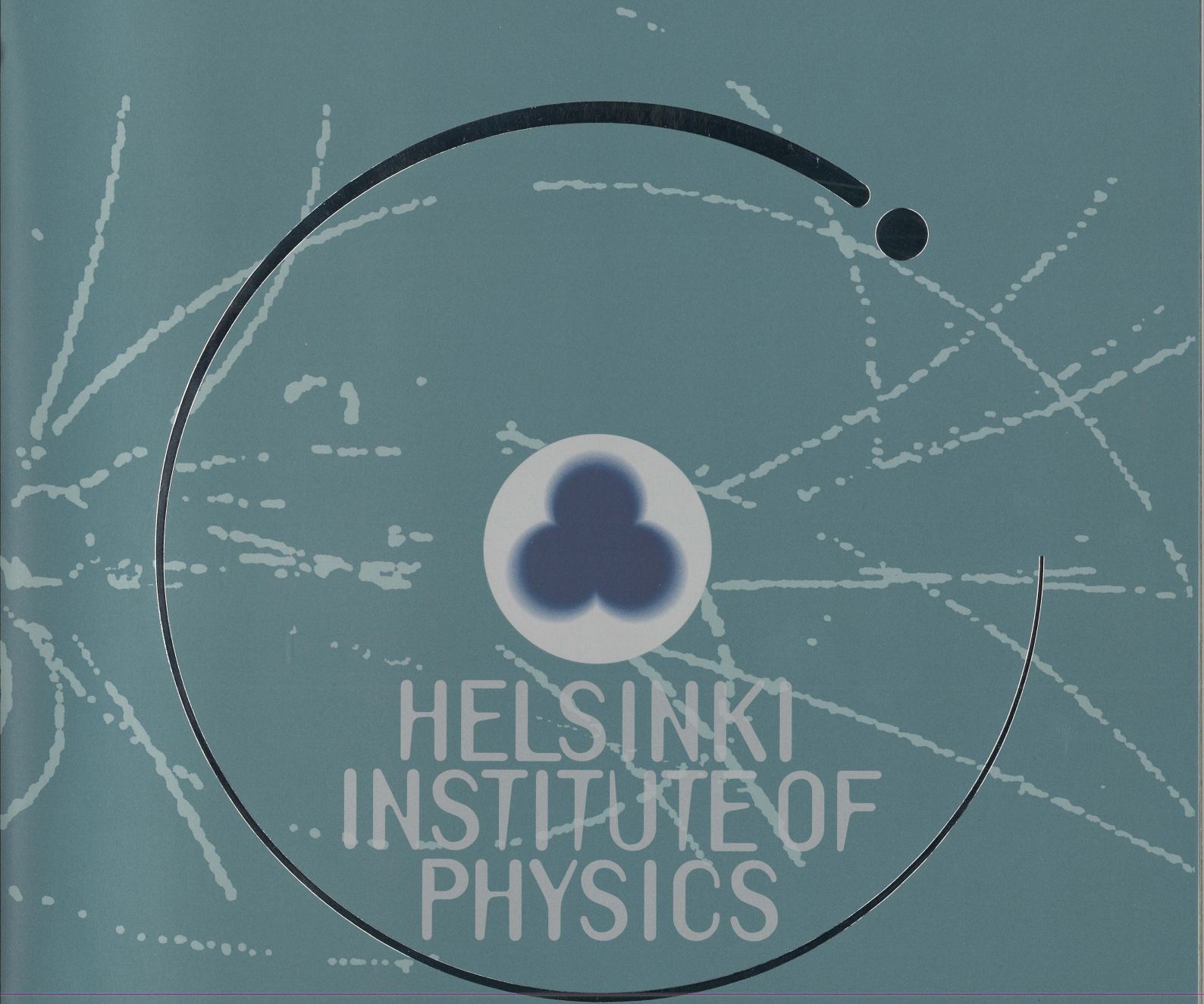
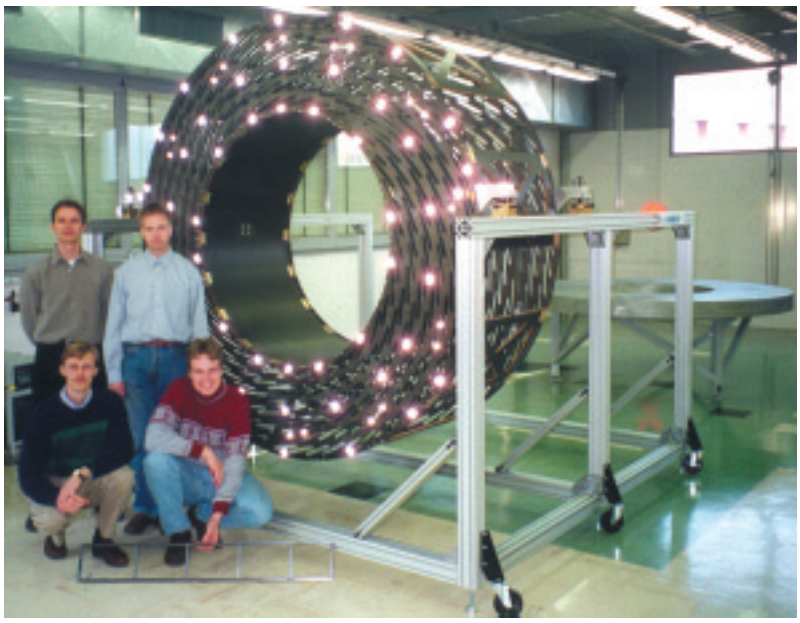
Annual Report 1999



HELSINKI INSTITUTE OF PHYSICS

Annual Report 1999



The Big Wheel is a full-scale, partial prototype of the outer part of the CMS tracker barrel.

Annual Report '99 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 University of Jyväskylä. The highest decision-making body is the Board of the Institute. HIP funding is decided as a separate item in the annual budget plan of the Finnish government. The Institute also obtains funding from other sources: Ministries, the Academy of Finland, the National Technology Agency (TEKES) and companies. HIP has offices and laboratories at four locations: University of Helsinki in Helsinki, Helsinki University of Technology in Espoo, University of Jyväskylä in Jyväskylä and CERN in Geneva. The Institute is responsible for coordinating Finland's relations with CERN and other international high-energy physics research institutions.

As described in detail below, the main topics of research are mathematical physics, quantum optics, statistical physics, cosmology, phenomenology, 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 third meeting on June 14, 1999 in Helsinki. The SAB made a number of recommendations for further development of the Institute and strongly supported efforts to have longer-term appointments for outstanding researchers and tight collaboration with host university physicists.

