ANNUAL REPORT
2003

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

PREFACE

Kylmälaboratorio, the Finnish name of the LTL is widely known among the big public. The name was selected nearly 40 years ago by Olli V. Lounasmaa, the founder and long-time director of the laboratory. In year 2003, after the death of Academician Lounasmaa, Paavo Uronen, the Rector of the Helsinki University of Technology, suggested that the LTL could be renamed after its founder. The suggestion was discussed among the personnel of the laboratory and a popular vote was organized. The members of the LTL decided, instead of the renaming, to establish a Prize/Lecture series, carrying the name of Olli V. Lounasmaa.

Only one third of the funding of the LTL is coming from its host organization, the HUT. This is a painfully low percentage for a laboratory which is specialized in basic experimental research. Consequently, the other funding sources, granting long-term research contracts, are becoming important for the continuation of the unique research program of the laboratory. In FP6, the European Union's 6th Framework Program, the support for Research Infrastructures continued on slightly reduced funding level. The ULTI application of the LTL was one of the 24 funded Research Infrastructures and the only one from Finland. The ULTI proposal received the second highest points among about 200 applications, and will be funded for the period of 1.4.2004 – 31.3.2008. The evaluation report of the ULTI proposal is attached as Appendix I

The hard and innovative work of the scientists of the LTL was recognized also outside the laboratory. Academy Professor Riitta Hari shared, together with Wolfgang Baumeister and Nikos K. Logothetis, the 2003 Louis-Jeantet Prize for Medicine. This prestigious Swiss prize was granted for the 18th time. The value of the prize is best reflected by the fact that 20% of the previous winners have later received the Nobel Prize in Medicine. Professor Riitta Salmelin was the first recipient of the new Philips Nordic Prize for her studies on dyslexia. The Philips Prize is established for improvement of the research on children's neurological disorders and it was handed to Salmelin by the Crown Princess Victoria. Academy Professor Matti Krusius was granted the title of Knight, First Class, of the Order of the White Rose of Finland. Dr. Markus Ahlskog was elected to the professorship in applied physics in University of Jyväskylä. The previous holders of this professorship are the undersigned from 1992 to 1995 and Academy Professor Jukka Pekola from 1995 to 2002. M.Sc.Tech. René Lindell and M.Sc.Tech. Leif Roschier participated in the VentureCup Finland competition. Their business idea called Cryoamp placed among the 10 finalist in the field of 252 participants.

The LTL has over the years enjoyed of the visits of several famous scientists. The year 2003 was not an exception. The 2003 Nobel Prize in physics was granted to Alexei Abrikosov, Vitaly Ginzburg and Anthony Leggett for their pioneering contributions to the theory of superconductors and superfluids (http://www.nobel.se/physics/index.html and http://www.nobel.se/physics/laureates/2003/index.html). The Nobel Committee used in the justification of the Prize also material produced by the ROTA group of the LTL. Professor Legget has visited the LTL in 1970s. Academician Ginzburg and Professor Leggett visited the Low Temperature Laboratory on 15.12. 2003. The LTL organized, in collaboration with the Finnish Physical Society, two symposia, one for about 100 physics students of the HUT (Meet the Nobel Laureates 2003), and the other one for general public at House of Estates (Nobel Symposium).

Mikko Paalanen
Director of the LTL

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

PERSONALIA

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

SENIOR RESEARCHERS

Mikko Paalanen, Dr. Tech., Professor, Director of the LTL
Riitta Hari, M.D., Ph.D., Academy Professor, Head of the Brain Research Unit
Peter Berglund, Dr. Tech., Docent, Technical Manager
Markus Ahlskog, Dr. Tech.
Anne Anthore, Ph.D., from 1.11.
Harry Alles, Dr. Tech.
Vladimir Eltsov, Ph.D.
Nina Forss, M.D., Ph.D., Docent, Part-time
Pertti Hakonen, Dr. Tech., Professor
Tero Heikkilä, Dr. Tech.
Päivi Helenius, Dr. Psych., on leave
Risto Hänninen, Dr. Tech.
Veikko Jousmäki, Ph.D.
Ken-Ichi Kaneko, Dr., until 24.7.
Erika Kirveskari, M.D., Ph.D., part-time
Jaakko Koivuniemi, Dr. Tech., on leave
Nikolai Kopnin, Ph.D., Prof.
Juha Kopu, Dr. Tech., from 1.10.
Matti Krusius, Dr. Tech., Academy Professor
Sari Levänen, Dr. Psych., 9.6.–31.8.
Jukka Pekola, Dr. Tech., Academy Professor
Hanna Renvall, M.D., Ph.D.
Stephan Salenius, M.D., Ph.D. part-time, until 30.4.
Alexander Savin, Ph.D.
Riitta Salmelin, Dr. Tech., Professor
Martin Schürmann, M.D., Ph.D., Docent
Alexander Sebedash, Ph.D.
Cristina Simões, Dr. Tech.
Erkki Thuneberg, Dr. Tech., Professor, part-time
Igor Todoschenko, Ph.D.
Juha Tuoriniemi, Dr. Tech., Docent
Simo Vanni, M.D., Ph.D.
Minna Vihla, M.D., Ph.D., part-time, from 1.6.
Grigori Volovik, Ph.D., Visiting Professor

ADMINISTRATION AND TECHNICAL PERSONNEL

Teija Halme, secretary
Marja Holmström, Lic. Phil., Laboratory Administrator
Antti Huvila, technician
Mia Illman, laboratory assistant
Arvi Isomäki, technician
Juhani Kaasinen, technician
Antti-Iivari Kainulainen, laboratory assistant from 1.4.
Helge Kainulainen, technician
Pirjo Kinanen, financial secretary
Tuire Koivisto, secretary
Markku Korhonen, technician
Sami Lehtovuori, technician
Satu - Anniina Pakarinen, project secretary
Liisi Pasanen, secretary
Kari Rauhanen, technician
Antero Salminen, technician
Ronny Schreiber, technician, 3.2 - 23.3. and 21.7 - 21.9.

GRADUATE STUDENTS (SUPERVISORS)

Gina Caetano, M.Sc. Tech.
(Veikko Jousmäki, Riitta Hari)
Antti Finne, M.Sc.Tech.
(Matti Krusius)
Jouni Flyktman, M.Sc.Tech.
(Jukka Pekola)
Yevhen Hlushchuk, M.D.
(Riitta Hari)
Jaana Hiltunen M.D.
(Raimo Joensuu)
Kirsi Juntunen, M.Sc. Tech.
(Juha Tuoriniemi)
Juha Järveläinen, M.D.
(Riitta Hari)
Jani Kivioja, M.Sc. Tech.
(Jukka Pekola)
Jan Kujala, M.Sc. Tech.
(Riitta Salmelin)
Markku Kujala, M.Sc. Tech.
(Matti Krusius)
Mia Liljeström, M.Sc. Tech.
(Riitta Salmelin)
René Lindell, M.Sc. Tech.
(Pertti Hakonen)
Antti Niskanen, M.Sc. Tech.
(Jukka Pekola)
Teemu Ojanen, M. Sc. Tech.
(Tero Heikkilä)
Lauri Parkkonen, M.Sc. Tech.
(Riitta Hari)
Tiina Parviainen, M.Sc. Psych.
(Päivi Helenius, Riitta Salmelin)
Elias Pentti, M. Sc. Tech.
(Juha Tuoriniemi)
Marjatta Pohja, M.D.
(Stephan Salenius, Riitta Hari)
Tuukka Raij, M.D
(Riitta Hari, Nina Forss)
Leif Roschier, M.Sc. Tech.
(Pertti Hakonen)
Mika Seppä, M.Sc. Tech.
(Riitta Hari)
Mika Sillanpää, M.Sc. Tech.
(Pertti Hakonen)
Linda Stenbacka, M.D.
(Simo Vanni)
Topi Tanskanen, M.Sc. Psych.
(Riitta Hari)
Reeta Tarkiainen, M.Sc. Tech.
(Pertti Hakonen)
Jussi Toppari, M.Sc. Tech.
(Jukka Pekola)
Fan Wu, M.Sc.
(Pertti Hakonen)
Janne Viljas, M.Sc. Tech.
(Erkki Thuneberg)

UNDERGRADUATE STUDENTS

Sakari Arvela
Samuel Aulanko
Samuli Hakala
Linda Henriksson
Kaisa Hytönen
Marianne Inkinen
Antti Jalava
Heikki Junes
Kaarle Kulvik
Jussi Kumpula
Hannu Laaksonen
Ari Laiho
Teijo Lehtinen
Mika Martikainen
Tommi Nieminen
Vesa Norrman
Ville Pietilä
Antti Puurula
Pauli Pöyhönen
Tomi Ruokola
Miiamaaria Saarela
Timo Saarinen
Anssi Salmela
Sanna Silanen
Juho Simpura
Taru Suortti
Johanna Uusvuori
Nuutti Vartiainen
Vesa Vaskelainen
Saija Wichmann
Mikko Viinikainen
Pauli Virtanen

VISITORS FOR EU PROJECTS

NEURO - BIRCH III (Brain research)

Barber, Colin, Prof.	University of Nottingham, Department of Medical Physics, Nottingham, UK, 10.2. – 15.2., 24.2. – 26.2. and 17.9. – 20.9.
Garrido, Marta, Ms.	Instituto di Biofisica e Engenharia Biomedica, Lisbon, Portugal, 3.3. – 2.6.
Gobbelé, René, Dr.	University of Aachen, Department of Neurology, Aachen, Germany, 13.4. – 18.4.
Hupé, Jean-Michel, Dr.	CNRS /CERCO–Université Paul Sabatier, Toulouse, France, 22.4. – 3.5. and 15.7. – 26.7.
König, Reinhard, Dr.	University of Bayreuth, Germany, 11.3. – 4.4.
Nahum, Mor, Ms.	Hebrew University of Jerusalem, Center of Neural Computation, Jerusalem, Israel, 21.4. – 8.5.
Narici, Livio, Prof.	University of Roma Tor Vergata, Roma, Italy, 21.9. – 28.9.
Nobre, Anna, Dr.	University of Oxford, Department of Experimental Psychology, Oxford, UK, 20.3. – 29.3.
Pammer, Kristen, Dr.	University of Newcastle upon Tyne, Department of Psychology, Newcastle upon Tyne, UK, 7.1. – 22.2.
Peresson, Marco, Dr.	University of Roma Tor Vergata, Roma, Italy, 21.9. – 28.9.
Wen, Yaqin, Dr.	University of Nottingham, Department of Medical Physics, Nottingham, UK, 8.2. – 25.2. and 17.9. – 30.9.

ULTI III (Low Temperature Physics)

Balibar, Sebastien, Prof.	CNRS/ENS, Paris, France, 14.4. – 10.5. and 28.9. – 5.10.
Barcelo, Carlos, Dr.	Instituto de Astrofisica de Andalucia, Extragalactic Astronomy, Granada, Spain, 1.11. – 15.11.
Barenghi, Carlo, Prof.	University of Newcastle, Department of Mathematics, Newcastle upon Tyne, UK, 22.4. – 25.4.
Blaauwgeers, Rob, Dr.	University of Leiden, The Netherlands, 16.1. – 30.1. and 20.10. – 4.11.
Bunkov, Yuri, Prof.	CNRS/CRTBT, Grenoble, France, 9.1. – 14.1.
Delahaye, Julien, Dr.	CNRS/CRTBT, Grenoble, France, 23.8. – 31.8.
Dziarmaga, Jacek, Dr.	Jagellonian University, Krakow, Poland, 22.9. – 27.9.
Eska, Georg, Prof.	University of Bayreuth, Germany, 17.9. – 16.10.
Giazotto, Francesco, Dr.	NEST/INFM & Scuola Normale Superiore, Department of Condensed Matter Physics, Pisa, Italy, 5.4. – 20.5.
Gordeev, Alexey, Mr.	Charles University, Department of Mathematics and Physics, Prague, Czeck Republic, 30.6. – 30.9.
Hekking, Frank, Prof.	CNRS/CRTBT, Grenoble, France, 2.2. – 12.2. and 24.7. – 2.8.
Janu, Zdenek, Dr.	Charles University, Prague, Czech Republic 19.5. – 30.6.
Johansson, Göran, Dr.	Institut für Theoretische Festkörberphysik, Karlsruhe, Germany, 1.6. – 5.6. and 10.11. – 14.11.
Kivotides, Demosthenes, Dr.	University of Newcastle, UK, 5.10. – 18.12.
Meschke, Matthias, Dr.	CNRS/CRTBT, Centre de Recherche de Trés Basses Températures, Grenoble, France, 27.1. – 5.2.
Pickett, George, Prof.	Lancaster University, Department of Physics, Lancaster, UK, 21.2. – 22.2. and 10.9. – 20.9.
Schoepe, Wilfried, Prof.	University of Regensburg, Department of Physics, Regensburg, Germany, 18.2. – 25.2.
Schützhold, Ralf, Dr.	Institut für Theoretische Physik, Dresden, Germany, 15.6. – 21.6. and 14.9. – 20.9.
Skrbek, Ladislak, Dr.	Charles University, Prague, Czech Republic, 2.1. – 4.1. and 23.6. – 4.7.
Vinen, William, Prof.	University of Birmingham, Department of Physics and Astronomy, Birmingham, UK, 3.11. – 9.11.
Zaikin, Andrei, Prof.	Forschungszentrum Karlsruhe, Institut für Nanotechnologie, Karlsruhe, Germany, 10.3. – 14.3. and 20.3. – 22.3.

OTHER VISITORS

Abanine, Dmitri, Mr.	Landau Institute for Theoretical Physics, Moscow, Russia, 9.1. – 23.1.
Andreev, Alexander, Acad.	Kapitza Institute for Physical Problems, Moscow, Russia, 9.8. – 30.8.
Bailey, Anthony, Prof.	University of Oxford, Section of Child and Adolescent Psychiatry, Oxford UK, 7.11. – 9.11.
Barash, Yuri, Prof.	Lebedev Physical Institute, Department of Theoretical Physics, Moscow, Russia, 1.10. – 31.10.
Brown, Peter, Prof.	University College London, Institute of Movement Neuroscience, London, UK, 30.10. – 1.11.
Capilla, Jose, Prof.	Universidad Politechnica de Valencia, Spain, 10.12.
Curio, Gabriel, Dr.	Benjamin Franklin Clinic, Department of Neurology, Berlin, Germany, 21.8. – 29.8.
Dierk, Rainer, Prof.	University of Bayreuth, Germany, 27.9. – 4.10.
Feigel´man, Mikhail, Prof.	Landau Institute for Theoretical Physics, Moscow, Russia, 23.7. – 25.7.
Fujii, Muneaki, Prof.	Kumamoto University, Department of Physics, Kumamoto Shi, Japan, 4.8. – 19.9.
Ginzburg, Vitaly, Acad.	Lebedev Physical Institute, Moscow, Russia, 15.12.
Goebel, Rainer, Prof.	University of Maastricht, Department of Neurocognition, Maastricht, The Netherlands, 16.3. – 18.3.
Gracco, Vincent, Prof.	McGill University, Department of Communicaton, Montreal, Canada, 30.11. – 5.12.
Ichimura, Koichi, Dr.	Hokkaido University, Division of Physics, Sapporo, Japan, 17.2. – 11.4.
Kaneko, Ken–ichi, Dr.	Kyoto University, Otolaryngology – Head and Neck Surgery, Sakyoku, Japan, 1.1. – 31.7.
Kubota, Minoru, Prof.	University of Tokyo, Institute for Solid State Physics, Kashiwa, Japan, 4.3. – 7.3.
Kuo, Nissen, Dr.	National Yang–Ming University, Laboratory for Cognitive Neuropsychology, Taipei, Taiwan, 18.11. – 18.12.
Legget, Anthony, Prof.	University of Illinois, Urbana, Illinois, USA, 15.12.
Lemm, Steven, Mr.	Benjamin Franklin Clinic, Department of Neurology, Berlin, Germany, 21.8. – 5.9.
Melnikov, Alexander, Dr.	Institute for Physics of Microstructures RAS, Department of Superconductivity, Nizhny Novgorod, Russia, 19.5. – 17.6.
Merzenich, Michael, Prof.	University of California, Keck Centre for Integrative Neurosciences, San Francisco, California, USA, 11.12. – 13.12.
Morita, Takeshi, Dr.	Kyoto University, Otolaryngology – Head and Neck Surgery, Kyoto, Japan, 23.9. – 31.12.

Ninjouji, Takashi, Mr.	NTT DoCoMo Inc., Media Computing Laboratory, Multimedia Laboratories, Yokosuka Kanagawa, Japan, 20.1. – 31.12.
Nishitani, Nobuyuki, Dr.	Research Institute, National Rehabilitation Center for the Persons with Disabilities, Tokosozawa, Japan, 5.6. – 3.7.
Parshin, Alexander, Prof.	Kapitza Institute for Physical Problems, Moscow, Russia, 24.2. – 10.3., 15.4. – 30.4. and 21.9. – 11.10.
Quesney, Felipe, Prof.	Universidad Complutense de Madrid, Centro de Magnetoencefalografia Dr Pérez–Modrego, Spain, 4.8. – 26.8.
Reppy, John, Prof.	Cornell University, Department of Physics, Ithaca, NY, USA, 29.9. – 30.9.
Ryazanov, Valery, Prof.	Russian Academy of Sciences, Institute of Solid State Physics, Laboratory for Superconductivity, Chernogolovka, Russia, 28.12. – 31.12.
Semenov, Vasili, Prof.	Stony Brook University, Department of Physics and Astronomy, NY, USA, 1.4. – 6.4.
Sonin, Edouard, Prof.	Hebrew University of Jerusalem, Racah Institute of Physics, Jerusalem, Israel, 7.8. – 7.10.
Sorrentino, Alberto, Mr.	Universita´di Genova, Dipartimento di Fisica, Genova, Italy, 4.6. – 26.6.
Tsubota, Makoto, Prof.	Osaka City University, Department of Physics, Osaka, Japan, 11.3. – 12.3.
Tsuneta, Taku, Mr.	Hokkaido University, Department of Physics, Sapporo, Japan, 1.1. – 24.1.
Turner, Robert, Prof.	University College London, Wellcome Department of Cognitive Science, London, UK, 21.5. – 23.5.
Volkov, Andy, Dr.	University of Manchester, Department of Physics and Astronomy, Manchester, UK, 25.4. – 27.4.
Yamaguchi, Takahide, Dr.	University of Tsukuba, Department of Physics, Tsukuba, Japan, 1.1. – 17.6.
Zyuzin, Alexander, Dr.	Ioffe Physical –Technical Institute, RAS, St. Petersburg, Russia, 7.4. – 12.4., 2.6. – 15.6. and 15.9. – 4.10.

