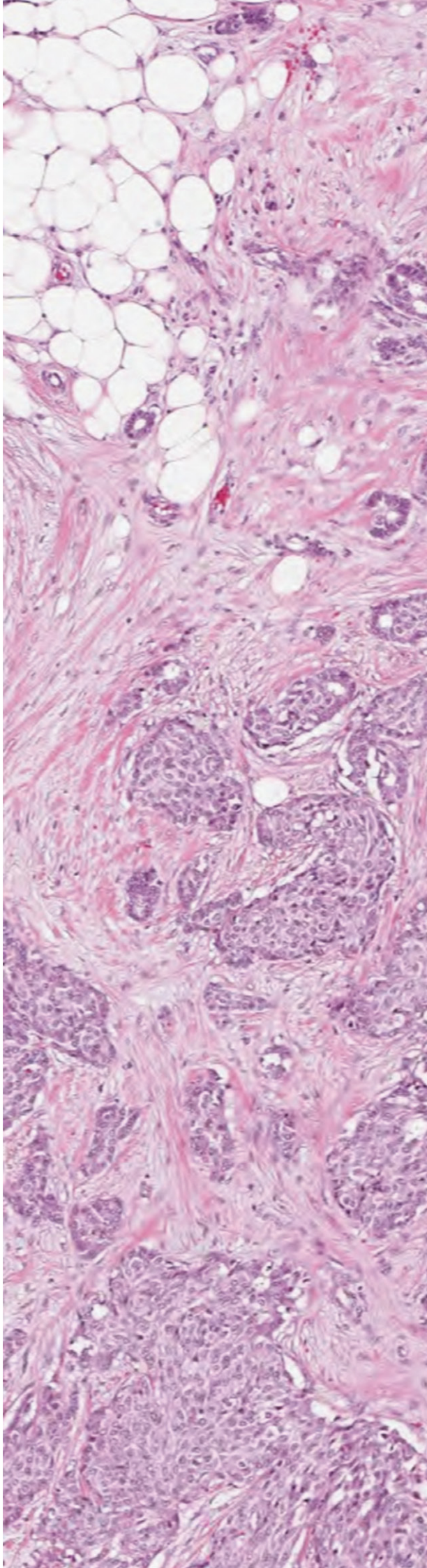
"We believe that digitization of the pathology work flow has the potential to increase both efficiency and quality of care."

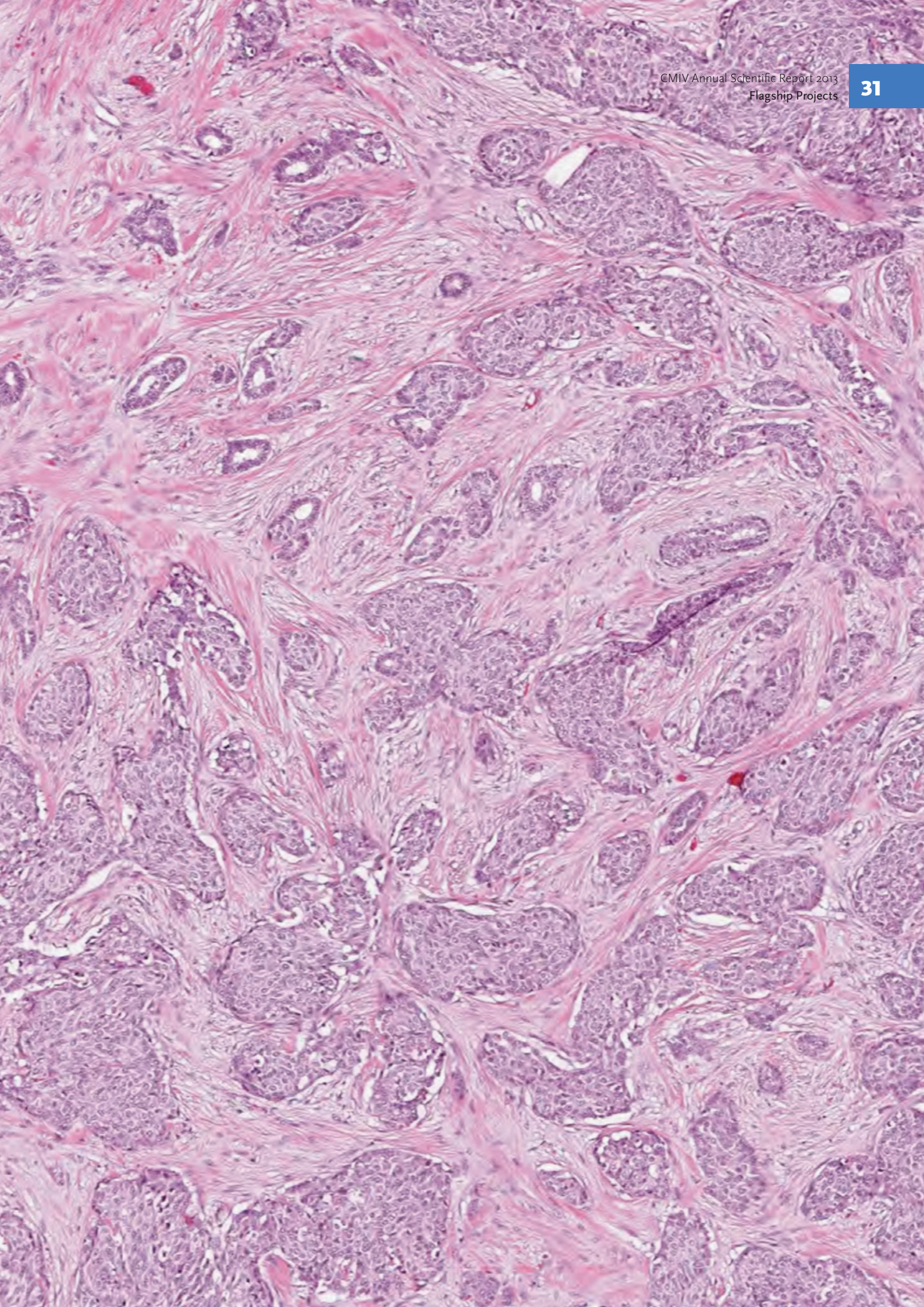
ASSISTANT PROFESSOR CLAES LUNDSTRÖM

Analyzes of the pathology department show that digitization of the workflow from referral, finished preparation and scanning of samples to the pathologist´s workstation may result in a better overview of the workload, less administration and shorter turnaround times. Digital pathology also entails unique opportunities for collaborations between hospitals both regionally and worldwide as the digital samples can be sent instantly.

– We are now focusing on strengthening the research and finding digital solutions that will work in the clinical setting, says Claes.

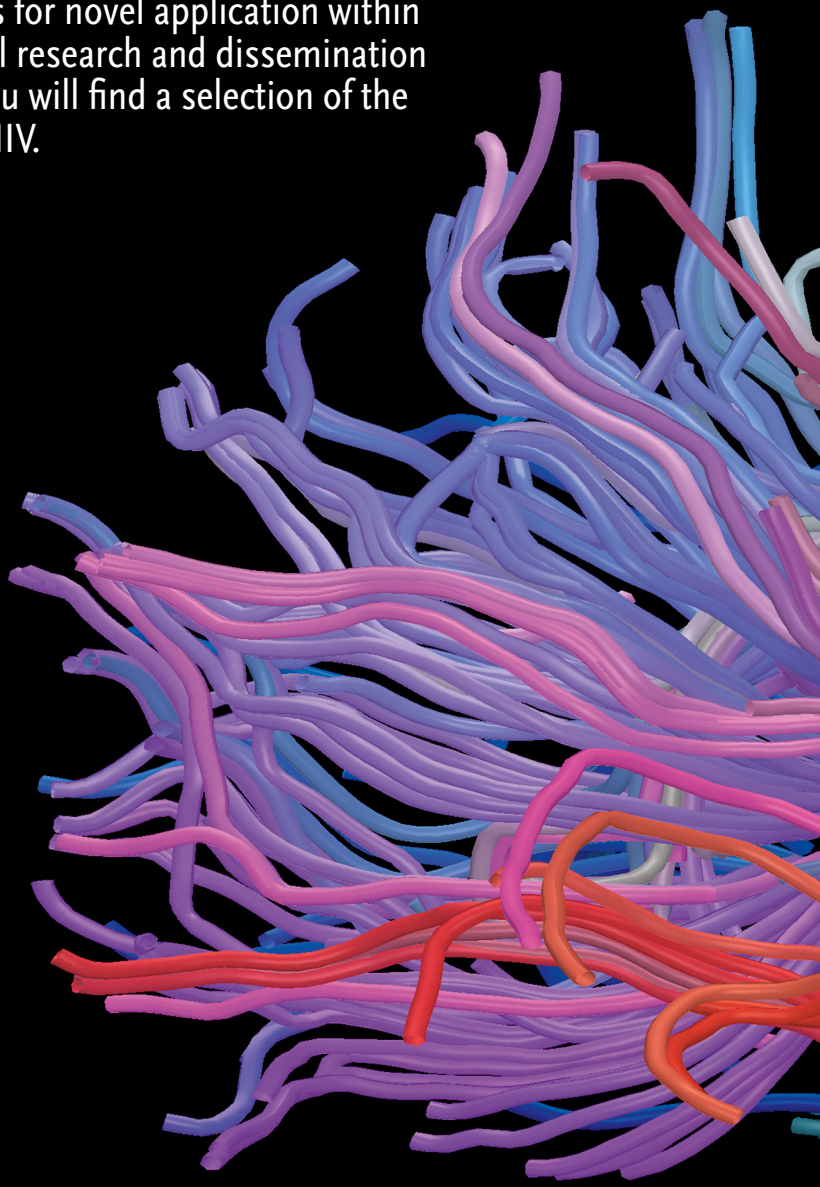
The pathologist´s workstation is developed by Sectra AB in close collaboration with CMIV and pathologists to ensure novel solutions with high usability.





32 RESEARCH PROJECTS

The research within CMIV is based on innovations in medical image science and visualization. Future directions will strengthen the interdisciplinary approach to enhance the possibilities of image-based diagnosis and treatment. At CMIV research is conducted within several medical problem areas, combining a number of technologies for novel application within clinical routine, medical research and dissemination of information. Here you will find a selection of the research projects at CMIV.



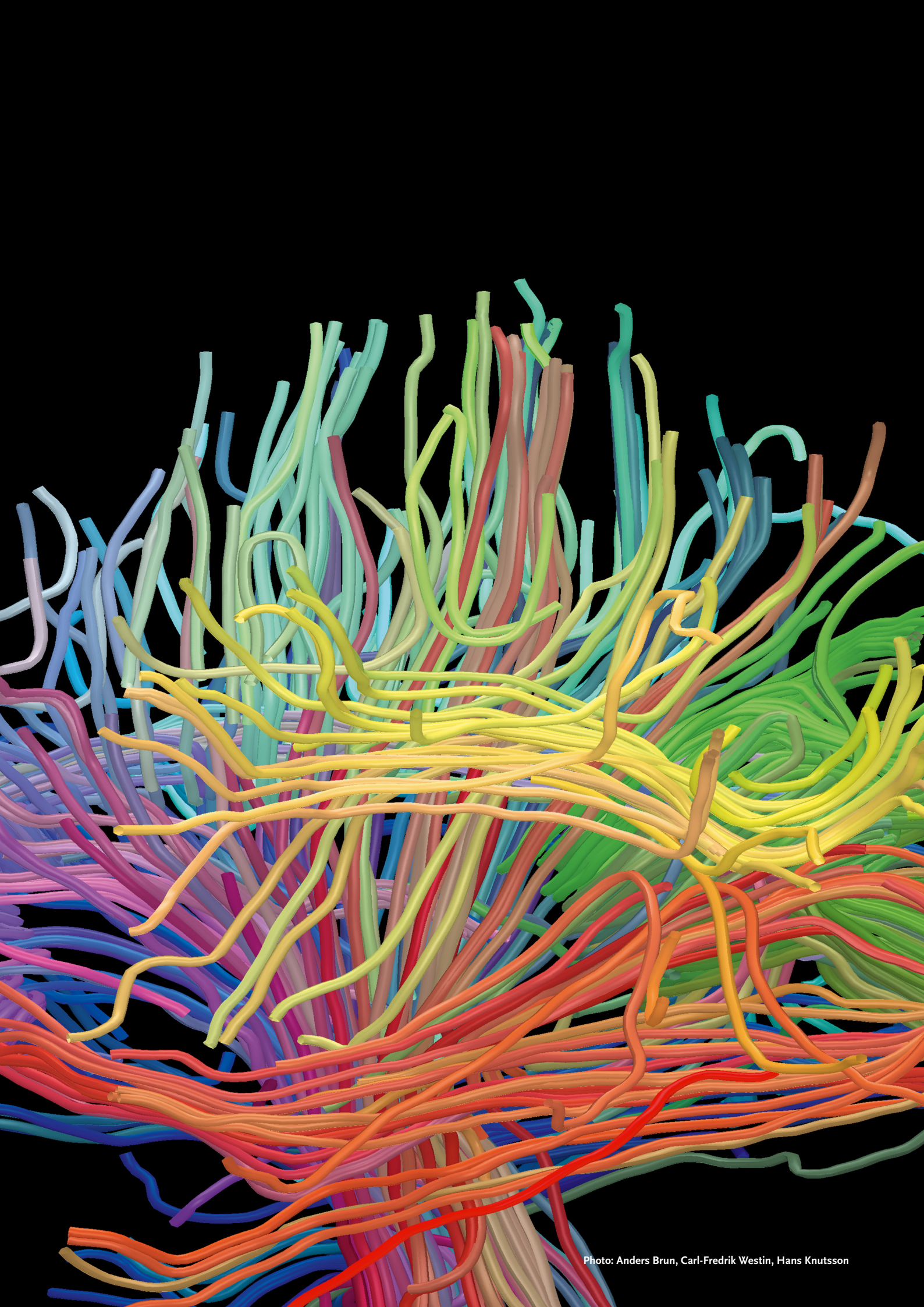


Photo: Anders Brun, Carl-Fredrik Westin, Hans Knutsson

POPULAR SCIENTIFIC SUMMARY
PETTER DYVERFELDT

Quantification of Hemodynamic Markers with Novel 4D Magnetic Resonance Flow Imaging

THE MAIN FUNCTION OF our arteries is to distribute blood flow to the organs of our body. Arteries can sometimes become constricted and this may affect the blood flow to downstream vasculature. Today, the risk that a constriction affects the blood flow is assessed based on the size of the constriction. It has been known for quite some time that abnormal blood flow is both an indicator of arterial disease and a risk factor for disease progression. Unfortunately, appropriate tools for measuring these flow effects in humans have been lacking. Consequently, we still use measures such as the size of a constriction to assess the status of the blood flow. The purpose of this project is to develop methods for the determination of some of the most important aspects of blood flow.

Many arterial diseases are related to atherosclerosis. The atherosclerotic disease process starts when we are young with deposition of fat in the arterial wall. This early process does not affect the size of our arteries but it does make them stiffer. Arterial stiffness alters the pressure wave that the heart generates when it contracts. Altered pressure wave is a strong marker of several cardiovascular diseases. Today's methods can only measure this in a few arteries, and the information that can be obtained represents an average. However, arterial stiffness varies within an artery. If we could measure those variations we could increase and improve the clinical applicability of pressure wave measurements.

The more advanced stages of atherosclerotic disease are characterized by large deposits of fat in the arterial wall. These deposits, plaques, constrict the arterial lumen. The plaques may rupture, which can cause stroke or a heart attack. The blood flow in constricted arteries can become turbulent. Several studies indicate that turbulent forces increase the vulnerability of the plaques and their risk of rupture. Today's techniques for assessing the effects of flow on the vessel wall focus on forces that exist also in normal

PROJECT NAME
Quantification of Hemodynamic Markers with Novel 4D Magnetic Resonance Flow Imaging

PROJECT LEADER
Petter Dyverfeldt, Department of Medical and Health Sciences, Division of Cardiovascular Medicine

MAIN PROJECT PARTICIPANTS
Belén Casas Garcia, Jonas Lantz, Tino Ebbers, Toste Länne

GRANTS
Swedish Research Council 2014-2017

KEY PUBLICATIONS
Hope MD, Sigovan M, Wrenn SJ, Saloner D, Dyverfeldt P. MRI hemodynamic markers of progressive bicuspid aortic valve-related aortic disease. J Magn Reson Imaging 2013; In Press. Early view: dx.doi.org/10.1002/jmri.24362.

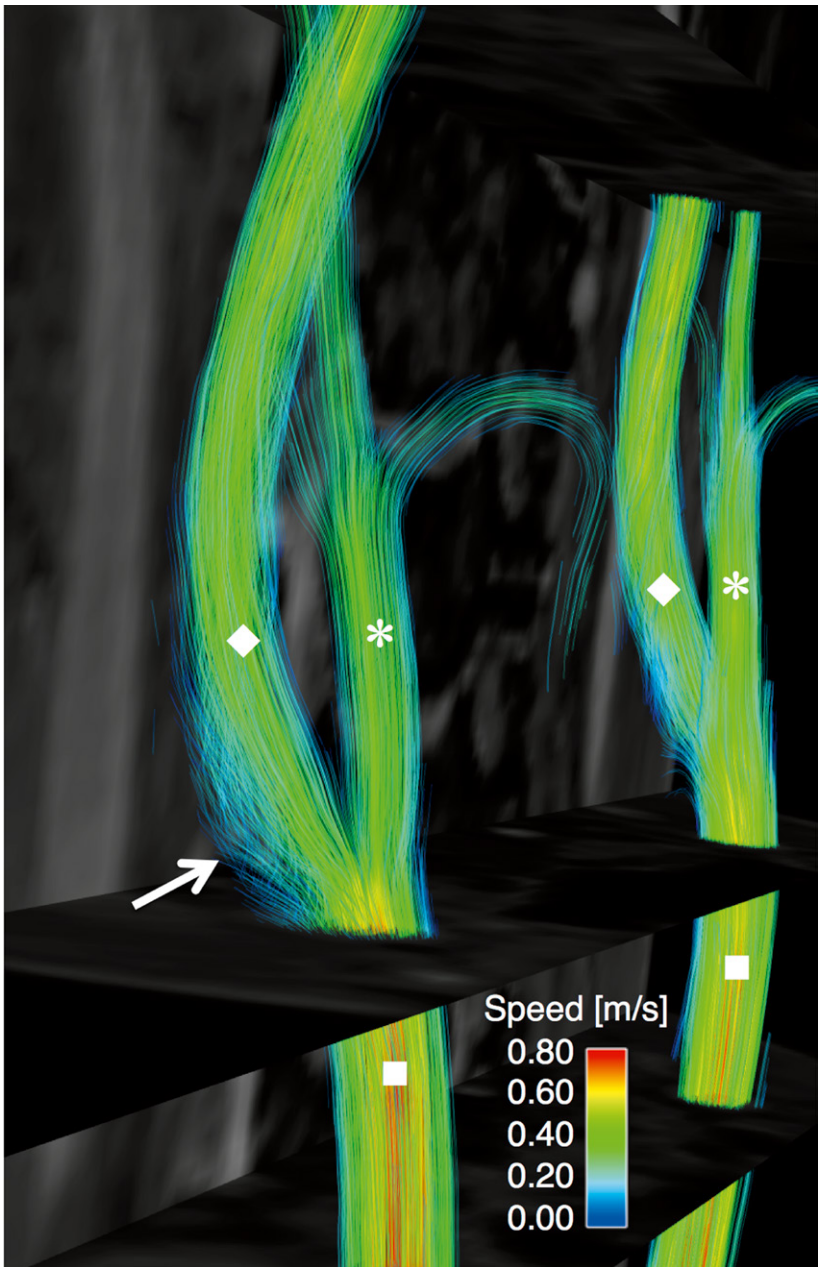
Dyverfeldt P, Deshpande VS, Kober T, Krueger G, Saloner D. Reduction of Motion Artifacts in Carotid MRI using FID Navigators. J Magn Reson Imaging 2013; In Press. Early view: dx.doi.org/10.1002/jmri.24389.

Dyverfeldt P, Hope MD, Tseng EE, Saloner D. Noninvasive Magnetic Resonance Measurement of Turbulent Kinetic Energy for the Estimation of Irreversible Pressure Loss in Aortic Stenosis. J Am Coll Cardiol Img 2013; 6(1):64-71.

blood flow in healthy arteries. However, methods that permit assessment of the impact of turbulent forces do not exist. We will develop methods for the determination of pressure wave velocity and the effects of turbulent flow on the vessel wall. In achieving our goals we plan to use an advanced magnetic resonance imaging (MRI) technique referred to as 4D flow MRI, which permits comprehensive assessment of time-varying three-dimensional (time + 3D = 4D) blood flows. This technique has the potential to unveil information about key aspects of blood flow. However, dedicated research efforts are needed to realize this potential.

Additionally, we want to be able to measure these aspects of blood flow in the coronary arteries, where many of the most dangerous vascular diseases happen. 4D flow MRI is today used primarily to study blood flow in the heart and the greater vessels. We will improve the technique for application in coronary arteries. Successful application of MRI in the coronary arteries requires that the motion of the arteries due to breathing and cardiac contraction be taken into account. If this is not done the images get blurry.

Being able to measure aspects of blood flow that have previously not been measurable will lead to an increased understanding of the interrelationship between blood flow and vascular disease. It will also open up for new ways to assess and risk-stratify vascular disease. This will offer improved care for the vast population of patients with vascular disease and financial benefits for the health care system.



4D flow MRI visualization of blood flow in the left and right carotid bifurcation (the forking of the arteries supplying the head and neck with oxygenated blood) of a normal volunteer using streamlines color-coded by flow speed. The carotid bifurcation comprises the common (square), internal (diamond) and external (asterix) carotid arteries. Arrow: Slow recirculating flow in the carotid bulb.

POPULAR SCIENTIFIC SUMMARY
TINO EBBERS AND JAN ENGVALL

DOPPLER-CIP

PROJECT NAME
DOPPLER-CIP

PROJECT LEADER
Tino Ebbers and Jan Engvall, Department of Medical and Health Sciences, Division of Cardiovascular Medicine

MAIN PROJECT PARTICIPANTS
Johan Kihlberg, Petter Dyverfeldt, Eva Olsson, Carl-Johan Carlhäll, Lars-Åke Levin, Magnus Husberg, Magnus Janzon

GRANTS
EU grant, 2010-2014

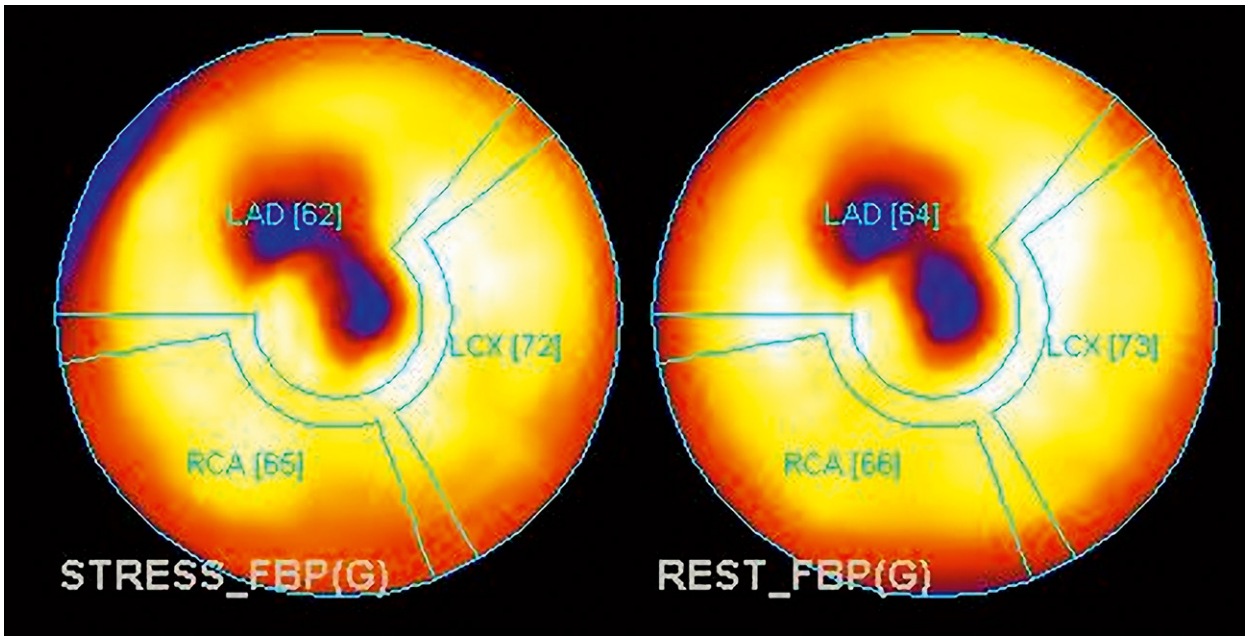
KEY PUBLICATIONS
Rademakers F, Engvall J, Edvardsen T, Monaghan M, Sicari R, Nagel E, Zamorano J, Ukkonen H, Ebbers T, Di Bello V, Voigt JU, Herbots L, Claus P, D'hooge J. Determining optimal noninvasive parameters for the prediction of left ventricular remodeling in chronic ischemic patients. Scand Cardiovasc J. 2013 Dec;47(6):329-34. doi: 10.3109 and 14017431.2013.857039.

CORONARY ARTERY DISEASE is the most prevalent cause of cardiovascular disease. It is defined by the narrowing and occlusion of coronary arteries with subsequent imbalance between myocardial oxygen consumption and supply. This imbalance causes either myocardial cell death (infarction) or chronic ischemia (viable myocardium), both leading to changes in the shape of the heart (morphologic remodeling) and functional deterioration. In the long term, patients suffer from heart failure or die.

Restoring blood flow to a region of chronic ischemia can stop the process of remodeling and allow partial or full recovery of function. The current therapeutic approaches are either to restore blood flow by mechanical dilatation of the stenosed coronary vessel (i.e., balloon angioplasty, PCI) or by surgically bypassing the stenosis (coronary artery bypass grafting). Preprocedural investigations as well as the therapeutic measures undertaken are costly and carry a considerable risk for the patient. The response of chronically ischemic myocardial cells to therapy depends on many factors. Little is known, however, about the exact relation between these pathophysiologic factors and functional recovery of the myocardium for a given therapeutic strategy.

Therefore, the purpose of DOPPLER-CIP is to determine the optimal noninvasive parameters (myocardial function, perfusion, ventricular blood flow, cell integrity) for the prediction of left ventricular morphologic and functional remodeling in chronic ischemic patients.

DOPPLER-CIP is a multi-center observational study. All patients with ischemic heart disease included in this study undergo at least two noninvasive stress imaging examinations at baseline. The presence/or absence of



left ventricular (LV) remodeling will be assessed after a follow-up of 2 years, during which all cardiac events will be registered.

After completion, DOPPLER-CIP will provide evidence-based guidelines toward the most effective use of cardiac imaging in the chronically ischemic heart disease patient. The study will generate information, knowledge, and insight into the new imaging methodologies and into the pathophysiology of chronic ischemic heart disease.

In Linköping, almost all 192 patients have undergone at least three stress imaging tests. We will have an excellent opportunity to compare the different modalities in our local material. The patients in this study have helped us develop new MRI-based methods for the measurement of wall motion abnormalities and for 3D-visualization of intracardiac blood flow.

POPULAR SCIENTIFIC SUMMARY
JAN ENGVALL AND ANDERS PERSSON

Measuring Cardiac Perfusion Using Dynamic CT Adenosin Testing

ATHEROSCLEROTIC CORONARY ARTERY disease is caused by changes to the wall known as plaque. The plaque consists of deposits of cholesterol, cells and calcium sometimes causing obstruction to the coronary flow. The diagnosis of coronary artery disease rests on the visualization of atherosclerotic plaque or limitations to flow. Invasive investigation should be reserved for patients with a high likelihood of significant disease. Various exercise tests are employed to uncover effects of obstruction that may be silent at rest. Myocardial blood flow may be visualized in different ways, most often using a gamma camera to trace the myocardial uptake of injected markers. The relationship between myocardial blood flow and the tracer molecules has been shown to be fairly linear within the range of normal resting coronary flow while uptake rolls off with increasing flow.

An alternative approach to calculating myocardial blood flow could be to use effects of angiographic contrast media in cardiac computed tomography (CT). Recent improvement in CT technology with higher temporal resolution and more advanced software has motivated a renewed interest in this method. There are a number of critical prerequisites for using this approach: the scanning of the left ventricle must be fast to be able to detect the short-lived phase of increase in attenuation that comes with the wash-in of contrast, the X-ray detector has to be large enough to allow coverage of the entire heart and reconstruction and evaluation of the recording need to be fast and accurate. Ideally, the contrast medium itself should not induce any change in coronary flow. A number of smaller studies have been published but the method still needs extensive validation

PROJECT NAME
Measuring cardiac perfusion using dynamic CT adenosin testing

PROJECT LEADER
Jan Engvall, Department of Medical and Health Sciences, Division of Cardiovascular Medicine and Anders Persson, Department of Medical and Health Sciences, Division of Radiological Science

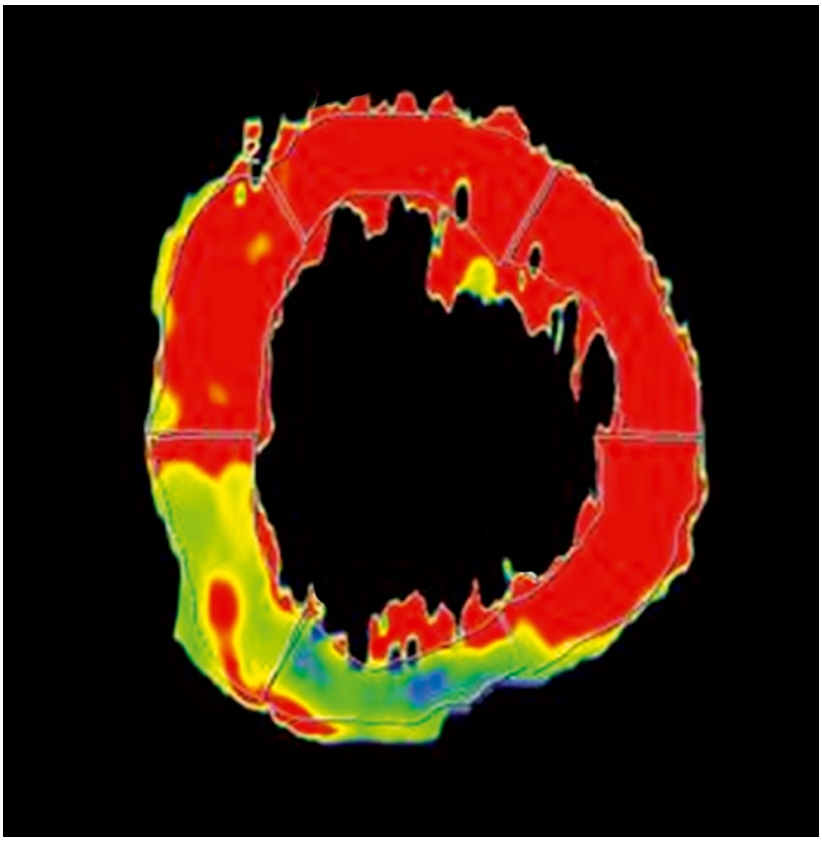
MAIN PROJECT PARTICIPANTS
Jakob de Geer, Marcus Gjerde, Petter Quick

GRANTS
Magnus Bergvalls stiftelse

before being incorporated into clinical practice.

Thus, the purpose of this study was to evaluate the variation in blood flow in cardiac segment determined to be normal or abnormal according to the gamma camera result. In addition, we wanted to compare CT blood flow values obtained with manual delineation of the cardiac wall with those obtained with automated software.

A positive but moderate correlation was found between CT and the gamma camera. Large variations in CT blood flow were detected which suggests that a single cut-off value for stress myocardial blood flow is inadequate to detect ischemic segments.



POPULAR SCIENTIFIC SUMMARY
EBO DE MUINCK

Magnetic Resonance and Carotid Ultrasound Observations

WORLDWIDE, THE MOST COMMON cause of death is cardiovascular disease and the dominant cause of cardiovascular disease is atherosclerosis. Atherosclerosis is caused by accumulation of fat, primarily cholesterol in the wall of arteries. When the fat builds up in the arterial wall it causes thickening of the vessel wall and the thickened area bulges out into the vessel, causing narrowing of the artery. The areas with fat accumulation are called atherosclerotic plaques. Sometimes these plaques rupture causing a blood clot to form at the site of rupture. The clot completely occludes the artery and stops blood flow. This causes a heart attack if it happens in the arteries of the heart or a stroke if it happens in the arteries feeding the brain.

We have developed an imaging method to identify plaques that are at high risk of rupture. We anticipate that this method will allow us to identify patients with rupture prone plaques and treat them before they suffer from a heart attack or stroke. The method uses magnetic resonance imaging (MRI) and can measure how much fat and blood there is inside atherosclerotic plaques (Figure 1). Plaques with a high fat content and a lot of blood are

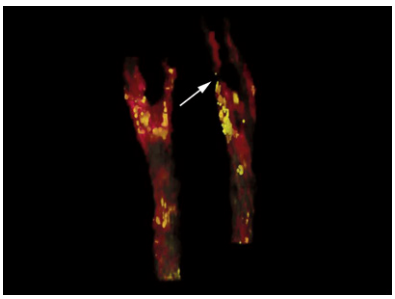


Figure 1. Magnetic resonance image of a patient with atherosclerotic plaque in both carotid arteries. The plaque has caused a severe narrowing in the right carotid artery (arrow). The amount of fat in the plaques is shown in yellow and the amount of blood is in red.

PROJECT NAME
Magnetic Resonance and Carotid Ultrasound Observations (MR CARUSO)

PROJECT LEADER
Ebo de Muinck, M.D., Ph.D, Department of Medical and Health Sciences, Division of Cardiovascular Medicine

MAIN PROJECT PARTICIPANTS
Marcel Warntjes, Petter Dyverfeldt, Johan Kihlberg, Rodrigo Moreno, Daniel Forsberg, Toste Länne, Anne-Marie Landtblom, Darren Treanor

GRANTS
Swedish Heart and Lung Foundation

KEY PUBLICATIONS
Moreno R, Koppal S, de Muinck ED. Robust estimation of distance between sets of points. Pattern Recognition Letters 2013;34:2192-2198.

at higher risk of rupture since fat and blood increase inflammation inside a plaque and inflammation leads to rupture.

We also measure turbulence in the blood that flows through the arteries, which is a third factor that can contribute to plaque rupture. Atherosclerotic plaques lead to narrowing of arteries and when blood flows through such a narrowing there is a lot of turbulence immediately behind the narrowing. Turbulent blood flow acts on the vessel wall and increases inflammation inside the plaque, thereby increasing the risk of plaque rupture (Figure 2).

In this project we study patients who are scheduled for surgical removal of atherosclerotic plaque that has caused a narrowing in one of the arteries that leads to the brain (Figure 3). This surgical procedure is called 'endarterectomy'. Before surgery, the patients undergo MRI of their carotid arteries and we measure the amount of fat and blood inside the plaque that is to be removed as well as the amount of turbulence caused by the narrowing. After surgery we study the plaque in a microscope. For this purpose the plaque is cut into a series of very thin sections and the amount of fat and blood as well as the amount of inflammatory cells is measured on each section. Then a 3D reconstruction of the plaque is generated based on these sections. This 3D rendering is compared with the MRI images by overlaying images.

We anticipate that the current study will result in an imaging method that will help identify patients with atherosclerotic plaques that are at high risk for rupture. These patients can then be treated to prevent plaque rupture and stroke.

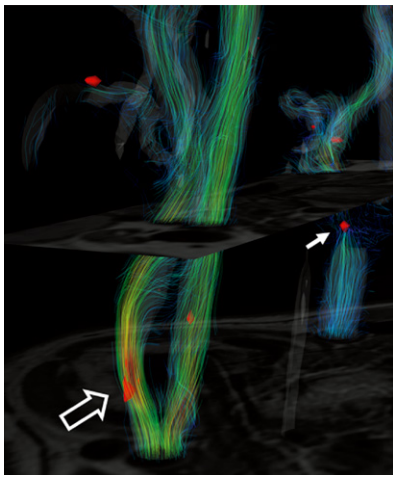


Figure 2. MRI turbulence data from a patient with carotid artery stenosis. The intensity of turbulence is graded according to a color scale, showing areas with a lot of turbulence in red and yellow downstream from a carotid artery stenosis (solid arrow) and at the outer wall of the contra-lateral internal carotid artery (open arrow).

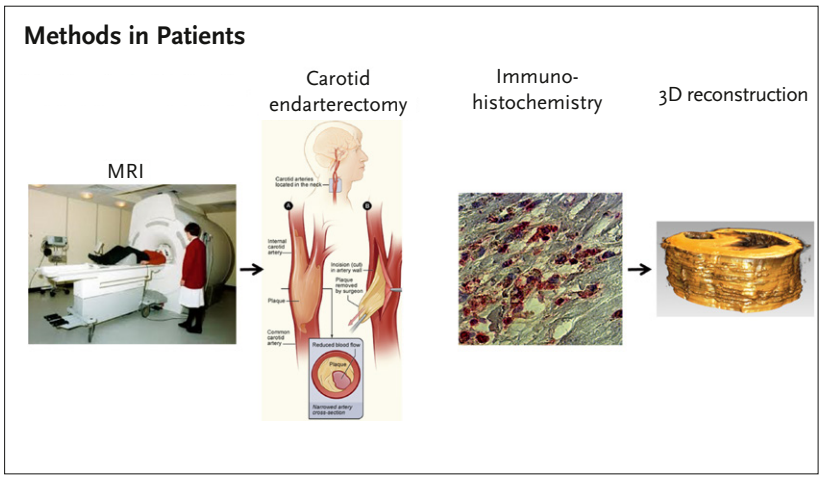


Figure 3. Methods in Patients

POPULAR SCIENTIFIC SUMMARY
ÖRJAN SMEDBY

Computer-Assisted Coronary CT Angiography Analysis

PROJECT NAME
Computer-Assisted Coronary CT Angiography Analysis

PROJECT LEADER
Örjan Smedby, Department of Medical and Health Sciences, Division of Radiological Sciences

MAIN PROJECT PARTICIPANTS
Chunliang Wang, Anders Persson, Hans Frimmel, Rodrigo Moreno

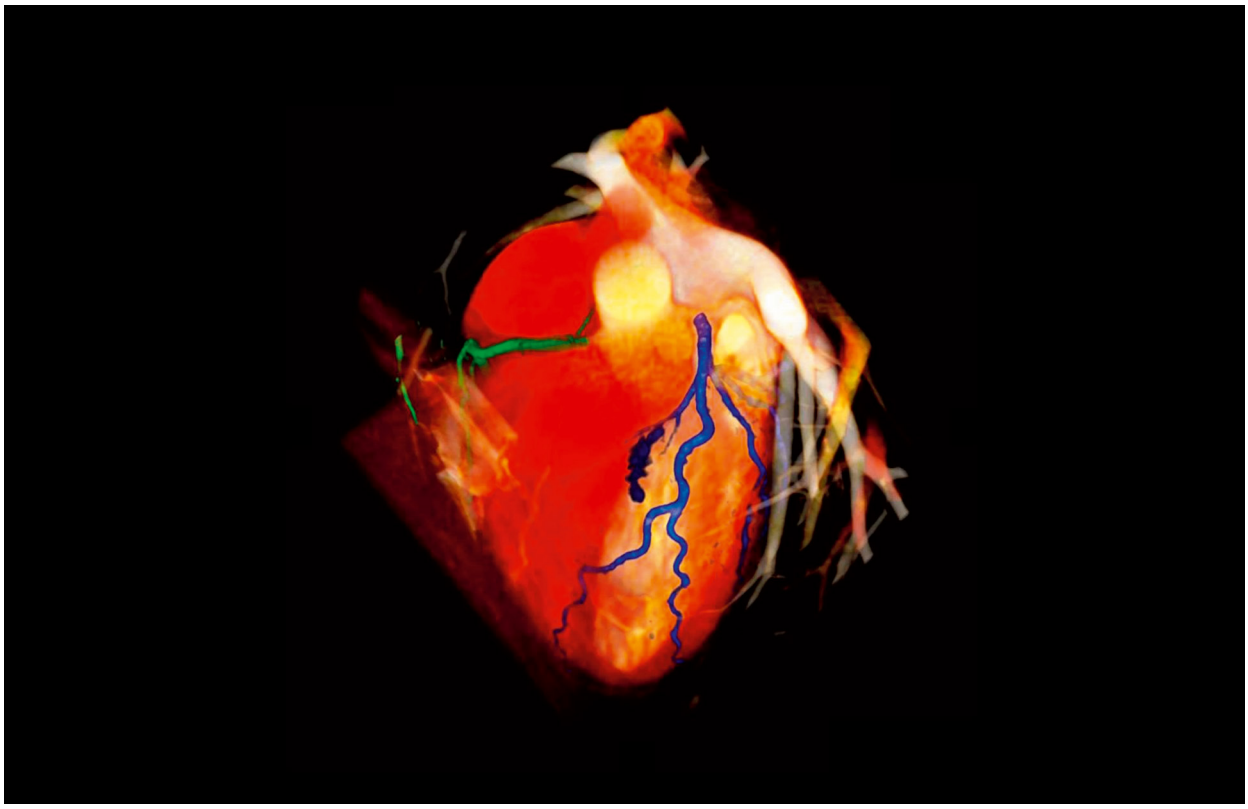
GRANTS
Swedish Heart-lung fundation 2008-2009
Swedish Heart-lung fundation 2010-2011
Swedish Heart-lung fundation 2012-2013
VR-NT 2012-2014

KEY PUBLICATIONS
C. Wang and Ö. Smedby, "Coronary artery segmentation and skeletonization based on competing fuzzy connectedness tree," Med Image Comput Comput Assist Interv Int Conf Med Image Comput Comput Assist Interv, vol. 10, no. Pt 1, pp. 311–318, 2007.

C. Wang and Ö. Smedby, "Integrating automatic and interactive methods for coronary artery segmentation: let the PACS workstation think ahead.," International journal of computer assisted radiology and surgery, vol. 5, no. 3, pp. 275–285, 2010.

C. Wang, H. Frimmel, and Ö. Smedby, "Level-set based vessel segmentation accelerated with periodic monotonic speed function," presented at the Medical Imaging 2011: Image Processing, Lake Buena Vista, Florida, March 11, 2011.

DESPITE WORLDWIDE EFFORTS to investigate and control cardiovascular risk factors, coronary artery disease remains the primary cause of death, in particular among Western nations. Examination of the coronary arteries was conventionally done by selective coronary angiography (CA) which requires flexible tubes to be inserted into the coronary vessels. This is a costly and invasive procedure and may cause severe complications in some patients. A new imaging technique, coronary computed tomography angiography (CCTA), which collects computed tomography (CT) scans after injecting contrast agent into a vein in the arm, is rapidly replacing the conventional exam because of the ability to reduce risk and discomfort to the patient. However, giving diagnosis based on the hundreds of images generated from the CT scan for each patient is not as easy as reading the CA images. It requires the radiologists to go through all slices while building an overview of the arteries based on their subjective observation instead of quantitative measurements. The aim of this work is to develop and evaluate a computer



3D rendered coronary CT angiography from our software. The left coronary artery (blue) and right coronary artery (green) were segmented using the "virtual contrast injection" method.

tool that uses intuitive 3D visualization technique to present the coronary arteries. The tool uses the images from the new CCTA method and presents them in a manner similar to traditional catheter angiography. It also provides automatic quantification tools to measure the reduction of the vessel lumen. In the first part of the project, a new image segmentation algorithm, called "virtual contrast injection" was developed based on the gray-scale fuzzy connectedness theory. It was used to separate the vessels from the heart chambers and find their centerlines. To build a fully-automatic work flow, additional methods such as finding the heart in a 3D volume were developed and integrated into an open source medical image visualization software, OsiriX.

To test the diagnostic accuracy of the software, 3D views that show if any narrowing of the arteries (stenosis) is present were performed. The results were compared with the conventional 2D method and an alternative commercial 3D method. The study show that the software developed in this project was as good at classifying coronary arteries as the conventional 2D method while the alternative commercial method was considerably less efficient.

Finally, we have developed a faster version of the "level set" algorithm, which is particularly suitable for defining (segmenting) blood vessels from surrounding tissue. The new method is 10-20 times faster than conventional methods without loss of accuracy, making it possible to quantitatively analyze stenosis without delays.

POPULAR SCIENTIFIC SUMMARY
ÖRJAN SMEDBY

Quantitative Assessment of Trabecular Bone Structure

PROJECT NAME
Quantitative assessment of trabecular bone structure

PROJECT LEADER
Örjan Smedby

MAIN PROJECT PARTICIPANTS
Rodrigo Moreno, Eva Klintström, Magnus Borga, Torkel Brismar (KI)

GRANTS
Swedish Research Council 2007-2009

KEY PUBLICATIONS
Moreno R, Borga M, Smedby Ö. Generalizing the Mean Intercept Length Tensor for Gray-Level Images. Medical Physics 2012;39:4599-4612.

Klintström E, Smedby Ö, Moreno R, Brismar TB. Trabecular bone structure parameters from 3D image processing of clinical multi-slice and cone-beam computed tomography data. Accepted for publication in Skeletal Radiology.

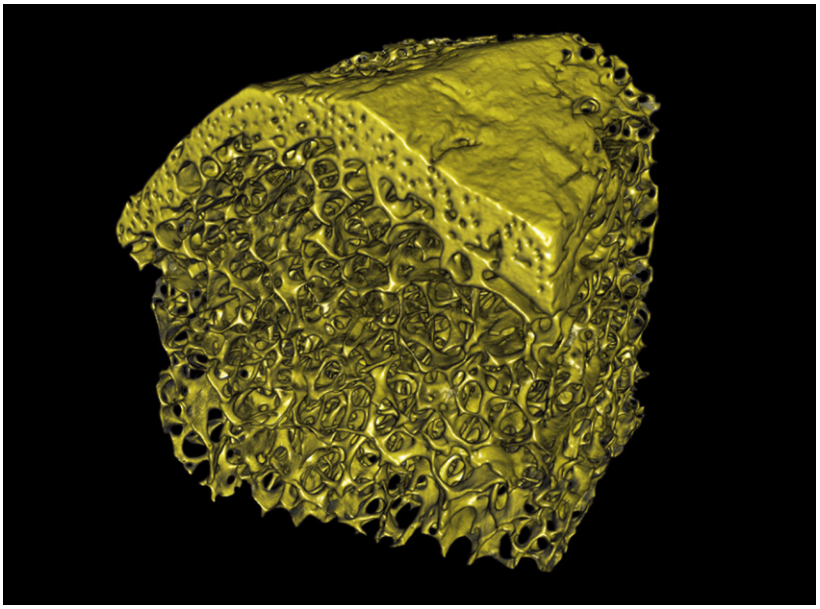
Moreno R, Borga M, Smedby Ö. Evaluation of the plate-rod model assumption of trabecular bone. In: Biomedical Imaging (ISBI), 2012. 9th IEEE International Symposium on Biomedical Imaging (ISBI 2012), 2-5 May 2012, Barcelona, Spain. 2012. p. 470-473.

PATIENTS SUFFERING FROM osteoporosis have an increased risk of fractures. To study this in patients, one usually measures the amount of calcium in the bone, which is reduced in osteoporosis. However, the condition is also characterized by a change in the internal structure of the bone, which may be more important for its strength than the reduced calcium content. The internal structures of the bone are called trabeculae, and they are usually portrayed as either narrow rods or flat plates. Earlier, the 3D microstructure could only be studied in bone specimens removed from the body, where properties such as the spacing and thickness of the trabeculae and the number of branching points can be measured. This project aims to study this structure in the living human by using methods available in a radiological department, in particular different types of computed tomography (CT) methods. Since the trabeculae are often less than 0.2 µm thick, the limited resolution of the radiological methods may be a problem. Therefore, we have focused on developing new image processing techniques for as accurate measurements as possible in the available images.

Most analysis methods presuppose that you start by deciding, for each point in the volume examined, whether it consists of bone or other tissue, i.e. the region is divided into two regions (segmentation). In other words, an image with many shades of grey is first converted into one consisting of only two: black and white. We have found, however, that using methods that op-

erate directly on the original grayscale image are more reliable than those starting with a segmentation step. To study how the structure of the bone differs between different directions we use mathematical concepts called tensors. With these tools, it is also possible to test to what extent the traditional assumptions about trabeculae being shaped as rods or plates are valid.

In the future, we hope that these methods will be useful in particular to evaluate the effects of treatment against osteoporosis. With better tools to measure the structure of the bone trabeculae it will be possible to draw such conclusions at an earlier stage, hence the number of subjects and the observation times in clinical trials may be reduced.



POPULAR SCIENTIFIC SUMMARY
HANS TROPP AND HANS KNUTSSON

Quantitative Musculoskeletal Imaging for Assessment of Idiopathic Scoliosis

PROJECT NAME
Quantitative musculoskeletal imaging for assessment of idiopathic scoliosis

PROJECT LEADER
Hans Tropp, Department of Clinical and Experimental Medicine, Division of Orthopaedics and Hans Knutsson, Department of Biomedical Engineering, Division of Medical Informatics

MAIN PROJECT PARTICIPANTS
Ludvig Vavruch and Daniel Forsberg

GRANTS
Swedish Research Council (2008-2013)
VINNOVA (2012-2014)

KEY PUBLICATIONS

D. Forsberg, C. Lundström, M. Andersson, and H. Knutsson, "Model-based registration for assessment of spinal deformities in idiopathic scoliosis", Physics in medicine and biology, vol. 59, iss. 2, pp. 311-326, 2014.

D. Forsberg, C. Lundström, M. Andersson, L. Vavruch, H. Tropp, and H. Knutsson, "Fully automatic measurements of axial vertebral rotation for assessment of spinal deformity in idiopathic scoliosis", Physics in medicine and biology, vol. 58, iss. 6, pp. 1775-1787, 2013.

L. Vavruch, and H. Tropp, "A comparision of Cobb angle: Standing versus supine images", submitted to Spinal Deformity (currently under revision).

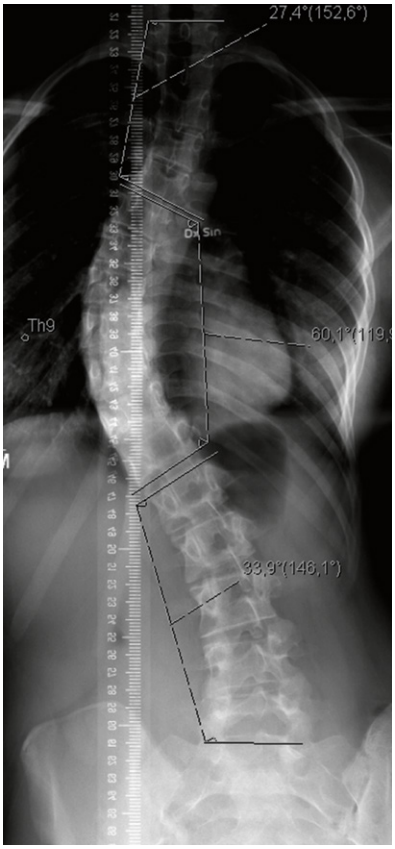


Figure 1. An example of a frontal radiograph of a scoliotic spine. Included in the image are measurements of the Cobb angle.

DEFORMITY OF THE spine can be classified into different types. The most common are neuromuscular scoliosis, idiopathic scoliosis and congenital malformations. A progressive deformity leads to postural problems, pain and in the long run sometimes impairment of the heart and lungs. Scoliosis affects the spine by causing a sideways displacement of the vertebra, which can be observed on a frontal radiograph. However, the deformation of a scoliotic spine is not limited to a single plane. Instead there is a 3D deformity at hand, including a rotation and a structural change of the vertebrae in the spine over time. Despite the 3D nature of the deformity, clinical practice for assessing the deformity is to use measures based upon 2D imaging, where the Cobb angle is the most commonly employed measure.

Performing a full 3D assessment based upon 2D radiographs is a challenging task, although some successful examples have been reported in the literature. On the other hand, 3D

imaging, as provided by computed tomography (CT), provides excellent opportunities for performing 3D assessments of spinal deformities. Radiation dose has earlier been a major concern limiting the use of CT in clinical practice; however, today the dose has been significantly reduced due to improved detectors, imaging protocols and reconstruction algorithms. Thus, with the current state of the art CT scanners it is possible to acquire image data suitable for 3D assessments of spinal deformities.

We will develop methods both for description of structural changes of each vertebra and a 3D measurement of the curved spine. The methods are intended to be employed to quantify the severity of spinal structural changes, which allows for an improved diagnostic accuracy and for better monitoring of the disease. They also provide a better understanding of how the disease evolves and how different treatments reduce spinal deformities.

In particular, we are focusing on:

- Determining the relationship between the Cobb angle as observed from radiographs with the patient in standing and in supine position. This is relevant, since current clinical practice is based upon the Cobb angle from radiographs with the patient in standing position and not in lying down as is the case for CT examinations.
- Developing computerized methods based upon advanced image analysis, which can be employed for assessing various measures related to quantifying the 3D deformity in scoliosis. Automatic and robust methods are needed in order to limit the effects of intra- and inter-observer variability associated with manual methods.
- Determining the relationship between the Cobb angle and the axial vertebral rotation. This is relevant, since the axial vertebral rotation is of many clinicians considered as a differentiating factor between different types of scoliosis.
- Investigating how the axial vertebral rotation is affected by different surgical techniques for correcting spinal deformities.

Figure 2. Visualizing the scoliotic spine in 3D allows the viewer to observe the true 3D deformity at hand, i.e. not only a sideways displacement of the vertebrae but also a rotation and a deformation of the vertebrae.

POPULAR SCIENTIFIC SUMMARY
OLOF DAHLQVIST LEINHARD

Whole Body MRI-Based Fat and Muscle Measurement

PROJECT NAME
Whole body MRI-based fat and muscle measurement

PROJECT LEADER
Olof Dahlqvist Leinhard, Department of Medical and Health Sciences, Division of Radiological Sciences

MAIN PROJECT PARTICIPANTS
Magnus Borga, Professor, Thobias Romu, PhD Student, Anette Karlsson, PhD Student, Thord Andersson, PhD Student, Patrik Tunon, MSc Student

GRANTS
FORSS Research council of South-east Sweden 2012-2014

KEY PUBLICATIONS
Lidell M, Betz M, Dahlqvist Leinhard O, Heglind M, Elander L, Slawik M, Mussack T, Nilsson D, Romu T, Nuutila P, Virtanen K, Beuschlein F, Persson A, Borga M, Enerbäck S. Evidence for Two Types of Brown Adipose Tissue in Humans. Nature Medicine, Volume 19(5):631-634, 2013, DOI:10.1038/nm.3017.

Romu T, Borga M, Dahlqvist Leinhard O. MANA – Multi Scale Adaptive Normalized Averaging. In proceedings of the 8th International Symposium on Biomedical Imaging (ISBI'11), Chicago, USA, 2011.

Dahlqvist Leinhard O, Johansson A, Rydell J, Smedby Ö, Nyström F, Lundberg P, Borga M. Quantitative Abdominal Fat Estimation Using MRI. 2008 19th International Conference on Pattern Recognition, ICPR 2008 , art. no. 4761764.

THE METABOLIC SYNDROME is a disorder involving alterations of the normal biochemical processes of the body. High blood pressure, high blood sugar level, excess body fat around the waist and abnormal cholesterol increase the risk of heart disease, stroke and diabetes. In the metabolic syndrome several of these risk factors occur together, dramatically increasing the risk further. Body Mass Index (BMI), weight and waist circumference do not tell the whole story about the metabolic syndrome. A better understanding of the effect of drugs and different life styles requires biomarkers reflecting where and how the body stores fat, build muscles and reacts on physical exercise. Fat stored diffusively in and in between the internal organs is much more dangerous than fat stored as subcutaneous fat and weight gain due to increased muscle mass is rather positive than negative for your health.

Body composition measurement with magnetic resonance imaging (MRI) enables safe and accurate quantification of fat and how it is stored in the body. The technology can determine diffuse storage of fat in the liver, pancreas and muscles, fat stored between the internal organs in the abdomen, and subcutaneous fat. The technique also allows quantification of the volume of muscles.

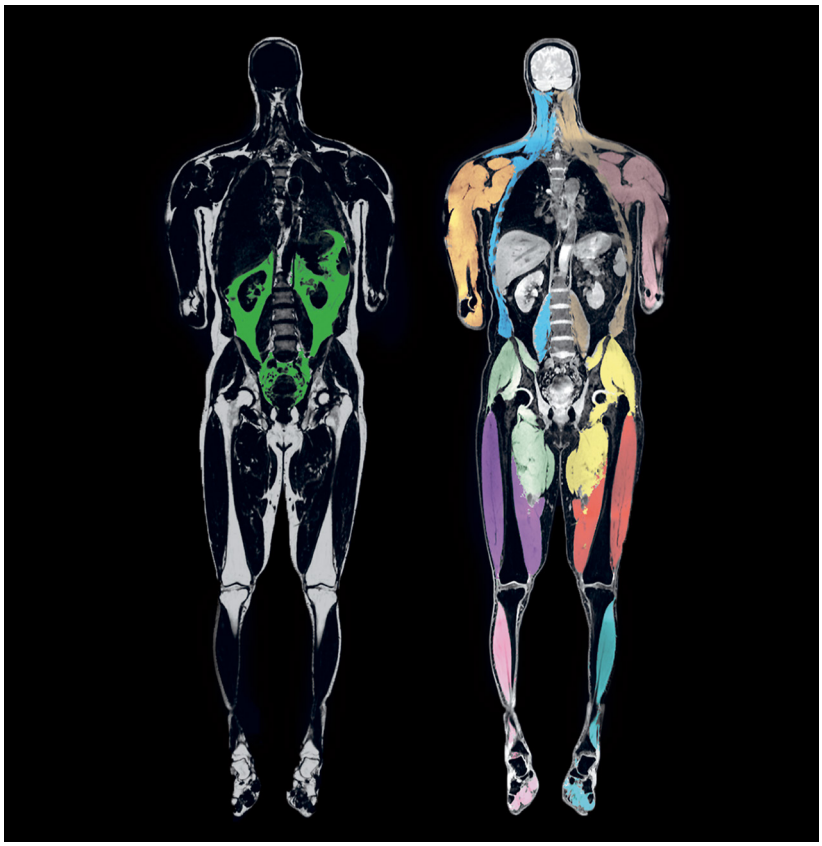
In this project we develop a technique for detailed analysis of fat and muscle tissue in the body based on whole body MRI examination (see figure). Recent technical development of MRI scanners enables high-resolution images of the complete body without exposing the subject to ionizing radiation or other known health risks. The technique can be applied in large-scale research studies to provide a better understanding about different body composition phenotypes.

We apply the technique in a number of clinical studies. In one project we study fibromyalgia where we recently showed an increased fat content in the

thigh muscles of fibromyalgia patients. Another project regards whiplash associated disorders, where fat infiltration in deep neck muscles may affect the outcome of patient rehabilitation. We also study the effect of anti-obesity therapies and the role of abdominal and liver fat in diffuse liver disease.

Furthermore, we use the technique to provide better understanding of Sarcopenia, the decline of muscle tissue with age, which is one of the most important causes of functional decline and loss of independence in older adults.

Another important application area of the technique is imaging of brown adipose tissue (BAT). Recently, we demonstrated the presence of BAT between the shoulder blades in human infants. BAT is an organ that allows non-shivering thermogenesis in mammals and is a potential target for anti-obesity therapies.



Automatically segmented whole body fat and water separated dataset from a 10 minutes MRI examination where abdominal fat (left) and different muscle groups (right) are shown in different colors.

