Contents

LOW TEMPERATURE LABORATORY (LTL) 2002

PREFACE

The year 2002 ended with sad news for the LTL. Academician Olli V. Lounasmaa, the founder and former director of the Laboratory, died suddenly on 27th of December on his vacation trip to India. In Academician Lounasmaa we lost a trusted adviser, avid supporter and a genuine friend. We are thankful for the valuable scientific and social inheritance left by him. The LTL will have hard time to adjust to the world after him. An obituary, written by his students and close colleagues Peter Berglund, Riitta Hari, Matti Krusius and the undersigned, is presented right after the preface.

During the year 2001, the construction of the 3T-fMRI facility was successfully completed, thanks to the generous support of the Tekes, the Academy of Finland, the Jenny and Antti Wihuri Foundation, and the Helsinki University of Technology. Year 2002 marked the completion of the organizational structure around the magnet; the Advanced Magnetic Imaging Center was founded. The AMI Center, fully owned by the HUT, is financially part of the Department of Electrical Engineering and Information Science. The Scientific Director of the Center, Academy Professor Riitta Hari, comes from the Low Temperature Laboratory. Professor Raimo Sepponen, the leading MRI expert from the Department of Electrical Engineering and Information Science, was elected as the Technical Director of the Center. In the Board of the AMI Center, the HUT has three representatives, and the Helsinki University and Helsinki-Uusimaa Hospital Consortium both one representative. The AMI Center, together with the MEG equipment of the LTL form a unique brain research facility in the whole world. The total value of the recent hardware investment in the brain research on the HUT campus is close to 10 Meuro.

Parallel to the strengthening of the brain research, the LTL has been investing in the low temperature nanoelectronics. This effort was started in 1996 and by 2002 the Nanophysics Group of the LTL had grown to nearly ten scientists. The nanoelectronics effort of the LTL received a considerable boost by the move of Academy Professor Jukka Pekola from University of Jyväskylä to the LTL. The undersigned and Jukka Pekola founded the nanophysics effort in Jyväskylä already in 1992. With Jukka Pekola and his new Picophysics Group the LTL will become one among the ten best sites of low temperature nanoelectronics in the whole world. The position of the LTL is further improved by the close collaboration with the VTT Quantum Electronics Group, lead by Research Professor Heikki Seppä.

The LTL has a long record in organizing various conferences. Year 2002 did not break this tradition, thanks to Dr. Harry Alles, who was in charge of the Kevo Winter School on "Some Topics of Low Temperature Physics". The total attendance of this international School was 25 scientists. The 500-page Proceedings were published in JLTP 129 (2002).

This year was also an evaluation year of the whole scientific program of the LTL. In the past, the laboratory has been evaluated on regular intervals, with the previous full reviews in 1994, 1997, and in 2000. The LTL is one of the Centers of Excellence selected by Academy of Fin-

land for the six year term 2000 – 2005. The 2002 evaluation, conducted by Professors Hans Ott from ETH, Zürich, and Fernando Lopes da Silva from Amsterdam, was a midterm review of the Center-of-Excellence status of the LTL. The separate evaluation reports of Professors Ott and Lopes da Silva can be found in the Appendix. According to the reports, the LTL is continuing successfully its scientific program.

The staff of the LTL received several significant promotions and honors during the year 2002. Docent Riitta Salmelin obtained the status of full Professor of the HUT. Professors Pertti Hakonen and Riitta Salmelin were elected to the membership of Academia Europaea. Academy Professor Riitta Hari was granted the prestigious Canadian Justine et Yves Sergent Prize of Neuroscience and Dr. Psych. Päivi Helenius the Norman Geschwind Prize of the International Rodin Academy for her studies of dyslexia. Dr. Tech. Kimmo Uutela received the best thesis Prize of Teknisten Akateemisten Liitto TEK ry and Tekniska Föreningen i Finland. The thesis of Dr. Tech. Tauno Knuuttila, and especially the new low temperature world record published in the thesis, earned Dr. Knuuttila the International Peter Kapitza Prize of 2003, granted by the International Institute of Refrigeration. DI Lauri Parkkonen and Dr. Ole Jensen were awarded the Young Investigator Award in the Biomag 2002 Conference. Docent Peter Berglund was granted the Bronze Service Medal by our University for his dedicated work for the LTL. Finally, our long time visitor, Russian Academician Alexander Andreev was elected to the Finnish Academy of Sciences and Letters as a foreign member. The high quality of the research in the LTL is based on these personal achievements and the whole laboratory is happy and proud of them.

Mikko Paalanen

Director of the LTL

IN MEMORIAM

Academician Olli V. Lounasmaa

20.8. 1930 – 27.12. 2002

Academician Olli V. Lounasmaa, founder and long-term director of the Low Temperature Laboratory, died suddenly on December 27, 2002 at the age of 72 in Goa, India, where he had just arrived for a holiday with his wife and two grand daughters.

Lounasmaa was internationally one of the most celebrated scientists in Finland. Within the country he was known as a colorful reformer of Finnish research practices and science policy. He was born in Turku on August 20, 1930, passed his matriculation examination at the Normal Lyceum in Helsinki in 1949, and received his Master's degree from Helsinki University in 1953. He then continued his studies in the Clarendon Laboratory of the University of Oxford, UK, where he submitted his doctoral thesis in low temperature physics in 1958. He gained further international experience by working as a visiting scientist in Argonne, USA, in 1960-1964. He was appointed professor of technical physics at the Helsinki University of Technology in 1965.

Olli Lounasmaa's principal scientific achievements took place at the Low Temperature Laboratory which he founded at the Helsinki University of Technology in 1965. He was the Head of the Laboratory until his retirement in 1995. From the start the Laboratory focused on low temperature physics and soon became an international centre in the field. New and innovative refrigeration technology was developed which opened novel areas for low-temperature research, foremost the helium-3 superfluids and the ordering of nuclear magnetic moments in solids. His

work on superfluid helium-3 was especially mentioned by the Nobel Committee in 1996, when the Nobel Prize was awarded to the discoverers of helium-3 superfluidity.

In the early 1980s Lounasmaa started a research programme on magnetic fields produced by human brain activity, by first developing multi-channel neuromagnetometers based on the superconducting quantum interference device (SQUID). For the development and production of such devices and measuring systems a separate commercial company was later established. Today dozens of brain research groups around the world are using the instruments and analyzing methods which originate from Lounasmaa's Low Temperature Laboratory.

Olli Lounasmaa was a pioneer of post-war science in Finland. From the start he had wide international contacts and his goal was to raise the laboratory to a leading position in the world. It had a modern scientific programme - his principle was to focus clearly on important issues and adopt a "no nonsense" stance. He was an avid supporter of basic research, who championed for the quality in research and the establishment of centres of excellence already in the early 1980ies. He boldly advocated a multidisciplinary approach at the initial stages of the laboratory's brain research. He reformed graduate education by making it a full day professional activity, which guaranteed the success of even the most difficult projects through efficient teamwork and supervision.

Olli Lounasmaa's scientific output was prolific and he was awarded several international and national prizes and honors. He received the Fritz London Award (USA 1984), the Forschungspreis of the Alexander von Humboldt Stiftung (Germany 1993), and the Kapitza Gold Medal (Russia 1995). He was a foreign member of the National Academy of Sciences of the USA and the Royal Swedish Academy of Sciences. He received honorary doctorates from the Helsinki University of Technology, Tampere University of Technology, and from the Faculties of both Medicine and Philosophy of the University of Helsinki. He was appointed Academician in 1997.

Olli Lounasmaa was an inspiring and popular leader who supported his students energetically, but who also expected industrious enthusiasm from them. His advice to the young researcher regarding the daily timetable became famous: work hard for 16 hours, take 1 hour for meals and 1 hour for dating the opposite sex, and sleep for the rest of the time. These and other words of wisdom he recorded in his memoirs, a manuscript of 900 pages, which he finished just before leaving on his vacation to India. In Olli V. Lounasmaa we have lost a remarkable scientist, an energetic and efficient science manager, and a long-standing friend.

SCIENTIFIC ADVISORY BOARD

The Scientific Advisory Board has the following members:

Prof. Fernando Lopes da Silva	University of Amsterdam, The Netherlands
Prof. Michael Merzenich	University of California, San Fransisco, USA
Prof. Hans Mooij	Delft University of Technology, The Netherlands
Prof. Yrjö Neuvo	Nokia Ltd, Helsinki, Finland
Prof. Douglas Osheroff (chairman)	Stanford University, California, USA
Prof. Hans Ott	ETH, Zürich, Switzerland
Prof. Stig Stenholm	Royal Institute of Technology, Stockholm, Sweden
Prof. Semir Zeki	University College London, UK

Physics research evaluation meeting was held May 31. (Report as Appendix I)

Evaluator: Prof. Hans Ott.
Observers:

Secretary General Ritva Dammert	Academy of Finland
Prof. Pekka Hautojärvi	Academy of Finland/HUT
Science Secretary Anu Huovinen	Academy of Finland.

Brain research evaluation meeting was held June 10. (Report as Appendix II)

Evaluator: Prof. Fernando Lopes da Silva
Observers:

Science Secretary Jaana Aalto	Academy of Finland
Secretary General Ritva Dammert	Academy of Finland
Prof. Hilkka Soininen	Academy of Finland/University of Kuopio

PERSONALIA

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 26 person years

Mikko Paalanen, Dr. Tech., Prof., 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.
Harry Alles, Dr. Tech.
Sergei Boldarev, Dr., starting from 1.2.
Julien Delahaye, Ph.D., until 31.5.
Vladimir Eltsov, Ph.D.
Nina Forss, M.D., Ph.D., Docent, on leave until 28.2.
Pertti Hakonen, Dr. Tech., Professor
Tero Heikkilä, Dr. Tech., starting from 9.9.
Päivi Helenius, Dr. Psych. on leave starting from 22.7.
Matti Hämäläinen, Dr. Tech., Docent, on leave
Ole Jensen, Ph.D., 1. – 31.1.
Veikko Jousmäki, Ph.D.
Ken-ichi Kaneko, Dr.
Erika Kirveskari, M.D., starting from 1.8.
Jaakko Koivuniemi, Dr. Tech., on leave
Nikolai Kopnin, Prof.
Matti Krusius, Dr. Tech., Academy Professor
Olli Lounasmaa, Ph.D., Academician, until 27.12.
Jussi Numminen, M.D., Ph.D., part-time
Jukka Pekola, Dr. Tech., Academy Professor, starting from 1.6.
Juha Päällysaho, Ph.D., until 31.7.
Stephan Salenius, M.D., Ph.D., part-time
Riitta Salmelin, Dr. Tech., Professor
Martin Schürmann, M.D., Ph.D.
Alexander Sebedash, Ph.D.
Cristina Simoes, Dr. Tech.
Igor Todoschenko, Ph.D.
Juha Tuoriniemi, Dr. Tech., Docent
Simo Vanni, M.D., Ph.D., starting from 9.9.
Minna Vihla, M.D., Ph.D., 1. – 31.1.
Grigori Volovik, Ph.D., Visiting Professor

GRADUATE STUDENTS (SUPERVISORS) 20 person years

Sari Avikainen, M.D., until 31.7.
(Riitta Hari)

Rob Blaauwgeers, M.Sc., until 9.9.
(Matti Krusius)

Antti Finne, M.Sc. Tech.
(Matti Krusius)

Yevhen Hlushchuk, M.D. from 5.8.
(Riitta Hari, Nina Forss)

Risto Hänninen, M.Sc. Tech.
(Erkki Thuneberg)

Kirsi Juntunen, M.Sc. Tech.
(Juha Tuoriniemi)

Juha Järveläinen, M.D.
(Riitta Hari)

Katri Cornelissen, M.D., 15.4. – 31.5.
(Riitta Salmelin)

Jan Kujala, M.Sc. Tech.
(Riitta Salmelin)

Mia Liljeström, M.Sc. Tech., from 1.9.
(Riitta Hari)

René Lindell, M.Sc. Tech.
(Pertti Hakonen)

Juha Martikainen, M.Sc. Tech., until 30.6.
(Juha Tuoriniemi)

Lauri Parkkonen, M.Sc. Tech.
(Matti Hämäläinen)

Marjatta Pohja, M.D.
(Stephan Salenius, Riitta Hari)

Tuukka Raij, M.D.
(Riitta Hari)

Hanna Renvall, M.D.
(Riitta Hari)

Leif Roschier, M.Sc. Tech.
(Pertti Hakonen)

Mika Seppä, M.Sc. Tech.
(Matti Hämäläinen)

Mika Sillanpää, M.Sc. Tech.
(Pertti Hakonen)

Cristina Simões, M.Sc. Tech.
(Riitta Hari)

Topi Tanskanen, M.Sc. Psych.
(Riitta Hari)

Antti Tarkiainen, M.Sc. Tech.
(Riitta Salmelin)

Reeta Tarkiainen, M.Sc. Tech.
(Pertti Hakonen)

Janne Viljas, M.Sc. Tech.
(Erkki Thuneberg)

Tiina Vuorinen, M.Sc. Psych.
(Päivi Helenius, Riitta Salmelin)

UNDERGRADUATE STUDENTS

Lasse Aaltonen

Janne Antson

Samuel Aulanko

Samuli Hakala

Pekka Huhtala

Marianne Inkinen

Heikki Junes

Jussi Kumpula

Hannu Laaksonen

Reetta Lehtonen

Mika Martikainen

Vesa Norrman

Juho Peltonen

Elias Pentti

Pauli Pöyhönen

Antti Puurula

Tomi Ruokola

Miiamaaria Saarela

Timo Saarinen

Anssi Salmela

Ulf Skutnabba

Johanna Uusvuori

Nuutti Vartiainen

Vesa Vaskelainen

ADMINISTRATION AND TECHNICAL PERSONNEL 14 person years

Teija Halme, secretary

Marja Holmström, Lic. Phil., Laboratory Administrator

Antti Huvila, technician

Mia Illman, laboratory assistant

Arvi Isomäki, technician

Juhani Kaasinen, technician

Helge Kainulainen, technician, starting from 25.9.

Pirjo Kinanen, financial secretary

Tuire Koivisto, secretary, on leave 1.1. – 31.7.

Markku Korhonen, technician

Sami Lehtovuori, technician

Satu - Anniina Pakarinen, project secretary

Liisi Pasanen, secretary

Kari Rauhanen, technician

Antero Salminen, technician

Ronny Schreiber, technician, until 17.9.

VISITORS FOR EU PROJECTS

NEURO- BIRCH III (Brain research)

Ahissar, Merav, Dr.	Department of Psychology, Hebrew University, Jerusalem, Israel, 5. - 25.8.
Bailey, Anthony, Dr.	Institute of Psychiatry, MRC Child Psychiatry Unit, London, UK, 24. - 26.5., 6. - 10.6., and 13. - 16.6.
Borgmann, Christian, Mr.	Institute of Experimental Audiology, Münster University Hospital, Münster, Germany, 14. - 24.11.
Braeutigam, Sven, Dr.	The Open University, Milton Keynes, UK, 24. - 27.5., 6. - 10.6., and 14. - 16.6.
Caetano, Gina, Ms.	Instituto de Biofisica e Engenharia Biomedica, Lisbon, Portugal, 5.4. - 8.7. and from 9.10.
Carozzo, Simone, Dr.	University of Genoa, Institute of Neurophisiopatology, Genoa, Italy, 17. - 24.7. and 26. - 30.9.

Cornelissen, Piers, Dr.	Newcastle University, Newcastle on Tyne, UK, 3.4. - 31.5.
Gobbelé, René, Dr.	RWTH Aachen, Aachen, Germany, 4. - 10.11.
Goebel Rainer, Dr.	Maastricht University, The Netherlands, 16. - 25.4.
Koch, Giacomo, Dr.	University of Rome "Tor Vergata", Rome, Italy, 9.9. - 20.10.
König, Reinhard, Dr.	University of Bayreuth, Bayreuth, Germany, until 28.2., 9.3. - 24.5., and 12. - 30.11.
Lütkenhöner, Bernd, Prof.	Universitätsklinikum Münster, Münster, Germany, 14. - 24.11.
Mansfield, Uma, Dr.	Institute of Neurological Sciences, Glasgow, UK, 18.7. - 14.8.
Massone, Anna Maria, Dr.	INFM, Genoa, Italy, 7. - 17.7. and 26. - 30.9.
McCulloch, Daphne, Prof.	University of Glasgow, UK, 18.7. - 5.8.
Montez, Teresa, Ms.	IBEB – FCUL, Department of Physics, Lisboa, Portugal, 20.1. - 19.2.
Nahum, Mor, Ms.	Hebrew University, Center of Neural Computation, Jerusalem, Israel, 5.8. - 1.10.
Narici, Livio, Prof.	University of Roma Tor Vergata, Roma, Italy, 4. - 31.7. and 26. - 30.9.
Piana, Michele, Dr.	Dipartimento di Fisica Universitá di Genoa, Genoa, Italy, 10. - 17.7. and 26. - 30.9.
Riani, Massimo, Dr.	University of Genoa, Genoa, Italy, 26. - 30.9.
Simpson, William, Dr.	Glasgow Caledonian University, Glasgow, UK, 25. - 28.7.
Smeets, Sandra, Ms.	Maastricht University, Maastricht, The Netherlands, 15.4. - 15.7.
Stancak, Andrej, Dr.	Charles University Prague, Third Faculty of Medicine, Prague, Chzeck republic, 2.5. - 31.7.
Swithenby, Stephen, Prof.	The Open University, Milton Keynes, UK, 21. - 24.6.
Torriero, Sara, Dr.	S. Lucia I.R.C.C.S., Roma, Italy, 9.9. - 28.10.
Wallace, Simon, Mr.	Institute of Psychiatry, MRC Child Psychiatry Unit, London, UK, 6. - 10.6.

ULTI III (Low Temperature Physics)

Balestro, Franck, Mr.	CRTBT/CNRS, Grenoble, France, 8. - 13.10.
Balibar, Sebastien, Prof.	ENS, Paris, France, 19.4. - 3.5.
Barash, Yuri, Prof.	Lebedev Physical Institute, Moscow, 15.1. - 15.2.
Delahaye, Julien, Dr.	CRTBT/CNRS, France, 26.10. - 3.11.

Eska, Georg, Prof.	University of Bayreuth, Bayreuth, Germany, 20.2. - 8.3.
Fischer, Uwe, Dr.	University of Tübingen, Institut für Tübingen, Tübingen, Germany, 11.6. - 6.8.
Jochemsen, Reyer, Dr.	Leiden University, Kammerligh Onnes Laboratory, Leiden, The Netherlands, 16. - 20.4., 26.4. – 1.5. and 25.6. - 7.7.
Makhlin, Yuriy, Dr.	Institut für Festkörperphysik, Universität Karlsruhe, Karlsruhe, Germany, 24. - 27.3.
Ott, Hans, Prof.	ETH, Zürich, Switzerland, 30.5. - 1.6.
Rupp, Eckart, Mr.	Fachklinik Herzogenaurach, Herzogenaurach, Germany, 7. - 10.1.
Schakel, Adriaan, Dr.	Freie Universität Berlin, Germany, 1.1. - 30.6.
Skrbek, Ladislav, Dr.	Institut of Physics and Charles University, Prague, Czech Republic, 28.1. - 15.2., 11.6. - 11.7., and 4. - 19.11.
Sonin, Edouard, Prof.	Hebrew University of Jerusalem, Racah Institute of Physics, Jerusalem, Israel, 4.2. - 5.3., 4. - 30.6., and 2. - 9.10.
Volodin, Alexander, Dr.	Katholieke Universität Leuven, Leuven, Belgium, 15. - 29.9.
Wilhelm, Frank, Dr.	Ludwig-Maximilian University of Münich, Germany, 18. - 22.12.
Zaikin, Andrei, Prof.	Forschungszentrum Karlsruhe, Institut für Nanotechnologie, Karlsruhe, Germany, 2. - 5.4. and 15. - 19.4.

OTHER VISITORS

Andreev, Alexander, Prof.	Kapitza Institute for Physical Problems, Moscow, Russia, 18.8. - 18.9.
Asano, Yasuhiro, Dr.	Hokkaido University, Sapporo, Japan, 10. - 16.3.
Ducla-Soares, Eduardo, Prof.	IBEB-Lissabon, Portugal, 13. - 17.11.
Feigelman, Mikhail, Prof.	Landau Institute for Theoretical Physics, Moscow, Russia, 29.1. - 1.2.
Fetter, Alexander	Stanford University, Stanford, California, USA, 19. - 20.4. and 26. - 27.4.
Gross, Joachim, Mr.	Heinrich-Heine-Universität, Düsseldorf, Germany, 3.-7.5.
Haller, Kristjan, Prof.	Institute of Physics, Tartu University, Estonia, 12.12.
Hlushchuk, Yevhen, Dr.	Lviv State Emergency Hospital, Ukraine, 2. - 8.3.
Ichimura, Koichi, Dr.	Hokkaido University, Sapporo, Japan, 10. - 16.3.
Inagaki, Katsuhiko, Dr.	Hokkaido University, Sapporo, Japan, 10. - 16.3.
Kopu, Juha, Dr.	Institut für Theoretische Festkörperphysik, Karlsruhe, Germany, 1.10.

Korshunov, Sergey, Dr.	Landau Institute for Theoretical Physics, Moscow, Russia, 3. - 14.5.
Lepore, Franco, Dr.	University of Montreal, Canada, 1.11.
Lessonde, Maryse, Dr.	University of Montreal, Canada, 1.11.
Lin, Yung-Yang, Dr.	The Neurological Institute, Veterans General Hospital, Paitau, Taipei, 5. - 22.2.
Linkenkaer-Hansen, Klaus, M.Sc.	BioMag Laboratory, Helsinki University Central Hospital, Helsinki, Finland, 21.12.
Martin, Ivar, Dr.	Los Alamos National Laboratory, New Mexico, USA, 11.7.
Melnikov, Alexander, Dr.	Institute for Physics of Microstructures RAS, Nizhny Novgorod, Russia, 25.2. - 23.3. and 1. - 28.9.
Nishitani, Nobuyuki, Dr.	Research Institute, National Rehabilitation Center for the Disabled, Tokyo, Japan, 19.6. - 16.7.
Obraztsov, Alexander, Dr.	Moscow State University, Russia, 29.1.
Parshin, Alexander, Prof.	Kapitza Institute for Physical Problems, Moscow, Russia, 1. - 15.2. 20.5. - 3.6., 14.10. - 3.11., and 1. - 21.12.
Ryazanov, Valery, Prof.	Institute of Solid State Physics, Russian Academy of Sciences, Chernogolovka, Moscow region, Russia, 4. - 5.4.
Savoy, Robert, Dr.	Rowland Institute at Harward, 16. - 22.3.
Schön, Gerd, Prof.	University of Karlsruhe, Germany, 20.12.
Skyba, Peter, Dr.	Institute of Experimental Physics of Slovak Academy of Sciences, Kosice, Slovakia, 20. - 27.11.
Tanda, Satoshi, Prof.	Hokkaido University, Sapporo, Japan, 10. - 16.3.
Thuneberg, Erkki, Prof.	University of Oulu, Every Friday
Wang, Tailhong, Dr.	Institute of Physics, Chinese Academy of Sciences, Beijing, China, 15. - 29.9. and 22.10. - 15.12.
Yamaguchi, Takahide, Dr.	University of Tsukuba, Tsukuba, Japan, 21.5. - 21.11.
Zyuzin, Alexander, Dr.	Ioffe Physical-Technical Institute RAS, St. Petersburg, Russia, 6.5. - 12.6. and 1.10. – 1.11.

Group visits

Students and their parents from Seppo school, 17.1.

School teachers from Espoo (29 participants), 30.1.

IEA Executive Board, 24.4.:

Prof. Dr. G. Deutscher,	Tel Aviv University, Israel
Prof. Dr. P. Komarek	Research Center Karlsruhe (FZK), Germany
Dr. L. Martini	CESI, Business Unit Tests & Components, Italy

Dr. Ok-Bae Hyun	Korea Electric Power Research Institute, Republic of Korea
Dr. G. Hon	Korea Atomic Energy Research Institute, Republic of Korea
Mr. Å. Sjödin	Elforsk AB, Sweden
Mr. D. Rose	Engineering Industries Directorate, Department of Trade and Industry, UK
Dr. A.M. Wolsky	Energy Systems Division, Argonne National Laboratory, USA
Mr. T. Kato	New Energy and Industrial Technology Development Organisation (NEDO), Japan
Mr. O. Tsukamoto	New Energy and Industrial Technology Development Organisation (NEDO), Japan
Prof. R. Flükiger	Department Condensed Matter Physics (DPMC), Switzerland

30 psychology students from upper secondary school from Tapiola, 12.9.

First year physics students and their parents (60 participants) 19.10.

Students from physics group from Meilahti secondary school, 6.11.

Participants of the Technological Associations mathematic competition for upper secondary school (50 students), 8.11.