Group visits

Tutors from HUT (9 participants), 12.5.
Salon seudun ystävät, 26.5.:

Rahoitusjohtaja Ilkka Arjaluoto, Rautaruukki
Opetustoimen johtaja Rauno Jarnila, Helsinki
Johtaja Kaarlo Jännari, Rahoitustarkastus
Toimitusjohtaja Olavi Kuusela, Valio
Johtaja Esko Lindstedt, Danisco Sugar
Teollisuusneuvos Aarre Metsävirta, M-Real Oyj
Kanslianeuvos Sinikka Mertano
Pankinjohtaja Erkki Perksalo, Nordea
Asiamies Lasse Ristikartano, Kunnallisalan kehittämissäätiö

Pääjohtaja Veli-Pekka Saarnivaara, TEKES
Maaseutuneuvos Eero Uusitalo, Maa- ja metsätalousministeriö

A delegation from the National Natural Science Foundation of China (NSCF) (8 participants), 26.8.

Mr Hian Jianquo, Director General
Mr Jing Daping, Director General
Mr He Minghong, Professor
Mr Peng Lianming, Director General
Mr. Tang Xianming, Director of Division
Mr Lu Rongkai, Director of Division
Ms Eeva Laurila, Academy of Finland
Ms Viestintäharjoittelija Elsi Huttunen

A delegation from China (20 participants), 22.9.

Helsinki City Tourist Guides (20 participants), 1.10. and 2.10.

Chairman Pasi Kivinen with 30 members of the Physics Club of University of Jyväskylä, 19.11.

15 persons from the Union of Technical Academic Employees (TEK), 27.11.

TV-serie “Luontoa lähellä” film group, 2.12.

During 2003 there were 10 visits by groups from high schools and universities with about 20 persons/group.

INTERNATIONAL COLLABORATIONS

COSLAB (COSMOLOGY IN THE LABORATORY)

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

Funding: ESF, Physical and Engineering Sciences.

Duration: 1.1. 2001 - 31.12. 2005.

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

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

WEB-address:

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

LANGUAGE

Local representative: Riitta Salmelin

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

Connectivity in Language Rehabilitation in Aphasic Patients.

Duration: 1.3. 2000 - 28.2. 2003

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

The aim of the collaborative project was 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

Coordinator: **Riitta Hari**

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

Duration: 1.4. 2001 - 31.9. 2003

Visitors: see page 6

In the 3 Neuro-BIRCH programmes the Brain Research Unit of the LTL has provided equipment, expertise, training, and scientific collaboration for 50 research teams of European scientists from 15 countries in the field of neuromagnetism. Altogether 20 person years of EU scientists were hosted, most of them for joint collaboration projects. The total duration of the 3 programmes was 9 years.

Web address: http://boojum.hut.fi/eu.html

ULTI III - ULTRA LOW TEMPERATURE INSTALLATION

Coordinator: Mikko Paalanen

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

Duration: 1.4. 2000 - 31.3. 2004

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

Visitors: see page 6.

The ULTI III Large-Scale Facility has offered expertise and equipment for outside users to undertake measurements at temperatures from 4 Kelvin down to the lowest attainable. The facility is located in the Low Temperature Laboratory of the Helsinki University of Technology. ULTI III facility contributes to the scientific progress and technical development of ultra low temperature physics in Europe, serves as a first-rate educational center for young physicists, and acts as a node for scientific collaboration between Russia and the EU countries. The visitors are integrated to the in-house research, including experimental programs on refrigeration and cryogenics in the liquid-helium range and below, and experimental and theoretical studies of quantum fluids and, solids, nuclear magnetism, and electrical transport in normal and superconducting structures of nanometer size. Equipment for high-precision optical interferometry at low temperatures and electron beam lithography for making nanosize samples are available for the visitors as well. During 2003 altogether 21 European visitors used the facility for 14 months.

Web address: http://boojum.hut.fi/eu.html

COMPASS SPIN POLARISED TARGET (CERN AND HIP)

Peter Berglund, Jaakko Koivuniemi and Kenneth Gustafsson (HIP)

Duration: 1998 - 31.12.2003

After confirmation of the original EMC result by experiments at CERN and SLAC it is now firmly established that the spin content of the nucleon is not entirely due to the quark spins. Competing explanations exist for this result. In the gluon interpretation it is the polarised glue Delta G which lowers the quark's contribution to the nucleon spin, whereas in an alternative model negatively polarised strange quarks are responsible.

Several ways exist in which a new muon experiment can resolve these ambiguities in interpretation. The probability that a quark spin in a transversely polarised nucleon is oriented parallel or antiparallel to the nucleon spin can in principle be measured in deep-inelastic scattering. Such a measurement requires a transversely polarised target and the knowledge of the spin dependent fragmentation functions for the transverse case.

During the run 2003, 270 Tbytes of data was recorded. The D0 and D* peaks were seen for the first time. They are needed to determine the gluon contribution to the nucleon spin. The properties of the COMPASS spectrometer are better understood, but the signal-to noise ratio did not yet allow determining the gluon polarization with desired accuracy.

Web address: http://wwwcompass.cern.ch/

Publication

Ball, J., Baum, G., Berglund, P., Daito, I., Doshita, N., Gautheron, F., Goertz, St., Harmsen, J., Hasegawa, T., Heckmann, J., Horikawa, N., Iwata, T., Kisselev, Yu., Koivuniemi, J., Kondo, K., Le Goff, J.M., Magnon, A., Meier, A., Meyer, W., Radtke, E., Reicherz, G., and Takabayashi, N., *First results of the large COMPASS 6LiD polarized target*, Nuclear Instruments and Methods in Physics Research A, **498** (2003), pp 101-111

LOW TEMPERATURE PHYSICS RESEARCH

NANOELECTRONICS AT LOW TEMPERATURES

NANO group

M. Ahlskog, **P. Hakonen**, T. Heikkilä, A. Laiho, T. Lehtinen, R. Lindell, M. Paalanen, L. Roschier, M. Sillanpää, R. Tarkiainen, V. Vaskelainen, and T. Yamaguchi

Visitors: J. Delahaye, E. Sonin, and A. Zyuzin

We have developed, among others, record-sensitive SET-components made out of carbon nanotubes and nearly back-action-free, reactively read superconducting electrometers. In addition, we have developed a novel, low-noise current amplifier, Bloch Oscillating Transistor, which lies between the superconducting quantum interferometer (SQUID) and the SET according to its characteristics. The same circuit has been employed for measurements of very small noise currents and their higher order moments. One of the central themes in the successful development of the above mentioned devices has been a long-term undertaking of understanding the dissipative quantum dynamics of a single, mesoscopic Josephson junction.

Shot noise and single Josephson junctions

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

We have made careful measurements of conductance versus current for solitary, resistively confined small Josephson junctions. Our results show, for the first time, that the Cooper pair blockade is strongly sensitive to the non-Gaussian nature of shot noise. In our measurements, in which shot noise was induced by quasiparticle current in a nearby SIN-junction, we find a linear decrease in zero bias conductance with increasing shot noise power as well as an asymmetry of IV curves that depends on the sign of the applied current. Our results provide evidence of a ratchet effect induced by shot noise. Both the asymmetry and the ratchet effect are consequences of the non-Gaussian nature of shot noise.

These investigations of Coulomb blockade can be applied into detection of small current noise sources at the level of 0.2 fA/$\sqrt{\text{Hz}}$. The high sensitivity is achieved thanks to the large band width, ~ 1/*RC*, of a 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.

Bloch oscillating transistor

J. Delahaye, **P. Hakonen**, R. Lindell, M. Paalanen, and M. Sillanpää

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, in a suitably biased Josephson junction Zener tunneling up to a higher band will lead to a blockade of Cooper-pair tunneling (Bloch oscillation). 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 100 kΩ, and on the emitter there is a tunable, SQUID-type Josephson junction with E_J/E_C ~ 0.1 - 5. 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 have shown that a BOT is a good candidate for a low noise amplifier for applications at intermediate impedance levels. The fact that our results have been published in Science, reflects the international interest in such a device. We have also studied the noise properties of BOTs and shown that the equivalent input current noise can be made at least by a factor of five smaller than the shot noise calculated directly from the input base current.

Inductively read superconducting SET (L-SET)

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

Rf-SET electrometry, previously performed successfully on MWNTs, has been extended towards inductive read-out schemes in superconducting Cooper pair transistors (SSET). In our setup, the charge-induced change of SSET inductance was determined using reflection measurements at frequencies around 700 MHz. The back action of this kind of electrometer is basically governed by the preamplifier, the contribution of which we reduced by using a circulator at mixing chamber temperature. The best charge sensitivity, ~ 10^{-4} e/$\sqrt{\text{Hz}}$, was achieved in an operation mode which took advantage of the nonlinearity of the Josephson potential. Ac-

cording to our simulations, quantum limited performance (~ 10^{-6} e/$\sqrt{\text{Hz}}$), should be within reach using samples where the ratio of Josephson and Coulomb energies is reduced down to 0.3.

800 MHz SQUID amplifier

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

In order to reach the quantum limited performance of rf-SET electrometers, preamplifiers with a noise temperature of 100-200 mK are needed. One way to achieve such a sensitivity is to use SQUIDs as amplifiers. 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 our 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. First experiments using the amplifier indicate a gain of 2 dB in an unmatched configuration, which is slightly more than expected. In matched case, the gain will increase up to 20 dB.

Transport in Carbon Nanotubes

M. Ahlskog, **P. Hakonen**, M. Paalanen, L. Roschier, R. Tarkiainen, and A. Zyuzin

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

There are several classes of experiments that call for good quality MWCNTs for their successful implementation. For this purpose, we have tested tubes made using plasma-enhanced CVD (PECVD) method by S. Iijima in Japan. These MWCNTs 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. These tubes have been employed in rf-SET work where they gave a charge resolution of $1 \cdot 10^{-5}$ $e/\sqrt{\text{Hz}}$. This value is an order of magnitude worse than predicted, indicating that there are either inherent fluctuations (disorder) on the nanotubes or the electron-phonon coupling is extremely weak.

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PICO group

Mesoscopic physics and its sensor applications

A. Anthore, J. Flyktman, J. Kivioja, T. Nieminen, A. Niskanen, **J. Pekola**, A. Savin, and J. Toppari.

Visitors: F. Giazotto, F. Hekking

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

Electronic micro-refrigeration and cold electron Josephson transistor

A. Anthore, J. Flyktman, F. Giazotto, T. Heikkilä, F. Hekking, **J. Pekola**, A. Savin

We have recently demonstrated state-of-the-art superconductor based micro-refrigerators. The performance of these NIS coolers is, however, still far from ideal especially at the lowest temperatures, where the most interesting physics could be found. In general low electron temperature is always a challenge and cooling electrons directly by this method seems most appropriate to achieve this. Recently we also observed that the electron energy distribution in the cooled metal is not always thermal, *i.e.*, it does not obey Fermi-Dirac distribution and the system does not thus have a temperature in a strict sense. This deviation is due to the slow inelastic electron-electron relaxation in a mesoscopic conductor, and it can be exploited in interesting new devices, *e.g.*, in a “cold electron Josephson transistor”, where the cooler controls the electronic energy distribution of the normal electrode N of a SNS Josephson junction. Recently we demonstrated the operation of such a transistor in the thermal regime, *i.e.*, when the temperature of N was controlled by the electronic cooler.

A very challenging objective is to develop an easy to use, miniaturized refrigerator from room temperature down to millikelvin temperatures. Development of the solid state microcooler and extending its temperature range up using the NIS technique is not a viable route at least above liquid helium temperature (4.2 K). We have started collaboration with Dir. Sami Franssila at the Microelectronics Centre of HUT to exploit micromachining techniques on silicon to develop fluidic microcoolers in the temperature range above the present range of NIS refrigerators.

Flux and charge controlled Cooper pair pump ("sluice") for a quantum triangle

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

Metrological standards of two of the important electrical quantities, voltage and resistance, are based on quantum devices operating at low temperatures. Voltage is defined through the Josephson effect and resistance through the quantum Hall effect. What is missing is the modern standard of electric current, which would thus complete the metrological triangle and pose a critical test on one of the fundamental constants of nature, h, the Planck's constant. There have been attempts to realise a charge pump by applying periodic gate potentials to single-electron tunnelling arrays, and to Josephson junction arrays, and by applying an acoustic wave to trap single electrons in a travelling potential through a narrow semiconducting channel. The first of these methods suffers from very low yield: Maximum currents are just few picoamperes, which is far too small to be applied in metrology. Josephson pumps can produce larger current, but up to now they have suffered from leakage current, which is a consequence of macroscopic quantum coherence in superconductors. The acoustic pump yields a high enough current but accuracy is rather poor presumably due to local heating in the conducting channel. We have recently proposed and performed the first experiments on a new type of a superconducting charge pump, which combines the high speed (current) and low leakage by making benefit of the techniques presently employed in manipulations of Josephson junction based quantum bits. This is a joint effort between LTL and VTT Information Technology.

Quantum coherence experiments using a hysteretic DC-SQUID

J. Kivioja, T. Nieminen, **J. Pekola**

One of the advantages of SQUIDs is that they can provide a measurement, which disturbs the measured system very little: the SQUID is inherently not a dissipative element but a reactive one. We investigate the use of hysteretic DC-SQUIDs to measure dynamics of fragile quantum systems. At the first stage we have studied how the cross-over from thermally activated switching into macroscopic quantum tunnelling is modified in SQUIDs with low critical current due to the quantized energy levels in the SQUID potential. This work is done in collaboration with Dr. Olivier Buisson's group at CNRS Grenoble.

In 2003 three other related activities have been started

1. Application of rapid single flux quantum (RSFQ) devices to very low temperatures [in collaboration with Professors **Dmitri Averin** and **Vasili Semenov** at Stony Brook University (New York)]

2. Feasibility study of a tetrahedral Josephson junction quantum bit experiment **[**in collaboration with Professor **Valery Ryazanov** at ISSP and Professor **Mikhail Feigel'man** at Landau Institute Chernogolovka]

3. Investigation of non-Gaussian noise and full counting statistics (FCS) of current using a Josephson junction threshold detector

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ULTRALOW TEMPERATURE RESEARCH

YKI group

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

Superconductivity of Lithium

K. Juntunen and **J. Tuoriniemi**

The research efforts at the YKI-cryostat are shared between two main projects: the search for superfluidity in ^{3}He-^{4}He mixtures and the studies of nuclear magnetism in pure metals, most recently in lithium.

During the year 2003 the cryostat was occupied for the measurements on lithium metal (K. Juntunen and J. Tuoriniemi). We cooled down two different types of samples, both hermetically sealed by copper capsules. The first was meant for the search of superconductivity. For this purpose the sample could be bulky but had to be extremely well protected from any magnetic stray fields (at nT level). The second was meant for the NMR measurements on highly

polarized nuclei. For this purpose the sample had to be thin (tens of μm) and had to be placed into the bore of our second superconducting magnet in the cryostat (to be polarized in several T). Both types of samples produced interesting and to some extent unexpected results. No superconductivity of lithium was detected down to about 100 μK, but, instead, rather peculiar magnetic behavior was observed below fields of about 1 μT and temperatures below about 500 μK. Data on only one sample of this type could be collected due to problems with the SQUID sensors, and so, obviously, these investigations have to be carried on further in order to draw any conclusions about the origin of the magnetic signals. A wealth of NMR data was collected during two cool downs, about four months each. The behavior at high nuclear polarizations and in low magnetic fields was characterized by extraordinarily strong response at very low frequencies, well below the usual Larmor band in the local magnetic field. On the basis of such alterations of the NMR line shapes, measurements of hysteretic losses, and of the determination of the entropy-field-temperature relationships, we can sketch a phase diagram with at least four distinct regions in the temperature-magnetic field plane. The paramagnetic and a ferromagnetic phase are most reliably identifiable but the nature of the other two spin states is far less clear. The analysis of the results is still on its way and will eventually establish the thesis work of K. Juntunen.

Cooling of He mixtures

E. Pentti, A. Sebedash, and **J. Tuoriniemi**

The work on helium mixtures was continued at two fronts. The results of the first set of experiments, terminated during the previous year, were analyzed by E. Pentti in his M.Sc. thesis. The emphasis was at the thermal analysis aiming at better understanding of the conditions during the previous measurements and also at finding the optimal cooling conditions for the helium mixtures. The next set of experiments, based on a novel cooling technique of adiabatic mixing of superfluid ^{3}He with ^{4}He being released from a melting ^{4}He crystal, is about to be installed into the cryostat. This experiment has been prepared in collaboration with the Kapitza Institute, Moscow (A. Sebedash).

Publications

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ROTA group

Topological objects in coherent quantum systems

S. Boldarev, V. Eltsov, A. Finne, M. Kujala, A. Kulvik, and **M. Krusius**

Visitors: R. Blaauwgeers, G. Eska, A. Gordeev, Z. Janú, and L. Skrbek.

