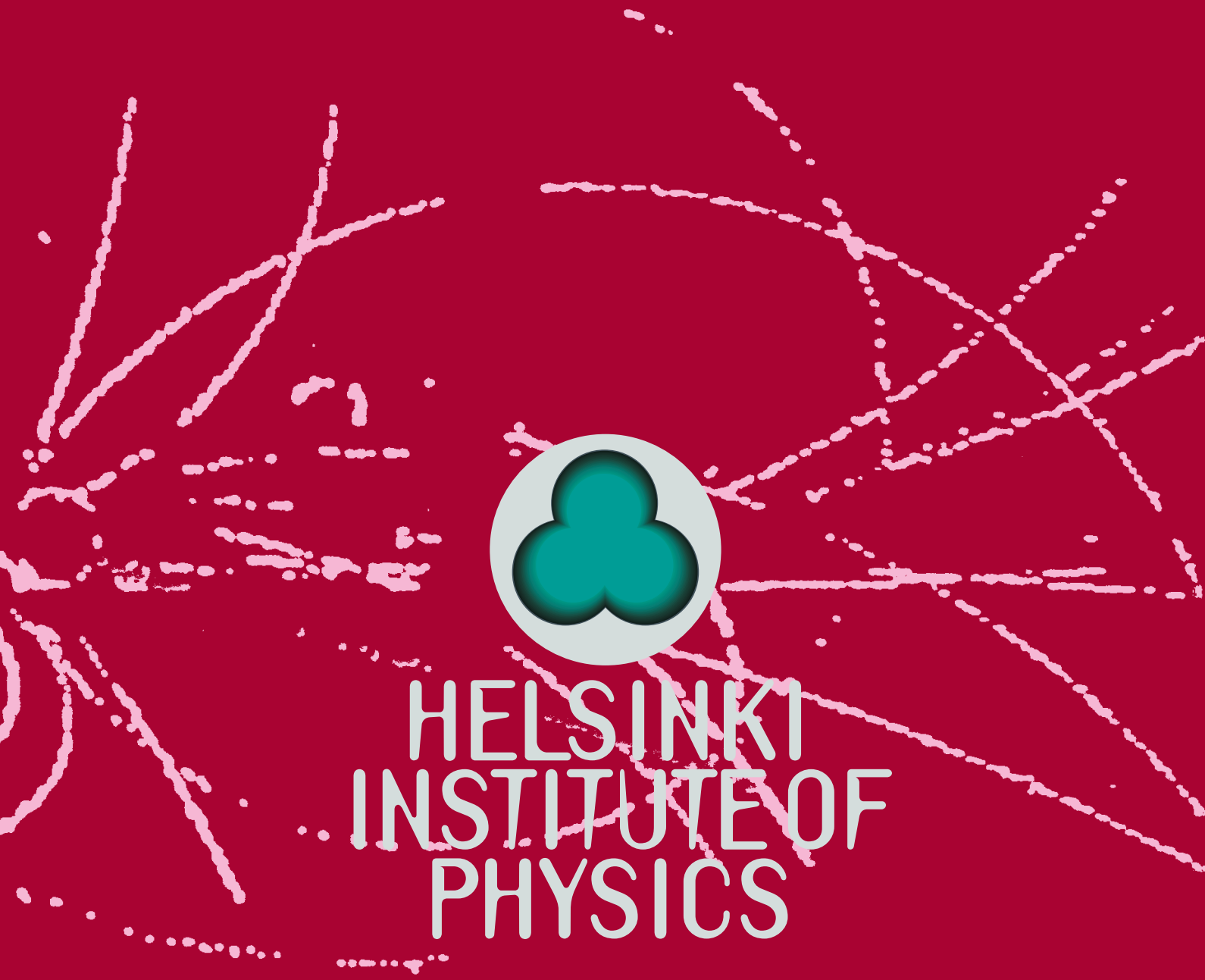
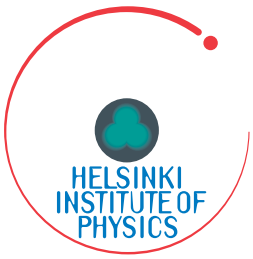
Annual Report 1998



HELSINKI INSTITUTE OF PHYSICS



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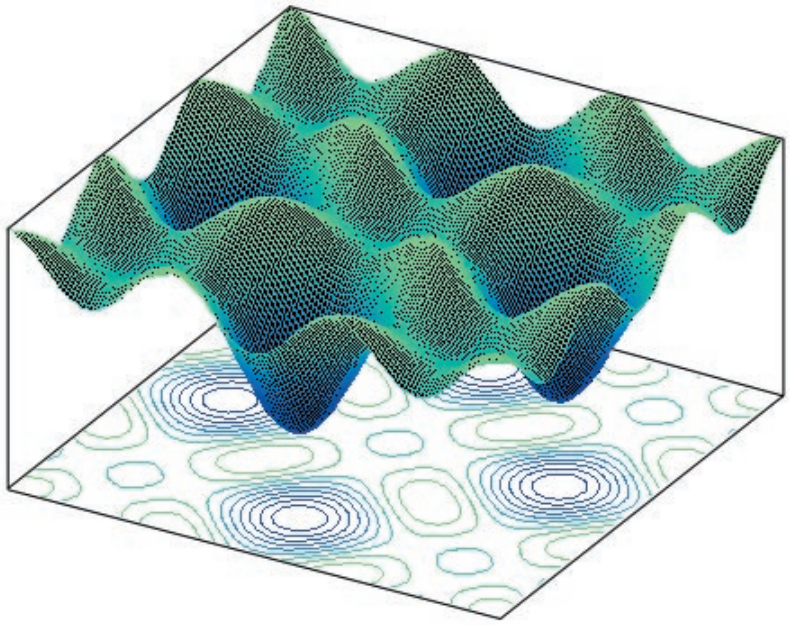


Spatially periodic laser fields appear as optical lattices for cold atoms. Atoms can also be localised into lattice sites via laser cooling. As densities increase collisions and other interactions between atoms become important.

Annual Report '98 Helsinki Institute of Physics

Contents

Introduction

Eero Byckling

The Helsinki Institute of Physics (HIP) is the national research institute for theoretical and particle physics in Finland. It was founded in September 1996. The main fields of research are high and low energy theoretical physics, experimental particle physics and technological research related to particle accelerators. The Institute also supports graduate education at universities and training at CERN.

HIP is an independent national institute and is supervised by the University of Helsinki, Helsinki University of Technology and the University of Jyväskylä. The highest decision-making body is the Board of the Institute. HIP funding is decided as a separate item during the annual planning of the Finnish governmental budget. The Institute also obtains funding from other sources: Ministries, the Academy of Finland, the Technology Development Centre of Finland (TEKES) and companies. HIP has offices and laboratories at four locations: the University of Helsinki, Helsinki University of Technology in Espoo, the University of Jyväskylä and CERN in Geneva. The Institute has the responsibility of coordinating Finland's relations with CERN and other international physics research institutions.

As described in detail below, the main topics of research are mathematical physics, quantum optics, statistical physics, experimental particle physics at CERN, design of parts of the CMS and ALICE experiments for the LHC accelerator, and technological development work on a project management system for the LHC project.

A six-member Scientific Advisory Board (SAB) has been nominated for a three-year period 1997-2000. The SAB held its second meeting on September 17, 1998 in Geneva. It made the following recommendations for further development of the Institute: 1) HIP should actively look out for qualified scientists and offer them secure positions. 2) The new chair in experimental particle physics should be used to take advantage of Finland's commitment to experimental particle research. 3) An adequate laboratory and scientific equipment infrastructure should be established within HIP. 4) The SAB is pleased to see the orientation of the research programme and future resource allocation towards the physics programme with LHC. 5) The SAB supports the activities of the theory group. 6) Research activities outside the LHC project should be kept alive. 7) The SAB appreciates the existence of a strong technology development programme at HIP.

The Board has approved a Research Plan for 1999, which implements a number of actions that are in accordance with recommendations formulated by the SAB. The size of the basic HIP budget in 1999 is the same as in 1998. However, some additional funding has been obtained for the Common Fund and equipment expenses for the LHC experiments CMS, ALICE and ATLAS. Further, outside project funding, mainly from the Academy of Finland and TEKES, will increase by some 40% from 1998 to 1999.

The active graduate education and student training programme at the institute is strengthened by collaboration with university departments and CERN. HIP scientists have given lecture courses at graduate level and supervised thesis work. The Institute has offered research positions and a stimulating environment to undergraduate and graduate students and has coordinated the National Graduate School in Particle and Nuclear Physics, in which the physics departments of the Universities of Helsinki and Jyväskylä participate. The Institute has organised international seminars and conferences, and has had an extensive visitors programme. Undergraduate and graduate students have been chosen as CERN trainees.

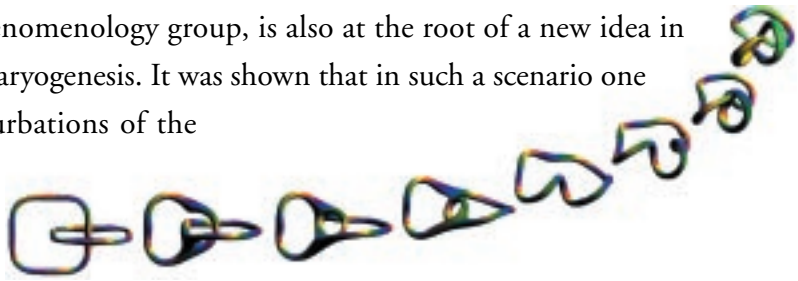
Below we discuss the research results. Some significant results have already brought HIP scientists to the attention of the international scientific community. These successes are reflected in the increase of resources available for research work at HIP.

HELSINKI INSTITUTE OF PHYSICS

Main Research Results

Theory

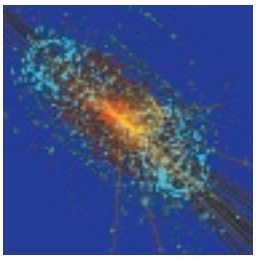
Knot-like solitonic solutions have been discovered that are candidates for the low energy effective theory for QCD, and a new proof was developed for the Kolmogorov-Arnold-Moser theorem in Hamiltonian dynamics. Memory effects in many-particle diffusion have been studied. A new method by which the memory function associated with the generalised Langevin equation can be evaluated numerically was developed. Pseudopotential first principles calculations for several metal alloys were performed. A general proof that a full Bell measurement can not be performed with linear optical elements only was developed. Supersymmetry, actively studied in the particle phenomenology group, is also at the root of a new idea in cosmology, called B-Ball Baryogenesis. It was shown that in such a scenario one obtains isocurvature perturbations of the microwave background which can be measured in the near future.



High Energy Physics

The group's measurement of the rare decays of beauty quarks in the LEP with record precision contributes to the understanding of one of the major puzzles in today's high energy physics: the CP violation. The group has started extensive testing and application of its novel method of reconstructing the quark-gluon final states in hard scattering processes. As the first step, $e^+e^- \rightarrow b\bar{b}$ events at LEP1 energies, W^+W^- and hypothetical H^+H^- events at LEP2 energies were investigated and the most probable colour configurations of these events were identified. Several applications of the method in future pp- and e^+e^- colliders have been identified and reported at workshop meetings. The group has also begun testing the Gas Electron Multiplier detectors. In the context of international collaboration on the design of the next e^+e^- linear collider and its detectors (TESLA), the group has prepared the preliminary design for an Si-pixel sensor-based vertex detector and studied various alternatives for a GEM-based intermediate tracker.

LHC



Approval of the Technical Design Report for the CMS Tracker by the CERN LHC Committee (LHCC) was the most important milestone achieved in the LHC programme in 1998. The HIP CMS projects contributed in a significant way to the preparation of the critical parts of the document, such as the event simulation needed to verify the physics performance of the planned detector and the detailed technical design of the Tracker support structure. A new, production-friendly approach to construction of carbon fibre composite structures was presented for the barrel structure. For validation of CMS detector modules, a high precision Beam Telescope was built for the CERN H2 test beam. It utilizes a new high performance data acquisition system (ROXI) developed at HIP. In the software development for analysis of the CMS experiment important steps were taken to move towards modern, object-oriented software. A new research project, the Nuclear Matter project, was started when HIP joined the ALICE project for LHC and the ongoing ISOLDE-experiments at CERN.

Technology

The main outcome of the technology programme, the Tuovi Web Data Management system, went into full-scale production use at CERN, DESY and the Max-Planck Institute. The registered user base has increased to 3000 users and with global guest use, the system serves some 8000 users in the High Energy Physics community worldwide. A major release of the software was delivered which comprised numerous, sought-after new features. TuoviWDM is also being used by CERN's administrative division to manage tendering and contract-related documentation. The delegates from CERN member states have access to this information, and in addition, they have their own information sharing forum via TuoviWDM. Another national R&D project, and a major collaborative effort between industrial partners from all over Scandinavia, has further strengthened collaboration with industry. Nordisk Industrifond is funding the Nordic initiative, in which CERN is participating as an expert partner.