EESTEL and SIK students and visitors from Finland, Poland and Estonia, 19.11

INTERNATIONAL COLLABORATIONS

International collaboration has been a cornerstone in the research policy of LTL since the start of the laboratory in 1965. What originally was personal contacts and research visits to prominent physics laboratories later became organized collaborations between LTL and foreign universities and research centers. The first government funded programme was the ROTA collaboration between Finland and Russia that started in 1979 under the auspices of the Science Academies in Finland and in the Soviet Union (Moscow and Tbilisi, Georgia). This led to our now well established position in the forefront of superfluid ^{3}He research. It was followed by research collaborations in Risø and Berlin where LTL knowhow in nuclear refrigeration was utilized. In 1990 our collaboration with CERN was started and it led to the manufacture and operation of the world's largest dilution refrigerator for the SMC collaboration.

When Finland joined the European Union the LTL managed to obtain in 1994 a status of center of excellence both in the field of brain research (Neuro-Birch) and ultra low temperature physics (ULTI), a status that presently is given to only about 200 scientific organizations in the whole Europe. This has enabled us to offer the use of our facilities to qualified researchers from all Europe. Below is a list of the ongoing projects where we are the coordinators as well as a list of other efforts presently under development.

LTL-COORDINATED COLLABORATIONS

COSLAB (Cosmology in the Laboratory)

Funding: ESF, Physical and Engineering Sciences

Coordinators: Professors Tom Kibble and Grigory Volovik

Duration: 1.1. 2001 - 31.12. 2005

Participants: 11 groups from European universities and research institutes

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.

WEB-address:

http://www.esf.org/esf_article.php?language=0&article=7&domain=1&activity=1

LANGUAGE

Funding: EU, Quality of Life Management and Living Resources (LSDE),

Connectivity in Language Rehabilitation in Aphasic Patients.

Coordinator: Professor Riitta Salmelin

Duration: 1.3. 2000 - 28.2. 2003

Paticipants: 11 groups from different European universities and research institutes.

The aim of the collaborative project is to elucidate functional connections in the human brain during language processing, making use of the modern imaging techniques (EEG/MEG, fMRI, PET). Results collected from unimpaired subjects have been applied, in particular, to target and evaluate rehabilitation in aphasic patients.

NEURO-BIRCH III

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

Coordinator: Academy Professor Riitta Hari

Duration: 1.4. 2001 - 31.9. 2003

Participants: Open for qualified European brain scientists

WEB-address: http://boojum.hut.fi/eu.html

The Brain Research Unit of the LTL provides equipment, expertise, training, and scientific collaboration for European scientists in the field of neuromagnetism. Both in-house and joint collaboration projects are carried out. Suggestions for new research initiatives are invited. The programme covers the expenses for travel, accommodation, and subsistence of European researcher for up to 54 visitor months.

ULTI III

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

Coordinator: Professor Mikko Paalanen

Duration: 1.4. 2000 - 31.3. 2004

Participants: Open for qualified European low temperature scientists

WEB-address: http://boojum.hut.fi/eu.html

The LTL provides research opportunities for European senior researchers, post-doctoral fellows, and graduate students in low temperature physics for up to 72 visitor months. The programme covers the expenses for travel, accommodation, and subsistence of the individual researcher while they are conducting their research work at the LTL.

PARTICIPATION IN OTHER INTERNATIONAL COLLABORATIONS

LTL is also participating in the following international projects:

COMPASS collaboration at CERN with Helsinki Institute of Physics (HIP) : (Doc. Peter Berglund and Dr. Jaakko Koivuniemi) Web-link: http://wwwcompass.cern.ch/

Finnish-Russian Exchange Programme in Low Temperature Physics (Coordinator: Acad. Prof. Matti Krusius)

Finnish-Taiwanse Exchange Programme in Low Temperature Physics (Finnish Coordinator: Prof. Mikko Paalanen)

Finnish-Taiwanse Exchange Programme in Brain Science (Finnish Coordinator: Acad. Prof. Riitta Hari)

SQUBIT-2 (Acad. Prof. Jukka Pekola) A starting EU-financed effort that aims at the development of an elementary scalable quantum processor using Josephson junction, single-electron and SQUID technologies to achieve initiation, processing and read-out of information.

LOW TEMPERATURE PHYSICS RESEARCH

NANOELECTRONICS AT LOW TEMPERATURES

The nanophysics research of the LTL was started in 1996. By the year 2002 the Nano Group, headed by Pertti Hakonen, had already grown to nine scientists and the basic research facilities were ready. In the year 2002 the nanophysics research efforts expanded significantly when Jukka Pekola from University of Jyväskylä moved back to his old Alma Mater and founded the Pico Group. The research agenda of the new Pico Group includes, among other topics, studies of miniaturized picowatt coolers and picoamp current pumps.

Both the Nano and the Pico Group work in the focused area of low temperature nanoelectronics, which is often also called quantum electronics. They share the existing experimental infrastructure and, together, are already among the ten leading quantum electronics groups in the world. Tero Heikkilä, hired as a postdoc by the Theory Group, will further strengthen the nanoelectronics research at the LTL. Part of the Pico Group will be located at the Micronova, the common microlectronics research center of the HUT and the VTT. With this arrangement the LTL will improve its collaboration with the corresponding research groups at the VTT and its access to the clean rooms of Micronova.

NANO GROUP

M. Ahlskog, J. Antson, J. Delahaye, **P. Hakonen**, R. Lindell, M. Paalanen, L. Roschier, M. Sillanpää, R. Tarkiainen, and T. Yamaguchi

Visitors: E. Sonin, T. Tsuneta, T. Wang, A. Zaikin, and A. Zyuzin

Our work in mesoscopic physics concentrates on studies of ballistic and diffusive phase-coherent electron motion supplemented by the competition between Coulomb and superconducting correlations. Approximately 2/3 of our experimental investigations are carried out on aluminum based Josephson junction nanocircuits while the remaining 1/3 deals with carbon nanotubes.

Single Josephson junctions

Macroscopic quantum phenomena are very intricate in single Josephson junctions. By varying Ohmic dissipation, a Josephson junction can be driven across a superconductor/insulator (SI) transition. In our earlier experiments we investigated this transition as a function of E_J/E_C, the ratio of Josephson coupling and Coulomb blockade energy, when the shunt resistance became smaller than $R_Q = h/4e^2 = 6.5$ kΩ. During the past year we have investigated the effect of shot noise on the SI-transition. A strong modifi-

cation of the Coulomb blockade was observed in the experiments on the insulating phase.

The insulating phase is governed by power-law-like dependence, both as a function of temperature T and voltage V. The exponent of the power law, 2α-2, is governed by the parameter $\alpha = R_C/R_Q$ where R_C describes the dissipative ohmic environment. Hence, in the case of large exponents 2α-2 >> 1, there is a strong influence of tiny changes in temperature on resistance, or alternatively, a high sensitivity to any external noise source. We utilized this phenomenon by turning a Coulomb blockaded Josephson junction into an ultra sensitive noise detector.

Our new method allows measurements of current noise at a level of 0.5 fA/$\sqrt{\text{Hz}}$. The high sensitivity is achieved thanks to the large band width, ~ 1/RC, of the detector junction. The voltage resolution, assuming perfect capacitive coupling from a noise source, is on the order of $5 \cdot 10^{-11}$ $V/\sqrt{\text{Hz}}$. This sensitivity is sufficient to measure, for example, back action noise from a superconducting SET, the experimental study of which has been started.

Bloch oscillating transistor

A Bloch oscillating transistor (BOT) is a new type of a 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 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 investigated the experimental realization of BOTs using four angle shadow evaporation: The base electrode is connected via a Cu-AlO_x-Al SIN junction, the collector has a Cr-resistance of 50 kΩ, and on the emitter there is a tunable, SQUID-type Josephson junction with $E_J/E_C \sim 0.4$ - 4. The maximum current gain, measured so far, is about 30. The input and output impedances were 1 MΩ and 30 kΩ, respectively. The dynamic range was found to be small, about 30 pA. Altogether, we were able to show that a BOT is a good candidate for a low noise amplifier for applications at intermediate impedance levels. These results have been accepted for publication in Science.

Spectroscopy using inelastic Cooper-pair tunneling in Josephson junctions

In addition to the zero bias regime, Coulomb blockaded Josephson junctions can be employed as detectors of phase fluctuations in the subgap region at $2eV > E_C$. According to the so called $P(E)$-theory (phase fluctuation theory), non-coherent Cooper pair tunneling is allowed only if energy is exchanged with the surroundings. Thus, inelastic Cooper pair tunneling can be employed to study environmental modes, including transitions between energy levels of anharmonic oscillators.

Using this method, we have performed detailed spectroscopic investigations on small SQUID loops, which are driven from the nearly classical limit ($E_J/E_C \gg 1$) deep into the quantum regime ($E_J/E_C \sim 1$). Our results yield evidence for higher energy bands of the macroscopic phase variable in a regime ($E_J/E_C \sim 1$) where they have not been investigated before. In addition, our experiments also provide the first verification that multiphoton transitions between the levels of a quantum mechanical harmonic oscillator play a prominent role in electron tunneling in a mesoscopic tunnel junction.

Radio-frequency single electron transistors

A setup for rf-SET measurements was successfully completed. Using Al-devices with $E_C \sim$ 1-2 K a sensitivity of $5 \cdot 10^{-5}\ e/\sqrt{\text{Hz}}$ was obtained. It was concluded that the predicted sensitivity was not reached because of heating of the SET island by the rather large power needed to operate the rf-SET. In order to prevent such a degradation, $E_C \sim$ 10 K is required. The importance of a large E_C is two-fold: it allows larger AC voltage amplitude over the SET and it allows lower normalized temperature t which is hard to reach otherwise due to the heating effects. It is difficult, however, to make SETs with $E_C \sim$ 10 K lithographically from Al, but using carbon nanotubes it is quite straight forward.

Two PECVD nanotubes (see below) with a diameter of 5 nm were tried as rf-SETs in the high E_C regime. The measured diamond patterns showed substantial variation in magnitude, presumably due to the fact that the quantum capacitance of the tubes did not remain fixed. The best charge sensitivity was $1 \cdot 10^{-5}\ e/\sqrt{\text{Hz}}$. This value is an order of magnitude worse than predicted, indicating that there are either inherent fluctuations on the nanotubes or the electron-phonon coupling is extremely weak.

Transport in carbon nanotubes

The electrical properties of carbon nanotubes depend on several factors, *e.g.* the number of concentric layers, number of conducting channels, disorder strength, and carrier concentrations (the level of doping), which can all vary over a wide range and which all are hard to control experimentally. During the past year we have continued our studies on catalytically grown CVD multiwalled carbon nanotubes (MWCNT). Due to strong scattering, the Luttinger liquid model is not expected to work well for our disordered CVD nanotubes. These tubes provide rather unique diffusive systems to study transport in one dimension, with interesting cross-overs to either 0 or 2 dimensions, depending on the diffusion constant and temperature.

Measurements on CVD tubes with good-quality contacts ($R_c \sim$ 1 kΩ) and resistance of $\sim$ 30 kΩ/μm displayed rather large conductance corrections proportional to ln(T), which we have analyzed in terms of the interaction effects. The logarithmic temperature dependence is a rather unexpected finding for a one dimensional sample at low temperatures $T = 0.1 - 1$ K, where both the phase and thermal coherence lengths are less than the length but longer than the circuference of the tube. The logarithmic tempera-

ture dependence is, however, predicted for 0- and 2-dimensional samples. 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.

Using high impedance Al-AlO_x-NT contacts ($R_c \sim 100$ kΩ), we have studied the tunneling density of states for CVD-grown MWCNTs. After tunneling the electron has to penetrate the Coulomb barrier, a time-dependent self energy which reduces the tunneling probability. The self-energy has a maximum value right after the tunneling and decreases as soon as the electron charge is redistributed in the nanotube. Thus, the tunneling density of states is a direct measure of the field diffusion that, in turn, reflects the structure of the nanotube. However, an accurate comparison against theoretical calculations has turned out to be difficult because the differential conductance displays substantial additional variation.

In our future experiments we will turn to cleaner nanotubes. One issue that has not been much investigated so far is the interlayer coupling in MWCNTs. The intershell coupling should be small and, thus, by burning off shells in MWCNTs and by contacting electrically to two different layers, Coulomb drag between two concentric electron gases can be studied. For such experiments we have obtained tubes produced using plasma-enhanced CVD (PECVD) method by S. Iijima in Japan. These tubes have a diameter in the range of 3-10 nm, and they are of better quality and uniformity than the tubes made using previous methods of synthesis. The measured 2-point resistance varies from 10 kΩ to 2 MΩ, which we interpret as depending on whether the outer layer is metallic or semiconducting. Development of methods for burning off layers from these tubes have been started.

Development of measuring facilities for high frequencies

Shot noise measurements of nA-currents require a sensitivity of a few femtoamperes. One way to achieve such a sensitivity is to use SQUIDs as amplifiers. We made a design for a SQUID-amplifier for 100 kΩ sources with 5 MHz band in collaboration with the Microsensing group of VTT Information Technology. According to simulations, the effective noise temperature of the device is on the order of 150 mK, i.e., by a factor of ten lower than in the HEMT based systems. Due to manufacturing problems at VTT, however, the delivery of the amplifier has taken more than a year and it is still at the production stage. We are also developing methods to measure the frequency dependence of quantum noise in mesoscopic circuits. Both SETs and Josephson junctions have been considered as mixers for this kind of work.

For rf-SET read-out, we have developed a compact, low noise 4K preamplifier based on Agilent ATF35143. The amplifier has a small bias current of 8 mA, a gain of 16 dB, and a noise temperature of 3 K. We have also checked various high frequency components, i.e. attenuators, couplers, etc., how they work at dilution refrigerator temperatures.

PICO GROUP

J. Pekola

The PICO research group was founded along the move of Academy Prof. Jukka Pekola from the University of Jyväskylä to Helsinki University of Technology in the fall 2002. In a broad context, the group investigates mesoscopic physics and its device applications. Main focus is on charge transport and thermal properties of both metallic and semiconducting nano- and microstructures at low temperatures. Particular research topics include nonequilibrium in electronic nanostructures, thermometry and electronic cooling, quantum coherence in small Josephson junction devices and quantized and coherent single charge pumping.

The personnel and the lab space of PICO are located in the Micronova building (HUT and VTT research centre for microelectronics and nanotechnology) and in the main premises of LTL. Samples and devices are fabricated in the clean rooms of LTL and of VTT Centre for Microelectronics in Micronova, experiments at low temperatures (0.01 – 4 K) are performed both in Micronova building and in LTL. From the beginning of 2003 the group will consist of two senior researchers (Prof. Jukka Pekola and Dr. Alexander Savin), three graduate students (Jani Kivioja, Jussi Toppari and Antti Niskanen), and one finishing undergraduate student (Jouni Flyktman). On the national level the group has close contacts to the nanoresearch groups at the University of Jyväskylä, at the HUT and the VTT. We collaborate with many research groups in Europe (CNRS Grenoble, SNS Pisa, and several others through EU networks) and with the State University of New York at Stony Brook in US.

The PICO research group has presently direct access to the following experimental facilities:

1) Two ^{3}He/^{4}He dilution refrigerators, one of them down to 10 mK temperature for high frequency experiments, the other one down to 40 mK with only 4 h cooldown time. These are equipped with carefully filtered signal lines for low noise measurements and with Coulomb blockade absolute thermometry (CBT).

2) Nanolithography in the clean room at LTL.

ULTRA-LOW TEMPERATURE RESEARCH ON HELIUM MIXTURES AND LITHIUM METAL (YKI)

K. Luntunen, J. Martikainen, E. Pentti, A. Salmela A. Sebedash, **J. Tuoriniemi**, and J. Vusvuori.

In the mid of the year 2002 the primary research duty at the YKI-cryostat was temporarily shifted from the experiments on helium mixtures to the study of the properties of lithium metal at ultra-low temperatures. At the same time the main responsibility of the daily upkeep of the cryostat was transferred from J. Martikainen to K. Luntunen.

During the first half of the year 2002 the work on ^{3}He/^{4}He-mixtures was continued, as planned, by performing experiments at elevated pressures up to 10 MPa so that the

maximum ^{3}He-concentrations could be increased to 9.5 %. These measurements completed our studies of the dilute ^{3}He-quasiparticle gas both in the hydrodynamic and ballistic regimes by means of an extremely sensitive SQUID-amplified vibrating-wire resonator. The new data form a consistent extension to our previous observations although not all details of the discovered behavior are yet fully understood. No indication of the searched superfluid transition of the ^{3}He component was obtained. The model calculations of the thermal behavior of the experimental cell were continued to aid determining any possible improvements to the setup and its performance.

The experiments on lithium aim, on one hand, at observing the superconductivity of this metal, speculated to occur at millikelvin temperatures, and, on the other hand, to study the nuclear magnetism of this light element. We have cooled down two different types of lithium samples: fairly bulky semispherical lumps with a radius of the order of 1 mm, hermetically shielded by a copper capsule and well protected against ambient magnetic fields in order to allow a superconducting transition to occur even with an extremely low critical magnetic field, and thin samples for NMR-measurements, flattened to about 50 µm, sealed between thin copper foils and placed inside the second stage superconducting magnet in order to perform cascade adiabatic nuclear demagnetization cooling on the sample. For the superconductivity samples we have made, tested and assembled very effective multi-layered magnetic shields, in which the magnetic field has been verified to remain below 20 nT upon cooling down the system and which have a shielding factor of the order of one million against the stray magnetic fields in the cryostat. The lithium lumps within these shields have been cooled down to 100 µK – no superconducting transition has been observed, but, instead, very interesting magnetic behavior was found below about 500 µK. We observe several magnetically ordered phases as the function of the temperature and the magnetic field below 1 µT. We also have some preliminary data on the NMR sample. We have been able to observe many of the standard features of highly polarized spin systems. In addition to these we find an unexpectedly strong low frequency response, which suggests that the nuclear spin system exhibits a ferromagnetically ordered state at surprisingly high nuclear spin temperatures. This can be understood only if an exceptionally strong exchange process is active in lithium.

The preparations for the second set of experiments on ^{3}He/^{4}He-mixtures have been continued in collaboration with Kapitza Institute, Moscow. Some auxiliary devices developed for this project have been tested in the cryostat at microkelvin temperatures in parallel with the work on lithium. The plan for the future is to utilize a novel method of cooling the ^{3}He/^{4}He mixtures by adiabatic melting of solid ^{4}He. The essential feature is to produce self-cooling in the liquid and so completely eliminate the enormous thermal barrier between the liquid and any external refrigerant. The cooling effect will occur due to the absorbed heat of mixing when the ^{3}He component will dissolve into ^{4}He once the ^{4}He crystal is allowed to melt. The copper nuclear stage of our refrigerator will be employed for pre-cooling the ^{3}He component below its superfluid transition temperature prior to the adiabatic melting of ^{4}He.

TOPOLOGICAL OBJECTS IN COHERENT QUANTUM SYSTEMS

R. Blaauwgeers, S. Boldarev, V. Eltsov, A. Finne, J. Kumpula, **M. Krusius**

Visitors: G. Eska, L. Skrbek

This research project studies experimentally topologically stable defect structures which are formed in the order parameter field of coherent quantum systems. The most widely known example of such defects is a quantized vortex line. The largest variety of defects of different dimensionality, topology, and structure have been identified so far in the ^{3}He superfluids which are described by a multi-component order parameter field.

During the last two years our work has been concentrated on studying a two-phase system where a stable first order phase boundary divides a long cylindrical sample into equal sections of two superfluids, ^{3}He-A and ^{3}He-B. Since these two fluids are phase coherent across their interface, this situation gives rise to unusual phenomena when the sample is slowly accelerated to uniform rotation. The most important issue is an instability of the AB boundary, where the originally smooth interface becomes corrugated by surface ripplons. This surface instability between two superfluids is closely related to the famous Kelvin-Helmholtz instability of classical hydrodynamics. It was first solved by Lord Kelvin in 1871 for ideal inviscid and incompressible fluids. He considered two stratified fluid layers of different density in the gravitational field which are flowing tangentially at varying velocities with respect to each other. Our example is the first case of its kind in coherent quantum systems.

Superfluid analogue of the ideal Kelvin-Helmholtz instability

The phase boundary between the A and B phases of superfluid ^{3}He is stabilized in the magnetic field gradient of a solenoidal superconducting magnet. Using nuclear magnetic resonance techniques, the evolution of quantized vorticity as a function of rotation Ω is monitored in the two phases.

There exists a large difference in the topology and structure of vortex lines in the two phases. This gives rise to an energy barrier, which prevents vortex lines from crossing the AB interface. When the difference in the number of vortex lines between the two phases increases, their relative tangential (or shear) velocity increases. Ultimately at some critical angular rotation velocity Ω_c, the stability limit of the interface is reached, it suffers an instability and becomes corrugated in a standing wave pattern. The vorticity in the deepest corrugation of the interface then penetrates across the interface from the A-phase section to the B phase. This process occurs in a sudden burst, as a rapid non-equilibrium event, in which a small random number of circulation quanta breaks through the AB interface. After the event the phase boundary stabilizes, since the velocity difference between the two superfluids is now reduced. If the rotation continues increasing, then the instability happens repeatedly at a constant value of B-phase superflow velocity.

We have found that the critical velocity of the superfluid Kelvin-Helmholtz instability obeys a dependence on temperature and stabilizing magnetic field which closely follows the predictions of a formula analogous to that which was derived by Lord Kelvin. Thus the instability can now be used as a well-behaved method to inject a small random number of vortex loops from the AB interface into the vortex-free superflow on the B-phase side. By varying the temperature T or the current in the stabilizing solenoid, the injection point can be continuously scanned in a predictable manner across the (Ω,T) plane. This property we have used to examine the fate of the injected vortex loops in the B-phase superflow.

Transition to superfluid turbulence

It has been known since the mid 90ies that a vortex loop in the B phase, which is injected in high-velocity vortex-free superflow, expands to a single rectilinear vortex line in the rotating state. This has been observed in a number of detailed measurements with single-vortex resolution. On the other hand, more recent measurements in the Lancaster University have indicated that below 0.2 T_c tangled vorticity can be generated even in a quiescent bath of ^{3}He-B with an object which moves at a sufficiently high velocity. Controlled vortex-loop injection in ^{3}He-B, using the superfluid Kelvin-Helmholtz instability, provides an efficient tool to resolve this controversy.

The initial state in our measurements is vortex-free superflow of ^{3}He-B. Vortex loops are injected at a controlled temperature and flow velocity. We then determine the total number of rectilinear vortex lines in the final stable state. These measurements have shown that at $(0.6 \pm 0.03)\ T_c$ an abrupt transition takes place in the character of the dynamic process by which the vorticity evolves following the injection: Above 0.6 T_c a loop expands in a stable manner to a single rectilinear vortex line. Below 0.6 T_c even a single vortex loop in a dynamic state is unstable and gives rise to a dense vortex tangle. The tangle fills the entire ^{3}He-B sample width at a density which already exceeds the equilibrium value, but which has the polarization of the equilibrium state, such that no large-scale superflow remains. The tangled vorticity then decays into an equilibrium cluster of rectilinear vortex lines. This means that below 0.6 T_c the final state of the sample, after injection of any number of vortex loops, is invariably found to be the equilibrium state in rotation.

The abruptness of the transition between the two types of vortex loop expansion is surprising. The explanation for the transition has been traced to the temperature dependence of mutual friction: At 0.6 T_c the critical parameter describing the effect from mutual friction drops below a critical value and Kelvin oscillations of a vortex line are not any more critically damped below this temperature. When a section of a vortex in this temperature regime is oriented along the superflow, it becomes unstable with respect to a corrugation instability. This leads to the formation of loops which reconnect and multiply into tangled vorticity. The NMR absorption measurement also provides a direct signal from the epoch of tangled vorticity. This signal monitors the decay of the vortex density when it relaxes towards that of the equilibrium state in rotation. These

results demonstrate for the first time the existence of a critical parameter, which depends only on the superfluid properties and which regulates the occurrence of turbulence. In ^{3}He-B we are fortunate to find this parameter to traverse its critical value in the middle of the experimentally accessible temperature range.

The need for more follow-up measurements

A whole complex of new questions can now be asked about the superfluid Kelvin-Helmholtz instability and its applications. So far the measurements have been performed at high liquid pressures of 29 and 34 bar. Does the present understanding also explain the superfluid Kelvin-Helmholtz instability and the transition to turbulence at low pressure and particle density? Grigory Volovik has predicted that there exists another branch for the critical superflow velocity which governs the stability of the AB interface in the $T \to 0$ limit. This branch lies higher by a factor of $\sqrt{2}$ compared to the branch studied until now. The present measurements down to a temperature of 0.4 T_c do not show any such increase. For more definitive answers the temperature dependence should therefore be examined to below 0.2 T_c. The decay of the initial turbulent vortex tangle should be measured as a function of temperature also down to the lowest temperatures, to explore the mechanisms by which a tangled vorticity decays in the $T \to 0$ limit.

