ANNUAL REPORT
2004

HELSINKI UNIVERSITY OF TECHNOLOGY
Low Temperature Laboratory
Brain Research Unit and
Low Temperature Physics Research
http://boojum.hut.fi

PREFACE

In 2005, the LTL will celebrate its 40th anniversary. Most of our facilities were built in 1970s. At the beginning of 2006 we will finally move to new premises, which will be renovated for us in Puutalo, at the center of the TKK campus. The renovation of Puutalo, built in 1963, will start in summer of 2005, and during 2004 we have been quite busy in finishing the plans of the new laboratory. The floor space of our laboratory will increase from 2100 to over 3000 m2, providing enough room for about 100 people working in our brain research, nanophysics and low temperature physics research groups.

The year 2004 was started with a workshop on Quantum Phenomena at Low Temperatures in Lammi, Finland, on January 6–11. The workshop, attended by 87 scientists from 18 countries, was organized as a users meeting of the ULTI facility, which the LTL is operating by the funds from the European Commission. The first day of the workshop was dedicated to the memory of Academician Olli V. Lounasmaa, who passed away on 27th of December, 2002. The following colleagues of Olli had accepted the invitation to speak in the memorial session:

George Pickett, Lancaster University, Lancaster
Alexander Andreev, Kapitza Institute, RAS, Moscow
Michael Steiner, Hahn-Meitner Institute, Berlin
Joe Vinen, University of Birmingham, Birmingham
Poul-Erik Lindelof, Nils Bohr Institute, Copenhagen
Yuri Mukharsky, CEA, Saclay
Hans Ott, ETH, Zürich and
Sebastien Balibar, ENS, Paris.

The contributions to the memorial session were published in a special issue of JLTP 135, 5/6, June 2004. The issue contained altogether 23 articles from scientist who had known Olli during his long career in low temperature physics and neuromagnetism.

In 2003, the LTL established a Memorial Prize carrying the name of late Academician Olli V. Lounasmaa. In 2004 an International Selection Panel of Professors Mauri Airila, Pekka Hautojärvi, Mikko Paalanen (chairman), Hans Ott and Stig Stenholm was formed to seek candidates and elect the first Prize winner. The panel received three nominations. The first Olli V. Lounasmaa Memorial Prize was awarded to Professor John Clarke from University of California, Berkeley, for his pioneering research and development work on ultra sensitive magnetometers called SQUIDs. The Prize was financially supported by Helsinki University of Technology, Finnish Academy of Sciences and Letters, and Finnish Cultural Foundation.

The international Scientific Advisory Board (SAB) visited the LTL on May 6th, 2004, for the biannual evaluation meeting. The members of the board, Professors Fernando Lopes da Silva and Hans Ott, had been elected by the Academy of Finland already in year 2000 when our laboratory became one of the 26 Centers of Excellence (CoEs) for the funding period of 2000-2005. This evaluation meeting was the 3rd and the last one of this Board, and the reports can be found in Appendix I and II. The previous reports of the same Board were published in the 2000 and 2002 Annual Reports.

The call for new national CoEs for the funding period 2006-2011 was opened in 2004. The Academy of Finland received altogether 143 applications. The LTL submitted two proposals for the CoE program, one in Low Temperature Quantum Phenomena and Devices and another one in Systems Neuroscience and Neuroimaging. Both of our proposals were among the 56 applications which survived to the second round. The final selection of 20 new CoEs will take place in June 2005.

Two scientists of the LTL received special recognition in 2004. Riitta Hari was elected, among 17 other foreign scientists, to the National Academy of Sciences of the USA, and Grigory Volovik was awarded the 2004 Simon Prize by the Institute of Physics of UK. The National Academy of Sciences of the USA, founded in 1863 by President Abraham Lincoln, has about 2340 American and 342 foreign members, Riitta being presently the only one from Finland. The Simon Prize has been awarded since 1959 to 21 scientists, and 5 of them have later received the Nobel Prize.

Mikko Paalanen

Mikko Paalanen

Director of the LTL

SCIENTIFIC ADVISORY BOARD

The Scientific Advisory Board (SAB) of the LTL has the following members:

Prof**. Fernando Lopes da Silva**, University of Amsterdam, The Netherlands
Prof. **Hans Ott**, ETH, Zürich, Switzerland

The SAB was nominated by the Academy of Finland in year 2000 for the 6 year funding period of our Centre of Excellence.

The 3rd evaluation meeting of our CoE was held on May 6, 2004.

The evaluation of the Centre was done in two parts, one concentrating on the low temperature physics and the other one on the program in brain research.

The reports are presented in Appendix I and II, respectively.

The evaluation meeting was attended by:

Prof. **Hans Ott**, evaluator of the physics research
Prof. **Fernando Lopes da Silva**, evaluator of the brain research
Science Advisor **Anu Huovinen**, Academy of Finland
Science Advisor **Merja Kärkkäinen**, Academy of Finland
Prof. **Timo Jääskeläinen**, Academy of Finland/Joensuu University
Prof. **Hilkka Soininen**, Academy of Finland/University of Kuopio
Leading Technology Expert **Oiva Knuuttila**, Tekes

PERSONNEL

The number of persons working in the LTL fluctuates constantly since many scientists are employed for relatively short periods only and students often work on part-time basis.

SENIOR RESEARCHERS

Mikko Paalanen, Dr. Tech., Professor, Director of the LTL
Riitta Hari, M.D., Ph.D., Academy Professor, Head of the Brain Research Unit
Peter Berglund, Dr. Tech., Docent, Technical Manager
Markus Ahlskog, Dr. Tech., until 31.1.2004
Anne Anthore, Ph.D., until 31.7.2004
Harry Alles, Dr. Tech.
Vladimir Eltsov, Ph.D.
Nina Forss, M.D., Ph.D., Docent, part-time
Pertti Hakonen, Dr. Tech., Professor
Tero Heikkilä, Dr. Tech., on leave 15.8.2004-31.3.2005
Päivi Helenius, Dr. Psych., part-time
Risto Hänninen, Dr. Tech., until 29.2.2004
Veikko Jousmäki, Ph.D.
Erika Kirveskari, M.D., Ph.D., part-time
Nikolai Kopnin, Ph.D., Professor

Juha Kopu, Dr. Tech.
Matti Krusius, Dr. Tech., Academy Professor
Matthias Meschke, Ph.D., from 1.6.2004
Takeshi Morita, M.D., Ph.D.
Jukka Pekola, Dr. Tech., Academy Professor
Hanna Renvall, M.D., Ph.D.
Alexander Savin, Ph.D.
Riitta Salmelin, Dr. Tech., Professor
Martin Schürmann, M.D., Ph.D., Docent
Alexander Sebedash, Ph.D.
Oguz Tanzer, M.Sc. Tech., part-time from 1.9.2004
Erkki Thuneberg, Dr. Tech., Professor, part-time until 31.5.2004
Igor Todoschenko, Ph.D.
Taku Tsuneta, Ph.D., from 1.11.2004
Juha Tuoriniemi, Dr. Tech., Docent
Simo Vanni, M.D., Ph.D.
Minna Vihla, M.D., Ph.D.
Grigori Volovik, Ph.D., Professor

ADMINISTRATION AND TECHNICAL PERSONNEL

Teija Halme, secretary
Marja Holmström, Lic. Phil., Laboratory Administrator, until 31.1.2004
Antti Huvila, technician
Mia Illman, laboratory assistant, on leave 19.10.2004-31.5.2005
Arvi Isomäki, technician
Juhani Kaasinen, technician
Helge Kainulainen, technician
Tuire Koivisto, secretary
Markku Korhonen, technician
Sami Lehtovuori, technician, until 13.2.2004
Seppo Mattila, civil alternative servant, 30.8.2004 – 31.8.2005
Pirjo Muukkonen, financial secretary
Satu-Anniina Pakarinen, project secretary
Liisi Pasanen, secretary
Ronny Schreiber, technician, 2.2.-31.3.2004, 19.7.-22.8.2004

GRADUATE STUDENTS (SUPERVISOR)

Gina Caetano, M.Sc. Tech. (Veikko Jousmäki, Riitta Hari)
Antti Finne, M.Sc. Tech. (Matti Krusius)
Jouni Flyktman, M.Sc. Tech. (Jukka Pekola)
Linda Henriksson, M.Sc. Tech. (Simo Vanni)
Jaana Hiltunen, Phil. Lic. (Riitta Hari)

Yevhen Hlushchuk, M.D. (Riitta Hari)
Annika Hultén, M.Sc. Psych. (Riitta Salmelin, Matti Laine)
Heikki Junes, M.Sc. Tech. (Harry Alles)
Kirsi Juntunen, M.Sc. Tech. (Juha Tuoriniemi)
Juha Järveläinen, M.D. (Riitta Hari, Martin Schürmann)
Jani Kivioja, M.Sc. Tech. (Jukka Pekola)
Jan Kujala, M.Sc. Tech. (Riitta Salmelin)
Markku Kujala, M.Sc. Tech., until 31.10.2004 (Matti Krusius)
Teijo Lehtinen, M.Sc. Tech. (Pertti Hakonen)
Mia Liljeström, M.Sc. Tech., on leave 4.5.2004 – 14.3.2005 (Riitta Salmelin)
René Lindell, M.Sc. Tech. (Pertti Hakonen)
Sanna Malinen, M.Sc. Tech. (Riitta Hari)
Antti Niskanen, M.Sc. Tech. (Jukka Pekola)
Teemu Ojanen, M.Sc. Tech. (Tero Heikkilä)
Lauri Parkkonen, M.Sc. Tech. (Riitta Hari)
Tiina Parviainen, M.Sc. Psych. (Riitta Salmelin)
Elias Pentti, M.Sc. Tech. (Juha Tuoriniemi)
Marjatta Pohja, M.D. (Stephan Salenius, Riitta Hari)
Tuukka Raij, M.D. (Riitta Hari, Nina Forss)
Leif Roschier, M.Sc. Tech. (Pertti Hakonen)
Miiamaaria Saarela, M.Sc. Phych. (Riitta Hari)
Mika Seppä, M.Sc. Tech. (Riitta Hari)
Mika Sillanpää, M.Sc. Tech. (Pertti Hakonen)
Linda Stenbacka, M.D. (Simo Vanni)
Topi Tanskanen, M.Sc. Psych. (Riitta Hari)
Reeta Tarkiainen, M.Sc. Tech. (Pertti Hakonen)
Andrey Timofeev, M.Sc. (Jukka Pekola)
Nuutti Vartiainen, M.D. (Nina Forss, Riitta Hari)
Janne Viljas, M.Sc. Tech. (Erkki Thuneberg)
Fan Wu, M.Sc. (Pertti Hakonen)

UNDERGRADUATE STUDENTS

Sakari Arvela, until 31.7.2004
Samuli Hakala, until 11.7.2004
Liisa Helle
Linda Henriksson
Kaisa Hytönen
Antti Jalava
Kaarle Kulvik
Hannu Laaksonen
Jussi Leinonen, 17.5.-13.8.2004
Kristiina Luoma, 31.5.-31.8.2004

Matti Manninen
Walter Masalin, 24.5.-11.8.2004
Juha Muhonen
Tommi Nieminen
Vesa Norrman, until 31.5.2004
Antti Paila
Tommi Piirainen, 1.3.-31.5.2004
Jussi Polkko, 17.5.-31.8.2004
Antti Puurula, until 31.5.2004
Tomi Ruokola
Timo Saarinen
Anssi Salmela
Juho Simpura, until 31.8.2004
Taru Suortti, until 29.2.2004
Jaakko Tölö, 1.6.-31.8.2004
Johanna Uusvuori
Vesa Vaskelainen, until 31.10.2004
Mikko Viinikainen, until 31.8.2004
Pauli Virtanen
Juha Voutilainen

VISITORS FOR EU PROJECTS

ULTI III (1.1.2004 - 31.3.2004) Low Temperature and Nano Physics

Balibar, Sebastien, Prof., CNRS/ENS, Paris, France, 5 – 6.1., 11 – 14.1., 15 – 22.2.

Barenghi, Carlo, Prof., University of Newcastle, UK, 6 - 11.1.

Blaauwgeers, Rob, Dr., Leiden University, The Netherlands, 6 – 11.1.

Bunkov, Yuri, Prof., CNRS, Paris, France, 6 – 11.1.

Büttiker, Markus, Prof., Université de Genève, Switzerland, 6 – 11.1.

Delsing, Per, Prof., Chalmers University of Technology, Gothenburg, Sweden, 6 – 11.1.

Eremets, Mikhail, Dr., Max-Planck Institut für Chemie, Mainz, Germany, 6 – 11.1.

Fisher, Shaun, Dr., Lancaster University, UK, 6 – 11.1.

Giazotto, Francesco, Dr., SNS, Pisa, Italy, 6 – 18.1.

Glattli, Christian, Dr., ENS, Paris, France, 6 – 11.1.

Janu, Zdenek, Prof., Czech Academy of Sciences, Prague, Czech Republic, 6 – 11.1.

Jochemsen, Reyer, Dr., Leiden University, The Netherlands, 6 – 11.1.

Lindelof, Poul-Erik, Prof., Nils Bohr Institute for Astronomy, Denmark, 6 – 11.1.

Mukharsky, Yury, Dr., CEA, Saclay, France, 6 – 11.1.

Pickett, George, Prof., University of Lancaster, UK, 6 – 11.1.

Placais, Bernard, Dr., ENS, France, 6 – 11.1.

Pothier, Hugues, Dr., SPEC, CEA, Saclay, France, 6 – 11.1.

Reatto, Luciano, Prof., INFN, Milan, Italy, 5 – 11.1.

Schopol, Nils, Prof., University of Tuebingen, Germany, 6 – 11.1.

Skrbek, Ladislav, Dr., Czech Academy of Sciences, Prague, 5 – 6.1., 11 – 16.1.

Sonin, Edouard, Prof. Racah Hebrew University of Jerusalem, Israel, 3.2.–5.3.

Zorin, Alexander, Dr., PTB, Braunschweig, Germany, 6 – 11.1.

ULTI (1.4.2004 - 31.12.2004) Low Temperature and Nano Physics

Bunkov, Yuri, Prof., CNRS, Grenoble, France, 8 – 17.8., 22 – 28.8.

Giazotto, Francesco, Dr., SNS, Pisa, Italy, 25.4. – 22.5.

Gordeev, Alexey, Mr., Charles University, Department of Mathematics and Physics, Prague, 19.4.–18.5.

Hekking, Frank, Prof., CNRS, Grenoble, France, 10 – 19.8.

Janu, Zdenek, Prof., Czech Academy of Sciences, Prague, 18.10. – 18.11.

Kivotides, Demosthenes, Dr., University of Newcastle, UK, 19.4. – 6.7.

L'vov, Viktor, Prof., Weizmann Institute of Science, Rehovot, Israel, 14 – 17.8.

Rabaud, Marc, Prof., FAST, Orsay, France, 17 – 21.4.

Schakel, Adriaan, Dr., Leipzig University, Germany, 7 – 22.8.

Schoepe, Wilfried, Prof., University of Regensburg, Germany, 16.9. – 7.10.

Schützhold, Ralf, Dr., Institut für Theoretische Physik, Technische Universität, Dresden, Germany, 15 – 28.8.

Skrbek, Ladislav, Dr., Czech Academy of Sciences, Prague, 25.4. – 1.5.

Sonin, Edouard, Prof., Racah Hebrew University of Jerusalem, Israel, 8.8. – 8.10.

Steiner, Michael, Prof., Hahn-Meitner Institute, Berlin, Germany, 17.8. – 13.9.

Strunk, Christoph, Prof., University of Regensburg, Germany 21 – 25.6.

OTHER VISITORS

Andersson, Jesper, Dr., Karolinska Universitetssjukhuset, Stockholm, Sweden, 29.2. – 7.3.

Andreev, Alexander, Acad., Kapitza Institute for Physical Problems, RAS, Moscow, Russia, 18.8. – 17.9.

Bailey, Anthony, Prof., University of Oxford, Section of Child and Adolescent Psychiatry, Oxford, UK, 9 – 11.1.

Barber, Colin, Dr., Queens Medical Centre, Nottingham, UK, 6. – 10.9.

Bid, Aveek, Mr., Physics Department, Indian Institute of Science, Bangalore, India, 29.5. – 12.6.

Boldarev, Sergei, Dr., Kapitza Institute for Physical Problems, RAS, Moscow, Russia 1.1. – 31.8.

Bonte, Milene, Ms., University of Maastricht, Department of Cognitive Neuroscience, Maastricht, The Netherlands, 9.1. – 2.7.

Braeutigam, Sven, Dr., Open University, Milton Keynes, UK, 9 – 11.1.

Brusov, Peter, Prof., Rostov State University, Rostov-on-Don, Russia, 17 – 21.8.

Clarke, John, Prof., University of California, Berkeley, USA, 6 – 10.11.

Eisenstein, James, Prof., California Institute of Technology, Condensed Matter Physics, Pasadena, CA, USA, 26 – 29.6.

Feigelman, Mikhail, Prof., Landau Institute for Theoretical Physics, RAS, Moscow, Russia, 6 – 8.4.

Gozdz, Patryk, Mr., Institute of Solid State Physics, Darmstadt, Germany 2.6.

Hesse, Maike, Dr., Neurology Clinic University Hospital RWTH Aachen and Research Center Jülich , Germany, 7 – 17.12.

Iijima, Sumio, Prof., Meijo University, Dept. of Materials Science and Engineering, Nagoya, Japan, 21 – 24.10.

Khalatnikov, Isaak, Acad., Landau Institute for Theoretical Physics, RAS, Moscow, Russia, 9 – 29.8.

Lebedev, Vladimir, Prof., Landau Institute for Theoretical Physics, RAS, Moscow, Russia, 18 – 22.4.

Lesovik, Gordey, Dr., Landau Institute for Theoretical Physics, RAS, Moscow, Russia, 4 – 10.10.

Lindelof, Poul-Erik, Prof., Niels Bohr Institute, Copenhagen, Denmark, 29 – 31.8.

Longcamp, Marieke, Dr., Institute for Physiological and Cognitive Neurosciences, CNRS, Marseille, France, 25.1. – 31.12.

Lopes da Silva, Fernando, Prof., University of Amsterdam, The Netherlands, 5 – 8.5.

Majumdar, Alak, Prof., Southern Block Laboratories, I.I.T. Kanpur, India, 20 – 24.5.

Melnikov, Alexander, Dr., Institute for Physics of Microstructures, RAS, Department of Superconductivity, Nizhny Novgorod, Russia, 8.3. – 8.4.

Ninjouji, Takashi, Mr., NTT DoCoMo Inc., Media Computing Laboratory, Multimedia Laboratories, Yokosuka Kanagawa, Japan, 1 – 21.1.

Ott, Hans, Prof., ETH Hönggerberg, Zürich, Switzerland, 5 – 8.5.

Pammer, Kristen, Dr., University of Newcastle upon Tyne, Department of Psychology, Newcastle upon Tyne, UK, 1.1. – 29.2.

Parshin, Alexander, Prof., Kapitza Institute for Physical Problems, RAS, Moscow, Russia, 8 – 28.2., 17.4. – 1.5., 7 – 22.8.

Ramakrishanan, Srinivasan, Prof., Tata Institute, Mumbai, India 12 – 18.7.

Ramish, Mani, Dr., Gordon McKay Laboratory of Applied Physics, Harvard University, Cambridge, MA, USA, 17 – 20.6.

Ryazanov, Valery, Prof., Institute of Solid State Physics, Laboratory for Superconductivity, RAS, Chernogolovka, Russia, 1 – 6.1.

Sauls, James, Prof., Northwestern University, Department of Physics and Astronomy, Evanston, IL, USA, 2 – 5.6.

Semenov, Vasili, Dr., State Univ. of New York, Stony Brook, USA, 5 – 8.7.

Simões, Cristina, Dr., Department of Psychology, Trinity College, Dublin, Ireland, 19 – 28.3.

Sudbø, Asle, Prof., NTNU, Institutt for fysikk, Trondheim, Norge, 7 – 8.1.

Sungkit, Yip, Dr., Institute of Physics, Academia Sinica, Taipei, 1 – 3.8.

Thorpe, Vivien, M.Sc., University of Nottingham, UK, 6 – 10.9.

Timofeev, Andrey, Dr., Institute of Solid State Physics, RAS, Chernogolovka, Russia, 23.2. – 31.3.

Tsubota, Makoto, Prof., Osaka City University, Department of Physics, Osaka, Japan, 15 – 17.3.

Tsuneta, Taku, Dr., Hokkaido University, Department of Physics, Sapporo, Japan, 1 – 24.1., 20.6. –20.9.

Ullom, Joel, Dr., National Institute of Standards and Technology (NIST), Boulder, USA, 11 – 13.1.

Watanabe, Michio, Dr., National Institute of Standards and Technology (NIST), Boulder, USA, 21 – 23.6.

Williams, Amanda, Dr., Guy's and St. Thomas' Hospital, 1 –2.1.

Wyborne, Martin, Prof., Dartmouth College, New Hampshire, USA, 30.5. – 3.6.

Zyuzin, Alexander, Dr., A.F. Ioffe Physical–Technical Institute, RAS, St. Petersburg, Russia, 17 – 21.5.

GROUP VISITS

About 10 groups from various high schools in Finland

Taiwanese delegation, 15.6.

Dr. Ovid J.L. Tzeng, Vice President, Academia Sinica
Dr. Chao-Han Liu, Chancellor, University System of Taiwan
Dr. Chang Chun-Yen, President, National Chiai Tung University
Dr. Yan-Hwa Lee, President, National Yang-Ming University
Mr. Andy Yih-ping Liu, 1st Secretary, Taipei Economic and Cultural Office

Chinese delegation, 23.6.

Cui Ruijie, Director General, Department of Personnel and Education, Commission of Science Technology and Industry for National Defence
Yang Zhihong, Director of Division, Department of Personnel and Education, Commission of Science Technology and Industry for National Defence
Yin Weijun, Director of Division, Department of Personnel and Education,

Commission of Science Technology and Industry for National Defence
Cheng Yongbo, Interpreter, Nanjing University of Aeronautics and Astronautics
Prof. Xu Fuming, President, Nanjing University of Science and Technology
Prof. Guo Dacheng, Vice President, Beijing Institute of Technology
Prof. Zhou Yu, Vice President, Harbin Institute of Technology
Prof. Gao Wanxin, Vice President, Harbin University of Engineering
Prof. Zheng Zhiming, Dean of School of Science, Beijing University of Aeronautics and Astronautics
Prof. Liu Yiheng, Vice Director, Nanjing University of Aeronautics and Astronautics

Suomen Rakennusinsinöörien Liitto RIL and its American sisterorganization ASCE, 28.6.

Jyrki Keinänen (CEO)
Jaakko Heikkilä (chairman)
Erkki Pätiälä (vice chairman)
Anu Karvonen
Kaisa Venäläinen

and 11 members of ASCE

STUK-visit to MEG and fMRI, 16.9.

Ritva Parkkinen
Petri Sipilä
Markku Pirinen
Helinä Korpela
Asko Miettinen
Raimo Turkka
Juhani Karppinen
Tuija Rahikainen
Tiina Verapan
Vilma Mannila

Paavo Uronen and Munkkiniemi Rotary Club, 7.10.

OLLI V. LOUNASMAA MEMORIAL PRIZE 2004

The first Olli V. Lounasmaa Memorial Prize was awarded to Professor **John Clarke** from Berkeley University, USA, for his pioneering research and development work on ultra sensitive magnetometers called SQUIDs. The award ceremony took place on November 8, 2004, in the House of Estates in downtown Helsinki, at the monthly meeting of the Finnish Academy of Science and Letters. Professor Clarke was elected for the Prize by an international Selection Committee of Professors **Mauri Airila** (vice rector of TKK), **Pekka Hautojärvi** (TKK**), Mikko Paalanen** (chairman, TKK), **Hans Ott** (ETH, Switzerland) and **Stig Stenholm** (KTH, Sweden). Helsinki University of Technology, Finnish Academy of Sciences and Letters, and the Finnish Cultural Foundation financially supported the Memorial Prize.

On November 7th Prof. Clarke gave a lecture SQUIDs: From Cosmology to Magnetic Imaging in Microtesla Fields in Helsinki University of Technology.

The speech given by Mikko Paalanen during the award ceremony is given in Appendix III.

INTERNATIONAL COLLABORATIONS

CERN COLLABORATION (COMPASS)

Coordinator: **Peter Berglund**

The LTL joined the Spin Muon Collaboration (SMC) NA47 in 1991 with the task of building a large dilution refrigerator to cool the polarised target. This refrigerator, the largest in the world, was operated very sucessfully until 1996 when SMC was completed. The sucessor of SMC, the COMPASS experiment, continued to investigate the spin content of the nucleon, using the same equipment, but considerably modified by us. Our COMPASS participation lasted from 1998 to the end of 2003 when we decided to resign from the collaboration as the timescale of the experiment and the particle physics research was outside the scope of the research policy of the LTL. However, our long standing contributions still make us co-authors of COMPASS publications.

COSLAB (COSMOLOGY IN THE LABORATORY)

Coordinators: **Grigory Volovik** (LTL) and **Tom Kibble** (Imperial College, London, UK)

Funding: ESF, Physical and Engineering Sciences

Duration: 1.7. 2001 - 30.6. 2006

Participants: 14 groups from European universities and research institutes in 12 countries.

Condensed matter systems at low temperatures and the universe, evolving after the "Big Bang", have many analogies. The aim of this programme is to exploit these analogies through studies of ultra-low-temperature superfluid helium and of other condensed-matter systems, such as atomic Bose condensates, superconductors, Josephson junction arrays and liquid crystals, together with theoretical work to establish the validity of the analogy. The required sensitivity demands the most sophisticated apparatus, in particular state-of-the-art cryogenic equipment.

A COSLAB workshop on Turbulence and Vacuum Instability in Condensed Matter and Cosmology was held in Lammi, Finland, August 17-22, 2004.

ULTI III - ULTRA LOW TEMPERATURE INSTALLATION

Coordinator: **Mikko Paalanen**

Funding: EU's 5th framework program, Improving Human Potential, Transnational Access to Major Research Infrastructures.

