LASERLAB
Amsterdam

Institute for Lasers,
Life and Biophotonics

ANNUAL REPORT 2011

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1. PREFACE

This is the second annual report of LaserLaB Amsterdam, the interfacultair Onderzoeksinstituut of the VU University in collaboration with the VU Medical Center, the University of Amsterdam and the Academic Medical Center. LaserLaB Amsterdam was established in the spring of 2010. The opening of LaserLaB Amsterdam was celebrated on October 22, 2010 with a symposium at the Koninklijke Nationale Academie voor Wetenschappen, Trippenhuis, Amsterdam.

In 2011, LaserLaB Amsterdam could celebrate the award of an ERC starting grant (Prof. Croce) and an ERC proof of concept grant (Dr. Iannuzzi) from the European Union. On the national level LaserLaB Amsterdam also performed exceptionally well. Within the Innovational Research Incentives Scheme (vernieuwingsimpuls), two VICI's (Prof. Croce and Dr. Peterman), a VIDI (Dr. Knoop) and two VENI's (Dr. Van Oort, Dr. Millo) were awarded to LaserLaB Amsterdam participants. LaserLaB Amsterdam continued to fare well within the national competition with several grants from FOM, NWO-ECHO, STW, and NanonextNL, and a remarkable combined grant total of 4.9 M€ for the new faculty Prof. Dr. Roberta Croce.

LaserLaB Amsterdam (LLAMS) is one of the founding fathers of LASERLAB-Europe, an Integrated Infrastructure Initiative of the European Union, forming a consortium of the 27 major laser centers in Europe. Within LASERLAB-Europe, LLAMS provides Transnational ACCESS to European scientists, who are welcome to use our advanced laser-based facilities. LASERLAB-Europe submitted its 4 year renewal proposal in 2010 and in 2011 the renewal was awarded. Strategically, Laserlab Amsterdam is firmly embedded in the activities of LASERLAB-Europe, participating in the Innovative radiation sources at the extremes (INREX) and Laser and Photonics for Biology and Health (BIOPTICHAL) programs of the awarded prolongation Laserlab Europe III.

In summary, we can look back at a very successful year.

Johannes F. de Boer
Director

LASERLAB-Europe: a consortium of the 27 major laser centers in Europe

2. DESCRIPTION OF LASERLAB AMSTERDAM

MISSION

The mission of LaserLaB Amsterdam is groundbreaking scientific research based on the interaction of light with matter, spanning from the research on atoms and molecules to the investigation of living cells and tissue and sustainable energy sources Within LaserLaB, research is conducted in close collaboration between physicists, chemists, biologists and physicians. LaserLaB Amsterdam is hosted at the VU University, with participating research groups at the UvA, AMC and VUmc. LaserLaB is a founding partner of the new imaging center VU University medical imaging center. LaserLaB Amsterdam is part of LASERLAB-Europe, an Integrated Infrastructure Initiative of the European Union, forming a consortium of the 27 major laser centers in Europe.

STRATEGY and FUTURE VISION

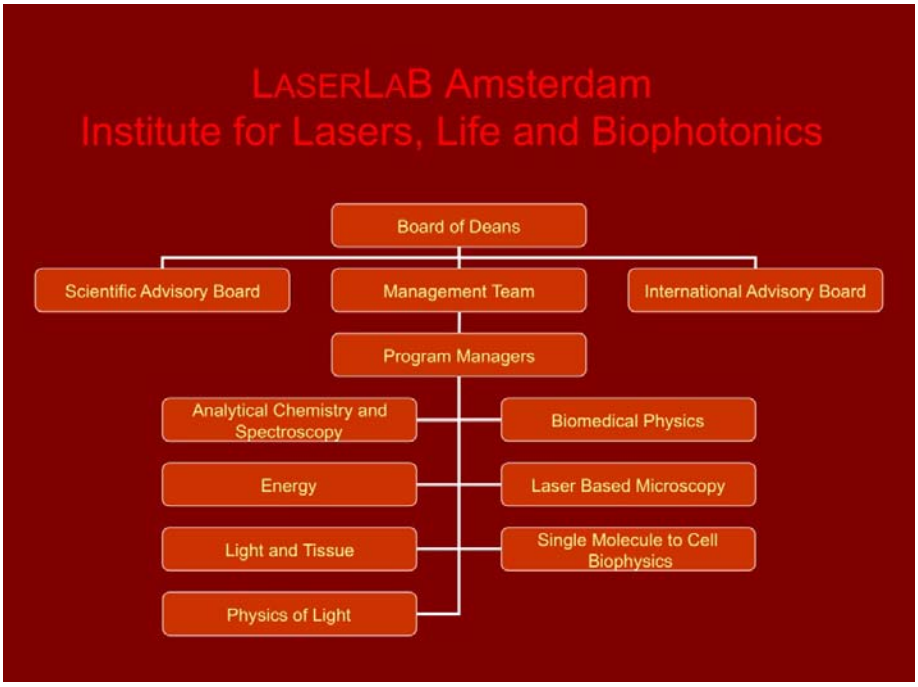
The increasing demand for health and longevity requires a better understanding of the basic processes of life. The LaserLaB research is focused on the development and application of novel optical methods, techniques and instruments to study the interaction between proteins, DNA, cells and tissue. This knowledge will lead to innovative diagnostic and therapeutic techniques.

Energy production will play a crucial role in our future. The process of photosynthesis in plants serves as an example for renewable energy production. By studying this process, it is possible to develop more efficient solar cells or biofuels. The laser has made it possible to study the structure of living materials and matter and the chemical and physical processes that take place within them.

Fundamental laser physics is firmly anchored within LaserLaB, studying the evolution of spectral lines in the universe, developing new X-ray sources, and advancing ultra-precise atomic clocks and GPS navigation.

LaserLab will serve as a powerful multidisciplinary educational faculty, especially for national and international (Master's) students and strives to continue and strengthen its unique position in Europe.

3. STRUCTURE OF LASERLAB AMSTERDAM



The core of LaserLaB Amsterdam are the programs directed by the program leaders. Programs are centered on 7 themes that constitute the long term research mission of the institute.

1 Analytical Chemistry and Spectroscopy

Program manager: Prof. dr. W.J. Buma

Both Amsterdam universities have a strong history and track record in the area of analytical chemistry and spectroscopy, in particular with respect to the application of laser-based research. Currently, three groups (one in analytical chemistry, two in fundamental spectroscopy) are active. The research theme comprises activities in Molecular spectroscopy (Buma/Brouwer/Woutersen/Williams/Zhang UvA), Ultrafast photodynamics and spectroscopy in the gas phase (Janssen, VU), and Biomolecular (Analysis and) Spectroscopy (Gooijer/Ariese/van der Zwan, VU). Each of the three groups thus brings in complementary expertise that allows them to cover together the full range of chemical-spectroscopic research. Research in the area of analytical chemistry and spectroscopy is dedicated to both fundamental science and applications, with a close connection to industry.

2 Biomedical Physics

Program manager: Prof. dr. J.F. de Boer

The long-term goal of the research program Biomedical Physics is to develop the next generation optical techniques for the diagnosis, understanding, and treatment of disease. In clinical medicine, significant progress in screening, diagnosis and treatment has been fuelled by the exact sciences and has for instance led to imaging techniques such as X-ray, MRI and PET imaging. Optical techniques have the advantages of using non-ionizing radiation, being non- or minimally invasive with unprecedented resolution (down to molecular level), and having the capability of spectroscopic analysis of tissue. A main thrust of the research is in the area of Optical Coherence

Tomography (OCT). OCT creates in-vivo cross-sectional images approaching the cellular level in a non-invasive or minimally invasive way. OCT can potentially provide “optical biopsies” for real time in-vivo diagnosis. Just as fluorescence has revolutionized cell biology, we expect minimally invasive imaging of targeted fluorophores to have a major impact in clinical medicine. Research is sponsored by FOM, NIH, and ZonMW through a VICI grant (Dr. de Boer).

3 Energy

Program manager: Prof. dr. R. van Grondelle and Prof. dr Roberta Croce.
Energy Research in LaserLaB Amsterdam is focused on the study of the fundamental events of the natural process of Photosynthesis. These include the capture of solar photons, the transfer of the electronic excitation to the photosynthetic reaction center where a charge separation is driven. All these events occur on a timescale of 10-15 to 10-9 seconds and are studied with ultrafast pulsed lasers using techniques such as pump-probe spectroscopy in the visible and mid-infrared, multi-dimensional photon echo, streak-camera detected fluorescence. Based on this knowledge artificial, bio-inspired photosynthetic systems are designed and studied using the same methods with the aim to develop a future ‘bio-solar cell’.

4 Laser-Based Microscopy

Program manager: Prof. dr. M.L. Groot
Within this program we develop nonlinear and coherent microscopic tools for studies on cellulair and tissue scale in the field of neurobiomedical research.The ability to look at living organisms with microscopic resolution has been of tremendous importance for understanding biological structure and function. Here, we develop nonlinear optical techniques to obtain images in deep-tissue with sub-cellular resolution, with and without external contrast agents (dyes, GFP). Label-free in-vivo images are obtained through third harmonic generation. Current research lines are the development of multipulse microscopies to obtain sub-diffraction resolution and the application of THG and digital holography in neuromedical research. This research is closely integrated with the Neuroscience Campus Amsterdam.

