Technische Universität Braunschweig

Physikalisch-Technische Bundesanstalt PTB

Summer School of Metrology 2012

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Burg Warberg, Elm

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international graduate school of metrology

braunschweig igsm

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Welcome

Prof. Dr. Joachim Ullrich

Present Position	President of the Physikalisch-Technische Bundesanstalt, Berlin/Braunschweig

Academic Record

since 2012	President of the Physikalisch-Technische Bundesanstalt, Berlin/Braunschweig
2008 – 2011	Chair of Management Board, Center for Free Electron Laser Science (CFEL), Hamburg
since 2006	Center for Free Electron Laser Science (CFEL), Hamburg, Head: Advanced Study Group Member of Management Board
2006	Philipp Morris Forschungspreis (together with Robert Moshammer)
since 2003	Consultant Professor, Fudan University, Shanghai
2002 – 2006	Temporary Director, Max-Planck-Inst. für Kernphysik, Heidelberg, Dept. Heavy Ion Physics
since 2002	Honorary Professor, Universität Heidelberg
since 2001	Director and Scientific Member at the Max Planck Institut für Kernphysik, Heidelberg
1999	Gottfried-Wilhelm-Leibniz-Förderpreis, Deutsche Forschungsgemeinschaft
1997 – 2001	Full Professor, Universität Freiburg
1995	Visiting Scientist, Kansas State University, University of Missouri
1994	Habilitation in physics, Universität Frankfurt
1989 – 1997	Scientist, Gesellschaft für Schwerionenforschung, Darmstadt
1987	Doctorate, Universität Frankfurt
1983	Dipl.-Phys., Universität Frankfurt

Quantum Hall Effect and the New SI System

Prof. Dr. Klaus von Klitzing

Present Position	Director at Max Planck Institut für Festkörperforschung

Academic Record

since 1985	Director at the Max Planck Institut für Festkörperforschung and Honorary Professor at the Universität Stuttgart
1980 – 1984	Professor at the Technische Universität München
1969 – 1980	University Würzburg, Habilitation (1978), Dr. rer. nat. in Physics (1972)
1962 – 1969	Technische Universität Braunschweig, Diploma in Physics

Scientific Interest	Low dimensional electron systems

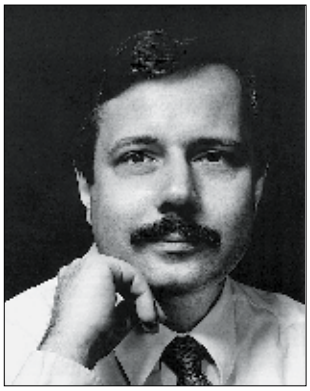
Abstract

The quantum Hall effect plays a very important role in metrology since all calibrations of electrical resistors are based on this effect. Different two-dimensional electron systems were used to demonstrate that the quantized Hall resistance R_K is independent of the material (silicon, carbon, gallium arsenide) within the experimental uncertainty of about 1 part in 10^{10} and identical with the fundamental constant h/e^2 (h = Planck constant, e = elementary charge). Since 1990 all calibrations of electrical resistors are based on an internationally agreed best value for the quantized Hall resistance with the value 25812.807 Ohm (conventional von Klitzing constant $R_{K\text{-}90}$). However, such a definition is not compatible with the official international system of units (SI system). The same problem is present with the Josephson effect which allows the realization of electrical voltages based on an internationally agreed value for the conventional Josephson constant $K_{J\text{-}90}$ (which is connected to the fundamental constant $K_J = 2e/h$), but such a voltage is not compatible with our SI system.

This conflict between SI units and practical units for electrical quantities can be resolved if new definitions for the SI base units as recommended by the General Conference on Weights and Measures (CGPM 24, October 2011) are accepted. The basic idea for this new SI system is the direct link between fixed values of fundamental constants and SI base units as realized already for the unit of length (fixed value for the velocity of light). If fixed values for h und e within a new SI system are accepted, all calibrations of electrical units (based on Josephson and quantum Hall effect) are automatically in agreement with the SI system. However, the present definitions of the base units "kilogram" and "ampere" have to be given up.

The lecture presents an overview about the QHE and its applications in metrology and summarizes the experimental situation for a new definition of the base unit "kilogram".