POPULAR SCIENTIFIC SUMMARY
PETER LUNDBERG

Liver Intrinsic Function Evaluation

PROJECT NAME
Liver Intrinsic Function Evaluation (4LIFE)

PROJECT LEADER
Peter Lundberg, Department of Medical and Health Sciences, Division of Radiological Sciences

MAIN PROJECT PARTICIPANTS
Per Sandström, Stergios Kechagias, Sven Almer, Örjan Smedby, Olof Dahlqvist Leinhard, Nils Dahlström, Mikael Forsgren, Thobias Romu, Johan Kihlberg, Gunnar Cedersund, Bengt Norén, Torkel Brismar

GRANTS
Swedish Research Council (VR) 2008-2010/2011, Swedish Research Council (VR) 2012-2014/2015, VINNOVA 2013-2017

KEY PUBLICATIONS
Forsgren MF, Dahlström N, Karlsson M, Dahlqvist Leinhard O, Smedby Ö, Cedersund G, Lundberg P (2014) "Whole Body Mechanistic Minimal Model for Gd-EOB-DTPA Contrast Agent Pharmacokinetics in Evaluation of Diffuse Liver Disease", (Abs. CID: 1860336), (SAR 2014, Boca Raton, Florida, USA).

Norén B, Forsgren MF, Dahlqvist Leinhard O, Dahlström N, Kihlberg J, Romu T, Kechagias S, Almer S, Smedby Ö, Lundberg P (2013) Separation of Advanced from Mild Hepatic Fibrosis by Quantification of the Hepatobiliary Uptake of Gd-EOB-DTPA Eur Radiol 2013 Jan;23(1):174-81. doi: 10.1007/s00330-012-2583-2. Epub 2012 Jul 27.

Dahlqvist Leinhard O, Dahlström N, Kihlberg J, Sandström, P., Brismar TB, Smedby Ö, and Lundberg P. (2012) Quantifying differences in hepatic uptake of the liver specific contrast agents Gd-EOB-DTPA and Gd-BOPTA: a pilot study. Eur Radiol. 2012 Mar;22(3):642-53. Epub 2011 Oct 9.

LIVER INTRINSIC FUNCTION Evaluation (4LIFE) is a four year research project that, with the help of magnetic resonance (MR, MRS and MRI), will develop new methods for diagnosing liver disease at CMIV. The new technology is expected to result in safer liver surgery. A goal for the project is to develop an intuitive and simple tool for evaluation of liver status, which further on will be able to simulate surgical procedures to foresee how they will affect the liver.

With the help of MR it is possible to measure several parameters in the liver without invasive procedures. The MR also enables a better overview of the liver status as a whole than biopsies, as they only show status at the location where the sample is taken. If the biopsy is extracted from the wrong area there is a risk that important information is overlooked.

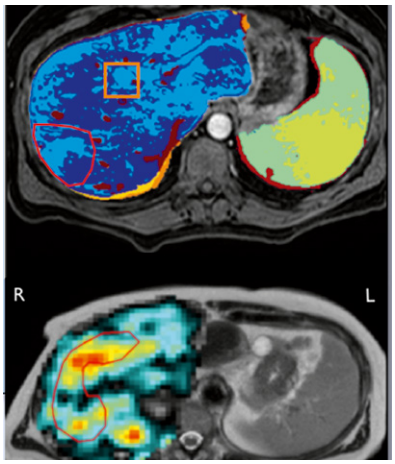
Many liver diseases are diagnosed when they are in an advanced stage and the liver is already seriously damaged. At that time, surgery is the only treatment option. In order for the patient to survive a liver tumor surgery, a healthy piece of the liver has to be left in the body. The liver is then growing during 4-5 weeks to regain almost full size and function. The first week after the surgery is a critical time since the small piece of liver has to manage the job of a full liver.

Today, determination of how much of the liver to remove is difficult as only

a rough estimate of the liver function can be made. Occasionally, patients may suffer from liver failure following radical surgery. On the other hand, some patients are wrongly judged unfit for surgery when the rough estimate suggests that they will not survive the procedure. With a better estimate of size and function in the liver residue more patients could have surgery. This project will develop a tool where data from different types of liver measurements may be gathered. The data will support the physician in determine how to treat the patient. All MR measurements are conveniently done at the same occasion.

The magnetic resonance technology may, among other things, be used to measure the amount of fat in the liver, measure the uptake of a contrast agent to get an idea of how well the liver works and measure levels of many different elements, including iron and phosphorus compounds.

One of the MR methods used is elastography. The examination shows fibrosis, formation of connective tissue, in the liver. The connective tissue makes the liver less flexible and impairs the function in fibrotic areas. During MR elastography vibrations are sent into the patient´s body. The vibrations are propagated differently depending on the flexibility of the tissue. Through registration of the different vibrations the MR-scanner can separate healthy from diseased tissue.



The uptake of hepatocyte specific contrast agent through a range of transport mechanisms is shown. On the lower panel the regional liver elasticity is shown; elasticity is a mechanical tissue property that is determined by the degree of fibrosis.

POPULAR SCIENTIFIC SUMMARY
PETER LUNDBERG

PRESTO-CAN for Three-Dimensional Functional MRI

PROJECT NAME
PRESTO-CAN for three-dimensional functional MRI

PROJECT LEADER
Peter Lundberg, Department of Medical and Health Sciences, Division of Radiological Sciences

MAIN PROJECT PARTICIPANTS
Maria Magnusson,
Olof Dahlqvist Leinhard,
Helene van Ettinger-Veenstra

GRANTS
Swedish Research Council (VR), Cancerfonden, Knowledge foundation.

KEY PUBLICATIONS
Magnusson M, Dahlqvist Leinhard O, Brynolfsson P, Thyr P, Lundberg P. 3D Magnetic Resonance Imaging of the Human Brain — Novel Radial Sampling, Filtering and Reconstruction. In: Proceedings of the 12th IASTED International Conference on Signal and Image Processing, Acta Press, 2010.

Magnusson M, Dahlqvist Leinhard O, Brynolfsson P, Lundberg P. A 3D-plus-time radial-Cartesian hybrid sampling of k-space with high temporal resolution and maintained image quality for MRI and fMRI. In: Proceedings of the 19th Scientific Meeting & Exhibition of ISMRM, Montréal, Québec, Canada, 2011.

Magnusson M, Dahlqvist Leinhard O, van Ettinger-Veenstra, H, Lundberg P. FMRI Using 3D PRESTO-CAN - A Novel Method Based on Golden Angle Hybrid Radial-Cartesian Sampling of K-Space In: Proceedings of the 20th Scientific Meeting & Exhibition of ISMRM, Melbourne, Australia, Montréal, 2012.

THE MAGNETIC RESONANCE images (MRI) are not produced directly by the MRI scanner. Instead raw data from the scanner is temporary stored in the so called k-space. The raw data comes in to k-space as sinus waves of different frequencies. These frequencies can then be transformed into images by a mathematical operation. This is called reconstruction. Normally, the frequency measurements are performed in thin 2D slices of the body which are reconstructed and combined in a stack to form an image volume. Occasionally, k-space is measured directly in 3D with a square pattern called Cartesian sampling pattern (figure 1, left).

In contrast to the 3D Cartesian geometry, our method PRESTO-CAN samples k-space using a hybrid between a radial geometry and a Cartesian geometry (figure 1, right). The large

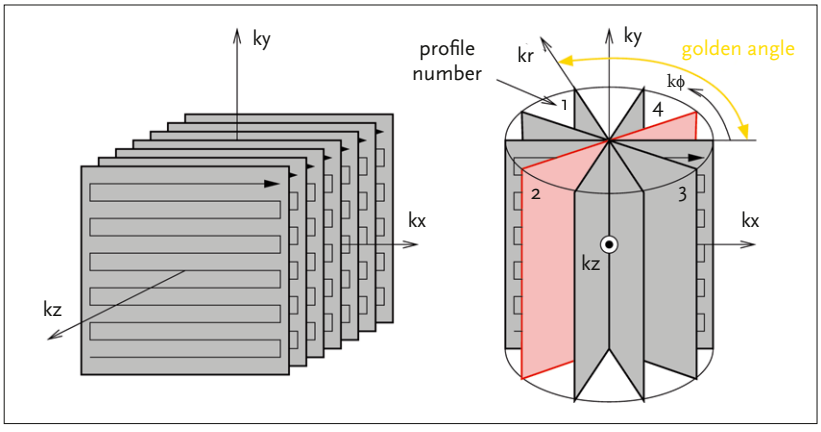


Figure 1 Left: 3D Cartesian sampling of k-space. Right: PRESTO-CAN sampling of k-space.

steps in the angular direction gives a fast recording of the important information located in the center of k-space.

The method was developed having functional MRI (fMRI) applications in mind. In fMRI, MRI-volumes are recorded during a time period when a person/patient performs a particular task. By analyzing the MRI time sequence, it is possible to detect brain activity. Accordingly, it is desirable with a high time resolution. PRESTO-CAN has shown to provide excellent temporal resolution and satisfactory image quality. We have also been able to demonstrate that it is indeed possible to detect neural activity with fMRI using PRESTO-CAN, see figure 2.

As seen to the right in figure 1, there are more densely sampled data in the inner part of k-space. It has been shown that by removing parts of the inner over-sampled k-space at certain time points, the time resolution can be further increased. However, this gives a more complicated sampling pattern and a non-trivial reconstruction. Consequently, we previously got disturbing image artifacts, which probably affected the fMRI-detection in a negative way. To eliminate these artifacts we have improved the image quality by implementing a recently published improved reconstruction technique.

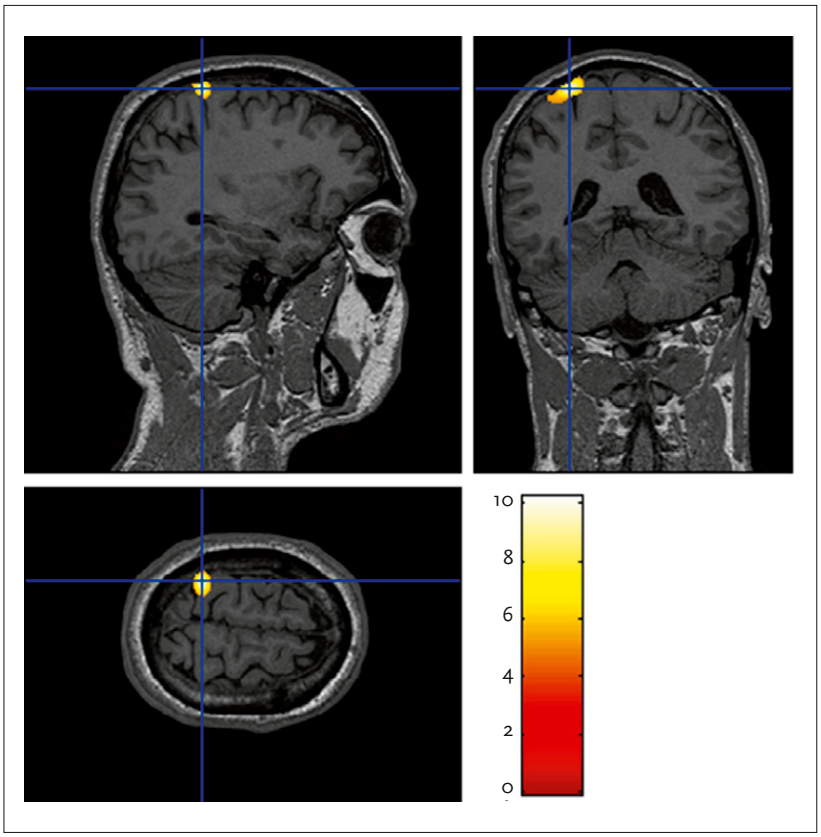


Figure 2 fMRI-activation in motor cortex, computed from MRI-data based on PRESTO-CAN.

A major advantage of the PRESTO-CAN sequence for neurological research is that it allows for whole brain coverage. We aim to demonstrate this in a comparative fMRI study between PRESTO-CAN and conventional techniques.

The rather simple geometry of PRESTO-CAN makes it easy to include standard procedures for speeding up the data acquisition further, such as parallel imaging which can be combined with unique 3D motion correction schemes. These possibilities will be investigated further.

POPULAR SCIENTIFIC SUMMARY
MARIA ENGSTRÖM

Sleep Abnormality Network Description: Modeling and Analysis in Neuroimaging

PROJECT NAME
Sleep Abnormality Network Description: Modeling and Analysis in Neuroimaging (SAND:MAN)

PROJECT LEADER
Maria Engström, Department of Medical and Health Sciences, Division of Radiological Sciences

MAIN PROJECT PARTICIPANTS
Karin Lundengård, Helene van Ettinger-Veenstra, Natasha Morales-Drissi, Martin Ulander, Gunnar Cedersund, Fredrik Elinder, Peter Lundberg, Anders Tisell, Thomas Karlsson, Henriettae Ståhlbrandt, Anne-Marie Landtblom, Tove Hallböök

GRANTS
The Research Council of South East Sweden (FORSS), The Kleine-Levin Syndrome (KLS) foundation

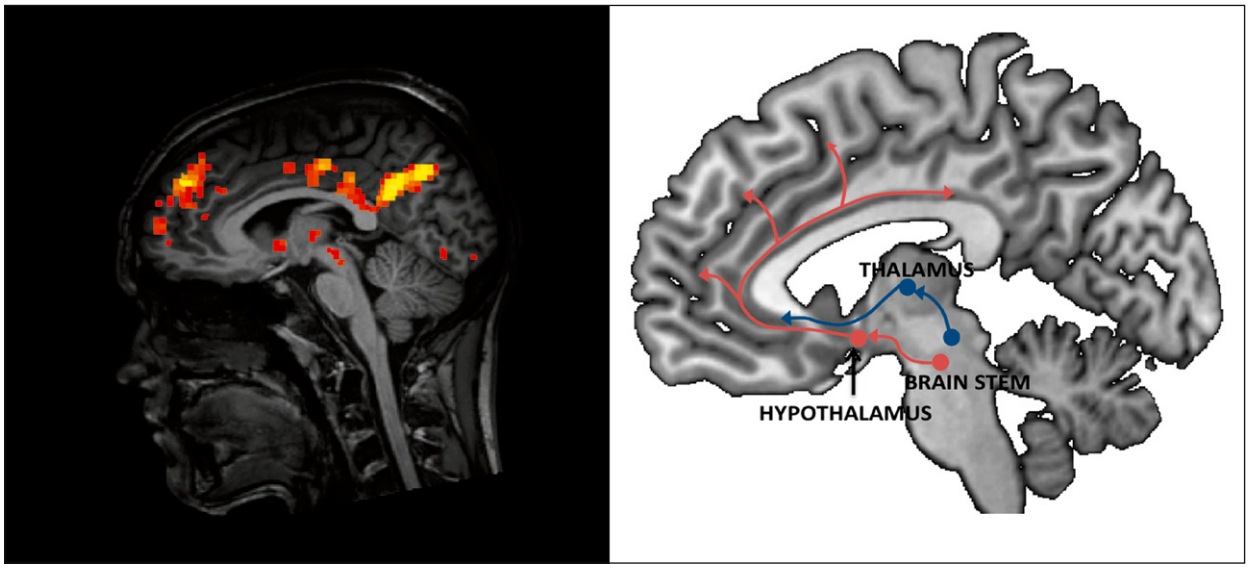
KEY PUBLICATIONS
M. Engström, P. Vigren, T. Karlsson, A-M Landtblom, Working memory in 8 Kleine-Levin Syndrome patients: An fMRI study. Sleep, 32:681-688, 2009.

M. Engström, G. T. Karlsson, A-M Landtblom. Thalamic Activation in the Kleine-Levin Syndrome. In press Sleep, 2014.

M. Engström, A-M Landtblom, T. Karlsson. Brain and effort: brain activation and effort-related working memory in healthy participants and patients with working memory deficits. Frontiers in Human Neuroscience, 7;140:1–17, 2013.

SLEEP IS A NATURALLY recurring state, which still is a mystery since the function and purpose of sleep is not fully understood. In this project we explore the networks of the human brain that are involved in the regulation of sleep and wakefulness. For this quest, patients with sleep disorders provide keys to the understanding of why we sleep and why we wake up.

By investigating patients with excessive sleepiness due to brain inflammation, von Economo in the early 20th century detected brain areas involved in the regulation of sleep and wakefulness. Almost a century later, scientists discovered an important sleep-regulating substance, orexin, which is produced in a certain area of the brain, the hypothalamus (see figure). Loss of orexin causes the sleep disorder narcolepsy. Patients with narcolepsy have involuntary sleep attacks during daytime and poor nighttime sleep. Kleine-Levin syndrome is another sleep disorder where the patients can sleep for extremely long periods, up to several weeks. These sleep disorders often debut in the childhood or adolescence, but many patients are not diagnosed until adulthood. Thus narcolepsy and Kleine-Levin syndrome are under-diagnosed disorders and novel methods for early diagnosis are urgent. In addition, the relations between disease mechanisms and the patients' symptoms



Left panel: Brain activation in one narcolepsy patient. *Right panel: Schematic image of brain areas that regulate sleep and wakefulness.*

are still unresolved. The aim of the SAND:MAN project is to investigate the neurobiology of sleep disorders in order to improve the well-being of the affected patients by defining imaging biomarkers for early diagnosis and for assessment of treatment effects.

The neurobiology of sleep disorders is investigated by visualization of the neural function in brain areas that are important for the regulation of sleep and wakefulness. Such visualization is obtained by brain scanning, so called functional Magnetic Resonance Imaging (fMRI). By fMRI, the activity in the synapses of the nerve cells can be measured through the increased blood flow that arises in response to the activity. This blood flow response is, however, much slower than the synaptic activity. Therefore we simultaneously also measure the brain's electrical activity by EEG. In this way we can measure faster neural responses. In addition, we measure the concentrations of signal substances that regulate synaptic activity in the brains of patients with sleep disorders.

In order to understand the function of such a complex system as the human brain it is necessary to formulate hypotheses of the neurobiological mechanisms that generate measured data. Here, these hypotheses are formulated using mathematical expressions that constitute mechanistic models of brain function. Accurate measurements of neural function combined with advanced mathematical modeling form a new approach to the studies of human brain function. In line with the early discoveries of von Economo, we expect that brain imaging in patients with sleep disorders could provide new views on the neurobiology that governs sleep and wakefulness.

POPULAR SCIENTIFIC SUMMARY
MARIA ENGSTRÖM

Functional MRI Studies of Normal and Impaired Language Function

PROJECT NAME
Functional MRI studies of normal and impaired language function

PROJECT LEADER
Maria Engström, Department of Medical and Health Sciences, Division of Radiological Sciences

MAIN PROJECT PARTICIPANTS
Thomas Karlsson, Anne-Marie Landtblom, Peter Lundberg, Helene Van Ettinger-Veenstra, Helena Gauffin, Anita McAllister, Daniel Ulrici

GRANTS
Henry och Ella Margareta Ståhls stiftelse

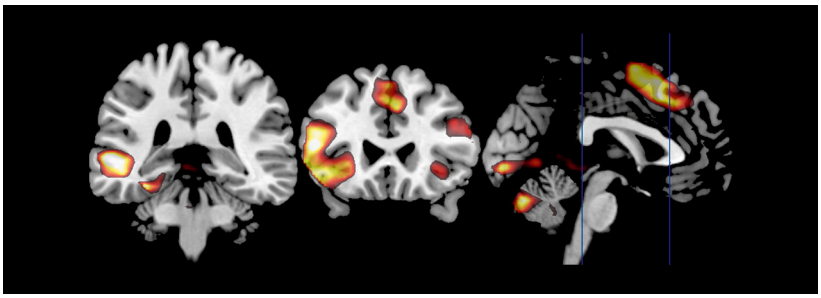
KEY PUBLICATIONS
H. Gauffin, H. van Ettinger-Veenstra, A-M Landtblom, D. Ulrici, A. McAllister, T. Karlsson, M. Engström. Impaired language function in generalized epilepsy: Inadequate suppression of the default mode network. Epilepsy & Behavior, 28:26–35, 2013.

H.M. Van Ettinger-Veenstra, M. Ragnehed, A. McAllister, P. Lundberg, M. Engström. Right-Hemispheric Cortical Contributions to Language Ability in Healthy Adults. Brain and Language, 120:395–400, 2012.

H.M. Van Ettinger-Veenstra, M. Ragnehed, M. Hällgren, T. Karlsson, A-M Landtblom, P. Lundberg, and M. Engström. Right-hemispheric brain activation correlates to language performance. NeuroImage, 49:3481-3488, 2009.

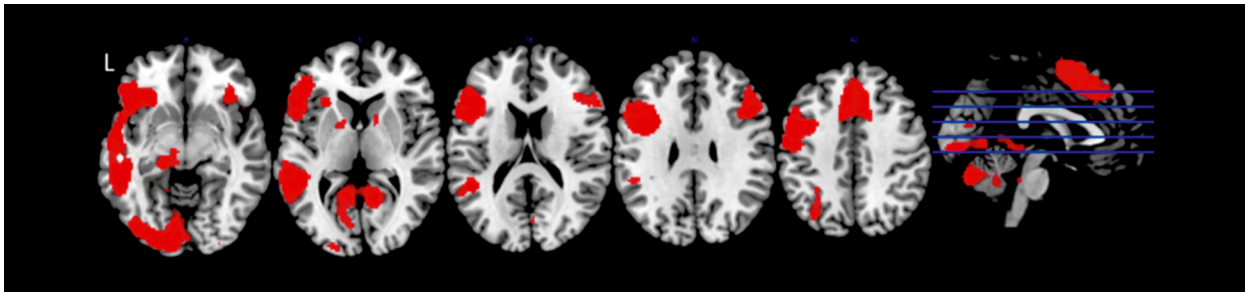
LANGUAGE ABILITY PLAYS an important role when communicating with others. Although the most important areas of the brain that are involved in language function are identified, the relation between activation in these areas and language ability is not fully uncovered. That is to say, we do not know in detail the relation between the magnitude and extent of language activation as measured by brain scanning and individual performance on language tests. In this project we approached this research question by investigating healthy individuals and patients with epilepsy by functional Magnetic Resonance Imaging (fMRI) and standardized language tests.

For most people the brain's left hemisphere is dominant for language. This means that the left side of the brain executes language tasks, such as reading and talking. However, the brain's right side is also often activated



Language function in healthy subjects, coronal slices: The left side is dominant, however, activation in the right hemisphere is also present.

during language tasks, but the role of the right hemisphere in language remains elusive. We have shown that the right side of the brain plays an important role in supporting language ability. We have also shown that patients with generalized epilepsy have subtle language deficits and that inability to suppress brain networks that are not used for language processing could explain language problems in epilepsy. This work adds value to the recently emerged research field of the brain's resting state network or the default mode network. This network is engaged when we are at rest, when we are mind wandering and "thinking about nothing". When performing executive tasks, such as language processing, this network should be suppressed for an optimal usage of the brain's resources.



Language function in healthy subjects, axial slices: The left side is dominant; however, activation in the right hemisphere is also present.

POPULAR SCIENTIFIC SUMMARY
NINA NELSON

Functional Neuroimaging in Former Preterm Children with Very Low Birth Weight

IF A CHILD is born very early, it enters a life full of obstacles. After its struggle to survive, there is a struggle to keep up with its peers at school. In south-Sweden, a group of premature children and a group of full-term born children as a control group was followed over time. It was discovered that many of the premature born children had cognitive difficulties but many of them were overcome when they entered their teens. There is a need to understand how remaining cognitive problems, in specific language and working memory abilities, or other effects of their premature birth are visible in relation to their brain function. Therefore, a functional magnetic resonance imaging (fMRI) study was set-up to investigate this group, now around thirteen years old. With fMRI you can measure brain activity. The method register changes in blood flow in the brain, and blood flow increases when a brain area becomes more active and needs more energy.

There is always activity in the brain, but the location depends on what the person is doing. When a person is engaged in a task, activity may be seen in language or attention networks. In contrast, when a person is at rest, brain activity in the so-called default mode network emerges. This network can be seen in the figure, it looks very sym-

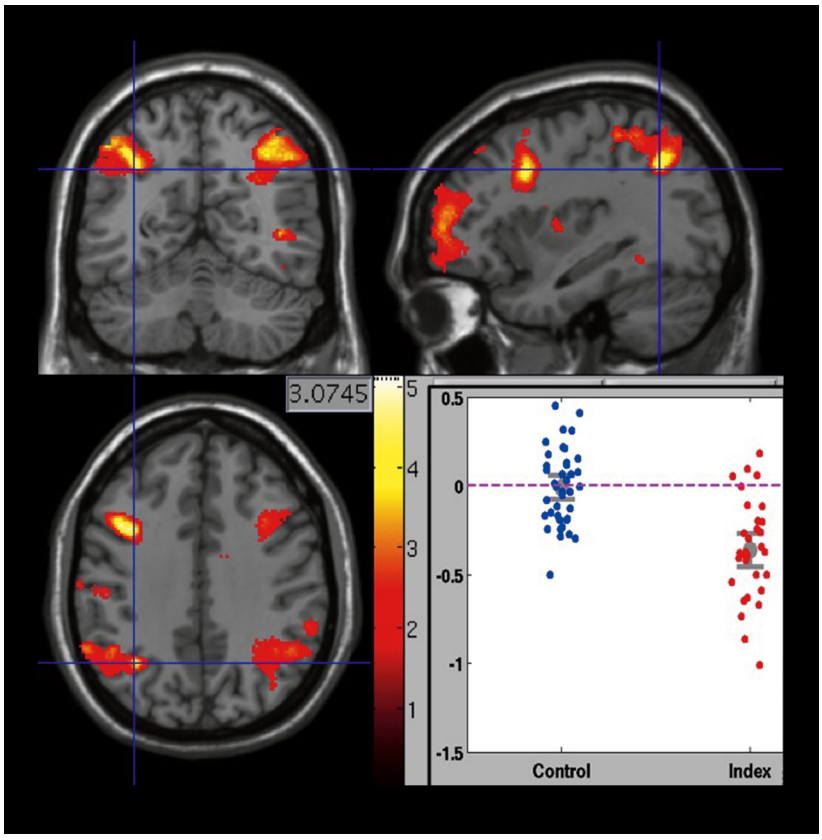
PROJECT NAME
Functional neuroimaging in former preterm children with very low birth weight

PROJECT LEADER
Nina Nelson, Department of Clinical and Experimental Medicine, Division of Pediatrics

MAIN PROJECT PARTICIPANTS
Carin Widén, Ingemar Leijon, Maria Engström, Thomas Karlsson, Helene van Ettinger-Veenstra

metrical between the two brain halves. The default mode network is thought to be responsible for every day thought monitoring; when you are thinking about what you plan to do tomorrow or what is for dinner tonight. Since the network is active in persons that are not doing a task, it logically follows that its activity is suppressed, whenever a persons attention is drawn by a task. This suppression is what is shown in the figure.

We have plotted individual brain activation values for the part of the default mode network that is under the crosshair, called the inferior parietal lobe. The scatterplot shows that the control group in blue scored around 0; no activation or suppression thereof. The premature group in red scored significantly below 0. This means that the premature born children have more suppression of the default mode network. What does this imply? One explanation is that the premature born children experience the task as quite difficult, and need their full attention, in contrast to the control group. But if we take into account the previous findings about the initial cognitive setbacks of the premature born children which they later successfully overcome, this difference in network suppression could also represent a long-term strategy of the premature group. They learned to more efficiently direct their attention and brain resources towards a task. It is of interest to explore whether the whole network indeed functions differently between groups, and if the premature born children show more changes in brain activity that may point to different cognitive strategies. This will be linked to changes in brain anatomy, which may reveal the long-term impact of a very early birth.



POPULAR SCIENTIFIC SUMMARY
ANNE-MARIE LANDTBLOM AND MARIA ENGSTRÖM

Clinical, Psychosocial and Imaging Studies of Fatigue in Multiple Sclerosis

PROJECT NAME
Clinical, psychosocial and imaging studies of fatigue in multiple sclerosis

PROJECT LEADER
Anne-Marie Landtblom, Department of Clinical and Experimental Medicine, Division of Neurology
Maria Engström, Department of Medical and Health Sciences, Division of Radiological Sciences

MAIN PROJECT PARTICIPANTS
Anna-Christina Ek, Thomas Karlsson, Gullvi Flensner, Olle Söderhamn

GRANTS
Swedish Research Council (VR)

KEY PUBLICATIONS
Flensner G, Ek AC, Söderhamn O, Landtblom AM. Sensitivity to heat in MS patients: a factor strongly influencing symptomology – an explorative survey. BMC Neurol 2011;11:27.

Flensner G, Landtblom AM, Söderhamn O, Ek AC. Work capacity and health-related quality of life among individuals with multiple sclerosis reduced by fatigue: a cross-sectional study. BMC Public Health. 2013 Mar 15;13:224. doi: 10.1186/1471-2458-13-224.

Engström M, Flensner G, Landtblom AM, Ek AC, Karlsson T. Thalamo-striato-cortical determinants to fatigue in Multiple Sclerosis. Brain & Behaviour, 2013 November; 3(6): 715–728.

MULTIPLE SCLEROSIS (MS) IS AN inflammatory disease affecting the nerve cells of the brain and spinal cord. The disease damages the nervous system communication resulting in a wide range of physical and mental symptoms. Fatigue, extensive tiredness and exhaustibility, is a common symptom of multiple sclerosis (MS). Fatigue is often found to be a more decapitating symptom than paresis. In this project we have aimed to describe fatigue from an epidemiological, psychosocial (effect on employment), physiological (coupling to heat sensitivity), clinical (effect on cognition) and interventional (cryotherapy) point of view.

Fatigue can be either peripheral or central. The neuronal mechanisms are not fully uncovered but the hypotheses for central fatigue involve the feedback loops between the basal ganglia and the motor cortex.

We have used functional magnetic resonance imaging of the brain (fMRI) to investigate the neuronal

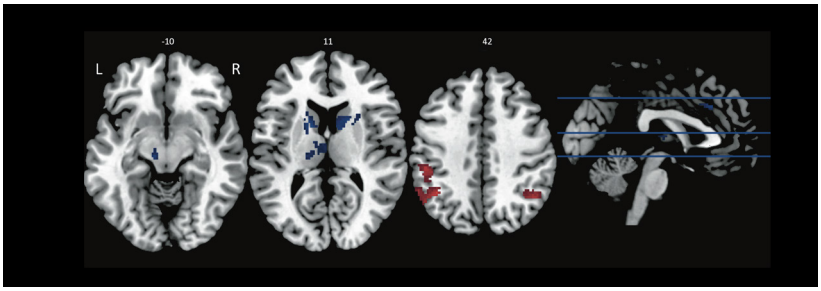


Figure 1. Differences in brain activation between MS participants and healthy participants in regions of interest in the brain. The red colour represents areas that were more activated in MS participants compared to controls, and the blue colour represents areas that were less activated in MS participants compared to controls.

activity involved in the enhancement of cognitive problems due to fatigue among patients with MS. In fMRI, changes to the blood flow in the brain are measured. Increased blood flow corresponds to increased activity in that area of the brain. The patients were performing verbal tasks during the scan. A control group of healthy participants were also investigated.

The patients were then examined in the same way after having a treatment with cryotherapy, i.e. having put on an active cooling garment with running cold water to lower the body temperature. The measurements were repeated to see if the cooling had improved the cognitive functions.

The fMRI experiments showed correlation between activation in specific areas of interest in the brain and perceived fatigue during the working memory tasks. The areas activated were the right substantia nigra and the left posterior parietal cortex. Neuropsychological investigations revealed clear effects on the working memory in the patients with MS and fatigue compared with the control group.

It is important to describe fatigue to gain acceptance for this decapitating symptom. It is of great relevance to continue to investigate the physiological mechanisms behind the symptom. The results of this study have identified areas of the brain that are involved. The project will go on investigating the intervention effect of the cooling garment where the fMRI will be of great interest and can help in determining how fatigue acts physiologically.

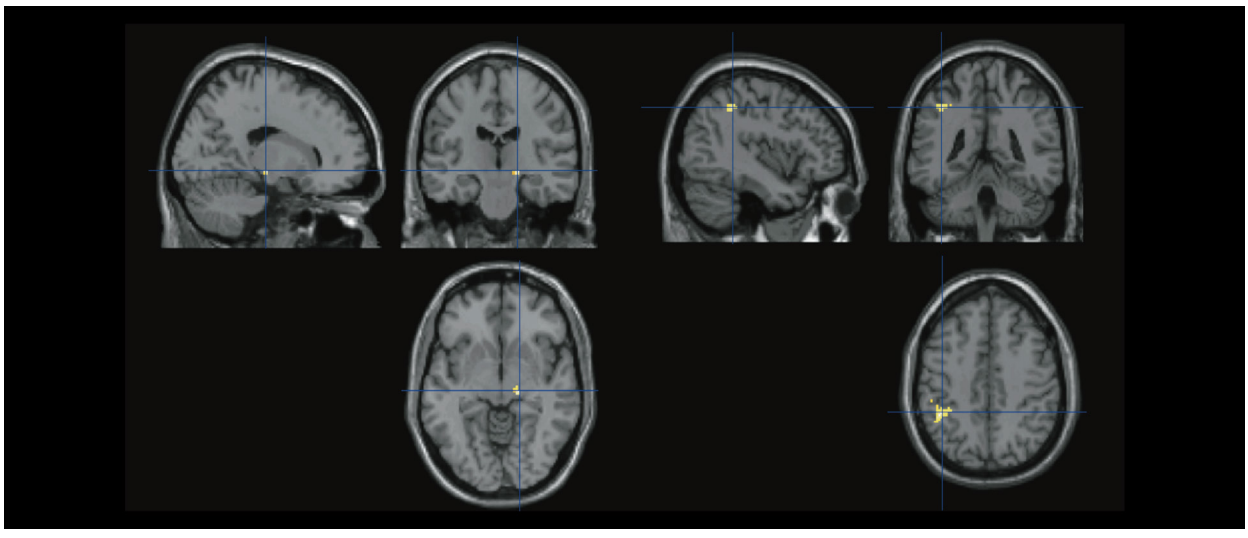


Figure 2. Brain activation with positive correlation to perceived fatigue during the working memory task. The images show activation in regions of interest: the right substantia nigra and the left posterior parietal cortex.

POPULAR SCIENTIFIC SUMMARY
ANNE-MARIE LANDTBLOM AND MARIA ENGSTRÖM

Clinical, Imaging and Memory Investigation in Patients with the Kleine Levin Syndrome

PROJECT NAME
Clinical, imaging and memory investigation in patients with the Kleine Levin syndrome

PROJECT LEADER
Anne-Marie Landtblom, Department of Clinical and Experimental Medicine, Division of Neurology
Maria Engström, Department of Medical and Health Sciences, Division of Radiological Sciences

MAIN PROJECT PARTICIPANTS
Maria Engström , Peter Lundberg, Thomas Karlsson, Olof Dahlqvist Leinhard, Anders Tisell, Patrick Vigren

GRANTS
Kleine Levin Foundation, USA

KEY PUBLICATIONS
Vigren P, Tisell A, Engström M, Karlsson T, Leinhard Dahlqvist O, Lundberg P, Landtblom AM. Low thalamic NAA-concentration corresponds to strong neural activation in working memory in Kleine-Levin syndrome.PLoS One. 2013;8(2):e56279. Epub 2013 Feb 25.

Engström M, Landtblom AM, Karlsson T. Brain and effort: brain activation and effort-related working memory in healthy participants and patients with working memory deficits. Front Hum Neurosci. 2013 Apr 17;7:140. doi: 10.3389/fnhum.2013.00140.

Engström M, Karlsson T, Landtblom AM. Thalamic activation in the Kleine-Levin syndrome. SLEEP, 2014;37(2):379-386.

SLEEP DISORDERS IN young individuals are acknowledged as a growing problem. Some disorders increase, especially delayed sleep phase syndrome (DSLP), but also narcolepsy as a consequence of the Pandemrix vaccinations. Some of the rarer sleep disorders are hard to diagnose, especially the periodically occurring hypersomnia, Kleine-Levin syndrome (KLS). The diagnostic tools used are mainly clinical, but in narcolepsy also laboratory.

We have developed laboratory tools to support the diagnosis of the Kleine-Levin syndrome, including neuropsychological testing to identify working memory deficits. We also used measures of cerebral blood flow in our diagnostic set up for KLS. Over the years we have gathered a large number of KLS patients from the Nordic countries (n=30) who take part in clinical and scientific procedures. This gives us the opportunity to compare young individuals with the disorder. Future goals are to investigate also other sleep disorders within a larger project, outlined by assistant professor Maria Engström and in collaboration with colleagues in Gothenburg, see Engström's report the SAND:MAN project.

In this study we examined frequency, duration and type of sleep periods the patients had. We also performed basic investigations including blood flow measurements in the brain (fMRI), where increased blood flow corresponds to increased activity in that part

of the brain. The fMRI measurements were combined with cognitive tests of the working memory, and also neuropsychological investigations. The tasks had varying difficulty and therefore required different effort levels. Measurements were also performed in resting state. Our results show that there are areas in the brain that are activated differently in patients with KLS compared with healthy individuals. The differences between patients with KLS and healthy controls were demonstrated in the resting state. In activated state during the working memory test, patients with KLS showed increased activation in some parts of the brain while other parts were less activated compared with healthy individuals. The differences in activation in these areas could be used to part the KLS patients from the healthy individual in most of the cases; hence the techniques have the potential to be developed into diagnostic tools of KLS.

As mentioned above our present goals are to investigate also other sleep disorders within a larger project. We also plan additional studies regarding genetics and physiology. For example we will investigate the role of body temperature in relation to sleep episodes.

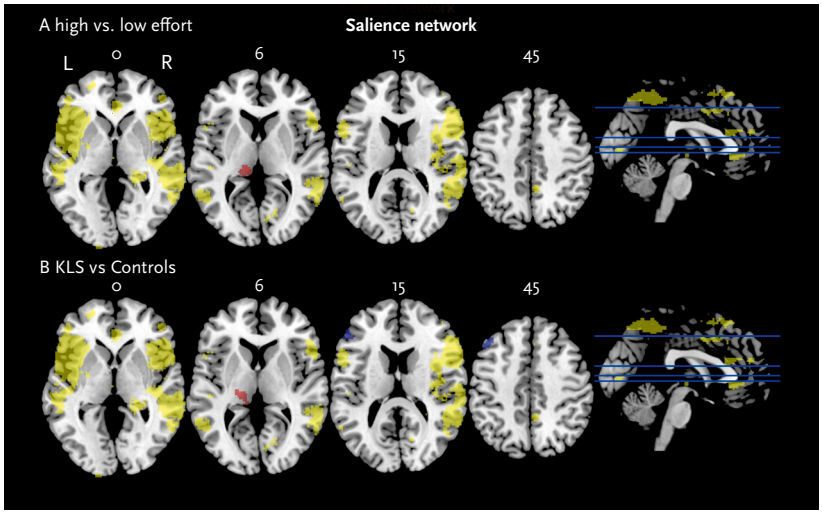


Figure 1. Functional connectivity in the salience network. Neural processing is often performed by an integrated network of several regions in the brain. Functional connectivity studies investigate the interaction of regions within these networks. Yellow areas show the network in selected slices. Red and blue areas show connectivity differences. (A) Red colour denotes regions that are more strongly coupled to the network at a high effort level compared to a low effort level. Blue colour denotes regions that are more strongly coupled to the network at a low effort level. (B) Regions that are more strongly (red) respectively more weakly (blue) coupled to the network in patients with periodic idiopathic hypersomnia (KLS) compared to healthy individuals at the high effort level.

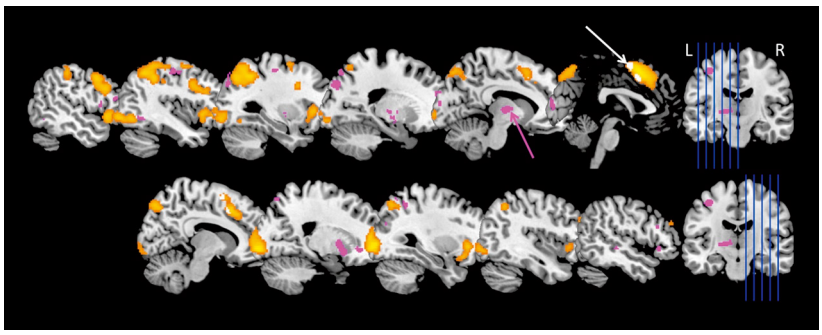


Figure 2. Typical working memory activation in healthy individuals and thalamic hyperactivation in KLS patients. In other parts of the brain KLS patients had less activation than healthy individuals.

POPULAR SCIENTIFIC SUMMARY
ANNE-MARIE LANDTBLOM

Clinical and Imaging Studies of Multiple Sclerosis

PROJECT NAME
Clinical and Imaging studies of multiple sclerosis

PROJECT LEADER
Anne-Marie Landtblom, Department of Clinical and Experimental Medicine, Division of Neurology

MAIN PROJECT PARTICIPANTS
Peter Lundberg, Olof Dahlqvist Leinhard, Marcel Warntjes, Anders Tisell, Örjan Smedby

GRANTS
Swedish Research Council (VR)

KEY PUBLICATIONS
Tisell A, Leinhard OD, Warntjes JB, Aalto A, Smedby Ö, Landtblom AM, Lundberg P. Increased concentrations of glutamate and glutamine in normal-appearing white matter of patients with multiple sclerosis and normal MR imaging brain scans. PLoS One. 2013 Apr 17;8(4):e61817. doi: 10.1371/journal.pone.0061817.

MULTIPLE SCLEROSIS (MS) is an inflammatory disease affecting the nerve cells of the brain and spinal cord. The disease damages the nervous system communication resulting in a wide range of physical and mental symptoms. The symptoms may occur in isolated attacks or build up over time.

Together with inflammation, destruction of the insulating covers of nerve cells and the formation of lesions in the central nervous system are the main characteristics of MS. However, not all MS patients have the typical lesions in the brain. In fact, MS could be seen as a generic group for a variety of disease patterns and this perspective may help the endeavors to find more specific treatment in the future. Since not all patients have lesions in their brain, they cannot be the explanation for the neuronal damage. Patients without lesions have almost equal disability from the disease. New methods that can look deeper into the cause of MS is therefore of great interest.

Using magnetic resonance (MR) technique we can measure the levels of different metabolites in the brain. High levels of some substances reflect healthy tissue whereas others reflect damage. Using this method we have followed MS patients treated with the pharmaceutical Copaxone. Copaxone has been shown to decrease the lesions and slows down the progression of the

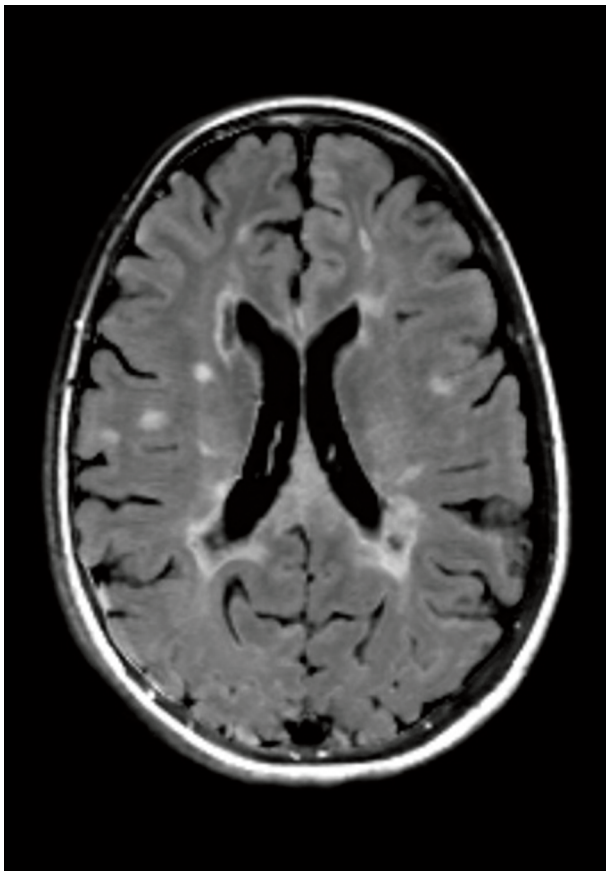


Figure 1. Image of the brain using MRI with conventional technique, showing lesions in the brain which can be a sign of MS, arteriosclerosis or insignificant signs in a healthy person over the age of 40.

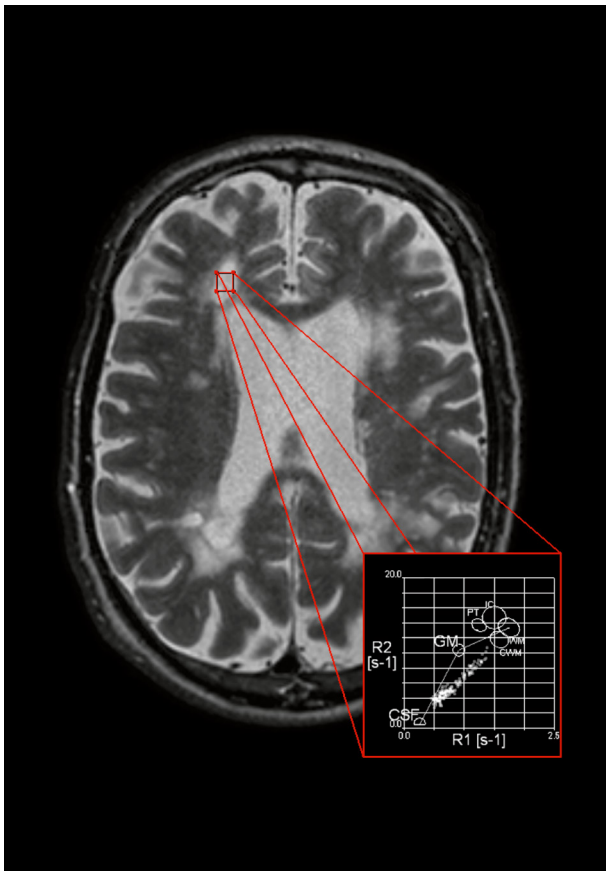


Figure 2. MR based method to discriminate between different types of brain lesions. Image by Örter and Warntjes, 2008.

disease. The results showed that the treatment slowed down the biochemical development of the disease.
Brain lesions can be seen both in MS and cerebral arteriosclerosis and is therefore often hard to use as basis for a diagnosis. Since the possibility to discriminate these lesions would be a valuable tool for diagnosis we have performed a pilot project aiming to develop an MR method to determine such differences.

The project has until now examined about 10 patients with MS, 10 patients with known cerebral arteriosclerosis with ischemia, and a few patients with diagnostic problems, where MS or arteriosclerosis could not be decided from the clinical and laboratory study. Preliminary results revealed a trend that may help in differentiating these two conditions and this will be investigated further.

POPULAR SCIENTIFIC SUMMARY
CLAES LUNDSTRÖM

A Signal Processing Approach to Direct Volume Rendering

IN THIS PROJECT we explore the application of state-of-the-art signal processing techniques in volumetric visualization. The goal is to extract additional information that will provide more knowledge about the content inside the dataset.

One approach we have investigated is the use of existing knowledge about vessel shape together with adaptive data filtering to automatically adjust visualizations to local variations in the data. The primary application is varying concentrations of contrast agent in computed tomography angiography (CTA). The concentration of contrast agent affects the received signal. When working with CTA, the visualization of the entire vascular tree is prohibited by local changes in contrast agent concentration. These local changes are, in our approach, modelled by filters designed to detect and measure vessel like structures. As a result, our algorithms

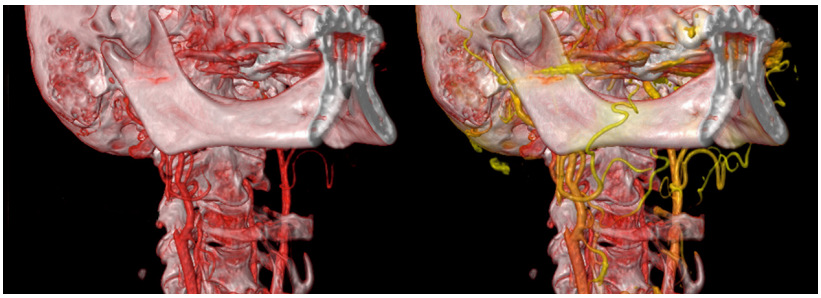


Figure 1. Enhanced vessel visualization using locally adaptive transfer functions (right) better depicts the full vascular tree than standard methods (left).

PROJECT NAME
A Signal Processing Approach to Direct Volume Rendering

PROJECT LEADER
Claes Lundström PhD, Department of Science and Technology, division of media and information technology

MAIN PROJECT PARTICIPANTS
Stefan Lindholm, Anders Ynnerman

GRANTS
Swedish research Council (VR)

KEY PUBLICATIONS
S. Lindholm, D. Jönsson, H. Knutsson, A. Ynnerman. "Towards Data Centric Sampling for Volume Rendering". Proceedings of SIGRAD 2013, Norrköping, Sweden.

G. Läthén, S. Lindholm, R. Lenz, M. Borga. "Automatic Tuning of Spatially Varying Transfer Functions for Blood Vessel Visualization". In IEEE Transactions on Visualization and Computer Graphics, 12(18):2345-2354, 2012.

C. Lundström, A. Persson, S. Ross, P. Ljung, S. Lindholm, F. Gyllensvärd, A. Ynnerman. "State-of-the-art of visualization in post-mortem imaging". Acta Pathologica (APMIS) 120: 316-326, 2012.

are capable of visualizing the full cardiovascular tree by locally adapting the transfer function (figure 1).

Another approach we have investigated is to include knowledge from the user in the reconstruction step of the volume rendering pipeline. By doing so, we are able to prevent artifacts in the form of falsely classified samples due to interpolation effects that arise from the assumption of data continuity. Figure 2 illustrates the problems that arise from applying continuous data assumptions on data that are perceived as discrete.

In the figure, the rendering on the left corresponds to a high resolution reference image. The middle and right images are both renderings from down sampled version of the same data. Of these, the middle image applied a fully continuous model (the standard in many areas of medical imaging), whereas the image on the right applied a piecewise continuous data model. By utilizing the existing classification from the visualization pipeline also in the reconstruction step, the piecewise continuous data model can, for example, help prevent the construction of false tissue layers. An example of this is illustrated in figure 3, where a non-existent layer of dentine is shown between the (harder) enamel and (softer) surroundings of the tooth.

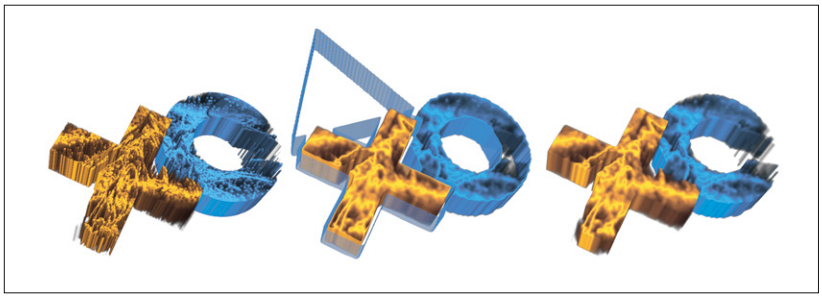


Figure 2. Comparison of standard continuous reconstruction (middle) and adapted, boundary aware, reconstruction (right) from a high resolution reference image (left).

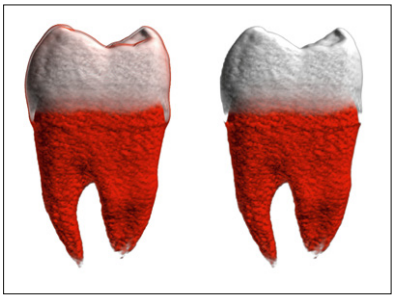


Figure 3. Erroneous sheet artifacts commonly found in traditional volume rendering can be suppressed by utilizing classification information in the reconstruction step.

POPULAR SCIENTIFIC SUMMARY
GUDRUN ALM CARLSSON

Tissue Classification Using Dual Energy CT and Iterative Reconstruction

PROJECT NAME
Tissue Classification using Dual Energy CT and Iterative Reconstruction

PROJECT LEADER
Gudrun Alm Carlsson, Department of Medical and Health Sciences, Division of Radiological Sciences

MAIN PROJECT PARTICIPANTS
Alexandr Malusek, Maria Magnusson, Michael Sandborg

GRANTS
Cancerfonden 2013-2014

KEY PUBLICATIONS
Magnusson, M., Malusek, A., Muhammad, A. and Alm Carlsson, G. Iterative Reconstruction for Quantitative Tissue Decomposition in Dual-Energy CT. In: Proceedings of the 17th Scandinavian Conference, SCIA 2011, Ystad, Sweden, May 2011, (pp. 479-488). Springer Berlin/ Heidelberg.

Malusek, A., Karlsson,M., Magnusson, M., and Alm Carlsson, G. The Potential of Dual-energy Computed Tomography for Quantitative Decomposition of Soft Tissues to Water, Protein and Lipid in Brachytherapy. Physics in Medicine and Biology 58, no. 4 (February 21, 2013): 771.

Malusek, A., Magnusson, M., Sandborg, M., Westin, R. and Alm Carlsson, G. Prostate tissue decomposition via DECT using the model based iterative image reconstruction algorithm DIRA. Accepted at the SPIE conference Physics of Medical Imaging, San Diego, California, USA, February 16-20, 2014.

TODAY'S COMPUTED TOMOGRAPHY (CT) images are affected by artifacts caused by the X-ray spectrum. These artifacts are called beam-hardening artifacts. Due to the artifacts the CT-images are not completely quantitatively accurate. We have developed a mathematical method, an algorithm, which eliminates the artifacts. With our dual energy iterative reconstruction algorithm (DIRA) the pixels of the image can be classified into bone (red regions) and soft tissue (blue regions). Bone pixels carry information about percentages of compact bone, red and yellow bone marrow. Soft tissue pixels carry information about percentages of water, protein and lipid. It is also possible to reclassify a specific tissue, e.g. the liver can be classified into liver tissue, lipid and iron. Consequently, DIRA provides quantitative information that can be used for improved medical diagnosis and treatment. As an example, DIRA can be used for determination of lipid content in the liver or the composition of plaques in aorta. The method can also be used in radiation treatment planning of brachytherapy for prostate cancer.

To verify the method we applied DIRA to simulated projection data of a mathematical phantom of the human pelvic region by using "DRA-

SIM", a CT-simulation tool provided by Siemens. The X-ray spectra used were 80 and 140kV and the geometry was basically the same as for the real CT-Scanner at CMIV.

Figure 1 shows conventionally filtered back-projection reconstructed images for 80kV in color which is equivalent to 0 iterations of DIRA (left) and after 4 iterations in DIRA (right). It is apparent that the beam-hardening artifacts corrupt the image causing streaks and shift of values after 0 iterations (left). These artifacts are to a large extent reduced after 4 iterations (right). The image for 140kV was improved in a similar way.

The soft tissue of the images for 80 and 140kV were then classified into the base material triplet lipid, protein and water (LPW), see figure 2. The classification based on the 4th iteration is consistent with the true values and provides quantitative information of the tissue. As mentioned above, such information can be used for improved medical diagnosis and treatment.

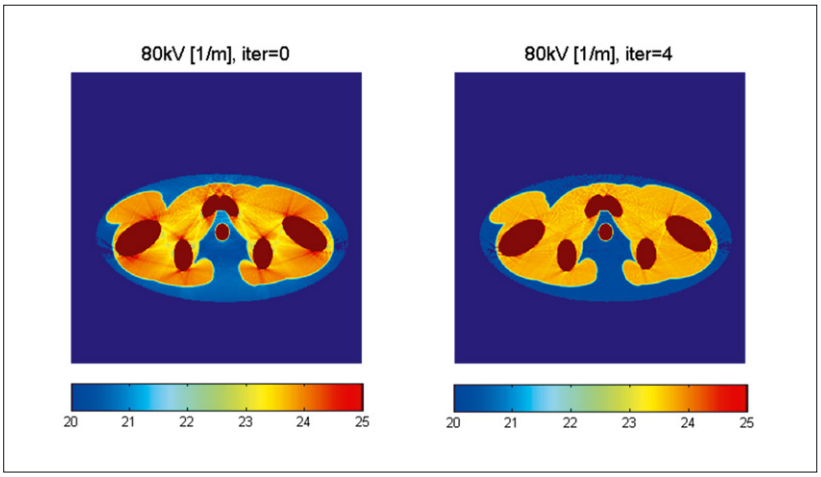


Figure 1. Suppression of the beam hardening artifact from iteration 0 to iteration 4 in DIRA.

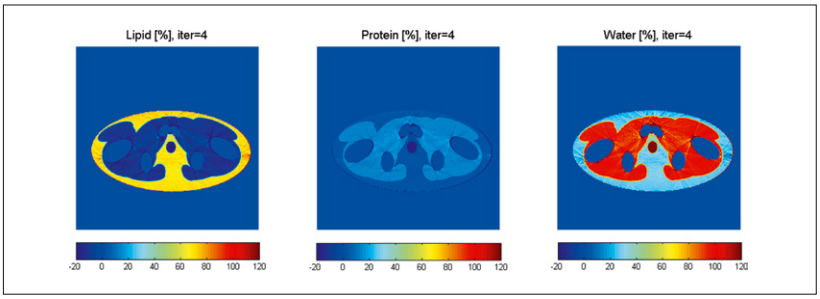


Figure 2. Soft tissue classification into lipid, protein and water (LPW) after 4 iterations of DIRA.

POPULAR SCIENTIFIC SUMMARY
MICHAEL FELSBERG

Visualization-adaptive Iterative Denoising of Images

DIGITAL IMAGES ARE omnipresent and are used in a broad spectrum of countless applications, ranging from digital photography to medical diagnostics. A quite common problem is that the image data you collect is incomplete or distorted. Image reconstruction and image enhancement are fundamental methods of image processing, which normally focus on the so-called inverse problem, which is to reconstruct a high quality image from incomplete and noisy data. Usually these methods do not take into account that ultimately it is a human observer looking at a visualization of the image. When you look at printed photographs or when radiologists analyze images from a computed tomography (CT) scan, it is in fact a transformed version of the originally measured data that is shown. Normally image processing methods do not take into account this visualization process.

The goal of this project is to develop new methods to improve and reconstruct images while taking into account domain knowledge of the imaging and visualization process.

The enhancement of noisy images is determined by a balance between the deviation from the original image data and how "soft" and "clean" the result obtained should be perceived. In our approach, we use the transfer function that is used in the visualization process for determining this balance between deviation and smoothness. This leads to results that are superior to the traditional workflow where denoising and visualization are performed sequentially. The resulting non-linear system for image enhance-

PROJECT NAME
Visualization-adaptive Iterative Denoising of Images (VIDI)

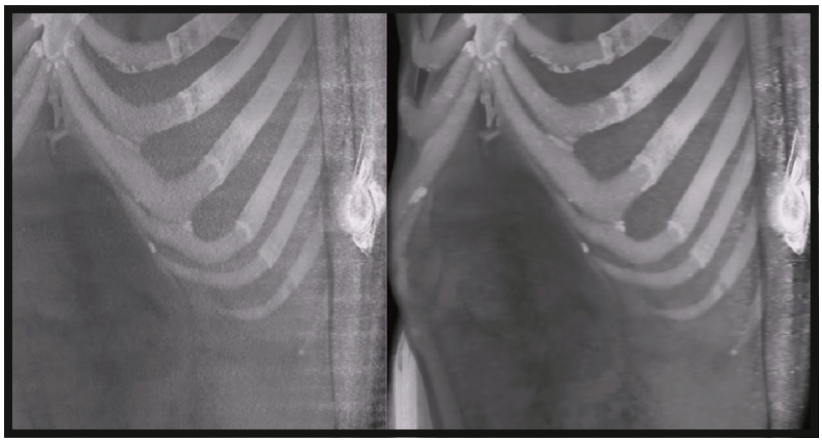
PROJECT LEADER
Michael Felsberg, Department of Electrical Engineering, Division of Computer Vision

MAIN PROJECT PARTICIPANTS
Claes Lundström, Freddie Åström

GRANTS
Swedish Research Council 2013-2016

KEY PUBLICATIONS
F. Åström, M. Felsberg, G. Baravdish, and C. Lundström. Targeted Iterative Filtering. In Fourth International Conference on Scale Space and Variational Methods in Computer Vision, 2013.