Theory Programme

Antti Niemi

The purpose of the Theory Programme is to conduct vigorous research in selected areas pertaining to all theoretical physics. In 1998 the Theory Programme consisted of five projects: laser physics and quantum optics, mathematical physics, particle cosmology, particle phenomenology, and statistical physics and materials science, with some overlap between the projects. Theory Programme research strategy emphasises novelty and flexibility as the means to achieve a high standard.

Laser physics and quantum optics

In 1998 quantum information was established as a major research field in the Project. We found a general proof that a full Bell measurement can not be performed with linear optical elements only. Such a measurement is required for perfect teleportation in the Innsbruck scheme. Similarly, we explored the practical limits for the security of quantum cryptography protocols and established good contacts with the Nordic research groups that work on related communications experiments. A scheme for quantum bit preparation using the STIRAP technique was developed. Finally, the Project had the privilege of hosting an international quantum information workshop in Helsinki in September. The meeting was organised by the EU TMR network "The Physics of Quantum Information", and chaired by Professor Anton Zeilinger from Innsbruck.

We have also continued our well-established research on time-dependent quantum systems, cold atomic collisions, cavity QED processes, and wave packet dynamics with Bose-Einstein condensates. Some of this work was performed in collaboration with theoreticians and experimentalists in Copenhagen and at NIST, USA.

Towards the end of 1998 external funding, especially by the Academy of Finland, became an increasingly important factor in the Project's activities. We are, for example, participating in the National Graduate School in Modern Optics and Photonics. External funding is expected to exceed Institute support in 1999.

Mathematical physics

Recently it was established by L. Faddeev and A. Niemi that knotlike solitons are present in a number of theoretical models in many different areas of physics. Of particular interest is the proposal that the infrared limit of Yang-Mills theory describes the dynamics of knotlike fluxtubes. The investigation of the infrared limit of Yang-Mills theory has also revealed a number of unexpected mathematical structures related to group representation theory in terms of coadjoint orbits and their symplectic structures. The indications of these and other related observations are being studied actively at present.

Y. Stroganov has worked on estimates for knot energy with A. Niemi and analysed the Bethe Ansatz equations in nonstandard cases, like that of the Hofsdater problem.

A. Kupiainen, with J. Bricmont and K. Gawedzki, has developed a new approach to the Kolmogorov-Arnold-Moser theory of preservation of quasiperiodic motion in Hamiltonian dynamics. The approach is based on the Renormalization Group method in Quantum Field Theory. It is hoped that this approach will shed light on the scaling properties of these theories near the breakdown of the last tori.

C. Montonen has been investigating Supersymmetric gauge theories, with (SQCD) and without matter fields (SYM), and with or without extended supersymmetry. Parts of the low-energy effective action for N=2 SYM have been explicitly derived in order to ascertain that Seiberg-Witten duality is not broken by unforeseen effects. The various phases of N=1 SQCD have been studied and the effect on them of soft breaking of supersymmetry has been extensively investigated.

Particle Cosmology

Activity in Particle Cosmology has focused on lattice simulations of the high temperature field theory, inhomogeneous nucleosynthesis

and baryogenesis. In particular, a novel idea developed in Helsinki and dubbed B-Ball Baryogenesis has received much attention. It is based on the recent observation that the spectrum of the minimal supersymmetric standard model (MSSM) admits non-topological solitons carrying baryonic charge, or B-balls. If supersymmetry breaking from the hidden sector is mediated by gravity, it turns out that B-balls are unstable but long-lived. Their formation requires inflation, during which effectively massless squark fields are subject to fluctuations and find their way to a global minimum, called the Affleck-Dine condensate. The condensate then breaks up into B-balls. They typically decay much later than the electroweak phase transition, producing both baryons and light neutralinos. Thus B-balls may be the source of both baryons and cold dark matter.

In an interesting development it was pointed out by K. Enqvist and J. McDonald that inflationary fluctuations in the squark fields result in isocurvature perturbations of the microwave background. The result was published in Phys. Rev. Lett. 81 (1998) 3071-3074. The effect is particularly pronounced if all the dark matter originates from the B-ball decay, and should in fact be observable in the angular power spectrum as measured by the forthcoming satellite experiments MAP and Planck. The particle cosmology group is participating in the scientific effort of the latter experiment as part of the Planck Surveyor Mission Low Frequency Consortium.

Particle Phenomenology

The nature of electroweak symmetry breaking and supersymmetry pose some of the most burning questions for today's high energy physics. One of the most important issues in building supersymmetric models at the moment is the breaking method of supersymmetry. We have studied the phenomenologically best motivated gauge-mediated supersymmetry breaking (GMSB) models and have found that almost all of the models are allowed. An algorithm for finding the full particle spectrum for these models has been presented and the spectra obtained. If unification is assumed, the minimal GMSB model is found to be mostly inconsistent because of the constraints from nucleon decay.

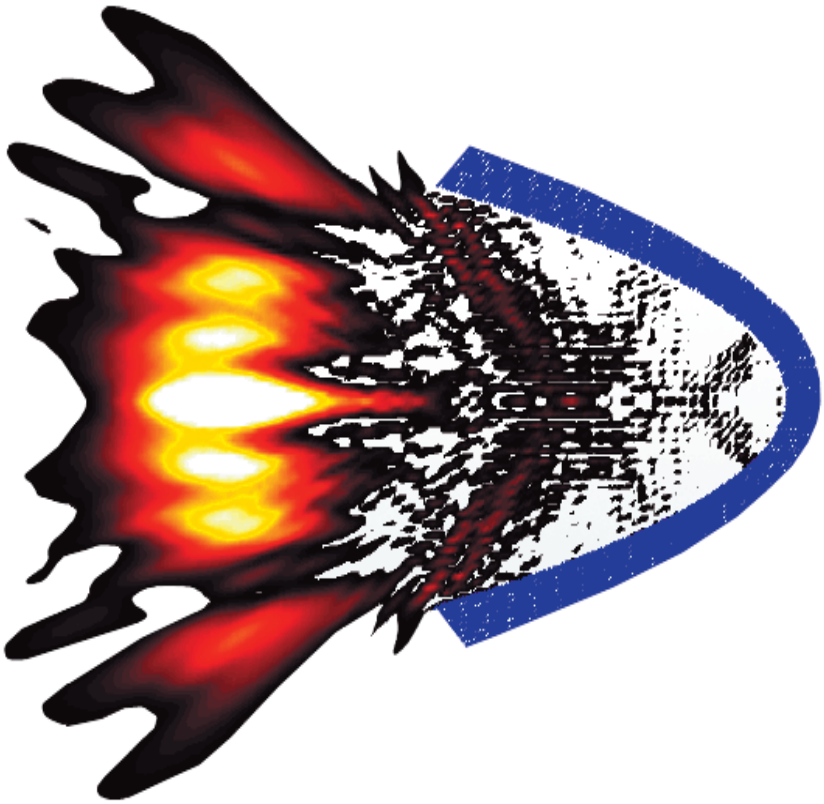


Fig. 1
Energy density distribution of a single photon which has been reflected from a mirror formed by atoms

Another important and experimentally crucial question in supersymmetric models is the possible conservation of R-parity. We have found the constraints on products of R-violating couplings from neutral meson mixings and demonstrated that the bounds depend strongly on the basis chosen for separate quark superfield. A combination of these field rotations, the Kobayashi-Maskawa matrix, can be tested in the framework of the Standard Model, but separate field rotations are as yet untested.

Recent results for nonvanishing neutrino mass add to the motivation for left-right (LR) models with naturally light left-handed neutrinos. The lightest Higgs bosons, their mass and their phenomenology in future colliders, have

been investigated in supersymmetric left-right models both for small and large values of right-handed scale, which determines the fate of the R-parity. Monte Carlo generators are being prepared for several processes for a detailed investigation of models in detectors.

With new B-meson experiments, both at the specialised facilities and at LHC, the B decays are expected to give information on new physics. Novel decay channels based on the quark level decay $b \to ss\bar{d}$ have been suggested for this purpose. The box-mediated decay $b \to ss\bar{d}$ is predicted to occur with an extremely small branching ratio of below 10^{-11} by the Standard Model of particle physics and thus provides an excellent channel for testing new physics.

Recently, the nonperturbative aspects of supersymmetric gauge theories, confinement, duality and dynamic supersymmetry breaking have been clarified by Seiberg and Witten. The real world, however, is not supersymmetric and thus it is important to extend these analyses to non-supersymmetric theories, e.g. to QCD. To this end, we have investigated supersymmetric QCD with generic soft supersymmetry breaking terms and have revealed the fate of the nonperturbative aspects of supersymmetric QCD after supersymmetry breaking. We have clarified the vacuum structure for different flavours of quarks, including chiral symmetry breaking and non-breaking phases. Furthermore, we have found strong suggestions that Seiberg's duality may be valid even after supersymmetry breaking.

The low energy effective action of the N=2 supersymmetric Yang-Mills theory based on the conventional effective field theory method and the constant field approximation technique has been studied. This work has presented quantitative clarification of Seiberg's non-perturbative arguments.

Quantum field theory on noncommutative space-time has been formulated. Contrary to the common belief that noncommutativity of space-time is the key to removing ultraviolet divergences, we have shown that ultraviolet divergences persist for field theories on a noncommutative plane, while on a noncommutative cylinder they are absent. Thus, the ultraviolet behaviour of a field theory in noncommutative spaces is sensitive to the topology of space-time, namely to its compactness. General arguments have also been presented for higher space-time dimensions.

Statistical Physics and Materials Science

The activities of the Statistical Physics and Materials Science Project concentrate on the theory of equilibrium and nonequilibrium critical phenomena and dynamics in strongly interacting many-body systems, in particular as applied to complex systems, polymers, disordered materials, and surface physics. Significant progress has been made in the following problems.

We have studied memory effects in many-particle diffusion, and developed a new method through which the memory function associated with the generalised Langevin equation can be evaluated numerically. Studies of several strongly interacting systems, such as models of O/W(110) and polymer chains on sur-

faces have revealed the existence of a nontrivial intermediate power law in the time-dependence of the memory function even for purely dissipative cases.

We have performed pseudopotential first principles calculations for several metal alloys. In bulk alloys, the main interest has been in transition metal aluminides, e.g. in the Al-Zr system whose complicated phase diagram has been explained from first principles. We have demonstrated that the heats of formation of such a system can be obtained accurately enough to explain the features of the phase diagram. We have also performed calculations for defects in Zr-rich alloys, demonstrating that defects play an important role in the competition between different alloy phases.

We have studied numerically the Faddeev-Hopf knots that have a nontrivial Hopf charge and minimize Faddeev's Lagrangian. We have identified the topologically stable structures of such knots without symmetry restrictions. We have also shown that a linked combination of two un-knots relaxes into different minimum energy configurations depending on their charges and their relative handedness and direction (Fig. 2).

The dissipative quantum dynamics of magnetic structures has been investigated theoretically. We have shown that both phonons and nuclear spins will have particularly strong dissipative/decohering effects on the quantum tunnelling of domain walls in ferromagnets. We have also studied the quantum dynamics of two coupled nanomagnets, such as the Mn-12 acetate complex. This has enabled us to model a realistic Quantum Measurement Apparatus where the apparatus, system and environment can all be treated quantum mechanically.

Imbibition of water into paper includes both liquid flow and front propagation through a disordered medium. We have developed a phase field model accounting for both physical mechanisms. Unlike previous models it allows us to understand the slowing down of the liquid flow, the emergence of a driving induced lateral correlation length, avalanche motion and anomalous scaling in the interface fluctuations.

In collaboration with the theoretical ecologist I. Hanski we have modelled complex dynamics of host-parasitoid interaction for various insect species. We have been able to explain the two year cycles in the very abundant moth genus Xestia in northern Lapland with its variations from east to west. Another project concerns the endangered butterfly Melitaea Cinxia on Åland and complex spatiotemporal patterns in its habitat occupation.