5 Light and Tissue

Program manager: Prof. dr. T.G. van Leeuwen
The research activities in the program “Light and Tissue” at the Academic Medical Center focus on the physics of the interaction of light with tissue, and to use that knowledge for the development, introduction and clinical evaluation of (newly developed) optical imaging techniques for gathering quantitative functional and molecular information of tissue. Within our group, we focus on optical techniques as optical coherence tomography (OCT), spectrographic monitoring and imaging, photo-acoustic and fluorescence imaging, along the following research lines:
1. Functional imaging and forensic applications: VIDI grant of Dr Aalders, in cooperation with Neonatology, Ophthalmology and the Netherlands Forensic Institute.
2. Molecular imaging: VENI grant of Dr Faber, with clinical spin-offs towards Ophthalmology and Urology and the NKI.
3. Integration and combination of different imaging technologies, (“from cleanroom to clinic”) in cooperation with TU/e, UT, gastro-enterology and experimental clinical chemistry.

6 Single Molecule to Cell Biophysics

Program manager: Prof. dr. G. Wuite
The research in this program focuses on exploring biophysical questions on the level from single molecules to cells. A central question is how protein and DNA structural

dynamics are related to their function. The aim is to work with increasingly complex assemblies of biomolecules in order to investigate the emergent properties from these systems. This approach bridges experimental systems biology and single-molecule manipulation techniques. We are also focusing more and more on single-biomolecule dynamics in living cells or organisms. We use a variety of optical techniques such as super-resolution fluorescence microscopy, single-molecule fluorescence spectroscopy, optical tweezers, tethered particle motion, AFM, as well as combinations of these techniques. The data obtained are related to biochemical studies and used for theoretical modeling

7 **Physics of Light and Matter**

Program manager: Prof. dr. K.S.E. Eikema

The research activities carried out in the program “Physics of Light and Matter” concentrate on performing ultra-precision experiments, which includes the development of advanced lasers sources (such as frequency comb lasers, ultra-stable lasers, extreme ultraviolet lasers and TeraWatt short pulse lasers) and spectroscopic methods to cool, manipulate and trap atoms, molecules and ions. The exciting possibilities due to advanced lasers and methods to control matter are explored in two major themes. One is “Fundamental physics at the atomic scale”, which includes searching for a possible variation of fundamental constants, testing quantum-electrodynamic theory in atoms and small molecules, and studying matter at ultra-low temperatures. The other theme is “Applied Laser Spectroscopies” which ranges from spectroscopy of astrophysically relevant gas-phase species, sensitive detection of molecules in liquids and mono-layer surfaces, light scattering studies, development of miniature lasers for length measurement, to imaging with ultrafast X-rays a at sub-cellular level.

4. SWOT ANALYSIS

Strengths
The strength of LaserLaB Amsterdam is its faculty. Hiring within the LaserLaB Programs and the Dept of Physics has been based for a long time on potential earning capacity of faculty candidates. The strong performance in ERC (EU), Innovational Research Incentives Scheme (vernieuwingsimpuls), and national Program and project grants is a result of this policy. LaserLaB Europe provides a strong platform for international visibility and exchange of scientists through the Access program. Within the VU University, LaserLaB Amsterdam is considered a research crown jewel with the largest number of NWO-scholarships (Veni, Vidi, Vici) on VU-campus. Research cores are well positioned to participate in regional and national funding initiatives. Neuroscience campus, the institute AIMMS, the institute Quantivision, and the VU medical Imaging center provide an excellent environment for cross disciplinary collaborations on the campus

Weaknesses
LaserLaB Amsterdam has three main research cores, Physics of Light and Matter, Sustainable Earth/Energy/Environment, and Life & Health. The latter two are firmly embedded within the focus areas of the campus, while Physics of Light and Matter forms a foundation for the two other core activities through the development of advanced (laser)techniques. Each of the themes has not yet enough mass to achieve an agenda setting position within the national or European research agenda. Mass has to be generated by strategic alliances within the regional and national setting.

Opportunities
Within the Life & Health research core, LaserLaB has a strategic alliance with the UvA (Prof. Buma) and the AMC (Prof. van Leeuwen) as participants. The topsector area plans for Life Sciences and Health provides a strong opportunity to expand the research. The Innovative Medical Device Initiative (IMDI) is mentioned at several occasions in the Life Sciences and Health topsectorplan. LaserLaB participates in the institute Quantivision (iQ) which is a joint initiative of the VUmc, VU, NKI, UvA and AMC and one of the eight cores of excellence of the IMDI initiative. iQ provides the critical mass within the Amsterdam regio to achieve an agenda setting research program. LaserLaB also participates in the VU Medical imaging center to shape the life and health research agenda.

Within the Sustainable Earth/Energy/Environment research core both VU and UvA participate in the major initiative 'Fuels by Photosynthesis'. The initiative is based on the strong photosynthesis activity at VU and aims to establish a FOM/NWO focus group that will form the core of a joint VU-UvA Energy program, including research in photosynthesis, catalysis, photoconversion & artificial photosynthesis, theoretical systems physics/biology, microbiology, theoretical chemistry and photochemistry. The program will include a VU-UvA Energy&Sustainability master teaching program.

Within the Physics of Light and Matter (PLM) core, LaserLaB provides a nucleus within the Netherlands for ultra-high precision tests of physics and development of techniques for controlling atomic, molecular, and ionic matter. Efforts are ongoing for ultraprecise optical clock dissemination on a European scale and for navigation of the future. The advanced laser techniques that are developed at the PLM core provide strong opportunities for collaborations with the two other core activities within LaserLaB Amsterdam and Laserlab Europe (Joint Research Activities INREX and BIOPTICHAL). PLM is well positioned through international collaborations with Fritz Haber Institute (G. Meijer, Berlin) and the ETH (F. Merkt, Zurich), and with companies such as Menlo and Toptica in Germany, and IMRA in the USA, and research groups worldwide for theoretical support.

Threats

The predominant threat to the Research Institute and academia in general is the downward pressure on budgets for investment in research and education. The strategy to counter this threat is excellence and relevance. LaserLaB Amsterdam strives for excellence, as is evident from the success in European and national competitions, and has focused its efforts on two of the major societal problems that will have a national and global impact: Energy and Life & Health.

Housing in the near and distant future will become a topic of crucial importance. The excellent research facilities of LaserLaB require the lowest vibration levels possible for the lab space. A transition to the O&O building was not possible due to the presence of an underground parking structure. Housing in the new VUmc Imaging center also seems not feasible. To maintain the presence of LaserLaB at the VU campus, a new building needs to be planned that is designed to meet our standards. If the strategic alliance of the VU exact sciences with the UvA would result in the relocation of parts of LaserLaB to Science Park, that would constitute a serious threat to the cohesion within LaserLab and the presence of a high-tech exact science facility at the VU campus.

5. GRANTS, NEWS AND HIGHLIGHTS OF THE YEAR 2011

Research grants
In 2011 LaserLaB researchers received several prestigious grants from international and national funding sources. (for details on awarded amounts see Section 7c).

***ERC Ideas starting Grant:* Prof. dr. Roberta Croce**
Acclimation strategies of algae and plants
Life on earth is sustained by the process that converts sunlight energy into chemical energy: photosynthesis. It takes place in plants, algae and photosynthetic bacteria. These organisms are much more dynamic than we usually think they are and there are able to change their operational behavior on a time scales ranging from seconds to weeks. This dynamic behavior is of paramount importance for their performance and survival under varying natural conditions. How do the organisms respond to varying environmental conditions and how does this influence their photosynthetic performance? These are the central questions that Prof. Croce is trying to answer at the molecular level. Over the last years she has developed and optimized a range of methods that now allow her to take up this challenge. This involves a high level of integration of biological and physical approaches, ranging from plant and algae transformation to ultrafast spectroscopy. Understanding these processes will in the future help to increase the efficiency of food and biofuel production.

***ERC Proof of Concept:* dr. Davide Iannuzzi**
Small, but many: scalability to volume production in fiber-top technology
During his ERC Starting Independent Research Grant, Davide Iannuzzi came up with a new idea that allows the fabrication of micromachined structures on the tip of an optical fiber with a series of cost effective steps. He has now obtained the support of ERC to demonstrate the scalability of that fabrication method. With this Proof-of-Concept grant, he will be able to show that, thanks to this invention, cost effective batch production of fiber-top cantilevers is indeed possible.

***VICI grant:* Prof. dr. Roberta Croce**
Harvesting the sun....safely
Her research focuses on the understanding of the basic mechanisms of the light- reactions of photosynthesis, in particular light absorption, excitation energy transfer and photoprotection in plants and algae. The approach is strongly multidisciplinary, ranging from genetics to ultrafast spectroscopy.

***VICI grant:* dr. Erwin Peterman**
Intracellular-traffic monitoring in living animals with single-motor resolution
Intracellular transport, driven by motor proteins, is an essential process to distribute biomolecules, organelles and other cargo in our cells. Since diffusion is often too slow, defects in this active transport mechanism can result in disease. In the cell, however, motor proteins do not work on their own. In general, more than one motor is connected to a single cargo, often motors of different species. The goal of the project is to obtain a quantitative understanding of the way motor proteins cooperate to drive intracellular transport in vivo. To this end, motor proteins will be visualized while they are 'on the job': transporting their natural cargo in their natural habitat, cells in a living, multicellular organism. As a model organism the small multicellular animal *C. elegans*. will be used; this choice, however, poses an exciting challenge to our fluorescence imaging capabilities and requires development of novel fluorescence microscopy tools that allow ultrasensitive fluorescence imaging in (relatively) thick samples. To achieve this, methods will be developed for wide-field 2-photon fluorescence microscopy, 2-photon photo-activation of fluorophores, and non-imaging confocal fluorescence microscopy. If successful, these methods will allow us to obtain a view on intracellular transport in vivo with unprecedented accuracy, which will form the basis of a complete, quantitative understanding of this essential cellular process.

