GSISH

BERTI

Technische Universität München

Annual Report 2013/2014

TUM Graduate School of Information Science in Health (GSISH)

Biomedical Imaging & Informatics: European Research and Training Initiative (BERTI)

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TUM Graduate School of Information Science in Health (GSISH)

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http://gsish.tum.edu
http://www.berti.tum.de

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Directors´ Messages

Message by the GSISH Director

PROF. DR. RER. NAT. AXEL HAASE

“By offering a tailor-made doctoral education, the GSISH´s vision is to educate a new generation of uniquely trained scientists.”

The importance of biomedical informatics and biomedical engineering for the healthcare sector has risen continuously during the last years. The fast scientific progress achieved in biomedical science has to be translated back to the medical field so that high quality and effective health care can be assured. In order to handle the massive complexity that comes along with new possibilities of processing medical data and an increasing amount of acquired data in many different quantitative measurements which affect directly the clinical decision-making process, we need multidisciplinary collaboration of a broad spectrum of disciplines. We believe, that we need for this scientific interaction experts in information science, natural sciences and engineering that have a profound understanding of the biomedical disciplines terminology and scientific culture, that true multidisciplinarity can arise and, in the end, progress in clinical applications can be achieved. GSISH’s mission is to train a new generation of researchers, who have a profound background in information science but at the end will be both: experts in information science and the medical field. We believe that especially the information science related disciplines such as informatics or medical engineering will be the most important drivers and mediators for innovation in all health-related scientific disciplines. They are the ones, which embrace and support those fields, and also facilitate the pioneering of new services in medicine.

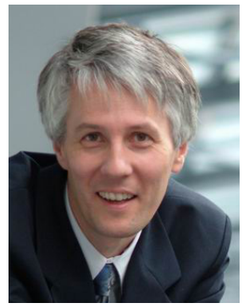
To accomplish our ambitious goal, GSISH has developed a new approach and overall concept for education and research for doctoral candidates working at the interface of information science and healthcare thereby placing strong emphasis on the scientific training. For realizing our approach, GSISH can draw upon an innovative scientific community with a longstanding research tradition. As an interdisciplinary graduate school, we provide excellent opportunities for conducting doctoral research and qualify for the best jobs available, both in academia, university hospitals, and industry.

I would like to take the occasion to thank all those who contributed to the success of the school - our supporters, our cooperation partners, our national and international faculty, our management office and of course our doctoral candidates for their continuous input.
GSISH’s mission has been to train future experts at the interface of information sciences and health. However we have to realize that data are acquired using technologies developed in natural sciences and engineering. Those are applied to scientific problems in biology and medicine. For a true multidiciplinarity all natural sciences, engineering, informatics, and biosciences have to come together. The future of GSISH will be placed in this area, which is often named “bioengineering”, where young researchers have a bright future for activities in academia and industry.

On behalf of all members of the GSISH, Alois Knoll and I are pleased to present the GSISH Annual Report of 2014. The report gives an overview of the research activities of the international graduate school for the scientific year 2013/2014.

Axel Haase
GSISH Director

Message by the GSISH Co-Director



PROF. DR.-ING. ALOIS C. KNOLL

“A multidisciplinary and international setting can only be as good as the people involved.”

Revolutionizing doctoral education is the very ambitious aim of the TUM Graduate School of Information Science in Health (GSISH). Traditionally, doctoral candidates work with one professor for several years, during which time they contribute to the chair’s scientific work and also are involved in teaching. Further they are given the opportunity to write a doctoral thesis. This approach still works well within highly specialized disciplines. However, it does not meet the requirements of the GSISH, which aims to advance medical progress by natural sciences, engineering, informatics and medicine. Here, we want to achieve an active, cross-discipline exchange.

To attain this, GSISH has established a new concept for training doctoral candidates, who come from such diverse disciplines as computer science, engineering, physics or chemistry, and whose goal is to develop applications for the medical field. GSISH’s central theme is that the school will provide as much guidance to the doctoral candidates as necessary – however, the main purpose is to provide challenging opportunities, which will aid and encourage them to develop their individual scientific profile. To meet this aim, the GSISH provides high level scientific and interdisciplinary skills training, international exchange, a large variety of transferable skills courses as well as social activities.

To realize our vision, coordinated efforts have been put into place. The GSISH has profited greatly from the support of the TUM Executive Board of Management, the TUM Graduate School as well as the Deans of the Departments of Medicine and Computer Science. The GSISH would not be where it is today without the generous support of the Bavarian State Ministry of Sciences, Research and the Arts; and it has also benefited significantly from other partners such as the General Electric Research Center Europe, or the Helmholtz Center Munich.

Besides that in 2013 we successfully handed in a propsal to the European Union and are funded with a total budget of three million Euro for the new doctoral program named *Biomedical Imaging & Informatics - European Research and Training Initiative (BERTI)*. As well as GSISH also this program reaches across the traditional borders between different disciplines and embraces multidisciplinary collaboration in every dimension.

With the current landscape, I it is a plausible next step to transfer the gained knowledge in interdisciplinary graduate training to the initiative BioEngineering. I am personally excited to support this important step.

Alois C. Knoll
GSISH Co-Director

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TUM Graduate School of
Information Science in Health (GSISH)

Status October 2014

Message by GSISH Managing Director

A warm welcome also from my side.

In May 2013 I joined the GSISH management team, because I believe in the idea of an interdisciplinary graduate education. We need T-shaped researchers, thinkers and believers to face the challenges in health care and explore the fascinating mysteries of nature. We challenge our doctorate candidates, not only to become experts in their core field, but also to gain an understanding for other disciplines in order to build bridges and act as a broker.

Within our team it is a great pleasure to support your faculty and the doctoral candidates in the necessary administrative work, facilitate individual assistance for the projects, and be a dialog partner for our members and also address topics beyond the scientific work. At TUM we see our doctoral candidates as young researchers -like the EU term early stage researcher- still they need training, however, we embolden them to find their own way.

For the GSISH this year has been very challenging. BERTI started with the Kick Off in January, followed by a very intense phase of recruiting the 14 doctoral candidates and the project is now running very well as you can assure yourself on pages 38 - 57 of this Annual Report.

Within GSISH we also recruited new doctoral candidates, who are very motivated to generate their individual curriculum within our graduate school. However, many of our members, mostly stipends were able to finish their doctorate this year and we are very proud of having now 23 alumni.

Starting in 2008 GSISH had a transit time till end of 2014; therefore we are obliged to proof the importance of a graduate school exclusively at the interface of computer science, natural sciences, engineering and medicine. In our opinion we have some good arguments: More than 189 journal publications, 349 congress publications, 26

DR. PETRA DORFNER

"We need T-shaped researchers, thinkers and believers to face the challenges in health care."

international exchanges, and 25 exclusive scientific events for GSISH. GE invested more than 700K € within the last years in our doctoral projects, we convinced the EU to finance our proposal BERTI with 3M € till 2017, by our lean management we were able to spend more than 75% directly for our doctoral candidates, and summing up we quadrupled the investment of the TUM Executive Board.

With the experience we gained during the last years, we are now ready for the challenge of transporting the idea of interdisciplinary doctoral education in a TUM School of Bioengineering.

Dr. Petra Dorfner
GSISH Managing Director

TUM Graduate School

The TUM-GSISH is part of TUM Graduate School (TUM-GS), which is the umbrella organization that embraces all TUM graduate centers, set up by TUM´s 13 departments and interdisciplinary research centers. By being affiliated to the umbrella organization of TUM Graduate School, GSISH ensures its members the highest quality possible in doctoral education, as the entire diversity of TUM´s excellent scientific qualification program.

Together with TUM-GS, GSISH provides high-level answers to the increasing complexity of research matters and today´s expectations of labor markets. The integration of GSISH into TUM Gradate School will, moreover, guarantee its long-term operation and its ongoing development.

TUM Graduate School aims at providing an environment with optimal conditions for outstanding individual doctoral education. Established in 2008, the Graduate School of Information Science in Health has always followed this approach and supported more than 45 doctoral candidates and supervisors in their research on the interface of medicine, computer science, natural science and engineering in 2013.

The mission of our school is to educate a new type of scientist while **establishing true multidisciplinarity**, understanding other ways of thinking, bridge cultural gaps and build common ground and start early on with **joint research and training**.

According to this mission we would like to list the value add for the different participants of our Graduate School in the following:

Doctoral Candidates
- Interdisciplinary Research
- Home when working in more than one Faculty
- Individualized Training
- International Experience and Network
- Financial Support

Professors
- Collaborative Projects
- Financial Support
- Support in Organizational and Bureaucratic Issues
- Support in Writing Proposals
- International Network

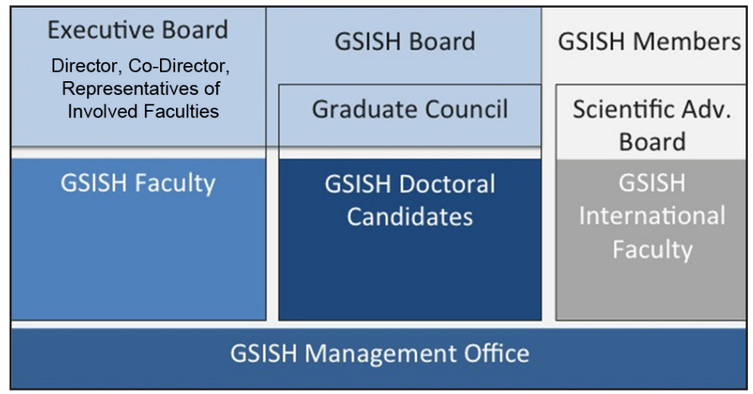
Technische Universität München
- Interdisciplinary Graduate School in the field of Health Care
- Pool of Competences
- Connection for Faculties
- Structural Program for International Partners

Currently the GSISH has **47 doctoral candidates**, of which **47% have an international background** (23% are from countries outside of Europe). Further **more than 25% are female**. Our faculty is rooted in various disciplines and highly motivated to train outstanding doctoral candidates in the interdisciplinary field. Coming from eight departments of TUM and also from other institutions in the Munich area they represent an unique network.

Besides that, the GSISH is very proud of the extraordinary achievements of its **23 alumni**, who are making an impact in so many areas in Germany and around the world. They are entrepreneurs (e.g. Dr. Thomas Wendler, Co-Founder of SurgicEye GmbH / Munich, Germany), industrial property agents (Dr. Andreas Oancea, patent attorney, Wuesthoff&Wuesthoff GmbH / Munich, Germany), cutting-edge scientists (e.g. Dr. Lukas Gorzelniak, Research Scientist at Philips Research / Eindhoven, Holland or Dr. Suraj Nair, Research Fellow at TUM Create / Singapore), and above all, committed to never standing still.

GSISH`s quality is defined by both our talented doctoral candidates and by our senior researchers. In particular, it is our Principal Investigators who lay the foundation for our multidisciplinary doctoral education.
The organizational structure of GSISH is as following:
The Executive Board of GSISH is headed by Prof. Axel Haase, Director, and Prof. Alois Knoll, Co-Director of the school. Further Prof. Henningsen, Prof. Bungartz, Prof. Kuhn, Prof. Lüth, Prof. Mewes, Prof. Pfeiffer, and Prof. Schwaiger are members of the GSISH Executive Board.

The GSISH management staff consists of two permanent staff, Dr. Petra Dorfner and Katharina Lang; further Dr. Andrea Glogger was hired as executive project manager of BERTI in October 2014. The team is continuously supported by student assistants and interns.



GSISH - Involved People.

