Cover photo:
The architecture of plant stems is often astonishing. The picture shows a cross-section of the stem of a bittersweet plant (*Solanum dulcamara*, one of the species in the Radboud University Plant Collection), which happily survives a long period of flooding, thanks to the formation of new adventitious roots. Bittersweet is a wild plant species that is very common in northern Europe and it is closely related to many important food crops such as potato, tomato and aubergine. Research on bittersweet includes a study of water stress i.e. the response of the plant during periods of flooding.

Photo provided by Dr Elisabeth Pierson (General Instrumentation, Science Faculty).
Preface

Academic issues and complex societal problems increasingly require expertise from various backgrounds as well as approaches from several points of view. It is therefore no surprise that the advancement of science and breakthroughs in knowledge appear on the borderlines between disciplines. For that reason, most of our research institutes are organized thematically. Within each of the themes, researchers – often representing different disciplines – work together to provide answers and to solve problems. In addition, they cooperate with other experts, both inside and outside academia.

With the intention of further enhancing multi- and interdisciplinary research on our campus, a new and broad inter-faculty theme has been identified. This theme is of major importance to society and it also provides an opportunity to focus our best researchers and our excellent facilities on one of the greatest challenges of our time. It covers much of our academic profile (see page 6) and relates to many of our societal themes (see page 17). This new theme – The Healthy Brain – also fits very well into the National Science Agenda which the Dutch government formulated in 2015 after consultation with stakeholders across the nation.

The Healthy Brain

The human brain is the most complex biological system known to man. It allows us to have thoughts, speak languages, feel emotions, initiate actions, store and retrieve memories, and navigate our world each and every day. It enables us to be the conscious and social human beings that we are, both creating and interacting with increasingly complex environments. To understand the workings of this crucial human organ is a daunting task. Fortunately, due to developments in several scientific fields, the endeavour to understand the organization of the brain and how it interacts with its environment has progressed further in the past few decades than in the two millennia before. Nevertheless, we are still only at the beginning of unravelling the mysteries of this complex system. Hence, it is widely recognized that understanding the brain will be the major scientific challenge of the 21st century. This challenge can only be met successfully if researchers from a wide range of disciplines join forces. Moreover, it can only be done at a place where excellence in the relevant research fields is available. The Radboud campus – where Radboud University, the Radboud University Medical Center and the Max Planck Institute for Psycholinguistics are located – is such a place. Moreover, our researchers have taken the initiative to cooperate to meet this major scientific challenge. The motivation to do this is driven by a common curiosity about what makes us human. Therefore in 2015, a campus-wide research programme focusing on The Healthy Brain was set up to accelerate our understanding of how the human brain works in health and disease. The Healthy Brain will make science better, improve education, and foster further interactions with society.

The most significant results achieved by our researchers in 2015 are presented in this Research Report. It is not only a transparent way to account for the resources that society has allocated to us; it also shows why we have confidence in our future.

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IStock (p. 34)
Sabine Joosten/Hollandse Hoogte (p. 38)
Filip Franssen/Hollandse Hoogte (p. 42)
Jeroen Stekelenburg (p. 47)
Dutch Discontents: onderzoek Diamantbuurt Amsterdam (still) (p. 48)
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Marijn van der Meer/Quest (p. 76)
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Albert Neeboer/Royal Press Europe (p. 87)
Martijn Verdoes (p. 90)
Andrei Tchernov (p. 97)
Steve Rhodes/Hollandse Hoogte (p. 100)
Arno Engels/TechnoCenter FNWI (p. 114)

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Our ambition
In the years ahead, we not only aim to stay in the top echelons of universities in the Netherlands, but also to be among the very best in Europe, while at the global level we expect to achieve greater recognition. As a consequence, we aim to consolidate and improve the quality of our research, based on the significant progress we have already achieved. In addition, we will intensify the internationalization of the University and the impact of our research. We will also strengthen our collaboration with strategic partners, both in the academic community and in society as a whole. We aim to keep and attract talented staff and provide an optimal climate for performing high-quality research. In 2015 we made good progress towards achieving these aims.

Our academic profile
Research at the University takes place in 15 dedicated institutes. These are responsible for planning programmes as well as for training and supervising new generations of researchers. We do our best to ensure that all programmes within the institutes remain competitive internationally and that they make a major contribution to related research communities. These institutes are the units that are peer reviewed according to the national research evaluation protocol every six year. Ten sub-disciplines have been identified where the quality exceeds the high level achieved by researchers in the rest of the University. These ten areas are listed below.

Organic Chemistry
The focus within Chemistry is on Organic Chemistry, alongside Material Science, Life Science, Biomedical Science and Supra-Molecular Chemistry. We concentrate in particular on Synthesis, Physical Organic Chemistry and the Life Sciences. The core of the latter research takes place at the Institute for Molecules and Materials, but it also includes the Radboud Institute for Molecular Life Sciences. The research infrastructure and facilities in both

On 30 October 2015, the FELIX Laboratory was officially opened by Sander Dekker, vice-minister for Education, Culture and Science. The FELIX Laboratory is a merger of the FELIX facility located in the former FOM Institute Rijnhuizen and the FLARE Laser, which was developed in Nijmegen. The combination of FELIX’s radiation in the infrared region and the continuous high magnetic fields at HFML offers scientists opportunities to study matter and materials in conditions that cannot be found anywhere else in the world.
institutes are excellent. The numerous prestigious grants awarded over the years reflect the high quality of the research in Organic Chemistry. These include European Research Council (ERC) Advanced Grants, Netherlands Organisation for Scientific Research (NWO) Spinoza prize, Vici grants and – together with the Eindhoven University of Technology and the University of Groningen – one of the 12 highly prestigious ‘Gravitation’ programmes for major projects that will be extended over the coming decade.

In 2015, Researchers in the Bio-Organic Chemistry group (led by Prof. Jan Van Hest) developed and studied a nanomotor with chemotactic behaviour which could move against flow. This nanomotor may be used to deliver drugs to late-stage tumours where high interstitial pressure inhibits the use of current delivery agents. (Angew. Chemie Int. Ed.)

Prof. Wilhelm Huck and his Physical Organic Chemistry group have looked at the impact of the environment on gene expression. The group has shown that the composition of the environment is very important for gene expression, suggesting that environmental factors should be taken into account when studying cellular reactions. (Nature Nanotech)

Prof. Alan Rowan and his colleagues at Molecular Materials have shown that matrix stress-stiffening should be taken into account as a mechanical cue in developments related to future extracellular matrix mimetic biomaterials, as this has an effect on the fate of stem cells. (Nature Materials). Prof. Matthias Bickelhaupt (Theoretical Chemistry) was elected as a Fellow of the Royal Society of Chemistry. (For more details, see pages 90 and 106).

Physics of Condensed Matter
At Radboud University research on the Physics of Condensed Matter is closely connected with research in Chemistry. Our researchers contribute to the Dutch national programmes Nanonext, as well as to EU programmes. International cooperation is excellent, for example through our unique infrastructure, including the High Field Magnet Laboratory (HFML) and three advanced Free-electron Laser Units (FELIX/FELICE/FLARE). Experimental Physics of Condensed Matter and Theoretical Physics of Condensed Matter are areas in which we lead worldwide. The work on graphene, involving cooperation between experimental and theoretical physicists, 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, who is currently an Extraordinary Professor here. The award of NWO Spinoza prizes and ERC Advanced Grants also demonstrates the strong reputation of our research groups in this field. Since 2013, the Netherlands Magnetic Resonance Research School – a collaborative venture together with colleagues from the Universities of Utrecht, Wageningen, Leiden, and Eindhoven – has been a perfect platform for training young researchers.

In 2015, Dr Bas van de Meerakker and his colleagues at Molecular and Laser Physics have imaged resonances in low-energy NO-He inelastic collisions in collaboration with the Theoretical Chemistry group led by Prof. Gerrit Groenenboom, resulting in unprecedented insights into the most intimate details of molecular collisions: the evolution of colliding particles from initial to final states and their associated trajectories or, in a quantum mechanical context, the dynamics of individual partial waves. (Science)

The FELIX Users and Operators group, led by Dr Britta Redlich, has – in collaboration with groups from the UK – demonstrated laser control of quantum states in silicon and researchers have observed these states using conventional electrical measurement. This discovery may bring us a step closer to designing a solid-state quantum computer. (Nature Communications)

Dr Lex Van der Meer’s Free Electron Laser Technology group has worked on two important technical breakthroughs: they completed the FLARE optical transport

Key figures Radboud University

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Research input

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Research output

| Dissertations: | 358 |
| Scientific publications: | 6910 |
| Professional publications: | 1022 |
| Annotations: | 289 |
| Patents | 15 |
system between FLARE and the HFML and they succeeded in recommissioning FELICE.

Dr Uli Zeitler and his colleagues at Semiconductors and Nanostructures (HFML) have revealed, in collaboration with the Universities of Groningen and Hong Kong, that transistors made from ionic-gated ultrathin MoS₂ not only superconduct at low temperatures but also continue to superconduct in a high magnetic field. This phenomenon might provide the basis for future innovative spintronic devices. (*Science*)

The Spectroscopy of Surfaces and Interfaces group (led by Prof. Theo Rasing) discovered a conceptually new approach for ultrafast tunable magneto-optical modulation, which was achieved with the help of counter-propagating laser pulses inside a transparent medium. (*Nature Photonics*)

As a new mark of recognition in 2015, Prof. Katsnelson was elected as a foreign member of the Uppsala Royal Academy of Sciences. For more details, see page 106.

**Astrophysics**

Researchers in the Netherlands have played a leading role in astrophysical research for many decades. Since 2001, when a group of highly talented researchers came to the University, this research – which focuses on the evolution of double stars, compact objects and astrophysical particles – has become very competitive internationally.

The quality of the research is reflected in the successful acquisition of highly prestigious grants such as ERC Advanced Grants, the NWO Spinoza prize and an ERC Synergy grant.

In 2015, Prof. Gijs Nelemans’ team showed that the observed population of neutron-star low-mass X-ray binaries is dominated by ordinary systems, while ultra-compact systems dominate the intrinsic population. They also showed that black holes receive large natal kicks.

Dr Marijke Havervorn proved the value of processing the linearly polarized component to the LOFAR all-sky survey, detecting structures across a large part of the sky. These are studied in order to characterize the magnetized plasma in the solar neighbourhood.

Prof. Sjibrand de Jong, Dr Charles Timmermans and Dr Jörg Hörandel lead the radio detection of cosmic ray showers (AERA) in the Pierre Auger Observatory for the study of the highest energy cosmic rays, which enabled absolute energy measurement using a lateral density function developed at IMAPP. Among the highlights in 2015 were the election of Prof. Sjibrand de Jong as president of the CERN Council in Geneva and the election of Prof. Renate Loll as a member of the Royal Academy of Sciences in the Netherlands. Prof. Conny Aerts obtained a second ERC Advanced Grant. For more details, see page 114.

**Microbiology**

The composition, functioning and evolution of ecosystems are key to our research on gene-environment interactions. This research covers all major biotic organisms, including micro-organisms, 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. Our microbiologists specialize 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, has led to revolutionary insights and a series of world-class publications.

The team has received three ERC Advanced Grants and Prof. Mike Jetten received the NWO Spinoza prize for discovering many new bacteria and elucidating their unique properties. Together with TU Delft, NIOZ and Wageningen UR, this team received an NWO ‘Gravitation’ grant and it participates in a project led by the University of Utrecht in which VU Amsterdam and Wageningen UR are also involved.

In 2015, IWR microbiologists made several discoveries including the identification of bacteria capable of complete nitrification (*van Kessel et al., Nature*). Through synergistic research using state-of-the-art, complementary methods the bacteria were discovered and identified as Nitrospira. This was one of the unknown bacteria that were predicted to exist but had escaped identification until now. Important new findings of this group include unravelling the crystal structure of the important protein complex hydrazine synthase of anammox bacteria that is responsible for the production of hydrazine (rocket fuel) (*Dietel et al., Nature*), and important properties of the anammox cell wall (*van Teeseling et al., Nature Comm.*).

The microbiologists at IWR will continue to investigate the role of anaerobic methane 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, supported by an ERC Advanced Grant recently obtained by Prof. Huub op den Camp. For more details, see page 100.

**Cognitive Neurosciences**

Insights into brain and cognition have advanced considerably in recent years and are the core research topics of 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. Excellent advanced infrastructure and facilities as well as the multidisciplinary approach taken in Nijmegen ensure high-quality research. This is apparent from the many grants that have been received – against strong competition – by researchers working at this institute. These achievements include leadership of large European and global research programmes, ERC Advanced Grants, a Spinoza prize, several NWO Vici grants and an NWO ‘Gravitation’ grant.

In 2015, it was found that administration of testosterone alleviates avoidance behaviour in patients with social anxiety disorder. It influences gaze behaviour and actual avoidance behaviour in healthy and anxious participants. At a neural level, it biases the amygdala towards a threat approach. These results have led to further investigations of the effects of testosterone in treating anxiety disorders.

Investigations of cognitive control have shown that the stimulant methylphenidate amplifies the salience of task-relevant information, leading to enhanced processing of targets, but also increased attention to distractors which are drawn from the same category. Decision-making studies have revealed that choices to either exploit or explore resources depend on the social context as well as the expectation model in the environment.

Correlated changes across synaptically coupled networks modify functional connectivity throughout the brain. This coupled activity has been traditionally quantified using covariance, although this measure could not distinguish between direct and indirect connectivity. The use of partial correlations provides a solution, although it makes strict assumptions regarding the underlying data. New com-
Computational methods provide a robust solution; this probabilistic generative model allows the estimation of functional connectivity in terms of both partial correlations and a graph representing conditional independencies.

Functional connectivity in the networks allows system-level consolidation and mnemonic representations in the brain. It has been proposed that neuronal oscillations could mechanistically mediate this consolidation. Experimental observations from the human brain and cross-frequency phase amplitude coupling analyses now suggest that hierarchically nested loops of oscillations, spindles and ripples provide a fine-tuned temporal window for the transfer of hippocampal memory traces.

NWO Vici grants were awarded to Profs Asli Özyürek (affiliated PI, CLS), Roshan Cools, and Joris Veltman. ERC starting grants were awarded to Drs Michael Cohen and Floris de Lange. An ERC Consolidator Grant was awarded to Dr Erno Hermans. For more details, see page 54, 62 and 68.

**Infection and Immunology**
The interface between micro-organisms and man is where fundamental as well as clinical translational research in infection and immunology takes place at the University. This research includes the study of defence mechanisms and inflammation after infection, inflammatory diseases (such as auto-immune diseases), as well as cancer and transplantation. There is close cooperation with researchers at clinical centres for infectious, inflammatory and immune diseases e.g. within the NWO ‘Gravitation’ programme, which is led by the Netherlands Cancer Institute (NKI) in Amsterdam. A number of prestigious grants were acquired, including ERC Advanced Grants, the Spinoza prize and the NWO Vici grants, acknowledging the excellent performance of the teams working on infection and immunology.

In 2015, Prof. Gosse Adema (Cancer development and immune defence) demonstrated that rationally designed sialic acid-blocking compounds formulated into nanoparticles coated with tumour-specific antibodies successfully prevent metastasis of cancer. Cysteine cathepsins are important regulators of both health and disease. To investigate mechanisms important for cathepsin S mediated pathology, reliable molecular tools that can monitor cathepsin S activity are needed. Prof. Carl Figdor (Cancer development and immune defence) received a large EU consortium grant (PRECIOUS, €8.3 million) to develop and clinically test biodegradable nanomedicines for cancer immunotherapy.

Prof. Gosse Adema (Cancer development and immune defence) also received an EU ITN grant (IMMUTRAIN, €3.9 million) for developing immunotherapy against cancer. Dr Teun Bousema and colleagues showed that the mosquitocidal drug ivermectin can be safely given in combination with a standard antimalarial and that it can reduce the likelihood of malaria transmission by reducing the life span of feeding mosquitoes (Ouédraogo et al., *Clinical Infectious Diseases*, 2015).

The group led by Prof. Marlies Hulscher developed quality indicators (QIs) that can be used to measure the appropriateness of antibiotic use in the treatment of all bacterial infections in hospitalized adult patients (van den Bosch et al., *Clinical Infectious Diseases*, 2015).

Dr Martijn Verdoes (Cancer development and immune defence) and his colleagues have developed a novel probe that selectively targets cathepsin S, which can be used to non-invasively image cancer cells in mice.

**Figure 1:** Normalized citation impact scores – i.e. citations in relation to the world average per subject area – of scientific publications (according to Web of Science) at Radboud University per period of time. (world average = 1.0)
Prof. Anna Simon (Inflammatory diseases) and colleagues published results furthering our understanding of the genetic mechanisms involved in the onset of Schnitzler’s syndrome, a rare auto-inflammatory syndrome. Rheumatoid arthritis (RA) is a chronic auto-immune disease that affects the joints of 1% of the world population. For more details, see page 80 and 90.

**Cyber security**

Cyber security is about regulating access to digital assets, which can be information or services. Good digital security begins with security requirement engineering, *i.e.* identifying actors, their assets and interests, and their authorization levels (who is allowed to do what).

One research topic at the Institute for Computing and Information Sciences (iCIS) is identity-centric security, which focuses on identity management. This includes investigating the policies and protocols used for identity management, mechanisms such as smart cards, RFID tags, and biometrics that can be used for this, as well as their impact on privacy and anonymity. Another research topic is software security, which includes the role that software plays on the one hand in providing security and on the other as a source of security vulnerabilities. The focus is on ways to ensure the correct implementation of security functionality and the lack of security vulnerabilities, by formal specification of the security properties of code, and checking these by means of verification, typing, (penetration) testing or code inspection. A broader research topic is formulating and formalizing security policies and security rules, as well as methods for risk management and risk assessment.

iCIS is a leading international institute. Its reputation is reflected in excellent assessments as well as the award of an ERC Advanced Grant, NWO Vici and Vidi grants, and several Veni grants.

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**ERC Advanced Investigator Grant 2015**

Prof. Huub op den Camp (Professor of the Microbiology of acidic volcanic ecosystems) received a highly prestigious ERC Advanced Investigator Grant.

**Previous ERC Advanced Grant laureates**

1. Prof. Pieter Muysken | 2008
2. Prof. Mike Jetten | 2008 and 2013
3. Prof. Heino Falcke | 2008
4. Prof. Conny Aerts | 2008 and 2015
5. Prof. Wilhelm Huck | 2009
6. Prof. Carl Figdor | 2010
7. Prof. Stephen Levinson | 2010
8. Prof. Guillén Fernández | 2010
9. Prof. Roeland Nolte | 2011
10. Prof. Bart Jacobs | 2012
11. Prof. Nico Verdonschot | 2012
12. Prof. Mikhail Katsnelson | 2013
13. Prof. Theo Rasing | 2013
14. Prof. Henk Stunnenberg | 2013
In 2015, the IRMA research has produced a new form of revocation, which is quite subtle for privacy-friendly credentials, and a new form of self-enrolment via electronic identity documents (such as passports). The latter has led to a new project with national telecom provider KPN.

The ERC-funded research on quantum computing has led to a new axiomatic basis for quantum foundations in the form of ‘effectus’ theory, which was developed in Nijmegen. This forms the basis for much current research. Research by Dr Peter Schwabe pursued within his Veni project on ‘High-speed, high-security cryptography’ led to the new signature scheme presented at Eurocrypt. Dr Lejla Batina strengthened her research group using her Vidi grant to focus on the physical security of smart cards and other embedded security devices. For more details, see page 120.

**Human Genetics**

We specialize in 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. Our human genetics researchers, who have access to modern bio-informatics equipment, use the very latest techniques. Translational research at the University is also very successful. Some of the newest genetic techniques for diagnosis, such as DNA chips and Exome sequencing, were used in Nijmegen for the first time worldwide. The excellent Human Genetics team has published numerous 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 highly competitive funding bodies in the Netherlands and in the EU.

Significant achievements such as an ERC Advanced Grant and many NWO Vici grants reflect the academic reputation of the researchers working in this sub-discipline.

In 2015, Dr Ruben Cremers showed that known susceptibility to single nucleotide polymorphisms (SNPs) for sporadic prostate cancer is also associated with hereditary prostate cancer (HPC), warranting a reconsideration of HPC and a restrictive policy for prostate-specific antigen testing in men with a positive family history (Cremers *et al.*, *Prostate*, 2015).

Dr Marjolijn Ligtenberg (Tumours of the digestive tract) further defined internationally accepted criteria for accurately identifying individuals with pathogenic mutations in E-cadherin (CDH1), a gene known to cause a predisposition to gastric and breast cancer.

Using whole-exome sequencing, Prof. Nicoline Hoogerbrugge (Tumours of the digestive tract) and her colleagues have identified a rare novel genetic cause of adenomatous polyposis (AP), an inherited disorder characterized by cancer of the large intestine (colon) and rectum.

Researchers working on the Sensory disorders theme published research elucidating the molecular genetic background of patients with chronic central serous chorioretinopathy (cCSC), a disease that causes blurry vision and is often misdiagnosed as a subtype of age-related macular degeneration (AMD). The results may impact patient care in the future, as therapies for cCSC and AMD are different.

Prof. Hannie Kremer (Sensory disorders) identified a genetic cause of unilateral and asymmetric hearing impairment, thus enhancing our understanding of hearing disorders. One study examined the genetic mechanisms underlying Specific Language Impairment (SLI). A study in molecular techniques investigated an isolated popu-
lation on Robinson Crusoe Island (Chile) where there is a high incidence of SLI. A single rare coding variant of the protein NFXL1 was found to be significantly associated with language impairment. Subsequent analysis of people from the UK affected by SLI revealed changes which probably affect this protein in more individuals than would be expected by chance. Coding variants within NFXL1 thus appear to suggest an increased risk of SLI. For more details, see page 76 and 90.

**Linguistics**

Our linguists carry out ground-breaking research in language, language behaviour, language and speech technology, and communication. This research focuses on two main themes: *Language in the mind* (including learning a mother tongue and the production and processing of language) and *Language in society* (covering the use of language in a variety of cultures and subcultures). These researchers are among the best of the world and there is close multidisciplinary cooperation with other institutes on the campus such as 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 NWO Spinoza prize, and they participate in the prestigious NWO ‘Gravitation’ programme *Language in Interaction*.

In 2015, researchers demonstrated that women are better at learning a second language than men. This is the case in all languages and cultures, according to Dr Frans van der Slik, Prof. Roeland van Hout and Dr Job Schepens, and therefore they conclude it must be a genetic factor. They reached this conclusion after analysing the results of 27,119 state exams in Dutch as a second language, from adult men and women from 88 different countries. Gender differences were analysed across countries of origin and continents, and across mother tongues and language families. Female learners consistently outperformed male learners in speaking and writing proficiency. This gender gap remained remarkably robust and constant when other learner characteristics, such as education, age of arrival, length of residence and hours studying Dutch, were taken into account.

Dr Stefan Grondelaers contributes to the large national survey Sprekend Nederland (Talking Dutch), which was established to chart the diversity and dynamism of contemporary spoken Dutch. The Dutch that is spoken in the Netherlands is a relatively homogenous, standardized language. However, it features substantial accent and dialect variation. This research not only collects the production of spontaneous speech, but also the perception of accents. The Dutch systematically associate the Limburg accent with ‘cosiness’ and happiness, but also with stupidity; people from the Randstad (an urban conglomeration in the west of the country) are deemed prestigious but cold and distant on the basis of their accent. The Groningen accent is not associated with any desirable social qualities. The most shocking thing about these stereotypes is that they are applied uncritically to speakers who have these accents, people about whom we know virtually nothing. Prof. Asifa Majid won a prestigious KNAW Ammodo award for her innovative research on the relationship between language, cognition, and the senses. For more details, see page 62.

**Business and Law**

The Business and Law Research Centre has close ties with fourteen highly renowned law firms, financial institutions and companies, most of which operate internationally. Their lawyers work together with our researchers on academic research in 1) company law, 2) financing, security rights and insolvency, 3) business and
patrimonial law, and 4) financial law. The Research Centre has produced numerous authoritative text books, monographs and serial volumes. The research groups are also very successful in raising funds.

In 2015, important research results were obtained within the context of an International Working Group (IWG) on the European Banking Union. The creation of the European Banking Union has led to a historical shift of powers from the Eurozone Member States to the European Union. The IWG, which consists of leading scholars and practitioners in the financial sector, has examined the effects of the creation of the Union on the daily supervision of large banks in Europe and has also analysed the position of bank creditors and shareholders. This thematic approach covers the Single Rulebook and CRD IV, the Single Supervisory System, and the Single Resolution Mechanism from a legal and economic perspective. Key issues such as the judicial protection of supervised credit institutions, implications for financial market governance, and risk management and compliance, are examined alongside case studies. A book on this topic was published by Oxford University Press and presented during an international conference organized by the Centre on 24 September 2015 at the Dutch Central Bank in Amsterdam.

A strong area of research that the Centre is traditionally engaged in is international and comparative insolvency law. A permanent network of insolvency experts from 20 countries across the globe contribute to the Oxford International and Comparative Insolvency Law Series. In 2015, a comprehensive volume on ‘Ranking and Priority of Creditors’ was finalized. This volume deals with what many would regard as the raison d’être of insolvency law: the creditors’ claims.

A large-scale research project on the horizontal (private law) effects of European Union Law was completed in 2015. The outcome of this project will be published in a separate volume in the prominent Ius Commune Casebooks series (Hart Publishing). The purpose of the volume is to inform academics, judges, practitioners and students about the relevance of existing EU law for private law. Prof. Michael Veder has been appointed as a member of the European Commission Group of experts on Restructuring and Insolvency Law. For more details, see page 34.

Our academic reputation
As in previous years, in 2015 many of our researchers were recognized for their achievements and their contributions to international academic publications. The quality of our research is also reflected by the normalized citation impact scores (see page 10, Figure 1).

Newly elected members at national and international academic societies
• Profs Renate Loll (Theoretical High Energy Physics), Mirjam Ernestus (Psycholinguistics) and Janneke Gerards (International and European Law) were elected as members of the Royal Netherlands Academy of Arts and Sciences (KNAW).
• Profs Barbara Franke (Molecular Psychiatry), Mihai Netea (Experimental Medicine) and Peer Scheepers (Sociology) were elected as members of the Academia Europaea.
• Prof. Matthias Bickelhaupt (Theoretical Chemistry) was elected as a Fellow of the Royal Society of Chemistry (UK).
• Prof. Mikhail Katsnelson (Theory of Condensed Matter) was elected as a foreign member of the Uppsala Royal Academy of Sciences.
• Prof. Karin Roelofs (Clinical Psychology) was elected as a member of the Young Academy of Europe.

Examples of recognition
• Prof. Gerbert Kraaykamp and Dr Roza Meuleman were appointed National Coordinators of the 8th round of the European Social Survey (by NWO-ESSNeth).
• Prof. Sophie van Bijsterveld received the Jhr Mr A.F. de Savornin Lohman Award for her book on the relationship between government and religion in the Netherlands.
• Prof. Verloo received the ECPG Gender and Politics Career Achievement Award. This prize is awarded every two years to honour an exceptional career in research,
Higgs boson in 2012 from the Dutch society for the Advancement of Science, Medicine and Surgery.

- Prof. Judith Prins received the 2015 NVPO (Dutch Psycho-oncology society) award for her contribution to psychosocial oncology.
- Dr Heres was granted the Van Poeljeprijs 2015 for Best Dissertation in Public Administration.
- Drs Sabine Stoltz and Yvonne van den Berg received the Hermen J. Jacobs prize for developing an online tool to support primary school teachers in making seating arrangements that promote social cohesion in the class.
- Drs Mark Dingemanse, Francisco Torreira and Prof. Nick Enfield won the 2015 Ig Nobel Prize.

ment. On the other hand, some research equipment is too large – and expensive – for one university to purchase alone (this is, for example, the case with research in Astronomy, Astrophysics, Particle Physics and High Magnetic Fields). This is one reason why our researchers regularly join forces with colleagues at other institutes around the world. We put such strong emphasis on international cooperation in order to complement and create synergy (of expertise and/or facilities), to increase critical mass, to form international research consortia, to recruit talented students and to provide our PhD students with the best job opportunities. Many of our doctoral candidates, post-doctoral researchers and other staff were born outside the Netherlands: 24.5% 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.

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 crucial to this aim. 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.

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. 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.

In 2015 such fellowships were awarded to the following researchers: Dr Jamie Farnes (Sydney Institute for Astronomy, Australia), Dr Alessandro Maranesi (University of Pavia, Italy), Dr Silvia Menchon (Universidad Nacional de Cordoba, Argentina), Dr Pablo Roman (Universidad Nacional de Cordoba, Argentina), Dr Asuncion Fresnoza-Flot (Catholic University of Louvain, Belgium), Dr Andrew Reid (Heinrich Heine University, Düsseldorf, Germany), Dr Vincent Henaux-Brunet (University of Surrey, UK) and Dr Asya Zhelyzakova (Center for Comparative and International Studies (CIS), Zürich, Switzerland).

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.

Each Professorship enables an eminent researcher to conduct research in Nijmegen for about six months.

In 2015 such professorships were awarded to the following researchers: Prof. Charles Sabel (Columbia Law School, USA) who does research at the Institute for Management Research, Prof. Michael Frank (Brown University, USA) who is participating in research at the Donders Institute for Brain, Cognition and Behaviour, Prof. Sterl Phinney (Cal Tech, USA) who joined the Institute for Mathematics, Astrophysics and Particle Physics, Prof. Ron Mangun (University of California Davis, USA) who works at the Donders Centre for Cognitive Neuroimaging, Prof. Bart Krekelberg (Rutgers University, USA) who does research at the Donders Centre for Cognitive Neuroimaging and Prof. Sebastiaan Faber (Oberlin College, USA) who joined the Institute for Historical, Literary and Cultural Studies.

Radboud Research Facilities

The Dutch province of Gelderland together with Radboud University financed a project called Radboud Research Facilities to provide advanced research equipment for medical and scientific studies. This state-of-the-art equipment is also accessible for companies in the region. These facilities provide an important stimulus for some of the top research areas at the University. They are dedicated to research on developing new drugs, new diagnostics, new surgery techniques, brain research, research on behaviour, mobility research, genetics, digital security in healthcare and climate research. Radboud Research Facilities is of particular interest to young start-up companies, for example those working in healthcare, chemistry and life sciences, as access to high-tech equipment is crucial for product development. These young companies often lack the resources to make investments in equipment.

In 2015, the objectives of Radboud Research Facilities were made more explicit. Through active marketing the opportunities for exploitation of our infrastructure with third parties were actively explored. As a result an extra sixteen facilities were made available for cooperation with external partners. Prof. Floris Rutjes (Synthetic Organic Chemistry) and Prof. Elias Vlieg (Solid-State Chemistry) both received a grant from Radboud Research Facilities to extend an NMR machine and a single crystal diffractometer, both of which will be made available to external users.

New large research infrastructure

On 30 October 2015 the FELIX laboratory (for free-electron laser experiments) was officially opened by Sander Dekker, Dutch vice-minister for Education, Culture and Science. The FELIX laboratory is a merger of the FELIX facility located in the former FOM Institute Rijnhuizen and the FLARE laser which has been developed in Nijmegen. The new, combined facility has been open, with some limitations, for users since 2013 and has become fully operational in 2015.

Also in October 2015, the beam-line from the FELIX Tetrahertz laser to the high field magnet at High Field Magnet Laboratory (HFML) was finished. The established beam-line travels along an 86 meter aligned optical path and is guided by 41 gold coated mirrors placed at 45 degree angles. The combination of FELIX’s radiation in the infrared region and the continuous high magnetic fields at HFML gives scientists the opportunity to study matter and materials in conditions that cannot be found anywhere else in the world. Even though the beam-line between FELIX and HFML has only recently been completed, the first successful measurements have already been made.

The experiment garden is a research facility for modern plant and ecology research. It includes a new greenhouse, climate rooms, fields for experiments and the unique Nijmegen Phytotron. The latter allows investigations of root development within the soil under open field conditions and without the influence of stress factors.

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*In most cases the percentage exceeds 8.2%, which would be expected if the percentage of total grants was equivalent to the University’s share of core funding (core funding is based on student numbers and the number of graduations per year).
The completion of these facilities provides a niche in fundamental and applied research for cooperative projects with companies and governments. The fully renewed greenhouse – together with climate room facilities and the Phytotron – was officially opened – together with the FELIX laboratory – on 30 October 2015.

In 2015, the Radboud Radio Lab received funds to support the BlackHoleCam project, to channel the instrumentation efforts in Astrophysics, and to provide an efficient bridge to (local) industry.

Grants and awards for excellent young scientists

Twenty Radboud researchers received an NWO Veni grant in 2015. This will enable them to do research for three years after graduating with a PhD. The winners this year were Drs Piray Atsak, Tessel Bauduin, Erik Bijleveld, Ellen van den Bogaard, Annemarie Boleij, Inti Brazil, Shih-Chin Cheng, Janna van Diepen, Nina Geerdink, Jayne Hehir-Kwa, Marloes Henckens, Maartje Luijten, Joan Marcut, Johan Mentink, Monique van Scherpenzeel, Niels Spierings, Evan Spruijt, Wouter Verdurmen, Connie de Vos and Fleur Zeldenrust.

Eleven post-doctoral researchers received an NWO Vidi grant in 2015. This major achievement will enable them to develop their line of research for five years. These grantees were awarded to Prof. Alexander Khajetoorians and Drs Geert van den Bogaart, Teun Bouwma, Mirjam Broersma, Marcel van Gerven, Floris de Lange, Jan-Mathijs Schoffelen, Maarten Solleveld, Roel Willems, Annemieke Petrigiani and Bart Sneets.