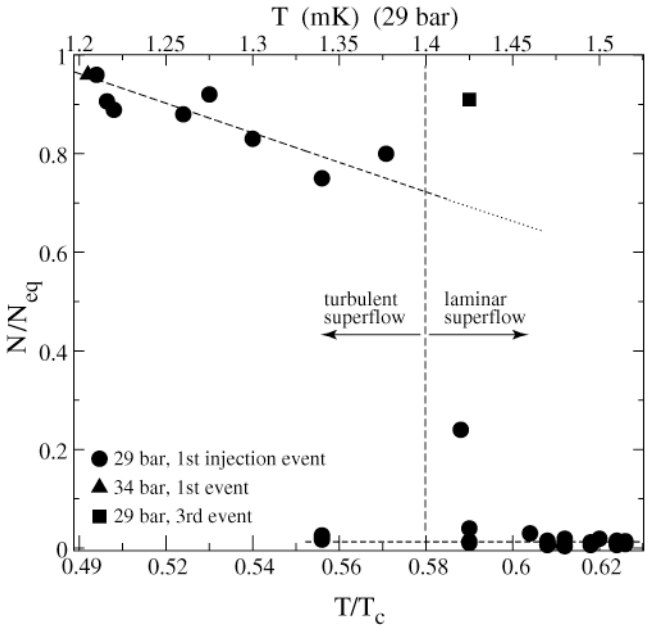

Fig.1. Relative number of rectilinear vortex lines N/N_{eq} in the final stable state after the injection, measured as a function of temperature. This plot demonstrates the abruptness of the transition from a final state with a few vortex lines above 0.6 T_c to one which is essentially the equilibrium state below ~ 0.54 T_c. Here the injection method has been a sudden leak of a small number of vortex lines through the orifice which separates the initially vortex-free sample from the rest of the liquid ^{3}He volume.

Reconstruction of the rotating refrigerator

In the continuation we plan to extend our measuring range to lower temperatures. A new refrigerator insert has been constructed by Sergey Boldarev for this purpose. It will be installed in place of the existing ^{3}He-^{4}He dilution refrigerator which is presently used for precooling the nuclear cooling stage of the rotating cryostat. The new precooler has been designed to produce a lower minimum temperature and to achieve a larger cooling power. In separate running tests the insert was found to cool with a heat load of 2 μW to below 10 mK. The minimum temperature was insensitive to the ^{3}He circulation which could be varied between 0.3 and 0.7 millimole/s. The new insert will be installed during the current year.

INTERFACES IN QUANTUM SYSTEMS

H. Alles, H. Junes, I.A. Todoshchenko, and V. Vaskelainen

Visitors: R. Jochemsen and A.Ya. Parshin

At low temperatures the crystal surface in equilibrium with its liquid or vapor phase is a smooth flat face, a facet, which nearly coincides with one of the crystal lattice planes. The increasing thermal fluctuations cause the facet to disappear at a certain higher temperature, at the so-called roughening transition above which the crystal surface becomes rough (rounded). As there is an infinite number of different crystallographic orientations, the real crystals should show many types of facets at low temperatures. However, it has been predicted that the helium crystals, the best candidates for studying the roughening transitions and faceting, should show only a few types of facets as the large zero-point fluctuations would keep some parts of the surface rough and the higher order facets could not be observed. These zero-point fluctuations are, at the same time, also the reason why the liquid/solid interface of helium, contrary to all other liquid/solid interfaces, exists down to the absolute zero and enables thus the studies at ultra low temperatures. Compared with ordinary crystals the dynamics of helium crystals is very fast at low temperatures because the crystals are surrounded with a superfluid with good thermal conductivity and the latent heat of crystallization is small.

During recent years the Interface Group has been concentrating on the studies of *bcc* ^{3}He crystals by interferometric means. We have built a unique Fabry-Pérot interferometer inside our nuclear demagnetization cryostat and discovered already in the first set of experiments that ^{3}He crystals show actually many different types of facets as we identified more than ten types of facets at 0.55 mK. We measured also the growth anisotropy of ^{3}He crystals and extracted the step free energies of different facets. Before our measurements only three types of facets have been found both in ^{4}He and ^{3}He. The interpretation of our results is such that contrary to expectations the coupling of the liquid/solid interface to the crystal lattice is much stronger in ^{3}He compared with ^{4}He in spite of larger zero-point oscillations in ^{3}He.

Unlike ^{4}He, in ^{3}He also the magnetic properties can be studied thanks to a nonzero nuclear spin of a ^{3}He atom. Above the Néel temperature (T_N = 0.93 mK at the melting pressure) the nuclear spins of solid ^{3}He are disordered. During 2002 we have performed the measurements on the growth kinetics of ^{3}He crystals near T_N and found, for a surprise, that above T_N, in the paramagnetic phase the (100) facets have the lowest mobility instead of the (110) facets which have the largest step height in the *bcc* lattice and should be the slowest facets if one assumes the well-known spiral growth mechanism. At the moment there is no clear explanation to that experimental finding.

Below T_N the nuclear spins of ^{3}He are believed to transform into an antiferromagnetic up-up-down-down (u2d2) structure and we have found that below the antiferromagnetic transition the two basic facets (110) and (100) reveal two different growth dynamics. The facets can grow either in a "fast" spiral growth mode which was observed already in our earlier experiments at our lowest temperature of 0.55 mK or in a slower mode which is characterized by a small, temperature-independent mobility. We attribute this additional growth resistance in the slower mode to the presence of the surface magnons which could exist at certain orientations of the antiferromagnetic domain with respect to the surface.

Each type of facets has its own roughening transition temperature and above all roughening transition temperatures the equilibrium crystal shape should be rounded as a honey drop at a table. In ^{3}He no facets have been seen above about 100 mK. It is believed, however, that the roughening transition of the (110) facets on *bcc* ^{3}He crystals is at much higher temperature, probably about 0.26 K as deduced from the surface tension measurements by Rolley *et al.* In order to clear out the situation we are currently in a progress to perform a systematic study on the shape of ^{3}He crystals in the temperature range of (80…120) mK. In this temperature range, additionally to the large latent heat of crystallization the thermal conductivity of the normal ^{3}He liquid is very poor and the dynamics of crystals is very slow as in ordinary crystals.

THEORY

T. Heikkilä, R. Hänninen, N. Kopnin, J. Viljas, and **G. Volovik**

Visitor: E. Thuneberg, University of Oulu

Superfluid ^{3}He

Superfluid ^{3}He-A has domain-wall like structures, which are called solitons. We study the effect of solitons on the NMR spectrum by calculating the frequency shifts and the amplitudes of the soliton peaks for both longitudinal and transversal oscillations of magnetization. The effect of dissipation coming from normal-superfluid conversion and spin diffusion is calculated. The calculations are in good agreement with experiments except a problem in the transversal resonance frequency of the splay soliton.

We study the Josephson effect in superfluid ^{3}He by solving numerically the Ginzburg-Landau equations for a two-dimensional weak link. We study symmetry properties of the energy functionals, and their relation to the conserved supercurrents which play an essential role in the weak link problem. The bulk phases on the two sides of the weak link can be chosen separately, and very general soft degrees of freedom may be imposed as boundary conditions. We study all four inequivalent combinations of A and B phases which are possible for a hole in a planar wall, including weak links with a pinned A-B interface. In all cases, some illustrative current-phase relations (CPR's) are calculated and the critical currents are mapped. Phase diagrams covering the relevant phase space in zero magnetic field are constructed.

Vortices on the A-B interface were studied by numerical simulation. The order parameters of both A and B phases we discretized on a two-dimensional lattice. The initial states of a continuous vortex and a vortex sheet were found to lead to the same continuous structure when pressed against the A-B interface by net superflow. Two different structures of the surface vortex sheet were found as a function of the superflow velocity.

Condensed matter and cosmology

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. The monograph by professor Volovik, "The Universe in a Helium Droplet", where the basic ideas of connections between condensed matter, cosmology and high-energy physics are presented, will be published by Oxford University Press in 2003.

These connections allow us to simulate the least known features of high-energy physics and cosmology, the properties of the quantum vacuum. In particular, the vacuum energy estimated using the methods of particle physics is now in huge disagreement with modern cosmological experiments. This is the cosmological constant problem. A major advantage of condensed matter is that it is described by a quantum field theory in which the properties of the quantum vacuum are completely known from first principles: They can be computed, at least numerically, and they can be measured experimentally in a variety of quantum condensed matter systems, such as quantum liquids, superconductors, superfluids, ferromagnets, etc. We have shown, for example, how the cosmological constant problem can be solved using the quantum-liquid analogy of the quantum vacuum: The trans-Planckian degrees of freedom of the quantum vacuum completely cancel the big cosmological constant without any fine-tuning. This is the

result of the stability of the quantum vacuum. If the vacuum is out of equilibrium, the cancellation is not complete, and the deviations from the homogeneous state lead to a non-zero but small cosmological constant, in agreement with observations.

This theoretical work is closely connected to the experimental effort in the laboratory, where the analog of the Kelvin-Helmholtz instability has been found and investigated at the interface separating two superfluids, or separating two domains of the same fluid which move with different velocities. While in conventional liquids and gases the mathematical descriptions of interfacial instability are inevitably only approximate, since they often neglect viscosity. It appeared that superfluids are the only real ideal objects where mathematical descriptions can be implemented without reservations. ROTA group made the first experiment where the perfect situation for the investigation of the Kelvin-Helmholtz instability was achieved. The stable nondissipative initial state is the vortex sheet between two superfluids was prepared, and the critical velocity of instability of the vortex sheet was manifested by formation of vortices.

We modified the theory of Kelvin-Helmholtz instability to the case of two-fluid dynamics in superfluids. The obtained criterion for the instability is in a good agreement with experimental data for the critical velocity of the onset of instability. It appeared that the mechanism of the interface instability has many common features with the vacuum instability beyond the horizon of the black hole, if the black hole lives on a brane embedded in higher dimensional space. The idea that our Universe lives on a brane embedded in higher dimensional space is popular at the moment. It is based on an old idea of extra compact dimensions introduced by Kaluza and Klein. Branes can be represented by topological defects, such as domain walls (membranes), strings and interfaces between different quantum vacua. In the ROTA experiments the role of the brane is played by the interface between two superfluid phases two quantum vacua. The interface instability is analogous to the vacuum instability beyond the horizon caused by interaction of matter living on brane, represented by the surface waves ripplons, with the matter living in higher-dimensional space represented by quasiparticles in bulk superfluids.

In principle, it is possible to construct the experimental cell with the shallow water geometry, where the spectrum of ripplons becomes “relativistic”, and the analogy with the black-hole horizon becomes exact. This will allow us to investigate experimentally different mechanisms of the vacuum decay inside the black hole, and also to simulate the physical singularity inside the horizon. At low temperatures we expect that the time of the decay of our black hole will be long enough to study the other properties of the black hole, such as the Bekenstein entropy related to the black-hole horizon, Hawking radiation, and Corley-Jacobson lasing effect. We analyzed theoretically the entropy related to the black-hole horizon using this quantum-liquid analogy.

Recent ROTA experiments with the interface demonstrated also that under special conditions the interfacial instability produces the turbulent flow of the superfluid component. We analyzed this turbulent state and conditions under which it arises, and

found that this represents a new class of turbulence which can shed light on the phenomenon of turbulence in general.

Vortex dynamics

The other theoretical activity was devoted to the novel organization of the quantum vorticity revealed by the ROTA group experiments. In isotropic macroscopic quantum systems vortex lines can be formed while in anisotropic systems also vortex sheets are possible. Based on measurements of superfluid ^{3}He-A, we present the principles which select between these two competing forms of quantized vorticity: sheets displace lines if the frequency of the external field exceeds a critical limit. The resulting topologically stable state consists of multiple vortex sheets and has much faster dynamics than the state with vortex lines. We also considered the structure of the experimentally observed vortex sheet formed at the interface between the vortex-full and vortex-free superfluid phases, and the transformation of the bulk vorticity into the sheet vorticity.

Studies of the vortex dynamics are continued. The main results are summarized in the Review by professor Kopnin, `Vortex dynamics and mutual friction in superconductors and Fermi superfluids', Reports on Progress in Physics **65**, 1633-1678 (2002). The role of quasiparticle excitations is elucidated. Excitations in vortex cores in superconductors and other Fermi superfluids are single-particle excitations with a peculiar energy spectrum. These excitations which are similar to fermion zero modes on cosmic strings are responsible for many important thermodynamic properties of superfluids and superconductors, such as specific heat, London penetration length, etc. They also determine dynamic characteristics of superconductors and superfluids through their interaction with vortices. Flux flow resistance, the Hall effect in type II superconductors and the mutual friction in superfluids are the most important phenomena that strongly depend on vortex core excitations. These phenomena determine electromagnetic responses of type II superconductors and the hydrodynamic behavior of superfluids and are of great significance for practical applications of superconducting devices and for understanding of the most fundamental properties of correlated electrons and other Fermi particles. In this review we consider the dynamic properties of superconductors and superfluids and outline the basic ideas and results on the vortex dynamics in clean superfluid Fermi systems. The forces acting on moving vortices are discussed including the problem of the transverse force, which was a matter of confusion for quite some time. We formulate the equations of the vortex dynamics, which include all the forces and the inertial term associated with excitations bound to the moving vortex.

Mesoscopic electronics

Theoretical studies of mesoscopic superconductors (by N. Kopnin) were concentrated on properties of ballistic point contacts and on the role of weak disorder. It is shown that weak impurity scattering produces a narrow band with a finite density of states

near zero energy in the mid-gap energy spectrum of a macroscopic superconducting weak link. The equivalent distribution of transmission coefficients of various conducting quantum channels is found that reproduces the microscopic density of localized states in the contact. It is also found that multiple Andreev reflections mediating the transport in superconducting point contacts are strongly affected by a small amount of impurities in the area of the contact. We also argue that the model based on Zener transitions within independent conducting channels is not suitable for kinetic processes in multichannel contacts.

The theoretical research in the Nano and Pico groups (by T. Heikkilä) is closely related to the experimental activities in the two groups, on the quantum-mechanical phenomena in tiny Josephson junctions and on nonequilibrium effects in normal-superconducting heterostructures. Under special scrutiny are the superconductor-insulator transition in small superconducting junctions and the effect of a nonlinear environment on the superconducting phenomena. These subjects are also relevant for quantum computing. Related research is carried out on the statistics of current fluctuations in the measurements of quantum-mechanical phenomena. In the normal-superconducting structures we concentrate on studying the nonequilibrium energy distributions of electrons and its effect on the so-called supercurrent transistor.

COMPASS SPIN POLARISED TARGET (CERN AND HIP)

P. Berglund, J. Koivuniemi and K. Gustafsson (HIP)

Our role in the COMPASS experiment is maintaining, operating and developing the dilution refrigerator, which is essential to a properly functioning target. The target group consists of about 25 members from 7 institutes from Finland, France, Germany, Japan, and Switzerland. About 5 of these members are permanently at CERN, but the number varies all the time.

The COMPASS target is described in

http://wwwcompass.cern.ch/compass/detector/target/welcome.html

The homepage of COMPASS is

http://wwwcompass.cern.ch/

In 2002 our personnel contribution at CERN was augmented by 1 person as Dr. Kenneth Gustafsson joined the target group. After successfully contributing to the target activity Gustafsson shifted his interests from the target towards offline analysis of data stability and development of software tools.

During the run between 27th of May and 18th of September about 260 TBytes of data was taken. High average target spin polarisations of +54% and -46 % were achieved in both longitudinal and transverse modes. The target operated well during the 100 days of data taking. In 2003 the same target material 6LiD will be used. The material has been produced at Bochum and has high effective polarisation per nucleus with high density of deuterons.

The COMPASS experiment has two main physics subprograms: the presently active muon program and the future hadron program. Both subprograms have multiple physics goals. The main goal of the muon program is measuring the contribution of the gluons to the spin of the nucleon, the so-called ΔG/G quantity. The photon-gluon-fusion (PGF) is the favored process.

A second physics goal of the muon program is measuring the so-called "transversity" of the nucleon. Transversity, i.e. the transverse spin distribution of the quarks of the nucleon, has never been measured before. The expected precision of the transversity measurement is presently lower as the old, smaller acceptance SMC magnet is used, instead of the planned Oxford Instrument Systems magnet. However, there exists a strong interest in measuring transversity in the particle physics community. This interest has been fueled by the progress being made on the theory side in the past decade. The transition from Deep Inelastic Scattering (DIS) to semi-inclusive DIS presently enables transversity measurements both at the DESY-Hermes experiment and at COMPASS. In practise transversity is measured by detecting the scattered muon and the leading pion (current fragment) in the transverse mode. The azimuthal angle of the pion distribution carries information on the transverse spin of the struck quark of the nucleon.

BRAIN RESEARCH UNIT

Functions of the human cerebral cortex have been studied by measuring magnetic fields from outside of the head. The magnetoencephalographic (MEG) method allows totally non-invasive studies of healthy and diseased human brain 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). Since 1994, an important part of the research has been done in collaboration with European scientists visiting the laboratory through the Neuro-BIRCH (Biomagnetic Research Center in Helsinki) Large-Scale Facility, financed by the European Union. The third funding period of the Large-Scale Facility (Neuro-BIRCH III) started in April 2000 and will continue until September 2003.

In 2002 we were happy to add a new complementary method to our brain research tools, the functional magnetic resonance imaging (fMRI). Advanced Magnetic Imaging (AMI) Centre was inaugurated in February 2002 at the HUT campus, and it operates a 3 Tesla MRI/fMRI superconducting magnet (General Electric 3T Signa) for whole-body imaging — the only high-field magnet in Nordic countries so far. MEG with its superb temporal resolution complements fMRI that has excellent spatial resolution.

AUDITION, TOUCH, AND AUDIOTACTILE INTERACTION

G. Caetano, **N. Forss,** R. Gobbele, **R. Hari**, Y. Hlushchuk, M. Illman, **O. Jensen**, **V. Jousmäki**, K.-I. Kaneko, R. Lehtonen, **J. Mäkelä**, L. Parkkonen, H. Renvall, **M. Schürmann**, **C. Simões**

Binaural hearing

We recently introduced a novel "frequency-tagging" method to follow inputs from each ear to the auditory cortices of both hemispheres. The method relies on labeling of continuous tones with amplitude modulation that was of different frequency in the left and right ear. Both hemisphere- and ear-specific information was obtained on binaural interaction by analyzing the cortical MEG signals in frequency and time domains.

As the method has potential value for assessing plastic changes in patients with unilateral hearing deficits, we studied 10 healthy adults to find out relationships between stimulus intensity and binaural interaction. Cortical signals were measured to amplitude-modulated sounds (carrier frequency 1 kHz), presented monaurally or binaurally at 45, 60 and 75 dB SL. The modulation frequencies were 39.1 Hz for the right ear and 41.1 Hz for the left. We found stronger suppression of ipsilateral than contralateral responses in both hemispheres during binaural stimulation, a shift of hemispheric balance towards the contralateral hemisphere for inputs from both ears during binaural stimulation, and similar patterns of binaural interaction at all three stimulus intensities. This type of information will be useful when the method will in the near future be applied to studies of patients with congenital hearing deficits.

Brainstem auditory evoked magnetic fields

The work on the magnetic brainstem responses continued by source modelling attempts. Conventional ECD models gave reasonable source estimates. However, these models were further augmented by using high-accuracy BEM conductor models and the Galerkin method; still the improvement over normal BEM models was smaller than expected. Thus, it seems that most of the inaccuracy in the source locations is attributable to the multiple generator sites that are simultaneously active particularly during the later brainstem responses, thus rendering single dipole models insufficient.

Distal-to-proximal finger representation in area 3b

In area 3b of the monkey primary somatosensory cortex SI, the proximal phalanxes of the fingers are represented close to the surface and the fingertips in the depth of the central sulcus. To study whether a similar arrangement might exist in humans, we applied tactile stimuli to the distal and proximal phalanxes of the index finger of 11 healthy adults. The sources of MEG responses to the proximal stimuli were located on average 3 mm ($p < 0.003$) deeper in the posterior wall of the central sulcus to distal than proximal stimuli, thereby suggesting that the distal-to-proximal representation of

the human index finger in theSI cortex is similar in arrangement and extent to that in monkeys.

Interaction between the SI and SII cortices

Phase-locking between neuronal networks has previously been proposed as a mechanism for integration and exchange of information. To learn about the functional relationships between the primary and secondary somatosensory cortice (SI and SII), we computed phase-locking values between MEG signals elicited by electrical stimulation of the right median nerve. We observed statistically significant phase-locking, at frequencies of ~20 Hz and about 80–90 ms after the stimuli, between sensors picking up signals from the left SI and the right SII cortices. Further analysis, by means of phase-locking statistics, showed that a substantial part of the SI–SII phase-locking remained unexplained by common phase-locking to the stimuli, thereby implying intrinsic interaction within the somatosensory network. These findings reveal a unique interaction in the sensorimotor system.

Audiotactile interaction

In daily life, humans typically process stimuli of more than one sensory modality at the same time. We have now also demonstrated that “hands may help hearing”: Nine normal-hearing subjects performed a loudness-matching task, adjusting a probe tone to sound equally loud as a reference tone. When the subjects were simultaneously touching a tube that vibrated in synchrony with the probe tone, they chose on average 12% lower intensities than when they did not touch the tube, suggesting facilitatory interaction between auditory and tactile senses.

On the other hand, we found suppressive audiotactile interaction in an MEG study when the subjects received unilateral tone pips or electric median nerve stimuli, or both stimuli simultaneously, alternately to the left and right side. Interaction occurred at about 80 ms in the contralateral posterior parietal cortex and at 100–130 ms in the contralateral parietal opercula between the SII cortex and the auditory cortex. The interaction was significantly stronger in the left than the right hemisphere, and in most subjects the interaction likely resulted from inhibition of auditory responses during the spatially and temporally concordant audiotactile stimulation.

Tactile processing in dyslexic adults

We have previously shown by psychophysical tests and with MEG recordings that dyslexic adults are slow in processing auditory and visual stimuli presented in rapid succession. As a novel interpretation, we recently proposed sluggish attentional shifting (SAS) to be the cause of these deficits. Because the SAS theory would predict pansensory deficits, we recorded somatosensory evoked fields to repetitive tactile stimuli from 8 dyslexic and 8 normal-reading adults. Three successive stimuli, produced by diaphragms driven by compressed air, were delivered to thumb, index finger, and thumb in

sequence at stimulus-onset-asynchronies of 200 ms and 100 ms in different runs. The results demonstrate abnormal response recovery in the right somatosensory cortex of dyslexic subjects, in agreement with the proposed pansensory nature of processing deficits in dyslexia.

CORTEX-MUSCLE COHERENCE

R. Hari, O. Jensen, V. Jousmäki, M. Pohja, and S. Salenius, and A. Stancak

Reproducibility of cortex–muscle coherence

Cortex–muscle coherence has been increasingly applied in the investigation of movement disorders, for example tremor, Parkinson's disease, dystonia, and cortical myoclonus. However, feasible application of the corticomuscular coherence in the follow-up or routine clinical studies requires information on the reproducibility of its strength and frequency in repeated studies and on the variability of these values in normal healthy subjects.

We quantified cortex–muscle coherence in healthy subjects who were repeating unilateral and bilateral isometric hand muscle contractions twice within the same measurement. The results of the repetitions were highly similar, with correlation coefficients of 0.79–0.89 for coherence strength and 0.82–0.84 for frequency

Bimanual movements and coherence

Cortx-muscle coherence has been typically observed mainly during static contractions, hold-ramp-hold movements, or following phasic movements, but not during continuous dynamic movements. We asked the subjects to perform bimanual movements involving slow, continuous symmetric and asymmetric movements, or steady contraction of one hand and continuous alternate movements of the other. MEG–EMG coherence was seen at 15–45 Hz during continuous dynamic movements. In addition, MEG-EMG coherence for the isometrically contracting muscle showed amplitude modulation paralleling the right hand's back-and-forth movements.

CORTICAL ACTIVATION ASSOCIATED WITH PAIN

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

Most pain is caused by injury or inflammation. Although unpleasant, it serves an important role in alerting for impending tissue damage, and in enforcing to rest after injury to promote healing . However, as pain becomes chronic it looses its beneficial function and turns out to be only destructive. In order to understand pain processes and the neuropathological mechanisms underlying chronic pain, neural basis of acute pain in healthy subjects must be conceived.

Acute pain in healthy subjects

We use a thulium-YAG stimulator (BLM 1000 Tm:YAG®, Baasel Lasertech, Starnberg, Germany) that produces brief laser stimuli (1 ms in duration, 2000 nm in wavelength) to selectively activate the nociceptive nerve fibers of the skin. Our earlier studies have shown that the earliest cortical responses to laser stimuli applied to hand dorsum peak at 150–200 ms, corresponding to conduction velocity of 5–7 m/s and thus to activation of myelinated Aδ-fibers. To stimulate selectively the small, unmyelinated C-fibres of the skin, we restricted the beam to a tiny (0.2–0.3 mm^2) skin area. The cortical responses following this type of laser stimuli peaked at about 840 ms, corresponding to conduction velocity of unmyelinated C-fibres. Our recordings in healthy subjects indicated that the two nociceptive fibre systems, Aδ- and C-fibres, can be selectively and reliably stimulated.