Single-Atom Magnetometry



Prof. Dr. Roland Wiesendanger

Present Position	Managing Director of the Institute of Applied Physics at the Universität Hamburg

Academic Record

2010	Nanotechnology Recognition Award of the American Vacuum Society
2008	Advanced Grant of the European Research Council (ERC) , Elected Member of the German Academy of Technical Sciences "acatech"
2005	Elected Founder Member of the Hamburg Academy of Sciences
since 2003	Managing Director of the Institute of Applied Physics at the Universität Hamburg
2003	Philip Morris Research Prize (together with Dr. Matthias Bode)
2000	Elected Member of the German Academy of Sciences "Leopoldina"
1999	Karl Heinz Beckurts Prize
1992	Offer for a Full Professor position (C4) at the Universität Hamburg, Gaede Prize (German Vacuum Society), Max Auwärter Prize (Austrian Physical Society)
1991 – 1992	Private Lecturer at the Universität Basel
1990	Habilitation at the Universität Basel
1987	Ph.D. at the Universität Basel
1986	Diploma in Experimental Physics
1981 – 1986	Studies of Physics, Mathematics and Astronomy at the Universität Basel

Abstract

Based on the development of spin-polarized scanning tunneling microscopy (SP-STM) [1], we have recently established the novel method of single-atom magnetometry [2,3] which allows the measurement of magnetization curves and the determination of magnetic moments on an atom-by-atom basis. While the sensitivity level of single-atom magnetometry is below one Bohr magneton, it can easily be combined with the atomic-resolution imaging and manipulation capabilities of conventional STM, thereby offering a novel approach towards a rational material design based on the knowledge of the atomic-level properties and interactions within the solid state [4]. Moreover, an atom-by-atom design and realization of all-spin logic devices [5] has recently been demonstrated by our group based on the combined knowledge derived from surface physics, nanoscience and magnetism.

[1] R. Wiesendanger, Rev. Mod. Phys. 81, 1495 (2009)
[2] F. Meier et al., Science 320, 82 (2008)
[3] L. Zhou et al., Nature Physics 6, 187 (2010)
[4] A. A. Khajetoorians et al., submitted to Nature Physics
[5] A. A. Khajetoorians et al., Science 332, 1062 (2011)

Basics of Surface Topography Measurement

Prof Richard Leach

Present Position: Principal Research Scientist in the Engineering Measurement Division, National Physical Laboratory, Teddington, UK

Visiting Professor, Wolfson School for Mechanical and Manufacturing Engineering, Loughborough University

Academic Record

2000	PhD Surface metrology (University of Warwick)
1994	M.Sc. Industrial Measurement Systems (Brunel University)
1989	B.Sc. Applied Physics with Microelectronics and Computing (Kingston University)

Scientific Interests: Micro and nano scale dimensional standards and optical metrology | micro force | thrust and impulse

Abstract

We are all used to the simple concept of "a surface". Often referred to as some sort of boundary between a material and its surrounding environment, surfaces can have a profound effect on the way a component functions. For this reason, the quantitative measurement of surfaces has been carried out for many decades and there is a huge range of instruments available. This lecture will discuss the concept of a surface and address the two most common techniques for measuring a surface: contacting styli and optical methods. But why can we rarely get these methods to agree on the measurement of the same surface? Which method gets closest to the "real" surface? The paper will then address the issues associated with both methods and formulate a framework in which we may be able to correct some of the systematic errors that are common to surface measuring instruments, and get closer to the proverbial real surface.

Multiscale 3D Metrology

Prof. Dr. Wolfgang Osten

Present Position	Full professor, director, Institut für Technische Optik, Universität Stuttgart

Academic Record

2006 – 2010	Vice rector for research and technology transfer, Universität Stuttgart
since 2002	Full professor, director, Institut für Technische Optik, Universität Stuttgart
1991 – 2002	Director, Dept. Optical 3D-Metrology, Inst. f. angew. Strahltechnik (BIAS), Bremen
1988 – 1991	Head, Institute for Digital Image Processing at the ZKI
1984 – 1991	Zentralinstitut für Kybernetik und Informationsprozesse (ZKI), Berlin
1983	PhD, Martin-Luther-Universität Halle-Wittenberg
1979 – 1984	Technical staff, Abt. Opt. Metrologie am Inst. für Mechanik d. Akad. d. Wissenschaften
1979	Diploma in Physics, Friedrich-Schiller-Universität Jena

Scientific Interests	New concepts for industrial inspection and metrology by combining modern principles of optical metrology, sensor technology and image processing | development of resolution enhanced technologies for the investigation of micro and nano structures

Abstract

The objective of optical surface inspection is the measurement and description of the surface topography in different scales (global shape, waviness, microstructure/roughness) and the detection of global and local deviations from the wanted shape (different kinds of surface defects). As critical areas we denote those parts of the object where the resolution of the current sensor is not high enough to resolve the surface details sufficiently well with respect to the derivation of a reliable inspection result. To enable an efficient inspection process for such cases the concept of multi-scale sensor fusion was introduced. The new quality of this concept is characterized by the fact that the data acquisition in a certain scale is controlled by the measurement results obtained in the previous scale. Both, the current type of sensor to be used and the current measurement area, are specified by the respective preceding scale. Different features such as the fractal dimension, texture features and the power spectral density are candidates for the indication of critical areas. Thus, the area of interest is reduced step by step while the boundary conditions for high-resolution sensors are improved.