Three – more senior – researchers received NWO Vici grants in 2015. These substantial grants will enable them to further develop their line of research for five years. These grants were awarded to Profs Rosihan Coils, Asli Özyürek and Joris Veltman.

Four very prestigious ERC Consolidator grants were awarded to Profs Isabela Granic and Alicia Montoya and to Drs Erno Hermans and Peter Jonker. These substantial grants will enable them to further develop their line of research.

Societal impact

A key characteristic of our University is our involvement in important societal issues and much of our research agenda is inspired by societal need. For example, we make a significant contribution to achieving the Dutch government’s innovation targets. Our societal impact is mainly in the context of seven overarching themes:

1. Europe’s “worlds”
2. Language and communication
3. Developing society and justice
4. Behaviour and education
5. Molecules and materials
6. Water and wetlands
7. Personalized medicine.

Below we highlight projects completed in 2015 that illustrate the societal relevance of these research themes.

Europe’s “worlds”

• From October 2015 until February 2016, unique art treasures have been on display in De Nieuwe Kerk in Amsterdam as part of the exhibition ‘Rome. Emperor Constantine’s Dream’. They illustrate one of the most fascinating themes from antiquity: the transformation of Rome in the fourth century AD from a multi-religious imperial capital full of temples with colossal statues of the emperor into a centre of papal power dominated by churches with crosses. Christianity’s evolution in a relatively short time from a small faith community into the dominant religion which had a crucial influence on the development of the Western world is an astonishing success.
Introduction

Language and communication
• April 2015 saw the launch of NovoLanguage, a spin-off company from CLST. NovoLanguage makes products for language learners by using innovative language and voice technology. The company’s strength is the attention paid to spoken fluency in their new products. This is a feature that Dr Helmer Strik, one of the company’s founders, believes is less common in other language training products. The company has its origins in research and the usage data generated by the applications will enable CLST to continue to enrich its research. Close cooperation with NovoLanguage, which is located on the Nijmegen campus, also means students have the opportunity to experience how aspects of their research work out in practice.
• Aside from initiating NovoLanguage, Dr Helmer Strik – together with an international consortium of partners – has completed the European LLP project ‘Games Online for Basic Language learning’ (GOBL) to provide young people and adults with the possibility to improve their basic communicative skills in Dutch, English, and French, through web-based mini-games. Educational mini-games are small, self-contained games which focus on well-defined learning topics that are highly motivating, reusable and cost-effective. The games are available for free at www.gobl-project.eu.
• Dr Simone de Droog received a valorisation research grant from the Ministry of Health, Welfare and Sport for the Groentefroetels project to encourage vegetable consumption by children.

Developing society and justice
• Stefan Schevelier, who works in PTR’s Modernity Contested programme, developed a democracy game ‘Wie is de beste burger?’ (Who is the best citizen?), in which the players are confronted with the questions and problems encountered by participants in a democracy.
• The Municipality of Rotterdam, which greatly values the contribution of the Radboud Excellence Initiative project team to transferring long-term care from Dutch national government to the municipality (Prof. Charles Sabel and researchers from the Governance and Innovation in Social Services research group).
• Prof. Mieke Verloo was invited by the European Parliament to deliver a keynote speech on the wage gap between men and women.
• Within the scope of the French-Dutch economic year, Prof. Jonker, was invited to speak about Dutch best practice in the field of the circular economy at a conference in the Paris City Hall, which was attended by professionals and council members from the greater Paris area. The participants reflected on the strategic plan for the City of Paris and the surrounding municipalities.
• As of 1 September 2015, the European Commission selected the Centre for Migration Law as a Jean Monnet Centre of Excellence in EU Citizenship and Migration.
• The HIPERSENSE project was successfully implemented by the Department of Astrophysics along with four private entrepreneurs. A new stand alone data-processing unit and power unit was built, which supports the Blackgem project in Chile by (big) data processing and provision of energy at remote areas or in places where the normal mains power supply would be overloaded. Similar applications of this new system are possible in telecom, in refugee camps and emergency hospitals, and in smart grid optimization.

Behaviour and education
• Relapse rates in abstinent alcoholics can be significantly reduced by approximately 8% by means of a simple computer-based alcohol-avoidance training in which the patients are trained to push pictures of alcoholic drinks away. The empirical evidence in favour of this training is so strong that it has been added to the official German guidelines for treating addictions. It will soon be introduced as a standard treatment option from which thousands of patients may benefit. More research at BSI will be conducted to further improve this training.
• Researchers at BSI have tested and evaluated eight different programmes in schools and mental health agencies aimed at reducing anxiety and depression. Some programmes involved conventional evidence-based practice interventions, while others involved new technologies such as applied games. The results shed light on the type of intervention programmes that do or don’t work and they will shape the future agenda for mental healthcare among young people. Because of this work Prof. Isabela Granic was nominated for the Huijbregtsenprijs (an award for scientific research that is novel and has compelling applications).
• In cooperation with National Geographic and the Axas Research Fund, Dr Esther Aarts (Donders Institute made a video on how to reduce irrational eating. This video has had a large number of hits on YouTube.
• In the blog ‘DondersWonders’ researchers at the Institute write non-specialist articles on neuroscientific topics for the general public. With two blogs per week, over 100,000 views in 2015 and regular radio and TV interviews resulting from it, it can be said to be a big success.
• Donders researchers actively participate in educational development. Jurjen van der Helden and Harold Bekkering published a book in which they describe important insights related to understanding the ‘learning individual’. They offer suggestions for educational practice in literacy, numeracy and social interaction.

Molecules and materials
• Several scientists at the IMM received grants in 2015 for public-private partnerships: Prof. Alan Rowan (Molecular Materials) received a large grant for a supergel for wound dressing (ZonMw).
• Dr Jeroen Jansen and Prof. Lutgarde...
Buydens (Analytical Chemistry) received a TA-COAST grant for outfitting the future factory with online analysis. Comprehensive Analytical Sciences and Technology (COAST) is a public-private partnership with more than 60 members, including representatives of all major Dutch industries and academic partners.

- Prof. Elias Vlieg (Solid-State Chemistry) has co-received a grant in a Chemical Industrial Partnership Programme (FOM and NWO-CW) to investigate the wetting behaviour of oil-electrolyte-mineral systems.
- Professor Jan Van Hest (Bio-Organic Chemistry) acquired a Horizon 2020 grant for an Innovative Training Network on Nanomedicine.
- From 2015 onwards, Radboud University became part of the Knowledge and Innovation Community Raw Materials of the European Institute of Innovation and Technology, which is a spearhead of European innovation policy. As a result, scientists from the university are more easily able to submit project proposals (together with industrial partners).

Water and wetlands

- The Department of Environmental Science obtained an EU Marie Curie grant for five PhD projects, in cooperation with Unilever UK. The objective is to develop environmental footprints for consumer production, with a focus on energy, water, land and chemicals. Likewise, funding from the Dutch government was obtained to study and regulate invasive species.
- The current biogeochemical and ecological research of the Aquatic Ecology group will be extended to include novel applications related to restoring heavily disturbed wetlands (e.g. the Wadden Sea, peatlands and lakes), wet agriculture (paludiculture), coastal protection and preventing land subsidence. This work is supported by several new grants (including one from STW).
- In order to explore potential innovation Prof. Mike Jetten (Ecological Microbiology) received an ERC Proof of Concept grant as a special grant within the context of the ERC Advanced Grants he obtained in 2008 and 2013. This grant will allow Mike Jetten and his colleagues to further explore possible applications involving the bacteria they discovered for wastewater treatment. These bacteria – which include the famous anammox and methylomirabilis – can remove nitrogen compounds and methane from water without oxygen and without exhausting greenhouse gases. This provides perspectives for sustainable and more economic beneficial waste-water treatment.

Personalized medicine

- Spin-off SPL Medical, an enterprise for the production and registration (commercialization) of the contrast material Combidex, was founded with the involvement of Prof. Jelle Barentsz. Combidex-enhanced magnetic resonance imaging (MRI) is more effective than more invasive surgical processes for revealing small and otherwise undetectable lymph node metastases in patients with cancer.
- Bas Bloem received the Holst Memorial Lecture Award 2015 for his research in the field of healthcare innovation.

We participate in and initiate regional development programmes

- With a Kolff postdoc grant from the Dutch Kidney Foundation for the project ‘Chronic kidney disease causes progressive decline of kidney function’, Dr Jan van den Brand will use novel statistical models to describe and predict commonly occurring trajectories of decline in kidney function. These trajectories reveal a more informative patient phenotype. Moreover, the
trajectory for an individual patient can be extrapolated to make a detailed prognosis.

• In the ParkinsonNext project six entrepreneurs together with Radboudumc, Radboud University (Department of Digital Security Faculty of Science) and the ParkinsonNet Foundation developed supporting self-care products that help communication between a patient and a healthcare provider and among healthcare providers themselves. These applications are provided to a large number of patients with self-care products allowing the entrepreneurs to test the new healthcare products. In this care segment, in which there is more and more emphasis on the use of portable sensors (smartphones, activity meters and heart rate monitors) concern about the safety of personal data is increasingly important.

Transfer of knowledge and technology
A subsequent outcome of the research and education performed at our University, academic knowledge is being converted into practical results with societal value in various ways. By transferring knowledge and technology to society we stimulate innovation and create conditions for entrepreneurship. At the same time societal problems are an important inspiration for academic research at our institutes.

We encourage the use of academic knowledge in society by focusing on the following activities: publishing articles and books aimed at professionals in society, post-academic education, joint research with private and public partners, public events, the formulation of guidelines, facilitating the establishment of new companies, supporting start-up companies and educating students in entrepreneurship. The University also participates in and initiates regional development programmes.

A few examples of activities related to technology transfer are:

The project ‘Gelderland valoriseert’ (‘Gelderland puts science into practice’) is designed to further develop the region as well as entrepreneurs by stimulating cooperation between knowledge institutions, companies and societal organizations. In 2015, the contribution of Radboud University to this project was reinforced.

In 2015, researchers at the University submitted a total of 15 patents in Chemistry, Health Sciences and Life Sciences. Furthermore, six spin-off companies started up on the basis of previously developed intellectual property.

The proportion of researchers financed by research contracts in relation to the number of researchers financed by core funding (see key figures on page 7 and Figure 2 on page 12) shows that our University is successful in acquiring projects with societal relevance.

From 2015 onwards, the activities at the University that are designed to maximize knowledge and technology transfer will be monitored according to specific indicators. In addition, a selection of most interesting examples of societally relevant results from research have been identified. These examples will be presented in ‘narratives’ which display both the research itself and the impact of its results in society.

Setting up the Radboud Innovation unit
On 1 September 2015 the Radboud Innovation unit was launched with the mission to provide scientists with support and advice on displaying and enhancing the social, cultural and economic value of their knowledge and skills. To this end Radboud Innovation encourages a university-wide commitment to social and economic issues. The unit is a central source of knowledge in the field of external (regional, national and European) funding of research and novel enterprise, legal rules, the possibilities for public-private cooperation and access to facilities.

In its first months Radboud Innovation developed a network in which all faculties are directly involved. Together with faculty representatives it was determined how Radboud Innovation should be build up in the years ahead. This involves in particular Research Support (advice and guidance in writing applications for research funding) Project Development (public-private partnerships, links with regional, national and European issues and priorities), Business Development (promoting and supporting new businesses) and the provision of research facilities (Radboud Research Facilities) and real estate facilities (BVCampus) to third parties.

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

These international committees assess the institutes according to the Standard Evaluation Protocol (SEP) for Academic Research in the Netherlands, which includes evaluating the training and education programme for PhD students. As of 2015 a revised version of this protocol was introduced (SEP2015-2021) which has three criteria: research quality, relevance to society, and viability. The assessments, which range from excellent to unsatisfactory, are defined as follows:

1. World leading/excellent
2. Very good
3. Good
4. Unsatisfactory

In 2015 the research at three institutes was evaluated and assessment reports on two of these have already been received.

Institute for Computing and Information Sciences (iCIS)
The research and education of doctoral candidates at iCIS was evaluated in 2015. The assessment report arrived early in 2016. The committee lauded the direction the
Institute had chosen in recent years and it summarized its findings as follows:
Research quality at iCIS is excellent based on the key indicators, such as awards and grants, best paper awards in high-quality publication venues, the use of software tools and participation in national and international research programmes. iCIS plays an important role in contributions to society on a wide range of topics. The committee applauds the flat and open organizational structure, the growing record in attracting external funding, the strong ties to other disciplines and the solid contacts with government and industrial partners. PhD students appear to be extremely positive about the open environment, training and external educational, presentation and networking opportunities that are available to them. The committee commends iCIS on its recruitment of students (in terms of diversity-) and also on incentives for timely completion of the PhD. The committee is satisfied with the steps, policies and procedures in place at iCIS to ensure research integrity. In conclusion, iCIS scored best among all Computer Science institutes in the Netherlands.

Institute for Mathematics, Astrophysics and Particle Physics (IMAPP)
The Mathematics department of IMAPP participated in a national assessment of Mathematics research. Early in 2016 the committee sent a draft report (the final version is in preparation). Some quotes:

The Algebra & Topology programme as a whole has been doing excellent research in the period of evaluation. The three chairs in the Mathematical Physics programme all have outstanding international reputations and during the evaluation period promising staff members were hired. A new start of the Applied Stochastics programme was made in 2012 with the appointment of a chair whose research shows impressive breadth, covering statistical physics, mathematical statistics and also statistical consulting at a very high level. The programmes put effort into increasing the number of students enrolling...and have been spectacularly successful in this. In addition, there are a number of very good initiatives that are relevant to society. The three underlying programmes are well aware of their strengths and weaknesses and were able to convince the committee that they have a clear strategy for the years ahead. Looking forward, the fusion of three programmes is considered an excellent move by the committee. Like all mathematics PhD programmes in the Netherlands, Nijmegen is doing very well in training and supervising its PhD students. The committee approves of the research integrity regulations and more specifically the guidelines that are in place. In conclusion, the committee scored 'very good' for all three criteria.

Academic integrity
The University Board actively promotes academic integrity and accountability by increasing awareness among researchers. Research institutes reported on current practice, improvements and the implementation of rules for sound scientific conduct. These practices include dedicated seminars for staff, doctoral candidates and Research Master’s students.

In addition to the confidential advisers for academic integrity at the university level, several research institutes also appointed their own confidential advisers on this issue. Based on a meeting organised by the Advisory Council for Academic Integrity – including deans, research institute directors, the university-level confidential advisers for academic integrity and the Rector Magnificus – university guidelines were developed. These guidelines cover the duties and roles of decentralised confidential advisers for academic integrity, in relation to the University’s overarching confidential advisers for academic integrity. They meet twice a year for reflection among peers.

In line with the Netherlands Code of Conduct for Scientific Practice, it is recognized that one of the most important ways to ensure reliable, verifiable and responsible research is good data management and safe storage in approved repositories. To implement the University’s Policy on Storage and Management of Research Data, three pilots were started: two at Radboud University and one at Radboudumc.

The Research Information Services (RIS) interface allows researchers at six faculties to upload their dataset to a national certified data archive. The RIS interface links research data and publications to one another, registers them and makes them accessible on the internet. This RIS interface is now taken into use. Two other pilots – both designed to manage data during the whole data life cycle – one at Radboudumc and one at the Donders Institute, are currently developed. The intention is to combine all pilots in due course to provide a campus-wide solution for data management and storage.
The Research Institute for Philosophy, Theology, and Religious Studies (PTR) enhances knowledge related to fundamental questions about society, human beings and their place in the natural world. Its research is organized in three interdisciplinary thematic programmes.

**Programme 1: Competing Worldviews**
Researchers working in this programme investigate ‘Philosophy, Theology, and Science as Competitors and Complements’. In the course of history, theology, philosophy and the sciences have emerged as large interpretative and explanatory frameworks. In some periods, these frameworks complemented each other; in others, they were rivals. This programme focuses on this history and the current state of the interaction between frameworks. Key topics are concepts (e.g., soul, cause, heresy, and Catholicism), institutions (e.g., universities, courts, monasteries, and public discourse), methods (e.g., exegesis, experiment, and analysis) and documents (e.g., encyclicals, inquisitional proceedings, and university textbooks). The programme is coordinated by Prof. Christoph Lüthy.

**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, 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 is coordinated by Prof. Peter Nissen.

Programme 3: Modernity Contested
Modernization involves the discovery of subjectivity and the dominance of science in the domains of knowledge, societal differentiation, rationalization and secularization. The process of modernization is essentially contested. The critique of modernity and of its symptoms, whether inspired by religious, philosophical, or societal concerns, is pitted against equally passionate apologies. Contemporary culture is marked, for instance, by heated debates about Islam, and about religion in general. Researchers working in this programme investigate the status and legitimacy of various contestations of modernity. This programme is coordinated by Prof. Gert-Jan van der Heiden.

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 collections 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 at the Institute collaborate with colleagues locally, nationally and internationally. Locally, collaboration consists of joint research groups with other faculties and institutes, including the Faculty of Arts (e.g. the Radboud Medieval and Early Modern Studies) and the Donders Institute. Nationally, members of PTR participate in various research schools. Internationally, PTR researchers collaborate extensively with researchers and research groups at many universities abroad, including such high-ranking institutes as the Massachusetts Institute of Technology, University College London, and Paris VII/Diderot.

Programme 1 continues a series of joint-degree PhD projects with universities in Berlin, Brussels, and Pisa. It also initiated collaboration with Heriot-Watt University (Edinburgh) on opening up the personal archives of Sir Charles Lyell. Furthermore, the programme has engaged in fruitful collaborations with the Internationale Gesellschaft für Theologische Mediävistik as well as the Centre d’études en sciences sociales du religieux (EHESS, Paris) and the Ecole des Hautes Etudes en Sciences Sociales (EHESS; Paris), the Institutum Carmelitanum (Rome), and the international research group working on Cathars, CIRCAED.

Researchers in Programme 2 collaborate within the new Research Network on Death Rituals (universities of Zurich, Fribourg, Lancaster, Bath, Copenhagen and Radboud University) and within the AHRC research network Crossing-Over: New Narratives of Death. Further partners include the Ruhr-Universitat Bochum, the Central European University Budapest, Rutgers University, and the Salesian Pontifical University in Rome.

Researchers in Programme 3 collaborate with the Institute of Hermeneutics (Zurich University), the Geneva Institute of Social Studies, RGGU (Moscow), Arizona State University, the International Society for Psychoanalysis and Philosophy, the Collegium Phaenomenologicum, the Symposium Phaenomenologicum, the Institute Dialog Ethik in (Zurich), the universities of Pretoria, Stellenbosch, Sao Paolo, Bristol, Paris VII/Diderot, Stockholm, and the Freud Museum in Vienna.

Research results
In Programme 1, a group of researchers developed a multifaceted account of public theology, bringing together various approaches. These include research into the spirituality of societal renewal,
which reveals the hidden forces that still shape the dynamics of public life; research into the spirituality of religious orders and congregations; and research on the theological origin of a secular public. These approaches converge in a view that understands public theology as a form of apologetic communication. Daniela Müller explained in a monograph how heresy provided new impulses to the evolution of Christian doctrines and a European culture of dispute, and specifically examined the role that women played in this process. Lyke de Vries translated and examined a hitherto unknown 1616 report for the Vatican censors on the works of the controversial Renaissance physician Paracelsus, which, somewhat unexpectedly, was written by the papal botanist Johannes Faber, himself a partisan of Paracelsus. Davide Cellamare retraced the emergence of a new type of Renaissance psychology between Melanchthon in Wittenberg and Snellius Sr. in Leiden, showing the first beginnings of a new mind-body dualism. Sanne Stuur investigated the way in which the philosopher Paul Cassirer modified his initial Kantianism step by step as a consequence of his encounter with the physics of Albert Einstein.

Doina Rusu and Christoph Láthy discovered that Francis Bacon’s posthumous Syrva sylvarum (1626) is not a Baconian book at all, but a pile of notes that Bacon’s erstwhile chaplain, in need of money and patronage, falsely peddled as a genuine work. Thanks to the efforts of Paul Bakker and Michiel Streijger, the edition of John Buridan’s commentary on Aristotle’s Physics, finally came to fruition with the publication of the first of three volumes. Frederik Bakker and Carla Rita Palmerino traced a thought experiment employed by Galileo Galilei to the ancient philosopher Plutarch. And Hans Thijssen investigated the reasons why philosophy stopped looking for happiness and developed into a purely theoretical discipline.

In Programme 2, researchers refined the concept of ‘continuing bonds’, which is widely used in the contemporary study of bereavement, in the sense that these bonds have an expiry date and need to be located between physical and social death. They also analysed the crisis of meaning concerning death and dying as a threefold process of fading vocabularies, namely that of verbal, ritual, and symbolic vocabularies or repertoires. Other researchers contributed to linking together the approaches of socio-cognitive Discourse Analysis with the Theory of the Dialogical Self.

Other researchers proposed a unified solution to three puzzles involving negation, denial and commitment in ‘non-canonical reports’. They also proposed a non-representational model of basic coordinated collaboration between humans. Others proposed new ways in which cognitive neuroscience can contribute to improving our everyday self-understanding. The concepts of ‘heresy’ and ‘determinism’ in biblical texts were studied and it was demonstrated that determinism is not an all-encompassing framework in the Hebrew Bible.

In Programme 3, Philippe van Haute and Herman Westerink published a new edition of Freud’s Drei Abhandlungen zur Sexualtheorie that deviates from earlier editions in crucial respects, thus forcing interpreters to rethink the evolution of Freud’s work and in particular the status of sexuality in relation to the Oedipus complex and the law. Annabelle Dufourcq problematized the difference between real and imaginary from a phenomenological perspective. The researchers working in the NWO-funded research programme on the contemporary philosophical readings of Saint Paul organized an international, multi-disciplinary conference bringing together philosophers, theologians and classicists. Gert-Jan van der Heiden showed how the philosophical interpretations of Paul’s concept of faith emphasize the ethical rather than the epistemological dimension of this concept.

Marcel Becker’s research showed how Aristotle’s virtue ethics helps us to understand the ethical dimensions of the human interaction with the new digital media. Jean-Pierre Wils re-examined MacIntyre’s virtue ethics in light of his critique of modernity, thus showing the complicated relationship between virtue ethical concepts and narratives of modernity. Marin Terpstra published a monograph that shows why modernity is contested and why this implies that there is no unchallenged standard to identify modernity. Evert van der Zweerde’s research on the South Caucasian region shows how religion, nationalism and democracy influence each other in societies that are only now beginning to modernize.

Joas Wagemaker’s and Martijn de Koning’s studies on Salaifism and Jihadism in Islam studies show that ‘Salaifism’ refers to a diverse group in which the tendency to violence is characteristic of only a small proportion of its supporters. Also, it has become clear that the ideology of Salaifists and Jihadists should be taken into account in the actions of this movement, and that these actions should not be understood in terms of socio-economical and political reasons alone. It has also become clear in the research by Karin van Nieuwkerk that the study of Islam should include a study of why people leave Islam.

Societal impact
It is in the nature of research in the humanities, as practised in our faculty, that its societal and cultural relevance manifests itself primarily in active participation in the public sphere. In part this involves informing the general public through publications, lectures, and media appearances, but in particular we consider it our responsibility to enhance the quality of the public debate by providing expert advice and ethical reflection for its participants, by way of publications, workshops, and training programmes. Therefore, a substantial portion of our research output consists of publications and lectures aimed at a general audience, media appearances, and so on.
Researchers working on Programme 1 presented their research to the larger public in the 50th-anniversary conference on the encyclical Gaudium et Spes; in a public debate on Nijmegen’s theological position (Theologia noviomagensis); and in book presentations and public lectures, including one at the Senate in The Hague. An interactive app (‘Games of Gods’) was developed, which offers a guided tour through Xanten Cathedral. They also addressed audiences ranging from primary and high schools, students at summer schools and Radboud’s Honours Academy to senior citizens. Paul Bakker and Cees Leijenhorst organized and participated in dozens of public events for Radboud Reflects, the Science Café, LUX and the Radboud Ambassadors Lectures. William Duba’s research on the medieval paper revolution was featured in various national newspapers. Carla Rita Palmerino gave the Dijksterhuis Lecture, honouring E.J. Dijksterhuis’ scientific and literary legacy, and Christoph Lüthy delivered the Buitendijk Lecture, reflecting on the contorted history surrounding the university as an institution.

Researchers working in Programme 2 sought to contribute to a better understanding of the changing patterns of death, dying, and bereavement in the contemporary world, and they did this by sharing their knowledge with professionals of the three major Dutch funeral companies, by giving lectures for a broader audience, through popular publications, and through media performances. They co-organized an expert meeting with over 130 professionals on ethics and etiquette in dealing with human remains at the anatomical museum of Radboudumc. Other researchers are involved in the Life Insight Application Study to enhance quality of life among cancer patients, in cooperation with Cancer Fund/Alpe d’HuZes and Janssen Pharmaceutical Companies. A number of researchers also participated in a symposium on religion in a secular society in the Senate Building of the Dutch Parliament. Most scholars working within Programme 2 are regularly invited for public lectures, radio talks, or newspaper interviews. Peter Nissen was a member of the KNAW Foresight Committee for theology and religious studies, which published its report in 2015.

In contemporary society, the role of Islam is a much-debated issue. As far as Programme 3 is concerned, the chair of Islam Studies participates significantly in this debate. Joas Wagemakers and Martijn de Koning edited a volume for a general audience to which all staff members contributed. Martijn de Koning was an expert witness at the trial of the so-called ‘Contextzaak’ and wrote a report. Since the attacks in Paris, Salafism, Jihadism and radicalization are important themes in the media. On these topics, lectures were organized in cooperation with Radboud Reflects, and staff members were interviewed in various national news media (Volkskrant, Trouw, De Gelderlander, and the TV programme Nieuwsuur).

Stefan Schevelier, who also works in Programme 3, developed a democracy game ‘Wie is de beste burger?’ (Who is the best citizen?), in which the players are confronted with the questions and problems encountered by participants in a democracy. Jean-Pierre Wils contributed to a Swiss committee to develop a model for an oath for physicians and more generally contributed to reflections on the ethical dimensions of healthcare. Wils is also often invited by societal institutions to give advice on the political, ethical and cultural dimensions of their policies.

**Future research**

The group engaged in systematic religious studies will integrate their research within the Global Network of Public Theology. Two international conferences are planned: ‘Kierkegaard and Public Theology’ and ‘Kant and Public Theology’. Church historians will investigate the relationship between impurity and sexual restriction in relation to conventional views of women in the church. Inquisitorial trials will be examined as a model for the...
Key publications


Dissertations: 9
Scientific publications: 270
Professional publications: 139
tribunals of the French Revolution during the ‘Grande Terreur’. The Center for the History of Philosophy and Science has planned several international conferences, including ‘Athanasius Kircher’s Science’, ‘Space, Imagination and the Cosmos’, and ‘The Ideas of Phenomenology’. It will also contribute to the encounter of giants: Peter Sloterdijk and Bernard Stiegler. Part II of Buridan’s Commentary of Aristotle’s Physics and vol. I of the Oxford edition of Descartes’ Correspondence will be published.

Within Programme 2 the research on death, ritual, and spirituality will be continued, also comparatively in Europe. Related research into material religion will be further explored, in cooperation with a number of museums in the Netherlands and abroad. Research on growing evangelical churches in the Netherlands will be extended in collaboration with universities in Belgium and the UK. The Cognition, Culture and Language group will organize a workshop to prepare a research grant application on linguistic culture from a cognitive perspective.

In Programme 3 the work on virtue ethics, on the conflicts in modernity and on the origin of Freud’s thought will be continued. A series of new projects will be started concerning the phenomenology of animality, the hermeneutics of testimony and attestation, and the status of asceticism, mysticism and spirituality in Foucault and De Certeau. In Islam Studies researchers will continue to work on the questions of citizenship in the Arabic world and will start a new line of research on moving in and out of Islam as well as the re-enchantment of Christian and Moorish celebrations in the Mediterranean.

Awards and grants

- Brenda Mathijssen MA was awarded a Frye Stipendium.
- Prof. Carla Rita Palmerino delivered the Dijksterhuis Lecture, on ‘E.J. Dijksterhuis, Ferryman between the Exact Sciences and Literary Culture’.
- Prof. Christoph Lüthy delivered the Buytendijk Lecture, on ‘The Usefulness of the University. A History of Unfulfilled Expectations’.
- Dr Delphine Bellis won a three-year postdoctoral fellowship at Ghent University, from the Research Foundation Flanders (FWO).
- Dr Erik Dücker obtained access to the family-owned scientific heritage of the 19th-century ‘father of geology’, Sir Charles Lyell, thanks to a matching construction between the RU and Heriot-Watt University, Edinburgh.
- Lyke de Vries MA obtained an NWO PhD grant.
- Prof. Peter Nissen delivered the Comenius Lecture in Naarden.
- Prof. Philippe van Haute was appointed extraordinary professor by the University of Pretoria.
- As part of a Memorandum of Understanding with the Indonesian government, three PhD projects on Islam in Indonesia are to be initiated.
- Prof. Sophie van Bijsterveld received the Jhr. Mr. A.F. de Savornin Lohman Award for her book on the relationship between government and religion in the Netherlands.
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 literature and literary theory, cultural studies, history, art history and archaeology. HLCS research is based on a common focus: ‘Europe and its Worlds’.

‘Europe and its Worlds’ is a research theme in which questions as to whether and how ‘Europe’ consists of different worlds are addressed, how it differs from the rest of the world, and how it interacts with other worlds. Researchers collaborate in thematic groups to explore the spaces, cultural practices, beliefs, texts and ideas related to this 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 mainly 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 and provides services in the field of image research and delivery of image material (www.ru.nl/ckd)
- The Auxilia archaeological project bureau (Provincial Roman History; the analysis of excavations in the former territories of Germania Inferior (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

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

Prof. André Lardinois is one of the founders and chair of the Network for the Study of Archaic and Classical Greek Song, which is engaged in the study of archaic Greek lyric, iambic and elegiac poetry and song, with representatives in most European countries as well as in a number of major American universities (Berkeley, Harvard, Stanford and Yale). The aim of this network is to pool the resources of individual scholars, who now often work in isolation, by holding regular meetings, keeping in contact through a network website and a newsletter, and defining topics of common interest within archaic Greek poetry that groups of scholars in different countries can work on together.

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. Another aim is to help institutions becoming more visible beyond their national boundaries and to facilitate cooperation between the participating institutions.

Dr Marguérite Corporaal is the leader of the International Network of Irish Famine Studies, a platform in which Famine scholars present their research and work on joint publications which approach the Great Hunger from interdisciplinary viewpoints and generate more generally applicable insights into the socio-cultural and economic contexts in which famines occur. Additionally, the network offers an internet forum where digitalized resources can be published, thereby creating an archive through which public organizations with an interest in the Famine can have access to reliable information.

Research results

Although there are many works dealing with Pompeii and Herculaneum, until recently none of them has tried to encompass the entire spectrum of material related to their reception in popular imagination. In his book Pompeii’s Ashes. The Reception of the Cities Buried by Vesuvius in Literature, Music, and Drama, Prof. Eric Moormann surveys a broad variety of such works, ranging from travelogues between ca. 1740 and 2010 to 250 years of fiction, including stage works, music, and films. The first chapters provide an in-depth analysis of the excavation history and an overview of the reflections of travellers. The remaining chapters discuss historical novels, contemporary adventures, time travelling, mock manuscripts, and works dedicated to Vesuvius. Pompeii’s Ashes demonstrates how the ceaseless fascination with the oldest still-running archaeological projects in the world began, developed, and continues today.

Two famous paintings attributed to the medieval Dutch master Hieronymus Bosch, ‘Christ Carrying the Cross’ (around 1515-16) and ‘The Seven Deadly Sins’ (around 1500), are thought to have been imitations painted around the same time. This conclusion was made after years of research by the Bosch Research and Conservation Project (BRCP). Paintings were compared using infrared reflectography, ultra high-resolution digital macro photography and other modern techniques. Prof. Robert Erdmann, Dr Matthijs Ilsink, Prof. Jos Koldeweij and Prof. Ron Spronk are members of the project team, alongside researchers...
Jensen and Marguérite Corporaal demonstrate the value of HLCS as an Act of International Diplomacy: English translations of Willem van Haren’s Political Poetry during the War of the Austrian Succession in the Journal for Eighteenth-Century Studies. In the eighteenth century, the worlds of diplomacy and poetry were inextricably connected. This volume provides scholars with a current, synthetic introduction to the Observant Movement. In essays the authors also seek to expand the horizons of the study of Observant reform and to open up new avenues for future scholarship. Dr Bert Roest is one of the editors and contributors.

Dr Lotte Jensen and Dr Marguérite Corporaal published ‘Poetry as an Act of International Diplomacy: English translations of Willem van Haren’s Political Poetry during the War of the Austrian Succession’ in the Journal for Eighteenth-Century Studies. In the eighteenth century, the worlds of diplomacy and poetry were inextricably connected. This is demonstrated by the work of the Dutch statesman and poet Willem van Haren (1710-1768), whose political poems played an important role in the negotiations of international political relations during the War of the Austrian Succession. It is argued that the great interest in Van Haren’s work in England is due to the country’s positioning in the European conflict as well as Anglo-Irish relations during the 1740s. Lotte Jensen and Marguérite Corporaal demonstrate the value of HLCS theme groups that combine expertise from a variety of disciplines.

By combining cultural studies and international relations they have opened up new perspectives on literary texts.