The Board has approved a Research Plan 2000. The size of the basic HIP budget in 2000 will be the same as in 1999. However, some additional funding has been obtained for the Common Fund and equipment expenses for the LHC experiments CMS, ALICE and ATLAS. Furthermore, outside project funding, mainly from the Academy of Finland and TEKES, increases somewhat from 1999 to 2000. Some fields of theoretical research have been particularly successful in obtaining sizeable research grants and nominations to professorships at universities. The Institute has been active in the founding of two new Chairs, one in the University of Helsinki and the other in the Helsinki University of Technology.

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 the graduate level and supervised thesis work. The Institute has offered research positions and a stimulating environment to undergraduate and graduate students, and has participated at several Graduate Schools of the Academy of Finland. The Institute has organized international seminars and conferences, and has had an extensive visitors programme. Undergraduate and graduate students have been chosen as trainees at CERN.

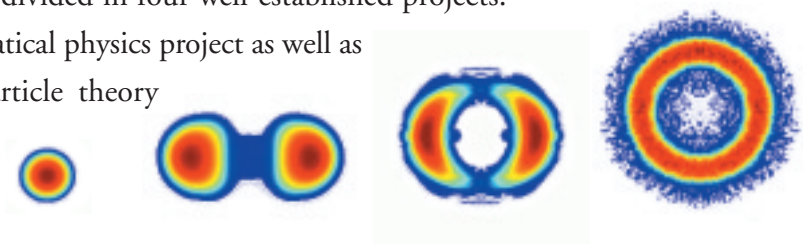
Below we discuss the research results. Some significant results have already brought HIP scientists to the attention of the international scientific community. These successes are reflected in the increase of resources available for research work at HIP.

HELSINKI INSTITUTE OF PHYSICS

Highlights of Research Results

Theory Programme

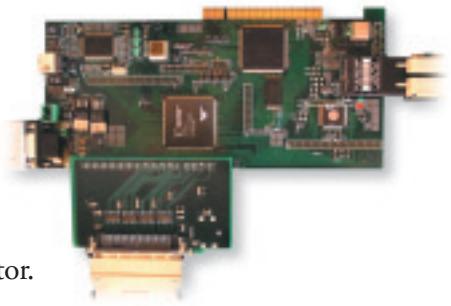
In mathematical physics A. Kupiainen has proven together with R. Lefevere and J. Bricmont bounds for the PDF of 2D turbulence, which allows for a rigorous proof for the uniqueness of the stationary state. In laser physics and quantum optics it was shown that the encryption security guaranteed by the basic laws of quantum mechanics can be extended even to practical experiments provided the parameters are chosen properly. In particle theory and cosmology it was found out that, assuming that polarization information can be fully exploited, an isocurvature perturbation can be detected by Planck Surveyor Mission if it contributes more than 4% to the anisotropy angular power spectrum at large scales. In statistical physics and materials science an unexpected intermediate power-law dependence of the velocity correlation and associated memory functions in the diffusive dynamics of strongly interacting particles was revealed. The theory programme has remained divided in four well-established projects. Among them the mathematical physics project as well as cosmology within the particle theory project have both seen a modest expansion.



High Energy Physics Programme

Equipped with more than a decade of experience in developing, designing, constructing and operating some of the key subdetector systems of the DELPHI experiment at LEP, the HEP Programme now concentrates on challenges posed by the LHC experiments. The physics analysis contributions of the Helsinki group are based on hands-on experience in building instruments used in identifying heavy quarks, in reconstructing the asymptotic states of quarks and gluons, jets, and manifestations of their colour connections, colour dipoles. The special know-how in precision detector systems and their aging properties in intense radiation has been gained by determined laboratory studies and the modern facilities constructed in Finland since 1985. A generation of young experimentalists, with positions in the international research community, has been trained in this environment. The approach adopted by the HEP Programme has received unanimous approval in all the international evaluations conducted in Finland. By maintaining a detector laboratory for HIP contributions to experimental high energy physics, the HEP Programme is committed to LEP-style participation at LHC.

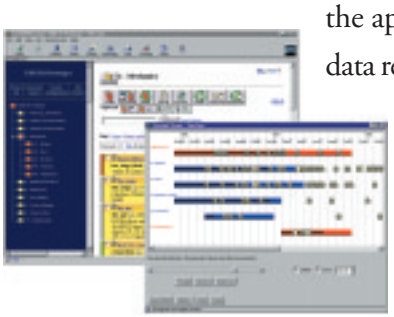
LHC Programme



Construction of the CMS detector system was initiated in 1999 for several subdetectors. In the CMS Tracker project, in which the HIP LHC Programme is mainly participating, R&D work was still continued but the last milestones for final design were achieved. The main change in global design was that installation of the Tracker will be completed a single phase to avoid any later interruptions in operation of the LHC accelerator. For the HIP LHC Programme, one of the main achievements in 1999 was completion of the full-scale 'Big Wheel' prototype for the mechanical structure of the outer part of the CMS Tracker. For the CMS software a concerted effort has been directed towards full adoption of new software techniques. The CMS software milestone 'Proof of Concept' of the new object-oriented software paradigm was successfully completed and favourable progress achieved in the next step of the milestones, the 'Functional Prototype'. In the detector development activities a new project was initiated to study new, recently discovered aspects in the radiation hardness of silicon detectors. General CMS detector prototype tests were launched at the H2 beam with the HIP Silicon Beam Telescope providing the reference tracking. For the muon trigger of the CMS, a prototype readout chain was designed and built at the Tekniikantie laboratory in Helsinki, ready to be tested in a beam at CERN in 2000. For ALICE, prototype development for tracking detectors was continued in Jyväskylä and at CERN.

Technology

In addition to expanding the use of the Tuovi Web Data Management system within High Energy Physics community, new areas for applying the system have been investigated and initiatives launched. Main focus has been on enlarging the use of Tuovi technology to access data repositories other than the engineering and administrative repositories at CERN. The challenge of accessing the multitude of physics databases available has been studied to pinpoint those potential applications that would best benefit the user community. Especially closer collaboration within the CMS community has been initiated and collaborative research has begun. In the meantime, the main activity within the Engineering Data Management activity at CERN has gained further momentum, and the application has been extended to access all engineering data repositories at CERN. The big kickoff of the major work with CERN's EDMS team was scheduled for the millennium change. Collaboration between Scandinavian industry-research consortia and CERN has continued to be active, resulting in several research reports and publications.



Theory Programme

Kari Enqvist

The purpose of the Theory Programme is to conduct top class research in a few selected subject fields, with emphasis on topicality, flexibility and high professional standard. At present the Programme is divided into four projects: mathematical physics, laser physics and quantum optics, particle theory and cosmology, and statistical physics and material sciences. Each project has chosen to focus on a number of different topics which reflect the general interests of the given subfield. In Theory Programme the responsibility lies very much on the shoulders of the project leaders. In 1999 the projects have been very successful in competing for both domestic and international outside funding, which forms an important criterion by which the projects are judged.