Involved People

GSISH Executive Board

Prof. Dr. rer. nat. Axel Haase
Director
TUM, IMETUM

Prof. Dr.-Ing. Alois Knoll
Co-Director
TUM, Informatics

Prof. Dr. med. Peter Henningsen
Dean Medicine
TUM, Medicine

Prof. Dr. Hans-Joachim Bungartz
Dean Informatics
TUM, Informatics

Prof. Dr. med. Klaus A. Kuhn
Further Representative Medicine
TUM, Medicine

Prof. Dr. rer. nat. Dr.-Ing. Tim C. Lüth
Representative Mechanical Engineering
TUM, MiMed

Prof. Dr. rer. nat. Hans-Werner Mewes
Representative Life Sciences
Helmholtz Zentrum München

Prof. Dr. rer. nat. Franz Pfeiffer
Representative Physics
TUM, Physics

Prof. Dr. med. Markus Schwaiger
Representative of outstanding interdisciplinary Research Projects
TUM, Medicine

GSISH Faculty

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TUM, Informatics
Prof. Dr. med. Stephanie E. Combs
TUM, Medicine
Prof. Dr. med. Robert Bauernschmitt
Isarherzzentrum München
Prof. Dr. oec. troph. Hannelore Daniel
TUM, Molecular Nutrition Unit
Prof. Dr. rer. nat. Claudia Eckert
TUM, Informatics / Fraunhofer Institution AISEC
Prof. Dr. med. Rüdiger von Eisenhart-Rothe
TUM, Medicine
Prof. Dr. med. Hubertus Feußner
TUM, Medicine
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TUM, Chemistry
Prof. Dr. med. Bernhard Hemmer
TUM, Medicine / Neuro-Kopf-Zentrum
Prof. Dr.-Ing. Joachim Hornegger
Friedrich-Alexander Universität Erlangen-Nürnberg
Prof. Dr. rer. nat. Alexander Horsch
TUM, Medicine
Prof. Dimitrios C. Karampinos, PhD
TUM, Medicine
Prof. Alfons Kemper, PhD
TUM, Informatics
Prof. Dr. med. Eberhard Friedrich Kochs
TUM, Medicine
Prof. Dr. med. Arthur Konnerth
TUM, Medicine
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Johannes Gutenberg Universität Mainz, Informatics
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LMU, Economics / Helmholz Zentrum München
Prof. Dr. rer. nat. Ulrich Mansmann
LMU, Medicine
Prof. Dr. med. Alexander Meining
TUM, Medicine
Prof. Dr. med. Thomas Meitinger
TUM, Medicine / Helmholtz Zentrum München
Prof. Dr. rer. nat. Björn Menze
TUM, Informatics
Prof. Dr. med. Thomas Misgeld
TUM, Medicine
Prof. Dr. med. Michael Molls
TUM, Medicine
Prof. Nassir Navab, PhD
TUM, Informatics
Prof. Vasilis Ntziachristos, PhD
TUM, Electrical Engineering and Information Technolgy / Helmholtz Zentrum München
Prof. Dr. rer. nat. Fridtjof Nüsslin
TUM, Biomedical Physics
Prof. Dr. med. Christian Peschel
TUM, Medicine
Prof. Dr. med. Dr. h.c. Maximilian Reiser
LMU, Medicine
Prof. Dr. rer. nat. Burkhard Rost
TUM, Informatics
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TUM, Medicine
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TUM, Medicine
Prof. Dr. rer. nat. Fabian J. Theis
TUM, Mathematics
Prof. Dr. med. Kurt Ulm
TUM, Medicine
Prof. Dr. oec. publ. Stefan Wagenpfeil
Universität des Saarlandes, Medicine
Prof. Dr. rer. nat. Dr. med. Heinz-Erich Wichmann
LMU, Epidemiology / Helmholtz Zentrum München
Prof. Dr. rer. nat. Sibylle Ziegler
TUM, Medicine
Prof. Dr. med. Claus Zimmer
TUM, Medicine / Neuro-Kopf-Zentrum

Mentors

Dr. rer. nat. Marion I. Menzel
GE Global Research Europe
Dr. rer. nat. Thomas Wendler
SurgicEye GmbH

International GSISH Faculty

Basia Belza
The University of Washington
Peter Elkin
Mount Sinai School of Medicine
Gregory D. Hager
Johns Hopkins University
Paul Harris
Vanderbilt University
Stan Huff
The University of Utah / Intermountain Healthcare
Casimir A. Kulikowski
Rutgers University
Blackford Middleton
Harvard University / Partners Health Care
Mamoru Mitsuishi
The University of Tokyo
Matthias Nahrendorf
Harvard Medical School
Shu Takagi
The University of Tokyo
Russell H. Taylor
Johns Hopkins University
Ralph Weissleder
Harvard Medical School
Guang-Zhong Yang
Imperial College

GSISH Facts & Figures

Input & Outcome

In order to quantify the activities of GSISH within the last 6 years, we generated a chart to visualize the input and the corresponding outcome.

Input

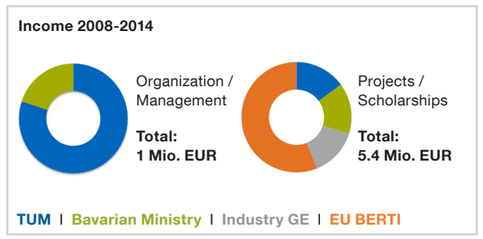
76 young researchers being supervised by **54 professors and supervisors**
11 different disciplines I **18** foreign countries
Financed with **1.6 Mio EUR** TUM intern I **1 Mio EUR** from the Bavarian Ministry
Financial support by industry (GE) **800.000 EUR**

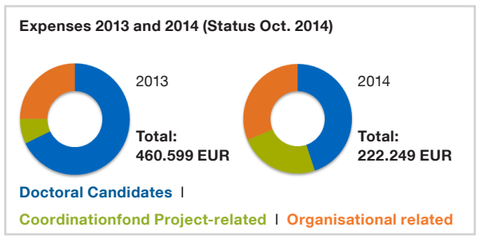
Outcome

23 Alumni
189 Journal Publications (**69** First Authorships)
349 Congress Publications (**132** First Authorships)
362 International Conferences I **55** National Conferences I **26** International Research Stays
142 Workshops and Seminars I **93** Transferable Skills Courses
25 GSISH Scientific Events (Symposia, Workshops, Summer/Winter Schools) I **8** Granted Proposals
1 ITN BERTI (Coordination Prof. Knoll / GSISH funded with **3 Mio EUR**)
1 ITN MacSeNet (Associated Partner / Prof. Menze)

Resources & Finances

TUM and the Bavarian Ministry invested each 1Mio EUR in GSISH in 2008, and due to successful projects TUM added 0.6 Mio EUR supplementary in the years afterwards. Further we were able to rise 0.75 Mio EUR from GE Global Research Europe and successfully apply for an EU ITN project with 3 Mio EUR funding. In the following we split the incomes for organization/management and projects/scholarships. The original investment of TUM with 1.6 Mio EUR has meanwhile been **quadrupled** and GSISH showed its potential of development.





Accured from 2009 till 2012, **more than 75% of the expenses were spent directly on projects for doctoral candidates** (scholarships, project means, summer schools, support for traveling, etc.). As more and more GSISH stipends have finished their doctoral thesis and therefore the scholarship funds have been reduced, our overall expenses are declining, too. However, far more than half of the budget is spent for our doctoral candidates. Due to the responsible management end of 2014 there will be means left. Subtracting the planned costs for current doctoral candidates, the remaining funds can be allocated to support the financing of the School of Bioengineering in 2015.

Fast Facts about GSISH Doctoral Candidates

(including BERTI ESRs)

GSISH Doctoral Candidates do not only work within multidisciplinary research groups, they themselves have a very diversified background with 64% of them coming from one of the 18 foreign countries represented in GSISH.

Hansjörg Baurecht
Supervisors:
Prof. Dr. Stefan Wagenpfeil
PD Dr. Stephan Weidinger

Start of PhD-work at GSISH:
February 2010

Development of a statistical method to identify pleiotropic loci for atopic eczema and psoriasis using GWAS data

Atopic eczema and psoriasis are common chronic inflammatory skin diseases which rarely co-exist within the same patient, reflecting mutually exclusive immunological features. Genome-wide association studies have identified eczema- and psoriasis-specific but also co-incident susceptibility loci.

These loci may represent overlapping pathophysiological mechanisms and important switch points in pathways determining susceptibility to one or both diseases.
Using imputed genome-wide association data from 6 independent case-control cohorts comprising more than 18,000 individuals, we aim to systematically compare and contrast eczema and psoriasis on a genomic level. Analytical approaches based on meta-analysis techniques are developed and applied to the genome-wide datasets.

Chen Chen
Supervisors:
Prof. Dr. Alexander Horsch
Prof. Dr. Alois Knoll

Start of PhD-work at GSISH:
May 2010

Physiological telemonitoring of chronically ill patients with mobile multimodal biosensor measurements

Remote monitoring systems for elderly using modern ICT is quite popular nowadays, attracting researchers' attention. In this paper, we propose a wireless body sensor network (WBSN) platform prototype with three-layered framework which integrates wearable sensors, smartphone and PC for monitoring physical activities of elderly over distance. We build the system based on Bluetooth and WLAN communication technologies and transmit captured data from sensors to application running on a smartphone and then further to a remote server for health assessment.

The Ph.D project aims to create a generic design and prototype implementation based on open healthcare and ICT standards applying model-driven software development, this Ph.D. project shall address the following research question:
How can model-driven software design enable flexible integration of multimodal biosensor data acquisition in- and outside the home of chronically ill patients in the electronic patient record at medical centers, in order to support secure telemonitoring of physiological parameters.

3D multispectral reconstruction and visualization for skin cancer detection

This project aims to develop methods and algorithms to perform a 3D reconstruction of the skin surface using multi spectral images from a specialized scanner. It furthermore aims to register and match the result to previous scans of the same patient in order to track skin disease progression.

The last step will be the development of methods and algorithms for visualizing the resulting multi spectral images, and, if possible, to automatically compute important metrics for suspicious naevi corresponding to the typical medical criteria. Finally, an intuitive presentation of the results and evaluations will be developed to aid the physicians in their work. One of the main motivations of this work is to improve skin cancer detection in early stages.

Alexandru O. Duliu
Supervisors:
Prof. Dr. Nassir Navab
Prof. Dr. Johannes Ring

Start of PhD-work at GSISH:
November 2010

Robot-assisted microscopic manipulation for vitreo-retinal ophthalmologic surgery

The project aims towards research and development of an innovative robotic assistance device for vitreo-retinal surgery. Eye surgeons around the world have to deal with every day scenarios demanding high-precision manipulation of surgical devices. The manipulation accuracy can be in the scale of microns which is very difficult to achieve even by the most trained and experienced surgeon.

Till date a few robotic devices exist to assist surgeons in such high-precision tasks. However, these devices have some limitations in terms of usability respectively integration and are not yet widely used. We propose an innovative robotic device towards overcoming the current limitations. Main focus will be the development, control and evaluation of this apparatus such that inadequateness of prevalent devices and methods can be improved, the delicate technique of vitreo-retinal surgery can be facilitated, the risk of complications reduced and new perspectives for novel therapeutic strategies may become feasible.

Martin Eder
Supervisors:
Prof. Dr. Alois Knoll
Prof. Dr. Dr. Chris P. Lohmann

Start of PhD-work at GSISH:
June 2010

Sebastian Fürst
Supervisors:
Prof. Dr. Sibylle Ziegler
Prof. Dr. Axel Haase

Start of PhD-work at GSISH:
September 2010

Reducing Motion and Attenuation Artefacts in Hybrid MR-PET Imaging

Similar to the already commercially available and for both the patient and the physician highly advantageous PET/CT scanners (positron emission tomography/computed tomography), MR-PET (magnetic resonance/positron emission tomography) is a multimodal medical imaging concept yielding functional information embedded in an anatomical view of the human body. Although the first studies give a positive outlook for the future, there is still a number of open issues in the context of combining MR and PET. Since a PET image requires several minutes to be acquired, it is the sum of information of several breathing and heart cycles. This motion of the inner structures in addition to external patient motion leads to image artefacts, making tumour volume definition as well as tracer uptake quantification of PET data inaccurate. Such artefacts could be corrected through MRI (magnetic resonance imaging) motion registration and the use of this information as an input for the PET reconstruction. Although the PET detector ring will be integrated within the MR component, radiofrequency coils have to be placed in the field of view of the PET detector ring. These coils are devices that facilitate a higher MR image quality, but in this case lead to a lower PET image quality due to their position and the resulting attenuation of the gamma rays. The exact effects that the coils have on the PET component need to be studied and possible correction techniques be developed. The above mentioned research and development on both topics will be done within the scope of this project.

José F. Gardiazabal
Supervisors:
Prof. Dr. Nassir Navab
Prof. Dr. Sibylle Ziegler

Start of PhD-work at GSISH:
January 2012

Navigated gamma probes for tomographic reconstruction

Functional imaging systems for intraoperative guidance have shown remarkable results. These results, even tough very positive in some cases, tend to suffer from high variability, highly correlated with the experience of the operator. A highly trained user produces datasets that, once reconstructed, can rival a gantry-based SPECT machine, while a novice user usually cannot get similar results.