Societal impact

The institute of Historical, Literary and Cultural Studies targets three groups in society: pupils and teachers at secondary schools, inhabitants of the Nijmegen region, and the general public who are interested in history, culture and literature. The research programme addresses the first group through a large number of lectures for secondary school pupils given at schools or at Radboud University. The second group is reached through the various initiatives of the institute that address historical and cultural awareness of the Nijmegen-Arnhem region and encourage the use of historical, cultural and literary research in society, through involvement in a substantial number of local boards and initiatives. The third group, which is the most diverse, is targeted in a variety of ways. The three most successful approaches are through exhibitions; through publications in national newspapers, blogs and journals targeting a wide audience, e.g. through radio and television broadcasts; and through translations of foreign-language literary and historical texts into Dutch.

From October 2015 to February 2016, unique art treasures were on display in De Nieuwe Kerk in Amsterdam as part of the exhibition ‘Rome. Emperor Constantine’s Dream’. They illustrated one of the most fascinating themes from antiquity: the transformation of Rome in the fourth century AD from a multi-religious imperial capital full of temples with colossal statues of the emperor into the centre of papal power dominated by churches with crosses. Christianity’s evolution in a relatively short time from a small faith community into the dominant religion, which had a crucial influence on the development of the Western world, is an astonishing success story that can largely be attributed to a single person: the Emperor Constantine the Great. The exhibition was created through collaboration between Prof. Sible de Blaauw, Prof. Eric Moormann and three renowned museums in Rome: the Capitoline Museums, the National Roman Museum and the Vatican Museums.

The jazz heard in documentaries about the liberation was nearly always added to the images at a later stage. The actual liberation music was much more versatile. It has been brought back to life in the exhibition ‘Songs of Liberation’ in the National Liberation Museum in Groesbeek, based on a unique collection of more than 300 pieces of sheet-music, recently donated to the museum from the US. ‘Songs of Liberation’ also looked further than the summer of 1945. From the introduction of jazz in the Netherlands in the 1920s to censorship and Schlager-music in the occupation years. After the war, American and British music thrived in the transition from jazz to rock ’n roll and pop music. On the occasion of this exhibition, Prof. Frank Mehring published a richly illustrated book entitled Soundtrack of liberation. Songs, sounds and dances in the summer of 1945.
Alicia Montoya (Professor of French Literature and Culture) was awarded an ERC Consolidator Grant for ‘Middlebrow Enlightenment. Disseminating Ideas, Authors and Texts in 18th-century Europe (MEDIATE)’. By developing a state-of-the-art database, this project will identify not the ‘high’ Enlightenment texts studied within the history of ideas, nor the ‘low’ forbidden texts of book history, but rather the real best-sellers of the 18th century.

Compared to other countries, the Netherlands generally scores high in the field of literary translation. But even here there is room for improvement. Translations are not always easy to read, can be stylistically very different from the original and in some cases downright incomprehensible. How can this be explained and how can it be prevented? And what are the characteristics of a good literary translation? These and other questions about literary translation were discussed by Prof. Maarten Steenmeijer in the first ‘State of the Translation lecture’ in SPUI25 in Amsterdam. The state of literary translation in the Netherlands is also the central theme in Schrijven als een ander. Over het vertalen van literatuur (Writing as someone else. About translating literature). In this book, literary critic and translator Maarten Steenmeijer uses examples to demonstrate and explain what can go wrong in translating literature and why.

Thinking Through Fashion is the first book designed to help readers understand the context of fashion. It aims to help them grasp both the relevance of social and cultural theory to fashion, dress, and material culture and, conversely, the relevance of those fields to social and cultural theory. It does so by offering a guide through the work of selected major thinkers, introducing their concepts and ideas. Each chapter is devoted to a key thinker, capturing the significance of their thought to the understanding of the field of fashion, while also assessing the importance of this field for a critical engagement with these thinkers’ ideas. It is a guide and reference for students and scholars in the fields of fashion, dress and material culture, the creative industries, sociology, cultural history, design and cultural studies. The editors are Agnès Rocamora (University of the Arts London) and Prof. Anneke Smelik.

Future research
Prof. Alicia Montoya was awarded an ERC Consolidator Grant for ‘Middlebrow Enlightenment. Disseminating Ideas, Authors and Texts in 18th-century Europe (MEDIATE)’. By developing a state-of-the-art database, this project will identify not the ‘high’ Enlightenment texts studied within the history of ideas, and not the ‘low’, forbidden texts of book history, but the real best-sellers of the 18th century. These texts represented the most visible face of the Enlightenment to readers on the ground, but have hitherto never really been studied. It will elaborate a typology of this corpus, describing its generic traits, intended readers, relationship to major political-religious debates, and how readers in different parts of Europe appropriated these texts through translations, reworkings and other uses. The project thus brings an ambitious, bottom-up approach to intellectual history, using book history data and innovative digital tools to argue that the Enlightenment was fashioned not only by the progressive intellectuals we know today, but just as importantly, also by a large mass of forgotten, middlebrow best-sellers that need to be adequately studied if we are to truly understand how we ‘became modern’ (or not).

On average the Dutch are the tallest people in the world. But at the beginning of the 19th century, this wasn’t the case. Why we have since become so tall? In the context of the NWO’s ‘Free Competition in the Humanities’, Prof. Jan Kok received a grant to clarify this mystery. The research uses inspection reports of conscript 19 year-old boys born between 1811 and 1922 that will be linked to their life courses. An explanation of this phenomenon should probably be sought in broad access to good food, as well as in the reduction of childhood diseases and child labour. The researchers will map the size and composition of the family of the conscripts and their later life course (marriage, children, career, and life expectancy), as well as their social background and place of origin. By recording the lengths of the fathers and sons of the conscripts, they also aim to elucidate a possible genetic component.
Institute for Historical, Literary and Cultural Studies

Key publications


Mixson, J.D. & Roest, B. (Eds.). (2015). A Companion to Observant Reform in the Late Middle Ages and Beyond (Brill’s companions to the Christian tradition, 59). Leiden/Boston: Brill.
Director: Prof. Olivier Hekster

Olivier Hekster has been Professor of Ancient History at Radboud University since 2004. He obtained his doctorate degree cum laude with a thesis entitled Commodus. An Emperor at the Crossroads. Olivier Hekster focuses his research on the role of ideology in ancient Rome, specifically on Roman imperial representation. He has been Lecturer in Ancient History at Wadham College Oxford and Fellow and Tutor of Ancient History at Merton College Oxford, spent a year at the Commission for Ancient History and Epigraphy in Munich on a Humboldt Research Fellowship for Experienced Researchers, was a member of Royal Academy’s The Young Academy (2005-2010) and has chaired of the international network Impact of Empire since 2006. He recently obtained a large personal grant (Vici) from NWO.

Within the same programme Prof. Hans Bak obtained a PhD position for Iris Plessius. When the peace of Westminster was signed in 1674, the Dutch colony formerly known as New Netherland came into the hands of the British after a ten-year struggle. The moment the Dutch surrendered, the victors began to write the history of the United States from a British perspective, largely ignoring the influence of other European countries. The objective of this project is to assess the role the Dutch played in the genesis of the United States during the formative years of the 17th and 18th centuries by exploring the relationships that existed between the Native Americans and the Dutch from 1674 till 1783.

Prof. Johan Oosterman and Dr Jan Kuys have acquired funding from the NWO programme ‘Added Value through Humanities’. At the beginning of the fifteenth century, Duchess Mary of Guelders had a prayer book made in a cloister near Arnhem. It ranks as the highlight of book production from the Northern Netherlands around 1400 and reflects the ambitious and internationally oriented culture in Guelders at the time. The context in which it functioned, however, is still largely unknown. The aim of this project is to make this context visible by investigating the relationship between the prayer book, the duchess who had it made and used it, the time in which it was created, and the places the book and Mary of Guelders can be connected to. Traces of these places in the landscape will be marked physically by the use of signs as well as virtually on the website www.mariavangelre.nl.

Prof. Jan Kok and Dr Angélique Janssens are partners in the Marie Curie ETN ‘Methodologies and Data mining techniques for the analysis of Big Data based on Longitudinal Population and Epidemiological Registers’ (LONGPOP). In recent decades, research teams across Europe have developed longitudinal population registers and large research databases, opening up avenues for new linkages between different data sources and resulting in the reconstruction of hundreds of thousands of individual life courses and multidimensional biographies of people. Such databases provide the foundations for a much better understanding of stability and transformation in societies. LONGPOP will create a network of research teams to share experiences, start joint research across national and disciplinary boarders, create a training track for specialists in the field, and increase the number of users of these rich databases, making them accessible to more scientists and stakeholders.

Prof. Sible de Blaauw obtained a PhD position for Maarten van Deventer within NWO’s ‘PhDs in the Humanities’ programme. During Late-Antiquity and the Early-Medieval period, Rome’s inhabitants were surrounded by ancient institutions, traditions and a cityscape conveying messages of civic prosperity and glory. At the same time Rome’s dwindling population, wars, unrest and declining financial strength resulted in the decline of the cityscape. The need arose for a new shared identity that could function as a source of self-esteem and coherence. How did Rome’s inhabitants shape their new collective cultural identity and what was the role of the cultural heritage of the city of Rome? This research will focus on archaeological and iconographical sources.

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The Business & Law Research Centre – Onderzoekcentrum Onderneming & Recht (OO&R) – is a cooperation between the Faculty of Law and fifteen prominent, mostly international, law firms and Dutch multinationals.

The mission of the Centre is:
• to conduct high-quality (national and international) academic research in Business and Law
• to enhance the understanding of the theories which apply to Business and Law in the context of social, economic, political and financial developments
• to encourage practicality in academic research, particularly by analysing the fundamental principles and foundations of (business-oriented) private law
• to explore and initiate applications of academic research (e.g. in the area of national and international rules, regulations, principles and best practices)
• to educate and supervise Masters students and young researchers.

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

A major theme of 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 KNAW. In 2014 the Centre was evaluated by an International Peer Review Committee. The committee considered research conducted by the Centre to be excellent and emphasized its success in strengthening its international profile.

The Centre, which offers a comprehensive Research Masters programme to gifted students (certified by the Accreditation Organisation NVAO), is actively involved in a wide range of postgraduate educational and professional training programmes.

Research facilities
The Centre houses a collection of books, journals and electronic publications on international and domestic Business and Law that is unique in the Netherlands.

Collaboration
The unique collaboration with its partners has led to cross-fertilization between legal practice and the academic world. The Centre has regulations, which dictate that all parties involved guarantee academic independence. The following partners participate in the Centre: AEGON, Akzo Nobel, 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 and Stichting Eumedion.

The Centre encourages international cooperation. There is close collaboration with: the Chair in Corporate Finance (Nijmegen School of Management), the Max Planck Institute for Comparative and International Private Law (Hamburg, Germany), the Nottingham Trent University (UK) and the Network for Studies on Pensions, Ageing and Retirement (Netspar, Tilburg). New options are currently being considered to capitalize on existing ties with the University of Oxford (UK) to establish structural collaboration through joint research projects and research mobility programmes. Within the framework of International Working Groups (IWGs) established by the Centre in financial law, agency law, insolvency law and European law, there is structural collaboration with leading academics and practitioners from universities and institutions in over 20 countries. The Centre also plays an active role in various projects of the European Commission and international GO/NGOs (e.g. the IMF and INSOL Europe).

- Prof. Carla Sieburgh regularly conducts visiting research at the Department of Law of the European University Institute.
- Irene Aronstein (LL.M.), Sanne van Dongen (LL.M.) and Roderic ter Rele (LL.M.) completed a visiting research position at the Max Planck Institute for Comparative and International Private Law in Hamburg.
- Kim Geurts (LL.M.) completed a visiting research position at St. John’s University, New York.

**Research results**

The creation of the European Banking Union results in a historical shift of powers from the Eurozone Member States to the European Union. The IWG on the European Banking Union, which consists of leading scholars and practitioners in the financial sector, has examined the effects of the creation of the Union on the daily supervision of large banks in Europe and has also analysed the position of bank creditors and shareholders. The thematic approach

René Maatman (Professor of Asset Management) and Mark Heemskerk (Professor of Pension Law) obtained a research grant from Netspar for their project ‘Pension rights and ownership: a legal analysis in an economic context’.
A strong area of research is international and comparative insolvency law. A permanent network of insolvency experts from 20 countries across the globe contribute to the Oxford International and Comparative Insolvency Law Series. In 2015, a volume on ‘Ranking and Priority of Creditors’ was finalized. This volume deals with what many would regard as the raison d’être of insolvency law: the creditors’ claims. To run insolvency proceedings effectively, insolvency law must enforce ‘collectivization’ on the debtor’s creditors. Their claims must be ‘translated’ from the largely bilateral world of debtor/creditor law to the world of collective insolvency proceedings which are designed to resolve the debtor’s general default.

The collapse of the Lehman Brothers group in September 2008 triggered a shockwave in global financial markets and it is often considered to be the defining moment of the financial crisis. Many issues encountered in bankruptcy proceedings opened against entities belonging to the Lehman Brothers group were unprecedented in terms of scope and complexity. Substantial efforts were made to address these issues in the absence of pre-existing public know-how. In collaboration with key parties in the proceedings and independent third party experts, the Centre has prepared a volume – to be published in 2016 by Oxford University Press – containing main lessons from the Lehman proceedings. Another research project analyses the interaction of agency law and specific commercial contexts. The comparative approach provides innovative perspectives and insights, as well as practical guidance on solving commercial problems. A book published by Oxford University Press will be launched in collaboration with the Commercial Law Centre of the University in Oxford during an international seminar at Brasenose College, Oxford. A large-scale research project on the horizontal (private law) effects of European Union Law was completed in 2015. The outcome of this will be published in a separate volume in the prominent Ius Commune Casebooks series.

Societal impact
Legal research nearly always relates to legal practice and is therefore by its nature of societal relevance. The Centre closely cooperates with and advises external partners such as law firms, courts, government bodies, ministries, NGOs and European organisations.

Many publications – mainly papers in professional journals and case notes – are written with legal practice in mind. Academic publications also provide a solid foundation for legal practice. Researchers at the Centre regularly participate in national and international public advisory bodies. The results of this advisory work are generally made accessible for judges, lawyers, politicians, students and the general public.

Numerous researchers at the Centre contribute to the Centre for Post-academic Legal Education (CPO), the leading provider of post-academic legal education in the Netherlands. 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 and seminars relating to the appeal of the Netherlands as a country of incorporation, the European Banking Union, price-sensitive information in capital
markets, outsourcing in the financial sector and current issues of pension law are important examples.

The Centre has been commissioned to carry out two research projects by the Dutch Ministry of Security and Justice:

• ‘Businesses in financial distress and the position of employees’: this project aims to analyse whether legal reform is needed regarding the legal position of employees and the preservation of employment opportunities when businesses are in financial distress.
• ‘Foreign investments and national security’: this project aims to analyse to what extent shareholder positions in Dutch operating companies can provide access to (confidential) information and grant influence on decisions which may have an impact on national security.

Future research
The financial crisis exposed many weaknesses in the 2007 MiFID regime. In view of this, the 2007 MiFID regime will be replaced by the MiFID II regime in January 2017. MiFID II aims to strengthen the framework for the regulation of markets in financial instruments, including where trading in such markets takes place over-the-counter (OTC), in order to increase transparency, better protect investors, reinforce confidence, address unregulated areas, and ensure that supervisors are granted adequate powers. MiFID II will have a major impact on investment firms and financial markets. Participants in the project are leading scholars with broad practical experience and leading practitioners in the field. Research collaboration within the context of the Oxford International and Comparative Insolvency Law Series will be furthered within the context of a new project on the treatment of secured creditors in insolvency proceedings. The course of insolvency proceedings and the prospects of corporate rescue are significantly influenced by security rights granted to pre-commencement financiers of the debtor. The all-embracing nature of such an security packages often enable secured creditors to block a composition or going concern scenario, which could otherwise have preserved viable businesses in financial distress. An IWG of insolvency experts will be analysing the position of secured creditors in insolvency proceedings (e.g. enforcement rights, ranking and participation rights). New domestic legislation of participating countries aimed at promoting corporate rescue and introducing new pre-insolvency enforcement routes (e.g. pre-packaged arrangements) will also be discussed. The recent appointment of Prof. Guido Ferrarini (University of Genoa) to the Van der Grinten chair of the Centre strengthens international collaboration in the field of financial law. A new research project will be initiated by Prof. Guido Ferrarini and Prof. Danny Busch on ‘Corporate governance in the financial sector’.

New research initiatives include topics such as the private law treatment and legal protection of big data (in collaboration with researchers of the Digital Security Group of the Institute for Computing and Information Sciences, Radboud University), the liability of directors and supervisory directors, cross-border conversion of companies and financing the supply chain.

Awards and acknowledgements
• Prof. Danny Busch has been appointed as a member of the Disciplinary Commission of Banks.
• Prof. Michael Veder was appointed as a visiting professor at the Nottingham Law School and is a member of the European Commission Group of experts on Restructuring and Insolvency Law.
• Marloes van de Moosdijk (LL.M.) was awarded the annual Frye stipend to conduct research abroad within the context of her PhD research on (unjustified) enrichment in EU law.
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 analyse national, European and international developments in constitutional, administrative and criminal law.

From a methodical perspective, the research carried out within SteR is characterised by the broad scope of its positive law-oriented and dogmatic approach, with a strong emphasis on practice; a legitimate place for meta-juridical research, based on the premise that conceptual analyses and empirical evidence can be necessary for proper positive law-oriented/dogmatic research; a specific emphasis on national legal principles within a changing and challenging international legal framework.

SteR consists of two research programmes:

- Principles of Public Law
- Migration Law (CMR)

‘Principles of Public Law’ brings together researchers with a focus on the main principles of public law. They analyse the relationship between principles of the democratic constitutional state (the rule of law, fundamental human rights, democratic accountability, access to justice) and national and international social developments. The principles are studied with a keen eye on European and global developments. The programme combines the expertise and know-how of constitutional, criminal, administrative, European and jurisprudential scholars. Moreover the programme 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 and access to justice. Methods used to understand the impact of civil, criminal and administrative law at various court levels are also an important research topic.

‘Migration Law’ 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.

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

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), the Glasgow Refugee, Asylum and Migration Network (GRAMNet) (UK), the Working Group on Policing of the European Society of Criminology, and the International Penal and Penitentiary Foundation (IPPF). It also has close ties with the Max Planck Institute for Foreign and International Criminal Law (Freiburg, Germany), 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).

Prof. Elspeth Guild and Dr Paul Minderhoud are experts in the new Network on Free Movement of Workers and Social Security Coordination, which is funded by the European Commission. In 2015 the Brazilian foundation for scientific research 'Capes' and NUFFIC cofounded a project in which a small group of Kant scholars, both from Brazil and SteR investigated a renewed interpretation of Immanuel Kant’s *Metaphysics of Morals* (1797). In order to reach the objectives of this project, academic exchanges have (and will continue to) take place, joint conferences have (and will) be organized and interesting contributions have (and will) be published. Directors of this programme are Prof. Thomas Mertens and Prof. Alessandro Pinzani (Florianopolis).

In the Netherlands, SteR collaborates with the Council for the Judiciary, the Ministry of Security and Justice, as well as several courts and municipalities. Within the University, SteR researchers collaborate with researchers from the Faculty of Management in the interdisciplinary network 'EUROPAL', which focuses on the Europeanization of Policy and Law.

Research results

In 2015 SteR organised several seminars. Dr Eva Rieter and Rosa Möhllein organized a conference on ‘Urgency and Human Rights’ (29–30 May) together with researchers of Ghent University and Seconda Università di Napoli, Italy. Dr Hansko Broeksteeg en Dr Ronald Tinnevelt organised a seminar on ‘The political party: an anomaly in Dutch constitutional law’ (July 2015). In close collaboration with Ghent University a seminar was organised
on the ‘Procedural review in fundamental rights cases’ (Ghent, Belgium, 21-22 May). In 2015, the law faculty hosted the annual ‘Constitutional Law Conference’, about the constitutional relations within the Kingdom of the Netherlands, with contributions by Dr Hansko Broeksteeg, Dr Joost Sillen en Prof. Ben Vermeulen. Prof. Raymond Schlössels, Prof Roel Schutgens and Dr Hans Peters organised, in close cooperation with the president and two members of the Supreme Court, a seminar on 100 years of public law jurisprudence by the Supreme Court. CMR organised a seminar on the Recast Reception Conditions Directive (2013/33/EU) (December 2015) and a CMR/Europal seminar on ‘New perspectives on the study of decision making in migration offices’ (September 2015).

Prof. Henri De Waele was Visiting Professor at National Taiwan University and National Cheng Chung University and delivered a keynote speech on the European Public Prosecutor’s Office at a conference hosted by the Taiwan Ministry of Justice. Prof. Piet Hein Van Kempen gave a key note speech at the 13th UN World Congress of Crime Prevention and Criminal Justice, on ‘Institutional Corruption and Fraud, Criminalization and the Problem of Imprisonment’ (13 April 2015, Qatar). Prof. Paul Bovend’Eert spoke at the 12th Asian law Institute International Conference (Taiwan University), on ‘Judicial Independence and separation of powers’. Dr Paul Minderhoud gave keynote speeches about ‘Frontier Workers in the EU: A Comparative report’ at the seminar on 30 years of free movement of workers between Portugal and Spain, (Lisbon, October 2015) and ‘Solidarity (still) in the making or a bridge too far?’: Presentation at the ACELG’s Annual Conference (Amsterdam, November 2015). Prof. Janneke Gerards delivered the ‘Rechtspraaklezing 2015’ the key note speech during the annual conference for judges in The Netherlands (Leiden, September 2015).

Societal impact
Legal research nearly always relates to legal practice and is therefore by its nature of societal relevance. SteR closely cooperates with and advises external partners such as law firms, courts, government bodies, ministries, NGOs and European organisations. Many publications – mainly papers in professional journal and case notes – are written with legal practice in mind. 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 EU directives. SteR researchers regularly participate in national and international public advisory bodies. The results of this advisory work are generally made accessible for judges, lawyers, politicians, students and the general public. Numerous SteR researchers contribute to the Centre for Post-academic Legal Education (CPO), the leading provider of post-academic legal education in the Netherlands.
Director: Prof. Roel Schutgens

Roel Schutgens was appointed as a Full Professor in Jurisprudence in 2010. After his study of Dutch Law at the Radboud University Nijmegen (cum laude, 2004), he was a PhD Fellow at the Department of Constitutional and Administrative Law in Nijmegen from 2004 to 2009. He obtained his PhD cum laude in 2009 with the thesis Onrechtmatige wetgeving (Unlawful Legislation), a study on the various forms of judicial review of legislation within the Dutch legal system. He has been the chairman of the SteR board since December 2015. Roel Schutgens’ research interests include state liability, legislation, judicial review, and general constitutional law. He is a member of the board of Themis, the oldest Law Journal in the Netherlands and he is a deputy judge at the Gelderland District Court.

In 2015, Prof. Janneke Gerards participated in the Commissie-Wolfsen, the committee that advised the Dutch government on a reform of the system of state-funded legal aid. In response to the increasing number of asylum seekers in the Netherlands and the installment of a refugee reception centre in the vicinity of Nijmegen, CMR took several initiatives to support lawyers and volunteers and in offering lectures to the refugees themselves.

Dr Sven Brinkhoff’s dissertation on ‘Starting information for a criminal investigation’ had broad societal impact. The book attracted attention in national news media such as NRC, Trouw, KRO-Brandpunt, Een Vandaag, Radio 1, Radio 5, BNR).

Future research
Within the programme ‘Principles of Public Law’ research on 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 will continue.

Dr Karin Zwaan will contribute to an AHRC research project Researching Multilingually: at the Borders of Law, Health, Conflict and State Security”

On the occasion of its 20th anniversary in 2016, CMR will organise a conference on the current challenges in migration (law).

Grants and Awards
• On 28 September 2015, the Royal Netherlands Academy of Arts and Sciences installed Prof. Janneke Gerards as a new elected member.

• NWO and the German funding agency DFG awarded Dr Anita Böcker and Dr Cornelia Schweppe (University of Mainz) an Open Research Area in Europe grant for their project ‘Emergence and Significance of Transnational Care Arrangement’.

• As of 1 September 2015, the European Commission selected the Centre for Migration Law as a Jean Monnet Centre of Excellence in EU Citizenship and Migration.

• Dr Asuncion Fresnoza-Flot received a 2 years-fellowship for her project ‘Marital break-up and state policies: A case study of Filipino migrant women in the Netherlands, Belgium and Germany’ from the Radboud Excellence Initiative.

• The Dutch Ministry of Security and Justice awarded Prof. Piet Hein van Kempen and Dr Masha Fedorova a grant for their project ‘Foreign Terrorist Fighters’: Criminalising stay in a terrorist territory? An evaluation in light of criminal law, human rights and public international law parameters’ and another grant for the project ‘International law and cannabis’.

• The Dutch Ministry of Security and Justice awarded Prof. Leny de Groot-van Leeuwen, Prof. Miek Laemers and Dr Anita Böcker a grant for the Project ‘The transfer of judicial tasks to governing bodies’

• Dr Rian de Jong, Dr Hansko Broeksteeg and Prof. Jan Terpstra received a grant from the Dutch Ministry of Security and Justice for a project on ‘Public order law’ (in cooperation with Utrecht University).

• Prof. Jan Terpstra and Dr Bas van Stokkum received a Police Academy-grant for a project on ‘Changes in organisation and tasks of the police’.
The Institute for Management Research (IMR) is the research institute of the Nijmegen School of Management (NSM). Its members carry out high-quality, multidisciplinary research on the environment, the economy and governance of our society. Researchers in business administration, economics, political science, public administration, geography, planning, and environment studies combine their expertise, theories and methodological approaches to study complex societal issues and develop pertinent solutions. IMR also prepares PhD students for an academic, business or government career, provides post-academic education, and plays a leading role in societal debates in order to carry out its main task: creating knowledge for society.

The core of the IMR is formed by the ‘hotspots’ – collaborative networks of researchers in different disciplines with a joint interest in a specific research topic. Two overarching structures – the IMR Academy and the Doctoral School – ensure cohesion of the institute and among researchers.

Hotspots
Research at the IMR is concentrated in these multidisciplinary hotspots, where academics bundle their expertise on specific issues and societal problems.

Gender and Power in Politics and Management
The mission of this hotspot is to engage in gender & equality research that is renowned nationally and internationally. It aims to make Nijmegen ‘the place to be’ for scholars and practitioners who are interested in original, critical and rigorous scholarship and relevant interventions designed to challenge inequalities in politics and management. Coordinators: Profs. Benschop and Verloo.
**Europeanisation of Policy and Law (EUROPAL)**
The aim of this hotspot is to build knowledge on the process of Europeanisation for public organizations and academics, by combining theoretical and methodological approaches from different disciplines. Researchers analyse EU policies and law, and draw implications for politics, policy-making and public management in various policy sectors, ranging from water to migration. Coordinator: Dr Mastenbroek.

**Innovation and Entrepreneurship in Business Ecosystems**
The aim of this hotspot is to provide guidelines for a variety of actors who wish to encourage the development of innovative ecosystems and create value in this area for policy makers and others. Researchers do this by investigating when, how and why innovation and entrepreneurial activities can best be orchestrated. Coordinator: Dr Hillebrand.

**Governance and Innovation in Social Services (GAINS)**
The dual focus of this hotspot is on the adoption and governance of innovation in social services as well as in their governance. Its mission is to:
- Be an internationally recognised centre of academic excellence on governance and innovation in social services.
- Help develop and maintain governance infrastructures and methods for continued experimentation, learning and adaptation at various levels and across multiple professional funding and policy regimes. Coordinator: Dr Helderman.

**Glocal: Global-Local Divides and Connections**
The mission of this hotspot is to advance innovative critical research on global-local divides and connections in the field of borders, conflicts and development. Coordinators: Dr Van Houtum, Dr J. Smits and Dr Verkoren.

**Integrated Decision-Making: ID**
The idea behind this hotspot was to develop and test theories and methods for complex decision-making that combine individual preferences and intra-organisational behaviour, as well as study the potential impacts of intervention strategies. Such knowledge is needed for example in planning for sustainable urban areas, finding ways of reducing energy consumption, operational risk management in the financial sector and adaptive delta management. Coordinators: Profs. Rouwette and Marchau.

**Research facilities**
The IMR houses two labs (the Visa Skills and Decision Labs), both of which are equipped with proprietary software. These labs facilitate top-level research using advanced research methods, in particular on decision-making. The labs are increasingly used by external parties.
- In the Visa Skills Lab, group-based decision-making – for example in brainstorming, scenario development, priority-setting, and voting procedures – is studied. This allows researchers to involve multiple stakeholders in exploring problems and developing intervention strategies and to evaluate interventions. For example, researchers in the hotspot ID used the lab for a scenario planning project for the City of Nijmegen.
- The Decision Lab supports research on individual and group decision-making and makes it possible to test theories, for example in behavioural economics. Issues such as financial decision-making, market design, negotiations, and strategies for conflict resolution are addressed.

The IMR hosts several large databases. Significant developments made in 2015 include the following:
- The Global Data Lab (GDL) launched its GDL Area Database,
which provides free downloadable indicators on health, education and labour at the level of sub-national regions, covering 20 million people in 110 Low and Middle Income Countries (LMICs). Coordinator: Dr J. Smits.

• In 2015, a new dataset was created by researchers of the hotspot Innovation in cooperation with Netherlands Enterprise Agency (RVO) and Panteia/EIM on sustainable energy innovations, enabling the study of multi-organisational innovation projects.

Collaboration
Researchers at the Institute collaborate with various national and international colleagues.

• Nationally, there is formal collaborations with all Dutch universities, several Universities of Applied Sciences, notably HAN and AVANS, TNO and the African Studies Centre.

• Internationally, the Institute cooperates with many universities, including Oxford, Copenhagen, Duisburg-Essen, Antwerp, Oslo, European University Institute Florence, Barcelona, Gothenburg, TU Vienna, Linkoping, Sciences Po in Paris, Middle East Technical University (METU) near Ankara, Middle East Technical University (METU) near Ankara, Outside Europe: the Universities of Yale, Cornell and Dayton, the University of Ghana and Technion (Israel).

Examples of institutional collaborations:
• Dr Smeets collaborates with researchers at the Universities of Aarhus and Copenhagen on the Building a New Europe (BNE) project, which is financed by the Danish Council for Independent Research (DFF). They analyse negotiations in relation to financial, fiscal, economic and political integration, in the wake of the euro crisis.

• Prof. Verbeek collaborates with the Political Science Department at the University of Bologna, to carry our three joint PhD projects on, among others, conflict and political communication in 2015-2018.

• Prof. Van Riel cooperates with the Institute of Economics and Entrepreneurship at Lobachevsky University (Nizhni Novgorod, Russia). On 8 December 2015 a joint seminar was held on ‘Interdisciplinary research on innovation projects’ as a platform for starting new projects.

Research results
A selection of results achieved in 2015:

Based on data on household durable products (TVs, fridges, phones, etc.), the quality of houses (building material, number of rooms, etc.) and access to basic services, collected by the Global Data Lab, the International Wealth Index was developed, enabling a powerful estimation of incomes in poor countries. Dr J. Smits published a UNESCO/EFA World Education blog about the use of this index.

Profs. Vermeulen and Knoben have demonstrated the importance of communities in explaining organizational resistance to institutional pressures by researching active resistance by owners of small bars to regulations about smoking. Their findings were published in the prestigious *Academy of Management Journal* (co-authored with Tal Simons, Tilburg University).

Dr Hillebrand and Dr Driessen found that firms increasingly need partners such as government bodies, NGOs and other companies to create value for customers. Marketing should therefore also target these stakeholders. They developed a theoretical framework for ways is which firms can achieve this. Their finds were published in the *Journal of the Academy of Marketing Science*.

Conferences organised or co-organised by IMR researchers:

**International conference on gender**
Some 40 researchers from eight European countries attended a conference on gender equality training and gender in curricula. The conference was organised under the flag of two European FP7 projects: EGERA and STAGES.

**Conference on experimental finance**
This was the 6th Annual Meeting of the Society for Experimental Finance, the leading organization of researchers in experimental finance worldwide. Keynote speakers were Bruno Biais (Toulouse School of Economics) and Nobel Laureate Vernon Smith (Chapman University, USA).

**IIAS study group on ‘Co-production of Public Services’**
The Institute hosted the 3rd International Institute of Administrative Sciences (IIAS) study group on ‘Co-production of Public Services’. Co-production refers to the involvement of citizens and public sector professionals in delivering public services.

**International Public and Political Leadership conference**
The first international conference of the international academic network Public and Political Leadership (PUPOL) was organised. The aim of this network is to help tackle social problems through a focus on the role of leaders and leadership.

**Grants received in 2015 included:**

• A Marie Curie grant was awarded to Dr Malejaq (CICAM) for his project ‘State Fragmentation and Sub-State Actors in a Comparative Perspective: Somalia and Afghanistan’.

• Dr Van der Kamp-Alons received a Marie Curie Fellowship for her research on multilateral and transatlantic trade negotiations such as the Transatlantic Trade and Investment Partnership (TTIP). The fellowship lasts for three years, the first two of which she will spend at Boston University working with Professor Vivien Schmidt.

• Dr Honingh and Prof. Van Thiel were awarded a NRO grant for a one-year literature study into the effects of the quality of school boards in different countries.

• Dr Asya Zhelyazkova (ETH Zürich) received a Radboud Excellence Fellowship, on behalf of the NSM, to conduct research in Nijmegen with EUROPAL researchers.
Sascha Füllbrunn – an Assistant Professor in Economics and Business Economics – published his work on the effect of gender on trading and competition in financial markets in the highly prestigious American Economic Review. Moreover, he co-organised the successful Experimental Finance Conference in Nijmegen, which included a contribution by Nobel Laureate Vernon Smith.