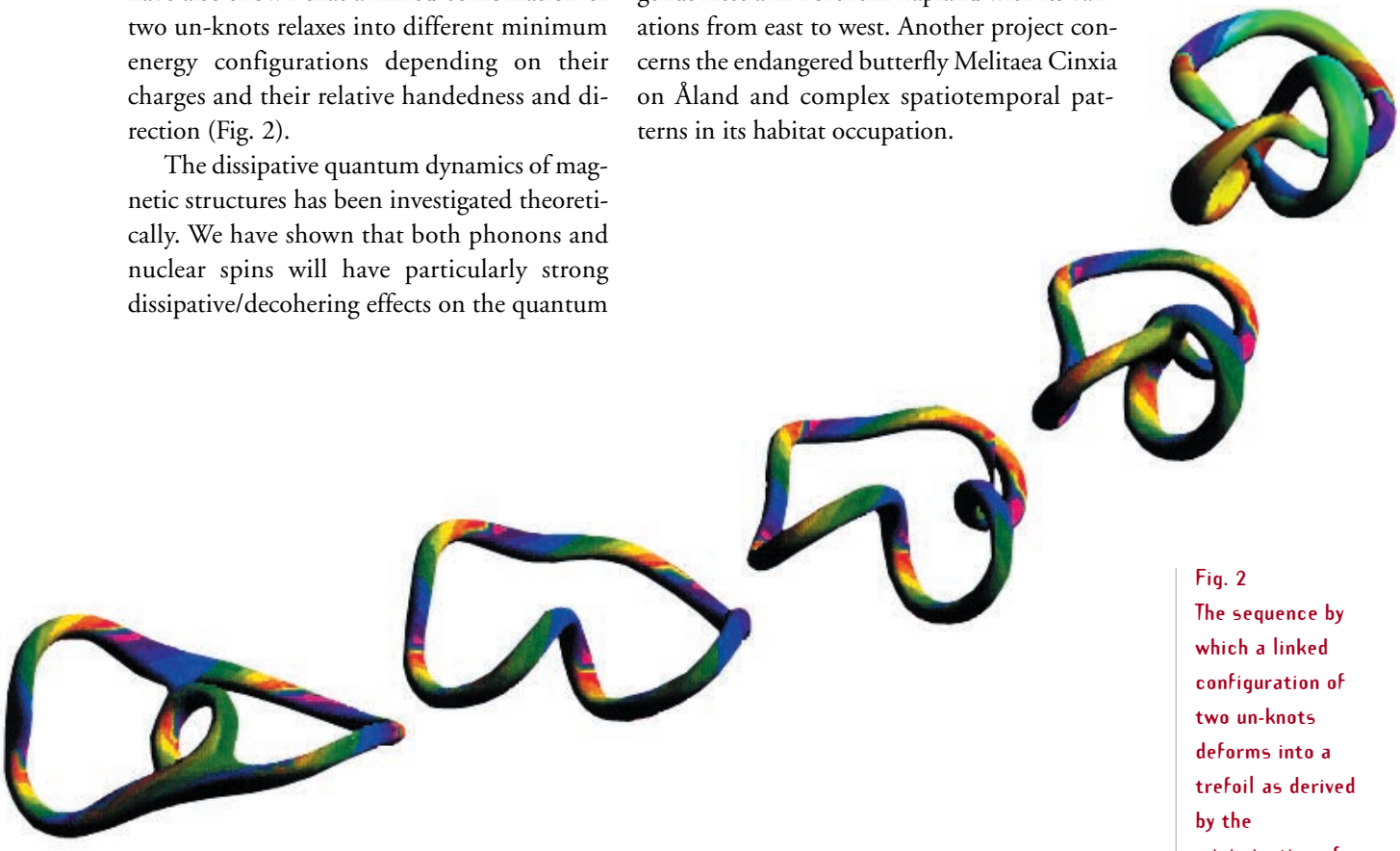


Fig. 2
The sequence by which a linked configuration of two un-knots deforms into a trefoil as derived by the minimization of Faddeev's Lagragian.

High Energy Physics Programme

Risto Orava

The mission of the LEP Programme is to search for fundamental knowledge on the origins of mass and on the strong force, e.g., colour confinement and quark interactions. The Standard Model (SM) describes the experimentally observed properties of fundamental particles and their interactions exceedingly well. As a theory, however, the SM is incomplete and does not answer questions such as: Why are there only three families of quarks and leptons? How do the basic building blocks of matter acquire their measured masses? What is the general framework for unifying gravity with the interactions treated by the SM and for particle classification in such a superstructure? The strategy in investigating these basic questions of today's high energy physics is based on active participation in leading experiments - in their construction, operation, and data analysis and in physics analysis. The analysis group must (1) be active, gaining its expertise and ideas from hands-on participation in detector construction, (2) interact with phenomenologists and (3) be supported by an adequately equipped experimental laboratory.

Electron-Positron Physics

Physics analysis activity in the high energy physics programme has centered on study of the data collected by the DELPHI experiment at the LEP collider at energies around the Z^0 pole and above the WW threshold. The large data sets for decays of the Z^0 bosons have been used to continue the studies in heavy flavour physics. The V_{ub} element in the quark mixing matrix has been measured using a new technique which minimises the theoretical uncertainties. The V_{ub} matrix element was determined with record precision, thus improving the Standard Model predictions for values of the CP violating phases in B decays. This study is of special relevance regarding future B factories and LHC in clarifying the origin of CP violation. With the record performances of the LEP-2 collider, which is running at the highest energies ever achieved in e^+e^- collisions, larger data samples have been available for studies of hadronic decays of the W bosons and for searches for new particles. In these analyses original techniques for reconstructing hadronic systems, developed by the Helsinki

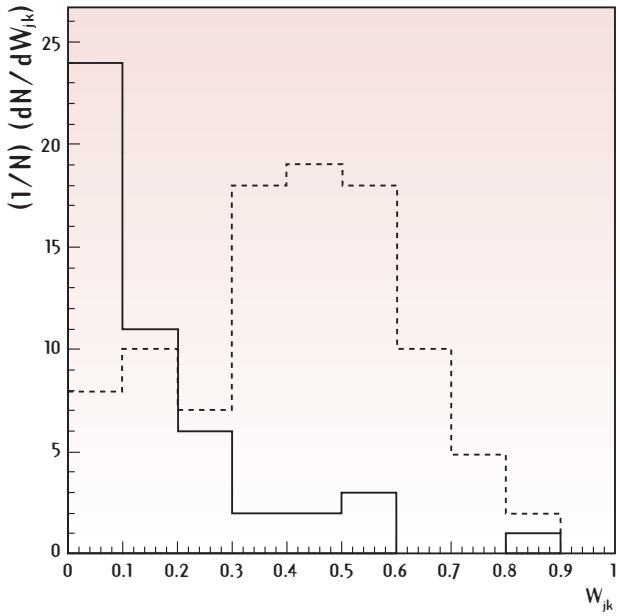


Fig. 1. **The distribution of weights, corresponding to strength of colour connections for $Z^0 \to b\bar{b}$ (solid line) and $Z^0 \to b\bar{b}g$ (dashed line), showing the identification capabilities of the algorithm developed by the Helsinki group.**

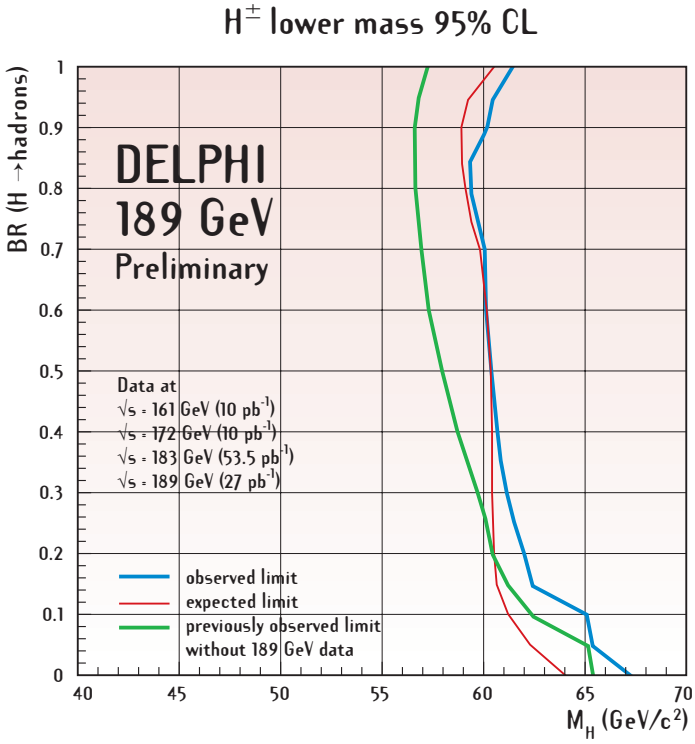


Fig. 2. **The 95 % C.L. lower limit on the charged Higgs mass established by analysis of the high energy LEP data collected by DELPHI for different values of the assumed hadronic $H^{\pm}$ decay branching ratio.**

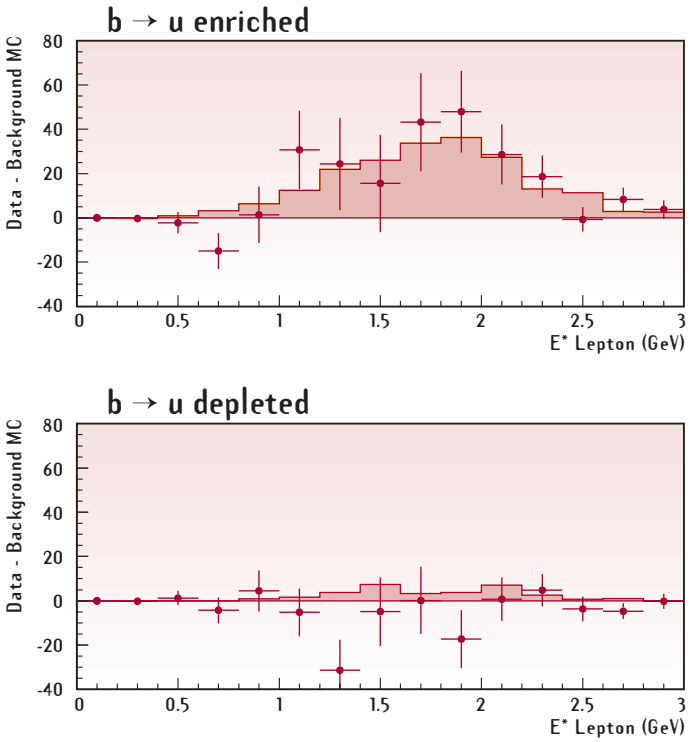


Fig. 3. **The spectrum of lepton energy in the *B* rest frame for selected semileptonic *B* decays after removal of the backgrounds and $b \to c\ell\nu$ decays. The upper plot, enriched in signal decays, shows an excess of decays corresponding to the observation of the $b \to u\ell\nu$ transition.**

group, were utilised. In the search for new physics, these techniques, tested in the study of $Z^0 \to b\bar{b}g$ events, have been applied to the new high energy data to investigate the colour-interconnections in fully hadronic decays of pair-produced W bosons and to discriminate between these decays and those of possibly charged Higgs bosons.

Detector Research & Development

Extensive tests of a new type of gaseous radiation detector, the Gaseous Electron Multiplier (GEM), have been performed. Several different gas mixtures were tested with GEMs manufactured in collaboration with CERN (F. Sauli et al.) The group is developing GEM technology further in collaboration with CERN and VTT Microelectronics. The present manufacturing process, based on wet etching technology, is capable of producing GEM holes in KAPTON with a maximum thickness of 75 μm. To overcome this limitation, the reactive ion etching method (RIE) for processing thicker KAPTON and similar materials is being studied at VTT.

A new two-dimensional readout board design for GEMs was invented by the group and presented at CERN and DESY. A data acquisition system for GEM readout was designed and configured. The design is based on a 128-channel preamplifier chip (HELIX), a fast 8-channel ADC/DSP module (ROXI), a 22-channel sequencer (SEQSI) and a Pentium processor. The data is transferred between DAQ modules via a VME bus. The data acquisition software is partly written and running in a Windows NT environment. The final version will utilise LabView routines.

The new resistive vacuum evaporator enabled the detector group to produce its own metallisations on various detector window materials and to manufacture metallised polymer foils for GEM studies.

The group studied the formation of chemical compounds created by electron avalanches in proportional mode. The dependence of their abundance on radiation intensity was measured and studies to find out the effects of various gaseous additives on the chemical balance in electron avalanches began. For identification of different compounds, the HP GCD mass spectrometer was combined with the DANI GC, rendering a two-dimensional gas chromatography possible.

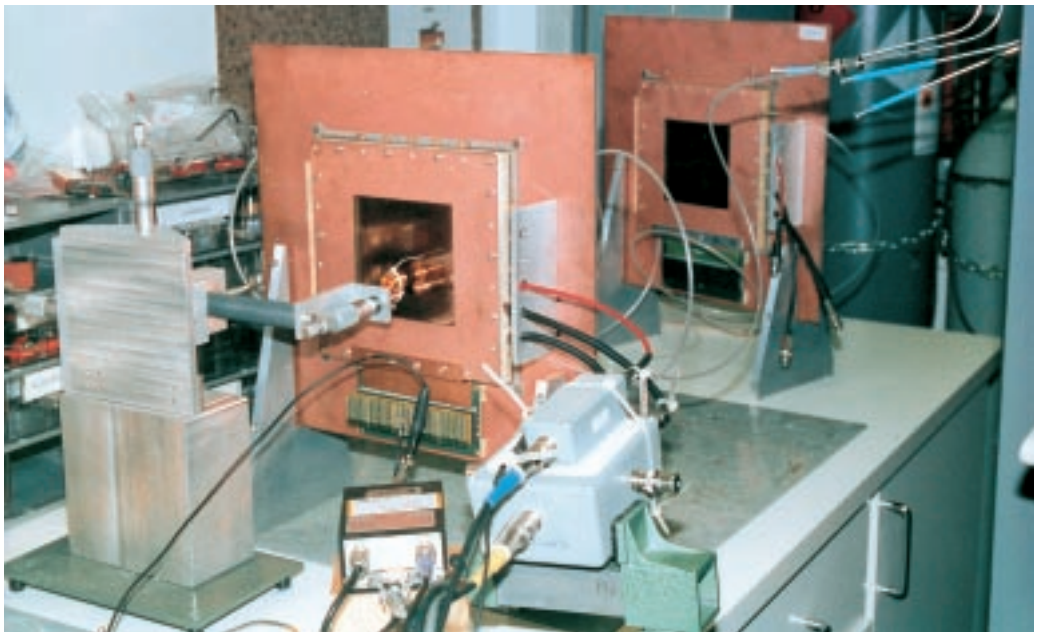


Fig. 4. **The GEM detectors (manufactured in collaboration with CERN) under operational testing in the Innopoli detector laboratory of HIP.**

LHC Programme

Jorma Tuominiemi

One of the main goals of the HIP LHC programme is to participate in the design, construction, and operation of, and analysis of data from the Central Tracker of the CMS detector system. A major milestone in 1998 was the preparation of the Technical Design Report (TDR) on the Tracker. It required extensive efforts and expertise from the HIP groups in detector and physics simulation, technical design and prototype construction. The CERN LHC committee approved the TDR in July. The HIP LHC program consisted in 1998 of three projects, Software and Physics project, CMS Tracker Project and Nuclear Matter project.