This experimental research project is concerned with coherent quantum systems. The most important examples of such condensed-matter systems are superconducting metals, superfluid helium liquids, and gaseous Bose-Einstein condensed alkali atom clouds. They obey the laws of quantum mechanics in macroscopic scale. They are comparatively well understood since the best theories of condensed matter physics can be used to describe them.

The state of these systems is described with an order-parameter field, which is similar to a Schrödinger wave function of atomic physics and contains the spatial and temporal information about the coherent condensate. The order parameter field may contain defects, structures which are topologically stable owing to the continuity requirement of the coherent condensate. In practice this means that such structures cannot have loose ends in the bulk system. The most important example of such topologically stable defects is a quantized vortex line.

The largest variety of defects of different dimensionality, topology, and structure exists in the helium-3 superfluids. These Fermi systems are experimentally clean, structurally simple, and theoretically well understood. All their complexity is contained in the symmetry and structure of the multi-component order parameter field. Owing to their almost ideal properties these systems are well suited as laboratory analogue models in which various quantum mechanical phenomena can be studied under direct external control from the laboratory. This is the centerpiece of our investigations: The design of accurately engineered experiments which reveal the detailed response of these quantum mechanical systems.

Superfluid Turbulence: Recent research has been concerned with turbulent hydrodynamics of superfluids. In the study of turbulence, superfluids have the advantage that their vortices are well-defined structures, quite unlike the vortices of classical viscous fluids. It is hoped that by studying turbulent superflow, *i.e.* the chaotic motions in a disordered tangle of quantized vortex lines, more will be understood about the fundamental laws that govern turbulence in general.

Our experiment is designed to study the evolution and decay of a turbulent vortex network in a long rotating column. This is accomplished by first setting the column in vortex-free rotation at constant velocity. Here the normal excitations are corotating with the cylindrical container walls, while the superfluid fraction behaves differently: It is decoupled from the rotation and remains therefore stationary in the laboratory frame. In the rotating coordinate frame, which is usually the working frame in rotating hydrodynamics, the superfluid fraction flows at great velocity.

The next step is to inject a few small vortex loops in the rapid superflow. Different injection methods can be used. With nuclear magnetic resonance measurement, which is performed non-invasively from the outside, we can then follow the evolution of the injected loops in the superfluid stream. If the damping of vortices is sufficiently low, which requires low temperatures, the loops develop first into a rotating vortex tangle, which later decays into an array composed of rectilinear vortex lines. This is the stable equilibrium configuration of quantized vorticity in rotation. The structure in which the vorticity expands into the vortex-free superflow is sketched in the adjacent figure. The measurement allows us to analyze the rate at which the turbulent front moves along the column in both directions, how the initial tangled vortex density builds up at a fixed location in the column, how the tangle polarizes and the large-scale superflow is removed, and finally how the tangle decays into rectilinear lines.

In the investigation of superfluid turbulence the advantages of such a measurement are the following: (i) It makes use of a new superfluid system - the B phase of superfluid helium-3 - in which the damping of quantized vortex lines changes dramatically as a function of temperature. Therefore the measurements allowed for the first time to determine the influence of vortex damping on superfluid turbulence and to identify the existence of a transition between regular and turbulent superflow. (ii) The measuring technique is new, both with respect to the generation of turbulence and its detection, and in many ways more effective than earlier efforts. It is hoped that the more detailed information about the temporal and configurational behaviour of the turbulent state will help us to clarify the understanding of dissipation in superfluid turbulence.

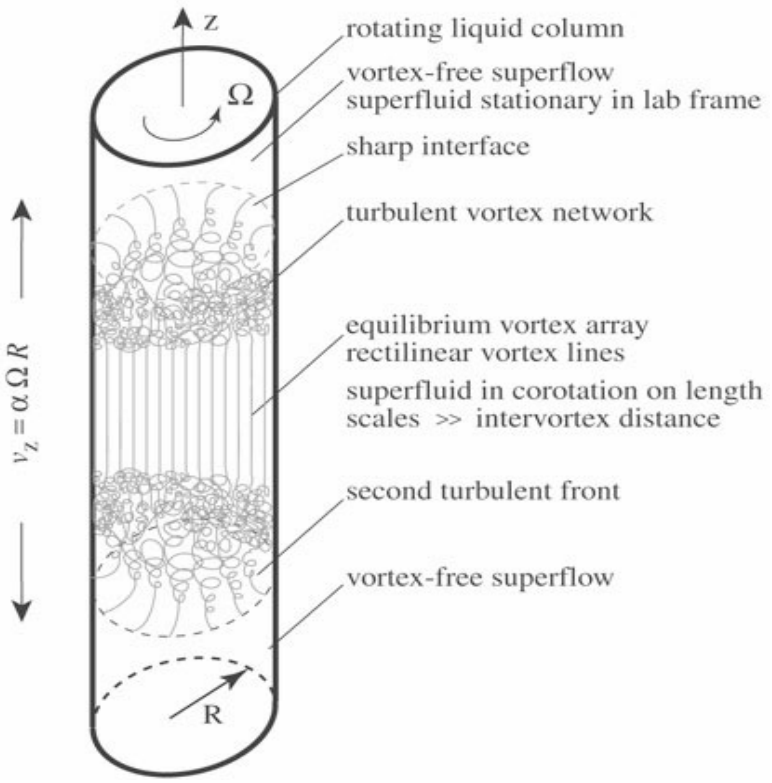

Fig. 1. Expansion of quantized vorticity in a rotating superfluid column. Initially the column rotates in the vortex-free state. When vortex loops are injected they develop into a superfluid tangle which then expands in the column. The velocity of the two turbulent fronts propagates at a velocity which is controlled by the dissipative mutual friction α.

Many unsolved questions shroud superfluid turbulence, especially its dissipation mechanisms. For instance, what happens in the zero-temperature limit where the density of normal excitations approaches exponentially zero and the superfluid fraction should be totally decoupled from the laboratory. Nevertheless, we now know from our measurements that quantized vortices are both formed at the lowest temperatures and that their tangled state decays more and more rapidly with decreasing temperature. In contrast a superfluid with nodes in its energy gap, like the A phase of superfluid helium-3, is practically always in a state where vortex motion is highly damped and superfluid turbulence does not appear even in the zero temperature limit. How are these facts reconciled and what are the explanations for such unusual behaviour? These are the burning questions in our current work.

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INTERFACE group

Interfaces in quantum systems

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

Visitors: S. Balibar, R. Jochemsen, and A.Ya. Parshin.

Helium crystals provide a good model system for verification of different theoretical concepts concerning the study of all crystal surfaces and on top of that they have several interesting properties related to their quantum nature. During recent years we have been studying the shape and growth dynamics of the body-centered cubic (bcc) ^{3}He crystals along their melting curve from 0.5 mK up to several hundreds of mK. As the first significant result, more than ten different types of facets (smooth flat crystal faces) were identified and the velocities of these facets were measured as a function of the applied overpressure.

The next set of experiments was performed near the magnetic ordering temperature of a bulk solid ^{3}He just below 1 mK. In these studies it was found that facets grow with two different mechanisms. In addition to the well-known spiral growth, a slower growth mode, characterized with a very small growth anisotropy in the ordered state, was discovered. It was observed also that the mobility of the (100) type of facets is strongly suppressed above the transition. This is surprising because in that disordered paramagnetic phase the slowest facets were expected to be of the (110) type which have the largest interplanar distance in the bcc-lattice.

Careful measurements on the growth dynamics of ^{3}He crystals were carried out also near 100 mK, the highest temperature at which facets have been detected in ^{3}He. From the experimental data the step free energies of the (110) facets at different temperatures were extracted. By applying the renormalized group theory developed by Nozières and Gallet to the measured temperature dependence, it was found that the coupling of the liquid-solid interface is uniquely weak in ^{3}He in this temperature range.

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THEORY

Condensed matter at low temperatures

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

Visitors: D. Abanine, A. Andreev, Yu. Barash, A. Mel'nikov, E. Sonin, E. Thuneberg, and A. Zyuzin

The theoretical research is closely related to the experimental work done at the Low Temperature Laboratory. The main objects of the study are quantized vortices formed when the superfluid phases of ^{3}He at temperatures below 3 mK are put into rotation. The structure, nucleation, and dynamics of the vortices and their interaction with other objects like surfaces, solitons, and the interface between two superfluid phases are under investigation. In addition connections of ^{3}He physics to other branches of physics, for example, classical turbulence, instability of interfaces, cosmology, black-hole horizon, quantum vacuum of relativistic quantum fields, etc are studied.

The theoretical research in the NANO and PICO groups is closely related to their experimental activities 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 topics 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.

Theory of superfluid turbulence

G. Volovik and N. Kopnin.

Recent ROTA experiments demonstrated new phenomenon in superfluid turbulence. 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. It appears that superfluid turbulence is governed by two dimensionless parameters. One of them is the intrinsic parameter q which characterizes the relative value of the friction force acting on a vortex with respect to the non-dissipative forces. The inverse parameter 1/q plays the same role as the Reynolds number $\mathrm{Re} = UR/\nu$ in classical hydrodynamics. It marks the transition between the laminar and turbulent regimes of vortex dynamics. The developed turbulence occurs in superfluids at $q << 1$, and it is characterized by a logarithmically modified Kolmogorov cascade. Another parameter of superfluid turbulence is the superfluid Reynolds number $\mathrm{Re}_s = UR/\kappa$, which contains the circulation quantum κ characterizing quantized vorticity in superfluids. The two parameters q and Re_s control the crossover or transition between two classes of superfluid turbulence: (i) The classical regime, where a logarithmically modified Kolmogorov cascade is effective, vortices are locally polarized, and the quantization of vorticity is not important; and (ii) The Vinen quantum turbulence where the properties are determined by the quantization of vorticity. The phase diagram of these dynamical vortex states is suggested.

Connection to cosmology and particle physics

G. Volovik

We continued to study the least known features of high-energy physics and cosmology - the properties of the quantum vacuum - using the condensed matter analogy.

In collaboration with A.I. Zelnikov from University of Alberta (Canada) we studied temperature correction to the free energy of the gravitational field. We found that the leading correction to the Newton constant is universal since it is determined only by the number of fermionic and bosonic fields, and does not depend on whether or not the gravitational field obeys the Einstein equations. Exactly the same corrections exist in the hydrodynamic of quantum liquids, such as superfluid ^{3}He and ^{4}He, where they can be measured.

In relation to the problem of cosmological constant and vacuum energy, which was usually thought of as the subject of general relativity, we found that the vacuum energy is important for the Universe even in the absence of gravity. We calculated the vacuum energy in the presence of matter in special relativity, and found that, as in general relativity, the vacuum energy density is on the order of the energy density of matter.

In general relativity we considered the vacuum response to the non-steady-state perturbations. The phenomenological theory was suggested for the time dependent cosmological constant, in which the Einstein equations are slightly modified to include the non-covariant corrections.

We suggested modification of the Pati-Salam model of the unification of quarks and leptons adding the SU(4) family group for four generations of fermions. In this model the creation of baryons and leptons in the process of electroweak baryogenesis must be accompanied by the creation of fermions of the 4-th generation. As a result the excess of baryons over antibaryons leads to the excess of neutrinos over antineutrinos in the 4-th generation. This fourth-generation neutrino is about 50 times heavier than baryion, and thus it may be a good candidate for the non-baryonic dark matter.

Nonstationary properties of superconductors and superfluids

K. Kopnin

Collaborator: V.M. Vinokur

Phenomena under consideration include vortex structure and dynamics, transport in point contacts, tunnel junctions, and nanowires. The Andreev bound states in vortex cores, point contacts and other heterostructures are being studied; the crucial effects of these states in the transport phenomena are being clarified.

A new class of superfluid turbulence is discovered experimentally under conditions that the normal component is clamped in the container frame due to high viscosity. The transition to superfluid turbulence is found to be velocity independent; it is determined by the ratio of the mutual friction parameter that depends on temperature. A theoretical model is proposed that describes the onset of turbulence.

The electronic transport in clean multichannel superconducting point contacts is studied. A scattering by small amount of impurities is shown to lead to an effective momentum relaxation at low voltages that results in a linear voltage dependence of the current through the contact. For high voltages, electrons do not have time to relax, and the transport is ballistic. The theory of single-electron transport is developed in clean and disordered Andreev wires, *i.e.*, normal conductors surrounded by a superconductor. Vortices in type II superconductors are

examples of such Andreev wires. Clean Andreev wires are shown to be similar to usual normal wires: the transport is associated with the transverse Andreev modes.

Nonequilibrium effects in superconductor-normal metal systems

T. Heikkilä

Collaborators: Frank Hekking, Francesco Giazotto, Fabio Taddei, Rosario Fazio and Fabio Beltram

We study theoretically the nonequilibrium dynamics of superconductor-insulator-normal-metal-insulator-superconductor (SINIS) systems. Such devices can be used as efficient Peltier coolers. In our work, we study the ultimate limits of such cooling and the nonequilibrium electron energy distributions in these systems, including the role of energy relaxation quantitatively. Moreover, we study a system which combines a SINIS cooler with a superconductor-normal-metal-superconductor Josephson weak link and show, in different limits of parameters, how such a system can be used as an accurately tunable supercurrent transistor.

Measurements of current fluctuations in mesoscopic systems

T. Heikkilä and P. Virtanen.

Collaborators: Edouard Sonin, Göran Johansson, Frank Wilhelm

In this project, we study theoretically how the current fluctuations and their statistics can be measured in mesoscopic systems. We study the limitations of classical measurement schemes in measuring the third and higher cumulants of fluctuations, and consider novel mesoscopic detectors, which allow for a sensitive and large-bandwidth detection of noise. Moreover, in such detectors, one can access the nonsymmetrized noise, which is not possible in classical schemes. We also examine a scheme for the calculation of different moments of current statistics, exploiting the quasiclassical Keldysh counting-field method.

Thermoelectric effects in normal-metal superconductor systems

P. Virtanen and **T. Heikkilä.**

We theoretically examine the thermopower of a mesoscopic normal-metal wire in contact to superconductors. In such devices, the recent experiments have shown that the thermopower, *i.e.,* the voltage created by the temperature difference in the absence of charge currents, can exceed the known theoretical predictions by a few orders of magnitude, and moreover, it can be controlled with the magnetic flux. Using the quasiclassical Keldysh theory, we show that the presence of supercurrent in such systems leads to the observed thermoelectric effects. Our theory shows a fair agreement with the experimental observations and predicts how the theory can be confirmed.

Quantum measurements through resonant circuits

T. Ojanen and **T. Heikkilä.**

Collaborator: Dmitri Averin

We consider the measurement of a quantum two-level system through a harmonic oscillator coupled to it. The aim is to study how the two-level-system changes the correlators of the oscillator and how the oscillator dephases the two-level system. We study different types of couplings and look for the possibility to do quantum nondemolition measurements.

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BRAIN RESEARCH UNIT

The goals of our Brain Research Unit are to address human brain functions at systems level, mainly by applying and developing noninvasive brain imaging technologies. We also design and construct stimulation and monitoring devices to create as-natural-as-possible environments for experimentation on systems neuroscience.

Within this framework, we have continued to study functions of the human cerebral cortex by measuring magnetic fields outside the head. This magnetoencephalographic (MEG) method allows a totally non-invasive view into healthy and diseased human brains during dif-ferent 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). Between year 1994 and 2003, an important part of the research was 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) ended in September 2003. During the whole duration of the EU Neuro-BIRCH facility we offered expertise and equipment for state-of-the art neuromagnetic recordings for over 140 scientists from 50 different user groups from 15 countries, for altogether 20 person years.

In 2003, we worked extensively on MEG characterization of human sensory, motor, cognitive and language functions, with work on brain disorders as well. We also started to intensively use the new Advanced Magnetic Imaging (AMI) Centre of HUT for functional magnetic resonance imaging (fMRI); fMRI with its excellent spatial resolution complements the superb temporal resolution of MEG in tracking activation patterns and sequences in the human brain. The AMI Centre operates a 3 Tesla MRI/fMRI superconducting magnet (General Electric 3T Signa) for whole-body imaging, and with our 548 magnet hours we were the largest single user of the Centre in 2003.

MEG STUDIES

Auditory, tactile, and audiotactile processing

N. Forss, R. Hari, E. Hlushchuk, M. Illman, O. Jensen, **V. Jousmäki,** R. Lehtonen, J. Mäkelä, J. Numminen, L. Parkkonen, H. Renvall, **M. Schürmann**, and C. Simoes

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In monkeys, separate well-ordered somatotopic maps exist in cytoarchitetonic areas 3a, 3b, 2 and 1 in the primary somatosensory cortex (SI). For example, in area 3b, the representations of proximal phalanges of fingers are near the surface and those of the fingertips in the depth of the central sulcus. We have now demonstrated a similar fine-grained arrangement in humans by means of MEG recordings.

In daily life, humans typically process stimuli of more than one sensory modality at the same time. We have previously demonstrated audiotactile interaction in many settings: (i) incongruent audiofeedback can change tactile percept ("parchment skin illusion"), (ii) keeping hands on a vibrating tube may enhance perceived loudness of a simultaneously presented sound of the same frequency, and (iii) the auditory cortex of a deaf may react to vibration presented to palms. In recent MEG experiments we have shown an early suppressive audiotactile interaction in the superior parietal lobe and a later one in the region of the second somatosensory and the auditory cortices.

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Oscillatory brain activity

R. Hari, M. Pohja and S. Salenius.

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By recording simultaneously rhythmic brain activity and electromyographic activity of a contracting muscle, we showed in 1997 that "cortex speaks to the muscle" at about 20 Hz and that cortex always leads in time. This "cortex–muscle coherence" has now become rather popular worldwide. We have recently quantified cortex–muscle coherence in healthy subjects during bimanual movements. The rhythmic interaction may reveal interesting information in several motor disorders. We have also shown, both applying benzodiazepines and using modelling of oscillating neuronal networks, that the motor-cortex 20-Hz activity most likely reflects inhibitory phenomena.