The presentation gives an overview about the advantages and limitations of optical surface metrology, describes the concept of multi-scale sensor fusion and illustrates the advantages of the new technology using several measurement problems as an example.

Laser-based Metrology in the Terahertz Frequency Range

Dr.-Ing. Mark Bieler

Present Position	Head of Working Group Terahertz-Optics, Physikalisch-Technische Bundesanstalt (PTB)

Academic Record

since 2004	Staff scientist at the Physikalisch-Technische Bundesanstalt
2003 – 2004	Postdoctoral stay at the University of Toronto
1999 – 2003	PhD research on "Ultrafast Optoelectronic Switches: Physics of Pulse Generation and Applications to High-Frequency Device Characterization"
1994 – 1999	Studies in electrical engineering, Technische Universität Braunschweig and University of Bath, UK, with emphasis on semiconductors and optoelectronics

Scientific Interests	Investigation of ultrafast photocurrents in semiconductors | characterization of high-speed electronic devices | high-frequency electric field measurements | study of terahertz phenomena

Abstract

The steady increase in operating frequency and bandwidth of electrical devices imposes the need for reliable measurements of electrical signals in the GHz and THz frequency range. Femtosecond lasers are well suited for this purpose since they offer (i) an unprecedented bandwidth that is not accessible with purely electrical devices and (ii) allow for traceable measurements in which the time or frequency axes are traceable to the unit of time. This presentation will discuss these laser-based measurement techniques and show how amplitude, phase and frequency of continuous-wave and pulsed signals at GHz and THz frequencies can be measured in a straightforward way.

Who Needs Dosimetry?

Dr. Ulrike Ankerhold

Present Position	Head of Department Dosimetry for Radiation Therapy and Diagnostic Radiology, Physikalisch-Technische Bundesanstalt (PTB)

Academic Record

since 2009	Head of Department Dosimetry for Radiation Therapy and Diagnostic Radiology, PTB
2003 – 2009	Head of Working Group Photon dosimetry, Department Radiation Protection Dosimetry, PTB
since 1997	Scientist in the Division Ionizing Radiation, PTB
1995 – 1997	PostDoc, Physikalisches Institut, Universität Bonn
1995	Dr. rer. nat. in physics, Universität Bonn
1991	Diploma in physics, Universität Hannover

Scientific Interests	Measuring techniques and radiation transport calculations for metrology in dosimetry | national and international standardization and recommendations in the field of dosimetry

Abstract

Ionizing radiation can be helpful, e.g. in diagnostic radiology or for combating cancer, but it can also be harmful. This paradox is reflected in the two fields of dosimetry: radiation protection dosimetry to ensure the health of occupationally exposed workers and the general public as well as dosimetry for the medical application of ionizing radiation to restore the health of patients. An overview of both fields with the different measuring quantities and units as well as their challenges will be given.

General literature: F.H. Attix: **Introduction to Radiological Physics and Radiation Dosimetry**, John Wiley & Sons (publisher), 1st edition, ISBN 978-0471011460

Mechanical Quantities – Measuring Force and Torque

Dr.-Ing. Dirk Röske

Present Position	Head of Working Group Realization of Torque, Physikalisch-Technische Bundesanstalt (PTB)

Academic Record

since 2007	Head of Working Group Realization of Torque, PTB
1999	Dr.-Ing., doctoral thesis about mechanical effects on strain gauge based torque measurement at Technische Universität Braunschweig
since 1991	Scientist in Torque Laboratory at Physikalisch-Technische Bundesanstalt in Berlin, since 1993 in Braunschweig
1987 – 1990	Scientist in Force Laboratory at Amt für Standardisierung, Messwesen und Warenprüfung in Berlin
1987	Dipl.-Phys., Theoretical Physics, University Odessa

Scientific Interests	Torque metrology | force metrology | multi-component measurements | data evaluation and uncertainty estimation

Abstract

The importance of the mechanical quantities force and torque in many applications in industry and daily life can hardly be overestimated. Very often questions of safety are involved, for example in material testing with tension and torsion or when the tires of a car have to be fixed with the right tightening torque of the screws. Some other major fields for the measurement of force and torque are driving technology, power generation, assembling and automation, medicine. For all these applications, a profound metrological basis of the mechanical quantities force and torque is necessary and will be presented.