At the same time, new hand-held detectors have been developed, and it is now possible to use a 2D gamma camera with hundreds of pixels instead of a single detector device. This new detector opens the door for faster acquisitions and better quality reconstructions, but presents big challenges for the calibration, acquisition pipeline and the reconstruction schemes. The proper solution to those challenges is critical to exploit the advantages of these new detectors.

This work presents the first steps towards solving those problems.

Denoising of Diffusion MRI Data Using Prior Knowledge

Diffusion magnetic resonance imaging (diffusion MRI) is an emerging non-invasive imaging method which provides a novel characterization of biological tissue. Notably, it allows examining the orientation and integrity of nerve fiber tracts in the human brain. Diffusion-MRI-based quantification of nerve fiber integrity allows improved diagnosis of diseases such as multiple sclerosis, whereas information about nerve fiber orientation can be used for treatment planning. Moreover, diffusion MRI has a wide variety of additional potential applications in biology and medicine, both inside and outside the central nervous system. This biomedical imaging method has been established for early stroke diagnosis, and many other applications are still in development and have great innovation potential. Diffusion MRI is feasible on most clinical MR scanners.

The obtained data is in most cases six-dimensional, and the major problem is the trade-off between scan time, image resolution and signal-to-noise ratio. The goal of the ongoing project is to investigate whether combinations of available and novel image denoising methods can improve the quality of diffusion MRI data and e.g. allow a more reliable diagnosis of multiple sclerosis.

Vladimir Golkov
Supervisors:
Prof. Dr. Axel Haase
Prof. Dr. Daniel Cremers
Dr. Marion I. Menzel
Dr. Jonathan Sperl

Start of PhD-work at GSISH:
June 2013

HealthcareRobotics (HeRo)

Steerable catheters and sheaths for endovascular interventions are commonly used in the diagnosis and treatment of electrophysiological cardiac disorders and are finding increasing applications in structural heart repair. As the range of clinical procedures increases, so does the demand for accurate and flexible tip steering.

Conventional steerable tools have a fixed bending region, but in many cases it is desirable to be able to choose the bending region or even to have 2 independently controlled bending regions to enable control of the tip angle and tip location independently.

This Ph.D. work will consist of design, modeling, fabrication, and evaluation of disposable snake robot mechanisms for endovascular tools.

Eva Graf
Supervisors:
Prof. Dr. Tim C. Lüth
Prof. Dr. Alois Knoll

Start of PhD-work at GSISH:
June 2013

Sven M. Haase
Supervisors:
Prof. Dr. Joachim Hornegger
Prof. Dr. Hubertus Feußner
Prof. Dr. Alois Knoll

Start of PhD-work at GSISH:
January 2012

Time-of-Flight for 3D Endoscopy and Open Surgery

Minimally invasive procedures are of growing importance in modern surgery. Orientation is a major issue during these interventions as conventional endoscopes only cover a limited field of view.

We propose the application of a Time-of-Flight (ToF) satellite camera at the zenith of the pneumoperitoneum to survey the operation situs. Due to its limited field of view we propose a data fusion of different 3-D views to reconstruct the situs using photometric and geometric information. We are able to reconstruct the entire abdomen with a mesh-to-mesh mean error of less than 5mm compared to CT ground truth data, at a frame rate of 3Hz.

The framework was evaluated on real data from a miniature ToF camera in an open surgery pig study and for quantitative evaluation with a realistic human phantom. With the proposed approach to operation situs reconstruction we improve the surgeons‘ orientation and navigation within the human body and therefore speed up surgical interventions and increase safety.

Alexander Hartl
Supervisors:
Prof. Dr. Sibylle Ziegler
Prof. Dr. Nassir Navab
Prof. Dr. Markus Schwaiger

Start of PhD-work at GSISH:
November 2009

Computational modeling of detection physics for 3D intraoperative imaging with navigated nuclear probes

Nuclear medicine imaging modalities assist commonly in surgical guidance given their functional nature. However, when used in the operating room they present limitations. Pre-operative tomographic 3D imaging can only serve as a vague guidance intra-operatively, due to movement, deformation and changes in anatomy since the time of imaging, while standard intra-operative nuclear measurements are limited to 1D or (in some cases) 2D images with no depth information.

To resolve this problem we propose the synchronized acquisition of position, orientation and readings of gamma probes intra-operatively to reconstruct a 3D activity volume. In contrast to conventional emission tomography, here, in a first proof-of-concept, the reconstruction succeeds without requiring symmetry in the positions and angles of acquisition, which allows greater flexibility and thus opens doors towards 3D intra-operative nuclear imaging.

Multinuclear NMR-Spectroscopy applied on a PET/MR System

Metabolic data of cells and tissues provide detailed information about their physiological state and can therefore help to detect diseases and monitor their therapy. Cancer, ischemia, and neurodegenerative disorders cause significant changes of the extra- and intracellular environment, altering the glucose metabolism, the sodium balance, energy levels, and the pH. Magnetic resonance imaging (MRI) is a non-invasive technique with strong potential to visualize disease-associated metabolic changes in the clinics.

Embedded in the “Sonderforschungsbereich” 824, this project aims to apply multinuclear NMR spectroscopy on a 3 T PET/MRI system. Besides sodium-23 and phosphorus-31 spectroscopy, this thesis will focus on in vivo and in vitro measurements with carbon-13 compounds since they can be used to sense metabolic processes and alterations of the pH. To overcome one main drawback of MRI- the small sensitivity of metabolically relevant molecules- dynamic nuclear polarization (DNP) protocols should be established and applied simultaneously.

Christian Hundshammer
Supervisors:
Prof. Dr. Steffen Glaser
Prof. Dr. Axel Haase
Prof. Dr. Markus Schwaiger

Start of PhD-work at GSISH:
July 2014

Pseudonymity in Translational Research

In translational medical research, complex data from heterogeneous sources have to be integrated, e.g. clinical data, study data, bio-bank data, images and the results of “omics” analyses (genomics, proteomics, metabolomics, etc.). IT security and data safety poses significant challenges as data are highly sensible and their use may be restricted to specific purposes only. Patient privacy has to be guaranteed, and access privileges need to be kept to a minimum. Informed consent and anonymity are principles of central relevance.

The goal of my dissertation will be to perform research on security and pseudonymity concepts for health information systems that ensure a maximum degree of integrity on one hand and anonymity on the other hand. Aspects like k-anonymity and prevention of linkage need to be explored.

Existing data protection concepts have to be evaluated and further developed regarding requirements for integrating various types of data sources. Single-Sign-on, identity and access rights as well as information flow management will play an important role from the application perspective. On the research side, appropriate security models and security primitives need to be investigated to allow one to rigorously argue about the security of the developed concepts and architectures against various attacks and forms of abuse.

Florian Kohlmayer
Supervisors:
Prof. Dr. Klaus A. Kuhn
Prof. Dr. Claudia Eckert

Start of PhD-work at GSISH:
September 2009

Eugen Kubala
Supervisors:
Prof. Dr. Steffen J. Glaser
Prof. Dr. Markus Schwaiger
Dr. Marion I. Menzel

Start of PhD-work at GSISH:
July 2014

^{13}C Metabolic Magnetic Resonance Imaging with Hyperpolarized ^{13}C-labelled Metabolites

Detection of abnormal metabolic fluxes or unusual accumulation of metabolites in tissue could be used to monitor the cancer in humans. Malignant tumor cells are characterized by altered energy metabolism pathways involving substrates such as glucose and glutamine. Imaging of the altered metabolism pathways can not only support the initial diagnosis, but also monitor progress in terms of staging, restaging, treatment response, and identification of recurrence, both at the primary tumor and at distant metastatic sites.

Metabolic magnetic resonance imaging with hyperpolarized ^{13}C-labelled substances (^{13}CMMR) allows non–invasive investigation of in vivo metabolism. Using ^{13}CMMR, metabolism of ^{13}C-glutamine, ^{13}C-glutamate, ^{13}C-2-oxoglutarate will be studied in vivo in real time and accumulation and local increase in its metabolism can localize the tumor and find changing in its metabolism.

Marika Kuschan
Supervisors:
Prof. Dr. Axel Haase
Walter Kucharczyk, FRCPC, MD

Start of PhD-work at GSISH:
January 2012

Motion Compensation in MRI and MRI-PET

Magnetic Resonance Imaging (MRI) has evolved into one of the most important imaging tools, which is used in clinical diagnosis. One of its major advantages is the excellent soft-tissue contrast. To receive high-resolution images, the acquisition time can take up to several tens of minutes. However, long acquisition times lead to strong motion sensitivity. This dependency results in less image quality with undesirable image artifacts or blurring, which often renders a complicated diagnosis. During the imaging process two types of motion occur, namely periodic motions like the more or less regular pulsing of the heart and more random movements of extremities, for example, which mostly appear from the unconsciousness or tightness of the muscles. Various methods have been developed to overcome motion sensitivity in MRI.

Navigator techniques that detect and correct for motion in several applications, have been established since 1989, however increased scan times are necessary. External devices such as respiratory pillows or ECGs are used for motion triggering, although not all motions are amenable for external detection. This PhD project aims to gain in a motion compensation method of general adaptability for all motion types and easy integrability in clinical daily routine. Using a general approach, this can be extraordinary useful in all fields of NMR: spectroscopy, neuroimaging, cardio imaging, angiography, diffusion imaging and of course, patient monitoring. Motion compensation can also be useful in all kinds of hybrid imaging methods, including PET/MRI.

Pseudonymity in Translational Research

The principal goal of the project is to establish a network of clinical centres in order to advance collaborative work among researchers which are mostly medical and/or biomedical experts trying to improve health care for patients.

Steps to achieve this are:
i) Setup of a web-based register, which is adherent to international laws and regulations concerning health care and medical research data;
ii) Comprehensive management of data resulting from patient examinations, biological materials including DNA, RNA etc.;
iii) Enhancing the collaborative work in research networks by simplifying and accelerating exchange of research results according to privacy laws and regulations;
iv) Developing and advancing of a research platform which is built upon highest security requirements for a secure management of sensitive patient data.

Ronald Lautenschläger
Supervisors:
Prof. Dr. Klaus A. Kuhn
Prof. Dr. Claudia Eckert

Start of PhD-work at GSISH:
March 2009

Data Mining and Machine Learning Methods for High-dimensional Patient Data in Dementia Research: Voxel Features Mining, Subgroup Discovery and Multi-view Learning

Neuroimaging techniques such as [18F]-fluoro-2-deoxy-glucose ([18F]-FDG) positron emission tomography (PET) for the assessment of cerebral glucose metabolism are widely applied in the diagnosis and research of dementing disorders such as Alzheimer´s disease (AD). The understanding of associations between basic pathomechanisms and their clinical expression as dementia is of major interest. Usually, subsets of patients are pre-defined on the basis of clinical data and correlations between clinical and neuroimaging findings are subsequently identified according to a priori hypotheses.

However, important associations remain undiscovered because of these constraints. The present project therefore takes the opposite approach, starting with the imaging data to identify clusters of distinctive imaging patterns and generating subgroups of patients according to their affiliation to these clusters. Subsequently, differences and commonalities between these clusters are addressed in terms of non-imaging variables, such as demographic variables and psychometric test results. Hence, more complete descriptions of interesting subgroups will be obtained. To achieve this goal, data-mining and clustering algorithms will be applied to whole brain scans for the first time in a close collaboration of the relevant institutions.

Rui Li
Supervisors:
Prof. Dr. Stefan Kramer
Prof. Dr. Alexander Drzezga
Prof. Dr. Markus Schwaiger
Prof. Dr. Robert Perneczky

Start of PhD-work at GSISH:
November 2010

Rebekka Löb
Supervisors:
Prof. Dr. Sibylle Ziegler
Prof. Dr. Axel Haase

Start of PhD-work at GSISH:
November 2010

Dynamic Reconstruction from Simultaneously Acquired PET/MR Data

In recent years the combination of Positron-Emission-Tomography (PET) and Magnetic Resonance (MR) imaging has gained increased interest. Among the unprecedented opportunities provided by integrated PET/MR scanners are an excellent spatial alignment of both modalities and practically simultaneous data acquisition. The Munich HYCON (Munich HYbrid imaging CONsortium) is currently installing one of the first fully-integrated whole-body PET/MR scanner in the Nuclear-Medicine Department at the Klinikum rechts der Isar.