Laser Physics and Quantum Optics

Current encryption techniques are usually based on a complexity of assumptions which could be broken by quantum computers. On the other hand, quantum mechanics allows us to create secure communication in which security is guaranteed by the basic laws of quantum mechanics. The simple principles of this scheme have been known since 1984. However, it is beyond current technology to implement them in the proposed idealized manner. We were able to show that the security guarantee can be extended even to practical experiments, including all their compromises, if the parameters are chosen properly.

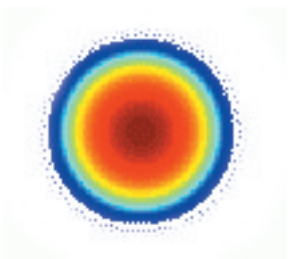
Bose-Einstein condensates can be effectively manipulated with external fields, e.g. they can be confined to optical traps created with light fields. We have previously shown how by shaking the trap an alkali atom condensate can be split into two clearly separated parts. We have now found a method for deforming the separated parts further, so that eventually they combine into a simple toroidal structure. Such structures can be further used, e.g. to study solitons, vortices and superfluidity.

In addition to these specific topics we have continued our work on atomic collisions in optical lattices and in laser-cooled magnesium gases, evaporative cooling of magnetically trapped alkali atoms, output coupling of Bose-Einstein condensates, STIRAP processes (stimulated Raman scattering involving adiabatic passage), cavity QED, molecular wave packet dynamics, and Bell measurements in quantum information.

International contacts were strengthened in 1999. The European Science Foundation initiated a programme on quantum information technology (QIT), with the Project as one of the participants. We also participated in the preparation of two EU network applications, which have now been accepted by the Commission, with the Project as a full contractor in the IST-EQUIP and IHP-CAUAC networks. The latter network is related to our ongoing collaboration with groups in Copenhagen and National Institute of Standards and Technology (NIST), Gaithersburg, on collisions between laser-cooled alkaline-earth atoms.

Mathematical Physics and Field Theory

Various aspects of field theoretical knotlike configurations have been studied by Faddeev and Niemi, including a topological construction of the interaction vertex and the identification of knotlike structures in a particular limit of the Weinberg-Salam model. A reparametrization of a generic off-shell Yang-Mills connection in terms of the SU(N) coadjoint structure has also been derived. Kashaev's volume conjecture on the asymptotic behaviour of the coloured Jones polynomial has also been of particular interest. This work has recently drawn wide attention both as a mathematically important result and also due to its relation to quantum gravity as a limit for topological quantum field theory.



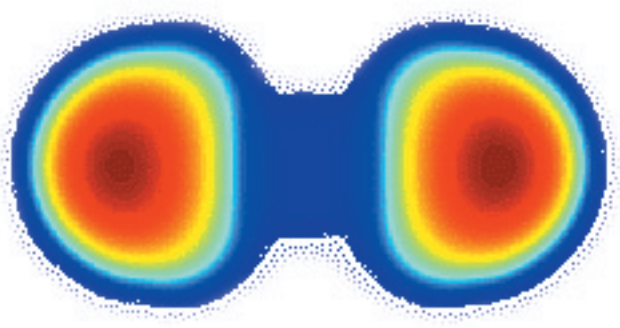


Fig. 1. Simulation of a Bose-Einstein condensate in an optical trap, which is shaken periodically. The condensate first splits into two parts, which then recombine into a symmetric ring structure. The diameter of the ring is about 4 μm, the duration of the process 0.4 s in this example.

Gerard 't Hooft and Leonard Susskind have argued that theories that include gravity are holographic - it should be possible to describe all the degrees of freedom and their dynamics in terms of a theory that occurs in one less dimension than that of the world. Recently, a concrete framework to test these ideas has been found in string theory by the so-called AdS/CFT duality. This duality suggests that a string theory in anti-de Sitter spacetime has a holographic dual as a field theory on the boundary of spacetime, i.e. in one less dimension. E. Keski-Vakkuri has been investigating the formation of black holes in anti-de Sitter space and its holographic interpretation in the dual theory. The current understanding is that black hole formation corresponds to thermalization of an off-equilibrium initial state in the boundary theory. Together with U. Danielsson and M. Kruczenski (Uppsala Univ.) he has showed that one can use 2-point functions through the AdS/CFT conjecture to probe the collective exitations in the off-equilibrium state and gain information on how the state begins to approach thermal equilibrium as a black hole is about to form in anti-de Sitter space. Thus one obtains holographic information about black hole formation in bulk.

A. Kupiainen has together with R. Lefevere and J. Bricmont, proven bounds for the PDF of 2D turbulence. This allow for a rigorous proof for the uniqueness of the stationary state. Together with A. Schenkel, A. Kupiainen has been applying the Renormalization Group method developed in cooperation with J. Bricmont and K. Gawedzki to the study of preservation of quasiperiodic motion in Hamiltonian PDEs.

C. Montonen has investigated supersymmetric gauge theories: Effective actions for N = 2 super-Yang-Mills, 1/4-BPS states in N = 4 super-Yang-Mills and N = 1 superconformal theories. He has also participated in a collaboration investigating the response of different kinds of matter to extremely high magnetic fields.

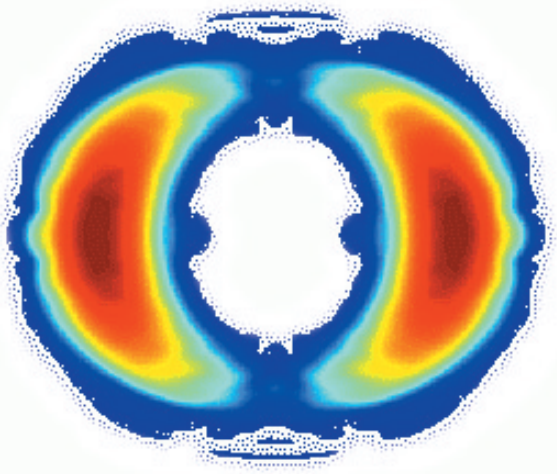
J. Lukkarinen has been working on quantum ensemble theory with an aim of developing a realistic statistical description of small, but not necessarily completely isolated, quantum mechanical systems. This has motivated a closer look on the continuum limit of the lattice regularized path integrals and lead to an algorithm for practical Monte Carlo simulations of these non-canonical ensembles.