F. Åström, V. Zografos, and M. Felsberg. Density Driven Diffusion. In 18th Scandinavian Conferences on Image Analysis, 2013.



The overall aim of this project is to support radiologist to formulate accurate diagnoses from noisy image data. We develop image noise reduction tools which incorporate a transfer function into the filtering scheme, thus we not only take structural image information into account but also utilize the desired visualization window.

ment replaces ad hoc methods and is based on an approach directly derived from the actual transfer function.

The case of incomplete data requires specific knowledge of the image acquisition process to formulate an optimal reconstruction method. A few existing systems use local imaging properties, such as the so-called point spread function, or special imaging techniques, such as projections, embedded in the image enhancement process. By integrating reconstruction and image enhancement in a joint approach, an optimal trade-off between the deviations in both sub problems is achieved.

By deriving image enhancement methods from knowledge of both the imaging and the visualization process, a new uniform approach is obtained. This approach will provide new insights into the theory of iterative image enhancement and is expected to lead to significant advances in the field, particularly for the non-linear functions above that are derived from fundamental principles. In this project, we extend our previous results on some sub-problems:

Combining analytical computed tomography (CT) reconstruction with algebraic methods, applying known solutions of regularization problems in terms of integral transforms on the CT image reconstruction, identifying the systematic connection between fundamental principles and diffusion formulations for image enhancement as well as understanding and modeling of the visualization process, particularly with feedback from the observer.

POPULAR SCIENTIFIC SUMMARY
RODRIGO MORENO

Medical Image Analysis Through Tensor Voting

PROJECT NAME
Medical image analysis through tensor voting

PROJECT LEADER
Rodrigo Moreno, Department of Medical and Health Sciences, Division of Radiological Sciences

MAIN PROJECT PARTICIPANTS
Örjan Smedby, Magnus Borga, Tino Ebbers, Chunliang Wang

GRANTS
Swedish research Council 2013-2015

KEY PUBLICATIONS
Moreno, R., Garcia, M.A., Puig, D. Tensor voting for robust color edge detection. In Advances in low-level color image processing, Celebi, E., Smolka, B. (Eds), Springer, 2014, pp.279-301.

Moreno, R., Wang, C. Smedby, Ö. Vessel wall segmentation using implicit models and total curvature penalizers. In Proc. Scandinavian Conference on Image Analysis (SCIA), 2013, Lecture Notes in Computer Science 7944, pp. 299-308.

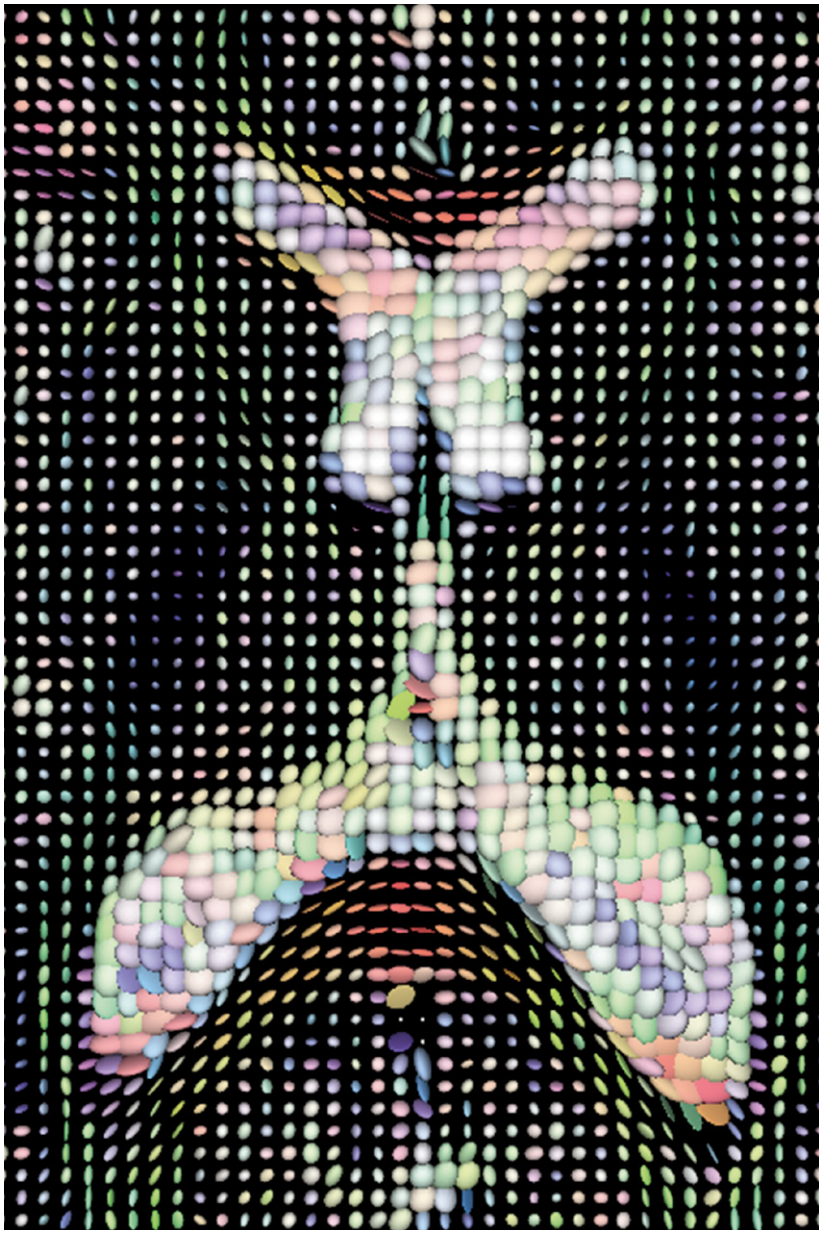
Moreno, R., Garcia, M. A., Puig, D., Pizarro, L., Burgeth, B., Weickert, J. On improving the efficiency of tensor voting. IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol. 33, No. 11, 2011, pp. 2215-2228.

TECHNOLOGICAL ADVANCES IN medical imaging have largely improved the diagnosis of illness. However, these advances also impose a burden to physicians, since the amount of information acquired through medical imaging is usually huge. Medical image analysis techniques aim at helping physicians in the analysis of these data. The potential high impact in the public health systems has fostered the research in this area in the recent years. One of the aims of computer vision is to extract information from images. Since both areas deal with image analysis, it is not surprising that many tools that have been proven effective in computer vision, also have been adapted to images acquired through medical imaging modalities and vice versa.

Many problems in medical image analysis have not completely been solved due to low resolution and noise present in the images. Using perception-based methods for this type of problems is promising given the largely reported success in computer vision applications in noisy conditions. Perception-based methods use psychological theories on how humans manually identify regions of interest in the images. One of the most versatile of these techniques is tensor voting. Tensors can be used for describing physical properties and geometry in a mathematical way. In tensor voting the information provided by individual tensors are propagated using - perception-based rules in order to detect regions of interest in the images. We have successfully used tensor voting for image denoising, edge detection and segmentation tasks in color images. This method may potentially be beneficial for problems in medical images, such as blood vessel segmentation, detection of bifurcations, detection of separation points and vortices in blood

flow, tractography, and detection of nodes in trabecular bone. However, important theoretical extensions of tensor voting are still required to tackle these problems. These extensions are not straightforward due to the inherent complexity of the theory of tensors and the difficulty of proposing efficient implementations. In this line, the main aim of this project is to propose efficient theoretical extensions of tensor voting to make it suitable to different medical image applications.

An additional challenge for automated methods aiming at mimicking human's performance in analysis of medical images is that, radiologists not only use their perception but also their extensive knowledge in radiology for detecting and assessing structures of medical importance. Combining perception-based methods and machine learning strategies is a promising approach for this issue, which will also be explored in this project.



Diffusion Tensor Image (DTI) of a section near the ventricles in the brain. The orientation of the depicted ellipsoids indicates the main direction of fibers in the white matter. Tensor voting could be used to extract the trajectory of fibers in order to create connectivity maps in the brain (tractography).

POPULAR SCIENTIFIC SUMMARY
MICHAEL SANDBORG

Optimizing Radiographic Procedures – Dose vs. Image Quality

PROJECT NAME
Optimizing radiographic procedures – dose vs. image quality

PROJECT LEADER
Michael Sandborg, Department of Medical and Health Sciences, Division of Radiological Sciences

MAIN PROJECT PARTICIPANTS
Alexandr Malusek, Gudrun Alm Carlsson

KEY PUBLICATIONS
Michael Sandborg, Anders Tingberg, Gustaf Ullman, David R. Dance and Gudrun Alm Carlsson. Comparison of clinical and physical measures of image quality in chest and pelvis computed radiography at different tube voltages. Medical Physics, 2006, 33(11), 4169-4175.

Michael Sandborg, Anders Tingberg, David Dance, Birgitta Lanhede, Anja Almén, Graham McVey, Patrick Sund, Jack Besjakow, Sören Mattson, Lars-Gunnar Månsson and Gudrun Alm Carlsson. Demonstration of correlations between clinical and physical image quality measures in chest and lumbar spine screen-film radiography. British Journal of Radiology, 2001, 74(882), 520-528.

David R Dance, Anne Thilander-Klang, Michael Sandborg, Claire L Skinner, Isabel Castellano Smith, and Gudrun Alm Carlsson. Influence of anode/filter material and tube potential on contrast, signal-to-noise ratio and average absorbed dose in mammography: a Monte Carlo study. British Journal of Radiology, 73 1056-1067, (2000).

BEFORE X-RAY EXAMINATIONS, the staff at the radiology department will take measures to minimize the radiation exposure and at the same time make sure that the image quality is sufficient for the radiologist to make a correct diagnosis. This process is called dose and image quality optimization. It requires that both the image quality and the patient absorbed dose can be measured and balanced against each other. An improved image quality may results in an increased absorbed dose for the patient. Our research shows that large dose reductions are possible without reducing clinical image quality.

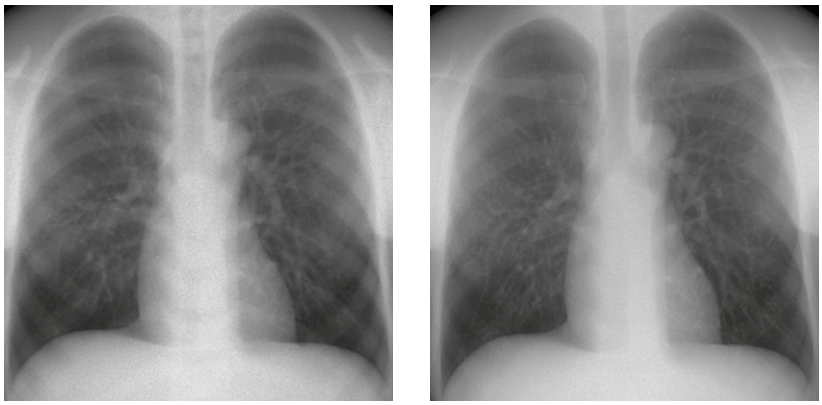
Our objective is to develop and use computer simulations of the complete X-ray imaging system to predict image quality and absorbed doses in the patient. To reach this goal, we are developing a computer model of the imaging system, a so called virtual X-ray system, by searching for correlations between the subjective assessment of clinical image quality by the radiologist and of objective image quality by the computer model observer. The model observer is able to use all the information in the radiograph and computes an index of image quality depending on the diagnostic task (for example finding a lung- or breast tumor). The model observer can be used in a very cost-effective manner to search for settings on the X-ray unit that minimizes the patient exposure. A key part of the model is the database of patient like, three-dimensional volumes of different parts of the human anatomy. The image below is an example in chest imaging.

Our virtual model of the imaging system provides unique possibilities not just to assess existing X-ray systems, but also to explore future imaging systems before constructing expensive prototype systems. The research therefore gives important

design information to manufacturers of X-ray imaging systems.

An example of a model observer is the signal-to-noise ratio for a clinically relevant structure, for example a contrast-filled vessel. The signal-to-noise ratio measures how well this vessel can be detected (safely diagnosed) in a radiograph where the visibility of the vessel is limited by the noise in the image when a limited number of X-rays are used to form the radiograph. This is similar to the case of taking ordinary photographs under poor lighting conditions that will result in noisy images.

Our research aims to find optimal settings on the X-ray unit that maximizes the ratio of image quality per absorbed dose in the patient, i.e. maximizing the dose efficiency. Our investigations so far show a clear indication that dose reductions of up to 50% are possible using optimal settings in clinical practice.



The figure shows a simulated (computed) chest radiography to the left and a real radiograph of the same lung to the right.

POPULAR SCIENTIFIC SUMMARY
MARCEL WARNTJES

Clinical Implementation of Synthetic MRI

PROJECT NAME
Clinical Implementation of Synthetic MRI

PROJECT LEADER
Marcel Warntjes, Department of Medical and Health Sciences, Division of Cardiovascular Medicine

MAIN PROJECT PARTICIPANTS
Anne-Marie Landtblom, Peter Lundberg, Maria Engström, Tino Ebbers, Ebo de Muinck, Jan Engvall, Stefan Tell, Peter Johansson, Sten Bergström, Lisa Warnroth, Anders Swenningsson, Richard Birgander, Elna-Marie Larsson, Tobias Granberg, Leszek Stawiarz

GRANTS
Henry och Ella Margareta Ståhls stiftelse

KEY PUBLICATIONS
H. Gauffin, H. van Ettinger-Veenstra, A-M Landtblom, D. Ulrici, A. McAllister, T. Karlsson, M. Engström. Impaired language function in generalized epilepsy: Inadequate suppression of the default mode network. Epilepsy & Behavior, 28:26–35, 2013.

H.M. Van Ettinger-Veenstra, M. Ragnehed, A. McAllister, P. Lundberg, M. Engström. Right-Hemispheric Cortical Contributions to Language Ability in Healthy Adults. Brain and Language, 120:395–400, 2012.

H.M. Van Ettinger-Veenstra, M. Ragnehed, M. Hällgren, T. Karlsson, A-M Landtblom, P. Lundberg, and M. Engström. Right-hemispheric brain activation correlates to language performance. NeuroImage, 49:3481-3488, 2009.

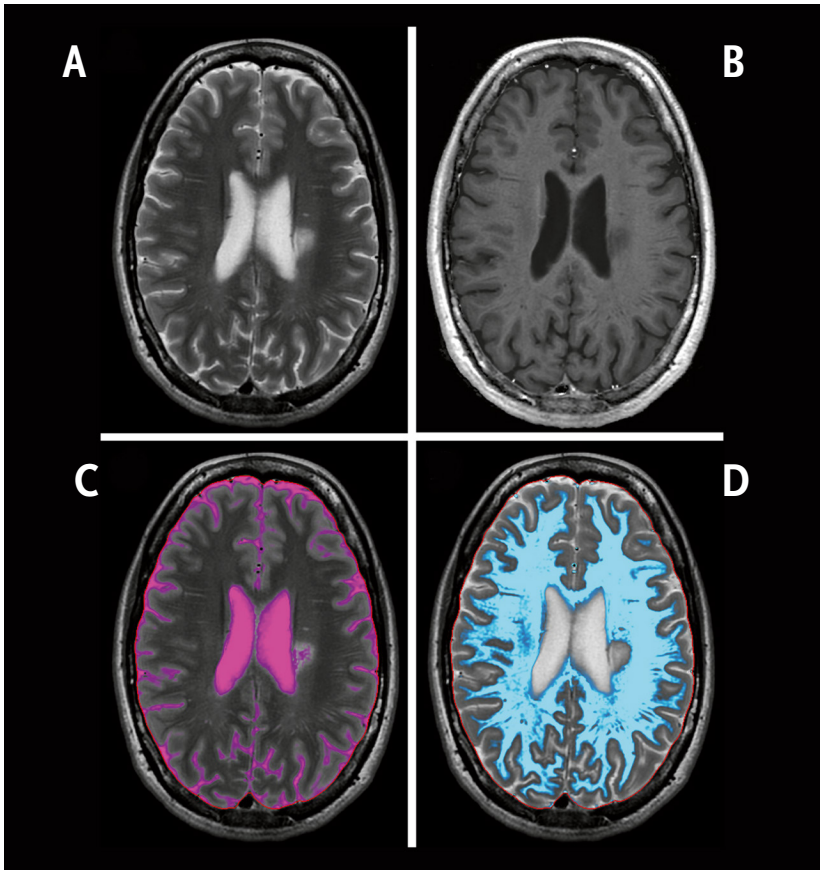
SYNTHETIC MRI IS A technique to quantify physical properties of a patient using Magnetic Resonance Imaging (MRI). Based on these physical properties a range of conventional MR images can be recreated and tissue can be recognized and assessed automatically. This means that a relatively short scan time of 5-7 minutes is sufficient to reproduce a large part of a normal MR examination and, additionally, to provide more objective means of patient follow-up.

A close collaboration between researchers at CMIV with various university hospitals, including Linköping, Umeå, Örebro and Uppsala, ensured the clinical relevance of the technique. A number of technical and clinical studies were performed to validate the various aspects of synthetic MRI on scan time reduction and automatic brain segmentation. After the initial prototype phase more hospitals became involved, among which a number in the US, to introduce synthetic MRI as a standard procedure into the clinical workflow. For example, in the radiology department at Linköping University Hospital synthetic MRI is now used as a standard protocol for MS patients and a research protocol for brain tumor patients. In the entire County Council of Västerbotten it is used as standard protocol for MS patients.

Currently an increasing number of evaluation projects are ongoing to validate the time reduction on the MR scanner and to assess the robustness of the technique on diseases such as multiple sclerosis (MS), hydrocephalus, cancer and dementia in clinical

practice. Exciting new research ideas are worked out such as automatic MS lesion detection and brain myelination assessment. Also on other anatomies synthetic MRI is tested. Examples are the assessment of the prostate and of plaques in the large vessels. A new quantification sequence is developed which is so fast that the entire heart chambers can be measured within one single breath-hold.

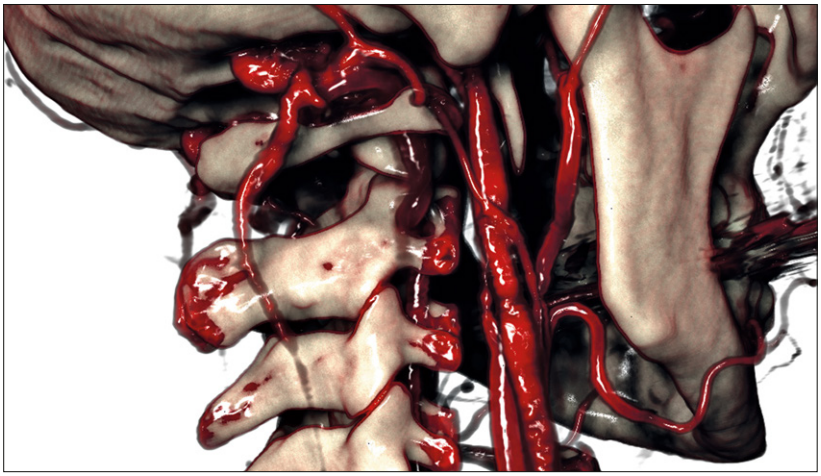
In the history of MRI, general images were acquired which were subjectively interpreted by radiologists. With the advent of synthetic MRI we believe that this is going to change dramatically: Scan times will be shorter and the decision support will be more based on numbers and statistics. Automated analysis can make the work of the radiologist both faster and more objective. The technique is available on most scanner brands which will decrease the variation between different hospitals. Synthetic MRI is a clear example of excellent cooperation between university, hospital and commercial companies, made possible by CMIV.



Example of synthetic MRI on the brain: Based on a single acquisition different conventional images can be recreated such as a T2-weighted (A) or a T1-weighted (B) image. Additionally the sequence serves as input to automatic tissue segmentation, such as cerebrospinal fluid (C) or white matter (D). Automatic tissue segmentation enables objective patient monitoring.

POPULAR SCIENTIFIC SUMMARY
ANDERS YNNERMAN

Methods for High-quality Illumination in Interactive Volume Graphics



PROJECT NAME
Methods for high-quality illumination in interactive volume graphics

PROJECT LEADER
Anders Ynnerman, Department of Science and Technology, Division for Media and Information Technology

MAIN PROJECT PARTICIPANTS
Daniel Jönsson, Joel Kronander, Timo Ropinski

GRANTS
The Swedish Research Council 2011

KEY PUBLICATIONS
A Survey of Volumetric Illumination Techniques for Interactive Volume Rendering, Daniel Jönsson, Erik Sundén, Anders Ynnerman, Timo Ropinski, Computer Graphics Forum doi: 10.1111/cgf.12252 – 2013.

Historygrams: Enabling Interactive Global Illumination in Direct Volume Rendering using Photon Mapping, Daniel Jönsson, Joel Kronander, Timo Ropinski, Anders Ynnerman, IEEE Transactions on Visualization and Computer Graphics (TVCG), Volume 18, Number 12, page 2364--2371 - December 2012.

Efficient Visibility Encoding for Dynamic Illumination in Direct Volume Rendering, Joel Kronander, Daniel Jönsson, Joakim Löw, Patric Ljung, Anders Ynnerman, Jonas Unger, IEEE TVCG, Volume 18, Number 3, page 447-462 – 2012.

AN ESSENTIAL INGREDIENT IN understanding of the structures found in volumetric data is the ability to interactively change rendering parameters and camera settings. In this project we strive to increase the clarity of images and improve the perception of depth and detail by developing efficient algorithms for shading of volumetric data in real time. However, being able to perform simulations of the ways light absorbs and reflects, while still being able to interactively explore the data, is a computationally daunting task. Several approaches to this problem exist, but with the demand for interactivity, compromises with respect to the physical accuracy of the light transport in the volume have to be made. Our research therefore has focused on

Displaying a computed tomography scan of a wrist. By applying advanced shading it becomes intuitive to understand the shape, location and size of the vessels and skeleton.

developing efficient methods for simulating physically based light interaction of volumetric objects from computed tomography (CT) scans, mimicking the real world matter-light interaction, while still allowing interactive data exploration. This lifelike object-light interaction was previously not possible until we in this project were able to simulate realistic light interactions interactively using photon maps. The maps have a data structure that enables recording of the photons path history, thus avoiding costly recalculation of photon paths. The image below shows a screen shot of such an interactive rendering of a volumetric data set from at CT scan of hand.

We are now extending our methods to 4D CT scans and thereby enabling examination of the hand's function with realistic shading. The key to this is to utilize correlation between the changes in time and the changes of light transport for individual photons.

POPULAR SCIENTIFIC SUMMARY
ANDERS PERSSON

Low-Dose Computed Tomography Below 1 milliSievert

PROJECT NAME
Low-Dose Computed Tomography Below 1 milliSievert

PROJECT LEADER
Anders Persson, Department of Medical and Health Sciences, Division of Radiological Sciences

MAIN PROJECT PARTICIPANTS
Nils Dahlström, Mischa Woisetschläger, Lilian Henriksson, Petter Quick, Mannudeep Kalra

KEY PUBLICATIONS
Kalra M, Woisetschläger M, Dahlström N, Singh S, Lindblom M, Choy G, Quick P, Schmidt B, Sedlmair M, Blake MA, Persson A. Radiation Dose Reduction with Sinogram Affirmed Iterative Reconstruction Technique for abdominal CT. J Comput Assist Tomogr, 2012, 36(3):339-346.

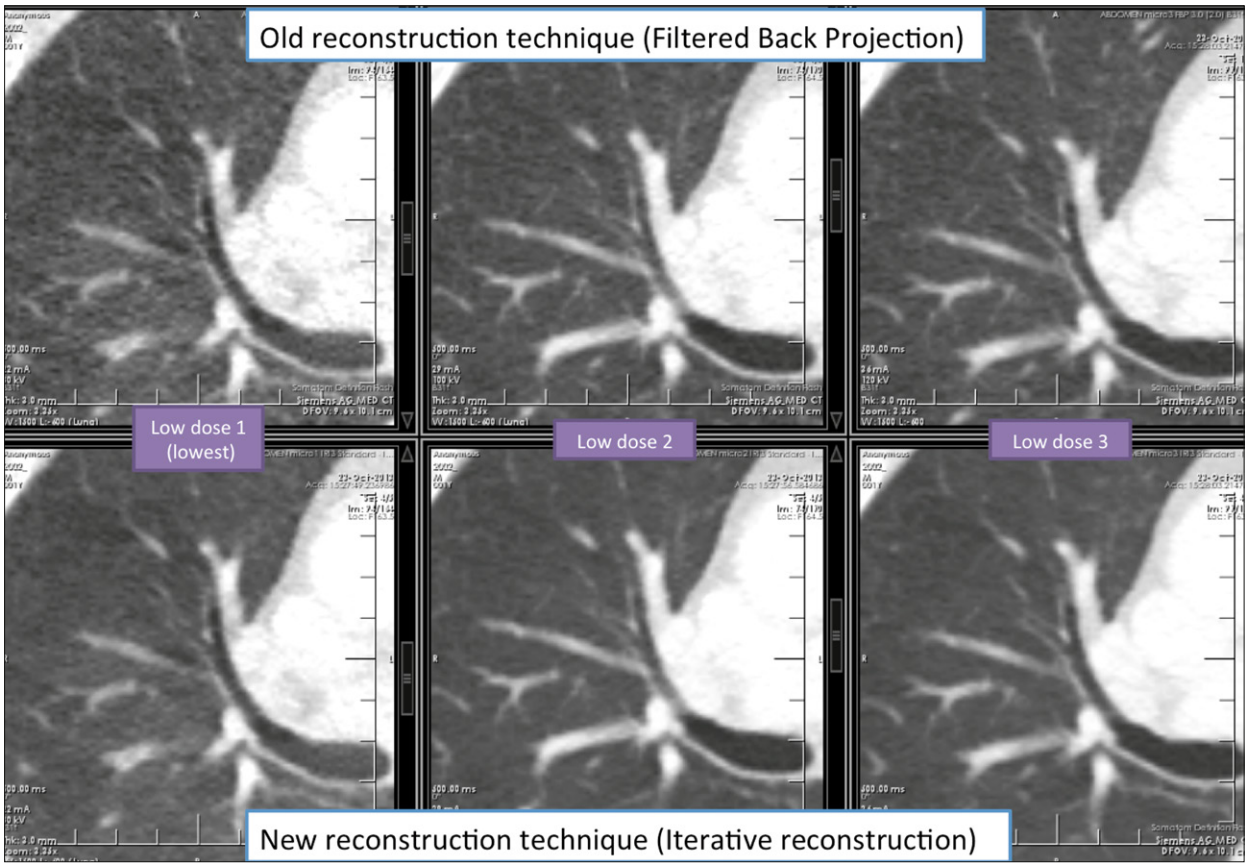
Kalra M, Woisetschläger M, Dahlström N, Singh S, Digumarthy S, Do S, Pien H, Quick P, Schmidt B, Sedlmair M, Shepard J-A O and Persson A. Sinogram-Affirmed Iterative Reconstruction of Low-Dose Chest CT: Effect on Image Quality and Radiation Dose. American Journal of Roentgenology, 2013, 201(2), W235-W244.

MEDICAL IMAGING IS USEFUL and necessary when examining and taking care of patients. X-rays have been used for more than a hundred years for imaging of the chest and skeleton. With the invention of Computed Tomography (CT) X-ray in the 1970's, X-rays could be used to image all parts of the body. The first machines could produce only a few images (slices) of a limited region, e.g. the patient's head, but since the mid-90's a CT machine can scan the whole patient, and nowadays this takes just a few seconds.

The main problem is that X-rays are associated with a risk of cancer. The benefit of a well performed CT outweighs this risk, but it is important to continue improving the technique to limit the radiation dose the patients are exposed to.

Thanks to modern computers becoming more and more powerful, it is now possible to use advanced techniques and improved calculations on the CT data, resulting in high quality images. These so-called iterative techniques make it possible to use less X-rays in the CT scan and still obtain images of high quality.

An important research question is therefore how to lower the radiation dose as much as possible and still obtain acceptable images. This is important to study in real patients. Therefore, the 400 patients involved in this project receive an extra CT scan with very low dose together with their



standard CT scan. The extra X-ray dose amounts to less than 1 mSv, which is about one third of the radiation dose we are exposed to each year from the earth and the sky.

The data from both the low-dose scan and the standard scan are stored in a digital archive. From this data, images can then be produced using both old and new techniques, in a number of ways. Generally, the low-dose images are of unacceptable quality when the old technique is used (see figure). This project compares the best images we can reconstruct from low-dose data, using the best available iterative technique, with the standard-dose images. Since we have access to novel iterative techniques that are still in development, the research results will be relevant when these techniques are introduced on the market.

If the X-ray dose can be lowered in all or many of the very common CT examinations, CT will be a safer and more valuable technique, especially for patients that are young or have to go through many CT examinations.

POPULAR SCIENTIFIC SUMMARY
ANDERS PERSSON

Forensic Science – Virtual Autopsy

PROJECT NAME
Forensic Science - Virtual Autopsy

PROJECT LEADER
Anders Persson, Department of Medical and Health Sciences, Division of Radiological Sciences

MAIN PROJECT PARTICIPANTS
Christian Jackowski, Maria Lindblom, Mischa Woisetschläger, Johan Berge, Anna Bodén

GRANTS
KK-stiftelsen 2008-2010
RMV forskningsfond 2008-2010
RMV forskningsfond 2009
Konung Gustav V:s och Drottning Victorias frimurarstiftelse 2008-2012

KEY PUBLICATIONS
Ljung P, Winskog C, Persson A, Lundström C, Ynnerman A. Full Body Virtual Autopsies Using A State-of-the-art Volume Rendering Pipeline. IEEE Transactions on Visualization and Computer Graphics. 2006;12(5):869-876.

Persson A, Lindblom M, Jackowski C. A state-of-the-art pipeline for postmortem CT and MRI visualization: from data acquisition to interactive image interpretation at autopsy. United Kingdom: Informa Healthcare; Acta Radiologica. 2011; 52 no. 5 522-536.

C. Jackowski, N. Schwendener, S Grabherr, A. Persson. Postmortem cardiac 3T magnetic resonance imaging: Visualizing the sudden cardiac death? Journal of the American College of Cardiology, 2013; Volume 62, Issue 7, 13 August 2013, Pages 617–629.

A RECENT ADDITION to the autopsy workflow is the possibility of conducting postmortem imaging using computed tomography (CT) and magnetic resonance imaging (MRI) in a virtual autopsy. The results from these modalities can provide additional information to the autopsy report. The images give a fast overview of damages to the skeleton, air pockets and foreign objects that is not possible to achieve with conventional methods. Blood cloths and bleedings can also be identified in the images.

At CMIV postmortem imaging has been used in routine work since 2003. Mostly homicides are analyzed and the imaging gives the police an early report allowing the traditional autopsy to wait for the crime scene investigation to finish. During the scan the body stays sealed in the bag preserving any evidence, as fibers and body fluids, present on the body. The images produced during the virtual autopsy are conveniently presented and easy to understand in court.

This project has focused on optimizing the total workflow for the post mortem imaging and developing a new type of software that can visualize full body data-sets and three-dimensional

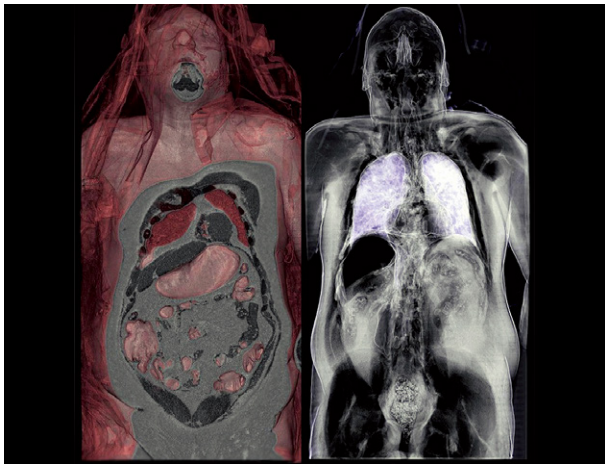


Figure 1. Postmortem Dual Energy computed tomography angiography. The captured data rendered with two different translucencies settings so that soft tissue and air in the body can be visualized by volume rendering 3D.

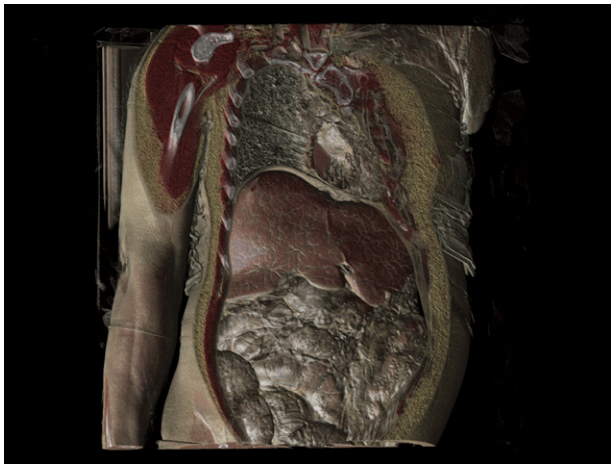


Figure 2. Postmortem Dual Energy computed tomography of a deceased person. Soft tissue rendered with different colours and different translucencies. Part of the anterior tissue virtually removed from the body so that the underlying organs can be studied.

visualization. The conditions when scanning a dead body is not the same as for a living patient. When using the CT it is possible to use high radiation doses without concern for long term effects and there are no artifacts caused by movement. This allows images with high resolution. The bodies are scanned at two different energy levels at the same time, dual energy CT, improving soft tissue discrimination and visualization.

The MRI examinations are sensitive to the body temperature and it is difficult to generate images with good contrast when scanning a cold body. At CMIV the clinically established protocols has been adjusted for optimal image quality at any given temperature. If a natural death is suspected the heart is examined using specific MRI protocols revealing heart attacks.

The number of autopsies performed is decreasing and natural deaths are rarely investigated. The virtual autopsy is therefore not only a useful complement to the traditional autopsy in the forensic investigation. It could be used instead of autopsy for natural deaths which would otherwise not be investigated to improve medical education, quality assurance and reliable mortality statistics. It is also an alternative when the invasive autopsy is not agreed by the next of kin due to personal or cultural reasons.

POPULAR SCIENTIFIC SUMMARY
THOMAS KARLSSON

A New Perspective on Selective Attention: Is There a Link Between the Physiology of Hearing and Cognitive Mechanisms?

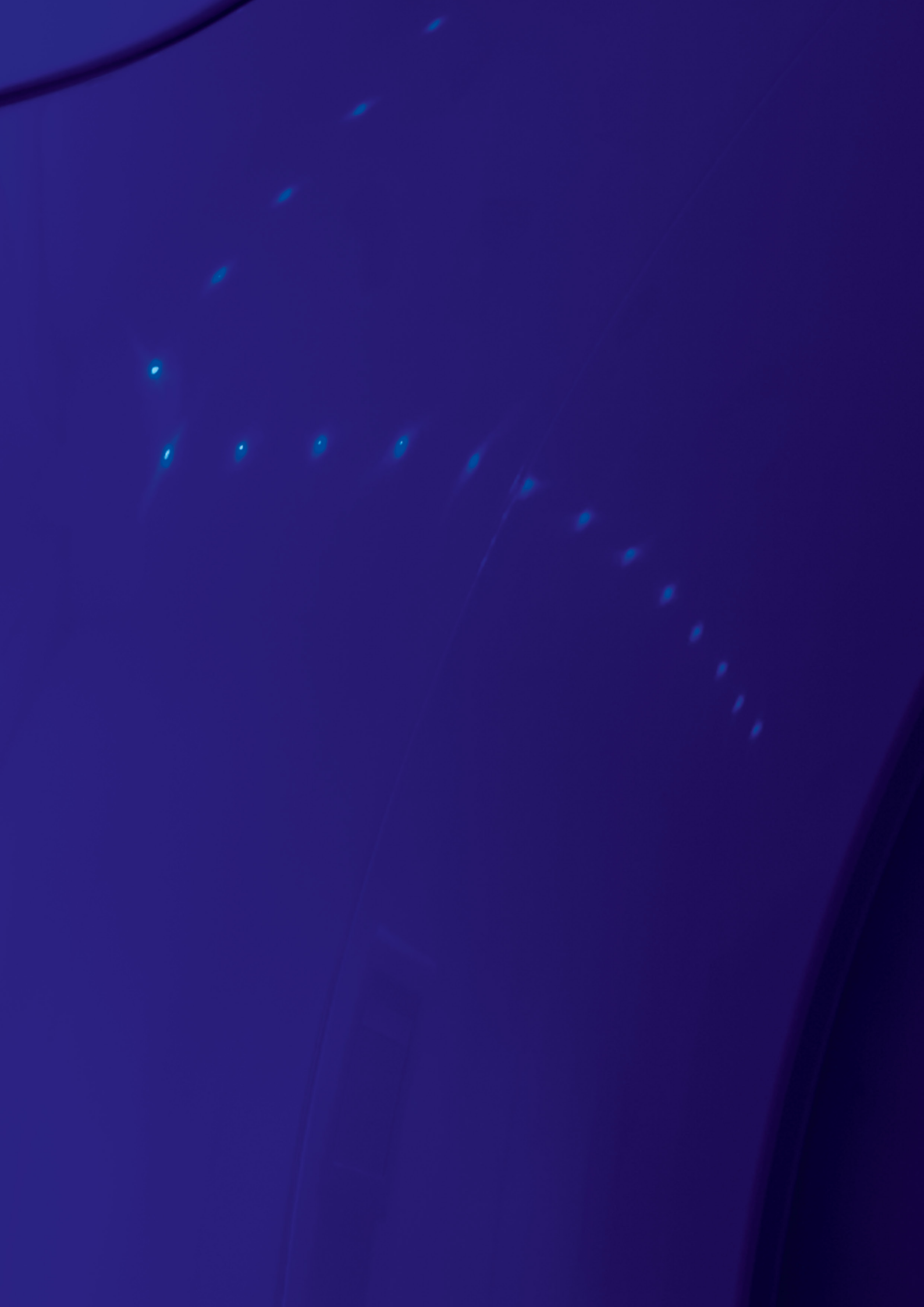
WHAT ENABLES US TO follow a voice in the presence of other voices? A number of psychological theories compete to give the best answer to this question. The debate mainly concerns where the filtering of the irrelevant material, in this case the voices we don't wish to follow takes place: Some suggest that the filtering takes place early, before the irrelevant material is processed whereas others suggest that the filtering is late, after some processing. Our previous psychological research has repeatedly found a relationship between cognitive capacities and the capability to control the extent to which irrelevant sound is processed, and within the physiological/biological research tradition one has found outer hair cells of the ear to be involved in the filtering of irrelevant sound. Using functional magnetic resonance imaging (fMRI), the research project proposed here will juxtapose psychological and physiological/biological theories and methods to investigate whether there is a relation between cognitive capacities and the capability to control the outer hair cells' response to sound. The relationship would show that cognitive abilities modulate the filtering of irrelevant material and that the filtering takes place at a very early stage in the information processing (i.e., the inner ear). The project has consequences for theories of selective attention and it has its most prominent application in the understanding and treatment of hearing impairment.

PROJECT NAME
A new perspective on selective attention: Is there a link between the physiology of hearing and cognitive mechanisms?

PROJECT LEADER
Thomas Karlsson, Department of Behavioral Science and Learning, division of Disability Research

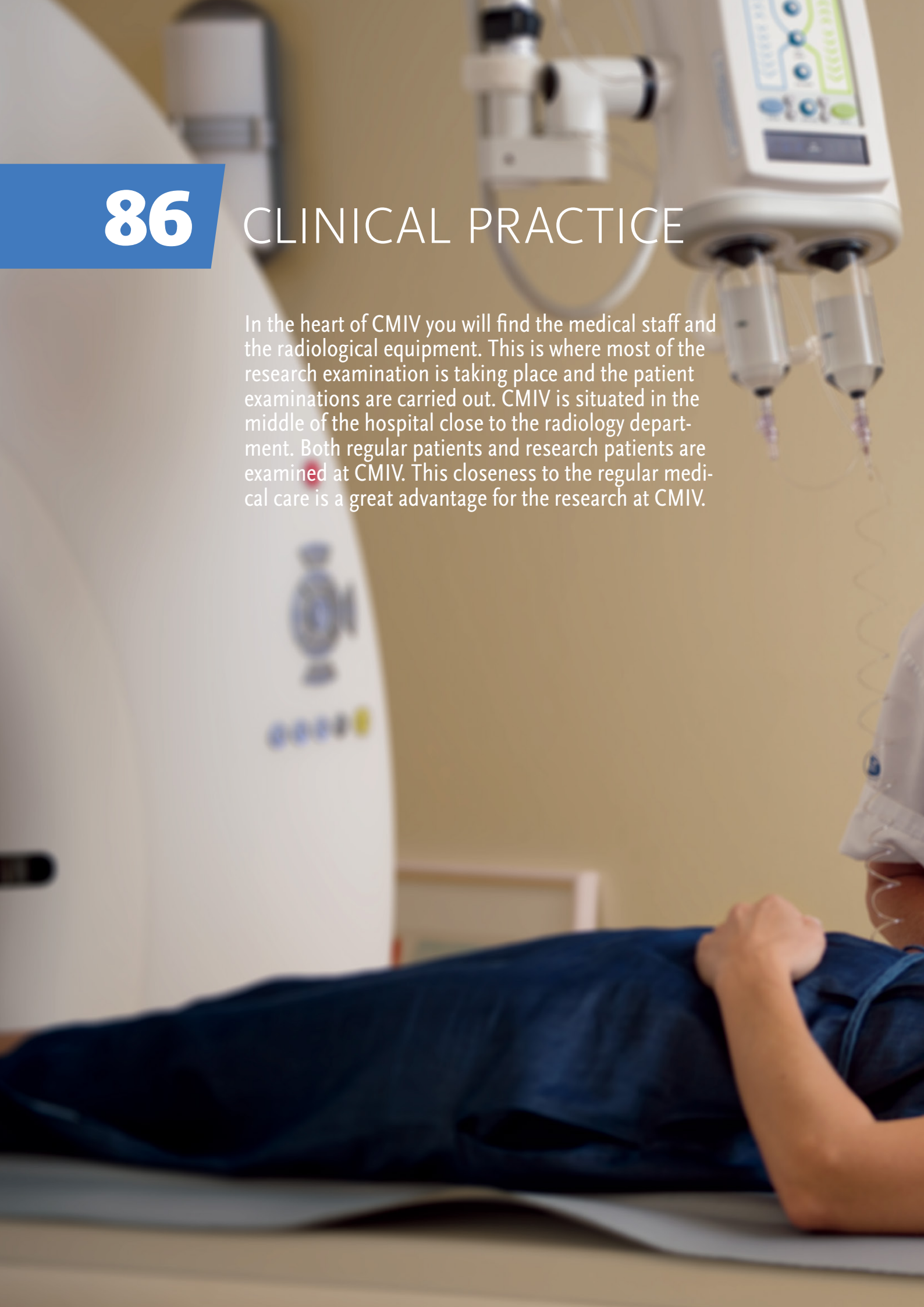
MAIN PROJECT PARTICIPANTS
Örjan Dahlström, Jerker Rönnberg, Niklas Rönnberg, Carine Signoret, Patrik Sörqvist

GRANTS
Riksbanken Tercentenary Foundation



86 CLINICAL PRACTICE

In the heart of CMIV you will find the medical staff and the radiological equipment. This is where most of the research examination is taking place and the patient examinations are carried out. CMIV is situated in the middle of the hospital close to the radiology department. Both regular patients and research patients are examined at CMIV. This closeness to the regular medical care is a great advantage for the research at CMIV.




Sjuksköterska

MRI Research and Clinic Walk Hand in Hand

There is a close relationship between MR research and clinic at CMIV. Questions that arise during clinical work are passed on to become research projects. At the same time new methods may be tested in research project and used clinically when verified.

AT CMIV THERE are around 10 radiology nurses and biomedical analysts working with magnetic resonance imaging (MRI). They produce the images and process them according to the medical referral.

–There are extensive calculations involved in the production of MR images, says Johan Kihlberg, radiology nurse and team leader at CMIV.

–Depending on the medical question at hand it can require calculations of for example flow and volume or for identification of nerve fibers.

Johan is responsible for the MR research as well as development and maintenance of the clinical work. Half of his time is devoted to his own research as a CMIV PhD student.

The camera time at CMIV is split fifty-fifty between research and clinic. All types of MR examinations might end up at CMIV but the focus lies in abdominal, cardiac, blood vessel and neuro scans.

–We have experience and routine from the research scans in these areas and it's therefore natural that we focus our resources on them, says Johan.

There is a close relationship between MR research and clinic at CMIV. Questions that arise during clinical work are passed on to become research projects. At the same time new methods may be tested in research project and used clinically when verified.

–In one of our research projects we have verified a method to measure liver fat with MR against the standard methods ultrasound and biopsies. Now we have taken the noninvasive MR method into clinical use, explains Johan.

MRI is based on a large magnet placing a magnetic field over the patient and a radio pulse turning on and off. A coil placed as close to the body as possible works as an antenna and takes up the signal emitted back from the body.

At CMIV there are two MR cameras with different field strength. The higher field strength, 3 tesla instead of 1.5, is an advantage in specific methods. For example in fMRI which is a method that measures brain activity the images will be much clearer and spectroscopy, a method to measure metabolites in the body the values will be more specific in the 3 tesla.

In the near future both MR cameras will be upgraded with the latest software from Philips. The 1.5T will be equipped with new, more effective coils and to the 3.0T phosphor spectroscopy technique will be added.

Assistant Nurses Caring for the Patients

The assistant nurses are in charge of the logistics and booking the examinations making sure that the work flow is efficient. Much of their work is about caring for the patients and making them comfortable about the examination.

THE ASSISTANT NURSES at CMIV are taking care of the patients when they arrive for their examinations. They make sure that the patients are ready on time and help them when they are done. Much of their work is about caring for the patients and making them comfortable.

Assistant nurses are also in charge of the logistics and booking the examinations making sure that the work flow is efficient. The clinical routine examinations made at CMIV are booked at the radiology department next door.

Carina Johansson and Mona Cederholm are in charge of the research booking at CMIV. They both have long experience from working as assistant nurses at the radiology department in Linköping. Now they are devoting half of their time to the research booking at CMIV while still working half time at the radiology department.

–We are a good team, the schedule is not always easy to work out but we solve it together, says Mona Cederholm.

As they are alternating weeks in the research booking there is always one of them on duty. Having full time focus on the booking has increased the efficiency at CMIV. The research projects are finished faster and empty slots are often filled with patients from other departments. The overview Mona and Carina have of the schedule makes them a valuable asset to the daily work flow.

–As we have the schedule overview and patient experience we often help out where ever needed at CMIV, continues Carina Johansson.

It is not unusual that patients are worried about their examination, both regarding the experience in the camera and what might be found in the images. This is an important responsibility for the assistant nurses.

–We sometimes spend hours on the phone calming patients down, explaining the procedure and convincing them to come in for their appointment, explains Carina and Mona.


MONA CEDERHOLM
Undersköterska
Röntgenkliniken

Enlighten the Body with Computed Tomography

The radiology nurses perform CT examinations on the radiologists request. The method produces slices of data that stacked together can show images from any angle or in 3D depending on the purpose.

LILIAN HENRIKSSON AND PETTER QUICK are radiology nurses at CMIV, both specialized in computed tomography (CT) with long experience in the field. They perform CT examinations on the radiologist's ordination ensuring that the correct images are taken and processes the images to show the best view of what the radiologist is looking for. The method produces slices of data that stacked together can show images form any angle or in 3D depending on the purpose.

The CT at CMIV has two X-ray sources and two detectors. This has two main advantages explains Lilian Henriksson. First, the examination may be performed much faster than with regular CT. This is useful for example when analyzing a beating heart where the movement otherwise may disturb the images or if the patient is restless and unable of lying still. Second, if the X-ray sources are used at

different energy levels it is possible to distinguish between different tissues and materials that would otherwise be impossible.

–The technique is called dual energy and is often used to lower artifacts from metal implants. The machine simply produces faster and better images than a regular CT, explains Petter Quick.

Scanning larger patients is another advantage with the two X-ray sources. To penetrate a large body higher radiation doses than a single source machine can produce is required.

With the CT it is possible to scan the whole body. Any referral coming through the radiology department at the hospital may end up at CMIV. However, the majority of the CT examinations at CMIV are of the heart and blood vessels. In collaboration with the pathology department CMIV also performs postmortem scans of forensic cases to be used in virtual autopsies.

Apart from managing the advanced imaging techniques, another side of the job is to guide the patients through the procedure.

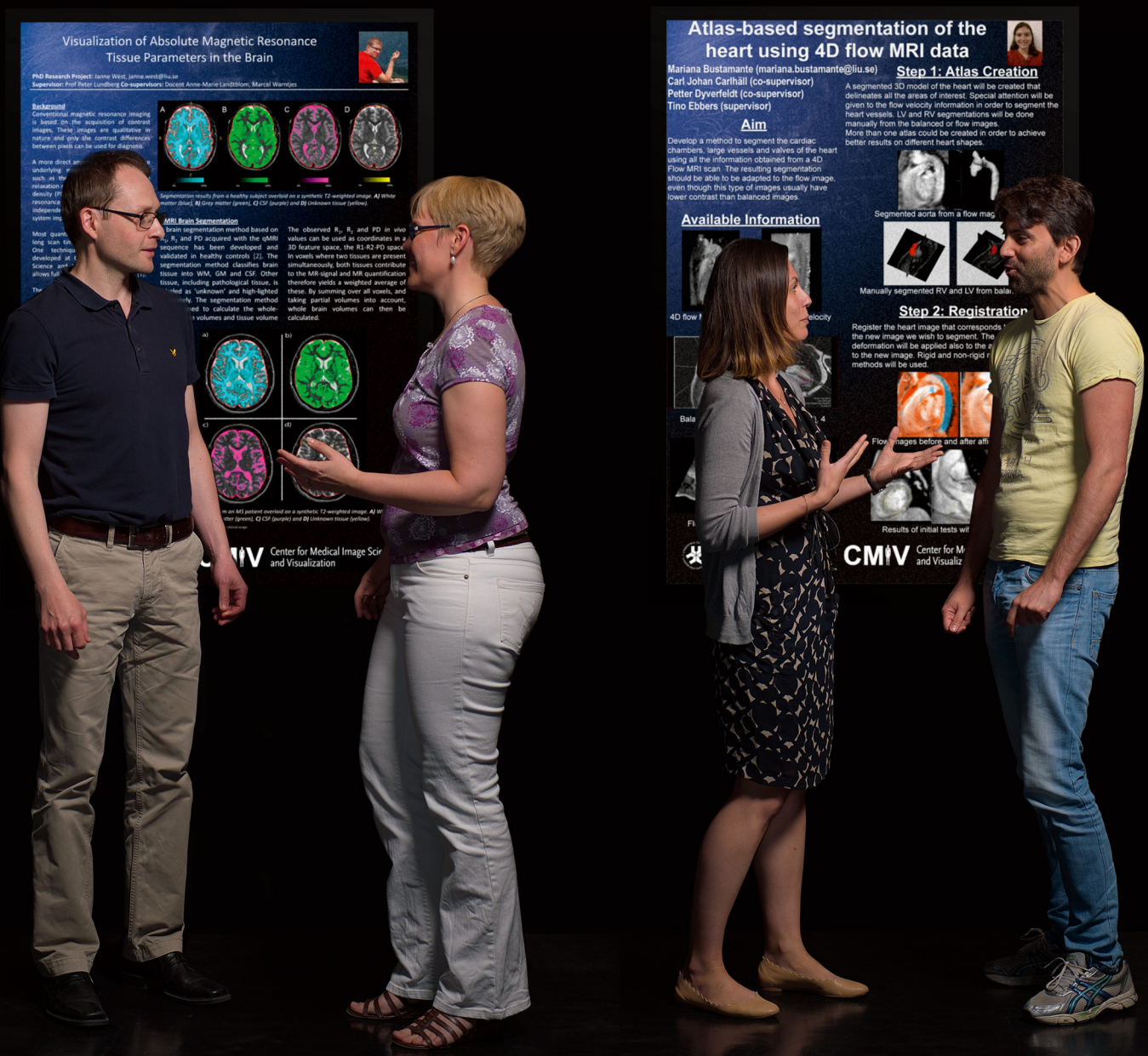
–If the patients understand the procedure it is easier for them to cooperate during the examination, says Lilian Henriksson.

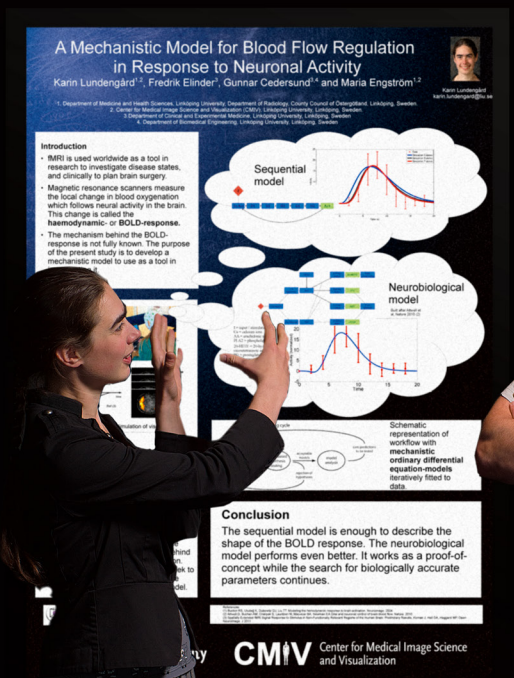
The research studies performed on CT are done with patients already scheduled for a CT scan to avoid unnecessary radiation exposure. Several projects are working on lowering the radiation doses without compromising image quality. One of them is a method to scan scoliosis patients fast and at low radiation doses using dual energy, a method implemented in clinical use at the hospital. Another ongoing study investigates the possibility to use abdominal scans to simultaneously measure the bone density to identify osteoporosis.

–CMIV is now planning on replacing the current CT with the latest, even more advanced, model from Siemens. This will lead to new opportunities in research and development, Lilian concludes.

94 THE CMIV RESEARCH SCHOOL

The CMIV research school offers a doctoral program with both medical and technological entries and coherent research education. A basic principle for our doctoral program is the close connection between different disciplines as medicine and technology. Currently there are around forty PhD students admitted to the research school. Here a selection of them presents their research.




A Mechanistic Model for Blood Flow Regulation in Response to Neuronal Activity
Karin Lundengård[1,2], Fredrik Elinder[3], Gunnar Cedersund[3,4] and Maria Engström[1,2]
Karin Lundengård
karin.lundengard@liu.se
1. Department of Medicine and Health Sciences, Linköping University, Department of Radiology, County Council of Östergötland, Linköping, Sweden.
2. Center for Medical Image Science and Visualization (CMIV), Linköping University, Linköping, Sweden.
3.Department of Clinical and Experimental Medicine, Linköping University, Linköping, Sweden
4. Department of Biomedical Engineering, Linköping University, Linköping, Sweden
Introduction
fMRI is used worldwide as a tool in research to investigate disease states, and clinically to plan brain surgery.
Magnetic resonance scanners measure the local change in blood oxygenation which follows neural activity in the brain. This change is called the haemodynamic- or BOLD-response.
The mechanism behind the BOLD-response is not fully known. The purpose of the present study is to develop a mechanistic model to use as a tool in
Sequential model
Neurobiological model
Schematic representation of workflow with mechanistic ordinary differential equation-models iteratively fitted to data
Conclusion
The sequential model is enough to describe the shape of the BOLD response. The neurobiological model performs even better. It works as a proof-of-concept while the search for biologically accurate parameters continues.
CMIV Center for Medical Image Science and Visualization

SUPERVISORS
Magnus Borga,
Olof Dahlqvist Leinhard, Ola Friman

PROJECT
Fat- and water Imaging Project
Quantitative Muscle Project
Brown Adipose Tissue Project

BACKGROUND
Master of Science, Engineering Biology, specialization in Biomedical Engineering
The Institute of Technology, Linköping University, 2005-2011

Research Engineer, Department of Biomedical Engineering, Linköping University, Linköping 2011-2012

Annette Karlsson

Assessing Muscle Volume Using Magnetic Resonance Imaging

DURING A 10 MINUTE MR-scan images of a patient's whole body may be taken. The method developed in our research can use these images to determine that patient's muscle volume, both total muscle volume and the volume of separate muscle groups. The presented method can also determine the amount of fat within the muscle. Fat inside the muscle is a sign that the muscle is injured.

The muscle system is important for us as the muscles make it possible to walk and provides stability to the body. If the muscles are hurt or decreased in volume the result is immobility and pain. The possibility to measure the muscle volume and the amount of fat in the muscles is a useful tool in finding the right treatment and rehabilitation for patients. This automatic muscle volume method will be applied in a clinical study in order to investigate if the muscle volume in patients suffering from whiplash associated disorder is different from healthy controls.
However, measuring the muscle volumes of patients is not easily done. Scales and measuring tapes are not accurate since they do not discriminate between muscles and fat. With an MR-scanner, images are created where all the soft tissue, for example liver, fat and muscles may be shown separately. A pair of images where the first only shows fat tissue while the second shows all the tissue containing water is shown in Fig. 1.

For a trained human, it is easy to distinguish e.g. the liver from the muscles as the human knows where the liver is located and its shape. However, when calculating the volume of the muscles, each small image element must be included for each muscle group. This is too expensive why automatic solutions are needed.

For a computer, organs like the liver and the muscles look very similar as they have similar intensity values in the images (Fig. 1). The computer has no knowledge about where the liver is located or its shape. This method's solution is to manually pre-define the muscle groups within an image, as shown in Fig. 2. When a new image with no pre-defined muscles is produced the old images are adapted so that they become as similar to the new image as possible. The adapted labels are in that process overlaid onto the new image and an automatic solution for the new muscles is achieved. The volume is calculated by a sum of all the small image elements. A typical result is shown in Fig. 3.

Figure 1. A paired magnetic resonance image where the left shows all the water within a whole body and the right shows all the fat.

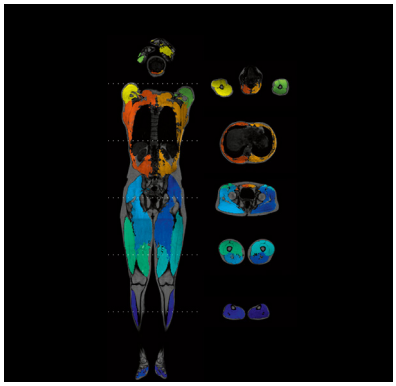


Figure 2. Manually defined muscle groups where a trained human has marked the different muscles shown in different colors. Tissue with grey-color are not muscle tissue.

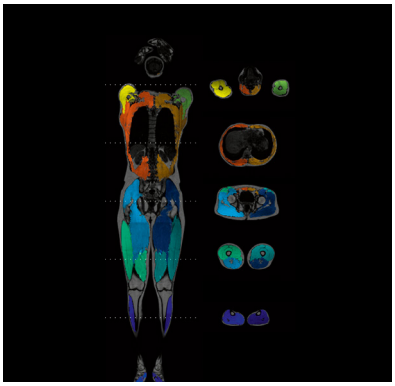


Figure 3. A typical result from the automatic method. The different muscle groups are shown in different colors. Grey color indicated that the automatic method has not considered that tissue as muscle tissue.