***VIDI grant*: dr. Steven Knoop**
Giant few-body states probed with ultracold atoms

The description of bound states consisting of a few quantum particles requires detailed knowledge on their mutual interaction. However, if the interaction becomes very large, suddenly the binding laws are universal, irrespective of whether the particles are nucleons, atoms and molecules. For the three-body problem, a hallmark prediction in quantum mechanics is the existence of giant, weakly bound, trimer states that exhibit remarkable properties and have fascinated physicists among different fields for many years. It is only since the advent of ultracold atoms that signatures of these so-called Efimov states can now be observed experimentally.
Dr Knoop will study these giant few-body states in an ultracold mixture of metastable helium and rubidium atoms, contained in an optical dipole trap. The large mass ratio between the two species facilitates the observation of a series of Efimov states to provide the first experimental verification of the geometrical scaling properties of the Efimov states, the central part of Efimov's prediction. The Laser Centre of the Vrije Universiteit Amsterdam provides the ideal location because of its long-term experience on ultracold metastable helium.

VENI grant: **dr. Bart van Oort**
Mapping photosynthetic energy migration in relation to stress with novel microscopies
Sunlight provides the energy for plants to grow, provided that the solar energy reaches the right places in a plant. The scientists will build a new microscope to study how plants show solar energy the way. They will pay special attention to the influence of growth conditions.

VENI grant**: dr. Diego Millo**
Harvesting electricity from bacteria
Some bacteria are able to convert waste into electricity and deliver it directly to electrodes. This process occurs through proteins wiring the bacteria to the electrodes. Using a combination of electrochemistry and Raman spectroscopy, dr Millo will probe these proteins to learn how to optimize the whole process.

NWO-ALW Middelgroot**: Prof. dr. Marloes Groot**
Following coupled multi-electron/proton transfer reactions in enzymes in real-time"
The investment will be used to develop a new experimental window on enzyme dynamics. To better understand the design principles of enzymes, a laser setup will be developed that will induce multiple turnovers of enzymes, each time monitoring whether it has been successful or not, while tracking which structural changes make the difference.

NWO Middelgroot: **dr. John Kennis**
From sunlight to fuel: a versatile all-timescale spectrophotometer to assess solar energy conversion in artificial photosynthetic devices.
Solar energy is recognized as the prime sustainable energy source, as only 0.01% of the incident solar radiation needs to be stored to cover the global energy requirement. Large knowledge gaps exist today on how to efficiently store solar energy in fuels, which has precluded the deployment of solar fuel technology at any meaningful large scale.
The research program aims at functional assessment of artificial photosynthetic modules at varying degrees of functional integration through the application of advanced time-resolved spectroscopic methods. Dr Kennis will install and develop a versatile spectrometer that spans the femtosecond-to-millisecond timescale, with UV-visible, infrared and Raman detection capabilities, and multi-pulse catalytic turnover capacity.

NWO-CW ECHO**: dr. Sander Woutersen**
Slippery when wet: How water lubricates molecular machines
Surprisingly, the presence of small amounts of water trongly accellerates movement in molecular machines. The underlying mechanisms are studied in this project. Can this phenomenon explain why biomolecular machines only function optimally in water?

NWO-CW ECHO**: Prof. dr. Wybren Jan Buma**
Molecular machines at work in the gas phase

Inspired by nature, scientists attempt to construct molecules that can carry out the same functions as macroscopic machines. This project aims to understand the instruction manuals of machines at that scale, by studying how the structure is affected by controlled perturbations of its environment.

NWO CW BAZIS: **dr. Freek Ariese, prof. dr. Wilfried Niessen, Peter Schoenmakers**
From the NWO CW BAZIS program, grant was obtained by Freek Ariese in collaboration with Wilfried Niessen (VU-Chemistry) and Peter Schoenmakers (UvA Chemistry) to invest in "*Instrumentation for targeted bioanalysis of living systems*". The LaserLaB component is being used for Raman microscopy equipment.

ESA-ESTEC Network/Partnership program**: dr. Davide Iannuzzi**
This program aims at the development of instruments and methods to study cells under hypergravitational conditions.

FOM programme**: dr. Erwin Peterman**
Barriers in the brain: the molecular physics of learning and memory
Receptor proteins in synapses enable contact between brain cells and therefore play a crucial role in learning and memory. The fundamental physical processes that regulate the strength of these contacts are poorly understood. Goal of this FOM project is to unravel these processes, in particular those that regulate receptor location in a dynamic and restricted space. The project will be coordinated by Dr Erwin Peterman and will be carried out at VU University, Utrecht University, Leiden University and the Technical University of Eindhoven. This fascinating and complex problem will be tackled with a multidisciplinary approach: from theoretical physics to soft matter, from biophysics of model systems and cells to neurobiology.

FOM grant**: dr. Steven Knoop**
Ultracold controlled chemistry
Steven Knoop receives a grant from FOM ("projectruimte") to investigate atom-exchange reactions in atom-molecule collisions at nanokelvin temperatures. The grant amounts to 394 k€ and gives an opportunity for one PhD student and budget for equipment and other investments.

FOM/ALW: Prof. dr. Roberta Croce
Studying the regulation of light harvesting in the green alga Chlamydomonas to improve its productivity under mass culture conditions

FOM program: Prof. dr. Roberta Croce
The thylakoid membrane – a dynamic switch.

STW Perspectief program: dr Erwin Peterman
Super-resolution microscopy ('nanoscopy'): from sharp images towards imaging of molecular interaction
LaserLaB is is one of the participants in this project, supervised by prof. Erik Manders (UVA) with a total budget of M€ 5,4. Erwin Peterman, in collaboration with Yves Bollen (VU-FALW) and Adriaan Houtsmuller (Erasmus MC), will focus on the development of nanoscopic methods that will enable them to follow biomolecular movement in living cells at the millisecond time scale with super-resolution.

Nanonext NL project**: Prof dr. Gijs Wuite**
Dynamic Force Microscopy of (non)specific DNA/protein interaction

Nanonext NL project: **Erwin Peterman**
Nanomolecular motors in cellular force production

NanonextNL project: **dr. Freek Ariese**
Spectroscopy at the nanometer scale

Freek Ariese obtained a research grant from the NanonextNL program for a collaborative project with Philips Innovation Sciences. The research will focus on the combination of scanning probe microscopy technologies with molecular spectroscopic characterization, aiming at spatial resolution in the low nanometer range.

FES/BioSolar Cells: **prof, dr. Roberta Croce**
System-level integration of the process of photosynthesis in vivo. Application to various C3 plants

FES/BioSolar Cells: **prof. Dr. Roberta Croce**
Microalgae as photosynthetic cell factories for biofuel production

EMBO Long-Term Fellowship: **dr. Graeme King**
Graeme King receives EMBO Grant for research that aims to unravel the interplay between DNA's mechanical and electrostatic character and its biological role.

Research and publicity highlights of 2011

Hong Zhang **wins New Ideas Competition 2011**
Hong Zhang has won the Science Park New Ideas Competition 2011 together with Maurice Aalders from the UvA university hospital AMC. The two researchers developed a catheter that is able to detect microbial infections at an early stage.

Johannes de Boer wins the **G.G. Stokes Award 2011** for his seminal contributions to the development of polarization sensitive Optical Coherence Tomography (OCT).

Stefan Witte: **Live brain imaging without labels**
A minimally-invasive brain imaging technique can help researchers visualize individual neurons in live animals without using potentially harmful labels, a study finds. "Label-free live brain imaging and targeted patching with third-harmonic generation microscopy," by Stefan Witte, Adrian Negrean, Johannes C. Lodder, Christiaan P.J. de Kock, Guilherme Testa Silva, Huibert D. Mansvelder and Marie Louise Groot, Proceedings of the National Academy of Sciences, Published online March 28, 2011.

Maurice Janssen: **Novel Reaction Microscope on Cover of ChemPhysChem**
A novel Reaction Microscope for Imaging and Pulse Shaping Control in Photodynamics was developed in the VICI research of Prof. Maurice Janssen (LaserLaB and Chemistry Department). An invited review on the recent research in Amsterdam was selected for the cover of the journal ChemPhysChem. The topical issue is dedicated to Jacobus van `t Hoff (1852-1911), the first Nobel Laureate in Chemistry (1901) and the co-founder of the field of Physical Chemistry.

Stefan Witte, Marloes Groot, Huib Mansvelder: **Live brain imaging without labels**
A minimally-invasive brain imaging technique can help researchers visualize individual neurons in live animals without using potentially harmful labels, a study finds.

Rienk van Grondelle at NRC**; Solar Fuels by Photosynthesis**
Plants can be as efficient as solar cells. Scientists attempt to improve the fotosynthetis efficiency of agricultural plants. Plants use solar energy with a much lower efficiency than modern silicium-based solar cells, but scientist (biologists and biophysicists) are helping them to catch up.