Cortical processing of painful stimuli

As the next step, we compared cortical activation patterns to stimulation of these different pain fibres. The results showed that Aδ- and C-fibre mediated nociceptive inputs are processed within different time windows in a common cortical network that includes the bilateral SII cortices and the posterior parietal cortex (PPC). The strong, consistent activation of the SII cortices, together with the lacking or very weak SI activation, could indicate that the SII cortex is the "primary" projection cortex for pain. The observed PPC activation may be related to sensorimotor coordination targeted to produce precise motor acts to reduce or prevent the pain; continuous evaluation of the perceived pain may also accentuate activation of the PPC. Reliable temporospatial characterization of cortical responses to first and second pain offers an unique tool to study two distinctive pain fibre systems on a cortical level and thus may open new possibilities in clinical applications.

Coupling of nociceptive and motor cortices

Pain is often associated with muscle tension. Combination of these symptoms may lead to a vicious circle in which muscle tension elicits pain and the pain further enhances the painful muscle contraction. It is, however, not fully understood how the pain increases muscle tension.

As suppression of the motor-cortex spontaneous ~20 Hz oscillations have been shown to indicate excitation of the MI cortex, we monitored modulation of ~20 Hz oscillations during selective thulium-laser stimulation of either Aδ- (first pain) or C-fiber (second pain) endings in 9 healthy subjects. The ~20 Hz rhythm was significantly suppressed after both Aδ- and C-fiber stimuli. The onsets of the ~20 Hz suppressions coincided roughly with the peaks of the simultaneously recorded evoked responses from the contralateral SII cortex, and the excitation lasted for about 1 s after the laser pulse. These results indicate functional connection between nociceptive system and the primary motor cortex; the primary motor cortex is automatically excited by both Aδ- and

C-fiber mediated noxious input. Such mechanism may normally serve to facilitate goal-directed protective movements. Excitation of the MI cortex by noxious input may also explain the abnormal muscle tension frequently associated with pain.

VISUAL BRAIN FUNCTIONS

J. Bullier (Toulouse, France), M. Dojat (Grenoble, France), R. Goebel (Maastricht, The Netherlands), **R. Hari**, R. Näsänen (Finnish Institute of Occupational Health), **J. Päällysaho**, A. Raninen (University of Helsinki), C. Segebarth (Grenoble, France), S. Smeets, (Maastricht, The Netherlands), T. Tanskanen**, S. Vanni**, J. Warnking (Grenoble, France)

Timing in human visual processing

We combined data from surface-oriented fMRI analysis and retinotopic mapping with source models of visually evoked potentials (VEPs). We were able to strongly constrain the VEP source model in the retinotopic areas, whereas areas higher in the anatomical hierarchy were inversely modelled. We used Brain à la Carte toolbox (from Grenoble) and developed further functions to extract the position and orientation of current dipoles from fMRI data. The fMRI data were projected onto an anatomical model of the gray matter where the position and orientation of surface was known at each point. This method was further applied to study interactions between two patterns in the visual field, with the aim to find out the first areas integrating spatial information across the visual field, and to follow their timing using fMRI-constrained MEG source models.

Cortical plasticity in hemianopia

Homonymous hemianopia (blindness of the left or right visual hemifield) follows from a lesion to primary visual cortex or the end of the pathway (radiatio optica) conveying information from the eye to the cortex. In this ongoing MEG study we follow patients with homonymous hemianopia during their rehabilitation. In our earlier study we found that after rehabilitation with flickering stimulus, the temporal lobe contralateral to the affected visual field generates stronger responses than the corresponding area after stimulation of the healthy hemifield. We suggested that this response is compensatory to reduced efficiency of the low-level visual processing when the primary visual area or radiatio optica are damaged. The patients are now rehabilitated for one year and followed with MEG at two-month intervals.

Combined fMRI–MEG study of visual cortical functions

In this ongoing study the aim is to study interactions in human visual cortex by combining MEG and fMRI methods. First the individual retinotopic mapping of the visual cortices is found by means of fMRI and then that information is used for selecting in-

dividually suitable stimulus locations for MEG recordings. The cortical patches are stimulated by presenting coherent and incoherent motion at the corresponding locations of the visual field, and then synchrony between the stimulated cortical patches will be analyzed. Several MEG and fMRI recordings have been carrried out to settle the final experimental setup. In MEG recordings, different stimulation sites were tagged with different stimulation frequencies which allow the corresponding brain areas to be differentiated in frequency domain. The first fMRI mappings suffered from signal losses in the posterior parts of the brain but now the causes for these field-inhomogeneity-related artefacts have been identified and recorded, and the protocol has been modified accordingly.

Effect of display duration on face recognition and cortical responses

We studied how the duration that a face is available for visual observation affects face recognition and cortical responses to faces by replacing, once every 2500 ms, a continuous pixel noise mask by a face image for 17–200 ms. The subject's task was to report which of the six prelearned faces had been presented. Brain responses were recorded with a whole-scalp neuromagnetometer. To define the locations and latencies of the most prominent responses to faces, we also presented intact and scrambled faces for 500 ms without masking. The strongest effects of display duration (DD) were observed in temporo-occipital areas ~155 ms after stimulus onset. At the two shortest DDs, 17 and 33 ms, these responses exceeded the baseline noise level but did not differ from each other. They then increased for 50–83-ms DDs, and reached their maximum amplitude at DDs of about 100 ms. A later response around 300 ms showed a similar tendency. Face recognition performance was above chance level even at 17-ms DD, improved markedly for 33-ms DD, and at 50-ms DD more than 90% of the faces were recognized correctly. Thus, the proportion of correct recognitions increased and reached its maximum at shorter display durations than did the cortical responses.

THE HUMAN MIRROR-NEURON SYSTEM

S. Avikainen, **R. Hari**, J. Järveläinen, K.-I. Kaneko, M. Martikainen, S. Liuhanen, N. Nishitani (Tokorozawa, Japan), M. Saarelainen, and **M. Schürmann**

As social creatures, we spend a considerable part of our waking time in predicting the intentions of our cocitizens. This largely unconscious cerebral computing is based on sensory cues derived from other persons' behavior, gestures, and vocalizations. Recent studies indicate that this socially very important “reading of other persons’ minds” is based on a “mirror-neuron system” (MNS). The monkey frontal cortex has been shown to contain “mirror neurons” that discharge both when the monkey performs hand actions and when it observes another individual to make similar actions. Human functional imaging studies, including our previous MEG studies, have demonstrated a similar MNS system in the human brain, comprising at least the Broca's region, the primary motor cortices.

Viewing tool use

The monkey mirror neurons in area F5 are very specific to movements related to objects, and are not activated by tool use. Because tool use is a pivotal human trait, the human MNS might behave in a different manner during observation of tool use.

We have studied reactivity of the human motor cortex during goal-directed and meaningless tool use. The experimenter moved with chopsticks small objects from one plate to another or just moved the sticks above the plates without touching the objects. The human motor cortex seems to react more strongly to the goal-directed acts, suggesting differences between the human and monkey MNSs.

Contagious yawning

Some gestures, like yawning, are very contagious. We have started to study the neural basis of this contagiousness by presenting videotape stimuli of yawning actors to subjects participating in a fMRI study in Jülich Research Center (Germany). The results analyzed sofar suggest that the contagiousness of yawning is not based on the mirror-neuron system. Yawn-viewing-specific activation was observed in the right posterior superior temporal sulcus (STS) and bilaterally in the anterior STS; these areas are involved in the analysis of social visual cues. Moreover, the desire to yawn during yawn observation correlated negatively with activation of the left amygdala-hippocampal region, suggesting that yawns are more contagious in subjects that lack amygdala-related emotional arousal.

MNS function in disorders of social communication

Autism is associated with impairment in attribution of mental states and with poor imitation skills. We have started to study whether the MNS activation would differ in high functioning autistic Asperger subjects from that in control subjects when they view and imitate orofacial gestures presented as still pictures. In both groups of subjects, the activation progressed dynamically from the occipital cortex to the superior temporal sulcus, the inferior parietal lobule, and the inferior frontal lobe, and finally to the primary motor cortex in both hemispheres.In Asperger subjects, the signals seem more scattered and activations somewhat delayed. However, the large overlap of activations, both in source strengths and latencies suggests that dysfunction of the MNS can account only a part of the imitation and social impairments of AS subjects.

Problem of agency in auditory processing

The existence of the MNS means that overlapping brain areas may be activated when persons view and perform motor acts. This leads to the problem of agency: how does one know who was the agent of the motor act when both self-executed and observed movements are associated with overlapping brain activation. Some patients may really confuse these two, experiencing being under “alien control”. In the healthy brain, “ef-

ference copies" from the movement-command area inform other brain areas about the forthcoming consequences of the action. We are now exploring the role of efference copies in healthy subjects by comparing responses of the auditory cortex to sounds triggered by the subject's own motor acts with responses to identical sounds produced externally. Preliminary analysis shows that the responses are dampened to the self-produced sounds. This result is an extension of our previous findings on suppression of the subject's own vocalization in the auditory cortex.

LANGUAGE PERCEPTION AND PRODUCTION – FUNCTION AND DYSFUNCTION

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Extraction of phonetic information in fluently reading and dyslexic subjects

Hemodynamic studies suggest that regions surrounding the left auditory cortex are more strongly involved in processing speech than non-speech sounds. Neurophysiological measures of change detection have indicated cortical sensitivity to phonetic contrasts by 200 ms after stimulus onset. Whether linguistic processing is reflected in the robust activation at about 100 ms, with generators in the auditory cortex, remains unsettled. We used MEG to record auditory responses of 10 normally reading and 10 dyslexic adults. The speech stimuli were synthetic Finnish vowels (/a/, /u/) and consonant-vowel syllables (/pa/, /ka/). The non-speech stimuli were simple sine-wave tones and complex non-speech sounds, composed of the F2 and the F1 to F3 formant frequencies of the speech sounds, respectively. All sounds evoked a prominent response in the bilateral auditory cortices, peaking at 100 ms (N100m). Based on the peak amplitude and the onset and peak latencies of the N100m response, we assume that the time window 50–100 ms after stimulus onset reflects phonetic analysis. Cortical processing of speech sounds was differentiated from that of nonspeech sounds by longer N100m peak latencies and increased left-hemisphere involvement. Responses to sounds with rapid transitions differed from those to steady-state sounds for the complex nonspeech stimuli but not for the speech stimuli. The speech *vs.* nonspeech dissociation was qualitatively similar in normally reading and dyslexic groups. In the dyslexic subjects, however, the N100m latencies failed to show the typical ipsilateral lag, and the right-hemisphere responses were reduced for speech and nonspeech sounds alike. We propose that altered hemispheric balance derives from abnormalities within the left planum temporale (PT) or in the communication between the PT and the auditory cortex (Heschl's gyrus), which result in defective auditory processing in dyslexia, in the time window when phonetic information is extracted.

Early perception of auditory and visual language in children

Based on these data and our previous studies on visual language perception in normally reading and dyslexic adults we have launched a study on children who have just entered school and are at the verge of learning to read fluently. In these children, we hope to characterize both cortical dynamics of speech *vs.* nonspeech processing and the stages of visual feature and letter-string analysis in word preception, combined with thorough behavioural testing. The two imaging paradigms will separately provide information about the development of cortical correlates of speech perception and reading acquisition, but we will also search for interdependence of these measures. During the past year we have collected data from 10 girls and 10 boys with no expected difficulties with language perception. When these data have been analyzed, we will continue with dyslexic children.

Cognitive and neural correlates of language learning

A central feature of human language is the ability to acquire new words. While first language acquisition (in childhood) has received considerable interest, less is known about the neurocognitive mechanisms of continuous language learning (*e.g.* changes in vocabulary throughout the life span) and re-learning (adult aphasics). Our recent study on anomia treatment in three chronic aphasic patients yielded surprisingly uniform neurophysiological changes that accompanied training-induced improvement in naming. In all patients, naming-related changes were found in the left inferior parietal region. In earlier functional imaging studies this region has often been related to verbal working memory function. Based on location, timing (starting at 400–500 ms after picture presentation), the training procedure (semantic contextual priming), and the subjects' behavioural profile, we interpreted this activation as more effective access to the phonological representation of the target words.

However, in aphasia the timing of cortical events may be considerably altered and delayed with respect to intact function. Having no individual measure of time windows for semantic and phonological processing in these aphasics, we remained somewhat uncertain as to whether the left inferior parietal activation was more strongly associated with strengthening of the semantic or phonological processing stage. To gain more understanding of these aspects of word learning, we have now acquired MEG data from five young healthy participants who were taught names of very rare items (mainly ancient Finnish farming tools) they did not know. In an attempt to differentiate phonological encoding and semantic integration during word learning, four conditions of unfamiliar items were employed: (a) items for which both the name and the usage were provided in training, (b) items for which only the usage was provided, and (c) items for which only the name was provided, (d) items for which no information was provided (baseline). Computerised daily training to the preset criterion (98% correct) took 1–2 weeks. Naming-related MEG measurements were performed at the beginning, during the training (50% correct) and at the end of training (98% correct). Three

individuals again showed sensitivity to semantic training in the left inferior parietal cortex, with similar timing of activation. Intriguingly, these three subjects also showed semantic priming effects after training. We believe that, in these three individuals, we tapped a spatiotemporally uniform cortical correlate of effective semantic integration during word learning. The other two subjects also showed sensitivity to the semantic content of the trained stimuli, but the cortical loci were different (right hemisphere). Interestingly, these two subjects learned very fast and they failed to show semantic priming effect on the unfamiliar items for which semantic information was provided during training, thus suggesting that they used different neurocognitive strategies than the other three subjects. Our present results are the first direct demonstration that the left inferior parietal cortex is important for lexical acquisition in normal adults, specifically for the integration of new semantic information into the mental lexicon.

Real-time neural connectivity during natural reading

Higher cognitive functions are thought to build on connectivity within large-scale neuronal networks, supported by intra- and interareal correlation of rhythmic activity. Intracranial recordings provide accurate localization of the neuronal populations involved but are limited in spatial extent. With neurophysiological brain imaging techniques, on the other hand, synchronization has only been sought at the sensor level, without identification of source areas. We have recently started to use our new MEG analysis tool, Dynamic Imaging of Coherent Sources (DICS), to characterize the synchronously firing large-scale neural networks in a natural reading task in 10 right-handed German-speaking male subjects. Vertical and horizontal electro-oculogram (EOG) and electromyogram (EMG) across the mouth were recorded. Frequency ranges of interest 3–7, 9–13, 15–19, 19–23, and 35–45 Hz were selected on the basis of power and correlation spectra (MEG-MEG, EMG-MEG, EOG-MEG). Localization was done on cross-correlation spectra which retain amplitude and phase relationships between sensor signals. The cortico-cortical nodes were found predominantly in the left hemisphere, around the hand motor area and in the premotor cortex anterior to the hand area, in the dorsolateral prefrontal cortex, and around the intraparietal sulcus. Taking these areas as reference regions further suggested coherence with the left inferior parietal cortex, right thalamus, and right cerebellum. In each individual, the network remained fairly similar at all frequency ranges but was usually clearest at the lowest frequency (3–7 Hz). Using EOG as reference emphasized visual areas in the occipital cortex and parieto-occipital sulcus. The left hand area was a strong nodal point in reading and rest alike, possibly reflecting a fundamental organizational principle of cortico-cortical connectivity in right-handed subjects. We are currently developing measures to quantify the differences in synchronicity (as a function of time) across different experimental conditions (normal reading, word-by-word-reading, rest).

DEVELOPMENT OF CLINICAL APPLICATIONS OF MEG

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

Language lateralization

Knowledge about language lateralization is essential in planning brain surgery on patients with brain tumor or epilepsy. The hemispheric dominance for language is routinely determined with the invasive Wada test. Because of the health risks and difficulties in interpretation involved in this procedure, attempts have been made to develop a noninvasive test.

To evaluate language lateralization noninvasively, we employed a simple auditory paradigm: The subjects listened to pairs of binaural tones or Finnish vowels while the cortical responses were recorded. The peak strength of the 100-ms onset-response was quantified in the left and right temporal regions, and the hemispheric laterality index was calculated. In this ongoing study, we have tested 10 strongly left-handed, 3 weakly left-handed, and 4 strongly right-handed subjects so far. All right-handers as well as the weakly left-handed subjects showed left-hemispheric dominance, whereas the vast majority of the strongly left-handed subjects showed right-hemisphere dominance for speech sound processing. This approach might provide a useful noninvasive tool for evaluation of language lateralization in clinical settings.

Clinical routines

The 'CliniMEG' team was establisehd at BRU 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

J. Gross (Düsseldorf, Germany), J. Kujala, M. Liljeström, L. Parkkonen, **R. Salmelin,** M. Seppä, A. Schnitzler (Düsseldorf, Germany), and A. Tarkiainen

MEG source localization accuracy

An important and frequent practical problem in MEG data analysis is whether the spherical conductivity model for the brain and head, which is fast to compute and easy to create, provides sufficiently accurate results or whether a realistic head model with one or several layers should be used, instead. Theoretical approaches which assume no noise unequivocally recommend use of the computationally heavy realistic shape.

However, in practice, the simple sphere model seems amply sufficient. We have performed computer simulations to quantify the effect of realistic noise on source estimation errors over the entire brain, using various spherical and realistic conductivity models. We found that the noise typically present in brain signals masked the errors due to the different conductor models so that in most situations the models gave comparable results. Thus the traditionally used spherical model is an adequate choice for many research applications. The use of more refined head models may improve the results to some extent, but at the expense of computation time. Active cortical areas around the vertex and in the temporal, frontoparietal and occipital regions can typically be found with 2 to 4 mm accuracy, while determining source areas in the anterior frontal lobes and in deep brain structures may yield clearly larger errors.

Dynamic imaging of coherent sources (DICS)

Our recently introduced analysis method DICS estimates distribution of power and coherence in the entire brain, using spatial filtering. Because of the spatially inhomogeneous sensitivity profile of the MEG sensors, the spatial resolution of the resulting maps is not isotropic across the brain. A convenient analytic expression has now been developed for computation of the spatial resolution at any given point in the brain, as a function of the signal-to-noise ratio. The resolution map can be displayed on anatomical MRI in the same way as the functional maps. Using a bootstrap method, we also obtain confidence volumes for local maxima, as a measure of uncertainty of localization.

Three methods for localizing cortical rhythmic activity from MEG signals were tested and compared, (i) the traditional sequential dipole modelling of filtered data in the time domain, (ii) our new DICS method which uses a spatial filter in the frequency domain, and (iii) frequency-domain minimum current estimate, which is a frequency-domain imprementation of the MCE analysis tool developed earlier in our lab. The methods were evaluated using both measured and simulated data. We found that the methods gave comparable results, and that all three methods localized the principal sources of oscillatory activity very well. Traditional dipole modelling is a powerful tool once appropriate subsets of sensors have been selected, based on the spatial distribution of the frequency spectra. In neither frequency-domain MCE nor DICS need assumptions be made about how many sources are active or over which areas these sources can be found. Frequency-domain MCE provides a good overview of the data. DICS seemed to be more sensitive than the other methods, as it gives the possibility to investigate weaker sources by removing the field of previously located stronger sources.

High-resolution boundary element models

In collaboration with Center for Scientific Computing, the Galerkin method for efficient and accurate use of boundary element models (BEM) has been evaluated. This method greatly facilitates the MEG forward calculation, particularly when the realistic

conductor model consists of a very large number of triangles (tens of thousands or more). Detailed triangle networks with different numbers of triangles were constructed from MR images, and the Galerkin method was used in modelling the brainstem auditory evoked fields, which – due to their depth in the brain – should benefit more from the accurate conductor model than the cortical sources.

Visualization of MEG data on MRI

A fast sinc interpolation method was developed that is applicable to one or more dimensional data. The method is a derivation of fast Fourier transform (FFT) algorithms and gives 20% savings in typical situations. The new algorithm is very well suitable for MR image interpolation. Research for creating 3D brain surface tessellations going into sulci was continued. A new adaptive method for MRI data segmentation and bias field correction was implemented. Also, some tools for reading and converting MR image files from the native format of MR imaging device were created.

FUNCTIONAL MAGNETIC RESONANCE IMAGING

S. Aulanko, G. Caetano, **N. Forss**, **R. Hari**, J. Hiltunen (Institute of Occupational Health), Y. Hlushchuk, **R. Joensuu** (AMI Centre), **V. Jousmäki,** H. Kainulainen, H. Laaksonen, S. Närvänen, **J. Numminen**, J. Peltonen, P. Pöyhönen, T. Raij, **R. Salmelin**, R. Schreiber**, M. Schürmann**, T. Tanskanen, and **S. Vanni**

Advanced Magnetic Imaging (AMI) CentRE

We have taken active part in the organization and running of the Advanced Magnetic Imaging (AMI) Centre that was inaugurated in February 2002. The center, designed and built by a HUT-based concortium and financed among others by TEKES and Wihuri Foundation, houses a 3-Tesla magnet by General Electric that we have started to use to complement our MEG studies.

As newcomers to the fMRI field, we have during the setup period intensively educated ourselves, organizing several theoretical and hands-on fMRI courses and internal weekly seminars. We have also collaborated with experienced fMRI groups (MGH, Boston; FIL, London; NIH, Bethesda; Jülich Research Centre, Germany; AIV-Institute, Kuopio, Finland).

AMI Centre's fMRI recordings are now running smoothly, and state-of-the-art analysis software (e.g. SPM, BrainVoyager, Brain-a-la-Carte) has been installed. The first ongoing studies assess retinotopic mapping, audiotactile interaction, language, and pain.

Development of the stimulus environment

We have tested and installed several stimulators, monitoring devices, and trigger interfaces to be used in fMRI experiments. Stimulators include a 8-channel pneumatic tactile stimulator, a 2-channel vibrotactile stimulator, an upgrade of the visual stimulator to obtain wider visual angle inside the fMRI scanner, and an acoustic stimulator system based on electrostatic headphones. To monitor the subject during a fMRI experiment we have tested optical microphones and CCD cameras; the final installation will take place in 2003. In addition, we have set up optically isolated input/ouput interfaces for fMRI scanner pulses and for triggering various stimulators in fMRI experiments. We have started to build our own feedtrough filters for the electrostatic headphones to reduce increased MR image noise associated with headphone cables. We have also tested a mathematical algorithm, independent component analysis, to extract scanner noise from the subject's speech recorded with the optical microphone.

For visual experiments we have built a stimulation system that allows a wide visual angle (45 deg x 25 deg) with good spatial resolution, accurate timing, and controlled contrast. On the basis of psychophysical experiments carried out earlier, we have selected experimental parameters and improved a self-made vibrotactile stimulator to study audiotactile interactions in normal hearing subjects in MEG and fMRI.

Software development

The GE MRI system produces images in GE's native Genesis format which can not be directly utilized by most analysis programs. A user-friendly Matlab script was written that transforms the Genesis images directly to Analyze format, which is typically accepted by most analysis software packages. Other format transformations between analysis programs have been programmed as well.

Effect of stimulus repetition on fMRI and MEG signals

The characteristics of blood oxygenation level-dependent (BOLD) fMRI and MEG responses to vibrotactile stimuli in humans were studied and compared in collaboration with the NMR Group of A.I. Virtanen Institute (Kuopio). The stimuli, presented with interstimulus intervals (ISIs) ranging from 1 to 5 s, yielded highly reproducible MEG responses, with current dipoles in the primary somatosensory (SI) cortex in all subjects. BOLD fMRI responses to similar stimuli showed substantial intrasubject variation in the activation sites around the SI cortex. The MEG responses from SI were stronger at longer than shorter ISIs. The BOLD response amplitudes did not show a similar ISI dependence, but the activated brain area was larger when longer ISIs or longer stimuli were applied. Our results support the view that combined use of brain mapping methods provides complementary information, and should be considered in functional brain examinations.

TEACHING ACTIVITIES

COURSES

Nikolai Kopnin, lecturer, **Janne Viljas**, teaching assistant, Low Temperature Physics: Theory (Kyl-0.104)

Prof. Pertti Hakonen, lecturer, Licentiate Seminar in Measurement Techniques: Quantum Measurement (Kyl-0.106)

SUPERVISION OF SPECIAL PROJECTS

Harry Alles supervised **Heikki Junes'** special project *Measuring the facet velocities on a growing ^{3}He crystal imaged by a Fabry-Pérot interferometer*

Harry Alles supervised **Vesa Vaskelainen's** special project *Extracting the surface tension value of rounded ^{3}He crystals imaged by a Fabry-Pérot multiple-beam interferometer*

Matti Krusius supervised **Jussi Kumpula's** special project *Lämpötilan mittaus alueella 20 mK - 50 K (Temperature measurement between 20 mK and 50 K)*

Jussi Numminen supervised **Paavo Pöyhönen's** special project *fMRI data analysis environment at the AMI centre of the Helsinki University of Technology: Image formats, image format conversions and analysis programs*

Riitta Salmelin supervised **Hannu Laaksonen's** special project *Aivojen rytmisen taustatoiminnan vaihtelu sujuvasti lukevilla ja lukihairioisilla aikuisilla (Modulation of the rhythmic background activity of the brain in fluently reading and dyslexic adults)*

ACADEMIC DEGREES

Diploma thesis

Mia Liljeström graduated as M.Sc. from the Department of Electrical and Communications Engineering on September 10. Her diploma thesis *Localization of rhythmic activity in the human brain: A comparison of three different methods* was done in the LTL. Supervisor: Prof. Raimo Sepponen. Instructor: Prof. Riitta Salmelin.