Software and Physics

Three major releases of CMSIM, the CMS simulation software package, were issued during 1998. An important application of CMSIM was preparation of the Tracker Technical Design Report, where detector performance simulation with CMSIM played an essential role (Fig.2). Using the new results from CMSIM, parametrizations of the Tracker's performance were accordingly upgraded. Important new calibration methods were also studied with CMSIM and significant progress was achieved in pattern recognition and reconstruction of charged particle tracks and interaction vertices, using neural network methods also.

Work on the GEANT4 detector simulation package, based on Object Oriented (OO) software techniques, was continued in worldwide, interdisciplinary collaboration. Particular topics that are the responsibility of the HIP group are the maintenance of the GEANT4 libraries in the CMS system, coding of the magnetic field of the CMS detector and development of the hadronic shower simulation toolkit for the LHC experiments. In the last of these, work has been devoted both to the development of an intra-nuclear cascade model based on the High Energy Transport Code and to its rewriting in C++ programming language. GEANT4 was also successfully applied to description of the HIP's Silicon Beam Telescope (SiBT). Analysis of data from the SiBT experiments was used as a testing environment for modern OO software. Unified Modelling Language (UML) was used for the OO analysis and design. New LHC++ environment tools, such as Rational Rose, Objectivity data bases, IRIS Explorer and CVS were successfully used in the software architecture design, engineering and implementation.

In physics simulation the discovery potential studies on the Standard Model and the Minimal Supersymmetric Standard Model Higgs bosons were upgraded through more realistic detector description. These studies confirmed earlier results on the power of the detector design to reach the main scientific goal of the LHC programme. Studies of decays of the Higgs boson into two tau-leptons were extended to include the final states with two isolated high energy hadrons, making it possible to extend the discovery range significantly. Furthermore, detailed studies on tagging the b-jets and tau-leptons through observation of their decay vertices, very important in discovering the supersymmetric Higgs bosons, were performed using the CMSIM simulation package.

CMS Tracker

A new design for the main components of the MSGC barrel support structure for the Tracker TDR was presented. The design is based on a new and production-friendly approach to constructing carbon fibre composite structures. It removes the need for complex and costly tools and reduces the throughput time of the manufacturing process, even enabling last minute layout changes if necessary.

The prototype built (Fig. 1) behaved according to expectations, which

Fig. 1. **The design and the manufacturing method of the MSGC support structure were verified by building first a smaller sector prototype and then a full-scale prototype of a two-layer disc supporting the two innermost layers of the final MSGC barrel. To measure the disc's static stiffness a water-cooled measuring frame equipped with capacitive probes was constructed.**

also proved the reliability of the simulation models. Reference measurements were made using photogrammetry, which will also be used in the survey of the final support structure and of the whole Tracker. The design of the carbon fibre frame supporting the detector modules was improved such that it is now based on the same manufacturing principle as the rest of the support structure, which should substantially lower the manufacturing costs of the final structures.

The precision with which the frames are mounted in the wheel, as well as the performance of their integrated cooling system, were verified experimentally. The HIP mechanics team also contributed to the development of the Tracker alignment and monitoring system by participating in the testing of the laser diodes to be used in the system. In addition to the actual R&D for the Tracker the mechanics group is engaged in development and implementation of the CERN Engineering Data Management System (EDMS) by being one of its most active pilot users.

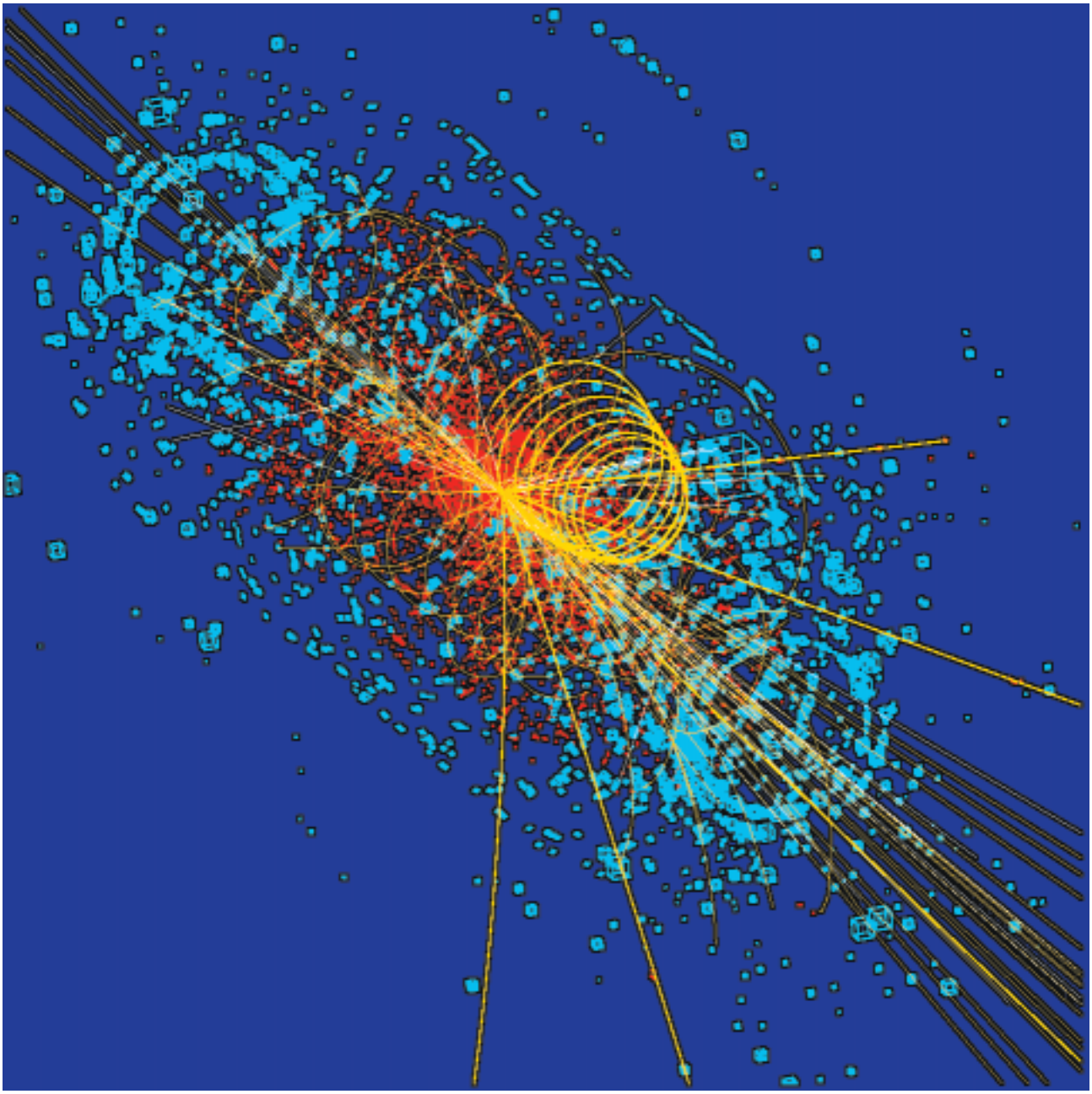
The upgrading of the SiBT for the CERN SPS H2 beam line was finalised successfully. The new version was completely rebuilt: the area of the detectors was increased, the readout electronics was upgraded and a new high performance data acquisition system was implemented. The beam telescope was successfully tested with pions and muons in the H2 beam line during the summer. The telescope now provides high precision tracking data for tests of the CMS detectors in H2 beam.

In the LHC environment detectors are exposed to very high radiation doses. In order to study the effects of the radiation damage on the silicon detectors a new project was initiated. The aim of the project is to study the possibilities for building a detector irradiation facility in the accelerator laboratory of the University of Jyväskylä (JYFL). A letter of intent was written jointly with the groups from CERN and from the Universities of Pisa and Oulu. The JYFL programme advisory committee approved this preliminary proposal in October. The facility could be used for the remaining R&D tests of the CMS silicon detectors and later for the quality control of the detector modules at the construction phase.

Work on the CMS trigger and data acquisition system has concentrated on the development of a test facility for fibre optic links. Because of the exceedingly high data production rates of the CMS detector system high-speed fibre optic links are needed in large numbers. A LINX PCI board was developed by the HIP group to evaluate various commercial link components that could be used in CMS, and to test different link protocols and data compression and formatting schemes at full speed. The board can also be used in radiation tolerance tests of link components, which play an important part in the development of reliable data readout systems for the LHC experiments. Towards the end of the year, a common project was started with the University of Warsaw to develop a combined data and trigger link for the RPC muon detector. A full prototype readout chain will be built next year, incorporating multiplexing and data compression.

Nuclear Matter

Nuclear matter physics was included in the research activities of HIP in 1998 with the aim of gaining a fundamental understanding of extreme states of this most dense form of matter. The main part of the Nuclear Matter project focuses on the design and building of the ALICE experiment for LHC in parallel with theoretical activity on very high energy heavy ion collisions, which may ultimately lead to discovery of a new form of matter, the quark-gluon plasma. This high energy research is accompanied by active participation in studies of low temperature exotic nuclear matter at the CERN ISOLDE facility.The main activity of the HIP ALICE group concentrates on the Inner Tracking system (ITS), based on silicon pixel detectors (SPD), silicon drift detectors (SDD) and silicon strip detectors (SSD). In 1998 the HIP ALICE group participated in beam tests of production grade SDD prototypes and developed software for the data analysis. Substantial progress was also achieved in R&D on a fast micro-channel plate (MCP) detector that will form the Forward Multiplicity Detector (FMD). The theory group is involved in the Hard Probe Collaboration which



is addressing the problems related to the experimental signals in the ALICE detector that originate from hard partonic interactions in the heavy ion collisions. In addition, the group has made extensive model calculations for the present CERN SPS heavy ion experimental programme. ISOLDE at CERN, is the leading research accelerator facility in the world, for using intense and exotic radioactive ion beams in nuclear and solid state physics. Finland became a full collaborator in the ISOLDE project in 1998. Three important experiments on structural features of exotic nuclei 34Al, 35Al and 133Sn, consisting of highly asymmetric neutron-proton matter, were conducted in 1998.

Fig. 2. Detector performance simulation with CMSIM.

Technology Programme

Ari-Pekka Hameri

Year 1998 marks a significant expansion in the use of the Tuovi Web Data Management system. The system is in production use in all major European high energy physics laboratories. At CERN, the LHC project experiments and the administrative division, at DESY, the Tesla and Hera projects and at the Max-Planck Institute, the new stellarator project are exploiting the system to manage the documents in their distributed engineering and design projects. In parallel, the programme has developed project management and communication visualisation tools. Integration of these subsystems with TuoviWDM will form the main challenge for the year 1999. An integrated system provides the means for proactive project management in a distributed operating environment. New applications for the system are being explored within the scope of distributed event data storage and handling, a major challenge once LHC starts to produce collision data. The support from all levels of CERN's management has been most beneficial for this development and is gratefully acknowledged by the programme.

Distributed Document Management

The days before October 1998 were filled with development and testing of the new version of TuoviWDM. This major release, with its novel functionality and technology, was a direct response to feedback from users at CERN, DESY and the Max-Plank Institute. These sites total some 2500-3000 registered users, not counting 'guest' users in collaborating institutes who outnumber registered users roughly by a factor of two. Thus, the current TuoviWDM user base totals some 7500 - 9000 users in the high energy physics community worldwide. Feature and technology highlights of the latest version of TuoviWDM include:

- document lifecycle management and version control in response to the needs of the engineering projects.