The aim of this project is to develop new image generation algorithms that make use of such novel integrated devices. A special focus will be their evaluation on clinically relevant data. It is proposed for the first time to incorporate MR-based anatomical information in order to improve the quality of four-dimensional (4D) PET reconstruction, both of radiotracer uptake and of physiological kinetic parameters.

Subhamoy Mandal
Supervisors:
Prof. Dr. Daniel Razansky
Prof. Dr. Vasilis Ntziachristos

Start of PhD-work at GSISH:
July 2013

Visual Quality Enhancement in Optoacoustic Imaging

Multi-Spectral Optoacoustic Tomography (MSOT) is capable of high resolution 3D visualization of molecular probes located deep in scattering living tissues. This method can simultaneously deliver anatomical, functional and molecular information with both high resolution and penetration capabilities. The present generation of the MSOT systems can scan 3D volumes at video rate and provide real time visualization of the imaged tissue. The dissertation work is based on the new generation MSOT system(s), and aims to develop better visualizations in real time for the multi-dimensional and multi-spectral data in a clinically valuable way.

The primary objectives of the project are visual quality improvement of MSOT images, and enhancement of system capabilities for pre-clinical and clinical investigations. Thus, the research envisages development of new parameter optimization strategies for image reconstruction and quantification. Multi-resolution and scale- space signal processing techniques are being employed to enhance resolution and improve the signal to noise ratio (SNR) in optoacoustic images, aided with GPU based acceleration. Further, the project aims to develop quality benchmarks for image quality and algorithms (in terms of computational complexity and operation time), thus enabling evaluation of the efficacy of methodologies for imaging biological specimens *in vivo*.

Robot-assisted microscopic manipulation for vitreo-retinal ophthalmologic surgery

The project aims towards research and development of an innovative robotic assistance device for vitreo-retinal surgery. Eye surgeons around the world have to deal with every day scenarios demanding high-precision manipulation of surgical devices. The manipulation accuracy can be in the scale of microns which is very difficult to achieve even by the most trained and experienced surgeon.

Till date a few robotic devices exist to assist surgeons in such high-precision tasks. However, these devices have some limitations in terms of usability respectively integration and are not yet widely used. We propose an innovative robotic device towards overcoming the current limitations. Main focus will be the development, control and evaluation of this apparatus such that inadequateness of prevalent devices and methods can be improved, the delicate technique of vitreo-retinal surgery can be facilitated, the risk of complications reduced and new perspectives for novel therapeutic strategies may become feasible.

M. Ali Nasseri
Supervisors:
Prof. Dr. Alois Knoll
Prof. Dr. Dr. Chris P. Lohmann

Start of PhD-work at GSISH:
Feb 2011

Fast semi-analytical acoustic inversion for quantitative optoacoustic tomography

Optoacoustic (or photoacoustic) tomography is a hybrid imaging modality that has recently demonstrated unprecedented high-resolution imaging of chromophore distribution and vasculature deep in tissues of small animals. Optoacoustic imaging relies on detection of ultrasonic signals induced by absorption of pulsed light. The amplitude of the generated broadband ultrasound waves reflects local optical absorption properties of tissue. Since scattering of ultrasonic waves in biological tissues is extremely weak, as compared to that of light, biomedical optoacoustic imaging combines high optical absorption contrast with good spatial resolution limited only by ultrasonic diffraction.

Major focus of the project is the development of advanced imaging algorithms including multi-spectral real-time imaging. The resulting image reconstruction method is intended to significantly improve existing techniques. Also part of the project is the demonstration of the new method with experimental phantoms and pre-clinical data.

Daniel Queirós
Supervisors:
Prof. Dr. Vasilis Ntziachristos
Prof. Dr. Markus Schwaiger

Start of PhD-work at GSISH:
October 2010

Johannes Scholz
Supervisors:
Prof. Dr. Axel Haase
Prof. Dr. Sybille Ziegler
Dr. Marion I. Menzel

Start of PhD-work at GSISH:
May 2011

Quantified PH Determination with hyperpolarized Magnetic Resonance

pH is a key parameter in many biochemical processes. Several diseases like cancer, inflammation, hypoxia and many others come along with alterations in pH. To use the pH value as a disease marker, it would be desirable to detect pH in vivo spatially separated and even more favorable in a non-invasive way, but so far no clinical tool is established to map pH in vivo. Using hyperpolarized ^{13}C-Bicarbonate (^{13}C-BiC) in magnetic resonance imaging (MRI) could close this gap.

This work deals with the quantification of the quality of pH detection and compares it with the current medical “gold-standard” of pH electrode measurements. Different sources of errors of pH were taken into account and its influence in time and spatial dimensions to pH phantoms and the translation to *in vivo* targets.

Amitkumar Shah
Supervisors:
Prof. Dr. Nassir Navab
PD Dr. Tobias Maurer
Dr. Benjamin Frisch

Start of PhD-work at GSISH:
September 2014

Tracking and Navigation in Intraoperative Imaging

I am currently working on developing multimodal image guidance for Prostate biopsy procedure. Traditional transrectal ultrasound guided prostate biopsy has limitations in finding cancer sites which might lead to a false diagnosis. However, MRI and novel Ga^{68} PSMA PET imaging have shown much better accuracy in detection of cancer suspicious regions. Hence, we are developing a solution where these imaging modalities can be used for guidance along with ultrasound in prostate biopsy.

It will improve the prostate cancer diagnosis and an early treatment can be started. The work involves 3D ultrasound image reconstruction, image registration of MRI with ultrasound and live image rendering based on patient and tool tracking information. All of these tasks fit well in tracking and navigation part of intra-operative imaging. This work is in collaboration with the urology department of Klinikum rechts der Isar. It is also a part of my EU FP7 Marie-curie Network Picosec project.

Advanced diffusion MR Methods to study human brain

Diffusion weighted magnetic resonance imaging (DWI) is a non-invasive imaging method that allows for estimating the molecular self-diffusion of water molecules within the surrounding biological tissue. With the rigorous formulation of the diffusion tensor, the three dimensional process reflecting tissue anisotropy could be adequately described. One major advantage of DTI-based measures is their enormous sensitivity for detecting alterations of the microscopic tissue composition, although DTI typically samples only a very small subset of the full diffusion information encoded in q-space. In this project a technique called Diffusion Spectrum Imaging (DSI) is used to obtain the full q-space information. Based on DSI data, more advanced diffusion metrics like Kurtosis are derived. To reduce the acquisition time of the DSI data, a recently proposed combination of Compressed Sensing (CS) with DSI will be evaluated. Therefore a clinical study in collaboration with the Max Planck Institute of Psychiatry will be realized. One major issue to be examined is the sensitivity of Kurtosis to characterize the progress of the disease Multiples Sclerosis (MS). Furthermore the DSI data is used for a more robust fiber tracking based on the Orientation Distribution Function (ODF). A second field of research of this project will be alternative acquisition techniques for DSI data which don’t have the typical disadvantages of single shot Echo Planar Imaging (EPI) like low SNR and strong image artifacts.

Tim Sprenger
Supervisors:
Prof. Dr. Axel Haase
Dr. Marion I. Menzel

Start of PhD-work at GSISH:
February 2012

Risk of falls in elderly: the role of gait, physical activity, balance and anemia

Falls are known to be a major cause for massive injuries or even death in elderly. This PhD project investigates the influence of anemia, gait, physical activity and balance on the risk of falls in elderly people.

After a detailed literature review, data of more than 1000 participants of the KORA Age study aged 65+ will be analyzed. Gait parameters have been measured with the GAITRite system, anemia is detected by Hb levels, folate and vitamine B12 levels and the glomerular filtration rate from blood samples. Fall risk has been assessed with a questionnaire covering the year before the examination.

Linear and logistic regression models will be used to analyse the correlation between the different parameters and to analyse the influence of confounders such as age, sex or multimorbidity.

Kathrin Thaler-Kall
Supervisors:
Prof. Dr. Alexander Horsch
PD Dr. Christa Meisinger
Prof. Dr. Alois Knoll

Start of PhD-work at GSISH:
January 2011

Maria Esmeralda Vicedo Jover

Supervisors:
Prof. Dr. Burkhard Rost
Prof. Dr. Johannes Buchner

Start of PhD-work at GSISH:
May 2011

Disease Prediction Using Protein Disorders

Unstructured proteins (intrinsically disordered proteins and intrinsically disordered regions) lack stable tertiary and/or secondary structure in physiological conditions yet fulfills a biological function. Several disordered proteins were shown to be associated with human diseases, such as cancer, cardiovascular disease, neurodegenerative diseases, and other.

The aim of this project is to predict human diseases based on the disordered proteins.

Baiba Vilne

Supervisors:
Prof. Dr. Christian Peschel
Prof. Dr. Hans-Werner Mewes

Start of PhD-work at GSISH:
March 2009

Regulatory networks of hematopoietic stem cells and its microenvironment

The lifelong daily production of blood depends on hematopoietic stem cells (HSCs), a small population of cells furnished with a dual capacity to differentiate into all blood lineages and dynamically increase their number by undergoing self-renewing divisions. HSCs are thought to reside within a supportive microenvironmental niche which integrates both cell-intrinsic and cell-extrinsic signals and thus helps to balance their cell-fate decisions. Despite extensive study, precise signalling mechanisms coordinating HSC-fate decisions have remained largely elusive.

In this study, we aim to perform gene expression kinetics analysis of HSCs and their microenvironment at different timepoints of co-culture and compare the obtained expression patterns with those of HSCs and the microenvironment cells when cultured separately. Thereafter, using different bioinformatics and systems biology approaches, gene expression kinetics data will be used to construct a dynamic gene regulatory network which would allow us to model, predict and control the behaviour of HSCs in their microenvironment.

Autonomous Systems in Biomedical Engineering: Development of automatic, patient adapting regulation of blood pressure in cardio-vascular intensive care based on the neuro-fuzzy method

Current patient care on intensive care units are still based on physiological monitoring data and personal experience of the physician in charge. As a consequence, medication and infusion are organized manually by the ICU personnel in charge. This way of regulating medication often leads to irregularities in respect to patient care.

The aim of the projects is thus to overcome this state of the art and develop an autonomous, self-adaptive system, which improves the medication of emergency patients.

Anna Nicole Vogler

Supervisors:
Prof. Dr. Alois Knoll
Prof. Dr. Robert Bauernschmitt

Start of PhD-work at GSISH:
March 2010

Quantitative X-ray phase-contrast tomography for biomedical research at laboratory X-ray sources

Grating-based X-ray phase-contrast tomography is an emerging modality that is based on a fundamentally different image formation process compared to conventional attenuation-based imaging and might improve diagnostics in the future by providing additional information and enhanced soft-tissue contrast.

In this project, we investigate the potential of the technique for quantitative tissue characterisation and aim to gain insight into its diagnostic capabilities. For this purpose, an experimental phase-contrast imaging system optimised for biomedical research has been developed in our lab. Various studies are performed in strong collaborations with the Radiology Departments of the Klinikum rechts der Isar and the Klinikum Grosshadern. Topics range from oncology to fibrosis and atherosclerotic plaque.

Marian S. Willner

Supervisors:
Prof. Dr. Franz Pfeiffer
Dr. Julia Herzen
Dr. Alexander Fingerle

Start of PhD-work at GSISH:
June 2011

Johannes Wolf
Supervisors:
Prof. Dr. Franz Pfeiffer
Prof. Dr. Alois Knoll

Start of PhD-work at GSISH:
June 2012

Modeling of X-Ray Phase-Contrast Mammography

Based on our pre-clinical and methodological studies of phase-contrast x-ray imaging, we develop concepts for translating phase-contrast radiography and CT to clinical applications. This project focuses on experimental and numerical case studies to evaluate the potential of x-ray phase contrast for a range of potential clinical cases, including specifically mammography, neuroradiology, and oncologic imaging.

For this project we strongly collaborate with medical experts at the university hospitals in Munich - the Klinikum rechts der Isar and Klinikum Grosshadern.

Patrick Wucherer
Supervisors:
Prof. Dr. Nassir Navab
Prof. Dr. Ekkehard Euler

Start of PhD-work at GSISH:
January 2013

Simulator for multidisciplinary medical team training

In highly dynamic and complex high-risk domains -such as surgery- systematic training in the relevant skills is the basis for safe and high-quality performance. Traditionally, assessment and training in surgery traditionally concentrated upon proficiency and acquisition of surgeons‘ technical skills. As the fundamental impact of non-technical skills -such as communication and coordination- is increasingly acknowledged for safe delivery of surgeries, comprehensive training approaches are missing.