Duration: 1.4. 2000 - 31.3. 2004

Participating groups of the LTL: INTERFACE, NANO, PICO, ROTA, THEORY and YKI

Visitors: see page 8

The ULTI III Large-Scale Facility has offered expertise and equipment for outside users to undertake measurements at temperatures from 4 Kelvin down to the lowest attainable. The facility is located in the Low Temperature Laboratory of the Helsinki University of Technology. ULTI III facility contributes to the scientific progress and technical development of ultra low temperature physics in Europe, serves as a first-rate educational center for young physicists, and acts as a node for scientific collaboration between Russia and the EU countries. The visitors are integrated to the in-house research, including experimental programs on refrigeration and cryogenics in the liquid-helium range and below, and experimental and theoretical studies of quantum fluids and, solids, nuclear magnetism, and electrical transport in normal and superconducting structures of nanometer size. Equipment for high-precision optical interferometry at low temperatures and electron beam lithography for making nanosize samples are available for the visitors as well. During 2004 altogether 22 European visitors used the facility for 5,5 months

Workshop Quantum Phenomena at Low Temperatures, Lammi 7-11.1.2004

ULTI - ULTRA LOW TEMPERATURE INSTALLATION

Coordinator: **Mikko Paalanen**

Funding: EU's 6th framework program, Transnational Access to Major Research Infrastructures.

Duration: 1.4. 2004 - 31.3. 2008

Participating groups of the LTL: INTERFACE, NANO, PICO, ROTA, THEORY and YKI

The ULTI Large-Scale Facility continues the services of ULTI III for European scientists. It will provide them with 72 visitor months in the LTL and full access to its research facilities.

During 2004 altogether 15 European visitors used the facility for 11,3 months (see page 9).

WORKSHOPS

QUANTUM PHENOMENA AT LOW TEMPERATURE (ULTI III USERS MEETING)

The Low Temperature Laboratory organized a Workshop on Quantum Phenomena at Low Temperatures in Lammi, Finland, on January 7 - 10, 2004. It attracted 87 scientists from 18 countries. The first day of the Workshop was dedicated to the memory of Academician Olli V. Lounasmaa, who passed away on 27th of December, 2002.

The main part of the workshop belonged to a series of users meetings sponsored by ULTI I, II and III, the three consecutive European Union visitor programmes of the Low Temperature Laboratory. The previous meetings were organized in 1994, 1998 and 2001. The object of the Workshop was to review the progress of the ongoing ULTI III projects (EU grant number HPRI-1999-CT-00050 in the Transnational

Access to major Research Infrastructures programme, 2000 - 04) and explore the possibilities for future experiments.

The scientific programme of the symposium consisted of 36 oral contributions and 21 posters in four main areas:

Superfluid Turbulence
Quantum Fluids and Solids
Condensed Matter and Cosmology
Quantum Electronics

The Proceedings of the Workshop, containing 13 contributions, were published in JLTP 136, 5/6, in September 2004.

TURBULENCE AND VACUUM INSTABILITY IN CONDENSED MATTER AND COSMOLOGY

Lammi, Finland, August 17-22, 2004.

Organizer: Grigory Volovik

The workshop was attended by 39 participants from 12 different countries.

Additional COSLAB workshops in 2004:

The ESF-COSLAB Network Conference 2004 was held in Ambleside, Lake District, UK, on 10-17 September 2004.

A meeting on Disorder and Topological Defects, a Helium Primer was held in Chamrousse, Grenoble, France, on 17-22 December 2004.

LOW TEMPERATURE PHYSICS RESEARCH

NANOELECTRONICS AT LOW TEMPERATURES

NANO group

M. Ahlskog, **P. Hakonen**, T. Lehtinen, R. Lindell, M. Paalanen, A. Paila, L. Roschier, M. Sillanpää, R. Tarkiainen, V. Vaskelainen, F. Wu

Visitors: J. Delahaye, Yu. Makhlin, E. Sonin, T. Tsuneta and A. Zyuzin

In nanophysics research we make small, less than one micron samples by processes developed in the semiconductor industry and study their electrical conductivity at low temperatures. In both normal and superconducting nanosamples quantum mechanical wave character of the electrons and their Coulomb repulsion lead to new phenomena, which we try to utilize in new sensor applications. We have developed, among others, record-sensitive SET-components made out of carbon nanotubes and nearly back-action-free, reactively read superconducting electrometers. In addition, we have developed a novel, low-noise current amplifier, Bloch Oscillating Transistor, which lies between the superconducting quantum interferometer (SQUID) and the SET according to its characteristics. The same circuit has been employed for measurements of very small noise currents and their higher order moments.

SHOT NOISE AND SINGLE JOSEPHSON JUNCTIONS

J. Delahaye, **P. Hakonen**, T. Heikkilä, R. Lindell, M. Paalanen, M. Sillanpää, E. Sonin, and T. Yamaguchi

We have continued measurements of conductance versus current for solitary, resistively confined small Josephson junctions. Our results show, for the first time, that the Cooper pair blockade is strongly sensitive to the non-Gaussian nature of shot noise. In our most recent measurements shot noise of a SET is connected through a small coupling capacitor to the detector junction. We find both symmetric and antisymmetric effects that can be related to the second and third moments, respectively. It is not quite clear yet, what is the actual quantity that is measured for the third moment in the case of quantum noise but our data provide a unique testing ground for theoretical calculations.

BLOCH OSCILLATING TRANSISTOR

P. Hakonen and R. Lindell

Bloch Oscillating Transistor (BOT) is a novel mesoscopic transistor (three terminal device) in which a large supercurrent is controlled by a small quasiparticle current. The operating principle of a BOT utilizes the fact that, Zener tunneling up to a higher band will lead to a blockade of Cooper-pair tunneling (Bloch oscillation) in a suitably biased Josephson junction. Bloch oscillation is resumed only after the junction has relaxed to the lowest band. Using a quasiparticle control current, this process can be made faster. Since, one quasiparticle triggers several cycles of Bloch oscillations, a high current gain can be achieved.

We have studied the device characteristics of BOTs and compared them with simulations based on time dependent phase-fluctuation theory. We have concentrated our studies to small ratios of Josephson and Coulomb energies $E_J/E_C \sim 0.1 - 0.3$ at which the theory based on perturbation expansion works the best. We have measured current gain, power gain, linear range, input impedance, output impedance, and noise temperature, and found a reasonable agreement between theory and experiment. For example, we can explain the measured noise temperature of 0.4 K and the current gain of 30 within a factor of two.

INDUCTIVELY READ SUPERCONDUCTING SET (L-SET)

P. Hakonen, L. Roschier, and M. Sillanpää

We have made semiclassical analysis of the charge sensitivity of the inductive "L-SET" read-out scheme of superconducting Cooper pair transistors (SCPT). In this method, the charge-induced change of SCPT inductance is determined using reflection measurements at frequencies around 700 MHz. Our model agrees well with the measured data. We have been able to show that the L-SET is able to reach the quantum limited resolution using regular aluminum samples in the regime of $E_J/E_C \sim 0.1$. We have also estimated the back action noise from an L-SET and found that a very large S/N ratio of ~ 1000 can be observed for its internal qubit.

CAPACITIVELY READ SUPERCONDUCTING SET (C-SET)

P. Hakonen, T. Lehtinen, Yu. Makhlin, A. Paila, L. Roschier, and M. Sillanpää

In addition to the development of ultra sensitive charge detector, the L-SET, we have worked on its dual circuit C-SET, which is based on the quantum capacitance of superconducting SET. This is a sensitive phase detector which, according to our estimations, is a good candidate for a read-out device for charge-phase qubits. Our C-SET measurements present the first determination of capacitance renormalization in a macroscopic quantum system, the split Cooper pair box (CPB) over its phase-gate bias plane. Our radio-frequency reactive measurement scheme allows to probe purely the capacitive susceptibility due to the CPB band structure. We were able to account for the results using the standard CPB description with parameters determined independently by spectroscopic means. In addition, we could show that the method offers an efficient way to do non-demolition readout of the CPB quantum state, as well as to do studies of fast phase fluctuations at a sensitivity of 1 mrad/$Hz^{1/2}$.

The applicability of the L-SET and C-SET depend very much on the achievable sensitivity. Our analysis indicates that the quantum limit of energy sensitivity (hbar per unit band width) can be reached rather well in L-SET, better than in the ordinary rf-SET. Both L-SET and C-SET are integrated qubit-detector systems in which reactive measurements of the qubit state can be performed, with good prospects of making it in a quantum nondemolition way .

800 MHZ SQUID AMPLIFIER

P. Hakonen, T. Lehtinen, and M. Sillanpää

In order to reach the quantum limited performance of rf-SET electrometers, preamplifiers with a noise temperature of 100-200 mK are needed. One way to achieve such a sensitivity is to use SQUIDs as amplifiers. Our first SQUID

amplifier design gave a gain of 20 dB and a band width of 100 MHz. The biggest problems were connected with a large capacitive feedback and the large ground inductance connecting the input and output sides of the amplifier. We have made a new design in which these problems should be eliminated.

TRANSPORT IN CARBON NANOTUBES

M. Ahlskog, **P. Hakonen**, M. Paalanen, R. Tarkiainen, and T. Tsuneta, F. Wu, and A. Zyuzin

Our studies of very disordered, catalytically grown CVD multiwalled carbon nanotubes (MWCNT) were completed during the past year. Resistance vs. temperature measurements on CVD tubes with good-quality contacts ($R_c \sim 1$ kΩ) and resistance of ~ 30 kΩ/μm displayed rather large conductance corrections which we have analyzed in terms of the interaction effects. As a function of voltage, heating effects tend to dominate, and the dependence can be best modeled by using the equation for diffusive heat transport. The density of states of these tubes has been studied using high impedance Al-AlO_x-NT contacts ($R_c \sim 100$ kΩ). We have compared our results with the theoretical calculation on tunneling into 1-dimensional disordered system, and obtained good agreement with the results beyond the first order corrections.

During the past year, the main emphasis of our carbon nanotube work was shifted towards high frequency transmission/reflection measurements as well as to studies of current-current fluctuations. A new measurement setup was constructed for electrical noise measurements at frequencies of 600 – 900 MHz. It is intended for high impedance samples with a built in tunnel junction calibration source. We have made our first measurements of shot noise both in the tunneling regime as well as in quantum transport regime. We obtained an unexpectedly small Fano-factor ~ 0.1 for MWCNTs, and clear indications that electron-phonon interactions play a role at large bias.

Within the ELENA consortium funded by the Academy of Finland, we have extended our collaboration with the Aerosol-group of Prof. Esko Kauppinen. Our joint goal is to make CVD grown SWNT samples on TEM grids so that we could measure, on the same sample, both conductance and noise as well as the chirality. First samples using the tubes of the Aerosol-group were manufactured.

A second new direction with CNTs - superconductivity induced by the proximity effect - was also started. The goal is to make large-bandwidth charge sensitive devices. This can be achieved either by FET-type of devices (rf-SET etc.) or hybrid devices based on superconductivity. Superconductivity can be induced in to CNTs by proximity effect which would result in a strong reduction of the impedance of the tube. Once the impedance is close to 50 Ohms, no matching circuitry is needed and broad band operation is achieved.

PICO group

A. Anthore, J. Kivioja, M. Meschke, T. Nieminen, A. Niskanen, **J. Pekola**, A. Savin, A. Timofeev

Visitors: F. Giazotto, and F. Hekking

We investigate mesoscopic physics and its sensor applications. The main focus is on charge transport and thermal properties of both metallic and semiconducting nano- and microstructures. Particular research topics include electronic cooling, nonequilibrium in electronic nanostructures, (nano)thermometry, small superconducting (Josephson) junction devices, quantized and coherent charge pumping, and noise and full counting statistics of charge transport. Samples and devices are fabricated in the clean rooms of the Low Temperature Laboratory and of Micronova centre for micro- and nanotechnology, experiments at low temperatures (0.01 - 4 K) are performed both in Micronova building and in the Low Temperature Laboratory.

ESCAPE DYNAMICS IN HYSTERETIC JOSEPHSON JUNCTIONS AND DC-SQUIDs

F. Hekking, J. Kivioja, M. Meschke, T. Nieminen, and **J. Pekola**

Josephson junctions switch from a superconducting state into a dissipative normal state when approaching their critical current. We have investigated how the cross-over from thermally activated switching into macroscopic quantum tunnelling is modified in Josephson junctions and SQUIDs with low critical current. We have observed, for the first time, a new regime, which we call underdamped phase diffusion in switching dynamics of intermediate Josephson junctions. Also, we have observed how quantum levels in a metastable potential influence the cross-over from tunnelling behaviour into thermal activation. This work is done in collaboration with CNRS Grenoble.

ELECTRONIC MICRO-REFRIGERATION AND COLD ELECTRON JOSEPHSON TRANSISTOR

A. Anthore, F. Giazotto, T. Heikkilä, F. Hekking, **J. Pekola**, M. Meschke, and A. Savin

Based on our encouraging results in refrigerating electrons down to about 50 mK using standard tunnelling refrigerators (NIS refrigeration), we have now focused on finding ways to achieve even lower temperatures. This can be accomplished by employing superconductors with lower critical temperature than the commonly used aluminium, and by improving thermalization of the superconducting reservoirs at the secondary side of the refrigerator. Another focus in this project is to find ways to create far from equilibrium electron energy distributions to exploit them in refrigerator-controlled cold electron transistors. Thermometry at the low end of the temperatures achieved by the microrefrigerators is problematic, because no calibration can typically be safely extrapolated into this regime: Coulomb blockade and noise measurements are now prime candidates to provide a way to determine temperatures in this regime.

FLUX AND CHARGE CONTROLLED COOPER PAIR PUMP ("SLUICE") FOR A QUANTUM TRIANGLE

J. Kivioja, A. Niskanen, and **J. Pekola**

Single-electron pumps are known to produce extremely accurate current sources but their yield in terms of maximum achievable current is very low, far too small to be applied in metrology. Josephson pumps can produce larger current, but up to now they have suffered from leakage current, which is a consequence of coherent tunnelling in superconductors. We have recently performed experiments on a new type of a superconducting charge pump, which combines the high speed (current) and low leakage by making benefit of combining flux and charge control in a mesoscopic superconducting circuit. An improved current pump can be created by replacing the tunable single Josephson junctions by Josephson junction arrays in the device. Experiments on these structures are to be run soon. This is a joint effort between LTL, VTT Information Technology and Mikes.

OTHER ACTIVITIES

J. Kivioja, M. Meschke, T. Nieminen, **J. Pekola**, A. Savin, and A. Timofeev

The hysteretic Josephson junctions described above have been employed in 2004 in two experiments as non-invasive ammeters. In one of them, shot noise of a mesoscopic conductor could be measured by detecting the resonant activation of a Josephson junction due to fluctuations of current at the plasma frequency of the Josephson junction. This will provide a way to perform spectroscopic noise measurements in the future. In another experiment, topologically protected tetrahedral Josephson junction qubits have been measured by escape techniques: this project has been recently started in collaboration with ISSP and Landau Institutes in Chernogolovka.

In a European FP6 project "RSFQubit" (2004-2006), Josephson junction control and readout circuits for very low temperature operation are being developed. Our group participates in this project with aim to down-scale the device parameters to reduce the heat dissipation to a level tolerable at temperatures around 50 mK.

Finally, based on our long-term experience in thermal properties of mesoscopic structures and thermometry, a metrological Coulomb blockade thermometer is being developed in collaboration with Mikes and TKK Microfabrication group.

ULTRALOW TEMPERATURE RESEARCH

YKI group

MICROKELVIN EXPERIMENTS

K. Juntunen, J. Muhonen, E. Pentti, A. Salmela, A. Sebedash, and **J. Tuoriniemi**.

The research efforts at the YKI-cryostat have been shared between two main projects: studies of self-cooled ^{3}He -^{4}He mixtures close to the melting pressure and investigations on nuclear magnetism in pure metals, most recently in lithium. The ultimate goal of the helium mixture experiment is to search evidence for superfluidity of dilute ^{3}He.

The demagnetization experiment on lithium was carried to the end at the turn of the years 2003–2004. The ordering temperature of the nuclear spin system was

established to be 300 nK at zero field. The wealth of data collected during the last year were further analyzed to construct the ordering phase diagram and to better understand the behavior of the spin system.

The mixture experiment will utilize a completely new cooling method entitled "adiabatic melting". The mixture in the experimental chamber will be pressurized at a low temperature until the ^{4}He component will solidify at about 2.5 MPa. ^{4}He can be transferred in to and out of the cell through a superleak filling line, even though ordinary capillaries will be blocked by solid helium under the conditions of the experiment. ^{3}He will be expelled from the ^{4}He crystal and float on top of the solid phase. There, it will be cooled across the superfluid transition temperature by our copper nuclear refrigeration stage. Subsequently, the ^{4}He crystal will be melted by removing some of the ^{4}He through the superleak, and the ^{3}He will be diluted by the remaining liquefied ^{4}He being released from the solid. This produces further cooling due to the absorbed heat of mixing. The cooling ratio increases as the temperature goes down and the minimum achievable temperature is determined by the residual heat leak to the liquid.

The main experimental chamber was cooled down to the microkelvin regime for the first time in the midst of the report year. No serious flaws were observed and the cell could be refrigerated down to about 0.2 mK, lower than required for successful adiabatic melting, whether or not it was filled with liquid helium mixture. Some of the diagnostic devices were still not operable and the superleak filling line was not installed, so that the final cooling performance had yet to remain to be demonstrated. The missing items were worked on at the end of the year and the completed setup will be ready to be cooled down soon next year.

ROTA group

DYNAMICS IN COHERENT QUANTUM SYSTEMS

S. Boldarev, V. B. Eltsov, A. Finne, R. Hänninen, J. Kopu, M. Kujala, A. Kulvik, **M. Krusius**, and T. Ruokola

Visitors: A. Gordeev, Z. Janú, W. Schoepe, L. Skrbek, M. Tsubota, and E. Thuneberg

This research project investigates topological defects in coherent quantum systems. The state of a coherent many-body quantum system is described with an order parameter field which may contain defects of different dimensionality and structure. These are topologically stable owing to the continuity requirements imposed on the quantum condensate. The most important example is a quantized line defect – a vortex line in superfluids or a flux line in superconductors. The goal of our work is to resolve the underlying order parameter structure of the defect, its nucleation, annihilation, and the various dynamic phenomena which govern its propagation and distribution.

Our work concentrates primarily on helium-3 superfluids with a multi-component vectoral order parameter field. The largest variety of defects of different topology and structure is found there. These Fermi systems are experimentally clean, structurally simple, and theoretically well understood. They can effectively be used as laboratory analogue models to study general questions common to coherent quantum systems or problems of even wider significance, which cannot be tackled by direct observation.

Superfluid turbulence: Our recent research has been concerned with the nature of superfluid hydrodynamics as a function of vortex damping. The damping arises from the coupling between the superfluid and normal components, known as mutual friction. In our measurements we track the number of vortices with NMR techniques. It turns out that in the isotropic ^{3}He -B phase at high-temperatures the number of vortices remains a conserved quantity in dynamic processes, i.e. at high mutual friction damping the evolution of vortices follows predictable regular trajectories. This is similar to the situation in superconductors. Below 0.6 T_c an abrupt transition takes place to turbulent hydrodynamics, when the dissipative friction component drops to such low level that vortices start to travel with the externally applied flow, owing to the presence of a reactive component in mutual friction. In this regime the number of those vortices, which are in a state of dynamic evolution, increases in a sudden turbulent burst to the equilibrium value of the rotating flow state. This situation is known from superfluid ^{4}He. Thus this experiment bridges the gap in dynamics between superconductors and traditional He superfluidity. The controlling element in this distinction is mutual friction dissipation, a feature whose importance had not been properly appreciated prior to our experiment.

Our experiment is performed similar to modern efforts in classical turbulence or a typical study of superfluid turbulence in simulation calculations. A vortex-free state at high flow velocity is created in which a seed vortex loop is injected. We have at present three techniques available for injection:

The most controlled method is to use the superfluid Kelvin-Helmholtz instability of the first order interface between the A and B phases of superfluid ^{3}He. With this technique on an average 10 vortex loops are injected from ^{3}He-A across the AB phase boundary into the vortex-free ^{3}He-B at a critical rotation velocity, which can be controlled with the external magnetic field.

The second method is to increase the rotation velocity relatively rapidly from a stable lower to a stable higher value while one or more curved vortex loops are present in the ^{3}He-B sample. Two situations have been identified, where curved vortex loops exist: (i) the equilibrium vortex state in rotation and (ii) a remnant vortex at zero rotation.

The third injection method involves neutron irradiation of the rotating vortex-free ^{3}He-B. Here a thermal neutron is captured by a ^{3}He nucleus and the reaction energy of 764 keV heats the liquid locally in a volume of ~100 μm diameter to the normal state. This bubble then cools with a thermal relaxation time of ~1 μs through T_c into the superfluid phase. During the transition a tangle of vortices is created within the neutron bubble. From this tangle the largest suitably oriented vortex loops are picked out and extracted into the rotating flow. Their number depends on the applied flow velocity.

The three injection methods are complementary, revealing different aspects of vortex dynamics in applied flow. We have employed them to study three different questions:

Superfluid turbulence is a collective phenomenon, where topologically stable vortex loops interact, intersect, and reconnect in the bulk applied flow. How does such a complicated state arise from an initial state with only one vortex loop?

In rotation the sudden explosion in vortex number is created in a spatially localized turbulent burst. What is the structure of the vortex cluster which is formed after the burst, when the vortices propagate along the long rotating column, to replace the metastable vortex-free flow of ^{3}He-B with the equilibrium vortex state, which consists of an ordered array of rectilinear vortex lines?

The propagating vortex cluster forms in a helically twisted configuration, as can be inferred from an analysis of its NMR signature. How does a helical vortex cluster relax to rectilinear lines?

These three processes are described below.

1) Vortex multiplication in applied flow - the precursor to superfluid turbulence: We have investigated the precursor mechanism to superfluid turbulence in rotating ^{3}He -B, the process by which the number of quantized vortices increases from one or a few initial loops to such densities that turbulence in the bulk volume can switch on. Our measurements reveal a sharp division in behaviour as a function of temperature. Below a threshold temperature of ~ 0.6 T_c a curved vortex loop starts a process of vortex multiplication, which continues until eventually the stable equilibrium state of rectilinear vortex lines is reached.

We find that vortex multiplication in the low temperature regime proceeds in two different stages. If the initial density of vortices is low, the number of vortices first grows linearly in time. When a sufficient vortex density has been locally reached somewhere in the sample, there occurs a sudden switch-on to superfluid turbulence, where the vortex number increases abruptly. The linear regime was observed here for the first time. It has the following key features:

It operates in externally applied flow only at low temperatures. The probability of creating new vortices changes abruptly from zero to one over a narrow temperature interval.

Vortex multiplication occurs even at the lowest applied flow velocities that can still be detected with our NMR techniques.

The presence of curved vortex loops connecting to the cylindrical lateral boundary of the sample is necessary.

The multiplication proceeds independently in different parts of the sample volume.

Numerical simulation calculations by our colleagues Risto Hänninen and Makoto Tsubota in the Osaka City University exhibit a similar initial regime of linear growth in vortex number. We attribute this multiplication to the instability of single curved vortices at low vortex damping. When such a curved loop moves in the applied flow, it orients itself partly along the flow through the interplay of mutual-friction forces and the selfinduced velocity component from its own curvature. When it then collides with the sample boundary, sharp reconnection kinks are formed and excite Kelvin waves. Excitations of proper wave length and orientation with respect to the applied flow start expanding if the vortex segment connecting to the boundary has a sufficiently long section parallel to the flow. This requirement restricts the multiplication process to low temperatures. Expanding wavelike distortions may then lead to additional reconnections with the wall, to the formation of secondary loops, and to continued vortex production.

2) Structure of vortex cluster propagating in rotating superfluid column: What happens in a rotating superfluid column if one section of the column is filled with

the equilibrium number of vortex lines while the rest is vortex-free? How is the originally vortex-free section dragged into rotation?

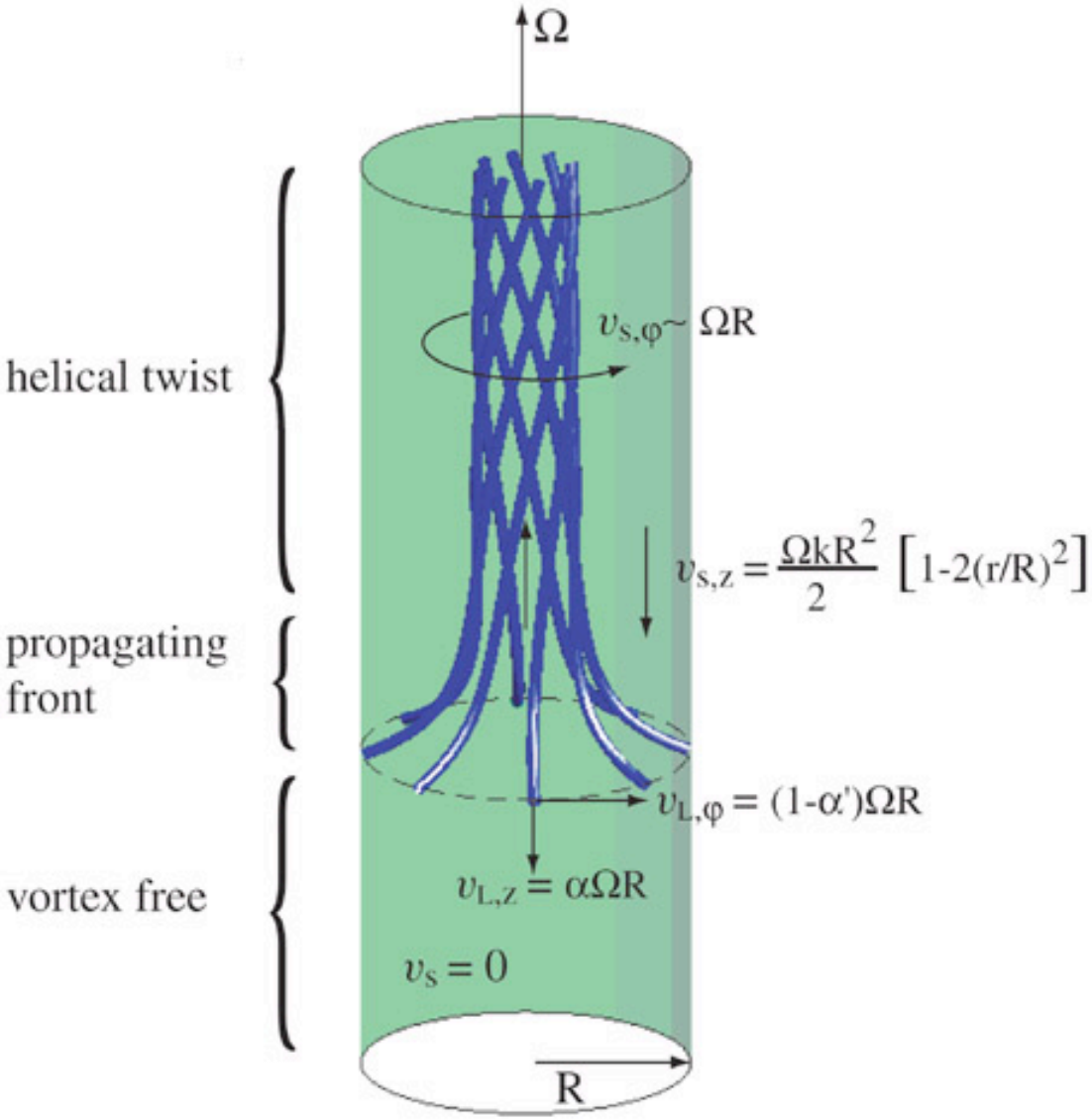


Fig. 1. Dynamic state of vortex propagation in ^{3}He-B. A helically twisted vortex cluster expands in spiral motion down a long rotating column. It ultimately replaces the initial vortex-free state with rectilinear vortex lines (which in this figure are less in number than in the equilibrium vortex state). This transient state can be created after a rapid increase of the rotation velocity from zero to a low final stable value ~ 1/R mm/s, while a remnant seed vortex is present in the sample. From the seed vortex a small cluster of vortex lines is produced by a rapid succession of wall collisions. Here the cluster has formed a sharp front towards the vortex-free section of the column, into which it expands in spiral motion, leaving behind helically twisted vortex lines. When the front has reached the bottom of the column the helix is slowly expelled and the vortices straighten to rectilinear lines. The existence of this new configuration of quantized vorticity shows that even at low vortex damping also dynamic states can be organized and not only turbulent.

