



Ludwig Boltzmann Institute  
Clinical Forensic Imaging

# ANNUAL REPORT 2012

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## 1. Overview of the Ludwig Boltzmann Institute for Clinical-Forensic Imaging

### 1.1 Aims

The main goals of the LBI-CFI are:

1. to provide specific studies forming the scientific basis for the routine application of radiological methods in clinical forensic medicine; and
2. to establish a juridical basics for the implementation of clinical forensic imaging (CFI) into the forensic routine examination of living persons.

#### Ad 1)

Objectives regarding the establishment of a foundation for clinical forensic imaging are pursued relying on the dedication of all team members. Based on an interdisciplinary discussion of the studies and their current state at regular meetings, the different research areas constantly grow together to form a coherent entity.

#### Ad 2)

To ensure the interaction of juridical research with the routine forensic work of the Clinical-Forensic Care Unit (CFCU), one member of the law team is present at the daily meetings of the CFCU team where all examined cases are presented. Additionally, specific legal questions regarding clinical forensic examinations are discussed, helping direct the juridical research towards a focus on practical issues.

Generally, the research strategy of the LBI-CFI comprises:

1. Daily case work in forensic medicine and, particularly, clinical forensic medicine as a basis for the definition of the areas of research and specific research questions
2. Logical and systematic approach to scientific questions aimed at increasing knowledge and understanding in the different areas of research
3. Hypothesis driven and mainly prospective study design with clear objectives regarding the methodology of data analysis
4. Ethical correctness at all study stages, and the approval of studies by the local ethics committee
5. Encouragement and promotion of the scientific and personal skills of young researchers concerning posing of scientific questions, study design, study performance, and data analysis, as well as in relation to scientific writing and presentation of results
6. Backflow of the achieved study results into routine forensic work and instructing institutions such as the prosecution authorities

## 1.2 Quantity structure

### Finances

Table 1 presents an overview of the 2012 finances. The income consisting of cash and in kind contributions of the LBG GmbH and the institutional partners was approximately 1,46 Mio Euros. The expenses amounted to 1,59 Mio Euros (cash and in kind contributions), the additional expenditures were covered by the surplus of the last years.

<b>Finances</b>	<b>2012</b>
<b>Income</b>	1'456'651
<i>Personnel</i>	940'308
<i>Material expenses</i>	259'593
<i>Research expenses</i>	348'680
<i>Assets</i>	44'876
<b>Expenses in total (EUR)</b>	1'593'457

Table 1: Overview of finances 2012

### Human resources

Table 2 shows an overview of the team at the LBI-CFI.

<b>Staff (01.12.2012)</b>	<b>Head Count</b>		<b>Fulltime Equivalentents</b>	
	Total	Women	Total	Women
Management & Key Researchers	4	3	3,1	2,6
Medical Doctors	7	5	6,1	4,1
Law & Criminalistics	3	2	2,4	2
Computer Graphics & MR Physics	5	0	5	0
Administrative & Technical Staff	3	2	2,5	1,5
<b>Total</b>	<b>22</b>	<b>12</b>	<b>19,1</b>	<b>10,2</b>

Table 2: Overview of human resources 2012

### 1.3 Institutional partners



#### **Medical University of Graz**

The Medical University of Graz (MUG) is one of four medical universities in Austria. Their strategic interest in supporting the LBI-CFI is founded on aims to enhance the Institute of Forensic Medicine and to obtain new infrastructural possibilities in the field of forensic, pathologic and anatomic imaging, particularly for research purposes. Five years after its establishment, the LBI-CFI has acquired a wealth of technical expertise and project experience, and its staff is intended to work as a nucleus in the field of forensic, pathologic and anatomic imaging at the MUG.

The role of the MUG in the LBI-CFI is to offer availability of the research cases together with the Superior Court of Appeal of Styria and Carinthia, and to provide the infrastructure.

## **SIEMENS**

#### **Siemens AG Österreich**

Siemens AG is one of the world's largest suppliers of the healthcare industry. In helping to reach research targets, Siemens will primarily be involved in the technical and methodological aspects of the research. The main strategic interest of Siemens for the participation in the LBI-CFI is the chance to enhance creative and strategic solutions in a new and - to date - undeveloped field. By participating in and supporting the research of the LBI-CFI Siemens gets a unique opportunity in this market.

Their role in the LBI-CFI is to support research in the field of forensic imaging by contributing expertise in different areas.



#### **Karl-Franzens-University of Graz**

The Institute of Criminal Law, Criminal Law Procedure and Criminology of the Karl-Franzens-University of Graz (KFUG) provides the scientific background for a legal framework in which the validity and applicability of forensic radiological imaging as evidence in criminal procedures can be evaluated. A long-term accompanying study evaluates stepwise the expected advantages of modern imaging techniques as evidence in legal procedures. Therefore, the close cooperation between forensic medical doctors, prosecutors and judges from the Superior Court of Appeal of Styria and Carinthia (OLG) is of primary importance. One of the basic scopes of this partner is to participate in national and international scientific

research and discussions about criminal law and criminal law procedures. The partnership with the LBI-CFI allows this partner to have influence in the development and implementation process with respect to possible legal implications from the beginning.

Their role is to support the evaluation of the impact of clinical forensic imaging in routine juridical work in national and international legal systems, and to support the LBI-CFI in the evaluation of the advantages and disadvantages of imaging techniques in criminal proceedings.



### **Superior Court of Appeal of Styria and Carinthia**

Commissioning forensic expert opinion only weeks or months after an incident makes the forensic assessment difficult. The OLG and the BMJ support the LBI-CFI with the aim of ensuring that the LBI-CFI is commissioned and integrated as early as possible into clinical forensic cases in Styria and Carinthia to be able to conduct the planned studies. Their strategic interest is to improve the evidence situation based on a complete collection of findings and an objective documentation. Moreover, their intention is to reduce the length of legal proceedings and revisions, and, therefore, to reduce costs.

Their role is to cover the user's perspectives, to provide the knowledge of legal proceedings, to grant access to court files, and to support the application of clinical forensic imaging in the investigation procedure. The OLG and the BMJ do not dispose of funds to directly finance research.



UniversitätsKlinikum Heidelberg

### **Heidelberg University Hospital**

In June 2012, the University of Heidelberg along with its Institute of Forensic and Traffic Medicine with its chair Professor Dr. Kathrin Yen, the former director of the LBI-CFI, became a new partner of the LBI-CFI. It aims to cooperate with the LBI-CFI for implementing its research program, particularly in postmortem studies where a direct validation of imaging findings is possible. The results of these studies are invaluable as a basis of knowledge and experience in forensic imaging generally, and specifically for the implementation of radiological imaging in living victims.

Their role is to perform postmortem forensic imaging studies in close cooperation with the LBI-CFI with taking advantage of its specific infrastructure.

## 1.4 Supervisory Board und Scientific Advisory Board

### 1.4.1 Supervisory Board

The Supervisory Board of the LBI-CFI consists of representatives from the five partner institutions (MUG, Siemens, KFUG, OLG and University of Heidelberg) and the management of the LBG GmbH. The Board monitors the performance of the LBI-CFI, but also allows the partners to make suggestions, to decide together and to commission the director of the LBI-CFI with the implementation of the decisions. Equally, the director can submit proposals or change requests, which are then decided upon by the Board.

The members of the Supervisory Board are:

- Vizerektor Univ.Prof. Dr. Irmgard Lippe (Medical University Graz) as chair
- Mag. Gerd Obetzhofer (Oberlandesgericht Graz)
- Vizerektor Univ.Prof. Dr. Martin Polaschek (Karl-Franzens University Graz)
- Prof. Dr. Kathrin Yen (Universitätsklinikum Heidelberg)
- Mag. Claudia Lingner (Ludwig Boltzmann Gesellschaft GmbH)
- Dr. Erich Heiss (Ludwig Boltzmann Gesellschaft GmbH)
- Mag. Marisa Radatz (Ludwig Boltzmann Gesellschaft GmbH) until November 2012
- Dr. Peter Mayrhofer (Ludwig Boltzmann Gesellschaft GmbH) since December 2012

Since summer 2012, Siemens AG Österreich has decided, temporarily not to be represented in the Supervisory Board.

The meetings of the Supervisory Board took place on 20.3.2012 and 11.12.2012 at the Institute in Graz.

### 1.4.2 Scientific Advisory Board

The Scientific Advisory Board consists of 5 experts representing the different disciplines involved in the LBI-CFI and the management of the LBG GmbH.

The members of the Scientific Advisory Board are:

- Univ.Prof. Dr. Walter Bär (Institut für Rechtsmedizin der Universität Zürich) as chair
- Prof. Dr. Dorothee Auer (University of Nottingham, Queen's Medical Centre Campus)
- Univ.Prof. Dr. Hansjürgen Bratzke (Zentrum der Rechtsmedizin der Johann Wolfgang Goethe Universität Frankfurt am Main)
- Univ.Prof. Dr. Karl-Olof Lövblad (HCUG, Unité de Neuroradiologie, Geneva)
- Prof. Dr. Gustav Strijkers (Department of Biomedical Engineering, Eindhoven University of Technology)

The meeting of the Scientific Advisory Board took place on 13.9.2012 at the LBI-CFI in Graz.

## 1.5 Human resources and development

### 1.5.1 Human resources

Human resources of the LBI consist of a director, three key researchers covering forensic medicine, radiology, and law, and two senior researchers in computer graphics with responsibility for the work in their research areas, 14 researchers with various educational backgrounds (i.e. forensic medicine, radiology, physics & engineering, law and IT), two team assistants for the administrative support and one technologist for performing the radiologic scans. All employees are located in Graz.



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The staff is organized in four content-based teams:

1. The team Forensic Medicine I covers the two research areas “hematomas and other injury of soft tissues” and “traumatic brain injury” and consists of one key researcher (Eva Scheurer) and 5 researchers in forensic medicine, MR physics and criminalistics.
2. The team Forensic Medicine II is responsible for the research area “radiologic evidence in forensic reconstruction and age estimation” and consists of two key researchers (Felicitas Dahlmann and Thomas Ehammer), one in forensic medicine and one radiologist, as well as 4 researchers in forensic medicine and radiology.
3. The team Computer Graphics is responsible for the research area “computer-aided tools for forensic Case Analysis: Preparation and Presentation” and consists of two senior

researchers in computer graphics (Alexander Bornik und Martin Urschler) and one software developer.

4. The team Law is responsible for the research area “juridical issues of radiological methods in clinical forensic medicine” and consists of one key researcher (Reingard Riener-Hofer), one researcher and one expert in law.

The technologist in radiology and the two team assistants do not belong to a specific research team, but support all teams by taking responsibility for efficient organizational and administrative processes



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2012 the LBI-CFI consisted of the following 25 employees (see overview in Table 3).