The overall aim of the project is to investigate a novel learning environment for the assessment and training of both technical and non-technical skills of entire multidisciplinary operating room (OR) teams. Specifically, we first proceed by optimally integrating a virtual reality (VR) procedural simulator into a simulated OR, and further advance the learning environment for multidisciplinary team training. Secondly, we aim to develop robust performance metrics for objective assessment of surgeons‘ technical skills (e.g. instrument handling, identification of complications) and non-technical skills (e.g. situational awareness, interpersonal communication). Thirdly, we are specifically interested in errors that occur during adverse events and psychophysical stress of the surgical staff. We want to research the role of deliberate exposure to adverse events in the augmentation of error perception and mediation of error recovery strategies. Lastly, we establish and investigate professionals‘ skills transfer into OR-practice, respectively for technical and non-technical skills.

Development of a holistic additive-manufacturing technology Plattform for Melt Electrospinning

Melt electrospinning refers to electrostatically drawing viscous polymers liquids in a fused state, which allows the production of nano-scaled fibres as a basis for the design of highly-porous and well-ordered scaffolds.
In the field of tissue engineering these structured fibre “meshes“ mimic the extracellular matrix and provide a spatial micro-environment for promoting significantly enhanced cell growths.
The innovative technology triggers a paradigm shift in scaffold manufacturing and stands out for a promising contribution to the future of tissue engineering applications.
However, a transfer from bench to bedside still lacks feasibility. The technical challenge is seen in the complexity of the multi-parametric process; the stumbling block from an economic perspective is the comparatively low-throughput, contemporary preventing broader clinical applications.
My research aims at fostering precision and accuracy to accomplish a highly automated and up-scaled production of scaffolds. Systematic product development methodologies will meet all multidisciplinary requirements and generate a Technology Platform to address the surge of industrial demand.

Felix Wunner
Supervisors:
Prof. Dr. Dietmar W. Hutmacher
Prof. Dr. Axel Haase

Start of PhD-work at GSISH:
May 2014

Analysis and Visualization of Colon Motility

Image registration is often described as the process of bringing two or more images into spatial alignment. An important application of image registration is the construction of a larger field of view of a scene from its partially overlapping observations using intensity information. In intensity-based image registration, however, consistency between partial images has often been addressed in terms of pixel intensity value correspondences in the overlapping region. Our research investigates different consistency measures to be used as regularization in intensity-based registration of partially overlapping images.

First, a method for ensuring local consistency and smoothness is proposed. We propose a new technique called structure propagation for creating structural probability maps based on the geometry of locally salient structures. Second, we introduce a novel regularization term into the intensity-based registration framework to ensure global shape consistency. To this end, we propose Hough space parametrization of target anatomy or region together with a voting scheme during registration.

Mehmet Yigitsoy
Supervisor:
Prof. Dr. Nassir Navab

Start of PhD-work at GSISH:
November 2010

GSISH Doctoral Projects

Oliver Zettinig
Supervisors:
Prof. Dr. Nassir Navab
PD Dr. Tobias Maurer
Dr. Benjamin Frisch

Start of PhD-work at GSISH:
September 2014

Advanced Ultrasound Imaging Techniques for Computer Assisted Interventions

In many clinical applications, ultrasound imaging is the modality of choice. It is broadly available, allows for fast acquisitions, offers high frame rates, and does not expose the patient to ionizing radiation or nephrotoxic contrast agent. However, interventional usage of ultrasound imaging poses additional challenges, for instance the requirement of accurate deformable registration to relate tomographic pre-operational images to intraoperative ultrasound images.

The aim of this project is to develop advanced imaging techniques based on ultrasound to assist the clinical workflow in the operating theater. This does not only include novel segmentation and registration algorithms but also considers robotic solutions for automated ultrasound acquisitions.

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Dr. rer. nat. Cana Selen Atasoy
Automatic Tissue Recognition for Targeted Optical Biopsy in Cancer Surveillance

Dr.-Ing. Sebastian Bauer
Rigid and Non-Rigid Surface Registration for Range Imaging Applications in Medicine

Dr. rer. nat. Benedikt Baumgartner
Automation of a Portable Heart-Lung Machine and Patient Monitoring with Data Mining Methods

André Dias, PhD in Computer Science
Associations of pulmonary parameters with accelerometer data. Focusing on Cystic Fibrosis and COPD

Dr. rer. nat. Thomas Gaaß
Acceleration of radial data acquisition in medical imaging via iterative histogram constrained reconstruction

Dr. rer. nat. Lukas Gorzelniak
Towards a methodology for improving the comparability of accelerometer-based results for physical activity measurements in older adults

Dr. rer. nat. Mara Lena Hartsperger
Quantitative Analysis of Systems-Biological Networks

Dr. rer. nat. Nuria Hirsch
BOLD-based Magnetic Resonance Imaging of Hypoxia in the Human Brain -Adaptation of Measurement and Data Analysis Strategies for Clinical Requirements

Dr.-Ing. Kurt Höller
Novel Techniques for Spatial Orientation in Natural Orifice Translumenal Endoscopic Surgery (NOTES)

Dr. rer. nat. Oleksandr Khegai
Quantification methods for time-resolved metabolic magnetic resonance imaging using hyperpolarized [1-13C]pyruvate

Dr. rer. nat. Anja Kretschmer
Genetic and epigenetic mechanisms in the atopic eczema associated RAD50-locus

Dr. rer. nat. Gregor Lamla
Identity Management in Distributed Environments in Support of Translational Medical Research

Dr. rer. nat. Tobias Lasser
Tomographic Reconstruction Methods for Optical and Intra-operative Functional Imaging

Dr. rer. nat. Suraj Nair
Visual Tracking of Multiple Humans with Machine Learning based Robustness Enhancement applied to Real-World Robotic Systems

Dr.-Ing. Andreas Oancea
Optoacoustic System and Method for Mesoscopic Imaging

Dr. rer. nat. Fabian Prasser
Incremental Ontology-Based Integration for Translational Medical Research

Dr. rer. net. Tobias Reichl
Advanced Hybrid Tracking and Navigation for Computer-Assisted Interventions

Dr. rer. net. Christine Rümenapp
Magnetic Resonance with Magnetic Nanoparticles - Fabrication and Characterisation

Dr. rer. nat. Christian Schäfer
Predicting the structural effect of point mutations

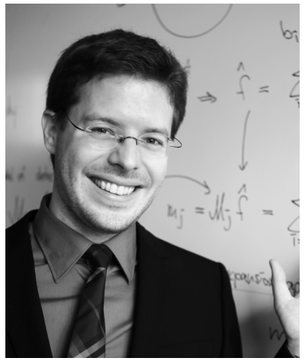
Dr. rer. nat. Dominik Schmelcher
Integrationskonzepte und -lösungen zur Etablierung einer Forschungsinfrastruktur für Biobanken

Dr. rer. nat. Dzhoshkun I. Shakir
Intra-operative Nuclear Imaging Based on Positron-emitting Radiotracers

Dr. rer. nat. Thomas Wendler
3D intraoperative imaging with navigated nuclear probes

Dr. rer. nat. Sebastian Wurst
Incremental Dataspace Integration in Medicine

Quotations by GSISH Alumni



Dr. rer. nat. Tobias Lasser

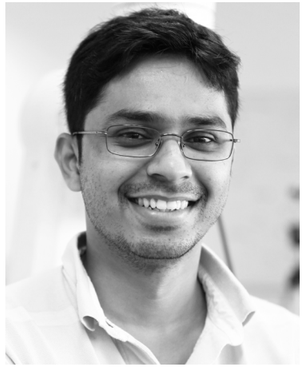
“The GSISH provided a perfect framework to perform research. The structured dissertation program provided a solid background for me to lean on, while still allowing more than enough freedom in research. The requisite credit points to be earned during the curriculum are all based on activities natural to ‘doctoral life‘, and in my case didn’t require any additional efforts.

A particularly welcome addition to the regular scientific program were the transferable skills courses offered by GSISH, as this kind of courses was just not available otherwise. Examples include rhetoric and time-management seminars as well as career-planning and leadership workshops.“

Dr. rer. nat. Lukas Gorzelniak

“The GSISH provided an ideal framework to conduct interdisciplinary research at the interface of informatics and medicine. During the course of my doctoral studies I became familiar collaborating with engineers, medical doctors, epidemiologists and statisticians at different research laboratories, clinics and institutes.

Beyond the work on my thesis, the GSISH provided many opportunities to broaden one‘s professional horizon by means of international workshops, summer schools and symposia. The curriculum of the GSISH also includes so called soft skill training courses, designed to develop leadership, communications and organizational skills.“



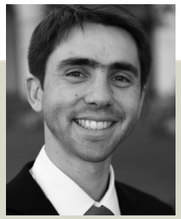
Dr. rer. nat. Suraj Nair

“I was enrolled in GSISH as an associate member and primarily involved in the project ´Robot-assisted microscopic manipulation for vitreo-retinal ophthalmologic surgery`. My experience at GSISH over was very pleasant and professionally beneficial. I was involved in various colloquiums and seminars through which I interacted with many important people in the area of Biomedical Engineering and Imaging. These events were always very well organized and managed resulting in maximum throughput for the candidates. The doctoral program was very well structured and was realized in a systematic manner through regular milestones and professional guidance. Overall, my experience with GSISH and its members was very helpful both personally and professionally, I would recommend GSISH to fellow students and professionals.“

“GSISH managed to generate a milieu where people coming from different worlds meet and exchange.“
Dr. rer. nat. Thomas Wendler

“GSISH provided the great chance to practice this interdisciplinarity not only in talks or meetings but also while having fun and party in a Biergarten or at an excursion.“
Dr.-Ing. Kurt Höller

“GSISH puts a large emphasis on interdisciplinarity and also on international collaboration.“
Dr. rer. nat. Selen Atasoy



Dr. rer. nat. Thomas Wendler

Dr. rer. nat. Selen Atasoy

Dr. rer. nat. Fabian Prasser

Dr.-Ing. Kurt Höller

Dr. rer. nat. Tobias Reichl

Dr. rer. nat. Christian Schäfer

“In our interdisciplinary setting, it is not sensible to perform research in the ivory tower, since whatever we design needs to actually be applicable to the medical setting.“
Dr. rer. nat. Tobias Reichl

“As interdisciplinarity was at the heart of my research project, the interdisciplinary environment provided by GSISH offered great opportunities.“
Dr. rer. nat. Fabian Prasser

“I liked seeing my vision getting realized while having the freedom to incorporate own ideas into my project.“
Dr. rer. nat. Christian Schäfer

Biomedical Imaging & Informatics -
European Research and Training Initiative (BERTI)

Status October 2014

Message by BERTI Executive Programme Manager

I am very happy and proud to be the Programme Manager of BERTI *Biomedical Imaging & Informatics - European Research and Training Initiative*, a HP7 programme funded by the European Union with over 3 Mio €. To realize this programme we put coordinated efforts into place. Special thanks go to Dr. Ursula Mühle, who initiated the project and Dr. Marion Menzel has been a constant supporter of BERTI; Dr. Petra Dorfner and Katharina Lang for their relentless, unfailing and professional set-up of BERTI.

BERTI now has come to life and is a truly international project where excellent training goes along with attending outstanding research projects. In the spirit of HP7 people 2013 BERTI 'aims to improve career perspectives of early-stage researchers in both public and private sectors, thereby making research careers more attractive to young people. In particular, the action aims to add to the employability of the recruited researchers through exposure to both academia and enterprise, thus extending the traditional academic research training setting and eliminating cultural and other barriers to mobility.'

Research across borders is put into reality. From 151 application from 35 countries, we recruited fourteen researchers from ten countries. All of them started with their research projects this year. We are confident that the chosen ones will excel in their research projects and continue with the high standard and efficiency TUM asks of their doctoral candidates. Building upon TUMs Graduate School of Information Science in Health (GSISH) BERTI lays the basis of excellent supervision and mentoring. This is achieved by assigning two supervisors from academia and one supervisor from the GE global research centre next to TUM campus Garching.

Personally I enjoy working with our BERTI ESRs, real pioneers in research, who are highly motivated. They already handed in the first abstracts to conferences and are participating in entrepreneurial idea generation and start-up challenges.

DR. ANDREA GLOGGER

"Training at this high level of excellence is a challenge that I full heartedly embrace."

I am convinced that the BERTI ESRs will excel in their field of research.