Our experiment reveals a new transient vortex state, a vortex front, which joins the two parts of the superfluid sample. The vortex front travels through the sample in a steady-state configuration at constant velocity, extending the vortex state into the

vortex-free region. A time-of-flight measurement between two NMR detection coils gives the propagation velocity of the front. It turns out to be close to the axial expansion velocity of a single vortex line. Behind the front the superfluid component is approximately in solid-body rotation, but the configuration is not yet in equilibrium: The vortices are twisted in a helical structure around the rotation axis. This is inferred from an analysis of the NMR signals which are measured while the front passes through a spectrometer coil and its internal structure is scanned by the time-dependence of the absorption line shape.

Numerical simulations of the propagation dynamics were performed using two different approaches:

1. by solving the approximate coarse-grained hydrodynamic equations and
2. by studying states composed of discrete vortex lines, which are constructed with Biot- Savart integration along lines confined within sample boundaries which fulfill Laplace ´s equation (the requirement that the perpendicular component of the flow velocity vanishes at the boundary).

These simulations support the experimental conclusions about the propagation of the front and about the helical cluster behind the front.

3) Relaxation of helical vortex cluster to rectilinear lines: The twisted vortex cluster eventually relaxes to the equilibrium state of rectilinear vortex lines. The process can be most conveniently examined using the neutron absorption technique for vortex loop injection. Here the injection occurs randomly over the entire length of the long sample column. The timing of the NMR signatures arriving from our two NMR spectrometer coils allows us to locate the site of the turbulent burst since the propagation velocity is known. In this way one can determine the dependences of the relaxation time for the unwinding of the helix. The process is currently under study. Counterintuitively we find from the experiment that the relaxation process speeds up with decreasing temperature.

Technical development work: The past year was spent replacing our ^{3}He -^{4}He dilution refrigerator in the rotating installation with a new and more powerful precooler of the nuclear refrigeration stage. The new dilution refrigerator has been designed and constructed by Sergey Boldarev. In January 2004 the former refrigerator was cut off from its pumping head and the installation of the new device started. In the summer test runs followed, which finally were completed just before Christmas. A minimum temperature of 7 mK was measured with a residual heat leak of 1/4 μW to the mixing chamber. The maximum flow rate of the installation is 3/4 mmole/s. The new precooler will make it possible to perform measurements on the vacuum state of quasiparticle excitations in the zero temperature limit ~ 0.1 T_c ~ 0.1 mK of this system of fermion condensates.

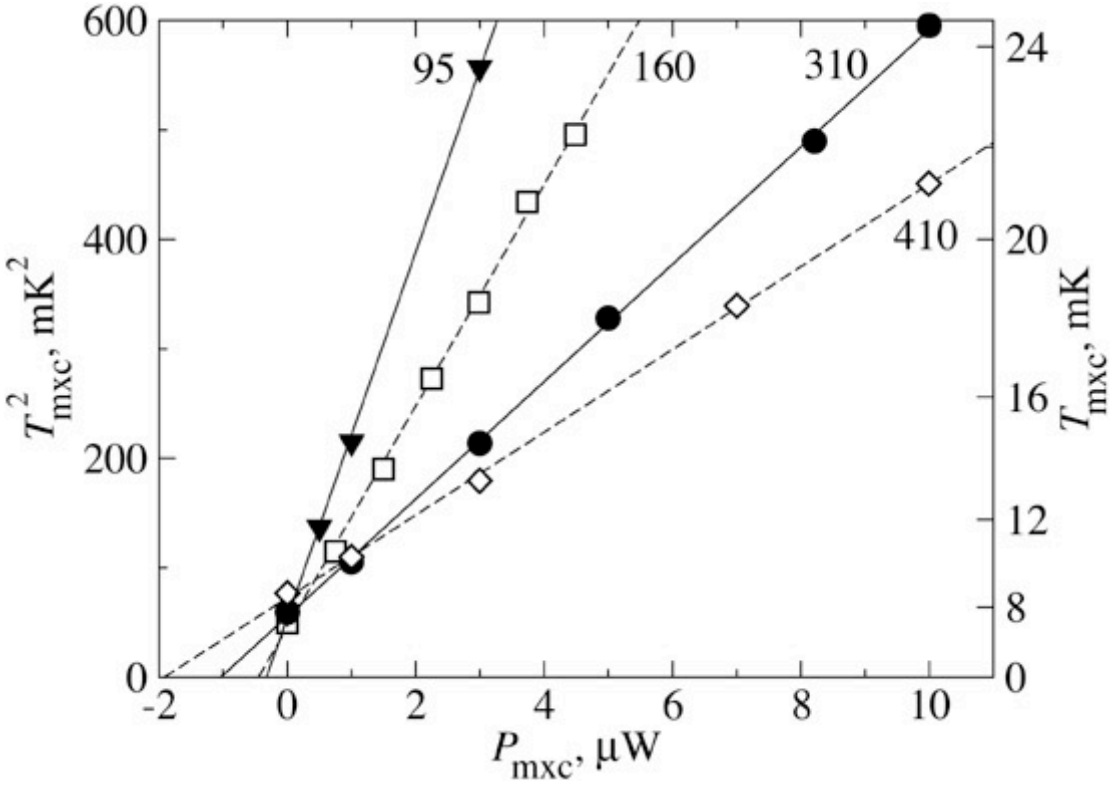


Fig. 2. Load curve measurements of the new ^{3}He -^{4}He dilution refrigerator: the temperature of the mixing chamber Tmxc in mK plotted as a function of the electrical heating power Pmxc applied to the mixing chamber. The temperature is measured with a ^{3}He melting pressure thermometer fixed on an isolated heat exchanger which is immersed in the He bath inside the mixing chamber. The heating is applied in steady state to an electrical heater mounted on the mixing chamber. The different load curves have been measured at various stable ^{3}He flow rates, as marked next to each line in μmole/s.

INTERFACE group

INTERFACES IN QUANTUM SYSTEMS

H. Alles, H. Junes, M. Manninen, J. Simpura, and I.A. Todoshchenko

Visitors: S. Balibar and A.Ya. Parshin

Helium crystals represent a good model system in which general properties of crystalline surfaces such as the equilibrium crystal shape, surface phase transitions, and elementary mechanisms of the crystal growth can be studied. In addition, helium crystals reveal several exceptional and surprising phenomena like the crystallization waves which propagate on the superfluid-solid interface. This kind of phenomena are possible because of quantum properties of liquid and solid helium which show up at ultra low temperatures close to the absolute zero.

The crystals are typically recognized by the smooth flat planes – facets – on their surface, which appear in the directions of high-symmetry crystallographic orientations. Generally, the lower the temperature, the more facets should be on the crystal surface. On the surface on helium crystals, due to the small surface energy, the facets are present only in the vicinity of the absolute zero temperature. Therefore, for a long time it was thought that the large zero-point energy of helium atoms will prevent the observations of more than just a few different types of facets

on helium crystals. However, we have discovered a few years ago, with our unique low-temperature Fabry-Pérot type of interferometer, that on the surface of ^{3}He crystals there exist at least eleven different types of facets.

As temperature rises and thermal fluctuations increase, the facets should disappear at the successive roughening transition temperatures till crystals become completely rounded. In ^{3}He, no facets have been observed above 0.1 K which is nearly three times lower value than calculated from theory. In order to solve that discrepancy, we have performed careful measurements on the shape of ^{3}He crystals in the temperature range of 0.06…0.11 K and extracted the temperature dependence of the step free energy of facets (see figure). We have also shown that the facets do not show up above 0.1 K because of increasing quantum fluctuations of the liquid-solid interface. Below 0.1 K, paradoxically, the fluctuations become more and more damped due to the Fermi degeneracy of the liquid ^{3}He. From our experimental data in this temperature range we have obtained also the value for the surface tension of ^{3}He crystals and found it to be isotropic, temperature-dependent and in a good agreement with the value measured at higher temperatures by Rolley et al. [Europhys. Lett. 8, 523 (1989)].

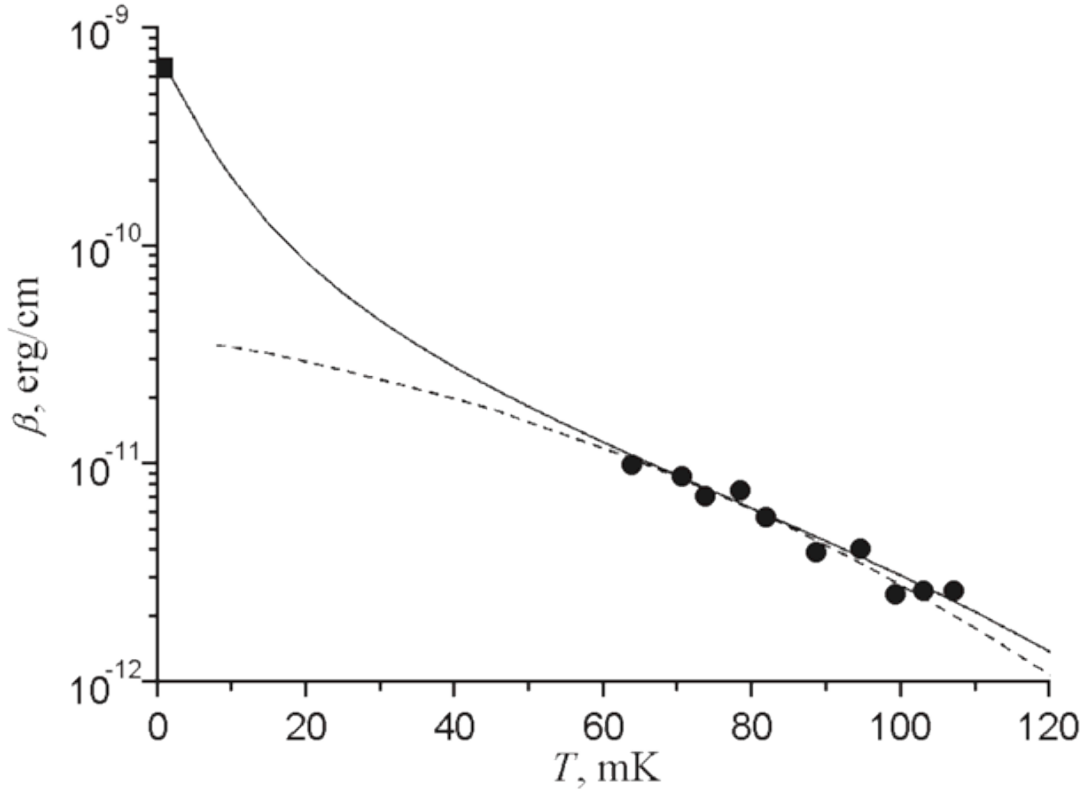


Fig. 1. Measured free energy of a step on the (110) facet of a bcc ^{3}He crystal as a function of temperature. Dashed curve is a fit to the theory of renormalization by thermal fluctuations and the solid curve a fit to the generalized renormalization theory which takes into account also quantum fluctuations of the liquid-solid interface.

THEORY

DYNAMICS OF SUPERFLUID TURBULENCE IN ^{3}He

N.B. Kopnin, **G. Volovik** in collaboration with Victor S. L'vov (The Weizmann Institute of Science, Israel) and Sergey V. Nazarenko (University of Warwick, UK)

This theoretical work is closely connected to the experimental effort in the laboratory. New class of superfluid turbulence has been recently discovered experimentally by ROTA group under conditions that the normal component is clamped in the container frame due to its high viscosity. In contrast to classical turbulence, the transition to superfluid turbulence has been found to be velocity independent. According to the experiment, a few seed vortices injected into the ^{3}He-B superflow triggered a transition into a state with a turbulent vortex tangle for temperatures $T < 0.6\ T_c$ while the same injection at higher temperatures did not create any substantial number of vortices in the final state. In these measurements, the superfluid Reynolds numbers as high as 200 have been reached without any noticeable dependence of the transition temperature on the initial superflow velocity.

The theoretical model supported by numerical simulations has been developed that explains the transition to turbulence in terms of the vortex instability governed by the mutual friction between the normal and superfluid components that appears in the presence of quantized vortices [Theory: 5]. The coarse grained description of the developed superfluid turbulence was derived, which is characterized by two Reynolds parameters, one of them being independent of flow velocity [Theory: 16]. The spectrum of developed turbulence was calculated. It was shown that it is modified by the nonlinear energy dissipation caused by the mutual friction between quantized vortices and the normal component of the liquid. In some region of two Reynolds parameters characterizing the flow of a superfluid, a new state of the fully developed turbulence was found. This state displays both the Kolmogorov-Obukhov scaling law $E(k) \sim k^{-5/3}$ and the new scaling law $E(k) \sim k^{-3}$, each in a well separated range of k [Theory: 7].

NONEQUILIBRIUM PROPERTIES OF MESOSCOPIC SUPERCONDUCTORS

N.B. Kopnin in collaboration with V.M. Vinokur (Argonne National Laboratory, USA) and A. S. Mel'nikov (Nizhny Novgorod, Russia)

Theoretical studies of mesoscopic superconductors were concentrated on the effects of weak disorder on transport properties and energy states of Andreev wires, *i.e.*, in normal conductors surrounded by a superconducting environment. Vorices in type II superconductors and filamentary intermediate state of type I superconductors in addition to artificially fabricated SN heterostructures can be the examples of such Andreev wires.

Like in usual conductors, the single electron transport in Andreev wires is associated with transverse modes confined in the normal region. However, in contrast to the usual conductors, the heat conductance of ballistic Andreev wire appears to be substantially lower than what can be obtained from the Wiedemann-Franz law using the normal electrical conductance of the wire due to much smaller

group velocity of the Andreev modes. In disordered Andreev wires with a long mean free path, the ballistic transport changes to diffusion. In addition to the known Andreev diffusion decreasing with an increase in the mean free path, the heat conductance includes a diffusive drift along the Andreev states produced by a small particle-hole asymmetry. This drift contribution increases with increasing mean free path. The conductance thus has a minimum, which should lead to a peculiar re-entrant localization of transport as a function of the mean free path [Theory: 19].

TOPOLOGICAL QUANTUM PHASE TRANSITIONS

G. Volovik in collaboratoin with Frans Klinkhamer (University of Karlsruhe, Germany)

There is a class of quantum phase transitions which occur without change of symmetry and is related to the change of the topology of the fermionic spectrum. Lifshitz transition with change of the topology of Fermi surface in metals is an example. The other types of such transitions are related to point and line nodes in the spectrum of fermions. In particular there can be quantum phase transitions that separate a vacuum state with fully-gapped fermion spectrum from a vacuum state with topologically-protected Fermi points (gap nodes). In the context of condensed-matter physics, such a quantum phase transition with Fermi point splitting may occur for a system of ultracold fermionic atoms in the region of the BEC--BCS crossover, provided Cooper pairing occurs in the non-s-wave channel. For elementary particle physics, the splitting of Fermi points may lead to CPT violation, neutrino oscillations, and other phenomena [Theory: 4].

CONNECTION TO COSMOLOGY AND PARTICLE PHYSICS

G. Volovik in collaboration with Carlos Barcelo (Instituto de Astrofisica de Andalucia, Spain)

There are fundamental relations between three vast areas of physics: particle physics, cosmology and condensed matter. These relations constitute a successful example of the unity of physics. Fundamental links between cosmology and particle physics, in other words, between macro- and micro-worlds, have been well established. There is a unified system of laws governing all scales from subatomic particles to the Cosmos and this principle is widely exploited in the description of the physics of the early Universe, baryogenesis, cosmological nucleosynthesis, *etc*. The connection of these two fields with the third ingredient of the modern physics - condensed matter - is the main goal of our program. These connections allow us to simulate the least known features of high-energy physics and cosmology: the properties of the quantum vacuum.

Starting from the assumption that general relativity might be an emergent phenomenon showing up at low-energies from a condensed-matter-like underlying structure, we re-analyzed the stability of Einstein static Universe. In this scenario, it is sensible to consider a general relativistic configuration as in contact with a thermal reservoir. We calculated the free energy at a fixed temperature of an Einstein configuration filled with radiation and found that the Einstein state is actually stable under the stated condition [Theory: 1]. This differs from the prediction of the fundamental general relativity: though the same local equations of general relativity were used, the global properties of the Universe appeared to be different in emergent and fundamental gravity.

The dark energy (the vacuum energy), estimated using the methods of particle physics, is now in huge disagreement with modern cosmological experiments. This is the main cosmological constant problem. The condensed-matter experience gives the hint how this problem can be solved: the trans-Planckian degrees of freedom completely cancel the contribution of zero-point fluctuations to the vacuum energy due to thermodynamic identity. The next step is to find the origin of the observed small cosmological constant L. We discussed from the condensed-matter point of view the recent idea that the Poisson fluctuations of cosmological constant about zero could be a source of the observed dark energy. We calculated the magnitude of thermodynamic fluctuations of L and found that it can be consistent with observations for the special choice of the volume of the Universe, which must be much bigger than the volume within the cosmological horizon [Theory: 17].

We applied the thermodynamic principles also for the problem of coexistence of several quantum vacua [Theory: 15, 20]. We found that at the coexistence point all the vacua have zero cosmological constant. The coexistence of vacua can be regulated by the exchange of the global fermionic charges between the vacua, such as baryonic, leptonic or family charge. If the coexistence is regulated by the baryonic charge, all the coexisting vacua exhibit the baryonic asymmetry which could explain the excess of matter over antimatter in our Universe.

NONEQUILIBRIUM AND THERMOELECTRIC EFFECTS IN NORMAL-SUPERCONDUCTING HETEROSTRUCTURES

T. T. Heikkilä, N.B. Kopnin, J. Voutilainen, and P. Virtanen, in collaboration with the Pico group and F. Giazotto, F. Taddei, R. Fazio, and F. Beltram, Scuola Normale Superiore, Pisa, Italy

We have studied theoretically the nonequilibrium dynamics of superconductor-insulator-normal-metal-insulator-superconductor (SINIS) systems. Such devices can be used as efficient Peltier coolers. We have studied the ultimate limits of such cooling and the nonequilibrium electron energy distributions in these systems, including quantitatively the roles of energy relaxation [Pico: 13] and possible nonequilibrium induced in the superconductors. Moreover, we have studied a system which combines a SINIS cooler with a superconductor-normal-metal-superconductor Josephson weak link and shown how such a system can be used as an accurately tunable, low-dissipation supercurrent transistor with high current and power gains [Theory: 2, Pico: 8]. Based on this theory, the first experimental operation of such a “cold electron transistor” has been demonstrated in the Pico group [Pico: 11].

We have also theoretically examined the thermoelectric phenomena in mesoscopic normal-metal wires in contact to superconductors [Theory: 13, 14]. In such devices, recent experiments have shown that the thermopower, *i.e.*, the voltage created by the temperature difference in the absence of charge currents, can exceed the previously known theoretical predictions by a few orders of magnitude, and moreover, it can be controlled with a magnetic flux. In our study, we have shown that the presence of supercurrent in such systems leads to the observed thermoelectric effects. Our theory is in good agreement with the experimental observations and predicts how it can be confirmed via an experiment slightly different from the previous ones.

QUANTUM MEASUREMENTS AND CURRENT FLUCTUATIONS

T. T. Heikkilä, T. Ojanen, and P. Virtanen, in collaboration with the Nano group and E. B. Sonin (Racah Hebrew University of Jerusalem, Israel), G. Johansson (University of Karlsruhe, Germany and Chalmers University of Technology, Gothenburg, Sweden) and F. K. Wilhelm (Ludwig-Maximilian University of Munich, Germany)

We have studied theoretically how the current fluctuations and their statistics can be measured in mesoscopic systems. We have considered the limitations of classical measurement schemes in measuring the third and higher cumulants of fluctuations [s1, Nano: 3]. Cyclostationary driving provides an easier access to the odd cumulants compared to DC driving. We have also considered novel mesoscopic detectors based on a small Josephson junction with a high-resistance environment, which allow for a sensitive and large-bandwidth detection of noise [Nano: 2, 3]. Moreover, in such detectors, one can access the asymmetry of the noise, which is not possible in the standard schemes. Such a detector has been recently realized in the Nano group [Nano: 2]. We have also examined a scheme for the calculation of different cumulants of current statistics in multiterminal structures, exploiting the quasiclassical Keldysh counting-field method.

We have studied the measurement of a quantum two-level system through a harmonic oscillator (representing a resonant circuit) coupled to it. We have shown that a fast reflection measurement can be used as a direct probe of the quantum state of the system [s2]. This study is closely related to the experiments done in the Nano group.

Publications not yet in print

[s1] Tero T. Heikkilä and Leif Roschier, Cyclostationary measurement of low-frequency odd moments of current fluctuations, Phys. Rev. B 71, 085316 (2005).

[s2] Teemu Ojanen and Tero T. Heikkilä, State-dependent impedance of a strongly coupled oscillator-qubit system, Phys. Rev. B (submitted) (2004) [cond-mat/0501043].

BRAIN RESEARCH UNIT

At the Brain Research Unit we aim to address human brain functions at systems level, mainly by applying noninvasive brain imaging methods that we continuously develop and sharpen. We also design and construct stimulation and monitoring devices to create as-natural-as-possible environments for experimentation on systems neuroscience.

Within this framework, we have continued to study functions of the human cerebral cortex by measuring weak magnetic fields outside the head. This magnetoencephalographic (MEG) method allows a totally non-invasive view into healthy and diseased human brains during different tasks and conditions. Our 306-channel neuromagnetometer (Vectorview, Neuromag Ltd), functional since 1998, houses 204 gradiometers and 102 magnetometers with a whole-scalp coverage. To combine functional and structural information, we typically integrate MEG data with the subject's magnetic resonance images (MRIs).

In 2004, we have continued to work extensively on MEG characterization of human sensory, motor, cognitive and language functions, both in healthy and diseased brains. In addition, we have considerably expanded our efforts to also use functional magnetic resonance imaging (fMRI) at the Advanced Magnetic Imaging (AMI) Centre of HUT; fMRI with its excellent spatial resolution complements the superb temporal resolution of MEG in tracking activation patterns and sequences in the human brain. The AMI Centre operates a 3 Tesla MRI/fMRI superconducting magnet (General Electric 3T Signa) for whole-body imaging, and we continued to be the largest single user group of the Centre in 2004.

MEG STUDIES

SENSORY AND MOTOR PROCESSING

G. Caetano, **N. Forss, R. Hari**, Y. Hlushchuk, M. Illman, O. Jensen, **V. Jousmäki**, R. Lehtonen, T. Morita, **J. Numminen**, L. Parkkonen, M. Pohja, H. Renvall, **S. Salenius**, **M. Schürmann**, and C. Simões

Collaborators:

Helsinki University Central Hospital
Department of Clinical Neurophysiology, University of Helsinki
Dept. of Physics, Univ. of Pittsburgh, USA
Dept. of Mathematics, Univ. of Pittsburgh, USA
Dept. of Mathematics, Boston Univ., USA
F.C. Donders Centre for Cogn. Neuroimaging, The Netherlands
Institute of Technology, Lisbon University of Technology
Brain Work Laboratory, Institute of Occupational Health
National Rehabilitation Center, Tokorozawa-shi, Japan.

In daily life, humans typically process stimuli of more than one sensory modality at the same time; one example is audiotactile interaction. We found that vibrotactile stimuli can facilitate hearing, lowering the detection thresholds by about 12%. Our recent fMRI study indicated a 85-mm^3 region in the posterior auditory belt area co-activated by auditory and vibrotactile stimuli; this brain region might subserve

processing of audiotactile events that arise during dynamic contact between hands and environment.

Our studies on tactile processing have indicated phase-locking between the primary and secondary somatosensory cortices 70–100 ms after median nerve stimuli in the 20-Hz frequency range, as an indication of participation of these distant brain areas in the same large-scale cortical processing circuitry for touch.

By recording simultaneously rhythmic brain activity and electromyographic activity of a contracting muscle, we showed in 1997 that "cortex speaks to the muscle" at about 20 Hz and that cortex always leads in time. This "cortex–muscle coherence" has now become rather popular worldwide. We have shown that the reliability and reproducibility of the signals is good within one recording session but that caution is needed when interpreting absolute levels or changes in the strength of coherence in single subjects between the sessions, for example during follow-up of various patient groups.

Studies have been completed on sensory-level processing deficits in subjects with dyslexia and on the search for brain correlates for behavioural measures of face recognition during spatial noise masking.

Publications

Furey ML, Tanskanen T, Beauchamp M, Avikainen S, Uutela K, Hari R and Haxby JV: Modulation of early and late neural responses to faces and houses by selective attention. Submitted.