Nanophotonic structures of metal nanoparticle chains and arrays

David Citrin

Present Position	Professor of Electrical and Computer Engineering, Georgia Institute of Technology
	Coordinator for Chaos-based Communications, UMI 2958 Georgia Tech-CNRS, Georgia Tech Lorraine, Metz, France

Academic Record

since 2006	Coordinator for Chaos-based Communications, UMI 2958 Georgia Tech-CNRS, Georgia Tech Lorraine, Metz, France
since 2001	Professor of Electrical and Computer Engineering, Georgia Institute of Technology, Atlanta, USA
1995 –2001	Assistant Professor of Physics, Washington State University, Pullman, Washington
1993 –1995	Research Fellow, Center for Ultrafast Optical Science, University of Michigan, Ann Arbor, Michigan
1991 –1993	Post Doctoral Fellow, Max Planck Institut für Festkörperforschung, Stuttgart
1991	PhD in Physics, University of Illinois, Urbana, Illinois

Scientific Interests: Nanophotonics | plasmonics | terahertz science and technology | photonic crystals | chaos-based communications

Abstract

Nanoparticle chains and arrays of metal nanoparticles have remarkable optical properties associated with the excitation of surface plasmon polaritons – hybrid plasmonic-electromagnetic excitations of the overall structure. While considerable past interest has focused on guided waves by such structures, nanoparticle chains and arrays may also provide the basis of various other optical elements, such as lenses, as well as for vector-optical elements, in which the s- and p-polarized components of an incident optical field undergo markedly different processing in the transmission or reflection direction. These various applications of nanoparticle chains and arrays will be discussed with an emphasis on the generation of optical vector beams.

Near-field Optics and Optical Nanometrology

Prof. Dr. Pavel Tománek

Present Position	Full professor of Applied Physics and Head of Laboratory of Optical Nanometrology, Brno University of Technology, Faculty of Electrical Engineering and Communication, Czech Republic

Academic Record

since 2000	Professor, Applied Physics, Optics and Nanotechnology, Brno University of Technology
1983 – 1988	Visiting Professor, University Tlemcen, Algeria
1982	Habilitation, Physics, Technical University, Brno
1981	Dr. rer. nat., Applied Physics, Palacký University, Olomouc
1980	Ph.D., Quantum Optics and Electronics, Technical University, Brno
1966	Diploma, Applied Physics, Optics and Fine mechanics, Palacký University, Olomouc, Czech Republic

Scientific Interests	Holography | optical information processing (1966-2000) | optical fiber sensors (since 1983) | optical near field phenomena and local spectroscopy (since 1991)

Abstract

In the early nineties of the 20th century and 10 years after the investigation of STM, with a boom of nanotechnology, the characterization optical techniques allowing to see (nanoscopy) and measure (nanometrology) nanostructures, started to be deeply investigated in details.

First, an overview of the short history of the near-field optics as well as of various types of local optical microscopes will be presented.

Then a nanoscale measurement of different contrasts will be explained and some applications in the field of material and electrical engineering will be shown.

Primary Reference Methods in Chemistry

Dr. Bernd Güttler

Present Position	Head of Department Metrology in Chemistry, Physikalisch-Technische Bundesanstalt (PTB)

Academic Record

since 2002	Head of Department Metrology in Chemistry, PTB
2000 – 2002	Head of Project Micro- and Nanoanalytical Measurements, PTB
1995 – 1996	Presidential staff sector, PTB
1990 – 1999	Research Scientist in solid state chemistry, PTB
1988 – 1989	Research Scientist, Interdisciplinary Research Centre (IRC) in Superconductivity, Cavendish Laboratories, University of Cambridge, UK
1988	Ph.D. (Dr. rer. nat.) in crystal physics, Universität Hannover
1986 – 1988	Research Assistant, Department of Earth Sciences, University of Cambridge, UK
1985 – 1986	Scientific Assistant, DFG-Sonderforschungsbereich 173 "Transport, Kinetics & Chemical Processes in Solids", Universität Hannover

Scientific Interests	Metrology in chemistry | precision measurement methods in chemistry | optical and mass spectrometry | nanotechnologies for chemical analysis

Abstract

Internationally comparable measurement results require traceability to recognised references, ultimately to the SI units, also in chemistry.

These results are often used as a basis for important legislations, decisions and agreements on an international level for example in health care, environmental protection or food safety. The concept for higher order and primary reference methods, traceability and the special problems associated with its application to chemical analysis as compared to metrology in general are described.

Current approaches to establish traceability of chemical measurement results will be presented. It will also be shown how such methods can be established and used efficiently.