PH.D. dissertations

Cristina Simões defended her Ph.D. thesis *Neuromagnetic characterization of the human secondary somatosensory cortex* on November 15. The opponent was Prof. Eduardo Ducla-Soares, Institute of Biophysics and Medical Physics, University of

Lisbon, Portugal. The work, carried out in the LTL, was supervised by Acad. Prof. Riitta Hari.

Rob Blaauwgeers defended his Ph.D. thesis *Unconventional quantized vortices, A study on ^3He and UPt_3* on July 6. The Ph.D. thesis examination committee were Prof. Dr. Matti Krusius, Prof. Dr, G. Frossati, Prof. Dr. R. de Bruyn Ouboter, Prof. Dr. P.H. Kes, and Prof. Dr. ir. W. van Saarloos. The work, carried out in the LTL, was supervised by Academy Professor M. Krusius. The Ph.D. degree was granted by the University of Leiden.

SYMPOSIA

Kevo Winter School

This Winter School was organized by Dr. Harry Alles in Kevo, the Subarctic Research Institute of University of Helsinki on April 20-26, 2002.

The graduate student research seminar was combined with lecture courses of several well-known scientists both from the LTL and from abroad. The foreign lecturers were Prof. Alexander Fetter from Stanford University and Prof. Sébastien Balibar from ENS. The total number of participants of the Winter School was 25 and there were altogether 30 hours of lectures and presentations. The Proceedings of the School contains four review and four research articles which were edited by Dr. Harry Alles and appeared in the December 2002 issue of the Journal of Low Temperature Physics.

FMRI-Based Experiments – A 4-Day Workshop At HUT

About 100 persons participated in the lectures and 30 in the hands-on training of the 4-Day Workshop FMRI-based experiments at HUT March 18-21, 2002. The teacher was Dr. Robert Savoy from Boston MGH, and the Course was organized by BRU members at the AMI Centre and was made open to interested (and paying) participants from the whole Finland.

RESEARCH SEMINARS ON LOW TEMPERATURE PHYSICS

Organized by Vladimir Eltsov, Pertti Hakonen and Matti Krusius

Dr. Jaakko Koivuniemi, CERN, Switzerland: *Status and results of the COMPASS collaboration at CERN* (Jan 7)

Prof. Yuri Barash, P.N. Lebedev Physical Institute, Russian Academy of Sciences, Moscow, Russia: *Josephson currents between two chiral superconductors* (Jan 25)

Dr. Alexander Obraztsov, Moscow State University, Moscow, Russia: *Carbon nanotube thin film growth and application in cathodoluminescent light source* (Jan 29)

Prof. Mikhail Feigelman, Landau Institute of Theoretical Physics, Moscow, Russia: *Topologically protected quantum bits from Josephson junction arrays* (Jan 30)

Dr. Adriaan Schakel, Freie Universität Berlin, Germany: *New metallic states in 2DEGs* (Feb 4)

Prof. Yuri Barash, P.N. Lebedev Physical Institute, Russian Academy of Sciences, Moscow, Russia: *0 - pi transition in tunnel junctions with ferromagnetic interfaces* (Feb 5)

Dr. Alexander Melnikov, Institute for the Physics of Microstructures RAS, Nizhny Novgorod, Russia: *Vortex structures, quasiparticle excitations and phase-coherent transport in the mixed state of mesoscopic superconductors* (Mar 4)

Dr. Yasuhiro Asano, Department of Applied Physics, Hokkaido University, Sapporo, Japan: *DC Josephson effect in SNS junctions of anisotropic superconductors* (Mar 12)

Dr. Koichi Ichimura, Division of Physics, Hokkaido University, Japan: *STM and/or STS on low dimensional conductors* (Mar 13)

Dr. Katsuhiko Inagaki, Department of Applied Physics, Hokkaido University, Sapporo, Japan: *Electrical properties of rf-sputter-evaporated cantilevers with conductive oxides TiO and ITO - Preliminary study for cryogenic nano-potentiometry* (Mar 13)

Prof. Mikio Nakahara, HUT: *Vortices in Bose-Einstein condensates* (Mar 18)

Dr. Yuriy Makhlin, Universität Karlsruhe, Germany: *Quantum state engineering with Josephson-junction devices* (Mar 25, 26 and 27)

Prof. Valery Ryazanov, Institute of Solid State Physics, Russian Academy of Sciences, Chernogolovka, Moscow region, Russia: *Induced superconductivity in a ferromagnet: Josephson pi-junctions in superconductors-ferromagnet-superconductor system* (Apr 4)

Prof. Andrei Zaikin, University of Karlsruhe, Germany: *Interaction-induced quantum dephasing in mesoscopic rings* (Apr 18)

One day symposium about surface instabilities in quantum systems in the presence of parallel flow (May 10)

- Dr. Vladimir Eltsov, LTL: *Measurements in rotation on the shear flow instability of the phase boundary separating the A and B phases of superfluid ^{3}He*
- Prof. Grigory Volovik, LTL: *Shear-flow instability in superfluids in two-fluid hydrodynamics and its relation to the classical Kelvin-Helmholtz instability of ideal fluids*
- Dr. Sergey Korshunov, Landau Institute for Theoretical Physics, Moscow, Russia: *Analogue of the Kelvin-Helmholtz instability on the free surface of a superfluid*
- Prof. Erkki Thuneberg, LTL and University of Oulu: *Instabilities of the moving AB phase boundary in superfluid ^{3}He as a mechanism of vortex formation*

Prof. Mikko Paalanen, LTL: *Multiwalled carbon nanotubes: Luttinger liquids or not?* (May 15)

Prof. Hans Ott, ETH, Zürich, Switzerland: *Superconductivity of MgB2* (Jun 1)

Dr. Ivar Martin, Los Alamos National Laboratory, New Mexico, USA: *Local moment in a superconductor: A candidate qubit* (Jul 11)

Prof. Alexander Andreev, Kapitza Institute for Physical Problems, Russia: *Facet growth in helium crystals* (Sep 10)

Dr. Alexander Volodin, Department of Solid State Physics and Magnetism, Katholieke Universiteit Leuven, Belgium: *Magnetic force microscopy of vortex pinning at grain boundaries in superconducting thin films* (Sep 17)

Dr. Juha Kopu, Institut für Theoretische Festkörperphysik, Universität Karlsruhe, Germany: *Triplet correlations in half metal/superconductor heterostructures* (Oct 1)

M.Sc. Franck Balestro, Grenoble, France: *MQT and quantum dynamic in Josephson junction and DC SQUID* (Oct 9)

Prof. Grigori Volovik, LTL: *Simulation of black hole at AB-brane* (Oct 15)

Dr. Ladislav Skrbek, Joint Low Temperature Laboratory, Institute of Physics and Charles University, Prague, Czech Republic: *Quantum turbulence in He II and ^{3}He-B* (Nov 11)

Dr. Frank Wilhelm, Ludwig-Maximilian University of Münich, Germany: *Operation of superconducting quantum bits under hostile conditions* (Nov 13)

Dr. Peter Skyba, Institute of Experimental Physics of Slovak Academy of Sciences, Kosice, Slovakia: *Surface oscillation modes of HPD – nonlinear phenomena in superfluid ^{3}He-B* (Nov 26)

Prof. Kristjan Haller, Institute of Physics, Tartu University, Estonia: *Nanotechnology related research in the Institute of Physics of Tartu University* (Dec 12)

Dr. Frank Wilhelm, Ludwig-Maximilian University of Munich, Germany: *Operation of superconducting quantum bits under hostile conditions* (Dec 19)

Prof. Gerd Schön, University of Karlsruhe, Germany: (Dec 20) *Dephasing and renormalization in model systems*

RESEARCH SEMINARS OF THE BRAIN RESEARCH UNIT

Organized by Martin Schürmann

Dr. Martin Schürmann, LTL: *Paper: Kosslyn SM, Ganis G, Thompson WL. "Neural foundations of imagery" Nat Rev Neurosci. 2001:635-42* (Jan 21)

Ms. Maria Liljeström (formerly Husberg), LTL: *Localization of rhythmic activity in the human brain: a comparison of three different methods* (Jan 21)

M.Sc. Klaus Linkenkaer-Hansen, BioMag Laboratory, Helsinki University Central Hospital: *Scaling and criticality in large-scale neural activity* (Jan 21)

Dr. Marjatta Pohja, LTL: *Cortico-muscular coupling in mirror movements? A magnetoencephalografic case study* (Feb 11)

M.Sc.Tech. Hanna Renvall, LTL: *Paper: Auditory cortical responses to speech-like stimuli in dyslexic adults (Renvall & Hari, in press)* (Feb 11)

M.Sc. Teresa Montez, IBEB-FCUL, Lisbon, Portugal: *Effects of band-pass filtered noise on cortical face responses* (Feb 18)

fMRI study circle (Feb 25)

fMRI study circle (Mar 4)

Dr. Simo Vanni, Toulouse, France and LTL: *Seeding dipole position and orientation from BOLD signal* (Mar 6)

fMRI study circle (Mar 11)

Dr. Juha Järveläinen, LTL*: Paper: Maess B, Koelsch S, Gunter TC, Friederici AD "Musical Syntax is processed in Broca's area: an MEG study" Nature Neuroscience 2001, 4:540-5* (Apr 8)

Planning for further fMRI-related seminar talks, based on paper "Functional MRI: an introduction to methods", Jezzard P, Matthews PM, Smith SS, eds, Oxford University Press 2001 (Apr 8)

Acad. Prof. Riitta Hari, LTL: *Planning of BRU research and AMI projects for 2002* (Apr 15)

Dr. Stephan Salenius, LTL and Functional Imaging Laboratory, London,UK: *Practical experience with fMRI studies in FIL* (Apr 17)

Prof. Rainer Goebel, Department of Neurocognition, Faculty of Psychology, University of Maastricht, The Netherlands: *fMRI studies of object perception and mental imagery at high spatial and temporal resolution* (Apr 18)

Ms. Linda Stenbacka, Faculty of Medicine, University of Helsinki, Helsinki, Finland: *Comparison of minimum norm estimates and dipole localization for MEG recordings from visual cortex: a simulation study* (Apr 22)

Prof. Rainer Goebel, Department of Neurocognition, Faculty of Psychology, University of Maastricht, The Netherlands: *Combining diffusion-tensor imaging and functional MRI* (Apr 22)

M.Sc.Tech. Cristina Simões, LTL: *Paper: Spatial and temporal resolution in fMRI (chapter 7, Functional MRI by Jezzard et al.)* (Apr 29)

Dr. Reinhard König, University of Bayreuth, Bayreuth, Germany: *Paper: Selection of the optimal pulse sequence for functional MRI (chapter 6, Functional MRI by Jezzard et al.)* (May 6)

Ms. Riikka Möttönen, LTL and Laboratory of Computational Engineering, HUT: *Paper: Effective paradigm design (chapter 9, Functional MRI by Jezzard et al.)* (May 6)

Dr. Andrej Stancak, Institute of Physiology, Charles University Prague, Czech Republic: *Sensorimotor cortex activation in EEG and functional MRI* (May 16)

M.Sc. Tech. Mika Seppä, LTL*: Paper: Preparing fMRI data for statistical analysis and Head motion and its correction (chapters 12, 13, Functional MRI by Jezzard et al)* (May 16)

M.Sc. Tech. Antti Tarkiainen and Ms. Hanna Renvall, LTL*: Paper: Statistical analysis of activation image (chapter 14, Functional MRI by Jezzard et al.)* (May 20)

M.Sc. Psych. Topi Tanskanen, LTL: *Paper: Registration, brain atlases and cortical flattening (chapter 15, Functional MRI by Jezzard et al.)* (May 27)

M.Sc. Tech. Jan Kujala, LTL: *Paper: Extracting brain connectivity (chapter 16, Functional MRI by Jezzard et al.)* (May 27)

Juha Järveläinen, M.D. LTL: *First aid in AMI and MEG* (Jun 3)

Tuukka Raij, M.D.: *Paper: Clinical applications of fMRI (chapter 18, Functional MRI by Jezzard et al.)* (Jun 3)

Dr. Merav Ahissar, Hebrew University Jerusalem, Israel: *The 'retain and compare' deficit in dyslexia* (Aug 19)

Tuukka Raij M.D., LTL: *Meeting report: Riken Summer School 2002: Seeing Brain in Action, Tokio, Japan* (Aug 26)

M.Sc. Tech. Jan Kujala, LTL: *Meeting report: BIOMAG 2002, Jena, Germany* (Sep 2)

Acad. Prof. Riitta Hari, LTL: *Technical note: On the use of filters in EEG and MEG* (Sep 2)

M.Sc. Tech. Lauri Parkkonen, LTL: *Technical note: On the dynamic range of the Vectorview system* (Sep 2)

M.Sc. Psych. Tiina Vuorinen, LTL: *Meeting report: The science of aphasia: neuroimaging of language* (Sep 9)

M.Sc. Tech. Hanna Renvall, LTL: *Meeting report: Human Brain Mapping 2002, part 1* (Sep 16)

M.Sc. Tech. Cristina Simões, LTL*: Meeting report: Human Brain Mapping 2002, part 2* (Sep 16)

Mr. Pauli Pöyhönen, LTL: *The analysis programs available at the AMI and how do they work together* (Sep 23)

Mr. Hannu Laaksonen, LTL: *Image formats, their usability and analyzing & conversion possibilities* (Sep 23)

Mr. Juho Peltonen, LTL: *Using the spiral EPI fMRI sequence at the AMI in practice* (Sep 23)

Dr. Simo Vanni, LTL: *Interaction of visual pattern onset processes. An MRI assisted EEG source modeling study* (Sep 30)

Furthermore MEG questions (Sep 30)

Acad. Teuvo Kohonen Neural Networks Research Centre, HUT: *Modeling of automatic capture and focusing of visual attention* (Oct 2)

Dr. Giacomo Koch and Dr. Sara Torriero, University of Rome, "Tor Vergata", Rome, Italy: *Parieto-frontal interactions in visual-object and visual spatial working memory: Evidence from transcranial magnetic stimulation* (Oct 7)

MEG questions: *Artifacts in MEG* (Oct 15)

Dr. Nina Forss, LTL: *Cortical processing of pain* (Oct 21)

Tuukka Raij, M.D. LTL: *Pain and the functional state of motor cortex* (Oct 21)

Marjatta Pohja, M.D. LTL: *Meeting report: Clinical Neurophysiology, Barcelona, Spain* (Oct 8)

Dr. Maryse Lessonde, University of Montreal, Canada: *Callosal agenesis* and Dr. Franco Lepore, University of Montreal, Canada: *Crossmodal plasticity* (Nov 1)

MEG questions "Dipole models" (Nov 5)

M.Sc. Tech. Cristina Simões, LTL: *Preparing for defense of dissertation* (Nov 11)

M.Sc. Tech. Lauri Parkkonen, LTL: *MEG questions, part 1/3* (Nov 18)

Prof. Riitta Salmelin, LTL: *Functional neurobiology of language* (Nov 25)

M.Sc. Psych. Tiina Vuorinen, LTL*: Children's evoked responses to written words vs. symbols and speech vs nonspeech sounds* (Nov 25)

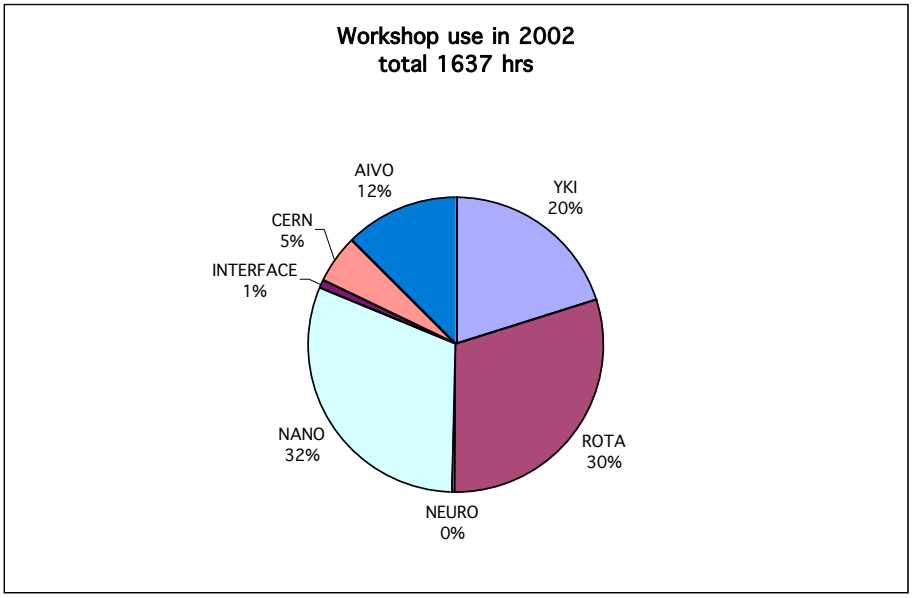
M.Sc. Tech. Lauri Parkkonen, LTL: *MEG questions, part 2/3* (Dec 2)

Dr. Veikko Jousmäki, LTL: *MEG questions: stimulator systems* (Dec 18)

TECHNICAL SERVICES

MACHINE SHOP

A. Huvila, J. Kaasinen, M. Korhonen, M. Lehtovuori, and K. Rauhanen.

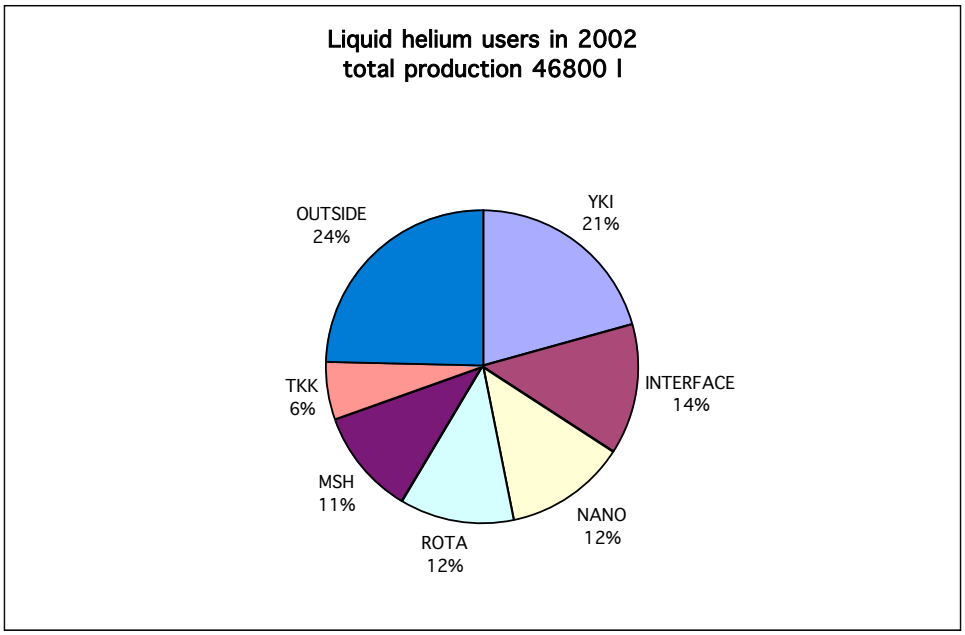


Distribution of the workload for different users' groups.

CRYOGENIC LIQUIDS

A. Isomäki, A. Salminen and A. Huvila

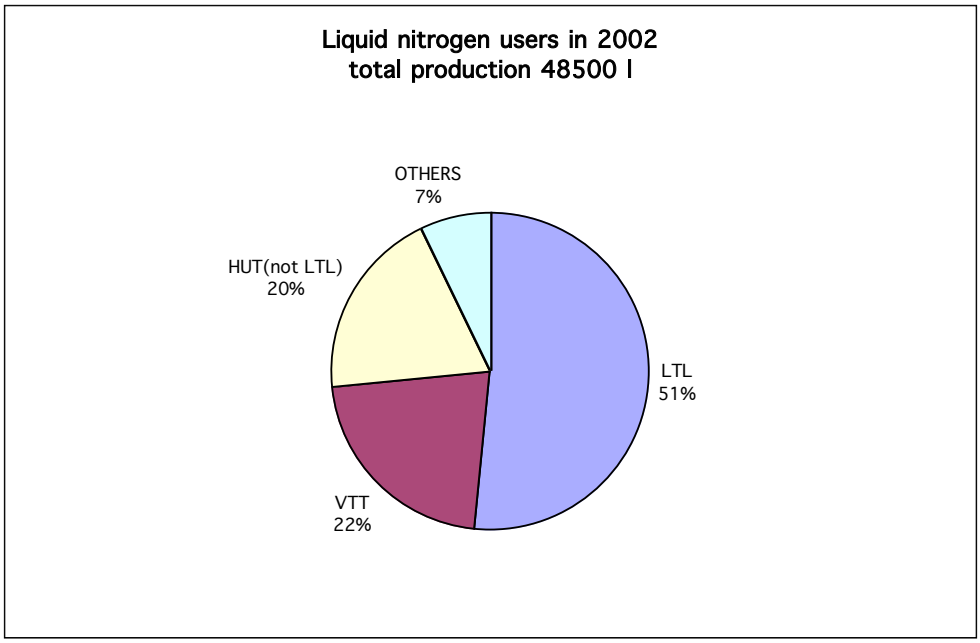
Helium



The total amount of liquid helium delivered to the users was about 47 000 liters.

The helium liquefaction equipment (Linde TCF-20) has been in use for over 14 years. Our helium gas storage capacity is 12.5 cubic meters at high pressure (150 bars) which corresponds to about 2500 liquid liters. The liquid storage capacity is at present about 3500 liters of liquid helium in various cryogenic containers.

Nitrogen



Our nitrogen liquefier (Linde - LINIT 25) was installed in 1996 and about half of its production goes outside the LTL. The total amount produced this year was 48 500 liters. The distribution of the users is shown above.

ACTIVITIES OF THE PERSONNEL

PERSONNEL WORKING ABROAD

Berglund, CERN, Switzerland, 19.8. – 6.9.

Hämäläinen, Athinoula A. Martinos Center for Biomedical Imaging, Massachusetts General Hospital, Massachusetts, USA, 1.1. – 31.12.

Koivuniemi, CERN, Switzerland, 1.1. – 31.1.2.

Pekola CNRS-CRTBT, France, 1.6. – 31.7.

CONFERENCE PARTICIPATION AND LABORATORY VISITS

Ahlskog — Poster, *Transport in disordered multiwalled carbon nanotubes*, Fysiikan päivät 2002 (The XXXVI Annual Conference of the Finnish Physical Society), Joensuun yliopisto, Joensuu, Finland (14. - 16.3.)

Ahlskog

Invited talk, *Transport in disordered multiwalled carbon nanotubes*, 10th MEL-ARI/NID Workshop, Helsinki, Finland (1. - 3.7.)

Poster, *Transport in disordered multiwalled carbon nanotubes*, Nanotube-2002: International Conference on the Science and Applications of Nanotubes, Boston, Massachusetts, USA (6. - 11.7.)

Alles

Invited plenary talk, *Interfaces in quantum systems - the surface of helium crystals*, Fysiikan päivät 2002 (The XXXVI Annual Conference of the Finnish Physical Society), Joensuun yliopisto, Joensuu, Finland (14. - 16.3.)

Session chairman and organizer of the Kevo Winter School, Kevo Subarctic Research Institute, Kevo, Finland (20. - 26.4.)

Invited talk, *Faceting and growth kinetics of helium-3 crystals*, The 23rd International Conference on Low Temperature Physics, LT23, Hiroshima, Japan (20. - 27.8.)

Poster, *Vibrating wire measurements in superfluid 3He at the melting curve down to 0.53 mK*, ULT2002, International Symposium on Ultra Low Temperature Physics, Kanazawa, Japan (28. - 31.8.)

Invited talk, *Faceting and growth kinetics of 3He crystals*, Fourth International Conference on Cryocrystals and Quantum Crystals, Freising, Germany (27. - 31.10.)

Berglund

Participation, COMPASS target activity, COMPASS collaboration experiment, CERN, Geneva, Switzerland (19.8. - 6.9.)

Participation, Compass Workshop, Future Physics @ Compass, CERN, Geneva, Switzerland (25. - 28.9.)

Blaauwgeers

Invited talk, *Shear flow and Kelvin-Helmholtz instability in superfluids*, The 23rd International Conference on Low Temperature Physics, LT23, Hiroshima, Japan (20. - 27.8.)

Poster, *NMR setup to study vortex transitions in 3He-A*, ULT2002, International Symposium on Ultra Low Temperature Physics, Kanazawa, Japan (28. - 31.8.)

Eltsov

Invited talk, *Vortex sheets at phase boundaries and domain walls in 3He*, Workshop of the European Science Foundation Programme "Vortex" , Prague, Czech Republic (3. - 7.4.)