	Function	Entrance	Exit date	Remarks
<b>Management &amp; Key Researchers</b>				
Scheurer Eva	Director, Key Researcher Forensic Medicine & Physics	09.05.2008		
Dahlmann Felicitas	Key Researcher Forensic Medicine	23.04.2012		
Ehammer Thomas	Key Researcher Radiology	01.11.2010		Parental leave from 29.08.2012 to 28.12.2012
Riener-Hofer Reingard	Deputy Director, Key Researcher Law	01.03.2010		
<b>Medical Doctors</b>				
Baumann Pia	Researcher, Resident Forensic Medicine	01.07.2011	31.12.2012	
Grassegger Sabine	Researcher Radiology	02.04.2012		
Hassler Eva Maria	Researcher, Resident Forensic Medicine	01.07.2010	30.09.2012	

Kauderer Clemens	Researcher, General Practitioner	01.12.2012	
Klasinc Isabella	Researcher, General Practitioner	15.10.2012	
Krebs Nikolaus	Researcher, Resident Forensic Medicine	01.10.2008	
Ogris Kathrin	Doctoral Student, Resident Forensic Medicine	02.05.2012	
Pivec Sonja	Researcher, Resident Forensic Medicine	15.06.2011	31.08.2012
Schillfahrt Florian	Researcher, Resident Forensic Medicine	01.08.2011	31.05.2012
Tamegger-Jelinek Nathalie-Belin	General Practitioner	01.02.2010	Clinical-Forensic Care Unit, Maternity leave since 16.04.2012
<b>Law &amp; Criminalistics</b>			
Kainz Simone	Doctoral Student Law	01.04.2011	
Schick Peter	Scientific Expert Law	01.10.2008	Em. Professor KFUG
Webb Bridgette	Researcher Criminalistics	01.12.2012	Temporary contract for a specific project
<b>Computer Graphics &amp; MR Physics</b>			
Bornik Alexander	Senior Researcher, Visualization Specialist	01.12.2008	Parental leave from 01.02.2012 to 31.03.2012
Höller Johannes	Software Engineer	15.11.2010	
Neumayer Bernhard	Doctoral Student MR Physics	16.01.2012	
Petrovic Andreas	Doctoral Student MR Physics	06.07.2009	
Urschler Martin	Senior Researcher, Segmentation Specialist	01.12.2008	
<b>Administrative and Technical Staff</b>			
Habersatter Stefanie	Teamassistant	13.04.2010	Maternity leave since 16.09.2011
Reisner Evelyn	Executive Teamassistant	01.10.2008	
Schachner Silvia	Teamassistant	14.03.2011	Maternity leave substitution
Widek Thomas	Technologist, Radiology	03.05.2011	

Table 3: Overview of staff in 2012

- Alexander Bornik was on parental leave from 01.02.2012 to 31.03.2012.
- Nathalie-Belin Tamegger-Jelinek took her maternity leave in April and had a son in June. In October 2012 she came back for a minor employment at the CFCU.
- Felicitas Dahlmann joined the LBI-CFI in April as a key researcher of the Team Forensic Medicine II and as head of the Clinical Forensic Care Unit.
- Florian Schillfahrt left the LBI-CFI at the end of May to start a residency in urology.
- Thomas Ehammer took his parental leave from 29.08.2012 to 28.12.2012.
- Sonja Pivec left the LBI-CFI at the end of August in order to complete her residency in general medicine.
- Eva Hassler left the LBI-CFI at the end of September in order to begin a specialization in radiology.
- As of 15.10.2012 Reingard Riener-Hofer has been appointed as deputy director of the LBI-CFI.
- Pia Baumann left the LBI-CFI at the end of the year in order to complete her specialization in forensic medicine in Geneva.

#### 1.5.2 Career development

##### Internal education and training

Concerning continuing education and training of the researchers of the LBI-CFI, the following internal trainings were organized in 2012:

- Educational presentation on manner of hypothermia/freezing by Florian Schillfahrt (06.03.2012)
- Introduction to microscopy von Herrn Mag. Reinhold Doljar (Leica) (07.03.2012)
- Educational presentation on drowning by Nikolaus Krebs (28.03.2012)
- Educational presentation on identification of the deceased by Pia Baumann (27.07.2012)
- Educational presentation on intoxication by Kathrin Ogris (28.09.2012)
- Journal club meeting of all researchers with presentations of current scientific papers and discussion (31.10.2012)

At the beginning of 2012 review meetings of the director with all employees took place with the aim of a positioning and to discuss individual career development.

In November 2012, a team development workshop was held under the guidance of an external specialist, Bernd Peters, and his partner Beate Ehmke. This 2-day event served to improve communication between team members. Collaboration, intellectual and operational possibilities, both on an interpersonal as well as organizational level, were reassessed and optimized thanks to team supervision.



In regular fortnightly meetings, the entire team of the LBI-CFI meets to exchange information regarding the current state and recent developments of their research, as well as for an interdisciplinary discussion of their studies to ensure optimal communication and cooperation between the researchers.

Daily morning meetings are held for all team members concerned with the Clinical Forensic Care Unit. Here, all examined cases are presented including the demonstration of photographs taken of characteristic morphologic findings. Additionally, any legal questions of the forensic medical doctors regarding clinical forensic examinations are discussed with the member of the law team present.

#### External education and training

Team members of the LBI-CFI regularly participate in educational lectures and meetings, PhD and diploma presentations as well as workshops of Graz University of Technology and Medical University Graz, and in the context of scientific conventions (e.g., at ISMRM, ISALM, ESMRMB).

Examples of externally organized activities with educational aspects, in which researchers of the LBI-CFI participated during 2012 are:

- Workshop “Prozess zur Erfindungsmeldung” with Dr. Siegling (AWS Innovationsconsulting) in Graz, organized by the LBG GmbH (10.01.2012)

- Biostatistikurs, organized by the Institut für Medizinische Informatik, Statistik und Dokumentation der Medizinischen Universität Graz (MUG) (17.-18.01.2012)
- Workshop „Viel Stoff – wenig Zeit. Wege aus der Vollständigkeitsfalle“, organized by the MUG (01.03.2012)
- Workshop „Karriereplanung für Wissenschaftlerinnen“, organized by the Koordinationsstelle für Geschlechterstudien, Frauenforschung und Frauenförderung, KFUG (05.03.2012)
- Workshop „Scientific Writing in Medical Science“, organized by the MUG (05.03., 12.03. and 22.03.2012)
- 10. Internationale Kasseler Fortbildung: „Medizinische Diagnostik bei Kindesmisshandlung“, organized by the Arbeitsgemeinschaft Kinder- und Jugendgynäkologie e.V. (16.-17.03.2012)
- Workshop „Scientific Writing in Medical Science – advanced“, organized by the MUG (22.03. and 29.03.2012)
- Workshop „Lehren an der MUG: Abläufe und AnsprechpartnerInnen“, organized by the MUG (02.05.2012)
- Workshop „Erfolgreich Kommunizieren in schwierigen Situationen“, organized by the MUG (15.05.2012)
- FWF-Coaching Workshop, organized by Fonds zur Förderung der wissenschaftlichen Forschung (FWF), Graz (22.05.2012)
- Workshop „Verbesserung der Prüfungsqualität: Key-Features, klinisch-praktische Prüfungen im OSCE-Format und mündliche Prüfungen“, organized by the MUG (04.06. and 05.06.2012)
- Workshop „RF Coil Design: Design and Build Your Own“, organized by the ESMRMB, Berlin (04.-08.06.2012)
- Workshop „Justizanstalt – Ein unbekannter Mikrokosmos“, organized by the Verein Kriminalistische Studiengesellschaft, Graz (14.06.2012)
- Visit of „Universitätenforum und Technologiegespräche, Europäisches Forum Alpbach“, organized by Europäisches Forum Alpbach, Alpbach (22.-25.08.2012)
- „Introductory Seminar for Experts“ organized by Hauptverband der allgemein beeideten und gerichtlich zertifizierten Sachverständigen Österreich, Seggau (22.-23.09.2012)
- Workshop „Statistik Grundlagen“, organized by the MUG (15.10.2012)
- Workshop „MR Safety“, organized by the ESMRMB, Vienna (18.-20.10.2012)
- Workshop „Lehre und Recht“, organized by the MUG (06.11.2012)
- Expert conference: „Medizinische und rechtliche Probleme bei Verdachtsdiagnose Kindesmisshandlung“, Frankfurt, organized by Stiftung Forensisches Forum, Frankfurt (10.11.2012)
- Workshop „Blutspurenmuster-Verteilungsanalyse“, organized by the Institute of Forensic Medicine, München (12.-16.11.2012)

Simone Kainz successfully participated in the one-year program “Career Program for Women Scientists. Competence, Strategy, Networking” from January 2012 to December 2012. The target group for this program was female doctoral students and Post-Docs of any discipline offered by the University of Graz, the Graz University of Technology, the Medical University of Graz, and the University of Music and Performing Arts Graz. Learning objectives of the program were:

- Personal situation assessment and developing professional focus
- Strategic approaches to career planning
- Skills related to professional everyday life in scientific organizations
- Insight into university’s (informal) structures
- Networking

### 1.5.3 Team Events

On 08.03.2012 the LBI-CFI skiing day took place in the ski resort of Tauplitz. Perfectly organized by Andi Petrovic, nine people started early in the morning to enhance the teamfeeling by enjoying one day with skiing together. Unfortunately, it was snowing all day. In the evening the day was rounded up by a dinner with the entire team at the restaurant “Gösser Bräu” in Graz.

At the end of summer, on the 25.09.2012, the team of the LBI-CFI went on a trekking trip to



the “Wipfelwanderweg” in Rachau near Knittelfeld. The team enjoyed warm weather and a fantastic panorama from above the canopy. In the afternoon a late lunch was taken in the shady garden of a nice restaurant in Knittelfeld.

The LBI-CFI christmas dinner took place on 11.12.2012 at the Restaurant Regina Margherita in Graz, where the team enjoyed an excellent Italian meal and celebrated the end of a successful and interesting year.

## 1.6 Infrastructure

The institute is located on the second floor of Universitätsplatz 4 neighbouring the Institute for Forensic Medicine of the Medical University Graz, with which it shares some rooms (e.g., kitchen, examination room, autopsy rooms). A second branch of the institute is located in two office rooms at Elisabethstrasse 27. This second office with workplaces for 5 team members is within walking distance (approx. 7 minutes) from the main office.

The scientific MR and CT scans are performed on scanners at the Department of Radiology, LKH Graz (MRI: 3T TimTrio, Siemens AG, Erlangen, Germany, CT: Sensation 64, Siemens AG, Erlangen, Germany), and at the Privatklinik der Kreuzschwestern (CT/MR Zentrum Graz-Geidorf; MRI: 3T Verio, Siemens AG, Erlangen, Germany), where also routine CT scans are performed in age estimation cases. X-rays (only for routine purposes) are performed at the Radiologiepraxis Dr. Uranitsch, Graz.

## 1.7 Highlights of the year

A highlight concerning the regional implementation of a routine service of clinical forensic medicine took place on 12. June 2012 when the LBI-CFI organized a moderated expert discussion focusing on "Klinisch-Rechtsmedizinische Versorgung in der Steiermark – Quo imus".

The relevance of the subject, i.e., to provision forensic services to living victims in entire Styria and its financing, was a result of the "Jour Fixe" meeting in February 2011, where representatives from the LBI-CFI, the prosecution (StA Graz), criminal and state police (Graz and Styria) as well as the University Hospital (LKH-Universitätsklinikum Graz) discussed how examinations at other places of Styria could be organized in order to facilitate documentation and securing of evidence in victims living at greater distances from Graz.

Various perspectives on the possibilities concerning organization and infrastructural limitations of such examinations were offered by

- Oberstleutnant Kornberger (Landeskriminalamt, Steiermark)
- Mag. Pichler (Staatsanwaltschaft, Graz)
- Oberpfleger Kapeller (LKH-Univ. Klinikum, Graz)
- Oberarzt Dr. Naglis (Abteilung für Frauenheilkunde und Geburtshilfe LKH, Leoben-Eisenerz)

- Mag. Egger (Gewaltsschutzzentrum, Steiermark)
- Dr. Scheurer (LBI-CFI)



In addition to the different aspects of the presenters based on the aim and function of their institution the talks included practical examples of cases which enlightened needs and current problems concerning organization and infrastructure. Finally, the participants agreed in the opinion that interdisciplinary and interinstitutional collaboration is extremely important and should further be enhanced, as demonstrated by the promising results already yielded by this approach.

Another highlight in 2012 was the LBI-CFI lecture series “The interdisciplinary world of forensic imaging” where we succeeded to invite nationally and internationally renowned speakers to speak about their specialist field including forensic medicine, MR physics and methodology, radiology and imaging, computer graphics, law enforcement, prosecution and criminal law as well as victim support. In 2012, the five lectures were given by Univ.-Prof. DDr. C. Boesch (Bern, Switzerland), Mag. C. Koller (Graz, Austria), PD Dr. C. Jackowski (Zürich, Switzerland), Prof. Dr. A. Schmeling (Münster, Germany) and Univ.-Prof. DDr. C. Kopetzki (Vienna, Austria) (see section 3.3). The lectures attracted an interdisciplinary and very interested audience. The series will be continued next year.