Self-assembled Nanoscopic Rulers for Microscopy

Prof. Dr. Philip Tinnefeld

Present Position	Professor of Biophysical Chemistry, Institut für Physikalische und Theoretische Chemie, TU Braunschweig

Academic Record

since 2010	Full Professor (W3) of Biophysical Chemistry, TU Braunschweig
2009	Academy Prize for Chemistry of the "Akademie der Wissenschaften zu Göttingen"
2007 – 2010	Associate Professor (W2) of Biophysics, Ludwig-Maximilians-Universität, München
2007	Visiting Professor of Biophysics, Ludwig-Maximilians-Universität, München
2003 – 2007	Assistant Professor (C1), Physics Faculty, Applied Laser Physics & Spectroscopy, Universität Bielefeld (Department Prof. M. Sauer)
2006	Habilitation, venia legendi for Physics
2002 – 2003	Postdoc in the groups of Shimon Weiss (UCLA), Markus Sauer (Heidelberg) and Frans C. DeSchryver (Leuven)
2001	Schloessmann Award of the Max-Planck-Society
1999 – 2002	Ph.D. , Physical Chemistry, Universität Heidelberg, supervised by Prof. Dr. J. Wolfrum
1998	M. Sc., Physical Chemistry, Universität Heidelberg

Scientific Interests	Single-molecule fluorescence spectroscopy | super-resolution microscopy | DNA nanotechnology

Abstract

In recent years, a number of approaches have emerged that enable far-field fluorescence imaging beyond the diffraction limit of light, namely super-resolution microscopy. These techniques are beginning to profoundly alter our abilities to look at biological structures and dynamics and are rapidly spreading into biological laboratories around the world. Here, I will summarize our efforts to advance super-resolution imaging and focus on the development of self-assembled nanoscopic rulers for calibration and evaluation of super-resolution microscopes. These nanoscale rulers are made of self-assembled DNA nanostructures and arrange a precisely defined number of fluorescent dyes with nanometer precision, so that the resolving power of a microscope can be easily tested. We demonstrate the potential of the nanoscale rulers with different super-resolution techniques including stimulated emission depletion microscopy and super-resolution microscopy that is based on the successive localization of single molecules. The DNA based bottom-up approach to microscopy standards has the potential to be widely applied beyond super-resolution imaging.

Small Forces on Small Length Scales – the Physics of Biological Cells

Prof. Dr. Sarah Köster

Present Position	Professor at the Institute for X-ray Physics, Universität Göttingen

Academic Record

since 2011	Professor, Universität Göttingen
2008 – 2011	Junior Professor, Universität Göttingen
2006 – 2008	Postdoc, Harvard University, Cambridge, USA
2003 – 2006	PhD work (Universität Ulm, Boston University, Max Planck Institute for Dynamics and Self-Organiszation, Göttingen)
1998 – 2003	Studies in physics, Universität Ulm

Scientific Interests: Biophysics | cell mechanics | cytoskeletal proteins | microfluidics | microscopy/imaging | x-ray scattering and imaging

Abstract

Biological cells and their components (such as proteins, organelles or the membrane) are micro- and nanoobjects. A thorough understanding of the biological, chemical and physical properties of these systems is important i) from a medical point of view and ii) for the advancement of material sciences.

For investigations of biological systems, experimental methods are necessary that probe the system on the relevant length (nanometers to micrometers), force (piconewton to nanonewton) and time (subseconds to days) scales. I will show some suitable techniques as well as examples of such studies.

An overview will be given of microfluidics, micropatterning, microscopy and x-ray scattering methods.

Precision Spectroscopy of Simple Atomic Systems

Dr. Thomas Udem

Present Position	Scientist at the Max-Planck-Institut für Quantenoptik, Garching

Academic Record

since 2004	Permanent position at Max-Planck-Institut für Quantenoptik
2004	Habilitation, Ludwig-Maximilians-Universität München
2000 – 2003	Research position at Max-Planck-Institut für Quantenoptik
2000	Postdoc at NIST, Boulder, Colorado, USA
1997 – 2000	Postdoc at Max-Planck-Institut für Quantenoptik, Garching
1997	PhD, Ludwig-Maximilians-Universität München
1993	Diploma, Universität Giessen

Scientific Interests: Ultraprecise laser spectroscopy, atomic physics, quantum optics, metrology | precision spectroscopy of simple atoms, hydrogen and hydrogen-like systems | test of fundamental laws | search for slowly varying constants | frequency combs infrared and extreme ultraviolet | ion traps | intra-cavity high harmonic generation

Abstract

I will review the status and prospects of experimental tests of quantum electrodynamics using simple atomic systems. The narrow band 1s-2s transition in atomic hydrogen has been measured with almost 15 digits uncertainty using an optical frequency comb and a cesium atomic clock as a reference. For fundamental tests and the determination of the Rydberg constant other transition frequencies have to be determined. I will describe how constants are determined in general and what types of constants can be distinguished.

