The cover photograph represents a ‘magical’ text that is part of HS 194, a late medieval English manuscript in the collection of the Nijmegen University Library. The first lines of this manuscript state that the charm was written by “our Lord’s fingers” and found by Joseph of Barmaphe – a misinterpretation of the Latin ‘Ioseph ab Arimathea’ – when he took Christ down from the cross. It goes on to offer protection against all kinds of dangers to anyone wearing this charm on their body. The charm itself consists of Latin formulas and a list of divine names. Within this manuscript there are also a number of vernacular texts that are not found in any other manuscript in the world, as well as more charms and some religious texts. Dr Sandor Chardonnens (Assistant Professor of English Language and Culture) and Rosanne Hebing, MA (Assistant Professor of Old and Middle English) have recently published on the manuscript – and on this particular charm.

The entire 15th century English manuscript (HS 194:125x85 mm), which is entitled Liber precum, is available online at:
http://wwwextern.ubn.ru.nl/BookReader/MMUBN000008_Hs%20194/#page/8/mode/2up
In 2013, we celebrated our University’s 90th anniversary. During the past 90 years, Radboud University Nijmegen has developed into a reputable academic institution. And, in the last decade it has matured into one of Europe’s top education and research centres.

The scale of this achievement is best illustrated by a graph produced by the European Research Council: Acquisition of ERC grants by host institution (see page 6), which shows a ‘league table’ of ERC grants awarded to institutions. Our University is now one of the top 25 research centres in Europe. In this country, too, our research performance is way above the national average – a status that is reflected in the number of the most competitive grants we have acquired from the Netherlands Organisation for Scientific Research (NWO; see page 19).

We look back with great pleasure on a number of exciting events that took place on the occasion of the University’s anniversary, in particular the award of an Honorary Doctorate to the German Chancellor Dr Angela Merkel.

Other major highlights that made 2013 such a successful year include Prof. Mikhail Katsnelson’s NWO Spinoza prize, while four Radboud professors received an ERC Advanced Investigator grant. Prof. Mike Jetten’s innovative proposal for an NWO ‘Gravitation’ grant met with success, as did Prof. Heino Falcke’s application for an ERC Synergy grant.

These and other remarkable programmes – including many with a considerable impact on society – show that our University is in very good shape, ready to meet the challenges we expect in the years ahead.

Prof. Gerard Meijer  
President

Prof. Sebastian Kortmann  
Rector Magnificus
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Introduction

Radboud University Nijmegen is a student-oriented research university. We value quality, combining excellent education with leading-edge research. We focus in particular on four of the five major academic domains: Arts & Humanities, Social Sciences, Natural Sciences & Life Sciences. For work in the fifth domain (Technical Sciences) – which is not one of our core competences – we cooperate closely with colleagues at the University of Twente, Eindhoven University of Technology and Wageningen University & Research Centre. Our academic expertise is also closely related to important societal issues, both in the public and in the private domain.

Our ambition

Research at the University takes place in 17 dedicated institutes. These are responsible for planning programmes as well as for training and supervising new generations of researchers. We aim to ensure that all programmes within the institutes are internationally competitive and that they make a major contribution to each research community. Consequently, in independent peer review assessments, all programmes need to receive at least a “very good” score for the main criteria: quality, productivity, societal relevance and vitality.

In terms of these criteria, all Radboud research programmes have evolved and improved in recent years. The quality of research has been further enhanced by close cooperation with partners around the world, who complement our areas of expertise.

We aim to become one of the leading academic institutions in the world and in 2013 we once again made good progress towards achieving this goal. In September 2013 the European Research Council (ERC) published statistics on the achievements of European Universities and Research Institutions in terms of numbers of ERC Advanced and ERC Starting grants received. It showed that Radboud University Nijmegen is 22nd in Europe (see Figure 1), even without including the significant successes at the end of 2013.

Aims for the near future include 1) increasing our academic impact, 2) strengthening our societal impact and 3) intensifying the use of our research results.

Our academic profile

We intend all research done at Radboud University Nijmegen which is not already leading nationally – and competitive internationally – to be so in the foreseeable future. Within all of our research, nine sub-disciplines have been identified where the quality exceeds the high level achieved by researchers in the rest of the University.

Figure 1: Acquisition of ERC grants by host institution. Total value in millions of euros. Source: European Research Council Executive Agency, 2013.
These nine areas are listed below.

**Organic Chemistry**
The focus within Chemistry, which includes Material Science, Life Science, Biomedical Science and Supra-Molecular Chemistry, is on Organic Chemistry. We concentrate on Synthesis and on Physical Organic Chemistry and recently we have begun to focus more on the Life Sciences. This research is mainly done in the Institute for Molecules and Materials, but it also takes place in the Nijmegen Centre for Molecular Life Sciences. The research infrastructure and facilities in both institutes are excellent. Evidence of top-quality research in Organic Chemistry is provided by the numerous prestigious grants awarded in recent years. These include ERC Advanced grants, Spinoza Awards and Netherlands Organisation for Scientific Research (NWO) Vici grants. In 2012, the Organic Chemists at the University received – together with the Eindhoven University of Technology and the University of Groningen – one of the six highly prestigious ‘Gravitation’ grants from the NWO for work that is planned to be carried out over the next decade.

In 2013, the Bio-Organic Chemistry group (led by Prof. Van Hest) developed a novel shape transformation technique that is used to prepare tubular polymersomes by adding a crosslinker. Some of the advantages of tubular shapes include applications for these vesicles as drug delivery vehicles or artificial organelles. Prof. Huck and his Physical Organic Chemistry group are working on understanding how cells have adapted to the phenomenon of ‘crowding’, i.e. the interior of a living cell is filled with proteins and other macromolecules are packed together. Dr Feiters (Synthetic Organic Chemistry) and colleagues were granted a Life Science Pre-Seed subsidy from the Netherlands Genomic Initiative (NGI), which they will use to design novel viral therapies for Dengue Fever and other viral threats.

**Physics of Condensed Matter**
At Radboud University Nijmegen research on the Physics of Condensed Matter is strongly interrelated with research in the field of Chemistry. It contributes to the Dutch national programmes Nanoned and Nanonext, as well as to EU programmes. Thanks to unique infrastructure, including the High Field Magnet Laboratory (HFML).
and three advanced Free-electron Laser Units (FELIX/FELICE/FLARE), international cooperation is excellent. Leading areas are the Experimental Physics of Condensed Matter and Theoretical Physics of Condensed Matter. The cooperation between experimental physicists and theoretical physicists on graphene formed the basis for the 2010 Nobel Prize in Physics, which was awarded to former Associate Professor and current Extraordinary Professor André Geim and Professor Konstantin Novoselov, a PhD graduate from the University and currently also an Extraordinary Professor. In 2013, Prof. Katsnelson was awarded the most prestigious scientific prize in the Netherlands (the Spinoza Prize) by the Netherlands Organisation for Scientific Research (NWO). He also received an ERC Advanced Investigator Grant. In addition, Prof. Rasing received an ERC Advanced Grant for experiments with a new femtosecond X-ray source in Stanford and the Nijmegen picosecond Terahertz free-electron laser designed to discover how magnetic order emerges from chaos. Dr Zeitler (HFML) participated in a successful application for ten-year funding within a European ‘Flagship’ programme on graphene. Prof. Kentgens and colleagues from the Universities of Utrecht, Wageningen, Leiden, and Eindhoven received an NWO Graduate School subsidy for establishing the Netherlands’ Magnetic Resonance Research School.

**Astrophysics**

Astrophysical research has been strong in the Netherlands for many decades. Since 2001, when a group of highly talented researchers came to the University, astrophysical research, which focuses on the evolution of double stars, compact objects and astrophysical particles, has become truly competitive internationally. The quality of the research is reflected in the successful acquisition of highly prestigious grants such as ERC Advanced grants and the Spinoza Award.

In 2013, Profs. Heino Falcke (coordinator; Radboud University Nijmegen and ASTRON), Michael Kramer (Max Planck Institute for Radio Astronomy) and Luciano Rezzolla (Goethe University Frankfurt and the Max Planck Institute for Gravitational Physics) acquired an ERC Synergy grant for their project ‘BlackHoleCam’. This team of European astrophysicists will use this grant to create for the first time an accurate image of a black hole. A total of 161 refereed publications were published by members of the Department of Astrophysics in 2013, including four in *Nature* and *Science*.

**Microbiology**

The composition, functioning and evolution of ecosystems is central to research on gene-environment interactions at the University. This research covers all major biotic organisms, including microorganisms, plants and animals, and their interactions. Adaptations – as well as stress responses – by these organisms are investigated in terms of how their molecular and physiological mechanisms are regulated. The team of microbiologists at the University specializes in the reactions of ecosystems to the quantity and quality of water. In particular, their research on Anammox bacteria, which efficiently degrade ammonium without oxygen, led to revolutionary insights and a series of world-class publications. The team has twice received an ERC Advanced grant and, in 2012, Prof. Mike Jetten received the NWO Spinoza prize for discovering many new (anammox) bacteria and elucidating their unique useful properties.

In 2013, Prof. Mike Jetten received a second ERC advanced investigators grant to study the ecology of methane oxidizing microorganisms. His team also received an NWO ‘Gravitation’ grant to establish the Soehngen Institute of Anaerobic Microbiology (SIAM) together with NIOZ, Wageningen UR and TU Delft. Prof. Jetten’s group is also involved in a ‘Gravitation’ grant programme to establish the Earth System Sensitive Centre, which is led by Utrecht University with the participation of Radboud University Nijmegen, the VU University Amsterdam and Wageningen UR. Dr Frank van de Veerdonk received the 2013 Best Young Researcher award from the American Society for Microbiology for outstanding performance in fungal immunology research.

**Figure 2:** Researchers (in FTEs) per year
Cognitive Neurosciences
Leading-edge research on brain and cognition has taken off in recent years and, as a result, several reputable institutes on the campus joined forces to form the Donders Institute for Brain, Cognition and Behaviour. Affiliated institutes (also located on the campus) are: the Max Planck Institute for Psycholinguistics, the Centre for Language Studies and the Behavioural Science Institute. The University’s cognitive neuroscience research covers all aspects of cognition: from molecules and genes, neurons and networks of brain areas, to behavioural and clinical implications. The excellent advanced infrastructure and facilities – as well as the multi-disciplinary approach taken by Nijmegen physicists, biologists, chemists, psychologists and informaticists – ensure high-quality research. This is apparent from the many grants that have been won – against strong competition – by this institute. These include an ERC Advanced grant, a Spinoza prize and several NWO Vici grants.

In 2013, the Donders Institute, the MPI for Psycholinguistics and the Institute for Language, Logic and Computation at the University of Amsterdam launched a joint ‘Language in Interaction’ project. This major project was awarded an NWO ‘Gravitation’ grant in December 2012 for research on language covering the full range from genetic building blocks to social interaction. The Donders Institute takes the lead in a number of pioneering national and international consortia, including many that received grants in 2013. For example, Healthpac (Perception and Action in Health and Disease) is a European integrative doctoral programme (IDP) that brings together research institutes in Zürich, London, and the Netherlands with seven European companies. Aggressotype is a large EU-funded project on pathological aggression in children and adolescents with attention deficit/hyperactivity disorder (ADHD) and conduct disorder (CD). The Human Brain Project was selected by the EU as one of two flagship projects.

Infection and Immunology
The interface between micro-organisms and man is the stage for fundamental research and clinical translational research at the University. It includes defence mechanisms and inflammation after infection, inflammatory diseases (such as autoimmune diseases), as well as cancer and transplantation. There is close cooperation with researchers at clinical centres for infectious, inflammatory and immune diseases. The successful acquisition of a number of prestigious grants, including the ERC Advanced grant, the Spinoza prize and the NWO Vici grants, confirms the excellent performance of the teams working on infection and immunology. In 2013 Dr Annemarie Boleij and Dr Harold Tjalsma published – in The Lancet Infectious Diseases – their view on bacterial features that determine the specific association between Streptococcus gallolyticus and colorectal cancer and how infections with this opportunistic gut pathogen can be used for the early detection of malignant colonic disease.

The group led by Prof. Jolanda de Vries published – in Cancer Research – the first clinical study of therapeutic vaccination against cancer using naturally occurring plasmacytoid dendritic cells (pDC).

A consortium led by Prof. Jack Neefjes (NKI, Amsterdam), which included Radboud Professor Carl Figdor, was awarded an NWO ‘Gravitation’ grant to set up the Institute for Chemical Immunology (ICI).

Prof. Robert Sauerwein (Dept. of Medical Microbiology) received a personal grant from the Bill & Melinda Gates Foundation to further develop a malaria vaccine.

Figure 3: Academic publications per year
Introduction

**Human Genetics**
The main research areas in this field at the University include identifying the genes involved in congenital abnormalities, intellectual disability, psychiatric diseases, heritable development of tumours, deafness, and blindness – as well as the mode of action of these genes. Human Genetics researchers at the University have access to modern bio-informatics equipment and the latest techniques. Translational research is also highly successful. Some of the newest genetic techniques for diagnosis, such as DNA chips and Exome sequencing, were applied in Nijmegen for the first time worldwide. The excellent Human Genetics team has published very large number of papers in top journals such as *Cell*, *Nature Genetics*, *Science* and the *New England Journal of Medicine*, and they have succeeded in acquiring multi-million-euro grants from competitive research funding bodies in the Netherlands and in the EU. Significant achievements in 2013 underscore the academic reputation of the researchers working in this sub-discipline.

Several major results were published by investigators working in the Department of Ophthalmology in 2013. Dr. A. den Hollander and colleagues revealed that a functional variant in the CFI gene confers a high risk of age-related macular degeneration (AMD). The group led by Prof. Franke (Genetics of Brain Function and (Psychiatric) Malfunction) showed that specific Single Nucleotide Polymorphisms (SNPs) are associated with a range of psychiatric disorders. The group led by Prof. Hans van Bokhoven (Molecular neurogenetics) published several papers on their findings on the role and mechanism of epigenetic modifications (post-translational histone modifications) in development, neurodevelopment and memory formation. Prof. Henk Stunnenberg (Dept. of Molecular Biology) was awarded an ERC Advanced Grant for his project ‘SysStemCell’.

**Linguistics**
Ground-breaking linguistics research in language, language behaviour, language and speech technology, and communication is carried out in Nijmegen. The research focuses on two main themes: Language in the mind (including learning a mother tongue, the production and processing of language) and Language in society (covering the use of language in a variety of cultures and subcultures). The linguistic researchers at the University are among the best of the world and there is close multi-disciplinary cooperation with other institutes on the campus (especially the Max Planck Institute for Linguistics and the Donders Institute for Brain, Cognition and Behaviour). They have received prestigious grants including ERC Advanced grants and the Spinoza Prize.

Only human beings have a communication system that combines a finite number of meaningless elements (sounds) with a potentially infinite set of meaningful concepts. But where do these meanings come from? Large-scale cross-cultural comparisons reveal little evidence for absolute universals in the meaning of words, which would be consistent with the cultural relativity view. However, there are striking statistical regularities in how meaning is carved up into words, suggesting that similar perceptual and cognitive constraints work across diverse languages. Research with infants in 2013 provides evidence for some of these conceptual structures early in child development; these are in place well before language learning.

**Business and Law**
The Business & Law Research Centre has close ties with fourteen highly renowned – mostly international – law firms, financial institutions and companies. They work...
together on academic research in 1) company law, 2) financing, security rights and insolvency, 3) business and patrimonial law, and 4) financial law. With excellent facilities and a very good library, the Research Centre has produced numerous authoritative textbooks, monographs and serial volumes. The various research groups are also very successful in raising funds.

In 2013 the book Corporate Boards in Law and Practice was published by Oxford University Press. The authors analyze corporate boards, their regulation in law and codes as well as the way they operate in ten European countries.

The Centre has also invested heavily in international research in Insolvency Law. A milestone was the launch of the International and Comparative Insolvency Law (ICIL) Series, published by Oxford University Press. Within the framework of this series, the discrepancies and common features of domestic insolvency laws in twenty countries across the world are inventoried and critically analyzed. In 2013 the second volume of the series on Treatment of Contracts in Insolvency was published.

Internationalization

The focus of much research at the University is international. The reasons for this are that either the research equipment is too large – and expensive – for one university to purchase alone (this is the case for research in Astronomy, Astrophysics, Particle Physics and High magnetic fields) or because the research topic has global dimensions. Here one can include research on human health, education, literature, international law, computer security and nature management. This is why Radboud researchers regularly join forces with colleagues at other institutes around the world. The main reasons why we put such a strong emphasis on international cooperation are: in order to complement and create synergy (of expertise and/or facilities), to increase critical mass, to form international research consortia, to recruit

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ERC Advanced Investigator Grant 2013

Profs. Mikhail Katsnelson (Professor of Theoretical Physics), Theo Rasing (Professor of Spectroscopy of Solids and Interfaces), Henk Stunnenberg (Professor of Molecular Biology) and Mike Jetten (Professor of Ecological Microbiology) each received a highly prestigious ERC Advanced Investigator grant.

Previous laureates

1. Prof. Pieter Muysken
   ERC Advanced Grant 2008

2. Prof. Mike Jetten
   ERC Advanced Grant 2008

3. Prof. Heino Falcke
   ERC Advanced Grant 2008

4. Prof. Conny Aerts
   ERC Advanced Grant 2008

5. Prof. Wilhelm Huck
   ERC Advanced Grant 2009

6. Prof. Carl Figdor
   ERC Advanced Grant 2010

7. Prof. Stephen Levinson
   ERC Advanced Grant 2010

8. Prof. Guillén Fernández
   ERC Advanced Grant 2010

9. Prof. Roeland Nolte
   ERC Advanced Grant 2011

10. Prof. Bart Jacobs
    ERC Advanced Grant 2012

11. Prof. Nico Verdonck
    ERC Advanced Grant 2012
Introduction

talented students and to provide our PhD students with the best job opportunities. A substantial number of the doctoral candidates, post-doctoral researchers and other staff working at the University were born outside the Netherlands (23% of all researchers in FTE). The illustration on the inside front cover of this report shows some of our international partner institutions around the globe.

Societal impact
It has always been the ambition of this University to be engaged in important societal issues and much of the research agenda is inspired by demands from society. For example, we make a significant contribution to achieving the Dutch government’s innovation targets. Our societal impact is concentrated in seven main themes: 1. Europe’s “worlds” 2. Language and communication 3. The development of society and justice 4. Behaviour and education 5. Molecules and materials 6. Water and wetlands 7. Personalized medicine.

Some highlights of our work in 2013 illustrate the societal relevance of research related to these themes.

Europe’s “worlds”
- The project The diversity of Islamic finance in a comparative perspective has proved useful for those wishing to make contacts between Islamic and conventional financial systems. Advice has been given to the Dutch Ministry of Finance, Holland Financial Centre, Sustainable Finance Lab and the OIKOS Foundation.
- The Gruuthuse manuscript – the most important collection of Dutch literary texts from the Middle Ages – was featured in the Gruuthuse museum in Bruges from March to June 2013. That is remarkable because, since its discovery in around 1840, it has rarely been made available to the public. Jos Koldeweij, Professor of Medieval and Early Christian Art History, was the guest curator of the exhibition. The Gruuthuse manuscript is a compilation of 170 songs, poems and prayers and for almost all of them this manuscript is the only known source. The Egidius song – the best known – is of great importance for Dutch literature and for music historians. The key motifs of the exhibition are the themes that are also in the manuscript: music, love, ‘const’ (art), companionship and devotion. Not only do they provide a picture of the rich content of the manuscript, they also tell us a great deal about the cultural, social and religious climate at the time.

Language and communication
- CLS has bundled its externally funded projects that involve language and speech technology in a dedicated institute: the Centre for Language and Speech Technology (CLST). Through CLST, CLS collaborates with many social and commercial partners.
- The Fowlt.net spelling checker – as well as the Dutch version Valkuil.net – is not like other spelling checkers, which check individual words against a standard list, underlining those that aren’t found in that list. Instead, Fowlt.net finds errors by looking at the context of each word. Fowlt.net knows and recognises such lexical contexts because it contains large numbers of controlled error-free example texts. The programme can therefore easily find errors that other spelling checkers have difficulty with, such as the difference between ‘its’ and ‘it’s’ and between ‘you’re’ and ‘your’. Fowlt.net was developed by Research Master’s student Wessel Stoop, together with PhD student Maarten van Gompel, web designer Monica Hajek, and Prof. Antal van den Bosch.
- Researchers working on the ‘Curious Minds’ project examined the way children learn science and technology in relation to communication and language learning.

Development of society and justice
- Examples of societal impact include the participation of Prof. Michael Veder and Prof. Tomáš Richter in the Advisory Commission of the European Commission on cross-border insolvency law and the membership of Prof. Carla Klaassen in the State Advisory Commission on Private Procedural Law.
- The Dutch Ministry of Justice has chosen the CMR group to evaluate its new asylum procedure.
- Prof. Van Thiel was appointed to the Committee to Evaluate Police Law, which was established by the Dutch Ministry of Safety and Justice.
- The Dutch Central Health Insurance Board (CVZ) commissioned a study by Prof. Van Thiel, Dr Helderman and Dr De Kruijff. This study focuses on changes in the government’s position on health insurance, the tasks and roles of CVZ, and implications for its legitimacy as a quasi-autonomous non-governmental organization (QUANGO).

Behaviour and education
- Prof. Bekkering worked on translating insights from Cognitive Neuroscience into Education. Together with a major publisher (Malmberg) he developed animations, which can be used to improve word learning in primary schools.
- The Dutch national government decided to raise the minimal drinking age from 16 to 18. The BSI line of longitudinal studies on the role of parental rule setting and drinking – conducted over the past ten years – helped generate rational support for this decision. This far-reaching change in policy has a Twenty-three percent of all researchers working at our University were born outside the Netherlands.
potentially huge impact on the detrimental consequences of early-age drinking.

• A tool-kit on civic virtue and ethical education developed by PTR researchers was presented at a conference with school leaders (25 September 2013).

Molecules and materials

• There are cooperative arrangements with major companies in the Netherlands, including DSM, Philips, NXP, Solvay, Unilever and AkzoNobel. In addition, the large-scale research infrastructure at the IMM has resulted in business relationships with medium-sized technology-oriented enterprises in the Nijmegen area.

• Prof. Rowan obtained an STW Valorisation grant for the further application of ‘Smart Patches’. These are patches that are biologically similar to the skin and protect against bacteria, but release wound fluids and are easy to remove.

• Another STW Valorisation grant has been obtained by Dr Schermer (Applied Materials Science) and start-up Solar Swing for developing semi-transparent solar blinds that regulate the transmitted light and generate electricity.

Water and wetlands

• IWWR has structural collaborations with a large number of companies and partners engaged in nature and water management and applications were stimulated by new results.

• The microbiologists showed that anammox bacteria can remove nitrogen compounds from wastewater at low temperatures, using both ammonium or methane as an electron donor, thus considerably extending the application of these processes in municipal waste water treatment systems.

• The aquatic ecologists closely cooperate with the spin-off company B-Ware, which valorises biogeochemical and ecological state-of-the-art knowledge for nature management and water management, together with a number of governmental organizations. One of the

Radboud University Nijmegen has the following faculties:

• Faculty of Philosophy, Theology and Religious Studies
• Faculty of Arts
• Faculty of Law
• Faculty of Social Sciences
• Nijmegen School of Management
• Faculty of Science
• Medical Centre (Faculty of Medicine and University Hospital)

Fundamental and applied research is carried out within specialized institutes:

• Research Institute for Philosophy, Theology and Religious Studies
• Institute for Historical, Literary and Cultural Studies
• Research Centres of the Faculty of Law
• Institute for Management Research
• Nijmegen Institute for Social & Cultural Research
• Centre for Language Studies
• Behavioural Science Institute
• Donners Institute for Brain, Cognition and Behaviour
  - Centre for Cognition
  - Centre for Cognitive Neuroimaging
  - Centre for Neuroscience
• Institute for Genetic and Metabolic Diseases
• Research Institute for Oncology
• Nijmegen Institute for Infection, Inflammation and Immunity
• Nijmegen Centre for Evidence-Based Practice
• Nijmegen Centre for Molecular Life Sciences
• Institute for Water and Wetland Research
• Institute for Molecules and Materials
• Institute for Mathematics, Astrophysics and Particle Physics
• Institute for Computing and Information Sciences

Preparing for a career in research with Research Masters studies:

• Behavioural science: the study of behavioural regulation
• Cognitive neuroscience
• Historical sciences
• Art and visual culture
• Language and communication: the empirical study of human communicative capacities
• Literature and literary sciences: new philology
• Molecular mechanisms of disease
• Business and Law
• Philosophy
• Social cultural science: comparative research on societies
Introduction

collaborative programmes in 2013, which was financed by the European Regional Development Fund (ERDF), involved developing innovative solutions for combining water storage, water purification and biomass production.

Personalized medicine
• The group led by Prof. Scheffer now offers diagnostic exome sequencing for a wide variety of genetically heterogeneous hereditary disorders, including intellectual disability, movement disorders, blindness and deafness (www.genomediagnostics-nijmegen.nl).
• Prof. J. Smeitink was invited by the Netherlands Federation of University Medical Centres and the Dutch Ministry of Public Health, Welfare and Sport, to give his view on current and future diagnostics and treatment for patients with rare diseases.
• Dr Rob Baltussen contributed to the WHO guidelines of HIV treatment.
• A 2nd Phase STW Valorisation grant was awarded to Prof. Peter Lucas to move towards the market introduction of a smartphone app that will support COPD patients in detecting any worsening of their condition.
• Prof. Rutjes participates in the European Lead Factory, a EU project with 30 partners who are working on building a huge library of new chemical compounds that are potentially relevant for new medicines. Within this project new compounds will be identified, screened and further developed. Universities, research institutes, small-medium enterprises and large companies can access the database.
• Prof. Bert van der Kogel received a ESTRO Lifetime Achievement Award for his major impact on healthcare with contributions to radiobiology and translational research in radiation oncology. His research substantially changed the practice of the profession.
• Dr L. Joosten developed a new diagnostic test for Lyme disease and he contributed to the advice for The Health Council of the Netherlands about novel diagnostic tools for Lyme disease.

Knowledge and technology transfer

Knowledge and technology transfer is one of the core tasks and a key ambition of Radboud University Nijmegen. Promoting knowledge and technology stimulates innovation and creates conditions for entrepreneurship.

In order to encourage the use of academic knowledge in society the University has focused on the following activities: post-academic education, joint research with private and public partners, public events, the formulation of guidelines, facilitating the establishment of new companies, encouraging start-up companies and educating students in entrepreneurship.

Over the past decade the University has successfully spun off dozens of innovative companies. These are now run by innovative high-tech entrepreneurs, using the latest insights from academic research. This has also given a considerable boost to employment in the region.

Researchers at the KNAW-Rathenau Institute compared several quality parameters of Dutch universities and in their 2012 report they described Radboud University Nijmegen as a very entrepreneurial university. This conclusion was based on the relationship of contract research to core funding.

Some examples of knowledge and technology transfer in 2013:

Indicators for knowledge and technology transfer

In 2013, the universities in the Netherlands joined forces to formulate indicators for the conversion of academic results into societal results. In the next two years the activities at this University that are designed to maximize knowledge and technology transfer will be checked according to these indicators.

Activities for the general public

Jos Koldeweij (Professor of History of Art) is one of the founders of the ‘Bosch Research and Conservation Project (BRCP). The BRCP is an international history of art research project. Modern technologies are being applied for a fundamental reevaluation of the work from Jheronimus Bosch (approx. 1450-1516). Art historians, conservators and restorers from institutions around the globe are cooperating to analyze and conserve the heritage of one of the world’s most creative artists ever.

Five hundred years after the anniversary of Jeroen Bosch’s death, during the ‘Bosch year 2016’ three of his triptychs in Venice will be returned to his city of birth Den Bosch.

Patents and licences

In 2013, Researchers at the University submitted a total of 20 patents in Chemistry, Health, Life Sciences, Linguistics and Neurocognition. Furthermore, three spin-off companies started up on the basis of previously developed intellectual property.

Public-private cooperation

The University also invested in a project called ‘Knowledgealliance Rhein-Waal 2020’. The University thus contributes – together with other knowledge institutions and SME companies – to an innovative region that extends across the nearby border with Germany. The project financed eleven grants for entrepreneurs which stimulate innovative, transboundary enterprises. For more information see www.knowledgealliance.eu.
Starting new businesses and education on entrepreneurship

In the courses ‘Durable entrepreneurship’ and ‘Policy, entrepreneurship and innovation’ the University teaches its students about entrepreneurship. Students get the opportunity to orient themselves within this domain, and learn how to write a business plan in relation to their own field of study.

Our academic reputation

When comparing the impact scores achieved by all publications at universities in the Netherlands during two periods (2003-2006 vs. 2007-2010), it appears that the impact score of Radboud University Nijmegen has increased more than that of other universities (see Figure 5). Our overall impact score is now fourth highest among the universities in this country.

NWO ‘Gravitation’ grant

The Dutch government uses the NWO ‘Gravitation’ grant to encourage excellent research involving consortia of the best researchers in the Netherlands. It is dedicated to academic work that has the potential to be ‘best in the world’ within specific fields of science. The best research teams receive funding for a period of 10 years. One of the six consortia which received such a programme in 2013 is coordinated by Radboud University Nijmegen and we participate in two other ‘Gravitation’ grants.

Prof. Mike Jetten (Dept. Microbiology) received a ‘Gravitation’ grant to establish the Soehngen Institute of Anaerobic Microbiology (SIAM) together with NIOZ, Wageningen UR and TU Delft. Prof. Jetten’s group is also involved in a ‘Gravitation’ grant to establish the Earth System Sensitive Centre, which is led by Utrecht University with the participation of Radboud University Nijmegen, the VU University in Amsterdam and Wageningen UR.

Prof. Carl Figdor (Dept. of Tumour Immunology) is involved in a ‘Gravitation’

Prof. Mikhail Katsnelson (Professor of Theoretical Physics) was one of the four NWO Spinoza prize laureates in 2013 (photo: Ministerie OCW).

Previous laureates

1 Prof. Pieter Muysken
   Spinoza Award 1998
2 Prof. Anne Cutler
   Spinoza Award 1999
3 Prof. Bert Meijer
   Spinoza Award 2001
4 Prof. Henk Barendregt
   Spinoza Award 2002
5 Prof. Peter Hagoort
   Spinoza Award 2005
6 Prof. Carl Figdor
   Spinoza Award 2006
7 Prof. Theo Rasing
   Spinoza Award 2008
8 Prof. Henk Falcke
   Spinoza Award 2011
9 Prof. Ieke Moerdijk
   Spinoza Award 2012
10 Prof. Mike Jetten
    Spinoza Award 2012
grant that will be used to establish the Institute for Chemical Immunology (ICI), which is led by the Netherlands Cancer Institute (NKI) in Amsterdam.

NWO Spinoza Prize
The NWO awards the annual NWO Spinoza Prize to a maximum of four Dutch researchers who are the very best in their field, both nationally and internationally. These scientists receive this prestigious prize for outstanding, groundbreaking research as well as their record in inspiring young researchers. In 2013, Prof. Mikhail Katsnelson (Professor of Theoretical Physics) was one of the four laureates. He won this prize for his innovative research on the theory of condensed matter, in particular in relation to the properties of graphene. Prof. Katsnelson works closely together with the two 2010 Nobel prize winners Prof. Geim and Prof. Novoselov.

ERC Advanced Investigator grant
Prof. Mikhail Katsnelson also received the prestigious ERC Advanced Investigator grant to further develop new theories on physical properties at nanoscales and during hyperspeed measurements. Prof. Theo Rasing (Professor of Spectroscopy of Solids and Interfaces) was awarded an ERC Advanced grant, which he will use to reveal how a magnetic order appears out of chaos and how a magnetic system can be switched from one state to another.

Prof. Henk Stunnenberg (Professor of Molecular Biology) will use the ERC Advanced grant he received to study in detail how the genome operates.

Prof. Mike Jetten (Professor of Ecological Microbiology) received an ERC Advanced grant for the second time. He will use this second grant to study the ecology of anaerobic methane oxidizing microorganisms such as *Methylomirabilis oxyfera*.

ERC Synergy grant
The ERC Synergy Grants (maximum: €15 million) are the largest and most competitive grants from the European Research Council. The selection procedure for awarding this grant is very severe (scientific excellence is the criterion). In 2013, Prof. Falcke – as the coordinator of a team of European Astrophysicists – received an ERC Synergy grant to compose for the first time an accurate image of a black hole. This team will test predictions based on current gravitation theory, including Einstein’s general theory of relativity.

Newly elected members at national and international academic societies
- Profs. Heino Falcke (Astrophysics and Radio astronomy), Arthur Hartkamp (European Private Law), Mike Jetten (Ecological Microbiology), Mikhail Katsnelson (Theoretical Physics), Renate Loll (Theoretical Physics), Asifa Majid (Language, Communication and Cultural Cognition), Gerard Meijer (Experimental Molecular Physics), Roeland Nolte (Organic Chemistry), Theo Rasing (Experimental Physics), Jan Smeitink (Mitochondrial Medicine) and Ellen van Wolde (Exegesis Old Testament) have been elected to the Academia Europaea.
- Prof. Han van Krieken (Pathology) was elected as president of the European Society of Pathology.
- Prof. Roshan Cools (Cognitive Neuropsychiatry) became a Fellow

**Figure 5:** Citation impact of publications from all universities in the Netherlands in two periods (2003-2006 vs. 2007-2010) and percentage increase. Source: Dialogic WTI-2 Report 2012.
of the Association for Psychological Science.

• Prof. Taco Brandsen (Public Administration in International Comparative Perspective) was appointed as the new Secretary-General of the European Association for Public Administration Accreditation.

• Prof. Joost Drenth (Molecular Gastroenterology and Hepatology) was appointed to the Governing Council of the World Gastroenterology Organisation.

• Prof. Alan Sanfey (Social and Cultural Psychology) was elected to the Board of the Society for Neuroeconomics.

• Profs. H. Brunner (Human Genetics) and Christoph Lüthy (History of Philosophy) were elected to the Royal Netherlands Academy of Arts and Sciences.

Radboud Excellence Initiative

At Radboud University Nijmegen we feel strongly that the climate for research within the university should have an international dimension. International partnerships between researchers and leading academics around the world are a high priority. The Radboud Excellence Initiative promotes contacts and cooperation between outstanding academics. Under this initiative, very talented scientists based outside the Netherlands can work at the University for shorter or longer periods. The first call for Fellowships and Professorships was announced in 2013. The results of this new initiative will take effect in 2014.

Radboud Excellence Fellowships

These are intended for exceptionally talented young researchers, who are selected on the basis of their academic record, as well as a promising original research plan. Twenty Fellowships will be offered every year. These are intended for researchers based outside the Netherlands who have obtained their doctorates between two and twelve years ago. Each Fellowship funds a research project lasting one to two years, to be conducted in one of our ‘top’ research groups.

Radboud Excellence Professorships

These are intended for leading academics whose research has had a significant impact in their discipline and beyond, and who can be expected to remain active as researchers for at least several years. The University will award between two and four Excellence Professorships every year. Each Professorship enables an eminent researcher to conduct research in Nijmegen for about six months.

External evaluations

Our research institutes are periodically evaluated by an international committee of peers. Plans for further improvements are based on their assessment and recommendations.

The review committees assess the institutes according to the Standard Evaluation Protocol for Academic Research in the Netherlands, which includes an evaluation of the training and education programme for PhD students. For each programme, there are four criteria: 1) quality, 2) productivity, 3) relevance and 4) vitality & feasibility. The assessments, which range from excellent to unsatisfactory, are defined as follows:

• Excellent: leading, at the forefront worldwide
• Very good: internationally competitive, leading nationally
• Good: nationally competitive, visible internationally
• Satisfactory: visible nationally
• Unsatisfactory: not worth pursuing.

In 2013 the research at four institutes at Radboud University Nijmegen was evaluated and from a fifth institute (NISCO) two research programmes participated in a national disciplinary research assessment.

Donders Institute for Brain, Cognition and Behaviour (DI)

The committee rated the performance of the Institute over the past six years as “excellent.” The Evaluation Committee confirmed the Donders Institute’s international reputation by stating that it “has had an important and substantial impact in the international field” and that the Principal Investigators were recognized as “top researchers in their field.” The committee
was impressed by what has been achieved in six years and observed an extraordinary spirit of cooperation: “The Institute is a very stimulating environment for top researchers as well as for young talent.” The four themes of the DI were also assessed. Both the quality and the productivity were in each case rated as “very good to excellent” or “excellent.” The DI produced a plan to implement the points for improvement as mentioned in the committee’s report.

Research Institute for Philosophy, Theology and Religious Studies (PTR) The institute PTR was overall assessed as “very good.” The evaluation committee praised the leadership of PTR “exceptionally well” for its progress in constituting new research programmes. The Committee “is impressed with the progress made in just a couple of years, and with the general enthusiasm, sense of expectation, and energy that has created an excellent atmosphere within the institute.” Furthermore the Committee “welcomes the fact that the institute has not only succeeded in establishing an administrative unity for the institute, but that it has also created a unity with respect to the content of the research. This has given the institute a clear and coherent profile that makes it visible both nationally and internationally.” The institute is currently writing a plan to implement the recommendations of the committee.

Institute for Management Research (IMR) The research and education of doctoral candidates at IMR have been evaluated. A definitive assessment report is expected early in 2014.

Institute for Science Innovation & Society (ISIS) Research at ISIS has also been evaluated and the assessment report is expected early in 2014.

Nijmegen Institute for Social & Cultural Research (NISCO) Finally, two programmes at NISCO – Cultural Anthropology and Sociology – have been assessed. The reports on these assessments will also be delivered in 2014.

Academic integrity The University Board actively promotes academic integrity and accountability by stimulating awareness on this topic among all those engaged in research. All research institutes reported on current practice, improvements and further implementation of rules for sound scientific conduct. These practices include dedicated seminars for staff, doctoral candidates and Research Master’s students, new policies related to data storage and management (data acquisition, data analysis and reporting), and critical assessments by expert colleagues.

We avoid experiments with animals wherever possible and explore alternative methods in which no animals are involved. Where animal experiments do take place, we aim to optimize conditions and critically summarize all available evidence by engaging in systematic reviews. These reviews have long been carried out for clinical trials and are now also being applied to animal studies (see: www.SYRCLE.nl). Systematic reviews produce better quality science, help to implement the best-practice three Rs (Replacement, Reduction and Refinement) and, last but not least, improve patient safety.

As required by law, experiments that include human or animal subjects are subject to approval by an independent ethics committee.

When weaknesses in the security of commercial digital devices have been identified by the Institute for Computing and Information Sciences (ICIS), results are reported first to the companies or authorities involved, before they are made public.

Academic integrity and accountability remain important issues. To strengthen awareness of these topics, the Executive Board installed the University Advisory Council on Scientific Integrity in 2013. This council operates as a university
think tank on various aspects of scientific integrity. The council plays an active role in implementing the recommendations of the university’s committee on scientific integrity, which were published in October 2012.

In November 2013 the Executive Board decided on the University Policy on Storage and management of Research Data, which is being implemented in the Research Data Management project.

Grants and awards for excellent young scientists
Many young scientists and a Research Master’s student received prestigious national or international grants or awards in 2013, competing with some of the best in the world.

Nineteen researchers received an NWO Veni grant in 2013. This will enable them to do research for three years after graduating with a PhD. The winners this year were Drs Thomas Boltje, Jordy Bouwman, Cindy Dieteren, Katharina Ettwig, Christian Gilissen, Sean Gryb, Nina Hubner, Giedo Jansen, Sander Lestrade, Mercedes Martin-Benito, Sven Meeder, Wim Noorduin, Peter Schwabe, Alexandra Silva, Jurjen Tel, Sicco Verwer, Jenny van der Wijst and Jialiang Xu.

Ten post-doctoral researchers received an NWO Vidi grant in 2013. This major achievement will enable them to develop their line of research for five years. These grants were awarded to Drs Christian Beckmann, Christian Döller, Leonie Kamminga, Dirk Lefeber, Kristin Lemhöfer, Hendrik Marks, Klaas Mulder, Rinke Stienstra, Walter van Suijlekom and Silke Weinfurtner.

Five more senior researchers received NWO Vici grants in 2013. These substantial grants will enable them to further develop their line of research for five years. These grants were awarded to Profs. Barbara Franke, Bram van Ginneken, Joost Hoenderop and Karin Roelofs and Dr Ronald Roepman.

Four prestigious Starting Grants from the European Research Council were awarded to Drs Corien Bary, Geert van den Bogaart, Bas van de Meerakker and Mangala Srinivas. This grant allows budding top researchers to initiate their own line of investigation.

ERC Consolidator Grants have been awarded to four researchers:
• Prof. Peter Friedl for his study on tumour biology in live animal models using novel multiphoton microendoscopy technology to map cancer progression, metastasis and therapy response.
• Dr Ronald van Rij for his study on the defence system of mosquitoes against viruses such as Dengue Fever and West-Nile virus that are increasingly invading western countries.
• Prof. Moniek Buijzen for her research on applying social media in health campaigns targeting young people in order to encourage greater mobility and healthier eating.
• Prof. Andrea Evers for studying the influence of individual expectations on the outcome of medical treatments involving physical responses, for example by the immune system.

One young researcher – Vitória Piai MSc – received an NWO Rubicon Scholarship to enable her to go abroad to conduct research immediately after gaining her doctorate.

Reorganization of research institutes at Radboud University Nijmegen Medical Centre
In 2013, the Board of Directors of the Radboud University Medical Center (Radboudumc) decided to establish a new organizational structure for its research activities. After thorough evaluation of 42 research topics within the current six research institutes, the board identified 17 disease-related themes, covering the full spectrum from molecule to man to population, and two generic themes. Together, these 19 fields will form the Radboudumc research profile. A new organizational structure designed to optimally support research in these areas will be implemented from January 2014. It will comprises three (instead of six) institutions: the Radboud Institute for Molecular Life Sciences, the Radboud Institute for Health Sciences and the Donders Centre for Neuroscience.