## 1.8 Public relations

### 1.8.1 Media contacts and reports

The Ludwig Boltzmann Institute for Clinical-Forensic Imaging received numerous requests for TV and radio interviews as well as for interviews for printed media reports. These requests were accepted whenever possible.

A selection of contributions released to the public is listed below:

- Magazine article about the „Lange Nacht der Forschung“ in “Science”, title: “Lange Nacht der Forschung”, April 2012
- Magazine article about the „Lange Nacht der Forschung“ in „Kleine Zeitung“ entitled „Dabei sein. Staunen. Forschen.“, 22.04.2012
- Magazine article about the “Lange Nacht der Forschung” in “Kleine Zeitung” entitled „Auf zur langen Nacht der Forschung!“, 26.04.2012
- Magazine article about the „Lange Nacht der Forschung“ in „Kleine Zeitung“ entitled „Eine erhellende Forschungs-Nacht“, 28.04.2012
- Magazine article about developments in forensic medicine in “Krone Zeitung” entitled „Die Gerichtsmedizin der Zukunft: Wie neue technische Verfahren die Obduktion bald revolutionieren könnten“, 05.05.2012
- OTS press release concerning the expert discussion on 12.06.2012 entitled „Körperliche und sexuelle Gewalt: Verbesserung der Beweissicherung“, 06.06.2012
- APA press release concerning the expert discussion on 12.06.2013 entitled „Beweissicherung für Gewaltopfer: Je schneller umso rechtlich sicherer“, 12.06.2012
- Radio report about the expert discussion on 12.06.2013 – OE1, title: “Wissen aktuell: Gerichtsmedizin und Beweissicherung”, 12.06.2012
- Article about the „Clinical-Forensic Care Unit” entitled “CSI: Gerichtsmediziner wollen mehr Kompetenz”, 13.06.2012 (steiermark.orf.at)
- Magazine article entitled “Die Wissenschaft vom blauen Fleck” in “Die Presse”, 01.07.2012
- Radio report in „Morgenjournal“ – OE1, title: “Gewalt in der Familie: Beweis oft schwierig”, 27.11.2012

### 1.8.2 Public presentations

The scientific work and other activities of the LBI-CFI were presented to the non-scientific public at the following research exhibitions:

Lange Nacht der Forschung, Graz, 27.04.2012:

The institute showcased itself for the first time at the Austrian-wide “Lange Nacht der Forschung”. Clinical forensic medicine was presented with the motto “Auf der Spur des Verbrechens – Forensik hautnah” using an interactive criminal case. Visitors investigated this case by applying various methods, e.g., analysis of traces, microscopy, DNA matching as well as 3D reconstruction and visualization, thus, gaining an insight into the world of forensics under the guidance of the LBI-CFI team. In parallel, Eva Scheurer gave a public lecture entitled “CSI Forensic Imaging – Vision and Reality” at Kottulinsky’s organized by the Lange Nacht der Forschung.



For providing us with mineral water and Mannerschnitten as well as for other in kind donations we thank our sponsors (Autohaus Weberhofer e.U. – Opel Service Partner, Institut für Zellbiologie, Histologie und Embryologie, Medizinische Universität Graz, Interspar GmbH, Murpark, Landeskriminalamt Steiermark, Sanova Pharma Medical Systems GmbH). The presentation was very popular and attracted many visitors.

Family afternoon: 3D scan with Einstein junior in Graz, 15.12.2012:

The Einstein junior children's afternoon "3D-Scan with Einstein Junior" took place in cooperation with the Kinderbüro in Graz. Children from 8-12 years were invited to solve a criminal case using different forensic methods, while their parents listened to the presentation of Eva Scheurer on forensic imaging. Additionally, the young researchers were given the opportunity to get a 3D-surface scan of themselves or of their favourite stuffed animal. By request this 3D scans were sent to the children and their parents. The children's afternoon was a great success amongst both young and old.



Meet Science 2012 organized by the LBG GmbH, Vienna, 23.10.2012: Presentation of a short film on the research activities of the LBI-CFI

Presentation of the new book "Klinisch-forensische Medizin – Interdisziplinärer Praxisleitfaden für Ärzte, Pflegekräfte, Juristen und Betreuer von Gewaltopfern", Vienna, 13.11.2012: Talk entitled „Nutzen einer klinisch-forensischen Ambulanz aus Sicht der Justiz“ given by Peter Schick

## 2. Research program and results

### 2.1 Projects

The research program of the LBI-CFI during the year 2012 was conducted with five main focuses, each comprised of different studies, which are briefly described in the following sections.



Across all studies, some of which were conducted in parallel, a total of 216 MRI scans of living and deceased subjects were made. Table 4 shows an overview of the studies in which MRI scans were performed.

<b>MRI</b>	<b>2012</b>
Blood volumes in pork belly	1
Subcutaneous blood in living persons	21
Traumatic brain injury	1
Strangulation study	9
Dental MRI	9
Age estimation using MRI	173
Whole Body MRI after trauma	2
<b>Total</b>	<b>216</b>

Table 4: Overview of research MRI scans 2012

### 2.1.1 Hematomas and other injury of soft tissues

#### Artificial hematomas in subcutaneous fatty tissue of living volunteers

##### *Introduction*

The aim of the hematoma study, which was completed in 2012, was to evaluate the MR characteristics of injected volumes of blood in the subcutaneous fatty tissue of 20 healthy living volunteers regularly over a time span of several weeks using MRI as well as infrared (IR) and visual photography.

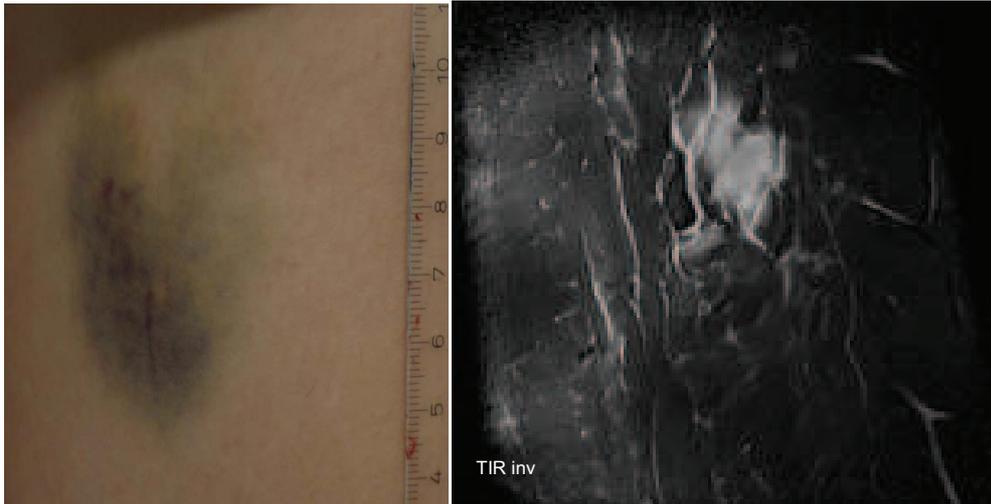
##### *Materials & Methods*

A blood sample was drawn from all volunteers at the beginning of the study. These samples were used for blood gas analysis and to create reproducible artificial hematomas by injecting a fixed blood volume into the subcutaneous tissue of the thigh. The hematomas were then measured using standard, commercially available, MR sequences over a period of two weeks and documented using visual and IR photography.

By the beginning of 2012, data acquisition for our in vivo study on artificially created hematomas, by injection of autologous blood, was completed. ROI analysis was performed on T1w, T2w and PDw scans. With the gradient echo acquisitions, fat-water separation was performed, and the time span of the average water fraction in the hematoma were computed, as well as - in collaboration with Jena - quantitative susceptibility maps of the hematoma.

##### *Results / Progress 2012*

Quantitative evaluation of the contrast in IR images compared to visual photos showed a significant enhancement of hematoma visibility. This could be used for easier detection of hematomas particularly in children and darker skinned persons.



Analysis of the signal behavior of the hematomas in the MR images gave insight into the body's reaction to subcutaneous hematomas. This study provides data which was not previously available to this extent and, therefore, will be of particular importance in clinical forensic medicine. The behavior of the MR contrast was modelled and this model was used for the determination of hematoma age, which is still an unsolved problem. The model for hematoma age estimation is based on an MR sequence with proton density weighting and inversion recovery sequences, and provides lookup tables which allow the determination of a hematoma's age with a confidence interval of about  $\pm 1$  day up to two weeks. Finally, the model provides information which allows for a fast visual estimation without any calculations.

In the evaluation of fat-water images a decrease of the water fraction was observed, indicating the resorption of the blood volume.

The results of the quantitative susceptibility maps indicate that deoxygenation of blood, which makes it more paramagnetic, is very quick and already completed at the first time point of our measurements. However, further analysis will be required to refine these results.

### *Outlook*

First experiments to create artificial hematomas by impact of an accelerated mass were performed. So far, no convincing results could be achieved and further experiments are necessary. Prior investigation of the tissues' mechanical properties is needed to create well defined hematomas.

Relaxometry methods for T2 quantification have been refined in collaboration with Göttingen, where an accelerated acquisition strategy was combined with an accurate model for T2 quantification. The corresponding paper is currently being finalized. A thorough relaxometric analysis of our in vivo hematoma data is planned for the future.

### Diffusion weighted (DWI) and diffusion tensor MRI (DTI) for the evaluation of traumatic muscle lesions

In first experiments, DTI was used to investigate sharp force injuries in a meat phantom. Sharp force injuries, such as stab wounds, often cannot be seen in MR images because they

collapse as soon as the weapon is removed. Nevertheless, a stab wound is expected to influence the preferred direction of water diffusion, which should make it visible in DTI visualizations based on DWI.

Initial results showed that parameter optimization is very important for the imaging of stab wounds. Also, since relaxometric parameters are strongly dependent on temperature, future phantom measurements will include temperature control to simulate real body conditions.

### Temperature dependence of MRI contrast in postmortem tissue

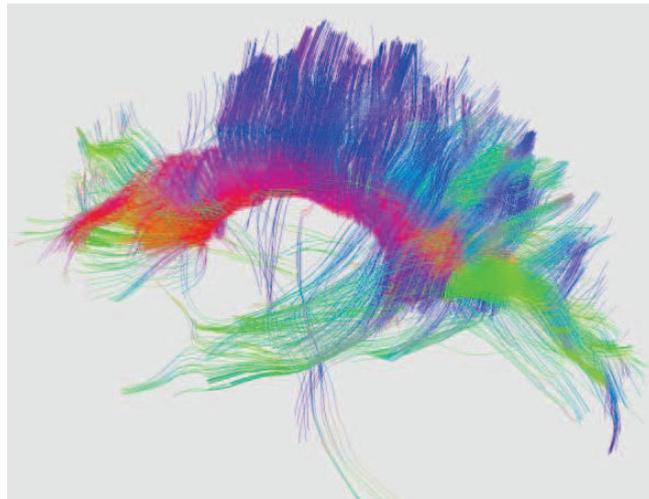
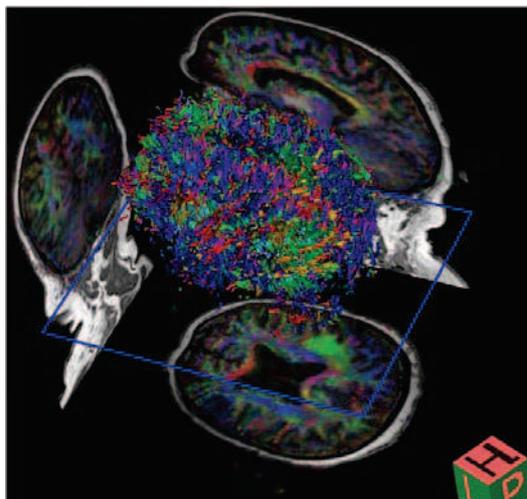
Post-mortem MRI is impeded by a loss of contrast due to the lower temperature (4-10°) of the corpses. In order to characterize the dependence of contrast on temperature relaxometrics, measurements on pork tissue phantoms (liver, muscle, fatty tissue) were conducted for temperatures ranging between 4° and 36° C. In further investigations, contrast for several tissues and sequences was simulated to optimize the sequence parameters. This work was done in the context of a diploma thesis in collaboration with the University of Technology Graz.