Optical Frequency Combs

Dr. Steven T. Cundiff

Present Position	JILA Fellow
	Physicist, Quantum Physics Division, National Institute of Standards and Technology
	Professor Adjoint, Department of Physics and Department of Electrical, Computer and Energy Engineering, University of Colorado

Academic Record

since 2008	Professor Adjoint, Physics and Electrical Engineering, University of Colorado
2004 – 2008	Associate Professor Adjoint, Physics and Electrical Engineering, University of Colorado
since 1999	JILA Fellow
1998 – 1999	JILA Associate Fellow
1997 – 2003	Assistant Professor Adjoint, Physics and Electrical Engineering, University of Colorado
1995 – 1997	Post-doctoral Member of Technical Staff, Bell Laboratories, Lucent Technologies
1993 – 1994	Post-doctoral Scientist, Universität Marburg
1992	Ph.D., Applied Physics, University of Michigan
1991	M.S., Applied Physics, University of Michigan
1985	B.Sc., Physics, Rutgers University

Scientific Interests: Ultrafast optics | multidimensional Fourier transform spectroscopy | optical frequency combs | optical arbitrary waveform generation, semiconductor quantum optics

Abstract

I will introduce the basic concepts of frequency combs and the correspondence between the pulse train in the time domain and a comb in the frequency domain. I will then discuss the generation of frequency combs using mode-locked lasers. The use of frequency combs in optical frequency metrology and optical atomic clocks will be reviewed. The quantum limits to the width of the comb lines will be discussed. Finally I will mention work towards optical arbitrary waveform generation by manipulating the phase and amplitudes of the comb lines.

[1] J. Ye and S.T. Cundiff, eds. *Femtosecond Comb Technology* (Springer, New York, 2004).
[2] S.T. Cundiff and J. Ye: *Colloquium: Femtosecond Optical Frequency Combs*, Rev. Mod. Phys. 75, 325 – 340 (2003).
[3] S.T. Cundiff, J. Ye and J.L. Hall: *Rulers of Light*, Scientific American (April 2008).
[4] J.K. Wahlstrand, J.T. Willits, C.R. Menyuk and S.T. Cundiff: *The quantum-limited comb lineshape of a mode-locked laser: Fundamental limits on frequency uncertainty*, Opt. Express 16, 18624 – 18630 (2008).
[5] S.T. Cundiff and A.M. Weiner: *Progress Article: Optical Arbitrary Waveform Generation*, Nature Photonics 4, 760 – 766 (2010).

Traceable Results in Medical Diagnostics

Dr. Claudia Swart

Present Position	Staff scientist in working group Inorganic Analysis, Physikalisch-Technische Bundesanstalt
Academic Record	
since Sept 2008	Staff scientist at PTB: speciation of selenium and bromine in biological and environmental samples
2005 – 2008	Postdoc at Bundesanstalt für Materialforschung und –prüfung (BAM) in Berlin: speciation of arsenic in water and fish
2001 – 2005	PhD at the Institute of Inorganic and Analytical Chemistry at FU Berlin on the analysis of Roman bricks with ICP-OES/-MS: comparison of RFA und ICP
1996 – 2001	Studies in chemistry at the Universität Regensburg
Scientific Interests	Traceability in species analysis | metrology for metalloproteins in human serum | bromine species in water | coupling of separation techniques to ICP-MS

Abstract

Metalloproteins are especially important in medical diagnosis as they represent about 30% of the whole proteome (the sum of all proteins). Among them, some proteins like iron (Fe) containing the proteins haemoglobin (Hb) and transferrin (Tf), which are responsible for the transport of oxygen and Fe, occur in high concentrations. Others, like selenoproteins, show only low concentrations (µg/kg) in serum and tissues but they play an important role in the human body. Among them are enzymes like gluthatione peroxidases which are important in cancer prevention, while others like iodthyronine-5'-deiodonase are necessary in the hormone balance. However, the range between deficiency (70 µg per day for adults) and toxicity (700 µg per day for adults) is rather narrow in some cases like Se. Moreover, not only the dose but also the binding form is crucial for the uptake and effectiveness of metals in the body. Therefore, precise and traceable elemental speciation analysis is necessary to distinguish between health and disease.

Ball and Chain of the Avogadro Project

Dr. Guido Bartl

Present Position	Staff scientist in the Working Groups "Interferometry on Spheres" and "Interferometry on Prismatic Bodies" at the Physikalisch-Technische Bundesanstalt
Academic Record	
since 2010	Staff scientist at the Physikalisch-Technische Bundesanstalt
2006 – 2010	Doctorate at the Physikalisch-Technische Bundesanstalt and TU Braunschweig
2006	Diploma in physics, Universität of Oldenburg
Scientific Interests	Optical testing | length measurement by interferometry | development of related data evaluation techniques

Abstract

The presentation is about the activities of the international research project which aims at the redetermination of the Avogadro constant. This goal shall be achieved by counting the atoms in an isotopically enriched silicon crystal. The counting procedure is based on the measurements of the lattice constant and the molar mass of this crystal and the mass and the volume of a 1kg silicon sphere made of the same crystal. Several difficulties had to be overcome on the way to a relative uncertainty of currently 3 x 10^{-8}.