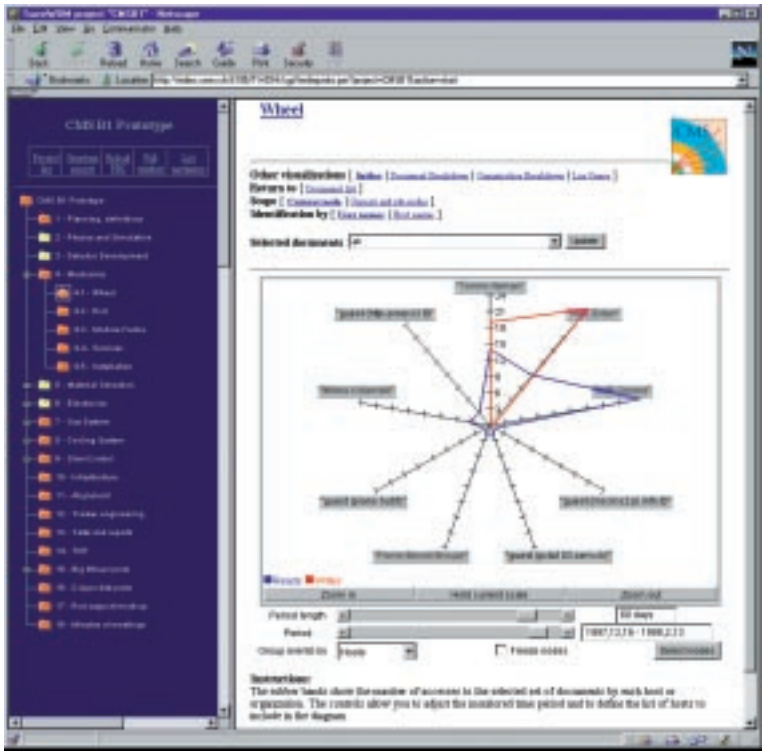


Fig. 1. Tracking communication in distributed collaboration.

• an interface with the CERN EDMS environment, which permits worldwide access to product data via TuoviWDM. Product data for the LHC, ATLAS, CMS and ALICE projects is stored at CERN in various systems: a commercial product data management system, the CERN drawing directory and library information systems. TuoviWDM unifies all these in one coherent WWW interface.

• an interface with CERN's financial and administrative divisions' applications environment that runs, notably, the Contracts Follow-up application, which integrates TuoviWDM as its document management solution.

• a completely revamped administrative tool to setup and manage TuoviWDM projects on the web. Users can define their user interface preferences with an easy-to-use web interface.

Project	Aim	Partners	Duration
MYKO (Tekes)	Document management in distributed projects	Valmet, Jaakko Pöyry, ABB, Nokia Telecommunications, UPM-Kymmene, HIP	1/97–4/99
Fit-Pro (Tekes)	Project management practices in one-of-a-kind industries	Kamewa, Larox, Nokia Telecommunications, Valmet, Wartsila NSD, TAI Research Centre, HIP	9/98–9/99
CoDisCo (Nordisk Industrifond)	Connecting Distributed Competencies: true networking in distributed operations	IGP (N), Hönnun og ráðgjöf (IS), SINTEF (N), Kockums Computers Systems (S), Logimatic (DK), HIP (FIN), Aker Finnyards (FIN), CERN (CH)	9/98–9/00

Industrial collaboration in technology programme.

Today the system is a viable entry-level alternative to commercial product data management solutions, which are slowly finding their way into large engineering projects in the HEP community. This notion is supported by DESY's decision to choose TuoviWDM as their solution as they commence and proceed in their product data development effort.

Project tools

A work package management system has been designed and implemented based on experience from the earlier prototype and pilots with the experiments at CERN. The tool is also being integrated with the TuoviWDM, enabling the user to control both work and document structures in the same system. In addition, a link with a scheduling programme has been established to batch transfer tasks and date structures for setting up a work package management system with TuoviWDM. The format used for the work packages is compatible with major spreadsheet applications. In 1999 closer work with the database developers at CERN and the AS division will continue. Applets for visualising networked communication have been implemented with TuoviWDM. These tools allow project administrators to examine project activities against time evolution and study how work is progressing in reality. This way the management is able to react proactively to imminent problems. A special schedule viewer has been completed which allows viewing of project timetables on-line by mapping the document process in the same schedule. The tool provides project managers with combined access to scheduling, work definitions and project documents.

Process and quality control

The level of industrial co-operation was increased significantly during 1998 when two new research projects were established to promote knowledge dissemination between project-oriented industry and the HEP community. The aim of these projects is to test the TuoviWDM tool jointly with industrial companies and to develop related project and document management practices. At the end of the year three joint industrial projects were in progress:

The MYKO project is a joint project with five Finnish companies, funded by the Technology Development Centre of Finland. The main goal of the project is to study document management practices in a multi-partner project and to develop models and practices for efficient communication between these partners.

The FIT-PRO project is a joint project with Helsinki University of Technology's TAI Research Centre and five Finnish companies, funded by the Technology Development Centre of Finland. The one-year project aims at developing project management practices, product management practices and the related information tools needed by a project-oriented company.

The CoDisCo (Connecting Distributed Competencies) project is being carried out in co-operation with Scandinavian research organisations, companies and CERN. The project is funded by Nordisk Industrifond. The project aims to exploit the latest networking technology to increase the productivity of geographically distributed operations and to reveal their hidden potential.

These projects have already proved that tools and practices originally developed for scientific research organisations are capable of serving industrial needs also. The level of information technology infrastructure has proved to be even better in research organisations than in industry. At the same time, practices developed in managing industrial projects have enormous potential for improving the efficiency of construction of large scientific instruments, such as the LHC at CERN.

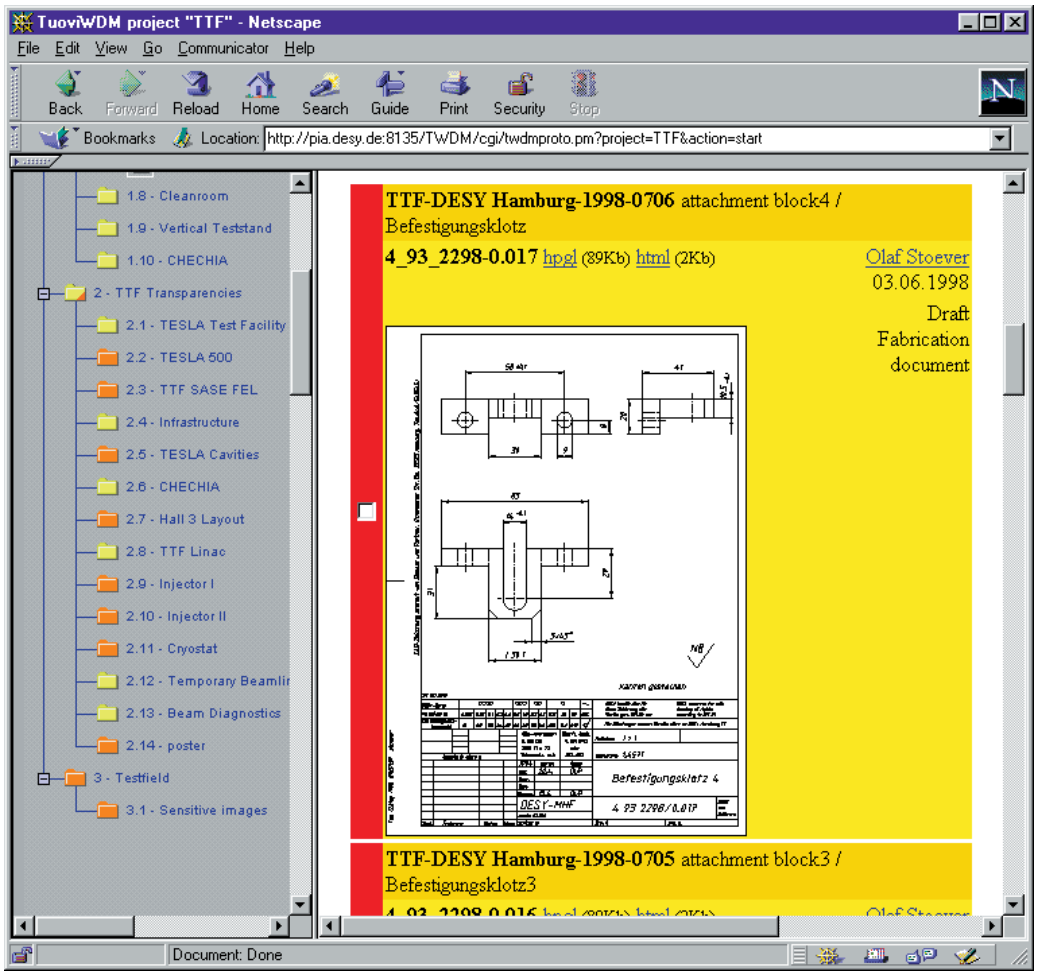
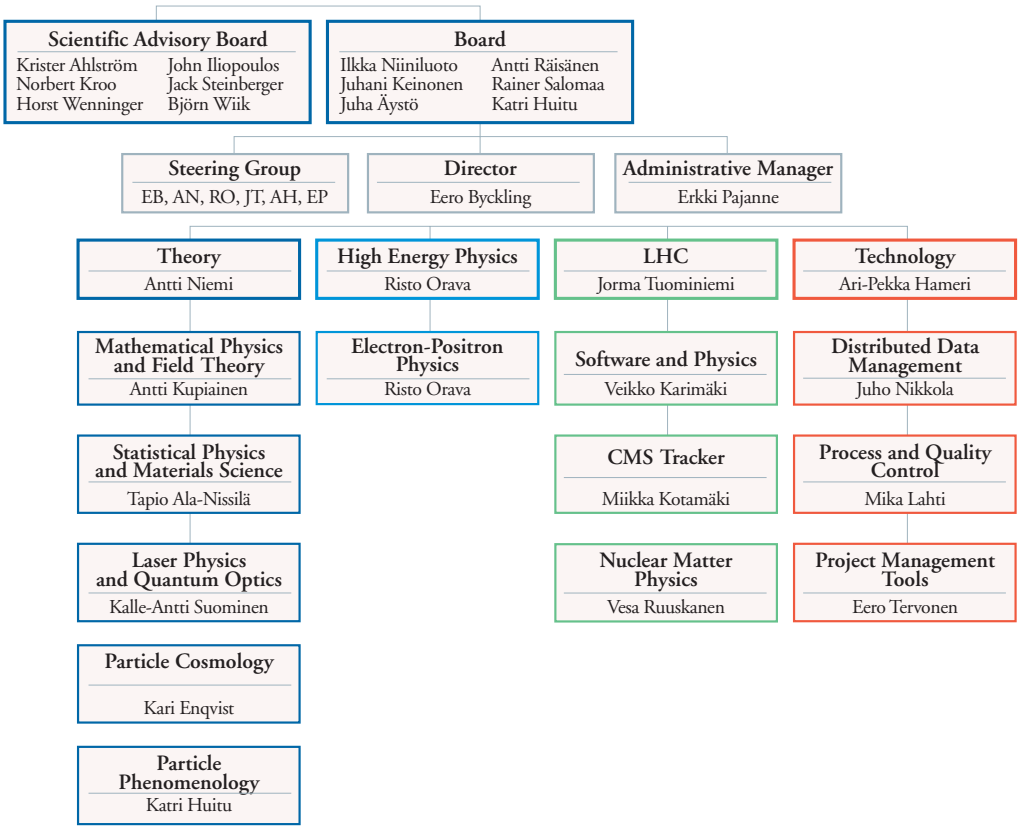


Fig. 2. Tuovi WDM in use at DESY.

Organization and Personnel

Organization



The Institute Board

Chairman	**Ilkka Niiniluoto,** Vice Rector (University of Helsinki)
Vice Chairman	**Antti Räisänen,** Vice Rector (Helsinki University of Technology)
Members:	**Juhani Keinonen,** Professor (University of Helsinki)
	Rainer Salomaa, Professor (Helsinki University of Technology)
	Juha Äystö, Professor (University of Jyväskylä, Appointed by the Ministry of Education)
	Katri Huitu, Docent (Chosen by personnel of HIP)

The Board: Keinonen, Räisänen, Huitu, Salomaa, Niiniluoto, Äystö.

The Scientific Advisory Board

Chairman:	**Horst Wenninger,** Research and Technical Director (CERN)
Members:	**Krister Ahlström,** President and CEO (A. Ahlström Corporation, Finland)
	John Iliopoulos, Professor (École Normale Supérieure, Paris, France)
	Norbert Kroo, Director (Institute for Solid State Physics, Hungarian Academy of Sciences)
	Jack Steinberger, Professor (CERN, Nobel Prize in Physics in 1988)
	Björn H. Wiik, Director General (DESY)

The Scientific Advisory Board: Steinberger, Wiik, Iliopoulos, Ahlström, Wenninger, Kroo.