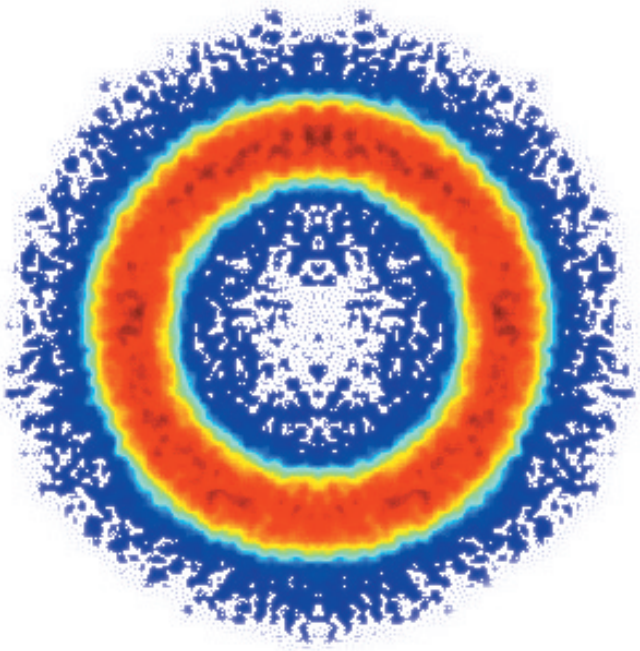
Particle Theory and Cosmology

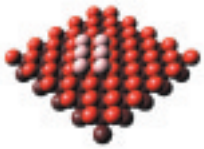
Research on the Project in 1999 has focused on the following ten topics:

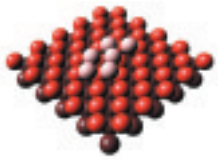
Hierarchy problem. We have shown that the familiar gauge hierarchy between the fundamental Planck scale M_{Pl} and the electroweak scale can be naturally explained in higher dimensional theories with relatively large radii in extra dimensions. We show that radiative corrections can drive the electroweak Higgs mass, which at high energies is of the order of M_{Pl}, close to the electroweak scale at low energies, thus inducing a large hierarchy without fine tuning of parameters.

Supersymmetry breaking. The phenomenology of supersymmetric models is largely determined by the method of supersymmetry (SUSY) breaking. The smallest change in the conventional minimal supersymmetric standard model is to assume that the soft SUSY breaking parameters are not universal









at high scale. We have investigated the implications of nonuniversal gaugino masses.

The flavour-changing neutral current problems are solved in models where SUSY is broken by gauge mediation. Assuming an *SO* (10) unification group, perturbativity of the gauge couplings and unification restrict the messenger sector and lead to testable phenomenological predictions.

The anomaly-mediated SUSY breaking has come under scrutiny recently. Unfortunately, the sleptons remain tachyonic in pure anomaly mediation. We have studied the possibility of increasing the slepton mass squares. We have found suitable contributions e.g. in $E_6 \rightarrow SO(10) \times U(1)$-type models.

Gauge-coupling unification. The unification of gauge couplings has been considered to be a strong indication of supersymmetry. We have investigated corrections to the unification in the presence of higher dimensional operators and found that with the allowed corrections, proton decay constraints allow even nonsupersymmetric ***SU*** **(5)** grand unified model. Running of the gauge couplings changes in the presence of extra dimensions due to Kaluza-Klein excitations. We have shown that the unification scale in this case is also strongly dependent on the presence of higher dimensional corrections.

CP violation. The supersymmetric models contain many new sources of CP violation, which is currently undergoing experimentation. We have shown that trilinear scalar couplings can have a significant effect on the observed CP phenomena in kaon physics. They may also enhance ε'/ε, and the supersymmetric contribution can be of the order of the KTeV result.

Left-right symmetric models. The observational results for nonvanishing neutrino mass add to the motivation for left-right models with naturally light left-handed neutrinos. We have continued to study the phenomenology of these left-right models. Monte-Carlo generators for the PYTHIA program have been implemented for several processes both for the LHC and for the linear collider in collaboration with the Lund group.

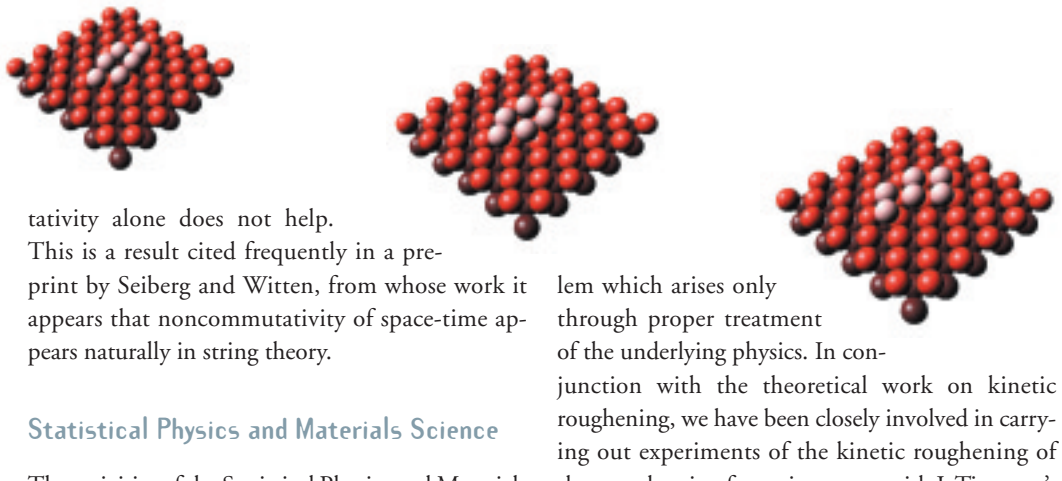
Nonstandard big bang nucleosynthesis. We have studied the effect of antimatter domains on big bang nucleosynthesis (BBN). Some models of baryogenesis produce an antimatter-matter domain structure in the early universe. Depending on the size of these domains, antimatter is annihilated before the current era, but may affect BBN or the cosmic microwave background (CMB) spectrum. Based on underproduction of He-4 or overproduction of He-3 in BBN we obtain upper limits for the amount of antimatter in the early universe that are more than an order of magnitude tighter than the limit from CMB.

Anisotropy of the cosmic microwave background. Future satellite missions, MAP and Planck, will measure the anisotropy of the CMB with high resolution and accuracy, providing us with an unprecedented amount of information about the early universe. The cosmology group at HIP is part of the Planck Low Frequency Instrument (LFI) consortium. The anisotropy is mainly due to density perturbations in the early universe, which in the general case is a combination of adiabatic and isocurvature perturbations. The nature and spectrum of these initial perturbations are practically the only observational window on the physics of the first second of the universe. While the adiabatic component is expected to dominate, the presence of an isocurvature component is an important signature in many models for the very early universe. Assuming that polarization information can be fully exploited, we find that an isocurvature perturbation can be detected by Planck if it contributes more than 4% to the anisotropy angular power spectrum at large scales.

Neutrino oscillations in the early universe. We have studied neutrino asymmetry growth in active-sterile neutrino oscillations and found that the final sign of the asymmetry shows regions of chaotic and regular behaviour in the space of oscillation parameters. As the sign of the asymmetry affects the helium abundance produced in BBN, neutrino oscillations appear to induce an inherent uncertainty in the abundance estimates.