Uncertainty of Laser Tracker

Dr. Ernst Wiedenmann

Present Position: Director of Research & Development at AiMESS Services GmbH

Academic Record

since 2009	AiMESS Services GmbH
2008 – 2009	Executive Manager MRI Systems, Albatross Projects GmbH
2000 – 2007	Chairman technical committee "Length" of German Calibration Services (DKD)
1998 – 2007	Manager Measuring and Calibration Center of Carl Zeiss
1997	PhD in Physics, Universität Würzburg
1991	Diploma in Physics, Universität Freiburg

Scientific Interests: Dimensional mMetrology | optical measuring technologies

Abstract

In the world of dimensional metrology, there are many different instruments to provide measurement results over many decimal orders of length. From the nano cosmos with Ångström and nanometer to the universe with light years, scientists and engineers always have been asking: how long? How big? How far?

The second question is motivated by scientific professionalism as well as natural competition: how "good" is the measurement? Which is the best way of measurement? To answer these questions, it is necessary to qualify measurement results to get the measurement uncertainty.

In this lecture I will give an example for both questions. For this purpose I have chosen an instrument which is able to perform a lot of different measurement tasks given by industrial applications. In the dimensions from 1 m to 100 m, laser trackers are the most flexible and most "accurate" instrument available. I will give an overview of the possibilities and functionality of the instrument. The second part will be the calculation of the measurement uncertainty of a measurement process performed by a laser tracker.

In addition to my main task, I will give first preliminary results of a new optical measurement system. It is the first time the physical effect of energy transformation will be used in dimensional metrology.

Optical and Laser metrology in Automotive Research and Development

Dr. Bernd Stoffregen

Present Position	Head of Metrology Department, Technical Development, Volkswagen AG

Academic Record

since 1993	Head of Metrology Department, Volkswagen R&D, Wolfsburg
since 1979	R&D Center of Volkswagen in Wolfsburg
1979	Doctoral degree Dr.rer.nat., Physics at the TU Braunschweig with a thesis on "Statistics of Speckle Effects"
1976	Diploma in Physics, TU Braunschweig

Scientific Interests	Optical metrology in mechanical engineering | optical methods for the analysis of combustion and flow | measurement and test methods in automotive engineering

Abstract

Optical measurement methods are widely used in mechanical engineering and they are a precious tool for the development of automobiles. In this lecture an overview will be given on optical methods for geometrical measurements, applied interferometry for vibration analysis and laser optical methods for the analysis of flow and combustion processes.

The Future of the Second

Prof. Dr. Fritz Riehle

Present Position	Head of PTB division Optics

Academic Record

2011	Honorary Professor at Leibniz Universität Hannover
since 2000	Head of PTB division "Optics"
1989	Section Leader "Unit of Length" at the PTB, Braunschweig
1982 – 1987	Scientist at the PTB, Berlin, Leader "Basic Radiometry" at BESSY
1977 – 1982	Scientific Assistant, Phys. Inst., Technische Universität Karlsruhe
1981	Habilitation, Physics, Technische Universität Karlsruhe
1977	Dr. rer. nat., Technische Universität Karlsruhe
1975	Diploma in Physics, Technische Universität Karlsruhe

Scientific Interests: Optical atomic clocks | precision measurements | atom interferometry | metrology

Abstract

The present definition of the second in the International System of Units is based on a microwave transition in atomic caesium. Currently, atomic clocks employing transitions in the optical regime challenge and outperform [1] the best microwave fountain clocks with respect to the achieved accuracy and stability. This presentation compares the performance and prospects of the various species and different approaches utilized in optical atomic clocks. Furthermore, the concept and application of "secondary realizations of the second" [2] that has been introduced is outlined to make best use of the new optical standards for practical applications and to present the first step towards a future re-definition of the second.

[1] C.W. Chou, D.B. Hume, J.C.J. Koelemeij, D.J. Wineland, and T. Rosenband: *Frequency Comparison of Two High-Accuracy Al+ Optical Clocks*, Phys. Rev. Lett. 104 070802 (2010)

[2] P. Gill, F. Riehle: *On Secondary Representations of the Second*, Proceedings of the 2006 European Frequency and Time Forum EFTF, Braunschweig, 2006, 282 - 288, ISBN 3-9805741-8-0, (http://www.eftf.org/proceedings/proceedingsEFTF2006.pdf)