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<td>This university</td>
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<td>Percentage of all grants acquired</td>
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<td>Percentage of all grants acquired</td>
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<td>Vidi Call</td>
<td>8.1%</td>
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<td>This university</td>
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<tr>
<td>Percentage of all grants acquired</td>
<td>3.8%</td>
<td>Vici Call</td>
<td>10.0%</td>
<td>9.7%</td>
<td>14.3%</td>
<td>17.9%*</td>
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*Performance consistently far exceeds 7.3 %, which would be expected if the percentage of total grants were equivalent to the University’s share of core funding (core funding is based on student numbers and the number of graduations per year).

Table 1. Success rate in acquisition of personal grants for research (NWO)
The Research Institute for Philosophy, Theology and Religious Studies (PTR) aims to enhance knowledge of fundamental academic issues relating to society, human beings and their place in the natural world. It conducts interdisciplinary research on three dominant themes in philosophy, theology and religious studies, each of which is addressed in a distinct research programme.

Programme 1: Competing Worldviews
This programme, which has the subtitle Philosophy, Theology, and Science as Competitors and Complements, addresses the complex relationship between philosophical, scientific and religious views on humankind, society and the natural world. Both the history and the current status of these problematic issues are investigated. The programme encompasses projects that focus on specific concepts (such as that of ‘natural law’), methods (e.g. explanation vs. understanding) and institutions (e.g. the Inquisition or the University). It is carried out by researchers working on the History of Philosophy (Prof. Lüthy), Systematic Religious Studies (Prof. Hübenthal), History of Church and Christianity (Prof. Müller) and Fundamental Philosophy (Prof. Van Haute).

Programme 2: Cognitive Humanities
Culture – which includes language and religion – and the human cognitive system are inextricably intertwined. On the one hand, language, religion and other cultural artefacts are products of the
human mind. On the other hand, they provide a unique cognitive niche within which the human mind can function and flourish. Researchers working in the Cognitive Humanities programme investigate language and religion by using existing knowledge of the human cognitive system. Conversely, they investigate the human cognitive system through insights into language and religion. The programme involves collaboration between researchers working on Comparative Religious Studies (Prof. Venbrux), Empirical and Practical Religious Studies (Prof. Hermans), Textual Sources of Judaism and Christianity (Prof. van Wolde) and Philosophy of Mind and Language (Prof. Slors).

Programme 3: Modernity Contested
Modernity encompasses the impact of science and technology as well as the rationalization and individualization of society. It questions and reshapes religious identities and puts community ideals under pressure. The process of modernization is therefore highly contested – both from the inside by Western criticism and from the outside perspective of non-Western societies. Researchers working in this programme investigate the status and legitimacy of various contestations of the modernity process. The programme also focuses on concepts of citizenship emerging after the Arab Spring revolutions.

It involves collaboration between researchers in Islam Studies (Prof. van Nieuwkerk) and Practical Philosophy (Prof. Wils).

In 2013, the PTR Research Institute was assessed by a committee of internationally renowned researchers in philosophy, theology and religious studies. The committee’s report highlights the areas in which the Institute is excellent and constructively identifies opportunities for improvement. The Institute’s research is assessed overall as being “very good” – as reflected in a solid grade of 4 (the maximum is 5).

Research facilities
The faculty library, which is integrated in the central humanities library, has excellent collections of books and journals on philosophy, theology and religious studies. It houses one of the world’s largest microfilm collection of medieval and Renaissance manuscripts on logic, semantics, natural philosophy, metaphysics and theology. The library also contains several special collections and includes the Catholic Documentation Centre – a unique source for anthropological and missiological research.

Collaboration
Researchers in the PTR Research Institute collaborate intensively with colleagues, locally, nationally and internationally. Locally collaboration consists in joint research groups with other faculties and joint conferences such as the the 2013 Europe and its Worlds conference, a joint project of the Arts faculty and PTR. Nationally, they participate in accredited (Royal Netherlands Academy of Arts and Sciences; KNAW) research schools. The newly founded Research School for Philosophy offers philosophers new options for joint projects and PhD training. Other PTR researchers participate in the Netherlands School for Advanced Studies in Theology and Religion, in the Netherlands Interuniversity School for Islamic Studies and in the Research School for Medieval Studies. Internationally, researchers collaborate extensively with colleagues from numerous, often well-known academic institutions.

There is collaboration with various international research groups, including those working in high-ranking institutes such as the Universities of Edinburgh, Berlin and Paris IV (la Sorbonne). For instance, the Centre for the History of Philosophy and Science collaborates, via a series of joint-degree PhD projects, with the University of Bucharest, the Free University of Brussels, the Innovationszentrum Wissensforschung, Freie Universität in Berlin, and the École normale supérieure in Paris. These collaborative projects are not only funded by the respective universities, but also by the EU or the Max Planck Gesellschaft. The political philosophy research groups at Radboud University Nijmegen and the Catholic
University of Leuven collaborate on the basis of an agreement between the two universities that is currently being renegotiated. And the comparative religious studies chair cooperates with the Universities of Hull and Sheffield in the AHRC-funded network Crossing Over: New Narratives of Death. The Institute’s three research programmes allow for programme-based cooperation with existing research institutes.

Researchers working in Programme 1 are forming a consortium with the École normale supérieure (Paris) and a number of West and East European universities. They also continued interdisciplinary collaboration on the history of Christian eschatological movements with the international research group CIRCAED. Programme 2 is in the process of acquiring Netherlands Organisation for Scientific Research (NWO) funding for collaboration with the Religion, Cognition and Culture MINDlab of the University of Arhus, Denmark. Those involved in programme 3 collaborate with The Freiburg Institute of Advanced Studies, the Geneva Institute of Social Studies as well as with the RGGU (Moscow), the Arizona State University, and the University of the West of England/Bristol.

Research results

Programme 1: Competing Worldviews

Prof. Bakker was the first to produce an overview of Aristotelian philosophy in the late 15th century, a period characterised by the transition from the Middle Ages to the Renaissance. Prof. Lüthy, Dr Hirai, Dr Sakamoto, Dr Bakker and Dr Palmerino conceived an ambitious NWO-funded project on 16th-century atomism, providing a deeper understanding of early scientific conceptions of matter. Prof. Müller charted the transition from the Roman religion to Christianity, focusing on the development of the concept of the paganus. Examining the practice of canon law over the past two centuries, Dr Ackermans prepared an edition of Prof. Pieter Smulder’s diary during the Second Vatican Council.

There is a new research line under the leadership of Prof. Hübenthal (Public Theology), which is part of the systematic religious studies group. Dr van Erp developed a project that gauged the impact of Schillebeeckx’ theology on the evolution of public theology and Prof. De Haardt presented novel insights into the theology of cities and public spaces. In the fundamental philosophy group, Prof. van der Heiden finished a book on Ontology after Onto-theology: Plurality, Event and Contingency in Contemporary Philosophy. Prof. Van Haute and Dr Westerink worked on an edition of Freud’s 1905 Drei Abhandlungen zur Sexual Theorie (Three Essays on the Theory of Sexuality). Dr Vasterling prepared a book on Hannah Arendt (to be published in 2014).

Programme 2: Cognitive Humanities

Dr Bary has set up a multi-disciplinary project on the ways in which the perspective of, for example, the author or protagonist of a story is represented in ancient Greek language and has produced initial results. Prof. van Wolde and R. Vardi (MA) analysed the meaning of words in the minds of Biblical Hebrew language users by studying patterns of associations between words, collocations and larger constructions in their contexts of use. This approach enables them to access the ancient human mind through the study of language.

Prof. Geurts co-authored a high-impact paper on the development of infants’ understanding of others, showing that the conventional wisdom on this topic needs serious adjustment. Dr Buskes demonstrated that the growth of human culture is the result of cumulative processes of selection. Prof. Slors published a new model of effective conscious intentions and Dr de Bruin developed an account of our ability to understand the emotions of others based on the ‘situated cognition’ paradigm.

Prof. Wijsen analysed the discourse on Islamic extremism in Tanzania and Indonesia, showing how participants position themselves as ‘normal’ believers by silencing and ridiculing ‘extremist’ Muslims. Prof. Hermans tested and validated a new means of measuring the spiritual transformation of Christian school leaders in South Africa.

Prof. Venbrux, Dr Quartier, Dr Venhorst and B. Mathijssen (MA) developed a framework that unifies a range of case studies on European ways of dealing with death. A series of studies published by Dr Hense, Dr Jespers, Profs. Nissen and Van der Velde illuminated the lure of Catholic monastic spirituality, Buddhist practices and imagery, and the process of religious transformation among immigrant Muslims.

Programme 3: Modernity Contested

Dr Borg has successfully used poetry as a source for interpreting historical transformations in Islam. This approach also proved fruitful for the study of new Muslim identities. Dr Meijer analysed the use of the term ‘citizen’ by Arab Spring activists and discovered a serious lack of knowledge among such activists about political developments in the Middle East. Dr Becker has identified and analysed the main networks of public Muslim da’wa activism in Germany and its new logic of ‘connective activism’ involving the use of social media. Dr Wagemakers investigated the role of the Palestinian question in the development and ideology of radical Islam. He discovered that Palestinians are not widely represented among radical Muslims and that Palestinian issues are not always at the top of lists of grievances.

Prof. van der Zweerde investigated democracy, human rights, religion and national identity in the South Caucasus. His studies provided significant new insights into the problems that emerge when modernity meets non-Western regions. In collaboration with Dr Becker, Van der Zweerde also edited a special issue of Religion, State and Society on Christian Social Thought. Dr Terpstra published
on ‘political theology’, concluding that the Roman Catholic Church accepts liberal democracy precisely because it is implicitly committed to the idea that politics is based on fundamental values. Prof. Wils published a book on the future and the political shape of healthcare systems in Europe which argues that, although the market-economy model is still dominant in politics, an alternative model is starting to appear. Prof. van Tongeren published on the good life, friendship, forgiving and retribution, and human dignity.

Awards and grants

• Dr Bary has acquired a prestigious ERC starting grant for her project on the Language of Perspective.
• Prof. van Tongeren received the 2013 Socrates award for best Dutch philosophy book for his book *Leven is een kunst. Over morele ervaring, deugdethiek en levenskunst* (Zoetermeer 2012).
• Prof. Lüthy was elected to the Royal Netherlands Academy of Arts and Sciences (KNAW); he also obtained one of the three 2013 Radboud Science Awards for his book on David Gorlaeus (2012).
• Dr Bellis acquired a Veni postdoc grant from NWO.
• Dr Cimino received a grant from the Fritz Thyssen Foundation for the publication of his book on Heidegger.
• Prof. van Wolde was elected as a member of the Academia Europaea, ‘The Academy of Europe’.
• Dr Spruit has been elected Visiting Prof. for 2014 by the Royal Netherlands Academy of Arts and Sciences (KNAW).
• S. Bultman (MA) received a Frye Stipend.

Societal impact

The societal impact of PTR research has three strands. Firstly, many researchers contribute to societal debate via public lectures and discussions, contributions to newspapers and publications for wider audiences. The Soeterbeeck Programme is an important platform for dissemination of research through debates and lectures. Many PTR researchers contributed to this programme via lectures, as interviewers or as advisors. In addition, researchers contributed to public events throughout the Netherlands and abroad. For instance, Prof. van Wolde was interviewed in front of a live audience by Wim Brands and Prof. Slors was interviewed twice for Dutch TV channel VPRO’s programme *Labyrinth*; he also spoke at, for example, the Radboud TEDx conference, the Oerol festival and Lowlands. Dr Palmerino engaged with eminent academics such as Profs. Hans Clevers, Erik Verlinde and Willem Knoops in a discussion on the nature of thought experiments (*NRC Handelsblad*, 31 August 2013). Dr Spruit and Prof. Lüthy both wrote for important daily newspapers (*Trouw*, supplement ‘Letter and Geest’; and *Neue Zürcher Zeitung*, supplement ‘Feuilleton’). Dr Bax participated in a dossier on the future of the humanities for *De Groene Amsterdammer* (31 October 2013). Prof. Bransen published a widely discussed book on the influence of ‘experts’ on public opinion.

A second strand consists of contributions to sustaining cultural heritage and cultural memory. Thus, for instance, the new research line of the chair of systematic religious studies on Public Theology immediately generated interest and collaboration from the ‘Thijmgenootschap’ and ‘Justitia et Pax Nederland’, organizations which are interested in new accounts of how they can enter into a theologically informed dialogue with a secularized society. Prof. van Wolde participated in the University’s Lustrum Programme *Radboud Kids*.

Thirdly, PTR researchers frequently provide advice to arrange of organizations and authorities, including the Dutch national coordinator for terrorism and security (NCTV). The PIM project (*publiek Islamitische Missiewerking*) is financed by the Ministry of Justice. A report for the Norwegian NGO NOREF, *Explaining the Arab Uprisings. Citizenship as Agency of Change*, has been published. The project *The diversity of Islamic finance in a comparative perspective* has facilitated contacts between Islamic and conventional financial systems. Advice has been given to the Ministry of Finance, Holland Financial Centre, Sustainable Finance Lab and The OIKOS Foundation. The project on *Comparing European Death Ways* is in the process of...
Key publications


Dissertations: 12
Scientific publications: 234
Professional publications: 105
of setting up a funerary academy with stakeholders such as DELA. Finally, a tool-kit on civic virtue and ethical education was developed by PTR researchers and presented at a conference with school leaders (25 September 2013).

Future research
In programme 1 new lines of research, for example, on the Humanist revival of pre-Socratic philosophy and atomism, will be initiated, while various book projects will be completed. The NWO project on 16th-century atomism will continue. In programme 2 an Etty Hillesum project will start in the memorial year 2014, as well as a project on the lure of monastic spirituality. Cognitive linguistic studies of Biblical Hebrew will focus on the categories of emotion and motion, deepening our knowledge of ancient cognition. The more general interdependence of language, culture and cognition will become a unifying line of inquiry. Furthermore, NWO-funded projects on eschatology and spiritual care for cancer patients will commence. In programme 3 a joint research project with the Norwegian NGO NOREF on the reawakening of citizens after the Arab uprisings will start. An EU-funded COST project, involving 29 researchers, all from different universities, will work on forming a large research consortium for the purpose of preparing further European grant proposals. Current research on future concepts and models of democracy – as well as on the problematic relationship between both Western and non-Western religions and modernization processes – will be continued.
Institute for Historical, Literary and Cultural Studies

The Institute for Historical, Literary and Cultural Studies (HLCS) is part of the Faculty of Arts. Its main objective is to create a stimulating environment for research in the fields of literature and literary theory, cultural studies, history, art history and archaeology. From 2014 onwards, HLCS research will be organized in two programmes based on a common focus and a specific period: ‘Europe and its Worlds before 1800’ and ‘Europe and its Worlds after 1800’.

‘Europe and its Worlds’ is a research theme in which the question as to how ‘Europe’ consists of different worlds is addressed, how it differs from the rest of the world, and how it interacts with other worlds. Within these programmes, researchers collaborate in thematic groups to explore the spaces, cultural practices, beliefs, texts and ideas related to the central theme. The groups combine expertise from a variety of disciplines and function as platforms for discussing research plans and results, ensuring communication between researchers and supporting academic integrity. The results of HLCS research are intended for a scholarly audience of peers, but often for a wider audience as well.

Research facilities

- The Humaniora Library (155,000 volumes, 15,500 serial volumes, 750 serial subscriptions and 600 manuscripts)
- The Catholic Documentation Centre: archives – and publications – of Catholic institutions and individuals in the Netherlands, 1800-present (www.ru.nl/kdc)
- The Centre for Art Historical Documentation: manages a large collection of visual material, providing services related to image research and the delivery of image material (www.ru.nl/ckd)
- The Auxilia archaeological project bureau (Provincial Roman History; excavations in the former territories of Germania Inferior, especially in Ulpia Noviomagus Batavorum (www.ru.nl/auxilia)
- Kunera: a database of over 15,000 medieval pilgrim badges and ampullae of religious and profane subjects (www.kunera.nl).
Collaboration

HLCS focuses on establishing European research networks with prominent partners in its areas of expertise.

Prof. Olivier Hekster and Dr Gerda de Kleijn are members of the Executive Board of the International Network ‘Impact of Empire’, whose members study the Roman Empire and the consequences of its actions for the regions it dominated. The network is directed by an international board of highly respected scholars studying the Classics, Archaeology, Ancient History, and History of Law from the Institute of Advances Studies (Princeton), CNRS (Paris), Leiden University, Università La Sapienza (Rome), Universität Wien, New York University, Universität Heidelberg and the University of St Andrews.

In the research project ‘Transcultural Critical Editing: Vernacular Poetry in the Burgundian Netherlands, 1450–1530’ Prof. Johan Oosterman is collaborating with researchers from Queen Mary University of London, Cambridge University, Utrecht University and Ghent University. The objective of the project is to develop understanding of transcultural exchange in pre-modern societies by editing French and Dutch poetry produced in the Burgundian Netherlands, during the period 1450–1530, in ways that identify communication across language communities.

Prof. Odin Dekkers and Dr Usha Wilbers are members of the core group of ESPRit, the European Society for Periodical Research, which was founded by periodical researchers from Austria (University of Salzburg), Belgium (University of Ghent), England (University of Salford, Manchester; Manchester Metropolitan University), the Netherlands (Radboud University Nijmegen), Scotland (Edinburgh Napier University), and the United States (New Jersey City University). The aim of the organization is to bring together the resources of individual scholars from various disciplines who work with periodicals.

Prof. Carla van Baalen is one of the founders of the European Information and Research Network on Parliamentary History (EuParl), which connects European research institutions and experts in parliamentary history. The network facilitates the exchange and dissemination of knowledge and promotes comparative studies on the development of parliamentary culture in Europe. It also seeks to help increase the visibility of institutions beyond their national boundaries and it facilitates cooperation between the participating institutions.

Research results

An important new book about Nero’s Domus Aurea by Prof. Eric Moormann and Dr Paul Meyboom (Leiden University) describes the results of twenty years of research on the construction and decoration of the ‘Golden House’, the biggest palace in Rome, which was built in the first century AD. They discovered that the Domus Aurea was built within four years, including the painted and marble decoration, a gigantic task for the painters and marble workers who decorated the hundreds of square meters wall and floor. The different types of decorations provide insight into the relationship between the ornaments and the status and function of the rooms.

PhD student Bart Verheijen’s Master’s thesis about two centuries of historiography and the historiographical debate on the French Revolution, which was awarded the Prix de Paris in 2010, was published as a book in which he describes how the revolutionary terror determined thinking about French politics and society for a considerable time. Verheijen: ‘The question arises as to whether our European democratic ideals remain connected with the revolution. And, based on this, should we embrace or reject the revolutions in the Arab world?’
Police and politics at the LUX cultural centre in Nijmegen. In six episodes, scholars investigated Europe’s identity on the basis of films they had chosen. They offered clear characterizations of the associated political developments in the relationship between France and the Netherlands. At first the King had the most power but, bit by bit, power shifted to the Government, the House of Representatives and the electorate. Kingdom, democracy, and their relationship — these are the subjects of the 2013 Yearbook Parliamentary History, which was presented in The Hague on 19 November, ten days before the start of the official commemoration of two centuries of the Kingdom.

Europa in alle staten (Europe in all states), a book co-written by political historians at HLCS, provides an overview of the history of European integration by describing structural dilemmas such as supranationality versus the nation state or the tensions between deeper integration and the inclusion of new members. A lot of attention is also paid to the broader context of post-war politics, the architects of integration, the structural issues of transfer of sovereignty and solidarity, euro scepticism and the democratic deficit. For each phase in the history of the EU, the authors offer clear characterizations of the associated political theory and historical themes. Europa in alle staten provides a valuable insight into the functioning of the EU as it is now as well as its genesis.

Awards

Dr Matthijs Ilsink, Lecturer in Art History and coordinator of the Bosch Research and Conservation Project, received the Karel van Mander Prize 2013 for his dissertation Bosch en Bruegel als Bosch (2009, cum laude). The Karel van Mander Prize is awarded annually to an exceptional art historical publication of academic interest. Once every five years, this prize is awarded within the field of medieval art and crafts up to 1550, which is Dr Ilsink’s area of expertise.

Societal impact

While the concept of societal impact is often included in general academic assessment protocols, it is rarely prioritized or made operational. The HLCS director encourages staff members working in specific areas of research to spend up to fifty percent of their time on addressing the societal impact of their work and takes this into account in his assessment of their output.

The Gruuthuse manuscript – the most important collection of Dutch literary texts from the Middle Ages – was featured in the Gruuthuse museum in Bruges from March to June 2013. That is remarkable because, since its discovery around 1840, it hasn’t often been made available to the public. Jos Koldeweij, Professor of Medieval and Early Christian Art History, was guest curator of the exhibition. The Gruuthuse manuscript is a compilation of 170 songs, poems and prayers and for almost all of them this manuscript is the only known source. The Egidius song – the best known song – is of great importance for Dutch literature and for music historians. The key motifs of the exhibition are the themes in the manuscript: music, love, ‘const’ (art), companionship and devotion. Not only do they provide a picture of the rich content of the manuscript, they also tell us a great deal about the cultural, social and religious climate of the time.

The Golden Age was a period of vibrant economic and cultural prosperity. But the eighteenth century was anything but boring, according to historian Dr Joost Rosendaal. He wrote the book Uit de plooi. De achttiende eeuw in beweging, on the occasion of the exhibition with the same title in Museum Het Valkhof in Nijmegen. He describes the eighteenth century as a century of development, in which there was more scope for different faiths and dissenters. The scientific revolution got a foothold with a wider audience and citizens increasingly claimed a role in governance. According to Rosendaal, the Dutch revolution started in this period, and thus the modern, democratic Netherlands as we know it now.

Dr Alicia Montoya is director of the newly established Knowledge Centre France-Netherlands, that promotes, compiles and disseminates the results of Dutch research in the field of Franco-Dutch relations. The centre aims to create interdisciplinary, fruitful collaborations within the academic community, while giving exposure to expertise in this area by means of an annual conference and the publication of its results. The centre can be consulted whenever specific expertise is needed in the area of current or historical developments in the relationship between France and the Netherlands.

On the occasion of the 90th anniversary of the Faculty of Arts, a series of film debates entitled ‘Denkbeelden Europa’ was organized at the LUX cultural centre in Nijmegen. In six episodes, scholars investigated Europe’s identity on the basis of films they had chosen.
Every film was introduced, watched, and then discussed with the audience.

‘Europe’ appears to be something that is far removed from people’s own lives, with decisions made in Brussels. Who really feels European? Isn’t a sense of togetherness essential for the success of the unification of Europe? However, it seems difficult to feel solidarity with people who do not share the same basic values. Does a European identity exist and if so, what does it look like? Or, if it doesn’t exist, how can we create it? What elements should it contain? And does it actually make sense to try and formulate such an identity?

Future research
Prof. Eric Moormann obtained a PhD position for Marenne Zandstra within the Netherlands Organisation for Scientific Research (NWO)’s ‘PhDs in the Humanities’ programme. In the first century AD, the Roman army brought new objects and ideas to the RhineLand, facilitating a major transformation of culture. This army had two distinctive but largely ignored features: not only was it very mobile, but the soldiers also had very diverse backgrounds. Taking the Lower RhineLand as a case study, the project maps out the markers of this cultural diversity in order to get a better understanding of the composition of the Roman army in the Lower RhineLand in the first century AD and therefore of the effects that its mobility had on the cultural transformation of this border region.

Dr Sven Meeder received an NWO Veni award for his project ‘Spreading knowledge and reforms: Scholarly networks in the Carolingian era’. The ninth-century revival of learning known as the ‘Carolingian Renaissance’ derived from Charlemagne’s deep concern for the correct cult of God within his empire, but it quickly resulted in diverse creative outbursts of textual culture that were independent of royal aims. It was in this creative process that the biblical, Christian and antique traditions were appropriated to form the melting pot of post-Roman European culture. How this revival of learning could take such flight is still not well understood. The aim of this project is to study the learned networks that formed the basis of the Carolingian revival of learning. Its main hypothesis is that these networks, rather than royal decrees, shaped and directed the revival of scholarship at the local level.

In the context of the NWO’s Free Competition in the Humanities Dr Angélique Janssens received a grant for a research programme entitled ‘Genes, Germs and Resources. The role of the family and disease environment in mortality and longevity in the Netherlands, 1812-2015’. This programme will focus on the phenomenon of familial influences on early death and exceptional survival in the Netherlands between 1812 and 2015, adopting an innovative framework which takes into account the simultaneous effects of resources, germs and genetic influences. The influence of these factors will be studied through a multi-generational approach in which families will be followed over a time span of 200 years. The goal is to reveal the role of familial influences on survival and the changing interactions between social-structural and biological-genetic factors in mortality and longevity within changing disease environments from the nineteenth century until today. The programme is being carried out in collaboration with the Department of Medical Statistics and Bioinformatics, Section of Molecular Epidemiology of Leiden University Medical Centre.

A new field in the creative industry involves integrating fashion and technology, for example by embedding electronics, micro-processors, solar panels, LEDs, or interactive interfaces into fabrics, textiles or clothing. However, while a promising future for fashion-able technology, or ‘wearables’, has been announced many times, not much has been achieved in practice. Wearables rarely leave the lab or catwalk. The interdisciplinary research project ‘Crafting Wearables’, which is led by Prof. Anneke Smelik, aims at designing wearables that are robust, fashionable as well as commercially viable. In order to achieve this aim, the team and a range of partners bring...
Key publications


Dissertations: 5
Scientific publications: 201
Professional publications: 265
Director: Prof. André Lardinois

André Lardinois has been a Professor of Greek Language and Culture at Radboud University Nijmegen since 2001. He received his PhD from Princeton University in 1995 with a dissertation on proverbial expressions in archaic Greek poetry, after which he taught for six years at the University of Minnesota. His main interests are Greek lyric poetry and Greek drama. He is a founding member of the European Network for the History of Ancient Greece, and founder and co-chair of the Network for the Study of Archaic and Classical Greek Song. He is also the academic director of the National Research School in Classical Studies (OIKOS) and chair of the Dutch Council of National Research Schools in the Humanities (LOGOS).

together the fields of fashion, technology, industry, and academic scholarship. As a result, the project will not only craft wearables but also analyse how fashionable technology relates to identity, comprehend its social impact, bring technology closer to fashion design and make it a competitive branch of the creative industry in the Netherlands. The consortium partners are: ArtEZ Hogeschool in Arnhem, Audax, Freedom of Creation, INNTEX, MODINT, Philips, Radboud University Nijmegen, Solar Fiber, the Tilburg Textile Museum, Eindhoven University of Technology and XSENS.
Research Centres of the Faculty of Law

**Internationalisation**
The faculty’s policy is to continue exploring options for international cooperation and the institutionalization of contacts. Incorporating international and European law in legal research is essential in a world of interwoven legal systems. The faculty board intends to form – or join – European consortia in key areas, including Insolvency Law, Financial Law, European Private Law, Migration Law, Fundamental Rights and Security-related issues.

**Societal relevance**
Legal research almost always relates to legal practice and is therefore by its nature of societal relevance. The faculty co-operates closely with – and also advises – external partners such as civil-law notary offices and law firms, financial organisations, international businesses, courts, government bodies, ministries, NGOs and European organisations.

Publications – mainly papers in professional journal and case notes – are written with legal practice in mind. The Centre for Post-academic Legal Education (Centrum voor Postacademisch Juridisch Onderwijs, CPO) provides post-academic education for lawyers and judges. Academic publications also provide a solid foundation for legal practice. One aspect of the centre’s mission is to make academic research more practice-oriented, for example by preparing best practices, legislative proposals and European Union directives.

**The Business & Law Research Centre (Prof. Corjo Jansen)**
The Business & Law Research Centre – Onderzoekcentrum Onderneming & Recht (OO&R) – involves cooperation between the Law Faculty and fifteen prominent, mostly international, law
firms and Dutch multinationals. The Centre conducts fundamental research in ‘Business and Law’. It also offers a comprehensive educational programme for gifted young scholars and is actively involved in a wide variety of postgraduate educational and professional training programmes.

The academic mission of the Centre is:
1. to conduct high-quality (domestic and international) academic research in Business and Law
2. to enhance the understanding of theories which apply to Business and Law in the light of social, economic, political and financial developments
3. to encourage a practical approach in academic research without compromising academic quality, particularly by analyzing the fundamental principles and foundations of (business-oriented) private law
4. to explore and initiate applications of academic research, for example in national and international rules and regulations
5. to educate and supervise Master’s students and young researchers.

The four key research programmes of the Centre are:
1. Company Law
2. Finance, Security Rights and Insolvency Law
3. Business and Patrimonial Law
4. Financial Law

A major theme of the research in all programmes relates to European private law, comparative law and private international law.

The Centre, which was established in 1991, is recognized as a research school by the Royal Academy of Arts and Sciences (KNAW). In 2009, accreditation was renewed and it will be valid until 2015. The Centre’s educational programme for gifted young scholars is certified by the Accreditation Organization NVAO.

Research facilities
The Centre houses the Information and Documentation Centre for Business and Law (CIDOR), which has a collection of books, journals and electronic publications on international and domestic Business Law that is unique in the Netherlands.

Collaboration
The Centre combines academic excellence with the expertise and practical experience of its partners. This unique collaboration has led to cross-fertilization between legal practice and academia. The Centre has regulations, which dictate that all parties involved guarantee academic independence. The following partners currently participate: AEGON N.V., AkzoNobel, Allen & Overy, APG Asset Management, De Brauw Blackstone Westbroek, Clifford Chance, Freshfields Bruckhaus Deringer, Houthoff Buruma, ING Bank, Loyens & Loeff, NautaDutilh, Pels Rijcken & Droogleever Fortuijn, Rabobank Netherlands, Stibbe, Stichting Eumedion.

Staff
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Prof. J. Bast (o)
Prof. F.E.J. Beekhoven van den Boezem (o)
Prof. P.P.T. Bovend’Eert (o)
Prof. C.D.J. Bulten (o)
Prof. D. Busch (o)
Prof. D.R. Doorenbos (o)
Prof. J.C.J. Dute (e)
Prof. N.E.D. Faber (o)
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Prof. A.B. Terlouw (o)
Prof. J.B. Terpstra (p)
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Prof. P.M. Veder (p)
Prof. P.C. Vegeter (e)
Prof. L.G. Verburg (o)
Prof. H.L.E. Verhagen (o)
Prof. B.P. Vermeulen (p)
Prof. H.C.F.J.A. de Waale (o)

Tenured
Full Professors 14.4 FTE
Associate Professors 5.8 FTE
Assistant Professors 3.6 FTE
Researchers 2.5 FTE
Lecturers 0.8 FTE

Non-tenured
Researchers 6.7 FTE
Lecturers 11.4 FTE
Doctoral candidates 27.1 FTE

Research funding
- Core
- Grants
- Contracts

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The Centre, which has excellent international connections, encourages international cooperation in all of its research programmes. There is close collaboration with the following chairs and research institutes: the Chair in Corporate Finance (Nijmegen School of Management), the Max Planck Institute for Comparative and International Private Law (Hamburg, Germany), and the Network for Studies on Pensions, Aging and Retirement (Netspar, Tilburg, the Netherlands).

Within the framework of International Working Groups established by the Centre, there is structural collaboration with leading academics and practitioners from universities and institutions around the globe. The Centre also plays an active role in various international GO/NGOs (for example, the IMF and INSOL Europe).

Research results
In 2013 the book Corporate Boards in Law and Practice was published by Oxford University Press. The authors analyse the corporate boards, their regulation in law and codes as well as the way they actually operate in ten European countries. Corporate boards play a central role in corporate governance and are thus regulated in the corporate law and corporate governance codes of all industrialized countries. Yet, while there is a common core of rules on the boards, there are still considerable differences. These differences depend partly on shareholder structure, partly on historical, political and social developments and especially on employee representation on the board. More recently, in particular with the rise of the international corporate governance code movement, there has been a clear tendency towards convergence, at least in terms of the formal provisions of the codes. This project was carried out by an International Working Group jointly established by the Centre and the Max Planck Institute.

The Centre has invested substantially in international research in Insolvency Law. A milestone was the launch of the International and Comparative Insolvency Law (ICIL) Series, published by Oxford University Press. Within the framework of this series, the discrepancies and common features of domestic insolvency laws in twenty countries across the world are inventoried and critically analysed. The project’s ambition is to present the material within a structure and with a level of detail that is on par with the leading national legal literature of participating countries. In 2013 the Centre published the second volume of the series on Treatment of Contracts in Insolvency. This topic is of particular importance to the international insolvency community, as virtually any insolvency needs to deal with the matter of contractual obligations (ranging from insolvent multinationals to the SME sector). It is essential for commercial lawyers to consider the implications of insolvency (whether of their client or of the counter-party) on any contract that is under discussion, particularly where international aspects are involved.

Awards and acknowledgements
• Prof. Arthur Hartkamp has been appointed as a member of Academia Europaea.
• Prof. Corjo Jansen was knighted, in part for his contribution to legal historical research (notably on administration of justice during the Second World War).
• Dr Bas de Jong was awarded a grant by the Niels Stensen Foundation to conduct research as a visiting scholar at Cambridge University.
• Charlotte Spierings was awarded the Frye Stipend for promising young female researchers.
• Prof. Mark Heemskerk was awarded a grant by the Instituut Gak for his research project ‘The Role of Pension Funds in Active Ageing and Solidarity between Generations’.

Societal impact
The Centre has influenced public debate on a wide variety of topics which are of direct relevance to financial and commercial legal practice. Research projects relating to corporate governance, insolvency fraud and regulation of financial institutions are important examples.

The Centre plays an active role in various consultations launched by the Dutch and European legislators, for example a response to the EU Consultation on a possible Recovery and Resolution Framework for Financial Institutions other than Banks. Research was also commissioned by the Dutch Ministry of Security and Justice on ways of improving bankruptcy law. Based on a comparative study conducted by the Centre, a report provides recommendations on improving, for example, a pre-insolvency plan, the insolvency composition scheme and silent administration. The report serves as preparation for an insolvency bill, which is scheduled to be finalized in 2014. The Centre’s societal impact was enhanced by the participation of Prof. Michael Veder and Prof. Tomáš Richter in the Advisory Commission of the European Commission on cross-border insolvency law and the membership of Prof. Carla Klaassen in the State Advisory Commission on Private Procedural Law.

Future research
A major international research theme in 2014 relates to Financial law. International Working Groups are currently working on research projects dealing with new EU legislation, including the highly controversial European Directive on Alternative Investment Fund Managers, which was adopted after much debate in October 2010 (AIFMD). The AIFMD, which is a direct regulatory response to the financial crisis, has a significant impact on the manner in which investment managers may operate and offer non-retail funds (including hedge, private equity, real estate and infrastructure), which are currently largely unregulated. The results will be published by Oxford University Press in the first half of 2014. Another major project will critically assess various aspects of the European
Banking Union from a legal and an economic perspective. Main topics include general aspects of the European Banking Union, the Single Rulebook & CRD IV, the Single Supervisory Mechanism and the Single Resolution Mechanism.

Research for the third volume on ‘Ranking and Categories of Claims’ of the ICIL Series has officially commenced. The Centre is also working on a second edition of a book on the influence of European law on national private law. Another international project deals with ‘Transnational Securities Law’. A team of globally renowned academics and expert practitioners in the field has been brought together to present the first comprehensive analysis of the Geneva and Hague Securities Conventions and related initiatives (including those of UNCITRAL and regulatory authorities). It explores the international harmonization of the law relating to securities, and identifies issues that have not yet been harmonized. The project intends to explain the current international law on intermediated and non-intermediated securities and suggests solutions to problems where there are gaps in the legislation or where the current framework could be improved.

Research Centre for State and Law
(Prof. Thomas Mertens)

The Centre for State and Law – Onderzoekcentrum voor Staat en Recht (SteR) – focuses on key issues and basic principles of public law. Its researchers critically analyze national, European and international developments in constitutional law, administrative law and criminal law. The Centre provides a stimulating environment in which high-quality, national and international multidisciplinary and comparative research can flourish. SteR includes three research programmes:

1. Centre for Migration Law (CMR)
2. Administration of Justice

The CMR brings together researchers from various disciplines to provide a stimulating context for fundamental and applied research on international and national migration law and the protection of minorities. It is unique in Europe, thanks to its interdisciplinary approach and its international staff, who include lawyers, sociologists, anthropologists and political scientists.

Researchers working on the theme ‘Administration of Justice’ focus on law in action – the workings of courts, public prosecutors and the legal profession. New developments in procedural law are monitored closely against the background of the principles of effective legal protection. Methods used to understand the impact of civil, criminal and administrative law (including tax law) at various court levels are also an important research topic.

Researchers working on the theme ‘Principles of Public Law’ focus on the main principles of public law from the national, European and international perspective. They analyse the relationship between key constitutional principles (the rule of law, democracy, human rights, transparency, participation and accountability) and national and international political, social and legal developments. Due to the Europeanization and internationalization of law, these concepts are continuously evolving. Research therefore extends to exploring European and international developments, as well as their impact on the fundamental concepts of national law. The programme brings together the expertise and know-how of scholars of constitutional, criminal, administrative, and European law, as well as jurisprudence, in order to obtain a more comprehensive understanding of the principles of public law.

Prof. Henri de Waele (Professor of International and European Law) received funding from the European Commission’s Directorate-General for Competition for a project set up to train judges in European Competition Law.
Key publications

Business and Law Research Centre


Research Centre for State and Law


Collaboration

The SteR participates in numerous international projects and networks, the Odysseus Network of Experts in European Migration and Asylum Law, which is coordinated by the Université Libre de Bruxelles (Belgium), the academic Netzwerk Migrationsrecht (Germany) and the International Penal and Penitentiary Foundation (IPPF), of which Prof. van Kempen is Secretary General. It also has ties with the Max Planck Institute for Foreign and International Criminal Law (Freiburg, Germany), the University of Bergen (Norway), National Taiwan University, and several universities participating in the International Research Universities Network (in particular with the University of Glasgow, the University of Münster and the University of Poitiers).

CMR is responsible for coordinating the European Network on Free Movement of Workers, which is funded by the European Commission. Dr Karin Zwaan participates in the Glasgow Refugee, Asylum and Migration Network (GRAMNet) in a project entitled ’Researching Multilingually: at the Borders of Law, Health, Conflict and State Security’. This project was established through the UK Economic and Social Research Council.

Within the Netherlands, SteR collaborates with the Council for the Judiciary, the Ministry of Security and Justice, as well as several courts, municipalities and lawyers.

Research results

CMR researchers have participated in – and written the synthesis report for – comparative research on family reunification legislation in six Member States coordinated by the Irish Immigration Council and funded by the European Commission. They presented their results at an international conference in Dublin and at the EU Institutions. Other CMR researchers have been involved with the University of Madrid Comillas on ’Best Practice of Integration measures of the Highly Skilled’. For the UNHCR research is conducted on the position of Roma and asylum and on the implementation of the Aznar Protocol. For the Research and Documentation Centre (WODC) of the Dutch Ministry of Security and Justice CMR completed a research project about the multilayered-structure of migration law. A seminar on Judicial Scrutiny and Credibility Assessment in Asylum Procedures was organized together with the International Association of Refugee Law (IARL).

Within the programme ’Principles of Public Law’, Prof. Janneke Gerards and Dr Joseph Fleuren presented the results of an extensive comparative legal project, financed by the WODC, on the implementation of the European Convention on Human Rights and the case-law of the European Court of Human Rights in national case-law. Based on a comparison of six different legal systems, they investigated whether there is a clear correlation between the constitutional system for implementing international treaties and the impact of the European Convention on Human Rights on national law. Contrary
to expectations, they found no such correlation. Instead, they have shown that the influence of the European Convention on national law is explained by other factors. Their findings are of great importance to the current Dutch debate about the impact of European law and the need for constitutional change.

Prof. R.J.B. Schutgens was appointed preliminary reporter on Parliamentary immunity for the 2013 assembly of the prestigious Nederlandse Juristen-Vereniging (the Netherlands’ Jurists Association). As co-organizer Prof. Piet Hein van Kempen was responsible for the scientific part of the programme of an international four-day conference on ‘Management of high-risk offenders’ in Wellington, New Zealand.

Awards and acknowledgements

• Prof. Henri de Waele’s project on training judges in European competition law was funded by the European Commission’s Directorate-General for Competition.
• Ainul Fajri from Indonesia has received a scholarship from the Indonesian Government to conduct her PhD research on Rohingya Muslims at the SteR.
• Elisa Fornale (Switzerland) has been awarded a Marie Curie grant (FP7) for a two-year position at the SteR.
• The Ministry of Security and Justice awarded a grant for Prof. Piet Hein van Kempen’s and Dr Masha Fedorova’s research project ‘The international legal space for (experiments on) regulating or legalizing the cultivation of cannabis plants’.
• The Council for the Judiciary awarded a grant for Prof. Piet Hein van Kempen’s and Prof. Leny de Groot-van Leeuwen’s research project on ‘Effects on society of better reasoned judgments in criminal cases’.

Societal impact

SteR researchers are often asked for advice by both national and international public bodies. Research results are made accessible for judges, lawyers, politicians, students and the general public. Several CMR publications led to parliamentary questions this year. The Ministry of Justice has chosen the CMR to evaluate the new asylum procedure.

In October 2013 the Dutch Parliament assigned Prof. Paul Bovend’Eert to evaluate the 2012 Cabinet Formation Process in the Netherlands. The research group also consists of Prof. Carla van Baalen and Dr Alexander van Kessel of the Centre for Parliamentary History. The group is asked to make recommendations on new parliamentary procedures relating to Cabinet Formation (Art. 139a Standing Orders Second Chamber).

Future research

Several SteR researchers collaborate in the interdisciplinary network ‘EUROPAL’, focusing on the Europeanization of Policy and Law, together with colleagues from the Institute for Management Research at the University. Special attention will be paid to the practical consequences of migration law and policies and to access to justice in asylum and equal treatment cases.

The CMR will concentrate its research on the Europeanization of migration law.

Within the programme ‘Principles of Public Law’ the results of a comparative study on 28 constitutions and constitutional systems of the current 28 EU Member States will be presented. Taking a fairly straightforward functional approach to constitutional law, a uniform format has been chosen, addressing the most important topics expressed in the constitutions of the EU Member States: sources of constitutional law, form of state, form of government and political system, government powers and their limits, vertical division of powers, the judiciary and fundamental rights.

Within the programme ‘Administration of Justice’, research on judicial decision-making and lawyers’ ethics as well as on the jurisdiction of the European Court of Justice will continue.