### 2.1.2 Forensic aspects of traumatic brain injury

#### *Introduction*

The aim of the study “Blunt head trauma: correlation of post-mortem MRI and histological analysis of the brain” is to detect specific differences in form of MRI detectable traumatic lesions between a group of deceased of subjects with a blunt head trauma and a group of deceased controls without brain trauma. Various aspects such as the characteristics of visible lesions in MRI, the estimation of impact power, the direction of the force of impact or the age of the findings are core issues in forensic evaluation. Thus, the validation and correlation of MRI findings with macroscopic, histological, chemical as well as physical methods might improve our ability to draw forensic conclusions.

Additionally, the deposition of iron in brain tissue as a consequence of brain injury is investigated. Abnormally high iron deposition in the human brain has been shown to play a role in several neurological disorders and is linked to the process of neurodegeneration. The rupture of nerve fibres leads to a rapid loss of white matter tissue which might be paralleled by iron deposition.



### *Methods*

A group of deceased subjects with a blunt head trauma and a control group of deceased subjects without brain trauma are compared concerning morphologic differences as well as specific quantitative MR-parameters, which might indicate the extent of posttraumatic edema or the degree of demyelination. Prior to an inclusion of subjects in the study, informed consent is obtained from the next of kin and if applicable from the prosecution. Thereafter, a standardized temperature adjusted MR scan protocol is used. Images are stored in anonymized form and read independently by radiologists. Tissue specimens of the brains are taken from pre-specified white and grey matter regions for microscopic examination and chemical determination of trace element concentrations (iron, calcium, zinc and others).

### *Results / Progress 2012*

It was shown that increased iron levels can be found in white and deep grey matter structures in subjects having died as a consequence of traumatic brain injury. Posttraumatic diffusivity changes were observed in white matter regions and quantified using specific MR imaging techniques (DWI and DTI) in deceased subjects. Considering a posttraumatic damage or even a loss of directional nerve fibre structures, these results indicate the presence and the extent of posttraumatic diffuse axonal injury. These results were presented at the 9th world congress of the International Brain Injury Association in Edinburgh.

### 2.1.3 Radiologic evidence in forensic reconstruction and age estimation

#### Detection and forensic interpretation of soft tissue findings in living and post-mortem subjects after strangulation using MRI

##### *Introduction*

The diagnosis of strangulation in surviving victims based on objective findings is important in the criminal proceedings relating to the assault. The gold standard is an external examination which often shows no signs of injury, despite a credible history of strangulation. The aim of this study is to evaluate the diagnostic performance of a native MRI scan when considering strangulation.

##### *Materials & Methods*

Besides an external examination with photo documentation, the study also involves an examination using native MRI scans on a 3T scanner of living and deceased victims of strangulation incidents as well as of control groups including living and deceased persons without injury.

### *Results / Progress 2012*

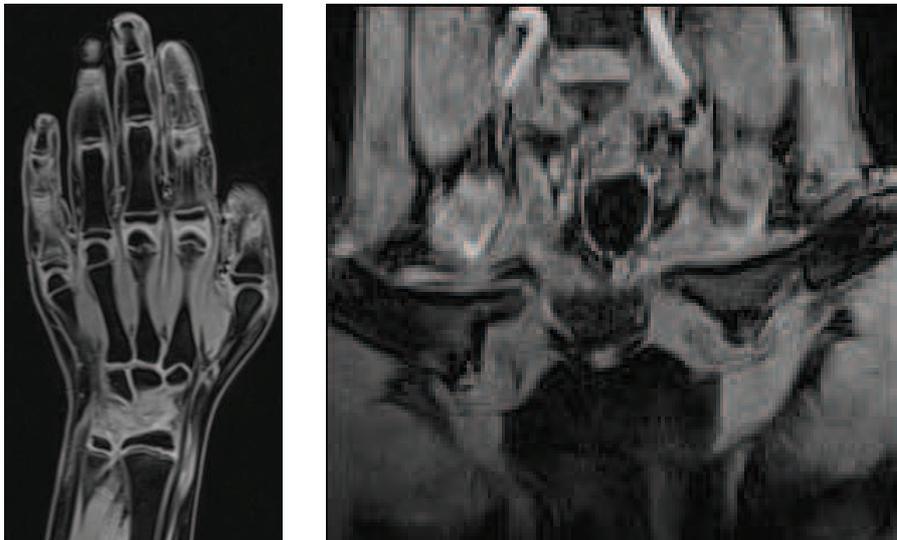
Preliminary results were presented at the 20th ISMRM Meeting in Melbourne in May 2012.

In 2012, we aimed to compare radiological findings of a native MRI scan with external findings in strangulated subjects to enhance forensic reconstruction of the event. We found that MRI findings of the neck not only complement the forensic external examination to achieve a high sensitivity and specificity for the diagnosis of strangulation, but that they also add important information on the attack and the assailant himself. These results were summarized as an abstract, which was accepted by the ISMRM and will be presented at the 21st ISMRM Meeting in Salt Lake City, USA.

### Validation study: forensic age estimation of living persons using MR imaging of wrist, clavicles and wisdom teeth

In addition to an external examination of the person the gold standard in forensic age estimation is based on the evaluation of an OPG (orthopantomogram, a panoramic dental x-ray), a radiograph of the hand and wrist, and a CT of the clavicles. These methods are associated with radiation exposure - a recurrent issue of public and political debate. An adequate or even better alternative using MRI would be highly appreciated.

The aims of this ongoing study are 1) to investigate all of the information currently used for forensic age estimation in living adolescents in the same individuals and 2) to determine statistically relevant reference values for middle European males which can be used for forensic age estimation by performing an MRI examination of three body regions in a single session.



In this ongoing study healthy male subjects between 13 and 24 years undergo a 3T MRI examination of the wisdom teeth, the clavicles and the hand and wrist. The study was approved by the ethics committee. To date data from 226 volunteers were collected.

For the evaluation internationally recognized standards for are used (e.g. the Greulich-Pyle method, the Kellinghaus method and the Demirjian method). Currently, we are primarily

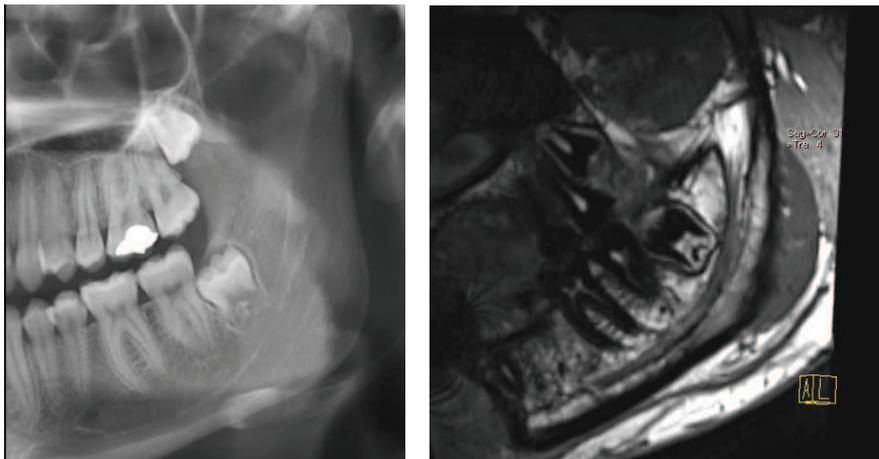
recruiting subjects in the lower age range (13-18 years) where recruiting is more complicated due to the information and needed consent of the parents. From a long-term point of view, MRI examinations might replace the use of ionizing radiation for the purpose of age estimation.

#### Dental age estimation: comparison of orthopantogram (OPG) and dental MRI

Dental age estimation is an important part of forensic age estimation in living adolescents, and is usually based on the evaluation of the development of the third molars in an OPG. However, the use of ionizing radiation without medical indication is not permitted in many countries, and a radiation-free alternative would be greatly appreciated. In this study the OPG was compared to dental MRI in healthy young volunteers with known age.

The diagnostic value of dental MRI for the evaluation of developmental criteria of wisdom teeth was assessed by comparing the results yielded on the basis of the OPG performed for dental reasons with those of the MRI in 30 volunteers.

By December 2012, the data acquisition and the evaluation of this prospective study was completed.



#### Evaluation of in vivo MR spectroscopy for the estimation of age in living persons in the pension age

The non-invasive estimation of age in living persons after completed development of the body is only possible if radiological data from their adolescence can be assessed. However, such data is often not available. Several studies have shown that the fat content of vertebral bone marrow correlates with a person's age. However, so far all studies covered a wide maturity range instead of a specific age group. In 2012 a pilot study was prepared to investigate the applicability of proton MR spectroscopy in situ to determine a person's age in a range between 55 and 70 years. These preparations included the establishment of the methodology together with cooperation partners in Bern, Switzerland, as well as the necessary infrastructure.

#### 2.1.4 Computer-aided tools for forensic case analysis: preparation and presentation

##### *Introduction*

In accordance with the research program of the past years we have established a number of basic algorithmic techniques and software applications for the planned forensic software toolbox. Our main concern is the processing of forensic findings from photographic and volumetric (MRI/CT) data, and the visualization of forensic findings in the context of easy-to-understand reference models.

##### *Current State & Results*

###### *1. Visualization & Interactive Segmentation for Analysis & Presentation*

We have finished the implementation of the second prototype of our forensic software toolbox, i.e. the generic forensic case analysis and presentation application based on integrated segmentation and visualization of 3D data. The integration of a number of already existing segmentation methods as well as a new user interface for interactive 3D segmentation has been accomplished. Simultaneously, we have started adapting our core software tool to forensic applications. After our first journal publication using the previous software prototype was printed in the July/August 2012 issue of IEEE Computer Graphics & Applications, we have recently started to work on another publication for a forensic medicine journal. It shows the application of the tool in the respective contexts, forensic case analysis and preparation for presentation in court, based on a number of real cases. A first glimpse of this publication has been submitted to the Eurographics Workshop on Visual Computing for Biology and Medicine (VCBM 2012).

New features of our core software tool include support for drag & drop based scene content composition and editing, improved support for textured surface models, performance improvements by acceleration techniques such as early ray termination and empty space leaping in the rendering component, based on tight fitting bounding geometries. State of the art segmentation algorithms like level set methods, region growing and geodesic active contours were included. An important recent contribution was the implementation of multi-touch based interaction techniques which simplify common 3D scene navigation and editing tasks.

In the context of segmentation we have also started a cooperation with the Ludwig Boltzmann Institute for Lung Vascular Research in Graz in the form of a master thesis supervised by Dr. Martin Urschler. The student, Michael Helmberger, is working on the segmentation of lung CT vascular trees and investigating several measures of vascular tree geometry to find correlations with pulmonary hypertension. Other students of Dr. Urschler are Kerstin Hammernik, who is working on registration of 3D volumetric data, Marc Steiner, who is working on implicit statistical shape models, and Christoph Gratl, who defended his master thesis on a statistical appearance model in autumn 2012.

## *2. MRI signal for Segmentation & Transfer Functions*

Most of our program lines are working with MR imaging protocols, which are subject to change due to ongoing research. Besides the tendency of MRI to involve imaging artefacts such as inhomogeneities due to a non-homogeneous magnetic field, the mapping of tissues to the MR signal in general is ambiguous. Different protocols map tissue types to differing intensity ranges, and the ranges overlap for many tissue types. Thus, the interpretation of the MR signal intensities is a very hard task.