Hari R: Magnetoencephalography in Clinical Neurophysiological Assesment of Human Cortical Functions. In E Niedermeyer and F Lopes da Silva (Eds) Electroencephalography: Basic Principles, Clinical Applications, and Related Fields. 5th edition, Lippincott, Williams & Wilkins 2004, pp. 1165–1197.

Hlushchuk Y, Forss N and Hari R: Distal-to-proximal representation of volar index finger in human area 3b. Neuroimage 2004, 21: 696–700.

Jensen O, Goel P, and Kopell N, Pohja M, Hari R and Ermentrout B: On the human motor-cortex beta rhythm: Sources and modelling. Neuroimage, in press.

Jääskeläinen IP, Ojanen V, Ahveninen J, Auranen T, Levänen S, Möttönen R, Tarnanen I, and Sams M: Adaptation of neuromagnetic N1 rsponses to phonetic stimuli by visual speech in humans. NeuroReport 2004, 15: 2741–2744.

Möttönen R, Schürmann M and Sams M: Time course of multisensory interactions during audiovisual speech perception in humans: A magnetoencephalographic study. Neurosci Lett 2004, 363: 112–115.

Numminen J, Schürmann M, Hiltunen J, Joensuu R, Jousmäki V, Koskinen SK, Salmelin R and Hari R: Cortical activation during a spatiotemporal tactile comparison task. Neuroimage 2004, 22: 815–821.

Näsänen R, Kaukiainen A, Hero V, Päällysaho J, Müller K, Hari R, Akila R, Sainio M: Effects of long-term occupational solvent exposure on contrast sensitivity and performance in visual search. Environ Toxicol Pharmacol 2005, 19: 497-504.

Pohja M, Salenius S and Hari R: Reproducibility of cortex–muscle coherence. Neuroimage, in press.

Schürmann M, Caetano G, Jousmäki V and Hari R: Hands help hearing: Facilitatory audiotactile interaction at low sound-intensity levels. J Am Soc Acoust 2004, 115: 830– 832.

Simões C, Salenius S and Curio G: Short-term (≈ 600 ms) prediction of perturbation dynamics for 10- and 20-Hz MEG rhythms in human primary sensorimotor hand cortices, NeuroImage 2004, 22: 387–393.

Raij T and Jousmäki V: MEG studies of gross-modal integration and plasticity. In The Handbook of Multisensory Processes, Ed. Gemma Galvert, Charles Spence and Barry E. Stein, MIT Press, Cambridge, Massachusetts, USA, 2004, pp 515–528.

Renvall H, Lehtonen R and Hari R: Abnormal response recovery in the right somatosensory cortex of dyslexic adults. Cerebral Cortex 2005, 15; 507–513.

Tanskanen T, Näsänen R, Montez T, Päällysaho J and Hari R: Face recognition and cortical responses show similar sensitivity to noise spatial frequency. Cerebral Cortex 2005, 15; 526–534.

PATHOPHYSIOLOGY OF ACUTE AND CHRONIC PAIN

N. Forss, R. Hari, E. Kirveskari, M. Pohja, T. Raij, and N. Vartiainen

Collaborators:

Helsinki University Central Hospital
Charles University, Prague, Czech Republic

Pain is a serious problem in clinical medicine. We have shown that with small modifications to the intensity and area of painful stimulation with a thullium laser (applying a restricting hole at the tip of the handpiece of the laser), we can reliably differentiate brain responses elicited by two nociceptive fibre systems, Ad- and C-fibres, corresponding to first and second pain. The most important source areas in the brain were the second somatosensory cortex SII and, in contrast to many previous brain imaging studies, the posterior parietal cortex PPC and not the primary somatosensory cortex SI reported by many groups; in fact, SI lesions do not affect pain perception.

We have also shown, by using both the rhythmic 20-Hz activity and the 20-Hz cortex–muscle coherence as tools to probe the functional state of the primary motor cortex MI, that the M1 cortex is automatically activated by laser stimuli, both after Ad- and C-fibre stimulation, This effect is functionally useful during acute pain but a likely source of a vicious cycle during chronic (tension) pain when the pain turns from a symptom to a disease.

In a recent fMRI study we addressed the very basic question how humans are able to differentiate events surfacing from their own mind from those arising from the external world. We screened among 103 volunteers 14 suggestion-prone healthy subjects who rated during fMRI the experienced reality of pain when the pain was induced either by laser pulses to the skin or by hypnotic suggestion. Both pain states were associated with activation of the brain's pain circuitry but with some interesting differences. During suggestion-induced pain, the reality estimates correlated positively with activation strengths in the rostral and perigenual anterior cingulate cortex and in the pericingulate regions of the medial prefrontal cortex, and

other correlation analyses suggested that these areas likely contribute to monitoring of the source of information in the external world.

Publications

Forss N, Raij T, Seppä M and Hari R: Common cortical network for first and second pain. Neuroimage 2005, 24: 132–142.

Raij T, Forss N, Stancak A and Hari R: Modulation of motor-cortex oscillatory activity by painful Ad- and C-fiber stimuli. Neuroimage 2004, 24: 569–573.

Raij T, Numminen J, Närvänen S, Hiltunen J and Hari R: Brain correlates of subjective reality of physically and psychologically induced pain. Proc Natl Acad Sci USA 2005, 102: 2147–2151.

Stancak A, Raij T, Pohja M, Forss N and Hari R: Oscillatory motor cortex–muscle coupling during painful laser and nonpainful tactile stimulation. Neuroimage, in press.

VISUAL PHYSIOLOGY AND PATHOPHYSIOLOGY

S. Vanni, L. Henriksson, L. Stenbacka, and J. Tölö

Collaborators:

CERCO laboratory, CNRS/Université Paul Sabatier, Toulouse, France
Vision Science Center, Australian National University (ANU), Canberra, Australia
Department of Bio and Environmental Sciences, University of Helsinki, Helsinki, Finland
Lea-Test Ltd, Helsinki, Finland
Finnish Institute of Occupational Health, Helsinki, Finland

About thirty distinct functional areas in each human hemisphere participate in seeing. Routing of information in this system is dynamic, and processing effective. We are studying the early phase of visual processing and hope to better understand the relation between measured neuromagnetic or BOLD signal and biological image analysis. We also hope to distribute knowledge to clinicians and help development of mechanical applications of vision.

We have developed multifocal fMRI together with Andrew James, from ANU. Because the method is based on general linear model, it allows versatile and robust mapping and quantification of multiple local activations in V1. We are searching for stimulation parameters giving more robust signals from the extratsriate cortices and ways to efficiently quantify visual parametric responses.

We have worked on timing of plaid perception, together with Jean-Michel Hupé from the CERCO laboratory. This paradigm studies the segregation and integration of visual objects.

After primary visual cortex activation, activation distributes to parieto-occipital and temporo-occipital regions before more wide distribution in the back of the brain. This suggests, in line with the theory by Jean Bullier from CERCO laboratory, that middle-tier areas in the anatomical hierarchy are contributing to information processing early in the processing cascade. We assume that the parieto-occipital area is the human homologue to monkey V6, and we are starting collaboration with Claudio Galletti from University of Bologna to study this issue further.

Homonymous hemianopia, blindness of the left or right visual half-field, is a common disability in elderly population. Together with Antti Raninen, Lea Hyvärinen and Risto Näsänen, our three Finnish collaborators, we follow evoked fields of two patients during psychophysical flicker rehabilitation of their hemianopic field, and one of the patients participates in fMRI measurements.

Publications

Vanni S, Henriksson L, James A: Multifocal fMRI of visual cortices, Neuroimage (in press)

Vanni S: Cortical visual information processing. [in finnish] Duodecim 2004, 120: 2655-2662.

Vanni S: Näkökyky, näköseula ja liikennenäkö. [in finnish] Liikenne 2004, 4;13-14.

BRAIN BASIS OF SOCIAL INTERACTION

R. Hari, L. Helle, J. Järveläinen, K.-I. Kaneko, M. Martikainen, T. Morita, M. Saarelainen, and **M. Schürmann**

Visitor: **N. Nishitani** (Tokorozawa, Japan).

Collaborators:

Laboratory of Computational Engineering, HUT
Institute of Medicine, Research Centre Jülich, Jülich, Germany
C. & O. Vogt Brain Research Institute, Düsseldorf, Germany
Research Institute, National Rehabilitation Center, Tokorozawa-shi, Japan
Kyoto Medical School, ENT-Department, Kyoto, Japan

Proper interpretation of the intentions of our fellow human beings is an essential ability for successful communication in the society. Recent research suggests that the mirror-neuron system (MNS), first discovered in monkeys, is important for such social cognition. The MNS is activated both when the subject views another person performing motor acts and when he himself performs similar movements. The MNS therefore could form the basis for understanding the intentions of other persons and be a good candidate for the neurophysiological locus of disorders resulting in difficulties of smooth and reciprocal social communication, such as in autism and schizophrenia. However, the motor MNS might be just the tip of an iceberg among various mirroring systems that allow people to interact with each other in an understanding, predictive, and emphatic manner. Our aim is to strenghen studies of social interaction within this framework.

We have demonstrated with MEG recordings a considerable delay in the MNS activation sequence in highly-functioning asperger subjects who also have difficulties in imitation and action understanding; the delay indicates abnormalities in the connection between the inferior parietal lobe (that is important for coding motor actions and for addressing intentions) to the inferior frontal gurus (“Broca’s area” that is the human homologue of the monkey mirror- neuron area F5 and an important action–perception interface, also relevant for goal setting).

Interestingly the inferior frontal gyrus did not show any extra activation during contagious yawning, indicating that it is important only for imitation of new skills, not for release of stereotypic contagious motor patterns.

In monkeys, the mirror neurons are not activated by tool use. In contrast, we showed that the human primary motor cortex is activated when the subjects observe goal- and no-goal- directed chopstick use; the effect was stronger for the goal-directed movements. Interestingly, the effect at the motor cortex was the stronger the more experience the subjects themselves had about chopstick use. This important finding is the first one to indicate that the MNS is shaped by experience.

Publications

Hari R: Assessing mind by reading brain and body during social interaction; Thoughts about human mirroring systems. In Braaten S (Ed): "Foundations of (pre)verbal intersubjectivity in light of new findings". Theory Forum Symposium in The Norwegian Academy of Science and Letters. Olso, Norway, October 2004.

Hari R and Nishitani N: From viewing of movement to imitation and understanding of other persons' acts: MEG studies of the human mirror-neuron system. In N Kanwisher and J Duncan (Eds) Functional Neuroimaging of Visual Cognition. Attention and Performance XX. Oxford University Press, Oxford 2004, pp. 463–479.

Järveläinen J, Schürmann M and Hari R: Activation of the human primary motor cortex during observation of tool use. Neuroimage 2004, 23: 187–192.

Järveläinen J, Schürmann M, Avikainen S, Cannon TD, Lönnqvist J, Huttunen M and Hari R: Disease-specific decrease in reactivity of the primary motor cortex during action observation and execution in twins discordant for schizophrenia. Submitted.

Martikainen MM, Kaneko K and Hari R: Responses to self-triggered sounds are suppressed in the human auditory cortex. Cerebral Cortex 2005, 15: 299–302.

Möttönen R, Järveläinen, J Sams M and Hari R: Viewing speech modulates activity in the left SI mouth cortex. Neuroimage 2005, 24: 731–737.

Nishitani N, Avikainen S and Hari R: Abnormal imitation-related cortical activation sequences in Asperger's syndrome. Ann Neurol 2004, 55: 558–562.

Nishitani N, Schürmann M, Amunts K and Hari R: Broca's region: From action to language. Physiology (Bethesda) 2005, 20: 60–69.

Schürmann M, Hesse MD, Stephan KE, Saarela M, Zilles K, Hari R and Fink GR: Yearning to yawn: Brain correlates of yawn observation. Neuroimage 2005, 24: 1260- 1264.

LANGUAGE PERCEPTION AND PRODUCTION

P. Helenius, A. Hultén, K. Hytönen, A. Jalava, J. Kujala, H. Laaksonen, M. Liljeström, T. Parviainen, J. Polkko, A. Puurula, T. Saarinen, **R. Salmelin**, J. Uusvuori, **M. Vihla**, and M. Viinikainen

Collaborators:

Department of Psychology, Åbo Akademi University, Turku
Department of Psychology, Temple University, Philadelphia, USA
Department of Neurology, Heinrich-Heine University, Düsseldorf, Germany
Department of Psychology, University of Maastricht, The Netherlands
Centre de Recherche, Institut Universitaire de Gériatrie de Montréal, Canada

MEG is an invaluable tool in characterizing the successive and largely overlapping stages in language processing, from sensory analysis (visual, auditory, tactile) to linguistic assessment, memory search, and motor function.

We have previously shown that when fluently speaking individuals read words out loud activation proceeds from Broca's area to motor cortex. In developmental stutterers, this order is reversed; abnormalities seem to be limited to processes specifically involved in overt speech production rather than core linguistic analysis. Recently, we found that these 'production' areas also show activation while subjects are only listening to spoken sentences, but know that they will need to repeat or transform them after a short delay. In stutterers, abnormalities again emerged in the same areas as in the production task. Task-related modulation of the motor cortical 20-Hz rhythm has further demonstrated strong emphasis of face area in fluent speech production but additional involvement of the adjacent hand area in stutterers. Our recent data on fluent speakers demonstrated involvement of the hand area specifically in production of non-speech mouth movements, regardless of sequence complexity. These data suggest that motor cortical specialization for verbal mouth movements may not have developed normally in individuals who stutter.

In speech perception, lexical-semantic processing is reflected in sustained, bilateral activation of the superior temporal cortex from ~200 ms onwards. We have recently shown that both meaningful linguistic context (top-down) and acoustic-phonetic (bottom-up) cues enhance speech-sensitive analysis at the onset of this sustained response, at 200-300 ms. In dyslexic individuals, onset of the lexical-semantic processing stage is delayed by about 50 ms. It would be tempting to interpret the prelexical abnormality as cortical reflection of impaired phonological processing in dyslexia. However, it could equally well reflect irregularities in basic auditory processing. Interestingly, our recent comparison of speech vs. nonspeech analysis in dyslexia points to abnormalities in general auditory processing that occur in the time window (~100 ms) when phonetic information is extracted. Such an account could help to reconcile the existing, seemingly disparate reports of either auditory or phonological impairments in dyslexia.

Publications

Biermann-Ruben K, Salmelin R and Schnitzler A: Right rolandic activation during speech perception in stutterers: an MEG study. Neuroimage 2005, 25: 793-801.

Bonte M, Parviainen T, Hytönen K and Salmelin R: Time course of top-down and bottom-up influences on syllable processing in the auditory cortex. Cereb Cortex, in press. [2005 Apr 13; Epub ahead of print]

Cornelissen K, Laine M, Renvall K, Saarinen T, Martin N and Salmelin R. Learning new names for new objects: cortical effects as measured by magnetoencephalography. Brain Lang 2004, 89: 617-622.

Parviainen T, Helenius P and Salmelin R. Cortical differentiation of speech and nonspeech sounds at 100 ms: implications for dyslexia. Cereb Cortex, in press. [2004 Nov 24; Epub ahead of print]

Saarinen T, Laaksonen H, Parviainen T and Salmelin R: Motor cortex dynamics in visuomotor production of speech and non-speech mouth movements. Cereb Cortex, in press. [2005 Apr 27; Epub ahead of print]

Salmelin R and Helenius P: Functional neuroanatomy of impaired reading in dyslexia. Sci Studies Reading (Special Issue) 2004, 8: 257-272.

Stemmer B, Vihla M and Salmelin R: Activation of the human sensorimotor cortex during error-related processing: a magnetoencephalographic study. Neurosci Lett 2004, 362: 44-47.

CLINICAL APPLICATIONS OF MEG – CLINIMEG

N. Forss, R. Hari, E. Kirveskari, R. Salmelin, and M. Seppä.

Collaborators:

Helsinki University Central Hospital
Departments of Clinical Neurophysiology and Neurology, University of Helsinki

The 'CliniMEG' team was establisehd at the Brain Research Unit in 1997 to develop, in collaboration with the Department of Clinical Neurosciences at the Helsinki University Central Hospital, clinical applications of MEG to routine use. Since 2001, when most of the routines and software developed in BRU for preoperative studies of patients with brain tumors and epilepsy were transferred to the Department of Clinical Neurophysiology, Helsinki University Central Hospital, the BRU CliniMEG staff still continues to consult and help in more complex localization and analysis problems of MEG evaluation.

METHODOLOGICAL DEVELOPMENT

LOCALIZATION OF CORTICAL RHYTHMIC ACTIVITY

J. Kujala, M. Liljeström, and **R. Salmelin**

Collaborators:

F.C. Donders Centre for Cognitive Neuroimaging, Nijmegen, The Netherlands

Cortical rhythmic activity is increasingly employed for characterizing human brain function. Using MEG, it is possible to localize the generators of these rhythms. Traditionally, the source locations have been estimated using sequential dipole modeling. Recently, two new methods for localizing rhythmic activity have been developed in our laboratiry, Dynamic Imaging of Coherent Sources (DICS) and Frequency-Domain Minimum Current Estimation (MCE_{FD}). With new analysis methods emerging, the researcher faces the problem of choosing an appropriate strategy. We compared the performance and reliability of these three methods using both simulated and real data. All three approaches localized the principal sources of oscillatory activity very well. Dipole modeling is a very powerful tool once appropriate subsets of sensors have been selected. MCE_{FD} provides simultaneous localization of sources and was found to give a good overview of the data. With DICS, it was possible to separate closeby sources that were not retrieved by the other two methods.

Publications

Liljeström M, Kujala J, Jensen O and Salmelin R: Neuromagnetic localization of rhythmic activity in the human brain: a comparison of three methods. Neuroimage 2005, 25: 734-745.

SHARPENING METHODS FOR FUNCTIONAL MRI (fMRI) AND DIFFUSION TENSOR IMAGING (DTI)

S. Arvela, **R. Hari**, J. Hiltunen, Y. Hlushchuk, **R. Joensuu**, **V. Jousmäki**, S. Malinen, P. Pöyhönen, V. Renvall, **M. Schürmann**, M. Seppä, T. Suortti**,** **O. Tanzer**, and **A. Tarkiainen**

FMRI reveals changes in blood oxygen level dependent (BOLD) signal after considerable processing. The whole acquisition and analysis chain of fMRI has remained unexplored with functional phantoms because no such devices have been available. We have designed, implemented and tested an fMRI phantom where electric current applied to a thin wire within proton-rich medium substituted BOLD distortion of the magnetic field; the scanner detects these two distortions as practically identical signal changes. The phantom has a number of possible applications. Signal changes across sessions, days, instruments, and individuals could be monitored. Placing the phantom close to a subject during an fMRI experiment could allow differentiating signal changes due to instrumentation from changes in the subject's state and performance during the experiment. The spatial extent of brain activations and effects of various changes in the chain of image formation could be analyzed utilizing current-induced "activations". Furthermore, the phantom could expedite fMRI sequence development by reducing the need to scan human subjects, who, besides, introduce uncertainty to the signal. Thus, this fMRI phantom could be useful for both cognitive fMRI studies and scanner calibration.

Diffusion tensor imaging (DTI) and tractography have been widely applied to study fiber tracts of white matter in human brain, and more recently also of other human anatomical structures. We have obtained the first DTI and tractography results of human distal peripheral nerves (median, ulnar, and radial nerves in the upper limb and tibial and peroneal nerves in the lower limb). We first quantified the apparent diffusion coefficient and the fractional anisotropy index, and then visualized the nerves in 3D with tractography, which nicely illustrated the 3D course of the nerves and distinguished then from surrounding muscle tissue and ligaments. Further studies will show whether DTI of distal peripheral nerves is useful in the diagnosis and follow-up of nerve lesions, entrapments, and regeneration. Peripheral nerves, as well-lineated structures that also contain abundant branching into bundles of different diameters, could be used as "living phantoms" for testing and validating different tractography methods.

FMRI can reveal human brain activations with high precision which may, however, be impaired by movement of cerebrospinal fluid and deformation of brain tissue associated with cardiac pulsations. We have shown that correcting for such artifacts by time-locking the fMRI data acquisition to the cardiac cycle improves signal detection both in cortex and thalamus in studies of somatosensory processing. Variance of the BOLD signal decreased on average by 23% in thalamus and by 32% in SII during cardiac triggering compared with conventional imaging. Consequently, both thalamic and SII responses were seen in a larger number of subjects. Group analysis of cardiac-triggered data revealed somatotopical organization for activations in the ventroposterior thalamus for the three stimulus sites. At the cortical level, two distinct activation areas were observed to both finger and toe stimuli, one in the SII cortex and the other deeper in the insula.

Publications:

Hiltunen J, Suortti T, Arvela S, Seppä M, Joensuu R and Hari R: Diffusion tensor imaging and tractography of distal peripheral nerves at 3 T. Clin Neurophysiol, under revision.

Malinen S, Schürmann M, Hlushchuk Y, Forss N and Hari R: Improved differentiation of tactile activations in human thalamus and second somatosensory cortex using cardiac-triggered fMRI. Submitted.

Renvall V, Joensuu R and Hari R: Functional phantom for fMRI, a feasibility study. Submitted.

DEVELOPMENT OF THE STIMULUS ENVIRONMENTS IN MEG AND fMRI

K. Hytönen, **V. Jousmäki**, H. Kainulainen, R. Schreiber, and **S. Vanni**

Collaborators:

Laboratory of Computational Engineering, Helsinki University of Technology
Institute of Occupational Health, Helsinki, Finland

The development of MEG and fMRI compatible stimulators aims to develop and test novel, selective, and artefact-free stimulators to be used in functional brain imaging modalities. In addition, we aim to build simple interfaces between commercial functional brain imaging instruments and stimulators.

Our novel MEG-compatible tactile stimulators were tested succesfully in MEG recordings at the National Rehablitation Center in Tokorozawa, Japan.

The upgrade of our 3T MRI scanner resulted in new demands for auditory and visual stimulators due to the lack of space inside of the head coil. We have designed and tested new improved solutions. In addition, we have tested an fMRI-compatible thermal stimulator and selected a new eye tracking system for the fMRI experiments.

TEACHING ACTIVITIES

COURSES

Theory of Superconductivity (Kyl-0.104)

Post-graduate lecture course, lecturer: **Nikolai B. Kopnin**

Topics:

The Bardeen-Cooper-Schrieffer theory of superconductivity
Normal-superconducting interfaces
Josephson and tunneling phenomena, weak links
Superconducting nanostructures

Dissipation in quantum mechanics (Kyl-0.106)

Post-graduate seminar course, lecturers: **Jukka Pekola** and **Tero Heikkilä**

Seminars:

Markku Stenberg: Dissipaatio kvanttimekaniikassa - yleiset konseptit
Teemu Ojanen: Polkuintegraalit avoimissa systeemeissä
Pauli Virtanen: Caldeira-Leggett -malli ja fluktuaatiot kvanttipiireissä
Rene Lindell: P(E)-teoria ja ympäristön fluktuaatiot
Mika Sillanpää: Kaksitilasysteemin dekoherenssi- ja dephasing-ajat
Jani Kivioja: Josephsonin liitoksen pakonopeudet

RESEARCH SEMINARS ON LOW TEMPERATURE PHYSICS

Organized by **Vladimir Eltsov**

Jaakko Koivuniemi: The present status of the COMPASS experiment at CERN (5.1.)

Edouard Sonin: Rotation-induced 3D vorticity in superfluid films on porous substrates (5.3.)

Makoto Tsubota: Dynamics of quantized vortices in rotating Bose-Einstein condensates (16.3.)

Vladimir Lebedev: Classical turbulence: what we know and what do we want to know? (19.4.)

Marc Rabaud: On wind wave formation in a Hele-Shaw cell (20.4.)

Vladimir Lebedev: What we know about the passive scalar problem? (22.4.)

Ladislav Skrbek: Flow phase diagram for helium superfluids (26.4.)

Alak Majumdar: Resistivity minima in bulk disordered alloys (24.5.)

Leif Roschier: Carbon nanotube single-electron devices at audio and radio frequencies (1.6.)

James Sauls: Andreev's "Daemon" - Phase-sensitive control of heat through Josephson junctions (2.6.)

Martin Wybourne: Thermal and mechanical properties of mesoscopic structures (2.6.)

Janne Viljas: Josephson effects and textural dynamics in superfluid helium three (4.6.)

Aveek Bid: Study of 1/f noise in metallic nanowires (10.6.)

Ramesh Mani: Zero-resistance states induced by electromagnetic wave excitation in GaAs/AlGaAs devices (18.6.)

Christoph Strunk: The magnetoresistance of multiwall carbon nanotubes - Probing the electron structure (23.6.)

James Eisenstein: Bose condensation of excitons in the quantum Hall regime (28.6.)

S. Ramakrishnan: Unusual ground states in certain rare earth transition metal intermetallics (14.7.)

Sungkit Yip: Spinor bosons in optical lattice (2.8.)

Edouard Sonin: Search for Tkachenko waves: helium, pulsars, and Bose--Einstein condensate (24.8.)

Isaac. M. Khalatnikov: The great Russian physicist Gamov (26.8.)

Yuriy Bunkov: Search for dark matter with superfluid ^{3}He (27.8.)

Michael Steiner: Research goals and research opportunities at Hahn-Meitner-Institut Berlin (7.9.)

Alexander. F. Andreev: Electron pairs for HTSC (10.9.)

Juha Muhonen, Antti Paila, Tomi Ruokola, Matti Manninen, Juho Simpura, Jussi Leinonen, Juha Voutilainen: Summer student seminar (13.9.)

Sumio Iijima: Carbon nanotubes for nanotechnology (22.10.)

John Clarke: SQUIDs: From cosmology to magnetic resonance imaging in microtesla fields (8.11.)

Zdenek Janu: Low field SN transition in La (hint to understand high-temperature superconductivity?) (12.11.)

RESEARCH SEMINARS ON NANO PHYSICS

Organized by **Jukka Pekola**

Nikolai Kopnin: Re-entrant localization of single particle transport in disordered Andreev wires (13.1.)

Mika Sillanpää: The inductive single-electron transistor (L-SET) Alexander Savin: Cold electron transistor (20.1.)

Leena Uusipaikka: Metrological requirements for a low-temperature thermometer (27.1.)

Matias Aunola: Josephson junction devices and Mathieu's functions - how are they connected? (3.2.)

Leo Stodolsky: Adiabatic quantum logic with SQUIDs (11.2.)

Jukka Pekola: Influence of noise on a Josephson junction threshold detector (17.2.)