The Centre for Notarial Law (Prof. Freek Schols)

The Centre for Notarial Law – Centrum voor Notarieel Recht (CNR) – was established in 2006. Its research focuses on notarial law, in particular family property law (personal and family law and the relationship between property law, inheritance law and estate planning). The strength of the CNR’s research lies in combining tax and civil law and cross-fertilization between legal practice and academia. Particular attention is paid to the impact of these fields on general property law and to the combination of legal fields, for example, marital property law, real-estate law and company law. CNR researchers seek to provide a firm foundation for notarial practice.

Collaboration

Nationally, the CNR cooperates with ABN Amro Bank NV on estate planning and monitors the academic level of the consultancy services provided by the bank. The CNR also cooperates with notarial organizations such as Netwerk Notarissen.

Research results

Staff members at the CNR regularly write articles for authoritative national and/or international academic journals and professional
Future research

Continuing projects include the historical development and the current legal position of the surviving spouse in Dutch civil law, the legal exegesis of the provisions of last wills, delegation of last wills to third parties, wills for persons lacking will-making capacity, the new inheritance tax law, international aspects of estate planning and developments in the legislation on marital property. ‘Inheritance law and the de facto spouse’ and ‘The development of the notarial profession 1850-1950’ are new projects.

Societal impact

The Centre has influenced public debate on a wide variety of topics. There are strong links between the CNR and legal practice. Moreover, the Centre participates in shaping legislative proposals.

The CNR’s research creates an important academic basis for notarial practice relating to family property law in the Netherlands. Researchers advise the Dutch government and members of to the Dutch House of Representatives on several private law issues and lecturers work, for example, for the SBN (professional education for notaries), the Orde van Advocaten (professional education for barristers), the KNB (Royal Notarial Association), the estate planners of EPN (Association of Estate Planners in Notarial Practice) and Novex (the Dutch Association for Executors).
The Institute for Management Research (IMR), the research institute of the Nijmegen School of Management (NSM), brings together researchers from a variety of disciplines: business administration, economics, political science, public administration, human geography and environment studies. They combine their expertise to create knowledge in the service of society by conducting research on the design, development and performance of public and private structures that regulate, govern and manage human interactions.

IMR Academy

A multidisciplinary approach is encouraged through the IMR Academy, which organizes academic workshops, lectures and conferences. The Academy is a powerful platform where science meets society, building a climate of dialogue, debate and exchange for researchers from various disciplines and backgrounds. Important themes such as sustainability, accountability, conflicts, governance and borders inspire the Academy.

Research ‘hotspots’

The IMR has identified a limited set of ‘hotspots of research’. In these multidisciplinary collaborative efforts academic expertise is bundled that is most relevant when addressing specific societal problems. The two following hotspots have a formal status, while various other hotspots are under construction. These will be formalized in 2014.

Hotspot: Gender and Power in Politics and Management

The aim here is to better understand the dynamics and interactions between power, gender and other forms of diversity in order to help reduce gender inequalities in society. These researchers participate actively in societal debates, develop strategies and measures for
changing societal systems and have a long history of productively comparing and combining disciplinary paradigms and methods. Coordinators: Profs. Benschop and Verloo.

Hotspot: Europeanization of Policy and Law (EUROPAL)
This research cluster revolves around the adaptation of national policies by member states under pressure from the EU, and vice versa. It involves investigating the impact of EU laws and policies on national laws, policies, and policy making (‘downloading’), as well as how member states seek to influence laws and policies at the EU level (‘uploading’). Coordinator: Dr Mastenbroek.

Other contributions to international academic debates
Entrepreneurial principal investigators and researchers from various disciplines increasingly join forces to generate a growing number of other projects and potential hotspots, among which:

Innovation & Entrepreneurship in Businesses and Regions
IMR researchers from a various disciplines carry out research on sustainable innovation in businesses and regions at an internationally competitive level. For example, researchers from the departments of Business Administration and Geography, Planning and Environment do research on orchestrating and managing sustainable innovation in networks of stakeholders. The group investigates multi-stakeholder interactions.

Participatory Research Methods
IMR researchers contribute to the international academic debate on methodologies for involving multiple stakeholders in analysing complex societal problems. Their expertise resulted in the launch in 2010 of the Erasmus Mundus-financed two-year Masters programme in System Dynamics (in collaboration with the Universities of Bergen, Lisbon and Palermo).

Inequality and Development
An interdisciplinary group investigates inequality and development in low-income countries, making extensive use of the Database Developing World (DDW). Issues tackled include school attendance, child labour, gender inequality in Muslim countries, (reproductive) health and poverty, and water supply. In the Global Data Lab (GDL), instruments, such as indicators, specialized databases and web-based tools are developed for measuring and analyzing societal progress.

International Relations and Borders
This group combines the expertise of the Centre for International Conflict Analysis and Management (CICAM), the Nijmegen Centre of Border Research (NCBR), and researchers in International Politics and Economics. Together they investigate how local dynamics influence peace missions (in collaboration with the Dutch Defence Academy).

Staff

Prof. P.M. Ache (o)
Prof. Y.W.M. Benschop (o)
Prof. J.M.M. Bloemer (o)
Prof. F.W.M. Boekema (o)
Prof. R. ten Bos (o)
Prof. T. Brandsen (p)
Prof. B. Dankbaar (o)
Prof. A.M.A. van Deemen (p)
Prof. J.A.C.M. Doorewaard (o)
Prof. M. Dühr (p)
Prof. S. Dühr (p)
Prof. H. Ernste (o)
Prof. B.J.J.M. van der Heijden (o)
Prof. R.E.C.M. van der Heijden (o)
Prof. I. Helsoot (e)
Prof. P. H.J. Hendriks (p)
Prof. M. Herweijer (e)
Prof. G. de Jong (o)
Prof. J. Jonker (p)
Prof. E. Hospers (e)
Prof. G.U. Weitzel (o)
Prof. J.A.M. Vennix (o)
Prof. J.A. Verbeek (o)
Prof. M.M.T. Verloo (p)
Prof. P.A.M. Veurne (p)
Prof. D.E.M. Verweij (e)
Prof. E.G.J. Vosselman (o)
Prof. M.S. de Vries (o)
Prof. G.U. Weitzel (o)
Prof. M.L.J. Wissenburg (o)

Tenured

Full Professors 12.2 FTE
Associate Professors 11.6 FTE
Assistant Professors 22.9 FTE
Researchers 0.8 FTE
Lecturers 0.3 FTE

Non-tenured

Researchers 8.0 FTE
Doctoral candidates 43.8 FTE

Core Grants Contracts

Decision Making in Urban Development
Researchers from planning studies investigate property rights, real estate markets, and local tax jurisdictions in order to understand their effects on resource allocation. In collaboration with researchers in decision theory and behavioural economics they use Institutional Theory to study the processes of land and property development and enriched it with experimental approaches to analyzing decision-making processes.

Social Innovation and Health Services
This group focuses on health services. Their aim is to understand the conditions and contexts in which societal innovations likely flourish. Multidisciplinary research takes place across service
organizations, across cities and regions, across service sectors and across welfare states.

**Research facilities**

The IMR has two laboratories (Visa Skills Lab and Decision Lab), each equipped with specialized software. These labs facilitate top-level research designed to support the development and improvement of methods. In the Visa Skills Lab, group-based decision-making (e.g. brainstorming sessions, scenario development, priority-setting, voting procedures and collective writing of documents) is investigated. This allows researchers to involve societal stakeholders in exploring problems, developing strategies for intervention and investigating the effectiveness of interventions.

The Decision Lab supports individual and group decision-making research, and facilitates theory testing and model building (e.g. in behavioural economics). The experimental setting reveals variables that often remain hidden in field research. Issues such as behavioural modelling of attitudes to uncertainty, financial decision-making, institution and market design processes, strategic interactions in game-theoretical settings, cooperation and negotiation in land and property development, and strategies for conflict resolution are addressed.

The IMR hosts and participates in the construction of large databases such as the Global Data Lab (GDL), an open infrastructure containing data on over 20 million people in 110 low and middle-income countries. The GDL team compares countries and regions – especially in the Global South – in terms of health, education and labour. Another database focuses on industrial real estate (property, economic value, maintenance levels, etc.). The IMR also coordinates the Global eXperimental Panel (GXP), an innovative collaborative platform for conducting online experiments in various domains of decision-making.

**Collaboration**

As part of an ambition to further develop networks, several institutional collaborations were initiated:

- **Prof. Benschop and Dr Van den Brink** participate in the European Consortium FP7 Science in Society with the project: ‘Gendering the Academy and Research: Combating Career instability and Asymmetries (GARCIA)’. Partners are: the University of Trento (Italy), Université Catholique de Louvain (Belgium), the University of Iceland, Université de Lausanne (Switzerland), Joanneum Research Forschungsgesellschaft MBH (Austria) and ZRC Center Slovenske Akademije Znanosti (Slovenia).

- Dr Bleijenbergh participates in the European Consortium FP7 Science in Society with the project: ‘Effective Gender Equality in Research and Academia (EGERA)’. Partners are: the Autonomous University of Barcelona (Spain), Middle East Technical University (Turkey), the University of Antwerp (Belgium), and the University of Vechta (Germany). Participating research institutions include CzechGlobe Global Change Research (Czech Republic) and CESIS (Portugal).

Dr Martens received a European COST subsidy for his project ‘Transport Equity Analysis: assessment and integration of equity criteria in transportation planning (TEA)’. Partners are: Technical University of Madrid (Spain), The French Institute of Science and Technology for Transport, Development and Networks, Oxford University (UK) and Technion (Israel).

Together with the University of Vienna (Austria) and Middle East Technical University (Turkey), Prof. Lagendijk (principal applicant), Dr Dormans, Prof. Ernst and Dr Van Melik obtained an NWO Joint Programming Initiative Urban Europe grant for their project ‘Practices and policies for neighbourhood improvement: towards Gentrification 2.0’.

Prof. Lauche and Prof. Van der Krabben received NWO funding for a four-year project on innovation ecosystems in the creative sector (FuturA), which was developed with Delft University of Technology and the Royal Institute of Dutch Architects. Eight organizations from the building sector participate in the project.

Prof. Vermeulen and Dr Knoben were granted €4.2 million for their project ‘Coordinated Country Case Studies: Innovation and Growth, Raising Productivity in Low Income Countries’ from the UK Department for International Development (DFID). The consortium includes researchers from Tilburg University, the University of Leiden and Technopolis.

Together with The Netherlands Study Centre for Technology Trends (STT) – part of the Netherlands Royal Institute of Engineers (KIVI) – collaboration was initiated in 2013 around Foresight studies on technological development in complex societal systems.

**Research results**

Various types of output have been produced:

In 2013, 19 dissertations were defended, a record number. In particular, Dr Webbink’s dissertation generated considerable societal and media attention, and was therefore nominated for the Radboud University Media Prize for young talent. She addressed child labour in the developing world, drawing attention to the high degree of involvement of children in unpaid work in and around the house in Africa and Asia.

- In May 2013, Prof. Freeman (University of Virginia), a visiting professor at IMR, received an honorary doctorate from Radboud University Nijmegen, on behalf of the NSM, for his outstanding contribution to the development and application worldwide of stakeholder theory. He discussed his work with PhD and Masters students in various workshops.
Dr Cavaghan commenced an Intra European (IEF) Marie Curie post-doc project, moving to Nijmegen from the University of Edinburgh. The IEF is worth €176,000 over two years.

Three PhD grants from HAN University of Applied Sciences were used to intensify research collaboration between the IMR (Profs. Van Kranenburg, B. Van der Heijden and Van Riel) and HAN.

Awards

Dr Aalbers received the Richard Beckhard Memorial Prize 2013 from the MIT Sloan Management Review for his paper ‘Creating Employee Networks That Deliver Open Innovation’, which was co-authored by Eoin Whelan (Kemmy Business School of the University of Limerick, Ireland), Salvatore Parise (Babson College in Waltham, Massachusetts) and Jasper de Valk (Industry Manager, Google Netherlands).

At the Academy of Management conference, Dr Knoben received a best paper award for ‘Inconsistency in Performance Feedback and R&D Investment’ (together with G. Lucas, MSc and Prof M. Meeus) and Dr Henseler received the prestigious Harold E. Fearon Best Paper Award for ‘Who Owns the Customer? Disentangling Customer Loyalty in Indirect Distribution Channels’ (co-authored by Prof. A. Eggert and Dr S. Hollmann, University of Paderborn, Germany), which was published in the Journal of Supply Chain Management in 2012.

Prof. Vosselman received the Emerald Outstanding Paper Award 2013 for ‘Research paradigms, theoretical pluralism and the practical relevance of management accounting knowledge’, which was published in Qualitative Research in Accounting and Management and co-authored by Prof. Van der Meer-Kooistra (University of Groningen).

• Scientifically interesting results were published in high-quality journals. Two examples:
  - Dr Bohn reported in the Journal of International Money and Finance that fighting corruption might have negative consequences (particularly in developing countries), by increasing the central bank’s incentives for conducting inflationary policies, because short-run expansionary effects will no longer be consumed by government expropriation.
  - Dr Van der Kamp-Alons published a paper in the Journal of Contemporary European Research, arguing that individual European member states and their preferences are crucial in understanding European external trade policy.

A series of academic conferences, workshops and lecture series were partly or mainly organized by IMR researchers. For example, the Alexander von Humboldt lectures with the theme 'Science in/ and/of Society', and the conferences 'Breaking Male Dominance', 'Borders and Conflicts in an Age of Globalization' and 'Sustainable Employability, Challenges for HRM Innovation'.

Various grants were acquired. For example:

The Netherlands Organisation for Scientific Research (NWO) granted PhD funding to Profs. Verweij (CICAM/ Political Sciences) and Lauche (Business Administration). NWO also granted Research Talent funding for Prof. Van Thiel (Public Administration)’s project ‘Contracts, deals and bargains: negotiating by public servants’, investigating whether the need for public accountability leads to risk-averse strategies. The project makes use of IMR lab facilities, a novelty in public administration.

Giedo Jansen, MSc, obtained a Veni grant for his project ‘Freelancers on politics and polder’, used to initiate a study on patterns of political alignments among the self-employed in the Netherlands.

Laura Visser, MSc is a doctoral candidate at IMR. In her research project she tackles issues such as patient empowerment and improving the quality of care in care communities by combining sociological theories with insights from marketing, organization theory and human resource management.
Key publications


Dissertations: 19
Scientific publications: 263
Professional publications: 132

Societal impact

Relationships between IMR researchers and societal stakeholders were further intensified and ideas were exchanged with key entities.

Prof. Van Thiel was appointed as a member of the Committee to Evaluate Police Law, which was established by the Ministry of Safety and Justice.

The Dutch Central Health Insurance Board (CVZ) commissioned a study by Prof. Van Thiel, Dr Helderman and Dr De Kruijf. This study focuses on the government’s changing position, the tasks and roles of CVZ, and implications for its legitimacy as a quasi non-governmental organization.

Prof. Brandsen was appointed as the new Secretary-General of the European Association for Public Administration Accreditation. The EAPAA accredits degree programmes in public administration, public management and public policy.

Dr Essers spoke at the European Parliament on Entrepreneurial and Professional Challenges for New European Women.
The Centre for International Conflict Analysis and Management (CICAM) brought various speakers from science, policy and practice to Nijmegen, including former Minister Jan Pronk, to lecture about recent developments in conflict and peace building.

The Temporary Committee on Dutch Housing Corporations consulted Prof. Brandsen, Dr Helderman and Prof De Kam during preparations for the formal parliamentary investigation into Dutch policy on these organizations. These three researchers published a recent report that was commissioned by the Dutch Scientific Council for Government Policy (WRR).

Prof. De Vries was appointed as a member of the Group of Independent Experts on the European Charter of Local Self-Government of the Council of Europe.

Prof. R. Van der Heijden participated in the Advisory Committee on Logistics 2040 of the Council for the Environment and Infrastructure, which published the report ‘Dutch Logistics 2040: Designed to Last’ commissioned by the Ministry of Infrastructure and Environment in October 2013. He presented the report on behalf of the committee at the Dutch Embassy in Athens to an audience of entrepreneurs engaged in logistics.

Future research
In October 2013, an international committee assessed the IMR. The committee expressed its appreciation for the many positive developments since the previous assessment in 2008. Various suggestions for further development were formulated. IMR management will translate these suggestions in an update of its research policy and implement them in 2014.

The committee advised continuing the strategy that was implemented since the previous assessment, in order to develop IMR as a multidisciplinary research institute. This implies, for example, clustering research around specific fields of expertise across NSM’s disciplines.

Another suggestion was to focus more strongly on talent spotting and encouraging the submission of grant proposals (NWO, ERC, etc.). In response, the IMR appointed a second programme development officer, who contributed to the coordinated submission of three Vidi proposals and the preparation of nine Veni proposals in November/December 2013. Moreover, Dr Knoben, who obtained a Veni grant, was appointed to the Department of Economics in January 2013.

The successful initiative of the IMR Doctoral School will be continued by a) increasing the capacity of PhD research by investing in new PhD positions, b) strengthening educational and coaching activities within the school and c) more clearly regulating the position and supervision of external PhD candidates.

Collaborations will be further elaborated and intensified with partners within and outside the University. In view of new projects, the IMR seeks new partnerships with a range of societal and academic organizations.
Researchers at the Nijmegen Institute for Social & Cultural Research (Nijmeegs Instituut voor Sociaal en Cultureel Onderzoek: NISCO) use integrated multidisciplinary and comparative approaches to describe and explain changes in socio-cultural participation and organization in both Western and non-Western societies. A range of theoretical approaches, research designs, data collections and analyses constitute complementary aspects of a single research framework, each contributing to this common research goal.

Public opinion polls, questionnaires and surveys are important tools in sociological research.

Researchers at NISCO focus on three themes: inequality, cohesion, and modernization. To understand the dynamics of societal phenomena and processes, they examine these aspects from a historical perspective within a single society, in a comparative perspective across different societies and moreover, from a historical perspective in different societies. The accredited Research Masters programme in Social Cultural Science provides high-level training in theories and methods for conducting comparative research on societies. NISCO – a research institute of the Faculty of Social Sciences – consists of two research groups: 1) the Research Group in Cultural Anthropology and Development Studies and 2) the Research Group working on Sociology.

Inequality
This theme centres on differences in access to and control over resources that affect peoples’ opportunities, such as educational attainment, success in the labour market and health. Research focuses on the effects of resources on socio-economic achievement
and on how variation between and within countries is affected by structural social features and national policies. Ways in which individual, family and group resources affect outcomes – such as cultural and political participation as well as intragenerational and intergenerational mobility – are also studied.

**Cohesion**
The aim of this research theme is to describe and explain differences in social participation in formal organizations as well as in informal social networks, including families and other groups. First, developments in the relationships between individual resources and both pro-social attitudes and anti-social behaviour are explored, focusing on variations among societies with different welfare-state regimes. Second, comparative examinations are made of the extent to which social groups display exclusionist attitudes and behaviour towards particular out-groups, taking differences in economic, cultural and demographic contexts into account.

**Modernization**
Researchers at NISCO compare economic and technological developments as such and particularly those that accompany secularization in Dutch and European societies with such processes taking place in other societies. Much attention is paid to belief systems and to meaning derived from religion, to conceptions of justice and altruism and the implications for participation in society. NISCO researchers also focus on modernization processes in developing countries and their effects on inequality and poverty, as well as on social and political cohesion, while also including other aspects, such as gender differences and ethnic identities. In this context, responses of governments to different aspects of modernization processes impacting at different levels (e.g. civil society organisations and individual citizens) are also investigated and assessed.

**Research facilities**
Researchers at NISCO specialize in collecting large-scale data for relevant scientific communities. These include both longitudinal collections – on individuals and their life courses and networks within specific social contexts (in the Netherlands: Family Survey Dutch Population, Social and Cultural Developments in the Netherlands) – as well as cross-national collections that contain a wide range of countries (e.g. the European Social Survey). These data are valuable for comparative research, providing useful opportunities for multidisciplinary cooperation. All of the data were collected with additional funding from the Netherlands Organisation for Scientific Research (NWO), thereafter transparently documented and deposited at Data Archiving and Networked Services (DANS) so that they can be used by the scientific community, while maintaining high levels of transparency and and contributing to scientific integrity. These data were downloaded by more than 2000 colleagues in the period 2007-2012.

**Collaboration**
Members of NISCO have continued to cooperate with top international institutes to join forces and share complementary scientific views, like: the Department of Sociology of the Catholic University of Leuven, Belgium; Bergen Pacific Studies Research Group, University of Bergen, Bergen, Norway; Centre de Recherche et de Documentation sur l’Océanie, Aix-Marseille Université, Marseille, France; Department of Anthropology, Collaborative Research Centre on Human-Environment Interaction as well as the Department of Sociology at Universität Köln in Germany. Within the Netherlands, access to international collaborations run through the European Research Centre on Migration and Ethnic Relations, Utrecht University, the Nederlands Studiecentrum Criminaliteit en Rechtshaving and the NWO Institute/Vrije Universiteit in Amsterdam. NISCO has established international partnerships through the South Africa-Netherlands Research Programme on Alternatives in Development (SANPAD).
Members of NISCO cooperate with counterparts in other Dutch research schools in order to strengthen international collaboration and provide education to young cohorts of doctoral candidates, including the Research School for Resource Studies for Development (CERES) and the Interuniversity Centre for Social Science Theory and Methodology (ICS).

NISCO staff also participate in networks, such as the European network for research expertise on Economic change, Quality of life and Social cohesion (EQUALSOC); the European Consortium for Sociological Research (ECSR); the European Association of Social Anthropologists (EASA); the European Association of Development Research and Training Institutes (EADI); the European Society for Oceanists (ESO), the Research Network on European Port Cities; ERANET Learning in Knowledge Society; the Network of Excellence ‘Enhancing the Interest in Science in a Developing Europe’ (EISDE); the Development Policy Review Network, and the International Civil Society Forum on Conflicts (INFOCON).

Research results
Under the heading of inequality, NISCO researchers studied to what extent parents’ field of study affects children’s educational level and field of study. They showed that, over the last five decades, economics and related studies have become more popular among men. It was established that parents’ field of study is of significant importance for children achieving a high level of education, and that its relevance has increased over the years. These results supported the idea that educational expansion does not necessarily lead to increasing meritocracy in western societies.

Another contribution on inequality analyzed the impact of the Millennium Village Project (MVP) in Sauri, Kenya on poverty. Researchers found that higher agricultural productivity affected self-consumption, production margins and total (surrogate) income, but had an insignificant impact on cash incomes among targeted households, when compared to neighbouring villages. These outcomes are explained by the fact that much of the output of improved productivity is consumed rather than sold on the market.

Cohesion in societies is studied via social capital: formal (contacts within formal organizations) and informal (contacts outside of formal organizations). In particular, researchers inquired to what extent formal and informal social capital can be substituted for each other. They found strong evidence for cross-national equivalent measurements relating to informal and formal social capital. They rejected the hypothesis on substitution of formal and informal social capital for all countries under consideration, except for Romania; and they corroborated the hypothesis on the complementary nature of formal and informal social capital.

Regarding formal social capital, power asymmetries within partnerships between Northern and Southern NGOs are thought to be undesirable. Researchers examined ways in which the institutional design of the partnerships affect local partners’ room to manoeuvre. They demonstrated that Northern agencies unilaterally set rules that govern these partnerships; similarities and differences between the rules of the three agencies can, above all, be attributed to the corresponding and divergent nature of their norms, values and beliefs; and informal rules allow for more flexibility.

Modernization processes are examined during research on Marian pilgrimage. Researchers studying religion came across specific problems such as peoples’ profound emotions and private suffering that may strongly inhibit communication. The elicitation method was used to overcome the problem of silence and outbursts of tears among emotionally touched respondents, which seriously hampered initial interviews based on verbal stimuli. In contrast to this, emotional responses to the iconographic stimuli appeared to evoke stories which revealed important religious meanings, whereas precisely this emotional dimension made it difficult for the people to express themselves when approached using conventional interview techniques.

Other researchers depicted and interpreted changes in the organizational structure of the Holy Week celebrations in Andalusia over the past three decades. They argued that women were able to stake out a larger space in religious organisations due to changes in the functions of these sodalities in the political and economic domain and to overall pressures from women to change gender relations.

Awards and acknowledgments
Prof. Scheepers was acknowledged by a leading global scientific publisher as one of the 1% most cited general social scientists in the world during the period 2001-2010.

Societal impact
Members of NISCO share the view that their knowledge should be shared with societal and scientific stakeholders. They therefore regularly advise a wide range of public and private institutions and have advisory positions in a variety of domains. This work includes supporting international data collections (European Social Survey and the European Value Survey), national data collections (Centraal Bureau voor de Statistiek, Data Archiving and Networked Services, Algemene Rekenkamer, Wetenschappelijk Onderzoeks- en Documentatie Centrum). More specific data collections relating to the ‘Causes and Consequences of Early Socio-Cultural Integration Processes among New Immigrants in Europe (SCIP)’ continue to be collected, together with Centraal Bureau voor de Statistiek and the Sociaal en Cultureel Planbureau for which Dr Lubbers received additional funding from the Netherlands Organisation for Scientific Research (NWO; ‘medium investment’). Data were collected on funding.
This was a fruitful year for NISCO. New assistant professors who were appointed (tenured positions, core funded) provided excellent opportunities to broaden the scope of research themes from which teaching programmes eventually also strongly benefit.

The research programmes of the Cultural Anthropology and Development Studies Research Group will continue to focus on more specific topics included in a contract with Population Council (NGO) to design a mixed-method impact evaluation for a project entitled ‘Bangladeshi Association for Life Skills, Income and Knowledge for Adolescents’ (BALIKA), financed by the Dutch Embassy in Dhaka, Bangladesh. The aim of this project is to reduce the incidence of child marriage through a mixture of interventions, mostly targeting young girls (12-18). The involvement includes capacity building of local Population Council staff on evaluation methodologies. There is also a new framework contract with the Ministry of Foreign Affairs developed by Dr van Kempen for an ‘Establishing Impact’ tender. The framework contract makes it possible to compete with a select set of consortia for a large number of impact evaluations in development cooperation and foreign policy. Other programmes funded by the Ministry of Foreign Affairs, Cordaid and other aid agencies will lead to a series of PhD theses, which will be defended in years to come.

In the Sociology Research Group the focus is on projects related to the key themes inequality, cohesion and modernization, which are partially funded by NWO, with publications containing life-course analyses and multi-level modelling on topics such as: the composition of neighbourhoods and the effects on their inhabitants, attitudes of parents to children’s socialisation with the aim of avoiding deviancy and delinquency, integration processes of migrants and labour market vulnerabilities as well as inter-ethnic prejudice and contacts in European social contexts. The NWO PROO as well as

provided by public and private organizations engaged in development cooperation (DGIS/Ministry of Foreign Affairs, Cordaid, ICCO, Solidaridad, Hivos, Oxfam-Novib). Moreover, advice was given to the Ministry of Foreign Affairs, Directoraat-Generaal Wonen Bouwen en Integratie, Stichting Lezen, de Brabantse Netwerkbibliotheek, the Kenniskamer of the Ministry of Economic Affairs, the Centre for Development Cooperation (COS) Gelderland, Royal Tropical Institute (KIT), Fairfood, SNV Netherlands Development Organisation, Nederlandse Vereniging voor Technisch Facilitair Management in de Gezondheidszorg (NVTG) and others.

Prof. Breedveld served as an intermediary consultant, disseminating scientific insights related to sports, particularly to the Dutch Olympic Committee/Sports Federation NOC*NSF. Prof. Hoebink and Dr Schulpen advised the Ministry of Foreign Affairs, the Dutch Parliament and several private aid organisations and appeared in the media – including in widely read Dutch journals such as Internationale Spectator, Trouw, Financieel Dagblad and De Volkskrant – commenting on international cooperation. Prof. Ruben is Director of the Policy and Operations Evaluation department (IOB) of the Netherlands Ministry of Foreign Affairs. IOB reports, which are public, are submitted to the Dutch Parliament. Prof. Kraaykamp became the National Coordinator for the European Social Survey on behalf of NWO. Prof. Eisinga was an advisor to the Open Research Area Plus, assisting the National Science Foundations of France, Germany, the Netherlands and the USA. Prof. Scheepers advised the Scientific Advisory Board of the European Social Survey and Centraal Bureau voor de Statistiek and disseminated knowledge, jointly with Dr Tolsma, to Sociaal en Cultureel Planbureau, Raad voor de Maatschappelijke Ontwikkeling, Forum and Cosmicus. NISCO researchers participated widely in public debates and media presentations on topics such as the role of ethnic diversity and social capital in European societies.

Future research
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Key publications


Dissertations: 4
Scientific publications: 112
Professional publications: 9
**Director: Prof. Peer Scheepers**

Peer Scheepers is a Professor of Comparative Methodology at Radboud University Nijmegen. Previously, he worked as an endowed professor on ethnic relationships. Prof. Scheepers – a member of the Royal Netherlands Academy of Arts and Sciences (KNAW) – chairs the national committee for evaluating Research Masters Programmes in the Societal Sciences for the Nederlands-Vlaamse Accreditatie Organisatie (NVAO). On behalf of the Netherlands Organisation for Scientific Research (NWO), he is a member of the Scientific Advisory Board of the European Social Survey, which provides a high-quality large-scale data infrastructure for the European scientific community. Prof. Scheepers’ work focuses on comparative studies of pro-social attitudes and social behaviour as well as ethnic exclusionism.

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The HORIZON 2020 tenders offer fruitful opportunities to exploit previously developed expertise in these fields to develop national and international cooperative research programmes. Veni laureate Dr Tolsma started his research and, moreover, received a TALENT grant to explain the causal impact of ethnic diversity on social cohesion between and within ethnic groups. Dr Lubbers will use very recent data from the NWO-funded programme on ‘Causes and Consequences of Early Socio-Cultural Integration Processes among New Immigrants in Europe (SCIP)’. Cross-national research in the research programmes is being extended across the board. The NWO programme on Conflict and Security, which has funded studies on the correlates of ethnic diversity in local communities in Europe, will be finalized by one PhD and two post-docs. This programme has also funded research on ethno-religious conflicts in South-east Asia (Indonesia and the Philippines) which will be finalized by four PhD students plus one post-doc, jointly supervised by researchers from the Cultural Anthropology and Sociology departments. Both research programmes are headed by Principal Investigator Prof. Scheepers.

**Scientific integrity**

There is a long-standing tradition, built by NISCO researchers, to provide the scientific community with well-documented data to improve scientific transparency and integrity. This tradition has been widely recognized as among one of the best practices. Last year, it was taken as an example at Radboud University Nijmegen from which other researchers have derived best practices for their own research in order to improve transparency and ensure integrity.
Centre for Language Studies

The Centre for Language Studies (CLS) carries out leading-edge research in Linguistics, Language and Speech Technology, and Communication in a stimulating academic environment. Key aspects are innovation, an interdisciplinary approach, and a strong commitment to acquiring research funds, which helps strengthen the profile of research done at the Centre, both in the Netherlands and abroad.

Research at CLS takes place in two programmes:
• Researchers working on Language in Mind consider language to be a window into the cognitive functioning of the brain. They aim to explain how the architecture of the language system interacts with human language processing skills. Using data from native and foreign language acquisition, from language production and comprehension, as well as from spoken and signed languages, they develop and test comprehensive theories about language processing on the one hand and the structure of the language system on the other, employing a wide variety of research methods.
• Researchers working on Language in Society see language as a social tool that is essential for society, studying it in its historical, cultural and social context. They focus on language contact, sociolinguistic variation and the interactional foundations of language. In addition, they study various aspects of functional communication, including language use in the classroom and other multilingual contexts, speech technology designed to improve communication with the disabled, and persuasive communication.

Each programme contains several PI groups, which create platforms for discussing research plans and results, facilitating communication between researchers and helping to support scientific integrity.

The richness of languages in Africa and the Caribbean – in particular the use of ideophones – is studied at the Centre for Language Studies.
**Research facilities**

CLS research is largely empirical, using large databases and experimental techniques. As a result, facilities such as experimental laboratories with appropriate equipment, powerful computers and sophisticated software – as well as enriched written, spoken, and multimodal (sign) language databases – play an increasingly important role. The Executive Board has established Linguistics as a focal area of research for the University and structural investment in CLS research has been used to create a state-of-the-art psycholinguistic laboratory, including a web experimentation site, facilities for making observations with video recordings and a state-of-the-art computer lab.

**Collaboration**

Widespread international collaboration among CLS researchers has contributed to the growing success of international recruitment over the past few years: 25 percent of senior CLS members now come from abroad to work in Nijmegen, as well as 40 percent of PhD students.

CLS aims to develop a ‘research triangle’ with the universities of Cologne (Germany) and Leuven (Belgium) for long-term collaboration on European grant proposals which require interdisciplinary collaboration as well as an increase of scale.

CLS is engaged in long-standing collaboration with the Max Planck Institute for Psycholinguistics (MPI) and with the Donders Institute for Brain, Cognition and Behaviour. Together with MPI and Donders, CLS participates as a partner in the International Max Planck Research School. CLS researchers also collaborate with researchers from the Donders Institute and the MPI in the Baby Research Centre.

Examples of current formal international collaboration include:

- Collaboration with the Universities of Bergamo, York, Osnabrück, Paris VIII and The American University of Paris in the Netherlands Organisation for Scientific Research (NWO) project ‘Varieties of Initial Learners in Language Acquisition’ (VILLA).
- Coordination of the Marie Curie International Training Network ‘Bayesian Biometrics for Forensics’ (BBfor2), with Universidad Autonoma de Madrid (Spain), Politecnico di Torino (Italy), University of Twente (NL), Idiap Research Institute (Switzerland), University of York (UK), KU Leuven (Belgium), Hogskolan i Halmstad (Sweden), the Netherlands Forensic Institute, Agnito Voice Biometrics (Spain), TNO (NL) and the MARCS Institute (Australia).
- Collaboration with Aarhus University (Denmark), the University of Antwerp (Belgium), the University of Hasselt (Belgium), Wirtschaftsuniversität Wien (Austria), Copenhagen Business School (Denmark), Aalto University (Finland) in the project ‘Linguists for Business Research Initiatives’ (LIBRI).
- Participation in the Marie Curie International Training Network ‘Investigating Speech Processing In Realistic Environments’ (INSPIRE) with the Technical University of Denmark, KU Leuven, Philips Research Laboratories Eindhoven (NL), Technical University Eindhoven (NL), Tampere University of Technology (Finland), Universidad del Pais Vasco (Spain), University College London (UK), University of Edinburgh (UK), University of York (UK) and University of Sheffield (UK).
- Collaboration with the University of Arizona (USA), University of Alberta (Canada), University of Victoria (Canada) and the University of Canterbury (New Zealand) in the project ‘Speech reduction across languages and dialects’, funded by the National Science Foundation (USA).
- Collaboration in the large-scale cross-linguistic project ‘Evolution of semantic systems’, which is funded by MPI Nijmegen, as part of a consortium of 45 universities across Eurasia.

**Research results**

Only humans have a communication system that combines a finite number of meaningless elements (sounds) with a potentially infinite set of meaningful concepts. But where do these meanings come from? According to some scholars, the meanings of words are largely
the same for all people and are shaped in only a limited way by experience. According to others, such meanings vary substantially from culture to culture and every infant must learn a different system. Recent research supports a more nuanced picture than this dichotomy suggests. Large-scale cross-cultural comparisons reveal little evidence for absolute universals in the meaning of words, which would be consistent with the cultural relativity view. However, there are striking statistical regularities in how meaning is carved up into words, suggesting that similar perceptual and cognitive constraints are in operation across diverse languages. Recent research with infants shows evidence for some of these conceptual structures early in child development; these are in place well before language learning.

In contrast to what the story about the Tower of Babel suggests, it is sometimes the case that speakers of different languages are able to understand each other. Cognates, words with similar form and meaning across languages, were automatically identified and used successfully for measuring cross-linguistic similarities that are consistent with other accounts of language history. This is one of the main conclusions in a study on distributions of cognates by PhD student Job Schepens, MSc (CLS), Prof. Ton Dijkstra (CLS and Donders), Dr Franc Grootjen (Donders), and Walter van Heuven (University of Nottingham), which was published in *PLoS ONE*.

The perception of non-native varieties of a language by both native and non-native speakers was studied with regard to comprehensibility, interpretability, attitude, status and image. For this type of study new methods were developed in order to collect data or to create adequate stimuli (e.g. corpus linguistics and varieties of matched-guise techniques). Results show that for native receivers, but also for non-native speakers of other languages than the original speaker, communication in the native variety is more successful than in a non-native variety.

It is widely believed that people are bad at naming odours. This has led researchers to suggest that representations of smell are inaccessible to the language centres of the brain. But is this really so? Prof. Asifa Majid and Dr Niclas Burenhult (from Lund University, Sweden) have found new evidence that this is not true in all languages. In Jahai, a hunter-gatherer language spoken in the Malay Peninsula, there are around a dozen different words to describe different qualities of smell. This questions the view that there is a biological limitation to our inability to name smells and means that the inability to name smells is a product of culture and not biology.

Dr Mark Dingemanse received the 2012 *Anélia/AVT* Dissertation Prize for his dissertation *The Meaning and Use of Ideophones in Siwu (2011)*. For this award, which was jointly presented by the Dutch Society for General Linguistics (AVT) and the Dutch Association for Applied Linguistics (Anélia), an independent jury chooses the best dissertation in linguistics at a Dutch university.

The Max Planck Society for the Advancement of Science awarded Mark Dingemanse the Otto Hahn Medal for the work reported in his thesis. The Otto Hahn Medal is awarded annually to a small number of young scientists for ‘outstanding scientific achievements’.

Prof. Asifa Majid, Professor of Language, Communication and Cultural Cognition, was elected to the Academia Europaea. Its members are scientists and scholars who aim to promote international and interdisciplinary research and provide independent advice on matters of scholarly interest or concern to legislatures, governments, universities and the media, as well as to professional, industrial and commercial organisations in Europe.

**Societal impact**

Knowledge dissemination to the general public, raising awareness of the essential role of language and communication in society and developing ‘products’ based on CLS research, is encouraged. CLS concentrates its externally funded projects that involve language and speech technology in a dedicated institute: the Centre for Language and Speech Technology (CLST). Through CLST, CLS collaborates with many social and commercial partners.

The website Gebareninzicht, which went live in March, has received wide acclaim among target users. It contains information on sign language research.

Prof. Helen de Hoop contributed to the understanding of linguistic descriptive analysis by providing a lecture for a general audience during the Nijmegen annual Four-day March. It is not uncommon for people to undervalue the language variants of out-groups. However, from the perspective of linguists, no one variety is ‘better’ or ‘worse’ than any other. There are no linguistic arguments in favour of prescriptive variants of a language, such as a preference in Dutch for *beter dan* (‘better than’) rather than *beter als* (‘better as’).

Stemmen van Afrika (Voices of Africa), a website about the linguistic diversity of Africa, was presented at the Drongo Festival of Multilingualism in September. Africa has approximately two thousand different languages and, like biodiversity, linguistic diversity should be cherished. On this website, the languages of Africa are made

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**Awards**

Dr Sander Lestrade received the Keetje Hodshon Prize for his dissertation *The Space of Case* (published in 2010). This prize is awarded by the Royal Holland Society of Sciences and Humanities to encourage young researchers.
empirical studies on the effects of new media on literacy have not yet produced any clear results. The aim of this project is to bring some order to this somewhat chaotic range of opinions and findings.

Within the NWO theme 'Creative Industry', funding for a public-private cooperation research project was acquired by Dr Helmer Strik, Prof. Toni Rietveld, Dr Lilian Beijer and Dr Catia Cucchiarini. Neurological patients often suffer from dysarthric speech and diminished speech intelligibility, which has a negative effect on their active participation in society. In the programme 'Challenging speech training in neurological patients through interactive gaming' CLS will cooperate with the Sint Maartenskliniek and game developer Waag Society to conduct research on the effectiveness of games based on Automatic Speech Recognition in treating these patients.

Dr Sander Lestrade was awarded an NWO Veni scholarship for his research on the complexity of case marking. One of the most important functions of language is to make clear who does what, for example, who hits and who is hit. The strange thing is that languages make this much more difficult than is strictly necessary. The aim of this project is to find out what causes this complexity.

Prof. Enny Das acquired EU funding to set up an international research exchange network with partner institutes from Germany, Belgium, and Australia. Narratives play an increasingly important role in communication about health issues, especially online. News reporters not only report the cold facts about an upcoming epidemic, but also employ techniques that are used in novels and film. In spite of their increasing use, relatively little is known about the effects of narratives in a health communication context, as expertise on narratives is scattered across different disciplines. The objective of the HealthNar programme is to strengthen and consolidate the emerging field of narrative health communication and to encourage multidisciplinary exchange of research on narratives and health, by bringing together renowned international experts.

Future research

Prof. Wilbert Spooren obtained a PhD position for Lieke Verheijen within NWO’s ‘PhDs in the Humanities’ programme. Because the language used in new media can deviate from the conventional norms of spelling, grammar, and punctuation, some adults are worried that it may degrade young people’s reading, writing, or spelling skills. Linguists, on the other hand, point out what they see as positive aspects of using new media, such as increased exposure to text, increased motivation to read and write, and increased phonological and metalinguistic awareness. Previous
Key publications


Dissertations: 13
Scientific publications: 305
Professional publications: 31
Patents 1
scholars with backgrounds in health psychology, media psychology, health communication, the arts and interactive communication.

Dr Onno Crasborn – together with Dr Kearsy Cormier from University College London – received a grant from the Digging into Data Challenge, an international competition designed to promote innovative humanities and social science research using large-scale data analysis. This project will develop cross-linguistic annotation protocols for exploring the content of sign language video datasets. The main potential for progress lies in standardised lemmatisation protocols for lexicalised signs and in protocols for annotating partly-lexical and non-lexical elements (including gestures). The new annotation protocols and resulting corpora will enable users to dig into the content of existing video data and to enable cross-linguistic research with sign language corpora.