Awards and acknowledgements

Prof. Verloo received the ECPG Gender and Politics Career Achievement Award. This prize is awarded every two years to honour an exceptional career in research, mentoring and service to the profession in the field of gender and politics in Europe.

Prof. Hendriks ranked first on an important list of citation classics in 25 leading journals on knowledge management. By 3 January 2014, his 1999 article ‘Why share knowledge? The influence of ICT on the motivation for knowledge sharing’ had been cited 953 times.

Prof. Sabel (Professor of Law and Social Science at Columbia Law School) started a Radboud Excellence Professorship, which involved conducting research with GAINS researchers.

Dr Heres was granted the Van Poeljeprize 2015 for best dissertation in the field of public administration.

Dr Van den Brink became a member of the KNAW Young Academy.

On 7 July 2015, Daan Boezeman was awarded his PhD cum laude. His dissertation ‘Transforming Adaptation. Authoritative knowledge for climate change governance’ discusses how researchers and policymakers together assemble relevant authoritative knowledge on three climate problems: the second Delta Commission, the adaptation to heat in Dutch cities, and regional water management in Groningen.

Societal impact

IMR researchers organised several training courses for the public sector. For example, GENDER researchers contributed to the RMA course on ‘Diversity and Inclusion – the new generation’ and Prof. Knoben teaches in the TIAS post-master programme.

Several IMR researchers are members of advisory bodies, including:
• Prof. Leyenaar, The Council for Public Administration
• Prof. Benschop, Police Diversity Council

• Prof. Van der Krabben, Regional Planning Committee for Province of Gelderland
• Prof. Sent, Member Senate of the Netherlands
• Prof. Leroy, Committee member of the Health Council of the Netherlands.

A societal mark of recognition was granted to Dr Aalbers, by winning the ROA Professional Publication Prize for his Dutch article on ‘The Adaptive Organization’ (co-author: Jasper de Valk).

IMR researchers participated in social media, radio and TV programmes and published various newspaper articles. For example, Dr Van Houtum was interviewed regularly, in particular on the EU’s border policy and the current migration debate.

Since November 2015 a team of IMR Political Scientists (‘Team Verbeek’) have contributed to public debate on US politics via a competition with a VU Amsterdam team on the outcome of the 2016 US elections. Their contributions appear in the daily newspaper De Volkskrant.

IMR researchers regularly cooperate with societal partners. A striking example is the Municipality of Rotterdam, which greatly values the contribution of the REI project team to transferring long-term care from Dutch national government to the municipality (Prof. Sabel and GAINS researchers).

Cooperation with Nijmegen Municipality culminated in an interactive ‘Nijmegen City of Knowledge’ event, which was attended by over 100 participants. Steps were also taken towards closer collaboration with the Province of Gelderland.

Societal partners include the National Police; UN Women; UN habitat; ABN-Amro; the Council for Health and Society; the Court of Audit; the Ministry of Infrastructure & Environment; the Rand Corporation; the World Bank; the orthopaedic hospital Sint Maartenskliniek; the Association of Provinces of the Netherlands
Key publications


Dissertations: 12
Scientific publications: 229
Professional publications: 94
(IPO); Rijnstate Hospital in Arnhem; the Netherlands Enterprise Agency (RVO); the Confederation of Netherlands Industry and Employers (VNO-NCW); Ocfam Novib; and the Clingendael Institute.

IMR researchers are regularly consulted by public authorities. For instance, Prof. Verloo was invited by the European Parliament to deliver a keynote speech on the wage gap between men and women. Within the scope of the French-Dutch economic year, Prof. Jonker, was invited to speak about Dutch best practice in the field of the circular economy at a conference in the Paris City Hall, which was attended by professionals and council members from the greater Paris area, reflecting on the strategic plan for the City of Paris and the surrounding municipalities.

An example of written communication of interest to the public: Dr Van Melik and Profs. Ernste and Hospers published a well-received edited volume on cities: *Visies op de stad: Van tuindorp tot smart city* (Visions on the city: from garden village to smart city).

**Future research**
A selection of projects that will start in 2016:

- In the autumn of 2015, a Radboud Excellence Fellowship was awarded to Dr Asya Zhelyazkova. Currently Dr Zhelyazkova is working as a post-doctoral researcher at the Center for Comparative and International Studies of the ETH in Zürich. In the summer of 2016, she will join the hotspot EUROPAL to study the delegation of European implementation powers to national executive institutions, the quality of outcomes, and the quality and transparency of ex-post evaluations. This project, which builds on earlier cooperation, will strengthen the international EUROPAL network.
- The EUROPAL hotspots will also take advantage of networking opportunities presented by the Dutch presidency of the European Union in the first half of 2016 by organizing a conference.
- Dr Beckers will cooperate with colleagues from several governmental and NGO organisations (including UAF and the Central Agency for the Reception of Asylum Seekers (NL). The team will work on the European Commission (DG HOME) project ‘Skills2Work’. This project builds on the results of the DIVERSE project, which ended in 2014 (covering recognition of the skills of migrant workers). The Skills2Work project (Valuing Skills of Beneficiaries of International Protection in the European Union) was established to improve labour market perspectives through job-matching early in the asylum procedure. This project is being conducted in Belgium, Hungary, Ireland, Italy, the Netherlands, Slovak Republic, Slovenia, Spain, and the United Kingdom.
- In 2016, Profs. Meurs and Marchau will start working on the NWO project ‘Smart Urban Regions of the Future (SURF) project: Smart Cities’ Responsive Intelligent Public Transport Systems (SCRIPTS), which is coordinated by TU Eindhoven and will strengthen collaboration with TU/e and TU Delft, GVB and HAN, among other partners. This project, which builds on a solid track record and cluster of projects on logistics, transport and smart cities research, will include two PhD projects.
Within the Nijmegen Institute for Social and Cultural Research, academic research focuses on developments in society with a multidisciplinary and comparative perspective. Descriptive and explanatory research is carried out on inequality, cohesion and modernization in both Western and non-Western societies. Innovative theoretical approaches, analytical methodologies and strategies for data collection are implemented using comparative research designs.

NISCO – a research institute of the Faculty of Social Sciences – has two research groups: Cultural Anthropology and Development Studies (CAOS) and Sociology. To advance knowledge on the dynamics of societal phenomena, NISCO researchers mostly examine topics from a comparative perspective across different societies, but historical research within single communities or societies is also done, as well as trend studies on developments in different societies. A highly reputed Research Master’s programme in Social and Cultural Sciences offers high-quality training in theory building and analytical methods for conducting empirical comparative research on individuals in societies. Scientists at NISCO focus on three topical research themes: inequality, cohesion, and modernization.

**Inequality**
The main focus within this theme is on differences in access to – and control over – resources that affect peoples’ opportunities, e.g. in education, success in the labour market, identity, as well as family formation and health. Social inequality is studied from both an intra-generational and an inter-generational perspective.

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1  NISCO: Nijmeegs Instituut voor Sociaal en Cultureel Onderzoek
Researchers examine the effects of social, cultural and economic resources on socio-economic achievement and consider how differences between and within countries are affected by structural conditions (such as wealth and unemployment), the cultural climate and national policies. Various aspects of individual, family, social groups and country contexts are thought to affect outcomes. Diversity in terms of gender and ethnicity is studied from both an anthropological and a sociological perspective.

Cohesion

Within this research theme researchers describe and explain differences in social participation and connection to formal organisations (companies, communities and political parties), as well as in informal social networks, such as in families, in ethnic groups and among friends. Developments in the relationships between an individual’s social and cultural resources and pro-social attitudes (support, giving intentions) and anti-social behaviours (criminality) are explored, focusing on variations in and among societies at different stages of development and with different welfare-state regimes. Furthermore, comparisons are made to show which social groups have intolerant attitudes towards (ethnic) out-groups, taking differences in economic, cultural and demographic contexts into account. Attitudes and behaviours of migrant groups are also studied in relation to their social integration.

Modernization

Researchers at NISCO study economic, cultural and technological developments, and particularly those that are associated with secularization and modernisation of opinions in Dutch and other societies. A great deal of attention is paid to belief systems, constructing identities and meanings derived from religion, to conceptions of citizenship, justice and altruism, and to the implications of these concepts 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 developments in social and political cohesion. Furthermore, various reactions to modernization processes are the subject of research on the role of governments, civil society organisations and individual citizens.

Research facilities

Within NISCO the collection of high-quality data is greatly valued, as it provides excellent opportunities for multidisciplinary comparative research and cooperation. Researchers at NISCO therefore contribute to the academic community by involvement in large-scale data collections. Data facilities include both longitudinal collections – on Dutch individuals and their life courses and networks (Family Survey Dutch Population (FSDP), Netherlands Longitudinal Life-course Survey (NELLS), Social and Cultural Developments in the Netherlands (SOCON)) – as well as cross-national collections that contain information related to a wide range of topics (e.g., the European Social Survey (ESS) and the New Immigrant Survey Netherlands (NIS2NL)). Within the Anthropology Department small-scale data is collected in the Netherlands and in developing countries using ethnographic field research. Large-scale data often are collected with additional funding from the Netherlands Organisation for Scientific Research (NWO). These are transparently documented and deposited at the Royal Netherlands Academy of Arts and Sciences’ Data Archiving and Networked Service (DANS). NISCO-generated Dutch data have been widely used by colleagues both nationally and internationally.

Academic integrity

Within NISCO high standards of academic integrity are communicated to all researchers. Since 2014, the Institute has established a system of annual archiving of information related to all academic publications by its researchers. This makes it possible to carry out security checks with respect to fraud, plagiarism and data construction. A long-standing tradition has been built up by NISCO researchers to provide the academic community with well-documented open-source data with the goal of improving academic transparency and integrity. Such data makes it possible to control and repeat academic research results, thus promoting integrity. This tradition has been widely recognized as best practice and both data and publications are carefully archived together with source information at the University and at DANS-KNAW.
Collaboration

Members of NISCO collaborate with colleagues in Dutch research schools in order to advance national and international alliances and provide education to PhD candidates, including the Research School for Resource Studies for Development (CERES) and the Interuniversity Centre for Social Science Theory and Methodology (ICS). Scholars at NISCO work together with top international institutes, such as the Social Science Research Center (WZB), Berlin; Pacific Studies Research Group University of Bergen, Norway; Ohio State University, Columbus, USA; London School of Economics, London, UK, Centre de Recherche et de Documentation sur l’Océanie, Aix-Marseille Université, France; Collaborative Research Centre on Human-Environment Interaction, as well as with several departments of the German universities of Bamberg, Cologne, Göttingen, Heidelberg, Konstanz and Munich, the Danish University of Aalborg and the British universities of Cambridge, Essex, London, Oxford and St. Andrews. Within the Netherlands collaboration is established with the Institute for Migration and Ethnic Studies (IMES), the Netherlands Studiecentrum Criminaliteit en Rechtshandhaving (NSCR), the Mulier Institute, the Netherlands Institute for Social Research (SCP) and Statistics Netherlands (CBS). Researchers have additionally visited or received guests from the University of California, the University of Applied Sciences Upper Austria, the Berlin Social Science Centre, the Siberian Federal University and the University of Trento.

NISCO staff also participates in a variety of academic networks, such as the European Association of Social Anthropologists (EASA); the European Association of Development Research and Training Institutes (EADI); the European Network for Research Expertise on Economic change, Quality of Life and Social Cohesion (EQUALSOC); European Research Centre on Migration and Ethnic Relations (ERCOMER); Network of Migrant Mothers Caring for Children (EQUALSOC); European Research Centre on Migration and Ethnic Studies (IMES), the European Consortium for Sociological Research (ECSR); the European Consortium for Pacific Studies (ECOPAS), the European Society for Oceanists (ESFO), the network on Digital Literacy and Multimodal Practices of Young Children (DigiLitEY), EU Kids Online, the European Research Network on Transitions in Youth (TITY), 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). NISCO has also established international partnerships through the South Africa-Netherlands Research Programme on Alternatives in Development (SANPAD).

Research results

In the field of inequality, NISCO researchers explored cross-temporal gender differences in the effects of family resources on educational attainment in the Netherlands. Results showed that – especially in earlier cohorts – the effects of parental educational resources were gender-specific: the mother’s education affected women’s educational attainment most, whereas the father’s education mainly influenced men’s education. This pattern is less prominent in more recent cohorts. Results further indicated that for girls only, growing up with a working mother becomes increasingly beneficial over time. Anthropological research showed how economic empowerment helps women to reduce their reproductive health vulnerability in Northern Tanzania. Women’s employment has a positive impact on ‘health-seeking’ behaviours during pregnancy and at child birth. This indicates that any policy that increases women’s economic empowerment may be influential in improving women’s position in developing countries.

Cohesion in societies is a common focus of study, looking at the effects of ethnic diversity on bonding and bridging social capital. NISCO sociology researchers investigated whether ethnic diversity effects depend on the geographic scale at which they are measured. Indeed it was found that in small localities ethnic diversity was positively associated with bridging social capital, but that at larger scales the findings are more mixed. A major problem with research on ethnic diversity lies in the use of cross-sectional information. NISCO research therefore employs German longitudinal data to deal with this issue. Fixed effects panel regressions were used to analyse the consequences of changes in ethnic diversity between 2003 and 2008. Findings indicated that more ethnic diversity has a negative effect on political participation only. No evidence is found that ethnic diversity is related to other expressions of social capital. CAOS researchers investigated the impact of urban policies on creating fruitful, practical distributions of people, authorities and spaces in neighbourhoods. Ethnographic research on Amsterdam’s Diamantbuurt was employed to reach these conclusions. Another anthropological study investigated recent conceptualizations of citizenship (beyond the nation state) with new perspectives on ‘governance assemblages’ comprising both state and non-state actors. This study showed that assemblage processes impose a citizenship agenda on these neighbourhoods, distinguishing between ‘good’ and ‘bad’ citizens.

Modernization processes are mostly examined within CAOS research studies. A state-of-the-art article investigated the relationship between decentralization processes and mineral resource conflicts in the Philippines. It showed that institutional negotiation processes lead to a range of conflicts. Emerging in addition to all sorts of institutional struggles, locally elected politicians raised important concerns about the elite’s role in decentralization processes. Another study raised the question whether the relevance and effectiveness of donor strategies by NGOs are linked to the ability to adjust to local contexts. It drew on institutional theory and found out that, besides the more commonly identified unequal power relationships between donor and recipient, processes of homogenization stem from NGOs themselves and from their organizational characteristics (mission,
Anouk de Koning (Assistant Professor Cultural Anthropology and Development Studies) received an ERC Starting Grant for her project ‘Reproducing Europe: Migrant Parents and Contested Citizenship’. This multi-sited anthropological study examines citizenship in a Europe where the presence of migrants has increasingly come to be seen as a burden or threat. Anouk de Koning’s interest in Urban Anthropology is apparent from various research projects and the book *Introducing Urban Anthropology* (Routledge) which she published together with Dr Rivke Jaffe in 2015.

Institutions and act as consultants. For instance, advice was given to the Dutch AIDS Fund, the Dutch Ministry of Foreign Affairs, NGOs in Indonesia, Stichting Lezen, and SNV Netherlands Development Organisation. Scholars also give advice on international data collection (such as the European Social Survey/ Swiss longitudinal youth survey) and national data collections (DANS-KNAW and Statistics Netherlands). Conferences were organised by NISCO staff on the conflict in Yemen, policy making in relation to climate change, the relationship between Europe and the Pacific, and NISCO researchers organized a workshop on the European Social Survey. Moreover, NISCO played a leading role in organizing a Radboud summer school course on gender as a core concept in society and science.

Koen Breedveld served as an expert in the field of sports in various ways: as a consultant to the Dutch Parliament, the Ministry of Health, Welfare and Sport and NOC/NSF. Paul Hoebink and Lau Schulpen advised the Ministry of Foreign Affairs, the Dutch Parliament and several private aid organisations and appeared widely in the media discussing international development cooperation. Maarten Wolbers is treasurer of the Dutch Sociological Association (NSV), and together with Jochem Tolsma he presented an edited volume on educational differentiation to Minister Bussemaker of OCW. Toon van Meijl organised a highly valued international ESF/ECOPAS conference on Europe and the Pacific in Brussels. Gerbert Kraaykamp was appointed as National Coordinator of the European Social Survey and became a member of the advisory board of CUPESSE. In collaboration with the Netherlands Institute for Social Research (SCP), Gerbert Kraaykamp composed a report on opinions in Europe, and Marcel Lubbers wrote a report on East-European migration, both of which were offered to the Dutch Parliament. Peer Scheepers is a member of the Scientific Advisory Board on data collection at Statistics Netherlands and was invited to give a keynote speech during the visit of the Dutch Royal family to Denmark.
Key publications


Dissertations: 6
Scientific publications: 133
Professional publications: 34

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Nijmegen Institute for Social and Cultural Research (NISCO)
Future research

In 2015 NISCO proved especially successful in acquiring funds for doing research. For example, two ERC Starting Grants were obtained within the CAOS group. Moreover, additional (temporary) personnel (UD, postdocs and PhDs) were hired to encourage research output. It is foreseen that this recent change in staff composition, and expected new personnel from the ERC projects, will feed research initiatives, contribute to the Faculty’s educational programme, and help broaden the scope of NISCO research themes. Moreover, CAOS researchers have adapted their publication strategy by focusing more on high-ranked journal publications. It is also expected that in 2016 a new professor of developmental studies will be appointed to further stimulate research and education within CAOS.

Research within the CAOS group focuses on issues related to cultural diversity and its consequences for socio-economic inequality. In 2015 an innovative new research programme was established and several initiatives were undertaken to acquire external funding. Staff are currently finishing a SUSO project on the vulnerable position of sex workers. Cooperation with the Sociology group (Prof. Scheepers) on ethno-religious conflicts in South-East Asia (Indonesia and the Philippines), which is NWO-funded, will result in two additional PhD students finalizing their thesis. Furthermore, a research programme funded by NWO/WOTRO that involves examining value chains in order to gain better insight into the increasing role of the market in development processes will result in four dissertations by Ethiopian PhD students.

In the Sociology group the Niels Spierings’ Veni project will start in 2016 and a replacement postdoc will be hired. Various sociological research projects are related to the key NISCO themes of inequality and cohesion. Several PhD students (partially funded by NWO) are working on these themes and associated publications are expected. Topics that are investigated include the relationship between unemployment and radicalism, the integration and opinions of recent migrants, the female advantage in education, inequalities in late careers and the relationship between major life events and sports participation. Two PhD students and a postdoc will continue working on the NORFACE MIFARE project led by Marcel Lubbers on migrants’ welfare-state benefit dependency and attitudes.

Sociological research mostly employs life-course analyses and multi-level modelling, which has proved to be of international interest. Maarten Wolbers recently acquired a grant from the Gak Institute on vocational education and youth labour market integration. A PhD student and postdoc will start working on this project in 2016. Collaboration between the Department of Sociology and the SCP will result in publications on behalf of the Dutch Ministry of Foreign Affairs in 2016. It is further expected that a new professor of gender and diversity will join NISCO, thus extending research on gender-related issues. This appointment will strengthen NISCO’s intention to achieve further cooperation between Sociology and CAOS researchers.
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.

The BSI, which is the largest research institute of the Faculty of Social Sciences, is accredited as a research school by the Royal Netherlands Academy of Arts and Sciences (KNAW). A two-year Research Master’s programme in Behavioural Science (www.ru.nl/education/masters/behavioural-science) is taught within the BSI Graduate School, which is officially recognized by the Netherlands Organisation for Scientific Research (NWO).

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 psychophysiological processes), ii) social-contextual factors (home, school, peer groups, work and the media), and iii) the dynamic interplay between these factors. In addition, they study reverse associations and explore 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, psychophysiological, neuroscience, genetic and virtual reality measurements.
The three main research themes at BSI are:

**Development and Learning**
We all keep developing and learning throughout our lives. Within BSI, the biological, cognitive, and behavioural processes related to life-long learning are investigated. Fundamental research in this theme adds to knowledge on how people learn, revealing the underlying processes (e.g. plasticity) that support cognitive, social, emotional, and motor development. The focus is on the development of infants, motor learning, language acquisition, peer relations, teaching, coaching and training. Researchers look at various contexts and factors that shape development, including family, school, workplace, community, culture, media, and also at physiological and genetic influences. Many of these factors are investigated using longitudinal designs that monitor target groups over several months or even years. This research has implications for primary and secondary education, prenatal consulting and early child care, interventions in schools, and assistance for students with special needs or developmental disabilities. The aim is to produce insights that directly and indirectly help all members of society (young and old) to live fulfilling and productive lives.

**Psychopathology, Health and Well-Being**
Physical and mental health are influenced by a combination of genes, nurture and lifestyle. At the BSI research focuses on encouraging behaviours that lead to a healthier lifestyle and a feeling of well-being on the one hand and treatment of mental disorders on the other. Researchers look at both internalising and externalising psychopathologies, such as anxiety, depression, burnout, ADHD, addictive behaviours (smoking, alcohol, drugs) and eating disorders. Genes, neurobiological processes, behaviour and environment are all taken into account. Promotion of health and well-being involves looking at food choice, self-control, coping strategies, need satisfaction, mindfulness, sport and exercise, work-life balance, sleep and recovery. For psychopathologies the roles of implicit and explicit processes, cognitive bias, motivation and reward are also considered. Both preventive and curative interventions are developed and tested. Behaviour and interventions are not only studied in a clinical setting, but also in families, schools and at work. Research interests cover the whole lifespan: from babies, children, adolescents, students, families and working life to the elderly.

**Social Processes and Communication**
Because much behaviour is altered by external factors, it is important to examine the influence of the social context on intra-individual processing. Researchers working on this theme investigate how social interactions are related to individual mental health and well-being. They look at interpersonal relationships, group dynamics and media influences. Interaction between automatic and controlled aspects of social behaviour is studied, for example in face perception, decision-making and creativity, and attitudes towards others.

One goal is to define the key factors that distinguish the positive and negative features of close relationships (e.g. social support and conflict). This is studied in the family context, in schools and in the workplace. Another topic of interest in this theme is exploring group processes relating to aggression, social status, leadership, prejudice and social norms. Another focus is on the efficacy and impact of media campaigns (i.e. advertising and marketing) and social media. This information is used to promote healthy and effective behaviour via the social and media environments that target groups operate in.
BSI research takes place in the following seven research groups: Communication and Media, Developmental Psychopathology, Experimental Psychopathology and Treatment, Learning and Plasticity, Social Cognition, Social Development, Work, Health and Performance. These groups all work on the three main themes described above.

Research facilities
The most important resource for the BSI is the availability of participants. For this, the institute has established a large network of schools, healthcare and youth care institutions and governmental institutions. Much of the research is conducted at these sites, using mobile technology. Laptops, tablets, smartphones and wearable devices enable researchers to gather data outside the classic lab setting.

The institute also has in-house facilities that are used to test participants in more standardized conditions:
• A Virtual Reality Lab for immersive, three-dimensional computer-generated environments
• A Sport Lab for behavioural and psychophysiological measures during exercise
• A Physiological Measurements lab, shared with the Donders Centre for Cognition, for measuring neurocognitive and biomechanical data
• Different types of Eye-trackers for measuring visual attention and eye movements
• Stabilometric platforms for research on freeze-approach-avoidance behaviour
• Observational labs with one-way screens and multiple cameras
• A computer lab with 22 identical cubicles for computerized experiments
• A Bar Lab for observational studies of social behaviour in a natural setting
• A Mobile lab to accommodate a standardized experimental setup outside the university
• Through its participation in the Donders Centre for Cognitive Neuroimaging (DCCN), the BSI has full access to neuroimaging facilities.

Collaboration
Researchers within the BSI collaborate with a large number of international and national partners. The Institute’s strategy is to link a number of these renowned scholars to Nijmegen as international fellows. 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 run by these fellows. BSI fellows that visited the institute in 2015 were Profs. Charles Perfetti (Pittsburgh), Alex Todorov (Princeton), Marcel Brass (Ghent), William Bukowski (Montreal), Stefan Hofmann (Boston), Jasper Smits (Austin), Goran Kecklund (Stockholm) and Marientina Gotsis (Los Angeles).

There are formal collaboration arrangements with numerous universities (e.g. the University of Cologne, Australian Catholic University, Indiana University, University of Virginia, research laboratories (e.g. Addiction Swiss, Haskins Laboratories), multiple Dutch Universities, and various institutes for applied research (e.g. Trimbos Institute, TNO, NJJ, Juridical Youth Institute). Within Radboud University there are formal collaboration arrangements with the Radboud University 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 (Prof. Alan Sanfey and Prof. Karin Roelofs).

BSI researchers also work with many societal partners. They collaborate with a large number of schools, healthcare and youth care institutions, as well as governmental institutions such as the police academy. The BSI hosts the ZonMw-funded 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 internalising problems in youth. BSI also has the lead in the Games for Emotional Health consortium, a multidisciplinary network that incorporates international award-winning game designers and scientists. The GEMH consortium is partially funded by an NWO Creative Industries grant. It includes veteran game designers in Silicon Valley such as Josh Whitkin (Sims series), Robin Hunicke (Journey) and Evan Hirsch (Ubisoft, Walt Disney, Microsoft Live Labs).

Awards and acknowledgements
• Prof. Isabela Granic received an ERC Consolidator Grant for the project Video games for the prevention of depression and anxiety: A 21st century approach to emotional and mental health in adolescents.
• Prof. Ludo Verhoeven received an NRO grant for the project Dynamic assessment of reading development.
• Prof. Karin Roelofs was elected as member Young Academy of Europe (YEA) and received the Radboud Science Award.
• Dr Yvonne van den Berg received the Hermesdorf prize for young talent, because of her presence in an overwhelming number of media with her dissertation Peers in Proximity.
• Dr Maartje Luijten received an NWO Veni grant for her project The transition into habitual smoking in high-risk adolescents.
• Dr Erik Bijleveld received an NWO Veni grant for his project When it matters most: The impact of incentives on human performance.
• Dr Barbara Müller received a Jacobs Foundation grant for the project Consequences of growing up in a technical world: The development and psychological consequences of anthropomorphism in early childhood.
Isabela Granic (Professor of Developmental Psychopathology) received an ERC Consolidator Grant for her project ‘Video games for the prevention of depression and anxiety: A 21st century approach to emotional and mental health in adolescents’. She leads a multidisciplinary team of clinical psychologists, neuroscientists and game designers who develop novel games based on biofeedback. The aim is to make children and their families happier, more healthy emotionally and more social.

- Prof. Toon Cillessen received a NRO grant together with a large consortium of researchers for the project What really works against bullying: Cluster-randomized trials of effectiveness in school practice.
- Prof. Ron Scholte received a ZonMw grant for the youth care projects Transformation and Outcome: The story behind the numbers and Prevalence and outflow of youth with light mental disorders and psychiatric problems.
- Dr Roseriet Beijers received a KNAW Sara van Dam grant for her project Biological Embedding of Early Life Experiences.
- Dr Maartje Luijten received a grant from Stichting ’t Trekpaert for Development of Video Games to Reduce Smoking Behaviour.
- Prof. Verhoeven and Dr Segers received a grant for their project titled Dynamic assessment in immersion kindergarten classrooms.
- Dr Simone de Droog received a valorisation research grant from the Ministry of Health, Welfare and Sport for the Groentefroetels project to encourage vegetable consumption by children.
- Dr Mina Johnson received part of an NSF award for the project STEM Learning in Embodied Environments.
- Dr Stoltz and Dr Van den Berg received the Hermen J. Jacobs prize for developing an online tool to support primary school teachers in making seating arrangements that promote social cohesion in the class.

Research results

Development & Learning

Intestinal microbiota are essential for healthy development and are currently a hot topic in science. In a project together with Wageningen University it was found that maternal prenatal stress is strongly associated with the infant’s intestinal microbiota. Mothers with the highest stress had infants with more potentially pathogenic bacteria. Interventions with probiotics could therefore enhance offspring development.

Children vary in the extent to which their development is shaped by particular experiences, for better (e.g. social support) and for worse (e.g. maltreatment). An influential hypothesis in this field states that when different levels of plasticity are optimal in different environmental states and the environment fluctuates unpredictably, natural selection may favour parents producing offspring with varying levels of plasticity. Researchers developed the first mathematical model that examines this hypothesis and initial results support the hypothesis’ logical coherence under restrictive conditions.

With respect to the role of language in school learning, brain correlates of lexical consolidation were found. Lexical retrieval was shown to enhance word recall from memory, and lexical learning was found to predict phonological awareness, reading comprehension and science learning. The results of these studies are used to build ICT-based interventions.

Experimental studies showed that children with congenital motor disorders benefit from implicit learning. However, parallel field studies on schools and sport clubs showed that standard teaching is predominantly explicit. Therefore a handbook on implicit motor teaching techniques that can be used in practice will be developed with partners outside the academic community.

Researchers showed that advanced planning of an action can lead people to feel less ‘agency’ and less responsibility. In a set of eight experiments, participants repeatedly performed simple actions that they either planned or did not. It was consistently shown that advanced planning reduced feelings of agency and responsibility. This unexpected effect can have far-reaching implications, for instance in the domain of justice, where premeditated actions are often punished more heavily than impulsive behaviour.
A sleep-monitoring study among 100 Dutch elite athletes was completed. The findings highlight the importance of pre-sleep behaviour, indicate how sleep architecture responds to variability in training load, and provide initial insight in the relationship between sleep and performance. These results will lead to future intervention studies, developed and implemented with project partners including the Dutch Olympic Committee.

The effects of the introduction of ‘New Ways of Working (NWW)’ were examined in a three-wave intervention study in a financial company. It resulted in a shift from office-hours to hours worked at home, and a reduction of commuting time. Co-worker support, work-home balance, stress levels, and fatigue remained largely unaffected, which implies that it is possible to implement NWW without affecting the well-being of employees.

In order to find out to what extent burnout is related to cortisol concentrations in the body, three groups were compared: employees with clinical burnout, with non-clinical burnout, and a reference group of healthy employees. Evidence was found for a lower cortisol awakening response in burnout patients (the peak in cortisol levels that appears 30 minutes after awakening).

Psychopathology, Health and Well-Being

Four randomized controlled trials on the effectiveness of using video games to prevent and treat anxiety and depression were completed this year. The results of this innovative approach look promising, with all studies showing significant improvements in terms of reducing anxiety or depressive symptoms. In two of these studies, young people who played regular commercial games also showed improvement of symptoms. This suggests that even mainstream games may improve emotional health.

The ‘Op Volle Kracht’ (OVK) depression prevention programme was rigorously tested in secondary schools, including follow-ups up to two years after the intervention. Results showed that OVK does not alleviate depression in young people.

Research among delinquents who score high on psychopathic traits showed that they judged moral transgressions as less severe than the control group, and were less affected by pictures depicting moral emotions. Additionally, the delinquents high on psychopathic traits demonstrated more morally inappropriate behaviour.

It was found that testosterone administration alleviates avoidance behaviour in patients with social anxiety disorder. It influences gaze behaviour and actual avoidance behaviour in healthy and anxious participants. At a neural level, it biases the amygdala towards threat approach. These results have led to further investigations on the effects of testosterone in treating anxiety disorders.

In several large-scale randomized controlled trials with abstinent alcoholics (over 4000 participants), it was found that relapse rates can be reduced by 8-10% by means of a simple joystick-based alcohol-avoidance training. In this intervention patients are repeatedly trained to push pictures of alcoholic drinks away.

In a large randomized controlled trial of patients with psychosis and post-traumatic stress disorder, it was found that trauma-focused treatments were effective and safe in this population, and that they prevented revictimization.

Twitter data analysis showed that a small number of journalists can control the Twitter news flow, due to the tightly knit network consisting of distinct regional and national news production communities. This may have detrimental consequences, such as ‘pack’ journalism, echo chambers, and information cascades.
Researchers working on influence studied location-based advertising (LBA) in a virtual reality lab experiment, together with the Centre for Language Studies, the University of Amsterdam and the Breda University of Applied Sciences. The advantages of location-based advertising appear to emanate from the congruency between advertisement and product location.

Societal impact
The aims of the BSI are both fundamental (to understand behaviour) and applied to societal challenges (to influence behaviour). BSI’s strategy is that on the one hand fundamental research is translated into practical prevention guidelines and interventions, for example on addiction, food choice, stress, reading acquisition, anxiety and depression. These interventions, in turn, are subjected to scientific investigation, if possible in randomized controlled trials. On the other hand, fundamental understanding of topics related to societal issues, such as adolescent alcohol consumption and children’s reading problems, plays an important role in the research agenda of the institute. Increasingly, knowledge or actual interventions are disseminated to a broad audience via ICT products, such as apps or websites. Researchers also regularly appear in the media and publish the results of their scientific work in professional magazines. The institute’s strategy is that most research conducted at BSI will stem from societal questions and/or be aimed at solving societal issues. Four examples of this are:

1. A tool was developed and validated to assess the extent to which children at kindergarten are able to construct unconfounded experiments, an essential part of scientific reasoning. In this tool, children were challenged to design experiments using two ramps with up to four independent variables: weight of the ball, steepness of the slope, place of the starting gate, and surface texture of the slope. Along the same lines, we developed and validated a serious game to assess their scientific reasoning in the so-called Hippo app consisting of three games: slides, seesaw, and pendulum in which children were asked to set variables correctly in order to provide a hungry hippo with a drink or some food.

2. Relapse rates in abstinent alcoholics can be significantly reduced by approximately 8% by means of a simple computer-based alcohol-avoidance training in which the patients are trained to push pictures of alcoholic drinks away. The empirical evidence in favour of this training is so strong that it has been added to the official German guidelines for treating addictions. It will soon be introduced as a standard treatment option from which thousands of patients may benefit. At the same time, more research will be conducted to further improve the training.