Rene Lindell: The effect of shot noise on the Coulomb blockade of a Josephson junction (24.2.)

Tero Heikkilä: Cyclostationary measurement of low-frequency odd moments of current fluctuations (2.3.)

Pauli Virtanen: Calculating fluctuations of current in mesoscopic junctions (9.3.)

Pertti Hakonen: Novel quantum amplifiers based on mesoscopic, superconducting Josephson junction (16.3.)

Shakil Awan: Quantum metrology at NPL (23.3.)

Andrey Timofeev: Design aspects of superconducting tetrahedral quantum bits (30.3.)

Michael Feigelman: Coulomb blockade of proximity effect at large conductance (6.4.)

Anne Anthore: Depairing in mesoscopic superconductors (13.4.)

Antti Lassila: Traceable dimensional measurements on nanometer range (20.4.)

Teemu Ojanen: On open quantum systems and measurements (27.4.)

Jani Kivioja: Escape measurements on DC-SQUIDs with small junctions (4.5.)

Juha Hassel: Josephson arrays in electrical metrology (11.5.)

Jukka Pekola: Nonequilibrium heating of superconductors (18.5.)

Nikolai Kopnin: Loss of Andreev backscattering in superconducting quantum point contacts (25.5.)

Antti Manninen: AC voltage standard based on Josephson effect (8.6.)

Juha Vartiainen: On optimal quantum gate decompositions (15.6.)

Michio Watanabe: Fabrication and measurement of small-capacitance Nb Josephson junctions (22.6.)

Vasili Semenov: Sub-kelvin SFQ (single flux quantum) circuits (6.7.)

Teemu Ojanen: Quantum measurement using a harmonic oscillator (11.8.)

Frank Hekking: Thermal fluctuations in an underdamped Josephson tunnel junction (17.8.)

Fan Wu: Shot noise measurements in multiwalled carbon nanotubes (24.8.)

Matthias Meschke: Observation of non-Gaussian noise by a Josephson junction threshold detector? (1.9.)

Teijo Lehtinen: Performance of the new high-frequency SQUID amplifier (7.9.)

Pauli Virtanen: Measuring non-Gaussian fluctuations through incoherent Cooper pair tunneling (14.9.)

Alexander Savin: RSFQubit - description of the project (28.9.)

Edouard Sonin: Coulomb blockaded tunnel junction as a noise probe (5.10.)

Mikko Paalanen: Superconductor-Insulator transition (19.10.)

Antti Niskanen: Report on highlights at the Applied Superconductivity conference ASC 2004 (26.10.)

Jani Kivioja: Observation of transition from escape dynamics to underdamped phase diffusion in a Josephson junction (7.12.)

RESEARCH SEMINARS OF THE BRU

Organized by **Martin Schürmann** and **Hanna Renvall**

Veikko Jousmäki: Meeting report - SfN Symposium "Multisensory Integration" 2003 (12.1.)

Jan Kujala: Meeting report - Society for Neuroscience 2003 (12.1.)

Elia Formisano: University of Maastricht, Netherlands: Tonotopy in auditory cortex: 7T fMRI in humans (19.1.)

Lauri Parkkonen: BRU literature review (26.1.)

Topi Tanskanen: Meeting report - Society for Neuroscience 2003 (2.2.)

Mia Liljeström: Correlating psychophysics and BOLD data (summary of seminar talk in HUT S-114.740 2003) (2.2.)

Martin Schürmann: BRU literature review (16.2.)

Marieke Longcamp: Motor-perceptual interactions in the visual perception of graphic stimuli (23.2.)

Jan Kujala: Intersubject averaging methods [in fMRI studies] (summary of seminar talk in HUT S-114.740 2003) (23.2.)

Yevhen Hlushchuk: Travel report "Brain Voyager course 2004 Maastricht" (8.3.)

Gina Caetano: Event-related functional MRI (summary of seminar talk in HUT S-114.740 2003) (22.3.)

Tuukka Raij: Meeting report - Society for Neuroscience 2003 (22.3.)

Marjatta Pohja: Work in progress: Reproducibility of corticomuscular coherence, BRU journal club (29.3.)

Yevhen Hlushchuk: Software demonstration - advanced features of Brain Voyager QX, BRU journal club (29.3.)

Gina Caetano: Work in progress: Evidence of vibrotactile input to human auditory cortex, BRU journal club (5.4.)

Martin Schürmann: BRU literature review, BRU journal club (19.4.)

Simo Vanni: Rehabilitation of the blind visual field in homonymous hemianopia, BRU journal club (26.4.)

Erika Kirveskari: Work in progress: Development of a language lateralization test in MEG, BRU journal club (26.4.)

Jaana Hiltunen: BRU/LTL and FIOH: BRU literature review, BRU journal club (3.5.)

Tuukka Raij: Suggestion, hypnosis, and psychogenic pain, BRU journal club (10.5.)

Antti Puurula: Late neuromagnetic sources in a perception in noise paradigm: speech is special?, BRU journal club (17.5.)

Fredrik Ullen: Karolinska Institute, Stockholm, Sweden: Neural control of rhythmic sequences, BRU journal club (24.5.)

Milene Bonte: University of Maastricht/NL and Syllable processing in the auditory cortex: the influence of acoustic cues and sentence context, BRU journal club (31.5.)

Riitta Hari: "Basics and applications of MEG" (4.6.)

PhD students' reports in long session (7.6.)

Juha Järveläinen: Reactivity of human primary motor cortex during action observation (summary of PhD work so far) (7.6.)

Yevhen Hlushchuk: Guidelines for MEG helium transfer (7.6.)

Tiina Parviainen: Perception of auditory and visual linguistic units related to normal and abnormal languge development (summary of PhD work so far) (7.6.)

HBM/FENS/Biomag2004 reports (6.9.)

Iiro Jääskeläinen: LCE/HUT: Short-term plasticity in the auditory system 20.9.2004 (13.9.)

Summer students' reports (13.9.)

Tuukka Raij: Brain correlates of subjective reality of physiologically and psychologically induced pain (27.9.)

Timo Saarinen: Rolandic 20-Hz modulation during speech and non-speech mouth movements (6.10.)

Aapo Nummenmaa: LCE/HUT: Bayesian aspects of the MEG inverse problem (11.10.)

Yevhen Hlushchuk: SI and SII cortices: Cytoarchitectonics revealed with MEG & fMRI (18.10.)

Riitta Hari: Discussion on the book by Daniel M. Wegner: The Illusion of Conscious Will (25.10.)

Seppo Mattila: Astronomical and medical imaging (1.11.)

Mikko Sams, LCE/HUT: Neurocognition of audiovisual speech perception: unisensory, multisensory, motor, mirror (8.11.)

Takeshi Morita: Abnormal loudness change and N100m (15.11.)

Marieke Longcamp: Motor perceptual interactions: theoretical framework (22.11.)

Gina Caetano and Hannu Laaksonen: MEG analysis methods (29.11.)

Marja-Liisa Halko: HU: Neuroeconomics - where do we stand? (13.12.)

SPECIAL ASSIGNMENTS

Kaisa Hytönen: Ärsykelaitteistot Kylmälaboratorion aivotutkimusyksikössä. Supervised by **Riitta Salmelin**.

Kaisa Hytönen: An MEG study on neural processing of natural speech: syllables, words, and sentences. Supervised by **Riitta Salmelin**.

Jussi Leinonen: Vortex front propagation in rotating superfluid ^{3}He -B. Supervised by **Matti Krusius**

Juha Muhonen: Cold reconnectable superconducting inputs for a SQUID. Supervised by **Juha Tuoriniemi**

Matti Manninen: Testing the HAMAMATSU C7500-51 type of CCD video camera for a low temperature application. Supervised by **Harry Alles**.

Antti Paila: The background charge noise of a single-electron transistor on a silicon substrate containing a layer of niobium as a ground plane. Supervised by **Pertti Hakonen**

Tomi Ruokola: Kelvin-Helmholtz instability in superfluid ^{3}He. Supervised by **Juha Kopu**.

Juho Simpura: Finding the smooth shape of ^{3}He crystals using a Fabry-Pérot interferometer. Supervised by **Harry Alles**.

Johanna Uusivuori: Timing of phonological and semantic analysis in written word perception. Supervised by **Riitta Salmelin**.

Pauli Virtanen: Fluctuation of current in mesoscopic junctions. Supervised by **Tero Heikkilä**

Pauli Virtanen: Measuring fluctuations with Josephson junctions. Supervised by **Tero Heikkilä**

Juha Voutilainen: Nonequilibrium behaviour in mesoscopic SINIS structures. Supervised by **Tero Heikkilä** and **Nikolai Kopnin**.

ACADEMIC DEGREES

DIPLOMA THESES

Sakari Arvela graduated as M.Sc. from the Department of Engineering Physics and Mathematics on February 6. His diploma thesis *Quadrature surface coil for specialized targets in MRI* was done it the LTL. Supervisor: Prof. Toivo Katila. Instructor: Dr. Raimo Joensuu.

Linda Henriksson graduated as M.Sc. from the Department of Engineering Physics and Mathematics on August 24. Her diploma thesis *Topographical and quantitative characterization of visual field representation in human cortex with multifocal fMRI* was done in the LTL. Supervisor: Prof. Toivo Katila. Instructor: Dr. Simo Vanni.

Marianne Inkinen graduated as M.Sc. from the Department of Electrical and Communications Engineering on December 5. Her diploma thesis *Time windows of phonological and semantic analysis spoken word perception* was done in the LTL. Supervisor: Prof. Iiro Jääskeläinen. Instructor: Prof. Riitta Salmelin.

Heikki Junes graduated as M.Sc. from the Department of Engineering Physics and Mathematics on March 9. His diploma thesis *Liquid-solid interface of ^{3}He images using a Fabry-Pérot interferometer* was done in the LTL. Supervisor: Prof. Martti Salomaa. Instructor: Dr. Harry Alles.

Teijo Lehtinen graduated as M.Sc. from the Department of Engineering Physics and Mathematics on November 16. His diploma *thesis DC SQUID Microwave Amplifier* was done in the LTL. Supervisor: Prof. Pekka Hautojärvi. Instructor: Prof. Pertti Hakonen.

Sanna Malinen graduated as M.Sc. from the Department of Engineering Physics and Mathematics on November 4. Her diploma thesis *Cardiac-triggered fMRI: Application to study somatotopic organization in the human brain* was done in the LTL. Supervisor: Prof. Toivo Katila. Instructor: Prof. Riitta Hari.

Pauli Pöyhönen graduated as M.Sc. from the Department of Engineering Physics and Mathematics on January 19. His diploma thesis *Reference scan phase correction of echo-planar images* was done it the LTL. Supervisor: Prof. Risto Nieminen. Instructor: Dr. Raimo Joensuu.

Miiamaaria Saarela graduated as M.Sc. from the Department of Psychology, University of Helsinki on March 23. Her pro gradu thesis *Kehonkuvan muokkautuminen kehon ulokkeen yhteydessä* was done in the LTL. Instructor: Prof Riitta Hari.

Mikko Viinikainen graduated as M.Sc. from the Department of Engineering Physics and Mathematics on May 27. His diploma thesis *Dynamic imaging of coherent sources: simulations and estimation of parameters* was done in the LTL. Supervisor: Prof. Timo Eirola. Instructor: Prof. Riitta Salmelin.

Ph.D. DISSERTATIONS

Leif Roschier defended his Ph.D. thesis *Carbon nanotube single-electron devices at audio and radio frequencies* on June 1, 2004. The opponent was Professor Martin N. Wybourne from Dartmouth College, New Hampshire, USA and supervisor Professor Pertti Hakonen.

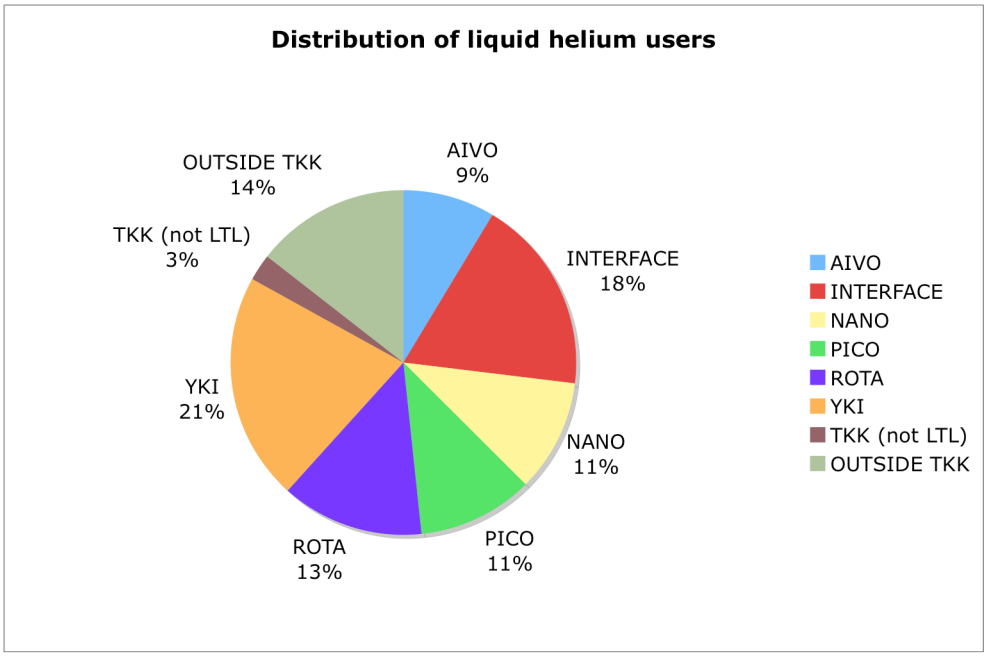
Janne Viljas defended his Ph.D. thesis *Josephson effects and textural dynamics in superfluid helium three* on June 4, 2004. The opponent was Professor James A. Sauls from Northwestern University, Evanston, Illinois, USA and supervisor Professor Erkki Thuneberg.

Antti Niskanen defended his Ph.D. thesis *Control of quantum evolution and Josephson junction circuits* on November 26, 2004. The opponent was Professor Gerd Schön from University of Karlsruhe, Germany and supervisors Professors Jukka Pekola, Martti Salomaa and Heikki Seppä.

TECHNICAL SERVICES

WORKSHOP

S. Kaivola, A. Huvila, J. Kaasinen, and M. Korhonen

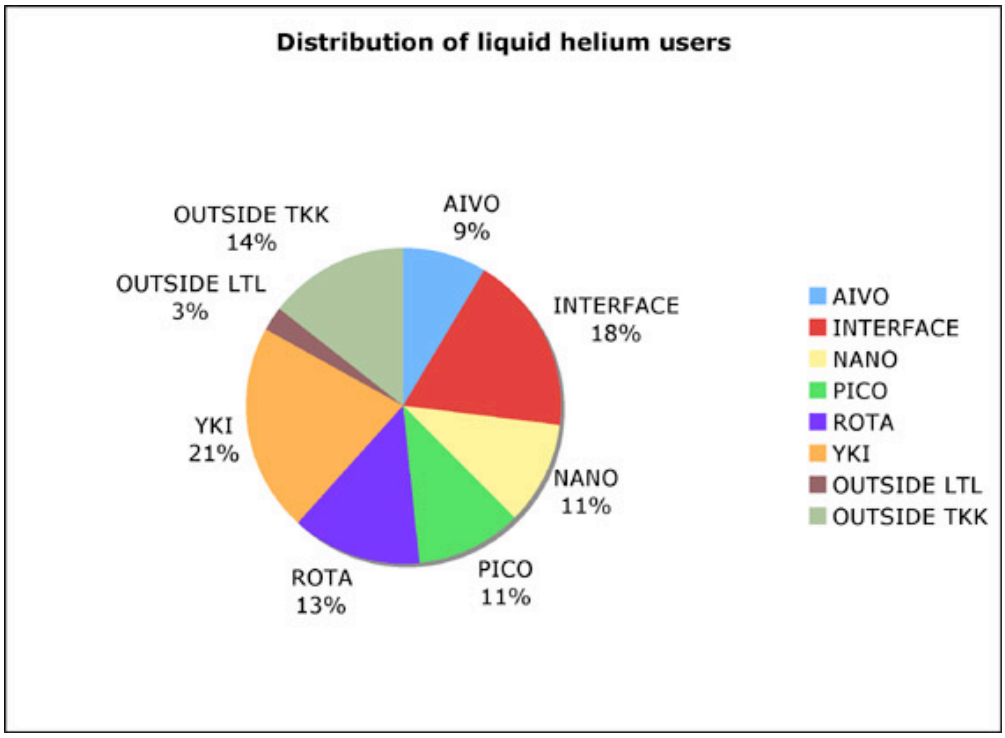


The total number of machine hours was 1 524 h

CRYOGENIC LIQUIDS

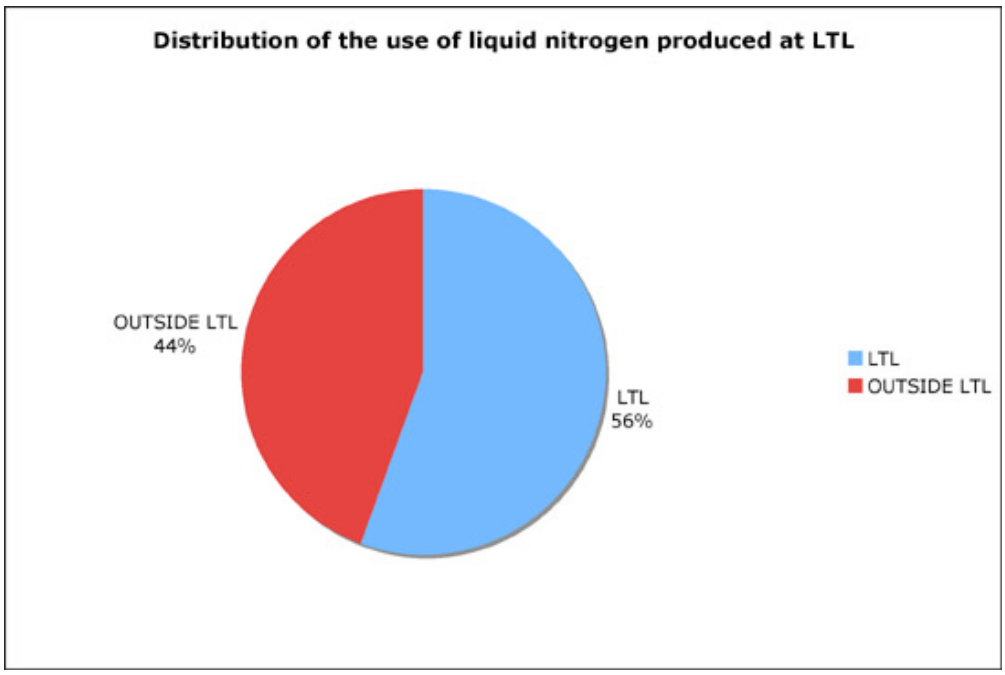
A. Isomäki, A. Huvila

Liquid helium



The total production of liquid helium was 59 000 l.

Liquid nitrogen



The total production of liquid nitrogen was 45 000 l.

ACTIVITIES OF THE PERSONNEL

AWARDS AND HONORS

The 2004 Simon Prize of The Low Temperature Group of the Institute of Physics, London, UK, was given to **Grigory Volovik** for his pioneering research on the effects of symmetry in superfluids and superconductors and the extension of these ideas to quantum field theory, cosmology, quantum gravity and particle physics.

The Prize was awarded at the Simon Memorial Prize Conference in London on September 22, 2004.

Riitta Hari was elected to the National Academy of Sciences of the USA, on April 20, 2004, for her pioneering use of the magnetoenchephalography (MEG), to record the spatiotemporal pattern of brain activity of humans doing realistic cognitive tasks. She is presently the only foreign associate of the Academy working in Finland.

PERSONNEL WORKING ABROAD

Hari, National Rehabilitation Center for Persons with Disabilities, Tokorozawa, Japan, 13.1.- 14.2. 2004.

Heikkilä, University of Basel, Switzerland, 15.8. 2004 – 31.3. 2005.

Jousmäki, National Rehabilitation Center for Persons with Disabilities, Tokorozawa, Japan, 22.8. - 5.9. and 25.10. – 24.11. 2004.

CONFERENCE PARTICIPATION AND LABORATORY VISITS

Alles

Invited talk, Optical studies on the shape of ^{3}He crystals, ULTI III users meeting, Quantum Phenomena at Low Temperatures, Lammi, Finland (7 - 11.1.)

Invited talk, These spectacular helium crystals (in Estonian), The XXXIV Annual Conference of the Estonian Physical Society, Tartu, Estonia (13 - 14.2.)

Anthore

Invited talk, Depairing in mesoscopic superconductors, Grenoble, France (24.2.)

Oral presentation, Tailoring Josephson coupling through superconductivity- induced nonequilibrium, 8th Workshop from Andreev Reflections to International Space Station, Björkliden, Kiruna, Sweden (20 - 28.3.)

Caetano

Poster, Convergence of vibrotactile stimuli to human auditory cortex, FENS 2004, Lisboa, Portugal (10 - 14.7.)

Eltsov

Invited talk, Turbulence in rotating superfluid ^{3}He -B, International Symposium on Quantum Fluids and Solids, Trento, Italy (5 - 9.7.

Invited talk, Vortex formation in neutron-irradiated ^{3}He -B flow, ESF COSLAB Network Conference: Disorder and Topological Defects, a Helium Primer, Chamrousse, France (17 - 22.12.)

Oral presentation, Dynamics of vortex sheets in rotating ^{3}He -A, Superfluids Under Rotation-2004, Trento, Italy (9 - 10.7.)

Finne

Invited talk, Turbulence in rotating superfluid ^{3}He -B, Quantum Phenomena at Low Temperatures, ULTI III users meeting, Lammi, Finland (7 - 11.1.)

Oral presentation, Superfluid turbulence in rotating ^{3}He-B, Fysiikan päivät 2004 (The XXXVIII Annual Conference of the Finnish Physical Society), Oulu, Finland (18. - 20.3.)

Oral presentation, Vortex line formation and dynamics in ^{3}He -B, Superfluids Under Rotation 2004, Trento, Italy (9 - 10.7.)

Poster, Kelvin wave instability of curved vortex lines in rotating ^{3}He -B, QFS 2004, Trento, Italy (3 - 10.7.)

Hakonen

Invited talk, Novel quantum amplifiers based on mesoscopic superconducting Josephson junction, March Meeting of APS, Montreal, Canada (22 - 26.3.)

Invited talk, Mesoscopic Josephson junction as a noise detector, Noise and Information in Nanoelectronics, Sensors, and Standards, Maspalomas, Gran Canaria, Spain (25 - 28.5.)

Invited talk, Influence of disorder on the electrical transport properties of MWNTs, Caramel-Elena Carbon Nanotube Meeting, Helsinki, Finland (30 - 31.8.)

Oral presentation, L-SET and C-SET: the reactively read Cooper pair transistors, SQUBIT-2 Yearly Meeting, Rome, Italy (19.9.)

Oral presentation, The inductive single-electron transistor, 5th Quantum Information Processing and Communication Workshop, Rome, Italy (20 - 22.9.)

Participation, Quantum Phenomena at Low Temperatures, Lammi, Finland (7 - 11.1.)

Hari

Invited plenary talk, Brain basis of social interaction, Tiede ja psykiatrian tulevaisuus, Hanasaari, Espoo, Finland (13.5.)

Invited plenary talk, Reading brains and minds: Advances of modern brain imaging, The Origins and the Present State of our Western Conceptions of the Structure, Functions and Diseases of the Brain, Helsinki, Finland (24.5.)

Invited plenary talk, About brain basis of social cognition Keynote, Psykologia 2004, Turku, Finland (24 - 25.8.)

Invited talk, Reactivity of human brain rhythms, Max-Planck Institute of Brain Research, monthly seminar, Frankfurt, Germany (19.1.)

Invited talk, Reactivity of Human Magnetoencephalographic Brain Rhythms, visiting lecture, Tokorozawa, Japan (6.2.)

Invited talk, Aivokuvantaminen – ikkuna ihmisaivoihin, Suomen Akatemian Tiedeaamiainen, Helsinki, Finland (20.4.)

Invited talk, Sequences of human cortical activation: Insights from MEG, Segerfalk Symposium, Lund, Sweden (8 - 9.5.)

Invited talk, New views of human brain function, 2nd Neuroscience Center Annual Meeting, Helsinki, Finland (2.9.)

Invited talk, Changing views of human brain function, 2nd Neuroscience Center Annual Meeting, Helsinki, Finland (2.9.)

Invited talk, Sosiaaliset aivomme (Our social brain), Lääketieteellisen tdk:n HY Cursus Pelkosen 30-vuotisjuhla, Helsinki, Finland (3.9.)

Invited talk, Temporal dynamics of the human mirror-neuron system, Theory Forum Symposium in the Norwegian Academy of Science and Letters, Foundations of (pre)verbal intersubjectivity in light of new findings, Oslo, Norway (3 - 5.10.)

Invited talk, Aivotutkimusta 3 teslan magneetilla (Brain research with a 3- tesla magnet), Neuroklinikan tiistaitapaaminen, Helsinki, Finland (12.10.)

Invited talk, Magnetoencephalograph (MEG): From basics to clinical applications (altogether 3 lectures), Short Course on Imaging Techniques in Cognitive Neurology, Mexico City, Mexico (8 - 10.11.)

Invited talk, How do we mirror other people's actions, Seminar of the Collaborative Research Centre on Experimental Hepatology, Duesseldorf, Germany (23.11.)

Invited talk, Audiotactile Interaction in Humans, Seminar of Department of Neurology, Aachen, Germany (24.11.)

Lecture, Ihmisaivojen kuvantaminen; Imaging the human brain, Helsingin yliopiston lääketieteellisen tiedekunnan neurobiologian kurssi, Helsinki, Finland (6.9.)

Lecture, Functional brain imaging, Functional neuroanatomy lecture course of University of Helsinki Neuroscience Center, Helsinki, Finland (18.11.)

Participation, Fondation Fyssen, International Prize Ceremony, Paris, France (19.3.)

Participation, 10th Annual Meeting of the Organizations of Human Brain Mapping, Budapest, Hungary (13 - 17.6.)

Heikkilä

Invited talk, Thermopower induced by the supercurrent in superconductor- normal-metal structures, Frontiers of Quantum and Mesoscopic Thermodynamics, Prague, Czech Republic (26 - 29.7.)