As part of NWO’s Free Competition in the Humanities Dr Crasborn was granted a research programme designed to resolve some long-standing issues in sign language research by developing a morphological approach to sub-sign meaning. An inventory of sub-sign form-meaning units and their combinatorial potential will be very useful for understanding the morphological structure of signs, comprehending and producing new sign formations and improving psycholinguistic studies, as well as for applied linguistics (language education, and lexicography). Large sets of annotated data (corpora) will be used to study the occurrence and distribution of meaning units smaller than the sign (lexeme).
The Behavioural Science Institute (BSI) conducts research on human behaviour. The aim of the institute is both fundamental (to understand behaviour) and applied to societal challenges (to influence behaviour). A distinctive feature of the BSI is an integrative approach to human behaviour that transcends the traditional disciplinary boundaries of psychology, education and communication science.

BSI researchers investigate the nature and development of human behaviour. They study the ways in which it is influenced by i) individual factors (cognitive, affective, motivational and psycho-physiological processes), ii) social-contextual factors (home, school, peer groups, work organization and advertising), and iii) the dynamic interplay between these factors. In addition, they study reverse associations, i.e., how human behaviour influences individual factors and the social context. Both ‘normal’ behaviour and psychopathology are the subject of research which involves laboratory experiments and field studies, large-scale longitudinal studies and randomized controlled trials. Studies include behavioural, self-report, psycho-physiological, neuroscience, genetic and virtual reality measurements.

BSI research is integrated in the following programmes (in alphabetical order):

Communication Science
The production, content, and reception of mediated communication are investigated. Research focuses on influence (commercial and social marketing communication), information (journalism and
news), and culture (media and consumer culture). The group takes a multidisciplinary approach (combining media-psychological with sociological perspectives), which is multi-method (using various quantitative and qualitative research methods), and has a keen interest in developments in the media landscape. There is considerable emphasis on ‘academic social responsibility’, and the group supports several initiatives designed to bridge the academy-society divide.

Developmental Psychopathology

The aetiology of emotional and behavioural problems in children, adolescents and their families are studied. Fundamental research is conducted across multiple levels of analysis, from genetic and neural processes to emotional, cognitive and social mechanisms, through to community and cultural factors. Insights from fundamental studies are applied in developing innovative intervention programmes, which are evaluated in order to strengthen and/or refine them.

Experimental Psychopathology and Treatment

Research focuses on abnormal psychology through the experimental study of cognitive and neuro-biological processes. A multi-modal approach is used and experimental methods (ranging from reaction times and verbal reports to eye-tracking, fMRI, EEG, MEG, and behavioural tests in real and virtual environments) are applied to cognitive processes in psychological dysfunctions. This is done in order to assess patients’ current status, re-train them, as well as predict treatment success and relapse.

Learning and Plasticity

Researchers in this programme explore the micro-analysis of learning and cognitive plasticity. The main focus is on learning and developing communication and cognition in normal and atypical populations. Particular attention is paid to the cognitive constraints related to learning a first and second language – both spoken and written – in terms of representation and control. To gain more insight into the dynamics of learning, the neural principles of brain plasticity are also taken into account.

Social Cognition

The main theme of this programme is the interaction between automatic and controlled aspects of behaviour. Several aspects are investigated, including the interactions between implicit and explicit components of attitudes, person perception, prejudice and interpersonal relationships and the role of conscious and unconscious processes in decision making and the pursuit of happiness.

Social Development

Fundamental processes of both typical and atypical social development and related cognitive processes over the human life span are studied from a behavioural, psychobiological and neuroscientific perspective. Clinical applications are also investigated. Areas of research include early child development and child care, peer relationships, ADHD, cognitive and motor processes in sighted and visually impaired children, as well as successful aging among older adults.

Work, Stress and Health

The fundamental goal here is to advance knowledge of the cognitive, motivational and physiological processes that underlie task behaviour and performance. The applied goal is to provide evidence-based guidelines, which can be used to design healthy work, prevent stress, and promote recovery, motivation, learning and performance in the context of work and sports. This research programme comprises three interrelated research themes: 1) stress, fatigue and recovery, 2) new systems of work organisation, and 3) motivation, learning and performance.

Research facilities

The Behavioural Science Institute has excellent research facilities:

- A Virtual Reality Lab for immersive, three-dimensional computer-generated environments
- Mobile labs to accommodate various experimental setups outside the university
Researchers within the BSI collaborate with numerous international and national partners. A number of these are linked to the BSI as international fellows. The Institute’s strategy is to link these renowned scholars to Nijmegen. They visit at least once a year to give workshops, lectures and to work on joint publications. Some of the PhD students working at the BSI conduct part of their projects in the labs of these fellows. Currently, Profs. Charles Perfetti (Pittsburgh University), Alex Todorov (Princeton University), Janet van H ell (Pennsylvania State University), Mitchell Prinstein (University of North Carolina), Marcel Brass (University of Ghent), William Bukowski (Concordia University), Emmanuel Kuntsche (Lausanne) and Goran Kecklund (Stockholm University) are BSI fellows.

There are formal collaboration arrangements with numerous international universities (e.g., University of Cologne, Australian Catholic University, Indiana University, University of Virginia), research laboratories (e.g., Haskins Laboratories in New Haven), multiple Dutch Universities, and institutes for applied research (e.g., Trimbos Institute, TNO). Within Radboud University there are formal collaboration arrangements with the Medical Centre, the Donders Centres for Cognition (DCC) and Cognitive Neuroimaging (DCCN), and the Max Planck Institute for Psycholinguistics. The BSI also employs two Principal Investigators at DCCN (Dr Alan Sanfey and Prof. Karin Roelofs).

The BSI hosts the ZonMw-funded centre of excellence ‘Academic Centre Youth Nijmegen’ which is a consortium of 14 knowledge, policy and clinical institutions in the Nijmegen region. The aim is to improve the prevention and care of internalizing problems in youth.

Research results
Within the Communication Science programme, researchers found that marketing techniques can be used to promote healthier behaviour. However, they concluded that great care should be taken by health practitioners, because video games containing any type of food cue – including healthy ones – stimulate unhealthy snacking. Researchers found that competitive pressure in newsrooms increases the influence of television news on viewers. They also recommended that in the contemporary media environment journalists should improve transparency and accountability towards the public.

Within the Developmental Psychopathology programme, a series of studies stressed the impact of the way in which children imitate food intake and food purchasing patterns, and the processes underlying this. These studies were used to develop an intervention programme. Two large randomized controlled prevention trials focusing on programmes to train parents to effectively educate their children to refrain from smoking and drinking did not produce significant effects. These studies provided important insights about the timing and content of substance use prevention programmes. On the other hand, a smoking cessation intervention was clearly shown to be effective. Mixed findings in a series of longitudinal studies on gene-environment interactions related to loneliness, smoking and marihuana use in adolescents illustrated the complex nature of the interplay between genetic vulnerability factors and the environmental factors which affect psychopathology.

Members of the Experimental Psychopathology and Treatment programme identified factors that predict which alcoholics will profit from a relapse-reducing joystick training. They found that social stress reactions can be reduced by a training using a joystick to select smiling faces. A novel task was developed to investigate approach-avoidance tendencies in decision making. It was found that, for those with a genetic vulnerability to affective disorders, there is reduced downregulation of the amygdala by the prefrontal cortex, and that in patients with remitted depression, carriers of risk genes affect cognitive processes if they have experienced childhood trauma. The Wall Street Journal published an article on Bernd Figner’s work on risky decision making.

Within the Learning and Plasticity programme, the focus was on neurocognitive and social markers in the learning and development of sensory, motor, visuo-spatial, speech, language, literacy, mathematics, and science abilities, following experimental and quasi-experimental designs to test predefined hypotheses in both children and adults. Moreover, the development of such abilities in children with cognitive disorders or specific language, hearing or vision impairment was examined in prospective studies as well as in intervention studies. Finally, the impact of construction in educational
gaming – and the role of teacher beliefs and school diversity – on student learning were studied.

In the Social Cognition programme, researchers working in the Person Perception Lab validated seven computational models for the social judgment of faces (identifying characteristics such as attractiveness, competence, dominance, extroversion, likability, threat and trustworthiness). The validated stimuli have been made available for use by other researchers. Research on social influence expanded on classic findings on obedience and showed that defying authority is more exhausting for individuals high in need for closure, than for people low in need for closure. Researchers working in the Decision Neuroscience lab showed for the first time that top-down strategies such as reappraisal strongly affect socio-economic decisions.

In the Social Development programme, the effects of maternal prenatal stress on infants’ stress responses and later development were investigated. Also, the conditions under which stressful environments do or do not impair cognitive development were examined. It was demonstrated that parental behaviours may increase adolescents’ susceptibility to deviant peer influence and risk. The implicit processes that may underlie peer influence among adolescents were investigated and friendship network types and their predictors in the second half of adult life were also examined. Research on ADHD showed consistently reduced activation of the ventral striatum during reward anticipation.

In the Work, Stress and Health programme, longitudinal and intervention studies on the association between psychosocial work characteristics and sleep quality were reviewed. It was concluded that demanding work and a low degree of control at work predict poor sleep quality. In one of a series of studies on modern working life, the goal was to identify trends in the prevalence of physical workplace violence across Europe, as well as to reveal factors that may explain trends. It was found that workplace violence has increased significantly. Violence appears to be particularly prevalent in jobs involving regular use of computers. This may be because the nature of making contact with clients is changing.

Awards and acknowledgments
• Prof. Moniek Buijzen received an ERC Consolidator Grant for her research on applying social media in health campaigns targeting young people in order to encourage exercise and eating healthier food.
• Prof. Karin Roelofs received an NWO Vici grant for the project Police in Action: The role of freeze-fight-flight in posttraumatic stress symptoms.
• Profs. Toon Cillessen, Isabela Granic, Karin Roelofs, and Daniel Wigboldus each received an NWO Onderzoekstalent grant.
• Prof. Ron Scholte received a ZonMw grant for research on the effectiveness of the social network strategy in societal youth care.
• Prof. Rutger Engels received an Achmea grant for developing and testing a resiliency programme on residential youth care.
• Prof. Moniek Buijzen, Dr Simone de Droog, and Dr Esther Rozendaal received an NWO Meerwaarde Plus Valorisation Grant for their project The World of the Veggiefruities.
• Dr Gero Lange received a German Research Foundation (DFG) Starting Grant.
• Prof. Cilia Witteman received a grant from Fonds Kinderpostzegels to study the assessment of child abuse.
• Dr Monique van de Ven received a grant from the Stichting Astmabestrijding to study automatic processes in the medication adherence of adolescents with asthma.
• Dr Sabine Stoltz received a Jacobs Foundation research grant.
Key publications


Dissertations: 32

Scientific publications: 415

Professional publications: 71

Societal impact

Within BSI fundamental research, for example on addiction, occupational stress, reading acquisition, anxiety and depression, is translated into practical prevention guidelines and interventions. These interventions, in turn, are subjected to scientific investigation, if possible in randomized controlled trials. On the other hand, societal issues, such as adolescent alcohol consumption and children’s reading problems, serve as the starting point for a more fundamental understanding of such topics. Most research conducted at BSI stems from societal questions and/or is designed to answer societal questions. Four examples of this are:

1. The Dutch national government decided to raise the minimal drinking age from 16 to 18. The BSI line of longitudinal studies on the role of parental rule setting and drinking, conducted over the past ten years, contributed to rational support for this decision. This far-reaching change in policy has a potentially huge impact on the detrimental consequences of early-age drinking.
2. An intelligence test for detecting mild intellectual disabilities was published: ‘SCreener voor Intelligentie en Licht verstandelijke beperking’ (SCIL; Screener for intelligence and light intellectual disability). It has been estimated that about 15 to 25% of prison inmates in the Netherlands may have mild or more serious intellectual disabilities. The SCIL helps gain more insight into the prevalence of intellectual disabilities among prisoners and forensic patients, and to detect individuals who need specific care and treatment.

3. Researchers working on the Curious Minds project examined children’s science and technology learning in relation to communication and language learning. In collaboration with ‘Expertisecentrum Nederlands’, part of children’s discovery learning in the classroom was videotaped and brought together in a nation-wide web-based learning environment (www.samenonderzoeken.nl), which is available to teachers wishing to implement science and technology lessons for school children.

4. In 2013 the project The World of the Veggiefruits was set up. This is an NWO-funded health intervention designed to encourage preschool children to eat more fruit and vegetables. The output is a series of reading books promoting fruit and vegetables with the help of animal characters (the Veggiefruits), a Facebook page, a school fruit and vegetable project, and an interactive reading app for pre-schoolers and parents. Next year the programme will be launched nationwide.

Future research
In the next few years BSI will continue to deliver top-level behavioural research with societal relevance. Most of the grants acquired provide researchers with money for research that is closely linked to societal problems. This link will continue to lead to innovative new projects. The BSI is working on a new structure of research themes, designed to encourage even more internal and external collaboration. This new structure will be flexible so that BSI can focus its research on current topics of interest in society, without losing its solid basis in fundamental research. One of the ways to keep investing in fundamental research and in new ideas is through the annual BSI graduate school round, in which promising candidates are selected to start their own PhD project. BSI will maintain these graduate school positions in the future. The BSI sees significant opportunities in Challenge 1, 6 and 7 in the EU Horizon 2020 research programme. A ‘warm-up’ information session was held in 2013 and this will be followed by more plenary and individual sessions for BSI researchers. The aim is to encourage all researchers to participate in international consortia that apply for EU funding.
Donders Institute for Brain, Cognition and Behaviour

The Donders Institute is an interdisciplinary research institute at Radboud University Nijmegen with a fully integrated Graduate School that focuses on understanding human cognition and behaviour by probing the neural, genetic, molecular, and computational processes that underlie cognitive phenomena such as language, goal-directed action and memory. Its research agenda is mainly fundamental, but it has substantial impact on comprehending specific brain-based disorders, developing novel brain-inspired technology and optimizing educational curricula.

Understanding mind and brain

Over 500 researchers at the Donders Institute share the goal of advancing understanding of the human mind. This goal requires an interdisciplinary approach. Hence, the Donders Institute was established in 2008 and geared towards interdisciplinary collaboration by bringing together scientists with diverse backgrounds from the Faculties of Social Sciences, Arts, Medicine and Natural Sciences, as well as from the Max Planck Institute for Psycholinguistics (MPI). The full spectrum of research – from molecule to man – takes place within four specific themes:

Language and Communication

Studying Language and Communication involves understanding core language and communication ‘operations’ and working out how these are grounded in – or related to – other domains of cognition, including perception, action, memory, and sociality. An important goal is to determine how the human language faculty is rooted in the ‘language-ready’ human brain.

Perception, Action and Control

Researchers working on Perception Action and Control study sensorimotor mechanisms, their cognitive and social components, their clinical implications, and their relevance for robotics. Research methods include theoretical analysis, psychophysical and behavioural studies, neurophysiological techniques, neuroimaging, clinical and pharmacological interventions, as well as developmental and genetic approaches.

Plasticity and Memory

The development and decay of the healthy – and the maladaptive – brain is the main focus of researchers working on this theme. They study the mechanistic underpinnings and behavioural consequences of long-term changes in neural structure and function. Genetic, molecular and cellular methods, animal models, as well as human neuroimaging and cognitive neuropsychology are applied.

Brain Networks and Neuronal Communication

This theme focuses on brain networks, ranging from communication between individual neurons to communication between areas of the brain and the outside world. Researchers combine developing new techniques for electrophysiological and anatomical measurements of connectivity and activation with data analysis and the experimental application of these techniques in studies of cognition in humans, primates and rodents. Computational modelling integrates multi-level experimental data in an attempt to arrive at a clearer understanding of cognitive processes.

Benefits for society

Research conducted at the Donders Institute has considerable potential for benefiting society. A key aim is to enhance understanding of the human brain by disseminating expertise and knowledge to a variety of stakeholders such as:

- The general public is mostly informed via the media. Donders researchers regularly appear on national and international television (i.e. ‘Pavlov’, ‘Tegenlicht’ and the National Science Quiz), in numerous national and international newspapers (including the Gelderlander, NRC, Frankfurter Allgemeine Zeitung, and the New York Times), on radio (e.g. Dutch National Radio, BBC, and CNN) and on many websites.
- New findings and knowledge are disseminated to industry, mostly through numerous collaborations with commercial partners varying from smaller companies manufacturing technical devices (such as Noldus and Otticon) to large multinationals (Philips, Siemens, Heinz, DSM, Danone, etc.). Contacts are mutually beneficial in terms of scientific expertise and/or the use of facilities.
- Implementing new findings in clinical practice is part of the daily work of the Donders clinicians as is education of peers, patients and patient organisations through lectures and meetings (Parkinsonnet.nl) and active participation in e-science developments (the digital Parkinson poli and Parkinson TV), thus directly promoting the impact of research outcomes.
- Together with major national publishers of school materials, e.g. (Malmberg) Donders researchers contribute to educational development. Recent insights are used to develop learning programmes for primary schools as well as those focusing on anxiety, habits and perception.
- Through participation in public debate Donders researchers contribute to regional and national policies by discussing the impact of neuroscientific insight on economic and social development. At the national level, researchers at the institute serve on committees of national research policy organisations such as the Netherlands Organisation for Scientific Research (NWO) and the Royal Netherlands Academy of Arts and Sciences.
Grants and collaboration

Donders researchers received several prestigious grants in 2013. Two NWO Vici grants were awarded to Profs. Barbara Franke and Karin Roelofs and three Vidi grants went to Drs. Kristin Lehbofer, Christian Beckmann and Christian Döller.

In 2013 the Donders Institute, the MPI for Psycholinguistics and the University of Amsterdam started their joint ‘Language in Interaction’ project which was awarded a €27.6 million ‘Gravitation’ grant for research on language from genetic building blocks to social interaction.

The Donders Institute actively collaborates with leading national and international research institutes, companies and other potential users of its research. Joining forces makes it possible to extend and international research institutes, companies and other potential users of its research. Joining forces makes it possible to extend research beyond the confines of the institute and to valorise research results. The Donders Institute takes the lead in a number of pioneering national and international consortia, including those that received grants in 2013:

- **Healthpac (Perception and Action in Health and Disease)** is a European integrative doctoral programme (IDP) that received a €3.3 million research grant to reveal the neural mechanisms of sensorimotor control and its disorders.
- **Aggressotype** is a large EU-funded project worth €6 million on pathological aggression in children and adolescents with attention deficit/hyperactivity disorder (ADHD) and conduct disorder (CD).
- **Matrics** is a large EU-funded consortium (€4.5 million) that focuses on deconstructing aggression in CD and callous unemotional (CU) traits into different behavioural dimensions coupled to imaging and genetic and epigenetic readouts. The Human Brain Project was selected by the EU as one of two flagship projects. The Donders Institute will contribute its knowledge and expertise in cognitive neuroscience and neuroinformatics.

PhD students themselves exemplify the multidisciplinary character of the institute.

Dr Christian Döller is ‘Speaker’ of the DGCN and in 2013 Prof. Ardi Roelofs succeeded Prof. Ruud Meulenbroek as the director of the MSc programme.

Graduate School highlights in 2013:

- PhD students successfully organized the 6th edition of the ‘Donders Discussions’; an international neuroscience conference for PhD students. Over 200 participants from 14 countries attended this two-day event, making it the most international so far.
- The 100th PhD thesis published in the Donders Series was celebrated with an international alumni event.
- The Masters programme celebrated its 10th birthday with a one-day symposium featuring international speakers.

Research Assessment

In 2013, an external assessment committee of internationally recognized experts chaired by Professor Michael Gazzaniga – an eminent researcher and the founding president of the Cognitive Neuroscience Society – visited the Donders Institute. The committee rated the performance of the Institute over the past six years as “excellent”. The committee confirmed the Institute’s international reputation by stating that it “has had an important and substantial impact in the international field” and that the Principal Investigators were recognized as “top researchers in their field”. The committee was impressed by what has been achieved in six years and observed an extraordinary spirit of cooperation: “The Institute is a very stimulating environment for top researchers as well as for young talent.” Both the quality and the productivity of the four Donders themes were rated as very good to excellent or excellent.

Future developments

In 2014 the Institute will further develop its strategy, while implementing the recommendations of the external assessment committee.

- New hires and talent development programmes will be made in such a way that they increase gender diversity and further strengthen research focus.
- The link with the University Medical Centre will be optimized by focusing research on five disease areas that are aligned with the Donders research themes.
- The Graduate School will take the next step by cooperating closely with other Masters programmes at the University to enhance its interdisciplinary nature; it will further integrate its Masters and PhD training to offer an attractive, fully integrated programme.
- A new initiative will be set up, fostering knowledge transfer in terms of communicating fundamental neuroscientific insights, training beyond university education, commercialization, and R&D cooperation covering four areas: medicine, technology, education and food.
The Donders Centre for Cognition (DCC) is one of three centres at the Donders Institute for Brain, Cognition and Behaviour (DI). Scientists from a range of disciplines jointly study the psychological, formal and neurobiological principles of information processing in biological and artificial cognitive systems. Research collaboration with the Donders Centre for Cognitive Neuroimaging (DCCN) and the Donders Centre for Neuroscience (DCN) embraces four Donders research themes: Language and Communication (LC), Perception, Action and Control (PAC), Memory and Plasticity (MP) and Brain Networks and Neuronal Communication (BNNC).

In the **LC theme**, DCC researchers study the cognitive processes and representations underlying the use of language in a variety of contexts, including speaking, reading and listening, at the levels of word, sentence, and discourse. Various techniques are used, including studies of reaction time, eye-tracking, neuro-imaging and computational modelling, with a special research focus on contextual flexibility and multilingualism.

In the **PAC theme**, the research focus is on the basic sensorimotor aspects, as well as the cognitive, contextual and social components of perception-action coupling and their ethical, legal and societal implications. Research methods include clinical and behavioural studies, neurophysiological and neuroimaging techniques, developmental approaches and computational modelling. Key focus areas are Sensorimotor Integration, Intention and Control, and Social Interaction.

Researchers working on the **MP theme** study brain-behaviour relationships with the aim of bridging the gap between cognitive and systemic as well as basic and clinical neurosciences. One key focus area is the interplay between executive control, learning
and memory using interdisciplinary, patient-centered studies or ageing individuals in combination with structural and functional neuroimaging methods. Other research focuses on the mechanisms underlying neuroplasticity and the role pathological oscillations in electrical brain activity, using healthy subjects, patients, and animal models in combination with pharmacological or genetic manipulations.

Researchers working within the BNNC theme focus on natural and artificial intelligent systems, and their interaction. Main research topics are Brain Decoding and Brain-Computer Interfaces (BCI), both of which involve computational modelling, symbolic AI techniques, and methods development as important components. Work on brain decoding focuses on understanding cognitive phenomena, both in terms of localized neuronal processing using ECoG and EEG recordings as well as on large-scale functional integration using MRI and MEG recordings. Work in the BCI domain focuses on exploiting real-time brain-computer interfaces as an experimental method for cognitive neuroscience and as reliable technique for new applications in control, consciousness detection and neuro-feedback.

Research facilities

- The Baby Research Center has facilities for behavioural and neuro-scientific research with infants and young children, including several Tobii eye-trackers, an fNIRS system with 32 sources and 16 detectors and a 32-channel active EEG setup.
- The sensorimotor lab is equipped with a vestibular motion platform and combined EEG apparatus (96 channels), eye and body motion-tracking devices, and VR stimulus displays.
- The sensorimotor lab has been expanded with motor learning robotics technology, including a vBOT robotic manipulandum and a PHANToM haptic interface device.
- The DCC installed a computer cluster for high-performance scientific computing.
- Several EEG/ERP laboratories for measuring brain activity during cognitive tasks and online processing in Brain-Computer Interfacing.
- Laboratories with 2D and 3D motion-tracking systems.
- A cognitive Artificial Intelligence laboratory to study human-computer interaction and intelligent behaviour.
- Several laboratories for perception and language studies using visual/auditory stimuli, including remote eye-tracking systems.
- Animal laboratories for electrophysiological recordings and behavioural studies in rats.
- Facilities for stereotactic animal surgery including microtome for histological verification.
- Neuropsychology lab.
- A Brain Computer Interface Lab.

In addition, DCC researchers have access to DCCN’s brain-imaging facilities (fMRI, MEG, EEG and TMS).

Collaboration

DCC strives for cooperation with excellent national and international partners, seeking to develop and strengthen research within the four Donders themes by sharing equipment, people and ideas. Researchers and research groups at the DCC have formed strategic alliances with other international research groups in order to establish a distinct competitive edge, to provide synergies, and to combine resources in order to acquire financial support for research and related infrastructure. Extensive cooperation in terms of complementary research, products, or services also takes place with business partners and non-profit organizations.

The DCC is engaged in structural collaboration with many universities, including:

- Jagiellonian University Kraków, Poland (a partner in the international research universities network IRUN): on epilepsy and pain research as well as language studies.
- King’s College, London: collaboration on amnesia and contextual memory research.
- UCL London: computational modelling of amnesia/working-memory capacity/semantics and pain.
• Oxford University, Oxford: computational modelling of associative learning.
• Duke University, Durham, NC: episodic memory and ageing.
• University of Hamburg: sensorimotor control.
• Universität Zürich: Neural correlates of prospective memory.
• University of Ghent: lexical statistics and databases.
• University of Nottingham: multilingual research.
• University of Leipzig: syntactic processing and language production.
• University of Tübingen: morphological and speech processing.
• Universities of Tokyo and Nagoya, Japan: multilingual research.
• Hanyang University, Seoul, South Korea: speech perception.
• Yale-University, New Haven, USA: on DTI imaging in rats.
• Saratov State University, Russia: Network analyses and seizure prediction.
• Lancaster University, UK and the University of Uppsala, Sweden within the Marie Curie International Training Network ‘ACT - Early Social Development’.
• University College London: testing the Predictive Coding Framework.
• Magdeburg University: on performance monitoring.
• University of Chemnitz, University College London, the University Paul Sabatier, Toulouse, University Paris Descartes: in the context of an EU STREP FET consortium grant on spatial cognition.
• University of California, San Diego, USA: on colour perception.
• Pennsylvania State University: Motion planning.
• Technical university Dresden: executive control and intention development across childhood and adolescence.
• University of Oldenburg: memory and executive control in brain-injured patients.

**Research results**

**Language and communication**

Perceptual learning studies showed that listeners can recognise speech using allophonic representations; hence the functional units of language perception are not necessarily phonemic. Longitudinal RT/EEG word learning studies found that adult class-room learners of a foreign language quickly become sensitive to the sublexical, lexical, and emotional properties of the new language. Larger frequency effects in L2 processing were argued to be due to ‘lexical entrenchment’ (i.e., the strength of the new word in the lexicon), irrespective of bilingualism, language dominance or language similarity. In lexical bilingual processing, so-called ‘identical cognates’ (e.g., Dutch-English ALARM) were found to be represented in the lexicon twice. In monolingual auditory sentence comprehension, superfluous prosodic breaks had more severe processing consequences than missing prosodic breaks. Using a strong context, the language comprehension system can make predictions in terms of broad semantically defined classes of words, thus going beyond specific words. Lexical selection in spoken word production was shown to be a competitive process under executive control.

Evidence from neuroimaging indicates that the anterior cingulate cortex (ACC) underlies domain-general executive control in spoken word production.

**Perception, Action and Control**

The neural basis of feedback processing was examined within the University’s baby research centre, showing that feedback-guided performance in 2½-year-old toddlers directly relates to the functionality of their neural feedback processing. Furthermore, Bayesian computational-level models were developed to explain properties of human action understanding. A further major result described the neurophysiological characteristics of a mechanism that supports human communicative innovation, thus opening the way for a better understanding of the neural implementation of human symbolic communication. Researchers at the sensorimotor lab reported that vestibular cues improve the formation and recall of multiple control strategies in moving environments. Their imaging studies – in combination with novel analysis techniques – revealed the reference frames of oscillatory activity during reach planning as well as the cortical organization of saccade generation. Another major finding was that real and fictive outcomes are processed differently in an instrumental learning task but converge on a common adaptive mechanism. Finally, the implications of brain research for assessing ethical and/or legal responsibility were formulated.

**Memory and plasticity**

The cognitive mechanisms of working memory and episodic memory formation were examined in brain-diseased patients as well as in normal ageing. An important result was that older adults compensate for impaired white matter with greater neural activity in the prefrontal and medial temporal lobe. Furthermore, it was demonstrated that early and late stages of working-memory maintenance contributed differentially to long-term memory formation. In clinical populations, it was shown that individuals with psychopathy demonstrate reversal deficits in explicit but not in implicit learning conditions. Researchers also reported about the site-specific effects of different types of electrical stimulation of the thalamus on electroencephalographic epileptic activity as generated in the cortico-thalamo-cortical system of genetic epileptic animals. New candidate anti-epileptic drugs were proposed.

**Brain Networks and Neuronal Communication**

New methods and application domains for brain-computer interfaces were developed and tested. Furthermore, new Bayesian models were designed that allow fusion of multiple sources of neuroimaging data and clustering of brain networks. A further important demonstration was that perceived images could be reconstructed from human brain activity using linear decoding approaches. Other work showed that rhythmic neuronal synchronisation in visual cortex entails spatial phase relation diversity that is modulated by visual stimulation and selective attention,
Prof. Bekkering worked on translating insights from Cognitive Neuroscience into Education. Together with a major publisher (Malmberg) he developed animations, which can be used to improve word learning in primary schools. He is also involved in a national project on improving number processing in primary schools, mainly by integrating the sensorimotor system while learning mathematics. Recently, he focused on feedback principles in order to foster learning.

DCC is also involved in Radboud Research Facilities, an initiative by the Province of Gelderland to stimulate the regional economy by contributing to the innovation strength of small and medium-size enterprises by valorising scientific knowledge.

In collaboration with physical therapists at the Applied University Nijmegen (HAN), Prof. Meulenbroek studies the viability of haptic tracking methods for lower-limb rehabilitation.

The Baby Research Centre conveys research findings to professionals working with young children. Dr Hunnius has been co-organizing a series of annual symposia for Infant Mental Health professionals and has given lectures to psychotherapists (e.g., SPON; GGNet), health care professionals (e.g., NIDCAP; Amphia Ziekenhuis), and educational professionals (e.g., Boekstart; NSDSK). She also chairs the Baby Brain & Cognition Network in the Netherlands.

Prof. Kessels has given lectures to the general public, focusing on neuropsychology and cognitive rehabilitation, as well as ageing and dementia (Hersenstichting, Alzheimer Nederland). Ties have been formalized with clinical institutes (Vincent van Gogh Institute for Psychiatry at Venray, Groot Klimmendaal Rehabilitation Centre in Arnhem, the Pompestichting in Nijmegen, and Kempenhaeghe Epilepsy Centre). There are numerous collaborations with companies designed to valorize research results in clinical applications (e.g. Pearson Test Publishers, Hogrefe Test Publishers, Metrisquare).

Dr Kristin Lemhöfer (Assistant Professor of Psycholinguistics) won an NWO Vidi grant for her project 'Learning a second language in the wild'. A second language is usually not learned in classrooms, but, as she puts it, ‘in the wild’. Dr Lemhöfer investigates when people learn languages in a natural way, when they don’t, and the neurocognitive mechanisms behind this phenomenon.

which, in turn, could have important consequences for communication with downstream areas of the brain.

Awards and acknowledgements

• Dr Kristin Lemhöfer received a Vidi grant from the Netherlands Organisation for Scientific Research (NWO) on tracking second language acquisition through natural language immersion. She also received an Aspasia grant from NWO (awarded to encourage the academic career of female researchers).
• Dr Sabine Hunnius also received an NWO Aspasia Grant.
• Drs. Vitoria Piai obtained a Rubicon grant and a Niels Stensen Fellowship.
• Drs. Janny Stapel received a Marie Curie Intra-European Fellowship.
• Dr Markus Paulus received a 2013 George Butterworth Young Scientist Award (from the European Association of Developmental Psychology).
• Dr Van Gerven received an NWO EW grant on Bayesian modelling of brain networks.
• EU Marie Curie Innovative Doctoral Program grant HealthPAC (Perception and Action in Health and Disease). Work package leaders: Prof. Medendorp and Prof. Meulenbroek.
• Dr Joukje Oosterman received an IASP Early Career Research Grant.
• Drs. Marjolein van der Waal received an NWO Onderzoekstalent Grant.
• Prof. Desain received an award from the European Regional Development Fund to develop communication technology for sick and disabled children, in cooperation with the German A.J. Kwak-Stiftung.

Societal impact

Researchers contribute to the dissemination of fundamental research and its technological and educational applications via teaching programmes, public conferences and the media.
Donders Institute for Brain, Cognition and Behaviour
Centre for Cognition

Key publications


Dissertations: 25
Scientific publications: 232
Professional publications: 27

The BrainGain project, which is headed by Prof. Desain, culminated in a public event: ‘BreinFest’. This project, which received excellent reviews, emphasized the valorisation and application of the Brain-Computer Interface, Neurostimulation and Neurofeedback. Its spin-off company Mind-Affect develops communication devices for ALS patients.

Dr Haselager has played a central role in guiding and organizing platforms for the ethical thinking needed for new neuro-technologies. He also appeared in many press releases and gave various public lectures about the societal impact of Cognitive Neuroscience and AI research (neurolaw, robotics, gender and neuroscience).

There has been broad media attention for Dr Van Gerven’s paper on the decoding of perceived images (Volkskrant, NRC, Radio 1, BBC World Radio, Wired, etc.). Prof. Bekkering was one of five prominent scientists in the Dutch TV programme Labyrinth, giving his view on future developments in cognitive neuroscience.
Future research

Adopting a multi-disciplinary approach, DCC will continue to study the relationship between brain and cognition, with a focus on applied studies and research within the four Donders themes. One of DCC’s objectives is to increase the proportion of external funding from the new European Framework Programme for Research and Innovation (Horizon 2020). Researchers plan to participate and/or coordinate new research proposals in this programme.

New neurocognitive research will start in the framework of the Gravitation grant (Language in Interaction). Three of its work packages will be coordinated by staff employed at the DCC. Furthermore, four PhD projects will start in 2014, under the supervision or co-supervision of Profs. Bekkering, Schriefers, Roelofs, Toni, McQueen, and Medendorp.

Dr Lemhofer will start the research funded by her Vidi award, entitled ‘Tracking second language acquisition through the wilds of natural language immersion’. Prof. Dijkstra will work on a series of new longitudinal studies on adult foreign language learning.

DCC will increase its contributions in computational modelling and machine learning to all Donders’ themes. Furthermore, the applicability of Brain-Computer Interfaces for semantic probing will be pushed. Studies will also further strengthen links between theoretical research on cognition and neuroscience, and societal, legal and ethical issues.

Prof. Bekkering coordinates a TOP grant from NWO-MaGW that – together with co-workers of the Donders Institute – enables him to investigate the interactions between intention and action during social interaction.

Within the Baby Research Centre, researchers will study how infants learn to understand other people’s actions.

Prof. Medendorp will be running both his ERC-consolidator programme and his Vici project, working on sensorimotor integration and decision making in dynamic environments. He also leads a work package in a EU STREP Consortium grant on Spatial Cognition.

Profs. Meulenbroek and Medendorp will start their respective work packages in the context of an EU Marie Curie Innovative Doctoral Programme grant entitled, HealthPAC (Perception and Action in Health and Disease).

Other ongoing work includes four Brain & Cognition grants (Prof. Bekkering, Profs. Desain and McQueen, Profs. Kessels and Fasotti, and Prof. Toni), an STW EarOpener grant (Prof Desain and Prof. McQueen), three Veni projects (Dr Flecken, Dr Selen, Dr Maij), two Vidi projects (Prof. Kessels, Dr Fiebach) and several open competition projects funded by NWO (Dr van Gerven, Prof. Medendorp). With the arrival of Dr Schutter a new research line on brain stimulation and neuroplasticity will be developed.
The Donders Centre for Cognitive Neuroimaging (DCCN) conducts basic and applied research in cognitive neuroscience. Much of the recent rapid progress in this field is driven by the development of complex neuro-imaging techniques for the \textit{in-vivo} scanning of activity in the human brain, an area in which the DCCN plays a leading role.

Research at the DCCN focuses on central cognitive functions. The aim is to unravel these complex functions and understand how they are represented in the brain. This is done by identifying the networks of brain areas that are vital to each of these functions and determining the role of – and interactions between – regions. In order to achieve this, it is also necessary to understand how neurons make networks and how networks carry out cognitive functions, in other words, how to get from neurons to cognition. Research at the centre is also designed to establish how the different brain areas coordinate their activity with very high temporal accuracy in order to enable human cognition.

Another important aspect of the research is improving the imaging methods themselves by optimally combining imaging techniques with high spatial (fMRI) and high temporal (MEG, TMS and EEG) resolution and by developing advanced data analysis tools to extract relevant information from the highly complex signals which these systems provide. In recent years, some aspects of both the cognitive and the methodological research have been combined in projects related to the brain-computer interface, work for which both a deep understanding of brain functioning and technical excellence are required.

All research at the DCCN is done within the context of the Donders Institute for Brain, Cognition and Behaviour. Research is organized in Principal Investigator (PI)-led groups, which each work within one of the four major research themes of the Institute.

\textbf{Language and Communication}

A fascinating challenge in cognitive neuroscience is to construct a device that would translate brain signals into speech. A device of such kind could restore communication to aphasic patients with severe word finding problems, due to their inability to retrieve the word-sound patterns.
With this goal in mind, researchers investigated the brain activity related to representations of particular concepts that are part of the system of conceptual knowledge. In a series of experiments they used state-of-the-art machine learning techniques combined with EEG and fMRI. They also explored patterns of brain activity that are characteristic for the processing of different semantic categories, e.g. animals and tools. Researchers learned to predict the category of a perceived object from EEG or fMRI in individual subjects at the single-trial level. Moreover, it was possible to localize the shared substrate for semantic processing when the object was presented in different modalities, such as a picture of a dog, the auditory or visual word “dog” and the sound of barking.

The PI working on this theme is Prof. Hagoort.

Perception, Action and Control
Researchers within this theme explore how perceptual and conceptual information can structure action plans as well as the brain dynamics that make human action possible. It has been shown that planning and understanding actions designed to change the mental state of other people (communicative actions) rely on shared neuronal computations operating over temporal scales that are independent of transient sensorimotor behaviour. This finding indicates that human communication relies on shared inferential mechanisms, rather than sensorimotor couplings.

How is visual information represented in the brain and how are visual representations adjusted to better serve behavioural demands? Research has focused on these and other questions relating to the neural basis of visual perception. Results have shown that extensive training on a visual task can lead to targeted functional reorganization of the visual cortex, which refines the cortical representation of behaviourally relevant information. Researchers in this group also explore the extent to which perceptual uncertainty is represented in the human visual cortex.

The mechanisms of individual and interactive decision-making are investigated. One group studies how social factors such as trust, fairness and cooperation change choices, in contrast to ‘rational’ models of behaviour, and also constructs biologically-based models of emotional influences on decision-making, such as guilt and empathy. Results show that expectations of social exchange can radically alter decisions and that affective factors play an important role in decision-making. These findings are strengthened by examining the neural systems underlying interactive choice.

How do we control our emotions and emotional actions? Research has shown that frontal control over limbic structures is critical to controlling emotional actions and that steroid hormones such as testosterone have an important impact on these neural structures. The researchers apply multiple neuroscience techniques (such as fMRI and EEG) as well as direct hormonal and neural interventions for mechanistic testing of the systems involved in healthy individuals and in patients with anxiety and aggression-related disorders.

Brain mechanisms of motivation and cognition are assessed, with the ultimate translational aim of improving the treatment of neuropsychiatric disorders that are characterized by motivational and cognitive problems. Two key findings were published in 2013. Firstly, researchers used a genetic approach to establish the facts that dopamine and serotonin are important for different forms of cognitive flexibility. Secondly, it was shown that dopaminergic drug effects on cognition can be predicted from individual differences in structural brain connectivity.
The PIs working on this theme are Prof. Toni, Dr de Lange, Dr Jehee, Dr Sanfey, Prof. Roelofs and Prof. Cools.

Plasticity and Memory
How does the brain map space and form memories? For the first time, DCCN researchers were able to decode the distribution of cell-type specific representations of space in humans at the level of cortical layers. In addition, it was shown that memory retrieval is driven by hippocampal attractor dynamics and researchers provided initial evidence for spatial remapping in humans. In sum, DCCN’s results open up the possibility of a detailed meso-level description of a memory map in the human brain.

Information on the research line ‘Memory and Emotion’ headed by Prof Fernández can be found in the section on the Donders Centre for Neuroscience.

The PIs working on this theme are Dr Döller and Prof. Fernández.

Brain, Networks and Neuronal Communication
The Neuronal Oscillations group investigates how oscillatory brain activity is involved in routing information between brain regions. This group has shown that alpha band oscillations (10-12 Hz) in sensory regions are under top-down control. Bottom-up processing is reflected by gamma band activity (30-100 Hz) controlled by alpha oscillations. There has been particular focus on understanding the interaction between alpha and gamma oscillations. To do so the group has been using different techniques in various combinations, including pharmacology, TMS and MEG, EEG and fMRI and animal data.

The ‘MR techniques in brain function’ group conducts research that is designed to improve the ability to measure brain function, structure, and connectivity using magnetic resonance techniques. To achieve these goals the group either develops novel techniques or improves existing methodologies. Areas of interest include the acquisition of fMRI data, diffusion tensor imaging and proton spectroscopy.

The Statistical Imaging Neuroscience group develops unified approaches to analyzing neuroimaging data in order to provide imaging neuroscientists with powerful multimodal research tools and clinicians with advanced practical tools. These tools are used to investigate cognition in clinical settings (dementias, MS, addiction and oncology) and in other challenging imaging scenarios, such as pharmacological studies and studies of early brain development in neonates.

The PIs working on this theme are Prof. Jensen, Prof. Norris and Prof. Beckmann.

Research facilities
• four MR scanners – dedicated to research at 1.5, 3, and 7 Tesla – for measuring structural anatomy and functional brain activity with high spatial resolution
• a 64-channel EEG system for measuring EEG in the MR scanners
• a whole-head, 275-channel MEG system, for measuring neuronal activity with high temporal and good spatial resolution
• two EEG laboratories and two behavioural laboratories
• integrated stimulus presentation and eye-tracking facilities
• centralized data storage and central computation power
• a laboratory for multimodal non-invasive brain stimulation (TMS-EEG, TCS-EEG).