Affleck-Dine baryogenesis. The scalar potential of supersymmetric theories contains degenerate vacua called flat directions. During inflation scalar condensates can form in the flat directions and become charged with a baryon number. The condensate is not stable but decays into nontopological solitons. We have studied the dynamic evolution of condensate fragmentation and the cosmological consequences of the solitons.

Quantum field theory and noncommutative geometry. A quantum field theory (QFT) on noncommutative space-time has been formulated. Contrary to popular belief, noncommutativity alone does not remove the ultraviolet divergences. In addition one needs the space-time to be compact, i.e. closed at least in several directions. This result brings us to the strong suggestion that unless the ordinary QFT is combined with another interaction, gravity, which would necessarily change the basic space-time to a compact one, noncommu-



tativity alone does not help. This is a result cited frequently in a preprint by Seiberg and Witten, from whose work it appears that noncommutativity of space-time appears naturally in string theory.

Statistical Physics and Materials Science

The activities of the Statistical Physics and Materials Science Project focus on the theory of equilibrium and nonequilibrium behaviour and dynamics in strongly interacting many-body systems, particularly as applied to complex systems, polymers, disordered materials and surface physics. Significant results have been obtained in the following problems.

We have revealed an unexpected intermediate power-law dependence of velocity correlation and associated memory functions in the diffusive dynamics of strongly interacting particles. Studies of several surface adsorption systems and non-Brownian sedimentation dynamics indicate that this power-law behaviour is a common feature even in strongly dissipative systems and can be qualitatively related to the nature and strength of the effective interparticle interactions. We have also studied the diffusion of adatom clusters on metal surfaces and found new collective mechanisms which can only be revealed by newly developed saddle-point search methods (Fig. 2). We have applied the wavefunction Monte Carlo method to the quantum dynamics of light adatoms on metal surfaces.

Knowledge of elementary processes in surface diffusion has been used to predict the macroscopic morphological evolution of growing crystal surfaces. Of general technological interest is the case in which an initially rough surface is smoothed for some time before eventually three-dimensional surface structures develop due to kinetic instabilities. Within an analytic continuum approach we are able to predict the layer thickness of minimal roughness, based only on microscopic properties of the growth process.

We have continued our work on the properties of disordered fibre networks and on the dynamics of fronts in such systems. We have obtained new results for the kinetic roughening of fronts in the case where there are power-law types of spatial correlations in the underlying network. We have introduced and extended a continuum phase-field model to describe the dynamics and kinetic roughening of wetting fronts in porous media. This model results in novel predictions due to nonlocality of the problem which arises only through proper treatment of the underlying physics. In conjunction with the theoretical work on kinetic roughening, we have been closely involved in carrying out experiments of the kinetic roughening of slow combustion fronts in a paper with J. Timonen's group at Jyväskylä. Our most recent results invalidate the previously claimed directed percolation depinning behaviour of combustion fronts at short scales.

In collaboration with Prof. J. Hietarinta (University of Turku) we have continued our numerical studies on the topological stable structures of the Faddeev-Skyrme model. For some values of the Hopf charge Q we have found new ground state configurations that improve the analytically predicted behaviour for the total energy $E\alpha|Q|^{3/4}$. For all the systems studied we have created video animations for minimization processes. They can be used to investigate the elementary processes that change the system from one topological configuration to another.

We have continued first principles calculations for metallic alloys and alloy surfaces. Within the pseudopotential framework, we developed a method that improves the stability and transferability of the pseudopotentials and applied this method to Pd-Al alloys. We have also applied the ab initio methods to Pd and CO on Pd(111) surface and S on pure and Ge-doped Ag(111) surfaces. Moreover, the study of defect-defect interactions in Al has been extended to divacancy-impurity complexes.

In joint efforts with the Department of Ecology and Systematics of Helsinki University (Acad. Prof. I. Hanski) we examined the consequences of spatial extension and landscape heterogeneity on insect population dynamics. We were able to relate the existence and location of an apparent phase boundary in the boreal moth (genus Xestia) abundance in Finnish Lapland to less favourable forest resources in regions with lakes and swamps. For the endangered butterfly Melitaea cinxia on Åland we examined the possible existence of host-parasitoid patterns and their 'freezing' due to disorder in location of habitat patches.

Fig. 2. The sequence by which a six-atom Cu cluster on a Cu(100) surface changes orientation.

High Energy Physics Programme

Risto Orava

The High Energy Physics Programme is responsible for the study of particle physics at high energies in e^+e^- collisions and the development of new particle detection techniques to cope with the challenges of experimentation at future particle colliders. The DELPHI experiment at the CERN LEP collider provides high-quality data to address some of the open questions in the search for fundamental knowledge on the origin of mass, on the physics of flavours and on the strong force. While an active programme of physics studies is carried out at LEP, the group is engaged in the transfer of know-how acquired in more than a decade of experience with designing, constructing and operating some of the most challenging and successful detector subsystems of DELPHI to future particle physics experiments at the LHC and later at a high energy linear collider. The High Energy Physics Programme is actively engaged in the development of novel experimental techniques and, in cooperation with theorists, develops optimal data analysis strategies.

Electron - Positron Physics

With large statistics at the highest collision energy ever achieved, the LEP-2 collider has allowed a new step in the search for the elusive Higgs bosons. Due to the excellent performance of the silicon Vertex Tracker and of the other subsystems of the DELPHI detector and to a novel event reconstruction technique developed by the Helsinki group, a new domain in the search for charged Higgs bosons has become accessible. In fact, the existence of a charged Higgs with a mass up to 75 GeV/c^2 has already been excluded by DELPHI and the region of $M_H > M_W = 80.4\ GeV/c^2$, favoured by supersymmetric models, is now becoming accessible to searches performed by our group with the DELPHI data (see Fig. 1).