Publications

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Pathophysiology of acute and chronic pain

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

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One serious problem in experimental pain research is stimulus nonselectivity. With small modifications to the intensity and area of stimulation with a thullium laser, we have recently been able to selectively stimulate the two nociceptive fibre systems, Aδ - and C-fibres; the corresponding responses in the secondary somatosensory cortex SII peaked at 150–200 ms and at 800–850 ms. Such a reliable temporospatial differentiation of cortical responses to "first" and "second" pain offers an unique tool for further basic research as well as for clinical assesment of patients with chronic pain.

We are also interested in the connection between pain and motor activation. Our preliminary data indicate that noxious stimuli may automatically activate the motor cortex, an apparenly useful phenomenon in acute pain but a source of a vicious cycle during chronic (tension) pain. We have studied the pain–motor cortex connection in healthy subjects by monitoring the reactivity of the 20-Hz motor-cortex rhythms.

Publications

Forss N, Raij T, Seppä M and Hari R, Common cortical network for first and second pain. *Submitted*.

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The human mirror-neuron system

S. Avikainen, **R. Hari**, J. Järveläinen, K.-I. Kaneko, M. Martikainen, S. Liuhanen, M. Saarelainen, and **M. Schürmann**

Visitor: N. Nishitani (Tokorozawa, Japan).

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Proper interpretation of the intentions of our fellow human beings is an essential ability for successful communication in the society. Recent research suggests that the mirror-neuron system (MNS), first discovered in monkeys, is important for such social cognition. The MNS is activated both when the subject views another person performing motor acts and when he himself performs similar movements. The MNS therefore could form the basis for understanding the intentions of other persons and be a good candidate for the neurophysiological locus of disorders resulting in difficulties of smooth and reciprocal social communication, such as in autism and schizophrenia.

We have demonstrated with MEG recordings that the human MNS comprises at least Broca's region, the primary motor cortex, the inferior parietal cortex, and the superior temporal sulcus; all these structures are activated in both hemispheres and in a nice sequence that is prolonged in its frontal part in high-functioning autistic subjecta; autism is associated with impairment in attribution of mental states and with poor imitation skills. Broca's area seems to be especially important for imitation of gestures. Interestingly, activation of Broca's area did not increase during contagious yawning compared with mouth-moving stimuli, suggesting that yawn contagiousness is a very automatic release phenomenon.

A related field of study has focused on 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. We have addressed the role of "efference copies" for the sense of agency: responses to simple tones were reduced when the subjects triggers them herself by a button press.

Publications

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Language perception and production

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

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Linguistic communication is an integral part of human cognition and of humanity itself. Deficits in language perception and production are often experienced as exceptionally debilitating and even unbearable. Modern functional neuroimaging has made it possible to track the neurophysiology of linguistic processes noninvasively, from outside of the skull. Individual cerebral maps of language representation and its functionality would be extremely useful when preparing for brain surgery, in language rehabilitation and re-learning after brain injuries, and in diagnosis and therapeutic treatment of developmental language disorders. For this type of mapping to be truly relevant, however, we must understand the representation of language function in the normal brain. One of our main approaches in mapping the cerebral representation of language is to compare subjects who have intact language function with subjects who have a functional developmental disorder, with no obvious structural correlate, in a specific aspect of language, like reading (dyslexia) or speaking (stuttering). Such comparisons have provided us with initial estimates for cortical areas and time windows which are potentially critical to the normal function (fluent reading or speech). Detailed studies are then designed to determine the specific functional roles of the distinct activation patterns.

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Visual field restitution in hemianopia, neuromagnetic evidence

S. Vanni
Collaborators: A. Raninen, L. Hyvärinen, R. Näsänen, Helsinki University, Finnish Institute for Occupational Health and Lea-Test Ltd.

Homonymous hemianopia results from a lesion of the optic radiation or primary visual cortex. Neuromagnetic responses were recorded for the left and right visual field stimulation. Psychophysically, both patients were trained twice a week with flicker and they showed clear recovery. Neuromagnetic recordings showed clear responses from the healthy hemifield, which were similar in all measurements. In contrast, from the affected hemifield mainly noise was recorded before the rehabilitation but during rehabilitation clear responses emerged for both subjects. In the electro-oculographic channels, no signals above the prestimulus baseline noise levels were present. These results confirm earlier psychophysical and neuromagnetic findings of restitution of functional visual field in hemianopic patients due to rehabilitation. Earlier, the strongest opposition to results after training claimed that there might be contamination of the behavioural data due to learning to compensate the visual field loss with eye movements. We found no systematic eye-movements, which could explain our results, strongly suggesting a causal relationship between training and the emerging neuromagnetic responses.

Neural dynamics of transparency perception

L. Stenbacka and **S. Vanni**.

Visitor: J.-M. Hupé

Collaborator: CERCO, CNRS-Université Paul Sabatier, Toulouse, France

Viewing ambiguous visual stimuli for continuous periods of time leads to spontaneous alternations of the perception of the visual input. For instance, prolonged observations of moving plaid stimuli lead to alternating bi-stable perceptions of either a rigid moving pattern (“coherency”) or two overlapping gratings moving in opposite directions (“transparency”) (Wallach, 1935; Hupé & Rubin, 2003). Using functional imaging techniques, it is possible to isolate neural correlates of perceptual changes that are independent of the sensory stimulation. The present study uses MEG to measure the precise timing of the neural changes for moving plaid stimuli. It should therefore be possible to localize the processes that trigger the change of percept. We presented plaid stimuli for 450 msec with slightly different physical properties, so the perception was strongly biased towards one or the other interpretation. We observed MEG signals specific of the percepts in every subject. Some of these signals are very early and localized over the occipital cortex. We are now processing these data systematically in order to find the earliest responses specific of the percepts and try to localize their sources.

Clinical applications of MEG – CliniMEG

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Collaborators:
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Department of Clinical Neurophysiology, University of Helsinki

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.

Publications

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METHODOLOGICAL DEVELOPMENT

Coherence in brain function

J. Kujala, M. Liljeström, **R. Salmelin,** H. Seppä and **A. Tarkiainen**

Visitor: J. Gross (Düsseldorf, Germany)

Collaborator: Department of Neurology, Heinrich-Heine University, Düsseldorf, Germany

When using time-sensitive imaging techniques (*e.g.* MEG), subjects are shown a large number of isolated stimuli, or they perform a specific task several times (80-100 repetitions), and brain activity is averaged over the repetitions. This approach enhances the systematic task-related changes of cortical activation and reduces the effect of random background activity. For natural, continuous language tasks averaging of MEG signals with respect to fixed triggers is not possible or meaningful. Instead, one should be able to describe possible connections between different brain areas based directly on the time series of activation in these areas. In collaboration with the MEG group at the University of Düsseldorf, we have recently developed the first analysis and visualization tool for extracting cortico-cortical interaction strengths and interareal delays from MEG signals. So far, our novel method has been tested on analysis of simple finger movements. We are now developing DICS into a tool that can be directly applied to characterization of natural linguistic processes.

Publications

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Development of the stimulus environments in MEG and fMRI

S. Aulanko, **V. Jousmäki,** H. Kainulainen and R. Schreiber

The development of MEG and fMRI compatible stimulators aims to develop and test novel, selective, and artefact-free stimulators to be used in functional brain imaging modalities. In addition, we aim to build a simple interface between commercial functional brain imaging instruments and stimulators. The development work has been focused on stimulators that can be used to stimulate tactile sense and on designing new interfaces between the existing stimulators.

Publication

Vigário R, Ziehe A, Müller K-R, Wübbeler G, Trahms L, Mackert B-M, Curio G, Jousmäki V, Särelä J and Oja E: Blind decomposition of multimodal evoked responses and DC fields. *Exploratory Analysis and Data Modeling in Functional Neuroimaging* 2003: 163-191

FUNCTIONAL MRI (FMRI)

Tactile processing

R. Hari, **V. Jousmäki, J. Numminen, R. Salmelin, M. Schürmann,** and T. Raij

Collaborators:

Advanced Magnetic Imaging Centre (AMI/HUT).
Helsinki University Central Hospital, Töölö Hospital.
Institute of Occupational Health, Helsinki.
Department of Clinical Neurophysiology, University of Helsinki.
Laboratory of Computational Engineering, HUT.
Department of Biomedical NMR and National Bio-NMR Facility, University of Kuopio
Keski-Suomen Magneettikuvaus Ltd, Jyväskylä

We have started to actively develop functional magnetic resonance imaging (fMRI) to complement with its excellent spatial accuracy the temporally precise information obtained by MEG recordings.

The characteristics of blood oxygenation level-dependent (BOLD) fMRI and MEG responses to vibrotactile stimuli presented at different interstimulus intervals were studied and compared in collaboration with the NMR Group of A.I. Virtanen Institute (Kuopio). The MEG responses from the primary somatosensory cortex SI were stronger at longer than shorter ISIs. The BOLD response amplitudes did not show a similar ISI dependence, but activated clusters were larger when longer ISIs or longer stimuli were applied. These results support the view that combined use of brain mapping methods provides complementary information, and should be considered in functional brain examinations.

In another study, tactile sensory memory was studied with brief trains of tactile stimuli presented in different spatiotemporal patterns to three fingers. Comparison of the patterns activated inferior parietal cortex, supplementary motor area (SMA), and right dorsolateral prefrontal cortex (DLPFC). The rhythmic tactile stimulus as such, without any task-specific enhancement, activated also left cerebellum and (mainly left) putamen supporting the idea that these structures are related to perception of temporal order of tactile stimuli.

The importance of top-down *vs* bottom-up activations of pain-processing areas has been addressed in fMRI recordings.

Publications

Tuunanen P I, Kavec M, Jousmäki V, Usenius J P, Hari R, Salmelin R, Kauppinen R A: Comparison of BOLD fMRI and MEG characteristics to vibrotactile stimulation. *Neuroimage* 2003, 19: 1778-1786.

Numminen J, Schürmann M, Hiltunen J, Joensuu R, Jousmäki V, Koskinen S, Salmelin R and Hari R: Cortical activation during a spatiotemporal tactile comparison task. *Neuroimage in press.*

Hari R and Joensuu R: Magneettikuvia elävistä kudoksista ja elimistä. Lääketieteen ja fysiologian Nobelin palkinto 2003. *Duodecim* 2003, 119: 2420-2422.

Multifocal visual functional magnetic resonance imaging

L. Henriksson and **S. Vanni**

Collaborator: A. James**,** Centre for Vision Sciences, Australian National University, Canberra, Australia.

We have applied multifocal stimulation technique, recently developed for electroretinograms and visual evoked potential measurements, to functional magnetic resonance imaging (fMRI). In collaboration with mathematician Andrew James (Australian National University, Canberra, Australia) different kinds of visual stimuli and imaging parameters were tested. Eventually, with multifocal stimulus cortical responses to 60 local visual field stimuli were measured in parallel. In the unfolded cortex, representations of the 60 visual field regions could be distinguished. This method allows a new way of retinotopic mapping of human visual cortex, and estimation of local anisotropy of visual field representation in single individuals. In future, it will be used as a powerful constraint of inverse solutions in magnetoencephalography to study quantitatively the timing and magnitude of retinotopic visual processes. In addition, multifocal fMRI allows robust localization of primary visual cortex, which could be applied as preoperative mapping for neurosurgery patients.

Characterization of human visual areas at the parieto-occipital region

R. Hari, L. Stenbacka and **S. Vanni**

Earlier functional magnetic resonance imaging (fMRI) and magnetoencephalographic (MEG) data has indicated that human parieto-occipital (PO) region is sensitive to luminance stimuli, eye-blinks and saccades. In addition, it becomes active very early, coincidently with the primary visual cortex. In monkeys, the PO region houses the V6 complex, an important connection between dorsal visual and more rostral parietal and frontal sensorimotor areas. We aim to localize the luminance-sensitive area in the human PO region, and characterize its sensitivity to saccades and blinks in darkness with fMRI. In addition, we want to compare the sensitivity of this area to known parameters activating monkey V6 complex. Location and cortical orientation obtained from fMRI analysis could be further incorporated to a priori models of MEG source analysis when studying early visual processing dynamics.

BRAIN publications from earlier activity

Vanni S, Dojat M, Warnking J, Segebarth C, and Bullier J: Exploring the timing of human visual processing. *Time and Mind: Information processing perspectives* 2003: 125-139.

Bräutigam S and Swithenby S J: Endogenous context for visual processing of human faces. *NeuroReport* 2003, 14, 10: 1385-1389.

TEACHING ACTIVITIES

COURSES

Pertti Hakonen, **Tero Heikkilä**, **Jukka Pekola** and **Edouard Sonin** lecturers, *Nanophysics and nanotechnology* (Kyl-0.108).

SUMMER SCHOOL

European Advanced Cryogenics School 2003 (Kyl - 0.102)

The Low Temperature Laboratory organized an intensive, 10-day long European Advanced Cryogenics School in 15.9. - 25.9. 2003. The School provided training at doctoral level for 46 European students from 11 different countries, in the field of cryophysics and engineering. The scientific and technical topics of the school were selected to give the students the capacity to use, develop and design cryogenic instruments, needed for basic research and industrial applications. In addition to five days of theory lectures, the program included laboratory demos (LTL, Nanoway Ltd., and Picowatt) and visits to both government laboratories (VTT, MIKES) and private enterprises (Elekta Neuromag Ltd.).

The School followed the format developed for the first European Advanced Cryogenic School, organized by Dr. **Henri Godfrin** in Grenoble in September 2002. **Mikko Paalanen** acted as the Chairman of the School. The main lectures of the School were given by **Peter Berglund**, **Fons de Waele** (Technische Universiteit Eindhoven), **Nikolai Kopnin**, **Matti Krusius**, **Jukka Pekola**, **George Pickett** (Lancaster University), **John Saunders** (Royal Holloway and Bedford New College) and **Hermann Suderow** (Universidad Autonoma de Madrid). In addition, 21 other scientists were involved in other parts of the program.

The school was financially supported by ERASMUS program (-IC-1999-1-ERASMUS-EPS-1), Helsinki University of Technology, Finnish National Graduate School in Material Physics, Low Temperature Laboratory, Elekta Neuromag Oy, and by MIKES.

SPECIAL ASSIGNMENTS (SUPERVISOR)

Linda Henriksson, *Visual stimulus optimization for multifocal fMRI,* Department of Engineering Physics and Mathematics (**Simo Vanni**).

Hannu Laaksonen, *Modulation of rhythmic brain activity in fluently reading and dyslectic adults,* Laboratory of Biomedical Engineering (**Riitta Salmelin**)

Ari Laiho, *Oxygen plasma etching of resist residues for nanocircuit fabrication,* Department of Engineering Physics and Mathematics (**Pertti Hakonen)**.

Tommi Nieminen, *Escape measurements on a hysteretic DC-SQUID,* Department of Engineering Physics and Mathematics (**Jukka Pekola).**

Ville Pietilä, *Effect of driven noise in a Josephson junction,* Department of Engineering Physics and Mathematics (**Tero Heikkilä).**

Pauli Pöyhönen, *FMRI data analysis environment at the AMI Centre of the Helsinki University of Technology*: *Image formats, image format conversions and analysis programs*, Department of Engineering Physics and Mathematics (**Jussi Numminen).**

Ville Renvall, *Design and evaluation of a functional magnetic resonance imaging phantom,* Department of Engineering Physics and Mathematics (**Raimo Joensuu**).

Sanna Silanen, *Correlating fMRI data with subjective pain rating*, Laboratory of Biomedical Engineering (**Riitta Hari, Jaana Hiltunen, Tuukka Raij**).

Juho Simpura, *Implementing surface fitting on a parallel computer platform to study the shape and growth dynamics of ^{3}He crystals*, Department of Engineering Physics and Mathematics (**Harry Alles)**.

Johanna Uusvuori, *Magnetic shielding to nanotesla level at low temperatures,* Department of Engineering Physics and Mathematics (**Juha Tuoriniemi)**.

Pauli Virtanen, *Thermopower induced in an Andreev interferometer,* Department of Engineering Physics and Mathematics (**Tero Heikkilä).**

ACADEMIC DEGREES

Diploma theses

Elias Pentti, *Thermal Modeling of an Experiment on Dilute ^{3}He-^{4}He Mixtures at Ultralow Temperatures* (Tfy-3) Supervisor: **Pekka Hautojärvi**. Instructor: **Juha Tuoriniemi**

Jouni Flyktman, *Probing Energy Distribution of Electrons in Mesoscopic Wires* (Tfy-3) Supervisor: **Kimmo Saarinen**. Instructor: **Jukka Pekola**

Ph.D. dissertations

Antti Tarkiainen, Brain Research Unit, Low Temperature Laboratory, HUT defended his thesis *Cortical dynamics of visual feature and object-level processing in the human occipitotemporal cortex: MEG source analysis and evaluation of conductivity models* for the degree of Doctor of Science in Technology on March 28, 2003. The opponent was doctor **Anna Christina Nobre** from **University of Oxford, UK**. **(**Supervisor: **Riitta Salmelin)**

Risto Hänninen, Low Temperature Laboratory, HUT defended his thesis *Simulations of topological defects and impurities in superfluid ^{3}He* for the degree of Doctor of Science in Technology on October 3, 2003. The opponent was Professor **Dierk Rainer** from **University of Bayreuth, Germany**. **(**Supervisor: **Erkki Thuneberg)**

Teija Silén, Department of Neurology, University of Helsinki, defended her thesis *Somatosensory and motor cortical activity in patients and carriers of Unverricht-Lundborg type progressive myoclonus epilepsy*, for the degree of Doctor in Medicine on October 31, 2003. The opponent was Professor **Peter Brown** from **University College, London. (**Supervisors: **Riitta Hari** and **Nina Forss)**

Sari Avikainen, Department of Neurology**,** University of Helsinki, defended her thesis *Cortical mechanisms of action obsevation, imitation and social perception in healthy and autistic subjects* for the degree of Doctor in Medicine on November 8, 2003**.** The opponent

was Professor **Anthony J. Bailey** from **Park Hospital, Oxford, UK**. **(**Supervisor: **Riitta Hari)**

Hanna Renvall, Department of Radiology, University of Helsinki, defended her thesis *Temporal processing of sensory information in developmental dyslexia:neuromagnetic and psychophysical studies* for the degree of Doctor in Medicine on December 12, 2003.The opponent was Professor **Michael M. Merzenich** from **University of California**, **San Francisco, USA. (**Supervisor: **Riitta Hari)**

Research seminars on low temperature physics

Organisers: **V. Eltsov, P. Hakonen, T. Heikkilä and G. Volovik**

Yuri Bunkov, CNRS-CRTBT, Grenoble, France, *NMR of ^{3}He in aerogel*, 13.01.