Peter Gross: **LaserLaB elucidates genetic code with force**
How is DNA in living organisms being processed and read? Researchers at VU LaserLaB have grabbed DNA molecules and applied force to study that. They demonstrated that as the pulling force increases, the two strands of DNA stretch, show less coiling and finally let go. DNA proves very stable, so proteins must apply significant force to specifically open and interact with a double-stranded helix. Vici-laureates Gijs Wuite and Erwin Peterman and their co-workers published these results together with colleagues from France and Denmark in the renowned journal Nature Physics.

Gijs Wuite **wins the Faculty of Science Education Prize 2010/2011**.

Gijs Wuite: **Inaugural lecture**

Fiber-top technology forms basis for new VU spin-off company Optics11.
In 2005, research by physist *Davide Ianuzzi* and collegues led to the development of fiber-top technology. After five years of further research, this technology is now launched onto the market

Raoul Frese: **COST project**
COST is an intergovernmental framework for European Cooperation in Science and Technology, allowing the coordination of nationally-funded research on a European level

Steven Stolte: **A newly discovered interference effect for an inelastic collision between NO and Ar**
Steven Stolte et.al. reveal an interference effect for an inelastic collision between NO and Ar that became observable at a complete quantum mechanical resolution. They published their results in Nature Chemistry.

Wim Vassen: **Ultracold helium gas tests the boundaries of physics**
In a small cloud of helium atoms, physicists from the LaserLaB Amsterdam have tested the theory of quantum electrodynamics to an accuracy of 12 significant figures. Quantum electrodynamics describes the structure of atoms and is one of the most fundamental theories of physics. For this experiment, the researchers cooled helium gas to one millionth of a degree above absolute zero. They then captured it in the focal point of a laser beam and subsequently irradiated it for a long period of time with a second laser beam of a very precisely determined colour. The measurement they made is 1000 times more accurate than the theory can currently predict. With the result, the researchers could even determine the size of a helium atom nucleus. The researcher's findings were published on 8 July in the renowned journal Science.

Wim Ubachs: **Ghost particles observed in molecules**
Researchers of LaserLaB VU Amsterdam and FOM have demonstrated that the effects of ghost particles, which are explained by Quantum Electrodynamics theory, not only occur in atoms but also in molecules. They accomplished that with ultraprecise laser spectroscopic measurements of specially prepared fast rotating hydrogen molecules. The outcome of these studies was published in the renowned journal Physical Review Letters.

Gijs Wuite: **live on BNR news radio in the Summer serie Jonge Academie**.

Ingeborg Iping Petterson: **Detection of concealed explosives**
Using a technique called time-resolved Raman spectroscopy, researchers at LaserLaB Amsterdam have been able to detect the presence of DNT (dinitrotoluene), as well as other compounds found in many explosive materials, through layers of non-transparent packaging materials.
This collaborative project with Spanish forensic experts from the University of Acalá was made possible through the LASERLAB-EUROPE Access Program, and attracted a lot of attention at conferences and in the international,chemistry press. Another application area of time-resolved Raman spectroscopy that the LaserLaB Amsterdam team is currently working on is non-invasive disease diagnosis through skin.

New professors
Prof. dr. Roberta Croce joined the Energy Section of LaserLaB in March 2011.

Retired professors
Prof. dr Cees Gooijer of the Biomolecular Spectroscopy Section retired as of 1 June 2011.

6. INPUT LASERLAB AMSTERDAM

Research input is calculated according to the following general guidelines for VU interfaculty research institutes (IOZIs): Scientific staff is assumed to spend 40% of time on research, postdoctoral researchers and PhD students 100%. Technical support staff is not included

VU University (incl. FOM employees)

- Total fte FEW (including PhD students): 80.0
  1st funding 10.9 (7.0 excl. PhD students)
  2nd funding 47.9
  3rd funding 21.2

- Total fte PhD student FEW: 36.0
  1st funding 3.9
  2nd funding 21.5
  3rd funding 10.6

- Total new started PhD students FEW: 17
  1st funding 1
  2nd funding 12
  3rd funding 4

  Total fte FALW 1.7

University of Amsterdam

- Total fte: 21.1
- Total fte PhD students: 12.6

Amsterdam Medical Centre

- Total fte: 15.5
- Total fte PhD students: 11.3

Total LaserLaB Amsterdam

- Total fte (including PhD students): 118.3
- Total fte PhD student: 59.9

Earning power (FEW only)

Total value of grants acquired in 2011: 10 800 k€
(of which 7300 k€ 2nd and 3500 k€ 3rd funding)

Research input FEW WP1 = 7.0 fte (staff 40% + PD 100%)

Earning power per 10 WP1 = 15.400 k€

Total research input FEW WP (staff 40% + PD 100% + PhD 100%) = 80.0 fte

Earning power per 10 WP = 1350 k€

(In comparison: in 2010 the total grant value acquired at FEW was 10 800 k€; the earning power per 10 WP1 (7.5 fte) was 14 900 k€ and the earning power per 10 WP total (62.0 fte) was 1800 k€.)

7. OUTPUT RESEARCH INSTITUTE

a) Overall scientific output LaserLaB Amsterdam

Total number of theses: 21

Total number of scientific papers, refereed: 152

Total number of scientific papers, non-refereed: 3

Total number of books: 1

Total number of book chapters: 6

Scientific Output (per theme)

Theme Analytical Chemistry and Spectroscopy

- Number of theses: 6

Szymon Smolarek
UV and IR laser spectroscopy of isolated molecular structural dynamics
promotor: prof. dr. W.J. Buma
co-promotor: dr. M. Drabbels and dr. A.M. Rijs
defense: 26 January 2011

Tanzeela Nazir Raja
Fluorescence spectroscopy and imaging of dynamics and microstructure of acrylic polymer emulsions
promotor: prof. dr. A.M. Brouwer
defense: 14 June 2011

Yu Wang
Structured doping of upconversion nanosystems for biological applications
promotoren: prof. dr. W.J. Buma, prof. dr. X.G. Kong; co-promotoren: dr. H. Zhang, dr. ir. M.C.G. Aalders
defense: 5 July 2011

Van-Anh Nguyen
Photoinduced processes in functionalized and organized dye systems
promotor: prof. dr. A.M. Brouwer, co-promotoren: dr. R.M. Williams and dr. Le Cong Hoa
defense: 21 September 2011

Ivonne Lammers
Chiral discrimination by phosphorescence
promotor: prof. dr. C. Gooijer, co-promotor dr. F. Ariese
defense: 14 November 2011

Silvia Tardioli
Optical methods for structure elucidation of protein-ligand interactions: fluorescence and ultraviolet resonance Raman spectroscopy
promotor: prof. dr. C. Gooijer, co-promoter dr. G. van der Zwan
defense: 15 November 2011

- Number of scientific papers, refereed : 23

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Computational Study on the Anomalous Fluorescence Behavior of Isoflavones.
Journal of Physical Chemistry A, 115(9), 1493-1499

P. Bodis, S. Yeremenko, J. Berna, W.J. Buma, D.A. Leigh, and S. Woutersen.
Bimodal dynamics of mechanically constrained hydrogen bonds revealed by vibrational photon echoes
J. Chem. Phys. **134**, 134504

A.M. Brouwer
Standards for photoluminescence quantum yield measurements in solution (IUPAC Technical Report)
Pure and Applied Chemistry 83, 12, 2213-2228

N.B. Brauer, S. Smolarek, X. Zhang, W.J. Buma, and M. Drabbels
Electronic spectroscopy of aniline ions embedded in helium nanodroplets
J. Phys. Chem. Letters **2**, 1563

R.H. Bremmer, D.M. de Bruin, M. de Joode, W.J. Buma, T.G. van Leeuwen, and M.C.G. Aalders
Biphasic oxidation of oxy-hemoglobin in bloodstains
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Castro-Puyana, M.G., Lammers, I., Buijs, J.B., Gooijer, C. & Ariese, F.
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Analytical and Bioanalytical Chemistry, 400(9), 2913-2919

Castro-Perez, J., Roddy, T.P., Nibbering, N.M.M., Shah, V., McLaren, D.G., Previs, S., Attygalle, A.B., Herath, K., Chen, Z., Wang, S.P., Mitnaul, L., Hubbard, B.K., Vreeken, R.J., Johns, D.G. & Hankemeier, Th.
Localization of Fatty Acyl and Double Bond Positions in Phosphatidylcholines Using a Dual Stage CID Fragmentation Coupled with Ion Mobility Mass Spectrometry
Journal of the American Society for Mass Spectrometry, 22(9), 1552-1567

Deneckere, A., Vries, L. de, Vekemans, M., Voorde, L. van de, Ariese, F., Vincze, L., Moens, L. & Vandenabeele, P.
Identification of inorganic pigments used in porcelain cards based on fusing Raman and X-ray fluorescence (XRF) data
Applied Spectroscopy, 65 (11), 1281-1290

Eyles, C.J., Brouard, M., Yang, C.H., Klos, J., Aoiz, F.J., Gijsbertsen, A., Wiskerke, A.E. & Stolte, S.
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D.D. Günbaş, L. Zalewski, A.M. Brouwer

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Chemical Communications, Vol. 47 (2011), p. 4977-4979