3. Researchers have tested and evaluated eight different programmes in schools and mental health agencies aimed at reducing anxiety and depression. Some programmes involved conventional evidence-based practice interventions and others involved new technologies such as applied games. The results shed light on the type of intervention programmes that do or don’t work and they will shape the future agenda for mental healthcare among young people. Because of this work Prof. Isabela Granic was nominated for the Huijregtsenprijs (an award for scientific research that is novel and has compelling applications for society).

4. With the Hermen J. Jacobs prize and a grant from the Kinderpostzegels foundation, an online tool was developed that helps schools and teachers. They can monitor the social-emotional functioning of the children and create new seating arrangements based on the targets and knowledge of the teacher. Examples of these goals can be to improve the social inclusion of children with externalizing problems, to support new or better social relationships between all students, or to strengthen existing friendships. The tool combines common sociometric methods with recent BSI research on classroom seating arrangements.

Future research
Over the next few years BSI will continue to deliver top-level behavioural research with societal relevance. Most of the grants acquired fund research that is closely linked to societal problems, leading to innovative new projects. BSI will continue to invest in fundamental research and in new ideas through the annual BSI Graduate School round, in which promising candidates are selected to start their own PhD project. The number of therapeutic applications of BSI findings will grow, and more and stronger ties with international partners will help with both successful fundamental research and broader dissemination of the results. The BSI employs over 200 researchers from a wide range of countries and scientific backgrounds. Due to the open and collaborative atmosphere within the institute, researchers can capitalize on collective strengths and share knowledge.

Most future projects will be designed to improve people’s lives, using an integrative approach to behaviour, physiology and neuroscience. Some examples:
- Research on the positive and constructive side of mediated communication will intensify, focusing on how media can intentionally or unintentionally contribute to well-being.
- Studies on gene-environment interactions in addictive behaviour will be expanded with novel techniques for studying addictive behaviour, together with colleagues from all over the world in large research networks such as the International Cannabis Consortium.
Key publications


Dissertations: 25 | Scientific publications: 407 | Professional publications: 89
Director: Prof. Toon Cillessen

Toon Cillessen has been Professor of Developmental Psychology at Radboud University since 2006. He previously held appointments at Duke University and the University of Connecticut. His research interests include the development of social competence, aggression and antisocial behaviour, peer influence, and quantitative methods for developmental research (sociometry, social networks, longitudinal data analysis). He is a Consulting Editor for the journals Developmental Psychology, International Journal of Behavioral Development, Journal of Applied Developmental Psychology, Journal of Research on Adolescence, Merrill-Palmer Quarterly, and Social Development.

- New research will examine how dysfunctional approach-avoidance behaviour can be modified by behavioural training, hormone administration and brain stimulation. Also the predictive value of approach-avoidance tendencies for developing PTSD in police officers will be tested.
- A long-standing goal is to examine important links between speech and reading. In a collaborative project with Haskins Laboratories a brain-based hypothesis for atypical reading development will be tested. The idea is that phonological deficits (and later reading deficits) can be traced to earlier problems in speech perception and production.
- Longitudinal studies will focus on psychobiological and neurocognitive influences on development from pregnancy until young adulthood, in the general population and in vulnerable groups (e.g. preterms, children with ADHD, children from high-risk environments).
- An important topic will be food consumption. Insights from fundamental research on preferences for certain foods and food choice will be translated into concrete interventions, such as training programmes to change people’s habits.

As can be seen from these projects, much of the future research within BSI will focus on Health Behaviour.
The Centre for Language Studies (CLS) carries out top-level 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.

Research at CLS takes place in two programmes:

• Researchers working within the Language in Mind programme 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 within the Language in Society programme 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, language and speech technology designed to improve text production and communication with the disabled, and persuasive communication.

Each programme contains seven smaller groups led by principal investigators. These thematically coherent groups create platforms for discussing research plans and results, facilitating communication.
between and among junior and senior researchers, and helping to support academic integrity.

**Research facilities**

CLS research is largely empirical, using large databases, and experimental and computational methods and 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. Thanks to a structural investment in CLS research by the Board, there is now a state-of-the-art language laboratory, including a web experimentation site, instruments for eye tracking and measuring language behaviour, facilities for making observations with video recordings, and a high-end computing cluster with large storage facilities.

**Awards**

Prof. Asifa Majid won a prestigious Ammodo KNAW award for her innovative research on the relationship between language, cognition, and the senses. The award, which is intended to encourage unfettered fundamental scientific research by internationally recognised researchers working in the Netherlands, consists of €300,000, to be used by eight recipients per year at their own discretion to fund either their own research or a research project which they are leading into fundamental scientific issues.

Prof. Mirjam Ernestus has been elected as a member of the Royal Dutch Academy of Arts and Sciences (KNAW).

**Collaboration**

Widespread international collaboration among CLS researchers has contributed to the growing success of international recruitment in recent years: 25 percent of lecturers have come from abroad to work in Nijmegen, as have 40 percent of our PhD students.

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 the Donders Institute, 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 and in the national Language in Interaction Consortium.

Examples of formal international collaboration in 2015:

- **Collaboration in HealthNar**, a programme established to strengthen and consolidate the emerging field of narrative communication in healthcare, with the University of Antwerp (Belgium), the University of New South Wales, Sydney (Australia), Universitäts Linz (Austria), Universität Augsburg (Germany), Edith Cowan University, Perth (Australia) and Bowling Green State University, Ohio (USA). The aim is to build a multidisciplinary research exchange network dedicated to the use of narratives in relation to health, by bringing together renowned international scholars working on health psychology, media psychology, health communication, the arts and interactive communication. HealthNar was founded by the International Research Staff Exchange Scheme (IRSES).
- **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 with Aarhus University (Denmark), the University of Antwerp (Belgium), Vienna University of Economics and Business (Austria), Copenhagen Business School (Denmark),...**
Aalto University (Finland) in ‘Linguists for Business Research Initiatives’ (LIBRI), an international network of linguists collaborating to advance cross-disciplinary aspects of research on the role of language and communication in business and organisational settings.

• Collaboration in the large-scale, cross-linguistic project ‘Evolution of Semantic Systems’, which is funded by MPI Nijmegen within a consortium of 60 universities across Eurasia. The main aim of the EoSS project is to investigate how meanings vary in space and change over time, by collecting data from at least 50 Indo-European languages.

Research results

Women are better at learning a second language than men. This is the case in all languages and cultures, according to Dr Frans van der Slik, Prof. Roeland van Hout and Dr Job Schepens, and therefore they conclude it must be a genetic factor. They reached this conclusion after analysing the results of 27,119 state exams in Dutch as a second language, from adult men and women from 88 different countries. Gender differences were analysed across countries of origin and continents, and across mother tongues and language families. Female learners consistently outperformed male learners in speaking and writing proficiency. This gender gap remained remarkably robust and constant when other learner characteristics were taken into account, such as education, age of arrival, length of residence and hours studying Dutch.

Deaf signers of Sign Language of the Netherlands (NGT, Nederlandse Gebarentaal) often combine their signing with mouthings: silent articulations of lexical items from spoken Dutch. In his dissertation, Dr Richard Bank showed that the relationship between mouthings and signs appears to be not very strong. Although most signs are accompanied by so-called standard mouthings, mouthings do not necessarily have a one-to-one relationship with the signs they co-occur with. They can spread over adjacent signs to combine and group multiple signs under one mouthing, or they can occur in the sign stream without an accompanying sign, fulfilling a role that could have been taken by a manual sign as well. The general conclusion is that mouthings: silent articulations of lexical items from spoken Dutch. Dr Stefan Grondelaers contributes to the large national survey Sprekend Nederland (Talking Dutch), which was set up to chart the diversity and dynamism of contemporary spoken Dutch. The Dutch that is spoken in the Netherlands is a relatively homogenous, standardized language. However, it features massive variations in accent and dialect. This research involves not only collecting the production of spontaneous speech, but also the perception of accents. The Dutch systematically associate the Limburg accent with ‘cosiness’ and happiness, but also with stupidity; people from the Randstad are deemed prestigious but cold and distant on the basis of their accent. The Groningen accent is not associated with any desirable social qualities. The most shocking thing about these stereotypes is that they are applied uncritically to speakers who have these accents, people about whom we know virtually nothing.

Societal impact

Disseminating knowledge to the general public, raising awareness of the essential role of language and communication in society and developing ‘products’ based on research all play an important role at CLS. Researchers at the Centre bring together externally funded projects that involve language and speech technology in the Centre for Language and Speech Technology (CLST). Through CLST, CLS collaborates with many societal and commercial partners.

April 2015 saw the launch of NovoLanguage, a spin-off company from CLST. NovoLanguage makes products for language learners by using innovative language and voice technology. The company’s strength is the attention given to spoken fluency in their new products. This is a feature that Dr Helmer Strik, one of the company’s founders, believes is less common in other language training products. The company has its origins in research and the usage data generated by the applications will enable CLST to continue to enrich its research. Close cooperation with NovoLanguage, which is located on the Nijmegen campus, also means students have the opportunity to experience how aspects of their research work out in practice.

Aside from initiating NovoLanguage, Dr Helmer Strik – together with an international consortium of partners – has completed the European LLP project ‘Games Online for Basic Language learning’ (GOBL) to provide young people and adults with the possibility to improve their basic communicative skills in Dutch, English, and French, through web-based mini-games. Educational
Future research

Prof. Aslı Özyürek has been awarded a Vici grant for ‘Giving cognition a hand: Linking spatial cognition to linguistic expression in native and late learners of sign language and bimodal bilinguals’. Thinking and speaking about space are basic elements for our everyday communication. When deaf people sign, they express spatial relations visually. They have to sign with their hands and body, for instance, if something is in, on, under or to the left or right of something else, close or wide apart. The way they sign it resembles how they perceive the situation they describe. The description is therefore much more iconic and much less abstract than in spoken language. Özyürek’s project will investigate whether this aspect of sign language influences the spatial cognition of sign language users.

Dr Mirjam Broersma was awarded a Vidi grant for her project ‘We learn from our mistakes – or do we? Towards more efficient use of talking and listening experience in a second language’. Anyone who learns a second language is confronted with ‘strange’ new sounds. The chance of making mistakes is considerable, but how do you learn from these errors if you don’t notice them yourself? She will investigate the best way of making somebody aware of their mistakes with respect to improving their skill in a language.

Dr Roel Willems focuses on how the brain plays a role in how we understand language. He looks at how parts of our brain that are not traditionally thought of as being involved in language play a role when we understand language, most notable stories. He has acquired a Vidi grant for ‘Why do we like stories?’ If we read a story, we sympathise with the main character and see in our imagination what we are reading. People differ enormously in which stories they prefer. This project will study how our ability to imagine things influences the way we value stories and how this differs from one person to another.
Key publications


Dissertations: 15
Scientific publications: 254
Professional publications: 67
Dr Connie de Vos was awarded a Veni scholarship for ‘The face in sign language interaction’. In spontaneous conversations, sign language users not only use their hands, but also their body movements and facial expressions. Through a comparison between Dutch sign language and the young Balinese sign language Kata Kolok, the origin and functions of these facial expressions will be determined.

Prof. Antal van den Bosch has received a grant for research on the exchange between different disciplines of data from scientific texts. The grant, which has been obtained from the EU’s Horizon 2020 project ‘FutureTDM: Scientific Information in the Digital Age’, will be used to make an inventory of the state of affairs in the field of Text and Data Mining (TDM) and answer the question as to how best to increase the use of TDM in scientific texts. TDM enables researchers from different disciplines to analyse, extract insights and knowledge, and exploit diverse, complex datasets from various digital media. In the EU, the use of TDM is significantly lower than in some countries in the Americas and Asia. Competitive advantage is being lost and opportunities for knowledge discovery are being missed. The aim of the Future TDM project is to improve the uptake of TDM in research environments in the EU.
The aim of the Donders Institute is to increase our understanding of the neural basis of human cognition and behaviour, both in health and disease.

Comprehending this complex organ in our heads and how it enables our thoughts, emotions and actions has sparked curiosity for centuries. It’s essential to strive for this understanding if we are to be able to answer fundamental questions about human beings. Recent technological and theoretical advancements are delivering unprecedented insights into the way the brain works, making it possible to answer more applied questions as well.

The Donders Institute is home to about 600 researchers from more than 35 countries who share the common goal of contributing to advancing the brain, cognitive and behavioural sciences through investigator and curiosity-driven research, and improving health, education, nutrition, and technology by applying advances in this field. The Institute’s mission includes conducting excellent interdisciplinary research at the unique interface between genetic, molecular and cellular processes at one end of the spectrum and computational, system-level neuroscience with cognitive and behavioural analyses at the other end. Within this wide interdisciplinary range the Institute focuses on four research themes:

- Language and Communication
- Perception, Action and Control
- Plasticity and Memory
- Brain Networks and Neuronal Communication.

Researchers who are renowned worldwide work with young ambitious scientists in small research groups that form a highly interactive, collaborative cross-faculty network that tackles research questions that are too complex to be answered by single groups.
This interdisciplinary, cooperative culture – combined with excellent multidisciplinary research – is also at the core of the Donders Graduate School, which integrates a renowned Research Master’s programme with ambitious PhD training. The Master’s programme is structured in four tracks that are fully aligned with the four research themes of the Donders Institute, thus integrating young students optimally in the research. The PhD training programme supports young scientists by providing general academic skills while helping them move towards their own independent lines of research.

**Research facilities**

The Donders Institute has the very best equipment and technical staff, which allows researchers to carry out the most advanced work.

To understand human brain function and dysfunction at the cognitive and behavioural level a large number of laboratories are used, with set-ups for baby and toddler studies, an artificial intelligence laboratory, and numerous sensorimotor facilities, including a fall simulator, a vestibular sled and chair, ‘reach-in’ 3D visualisation and force-feedback virtual reality equipment.

To measure human brain function with precision while individuals perform specific cognitive tasks, the Institute employs a comprehensive set of neuroimaging tools comprising four research-only MRI scanners, including a joint-venture high-field system that is housed at the Erwin L. Hahn Institute, a whole-head MEG system, several multi-channel EEG and near-infrared spectroscopy systems. These neuroimaging facilities are complemented by equipment enabling modulation of human brain function such as several transcranial magnetic stimulation (TMS) and transcranial direct current stimulation (tDCS) laboratories.

To decipher underlying biological mechanisms the Institute also uses a broad range of other laboratories on campus, covering all levels from molecular biology to animal behaviour. State-of-art techniques are available in the forefront of sequencing technology developments, including large data sets of patient cohorts and neural stem-cell cultures. The central animal facility provides animal MRI, PET, CT/SPECT and a great variety of behavioural tasks for rodents. In addition, several other technologies are available, such as 2-photon microscopy, multi-unit in-vivo electrophysiology and optogenetics – just to mention a few – and these are being further developed locally within the context of the Radboud Research Facilities and Radboudumc Technology Centres.

These experimental tools are complemented by high-performance computing facilities, which enable advanced data analyses, data modelling and simulations for which the Institute is well known. This computer infrastructure also supports very large-scale studies, creating large databases of several thousands of individuals for brain-imaging genetics and patient cohorts.

**Research funding**

- Core
- Grants
- Contracts

(o), (e) and (p) see Glossary

**Staff**

**Tenured**

- Full Professors 25.96 FTE
- Associate Professors 12.38 FTE
- Assistant Professors 28.52 FTE
- Researchers 22.35 FTE

**Non-tenured**

- Researchers 133.05 FTE
- Doctoral candidates 225.78 FTE

**Prizes and awards (in alphabetical order)**

- Bas Bloem received the Holst Memorial Lecture Award 2015 for his research in the field of healthcare innovation.
- Mark Dingemans, Francisco Torreira and Nick Enfield of Nijmegen’s Max Planck Institute for Psycholinguistics won the 2015 Ig Nobel Prize.
- Barbara Franke was elected as a member of the Academia Europaea.
- Marloes Henckens was selected for the Lindau Nobel Laureate Meeting.
- The Branco Weiss Fellowship and the 2015 Hermesdorf Prize ‘International’ were awarded to Marijn Kroeze.
- Karin Roelofs was awarded a Radboud Science Award and has been appointed to the Young Academy of Europe.
- Carmen Sandi (Lausanne) was awarded the Radboud University Medical Centre’s 2015 Valkhof Chair.
- Mirjam Ernestus, an affiliated PI (CLS) of the Donders Institute, was elected as a member of The Royal Netherlands Academy of Arts and Sciences (KNAW).
- Peter Kok was awarded the Dutch 2015 Neurofederation PhD thesis prize.
Personal grants

- NWO Veni grants were awarded to Piray Atsak, Inti Brazil, Marloes Henkens and Fleur Zeldenrust
- NWO Vidi grants were awarded to Marcel van Gerven, Floris de Lange, Jan-Mathijs Schoffelen, and Roel Willems
- NWO Vici grants were awarded to Asli Özyürek (affiliated PI, CLS), Roshan Cools, and Joris Veltman
- ERC starting grants were awarded to Michael X. Cohen and Floris de Lange
- An ERC consolidator grant was awarded to Erno Hermans.

Collaboration

Research carried out at the Donders Institute is conducted in a collaborative national and international setting. In Nijmegen the Centre for Language Studies at the Radboud University and the Max Planck Institute for Psycholinguistics are affiliated institutes. In Germany the Institute collaborates with the University of Duisburg-Essen – a preferred partner of Radboud University – on the operation of a joint research centre for high-field MR imaging, the Erwin L. Hahn Institute, in Essen.

Furthermore, the Institute actively strives to collaborate in research consortia with leading institutes, industrial partners and other potential users of its research. Joining forces in this way extends research across the borders of the Institute and makes valorisation of research results possible. The Institute participates in a large number of high-quality, innovative consortia, including:

- An NWO Gravitation Grant Language in Interaction, which is coordinated in Nijmegen, brings together 50 researchers from eight universities and one research institute in the Netherlands.
- Fourteen large EU consortium grants, including: Aggressotype, Matrices, and PERS. The consortia mentioned each bring together over 15 European academic and industrial partners and all three are coordinated by the Donders Institute.
- Five EU (Marie Curie) training networks, such as Healthpac (led by the Donders Institute), Childbrain and BrainTrainMat.
- Four national and regionally funded projects that bring together Dutch universities and private-sector partners. Examples are FOCOM and NeuroCIMT.
- Two consortium projects: BIG and Cognomics, with the Donders Institute, the Radboudumc, and the Max Planck Institute for Psycholinguistics as initiating partners.
- The Institute is a collaborating partner in the Human Brain Project, which was selected by the EU as one of two flagship projects, and contributes to the US Human Connectome Project.

See the Institute’s website for more details on all of these collaborations.

Societal impact

Research conducted at the Institute has considerable potential for benefiting society, especially in education, medicine, technology and food. A key aim is to disseminate expertise and knowledge to a variety of stakeholders.

- To inform the general public, Donders researchers regularly appear on national television (in programmes such as ‘De Kennis van Nu’, ‘Tijd voor Max’ and RTL Late Night), in numerous national and international newspapers (including the New York Times, NRC, de Volkskrant, de Gelderlander), on radio (e.g. Dutch National Radio, BBC, the Voice of America), at large festivals (e.g. Down the Rabbit Hole) and on many websites. Esther Aarts investigates how deep down in our brains our reactions to food are triggered. In cooperation with National Geographic and the Axa Research Fund, she made a video on how to reduce irrational eating. This video has a large number of hits on YouTube. In the blog ‘DondersWonders’ researchers at the Institute write non-specialist articles on neuroscientific topics for the general public. With two blogs per week, over 100,000 views in 2015 and regular radio and TV interviews resulting from it, it can be said to be a big success.

- To inform the scientific community, Donders researchers took the active lead in workshops and in organizing international conferences. One example is the International Conference on Genetic & Epigenetic Pathways of Disease, Greece, co-organized by Hans van Bokhoven. Neuropsychological tests developed by Roy Kessels and colleagues, such as the ‘Nijmegen-Venray Confabulation List’, have been published or translated into other languages, as is the case with the ‘Location Learning Test’.

- Donders scientists disseminate new findings and knowledge to industry, mostly through numerous mutually beneficial collaborations with commercial partners varying from smaller companies that manufacture technical devices (such as Noldus and Otticon) to large multinationals (e.g. Philips, Siemens, Heinz and Danone). In 2015 the Institute joined ‘ICT for Brain, Body & Behaviour’ (13B), a European network of ICT companies and knowledge institutes in the field of brain, cognition, physiology and behaviour with the aim of connecting business and innovating through joint R&D projects. The Institute is also involved in ‘Radboud Research Facilities’, an initiative by the province Gelderland to stimulate the regional economy by contributing to innovation by small and medium-size enterprises that apply scientific knowledge.
Chair of the Board of Directors: Prof. Guillén Fernández

Guillén Fernández trained as a neurologist and cognitive neuroscientist in Bonn, Magdeburg, and Stanford before becoming a founding Principal Investigator at the Donders Center for Cognitive Neuroimaging in 2002. He then became a professor (in 2006), head of the Cognitive Neuroscience department (in 2010) and director of the Donders Center for Neuroscience (also in 2010). In his research on human cognitive neuroscience, he specializes in the cerebral basis of memory, emotion and the way they interact. He has received an Advanced Investigator Grant from the European Research Council and he has been a member of the Academia Europaea since 2014.

Donders Institute for Brain, Cognition and Behaviour

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• Research is well embedded in clinical care within Radboudumc and beyond. Implementing new findings in clinical practice is part of the daily work of the Donders clinicians as is the education of peers, patients and patient organisations through lectures, meetings and forums (e.g. depressievereniging.nl and NEKAD). Donders researchers participate actively in e-science developments such as the digital Parkinson polyclinic and Parkinson TV or mental e-health applications, partly in collaboration with patient organisations, thus directly promoting the impact of research.

• Donders researchers actively participate in educational development. Jurjen van der Helden and Harold Bekkering published a book in which they describe important insights into the ‘learning individual’. They offer suggestions for educational practice in literacy, numeracy and social interaction.

• Through participation in public debate Donders researchers contribute to regional and national policies by discussing the impact of neuroscientific insights on economic and social development. They also play a key role in guiding and organising platforms for the ethical thinking needed to apply new neurotechnologies. At the national level, researchers at the Institute serve on committees of research policy organisations such as the Netherlands Organisation for Scientific Research (NWO), the Royal Netherlands Academy of Arts and Sciences (KNAW), the National Initiative Brain and Cognition, and the Rathenau Institute. Researchers at the Institute collaborate with external partners in areas such as psychiatry (i.e. those working in the Pompe Clinic in Nijmegen), with the Netherlands Forensic Institute (NFI) and the Dutch Department of Education.
The mission of researcher working on the Language and Communication theme (LC) is to understand something that is uniquely human: language. An important feature of this theme is the substantial involvement of researchers from two affiliated institutes: there are Donders Principal Investigators and Research Fellows at the Max Planck Institute for Psycholinguistics and at the Centre for Language Studies.

LC theme researchers have three key objectives: a) to understand core language and communication operations, and to determine how these are related to other domains of cognition; b) to determine how the human language faculty is rooted in the 'language-ready' human brain; and c) to understand the balance between the universality and the variability of language and language processes. LC uses neuroscientific, behavioural, linguistic, genetic and computational techniques and seeks explanations at multiple levels (neurobiological, psychological and linguistic). The ultimate goal is to link these domains and thus move towards a fuller understanding of the human language faculty, from the molecular to the societal level.

Research results

One study examined the genetic mechanisms underlying Specific Language Impairment (SLI). Another study using molecular techniques investigated an isolated population on Robinson Crusoe Island (Chile) where there is a high incidence of SLI. A single rare coding variant of the protein NFXL1 was found to be significantly associated with language impairment. Subsequent analysis of
people from the UK affected by SLI revealed changes which probably affect this protein in more individuals than would be expected by chance. Coding variants within NFXL1 thus appear to confer an increased risk of SLI.

Other research explored relationships between language and memory by measuring oscillatory brain activity. In a word-learning study, patterns of oscillatory activity changed as a result of memory-consolidation processes. Power in the theta band (4-8Hz) has previously been associated with word-recognition processes. In line with this, the theta increase was lower with new words learned on the same day as the test compared to words that were already known. But theta responses to novel words that had been acquired 24 hours earlier were indistinguishable from responses to known words. Overnight consolidation thus enables novel words to acquire lexically-integrated, neural representations. In a speech production study, participants either judged whether pictures were expected after reading sentences or named the pictures. Across the two tasks, beta desynchronization was observed in brain areas associated with memory processes and in areas associated with motor processes. Memory and motor components of word production thus appear to be reflected in overlapping beta-band brain oscillations.

LC researchers also examined when speakers plan their utterances in conversations. The results showed that participants initiated the cognitively demanding aspects of speech planning only shortly before the end of the preceding speaker’s turn. Because it is smart to wait with demanding aspects of planning, this may be the default in everyday conversations.

Finally, a functional Magnetic Resonance Imaging study examined the effects of communicative intent. Utterances with gestures (but not those without) produced additional activity in the right middle temporal gyrus when participants were addressed. Marking communicative intent with gaze direction thus appears to modulate the processing of speech–gesture utterances in brain areas associated with the semantic processing of multi-modal communicative acts.

Future research
Researchers working on the LC theme will continue to pursue its key objectives in 2016. An important vehicle for this is the NWO ‘Language in Interaction’ Gravitation grant, which supports a national consortium of researchers including many LC theme members. PhD and postdoctoral projects already funded by the grant will continue next year, and new projects will start. In particular, the consortium has identified six fundamental questions about language science. In line with the LC theme’s goals, these questions are interdisciplinary and multi-level in nature. New projects seeking to answer these questions will begin in 2016.
The mission of researcher working on the Perception, Action and Control (PAC) theme is to understand the relationships between the brain and cognitive mechanisms of perception-action integration in the domains of perceptual inference, sensorimotor functions, cognitive control, decision-making, and social interactions in health and disease. The PAC theme broadly investigates the initial integration between perception and action (during sensorimotor integration), how it is regulated (during decision-making) and how it is exploited (during social interactions). At the level of sensorimotor integration, researchers examine how sensory processing and motor performance interact within the perception-action cycle. At the level of decision-making, researchers study how the perception-action cycle is regulated on the basis of cognitive, motivational, and emotional factors. At the level of social interactions, researchers study how the perception-action cycle is used when directly interacting with other agents. At each level of investigation, research also focuses on understanding neurological and psychiatric populations, as well as with on the potential social implications of this research. PAC researchers address these issues at the system level; from genes to neuromodulators, from single neurons to brain circuits, from individual organisms to multiple interacting agents. These issues are examined by combining multiple techniques, from electrophysiological and neuroimaging methods to clinical and psychopharmacological studies, from genetic and neurobiological methods to developmental and psychophysical studies, and from computational modelling to

Principal investigator Floris de Lange received an ERC Starting Grant and an NWO Vidi grant. We often say ‘Seeing is believing’, but the exact opposite is true: to a large extent, our expectations determine what we see. Floris de Lange investigates how expectations change the brain processes that underlie perception, and what the consequences of that are.

Theme 2: Perception, Action and Control
Prof. Alan Sanfey (speaker)
theoretical analyses. This multidisciplinary and multi-level approach creates the opportunity for different analytical and theoretical perspectives, providing a fertile ground for effective interactions between fundamental and clinical neuroscientists, and thus, this theme fully integrates the ‘Disorders of movement’ research theme at the Radboudumc.

Research results
A recent study in the perceptual domain, demonstrated that sensory uncertainty could be reliably estimated from the brain, and that this knowledge about the uncertainty of the underlying stimulus is then used in perceptual judgements. Examining sensorimotor integration, researchers revealed the response properties of auditory cortex neurons in awake monkeys, as well as explorations of how different cue representations act within and across effector systems. Another group investigated brain activity that underlies predicting physical movements of objects and a clinical study at Radboudumc has sought to evaluate whether aerobic exercise can lead to significant improvements in motor defects observed in Parkinson’s patients. Investigations of cognitive control have shown that the stimulant methylphenidate amplifies the salience of task-relevant information, leading to enhanced processing of targets, but also increased attention to distractors which are drawn from the same category. Decision-making studies revealed that choices to either exploit or explore resources depend on the social context as well as the expectation model of the environment. Research on social interaction has shown that patients with damage to the ventromedial prefrontal cortex are impaired in terms of non-verbal communicative tasks, indicating that this brain area is necessary for social interactions that require applying knowledge about a social partner. Finally, a pharmacological intervention study demonstrated that the administration of testosterone increases amygdala activation during threat.

Future research
Researchers will continue to focus their work as described in the mission. There will be an increased focus on efforts to align the work of the basic and applied scientists in order to generate and test models of normal and abnormal function, with the ‘Disorders of movement’ theme at Radboudumc playing a vital role in this regard.

In addition, initial efforts will be undertaken to examine the potential relevance of PAC research in questions of public policy. Other studies will examine how we predict events, and how we then employ these predictions to act in optimal ways, and work on addiction will examine the underlying mechanisms involved in pathological gambling. The theme will continue leading the HealthPac consortium, the innovative doctoral programme that focuses on understanding the neural mechanisms of sensory-motor control and its disorders, and to use this knowledge to enhance the quality of life. PAC researchers also remain involved in the ‘Language in Interaction’ Gravitation grant.

Key publications


Dissertations: 15
Academic publications: 589
Professional publications: 9

Staff

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<td>Prof. I. Toni (p)</td>
<td>Prof. M. Ullsperger (p)</td>
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<td>Prof. R.A. Wevers (o)</td>
<td>Prof. R.J.A. van Wezel (o)</td>
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<td>Prof. M.A.A.P. Willemse (o)</td>
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Research funding

Core Grants Contracts

Dissertations: 15
Academic publications: 589
Professional publications: 9

(0), (e) and (p) see Glossary
Researchers within the Plasticity and Memory (PM) theme tackle the mechanistic underpinnings and behavioural consequences of long-term changes in neural structure and function. More specifically, the mission is to unravel how neuroplasticity supports adaptation to external and internal challenges, as well as learning and memory throughout the life span. The theme combines a focus on major mental health problems with the ability to have an impact on other areas such as education.

Research is closely integrated with the Radboudumc research themes ‘Neurodevelopmental disorders’, ‘Stress-related disorders’, and ‘Alzheimer disease’ and divided in three subthemes: a) development, studying the mechanisms and consequences of normal and abnormal neurodevelopment, i.e. neurodevelopmental disorders and intellectual disability; b) adaptation, focusing on the neurobiological effects of external and internal challenges, such as environmental factors, stress, and brain damage, as well as their behavioural and emotional consequences with a clinical focus on affective disorders; c) learning and memory, investigating the neural and cognitive mechanisms underlying normal and impaired learning and memory and translating these mechanisms into clinically and educationally relevant constructs. The clinical focus of this subtheme is Alzheimer disease.

Joris Veltman (Professor of Translational Genomics) was awarded an NWO Vici grant, which will enable him to further explore the role of spontaneous mutations in intellectual disability and expand this to male infertility. He will examine the entire genome of patients and their parents and investigate how paternal age at conception and reproductive technologies impact the number of these mutations in parents’ offspring.
Researchers working on development showed that the serotonin transporter 5-HTTLPR genotype moderates the effect of stress on the severity of attention deficit hyperactivity disorder (ADHD) via changes in brain regions involved in social cognitive processing and cognitive control.

Researchers working on adaptation used structural magnetic resonance imaging to show that even in a healthy population different types of childhood adversity are related to specific alterations in brain structure, which are modulated by sex. These findings may help understand neurodevelopmental consequences related to childhood adversity. Other researchers showed that stress can cause a shift away from more controlled processing, depending on the hippocampus towards more reflexive processing supported by the amygdala and striatum, which is mediated by activation of the mineralocorticoid receptor (MR) for cortisol.

Researchers working on learning and memory investigated the relationship between behavioural performance and prefrontal activation by modulating different levels of working-memory load. They examined how healthy elderly subjects performed a spatial working-memory task and how this was related to haemodynamic changes as measured by two functional Near-Infrared Spectroscopy channels. The results showed that bilateral prefrontal activation may not always be successful in compensating brain damage. Individual behavioural performance should be taken into account to be able to distinguish successful and unsuccessful compensation or declined neural efficiency.

Future research
A European Training Network coordinated by Barbara Franke, which involves Jan Buitelaar and Alejandro Arias-Vasquez, Annette Schenck, and Nanda Rommelse, will continue working on the aetiology of ADHD and autism. Aart Schene and collaborators received funding from the ‘Fonds psychische gezondheid’ to develop e-based cognitive interventions in depression. After an excellent mid-term evaluation from the Helmholtz society, Indira Schenck, and Nanda Rommelse, will continue working on the aetiology of ADHD and autism.

Key publications


The mission of researchers working on the Brain Networks and Neuronal Communication (BNNC) theme is to characterise and understand how groups of neurons interact and which mechanisms are involved in influencing behaviour and cognition. The research focus is on the network perspective, with the aim of understanding neural coding and communication at various levels. Vertical integration is approached experimentally by applying and developing state-of-the-art methodology, spanning the full range from recording individual neurons in animals to human imaging of brain networks. The experimental methods are complemented by the development of advanced analysis techniques, which also embrace the various levels. Theoretically, computational principles for neuronal coding and communication are developed using computational models ranging from synaptic communication to network dynamics.

It is becoming increasingly clear that cognition and behaviour need to be understood at the level of dynamic network interactions involving several brain regions. Likewise, it is now also recognised that pathologies in neural communication may underlie neurological and psychiatric disorders. Researchers working on the BNNC theme are therefore involved in numerous clinically-related projects.

The aim of the theme is to make theories, method developments and state-of-the-art techniques available to the broader community. This is achieved through various proactive efforts to disseminate and educate, including making toolboxes and databases publicly available.