Poster, *Vortex lines at an interface between superfluids of different symmetry*, The 23rd International Conference on Low Temperature Physics, LT23, Hiroshima, Japan (20. - 27.8.)

Poster, *Instability of AB interfaces of different shapes in rotating He-3*, The 23rd International Conference on Low Temperature Physics, LT23, Hiroshima, Japan (20. - 27.8.)

Oral presentation, *Vortex formation by interface instability in superfluid He-3*, ULT2002, International Symposium on Ultra Low Temperature Physics, Kanazawa, Japan (28. - 31.8.)

Finne

Poster, *Vortex lines at the phase boundary between superfluid 3He-A and 3He-B*, Fysiikan päivät 2002 (The XXXVI Annual Conference of the Finnish Physical Society), Joensuun yliopisto, Joensuu, Finland (14. - 16.3.)

Oral presentation, *Hydrodynamics of the interface between superfluid 3He-A and 3He-B*, CWS-2002, 3-rd International Workshop on Low Temperatory Physics in Microgravity Environment, Chernogolovka, Moscow region, Russia (12. - 18.8.)

Invited talk, *Cortical processing of pain,* Brain Research Center Seminar, University of Kuopio, Finland (30.9.)

Participation, Wallenberg Symposium: Learning and Memory - from Brains to Robots, Stanford, California, USA (25. - 26.10.)

Hakonen

Oral presentation, *Quantum amplifiers for qubit read-out,* RSFQubit network negotiations, Berlin, Germany (19. - 20.1.)

Invited talk, *Multiwalled carbon nanotubes as building blocks in nanoelectronics*, Carbon based molecular electronics, Great Malvern, UK (17. - 19.4.)

Poster, *Coulomb blockade of Cooper pairs in a single Josephson junction under the influence of shot noise*, Localisation 2002, International Conference on Quantum Transport and Quantum Coherence, Sophia University, Tokyo, Japan (16. - 19.8.)

Invited brief report, *Bloch oscillating transistor - a new quantum amplifier*, The 23rd International Conference on Low Temperature Physics, LT23, Hiroshima, Japan (20. - 27.8.)

Invited talk, *Superconductor-insulator transition in a single Josephson junction*, Electron Interference and Decoherence in Nanostructures, Dresden, Germany (4. - 8.11.)

Hari

Research visit, St Lucia Hospital, Rome, Italy (21. - 25.1.)

Invited talk, *Sluggish attention shifting as a putative cause for temporal processing deficits in dyslexia*, Lecture, S. Lucia Hospital, Rome, Italy (23.1.)

Participation, IBRO World Congress of Neuroscience 2003 Program Committee Meeting, Prague, Czech republic (7. - 9.3.)

Invited talk, *Ihmisaivojen kuvantamisesta (About human brain imaging),* Ruoholahden Rotary-klubi, Helsinki, Finland (25.3.)

Invited talk, *Ihmisaivojen kuvantamista TKK:n Kylmälaboratorion Aivotutkimusyksikössä (Imaging of human brain functions in the Brain Research Unit of the LTL at HUT),* Sigrid Juselius -säätiön vuosikokous (Sigrid Juselius - Foundation's Annual Meeting), Helsinki, Finland (22.4.)

Visit, McGill University, Montreal Neurological Institute, Montreal, Canada (18.5.)

Hari

Invited talk, *Mitä uutta aivotutkimuksessa? (What is new in brain research?),* Suomen Akatemian Tiedeaamiainen, Helsinki, Finland (31.5.)

Invited plenary talk, *Reading other minds: The human mirror-neuron system*, Neuroscience in the Third Millennium, Castá, Slovakia (1. - 4.6.)

Session chairman, *Imaging brain structure and function*, Neuroscience in the Third Millennium, Castá, Slovakia (1. - 4.6.)

Consultation, Neuro-BIRCH III, Technical Review and Hearing of EU Infrastructures, Brussels, Belgium (7.6.)

Invited plenary talk, *Reading other minds: The human mirror-neuron system*, The Justine and Yves Sergent Conference, Montreal, Canada (17.6.)

Visit, Montreal University, Department of Geriatrics, Montreal, Canada (17.6.)

Invited talk, *From viewing of movements to imitation and understanding of other persons' acts: MEG studies of the human mirror-neuron system*, Attention & Performance, XX. Functional Brain Imaging of Visual Cognition, Erice, Sicily, Italy (1. - 7.7.)

Invited plenary talk, *Neuromagnetic studies of the human mirror-neuron system*, 13th International Conference on Biomagnetism, Jena, Germany (10. - 14.8.)

Invited talk, *Ihmisaivojen kuvantamisen edistysaskeleita (Progress in human imaging*), Neurotieteet viitoittamassa tulevaisuuttamme, Etelä-Karjalan keskussairaalan neurologian vastuuyksikön 20-vuotisjuhla (Neuroscience Guiding our Future, 20th Anniversary of Etelä-Karjala Neurology Services), Lappeenranta, Finland (6.9.)

Session chairman, Dyslexia, Rodin Remediation Academy Dyslexia Conference, The Art of Reading, Munich, Germany (13. - 15.9.)

Participation, Meeting of Rodin Academy (acting and corresponding member), Rodin Remediation Academy Dyslexia Conference, The Art of Reading, Munich, Germany (15.9.)

Participation, Cognitive neuroscience beyond the imags given, Opening Conference of the F.C. Donders Centre for Cognitive Neuroimaging, Nijmegen, The Netherlands (19.9.)

Visit, F.C. Donders Centre for Cognitive Neuroimaging, Nijmegen, The Netherlands (20.9.)

Invited talk, *Temporal dynamic of human brain function: The magnetoencephalographic approach*, The Carl Wegelius Symposium on Modern Trends in Imaging, Helsinki, Finland (11. - 12.10.)

Hari

Invited plenary talk, *How our brains react to other persons' actions: Neuromagnetic studies of the human mirror-neuron system*, Frontiers in Medicine. Biomedicum Helsinki Seminars, Helsinki, Finland (14.10.)

Visit, Stanford University School of Medicine, Department of Radiology, Lucas MRS Building, Stanford, California, USA (24.10.)

Invited talk, *Action observation and imitation: The human mirror-neuron system*, Wallenberg Symposium: Learning and Memory - from Brains to Robots, Stanford, California, USA (25. - 26.10.)

Invited talk, *Temporspatial imaging of human brain functions*, Viikki Biocenter lecture, Helsinki, Finland (25.11.)

Invited talk, *Exploring frontiers of clinical neuroscience using MEG, Frontiers in Magnetoencephalography: Towards understanding brain development and disorders*, Oxford, UK (30.11.)

Consultation, Mid-term review meeting of EU FET Programme Neuro-IT projects, Mid-term review of 4 Neuro-IT projects, Leuven, Belgium (2. - 4.12.)

Invited talk, *Activation sequences in the human brain: The magnetoencephalographic (MEG) approach*, FENS Winter School: Dynamic aspects of brain functions: Methodologies, concepts, models, Kitzbühel, Austria (8. - 15.12.)

Session chairman, Modelling, FENS Winter School: Dynamic aspects of brain functions: Methodologies, concepts, models, Kitzbühel, Austria (8. - 15.12.)

Helenius

Oral presentation, *Puheen herättämät aivovasteet lukivaikeuksisilla aikuisilla (Speech evoked cortical activation in dyslexic adults),* Lukitutkijatapaaminen 2002 (Annual Meeting of the Finnish Reading and Dyslexia Researchers), University of Turku, Finland (1. - 2.2.)

Lecture, *Sanojen herättämä aivoaktivaatio ja lukivaikeus (Dyslexia and cortical activation evoked by word presentation),* Helsingin yliopiston kurssi, Psykologian vapaa puoliarvosana (Course in the Helsinki University), Helsinki, Finland (21.2.)

Invited talk, *Speech-evoked cortical activation in dyslexia*, Neuroscience Finland 2002, PharmaCity, Turku, Finland (14. - 15.3.)

Hänninen

Poster, *Half quantum vortices on the A-B phase boundary in 3He*, The 23rd International Conference on Low Temperature Physics, LT23, Hiroshima, Japan (20. - 27.8.)

Poster, *Vortex textures and A-B phase boundary in rotating superfluid 3He*, ULT2002, International Symposium on Ultra Low Temperature Physics, Kanazawa, Japan (28. - 31.8.)

Oral presentation, *Vortices at the A-B phase boundary in superfluid 3He*, ESF summer school of COSLAB programme: Topological defects in cosmology and laboratory, Cracow, Poland (15. - 29.9.)

Jensen

Invited talk, *Phase encoding and decoding of memory representations in theta/gamma networks: Information transfer between synchronized networks*, Mechanism of Brain and Mind: 2nd Winter Workshop, Rusutsu, Hokkaido, Japan (9.1.)

Invited talk, *The physiological basis of cortical beta and gamma oscillations: recent findings and models*, RIKEN Brain Science Institute, Tokyo, Japan (16.1.)

Invited talk, *The functional significance of alpha and theta oscillations in working memory*, Tamagawa University, Department of Info-Communication Engineering, Tokyo, Japan (18.1.)

Invited talk, *Reconstruction of location using hippocampal place cells reveals a phase code*, Department of Neuroscience and Neurology, University of Kuopio, Finland (23.4.)

Jousmäki

Oral presentation, *Stimulus environment at the Low Temperature Laboratory*, MEG laboratory, MGH, Boston, Massachusetts, USA (5. - 12.7.)

Junes

Poster, *Growth kinetics of 3He crystals near the magnetic ordering transition*, Fysiikan päivät 2002 (The XXXVI Annual Conference of the Finnish Physical Society), Joensuun yliopisto, Joensuu, Finland (14. - 16.3.)

Oral presentation, *Growth kinetics of 3He crystals near the magnetic ordering transition*, Kevo Winter School, Kevo, Finland (20. - 26.4.)

Poster, *Growth kinetics of 3He crystals near the magnetic ordering transition*, CWS-2002, 3-rd International Workshop on Low Temperatory Physics in Microgravity Environment, Chernogolovka, Moscow region, Russia (11. - 18.8.)

Invited talk, *Growth kinetics of 3He crystals near the magnetic ordering transition*, 3He Neutron Study - The 2nd Summer School of the European Research and Training Programme on the Magnetic Properties of Solid 3He, Chateau de Passières, Chichilianne, France (22. - 27.9.)

Juntunen

Poster, *Experiment on superconductivity and nuclear magnetism in lithium metal*, Fysiikan päivät 2002 (The XXXVI Annual Conference of the Finnish Physical Society), Joensuun yliopisto, Joensuu, Finland (14. - 16.3.)

Järveläinen

Oral presentation, *Stronger reactivity of the human primary motor cortex during observation of live rather than video motor acts*, Neuroscience Finland 2002, Turku, Finland (14. - 15.3.)

Kopnin

Invited talk, *Spectral flow dissipation in superconducting point contacts*, Superconductors and Hybrid Structures at Extreme Scales and Conditions, Lorentz Center, Leiden, The Netherlands (22.4. - 3.5.)

Invited talk, *Impurity band and electronic transport in clean superconducting weak links*, Theory of Quantum Transport in Nanoscale Devices, St. Petersburg, Russia (3. - 7.6.)

Kopnin

Session chairman, Theory of Quantum Transport in Nanoscale Devices, St. Petersburg, Russia (3. - 7.6.)

Invited talk, *Vortex dynamics in superconductors and Fermi superfluids*, Progress in Condensed Matter Theory, Dresden, Germany (27.10. - 1.11.)

Krusius

Invited talk, *The non-singular vortex in 3He superfluids*, Workshop of the European Science Foundation Programme "Vortex" , Prague, Czech Republic (3. - 7.4.)

Invited talk, *Vortices in multicomponent superfluids, BEC and superconductors*, 19th General Conference of the EPS Condensed Matter Division, CMMP 2002-Condensed Matter and Material Physics, Brighton, UK (7. - 11.4.)

Invited talk, *Quantized vorticity in rotating 3He superfluids and the requirements on rotation*, The 23rd International Conference on Low Temperature Physics, LT23, Hiroshima, Japan (20. - 27.8.)

Poster, *Vortex lines across the AB phase boundary in rotating superfluid 3He*, The 23rd International Conference on Low Temperature Physics, LT23, Hiroshima, Japan (20. - 27.8.)

Session chairman, The 23rd International Conference on Low Temperature Physics, LT23, Hiroshima, Japan (20. - 27.8.)

Participation, ULT2002, International Symposium on Ultra Low Temperature Physics, Kanazawa, Japan (28. - 31.8.)

Lecture, *Toplogical defects in 3He superfluids: (1) 3He-B phase, (2) 3He-A phase, and (3) AB phase boundary* , ESF Summer School of COSLAB Programme: Topological defects in cosmology and laboratory, Cracow, Poland (15. - 29.9.)

Kujala

Poster, *Characterizing correlated activity in cognitive tasks with MEG*, Biomag 2002, Jena, Germany (9. - 14.8.)

Visit, Physikalisch-Technische Bundesanstalt, Berlin, Germany (14.8.)

Participation, Biomag 2002 satellite symposium, Leipzig, Germany (15.8.)

Participation, System Level Modeling, Columbus, Ohio, USA (18. - 22.11.)

Kumpula

Participation, Advanced European Cryogenic School, Grenoble, France (24. - 30.9.)

Lindell

Oral presentation, *Energy level spectroscopy of a SQUID,* 19th General Conference of the EPS Condensed Matter Division, CMMP 2002-Condensed Matter and Material Physics, Brighton, UK (7. - 11.4.)

Participation, International Conference on Quantum Transport and Quantum Coherence, Sophia University, Tokyo, Japan (16. - 19.8.)

Lindell

Oral presentation, *Energy level spectroscopy using inelastic Cooper pair tunneling*, The 23rd International Conference on Low Temperature Physics, LT23, Hiroshima, Japan (20. - 27.8.)

Paalanen

Invited talk, *Superconductor insulator transition in a single Josephson junction*, 2002 Winter Conference in Condensed Matter Physics, Quantum Coherence and Dissipation, Aspen, Colorado, USA (11. - 15.2.)

Participation, European Workshop on Micro-Nanotechnologies for Mobility, Grenoble, France (25. - 26.2.)

Invited talk, *Multiwalled carbon nanotube: Luttinger liquid or not?,* APS March Meeting, Indianapolis, Indiana, USA (18. - 22.3.)

Lecture, *How to organize an LT Conference*, Seminar, Northwestern University, Chicago, Illinois, USA (21.3.)

Lecture, *Multiwalled carbon nanotube: Luttinger liquid or not?,* Seminar, Northwestern University, Chicago, Illinois, USA (21.3.)

Invited talk, *Superconductor-insulator transition in a single Josephson junction*, NATO Advanced Research Workshop, Theory of Quantum Transport in Nanoscale Devices, St Petersburg, Russia (3. - 7.6.)

Consultation, Technical Review of ULTI III Large Scale Facility, Brussels, Belgium (12. - 13.6.)

Session chairman, Dephasing at low temperatures, Localisation 2002, International Conference on Quantum Transport and Quantum Coherence, Tokyo, Japan (16. - 19.8.)

Session chairman, Transport in nanotubes and nanostructures, The 23rd International Conference on Low Temperature Physics, LT23, Hiroshima, Japan (20. - 27.8.)

Participation, Meeting of low temperature commission C5 of IUPAP, Hiroshima, Japan (22.8.)

Invited talk, *Localization and interaction effects in carbon nanotubes*, COST Physics Action P5 Workshop on Mesoscopic Electronics, Catania, Italy (17. - 19.10.)

Invited talk, *Nanoelectronics and its applications*, Nanoactivation seminar organized by Tekes, Helsinki, Finland (3.12.)

Paetau

Invited talk, *Magnetoencephalography in childhood epileptic regression disorders*, Inaugural Conference of IASSID Europe, University College, Dublin, Ireland (12. - 15.6.)

Parkkonen

Poster, *MEG sees deep: Brainstem auditory evoked fields*, Human Brain Mapping, Sendai, Japan (1. - 5.6.)

Poster, *MEG sees deep sources: Measuring and modelling brainstem auditory evoked fields*, Biomag2002, Jena, Germany (20. - 23.8.)

Parkkonen	Visit to University of Rome, Tor Vergata, Rome, Italy (17.-18.9.)
Pentti	Poster, *Thermal modeling of an experiment on dilute 3He-4He mixtures at ultralow temperatures*, Fysiikan päivät 2002 (The XXXVI Annual Conference of the Finnish Physical Society), Joensuun yliopisto, Joensuu, Finland (14. - 16.3.)
Pohja	Poster, *Cortico-muscular coupling in mirror movents - a MEG study*, 11th European Congress of Clinical Neurophysiology, Barcelona, Spain (24. - 28.8.)
Raij	Poster, *Cortical responses to painful laser stimulation: Effects of interstimulus interval*, Riken Summer School: Seeing Brain in Action, Riken BSI, Saitama, Japan (23.7. - 2.8.)
Renvall	Oral presentation, *Ajallinen prosessointi kuulojärjestelmässä lukivaikeuksisilla aikuisilla (Auditory temporal processing in adult dyslexics),* Lukitutkijatapaaminen 2002 (Annual Meeting of the Finnish reading and dyslexia researchers), University of Turku, Finland (1. - 2.2.)
	Poster, *Abnormal recovery cycle in the right somatosensory cortex of dyslexic adults*, Neuroscience Finland 2002, PharmaCity, Turku, Finland (14. - 15.3.)
	Poster, *Abnormal recovery cycle in the right primary somatosensory cortex of dyslexic adults*, Human Brain Mapping 2002, Sendai, Japan (2. - 6.6.)
	Invited talk, *MEG studies of auditory temporal processing in dyslexia*, 25th Annual Mid-Year Meeting of the International Neuropsychological Society, Stockholm, Sweden (24. - 27.7.)
Roschier	Poster, *Towards solid state quantum measurement*, Fysiikan päivät 2002 (The XXXVI Annual Conference of the Finnish Physical Society), Joensuun yliopisto, Joensuu, Finland (14. - 16.3.)
Salmelin	Invited talk, *MEG and language research*, University of Groningen, The Netherlands (13. - 15.2.)
	Invited talk, *Cortical dynamics of reading in dyslexia*, Neuroscience Finland 2002, PharmaCity, Turku, Finland (14. - 15.3.)
	Invited talk, *Merkityksen merkit aivotoiminnassa (Signature of meaning in brain function),* Kieli keskellä kognitiota II. Seminaari merkityksen tutkimuksesta (Language within cognition II: Seminar on research into meaning), Helsinki, Finland (2.5.)
	Invited talk, *Cortical dynamics of covert reading*, Connectivity in language rehabilitation in stroke, Hamburg, Germany (11.5.)
	Invited talk, *Disruption of letter-string-specific activation in dyslexia*, Connectivity in language rehabilitation in stroke, Hamburg, Germany (11.5.)
	Invited talk, *MEG effects of language training*, Connectivity in language rehabilitation in stroke, Hamburg, Germany (11.5.)

Salmelin

Invited talk, *MEG in language research*, The Science of Aphasia. Functional Neuroimaging Studies of Language and Its Impairment, Maratea, Italy (14. - 19.6.)

Invited talk, *Kielen (oppimisen) häiriöiden ilmeneminen aikuisen aivoissa (Cortical correlates of impaired language(learning) in the adult brain),* Turun kieliaineiden tutkijakoulu: Kieli, ihminen ja teknologia (Language, human, and technology - Graduate School), Turku, Finland (28. - 30.8.)

Invited talk, *Lacking the fast route for written language: cortical dynamics of impaired reading in dyslexia*, The Art of Reading: Text, Pictures, Cultures, Munich, Germany (12. - 15.9.)

Invited talk, *Cortical dynamics of speech comprehension, ESF/EMRC exploratory workshop: Neurobiology of communication*, Cambridge, UK (25. - 26.9.)

Participation, Wallenberg symposium Learning and Memory - from Brains to Robots, Stanford, California, USA (25. - 26.10.)

Invited talk, *MEG aivojen kuvantamisessa (MEG in brain imaging),* Neuropsykologian erikoispsykologikoulutus: Neurotiede II (Special training in neuropsychology: Neuroscience II), Helsinki, Finland (15.11.)

Invited talk, *Probing dyslexia and neurodevelopmental disorders with MEG*, Frontiers in magnetoencephalography: Towards understanding brain development and disorders, Oxford, UK (30.11.)

Sillanpää

Participation, Jyväskylä International Summer School 2002, Jyväskylä, Finland (12. - 16.8.)

Simoes

Oral presentation, *Evidence for parallel processing in the human SI and SII cortices revealed by phase-synchrony*, 8th International Conference for Functional Mapping of the Human Brain, Sendai, Japan (2. - 6.6.)

Tanskanen

Poster, *Timing of contour integration in human visual cortex: MEG recordings*, Neuroscience Finland 2002, PharmaCity, Turku, Finland (14. - 15.3.)

Poster, *Human cortical responses to contours*, Association for Research in Vision and Ophthalmology, 2002 Annual Meeting, Fort Lauderdale, Florida, USA (5. - 10.5.)

Poster, *Effect of band-pass filtered noise on cortical face responses*, Vision Science Society Annual Meeting 2002, Sarasota, Florida, USA (10. - 15.5.)

Tarkiainen R.

Poster, *Transport in disordered multiwalled carbon nanotubes*, 19th General Conference of the EPS Condensed Matter Division, CMMP 2002-Condensed Matter and Material Physics, Brighton, UK (7. - 11.4.)

Tarkiainen R.	Oral presentation, *Carbon nanotubes as disordered wires*, Localisation 2002, International Conference on Quantum Transport and Quantum Coherence, Sophia University, Tokyo, Japan (16. - 19.8.)
.	Oral presentation, *Transport in disordered carbon nanotubes*, The 23rd International Conference on Low Temperature Physics, LT23, Hiroshima, Japan (20. - 27.8.)
Todoshchenko	Poster, *Faceting of bcc 3He crystals*, The 23rd International Conference on Low Temperature Physics, LT23, Hiroshima, Japan (20. - 27.8.)
	Poster, *Growth of facets on 3He crystals near the nuclear ordering transition*, ULT2002, International Symposium on Ultra Low Temperature Physics, Kanazava, Japan (28. - 31.8.)
Tuoriniemi	Session chairman, Condensed matter physics I, Fysiikan päivät 2002 (The XXXVI Annual Conference of the Finnish Physical Society), Joensuun yliopisto, Joensuu, Finland (14. - 16.3.)
	Poster, *Thermal contact to lithium metal*, The 23rd International Conference on Low Temperature Physics, LT23, Hiroshima, Japan (20. - 27.8.)
	Poster, *Towards superfluidity of 3He diluted by 4He*, ULT2002, International Symposium on Ultra Low Temperature Physics, Kanazawa, Japan (28. - 31.8.)
	Oral presentation, *Nuclear magnetism in simple metals; rhodium and lithium*, Hahn-Meitner-Institut, Berlin, Germany (6. - 10.11.)
	Participation, Seminar, Tieftemperaturphysik unterhalb 1K, Physikalisch-Technische Bundesanstalt Berlin, Germany (8.11.)
Vanni	Invited talk, *An fMRI assisted EEG source modeling study*, Monday Meetings of the Cognitive Science and Technology Group, Innopoli II, Espoo, Finland (21.10.)
	Invited talk, *Exploring the timing of human visual processing*, Seminar for Neuroinformatics, Helsinki University of Technology, Espoo, Finland (26.11.)
Viljas	Poster, *Equilibrium simulations of weak links in p wave superfluids*, Fysiikan päivät 2002 (The XXXVI Annual Conference of the Finnish Physical Society), Joensuun yliopisto, Joensuu, Finland (14. - 16.3.)
	Poster, *Equilibrium simulations of weak links in p-wave superfluids*, The 23rd International Conference on Low Temperature Physics, LT23, Hiroshima, Japan (20. - 27.8.)
	Poster, *Pinned A-B interface in a 3He weak link*, ULT2002, International Symposium on Ultra Low Temperature Physics, Kanazawa, Japan (28. - 31.8.)
	Invited talk, *Pi states and textural effects in superfluid 3He weak links*, Vortices in Josephson systems and nanostructures, Maratea, Italy (20. - 25.9.)

Volovik

Lecture, *Emergent phenomena at low energy*, Seminar in Landau Institute, Moscow, Russia (7.2.)

Invited talk, *Kelvin-Helmholtz instability in superfluids*, Seminar at Landau Institute, Chernogolovka, Moscow region, Russia (8.2.)

Lecture, *Universality classes of fermionic vacua*, Seminar at Landau Institute, Moscow, Russia (12.2.)

Lecture, *Effective relativistic quantum field theory emerging in systems with Fermi points*, seminar at Kapitza Institute, Moscow, Russia (14.3.)

Lecture, *Fermions on vortices and cosmic strings*, seminar at Kapitza Institute, Moscow, Russia (19.3.)

Invited talk, *From quantum liquids to black holes,* 19th General Conference of the EPS Condensed Matter Division, CMMP 2002-Condensed Matter and Material Physics, Brighton, UK (7. - 11.4.)

Session chairman, Vortices in multicomponent superfluids, BEC and superconductors, 19th General Conference of the EPS Condensed Matter Division, CMMP 2002-Condensed Matter and Material Physics, Brighton, UK (7. - 11.4.)