Collaboration
Because the research carried out at the Institute is conducted in an international setting, the DCCN strives to collaborate with research institutes both nationally and internationally. The DCCN is a research centre at Radboud University Nijmegen, in which the University of Maastricht, as well as the Radboud UMC and the Max Planck Institute for Psycholinguistics participate.

The DCCN collaborates with the University of Duisburg-Essen, Germany – a preferred partner of Radboud University Nijmegen – on the operation of a joint research centre for high-field MR imaging, the Erwin L. Hahn Institute in Essen.

The DCCN is engaged in numerous structural collaborations with academic institutions, including those with:
• University of Würzburg, Germany (affective neuroscience)
• University of Aachen, Germany (computational functional anatomy)
• King’s College London, UK (neonatal imaging)
• University College London, UK (neural representation of space)
• National Institute of Mental Health, Bethesda, USA (neuronal mechanisms of memory)
• University of Trento, Italy (decision neuroscience)
• University of California, Berkeley, USA (cognitive control)
• University of Edinburgh, UK (memory consolidation)
• University of Oxford, UK (image analysis and imaging genetics)
• Heinrich-Heine Universität, Düsseldorf, Germany (multilingualism)
• Vanderbilt University, Nashville, USA (fMRI, visual processing).
• Boston University, Boston, USA (visual processing; computational modeling)
• Brandeis University, Waltham, USA (theory)
• Princeton University, Princeton, USA (animal electrophysiology).

Awards and acknowledgements
• Dr de Lange received the 2013 Cortex Prize (from the Federation of the European Societies of Neuropsychology)
• Dr de Lange received the 2013 James S. McDonnell Scholar Award for Understanding Human Cognition
• Prof. Cools became a Fellow of the Association for Psychological Science
• Prof Roelofs received a Vici grant from the Netherlands Organisation for Scientific Research (NWO)
• Dr Sanfey was elected to the Board of the Society for Neuroeconomics
• Prof Beckmann and Dr Döller received a Vidi grant from NWO.

Societal impact
Research conducted at the DI has considerable potential for benefiting society in the fields of clinical neuroscience, neurotechnology, education and food. A key aim is to contribute to a better understanding of the nervous system by disseminating expertise and knowledge to both the scientific community and the general public.

An annual series of courses entitled ‘The cognitive neuroscience tool-kit’ attracts students and researchers from all over Europe. Fieldtrip – an advanced analysis software package which is used to analyze MEG and EEG data – has been developed and made available to the neuroscience community.

During the past year researchers at the DCCN appeared in various Dutch TV and radio programmes, including BNN’s Je zal het maar hebben, VPRO’s Labyrinth and NTR’s Hoe?Zo! Research at the DCCN featured in many newspapers and on numerous websites. In particular, Shanti Ganesh’s research on avatars and Marijn Kroes’ research on altering memories attracted a great deal of press attention. Staff at the DCCN gave a number of lectures, including Prof. Roelofs, who gave lectures for the Ministry of Security and Justice and Dr Sanfey, who is working with the police on the potential relevance of neuroscience. During the University’s 90-year lustrum in May 2013 Prof. Cools and Dr Sanfey gave TEDx talks and Prof Cools gave a Lecture for 90 primary school children at Radboud-Kids. PhD students at the centre helped with the final projects of Dutch secondary school students and one of those projects – on spatial memory – won a prestigious annual Royal Netherlands Academy of Arts and Sciences (KNAW) prize. During the Brain Awareness week, researchers at the centre gave Master classes at various high schools, thus reaching out to hundreds of students.

The DCCN is actively involved in transferring knowledge to non-academic partners as well as for commercialization. The DCCN has several collaborative projects with companies. The centre participates in the BrainGain, VIP Brain Networks, and the FO-COM consortia and it collaborates with several commercial partners including Siemens and Abbott. Furthermore, the DCCN is active at the European level. It participates in the EU-funded HealthPAC, ABRIM and Agressotype consortia and Prof. Norris is a member of the Horizon 2020 Advisory Group for the Societal Challenge ‘Health, demographic change and wellbeing’.

Prof. Cools is a member of the board of the Rathenau Institute, which promotes the formation of political and public opinion in relation to science and technology. DCCN’s researchers are also involved in setting up new companies. For example, Prof. Beckmann founded SBGneuro Ltd, a company that is helping pharmaceutical companies which are engaged in drug development. A collaboration with DSM resulted in a joint patent application for functional food.

Future research
Language and Communication
Future work will focus on various aspects of language production as well as related structural and functional changes. The balance and relationship between universal linguistic characteristics and individual variations, and how cognitive systems such as memory, action and control relate to language will be studied in the Language in Interaction project (NWO Gravitation).

Perception, Action and Control
Research will focus on the mechanisms that allow people to acquire and use shared knowledge during non-verbal communication as...
well as how the control of communicative actions differs from that of instrumental actions, both at the computational and at the neuronal level. This research is co-funded with an NWO Vici grant.

Assessments of the efficacy of psychopharmacological treatment in psychiatry (an NWO Vidi project) will be extended to include the effects of motivational manipulations for enhancing cognition (James McDonnell Scholar Award).

Research is expanding, both by zooming in on the mechanisms of visual expectation at the level of the cortical column, and zooming out to include interactions between motor, language and memory systems and perceptual experience (funded by a James McDonnell Scholar Award).

The way in which visual information is represented in the brain will be investigated as well as how visual representations are adjusted
to better serve behavioural demands. These and other issues are addressed using both theoretical modelling and experimental approaches, including functional brain imaging, neural decoding techniques and visual psychophysics.

Researchers will continue working on examining how social motivations such as trust, fairness and cooperation affect decision-making and will explore the relevance of these findings for social policy. This research is funded by an ERC Starting Grant.

The role of primary defensive freeze-fight-flight reactions in developing psychopathology will be assessed in developmental samples and in police officers at risk of developing post-traumatic stress symptoms. These research projects are funded by an ERC Starting Grant and an NWO Vici grant, respectively.

Research within the Plasticity and Memory theme
Researchers seek to understand the mechanisms of memory organization in the brain and test the overarching hypothesis that memories are stored in mnemonic networks. New studies will examine how these networks evolve, how they can be reconfigured and how they drive future decisions. This research is funded by an ERC Starting Grant and an NWO Vidi grant.

Brain, Networks and Neuronal Communication
The role of oscillatory brain activity will be investigated using multimodal approaches that employ combinations of MEG, EEG, TMS and fMRI. In particular, the role of phase of the brain oscillations will be investigated using these techniques as well as cross-frequency analysis. This knowledge will be incorporated in realistic physiological neuronal network models. The research is co-funded by Veni, Vici and other NWO grants.

Researchers will continue to explore the use of simultaneous multi-slice imaging, combined where necessary with low power radiofrequency pulses. These will be applied to increase the sensitivity of MR angiography and to make T2 and diffusion-weighted imaging more efficient at high static magnetic field strengths. This will partially be done in collaboration with Siemens. The development and application of layer-specific fMRI will be continued and extended to the language network.

New methods for characterizing the dynamics of functional anatomy and connectivity gradients in health and disease will be developed, as will new techniques for functional fingerprinting, with the goal of defining more specific targets for biomarker development. This research is funded by the Wellcome Trust, NWO (Vidi), Marie Curie, ERC Synergy and NIH blueprint programmes.
The researchers at the Donders Centre for Neuroscience aim to reveal biologically plausible mechanistic accounts for neural processes at the brain system level that underlie processes such as language, perception and cognitive control as well as long-term changes in neural structure and function underlying development, adaptation and memory. This fundamental research is closely related to clinical and technological applications.

The Donders Centre for Neuroscience (DCN) was founded in 2008 as part of the Donders Institute for Brain, Cognition and Behaviour (DI). It includes all of the neuroscience activities at the Faculty of Natural Sciences, Mathematics and Informatics (FNWI) as well as at the Radboudumc. Within DCN research is organized along the lines of the four Donders themes.

In DI Theme 1, DCN researchers study the genetic – and thus the molecular – basis of neural processes that enable language capabilities.

DCN Principal Investigator (PI) in theme 1 is Simon Fisher, a professor at the FNWI and director of the Max Planck Institute for Psycholinguistics.

Research in DI Theme 2 focuses on the neural processes underlying perception, action and control within three focus areas: (a) Perception – the neural underpinnings of visual and auditory perception in relation to developmental and acquired hearing impairments and impairment of vision. (b) Action – the basic and cognitive determinants of motor action as they are impaired in movement and muscle disorders. (c) Control – the mechanisms enabling on-going control of behaviour and emotion (in relation to disorders such as attention deficit hyperactivity disorder (ADHD)).

DI Theme 3 focuses on the mechanistic underpinnings and behavioural consequences of long-term changes in neural structure and function. Here, too, are three focus areas: (a) Development – the study of the determinants, mechanisms and consequences...
of normal and abnormal neurodevelopment, with a strong translational drive towards intellectual disability and autism. (b) Adaptation – the study of the neurobiological mechanisms underlying responses to environmental challenges which may lead to stress-related mental disorders such as mood and anxiety disorders. (c) Memory – focusing on the neural and psychological mechanisms underlying memory and disorders relating to memory impairments such as Alzheimer.

DI Theme 4 research focuses on brain networks and neuronal communication in order to reveal the fundamental principles of how local circuits compute in the brain. Both the role of spike timing and neural oscillations in selective attention are studied. Innovative experimental techniques applied together with computational models and mathematical analyses. Moreover, theoretical principles of reasoning and acting in noisy and uncertain environments are formulated and investigated and, using optimal control techniques.

Research facilities

The Clinical Neuroscience Unit (CNU) provides an interactive and efficient use of the available expertise and instrumentation for clinical investigators. It facilitates research that involves the assessment of brain function and structure as well as interventions designed to influence brain function in order to improve the diagnosis and treatment of neurological and neuropsychiatric disorders.

The Translational Neuroscience Unit (TNU) is a preclinical technology platform that is devoted to in-vivo and in-vitro neurosciences, focusing on a system-level approach to understand brain-based diseases. TNU provides behavioural researchers with state-of-the-art equipment as well as invasive measurements and manipulations, including optogenetics, microdialysis, multi-unit recordings, and highly sensitive biosensors. TNU bridges fundamental and clinical research by linking molecular, neuroimaging and clinical research.

Researchers working in the Neurophysics Unit (NPU) carry out model-inspired experimental, neurotechnological and neurocomputational research, comprising Biophysics, Neuroinformatics, Neurophysiology, Machine learning and they run the Donders Hearing & Implant Lab of Otolaryngology. The group has technical support staff, human psychophysics setups, and a state-of-the-art monkey electrophysiological facility.

Collaboration

The DCN collaborates both nationally and internationally with partners who have complementary expertise and with whom there is the potential for synergy. In the years ahead, the DCN will leverage its European contacts to tackle some of the ‘grand challenges’ outlined in the new European research agenda Horizon 2020. In 2013 many new grants were awarded to DCN researchers working either as a coordinator or as a participant in large EU research consortia. These are:

- Healthpac (Perception and Action in Health and Disease) – a European integrative doctoral programme (IDP) that unites research institutes in Zürich, London, and the Netherlands with seven European companies. DCN PI John van Opstal leads this consortium.
- Aggressotype – a large EU-funded project on pathological aggression in children and adolescents with attention deficit/hyperactivity disorder (ADHD) and conduct disorder (CD). It brings together 23 academic and private sector partners from 11 countries. DCN PI Barbara Franke coordinates this project.
- Matrics – a large EU-funded consortium that brings together 19 European academic and industrial partners and interacts with the Aggressotype consortium. DCN junior PI Jeffrey Glennon coordinates this consortium.
- DCN will contribute its knowledge and expertise in neuroinformatics to The Human Brain Project which was selected by the EU as one of two flagship projects.
Research results
In 2013 the €27.6 million Gravitation Programme ‘Language in Interaction’ was officially launched.

Theme 1 – Language and Communication
Prof. Fisher’s group (Neurogenetics of speech and language) revealed that targets directly regulated by the FOXP2 gene have been subject to Darwinian selection in recent human evolution. These findings are intriguing, given that FOXP2 mutations have been shown to play a role in speech and language disorders, and that the gene itself shows evidence of adaptive evolution.

Theme 2 – Perception, Action and Control
Perception:
The group led by Prof. van Opstal (Auditory system, gaze control & executive functions) found that the growth of ears (auricles) that occurs with age is related to sound localization and plasticity.
The group led by Prof. Van Wezel (Visual neurophysiology) showed that fMRI resting state fluctuations in the visual cortex may be a composite signal of different overlapping sources.

Action:
Prof. Bas Bloem and colleagues (Neurological movement disorders) found evidence that postural responses to backward and forward perturbations may be processed by different neural circuits, combined with the influence of startle pathways on postural responses to backward perturbations. These findings may explain the prominent backward instability seen in patients with Parkinson’s disease.

Control:
The group led by Prof. Buitelaar (Developmental neuropsychiatry) showed that EEG neurofeedback treatment for children with ADHD has failed to improve clinical symptoms and cognitive functioning. This finding challenges the efficacy of EEG neurofeedback, and questions the reimbursement of EEG neurofeedback by health insurance companies. The group led by Prof. Verkes (Disorders in the regulation of impulses and aggression) found evidence for gene-environment interaction in alcohol dependence. Individuals that carry a low-activity Met allele have a higher risk of developing severe alcohol dependence than individuals who are homozygous for the Val allele.

Theme 3 – Plasticity and Memory
Memory:
The group led by Prof. Olde Rikkert showed that cognitive function in elderly people with memory complaints can be reliably assessed with serious games, either in the hospital or at home. Prof. Marcel Verbeek and his colleagues (Neurochemistry of neurodegeneration) identified novel miRNAs as biomarkers for Alzheimer disease and identification of practical limitations to the quantification of miRNAs in CSF.

Development:
The group led by Prof. Franke (Genetics of Brain Function and (Psychiatric) Malfunction) showed that specific Single Nucleotide Polymorphisms (SNPs) are associated with a range of psychiatric disorders. In particular, variations in calcium-channel activity genes seem to have pleiotropic effects on psychopathology.
The group led by Prof. Van Bokhoven (Molecular neurogenetics) published several papers on their findings on the role and mechanism of epigenetic modifications (posttranslational histone modifications) in development, neurodevelopment and memory formation.

Adaptation:
The group led by Prof. Fernández (Memory and emotion) found that even early in the course of depression, brain regions involved in mood regulation show trait-related differences in cortical thickness in the paralimbic cortex, which is involved in mood regulation.

Theme 4 - Brain Networks and Neuronal Communication
The group led by Prof. Celikel (Neurophysiology) showed that one of the signalling proteins involved in cell-to-cell interaction is a key regulator of cognitive decline in aging.

Perception:
The group led by Prof. Kappen (Machine learning) found a novel method for detecting missing heritability in genetic data using Gaussian Processes and sequential Monte Carlo methods. As a result, they revealed for the first time most missing heritability in 46 yeast data sets. Prof. Francesco Battaglia and co-workers (Neuronal networks of memory) showed that the effective network structure that is induced by experience-related activity is mirrored in the subsequent sleep period.

Awards and acknowledgements
- Piray Atsak won a EBBS (European Brain and Behaviour Society) Young Investigator award.
- The Radboud Science Award 2013 went to Hans van Bokhoven and Arjan de Brouwer.
- Christian Döller was awarded an NWO Vidi grant for his research proposal ‘Mapping the memory landscape’.
- Erno Hermans and co-authors were awarded the Editors’ Choice Award of the Organization for Human Brain Mapping.
- Barbara Franke received an NWO Vici grant for her proposal ‘Fruit flies for ADHD research’. She also received the University’s Hermesdorf Award in the category ‘International’ for the media coverage of her research in 2012.
• The Young scientist award from the European Stroke Conference went to Ellen van der Holst.
• Carla Scholzel Dorenbosch was awarded the Quality of life in dementia-award.
• Richard van Wezel was granted a NUTS/Ohra fund.
• Marjolein Willemsen received the Isabelle Oberlé Award for her outstanding presentation on intellectual disability.

Societal impact
Brain research generates substantial societal interest, underscoring the importance of neuroscience-related research. Activities that are designed to increase the societal impact of DCN research target a wide variety of stakeholders, including clinics, patients and patient organizations (newsletters and magazines), high-school students (Master classes), the general public (open days), the media (TV, newspapers and news sites), companies (R&D cooperation, development of new technology), third parties (NFU; Dutch federation of academic medical centres), court, GGZ (Geestelijke GezondheidsZorg) and peers.

A selection of these activities are listed below:
• Prof. Buitelaar participated in a public debate on classification in psychiatry, and its ethical and societal implications in the philosophical café in Utrecht;
• Dr. Den Ouden received a great deal of media attention (radio, TV, magazines) for her finding that serotonin and dopamine linked-genes influence how we base our choices on past punishments or rewards, and that this impact depends on which gene variant is inherited from parents.
• Prof. Geurts gave several courses on neuro-rehabilitation to allied health professionals organized by the Dutch Paramedic Institute (NPI).
• Prof. Roozendaal was featured in NTR Clipphanger ‘Wat is adrenaline’ and in VPRO-NTR Labyrinth-TV ‘Het gestresseerde geheugen’.
• The Kappen group gained a lot of attention due to the application of their successful Bonaparte software tool in the 13-year-old ‘cold case’ of Marianne Vaatstra, which led to the identification of the perpetrator.
• The group led by Prof. Bokhoven explained the genetic defects in dystroglycanopathies in an article in the ‘Prinses Beatrixfonds Spierkrant’.
• The group led by Dr. De Leeuw participated in a public awareness campaign about risk factors for stroke.
• The research by the group led by Prof. Fernández on how emotional memories might be deleted generated media attention around the globe, including the front page of the Wall Street Journal, NRC, BBC, Time Magazine and the Times.
• Prof. Franke spoke about dyslexia and the influence of genes on the functioning of the brain on the ‘Hersenstichting Publicksdag’.
• Neuropsychiatrist Prof. Verkes participated as an expert in conferences on criminal law, forensic psychiatry and forensic care.

Clinical applications and other notable developments:
• The swallowing studies carried out by the Department of Rehabilitation with patients with neuromuscular disorders resulted in adjustments of international protocols for standards of care for these patients.
• Prof. Olde Rikkert and his colleagues developed an Aging Monitor-Cognitive assessment BAMCOG, which is used to assess cognitive functioning in aging employees.
• Prof. Celikel’s group developed a wireless photostimulator for remote neural control, a robotic animal trainer, and novel algorithms to study structures from functional images of the brain.
• The group led by Prof. Steegeman developed a highly accurate Finite Element Model (FEM) for predicting transcranial direct current stimulation (tDCS) and transcranial magnetic stimulation (TMS) currents in brain structures.
• A patent was registered by a public-private consortium including Prof. Fernández: Protein hydrolysates as agents for overcoming addiction (European Patent Office: 12717282.3-1456, 26.04.2012).
• The researchers in the group led by Prof. Verbeek developed an algorithm for estimating the risk of Alzheimer based on cerebrospinal fluid investigations.
Key publications


Dissertations: 45
Scientific publications: 795
Professional publications: 2
Future research

Causal neuroscience

The brain is functionally structured at multiple levels, from local microcircuits of a few hundred neurons to brain networks that involve billions of neurons. Causal neuroscience uses experimental and data analytic tools to establish causal relationships between (micro)circuit changes and behaviour. Optogenetics disrupt these circuits by activating or inactivating specific cell types. DCN researchers will combine this “circuit–interrogation” with closed-loop stimulation using robotics and behavioural experiments. They also incorporate machine learning, databasing and model building approaches in order to draw quantitative conclusions.

Applied neuroscience

In order to help hearing-impaired patients, novel psychophysical techniques will be combined with NIRS-EEG imaging, advanced data acquisition and analysis algorithms to optimise hearing devices on an individual basis. In addition, novel learning paradigms will be developed as treatment strategies for sensory impairments with a central-nervous-system origin. Behavioural psychophysics (eye-hand and eye-head motor control, vestibular control) will be used to discover and characterize early markers for neurocognitive and neurodegenerative disorders.

Clinical neuroscience

The long-term goal is to understand the pathophysiological processes underlying neurological symptoms and mental disorders. This will enable (or improve) personalized care involving causative treatment and prediction of vulnerability. Neurocognitive and pharmacological research will enhance our understanding of the effect of psychotropic drugs and brain stimulation on social behaviour. The use of neuroimaging techniques, animal models and genetics will lead to a better understanding of the involvement of HPA-axis reactivity and the role of various neurotransmitter systems.

Translational neuroscience

Due to its complexity and the limits posed in research with humans, diseases of the brain can only be understood by taking a translational system-level approach. It is therefore a long-term goal to integrate in-vivo behavioural research using invasive electrophysiological, genetic, optogenetic and neurochemical measurements as well as in-vitro cellular and molecular techniques. Ultimately this will enable transfer of the results of molecular, electrophysiological, behavioural and imaging work in animals to human behavioural and neuroimaging research. Vice versa, it will enable the targeted use of animal models to help understand the function of genes and brain mechanisms revealed in human studies.
At the Institute for Genetic and Metabolic Diseases (IGMD) scientists working in a range of disciplines are engaged in research on rare genetic and metabolic diseases, using a molecule-to-man-to-population-and-back-to-man approach.

Within the Institute’s nine inter-related research themes, fundamental, applied and clinical researchers work closely together to answer specific, patient-related research questions that are designed to reduce the incidence of mortality, as well as the severity and duration of morbidity resulting from genetic and metabolic diseases. The intention is to elucidate the pathophysiology of specific diseases, design novel diagnostic methods, develop innovative forms of treatment and enhance the effectiveness of personalized medicine.

Research themes

Functional imaging
Functional imaging and monitoring is of vital importance for diagnosis, treatment and follow-up. Researchers working within this theme develop and clinically evaluate innovative, non-invasive functional imaging and monitoring techniques such as 2D and 3D echography, NMR spectroscopy, Near Infrared Spectroscopy and radioisotope imaging (PET and SPECT). The aim is to achieve timely detection of tissue damage in patients with cardiac, cerebral, liver, vascular and pancreatic disorders.

Molecular gastro-enterology and hepatology
Researchers working within this theme focus mainly on polycystic liver disease (PCLD), an autosomal dominant rare disorder, providing a unique opportunity to study human cystogenesis. The aim of this translational programme is to investigate key intracellular signalling pathways in PCLD in order to find potential therapeutic targets that can be tested in clinical trials. A second research line involves preventing complications associated with severe intestinal failure.
Genomic disorders and inherited multi-system disorder
Genetic factors are important in most human diseases and traits. This group focuses on finding such genes in order to improve patient care. Topics include intellectual disability, congenital abnormalities, psychiatric disorders, brain development and individual responses to treatment due to pharmacogenetic factors.

Glycosylation disorders
This research focuses on the complex biosynthetic and catabolic pathways of glycans in health and disease, with an emphasis on Congenital Disorders of Glycosylation (CDG). In parallel with developing novel analytic techniques, the research group applies a wide range of biochemical, genetic and cell biological methods to identify new disease entities, improve current diagnostics and better understand pathophysiological mechanisms – all aspects that are crucial for future therapeutic strategies.

Healthy ageing / healthy living
Understanding the process of healthy ageing as well as the role of exercise and activity in senescence are the main topics of this research programme, which covers human in-vivo approaches down to the genetic level. The metabolic syndrome is one of the major focuses of researchers working in this programme. Risk factors that contribute to the metabolic syndrome such as dyslipidaemia, hypertension and insulin sensitivity are studied both separately and combined (in patients with multiple risk factors).

Hormonal regulation
Research within this theme focuses on patient care and research on adrenal diseases. This work takes place in the recently established Radboud Adrenal Centre (RAC), a centre of expertise for the diagnosis and treatment of adults and children with adrenal diseases. The four main areas of interest are hyper/hypocortisolism, congenital adrenal hyperplasia, pheochromocytoma and primary aldosteronism.

Iron metabolism
The focus of this theme is on identifying and characterizing novel factors that might mediate the dysregulation of iron homeostasis in some of the world’s most prevalent diseases, including anaemias, rheumatic diseases, haemochromatosis, bacterial and malarial infections, cardiovascular disease and hepatic iron overload, hepatitis C and the metabolic syndrome. The iron regulatory hormone peptide hepcidin is currently the subject of several translational studies.

Mitochondrial medicine
The aim of research is to develop new forms of treatment for diseases and adverse-health conditions in which mitochondrial energy capacity is reduced. Defects of the human oxidative phosphorylation system are among the most frequently encountered inborn errors of metabolism and studying patients with these devastating disorders has revealed important information about the role that mitochondria play in the normal process of ageing as well as in neurodegenerative diseases such as Parkinson.

Renal disorders
Within this theme the regulation of the physiological development of the kidney is studied in order to better understand the pathogenesis of acquired and inherited kidney disorders. The aim is to be able to diagnose and ultimately cure or prevent them. Research projects are carried out at the genetic (gene defects, polymorphisms), the molecular (transport proteins), and the cellular (glomerular and epithelial cells) level. The results of fundamental and clinical research are integrated.

Research facilities
The effectiveness of IGMD research – and improved patient care – depends on an excellent laboratory infrastructure. State-of-the-art technology platforms are at the heart of this infrastructure, offering unique research opportunities. The core components of the Institute are the clinical departments Paediatrics, Nuclear Medicine,
The Radboudumc has several technology platforms which are available for its researchers (see: www.ncmls.eu/technology-platform) including the Animal Facility, the Radboudumc Biobank, the Microscopic Imaging Centre, Micro-array Facility Nijmegen, the Nijmegen Proteomics Facility, the Centre for Molecular and Biomolecular Informatics (CMBI), the Clinical Research Centres Nijmegen (children and adults), and the GMP facility. In 2013 all of these technology platforms were evaluated and the Radboudumc Board of Directors has set goals for 2014 including optimisation of the Radboudumc research infrastructure. This will result in a well-balanced range of technology platforms that are 1) of excellent quality, perfectly meeting research needs, 2) more visible and accessible to researchers at the Radboudumc, external researchers and business partners, and 3) more efficiently and effectively managed as part of University-wide research facilities.

Collaboration

Researchers at IGMD are involved in a wide range of regional, national and international networks, collaborating with groups at many national and international universities, research institutes and companies. The reasons for collaboration include complementing strengths, creating synergy, recruiting talent and enhancing earning capacity in (EU) consortium grants. A few examples are:

- Dr M. Doyley, University of Rochester, New York, USA (NWO and NIH grant)
- Prof. P. Nuutila, University of Turku, Finland (EU grant)
- Prof. J. Banales, University of Navarra, Pamplona, Spain (Zambon finance)
- Prof. V. Torres, Mayo Clinic, Rochester, USA (Novartis finance)
- Prof. X. Estivill, Centre for Genomic Regulation, Barcelona, Spain (EU grant)
- Prof. B. Kirchhof, University of Cologne, Germany
- Prof. G. Matthijs, University of Leuven, Belgium
- Prof. R Gerardy-Schahn, Hannover Medical School, Germany
- Prof. B. Levine, IEEM’s Environmental Physiology Laboratory, Dallas, USA (NIH grant)
- Prof. T. Cable, John Moores University, Liverpool, UK (EU grant)
- Prof. G. Eisenhofer, University of Dresden, Germany (EU grant)
- Prof. M. Schmitt, Technical University of Munich, Germany (EU grant)
- Prof. G. Weiss, Medical University of Innsbruck, Austria (EU grant)
- Prof. D. Turnbull, University of Newcastle upon Tyne, UK (EU grant)
- Prof. M. Zeviani, MRC Cambridge, UK (EU grant)
- Prof. O. Devuyst, University of Zurich, Switzerland (EU grant)
- Dr D. Miller, National Institute of Environmental Health Sciences, Durham, USA.

Research results

Many new research results were published in high ranking scientific journals. A selection is presented below.

Using a combination of enzymatic testing and whole exome sequence analysis, Dr R. Rodenburg, Prof. J. Smeitink and colleagues reveal the underlying genetic defect of two siblings with fatal neonatal mitochondrial encephalopathy: a heterozygous mutation in the ATP5A1 gene resulting in complex V deficiency. This study demonstrates the importance of functional studies in the diagnostic work-up of mitochondrial patients, in order to guide genetic variant prioritization and validate gene defects.

Dr A. Bouwer, together with others in the Genomics group, applied whole exome sequencing in order to identify mutations in MED12 as the cause of the X-linked Ohdo syndrome, a heterogeneous group of disorders characterized by intellectual disability. Together with other recent data, these findings suggest that aberrant chromatin modification is central to the pathogenesis of Ohdo syndrome.

Dr E. Morava, Dr D. Lefeber and colleagues performed a thorough genetic and biochemical analysis on a patient with intellectual disability and bleeding diathesis. They confirmed an autosomal recessive, generalized sialylation defect due to mutations in SLC35A1, underlining the importance of sialylation for normal CNS development and regular organ function.

Several major results were obtained in 2013 by investigators working in the Department of Ophthalmology. Dr A. den Hollander and colleagues revealed that a functional variant in the CFI gene confers a high risk of age-related macular degeneration (AMD). With these findings they show that rare, highly penetrant mutations contribute to the genetic burden of AMD. A second study carried out by this group demonstrates that mutations in RAB28 – encoding a farnesylated small GTPase – are associated with autosomal-recessive cone-rod dystrophy, revealing a crucial role for RAB28 in photoreceptor function and suggesting that mutations in other Rab proteins may also be associated with retinal dystrophies. Prof. F. Cremers and Dr R. Collin show that ZNF408 is mutated in familial exudative vitreoretinopathy, a disorder which can result in severe visual impairment and is crucial for the development of zebra fish retinal vasculature.

Major comments and reviews were published in high-impact journals, including the New England Journal of Medicine, Neuroscience and Biobehavioral Reviews, Nature Reviews Neurology, Nature Reviews Gastroenterology & Hepatology, Current Opinion in Genetics & Development and The EMBO Journal.
Dr J. Veltman received the ‘ZonMw Parel’ from the Netherlands Organisation for Health Research and Development for his research on ‘Human genomic disorders and genomic architecture’.

Several young IGMD researchers received Young Investigator awards and poster prizes from FEBS, EMBO and the American Association of Pharmaceutical Sciences.

Societal impact
On an individual basis Genetic and Metabolic diseases are considered to be rare diseases, although as a group they represent a substantial health burden. Research within IGMD is designed to reduce the incidence of mortality, as well as the severity and duration of morbidity resulting from these diseases and to raise political and public awareness about the need to develop adequate treatments, which are, in most cases, not yet available. Members of the IGMD therefore participate in a number of governmental advisory boards, including the Dutch Health Council, as well as in numerous national and international patient organizations. They frequently promote research at meetings involving the general public as well as at conferences and other forums. The Institute actively encourages collaboration between pharmaceutical companies and academia.

Several clinic studies were performed, the outcomes of which have direct implication for clinical practice. Prof. C. Tack, Dr B. de Galan and colleagues described the phenomenon of patients with type 1 diabetes exhibiting altered cerebral metabolism during hypoglycaemia, indicating that the brains of these patients are better able to endure moderate hypoglycaemia. Prof. J. Drenth and colleagues performed a randomized controlled trial indicating that Everolimus does not further reduce polycystic liver volume when added to long acting octreotide. Diagnostic exome sequencing has been implemented in daily clinical practice for several genetic disorders, such as inherited blindness, deafness, mitochondrial disorders and intellectual disability.

Awards

Prof. H. Brunner was elected to the Royal Netherlands Academy of Arts and Sciences and honoured with the highly prestigious Knight of the Order of the Dutch Lion for his service to medical research and the discovery of the genetic causes of over fifty rare syndromes.

Prof. J. Smeitink was elected as a member of the Academia Europaea and Advisory Board Member of the MRC Mitochondrial Biology Unit in Cambridge, UK. The Finnish Research Council for Health nominated Prof. Smeitink as a scientific advisory board member at the Centre of Excellence in Research on Mitochondria, Metabolism and Disease, which is led by Prof. Howard Jacobs.

In 2013 three IGMD investigators were awarded the highly prestigious Netherlands Organisation for Scientific Research (NWO) Vici grant, which is worth €1.5 million. Prof. B. Franke will use the grant to investigate the biological causes of ADHD through genetic research on fruit flies in combination with MRI scans of the human brain. Prof. J. Hoenderop will study the genetic aetiology and underlying pathophysiology of rare and acquired disorders in order to reveal physiological and pathophysiological processes related to Mg2+ in the human body and develop new therapies. The aim of Dr R. Roepman’s project is to explain the processes of ciliary signal transduction and the causes of ciliopathies, with the ultimate goal of developing antagonizing drugs that can be used to treat this group of severe diseases.

Two investigators were awarded prestigious NWO Vidi grants. Dr D. Lefeber aims to unravel the regulatory pathways that supply the sugar building blocks for membrane-bound dystroglycan glycosylation in muscle, brain and eye. Defects in this glycosylation process result in severe disorders such as muscular dystrophies, and new insights will make it possible to identify therapeutic targets. Dr R. Stienstra will investigate whether a problem in cleaning up old fat cells causes inflammation in adipose tissue, which subsequently leads to the development of diabetes.
Key publications


Khondrion is a spin-off company founded by Prof. Smeitink in order to develop treatment for patients with mitochondrial disease. In 2013 Khondrion received a large EU Marie Curie ITN grant to support the formation of a network with eight basic and translational laboratories and three associated partners, who will provide professional tools for training PhD students and disseminating knowledge.

Within IGMD, a task force has been set up to combine knowledge and expertise in clinical research, as well as the diagnosis and treatment of rare diseases. In line with the National Plan on Rare Disease, IGMD research groups have registered their activities as expert centres on the Orphanet website, in order to make these activities more visible to the international research community, to patients and patient organisations, and to the pharmaceutical industry.

Prof. J. Smeitink was invited by the Netherlands Federation of University Medical Centres and the Ministry of Public Health, Welfare and Sport, to present recent developments in mitochondrial research and to give his view on current and future diagnostics and treatment for patients with rare diseases.

Many other IGMD investigators have contributed to public discussions and events in order to explain the societal impact of their research. For example, Prof. M. Hopman performed physiological exercise measurements during the ‘Nijmegen Vierdaagse wandeltocht’ and Prof. J. Smeitink and his team organized the Mitochondrial Disease Information Day 2013 for patients and their parents.

Future

Researchers will continue to elucidate the pathophysiology of specific rare diseases in an attempt to develop novel diagnostic methods and innovative forms of treatment. Examples of new projects include:

• research designed to identify the disease causing variants and genes in Intellectual Disability disorders with the aim to provide novel insights into genetic control of cognition and improve diagnosis, personalized patient support and treatment (Dr B. de Vries, Prof. J. Veltman and Dr A. Schenck, ZonMw TOP grant)
• research on identifying ways of recognizing genetic variations in the normal population (Dr C. Gilissen, Veni grant);
• deciphering the role of defective Wnt signalling in hepatic cystogenesis (Prof. J. Drenth and Dr R. Roepman, IGMD grant)
• studying the opportunities for sweet regulation in mitochondrial disease (Dr D. Lefeber and Dr L. Nijtmans, IGMD grant)
• investigations designed to help understand the role of iron in kidney injury (Prof. D. Swinkels and Dr R. Masereeuw, IGMD grant)
• developing gene augmentation therapy for EYS-associated retinitis pigmentosa, employing a unique canine model with mutations in EYS (Dr R. Collin and Dr J. Klevering, IGMD grant)
• studying the mechanisms of protein-specific glycosylation, using mass spectrometry and 13C metabolic flux analyses (Dr M. van Scherpenzeel, FEBS and EMBO grant)
• investigating novel metabolic steps in the polyprenoid biosynthesis pathway, which is the crucial first step in protein N-glycosylation (Dr D. Lefeber and Prof. E. Swiezewska, Polish Academy of Sciences grant).
The main aim of the Research Institute for Oncology is to promote innovations in translational research in oncology and to reduce the morbidity and mortality rates of cancers. Researchers in several disciplines work together to reveal the pathology of tumours, develop new diagnostics and therapeutic strategies, and improve standards of care.

The Institute was founded in 2008 to coordinate and strengthen research in oncology and oncology-related topics. Built on a long-standing tradition and the strong reputation of existing research groups, the Institute works closely with the Radboud University Centre for Oncology (RUCO; the clinical centre).

The key principles of the Institute are:
• Research is patient-centred and relevant to patient care.
• Research is arranged in multidisciplinary themes that deliver added value beyond existing structures.
• Close collaboration with other University research institutes such as NCMLS and NCEBP is considered essential.

The Institute’s research themes are:

Theme 1. Imaging & biomarkers
The focus here is the diagnostic/prognostic efficacy and effectiveness of biomarkers, imaging techniques, cancer screening (general population) and routine follow-up policies (clinical population).

Theme 2. Genetics & heredity
The assessment of genetic factors is increasingly important for personalized treatment of cancer. Both cancer predisposing factors in the germline as well as tumour-specific genetic and epigenetic changes are studied in order to better understand the aetiology and clinical behaviour of tumours with the aim of optimizing diagnosis and surveillance as well as selecting and monitoring the most effective treatments.

Theme 3. Local therapies
Local therapies include diagnostic and therapeutic challenges associated with a variety of treatment options, including surgery, minimally invasive interventions, radiotherapy and combinations of these treatments.
Theme 4. Systemic therapies
The aim of targeted therapy is to optimize systemic therapies (i.e. select those with the fewest possible side effects). This is achieved through a multidisciplinary approach in the diagnostic and therapeutic phase of treatment, and with the translation of basic research to the clinic and vice versa. Besides a focus on specific tumour types, research also addresses the targets and molecular pathways in a variety of tumours in order to maximize benefit from the available knowledge and expertise across different tumours types and new targets for therapy. In addition, cellular therapies using cells of the immune system are being developed and tested in clinical trials.

Theme 5. Innovation in Care & Epidemiology
This theme includes research on measuring and improving the quality of life – and care – for cancer patients and their families during all phases of the disease, evaluating the effectiveness and economic implications of health care interventions, shared decision making, and epidemiological research on lifestyle and molecular/genetic factors for cancer aetiology, diagnosis and prognosis.

In 2013, the third Science Day of the Research Institute for Oncology – entitled Radboud Personalized Oncology – provided an opportunity to meet with colleagues and PhD students and discuss new ideas. The students participating in the Cancer Research block of the Bachelors programme Biomedical Sciences were invited to strengthen the connection between research and education. This day was again received with great enthusiasm and a scientific summary will be made available for medical specialists in their specialized news journal Oncology up to date.

Research facilities
The Institute supports both technological and non-technological platforms that are crucial to its research and serve the needs of other research institutes. These include Imaging, e.g. the Preclinical Imaging Centre PRIME, the Microscopy centre, High-throughput genomics, Proteomics, Clean-room facilities, a unit for the clinical application of new drugs, a unit for psychosocial research tools, Bio-informatics and Biostatistics, the Central Animal Facility, The Minimal Invasive Treatment expertise Centre (MITec), databases and biological banks of cancer patient groups such as PSI and the Comprehensive Cancer Centre Netherlands (IKNL).

Collaboration
Researchers at the RIO collaborate with those at many other centres and institutes around the world. RIO promotes the role of Radboudumc oncological researchers in consortia in order to fully exploit the strengths of oncological research within RIO and secure funding. Some examples:
- The Comprehensive Cancer Centre Netherlands (IKNL).
- The National reference centre for screening breast cancer.
- The Dutch Imaging Hub (Radboudumc, VUmc and UMC Groningen) focused on developing molecular imaging in oncological research.
- European Organisation for Research and Treatment of Cancer.
- The MD Anderson Cancer Center, Houston, TX, USA, (collaborative projects on the genetics of urological cancers).
- The Wisconsin Institutes for Medical Research, Medical Physics and Human Oncology, Madison, WI, USA.
- The World Sarcoma Network, a group led by the main reference centres around the world dedicated to developing and supporting innovative and collaborative clinical trials and sarcoma drug development, plus a number of global RARE CANCER Initiatives (international transatlantic collaborations).
• The head and neck oncology group works with the Institute of Cancer Sciences at the University of Manchester, UK on tumour hypoxia and gene signatures; University of Wisconsin School of Medicine on EGFR signalling; Muhimbili University Health & Allied Services in Dar es Salaam, Tanzania; and the National Dental Centre Singapore of Sing Health University on mandibular constructions.
• Philadelphia University in paediatric oncology, and with University of California Los Angeles in supportive care and e-health.

Research results
The group led by Dr Roland Kuiper published on the discovery and effects of germline mutations in the Spindle Assembly Checkpoint Genes BUB1/3 in Colorectal Cancer (in Gastroenterology) and contributed to a publication in Nature Genetics on lymphoid transcription factor gene PAX5 in acute lymphoblastic leukaemia in children.

The group led by Dr Paul Span contributed to the wide study published in Nature on somatic mutational processes in different cancer types entitled: “Signatures of mutational processes in human cancer”.

Prof. Iris Nagtegaal and Prof. Han van Krieken published in Nature Reviews Gastroenterology and Hepatology a review on the newest development in classification of colorectal cancer.

Dr Annemarie Boleij and Dr Harold Tjalsma published in The Lancet Infectious Diseases their view on bacterial features that determine the specific association between Streptococcus gallolyticus and colorectal cancer and how infections with this opportunistic gut pathogen can be exploited for the early detection of malignant colonic disease.

Dr Petra Muus published in New England Journal of Medicine the study on the effect of the ecuizumab on complement-mediated thrombotic microangiopathy and renal function.

The group led by Prof. Peter Mulder, Prof. Otto Boerman and Prof. Wim Oyen published on novel diagnostic tool in clear cell renal cell carcinoma using the Indium-111-labeled girentuximab immunoSPECT. This publication was chosen a Best Fundamental Research Paper published in European Urology in 2013.

The group led by Dr Harry Dolstra published in PLOS One the study on Natural Killer Cells Generated from Cord Blood Hematopoietic Progenitor Cells Efficiently Target Bone Marrow-Residing Human Leukemia Cells in NOD/SCID/IL2Rgnull Mice.

The group led by Prof. Jolanda de Vries published in Cancer Research the first clinical study of therapeutic vaccination against cancer using naturally occurring plasmacytoid dendritic cells (pDC), and in Blood the findings on the cross-presentation capacities of this naturally occurring human DC subset.

The group led by Prof. Hans de Wilt described in Breast Cancer Research and Treatment their four years’ experience of one-day core needle biopsy in a breast clinic.