We have deepened our understanding of MR signal inhomogeneities and MR segmentation by performing a literature review on methods for MR intensity correction. This was performed at the ICG by PhD student Vladimir Kanchev under the supervision of Dr. Martin Urschler. This work gives us several directions to implement an inhomogeneity correction scheme. A bachelor thesis (Marlene Vukmanic) in the form of a literature survey was performed under the supervision of Dr. Alexander Bornik, investigating current research on transfer functions in general and (semi-)automatic techniques to generate them.

We have also participated in a Marie Curie proposal with the goal of employing a post-doc from Maribor, Slovenia at Graz University of Technology, whose topic is the automated age estimation from MR images of the hand, the molar teeth, and the clavicle. This work will accompany the ongoing age estimation validation study (Radiologic evidence in forensic reconstruction and age estimation, section 2.1.3). The proposal was accepted, and Dr. Darko Stern will start to work on it in May 2013 accompanied by a master student.

## *3. Patient-specific & Generic 3D Reference Models for Case Presentation & Database Storage*

In addition to our initial results for visualizing anonymized patients using generic 3D body surface models, we have strengthened our efforts to reconstruct patient-specific models for the purpose of accurately localizing patient imaging data from different sources (photographs and MRI/CT) in relation to each other. We have performed a number of experiments with the Microsoft Kinect device, and found a reasonable and very cost effective setup to perform patient-specific 3D scans. With this method we are able to apply a texture to these 3D scans and to visualize them in combination with MR/CT data for presentation in court. We have submitted an abstract to this year's DGRM conference in Freiburg, where it was accepted, and we are currently in the process of finishing a paper for a forensic journal on the topic of visualizing generic and patient-specific 3D models.

In this context we have improved our generic 3D surface models for presenting injuries by integrating the updated version of the freely available MakeHuman project. This software allows the adjustment of the generic 3D model in its size, shape, gender and posture more freely. We plan to investigate this further and possibly add tools for semi-automatic placement and parameter adjustment of the generic model leading to a better fit to available scan data.

### 2.1.5 Juridical issues of radiological methods in clinical forensic medicine

Using the results from the medical and technical research of the other key areas as a starting point the juridical key area examines the implementation of radiological methods and evidence in the Austrian criminal procedure framework. This legal framework establishes a comprehensive and fundamental network of rules of evidence, including conditions for the performance, admission and prohibition of evidential measures. All legal issues that are required as a juridical basis for the routine application of the radiological techniques shall be analyzed and, if necessary, developed.

The requirements for implementing the imaging-based expertise into juridical preliminary proceedings are researched and principles for taking and processing evidence gained by clinical forensic imaging are defined. The legal principles of producing and processing CFI evidence are evaluated, and proposals concerning the adoption of new requirements are given.

The research activities in this area are inseparable from the forensic routine casework performed by the Clinical-Forensic Care Unit and the results of the other research areas of the LBI-CFI. For advisory purposes, a representative of the juridical team takes part in the daily meetings of the team of doctors responsible for the clinical forensic out-patient clinic. If a juridical problem is brought to the juridical team, the team supports the resolution of legal issues of various kinds. The correct accounting of the forensic expert charges in conformity with the law was an important topic during autumn 2012. Relevant proceedings are still ongoing.

Based on the interdisciplinary approach of the LBI-CFI there is a close collaboration with our partners, the Institute of Criminal Law, Criminal Law Procedure and Criminology of Graz University and the Superior Court of Appeal of Styria and Carinthia. In a collaborative effort reporting procedures for suspected physical violence cases are defined for the medical personnel, the police, child protection groups, institutions for victims of violence, social insurance companies as well as medical associations and professional representation boards. In cooperation with judges and public prosecutors an analysis of clinical-forensic methods in court proceedings is intended to demonstrate the importance of medico-legal expertise.

Regular Jour Fixe-meetings with representatives from the hospital, police and prosecution helps encouraging the practice oriented analysis of cases. This cooperation between the Medical University of Graz, State Criminal Police, Prosecution Graz and the LBI-CFI delivers interesting starting points for legal research. The cooperation with judges and public prosecutors helps achieving an analysis of court proceedings and demonstrates the progress in the field of clinical forensic methods.

The evaluation of bodily harm damages is also of significant importance with regard to tort and insurance law. Therefore, a closer contact to insurance companies is planned.

### Study „Standortbestimmung der Gerichtsmedizin in Österreich“

Within the general public the concept of forensic medicine is primarily associated with post-mortem examinations. Crime films and television series together with homicide reports in the media further reinforce this image. This study aimed to demonstrate the view of law enforcement authorities in relation to the contribution of forensic medicine. Furthermore, the study should be a starting point to more detailed information and clarification of the scope of forensic medicine including clinical forensic medicine.

A questionnaire which was made anonymous was developed by the judicial team of the LBI-CFI. In collaboration with the Federal Ministry of Justice this questionnaire was distributed in the form of an online-survey Austria-wide to prosecution services and magistrates. A scientific analysis of the survey results has been performed the results of which will be published in 2013.

### Study „Klinisch-rechtsmedizinischen Abklärung körperlicher Gewalt im Strafvollzug“

The aim of this study is to investigate if there is a need for clinical forensic examinations performed by a forensic medical expert regarding instances of bodily harm occurring in prison. Because of the sensitivity of the topic and the necessity to interview prison staff and maybe prisoners, the permission of the Austrian ministry of justice (BMJ) is required which is still under discussion. The study will be conducted by Obstl. Mag. Herbert Fuik, who is a doctoral student at the Institute of Criminal Law, Criminal Law Procedure and Criminology at the Karl-Franzens University Graz.

#### 2.1.6 Clinical Forensic Care Unit

The first Austrian Forensic Care Unit was established in October 2008 by the Ludwig Boltzmann Institute for Clinical-Forensic Imaging in Graz as a facility of the LBI-CFI together with its institutional partner the Medical University of Graz. The Clinical-Forensic Care Unit offers medico-legal examinations of living persons after incidents of suspected physical or sexual violence, as well as forensic age estimations in living persons, which is a traditional duty of clinical forensic medicine. The medico-legal documentation of injuries after acts of violence helps to improve not only the quality of the medico-legal expert opinion, but also the quality of the juridical decision-making in court by providing a greater legal security.

The service of the Clinical-Forensic Care Unit is available to all persons having suffered physical violence including accidents or sexual violence at no personal costs and independent of whether a report to the police has been made. An on-call service available 24/7 guarantees the availability of a medico-legal examination in the greater Graz area (hospitals, police stations, detention centres, and organizations offering help to victims, etc.) within 35 to 45 minutes. In relation to examinations outside this geographical radius, medico-legal assistance can be given by phone and email to ensure a successful examination by other physicians.



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Examinations in cases with suspected sexual assault or maltreatment of adults and children are usually conducted in the corresponding hospital departments in cooperation with a gynaecologist or specialized pediatrician. Additionally, two residents are members of the clinical child protection groups of the Department of Paediatric Medicine and the Department of Paediatric Surgery with weekly meetings and interdisciplinary discussions of suspected child abuse cases.

Selected persons examined at the Clinical-Forensic Care Unit, who match the inclusion criteria of current studies of the LBI-CFI are asked if they are willing to participate in the respective study.

The LBI-CFI is the first institution in Austria performing forensic age estimation examinations based on the guidelines issued by the German working group on age diagnostics (AGFAD). These examinations are an excellent example of applying clinical forensic imaging as a modern tool in forensic medicine.

For the enhancement of communication between prosecution, police, clinical and forensic medicine, the Jour Fixe-meetings (see section 1.7) provide substantial progress with respect to the optimization of processes for victims of violence. In April 2012 the Youth Welfare Service and in September 2012 the Victims Protection Center (Gewaltschutzzentrum), Steiermark were invited to the Jour Fixe. Additionally, the development of guidelines concerning clinical forensic examinations at the LKH Graz was coordinated by an interdisciplinary team of the LBI-CFI.

Table 5 presents an overview of the cases which have been seen at the Clinical-Forensic Care Unit in 2012. The age estimations are performed on behalf of the Federal Office for Migration and Refugees; the other cases are examined by order of the Office of Public Prosecution or on a consultation basis for clinicians. In total, 23% of all cases were not financially rewarded.

<b>Clinical-Forensic Care Unit</b>	<b>2012</b>
Physical violence (against adults > 18 years)	32
Sexual violence (> 18 y)	28
Physical child abuse (< 18 y)	54
Sexual child abuse (< 18 y)	26
Forensic age estimation in living persons	323
Other cases	8
<b>Cases in total</b>	<b>471</b>

Table 5: Overview of the cases seen at the Clinical-Forensic Care Unit 2012

## 2.2 Publications

### 2.2.1 Publication policies and intellectual property rights

Regarding publications, rules for the regulation of authorship have been defined according to good scientific practice. These are supervised and executed for each study by the key researcher or the responsible researcher of the corresponding team. Authorships are regulated under consideration of the general principles for author contributions as outlined in the “instructions for authors” of main scientific journals.

The acquired radiological scanning data are owned by the LBI-CFI which is responsible for its acquisition and has to comply with the national law regulations. Requests for the usage of these data for purposes other than scientific or those outlined in the research program are evaluated and decided upon by the Supervisory Board of the LBI-CFI. The whole output of the research activities is published in scientific journals of the various involved scientific areas, complying with the main target of the LBI-CFI to implement clinical forensic imaging in legal practice. The IPR of the institutional partners are handled according to the contract of 2008.

### 2.2.2 Publications

The scientific output in the form of publications, proceedings and abstracts (see the complete list of publications in section 5) was positive in 2012. Additionally, several book chapters are already in press and will be available in 2013. As in the years 2011 and 2012 extensive data was acquired high effort was put into evaluation and manuscript preparation. The related publications are pursued and will be published in 2013.

## 2.3 Participation in scientific conferences

As a portrayal of the interdisciplinarity of the LBI-CFI, numerous contributions to international scientific meetings and conferences within the scientific communities of forensic medicine, magnetic resonance in medicine, and computer graphics have been made. Overall in 2012, 15 oral presentations and 8 poster presentations were given by researchers of the LBI-CFI.