M. Juríček, M. Felici, P. Contreras-Carballada, J. Lauko, S.R. Bou, P.H.J. Kouwer, A.M. Brouwer, A.E. Rowan
Triazole–pyridine ligands: a novel approach to chromophoric iridium arrays
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Lehmann, C.S., Ram, N.B., Irimia, D. & Janssen, M.H.M.
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Towards the complete experiment: measurement of S((1)D(2)) polarization in correlation with single rotational states of CO(J) from the photodissociation of oriented OCS(v(2)=1 vertical bar JlM=111)
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Journal of Photochemistry and Photobiology A. Chemistry, 223(2-3), 88-96

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J. Phys. Chem. A **115**, 9669

J. Siekierzycka, M. Rosso-Vasic, H. Zuilhof, A.M. Brouwer
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S. Smolarek, A. Vdovin, A.M. Rijs, C.A. van Walree, M. Zgierski, and W.J. Buma
High-resolution spectroscopy of jet-cooled 1,1'-diphenylethylene: electronically excited and ionic states of a prototypical cross-conjugated system
J. Phys. Chem. A **115**, 9399

S. Smolarek, A. Vdovin, E.M.M. Tan, M. de Groot, and W.J. Buma
Spectroscopy and dynamics of methyl-4-hydroxycinnamate: the influence of isotopic substitution and water complexation
Phys. Chem. Chem. Phys. **13**, 4393

S. Smolarek, A. Vdovin, E. M.M. Tan, and W.J. Buma
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J. Phys. Chem. B **115**, 1275
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Structure elucidation of fluorescent H1 antihistamines by ultraviolet resonance Raman spectroscopy. Solvent structures of tripelenamine and mepyramine
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Chemphyschem, 12(8), 1459-1473

Y. Wang, K. Liu, X. Liu, K. Dohnalová, T. Gregorkiewicz, X. Kong, M.C.G. Aalders, W.J. Buma, and H. Zhang
Critical shell thickness of core/shell upconversion luminescence nanoplatform for FRET application

- Number of scientific papers, non-refereed: 1

Russel, D.H., Wang, Y. & Nibbering, N.M.M.
Preface IJMS honour issue Michael Gross
International Journal of Mass Spectrometry, 301, 1-2

- Number of book chapters: 1

T.N. Raja, A.M. Brouwer
Fluorescence spectroscopy in polymer science; in: Advanced fluorescence reporters in chemistry and biology III: applications in sensing and imaging (2011), p. 91-117

Theme Biomedical Physics

- Number of scientific papers, refereed: 6

Braaf, B., Vermeer, K.A., Sicam, V.A.D.P., Zeeburg, E., Meurs, J.C. van & Boer, J.F. de
Phasestabilized optical frequency domain imaging at 1-mu m for the measurement of blood flow in the human choroid
Optics Express, 19(21), 20886-20903

Burns, J.A., Kim, K.H., Boer, J.F. de, Anderson, R.R. & Zeitels, S. M.
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Otolaryngology and Head and Neck Surgery, 145(1), 91-99.

Hillenaar, T., Sicam, V.A.D.P., Vermeer, K.A., Braaf, B., Remeijer, L., Cals, R.H.H. & Boer, J.F. de
Wide-Range Calibration of Corneal Backscatter Analysis by In Vivo Confocal Microscopy
Investigative Ophthalmology and Visual Science, 52(5), 2136-2146

Kim, K.H., Park, B. H., Tu, Y.P., Hasan, T., Lee, B., Li, J. & Boer, J.F. de
Polarization-sensitive optical frequency domain imaging based on unpolarized light
Optics Express, 19(2), 552-561.

Vermeer, K.A., Schoot, J.H. van der, Lemij, H.G. & Boer, J.F. de

Automated segmentation by pixel classification of retinal layers in ophthalmic OCT images Biomedical Optics Express, 2(6), 1743-1756

Wu, H., Boer, J.F. de & Chen, T.C.
Reproducibility of Retinal Nerve Fiber Layer Thickness Measurements Using Spectral Domain Optical Coherence Tomography
Journal of Glaucoma, 20(8), 470-476

Theme Energy

- Number of theses: 2

Elisabeth Romero Mesa
The electronic structure of photosystem II. Charge seperation dynamics
promotor: prof. dr. Rienk van Grondelle, co-promotor dr. Jan Dekker
defense: 25 March 2011

Tjaard Krueger
From Disorder to Order: The functional flexibility of single plant light-harvesting complexes
promotor: prof. dr. R. van Grondelle
defense: 30 June 2011

- Number of scientific papers, refereed: 35

Caffarri, S., Broess, K., Croce, R. & Amerongen, H. van
Excitation Energy Transfer and Trapping in Higher Plant Photosystem II Complexes with Different Antenna Sizes
Biophysical Journal, 100(9), 2094- 2103

Chen, X., Larsen, D.S., Bradforth, S.E. & Stokkum, I.H.M. van
Broadband spectral probing revealing ultrafast photochemical branching after ultraviolet excitation of the aqueous phenolate anion
Journal of Physical Chemistry A, 115(16), 3807-3819

Cohen Stuart, T.A., Vengris, M., Novoderezhkin, V.I., Cogdell, R.J., Hunter, C.N. & Grondelle, R. van
Direct Visualization of Exciton Reequilibration in the LH1 and LH2 Complexes of Rhodobacter sphaeroides by Multipulse Spectroscopy
Biophysical Journal, 100(9), 2226-2233

Croce, R. & Amerongen, H. van
Light-harvesting and structural organization of Photosystem II: From individual complexes to thylakoid membrane
Journal of Photochemistry and Photobiology B. Biology, 104(1-2), 142-153

Di Donato, M., Wilderen, L.J.G.W. van, Stokkum, I.H.M. van, Cohen Stuart, T.A., Kennis, J.T.M., Hellingwerf, K.J., Grondelle, R. van & Groot, M.L.
Proton transfer events in GFP
Physical Chemistry Chemical Physics - PCCP, 13(36), 16295-16305

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Photosystem I of Chlamydomonas reinhardtii Contains Nine Light-harvesting Complexes (Lhca) Located on One Side of the Core
Journal of Biological Chemistry, 286(52), 44878-44887

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Biophysical Journal, 101(4), 934-942

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Excitation energy transfer and non-photochemical quenching in photosynthesis
European Biophysics Journal, 40(1), 180

Ilioaia, C., Kruger, T.P.J., Johnson, M.P., Horton, P., Ruban, A.V. & Grondelle, R. van
Fluorescence dynamics of plant light harvesting complexes studied by single molecule spectroscopy
European Biophysics Journal, 40(1), 176-177

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Origin of Absorption Changes Associated with Photoprotective Energy Dissipation in the Absence of Zeaxanthin
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Ilioaia, C., Johnson, M.P., Liao, P.N., Pascal, A.A., Grondelle, R. van, Walla, P.J., Ruban, A.V. & Robert, B.
Photoprotection in Plants Involves a Change in Lutein 1 Binding Domain in the Major Lightharvesting Complex of Photosystem II
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Kloz, M., Grondelle, R. van & Kennis, J.T.M.
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Fluorescence Intermittency from the Main Plant Light- Harvesting Complex: Resolving Shifts between Intensity Levels
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Fluorescence intermittency from the main plant light-harvesting complex: sensitivity to the local environment
Journal of Physical Chemistry B, 115(18), 5083-5095

Laptenok, S., Visser, N.V., Engel, R., Westphal, A.H., Hoek, A. van, Mierlo, C.P.M., Stokkum, I.H.M. van, Amerongen, H. van & Visser, A.J.W.G.
A general approach to detect folding intermediates from steady-state and time-resolved fluorescence of single tryptophan-containing proteins
Biochemistry, 50 (17), 3441-3450

Marin, A., Doust, A.B., Scholes, G.D., Wilk, K.E., Curmi, P.M.G., Stokkum, I.H.M. van & Grondelle, R. van
Flow of excitation energy in the cryptophyte light-harvesting antenna phycocyanin 645
Biophysical Journal, 101(4), 1004-1113

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Minor Complexes at Work: Light-Harvesting by Carotenoids in the Photosystem II Antenna Complexes CP24 and CP26
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The Hydrogen-Bond Switch Reaction of the Blrb Bluf Domain of Rhodobacter sphaeroides Journal of Physical Chemistry B, 115 (24), 7963-7971

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Novoderezhkin, V.I., Marin, A. & Grondelle, R. van
Intra- and inter-monomeric transfers in the light harvesting LHCII complex: the Redfield-Forster picture
Physical Chemistry Chemical Physics - PCCP, 13 (38), 17093-17103

Novoderezhkin, V.I., Romero Mesa, E., Dekker, J.P. & Grondelle, R. van
Multiple charge separation pathways in photosystem II: modeling of transient absorption kinetics
Chemical Physics, 12, 681-688

Oort, B.F. van, Marechal, A, Ruban, A.V., Robert, B., Pascal, A.A., Ruijter, N.C.A. de, Grondelle, R. van & Amerongen, H. van
Different crystal morphologies lead to slightly different conformations of lightharvesting
complex II as monitored by variations of the intrinsic fluorescence lifetime
Physical Chemistry Chemical Physics - PCCP, 13(27), 12614-12622

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Ultrafast carotenoid band shifts correlated with Chl(z) excited states in the photosystem II reaction center: are the carotenoids involved in energy transfer?
Physical Chemistry Chemical Physics - PCCP, 13(13), 5573-5575