Personnel

Theory Programme

A. Niemi, prof., programme director
A. M. Green, adj. senior scientist

Laser Physics Quantum Optics

K.-A. Suominen, docent, proj. leader
N. Lütkenhaus, senior scientist
N. Vitanov, senior scientist
J. Calsamiglia, grad. student
M. Havukainen, grad. student
J. Martikainen, grad. student
J. Piilo, grad. student

Mathematical Physics and Field Theory

A. Kupiainen, prof., proj. leader
L. Faddeev, academician, senior scientist
M. Gunaydin, senior scientist
N. Gawedzki, senior scientist
A. Izergin, senior scientist
Y. Stroganov, senior scientist
A. Volkov, senior scientist
C. Montonen, senior scientist
W. Chen, scientist
A. Rajantie, scientist
S. Virtanen, grad. student
J. Lukkarinen, grad. student
P. Pennanen, grad. student

Particle Cosmology

K. Enqvist, docent, proj. leader
H. Kurki-Suonio, senior scientist
T. Neuhaus, senior scientist
E. Sihvola, grad. student

Particle Phenomenology

K. Huitu, docent, proj. leader
M. Chaichian, prof., adj. senior scientist
T. Kobayashi, adj. senior scientist
D.-X. Zhang, senior scientist
K. Puolamäki, grad. student
J. Laitinen, student
P. Rahkila, student
T. Rüppel, student

Statistical Physics and Materials Science

T. Ala-Nissilä, prof., proj. leader
J.-M. Kosterlitz, prof.
K. Laasonen, prof., adj. senior scientist
S.-C. Ying, prof.
M. Alatalo, senior scientist
I. Koponen, senior scientist
M. Dubé, scientist
M. Rost, scientist
P. Salo, scientist
I. Vattulainen, scientist
J. Asikainen, grad. student
S. Badescu, grad. student
J. Heinonen, grad. student
T. Hjelt, grad. student
M. Kuittu, grad. student
E. Kuusela, grad. student
J. Lahtinen, grad. student
R. Linna, grad. student
S. Majaniemi, grad. student
M. Rusanen, grad. student
A. Sillanpää, grad. student
E. Falck, student
J. Kallunki, student
P. Nikunen, student
J. Sillanpää, student
J. Vinnurva, student

High Energy Physics Programme

R. Orava, docent, programme director (at CERN)

Electron-Positron Physics

P. Eerola, adj. senior scientist
H. Saarikko, adj. senior scientist
C. Rönnqvist, senior scientist
M. Sarakinos, senior scientist (at CERN)
V. Nomokonov, scientist (at CERN)
K. Österberg, scientist
R. Ostonen, scientist (at CERN)
M. Battaglia, grad. student (at CERN)
K. Honkavaara, grad. student (at Orsay)
A. Kiiskinen, grad. student (at CERN)
S. Czellar, lab. engineer (at CERN)
J. Heino, researcher
J. Ojala, researcher
K. Kurvinen, researcher
A. Lumme, researcher
M. Luoma, technician
R. Lauhakangas, lab. engineer
A. Numminen, technician

LHC Programme

J. Tuominiemi, docent, programme director

Software and Physics

V. Karimäki, docent, proj. leader (at CERN)
Ritva Kinnunen, senior scientist (at CERN)
J. Klem, scientist (at CERN)
A. Heikkinen, grad. student (at CERN)
H. Saarikoski, grad. student (at CERN)
M. Haapakorpi, student (at CERN)
J. V. Heinonen, summer trainee (at CERN)
T. Lampén, summer trainee (at CERN)
T. Parviainen, summer trainee (at CERN)
T. Rantala, summer trainee

CMS Tracker

M. Kotamäki, proj. leader (at CERN)
E. Pietarinen, senior scientist
A. Honkanen, scientist (at CERN)
K. Skog, grad. student (at CERN)
N. Eiden, grad. student (at CERN)
S. Ruotsalainen, grad. student (at CERN)
K. Suurpää, student
K. Banzuzi, student
K. Tammi, student (at CERN)
J. Alanen, summer trainee (at CERN)
E. Kallio, summer trainee (at CERN)
T. Mäenpää, summer trainee (at CERN)
K. Ollikainen, summer trainee (at CERN)
T. Vanhala, summer trainee (at CERN)

Nuclear Matter

V. Ruuskanen, prof., proj. leader
J. Äystö, adj. senior scientist
A. Jokinen, adj. senior scientist
W. Trzaska, adj. senior scientist

Technology Programme

A-P. Hameri, docent, programme director (at CERN)

Distributed Data Management

J. Nikkola, proj. leader (at CERN)
T. Kunnas, scientist (at CERN)
J. Leppänen, scientist (at CERN)
M. Niinimäki, scientist (at CERN)
R. Puittinen, scientist (at CERN)
H. Saloranta-Rönkä, document manager (at CERN)
M. Silander, scientist
M. Asplund, student (at CERN)
J. Hahkala, student
J. Koivisto, student
K. Lönnqvist, student (at CERN)
M. Syrjälahti, student (at CERN)
M. Puittinen, summer trainee (at CERN)
M. Ursin, summer trainee (at CERN)

Project Tools

E. Tervonen, proj. leader (at CERN)
A. Ali, senior scientist (at CERN)
M. Heikkurinen, scientist (at CERN)
V. Lavonius, scientist
M. Tuisku, scientist (at CERN)
J. Hurula, student
M. Andersson, summer trainee (at CERN)
A. Saarela, summer trainee

Process and Quality Control

M. Lahti, proj. leader (at CERN)
N. Raudasoja, scientist (at CERN)
J. Rehn, scientist
T. Anttonen, student
J. Leppänen, student
J. Moklin, summer trainee (at CERN)
P. Tran Minh, summer trainee (at CERN)

Administration and Support

E. Byckling, prof., director
A. Niemi, prof., advisor to the director
E. Pajanne, administrative manager
H. Luutonen, financial manager
K. Kraappa, secretary
M. Flygar, secretary (at CERN)
T. Jokinen, secretary
C. Sivori, secretary (at CERN)
O. Vuola, tech. coordinator (at CERN)
R. Rinta-Filppula, scientist
A. Numminen, technician
T. Vehviläinen, lab. engineer
M. Myllymäki, lab. engineer
V. Luomala, summer trainee (at CERN)
T. Vilkamo, summer trainee (at CERN)

Seminars

Seminars held in Helsinki

January 12th M. Battaglia (HIP)
Physics with identified particles in DELPHI

January 13th L. Faddeev (HIP/Steklov Inst., St. Petersburg, Russia)
Separation of selfaction and scattering effects in Quantum Field Theory

January 20th T. Prokopec (Nordita)
Reheating in Chaotic Inflationary Universes

January 27th E. Turunen (Lappeenranta University of Technology)
Introduction to Fuzzy Set Theory - what is it and what is it not

January 29th A. Izergin (St.Petersburg, Russia)
Some new results on correlation functions of solvable models in one space dimensions

February 3rd S. F. Huelga (Universidad de Oviedo, Spain)
Improved frequency standards using quantum entanglement

February 5th M. B. Plenio (Imperial College London)
Entanglement in Quantum Information Theory

February 10th J. Poutanen (Stockholm Observatory)
The Mystery of Gamma Ray Bursts

February 17th I. Koponen (HIP)
Cluster growth in submonolayer epitaxy

February 20th G. Eigen (University of Bergen, Norway)
Future B physics experiments

February 24th J. Louko (Albert Einstein Institute, Potsdam)
Why do Euclidean methods work in black-hole thermodynamics?

March 2nd Joint HIP and Finnish Mathematical Society Seminar K. Gawedzki (IHES, France)
Integrable systems and modular geometry

March 3rd S.-C. Ying (Brown University, USA/ HIP)
Crossover from classical hopping to quantum tunnelling in Surface Diffusion of H atoms

March 10th N. Lütkenhaus (HIP)
Theory for practical quantum cryptography

March 31st K. Österberg (HIP/Dept. Physics)
Recent results from LEP

April 21st M. Kosterlitz (Brown, USA)
The Kosterlitz-Thouless transition - 25 years on

April 28th J. M. Richard (Grenoble, France)
Borromean Binding

May 5th P. J. Pulkkinen (TFO)
Using sunspot data for studying solar activity and velocity structures

May 12th B. W. Shore (Fachbereich Physik, Uni. Kaiserslautern, Germany/ Lawrence Livermore Nat.Lab.,USA)
Counterintuitive Techniques for Pulsed Laser Population Transfer

May 19th M. Alatalo (HIP)
Metallic alloys from first principles

May 26th P. Pennanen (HIP)
Multi-quark systems in lattice QCD

June 2nd J. Lukkarinen (HIP)
Computations in the quantum microcanonical ensemble

June 4th S. Hands (University of Swansea, Wales)
Fixed Point Behaviour in the Three Dimensional Thirring Model

June 16th Z. Chvoj (Czech Republic)
Adatoms diffusion on surface with two different energy barriers

June 17th Cai-Dian Lü (Hamburg, Germany)
Charmless Non-Leptonic Two-Body B Decays in the Factorization Approach

July 3rd S. Brodsky (SLAC, USA)
Commensurate Scale Relations and The Abelian Correspondence Principle

July 7th M. Gunaydin (Penn. State University, USA)
Conformal field theory / Anti-de Sitter supergravity dualities and M-theory

August 11th M. Laine (CERN)
Q-ball thermodynamics

August 18th M. Noga (Bratislava, Slovakia)
Self-organized structures in the electron plasma

August 25th T. Neuhaus (HIP)
A Field Theoretic View on the Cosmic String

September 1st N. Romanenko (Dept. Physics, Helsinki / Gatchina, Russia)
On the phenomenology of a Z' coupling only to third-family fermions

September 8th J. Kirkby (CERN)
Are cosmic rays a cause of global warming?

September 11th K. Bergmann (Kaiserslautern, Germany)
Coherently Driven Dynamics in Atoms: Suppression of Ionization and Novel Atom Optics Elements

September 14th A. Yokosawa (Argonne National Lab., USA)
RHIC Polarized Collider and Spin Physics

September 15th Reports on Summer Conferences
J. Peltoniemi (Dept. Physics) - Neutrino 98, Takayama, Japan
K. Puolamäki (HIP) - ICHEP, Vancouver, Canada

September 17th M. Nalimov (St.Petersburg State University, Russia)
Convergent expansion for critical indices in the $\phi^4(n)$ model for large ϵ

September 22nd H. Rubinstein (Uppsala, Sweden)
The physics of the Universe when it was a teenager (recombination time)

September 29th D. Bruß, (Institute for Scientific Interchange, Torino, Italy)
How far can we go with quantum cloning?

October 6th S. Majaniemi (HIP)
Wetting in a random medium

October 13th P. Keränen (Dept. Physics)
AGNs and uhecrons

October 20th M. Roos (Dept. Physics)
Neutrino Oscillations and Related Issues

October 27th T. Kobayashi (Dept. Physics / HIP)
Breaking the supersymmetric QCD

November 3rd E. Oja (Helsinki University of Technology)
Neural computation - on the road to learning and intelligent systems

November 10th J. Hietarinta (University of Turku)
Faddeev-Hopf knots: Dynamics of the unknots

November 17th C. Cronström (Dept. Physics)
Canonical structure and quantisation of Yang-Mills theory

November 24th S. Wycech (HIP/ Warsaw, Poland)
The search for nuclear states of etas, kaons, antiprotons ...

December 3rd M. Battaglia (HIP)
In Search for the Higgs Boson: from DELPHI at LEP to the e^+e^- linear collider

December 8th Y. Strogonoff (Academy of Finland/ Institute for High Energy Physics, Protvino, Russia)
Integrable spin models and their relation to other fields of mathematical physics

December 15th L. Faddeev (Academy of Finland/ Steklov Inst., St. Petersburg, Russia)
Why I like Quantum Field Theory

December 22nd K. Maeda (Kyoto University, Japan)
Stability of Internal Space and Inflation

December 29th M. Laine (CERN)
High temperature spontaneous CP-violation in the MSSM?

Visitors

Theory Programme

Laser Physics and Quantum Optics

S. Huelga (Spain)	30.1. - 6.2.
M. Plenio (UK)	30.1. - 6.2.
C. Ross (UK)	7. - 9.2.
L. Prior (UK)	7. - 9.2.
B. Shore (Germany)	9. - 12.5.
P. Törmä (Austria)	5. - 9.6.
	11. - 28.9.
	14. - 18.12.
K. Bergmann (Germany)	10. - 13.9.
D. Bruß (Italy)	23.9. - 3.10.

Mathematical Physics

K. Gawedzki (France)	25.2. - 6.3.
J. Bricmont (USA)	1. - 3.4.
O. Tirkkonen (Denmark)	26.3. - 1.4.
M. Günaydin (USA)	7. - 15.7.
J. Kalkkinen (Sweden, Italy)	10. - 25.6.
S. Hands (UK)	3. - 7.6.
E. Keski-Vakkuri (USA, Sweden)	several visits
P. Pasanen (USA)	1. - 31.8.
Y. Stroganov (Russia)	1.10. - 31.12.
S. Wycech (Poland)	1.11. - 30.11.

Particle Cosmology

R. Mandolesi (Italy)	May
T. Prokopec (Denmark)	February
P. Elmfors (Sweden)	February
K. Kainulainen (Denmark)	December
K. Rummukainen (Denmark)	December
J. Louko (Germany)	August

Particle Phenomenology

M. Ioffe (Russia)	25.1. - 14.4.
C.-D. Lü (Germany)	12. - 18.6.
M. Günaydin (USA)	6. - 12.7.
H. Perez Rojas (Cuba)	3.8. - 2.9.
I. Roditi (Brazil)	4. - 12.8.
C. Jarlskog (CERN)	1. - 3.9.
A. Demichev (Russia)	3. - 15.3.,
	4.8. - 2.9.,
	1.10. - 30.12.
H. Rubinstein (Sweden)	19. - 22.9.
P. Presnajder (Slovakia)	1.10. - 15.12.
V. Fainberg (Russia)	21.11. - 20.12.
Y. Vernov (Russia)	15. - 29.12.
K. Maeda (Japan)	20. - 30.12.