Posters

Last Name	First Name	Title of Poster
Al-Hadhuri	Tawfik	**Two-photon microscopy of the molecular motion in phospholipid bilayers**
Atamas	Tatsiana	**In-plane and out-of-plane measurements of goniochromatic effect pigments**
Baumgarten	Sebastian	**Design of a facility for the precise simultaneous generation and measurement of force and torque**
Blobel	Gernot	**Challenges of Asphere Metrology**
Bug	Marion	**Secondary electron emission from water after proton impact: investigating the accuracy of track structures**
Cetin	Mehmet Fatih	**Light scattering in spin orbit coupling dominated systems**
Galovska	Maryna	**Approach for the form measurement of rotationally symmetic workpieces**
Gangula	Sheetal	**Quantitative mass spectrometry by LC-ESI-IT-MS**
Guan	Jun	**A novel 2D interferential encoder**
Häfner	Sebastian	**A rigidly mounted and vibration insensitive cavity for transportable optical Sr clock**
Kazda	Michael	**Technical implementation of Rapid Adiabatic Passage in the fountain PTB-CSF2**
Kruse	Andreas	**Characterisation of the state of polarisation of optical eigenmodes in semipolar InGaN laser structures**
Lämmerhardt	Nico	**Self-assembly of silicon cubes**
Mishra	Jayanta Kumar	**Enhancement of Eu3+ luminescence in group-III-nitrides by alloying and co-doping**
Mohajerani	Matin Sadat	**Optical studies on individual transitions in GaN:Zn,Si/AlGaN heterostructures**
Pinkert	Tjeerd	**XUV frequency comb metrology on He groundstate transitions**
Poretskiy	Mikhail	**Experimental calibration of a 3D velocity map imaging setup using HBr photo-dissociation**
Reichstein	Simone	**Fluorescence Analysis for Amines on Plasma Functionalized Surfaces**
Schmunck	Waldemar	**Influence of photon number statistics on the relative detection efficiency calibration of single photon detectors**
Sommerfeld	Martin	**White Light Interferometry**
Vogt	Stefan	**The Strontium Optical Lattice Clocks at PTB**
Wan	Yong	**Prospects for quantum logic spectroscopy of molecular ions**
Wang	Mingjie	**Electron Spectroscopy for Ion Cross-Section Measurement**
Wehrmann	Christof	**Wireless capacitative 8-channel helmet for EEG measurement**
Wernecke	Jan	**Direct structural characterisation of line gratings with GISAXS**
Yan	Hongdan	**Coupling of plasmons to molecular excitons**
Zhao	Ailun	**Investigation of efficiency of blue and green GaN LEDS**

Timetable

	Tuesday 29 May	Wednesday 30 May	Thursday 31 May	Friday 1 June	
09:00		Wolfgang Osten **Multiscale 3D Metrology**	Bernd Güttler **Primary Reference Methods in Chemistry**	Ernst Wiedenmann **Measurement Uncertainty of Laser Tracker**	**09:00**
09:30					09:30
10:00		Mark Bieler **Laser-based Metrology in the Terahertz Frequency Range**	Philip Tinnefeld **Self-assembled Nanoscopic Rulers for Microscopy**	Bernd Stoffregen **Optical and Laser Metrology in Automotive Research and Development**	**10:00**
10:30					10:30
11:00		Coffee Break	Coffee Break	Coffee Break	**11:00**
11:30					**11:30**
12:00		Ulrike Ankerhold **Who Needs Dosimetry?**	Sarah Köster **Small Forces on Small Length Scales – the Physics of Biological Cells**	Fritz Riehle **The Future of the Second**	12:00
12:30					**12:30**
13:00		Lunch	Lunch	Lunch	13:00
13:30	**Arrival**				13:30
14:00					**14:00**
14:30	Joachim Ullrich **Welcome**	Dirk Röske **Mechanical Quantities – Measuring Force and Torque**	Thomas Udem **Precision Spectroscopy of Simple Atomic Systems**		14:30
15:00	Klaus von Klitzing **Quantum Hall Effect and the New SI System**			**Departure**	**15:00**
15:30	Coffee Break	David Citrin **Nanophotonic Structures of Metal Nanoparticle Chains and Arrays**	Steve Cundiff **Optical Frequency Combs**		15:30
16:00					**16:00**
16:30	Roland Wiesendanger **Single-Atom Magnetometry**	Coffee Break	Coffee Break		**16:30**
17:00		Pavel Tománek **Near-Field Optics and Optical Nanometrology**	Claudia Swart **Traceable Results in Medical Diagnostics**		17:00
17:30	Richard Leach **Basics of Surface Topography Measurement**				**17:30**
18:00	**Get Together**	17:30 – 20:00 **Tour around the Kaiserdom Königslutter** including transfer	Guido Bartl **Ball and Chain of the Avogadro Project** + **Student Exercises**		18:00
18:30					18:30
19:00	Dinner		Dinner		**19:00**
19:30					19:30
20:00	**Guided Tour around Burg Warberg**	Dinner	**Student Poster Session**		**20:00**
20:30					20:30