Awards and acknowledgements
In 2013, the achievements of a number of scientists within the Institute were recognised by both national and international organisations.
• Dr Jeroen Hasselaar and Dr Marieke Groot received an EU grant for their project Patient-centred palliative care pathways in advanced cancer and chronic disease in FP7-HEALTH.
• Prof. Myrra Vernooij-Dassen, Dr Yvonne Engels and Dr Eddy Adang received an EU FP-7 grant for Comparing the effectiveness of palliative care for elderly people in long term care facilities in Europe (PACE).
• Prof. Hans de Wilt received two KWF grants, for Vitamin D status in colorectal cancer patients: determinants and role in disease progression and survival (in collaboration with Wageningen UR), and for The value of completion axillary treatment in sentinel node positive breast cancer patients undergoing a mastectomy. A randomized multicenter trial (in collaboration with UMCN+).
• Dr Katja Aben, Prof. Bart Kiemeney and Dr Inge van Oort received a KWF grant for their project A solid foundation for evidence-based quality improvement in prostate cancer care in The Netherlands.
• Dr Alina Vrieling, Prof. Bart Kiemeney, Prof. Fred Witjes and Prof. Ellen Kampman received the Alpe d’HuZes grant for their project The effect of dietary and lifestyle factors on prognosis and quality of life of bladder cancer patients.
• The Radboud Expertise Center for Pain and Palliative Medicine and department of Medical Oncology received two KWF grants: one to expand the telemedicine to elderly cancer patients, and the other for the Adolescent and Young Adult outpatient clinic.
• Chella van der Post, MSc and Chantal Driessen, MSc received KWF clinical fellowships for their PhD projects Identification of new hereditary forms of gastric cancer and Prediction of ototoxicity and nephrotoxicity in patients with locally advanced head and neck cancer treated with cisplatin-containing chemoradiotherapy, respectively.
• Dr Stanleyson Hato received a Bas Mulder Award for his project to indentify a biomarker that reflects the state of a disease, and predicts the clinical efficay of dendritic cell vaccination.
• Prof. Anne Speckens coordinates a multi-centre study on the effects of mindfulness on the quality of life of women with breast cancer (grant awarded by Pink Ribbon).
• Dr Stans Verhagen and Dr Hans Knoop received grants from the Pink Ribbon Foundation for a multi-centre trial evaluating the effectiveness of Internet therapy for fatigue in survivors of breast cancer.
• Dr Marjolijn Ligtengberg, Marjolijn Jongmans, MSc and Dr Richard de Voer received a MLDS Focus grant for their research project on the genetic background of colorectal cancer in adolescents and young adults.

• Prof. Ellen Kampman, Dr Alina Vrieling and Prof. Nicole Hoogerbrugge received a WCRF Research grant for health promotion materials on cancer awareness and prevention.

• Dr William Leenders received a grant from the Stichting Stop Hersentumoren for a project on targeting low grade glioma.

• KiKa (Children Cancerfree) awarded a grant to Dr Laurens van der Meer for studying the molecular pathways involved in the clearance of the protein drug Asparaginase, a key component of the multi-drug therapy regimen used to treat acute lymphoblastic leukaemia in children.

• Michiel Kroese, MSc, Prof. Gosse Adema and Prof. Peter Hoogerbrugge received a grant from the Villa Joep foundation to study the immunotherapy as part of multimodal therapy using a novel pre-clinical MYCN-neuroblastoma tumour mice model.

• Dr Stanleyson Hato and Dr Gerty Schreibelt were awarded René Vogels travel grants.

• A number of PhD students received various national and international prizes for their theses.

Societal impact
Cancer is a major health problem and places enormous physical and mental burdens on patients and their families. Improving the prevention, diagnosis, and therapy of cancer, as well as improving psycho-social assistance, is therefore essential. Researchers at the Institute serve as active members of various boards and committees both nationally (e.g. Dutch Cancer Society, ZonMw, Dutch Medical Oncology Society, Netherlands Foundation for the Detection of Hereditary Tumours, Biobanking and Biomolecular Resources Research Infrastructure, Dutch Haematology Society, Dutch Federation of University Medical Centre’s Committee for Paediatric Oncology, Dutch Society for Surgical Oncology, Dutch Workgroup for Head and Neck Tumours) and internationally (e.g. a large number of European scientific societies, International Agency for Research on Cancer, World Institute of Pain, EORTC, ECCO, and the editorial boards of several cancer journals).

Some of the new appointments of RIO members in the important national and international oncological societies and communities are listed below:

• Prof. Bert van der Kogel received a ESTRO Lifetime Achievement Award for his major impact on healthcare with contributions to radiobiology and translational research in radiation oncology. His research substantially changed the practice of the profession.

• Prof. Han van Krieken was elected as president of the European Society of Pathology.

• Prof. Bart Kiemenej received the Dominique Chopin Award 2013 from the European Association of Urology Section for Urological Research for his significant achievements in urological research and his contribution to European scientific networks.

• Prof. Judith Prins was appointed to the Scientific committee of Pink Ribbon and as chair of the peer group of the Dutch Society for Medical Psychology.

• Prof. Hans de Wilt became the chair of the Dutch Society for Oncological Surgery.

• Dr Carla van Herpen has joined the Guideline Committee of the Dutch Workgroup for Head & Neck tumours.

• The Radboud Expertise Center for Pain and Palliative Medicine – together with the Department of Medical Oncology – was recognized as an ESMO-designated centre of integrated oncology and palliative care (Dr Stans Verhagen, Prof. Kris Visser, Prof. Winette van der Graaf).

• Dr Lioe-Fee de Geus-Oei was appointed Professor of Molecular Imaging, Innovation and Translation at the University of Twente, further strengthening the collaboration of the Radboud umc with the University of Twente.

• Prof. Merel Ritskes-Hoitinga/SYRCLE received grants from ZonMw and the Dutch Ministry of Health, Welfare and Sport to promote the conduct of systematic reviews of animal studies by organising hands-on workshops and developing tools and guidelines to facilitate systematic reviews of animal studies.
Key publications


Dissertations: 53
Scientific publications: 945
Patents: 1
Future research
Research will concentrate on:
• cancer-related target genes and pathways
• anti-cancer nano-vaccines in the patient’s immune system
• the associations between genetic variants and cancer susceptibility, prognosis, and response to therapy
• the efficacy of functional imaging with respect to diagnosis, prognosis, and therapy using the Preclinical Imaging Centrum PRIME
• the mechanisms underlying invasion and metastasis
• novel molecular markers for imaging
• the efficacy of novel metabolic and epigenetic drugs for therapy and novel vaccine-based therapeutic strategies
• genetics, epidemiology and pharmacokinetics
• predictive factors and late effects of treatment
• psychosocial and quality-of-life issues.

Special attention will be paid to personalized oncology:
• The Vici grant awarded to Prof. Bram van Ginneken for his project entitled Lung CT Screening: More for Less will create a novel workflow with a more automatic, more comprehensive, and more individual approach to lung CT screening, which will result in screening with greater value and at lower cost.
• The STW grant for Prof. Jack Schalken’s project entitled Improvement of therapy efficacy against human cancers using specific miRNAs reversing the EMT phenotype will be used to develop a new therapy against cancer based on microRNAs, which the researchers hope will make the cancer cells lose their tumour properties.
• The question Will breast cancer screening be more effective and efficient by taking into account the individual risk of a woman developing breast cancer? is the main focus of the ZonMw Top subsidy programme led by Dr Mireille Broeders.
The Nijmegen Institute for Infection, Inflammation and Immunity (N4i) brings together research groups that focus on infectious diseases, inflammation and immunity – areas that are intimately connected. N4i’s ambition is to achieve national and international leadership in research in these areas. This research, which is inspired by observations at the bedside, is designed to improve the diagnosis, treatment and prognosis of patients with infections, as well as inflammatory and immunological disorders.

The research focuses on four themes that link Infection, Inflammation and Immunity.

**Theme 1. Pathogenesis and modulation of inflammation**
Although infectious agents are the main causes of inflammation, any tissue damage will lead to an inflammatory response. Issues that are addressed in this theme include host recognition of pathogens, inflammasome activation and cytokine responses during infection and autoinflammation, the pathogenesis of infection by bacteria (e.g., pneumococci, staphylococci, meningococci and Coxiella) and viruses (picorna viruses and dengue virus), molecular imaging tools for visualizing infection and inflammation, mechanisms of tissue damage in common inflammatory diseases (COPD, psoriasis and eczema), therapeutic interference with pattern recognition and signalling, strategies for preserving mucosal integrity in cancer chemotherapy and developing tools for monitoring inflammation and response to treatment.

**Theme 2. Invasive mycoses and compromised host**
Within this theme, invasive fungal infections are studied in relation to sophisticated medical treatments for immune-compromised and frail patients. Research focuses on understanding host defence mechanisms, in particular the recognition of fungal pathogens by the host, the immunogenetics of fungal infections, immunotherapy of fungal infections, exploring the epidemiology and management of invasive fungal infections, designing better diagnostics and therapies for invasive aspergillosis, candidemia, and other invasive fungal infections, exploring the epidemiology, mechanism and consequences of resistance against antifungal drugs.
Theme 3. Poverty-related infectious diseases

In developing countries infectious diseases are still a major cause of mortality. Poverty is a pivotal factor for vulnerability to infections such as tuberculosis, HIV and malaria. Within this theme the following issues are addressed: clinical development of vaccines and drugs for treating malaria, the pathogenesis and host defence against malaria, innate host defence against Mycobacterium tuberculosis and the role of mycobacterial genotypes, optimal diagnosis and treatment of tuberculosis (TB) – with a focus on complicated TB, evidence-based prevention and treatment of HIV/AIDS in the context of intravenous drug use in resource-poor countries, and optimal anti-HIV and anti-TB treatments in resource-poor settings, particularly for children.

Theme 4. Auto-immunity, transplantation and immunotherapy

Research on the inflammatory response is designed to obtain new insights into the pathogenesis of infectious diseases and non-infectious inflammatory disorders. Within this theme investigations focus on: phenotypes of autoimmune diseases of the skin, prediction of the course of chronic inflammatory rheumatic diseases, the mechanisms of tissue damage and optimal treatment strategies in systemic lupus erythematosus, developing biomarkers to monitor immune status and immunosuppressive treatment efficacy, immunological tolerance and immunosuppressive treatment after transplantation and transfusion, exploring the use of dendritic cells, regulatory T cells and NK cells for autoimmune diseases and transplant-related immunotherapy, designing new immunostimulatory drug treatments, developing vaccines against pneumococci and Plasmodium falciparum, and assessing the severity of psoriatic phenotypes and responses to treatment.

Research facilities

The core components of the Institute are clinical departments (Internal Medicine, Medical Microbiology, Paediatrics, Nephrology, Dermatology, Rheumatology, Haematology, Pulmonary diseases, Intensive Care Medicine and Nuclear Medicine), which provide access to patients and clinical material, and dedicated research laboratories (those directly connected to the clinical departments as well as the laboratories of Medical Microbiology, Clinical Pharmacy, Medical Immunology and Tumour Immunology). Furthermore, the Radboudumc has several technology platforms which are available to researchers: the Central Animal Facility, the Microscopic Imaging Centre (MIC), the Preclinical Imaging Centre (PRIME), the facilities for Genomics, Proteomics and Glycomics, the Centre for Molecular and Biomolecular Informatics, the Clinical Research Centre Nijmegen, a GMP facility for cellular therapy trials, and a Malaria parasites and mosquitoes breeding facility.

Collaboration

The research at N4i takes place within national and international research networks that focus on infection, inflammation and immunity. Collaboration is designed to bring in complementary expertise and thus create synergy, recruit talent and enhance earning capacity in (EU) consortium grants. The Institute collaborates with outstanding laboratories including:

- The Broad Institute of Harvard University and MIT, Boston, USA (NWO)
- The School of Medicine, University of Colorado, Aurora, USA (RU chair)
- The Institute of Medical Sciences, University of Aberdeen, UK (Wellcome trust)
- Institute for Evolutionary Biology, Pompeu Fabra University, Barcelona, Spain (ERC)
- Iuliu Ha iesan University of Medicine and Pharmacy, Iui-Napoca, Romania (ERC)
- The Kilimanjaro Christian Medical College, University of Moshi, Tanzania (NWO)
- The Eijkman Institute for Molecular Biology, Jakarta, Indonesia (EU)
- Health Research Unit, Padjadjaran University, Bandung, Indonesia (Aids fund)
- The London School of Hygiene & Tropical Medicine, UK (EU)
• Max-Planck-Gesellschaft zur Förderung der Wissenschaften, Berlin, Germany (EU)
• The Faculty of Health Sciences, Stellenbosch University, Cape Town, South Africa (EU)
• Universidad Peruana Cayetano Heredia, Peru (EU FP7 TANDEM)
• Faculty of Medicine, Imperial College London, London, UK (EU)
• The Department of Experimental Pathology, University of Bologna, Italy (EU)
• The Department of Biology, University of Konstanz, Konstanz, Germany (EU)

Research results
Prof. P. Verwey, J. van der Linden and colleagues have demonstrated a new azole resistance mechanism in the opportunistic mould Aspergillus fumigatus. Their findings indicate that a new mutation was selected for in the environment, possibly due to exposure to azole fungicides.

Prof. J. Schalkwijk, Dr E. van den Bogaard, and collaborators, revealed the working mechanism of an ancient dermatological therapy: coal tar cream used as a treatment for inflammatory skin diseases such as atopic dermatitis. Their findings open a new avenue for developing mechanism-based drugs for chronic inflammatory skin diseases and rehabilitates the use of coal tar in dermatological practice. In another study, carried out with Dr H. Zhou and E. Kounenov, they have shown that a compound targeting p53 mutants to restore the pro-apoptotic activity of p53, can rescue differentiation defects in skin epidermal cells carrying p63 mutations. This work suggests a novel concept of developing targeted therapy for phenotypically distinct diseases that are caused by a similar underlying molecular mechanism.

Prof. R. Sauerwein, Dr E. Bijker and others have shown that protection against malaria after immunization by chloroquine prophylaxis and sporozoites is mediated by preerythrocytic immunity.

Prof. M. Netea, S. Smekens and collaborators from Harvard University used functional genomics to identify the type 1 interferon pathway as central for host defense against Candida albicans, which causes mucosal and systemic infections in humans. Dr M Coenen and collaborators performed a genome-wide association analysis of anti-TNF drug response in patients with rheumatoid arthritis and identified eight genetic loci that are associated with the response. These promising results will be used to identify patients who will not respond adequately to treatment.

A new diagnostic assay is described by Dr M. van Deuren, T. Schoffelen and colleagues. They show that specific IFN-γ detection provides a good assay for previous Q fever, which is caused by C. burnetii infection, performs in a similar way and has practical advantages over serology and skin tests. A clinical test based on this methodology has been licensed to commercial partners and its clinical value will be further investigated.

Dr F. van de Loo, B. van den Brand and others studied the molecular mechanisms involved in autoimmune destructive arthritis, showing that Toll-like receptor 4 in bone marrow-derived cells as well as tissue-resident cells participate in aggravating the disease to full-blown joint swelling, inflammation and bone erosion. Dr P. van Lent and Prof. W. van den Berg investigated the role of Fc receptors in osteoclastogenesis and osteoclast function and produce results that suggest that the balance of Fc R-mediated inflammation as well as the direct inhibitory effect of immune complexes on osteoclastogenesis determines the net effect on bone loss.

Immunomodulating regulatory T-cell (Treg) therapy is a promising strategy in transplantation. Prof. I. Joosten, Dr J. Peters and collaborators provide new data that suggest that human secondary lymphoid organs help maintain and regulate Treg function and homeostasis. This knowledge may be used to optimize Treg immunotherapy.

Major comments and reviews were published in top journals, including the New England Journal of Medicine, Lancet Infectious Diseases, American Journal of Respiratory and Critical Care Medicine, Embo Molecular Medicine, Annals of the Rheumatic Diseases and PLoS Pathogens.

Awards and acknowledgements
Dr Ronald van Rij was awarded a prestigious ERC Consolidator Grant in order to investigate the biogenesis, mechanism and function of the small RNA-mediated antiviral defences of Dengue and West Nile virus transmitting mosquitoes.

Dr Leo Joosten was appointed visiting professor by the Brazilian Government in the context of its ‘Science without frontiers’ programme. He will evaluate the role of IL-32 in infections caused by Leishmania braziliensis chilensis and L. amazonensis.

The Dutch Kidney Foundation awarded €1.25 million to a Dutch consortium of laboratory specialists and nephrologists of all Dutch transplantation centres. Project leaders at the Radboudumc are Prof. Irma Joosten and Prof. Luuk Hilbrands. The aim of the project is to build up detailed knowledge of the immune response to kidney grafts in order to reduce rejection rates, extend the life span of donor kidneys, and ultimately achieve shorter waiting lists.

Prof. Jacqueline de Graaf, Dr Leo Joosten and Prof. Mihai Netea were awarded a more than €1 million grant from Cardiovascular Research Netherlands for research within the IN-CONTROL-programme, a broad study of the relationship between intestinal bacteria and inflammation as potential drivers of heart disease.
Dr Ellen van den Bogaard joined the 2013 European Society for Dermatological Research Academy for Future Leaders in Dermatology in Florence, Italy. Dr Frank van de Veerdonk received the 2013 Best Young Researcher award from the American Society for Microbiology for outstanding performance in fungal immunology research.

At the 2013 Autoinflammation meeting in Lausanne, Switzerland, Dr Monique Stoffels won the International Society for Systemic Autoinflammatory Disorders (ISSAID) Young Investigator Award for Basic Science. Dr Marjolein Garsen received two awards for her research on Cathepsin L in diabetic mice: at the 25th European Cell Study Group Meeting in Oxford and at the Dutch Nephrology Days.

Societal impact
The N4i focus on Infection, Inflammation and Immunity represents a research profile with major societal impact: infectious diseases are a major cause of morbidity and mortality worldwide. Clinical centres are excellent way for valorising research results and knowledge (e.g. the Nijmegen Centre for Immunodeficiency and Autoinflammation and the new established Radboudumc Centre for Infectious Disease). N4i’s strategy also includes, valorising innovative concepts and filing patents. N4i researchers publish on infectious and inflammatory disease and related subjects in public (new) media and are members of many national and international organizations (e.g. Royal Netherlands Academy of Arts and Sciences, Academia Europaea, the European Academic Scientific Advisory Council, the Health Council of the Netherlands, the Centre for Infection Control and ZonMw committees).

Major contributions have been made to reports for the Dutch government, medical guidelines and diagnostics tests. Some examples: the newspaper NRC interviewed Dr. L Joosten about a new diagnostic test for Lyme disease and he contributed to the advice for The Health Council of the Netherlands about novel diagnostic tools for Lyme disease; in a TV documentary made by the Netherlands Organisation for Scientific Research (NWO) Dr R. Baltussen explained his research on health insurance in Ghana and, as a member of an expert committee of the World Health Organisation, he contributed to developing guidelines for HIV treatment; the collaborative research done by Dr R. van Crevel and colleagues on TB and HIV has helped improve patient care and policy in Indonesia, by providing local evidence and validated protocols and SOPs.

Several clinical studies were performed, the outcomes of which have direct implications for clinical practice. Prof D. Burger, Dr de Kanter and colleagues demonstrated that, due to the absence of a clinically significant drug interaction, raltegravir can be recommended for combined HIV/HCV treatment including the hepatitis C virus protease inhibitor boceprevir. Prof. P van Riel, S van Dartel and colleagues describe results from the Dutch Rheumatoid Arthritis Monitoring registry, revealing differences in the risk of serious infections in patients with rheumatoid arthritis treated with adalimumab, infliximab and etanercept. Dr A. Simon, H de Koning and colleagues performed a 9-month clinical trial on Schnitzler’s syndrome, a chronic disabling autoinflammatory disorder. They demonstrated that monthly injections of 150 mg canakinumab, a monoclonal anti-interleukin-1 beta antibody, were an effective and well-tolerated treatment for patients with this syndrome and the data demonstrate that IL-1β plays a pivotal role in this disease.

Future
Investigators will continue collaborative research on the role of pattern recognition in infection and inflammation, natural immunity to infection in human evolution, resistance to antifungal drugs and the implications for clinical medicine, exploring the
Key publications


Dissertations: 33
Scientific publications: 769
Patents: 5
pathophysiology of infection with major pathogens (e.g. pneumococci, staphylococci, malaria parasites) and modulating immunological responses using humoral and cellular tools (e.g. regulatory T cells). They will also examine the role of epithelial barriers in disease, the correlates of protection in poverty-related infections, and the role of apoptosis-induced auto-antigen modifications in initiating autoimmunity.

Examples of new projects are: Microbiome and skin diseases (Dr P. Zeeuwen, NWO fellowship); A study of protective immunity and testing of new anti-malaria drugs in the controlled human malaria infection model (Prof. R. Sauerwein, Bill & Melinda Gates Foundation and Novartis); Determinants of rapid onset of atherosclerosis (Dr J. Van Diepen, Diabetes fund); New ways to treat gout (Dr L. Joosten, Reuma fund); Right on TAR-get (Prof. J. Schalkwijk, N4i grant); The interplay between inflammation and lipids pattern – a new chapter: IL-32 and HDL (Dr C. Popa, N4i grant); Epigenetic control of the dark side of regulatory T-cells in psoriasis (Dr H Koenen, N4i grant); The role of CD8+ T-cells in pre-erythrocytic immunity against Plasmodium falciparum malaria (Prof. R. Sauerwein, N4i grant), Can IL37 restrain inflammation and rejection of the transplanted kidney? (Dr W. Pulskens, Kidney Foundation).

The tradition of annual international Summer Frontiers Symposia on immunology will be continued in 2014. The next symposium is entitled ‘Age & Immunity’ and renowned international guest speakers have accepted an invitation.
Discoveries in medical science that prove to be valid, cost-effective and feasible should be applied in clinical practice. How an early discovery finds its way into clinical practice, however, is a science in itself. This is the main research focus of NCEBP. Three issues are central: are findings resulting from laboratory or animal research also applicable to human patients? Does applying them reduce sickness or mortality? And, if so, how should they be introduced as a structural part of daily clinical practice and public health? These issues are addressed in fields such as cancer, chronic pulmonary disease, cardiovascular disease and dementia. The NCEBP is bridging the gap between science and society.

The NCEBP comprises four closely interrelated research programmes, each consisting of three or four research themes.

**Epidemiology and Evaluation (Prof. Maroesea Rovers)**

**Theme: Molecular epidemiology (Prof. Bart Kiemeney)**

In this theme the main focus is on identifying molecular/metabolic and genetic determinants for disease and disease outcomes. Most of the research focuses on cancer, but other multifactorial diseases are also studied where there are overlapping specific mechanistic pathways (e.g. the 1-carbon metabolism) or overlapping research methodologies (e.g. genome-wide association analyses). Research addresses aetiological, diagnostic, prognostic and intervention issues.

**Theme: Evaluation of complex medical interventions (Prof. Gert Jan van der Wilt)**

Healthcare interventions can be complex in various ways. They may be technically complex or demand considerable delivery skills. They may also comprise multiple components (including contextual factors), each contributing critically to achieving the desired end-
point. Finally, they may be complex in terms of their effects, which can be many and varied, difficult to measure, and differentially distributed over time. These types of complexity pose considerable challenges to those evaluating healthcare interventions. Appropriate methodologies for such evaluation are developed and tested.

**Theme: Infectious diseases and international health**  
(Prof Rob Baltussen)  
The main goal here is to improve health in both low and high-income countries by developing the evidence needed for decision-making. To this end, research in clinical, public health and economic disciplines is integrated. The focus is on 1) poverty-related diseases, 2) public health and health systems in developing countries, and 3) general infectious diseases. Researchers also invest in building capacity, i.e. training local people to independently conduct research in low-income countries.

**Clinical Research (Prof. Sander Geurts)**  
**Theme: Human reproduction** (Prof. Jan Kremer)  
Advances in knowledge, an increase in demand for interventions and a growing awareness of the potential for prevention, diagnosis and therapy have made human reproduction an exciting research area. Relevant issues include the aetiology and prevention of reproductive and developmental disorders, as well as the safety, effectiveness and patient-centeredness of reproductive and obstetric care.

**Theme: Human movement and fatigue** (Prof. Sander Geurts)  
Many neurological, orthopaedic and oncological diseases affect the ability to move and physical fitness and may also cause excessive fatigue. By analyzing biomechanics, motor control and physical activity – as well as their interaction with cognition and emotion – this research is designed to disentangle the generic determinants from the disease-specific determinants of musculoskeletal impairments, movement disability, reduced physical fitness and fatigue. Both mechanistic and clinical research issues are addressed.

**Theme: Cardiovascular diseases** (Prof. Gerard Rongen)  
The main aim of the researchers working within this theme is to achieve greater understanding of the pathogenesis of cardiovascular disease. The focus is on the mechanisms and consequences of vascular injury. This theme covers human in vivo proof-of-concept studies as well as studies that are extended from concept to evidence-based medicine. The genetic and metabolic causes of atherosclerosis and thrombosis – and of their risk factors – are investigated. Regulating vascular tone in health and disease is another important research topic.

**Patient-centred Interventions (Prof. Andrea Evers)**  
**Theme: Effective primary care and public health** (Prof. Pim Assendelft)  
This research theme was established to support healthcare in the primary care population. The main challenges are promoting and preserving the health and functioning of ageing populations.

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### Staff

**Core Grants Contracts**

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**Research funding**

- **Core Grants Contracts**
- **Research funding**
- **Non-tenured Researchers**
- **Doctoral candidates**
- **12.2 FTE**

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**2012 RESEARCH REPORT 103**
Healthcare must be provided for all patient groups in the community (regardless of health problems, gender and age or social class) while combining a variety of approaches: health promotion, disease prevention, diagnosis and treatment of diseases, rehabilitation, supporting patients and palliative care.

Theme: Psychological determinants of chronic illness
(Prof. Andrea Evers)
The focus here is on improving the diagnostics and treatment of patients with chronic somatic illnesses, in particular with regard to the psychological determinants and consequences of somatic conditions. There are two linked sub-themes: ‘Psychological factors in chronic somatic illnesses’ and ‘Cognitive dysfunction’. Both focus on the psychological and neuro-psychological risk factors, consequences, diagnostics and treatments of these conditions in adults and children.

Theme: Mental health (Prof. Anne Speckens)
The aim of researchers working within this theme is to study the determinants, prevalence, prognostic significance and treatment of mental health problems from a patient-centred perspective. The focus is on mood disorders, somatoform disorders, violence against partner, ADHD and Autistic Spectrum Disorders. Many projects involve a developmental perspective and the study of the precursors, longitudinal course and age-related manifestations of these disorders.

Theme: Nijmegen Alzheimer Centre (Prof. Myrra Vernooij-Dassen)
The Nijmegen Alzheimer Centre develops and evaluates support programmes in order to improve the quality of care and quality of life for people with dementia and their families. Researchers working within this theme contribute to fundamental knowledge on Alzheimer’s disease.

Quality of clinical practice (Prof. Michel Wensing)
Theme: Implementation science (Prof. Michel Wensing)
The emphasis here is on improving healthcare practice, with a specific focus on primary care. It includes developing and evaluating performance indicators, interventions designed to achieve sustainable change, and the factors associated with changes in performance. Research fields include the education of health professionals, pharmaceutical patient care, out-of-hours care, structured chronic care and patient safety.

Theme: Quality of hospital and integrated care (Dr Hub Wollersheim)
Research within this theme is designed to measure and improve the quality and safety of patient care in hospitals, home care and nursing homes. In addition, handovers between these three settings or handovers with general practice are studied. Research covers clinical patient care across a wide range of diseases. This involves developing and evaluating quality indicators and effective implementation strategies, including integrated care systems.

Theme: Healthcare ethics (Prof. Evert van Leeuwen)
Work within this theme involves studying the ethical aspects of change processes. On a philosophical level, a conceptual analysis is made of the theories and concepts that underlie the processes of change. Together these studies make it possible to evaluate existing care in the light of changing norms and values, and they contribute to improving decision-making and the quality of care.

Theme: Quality of nursing and allied healthcare
(Prof. Theo van Achterberg)
Challenges covered by this theme include a search for scientific evidence to support clinical practice and professional development. While Medical care focuses on the diagnostics and treatment of diseases and their cure, Nursing and associated healthcare focuses on preventing disease and the consequences of illness and disease for human functioning, activities and participation.

Research facilities
Within the NCEBP, databases, ICT networks, registries and clinical research facilities are key because of the Centre’s research focus on clinical and population studies. Important examples of research facilities include:

- Academic networks of GP practices (including the GP Continuous Morbidity Registration), nursing homes, institutions for people with an intellectual disability, municipality health services, care facilities for homeless people and dental care sites.
- Large databases and biobanks of general population samples (The Nijmegen Biomedical Study) and of specific patient groups in the Radboud Biobank (e.g. congenital malformations, cancer, rheumatoid arthritis and inflammatory bowel diseases).
- A clinical research centre (CRCN) offering logistics and data management for human intervention studies.
- A pharmacology research laboratory comprising a wide variety of human in vivo models for proof-of-concept studies.
- A consultation facility for statistical genetics, cost-effectiveness issues, biostatistics and quality of care.
- A unique multidirectional balance perturbation platform to study human postural control at the limits of stability.
- The ‘Koploper programme’, a healthcare innovation in which professionals in primary care, public health, allied healthcare workers and the hospital jointly develop new approaches to prevention and care.
- The Minimal Invasive Technology expert Centre (MIteC) for evaluation of surgical innovations.
- A SYstematic Review Centre for Laboratory animal Experimentation (www.SYRCLE.nl).
- A psychophysiological research laboratory.
- MijnZorgnet, an online platform for Personal Health Communities. Patients ‘own’ this online space with their medical information and communication.
The NCEBP collaborates for research and/or faculty exchange with more than 40 universities around the world and with the European Union/ECDC, the WHO, UNESCO, the Centre on Birth Defects and Developmental Disabilities, various Centres for Disease Control and Prevention, INSERM (Paris), several Cochrane Centres, the MRC in London and deCODE Genetics in Reykjavik, Iceland. Within the scope of the EU 7th Framework Programmes EuroTARGET, IMPACT, AFRESH, TICD, EUWISE, TACTICS, TLEM-Safe, the institute collaborates with numerous public and private organisations.

Research results
In 2013, two PhD theses were judged to be of outstanding quality (cum laude): those written by Dr Erik Bischoff (‘Self-management of COPD and its exacerbations’) and by Dr John van de Ven (‘Cuticular drusen. Clinical and genetic studies on a subtype of age-related macular degeneration’). Some other research highlights are listed below.

• The Nijmegen Biomedical Study database and biobank was used in more than 140 scientific papers since 2007 with a cumulative Impact Factor (IF) of more than 2000 (mean IF = 16 per paper).
• Dr Bousema and colleagues completed the first ever dose-finding study on primaquine for blocking malaria transmission.
• Prof. Maroeska Rovers was invited to write advice on open access to participant data for the UK parliament with her colleagues from the Cochrane IPD methods group.
• Dr Niels Riksen and co-workers published a novel hypothesis on the role of epigenetic changes in monocytes in the development of atherosclerosis.
• Dr Bart Staal reached the New York Times with his publication in the Journal of the American Medical Association in which he points out that there is hardly any evidence that multiple spinal injection shots reduce pain in the long term.
Key publications


Dr Tjard Schermer and colleagues discovered that the harmful effects of cigarette smoking on the lungs are not amplified when patients with chronic obstructive pulmonary disease are given maximal inhaled bronchodilator treatment.

A multicentre randomized controlled trial, performed by Prof. Judith Prins and colleagues, was the first study to demonstrate the effectiveness of a self-management website for early breast cancer survivors (BREATHE) in reducing distress after curative treatment.

TOPICS-MDS, a large-scale data-sharing initiative led by Radboudumc for sharing the minimal datasets collected from all participants in the Nationaal Programma Ouderenzorg (n = 30,000 - 40,000) is open for external applications.

Brain Aging Monitor-Cognitive Assessment Battery (BAM-COG), developed by Prof. Marcel Olde Rikkert, Prof. Roy Kessels and colleagues, has proven to validly assess cognitive function by playing online serious games. This also allows people to do the assessment themselves at home.

The group led by Dr Marcel Verbeek developed an algorithm to predict the chance of Alzheimer’s disease based on CSF analysis.

A Lancet study by Prof. Myrra Vernooij-Dassen and colleagues showed that a structural approach to managing depression in nursing homes can reduce the prevalence of depression in somatic units.

In a large cluster randomized trial the group led by Prof. Theo van Achterberg and Dr Lisette Schoonhoven showed that it is possible to improve the hand hygiene of nurses in hospitals by 32%.

After a pilot phase in the Nijmegen region, the PRegnancy and Infant DEvelopment (PRIDE) Study was taken to the national level to include as many pregnant women as possible in this long-term cohort.

Awards and acknowledgements

- Prof. Bart Kiemeney received the Dominique Chopin Distinguished Researcher Award from the European Society for Urological Research.
- Prof. Andrea Evers received an ERC consolidator grant for the project ‘Empowering expectations for health and disease: Training the immune and endocrine system’.
- Prof. Ria Nijhuis-van der Sanden received the Paul Holders Award for her achievements in children’s physiotherapy.
- Prof. Chris van Weel was awarded with a fellowship of the World Organization of National Colleges, Academies and Academic Associations of General Practitioners/Family Physicians.
- The healthcare portal Zorg- en WelzijnInformatiePortaal, ZWIP (www.zwip.nl), was chosen by the public as the most important care innovation from the Dutch national programme for care of the elderly Nationaal Programma Ouderenzorg.
- The tool EASY-Care Twostep Older people Screening (TOS) and ZWIP were awarded the Dutch ‘De Eerstelijns Transformatieprijs’.

Dissertations: 89
Scientific publications: 1754
Patents: 3


• Prof. Gert Westert gave the 2013 NFU - Health Lecture entitled ‘Keuzes maken; onontkoombare vragen over het toenemende zorgaanbod’ (Making choices; inevitable questions about the increasing pressure on health care).
• Prof. Gert Westert gave an invited lecture entitled ‘Public reporting and accountability, the Dutch experience’ for the Australian National Health Performance Authority.

Societal impact
Much – if not most – of NCEBP research has direct societal impact and/or is immediately implemented in clinical care or public health. Achieving societal impact is, in fact, one of its main aims. NCEBP researchers also make a significant contribution to numerous national and international guidelines and reports and sit on important committees. NCEBP researchers develop performance indicators for primary and hospital care that are used for contracts for performance-related systems and they write evidence-based treatment guidelines and implementation plans for these guidelines. Some highlights in 2013 were:
• Dr Rob Baltussen contributed to the WHO guidelines of HIV treatment. His PhD student Rik Viergever contributed to a chapter in the latest World Health Report on setting health research priorities.
• The CELSUS program was initiated by IQ healthcare and VWS. This is a unique project in which policy makers and researchers work together on healthcare sustainability, one of the most enduring societal problems.
• Dr Mireille Broeders contributed to various information films on breast cancer screening.
• Prof. Harry van Goor spoke about the use of Google Glass in surgery on Dutch TV.
• The report ‘De Verpleegkundig Specialist biedt kansen. Onderzoeksrapport naar de inzet van Verpleegkundig Specialisten op de spoedpost te Eindhoven’ was presented to DG Curative Care Leon van Halder.
• The online health community ZWIP (Zorg- en WelzijnInformatie-Portaal), which was developed as part of a Nationaal Programma Onderenzorg transition project, is now part of the product portfolio of Protopics (http://www.protopics.nl). Care organizations that aim to implement the tool can now also be reimbursed, demonstrating the viability of the tool.
• Research findings on Growth Hormone treatment and training in infants with Prader Willi Syndrome were implemented in international guidelines.
• Dr Dick Thijsen is leading a pan-European consortium of experts on Fibromuscular dysplasia (FMD) to construct reference values for FMD.
• The Foundation of Technical Sciences in The Netherlands (STW) approved three valorisation grant applications from the orthopaedic department. These grants are used to commercialize research projects. The topics of the three projects are: a new meniscus prosthesis, an innovative system for fixing fractures of the clavicle and a method for calculating bone strength in patients with metastasized cancer.
• Prof. Maroeska Rovers and Prof. Andrea Evers are board members of the Dutch Researchers Innovational Research Incentives Scheme (Veni-Vidi-Vici).
• Prof. Pim Assendelft, Prof. Wil van den Bosch, Prof. Didi Braat, Prof. Richard Grol, Prof. Maria Hopman, Prof. Toine Lagro, Dr Nel Roeleveld, Prof. Anne Speckens, Prof. André Verbeek, Prof. Gert Jan van der Wilt and Prof. Gerhard Zielhuis are members of the Health Council of the Netherlands.

Future research
The Institute will continue to invest in research facilities such as biobanks as well as in large national and international networks. The focus of research will increasingly be on personalized health-care and patient-centred interventions. For example, researchers working in the Department of Rehabilitation will investigate – in collaboration with the University of British Columbia – whether neuroimaging techniques can be used to personalize treatment for improving postural balance after stroke. Dr Mireille Broeders’ group will start a project on personalized breast cancer screening using a TOP grant. Within the AGORA databank and biobank, new research projects, financed by NutsOhra, on individual risk prediction for hypospadias and renal function will start.

The cancer epidemiology group started a new research line on the pharmacogenetics of urological cancers and on the efficacy of routine follow-up in cancer. Furthermore, the effect of dietary and lifestyle factors on the prognosis and quality of life of bladder cancer patients will be studied in a project funded by Alpe d’HuZes and the Dutch Cancer Society.

The group led by Prof. Marcel Olde Rikkert and Dr René Melis will develop, implement and evaluate a networked care model for dementia (AlzheimerNet), which can serve as a blueprint for networked elderly care and chronic care in general.

With a €5.2 million STW Perspectief grant for a joint programme ‘Symbionics’, the Department of Rehabilitation – in collaboration with the University of Twente, TU Delft, UMC Groningen, UMC Maastricht en VUmc – will work on improving assistive devices in people with disabilities.

Whereas both the FDA/EMA require new drugs to undergo rigorous premarket clinical trials, the introduction of surgical procedures and devices is not regulated. The ambition of the group led by Prof. Maroeska Rovers is to revolutionize surgical clinical science, so that surgical procedures become more patient tailored, safer and efficient. With a €1.1 million grant from the Province of Gelderland the group will investigate minimally invasive surgery and radiotherapy in an MRI setting in the surgery room.
The ageing of the Dutch population will create enormous quality and efficiency challenges for healthcare. Cost-effectiveness will be central to healthcare policy for the next few decades. Maintaining the accessibility of healthcare for all will become a major challenge. NCEBP’s Department of IQ healthcare will continue to conduct research that will underpin accessibility solutions within its extensive knowledge programme matters funded by the Dutch Ministry of Health.

Healthcare networks will be one of the key areas of innovation in NCEBP’s research in the years ahead. Crucial communication and information sharing in healthcare is increasingly being facilitated by new technologies. Better understanding of network-related mechanisms in the networks of both patients and health professionals can provide new targets for improving healthcare delivery.

The NCEBP’s Epidemiology and Evaluation programme will continue to shift its focus from aetiology research to research related to prognostic/predictive aspects and the quality of care. For this, the new hospital information system (HIS) EPIC, which was launched in the autumn of 2013, will be extremely important, as it will improve observational research. Patient-oriented research will be supported by large biobanks such as the Radboud Biobank. Whole-genome sequencing costs will be reduced to such an extent that sequencing of large patients series will become possible. This will create tremendous opportunities for pharmacogenetics research.
Researchers at the Nijmegen Centre for Molecular Life Sciences (NCMLS) seek to achieve greater insight into the complexity of living cells in order to obtain comprehensive knowledge of both normal and pathological processes. These goals are pursued in the interests of fundamental research and education. Another central aim is to advance innovation in translational research by integrating diverse areas of scientific expertise within the molecular and medical sciences.

NCMLS is a leading multidisciplinary research school in the molecular mechanisms of disease and particularly in molecular medicine, cell biology and translational research. NCMLS accommodates research groups from the university medical centre (Radboudumc) and the Faculty of Science at the University.

Research is concentrated within seven main research themes, which overlap with the University’s ‘Top focus areas’, each dealing with understanding the molecular basis of disease.

1) Infection & Inflammation
This theme covers two important areas of biomedical research:
• Infectious diseases: The focus here is on the role of the innate immune system in pathogen recognition and host defence (against fungal, bacterial and viral infections), on pathogen-host interactions, vector biology, anti-microbial drugs and the development of drug resistance, vaccine development and the role of pathogens in the development of (chronic) inflammatory diseases.
• Inflammatory diseases: The aim is to identify disease mechanisms that encompass both the innate and adaptive immune system as well as modifier genes and post-translational modifications, including auto-antigens, to explain the tissue specificity of conditions such as rheumatoid arthritis, systemic sclerosis, gouty arthritis, psoriasis, and systemic lupus erythematosus.
2) Immune Regulation
This theme covers immunological and haematological research in three major biomedical fields:
- Molecular and functional analysis of normal and malignant blood cell development and immune control: the theme includes analysis of dendritic cells, regulatory T-cells and natural killer cells and aims at defining regulatory circuits effective in tolerance and immunity.
- Immunotherapy of cancer: development and clinical application of vaccination and imaging strategies for solid and haematopoietic malignancies and their microenvironment.
- Organ transplantation: development and clinical application of novel immune monitoring and intervention approaches in kidney transplantation.

3) Regenerative Medicine & Microenvironment
Within this theme, the two main topics are:
- Regenerative medicine: tissue-engineered constructs, based on extracellular matrix molecules, polymers and effector molecules, are designed and fabricated, and analysed in vitro and in vivo. Smart organ-specific bioscaffolds are prepared in such a way that they provide appropriate signals to the cells (to proliferate, migrate or differentiate). The focus here is on ceramics, calcium phosphates, collagens, glycosaminoglycans and effector molecules in relation to a selected number of tissues, i.e. cartilage/bone, skin, kidney and urogenital organs.
- Microenvironment in health and disease: the focus here is on collagens, glycosaminoglycans, matrix metalloproteinases and a number of effector molecules. The role of these components in cancers, nephropathies and degenerative cartilage diseases is studied in vitro as well as in vivo. Strategies to restore homeostasis in deranged and disease-associated microenvironments are pursued, including the use of glycomimetics.