Mike Cohen (Assistant Professor at the Science and the Medical Faculty), received an ERC Starting Grant and a Radboudumc Hypatia fellowship. His research focuses on the study of theta oscillations in the mid-frontal cortex. This activity, which is associated with preparing for an action and adapting behaviour, predicts how well people learn from their mistakes.
**Research results**

Computational studies found that neural communication across synapses are shaped by independent mechanisms where different modes of neurotransmitter release allow permissive or instructive changes in neuronal communication.

Correlated changes across synaptically coupled networks modify functional connectivity throughout the brain. This coupled activity has been traditionally quantified using covariance. A new probabilistic generative model allows the estimation of functional connectivity in terms of both partial correlations and a graph representing conditional independencies.

It has been proposed that neuronal oscillations could mechanistically mediate consolidation and mnemonic representations in the brain. Experimental observations from the human brain and cross-frequency phase amplitude coupling analyses now suggest that hierarchically nested loops of oscillations, spindles and ripples provide a fine-tuned temporal window for the transfer of hippocampal memory traces.

Systems level understanding of functional networks in the brain requires the study of neural circuits in high-spatial resolution. Most of our current knowledge on the subregions of brain locus of interest originates from animal studies. Application of high-field functional magnetic resonance imaging for mapping the functional organization of the human entorhinal cortex now describes the functional topography along the entorhinal cortex, localizing the human homologue of rodent entorhinal cortex subregions.

System-level studies of neural communication have outstanding promise in providing unique neurofeedback and brain-machine communication applications. In a recent study BNNC researchers identified a ‘regulation network’ that is activated during real-time fMRI neurofeedback experiments.

**Future research**

We will continue focus on development of data acquisition techniques while combining methods. MR multiband acquisition will be refined to further reduce the scan times. Imaging with laminar resolution will be improved by developing a statistical model to complement multi-unit recordings in freely behaving animals. Analysis approaches will be scaled to accommodate large and high-dimensional datasets, promoting strategic collaborations to enable vertical data integration.

The findings in humans and animals will be integrated with the aim of providing a system neuroscience perspective on neuronal communication and dynamics. Collaborations on clinical research will be extended to understanding neurological and psychiatric disorders at the network level. Brain-computer interfacing will be further developed, with the aim of improving communication – and device control – by disabled patients.
Radboud Institute for Health Sciences

The mission of the Radboud Institute for Health Sciences (RIHS) is to improve clinical practice and public health. It does so by providing evidence of the efficacy and efficiency of existing and new tests, treatments and policies, as well as innovative modes of healthcare delivery, by training young researchers in methodologies for obtaining such evidence and by developing new methodologies for improved research programmes in this field.

As evidence is typically obtained in probabilistic and qualitative rather than deterministic and mechanistic ways, research tends to be done among patients or the general population rather than through laboratory-based models. The Institute’s focus is on developing methodologies that optimize personalized healthcare and on the application of these tools in disease-oriented research themes. In line with the Radboudumc’s mission of having ‘a significant impact on healthcare’, the Institute aims to bridge the gap between science and society. Societal impact is at the core of the Institute’s ambitions.

Training of young researchers within the Institute is organized in a Royal Netherlands Academy of Arts and Sciences (KNAW)-accredited Graduate School.
Research at Radboudumc is organized in 18 themes. Four of these are embedded exclusively in the Donders Centre for Neuroscience and one in the Radboud Institute for Molecular Life Sciences (RIMLS). The theme ‘Healthcare improvement science’ is exclusive to RIHS. Within the other 12 themes RIHS researchers work closely together with colleagues at RIMLS. We believe that optimal progress can be achieved when molecule, man and population-oriented researchers work together on the same disease-oriented ‘playing field’.

**Healthcare improvement science**  
**Theme leader: Prof. Gert Westert**  
The main focus is on the structure, process and outcomes of healthcare in daily practice, with the aim of improving performance and delivery from the perspective of the patient. Researchers study existing and new interventions at the micro and macro level. Their aim is to explore which interventions or structures work in what circumstances. Immediate value for patients is paramount.

**Cancer development and immune defence**  
**Theme leader: Prof. Joop Jansen**  
Researchers working in this theme investigate resistance to therapy, the tumour micro-environment, cancer-cell trafficking and the interaction between the immune system and cancer. This basic knowledge is translated into novel forms of therapy that targets tumour cells. Strategies are also developed for expanding and manipulating immune cells for clinical use, exploiting and boosting the power of the immune system. For the translational part of this work, researchers carry out phase I, II and III clinical trials.

**Rare cancers**  
**Theme leader: Dr Carla van Herpen**  
Despite the rarity of each of the ‘rare’ cancers (i.e. an incidence <6/100,000 per year), they represent in total about 22% of all cases of cancer. Due to their low frequency, rare cancers pose particular challenges. The main aim is to improve diagnosis and prognosis and to perform personalized clinical studies and translational bench-to-bedside research in patients with rare cancers. This is being performed in a national and international collaborative setting and in relationship with patient advocacy groups, where applicable.

**Tumours of the digestive tract**  
**Theme leader: Prof. Iris Nagtegaal**  
Research in this theme is designed to improve the prognosis and treatment of patients with tumours of the digestive tract, with a focus on sporadic and hereditary forms of colorectal and pancreatic cancer. The aim is to achieve better prevention of cancer in high-risk patients and develop and implement new diagnostic tools for staging and therapy response. In addition, researchers are developing treatment innovations, ranging from improved surgical techniques to immunotherapy.
Urological cancers
Theme leader: Prof. Jack Schalken
Research involves identifying and evaluating the usefulness of new biomarkers and imaging techniques for risk, diagnostic, prognostic and predictive assessment in prostate, bladder and kidney cancer. In addition, new and existing prevention and treatment modalities in these types of cancer are evaluated. Synergistic multidisciplinary research collaboration – from molecular life sciences to population sciences – ensures a focus on ‘utility’ for patients and public health.

Women’s cancers
Theme leader: Prof. Leon Massuger
The goal of this theme is to improve the patient-centred quality of care in women’s cancers (breast, ovary, cervix, vulva, endometrium and pregnancy-related cancer) in partnership with patients through prevention, early diagnosis or implementation of new management strategies supported by a better understanding of carcinogenesis and tumour development, paying special attention to hereditary causes, preservation of fertility and individual post-treatment care.

Infectious diseases and global health
Theme leader: Prof. Mihai Netea
Researchers within this theme aim to have a significant and global impact on the control, treatment and elimination of infectious diseases. The theme combines cutting-edge research in immunology, microbiology, pharmacology and novel ‘omics’ methodology with translational and implementation research in immunology and infectious diseases. There are two research lines: Infectious diseases & host defence, and poverty-related infectious diseases.

Inflammatory diseases
Theme leader: Prof. Irma Joosten
Chronic inflammation is currently among the leading causes of morbidity and mortality in the Western world. Researchers working within this theme aim to translate results from the molecular and population level to the individual patient in order to improve diagnosis, disease management and the treatment of (chronic) inflammatory disorders.

Mitochondrial diseases
Theme leader: Prof. Jan Smeitink
The mission within this theme is to better understand the cellular bio-energetics in health and disease at all levels of complexity. Knowledge thus gained will enable the development of preventive measures and help to make substantial contributions to the development of rational treatment strategies for mitochondrial diseases.

Reconstructive and regenerative medicine
Theme leader: Prof. Wout Feitz
The focus within this theme is on the development and clinical translation of innovative diagnosis and therapies, including regenerative medicine and nano-medicine, for personalized care and cure of patients needing reconstruction of lost or damaged tissues. This will be achieved through transdisciplinary research by leading research groups in medicine, dentistry, biochemistry, chemistry, biology and materials science.

Renal disorders
Theme leader: Prof. Joost Hoenderop
Current and future care of patients with renal and renal-related disorders can be considerably improved. To achieve this, researchers working on this theme aim to increase knowledge of the molecular and immunological basis of rare glomerular and tubular disorders; they develop biomarkers for optimal prediction of disease prognosis; and apply strategies for preventing and improving renal replacement therapy.

Vascular damage
Theme leader: Prof. Gerard Rongen
In this theme the aim is to increase understanding of the causes and consequences of vascular injury and to translate this knowledge into improved personalized cardiovascular healthcare. Early detection of atherosclerosis, primary and secondary prevention of atherosclerosis, optimal treatment of atherosclerosis to preserve end organ function, and implementation of effective diagnostics and therapies in practice are key focus areas.

Sensory disorders
Theme leader: Prof. Anneke den Hollander
The research focus of this theme is to improve our understanding of the molecular mechanisms of retinal diseases, hearing impairment and deaf-blindness. By developing and improving diagnostic and predictive tests for sensory diseases, researchers aim to bring new personalized rehabilitation strategies and therapies into the clinic, including gene therapy and retinal and auditory implants.

Research facilities
RIHS hosts some of the 18 formal Radboudumc Technology Centers (www.radboudumc.nl/Research/TechnologyCenters), which offer research facilities for internal and external researchers:

- The Radboudumc Biobank, an infrastructure for collecting, storing and managing biomaterial and associated clinical data in a standardized manner. It contains large databases and biobanks of general population samples (e.g. the Nijmegen Biomedical Study) and of specific patient groups (e.g. congenital malformations, cancer, rheumatoid arthritis and inflammatory bowel disease).
- A clinical trial centre offering logistics and data management for adult and paediatric human intervention studies.
- Consultation facilities for biostatistics, health economics and research with electronic health records.
- The Minimal Invasive Technology expert Center (MiTeC) field lab, which is used to evaluate surgical innovations.
The group led by Mireille Broeders (Associate Professor of Health Evidence) is evaluating tailored follow-up schedules for patients treated for breast or colorectal cancer with curative intent, based on the length of the preclinical detectable phase and taking into account benefits and harm as well as patients’ and health professionals’ views. The same group is also investigating options for personalized breast cancer screening.

RIHS offers two junior researcher positions annually for projects proposed by a RIHS researcher, together with an international partner. Appointed PhD candidates carry out at least one year of the research abroad. Furthermore, a researcher or teacher from abroad is annually honoured with the ‘Richard Grol Visiting Scientist Award’.

There are formal collaborations with the Universities of Twente, Eindhoven and Groningen for, e.g., MITEC. At the Institute level, there is a formal partnership in the KNAW-accredited research school CaRe, together with CAPHRI (UM), NIVEL and EMGO+ (VUmc).

The Institute has formal ties with the HAN University of Applied Sciences, specifically in nursing sciences, physical therapy and musculoskeletal and neurohabilitation therapy, and with the Nederlands Paramedisch Instituut. The Institute is also a formal partner in ‘Sterker op eigen benen’, a consortium of five service providers for people with intellectual disabilities. Within the Academic Collaborative Centre AMPHI the Institute collaborates with seven Dutch Community Health Services (GGDs) and within UKON, the university network for long term care Nijmegen, RIHS collaborates with 14 care organizations (including 60 nursing homes). RIHS has collaborated with the Netherlands Comprehensive Cancer Organisation (IKNL), the National Expert and Training Centre for Breast Cancer Screening (LRCB), the RIVM, NIVEL, and the Dutch Ministry of Public Health, Welfare and Sports (VWS) for many years.

The RIHS collaborates in research and/or faculty exchanges with many 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

Collaboration

Although several research lines in the RIHS play a leading role worldwide, the Institute as a whole is best known in the Netherlands. To secure a transition to a more international level, RIHS has established formal partnerships with several international organizations and universities, as well as within the Netherlands with various academic and service organizations.

In addition to these technology centres, the RIHS has the following research facilities:

- 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.
- 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.
- A SYstematic Review Centre for Laboratory animal Experimentation (www.syrcle.nl), affiliated to the Technology Center ‘Central Animal Laboratory’.
- Consultation services for quality of care (IQ healthcare).
- Online platform for Personal Health Communities (MijnZorgnet).

In December 2015, the new cyclotron was opened by the Dutch Minister of Health, Welfare & Sport, Mrs. Edith Schippers. The cyclotron will give a boost to research with medical isotopes done by several RIHS researchers (www.radboudtranslationalmedicine.nl).

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Key publications


MRC in London and deCODE Genetics in Reykjavik, Iceland. Within the scope of the EU 7th Framework and Horizon 2020 Programmes TICD, IMPACT, EuroTARGET, EU-WISE, INTEGRATE-HTA, EURENOMICS, InSup-C, ASSURE, PACE, FAPIC, EYE-RISK, ENSAT-HT, MURAB, the Institute collaborates with numerous public and private organizations.

Research results
In 2015, three PhD theses received the predicate cum laude: Dr Nicolien Kuper (‘Secondary caries, mind the gap!’), Dr Nicole Saksens (‘Familial macular disease. Clinical and genetic studies on age-related macular degeneration and inherited macular dystrophies’) and Dr Dennis Vriens (‘Quantitative characterisation of solid tumours by 18F-FDG PET. What’s in a number?’). Some other research highlights are listed below.

Healthcare improvement science
Dr René Melis and colleagues showed that General Practitioners (GPs) applying the EASY-Care Two step Older people Screening procedure, which uses information that is readily available to GPs, can predict negative health outcomes in their older populations efficiently and almost as accurately as a complete specialist Comprehensive Geriatric Assessment (van Kempen et al. BMC Medicine, 2015).

Rare cancers
The group led by Prof. Winette van der Graaf showed that the outcome of synovial sarcoma patients significantly decreases with age regardless of primary tumour site, size, and treatment (Vlenterie et al. British Journal of Cancer, 2015).

Tumours of the digestive tract
A Dutch multi centre study by Prof. Hans de Wilt and colleagues demonstrated that chemoradiation followed by organ-sparing transanal endoscopic microsurgery is feasible in early rectal cancer patients. Almost 60% of patients thus treated have their rectum in situ with excellent function, without the need of a colostomy (Verseveld et al. British Journal of Surgery, 2015).

Urological cancers
Dr Ruben Cremers showed that known susceptibility to single nucleotide polymorphisms (SNPs) for sporadic prostate cancer shows a similar association with hereditary prostate cancer (HPC), warranting a reconsideration of HPC and a restrictive policy toward prostate-specific antigen testing in men with a positive family history (Cremers et al. Prostate, 2015).

Women’s cancers
A large international study of over 4,000 patients with breast cancer (stage-3), coordinated by Prof. Philip Poortmans, showed that regional radiation therapy after surgery improves survival (Poortmans et al. New England Journal of Medicine, 2015).
The first results of the Breast Cancer E-Health (BREATH) trial, a web-based self-management intervention to support the psychological adjustment of women after primary treatment, by reducing distress and improving empowerment, demonstrated that the intervention had an additional effect (van den Berg et al. *Journal of Clinical Oncology*, 2015).

**Infectious diseases and global health**

Dr Teun Bousema and colleagues showed that the mosquitocidal drug ivermectin can be safely given in combination with a standard antimalarial and can reduce the likelihood of malaria transmission by reducing the life span of feeding mosquitoes (Ouédraogo et al. *Clinical Infectious Diseases*, 2015).

The group led by Prof. Marlies Huischer developed quality indicators (QIs) that can be used to measure the appropriateness of antibiotic use in the treatment of all bacterial infections in hospitalized adult patients (van den Bosch et al. *Clinical Infectious Diseases*, 2015).

**Inflammatory diseases**

The trial carried out by Dr Marieke Coenen and colleagues showed for the first time that thiopurine dosing based on the genotype of thiopurine S-methyltransferase (TPMT) results in less haematological side effects in inflammatory bowel disease patients (Coenen et al. *Gastroenterology*, 2015).

Dr Alfons den Broeder and co-authors demonstrated that using a disease activity-guided, dose reduction strategy of tumour necrosis factor (TNF) inhibitors adalimumab or etanercept to treat rheumatoid arthritis is as good as continuing treatment unaltered with regard to major flaring, while resulting in successful dose reduction or stopping treatment altogether in two thirds of patients (van Herwaarden et al. *British Medical Journal*, 2015).

**Mitochondrial diseases**

Together with international colleagues Dr Chris Verhaak formulated guidelines for the optimal management of routine psychosocial care at infertility and medically assisted reproduction clinics (Gameiro et al. *Human Reproduction*, 2015).

**Reconstructive and regenerative medicine**

The Orthopaedics research group presented a methodology for developing subject-specific models that are able to simultaneously predict muscle, ligament, and knee joint contact forces along with secondary knee kinematics. With this work Verdonschot’s group won the international grand challenge competition, a global endeavour in which researchers are challenged to predict loads in the knee joint of a patient with a total knee replacement (Marra et al. *Journal of Biomechanical Engineering*, 2015).

**Renal disorders**

The Modification of Diet in Renal Disease (MDRD) formula is widely used in clinical practice to assess the correct drug dose. Profs Jack Wetzelts, Michel Wensing and Peter de Smet determined the validity of this formula in specific patient populations with renal impairment such as elderly, hospitalized and obese patients, patients with cardiovascular disease, cancer, chronic respiratory diseases, diabetes mellitus, liver cirrhosis and human immunodeficiency virus. They showed that in several specific patient populations with renal impairment the use of the MDRD formula is not valid or has uncertain validity (Eppenga et al. *PLoS One*, 2015).

**Vascular damage**

Dr Thijs Eijsvogels demonstrated that 15 minutes of exercise a day at a moderate intensity or 8 minutes exercise a day at a vigorous intensity significantly reduces the risk of all-cause mortality. Higher amounts of moderate-intensity physical activity are related to larger health benefits, whereas physical activity beyond the lowest effective dose for high-intensity exercise is not associated with further reduced mortality rates. Also, no evidence for an upper limit of exercise-induced health benefits was found (Eijsvogels et al. *Journal of the American Medical Association*, 2015).

**Sensory disorders**

Dr Jeroen Klevering and colleagues reported that patients with certain risk alleles develop neovascular age-related macular degeneration (AMD) on average 12 years earlier than persons without these risk alleles. A history of smoking makes the age at onset even earlier (Lechanteur et al. *Journal of the American Medical Association Ophthalmology*, 2015).

**Awards and acknowledgements**

- Dr Teun Bousema was among the top five nominees for the 2015 New Scientist Research Talent award for his research into malaria medicine.
- Dr Richard ten Broek was awarded the Catharina Pijs Dissertation Prize for his research on the formation of adhesions after reoperations in abdominal surgery. Ten Broek also received the 2015 RIHS PhD Award.
- Dr Philip van der Wees received the Najoua Mlika Cabanne Innovation Award from the Guidelines International Network (G-I-N) for his pivotal role into the multidisciplinary development and implementation of guidelines within healthcare.
- Dr Iris van Rooij received the ‘Marco Tonini Award’ from the Italian patient/parent organisation for anorectal malformations.
- Prof. Judith Prins received the 2015 NVPO (Dutch Psychosocial Oncology society) award for her contribution to psychosocial oncology.
Societal impact

Societal impact is at the heart of RIHS research. Much – if not most – RIHS research has direct societal impact and is implemented in clinical care or public health. For this, RIHS encourages researchers to act in close collaboration with public organizations on topics with high societal relevance. RIHS research leads, e.g., to more personalized treatment, to better cooperation between healthcare providers, to more efficient diagnostic protocols, and through all this to better and more efficient healthcare. Research results are shared with the professional and lay community through contributions to guidelines or protocols, professional and popular publications, newspaper and broadcasting items, board membership of (inter)national public (societal) advisory groups and policy institutes, outreach activities and public-private collaborations.

Some highlights in 2015 were:

- On November 12th her Majesty Queen Máxima opened the three innovative operating theatres of MITeC.
- Dr Philip van der Wees was one of the two senior authors of the paper in which the Guidelines International Network released principles for disclosure of interests and management of conflicts in published guidelines (Schünemann et al. Annals of Internal Medicine, 2015).
- Prof. Maria Hopman was a member of the Health Council committee that wrote the guidelines ‘Goede Voeding 2015’ (good diets 2015) that were handed to the Minister of Health, Welfare and Sport.
- Dr Janneke Grutters was one of the authors of a practical guideline on the use of decision modelling in diagnostic imaging (Sailer et al. European Radiology, 2015).
- Spin-off SPL Medical, an enterprise for the production and registration (commercialization) of the contrast material Combidx, was founded with the involvement of Prof. Jelle Barentsz. Combidx-enhanced magnetic resonance imaging (MRI) is more effective than more invasive surgical processes for revealing small and otherwise undetectable lymph node metastases in patients with cancer.
- IQ healthcare coordinates a nationwide research project set up by the Netherlands Federation of University Medical Centers (NFU) that aims to learn how to de-implement ineffective healthcare.
- As president of the Dutch Society of Haematology Prof. Nicole Blijlevens appeared as an expert in the media (Interview on Radio 1 and several items in national newspapers) about the ‘no
pay no cure’ deal arranged with several insurance companies, a pharmaceutical company and the Dutch Society of Haematology.

- Prof. Bart Kiemenej wrote an opinion column in the newspaper the Volkskrant about an alternative for scientific publishing which received a lot of attention.
- Prof. Nico Verdoncklot gave an orthopaedic biomechanics course in India as part of the Global Initiative of Academic Networks (GIAN) scheme, aimed to boost the quality of the country’s higher education through international collaboration.
- Prof. Pim Assendelft is the national ambassador for community-based prevention, which is supported by National Institute for Public Health and the Environment (‘RIVM’) and the Dutch College of General Practitioners. Furthermore, he is chair of the Health Council committee on reorientation of financing university medical research.
- Prof. Jan Kremer is a member of the National Council for Public Health and Society (‘Raad voor de Volksgezondheid en Zorg’), which advises the Dutch government and parliament, and he is Chairman of the Advisory Committee Quality of the Dutch Health Care Institute (‘Zorginstituut Nederland’).
- Dr Eddy Adang, Prof. Pim Assendelft, Prof. Wil van den Bosch, Prof. Maria Hopman, Prof. Jan Keunen, Dr Nel Roolveled, Prof. André Verbeek and Prof. Gerhard Zielhuis are members of the Health Council of the Netherlands.
- Prof. Hans Kaanders, Prof. Pim Assendelft, Prof. Ellen Kampman, Prof. Bart Kiemenej Prof. Koos van der Hoeven, Prof. Judith Prins and Prof. Peter Siersema are members of the scientific council of the Dutch Cancer Society.
- Prof. Pim Assendelft, Prof. Judith Prins, Prof. Maroeska Rovers, Dr Tom Scheenen, Prof. Michel Wensing and Prof. Gerhard Zielhuis are board members of the Dutch Innovative Research Incentives Scheme (Rubicon-Veni – Vidi-Vici).
- Prof. Nicole Blijlevens is chair of the committee Costs and Effects of the ZonMw Cost and Effectiveness programme (DoelmatighedsOnderzoek).
- Prof. Gerard Rongen is a member of the Central Committee on Research Involving Human Subject (‘CCMO: Centrale Mensgebonden Onderzoek’).

**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 healthcare and patient-centred interventions. For example, the research within MITeC will start and the ambition is to further revolutionize surgical clinical science, so that surgical procedures will become more patient-tailored, safer and efficient. Furthermore, Dr Mireille Broeders’ group is evaluating tailored follow-up schedules for patients treated for breast or colorectal cancer with curative intent, based on the length of the preclinical detectable phase and taking into account benefits and harms as well as patients’ and health professionals’ views. The same group is also investigating the possibilities of personalised breast cancer screening. Prof. Judith Prins will start a new research line on blended psychotherapy (face-to-face combined with e-health) for cancer survivors.

Dr Teun Bouwema will extend his malaria research with a prestigious NWO Vidi grant for the project ‘Malaria gametocytes – seeds of dispersion’. Malaria spreads by mosquitoes that become infected after biting malaria infected humans. His research will determine when humans are first infectious and what strategies malaria parasites use to maximize their spread. Uncovering parasite and human factors that influence the spread of malaria may lead to new opportunities for malaria elimination.

With a Kolff postdoc grant from the Dutch Kidney Foundation for the project ‘Chronic kidney disease causes progressive decline of kidney function’, Dr Jan van den Brand will use novel statistical models to describe and predict commonly occurring trajectories of decline in kidney function. These trajectories give a more informative patient phenotype. Moreover, the trajectory for an individual patient can be extrapolated to make a detailed diagnosis. With a Horizon 2020 Marie-Curie Fellowship for the project ‘CARDI-ACHE: The cardiovascular consequences of endurance exercise’, Dr Thijs Eijsvogels aims to elucidate the clinical importance of exercise-induced cardiac troponin elevations and myocardial fibrosis in endurance athletes. Better understanding of the clinical relevance of these adaptations is important to differentiate between the beneficial and the potentially harmful effects of exercise.

The ageing of the Dutch population will present enormous quality and efficiency challenges in healthcare. Cost-effectiveness will be central to healthcare policy for the next few decades. Four research groups will perform research on healthcare costs and effectiveness with grants from the ZonMw programme ‘DoelmatighedsOnderzoek’. Dr Rianne Gerritsen (In vivo reflectance confocal microscopy, a novel non-invasive tool for diagnosing skin cancer – a randomized controlled trial), Dr Willem de Boode (BeNeDuctus Trial), Prof. Maroeska Rovers and Prof. Fred Witjes (RACE – RADicale Cystectomy Evaluation. Comparative Effectiveness Study of Open versus Robot Assisted Laparoscopic Surgery), Prof. Camiel Rosman en Prof. Maroeska Rovers (ICAN trial. Intrathoracic versus Cervical esophagogastric ANastomosis after minimally invasive esophagectomy for oesophageal cancer).

Prof. Barentsz and colleagues will investigate whether multiparametric MRI should be implemented in prostate cancer screening with an Alpe d’HuZes grant. Other projects that received awards from the Dutch Cancer Society are: ‘Uniform FDG PET-guided GRAdient Dose prEscription to reduce late Radiation Toxicity
(UPGRADE-RT): a randomised controlled trial with dose reduction to the elective neck in head and neck squamous cell carcinoma’ (Prof. Hans Kaanders), ‘Evaluation of bladder cancer care in the Netherlands; a solid foundation for evidence-based quality improvement’ (Dr Katja Aben, Prof. Bart Kiemeney, Prof. Fred Witjes), ‘Personalised RISk-based MAmmography screening (PRISMA) - from one-size-fits-all to a tailored approach’ (Dr Mireille Broeders), ‘Minimal invasive breast cancer excision using breast lesion excision system under ultrasound guidance - a feasibility study’ (Dr Ritse Mann), ‘Aptamer-based multivalent cancer therapeutics: the road to efficient breast cancer detection and treatment’ (Dr Paul Span), ‘Body composition in renal cell cancer: associations with survival outcomes, tumour characteristics, lifestyle habits, and circulating biomarkers’ (Dr Alina Vrieling, Prof. Ellen Kampman, Prof. Peter Mulders).

These are just some examples of ongoing and new research in the Institute. In the short term, the Institute aims to strengthen its expertise in, e.g., data engineering / big data in health sciences, in data integrity with the start of a digital research environment, and in healthcare research among refugees and low-income subgroups in the population. Also, in 2016 the Institute will implement the link between the Biomedical Sciences MSc Programme and the research in the Institute. Every MSc student will choose a principal investigator group in one of the three Radboudumc research institutes as a training environment. Students will be increasingly seen as new colleagues. The longer-term policy of the Institute, along with those of the other two Radboudumc Institutes, has been described in a recent publication: Research Agenda 2025 (www.rihs.nl/about-us/reports).
Researchers at the Radboud Institute for Molecular Life Sciences (RIMLS) seek to achieve greater insights into the molecular basis of disease. This is achieved by integrating molecular and medical research to obtain multifaceted knowledge of normal and pathological processes. Findings are translated into clinical applications, into the development of diagnostics, and into the treatment of patients as part of personalized healthcare.

RIMLS – a leading research institute that focuses on the molecular mechanisms of disease – brings together research groups from the Radboudumc and the Faculty of Science (FNWI) of the University. Clinical and fundamental scientists who specialize in diverse areas of the life sciences work together closely in programmes designed to understand the underlying causes of disease. In line with the Radboudumc’s strategic vision to have ‘a significant impact on healthcare’, research is bundled into clinically-orientated research themes ranging from molecule to man. The RIMLS Graduate School integrates a dedicated two-year Research Honours MSc programme in Molecular Mechanisms of Disease (MMD) and a follow-up four-year PhD programme, thus creating a challenging yet enriching international learning environment where researchers at all levels are exposed to societally relevant multidisciplinary research questions related to the molecular basis of disease.
Research themes
RIMLS research comprises 13 themes, which are described briefly below.

Cancer development and immune defence
The primary goal here is to gain insight into the molecular, genetic and epigenetic processes that lead to the transformation of normal (stem) cells into malignant cancer cells. Insights into tumour microenvironments and interactions between the immune system and cancer are translated into specific forms of therapy, targeting the affected molecular pathways, and using (modified) immune cells to target tumour cells.

Rare cancers
Despite the rarity of each of the 186 rare cancers, they represent in total about a quarter of all cancer cases. Examples include head and neck cancer, sarcoma, thyroid cancer, neuroendocrine cancer, brain tumours, lymphoma, and paediatric cancer. The mission of this group is to improve diagnosis and prognosis for this patient group in both a national and international collaborative setting.

Tumours of the digestive tract
Research focuses on improving the prognosis and treatment of patients with tumours of the digestive tract, in particular colorectal and pancreatic cancer. Key objectives are to develop diagnostic tools for staging and therapy response, and to innovate in surgical techniques and immunotherapy. Improving knowledge of the aetiology, epidemiology and genetics of these tumours will improve cancer therapy in high-risk patients.

Urological cancers
Research is designed to identify and evaluate the effectiveness of new biomarkers and imaging techniques for risk, diagnostic, prognostic and predictive assessment in prostate, bladder and kidney cancer. In addition, the intention is to evaluate new and existing prevention and treatment modalities for these types of cancer. Synergistic multidisciplinary research collaboration – from molecular life sciences to population sciences – is the tool to ensure that there is a strong focus on ‘utility’ for patients and public health.

Women’s cancers
Central to this theme is improving patient-centred quality of care in women’s cancers (breast, ovarian, cervix, vulva, endometrium, and pregnancy-related) in partnership with patients. This includes prevention, early diagnosis or implementation of new management strategies, supported by a better understanding of carcinogenesis and tumour development, with special attention being paid to hereditary causes, preservation of fertility and personalized care after treatment.
Infectious diseases and global health
The mission within this theme is to achieve national and international leadership in research and research training in infectious diseases, immunity and global health. The main aim is to improve the diagnosis, treatment and prognosis of patients with infections through fundamental, translational and epidemiological-based investigative approaches to studying disease pathogenesis.

Inflammatory diseases
In the Western world, chronic inflammation is among the leading causes of morbidity and mortality. Central to this theme is understanding and controlling inflammatory disease for the benefit of patients by i) unravelling the (immune)pathogenesis of inflammatory disease processes; ii) elucidating the role of tissue specific factors in the regulation of local immunity and inflammation; iii) identifying druggable targets and biomarkers; iv) developing clinical grading tools; v) carrying out pharmacogenetic and epidemiological studies.

Mitochondrial diseases
The mission of researchers working on this theme is to understand the cellular bioenergetics in health and disease at all levels of complexity. The knowledge gained will make it possible to develop preventive measures and contribute substantially to the development of treatment strategies for mitochondrial diseases.

Reconstructive and regenerative medicine
This theme focuses on the development and clinical translation of innovative diagnoses and therapies – including regenerative medicine and nanomedicine – for personalized care and cure of patients needing reconstruction of lost or damaged tissues. This is achieved by transdisciplinary research involving leading research groups in medicine, dentistry, biochemistry, chemistry, biology and materials science.

Renal disorders
Current and future care of patients with renal and renal-related disorders can be improved considerably. To achieve this, the researchers aim to i) increase insight into the molecular and immunological basis of rare glomerular and tubular disorders; ii) develop biomarkers for optimal prediction of prognosis; iii) develop strategies for the prevention and improvement of renal replacement therapy.

Vascular damage
Early detection of atherosclerosis, primary and secondary prevention of atherosclerosis, optimal treatment of atherosclerosis to preserve end organ function, and implementation of effective diagnostics and therapies in practice are the key focus areas of this theme. The researchers probe the causes and consequences of vascular injury and translate this knowledge into improved personalized cardiovascular healthcare.

Sensory disorders
Research focuses on elucidation of the molecular mechanisms of retinal diseases, hearing impairment and deaf-blindness. By developing and improving diagnostic and predictive tests for sensory diseases, researchers hope to bring new personalized rehabilitation strategies and therapies, e.g. gene therapy and retinal implants, into the clinic.

Nanomedicine
This mechanism-based theme focuses on the design, synthesis and characterization of molecules and molecular assemblies in order to elucidate structure and function of natural systems. Knowledge gained is applied to developing nanostructured devices for diagnostics, targeted delivery and tissue repair. Examples include artificial cells, molecular probes and tissue-mimetic materials.