An overview of the contributions to the different scientific communities 2012 is given here:

### Forensic medicine

- Congress of the International Academy of Legal Medicine (IALM), 05.-08.07.2012, Istanbul, Turkey  
2 oral presentations
- Annual Scientific Meeting of the German Association of Forensic Medicine (DGRM), 18.-22.09.2012, Freiburg, Germany  
5 oral presentations
- Symposium on Interpersonal Violence in Social Proximity, 20.-21.09.2012, Freiburg, Germany  
1 oral presentation (invited lecture given by Eva Scheurer)
- Symposium für Forensische Odontostomatologie, Sanitätsakademie der Bundeswehr, 5.-7.12.2012, München, Deutschland  
1 oral presentation

### Magnetic resonance in medicine and biomedical engineering

- Annual Scientific Meeting of the International Society of Magnetic Resonance in Medicine (ISMRM), 05.-11.05.2012, Melbourne, Australia  
4 poster presentations
- Scientific Meeting of the European Society for Magnetic Resonance in Medicine and Biology (ESMRMB), 04.-06.10.2012, Lisbon, Portugal  
3 oral presentation and 1 poster presentation

### Computer graphics:

- International Symposium on Visual Computing, 16.-18.07.2012 Rethymnon, Crete, Greece  
1 oral presentation
- Eurographics Workshop on Visual Computing for Biology and Medicine (VCBM), 27.-28.09.2012, Norrköping, Sweden  
1 poster presentation

Radiology and other medical fields:

- Annual Meeting of the Radiological Society of North America (RSNA), 25.-30.11.2012, Chicago, USA  
1 poster presentation
- World Congress on Brain Injury of the International Brain Injury Association (IBIA), 21.-25.03.2012, Edinburgh, Great Britain  
1 oral presentation and 1 poster presentation
- Brain Research Imaging Center, University of Edinburgh, 23.03.2012, Edinburgh, Scotland  
1 oral presentation (invited lecture given by Nikolaus Krebs)

Additionally, the following meetings and symposia were attended by team members of the LBI-CFI:

01.-05.03.2012	Annual Meeting of the European Society of Radiology (ESR), Vienna
16.03.2012	AGFAD – Meeting, Berlin
22.03.2012	10 Jahre Kinderschutzlehrgang: Kinderschutz auf der Flucht, Vienna
14.-15.05.2012	Congress of the International Society of Forensic Radiology and Imaging (ISFRI), Zurich, Switzerland
14.06.2012	Workshop of the Criminalistic Study Association: „Justizanstalt – Ein unbekannter Mikrokosmos“, Graz
14.09.2012	Jahrestagung der Österreichischen Röntgengesellschaft (ÖRG), Graz
18.-19.10.2012	Wachauer Dialog 2012 – Der Mensch im Zentrum von Medizin und Recht, Dürnstein
18.-19.10.2012	100 Jahre Kriminologie in Graz: Kriminologische Entwicklungslinien interdisziplinär betrachtet, Graz
14.-15.11.2012	Abschlusskonferenz des EU-Daphne Projekts PROTECT II - Capacity Building in Risk Assessment and Safety Management to Protect High Risk Victims, Vienna
23.11.2012	Annual Meeting Österreichische Kinderschutzgruppen, Klagenfurt

### 3. Other activities

#### 3.1 Cooperations

##### 3.1.1 Scientific cooperations

Scientific collaborations with national and international institutions have been established in the different fields and areas of research of the LBI-CFI. These cooperations are beneficial for both the LBI-CFI and the cooperating institutions, as the conjointly performed studies result in an enhancement of the scientific output and in an increase of knowledge in the different fields.

##### Cooperations with a focus in forensic medicine

Besides the institutional partnership a scientific cooperation has been established with the *Institute of Forensic and Traffic Medicine, University of Heidelberg*, directed by Prof. Kathrin Yen, during the last year. This cooperation is intended to support the LBI-CFI particularly for the performance of postmortem imaging studies. Embedded in this cooperation is a scientific collaboration with the Department of Radiology of the University and University Hospital of Heidelberg.

For the research in dental MRI, a cooperation has been established with Prof. Norbert Jakse, *Department for Oral and Maxillofacial Surgery, Medical University Graz*, Dr. Julian Boldt, *Department for Oral and Maxillofacial Surgery, University of Würzburg*, and Andreas Hopfgartner, *Department for Experimental Physics, University of Würzburg*, as well as with *Dr. Heiko Merkens*, dentist with a private practice in Aachen. The main benefit for all collaborators in this field is the facilitated demonstration of wisdom teeth and other dental structures by MRI.

Within the research area “traumatic brain injury”, regional distribution of iron-, copper-, calcium-, manganese-, magnesium- and zinc-concentrations in human brain was determined in cooperation with Prof. Walter Goessler, *Department of Chemistry, University of Graz*. These results, in correlation with the results of quantitative MRI, impact the field of both, brain trauma research and research of neurodegenerative disorders.

The neuroimaging research unit of the *Department of Neurology, Medical University Graz* under the direction of PD Dr. Stefan Ropele and supported by the head of Department, Prof. Franz Fazekas, is specialized in quantitative MRI for assessing brain tissue changes. Myelin integrity, blood and iron are the most notable factors impacting MR relaxation behavior and MRI contrast and, thus, have to be differentiated when drawing conclusions about the origins of blunt force.

PD DDr. Johannes Haybäck, *Department of Pathology, Medical University Graz*, is our collaborator for the examination of microscopic traumatic changes of white matter tracts and for the detection of iron deposits for the correlation with MRI.

Further good and long standing scientific cooperations exist with:

Prof. Gerhard Ranner and Dr. Gerlinde Komatz, *CT/MR Zentrum Graz*, em. Prof. Rainer Riemüller and Prof. Franz Ebner, *Department of Radiology and Neuroradiology, Medical University Graz*, as well as Dr. Karl Fritz, *Krankenhaus der Barmherzigen Brüder, Graz-Eggenberg*, who support the LBI-CFI with radiologic reading and interpretation, and in relation to organizational procedures of radiological examinations.

Prof. Andrea Berghold and Dr. Franz Quehenberger, *Institute for Medical Informatics, Statistics and Documentation, Medical University Graz*, who support and cooperate with the LBI-CFI in relation to data analysis and statistical training of the researchers.

### MR physics

The most important collaboration in this field since the foundation of the LBI-CFI is with Prof. Rudolf Stollberger and his team of the *Institute for Medical Engineering, Graz University of Technology*.

A new cooperation has evolved with DI Tilman J. Sumpf, *Biomedizinische NMR Forschungs GmbH, Max-Planck-Institut for Biophysical Chemistry, Göttingen*, in the field of T2-mapping.

The institute of Prof. Jürg Reichenbach, *Department of Diagnostic and Interventional Radiology, Jena University Hospital* cooperates with the LBI-CFI in the field of traumatic brain injury and in the evaluation of subcutaneous hematomas by performing quantitative MR susceptibility mapping. This technique which is used to assess the basic magnetic properties of brain tissue helps differentiating between hemorrhages and calcifications. Normally, these are not distinguishable from each other in conventional MRI, and such a technique is, therefore, important in a forensic context.

Based on a cooperation with the group of Prof. Oliver Bieri (former head: Prof. Klaus Scheffler), *Radiological Physics, University of Basel Hospital, Basel*, a method for the mapping of myelin integrity (based on bSSFP sequences) could be applied in our study of traumatic brain injury to investigate ruptures and detracting of nerve fibres.

### Computer graphics

Our main cooperation is with the *Institute for Computer Graphics and Vision (ICG), Graz University of Technology*. Prof. Horst Bischof and Prof. Dieter Schmalstieg are world-renowned experts in their respective fields of computer vision and computer graphics. Through a set-up financing two post-docs via the ICG, a knowledge transfer in both directions is optimally established. Martin Urschler works together in depth with two other post-docs from ICG, Michael Donoser, an expert in image segmentation, and Thomas Pock, an expert in variational methods for low-level image processing. Alexander Bornik works together with a team of post-docs and PhD students on volume visualization techniques. This tight collaboration is also visible in the co-authorships of methodological computer vision and computer graphics papers (see publication list in section 5).

Another ongoing cooperation is with *RISC Software GmbH in Hagenberg*, with its research unit for medical informatics around Dr. Michael Giretzlehner. Johannes Höller is working in tight collaboration with this research unit, who are the developers of the BurnCase 3D

software, software used for the documentation of burns. Their concepts of generic 3D surface models of different genders, ages, and obesity levels as well as their methods for painting injuries on this 3D model are also important aspects in our 3D reference manikin model.

In 2012, a new cooperation with the *Ludwig Boltzmann Institute for Lung Vascular Research, Graz* (Dr. Zoltan Balint, Dr. Michael Pienn) was established, where we work together on the extraction and analysis of vascular structures from pulmonary CT images. This topic is the focus of a master thesis by Michael Helmberger under the supervision of Martin Urschler. Furthermore, we work together with the *Clinical Department for Prosthodontics of the Medical University Graz* (Dr. Susanne Vogl) on the topic of registration of jawbone images, a project done by Kerstin Hammernik and supervised by Martin Urschler. Another cooperation is with the *Department DIGITAL of JOANNEUM Research, Graz* (Dr. Martina Uray, Dr. Heinz Mayer) in the form of supervision of a master thesis by Martin Urschler. Here, the master student Michael Schneeberger is working on wound simulation software.

### 3.1.2 Non-scientific cooperations

Valuable cooperations in relation to the Clinical Forensic Care Unit exist with the *Departments of Pediatric Medicine and Pediatric Surgery* and their child protection groups, as well as with the *Department of Obstetrics and Gynecology*, both at the *Medical University Graz*.

As a practical interdisciplinary basis for the research at the LBI-CFI, regular Jour Fixe - meetings with representatives from the hospital (LKH Graz), police and prosecution are held. The aim of these meetings is to optimize communication and cooperation between the institutions concerned with incidents of violence. Five meetings have been held and several issues concerning processes and cooperation as well as real cases have been discussed and analysed. The results from these discussions have been incorporated into the activities of the Clinical Forensic Care Unit and will also be a central part in the juridical key area of research.

### 3.1.3 Third party projects

While some financing of the activities of the LBI-CFI has been slowly evolving from the Clinical-Forensic Care Unit, third party financing of research was not a priority for the institute during the first years, as the main limiting factor concerning the performance of the planned research program were not finances, but mainly the availability of experienced researchers.

However, in 2012 the time for applying for third party financing was ready. In November 2012 a proposal for a project entitled "Klinisch-forensisches Netzwerk (KfN) Steiermark" was submitted to the „Zukunftsfond Steiermark“ sponsored by the Land Steiermark. The idea of this project was a result of the expert discussion „Klinisch-Rechtsmedizinische Versorgung in der Steiermark – Quo imus“ which was held in June 2012. During this event, the need to cover Styria also at greater distances from Graz with clinical forensic services became

apparent. Thus, the objective of the submitted proposal was the comprehensive buildup of a network of medical institutions in Styria being capable and willing to offer clinical forensic services. With this clinical forensic network model Styria would be able to take on a pioneering role in Austria, and could subsequently serve as a prototype for other Austrian states. In particular, partner hospitals and clinics with specific infrastructural opportunities, i.e. having an emergency service and gynecological expertise at their disposal, are expected to participate. A Styria-wide hotline and an secured online platform exclusively accessible to network members is intended to support the Styrian medical and nursing professionals for the investigation of physical and sexual violence. A feedback on the acceptance of the proposal is expected in March 2013.

### **3.2 Membership in scientific associations**

Team members of the LBI-CFI are members of the following scientific associations:

- DGRM – Deutsche Gesellschaft für Rechtsmedizin
- SGRM – Schweizerische Gesellschaft für Rechtsmedizin
- ÖGGM – Österreichische Gesellschaft für Gerichtliche Medizin
- AGFAD – Arbeitsgruppe für Forensische Altersdiagnostik der DGRM
- Berufsverband Deutscher Rechtsmediziner
- ISMRM – International Society of Magnetic Resonance in Medicine
- ESMRMB – European Society of Magnetic Resonance in Medicine and Biology
- ESR – European Society of Radiology
- RSNA – Radiological Society of North America
- ÖRG – Österreichische Röntgengesellschaft
- ISFRI – International Society of Forensic Radiology and Imaging
- Identifizierungskommission des Bundeskriminalamts (IDKO), Deutschland
- Kriminalistische Studiengemeinschaft Steiermark
- FIRM – Forschungsinstitut für Recht in der Medizin
- DGPPN – Deutsche Gesellschaft für Psychiatrie, Psychotherapie, Psychosomatik und Neurologie
- DGS – Deutsche Gesellschaft für Suizidprävention
- NaSPro – Nationales Suizidpräventionsprogramm für Deutschland
- Forschungsfeld Neurowissenschaften der Medizinischen Universität Graz
- SIDS (sudden infant death syndrome)-AG Austria
- Eurographics

LBI-CFI team members actively participated in the following working groups of scientific associations:

- ESR - European Society of Radiology (Thomas Ehammer)
- ÖRG - Österreichische Röntgengesellschaft (Thomas Ehammer)
- Arbeitsgruppe Klinische Rechtsmedizin der DGRM (Nikolaus Krebs)
- AGFAD (Eva Scheurer, Pia Baumann)
- FIRM - Forschungsinstitut für Recht in der Medizin (Peter Schick)