Invited talk, *Emergent relativistic quantum field theory and gravity in vacua of Fermi point universality class*, COSLAB Workshop on Quantum Vacuum Properties in Condensed Matter Physics and Cosmology, Tours, France (17. - 20.5.)

Invited talk, *Kelvin-Helmholtz instability in superfluids,* 4-th Conference Landau Days, Chernogolovka, Moscow region, Russia (24. - 26.6.)

Session chairman, 4-th conference Landau Days, Chernogolovka, Moscow region, Russia (24. - 26.6.)

Invited plenary talk, *Vacuum in condensed matter and cosmological constant problems*, XVIII IAP Colloquium on the Nature of Dark Energy Observational and Theoretical Results on the Accelerating Universe, Paris, France (1. - 5.7.)

Invited talk, *Fermi point universality class: emergence of relativistic quantum field theory and gravity* , International Conference on Theoretical Physics THEORY-2002, Paris, France (22. - 27.7.)

Invited talk, *Kelvin-Helmholtz instability in superfluids, theory and experiment*, Seminar in CRTBT-CNRS, Grenoble, France (30.7.)

Invited talk, *Kelvin-Helmholtz instability in superfluids*, CWS-2002, 3-rd International Workshop on Low Temperatory Physics in Microgravity Environment, Chernogolovka, Moscow region, Russia (12. - 18.8.)

Invited talk, *Kelvin-Helmholtz instability in superfluids: experiment, theory and analog of black holes,* Workshop: Solitons, Collapses and Turbulence, Chernogolovka, Moscow region, Russia (18. - 22.8.)

Volovik

Invited plenary talk, *From quantum liquids to gravity, branes, and relativistic quantum fields*, Workshop on Branes, Gravity, Condensed Matter, and Nonlinear Quantum Mechanics: New Interfaces, King's College, London, UK (10. - 14.9.)

Session chairman, Workshop on Branes, Gravity, Condensed Matter, and Nonlinear Quantum Mechanics: New Interfaces, King's College, London, UK (10. - 14.9.)

Lectures, *Condensed matter/cosmology dictionary*, NATO Advanced Study Institute and ESF Summer School of COSLAB Programme: Topological defects in cosmology and laboratory, Cracow, Poland (15. - 29.9.)

Session chairman, NATO Advanced Study Institute and ESF Summer School of COSLAB Programme: Topological defects in cosmology and laboratory, Cracow, Poland (15. - 29.9.)

Invited talk, *Experimental observation of new class of turbulence in superfluid 3He-B*, seminar in Landau Institute, Chernogolovka, Russia (20.12.)

Vuorinen

Oral presentation, *Kielellisten ja ei-kielellisten äänien prosessointi vasemmalla kuuloaivokuorella (Processing of speech and non-speech sounds in left auditory cortex),* Lukitutkijatapaaminen 2002 (Annual Meeting of the Finnish Reading and Dyslexia Researchers), University of Turku, Finland (1. - 2.2.)

Poster, *Processing of speech and nonspeech sounds in human left auditory cortex*, Neuroscience Finland 2002, PharmaCity, Turku, Finland (14. - 15.3.)

Participation, The Neurobiology of Communication: Comparative and Evolutionary Perspectives on Receptive Language, Cambridge, UK (25. - 26.9.)

EXPERTISE AND REFEREE ASSIGNMENTS

Ahlskog

Referee, Applied Physics Letters

Referee, Physical Review B

Member, Program Committee of the SPIE International Symposium on Fluctuations and Noise, 1. – 4.6. 2003, Santa Fe, New Mexico, USA

Alles

Guest editor, Journal of Low Temperature Physics (December 2002 issue)

Organizer, Kevo Winter School, Kevo Subarctic Research Institute, Kevo, 20. - 26.4.

Referee, Journal of Low Temperature Physics

Berglund

Member, Finnish Academy of Technical Sciences

Member, International Cryogenics Engineering Committee, ICEC

	Member, Svenska tekniska vetenskapsakademien i Finland
	Advisory editor, Cryogenics
Forss	Referee, Clinical Neurophysiology
	Referee, NeuroImage
	Referee, Stroke
	Referee, European Journal of Neuroscience
	Referee, Human Brain Mapping
Hakonen	Fellow, American Physical Society
	Member, Academia Europaea, UK
	Member, Finnish Academy of Sciences and Letters
	Referee, Europhysics Letters
	Referee, Applied Physics Letters
	Referee, Journal of Applied Physics
	Referee, Journal of Low Temperature Physics
	Referee, Physical Review B
	Referee, Physical Review Letters
	Examination of Peter Ågren's PhD. thesis, committee member, Kungliga Tekniska Högskolan, Stockholm, Sweden (18.10.)
Hari	Associate Editor, Human Brain Mapping
	Assessment, research grant application NWO (Netherlands Organization for Scientific Research)
	Consultant, Department of Clinical Neurophysiology, Helsinki University Central Hospital (part-time)
	Coordinator, EU Large-Scale Installation Neuro-BIRCH III, Espoo, Finland
	Coordinator, Functional Brain Mapping, Finland-Taiwan Scientific Cooperation
	Member, Academia Europaea, UK
	Member, Academia Rodinensis Pro Remediatione
	Member, American Physiological Society
	Member, Editorial Board of Brain Topography
	Member, Editorial Board of Clinical Neurophysiology
	Member, Editorial Board of Human Brain Mapping
	Member, Editorial Board of inScight (web journal)

Member, Editorial Board of NeuroImage

Member, Editorial Board of Neuroscience Research

Member, European Dana Alliance for the Brain

Member, Finnish Academy of Sciences and Letters

Member, International Advisory Board, Neuroscience in the Third Millennium, Casta, Slovakia, 1.-5.6.2002

Member, Organizing Committee, Peter Wallenberg Symposium Learning and Memory - from Brains to Robots, Stanford, USA, 25.-26.20.2002

Member, Organizing Committee, The Art of Reading: Texts, Pictures, Cultures. Rodin Remediation Academy. Munich, Germany, 13.-15.9.2002

Member, Scientific Advisory Board of the National PET Center, Turku

Member, Society for Neuroscience, USA

Member , Scientific Board, 4th International Symposium on Noninvasive Functional Source Imaging Within the Human Brain and Heart, NFSI 2003, Chieti, Italy, 10.-13.9.2003

Member, Scientific Programme Committee, 6th IBRO World Congress of Neuroscience, Prague, Czech Republic, 10.-15.7.2003

Member, Steering Committee of the Helsinki Graduate School of Neurobiology

Referee, Annals of Neurology

Referee, Brain

Referee, British Journal of Psychology

Referee, Clinical Neurophysiology

Referee, European Journal of Neuroscience

Referee, Experimental Brain Research

Referee, Human Brain Mapping

Referee, Journal of Neurophysiology

Referee, NeuroImage

Referee, Neuroscience Letters

Referee, Proceedings of the National Academy of Sciences (PNAS)

Referee for appointment of a Professor in University of California, San Diego, USA

Referee for appoinment of Professor of Biophysics, Faculty of Science, University of Oulu

Helenius	Member, Academia Rodinensis Pro Remediatione
	Member, Cognitive Neuroscience Society
	Member, Organization for Human Brain Mapping
	Referee, Annals of Neurology
	Referee, Brain
	Referee, Human Brain Mapping
	Referee, NeuroReport
Jousmäki	Referee, Experimental Brain Research
Kopnin	Member, American Physical Society
	Opponent, Thesis evaluation of the Second Doctoral Thesis by A.S. Melnikov, Institute for Physics of Microstructures RAS, Nizhny Novgorod, Russia 13. – 14.5.
	Opponent, Thesis evaluation of the Ph.D. Thesis by N.M. Shchelkachev, L.D. Landau Institute for Theoratical Physics, Russia, 27.6.
	Pre-examiner of Ya.V. Fomin, L.D. Landau Institute for Theoretical Physics
	Referee, European Physical Journal B
	Referee, Pis'ma v Zurnal Eksperimental'noi I Teoreticheskoi Fiziki. (JETP Letters)
	Referee, Physical Review
	Referee, Physical Review Letters
	Referee, Journal of Experimental and Theoretical Physics (JETP)
Krusius	Advisory Editor, Physica B: Condensed Matter
	Adjunct member of Selection Committee for the International Fritz London Award in Low Temperature Physics
	Fellow of the American Physical Society
	Member, Academia Europaea
	Member, European Physical Society
	Member, Finnish Academy of Sciences and Letters
	Member, Finnish Physical Society
	Member of the Board, Low Temperature Section, Condensed Matter Division, European Physical Society
	Member of Ph.D. examination committee of Rob Blaauwgeers, Leiden University, 6.6.

	Member of International Advisory Board, International Conference on Low Temperature Physics, Hiroshima, Japan, 20. - 27.8. 2002
	Member of International Advisory Board, International Symposium on Ultra-Low Temperature Physics, Kanazawa, Japan, 28. - 31.8.2002
	Member of Program Committee, International Conference on Quantum Fluids and Solids – GFS 2003, Albuquerque, New Mexico, USA, 3. - 8.8.2003
	Member of Steering Committee, European Science Foundation Programme on Cosmology in the Laboratory (COSLAB)
	Referee, Physical Review Letters
	Secretary, Section on Physics and Astronomy of Finnish Academy of Sciences and Letters
Lounasmaa	Advisory Editor, Europhysics Letters
	Fellow, American Physical Society
	Foreign Member, National Academy of Sciences of the USA
	Foreign Member, Royal Swedish Academy of Sciences
	Honorary Fellow, Indian Cryogenics Council
	Honorary Member, Finnish Physical Society
	Member, Academia Europaea, UK
	Member, Board of the Center for Ultra-Low Temperature Research, University of Florida
	Member, Commission A1/2, International Institute of Refrigeration
	Member, European Physical Society
	Member, Finnish Academy of Sciences and Letters
	Member, Finnish Academy of Technical Sciences
	Member, Research Council of Helsinki University of Technology
	Member, Societas Scientiarum Fennica
Mäkelä	Member, National Defence Scientific Advisory Committee, Health- and Behavioral Sciences Division
	Referee, Audiology and Neuro-otology
	Referee, Cognitive Brain Research
	Referee, Human Brain Mapping
	Referee, NeuroImage
	Referee, Sleep Research Online
	Referee, Stroke

Paalanen	Coordinator of Low Temperature Physics Research, Finland-Taiwan Scientific Cooperation
	Coordinator of ULTI III (Ultra Low Temperature Installation) Large Scale Installation in EU-funded IHP program 1.4.2000 - 31.3.2004
	Fellow, American Physical Society
	Member, Academia Europaea, UK
	Member, Board of Arkhimedes (Finnish Physical Journal)
	Member, Board of High Speed Electronics Photonics, Nanoscience, and Quantum Devices Consortium in Chalmers University of Technology, Gothenburg, Sweden
	Member, Board of Uudenmaan Rahasto of Finnish Cultural Foundation
	Secretary, Comission C5 Low Temperature Physics, International Union of Pure and Applied Physics (IUPAP)
	Member, Editorial Board of Journal of Low Temperature Physics
	Member, Finnish Academy of Sciences and Letters
	Member, Finnish Academy of Technical Sciences
	Member, International Advisory Committee of an American TV program on low temperature physics (Chairman Professor Russel Donnelly, University of Oregon, USA)
	Member, International Advisory Committee of LT23, Hiroshima, Japan, 21-27 August, 2002,
	Member, International Advisory Committee, Localisation 2002 "Quantum Transport and Quantum Coherence" , Tokyo, Japan, 16-19 August, 2002.
	Member, International Program Committee and International Advisory Committee of EP2DS-15, The 15th International Conference on Electronic Properties of Two-Dimensional Systems, Nara, Japan, 14-18 July, 2003.
	Member, Resource Review Board of ATLAS experiment at CERN
	Member, Steering Board of Advanced Magnetic Imaging Center, HUT
	Member, Steering Board of CARAMEL, a nanotube research consortium in Chalmers, Sweden
	Member, Steering Committee of ESF-sponsored PiShift Network
	Referee for appointment of two docents at HUT
	Referee, Applied Physics Letters
	Referee, EU Science Programs
	Referee, Strategic Research Foundation (Stiftelsen för Strategisk Forskning), Sweden

	Referee, The Israel Science Foundation
	Referee, Journal of Low Temperature Physics
	Referee, National Science Foundation, USA
	Referee, Physical Review B
	Referee, Physical Review Letters
Salmelin	Member, Academia Europaea
	Member, Academia Rodinensis Pro Remediatione
	Member of Editorial Board, NeuroImage
	Member, Organizing Committee, Euresco Conference: The science of aphasia III, Maratea, Italy, 14.-19.6.2002
	Member, Organizing Committee: The science of aphasia IV, Trieste, Italy, 22.-27.8.2003
	Referee, Behavioural Brain Research
	Referee, Brain
	Referee, Brain and Language
	Referee, Cortex
	Referee, Clinical Neurophysiology
	Referee, Cognitive Brain Research
	Referee, European Journal of Neuroscience
	Referee, Experimental Brain Research
	Referee, Human Brain Mapping
	Referee, IEEE Transactions on Biomedical Engineering
	Referee, Journal of Clinical Neurophysiology
	Referee, Journal of Neuroimaging
	Referee, Journal of Neuroscience
	Referee, Journal of Speech, Language, and Hearing Research
	Referee, NeuroImage
	Referee, Neuroscience Letters
	Referee, Proceedings of the National Academy of Sciences, USA
	Referee, Psychophysiology
	Referee, Science
	Referee, Stroke

	Reviewer for grant applications, Academy of Finland
	Reviewer for grant applications, Human Frontier Science Program
	Reviewer for grant applications, National Science Foundation (USA)
	Reviewer for grant applications, Netherlands Organization for Scientific Research
	Reviewer for grant applications, The Wellcome Trust (UK)
Schürmann	Referee, NeuroReport
	Referee, International Journal of Psychophysiology
	Referee, Physica A
Volovik	Associate Editor, JETP Letters, Russia
	Foreign Member, Finnish Academy of Sciences and Letters
	Co-chairman, ESF Scientific programme 'Cosmology in the laboratory' (COSLAB), 2001 - 2005
	Editor, Vortices in Unconventional Superconductors and Superfluids, eds. N. Schopohl, R. Huebener, G.E. Volovik, Springer
	Editor, Artificial Black Holes, eds. M. Novello, M. Visser, and G. Volovik, World Scientific
	Member of the dissertation panel in Landau Institute, Chernogolovka, Russia, 27. - 28.6.2002. Ph.D. Thesis of N.M. Shchelkachev, S.V. Malinin, V.S. Novikov, S.V. Gubanov, A.A. Akhmetshin, and V.S. Vol'vovskii
	Member of International Advisory Board, International Symposium on Ultralow Temperature Physics, Kanazawa, Japan, 28. - 31.08.2002
	Organizer of Minicolloquium Vortices in Multicomponent Superfluids, BEC and Superconductors, at 19th General Conference of the EPS Condensed Matter Division, Brighton, UK, 7. - 11.4.2002
	Organizer, Workshop on Quantum Vacuum Properties in Condensed Matter and Cosmology, Tours, France, 17. - 20.5.2002

AWARDS

Riitta Salmelin was promoted to professor of HUT.

Pertti Hakonen and **Riitta Salmelin** were elected to the Academia Europaea

Riitta Hari received the Justine et Yves Sergent –Prize

Riitta Hari was granted the Knight, First Class, of the Order of White Rose of Finland by the President of the Republic of Finland on Dec 6.

Päivi Helenius was awarded the Norman Geschwind award for neuromagnetic and psychoacoustical correlates of impaired reading and abnormal sound sequence processing in developmental dyslexia

Lauri Parkkonen and **Ole Jensen** received the Young Investigator Award, First Prize in Biomag 2002.

Kimmo Uutela received the thesis prize granted by TEK and TfiF.

Tauno Knuuttila received the Peter Kapitza Prize of International Institute of Refrigeration.

LOW TEMPERATURE PHYSICS PUBLICATIONS

Journal articles

Alles, H., Babkin, A., Jochemsen, R., Parshin, A.Ya., Todoschenko, I.A., and Tsepelin, V., *Faceting on 3He crystals* , Proceedings of the National Academy of Sciences of the United States of America (PNAS), **99**, 4, pp. 1796-1800 (INTERFACE), 2002014

Blaauwgeers, R., Eltsov, V.B., Eska, G., Finne, A.P., Haley, R.P., Krusius, M., Ruohio, J.J., Skrbek, L., and Volovik, G.E., *Shear flow and Kelvin-Helmholz instability in superfluids* , Physical Review Letters, **89**, 15, pp. 155301-1/4 (ROTA), 2002054

Eltsov, V.B., Blaauwgeers, R., Kopnin, N.B., Krusius, M., Ruohio, J.J., Schanen, R., and Thuneberg, E.V., *Transitions from vortex lines to sheet: Interplay of topology and dynamics in a anisotropic superfluid,* Physical Review Letters, **88**, 6, pp. 065301-1/4 (ROTA), 2002003

Huhtala, P. and Volovik, G.E., *Fermionic microstates within the Painlevé-Gullstrand black hole*, JETP, **121**, 5, pp. 995-1003 (THEORY), 2002059D

Huhtala, P. and Volovik, G.E., *Fermionic microstates within the Painlevé-Gullstrand black hole*, Journal of Experimental and Theoretical Physics, **94**, 5, pp. 853-861 (THEORY), 2002059D

Kopnin, N.B., *Introduction to Ginzburg-Landau and Gross-Pitaevskii theories for superconductors and superfluids* , Journal of Low Temperature Physics, **129**, 5/6, pp. 219-262 (THEORY), 2002072

Kopnin, N.B., *Vortex dynamics and mutual friction in superconductors and Fermi superfluids* , Reports on Progress in Physics, **65**, pp. 1633-1678 (THEORY), 2002060

Martikainen, J., Tuoriniemi, J., Knuuttila, T., and Pickett, G., *Vibrating wire measurements in 3He-4He mixtures in the ballistic quasiparticle regime* , Journal of Low Temperature Physics, **126**, 1/2, pp. 139-144 (YKI), 2002013

Nishida, M., Hatakenaka, N., and Kurihara, S., *Supercurrent through hybrid junctions with anisotrophc Cooper-pair condensates*, Physical Review Letters, **88**, 14, pp. 145302-1/4 (THEORY), 2002022

Roschier, L., Tarkiainen, R., Ahlskog, M., Paalanen, M., and Hakonen, P., *Manufacture of single electron transistors using AFM manipulation on multiwalled carbon nanotubes* , Microelectronic Engineering, **61-62**, pp. 687-691 (NANO), 2002057

Schakel, A.M.J., *Entangled vortices: Onsager's geometrical picture of superfluid phase transitions*, Journal of Low Temperature Physics, **129**, 5/6, pp. 323-361 (THEORY), 2002073

Sillanpää, M.A. and Hakonen, P.J., *Titanium single-electron transistor fabricated by electron-beam litography*, Physica E, **15**, pp. 41-47 (NANO), 2002062

Todoschenko, I., Alles, H., Babkin, A., Parshin, A.Ya., and Tsepelin, V., *Vibrating wire measurements in superfluid 3He at the melting curve down to 0.53 mK* , Journal of Low Temperature Physics, **126**, 5/6, pp. 1449-1455 (INTERFACE), 2002021

Tsepelin, V., Alles, H., Babkin, A., Jochemsen, R., Parshin, A.Ya., and Todoshchenko, I., *Morphology and growth kinetics of 3He crystals below 1 mK* , Journal of Low Temperature Physics, **129**, 5/6, pp. 489-530 (INTERFACE), 2002078

Tsepelin, V., Alles, H., Babkin, A., Jochemsen, R., Parshin, A.Ya., and Todoshchenko, I.A., *Anisotropy of growth kinetics of 3He crystal below 1 mK* , Physical Review Letters , **88**, 4, pp. 045302-1/4 (INTERFACE), 2002002

Tuoriniemi, J., Martikainen, J., Pentti, E., Sebedash, A., Boldarev, S., and Picket, G., *Towards superfluidity of 3He diluted by 4He* , Journal of Low Temperature Physics, **129**, 5/6, pp. 531-545 (YKI), 2002079

Viljas, J.K. and Thuneberg, E.V., *Equilibrium simulations of 2D weak links in p-wave superfluids* , Journal of Low Temperature Physics, **129**, 5/6, pp. 423-471 (THEORY), 2002077

Viljas, J.K. and Thuneberg, E.V., *Pinhole calculations of the Josephson effect in 3He-B* , Physical Review B, **65**, pp. 064530-1/19 (THEORY), 2002004

Volovik, G.E., *Black-hole horizon and metric singularity at the brane separating two sliding superfluids* , Pis´ma v Zhurnal Eksperimental´noi i Teoreticheskoi Fiziki, **76**, 5, pp. 296-300 (THEORY), 2002056D

Volovik, G.E., *Black-hole horizon and metric singularity at the brane separating two sliding superfluids*, JETP Letters, **76**, 5, pp. 240-244 (THEORY), 2002056D

Volovik, G.E., *Fundamental constants in effective theory*, JETP Letters, **76**, 2, pp. 77-79 (THEORY), 2002051D

Volovik, G.E., *Momentum space topology of fermion zero modes on brane* , Pis´ma v Zhurnal Eksperimental´noi i Teoreticheskoi Fiziki, **75**, 2, pp. 63-66 (THEORY), 2002001D

Volovik, G.E., *Momentum space topology of fermion zero modes on brane*, JETP Letters , **75**, 2 , pp. 55-58 (THEORY), 2002001D

Volovik, G.E., *Fundamental constants in effective theory* , Pis´ma v Zhurnal Eksperimental´noi i Teoreticheskoi Fiziki, **76**, 2, pp. 89-91 (THEORY), 2002051D

Volovik, G.E., *On the Kelvin-Helmholz instability in superfluids* , Pis´ma v Zhurnal Eksperimental´noi i Teoreticheskoi Fiziki, **75**, 8, pp. 491-495 (THEORY), 2002034D

Volovik, G.E., *On the Kelvin-Helmholz instability in superfluids*, JETP Letters, **75**, 8, pp. 418-422 (THEORY), 2002034D

Book sections

Aranson, I.S., Kopnin, N.B., and Vinokur, V.M., *Nucleation of vortices in superfluid 3He-B by rapid thermal quench* , Vortices in Unconventional Superconductors and Superfluids, **132**, pp. 49-64 (THEORY), B2002009

Kopnin, N., *Impurity band in clean superconducting weak links,* Physical Review B, **65**, pp. 132503/1-4 (THEORY), B2002038

Kopnin, N.B., *Vortex dynamics and the problem of the transverse force in clean superconductors and fermi superfluids* , Vortices in Unconventional Superconductors and Superfluids, **132** , pp. 99-118 (THEORY), B2002010

Schakel, A.M.J., *Quantum field theory in condensed matter physics (Book Review)*, *Springer-Verlag*, pp. 206 (THEORY), B2002052

Schopohl, N., Huebener, R., and Volovik, G.E., *Preface* , Vortices in Unconventional Superconductors and Superfluids, **132**, pp. 1 (THEORY), B20020006

Volovik, G., *Effective gravity and quantum vacuum in superfluids*, Artificial Black Holes , **Chapter 6**, pp. 127-177 (THEORY), B2002058

Volovik, G.E., *The beautiful world of the vortex in: Vortices in unconventional superconductors and superfluids*, Solid-State Science, pp. 1-4 (THEORY), B2002027

Volovik, G.E., Eltsov, V.B., and Krusius, M., *What can superconductivity learn from quantized vorticity in 3He fuperfluids?*, Vortices in Unconventional Superconductors and Superfluids, **132**, pp. 21-48 (THEORY), B2002008

Volovik, G.E., *The beautiful world of the vortex* , Vortices in Unconventional Superconductors and Superfluids, **132**, pp. 1-4 (THEORY), B2002007

Conference proceedings

Roschier, L., Tarkiainen, R., Ahlskog, M., Paalanen, M., and Hakonen, P., *Manufacture of single electron transistors using AFM manipulation on multiwalled carbon nanotubes* , Proc. of 27th Int. Conf. on Micro- and nano-Engineering, **Microelectronic Engineering, 61-62**, 61-62, pp. 687-691 (NANO), C2002050

Theses

Blaauwgeers, R., *Unconventional quantized vortices: A study of 3He and UPt3*, Leiden University and Low Temperature Laboratory thesis, pp. 118 (ROTA), T2002026

BRAIN RESEARCH PUBLICATIONS

Journal articles

Alary, F., Simões, C., Jousmäki, V., Forss, N., and Hari, R., *Cortical activation associated with passive movements of the human index finger: An MEG study*, NeuroImage, **15**, pp. 691-696, 2002019

Avikainen, S., Forss, N., and Hari, R., *Modulated activation of the human SI and SII cortices during observation of hand actions*, NeuroImage, **15**, pp. 640-646, 2002020

Fujiki, N. , Jousmäki, V., and Hari, R., *Neuromagnetic responses to frequency-tagged sounds: *A new method to follow inputs from each ear to the human auditory cortex during binaural hearing*, The Journal of Neuroscience, **22**, pp. 1-4, 2002005