Poster, Cyclostationary measurement of low-frequency odd moments, Frontiers of Quantum and Mesoscopic Thermodynamics, Prague, Czech Republic (26 - 29.7.)

Hänninen

Poster, NMR response of solitons in superfluid ^{3}He -A, Quantum Phenomena at Low Temperatures, ULTI III users meeting, Lammi, Finland (7 - 11.1.)

Jousmäki

Oral presentation, AMI-keskuksen ärsykelaitteet, KNF-osaston maanantaipalaveri, Kuopio, Suomi (10.5.)

Junes

Oral presentation, Liquid-solid interface of ^{3}He imaged using a Fabry-Pérot interferometer, Presentation on Master's Thesis, Otaniemi, Finland (13.3.)

Poster, Experimental studies on the roughening transition in ^{3}He, Quantum Phenomena at Low Temperatures, ULTI III users meeting, Lammi, Finland (7 - 11.1.)

Poster, Experimental studies on the roughening transition in ^{3}He, The XXXVIII Annual Conference of the Finnish Physical Society, Oulu, Finland (18 - 20.3.)

Juntunen

Oral presentation, Nuclear ordering in lithium, International Symposium on Quantum Fluids and Solids, Trento, Italy (5 - 9.7.)

Kivioja

Oral presentation, Cooper pair sluice: A flux assisted charge pump, Fysiikan päivät 2004 (The XXXVIII Annual Conference of the Finnish Physical Society), Oulu, Finland (18 - 20.3.)

Oral presentation, Flux assisted Cooper pair pump, CPEM 2004, London, England (26.6. - 2.7.)

Oral presentation, DC-SQUID escape measurements, Escape measurements on DC-SQUIDs with small junctions: Macroscopic Quantum Tunneling, Prague, Czech Republic (26 - 29.7.)

Oral presentation, Meeting in Grenoble, France (14 - 19.11.)

Kopnin

Invited talk, Loss of Andreev backscattering in superconducting quantum point contacts, Landau Days, Moscow - Chernogolovka, Russia (21 - 23.6.)

Invited talk, Vortex instability and the onset of superfluid turbulence, Advanced Research Workshop Fundamentals of Electronic Nanosystems, St. Petersburg, Russia (27.6. - 2.7.)

Invited talk, Vortex instability and the onset of superfluid turbulence, COSLAB, Lammi, Finland (17 - 22.8.)

Kopu

Oral presentation, Kelvin-wave instability in vortex dynamics of rotating superfluid ^{3}He, COSLAB 2004, Ambleside, England (10 - 17.9.)

Poster, Orientational effect of non-rectilinear vortices in ^{3}He -B, Quantum Phenomena at Low Temperatures, ULTI III users meeting, Lammi, Finland (7 - 11.1.)

Krusius

Invited talk, Turbulence in rotating superfluid ^{3}He -B, Condensed Matter and Materials Physics CMMP04, Institute of Physics in UK, University of Warwick, Coventry, UK, (4 - 7.4.)

Invited talk, Turbulence in rotating superfluid ^{3}He -B, 20th General Conference of Condensed Matter Division of European Physical Society, Prague, Czech Republic (19 - 23.7.)

Invited talk, The hydrodynamics of superfluid ^{3}He -B, Todai International Symposium 2004 on Quantum Condensed Systems ISSP-9, Tokyo, Japan (16 - 19.11.)

Kujala

Poster, Constructing cortical networks from MEG data with dynamic imaging of coherent sources, 2nd Annual Symposium of the NorFA Functional Neuroimaging Network (Fun-NET), Turku, Finland (30.8. - 1.9.)

Lindell

Oral presentation, Measuring shot noise with a small Josephson junction, Fysiikan päivät 2004 (The XXXVIII Annual Conference of the Finnish Physical Society), Oulu, Finland (18 - 20.3.)

Poster, The Bloch oscillating transistor, Fysiikan päivät 2004 (The XXXVIII Annual Conference of the Finnish Physical Society), Oulu, Finland (18 - 20.3.)

Malinen

Participation, 11th Kuopio Bio-NMR Workshop, A.I.Virtanen Institute, University of Kuopio, Finland (12 - 14.9.)

Meschke

Participation, kick-off meeting for the new European Project RSFQubit, Rome, University of Rome La Sapienza, Italy, (18.9.)

Participation, Opening Ceremony of the Nanoscience Center Jyväskylä, University of Jyväskylä, Finland (20.10.)

Paalanen

Invited talk, Superconductor-insulator transition in a single Josephson junction, Joint Indian-Finnish Workshop on Physics and Technology below 20 K, Bangalore, India (16 - 19.2.)

Invited talk, New devices in quantum electronics and their applications, Arrays of Quantum Dots and Josephson Junctions, Medena, Croatia (21 - 27.10.)

Invited talk, Superconductor-insulator transition, University of Hamburg, Hamburg, Germany (28.10.)

Lecture, Application of quantum electronics in metrology, NPL, New Delhi, India (23.2.)

Participation, Nanoelectronics in Finland, ESF Eurocores program Fundamentals in Nanoelectronics, Lancaster, UK (20 - 21.5.)

Parviainen

Poster, Cortical dynamics of letter-string perception in beginning readers, Human Brain Mapping, Budapest, Hungary (13 - 17.6.)

Invited talk, Puheen havaitsemisen aivomekanismit normaaliin ja poikkeavaan kielelliseen kehitykseen liittyen (Cortical processing of speech sounds in normal

and abnormal language development), Suomen Erityiskasvatuksen Liitto ry, Opintopäivät, Helsinki, Finland (20 - 21.3.)

Invited talk, MEG studies of language perception in children, The 2nd FunNet Workshop on Time-Sensitive Neuroimaging of Language Function, Turku, Finland (30.8. - 1.9.)

Pekola

Invited talk, Flux-assisted adiabatic single island Cooper-pair pump (Sluice), MQC2004, International Workshop on Macroscopic Quantum Coherence and Computing, Naples, Italy, (7 - 10.6.)

Invited talk, Charge and flux controlled pumping of Cooper pairs, 20th General Conference of the Condensed Matter Division of the European Physical Society, Prague, Czech Republic (19 - 23.7.)

Oral presentation, Solid state microcooling and non-equilibrium at sub- kelvin temperatures, Frontiers of Quantum and Mesoscopic Thermodynamics, Prague, Czech Republic (26 - 29.7.)

Oral presentation, Kick-off meeting of RSFQubit EU project, Rome, University la Sapienza, Italy (18.9.)

Oral presentation, Annual Workshop of the SQUBIT-2 EU project, Rome, University la Sapienza, Italy (19.9.)

Pentti

Poster, New aspects on using fine copper powder as a nuclear refrigerant for helium mixtures, Fysiikan päivät 2004 (The XXXVIII Annual Conference of the Finnish Physical Society), Oulu, Finland (18 - 20.3.)

Raij

Oral presentation, Psychogenic and somatic pain share overlapping cortical network, Organization for Human Brain Mapping Annual Meeting, Budapest, Hungary (13 - 17.6.)

Renvall Hanna

Invited talk, Ajallinen tiedonkäsittely eri aistinjärjestelmissä lukihäiriöisillä aikuisilla, Lecture series "Yli esteiden - tutkimusta, kuntoutusta, harjoittelua", Helsinki, Finland (11.2.)

Invited talk, Ajallinen tiedonkäsittely eri aistinjärjestelmissä lukihäiriöisillä aikuisilla, Logopedian yksikön jatko- ja täydennyskoulutusohjelma, Tampere, Finland (24.3.)

Invited talk, Sensory processing in developmental dyslexia, 14th International Conference on Biomagnetism, Boston, USA (8 - 12.8.)

Lecture, Temporal processing of sensory information in developmental dyslexia: Neuromagnetic and Psychophysical Studies, Helsinki Biograduate School Research Discussions 2003-2004 , Helsinki, Biomedicum, Finland (21.1.)

Invited plenary talk, Neuromagnetic cortical responses to sensory stimuli: Examples and methodological considerations, Speech and Auditory Processing in Developmental Disorders: ERP meeting, Oxford, UK (22 - 24.9)

Renvall Ville

Invited talk, fMRI-phantom, Keskiviikkokerho, Radiologian yksikkö/ Helsingin yliopisto, Helsinki, Finland (6.10.)

Poster, fMRI phantom for an MR imager, Human Brain Mapping 2004, Budapest, Hungary (13 - 17.6.)

Saarela

Participation, 11th Kuopio Bio-NMR Workshop, A.I.Virtanen Institute, University of Kuopio, Finland (12 - 14.9.)

Salmelin

Invited plenary talk, The use of MEG for unravelling pathogenesis as exemplified by dyslexia, 12th Biennial Winter Workshop on Schizophrenia, Davos, Switzerland (7 - 13.2.)

Invited plenary talk, Mitä päässä liikkuu? Aivotoiminnan kuvantaminen kielen ja sen häiriöiden tutkimuksessa (What happens in the head? Functional brain imaging in research of language and its disorders), Studia Generalia Technologica, Espoo, Finland (26.4.)

Invited plenary talk, Time course of speech vs nonspeech perception, Speech and Auditory Processing in Developmental Disorders: Evidence from Brain Event-related Potentials, Oxford, UK (22 - 24.9.)

Invited talk, Aivotutkimus TKK:lla (Brain research at HUT), TKK:n OPO- päivä, Espoo, Finland (9.1.)

Invited talk, Assessing cortical representation of language with MEG, Kuopio Neuroscience Lecture Series, University of Kuopio, Finland (12.1.)

Invited talk, The sequence of cortical activation in speech and nonspeech perception, 22nd European Workshop on Cognitive Neuropsychology, Bressanone, Italy (30.1.)

Invited talk, Mitä aivoissa tapahtuu kun lukeminen ei suju ("What happens in the brain when reading is impaired"), TKK, Lääketieteellisen tekniikan seminaari (HUT, Seminar on Medical Technology), Espoo, Finland (25.3.)

Invited talk, Puheäänten käsittelyn aktivaatioketju ihmisaivoissa (Sequence of cortical activation in speech perception), FiCLA-seminaari "Kielen koko kyky" (FiCLA seminar "Language capacity"), Espoo, Finland (23 - 24.4.

Invited talk, Early cortical processes in fluent and impaired reading, 14th International Conference on Biomagnetism, Boston, USA (8 - 12.8.)

Invited talk, MEG in the study of language function, The 2nd FunNet Workshop on Time-Sensitive Neuroimaging of Language Function, Turku, Finland (30.8. - 1.9.)

Invited talk, Sujuvan lukemisen ja lukihäiriön hermostollinen perusta (Neural basis of fluent and impaired reading), Munkkiniemen Rotary-klubin viikkokokous (Weekly meeting of the Munkkiniemi Rotary Club), Helsinki, Finland (9.9.)

Invited talk, Lexical-semantic impairments in Finnish, Science of Aphasia 5: Cross-linguistic aspects of aphasia, Potsdam, Germany (16 - 21.9.)

Invited talk, Neurophysiology of fluent and impaired reading, Oxford Autumn School in Cognitive Neuroscience, Oxford, UK (27 - 30.9.)

Invited talk, Time-sensitive neuroimaging of language function and dysfunction, F.C. Donders Colloquia, Nijmegen, Netherlands (8.10.)

Invited talk, Cortical dynamics of language function, 10th Anniversary of Functional Imaging Laboratory, London, UK (15.10.)

Invited talk, Lukihäiriö MEG:n valossa (Dyslexia in light of MEG), HYKS Lastenneurologian yksikön jatko- ja täydennyskoulutusohjelma (HUS Child Neurology Unit Advanced Training Programme), Helsinki, Finland (26.10.)

Invited talk, Spatiotemporal mapping of language processing with MEG and fMRI, 4th International fMRI Meeting and Autumn School, Sorrento, Italy (12 - 14.11.)

Participation, The 3rd Peter Wallenberg Symposium, Espoo, Finland (27 - 29.5.)

Poster, Two routes for naming objects, one route for naming actions, 10th Annual Meeting of the Organization for Human Brain Mapping, Budapest, Hungary (13 - 17.6.)

Savin

Invited talk, RSFQ control and read-out circuits in the light of qubit operation, Wilhelm und Else Heraeus-Seminar on Processing of Quantum Information in RSFQ Circuits and Qubits", Bad Honnef, Germany (29.11. - 1.12.)

Oral presentation, Cold electron transistor, 5th Rencontres de Moriond in Mesoscopic Physics, La Thuile, Italy (31.1.)

Oral presentation, Electron cooling and control of Josephson current at sub Kelvin temperatures, NanoRes-2004, Nanoscale Properties of Condensed Matter Probed by Resonance Phenomena, Kazan, Russia (15 - 19.8.)

Participation, kick-off meeting for the new European Project RSFQubit, Rome, Italy (18.9.)

Participation, Nanoscience Seminar, Jyväskylä, Finland (20.10.)

Schürmann

Poster, Activation of posterior auditory belt area by vibrotactile stimuli (Martin Schürmann, Gina Caetano, Yevhen Hlushchuk, Veikko Jousmäki, Riitta Hari), 10th Annual Meeting of the Organization of Human Brain Mapping, Budapest, Hungary (13 - 17.6.)

Sillanpää

Invited talk, The inductive single-electron transistor (L-SET), IV International Workshop on Macroscopic Quantum Coherence and Computing, Naples, Italy (7 - 10.6.)

Oral presentation, The inductive single-electron transistor (L-SET), 5th Rencontres de Moriond in Mesoscopic Physics, La Thuile, Italy (25.1. - 1.2.)

Stenbacka

Poster, Activity of luminance sensitive area in the human parieto-occipital sulcus during voluntary blinks and saccades, Human Brain Mapping 2004, Budapest, Hungary (13 - 17.6.)

Tanzer

Poster, Computation of potential and magnetic field distribution using finite element method (FEM) employing Whitney elements, Biomag 2004, Boston, USA (8 - 12.8.)

Tarkiainen Antti

Participation, 11th Kuopio Bio-NMR Workshop (Advanced Magnetic Resonance Imaging: Beyond Anatomical Information), Kuopio, Finland (12 - 14.9.)

Tarkiainen Reeta

Oral presentation, Tunneling density of states in disordered multiwalled carbon nanotubes, CARAMEL-ELENA carbon nanotube meeting, Helsinki, Finland (30 - 31.8.)

Poster, Transport experiments on disordered carbon nanotubes, Quantum Phenomena at Low Temperatures, ULTI III users meeting, Lammi, Finland, (7 - 11.1.)

Todoshchenko

Poster, Surface of a ^{3}He crystal: crossover from quantum to classical behavior, International Symposium on Quantum Fluids and Solids, Trento, Italy (5 - 9.7.)

Uusvuori

Poster, Semantic and phonological priming in spoken language, Time- sensitive neuroimaging of language function, Turku, Finland (31.8. - 1.9.)

Vanni

Invited talk, Early visual processing in humans, CERCO laboratory seminar, Toulouse, France (24 - 28.3.)

Invited talk, Cortical dynamics in the human parieto-occipital area, Forum of European Neuroscience, Lisbon, Portugal (10 - 14.7.)

Invited talk, FMRI constrained EEG/MEG source analysis applied to studies of visual cortex, 11th Bio-NMR Workshop, Kuopio, Finland (12.9.)

Lecture, Visual cortical operations, Seminar of Neurosurgery Department, Helsinki, Finland (13.1.)

Lecture, The brain watching the environment, ARMI-days 2004, Helsinki, Finland (25 - 26.11.)

Poster (with Henriksson and James), Multifocal functional magnetic resonance imaging of human visual cortex, Human Brain Mapping 2004, Budapest, Hungary (13 - 17.6.)

Poster, Visual field restitution in hemianopia, neuromagnetic evidence, Human Brain Mapping 2004, Budapest, Hungary (13 - 17.6.)

Viljas

Invited talk, Spin-wave radiation from a ^{3}He Josephson junction, Quantum Phenomena at Low Temperatures, ULTI III users meeting, Lammi, Finland (7.1 - 11.1.)

Invited talk, Dissipative currents in superfluid ^{3}He weak links, Delft, Kavli Institute of NanoScience, Delft University of Technology, Netherlands (8.5.)

Virtanen

Poster, Thermopower induced by a supercurrent in mesoscopic superconductor-normal-metal structures, Fysiikan päivät 2004 (The XXXVIII Annual Conference of the Finnish Physical Society), Oulu, Finland (18 - 20.3.)

Volovik

Invited talk, Momentum-space topology and emergent relativity, Joint Indian-Finland Workshop on Physics below 20K, Bangalore, India (16 - 18.2.)

Invited talk, Classical and quantum regimes of superfluid turbulence, Quantum Phenomena at Low Temperatures, ULTI III users meeting, Lammi, Finland (7 - 11.1.)

Invited talk, Emergent relativistic quantum field theory and gravity, University of Karlsruhe, Karlsruhe, Germany (22.1.)

Invited talk, Superfluid turbulence in Helsinki experiments on ^{3}He, University of Karlsruhe, Karlsruhe, Germany (23.1.)

Invited talk, Momentum-space topology and emergent relativity, Colloquium Ehrenfestii , Leiden, Holland (24.3.)

Invited talk, Recent ^{3}He experiments in Helsinki: vacuum instability in the ergoregion and new phenomenon in superfluid turbulence, Leiden University, Leiden, Holland (25.4.)

Invited talk, Recent ^{3}He experiments in Helsinki: vacuum instability in the ergoregion and new phenomenon in superfluid turbulence, Scuola Normale Superiore, Pisa, Italy (29.4.)

Invited talk, Momentum-space topology in condensed matter: how the effective gravity and relativistic quantum fields emerge in quantum liquids, Scuola Normale Superiore, Pisa, Italy (30.4.)

Invited talk, Vacuum energy and cosmological constant in the effective Quantum Field Theory, Helsinki Institute of Physics, Helsinki, Finland (11.5.)

Invited talk, Superfluid turbulence in Helsinki experiments on ^{3}He, 6-th Conference "Landau Days", Chernogolovka, Russia (21 - 23.6.)

Invited talk, Horizon and ergoregion on the brane between two quantum vacua: A condensed-matter primer, COSLAB 2004 workshop, Ambleside, UK (10 - 17.9)

Invited talk, Conference summary talk, COSLAB 2004 workshop, Ambleside, UK (10 - 17.9)

Invited talk, Emergent physics: a condensed matter primer, Simon Memorial Prize Conference, London, UK (22.9.)

Invited lecture, The Universe in a helium droplet, University of Alberta, Edmonton, Canada (29.9.)

Invited talk, Emergent physics: a condensed matter primer, seminar at TRIUMF, Vancouver, Canada (4.10.)

Invited talk, Vacuum energy: a condensed matter primer, University of Alberta, Edmonton, Canada (6.10.)

Invited talk, Horizon and ergoregion on the brane between two quantum vacua: a condensed matter primer, University of Alberta, Edmonton, Canada (8.10.)

Invited talk, Emergent physics: a condensed matter primer, Perimeter Institute, Waterloo, Canada (13.10.)

Invited talk, Emergent physics: a condensed matter primer, Mc-Master University, Hamilton, Canada (14.10.)

Invited talk, Vacuum energy: a condensed matter primer, Perimeter Institute, Waterloo, Canada (15.10.)

Invited talk, Vacuum energy and cosmological constant: a condensed-matter primer, COSLAB Workshop Disorder and Topological Defects, a Helium Primer, Chamrousse-Grenoble, France (17 - 22.12.)

Lecture, The Universe in superfluid helium droplet, National Physical Laboratory, New Delhi, India (23.2.)

Lecture, Emergent physics: a condensed matter primer, Manchester University, Manchester, UK (20.9.)

Participation, 7 Editorial Board meetings of JETP Letters, Moscow, Russia (4.3., 8.4., 13.5., 2.9., 28.10., 2.12., 29.12.)

EXPERTISE AND REFEREE ASSIGNMENTS

Berglund

Reviewer of a research grant application, National Science Foundation, USA

Member, Tekniska Föreningen i Finland, Helsinki, Finland

Member, Finnish Academy of Technology

Member, Swedish Academy of Engineering Sciences (Finland)

Caetano

Referee, Experimental Brain Research, Springer-Verlag Heidelberg

Eltsov

Chairman of the session Rotating Superfluid ^{4}He, Superfluids Under Rotation - 2004, 9-10.07., Trento, Italy

Member of the organising committee for COSLAB Workshop on Turbulence and Vacuum Instability in Condensed Matter and Cosmology,17 - 22.8., Lammi, Finland

Member of the organising committee, ULTI III users meeting, 7 - 11.1., Lammi, Finland

Referee, Journal of Low Temperature Physics, Kluwer Academic / Plenum Publishers, The Netherlands

Reviewer of a grant application, National Science Foundation, USA

Forss

Reviewer of a grant application, Swedish Brain Power, Stockhom, Sweden

Hakonen

Chairman of the session Low Temperature Techniques, Quantum Phenomena at Low Temperatures, ULTI III users meeting, 7 - 11.1., Lammi, Finland

Chairman of the session Noise in mesoscopic systems, Quantum Phenomena at Low Temperatures, ULTI III users meeting, 7 - 11.1., Lammi, Finland

Member of the organizing committee, Quantum Phenomena at Low Temperatures (ULTI III users meeting), Lammi, Finland, 7 - 11.1.

Member of the organizing committee, Annual Meeting of the Finnish Physical Society 2005, Espoo, Finland

Referee, Applied Physics Letters, American Institute of Physics, USA

Referee, Phys. Rev. Lett., American Physical Society, USA

Referee, Surface Science, Elsevier

Hari

Chairman of the session Affective control of sensory information, 3rd Peter Wallenberg Symposium: Sensing and Feeling in Hanasaari, Espoo, Finland

Editorial board member, NeuroImage, Academic Press/ Elsevier

Editorial board member, Neuroscience Research, Elsevier

Member, National Academy of Sciences USA, 20.04.

Interview, Akatemiaprofessorin henkilöhaastattelu, Suomen Akatemia, magazine, Helsinki, 31.12.

Interview, Functional magnetic resonance imaging, Helsingin Sanomat, newspaper, Helsinki, 30.11.

Interview, Human brain as the target of research, Johtoporras, magazine, Helsinki, 31.12.

Radio interview, MEG research at BRU, Elekta, Magazine, Stockholm, 31.12.

Radio interview in Ylen aikainen; aivotutkimuksesta, Helsinki, 20.05.

Interview in Maakuntaradio, 28.5.

Member, editorial board of Brain Topography, Kluwer Academic Publishers, Nordrecht, The Netherlands

Member, editorial board of Clinical Neurophysiology, Elsevier

Member, editorial board of InScight (web journal), Academic Press/Elsevier

Member of the organising committee, The 3rd Peter Wallenberg Symposium: Sensing and Feeling, Hanasaari, Espoo

Consultation on Imaging Infrastructure, Faculty of Health Sciences, 30.8., University of Copenhagen, Denmark

Pre-examiner of the thesis of Maija Pihlajamäki, Kuopio University, Department of Neuroscience and Neurology, Kuopio, Finland

Pre-examiner of the thesis of Maija Purhonen, University of Kuopio, Department of Psychiatry, Kuopio, Finland

Referee, Cerebral Cortex, Oxford University Press, United Kingdom

Referee, European Journal of Neuroscience, Blackwell Publishing

Referee, Hearing Research

Referee, Journal of Neuroscience, USA

Referee, Journal of the Acoustical Society of America, USA

Referee, Neuroimage, Academic Press/ Elsevier

Referee, Neurology, American Academy of Neurology, Lippincott Williams & Wilkins, USA

Referee, Neuroreport

Referee, Neuroscience

Referee, Neuroscience Letters

Referee, Proc Royal Society B, Royal Society, UK

Referee, Suomen Lääkärilehti, Finland

Referee, Trends in Cognitive Science

Statement for the appointment of the director, Brain Repair Imaging Centre, Cardiff University, School of Psychology, Cardiff, Wales, UK

Statement for the appointment of a full professor in Otolaryngology, University of California, San Francisco, USA

Statement for the appointment of a professor in Psychology, The Hebrew University of Jerusalem, Jerusalem, Israel

Statement for the appointment of a professor in Psychology, The University of Nottingham, School of Psychology, Nottinham, United Kingdom

Coordinator of Functional Brain Mapping, Finland-Taiwan Scientific Cooperation, in the Academy of Finland, Bilateral exchange programme

Member of the Scientific Advisory Board, National PET Center (Positron Emission Tomography), Turku, Finland

Heikkilä

Chairman of the session Nonequilibrium Phenomena, Quantum Phenomena at Low Temperatures, ULTI III users meeting, 7.1. - 11.1., Lammi, Finland

Chairman of the session Superconductivity, Quantum Phenomena at Low Temperatures, ULTI III users meeting, 7.1. - 11.1., Lammi, Finland

Referee, Physical Review B, American Physical Society, USA

Referee, Physical Review Letters, American Physical Society, USA

Helenius

Referee, Experimental Brain Research, Springer Verlag, Würzburg, Germany

Referee, Neuroimage, Academic Press/ Elsevier

Hlushchuk

Postgraduate studies, fMRI Data Analysis, Brain Voyager QX, University of Maastricht, Department of Neurocognitive Sciences and Brain Innovation Group Ltd., Maastricht, Netherlands, 18. - 27.02.

Jousmäki

Pre-examiner of the thesis of Mika Tarvainen, Estimation Methods for Nonstationary Biosignals, Department of Applied Physics, University of Kuopio, Kuopio, Finland

Referee, Psychophysiology, Blackwell Publishing, Oxford, England

Juntunen

Referee, Journal of Low Temperature Physics, Kluwer Academic / Plenum Publishers

Kopnin

Chairman of a session, COSLAB workshop, 17. - 22.8., Lammi, Finland

Opponent for Ostrovskii P.M., Landau Institute for Theoretical Physics, RAS, Moscow, Russia, 25.6.