SUPERVISORS
Magnus Borga
Olof Dahlqvist Leinhard

BACKGROUND
MSc from Linköping University

Thobias Romu

Quantitative Water-Fat Imaging

TO STUDY THE distribution of various tissues within the human body we use a technique that separates water and fat in magnetic resonance (MR) images. An example of such images is seen in figure 1. By combining quantitative images where every pixel corresponds to an actual fat volume with automatic segmentation through anatomical atlases we study the amount of fat in different compartments in a cost effective way.

White adipose tissue (fat tissue) volume is very hard to measure by imaging since it is the most variable tissue in the human body. Its volume can take up everything from a few per cent of a person's total volume, to several times the volume of other tissues. Excess of adipose tissue carries a heighten risk of diabetes type 2, cardio vascular disease and cancer. However, the total amount of fat is not the strongest indicator of a higher risk. It has been shown that the central abdominal fat surrounding the liver, kidney and intestine correlate with the risk of developing type 2 diabetes. The problem is that current methods, such as waist circumference, are not accurate enough to make predictions on an individual level. At the same time, more accurate image based methods are too expensive.

We have created an inexpensive method for analysing water and fat separated images as well as protocols for speedy MRI accusation. We can cover the abdomen in 5-6 min, and the entire body in less than 10 min, making it possible to add the sequences to existing protocols without much work. After the data acquisition the abdominal fat can usually be measured without user interaction, by a system which learns from prior examinations. However, no bodies are identical to each other, so we have developed tools for those few cases where the automatic method fails, and by using those tools the abdominal fat can be measured in 1-3 min. For every new case the method learns a bit more about the possible variations, so it will handle those variations better in the future.

Abdominal fat is not the only fat of interest. The same methods are used to measure the amount of brown adipose tissue, a tissue which burns energy to produce heat. They are also used for the amount of subcutaneous adipose tissue, the amount of liver and pancreatic fat and breast density, which is a strong predictor of breast cancer.

A water and fat image from a set of images covering the whole body.

SUPERVISORS
Bengt Norén (co-supervisor), Gunnar Cedersund (co-supervisor), Olof Dahlqvist Leinhard (co-supervisor), Peter Lundberg (supervisor)

PROJECT
Non-Invasive Liver Biopsy (NILB)
Liver Intrinsic Function Evaluation (LIFE & 4LIFE)

BACKGROUND
Master of Science (MSc), Engineering Biotechnology, Systems Biology, Linköping University 2006 – 2011

Applications Engineer (October 2012–Present)
Wolfram MathCore AB

Research Assistant/Engineer, County Council of Östergötland, CKOC, Department of Radiation Physics 2009–2012

Mikael Forsgren

Determining Hepatic Function in Diffuse and Focal Disease Using Multimodal Magnetic Resonance Imaging

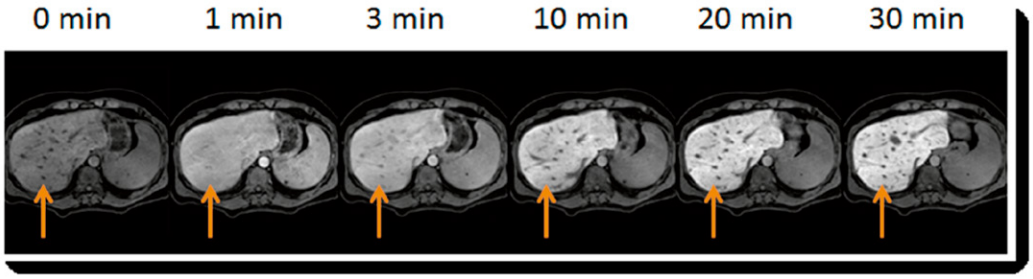
LIVER DISEASE IS a growing problem in modern society and we need good tools to investigate the liver accurately. The liver is one of the largest organs in the human body and it handles many vital tasks. The main tasks of the liver are to process nutrients, remove toxins, make bile and build proteins. My research aims towards developing a collection of techniques that in the end can be used for better and safer liver diagnostics.

Many liver diseases develop unnoticed and once the symptoms become visible the disease has often advanced so far that an operation is the only option. Importantly, as the disease progresses there is a loss in liver function and tools that accurately measure this are in high demand. For instance, when surgeons plan liver surgery they need to be sure that there will be enough function left in the liver after the surgery, so that the risk of liver failure is minimal.

The conventional method of diagnosing many liver diseases suffers from several drawbacks. Currently this method involves taking a small sample of the liver, a biopsy, by using a needle. Since the sample is so small (about 10 to 20 microliters) it can be difficult to know if it is representative for the entire liver. Also, there is a small risk of complications with the procedure.

In our projects we use novel imaging techniques in magnetic resonance (MR) cameras in order to determine liver function. We measure the liver function by injecting a contrast enhancing agent in the patient´s blood flow and image the liver for about 30 minutes. In the figure you can see how the liver lights up in the images due to this contrast agent. Once the images are processed we use mathematical models to determine the liver function. The contrast agent is taken up by the liver but only in areas of the liver that are healthy enough. Basically the healthy parts of the liver are very bright in the images compared to the areas suffering from major disease.

The final goal of this project is to combine the results of the MR exam and present them in a simple to use tool that shows the condition of the liver, for instance to surgeons planning liver surgery or to medical doctors treating patients.



An example of the images we use to calculate liver function. This image shows how the contrast enhancing agent is taken up by the liver (the orange arrows points to the liver), and increases the intensity in the images over time.

SUPERVISORS
Staffan Wirell (co-supervisor) Marcus Ressner (co-supervisor) Örjan Smedby (supervisor)

BACKGROUND
Bachelor of Science in diagnostic radiography nursing 2001

Master of Diagnostic imaging and physiology, 2008

Medical Ultrasound, 2009

Licentiate of Medical Science, 2011

Radiology nurse and sonographer, Department of Radiology, County Council of Östergötland, Linköping 2000-present

Carina Stenman

An Alternative Workflow Method for Ultrasound Examinations

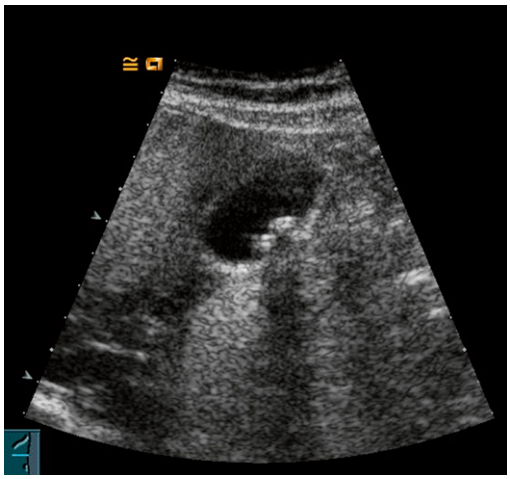
ULTRASOUND IS OFTEN a first choice for radiological examinations. It is a quick and safe diagnostic method. Thanks to recent technical progress in regard to image quality ultrasound is used to diagnose, for example, focal changes in the liver.

The most common way to document ultrasound examinations is to store still images. This method offers very limited possibilities for re-evaluation of an ultrasound examination. Especially when new clinical questions arise after the examination, re-evaluation is often not helpful. A possible solution is to use standardized examination protocols and store as cine-loops. The purpose of this project is to evaluate the introduced ultrasound method that is used at the radiology department in Linköping, with special consideration to reproducibility.

The Radiology department in Linköping uses a standardized method for ultrasound examinations. The examination is performed according to an examination protocol and then stored as cine-loops. Cine-loops are films where the scan covers 5-10 centimetres in 5-10 seconds depending on the target organ. The documentation should include both longitudinal and transversal views covering the whole organ or region of interest. The dynamic scans are saved in the Picture Archiving and Communication System (PACS) from where the films can be retrieved and reviewed on a later occasion at dedicated workstations.

The ultrasound examination is in suitable cases, such as technically uncomplicated normal ultrasound scans with a clear clinical question, performed by a radiographer. The advantage is that examinations performed by a radiographer can be evaluated later by a radiologist, thus increasing the availability of the radiologist for more advanced examinations.

A prerequisite for recommending this routine for general use is that no diagnostic information is lost in the process. The professional roles may become more clear-cut, with the radiographer concentrating on perfecting the examination technique and the radiologist on improving diagnostic skills, just as in other radiological modalities.



SUPERVISORS
Maria Engström, Gunnar Cedersund, Fredrik Elinder, Susanna Walter

PROJECT
SAND:MAN

BACKGROUND
BSc Biology with mathematics

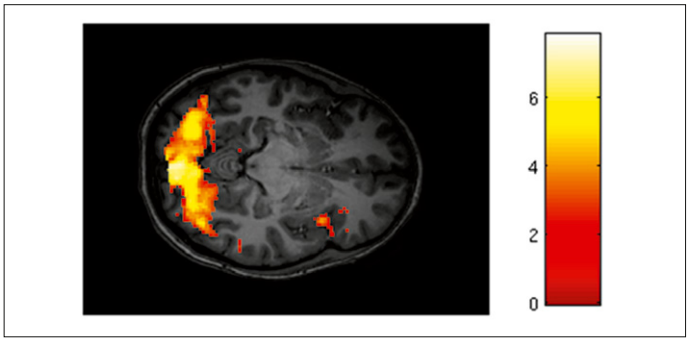
MSc Biology, Molecular genetics and physiology

Karin Lundegård

Neuromodelling of Sleep and Sleep Disorders

EVERY TIME WE do something, whether it is to breath, solve a math problem or look at a picture, the nerves in different areas of our brain will be activated. The activity in the brain can be measured in a magnetic resonance scanner, using a technique called fMRI (functional magnetic resonance imaging). fMRI is often used in brain research as it is very safe for the person being examined. It measures changes in the level of oxygen in the different areas of the brain. When the nerves of an area start to signal each other they need more oxygen and nutrients. More blood is then sent to the brain area to deliver oxygen and nutrients. Since the oxygen level is controlled by the nerve signals it is used as a measurement of the activity in the brain. However, it is not completely known how the nerve signal governs the oxygen levels and it is not possible to measure.

We know that the time it takes for the blood and oxygen to get to the active area (about 10 seconds) is much longer than the time it takes for the electric nerve signal to get there (about half a second), and we want to find out what happens during that time. Therefore we are building computer models of the human brain which can fill the knowledge gap between nerve signal and oxygen level. The models can then be used for looking at the nerve signals even though all we can measure is the oxygen level. We hope that by using these models we can develop a good tool for diagnosing and investigating complicated brain disorders from fMRI images. One such disorder is KLS (Kleine-Levin Syndrome), or sleeping beauty syndrome. KLS is a sleep disorder where afflicted patients have periods of excessive sleep and various psychological symptoms. The cause of the disease is unknown. If you look at an anatomical picture of the brain of a person with KLS, no tumors can be seen, nor any areas of dead nerve cells or anything else that makes them different from a healthy person. But if you look at the activity in the brain when they solve certain tasks their pattern of activation is different. Using models of brain activation, we may be able to figure out what is different in KLS patients, as compared to healthy individuals. This will allow medical doctors to make better diagnoses.



SUPERVISORS
Tino Ebbers (supervisor)
Petter Dyverfeldt (co-supervisor)
Jonas Lantz (co-supervisor)
Carl-Johan Carlhäll (co-supervisor)

PROJECT
Cardiovascular blood flow assessment

BACKGROUND
MSc in Biomedical Engineering
August 2010-March 2013, Linköping University (Linköping, Sweden)

MSc in Telecommunication Engineering
October 2003-March 2010, Universidad de Oviedo (Oviedo, Spain)

Systems engineer trainee
April 2010-July 2010, EADS Astrium (Madrid, Spain)

Belen Casas

Improved Diagnosis and Management of Heart Disease by 4D Blood Flow Assessment; Stenotic Blood Flow

NARROWING OF THE valves of the heart, valve stenosis, prevents the valves from opening fully which obstructs the blood flow. The blood flow after the valve will be turbulent and produces a pressure drop across the valve. Such pressure drop will cause the heart to perform additional work to increase the driving pressure and maintain the blood flow through the vascular system. Over time, this causes adverse remodeling of the heart muscle. In many patients with valve stenosis, the heart´s short-term compensatory mechanisms become less and less effective, ultimately leading to heart failure. It appears that the pressure drop over the valve is a crucial marker of the severity of the stenosis.

The current gold standard for measuring the pressure drop is catheterization, but this is an invasive procedure and cannot be applied routinely. In practice, the pressure drop is instead estimated non-invasively based on ultrasound measurements. This approach, however, does only work well for severe stenoses since mild pressure drops are masked by a pressure recovery phenomenon downstream of the stenosis. The irreversible pressure drop over the stenosis is directly related to the amount turbulence and a method monitoring this would be useful in detecting also mild stenoses.

The aim of this project is to propose and validate a non-invasive method to estimate irreversible pressure loss based 4D magnetic resonance imaging (MRI) measurements of the turbulent blood flow. Such a method should be suitable for assessment of mild, moderate and severe stenoses. In particular, it would be especially helpful for assessment of moderate and mild stenoses, for which current non-invasive methods often fail to provide a correct estimate of the pressure drop.

SUPERVISORS
Tino Ebbers, Carl-Johan Carlhäll, Petter Dyverfeldt

PROJECT
Cardiovascular blood flow assessment

BACKGROUND
MSc Computer Science
Uppsala University, Sweden,
2010–2012

Computer Engineering
Simon Bolivar University, Venezuela,
2001–2006

Mariana Bustamante

Automatic Quantification and Visualization of Blood Flow in the Heart

THE MAIN PURPOSE of the project is to develop a semi-automatic method to quantify, analyze and visualize blood flow patterns in the whole heart. It is a part of HEART4FLOW, a collaboration between researchers in different areas, whose aim is to develop the next generation of methods for noninvasive quantitative assessment of cardiac diseases and therapies.

The project intends to reach its goal by optimizing the most promising technique for intracardiac blood flow assessment at the moment, 4D flow MRI, and to utilize this technique to improve understanding of intracardiac blood flow dynamics in health and disease.

Analysis of 4D flow data is extremely time-consuming, especially during the heart segmentation stage. In spite of this limitation, some approaches have used the information available in the acquisitions to analyze values like flow components, kinetic energy, linear momentum and early vs. late diastolic inflow.

All of these methods require segmentation of the heart's chambers and large vessels, which present a problem in velocity MRIs, since the contrast between myocardium and blood is usually not very good (figure 1).

The first goal of the project is to develop a semi-automatic atlas-based segmentation method that can be used on 4D flow MRI data. A segmented 3D model of a heart, also called atlas, will be used as base for the registration and subsequent segmentation of the input heart image. Where available; other acquired MRI data, such as angiography or velocity information, will be used to improve the quality of the method.
A successful result will be a delineation of the cardiac chambers, large vessels and valves of the heart. Some manual interaction with the obtained delineation may be necessary to assure robustness.

The technique's results will be validated visually on dilated cardiomyopathy patients and healthy volunteers, with a focus on blood flow analysis. Furthermore, the accuracy of volume flow through different valves can be assessed by using the continuity equation.

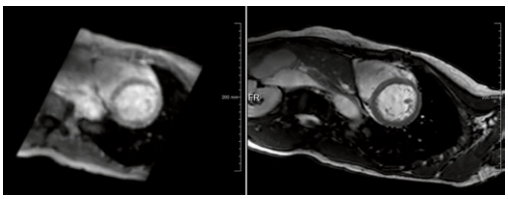


Figure 1. Flow Magnitude (left) and Short Axis balanced (right)

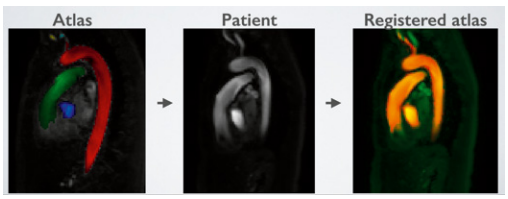


Figure 2. Atlas-based segmentation of large vessels.

SUPERVISORS
Hans Knutsson (supervisor), Mats Andersson (co-supervisor)

BACKGROUND
M.Sc. in Engineering Physics, KTH Royal Institute of Technology 2007–2012

Research Scientist, Elekta Instrument AB, Stockholm, Sweden (2012–present)

Jens Sjölund

Advanced MRI Techniques for Functional and Stereotactic Neurosurgery

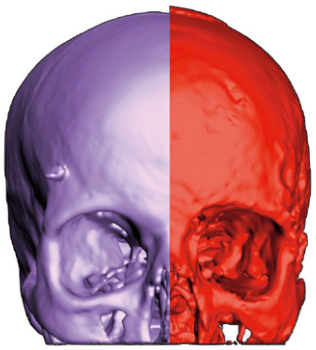
MANY BRAIN DISORDERS–e.g. tumors, vascular malformations and Parkinson's disease–can be treated either surgically or by focused radiation. The treated areas are often small and it is of course vital not to harm the surrounding healthy tissue. This places extremely high demands on the accuracy of the tools used by neurosurgeons; for example the Leksell Gamma Knife (a Swedish invention) can deliver focused radiation with accuracy better than one millimeter.

To take full advantage of this accuracy you need to know where to direct it, which is why you need imaging. This project deals with the imaging technique known as Magnetic Resonance Imaging (MRI). It was developed in the early 1970's by the chemist Paul Lauterbur and the physicist Sir Peter Mansfield, a feat for which they were awarded the Nobel Prize in physiology or medicine in 2003.

Since its introduction, the principles and applications of MRI have been subject to intense research. We strive to take these scientific land winnings and put them at the hands of those who make it matter–the neurosurgeons. Our emphasis is on segmentation, which means that an MR image is, more or less automatically, provided with a "map" that describes the locations of different anatomical and functional structures in the image. This map can comprise both the target of the treatment (e.g. a tumor) and normal, healthy, brain structures.

Accurate and robust segmentation methods have several clinical uses. The most obvious is to aid in defining the target of a treatment and identifying nearby structures which must be protected. To evaluate the effects of a procedure, new MR images are acquired and compared to the prior ones. Segmentation methods can facilitate this comparison by, for example, quantifying how much a tumor has shrunk. Yet another important application, specific to radiation therapy, is the need to accurately compute the radiation dose. This is something that typically requires additional X-ray imaging with little diagnostic gain, in particular for brain disorders. It is therefore desirable to do the dose calculations using only MR images. An important step in this direction is to use segmentation to identify tissue types that have different effect on the radiation (Figure).

A specific MR technique with an important role in this project is so called diffusion imaging, which provides means to segment nerve fibers by taking advantage of the fact that water travels easier along nerve fibers than across them. This could provide the neurosurgeon with a valuable insight into the wiring of the brain; allowing critical nerves to be spared, improving understanding of how epileptic seizures spread throughout the brain and facilitating treatment of conditions in which a nerve itself is the culprit (e.g. trigeminal neuralgia–one of the most painful conditions known to mankind).



Bone segmented from X-ray imaging (CT) in purple and from MRI in red.

SUPERVISORS
Susanna Walter (co-supervisor)
Maria Engström (co-supervisor)
Magnus Ström (supervisor)

BACKGROUND
2004 Medical degree, Karolinska Institute, Stockholm, 2004

Residency in internal medicine and gastroenterology and hepatology, Heart and Medicine Center, Department of Gastroenterology, County Council of Östergötland, Linköping, 2006 – present

Mats Lowén

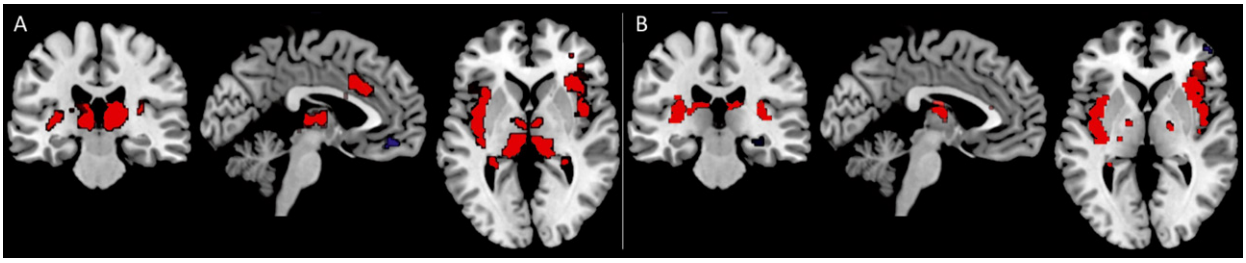
Brain Mechanisms in Irritable Bowel Syndrome

IRRITABLE BOWEL SYNDROME (IBS) is a common chronic syndrome characterized by recurrent abdominal pain or discomfort associated with altered bowel habits. In the absence of generally agreed upon biomarkers, the diagnosis relies on symptom reports and exclusion of organic disease.
The cause of IBS is not completely understood. Altered brain-gut interactions are thought to play an important role in the cardinal symptoms, particularly abdominal pain since it has been shown that hypersensitivity to distensions in the lower part of the bowel is present in some, but not all IBS patients. Increased knowledge about how the brain receives and processes the signal from the gastrointestinal tract is important to understand the basic mechanisms of IBS.

A growing number of brain imaging studies have demonstrated that IBS patients have an abnormal brain activity during rectal distensions but also during the expectation of rectal stimuli.
In spite of intensive studies of the syndrome, there is currently no effective medical treatment available. However, several studies have demonstrated a beneficial effect of hypnotherapy in IBS. Despite that hypnotherapy treatment for IBS has been used successfully for more than 20 years, the neural mechanisms of pain relief after a course of hypnotherapy still remain unclear.

The objective of this project is to learn and further develop functional magnetic resonance imaging (fMRI) as a method to study the pathophysiological mechanisms in IBS. It aims to identify differences in brain response to standardized cued rectal distensions between IBS and healthy controls. Another aim is to explore in what way a course of hypnotherapy and educational intervention affect the brain response to standardized cued rectal distensions in IBS patients.
The results show that there is a difference in how the brains of hypersensitive IBS patients respond, both to the rectal distension itself and to the expectation of distension compared to IBS patients with normal sensitivity and healthy individuals.

Gut directed hypnotherapy as well as disease related education resulted in symptom improvement and decreased bowel related anxiety. These subjective changes were correlated with changes in brain response. The present findings establish psychological therapy as an important strategy in IBS treatment.



Brain activation during expectation (A) and delivery (B) of rectal distension in hypersensitive IBS patients.

SUPERVISORS
Michael Sandborg,
Agnetha Gustafsson,
Gudrun Alm Carlsson

BACKGROUND
Master of Arts in Physics, Umeå University

Specialist in Medical Physics, 2010

Medical Physicist, Radiation therapy, University hospital, Linköping
1994 - present

Pernilla Norberg

Quantification and Optimization of Lung SPECT Images

CHRONIC OBSTRUCTIVE PULMONARY disease (COPD) is characterized by poor airflow with shortness of breath and cough as a result. The disease is chronic and worsens over time. Reduced ventilation in lung regions affected by COPD is correlated to disease advancement.

As the lung behaves in an asymmetric manner, the regional differences are ideally studied with the use of imaging. Single-photon emission computed tomography (SPECT) is a technique for imaging organ function using radioactive isotopes and a detector collecting information around the subject (Figure 1). SPECT is being increasingly used as a tool in respiratory research. It is common to interpret lung SPECT images by visual inspection. However, quantitative measures obtained from a SPECT image have the potential of providing more information.

The aim of the project is to generate quantitative measures from ventilation lung SPECT images that could be useful together with visual assessment to identify mild lung function reduction. It is important to detect lung function reduction in an early stage to be able to prevent further degeneration. COPD is one of today's most common diseases and more than 5% of the Swedish population are estimated to have COPD. The number of deaths due to COPD has been increasing since the 1970's unlike stroke and heart disease.
We have proposed a method, the CVT-method, which measures inhomogeneity caused by lung function reduction using the relative standard deviation, CV.

To provide image quality sufficient for the quantitative task of maximising the separation between healthy and mild COPD activity distributions using the CVT-method, optimisation of acquisition and reconstruction parameter values is needed. Examples of parameter values are activity level of the radioactive isotope, choice of collimator designed for high resolution or high sensitivity, algorithm reconstructing two dimensional projections into three dimensional images, number of updates for the iterative reconstruction algorithm and parameter values for the noise reduction filter.

The method is capable of identifying early COPD in computer simulated images of an anthropomorphic phantom with lesions mimicking early COPD, with a very high probability. The CVT-method is also shown to be capable of identifying patients with severe COPD, also this with a high probability (Figure 2). While our results are promising, the ultimate test of its applicability to detect less advanced stages of lung function reduction in human subjects is one of our future aims.

Figure 1. After inhalation of the radioactive gas (image to the left) the subject is positioned in between the two detectors (right). The radiation from the gas is collected at 120 different angles, equally spaced, over 360°. The total collection time is about 20 minutes.

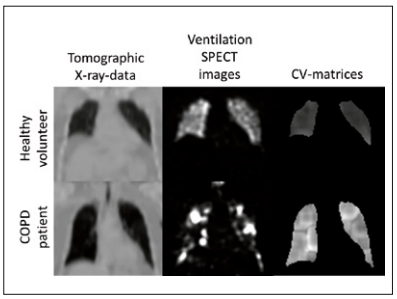


Figure 2. Top row shows a healthy volunteer and bottom row a patient with severe COPD. Notice the patchy gas distribution in the SPECT image and resulting high CV values in the CV-matrix for the patient compared to the healthy volunteer.

SUPERVISORS
Örjan Smedby, Sandro Rossitti, Anders Ynnerman

PROJECT
Augmented Reality in the Operating Room (ARIOR)

BACKGROUND
Degree in Systems and Computation Engineering (Licenciatura) University of Algarve, Portugal 1996-2002

Masters in Computer Graphics and Virtual Environments University of Minho, Portugal 2004-2006

Research/ Development in Computer Graphics Faunhofer-Institut für Graphische Datenverarbeitung, Darmstadt, Germany 2003

Research/ Development in Computer Graphics Centro de Computação Gráfica, Guimarães, Portugal 2003-2005

PhD Program Image Guided Diagnosis and Therapy. Medizinischen Universitäat Innsbruck, Austria 2008-2010

Filipe Marreiros

Visualization and Tracking for Surgery

THE GOAL OF this work is to explore new visualization and tracking techniques for surgery, particularly neurosurgery. The main interest is in brain tumor surgery to provide the surgeon visual information regarding tumors and eloquent areas, e.g. speech, motor and visual areas.

A central problem for all neuronavigation systems is the fact that, once the operation has started, the brain will be deformed to such an extent that the MRI image acquired preoperatively will no longer be a geometrically correct map of the area where the operation is carried out. This "brain shift" problem has attracted considerable attention, and the solutions proposed often involve some kind of real-time imaging, e.g. by ultrasound, to which the preoperative image is morphed. However, since the most relevant information (tumor extent, functional centers, and vessels) usually is present only in MRI, the real-time images cannot replace the preoperative images.

If the correct deformation is applied to the preoperative MRI image we still have to render it in such a way that the surgeon will perceive the important structures in the right position. Since the tumor can be located totally inside the brain the selection of the opacity levels and rendering types plays an important role. For instance if the tumor is rendered totally opaque then it will look like it is outside the brain, this is due to the occlusion depth-cue that can be stronger in stereoscopy.

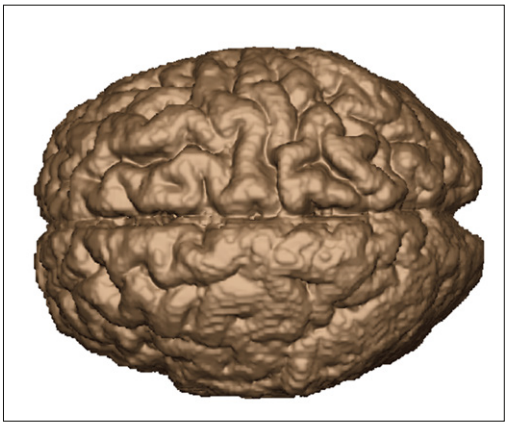


Figure 1. Pre-operative situation before brain shift.

Figure 2. Intra-operative situation. Volume deformation for compensation of brain shift.

SUPERVISORS
Professor Fredrik Palm, IMH
Professor Mårten Segelmark, IMH
Professor Anders Persson, CMIV

BACKGROUND
MSc. in Biomedicine, started PhD in June 2012

Stephanie Franzén

The Role of Hypoxia in the Development of Kidney Damage

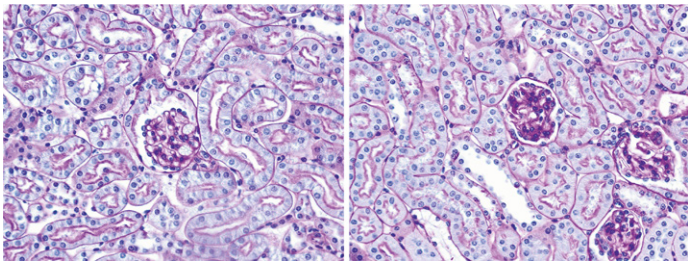
ONE THIRD OF all diabetes patients develop kidney damage during the course of their disease. The underlying mechanisms are, however, not yet completely known. Diabetes complication such as cardiovascular events is today one of the most common causes of death in the industrial world, whereas one in four Americans have metabolic syndrome which is indicated by obesity, diabetes, high blood pressure and high levels of plasma cholesterol.

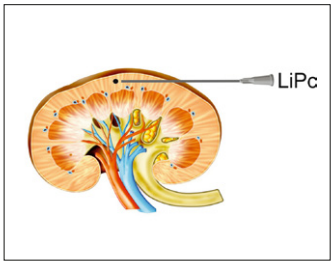
The kidneys main function is filtration of the blood, reabsorption of the filtered substances that are necessary such as glucose and sodium and excretion of substances that the body doesn't need into the urine. In early kidney damage, the filtration rate is increased i.e. glomerular hyperfiltration, and there is a small leakage of proteins to the urine, i.e. proteinuria. Kidney damage has been demonstrated to be reversible with antioxidant and citrulline treatment. During the continued development of kidney damage the filtration rate reaches a top peak and then declines again with further increases in proteinuria, which at this stage is irreversible.

Our hypothesis is that oxygen metabolism is the main underlying mechanism for developing kidney damage. It is known that diabetic kidneys present decreased oxygen tension, i.e. hypoxia. We are investigating if the hypoxia is caused by the increased consumption of oxygen that is occurring in a diabetic state. Therefore, we have performed several studies investigating the changes in oxygen consumption and oxygen tension with different treatments and can with that conclude that oxygen metabolism plays a key role in the development of kidney damage in diabetes.

We have recently presented an optimized methodology with electron paramagnetic resonance (EPR) oximetry to repetitively monitor intrarenal oxygen tension and we are currently looking at a short term study investigating if kidney tissue hypoxia occurs directly after the onset of diabetes in a mouse model of diabetic nephropathy.

In conclusion, previous studies demonstrate that hypoxia plays an important role in the development of kidney damage in the diabetic state and treatments for reversing or slowing down the disease is necessary.





SUPERVISORS
Karin Wårdell, Claes Lundström

PROJECT
Digital Pathology

BACKGROUND
Masters of Science in Electrical & Electronic Engineering, Universit Teknologi Petronas, Malaysia, 2004–2006

Bachelor of Electrical & Electronic, University of Teknologi Petronas, Malaysia, 1997-2002

External Research Assistant at Fulton Hogan NZ, New Zealand, 2011–2012

Lecturer at KDU University College, Kuala Lumpur, Malaysia, 2007-2011

Lecturer at HELP College of Arts & Technology, Kuala Lumpur, Malaysia, 2006

Research Officer, University of Teknologi Petronas, Perak, Malaysia 2003-2006

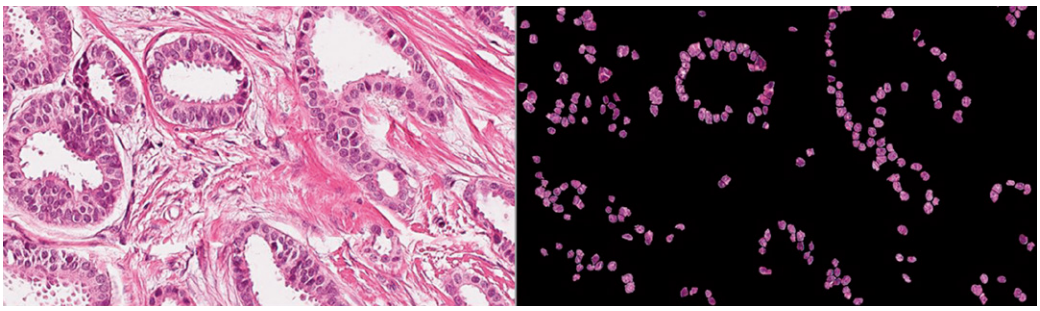
Kavitha Shaga Devan

Chromatin Analysis in Breast Cancer Using Ensemble Method

PATHOLOGICAL DIAGNOSIS IS considered to be the 'gold standard' in the diagnosis of cancer and many other malignant as well as benign diseases. The practice of cytology and histology demands the wide use of perceptual and cognitive skills for the decision making process. Thus, pathologists often have to undertake a very complex decision making process in the diagnosis of diseases. As a solution to this problem, digital pathology is a revolutionary concept that is slowly and steadily being introduced in the field of anatomic and surgical pathology. Digital histopathological images are currently gaining wide acceptance in clinical routine.

Image analysis has the potential to play a critical role in the identification of novel therapeutic targets and creation of new disease classification systems which will be able to improve prediction of treatment response. In our project, we aim to use image analysis algorithms to perform Nottingham Histologic Grading (NHG) for breast cancer. NHG is a widely used classification system to decide how advanced the breast cancer is.

Breast cancer is one of the leading causes of death among women worldwide. Accurate and early detection has the potential to greatly reduce mortality rates. Thus, it is valuable to learn if and how image analysis and machine learning methods can contribute to precise and reproducible cancer grading. To achieve this, our study investigates one part of NHG where the shape of the nucleus and the chromatin is assessed to see whether chromatin texture of the nucleus can be exploited as an independent factor for automated nuclear grading in histology images. Such an investigation is in particular relevant, as the perception of texture may vary between pathologists, which can hinder objective quantification of chromatin distributions.



SUPERVISORS
Morten Fjeld, Claes Lundström

PROJECT
Digital Pathology

BACKGROUND
Linköping University: Engineering degree in Applied Physics and Electrical Engineering with a minor in French, combined with a Master's degree in Biomedical Engineering, 2007-2012

Polytech'Montpellier: Exchange year at Electronique, Robotique et Informatique Industrielle, 2009-2010

Jesper Molin

Smarter Digital Pathology Based on Diagnostic Tasks and Cognitive Processes

WHILE NO CURE for cancer has yet been found, different treatment strategies have advanced rapidly during the last decades. The treatments have gone from a one-size fits all approach towards becoming more and more personalized. This development has put a pressure onto the diagnosing pathologists to deliver more detailed characterizations of the tumor biopsies. Together with the current lack of pathologists in Sweden this risk causing, if not severe implications, at least unnecessary emotional distress of patients waiting weeks on the lab results of their suspected cancer.

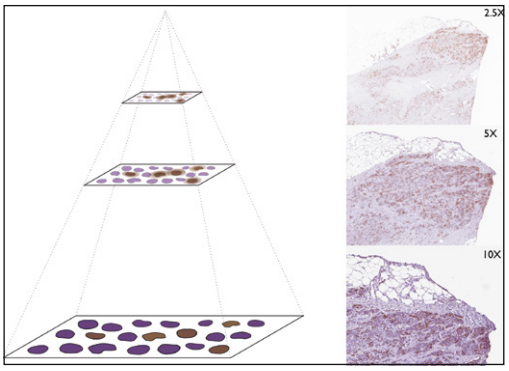
In recent years, the possibility of diagnosing cancerous tissue samples digitally has become available for clinical use. This makes it possible to create automatic systems that can aid and speed up the work of the pathologist. This project focuses on analyzing the thinking processes of the pathologist to gain new insights to how such automatic systems should be constructed and then using these insights to create prototype systems. Currently three different tracks are ongoing:

A think-aloud study has been carried out which has recorded pathologists' verbal statements and interaction with a computerized interface when diagnosing cases. The data is currently being analyzed.

A human-centered system to count positive cancer cells has been conceived. The system assists the pathologist to estimate the growth rate of a cancer which is used to calculate survival rates, used by oncologists for treatment planning.

Finally, different input devices for pathologist are being tried out for navigating the digitized tissue samples to improve the ergonomics. The computer mouse is not adapted for long term panning and zooming in the Google maps-like tissue sample interface, why input devices from other professional computer users are tried out. Such devices include for instance multi-touch stylus tablets from the photo-editing industry or the 3D-mice from the computer aided design (CAD) industry.

An import focus of all tracks is a close collaboration with clinicians to guarantee that relevant problems are solved to improve turnaround time and accuracy of cancer diagnostics.



An interactive system that shows different amount of detail at different zoom levels that help pathologists to estimate the growth rate of cancer.

SUPERVISORS
Claes Lundström, Anders Ynnerman

PROJECT
A Signal Processing Approach to Direct Volume Rendering

BACKGROUND
M.Sc. in Applied Physics and Eletrical Engineering - Linköping University, 2002 - 2008
Study Abroad Program – Royal Melbourne Institute of Technology, 2004

Intern – Siemens Corporate Research, USA 2007 - 2009
Software Engineer – Dpt. Science and Technology, Linköping University 2007

Stefan Lindholm

Scientific Visualization with Focus on Volume Rendering

THE PROJECTS WE explore intend to exploit state-of-the-art signal processing techniques to improve volumetric medical visualization. A key goal of our work is to maintain a simple, functioning interface for the end user even for more advanced, parameter heavy, algorithms.

One of the investigated approaches targets visualization of contrast enhanced blood vessels. In short, we have developed algorithms that search for "vessel like structures" in the volumetric data. This information is then used to locally adapt the visualization in such a way that surrounding tissue does not occlude the studied vessels.

The vessel filter described above is one example of how local neighborhoods can be used to extract additional information from the data itself. Another valuable source of information is, of course, the physician that performs the examination. In another project we have investigated how the manual classification entered by the user during runtime can be used in the interpolation step of the visualization pipeline. By re-using this information, which is already in the system, it is possible to reduce the number of misclassified samples at tissue borders, and thereby significantly reduce a common type of artifact without increasing the complexity of the interaction. The approach is exemplified in the Figure providing improved distinction between the bone and (contrast enhanced) vessels.

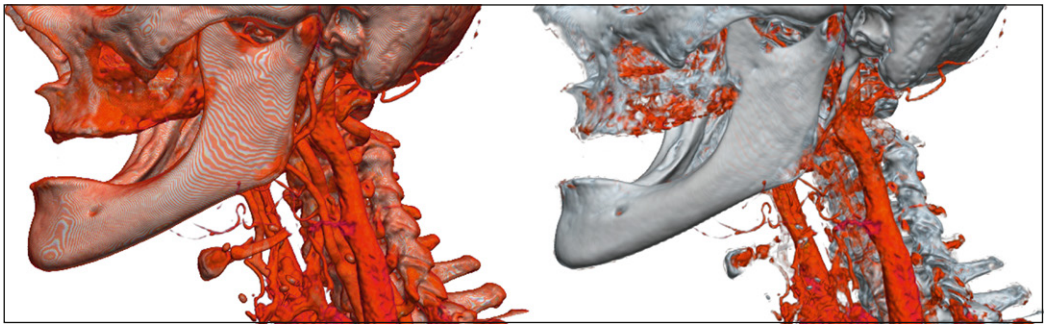


Figure. Comparison of standard continuous reconstruction (left) and adapted, boundary aware, reconstruction (right). Commonly occurring artifacts, such as the red sheet in the left image, can be reduced by using the already existing tissue classification also in the interpolation step of the visualization pipeline.

SUPERVISORS
Anders Persson (principal supervisor)
Jan Engvall (ass. supervisor)
Örjan Smedby (ass. supervisor)
Michael Sandborg (ass. supervisor)

Jacob De Geer

The Use of CT in Cardiac Imaging

THERE ARE A number of different ways to visualize myocardial perfusion. Traditionally, the most common way has been to use single-photon emission computed tomography (SPECT) but in recent years, more novel methods such as magnetic resonance imaging (MRI) and computed tomography (CT) have been introduced. With CT, there are a number of different approaches available but the one we have investigated is so-called dynamic CT perfusion (CTP) which utilizes continuous scanning during the contrast wash-in phase, with subsequent evaluation of the change in myocardial attenuation during this period. The purpose of the study was to compare the methods accuracy, using SPECT as reference method.

Our results showed only a moderate correlation between the methods, probably mainly due to the very different mechanisms involved. In addition, we observed a large variation in CTP blood flow in supposedly healthy cardiac segments, both within each patient but also between patients, leading to the conclusion that it is difficult to establish a single cut-off value for myocardial ischemia.

We also concluded that the CTP method itself was technically complex and hampered by small field of view, which in several cases caused accidental exclusion of large parts of the myocardium, rendering the exam useless.

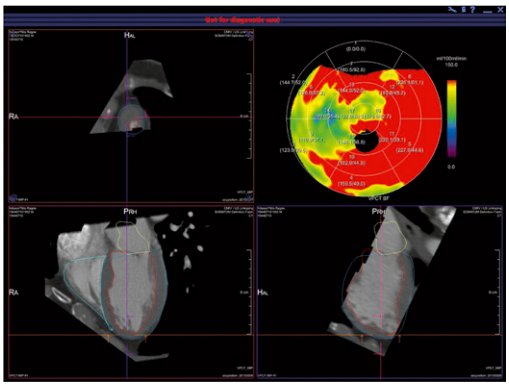


Figure 1. CTP with automated segmentation and estimation of per segment perfusion, expressed as an absolute value (ml/100 g tissue/min). Note the defect in the anterior wall caused by the limited FoV.

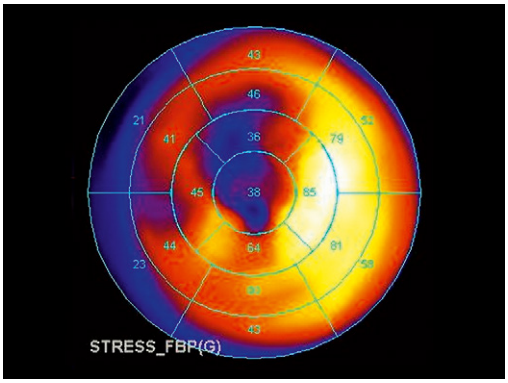


Figure 2. SPECT (same patient as in fig.1). Automated segmentation and semi-quantitative estimation of per segment perfusion, expressed as a percentage of the maximum uptake.

112 DISSERTATIONS

During 2013 several of the CMIV PhD students have finished their studies and defended their dissertations. The PhD students are an important part of CMIV and we are proud to present their dissertations here.

Jonatan Eriksson

**Linköping University, Department of Medical and Health Sciences,
Division of Cardiovascular Medicine**

Quantification of 4D Left Ventricular Blood Flow in Health and Disease

The main function of the heart is to pump blood throughout the cardiovascular system by generating pressure differences created through volume changes. Although the main purpose of the heart and vessels is to lead the flowing blood throughout the body, clinical assessments of cardiac function are usually based on morphology, approximating the flow features by viewing the motion of the myocardium and vessels. Measurement of three-directional, three-dimensional and time-resolved velocity (4D Flow) data is feasible using magnetic resonance (MR). The focus of this thesis is the development and application of methods that facilitate the analysis of larger groups of data in order to increase our understanding of intracardiac flow patterns and take the 4D flow technique closer to the clinical setting.

Roland Gårdhagen

**Linköping University, Department of Management and Engineering,
Applied Thermodynamics and Fluid Mechanics**

Turbulent Flow in Constricted Blood Vessels: Quantification of Wall Shear Stress Using Large Eddy Simulation

The genesis of atherosclerosis has previously been shown to be affected by the frictional load from the blood on the vessel wall, called the wall shear stress (WSS). Assessment of WSS can therefore provide important information for diagnoses, intervention planning, and follow-up. Calculation of WSS requires high-resolved velocity data from the vessel, which can be obtained using computational fluid dynamics (CFD). Since every vessel is unique, so is its WSS pattern. Hence the CFD simulations must be done in subject specific vessel models. Such can be created from anatomical information acquired with magnetic resonance imaging (MRI). In this work large eddy simulation (LES) was successfully used to simulate transitional flow in idealized as well as subject specific vessel models. It was shown that a scale resolving technique is to prefer for this application, since much valuable information otherwise is lost.

Sven Petersson

**Linköping University, Department of Medical and Health Sciences,
Division of Cardiovascular Medicine**

Fast and Accurate 4D Flow MRI for Cardiovascular Blood Flow Assessment

The study of blood flow is essential in understanding the physiology and pathophysiology of the cardiovascular system. Small disturbances of the blood flow may over time evolve and contribute to cardiovascular pathology. Wall shear stress is the frictional force of blood on the vessel wall and has been linked to the pathogenesis of atherosclerosis and aneurysms. Time-resolved three-dimensional (3D) phase-contrast magnetic resonance imaging (MRI), often referred to as 4D flow MRI, is a versatile and non-invasive tool for cardiovascular blood flow assessment. The use of 4D flow MRI permits estimation of flow volumes, pressure losses, wall shear stress, turbulence intensity and many other unique hemodynamic parameters. In this thesis, the accuracy of 4D flow MRI-based turbulence intensity mapping and wall shear stress estimation was investigated by using numerical simulations of MRI flow measurements.

Gunnar Läthén

**Linköping University, Department of Science and Technology,
Media and Information Technology**

Level Set Segmentation and Volume Visualization of Vascular Trees

Medical imaging is an important part of the clinical workflow. With the increasing amount and complexity of image data comes the need for automatic (or semi-automatic) analysis methods which aid the physician in the exploration of the data. One specific imaging technique is angiography, in which the blood vessels are imaged using an injected contrast agent which increases the contrast between blood and surrounding tissue. In these images, the blood vessels can be viewed as tubular structures with varying diameters. Deviations from this structure are signs of disease, such as stenoses introducing reduced blood flow, or aneurysms with a risk of rupture. This thesis focuses on segmentation and visualization of blood vessels, constituting the vascular tree, in angiography images.

Helene van Ettinger-Veenstra

**Linköping University, Department of Medical and Health Sciences,
Division of Radiological Sciences**

Mind Your Language, All Right? Performance-Dependent Neural Patterns of Language

The main aim of this dissertation was to investigate the difference in neural language patterns related to language ability in healthy adults. The focus lays on unraveling the contributions of the right-hemispheric homologues to Broca's area in the inferior frontal gyrus (IFG) and Wernicke's area in the posterior temporal and inferior parietal lobes. The functions of these regions are far from fully understood at present. Two study populations consisting of healthy adults and a small group of people with generalized epilepsy were investigated. Individual performance scores in tests of language ability were correlated with brain activation obtained with functional magnetic resonance imaging during semantic and word fluency tasks. Performance-dependent differences were expected in the left-hemispheric Broca's and Wernicke's area and in their right-hemispheric counterparts.

Mats Lidén

**Örebro University, School of Health
and Medical Sciences**

The Stack Mode Review of Volumetric Datasets: Applications for Urinary Stone Disease

During the last decades the acquisition and visualization of radiological images have rapidly evolved. The increasing amounts of volumetric image data particularly from modern CT systems necessitate a constant evolution of the radiological visualization techniques. The dominating display mode for volumetric images has been the stack mode display since its introduction in computerized image review. In the increasing amounts of image data, the stack mode display needs to be analyzed so that the information content in the high resolution datasets can be transformed into clinically relevant information for the management of the individual patient. In the present thesis some aspects of the stack mode display were analyzed using for the most part the size estimation of urinary stones in unenhanced CT as a model.

Bengt Norén

**Linköping University, Department of Medical and Health Sciences,
Division of Radiological Sciences**

Non-Invasive Assessment of Liver Fibrosis with 31P-Magnetic Resonance Spectroscopy and Dynamic Contrast Enhanced Magnetic Resonance Imaging

Diffuse liver disease have the potential of causing chronic liver disease (CLD) and development of fibrosis, possibly culminating in cirrhosis with an increased risk for hepatocellular carcinoma, HCC. A liver biopsy may be needed to help establish the diagnosis. There are, however, well-known drawbacks with biopsies such as the risk of complications and inaccurate staging due to sampling error. Up to date, no non-invasive technique, either alone or in combinations, can compete with liver biopsy although there are promising possibilities in the magnetic resonance (MR) technique. The present study aims at demonstrating phosphorus metabolite concentration changes and alterations in uptake/excretion of a hepatocyte specific contrast agent in patients with diffuse liver disease by applying two non-invasive quantitative MR techniques and to compare the results with histo-pathological findings, with focus on liver fibrosis.

Daniel Forsberg

**Linköping University, Department of Biomedical Engineering,
Medical Informatics**

Robust Image Registration for Improved Clinical Efficiency: Using Local Structure Analysis and Model-Based Processing

Medical imaging plays an increasingly important role in modern healthcare. In medical imaging, it is often relevant to relate different images to each other, something which can prove challenging, since there rarely exists a pre-defined mapping between the pixels in different images. Hence, there is a need to find such a mapping/transformation, a procedure known as image registration. Over the years, image registration has been proved useful in a number of clinical situations. Despite this, current use of image registration in clinical practice is rather limited, typically only used for image fusion. This thesis aims to overcome some of the issues limiting the use of image registration, by proposing a set of technical contributions and two clinical applications targeted at improved clinical efficiency.

118 EQUIPMENT

Through unique collaborations with the industry it is possible for CMIV to always have the latest and most advanced equipment. This is a prerequisite for the successful research carried out at CMIV.

CT

The Siemens SOMATOM Definition Flash is a scanner using two X-ray sources and two detectors at the same time. It enables scanning of every beating heart at any heart rate and at the lowest radiation dose possible. The CT provides one-stop diagnoses in acute care; even with large patients, regardless of condition, and heart rate. Dual-energy scanning is an amazing tool in exploration of new clinical opportunities.

MRI

The Philips Ingenia 3.0T is our most recently acquired MRI system with a 70 cm bore. It is equipped with Xtend gradient system (up to 45mT/m - 200 T/m/s) and two parallel RF transmissions (Multitransmit 4D), which adapt RF signals to each patient.

Multitransmit facilitates an increased image uniformity, contrast, and consistency, as well as faster imaging. A full range of receiver coils is available with analog-to-digital converters inside the coils (dStream RF). This samples the MR signal directly in the coil on the patient, and sends it to the reconstructor via a fibre-optic cable, resulting in up to 40 % higher SNR, and a dynamic range that exceeds 185dB.

Our Philips Achieva 1.5T has a 60 cm bore and is equipped with Nova Dual gradients with capability (up to 66 mT/m – 160 T/m/s), a 16-channel Freewave data acquisition system, and the latest software release. A full research agreement with Philips Medical Systems allows all possible clinical as well as technical research applications.

In addition, we have access to a GE Signa 1.5T HDxt and Discovery 750 3.0T MRI system.

Ultrasound

CMIV has access to several clinical ultrasound scanners, Vivid E 9 with Echopac BT 13 software for echocardiography and Siemens S2000 for vascular studies, as well as a dedicated scanner GE Logic E9 and a Vevo high frequency scanner for vascular research.

PACS

Sectra radiology PACS is a comprehensive workstation, designed to optimize the workflow. It ensures quick and easy access to patient data and images and provides instant access to all the tools needed integrated on the desktop – including RIS and clinical applications.

For storage and handling of echocardiographic image data (for both research and clinical use), one of the largest installations of the GE EchoPAC system in the world is available.

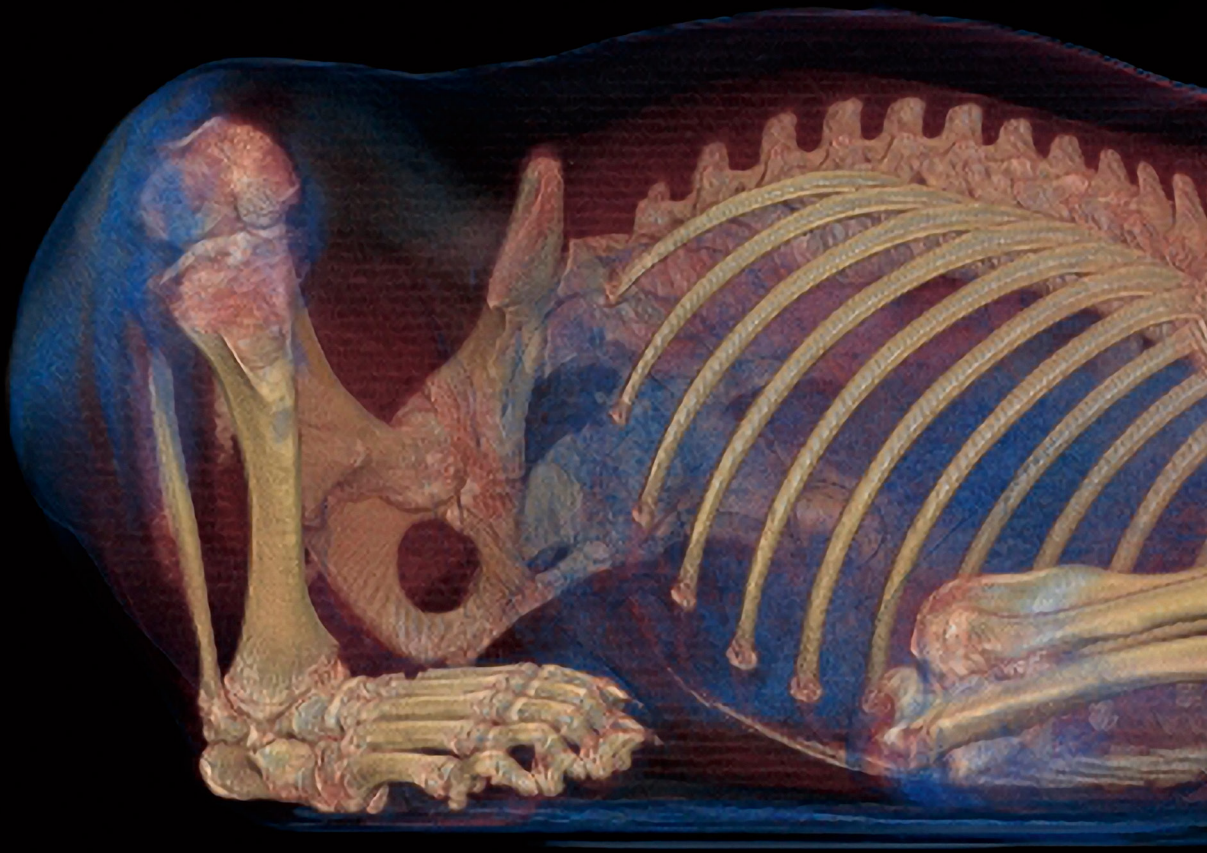
A number of advanced diagnostic workstations are available for clinical and research purposes.

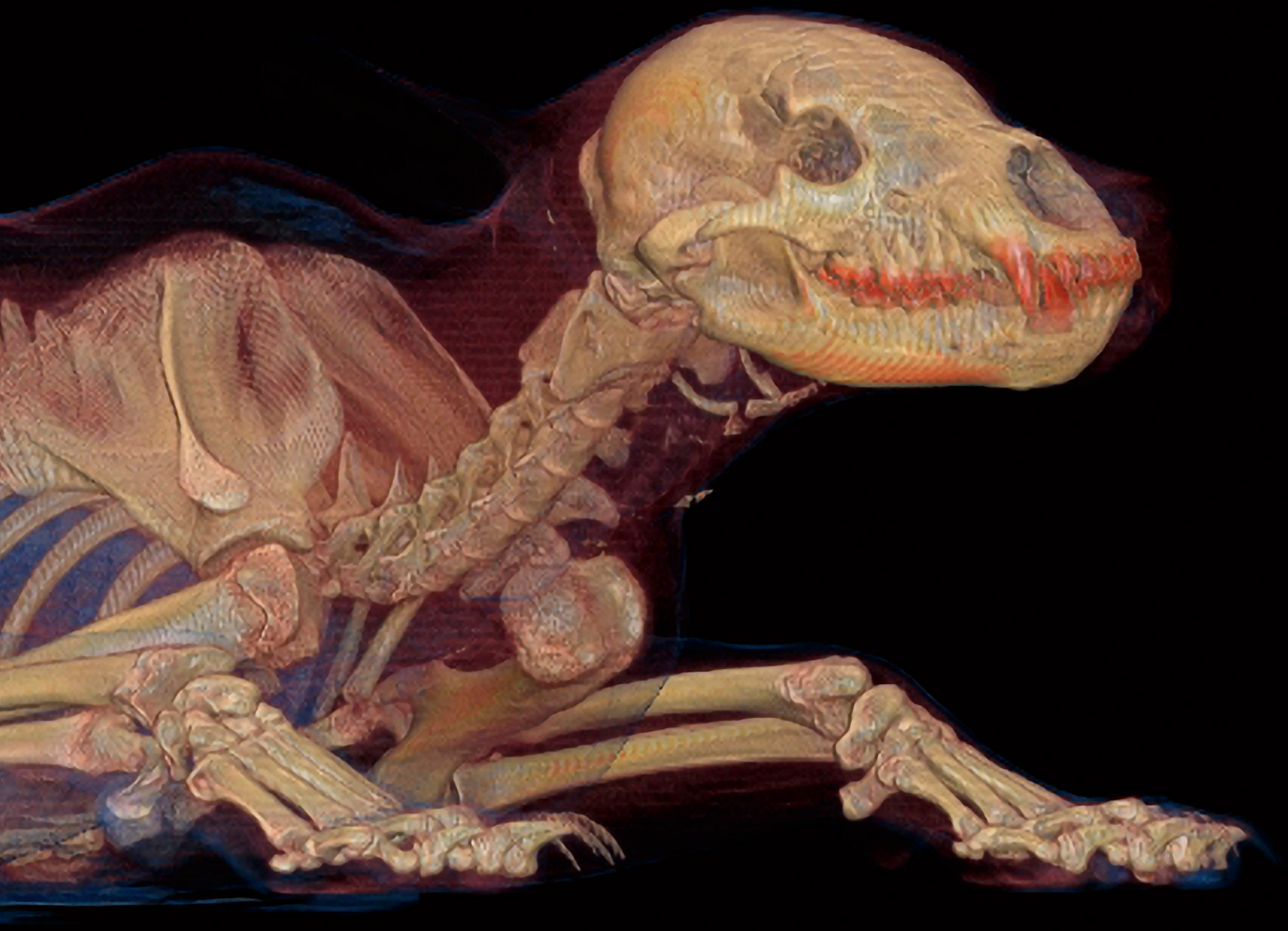
Visualization

CMIV has its own Virtual Reality theatre with a capacity of 70 persons. The theatre is built around Barco Galaxy NW-12 projector (12 000 lumens light output, WUXGA (1920x1200) resolution.) The NW-12 has an integrated active Infitec 3D stereo filter, allowing for optimal 3D visualization with passive stereo glasses. Using a Barco XDS 150 and an EXTRON DMS 3600 DVI switch, all computers at CMIV's network can be used for video conference system, allowing for 1080p HD conference meetings or video broadcasting. A Smartboard Interactive Whiteboard is available for interactive presentations and meetings.

Several Advantage Workstations from GE Medical Systems are available at the hospital.

In addition to the theatre there is also a Sectra visualization table complete with Sectra PACS. The Visualization Table is a large interactive screen with an image display system that enables interaction with 3D human body images rendered from CT or MR.