Matthias Meschke, CRTBT-CNRS, Grenoble, France, *First inelastic neutron scattering experiment on 2D Fermi Liquid He-3*, 4.02.

Frank Hekking, Université Joseph Fourier, Grenoble and Laboratoire de Physique et Modélisation des Milieux Condensés Magistère, CNRS, France, *Influence of a measurement on coherent charge transfer in an adiabatic Cooper pair pump*, 11.02.

Wilfried Schoepe, Institut für Experimentelle und Angewandte Physik der Universität Regensburg, Germany, *Vortex nucleation, transition to turbulence and cavitation: "System failure" experiments and extreme-value statistics*, 20.2.

George Pickett, Lancaster University, UK, *Latest experiments with superfluid ^{3}He in Lancaster*, 21.2.

Alexander Parshin, Kapitza Institute, Moscow, Russia, *Kinematic multiplication of elementary steps on the crystal surface*, 4.3.

Minoru Kubota, University of Tokyo, Japan, *Study of superfluids under rotation up to 1 revolution/sec and faster*, 7.3.

Makoto Tsubota, Osaka City University, Japan, *Recent topics on superfluid turbulence: Energy spectrum, Rotating turbulence*, 11.3.

Carlo Barenghi, University of Newcastle, UK, *Superfluid turbulence near zero temperature*, 23.4.

Carlo Barenghi, University of Newcastle, *How to determine the topological/geometrical complexity of vortex tangles?*, 24.4.

Anne Anthore, Quantronics group, CEA Saclay, France, *Electron-electron interactions mediated by magnetic impurities*, 6.5.

Göran Johansson, Institute for theoretical solid-state physics, University of Karlsruhe, Germany, *Sensitivity and back-action of the superconducting radio-frequency single-electron transistor in charge qubit read-out*, 3.6.

Alexander Mel'nikov, Insitute for Physics of Microstructures, Nizhny Novgorod, Russia, *Domain wall superconductivity in ferromagnetic superconductors and hybrid S/F structures*, 10.6.

Zdenek Janu, Institute of Physics of the Academy of Sciences of the Czech Republic, Prague, Czech Republic, *Unusual but universal behaviour of high-T_c superconductors in weak magnetic fields*, 18.6.

Ralf Schützhold, University of British Columbia, Canada, *Gravity wave analogues of black holes,* 19.6.

Mikhail Feigelman, Landau Institute, Russia, *Superconducting tetrahedral quantum bits,* 23.7.

Alexander Andreev, Kapitza Institute for Physical Problems, Moscow, Russia, *Thermodynamics of superfluidity,* 26.8.

George Pickett, University of Lancaster, UK, *The AB phase boundary in superfluid ^{3}He,* 12.9.

Ralf Schützhold, University of British Columbia, Canada, *Pattern recognition on a quantum Computer,* 16.9.

Jacek Dziarmaga, Intitute of Physics, Jagellonian University, Poland, *Images of dark solitons in a depleted BEC,* 23.9.

Dierk Rainer, University of Bayreuth, Germany, *Free energy functionals for Fermi-liquid superconductors,* 29.9.

John Reppy, Cornell University, USA, *High resolution heat capacity measurements and experimental tests of hyperuniversality,* 30.9.

Edouard Sonin, Hebrew University of Jerusalem, Israel, *Effect of shot noise on IV curve of Coulomb blockaded Josephson junction,* 6.10.

Yuri Barash, Lebedev Physical Institute, Moscow, Russia, *Josephson current through magnetic interfaces,* 14.10.

Demosthenes Kivotides, Mathematics Dept., Newcastle University, UK, *Why Superfluid turbulence is not classical,* 17.10.

Peter Dendooven, Kernfysisch Versneller Instituut, Groningen, the Netherlands, *Glowing in the cold: radioactive ions and atoms in superfluid helium,* 27.10.

W.F. Vinen, University of Birmingham, UK, *Kelvin wave cascade in quantum turbulence,* 5.11.

Vinen, Volovik, Kivotides and **Kopu**, *Discussion session on superfluid turbulence,* 6.11.

Carlos Barcelo, University of Portsmouth, UK, *Probing semiclassical analogue gravity in Bose-Einstein condensates with widely tunable interactions,* 7.11.

Pauli Virtanen, *Thermopower induced by the supercurrent in superconductor-normal-metal structures,* 10.11.

Göran Johansson, Institut fuer Theoretische Festkörperphysik, University of Karlsruhe, Germany, *Hot Cavity QED - Cavity QED at intermediate temperatures using Josephson qubits,* 11.11.

Elias Pentti, *Adiabatic expansion of ^{3}He in superfluid ^{4}He,* 9.12.

Research seminars on Nano Physics

Organised by **Jukka Pekola**

Jouni Ahopelto,VTT, *Nanoimprinting,* 27.2.

Vasili Semenov, State University of New York, Stony Brook, *SFQ control circuits for flux qubits,* 2.4.

Antti O. Niskanen, *Cooper pair sluice - A fast and accurate single island charge pump*, 13.5.

Tero Heikkilä and **Francesco Giazotto**, SNS, Pisa, *Supercurrent transistor with ultra-low dissipation*, 27.5.

Anna Clark, NIST, Boulder, *High power NIS refrigerators with 130 mK temperature reduction*, 21.7.

Frank Hekking, *Anomalous heating in SINIS coolers*, 1.8.

Jani Kivioja and **Antti O. Niskanen**, *The first measurements on the Cooper pair sluice*, 18.12.

Research seminars of the Brain Research Unit

Organised by **Martin Schürmann**

Riitta Hari, *Ethical issues*, 21.1.

Takashi Ninjouji, NTT-DoCoMo, Kanagawa/Japan *User interface research at NTT DoCoMo*, 27.1.

Veikko Jousmäki, *MEG questions: stimulator systems*, 3.2.

Lauri Parkkonen, *MEG questions, part 3/3*, 17.2.

Jan Kujala Meeting report *Mathematical Biosciences Institute Workshop: System Level Modeling*, 24.2.

Mika Seppä, *Software for scientific illustrations 1/2:* Questions to software wizards, 3.3.

Antti Tarkiainen, preparing for dissertation *Cortical dynamics of visual feature and object-level processing in the human occipitotemporal cortex: MEG source analysis and evaluation of conductivity models*, 10.3.

Mika Seppä, *Software for scientific illustrations 2/2:* Questions to software wizards, 17.3.

Anna C. Nobre, Brain and Cognition Laboratory, Department of Experimental Psychology, University of Oxford, UK: *Orienting attention to contents of mental representations*, 24.3.

Reinhard König, and Leibniz-Institute of Neurobiology, Magdeburg/Germany: *Category-specific representation of objects in the human brain: an MEG study of picture naming*, 31.3.

Jussi Numminen, LTL/BRU and HUS, *Cortical activation during a spatiotemporal tactile decision task*, Töölö functional MRI study with Martin Schürmann, Janna Hiltunen, Raimo Joensuu, Veikko Jousmäki, Seppo Koskinen, Riitta Salmelin, and Riitta Hari, 7.4.

Gina Caetano, *Literature review Desmond and Glover, estimating sample size in functional MRI (fMRI) neuroimaging studies: statistical power analysis, J Neurosci Meth 2002, 118: 115*, 14.4.

Jean Michel Hupé, CERCO, CNRS, Université Paul Sabatier, Toulouse/France: *Motion perception : from electrophysiology to psychophysics, defense of the phenomenological approach*, 28.4.

Ken-Ichi Kaneko, Meeting report *Association for Research in Otolaryngology, Midwinter Meeting in Florida*, 12.5.

Jan Kujala, DICS, 19.5.

Robert Turner, Wellcome Department of Imaging Neuroscience, Institute of Neurology, University College London, *From curiosity to tool: fMRI and imaging neuroscience*, 22.5.

Ken-Ichi Kaneko, *Binaural interaction in the human auditory cortex revealed by neuromagnetic frequency-tagging*, 9.6.

Yevhen Hlushchuk, *Literature review Warnking et al., fMRI retinotopic mapping - step by step, Neuroimage 2002, 17: 1665*, 16.6.

Felipe Quesney, McGill University, Montreal Neurological Institute and Centro de Magnetoencefalografia, Universidad Complutense, Madrid, *MEG in neurology: current trends, new indications and future perspectives*, 20.8.

Gabriel Curio, Department of Neurology, Freie Universität Berlin, Germany: *The Berlin Brain-Computer Interface (BBCI)*, 25.8.

Summer students' reports:
Linda Henriksson: *Visual stimulus optimization for multifocal fMRI*
Kaisa Hytönen: *Stimulus systems manual*
Antti Jalava: *Calculation of cross spectra and preprocessing of MEG data in Mathworks Matlab environment*, 1.9.

Hiroyuki Manabe, NTT/DoCoMo, Yokosuka, Japan, *Voiceless speech recognition using facial EMG*, 8.9.

Summer students' reports:
Taru Suortti: *Diffusion tensor imaging and tractography*
Sanna Silanen: *Correlating fMRI data with subjective pain rating*
Johanna Uusvuori: *Semantic priming*, 22.9.

Simo Vanni, *Meeting report, Vision Sciences Society 03 (VSS 03), Sarasota, Florida*
Mia Liljeström, *Meeting report, NorFa meeting, Stockholm (focus event-related fMRI)*
Jan Kujala, *Meeting report, NorFa meeting, Stockholm (focus residual movement correction for fMRI)*, 6.10.

Teija Silén, preparation for dissertation *Somatosensory and motor cortical activity in patients and carriers of Unverricht-Lundborg type progressive myoclonus epilepsy* (dissertation on 31 October 2003), 20.10.

Simo Vanni and **Antti Tarkiainen**, and AMI, *New features in SPM2 (ad-hoc teaching)*
Nina Forss, *Meeting report Prague 2003*
Hanna Renvall, *Meeting report Prague 2003*, 27.10.

Sari Avikainen, preparation for dissertation *Cortical mechanisms of action observation, imitation and social perception in healthy and autistic subjects* (dissertation on 08 November 2003), 5.11.

Miiamaria Saarela, *Neural foundation of the body image*
Gina Caetano, *Meeting report Prague 2003*, 10.11.

Hanna Renvall, preparation for dissertation *Temporal processing of sensory information in developmental dyslexia: neuromagnetic and psychophysical studies* (dissertation on 12 December 2003), 19.11.

Linda Stenbacka, *Luminance-sensitive area at the parieto-occipital junction*
Tiina Parviainen, *Meeting report RIKEN/Japan*, 24.11.

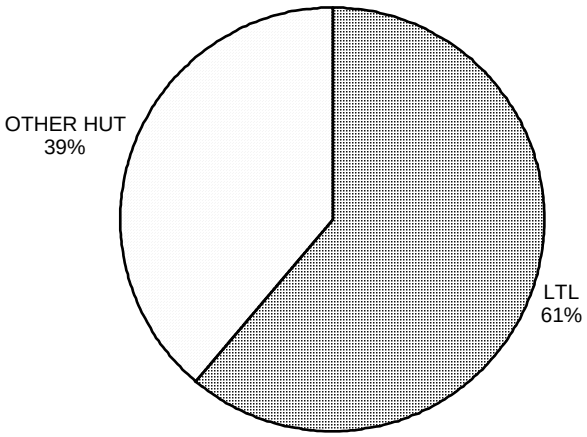
Vincent Gracco, McGill University, Montreal, *The neural control of speech: Some issues and data*, 1.12.

Cristina Simoes, *Meeting report - Society for Neuroscience 2003*, 8.12.

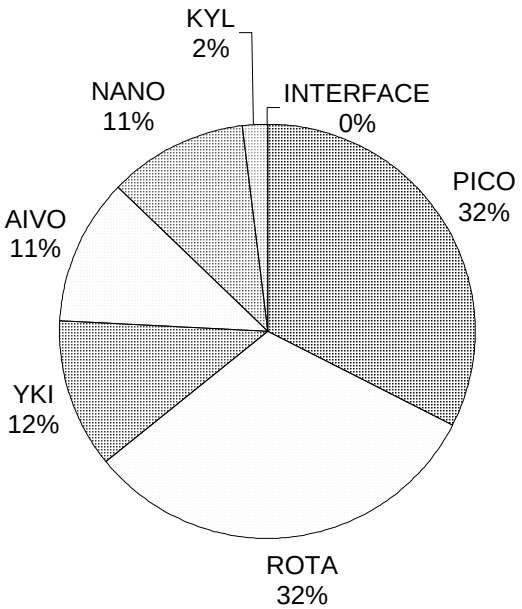
TECHNICAL SERVICES

MACHINE SHOP

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



Distribution of workshop hours in 2003.

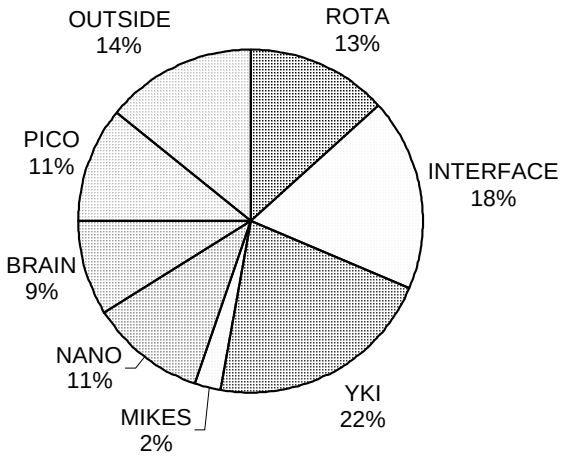


Distribution of the LTL use of the workshop during the whole year.

CRYOGENIC LIQUIDS

A. Isomäki, A. Salminen (on leave) and A. Huvila.

Helium



The total amount of liquid helium delivered to the users was about 59 600 liters.

The helium liquefaction equipment (Linde TCF-20) has been in use for over 15 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 55 000 liters. 30 000 liters of LN2 was used by LTL.

ACTIVITIES OF THE PERSONNEL

AWARDS

Hari	Physiologist of the year, Society for Physiology in Finland, Helsinki, 7.3.
Hari	Louis-Jeantet Prize for Medicine, Louis-Jeantet Foundation for Medicine, Geneva, Switzerland, 11.4.
Hari	Doctor Honoris Causa, Faculty of Sciences, University of Lisbon, Lisbon, Portugal, 13.5.
Krusius	Knight, First Class, of the order of the White Rose of Finland (SVR R I), Suomen Valkoisen Ruusun Ritarikunta, Helsinki, Finland, 6.12.

Salmelin	Philips Nordic Prize 2003 for Research on Neurodevelopmental Disorders, Philips AB, Stockholm, Sweden, 16.12.
Toppari	The best poster of the Annual Conference of the Finnish Physical Society 20. – 22.3.

PERSONNEL WORKING ABROAD

Berglund	CERN, Switzerland, 25. – 29.5. and 7. – 28.8.
Heikkilä	New York State University, Stony Brook, 5.9. – 4.10.
Hämäläinen	Athinoula A. Martinos Center for Biomedical Imaging, Massachusetts General Hospital, Massachusets, USA 1. – 31.1.
Kivioja	CRTBT-CNRS, Grenoble, France, 28.9. – 12.10.
Koivuniemi	COMPASS collaboration, CERN, Switzerland, 1.1. – 31.12.
Kopnin	Working abroad on *Vortex dynamics in superfluids*, Joint Scientific Research, The Abdus Salam International Center for Theoretical Physics, Trieste, Italy, 2.5. – 11.5.
	Working on abroad on *Research on nanoscale superconductors*, Argonne National Laboratory, Argonne, USA, 20.10. – 20.11.
Parkkonen	Working at the MEG Center, Universidad Complutense, Madrid, Spain, 16. – 31.1.
	Working at the Dipartimento di Fisica, University of Genova, Genova, Italy, 2.5. – 9.5.

CONFERENCE PARTICIPATION AND LABORATORY VISITS

Ahlskog	Invited talk, *Transport in disordered multiwalled carbon nanotubes* in the Workshop on Quantum Transport and Mesoscopic Physics, National Chiao-Tung University, Hsinchu, Taiwan, 9. – 11.1.
Alles	Poster, *The measurements on the shape of ^{3}He crystals near the roughening transition temperature* in Fysiikan päivät 2003 (The XXXVII Annual Conference of the Finnish Physical Society), Helsinki, Finland, 20. – 22.3.
Berglund	Lecture, *Practical cryotechniques & vacuum techniques* in European Advanced Cryogenics School 2003, Lammi, Finland, 15. – 25.9.
Caetano	Participation in the symposium, Neuroscience Finland 2003, Helsinki, Finland, 21.8. – 23.8.
	Poster, *Better-than-normal hearing through combined audiotactile stimulation* in the IBRO 2003 conference, Prague, Czech Republic, 10.7. – 15.7.
Eltsov	Invited plenary talk, *Turbulence in superfluid ^{3}He-B* in Conference on Low Temperatures NT33, Ekaterineburg, Russia, 17.6. – 20.6.
	Invited talk, *Criterion for the existence of superfluid turbulence* in the Third COSLAB Workshop, Bilbao, Spain, 10.7. – 16.7.