4) Energy & Redox Metabolism
Researchers in this area aim to improve our understanding of the principles of chemical and biochemical adaptation to energy and redox stress, in order to better define healthy responses within the normal physiological range and the pathophysiological thresholds for diseases in which mitochondrial function or energy transfer pathways are compromised. This research contributes to the well-being and treatment of mitochondrial disease patients and those with other conditions in which energy metabolism is compromised. Research is concentrated in three areas:
- ‘imaging’ of ATP/ADP/AMP and NAD(P)H concentration and fate with existing and novel biosensor reporters
- ‘imaging’ of metabolite fate with MRS and MRI
- the use of new strategies to follow mitochondrial shape and activity as well as cellular metabolic state and viability. The integration of ‘4D’ imaging and simultaneous recording of the behaviour of small molecules and macromolecular assemblies and cellular organelles is an important challenge.

Staff
Prof. G.J. Adema (o)
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Prof. J.H.M. Berden (o)
Prof. W.B. van den Berg (o)
Prof. R.J.M. Bindels (o)
Prof. O.C. Boerman (o)
Prof. J.H.L.M. van Bokhoven (o)
Prof. U. Brandt (o)
Prof. R.E. Brock (o)
Prof. H.G. Brunner (o)
Prof. P. Buma (p)
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Prof. F.P.M. Cremers (p)
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Prof. M.A. Huijnen (o)
Prof. J.A. Jansen (o)
Prof. J.H. Jansen (o)
Prof. L. Joosten (p)
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Prof. J.H.J.M. van Krieken (o)
Prof. B.J. Kullberg (o)
Prof. N.H. Lubsen (p)
Prof. L.F.A.G. Massuger (o)
Prof. G.J. Meijer (o)
Prof. J.W. Mouton (o)
Prof. M.G. Netea (o)
Prof. C.J.A. Punt (o)
Prof. F.G.M. Russel (o)
Prof. R.W. Sauerwein (o)
Prof. J.A. Schalken (p)
Prof. J. Schalkwijk (o)

Tenured
Full Professors 32.4 FTE
Associate Professors 16.5 FTE
Assistant Professors 26.0 FTE
Researchers 27.7 FTE

Non-tenured
Researchers 134.0 FTE
Doctoral candidates 186.0 FTE

Research funding

[Diagram showing research funding distribution: Core, Grants, Contracts]
5) Membrane Transport & Cell Dynamics
Membrane transporters are involved in a wide range of diseases in organs such as the brain, muscles, kidney, intestine, liver and bone. The ultimate aim of NCMLS research in this area is to provide a molecular basis for the understanding, diagnosis and potential cure of inherited and acquired diseases of transport proteins, such as channelopathies. Transport proteins currently studied within this theme are sodium (or hydrogen) and potassium ATPases, aquaporin water channels, transient receptor potential channels, organic anion and cation transporters, ATP-binding cassette (ABC) transporters and sodium co-transporters. Research integrates fundamental and clinical studies conducted at the genetic level (gene defects, polymorphisms), molecular level (transport and associated proteins), cellular (established model systems, isolated and transfected cells) and organism (conditional) knockout models levels. In addition, new tools will be developed and implemented in order to tackle the outlined scientific goals, including real-time imaging, large-scale screening assays at the mRNA and protein level, application of small interference RNA libraries, conditional knockout models, bioinformatics and functional analysis at the molecular level.

6) Genetic & Epigenetic Pathways of Disease
Researchers working on this theme aim to unravel the molecular basis of cell behaviour resulting from the genetic and epigenetic code contained in the nucleus in the context of health and disease. Basic and clinical research is combined to unravel the molecular pathways and cellular processes in specific (hereditary) tumourigenic pathways in normal and pathological conditions of development, in particular those of the nervous system. Members of this research group are engaged in technology development ranging from single molecule studies of reconstituted model chromatin through to the elucidation of epigenetic marks on a genome-wide level and the implementation of Next Generation Sequencing (NGS) in fundamental research as well as in a diagnostic setting.

7) Chemical & Physical Biology
The structure and function of proteins and their complexes play crucial roles in virtually all NCMLS research projects:
• At the molecular level researchers in this subtheme work on optimally exploiting the potential of molecular and biomolecular chemistry in order to modify, design and mimick proteins and their building blocks with the aim of modulating and analyzing their activities and properties in the cellular and subcellular environment. This is best illustrated by the following examples: 1) novel bio-orthogonal conjugation methods to study and interfere with biological processes; 2) stimulus-responsive cell-penetrating peptides; 3) use of non-proteinogenic amino acids in the diagnosis and treatment of disease; 4) mimicking cellular synthetic processes in microenvironments; and 5) hybrid cell systems: incorporating synthetic components into living cells.
• This subtheme relates to elucidating protein structure and protein-protein interactions at the cellular and multicellular level. Research topics are: 1) post-transcriptional events in gene expression; 2) cellular signalling pathways; 3) activation and deactivation mechanisms of tyrosine kinases and tyrosine phosphatases; 4) external control of cellular proliferation and differentiation; and 5) molecular probing of vascular pathology and angiogenesis.

Research facilities
The following research facilities are available to members of the NCMLS:

Animal models: The NCMLS has excellent links with the Central Animal Facility (CDL) for expert advice and access to facilities.
for animal testing. NCMLS has several disease-related animal models available, e.g., for arthritis, cancer, kidney disease, tissue engineering, neural disorders, metabolic disorders, osteoporosis, haematopoiesis, fungal and bacterial septicemia and malaria.

**Bioinformatics:** The CMBI, which is the Dutch national centre for computational molecular sciences, is housed on the ground floor of the RIMLS research tower. The Centre's facilities, databases and software packages are available to external scientists and there is a helpdesk for scientists who use the service facility. Currently, the CMBI is primarily involved in bioinformatics research and in maintaining a data and software infrastructure to help improve bioinformatics and/or computational small-molecule research.

**Flow Cytometry:** Flow cytometry is a sophisticated technique of single cell analysis used to simultaneously measure and analyse multiple physical characteristics of cells. State-of-the-art equipment available includes 2 Beckman-Coulter analyzers, a Beckman Coulter and a Becton Dickinson sorter.

**Genomics:** The Department of Human Genetics has a sequencing facility and a genotyping facility for expression profiling, genomic copy number profiling and high-density SNP profiling. Next-generation Genome Sequencers (Roche 454 FLX Titanium and Solexa) are used in the Departments of Human Genetics and Molecular Biology.

**Molecular Imaging:** The Microscopic Imaging Centre is a state-of-the-art facility for imaging of biological specimens that uses light microscopy (bright-field, confocal and fluorescence), conventional scanning and transmission electron microscopy, and sophisticated digital imaging. NCMLS also offers access to other techniques such as, Atomic Force Microscopy, Flow cytometry, FRET and FRAP.

**PRIME:** The Preclinical Imaging Centre has state-of-the-art equipment for small animal imaging: MRI (7 & 11.7 Tesla), PET/CT, SPECT/CT, bioluminescence imaging and in vivo multiphoton microscopy.

**Proteomics:** The Radboud Proteomics Centre comprises a considerable variety of mass spectrometry platforms; proteomics applications range from straightforward identification of proteins and their modifications, to comprehensive profiling of biological system and de novo mapping of yet unknown proteomes and subproteomes.

**Translational research and cellular therapy:** A Good Manufacturing Practice (GMP) facility with clean rooms is used for translational research e.g. immunotherapeutic cell therapy and stem cell transplantation.

**Collaboration**

NCMLS is a multiparty collaboration between specialist medical groups from the University Medical Centre and a number of groups from the science faculty. Technological development – alongside excellent research and education – are the key motivators for local as well as national and international collaboration. In terms of linking fundamental and clinical science an important objective is to establish strong ties with European and non-European partner institutes with synergistic research areas. The aim is to complete fully translational pipelines from molecule to man to patient to population.

Locally, NCMLS is allied with the Institute for Molecules & Materials and the Donders Institute, providing a solid platform for integrating chemical synthesis, nanoscience and neuroscience with molecular life sciences. Nationally, NCMLS has contacts with other Dutch UMCs and universities as well as with Dutch public private partnerships. Within Europe, there is increasing cooperation with the University of Duisberg-Essen, specifically the Graduate School of Biomedical Science (BIOME). A third International Research Universities Network (IRUN) workshop on immunology was hosted at NCMLS in May 2013 and a fourth is being planned in Glasgow in 2014. This network serves as a forum for building partner relationships with other participants from Universities in Münster, Glasgow, Poland and beyond. As part of the Glasgow-Radboud Memorandum of Understanding, there have been several exchanges (visiting lectureships) between NCMLS and the Institute of Molecular, Cell and Systems Biology, University of Glasgow, Scotland. These exchanges will be further developed as an integral part of the Masters and PhD programmes.

This multi-disciplinary nature of NCMLS ensures not only high-quality research within Molecular Life Sciences, but also offers excellent education programmes at BSc, MSc and PhD level.

**Molecule-2-Man (www.molecule2man.eu)**

The NCMLS is an active participant in Molecule-2-Man (MzM), an innovative multidisciplinary imaging platform strategically located at the University and Radboudumc, both of which have a long history of interdisciplinary research, education and healthcare. M2M is built on the strengths and proven track record of leading Nijmegen institutes: Molecules and Materials, Molecular life-sciences, Cognitive Neuroscience and Medical Sciences. Its aim is to reinforce existing local and national infrastructures by concentrating expertise and facilities in order to create a top European health technology campus in Nijmegen, which will implement and advance imaging technologies from the molecular level to entire organs and the human body itself (i.e. from molecule to man) and take translational research from the laboratory into the clinic (from bench to bed). M2M provides an ideal platform for exchange of knowledge and for access to state-of-the art instrumentation. It also facilitates collaboration with research institutes, small and medium-sized enterprises, and larger companies.
Key publications


Building inter-institutional collaboration possibilities e.g. visiting professorships/lecturers, exchange possibilities for Master’s and PhD students, technology workshops, is a key ambition for the years ahead and contacts in this regard are welcome. In 2013, a double PhD retreat exchange was organized with the Institute for Research in Biomedicine, in Barcelona (IRB). First students from IRB attended the Nijmegen PhD retreat, and then vice versa. This successful formula will be extended in 2014.

Research results

The following section describes some of research highlights from projects carried out by NCMLS researchers.

Theme 1: Ellen van den Bogaard and colleagues have identified the working mechanism of coal tar, one of the oldest treatments of skin diseases, and now plan to isolate coal tar fractions with favourable properties (colourless, less smell) that retain the desired in vitro biological effects. This exciting first step in seeking alternatives for classical coal tar therapy will aid in drug discovery for eczema based on the rehabilitation of the aryl hydrocarbon receptor as a *bona fide* drug target.

Theme 2: Rituximab (RTX) is a very effective drug for patients with B-cell lymphoma or various autoimmune disorders. Elena Kamburova and colleagues found that the effect of RTX on the immune response is not only determined by the extent of B-cell depletion, but also by the functional properties of the remaining B cells. These additional insights into the mechanism of action of RTX will help in the design of future therapeutic regimens.

Theme 3: When tumour cells invade extracellular matrix (ECM), the membrane-tethered matrix metalloproteinase MT1-MMP focally degrades ECM barriers and greatly enhances invasion efficacy. However, a long-standing controversy remained. What is the relevance of MMP function for (cancer cell) invasion, and would therapeutic MMP inhibition result in reduced migration. Katarina Wolf and colleagues solved the mystery by systematically analyzing different ECM conditions, cell types etc. They concluded that the molecular plasticity of cell migration in 3D tissue depends on the physics of ECM. This multi-parametric approach of 3D tissue invasion provides the basis for understanding tissue guidance and remodelling in cancer progression, inflammation and tissue regeneration.

Theme 4: Recent advances in computational and experimental biology anti-c make it possible to identify cancer-specific essential genes. One strategy is to screen for negative genetic interactions (GIs). Two genes have a negative GI when a loss-of-function mutation of one gene has no effect on cell viability but a double mutation results in a severe growth defect. Since most negative GIs in human cells are still unknown, a computational model was
constructed to predict negative GIs by systematically exploiting gene gain and loss patterns in genome evolution. Xiaowen Lu and colleagues demonstrated that predicted protein pairs more frequently have a negative GI than random proteins from the same complex. Furthermore, they applied the model to human protein complexes and predicted a list of novel cancer drug targets. By applying the approach to patient specific protein-protein interaction networks, effective personalized cancer care may be achieved.

Theme 5: Parathyroid glands release parathyroid hormone (PTH) into the circulation to maintain normal extracellular calcium ($Ca^{2+}$) and phosphate ($PO_4^{3-}$) concentrations. PTH levels depend on PTH release from secretory granules and synthesis of new PTH molecules that are secondary to PTH gene transcription. Silvia Ferré and colleagues identified the transcription factor HNF1β as a novel repressor of PTH gene transcription and that loss of PTH transcriptional inhibition by HNF1β contributes to the development of early hyperparathyroidism in patients with HNF1β abnormalities.

Theme 6: Genetic defects in the O-mannosylation pathway lead to dystroglycanopathies. Clinically, patients are characterized by severe muscular dystrophy, eye malformations and structural brain abnormalities. In about half of all patients with dystroglycanopathy the genetic defect is unknown. In a publication in the journal Science, researchers from the NCMLS and the Netherlands Cancer Institute identified novel candidate genes in a cohort of dystroglycanopathy patients. Mutations in two specific genes were found to be the underlying cause of disease in three families. Future work will focus on elucidating the functional role of the new candidate genes in the O-mannosylation pathway.

Theme 7: Vaccination is one of the most successful and cost-effective health interventions, which prevents several millions of deaths every year worldwide. Although clinical trial data has demonstrated the potential of Dendritic cell (DCs) vaccination in cancer immunotherapy, generating DCs in vitro is laborious, time consuming and expensive. Recent efforts to develop next-generation vaccines for infectious diseases and cancer involve a polymeric ‘synthetic DCs’ (sDCs) platform. Subhra Mandal and colleagues have demonstrated the potency of this novel approach to mimic cell functions with fully synthetic supramolecular complexes and to exploit the potential of sDCs in cancer immunotherapy.

Societal impact
NCMLS’s mission is in line with the Radboudumc’s strategic vision to ‘have a significant impact on healthcare’ and to advance ‘personalized medicine’, one of the major societal themes at the University. The importance of molecular life sciences-related research in society is given emphasis in education programmes and research at NCMLS. Training researchers in life sciences is of great importance for society since they will form the new generation of scientists and biotechnology entrepreneurs who will develop novel treatments and diagnostics. NCMLS researchers contribute actively to the dissemination of research results via public conferences, teaching in schools and colleges (e.g. Wetenschapsknoppunt, Radboud University Nijmegen) as well as in the media. Examples of media appearances in 2013 included: novel causes of intellectual disability (Hans van Bokhoven, Dirk Lefeber, Annette Schenck), stem cell transplantation (Willemin Hobe), new methods for tackling malaria (Robert Sauerwein), cause inherited blindness (Frans Cremers, Rob Collin, Susanne Roosig) and novel gene mutations in colorectal cancer (Roland Kuiper).

NCMLS researchers are actively involved in enhancing disease diagnosis, prevention and treatment. Clinical groups interact with patients and their relatives at Radboudumc on a daily basis, have close ties with patient organizations and are involved in public and strategic policy. Of particular note in 2013, the services to medical research and education of René Bindels and Han Brunner were recognised with a royal knighthood, Frans Russel was appointed by the Minister for Health, Welfare and Sport as member of the Dutch Medicines Evaluation Board (MEB) and Joost Drenth was elected as the new chairman of the National Society Committee of the United European Gastroenterology Federation (UEG). Furthermore, Han Brunner became a member of the Royal Netherlands Academy of Arts and Sciences (KNAW) and Jan Smeitink was elected as a member of the prestigious Academia Europaea. NCMLS is proud of these achievements and supports all staff in their contributions to national and international policy-decision making.

Future research
The following prestigious European research Council (ERC) grants and Veni and Vidi grants from Netherlands Organization for Scientific Research (NWO) were awarded to members of NCMLS, forming the basis for important future research. The associated Radboud University Nijmegen ‘Top focus area’ is noted in the parenthesis.

- Henk Stunnenberg (Dept. of Molecular Biology) was awarded an ERC Advanced Grant worth €2.5 million for his project SysStemCell. The aim of this project is to dissect regulatory transcriptional networks orchestrating mouse pluripotent embryonic stem cells (ESC) using state-of-the-art functional genomic, epigenomic and proteomic techniques (Human Genetics).
- Peter Friedl (Dept. of Cell Biology) was awarded an ERC Consolidator Grant worth €2 million to study tumour biology in live animal models using novel multiphoton microendoscopy technology to map cancer progression, metastasis and therapy response (Infectious Disease and Immunology).
- Ronald van Rij (Dept. of Medical Microbiology) was awarded an ERC Consolidator Grant worth €2 million. The antiviral immune system of the mosquito is a critical determinant for virus transmission (e.g. Dengue Fever and West Nile virus). In this project,
the biogenesis, mechanism and function of small RNA-mediated antiviral defence will be analyzed (Infectious Disease and Immunology).

- Geert van den Bogaart (Dept. of Tumour Immunology), was successful in obtaining an ERC starting grant to reveal new mechanisms of membrane organization (Infectious Disease and Immunology).

- Mangala Srinivas (Dept. of Tumour Immunology), was successful in obtaining an ERC Starting Grant to develop novel imaging agents for multimodal clinical and preclinical and clinical imaging, with a focus on in vivo cell tracking (Infectious Disease and Immunology).

- Four experienced researchers were awarded prestigious NWO Vidi grants, in order to develop their own innovative lines of research: 1) Leonie Kamminga, ‘Epigenetic regulation of cellular identity’ (Dept. of Molecular Biology), 2) Dirk Lefebre, ‘Unravelling a unique sugar layer in human brain and muscle’ (Dept. of Neurology), 3) Hendrik Marks, ‘Understanding embryonic stem cells’ (Dept. of Molecular Biology) and 4) Klaas Mulder, ‘Understanding how genes work together’ (Dept. of Molecular Developmental Biology) (all Human Genetics).

- Five young researchers received a Veni grant from the NWO: 1) Nina Hubner, ‘The railway network of our cells’ (Dept. of Molecular Biology), 2) Christian Gilissen, ‘Understanding differences in DNA’ (Dept. of Human Genetics), 3) Jurjen Tel, ‘Systems immunology at the single cell level’ (Dept. of Tumour Immunology), 4) Cindy Dieteren, ‘Features of an immunological serial killer’ (Dept. of Cell Biology), and 5) Jenny van der Wijst, ‘An ion channel and enzyme inextricably linked’ (Dept. of Physiology) (Human Genetics & Infectious Disease and Immunology).

Furthermore, in 2013, a number of large prestigious (consortium) grants were obtained. Full details can be found on the NCMLS website but particular highlights are:

- A consortium led by Prof. Jack Neefjes (NKI, Amsterdam) involving Prof. Carl Figdor (Dept. of Tumour Immunology) was awarded a €27.6 million NWO ‘Gravitation’ grant to initiate the Institute for Chemical Immunology (ICI) (Organic Chemistry - Chemical Biology).

- Prof. Gert-Jan Veenstra (Dept. of Molecular Developmental Biology), together with computational biologist Dr Simon van Heeringen and international colleagues received a European grant to set up a training network on Developmental and Computational Biology (DevCom)(Human Genetics).

- Dr Egbert Oosterwijk (Dept. of Urology), was awarded a Marie Curie Initial Training Network (ITN) grant to develop novel materials for tissue engineering and regenerative medicine.

- Robert Sauerwein (Dept. of Medical Microbiology) received a personal grant from the Bill & Melinda Gates Foundation to further develop a malaria vaccine (Infectious Disease and Immunology).
The IWWR encourages interdisciplinary cooperation among scientists engaged in microbial, animal, plant and environmental science. The Institute aims to integrate these disciplines and encourages joint research in order to enhance understanding of interactions between different life forms as well as their interactions with their habitats. The IWWR uses novel fundamental insights into these processes to make a significant contribution to innovative solutions for urgent global water problems.

The main aim of the IWWR is to be a world-class multi-disciplinary institute of water and wetland research focusing in particular on understanding the environmental stress responses of wetland systems at various levels of organization: from cellular levels via organisms to ecosystems. There is special interest in explaining the ways in which plants, animals and microorganisms adapt to changes in water quantity and quality. Within the IWWR there are five research themes, which focus on such stress adaptations and the conservation of wetland ecosystems. These themes highlight the multi-disciplinary nature of IWWR research and increase the visibility of the Institute, making it attractive for prospective Masters and PhD students, post-docs and tenure track scientists as well as for collaborators and a range of other stakeholders.

These themes are Microbial Biogeochemical Cycles, Plant Stress Responses, Animal Adaptation Physiology, Conservation Biology and Human-Environment Interactions. Researchers working on each theme study mechanisms of adaptation to environmental stressors for particular sets of species or at particular levels of biological organization. As a whole the IWWR covers stress responses to water problems from molecular mechanisms to changes at the global scale.

Researchers working on the Microbial Biogeochemical Cycles theme study the diversity and metabolism of aquatic microorganisms, how they interact with plants and animals and how they contribute to wetland biogeochemical cycles. In two themes (Plant Stress Responses and Animal Adaptation Physiology) the focus is on mechanisms of stress adaptations at the organismal level in plants and animals.

In Conservation Biology, the responses of animal and plant populations, species, communities and ecosystems to environ-
mental change (e.g. hypoxia, warming and eutrophication) are studied, together with a variety of stakeholders, providing the scientific basis for conservation measures. In Human-Environment Interactions, the responses of numerous species – including humans – to multiple environmental stressors are investigated using common principles.

Intensive collaboration within and between people working on these themes has resulted in powerful interdisciplinary consortia that carry out top-level research. Microbiology group leader Mike Jetten has received the most prestigious science award in the Netherlands (the Spinoza prize) in 2012 as well as an ERC Advanced Grant in 2008 and 2013. Prof. Jetten also received a highly prestigious €23 million ‘Gravitation’ grant to establish the Soehngen Institute of Anaerobic Microbiology (SIAM), together with TU Delft, Wageningen UR and the Royal Netherlands Institute for Sea Research (NIOZ). And he is a Principal Investigator at the Earth Systems Sensitivity Centre, a €30 million Gravitation consortium involving Utrecht University, the VU University Amsterdam, Radboud University Nijmegen and Wageningen UR.

The success of researchers working in microbiology – one of the centres of excellence at the University – is attributable to intensive national and international collaboration with experts including wetland bio-geochemists working on Microbial Biogeochemical Cycles. Researchers with different disciplinary backgrounds collaborate in a similar way, creating opportunities for funding and novel research.

Research facilities

All of the IWWR research groups are located in the Huygens Building, where they have access to state-of-the-art modern laboratory facilities – and a central analytical service. The equipment used includes:

- Large aquarium facilities for freshwater and seawater fish; for zebrafish research there is modern equipment, expertise and permits for producing transgenics.
- Light microscopy and electron microscopy facilities for ultra-structural analysis of micro-organisms, animals and plants.
- PHYTOTRON – a unique national research facility for detailed ecological research on sub-surface processes of terrestrial and semi-aquatic vegetation.
- Gas Chromatography and Mass Spectrometry (equipped with a direct thermo-desorption unit).
- Extensive bioreactor and culture facilities for wetland plants and animals, as well as for plant-soil interactions.
- Extensive molecular biological facilities, used to perform quantitative RT PCR, RNA interference, Ion Torrent sequencing technology and in-situ hybridisation.
- Analytical equipment, including a High Pressure Liquid Chromatograph with photodiode array detection.
- New greenhouses will be built in 2014.

Staff

<table>
<thead>
<tr>
<th>Tenured</th>
<th>Full Professors</th>
<th>4.5 FTE</th>
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<tr>
<td>Associate Professors</td>
<td>1.9 FTE</td>
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<tr>
<td>Assistant Professors</td>
<td>6.0 FTE</td>
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<tr>
<td>Researchers</td>
<td>1.2 FTE</td>
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Non-tenured

| Researchers           | 14.8 FTE         |
| Doctoral candidates   | 48.7 FTE         |

Research funding

![Research Funding Diagram]

Collaboration

Collaboration within the Institute opens up avenues for novel interdisciplinary research as well as more opportunities for funding. New initiatives for collaborative research in the context of the ‘Top’ sectors for scientific innovation identified by the Dutch Government have been started. Researchers working on the Plant Stress Response theme have interested several companies in their research on multiple plant stressors and obtained substantial grants from the Top sector Agrofood and Horticulture and The Dutch Technology Foundation (STW).

The Microbial Ecology and Aquatic Ecology groups have been involved in plans for regional development in which provinces, water management authorities and companies (including IWWR spin-off company B-Ware) interact. These plans have considerable relevance for the Top sector Water. Research within the Animal Adaptation Physiology theme continues to attract interest from fish aquaculture practices in the Netherlands and abroad, contributing significantly to discussions on fish welfare; interactive courses on fish welfare attracted a great deal of attention, also internationally.

To join forces with complementary research groups outside IWWR and to achieve successful valorisation, IWWR research is...
also conducted in close collaboration with over 100 national and international research groups, research institutes, companies, government organizations and NGOs.

**Research results**

The microbiologists at IWWR investigated the nitrogen fractionation of anammox bacteria, which contribute significantly to the loss of fixed nitrogen from the oxygen minimum zones and from wetland ecosystems. The role of rare earth elements in volcanic microbial life was investigated and the structure of a new cerium containing methanol dehydrogenase was elucidated. Several novel CS2 hydrolases were identified and studied together with chemists from the Institute for Molecules & Materials. Together with aquatic ecologists and the Chinese Academy of Sciences, the nitrogen and methane cycle in various wetland ecosystems were investigated.

Aquatic ecologists were able to unravel a number of exciting new plant-environment interactions, including the responses of peatlands to different nitrogen loads and the role of sulphide in a range of wetland types. Together with colleagues in environmental sciences, they showed for the first time that the concentration of mega-herbivores in marine protected areas will lead to total ecosystem collapse. The group was strengthened in 2013 by the appointment of two new scholars on tenure tracks, who are focusing on greenhouse gas emissions in lakes and on multi-trophic interactions in wetlands.

The environmental scientists at IWWR developed several systems in order to assess substances and products. They designed models to describe the accumulation and toxicity of oil spills as a function of their chemical properties and biological traits. Physical stressors and extreme events, such as temperature and desiccation, were shown to contribute most to the regional extinction of species.

The geneticists at IWWR finalized the analysis of the MADS-box gene subfamilies. The results indicate that these sub-families have all maintained the same basic set of functions, but that they are not always conserved between the orthologues. In the Meiosys project, they found that chromosome structure may modulate meiotic recombination frequencies.

IWWR’s plant molecular physiologists generated the first genetic linkage map of the new model species *Solanum dulcamara*, using AFLP and SNP markers identified by next-generation sequencing of *S. dulcamara* transcriptome. In collaboration with the plant ecologists they also identified hormones and genes involved in the formation of adventitious roots in *Solanum dulcamara* in response to flooding. These new tools and findings will strengthen the collaborative research of the Plant Science group in the IWWR.

The Ecogenomics group was the first to publish on the occurrence of extra floral nectaries in a crucifer, *Brassica juncea*. A comprehensive expression analysis of *Solanum dulcamara* plants under combinations of water stresses (water logging or drought) and herbivory by *Spodoptera exigua* revealed that induced responses to herbivores are affected by simultaneously occurring abiotic stress factors. Hormone analyses on the same samples were performed, showing a specific role for jasmonic acid and abscisic acid. Transcriptomic analyses of above-ground and below-ground jasmonic acid-induced *Brassica* plants revealed distinct differences in root and shoot-induced responses. A new research line on the role of gut microbes in overcoming plant resistance by cabbage root fly (*Delia radicum*) has yielded fruitful collaboration with the ecological microbiologists, which resulted in a first metagenome and the isolation of specific strains that can break down isothiocyanates.

IWWR’s plant ecologists reviewed the latest insights into how responses of plants to nutrients and soil biota determine plant community productivity and plant species coexistence. With the riverine plant species *Rumex palustris* they showed how plasticity depends on prior conditions and how this can explain apparently labile or inconsistent responses. A *Biology Letters* publication by the molecular ecologists showing how epigenetic modifications have a large impact on inbreeding depression received attention in the press worldwide.

The Organismal Animal Physiology group carried out further research on pain perception in fish and evaluated the consequences of stress load on fish performance in Dutch and European aquaculture practices. They published on thyroid hormone function in larval and adult stages of aquaculture-relevant species such as sea bass and sole. The translational value of zebrafish studies on thyroid hormone transporters resulted in a personal invitation to Dr Klaren to contribute to a highly prestigious symposium on MCT8. The group further developed a high-throughput assay for drug screening in relation to osteoporosis with transgenic zebrafish bone as target.

The Animal Ecology group published a new study testing whether oxygen can limit thermal tolerance, something which has been challenged for tracheated arthropods. Comparing species pairs spanning four different insect orders, it was shown that oxygen can indeed limit thermal tolerance in tracheates. Species that were poor at regulating oxygen uptake were consistently more vulnerable to the synergistic effects of warming and hypoxia, demonstrating the importance of respiratory control in setting thermal tolerance limits. Furthermore, the use of life-history analyses gained momentum via several publications.
Awards

- Prof. Mike Jetten received a knighthood in the order of the Royal Lion of the Netherlands for exceptional services to science
- Prof. Mike Jetten received a second ERC advanced investigators grant to study the ecology of methane oxidizing micro-organisms
- Dr Katharina Ettwig was awarded a Veni grant by NWO
- Stephanie van Dalen was awarded the 2013 Radboud Thesis Award
- Prof. Mike Jetten received a €23 million ‘Gravitation’ grant to establish the Soehngen Institute of Anaerobic Microbiology (SIAM) together with NIOZ, Wageningen UR and TU Delft
- Prof. Mike Jetten is involved in a €30 million Gravitation programme to establish the Earth System Sensitive Centre, led by Utrecht University with the participation of Radboud University Nijmegen, the VU University Amsterdam and Wageningen UR.

Patents

ARF9: Applicant: Nunhems BV, Title: ‘Plants with increased fruit size’, application number EP10005603.5 filed 28 May 2010, was accepted in 2013.

Societal impact

The IWWR establishes close relationships between fundamental researchers within the institute and external stakeholders, often applying novel insights. Such intensive interactions result in urgent societal challenges being translated into novel fundamental research. Novel insights into nature and water management are applied in collaborative studies with governmental and non-governmental organizations, water boards and national, regional and local authorities.

IWWR has structural collaborations with a large number of companies and partners engaged in nature and water management and applications were stimulated by new results. The microbiologists showed that anammox bacteria can remove nitrogen compounds from wastewater at low temperatures, using both ammonium or methane as an electron donor, thus considerably extending the application of these processes in municipal waste water treatment systems. The aquatic ecologists closely cooperate with the spin-off company B-Ware, which values biogeochemical and ecological state-of-the-art knowledge for nature management and water management, together with a number of governmental organizations. One of the collaborative programmes in 2013, which was financed by the European Regional Development Fund (ERDF), involved developing innovative solutions for combining water storage, water purification and biomass production.

IWWR’s plant scientists have established long-standing collaborations with seed companies. The knowledge of the plant geneticists about floral development may in the long term contribute to the development of new crop varieties. In collaboration with Nunhems and Enza Seeds the plant molecular physiologists obtained funding from the Netherlands Organisation for Scientific Research (NWO) for a Meerwaarde project on heat stress in plants and for a prestigious Top-sector project (‘Hot Tomatoes’). Plant ecologists are involved in a FP7 European consortium on root research that was established to optimize crop production. The Ecogenomics group has – together with East-West Seeds, Rijkzwaan and Syngenta – successfully acquired a STW project on Thrips resistance in peppers within the STW Perspectief programme ‘Green defences against Pests’.

Fish welfare, which is getting increasing attention in Western societies, remains central to our research on aggression and on fish stress coping strategies. A Dutch television documentary addressed fish welfare in aquaculture and sport fishing. A series of six day-courses on fish welfare were organized, informing participants about the welfare and ethics-related topics associated with the culture and capture of fish.
Key publications


Dissertations: 15

Scientific publications: 180

Professional publications: 33

Patents: 1
Director: Prof. Hans de Kroon

Hans de Kroon has been Professor of Experimental Plant Ecology at Radboud University Nijmegen since 2000. He graduated from Utrecht University, worked at several institutes in the USA and was an Associate Professor at Wageningen University. He specializes in below-ground traits of plants and has built an innovative experimental facility, the Nijmegen Phytotron. Another of his research interests is population modelling, through which the effects of traits are scaled up to responses at the level of natural populations and communities. He serves on the editorial boards of a number of leading scientific journals in his field.

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Future research

The microbiologists will continue to investigate the role of anaerobic and ammonium oxidizing bacteria in marine and freshwater ecosystems, both in laboratory bioreactors and natural oxygen-limited ecosystems. The fate of methane in various wetland and volcanic ecosystems will be assessed using stable isotopes as well as molecular and environmental genomic methods. The microbiome of several relevant wetlands plant and animal species will be investigated together with the plant and animal scientists at the IWWR.

In 2014 the Ecogenomics group will further analyze herbivore-induced responses in drought-stressed and waterlogged S. dulcamara and further explore the natural variations within the current collection in Nijmegen. The plant physiologists will continue to explore natural variation in Solanum dulcamara and use it to identify new traits that can allow plants to adapt to their environment. The plasticity of genetic networks and plants’ responses to a range of environmental cues will be studied in collaboration with various colleagues at IWWR, including plant ecologists. Moreover, the latter group will further focus on the environmental stress responses of crop plants such as maize.

The Organismal Animal Physiology group is increasingly focusing on fish welfare-related topics. Facilities for studying fish behaviour (zebrafish phenotyping) are being explored in conjunction with commercial companies. A PhD study will address the mechanisms of intestinal transport of toxic lipophilic feed components. A large European consortium is preparing a Horizon 2020 proposal designed to develop a monitor for chronic stress in fish, based on stress steroids in their scales.

Future Life Cycle Analysis research will focus on the global impact of products, in particular scaling aspects. Quality standards for pharmaceuticals will be subjected to uncertainty analysis. The potential for the accumulation of nano-materials will also be investigated. The number of climate-related environmental factors determining native and invasive species success will be extended.

The Aquatic Ecology group will further focus on the effects of global change on a full range of wetland types – including peatlands, coastal marshes and lakes – and expand its collaborative research on plant-micro-organism interactions (together with the Microbiology and Plant Ecology groups) with respect to carbon, nitrogen and sulphur cycling in wetlands.

The Animal Ecologists will study the responses of aquatic ectotherms to changing water temperature and oxygen concentrations, using a combination of experiments and models. Eco-evolutionary population models will be used to reveal the relative importance of phenotypic plasticity and rapid evolution for stochastic population dynamics and resilience. Experiments will test whether oxygen dynamics are mechanistically driving thermal performance responses in growth, maturation and reproduction.
Institute for Molecules and Materials

The Institute for Molecules and Materials (IMM) is an interdisciplinary research institute in chemistry and physics at Radboud University Nijmegen. Its mission is to fundamentally understand, design and control the functioning of molecules and materials. The institute is a centre of excellence that trains the next generation of leaders in science and entrepreneurship.

The IMM is composed of twenty research groups, each headed by a full professor. The main research themes are:
1. Structure and Dynamics of Molecules
2. Molecular Life-like Systems
3. Quantum Matter

The IMM has an annual turnover of €26 million and about 60% of the budget is obtained via research grants and contract research. The institute employs around 140 PhD students and every year some 30 students graduate. There is a strong focus on interdisciplinary research between experimentalists and theorists and between physicists and chemists.

Structure and Dynamics of Molecules
This research theme focuses on the constellation and motion of the atoms within molecules, molecular complexes, molecular and atomic collisions, and even chemical reactions. Examples include small organic molecules, non-covalently bounded complexes, and collisions between diatoms and noble gases. Experiments are often based on advanced spectroscopic techniques such as NMR, various laser techniques, and velocity-map imaging. Theoretical approaches include ab initio calculations, simulations, and DFT methods.
Molecular Life-like Systems
This research theme involves the design, synthesis and characterization of molecules and molecular assemblies in order to elucidate the structure and function of natural systems. Examples include artificial cells and organelles, enzyme-mimetic structures, orthogonal chemistry in living cells and analysis of biomolecular interactions. This research is based on expertise in bio/organic chemistry, supramolecular chemistry, microfluidics, microscopy, NMR spectroscopy techniques, and data analysis/chemometrics.

Quantum Matter
This focus theme on the study of properties of matter that is dominated by interactions between quantum particles, quantum coherence and quantum correlations and topology. The goal is to understand and develop new materials and concepts based on collective, emergent quantum effects. Examples include the study and control of magnetic materials at energy and time scales of the exchange interaction, sub-nanometre metal(-oxide) clusters, graphene and quantum dots. Properties are often studied under extreme conditions such as high magnetic fields, ultra-short laser pulses, and low temperatures.

Nanostructured Materials
This research theme involves the design, growth, synthesis and characterization of materials in which the properties partly stem from their nano-scale dimensions, with the aim of exploring novel property-function relationships. This includes supramolecular assemblies, nanoreactors, self-assembled monolayers, chiral clusters and solar cells. These materials are typically studied using microscopy (including SPM) and X-ray diffraction.

Research facilities
The national and international position of the IMM is enhanced by the availability of a number of large-scale experimental research facilities, including:

- A High Field Magnet Laboratory (HFML) for continuous fields up to 33 Tesla, and with funding to achieve 38 Tesla in 2014 and 45 Tesla in 2016.
- Free Electron Lasers for Infrared and Terahertz Experiments (FELIX) Facility. The terahertz laser (FLARE) and the infrared lasers (FELIX/FELICE) are fully tunable between 3 and 1,500 micron.
- A Large-Scale Facility for high-resolution liquid NMR (Nuclear Magnetic Resonance) and a Solid-State NMR Facility for advanced material science, including an 850 MHz proton NMR instrument.
- A Scanning Probe laboratory (NanoLab) with a wide range of Scanning Tunnelling Microscopy (STM) and Atomic Force Microscopy (AFM) techniques.
- A Trace Gas Facility for the application of laser diagnostics in biology and medicine.

In 2012 and 2013 the FELIX lasers were disassembled and moved from Nieuwegein to Nijmegen. It was a major achievement when on 14 July 2013 the FELIX-2 laser produced its first infrared photons in Nijmegen. This year the optical transport systems to all user stations will be installed, FELIX-1 and FELICE will be reconstructed, and FLARE will be further commissioned.

Other experimental facilities include:

- A Solar Cell Research Facility with dedicated growth, processing and analysis equipment for solar cell research, including Clean Rooms and an Outdoor Calibration Facility.
- A Thin Film Growth Laboratory, in which materials and thin films can be grown with atomic precision.
- X-ray crystallography service facilities, with diffractometers for both single and powder X-ray diffraction.
Collaboration
National and international collaborations are crucial for realizing the Institute's ambitions, e.g. for scientific interaction with high-profile research groups, forming of consortia for EU applications, increasing the international recognition of the IMM, exploiting the institute's large-scale research facilities, and signalling job opportunities for PhD students and postdocs.

The organic chemistry groups of the IMM have a longstanding collaboration with the Institute for Complex Molecular Systems (ICMS) at the Eindhoven University of Technology. The IMM also collaborates intensively with the Catholic University of Leuven in Belgium on single molecule spectroscopy. This collaboration involves the exchange of PhD students and postdocs as well as the use of the special equipment at the two locations. Several organic chemistry groups collaborate with the University of Barcelona. Within the field of graphene research, the groups at the IMM led by Profs. Katsnelson and Maan collaborate closely with Profs. Geim and Novoselov of the University of Manchester. Prof. Katsnelson also works closely together with scientists at the Universities of Uppsala, Hamburg, and Moscow.

The IMM is a partner in two formal collaborations with the Foundation for Fundamental Research on Matter (FOM). One partnership relates to the relocation and the 10-year exploitation of the free electron lasers 'FELIX and FELICE' in Nijmegen, and the other involves the joint running of the HFML and the promotion of materials research with high magnetic fields. The Engineering and Physical Sciences Research Council (EPSRC, UK) transferred a research contract on solid-state physics with free electron lasers to Nijmegen.

The EU-FP7 project on the European Magnet Field Laboratory (EMFL) involves investigating all legal, financial, organisational and employment issues required for a Founding Agreement for the EMFL. It is the intention that this agreement is signed by the three founding partners (Radboud University Nijmegen, Helmholtz Zentrum Dresden-Rossendorf (HZDR) and le Centre National de la Recherche Scientifique (CNRS) in Grenoble/Toulouse) and, in a later stage, by other stakeholders that may be identified. The HFML is the coordinating partner of this FP7 project.

Radboud University Nijmegen, FOM, and the Helmholtz-Zentrum Dresden-Rossendorf (HZDR) have a Cooperation Agreement, which is designed to strengthen scientific and technological collaborations in high magnetic field and free electron laser research.

Research results
Highlights are listed in the right-hand column and on the next two pages under the Institute's four main research themes.

Structure and Dynamics of Molecules
Dr Rijks and colleagues (Molecular and Biophysics) have studied the salt bridge interaction between glutamic acid and arginine in small peptides. Conformation-specific IR absorption spectra in combination with high-level quantum chemical calculations allowed them to determine how charged side chains interact.

Dr Van der Meerakker and co-workers from Molecular and Laser Physics obtained the first scattering images using a dedicated crossed beam apparatus that contains a 2.6-meter-long Stark decelerator. This apparatus was used to resolve, for the first time, diffraction oscillations in quantum state-resolved differential cross sections, using the scattering of NO radicals with rare gas atoms as a model system. (Nature Chemistry).

The Molecular Structure and Dynamics group (Prof. Oomens) has identified new reaction products in gas-phase peptide dissociation. This study indicates that peptide fragmentation chemistry is richer than was originally thought. Further insight into this chemistry may help to improve scoring algorithms applied in peptide and protein identification by sequencing based on mass spectrometry.