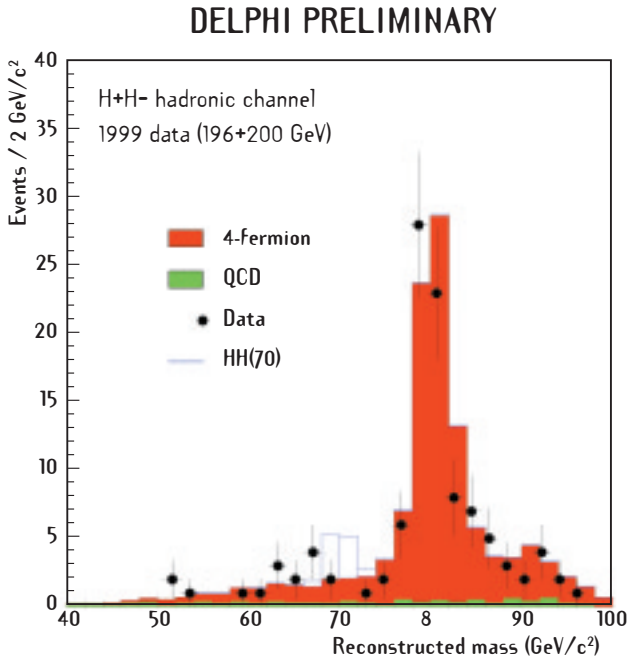


Fig.1 **The reconstructed mass obtained in the search for the charged Higgs boson. The dots show the distribution observed in the high energy data data collected by the DELPHI detector during year 1999, the solid histogram represent the Standard Model background processes while the open histogram shows the expected signal from a charged Higgs boson with mass of 70 GeV/c^2.**

While the new data collected at LEP-2 are being analysed in the search for signals of the new physics, significant analysis activity is devoted to the large Z^0 data sets collected during 1989-1995. The results of the analyses performed by the Helsinki group addressed the open problems in quantum-chromo dynamics (QCD) and heavy-flavour physics. The group has distinguished itself in developing new analysis methods for flavour tagging and reconstructing colour flow structures of multiplarton final states. After study of the $bb\bar{g}$ final state, preliminary results on the QCD analysis of heavy quark fragmentation have been obtained and reported to the HEP-99 Conference in Tampere. The study of the V_{ub} element in the CKM matrix has been finalized, obtaining the world's currently most accurate determination and pioneering of a new analysis technique that will be further exploited by experiments at the B factories.

With LEP-2 entering its final year of operation in 2000, the group is already involved in studies on physics and detectors for the future e^+e^- linear collider. These studies largely profit from expertise on detector design and operation and on physics analysis collected over more than a decade of contributions to the DELPHI experiment.

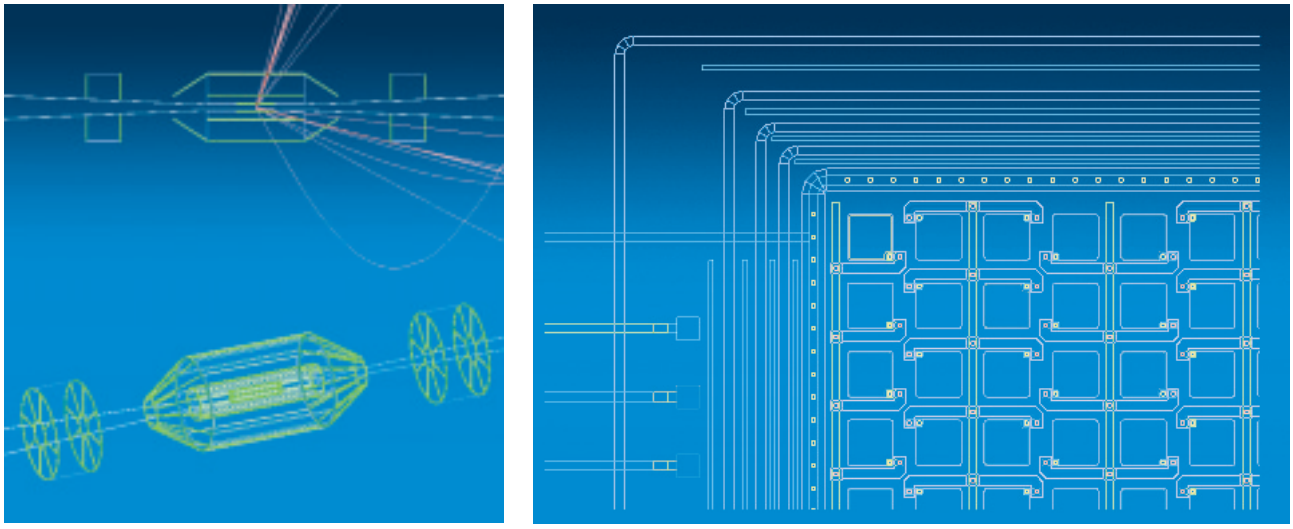


Fig. 2. Schematic view of the Vertex Tracker conceptual design proposed for the TESLA high energy linear collider (left) and layout of silicon pixel detectors developed for application in high resolution trackers (right).

Detector Research & Development

Innovative techniques for tracking detectors have been developed for application in high-rate particle physics experiments at LHC. Several alternative methods for manufacturing narrow Gas Electron Multipliers (GEMs) on thick, self-supporting foils yielding higher multiplication factors have been tested in collaboration with the VTT Microelectronics Laboratory. GEM channels with 200 μm diameter on 240 μm fibreglass plate have been successfully manufactured and tested with encouraging results. An extensive programme of simulation of the thick GEM channels performance has been carried out and its results have been used to optimise their design. In particular, the study of the characteristics of thick-foil GEM with cylindrical and double-conical holes has shown the advantages of this geometry in obtaining a higher effective gas gain with improved breakdown endurance. A gas analyser consisting of a tandem system of Gas Chromatographs has also been constructed to understand the mechanisms of gaseous detector aging in high-rate operations.

Microstrip Gas Chambers (MSGC) detectors equipped with a GEM amplifier layer have been built and characterized, using a dedicated data acquisition and control system. Radiation hardness tests, performed at the Paul Scherrer Institute (PSI) in November 1999, have demonstrated the reliable performances of these detectors in the challenging radiation environment expected for the LHC.

Test structures of newly designed hybrid silicon pixel sensors, aimed at optimization of their space resolution, have been designed, manufactured and characterized in the laboratory. The results, both in terms of their electrostatic characteristics and of the measured performances, are very encouraging and show that hybrid pixel sensors with analog read-out can achieve resolutions of the order of 7 μm for a read-out pitch of 100 μm. The conceptual design of a Vertex Tracker based on these sensors for application at the linear collider has been completed and its engineered implementation is being studied by the Helsinki group including new solutions for the mechanical structure and heat extraction.

LHC Programme

Jorma Tuominiemi

The goal of the HIP LHC Programme is to design and build the CMS and ALICE experiments for the CERN Large Hadron Collider in international collaboration and to prepare for their physical analysis. With these experiments HIP will participate and contribute to the next fundamentally important step in understanding of the basic structure of matter. The experiments are planned to begin in 2005. The HIP LHC Programmme is divided into three projects: 1) the CMS Software and Physics Project, the goal of which is to develop simulation and analysis software for the CMS Tracker and evaluate the physics discovery potential of the CMS detector design, 2) the CMS Tracker Project contributing to the design, construction and calibration of the tracker system as well as of its data acquisition and 3) the Nuclear Matter Project contributing to the design and construction of the ALICE Inner Tracker system as well as to heavy-ion physics evaluation. The project also participates in the ISOLDE Programme at CERN.