Fujiki, N., Riederer, K.A.J., Jousmäki, V., Mäkelä, J., and Hari, R., *Human cortical representation of virtual auditory space: differences between sound azimuth and elevation*, European Journal of Neuroscience, **16**, pp. 2207-2213, 2002069

Gross, J., Timmermann, L., Kujala, J., Dirks, M., Schmitz, F., Salmelin, R., and Schnitzler, A., *The neural basis of intermittend motor control in humans*, Proceedings of the National Academy of Sciences of the United States of America (PNAS), **99**, 4, pp. 2299-2302, 2002012

Helenius, P., Salmelin, R., Richardson, U., Leinonen, S., and Lyytinen, H., *Abnormal auditory cortical activation in dyslexia 100 msec after speech onset* , Journal of Cognitive Neuroscience, **14**, 4, pp. 603-617, 2002036

Helenius, P., Salmelin, R., Service, E., Connolly, J.F., Leinonen, S., and Lyytinen, H., *Cortical activation during spoken-word segmentation in nonreading-impaired and dyslexic adults*, The Journal of Neuroscience, **22**, 7, pp. 2936-2944, 2002023

Jääskeläinen, J., Hernesniemi, J., and Mäkelä, J., *Comments to magnetic source imaging in patients with arteriovenous malformations*, Neurosurgery, **51**, 3, pp. 1-2, 2002063

Järveläinen, J. and Schürmann, M., *The motor cortex 20 Hz rhythm reacts differently to thumb and middle finger stimulation: an MEG stud* , NeuroReport, **13**, 10, pp. 1243-1246, 2002045

Jensen, O. and Tesche, C.D., *SHORT COMMUNICATION Frontal theta activity in humans increases with memory load in a working memory task* , European Journal of Neuroscience, **15**, 8, pp. 1395-1399, 2002032

Jensen, O. and Vanni, S., *A new method to indentify multiple sources of oscillatory activity from magnetoencephalographic data*, NeuroImage, **15**, pp. 568-574, 2002017

Jensen, O., Gelfand, J., Kounios, J., and Lisman, J.E., *Oscillations in the alpha band (9-12 Hz) increase with memory load during retention in a short-term memory task* , Cerebral Cortex, **12**, pp. 877-882, 2002068

Jensen, O., Hari, R., and Kaila, K., *Visually evoked gamma responses in the human brain are enchanced during voluntary hyperventilation*, NeuroImage **15** pp. 575-586, 2002016

Juottonen, K., Gockel, M., Silén, T., Hurri, H., Hari, R., and Forss, N., *Altered central sensorimotor processing in patients with complex regional pain syndrome*, Pain, **98**, pp. 315-323, 2002041

Lin, Y.Y. and Forss, N., *Functional characterization of human second somatosensory cortex by magnetoencephalography* , Behavioral Brain Reserch, **135**, pp. 141-145, 2002075

Lütkenhöner, B., Lammertmann, C., Simões, C., and Hari, R., *Magnetoncephalographic correlates of audiotactile interaction*, NeuroImage, **15**, pp. 509-522, 2002015

Mäkelä, J.P., *The role of functional brain imaging in military medicine* , Revue Internationale des Services de Santé des Forces Armées, **75**, 3, pp. 155-160, 2002055

McGonigle, D.J., Hänninen, R., Salenius, S., Hari, R., Frackowiak, R.S.J,. and Frith, C.D., *Whose arm is it anyway? An fMRI case study of supernumerary phantom limb*, Brain, **125**, pp. 1265-1274, 2002030

Nishitani, N. and Hari, R., *Viewing lip forms: Cortical dynamics*, Neuron, **36**, pp. 1211-1220, 2002071

Paetau, R., *Magnetoencephalography in pediatric neuroimaging* , Developmental Science, **5**, 3, pp. 361-370, 2002049

Pohja, M., Salenius, S., and Hari, R., *Cortico-muscular coupling in a human subject with mirror movements - a magnetoencephalographic stud* , Neuroscience Letters, **327**, pp. 185-188, 2002039

Renvall. H. and Hari, R., *Auditory cortical responses to speech-like stimuli in dyslexic adults* , Journal of Cognitive Neuroscience, **14**, 5, pp. 757-768, 2002043

Saarelma, K., Renvall, H., Jousmäki, V., Kovala, T., and Hari, R., *Facilitation of the spinal H-reflex by auditory stimulation in dyslexic adults*, Neuroscience Letters, **327**, pp. 213-215, 2002040

Salenius, S., Avikainen, S., Kaakkola, S., Hari, R., and Brown, P., *Defective cortical drive to muscle in Parkinson's disease and its improvement with levodopa*, Brain, **125** , pp. 491-500, 2002011

Salmelin, R. and Sams, M., *Motor cortex involvement during verbal versus non-verbal lip and tongue movements* , Human Brain Mapping, **16**, pp. 81-91, 2002037

Schürmann, M., Kolev, V., Menzel, K., and Yordanova, J., *Spatial coincidence modulates interaction between visual and somatosensory evoked potentials*, NeuroReport , **13**, 6, pp. 779-783, 2002029

Schürmann. M., Raij, T., Fujiki, N., and Hari, R., *Mind's ear in a musician: where and when in the brain*, NeuroImage, **16** , pp. 434-440, 2002031

Silén, T, Karjalainen, T., Lehesjoki, A-L., and Forss, N., *Cortical sensorimotor alterations in Unverricht-Lundborg disease patients without generalized seizures*, Neuroscience Letters, **323**, pp. 101-104, 2002035

Silén, T., Forss, N., Salenius, S., Karjalainen, T., and Hari, R., *Oscillatory cortical drive to isometrically contracting muscle in Unverricht-Lundborg type progressive myoclonus epilepsy (ULD)*, Clinical Neurophysiology, **113**, pp. 1973-1979, 2002080

Simões, C., Alary, F., Forss, N., and Hari, R., *Left-hemisphere-dominant SII acivation after bilateral median nerve stimulation1*, NeuroImage, **15**, pp. 686-690, 2002018

Stenbacka, L., Vanni, S., Uutela, K., and Hari, R., *Comparison of minimum current estimate and dipole modeling in the analysis of simulated activity in the human visual cortices*, NeuroImage, **16**, pp. 936-943, 2002042

Tarkiainen, A., Cornelissen, P.L., and Salmelin, R., *Dynamics of visual feature analysis and object-level processing in face versus letter-string perception*, Brain, **125**, pp. 1125-1136, 2002025

Vihla, M., Kiviniemi, K., and Salmelin, R., *Auditory cortical activation in Finnnish and Swedish speaking Finns: A magnetoencephalographic study*, Neuroscience Letters, **322**, 141-144, 2002024

Book sections

Hämäläinen, M. and Hari, R., *Magnetoencephalographic characterization of dynamic brain activation: Basic principles and methods of data collection and source analysis*, Brain Mapping, The Methods, 2nd edition, pp. 227-253, B2002064

Conference proceedings

Cohen, D., Schläpfer, U., Ahlfors, S., Hämäläinen, M., and Halgren, E., *New six-layer magnetically-shielded room for MEG*, Proc. of 13th Int. Conf. on Biomagnetism, pp. 919-921, C2002046

Hari, R., *Brain rhythms and reactivity of the human motor cortex* , Proc. of Int. Symposium on Inter-areal Functional Coupling , Excerpta Medica - International Congress Series 1226, pp. 87-95, C2002028

Jensen, O., Pohja, M., Goel, P., Ermentrout, B., Kopell, N., and Hari, R., *On the physiological basis of the 15-30 Hz motor-cortex rhythm*, Proc. of 13th Int. Conf. on Biomagnetism, pp. 313-315, C2002047

Parkkonen, L. and Mäkelä, J., *MEG sees deep sources: measuring and modelling brainstem auditory evoked fields*, Proc. of 13th Int. Conf. on Biomagnetism, pp. 107-109, C2002048

Newspaper article

Hari, R., *Imitation is a lot more than just the sincerest form of flattery*, The Taipei Times, pp. 1-3, N2002066

Hari, R., *Commentary: The social brain*, Project Syndicate, pp. 1-3, N2002065

Reports

Simoes, C., Jensen, O., Parkkonen, L., and Hari, R., *Phase-locking between human SI and SII cortices*, HUT REPORTS , TKK-KYL-007, pp. 1-16, R2002061

Theses

Heikman, P., *Right unilateral and bifrontal electroconvulsive therapy in the treatment of depression with special reference to neurophysiological and clinical aspects*, Helsinki University and Low Temperature Laboratory thesis, pp. 120, T2002074
The work was carried out in the Department of Psychiatry, Helsinki University Central Hospital and the Brain Research Unit, Low Temperature Laboratory, Helsinki University of Technology. It was supervised by Doc. Kimmo Kuoppasalmi, MD, Department of Psychiatry, Helsinki University Central Hospital and National Public Health Institute, Helsinki.

Simões, C., *Neuromagnetic characterization of the human secondary somatosensory cortex*, Low Temperature Laboratory thesis, pp. 119, T2002067

APPENDIX I

REPORT ON THE PROGRESS OF THE FINNISH CENTRE OF EXCELLENCE

The Low Temperature Laboratory, Helsinki University of Technology

LOW TEMPERATURE PHYSICS RESEARCH

The evaluation is based on the site visit of the evaluator assigned by the Finnish Academy of Finland, on may 31, 2002. The report is intended to address the individual items that were indicated to be of major interest to the Finnish Academy of Science.

For the evaluation, the following information was made available:

- activity Report and Research Plan 2000-2005, provided prior to the site visit;
- oral presentations of the past activities and future plans by the leaders of the individual subgroups of the Centre;
- a tour of the laboratory (Cryo Hall and Clean room), providing contact with senior scientists and post docs; and
- a discussion session with PhD and Master students.

Individual Research Projects

a. Topological objects in macroscopic quantum systems

This project is still one of the scientifically most outstanding projects of the Centre. Technically it is virtually unmatched in the world and it addresses questions that are of high interest both experimentally and theoretically. A lot of the work invested in the last two years was devoted to an upgrade of the experimental facility. First experiments were devoted to investigations of the influence of interfaces on the vortex formation in the model material, superfluid ^{3}He. The mid- and long term plans for the project are, as usual, very ambitious, but there is no doubt that this group will carry its excellence and high international recognition into the future, certainly into the next three years of the CoE program.

b. Quantum field theories and superfluid ^{3}He

The output of this project which, somewhat regrettably, is carried by only one person (G. Volovik), is to a certain extent very speculative but at the same time highly original. The project is undoubtedly one of the scientific gems of the program. It relates in part with the experimental activities of section a) but it addresses very deep theoretical questions that are of utmost importance in physics in general. It will be both amusing and interesting to follow its further progress.

c. Dynamics of superfluid ^{3}He and superconductors

The first part of this project is intended to give additional theoretical support to project a). The project has considerably gained in strength since N. Kopnin has joined the effort as a visiting professor and his undisputed expertise in vortex physics is also beneficial for the second part of the project, where the vortex dynamics in the mixed state of cuprate superconductors, as well as aspects in mesoscopic superconductivity are investigated. All these topics have potential for novel results in the next three years.

d. Theory of Fermi superfluids

Also this project has strong ties to the experimental project a). Various different aspects in the rich physics of superfluid ^{3}He are being studied, to a great extent in the form of PhD projects. It seems that all PhD students in the theory program almost exclusively collaborate with E. Thuneberg who, after accepting a professorship at the University of Oulu, spends only a much reduced part of his time at LTL. These PhD projects are in progress and will certainly continue well into the next three years of the CoE program. As mentioned in the previous report, this situation is certainly not optimal, at least from the point of view of educating young scientists.

e. Interfaces in quantum systems

This project aims at studying surfaces of solid ^{3}He at very low temperatures and relies on highly skilled experimental techniques. The most recent sets of measurements has led to the discovery of a large number of facets on ^{3}He crystals and pioneering experiments measuring the growth velocity of several surfaces have been made. It was concluded that the coupling of the liquid-solid interface to the crystal lattice is much stronger in ^{3}He than in ^{4}He, definitely a counter intuitive result. Because of the high technical standard, the future of this project is bright. It will be possible to investigate various roughening transitions and new phenomena, delivering a lot of experimental input for comparisons with theoretical concepts or to stimulate new theoretical efforts.

f. Dilute mixture experiments

The most powerful refrigeration system of the laboratory (YKI –cryostat) is being used for studying superfluidity of ^{3}He diluted by ^{4}He. Again these experiments require an experimental facility and technical skills which, in the necessary combination, are not available elsewhere in the world. In this sense, also this subgroup clearly fulfills the conditions that are needed for the qualification of a centre of excellence. In the most recent experiments, the liquid with different degrees of ^{4}He dilution was cooled to temperatures well below 1 mK, but no transition has been observed as yet. The same group aims at observing the superconducting transition of Li metal. Also this experiment is very risky and may not lead to the attempted goal. This program should be continued but needs reevaluation after the next three year funding period.

g) Nanophysics research

As recommended in the previous report and in the best tradition of LTL, this group has identified and taken up a few technically very challenging issues in the physics of

nanostructured materials. The most recent successes encompass the realization of an ultra low noise single electron rf transistor (SET) on the basis of carbon nanotubes, the realization of a Bloch-oscillator transistor (BOT) and energy level spectroscopy in Josephson junctions. The continuation of these topics is very promising and thus recommended. Further development of the BOT may provide the laboratory with a new tool for studies related with so called quantum measurements and metrological applications. This subproject is also well suited to strengthen the ties of LTL with external, industrially oriented partners, such as VTT. The same is true for the development of low noise SET's, which will open new possibilities in the field of quantum measurements. Future work of investigating various properties of C_{60} nanotubes with new experimental possibilities, such as the rf-SET, is expected to lead to new basic, internationally recognized results.

General comments and recommendations

The overall performance of LTL related with research in low temperature physics continues to be excellent, in particular of the subgroups active in studying various properties of liquid and solid ^{3}He and the theory group. The outstanding performance is based on experimental facilities of highest technical quality. Their development is part of the program, in the best tradition of an experimentally oriented research unit. The performance of the nanophysics group has greatly improved and considering its recently achieved results, its future looks very promising. In view of the experimental difficulties that are related with many of the projects of LTL, the overall output in the form of publications is impressive.

The profile of the low temperature physics subunit of LTL is excellent. All projects are related with topics of high current interest in low temperature physics and many experiments are definitely at the forefront of this type of research. Some of them even seem to be unmatched on the world scale.

LTL has, overall, well responded to the evaluation report of 2000. Particularly visible are the improvements with respect to the nanophysics activities, in relation with both improved facilities (clean room) and innovative directions of research. The infrastructural support of the home institution was not brought up as being a problem and therefore seems to be adequate.

The training of young researchers is well developed. In most groups, the ratio between the numbers of senior researchers and PhD students is healthy. As noted in a previous report, the educational aspects in the theory group are still not optimal. With the departure of E. Thuneberg, the situation certainly has not improved. From the point of view of research output, however, the performance of the theory group is outstanding and the contact to the experimental groups seems to be better than two years ago. Working successfully in the given experimental projects, there is no doubt that young researchers acquire both high technical skills and are exposed to intellectually chal-

lenging problems. In this way they are being well prepared for academic, as well as industrial careers.

Within low temperature physics, the centre enjoys a very high international visibility, also reflected in a number of collaborations. Not surprisingly, very good and fruitful contacts exist with the Russian scientific community. The role of the lab as a European low temperature facility was not addressed during the evaluation. From the written report, this role does not seem to decisively influence the research program of LTL.

Since the low temperature physics program of LTL is clearly focussed on fundamental research, the direct societal and economic impact of these activities is low at first sight. However, the output of well trained students is one of the most important tasks of a university based unit and it is in this way, that a very efficient „technology transfer“ is achieved. The project on nanophysics is very well connected with at least one application oriented institution and it may well be that in the future, this research also has direct economic impact.

Since the present evaluation was done separately for the low temperature physics and the brain research subunits, respectively, not much can be said about new synergies between the two separate programs. This evaluator enjoyed a short presentation of the brain research program and he feels that no obvious changes in the present arrangement are necessary at present. It is recommended that LTL as a whole is recognized and supported as a centre of excellence during the next three year funding period. After this term, an in depth analysis of the sitation with respect to these two subunits seems, however, indicated.

Zürich, June 29, 2002

H.R. Ott

APPENDIX II

REPORT ON THE EVALUATION OF THE BRAIN RESEARCH UNIT

Low Temperature Laboratory

Helsinki University of Technology

June 10, 2002

This is a mid-term progress report of the evolution of the Brain Research Unit (BRU) of the Low Temperature Laboratory (LTL) since the last evaluation that was carried out by the full Scientific Advisory Board in June 2000. Here I focus on the BRU part of the laboratory since this is my field of expertise.

The BRU as a Center of Excellence

The basic question is whether the BRU continues to fulfill the requirements to be considered a Center of Excellence as concluded in 2000. On the basis of the scientific achievements of the group and the international impact of these activities, there is no doubt that the BRU has continued to achieve a degree of excellence on the field of MEG brain research. It fulfills certainly the role of laboratory of reference in the field not only in Europe but worldwide.

My qualification is based first, on an analysis of the publications of the group, that has a reputable score of papers of high impact in international journals of the highest standing in the field, as indicated in Table 3 of the BRU Report, namely in Neuron, Proceedings of National Academy of Sciences, Journal of Neuroscience, Annals of Neurology, Brain, NeuroImage, American Journal of Psychiatry, Human Brain Mapping, Journal of Cognitive Neuroscience. This means that of the 56 publications in journals with known impact factor that appeared in the period 2000-2002, 32 (57%) were published in journals with an IF equal or higher than 5. Second, on the prestigious invitations to Riitta Hari and Riitta Salmelin to deliver lectures at important international meetings, in addition to the honors and awards that these scientists received.

The international visibility of the BRU

The recognition of the BRU, along with the LTL, as European Large-scale Facility Center of Excellence has strengthened the international profile of the BRU. This international program Neuro-BIRCH III that was extended until 2003 has accommodated 22 visiting scientists for 28 person months in the past 2 years. It was possible to carry out 41 projects involving researchers from 12 countries. These activities have contrib-

uted very significantly to reinforce the position of the BRU in the international field. It has played a most valuable role in promoting neuro-cognitive research of high level.

Co-operation between the research groups

A high degree of co-operation between the research groups is present. First, the BRU in the whole maintains a regular series of seminars where the senior researchers and the Ph. D students working in the different brain research groups regularly meet and discuss on-going research and scientific strategies. Second the senior researchers participate in several projects and publish jointly quite often. Third, the BRU participates in the multidisciplinary neuroscience organization HUT Institute for Neurosystems and on the Graduate School for Neuroscience, although the role of the latter appears to be less important than desirable for the BRU young scientists. . Nevertheless it is worth noting, as in the previous report, that there is little scientific co-operation between the BRU researchers and the Physics Research Unit, but this is apparently not felt as a drawback by the BRU scientists.

Institutional support/core facilities

The MEG facility has been up-dated and continues to be at the forefront of the field, worldwide. The 3-tesla fMRI (Advanced Magnetic Imaging, AMI) apparatus, that was recently installed (February 2002) is becoming functional. The organization of the AMI facility is getting shape but this process involves the appointment of a number of people with a high level of expertise. This is currently a main preoccupation of the direction of the Laboratory. I share this concern and wish to emphasize that it is of the utmost importance for the responsible authorities to give to this issue a high priority. Ideally the AMI core personnel should form a multidisciplinary group consisting of a core of senior scientists, namely one physicist expert on MRI techniques in general and imaging in particular, one physicist with experience in functional studies of the brain (metabolic and electro-magnetic), one Neuro(psycho)physiologist. In addition the AMI needs also to have a good team of technicians and, of course, possibilities to accommodate Post-Docs and Ph. D. students and M.Ds (may be on part-time basis if they keep hospital appointments). I realize that this is a major investment and that the building-up of AMI is a process that has to be gradual and carefully planned. In any case in order for the BRU to maintain its position as a world Center of Excellence in advanced Neuro-Cognitive sciences it is absolutely necessary to realize this important extension of the existing MEG facilities with an expert AMI research center.

Opportunities for training of researchers

An important asset of the BRU is a continuing program of education and training in MEG oriented Neuro-Cognitive research. Two main aspects of this program may be distinguished: The regular Ph.D. program and the training of scientists from countries of the European Union as an essential part of the Large-scale Facility NeuroBIRCH

(III).The BRU has a steady output of Ph.D. degrees, on average just less than 2 per year for the last 10 years. With the recent appointment of one of the senior scientists (Riitta Salmelin) as professor it is likely that this number may rise in the future.

The number of new users of the Neuro-Birch III program has reached the impressive number of 22. This should be considered as a healthy demonstration of the success of BRU as a center of excellence that has a strong appeal to attract scientists from abroad. Nevertheless a word of caution has to be added: the fact that this flow of external researchers, who bring a large number of projects, puts a heavy burden on the permanent staff and even on the Ph.D. students working at the BRU.

Researchers: perspectives and needs of the BRU

The perspectives of the senior researchers improved with respect to the previous period of evaluation. Indeed two senior scientists (Riitta Salmelin and Matti Hämäläinen) obtained permanent positions. As stated above the acquisition of the AMI facility needs to be followed by a well planned investment in expert personnel. This is clearly a high order priority.

The collective interview that I had with 8 Ph.D. students left an excellent impression of the level of the PH.D. thesis work and of the enthusiastic engagement of both students and staff. Nevertheless some students pointed out that the ratio between senior staff and students, both those on the regular BRU program and the foreigners of the Neuro-BIRCH III, has reached a rather low level. The fact that two senior scientists have been, or still are, on leave of absence has certainly contributed to this situation. This issue should be carefully taken into account while recruiting new staff members particularly regarding the new AMI Lab.

Perspectives regarding the next 3-year period: assets and pitfalls

Funding appears to have been stabilized in the past years. It is clear that the integration of the MEG and the AMI laboratories needs extra funding. The plan to move to a new building at the beginning of 2006 will also need to reserve funds for the installation of the laboratories in the new building. It is to be recommended that the BRU will try to obtain substantial funds from the 6^{th} framework program of the European Union. The excellent track record of the senior scientists, along with their extended network of international collaborations, are also favorable assets in order to obtain funds from other international organizations, such as the Human Frontier Scientific Program Organization.

Scientifically the BRU has a number of already successful research lines that merit to be continued as in the field of sensory and motor cortical functions and cognitive and language functions. These are valuable assets. A number of research topics have a high degree of originality and there are all reasons to expect that the creativity and ingenuity of the staff will lead to new exciting developments.

For the immediate future an area that could be expanded is that of clinical applications. Also more attention could be given to the field of signal analysis, particularly with respect to the dynamical analysis of magnetic and electrical signals (e.g. temporal and spatial phase synchronization). With the acquisition of the new fMRI facility it is to be expected that new research lines aimed at integrating MEG and fMRI signals of brain function will receive high priority. Taking into consideration the strong links of the BRU to a physics environment it would be important that the Unit will contribute to basic research directed to the analysis of the biophysical/physiological fundamental processes underlying the generation of signals of brain activity detected by fMRI and by MEG/EEG. In this respect the BRU may consider establishing collaborative studies with groups working at this fundamental level elsewhere (e.g. Max-Planck Institutes).

A few additional remarks to think over

The next couple of years will be critical for the BRU to take the necessary steps to reach the same high level of expertise that it already has attained in MEG, in the area of fMRI neuro-cognitive research. Therefore the recommendations made above regarding the necessary investment of high quality staff for the AMI laboratory should be taken earnestly.

It does not need further emphasis to remark that in the field of neuro-cognitive research the competitiveness has grown appreciably in the last few years. Also in the field of MEG research the number of facilities in many countries has increased steadily. Thus the BRU is now active in a much more competitive filed than in the past. This implies that the BRU should choose main research lines where it may excel, and in doing this it should be selective rather than too extensive. The research on the integration of MEG/EEG and fMRI signals is such an area where a real gap is being felt, while the expertise of the BRU/AMI laboratories appears to provide an optimal environment for the achievement of frontline innovative research.

An evaluation is never complete without a few critical remarks and suggestions to be taken into consideration by the staff. Regarding the publications I noted a rather appreciable number (about 28%) in journals with an IF less than 3. These publications appeared mainly in journals specialized in short and rapid communications (NeuroReport, Neuroscience Letters). The staff should consider whether this should be the preferable publication policy. May be a smaller number of short publications in journals of higher ranking would be preferable.

The vitality of a center of excellence such as BRU depends not only on the level of the permanent staff and of the technical facilities, but also on that of the students that it can attract. This merits the utmost attention of the senior staff. Furthermore the BRU in tight collaboration with the University (HUT) and the Academy should develop a framework for career development of young scientists within this research field. This may offer more attractive perspectives for potential research students.

A note of concern is that the activities of the BRU in assisting research visitors (e.g NeuroBIRCH III) puts a heavy burden in the time of both the senior and junior staff of the Unit. The Funding Organizations when establishing the funds available for the recruitment of personnel should take this into account.

Amsterdam, July 17, 2002

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