Research facilities
The Radboudumc Technology Centres are linked to the Radboud University Research Facilities. Through this cooperation, a wealth of expertise is available that can be used to answer a wide variety of research questions. These facilities include:
- The Centre for Molecular and Biomolecular Informatics brings together experts from a range of disciplines e.g. sequence analysis, comparative genomics, in-silico drug design, systems biology, and protein structure analysis.
- The Genomics technology centre has four subunits: DNA isolation, DNA biobanking, high-throughput sequencing using targeted strategies and genome-wide sequencing strategies.
- The Mass spectrometry technology centre consists of strong analytical knowledge hubs that share hardware, protocols and reagents, and perform joined projects within proteomics, glycomics and metabolomics.
- The Microscopy facility forms a fully integrated multi-department centre with approximately 35 instruments hosted by several departments of the Radboudumc and the FNWI. Unique systems with national and international outreach include intravitral multiphoton microscopy, automated microscopy and 3D electron microscopy.
- The Central animal facility offers expert advice and access to facilities for animal testing and several disease-related animal models.
- The Imaging technology centre provides cutting-edge technology and service for in vivo imaging-related preclinical and clinical research questions.
- The MITeC technology centre integrates the development and evaluation of medical technology to deliver image-guided treatment in a patient-centred and cost-effective way.
- The Investigational Medicinal Products (IMP) technology platform enables the development, validation and production of IMPs according to European Good Manufacturing Practice regulations in order to produce novel imaging tools for diagnostics or develop novel radiopharmaceuticals, nanoparticles or cellular therapies.
in Barcelona. An official agreement has been made to participate in each other’s research and educational programmes. On 3 June 2015, Prof. Paul Smits, Dean of Radboudumc, signed an agreement with Prof. Joan Guinovart, the Director of IRB. This umbrella agreement paves the way for further strengthening of existing exchanges and exploring new opportunities for collaboration. Furthermore, IRB Masters students will be able to participate in the RIMLS Molecular Mechanisms of Disease (MMD) training programme.

Research results

Understanding the molecular mechanisms of disease is the common factor behind all of our research achievements, some of which are highlighted below.

Dr Willem Leenders and his colleagues working in Nanomedicine published data identifying a novel gene mutation in gliomas and thus achieved new insights that are potentially important for treatment. These findings have been filed in a patent application and licensed to a biotech company for further development.

Within the same research theme, Prof. Otto Boerman's research team developed a novel imaging technique for non-invasively determining programmed death ligand 1 (PD-L1) protein expression in tumours and metastases. In future, this technique could be used to select patients for anti-PD-L1 anti-cancer treatment, thus reducing unnecessary treatment costs and treatment-associated side-effects.

Prof. Gosse Adema (Cancer development and immune defence) demonstrated that rationally designed sialic acid-blocking compounds formulated into nanoparticles coated with tumour-specific antibodies successfully prevent metastasis of cancer. Cysteine cathepsins are important regulators of both health and disease. To investigate mechanisms important for cathepsin S mediated pathology, reliable molecular tools that can monitor...
Key publications

**Theme: Nanomedicine**


**Theme: Cancer development and immune defence**


**Theme: Tumors of the digestive tract**


**Theme: Urological cancers**

**Theme: Infectious diseases and global health**


**Theme: Inflammatory diseases**


**Theme: Mitochondrial diseases**

cathepsin S activity are needed. Dr Martijn Verdoes (Cancer development and immune defence) and his colleagues have developed a novel probe that selectively targets cathepsin S, which can be used to non-invasively image cancer cells in mice. In mammals, gender is determined by ‘sex’ chromosomes. Males have a single X chromosome, whereas females have two copies of this chromosome. To compensate for this difference, female cells shut off one X chromosome during early embryonic development in a process called X inactivation. The group led by Prof. Henk Stunnenberg (Cancer development and immune defence) published new insights into the dynamics of gene silencing during X-inactivation.

Dr Marjolijn Ligtenberg (Tumours of the digestive tract) further defined internationally accepted criteria for accurately identifying individuals with pathogenic mutations in E-cadherin (CDH1), a gene known to cause a predisposition to gastric and breast cancer. Using whole-exome sequencing, Prof. Nicole Hoogerbrugge (Tumours of the digestive tract) and her colleagues have identified a rare novel genetic cause of adenomatous polyposis (AP), an inherited disorder characterized by cancer of the large intestine (colon) and rectum. Prof. Jack Schalken (Urological cancers) and co-workers have developed a novel urine test that can be used to select patients for whom a prostate biopsy is needed. The SelectMDx test should lead to a significant reduction in the number of unnecessary biopsies.

Dr Ronald van Rij (Infectious disease and global health) and his colleagues discovered a new antiviral pathway that could lead to new opportunities for limiting virus replication in mosquitoes. Dr Richard Notebaart (Infectious disease and global health) developed a computational method for quantitative identification of cancer gene interactions whereby the under-expression of one gene combined with the over-expression of a partner gene is lethal. This method offers the promise of a new approach to killing cancer cells.

Prof. Anna Simon (Inflammatoy diseases) and her colleagues published results furthering understanding of the genetic mechanisms involved in the onset of Schnitzler’s syndrome, a rare auto-inflammatory disease. Rheumatoid arthritis (RA) is a chronic autoimmune disease that affects the joints of 1% of the world population. Dr Fons van de Loo (Inflammatory diseases) and his colleagues have developed a gene therapy tool which allows auto-regulated production of the anti-inflammatory protein interleukin-10 by cells in the joint. This approach could replace the current strategy of weekly injections and resultant side-effects. Dr Peter van der Kraan (Inflammatory diseases) and his colleagues discovered that BMP2 protein doesn’t alter the course of cartilage damage in osteoarthritis, a joint disease that results from breakdown of joint cartilage and underlying bone, but rather aggravates formation of osteophytes (bone spurs).

In a ground-breaking paper in Science, Prof. Ulrich Brand (Mitochondrial diseases), delineated the crystal structure of mitochondrial complex I, thus paving the way for further understanding of the molecular mechanisms of mitochondrial disorders. Prof. Frans Russel (Renal disorders) and his colleagues explained the onset of myopathy, the most common side-effect of statins. Statins are a group of commonly prescribed cholesterol-lowering drugs that effectively reduce the risk of major cardiovascular events. The observed results – involving mitochondrial complex III – will allow scientists to explore strategies for improved inhibition of cholesterol synthesis without impacting muscle bioenergetics.

Dr Willeke Daamen (Reconstructive and regenerative medicine) demonstrated a novel technology that can create and control the architecture of collagen constructs for applications in tissue engineering and regenerative medicine. Dr Roos Maasreew (Renal disorders) and her colleagues developed a living dialysis membrane consisting of functional human renal tubule cells that form an important step in the development of a bio-artificial kidney device.

Prof. Niels Riksen (Vascular damage) and his colleagues showed that metformin does not protect the heart in patients undergoing cardiac surgery (in contrast to earlier reports). Dr Hedi Claahsen van der Grinten (Vascular damage) reported on the role of adrenal steroid metabolites in congenital adrenal hyperplasia (CAH), a rare congenital disorder of the adrenal cortex.

Researchers working on the Sensory disorders theme published research elucidating the molecular genetic background of patients with chronic central serous chorioretinopathy (cCSC), a disease that causes blurry vision and is often misdiagnosed as a subtype of age-related macular degeneration (AMD). The results may impact patient care in the future, as therapies for cCSC and AMD are different. Prof. Hannie Kremer (Sensory disorders) identified a genetic cause of unilateral and asymmetric hearing impairment, thus enhancing the understanding of hearing disorders.

**Societal impact**

RIMLS’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 emphasized in education and research at RIMLS. Training researchers in life sciences is of great importance for society, since those currently working at RIMLS will form a new generation of scientists and biotechnology entrepreneurs who will develop novel treatments and diagnostics. The MMD master programme was rated first in the category Life Sciences in the Netherlands in 2012 and 2014 (Top-rated programme), and second in 2013 and 2015 (Keuzegids Masters), illustrating a strong commitment to excellent education at the institute.
Key publications

**Theme: Reconstructive and regenerative medicine**

**Theme: Renal disorders**


**Theme: Vascular damage**


**Theme: Sensory disorders**


Dissertations: 70
Scientific publications: 1432
Patents: 11
RIMLS researchers contribute actively to the dissemination of research results via public conferences, teaching in schools and colleges as well as in the media. Some examples: Dr Sanne Botden (Reconstructive and regenerative medicine) won the ZonMw Medical Innovation Prize for a patch that can be used to treat babies with a hole in the diaphragm (the patch received sixty percent of the over 19,000 ‘likes’ on Facebook) and Prof. Frans Russel (Renal disorders) appeared regularly in the media to discuss recent innovative research on cholesterol-lowering drugs (statins). Public outreach is considered to be very important. RIMLS – together with researchers working on the sensory disorders theme – organized a patient evening on inherited blindness. Likewise, Prof. Jan Smeitink (Mitochondrial medicine) organized a patient information day for patients with mitochondrial disorders as well as their families and carers. On World Kidney Day a large multidisciplinary team of researchers working on the Renal disorder theme made a seminal public contribution to raising awareness about kidney disease.

RIMLS researchers are actively involved in enhancing disease diagnosis, prevention and treatment. Their efforts have been acknowledged in high-level awards. Of particular note, Prof. Anneke den Hollander (Sensory disorders) received the Cogan Award, which recognizes promising researchers who have made important contributions to research in ophthalmology and visual science. Prof. Peter Friedl (Cancer development and immune defence) was awarded the 2015 Faculty Excellence Award by the MD Anderson Cancer Center, Texas, USA. Prof. Mihai Netea (Infectious diseases and global health) was elected as a member of the Academia Europaea.

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. Prof. Joost Drenth (Renal disorders), became an Honorary Member of The Hungarian Society of Gastroenterology. Prof. Leon Massuger (Women’s cancer) launched the national charity Ruby and Rose to raise money and awareness for research into ovarian cancer.

**Future research**

The following impressive Veni and Vidi grants from the Netherlands Organisation for Scientific Research (NWO) and European Research Council (ERC) subsidy were awarded to members of RIMLS, forming the basis for important future research:

- Dr Martijn Verdoes (Cancer development and immune defence) received a €1.5 million ERC starting grant for his research
proposing, which was entitled 'Checkpoints in Check: Novel Chemical Toolbox for Local Cancer Immunotherapy'. Dr Martijn Verdoes was also successful in obtaining a €1.1 million Tenure Track Fellowship from the Institute for Chemical Immunology (www.chemicalimmunology.nl), to further his research on chemical immunology.

- Three RIMLS researchers were awarded NWO Vidi grants – each worth €800,000 – to develop innovative lines of research: Dr Geert van den Bogaart (Cancer development and immune defence): *Activation of the immune system*, Dr Bart Sneets (Renal disorders): *Damage control in progressive kidney disease*, and Dr Bas Dutilh (Tumours of the digestive tract): *Bacteriophages in the human gut.*

- Five RIMLS researchers were awarded NWO Veni grants, each worth €250,000 to develop innovative lines of research. Dr Annemarie Boeij (Tumours of the digestive tract): *Do intestinal bacteria increase the risk of colon cancer in ulcerative colitis?*, Dr Ellen van den Bogaard (Inflammatory diseases): *Get rid of that itch!*, Dr Shih-Chin Cheng (Infectious diseases and global health): *The role of energy metabolism in the immune system*, Dr Janna van Diepen (Mitochondrial diseases): *The relationship between diabetes and arteriosclerosis*, and Dr Wouter Verdurmen (Nanomedicine): *Protein therapeutics against cancer.*

Furthermore, a number of large (consortium) grants were obtained:

- Prof. Carl Figdor (Cancer development and immune defence) received a large EU consortium grant (ENSA, €7.6 million) to develop and clinically test biodegradable nanomedicines for cancer immunotherapy.

- Dr Henri Timmers (Vascular damage) and his colleagues received a consortium grant (ENSAT, €7.6 million) to develop ‘omics-based’ strategies for improved diagnosis and treatment of endocrine hypertension.

- Several researchers from the sensory and inflammatory disease themes were awarded an EU consortium EYE-RISK grant (€6 million) to explore the combined roles of genetic and non-genetic factors in developing age-related macular degeneration.

- In 2016 a large European study (MDS-RIGHT, €6 million) for better diagnosis and treatment of severe anaemia and myelodysplastic syndromes will start to determine optimal treatment. The project will be coordinated by a core team from the Radboudumc consisting of Dr Gerwin Huls and his colleagues (Cancer development and immune defence).

- Profs. Niels Riksen (Vascular damage), Mihai Netea and Leo Joosten (Infectious diseases and global health) will participate in a large study (REPROGRAM, €6 million) of immune epigenetic reprogramming trained immunity in atherosclerosis. The aim of the study is to identify novel diagnostic targets and determine optimal treatment.

- Drs. Rogier Thurlings and Peter van Lent (Inflammatory diseases) will participate in a large EU consortium, ADIPOA-2, that is developing novel cellular therapies for treating osteoarthritis.

- An international training network (ITN) grant has been awarded to a consortium of European researchers coordinated by Prof. Jan van Hest (Nanomedicine). The focus of the network is to educate a new generation of young scientists in developments in nanomedicine, from particle synthesis and characterization to pharmacokinetics and bio-distribution.

- Prof. Gosse Adema (Cancer development and immune defence) also received an EU ITN grant (IMMUTRAIN, €3.9 million) for development of immunotherapy against cancer.

- Dr William Leenders (Nanomedicine) received a €1.9 million grant from Eurostars for a project designed to develop diagnostic blood-based tests for detection of cancer-causing genes in patients.

- An Alpe d’HuZes grant (€1 million) was awarded to Dr Jeroen van der Laak (Women’s cancers) and Prof. Iris Nagtegaal (Tumours of the digestive tract) to develop advanced image analysis software as prognostic tools for colon, breast and liver cancers.

- Drs. Gerben Ferwerda and Marien de Jonge (Infectious diseases and global health) have been awarded an EU consortium grant (PHC-10) to develop advanced miniaturized diagnostics for Respiratory Syncytial Virus infections in children.

- Drs. Toin van Kuppevelt and Willeke Daamen (Reconstructive & regenerative medicine) received a €600,000 consortium grant to improve lung regeneration in emphysema patients.

In addition to these grants, numerous personal subsidies from diverse national and European agencies have been awarded, forming the basis of research for 2016 and beyond. Full details can be found on the RIMLS website (www.RIMLS.nl).

### Academic integrity

Use of honest and transparent working ethics as well as clear rules of accountability play a pivotal role in research at RIMLS and all researchers are expected to comply with the academic integrity policies laid down by the Radboud University. These regulations are published on various websites. Promoting awareness of academic integrity is equally important and RIMLS continues to raise awareness of this topic in Masters and PhD programmes. In our Masters course ‘Science and Society’, students are shown how to recognize ethical and social questions and how to address these issues through practical and theoretical analyses. Furthermore, students discuss academic misconduct and integrity, e.g. in issues arising in data management, data analysis and scientific authorship. Societal and ethical issues may arise at any stage in a scientific career, and therefore, PhD candidates in their second year follow a compulsory two-day follow-up course. The goal here is to further develop integrity as a professional competency. Real problems are introduced by the students as ‘cases’ and matters relating to politics and media are analysed. Uniquely, senior researchers are also involved in the course, creating and maintaining awareness at all stages of participants’ careers. The Radboud Postdoc Platform also regularly organizes workshops on academic integrity.
Director: Prof. René Bindels

René Bindels has been Professor – and has held the Chair – of Physiology since 2003. After a postdoc position at the University of Alabama in Birmingham, USA, his research focused on regulating ion transport processes in the kidney and intestine (in health and disease) and he currently specializes in renal TRP channels and salt transporters. Prof. Bindels is an elected member of the Academia Europaea and a recipient of the Robert Pitts Lectureship of the International Union of Physiological sciences, the Carl W. Gottschalk Lectureship of the American Physiological Society and the Homer Smith Award of the American Society of Nephrology.

Academic integrity policy will be further expanded in 2016 with the campus-wide implementation of a digital lab-book licence which will promote transparent, traceable data storage and analysis. This concept is being further explored in ongoing efforts to set up an extensive Digital Research Environment (DRE) that will allow researchers to import, merge, optimize, store, analyse, archive and share research data in a more secure and traceable fashion.
The IWWR encourages interdisciplinary cooperation among scientists engaged in microbial, animal, plant and environmental science. The Institute integrates these disciplines in several themes and encourages joint research that enhances understanding of interactions between different life forms as well as the way they interact with their habitats. Based on novel fundamental insights into these processes, the Institute makes a significant contribution to innovative solutions to urgent global water problems.

The main aim of IWWR is to become a world-class multi-disciplinary Institute for water and wetland research, with a strong emphasis on understanding the environmental stress responses and adaptations of wetland systems at various levels of organization: from the cellular level via the organism to the ecosystem. Another important strand of research is explaining the ways in which plants, animals and micro-organisms adapt to changes in water quantity and quality. In addition to discipline-specific research, there are five research themes, which focus on adaptations to stress 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, postdocs and tenure track scientists, as well as for collaborators and a range of other stakeholders.

These interdisciplinary themes are Microbial Biogeochemical Cycles, Plant Stress Responses, Animal Stress Responses, Conservation Biology and Human-Environment Interactions. Researchers working on each theme study mechanisms of adaptation to environmental stressors for particular sets of...
Research facilities

All 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:

- A new greenhouse – together with climate room facilities and the Phytotron – was officially opened in 2015.
- PHYTOTRON – a unique national research facility for detailed ecological research on sub-surface processes of terrestrial and semi-aquatic vegetation.
- State-of-the-art light microscopy and electron microscopy facilities for ultrastructural analysis of micro-organisms, animals and plants.
- Extensive bioreactor and culture facilities for Micro-organisms extended in 2014 with a brand new lab to accommodate the NWO Gravitation research of Microbiology wetland plants and animals, as well as for plant-soil interactions.
- Gas Chromatography and Mass Spectrometry (equipped with a direct thermo-desorption unit).

Collaboration

Collaboration within the Institute opens up avenues for novel interdisciplinary research as well as more opportunities for funding. In the context of the Dutch ‘Top sectors’ that have been identified by the government as being of great economic significance, new collaborative research projects for innovation have been started. Researchers working on the Plant Stress Response theme are working together with several companies in their research on multiple plant stressors and they have obtained substantial grants from the Top sector Agrofood and Horticulture and The Dutch Technology Foundation (STW).

The IWWR has been involved in plans for regional development in which provinces, water management authorities and companies (including spin-off company B-Ware) interact. These plans, which were launched as ‘Waternext’, have considerable relevance for the Top sector Water. They are first being applied in the region between the cities of Arnhem and Nijmegen. Research on the Animal Stress

Intensive collaboration between people working on these themes has resulted in powerful interdisciplinary consortia that carry out top-level research.

One of the centres of excellence at the University is Microbiology. The success of researchers working in this field can be attributed to intensive national and international collaboration with experts covering a wide range of disciplines (Geology, Biochemistry, Structural Biology, Genetics and Metagenomics) and these also include wetland bio-geochemists working on Microbial Biogeochemical Cycles. Researchers with a variety of disciplinary backgrounds collaborate in a similar way, creating opportunities for funding and novel research.

Research facilities

Research funding

- Large aquarium facilities for freshwater and seawater fish; for zebrafish research there is modern equipment, expertise and permits for producing transgenes.
- 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.

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Responses to marine and wetland research continue to attract interest from fish aquaculture practices in the Netherlands and abroad, contributing significantly to discussions on fish welfare; there was considerable interest in interactive courses on fish welfare in the Netherlands.

The following structural national collaborations exist with (funding agencies included):
- Radboud University Medical Centre (NWO Gravitation grant SIAM)
- Delft University of Technology (NWO gravitation grants, ERC)
- Wageningen University and Research Centre (NWO gravitation grant SIAM, other NWO grants)
- NIOZ Royal Netherlands Institute for Sea Research (NWO gravitation grant NESSC, ERC, STW, NWO)
- University of Utrecht (NWO Gravitation grant NESSC, STW, NWO)
- Netherlands Institute of Ecology (NIOO) (NWO)
- B-Ware, spin-off company (provincial authorities, water boards, Ministry of Economic Affairs)
- Natuurplaza NGOs on campus (NWO)
- Institute for Public Health and the Environment (RIVM)
- University of Utrecht (NWO Gravitation grant NESSC, STW, NWO)
- University of Juiz de Fora, Brazil (NWO, the Brazilian Government)
- Uni Research AS (Bergen, Norway).

Internationally the Institute structurally collaborates with:
- Max Planck Institute for Marine Microbiology (Bremen)
- Max Planck Institute for Medical Research (Heidelberg)
- Max Planck Institute for Demography (Rostock)
- University of Juiz de Fora, Brazil (NWO, the Brazilian Government)
- University of Utrecht (NWO Gravitation grants, ERC, STW, NWO)
- University of Juiz de Fora, Brazil (NWO, the Brazilian Government)
- Uni Research AS (Bergen, Norway).

Research results
IWWR microbiologists made several discoveries including the identification of bacteria capable of complete nitrification (van Kessel et al. Nature). Through synergistic research using state-of-the-art and complementary methods the bacteria were discovered and identified as Nitrospira. This is one of the unknown bacteria that were predicted to exist but had escaped identification until now. Important new findings of this group include unravelling the crystal structure of the important protein complex hydrazine synthase of anammox bacteria that is responsible for the production of hydrazine (rocket fuel) (Dietl et al. Nature), and important properties of the anammox cell wall (van Teeseling et al. Nature Comm).

Animal physiologists are successfully using zebrafish as a model species for translational medicine, and in particularly applied studies on fish scales for bone formation and stress physiology (de Vrieze et al. Bone). Work by plant scientists on tomato fruit setting in collaboration with researchers from Bayer CropScience (Nunhems) was the basis for a patent application that was filed previously (de Jong et al. J Exp Bot). This collaboration is being extended with a second seed company (ENZA seeds) to include working on the effect of heat stress on pollen and fruit production in tomato. This work is further supported by two EU Marie Curie grants.

The IWWR’s aquatic ecologists have summarized their work in two reviews on the anthropogenic impacts of coastal ecosystems (van de Koppel et al. Ann Rev Marine Science) and freshwater fens, including targets for restoration (Lamers et al. Biol Reviews). How flooding and resource availability together affect the stability of ecosystems has been the topic of study of the plant ecologists, changing our view on how biodiversity buffers environmental disturbances (Wright et al. Nature Comm). Animal ecologists developed new methodologies for stochastic population modelling (Metcalfe et al. Methods Ecol Evol). In a study published in Nature Climate Change (Elshout et al.), the IWWR’s environmental scientists calculated realistic annual greenhouse-gas payback times for crop-based biofuels.

Societal impact
The IWWR contributes to solutions for some of the pressing water problems in the world. It does so by establishing close relationships based on novel insights between researchers at the Institute and external stakeholders. Such intensive interactions lead to solutions for urgent societal problems as well as new fundamental research. Novel insights into nature and water management are applied in collaborative studies with governmental and non-governmental organizations, water boards, as well as national, regional and local authorities.

The IWWR collaborates with a large number of companies and partners engaged in nature and water management. The microbiologists showed that anammox bacteria can remove nitrogen compounds from wastewater at low temperatures, using both ammonium and methane as an electron donor, thus considerably extending the application of these processes in municipal wastewater treatment systems. This work was boosted by an NWO Gravitation grant.

Aquatic Ecology and Environmental Biology, together with its spin-off company B-WARE Research Centre, has a longstanding tradition in applied ecological research on major global environmental issues (e.g. climate change, water quality and water quantity). A large suite of projects in 2015 have focused on evidence-based ecosystem management and restoration, including combined water storage and purification (Rich Water World), greenhouse-gas research in temperate and tropical lakes, the restoration of coastal areas based on species interactions, natural capping of landfills (PeatCap), and paludiculture (wet agriculture) in relation to land subsidence (Cinderella).
Applications in nature management are used to enhance the value of the Conservation Biology theme at IWWR. After a groundbreaking Nature publication on decline in bird species in relation to neonicotinoid insecticides which resulted, for example, in questions in the Dutch parliament, new work was started to unravel the cause and effect relationships. This requires more work on insect abundance in relation to neonicotinoid pollution, as a decline in insects is a likely cause of the decline in bird numbers. Funded by grants from the Triodos Foundation and NWO, this new work is immediately relevant for policy makers and the public.

Other successful applications of IWWR research include longstanding collaborations with seed companies designed to improve plants’ responses and tolerance to environmental stress factors such as heat and insect attacks. Biotechnology companies also use IWWR results e.g. to improve fish welfare. In addition, courses for various stakeholders were organized.

Future research
The Department of Environmental Science obtained an EU Marie Curie grant for five PhD projects, in cooperation with Unilever UK. The objective is to develop environmental footprints for consumer production, with a specific focus on energy, water, land and chemicals. Likewise, funding from the Dutch government was obtained to study and regulate invasive species.

The microbiologists at IWWR will continue to investigate the role of anaerobic methane 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, supported by an ERC Advanced Grant recently obtained by Prof. Huub Op den Camp. The microbiome of several relevant wetland plant and animal species will be investigated (together with the aquatic ecologists at the Institute). Various anaerobic microbial processes will be investigated in the SIAM Gravitation Consortium. Work on the cell biology and biochemistry of anammox bacteria will focus on the elucidated cell wall and various protein complexes.

The current biogeochemical and ecological research of the Aquatic Ecology group will be extended to include novel applications related to the restoration of heavily disturbed wetlands (e.g. the Wadden Sea, peatlands and lakes), wet agriculture (paludiculture), coastal protection and the prevention of land subsidence. This work is supported by several new grants (including one from STW).

The objective of future research in Plant Science is to explore natural variation in plants and to identify new traits that can help 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 external colleagues. This work is linked to the plans of the Experimental Plant Ecology group, continuing their focus on root interactions in relation to environmental stressors and their effort to apply this knowledge to crop responses to drought and nutrients, as well as managing dike vegetation. This experimental work has received a boost from the official opening of the new greenhouse complex in 2015.

The Organismal Animal Physiology group is increasingly focusing on topics related to fish welfare. Facilities for studying fish behaviour (zebrafish phenotyping) are being explored in conjunction with companies. The group will intensify its research on energy and oxygen availability by increasing collaboration with the Animal Ecology group at IWWR.
Institute for Water and Wetland Research

Key publications


Dissertations: 14

Scientific publications: 168

Professional publications: 47
The animal ecologists at IWWR 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 mechanistically drive thermal performance responses in growth, maturation and reproduction.

The environmental scientists at IWWR intend to report global estimates of changes in land use (Life Cycle Analysis). They will continue to work on the fate, accumulation and toxicity of nanoparticles and pharmaceuticals, on arctic species, as well as on linking the extinction of species to historical data and understanding the impact of longitudinal dam constructions in rivers.
The Institute for Molecules and Materials (IMM) is an interdisciplinary Chemistry and Physics research centre. Its mission is to understand, design and control the functioning of molecules and materials. The institute is a centre of excellence that is training the next generation of leaders in science and entrepreneurship.

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

The institute employs around 150 PhD students and every year some 30 of them graduate. There is a strong focus on interdisciplinary research between theorists and experimentalists as well as between physicists and chemists.

Structure and Dynamics of Molecules
The focus within this research theme is 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 Nuclear Magnetic Resonance (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
Researchers working on this theme focus on studying the 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 such as those during exchange interactions, in sub-nanometre metal clusters (including metal-oxide clusters), and graphene and quantum dots. Properties are often studied under extreme conditions such as high magnetic fields, ultra-short laser pulses, and low temperatures, using the highest time (femtosecond) and spatial (atomic) resolution.

Materials Design
This research theme involves the design, growth, synthesis and characterization of materials and structures in which the properties typically stem from their nanoscale dimensions and/or their hierarchical structure. The aim of the research is to explore novel property-function relationships. The materials and structures include supramolecular assemblies, nano-reactors, self-assembled monolayers, chiral clusters, graphene, and solar cells. These materials/structures are typically studied using microscopy (including Scanning Probe Microscopy (SPM)) and X-ray diffraction.

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

• A High-Field Magnet Laboratory (HFML) for continuous fields up to 37.5 Tesla. A hybrid magnet for achieving 45 Tesla is being constructed.
• Free Electron Lasers for Infrared and Terahertz Experiments (FELIX) Laboratory. The infrared lasers (FELIX/FELICE) and the Terahertz laser (FLARE) are fully tunable between 3 and 1,500 microns.
• A Large-Scale Facility for high-resolution liquid NMR and a Solid-State NMR Facility for advanced material science, including an 850 MHz proton NMR instrument.
• A Scanning Probe Microscopy laboratory (NanoLab) with a wide range of Scanning Tunneling Microscopy (STM) and Atomic Force Microscopy (AFM) techniques.
• A Trace Gas Facility for the application of laser diagnostics in biology and medicine.

In 2015 the FELIX Terahertz laser was combined with the HFML magnet and the first successful experiments were performed. The combination of FELIX’s radiation in the infrared region and the continuous high magnetic fields at HFML offers scientists the possibility to study matter and materials under conditions that are unique worldwide.

Collaboration
IMM coordinates the NWO Gravitation programme “Research Center for Functional Molecular Systems” in which the organic chemistry groups at IMM collaborate with the Institute for Complex Molecular Systems (ICMS) at Eindhoven University of Technology and the Stratingh Institute for Chemistry at the University of 2015 RESEARCH REPORT 107
Groningen to construct functional life-like molecular systems. The organic chemistry groups also collaborate intensively with colleagues at the Catholic University of Leuven in Belgium.

The NMR groups of the IMM are a partner in the National Roadmap Large-Scale Infrastructure “An ultra-high-field NMR facility for the Netherlands,” which is developing high-field NMR methodology.

Three IMM research groups (Analytical Chemistry, Molecular and Laser Physics, NMR) are involved in TA-COAST: the public private partnership for innovative analytical science and technology in the Netherlands. Scientists and research facilities at the IMM are part of the Dutch Astrochemistry Network (DAN) funded by NWO to study the origin and evolution of molecules in space, and of a large pan-European partnership focusing on innovation in ‘raw materials’ (RawMatTERS). This consortium includes more than 100 partners from 22 countries in the EU. Moreover, IMM groups are involved in various EU-Horizon2020 consortia.

The IMM is a partner in two formal collaborations with the Foundation for Fundamental Research on Matter (FOM), concerning:

- The decade-long exploitation of the free electron lasers ‘FELIX and FELICE’ in Nijmegen.
- The joint running of the HFML and promotion of materials research with high magnetic fields.

HFML coordinates the European Magnet Field Laboratory (EMFL), which develops and operates world-class high magnetic field facilities. The Engineering and Physical Sciences Research Council (EPSRC, UK) extended an access contract on UK use of the free electron lasers at FELIX and started a distributed research grant on solid-state physics operated by the University of Surrey.

Within graphene research, the groups at the IMM led by Profs. Katsnelson and Maan collaborate closely with their ex-colleagues Profs. Geim and Novoselov (University of Manchester). Prof. Mikhail Katsnelson also works closely together with scientists at the Universities of Uppsala, Hamburg, and Moscow. The SPM group led by Prof. Alex Khajetoorians collaborates with the Institute for Storage Ring Facilities (ISA) and Interdisciplinary Nanoscience Center (iNANO) of Aarhus University. There are numerous other bilateral collaborations with research groups, at a range of European and non-European universities e.g. Tsinghua, Jilin, and Peking University in China.

**Research results**

Highlights are listed below under the Institute’s four main research themes.

**Structure and Dynamics of Molecules**

Dr Bas Van de Meerakker and his colleagues at Molecular and Laser Physics have imaged resonances in low-energy NO-He inelastic collisions in collaboration with the Theoretical Chemistry group led by Prof. Gerrit Groenenboom, resulting in unprecedented views into the most intimate details of molecular collisions: the evolution of the colliding particles from initial to final states and the associated trajectories or, in a quantum mechanical picture, the dynamics of individual partial waves. (*Science*)

Dr Anouk Rijs and her colleagues at Molecular and Biophysics have shown that far-infrared action spectroscopy in combination with BOMD simulations is a conformer selective and powerful approach that can be used to decipher structural and dynamical information of molecules via their soft, delocalized vibrations. (*Phys. Chem. Chem. Phys.*)

The Molecular Structure and Dynamics group (led by Prof. Jos Oomens) has studied naphthalene breakdown – a polyaromatic hydrocarbon molecule that is abundantly present in the interstellar environment – by infrared multiphoton dissociation (IRMPD) spectroscopy using FELIX. The C$_2$H$_4$-loss product formed was identified as pentalene+, providing the first unambiguous experimental evidence that acetylene-loss from naphthalene leads to the formation of (anti-aromatic) pentalene species. (*Chemical Communications*)

The Felix Users and Operators group, led by Dr Britta Redlich, has, in collaboration with groups from the UK, demonstrated laser control of quantum states in silicon and has observed these states using conventional electrical measurement. This discovery may bring us a step closer to a solid-state quantum computer. (*Nature Communications*)

Dr Lex Van der Meer’s Felix FEL Technology group has worked on two important technical breakthroughs: they completed the FLARE optical transport system between FLARE and the HFML and they succeeded in recommissioning FELICE.

Prof. Gerrit Groenenboom and his colleagues at Theoretical Chemistry have studied – in collaboration with the Molecular and Laser Physics group – forbidden molecular transitions, using collision-induced absorption spectroscopy, and have developed a new method for calculating collision-induced absorption spectra. This allowed them to study the effects of interaction anisotropy in a strongly anisotropic system. (*Journal of Chemical Physics*)

**Molecular Life-like Systems**

Prof. Ger Pruijn and his colleagues at Biomolecular Chemistry have identified specific auto-antibodies with diagnostic value for the auto-immune disease inclusion body myositis. A patent application has been filed and a licence-agreement was made with the German company Euroimmun, who have developed a standardized blood test, which will soon become available for clinical chemical laboratories. (*Annals of the Rheumatic Diseases*)

The group led by Prof. Lutgarde Buydens (Analytical Chemistry) has developed and implemented new comprehensive chemometric
solutions in breath analysis in two application areas: clinical chemistry and aroma-release from food products. The group collaborated with Molecular and Laser Physics, Unilever (in a Ti-COAST project) and Radboudumc. (Analytical Chemistry, Journal of Breath Research)

Researchers in the Bio-Organoic Chemistry group (led by Prof. Jan Van Hest) developed and studied a nanomotor with chemotactic behaviour which could move against flow. This nanomotor may be used to deliver drugs to late-stage tumours where high interstitial pressure inhibits the use of current delivery agents. (Angew. Chemie Int. Ed.)