Eltsov — Invited talk, *Vortices in the A and B phases of superfluid ^{3}He and their interaction at the AB interface* in ESF Vortex III Conference, Crete, Greece, 20. – 28.9.

Finne — Oral presentation, *Non-linear vortex-line formation in rotating superfluid ^{3}He -B* in Fysiikan Päivät 2003 (The XXXVII Annual Conference of the Finnish Physical Society), Helsinki, Finland, 20.3.

Poster, *Relaxation of turbulent vortex network in rotating superfluid ^{3}He-B below 0.6 T_c* in QFS 2003: Quantum Fluids and Solids International Symposium, University of New Mexico, Albuquerque, New Mexico, USA, 3.8. – 8.8.

Flyktman — Poster, *Probing energy distribution of electrons in the normal metal island of a SINIS structure* at the school Dynamics of Interacting Electrons in Quantum Wires, Residencia "la Cristalera", Miraflores de la Sierra, Spain, 27.9. – 4.10.

Forss — Lecture, *Clinical applications* in the MEG Intensive Course, Helsinki University of Technology, Otaniemi, Finland, 8. – 10.2.

Participation in the symposium Neuroscience Finland 2003, Helsinki, Finland, 22. – 23.8.

Poster, *Common cortical network for A_δ - and C-fibre mediated pain* in IBRO 2003 conference, Prague, Czech Republic, 10. - 15.7.

Hakonen — Invited comment, *High frequency experiments in Helsinki* in the SQUBIT workshop, Pisa, Italy, 26. – 27.9.

Invited talk, *Oscillating Josephson junction* in the International Conference on Nanoelectronics, Lancaster, UK, 4. – 9.1.

Invited talk, *Bloch Oscillating Transistor* in the 33. Estonian Physics Days, Tarto, Estonia, 14. – 15.2.

Invited talk, *Ultrasensitive noise measurement scheme for mesoscopic circuits using a Coulomb blockaded Josephson junction* in the 17th International Conference on Noise and Fluctuations, ICNF 2003, Prague, Czech Republic, 18. – 22.8.

Oral presentation, *Control of Coulomb blockade in a mesoscopic Josephson junction using single electron tunneling* in the SQUBIT workshop, Pisa, Italy, 26. – 27.9.

Visit to Chalmers' Microfabrication labs, Radioengineering lab, and Quantum Electronics group, Gothenburg, Sweden, 2. – 5.11

Poster, *Coulomb blockaded Josephson junction as a noise probe in mesoscopic circuits* in the International Conference on Solid State Quantum Information Processing, Amsterdam, the Netherlands, 14.12.

Hari — Invited comment, *Ihmisaivojen kuvantaminen ja tekninen kehitystyö (ajatuksia ja provokaatioita) (Human brain imaging and related technological research (thoughts and provocation)* at the meeting Eettisten toimikuntien valtakunnalliset neuvottelupäivät, Helsinki, Finland, 5.6.

Hari

Invited plenary talk, *Towards studies of the social brain: The human mirror-neuron system* in the 13th Annual Rotman Research Institute Conference: Neuroimaging of Cognitive Functions, Toronto, Canada, 17. – 18.3.

Invited plenary talk, *Neuromagnetic view into human brain function* at the prize-giving ceremony of the Louis-Jeantet Foundation for Medicine awards in Genèva, Switzerland, 11.4.

Invited plenary talk, Doctor Honoris Causa, University of Lisbon, Faculty of Sciences, Lisbon, Portugal, 13.5.

Invited plenary talk, *The human mirror-neuron system: towards studies of the social brain* in the conference Neuroscience Finland 2003, Helsinki, Finland, 22.8.

Invited plenary talk, *Binaural interaction revealed by frequency tagging* in the International Conference on Auditory Cortex, Magdeburg, Germany, 13. – 18.9.

Invited plenary talk, *The human mirror-neuron system* in Neurokollogium Tübingen (German Research Council, Hertie Institute for Clinical Brain Research, Max Planck Institutes of Tübingen), Tübingen, Germany, 27.11.

Invited talk, *Mitä uutta kuvantaminen kertoo aivoistamme? (What new can imaging tell us about our brains?),* Tieteen Päivät 2003, Helsinki, Finland, 8.1.

Invited talk, *Can we study neural basis of social cognition?* in the 7th Finnish-Russian Winter School, Tvärminne, Finland, 15. – 16.1.

Invited talk, *MRI and fMRI as understood by a dummy* when the Neuroinstitute visits AMI, Espoo, Finland, 31.1.

Invited talk, *Aivotutkimusta TKK:ssa* at the meeting of the Professoriklubi (Professors' Club), Otaniemi, Espoo, Finland, 3.3.

Invited talk, *Ihmisaivojen kuvantamisen nykynäkymiä (Present and future in human brain imaging)* at the Annual Meeting of the Finnish Physiological Society, Espoo, Finland, 7.3.

Invited talk, *Ihmisen peilisolujärjestelmä (The human mirror-neuron system)* at the meeting of the Luonnonfilosofinen seura (the Finnish Society for Natural Philosophy), Helsinki, Finland, 13.3.

Invited talk, *MEG as a tool of basic neuroscience* at the Martinos Center Brain Mapping Meeting, Massachusetts General Hospital, Boston, USA, 19.3.

Invited talk, *Towards brain basis of social cognition* in the conference Bio-Tech Helsinki 03, Helsinki, Finland, 26.3.

Invited talk, *Ajatelmia magnetoenkefalografian (MEG) ja aivotutkimuksen kehityksestä (Thoughts about future developments of magnetoencephalography (MEG) and brain research)* in the symposium Tulevaisuusseminaari, Instrumentarium/Datex Helsinki, Finland, 31.3.

Invited talk, *From perception to imitation: Mirror neurons in the human brain,* in a seminar of Centre Medical Universitaire (CMU), Geneva, Switzerland, 10.4.

Hari

Invited talk, *Neuromagnetism: Past and Future* at the Elekta-Neuromag Inauguration Evening, Helsinki, Finland, 22.4.

Invited talk, *Audiotactile interaction in humans* in the symposium Body, Mind and Brain: A centenary in somatosensory neuroscience, London, England, 25.4.

Invited talk, *Basis of local field potentials, EEG and MEG* in the postgraduate course Organization of the Cerebral Cortex, Stockholm, Karolinska Institute, Sweden, 6.6.

Invited talk, *Temporal dynamics of the human mirror-neuron system* in the conference Human Brain Mapping 2003, New York, USA, 18. – 22.6.

Invited talk, *The role of temporal information in studies of human brain function* in the 7th Congress of the European Federation of Neurological Societies; Teaching Course: Localisation of Higher Cortical Functions, Helsinki, Finland, 30.8.

Invited talk, *Ikkuna ihmisaivoihin; A window to the human brain* in the seminar Bioinformatiikan avajaisilta, Otaniemi, Innopoli, Finland, 10.9.

Invited talk, *Neuromagnetic exploration of the connection between pain and the motor cortex* in the symposium Psyche, Soma and Pain. The XIX Symposium of the Signe and Ane Gyllenberg Foundation, Helsinki, Finland, 25. – 27.9.

Lecture, *Basics of MEG* in the MEG Intensive course, Helsinki University of Technology, Otaniemi, Finland, 8. – 10.2.

Lecture, *Ihmisaivojen kuvantaminen (Imaging the Human Brain)* in a course in neurobiology by the medical faculty of Helsinki University, Biomedicum, Helsinki, Finland, 8.9.

Visit to the Athinoula A. Martinos Center for Biomedical Imaging, Massachusetts General Hospital, Boston, USA, 19.3.

Heikkilä

Lecture, *Ultralow-dissipation supercurrent transistor*, Yale University, USA, 10.9.

Lecture, *Ultralow-dissipation supercurrent transistor*, New York State University, Stony Brook, USA, 26.9.

Visit to the Department of Physics, Academia Sinica, Taipei, Taiwan, 12. – 14.1

Visit to the Department of Physics, National Chiao Tung University, Hsinchu, Taiwan, 15. – 16.1

Invited talk, *Nonequilibrium-controlled SNS Josephson junctions* in the Workshop on Quantum Transport and Mesoscopic Physics, National Chiao Tung University, Hsinchu, Taiwan, 9. – 11.1.

Hänninen

Poster, *AB phase boundary and vortices in rotating superfluid ^3He* in the Workshop on Vortices in Superfluids and Superconductors, Pohto, Oulu, Finland, 4. – 8.1.

Hänninen — Oral presentation, *Vortices at the A-B phase boundary in superfluid ^3He* in the International Workshop on Superfluidity under Rotation 2003, ISSP, University of Tokio, Kashiwa and Lake Chuzenji near Nikko, Japan, 13. – 17.5.

Poster, *Structure of the surface vortex sheet at the AB phase boundary in superfluid ^3He* in the XXXVII Annual Conference of the Finnish Physical Society, Helsinki, Finland, 20. – 22.3.

Jousmäki — Invited talk, *Audiotactile interactions in humans* in the Workshop on Multisensory Integration, New Orleans, USA, 7. – 8.11.

Lecture, *Experimental setups and stimulators* in the MEG Intensive Course, Helsinki University of Technology, Otaniemi, Finland, 8. – 20.2.

Oral presentation, *Audiotactile interactions in humans* in a meeting at the MGH/MIT/HMS Athinoula A Martinos Center for Biomedical Imaging, Boston, USA, 3. – 6.11.

Participation in the prize-giving ceremony of the Louis-Jeantet Foundation for Medicine awards in Genèva, Switzerland, 11. – 12.4.

Participation in the Annual Meeting of the Society for Neuroscience, New Orleans, USA, 8. – 12.11.

Visit to Leibniz Institute for Neurobiology, Special Laboratory Non-Invasive Brain Imaging, Germany, 21. – 23.1.

Visit & discussions on auditory stimulator to be used in fMRI at MR Confon, Magdeburg, Germany, 5.12.

Järveläinen — Poster, *Activation of the human primary motor cortex during observation of meaningful tool use* in the Social Brain Congress, Gothenburg, Sweden, 25. – 27.3.

Kaneko — Poster, *Binaural Interaction in the Human Auditory Cortex Revealed by Neuromagnetic Frequency-Tagging: Effects of Stimulus Intensity* in the Association for Research in Otolaryngology 2003 MidWinter Meeting, Daytona Beach, Florida, USA, 23. – 27.2.

Poster, *Binaural Interaction in the Human Auditory Cortex: Effects of Stimulus Intensity* in the Conference, The 104th Annual Meeting of the Oto-rhino-laryngological Society of Japan, Tokyo, Japan, 22. – 24.6.

Kivioja — Poster, *Escape measurements on small Josephson junction and on SQUID* in the SQUBIT workshop, Pisa, Italy, 26. – 28.9.

Poster, *Superconducting Qubits: Nb-based SSET's and Cooper pair pumps* in the XXXVII Annual Conference of the Finnish Physical Society, Helsinki, Finland, 20. – 22.3.

Kopnin — Invited talk, *Quasiparticle transport along vortex cores in clean superconductors* in the Workshop on Vortices in Superfluids and Superconductors, European Science Foundation programme VORTEX, Pohto, Oulu, Finland, Finland, 4. – 8.1.

Invited talk, *Single-electron transport through the vortex core states* in the conference Landau Days 2003, Chernogolovka, Russia, 23. – 25.6.

Kopnin

Invited talk, *Single particle transport in disordered Andreev wires* in the NATO Advanced Research Workshop Theory of Quantum Transport in Metallic and Hybrid Nanostructures, St. Petersburg, Russia, 24. – 29.8.

Invited talk, *Re-entrant localization of single-particle transport in disordered Andreev wires* in the workshop Nanoscale Superconductivity and Magnetism, Argonne National Laboratory, USA, 10. – 14.11.

Participation in the meeting of the Scientific Council of the Landau Institute for Theoretical Physics, Moscow – Chernogolovka, Russia, 26. – 27.6.

Krusius

Invited talk, *Vortices at the AB phase boundary in rotating superfluid ^3He* in the workshop on Vortices in Superfluids and Superconductors, European Science Foundation programme VORTEX, Pohto, Oulu, Finland, Finland, 4. – 8.1.

Invited talk, *Kibble-Zurek scenario of topological defect formation in a non-equilibrium phase transition* in the seminar of the research group in superconductivity, University of Rome Tor Vergata, Italy, 25.2.

Invited talk, *Superfluid Kelvin-Helmholtz instability of the phase boundary between ^3He-A and ^3He-B* in the International Workshop on Superfluidity under Rotation, Chuzenji Lake, Nikko, Japan, 13. – 17.5.

Invited talk, *Turbulence in Superfluid ^3He-B* in the International Workshop on Superfluidity under Rotation, Chuzenji Lake, Nikko, Japan, 13. – 17.5.

Invited talk, *Quantized vortices and other topologically stable defects in coherent quantum fields: Superfluid helium-3 as a laboratory model* in the International Lars Onsager Centennial Conference - Transport, dissipation, and vortices, Trondheim, Norway, 1. – 5.6.

Invited talk, *Turbulence in superfluid ^3He-B* in QFS 2003: Quantum Fluids and Solids International Symposium, University of New Mexico, Albuquerque, New Mexico, USA, 3. – 8.8.

Invited talk, *Olli Lounasmaa in memoriam* in QFS 2003: Quantum Fluids and Solids International Symposium, University of New Mexico, Albuquerque, New Mexico, USA, 3. – 8.8.

Invited talk, *Vortex formation in superfluid ^3He-B* at a meeting of the Low Temperature Section of the Institute of Physics: Superfluid and Solid Helium, Conference Centre, Lancaster University, Lancaster, UK, 23.9.

Lecture, *Quantum fields in the laboratory: Topological defects in p-wave Cooper-paired ^3He superfluids* in the weekly colloquium of the Physics Department, University of Rome Tor Vergata, Italy, 26.2.

Lecture, *Quantized vorticity in the anisotropic fermion superfluid ^3He-A* in the International Workshop on Superfluidity under Rotation & Colloquium lecture of ISSP, University of Tokyo, Kashiwa, Japan, 13.5.

Lecture, *Helium liquids* in the European Advanced Cryogenics School 2003, Lammi, Finland, 15. – 25.9.

Kujala

Participation in the Finnish Neuroscience Annual Meeting, Biomedicum, Helsinki, Finland, 22. – 23.8.

Participation in the symposium Dynamical Neuroscience XI: Neuronal Variability and Noise, New Orleans, USA, 6. – 7.11.

Kujala	Poster, *Localization and characterization of correlated activity in continuous tasks with MEG* in the 1st Annual Symposium of the NorFA Functional Neuroimaging Network (Fun-NET), Stockholm, Sweden, 28. – 31.8.
	Poster, *Coherence based localization and characterization of cortical networks in cognitive tasks with MEG* in Neuroscience 2003, the Society for Neuroscience 33rd Annual Meeting, New Orleans, USA, 8. – 12.11.
Liljeström	Poster, *neuromagnetic localization of rhythmic activity in the human brain: a comparison of three different methods* in the 1st Annual Symposium of the NorFA Functional Neuroimaging Network (Fun-NET), Stockholm, Sweden, 28. – 31.8.
Martikainen	Poster, *Responses to self-triggered sounds are suppressed in the human auditory cortex* in the Society for Neuroscience Annual Meeting 2003 (+Dynamical Neuroscience XI symposium), New Orleans, Louisiana, USA, 8. – 12.11.
Numminen	Poster, in the Sixth IBRO World Congress of Neuroscience, Prague, Czech Republic, 10. – 15.7.
Paalanen	Participation in the committee meeting of *NoE on Supersensors*, FP6 of European Union, Chalmers University of Technology, Sweden, 24.3.
	Lecture, *Superconductor-insulator transition in a single Josephson junction* in the Workshop on Quantum Transport and Mesoscopic Physics, National Chiao Tung University, Taiwan, 9. – 11.1.
	Lecture, *New quantum devices* in the Workshop on Quantum Transport and Mesoscopic Physics, National Chiao Tung University, Taiwan, 9. – 11.1.
	Lecture, *Superconductor-insulator transition in single Josephson junction* at the Riken National Laboratory, Japan, 15. – 16.1.
	Lecture, *Bloch oscillating transistor* at the NEC Laboratories in Tsukuba, Japan, 17.1.
	Participation in the prize-giving ceremony of the Louis-Jeantet Foundation for Medicine Awards in Genèva, Switzerland, 11. – 12.4.
Parkkonen	Invited talk, *Neuromag software with focus on MCE and SSS* at the 14th Conference of the International Society for Brain Electromagnetic Topography, Santa Fe, New Mexico, USA, 19. – 23.11.
	Lecture, *Magnetoencephalography: principles and applications in research and clinical work* at Dipartimento di Neurofisiopatologia, Hospital San Martino, University of Genova, Italy, 6.5.
	Participation in the conference Neuroscience Finland 2003, Biomedicum, Helsinki, Finland, 22.8 – 23.8.
Pekola	Invited talk, *Adiabatic transport of Cooper pairs in Josephson junction circuits* in the workshop NATO ARW Coherent Charge and Spin Transport on a Nanoscale and the satellite workshop Strongly Correlated Electrons in Nanoscale Devices in Chernogolovka, Russia, 8. – 14.6.
	Lecture, *Fundamental limitations and non-thermal energy distribution of mesoscopic electron coolers* in a colloquium in Stony Brook University, New York, USA, 6. – 18.9.