Statistical Physics and Materials Science

S.C. Ying (USA)	23.1. - 14.8.
N. Provatas (USA)	1. - 11.3.
M. Kosterlitz (USA)	11.4. - 30.6.
M. Grant (Canada)	2. - 9.6.
S. Badescu (USA)	1.6. - 15.8.
Z. Chvoj (Chech Republic)	14. - 17.6.
N. Provatas (USA)	14. - 18.06.
L. Chen (USA)	14. - 30.6.
M. Haataja (Canada)	3. - 4.8.
M. Noga (Slovakia)	1. - 31.8.
M. Weinert (USA)	15. - 22.10.
C. Roland (USA)	15. - 22.10.

LHC Programme

J. Krolikówski (Poland)	17. - 20.12.
G. Wrochna (CERN)	17. - 20.12.
R. Romaniuk (Poland)	17. - 20.12.

Technology Programme

E. Eloranta (Finland)	15.5. - 30.6.

Conference Participation, Talks and Visits by Personnel

Theory Programme

Laser Physics and Quantum Optics

Workshop on Algorithms in Quantum Information Processing,
12-16 January, Aarhus, Denmark (N. Lütkenhaus)

Ørsted Laboratory, University of Copenhagen,
21-28 January, Copenhagen, Denmark
(K.-A. Suominen)

Nordita Workshop on Bose-Einstein condensation,
24 January, Copenhagen, Denmark (K.-A. Suominen)

Department of Physics, University of Jyväskylä
12 March, Jyväskylä, Finland (K.-A. Suominen)

Frühjahrstagung der Deutschen Physikalischen Gesellschaft,
16-19 March, Konstanz, Germany
(talk by N. Lütkenhaus)

XXXII Annual Meeting of the Finnish Physical Society,
19-21 March, Tampere, Finland (M. Havukainen, J.-P. Martikainen, J. Piilo, K.-A. Suominen)

Institut für Theoretische Physik und Synergetik, Universität Stuttgart,
20 March, Stuttgart, Germany (N. Lütkenhaus)

Group of Applied Physics, University of Geneva,
23-25 March, Geneva, Switzerland (N. Lütkenhaus)

Department of Physics, University of Joensuu,
24 March, Joensuu, Finland (K.-A. Suominen)

Institut für Theoretische Physik, University of Innsbruck,
25-27 March, Innsbruck, Austria (N. Lütkenhaus)

Royal Institute of Technology,
26-27 March, Stockholm, Sweden (K.-A. Suominen)

ITP Conference on Bose-Einstein Condensation,
30 March - 3 April, Santa Barbara, California, USA
(J.-P. Martikainen)

Escolar '98,
1-5 April, Rust, Burgenland, Austria (J. Piilo, invited lecture by K.-A. Suominen)

International Conference and Research Center for Computer Science,
10-15 May, Schloss Dagstuhl, Wadern, Germany
(N. Lütkenhaus)

National Institute for Standards and Technology,
16-26 May, Gaithersburg, Maryland, USA
(K.-A. Suominen)

Department of Quantum Physics, University of Ulm,
19-21 May, Ulm, Germany (N. Lütkenhaus)

University of Kaiserslautern,
25 May - 6 June, Kaiserslautern Germany
(talk by N. Vitanov)

DAMOP 1998,
27-30 May, Santa Fe, New Mexico, USA
(K.-A. Suominen)

Workshop on Quantum Control of Atomic Motion,
1-2 June, Albuquerque, New Mexico, USA
(K.-A. Suominen)

Joensuu Summer School on Optics,
8-12 June, Joensuu, Finland (J.-P. Martikainen)

GNSM Workshop on Quantum Computation and Mesoscopic Physics,
25-27 June, Pisa, Italy (invited talk by K.-A. Suominen)

Torino Workshop on Quantum Information,
28 June - 4 July, Turin, Italy (N. Lütkenhaus, J. Calsamiglia)

Quantum Information Workshop,
5-25 July, Benasque, Spain (N. Lütkenhaus, K.-A. Suominen)

Enrico Fermi Summer School on Bose-Einstein Condensation,
6-17 July, Varenna, Italy (J.-P. Martikainen)

ICAP 16,
3-7 August, Windsor, Ontario, Canada
(K.-A. Suominen)

The 8th Jyväskylä International Summer School,
10-21 August, Jyväskylä, Finland (J. Calsamiglia, J. Piilo)

Ørsted Laboratory, University of Copenhagen,
17-28 August, Copenhagen, Denmark
(K.-A. Suominen)

4th International Conference on Quantum Communication, Measurement and Computing,
22-27 August, Evanston, Illinois, USA
(N. Lütkenhaus)

The International Workshop on the Physics of Quantum Information,
24-26 September, Helsinki, Finland (J. Calsamiglia, N. Lütkenhaus, K.-A. Suominen, N. V. Vitanov)

Quantum Computing European Pathfinder Project Conference,
26-28 September, Helsinki, Finland (J. Calsamiglia, N. Lütkenhaus, K.-A. Suominen)

European Research Conference on Quantum Optics,
29 September - 4 October, Pascoli, Italy
(M. Havukainen, J. Piilo)

Innsbruck BEC Meeting,
19-20 October, Innsbruck, Austria (K.-A. Suominen)

Annual Meeting of the Bulgarian Physical Society,
24-26 October, Sofia, Bulgaria (talk by N. Vitanov)

Institute of Theoretical Physics, University of Innsbruck,
26 October - 1 November, Innsbruck, Austria
(K.-A. Suominen)

University of Bratislava,
29 November - 11 December, Bratislava, Slovakia (M. Havukainen)

Ørsted Laboratory, University of Copenhagen,
30 November - 11 December, Copenhagen, Denmark (K.-A. Suominen)

Centre for Quantum Computing, University of Oxford,
1-14 December, Oxford, UK (N. Lütkenhaus)

Master Class on Laser Cooling, Cold and Ultracold Collisions, and BEC,
3-9 December, Copenhagen, Denmark (J. Martikainen, J. Piilo, K.-A. Suominen)

Department of Physics, University of Hanover,
9-10 December, Hannover, Germany (K.-A. Suominen)

Planning Meeting for a Nordic Network in Quantum Information,
14-15 December, Stockholm, Sweden (J. Calsamiglia, talk by N. Lütkenhaus, K.-A. Suominen)

KTH-Electrum,
16 December, Stockholm, Sweden (J. Calsamiglia, N. Lütkenhaus)

Mathematical Physics and Field Theory

8th Nordic Network Meting on Supersymmetric Field and String Theories,
9 - 12 March, Stockholm, Sweden (T. Kärki, J. Lukkarinen, C. Montonen, A. Rajantie, S. Virtanen)

XXXII Annual Meeting of the Finnish Physical Society,
19-21 March, Tampere, Finland (C. Montonen)

Kyoto RIMS,
April, Kyoto, Japan (L. Faddeev)

Ascona Meeting on Turbulence,
April, Bourgogne, France (A. Kupiainen)

École Normale Supérieure,
14-16 May, Paris, France (C. Montonen)

IAS,
May, Princeton, USA (A. Kupiainen)

Gribov Memorial,
5-9 June, Bonn, Germany (invited talk by L. Faddeev)

Les Houches School on Field Theory,
15-23 June, (invited talk by L. Faddeev)

Institut des Hautes Études Scientifiques,
June, Bures-sur-Yvette, France (A. Kupiainen)

Ascona Meeting on Constructive field theory,
July, Bourgogne, France (A. Kupiainen)

Nordic Research Course: Duality in String and Field Theory,
4-14 August, Nordita, Copenhagen, Denmark (J. Lukkarinen, O. Pasanen)

9th Nordic Network Meeting on Supersymmetric Field and String Theories,
17-19 August, Gothenburg, Sweden (C. Montonen)

ICM-98,
17-23 August, Berlin, Germany (invited talk by L. Faddeev)

22nd Johns Hopkins Workshop on Current Problems in Particle Theory,
20-22 August, Gothenburg, Sweden (C. Montonen)

Feynman Integral Conference,
25-30 August, Florence, Italy (invited talk by L. Faddeev)

Erice Summer School,
31 August - 9 September, Italy (L. Faddeev, invited talk)

Program on Anomalies ESI,
October, Vienna, Austria (L. Faddeev)

Rutgers, Harvard, NYU, Brown, Northwestern,
November, USA (A. Kupiainen)

Preparatory School on String Theory, ICIMAF,
1-8 November, La Habana, Cuba (C. Montonen)

ICTP Introductory School on String Theory,
9-19 November, La Habana, Cuba (C. Montonen)

Particle Cosmology

Novel Monte Carlo Algorithms and Their Applications,
12-14 January, LANL, Los Alamos, USA (talk by T. Neuhaus)

Astroparticle Research Seminar,
23 January, Helsinki, Finland (talk by H. Kurki-Suonio)

XXXII Annual Meeting of the Finnish Physical Society,
19-21 March, Tampere, Finland (H. Kurki-Suonio, E. Sihvola)

PASCOS-98,
20-29 March, Boston, USA (invited talk by K. Enqvist)

Hot Non-Perturbative Particle Physics Network Meeting
24-25 April, Nordita, Copenhagen, Denmark (E. Sihvola, invited talk by K. Enqvist, talk by H. Kurki-Suonio)

Planck Miniworkshop,
25 May, University of Helsinki, Helsinki, Finland (invited talk by K. Enqvist, talk by H. Kurki-Suonio)

Cosmology and Particle Physics (CAPP-98) Workshop,
8-12 June, CERN, Geneva, Switzerland (E. Sihvola, invited talk by K. Enqvist, talk by H. Kurki-Suonio)

Workshop on The Cosmic Microwave Background & The Planck Mission,
22-26 June, Santander, Spain
(H. Kurki-Suonio, E. Sihvola)

SUSY98,
11-17 July, Oxford, UK (talk by K. Enqvist)

DARK98,
20-24 July, Heidelberg, Germany
(invited talk by K. Enqvist)

Lecture at Summer School on Particle Physics,
1 September, Kiljavanranta, Finland
(lecture by H. Kurki-Suonio)

VII Finnish COSPAR Meeting,
14-15 September, Kiljavanranta, Finland
(H. Kurki-Suonio)

LFI Consortium Meeting,
2-3 October, Rome, Italy (K. Enqvist)

Strong and Electroweak Matter (SEWM-98) workshop,
1-5 December, Copenhagen, Denmark

Bielefeld University,
November, Bielefed, Germany
(colloquium talk by T. Neuhaus)

Strong and Electroweak Matter Meeting,
1-5 December, Copenhagen, Denmark
(H. Kurki-Suonio, invited talk by K. Enqvist)

Particle Phenomenology

University of Cape Town,
1-10 January, Cape Town, South Africa
(lectures and talk by M. Chaichian)

Fysikum,
2-8 February, Stockholm, Sweden
(talk by K. Puolamäki)

ACCU Meeting,
9-11 March, CERN, Geneva, Switzerland (K. Huitu)

Nordic Susy Meeting,
9-11 March, Stockholm, Sweden
(talk by T. Kobayashi)

XXXII Annual Meeting of the Finnish Physical Society,
19-21 March, Tampere, Finland
(K. Huitu, talk by Puolamäki)

Academy of Sciences,
27 March-19 April, Havanna, Cuba
(lectures and talk by M. Chaichian)

Physics and Detectors for a Linear Collider, 2nd ECFA/DESY study, 1st Meeting,
5-7 April, Orsay, France (K. Huitu)

International Symposium on Lepton and Baryon Number Violation,
20-25 April, Trento, Italy (talk by K. Huitu)

ACCU Meeting,
8-11 June, CERN, Geneva, Switzerland (K. Huitu)

New York, Los Angeles and Santa Cruz Universities,
23 June -27 July, USA (M. Chaichian)

SUSY '98,
11-17 July, Oxford, England (talk by T. Kobayashi)

Concordia University,
13-22 July, Montreal, Canada (K. Puolamäki)

ICHEP '98 Conference,
23-28 July, Vancouver, Canada (K. Puolamäki)

Fysikum,
15 August, Stockholm, Sweden (K. Puolamäki)

Zuoz Summer School "Hidden Symmetries and Higgs Phenomena",
16-22 August, Zuoz, Switzerland
(J. Laitinen, K. Puolamäki)

CERN,
24-28 August, Geneve, Switzerland (K. Puolamäki)

International School of Subnuclear Physics,
29 August-7 September, Erice, Italy
(talk by K. Puolamäki)

School on Particle Physics,
31 August - 4 September, Kiljava, Finland
(lectures by K. Huitu)

Praha, Bratislava and Vienna Universities,
2-14 September (M. Chaichian)

Corfu Summer Institute,
6-26 September, Corfu, Greece
(talk by T. Kobayashi)

ACCU Meeting,
15-18 September, CERN, Geneva, Switzerland
(K. Huitu)

Academy of Sciences Bucharest and Iasi University,
18-26 October, Romania (lectures by M. Chaichian)