Chairman of the session Quantum Phenomena, Quantum Phenomena at Low Temperatures, ULTI III users meeting, 7.1. - 11.1., Lammi, Finland

Chairman of the session Vortices in Superfluids, Quantum Phenomena at Low Temperatures, ULTI III users meeting, 7.1. - 11.1., Lammi, Finland

Referee, Physical Review, Physical Review Letters, APS, USA

Referee, JETP and JETP Letters, Russia

Referee, Physica B and C, Elsevier, The Netherlands

Krusius

Chairman of the session Hydrodynamic Turbulence, the European Science Foundation Research Porgramme COSLAB - Workshop on Turbulence , 17 - 22.8., Lammi, Finland

Chairman of the session Quantum Defects in Condensed Matter, Quantum Phenomena at Low Temperatures, ULTI III users meeting, 7 - 11.1., Lammi, Finland

Chairman of the session Quantum Turbulence, Quantum Phenomena at Low Temperatures, ULTI III users meeting, 7 - 11.1., Lammi, Finland

Member of the editorial board, Physica B: Condensed Matter, Elsevier, The Netherlands

Secretary of the Section on Physics and Astronomy, the Finnish Academy of Sciences and Letters, Helsinki, Finland

Member of the board of the Low Temperature Section, Condensed Matter Division of the European Physical Society, Mulhouse, France

Member of advisory committee, the International Symposium on Quantum Fluids and Solids, 5-9.7., Trento, Italy

Adjunct member of the selection committee, the International Fritz London Award in Low Temperature Physics

Member of the steering committee, the European Science Foundation Programme, Cosmology in the Laboratory COSLAB

Lindell

Best poster award, Suomen Fyysikkoseura, Fysiikan päivät 2004, Oulu, Finland, 20.3.

Award, Venture Cup stage II, Venture Cup, Helsinki, Finland, 16.3.

Paalanen

Coordinator of ULTI III, EU funded Large Scale Facility, 1.4.2000 - 31.3.2004

Chairman of the organising committee, Indian-Finnish Joint Meetring on Physics and Technology below 20 K, Bangalore, India 16. - 18.2.

Coordinator of ULTI, EU funded Large Scale Facility 1.4.2004 - 31.3.2008

Chairman of the selection committee, Olli V. Lounasmaa Prize , Espoo, Finland

Member of the scientific advisory council, ESF Eurocores program Fundamentals of Nanoelectronics, Lancaster, UK

Member of the steering committee, European Science Foundation Programme Arrays of Quantum Dots and Josephson Junctions, Strasbourg, France

Member of the scientific program committee, The 24th International Conference on Low Temperature Physics, Orlando, Florida, USA

Member of the selection committee, Fritz London Memorial Prize, Duke University, USA

Reviewer of a grant application, National Science Foundation, Washington DC, USA

Reviewer of a grant application, United States Israel Binational Science Foundation, Jerusalem, Israel

Reviewer of a grant application, Swedish Research Council, Stockholm, Sweden

Reviewer of a grant application, Engineering and Physical Sciences Research Council, Swindon, UK

Reviewer of a grant application, NEST in FP6 of the European Commission, Brussels, Belgium

Referee for Achievement in Asia Award, Overseas Chinese Physics Association, Urbana, Ill. USA

Secretary, Comission C5, Low Temperature Physics, International Union of Pure and Applied Physics (IUPAP), APS, College Park, Maryland. WWW link: http://www.iupap.org/

Member of the board, High Speed Electronics Photonics, Nanoscience, and Quantum Devices, research consortium, Chalmers University of Technology, Gothenburg, Sweden

Chairman of the symposium Quantum Phenomena at Low Temperatures, Lammi, Finland 7 - 11.1.

Member of the Board, Uudenmaan Rahasto, Finnish Cultural Foundation, Järvenpää, Finland

Member of the steering board, Advanced Magnetic Imaging Center(AMI), HUT, Espoo, Finland

Member of the steering board, CARAMEL, a nanotube research consortium, Chalmers University of Technology, Gothenburg, Sweden

Member of the steering committee of ESF-sponsored PiShift Network, University of Twente, Twente, The Netherlands

Guest editor of JLTP vol. 135, Olli V Lounasmaa memorial issue, Low Temperature Physics and Techniques

Guest editor of JLTP vol. 136, Proceedings of the Workshop on Quantum Phenomena at Low Temperatures, Lammi Finland 7 - 10.1.

Referee, Physical Review B, American Physical Society, USA

Referee, Physical Review Letters, American Physical Society, USA

Fellow, American Physical Society

Member, Academia Europaea

Member, Finnish Academy of Sciences and Letters

Member, Finnish Academy of Technical Sciences

Member, Finnish Physical Society

Member, European Physical Society

Statement for the appointment of a professor in Åbo Akademi, Turku, Finland

Statement for the appointment of a professor in University of Turku, Turku, Finland

Statement for the appointment of a professor in Chalmers University of Technology, Gothenburg, Sweden

Statement for the appointment of a professor in University of Jyväskylä, Finland

Statement for the appointment of a professor in Lappeenranta University of Technology, Lappeenranta, Finland

Pekola

Chairman of the session: New materials and nanotechnology, Fysiikan päivät, Oulu, Finland, 18.3.04 - 20.03.04

Chairman of the sessions QubitsI & QubitsII, Quantum Phenomena at Low Temperatures, ULTI III users meeting, 7 - 11.1., Lammi, Finland

Member of the steering committee, Nanodev Strategic Research Center, Chalmers University of Technology, Göteborg, Sweden

Statement for the appointment of an associate professor in experimental condensed matter physics, Stockholm University, Department of Physics, Stockholm, Sweden

Visit to Pisa, Scuola Normale Superiore, Italy, 16 - 17.9.

Renvall Hanna

Referee, Brain, Oxford University Press, Oxford, UK

Referee, Psychological Research, Springer-Verlag, Heidelberg, Germany

Referee, Trends in Cognitive Sciences

Salmelin

Chairman, The 2nd FunNet Workshop Time-sensitive Neuroimaging of Language Function, 30.8. - 1.9., Turku, Finland

Chairman of the session Aphasia in sign language, Science of Aphasia 5, 16 - 21.9., Potsdam, Germany

Chairman of the session Early stages in language processing, 14th International Conference on Biomagnetism, 8 - 12.8., Boston, USA

Editor, Human Brain Mapping, Wiley, Hoboken, NJ, USA

Editorial board member, NeuroImage, Academic Press/ Elsevier

Interview: Aivojen aktivaatioketjut selittävät kielen häiriöitä, Mediuutiset (newspaper), Helsinki, Finland, 27.2.

Interview: Aivotutkijan työssä on leikin ilo, Helsingin Sanomat (newspaper), Helsinki, Finland

Interview: Viimeinen tutkimaton erämaa, Kauppalehti Optio (magazine), Helsinki, Finland, 22.1.

Interview: The YLE Teema -channel of the Finnish Broadcasting Corporation recorded 25.3. five performances from the seminar series Users view in medical technology ("Käyttäjien näkökulmia lääketieteelliseen tekniikaan") belonging to the study program of HUT Laboratory of Medical Technology , YLE Teema TV, Otaniemi, Finland, 3.5.

Member of the organising committee of Science of Aphasia 5, 16 - 21.9., Potsdam, Germany

Reviewer, Joint MRC/Wellcome Trust grant: Cambridge Behavioural and Clinical Neuroscience Centre, London, UK

Secretary of the organising committee, 16th Annual Conference of the Academia Europae, Helsinki, Finland

Reviewer, Medical Research Council (MRC), UK

Reviewer, The Wellcome Trust, UK

Referee, Cerebral Cortex

Referee, Journal of Neuroscience

Referee, Journal of Cognitive Neuroscience

Referee, Neurocomputing

Referee, Neuroimage

Statement for the appointment to docentship in Helsinki University of Technology, Espoo, Finland

Shürmann

Referee, Journal of Psychophysiology

Referee, Proceedings of the National Academy of Science, USA

Tuoriniemi

Chairman of a poster session, Quantum Phenomena at Low Temperatures, ULTI III users meeting, 7 - 11.1.

Interview Avannosta kylmän äärille, ET, Sanoma Magazines Finland, 1.11.

Member of the editorial board, Cryogenics, Elsevier

Member of the organising committee, ULTI III users meeting, Quantum Phenomena at Low Temperatures 7 - 11.1., Lammi, Finland

Referee, Journal of Low Temperature Physics, Kluwer Academic/Plenum Publishers, Dordrecht, The Netherlands

Referee, The European Physical Journal B, EDP Sciences, Les Ulis Cedex A, France

Vanni

Interview: Colourful world (Aistiradiaattori: värikäs maailma), Finnish Broadcasting Company (YLE), 18.8.

Interview: Tutkittu juttu: Näkemisen salat, YLE Channel 1, TV, Otaniemi, Finland, 25.3.

Referee, Clinical Neurophysiology

Referee, Radiation Protection Dosimetry

Research visit to CNRS, CERCO laboratory, Toulouse, France, 24 - 27.3.

Volovik

Chairman of the organising committee, COSLAB workshop on Turbulence and Vacuum Instability in Condensed Matter and Cosmology, 17 - 22.8., Lammi, Finland

Chairman of the session Aerogel, COSLAB workshop Disorder and Topological Defects, a Helium Primer, 17 - 22.12., Chamrousse, Grenoble, France

Chairman of a session, 6-th Landau Days, Chernogolovka, Russia, 21 - 23.6.

Chairman of the editorial board meeting of journal JETP Letters, 1.7. Moscow, Russia

Member of the organising committee, COSLAB workshop Disorder and Topological Defects, a Helium Primer, 17 - 22.12., Chamrousse, Grenoble, France

Member of the organising committee, COSLAB Conference 2004, 10 - 17.9., Ambleside, UK

Recipient of the Simon Memorial Prize, London, UK

Co-chairman of the European Science Foundation Programme COSLAB, France

PUBLICATIONS

BRAIN PUBLICATIONS

1) Cornelissen, K, Laine, M., Renvall, K., Saarinen, T., Martin, N., and Salmelin, R., Learning new names for new objects: Cortical effects as measured by magnetoencephalography, Brain and Language, 89, pp. 617-622, (2004)

2) Hari, R. and Nishitani, N,, From viewing of movements to understanding and imitation of other persons' acts: MEG studies of the human mirror-neuron system, Functional Neuroimaging of Visual Cognition Attention and Performance XX, pp. 463-479, (2004)

3) Hari, R., Magnetoencephalography in clinical neurophysiological assessment of human cortical functions, Electroencephalography: Basic Principles, Clinical Applications and related Fields, pp. 1165-1197, (2004)

4) Hlushchuk, Y., Forss, N., and Hari, R., Distal-to-proximal representation of volar index finger in human area 3b, NeuroImage, 21, pp. 696-700, (2004)

5) Järveläinen, J., Schürmann, M., and Hari, R., Activation of the human primary motor cortex during observation of tool use, NeuroImage, 23, pp. 187-192, (2004)

6) Jääskeläinen, I.P., Ojanen, V., Ahveninen, J., Auranen, T., Levänen, S., Möttönen, R., Tarnanen, I., and Sams, M., Adaptation of neuromagnetic NI rsponses to phonetic stimuli by visual speech in humans, NeuroReport, 15, 18, pp. 2741-2744, (2004)

7) Möttönen, R., Schürmann, M., and Sams, M., Time course of multisensory interactions during audiovisual speech perception in humans: A magnetoencephalographic study, Neuroscience Letters, 363, pp. 112-115, (2004)

8) Nishitani, N., Avikainen, S., and Hari, R., Abnormal imitation-related cortical activation sequences in Asperger's syndrome, Annals of Neurology, 55 , pp. 558-562, (2004)

9) Numminen, J., Schürmann, M., Hiltunen, J., Joensuu, R., Jousmäki, V., Koskinen, S.K., Salmelin, R., and Hari, R., Cortical activation during a spatiotemporal tactile comparison task, NeuroImage, 22, pp. 815-821, (2004)

10) Paetau, R., Saraneva, J., Salonen, O., Valanne, L., Ignatius, J., and Salenius, S., Electromagnetic function of polymicrogyric cortex in congenital bilateral perisylvanian syndrome, Journal of Neurology, Neurosurgery, and Psychiatry, 75, pp. 717-722, (2004)

11) Raij, T. and Jousmäki, V., MEG studies of gross-modal integration and plasticity, in the The Handbook of Multisensory Processes, Eds Calvert GA, Spence C & Stein BE, MIT Press, Cambridge, Massachusetts, USA, 2004, pp 515–528., (2004)

12) Raij, T., Forss, N., Stancák, A., and Hari, R., Modulation of motor-cortex oscillatory activity by painful Adelta- and C-fiber stimuli, NeuroImage, 23, pp. 569-573, (2004)

13) Salmelin, R. and Helenius, P., Functional neuroanatomy of impaired reading in dyslexia, Scientific studies of reading, 8, 3, pp. 257-272, (2004)

14) Schürmann, M., Caetano, G., Jousmäki, V., and Hari, R., Hands help hearing: Facilitatory audiotactile interaction at low sound-intensity levels, J. Acoust. Soc. Am., 115, 2, pp. 830-832, (2004)

15) Simões, C., Salenius, S., and Curio, G., Short-term (^600 ms) prediction of perturbation dynamics for 10- and 20-Hz MEG rhythms in human primary sensorimotor hand cortices, NeuroImage, 22, pp. 387-393, (2004)

16) Stemmer, B., Vihla, M., and Salmelin, R., Activation of the human sensorimotor cortex during error-related processing: a magnetoencephalography study, Neuroscience Letters, 362, pp. 44-47, (2004)

17) Vanni, S., Näkökyky, näköseula ja liikennenäkö, Tieteellis-ammatillinen aikakausilehti Liikenne, NR04, pp. 13-14, (2004)

18) Vanni, S., Näkötiedon käsittely aivokuoressa, Duodecim 2004, 120, pp. 2655-62, (2004)

LOW TEMPERATURE PHYSICS PUBLICATIONS

CERN

1) Doshita, N., Ball. J., Baum, G., Berglund, P., Gautheron, F., Goertz, St., Gustafsson, K., Hasegawa, T., Horikawa, N., Ishimoto, S., Iwata, T., Kisselev, Y., Koivuniemi, J., Kondo, K., Matsuda, T., Meyer, W., Reicherz, G. and Takabayashi, N., Performance of the COMPASS polarized target dilution refrigerator, Nuclear Instruments and Methods in Physics Research A, 526, pp. 138-143, (2004)

2) Gautheron, F., Ball, J., Baum, G., Berglund, P., Doshita, N., Goertz, St., Gustafsson, K., Horikawa, N., Kisselev, Y., Koivuniemi, J., Kondo, K., Meyer, W., and Reicherz, G., Cryogenic control system of the large COMPASS polarized target, Nuclear Instruments and Methods in Physics Research A, 526, pp. 147-152, (2004)

3) Kisselev, Y., Ball. J., Baum, G., Berglund, P., Doshita, N., Gautheron, F., Goertz, St., Horikawa, Koivuniemi, J., Kondo, K., Magnon, A., Meyer, W., and Reicherz, G., Local field in LiD polarized target material, Nuclear Instruments and Methods in Physics Research A, 526, pp. 105-109, (2004)

4) Koivuniemi, J., Ball. J., Baum, G., Berglund, P., Doshita, N., Gautheron, F., Goertz, St., Horikawa, N., Kisselev, Y., Kondo, K., Meyer, W., and Reicherz, G., NMR line shapes in highly polarized large 6LiD target at 2.5 T, Nuclear Instruments and Methods in Physics Research A, 526, pp. 100-104, (2004)

5) Kondo, K., Ball, J., Baum, G., Berglund, P., Doshita, N., Gautheron, F., Goertz, St., Hasegawa, T., Horikawa, N., Ishimoto, S., Iwata, T., Kisselev, Y., Koivuniemi, J., LeGoff, J.M., Magnon, A., Matsuda, T., Meyer, W., and Reicherz, G., Polarization measurement in the COMPASS polarized target, Nuclear Instruments and Methods in Physics Research A, 526, pp. 70-75, (2004)

6) Neliba, S., Baum, G., Berglund, P., Doshita, N., Finger, M., Gautheron, F., Goertz, St., Kisselev, Y., Koivuniemi, J., Kondo, K., Meyer, W., and Reicherz, G., Weight and volume measurement of the large COMPASS target, Nuclear Instruments and Methods in Physics Research A, 526, pp. 144-146, (2004)

INTERFACE

1) Alles, H. and Parshin, A.Ya., Optical imaging of helium interfaces, Journal of Low Temperature Physics, 135, 5/6, pp. 665-694, (2004)

2) Alles, Harry, Maailmaruumi külmim koht asub meie külje all, Horisont, 1/2004, pp. 10-13, (2004)

3) Todoshchenko, I.A., Alles, H., Junes, H.J., Parshin, A.Ya., and Tsepelin, V., Surface of a ^{3}He crystal: Crossover from quantum to classical behavior, Physical Review Letters, 93, 17, pp. 175301/1-4, (2004)

NANO

1) Sonin, E.B., Effect of the shot-noise on a Coulomb blockaded single Josephson junction, Physical Review B 70, pp. 140506, (2004)

2) Lindell, R.K., Delahaye, J., Sillanpää, M.A., Heikkilä, T.T., Sonin, E.B., and Hakonen, P., Observation of shot-noise-induced asymmetry in the Coulomb blockaded Josephson junction, Physical Review Letters, 93, 19, pp. 197002/1-4, (2004)

3) Roschier, L., Heikkilä, T., and Hakonen, P., Cyclostationary shot noise in mesoscopic measurements, Journal of Applied Physics, 96, 10, pp. 5927, (2004)

4) Roschier, L., Sillanpää, M., Taihong, W., Ahlskog, M., Iijima, S., and Hakonen, P., Carbon nanotube radio-frequency single-electron transistor, Journal of Low Temperature Physics, 136, 5/6, pp. 465-480, (2004)

5) Sillanpää, M., Roschier, L., and Hakonen, P., Inductive single-electron transistor, Physical Review Letters, 93, 6, pp. 066805/1-4, (2004)

6) Hassel. J., Seppä, H., Delahaye, J., and Hakonen, P., Control of Coulomb blockade in a mesoscopic Josephson junction using single electron tunneling, Journal of Applied Physics, 95, 12, pp. 8059-8062, (2004)

7) Lindell. R., Delahaye, J., Sillanpää, M., Paalanen, M., Sonin, E., and Hakonen, P., Mesoscopic Josephson junction as a noise detector, Proc. of SPIE - The Int. Society for Optical Engineering, 5472, pp. 19-27, (2004)

8) Hakonen, P., Kiviranta, M., and Seppä, H., Superconducting electronics at mK temperatures, Journal of Low Temperature Physics, 135, 5/6, pp. 823-838, (2004)

9) Lounasmaa, O.V. and Seppä, H., SQUIDs in neuro- and cardiomagnetism, Journal of Low Temperature Physics, 135, 5/6, pp. 295-335, (2004)

10) Roschier, L., Carbon nanotube single-electron devicesat audio and radio frequencies,Low Temperature Laboratory thesis, pp. 140, (2004)

11) Roschier, L. and Hakonen, P., Design of cryogenic 700 MHz HEMT amplifier, Low Temperature Laboratory Publications, TKK-KYL-010, pp. 1-8, (2004)

12) Roschier, L., Hakonen, P., Bladh, K., Delsing, P., Lehnert, K.W., Spietz, L. and Schoelkopf, R.J., Noise performance of the radio-frequency single-electron transistor, Journal of Applied Physics, 95, 3, pp. 1274-1286, (2004)

13) Roschier, L. and Hakonen, P., Design of cryogenic 700 MHz amplifier, Cryogenics 44, pp. 783-788, (2004)

14) Tarkiainen, R., Ahlskog. M., Zyuzin, A., Hakonen, P., and Paalanen, M., Transport in strongly disordered multiwalled carbon nanotubes, Physical Review B , 69 , pp. 033402/1-4., (2004)

15) Hakonen, P., Kauppinen, E., and Nordlund, K., Atomitason elektroniikkaa, Prosessori, ES Marraskuu , pp. 32-34, (2004)

16) Ahlskog, M., Laurent, C., Baxendale, M., and Huhtala, M., Electronic properties and Applications of carbon nanotubes, Encyclopedia of nanoscience and Nanotechnology, pp. 139-161, (2004)

17) Delahaye, J., Hassel, J., Lindell, R., Sillanpää, M,. Paalanen, M., Seppä. M,. and Hakonen, P., Bloch Oscillating Transistor and Coulomb blockade of Cooper pairs, pp. 183-186, (2004)

18) Sillanpää, M., Roschier, L., and Hakonen, P., Dynamics of the Inductive Single-Electron Tarnsistor, pp. 187-190, (2004)

PICO

1) Meschke, M., Pekola, J.P., Gay, F., Rapp, R.E., and Godfrin, H., Electron thermalization in metallic islands probed by Coulomb blockade thermometry, Journal of Low Temperature Physics, 134, 5/6, pp. 1119-1143, (2004)

2) Savin, A., Pekola, J., Prunnila, M., Ahopelto, J., and Kivinen, P., Electronic cooling and hot electron cooling effects in heavily doped silicon-on-insulator film, Physica Scripta, T114, pp. 57-60, (2004)

3) Kuzmin, L., Agulo, I., Fominsky, M. Savin, A., and Tarasov, M., Optimization of the electron cooling by SIN tunnel Junctions, Superconductor Science and Technology, 17, 5, pp. S400-S405, (2004)

4) Kivinen, P., Prunnila, M., Savin, A.M., Törmä, P., Pekola, J., and Ahopelto, A., Electron-phonon heat transport in degenerate Si at low temperatures, Physica Status Solidi (phys.stat.sol.)(c) 1, 11, pp. 2848-2851, (2004)

5) Kraak. W., Savin, A.M., Minina, N.Ya., Ilievskiy, and Poljanskiy, A.V., Modification of the energy spectrum und magnetic breakdown in a system of 2D holes at the GaAs/A10.5Ga0.5As heterojunction upon uniaxial compression, JETP Letters, 80, 5, pp. 351-354 (Pis´ma v ZhETF , 80 , 5 , pp. 398-402), (2004)

6) Taskinen, L.J., Kivioja, J.M., Karvonen, J.T., and Maasilta, I.J., Direct measurement of the electron-phonon relaxation rate in thin copper films, Physica Status Solidi (phys.stat.sol.)(c), 1, 11, pp. 2856-2859, (2004)

7) Pekola, J.P., Josephson junction as a detector of Poissonian charge injection, Physical Review Letters, 93, 20 pp. 206601/1-4, (2004)

8) Giazotto, F., Heikkilä, T.T., Taddei, F., Fazio, R., Pekola, J.P., and Beltram, F., Mesoscopic supercurrent transistor controlled by nonequilibrium cooling, Journal of Low Temperature Physics, 136, 5/6, pp. 435-452, (2004)

9) Toppari, J.J., Kivioja, J.M., Pekola, J.P., and Savolainen, M.T., Turnstile behavior of the Cooper pair pump, Journal of Low Temperature Physics, 136, 1/2, pp. 57-91, (2004)

10) Pekola, J., Trends in thermometry, Journal of Low Temperature Physics, 135, 5/6, pp. 723-744, (2004)

11) Savin, A.M., Pekola, J.P., Flyktman, J.T., Anthore, A., and Giazotto, F., Cold electron Josephson transistor, Applied Physics Letters, 84, 21, pp. 4179-4181, (2004)

12) Pekola, J., Schoelkopf, R., and Ullom, J., Cryogenics on a chip, Physics Today, May 2004, pp. 41-47, (2004)

13) Pekola, J.P., Heikkilä, T.T., Savin, A.M., Flyktman, J.T., Giazotto, F., and Hekking, F.W.J., Limitations in cooling electrons using normal-metal-superconductor tunnel junctions, Physical Review Letters, 92, 5, pp. 056804/1-4, (2004)

14) Minina, N.Ya., Kolokolov, K.I., Beneslavski, S.D., Bogdanov, E.V., Polyanskiy, A.V., Savin, A.M., and Hansen, O.P., Transformation of the fermi surface and anisotropy phenomena in 2D hole gas at GaAs/A1xGa1-xAs heterointerface under uniaxial stress, Physica E , 22 , pp. 373-376, (2004)

15) Kühn, T., Anghel, D.V., Pekola, J.P., Manninen, M., and Galperin, Y.M., Heat transport in ultrathin dielectric membranes and bridges, Physical Review B , 70 , pp. 125425/1-6.