Computed tomography scan of a young Brown Bear from the Swedish zoo Kolmården. The scanning of the bear was performed during research collaboration between CMIV and Kolmården. The aim of the project was to document and learn more about the physiology of wild animals. For CMIV the project was a unique opportunity to develop new methods without having to consider the radiation dose as most of the animals were not alive.

122 ORGANIZATION

CMIV is governed by its Board of Directors, with representatives from academia, health care and industry. The Scientific Council, appointed among the senior researchers affiliated with CMIV, manages the research agenda of CMIV. The day-to-day operations of CMIV are handled by a group of core staff.

Researchers

Gudrun Alm Carlsson	IMH, Radiological sciences
Mats Andersson	IMT, Medical informatics
Magnus Borga	IMT, Medical informatics
Carl-Johan Carlhäll	IMH, Cardiovascular medicine
Åsa Carlsson Tedgren	IMH, Radiological sciences
Olof Dahlqvist Leinhard	IMH, Radiological sciences
Nils Dahlström	IMH, Radiological sciences
Petter Dyverfeldt	IMH, Cardiovascular medicine
Tino Ebbers	IMH, Cardiovascular medicine
Maria Engström	IMH, Radiological sciences
Jan Engvall	IMH, Cardiovascular medicine
John-Peder Escobar Kvitting	IMH, Cardiovascular medicine
Michael Felsberg	ISY, Computer vision
Daniel Forsberg	ITN, Media and information technology
Håkan Gustafsson	IMH, Radiological sciences
Henrik Haraldsson	IMT, Biomedical modelling and simulation
Markus Heilig	National Institutes of Health/ National Institute of Alcohol Abuse and Alcoholism
Camilla Josephson	IEI, National economy
Hans Knutsson	IMT, Medical informatics
Matts Karlsson	IEI, Applied thermodynamics & fluid mechanics
Thomas Karlsson	IBL, Disability research
Anne-Marie Landtblom	IKE, Neurology
Reiner Lenz	ITN, Media and information technology
Peter Lundberg	IMH, Radiological sciences
Karljohan Lundin Palmerius	ITN, Media and information technology
Claes Lundström	ITN, Media and information technology
Toste Länne	IMH, Cardiovascular medicine
Maria Magnusson	ISY, Computer vision
Alexandr Malusek	IMH, Radiological sciences
Rodrigo Moreno	IMH, Cardiovascular medicine
Ebo De Muinck	IMH, Cardiovascular medicine
Nina Nelson	IKE, Pediatrics
Peter Nilsson	IFM, Chemistry
Eva Nylander	IMH, Cardiovascular medicine
Fredrik Palm	IMH, Drug research
Anders Persson	IMH, Radiological sciences
Hans Ringerz	IMH, Radiological sciences
Timo Ropinski	ITN, Media and information technology
Michael Sandborg	IMH, Radiological sciences
Örjan Smedby	IMH, Radiological sciences
Hans Tropp	IKE, Orthopaedics
Helene Veenstra	IMH, Radiological sciences
Susanna Walter	IKE, Gastroenterology
Chunliang Wang	IMH, Radiological sciences
Marcel Warntjes	IMH, Cardiovascular medicine
Karin Wårdell	IMT, Biomedical instrumentation
Anders Ynnerman	ITN, Media and information technology

Phd Students

Thord Andersson	IMT, Medical informatics
Ida Blystad	IMH, Radiological sciences
Mariana Bustamante	IMH, Cardiovascular medicine
Belèn Casas Garcia	IMH, Cardiovascular medicine
Olivier Cros	IMT, Medical informatics
Jakob De Geer	IMH, Radiological sciences
Jonatan Eriksson	IMH, Cardiovascular medicine
Mikael Forsgren	IMH, Radiological sciences
Stephanie Franzen	IMH, Drug research
Diana Fraser	IKE, Psychiatry
Marcus Gjerde	IMH, Cardiovascular medicine
Roland Gårdhagen	IEI, Applied thermodynamics and fluid mechanics
Gustaf Johansson	IMT, Medical informatics
Anette Karlsson	IMT, Medical informatics
Johan Kihlberg	IMH, Radiological sciences
Eva Klintström	IMH, Radiological sciences
Johan Kälvesten	IMH, Radiological sciences
Mats Lidén	Örebro University, School of Health and Medical Sciences
Stefan Lindholm	ITN, Media and Information Technology
Mats Lowén	IKE, Medical Gastroenterology and Hepatology
Karin Lundengård	IMH, Radiological sciences
Gunnar Läthén	ITN, Media and Information Technology
Filipe Marreiros	ITN, Media and Information Technology
Jesper Molin	Chalmers and Sectra AB
Tan Khoa Nguyen	ITN, Media and Information Technology
Pernilla Norberg	IMH, Radiological sciences
Eva Olsson	IMH, Radiological sciences
Sven Petersson	IMH, Cardiovascular medicine
Thobias Romu	IMT, Medical informatics
Kavitha Shaga Devan	IMT, Biomedical Instrumentation
Jens Sjölund	IMT, Medical informatics
Carina Stenman	IMH, Radiological sciences
Freddie Åström	ISY, Computer vision

Scientific Council

Magnus Borga	IMT, Medical informatics
Carl-Johan Carlhäll	IMH, Cardiovascular medicine
Olof Dahlqvist Leinhard	IMH, Radiological sciences
Tino Ebbers	IMH, Cardiovascular medicine
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Fredrik Palm	IMH, Drug research
Anders Persson	IMH, Radiological sciences
Hans Ringertz	IMH, Radiological sciences
Timo Ropinski	ITN, Media and information technology
Örjan Smedby	IMH, Radiological sciences
Susanna Walter	IKE, Gastroenterology
Anders Ynnerman	ITN, Media and information technology

Core Staff

Anders Persson	Director
Maria Kvist	Research coordinator
Marie Waltersson	Research coordinator
Björn Broo	IT manager
Olof Dahlqvist Leinhard	Director of doctoral studies
Marcel Warnties	Clinical scientist
Petter Dyverfeldt	Clinical scientist

Board of Directors

Jakob De Geer	IMH, Radiological sciences
Curt Karlsson	Linköping University
Torbjörn Kronander	Sectra AB
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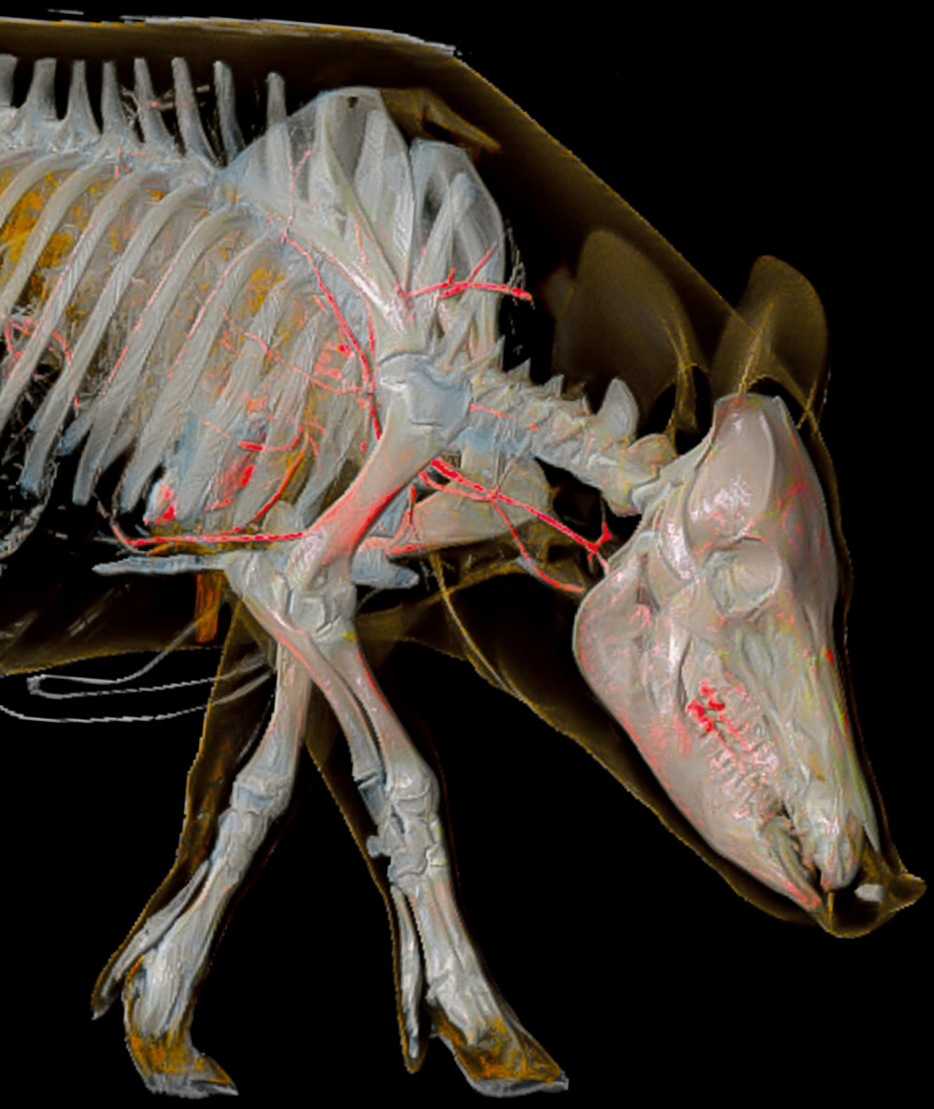
Nina Nelson	IKE, Pediatrics
Hans Ringertz	IMH, Radiological sciences
Thobias Romu	IMT, Medical Informatics
Anders Ynnerman	ITN, Media and information technology
Katrine Åhlström Riklund	Umeå University, Diagnostic Radiology

124 PUBLICATIONS

The CMIV researchers have published numerous articles and conference proceedings in the past years. Here you will find a list of publications from the last five years. The list is however not complete as the network of researchers is complex and publication flow hard to overview.



2013 Peer-reviewed Original Articles

*__Malusek A__, Karlsson M, **Magnusson M and Alm Carlsson G** 2013 The potential of dual-energy computed tomography for quantitative decomposition of soft tissues to water, protein and lipid in brachytherapy, Phys. Med. Biol. 58 771

Pachnerová Brabcová K, Ambrožová I, Kolísková Z, **Malusek A** 2013 Uncertainties in linear energy transfer spectra measured with track-etched detectors in space, Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment, Available online 18 March 2013

Jonas Unger, Joel Kronander, Per Larsson, Stefan Gustavson, Joakim Löw, and **Anders Ynnerman.** Spatially varying image based lighting using hdr-video. Computers & Graphics, 2013.

T Etiene, D Jonsson, **T Ropinski**, C Scheidegger, J Comba, LG Nonato, RM Kirby, **A Ynnerman,** and CT Silva. Verifying volume rendering using discretization error analysis. IEEE transactions on visualization and computer graphics, 2013.

T Etiene, D Jonsson, **T Ropinski**, C Scheidegger, J Comba, LG Nonato, RM Kirby, **A Ynnerman,** and CT Silva. Verifying volume rendering using discretization error analysis. IEEE transactions on visualization and computer graphics, 2013.

Katerina Vrotsou, **Anders Ynnerman**, and Matthew Cooper. Are we what we do? Exploring group behaviour through user-defined event-sequence similarity.Information Visualization, 2013.

Tinghög G, Andersson D, Bonn C, Böttiger H, **Josephson C**, Lundgren G, **Västfjäll D**, Kirchler M, Johannesson M. Intuition and cooperation reconsidered. NATURE 2013. 498:E1-E1doi:10.1038/nature12193. JIF > 5

Eriksson J, Bolger AF, **Ebbers T, Carlhäll CJ. 4D Blood** Flow Specific Markers of LV Dysfunction in Dilated Cardiomyopathy. Eur Heart J Cardiovasc Imaging 2013;14:417-24

Model-based registration for assessment of spinal deformities in idiopathic scoliosis **Daniel Forsberg, Claes Lundström, Mats Andersson, Hans Knutsson**, accepted for publication in Physics in Medicine and Biology

vPSNR: a visualization-aware image fidelity metric tailored for diagnostic imaging **Claes Lundström**, International Journal of Computer Assisted Radiology and Surgery, Vol. 8, No. 3, page 437-450, 2013

***D. Forsberg, C. Lundström, M. Andersson, L. Vavruch, H. Tropp, and H. Knutsson**, "Fully automatic measurements of axial vertebral rotation for assessment of spinal deformity in idiopathic scoliosis," Physics in medicine and biology, vol. 58, iss. 6, pp. 1775-1787, 2013.

D. Forsberg, C. Lundström, M. Andersson, and H. Knutsson, "Model-based registration for assessment of spinal deformities in idiopathic scoliosis," Physics in medicine and biology, vol. 58, iss. X, pp. XX-XX, 2013. (Accepted but not published yet)

***Moreno R,** Koppal S, **de Muinck ED**. Robust estimation of distance between sets of points. Pattern Recognition Letters 2013;34:2192-2198. Exercise Echocardiography Predicts Postoperative Left Ventricular Remodeling in Aortic Regurgitation. **Forsberg LM, Nylander E,** Tamás E. Scand Cardiovasc J. 2013 Nov 4. (Epub ahead of print)

Forsberg LM, Tamás E, Vánky F, Engvall J, Nylander E. Differences in recovery of left and right ventricular function following aortic valve interventions - a longitudinal echocardiographic study in patients undergoing surgical, transapical or transfemoral aortic valve implantation. Catheter Cardiovasc Interv. 2013 Apr 1. doi: 10.1002/ccd.24812. [Epub ahead of print]

Malou Friederich-Persson, Erik Thörn, Peter Hansell, Masaomi Nangaku, Max Levin and **Fredrik Palm**. Kidney hypoxia, attributable to increased oxygen consumption, induces nephropathy independently of hyperglycemia and oxidative stress. Hypertension 2013, 62(5):914-919. PMID 24019401. JIF > 5.

Johan Sällström, Terese Engström, Bertil B. Fredholm, A. Erik G. Persson and **Fredrik Palm.** Inhibition of sodium-linked glucose reabsorption normalizes diabetes-induced glomerular hyperfiltration in conscious adenosine A1-receptor deficient mice. Acta Physiol, accepted. PMID 2013 23901799.

***Malusek A, Karlsson M, Magnusson M, Alm Carlsson G** (2013). The potential of dual-energy computed tomography for quantitative decomposition of soft tissues to water, protein and lipid in brachytherapy. Phys Med Biol 58, 771-785

Norberg P, Persson L, **Alm Carlsson G**, Bake B, Kentson M, **Sandborg M** and Gustafsson A (2013). Quantitative lung-SPECT applied on simulated early COPD and humans with advanced COPD. EJNMMI Research 3, 28 JIF > 5

Dual-energy computed tomography of a mouse.

*Publications with authors from more than one faculty at LiU is marked with *.*
CMIV affiliated researchers are marked with bold and JIF > 5.

Sanchez R, Khong PL, **Ringertz H**. Radiologic protection in pediatric radiology: ICRP recommendations. Pediatr Radiol. 2013 Aug;43(8):920-1. doi: 10.1007/s00247-013-2703-4. Epub 2013 May 2. PubMed PMID: 23636541.

ICRP, Khong PL, **Ringertz H**, Donoghue V, Frush D, Rehani M, Appelgate K, Sanchez R. ICRP publication 121: radiological protection in paediatric diagnostic and interventional radiology. Ann ICRP. 2013 Apr;42(2):1-63. doi: 10.1016/j.icrp.2012.10.001. PubMed PMID: 23218172.

Al-Aubaidi Zaid Tj, **Tropp Hans**, Pedersen Niels W, Jespersen Stig M. Comparison of in-and outpatients protocols for providence night time only bracing in AIS patients - compliance and satisfaction. Scoliosis 2013:8(1):6.

Sköld Caroline**, Tropp Hans**, Berg Svante. Five-year follow-up of total disc replacement compared to fusion: a randomized controlled trial. Eur Spine J 2013

Forsberg LM, Tamás E, Vánky F, **Engvall J, Nylander E.** Differences in recovery of left and right ventricular function following aortic valve interventions: A longitudinal echocardiographic study in patients undergoing surgical, transapical or transfemoral aortic valve implantation. Catheter Cardiovasc Interv. 2013 Apr 1. doi: 10.1002/ccd.24812

Spångéus A, Wijkman M, Lindström T, **Engvall JE**, Ostgren CJ, Nystrom FH, **Länne T**. Toe brachial index in middle aged patients with diabetes mellitus type 2: Not just a peripheral issue. Diabetes Res Clin Pract. 2013 Mar 20. doi:pii: S0168-8227(13)00082-X. 10.1016/j.diabres.2013.03.004. [Epub ahead of print]

*Lantz J, **Ebbers T, Engvall J, Karlsson M.** Numerical and experimental assessment of turbulent kinetic energy in an aortic coarctation. J Biomech. 2013 Jun 7. doi:pii: S0021-9290(13)00241-8. 10.1016/j.jbiomech.2013.04.028. [Epub ahead of print]

Sjöblom P, Nystrom FH, **Lanne T, Engvall J,** Ostgren CJ. Microalbuminuria, but not reduced eGFR, is associated with cardiovascular subclinical organ damage in type 2 diabetes. Diabetes & Metabolism 2013 In press.

Rademakers F, **Engvall J,** Edvardsen T, Monaghan M, Sicari R, Nagel E, Zamorano J, Ukkonen H, Ebbers T, Di Bello V, Voigt JU, Herbots L, Claus P, D'hooge J. Determining optimal noninvasive parameters for the prediction of left ventricular remodeling in chronic ischemic patients. Scand Cardiovasc J. 2013 Dec;47(6):329-34. doi: 10.3109/14017431.2013.857039.

Diczfalusy E, **Andersson M, Wårdell K,** A diffusion tensor based finite element model of microdialysis in the deep brain, Computer Methods in Biomechanics and Biomedical Engineering 2013, DOI:10.1080/10255842.2013.789103.

Wårdell K, Zsigmond P, Richter J, Hemm S. Relationship Between Laser Doppler Signals and Anatomy During Deep Brain Stimulation Electrode Implantation Toward the Ventral Intermediate Nucleus and Subthalamic Nucleus. Neurosurgery. 2013 Jun;72 OPERATIVE NEUROSURGERY 2:ons127-ons140

Hirak Kumar Patra, Nisar Ul Khaliq, Thobias Romu, Emilia Wiechec, **Magnus Borga**, Anthony P. F. Turner, Ashutosh Tiwari, "MRI-Visual Order–Disorder Micellar Nanostructures for Smart Cancer Theranostics", Advanced Healthcare Materials, (Epub ahead of print), 2013.

Olivier Cros, Magnus Borga, Elin Pauwels, Joris J. J. Dirckx, Michael Gaihede, "Micro-channels in the mastoid anatomy. Indications of a separate blood supply of the air cell system mucosa by micro-CT scanning", Hearing Research, 301: 60-65, 2013.

*Martin E. Lidell, Matthias J. Betz, **Olof Dahlqvist Leinhard**, Mikael Heglind, **Louise Elander**, Marc Slawik, Thomas Mussack, Daniel Nilsson, **Thobias Romu**, Pirjo Nuutila, Kirsi A. Virtanen, Felix Beuschlein, **Anders Persson, Magnus Borga,** Sven Enerbäck, "Evidence for two types of brown adipose tissue in humans", Nature Medicine, 19(5): 631-634, 2013. JFI > 5

Thord Andersson, Gunnar Läthén, Reiner Lenz, Magnus Borga, "Modified Gradient Search for Level Set Based Image Segmentation", IEEE Transactions on Image Processing, 22(2): 621-630, 2013.

Linda Rattfält, Maria Lindén, Peter Hult, Per Ask, **Magnus Borga**, "Robust Heart Beat Detector Based on Weighted Correlation and Multichannel Input: Implementation on the ECG recorded with textile electrodes", International Journal of E-Health and Medical Communications, 4(1): 61-71, 2013.

J West, I. Blystad, M. Engström, JBM Warntjes, P Lundberg. Application of Quantitative MRI for Brain Tissue Segmentation at 1.5 T and 3.0 T Field StrengthsPlosOne 2013;8:e74795

Warntjes, M Engström, A Tisell, P Lundberg, Brain Characterization using Normalized Quantitative Magnetic Resonance Imaging. JBMPlosOne 2013;8:e10.1371

Tisell A, Leinhard OD, Warntjes JB, Aalto A, Smedby Ö, Landtblom AM, Lundberg P. Increased concentrations of glutamate and glutamine in normal-appearing white matter of patients with multiple sclerosis and normal MR imaging brain scansPLosOne 2013;8:e61817.

M Vågberg, T Lindqvist, K Ambarki, **JBM Warntjes, P** Sundström, R Birgander and A Svenningsson. Automated Determination of Brain Parenchymal Fraction in Multiple Sclerosis AJNR Am J Neuroradiol 2013;34:498-504

K Ambarki, T Lindqvist, **A Wåhlin**, **E Petterson, M Warntjes**, M Vågberg, R Birgander, J Malm **and A Eklund.** Evaluation of Automatic Measurement of the Intracranial Volume Based on Quantitative MR Imaging. AJNR Am J Neuroradiol 2012;33:1951-1956.

J West, JBM. Warntjes and P Lundberg. Novel Whole Brain Segmentation and Volume Estimation Using Quantitative MRI. Eur Radiol 2012;22:998-1007

***M. Engström**, G. Flensner, **A-M Landtblom**, A-C Ek, **T. Karlsson**. Thalamo- striato-cortical determinants to fatigue in Multiple Sclerosis. Brain & Behavior, 3(6):715–728, 2013.

J. West, I. Blystad, M. Engström, J. B. M. Warntjes, P. Lundberg. Application of Quantitative MRI for Brain Tissue Segmentation at 1.5 T and 3.0 T Field Strengths. Plos One, 8:e74795, 2013.

J. B. M. Warntjes, M. Engström, A. Tisell, P. Lundberg. Brain characterization using normalized quantitative magnetic resonance imaging. Plos One, 8:e70864, 2013.

***M. Engström, A-M Landtblom, T. Karlsson**. Brain and effort: brain activation and effort-related working memory in healthy participants and patients

with working memory deficits. Frontiers in Human Neuroscience, 7;140:1–17, 2013.

*__H. Gauffin, H. van Ettinger-Veenstra, A-M Landtblom__, D. Ulrici, A. McAllister, __T. Karlsson, M. Engström__. Impaired language function in generalized epilepsy: Inadequate suppression of the default mode network. Epilepsy & Behavior, 28:26–35, 2013.

__M. B. O. Lowén__, E. A. Mayer, M. Sjöberg, K. Tillisch, B. Naliboff, J. Labus, P. __Lundberg,__ M. Ström, __M. Engström__, __S. A. Walter__. Effect of hypnotherapy and educational intervention on brain response to visceral stimulus perception in the irritable bowel syndrome. Alimentary Pharmacology & Therapeutics, 37: 1184-1197, 2013.

Z-J Hu, M. Ahrén, L. Selegård, C. Skoglund, F. Söderlind, __M. Engström__, X. Zhang, K. Uvdal. Highly water-dispersible surface-modified Gd2O3 nanoparticles for potential dual-modal bio-imaging. Chemistry, a European Journal 19: 12658– 12667, 2013. **JIF>5**

__H. Gustafsson,__ M . Hallbeck, M. Norell, M. Lindgren, __M. Engström__, A. Rosén and __H. Zachrisson__. Fe(III) distribution varies substantially within and between atherosclerotic plaques. Magnetic Resonance in Medicine, DOI: 10.1002/mrm.24687, 2013.

*P. Vigren, __A. Tisell, M. Engström, T. Karlsson, O. Dahlqvist Leinhard, P. Lundberg, A-M Landtblom.__ Low Thalamic NAA-concentration Corresponds To Strong Neural Activation in Working Memory in Kleine-Levin Syndrome. Plos One, 8(2):e56279, 2013.

U. Källman, S. Bergstrand, A-C Ek, __M. Engström__, L-G Lindberg, M. Lindgren. Different lying positions and their effects on tissue blood flow and skin temperature in older adult patients. J. Adv. Nursing, 69:133–144, 2013.

*__A. Malusek, M. Karlsson, M. Magnusson, and G. Alm Carlsson__ The potential of dual-energy computed tomography for quantitative decomposition of soft tissues to water, protein and lipid in brachytherapy. Phys. Med. Biol. Vol.58, No.4, pp.771-785, 2013

*J Lantz, __T Ebbers, J Engvall and M Karlsson__: Numerical and Experimental Assesment of Turbulent Kinetic Energy in an Aortic Coarctation, Journal of Biomechanics, 2013, 46(11), 1851-1858.

Sarabjeet Singh, __Mannudep Kalra, Petter Quick, Michael Sandborg and Anders Persson__. Whole spine CT for evaluation of scoliosis in children: feasibility of sub-milliSievert scanning protocol Acta Radiologica 54, 226-230 (2013)

__Örjan Smedby__, Mats Fredrikson, __Jakob De Geer,__ Lars Borgen and __Michael Sandborg__ Quantifying the potential for dose reduction with Visual Grading Regression Br. J. Radiol. 86, 31197714 (2013)

__Pernilla Norberg__, Lennart Persson, __Gudrun Alm Carlsson__, Björn Bake, Magnus Kentson, __Michael Sandborg__, Agnetha Gustafsson Quantitative lung-SPECT applied on simulated early COPD and humans with advanced COPD. EJNMMI Research, 3:28, http://www.ejnmmires.com/content/3/1/28 (2013)

__Kalra MK, Woisetschläger M, Dahlström__ N, Singh S, Digumarthy S, Do S, Pien H, __Quick P,__ Schmidt B, Sedlmair Martin, Shepard JAO, __Persson A__. (2013) Sinogram- affirmed iterative reconstruction of low-dose chest CT: effect on image quality and radiation dose. AJR Am J Roentgenol, 2013(2):W235-244. doi: 10.2214/AJR.12.9569 [doi]

*__Norén B, Forsgren M, Dahlqvist Leinhard O, Dahlström N, Kihlberg J, Romu__ T, Kechagias S, Almer S, __Smedby Ö, Lundberg__ P. Separation of advanced from mild hepatic fibrosis by quantification of the hepatobiliary uptake of Gd-EOB- DTPA. European Radiology 2013; 23:174-181.

__Tisell A, Dahlqvist Leinhard O, Aalto A, Warntjes JBM, Smedby Ö, Landtblom AM, Lundberg P,__ Increased Concentrations of Glutamate and Glutamine in Normal-Appearing White Matter of Patients with Multiple Sclerosis and Normal MR Imaging Brain Scans, PLOS ONE In press 2013. (JIF: 3.7, GS: 1, ISI 1)

Vigren P, __Tisell A, Engström M, Karlsson T, Dahlqvist Leinhard O, Lundberg P, Landtblom__ AM. Low Thalamic NAA-concentration Corresponds To Strong Neural Activation in Working Memory in Kleine-Levin Syndrome. PLoS ONE 2013:8 (2) , art. no. e56279. (JIF: 3.7, GS: 0, ISI: 0)

__Gerdle B, Forsgren MF__, Bengtsson A, __Dahlqvist Leinhard__ O, Sören B, Karlsson A, Brandejsky V, Lund E, __Lundberg P__. Decreased muscle concentrations of ATP and PCR in the quadriceps muscle of fibromyalgia patients -a 31P MRS study. European Journal of Pain, 30 JAN 2013. (JIF: 3.1, GS: 1, ISI 0)

*Lundin F, __Tisell A__, Leijon G, __Dahlqvist Leinhard O,__ Davidsson L, __Grönqvist A__, Wikkelsø __C, Lundberg__ P. Preoperative and Postoperative 1H-MRS-Changes in Frontal Deep White Matter and the Thalamus in Idiopathic Normal Pressure Hydrocephalus. J Neurol Neurosurg Psychiatry 2013;84:188–193. (JIF: 5, GS: 2, ISI: 0) JIF=4.9

*__Norén B, Forsgren MF, Dahlqvist Leinhard O, Dahlström N, Kihlberg J, Romu T,__ Kechagias S, Almer A, __Smedby Ö, and Lundberg P.__ Separation Of Advanced From Mild Hepatic Fibrosis By Quantification Of The Hepatobiliary Uptake Of Gd-EOB-DTPA. Eur Radiol. 2013 Jan;23(1):174-81. (JIF: 3.5, GS: 4, ISI: 0)

__West J, Blystad I, Warntjes JBM, Engström M, Lundberg__ P (2013) Application of Quantitative MRI for Brain Tissue Segmentation at 1.5 T and 3.0 T Field Strengths PLoS ONE (Accepted).

*Vigren P, __Tisell A, Engström M, Karlsson T, Leinhard Dahlqvist O, Landtblom A-M, Lundberg P__ (2013) High thalamic fMRI-activity in working memory corresponds to low NAA-concentration in Kleine Levin syndrome. PLoS ONE 2013;8(2):e56279. doi: 10.1371/journal.pone.0056279. Epub 2013 Feb 25. Number of citations: 9

*__Tisell A, Dahlqvist Leinhard O, Warntjes JBM, Aalto A, Smedby Ö, Landtblom AM, Lundberg P__ (2013) Increased Concentrations of Glutamate and Glutamine in Normal-Appearing White Matter of Patients with Multiple Sclerosis and Normal MR Imaging Brain Scans PLoS ONE, (8), 4. Number of citations: 1

*__Norén B, Forsgren MF, Dahlqvist Leinhard O, Dahlström N, Kihlberg J, Romu T,__ Kechagias S, Almer S, __Smedby Ö, Lundberg__ P (2013) Separation of Advanced from Mild Hepatic Fibrosis by Quantification of the Hepatobiliary Uptake of Gd-EOB-DTPA Eur Radiol 2013 Jan;23(1):174-81. doi: 10.1007/s00330-012-2583-2. Epub 2012 Jul 27. Number of citations: 4

__Lowén M__, Mayer EA, Sjöberg M, Tillisch K, Naliboff B, Labus J, __Lundberg P,__ Ström M, __Craig AD(B), Engström M, Walter SA__ (2013) Effect of hypnotherapy and educational intervention on brain response to visceral stimulus in the irritable bowel syndrome, Alimentary Pharmacology & Therapeutics, 37 (12) 1184-1197. Number of citations: 3

Gerdle B, Forsgren MF, Bengtsson A, **Dahlqvist Leinhard** O, Sören B, Karlsson A, Brandejsky V, Lund E, **Lundberg P** (2013) Decreased muscle concentrations of ATP and PCR in the quadriceps muscle of fibromyalgia patients - a 31P MRS study, Eur J Pain 2013 Jan 30. doi: 10.1002/j.1532-2149.2013.00284.x. [Epub ahead of print] Number of citations: 1

Dyverfeldt P, Hope MD, Tseng EE, Saloner D. Noninvasive Magnetic Resonance Measurement of Turbulent Kinetic Energy for the Estimation of Irreversible Pressure Loss in Aortic Stenosis. J Am Coll Cardiol Img 2013; 6(1):64-71. **JIF > 5**

Hope MD, Sigovan M, Wrenn SJ, Saloner D, **Dyverfeldt P.** Magnetic Resonance Imaging Flow Markers of Progressive Valve-Related Aortic Disease. J Magn Reson Imaging 2013; In Press (http://dx.doi.org/10.1002/jmri.24362).

Dyverfeldt P, Deshpande VS, Kober T, Krueger G, Saloner D.Motion Compensated Carotid MRI using FID Navigators.J Magn Reson Imaging 2013; In Press (http://dx.doi.org/10.1002/jmri.24389).

HA Kiri-li, M Schaap, CT Metz, AS Dharampall, WB Meijboom, SL Papadopoulou, A Dedic, K Nieman, MA de Graaf, MFL Meijs, MJ Cramer, A Broersen, S Cetin, A Eslami, L Florez-Valencia, KL Lor, B Matuszewski, I Melki, B Mohr, I Öksüz, R Shahzad, **C Wang**, PH Kitslaar, G Unal, A Katouzian, M Orkisz, CM Chen, F Precioso, L Najman, S Masood, D Ünay, **R Moreno**, R Goldenberg, E Vuçini, GP Krestin, WJ Niessen. Standardized evaluation framework for evaluating coronary artery stenosis detection, stenosis quantification and lumen segmentation algorithms in computed tomography angiography. Medical Image Analysis, 17(8), pp. 859-876, 2013. DOI: 10.1016/j.media.2013.05.007. IF: 4.087, Quartile: 1.

Rodrigo Moreno, Sandeep Koppal, **Ebo de Muinck**. Robust Estimation of Distance Between Sets of Points. Pattern Recognition Letters, 34(16), pp. 2192-2198, 2013. DOI: 10.1016/j.patrec.2013.08.012. IF= 1.266, Quartile: 2.

Eva Klintström, Örjan Smedby, Rodrigo Moreno, Torkel Brismar. Trabecular bone structure parameters from 3D image processing of clinical multi-slice and cone-beam computed tomography data. Skeletal Radiology, in press. DOI:10.1007/s00256-013-1766-5. IF: 1.741, Quartile: 2.

***Vigren, P., Tisell, A., Engström, M., Karlsson, T., Leinhard Dahlqvist, O., Lundberg, P., Landtblom, AM. (**2013). Low thalamic NAA-concentration corresponds to strong neural activation in working memory in Kleine-Levin syndrome. PLOS One 8(2), e56279. doi:10.1371/journal.pone.0056279

Mård, S., **Karlsson, T.,** & Marcusson, J. (2013). Aspects of awareness in patients with Alzheimer's disease. International Psychogeriatrics (in press). doi:10.1017/S1041610212002335

***Engström, M., Landtblom, AM., & Karlsson**, T. (2013). Brain and effort: brain activation and effort-related working memory in healthy participants and patients with working memory deficits. Frontiers in Human Neuroscience, 7, DOI=10.3389/fnhum.2013.00140

Wikgren, A., **Karlsson, T**., Söderlund, H., Nordin, A., Roos, G., Nilsson, L-G., Adolfsson, R., & Norrback, K-F. (2013). Shorter telomere length is linked to brain atrophy and white matter hyperintensities (in press). doi: 10.1093/ageing/aft172

***Engström, M.,** Flensner, G., **Landtblom, A-M**., Ek, A-C., & **Karlsson, T**. (2013). Thalamo-striato-cortical determinants to fatigue in multiple sclerosis. Brain and Behavior, 3 (6), 2162-3279. doi:10.1002/brb3.181

Rademakers F, **Engvall J,** Edvardsen T, Monaghan M, Sicari R, Nagel E, Zamorano J, Ukkonen H, **Ebbers T**, Di Bello V, Voigt J-U, Herbots L, Claus P, D'hooge J. Determining optimal noninvasive parameters for the prediction of left ventricular remodelling in chronic ischemic patients. Scandinavian Cardiovascular Journal, In Press. 2013

*Lantz J, **Ebbers T, Engvall J. Karlsson M.** Numerical and Experimental Assessment of Turbulent Kinetic Energy in an Aortic Coarctation. J Biomech 2013;46(11):1851-8.

Eriksson J, Bolger AF, **Ebbers T** and **Carlhäll CJ**. Four-dimensional blood flow- specific markers of LV dysfunction in dilated cardiomyopathy. Eur Heart J Cardiovasc Imaging, 2013

Gottsäter M**, Länne T,** Nilsson P. J Hum Predictive markers of abdominal aortic stiffness measured by Echo-tracking in subjects with varying insulin sensitivity. Hypertension 2013. Accepted.

Sjöblom P, Nystrom FH, bT, **Engvall J,** Östgren CJ. Microalbuminuria, but not reduced eGFR, is associated with cardiovascular subclinical organ damage in type 2 diabetes. Diabetes and Metabolism 2013. Epub ahead of print.

Lindenberger **M, Lindström** T, **Länne T.** Decreased circulatory response to hypovolemic stress in young women with type 1 diabetes.. Diabetes Care. 2013. Epub ahead of print.

Yang Y, Zhang Y, Cao Z, Ji H, Yang X, Iwamoto H, Wahlberg E, **Länne T**, Sun B, Cao Y. Anti-VEGF- and anti-VEGFR- induced vascular alteration in mouse healthy tissues. PNAS. 2013. Epub ahead of print.

Dong M, Yang X, Lim S, Cao Z, Honek J, Lu H, Zhang C, Seki T, Hosaka K, Wahlberg E, Yang J, Zhang L, **Länne T**, Sun B, Li X, Liu Y, Zhang Y, Cao Y. Cold exposure promotes atherosclerotic plaque growth and instability via UCP1-dependent lipolysis. Cell Metab. 2013. 118-129 JIF > 5

Hager J, **Länne T, Carlsson** P, Lundgren F. Lower prevalence than expected when screening 70-year old men for abdominal aortic aneurysms. Eur J Vasc Endovasc Surg 2013. 453-459.

Spångéus A, Wijkman M, Lindström T, **Engvall JE**, Ostgren CJ, Nystrom FH**, Länne T.** Toe brachial index in middle aged patients with diabetes mellitus type 1: Not just I peripheral issue. Diabetes Res Clin Pract. 2013. Epub ahead of print.

Ljungberg L, Östgren CJ, Nyström F, **Länne T**. J. Associations of genetic polymorphisms in the Renin-Angiotensin System with central aortic and ambulatory blood pressure in type 2 diabetic patients. Renin-Angiotensin-Aldosterone System 2013. Epub ahead of print.

***. Björck H, Renner J**, Maleki S, Nilsson S, **Kihlberg J,** Folkersen L**, Karlsson M**, **Ebbers T**, Eriksson P and **Länne T.** Characterization of shear-sensitive genes in the normal rat aorta identifies Hand2 as a major flow-responsive transcription factor**.** PLOS ONE 2013;7(12):e52227.doi:10.1371/journal.pone.0052227.

Ljungberg L, Alehagen U, DeBasso R, Persson K, Dahlström U, **Länne T.** Circulating angiotensin-converting enzyme is associated with left ventricular dysfunction, but not with central aortic hemodynamics**..** Int J Cardiol 2013. Epub ahead of print. JIF>5

Tengblad A, **Länne T, Engvall J,** Nyström F, Östgren CJ. Sagittal abdominal diameter and waist circumference as markers of early organ damage in patients with type 2 diabetes. The Journal of Clinical Metabolism and Diabetes. 2013. In press.

Dahlén E, Tengblad A, **Länne T**, Clinchy B, Ernerudh J, Nyström FH, Östgren CJ. Sagittal abdominal diameter is a more independent measure compared with waist circumference to predict arterial stiffness in subjects with type 2 Diabetes – a prospective observational cohort study. 2013. Doi: 10.1186/1475-2840-12-55.

Bjarnegård N, Morsing E, Cinthio M, **Länne T**, Brodszki J. Cardiovascular function in adulthood following intrauterine growth restriction with abnormal fetal blood flow. Ultrasound Obstet Gynecol. 2013; 41(2):177-184.

Maleki S, Björck HM, Folkersen L, Nilsson R, Renner J, Caidahl K, Franco- Cereceda A, **Länne T,** Eriksson P. J. Identification of a novel flow-mediated gene expression signature in patients with bicuspid aortic valve. Mol Med (Berl) 2013;91(1):129-39.

Holm Å, **Carlsson Tedgren Å, Larsson T** 2013 Heuristics for integrated optimization of catheter positioning and dwell time distribution in prostate HDR brachytherapy Annals. Op.Res. accepted for publication

Holm Å, Larsson T and **Carlsson Tedgren Å** 2013 A linear programming model for optimizing HDR brachytherapy dose distributions with respect to mean dose in the DVH-tail Med. Phys. 40 081705-1-11

Lindborg L, Hultqvist M, **Carlsson Tedgren Å** and Nikjoo H 2013 Lineal energy and radiation quality in radiation therapy: model calculations and comparison with experiment Phys Med Biol. 58 3089-3105

Carlsson Tedgren Å and **Alm Carlsson G** 2013 Specification of absorbed dose to water using model based dose calculation algorithms for treatment planning in brachytherapy Phys. Med. Biol. 58 2561-2579

Thomson R M, **Carlsson Tedgren Å** and Williamson J F 2013 On the biological basis for competing macroscopic dose descriptors for kilovoltage dosimetry: cellular dosimetry for brachytherapy and diagnostic radiology Phys. Med. Biol. 58 1123-50

Smedby Ö , Fredrikson M, **De Geer J,** Borgen L, **Sandborg M**. Quantifying the potential for dose reduction with visual grading regression. Br J Radiol 2013;86:31197714. DOI:10.1259/bjr/31197714

***Norén B**, **Forsgren MF**, **Dahlqvist Leinhard O, Dahlström N, Kihlberg J, Romu T,** Kechagias S, Almer S, **Smedby Ö, Lundberg P.** Separation of Advanced from Mild Hepatic Fibrosis by Quantification of The Hepatobiliary Uptake of Gd-EOB-DTPA. European Radiology 2013;23(1):174-181. DOI:10.1007/s00330-012- 2583-2

Szabó Z, Berg S, Sjökvist S, Gustafsson T, Carleberg P, Uppsäll M, Wren J, Ahn H, **Smedby Ö**. Real-time intraoperative visualization of myocardial circulation using augmented reality temperature display. International Journal of Cardiovascular Imaging 2013;29(2):521-528. DOI:10.1007/s10554-012-0094-5

Stenman C, Jamil S, Thorelius T, Knutsson A**, Smedby Ö**. Do radiologists agree on findings in radiographer-acquired ultrasound examinations? Journal of Ultrasound in Medicine 2013;32(3):513-518. PMID:23443192

Kataria B, **Smedby Ö.** Patient dose and image quality in low-dose abdominal Computed Tomography (CT): a comparison between iterative reconstruction and filtered back projection. Acta Radiologica 2013;54:540-48. PMID:23474768

Tisell A, Dahlqvist Leinhard O, Warntjes JBM, Aalto A, Smedby Ö, Landtblom AM, Lundberg P. Increased Concentrations of Glutamate and Glutamine in Normal-Appearing White Matter of Patients with Multiple Sclerosis and Normal MR Imaging Brain Scans. PLoS ONE 8(4): e61817.2013 DOI:10.1371/journal.pone.0061817

Klintström E, Smedby Ö, Moreno R, Brismar TB. Trabecular bone structure parameters from 3D image processing of clinical multi-slice and cone-beam computed tomography data. Skeletal Radiol. 2013 Nov 24. [Epub ahead of print]

MK Kalra, P Quick, S Singh, **M Sandborg, A Persson.** Whole spine CT for evaluation of scoliosis in children: Feasibility of Sub-milli-Sievert scanning protocol. ACTA Radiologica, 2013 54 (2), 226-230 Number of citations: 2

A. Persson, J. Falk, **J. Berge, C. Jackowski**. Atlanto-Axial Rotatory Subluxations in Postmortem CT: Be Aware of a Pitfall. Forensic Science International, 2013, 225(1-3), 9-14.

S.Sing, **M. Kalra, P. Quick, M. Sandborg, A. Persson**. Sinogram Affirmed Iterative Reconstruction of Low Dose chest CT: Effect on Image Quality and Radiation Dose. American Journal of Roentgenology 2013, 201 (2), W235-W244 Number of citations: 2

C. Jackowski, N. Schwendener, W. Bär, **A. Persson**. Postmortem cardiac 3T magnetic resonance imaging: Visualizing the sudden cardiac death? Journal of the American College of Cardiology. In Press, Accepted Manuscript. Availabe online 3 April 2013 Number of citations: 2 **JIF>5**

*M E Lidell, M J Betz, **O D Leinhard**, M Heglind, L Elander, M Slawik, T Mussack, D Nilsson, **T Romu**, P Nuutila, K A Virtanen, F Beuschlein, **A Persson, Magnus Borga,** S Enerbäck. "Evidence for Two Types of Brown Adipose Tissue in Humans", Nature Medicine 19, 631–634 (2013) doi:10.1038/nm.3017. Number of citations: 31

***M Borga,** KA Virtanen, **T Romu, O Dahlqvist Leinhard, A Persson,** P Nuutila, S Enerbäck. Brown adipose tissue in humans: detection and functional analysis using PET (Positron Emission Tomography), MRI (Magnetic Resonance Imaging), and DECT (Dual Energy Computed Tomography). Methods in Enzymology; 537. Accepted for publication. Aug. 2013. In print April 2014.

MK Kalra, M Woisetschläger**, N Dahlström**, S Singh, S Digumarthy, S Do, H Pien P **Quick,** B Schmidt, M Sedlmair, JA O Shepard, **A Persson**. Sinogram-Affirmed Iterative Reconstruction of Low-Dose Chest CT: Effect on Image Quality and Radiation Dose. American Journal of Roentgenology 2013;201,(2), 235-244. Number of citations: 3

***J Kälvesten**, TB Brismar**, A Persson.** Potential Sources of Quantification Error When Retrospectively Assessing Metacarpal Bone Loss From Historical Radiographs by Using Digital X-ray Radiogrammetry: An Experimental Study Accepted for publication in Journal of Clinical Densitometry, 2013.

Vigren P, **Tisell A, Engström M, Karlsson T, Leinhard Dahlqvist O, Lundberg P, Landtblom AM**. Low thalamic NAA-concentration corresponds to strong neural activation in working memory in Kleine-Levin syndrome. PLoS One. 2013;8(2):e56279. Epub 2013 Feb 25.

***Engström M, Landtblom AM, Karlsson T.** Brain and effort: brain activation and effort-related working memory in healthy participants and patients with working memory deficits. Front Hum Neurosci. 2013, 7;140:1-17

***Gauffin H, van Ettinger-Veenstra H, Landtblom AM**, Ulrici D, McAllister A, **Karlsson T, Engström M**. Impaired language function in generalized epilepsy: inadequate suppression of the default mode network. Epilepsy Behav. 2013;28(1):26-35

***Engström M, Karlsson T, Landtblom AM**. Thalamic activation in the Kleine Levin syndrome. SLEEP, in press.JIF > 5

Engström M, Flensner G, **Landtblom AM, Ek AC, Karlsson** T. Thalamo-striato-cortical determinants to fatigue in Multiple Sclerosis. Brain & Behaviour 2013:3(6):715-728

2013 Peer-reviewed Proceedings

Joel Kronander, Stefan Gustavson, Gerhard Bonnet, **Anders Ynnerman**, and Jonas Unger. Aunified framework for multi-sensor hdr video reconstruction. Signal Processing: Image Communication, 2013.

Stefan Lindholm, Daniel Jönsson, **Hans Knutsson, and Anders Ynnerman.** Towards data centric sampling for volume rendering. In SIGRAD 2013, 2013.

Feature-enhancing zoom to facilitate Ki-67 hot spot detection. Jesper Molin, Kavitha Shaga Devan, **Karin Wårdell, Claes Lundström,** accepted to Digital Pathology, SPIE Medical Imaging, 2014

Targeted Iterative Filtering. Freddie Åström, **Michael Felsberg**, George Baravdish, **Claes Lundström**, Scale Space and Variational Methods in Computer Vision, 2013

Wårdell K, Haj-Hosseini N and Hemm S, Comparison between Optical and MRI Trajectories in Stereotactic Neurosurgery, IFMBE Proceeding, Vol. 41, p. 49-51, 2013.

*J Lantz, **T Ebbers, JE Engvall and M Karlsson**: Validation of turbulent kinetic energy in an aortic coarctation before and after intervention, SCMR 2013

F. Åström, **M. Felsberg**, G. Baravdish, and **C. Lundström**. Targeted iterative filtering. In :, number 7893 in Lecture Notes in Computr Science, pages 1–11, 2013.

F. Åström, V. Zografos, and **M. Felsberg**. Density driven diffusion. In 18th Scandinavian Conferences on Image Analysis, 2013, 2013.

***Alexandr Malusek, Maria Magnusson, Michael Sandborg**, Robin Westin, **Gudrun Alm Carlsson** Prostate tissue decomposition via DECT using the model based iterative image reconstruction algorithm DIRA. Proc SPIE 9033-124, (2014)

Jan Lindström, Markus Hulthén, **Gudrun Alm Carlsson, Michael Sandborg** Optimizing two radioluminescence based quality assurance devices for diagnostic radiology utilizing a simple model. Proc SPIE 9033-134, (2014)

Singh S, Pourjabbar S, Khawaja RD, Padole A, Choy G, **Kalra MK, Woisetschläger M, Dahlström N, Persson A.** Prospectively Acquired Low Doses in Abdominal CT and Role of Sinogram Affirmed Iterative REconstruction (Safire). RSNA 2013 [Poster presentation].

Sigovan M, Hope MD, Wrenn SJ, **Dyverfeldt P**, Saloner D. Improved Quantification of Abnormal Aortic Flow in 3D Compared to Standard 2D Approach. Soc. Cardiovascular Magn. Reson. 17th Scientific Sessions. San Francisco, CA, USA; 2013.

Dyverfeldt P, Hope MD, Sigovan M, Wrenn SJ, Saloner D. Reproducibility of Quantitative Analysis of Aortic 4D Flow Data. Soc. Cardiovascular Magn. Reson. 17th Scientific Sessions. San Francisco, CA, USA; 2013.

Rodrigo Moreno, Chunliang Wang, Örjan Smedby. Vessel Wall Segmentation Using Implicit Models and Total Curvature Penalizers. Lecture Notes in Computer Science, Vol 7944, pp. 299-308. Proc. Scandinavic Conf. Image Analysis (SCIA), Espoo, Finland, June 2013. DOI: 10.1007/978-3-642-38886-6_29.

***Rodrigo Moreno, Magnus Borga, Eva Klintström,** Torkel Brismar, **Örjan Smedby.** Correlations between fabric tensors computed on cone beam and micro computed tomography images. Proc. Computational Vision and Medical Image Processing: VipIMAGE 2013, CRC Press, pp. 393-398. Madeira, Portugal, Oct. 2013.

Marreiros FMM, **Smedby Ö**. Stereoscopic static depth perception of enclosed 3D objects. Proceedings of the ACM Symposium on Applied Perception; Dublin, Ireland. 2492501: ACM; 2013. p. 15-22. DOI:10.1145/2492494.2492501

Vigren P, **Tisell A, Engström M, Karlsson T, Leinhard Dahlqvist O, Lundberg P, Landtblom** AM. Low thalamic NAA-concentration corresponds to strong neural activation in working memory in Kleine-Levin syndrome. PLoS One. 2013;8(2):e56279. Epub 2013 Feb 25.

Tisell A, Leinhard OD, Warntjes JB, Aalto A, Smedby Ö, Landtblom AM, Lundberg P. Increased concentrations of glutamate and glutamine in normal-appearing white matter of patients with multiple sclerosis and normal MR imaging brain scans. PLoS One. 2013 Apr 17;8(4):e61817. doi: 10.1371/journal.pone.0061817. Print 2013.

***Engström M, Landtblom AM, Karlsson** T. Brain and effort: brain activation and effort-related work-

ing memory in healthy participants and patients with working memory deficits. Front Hum Neurosci. 2013, 7;140:1-17

***Gauffin H, van Ettinger-Veenstra H, Landtblom AM**, Ulrici D, McAllister A, **Karlsson T,** Engström M. Impaired language function in generalized epilepsy: inadequate suppression of the default mode network. Epilepsy Behav. 2013;28(1):26-35

S Singh, S Pourjabbar, Khawaja, A Padole, G Choy, M K Kalra, **N Dahlström, A Persson**. Prospectively Acquired Low Doses in Abdominal CT and Role of Sinogram Affirmed Iterative REconstruction (Safire). In proceedings of RSNA 2013.

***Engström M,** Flensner G, **Landtblom AM, Ek AC, Karlsson** T. Thalamo-striato- cortical determinants to fatigue in Multiple Sclerosis. Brain & Behaviour 2013:3(6):715-728

Forsberg D, Lundström C, Andersson M, **Vavruch L, Tropp H, Knutsson H.** Fully automatic measurements of axial vertebral rotation for assessment of spinal deformity in idiopathic scoliosis. Institute of Physics (IOP); Physics in Medicine and Biology. 2013;58(6):1775-1787.

Tiago Etiene, Daniel Jönsson, **Timo Ropinski**, Carlos Scheidegger, João Comba, L. Gustavo Nonato, Robert M. Kirby, **Anders Ynnerman**, Cláudio T. Silvia: Verifying Volume Rendering Using Discretization Error Analysis, IEEE Transactions on Visualization and Computer Graphics (TVCG), Volume 20, Number 1, page 140-154- jan 2014.

***A. Malusek, M. Magnusson, Michael Sandborg,** Robin Westin and **G. Alm Carlsson** Prostate tissue decomposition via DECT using the model based iterative image reconstruction algorithm DIRA . Accepted for SPIE conference Physics of Medical Imaging, San Diego, California, USA, February 16-20, 2014

***A. Malusek, M. Magnusson, Michael Sandborg,** Robin Westin and **G. Alm Carlsson** Prostate tissue decomposition via DECT using the model based iterative image reconstruction algorithm DIRA. Accepted for SPIE conference Physics of Medical Imaging, San Diego, California, USA, February 16-20, 2014

2013 Peer-reviewed Review Articles

Khoa Tan Nguyen, **Timo Ropinski**: Large-Scale Multiple Sequence Alignment Visualization through Gradient Vector Flow Analysis, IEEE Symposium on Biological Data Visualization, page 9-16 - October 2013.

CT för diagnostik av kranskärlssjukdom, Studentlitteratur. **Jan Engvall, Anders Persson**, in press 2013

A. Eklund, P. Dufort, **D. Forsberg**, and S. M. LaConte, "Medical image processing on the gpu – past, present and future," Medical image analysis, vol. 17, iss. 8, pp. 1073-1094, 2013.

M. Engström. Neuroimaging in Kleine-Levin Syndrome in Neuroimaging of Sleep and Sleep Disorders. M. Thorpy, E. Nofzinger, and P. Maquet, Eds. Cambridge University Press, 2013. Book.

***Borga M.,** Virtanen Kirsi A., **Romu T., Dahlqvist Leinhard O. Persson A**., Nuutila P., Enerbäck S. Brown adipose tissue in humans: detection and functional analysis using PET (Positron Emission Tomography), MRI (Magnetic Resonance Imaging), and DECT (Dual Energy Computed Tomography), accepted for publication in: Methods in Enzymology Volume 537: Methods of Adipose Tissue Biology. (Journal impact factor (JIF):1.6, No citations GS: 0, ISI: 0) 2014

Hope MD, Wrenn SJ, **Dyverfeldt P.** Clinical Applications of 4D Flow. Current Cardiovascular Imaging Reports 2013;6:128-139.

Hope MD, Sedlic T, **Dyverfeldt P**. Cardiothoracic Magnetic Resonance Flow Imaging. Journal of Thoracic Imaging; 2013;28(4):217-230.

***Rodrigo Moreno, Magnus Borga, Örjan Smedby**. Techniques for Computing Fabric Tensors: A Review. In: "Visualization and Processing of Tensors and Higher Order Descriptors for Multi-Valued Data", Bernhard Burgeth, Anna Vilanova, **Carl-Fredrik Westin** (Eds.), Springer, in press.

Landtblom AM. Update on imaging diagnostics in the Kleine Levin syndrome. Nordic Sleep Medicine Conference, Copenhagen, June 2013.

Knutsson H, Westin C. Tensor Metrics and Charged Containers for 3D Q-space Sample Distribution. In: Medical Image Computing and Computer-Assisted Intervention – MICCAI: MICCAI 2013, Nagoya, Japan, September 22-26 2013. Springer; 2013. Lecture Notes in Computer Science.

Andersson M, Knutsson H. Adaptive Spatio-temporal Filtering of 4D CT-Heart. In: Image Analyses: Image Processing, Computer Vision, Pattern Recognition, and Graphics. Berlin Heidelberg: Springer; 2013. p. 246-255. Lecture Notes in Computer Science, 7944.

Knutsson H, Westin C. Monomial Phase : A Matrix Representation of Local Phase. In: Visualization and Processing of Tensors and Higher Order Descriptors for Multi- Valued Data: Springer; 2013.

Knutsson H, Westin C. Charged Containers for Optimal 3D Q-space Sampling. In: Proceedings of the International Society for Magnetic Resonance in Medicine annual meeting (ISMRM'13): 21st Annual Meeting & Exhibition (ISMRM 2013), 20-26 April 2013, Salt Lake City, Utah, USA. International Society for Magnetic Resonance in Medicine (ISMRM); 2013.

Westin C, Nilsson M, Pasternak O, **Knutsson H.** Diffusion tensors from double-PFG of the human brain. In: ISMRM 2013: 21st Annual Meeting & Exhibition (ISMRM 2013), 20-26 April 2013, Salt Lake City, Utah, USA. The International Society for Magnetic Resonance in Medicine; 2013.

Lindholm S, Jönsson D, **Knutsson H, Ynnerman A**. Towards Data Centric Sampling for Volume Rendering. In: SIGRAD 2013: SIGRAD 2013, 13-14 June 2013, Norrköping, Sweden. 2013.

Khoa Tan Nguyen, Anders Ynnerman, Timo Ropinski: Analyzing and Reducing DTI Tracking Uncertainty by Combining Deterministic and Stochastic Approaches, International Symposium on Visual Computing, page 266-279 - 2013.

Daniel Jönsson, Erik Sundén, **Anders Ynnerman, Timo Ropinski**: A Survey of Volumetric Illumination Techniques for Interactive Volume Rendering, Computer Graphics Forum - 2013.

Timo Ropinski: Advanced Direct Volume Visualization, Morgan Kaufmann, page 289-322 - 2013.

Khoa Tan Nguyen, Timo Ropinski: Feature Tracking in Time-Varying Volumetric Data through Scale Invariant Feature Transform, SIGRAD, page 11-16 - June 2013.

Neda Rostamzadeh, Daniel Jönsson, **Timo Ropinski**: Comparison of Volumetric Illumination Methods by Considering the Underlying Optical Models, SIGRAD - 2013.

Julius Parulek, **Timo Ropinski**, Ivan Viola: Seamless Visual Abstraction of Molecular Surfaces, Spring Conference on Computer Graphics - 2013.

Alexander Bock, Norbert Lang, Gianpaolo Evangelista , Ralph Lehrke, **Timo Ropinski:** Guiding Deep Brain Stimulation Interventions by Fusing Multimodal Uncertainty Regions, Proceedings of the 2013 IEEE Pacific Visualization Symposium (PacificVis), page 97-104 - feb 2013

2012 Peer-reviewed Original Articles

Mukhopadhyay N D, Sampson A J, Deniz D, **Alm Carlsson G,** Williamson J and **Malusek A** Estimating statistical uncertainty of Monte Carlo efficiency--gain in the context of a correlated sampling Monte Carlo code for brachytherapy treatment planning with non-normal dose distribution Applied Radiation and Isotopes 2012. 70 315–23

*__Claes Lundström, Anders Persson, Steffen Ross,__ Patric Ljung, __Stefan Lindholm, Frida Gyllensvärd, and Anders Ynnerman.__ State-of-the-art of visualization in post-mortem imaging. Apmis, 120(4):316–326, 2012.

Daniel Jönsson, Joel Kronander, **Timo Ropinski**, and **Anders Ynnerman**. Historygrams : Enabling interactive global illumination in direct volume rendering using photon mapping. IEEE Transactions on Visualization and Computer Graphics, 18(12):2364–2371, 2012.

Joel Kronander, Daniel Jönsson, Joakim Löw, Patric Ljung**, Anders Ynnerman**, and Jonas Unger. Efficient visibility encoding for dynamic illumination in direct volume rendering. IEEE Transactions on Visualization and Computer Graphics, 18(3):447–462, 2012.

Joakim Löw, Joel Kronander, **Anders Ynnerman**, and Jonas Unger. BRDF models for accurate and efficient rendering of glossy surfaces. ACM Transactions on Graphics, 31(1), 2012.