Rupenyan, A.B., Vreede, J., Stokkum, I.H.M. van, Hospes, M., Kennis, J.T.M., Hellingwerf, K.J. & Groot, M.L.
Proline 68 Enhances Photoisomerization Yield in Photoactive Yellow Protein
Journal of Physical Chemistry B, 115(20), 6668-6677

Scholes, G.D., Fleming, G.R., Olaya-Castro, A. & Grondelle, R. van
Lessons from nature about solar light harvesting
Nature Chemistry, 3(10), 763-774

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On the involvement of Single-Bond Rotation in the Primary Photochemistry of Photoactive Yellow Protein
Biophysical Journal, 101(5), 1184-1192

Sznee, K., Dekker, J.P., Dame, R.T., Van Roon, H., Wuite, G.J.L. & Frese, R.N.
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Toh, K.C., Stojkovic, E.A, Stokkum, I.H.M. van, Moffat, K. & Kennis, J.T.M.
Fluorescence quantum yield and photochemistry of bacteriophytochrome constructs
Physical Chemistry Chemical Physics - PCCP, 13(25), 11985-11997

Valkunas, L., Chmeliov, J., Trinkunas, G., Duffy, C.D.P., Grondelle, R. van & Ruban, A.V.
Excitation Migration, Quenching, and Regulation of Photosynthetic Light Harvesting in Photosystem II
Journal of Physical Chemistry B, 115(29), 9252-9260

Weij - de Wit, C.D. van der, Dekker, J.P., Grondelle, R. van & Stokkum, I.H.M. van
Charge Separation is Virtually Irreversible in Photosystem II Core Complexes with Oxidized Primary Quinone Acceptor
Journal of Physical Chemistry A, 115(16), 3947-3956

Wientjes, E., Stokkum, I.H.M. van, Amerongen, H. van & Croce, R.
Excitation-energy transfer dynamics of higher plant photosystem I light-harvesting complexes
Biophysical Journal, 100(5), 1372- 1380

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The light-harvesting complexes of higher-plant Photosystem I: Lhca1/4 and Lhca2/3 form two red-emitting heterodimers
Biochemical Journal, 477-485

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The role of the individual lhcas in photosystem i excitation energy trapping
Biophysical Journal, 101(3), 745-754

Theme Laser Based Microscopy

- Number of theses: **1**

Andreas Stahl
Structurefunction relationship in photosynthetic and photo-active proteins: A mid-Infrared investigation with femtosecond time resolution
promotoren: prof. dr. M.L. Groot and prof. dr. R. van Grondelle
defense: 30 September 2011

- Number of scientific papers, refereed: 8

Di Donato, M., Stahl, A.D., Stokkum, I.H.M. van, Grondelle, R. van & Groot, M.L.
Cofactors Involved in Light-Driven Charge Separation in Photosystem I Identified by Subpicosecond Infrared Spectroscopy

Biochemistry, 50(4), 480-490

Di Donato, M., Wilderen, L.J.G.W. van, Stokkum, I.H.M. van, Cohen Stuart, T.A., Kennis, J.T.M., Hellingwerf, K.J., Grondelle, R. van & Groot, M.L.
Proton transfer events in GFP
Physical Chemistry Chemical Physics - PCCP, 13(36), 16295-16305

Rupenyan, A.B., Vreede, J., Stokkum, I.H.M. van, Hospes, M., Kennis, J.T.M., Hellingwerf, K.J. & Groot, M.L.
Proline 68 Enhances Photoisomerization Yield in Photoactive Yellow Protein
Journal of Physical Chemistry B, 115(20), 6668-6677

Stahl, A.D., Hospes, M., Singhal, K., Stokkum, I.H.M. van, Grondelle, R. van, Groot, M.L. & Hellingwerf, K.J.
On the involvement of Single-Bond Rotation in the Primary Photochemistry of Photoactive
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Biophysical Journal, 101(5), 1184-1192

Sytina, O., Alexandre, M.T., Heyes, D.J., Hunter, C.N., Robert, B., Grondelle, R. van & Groot, M.L.
Enzyme activation and catalysis: characterisation of the vibrational modes of substrate and product in protochlorophyllide oxidoreductase
Physical Chemistry Chemical Physics - PCCP, 13(6), 2307

Sytina, O., Novoderezhkin, V.I., Grondelle, R. van & Groot, M.L.
Modeling of Multi-Exciton Transient Absorption Spectra of Protochlorophyllide Aggregates in Aqueous Solution
Journal of Physical Chemistry A, 115(43), 11944-11951.

Sytina, O., Stokkum, I.H.M. van, Grondelle, R. van & Groot, M.L.
Single and multi-exciton dynamics in aqueous protochlorophyllide aggregates
Journal of Physical Chemistry A, 115(16), 3936-3946.

Witte, S.M., Negrean, A., Lodder, J.C., Kock, C.P.J. de, Testa-Silva, G., Mansvelder, H.D. & Groot, M.L.
Label-free live brain imaging and targeted patching with third-harmonic generation microscopy
Proceedings of the National Academy of Sciences of the United States of America, 108(15), 5970-5975.

- Number of conference proceedings: 1

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Label-free live brain imaging with third-harmonic generation microscopy.
In CLEO/Europe and EQEC 2011 Conference Digest. Optical Society of America.

Theme Light and Tissue

- Number of theses: 2

Rolf Bremmer
Non-contact spectroscopic age determination of bloodstains

promotor: prof. dr. A.G.J.M. van Leeuwen, co-promoter: dr. ir. M.C.G. Aalders
defense: 29 June 2011

Hartsuiker L.
Microspectroscopic characterization of gold nanorods for cancer cell detection
promoters: prof. dr. L.W.M.M. Terstappen, prof. dr. T.G. van Leeuwen, co-promoter: dr. C. Otto
defense: December 2011

- Number of scientific papers, refereed: 29

Barwari K, de Bruin DM, Cauberg ECC, Faber DJ, van Leeuwen TG, Wijkstra H, de la Rosette J, Laguna MP
Advanced diagnostics in renal mass using optical coherence tomography: a preliminary report
J ENDOUROL 2011;25 (2):311-315

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New optical diagnostic tools in renal cell cancer
MINERVA UROL NEFROL 2011;63 (3):213-225

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Measurements of wavelength dependent scattering and backscattering coefficients by low-coherence spectroscopy
J BIOMED OPT 2011;16 (3):030503

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In vivo low-coherence spectroscopic measurements of local hemoglobin absorption spectra in human skin
J BIOMED OPT 2011;16 (10):100504

Bosschaart N, Mentink R, Kok JH, van Leeuwen TG, Aalders MCG
Optical properties of neonatal skin measured in vivo as a function of age and skin pigmentation
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Acousto-optic-assisted diffuse optical tomography
OPT LETT 2011;36 (9):1539-1541

Bremmer RH, de Bruin DM, de Joode M, Buma WJ, van Leeuwen TG, Aalders MCG
Biphasic oxidation of oxy-hemoglobin in bloodstains
PLOS ONE 2011;6 (7):e21845

Bremmer RH, Kanick SC, Laan N, Amelink A, van Leeuwen TG, Aalders MCG *Non-contact spectroscopic determination of large blood volume fractions in turbid media*
BIOMED OPT EXPRESS 2011;2 (2):396-407

Bremmer RH, Nadort A, van Leeuwen TG, van Gemert MJC, Aalders MCG
Age estimation of blood stains by hemoglobin derivative determination using reflectance spectroscopy
FORENSIC SCI INT 2011;206 (1-3):166-171

de Kinkelder R, Kalkman J, Faber DJ, Schraa O, Kok PHB, Verbraak FD, van Leeuwen TG
Heartbeat-Induced Axial Motion Artifacts in Optical Coherence Tomography Measurements of the Retina
INVEST OPHTH VIS SCI 2011;52 (6):3908-3913

de Kinkelder R, van der Veen RLP, Verbaak FD, Faber DJ, van Leeuwen TG, Berendschot TTJM
Macular pigment optical density measurements: evaluation of a device using heterochromatic flicker photometry
EYE 2011;25 (1):105-112

Hartsuiker L, van Es P, Petersen W, van Leeuwen TG, Terstappen LWMM, Otto C
Quantitative detection of gold nanoparticles on individual, unstained cancer cells by scanning electron microscopy
J MICROSC-OXFORD 2011;244 (2):187-193

Heijblom M, Klaase JM, van den Engh FM, van Leeuwen TG, Steenbergen W, Manohar S
Imaging tumor vascularization for detection and diagnosis of breast cancer
TECHNOL CANCER RES T 2011;10 (6):607-623

Jose J, Grootendorst DJ, Vijn TW, Wouters MW, van Boven H, van Leeuwen TG, Steenbergen W, Ruers TJM, Manohar S
Errata: Initial results of imaging melanoma metastasis in resected human lymph nodes using photoacoustic computed tomography
J BIOMED OPT 2011;16 (11):119801

Jose J, Grootendorst DJ, Vijn TW, Wouters MW, Wouters M, van Boven H, van Leeuwen TG, Steenbergen W, Ruers TJM, Manohar S
Initial results of imaging melanoma metastasis in resected human lymph nodes using photoacoustic computed tomography
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Passive element enriched photoacoustic computed tomography (PER PACT) for simultaneous imaging of acoustic propagation properties and light absorption.
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Blood clearance and tissue distribution of PEGylated and non-PEGylated gold nanorods after intravenous administration in rats.
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Leproux A, van der Voort M, van der Mark MB, Harbers R, van de Ven SMWY, van Leeuwen TG
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CONTRAST MEDIA MOL I 2011;6 (5):389-400