Pekola	Lecture, *Fundamental limitations and non-thermal energy distribution of mesoscopic electron coolers* in a colloquium in Yale University, Yale, USA, 10. – 11.9.
	Lecture, *Microcoolers and - thermometers* in the European Advanced Cryogenics School 2003, Lammi, Finland, 15. – 25.9.
	Lecture, *Adiabatic transport of charge in circuits of small Josephson junctions* in a laboratory seminar at Scuola Normale Superiore, Pisa, Italy, 9.12.
	Oral presentation, *Fundamental limitations and non-thermal energy distribution of mesoscopic electron coolers* in the committee meeting, Nanodev Strategic Research Center; kick-off meeting (board member), Chalmers University of Technology, Göteborg, Sweden, 28. – 29.8.
Pohja	Poster, *Reproducibility of corticomuscular coherence* in the IBRO 2003 congress (International Brain Research Organisation), Prague, Czech republic, 11. – 15.7.
Raij	Oral presentation, *Noxious input activates the human motor cortex — Implications for tension-type pain?* in the SFN Annual Meeting 2003, Morial Convention Centre, New Orleans, USA, 8. – 12.11.
	Participation in the Gyllenberg symposium Psyche, Soma and Pain, Hanasaari Cultural Centre, Finland, 25. – 27.9.
	Participation in the symposium Dynamical Neuroscience, Wyndham Canal Place, New Orleans, USA, 6. – 7.11.
Renvall	Participation in the symposium Plasticity of the Central Auditory System and Processing of Complex Acoustic Signals, Prague, Czech Republic, 7. – 10.7.
	Poster, *Abnormal response recovery in the right primary somatosensory cortex of dyslexic adults*, IBRO Congress of Neuroscience, Prague, Czech Republic, 10. – 15.7.
Ruokola	Invited talk, *Tee-se-itse musta aukko* at Avaruus 2003 - Exhibition, Helsinki, Finland, 1.11.
Salenius	Invited talk, *Sensorimotor oscillations* in the Workshop on Magnetoencephalography, Cold Spring Harbor, USA, 1.8.
	Lecture, *Corticomuscular communication* in the MEG Intensive course, Helsinki University of Technology, Otaniemi, Finland, 8. – 10.2.
Salmelin	Invited plenary talk, *MEG and language* in the conference Korean Human Brain Mapping, Seoul, South Korea, 21.11.
	Invited talk, *Cortico-cortical coherence in continuous reading* in the symposium Connectivity in Language Rehabilitation in Stroke. 3rd Meeting, Toulouse, France, 15.2.
	Invited talk, *Cortical correlates of learning semantic and phonological associations* in the symposium Connectivity in Language Rehabilitation in Stroke. 3rd Meeting, Toulouse, France, 15.2.

Salmelin	Invited talk, *Miksi lukeminen käy niin hitaasti? Vastauksia ja uusia kysymyksiä MEG-tutkimusten pohjalta (What makes reading slow? Answers and new questions from MEG research)* in the symposium Lukitutkijatapaaminen (Annual Meeting of Finnish Dyslexia Researchers), Helsinki, Finland, 11.4. – 12.4.
	Invited talk, *MEG in language research*, University of Hamburg, Germany, 30.6.
	Invited talk, *Developmental dyslexia and MEG* in the 4th Science of Aphasia Conference "Aphasia: Cross–disciplinary aspects", Trieste, Italy, 22. – 27.8.
	Invited plenary talk, *Cortical dynamics of language function and dysfunction* in the 4th International Conference on Noninvasive Functional Source Imaging, NFSI2003, Chieti, Italy, 10. – 13.9.
	Invited talk, *Cortical dynamics of language function and dysfunction* in Leibniz Institute for Neurobiology in the Neuroscience Colloquium Series, Magdeburg, Germany, 8.10.
	Invited talk, *Introduction to magnetoencephalography* in the Experimental Neuropediatrics Course, Karolinska Institute, Stockholm, Sweden, 22.10.
	Invited talk, *Cortical dynamics of fluent and dyslexic reading* in the Neuroscience Colloquium, Karolinska Institute, Stockholm, Sweden, 22.10.
	Invited talk, *MEG - neuroscience research and clinical use* in a seminar at the Samsung Medical Center, Seoul, South Korea, 20.11.
	Invited talk, *Mitä aivojen kuvantamisella nähdään (What brain imaging tells us)* in Mahdollisuus lapselle ry:n juhlaseminaari, Helsinki, Finland, 27.11.
	Lecture, *MEG in the study of language* in the MEG Intensive Course, Helsinki University of Technology, Otaniemi, Finland, 8. – 10.2.
	Participation in the 1st Annual Symposium of the NorFA Functional Neuroimaging Network (Fun-NET), Stockholm, Sweden, 28. – 31.8.
Savin	Oral presentation, *Electronic cooling and hot electron effects in heavily doped silicon-on-insulator film* in the 20th Nordic Semiconductor Meeting, Tampere, Finland, 25. – 27.8.
	Poster, *Electron cooling by superconductor-semiconductor structures with Schottky barrier* in the 7th International Workshop "From Andreev Reflection to the International Space Station", Björkliden, Sweden, 22. – 29.3.
Schürmann	Lecture, *Introduction to the practical modules* in the MEG intensive course, Helsinki University of Technology, Otaniemi, Finland, 8. – 10.2.
Sillanpää	Oral presentation, *Bloch Oscillating Transistor – a new mesoscopic low-noise amplifier* in Fysiikan päivät 2003 (The XXXVII Annual Conference of the Finnish Physical Society), Helsinki, Finland, 20. – 22.3.
Simoes	Participation in the symposium Dynamical Neuroscience XI, New Orleans, USA, 6. – 7.11.
	Poster, *Short-term (~600 ms) prediction of perturbation dynamics for the mu-rhythm in human primary sensorimotor hand cortices* in the Society for Neuroscience 33rd Annual Meeting, New Orleans, LA, USA, 8. – 12.11.

Tanskanen	Participation in the symposium Dynamical Neuroscience XI: Neuronal variablility and noise, New Orleans, LA, USA, 6. – 7.11.
	Poster, *Face recognition and cortical responses: effect of display duration* in the Society for Neuroscience 33rd Annual Meeting, New Orleans, LA, USA, 8. – 12.11.
Tarkiainen Antti	Participation in General Electric Medical Systems Course for the Environment for Pulse Programming in C (EPIC) for Signa Horizon LX, Waukesha, Wisconsin, USA, 30.7. – 1.8.
Tarkiainen Reeta	Poster, *Noise in multiwalled carbon nanotubes*, Fysiikan päivät 2003 (The XXXVII Annual Conference of the Finnish Physical Society), Helsinki, Finland, 20.3.
Todoshchenko	Invited talk, *Effect of the nuclear ordering transition on the growth dynamics of ^{3}He crystals* in QFS2003: Quantum Fluids and Solids International Symposium, University of New Mexico, Albuquerque, NM, USA, 3. – 8.8.
Tuoriniemi	Lecture, *Handling of cryogenic liquids, fountain effect in superfluid He* in the European Advanced Cryogenics School 2003, Lammi, Finland, 15. – 25.9.
Uusvuori	Participation in the symposium, Neuroimaging: What are we really looking at?, Helsinki, Viikki and Biomedicum, Finland, 11.4.
	Participation in the conference, Neuroscience Finland 2003, Helsinki, Biomedicum, Finland, 21.8.
Vanni	Invited talk, *Näkötiedon käsittelyn dynamiikka ihmisen aivokuorella* in the meeting of the Clinical Neurosciences, Helsinki University Central Hospital, Helsinki, Finland, 14.1.
	Invited talk, *Functional imaging of visual cortices* in Imaging of the Orbita and Visual Tracts, symposium in University of Helsinki and Radiological Society of Finland, Helsinki, Finland, 5.9.
	Invited talk, *A review of human visual cortical processing* in the seminar, Update on Research of Sensory and Motor Functions. An Opportunity to a Child -Society, Helsinki, Finland, 27. – 28.11.
	Oral presentation: *Interaction appears first in the temporo-occipital region* in the conference of Visual Sciences Society 03, Sarasota, Florida, USA, 9. – 14.5.
Viljas	Poster, *Ginzburg-Landau simulations of a p-wave superfluid in constrictions* in the Workshop on Vortices in Superfluids and Superconductors, Pohto, Oulu, Finland, 4. – 8.1.
	Poster, *Dissipative currents in superfluid ^{3}He-B weak links* in the Symposium, QFS 2003: Quantum Fluids and Solids, University of New Mexico, Albuquerque, New Mexico, USA, 3. – 8.8.
Volovik	Invited comment, *Presentation of scientific work of V.B. Eltsov on Investigation of structure and dynamics of quantized vortices in superfluid ^{3}He for dissertation* in the Meeting of the Scientific Council of the Kapitza Institute, Moscow, Russia, 25.6.

Volovik

Invited plenary talk, *Marriage of condensed matter and particle physics: relativistic quantum field theory* in the conference Pomeranchuk and Physics at the Turn of Centuries, Moscow State University, Moscow, Russia, 24. – 28.1.

Invited talk, *Black-hole horizon at the vortex sheet between two sliding superfluids* in the Workshop on Vortices in Superfluids and Superconductors, Pohto, Oulu, Finland, 4. – 8.1.

Invited talk, *Kelvin-Helmholtz instability in superfluids and black hole horizon at the brane separating two quantum vacua* in a seminar in the Landau Institute, Moscow, Russia, 13.3.

Invited talk, *On vacuum energy and cosmological constant* in the 5-th conference Landau Days, Landau Institute for Theoretical Physics, Chernogolovka, Russia, 23. – 25.6.

Invited talk, *What can ^{3}He tell us on black holes and vacuum energy?* in the Third COSLAB Workshop, the University of the Basque Country, Bilbao, Spain, 9. – 16.7.

Invited talk, *Momentum-space topology and emergent relativity* in the 7th COE Workshop on Cosmos in Condensed Matter, Waseda University, Tokyo, Japan, 28.11.

Invited talk, *Artificial black holes* in a seminar in Waseda University, Tokyo, Japan, 29.11.

Invited talk, *What can one say on the quantum vacuum using condensed matter experience?* in the 13th workshop on General Relativity and Gravitation, Osaka City University, Japan, 1. – 4.12.

Invited talk, *The Theory of Everything: a condensed-matter primer* in a seminar in Osaka City University, Osaka, Japan, 10.12.

Invited talk, *Classical and quantum regimes of superfluid turbulence* in a seminar in the Landau Institute, Moscow, Russia, 25.12.

5 lectures on *Condensed matter physics and its parallels with particle physics and cosmology* in the XVII-th Spring School on Particles and Fields, National Cheng Kung University, Tainan, Taiwan, 25. – 28.3.

Lecture, *Condensed matter physics and its parallels in particle physics and cosmology,* a course of 6 lectures in Osaka City University, Osaka, Japan, 5. – 10.12.

Participation in a meeting for the election of the new director for the Landau Institute, Chernogolovka, Russia, 16.5.

Participation in the Committee meeting of the Dissertation Council of Landau Institute: defences of (1) PhD thesis by S.B. Bravy; (2) PhD thesis by A.O. Korotkevich; (3) degree Dr. of Sciences by L.V. Bogdanov; (4) degree of Dr. of Sciences by I.A. Lul'yanchuk, Landau Institiute, Chernogolovka, Russia, 26. – 27.6.

Participation in the election meeting of the scientific council and the deputy directors of the Landau Institute, Chernogolovka, Russia, 27.6.

Participation in the editorial board meeting of JETP Letters, Moscow, Russia, 9.10.

Volovik — Participation in the editorial board meeting of JETP letters, Moscow, Russia, 20.11.

Vuorinen — Invited talk, *Kielellisten ja ei-kielellisten äänteiden käsittely kuuloaivokuorella lukivaikeuksisilla ja normaalisti lukevilla aikuisilla* in the meeting Lukitutkijatapaaminen, Helsingin yliopiston psykologian laitos, Finland, 11. – 12.4.

Participation in the meeting: Neuroscience Finland 2003, Biomedicum, Helsinki, Finland, 21. – 23.8.

Poster, *Cortical dynamics of speech and nonspeech processing in 7-8 year old children* in Helsinki Winter School in Cognitive Neuroscience, University of Helsinki, Lammi, Finland, 2. – 8.3.

Poster, *Cortical dynamics of speech and nonspeech processing in adults and 7-8 year old children* in RIKEN Brain Science Institute Summer Program 2003, Saitama, Japan, 29.7. – 10.8.

EXPERTISE AND REFEREE ASSIGNMENTS

Ahlskog — Consultation, Carbon nanotubes in LTL, NEC Research Laboratories, Tsukuba, Japan, 12. – 14.1.

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

Referee for Applied Physics Letters (American Institute of Physics)

Ahlskog — Referee for Physical Review B (APS)

Alles — Referee for Journal of Low Temperature Physics (Kluwer Academic/Plenum Publishers)

Berglund — Member of Finnish Academy of Technical Sciences, Helsinki, Finland

Member of Svenska Tekniska Vetenskapsakademien i Finland, Helsinki, Finland

Eltsov — Member of the organising committee for Quantum Phenomena at Low Temperatures ULTI III Users Meeting, 7. – 11.1. 2004, Lammi, Finland

Opponent in the dissertation of P.M. Walmsley: *Textures, Vortices and Persistent Currents in a Slab of ^{3}He-A*, The University of Manchester, Manchester, UK, 08.05.

Referee for Journal of Low Temperature Physics (Kluwer Academic/Plenum Publishers)

Finne — Member of the organising committee of Quantum Phenomena at Low Temperatures, ULTI III users meeting, 7.1. – 11.1.2004, Lammi, Finland

TV interview by YLE (Finnish Broadcasting Corporation) in the "Luonto lähellä" -series: About Low Temperature World Records, Low Temperature Laboratory 8.12.

Referee for Clinical Neurophysiology (Elsevier)

Referee for NeuroImage (Academic Press/ Elsevier)

Forss	Referee for Stroke (Lippincott, Williams & Wilkins/ American Heart Assosiation, USA)
	Referee for Human Brain Mapping (Wiley, Hoboken, NJ)
	Referee for Journal of Physiology (The Physiological Society/ Cambridge University Press, UK
	Referee for Journal of Neurophysiology (American Physiological Society, USA
	Referee for Experimental Brain Research (Springer)
Hakonen	Opponent in Surita Devi's Licenciate thesis examination, Microfabrication labs, Radioengineering lab, and Quantum Electronics group, Chalmers Tekniska Högskola, Gothenburg, Sweden, 3.11
	Fellow of American Physical Society
	Member of Academia Europaea, UK
	Member of Finnish Academy of Sciences and Letters
	Referee for Europhysics Letters (EDP Sciences and Società Italiana di Fisica/EPS, France)
	Referee for Applied Physics Letters (American Institute of Physics)
	Referee for Journal of Applied Physics (American Institute of Physics)
	Referee for Journal of Low Temperature Physics (Kluwer Academic/Plenum Publishers)
	Referee for Physical Review B (APS)
	Referee for Physical Review Letters (APS)
Hari	Consultant, (part-time) Department of Clinical Neurophysiology, Helsinki University Central Hospital
	"Päivystävä professori" (The Professor on Call) and organiser in Tieteen Päivät 2003 (Science Days), Helsinki, Finland, 8.1.
	Chairman and organiser of the session: *Mirror neurons, intentions, and imitation*, in Human Brain Mapping 2003, New York, USA, 20.6.
	Chairman of the session: *Visible pain in the plastic brain*, in the symposium, Psyche, Soma and Pain. The XIX Symposium of the Signe and Ane Gyllenberg Foundation, Helsinki, Finland, 25. – 27.9.
	Member of the scientific board of the 4th International Symposium on Noninvasive Functional Source Imaging Within the Human Brain and Heart, NFSI 2003, Italy, 10. – 13.9.
	Member of the organising committee of Human Brain Mapping, 20.6.2003, New York, USA
	Member of the organising committee of the 6th IBRO World Congress of Neuroscience, Prague, Czech Republic, 10 – 15.7.2003
	Member of the organising committee of the 7th Portuguese Conference on Biomedical Engineering, Lisbon, Portugal

Hari

Coordinator of Neuro-BIRCH III, Large Scale Installation in FP5 (Fifth Framework Programme), EU/LTL, Espoo, Finland

Coordinator of Functional Brain Mapping, Finland-Taiwan Scientific Cooperation, a bilateral exchange programme of the Academy of Finland

Member of the scientific advisory board of the National PET Center (Positron Emission Tomography), Turku, Finland

Evaluator of the Center for Cognitive Neuroscience (Kognitiivisen neurotieteen tutkimuskeskus) (KNT), University of Turku, Finland

Associate Editor of Human Brain Mapping (Wiley, Hoboken, NJ)
Member of the editorial boards of
- Brain Topography (Kluwer Academic Publishers)
- Clinical Neurophysiology (Elsevier)
- NeuroImage (Academic Press/ Elsevier)
- Neuroscience Research (Elsevier)

Opponent in the doctoral dissertation: *Information Processing in Acute Psychosis* by MD Minna Valkonen-Korhonen, University of Kuopio, Kuopio, Finland, 14.11.

Referee for the appointment of a professor in
- University of Bristol, Bristol, UK
- Charles University, Prague, Czech Republic
- University of Newcastle, Newcastle, UK
- University of Liverpool, Liverpool, UK
- The Medical Faculty, University of Geneva, Switzerland

Interview for the magazine, DANA Alliance for Brain, London, United Kingdom, 15.12.