Physics and Detectors for a Linear Collider, 2nd ECFA/DESY Study, 3rd Meeting,
8-10 November, Frascati, Italy (talk by K. Huitu)

Statistical Physics and Materials Science

Universite de Sherbrooke,
9-11 January, Sherbrooke, Canada (talk by M. Dubé)

Universität Essen,
15 January, Essen, Germany(talk by M. Rost)

COSA workshop,
30-31 January, Lammi, Finland (T. Ala-Nissilä, M. Kuittu, talk by M. Rost)

Graduate Course on the Physics of Random Systems,
9-27 February, 13-17 April, and 14-20 June, Oslo, Norway (J. Asikainen, M. Kuittu)

Department of Physics, Washington State University,
11-14 March, Seattle, USA (T. Ala-Nissilä)

The American Physical Society March Meeting,
16-20 March, Los Angeles, California, USA
(T. Ala-Nissilä, talk by M. Dubé, T. Hjelt)

XXXII Annual Meeting of the Finnish Physical Society,
19-21 March, Tampere, Finland (talk by M. Alatalo, J. Asikainen, M. Kuittu, E. Kuusela, R. Linna, talk by S. Majaniemi, M. Rusanen)

Oakland University,
21-24 March, Rochester, USA (talk by M. Dubé)

McGill University,
24-27 March, Montreal, Canada (talk by M. Dubé)

Institute of Physics of the Czech Academy of Sciences,
2-7 April, Prague, Czech Republic (T. Ala-Nissilä)

Institut Laue-Langevin,
2-30 April, Grenoble, France (talk by M. Dubé)

Workshop on Problems of Surface Diffusion,
4-7 April, Prague, Czech Republic (T. Ala-Nissilä)

Institute of Physics of the Chech Academy of Sciences,
14-16 May, Prague, Czech Republic
(talk by M. Rost)

Quantum Fluids and Solids Symposium,
7-12 June, Amherst, USA (M. Dubé)

12th Nordic Symposium on Computer Simulation,
10-14 June, Jyväskylä, Finland (T. Ala-Nissilä, J. Asikainen, T. Hjelt, J. Kallunki, M. Kuittu, E. Kuusela, R. Linna, talk by S. Majaniemi, M. Rost, M. Rusanen)

University of Genova,
15-17 June, Genova, Italy (J. Heinonen, I. Koponen)

Applications of Field Theory in Statistical Physics,
15-18 July, Bonn, Germany (M. Rost)

XXth International Conference on Statistical Physics,
20-25 July, Paris, France (talk by M. Dubé, J. Heinonen, S. Majaniemi, I. Vattulainen)

8th Jyväskylä International Summer School,
3-27 August, Jyväskylä, Finland (T. Ala-Nissilä, J. Kallunki, M. Rusanen)

Workshop of Classical and Quantum Aspects of Disorder,
8-9 August, Jyväskylä, Finland (talk by M. Dubé, talk by S. Majaniemi, M. Kuittu)

International Summer School in Nanophysics,
11-20 August, Espoo, Finland
(J. Heinonen, R. Linna)

XI International Conference on Ion Beam Modification of Materials,
31 August - 4 September, Amsterdam, Netherlands
(M. Rusanen)

COSA workshop,
11-12 September, Orivesi, Finland (T. Ala-Nissilä, talk by M. Dubé, M. Kuittu, M. Rost)

Research School on Computational Methods in Condensed Matter Physics,
12-15 October, Sjökulla, Finland (T. Ala-Nissilä, M. Alatalo, J. Kallunki, J. Lahtinen, P. Salo)

Institute of Computer Applications, University of Stuttgart,
19-28 October, Stuttgart, Germany (E. Kuusela)

Statistical Mechanics Network Meeting on Life, Order and Disorder,
19-21 November, Copenhagen, Denmark
(talk by M. Dubé, talk by S. Majaniemi, M. Rost)

Department of Physics, Brown University,
24-29 November, Providence, R.I., USA
(T. Ala-Nissilä, T. Hjelt, J. Lahtinen)

MRS Fall Meeting,
30 November - 4 December, Boston, Mass., USA
(T. Hjelt, J. Lahtinen, two talks by T. Ala-Nissilä)

MECA workshop,
11 December, Oulu, Finland
(T. Ala-Nissilä, M. Alatalo, P. Salo)

Universität Würrburg,
18 December, Würrburg, Germany (talk by M. Rost)

High Energy Physics Programme

University of Uppsala,
8-14 January, Uppsala, Sweden
(seminar talk by M. Battagllia)

Physics Review of the LEP-DELPHI Collaboration,
2-6 February, CERN, Geneva, Switzerland
(plenary talk by R. Orava)

DIS98 Workshop,
4-8 April, Brussels, Belgium
(invited talk by R. Orava)

10th Conference on Physics at LEP NALep-98,
14-17 April, Naples, Italy
(invited talk by M. Battaglia)

Conference on Structure of Mesons, Baryons and Nuclei Meson-98,
May, Cracow, Poland (talk by V. Nomokonov)

HERA/DESY Meeting,
13 June, Hamburg, Germany
(invited talk by R. Orava)

ECFA-DESY Linear Collider Workshop,
28-30 June, Lund, Sweden (plenary talk by R. Orava)

SLAC Particle Physics Seminar at the Stanford Linear Accelerator Center, Stanford University,
13-31 July, California, USA (M. Battaglia)

XXIX International Conference on High Energy Physics ICHEP-98, University of British Columbia,
13-31 July, Vancouver, Canada (talk by M. Battaglia)

Seminar by the Rectors Conference of Finnish Polytechnic Institutions (ARENE),
13 September, Helsinki, Finland (talk by R. Orava)

5th Biennial Conference on Low Energy Antiproton Physics LEAP-98,
20-25 September, Cagliari, Italy
(talk by V. Nomokonov)

Workshop on Physics and Detectors for Future e^+e^- Linear Colliders,
25 September - 3 October, Keystone, Colorado, USA
(M. Battaglia, two invited talks by R. Orava)

LNS Journal Club Seminar at Cornell University,
25 September- 3 October, New York, USA
(M. Battaglia)

7th International Workshop on Vertex Detectors - Vertex 98,
28 September - 4 October, Santorini, Greece
(invited talk by K. Österberg)

DESY-ECFA Workshop,
5-6 October, DESY, Germany
(invited talk by R. Orava)

2nd International ECFA/DESY Workshop on Physics and Detectors for a Linear Electron-Positron Collider,
7-10 November, Frascati, Italy (plenary talk by M. Battaglia, talk by A. Kiiskinen, by V. Nomokonov and by K. Österberg)

3rd International Workshop on Ring Imaging Cherenkov Detectors RICH-98,
14-21 November, Ein Gedi, Israel (invited talk by M. Battaglia, talk by A. Kiiskinen)

LHC Programme

Software and Physics

LHC Software Workshop,
March, Barcelona, Spain (J. Klem)

XXXII Annual Meeting of the Finnish Physical Society,
19-21 March,Tampere, Finland (A.Heikkinen, V. Karimäki, H. Saarikoski, J. Tuominiemi)

III International Conference on Hyperons, Charm and Beauty Hadrons,
30 June -3 July, Genova, Italy (talk by R.Kinnunen)

CERN School of Computing,
September, Funcal, Portugal, (H. Saarikoski, M. Haapakorpi, J. Klem)

CMS Collaboration Meeting,
14-18 September, Lyon, France (A. Heikkinen, V. Karimäki, R. Kinnunen, J. Tuominiemi)

CMS Days in Split,
11-12 November, Split, Croatia
(talk by R. Kinnunen)

Working visits to CERN,
Geneva, Switzerland (H. Saarikoski, J. Tuominiemi)

Working visits to the University of Bern,
(J. Tuominiemi)

Participation in the meetings of the CMS Management Board, CMS Finance Board, EPS HEPP Board and RECFA at CERN,
(J. Tuominiemi)

CMS Tracker

CMS Workshop on Optical Links,
16 January, CERN, Geneva, Switzerland,
(talk by K. Banzuzi)

Workshop on Optical Alignment with Transparent Position Sensors,
6-8 April, Munich, Germany (S. Ruotsalainen)

CMS Collaboration meeting,
14-18 September, Lyon, France (A. Honkanen, M. Kotamäki, K. Skog)

European Commission Winter School on Low Dimensional Semiconductors for Optoelectronic Devices and Communication Systems,
6-13 December, Colchester, UK (K. Banzuzi)

Working visits to CERN,
Geneva, Switzerland (K. Banzuzi, C. Eklund, T. Mäenpää, E. Pietarinen)

Technology Programme

IFIP WG 5.7 Working Conference on Strategic Management of the Manufacturing Value Chain,
26-28 August, Scotland, UK
(talk by K. Tanskanen and A. - P. Hameri)

NORDNET '98 Conference on Project Management,
1-22 September, Oslo, Norway
(talk by A. - P. Hameri)

Publications

Theory Programme

Laser Physics and Quantum Optics

R. Dum, A. Sanpera, K.-A. Suominen, M. Brewczyk, M. Kus, K. Rzazewski, and M. Lewenstein,
Wave packet dynamics with Bose-Einstein condensates,
Phys. Rev. Lett. 80 (1998) 3899-3902

B.M. Garraway and K.-A. Suominen,
Wave-packet dynamics and quantum beats,
Phys. Rev. A 58 (1998) 440-449

B. M. Garraway and K.-A. Suominen,
Adiabatic passage by light-induced potentials in molecules,
Phys. Rev. Lett. 80 (1998) 932-935

M. Havukainen and S. Stenholm,
An open systems approach to calculating time dependent spectra,
J. Mod. Opt. 45 (1998) 1699-1716

P. Öhberg and S. Stenholm,
Hartree-Fock treatment of the two-component Bose-Einstein condensate,
Phys. Rev. A 57 (1998) 1272-1279

S. Stenholm,
The validity of the Gross-Pitaevski equation describing bosons in a trap,
Phys. Rev. A 57 (1998) 2942-2948

S. Stenholm and K.-A. Suominen,
Weisskopf-Wigner decay of excited oscillator states,
Optics Express 2 (1998) 378-390

K.-A. Suominen, Y.B. Band, I. Tuvi, K. Burnett, and P. S. Julienne,
Quantum and semiclassical calculations of cold atom collisions in light fields,
Phys. Rev. A 57 (1998) 3724-3738

K.-A. Suominen, E. Tiesinga, and P. S. Julienne,
Nonadiabatic dynamics in evaporative cooling of trapped atoms by a radio-frequency field,
Phys. Rev. A 58 (1998) 3983-3992

R.G. Unanyan, N.V. Vitanov and, S. Stenholm,
Suppression of incoherent ionization in population transfer via continuum,
Phys. Rev. A 57 (1998) 462-466

N. V. Vitanov,
Analytic model of a three-state system driven by two laser pulses on two-photon resonance,
J. Phys. B: At. Mol. Opt. Phys. 31 (1998) 709-725

N.V. Vitanov,
Adiabatic population transfer by delayed laser pulses in multistate systems,
Phys. Rev. A 58 (1998) 2295-2309

N.V. Vitanov, B.W. Shore, and K. Bergmann,
Adiabatic population transfer in multistate chains via dressed intermediate states,
Eur. Phys. J. D 4 (1998) 15-29

Particle Cosmology

J. Ahonen and K. Enqvist,
Magnetic field generation in first order phase transition bubble collisions,
Phys. Rev. D 57 (1998) 664

K. Enqvist and J. McDonald,
Can cosmic ray catalysed vacuum decay dominate over tunnelling?
Nucl. Phys. B 513 (1998) 661

K. Enqvist, A. Riotto, and I. Vilja,
Baryogenesis and the thermalization rate of the stop,
Phys. Lett. B 438 (1998) 278

K. Enqvist and J. McDonald,
Q balls and baryogenesis in the MSSM,
Phys. Lett. B 425 (1998) 309

K. Enqvist,
Primordial magnetic fields,
Int. J. Mod. Phys. D7 (1998) 331-350

K. Enqvist and J. McDonald,
D term inflation and B ball baryogenesis,
Phys. Rev. Lett. 81 (1998) 3071

K. Enqvist, P. Keranen, and J. Maalampi,
Testing neutrino magnetic moments with AGNs,
Phys. Lett. B 438 (1998) 295

P. Elmfors, K. Enqvist, and K. Kainulainen,
Strongly first order electroweak phase transition induced by primordial hypermagnetic fields,
Phys. Lett. B 440 (1998) 269

K. Enqvist and J. McDonald,
MSSM dark matter constraints and decaying B balls,
Phys.Lett. B 440 (1998) 59

Mathematical Physics

V. Baladi, M. Degli Esposti, S. Isola, E. Järvenpää, and A. Kupiainen,
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J. Kalkkinen and A. J. Niemi,
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Eur. Phys. J. C4 (1998) 723-739

R. M. Kashaev,
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A. Kupiainen,
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Cont. Math. 217 (1998) 83-99

J. Lukkarinen,
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Particle Phenomenology

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Limits on tanβ in SU(5) GUTs with gauge mediated supersymmetry breaking,
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Statistical Physics and Materials Science

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