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Patil CA, Kalkman J, Faber DJ, Nyman JS, van Leeuwen TG, Mahadevan-Jansen A
Integrated system for combined Raman spectroscopy-spectral domain optical coherence tomography
J BIOMED OPT 2011;16 (1):011007

Patil CA, Kirshnamoorthi H, Ellis DL, van Leeuwen TG, Mahadevan-Jansen A
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LASER SURG MED 2011;43 (2):143-151

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Multiple passive element enriched photoacoustic computed tomography
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J BIOPHOTONICS 2011;4 (10):759-767

Stehouwer M, Verbraak FD, de Vries HR, van Leeuwen TG
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NANO LETT 2011;11 (5):1887-1894

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J BIOMED OPT 2011;16 (7):075002

- Number of book chapters: 2

Faber DJ, van Leeuwen TG
Optical Coherence Tomography in: Welch AJ, van Gemert MJC, editors. Optical-Thermal Response of Laser-Irradiated Tissue. London New York: Springer; 2011. chapter 18, p. 713-741

Walsh JT, van Leeuwen TG, Duco Jansen E, Motamedi M, Welch AJ
Pulsed Laser Tissue Interactionin: Welch AJ, van Gemert MJC, editors. Optical-Thermal Response of Laser-Irradiated Tissue. London New York: Springer; 2011. chapter 15, p. 617-649

Theme Single Molecule to Cell Biophysics

- Number of theses: 6

Anitha Shanmugham
Exploring events along the bacterial Twin arginine Transport pathway
promoter: prof. dr. H. Lill, co-promotor: dr. Y. Bollen
defense: 20 January 2011

Siet van den Wildenberg
Single-protein motion on microtubules and in cell membranes
promotoren: prof. dr. C.F. Schmidt and prof. dr. S.M. van der Vies, co-promotor: dr. ir. E.J.G. Peterman
defense: 2 February 2011

Chase Brodersz
Mechanics and dynaics of biopolymer networks (Cum Laude)
promotor: prof. dr. F.C. MacKintosh
defense: 16 May 2011

Peter Gross
The DNA double helix challenged by force.
promotoren: prof. dr. G.J.L. Wuite, dr. ir. E.J.G. Peterman
defense: 19 May 2011

Izabela Piechocka
Biopolymers: from Structural Hierarchy to Nonlinear Rheology
promotoren: prof. dr. G.H. Koenderink and prof. dr. F.C. MacKintosh
defense: 23 November 2011

Marina Soares e Silva
Structure and dynamics of active actio-myosin networdk- An in vitro perspective
promotoren: prof. dr. G.H. Koenderink, prof. dr. F.C. MacKintosh
defense: 21 October 2011

- Number of scientific papers, refereed: 20

Baclayon, M., Shoemaker, G.K., Uetrecht, C., Crawford, S.E., Estes, M.K., Prasad, B.V.V., Heck, A.J.R., Wuite, G.J.L. & Roos, W.H.
Prestress strengthens the shell of norwalk virus nanoparticles
Nano Letters, 11(11), 4865.

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Molecular motors stiffen non-affine semiflexible polymer networks
Soft Materials, 7(7), 3186-3191.

Candelli, A., Wuite, G.J.L. & Peterman, E.J.G.
Combining optical trapping, fluorescence microscopy and micro-fluidics for single molecule studies of DNA-protein interactions
Physical Chemistry Chemical Physics - PCCP, 13(16), 7263-7272.

Das, M. & MacKintosh, F.C.
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Physical Review E, 84(6), 061906.

Evilevitch, A., Roos, W.H., Ivanovska, I.L., Jeembaeva, M, Jonsson, B. & Wuite, G.J.L.
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Fakhri, N., Enderlein, J., Pasquali, M., MacKintosh, F.C. & Schmidt, C.F.
Carbon nanotubes as mechanical probes of equilibrium and non-equilibrium cytoskeletal networks
European Biophysics Journal, 40(1), 159.

Gross, P., Laurens, N., Oddershede, L.B., Bockelmann, U., Peterman, E.J.G. & Wuite, G.J.L.
Quantifying how DNA stretches, melts and changes twist under tension
Nature Physics, 7(9), 731-736.

Heuveling, D.A., Visser, G.W.M., Salumbides - Baclayon, M., Roos, W.H., Wuite, G.J.L., Hoekstra, O.S., Leemans, C.R., Bree, R. de & Dongen, G.A.M.S. van
(89)Zr-Nanocolloidal Albumin-Based PET/CT Lymphoscintigraphy for Sentinel Node Detection in Head and Neck Cancer: Preclinical Results
Journal of Nuclear Medicine, 52(10), 1580-1584.

Ivanovska, I.L., Miranda, R., Carrascosa, J. L., Wuite, G.J.L. & Schmidt, C.F.
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Lansky, Z. & Peterman, E.J.G.
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Lin, Y.C., Koenderink, G.H., MacKintosh, F.C. & Weitz, D.A.
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Silva, M.S. e, Depken, S.M., Stuhrmann, B., Korsten, M., MacKintosh, F.C. & Koenderink, G.H.
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Sznee, K., Dekker, J.P., Dame, R.T., Van Roon, H., Wuite, G.J.L. & Frese, R.N.
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Biopolymers, 95(5), 312-321.

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How to Quantify Protein Diffusion in the Bacterial Membrane
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Yao, N.Y., Becker, D.J., MacKintosh, F.C., Pollak, M.R. & Weitz, D.A.

Nonlinear Viscoelasticity of Actin Transiently Cross-linked with Mutant alpha-Actinin-4
Journal of Molecular Biology, 411(5), 1062-1071.

- Number of scientic papers, non-refereed: 1

  Snijder, J., Wuite, G.J.L. & Roos, W.H.
  Voelen en Vervormen van Virussen
  Nederlands Tijdschrift voor Natuurkunde, 77, 70-74.

- Number of books: 1

  Peterman, E.J.G. & Wuite, G.J.L.
  Single Molecule Analysis, Series Methods in Molecular Biology.
  New York: Humana Press.

- Number of book chapters: 2

  Wildenberg, S.M.J.L., Prevo, B. & Peterman, E.J.G.
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  New York: Humana Press.

Theme Physics of Light

- Number of theses: 4

  Thomas van Dijk
  Experimental and Theoretical studies in Optical Coherence Theory
  promoters: prof. dr. T.D. Visser, Prof. dr. W.M.G. Ubachs
  defence: 4 April 2011

  Sven de Man
  Divide et Impera (Cum Laude)
  promoters: prof. dr. R.P. Griessen, dr. D. Iannuzzi
  defense: 14 June 2011

  Anne Lisa Wolf
  Frequency comb spectroscopy on trapped calcium ions
  promoters: prof. dr. K.S.E. Eikema and prof. dr. W.M.G. Ubachs, co-promoter: S van den Berg
  defense: 7 July 2011

  Dominik Kandula
  XUV Frequency Comb Metrology and the Ground State of Helium

promoters: prof. dr. K.S.E. Eikema, prof. dr. W.M.G. Ubachs
defense: 1 December 2011

- Number of scientific papers, refereed: 31

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Dickenson, G.D., Ivanov, T.I., Ubachs, W.M.G., Roudjane, M., Oliveira, N. de, Joyeux, D., Nahon, L., Tchang-Brillet, W.U.L., Glass-Maujean, M., Schmoranzer, H., Knie, H., Kubler, S. & Ehresmann, A.
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Journal of Chemical Physics, 134, 054309.

Jansen, P., Xu, L.-H., Kleiner, I, Ubachs, W.M.G. & Bethlem, H.L.
Methanol as a Sensitive Probe for Spatial and Temporal Variations of the Proton-to-Electron Mass Ratio
Physical Review Letters, 106 (10), 100801.

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XUV frequency comb metrology on the ground state of helium.
Physical Review A, 2011(84), 062512.

King, J.A., Murphy, M.T., Ubachs, W.M.G. & Webb, J.K.
New constraint on cosmological variation of the proton-to-electron mass ratio from Q0528-250
Monthly Notices of the Royal Astronomical Society, 417, 3010-3024.

Knoop, S., Schuster, T., Scelle, R., Trautmann, A., Appmeier, J., Oberthaler, M.K., Tiesinga, E. & Tiemann, E.
Feshbach spectroscopy and analysis of the interaction potentials of ultracold sodium.
Physical Review A, 83(4), 042704.

Koelemeij, J.C.J.
Infrared dynamic polarizability of HD+ rovibrational states.
Physical Chemistry Chemical Physics - PCCP.

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Physical Review A, 84.

Pang, X., Visser, T.D. & Wolf, E.
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Optics Communications, 284(24), 5517-5522.

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Optics Letters, 36(11), 2026-2028.

Rooij, R. van, Borbely, J., Simonet, J., Hoogerland, M., Eikema, K.S.E., Rozendaal, R.A. & Vassen, W.
Frequency Metrology in Quantum Degenerate Helium: Direct Measurement of the 2 (3)S(1) -> 2(1)S(0) Transition.
Science, 333(6039), 196--198.

Salumbides, E.J., Maslinskas, V., Dildar, I.M., Wolf, A.L., Duijn, E.J. van, Eikema, K.S.E. & Ubachs, W.M.G.
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Physical Review A, 83, 012502.