Software and Physics

The HIP Software Team continues to carry the responsibility for the maintenance of the CMS Fortran-based simulation tool CMSIM. CMSIM provides events for the ORCA (Object Oriented Reconstruction for CMS Analysis) reconstruction software and High Level Trigger (HLT) studies. During 1999 two major releases of CMSIM software were issued, the versions cms116 and cms117. Development of the SCRAM tool (Software Configuration, Release And Management) underwent considerable progress.

The HIP CMS Software Project participated actively in the Geometry and Tracking 4 (GEANT4) development work and was responsible for maintenance of the GEANT4 libraries for CMS. The GEANT4 Hadronic Physics Working Group is developing a hadronic shower simulation toolkit suitable for LHC experiments. The HIP activity included object-oriented (OO) analysis and design of an intranuclear cascade model based on High-Energy Transport Code (HETC). The first functional prototype of HETC was developed. ECAL geometry was implemented in GEANT4 in 1999.

In the Monarc collaboration the HIP team began a survey on feasibility creating a regional centre for CMS data analysis in Finland. The Centre for Scientific Computing in Finland (CSC) is a potential candidate. The Scientific Director of CSC, Kari Laasonen, visited CERN as a guest of the HIP team and met with key persons of the Monarc collaboration.

An important achievement occured in development of the calibration algorithm for detector position and orientation with reconstructed tracks. The method involves automatic optimization of calibration constants for individual detector sensors in 6-dimensional parameter space. The algorithm was successfully applied to the analysis of data from the Helsinki Silicon Beam Telescope (SiBT). The SiBT on-line monitoring software was updated for the 1999 H2 test beam and redesigned in C++. The off-line analysis package was also completed so that SiBT monitoring and analysis can now be performed entirely using OO software. The software was fully integrated with the CMS OO framework using Unified Modelling Language, Rational Rose 4.0 and other OO design tools. The design of the SiBT graphical user interface using a commercial toolkit (Qt) was another important milestone completed in 1999. GEANT4 has been successfully applied to SiBT detector description. The Software

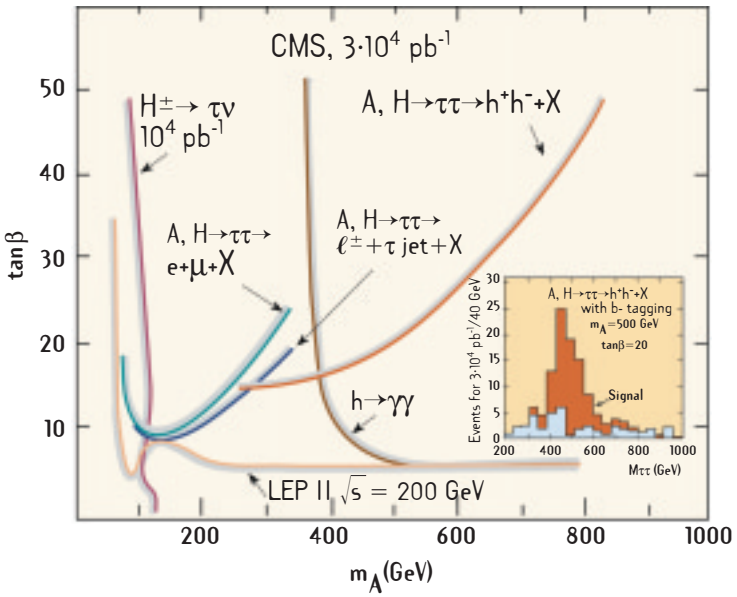


Fig. 1. The discovery regions for the Minimal Supersymmetric Standard Model Higgs bosons (h^0, H^0, A^0 and H^+) in the MSSM parameter space in the CMS experiment, for three years of running with the low luminosity of LHC. The small figure shows the mass of the Higgs boson (A,H) as reconstructed from the measured momenta of the decay products.

Project members participated actively in the analysis of the test beam data. The most important results were obtained in detector performance at various angles of incidence of the incoming tracks.

In physics simulation studies the main research subjects of the physics group of HIP in CMS have been the following: 1) development of the level 2 tau trigger for $H \rightarrow \tau\tau$ events, 2) Higgs discovery reach in the $H_{SUSY} \rightarrow \tau\tau$ and $H^{\pm} \rightarrow \tau\nu$ channels, 3) study of the observability of the $qq \rightarrow qqH$, $H_{SUSY} \rightarrow \tau\tau$ events and 4) verification of the level 1 trigger rates with the new OO software.

Since decay channels with τ's are among the most important for discovery of the Higgs boson at the LHC, an efficient tau trigger even at low E_t values ($E_t \gtrsim 60$ GeV) is highly desirable. This was shown to be possible because by using the collimated energy deposit of a τ jet in the electromagnetic calorimeter, the two-jet trigger rate can be reduced by a factor of 10 on level 2.

The $H_{SUSY} \rightarrow \tau\tau \rightarrow h^{+}+h^{-}+X$ channel was shown to be very promising for Higgs discovery in the large mass domain ($m_A \gtrsim 300$ GeV). Tight isolation cuts for the hard single-charged hadron from τ and a precise measurement of the missing transverse energy with maximal detector coverage was found to be necessary for Higgs mass reconstruction and further reduction of the QCD background. The $H \rightarrow \tau\tau$ decay modes with $h^{\pm}+\ell^{\pm}+X$ and $e^{\pm}+\mu^{\mp}+X$ final states were studied in the case of the Standard Model Higgs in the low mass (100 GeV $\leqslant m_H \leqslant$ 150 GeV) range in the $qq \rightarrow qqH$, $H \rightarrow \tau\tau$ events. The backgrounds could be reduced with τ selection cuts in the calorimeters and in the tracker and by detecting the energetic associated jets in the forward calorimeters. This channel was found to be important for measurement of the HWW coupling and may allow us to explore the entire m_A, tanβ parameter space in MSSM.

Studies of b-tagging in the associated channels $b\bar{b}H_{SUSY}$ and the τ tagging in the $H \rightarrow \tau\tau$ events with the impact parameter method were studied using the detailed simulation package CMSIM and full-track reconstruction. Sensitivity of the cross sections and branching ratios to the variation of the parameters of the general MSSM in the A, $H \rightarrow \tau\tau$ and $h \rightarrow \gamma\gamma$ processes were also investigated.

CMS Tracker

Mechanical structure. The main goal of the HIP Mechanics Group was to complete the Big Wheel prototype. The Big Wheel is a full-scale, partial prototype of the outer part of the CMS tracker barrel. The prototype was manufactured by Finnish industries and was funded by HIP, CERN and TEKES.