### 3.3 Lecture series and workshops

In 2012 the LBI organized the annual lecture series “The interdisciplinary world of forensic imaging” which is open to the public and for which nationally and internationally renowned speakers are invited to give a talk about their specialist field including forensic medicine, MR physics and methodology, radiology and imaging, computer graphics, law enforcement, prosecution and criminal law as well as victim support. In 2012, lectures were given by:

- Prof. Dr. Chris Boesch, „Grundlagen der in vivo MR-Spektroskopie und mögliche forensische Anwendungen“, 23.01.2012
- Mag. Cornelia Koller, “Rechtliche Rahmenbedingungen für klinisch-forensische Untersuchungen“, 19.03.2012
- PD Dr. Christian Jackowski, „Postmortales MRI am Herzen – Wie der plötzliche Herztod sichtbar wurde“, 11.06.2012
- Prof. Dr. Andreas Schmeling, „Forensische Altersschätzung am Lebenden“, 05.09.2012
- Prof. DDr. Christian Kopetzki, „Juristische und ethische Aspekte der medizinischen Forschung, 19.11.2012

### 3.4 Teaching and training activities

#### 3.4.1 Teaching activities

##### Academic teaching

- Appointment of Martin Urschler at Graz University of Technology, as a lecturer in „Medical Image Analysis” as a part of the computer science and biomedical engineering curricula, since SS 2008

- Appointment of Eva Scheurer at Medical University Graz, as a lecturer for the course “Gerichtsmedizin am Lebenden – Kindesmisshandlung, Sexualdelikte, häusliche Gewalt”, since WS 2010, with lectures by Felicitas Dahlmann, Eva Hassler, and Nikolaus Krebs
- Appointment of Eva Scheurer at Medical University Graz, as a lecturer for the interdisciplinary course “Bildgebende Methoden in der Gerichtsmedizin”, since WS 2012, with lectures by Alexander Bornik, Felicitas Dahlmann, Sabine Grassegger, Reingard Riener-Hofer, and Martin Urschler
- Appointment of Reingard Riener-Hofer at the FH Joanneum Graz, as a lecturer for the course “Rechtsgrundlagen für klinische Studien”, since SS 2012
- Seminar „Rechtliche Probleme der medizinischen Forschung“ at Karl-Franzens-University of Graz, given by Peter Schick and Eva Scheurer in cooperation with Reingard Riener-Hofer, SS 2012
- Laboratory Tutorial „Optische Grundlagen“ as a part of the biomedical engineering curriculum at Graz University of Technology, given by Bernhard Neumayer, SS 2012
- Laboratory Tutorial “Herzschrittmacher” as a part of the biomedical engineering curriculum at Graz University of Technology, given by Bernhard Neumayer, SS 2012
- Laboratory Tutorial “MR-Messung und -Auswertung” as a part of the biomedical engineering curriculum at Graz University of Technology, given by Bernhard Neumayer, WS 2012
- Laboratory Tutorial “Atmung/Gasaustausch” as a part of the biomedical engineering curriculum at Graz University of Technology, given by Andreas Petrovic, SS 2012
- Laboratory Tutorial “Fluoroptische Bildgebung” as a part of the biomedical engineering curriculum at Graz University of Technology, given by Andreas Petrovic, WS 2012

#### Non-academic teaching

Teaching and training topics of clinical forensic medicine to different kinds of trainees, e.g., police officers, social workers, kindergarten teachers, is considered important for the implementation of clinical forensic knowledge in Austria. It is thus, a strategic policy of management to support such activities and, particularly, to encourage the residents in forensic medicine to acquire experience in teaching. Table 6 shows the numbers of lectures given in the different fields; and below some examples of individual presentations are given.

Number of lectures	2012
Hospitals, Clinical Units, Medical Doctors	9
Victim Support Institutions, Child Protective Services	1
Police, Prosecution authorities, Court, Jurists	0
Training (kindergarten, medical care, social work, etc.)	3
<b>Total</b>	<b>13</b>

Table 6: Number of non-academic lectures given by team members 2012

Examples of non-academic teaching:

- Lecture on “Die klinisch-forensische Ambulanz in Graz“ given by Sonja Pivec at a training event for social workers and teachers organized by “Frauen für Frauen”, Burgenland, 28.02.2012
- Lecture on “Kindesmisshandlung in der Notfallmedizin“ given by Florian Schillfahrt, for the medical doctors and ambulance officers organized by the AGN, LKH Graz, 13.03.2012
- Lectures on “Spurensicherung und gerichtsverwertbare Dokumentation” given by Florian Schillfahrt and Nikolaus Krebs for the medical doctors of the Salzburger Landeslinik, 23.03.2012 and 23.10.2012
- Lecture on “CSI – Spurensicherung im klinischen Umfeld” at the “Pflegesymposium Netzwerk Pflege” given by Eva Scheurer, 12.04.2012
- Lecture on „Gerichtsmedizinische Aspekte der Misshandlung“ at “Jahrestreffen der österreichischen Kinderschutzgruppen” given by Felicitas Dahlmann, 23.11.2012

### Ongoing student projects

- Simone Kainz: „Die rechtsmedizinische Beurteilung von Körperverletzungsdelikten – Eine medizinrechtliche Studie“. *Doctoral thesis* (Supervision by Peter Schick). The official presentation of this dissertation was held in November 2012. The aim of the dissertation is to analyze the legal framework concerning clinical forensic examinations of living persons within the fields of medical and criminal procedure law. Two studies of the LBI-CFI are part of this dissertation. (“Wertigkeit (rechts)medizinischer Sachverständigengutachten in der gerichtlichen Urteilsfindung“ and “Beurteilung von Körperverletzungen“).

- Herbert Fuik: "Gewalt im Gefängnis". *Doctoral thesis* (Supervision by Gabriele Schmölzer). The dissertation is currently in the planning process. Due of the sensitivity of the topic and the requirement to interview prison staff and prisoners, the permission of the Austrian ministry of justice (BMJ) is required.
- Elisa Florina Ozegovic: „Die Rechtfertigung medizinischer Eingriffe aus Forschungs- und Lehrzwecken“. *Doctoral thesis* (Supervision by Peter Schick). Start in autumn 2011.
- Stefanie Christina Reumüller: „Einwilligung in die klinisch-forensische Untersuchung“. *Diploma thesis* (Supervision by Peter Schick). Start in summer 2012.
- Marc Steiner: *Master thesis* dealing with statistical shape models to represent strong prior shape knowledge for 3D image segmentation, which is an important part of our interactive real-time segmentation software (Institute for Computer Graphics and Vision, Graz University of Technology, in cooperation with the LBI-CFI).
- Michael Schneeberger: *Master thesis* at Joanneum Research on the topic of synthetic wound simulation. Martin Urschler supervises this thesis to deepen relationships with the group for human centered image analysis at the DIGITAL institute of Joanneum Research which is headed by Dr. Heinz Mayer.
- Michael Helmberger: *Diploma thesis* on the topic of "Segmentation and analysis of lung vascular structures from CT images" under the supervision of Martin Urschler, LBI-CFI. In this work the analysis of lung vascularity is used to detect pulmonary hypertension at an early stage in patients. Collaboration with the Ludwig Boltzmann Institute for Lung Vascular Research in Graz.
- Marlene Vukmanic: *Bachelor thesis* in form of a literature study on transfer functions and transfer function design in the context of volume rendering. In her thesis she also intends to implement selected methods in an encapsulated software component. Marlene Vukmanic is jointly supervised by Alexander Bornik, LBI-CFI.
- Kerstin Hammernik: *Master project* together with Dr. Susanne Vogl from the Clinical Department for Prosthetics at Medical University Graz. Her topic is the "Registration of Dental CT Images" for the purpose of jawbone implant analysis. The work is supervised by Martin Urschler, LBI-CFI.
- Barbara Kölbl: *Bachelor thesis* "Bildgebende Verfahren in der Rechtsmedizin" at the FH Joanneum Graz (Supervision by Manfred Tropper, FH Joanneum, and Thomas Widek, LBI-CFI)
- Bettina Pucher: *Bachelor thesis* „IR Photography of subcutaneous hematomas“, at Graz University of Technology in cooperation with the LBI-CFI (Supervision by Hermann Scharfetter, Institute for Medical Engineering, in cooperation with Andreas Petrovic and Eva Scheurer, LBI-CFI).
- Julia Krusz: *Diploma thesis* with the title „Temperature dependence of relaxation parameters and optimization of contrast for post-mortem MRI“ at Graz University of Technology in cooperation with the LBI-CFI (Supervision by Rudolf Stollberger, Institute for Medical Engineering, in cooperation with Andreas Petrovic and Eva Scheurer, LBI-CFI).

- Christoph Sirk: *Bachelor thesis* “Fast GPU implementation of advanced fitting algorithms for MRI” at the Institute for Medical Engineering, Graz University of Technology in cooperation with the LBI-CFI (Supervision by Rudolf Stollberger, Institute for Medical Engineering, in cooperation with Andreas Petrovic, LBI-CFI)
- Michael Steiner: *Diploma student* at Graz University of Technology, investigated the impact of varying brain temperature as a consequence of different post-mortem intervals for MRI. The temperature dependence of MR relaxation parameters and diffusion derived parameters were investigated in phantoms and by using data from the LBI-CFI study of post-mortem brains. Furthermore, this work included the development of strategies for correcting temperature mediated changes, essential when comparing MR relaxation and diffusion parameters in post-mortem MRI. (Supervision by Rudolf Stollberger, Institute for Medical Engineering, and Stefan Ropele, Departement of Neurology, in cooperation with Christian Langkammer, LBI-CFI).

### 3.5 Reviewing activities

#### Journals

*International Journal of Legal Medicine* (Eva Scheurer)

*Journal of Forensic and Legal Medicine* (Eva Scheurer)

*Forensic Science International* (Eva Scheurer)

*European Radiology* (Eva Scheurer)

*Medical Physics* (Alexander Bornik)

*IEEE Transactions on Pattern Analysis and Machine Intelligence* (Martin Urschler)

*Pattern Recognition* (Martin Urschler)

#### Conferences

*ISMAR* (Alexander Bornik)

*VMV* (Alexander Bornik)

*CVPR (Computer Vision and Pattern Recognition)* (Martin Urschler)

*BMVC (British Machine Vision Conference)* (Martin Urschler)

*ECCV (European Conference on Computer Vision)* (Martin Urschler)

*ISMIRM* (Andreas Petrovic)

## 4. Outlook

### Institutional partners

Collaboration with our institutional partners Medical University Graz (MUG), Siemens AG Österreich, the Institute of Criminal Law, Criminal Law Procedure and Criminology at the Karl-Franzens University Graz (KFUG), the Institute of Forensic and Traffic Medicine at the University of Heidelberg, Germany, as well as the Superior Court of Styria and Carinthia (OLG) is expected to continue. The combination of these institutions is an exceptional opportunity for the LBI-CFI and its interdisciplinary areas of research, and is essential in achieving its challenging goals. Similarly, there are scientific and strategic benefits for these partners. Furthermore, we are open to new partnerships which would be beneficial to research in the field of clinical forensic imaging, as well as those which target institutionalization of the provision of clinical forensic examinations.

### Scientific cooperations

In addition to the ongoing and valuable scientific cooperations listed in section 3.1, collaborations are planned with a number of institutions. Some of these are currently being established while others are still being evaluated.

For research being conducted in the fields of Hematomas and blunt force injury of soft tissues and Radiologic evidence in forensic reconstruction and age estimation cooperations which allow for higher numbers and a higher variety of study cases shall be intensified, e.g., the Institutes of Forensic Medicine in Munich and in Heidelberg.

Additionally, a closer cooperation with radiologists will be established to assist in the process of defining criteria for the diagnosis of forensically relevant lesions. Experience shows that both specialties, i.e., forensic medicine and radiology, lack specific knowledge for reliable diagnoses.

A focus on a closer cooperation between informatics and medical specialists may provide new tools for forensic diagnosing, reconstructing and, as is often crucial, the measurement of distances and volumes.