Prof. Wilhelm Huck and his Physical Organic Chemistry group have looked at environmental effects on gene expression. The group showed that the composition of the environment is very important for gene expression, suggesting that the environment should be taken into account when studying cellular reactions. (Nature Nanotech)

The Biophysical Chemistry group (Dr Marco Tessari) and the group led by Prof. Floris Rutjes (Synthetic Organic Chemistry) have improved the Signal Amplification By Reversible Exchange (SABRE) technique, a nuclear spin hyperpolarization technique that improves the sensitivity of NMR, by for example, in situ hyperpolymerization. Analytes at sub-micromolar concentrations in solution, such as dilute flavour compounds in coffee and doping substances in urine can now be detected and quantified. (Angew. Chemie Int. Ed.)

Quantum Matter
The group led by Prof. Nigel Hussey (Correlated Electron Systems, HFML) has found unambiguous evidence for low temperature diamagnetism, a property associated with superconductivity, at magnetic fields far above the zero-resistance state of the high Tc cuprate superconductor YBa₂Cu₃O₇. These findings shed light on a poorly understood and contentious region of the cuprate phase diagram. The measurements were jointly carried out at the HFML and the pulsed field magnet laboratory in Los Alamos, USA. (Phys. Rev. B)

Dr Uli Zeitler and his colleagues at Semiconductors and Nanostructures, HFML have revealed, in a collaboration with the Universities of Groningen and Hong Kong, that transistors made from ionic-gated ultrathin MoS₂ not only superconduct at low temperatures but also continue to superconduct in a high magnetic field. This phenomenon might provide a basis for future innovative spintronic devices. (Science)

The Spectroscopy of Surfaces and Interfaces group (led by Prof. Theo Rasing) discovered a conceptually new approach for an ultrafast tunable magneto-optical modulation achieved with the help of counter propagating laser pulses inside a transparent medium. (Nature Photonics)

Prof. Andrei Kirilyuk and his Atomic Nanostructures group studied the interaction of atomic motion with the electronic system of solids. This interaction is crucial for a wealth of material properties, such as conductivity. The interaction was studied in a model system of atomic clusters by pumping selected cluster vibrations with the FELIX laser and directly probing the response of the electronic system.

Profs. Mikhail Katsnelson and Annalisa Fasolino (Theory of Condensed Matter) have studied the properties of 2D graphene in a 3D space using simulations. They found that the elastic moduli for graphene had strong size and strain dependence, which has recently also been observed experimentally. This property is expected to be common to all 2D materials embedded in 3D. (Physical Review Letters)

Materials Design
The Applied Materials Science group (led by Dr John Schermer) worked on thin-film Epitaxial Lift-Off (ELO) III–V solar cells,
Key publications


which offer excellent characteristics for implementation in flexible solar panels for space applications. They showed however that copper diffusion might cause solar cell degradation when the cell is exposed to space conditions. For these applications a diffusion barrier or an alternative carrier material is thus required. *(Solar Energy Materials & Solar Cells)*

Understanding solid-state phase transitions in molecular crystals could allow the control of the stability of polymorphic forms, which is particularly interesting for the pharmaceutical and food industry. The Solid-state Chemistry, Solid-state NMR and Theoretical Chemistry groups developed a successful multidisciplinary approach in order to understand these transitions. *(Crystal Growth and Design and Faraday Discussions)*

Prof. Peter Christianen and his colleagues (Soft Condensed Matter & Nanomaterials, HFML) have studied single-layer transition-metal dichalcogenides, such as MoS$_2$, MoSe$_2$, WS$_2$ and WSe$_2$. These two-dimensional semiconductors have a honeycomb lattice, like graphene, but different properties. This makes them very promising for novel opto-electronic applications. *(Nano Letters)*

Prof. Alan Rowan and his colleagues at Molecular Materials have shown that matrix stress-stiffening should be taken into account as a mechanical cue in developments of future extracellular matrix mimetic biomaterials, as this has an effect on the fate of stem cells. *(Nature Materials)*

Dr Daniel Wegner and colleagues in the Scanning Probe Microscopy group (led by Prof. Alex Kajetoorians) visualized frontier orbitals of Pt complexes via scanning tunnelling spectroscopy and discovered ways to tune specific orbitals of these OLED molecules through targeted synthetic strategies. To demonstrate this, a tailored deep-blue triplet emitter was realized. This approach of finding and tuning electronic set screws constitutes a new strategy to design optoelectronic materials. *(Angew. Chem. Int. Ed.)*

The Solid State NMR group (led by Prof. Arno Kentgens) has studied the structure of tough multiple network elastomers by high-resolution solid-state NMR. They have found that the multiple cross-linked acrylate networks show a large gain in initial modulus and an up to 50 times increase in stress at break and fracture toughness, as compared to conventional single cross-linked networks.

**Awards and grants**

Several scientists at the IMM have received grants in 2015 for public private partnerships: Prof. Alan Rowan (Molecular Materials) received €2 million for a supergel for wound dressing (ZonMw). Dr Jasmin Mecinovic (Synthetic Organic Chemistry) obtained an €800,000 NCITA grant (NWO) for targeting histone lysine methyltransferases for cancer therapy. Dr Jeroen Jansen and Prof. Lutgarde Buydens (Analytical Chemistry) received a TA-COAST grant of €1 million for outfitting the future factory with on-line analysis. Prof. Elias Vlieg (Solid State Chemistry) has co-received a €3 million grant in a Chemical Industrial Partnership Programme (FOM and NWO-CW) to investigate the wetting behaviour of oil-electrolyte-mineral systems.

Prof. Floris Rutjes (Synthetic Organic Chemistry) and Prof. Elias Vlieg (Solid State Chemistry) both received a €100,000 grant from Radboud Research Facilities to extend an NMR machine and a single crystal diffractometer, which will both be made available to external users. The Applied Materials Science department received
Key publications


Dissertations: 36
Scientific publications: 317
Professional publications: 3
Patents 4

In addition, IMM wants to share its fascination with groundbreaking research with others. We therefore co-organize open days annually and invite high school students and their teachers to experience the inspiring research environment at the IMM. IMM also provides summer schools and participates in pre-university college education. Finally, IMM has contacts with popular scientific (web-based) media such as Kennislink.
Director: Prof. Elias Vlieg

Elias Vlieg has been Professor of Solid-State Chemistry at Radboud University since 1998. After a postdoc position 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 taken at 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.

Future research

The €27 million grant from the national investment in large infrastructures (NWO-BIG) in 2006 for the Nijmegen Centre for Advanced Spectroscopy (NCAS) provides the resources IMM needs to construct both a 45 Tesla hybrid magnet for the HFML (which will be ready in 2017), for creating research opportunities based on world-leading magnet technology, and a Free Electron Laser for research using Terahertz radiation (FLARE), to study magnetic excitations in molecules and for low-energy spectroscopy on large molecules and biomolecules. The coupling of the FLARE laser beam to the HFML high-field magnet provides a unique experimental set up, which IMM will continue to exploit in 2016.

The national Sector Plan for Physics and Chemistry (SNS) resulted in two new initiatives within IMM, namely in Chemical Biology and Advanced Spectroscopy of functional molecules and materials. This has led to exciting scientific results and, after two successful progress evaluations, the expectation is that SNS will continue as a structural source of funding after 2016.

The annual operational hours of the HFML have increased to 2,090 in 2015 and these will continue to increase in 2016. A challenge is the quest for structural funding for the operation of the HFML at the target level of 3,000 hours per year.

The NWO ‘Gravitation’ Research Centre for Functional Molecular Systems – in collaboration with partners in Eindhoven and Groningen – is of the utmost importance for IMM. The centre will be evaluated in 2016 and it’s expected that the remaining funding will subsequently be made available.

The Radboud Nanomedicine Alliance, a joint initiative of Radboud UMC, NCMLS, and IMM, focuses on developing new effective medicines and materials for the treatment of diseases, tailored to the situation of individual patients. As before, the available research facilities will be open for intense cooperation with chemical and biomedical industrial partners.

To continue the discovery and development of innovative materials, the IMM will actively pursue R&D funds that are available in the region (EFRO and Euregio) and will apply for funding from the Dutch ‘top’ sectors. Moreover, IMM will actively pursue funding for societal challenges within the European Framework programme and researchers will be encouraged to apply for individual grants.

Integrity

IMM follows ‘The Netherlands Code of Conduct for Scientific Practice’. Each new staff member is explicitly made aware of this document in the welcome letter they receive, and the code is listed on the IMM website. Implementation of this code is the task of senior researchers. A thematic afternoon on Scientific Integrity was organized and a course for all PhD students will be developed as part of their education programme.
The Institute for Mathematics, Astrophysics and Particle Physics (IMAPP) carries out 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
The main research areas of the Department of Mathematics are Mathematical Physics, Algebra and Topology, and Applied Stochastics. Overarching themes are the study of Symmetry and of Geometry in various incarnations, including noncommutative geometry, symplectic and Poisson geometry, as well as algebraic and arithmetic geometry. In addition to its disciplinary research, the department distinguishes itself from similar groups elsewhere by its active engagement in cross-disciplinary research together with researchers from other groups, notably those in Physics and Computer Science; and through the connections of the Applied Stochastics group with research groups from all over the university.

Astrophysics
Researchers at the Department of Astrophysics focus on five topics: compact objects (black holes, neutron stars and white dwarfs) in binary systems, supermassive black holes in the centres of galaxies, ultra-high-energy cosmic rays, gravitational wave astrophysics and stellar populations in a galactic setting. These are strongly connected: stellar-mass and supermassive black holes produce powerful relativistic jets, in which particles are accelerated to ultra-high energies. These particles can be detected on Earth as ultra-high-energy cosmic rays. Compact stellar binary systems are the
source population of periodic gravitational waves and, when black holes and/or neutron stars merge, of bursts of gravitational waves. The aim is to understand how populations of stars, (supermassive) black holes and the interstellar medium are all connected within the Milky Way Galaxy, as an example for galaxies in general.

**High-energy physics**

Within the Department of High-Energy Physics researchers carry out and analyze 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 as well as explorations of the theoretical foundations of elementary particle interactions, including gravity. There is a particular focus on electroweak symmetry breaking, the Higgs boson and on physics beyond the Standard Model. The research on quantum gravity focuses on the construction of quantum observables, that can be confronted through observation.

**Research facilities**

The experimental groups make use of the following leading national and international astronomical and astroparticle observatories: ESO, La Palma, LOFAR, Virgo, HST, Kascade-Grande and Pierre Auger, and high-energy particle accelerator (Large Hadron Collider [LHC]). Under development are the IMAPP-led BlackHoleCam, BlackGEM and MeerLICHT facilities. The Institute houses two optical telescopes and a radio interferometer. 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). In 2015 the Radboud Radio Lab received funds to support the BlackHoleCam project, to channel the instrumentation efforts in Astrophysics, and to provide an efficient bridge to (local) industry.

**Collaboration**

The research questions and themes studied at IMAPP are of international significance and these are explored by, and in collaboration with, scientists all over the world. Research facilities and collaborations are therefore also of an international nature. Moreover, researchers from 20 countries work at IMAPP. Mathematicians at IMAPP 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). They 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). Astronomical research is carried out within the framework of the top research school NOVA and in association with ASTRON, SRON, ESO- and ESA-ESTEC. The Nijmegen group co-leads the EGAPS survey, leads the BlackHoleCam, BlackGEM and MeerLICHT projects, is the expertise centre for cosmic ray detection with LOFAR, and is a member of the Virgo and CTA consortia. 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 of which are accredited by the Royal Netherlands Academy of Arts and Sciences (KNAW).

**Awards and acknowledgements**

- Prof. Eric Cator became editor-in-chief of Statistica Neerlandica.
- Dr Maarten Solleveld obtained an NWO Vidi grant.
- Dr Ioan Marcut obtained an NWO Veni grant.
- Dr Francesca Vidotto obtained an Excellence Award from the Women Professors Network.
- Dr Jens Kaad and Pablo Roman started work in a Radboud Excellence postdoc position in 2015.
- Dr Sam van Gool obtained an NWO Rubicon grant.
- PhD student Ruben Stienstra, after having already obtained a KHMW-ASML Prize for his 2014 Radboud Master’s thesis, also received both the GQT Prize and a University Study Prize for extending this work in 2015.
• Prof. Sijbren de Jong received a Royal knighthood: Ridder in de orde van de Nederlandse Leeuw.
• Prof. Sijbren de Jong was elected president of the CERN Council.
• Prof. Renate Loll was elected to the Royal Academy of Sciences in the Netherlands.
• Prof. Wim Beenakker held his inaugural lecture at the University of Amsterdam.
• Dr. Sascha Caron obtained an NLeSC e-science grant.
• The Dutch ATLAS group, which includes Dr Sascha Caron, Dr Frank Filthaut, Prof. Nicole de Groot, Peter Klok MSc, Dr Adriaan König and Prof. Olga Igonkina received the Snellius Medal for its contribution to the discovery of the Higgs boson in 2012 from the Dutch society for the Advancement of Science, Medicine and Surgery.
• Prof. Shrinivas Kulkarni (Caltech) received a Radboud University honorary doctorate.
• Prof. Sterli Phinney (Caltech) became a Radboud Excellence Visiting Professor.
• Prof. Conny Aerts obtained a second ERC Advanced Grant.
• Dr Peter Jonker obtained an ERC Consolidator grant.

Research results

• Prof. Gert Heckman worked on point mass configurations that admit rigid motions under Newton’s law. These exist in abundance if the number of particles and the space dimension increase. He proved that the range of the spectra of the angular momenta of all rigid motions form a convex polytope, and studied the push forward of the normalized measure under the real moment map.
• Dr Walter van Suijlekom established grand unification in a particle physics model previously derived from noncommutative geometry. Directly relevant physically (e.g. at the LHC), it also provides an important consistency check for the mathematical methods used.
• Prof. Klaas Landsman’s Bohrification programme on the foundations of quantum mechanics has led to a new approach to the classification of C*-algebras, and addresses (and partly solves) important issues in symmetry breaking, measurement, and more generally the emergence of classical properties in quantum mechanics.
• Prof. Ben Moonen completed his programme on the Mumford-Tate conjecture for surfaces. Some of the techniques involved have been picked up by PhD student Johan Commelin to handle further cases. In collaboration with Dr Anna Cadoret (Paris), Prof. Ben Moonen has also obtained new results on adelic Galois representations.
• The Applied Stochastics group led by Prof. Eric Cator has become a focal point in interactions with other research groups. Through the statistical helpdesk, ties are being strengthened with astrophysics, biology and health scientists. The research is fundamental as well as applied.
• Prof. Paul Groot worked on the final design of the BlackGEM and MeerLICHT telescopes for the detection of astrophysical transients and counterparts to gravitational wave sources. He investigates short-period variables and short-duration transients, in collaboration with Caltech, using the Palomar Transient Factory and data from the European Galactic Plane Surveys.
• In 2015, Prof. Gijs Nelemans’ team showed that the observed population of neutron-star low-mass X-ray binaries is dominated by “ordinary” systems, while “ultra-compact” systems dominate the intrinsic population. They also showed that black holes can receive large natal kicks.
• Dr Marijke Haverkorn proved the value of processing the linearly polarized component to the LOFAR all-sky survey, detecting structures across a large part of the sky. These are studied to characterize the magnetized plasma in the Solar neighbourhood.
• Dr Elmar Koerding constrained the dependence of the jet power on black hole spin, finding that magnetically arrested discs are disfavored by the data. He showed that it is likely that white dwarfs and even young stellar objects accrete matter using the same physics processes.
• Dr Soeren Larsen showed that multiple stellar populations are present in globular clusters of the Fornax dwarf spheroidal galaxy. His observations provide tight constraints on some scenarios for the origin of globular clusters.
• Dr Onno Pols showed that the observed abundances of heavy elements in binary carbon-enhanced metal-poor (CEMP) stars in the halo of the Milky Way require very efficient mass transfer by the wind of the Asymptotic Giant donor. The orbital periods indicate that the orbits shrink during this process. His models reproduce the observed number of CEMP stars.
• In 2015 the ATLAS consortium (from IMAPP: Prof. Nicole de Groot, Dr Frank Filthaut, Dr Sascha Caron, Dr Adriaan Koenig), analysed data of run 1 and prepared run 2. They contributed to the firmware upgrade to the muon read-out drivers for run 2, and a much improved trigger for events with missing transverse energy. The first 13 TeV results were presented at the EPS-HEP conference, only two months after stable beams in run 2 were declared. 28 results were presented, four of these submitted for publication. Modest deviations from the Standard Model were observed, including 2-sigma excesses in the search for a new resonance that decays into a pair of photons, and in the search for supersymmetry in the channel with jets, a Z-boson and missing energy.
• Prof. Sijbren de Jong, Dr Charles Timmermans and Dr Jörg Hörandel lead the radio detection of cosmic ray showers (AERA) in the Pierre Auger Observatory for the study of the highest energy cosmic rays, which enabled absolute energy measurement, using a lateral density function developed at IMAPP. Surprisingly, the highest energy cosmic rays appear to be nitrogen nuclei rather than iron nuclei.
• Prof. Heino Falcke and Dr Jörg Hörandel used radio emission from cosmic ray air showers, detected at LOFAR, to measure electric fields in thunderstorms.
• Prof. Renate Loll studied a beautiful explicit example of so-called ‘Wilson loops’ in the Causal Dynamical Triangulations (CDT)
formulation of nonperturbative quantum gravity. The results show that the observable universe exists nonperturbatively in gravity, and that the quantum curvature measured by it is large at all scales, giving us one more piece of information about what quantum spacetime looks like.

• Dr Frank Saueressig laid the computational groundwork for showing the existence of a corresponding fixed point explicitly, in renormalization group analysis for theories of Horava-Lifshitz type. These theories are conjectured to be well-defined in this regime by virtue of being asymptotically free.

• Profs Ronald Kleiss and Wim Beenakker successfully completed the construction of computer-aided searches for renormalization group invariants in large classes of theories. They gave a definitive proof that the Landau-Yang theorem, well-known from QED, does not hold in Standard-Model QCD.

• The noncommutative-geometry approach to SUSY theories successfully resulted in a book by Prof. Wim Beenakker, Dr Thijs van den Broek and Dr Walter van Suijlekom.

Societal impact

• The main contribution of IMAPP to society is to produce highly qualified scientists. In addition, IMAPP considers it very important to inform the general public and in more detail specific professionals such as journalists and teachers about the results of scientific research, including those from IMAPP. Besides IMAPP researchers also aim to encourage young people to consider a study at the Science Faculty. They do this by organising lectures, tournaments, open days, etc. Through cooperative projects with industrial partners new knowledge is transferred.

• In 2015 IMAPP researchers have been very active in outreach, giving courses for elderly people (HOVO), for non-science students (honours), many public lectures, and discussions/talks to lay audiences, e.g. in Science Cafes.

• Six ‘Public Nights’ on astrophysics in winter each draw 60 to 300 people per night. The Observatory gives more than 20 tours per year, and is the home base of two public amateur astronomy groups.

• IMAPP’s societal activities are largely integrated in the Radboud Pre-University College of Science, including teacher-training activities and masterclasses. Several schools in the wider Nijmegen region installed a cosmic-ray detector built by IMAPP. Each year several secondary school classes come for lab training in the NLT programme.

• In 2015 IMAPP organized the Mathematics tournament for secondary schools (Dr Wiebe Bosma), the largest activity of its kind in the Netherlands, which each year attracts about 500 participants. The national Olympiads in Mathematics (Dr Maarten Solleveld) and in Astrophysics were also organized by IMAPP staff members.

• Department members are very active in media, including social media and more than 15 articles in national newspapers and television shows. Astronomy news is spread on Twitter.

• Radboud Excellence Fellow Dr Jens Kaad was interviewed by the Gelderlander newspaper and the Radboud Radio Lab led to many interviews with Mark Klein-Wolt.

• Prof. Frank Verbunt is editor of the lay astronomy journal Zenit, writing a monthly column.

• The work of Dr Walter van Suijlekom on the Grand Unification in Physics led to an interview that was broadcast in the Dutch radio show De Kennis van Nu. Subsequently, Kennislink published an item about these results.

• Prof. Hans Maassen gave a public lecture entitled ‘The breakdown of Boolean logic in quantum physics’ at the George Boole bicentenary celebrations in Cork (Ireland).

• The ‘International Tables for Crystallography’, with significant contributions to the 6th edition by Dr Bernd Souvignier, are the definite reference work for crystallography, comprising articles and tables of data relevant to crystallographic research and to applications in all sciences concerned with the structure and properties of materials.

• The most visible collaboration with industry in 2015 was the HIPERSENSE project, in which a University-initiated and EFRO-funded, green power and computing module was completed in a
Key publications


Dissertations: 12
Scientific publications: 420
Professional publications: 9
collaboration between Radboud University, Pasman Generators, INCAA Computers, Mecon Engineering, and the Hogeschool Arnhem-Nijmegen. In the BlackGEM project active collaboration is ongoing with Airborne Composites in the Netherlands and the Fornax, Sybilla, Cilium and STA companies globally. Within the MeerLICHT and DOME projects collaboration with IBM is ongoing on green computing and exascale computing. Within the NOVA context the Department collaborated with an additional dozen Dutch industries.

• IMAPP contributes to the Regionaal Steunpunt Arnhem-Nijmegen, Natuur, Leven en Technologie, to Stichting natuurkunde.nl (editorial board) and makes an expert contribution to the ‘Higgs standup physics’ theatre show.

Future research
In pure mathematics, our researchers will continue to work on some of the major themes such as the Langlands programme and the theory of Motives. Dr van Essen and Dr Mueger are both working on the Jacobi conjecture, via completely different approaches; in particular Dr Mueger’s method – via the Mathieu conjecture – seems very promising. Prof Moonen has initiated the study of integral structures on Mumford-Tate groups in relation to moduli theory; this is directly relevant to several large open problems in arithmetic geometry.

After his success in applying noncommutative geometry to particle physics, Dr van Suijlekom intends to address the problem of formulating a mathematically rigorous, noncommutative geometric theory of quantum fields that is so far lacking. Besides ongoing international research (e.g. with Prof. Alain Connes) he expects results to appear from the discrete approach to quantum fields taken in his NWO Vidi project, as well as from the interaction with quantum gravity through the FOM-Vrij Programme (with Prof. Renate Loll, IMAPP) on the search for quantum spacetime.

Prof. Eric Cator and Dr Henk Don are starting a new promising project about disease spreading on networks. Using new clustering ideas, the goal of the project is to obtain a description of time-evolution and metastability for completely general networks.

With proposals for the BlackHoleCAM, MeerLICHT, BlackGEM and CTA projects underway, these are becoming a strong focus for research in the Astrophysics department. Industrial collaboration ties in with the Dutch ‘top’ sector High-Tech Systems & Materials. Collaboration within IMAPP (Applied Stochastics & Astrophysics) and FNWI has started as the core of cross-institute research involving computer science, stochastics and astrophysics.

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. In addition, the search potential for new physics at a high-luminosity LHC upgrade will be investigated. The theoretical research involving SUSY and quantum gravity will be extended.
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 fierce competition – further complicates the search for solutions.

The long-term aim of the Institute for Computing and Information Sciences is to contribute both to science and to society. The institute works from the perspective that computer scientists are not just the architects of the digital world, but have become the architects of the social world as well. At iCIS researchers aim to contribute at the highest levels of science and the institute educates Masters students and PhD graduates to become leading independent researchers. The societal focus is on diligence. Now that computing technology is shaping all aspects of modern societies, we need to be careful about how we employ these technologies. Concretely this translates into (1) addressing the increasing tension between those who wish to get access to more and more data for various forms of advanced analysis, and those who wish to shield data for various security and privacy reasons; (2) delivering techniques and tools for producing reliable software, in order to reduce the risks of failure or compromise.
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 an excellent score in the latest Research Assessment. iCIS is still the top Computing Science institute in the Netherlands.

Members of the institute advocate open source software as well as digital security through design and openness (in contrast with security through obscurity). In the same spirit, iCIS promotes a culture of openness when dealing with academic integrity. Work in progress (papers, research proposals and research methodology) is discussed regularly in small meetings within the institute, which are open to all members of iCIS. Software and data are made freely available whenever possible. Security weaknesses are first reported to the companies or authorities involved before they are made public.

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 analyse 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 to align 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 allow people to benefit most from this large repository of structured knowledge.

**Collaboration**
The network of iCIS consists of a well-balanced mixture of national and international partners who guarantee the academic success of the research themes Digital Security, Data Science and Software Science, and the basic research into their mathematical foundations.

Furthermore, the network of iCIS offers ample opportunity for the valorization of research. 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), TNO Delft, the Netherlands, Aalborg University, Denmark (Artist2), the Dutch Foundation for Internet Domain Registration (SIDN), the Dutch Banking Association (NVB, Amsterdam), Radboudumc (Parkinson-Next project), Thales and TNO-ESI, Eindhoven (Metis) and TILT (University of Tilburg).

**Research results**
In the realm of automata learning, MBSD has extended traditional learning algorithms to the learning of non-deterministic systems. This extension additionally enables partial and approximate learning, i.e., it is possible to construct a model that approximates the behaviour of a black-box system and different learned models of the same system can be ordered according to the required degree of precision. Using an adaptation of an algorithm for automata learning, as implemented in the LearnLib tool, Prof Frits Vaandrager and colleagues succeeded in learning a model of the Engine Status Manager (ESM), a software component that is used in Océ printers and copiers. Altogether, the group needed around 60 million queries to learn a model of the ESM with 77 inputs and 3,410 states.
Furthermore, MBSD has evaluated the effect of applying the formal commercial technique Analytical Software Design (ASD) in a number of industrial projects, which led to a strong reduction in the number of defects and an increase in productivity. To increase the return on investment of the modelling effort, Domain Specific Languages (DSLs) have been used to generate a number of artefacts from a single DSL instance, including code and models for simulation, performance analysis, formal verification and testing. DSLs have also been used to rejuvenate legacy software. Additional work was done on extending the features of the iTask system. One of its current features is that people and systems performing tasks are automatically informed when information they share is updated. In real world applications one can be faced with a huge amount of updates. This can happen for example if one wants to follow the movements of ships or planes on a screen. Finally, Prof. Rinus Plasmeijer and colleagues defined and implemented a new probabilistic constraint logic that offers support in capturing and reasoning with knowledge in situations that involve uncertainty. The logic was successfully applied as part of a coastguard surveillance application.

The DS group carries out research to help improve cybersecurity and preserve privacy in a society which is relying on ICT to an ever larger degree. This includes research on the security of hardware (notably for smartcards, RFID cards and other embedded devices) and software, applied cryptography, the design and implementation of privacy-friendly protocols, more basic work on methods for reasoning about quantum computations and forms of cryptography that will work with quantum computers. The group also carries out research at the interface between ICT and law, covering the legal challenges surrounding privacy and big data. Applications of ICT studied in the group include identity management solutions, healthcare applications, critical infrastructures such as the (smart) electricity grid, and payment solutions. The IRMA research has produced a new form of revocation, which is quite subtle for privacy-friendly credentials, and a new form of self-enrollment via electronic identity documents (such as passports). The latter has led to a new probabilistic constraint logic that offers support in capturing and reasoning with knowledge in situations that involve uncertainty. The logic was successfully applied as part of a coastguard surveillance application.

Methods were applied successfully in various medical domains, e.g., to better understand the comorbidity between autism and ADHD.

In collaboration with the CTGlab at the VU Medical Centre, Tom Heskes’ group developed MAGMA, a novel tool for gene set analysis of data from genome-wide association studies (GWAS). In a comparison study, MAGMA has been shown to be considerably faster and more powerful than existing tools and one of the few with desirable statistical properties such as a correct type I error rate. The group led by Prof. Herman Geuvers has successfully completed a formalization of the C11 standard in the proof assistant Cog, with as concrete output various papers at conferences and the cum laude PhD of Robbert Krebbers. In cooperation with researchers from Austria and the Czech Republic, further automation support for theorem proving has been provided.

**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 for analysing and describing clinical and pathological data which can be used to understand and improve the prognosis, diagnosis and treatment of several diseases, including neuro-degenerative diseases, testing ‘mindfulness’, etc.) and model checking, together with Océ and ASML. Work on offering home support to patients with COPD and pregnancy-related disorders by means of intelligent smart-phone apps is one of the first examples where part of the hospital treatment management has been moved to the home environment using off-the-shelf equipment. Within the METIS project support is provided to Thales (exploring new techniques for maritime surveillance) and TNO and the Dutch Ministry of Defence (new techniques for task planning).

Cybersecurity and privacy are increasingly important. 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 demand both from the public and from the private sector, on topics such as the smart grid (especially smart electricity metres and smart charging of electric vehicles), the security of web applications, electronic payment systems, electronic voting and identity cards. Many of these consultations involve short-term contract research projects via LaQuSo. Research continued on the privacy and security of medical data in collaboration with Radboudumc (the ParkinsonNext project). Prof. Bart Jacobs is a member of the National Cyber Security Council, which advises the Dutch Cabinet on cybersecurity issues and Dr Jaap-Henk Hoepman is a member of the Dutch commission on electronic voting that was set up by the Dutch Ministry of the Interior. Further evidence of societal relevance and impact is the fact that the Dutch Banking Association (NVB, Nederlandse Vereniging van Banken) funds a part-time chair in Information Security (Prof. Eric 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.

Awards and acknowledgements
Prof. Joan Daemen from STMicroelectronics, who was appointed as part-time professor in Symmetric Cryptography, held his inaugural speech in November. Dr Fabian Gieseke (University of Copenhagen) is funded by the Radboud Excellence Initiative to work on big data analytics in astronomy. Dr Alexandra Silva received an ERC Starting Grant and the Best Paper Award of the 26th International Conference on Rewriting Techniques and Applications (RTA 2015). Dr. Josef Urban was awarded an ERC Consolidator Grant. Maarten van der Heijden MSc received the Best Paper Award of ESQARU 2015, Hybrid Time Bayesian Networks.

Future research
In the context of iDark: the intelligent dark matter survey funded by the Netherlands eScience Center, Prof. Tom Heskes’ group will collaborate with colleagues working on Particle Physics, Astrophysics and eScience to determine the nature of dark matter by combining available data worldwide within the most general models of dark matter. Furthermore the group will continue developing and analysing novel algorithms for causal discovery from ‘big data’. The methods thus developed will be applied to ecological data (in collaboration with Prof. Mark Huijbregts, IWWR), cognomics data (in collaboration with Prof. Barbara Franke and Prof. Jan Buitelaar at Radboudumc) and Big functional genomics data. Within the EU projects TACTICS (obsessive compulsive disorders), OPTIMISTIC (myotonic dystrophy), and MATRICS (conduct disorder), the development and application of data mining and machine learning algorithms will continue in order to gain insight into disease progression and the causes of brain diseases. Research on side-channel analysis and on fast and safe implementations of cryptography will continue. Digital Security will start the project Privacy and security for purposes of big data in health’ (in collaboration with Prof. Bas Bloem at Radboudumc). Further e-Health research, including 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. The newly granted COST network EUTYPES, with iCIS as coordinator, will join forces to further develop type theoretic methods for software verification. At the national level, research in software verification, notably of C code, will be carried out with various industrial partners in the STW project Sovereign. Professors Arjen de Vries and Ralf Hinze joined the institute and their research will strengthen ICIS even further in Big Data/Information Retrieval and Software Technology.
Key publications


Dissertations: 10
Scientific publications: 215
Professional publications: 4
Director: Prof. Herman Geuvers

Herman Geuvers has been Professor of Computer-Assisted Reasoning since 2006 at the Institute for Computing and Information Sciences and since 2007 also at Eindhoven University of Technology. Since 2011, he has also been a professor of Theoretical Computer Science. He studied in Nijmegen, where he obtained his PhD. He specializes in logic in computer science, lambda calculus and type theory, and computer-assisted proving.

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Glossary

(c) Extraordinary chair
(o) Ordinary chair
(p) Personal chair

BSI Behavioural Science Institute
CLS Centre for Language Studies
CMIB Centre for Molecular and Biomolecular Informatics
CMR Centrum voor Migratiericht – Centre for Migration Law

KWF Koningin Wilhelmina Fonds – Dutch Cancer Foundation
MPI Max Planck Institute for Psycholinguistics, Nijmegen
NHS Nederlandse Hartstichting – Netherlands Heart Foundation

NIAS Netherlands Institute for Advanced Study
NIH National Institutes of Health
NISCO Nijmegen Institute for Social & Cultural Research

NWO Nederlandse Organisatie voor Wetenschappelijk Onderzoek – Netherlands Organisation for Scientific Research
OO&R Onderzoekscentrum voor Onderneming & Recht – Business and Law Research Centre

PTR Research Institute for Philosophy, Theology and Religious Studies

Spinoza The most prestigious prize for scientists in the Netherlands who are the highest-achieving researchers, awarded by NWO

REI Radboud Excellence Initiative

RIHS Radboud Institute for Health Sciences
RIMLS Radboud Institute for Molecular Life Sciences
SteR Onderzoekscentrum voor Staat en Recht – Centre for State and Law

STW Technologiestichting STW – Technology Foundation STW (Netherlands)

Venig grant Personal grant from NWO awarded over a period of three years to researchers who have recently obtained their PhD, to allow them to continue to develop their work

Vidi grant Personal grant from NWO awarded over a period of five years to researchers who wish to develop an innovative line of research in which they appoint one or more co-researchers

Vici grant Personal grant from NWO awarded over a period of five years to senior researchers who wish to establish their own research group

ZonMw ZorgOnderzoek Nederland NWO Medische Wetenschappen – Netherlands Organisation for Health Research and Development