*__Eklund A, Andersson M, Josephson C,__ Johannesson M, **Knutsson H**. Does parametric fMRI analysis with SPM yield valid results? An empirical study of 1484 rest datasets. NeuroImage 2012;61:565-578. JIF > 5

*__Sigfridsson A, Petersson S, Carlhäll CJ, Ebbers T.__ Four-dimensional Flow MRI using Spiral Acquisition. Magn Reson Med. 2012;68:1065-73

Itoh A, Stephens EH, Ennis DB, **Carlhäll CJ**, Bothe W, Nguyen TC, Swanson JC, Miller DC, Ingels NB Jr. Contribution of Myocardium Overlying the Anterolateral Papillary Muscle to Left Ventricular Deformation. Am J Physiol Heart Circ Physiol 2012;302:H180-87

Aneq MÅ, **Engvall J,** Brudin L**, Nylander E.** Evaluation of right and left ventricular function using speckle tracking echocardiography in patients with arrhythmogenic right ventricular cardiomyopathy and their first degree relatives. Cardiovasc Ultrasound. 2012 Sep 19;10:37.

Appel CF, Hultkvist H, **Nylander E**, Ahn H, Nielsen NE, Freter W, Vánky F. Transcatheter versus surgical treatment for aortic stenosis: patient selection and early outcome. Scand Cardiovasc J. 2012 Oct;46(5):301-7.

Aneq MÅ, Fluur C, Rehnberg M, Söderkvist P, **Engvall J, Nylander E**, Gunnarsson C. Novel plakophilin2 mutation: three-generation family with arrhythmogenic right ventricular cardiomyopathy. Scand Cardiovasc J. 2012;46(2):72-5.

Hedman K, Tamás E, **Nylander E.** Decreased aerobic capacity 4 years after aortic valve replacement in male patients operated upon for chronic aortic regurgitation. Clin Physiol Funct Imaging. 2012;32(3):167-71.

International Society for Strategic Studies in Radiology (IS3R). A statement about authorship from individual members of the International Society for Strategic Studies in Radiology (IS3R). Eur Radiol. 2013 Jan;23(1):1-2. doi: 10.1007/s00330-012-2713-x. Epub 2012 Nov 27. PubMed PMID: 23184074.

Khong PL, Frush D, **Ringertz H.** Radiological protection in paediatric computed tomography. Ann ICRP. 2012 Oct-Dec;41(3-4):170-8. doi: 10.1016/j.icrp.2012.06.017. Epub 2012 Sep 12. PubMed PMID: 23089016.

Ohrn A, Elfström J, **Tropp H,** Rutberg H. What can we learn from patient claims? -A retrospective analysis of incidence and patterns of adverse events after orthopaedic procedures in Sweden. Patient Saf Surg. 2012 Jan 20;6(1):2.

Tödt T, **Maret E**, Alfredsson J, Janzon M, **Engvall J, Swahn E.** Relationship between treatment delay and final infarct size in STEMI patients treated with abciximab and primary PCI. BMC Cardiovascular Disorders 2012; 12:9.

***Kindberg K, Haraldsson H, Sigfridsson A, Engvall**, Ingels NB Jr, **Ebbers T, Karlsson M.** Myocardial Strains From 3D Displacement Encoded Magnetic Resonance Imaging. BMC Medical Imaging 2012;12:9.

Wang C, Persson A, Engvall J, De Geer J, Czekierda W, Björkholm A, Fransson SG, **Smedby Ö**. Can segmented 3D images be used for stenosis evaluation in coronary CT angiography? Acta Radiol. 2012;53(8):845-51.

Wijkman M, **Länne T,** Grodzinsky E, Östgren C-J, **Engvall J,** Nyström F. Ambulatory systolic blood pressure predicts left ventricular mass in type 2 diabetes, independently of central systolic blood pressure. Blood Pressure Monitoring 2012; 17(4):139-144.

Åström Aneq M, **Engvall J,** Brudin L, **Nylander E**. Evaluation of Right and Left Ventricular Function Using Speckle Tracking Echocardiography in Patients with Arrhythmogenic Right Ventricular Cardiomyopathy and Their First Degree Relatives. Cardiovascular Ultrasound 2012, 10:37.

Erik Olsson, Carl Eckerström, Gertrud Berg,**Magnus Borga**, Sven Ekholm, Gudmundur Johannsson, Susanne Ribbelin, Görgan Starck, Anna Wysocka, Elisabet Löfdahl, Helge Malmgren, "Hippocampal volumes in patients exposed to low-dose radiation to the basal brain: a case–control study in long-term survivors from cancer in the head and neck region", Radiation Oncology, 7(202), 2012.

***Rodrigo Moreno, Magnus Borga, Örjan Smedby, "**Generalizing the mean intercept length tensor for gray-level images", Medical physics (Lancaster), 39(7): 4599-4612, 2012.

***Gunnar Läthén, Stefan Lindholm, Reiner Lenz, Anders Persson, Magnus Borga**, "Automatic Tuning of Spatially Varying Transfer Functions for Blood Vessel Visualization", IEEE Transactions on Visualization and Computer Graphics, 18(12): 2345-2354, 2012.

A Tisell, O. Dahlqvist Leinhard, JBM Warntjes and P Lundberg. Procedure for Quantitative 1H MRS and Tissue Characterization of Human Brain Tissue Based on the Use of Quantitative MRI. Mag Reson Med 2012.

Synthetic MRI of the brain in a clinical setting. **I Blystad, JBM Warntjes, O Smedby, A-M Landtblom, P Lundberg and E-M Larsson.** Acta Radiologica 2012;53:1158-1163.

Evaluation of Automatic Measurement of the Intracranial Volume Based on Quantitative MR Imaging. K Ambarki, T Lindqvist, A Wåhlin, **E Petterson, M Warntjes**, M Vågberg, R Birgander, J Malm and A Eklund.

AJNR Am J Neuroradiol 2012;33:1951-1956. Novel Whole Brain Segmentation and Volume Estimation Using Quantitative MRI. **J West, JBM Warntjes** and **P Lundberg**. Eur Radiol 2012;22:998-1007

M.B.O. Larsson, K. Tillisch, **A.D. (Bud) Craig, M. Engström**, J. Labus, B. Naliboff, **P. Lundberg,** M. Ström, E.A. Mayer and **S.A. Walter**. Brain responses to expectation and delivery of a visceral stimulus in IBS reflect visceral sensitivity thresholds. Gastroenterology, 142:463–472, 2012. JIF > 5

***Van Ettinger-Veenstra, M. Ragnehed,** A. McAllister, **P. Lundberg, M. Engström**. Right-Hemispheric Cortical Contributions to Language Ability in Healthy Adults. Brain and Language, 120:395–400, 2012.

***K Kindberg, H Haraldsson, A Sigfridsson**, H Sakuma, **T Ebbers and M Karlsson**: Temporal 3D Lagrangian Strain from 2D Slice Followed Cinc DENSE MRI, Clin Physiol Funct Imaging, vol 32(2):139-144, 2012 Number of citations: -

J Lantz, **R Gårdhagen**, **M Karlsson**: Quantifying Turbulent Wall Shear Stress in a Subject Specific Human Aorta Using Large Eddy Simulation, Med Eng Phys, vol 34(8):1139-1148, 2012

J Lantz and **M Karlsson**: Large Eddy Simulation of LDL surface concentration in a subject specific human aorta, J Biomechanics vol 45(3):537-542, 2012 Number of citations: 1

***K Kindberg, H Haraldsson, A Sigfridsson, J Engvall,** NB Ingels, **T Ebbers and M Karlsson:** Myocardial Strains from 3D DENSE MRI, BMC Med Imaging, vol 12(9), 2012 Number of citations: 1

***J Renner,** H Nadali Najafabadi, **T Länne** and **M Karlsson**: Subject-specific aortic wall shear stress estimations using semi-automatic segmentation, Clinical Physiology and Functional Imaging, Volume 32(6), 481–491, November 2012, Number of citations: -

***H M Björck, J Renner,** S Maleki, S Nilsson, **J Kihlberg**, L Folkersen, **M Karlsson, T Ebbers, P Eriksson and T Länne**: Flow dependent gene expression in the rat aorta under physiological conditions, PLoS One, 2012 vol 7(12) Number of citations: -

Lars Borgen, **Mannudeep K Kalra**, Frode Lærum, Isabelle W Hachette,Carina H Fredriksson, **Michael Sandborg and Örjan Smedby** Application of adaptive non- linear 2D and 3D postprocessing filters for reduced dose abdominal CT. Acta Radiologica 2012: 1–8.

Michael Sandborg, Jonas Nilsson-Althen, Håkan Pettersson and Sandro Rossitti. Patient organ radiation doses during treatment for aneurismal subarachnoid hemorrhage. Clinical Neuroradiology, 22(4), 315-325 (2012).

Kalra M K, Woisetschläger M, Dahlström N, Singh S, Lindblom M, Choy G, **Quick P**, Schmidt B, Sedlmair M, Blake MA, **Persson A**. Radiation dose reduction with sinogram affirmed iterative reconstruction technique for abdominal computed tomography. J Comput Assist Tomogr 2012 May:36(3):339-46.

Dahlqvist Leinhard O, Dahlström N, Kihlberg J, Sandström P, Brismar T, **Smedby Ö, Lundberg P.** Quantifying differences in hepatic uptake of the liver specific contrast agents Gd-EOB-DTPA and Gd-BOPTA : a pilot study. Germany: Springer; European Radiology. 2012;22(3):642-653.

Tisell A, **Dahlqvist Leinhard O, Warntjes JBM, and Lundberg P.** Procedure for Quantitative 1H

Magnetic Resonance Spectroscopy and Tissue Characterization of Human Brain Tissue Based on the Use of Quantitative Magnetic Resonance Imaging. Epub in Magnetic Resonance in Medicine 20 Nov 2012. (JIF: 3.3, GS: 0, ISI: 1)

Mellergård J, **Tisell A, Dahlqvist Leinhard O, Blystad I, Landtblom AM**, Blennow K, Olsson B, Dahle C, Ernerudh J, **Lundberg P,** Vrethem M. Association between Change in Normal Appearing White Matter Metabolites and Intrathecal Inflammation in Natalizumab-Treated Multiple Sclerosis. PLoS ONE 2012:7(9):e44739. (JIF: 3.7, GS: 0, ISI: 0)

Dahlqvist Leinhard O, Dahlström N, Kihlberg J, Sandström P, Brismar TB, **Smedby O, Lundberg P.** Quantifying differences in hepatic uptake of the liver specific contrast agents Gd-EOB-DTPA and Gd-BOPTA: a pilot study, Eur Radiol. 2012 Mar;22(3):642-53. (JIF: 3.5, GS: 11, ISI 2)

Lundin F, **Tisell A,** Leijon G, **Dahlqvist Leinhard O.,** Davidsson L , **Grönqvist A ,** Wikkelsö C, **Lundberg P** (2012) Pre-Postoperative 1H-MRS-Changes in Frontal Deep White Matter and the Thalamus in Idiopathic Normal Pressure Hydrocephalus J Neurol Neurosurg Psychiatry 2013 Feb;84(2):188-93. doi: 10.1136/jnnp-2012-302190. Epub 2012 Nov 7. Number of citations: 0 JIF 4.9

Tisell A, Dahlqvist Leinhard O, Warntjes JBM, Lundberg P (2012) Procedure for quantitative (1) H magnetic resonance spectroscopy and tissue characterization of human brain tissue based on the use of quantitative magnetic resonance imaging Magn Reson Med. 2012 Nov 20. doi: 10.1002/mrm.24554. [Epub ahead of print]

Mellergård, J, **Tisell, A, Dahlqvist Leinhard, O**, Dahle, C, **Landtblom, AM**, Ernerudh, J, **Lundberg, P,** Vrethem, M (2012) Magnetic resonance spectroscopy in multiple sclerosis: effects of natalizumab treatment and association to intrathecal inflammation. PLoS ONE 2012;7(9):e44739. doi: 10.1371/journal.pone.0044739. Epub 2012 Sep 17.

Dahlqvist Leinhard O, Dahlström N, Kihlberg J, Sandström, P., Brismar TB, **Smedby Ö,** and **Lundberg P**. (2012) Quantifying differences in hepatic uptake of the liver specific contrast agents Gd-EOB-DTPA and Gd-BOPTA: a pilot study. Eur Radiol. 2012 Mar;22(3):642-53. Epub 2011 Oct 9 Number of citations: 10

Blystad I, Warntjes JBM, Smedby Ö, Landtblom A-M, Lundberg P, and Larsson E-M (2012) Synthetic MRI of the brain in a clinical setting, Acta Radiol 2012 Dec 1;53(10):1158-63. doi: 10.1258/ar.2012.120195. Epub 2012 Sep 27. Number of citations: 1

Hope MD, **Dyverfeldt P**, Acevedo-Bolton G, Wrenn J, Foster E, Tseng E, Saloner D. Post-Stenotic Dilation: Evaluation of Ascending Aortic Dilation with 4D Flow MR Imaging. International Journal of Cardiology 2012; 19;156:e40-2.JIF>5

Arzani A, **Dyverfeldt P, Ebbers T,** Shadden SC. In Vivo Validation of Numerical Prediction for Turbulence Intensity in an Aortic Coarctation. Annals of Biomedical Engineering 2012; 40:860-70

Petersson S, Dyverfeldt P, Ebbers T. Assessment of the accuracy of MRI wall shear stress estimation using numerical simulations. J Magn Reson Imaging 2012; 36:128–138.

Sigovan M, Hope MD, **Dyverfeldt P,** Saloner D. Rationale and Methods for Quantifying Ascending Aortic Flow Eccentricity: Back to the Underlying Mechanism? Response J Magn Reson Imaging 2012; 36:507.

Rodrigo Moreno, Magnus Borga, Örjan Smedby. Generalizing the Mean Intercept Length Tensor for Gray-Level Images. Medical Physics, 39(7), pp. 4599-4612, 2012. DOI:10.1118/1.4730502. IF: 2.911, Quartile: 1.

Wikgren, M., **Karlsson, T**., Nihlbrink, T., Nordfjäll, K., Hultdin, J., Sleegers, J., Van Broeckhoven, C., Nyberg, L., Roos, G., Nilsson, L.-G., Adolfsson, R., & Norrback, K F. (2012). APOE ε4 is associated with longer telomeres, and longer telomeres among ε4 carriers predicts worse episodic memory. Neurobiology of Aging, 33(2), 335-344. http://dx.doi.org/10.1016/j.neurobiolaging.2010.03.004

Wikgren, M., Maripuu, M., **Karlsson, T**., Nordfjäll, K., Bergdahl, J., Hultdin, J., Del- Favero, J., Roos, G., Nilsson, L.-G., Adolfsson, R., & Norrback, K. F. (2012). Short telomeres in depression and the general population are associated with a hypocortisolemic state. Biological Psychiatry, 71(4), 294-300. http://dx.doi.org/10.1016/j.biopsych.2011.09.015 JIF > 5

Wikgren, M., **Karlsson, T.,** Lind, J., Nilbrink, T., Hultdin, J., Sleegers, K., Van Broeckhoven, C., Roos, G., Nilsson, L.-G., Nyberg, L., Adolfsson, R., Norrback, K-F. (2012). Longer leukocyte telomere length is associated with smaller hippocampal volume among non-demented APOE ε3/ε3 subjects. PLoS ONE 7(4), e34292. doi:10.1371/journal.pone.0034292.

Rudner, M**., Karlsson,T.,** Gunnarsson, J., & Rönnberg, J. (2013). Levels of processing and language modality specificity in working memory. Neuropsychologia, 51(4), 656-666. DOI: 10.1016/j.neuropsychologia.2012.12.011

***Björck HM, Renner J**, Shohreh Maleki S, Nilsson SFE, **Kihlberg J,** Folkersen L, **Karlsson M, Ebbers** T, Eriksson P, **Länne T**. Characterization of Shear-Sensitive Genes in the Normal Rat Aorta Identifies Hand2 as a Major Flow-Responsive Transcription Factor. PLoS ONE 2012;7(12)

***Kindberg K, Haraldsson H, Sigfridsson A, Engvall J**, Ingels NB, **Ebbers T, Karlsson M**. Myocardial strains from 3D displacement encoded magnetic resonance imaging. BMC Medical Imaging. 2012;12:9.

***Kindberg K, Haraldsson H, Sigfridsson A,** Sakuma H, **Ebbers T, Karlsson M.** Temporal 3D Lagrangian strain from 2D slice-followed cine DENSE MRI. Clin Physiol Funct Imaging. 2012;32(2):139-44.

Petersson S, Dyverfeldt P, Ebbers T. Assessment of the Accuracy of MRI Wall Shear Stress Estimation using Numerical Simulations. J Magn Reson Imaging. 2012;36(1):128-38.

Sigfridsson A, Petersson S, Carlhäll CJ, Ebbers T. 4D flow MRI using spiral acquisition. Magn Res in Med. 2012;68:1065-1073.

***Renner J**, Nadali NH, Modin D, **Länne T, Karlsson M**. Subjects-specific aortic wall shear stress estimations using semi-automatic segmentation. Clin Physiol Funct Imaging 2012 Nov;32(6):481-91.

Arzani A, **Dyverfeldt P, Ebbers T**, Shadden SC. In Vivo Validation of Numerical Prediction for Turbulence Intensity in an Aortic Coarctation. Annals of Biomedical Engineering. 2012;40(4):860-70.

Ambulatory systolic blood pressure predicts left ventricular mass in type 2 diabetes, independent of central systolic blood pressure. Wijkman M, **Länne T**, Grodzinsky E, Ostgren CJ, **Engvall J**, Nystrom FH. Blood Press Monit 2012;17(4):139-44.

Opposing effects of circadian clock genes Bmal1 and Period2 in regulation of VEGF-dependent angiogenesis in developing Zebrafish. Jensen L, Cao Z, Nakamura M, Yang Y, Bautigam L, Andersson P, Zhang Y, Wahlberg E, **Länne T**, Hosaka K, Cao Y. Cell Reports 2012;2(2):231-241.

Reduced defence of central blood volume during acute hypovolemic circulatory stress in aging women. Lindenberger M. and **Länne** T. Shock 2012;37:579-85.

Jennersjö P, Ludvigsson J, **Länne T,** Nyström FH, Ernerudh J, Östgren CJ.Pedometer-determined physical activity is linked to low systemic inflammation and low arterial stiffness in Type 2 diabetes Diabet Med 2012;29(9):1119-25.

Franck N, **Länne T,** Åstrand O, **Engvall J,** Lindström T, Östgren CJ and Nystrom Cardiovascular risk factors related to the PPARγ Pro12Ala polymorphism in patients with type 2 diabetes are gender-dependent. FH. Blood Pressure 2012; 21(2): 122-7.

Dahlén E, Andréasson T, Cinthio M, Nystrom F, Östgren CJ, **Länne T.** Is there an Underestimation of Intima-Media Thickness based on M-mode ultrasound technique in the abdominal aorta? Clin Physiol Funct Imaging 2012; 32(1):1-4.

Beaulieu L, **Carlsson Tedgren Å,** Carrier JF, Davis S D, Mourtada F, Rivard M J, Thomson R M, Verhaegen F, Waring T and Williamson J F 2012 Report of the Task Group 186 on model-based dose calculation methods in brachytherapy beyond the TG-43 formalism: current status and recommendations for clinical implementation Med. Phys. 39 6208-36

Adolfsson E, Karlsson M, **Alm Carlsson G, Carlsson Tedgren Å**, Lund E, Olsson S, Gustafsson H 2012 Investigation of signal fading in lithium formate EPR dosimeters using a new sensitive method Phys. Med. Biol. 57 2209-2217

Carlsson Tedgren Å, Elia R, Olsson S, Hedtjärn H and **Alm Carlsson G** 2012 Determination of absorbed dose to water around a clinical HDR 192Ir source using TL LiF:Mg,Ti demonstrates an LET dependence of detector response Med. Phys. 39 1133-1140

Holm Å, Larsson T and **Carlsson Tedgren Å** 2012 Impact of linear optimization model in dose planning for HDR brachytherapy of prostate cancer Med. Phys. 39 1021-1028

***Moreno R, Borga M, Smedby Ö.** Generalizing the Mean Intercept Length Tensor for Gray-Level Images. Medical Physics 2012;39:4599-4612. DOI:10.1118/1.4730502

Wang C, Persson A, Engvall J, De Geer J, Fransson SG, Björkholm A, Czekierda W, **Smedby Ö.** Can segmented 3D images be used for stenosis evaluation in coronary CT angiography? Acta Radiol. 2012 Oct 1;53(8):845-51. DOI:10.1258/ar.2012.120053

Blystad I, Warntjes J, Smedby Ö, Landtblom AM, Lundberg P, Larsson EM. Synthetic MRI of the brain in a clinical setting. Acta Radiol. 2012 Dec 1;53(10):1158-63. DOI:10.1258/ar.2012.120195

Hänni M, Leppänen O, **Smedby Ö.** Postangioplasty restenosis followed with magnetic resonance imaging in an atherosclerotic rabbit model. Int J Biomed Imaging. 2012;2012:747264. DOI:10.1155/2012/747264

***Lundström C., Persson A., Ross S.,** Ljung P**., Lindholm S., Gyllensvärd F, Ynnerman A.** State-of-the-art of Visualization in Post-Mortem Imaging. Acta Pathologica, Microbiologica et Immunologica Scandinavia. Apmis 2012;120 (4), 316-326 Number of citations : 5

S Tourancheau, M Sjöström, R Olsson, **A Persson**, T Ericson, J Rudling, **B Norén**. Subjective evaluation of user experience in interactive 3D visualization in a medical context. Society of Phot-Optical Instrumentation Engineers (SPIE),8318, Medical Imaging 2012: Image Perception, Observer Performance, and Technology Assessment, 831814 (February 20, 2012); doi:10.1117/12.910828, page 1-13.

M. Lundin, H. Geijer, T. Andersson. **A. Persson**. Virtual non-contrast dual-energy CT compared to single-energy CT of the urinary tract – a prospective study. Acta Radiologica 2012;53 (6), 689-694 Number of citations: 1

M. Kalra, M. Woisetschläger, **N. Dahlström,** S.Sing, M. Lindblom, G. Choy, **P. Quick,** B. Schmidt, M. Sedlmair, M. A. Blake, **A. Persson**. Radiation Dose Reduction with Sinogram Affirmed Iterative Reconstruction Technique for abdominal CT. Accepted for publication Journal of Computer Assisted Tomography. 2012; 36 (3), 339 Number of citations: 42

Wang C, Persson A, Engvall J, De Geer J, Björkholm A, Czekierda W, et al. Can segmented 3D images be used for stenosis evaluation in coronary CT angiography? Acta Radiol October 2012 vol. 53 no. 8 845-851.

GN Rutty, G Brogdon, F Dedouit, S Grabherr, GM Hatch, **C Jackowski**, P Leth, **A Persson**, T D Ruder, S Shiotani, N Takahashi, M J Thali, K Woźniak, K Yen, B Morgan. Terminology used in publications for post-mortem cross-sectional imaging International journal of legal medicine, 2012, 1-2 Number of citations: 6

***Läthén G, Lindholm S, Lenz R, Persson A, Borga M**. Automatic Tuning of Spatially Varying Transfer Functions for Blood Vessel Visualization. IEEE Transactions on Visualization and Computer Graphics. 2012; (18) 12, 2345-2354 Number of citations: 2

Mellergård J, **Tisell A, Lundberg P, Dahlqvist Leinhard O, Blystad I,** Dahle C, Ernerudh J, **Landtblom AM,** Blennow K, Vrethem M. Association between Change in Normal Appearing White Matter Metabolites and Intrathecal Inflammation in Natalizumab-treated Multiple Sclerosis. PLOS One 2012;7(9) Epub 120917.

***Blystad I, Smedby Ö, Landtblom AM, Lundberg P, Warntjes Larsson EM.** Synthetic MRI of the brain in a clinical setting. Acta Radiologica 2012;53(10):1158-63

2012 Peer-reviewed Proceedings

*__Moreno R, Borga M, Smedby Ö.__ Estimation of trabecular thickness in gray-scale images through granulometric analysis. Proc. SPIE 8314, 831451 (2012); DOI:10.1117/12.906734

*J Lantz, **T Ebbers, J Engvall and M Karlsson**: Large Eddy Simulation of Aortic Coarctation Before and After Surgery Artery 12, 18-20 October 2012, Vienna, Austria

Forsberg D, Farnebäck G, Knutsson H, Westin C. Multi-modal Image Registration Using Polynomial Expansion and Mutual Information. In: Biomedical Image Registration: Proceedings of the 5th International Workshop, WBIR 2012, Nashville, TN, USA, July 7-8, 2012. International Workshop Biomedical Image Registration, Nashville, TN, USA, July 7-8, 2012. Springer Berlin/Heidelberg; 2012. p. 40-49. Lecture Notes in Computer Science, 7359.

Johansson G, **Forsberg D, Knutsson H.** Globally Optimal Displacement Fields Using Local Tensor Metric. In: Image Processing (ICIP), 2012 19th IEEE International Conference on: 2012 IEEE International Conference on Image Processing, September 30 -October 3, 2012, Orlando, Florida, USA. 2012. p. 2957-2960.

Martin Törnros, David Berrios, Alexander Bock, Carter Emmart, Robert Harberts, and **Anders Ynnerman.** Interactive visualization of space weather data. 2012.

Khoa Nguyen, Alexander Bock, **Anders Ynnerman**, and **Timo Ropinski.** Deriving and visualizing uncertainty in kinetic pet modeling. In Deriving and Visualizing Uncertainty in Kinetic PET Modeling: EG Visual Computing for Biology and Medicine, 2012.

*__Claes Lundström, Anders Persson, Steffen Ross,__ Patric Ljung, **Stefan Lindholm, Frida Gyllensvärd, and Anders Ynnerman**. State-of-the-art of visualization in post-mortem imaging. Acta Pathologica, Microbiologica et Immunologica Scandinavica (APMIS), 120(4):316–326, 2012.

Daniel Jönsson, Erik Sundén, **Anders Ynnerman**, and **Timo Ropinski.** State of the art report on interactive volume rendering with volumetric illumination. In Eurographics 2012 - State of the Art Reports, Eurographics 2012 - State of the Art Reports, pages 53–74, 2012.

Daniel Jönsson, Per Ganestam, Michael Doggett, **Anders Ynnerman, and Timo Ropinski**. Explicit cache management for volume ray-casting on parallel architectures. In Eurographics Symposium on Parallel Graphics and Visualization (2012), Eurographics Symposium on Parallel Graphics and Visualization, pages 31–40, 2012.

G. Johansson, **D. Forsberg, and H. Knutsson**, "Globally optimal displacement fields using local tensor metric," in Image processing (icip), 2012 19th ieee international conference on, 2012, pp. 2957-2960.

Forsberg, G. Farnebäck, **H. Knutsson**, and C. -F. Westin, "Multi-modal image registration using polynomial expansion and mutual information," in Biomedical image registration, Springer, 2012, vol. 7359, pp. 40-49.

Khoa Tan Nguyen, Alexander Bock, **Anders Ynnerman, Timo Ropinski:** Deriving and Visualizing Uncertainty in Kinetic PET Modeling, Proceedings of the EG Visual Computing for Biology and Medicine, page 107-114 - 2012.

Alexander Bock, Erik Sundén, Bingchen Liu, Burkhard Wuensche, **Timo Ropinski**: Coherency-Based Curve Compression for High-Order Finite Element Model Visualization, IEEE TVCG (SciVis Proceedings), Volume 18, Number 12, page 2315-2324 - December 2012.

Daniel Jönsson, Joel Kronander, **Timo Ropinski, Anders Ynnerman**: Historygrams: Enabling Interactive Global Illumination in Direct Volume Rendering using Photon Mapping, IEEE Transactions on Visualization and Computer Graphics (TVCG), Volume 18, Number 12, page 2364-2371 - December 2012.

Daniel Jönsson, Per Ganestam, **Anders Ynnerman,** Michael Doggett, **Timo Ropinski**: Explicit Cache Management for Volume Ray-Casting on Parallel Architectures, EG Symposium on Parallel Graphics and Visualization (EGPGV), page 31-40 - 2012.

D. Forsberg, M. Andersson, and H. Knutsson, "Non-rigid diffeomorphic image registration of medical images using polynomial expansion," in Image analysis and recognition, Springer, 2012, vol. 7325, pp. 304-312.

Diczfalusy E; Dizdar N; Zsigmond P; Kullman A; Loyd D; **Wårdell K**, Simulations and visualizations for interpretation of brain microdialysis data during deep brain stimulation , IEEE-EMBS pp 6438 - 6441, 2012.

***Rodrigo Moreno, Magnus Borga, Örjan Smedby,** Evaluation of the plate-rod model assumption of trabecular bone, Biomedical Imaging (ISBI), 2012, 470- 473, 2012.

***Rodrigo Moreno, Magnus Borga, Örjan Smedby.** Evaluation of the Plate-Rod Model Assumption of Trabecular Bone. Proc. Int. Symposium on Biomedical Imaging (ISBI), pp. 470-473. Barcelona, Spain, May 2012. DOI:10.1109/ISBI.2012.6235586

***Rodrigo Moreno, Magnus Borga, Örjan Smedby**, "Estimation of Trabecular Thickness in Gray-Scale Images Through Granulometric Analysis", Progress in Biomedical Optics and Imaging-Proceedings of SPIE, 2012.

*J Lantz, **T Ebbers and M Karlsson**: Quantifying Turbulent Kinetic Energy in an Aortic Coarctation with Large Eddy Simulation and Magnetic Resonance Imaging 65th Annual Meeting of the APS Division of Fluid Dynamics (DFD 2012), 18-20 November 2012, San Diego, CA, USA

J Lantz and **M Karlsson**: Resolving flow and mass transport in a healthy subject- specific aorta using large eddy simulation 15th Annual SCMR Scientific Sessions, Orlando, FL, USA. 2-5 February 2012

***J Renner,** J Lantz, **T Ebbers**, **T Länne and M Karlsson**: Altered WSS in the human aorta with age – implications for wall remodeling and lesions?

ARTERY '12, Wien, Austria, 18-20 October 2012
Åström, G. Baravdish, and **M. Felsberg**. On tensor-based pdes and their corresponding variational formulations with application to color image denoising. Number 7574 in Lecture Notes in Computer Science, pages 215–228, 2012.

Örjan Smedby, Mats Fredrikson, **Jakob De Geer, and Michael Sandborg** Quantifying effects of post-processing with visual grading regression Proc. SPIE 8318, (2012)

Örjan Smedby, Mats Fredrikson, **Jakob De Geer, Michael Sandborg** Visual grading regression with random effects Proc. SPIE 8318, (2012)

Dahlström N, Dahlqvist Leinhard O, Kihlberg J, Quick P, Forsgren MF, Lundberg P, Persson A. Dual-Energy CT Detects Standard-Dose Gd-EOB-DTPA in the Hepatobiliary and Renal Systems of Patients Having Undergone Liver MRI. RSNA 2012 [Oral Scientific Presentation]

*__Norén B, Forsgren M, Dahlqvist Leinhard O, Dahlström N, Kihlberg J__, Romu T, Kechagias S, Almer S, **Smedby Ö, and Lundberg P**. Separation Of Advanced From Mild Hepatic Fibrosis By Quantification Of The Hepatobiliary Uptake Of Gd-EOB-DTPA. RSNA 2012

*__Forsgren MF,__ Ekstedt M, __Dahlqvist Leinhard O,__ Andregård __O, Dahlström N, Kihlberg J,__ Kechagias S, Almer S, __Smedby Ö, Lundberg P__. Prospective evaluation of liver steatosis comparing stereological point-counting biopsy analysis and 1H MRS. Poster. ISMRM, Melbourne 2012

*__Norén B, Forsgren MF, Dahlström N, Dahlqvist Leinhard O, Kihlberg J, Romu T,__ Kechagias S, Almer S, __Smedby Ö, Lundberg P__. Quantification of the hepatobiliary uptake of Gd-EOB-DTPA can separate advanced from mild fibrosis. Multimedia electronic poster. ISMRM, Melbourne 2012

__Dahlström N, Woisetschläger M__, Singh S, Digumarthy SR, __Kalra M, Persson A,__ Role of Sinogram Affirmed Iterative Reconstruction (Safire) technique in image quality and radiation dose reduction for chest CT examinations. European Congress of Radiology, Wien, 2012

__Woisetschläger M, Dahlström__ N, Singh S, Choy G, O'Connor O, Blake MA, __Kalra M, Persson A__. Radiation dose reduction with Sinogram Affirmed Iterative Reconstruction (Safire) technique for abdominal CT. European Congress of Radiology, Wien, 2012.

Fan Z, __Dyverfeldt P,__ Liu X, Zuehlsdorff S, Deshpande V, Saloner D, Li D. 3D Variable-Flip-Angle TSE with Prospective Self-Gating of Swallowing Motion: Initial Experience in Carotid Artery Wall MRI. 20th Int. Soc. Magn. Reson. Med. Melbourne, Australia; 2012.

Sigovan M, Acevedo-Bolton G, __Dyverfeldt P__, Owens C, Saloner D Ferumoxytol Enhanced 2D & 3D Phase Contrast MRI in dialysis fistulas. 20th Int. Soc. Magn. Reson. Med. Melbourne, Australia; 2012.

Liu J, __Dyverfeldt P__, Hope, MD, Saloner D. Accelerated 4D Flow Imaging with Compressed Sensing and Radial Undersampling Pattern on Cartesian Grid. 20th Int. Soc. Magn. Reson. Med. Melbourne, Australia; 2012.

Rayz V, __Dyverfeldt P__, Saloner D. 4D MRVo based CFD models supplement MRA data. 24th Annual Meeting of the International MRA Club. Utrecht, Netherlands; 2012.

*__Rodrigo Moreno, Magnus Borga, Örjan Smedby__. Estimation of Trabecular Thickness in Gray-Scale Images Through Granulometric Analysis. SPIE Medical Imaging, Vol. 8314, 831451. San Diego, USA, February 2012. DOI:10.1117/12.906734

__Chunliang Wang, Rodrigo Moreno, Örjan Smedby__. Vessel Segmentation Using Implicit Model-Guided Level Sets. Workshop 3D Cardiovascular Imaging: A MICCAI Segmentation Challenge, Nice, France, Oct 2012.

*__Engström, M., Karlsson__, __T., Landtblom, AM.,__ & __Craig, A. D.__ (2012). Mental energy - an fMRI investigation of the anterior insula and the anterior cingulate network. Paper presented at the 18th Annual Meeting of the Organization for Human Brain Mapping; Beijing, June 10-14.

*__van Ettinger-Veenstra, H., Gauffin, H.,__ McAllister, __A., Lundberg__, P., Ulrici, D., __Landtblom, AM., Karlsson, T., & Engstrom, M.__ (2012). Language deficits in Epilepsy: an fMRI study. Paper presented at the 18th Annual Meeting of the Organization for Human Brain Mapping; Beijing, June 10-14.

__Smedby Ö,__ Fredrikson M, __De Geer J, Sandborg M__. Visual grading regression with random effects. Proc. SPIE 8318, 831805 (2012); DOI:10.1117/12.913650

__Smedby Ö__, Fredrikson M, __De Geer J, Sandborg M__. Quantifying effects of post-processing with visual grading regression. Proc. SPIE 8318, 83181N (2012); DOI:10.1117/12.912321

*__Dahlqvist Leinhard O, Romu T, Kihlberg J,__ Gjellan S, Zanjani S, __Smedby Ö,__ et al. Validation of whole-body adipose tissue quantification using air displacement plethysmometry. ISMRM workshop on Fat–Water Separation: Insights, Applications & Progress in MRI, 19-22 February 1912, Long Beach, CA, USA. 2012.

*__Moreno R, Borga M, Smedby Ö__. Evaluation of the plate-rod model assumption of trabecular bone. In: Biomedical Imaging (ISBI), 2012. 9th IEEE International Symposium on Biomedical Imaging (ISBI 2012), 2-5 May 2012, Barcelona, Spain. 2012. p. 470-473. DOI:10.1109/ISBI.2012.6235586

__Wang C, Moreno R, Smedby Ö__. Vessel segmentation using implicit model- guided level sets. In: Proceedings of MICCAI Workshop 3D Cardiovascular Imaging: a MICCAI segmentation Challenge". Nice, France, 2012.

__M. Andersson__, K. Jagervall, P. Eriksson, __A. Persson__, G. Granerus, __Ö. Smedby__. How should renal artery stenoses be measured? European Congress of radiology, 2012, March 4.

S Tourancheau, M Sjöström, R Olsson, __A Persson__, T Ericson Evaluation of quality of experience in interactive 3D visualization: methodology and results. SPIE 8288, Stereoscopic Displays and Applications XXIII, 82880O (February 9, 2012); doi:10.1117/12.907962 Number of citations: 2

__C . Wang__, S. G. Fransson, __A. Persson__, __J. Engvall, J. D. Geer,__ C. Waldemar, A. Björkholm, __Ö. Smedby__. Can segmented 3D images be used for stenosis evaluation in coronary CT angiography? European Congress of radiology, 2012, March 4.

Simulations help us understand X-ray imaging (3 presentations. Topic: Physics in Radiology / Moderators: H. Bosmans (Leuven/BE), __A. Persson__ (Linköping/SE) European Congress of radiology, 2012, March 5, 08:30 - 10:00

__N. Dahlström,__ M. Woisetschlager, S. Singh, S. R. Digumarthy, __M. Kalra, A. Persson__. Role of Sinogram Affirmed Iterative Reconstruction (Safire) technique in image quality and radiation dose reduction for chest CT examinations. European Congress of radiology, 2012, March 4.

M. Woisetschlager__, N. Dahlström__, S. Singh, G. Choy, O. O'connor, M. A. Blake, __M. Kalra__, __A. Persson__. Radiation dose reduction with Sinogram Affirmed Iterative REconstruction (Safire) technique for abdominal CT. European Congress of radiology, 2012, March 4.

*__Läthén, R. Lenz, A. Persson, M. Borga__. Optimized Blood Vessel Visualization. Eurographics Conference on Visualization 2012.

S. Tourancheau, M. Sjöström, R. Olsson, __A. Persson__. Evaluation of quality of experience in interactive 3D visualization: methodology and results. In

proceedings for SPIE Medical Imaging San Diego Feb 8, 2012.

S Singh, S Pourjabbar, Khawaja, A Padole, G Choy, **M K Kalra**, **N Dahlström, A Persson**. Prospectively Acquired Low Doses in Abdominal CT and Role of Sinogram Affirmed Iterative REconstruction (Safire). In proceedings of RSNA 2014.

Mellergård J, **Tisell A, Lundberg P, Dahlqvist Leinhard O, Blystad I,** Dahle C, Ernerudh J, **Landtblom AM**, Blennow K, Vrethem M. Association between Change in Normal Appearing White Matter Metabolites and Intrathecal Inflammation in Natalizumab-treated Multiple Sclerosis. PLOS One 2012;7(9) Epub 120917.

Blystad I, Smedby Ö, Landtblom AM, Lundberg P, Warntjes M, Larsson E-M. Synthetic MRI of the brain in a clinical setting. Acta Radiologica 2012;53(10):1158-63

Eklund A, Andersson M, Knutsson H. fMRI Analysis on the GPU - Possibilities and Challenges. Elsevier; Computer Methods and Programs in Biomedicine. 2012;105(2):145-161.

Eklund A, Andersson M, Josephson C, Johannesson M, Knutsson H. Does Parametric fMRI Analysis with SPM Yield Valid Results? - An Empirical Study of 1484 Rest Datasets. Elsevier; NeuroImage. 2012;61(3):565-578. IFJ>5

Larsson M, Tillisch K, Mayer E, Naliboff B, Ström M, **Engström M,** et al. Do IBS patients without rectal hypersensitivity adapt to repeated aversive rectal distensions? in Neurogastroenterology and motility, vol 24, issue Supplement s2, pp 109-110

Larsson M, Tillisch K, Craig B, **Engström M**, Labus J, Naliboff B, et al. Brain Responses to Visceral Stimuli Reflect Visceral Sensitivity Thresholds in Patients With Irritable Bowel Syndrome. Elsevier; Gastroenterology. 2012;142(3):463- 472.JFJ>5

***M. Magnusson, O. Dahlqvist Leinhard, Helene van Ettinger-Veenstra, P. Lundberg** FMRI using 3D PRESTO-CAN - a novel method based on golden angle hybrid radial- Cartesian sampling of k-space. Proceedings of the ISMRM 20th Annual Meeting & Exhibition, Melbourne, Australia, May 5-11, 2012

2012 Peer-reviewed Review Articles

State-of-the-art of visualization in post-mortem imaging **Claes Lundström, Anders Persson, Steffen Ross,** Patric Ljung**, Stefan Lindholm, Frida Gyllensvärd, Anders Ynnerman,** APMIS (Acta Pathologica, microbiologica et immunologica scandinavia), Vol. 120, No. 4, 2012

M. Felsberg. Adaptive filtering using channel representations. In Mathematical Methods for Signal and Image Analysis and Representation, number 41 in Computational Imaging and Vision, pages 31–48. 2012.

Sengupta PP, Pedrizzetti G, Kilner PJ, Kheradvar A, **Ebbers T**, Tonti G, Fraser AG, Narula J. Emerging Trends in CV Flow Visualization. J Am Coll Cardiol Img. 2012;5:305-316. Number of citations: 3

Tisell A, Dahlqvist Leinhard O,Warntjes JBM, Landtblom A-M, Lundberg P (2012) Brain Atrophy in MS Patients Correlates with Creatine Concentrations. ISMRM, Melbourne, May 2012.

Tisell A, Mellergård J**, Dahlqvist Leinhard** O, Dahle C, Ernerudh J, Vrethem M, **Landtblom A-M, Lundberg P**. Decreased Creatine in NAWM Suggest a Reduced Gliosis in Natalizumab Treated MS Patients. ISMRM, Melbourne May 2012.

Warntjes JBM, Blystad I, Tisell A, Landtblom AM, Lundberg P. Multiparametric Quantitative Magnetic Resonance Imaging of the Normal Appearing Brain in Multiple Sclerosis. ISMRM, Melbourne, May 2012

West J, Aalto A, Warntjes JBM, Dahlqvist Leinhard O, Landtblom A-M, Smedby Ö, Lundberg P. Characterizing Normal Appearing White and Diseased Matter in Multiple Sclerosis Using Quantitative MRI. ISMRM, Melbourne, May 2012.

***Van Ettinger Veenstra H, Gauffin H, Landtblom AM**, McAllister A, **Lundberg P, Karlsson T, Engström M**. Language deficits in epilepsy, an fMRI study. The annual meeting of the organization for human brain mapping, June 10-14 2012, Beijing China.

Engström M, Craig A, Landtblom AM. Mental energy – an fMRI investigation of the anterior insular and the anterior cingulate network. The annual meeting of the organization for human brain mapping, June 10-14 2012, Beijing China.

***Landtblom, AM, Van Ettinger –Veenstra H, Gauffin H,** Ulrici D, McAllister A, **Karlsson T, Engström M.** Reorganization of language in epilepsy. Workshop of Synaptic Plasticity: from bench to bed side 29th sept.- 1st october 2012, Taormina Sicily.

Westin C, Knutsson H. Representation and Estimation of Tensor-Pairs. In: New Developments in the Visualization and Processing of Tensor Fields: Part V. Springer Berlin/Heidelberg; 2012. p. 267-280. Mathematics and Visualization.

Eklund A, Andersson M, Knutsson H. 4D Medical Image Processing with CUDA. In: Nvidia GPU Technology Conference, San Jose, USA, May 14-17,2012.

Eklund A, Andersson M, Knutsson H. A Functional Connectivity Inspired Approach to Non-Local fMRI Analysis. In: Proceedings of the 19th IEEE International Conference on Image Processing (ICIP), 2012: . 19th IEEE International Conference on Image Processing (ICIP), 2012, Sept. 30 2012-Oct. 3, Orlando, FL, USA. IEEE conference proceedings; 2012. p. 1245-1248. Image Processing, 2012.

Forsberg D, Andersson M, Knutsson H. Non-rigid Diffeomorphic Image Registration of Medical Images Using Polynomial Expansion. In: Image Analysis and Recognition: 9th International Conference, ICIAR 2012, Aveiro, Portugal, June 25-27, 2012. Proceedings, Part II. Springer; 2012. 7325p. 304-312. Lecture Notes in Computer Science, 7325.

Forsberg D, Andersson M, Knutsson H. Extending Image Registration Using Polynomial Expansion To Diffeomorphic Deformations. In: SSBA Symposium on Image Analysis, March 8-9, Stockholm, Sweden. 2012.

Khoa Tan Nguyen, Anders Ynnerman, Timo Ropinski: Analyzing and Reducing DTI Fiber Tracking Uncertainty by Combining Different Stochastic Approaches, Poster Presentation at EG Visual Computing for Biology and Medicine - 2012.

Alexander Bock, Norbert Lang, Gianpaolo Evangelista , Ralph Lehrke, **Timo Ropinski:** Supporting Deep Brain Stimulation Interventions by Fusing

Microelectrode Recordings with Imaging Data, Poster Presentation at Visual Computing for Biology and Medicine - 2012.

Bingchen Liu, Alexander Bock, **Timo Ropinski,** Martyn Nash, Poul Nielsen, Burkhard Wuensche: GPU-Accelerated Direct Volume Rendering of Finite Element Data Sets, Proceedings of the 27th Conference on Image and Vision Computing New Zealand, page 109-114 - nov 2012.

Timo Ropinski, Anders Ynnerman, Charl Botha, Jos Roerdink: Eurographics Visual Computing for Biology and Medicine, 2012.

Åsmund Birkeland, Veronika Solteszova, Dieter Hönigmann, Odd Helge Gilja, Svein Brekke, **Timo Ropinski,** Ivan Viola: The Ultrasound Visualization Pipeline-A Survey, arXiv - 2012.

Stefan Diepenbrock, **Timo Ropinski**: From Imprecise User Input to Precise Vessel Segmentations, EG Visual Computing for Biology and Medicine - 2012.

Daniel Jönsson, Erik Sundén, **Anders Ynnerman, Timo Ropinski**: Interactive Volume Rendering with Volumetric Illumination, Eurographics STAR program - 2012.

Timo Ropinski, Stefan Diepenbrock, Stefan Bruckner, Klaus Hinrichs, Eduard Gröller: Unified Boundary-Aware Texturing for Interactive Volume Rendering, IEEE TVCG, Volume 18, Number 11, page 1942-1955 - November 2012.

2011 Peer-reviewed Original Articles

Stenman C, Thorelius L, Knutsson A**, Smedby Ö**. Radiographer-acquired and radiologist-reviewed ultrasound examination – agreement with radiologist's bedside evaluation. Acta Radiologica 2011 Feb 1;52(1):70-4. DOI:10.1258/ar.2010.090260

Malušek A, Ploc O, Kovář I, Brabcová K and Spurný F 2011 Routine individual monitoring of aircraft crew exposure; Czech experience and results 1998–2008 Radiation Protection Dosimetry 144 684 –687

Ploc O, Pachnerová Brabcová K, Spurný F, **Malušek A** and Dachev T Use of energy deposition spectrometer Liulin for individual monitoring of aircrew Radiation Protection Dosimetry 2011. 144 611 –614

*__Claes Lundström__, Thomas Rydell, Camilla Forsell, **Anders Persson,** and **Anders Ynnerman.** Multi--touch table system for medical visualization: Application to orthopedic surgery planning. IEEE Transactions on Visualization and Computer Graphics, 17(12):1775–1784, 2011.

Erik Sundén, **Anders Ynnerman,** and **Timo Ropinski**. Image plane sweep volume illumination. IEEE Transactions on Visualization and Computer Graphics, 17(12):2125–2134, 2011.

*Fredriksson AG, Zajac J, Eriksson **J, Dyverfeldt** P, Bolger AF, **Ebbers T, Carlhäll CJ**. 4D Blood Flow in the Human Right Ventricle. Am J Physiol Heart Circ Physiol 2011;301:H2344-50

*Eriksson J, **Dyverfeldt P, Engvall J**, Bolger AF, **Ebbers T, Carlhäll CJ.** Quantification of Pre-systolic Blood Flow Organization and Energetics in the Human Left Ventricle. Am J Physiol Heart Circ Physiol 2011;300:H2135-41

Dyverfeldt P, Kvitting JP, Carlhäll CJ, Boano G, **Sigfridsson A,** Hermansson U, Bolger AF, **Engvall J, Ebbers T**. Hemodynamic Aspects of Mitral Regurgitation Assessed by Generalized Phase-Contrast Magnetic Resonance Imaging. J Magn Reson Imaging 2011;33:582-88

Forsberg LM, Tamás E, Vánky F, Nielsen NE, **Engvall J, Nylander E**. Left and right ventricular function in aortic stenosis patients 8 weeks post-transcatheter aortic valve implantation or surgical aortic valve replacement. . Eur J Echocardiogr. 2011;12(8):603-11.

*Aneq MÅ, **Nylander E, Ebbers T, Engvall J.** Determination of right ventricular volume and function using multiple axially rotated MRI slices. Clin Physiol Funct Imaging. 2011;31(3):233-9.

Baranowski J, Ahn H, Freter W, Nielsen NE, **Nylander E, Janerot-Sjoberg B, Sandborg M,** Wallby L. Echo-guided presentation of the aortic valve minimises contrast exposure in transcatheter valve recipients. Catheter Cardiovasc Interv. 2011;77(2):272-5.

Lau LS, Pérez MR, Applegate KE, Rehani MM, **Ringertz HG**, George R. Global quality imaging: emerging issues. J Am Coll Radiol. 2011 Jul;8(7):508-12. doi: 10.1016/j.jacr.2010.12.028. PubMed PMID: 21723489.

Bradley WG, Golding SG, Herold CJ, Hricak H, Krestin GP, Lewin JS, Miller JC, **Ringertz HG**, Thrall JH. Globalization of P4 medicine: predictive, personalized, preemptive, and participatory-summary of the proceedings of the Eighth International Symposium of the International Society for Strategic Studies in Radiology, August 27-29, 2009. Radiology. 2011 Feb;258(2):571-82. doi: 10.1148/radiol.10100568. PubMed PMID: 21273521. JIF > 5

Fritzell P, Berg S, Borgström F, Tullberg T, **Tropp H.** Cost effectiveness of disc prosthesis versus lumbar fusion in patients with chronic low back pain: randomized controlled trial with 2-year follow-up. Eur Spine J. 2011 Jul;20(7):1001-11.

Berg S, **Tropp HT**, Leivseth G.Disc height and motion patterns in the lumbar spine in patients operated with total disc replacement or fusion for discogenic back pain. Results from a randomized controlled trial. Spine J. 2011 Nov;11(11):991-8.

Ohrn A, Olai A, Rutberg H, Nilsen P, **Tropp H.** Adverse events in spine surgery in Sweden: a comparison of patient claims data and national quality register (Swespine) data . Acta Orthop. 2011 Dec;82(6):727-31.

Dyverfeldt P , Kvitting JPE, Carlhäll C-J, Boano, **Sigfridsson A,** Hermansson U, Bolger, **Engvall J, Ebbers T**. Hemodynamic Aspects of Mitral Regurgitation Assessed by Generalized Phase-Contrast Magnetic Resonance Imaging. JMRI 2011;33(3):582-588.

*__Haraldsson H, Sigfridsson A__, Sakuma H**,**

Engvall J, and Ebbers T. Influence of the FID and off-resonance effects in dense MRI. Magnetic Resonance in Medicine 2011;65(4):1103-11.

Åström Aneq M, **Nylander E, Ebbers T, Engvall J.** Determination of right ventricular volume and function using multiple axially rotated MRI slices. Clinical Physiology and Functional Imaging 2011;31(3):233-9.

Eriksson J, Dyverfeldt P, Engvall J, Bolger AF, **Ebbers T, Carlhäll CJ**. Quantification of Pre-systolic Blood Flow Organization and Energetics in the Human Left Ventricle. American Journal of Physiology. Heart and circulatory physiology 2011;300(6):H2135-41.

Jennersjö PE, Wijkman M, Wiréhn AB, **Länne T, Engvall J,** Nystrom FH, Ostgren CJ. Circadian blood pressure variation in patients with type 2 diabetes - relationship to macro- and microvascular subclinical organ damage. Prim Care Diabetes. 2011;5(3):167-73.

Forsberg LM, Tamás E, Vánky F, Nielsen NE, **Engvall J, Nylander E**. Left and right ventricular function in aortic stenosis patients eight weeks post transcatheter aortic valve implantation or surgical aortic valve replacement. Eur J Echocardiogr. 2011 Aug;12(8):603-11.

Tengblad A**, Länne T**, **Engvall J,** Nyström F, Östgren CJ. Sagittal Abdominal Diameter and Waist Circumference as Markers of Early Organ Damage In- Patients With Type 2 Diabetes. Journal of Clinical Metabolism & Diabetes. June 2011, 2(1). 1-6.

Aneq MA, Fluur C, Lindvall G, Rehnberg M, Söderkvist P, **Engvall J, Nylander E,** Gunnarsson C. Novel plakophilin2 mutation. Three generation family with arrhythmogenic right ventricular cardiomyopathy. Scand Cardiovasc J. 2011 Oct 28.

Franck N, **Länne T**, Astrand O, **Engvall J,** Lindström T, Ostgren CJ, Nystrom FH. Cardiovascular risk factors related to the PPARγ Pro12Ala polymorphism in patients with type 2 diabetes are gender dependent. Blood Press. 2011;2:122-127.

Richter J, Haj-Hossini N, Andersson-Engels S, **Wårdell K**, Fluorescence spectroscopy measurements in ultrasonic navigated resection of malignant brain tumors. Lasers in Surgery and Medicine, 43(1):8-14, 2011.

Diczfalusy E, Zsigmond P, Dizdar N, Kullman A, Loyd D, **Wårdell K,** A model for simulation and patient-specific visualization of the tissue volume of influence during brain microdialysis. Med Biol Eng Comput. 2011 Dec;49(12):1459-69.

M Warntjes, JI Jönsson**,** K.Uvdal and **M Engström A Hedlund**, M Ahrén, **H Gustafsson**, N Abrikossova**.** Gd2O3 nanoparticles in hematopoietic cells for MRI contrast enhancement. Int J Nanomedicine 2011;6:3233-3240

Quantitative MRI in Isotropic Spatial Resolution for Forensic Soft Tissue Documentation.**C Jackowski, JBM. Warntjes, J Kihlberg**, **J Berge,** MJ Thali, **A Persson**. J. Forensic Sci 2011;56:208--215

Magnetic resonance imaging goes postmortem: noninvasive detection and assessment of myocardial infarction by postmortem MRI. **C Jackowski, JBM Warntjes, J Berge**, W Bär, **A Persson**. Eur Radiol 2011;21:70--78

A. Hedlund, M. Ahrén, **H. Gustafsson**, N. Abrikossova, **M. Warntjes**, J-I Jönsson, K. Uvdal, **M. Engström**. Gd2O3 nanoparticles in hematopoietic cells for MRI contrast enhancement. International Journal of Nano Medicine, 6:1–8, 2011.

*__H. Gustafsson__, M. Ahrén, F. Söderlind, J. Cordoba, P-O Käll, P. Nordblad, P-O Westlund, K. Uvdal, **M. Engström**. Magnetic and Electron Spin Relaxation Properties of (GdxY1-x)2O3 (o ≤ x ≤1) Nanoparticles Synthesized by the Combustion Method. Increased Electron Spin Relaxation Times with Increasing Yttrium Content. Journal of Phyical Chemistry C, 115:5469–5477, 2011.

K Kindberg, C Oom, NB Ingels and **M Karlsson**: Strain Based Estimation of Time Dependent Transmural Cardiac Tissue Architecture in the Ovine Heart, Biomechanics and Modeling in Mechanobiology, Biomech Model Mechanobiol. 2011 Jul;10(4) Number of citations: 2

*H Åstrand, J Stålhand, J Karlsson, **M Karlsson**, B Sonesson and **T Länne**: In vivo estimation of the contribution of elastin and collagen to the mechanical properties in the human abdominal aorta - effect of age and gender, Journal of Applied Physiology, J Appl Physiol. 2011 Jan;110(1) Number of citations: 18

*D Modin, **J Renner, R Gårdhagen, T Ebbers**, **T Länne and M Karlsson**: Evaluation of Aortic Geometries Created by MRI Data in Man, Clin Physiol Funct Imaging. Nov;31(6):485-491, 2011
R Gårdhagen, J Lantz, F Carlsson and **M Karlsson**: Wall Shear Stress in a Stenosed Pipe using Large Eddy Simulation, WSEAS Trans Bio Biomed, vol 8(3):86-101, 2011

J Lantz, J Renner and **M Karlsson**: Wall Shear Stress in a Subject Specific Human Aorta - Influence of Fluid-Structure Interaction, Int J Appl Mech, vol 3(4):759-778, 2011, Number of citations: 5

Jasek Baranowski, H Ahn, W Freter, Nils Eric Nielsen**, Eva Nylander, Birgitta Janerot Sjöberg, Michael Sandborg** and Lars Wallby, Echo-guided presentation of the aortic valve minimises contrast exposure in transcatheter valve recipients, Catheterization and Cardiovascular Interventions, 2011, (77), 2, 272-275

Jakob De Geer, Michael Sandborg, Örjan Smedby and Anders Persson. The efficacy of 2D, non-linear noise reduction filtering in cardiac imaging: a Pilot study. Acta Radiologica 2011; 52: 716–722

Kechagias S, Zanjani S, Gjellan S, **Dahlqvist Leinhard O, Kihlberg J, Smedby Ö**, Johansson L, Kullberg J, Ahlström H, Lindström T, Nyström FH. Effects of moderate red wine consumption on liver fat and blood lipids: A prospective randomized study. Annals of Medicine. Volume 43, Issue 7, November 2011, Pages 545-554. (JIF: 5.1, GS: 9, ISI: 2) JIF>5

*__Romu T, Borga M, Dahlqvist Leinhard O__. MANA – Multi Scale Adaptive Normalized Averaging. In proceedings of the 8th International Symposium on Biomedical Imaging (ISBI'11), Chicago, USA, 2011. (JIF: N/A, GS: 4, ISI: 1)

Lundin F, **Tisell A, Dahlqvist Leinhard O**, Tullberg M, Wikkelsö C, **Lundberg P**, Leijon G. Reduced Thalamic NAA in Idiopathic Normal Pressure Hydrocephalus A Controlled 1H -MRS Study of Frontal Deep White Matter. Journal of Neurology, Neurosurgery & Psychiatry. 82 (7), pp. 772-778, 2011. (JIF: 5, GS: 11, ISI: 6) JIF>5

West, J, Warntjes, M, Lundberg P (2011) Novel Whole Brain Segmentation and Volume Estimation Using Quantitative MRI, Eur Radiol. 2012 May;22(5):998- 1007. doi: 10.1007/s00330-011-2336-7. Epub 2011 Nov 24. Number of citations: 8

Van Ettinger-Veenstra HM, Ragnehed M, McAllister A, **Lundberg P, Engström M**. (2012) Right-hemi-

spheric cortical contributions to language ability in healthy adults. Brain Lang. 2012 Mar;120(3):395-400. doi: 10.1016/j.bandl.2011.10.002. Epub 2011 Nov 23. Number of citations: 7

Larsson, M.B.O., Tillisch, K, Craig, A.D., **Engström, M.,** Labus, J., Naliboff, B., **Lundberg, P**., Ström, M., Mayer, E.A., **Walter, S.A**. Brain responses to visceral stimuli reflect visceral sensitivity thresholds in patients with irritable bowel syndrome, Gastroenterology. 2012 Mar;142(3):463-472.e3. doi: 10.1053/j.gastro.2011.11.022. Epub 2011 Nov 19. Number of citations: 15 JIF > 5

Lundin F, Tisell A, Dahlqvist Leinhard O, Tullberg M, Wikkelsö C, **Lundberg P,** Leijon G (2011) Reduced thalamic N-acetylaspartate in idiopathic normal pressure hydrocephalus: a controlled 1H-magnetic resonance spectroscopy study of frontal deep white matter and the thalamus using absolute quantification. J Neurol Neurosurg Psychiatry. 2011 Jul;82(7):772-8. Epub 2011 Jan 8. Number of citations: 8 JIF > 5

Dyverfeldt P, Kvitting JPE, Carlhäll CJ, Boano G, **Sigfridsson A,** Hermansson U, Bolger AF, **Engvall J, Ebbers T.** Hemodynamic Aspects of Mitral Regurgitation Assessed by Generalized Phase-Contrast Magnetic Resonance Imaging. J Magn Reson Imaging 2011;33:582-588.