Training at this high level of excellence is a challenge that I full heartedly embrace. I am looking forward to working with our outstanding fifteen training partners to provide and take doctoral training for our BERTI ESRs to a new level. I am more than happy to say that now the Partnership Agreement has been signed by all involved. Not limiting ourselves, we are currently also reaching out to other promising partners, in this case Lund University, for our training network. My vision is to enhance the ESRs career prospects in both the academic and non-academic sectors even further.

Dr. Andrea Glogger
BERTI Executive Program Manager

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Reflection by Dr. Marion I. Menzel

On a foggy Sunday in early 2014, upon seeing a good number of local and international academic partners filling up the meeting room, it suddenly hit me: “BERTI has come alive!”

BERTI, which stands for “Biomedical Imaging & Informatics – European Research and Training Initiative,” is a European Union (EU) funded program that will enable young researchers to broaden their scientific horizons. It is modeled on collaborative innovation, which mirrors the network of academic institutions that are at the core of healthcare activities within GE’s European Research Centre.

The program consists of six work packages focusing on: Advanced MR Neuroimaging, Cardiac MR Imaging, MR Thermometry, Phase-contrast XRay, Optoacoustic Imaging, and Healthcare Robotics. The goal is to engage and team up cross-disciplinary researchers at a time early in their careers when they don’t typically work with each other. In each work package, a minimum of two early stage researchers will team up to tackle different aspects of a larger research question.

Bringing it all together

It all started in 2011 with an initial discussion with the Technical University of Munich (TUM). We realized that the intersection of our various disciplines, such as physics, informatics, medicine and other related fields, can result in rich research in our common fields of biomedical imaging and informatics. We also realized that when our diverse disciplines get together, it results in some pretty animated research discussions. However, for us to be able to understand each other and the research problems we both face, we recognized that we needed to speak the “same language,” which requires scientific insight into one’s adjacent disciplines. While experienced researchers have that capability, researchers in the early stages of their education do not, as their education is “silo’d” by discipline and opportunities to learn across disciplines is not readily available.

DR. MARION I. MENZEL

Senior Scientist
Diagnostics, Imaging and Biomedical Technologies -
GE Global Research Center Europe

We wanted to change this and knew that the best route would be through the EU funding program FP7.

The 7th Framework Program (FP7) was the main R&D funding program of the European Commission. FP7 targets collaborative research in the European Union and encourages partnerships with universities. The €50,5 billion budget was allocated to a wide variety of research areas, such as renewable energy, transportation and healthcare. The program ran from 2007-2013 and has funded projects with ending dates through 2017. FP7’s successor program, Horizon 2020, has an even larger budget of €80 billion and will run from 2014-2020.

From the ground up

In November 2011 our TUM colleagues Ursula Mühle, Katharina Lang and myself started sketching what a potential application to the EU funding program FP7 could look like. We collected scientific ideas, developed a theme and concept, assembled partners, discussed projects, designed trainings, created a name… Hundreds of emails, several kilos of paper and many meetings later, we were delighted to finally submit the BERTI application at the end Jan 2012. Eight weeks of intensive work and then we had to wait… Early May 2012 the EU responded that despite a very good ranking our project ended just below the threshold … what a disappointment! It took us until August 2012 to decide to go for a second trial! To make a really long story short: we refined, rephrased and redrafted the application into BERTI version 2, taking into account the evaluation comments. In November 2012, we submitted once more and again had to wait. To our delight the European Commission responded in March 2013 – positively!!!

Since then, Petra Dorfner from TUM has undertaken much of the work from an administrative and organizational standpoint. And now, it gives me great pleasure to tell you that we have kicked off BERTI. We’ll get the science started, we are currently recruiting 14 doctoral candidates who will have access to multi-disciplinary training and I am certain we will all learn from this!

We were excited to welcome our national and international BERTI Partners for the BERTI Kick-Off Meeting, which took place from January 19-20, 2014 at the Forschungscampus Garching near Munich.

Reflection by Dr. Marion I. Menzel
Senior Scientist
Diagnostics, Imaging and Biomedical Technologies -
GE Global Research Center Europe

Originally published online on May 2nd, 2014 at
www.geglobalresearch.com/blog/

Mission & Value Add

Technology in healthcare is all about working across distinct disciplines. Cultural gaps have to be overcome. BERTI reaches across these traditional borders between different disciplines and embraces multidisciplinary collaboration in every dimension.

BERTI Early Stage Researchers (ESRs) will be able to navigate and understand the different aspects of disciplines and of stakeholders and be systematic in their approach towards the challenges in research and industry. Between industry and university, between medicine, informatics, physics and engineering, BERTI ESRs get the whole picture and lead research into the future. BERTI aims to train a new generation of creative, entrepreneurial and innovative ESRs, able to face current and future challenges and to convert knowledge and ideas into products and services for economic and social benefit.

BERTI will structure research in a way that cultivates excellence by extending the traditional academic research training setting, and equipping researchers with the right combination of research-related and transferable competences.

It will enhance career prospects in both the academic and non-academic sectors through international, interdisciplinary and inter-sectoral mobility combined with an innovation-oriented mind-set.

Involved People

BERTI is very proud to be associated with highly motivated pioneers and world-class experts, who are pursuing a cross-cultural approach.

Building upon TUM´s Graduate School of Information Science in Health (GSISH), each ESR (Early Stage Researcher) within the BERTI training programme is assigned two scientific supervisors as well as a mentor from the research center of the industry partner GE Global Research located at the TUM-Campus Garching, ensuring perfect training for both an academic and an industry career.
A comprehensive training package has been created to guide the ESRs through their research and support them throughout their careers. With this training background BERTI ESRs will be well equipped to gain active roles in national and international research projects.

Involved People

BERTI Scientific Training Partners

TUM
Prof. Dr.-Ing. Alois Knoll
BERTI Coordinator / TUM, Informatics

Prof. Dr.-Ing. Darius Burschka
TUM, Informatics

Prof. Dr. rer. nat. Axel Haase
IMETUM Zentralinstitut für Medizintechnik

Dr. rer. nat. Tobias Lasser
TUM, Informatics

Prof. Dr. rer. nat. Dr.-Ing. Tim C. Lüth
TUM, MiMed

Prof. Dr. rer. nat. Björn Menze
TUM, Informatics

Dr. rer. nat. Suraj Nair
TUM, Informatics

Prof. Vasilis Ntziachristos, PhD
TUM, Electrical Engineering and Information Technolgy

Prof. Dr. rer. nat. Franz Pfeiffer
TUM, Physics

TUM / Klinikum rechts der Isar (MRI)
Prof. Dr. med. Klaus A. Kuhn
TUM, Medical Statistics and Epidemiology

Dr. med. Petra Striebeck
TUM, Medical Statistics and Epidemiology

IBMI - Helmholtz Zentrum München
Dr. rer.nat. Andreas Bühler
Dr. biol. hum. Julia Niefnecker
Prof. Dr. Vasilis Ntziachristos, PhD

GE Global Research Center Europe
Dirk Beque, PhD
Christina Cozzini, PhD
Dr.-Ing. Carlos J. Härtel
Dr. rer. nat. Martin Janich
Guido Kudielka
Silke Lechner-Greite, PhD
Anne Menini, PhD
Dr. rer. nat. Marion I. Menzel
Victor Samper, PhD
Dr. rer.nat. Timo Schirmer
Dr. rer. nat. Jonathan Sperl
AnaBea Solana, PhD
Hiroyuki Tanaka, PhD

Cardiff University / CUBRIC
Prof. Derek K. Jones, PhD

Max-Planck-Institut für Psychiatrie / Neuroimaging
Dr. rer.nat. Michael Czisch
Dr. med. Philipp Sämann

L'Université de Lorraine / Imagerie Adaptive Diagnostique et Interventionnelle (IADI)
Prof. Jacques Felblinger
Freddy Odille, PhD
Pierre-André Vuissoz, PhD

Johns Hopkins University / Chair for Computer Science
Prof. Gregory Hager, PhD
Prof. Russell Taylor, PhD

Universitäts-Kinderspital Zürich (KiSpi) / Centre of MR Research
Malek Makki, PhD
PD Dr. phil. Ruth O´Gorman Tuura
Beat Werner

Erasmus MC / Department Radiation Oncology
Marteen Paulides, PhD, Assistant Professor
Prof. G.C. van Rhoon, PhD

Columbia University, UEIL / Ultrasound & Elasticity Imaging Lab
Prof. Elisa Konofagou, PhD

BERTI Non-Scientific Training Partners

TUM
Dr. rer. nat. Andreas Fleischmann
Pro Lehre

Dr. rer. nat. Annette Spiekermann
Pro Lehre

Dr. rer. nat. Alexandros Papaderos
TUM ForTE

UnternehmerTUM
Dr.rer.pol. Dominik Böhler
Oliver Bücken
Dr.rer.pol. Helmut Schönenberger

McKinsey & Company, Inc.
Dr.rer.nat. Stefan Biesdorf

Bayerische Patent Allianz
Peer Biskup

Vossius & Partner
Arnold Asmussen
Dr. jur. Marcus von Welser, LL.M.

Scholz and Friends Berlin GmbH
Dr. phil. Philipp Mehne
Stefan Wegner

Work Packages (WPs)

Six work packages are part of BERTI. Each work packages comprises mentors from Academia (TUM, Helmholtz and/or MPI plus one of the international partners JHU, Columbia, KiSpi, Université de Lorraine, Cardiff University, Erasmus Medisch Centrum), and at least one mentor from the industry partner GE.

WP 1 I MR Neuro
MR Neuro employs advanced MR imaging methods, accelerated by compressed sensing, to study degenerative changes in the brain.

Supervisors: Prof. A. Haase, Prof. B. Menze (TUM)
International Supervisor: Prof. D. Jones (CUBRIC)
Industry Mentor: Dr. M. I. Menzel (GE)

WP 2 I MR Cardiac
MR Cardiac develops methods for motion modeling and compensation in cardiac MRI to identify motion patterns and reduce patient discomfort during procedures.

Supervisor: Prof. D. Burschka (TUM)
International Supervisors:
Prof. J. Felblinger, Dr. F. Odille, Dr. P.-A. Vuissoz (IADI), Prof. G. Hager (JHU)
Industry Mentor: Dr. T. Schirmer (GE)

WP 3 I MR Thermometry
MR Thermometry enables realtime intervention monitoring of image-guided high intensity focused ultrasound and radiofrequency hyperthermia.

Supervisors: Prof. A. Haase (TUM)
International Supervisors: Prof. R. O´Gorman, Dr. B. Werner, Dr. M. Makki (KISPI),
Prof. G. van Rhoon, Dr. M. M. Paulides (Erasmus)
Industry Mentor: Dr. S. Lechner, Dr. T. Schirmer (GE)

WP 4 I XRay Phase-Contrast Tensor Tomography
XRay Phase-Contrast Tensor Tomography constitutes a novel XRay CT imaging modality suitable to obtain multimodal and tensorial scattering information.

Supervisors:
Prof. F. Pfeiffer, Dr. T. Lasser (TUM)
International Supervisor: tbd
Industry Mentor: Dr. C. Cozzini (GE)

WP 5 I Optoacoustic Imaging
Optoacoustic Imaging employs multispectral acquisition techniques in combination with ultrasound imaging for preclinical and clinical applications.

Supervisor: Prof. V. Ntziachristos (TUM / Helmholtz Zentrum München)
International Supervisors: Prof. E. Konofagou (UEIL)
Industry Mentor: Dr. J. Sperl (GE)

WP 6 I Health Care Robotics
Health Care Robotics utilizes miniaturized snake robots and image fusion for tracking of catheters.

Supervisors: Prof. A. Knoll, Prof. T. C. Lüth (TUM)
International Supervisors:
Prof. R. Taylor, Prof. G. Hager (JHU)
Industry Mentor: Dr. V. Samper, Dr. H. Tanaka (GE)

Facts & Figures

Excellence in Europe

Technische Universität München (TUM) is one of Europe's top universities. It is committed to excellence in research and teaching, interdisciplinary education and the active promotion of promising young scientists.

The university also forges strong links with companies and scientific institutions across the world. TUM was one of the first universities in Germany to be named a University of Excellence.