16) Niskanen, A.O., Control of quantum evolution and Josephson junction circuits,Low Temperature Laboratory thesis , pp. 108, (2004)

17) Savin, A., Pekola, J., Flyktman, J., and Giazotto, F., Strong enhancement of Josephson coupling under hot quasiparticle extraction, pp. 209-212, (2004)

ROTA

1) Finne, A.P., Boldarev, S., Eltsov, V.B., and Krusius, M., Measurement of turbulence in superfluid ^{3}He -B, Journal of Low Temperature Physics, 136, 5/6, pp. 249-279, (2004)

2) Finne, A.P., Boldarev, S., Eltsov, V.B., and Krusius, M., Vortex formation in neutron-irradiated rotating superfluid ^{3}He -B, Journal of Low Temperature Physics, 135, 5/6, pp. 479-512, (2004)

3) Finne, A.P., Eltsov, V.B., Blaauwgeers, R., Janu, Z., Krusius, M. and Skrbek, L., Time-of-flight measurements on quantized vortex lines in rotating ^{3}He -B, Journal of Low Temperature Physics, 134, 1/2, pp. 375-380, (2004)

4) Kivotides, D., Quantum turbulence decay, Physics Letters A, 326, pp. 423-428, (2004)

5) Kivotides, D., Topological noise scalings in superfluid and classical turbulence, Pis´ma v ZhETF, 80, 3, pp. 174 - 178., (2004)

6) Paalanen, M. and Krusius, M., Olli. V. Lounasmaa and his Low Temperature Laboratory, Journal of Low Temperature Physics , 135 , 5/6 , pp. 283-290, (2004)

THEORY

1) Barceló, C. and Volovik, G.E., A stable static Universe?, JETP Letters, 80, 4, pp. 209-213, (Pis´ma v ZhETF, 80, 4, pp. 239-243), (2004)

2) Giazotto, F., Heikkilä, T.T., Taddei, F., Fazio, R., Pekola, J., and Beltram, F., Tailoring Josephson coupling through superconductivity-induced nonequilibrium, Physical Review Letters, 92, 13 pp. 137001, (2004)

3) Heikkilä, T.T., Virtanen, P., Johansson, G., and Wilhelm, F.K., Measuring non-Gaussian fluctuations through incoherent Cooper-pair current, Physical Review Letters, 93, pp. 247005/1-4, (2004)

4) Klinkhamer, F.R. and Volovik, G.E., Quantum phase transition for the BEC-BCS crossover in condensed matter physics and CPT violation in elementary particle physics, JETP Letters, 80, 5, pp. 343-347 (Pis´ma v ZhETF, 80, 5, pp. 389-394), (2004)

5) Kopnin, N.B., Vortex instability and the onset of superfluid turbulence, Physical Review Letters, 92, 13, pp. 135301/1-4, (2004)

6) Kopu, J., Musta aukko laboratoriossa, Arkhimedes, 6/2004, pp. 20-23, (2004)

7) L'vov, V.S., Nazarenko, S.V., and Volovik, G.E., Energy spectra of developed superfluid turbulence, JETP Letters, 80, 7, pp. 479-483 (Pis´ma v ZhETF, 80, 7, pp. 546-550), (2004)

8) Viljas, J,K. and Thuneberg, E.V., Textural effects and spin-wave radiation in superfluid ^{3}He weak links, Journal of Low Temperature Physics, 136, 5/6, pp. 329-342, (2004)

9) Viljas, J. and Thuneberg, E., Dissipative currents in superfluid ^{3}He weak links, Low Temperature Laboratory Publications, TKK-KYL-011, pp. 1-9, (2004)

10) Viljas, J., Josephson effects and textural dynamics in superfluid helium three, Low Temperature Laboratory thesis, pp. 124, (2004)

11) Viljas, J.K., and Thuneberg, E.V., Dissipative currents in superfluid ^{3}He -B weak links, Physical Review Letters, 93, 20, pp. 205301/1-4, (2004)

12) Viljas, J.K., and Thuneberg, E.V., Dissipative currents in superfluid ^{3}He -B weak links, Journal of Low Temperature Physics, 134, 1/2, pp. 743-748, (2004)

13) Virtanen, P. and Heikkilä T.T., Thermopower induced by a supercurrent in superconductor-normal-metal structures, Physical Review Letters, 92, pp. 177004, (2004)

14) Virtanen, P., and Heikkilä, T.T., Thermopower in Andreev interferometers, Journal of Low Temperature Physics, 136, 5/6, pp. 401-434, (2004)

15) Volovik, G.E., Coexistence of different vacua in the effective quantum field theory and Multiple Point Principle, Pis'ma v Zhurnal Éksperimental'noi i Teoreticheskoi Fiziki (JETP Letters), 79, 3, pp. 131-135(101-105), (2004)

16) Volovik, G.E., On developed superfluid turbulence, Journal of Low Temperature Physics, 136, 5/6, pp. 309-326, (2004)

17) Volovik, G.E., On the thermodynamic and quantum fluctuations of the cosmological constant, JETP Letters, 80, 7, pp. 465-468 (Pis´ma v ZhETF, 80, 7, pp. 531-534), (2004)

18) Volovik. G., Fermi-point universality class: Emerging relativistic quantum fields & gravity, Proc. of Int. Conf. on Theoretical Physics, TH - 2002, pp. S943 - S955, (2004)

19) Kopnin, N.B., Mel'nikov, A.S., and Vinokur, V.M., Reentrant localization of single-particle transport in disordered Andreev wires, Physical Review B , 70 , pp. 075310/1-6, (2004)

20) Volovik, G.E., On contributions of fundamental particles to the vacuum energy, Proc. of I. Ya. Pomeranchuk and physics at the turn of centuries , pp. 234-.244, (2004)

YKI

1) Juntunen, K.I. and Tuoriniemi, J.T., Nuclear ordering in lithium and an upper limit on its ambient pressure superconducting transition temperatures, Physical Review Letters, 93, 15, pp. 157201/1-4, (2004)

2) Juntunen, K.I. and Tuorinimi, J.T., Experiment on nuclear ordering and superconductivity in lithium, Low Temperature Laboratory Publications, TKK-KYL-012, pp. 1-52, (2004)

3) Tuoriniemi, J. and Juntunen, K., Nuclei in cooperation, Journal of Low Temperature Physics, 135, 5/6, pp. 513-543, (2004)

Appendix I

Evaluation Report on the Low Temperature Physics Research

Low Temperature Laboratory, Helsinki University of Technology

By **Hans Rudolph Ott**, May 2004

The evaluation of the Centre is based on the site visit of the evaluator assigned by the Finnish Academy of Finland, on May 6, 2004. The report aims at addressing the individual items which, in a memorandum of February 28, 2002, were indicated to be of particular interest to the Finnish Academy of Finland. No other particular items were requested to be addressed in the present evaluation.

The evaluation is based on the following information:

annual report of LTL/HUT of 2002,

activity report and research plan 2002 - 2007.

Both these documents were provided prior to the site visit. During the site visit, further information was provided by oral presentations of the past activities and future plans by the leaders of the individual subprojects covering the low-temperature physics research of the Centre,

a tour of the laboratory (Cryo Hall), including short discussions with senior scientists and post doctoral students,

a short discussion session with PhD and Masters students.

1. Overall presentation of the Centre

The first presentation covered an overview on different general aspects of the Centre, which includes programs in low-temperature physics and brain research. The report provided an overview of past achievements in the form of publications, awards and honours, the development of the personnel, some statistical data on PhD education and awards and, finally, the development of the funding situation in the past and its expected trend in the near future. Comments and recommendations concerning the entire Centre are given in section 3 of this report.

2. Individual research projects

a) Electronic coolers and pumps

This project is a new activity for the centre and started with Academy Professor J. Pekola joining the LTL in 2002. The main goal of the project is to provide refrigerators that are of such small size that they can be accommodated on a chip of the type that is commonly used in microelectronics. It represents a relatively new approach to cryogenics, the traditional backbone of the laboratory, and is based on forced changes of the distribution function of conduction electrons in suitable materials. The method is very useful for experiments in the sub-Kelvin regime, involving electronic systems on the micro- or nanosize scale, a topic of research

which is of high current interest worldwide. The group is among the world leaders which develop this new approach to refrigeration. The plans for the future, in particular to develop solid state refrigerators which span the temperature regime up to room temperature, seem very ambitious but not completely unfeasible. In parallel, the group has also developed a device which is capable of a controlled transfer or pumping of Cooper pairs. Previous work by other authors has demonstrated the possibility of pumping single electrons. The new approach has the potential of pumping controlled amounts of charge at higher speed, The presentation also revealed a number of new ideas which are all very promising but require the solution of many technical problems. In this sense, the future plans (2004-07) are ambitious but confirm the high originality of the group' s thinking. There is little doubt that it will continue to visibly contribute to research and applications of mesoscopic electronic systems at the currently high international level. The group is also well positioned with respect to collaborations with outside partners in the academic, as well as in the industrial sector.

b) Quantum amplifiers and noise

This project, already well under way at the time of the last site visit has, under the leadership of Prof. P. Hakonen, continued its remarkable work on developing low-noise single electron transistors (SET) by adding an inductive device (L-SET) without interference of shot-noise and small back action. The related work on quantum amplifiers has met some difficulties with the practical realization of Bloch oscillator transistor (BOT) structures. Nevertheless, the potential of these new devices and combinations thereof is promising enough, to continue with this type of work, in particular in collaboration with the VTT. The development of this type of devices and related applications offers a wide range of experiments of more fundamental interest and the group has also made remarkable achievements in this respect. The group has obviously managed to transfer the high level technical know-how to solving difficult problems in the area of mesoscopic electronic systems and there is little doubt that, as the future plans reveal, it will continue to do so in the future. Somewhat less prominent than the rest of the program are the achievements in the experiments with multiwalled carbon nanotubes (MWNT), and this activity might be an item for reduction, if necessary. A particularly valuable asset is the now installed theoretical support. It would be nice, if this subgroup could support the planned experimental efforts towards realizing qubits.

c) Dynamics in coherent quantum systems

This activity is, in its field of research, unmatched in the world. This is primarily due to the availability of a home built experimental infrastructure that, after completion of the current substantial renovation work, will not be available in another laboratory. Although this monopoly also bears some obvious risks, the work that has been done and is foreseen for the near future, is of such high quality and interest to physics in general, that it would be absolutely foolish to consider a discontinuation. The oral presentation of the group's leader, Prof. M. Krusius, concentrated on the presentation and discussion of results in connection with turbulence in superfluid ^{3}He -B. Even this relatively narrow aspect, if considering all the other possibilities, revealed the richness in the behaviour of this seemingly simple fluid. Apart from serving as a model system for investigations of fluid dynamics and structures, the experimental installation will continue to serve as the

testing ground for theoretical ideas that were presented under d). The mere possibility of realizing, in a controlled way, situations which, in view of very general arguments, correspond to certain configurations in the universe, such as black holes, is too tempting to not at least be tried out.

d) Cosmological constant and vacuum energy

The presentation of this topic by Prof. G. Volovik started from the claim that for many body systems, such as quantum liquids and solids, the ground state energy corresponds to the vacuum energy. By discussing a thermodynamic analysis of the quantum vacuum, based on the knowledge of the ground state properties of condensed matter systems, such as the superfluid varieties of both He isotopes, and relating the vacuum energy to the cosmological constant, he emphasized the gross disagreement between theoretical and experimental evaluations of the magnitude of the cosmological constant in all cases. The entire program, embracing lot of other basic issues of relativistic quantum field theory and gravity, is original albeit speculative to some extent. The possible interaction, listed under future work, with experimental activities using the available infrastructure mentioned under c), is clearly a positive asset.

e) YKI - Mikrokelvin experiments

This extremely powerful refrigeration system has, as before, been used for experiments on mixtures of ^{3}He and ^{4}He. The indirect cooling of these mixtures with a Cu nuclear demagnetization stage has resulted in reaching temperatures of the liquid of between 10 and 100 mK. According to the group leader, Dr. J. Tuoriniemi, these efforts are planned to being terminated. They will be replaced by testing a new method of cooling Helium mixtures by adiabatic melting. Calculations indicate that higher cooling powers at very low temperatures might be achieved. The success of this enterprise is difficult to predict. While testing Li metal for superconductivity, evidence for some type of cooperative phenomenon was found by 7Li NMR in ultralow magnetic fields and below 100 mK. It is not quite clear, in what other way the characteristics of this new phenomenon may be clarified. In this sense, most of this activity is explorative in character and requires a long term involvement. The decision of the future of this project is clearly with the management of the Centre. The scientifically most efficient use of this unique facility (YKI cryostat) in the future might be the topic of a dedicated workshop involving external experts with relevant ideas.

f) lnterfaces of quantum crystals

Again, this project requires experimental skills and instrumental infrastructure which are hardly available at any other comparable institution. As the group leader, Dr. H. AlIes explained, Helium crystals are, first of all, good model systems for studying crystal growth aspects in general, and they are crystals that are influenced by quantum effects and exhibit some unusual properties that are not common to other crystals. As a highlight, the observation of the growth of a ^{3}He crystal by optical interferometry at sub-mK temperature should be mentioned. The analysis of available data indicates that the surface behaviour of a quantum solid turns to classical at temperatures very close to 0 K, a counterintuitive result, to say the least. Particularly this examples shows that surprises are often met where they are completely unexpected. The future of this enterprise is still bright. For example, the

predicted occurrence of crystallization waves in ^{3}He at very low temperatures or the influence of magnetic order onthe growth of ^{3}He crystals should definitely be examined in the future, as planned.

g) Dynamics of superfluid ^{3}He and superconductors

During the past two years, theoretical calculations and simulations in relation to the measurements of turbulence in superfluid ^{3}He -B, mentioned under c), were carried out in this project. Prof. N. Kopnin worked out a model for describing the onset of turbulence. An analysis of the stability of vortices seems to provide an explanation of the experimentally established phase diagram of turbulence, i.e., the distinct separation into regions of turbulent and regular superflow, separated by a narrow boundary region between 0.55 and 0.6 Tc. Further work covered aspects of single electron transport, especially heat transport, in Andreev wires. In the near future, ongoing work, again related with superfluid turbulence is planned. This effort will clearly enhance the impact and significance of the experimental work, mentioned above under c). Further planned work, related to non-equilibrium situations in mesoscopic superconductors will likely be beneficial to the experimental efforts mentioned under a) and b).

3. General comments and recommendations

The overall performance of the low-temperature physics part of the Centre continues to be excellent. The number of publications and their placement in high ranking journals, confirming the high quality of their content, are matching the expectations for a Research Centre of Excellence. This is clearly seen in a comparison of the respective output between LTL alone and HUT overall. As before, the main part of the scientific performance of LTL is based on outstanding technical expertise, both with respect to low-temperature equipment and the fabrication of mesoscopic electronic devices, as well as on general experimental skills of the involved persons. This combination offers opportunities for experiments that are not possible elsewhere and this should be considered in the choice of future projects. In view of the complexity and the difficulties characteristic for many of the experiments, the quantitative output in form of publications of the unit continues to be impressive.

The Centre has continued to slowly reorient its program, as requested in earlier evaluation reports. The Centre's decision to add the activity discussed in section 2a of this report to its curriculum, is judged to be very timely and well placed. The status of the programs 2a and 2b reflects a successful reorientation of the low-temperature physics part into a direction which covers a research field with potential for outstanding research in basic science but also for future applications. The combination of these two programs promises synergies that may not be available in other laboratories that are engaged in this type of research. The already existing co-operations with application oriented research organizations, such as VTT, add to the value of this part of the program. This part of the curriculum is also very well suited to contribute to the often desired technology transfer from academia to industry. In this cage this will not only happen in the form of new concepts and devices, but also in the form of well trained and technically competent Master graduates and PhD's.

As already indicated in section 2 of this report, the projects related to the physics of quantum fluids and solids continue to be of world class standard. Especially these

projects require a certain continuity in human resources with exceptional experimental skills. It is recommended that this aspect is watched and handled with the necessary attention, also in times of reduced financial support.

The visibility of the Centre in the community of low-temperature physics is, as before, very high and, with the successes of the groups involved in research on mesoscopic electronic systems, it may even have been enhanced. This is reflected in new collaborations in this field of research with prominent national and international partners. As expressed already in earlier reports, it would be favourable if the theoretical activities related to superfluids and superconductors had a broader local impact, mainly in the form of PhD education.

Overall, the training of young researchers is on a good track. The projects offer attractive opportunities for students to accomplish research results that are internationally well recognized and to acquire skills that will definitely be useful in a future research career, both in academia and industry. Given the international trend, the time for PhD students to obtain their degree is at the upper end of the accepted scale. A reduction of this time span will likely influence both the depth of the education and the quality and/or the quantity of the research results. It is the task of the local academic management to set the goals in this respect.

As mentioned above, the project related with the YKI cryostat may need some longer term perspective. Experiments in the temperature range of microKelvin are highly non trivial and often time consuming by nature. An optimal use of this outstanding facility might be achieved, if a related program, based on international collaborations, is installed. This might also be a possibility to raise external funding but would, of course, limit the free access to this installation of the local group.

During this evaluation, the question concerning the continuation of the Centre after the end of the running funding period arose more than once. At this time, the low-temperature physics part of the Centre clearly fulfills all the expectations that might be attached to a Centre of Excellence and there is no reason to believe that the situation will be different in 2005. It might be worthwhile to consider an extension of the new Centre by including a similarly competent partner in the national environment which is also active in the field of mesoscopic physics and enjoys a high international recognition.

The preceding comment is based on the assumption that the Centre is not continued in its present form. Both parts of the Centre, low-temperature physics and brain research, are both very strong pillars of the enterprise. In recent years, the development of both these parts has lead to a clear separation of scientific interests and, in particular, the brain research unit should now be accommodated in a more suitable scientific environment. This measure would certainly not weaken the scientific excellence and power of both these units but, in the cage of the brain unit, even lead to new and favourable opportunities.

Zürich, May 27, 2004 H.R.Ott

Appendix II

Evaluation Report of the Brain Research Unit (BRU)

Low Temperature Laboratory

Helsinki University of Technology

by **Fernando Lopes da Silva**, May 2004

This evaluation corresponds to the period 2002 - 2004 and it is the second mid-term evaluation since the meeting of the Scientific Advisory Board (SAB) in 2000, the first mid- term evaluation having taken place in 2002.

Main developments since the mid-term evaluation of 2002

The main new acquisition of the BRU in this evaluation period is the 3-Tesla MRl facility that was already recommended by the SAB in 1997, was ordered in 1999 and was finally installed at the beginning of 2002. This facility was placed in the Advanced Magnetic Imaging (AMI) Centre located in the Department of Electrical Engineering and is run by a consortium headed by BRU with Riitta Hari as the first Director. In its current Activity Report the BRU reports that it uses about 45 % of the MRI facility***. I share, however, the concern of the BRU that the increase of research in functional MRI (fMRI) has taken place at the cost of the MEG research potential. In my opinion this should be corrected, since the fMRI new facility should be considered an important extension of the brain research potential of the BRU without endangering its leading position in the MEG research field.***

Researchers: perspectives and needs

The BRU has an excellent core of researchers who fulfil a leading role in the world community of brain research, mainly in the MEG field and, more general, in the field of Cognitive Neurosciences. Nevertheless I agree with the statement in the Activity Report that the BRU suffers from a lack of resident senior scientists. This is especially evident after the acquisition of the AMI fMRl facility. In addition the well-known expert in MEG methodology Matti Hämäläinen left the group for a prestigious position at Harvard University. In this way the important handicap of the BRU concerning resident senior scientists became even more difficult to ignore. ***In my opinion the Academy should consider ways of redressing this situation with high priority, in order to reinforce the meagre resident senior staff, notwithstanding the excellent quality of the present senior scientists. In this context a useful suggestion made in the Activity Report is to create positions of visiting professorships for periods of 3 years. 1 suggest that this could possibly be a joint venture of the Helsinki Technical University (HUT) and the Academy, that would certainly yield valuable scientific dividends in a relatively short time.***

Position of the BRU within the Academy, questions of funding and organization

Research groups such as BRU, that are characterised by having a multi- and interdisciplinary character, have often difficulty in being fully recognised by funding institutions that are traditionally organised along rather rigid compartments that correspond to c1assic research fields. This is also the cage of the Academy of Finland. In my experience in the Netherlands a similar situation existed but it has

evolved in recent years to allow the growing flexibility of novel lines of research. For example two years ago an inter-/ multidisciplinary program on Cognition was created in order to stimulate this emergent new field of research, that cuts across the c1assic Research Councils. ***In my opinion the Academy should realize that the research of BRU needs to have a special position that runs horizontally across the 4 Research Councils, since the BRU involves activities covered by a1l 4 Councils: Biosciences, Culture and Society (Psychology), Natural Sciences and Engineering and Health.***

The new AMI Centre carries a heavy financial responsibility since the operational costs involved are substantial. The estimate of a cost of 350 euro/hour is in line with what is used in similar facilities in other countries, although about 25% higher than in our facility in Amsterdam. The problem, however, is that most research groups do not have sufficient funds to cover such expenses. ***Therefore it is necessary that the supporting organizations, such as the HUT and/or the Academy cover port of these running costs through the introduction of a <Measuring Fund>, the support of which may be requested by the researchers of the approved projects.***

Is the BRU a Centre of Excellence? - The international status of the BRU scientists

In my previous report I gave a positive reply to the question posed above. I am glad to acknowledge that the performance of the BRU since 2002 only reinforces this conclusion. Several objective arguments support this statement:

(i) The publication list of BRU consists of a most valuable and large series of papers published in Journals with a high impact. The largest number of papers have appeared in NeuroImage (IF ~ 6, 16 papers), while papers in Journals with even higher Impact factors (IF) have also appeared, such as Neuron (2), PNAS (2), Current Opinion Neurobiology (1), J. Neuroscience (2), Annals Neurology (2), Current Biology (1), Brain (3), J. Cognitive Neuroscience (5), Cerebral Cortex (1). Furthermore I am happy to note that the number of papers published in Journals with high impact is much larger than that published in Journals with relatively low impact.

(ii) An analysis of the citation scores of the senior scientists, particularly Riitta Hari (RH), Riitta Salmelin (RS), Nina Forss (NF), shows strong past profiles, that are much higher than the average (mean Impact factor ~ 6, sd ~ 3.5) within the scientific field characterised by the 18 Journals where they have been publishing. This can be objectively illustrated by examining the citation scores (number of citations per paper per year) of the 5 most cited papers of these 3 scientists (data taken from the ISI Web of Science):

RH - 61.3, 19.8, 18, 12.1, 8; RS - 18, 18, 15, 13, 10; NF - 14, 12, 11, 9, 6.

(iii) The international recognition for Riitta Hari has reached a remarkable level of excellence, since she was one of the recipients of the most prestigious Louis-Jeantet Prize of Medicine in 2003, was elected foreign associate of the National Academy of the USA in 2004, was awarded a honorary Doctor's degree of the University of Lisbon in 2003, and was elected the Physiologist of the Year by the Society of Physiology of Finland in 2003. Also Riitta Salmelin was distinguished by being awarded the Philips Nordic Prize for her work on dyslexia. In addition these senior scientists have given an impressive large number of prestigious lectures around the world.

In the face of the impressive list of honours received by Riitta Hari I consider strange that her appointment as Academy Professor was discontinued. ***I strongly support that this decision of the Academy should be revised, and consider that she is eligible for a long-term appointment as Academy Professor.***

Scientific achievements and co-operation between several groups

As stated in the previous report there are strong co-operations between the different researchers at various levels. I was very positively impressed by the fact that the BRU has extended its range of methodologies to include dynamical imaging of coherent sources of brain activity, temporal processing of brain signals, the merging of MEG and fMRI data and some clinical applications. In addition to those indicated previously, there are new forms of collaboration between the MEG and the AMI laboratories. This has led already to a number of interesting joint studies such as those aiming at finding the cortical routes of action and object naming, the characterization of human visual areas, the representation of pain in the brain and the functional organization of language systems. In the presentation of the results, and probably because the BRU and AMI are separate units, the description of these joint projects is spread over both reports in a way that does not give sufficient evidence to the intimate links between the MEG and fMRI studies. In this respect the site-visit gave, fortunately, a more comprehensive view of what is going on, than the written report. ***In a future report of activities it would be advisable to order the research projects by themes, regardless of which technique is used.***

General perspectives

The BRU has bright perspectives given the excellent research being carried out. However, the BRU has been living on the edge of financial equilibrium. The suspension of the position of Riitta Hari as Academic Professor represents a substantial decrease of income for the BRU. As stated above this decision was unfortunate and difficult to understand in view of the widespread international recognition of the excellence of the scientific work of Riitta Hari and her collaborators.

The situation of the AMI should be carefully evaluated by all the partners involved. I suggest that HUT, The Academy and the other partners should make ***a long-term business plan for running AMI*** in a stable way. It would be most appropriate to transform AMI in a ***National Facility*** with a Chief Executive that would have the administrative responsibilities, and an Independent Selection Panel for the evaluation and allocation of time to different projects.

A few general remarks

1) This site visit was most useful since it gave an excellent opportunity to recognize the important achievements that the BRU has realized, It was most rewarding to meet the graduate students who make an impressive group of talented young scientists. It became also clear that they are working in a most inspiring environment.

2) The combination MEG and fMRI is starting to yield the first important results. It is clear that in this respect the group needs to be strengthened by ***the appointment of senior visiting professorships*** for periods of 3 years, 1 suggest that this could possibly be a joint venture of the Helsinki Technical University (HUT) and the

Academy, that would certainly yield valuable scientific dividends in a relatively short time.

3) The appointment of Riitta Hari as ***Academy Professor*** should be resumed taking into consideration her exceptional stature as an original scientist and an inspiring and world recognized leader in the field of Cognitive Neurosciences.

Amsterdam, May 17, 2004 Fernando Lopes da Silva , M.D., Ph.D.

Appendix III

THE OLLI V. LOUNASMAA MEMORIAL PRIZE

Mikko Paalanen, chairman of the Selection Committee

Prize Ceremony in the House of Estates

Honored Chairman of the Academy, dear Members, Ladies and Gentlemen:

Academician Olli V. Lounasmaa passed away on December 27, 2002 at the age of 72. He was internationally one of the most celebrated Finnish scientists. In Finland we also remember him as a colorful reformer of research practices and science policy.

Many of us attended the memorial service organized in this very room about one and a half years ago. Among the speakers was Paavo Uronen, then the Rector of Helsinki University of Technology. In his memorial speech, Rector Uronen suggested that our academic community and especially the Helsinki University of Technology should honor Olli Lounasmaa by promoting his name on some visible and long lasting way. The task was given to the LTL, which Olli had founded and managed successfully for 35 years.

After discussing this proposal with Olli's family and with some of his former colleagues we decided to establish an international prize carrying his name - Olli V. Lounasmaa Memorial Prize. I would like to use this opportunity to thank the Lounasmaa family for the permission to use its name in this connection.

For Olli Lounasmaa, the ultra low temperature physics and its applications, especially in brain research, were close to his heart. In these research areas he obtained his international fame and reputation. Therefore it was clear for us from very beginning that the Memorial Prize should be given out to a scientist with significant contributions in the area of low temperature physics and its applications, including the imaging of human brain.

The first Olli V. Lounasmaa Prize has been awarded to Professor John Clarke from University of California, Berkeley campus, for his contributions over nearly 40 years in the development and characterization of SQUIDs, superconducting quantum interference devices, and in developing their applications. SQUIDs are very sensitive magnetometers, devices to measure very small magnetic fields. They are used for example in noninvasive detection of the tiny magnetic signals produced by human brain. The SQUID sensor is the corner stone of the brain research of the Low Temperature Laboratory.

John Clarke was born in 1942 in Cambridge England. In 1964 he started his graduate studies in the research group of Professor John Pippard. His first assignment was to build an ultra sensitive voltmeter based on Josephson junctions. Within one month he managed to make the first working JJ in England, which was quite an accomplishment for a 22-year-old starting student. My guess is that early success changed John's life and he became addicted to this area of science. John earned his PhD in 1968 from University of Cambridge. On the following year, at

the age of 27, University of California hired him as an assistant professor, and he has been working there until today. In 40 years he has published nearly 400 scientific articles in the area of superconductivity. The title of his first paper from year 1965 reads "A superconducting Galvanometer Employing Josephson Tunneling" and the title of his 376th paper from this year is "Detection of bacteria in Suspension by Using a Superconducting Quantum Interference Device". Between these two publications there are numerous important contributions in the applications of SQUIDs as sensitive sensors in biological and geophysical measurements, in material testing, in cosmology and recently in magnetic imaging and in quantum computing.

John Clarke has won numerous international recognition. I just want to mention two of them, the most important ones. Since 1986 he has been the Fellow of Royal Society, He is also the 1987 recipient of Fritz London Award. It has been said that an academic prize is as great as its recipients are. John Clarke is an excellent choice for the first OVL Memorial Prize.

At this point I would like to thank Helsinki University of Tehnology, Finnish Academy of Science and Letters and Finnish Cultural Foundation for financial support and for Finnish Academy of Science and Letters for including this Prize ceremony in their monthly program.