***Dyverfeldt P, Sigfridsson A, Knutsson H, Ebbers T.** A Novel MRI Framework for the Quantification of Any Moment of Arbitrary Velocity Distributions. Magnetic Resonance in Medicine 2011;65:725-731.

Eriksson J, Dyverfeldt P, Engvall J, Bolger AF, **Ebbers T, Carlhäll CJ.** Quantification of presystolic blood flow organization and energetics in the human left ventricle. Am J Physiol Heart Circ Physiol 2011;300:H2135-H2141.

Sigovan M, Hope MD, **Dyverfeldt P,** Saloner D. Comparison of 4D Flow Parameters for Quantification of Flow Eccentricity in the Ascending Aorta. J Magn Reson Imaging 2011;34:1226-1230.

Fredriksson AG, Zajac J, **Eriksson J**, **Dyverfeldt P**, Bolger AF, **Ebbers T, Carlhäll CJ.** 4D Blood Flow in the Human Right Ventricle. Am J Physiol Heart Circ Physiol 2011; 301(6):H2344-50.

Carme Julià, **Rodrigo Moreno**, Domenec Puig, Miguel Angel Garcia. Shape-Based Image Segmentation Through Photometric Stereo. Computer Vision and Image Understanding, 115(1), pp. 91–104, 2011. DOI:10.1016/j.cviu.2010.09.009. IF: 1.232, Quartile: 2.

Rodrigo Moreno, Miguel Angel Garcia, Domenec Puig, Carme Julià. Edge- Preserving Color Image Denoising Through Tensor Voting. Computer Vision and Image Understanding, 115(11), 1536–1551, 2011. DOI:10.1016/j.cviu.2011.07.005. IF: 1.232, Quartile: 2.

Rodrigo Moreno, Miguel Angel Garcia, Domenec Puig, Luis Pizarro, Bernhard Burgeth, Joachim Weickert. On Improving the Efficiency of Tensor Voting. IEEE Transactions on Pattern Analysis and Machine Intelligence, 33(11), pp. 2215– 2228, 2011. DOI:10.1109/TPAMI.2011.23. IF: 4.795, Quartile 1.

Fredriksson AG, Zajac J, **Eriksson J, Dyverfeldt P,** Bolger AF, **Ebbers T, Carlhäll C**J. 4-D Blood Flow in the Human Right Ventricle. Am J Physiol Heart Circ Physiol 2011;301:H2344-H2350.

*Modin D, **Renner J, Gårdhagen R, Ebbers T, L**änne **T, Karlsson M**. Evaluation of Aortic Geometries created by MRI Data in Healthy Volunteers. Clinical Physiology and Functional Imaging 2011;31, pp485–491.

Eriksson J, Dyverfeldt P, Engvall J, Bolger AF, **Ebbers T, Carlhäll CJ.** Quantification of presystolic blood flow organization and energetics in the human left ventricle. Am J Physiol Heart Circ Physiol 2011;300:H2135-H2141.

Åström Aneq M, **Nylander E, Ebbers T, Engvall J.** Determination of right ventricular volume and function using multiple axially rotated MRI slices. Clinical Physiology and functional imaging 2011.

Rolf MP, Hofman MBM, Gatehouse PD, Bloch KM, Heymans MW, **Ebbers T,** Graves M J, Totman JJ, Werner B, Rossum ACV, Kilner PJ, Heethaar RM. Sequence optimization to reduce velocity offsets in cardiovascular magnetic resonance volume flow quantification - A multi-vendor study. J Cardiovasc Magn Reson. 2011, 13:18

***Haraldsson H, Sigfridsson A**, Sakuma H, **Engvall J, Ebbers T.** Influence of the FID and Off-resonance Effects in DENSE MRI. Magnetic Resonance in Medicine 2011;65:1104-1112.

***Dyverfeldt P, Sigfridsson A, Knutsson H, Ebbers T.** A Novel MRI Framework for the Quantification of Any Moment of Arbitrary Velocity Distributions. Magnetic Resonance in Medicine 2011;65:725-731.

Dyverfeldt P, Kvitting JPE, Carlhäll CJ, Boano G, **Sigfridsson A,** Hermansson U, Bolger AF, Engvall J, Ebbers T. Hemodynamic Aspects of Mitral Regurgitation Assessed by Generalized Phase-Contrast Magnetic Resonance Imaging. J Magn Reson Imaging 2011;33:582-588.

***Sigfridsson A, Haraldsson H, Ebbers T, Knutsson H,** Sakuma H. In-vivo SNR in DENSE MRI; temporal and regional effects of field strength, receiver coil sensitivity, and flip angle strategies. Magn Reson Imaging 2011; 29, pp. 202-208.

Impaired abdominal aortic wall integrity in elderly men carrying the angiotensin-converting enzyme D Allele. Ljungberg L, **De Basso R**, Alehagen U, **Björck H,** Persson K, Dahlström U, **Länne T**. Eur J Vasc Endovasc Surg 2011; 42(3): 309-16.

Circadian blood pressue variation in patients with type 2 diabetes – relationship to macro- and microvascular subclinical organ damage. Jennersjö P, Wijkman M, Wiréhn AB, **Länne T, Engvall J**, Nyström FH, Östgren CJ. Prim Care Diab 2011(5):167-173.

Gender-specific association of the plasminogen activator inhibitor-1 4G/5G polymorphism with central arterial blood pressure. **Björck H,** Eriksson P, Alehagen U, Ljungberg L, **DeBasso R,** Persson K, Dahlström U, **Länne T**. Am J Hypertension 2011; 24(7): 802-8.

Zebrafish models to study hypoxia-induced pathological angiogenesis in malignant and nonmalignant diseases. Jensen L, Pegah R, Cao Z, **Länne T**, Wahlberg E and Cao Y. Birth Defects Research 2011; 93(2): 182-193.

Impaired compensatory response to hypovolemic circulatory stress in type 1 diabetes mellitus. **M. Lindenberger**, H. Olsen, T. **Länne.** Diab Vasc Dis Res 2011, 136-142.

Diameter and compliance of the greater saphenous vein - effect of age and nitroglycerin. **Zachrisson H, Lindenberger M**, Hallman D, Ekman M, Neider D **Länne T.** Clin Physiol and Funct Im 2011; 31(4): 300-6.

The association between circulating angiotensin-converting enzyme and cardiovascular risk in the

elderly – a cross-sectional study. Ljungberg L, Alehagen U; **Länne T,** Björck H, De Basso R, Dahlström U, Persson K. J Renin-Angiotensin- Aldosterone System. 2011; 12(3): 281-9.

*In-vivo estimation of the contribution of elastin and collagen to the mechanical properties in the human abdominal aorta: effect of age and sex. Åstrand H, Stålhand J, Karlsson J, **Karlsson M**, Sonesson B, **Länne T.** J Appl Physiol, 2011;110, 176-187.

Carlsson Tedgren Å, Hedman A, Grindborg J-E and **Alm Carlsson G** 2011 Response of LiF:Mg,Ti thermoluminescent dosimeters (TLDs) at photon energies relevant to the dosimetry of brachytherapy (< 1MeV) Med. Phys. 38 5539-50

De Geer J, **Smedby Ö, Sandborg M, Persson A**. The efficacy of 2D, non-linear noise reduction filtering in cardiac imaging: a pilot study. Acta Radiologica 2011 Sep 1;52(7):716-22. DOI:10.1258/ar.2011.100511

Kechagias S, Zanjani S, Gjellan S, **Dahlqvist Leinhard O, Kihlberg J, Smedby Ö**, Johansson L, Kullberg J, Ahlström H, Lindström T, Nyström FH. Effects of moderate red wine consumption on liver fat and blood lipids: a prospective randomized study. Annals of Medicine 2011;43(7):545-554. DOI: 10.3109/07853890.2011.588246 JIF > 5

Dahlqvist Leinhard O, Dahlström N, Kihlberg J, Sandström P, Brismar TB, **Smedby Ö, Lundberg.** Quantifying differences in hepatic uptake of the liver specific contrast agents Gd-EOB-DTPA and Gd-BOPTA: a pilot study. European Radiology 2011;22(3);642-653. DOI:10.1007/s00330-011-2302-4

Borgen L, **Kalra MK,** Lærum F, Hachette IW, Fredriksson CH, **Sandborg M, Smedby Ö.** Application of adaptive nonlinear 2D and 3D post-processing filters on reduced dose abdominal CT. Acta Radiologica 2012;53:335–342. DOI:10.1258/ar.2011.110563

Jackowski C, Warntjes M, Berge J, Bär W, **Persson A**. Magnetic resonance imaging goes postmortem: noninvasive detection and assessment of myocardial infarction by postmortem MRI. European Radiology. 2011;Jan;21(1):70-78. Number of citations: 25

Jackowski C, Warntjes M, Kihlberg J, Berge J, Thali M, **Persson A.** Quantitative MRI in Isotropic Spatial Resolution for Forensic Soft Tissue Documentation. Why and How? Blackwell; Journal of Forensic Sciences. 2011;56(1):208-215. Number of citations: 3

Persson A, Lindblom M**, Jackowski C.** A state-of-the-art pipeline for postmortem CT and MRI visualization: from data acquisition to interactive image interpretation at autopsy. United Kingdom: Informa Healthcare; Acta Radiologica. 2011; 52 no. 5 522-536. Number of citations: 8

De Geer J, Sandborg M, **Smedby Ö, Persson A**. The efficacy of 2-D, non-linear noise reduction filtering in cardiac imaging: a pilot study. Acta Radiologica. 2011;(52,7, 716-722). Number of citations: 7

***Lundström C, Persson A**. Characterizing visual analytics in diagnostic imaging. Visual Analytics. 2011. pp. 1-4. Number of citations: 2

***Lundström C,** Rydell T, Forsell C, **Persson A, Ynnerman** A. Multi-Touch Table System for Medical Visualization: Application to Orthopedic Surgery Planning. Visualization and Computer Graphics, IEEE Transactions. 2011;17, 1775 – 1784. Number of citations : 10

Landtblom AM, Lindehammar H, **Karlsson H**, **Craig AD**. Insular cortex activation in a patient with "sensed presence"/ecstatic seizures. Epilepsy Behav 2011;20(4):714-8.

Hypoxia-induced metastasis model in embryonic zebrafish. Rouhi P, Jensen LD, Cao Z, Hosaka K, **Länne T**, Wahlberg E, Steffen JF, Cao Y. Nature Protoc 2010;Dec 5(12):1911-8. JIF>5

2011 Peer-reviewed Proceedings

***M. Magnusson, O. Dahlqvist Leinhard, and P. Lundberg** A 3D-plus-time radial-Cartesian hybrid sampling of k-space with high temporal resolution and maintained image quality for MRI and fMRI Proceedings of the ISMRM 19th Annual Meeting & Exhibition, Montréal, Québec, Canada, May 7-13, 2011

***M. Magnusson, A. Malušek,** A. Muhammad and **G. Alm Carlsson** Determination of Quantitative Tissue Composition by Iterative Reconstruction on 3D DECT Volumes Proceedings of the 11th International Meeting on Fully Three- Dimensional Image Reconstruction in Radiology and Nuclear Medicine, Potsdam, Germany, July 11-15, 2011

***M. Magnusson, A. Malušek,** A. Muhammad and **G. Alm Carlsson** Iterative Reconstruction for Quantitative Tissue Decomposition in Dual-Energy CT Proceedings of SCIA 2011, Scandinavian Conference on Image Analysis, Ystad Saltsjöbad, Sweden, 23-27 May, 2011

*G. Ahlman**, M. Magnusson, O. Dahlqvist Leinhard,** and **Peter Lundberg** Increased temporal resolution in radial-Cartesian sampling of k-space by implementation of parallel imaging ESMRMB 2011, 28th Annual Scientific Meeting, Leipzig, Germany, October 6-8, 2011

***A. Karlsson, M. Magnusson, O. Dahlqvist Leinhard,** and **Peter Lundberg** Successful Motion Correction in Reconstruction of Radial MRI ESMRMB 2011, 28th Annual Scientific Meeting, Leipzig, Germany, October 6-8, 2011

***Magnusson M, Malusek A**, Muhammad A and **Alm Carlsson G** 2011 Iterative Reconstruction for Quantitative Tissue Decomposition in Dual-Energy CT, SCIA, Ystad May 2011, Image Analysis vol 6688, ed A Heyden and F Kahl (Berlin, Heidelberg: Springer Berlin Heidelberg) pp 479–88

***Magnusson M, Malusek** A, Muhammad A and **Alm Carlsson G** 2011 Determination of Quantitative Tissue Composition by Iterative Reconstsruction on 3D DECT Volumes. Fully 3D, Potsdam July 2011

M. Felsberg. Autocorrelation-driven diffusion

filtering. IEEE Transactions on Image Processing, 20(7):1797–1806, 2011.

Magnus Axholt, Martin A. Skoglund, Stephen D. O'Connell, Matthew D. Cooper, Stephen R. Ellis, and **Anders Ynnerman**. Accuracy of eyepoint estimation in optical see-through headmounted displays using the single point active alignment method. In IEEE Virtual Reality Conference 2012, 2011.

Magnus Axholt, Martin Skoglund, Stephen O'Connell, Matthew Cooper, Stephen Ellis, and **Anders Ynnerman**. Parameter estimation variance of the single point active alignment method in optical see-through head mounted display calibration. In Proceedings of the IEEE Virtual Reality Conference, IEEE Virtual Reality Conference, pages 27–24. IEEE, 2011.

Model-based transfer functions for efficient visualization of medical image volumes **Daniel Forsberg, Claes Lundström, Mats Andersson, Hans Knutsson**, Scandinavian Conference on Image Analysis, 2011.

Eklund, D. Forsberg, M. Andersson, and H. Knutsson, "Using the local phase of the magnitude of the local structure tensor for image registration," in Image analysis, Springer, 2011, vol. 6688, pp. 414-423.

D. Forsberg, C. Lundström, M. Andersson, and H. Knutsson, "Model-based transfer functions for efficient visualization of medical image volumes," in Image analysis, Springer, 2011, vol. 6688, pp. 592-603.

D. Forsberg, Y. Rathi, S. Bouix, D. Wassermann, **H. Knutsson**, and C. F. Westin, "Improving registration using multi-channel diffeomorphic demons combined with certainty maps," in Multimodal brain image analysis, Springer, 2011, vol. 7012, pp. 19-26.

D. Forsberg, A. Eklund, M. Andersson, and H. Knutsson, "Phase-based non-rigid 3D image registration: from minutes to seconds using CUDA," in Joint miccai workshop on high performance and distributed computing for medical imaging, 2011

Svalkvist A, **Ullman G**, Håkansson M, Dance DR, **Sandborg M, Alm Carlsson G**, Båth M (2011) Investigation of the effect of varying scatter-to-primary ratios on nodule contrast in chest tomosynthesis. In: Proc. SPIE Medical Imaging, Vol 7961, 79615Y.-79615Y.10

*__Magnusson M, Malusek A__, Muhammad A and **Alm Carlsson G** (2011). Iterative Reconstruction for Quantitative Tissue Decomposition in Dual-Energy CT. In: Proceedings of the 17th Scandinavian Conference on Image Analysis (SCIA), pp 479-488, Springer 2011 (ISBN: 978-3-642-21226-0)

*__Magnusson M, Malusek__ A, Muhammad A and **Alm Carlsson G** (2011), Determination of Quantitative Tissue Composition by Iterative Reconstruction on 3D DECT Volumes. In: Proceedings of the 11th International Meeting on Fully Three-Dimensional Image Reconstruction in Radiology and Nuclear Medicine, pp 120-123. Available at http://www.fully3d.org/

*__Rodrigo Moreno, Magnus Borga, Örjan Smedby__, "Soft classification of trabeculae in trabecular bone", Biomedical Imaging: From Nano to Macro, 2011, International Symposium on Biomedical Imaging. Proceedings, 1641-1644, 2011.

*__Thobias Romu, Magnus Borga, Olof Dahlqvist Leinhard__, "MANA - Multi scale adaptive normalized averaging", 2011 IEEE International Symposium on Biomedical Imaging: From Nano to Macro, International Symposium on Biomedical Imaging. Proceedings, 361-364, 2011.

K. Tillisch, **M.B.O. Larsson**, L.A. Kilpatrick, **M. Engström**, B.D. Naliboff, **P. Lundberg**, **S.A. Walter**, E.A. Mayer. Women with irritable bowel syndrome (IBS) show altered default mode network connectivity. Gastroenterology 2011;140(5 Suppl 1):S-364.

M Andersson, J Lantz and **M Karlsson**: Modeling of Subject Arterial Segments Using 3D Fluid Structure Interaction and 1D-0D Arterial Tree Network Boundary Condition The 6th international symposium on biomechanics in vascular biology and cardiovascular disease 2011

J Lantz and **M Karlsson**: Resolving Low-Density Lipoprotein (LDL) on the Human Aortic Surface Using Large Eddy Simulation 64th Annual Meeting of the APS Division of Fluid Dynamics 2011

J Lantz, **J Renner** and **M Karlsson**: Estimation of Wall Shear Stress in a Human Aorta Using Fluid-Structure Interaction The 6th international symposium on biomechanics in vascular biology and cardiovascular disease, 2011

Angelica Svalkvist, **Gustaf Ullman,** Markus Håkansson, David R. Dance, **Michael Sandborg, Gudrun Alm Carlsson,** Magnus Båth Investigation of the effect of varying scatter-to-primary ratios on nodule contrast in chest tomosynthesis. Proc. SPIE Medical Imaging 2011.

Sandborg M, Rossitti S, Pettersson H and Nilsson Althen J. Patient organ radiation doses during treatment for aneurismal subarachnoid hemorrhage. Accepted (NSFS 2011 Reykjavik)

Dahlström N, Dahlqvist Leinhard O, Sandström P, **Kihlberg J,** Brismar T**, Lundberg P, Smedby Ö**. Quantified hepatobiliary Gd-EOB-DTPA uptake rate reflects hepatobiliary function in patients. Radiological Society of North America, RSNA, Chicago 2011. [Oral Scientific Presentation]

Dahlström N, Kalra MK, Quick P, Persson A. Dual-Energy CT: Uncovering and Troubleshooting New Pitfalls and Artefacts. Educational Exhibit. RSNA 2011. Awarded Certificate of Merit.

Forsgren M, Dahlqvist Leinhard O, Cedersund G, **Dahlström N, Smedby Ö**, Brismar T, **Lundberg P**. The First Human Whole Body Pharmacokinetic Minimal Model for the Liver Specific Contrast Agent Gd-EOB-DTPA. ISMRM, Montreal 2011.

*__Romu T, Dahlqvist Leinhard O, Forsgren M__, Almer S**, Dahlström N,** Kechagias S, Nyström F, **Smedby Ö, Lundberg P, Borga M**. Fat Water Classification of Symmetrically Sampled Two-Point Dixon Images Using Biased Partial Volume Effects. ISMRM, Montreal 2011.

Sigovan M, Rayz V, **Dyverfeldt P,** Gasper W, Owens C, Saloner D. MRI assessment of the arterio-venous fistula. 19th Int. Soc. Magn. Reson. Med. Montreal, Canada; 2011.

Dyverfeldt P, Acevedo-Bolton G, Martin AJ, Saloner D. 3D Cine Phase-Contrast MRI of Flow Patterns and Turbulent Kinetic Energy in Patient-Specific Models of Carotid Disease under In Vivo Mimicking Flow Conditions. 19th Int. Soc. Magn. Reson. Med. Montreal, Canada; 2011.

Liu J, **Dyverfeldt P**, Saloner D. Accelerated Flow Imaging using Homotopic L0 Minimization. 23rd Annual Meeting of the International MRA Club. Banff, Canada; 2011.

*__van Ettinger-Veenstra, H., Karlsson, T.,__ Ulrici, D., Gauffin, H., **Landtblom, AM., & Engström, M**. (2011). Neural language processing in healthy and epilepsy

subjects. Paper presented at the 43rd Annual General Meeting of the European Brain and Behaviour Society; Seville, September 9-12.

*__Engström, M__., Flensner, G., __Landtblom, AM__., Ek, A.-C., & __Karlsson, T.__ (2011). Fatigue and cognitive effort in multiple sclerosis: an fMRI study. Paper presented at the 43rd Annual General Meeting of the European Brain and Behaviour Society; Seville, September 9-12.

*__Wang C,__ Frimmel H__, Smedby Ö.__ Level-set based vessel segmentation accelerated with periodic monotonic speed function. Proc. SPIE 7962, 79621M (2011); DOI:10.1117/12.876704

*__Moreno R, Smedby Ö, Borga__, M. Soft classification of trabeculae in trabecular bone. IEEE International Symposium on Biomedical Imaging: From Nano to Macro, 2011;1641-1644. DOI:10.1109/ISBI.2011.5872718

__C Jackowski__, MD, N Schwendener; __A Persson.__ Unenhanced Postmortem 3 T MRI to Visualize Myocardial Infarction prior to Autopsy. In proceedings of RSNA 2011.

__N Dahlstrom, M K Kalra, MD; P Quick; A Persson__. Dual-Energy CT: Uncovering and Troubleshooting New Pitfalls and Artefacts. In proceedings of RSNA 2011.

__Persson A__. Vitual Autopsy. 2nd Word Congress in Forensic Science. Chunquing, China, 2011, Oct 16.

__Persson A__. Postmortem Imaging, 1st Annual Symposium on Radiation Safety in CT. Mass General Hospital. Boston, 2011, Oct. 1.

__Persson A__. Postmortem Radiology, Annual Meeting German Association for criminalistics Munster. 2011, April 11.

__Persson A,__ Clinical application of image processing. European Congress of Radiology. 2011, March 6.

P. Liss, P. Hansell, A. Fasching, L-O. Magnusson, P. Quick, __F. Palm, A. Persson__. Evaluation of regional renal hemodynamics using dual source computed tomography. European Congress of Radiology. 2011 March 6.

__J Engvall__, __M Gjerde, J de Geer,__ E Olsson, __P Quick, A Persson__. Adenosine stress myocardial perfusion detected with CT compared with attenuation-corrected SPECT in EUROPEAN HEART JOURNAL SUPPLEMENTS, 2011; vol 13, issue A, pp A31-A31

*__Landtblom AM__, Lindehammar H, Karlsson H__, Craig AD__. Insular cortex activation in a patient with "sensed presence"/ecstatic seizures. Epilepsy Behav 2011;20(4):714-8.

__Eklund A, Andersson M, Knutsson H.__ Fast Random Permutation Tests Enable Objective Evaluation of Methods for Single Subject fMRI Analysis. Hindawi Publishing Corporation; International Journal of Biomedical Imaging. 2011;

__Eklund A, Andersson M, Knutsson H.__ True 4D Image Denoising on the GPU. Hindawi Publishing Corporation; International Journal of Biomedical Imaging. 2011;2011

__*Dyverfeldt P, Sigfridsson A, Knutsson H, Ebbers T.__ A novel MRI framework for the quantification of any moment of arbitrary velocity distributions. John Wiley and Sons, Ltd; Magnetic Resonance in Medicine. 2011;65(3):725-731.

__*Sigfridsson A, Haraldsson H, Ebbers T, Knutsson H__, Sakuma H. In vivo SNR in DENSE MRI: temporal and regional effects of field strength, receiver coil sensitivity, and flip angle strategies. Elsevier; Magnetic Resonance Imaging. 2011;29(2):202-208.

2011 Peer-reviewed Review Articles

__Larsson M__, Sjöberg M, __Craig A D, Engström M,__ Labus J, Mayer E A, et al. Brain Response to Expectation and Delivery of Rectal Distensions Before and After Hypnotherapy and Education Intervention in Irritable Bowel Syndrome (IBS) : an fMRI Study.

UEGW 2011, Stockholm, 22-26 October. 2011.
Lau LS, Pérez MR, Applegate KE, Rehani MM, __Ringertz HG,__ George R.: Global quality imaging: improvement actions. J Am Coll Radiol. 2011; (8) 330-334.

Lau LS, Pérez MR, Applegate KE, Rehani MM, __Ringertz HG__, George R.: Global quality imaging: emerging issues. J Am Coll Radiol. 2011; (8) 508-512.

Markl M, Kilner PJ, and __Ebbers T__. Comprehensive 4D velocity mapping of the heart and great vessels by cardiovascular magnetic resonance. J Cardiovasc Magn Reson. 2011; 13(1): 7. Number of citations: 42

__Ebbers T__. Flow Imaging: Cardiac Applications of 3D Cine Phase-Contrast MRI. Current Cardiovascular Imaging Reports, 2011; 4:127–133. Ebbers T. Flow Imaging: Cardiac Applications of 3D Cine Phase-Contrast MRI. Number of citations: 3

__*Warntjes M., Tisell, A., West, J., Landtblom, A-M, Lundberg, P__. Fully Automatic Brain Tissue Mapping on Multiple Sclerosis Based on Quantitative MRI, (RSNA 2011, Chicago, USA)

__*Tisell, A.,__ Mellergård, J., __Dahlqvist Leinhard, O__., Dahle, C., Ernerudh, J., Vrethem, M., __Landtblom, AM., Lundberg, P.__ Increased Glia in Multiple Sclerosis Patients Correlates with Intrathecal Inflammation (ESMRMB 2011, Leipzig, Germany).

__*Tisell, A.,__ Mellergård, J__., Dahlqvist Leinhard, O__., Dahle, C., Ernerudh, J., Vrethem, M., __Landtblom, AM., Lundberg, P__. Multiple Sclerosis Severity Score (MSSS) Correlates With Changes in NAWM Metabolism During Treatment (ESMRMB 2011, Leipzig, Germany).

__*Warntjes, M., West, J., Dahlqvist-Leinhard, O__., Helms, G__., Landtblom, A.M., Lundberg, P__. Using multi--parametric quantitative MRI to model myelin in the brain (ISMRM 2011, Montreal, Canada)

__*Warntjes, M., West, J., Dahlqvist-Leinhard, O.,__ Helms, G__., Landtblom, AM., Lundberg, P__.Estimation of total myelin volume in the brain (ISMRM 2011, Montreal, Canada)

__*Dahlqvist Leinhard, O.,__ Jaworski, J., __Aalto, A., Grönqvist, A., Tisell, A., Smedby, Ö., Landtblom, AM., Lundberg, P.__ Is Increased normal White Matter Glutamate Concentrations a Precursor of Gliosis and Disease Progression in

Multiple Sclerosis? (ISMRM 2011, Montreal, Canada)

Engström M, Flensner G, **Landtblom AM,** Ek AC, and **Karlsson T**. Fatigue and cognitive effort in multiple sclerosis: an fMRI study. (Brain & Cognition, Seville, Spain, 2011)

***Engström M,** Flensner G, Ek AC, **Landtblom AM** and **Karlsson T.** Aberrant brain activation in the core control network for cognitive function in MS. (RSNA, Chicago, USA, 2011)

Eklund A, Andersson M, Knutsson H. Improving CCA based fMRI Analysis by Covariance Pooling - Using the GPU for Statistical Inference. In: Joint MICCAI Workshop on High Performance and Distributed Computing for Medical Imaging, HP-MICCAI, September 22nd, 2011, Toronto, Canada. 2011.

Eklund A, Friman O**, Andersson M, Knutsson H.** A GPU accelerated interactive interface for exploratory functional connectivity analysis of FMRI data. In: Image Processing (ICIP), 2011: 18th IEEE International Conference on Image Processing (ICIP 2011), 11-14 September 2011, Brussels, Belgium. IEEE; 2011. p. 1589-1592. International Conference on Image Processing. Proceedings.

Eklund A, Friman O**, Andersson M, Knutsson H.** Comparing fMRI Activity Maps from GLM and CCA at the Same Significance Level by Fast Random Permutation Tests on the GPU. In: SSBA Symposium on Image Analysis, March 17-18, Linköping, Sweden. Linköping: Linköping University Electronic Press; 2011.

Knutsson H, Westin C**, Andersson M.** Representing local structure using tensors II. In: Proceedings of the 17th Scandinavian conference on Image analysis: . SCIA'11. Springer; 2011. p. 545-556.

***Dyverfeldt P, Sigfridsson A, Knutsson H, Ebbers T**. MR flow imaging beyond the mean velocity: Estimation of the skew and kurtosis of intravoxel velocity distributions. In: ISMRM 2011: ISMRM 19th Annual Meeting & Exhibition,7-13 May 2011, Montréal, Québec, Canada. International Society for Magnetic Resonance in Medicine (ISMRM); 2011.

Eklund A, Forsberg D, Andersson M, Knutsson H. Using the Local Phase of the Magnitude of the Local Structure Tensor for Image Registration. In: Image Analysis:17th Scandinavian Conference, SCIA 2011, Ystad, Sweden, May 2011. Proceedings. Image Analysis 17th Scandinavian Conference, SCIA 2011, Ystad, Sweden, May 2011. Springer Berlin/Heidelberg; 2011. 6688p. 414-423. Lecture Notes in Computer Science, 6688/2011.

***Forsberg D, Lundström C, Andersson M, Knutsson H.** Model-Based Transfer Functions for Efficient Visualization of Medical Image Volumes. In: 17th Scandinavian Conference, SCIA 2011, Ystad, Sweden, May 2011. Proceedings: 17th Scandinavian Conference on Image Analysis, SCIA 2011, Ystad, Sweden, May 2011. Heidelberg: Springer Berlin; 2011. 6688/2011p. 592-603. Lecture Notes in Computer Science, 6688.

***Forsberg D, Eklund A, Andersson M, Knutsson H.** Non-Rigid Volume Registration - A CUDA-based GPU Implementation of the Morphon. In: SSBA Symposium on Image Analysis, March 17-18, Linköping, Sweden. 2011.

***Forsberg D, Eklund A, Andersson M, Knutsson H.** Phase-Based Non-Rigid 3D Image Registration - From Minutes to Seconds Using CUDA. In: Joint MICCAI Workshop on High Performance and Distributed Computing for Medical Imaging, HP-MICCAI, September 22nd, Toronto, Canada. 2011.

Forsberg D, Rathi Y, Bouix S, Wassermann D, **Knutsson H,** Westin C**.** Improving Registration Using Multi-channel Diffeomorphic Demons Combined with Certainty Maps. In: Mulitmodal Brain Image Analysis: First International Workshop, MBIA 2011, Held in Conjunction with MICCAI 2011, Toronto, Canada, September 18, 2011, Proceedings. Springer Berlin/Heidelberg; 2011. 7012/2011p. 19-26. Lecture Notes in Computer Science, 7012.

Erik Sundén, **Anders Ynnerman, Timo Ropinski**: Image Plane Sweep Volume Illumination, IEEE TVCG(Vis Proceedings), Volume 17, Number 12, page 2125-2134 - December 2011.

Florian Lindemann, **Timo Ropinski**: About the Influence of Illumination Models on Image Comprehension in Direct Volume Rendering, IEEE TVCG(Vis Proceedings), Volume 17, Number 12, page 1922-1931 - December 2011.

Jörg Mensmann, **Timo Ropinski**, Klaus Hinrichs: Slab-Based Raycasting: Exploiting GPU Computing for Volume Visualization, Springer Communications in Computer and Information Science (CCIS), Volume 229, page 246--259 - 2011.

Stefan Diepenbrock, Jörg-Stefan Praßni, Florian Lindemann, Hans-Werner Bothe, **Timo Ropinski:** 2010 IEEE Visualization Contest Winner: Interactive Planning for Brain Tumor Resections, IEEE Computer Graphics and Applications - 2011.

Stefan Diepenbrock, Jörg-Stefan Praßni, Florian Lindemann, Hans-Werner Bothe, **Timo Ropinski:** Interactive Visualization Techniques for Neurosurgery Planning, Eurographics (Short Papers) - 2011.

Timo Ropinski, Steffen Oeltze, Bernhard Preim: Survey of Glyph-based Visualization Techniques for Spatial Multivariate Medical Data, Computers & Graphics - 2011.

Stefan Diepenbrock, **Timo Ropinski**, Klaus Hinrichs: Context-Aware Volume Navigation, IEEE Pacific Visualization - 2011.

2010 Peer-reviewed Original Articles

***Eriksson J**, **Carlhäll CJ, Dyverfeldt P, Engvall J,** Bolger AF, **Ebbers T.** Semi-Automatic Quantification of 4D Left Ventricular Blood Flow. J Cardiovasc Magn Reson 2010;12(1):9

***Stefan Lindholm,** Patric Ljung**, Claes Lundström, Anders Persson,** and **Anders Ynnerman.** Spatial conditioning of transfer functions using local material distributions. IEEE Transactions on Visualization and Computer Graphics, 2010.

Joel Kronander, Jonas Unger, Torsten Moeller, and **Anders Ynnerman**. Estimation and modeling of actual numerical errors in volume rendering. Computer Graphics Forum, 29(3):893–902, 2010.

Frida Hernell, Patric Ljung**,** and **Anders Ynnerman**. Local ambient occlusion in direct volume rendering. IEEE Transactions on visualization and computer graphics, 16(4):548–559, 2010.

*Spatial Conditioning of Transfer Functions using Local Material Distributions **Stefan Lindholm, Patric Ljung, Claes Lundström, Anders Persson** and **Anders Ynnerman,** IEEE Transactions on Visualization and Computer Graphics (Proceedings Visualization 2010), Vol. 16, No. 6, 2010

Helin LM, Tamás E**, Nylander E.** Preoperative longitudinal left ventricular function by tissue Doppler echocardiography at rest and during exercise is valuable in timing of aortic valve surgery in male aortic regurgitation patients. J Am Soc Echocardiogr. 2010 Apr;23(4):387-95.

Ullman G, Dance D, **Sandborg M, Alm Carlsson G,** Svalkvist A and Båth M (2010). A Monte Carlo-based model for simulation of digital chest tomosynthesis. Radiat Prot Dosim 139 159-163

Gholami S, Sarwal MM, Naesens M, **Ringertz HG**, Barth RA, Balise RR, Salvatierra O: Standardizing resistive indices in healthy pediatric transplant recipients of adult-sized kidneys. Pediatr Transplant. 2010; (14) 126-131.

Dahlen Y, Sääf M, **Ringertz H**, Klefbeck B, Mattsson E, Haglund-Åkerlind Y: Effect of standing on bone density and hip dislocation in children with severe cerebral palsy. Advances in Physiotherapy. 2010; (12) 187-193.

Rosendahl L, Ahlander BM, Björklund PG, Blomstrand P, Brudin L, **Engvall J**. Image Quality and Myocardial Scar Size Determined with Magnetic Resonance Imaging in Patients with Permanent Atrial Fibrillation: a Comparison of Two Imaging Protocols. Clinical Physiology and Functional Imaging 2010;30(2):122-129.

Wijkman M, **Lanne T, Engvall J,** Lindstrom T, Ostgren CJ, Nystrom FH. B-Blocker Treatment is Associted with High Augmentation Index and with High Aortic, but not Brachial, Pulse Pressure in Type 2 Diabetes. Journal of Clinical Metabolism & Diabetes, May 2010; 1(1).

Rosendahl L, Blomstrand P, Brudin L, Tödt T, **Engvall JE.** Longitudinal Tissue Doppler Peak Strain Detects a Smaller Risk Area than Visual Wall Motion Assessment in Acute Myocardial Infarction. Cardiovascular Ultrasound 2010;8:2.

Eriksson J, **Carlhäll CJ, Dyverfeldt P, Engvall J,** Bolger AF, **Ebbers T** Semi-Automatic Quantification of 4D Left Ventricular Blood Flow. J Cardiovascular MRI 2010;12:9.

Zachrisson H, Engström E, Engvall J, Wigström L, Smedby Ö, Persson A. Soft Tissue Discrimination ex vivo by Dual Energy Computed Tomography. Eur J Radiol 2010;75(2):124-8.

Warntjes JM, Kihlberg J, Engvall J. Rapid T1 Quantification based on 3D Phase Sensitive Inversion Recovery. BMC Medical Imaging 2010;10:19.

Hemm S, **Wårdell K**, Stereotactic implantation of deep brain stimulation electrodes: a review of technical systems, methods and emerging tools. Med Biol Eng Comput, 48(7), 611-24, 2010.

*Olov Åstrand, Martin Carlsson, Ingela Nilsson, Torbjörn Lindström, **Magnus Borga,** Fredrik Nyström, "Weight gain by hyperalimentation elevates C-reactive protein levels but does not affect circulating levels of adiponectin or resistin in healthy subjects", European Journal of Endocrinology, 163(6): 879-885, 2010.

***Olivier Cros**, Michael L. Gaihede, **Magnus Borga, Örjan Smedby,** "Mastoid structural properties determined by imaging analysis of high resolution CT-scanning", Hearing Research, 263(1-2): 242-243, 2010.

Gunnar Läthén, Jimmy Jonasson, **Magnus Borga,** "Blood vessel segmentation using multi-scale quadrature filtering", Pattern Recognition Letters, 31(8): 762-767, 2010.

JBM Warntjes, J Kihlberg and **J Engvall** Rapid T1 quantification based on 3D phase sensitive inversion recovery. BioMed Central 2010;10:19

***H.M. Van Ettinger-Veenstra, M. Ragnehed,** M. Hällgren, **T. Karlsson, A-M Landtblom, P. Lundberg,** and **M. Engström.** Right-hemispheric brain activation correlates to language performance. NeuroImage, 49:3481-3488, 2010. JIF>5

***M. Engström, J. Pihlsgård**, **P. Lundberg**, and **B. Söderfeldt**. Functional magnetic resonance imaging of hippocampal activity during silent mantra meditation. J Alternative and Complimentary Medicine, 16:1253-1258, 2010.

M. Engström, M. Karlsson, M. Crone, **M. Ragnehed**, W. Antepohl, **A-M Landtblom,** and **P. Lundberg.** Clinical fMRI of language function in aphasic patients: Reading paradigm successful, while word generation paradigm fails. Acta Radiologica, 51:679–686, 2010.

M. Ahrén, L Selegård, **A Klasson**, F Söderlind, N Abrikossova, C Skoglund, T Bengtsson, **M Engström,** P-O Käll, K Uvdal. Synthesis and characterization of PEGylated Gd2O3 nanoparticles for MRI contrast enhancement. Langmuir, 26:5753-5762, 2010.

M. Engström and B. Söderfeldt. Brain activation during compassion meditation: a case study. J Alternative and Complimentary Medicine, 16:597-599, 2010.

***JP Kvitting, A Sigfridsson**, **L Wigström**, AF Bolger, **M Karlsson:** Analysis of human myocardial dynamics using virtual markers based on magnetic resonance imaging. Clin Physiol Funct Imaging. Volume 30, Number 1, January 2010 , pp. 23- 29(7) Number of citations: 2

R Gårdhagen, J Lantz, F Carlsson and **M Karlsson**: Quantifying Turbulent Wall Shear Stress in a Stenosed Pipe using Large Eddy Simulation, ASME J Biomech Eng, J Biomech Eng. 2010 Jun;132(6) Number of citations: 10

*S Petersson, P Dyverfeldt, R Gårdhagen, M Karlsson and **T Ebbers**: Simulation of Phase-Contrast MRI of Turbulent Flow, Magnetic Resonance in Medicine, Magn Reson Med. 2010 Oct;64(4) Number of citations: 14

A Söderström, **M Karlsson** and K Museth: A PML Based Non-Reflective Boundary for Free Surface Fluid Animation, ACM Transactions on Graphics, Volume 29 Issue 5, 2010 (citations unknown)

Michael Sandborg, Sandro Rossitti and Håkan Pettersson Local skin and eye lens equivalent doses in interventional neuroradiology. Eur Radiol 20(3) 725-733, (2010)

Michael Sandborg, Jonas Nilsson Althén, Agnetha Gustafsson. Efficient quality assurance programs in radiology and nuclear medicine in Östergötland, Sweden. Rad Prot Dosim 139 (1-3), 410-417 (2010)

Gustaf Ullman, David R. Dance, **Michael Sandborg, Gudrun Alm Carlsson,** Angelica Svalkvist and Magnus Båth. A Monte Carlo--based model for simulation of digital chest tomosynthesis. Radiation Protection Dosimetry, 139 (1-3), 159- 163 (2010)

Ragnehed M, Dahlqvist Leinhard O, Pihlsgård J, Wirell S, Sökjer H, Fägerstam P, Jiang B, **Smedby Ö, Engström M** and **Lundberg P**. Visual Grading of 2D and 3D fMRI compared to image based descriptive measures. Eur Radiol. 2010 Mar;20(3):714-24. (JIF: 3.5, GS: 3, ISI: 1)

Ragnehed M, Leinhard OD, Pihlsgard J, Wirell S, Sokjer H, Fagerstam P, et al. **Lundberg, P.** (2010) Visual grading of 2D and 3D functional MRI compared with image-based descriptive measures. Eur Radiol. 2010 Mar;20(3):714-24. Epub 2009 Sep 2 Number of citations: 3

***Magnusson, M, Dahlqvist Leinhard, O, Lundberg, P** (2010) 3D Magnetic Resonance Imaging of the Human Brain – Novel Radial Sampling, Filtering and Reconstruction, Proc Int Conf Sign Imag Proc., Series: ACTA Press, ISSN: 1922- 809; In: Proc of the 12th IASTED International Conference on Signal and Image Processing (SIP 2010), August 23-25, 2010, Lahaina, Maui, USA. Calgary, AB, Canada : ACTA Press. ISBN: 978-0-88986-845-8 ; s. Track: 710-042-(8 pages) Number of citations: 3

Eriksson J, Carlhäll CJ, Dyverfeldt P, Engvall J, Bolger AF, **Ebbers T.** Semi-automatic Quantification of 4D Left Ventricular Blood Flow. Journal of Cardiovascular Magnetic Resonance 2010; 12(1):9.

***Petersson S, Dyverfeldt P, Gårdhagen R, Karlsson M, Ebbers T.** Simulation of Phase contrast MRI of Turbulent Flow. Magnetic Resonance in Medicine 2010;31:1075-1080.

Carme Julià, **Rodrigo Moreno**, Domenec Puig, Miguel Angel Garcia. "Image Segmentation Through Graph-Based Clustering From Surface Normals Estimated By Photometric Stereo. Electronics Letters, 46(2), pp. 134–135, 2010. DOI:10.1049/el.2010.2526. IF: 1.038, Quartile: 3.

Gustafsson, P. A., Birberg-Thornberg, U., Duchén, K., Landgren, M., Malmberg, K., Pelling, H., Strandvik, B., & **Karlsson, T.** (2010). School achievement and oppositional symptoms improved after EPA omega-3 fatty acid supplementation in children with ADHD. Acta Paediatrica, 99, 1540-1549.

***Sigfridsson A, Haraldsson H, Ebbers T, Knutsson H,** Sakuma H. Single Breath Hold Multiple Slice DENSE MRI, Magnetic Resonance in Medicine 2010;63(5):1411-14.

Kvitting JPE, Dyverfeldt P, Sigfridsson A, Franzén S, **Wigström L,** Bolger AF, Ebbers T. In Vitro Assessment of Flow Patterns and Turbulence Intensity in Prosthetic Heart Valves Using Generalized Phase-Contrast Magnetic Resonance Imaging. J Magn Reson Imaging 2010;31(5):1075-80.

Respiratory variations in the photoplethysmographic waveform. Acute hypovolaemia during spontaneous breathing is not detected. L Nilsson, T Goscinski, **M Lindenberger**, **T Länne**, A Johansson. Physiol Meas. 2010(7), 953-62.

Reduced arterio-venous shunting capacity after local heating and redistribution of baseline skin blood flow in type 2 diabetes assessed with velocity-resolved quantitative laser Doppler flowmetry. Fredriksson I, Larsson M, Nyström F, **Länne T**, Östgren CJ, Strömberg T. Diabetes. 2010(7), 1578-84. JIF>5

ß-blocker treatment is associated with high augmentation index and with high aortic, but not brachial, pulse pressure in type 2 diabetes. Wijkman M, **Länne T, Engvall J,** Lindström T, Östgren CJ, Nyström F. J Clinical Metabolism and Diabetes. 2010, 1(1):55-62.

Existence of tissue blood flow in response to external pressure in the sacral region of elderly individuals using an optical probe prototype. Bergstrand S, **Länne T,** Ek ACh, Lindberg LG, Lindén M, Lindgren M. Microcirculation 2010(4), 311-319.

Arterial properties along the upper arm in man – age-related effects and the consequence of anatomical location. **Bjarnegård N**. and **Länne T.** J Appl Physiol. 2010;108(1):34-8.

Carlsson Tedgren Å, de Luelmo S and Grindborg J-E 2010 Characterization of a 60Co unit at a secondary standards dosimetry laboratory-Monte Carlo simulations compared to measurements and results from the literature Med. Phys. 37 2777-86

Wang C, Smedby Ö. Integrating automatic and interactive methods for coronary artery segmentation: let the PACS workstation think ahead. Int J Comput Assist Radiol Surg. 2010 May;5(3):275-85. DOI:10.1007/s11548-009-0393-z

Smedby Ö, Fredrikson M. Visual grading regression – analysing data from visual grading experiments with regression models. British Journal of Radiology 2010;83(993):767-775. DOI:10.1259/bjr/35254923

Steigner ML, Mitsouras D, Whitmore AG, Otero HJ, **Wang C**, Buckley O, Levit NA, Hussain AZ, Cai T, Mather RT, **Smedby Ö,** DiCarli MF, Rybicki FJ. Iodinated contrast opacification gradients in normal coronary arteries imaged with prospectively ECG-gated single heart beat 320-detector row computed tomography. Circ Cardiovasc Imaging. 2010 Mar;3(2):179-86. DOI:10.1161/CIRCIMAGING.109.854307 JIF > 5

Zachrisson H, Engström E, Engvall J, Wigström L, Smedby Ö, Persson A. Soft Tissue Discrimination ex vivo by Dual Energy Computed Tomography. Eur J Radiol. 2010 Aug;75(2):e124-e128. DOI:10.1016/j.ejrad.2010.02.001

Eriksson P, Mohammed AA, **De Geer J, Kihlberg J, Persson A**, Granerus G, Nyström F, Smedby Ö. Non-invasive investigations of potential renal artery stenosis in renal insufficiency. Nephrol Dial Transplant. 2010 Nov;25(11):3607-14. DOI:10.1093/ndt/gfq259

Wang C, Ritter F, **Smedby Ö.** Making the PACS workstation a browser of image processing software: a feasibility study using inter-process communication techniques, Int J Comput Assist Radiol Surg. 2010;5(4):411-419. DOI:10.1007/s11548-010-0417-8

Adolfsson E**, Alm Carlsson G,** Grindborg J-E, Gustafsson H, Lund E and **Carlsson Tedgren Å** 2010 Response of lithium formate EPR dosimeters at photon energies relevant to the dosimetry of brachytherapy Med. Phys. 37 4946-59

Jackowski C, Persson A. Letter: Comments on the paper entitled "Is post-mortem CT of the dentition adequate for correct forensic identification? Comparison of dental computed tomograpy and visual dental record" by S. Kirchhoff et al. in INTERNATIONAL JOURNAL OF LEGAL MEDICINE, vol 124, issue 3, pp 259-259. Springer Science Business Media; 2010. 124(3)p. 259-259. Number of citations: 3

Eriksson P, Mohammed A, **De Geer J, Kihlberg J, Persson A,** Granerus G, et al. Non-invasive investigations of potential renal artery stenosis in renal insufficiency. Oxford University Press; Nephrology, Dialysis and Transplantation. 2010;25(11):3607-3614. Number of citations: 11

Zachrisson H, Engström E, Engvall J, Wigström L, Smedby Ö, Persson A. Soft tissue discrimination ex vivo by dual energy computed tomography. Elsevier; European Journal of Radiology. 2010;75(2):E124-E128. Number of citations: 9

Gimm O, Juhlin C, Morales O, **Persson A.** Editorial: Dual-Energy Computed Tomography Localizes Ectopic Parathyroid Adenoma: in Journal of Clinical Endocrinology and Metabolism (ISSN 0021-972X) (EISSN 1945-7197), vol 95, issue 7, pp 3092-3093. 2010. 95(7) p. 3092-3093. Number of citations: 2 JIF>5

Persson A. Will Medical Visualization Tools Meet Medical User Requirements in the Future? Radiation Protection Dosimetry. 2010;139(1-3):12-19. Number of citations: 0

***Lindholm S,** Ljung P**, Lundström C, Persson A, Ynnerman A.** Spatial Conditioning of Transfer Functions Using Local Material Distributions. IEEE; IEEE TRANSACTIONS ON VISUALIZATION AND COMPUTER GRAPHICS. 2010;16(6):1301-1310. Number of citations: 8

Woisetschläger M**,** Lussi A, **Persson A, Jackowski C.** Fire victim identification by post-mortem dental CT: Radiologic evaluation of restorative materials after exposure to high temperatures. United Kingdom: Elsevier Ltd; European Journal of Radiology. 2010; Number of citations: 13

*Scandurra I, Forsell C, **Ynnerman A , Ljung P, Lundström C, Persson A**. Advancing the state-of-the-art for Virtual Autopsies-initial forensic workflow study. Stud Health Technol Inform. 2010;160(Pt 1):639-43. Number of citations: 0

***Engström M, Karlsson M**, Croné M, **Ragnehed M**, Antepohl W, **Landtblom AM, Lundberg P.** Clinical fMRI of language function in aphasic patients: reading paradigm successful while word generation paradigm fails. Acta Radiol 2010;51(6):679-86.

2010 Peer-reviewed Proceedings

***M. Magnusson, O. Dahlqvist Leinhard, P.** Brynolfsson, P. Thyr and **P. Lundberg** 3D Magnetic Resonance Imaging of the Human Brain - Novel Radial Sampling, Filtering and Reconstruction Proceedings of the 12th IASTED International Conference on Signal and Image Processing (SIP 2010), Lahaina, Maui, USA, Acta Press, August 23 - 25, 2010

*Phase Based Volume Registration on the GPU with Application to Quantitative MRI **A Eklund, M Warntjes, M Andersson** and **H Knutsson**, SSBA 2010

Rodrigo Moreno, Miguel Angel Garcia, Domenec Puig. Robust Color Image Segmentation Through Tensor Voting. Proc. Int. Conference on Pattern Recognition (ICPR), pp. 3372-3375. Istanbul, Turkey, August 2010. DOI:10.1109/ICPR.2010.823

A Malusek, E Helmrot**, G Alm Carlsson**, Patient-specific kerma-area product as an exposure estimator in computed tomography: the concept and typical values, Proceedings of the International Symposium on Standards, Applications and Quality Assurance in Medical Radiation Dosimetry, IAEA, Vienna, 2010

A Malusek, G Alm Carlsson, Analysis of the tandem calibration method for kerma-area product meters via Monte Carlo simulations, Proceedings of the International Symposium on Standards, Applications and Quality Assurance in Medical Radiation Dosimetry, IAEA, Vienna, 2010

T. K. Nguyen, A. Eklund, H. Ohlsson, **F. Hernell,** P. Ljung, C. Forsell, **M. Andersson, H. Knutsson,** and **A. Ynnerman.** Concurrent volume visualization of real-time fMRI. In IEEE/EG International Symposium on Volume Graphics, pages 53–60, May 2010.

Magnus Axholt, Martin Skoglund, Stephen Peterson, Matthew Cooper, Thomas Schön, Fredrik Gustafsson, **Anders Ynnerman**, and Stephen Ellis. Optical see-through head mounted display: Direct linear transformation calibration robustness in the presence of user alignment noise. In Proceedings of the Human Factors and Ergonomics Society 54rd Annual Meeting 2010. Human Factors and Ergonomics Society, 2010.

M. Felsberg, F. Larsson, H. Wang, **A. Ynnerman**, and T. Schön. Torchlight navigation. In International Conference on Pattern Recognition, 2010.

*Advancing the state-of-the-art for Virtual Autopsie-initial forensic workflow study Isabella Scandurra, Camilla Forsell, **Anders Ynnerman,** Patric Ljung**, Claes Lundström, Anders Persson,** Studies in health technology and informatics 160 (Pt 1), 2010

Eklund A, Andersson M, Ohlsson H, **Ynnerman A, Knutsson H.** A Brain Computer Interface for Communication Using Real-Time fMRI. In: Proceedings of the 20th International Conference on Pattern Recognition: 20th International Conference on Pattern Recognition, Istanbul, Turkey, 23-26 August 2010. Los Alamitos, CA, USA: IEEE Computer Society; 2010. p. 3665-3669. International Conference on Pattern Recognition.

Michael Felsberg, Fredrik Larsson, Wang Han, **Anders Ynnerman**, and Thomas Schön. Torch guided navigation. In Proceedings of SSBA symposium 2010, pages 8–9, 2010. Number of citations: 1.

Staffan Klashed, Per Hemingsson, Carter Emmart, Matthew Cooper, and **Anders Ynnerman**. Uniview - Visualizing the Universe. In Eurographics 2010 - Areas Papers, EG 2010 - Short papers, Norrköping, Sweden, 2010. Eurographics Association.

Eklund, **M. Andersson**, H. Ohlsson, **A. Ynnerman,** and **H. Knutsson**. A brain computer interface for communication using real-time fmri. In International Conference on Pattern Recognition, 2010.

D. Forsberg, M. Andersson, and **H. Knutsson**, "Parallel scales for more accurate displacement estimation in phase-based image registration," in Pattern recognition (icpr), 2010 20th international conference on, 2010, pp. 2329-2332.

D. Forsberg, M. Andersson, and **H. Knutsson**, "Adaptive anisotropic regularization of deformation fields for non-rigid registration using the morphon framework," in Acoustics speech and signal processing (icassp), 2010 ieee international conference on, 2010, pp. 473-476.

Gunnar Läthén, Olivier Cros, Hans Knutsson, Magnus Borga, "Non-ring Filters for Robust Detection of Linear Structures", Proceedings of the 20th International Conference on Pattern Recognition, International Conference on Pattern Recognition, 233-236, 2010.

***M. Engström, T. Karlsson,** and **A-M. Landtblom**. Resting state functional connectivity in patients with periodic hypersomnia. ISMRM, Stockholm, Sweden, 2010.

M. Engström, M. Ragnehed, and **P. Lundberg**. On the Advantage of Data Driven Analysis in Aphasic Patients with Severe Language Latency. ISMRM, Stockholm, Sweden, 2010.

M Kinell, E Utriainen, J Hylén J Gustavsson A Bradley, **M Karlsson**, J Wren: Fan Shaped and Cylindrical Holes Studied in a Vane Film Cooling Test Rig, ASME TurboExpo, Glasgow, June, 2010

J Lantz**, J Renner** and **M Karlsson**: Wall Shear Stress in an MRI-based subject- specific human aorta using fluid-structure interaction, ASME Summer Bioengineering Conference, Naples, Florida, June 2010

R Gårdhagen, F Carlsson and **M Karlsson**: Large Eddy Simulation of Steady and Pulsating Flow in Asymmetric Stenosed Pipe, ASME Summer Bioengineering Conference, Naples, Florida, June 2010

J Lantz**, J Renner** and **M Karlsson**: MR-based Imaging for Patient Specific, Fully Coupled 2-Way Fluid-Structure Interaction of the Human Aorta, ISMRM 2010

***S Petersson, P Dyverfeldt, R Gårdhagen, M Karlsson,** and **T Ebbers**: Simulation of Phase-Contrast MRI Intravoxel Velocity Standard Deviation (IVSD) Mapping, ISMRM 2010

Kalra M, Persson A, Quick P, Sandborg M. Combining high pitch, low kV and 4D automatic exposure control technique for reducing CT radiation dose for mapping of pulmonary venous anatomy. RSNA 2010 In: SSJ05-05. 2010.

Persson A, Kalra M, Quick P, Dahlström N, Sandborg M, Singh S. Use of iterative reconstruction in image space (IRIS) to improve acceptability of 50 and 100 mAs abdominal CT : comparison of standard of care 200 mAs filtered back projection CT images. RSNA 2010 In: SSK15-04. 2010.

Kalra M, Persson A, Quick P, Digumarthy S**, Sandborg M**, Singh S. Can image space iterative reconstruction technique allow 60% dose reduction for thoracic CT? Results for a randomised prospective pilot study. RSNA 2010 In: SSQ03-06. 2010.

Kalra M, Persson A, Quick P, Sandborg M. Combining low kVp, lowest tube current, high pitch and fast table speed for minimizing radiation dose for whole body CT imaging of children with scoliosis. RSNA 2010 In: SSK14-08. 2010.

***Andersson M, Smedby Ö, Sandborg M**, Farnebäck G, **Knutsson H**. Adaptiv filtering of 4D-heart CT for image denoising and patient safety. Medicin-teknikdagarana Umeå, 2010.

Kihlberg J, Kalra M, Dahlström N, De Geer J, Rönn M, **Persson A,** Olofsson F, Bäck A. Applying 2D and 3D Postprocessing Algorithms to MR Images: Does Image Quality Improve? Can MR Imaging Duration Be Reduced? RSNA 2010

Dahlqvist Leinhard O, Dahlström N, Sandström P**, Kihlberg J,** Brismar T, **Smedby Ö, Lundberg P.** The hepatic uptake of Gd-EOB-DTPA is strongly correlated with the uptake of Gd-BOPTA. ISMRM 2010, Stockholm, 2010

***Engström, M., Landtblom, A-M., Karlsson, T.** (2010). The brain's default resting state in recurrent hypersomnia (Kleine-Levin syndrome). Paper presented at the Joint Annual Meeting ISMRM-ESMRMB 2010; Stockholm, May 1-7.

Karlsson, T., Birberg-Thornberg, U., Duchén, K., & Gustafsson, P. (2010). LC-PUFA supplemented to mothers during pregnancy and breast-feeding improves cognitive performance in their children four years later—an rct study. Paper presented at the 9th biennial scientific meeting of the International Society for the Study of Fatty Acids and Lipids (ISSFAL); Maastricht, May 29 - June 2nd.

***Karlsson, T., Engström, M., & Landtblom, A-M**. (2010). An fMRI investigation of mental effort in a complex working memory task. Paper presented at the 6th Annual Meeting of the Organization for Human Brain Mapping; Barcelona, June 6-10.

***Engström, M., Karlsson, T., & Landtblom, A-M**. (2010) Working memory functional connectivity in periodic hypersomnia (KLS). Paper presented at the 6th Annual Meeting of the Organization for Human Brain Mapping; Barcelona, June 6-10.

***Cros O**, Gaihede ML, **Borga M, Smedby Ö.** Mastoid structural properties determined by imaging analysis of high resolution CT-scanning. Hearing Research 2010;263(1-2):242-243.

Persson, A. DECT parathyriodea, In proceedings of Röntgenveckan 2010

Persson, A. DECT plaque, In proceedings of Röntgenveckan 2010

Persson, A, Kalra M, **Berge J.** Application of multienergy spectral CT imaging to virtual autopsy: How is it done and what does it add? In proceedings of RSNA 2010.

M. Kalra, A. Persson. Is high speed and high pitch dual source CT scanning with no ECG gating and no breath hold adequate for mapping pulmonary venous anatomy? In proceedings of RSNA 2010.

M. Kalra, A. Persson. Advanced radiation dose reduction capabilities of 128 slice multidetector-row dual source CT for EKG-gated cardiac CT applications. In proceedings of RSNA 2010.