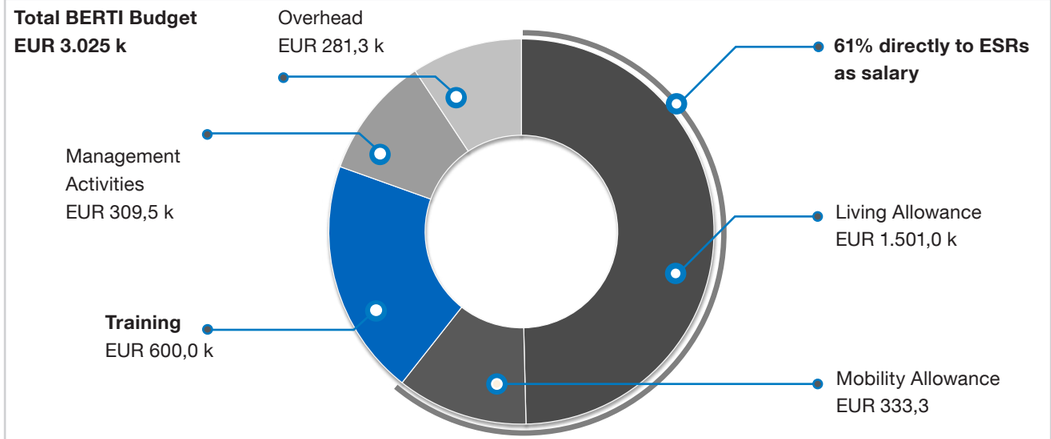
Moreover, TUM regularly ranks among the best European universities in international rankings.

Finances

BERTI is funded by the European Commission under Grant Agreement Number 605162 with over 3 Million €. With 61%, the vast majority of the budget is spend for the ESRs directly as living and mobility allowance, 20% finance their training activities, 10% are used for the projects management and the remaining 9% of the overhead are primarily used to pay taxes and fees.

Field	Budget (EUR k)	Budget (% of total)	Remarks
Living Allowance	EUR 1.501 k	50%	Part of salary to ESR
Mobility Allowance	EUR 333,3 k	11%	Part of salary to ESR
Training	EUR 600,0 k	20%	Training for BERTI ESRs
Management Activities	EUR 309,5 k	10%	Executive Programme Manager, Management Meetings, Audits, etc.
Overhead	EUR 281,4 k	9%	VAT, IT, etc.

Total BERTI Budget
EUR 3.025 k



Fast Facts about BERTI ESRs

BERTI ESRs do not only work within multidisciplinary research groups, they themselves have a very diversified background with 93% of them coming from one of the 9 foreign countries represented in BERTI.

Aurélien Bustin

WP 2 I MR Cardiac

Start of PhD-work at BERTI/GSISH: May 2014

Development of acquisition and reconstruction techniques in free breathing and 3D, combining several contrasts for quantified cardiac MRI

Performing an accurate assessment of cardiovascular disease is now a reality in clinical practice. Advances in cardiovascular imaging have produced faster imaging times when compared to conventional MRI scanners.
However, cardiac contraction is a major impediment to the acquisition of high-quality images. Generally patient motion results in image artifacts and the image quality is then considerably reduced.
This is why alternative techniques have to be proposed to implement adaptive imaging leading to the reconstruction of a motion-compensated image. The model can then be applied to real cardiac data in 3D free breathing scans.

Supervisor: Prof. D. Burschka (TUM)
International Supervisors:
Prof. J. Felblinger, Dr. F. Odille, Dr. P.-A. Vuissoz (IADI), Prof. G. Hager (JHU)
Industry Mentors: Dr. T. Schirmer, Dr. A. Menini (GEGRC)

Suat Cömert

WP 6 I MR Cardiac

Start of PhD-work at BERTI/GSISH: September 2014

Mechanisms for a continuum-robot type motion of a catheter or guidewire

Steerable catheters and sheaths for endovascular interventions are commonly used in the diagnosis and treatment of electrophysiological cardiac disorders, and are finding increasing applications in structural heart repair. As the range of clinical procedures increases, so does the demand for accurate and flexible tip steering.

Conventional steerable tools have a fixed bending region, but in many cases it is desirable to be able to choose the bending region or even to have 2 independently controlled bending regions to enable control of the tip angle and tip location independently. This Ph.D. work will consist of design, modeling, fabrication, and evaluation of disposable snake robot mechanisms for endovascular tools.

Supervisors: Prof. T. C. Lüth, Prof. A. C. Knoll (TUM)
International Supervisors: Prof. R. Taylor, Prof. G. Hager (JHU)
Industry Mentors: Dr. V. Samper, Dr. H. Tanaka (GEGRC)

Accelerated MR acquisition schemes for quantitative axonal and non-axonal metrics

Recent advances in MRI enable the quantification of microstructural properties of cerebral matter. These biological properties deepen our understanding of the brain in both health and disease and could assess the early onset of neurological disorders. Despite its potential, current applications are still limited by long acquisition times and low data quality.

The doctoral research focuses on addressing these limitations by developing novel methods for MR imaging of the brain. Work will evolve around optimizing the entire imaging pipeline, from data acquisition to analysis, in an effort to accelerate acquisition times whilst still capturing the most important aspects of cerebral matter.

Supervisors: Prof. B. Menze, Prof. A. Haase (TUM)
International Supervisor: Prof. D. Jones (Cardiff University)
Industry Mentor: Dr. M. I. Menzel (GEGRC)

Pedro Gómez

WP 1 I MR Neuro

Start of PhD-work at BERTI/GSISH: September 2014

Phase Contrast MRI for the Application of Cardiovascular Flow Measurement

Phase-contrast magnetic resonance (MR) imaging is a well-known method to measure and quantify the blood flow in the cardiovascular system. The phase contrast MRI which is used to measure and visualize the blood flow pattern with its 3 directional velocity in a 3D vascular volume, is called 4D flow MRI.

The goal is to decrease the acquisition time, reduce eddy-current artifacts and correct phase-offset errors by using parallel imaging and compress sensing techniques for better performance of 4D flow MRI in terms of image quality and speed.

Supervisor: Prof. A. Haase (TUM)
International Supervisors: Prof. R. O´Gorman, Dr. B. Werner, Dr. M. Makki (KISPI)
Industry Mentors: Dr. T. Schirmer (GEGRC)

Fatih S. Hafalir

WP 3 I MR Thermometry

Start of PhD-work at BERTI/GSISH: July 2014

Shufang Liu

WP 2 I MR Cardiac

Start of PhD-work at BERTI/GSISH: July 2014

Modeling of cardiac motion patterns by reconstruction of temporal dynamic deformation sequences

MRI is the golden standard for cardiac disease diagnostic. However, due to the respiratory motion and contract motion, the image quality is degraded.

The idea is to compensate the heart motion during reconstruction by including the heart motion model. The motion model can be extracted from the existing data, like raw MRI data, navigator, etc. Additionally, the motion model also has valuable meaning for better acquisition scheme.

Supervisor: Prof. D. Burschka (TUM)
International Supervisor: Prof. G. Hager (JHU)
Industry Mentor: Dr. T. Schirmer (GEGRC)

Xin Liu

WP 1 I MR Neuro

Start of PhD-work at BERTI/GSISH: July 2014

Development of silent diffusion MR acquisition schemes with reduced distortion

The aim of the project is as threefold: first, to implement the silent diffusion MR sequence. We plan to work on echo planar imaging (EPI) sequence with sinusoidal readout and the zero echo time sequence, which has the advantage of reduced distortion and low acoustic noise compared to traditional EPI.

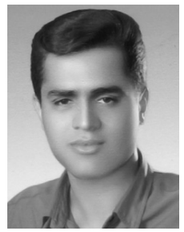
However, the controlling the motion induced phase error in multi shot sequence is quite complex, which is the major challenge of the current project. The second goal is to develop proper reconstruction frame for the silent MR sequence. The third goal is to validate the method on volunteer and patients studies as soon as the sequence is developed.

Supervisors: Prof. B. Menze, Prof. A. Haase (TUM)
International Supervisor: Prof. D. Jones (Cardiff University)
Industry Mentor: Dr. M. I. Menzel (GEGRC)

Development of combined ultrasound-optoacoustic endoscope and external probe for clinical applications

Optoacoustic imaging (Photoacoustic imaging) is an imaging technology based on the photoacoustic effect, and can be used for obtaining images of structures in turbid environments. The optoacoustic technique combines the accuracy of spectroscopy with the depth resolution of ultrasound.

Supervisors: Prof. V. Ntziachristos, Prof. Dr. Bjoern Menze (TUM)
International Supervisor: Prof. E. Konofagou (UEIL)
Industry Mentor: Dr. J. Sperl (GEGRC)



Jaber Malekzadeh

WP 5 I Optoacoustic Imaging

Start of PhD-work at BERTI/GSISH: November 2014

Assessment of molecular dynamics in brain tissue through accelerated diffusion and exchange imaging

Diffusion of water molecules and spin-spin relaxation can be measured, in vivo, through MRI. These measurements contain information of the underlying tissue microstructure and thus, they are of interest.

In this project we want to, first, assess these two contrasts within a clinical feasible time, using a modified pulse sequence and an accelerated acquisition scheme based on compressed sensing. Second, develop a model, or adapt an existing one, that allows one to extract tissue microstructural information out of the measurements. And third, validate the meaning of this information for brain diseases and brain plasticity in clinical and research environments.

Supervisors: Prof. B. Menze, Prof. A. Haase (TUM)
International Supervisor: Prof. D. Jones (CUBRIC)
Industry Mentor: Dr. M. I. Menzel (GEGRC)

Miguel Molina Romero

WP 1 I MR Neuro

Start of PhD-work at BERTI/GSISH: June 2014

Marwan Muhammad

WP 5 I Optoacoustic Imaging

Start of PhD-work at BERTI/GSISH: August 2014

Investigation of hyprid ultrasound - optoacoustic imaging

Marwan Muhammad's research explores the synergies between ultrasound (US) imaging and multispectral optoacoustic tomography (MSOT) imaging for real-time probing of tissue types and physiological states.

His work includes the development of a hybrid US / MSOT imaging system, the investigation of associated image formation and processing methods that optimally utilize the signals collected from the hybrid modality to improve tissue differentiation and the application of the new methods in experimental laboratory measurements and/or clinical situations for evaluation of their diagnostic relevance.

Supervisors: Prof. V. Ntziachristos, Prof. Dr. Bjoern Menze (TUM)
International Supervisor: Prof. E. Konofagou (UEIL)
Industry Mentor: Dr. J. Sperl (GEGRC)

Teresa Rincón

WP 2 I MR Cardiac

Start of PhD-work at BERTI/GSISH: June 2014

Development of improved image quality acquisition and reconstruction techniques integrating motion controlled B0, B1 and gradient linearity correction

The goal is to acquire high quality diagnosis images of moving organs like human heart. The fundamental challenge is motion correction due to cardiac and respiratory cycles.

My project is focused on the development of acquisition techniques in free breathing and 3D Cardiac Magnetic Resonance Imaging (MRI).

Supervisor: Prof. D. Burschka (TUM)
International Supervisors:
Prof. J. Felblinger, Dr. F. Odille, Dr. P.-A. Vuissoz (IADI), Prof. G. Hager (JHU)
Industry Mentor: Dr. T. Schirmer, Dr. A. Menini (GEGRC)

Real-time landmark-based image modality fusion

The project will focus on two primary tasks.
The first task will deal with the identification and tracking of non-static anatomical features as landmarks that are obtained from real-time image data from an ultrasound system during surgical intervention.

Thereafter, in the second task an interventional instrument has to be referenced to the landmark feature set. The instrument can be registered either by magnetic or optical tracking systems. Finally, the interventional tool and real-time ultrasound image data should be fused with clinical information extracted from pre-operative data set obtained from a separate image modality such as MRT or CT.

Supervisors: Prof. T. C. Lüth, Prof. A. C. Knoll (TUM)
International Supervisors: Prof. R. Taylor, Prof. G. Hager (JHU)
Industry Mentors: Dr. V. Samper, Dr. H. Tanaka (GEGRC)

Marta Scali

WP 6 I Healthcare Robotics

Start of PhD-work at BERTI/GSISH: September 2014

Model-based iterative reconstruction algorithms for XRay tensor tomography

XRay phase-contrast imaging is a recently developed biomedical imaging modality that uses the wave-optical interaction of x-rays with matter. In contrary to conventional, attenuation-based XRay imaging it can provide additional information on sub-pixel scattering features in the sample, and offers great potential for a number of diagnostic applications, particularly in computed tomography.