Dr Cuppen and co-workers (Theoretical Chemistry) have studied the long-timescale dynamics of adsorbed CO on water ice surfaces. They carried out a combined theoretical and experimental study into the mobility of carbon monoxide on the surface of amorphous solid water. It was found that the subnanometer-sized pores in the ice substrate are the determining factor for CO mobility.

Molecular Life-like Systems
Prof. Pruijn and co-workers (Bio-Molecular Chemistry) have studied the conversion of peptidylarginine to peptidylcitrulline, a process also known as citrullination of proteins, and developed a new detection method. The chemical difference between peptidylarginine and peptidylcitrulline is very subtle and therefore it is a major challenge to discriminate between citrullinated and non-citrullinated proteins.

Dr Jansen and Prof. Buydens (Analytical Chemistry) have applied chemometrics for a comprehensive disease diagnosis with flow cytometry, commonly used to characterize the properties of individual cells in suspensions like blood. Fingerprints of several healthy individuals were used to represent the 'Normal Operating Conditions', and for diseased individuals the deviations are signalled. (Patent is applied)

The Bio-Organic Chemistry group (Prof. Van Hest) has developed a novel shape transformation technique for the preparation of tubular polymersomes induced by the addition of a crosslinker. Concerning the advantages of tubular shapes they foresee applications for these vesicles as drug delivery vehicles or artificial organelles.
The Spectroscopy of Surfaces and Interfaces group (Prof. Rasing) has worked on the femtosecond control of magnetism at the nano scale. Using a combination of different optical techniques, magnetization control at the sub-micron level is achieved. To further reduce the dimension of the optically controlled area other approaches may be attempted, e.g. the use of plasmonic antennas. (Phys. Rev. Lett.)

Prof. Katsnelson and his Theory of Condensed Matter group have studied the massless Dirac fermions, which are the charge carriers in graphene and topological insulators. They developed a basic theory for electronic optics in graphene, which opens up the potential for new devices that can manipulate electronic beams.

Nanostructured Materials

The Applied Materials Science (Dr Schermer) group worked on the upconversion of long-wavelength (900-1000 nm) light to shorter wavelengths (550-660 nm) for solar cell applications. This up conversion provides a pathway to convert otherwise unabsorbed low-energy photons passing through the solar cell into higher-energy photons that are absorbed. The efficiency of the solar cells can thus be increased.

The group led by Prof. Christianen (Soft Condensed Matter, HFML) studied the giant diamagnetism of gold nanorods. They found drastically enhanced diamagnetism in gold nanoparticles that could be attributed to the behaviour of the free electrons within the small nanoparticles. (Phys. Rev. Lett.)

Dr Heus (Biophysical Chemistry) has documented structural elements that are essential in RNA folding and recognition of proteins, the RNA pseudotriloop (PTL). UV-melting and NMR spectroscopy were used to establish factors that contribute to the formation and stability of PTL structures and a consensus structure was determined.

Dr Zeitler and co-workers (Semiconductors and Nanostructures, HFML) have measured electron-electron correlation effects in graphene using high-field capacitance spectroscopy. This technique provides direct access to the electronic density of states and unveiled the many-body physics in graphene devices subjected to magnetic fields. (PNAS)

Dr Bas van de Meerakker (Assistant Professor of Molecular and Laser Physics) received an ERC Starting grant to study and control collisions between molecules in even greater detail than in the past. By slowing down molecules he can control their movements. He will also use the grant to reconstruct current experimental equipment.

Dr Rowan and co-workers (Molecular Materials) reported on self-assembled organic microfibers for nonlinear optics. The observed properties highlight the importance of the orientations of the dipoles as essential design parameters in future organic nonlinear optical materials. The facile processing conditions of these microfibers make it possible to easily transform these materials into actual optical devices.
Key publications


Dr Elemans and his colleagues (Scanning Probe Microscopy) revealed single molecule reactivity in an environmentally controlled liquid STM and were also able to manipulate this reactivity. The unique possibility to ‘see’ reactions occurring at the single molecule scale opens up a wealth of possibilities in developing new catalysts supported by active scaffolds like a biased surface. (Nature Chemistry)

Prof. Kirilyuk and co-workers (Spectroscopy of Surfaces and Interfaces) studied the magnetism of small mass-selected Terbium clusters, both experimentally and theoretically. The striking result is that the magnetic moment of the clusters oscillates with the number of atoms due to variations between ferro- and anti-ferromagnetic configurations in the clusters.

The Solid State NMR group (Prof. Kentgens) demonstrated that adaption and miniaturization of the NMR detection geometry makes it possible to provide in-depth analyses of intact thin film devices with µm thickness. These results show for the first time that NMR can contribute to the structural characterization of intact thin film materials and answer questions in relation to their functional behaviour.

Prof. Vlieg and his group (Solid State Chemistry) found that formation of a salt enables complete deracemisation of a racemic compound. Chiral purification is a very important step in the production of many products such as active pharmaceutical ingredients. The addition of a minor amount of pure compound in the beginning determines the handedness of the product.

**Awards and grants**

In 2013 Prof. Katsnelson was awarded the Spinoza Prize by the Netherlands Organisation for Scientific Research (NWO). This is the most prestigious scientific prize in the Netherlands. He also received an ERC Advanced Grant. He will use these grants to develop new physics theory for new phenomena that graphene and nano objects – such as quantum dots and magnetic molecules – bring to light. In addition, Prof. Rasing has received an ERC Advanced Grant for experiments with a new femtosecond X-ray source in Stanford and with the Nijmegen picosecond Terahertz free-electron laser to discover how magnetic order emerges from chaos. An ERC Starting Grant was awarded to Dr Van der Meerakker (Molecular and Laser Physics) for a study on molecular collision processes at low temperatures and with extremely high resolution.

Dr Zeitler (HFML) participated in the successful application for a European Flagship programme on graphene (€1 billion for 10 years). This flagship programme unites academic and industrial research on Graphene in order to achieve breakthroughs in technological innovation.
Four eminent scientists at the IMM, Prof. Katsnelson, Prof. Meijer, Prof. Nolte, and Prof. Rasing, were appointed as members of the Academia Europaea in 2013. Prof. Nolte was also elected as an Honorary Member of the Royal Netherlands Chemical Society (KNCV).

Prof. Kentgens and colleagues from the Universities of Utrecht, Wageningen, Leiden, and Eindhoven received an NWO Graduate School subsidy (worth €800,000) for starting the Netherlands’ Magnetic Resonance Research School. Prof. Parker and Dr Van der Meerakker have received an NWO-TOP grant (€760,000) for imaging astrochemical processes in the lab using the powerful ‘velocity map imaging’ technique invented in Nijmegen. Dr Blank (Molecular Materials) obtained an NWO-ECHO grant (€260,000) for investigating the largely unknown communication pathways between the active sites in enzymes. In the FOM Project Ruimte, Dr Titov (Theory of Condensed Matter) acquired funding for research on topological insulators, these materials are insulating in the bulk and electrical conductors at the surface.

Last but not least, four young scientists received an NWO-VENI grant to work at the IMM for a three-year period.

Societal impact
The valorisation of knowledge through university research and the societal impact of science are becoming increasingly important as indicators of scientific success. The IMM actively stimulates scientists to cross this bridge. There are cooperative arrangements with major companies in the Netherlands, including DSM, Philips, NXP, Solvay, Unilever and AkzoNobel. In addition, the large-scale research infrastructure at the IMM has resulted in business relations with medium-sized technology-oriented enterprises in the Nijmegen area.

During the past years the IMM has given birth to many spin-off companies, such as Chiralix, Encapson, FutureChemistry, Mercachem, Modiqquest, Noviotech, ReRa Systems, SensorSense, Sphere Fluidics, SynAffix, Syntarga, Synthon, TeraOptronics, and tf2 devices.

Dr Feiters (Synthetic Organic Chemistry) and colleagues were granted a Life Science Pre-Seed subsidy (€250,000 euro) from the Netherlands Genomic Initiative (NGI) for addressing novel viral therapeutics against Dengue and other viral threats. Prof. Rowan obtained an STW Valorisation grant for the further application of ‘Smart Patches’. These are patches that are biologically similar to the skin and protect against bacteria, but release wound fluids and are easy to remove. Another STW Valorisation grant has been obtained by Dr Schermer (Applied Materials Science) and start-up SolarSwing for developing semi-transparent solar blinds that regulate the transmitted light and generate electricity.

Prof. Huck is co-founder and member of the Board of Directors of Sphere Fluidics, a Cambridge-based company developing novel products and services for single-cell analysis. In 2013 the company has collected £1.6 million from a consortium of investors to further develop its business.

Prof. Rutjes participates in the European Lead Factory, a €396 million EU project with 30 partners who are working on building a huge library of new chemical compounds that are potentially relevant for new medicines. Within this project new compounds will be identified, screened and further developed. Universities, research institutes, small-medium enterprises and large companies can access the database.

Within the chemical NWO Gravitation Programme, the Research Centre for Functional Molecular Systems, a significant outreach
Director: Prof. Elias Vlieg

Elias Vlieg has been Professor of Solid State Chemistry at Radboud University Nijmegen since 1998. After a post-doc at AT&T Bell Laboratories, he was a group leader at the FOM Institute AMOLF from 1990-1997. With a background in physics, his profile illustrates the combined chemistry and physics approach of the IMM. His research focuses on understanding crystal growth and, as head of the Applied Materials Science group, on the use of thin film deposition for solar cells and electronic devices. He is vice-president of the International Organization for Crystal Growth.

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Future research
A continuing challenge is provided by a €27 million grant from the national investment in large infrastructures (NWO-BIG) in 2006 for the Nijmegen Centre for Advanced Spectroscopy (NCAS). This exceptional grant enables IMM to construct a new 45 Tesla hybrid magnet for the HFML and a Free Electron Laser for research using Terahertz radiation (FLARE). HFML’s new hybrid magnet will provide new research opportunities based on world-leading magnet technology. FLARE creates unique opportunities for studying magnetic excitations in molecules as well as low energy spectroscopy on large molecules and biomolecules. Moreover, it is optimally suited for spectroscopy on electrons in high magnetic fields.

The national Sector Plan for Physics and Chemistry (SNS) was approved in 2010 with a very positive outcome for Radboud University Nijmegen. Two new initiatives in Chemical Biology and Advanced Spectroscopy of functional molecules and materials were started within IMM. All new scientific staff members have now started (e.g. Prof. Hussey in September 2013) and they are currently producing results. After a successful first progress evaluation, the intention is to ensure that SNS continues as a structural source of funding after 2015.

The operational hours of the HFML will continue to increase towards 2,000 per year in 2014. This increase is thanks to a partnership between Radboud University Nijmegen and FOM (2011) and a €11 million National Roadmap grant (2012). A continuing challenge is the search for structural funding for the operation of the HFML at an ultimate level of 3,000 hours per year.

The successful implementation and exploitation of the ‘Gravitation’ project ‘Research Centre for Functional Molecular Systems (FMS)’ in collaboration with partners in Eindhoven and Groningen is of utmost importance for IMM. In 2013 FMS made a promising start: a project leader and ten PhD students were hired, several thematic meetings were held, outreach efforts (‘Kennislink’) were started, and a website was launched.

In 2014 the Radboud Nanomedicine Alliance, a joint initiative of Radboud UMC, NCMLS, and IMM, will be started with the appointment of five PhD students. This alliance focuses on developing new effective medicines and materials for the treatment of diseases, tailored to individual patients. The available research facilities will be open for intense cooperation with chemical and biomedical industrial partners.

Also in 2014, all leading scientists of the IMM will continue to make all ongoing research projects a big success and to acquire substantial new funding for future projects. In this way the Institute for Molecules and Materials will continue to strengthen its national and international reputation.
Institute for Mathematics, Astrophysics and Particle Physics

The Institute for Mathematics, Astrophysics and Particle Physics (IMAPP) conducts fundamental research in mathematics, high-energy physics and astrophysics with a special focus on interdisciplinary topics. The overarching research theme is the origin and evolution of the universe and its underlying mathematical structures. The Institute is also actively engaged in outreach.

Mathematics
This department focuses on three interdisciplinary themes, Mathematical Physics, Algebra & Topology and Applied Stochastics, which have well-established links with physics and computer science. The traditional areas – algebra, logic, analysis, geometry and stochastics – are studied in the context of these themes.

Astrophysics
Researchers in this department focus on observational and theoretical research in three areas of astronomy: astroparticle physics, compact objects and the structure and stellar populations in galaxies. Their main goals are to reveal the sources of the highest-energy particles in the universe, to understand the physics and populations of compact objects including gravitational waves, and to explain the evolution and structure of galaxies and their stellar populations.

High-energy physics
This group carries out and analyzes experiments in elementary particle physics at the smallest distance and the highest mass scales attainable. This research includes both accelerator-based and cosmic ray experiments and explorations of the theoretical foundations of elementary particle interactions, including gravity. There is a particular focus on electroweak symmetry breaking and the Higgs boson as an attempt to gain more insight into the structure of the vacuum.

Computer simulations of causal dynamical triangulations are used to illustrate the quantum properties of space-time and to understand quantum gravity.
Research facilities
The experimental astronomical groups make use of leading national and inter-
national astronomical and astroparticle observatories (ESO, La
Palma, LOFAR, Virgo, HST, Kascade-Grande and Pierre Auger) and
high-energy particle accelerators (Large Hadron Collider [LHC] and
Tevatron). The Institute houses two optical telescopes and a radio
interferometer, which are used for educational activities – and to
courage public participation. It also makes use of the faculty’s
mechanical and electronics workshops and the facilities of the
Amsterdam-based National Institute for Nuclear and High-Energy
Physics (Nikhef).

Collaboration
The research questions and themes studied at IMAPP are of
international significance and are being worked on by scientists
all over the world. Hence, the research facilities and collaborations
are also of an international nature. Moreover, IMAPP has many
international staff members.

Mathematicians based in Nijmegen are involved in the NWO
mathematics clusters DIAMANT (Discrete, Interactive & Algorithmic
Mathematics, and Algebra & Number Theory), GQT (Geometry and
Quantum Theory) and STAR (Stochastics - Theoretical and Applied
Research). Mathematicians at IMAPP make a major contribution
to GQT.

The elementary particle physics group – a partner in Nikhef – is
associated with the European Laboratory for Particle Physics
(CERN in Switzerland) and the Fermi National Accelerator Laboratory
(FNAL in the USA). Astronomical research is carried out within
the framework of the top research school NOVA and in association
with ASTRON, SRON and ESA. The Nijmegen group co-leads the
EGAPS survey, leads the BlackGEM and MeerLICHT projects, is
the expertise centre for cosmic ray detection with LOFAR, and is
a member of the Virgo consortium. IMAPP particle physicists and
astronomers are joint members of the Pierre Auger Observatory
Collaboration in Argentina, and of Nikhef.

All researchers at the Institute are members of one of the following
Dutch national research schools: Wonder (mathematics), OSAF
(elementary particles), LOTN (theoretical physics) and NOVA
(astronomy) – all accredited by the Royal Netherlands Academy
of Arts and Sciences (KNAW).

Research results
The Mathematical Physics Department continued its research
in Symmetry, Representation Theory, Special Functions, Non-
commutative Geometry, Algebraic Groups, Quantum Groups,
Algebraic Geometry, Differential Geometry, Quantum Field Theory,
Foundations of Quantum Mechanics, and Category Theory. Its two
youngest members, Maarten Solleveld and Walter van Suijlekom,
were exceptionally productive, both in publishing their research
and in acquiring grants. Solleveld collaborated with the renowned
mathematician Paul Baum and others on the Langlands Programme,
a major development in mathematics. Van Suijlekom collaborated
with Fields Medalist Alain Connes on the applications of non-
commutative geometry to particle physics. Within IMAPP, Lands-
man and van Suijlekom also started a collaboration with Renate
Loll and Frank Saueressig from the Theoretical High-energy Physics
Department in order to apply methods from non-commutative
geometry and quantum field theory to quantum gravity. This led
to a successful joint proposal. Landsman reached the national
press with his solution to the measurement problem in quantum
mechanics, an example of which is known as ‘Schrödinger’s Cat’.

The department that was formerly known as ‘Algebra & Logic’
has been renamed ‘Algebra & Topology’ to better reflect its current
research focus. Prof. Moonen started in September 2013 as the new
head of this department, occupying the Chair of Algebra. His research
area is Algebraic and Arithmetic Geometry. He has already organized
two international scientific meetings in Nijmegen, and in December
2013 his student Qizheng Yin obtained his doctorate for a truly out-
standing PhD thesis. Prof. Moonen has developed a new technique
that leads to a proof of the Tate conjecture for some classes of
algebraic surfaces and, together with Qizheng Yin, he has proved some conjectures of O’Grady. The Spinoza Prize awarded to Prof. Moerdijk in 2012 has given an enormous impulse to the Algebra & Topology group. Prof. Moerdijk has brought together a group of excellent young researchers working in homotopy theory, who greatly contribute to both the scientific level and the visibility of the department. Prof. Moerdijk and the other members of this group have obtained numerous new results, notably on the homotopy theory of higher categories and infinity operands. Dr Terwijn and PhD student Rutger Kuyper have proved a number of results in model theory relating to measure spaces. Dr Souvignier and collaborators have developed a new method that gives the structural conditions for the formation of twin crystals; this has concrete applications in the study of minerals.

The Applied Stochastics Department made a serious effort in 2013 to increase its scientific impact by continuing and extending its research at an international level. The department was reinforced by Dr Kang, who is working on the interplay between stochastics and combinatorics, as well as with a postdoc and a PhD student. The department has also started to collaborate with other successful research groups, including with the biostatistics group in the Radboud Medical Centre headed by Prof. Goeman, which is very promising. Furthermore, Dr Maassen now works one day a week as a full professor of Quantum Probability and Quantum Information at the University of Amsterdam.

In 2013 the Department of Astrophysics received funding for a number of new projects: participation by the Netherlands in the Cerenkov Telescope Array, led by Radboud University Nijmegen and the University of Amsterdam; the MeerLICHT and BlackGEM projects for optical telescopes set up to detect the optical signals emitted by radio transients and the gravitational wave events, respectively; and the BlackHoleCAM project to directly image the event horizon of the black hole in the centre of the Milky Way Galaxy. In 2013 design work started on BlackGEM and MeerLICHT, both of which are part of the Dutch ‘top’ sector High Tech Systems and Materials, specifically on the Advanced Instrumentation roadmap.

A total of 161 refereed publications were published by members of the Department of Astrophysics in 2013, including four in Nature and Science. Specific highlights were the detection of the first pulsar in the near vicinity of the super-massive black hole in the centre of our Galaxy, the detection of very large-scale outflows from the centre of the Milky Way Galaxy using radio telescopes, the detection of a pulsar that switches between radio emission and X-ray emission in a very unexpected way, the detection of a new type of X-ray transient in the near-by galaxy M86, the first systematic sample of cosmic-rays found in the radio using the LOFAR telescope, a systematic study of the young stellar population in the Tarantula nebula in the Large Magellanic Cloud, the first ever orphan after-glow of a gamma-ray burst using the PTF survey and the first cosmological results from the Planck satellite that studies the cosmic microwave background.

The IMAPP high-energy physics group which is involved in the ATLAS experiment has built on the Higgs-boson discovery in 2012, publishing a total of 105 articles in 2013. Using a dataset that was more than double that of the discovery, the quantum numbers of the new particle were determined in the WW and ZZ decay channels, establishing that it is indeed the long sought Higgs boson. The group also contributed to the first measurement of Higgs-boson production through the fusion of vector bosons. Dr Filthaut and Prof. de Groot received a FOM Projectruimte grant to investigate the production of the Higgs boson in association with a pair of top quarks, which makes it possible to directly measure the important coupling between the Higgs boson and a top quark. Members of the group also actively participated in a number of dedicated searches for supersymmetry (SUSY) by looking at the momentum imbalance in the detector caused by the lightest SUSY particle, which is stable and only weakly interacting. The LHC accelerator is currently undergoing an upgrade programme in order to run at a much higher energy of 14 TeV in 2015. The IMAPP group is taking advantage of this period to contribute – together with Nikhef colleagues in Amsterdam – to an improved read-out of the muon system.

The high-energy physics group which is involved in the Auger experiment aims to comprehend the physics governing air showers at the highest energies. This requires a better knowledge of the nature of the incoming cosmic rays, a subject which is currently under investigation. This same work will also be important for addressing additional physical and astrophysical questions relating to the origin of cosmic rays. The promising results based on analysis of the data produced by the newly installed AERA stage 2 radio detector, in which the high-energy and astrophysics departments of IMAPP collaborate, are being worked out in several PhD projects.

On the theory side, some research activities have focused on providing reliable theoretical predictions for SUSY searches at the LHC, which involves dedicated resummation techniques for calculating the sizable quantum corrections. In 2013 a big step was taken towards achieving the next level of precision in this context, which should become the new precision standard for the upcoming LHC searches. In addition, a new type of Callan-Symanzik equation for completely general quantum field theories was derived. This is expressed purely in terms of the unrenormalized parameters, and an investigation has started into the relation between colour and momentum flow in multi-particle QCD processes using the programme package CAMGEN/CAMORRA.

The recently started research activities in quantum gravity have gathered pace with the appointment of Dr Saueressig. The focus is on finding a fundamental theory of quantum gravity using a
purely quantum field theoretical approach. Its main tools are renormalization-group techniques and non-perturbative lattice methods known as Causal Dynamical Triangulations. This ‘minimalist’ ansatz has led to some very notable advances recently, including the unprecedented discovery of a second-order phase transition in the lattice formulation, a prerequisite for the existence of a well-defined continuum theory. The involvement of researchers from both theoretical high-energy physics and mathematical physics in this programme, which is funded by FOM, underlines the added value of the scientific breadth at the IMAPP.

Awards and acknowledgements
• Prof. Falcke received an ERC Synergy Grant
• Prof. Loll, Prof. Ambjorn, Prof. Landsman, Dr Saueressig and Dr van Suijlekom obtained a joint FOM Vrij Programma grant
• Prof. de Groot and Dr Filthaut received a FOM Projectruimte grant
• Dr van Suijlekom received an NWO Vidi grant
• Prof. Cator received an NWO Vrije Competitie grant
• Prof. Groot received an NWO Vrije Competitie grant
• Prof. Landsman received an NWO Vrije Competitie grant
• Dr Müger received an NWO Vrije Competitie grant
• Dr Solleveld received an NWO Vrije Competitie grant
• Dr Saueressig received a FOM Projectruimte grant
• Prof. Landsman received a grant from the Templeton World Charity Foundation
• Dr Martin-Benito received an NWO Veni grant
• Dr Gryb also received an NWO Veni grant
• Prof. Falcke and Prof. Loll were elected to the Academia Europaea
• Prof. de Groot and collaborators received a FOM Programma grant for the LHC
• Prof. de Groot and Dr Filthaut received a Radboud Science Award for working on the discovery of the Higgs boson
• Mr Balster received the Radboud University Bronze Medal for his longstanding outreach activities
• PhD student Marianne Heida received a Radboud Frye Stipendium for outstanding female PhD students.

Societal impact
IMAPP is involved in research at the forefront of science and is training researchers for academia, government and industry. It is essential for society to have well-trained researchers. IMAPP’s research is related to fundamental questions about the universe and the building blocks of nature. Many results will only reveal their full impact in future decades, but they could then have far-reaching consequences, changing the way we view the world. IMAPP plays an important role in national discussions on science and mathematics in secondary education. Prof. Cator taught a statistics course for high school teachers and he participated in the Google Curriculum on Mathematics, an important initiative designed to introduce innovative teaching in high schools. Involvement with Pre-University College, the Mathematics Tournament, the HiSPARC project, monthly observation nights, and the national Kangoeroe mathematics competition, will continue. In 2013 the leading Dutch newspaper de Volkskrant published interviews with Prof. Falcke, Prof. Landsman and Prof. Loll.

The recent connection of the Applied Stochastics Department with the biostatistics group is bound to have an impact on important health-related statistical problems. The Statistical Helpdesk is successful and will be further expanded in 2014.

Future research
With proposals for the BlackHoleCAM, MeerLICHT, BlackGEM and CTA projects approved, these will become a focal point for research in the Astrophysics Department in the years ahead. In the context of the Dutch ‘top’ sector High-Tech Systems & Materials we expect to see further developments in advanced instrumentation on light-weight carbon-fibre mirrors and structures, in green computing, also in collaboration with IBM, and in renewable

Prof. Eric Cator (Professor of Applied Stochastics) designed and taught a statistics course for secondary school teachers and he participated in the Google Curriculum on Mathematics, an important initiative designed to introduce innovative teaching in secondary schools.
Key publications


Dissertations: 12
Scientific publications: 434
Professional publications: 2
Erik Koelink, who graduated from Leiden University and has worked at the National Aerospace Laboratory in Amsterdam, Katholieke Universiteit Leuven, University of Amsterdam, and Delft University of Technology, became Professor of Analysis at Radboud University Nijmegen in 2007. His research focuses on the interaction between the representation theory of Lie algebras and quantum groups on the one hand and special functions on the other, with applications in mathematical physics. He is a member of the NWO cluster Geometry and Quantum Theory.

Within the experimental high-energy physics group, momentum-imbalance reconstruction algorithms will be developed to be run on a new topological processor of the first ATLAS trigger level. This new online selection method will be commissioned before the restart of data acquisition to ensure that events that are interesting for this project are recorded. In addition, the search potential for new physics at a high-luminosity LHC upgrade will be investigated. The theoretical researches for SUSY and quantum gravity will be extended.

The mathematical physics department will concentrate on methods originating in the mathematical foundations and analysis of quantum theory, applying these in quantum information theory, non-commutative geometry, theoretical physics and in pure mathematics. The Algebra & Topology group expects to profit from cross-fertilization between Topology and Algebraic Geometry, as for instance in the theory of Motives and applications of derived categories. In the near future the Applied Stochastics group will focus on greater cooperation, both within IMAPP and within the Science Faculty.
While computing is becoming increasingly pervasive, there are growing problems with software in terms of security (breaches of information access restrictions or privacy), reliability (the system behaves erratically), safety (use of the system is harmful), trustworthiness (low reliability of system services), efficiency (the system is unable to handle problems of a particular size) and conformity with requirements. The inherent complexity of computer-based artefacts – together with the slow pace of software development, high costs and strong competitive pressures – further complicates the search for solutions.

The Institute for Computing and Information Sciences (iCIS) was established to improve the fundamentals of software development via formal, mathematically founded theories, methods and tools that support the specification, design, analysis and evaluation of computer-based systems. Research aims include improving the quality of software, with an emphasis on enhancing reliability, security, architectures and system alignment. The quality of the research remains very high, resulting in many Netherlands Organisation for Scientific Research (NWO) grants in 2013, including three NWO Venis for Dr Alexandra Silva, Dr Peter Schwabe and Dr Sicco Verwer, an ASPASIA for Dr Lejla Batina and a TOP grant for Dr Elena Marchiori. Work at the Institute is inspired by problems encountered in society as well as by issues arising in other disciplines.

Members of the Institute advocate open source software as well as (digital) security by design and openness (in contrast with security through obscurity). In the same spirit, iCIS promotes a culture of openness when dealing with scientific integrity. Work in progress (papers, research proposals and research methodology) is discussed.
Research within iCIS is organized within three themes:

Model Based System Development (MBSD)
The approach used is to explore various formal methods for model construction, implementation, testing and validation, with the explicit aim of bridging the gap between theory and practice through collaboration with stakeholders from industry, in other application areas and in companies.

Digital Security (DS)
Researchers develop theories and formal methods, which they use to analyze and improve the security of the digital world. The scope of the research includes software and hardware (in particular smartcards and RFID), identity management, security protocols, applied crypto, quantum computation and legal aspects.

Intelligent Systems (IS)
The aim here is to develop and apply intelligent systems that are able to learn knowledge and reason with it. The long-term research goal is aligning computer-based intelligent systems with their users, answering questions such as how to optimally combine knowledge from human experts with measurement data, how to enable users to guide computerized proof assistants and how to let humans profit optimally from this large repository of structured knowledge.

Collaboration
International cooperation is an essential part of the work done at iCIS, because developments in computing take place around the globe. Partners include the Dutch Ministry of Internal Affairs for a project on business process reengineering (BPR), the University of Grenoble Joseph Fourier, France (Tarot), KU Leuven (EU project FutureID, ESF Cost network TRUDEVICE), IBM Research Zurich (EU project FutureID), Makerere University Kampala, Uganda (NUFFIC), TNO Delft, the Netherlands, Aalborg University, Denmark (Artists) and Océ Technologies, Venlo, the Netherlands (Octopus), the Dutch Foundation for Internet Domain Registration (SIDN), the Dutch Banking Association (NVB, Amsterdam), Radboudumc (ParkinsonNext project), Thales and TNO-ESI, Eindhoven (Metis) and TILT (University of Tilburg).

Research results
Prof. Herman Geuvers’ team has worked on a variety of methods and tools relating to proof assistants. They have redefined dependent type theory in a ‘context free’ fashion, which is important for implementations of type theory as a proof assistant. The MathWiki system was developed further, leading to a first prototype called ‘Agora’. The group has also obtained a variety of results on coinduction and coalgebra, notably providing coalgebraic descriptions of language equivalence and studying language determination. Prof. Barendregt – working together with Profs. Dekkers and Statman – finalized the handbook ‘Lambda Calculus with Types’ (833 pp), which was published by Cambridge University Press.

Prof. Heskes’s Machine Learning group is involved in three EU projects that are designed to reveal the causal mechanisms behind complex diseases. Within these projects, the Machine Learning group’s task is to develop new techniques for data fusion and causal analysis that make use of all available data to obtain a better understanding of the aetiology of the disease and to derive putative biomarkers. The group continued the successful line of research on causal discovery. In causal discovery, the goal is to learn the structure of causal processes (‘smoking causes ‘cancer’) from observations (‘correlation between smoking and ‘cancer’). Tom Claassen’s PhD thesis, on a logical approach towards causal discovery, received a cum laude distinction. In collaboration with researchers at the
Donders Institute for Brain, Cognition, and Behaviour, Heskes’s group developed novel probabilistic methods for inferring brain networks from diffusion-weighted magnetic resonance imaging (DWI) as well as resting state functional magnetic resonance imaging (fMRI) time series.

In collaboration with the Microbiology group at the University, Dr Marchiori’s team developed a method for improving the retrieval of anammox bacterial genome from metagenomes. Furthermore, in collaboration with the Netherlands Brain Bank group, the team analyzed brain data from donors with multiple sclerosis, using machine learning techniques in order to reveal associations between brain lesions and gender. The results indicated the presence of significant associations between brain lesions and gender in multiple sclerosis. Dr Marchiori’s team continued to perform research on methods for the study of complex systems described using machine learning techniques in order to reveal associations in collaboration with the Netherlands Brain Bank group, the team developed novel probabilistic methods for inferring brain networks from diffusion-weighted magnetic resonance imaging. 

In 2012 Prof. Rinus Plasmeijer’s team introduced a new programming paradigm called Task Oriented Programming, which should make developing distributed web-enabled multi-user systems much easier. In 2013 this team continued working on an implementation of this idea, the iTask system, in order to be able to develop more realistic applications in collaboration with industry partners. Practical applicability has been investigated in two areas. The Dutch Coast Guard uses the iTask system to design a new prototype for ‘coordinating ‘Search and ‘Rescue’. And TNO has been using the iTask system to investigate new ways of working on Navy Vessels in the hope that these can be operated with a much smaller crew. TNO has decided to use the system as a standard tool for this type of investigations.

The research in Prof. Frits Vaandrager’s team on automata learning is highly relevant in the security setting, as it makes it possible to obtain models of the behaviour of malware (botnets, for instance) and to discover security vulnerabilities in the communication protocols that are used in for instance bank cards. Significant funding has been obtained to continue research in this area through an NWO Veni grant for Dr Sicco Verwer, an NWO Free Competition proposal ALSEP, and a project LEMMA that was funded in the context of NWO’s Cyber Security programme.

The research in Prof. Peter Lucas’ team on eHealth continued in collaboration with clinical partners from Radboudumc. The aim of this research is to empower patients while improving the quality of health-care and reducing its costs. Patients are supported by smartphones equipped with an intelligent reasoning engine that can interpret signs, symptoms and sensor data (blood pressure, lung function and the results of biochemical lab tests) and offer feedback on their health status. The new concept of a multi-level Bayesian network, introduced by iCIS in 2012, offers useful tools for exploring the temporal evolution of disease interaction in very big healthcare datasets. This research was done in close collaboration with NIVEL. In addition, an NWO Free Competition grant was awarded to explore our new idea of state-based Bayesian network structure learning. Work on new frameworks of probabilistic logic also continued, both at the fundamental level and in the context of surveillance applications (in collaboration with Thales).

Research on privacy-friendly authentication using attributes under the name IRMA (I Reveal My Attributes; see irmacard.org) led to several publications, not only about the mathematical foundation of anonymous credentials and efficient implementation on smart-cards, but also about the eco-system for attribute-based authentication. This eco-system is now being tested in a small student pilot among students doing the Kerckhoff Security Master’s programme. Research on embedded security under the supervision of Dr Lejla Batina in new STW and NWO projects has led to the establishment of a security lab for side-channel analysis. Dr Peter Schwabe was awarded an NWO Veni grant to investigate super-fast safe crypto.

The ERC advanced grant ‘Quantum Computation, Logic, and ‘Security’ started in 2013. Three new PhD students and one postdoc, together with Prof. Bart Jacobs as Principal Investigator, have begun work on this new field. Robert Furber MSc and Prof. Bart Jacobs published a paper at CALCO’13 showing that the category of commutative C*-algebras with positive unital maps can be described as a Kleisli category of a monad. This result is interesting as it connects the mathematical work on C*-algebra in quantum and probability theory to categorical notions such as monads (as in program semantics).

Research on ‘Privacy by Design’ carried out within the Privacy & Identity Lab identified eight privacy design strategies, which were presented at the Privacy Law Scholars Conference at Berkeley and published in the journal Computer Law & Security Review. These strategies can be used to take privacy into account from the early stages of designing new information systems.

The paper ‘Dismantling Megamos Crypto: Wirelessly Lockpicking a Vehicle ‘Immobilizer’ by Flavio Garcia, Roel Verdult, and Baris Ege was accepted for the USENIX Security Symposium, but had to be withdrawn from publication following legal proceedings in the UK.

Research on applying state machine learning to security analysis – in collaboration between the DS and MBSD groups – was successfully applied to automate the security analysis of EMV bank cards and of smartcard readers used for Internet banking.

As a follow-up to earlier research carried out in the Laboratory for Quality Software (LaQuSo), which revealed security weaknesses in Blackboard Learn, a countermeasure was designed which was presented at NordSec2013. This countermeasure is also being tested to secure the University’s own Blackboard website.
Societal impact

The Institute’s impact is evident in various projects that were designed to improve the quality of software. Examples include those in the medical field (developing new tools and techniques to analyse and describe clinical and pathological data which can be used to understand and improve the prognosis, diagnosis and treatment of several diseases, such as neuro-degenerative diseases, testing ‘mindfulness’, etc.) and model checking, together with Océ and ASML. A 2nd Phase STW Valorisation grant was awarded to Prof. Peter Lucas to move towards the market introduction of a smartphone app that will support COPD patients in detecting any worsening of their condition.

Cyber security and privacy are increasingly important in today’s information society. Public interest in these topics continues to grow, making headlines in the news almost on a daily basis. The Digital Security group not only addresses these concerns through its research, but also plays an active role in public debates on these issues. The group’s expertise is in heavy demand from both the public and private sector, on topics such as the smart grid (especially smart electricity meters and smart charging of electric vehicles), the security of web applications (including the Blackboard learning system, which is also used at this University), electronic payment systems, electronic voting, and identity cards. Many of these consultations happen through short-term contract research projects via LaQuSo. Moreover, TenneT, the national electricity transmission operator in the Netherlands and much of Germany now funds a PhD student in the group, and research has started on the privacy and security of medical data in a new collaboration with Radboudumc (the ParkinsonNext project). Prof. Jacobs is a member of the National Cyber Security Council, which advises the Dutch Cabinet on cyber security issues and Dr Hoepman is a member of the Dutch commission on electronic voting “Electronisch stemmen in het stemlokaal” set up by the Ministry of the Interior. Further evidence of societal relevance and impact is the fact that the Dutch Banking Association (NVB, Nederlandse Vereniging van Banken) now funds a part-time chair in Information Security (Prof. Verheul). Bayesian techniques developed at iCIS are being used to combine data with background knowledge, for instance to localize sources of activity in the brain and to improve the performance of brain-computer interfaces. The iCIS ‘Web Deduction’ system (www.prover.cs.ru.nl) is used to teach logic in a number of courses at several universities.

Future research

Research on side-channel analysis and on fast and safe implementations of cryptography will intensify following the start of the new NWO and STW projects led by Dr Batina, the Veni grant of Dr Schwabe, and the European Science Foundation (ESF) COST network TRUDEVICE. A new EU project USEMP will start researching online social networks. USIMP will use legal, socio-logical and computer science techniques to provide transparency on the economic value of personal data. More research on the privacy and security of personal data, in particular medical data, will be carried out in the recently started ParkinsonNext project, in collaboration with Radboudumc, among others. PhD defences for two joint doctorates with the University of Leuven will take place early in 2014. Dr Marchiori’s team will continue to work on analysing complex systems represented by graphs. The focus will be on theoretical foundations of graph clustering and applications in life sciences and social and economic sciences. Multi-disciplinary research on e-health and bio-informatics will be further consolidated.
Key publications


Dissertations: 13
Scientific publications: 254
Director: Prof. Tom Heskes

Tom Heskes has been a professor since 2008, specializing in Artificial Intelligence, in particular Bayesian machine learning. Since 2007 he has been a Principal Investigator at the Institute for Computing and Information Sciences and an Affiliated Principal Investigator at the Donders Centre for Neuroscience. He won a prestigious Vici grant from the Netherlands Organization for Scientific Research in 2006 and is Editor-in-Chief of the journal Neurocomputing.

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through ongoing collaborations with Radboudumc, in particular within the Centre for Systems Biology and Bioenergetics. Several newly collaborations, with the Dutch brain bank (Alzheimer) and within the EU projects TACTICS (obsessive-compulsive disorders) and OPTIMISTIC (myotonic dystrophy), will support the development of data mining and machine learning algorithms to gain insight into disease progression and the causes underlying brain diseases. Further e-health research, including those on the self-management of chronic diseases, will move towards implementation in clinical practice. In collaboration with commercial companies, modelling workflows and active learning of software components will be taken to the next level, both in theory and in practice.
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Name</th>
<th>Description</th>
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<tbody>
<tr>
<td>BSI</td>
<td>Behavioural Science Institute</td>
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<td>CLS</td>
<td>Centre for Language Studies</td>
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<tr>
<td>CMBI</td>
<td>Centre for Molecular and Biomolecular Informatics</td>
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<td>CMR</td>
<td>Centrum voor Migratierrecht – Centre for Migration Law</td>
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<td>CNR</td>
<td>Centrum voor Notarieel Recht – Centre for Notarial Law</td>
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<td>DCC</td>
<td>Donders Centre for Cognition</td>
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<td>DCN</td>
<td>Donders Centre for Neuroscience</td>
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<td>DFG</td>
<td>Deutsche Forschungsgemeinschaft – German Research Foundation</td>
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<td>DFN</td>
<td>Diabetes Fonds Nederland – Dutch Diabetes Research Foundation</td>
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<tr>
<td>DI</td>
<td>Donders Institute for Brain, Cognition and Behaviour</td>
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<tr>
<td>ERC</td>
<td>European Research Council</td>
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<td>ESF</td>
<td>European Science Foundation</td>
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<tr>
<td>FELICE</td>
<td>Free Electron Laser for IntraCavity Experiments</td>
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<td>FELIX</td>
<td>Free Electron Laser Infrared Experiments</td>
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<tr>
<td>FLARE</td>
<td>Free-electron Laser for Advanced spectroscopy and high Resolution Experiments</td>
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<td>FOM</td>
<td>Stichting voor Fundamenteel Onderzoek der Materie – Foundation for Fundamental Research on Matter (Netherlands)</td>
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<td>FP7</td>
<td>EU Framework Programme 7</td>
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<td>FTE</td>
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<td>Full-time equivalent for research directly funded by government (core funding)</td>
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<td>FTE 2&lt;sup&gt;nd&lt;/sup&gt;</td>
<td>Full-time equivalent for research funded by KNAW or NWO (research grants)</td>
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<td>FTE 3&lt;sup&gt;rd&lt;/sup&gt;</td>
<td>Full-time equivalent for research funded by other public and/or private organizations (contract research)</td>
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<tr>
<td>HFML</td>
<td>High Field Magnet Laboratory</td>
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<td>HLCS</td>
<td>Institute for Historical, Literary and Cultural Studies</td>
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<td>ICIS</td>
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<td>IMAPP</td>
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<td>Institute for Management Research</td>
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<td>International Research Universities Network</td>
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<td>Institute for Water and Wetland Research</td>
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<td>Nijmegen Centre for Evidence-Based Practice</td>
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<td>NCMLS</td>
<td>Nijmegen Centre for Molecular Life Sciences</td>
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<td>NHS</td>
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<td>Netherlands Institute for Advanced Study</td>
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<td>NIH</td>
<td>National Institutes of Health</td>
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<td>NISCO</td>
<td>Nijmegen Institute for Social &amp; Cultural Research</td>
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<td>NSM</td>
<td>Nijmegen School of Management (i.e. Faculty of Management Studies)</td>
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<td>NWO</td>
<td>Nederlandse Organisatie voor Wetenschappelijk Onderzoek – Netherlands Organisation for Scientific Research</td>
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<td>N4i</td>
<td>Nijmegen Institute for Infection, Inflammation and Immunity</td>
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<td>OO&amp;R</td>
<td>Onderzoekscentrum voor Onderneming &amp; Recht – Business and Law Research Centre</td>
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<td>PTR</td>
<td>Research Institute for Philosophy, Theology and Religious Studies</td>
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<td>RIO</td>
<td>Research Institute for Oncology</td>
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<td>Spinoza Prize</td>
<td>The most prestigious prize for scientists in the Netherlands who are the highest-achieving researchers, awarded by NWO</td>
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<td>Onderzoekscentrum voor Staat en Recht – Centre for State and Law</td>
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<td>Radboudumc Veni grant</td>
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<td>ZonMw</td>
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