M. Kalra, A. Persson. Combining low KVp, lowest tube current, high pitch and fast table speed for minimizing CT radiation dose for children with scoliosis. In proceedings of RSNA 2010.

M. Kalra, A. Persson. Comparison of New Iterative Reconstruction in Image Space (IRIS) and Conventional Filtered Back Projection (FBP): Anthropomorphic Thorax Phantom Experiments at Different Radiation Dose Levels. In proceedings of RSNA 2010.

M. Kalra, A. Persson. Use of Iterative Reconstruction in Image Space (IRIS) to improve acceptability of 50 and 100 mAs in abdominal CT. In proceedings of RSNA 2010.

M. Kalra, A. Persson. Can image space iterative reconstruction teclinique aliow 60% dose reduction for thoracic CT? Results from a Randomized Prospective Pilot Study. In proceedings of RSNA 2010.

M. Kalra, A. Persson. Combining high pitch, low kVp and 4D automatic exposure control technique for reducing CT radiation dose for mapping of pulmonary venous anatomy. In proceedings of RSNA 2010.

M. Kalra, A. Persson. Can iterative reconstruction improve visualization of normal antomy and lesions on chest and abdominal CT images? In proceedings of RSNA 2010.

M. Kalra, A. Persson. Blotchy pixilated, textured appearance of CT images with iterative reconstruction: Relation with radiation dose. In proceedings of RSNA 2010.

J. Kihlberg, M. Kalra, A. Persson. Application of 2D and 3D post processing algorithms to MR Images; Does Image quality improve? Can MR Imaging Duration Be Reduced? In proceedings of RSNA 2010.

A. Persson, J. Falk, **J. Berge**, **C Jackowski**. Postmortem Luxations of Cervical Spine Vertebrae found in Computed Tomography--Based Autopsies: Frequency and Possible Causes. In proceedings of Röntgenveckan 2010.

J. De Geer, M. Sandborg, Ö. Smedby, A. Persson. Post processing noise reduction as a way of reducing the dose in cardiac CT without sacrificing image quality: A pilot study. European Congress of Radiology, Vienna 2010.

*I. Scandurra, C. Forsell, **A. Ynnerman,** P. Ljung, **C. Lundström, A. Persson**. Advancing the State-of-the-Art for Virtual Autopsies - Initial Forensic Workflow Study. The 13th World Congress on Medical and Health Informatics Medinfo 2010. 12-15th September 2010, Cape Town International Convention Centre, Cape Town, South Africa.

***van Ettinger-Veenstra HM, Ragnehed M, Hällgren M, Karlsson T, Landtblom AM, et al.** Right-hemispheric brain activation correlates to language performance. Neuroimage 2010;4:3481-8

***Sigfridsson A, Haraldsson H, Ebbers T, Knutsson H,** Sakuma H. Single Breath Hold Multiple Slice DENSE MRI. John Wiley and Sons, Ltd; Magnetic Resonance in Medicine. 2010;63(5):1411-1414.

***Magnusson M, Dahlqvist Leinhard O**, Brynolfsson P, Thyr P and **Lundberg P.** 3D Magnetic Resonance Imaging of the Human Brain — Novel Radial Sampling, Filtering and Reconstruction. In proceedings of the international conference on Signal and Image processing (SIP2010), Maui, Hawaii, USA, 2010. (JIF: N/A, GS: 3, ISI: 0)

2010 Peer-reviewed Review Articles

Carlhäll CJ, Bolger AF. Passing Strange – Flow in the Failing Ventricle. Circulation: Heart Failure 2010;3:326-31 JFI > 5

Hypoxia-induced retinopathy model in adult zebrafish. Cao Z, Jensen LD, Rouhi P, Hosaka K, **Länne T**, Steffensen J, Wahlberg E, Cao Y. Nature Protoc 2010;Dec 5(12):1903-10.JIF>5

Larsson M B, Tillisch K, Mayer E A, Jarcho J, Lalbus J, Naliboff B, et al. Brain response during expectation and delivery of visceral stimulation differs between IBS patients and healthy controls: an fMRI study. Neurogastroenterology and Motility (NGM 2010), August 26-29, 2010, Boston, Massachusetts, USA. 2010.

Michael Sandborg, Magnus Båth, Hannu Järvinen, Keith Faulkner. Justification and optimisation in clinical practice. In Chapter 24 of International Atomic Energy Agency (IAEA) Handbook on the Physics of Diagnostic Radiology (Accepted by Editorial board, 2010, In Print 2014)

*Mellergård, J., **Tisell, A., Dahlqvist Leinhard, O.,** Dahle, C., **Landtblom, AM.**, Ernerudh, J., **Lundberg, P.**, Vrethem, M.MR spectroscopy and quantitative MRI in multiple sclerosis patients treated with natalizumab: changes in normal appearing white matter are associated to intrathecal inflammation and clinical variables. (ECTRIMS 2010, Gothenburg, Sweden). (2010)

Warntjes, J.B., West, J., Landtblom, A-M., and **Lundberg, P.** Absolute Quantification of Myelin related Volume in the Brain. (ISMRM 2010, Stockholm, Sweden).

***M. Engström, T. Karlsson,** and **A-M. Landtblom.** Resting state functional connectivity in patients with periodic hypersomnia. ISMRM, Stockholm, Sweden, 2010.

***Eklund A, Andersson M, Warntjes M, Knutsson H**. Phase Based Volume Registration on the GPU with Application to Quantitative MRI. In: SSBA Symposium on Image Analysis, March 11-12, Uppsala, Sweden. 2010.

***Eklund A, Warntjes M, Andersson M, Knutsson H.** Fast Phase Based Registration for Robust Quantitative MRI. In: Proceedings of the annual meeting of the International Society for Magnetic Resonance in Medicine (ISMRM 2010): ISMRM Joint Annual Meeting, Stockholm, Sweden, 1-7 May 2010.

***Dyverfeldt P, Sigfridsson A, Knutsson H, Ebbers T.** A Novel MRI Framework for the Quantification of Any Moment of Arbitrary Velocity Distributions. In: Proc. Intl. Soc. Mag. Reson. Med. 18 (2010): ISMRM Joint Annual Meeting (2010), Stockholm, Sweden, 1-7 May 2010. ISMRM; 2010. p. 1359-1359.

***Sigfridsson A, Haraldsson H, Ebbers T, Knutsson H**, Sakuma H. SNR evaluation of 32 channel cardiac coils in DENSE MRI at 1.5 and 3T. In: ISMRM 2010: ISMRM 2010 Annual Meeting, 1-7 May 2010, Stockholm, Sweden. International Society for Magnetic Resonance in Medicine (ISMRM); 2010.

Eklund A, Andersson M, Knutsson H. Phase Based Volume Registration Using CUDA. In: Acoustics Speech and Signal Processing (ICASSP), 2010: The 35th International Conference on Acoustics, Speech, and Signal Processing (ICASSP 2010), March 14–19, Dallas, Texas, USA. IEEE; 2010. p. 658-661. IEEE International Conference on Acoustics, Speech and Signal Processing. Proceedings, 2010.

***Andersson M, Smedby Ö, Sandborg M,** Farnebäck G, Hans K. Adaptiv filtering of 4D-heart CT for image denoising and patient safety. In: MEDICINTEKNIKDAGARNA 2010 6-7 oktober 2010, Umeå. 2010.

Forsberg D, Andersson M, Knutsson H. Parallel Scales for More Accurate Displacement Estimation in Phase-Based Image Registration. In: Pattern Recognition (ICPR), 2010: . 20th International Conference on pattern Recognition (ICPR 2010), 23-26 August 2010, Istanbul, Turkey. IEEE Computer Society; 2010. p. 2329-2332. International Conference on Pattern Recognition.

Läthén G, Cros O, Knutsson H, Borga M. Non-ring Filters for Robust Detection of Linear Structures. In: Proceedings of the 20th International Conference on Pattern Recognition: 20th International Conference on Pattern Recognition, Istanbul, Turkey, 23-26 August 2010. Los Alamitos, CA, USA: IEEE Computer Society; 2010. p. 233-236. International Conference on Pattern Recognition.

Nguyen T K, Ohlsson H, **Eklund A**, **Hernell F**, Ljung P, Forsell C, et al. Concurrent Volume Visualization of Real-Time fMRI. In: Proceedings of the 8th IEEE/EG International Symposium on Volume Graphics: 8th IEEE/EG International Symposium on Volume Graphics, Norrköping, Sweden, 2-3 May, 2010. Goslar, Germany: Eurographics - European Association for Computer Graphics; 2010. p. 53- 60.

2009 Peer-reviewed Original Articles

Engström M, Vigren P, **Karlsson T**, **Landtblom AM**. The biology of hypersomnia clarified by working memory deficit in Kleine-Levin syndrome: An fMRI study. Sleep 2009;5:681-8. JIF > 5

Stefan Lindholm, Patric Ljung, Markus Hadwiger, and **Anders Ynnerman**. Fused Multi-Volume DVR using Binary Space Partitioning. In Hans-Christian Hege, Ingrid Hotz, and Tamara Munzner, editors, EuroVis09: Eurographics/ IEEE Symposium on Visualization, pages 847–854, Berlin, Germany, 2009. Eurographics Association.

Bothe W, Ennis DB, **Carlhäll CJ,** Nguyen TC, Timek TA, Lai DT, Itoh A, Ingels NB, Miller DC. Regional mitral leaflet opening during acute ischemic mitral regurgitation. J Heart Valve Dis 2009;18:586-97

***Kindberg K**, **Carlhäll CJ, Karlsson M,** Nguyen TC, Cheng A, Langer F, Rodriguez F, Daughters GT, Miller DC, Ingels NB. Transmural strains in the ovine LV lateral wall during diastolic filling. J Biomech Eng 2009;131(6):061004

Maret E, Todt T, Brudin L, **Nylander E, Swahn E,** Ohlsson JL, **Engvall JE**. Functional measurements based on feature tracking of cine magnetic resonance images identify left ventricular segments with myocardial scar. Cardiovasc Ultrasound. 2009 Nov 16;7(1):53.

Ostman-Smith I, Wisten A, **Nylander E,** Bratt EL, de-Wahl Granelli A, Oulhaj A, Ljungström E. Electrocardiographic amplitudes: a new risk factor for sudden death in hypertrophic cardiomyopathy. Eur Heart J. 2009 Nov 5

Tamás E, Nielsen NE, Vanhanen I, **Nylander E**. Measurement of physical work capacity in patients with chronic aortic regurgitation: a potential improvement in patient management. Clin Physiol Funct Imaging. 2009 Oct;29(6):453-7. Epub 2009 Sep 10.PMID: 19744088

Tamás É, Broqvist M, Olsson E, Franzén S, **Nylander E**. Exercise radionuclide ventriculography for predicting postoperative left ventricular function in chronic aortic regurgitation. J Am Coll Cardiovasc Imaging 2009;2:48-55

Rubesova E, Vance CJ, **Ringertz HG,** Barth RA: Three-dimensional MRI volumetric measurements of the normal fetal colon. AJR Am J Roentgenol. 2009 Mar;192(3):761-5

Larsson E-L, Aaro S, Ahlinder P, Normelli H, **Tropp H,** Öberg B. Long-term follow-up of functioning after spinal surgery in patients with Rett syndrome. Eur Spine J (2009) 18:506-511.

Perneros G, **Tropp H**. Development, validity, and reliability of The Assessment of Pain and Occupational Performance (POP): a new instrument using two dimensions in the investigation of disability in back pain. The Spine Journal 2009. Available on line.

Berg S, Fritzell P, **Tropp H** Sex life and sexual function in men and women before and after total disc replacement compared to posterior lumbar fusion. Eur Spine J 2009.

Berg S, Tullberg T, Branth B, Olerud C, **Tropp H** Total disc replacement compared to lumbar fusion A randomised controlled trial with two-year follow up. Eur Spine J 2009.

Dahlen E**, Länne T, Engvall J,** Lindström T, Grodzinsky E, Nyström F, Östgren CJ. Carotid intima-media thickness and apolipoproteinB / apolipoprotein A-I ratio in middle aged patients with type 2 diabetes. Diabetic Medicine 2009;26(4):384-90.

Wijkman M, **Länne T**, **Engvall J,** Lindström T, Östgren CJ, Nystrom FH. Masked nocturnal hypertension – a novel marker of risk in type 2 diabetes. Diabetologia 2009;52(7):1258-64.

Nguyen PK, Scott GC, **Engvall J,** Santos JM, McConnell MV, Wright G, Nishimura DG, Pauly JM, Hu BS, Yang PC. A Two Element Phased Array Coil Enabling Widespread Application of High Resolution MR Coronary Angiography. The Open Cardiovascular Imaging Journal 2009;1:30-38.

Johansson J, Blomstedt P, Haj-Hosseini N, Bergenheim AT, Eriksson O, **Wårdell K.** Combined diffuse light reflectance and electric impedance measurements for navigation aid in deep brain surgery. Stereotact Funct Neurosurg; 87:105-113, 2009.

R. M. Petoral Jr., F. Söderlind, **A. Klasson**, A. Suska, M. A. Fortin, P-O Käll, **M, Engström**, K. Uvdal. Synthesis and characterization of Tb3+ doped Gd2O3 nanocrystals: A bifunctional material with combined fluorescent labeling and MRI contrast agent properties. J. Phys. Chem. C, 113:6913-6920, 2009. JIF=4.8

***K Kindberg**, **CJ Carlhall, M Karlsson,** T Nguyen, A Cheng, F Langer, **F Rodriguez**, GT Daughters, DC Miller, NB Ingels: Transmural strains in the ovine LV lateral wall during diastolic filling, J Biomech Eng. 2009 Jun;131(6) Number of citations: 4

A Itoh, G Krishnamurthy, JC Swanson, W Bothe, DB Ennis, E Kuhl, **M Karlsson**, LR Davis, DC Miller and NB Ingels: Active stiffening of the mitral leaflets in the beating heart. Am J Physiol Heart Circ Physiol. 2009 Jun;296(6):H1766-73 Number of citations: 31

G Krishnamurthy, A Itoh, W Bothe, JC Swanson, E Kuhl, **M Karlsson**, D Miller, NB Ingels: Stress-strain behavior of mitral valve leaflets in the beating ovine heart. J Biomech. 2009 Aug 25;42(12):1909-16. Number of citations: 28

***P Dyverfeldt, R Gårdhagen, A Sigfridsson, M Karlsson, T Ebbers**: On MRI Turbulence Quantification, Magnetic Resonance Imaging, 2009 Sep;27(7):913-22 Number of citations: 14

G Krishnamurthy, A Itoh, JC Swanson, W Bothe, **M Karlsson**, E Kuhl, DC Miller, NB Ingels NB: Regional stiffening of the mitral valve anterior leaflet in the beating ovine heart. J Biomech. 2009, 42(16):2697-2701 Number of citations: 23

***J Renner**, D Loyd, **T Länne** and **M Karlsson**: Is a Flat Inlet Profile Sufficient for WSS Estimation in the Aortic Arch? WSEAS Transactions on Fluid Mechanics, Issue 4, Volume 4, October 2009, Number of citations: 1

*Erlingsson S, Herard S, **Dahlqvist Leinhard O,** Lindström T**, Länne T**, **Borga M** and Nystrom F. H. Men develop more intra abdominal obesity and signs of the metabolic syndrome after hyperalimentation than women. Metabolism. 2009 Jul;58(7):995-1001. (JIF: 3.1, GS: 22, ISI 16)

***Ragnehed, M., Engström, M., Söderfeldt, B., Knutsson, H, Lundberg**, P (2009) " Restricted Canonical Correlation Analysis in Functional MRI—Validation and a Novel Thresholding Technique", J Magn Reson Imag 29:146-154. Number of citations: 10

Hansson T, Nyman T, Björkman A, **Lundberg P,** Nylander L**,** Rosén B, Lundborg G (2009) Sights of touching activates the somatosensory cortex in humans, Scand J Plast Reconstr Surg Hand Surg 43(5): 267-269. Number of citations: 1

Ebbers T and Farnebäck G. Improving computation of cardiovascular relative pressure fields from velocity MRI, Journal of Magnetic Resonance Imaging 2009;30(1):54-61.

Kvitting JPE, Dyverfeldt P, Carlhäll C, Sigfridsson A, Bolger AF, **Ebbers T, Engvall J,** Magnetic resonance imaging offers unique possibilities to assess blood flow and its effects on the cardiovascular system, Läkartidningen 2009;106(30-31):1901-1904.

***Renner J**, **Gårdhagen R**, Heiberg E, **Ebbers** T, Loyd D, **Länne T, Karlsson M**. A Method for Subject Specific Estimation of Aortic Wall Shear Stress. WSEAS Transaction on Biology and Biomedicine, 2009 (6): 1109-9518. Number of citations: 4

Association of genetic variation on chromosome 9p21.3 and arterial stiffness. **Björck H**, **Länne T**, Alehagen U, Persson K, Rundkvist L, Hamsten A, Dahlström U,Eriksson P. J Int Med. 2009;265(3):373-81. JIF>5

Long-term hyperglycaemia impairs vascular smooth muscle cell function in women with type 1 diabetes mellitus. **Bjarnegård N**, Arnqvist H, Lindström T, Jonasson L, Jönsson A, **Länne T.** Diabetes and Vascular Disease Research. 2009;6:25-31.

Antonovic L, **Gustafsson H**, **Alm Carlsson G** and **Carlsson Tedgren Å** 2009 Evaluation of a lithium formate EPR dosimetry system for dose measurements around 192Ir brachytherapy sources Med. Phys. 36 2236-47

***Carlsson Tedgren Å** and **Alm Carlsson G** 2009 Influence of phantom material and dimensions on experimental 192Ir dosimetry Med. Phys. 36 2228-35

Petersson H, Sinkvist D, **Wang C, Smedby Ö.** Web-based interactive 3D visualization as a tool for improved anatomy learning. Anatomical Sciences Education 2009;2(2):61-68. DOI:10.1002/ase.76

Brismar TB, **Dahlström N**, Edsborg N, **Persson A, Smedby Ö,** Albiin N. Liver vessel enhancement by Gd-BOPTA and Gd-EOB-DTPA – a comparison in healthy volunteers. Acta Radiol. 2009;50(7):709-15. DOI:10.1080/02841850903055603

*Schaap M, Metz CT, van Walsum T, van der Giessen AG, Weustink AC, Mollet NRA, Bauer C, Bogunović H, Castro C, Deng X, Dikici E, O'Donnell T, Frenay M,

Friman O, Hoyos MH, Kitslaar PH, Krissian K, Kühnel C, Luengo-Oroz MA, Orkisz M, **Smedby Ö**, Styner M, Szymczak A, Tek H, Wang C, Warfield SK, Zambal S, Zhang Y, Krestin GP, Niessen WJ. Standardized Evaluation Methodology and Reference Database for Evaluating Coronary Artery Centerline Extraction Algorithms. Med Image Anal. 2009;13(5):701-14. DOI:10.1016/j.media.2009.06.003

Brismar T, **Dahlström N**, Edsborg N, **Persson A, Smedby Ö**, Albiin N. Liver Vessel Enhancement by Gd-BOPTA and Gd-EOB-DTPA – a Comparison in Healthy Volunteers. Informa Healthcare; Acta Radiologica. 2009;50(7):709-715. Number of citations: 21

2009 Peer-reviewed Proceedings

*__M. Magnusson, O. Dahlqvist Leinhard__, P. Brynolfsson, and **P. Lundberg** Radial k-space sampling: step response using different filtering techniques ISMRM Workshop on Data sampling and Image Reconstruction, The Enchantment Resort, Sedona, Arizona, USA, January 25-28, 2009

*__M. Magnusson, O. Dahlqvist Leinhard__, P. Brynolfsson, and **P. Lundberg** Improved temporal resolution in radial k-space sampling using an hourglass filter. Proceedings of the ISMRM 17th Scientific Meeting & Exhibition, Honolulu, Hawaii, USA, April 18-24, 2009

Syntetisk MRI – framtidens sätt att köra MRI. **JBM Warntjes**. Nyheter & Information, Philips Medicinska System 2009.

Wiklund J, Nicolas V, Rondao Alface P, **Andersson M, Knutsson H.** T-flash: Tensor Visualization in Medical Studio. In: Tensors in Image Processing and Computer Vision. 1 London: Springer-Verlag; 2009. p. 455-466. Advances in Pattern Recognition

Eklund A, Ohlsson H, **Andersson M, Rydell J, Ynnerman A, Knutsson H.** Using Real-Time fMRI to Control a Dynamical System. In: ISMRM 17th Scientific Meeting& Exhibition: ISMRM 17th Scientific Meeting & Exhibition, Honolulu, Hawaii, USA, 18-24 April 2009. 2009.

Brun A, Knutsson H. Tensor Glyph Warping - Visualizing Metric Tensor Fields using Riemannian Exponential Maps. In: Visualization and Processing of Tensor Fields: Advances and Perspectives. Springer Berlin/Heidelberg; 2009. p. 139-160. Mathematics and Visualization.

Svensson B, Brun A, Andersson M, Knutsson H. On Geometric Transformations of Local Structure Tensors. In: A review of tensors and tensor signal processing: Tensors in Image Processing and Computer Vision. Springer London; 2009. p. 179- 193.

***Brun A,** Martin-Fernandez M, Acar B, Munoz-Moreno E, Cammoun L, **Sigfridsson A,** et al. Similar Tensor Arrays - A Framework for Storage of Tensor Array Data. In: Tensors in Image Processing and Computer Vision: Tensor in Image Processing and Computer Vision. 1 Springer Science+Business Media B.V.; 2009. p. 407-428. Advances in Computer Vision and Pattern Recognition.

A. Eklund, H. Ohlsson, **M. Andersson, J. Rydell**, **A. Ynnerman,** and **H. Knutsson**. Using real-time fmri to control a dynamical system by brain activity classification. In Proceedings of International Conference on Medical Image Computing and Computer-Assisted Intervention (MICCAI'09), London, UK, September 2009. Springer.

Joakim Löw, **Anders Ynnerman**, P. Larsson, and J. Unger. HDRlight probe sequence resampling for realtime incident light field rendering. In Proceedings of the Spring Conference on Computer Graphics, pages 23–25, April 2009.

Karljohan Lundin Palmerius, Matthew Cooper, and **Anders Ynnerman**. Flow field visualization using vector field perpendicular surfaces. In Proceedings of the Spring Conference on Computer Graphics, pages 35–42, April 2009.

Lena Tibell, Matthew Cooper, **Anders Ynnerman**, Gunnar Höst, and Petter B Persson. Improved feature detection over large force ranges using history dependent transfer functions. In Third Joint Eurohaptics Conference and Symposium on Haptic Interfaces for Virtual Environments and Teleoperator Systems, WorldHaptics 2009, volume 3, pages 476–481, Salt Lake City, Utah, USA, 2009. IEEE, USA.

Kvitting JPE, Dyverfeldt P, Carlhäll CJ, Sigfridsson A, Ebbers T, Bolger AF, **Engvall J**. Magnetresonanstomografi ger unika möjligheter att bedöma blodflödet och dess inverkan på hjärt- och kärlsystemet. Läkartidningen 2009;106:1901-04.

Wårdell K, Johansson J, Richter J, Blomstedt P, Optical measurments for guidance during deep brain stimulation surgery, Medical Physics and Biomedical Engineering, World Congress, München, IFMBE Proceeding, Vol. 25/IX, 516-517, 2009.

Kajsa Tibell, Hagen Spies, **Magnus Borga**, "Fast Prototype Based Noise Reduction", Image Analysis, Lecture Notes in Computer Science, Vol. 5575, 159-168, 2009.

Gunnar Läthén, Thord Andersson, **Reiner Lenz, Magnus Borga**, "Momentum Based Optimization Methods for Level Set Segmentation", Momentum Based Optimization Methods for Level Set Segmentation, Lecture Notes in Computer Science, Vol. 5567, 124-136, 2009.

Thord Andersson, **Gunnar Läthén, Reiner Lenz, Magnus Borga,** "A Fast Optimization Method for

Level Set Segmentation", Image Analysis, Lecture Notes in Computer Science, Vol. 5575, 400-409, 2009.

R Gårdhagen, J Lantz, F Carlsson, **M Karlsson**: Wall Shear Stress In Turbulent Pipe Flow, ASME 2009 Summer Bioengineering Conference, Lake Tahoe CA, 2009.

***P Dyverfeldt, R Gårdhagen, A Sigfridsson, M Karlsson, T Ebbers:** On MRI Turbulence Quantification, MRI Turbulence Quantification, Presentation at ISMRM 2009

G Krishnamurthy Akinobu Itoh, Julia C. Swanson, Wolfgang Bothe, **M Karlsson**, E Kuhl, D. Craig Miller, Neil B. Ingels: Transient Tensing of the Mitral Valve Anterior Leaflet in the Beating Ovine Heart, JHVD Berlin 2009

Dahlqvist Leinhard O, Dahlström N, Sandström P, Freij A, **Kihlberg J,** Brismar T, **Smedby Ö, Lundberg P.** The hepatic uptake of Gd-EOB-DTPA is strongly affected by the hepatobiliary function. ISMRM, Honolulu, 2009.

Sandström P, **Dahlqvist Leinhard O, Dahlström N,** Freij A, **Kihlberg J,** Brismar TB, **Smedby Ö, Lundberg P**. Upptag i levern av kontrastmedlet Gd-EOB-DTPA påverkas kraftigt av leverfunktionen. Poster P157, Kirurgveckan, Halmstad 2009.

Dyverfeldt P, Eriksson J, Sigfridsson A, Kvitting JPE, Carlhäll C, Engvall J, Bolger AF, **Ebbers T.** Extending 4D Flow Visualization to the Human Right Ventricle. 17th Int. Soc. Magn. Reson. Med. Honolulu; 2009.

Rodrigo Moreno, Miguel Angel Garcia, Domenec Puig, Carme Julià. On Adapting the Tensor Voting Framework to Robust Color Image Denoising. Lecture Notes in Computer Science, Vol. 5702, pp. 492-500. Proc. Int. Conference on Computer Analysis of Images and Patterns (CAIP). Münster, Germany, September 2009. DOI:10.1007/978-3-642-03767-2 60

Rodrigo Moreno, Miguel Angel Garcia, Domenec Puig, Carme Julià. Robust Color Edge Detection Through Tensor Voting. Proc. Int. Conference on ImageProcessing (ICIP), pp. 2153-2156. Cairo, Egypt, November 2009. DOI:10.1109/ICIP.2009.5414337

Rodrigo Moreno, Domenec Puig, Carme Julià, Miguel Angel Garcia. A New Methodology for Evaluation of Edge Detectors. Proc. Int. Conference on Image Processing (ICIP), pp. 2157-2160. Cairo, Egypt, November 2009. DOI:10.1109/ICIP.2009.5414086

***Tisell, A., Engström, M., Karlsson, T.,** Vigren, P., **Dahlqvist Leinhard, O., Lundberg, P., & Landtblom, A-M.** (2009). Etiology of periodic hypersomnia explored by combined functional and molecular neuroimaging methods. Paper presented at the 2008 World Molecular Imaging Congress; Nice, September 10-13.

***Tisell, A., Engström, M., Dahlqvist Leinhard, O., Karlsson**, T., Vigren, P., **Landtblom, A-M.** and **Lundberg, P.** (2009). Combining fMRI with qMRS for understanding the etiology of periodic hypersomnia, ISMRM 2009, Hawaii, USA.

Börjesson, A., Andersen, P. and **Karlsson, T.** (2009). Cognitive changes in Amyotrophic Lateral Sclerosis (ALS) patients with the D90A SOD1 gene mutation, other types of familial ALS, and sporadic ALS. Paper to be presented at the Third International Research Workshop on Frontotemporal Dementia in ALS; London, Ontario, June 21-25.

Persson, J. Berge, M. Lindblom, **C. Jackowski**. A State-of-the-art Pipeline for postmortem CT and MRI visualization – From data acquisition to interactive image interpretation at autopsy. In proceedings of RSNA, Dec. 2009. Selected for publication in Radiographivs 2010.

M. Woisestchläger**. C. Jackowski, A. Persson.** Fire victim identification by post- mortem dental CT: radiologic evaluation of restorative materials after exposure to high temperatures. In proceedings of RSNA, Dec. 2009.

Persson A. Postmortem Dual Energy CT – the real Gold standard. SOMATOM World Summit 2009. Valentia, Spain.

***Engström M**, Vigren P, **Karlsson T, Landtblom AM.** The biology of hypersomnia clarified by working memory deficit in Kleine-Levin syndrome: An fMRI study. Sleep 2009;5:681-8.

***Ragnehed M, Engström M, Knutsson H, Axelsson Söderfeldt B, Lundberg P**. Restricted Canonical Correlation Analysis in Functional MRI-Validation and a Novel Thresholding Technique. Journal of Magnetic Resonance Imaging. 2009;29(1):146- 154.

2009 Peer-reviewed Review Articles

Kvitting JP, Dyverfeldt P, Carlhäll CJ, Sigfridsson A, Bolger AF, **Ebbers T, Engvall J.** MR allows a unique possibility to see how the blood flow affects the cardiovascular system. Läkartidningen 2009;106(30-31):1901-04

Kvitting JPE, Dyverfeldt P, Carlhäll C, Sigfridsson A, Bolger AF, **Ebbers T, Engvall J** Magnetresonanstomografi ger unika möjligheter att bedöma blodflödet och dess inverkan på hjärt-och kärlsystemet [in Swedish] Läkartidningen 2009;106:1901-1904.

***Engström, M., Tisell, A., Dahlqvist-Leinhard, O., Karlsson, T**., Vigren, P., **Lundberg, P., Landtblom, A.-M.** Kleine-Levin Syndrom (KLS) – A bipolar disorder? The Ninth International Review of Bipolar Disorders (IRBD 2009), Lisbon, Portugal.

***Tisell A, Engström M, Dahlqvist Leinhard O, Karlsson T**, Vigren P, **Landtblom AM, Lundberg P** Combining fMRI with qMRS for understanding the etiology of periodic hypersomnia, (ISMRM 2009, Hawaii, USA).

West J, Warntjes JB, Lundberg P, Landtblom AM. Accurate Estimation of Tissue Volumes by means of Quantitative MR on patients with Multiple Sclerosis (ISMRM 2009, Hawaii, USA).

Jaworski J**, Dahlqvist Leinhard O, Tisell A, Lundberg**

P, Landtblom AM. Treatment with glatiramer acetate prevents neurodegeneration in MS. An MRS study. (ECTRIMS 2009 Düsseldorf).

Eklund A, Ohlsson H, **Andersson M, Rydell J, Ynnerman A, Knutsson H.** Balancing an Inverted Pendulum by Thinking A Real-Time fMRI Approach. SSBA Symposium on Image Analysis, 18-20 March, Halmstad, Sweden, 2009.

***Sigfridsson A, Haraldsson H, Ebbers T, Knutsson H,** Sakuma H. In-vivo SNR in DENSE MRI: temporal and regional effects of field strength, receiver coil sensitivity, and flip angle strategies. In: Proceedings of the ISMRM Workshop on Cardiovascular Flow, Function & Tissue Mechanics: ISMRM Workshop on Cardiovascular Flow, Function & Tissue Mechanics, 11-13 September 2009, Sintra, Portugal. 2009.

***Sigfridsson A, Haraldsson H, Ebbers T**, Takase S, **Knutsson H,** Sakuma H. Flip Angle Strategies for Multiphase DENSE. In: ISMRM 17th Scientific meeting and Exhibition, Honolulu, Hawaii, USA, 18-24 April 2009.

Eklund A, Ohlsson H, **Andersson M, Rydell J, Ynnerman A, Knutsson H.** Using Real-Time fMRI to Control a Dynamical System by Brain Activity Classification. In: Medical Image Computing and Computer-Assisted Intervention – MICCAI 2009 12th International Conference, London, UK, September 20-24, 2009, Proceedings, Part I: 12th International Conference, London, UK, September 20-24, 2009, Proceedings, Part I. 1 Springer-Verlag; 2009. p. 1000-1008. Lecture Notes in Computer Science, 5761/2009.

2008 Peer-reviewed Original Articles

Malusek A, **Sandborg M and Alm Carlsson G**. CTmod - a toolkit for Monte Carlo simulation of projections including scatter in computed tomography. Computer Methods and Programs in Biomedicine 90, 167–178, (2008)

K. Lundin, M. Cooper, and **A. Ynnerman**. Haptic interaction with dynamic volumetric data. IEEE Transactions on Visualization and Computer Graphics, 14(2):263–276, March–April 2008.

J. Unger, S. Gustavson, P. Larsson, and **A. Ynnerman**. Free form incident light fields. Computer Graphics Forum, 27(4), 2008.

Carlhäll CJ, Nguyen TC**,** Itoh A, Ennis DB, Bothe W, Liang D, Ingels NB, Miller DC. Alterations in Transmural Myocardial Strain: An Early Marker of Left Ventricular Dysfunction in Mitral Regurgitation? Circulation 2008;118[suppl 1]:256–62 JIF> 5

Nguyen TC, Itoh A, **Carlhäll CJ,** Bothe W, Timek TA, Ennis DB, Oakes RA, Liang D, Daughters, GT, Ingels NB, Miller DC. The effect of pure mitral regurgitation on mitral annular geometry and saddle-shape. J Thor Cardiovasc Surg 2008;136:557-65

Nguyen TC, Itoh A, **Carlhäll CJ,** Bothe W, Oakes RA, Liang D, Ingels NB, Miller DC. Functional uncoupling of mitral annulus and left ventricle with pure mitral regurgitation and dopamine. J Heart Valve Dis 2008;17(2):168-78

Bothe W, Nguyen TC, Ennis DB, Itoh A, **Carlhäll CJ**, Lai DT, Ingels NB, Miller DC. Effects of acute ischemic mitral regurgitation on three-dimensional mitral leaflet edge geometry. Eur J Cardiothorac Surg 2008;33(2):191-97

Åström Aneq M, Lindström L, Fluur C, **Nylander E**. Long-term Follow-up of Patients With Arrhythmogenic Right Ventricular Cardiomyopathy Using Tissue Doppler Imaging. Scand. Cardiovasc. J 2008;42:368-74

Maret E, Brudin L, Lindström L**, Nylander E,** Ohlsson JL, **Engvall JE**. Computer-assisted determination of left ventricular endocardial borders reduces variability in the echocardiographic assessment of ejection fraction. Cardiovasc Ultrasound. 2008 11;6:55

Silén C, **Wirell S,** Kvist J, **Nylander E, Smedby O**. Advanced 3D visualization in student-centred medical education. Med Teach. 2008; 30(5):e115-24.

Maret E, Engvall J, Nylander E, Ohlsson J Feasibility and diagnostic power of transthoracic coronary Doppler for coronary flow velocity reserve in patients referred for myocardial perfusion imaging Cardiovasc Ultrasound. 2008; 29;6:12.

Hernelahti M, O. J. Heinonen, J. Karjalainen, **E. Nylander,** M. Börjesson. Sudden cardiac death in young athletes – time for a Nordic approach in screening? Scandinavian Journal of Medicine and Science in Sports. 2008 Feb, 18(2):132-9

Salminen H, Sääf M**, Ringertz H**, Strender LE. The role of IGF-I and IGFBP-1 status and secondary hyperparathyroidism in relation to osteoporosis in elderly Swedish women. Osteoporos Int. 2008; 19(2):201-9

Rosendahl L, Blomstrand P, Heiberg E, Ohlsson J, Björklund PG, Ahlander BM, **Engvall J.** Computer-assisted calculation of myocardial infarct size shortens the evaluation time of contrast enhanced cardiac MRI. Clin Physiol Funct Imaging. 2008;28:1-7.

Kvitting JP, Engvall J, Broqvist M, Franzen S, Andersson M, Ohlsson U, Nielsen NE. Recurrence of myxoma in the left ventricle with concurrent cerebral fusiform aneurysms after previous atrial myxoma surgery. J Thoracic and Cardiovascular Surgery 2008; 135:1172-3.

Haraldsson H et al. Improved Estimation and Visualization of Two-Dimensional Myocardial Strain Rate using MR Velocity Mapping. JMRI 2008; 28(3):604-611.

Dyverfeldt P, Kvitting JP, Sigfridsson A, Engvall J, Bolger A**, Ebbers T.** Intravoxel Velocity Standard Deviation Mapping Cardiovascular Blood Flow:

An In-vivo Feasibility Study of Generalized Phase Contrast MRI. JMRI 2008; 28(3):655-663.

Nguyen PK**,** Meyer C, **Engvall J**, Yang P, McConnell MV. Noninvasive Assessment of Coronary Vasodilation Using Magnetic Resonance Angiography in Patients at High Risk for Coronary Artery Disease. Journal of Cardiovascular Magnetic Resonance 2008;10:28.

Maret E, Brudin L, Lindstrom L, **Nylander E,** Ohlsson JL**, Engvall JE.** Computer-assisted determination of left ventricular endocardial borders reduces variability in the echocardiographic assessment of ejection fraction. J Cardiovascular Ultrasound 2008;6:55.

Rosendahl L, Blomstrand P, Ohlsson J, Björklund PG, Ahlander BM, Starck, SÅ, **Engvall J.** Late gadolinium uptake demonstrated with magnetic resonance in patients where automated PERFIT analysis of myocardial SPECT suggests irreversible perfusion defect. BMC Medical Imaging 2008, 8:17.

Antonsson J, Eriksson O, Blomstedt P, Bergenheim AT, Hariz MI, Richter J, Zsigmond P, **Wårdell K** Diffuse reflectance spectroscopy measurements for tissue type discrimination during deep brain stimulation,. J Neural Eng. 5 1-6, 2008. Number of citations: 13

C. Eckerstrom, E. Olsson**, Magnus Borga,** S. Ekholm, S. Ribbelin, S. Rolstad, G. Starck, A. Edman, A. Wallin, H. Malmgren, "Small baseline volume of left hippocampus is associated with subsequent conversion of MCI into dementia: The Göteborg MCI study", Journal of the Neurological Sciences, 272(1-2): 48-59, 2008.

Johanna Pettersson, **Karljohan Palmerius**, **Hans Knutsson**, Ola Wahlström, Bo Tillander, **Magnus Borga**, "Simulation of Patient Specific Cervical Hip Fracture Surgery With a Volume Haptic Interface", IEEE Transactions on Biomedical Engineering, 55(4): 1255-1265, 2008.

A. Klasson, M. Ahrén, E. Hellqvist, F. Söderlind, A. Rosén, P-O Käll, K. Uvdal, and M. **Engström**. Positive MRI contrast enhancement in THP-1 cells with Gd_2O_3 nanoparticles. Contrast Media & Molecular Imaging, 3:106-111, 2008.

F. Söderlind, M-A Fortin, R. M. Petoral Jr, **A. Klasson**, T. Veres, **M. Engström**, K. Uvdal, and P-O Käll. Colloidal synthesis and characterization of ultrasmall perovskite $GdFeO_3$ nanocrystals. Nanotechnology, 19:085608, 2008. JIF=3.8

CJ Thore, J Stålhand, **M Karlsson**: Towards a Non-invasive Subject Specific Estimation of Abdominal Aortic Pressure, Am J Physiol Heart Circ Physiol. Sep;295(3):H1156-64, 2008 Number of citations: 4

G Krishnamurthy, DB Ennis, A Itoh, W Bothe, J Swanson-Birchill, **M Karlsson**, E Kuhl, D C Miller and NB Ingels: Material Properties of the Ovine Mitral Valve Anterior Leaflet in vivo from Inverse Finite Element Analysis, Am J Physiol Heart Circ Physiol. Sep;295(3):H1141-49, 2008 Number of citations: 35

***Dahlqvist Leinhard** O, Johansson **A, Rydell J, Smedby Ö,** Nyström F, **Lundberg P,** Borga M. Quantitative Abdominal Fat Estimation Using MRI. 2008 19th International Conference on Pattern Recognition, ICPR 2008, art. no. 4761764

Warntjes JB, Dahlqvist Leinhard O, West J, Lundberg P. Rapid magnetic resonance quantification on the brain: Optimization for clinical usage. Magn Reson Med. 2008 Aug;60(2):320-9. (JIF: 3.3, GS: 33, ISI: 22)

Norén B, Dahlqvist O, Lundberg P, Almer S, Kechagias S, Ekstedt M, Franzen L, Wirell S, **Smedby Ö.** 31P Magnetic Resonance Spectroscopy separates advanced fibrosis from mild fibrosis in diffuse liver disease. Eur J Radiol. 2008 May;66(2):313

Kechagias, S., Ernersson, Å., **Dahlqvist, O**., **Lundberg, P**., Lindström, T., Nyström F. (2008) "Fast food based hyper-alimentation can induce rapid and profound elevations of serum aminotransferase levels in healthy subjects.", Gut, 57: 649 -654. Number of citations: 90 JIF > 5

Dyverfeldt P, Kvitting JPE, Sigfridsson A, Engvall J, Bolger AF, **Ebbers T** Assessment of Fluctuating Velocities in Disturbed Cardiovascular Blood Flow: In-Vivo Feasibility of Generalized Phase-Contrast MRI, Journal of Magnetic Resonance Imaging 2008;28:655-663.

Haraldsson H, Wigström W, Lundberg M, Bolger AF, **Engvall J, Ebbers T, Kvitting** JP-E. Improved Estimation and Visualization of Myocardial Strain Rate from Two-dimensional velocity MRI, Journal of Magnetic Resonance Imaging, 2008, 28(3): 604

A method for accurate localization of the first heart sound and possible applications. Ahlstrom C, Johansson A, **Lanne T,** Ask P. Physiol Meas. 2008;29(3):417-28.

Lower capacitance response and capillary fluid absorption in women to defend central blood volume in response to acute hypovolemic circulatory stress. M. Lindenberger, H. Olsen, and **T. Länne**. Am J Physiol Heart Circ Physiol 2008;295 H867-H873

Carlsson Tedgren Å and Ahnesjö A 2008 Optimization of the computational efficiency of a 3D collapsed cone dose calculation algorithm for brachytherapy Med. Phys. 35 1611-8

Carlsson Tedgren Å, Bengtsson E, Hedtjärn H, Johansson Å, Karlsson L, Lamm I-L, Lundell M, Mejaddem Y, Munck af Rosenschöld P, Nilsson J, Wieslander E, Wolke J 2008 Experience from long-term monitoring of RAKR ratios in 192Ir brachytherapy Radiother. Oncol. 89 217-221

Carlsson Tedgren Å and Grindborg J-E 2008 Audit on source strength determination for HDR and PDR 192Ir brachytherapy in Sweden Radiother. Oncol. 86 126-30

Larsson M, Eriksson P, **Kihlberg J**, **Smedby Ö.** Renal Artery Stenosis: Extracting quantitative parameters with a mathematical model fitted to Magnetic Resonance blood flow data. J Magn Reson Imaging 2008;27:140 –147. DOI:10.1002/jmri.21232

Silén C, Wirell S, Kvist J, **Nylander** E, Fyrenius A, **Smedby Ö.** Advanced 3D visualization in student-centred medical education. Medical Teacher 2008;30(5):e115-e120. DOI:10.1080/01421590801932228

Norén B, Dahlqvist O, Lundberg P, Almer S, Kechagias S, Ekstedt M, Franzén L, Wirell S, **Smedby, Ö**. Separation of advanced from mild fibrosis in diffuse liver disease using 31P magnetic resonance spectroscopy. European Journal of Radiology 2008;66(2):313-320. DOI:10.1016/j.ejrad.2007.06.004

Larsson M, **Persson A,** Eriksson P, **Kihlberg J, Smedby Ö.** Renal Artery Stenosis: Extracting Quantitative Parameters With a Mathematical Model Fitted to Magnetic Resonance Blood Flow Data. Institutionen för medicin och hälsa; Journal of Magnetic Resonance Imaging. 2008;27(1):140-147. Number of citations: 5

Wang C, Frimmel H, **Persson A, Smedby Ö.** An interactive software module for visualizing coronary arteries in CT angiography. Heidelberg/ Berlin: Springer; International Journal of Computer Assisted Radiology and Surgery. 2008;3(1-2):11-18. Number of citations: 13

Jackowski C, Persson A, Thali M. T, Whole Body Postmortem Angiography with a High Viscosity Contrast Agent Solution using Poly Ethylene Glycol (PEG) as Contrast Agent Dissolver. J Forensic Sci. 2008 Mar;53(2):465-8. Number of citations: 46

Jackowski C, Wyss M, **Persson A,** Classens M, Thali M.J,Lussi A. Ultra-high-resolution dual-source CT for forensic dental visualization discrimination of ceramic and composite fillings. Int J Legal Med. 2008 Jul;122(4):301-7 Number of citations: 22

Persson A, Jackowski C, Engström E, **Zachrisson H**. Advances of dual source, dual-energy imaging in postmortem CT. European Journal of Radiology. 2008;68(3):446-455. Number of citations: 28

***Dahlqvist Leinhard, O.,** Jaworski, J., Gustavsson, M., **Tisell, A**., Gladigau, D., **Landtblom, A-M., Lundberg, P.** Betainterferon treatment: Absolute quantification of white matter metabolites in patients with multiple sclerosis. ISMRM - International Society for Magnetic Resonance in Medicine in Toronto, May 3-9, 2008.

Jaworski J**, Dahlqvist Leinhard O, Lundberg P**, Gladigau D , Gustafsson Maria C, **Landtblom AM**. Follow-up of Absolute metabolite concentrations using MR spectroscopy in MS patients with betainterferon treatment. ACTRIMS/ECTRIMS Montreal Sept 2008.

Tisell A, Dahlqvist Leinhard O, Warntjes M, Engström M, Landtblom A-M, Lundberg P. (2008) Absolute quantification of LCModel water scaled metabolite concentration of 1H magnetic resonance spectroscopy (MRS) using quantitative magnetic resonance imaging (qMRI). Valencia, Spain. ESMRMB 2008.

***Tisell A, Engström M, Karlsson** T, Vigren P, **Dahlqvist Leinhard O, Lundberg P,** and **Landtblom A-M.** (2008) Etiology of periodic hypersomnia explored by combined functional and molecular neuroimaging methods. World Molecular Imaging Conference, Nice, 2008.

Vigren P, **Tisell A, Lundberg P, Landtblom AM**. Magnetic resonance imaging of the brain and magnetic resonance spectroscopy findings in patients with the Kleine Levin Syndrome. EFNS Madrid Aug 2008.

Rydell J, Knutsson H, Johansson A, **Dahlqvist Leinhard O**, **Borga M**. MRI Phase Unwrapping with Application to Water/Fat Separation. In: Proceedings of the SSBA Symposium on Image Analysis, 2008. 2008. p. 27-30.

Rydell J, Borga M, Knutsson H. Robust Correlation Analysis with an Application to Functional MRI. In: Acoustics, Speech and Signal Processing, 2008. ICASSP 2008. IEEE. IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP 2008, 31 March-4 April 2008, Las Vegas, NV, USA. IEEE conference proceedings; 2008. p. 453-456. IEEE International Conference on Acoustics, Speech and Signal Processing. Proceedings.

Ohlsson H, **Rydell J, Brun A,** Roll J, **Andersson M, Ynnerman A**, et al. Enabling Bio-Feedback using Real-Time fMRI. In: Proceedings of the 47th Conference on Decision and Control. 47th IEEE Conference on Decision and Control, Cancun, Mexico, December, 2008. p. 3336-3341.

***Rydell J,** Johansson A, **Leinard O D, Knutsson H**, Farnebäck G, **Lundberg P,** et al. Three Dimensional Phase Sensitive Reconstruction for Water/Fat Separation in MR Imaging using Inverse Gradient. In: Proceedings of the International Society for Magnetic Resonance in Medicine annual meeting (ISMRM'08): ISMRM 16th Scientific meeting and Exhibition, Toronto, Canada, 3-9 May 2008. p. 1519-.

Brodszki J, **Länne T,** Laurini R, Strevens H, Wide-Swensson D, Marsal K. Vascular mechanical properties and endothelial function in pre-eclampsia with special reference to bilateral uterine artery notch Brodszki. Acta Obstet Gynecol Scand. 2008;87(2):154-62.

2008 Peer-reviewed Proceedings

H. Ohlsson, **J. Rydell, A. Brun, A. Ynnerman** J. Roll, **M. Andersson,** and **H. Knutsson.** Enabling bio-feedback using real-time fMRI. In Proceedings of IEEE Conference on Decisionand Control, 2008.

F. Hernell, P. Ljung, and **A. Ynnerman**. Interactive global light propagation in direct volume rendering using local piecewise integration. In Proceedings of Volume Graphics, 2008.

K. Vrotsou**, A. Ynnerman**, and M. Cooper. Seeing beyond statistics: Visual exploration of productivity on a construction site. In Proceedings of International Conference Visualisation in Built and Rural Environments, 2008.

M. Jern, J. Rogstadius, J. Åström, and **A. Ynnerman**. Visual analytics presentation tools applied in html documents. In Proceedings of Information Visuualization 08, 2008.

Janerot-Sjöberg B, Winter R, **Engvall J**, Brodin L-Å. Mobila tekniker för diagnostik vid sängkanten. Läkartidningen 2008;105:3025-3030.

Gunnar Läthén, Jimmy Jonasson, **Magnus Borga**, "Phase Based Level Set Segmentation of Blood Vessels", Proceedings of 19th International Conference on Pattern Recognition, International Conference on Pattern Recognition, 2008.

Joakim Rydell, Magnus Borga, Hans Knutsson, "Robust Correlation Analysis with an Application

to Functional MRI", Acoustics, Speech and Signal Processing, 2008. ICASSP 2008. IEEE, IEEE International Conference on Acoustics, Speech and Signal Processing. Proceedings, 453-456, 2008.

Olof Dahlqvist Leinhard, Andreas Johansson, **Joakim Rydell, Örjan Smedby**, Fredrik Nystöm, **Peter Lundberg, Magnus Borga**, "Quantitative Abdominal Fat Estimation Using MRI", Proceedings of 19th International Conference on Pattern Recognition, 1-4, 2008.

J Renner, R Gårdhagen, M Karlsson : Subject Specific In-Vivo CFD Estimated Aortic WSSComparison Between Manual and Automated Segmentation Methods, ASME 2008 Summer Bioengineering Conference, Florida 2008.

J Lantz, **R Gårdhagen**, J Wren, **M Karlsson**: Heating in a Stenosed Coronary Artery With Pulsating Flow and Non-Newtonian Viscosity, ASME 2008 Summer Bioengineering Conference, Florida 2008.

R Gårdhagen, J Lantz, F Carlsson, **M Karlsson**: Large Eddy Simulation Of Flow Through A Stenosed Pipe, ASME 2008 Summer Bioengineering Conference, Florida 2008.

Dahlström N, Dahlqvist Leinhard O, Brismar T, Sandström P, **Kihlberg J, Lundberg P** and **Smedby Ö**. Leverfunktionsundersökning med leverspecifikt MR-kontrastmedel. Röntgenveckan, Uppsala 2008.

Dahlqvist Leinhard O, Dahlström N, Sandström P, Brismar T, **Kihlberg J, Smedby Ö, Lundberg P**. A liver function test based on measurement of liver specific contrast agent uptake. ISMRM, Toronto, Canada, 2008.

Dahlqvist Leinhard, O, Johansson, A, **Rydell, J, Smedby, O,** Nyström, F, **Lundberg, P, Borga, M**. "Quantitative abdominal fat estimation using MRI." In Proceedings of 19th International Conference on Pattern Recognition. Tampa, FL, USA: ICPR, 2008.

***Ebbers T, Haraldsson H, Dyverfeldt P, Sigfridsson A, Warntjes M,** and **Wigström L.** Higher order weighted least-squares phase offset correction for improved accuracy in phase-contrast MRI. 16th Int. Soc. Magn. Reson. Med. Toronto, 2008.

Dubuc, S. & **Karlsson, T.** (2008). Capacious memory. Paper presented at the Recollection Workshop: Remember/Know Paradigm, Neuropsychology, and Aging; Tours, May 28-30.

***Leinhard OD**, Johansson **A, Rydell J, Smedby Ö,** Nystrom F, **Lundberg P, Borga M.** Quantitative abdominal fat estimation using MRI. 19th International Conference on Pattern Recognition, 2008 DOI:10.1109/ICPR.2008.4761764

Wang C, Smedby Ö. An Automatic Seeding Method For Coronary Artery Segmentation and Skeletonization in CTA. The MIDAS Journal. 2008: (http://hdl.handle.net/10380/1434).

Jackowski, M. Warntjes, A. Persson, M. J Thali, J. Berge, MD. Postmortem Insitu MRI as an Adjunct to Autopsy for the Visualization of Myocardial Infarction. In proceedings of RSNA, Chicago Dec. 2008.

Wang, A. Persson, Ö. Smedby. Multi-Layer QuickTime Virtual Reality Object Movie: a new way to share high-dimensional post-processing results. In proceedings of RSNA, Dec. 2008.

A Persson, **J. Berge**, M. Lindblom, **C. Jackowski**. A State-of-the-art Pipeline for postmortem CT and MRI visualization – From data acquisition to interactive image interpretation at autopsy. In proceedings of RSNA, Dec. 2008.

Zachrisson H, Persson A, Engvall J, Stenestrand U, Janzon M. CT angiography-clinical experience from Linköping University Hospital. In: X Svenska Kardiovaskulära Vårmötet, 2008. 2008. p. 40.

C Jackowski, J.B.M. Warntjes, A. Persson, M.J. Thali, J. Berge. Postmortem in situ MRI as an adjunct to autopsy for the diagnosis of myocardial infarction. In proceedings of ISMRM, Toronto 2008.

Wang, P. Quick, A. Persson, Ö. Smedby Viewing 4D Cardiac CTA Datasets with Quicktime VR – An Alternative to Real-time Dynamic Volume Rendering. In proceedings of ECR 2008.

Wang, A. Persson, J. Engvall, M. Gjerde , Ö. Smedby Visualize Coronary Arteries In 3D Without Slabs: A Fast and Reliable 3D Segmentation Software For Coronary CTA. In proceedings of ECR 2008.

Rydell J, Knutsson H, Borga M. Bilateral Filtering of fMRI Data. IEEE Journal Of Selected Topics In Signal Processing. 2008;2(6):891-896.

Pettersson J, Palmerius K, Knutsson H, Wahlström O, Tillander B, **Borga M.** Simulation of Patient Specific Cervical Hip Fracture Surgery With a Volume Haptic Interface. IEEE; IEEE Transactions on Biomedical Engineering. 2008;55(4):1255- 1265.

Ohlsson H, Roll J, **Brun A, Knutsson H, Andersson M,** Ljung L. Direct Weight Optimization Applied to Discontinuous Functions. In: Proceedings of the 47th IEEE Conference on Decision and Control: 47th IEEE Conference on Decision and Control, Cancun, Mexico, December, 2008. IEEE; 2008. p. 117-122.

2008 Peer-reviewed Review Articles

Ringertz H, Wahlgren H: Pediatrisk radiologi. Övre luftvägar och lungor. In Radiologi, Studentlitteratur, Lund - Sweden 2008, 737-753.

Lidegran M, **Ringertz H**: Pediatrisk radiologi. Hjärta och stora kärl. In Radiologi, Studentlitteratur, Lund - Sweden 2008, 754-759.

Ringertz H, Ullberg U: Pediatrisk radiologi. Gastrointestinalkanalen. In Radiologi, Studentlitteratur, Lund - Sweden 2008, 760-772.

Johansson K, **Ringertz H**: Pediatrisk radiologi. Urinvägarna. In Radiologi, Studentlitteratur, Lund-Sweden 2008, 773-783.

Finnbogason T, **Ringertz H**: Pediatrisk radiologi. Rörelseorganen. In Radiologi, Studentlitteratur, LundSweden 2008, 784-796.

Ringertz H: The Big Picture. Heading into the future, a symbiotic relationship. Diagnostic Imaging Europe 2008;(6):40

Michael Sandborg Bildkvalitet vid projektionsradiografi (Kapitel i boken Radiologi, Redaktörer Pettersson, H – Aspelin, P) Studentlitteratur, ISBN: 9789144038872 (2008)

A Persson Virtual Autopsy in Forensic Medicine. SOMATOM Sessions, May 2008. www.siemens.com/healthcare-magazine.

A Persson. The heart examined with tomography in few seconds. Läkartidningen. 2008 Oct 22-28;105(43):3043-6.

162 ANNUAL ACCOUNTS

Since CMIV is part both of the university and the county council the finances are also split in two parts. These annual accounts are a summary of the two parts during the last five years.

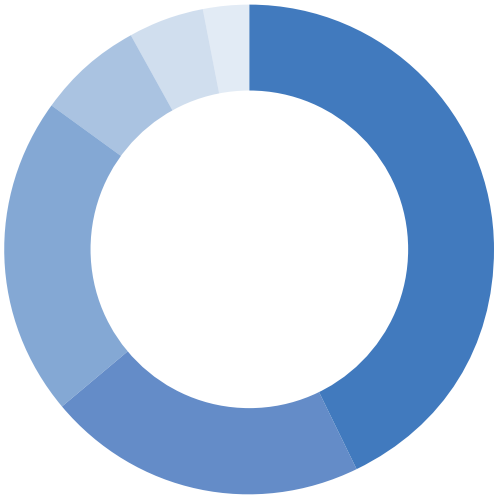
During 2009 - 2013, the cost per year to operate CMIV's infrastructure and R&D platform were approximately 12 million SEK. This was partially financed through a basic grant from the County council of Östergötland and Linköping University with 3.5 million, agreements with industry approximately 2 million, Wallenberg Foundation 1 million and clinical and research revenue from CT scan / MRI scans 6 million. The total turnover was approximately 30 million SEK per year.

The annual basic grant from Linköping University and the County Council of Östergötland is 3.5 million SEK distributed in 1 million each from technical and medical faculty and 1.5 million from the county council. The diagram shows an overview of how the grant is being used in the CMIV administration.

CMIV receives funding from research funds and the industry both directly to the R&D platform and to specific research projects. In addition, the affiliated researchers have their own funding; however these grants will not be presented here.

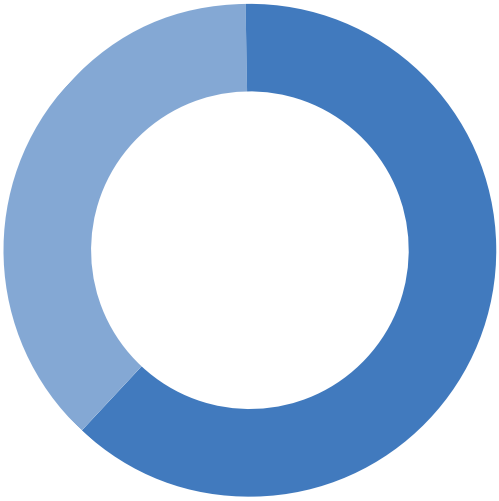
Year	2013	2012	2011	2010	2009
Total revenue	**35 576**	**32 629**	**32 800**	**26 876**	**27 349**
Expenses					
Staff expenses	-16 756	-15 102	-14 645	-13 632	-14 237
Cost of premises	-2 034	-2 145	-1 975	-1 683	-2 150
Misc. operating expenses	-8 876	-7 653	-9 549	-10 282	-5 557
Depreciation expenses	-5 336	-4938	-5 883	-3 291	-4 937
Financial expenses	-185	-125	-403	-103	-112
Total Expenses	**-33 187**	**-29 963**	**-32 455**	**-28 991**	**-26 993**
Result of operations	**2 389**	**2 666**	**345**	**-2 115**	**356**

Numbers in thousands of SEK.



Basic grant overview 2009-2013

- 43% - Salaries, CMIV staff
- 21% - Research school
- 21% - Clinical Scientists
- 7% - Central administration
- 5% - Travels and conferences
- 3% - Office supplies and computers



Research funding 2009-2013

- 63 250 - External funds
- 38 700 - Industrial funds

Numbers in thousands of SEK

Linköpings universitet

Landstinget i Östergötland

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