Based on these wave-optical interactions, we have recently developed a new XRay imaging scheme for XRay tensor tomography, which reconstructs for each voxel in the tomogram not only one scalar value, but a full scattering tensor with information on the structural orientation in each voxel. Based on this previous work, this project will now focus particularly on further developing and exploring iterative reconstruction schemes coupled with fast GPU implementations to obtain better tensor-CT results.

Supervisors: Prof. N. Navab, Prof. F. Pfeiffer, Dr. T. Lasser (TUM)
International Supervisor: tbd
Industry Mentor: Dr. C. Cozzini (GEGRC)

Saeed Seyyedi

WP 4 I XRay Phase-Contrast Tensor Tomography

Start of PhD-work at BERTI/GSISH: May 2014

BERTI Doctoral Projects

Yash Sharma

WP 4 I XRay Phase-Contrast Tensor Tomography

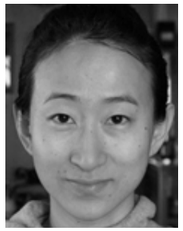
Start of PhD-work at BERTI/GSISH: September 2014

Sparse acquisition geometry for XRay Tensor Tomography

XRay imaging using a grating interferometer provides three contrast modalities namely- absorption contrast, phase contrast and dark-field. While the first two modalities have been widely studied, the dark field signal, which originates from the scattering of XRays inside the sample, is relatively new.

XRay tensor tomography is a novel technique that utilizes dark-field signal to extract the 3D orientation of specimen at sub-micron resolution without the need for resolving the actual microstructure. The current project aims to translate this technique from laboratory to commercial setups by optimizing the acquisition geometry and developing iterative techniques for sparse tomographic tensor reconstruction. The technique finds application in several areas of material science as well as medicine.

Supervisors: Prof. N. Navab, Prof. F. Pfeiffer, Dr. T. Lasser (TUM)
International Supervisor: tbd
Industry Mentor: Dr. C. Cozzini (GEGRC)



Mingming Wu

WP 3 I MR Thermometry

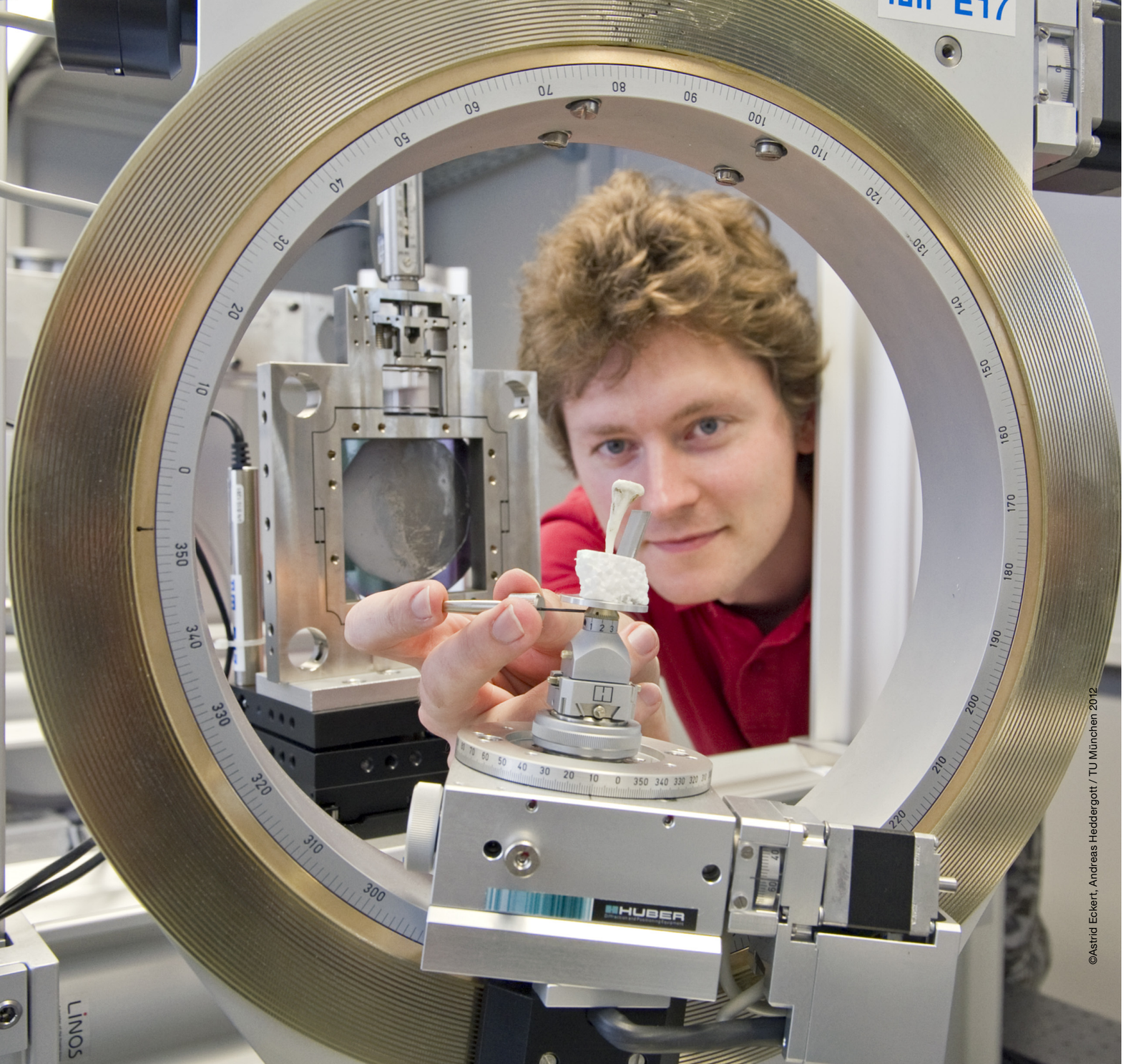
Start of PhD-work at BERTI/GSISH: June 2014

MR Thermometry Applications of MR Image Guided Therapy

RF-hyperthermia treatment has been proved to have a positive effect on patients treated with chemotherapy or radiotherapy. MR sequence development for an optimal and clinically feasible 3D-MR temperature mapping method for real-time MR- Image guided RF-hyperthermia treatment is aimed for. The developed temperature mapping sequences will be evaluated with means of phantom measurements and simulation.

One purpose is the quantification of the applied thermal dose in the patient during RF-hyperthermia treatment for better treatment control and evaluation. Therefore, 3D-coverage of the heated area is necessary. Accuracy plays a key role and is strived for. Different MR Image artifacts sources lead to temperature quantification errors and need to be avoided.
Finally, the setup will be implemented at Erasmus MC in Rotterdam allowing for in vivo testing involving patients.

Supervisors: Prof. A. Haase (TUM)
International Supervisor: Prof. G. van Rhoon (Erasmus)
Industry Mentor: Dr. S. Lechner-Greite (GEGRC)



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Research Outcomes

Status October 2014

Publications by GSISH and BERTI Doctoral Candidates

October 2013 - October 2014
(68 in total)

A. Kretschmer, G. Möller, H. Lee, H. Laumen, C. von Toerne, K. Schramm, H. Prokisch, S. Eyerich , S. Wahl, **H. Baurecht**, A. Franke, M. Claussnitzer, K. Eyerich, A. Teumer, L. Milani, N. Klopp , SM. Hauck, T. Illig, A. Peters, M. Waldenberger, J. Adamski, E. Reischl, S. Weidinger: "A common atopy-associated variant in the Th2 cytokine locus control region impacts transcriptional regu-lation and alters SMAD3 and SP1 binding." Allergy. 2014 May;69(5):632-42.

S. Gerdes, M. Laudes, K. Neumann, **H. Baurecht**, U. Mrowietz: "Wnt5a - a potential factor linking psoriasis to metabolic complications." Exp Dermatol. 2014 Jun; 23(6):438-40.

E. Rodríguez, **H. Baurecht**, AF. Wahn, A. Kretschmer, M. Hotze, S. Zeilinger, N. Klopp, T. Illig, K. Schramm, H. Prokisch, B. Kühnel, C. Gieger, J. Harder, L. Cifuentes, N. Novak, S. Weidinger: "An integrated epigenetic and transcriptomic analysis reveals distinct tissue-specific patterns of DNA methylation associated with atopic dermatitis." J Invest Dermatol. 2014 Jul;134(7):1873-83.

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Submitted Papers & Posters

October 2013 - October 2014

M. Eder, M. Karl, F. Schultheiß, J. Schürmann, A. Knoll, S. Riesner: “Design of an inherently safe worm-like robot.“ In Proceedings of the 2013 IEEE 11th International Sympo-sium on Safety Security and Rescue Robotics (SSRR2013). IEEE Press, October 2013.

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S. Duewel, M. Gersch, B. Feuerecker, **C. Hundshammer**, M. Schwaiger, S. Glaser, F. Schilling: “A Novel pH-Biosensor for Magnetic Resonance Imaging and Spectroscopy.” COST DNP school on hyperpolarization techniques. Marseille.

M. Kuschan, C. Meisinger, M. J. Eiber, F. Resmer, M. Müller, T. Lanz, A. Haase, M. Schwaiger, S. G. Nekolla: “Characterisation of a PET-optimized MR-carotids coil for hybrid imaging.” WMIC Annual Meeting 2014.

K. Thaler-Kall et al.: “The influence of spatial-temporal gait parameters on fall risk in elderly:results of the KORA-Age study”. submitted to J Gerontol A-Med, 2014.

National Conferences I October 2013 - October 2014:

87. Kongress der “Deutsche Gesellschaft für Neurologie” (DGN 2014)
München, September 2014

International Conferences I October 2013 - October 2014:

The 4th ISPDC Annual Meeting
Garching, Germany, October 10 – 12, 2013

IEEE International Symposium on Safety, Security and Rescue Robotics (SSRR 2013)
Linköping, Sweden, October 2013

HMIM 2013 Intermediate Event
Cambridge, USA, October 26 – November 02, 2013

IEEE Medical Imaging Conference
Seoul, South Korea, October 27 – 02 November, 2013

IEEE International Conference on e-Health and Bioengineering, EHB’13
Iasi, Romania, November 21-23, 2013

Annual Meeting Radiological Society of North America (RSNA)
Chicago, USA, 01 – 06 December, 2013

XNPIG Workshop & 3rd Symposium on Biomedical Phase-Contrast Imaging
Garmisch-Partenkirchen, Germany, 21 - 24 January, 2014

SPIE Photonics West Conference 2014
San Francisco, USA, Feb. 01 – 06, 2014

SPIE Medical Imaging Conference
San Diego, USA, February 2014

IEEE Global Engineering Education Conference (EDUCON2014)
Istanbul, Turkey, April 03 – 05, 2014

27th IEEE International Symposium on Computer-Based Medical Systems (CBMS)
New York, USA, May 2014

ISMRM (International Society for Magnetic Resonance in Medicine)
Salt Lake City, USA, May 09 – 16, 2014

Join Annual Meeting ISMRM-ESMRMB
Milan, Italy, May 2014

Annual Meeting of the Society of Nuclear Medicine (SNMMI 2014)
St. Louis, USA, June 07 – 11, 2014

4th International Conference on Information Processing in Computer-Assisted Interventions
Fukuoka, Japan, June 2014

Society in Europe Applied to Medicine Conference (SESAM)
Poznań, Poland, June 12 – 14, 2014

IEEE International Conference on Automation Science and Engineering (CASE 2014)
Taipeh, Taiwan, August 2014

21st European Conference on Artificial Intelligence (ECAI 2014)
Prague, Czech Republic, August 18 – 22, 2014

36th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC'14)
Chicago, USA, August 26 - 30, 2014

World Molecular Imaging Congress 2014 (WMIC)
Seoul, Korea, September 2014

17th International Conference on Medical Image Computing and Computer Assisted Interventions (MICCAI)
Boston, USA, September 2014

Annual Congress of the European Association of Nuclear Medicine (EANM 2014)
Gothenburg, Sweden, October, 2014

International Conference on X-Ray Microscopy (XRM 2014)
Melbourne, Australia, October 26 – 31, 2014

October 2013 - October 2014

Patrick Wucherer:
Chair for Computer Aided Medical Procedures, Johns Hopkins University
Baltimore, USA, April 22 – May 16, 2014.

Patrick Wucherer:
Keio University, Nagoya University
Japan, June 25 - July 05, 2014.

Eugen Kubala:
Technical University Denmark
Copenhagen, Denmark, August 11 – September 03, 2014.

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