Member of Academia Europaea, London, UK (The Academia Europaea is a European, non-governmental association acting as an Academy. The members are scientists and scholars who collectively aim to promote learning, education and research)

Member of Academia Rodinensis Pro Remediatione, Switzerland (Interdisciplinary scientific forum for exchange of facts and ideas on the complex problems related to developmental dyslexia and dysphasia)

Member of American Physiological Society, Bethesda, MD, USA

Member of European Dana Alliance for the Brain, London, UK (Association of Europe's leading brain scientists to raise the public profile of brain research)

Member of Finnish Academy of Sciences and Letters

Member of the Society for Neuroscience, Washington DC, USA

Member of the scientific programme committee of the 6th IBRO World Congress of Neuroscience, Prague, Czech Republic, 10. – 15.7.2003

Member of the steering committee of Helsinki Graduate School of Neurobiology, Helsinki, Finland

Hari	Referee for - Annals of Neurology (Wiley), - Clinical Neurophysiology (Elsevier) - NeuroImage (Academic Press/ Elsevier) - Journal of Speech, Language and Hearing Research, (American Speech, Language and Hearing Association, USA) - Neuroscience Research (Wiley) - Schizophrenia Research - Neuron (Cell Press, USA) - Journal of the Acoustical Society of America - Referee for Nature (Nature Publishing Group)
Heikkilä	Referee for Physical Review B (APS)
Helenius	Member of Academia Rodinensis Pro Remediatione, Switzerland (interdisciplinary scientific forum for exchange of facts and ideas on the complex problems related to developmental dyslexia and dysphasia)
	Member of Cognitive Neuroscience Society
	Member of Organization for Human Brain Mapping,
	Referee for Annals of Neurology (Wiley)
	Referee for Brain, (Oxford University Press, UK)
	Referee for Human Brain Mapping (Wiley)
	Referee for NeuroReport (Lippincott, Williams & Wilkins, USA)
Jousmäki	Referee for Experimental Brain Research (Springer)
Kopnin	Fellow of the American Physical Society
	Referee for European Physical Journal B, (EDP Sciences, Società Italiana di Fisica and Springer-Verlag)
	Referee for Physical Review (APS)
	Referee for Physical Review Letters (APS)
	Referee for Journal of Experimental and Theoretical Physics (JETP), (International Academic Publishing Company (IAPC) "Nauka/Interperiodica", Moscow, Russia)
Krusius	Chairman of the session Turbulence in Helium at QFS 2003: Quantum Fluids and Solids International Symposium, University of New Mexico, Albuquerque, New Mexico, USA, 3. – 8.8.
	Member of the organising committee of Quantum Fluids and Solids International symposium, Albuquerque, New Mexico, USA
	Secretary for the Section on Physics and Astronomy, Finnish Academy of Sciences and Letters
	Member of the Board of the Low Temperature Section of the Condensed Matter Division, European Physical Society, Mulhouse, France
	Adjunct member of the selection committee for the International Fritz London Award in Low Temperature Physics,

Krusius	Member of of editorial board Physica B: Condensed Matter (Elsevier)
	Fellow of the American Physical Society, USA
	Member of Academia Europaea, UK
	Member of the European Physical Society
	Member of the Finnish Academy of Sciences and Letters
	Member of the program committee of the International Conference on Quantum Fluids and Solids, QFS 2003, Albuquerque, NM, USA, 3. – 8.8.2003
	Member of the steering committee for European Science Foundation Programme on Cosmology in the Laboratory (COSLAB),
	Referee for Physical Review Letters (APS)
	Referee for Journal of Low Temperature Physics (Kluwer Academic/Plenum Publishers)
	Reviewer of a grant applications for the UK Government's leading funding agency for research and training in engineering and the physical sciences, Engineering and Physical Sciences Research Council, Swindon, UK
Kujala Markku	Member of the organising committee for Quantum Phenomena at Low Temperatures, ULTI III Users Meeting, 7.1. – 11.1.2004, Lammi, Finland
Mäkelä	Member of the National Defence Scientific Advisory Committee, Health- and Behavioral Sciences Division
	Referee for Audiology and Neuro-otology (Karger Publishers, Basel, Switzerland)
	Referee for Cognitive Brain Research (Elsevier)
	Referee for Human Brain Mapping (Wiley)
	Referee for NeuroImage (Academic Press/ Elsevier)
	Referee for Sleep Research Online (UCLA, Los Angeles, USA)
	Referee for Stroke, (Lippincott, Williams & Wilkins/ American Heart Assosiation, USA)
Paalanen	Chairman of the European Advanced Cryogenics School 2003, 15. – 25.9., Lammi, Finland
	Chairman of Quantum Phenomena at Low Temperatures, ULTI III Users Meeting, 7. – 11.1.2004, Lammi, Finland
	Member of the international program committee and international advisory committee of the 15th International Conference on Electronic Properties of Two-Dimensional Systems, Nara, Japan, 14. – 18.07.2003
	Secretary for Comission C5, Low Temperature Physics, in International Union of Pure and Applied Physics (IUPAP), APS, College Park, Maryland, until 31.12.2005
	Coordinator for the Finnish-Taiwanese Cooperation in Low Temperature Physics, Bilateral exchange program, Academy of Finland, until 31.12.2003

Paalanen

Coordinator of ULTI III, Large Scale Installation in the IHP programme, EU/LTL, Espoo, Finland, until 31.3.2004

Member of the selection committee for the Göran Gustafsson Prize, The Royal Swedish Academy of Sciences, Stockholm, Sweden, 1.12 – 31.12

Member of the evaluation committee for the Low Temperature Laboratory of Riken, Tokyo, Japan, 1. – 30.9.

Referee for research projects in FP5, Fifth Framework Programme, European Union, Thoulouse and Grenoble, France until 31.12.2003

Referee for grant applications to The National Science Foundation, Arlington, Virginia, USA 31.1.

Member of the editorial board of Journal of Low Temperature Physics (Kluwer Academic/Plenum Publishers)

Referee for a professorship in physics, University of Lappeenranta, Lappeenranta, Finland, 12.12.

Referee for a professorship in experimental physics, University of Turku, Turku, Finland, 6.12.

Referee for a professorship in physics, University of Rochester, Rochester, New York, USA, 15.11.

Referee for a professorship in physics, Northwestern University, Evanston, Illinois, USA, 15.8.

Referee for a professorship in physics, Case Western Reserve University, Cleveland, Ohio, USA, 20.3.

Referee for a professorship in physics, University of California, Berkeley, Berkeley, California, USA, 15.1.

Referee for a professorship in physics, Princeton University, Princeton, New Jersey, USA, 15.6.

TV interview in "Luonto lähellä" - series: Kylmälaboratorion kylmyysennätyksistä (Low Temperature World Records in Low Temperature Laboratory), YLE (Finnish Broadcasting Corporation), Helsinki, Finland, 8.12.

TV interview "Tutkittu juttu: Nanoteknologian lupaus", TV1, Helsinki, Finland, 9.4.

Member of the board of Uudenmaan Rahasto of Finnish Cultural Foundation

Fellow of American Physical Society

Member of Academia Europaea, UK

Member of Finnish Academy of Sciences and Letters

Member of Finnish Academy of Technical Sciences

Member of the steering board of PiShift Network, European Science Foundation,

Member of the steering board of the Advanced Magnetic Imaging Center (AMI Center), Helsinki University of Technology

Paalanen	Member of the steering board of CARAMEL, a nanotube research consortium, Chalmers University of Technology, Gothenburg, Sweden
	Referee for Journal of Low Temperature Physics, (Kluwer Academic/Plenum Publishers)
	Referee for Physical Review Letters (APS)
	Referee for Physical Review B (APS)
	Referee for Applied Physics Letters (APS)
Pakarinen	Secretary of the European Advanced Cryogenics School 2003, 15.9. – 25.9, Lammi, Finland
	Secretary of Quantum Phenomena at Low Temperatures, ULTI III Users Meeting, 7. – 11.1.2004, Lammi, Finland
Pekola	Planning of a joint experiment at the Institute of Solid State Physics, Chernogolovka, Russia, 20. – 21.11.
	Participating in a ULT Thermometry Project Meeting, at the Research Institute, CRTBT-CNRS, Grenoble, France, 11. – 12.12.
	Member of the Steering Committee of Nanodev Strategic Research Center, Chalmers University of Technology, Göteborg, Sweden, 28.08.
	Opponent in PhD dissertation of Franck Balestro, *Quantum dynamics of a DC-SQUID*, at the Université Joseph Fourier, Grenoble, France, 19. – 23.3.
	Referee for a professorship in experimental physics, University of Turku, Turku, Finland, 26.11.
	Member of the Finnish Academy of Science and Letters
	Member of the Finnish Academies of Technology
	Referee for - Physical Review Letters (APS) - Physical Review A (APS) - Physical Review B (APS) - Applied Physics Letters (American Institute of Physics) - Journal of Applied Physics (American Institute of Physics) - Journal of Low Temperature Physics (Kluwer Academic/Academic Press)
Salmelin	Organising committee member of the symposium The Science of Aphasia IV, Trieste, Italy, 22. – 27.8.
	Member of the organising committee of NorFA Fun-NET: 2nd Nordic Symposium on Functional Neuroimaging, Turku, Finland
	Member of the organising committee The Science of Aphasia V, Sep 16–21, 2004, Potsdam, Germany
	Member of the organising committee of the 16th Annual Conference of Academia Europaea, Helsinki, Finland, Sep 2–4, 2004

Salmelin

Member of the peer-review committee, BCN, School of Behavioral and Cognitive Neurosciences for the study of normal and pathological processes of the nervous system, University of Groningen, Groningen, The Netherlands, 14. – 15.12.

Associate editor of Human Brain Mapping (Wiley)

Member of the editorial board of NeuroImage (Academic Press/ Elsevier)

Member of Academia Europaea

Member of Academia Rodinensis Pro Remediatione (Interdisciplinary scientific forum for exchange of facts and ideas on the complex problems related to developmental dyslexia and dysphasia)

Referee for the journals:

- Brain (Oxford University Press)
- Brain and Language (Elsevier)
- Brain Research (Springer-Verlag)
- Cerebral Cortex (Oxford University Press)
- Clinical Neurophysiology (Elsevier)
- Cognitive Brain Research (Elsevier)
- European Journal of Neuroscience (Blackwell publishing)
- Human Brain Mapping (Wiley)
- IEEE Transactions on Biomedical Engineering (IEEE, Institute of Electrical and Electronics Engineers, USA)
- Journal of Clinical Neurophysiology (Lippincott, Williams & Wilkins, USA)
- Journal of Neuroscience (Society for Neuroscience, Washington DC, USA)
- Journal of Speech, Language, and Hearing Research, (American Speech-Language-Hearing Association, Rockville MD, USA)
- NeuroImage (Academic Press/ Elsevier)
- Neuron (Cell Press, USA)
- Neuropsychologia, (Springer-Verlag)
- Neuroscience (Nature Publishing Group, UK)
- Neuroscience Letters (Elsevier)
- Proceedings of the National Academy of Sciences , USA
- Psychophysiology (Cambridge University Press)
- Science (American Association for the Advancement of Science)
- Stroke (Lippincott, Williams & Wilkins/ American Heart Assosiation, USA)

Reviewer of grant applications for

- the Academy of Finland
- the Human Frontier Science Program, Strasbourg, France
- the National Science Foundation, USA
- the Netherlands Organization for Scientific Research
- the Wellcome Trust, London, UK (an independent research-funding charity that aims to improve human and animal health)

Schürmann	Referee for International Journal of Psychophysiology (Elsevier)
	Referee for Journal of Cognitive Neuroscience (MIT Press, Cambridge, MA, USA)
	Referee for Brain and Cognition (Elsevier)
	Referee for Cognitive Brain Research (Elsevier)
Tuoriniemi	Member of the editorial board of Cryogenics (Elsevier)
	Referee for Journal of Low Temperature Physics (Kluwer Academic Publishers / Plenum Publishing)
Vanni	Referee for European Journal of Neuroscience (Blackwell publishing)
	Referee for Human Brain Mapping (Wiley)
	Referee for NeuroImage (Academic Press/ Elsevier)
Viljas	Referee for Physical Review Letters (APS)
	Referee for Journal of Low Temperature Physics (Kluwer Academic Publishers / Plenum Publishing)
Volovik	Session chairman at the 5-th Conference Landau Days at the Landau Institute for Theoretical Physics, Chernogolovka, Russia, 23. – 25.6.
	Session chairman at the Third COSLAB Workshop, The University of the Basque Country, Bilbao, Spain, 9.7. – 16.7.
	Session chairman of the meeting of the editorial board of JETP Letters, Moscow, Russia, 28.8.
	Session chairman of the meeting of the editorial board of JETP Letters, Moscow, Russia, 25.12.
	Organiser of the Third COSLAB Workshop, The University of the Basque Country, Bilbao, Spain, 9. – 16.7.
	Co-chairman of COSLAB, a European Science Foundation Programme, France
	Associate editor of JETP Letters, (Nauka Interperiodika, Moscow, Russia)
	Opponent att the dissertation by D.I. Podolsky *Evolution of inhomogeneous cosmological models with relativistic matter*, Meeting of the Dissertation Council, Landau Institute, Chernogolovka, Russia, 26.6.
	Foreign member of the Finnish Academy of Sciences and Letters

APPENDIX I: EVALUATION SUMMARY REPORT

Transnational Access implemented as Specific Support Action (SSA)

Proposal Number: 505313	**Acronym: ULTI**

	Mark (0 to 5)
1. S&T Excellence *(Threshold 3/5; Weight 1)* The ultra low temperature Laboratory of Helsinki offers a unique facility for the temperature range from 4K to the lowest temperatures available in Europe. In fact the state-of-the-art low temperature measurement environments such as sub-mK cryostats can provide the lowest temperatures anywhere in the world. The existing facilities have recently been enhanced by the addition of microfabrication facilities which include electron-beam lithography. Some additional access can also be provided to class 100/1000 clean room areas. Such facilities are very rare worldwide and expensive to establish and maintain. There are 2 similar facilities in the USA and Japan. Access to low temperature facilities in Europe will soon be reduced further by the closure of the Bayreuth facility to outside access. The proposal attaches 34 letters of support from current and potential users many of whom refer to the unique facilities and in particular the rotating cryostat operating at mK. The facility clearly operates at a world class level and belongs to the leading institutions worldwide. Moreover, it provides a platform for first class education for young scientists. The unique infrastructure and the existing expertise guarantee highest quality research on an international level. It also acts as a node for the collaboration with Russian scientists who are well known to be leading in many aspects of ultra-low temperature physics. The ULTI facility has an excellent track record in creating a facility dedicated to high quality research. The past achievements document excellent scientific results from international cooperations. A wide range of science has been successfully undertaken ranging from cosmology to quantum fluids and nanoelectronics. They are keen to extend this range to new topics and users and there is good evidence of being able to do so. The services are well established and the newest technologies are continuously implemented.	5
2. Quality of the Management *(Threshold 3/5; Weight 0,5)* There is an extensive in-house research programme which covers most of the perceived research areas of external users and also the areas most relevant to the development of the facility itself such as refrigeration, cryogenics and nano-fabricated cryosensors. ULTI experiments are typically lengthy, i.e. 6-12 months of cryostat time.	5

Strong collaboration between the scientific staff at the facility and external users is therefore essential. The facility clearly thrives on this close collaboration and it has proved to be a highly effective method of working. The experiments are often complex and necessitate equipment construction or modification. In addition to the regular technical staff who are responsible for the He liquefier and the mechanical workshop, an additional engineer is hired specifically to train and assist users in the low temperature techniques necessary for them to conduct their experiments when on site. 75% of this technician's time is charged to the project. Graduate students are used to instruct on the use of e-beam lithography. The use of the clean room is provided only for experienced users although some assistance can be provided. Additional facilities for sample preparation are also made available to users as required. Logistic support of travel arrangements etc. is provided by a secretary. The letters of support are highly complementary about the excellent standard of scientific and technical support offered in the past. Selection procedures seem entirely appropriate with due priority given to first time users and those without access to similar facilities in their home country. The expert selection panel only meets once every 18 months, but proposals are evaluated twice per year remotely. Experience has led to the removal of the 3 month time limit for proposed projects which should widen access further. The selection of projects is purely by quality.	
3. European Added Value *(Threshold 3/5; Weight 1)* ULTI has an impressive track record in the attraction of new users drawn from a wide range of countries. ULTI has participated in 3 previous access programmes over the past 9 years and in each new contract period nearly half the groups have been new users. 60 groups were approached in the preparation of this proposal, 50% of them new groups, which yielded the 34 letters of support / expressions of interest in using the facility. Of these, 13 are new groups and 6 have no facilities in their country. These letters are evidence for the effective advertising programme which comprises the usual mix of adverts in journals, on the web and conferences as well as by directly addressing potential users. In particular, user meetings are held every 2 years which serve to spread good practice, encourage new users and provide feedback to the facility.	4.5
Total Score *(Threshold 3,5/5)*	4.80
Overall remarks *(highlighting strengths and weaknesses and providing recommendations for project negotiation, including recommended level of resources)*: This is an exceptionally good proposal providing access to state of the art low temperature facilities (replacement cost 5M€) at the Helsinki University of Technology. Strong in-house research provides excellent scientific collaboration with users on long and complex experiments. Technical and logistic support is good with 75% of a technician provided to train external visitors. The facility has long experience of providing facilities for outside users and has proved itself capable of producing high quality research evidenced by their publication record. In addition, they have an excellent track record in attracting new users from a wide range of	

Countries. The resources requested are modest as they request only 75% of a technician keeping the unit cost low. Due to the lengthy nature of the projects, the cost per project is inevitably relatively high.

Horizontal issues *(if relevant)*

Selection of proposals is on technical merit with priority given to new users and those for whom no comparable facilities are available in their home country. There are no gender issues.

ULTI reaches a wider community by publications in journals of high impact factor.

The training of students and their participation in the research is integral to the project.

	Y / N
Has the proposal passed all evaluation thresholds?	Y
Does this proposal have ethical issues that need further attention?	N