Salumbides, E.J., Dickenson, G.D., Ivanov, T.I. & Ubachs, W.M.G.
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Sprecher, D., Jungen, C., Ubachs, W.M.G. & Merkt, F.

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Journal of Microscopy, 242(1), 10-14.

Weerdenburg, F. van, Murphy, M.T., Malec, A.L., Kaper, L. & Ubachs, W.M.G.
First Constraint on Cosmological Variation of the Proton-to-Electron Mass Ratio from Two Independent Telescopes.
Physical Review Letters, 106(18), 180802.

Witte, S.M. & Eikema, K.S.E.
Ultrafast optical parametric chirped pulse amplification.
IEEE Journal of Selected Topics in Quantum Electronics.

Wolf, A.L., Morgenweg, J., Koelemeij, J.C.J., van den Berg, S.A., Ubachs, W.M.G. & Eikema, K.S.E.
Direct frequency-comb spectroscopy of a dipole-forbidden clock transition in trapped 40Ca+ ions.
Optics Letters, 36(1), 49-51.

Zhao, D., Haddad, M.A., Linnartz, H.V.J. & Ubachs, W.M.G.
C6H and C6D: electronic spectra and Renner-Teller analysis.
Journal of Chemical Physics, 135, 044307.

Zhao, D., Wehres, N., Linnartz, H.V.J. & Ubachs, W.M.G.
Electronic spectra and structure of the non-linear carbon chain C9H3.
Chemical Physics Letters, 501, 232-237.

Zhao, D., Haddad, M.A., Linnartz, H.V.J. & Ubachs, W.M.G.
Structure determination of the nonlinear hydrocarbon chains C9H3 and C11H3 by deuterium labeling.
Journal of Chemical Physics, 135, 074201.

Zuurbier, P., Man, S.P.J. de, Gruca, G.L., Heeck, K. & Iannuzzi, D.
Measurement of the Casimir force with a ferrule-top sensor.
New Journal of Physics, 13(023027

Number of publications, non-refereed: 1

Koelemeij, J.C.J.
Super GPS via glasvezelnetwerken.
Fotonica Magazine.

Number of book chapters: 1

Ubachs, W.M.G., Bagdonaite, J., Murphy, M.T., Buning, R. & Kaper, L.
Search for cosmological mu variation form high-redshift H2 absorption; a status report.
In C. Martins & P Molaro (Eds.), From Varying Couplings to Fundamental Physics (Astrophysics and Space Science Proceedings) (pp. 125). Berlin-Heidelberg: Springer.

b) Scientific Quality[1]

Analytical Chemistry and Spectroscopy

- Total number of citations

	2011	*Total*
A.M. Brouwer:	261	2609
W.J. Buma:	162	1647
C. Gooijer:	238	4004
M.H.M. Janssen:	177	1607
F. Ariese:	293	2941
G. van der Zwan:	122	2631
S. Woutersen:	309	3195
R.M. Williams:	231	2168
H. Zhang:	300	1760

- Mean H-index of tenured staff

A.M. Brouwer :	25
W.J. Buma:	22
C. Gooijer:	30
M.H.M. Janssen:	22
F. Ariese:	26
G. van der Zwan:	22
S. Woutersen:	25
R.M. Williams:	23
H. Zhang:	26

Biomedical Physics

- Total number of citations

	2011	*Total*
J.F. de Boer:	850	6610
R.M. Verdaasdonk:	40	576

- Mean H-index of tenured staff

J.F. de Boer:	41
R.M. Verdaasdonk:	15

Energy

Total number of citations	*2011*	*Total*
R. van Grondelle:	1503	17850
R. Croce:	370	2800
J.P. Dekker:	461	6899
R. Frese	86	1093
J.T.M. Kennis:	409	2196
I.H.M. van Stokkum:	804	6509

- Mean H-index of tenured staff

R. van Grondelle:	68
R. Croce:	33
J.P. Dekker:	51
J.T.M. Kennis:	28
I.H.M. van Stokkum:	49

Laser Based Microscopy

[1] For the calculation we have used the Web of Science

- Total number of citations

	2011	*Total*
M.L. Groot:	193	1133

- Mean H-index of tenured staff

M.L. Groot:	20

Light and Tissue

- Total number of citations

	2011	*Total*
A.G.J.M. van Leeuwen:	427	1885
M.C.G. Aalders:	192	1101
D.J. Faber:	171	598

- Mean H-index of tenured staff

A.G.J.M. van Leeuwen:	24
M.C.G. Aalders:	18
D.J. Faber	13

Single Molecule to Cell Biophysics

- Total number of citations

	2011	*Total*
D. Bald:	95	1036
Y.J.M. Bollen:	11	181
H. Lill:	73	1345
J. Luirink:	435	4773
F.C. MacKintosh:	838	6059
E.J.G. Peterman:	240	1913
P. van Ulsen:	79	595
G.J.L. Wuite:	373	1902

- Mean H-index of tenured staff

D. Bald:	16
Y.J.M. Bollen:	7
H. Lill:	22
J. Luirink:	41
F.C. MacKintosh:	39
E.J.G. Peterman:	28
P. van Ulsen:	12
G.J.L. Wuite:	24

Physics of Light

- Total number of citations

	2011	*Total*
H.L. Bethlem:	235	1995
K.S.E. Eikema:	163	1084
D. Iannuzzi:	117	703
S. Knoop:	91	364
J.C.J Koelemeij:	112	315
W.M.G. Ubachs:	460	3285
W. Vassen:	116	1537
T.D. Visser:	160	1643

- Mean H-index of tenured staff

H.L. Bethlem:	21
K.S.E. Eikema:	19

D. Iannuzzi:	14
W.M.G. Ubachs:	30
W. Vassen:	21
T.D. Visser:	23

c) Indicators of esteem

Analytical Chemistry and Spectroscopy

- Prestigious grants
  - VENI grant: Diego Millo, k€ 240
  - NanonextNL: Freek Ariese, k€ 145
  - NWO CW BAZIS: Freek Ariese, k€ 340
  - NWO-CW ECHO: Sander Woutersen, k€ 396
  - NWO-CW ECHO: Wybren Jan Buma, k€ 225

- Special professors
  - Prof. dr. H.J. Bakker
  - Prof. dr. W.L. Meerts
  - Prof. dr. W.M.A. Niessen
  - Prof. dr. J. Oomens

Energy

- Prestigious grants
  - ERC Ideas starting grant: Prof. dr. Roberta Croce, k€ 1700
  - VICI: Prof. dr. Roberta Croce, k€ 1500
  - NWO Middelgroot: dr. John Kennis, k€ 313
  - VENI: dr. Bart van Oort, k€ 240
  - FOM/ALW: Prof. dr. Roberta Croce, OIO + consumables
  - FES/BioSolar Cells: Prof. dr. Roberta Croce, k€ 450
  - FES/BioSolar Cells: Prof. Dr. Roberta Croce, k€ 450
  - FOM program: Prof. dr. Roberta Croce, k€ 550
  - NWO-CW ECHO: Prof. dr. Roberta Croce, k€ 260

- Special professors
  - Prof. dr. H.J. Hellingwerf
  - Prof. dr. G.J.M. Stienen

Laser-Based Microscopy

- Prestigious grants
  - NWO-ALW middelgroot: Prof. dr. Marloes Groot, k€ 400

Light and Tissue

- Editorships
  - Journal of Biomedical Optics: Prof. dr. T.G. van Leeuwen
  - Optics Letters: Prof. dr. T.G. van Leeuwen
  - Lasers in Medical Science: Prof. dr. T.G. van Leeuwen
  - International Journal of Cardiovascular Imaging: Prof. dr. T.G. van Leeuwen

Single Molecule to Cell Biophysics

- Prestigious grants
  - VICI: dr. Erwin Peterman; k€ 1500
  - STW-perspectief: dr. Yves Bollen and dr. Erwin Peterman; k€ 247
  - FOM program barriers in the brain; dr. Erwin Peterman; k€ 250
  - EMBO grant G. King; k€ 64
  - Nanonext NL Gijs Prof. dr. Wuite; k€ 270
  - Nanonext NL: Erwin Peterman; k€ 220

- Special professors
  - Prof. dr. G.H. Koenderink
  - Prof. dr. P.R. ten Wolde

Physics of Light

- Prestigious grants
  - ERC Proof of Concept: dr. Davide Iannuzzi, k€ 147
  - VIDI: dr. Steven Knoop, k€ 800
  - FOM grant dr Steven Knoop, k€ 394
  - ESA-ESTEC Network/Partnership program: Davide Iannuzzi, k€ 90

- Special professors
  - Prof. dr. E.A.A. Aben
  - Prof. dr. L. Kaper
  - Prof. dr. H.V.J. Linnartz

d) Societal Impact

Technical or economic impact

- Fiber-top technology forms basis for new VU spin-off company Optics11.
  In 2005, research by physist Davide Ianuzzi and collegues led to the development of fiber-top technology. After five years of further research, this technology is now launched onto the market

Awarded Patents 2011

- US7864822 B. E. Bouma, Seok-Hyun (Andy) Yun, Wang-Yuhl (William) Oh, Johannes F. de Boer, Guillermo J. Tearney; Process and apparatus for a wavelength tuning source – Issued Jan 4, 2011

- US8040608 : Conor L. Evans, Johannes F. De Boer, Mattijs De Groot; System and method for self-interference fluorescence microscopy. Issued 18 Oct 2011