For the area of research Forensic aspects of brain injury and function the recruitment of post-mortem cases is essential. In addition to the current methods of recruitment, corpses could also be obtained from other institutions. A corresponding cooperation has already been approved by the Department of Pathology, Medical University Graz.

With the group of Prof. Krenn, Department of Physics, University of Graz, a cooperation has been initiated and first test measurements on a SQUID-Magnetometer have been conducted. The SQUID-Magnetometry offers a unique possibility to characterize basic magnetic properties in a magnetic field with varying field strength and at varying temperatures. This could improve the understanding of field dependent effects and help to establish the results on other MRI systems as well as allow the further investigation of MRI contrast behaviour when the body temperature is not equal to in vivo conditions.

Still ongoing, is the evaluation of partners concerning the trauma-induced tissue changes on a histological level. This requires an extremely specialized expertise which could be acquired by establishing a scientific cooperation with a corresponding specialist. We will establish a collaboration with an expert in neurotrauma-pathology who will assist and supervise the analysis of histological data from e.g. APP and MFB stainings.

#### Computer-aided Tools for Forensic Case Analysis: Preparation and Presentation

It would be interesting to work together with people who already investigated automatic transfer function generation techniques, e.g., Carlos D. Correa (UC Davis, USA).

### **Teaching and training**

In the next period, the LBI-CFI lecture series “The interdisciplinary world of forensic imaging” for which nationally and internationally renowned speakers are invited to give talks about their specialist field including forensic medicine, MR physics and methodology, radiology and imaging, computer graphics, law enforcement, prosecution and criminal law as well as victim support, will be continued. The lecture series for 2013 has been planned with presentations by the following speakers: MSc. Vera Muschett (Institute of Molecular Biomedical Science at the Karl Franzens University Graz), Dr. Silke Grabherr (University Center of Legal Medicine Lausanne), Prof. Dr. Gustav J. Strijkers (Department of Biomedical Engineering, University of Technology Eindhoven), Prof. Dr. Richard Dirnhofer (Institute of Forensic Medicine, University Bern), Dr. Peter Schaden (Law office Thurner – Schaden Graz), Prof. Dr. Jürgen R. Reichenbach (Medical Physics Group, Center of Radiology, University Jena).

Similarly, the lectures on “Gerichtsmedizin am Lebenden – Kindesmisshandlung, Sexualdelikte, häusliche Gewalt” and “Bildgebende Verfahren in der Gerichtsmedizin” at the Medical University Graz, and seminars at the Institute of Criminal Law at the Karl Franzens University Graz are planned to be held next year.

## **5. List of publications**

### **5.1 Peer-reviewed papers**

Langkammer C, Krebs N, Goessler W, Scheurer E, Yen K, Fazekas F, Ropele S. Susceptibility induced gray-white matter MRI contrast in the human brain. *Neuroimage*, 59 (2):1413-19 (2012).

Langkammer C, Schweser F, Krebs N, Deistung A, Goessler W, Scheurer E, Sommer K, Reishofer G, Yen K, Fazekas F, Ropele S, Reichenbach JR. Quantitative susceptibility mapping (QSM) as a means to measure brain iron? A post mortem validation study. *Neuroimage*, 62 (3):1593-1599 (2012).

Urschler M, Bornik A, Scheurer E, Yen K, Bischof H, Schmalstieg D. Forensic-Case Analysis: From 3D Imaging to Interactive Visualization. *Computer Graphics and Applications, IEEE*, 32 (4):79-87 (2012).

## 5.2 Books, book chapters and other publications

Bornik A, Knecht W, Hadwiger M, Schmalstieg D. Clustered Deep Shadow Maps for Integrated Polyhedral and Volume Rendering - Advances in Visual Computing. In: 8th International Symposium on Visual Computing; Lecture Notes in Computer Science Rethymnon/Kreta 7431 (2012).

Donoser M, Urschler M, Bischof H. Learning Edge-Specific Kernel Functions For Pairwise Graph Matching. In: British Machine Vision Conference; Surrey (2012).

## 5.3 Abstracts and conference presentations

Baumann P, Widek T, Merkens H, Boldt J, Petrovic A, Kirnbauer B, Jakse N, Scheurer E. Dental age estimation of living persons: comparison of dental MRI with conventional orthopantomogram. 22nd Congress of the IALM, Istanbul, 5.-8. Juli 2012, Int J Legal Med 126:57 (2012). [Oral Communication]

Baumann P, Widek T, Merkens H, Boldt J, Petrovic A, Kirnbauer B, Jakse N, Scheurer E. Dental age estimation of living persons: comparison of MRI with the gold standard, the orthopantomogram. 20th Annual Meeting ISMRM, Melbourne, 5.-11. Mai 2012, Proc. Intl. Soc. Mag. Reson. Med. 20:4714 (2012). [Poster]

Bornik A, Urschler M, Scheurer E. Interactive, Integrated Segmentation and Visualization for Analysis and Presentation of Clinical Forensic Images. 3rd Eurographics Workshop on Visual Computing for Biology and Medicine, Norrköping, 27.-28. Sep. 2012, European Association for Computer Graphics (2012). [Poster]

Ehammer T, Pivec S, Grassegger S, Komatz G, Yen K, Scheurer E. High resolution magnetic resonance imaging of the neck in survivors of manual strangulation. 29th Annual Meeting ESMRMB, Lisbon, 4.-6. Okt. 2012, (2012). [Oral Communication]

Grassegger S, Pivec S, Scheurer E, Yen K, Ehammer T. Morphologische Evaluierung von Strangulationsverletzungen beim Lebenden mittels 3-Tesla-Magnetresonanztomografie (MRT) des Halses (ohne Kontrastmittelverstärkung). 91. Jahrestagung der DGRM, Freiburg, 18.-22. Sep. 2012, Rechtsmedizin 22 (4):304 (2012). [Oral Communication]

Hassler E, Neumayer B, Petrovic A, Ogris K, Widek T, Yen K, Scheurer E. Contrast evaluation of artificial hematomas in different MRI sequences over time. 29th Annual Meeting ESMRMB, Lisbon, 4.-6. Okt. 2012, (2012). [Oral Communication]

Hassler E, Petrovic A, Ogris K, Widek T, Neumayer B, Scheurer E. Contrast of artificial subcutaneous hematomas in different MRI sequences over time. 98th Annual Meeting RSNA, Chicago, 25.-30. Nov. 2012, (2012). [E-Poster]

Hassler E, Petrovic A, Ogris K, Widek T, Yen K, Scheurer E. Contrast of artificial subcutaneous hematomas in different MRI sequences over time. 22nd Congress of the IALM, Istanbul, 5.-8. Juli 2012, Int J Legal Med 126:58 (2012). [Oral Communication]

Hoeller J, Urschler M, Scheurer E. Dokumentation klinisch-forensischer Befunde anhand einer 3D-Rekonstruktion der Körperoberfläche mittels des Kinect Sensors. 91. Jahrestagung

der DGRM, Freiburg, 18.-22. Sep. 2012, Rechtsmedizin 22 (4):305 (2012). [Oral Communication]

Kainz S, Scheurer E, Riener-Hofer R. Der forensische Untersuchungsbericht - Definition eines Faktums. 91. Jahrestagung der DGRM, Freiburg, 18.-22. Sep. 2012, Rechtsmedizin 22 (4):298 (2012). [Oral Communication]

Krebs N, Langkammer C, Ropele S, Fazekas F, Gössler W, Yen K, Scheurer E. Posttraumatic white matter diffusivity changes in postmortem brain. 20th Annual Meeting ISMRM, Melbourne, 5.-11. Mai 2012, Proc. Intl. Soc. Mag. Reson. Med. 20 (2012). [Poster]

Krebs N, Langkammer C, Ropele S, Fazekas F, Yen K, Scheurer E. Post-mortem quantification of traumatic tissue changes in white matter regions using diffusion weighted MRI. 9th IBIA, Edinburgh, 21.-25. März 2012, Brain Injury 2012 26 (4-5):645-645 (2012). [Oral Communication]

Langkammer C, Krebs N, Goessler W, Yen K, Fazekas F, Ropele S, Scheurer E. Increased brain iron levels in fatal traumatic brain injury. 9th IBIA, Edinburgh, 21.-25. März 2012, Brain Injury 2012 26 (4-5):309-799 (2012). [Poster]

Langkammer C, Schweser F, Krebs N, Deistung A, Goessler W, Scheurer E, Sommer K, Reishofer G, Yen K. Quantitative susceptibility mapping as a means to measure brain iron. 10. Jahrestagung der Österreichischen Gesellschaft für Neurologie, Graz, 14.-17. März 2012, NeuroLogisch2012 (2012). [Poster]

Langkammer C, Schweser F, Krebs N, Deistung A, Goessler W, Scheurer E, Sommer K, Reishofer G, Yen K, Fazekas F, Reichenbach JR, Ropele S. Quantitative susceptibility mapping as a means to measure brain iron? A postmortem validation study. 20th Annual Meeting ISMRM, Melbourne, 5.-11. Mai 2012, Proc. Intl. Soc. Mag. Reson. Med. 20 (2012). [Poster]

Neumayer B, Hassler E, Widek T, Petrovic A, Scheurer E. Modelling of Contrast Changes in Soft Tissue Hematomas. 29th Annual Meeting ESMRMB, Lisbon, 4.-6. Okt. 2012, (2012). [E-Poster]

Petrovic A, Ogris K, Hassler E, Stollberger R, Scheurer E. Characterization of the time course of MR relaxation parameters for ageing blood. 20th Annual Meeting ISMRM, Melbourne, 5.-11. Mai 2012, Proc. Intl. Soc. Mag. Reson. Med. 20 (2012). [Poster]

Petrovic A, Stollberger R, Scheurer E. Optimization of MRI sequences for the assessment of dental age. 29th Annual Meeting ESMRMB, Lisbon, 4.-6. Okt. 2012, (2012). [Oral Communication]

Pivec S, Ehammer T, Fischer F, Komatz G, Voigt Z, Webhofer M, Yen K, Scheurer E. Diagnose einer Strangulation bei Lebenden mittels MR-Bildgebung. 91. Jahrestagung der DGRM, Freiburg, 18.-22. Sep. 2012, Rechtsmedizin 22 (4):304 (2012). [Oral Communication]

Pivec S, Scheurer E, Fischer F, Komatz G, Voigt Z, Webhofer M, Yen K, Ehammer T. Identification of living victims of manual strangulation by MR imaging of the neck. 20th Annual Meeting ISMRM, Melbourne, 5.-11. Mai 2012, Proc. Intl. Soc. Mag. Reson. Med. 20:4192 (2012). [Poster]

Riener-Hofer R, Kainz S, Scheurer E. Klinisch forensische Bildgebung - Treffpunkt zwischen Forensik und Radiologie. 91. Jahrestagung der DGRM, Freiburg, 18.-22. Sep. 2012, Rechtsmedizin 22 (4):303 (2012). [Oral Communication]

Scheurer E. Forensic imaging in living victims - methodological opportunities. 1st Symposium on Interpersonal Violence in Social Proximity, Freiburg, 20.-21. Sep. 2012, Rechtsmedizin 22 (4):354-355 (2012). [Oral Communication]

Sumpf T, Knoll F, Frahm J, Stollberger R, Petrovic A. Nonlinear inverse reconstruction for T2 mapping using the generating function formalism on undersampled Cartesian data. 20th Annual Meeting ISMRM, Melbourne, 5.-11. Mai 2012, Proc. Intl. Soc. Mag. Reson. Med. 20 (2012). [Poster]

#### **5.4 Diploma, bachelor, and master theses**

- Christoph Gratl (2012). „3D Morphable Models“. Diploma thesis, Institute for Computer Graphics and Vision, Graz, University of Technology (Supervision by Martin Urschler, LBI-CFI and Horst Bischof, Institute for Computer Graphics and Vision)