A novel, challenging manufacturing method was used for the Big Wheel discs. They were constructed by gluing water jet-cut carbon fibre plates together. This so-called jigsaw puzzle method was shows to be a very effective way to construct stiffness based carbon-fibre structures. The large size of the prototype required careful planning of the measurements and tests. Manufacturing accuracy is verified with two types of measurements: in a conventional way using touching measurement instruments and in a more modern way using digital photogrammetry. The measurements have shown that the structure satisfies the precision requirements. Further tests on the prototype are under way.

The prototypes of rods, the detector support elements, are manufactured of carbon fibre profiles made with pultrusion. The goal was to develop the carbon fibre pultrusion technique to produce very straight profiles, minimize the wall thickness and use a radiation-resistant matrix material. The goal was achieved with vinyl ester resin. The rods have been assembled and their structural behaviour will be tested in spring 2000.

In December 1999 the CMS Tracker Collaboration decided to also build the outer part of the tracker using silicon sensors instead of the MSGC detectors. The decision will bring some changes to the layout of the tracker but the division into inner and outer tracker will be maintained. Even when many details in the outer tracker design will change, the conceptual design, as verified by the Big Wheel prototype will also be perfectly valid with silicon detectors.

Detector activities. During summer 1999 the SiBT at the CERN SPS H2 beam line was operated successfully by the HIP Tracker Group. The telescope was used in two CMS detector tests. First, the final design prototypes of the Drift Tube Units of the muon detector were tested for their position resolution and track-finding efficiency, using the SiBT reference tracks. The results were excellent, allowing production of these modules to be launched on schedule this winter. Secondly, a new GEM-MSGC detector design was tested in the high magnetic field available at H2. SiBT reference tracks were used to determine the effects of the magnetic field on position resolution and hit efficiency of these detectors.

The operation interface of SiBT was improved by implementing a new web-based system, allowing remote monitoring of the bias voltages and leakage currents of the individual SiBT sensors. In addition,

a similar system for low-voltage monitoring was designed, but is yet to be implemented.

At the end of the test beam period the HIP Tracker Group obtained parasitic beam time to study charge division in silicon microstrip detectors when tilted relative to the direction of the particles. The report of the results will be submitted to Nuclear Instruments and Methods A.

In the LHC environment the detectors are exposed to high radiation doses. To study further the effects of radiation damage in silicon detectors a new project was initiated. The main aim of the project is to study the optimum structure of a radiation hard detector design and especially the effect of oxygenation of the silicon bulk. Layouts and characterization of the silicon strip detectors will be performed in the Microelectronics Instrumentation Laboratory at Kemi. The irradiation test will be carried out in the Accelerator Laboratory of the University of Jyväskylä subject to the approved Letter-of-Intent by the CERN-Helsinki-Kemi-Pisa collaboration. Neutron production tests were carried out at the Irradiation Facility in Jyväskylä during spring 1999. The results will be reported in Nuclear Instruments and Methods A.

The readout system of a new particle telescope for testing the silicon detectors using cosmic rays and beta particle sources at the CERN CMS Silicon Laboratory was completed in collaboration with the CMS Silicon Tracker Group of CERN. The telescope will be used as a test bench for the APV readout of the CMS tracker.

CMS Trigger and Data Acquisition. The research and development work for realizing the fibre optic links needed for the CMS RPC (Resistive Plate Chamber) detector progressed well, and is on schedule for the next milestone. Close contacts have been maintained throughout the year with the Warsaw CMS group. A prototype readout chain for RPC detectors has been designed and built and will be thoroughly tested in the laboratory and in the LHC-like test beam at CERN in 2000. The prototype chain is highly programmable and can therefore be used to test all aspects of RPC data transfer. It is built from several LINX modules, which have a very large FPGA (Field Programmable Gate Array) as their core component. These components can be used, for example, to implement the data compression and decompression algorithms planned for the RPC detector and to emulate detector data for test purposes.

It is also necessary to verify the radiation tolerance of the components to be used in the RPC readout system, even though the radiation levels in all parts of the RPC detector are quite modest on the LHC scale. The maximum value for the total ionizing dose is 100 Gy and for the neutron fluence 3×10^{12} neutrons/cm^2 integrated over the estimated 10-year lifetime of the experiment. Gamma and proton irradiation tests were initiated for some of the components (different makes of serializer/deserializer components and optoelectronic transceiver modules). The first results were encouraging, showing no total dose damage or displacement damage in any of them. More tests are needed, however, to study the possible single event upset (SEU) effects that can cause errors in operation of the system. The risk of such errors occurring and their consequences must be carefully assessed to find the most suitable components and to build a robust system.

The electronics for the SiBT are currently at a stable phase of development, as no major new developments have been implemented. The SiBT runs were successful regarding the quality of data obtained. However, with the present distributed data acquisition (DAQ) system at the H2 beam line synchronization between them turned out to be a severe problem that needed to be urgently addressed. As the H2 beam line central DAQ used for the SiBT readout is rapidly becoming obsolete, there is also a need for an independent SiBT DAQ system for year 2000.

Nuclear Matter

Nuclear matter physics was included in the research activities of HIP in 1998 in collaboration with the Department of Physics of the University of Jyväskylä. The main part of the Nuclear Matter Project is participation in the design and building of the ALICE experiment at LHC in parallel with theoretical studies of very high-energy heavy-ion collisions. The HIP ALICE group has collaborated with the Torino and St. Petersburg groups in in-beam tests and data analysis of silicon drift detectors of the inner tracking system. The main hardware activity has been focused on fast electronics and construction of the T0 detector for ALICE which will provide the starting signal for Time of Flight (TOF) detectors and will be part of the Forward Multiplicity Detector (FMD).

The group contributed to the electronics and the first successful in-beam evaluation of microchannel plate (MCP) based prototype of the T^0 detector. Options than MCP for T^0 detector will be explored in the future. Successful bonding tests of electronic chips and microcables for the silicon strip detectors was carried out at SELMIC Oy. A member of the HIP ALICE group also worked on

implementation of TUOVI to the ALICE experiment. The theory group was responsible for organizing the Hard Probe Collaboration (HPC) meeting in Jyväskylä. HPC systematically explores those hard partonic interactions, which in heavy-ion collisions could lead to observable experimental signals in the ALICE detector. The HIP group has performed a first systematic analysis of nuclear effects in parton distribution functions. The results are used with perturbative QCD to refine the estimates of the initial conditions in heavy-ion collisions at LHC.

High-energy research is accompanied by studies of low-temperature nuclear matter at the CERN ISOLDE facility. Four important experiments were conducted during 1999 including several beta decay measurements with important contributions to superallowed Fermi decay systematics at high Z values. A beta decay half-life of ^{77}KR, which is of great astrophysical interest since at temperature T > 1.5 GK the net two-proton capture rate on ^{68}Se becomes proportional to the beta decay half-life of ^{70}KR, was measured for the first time.

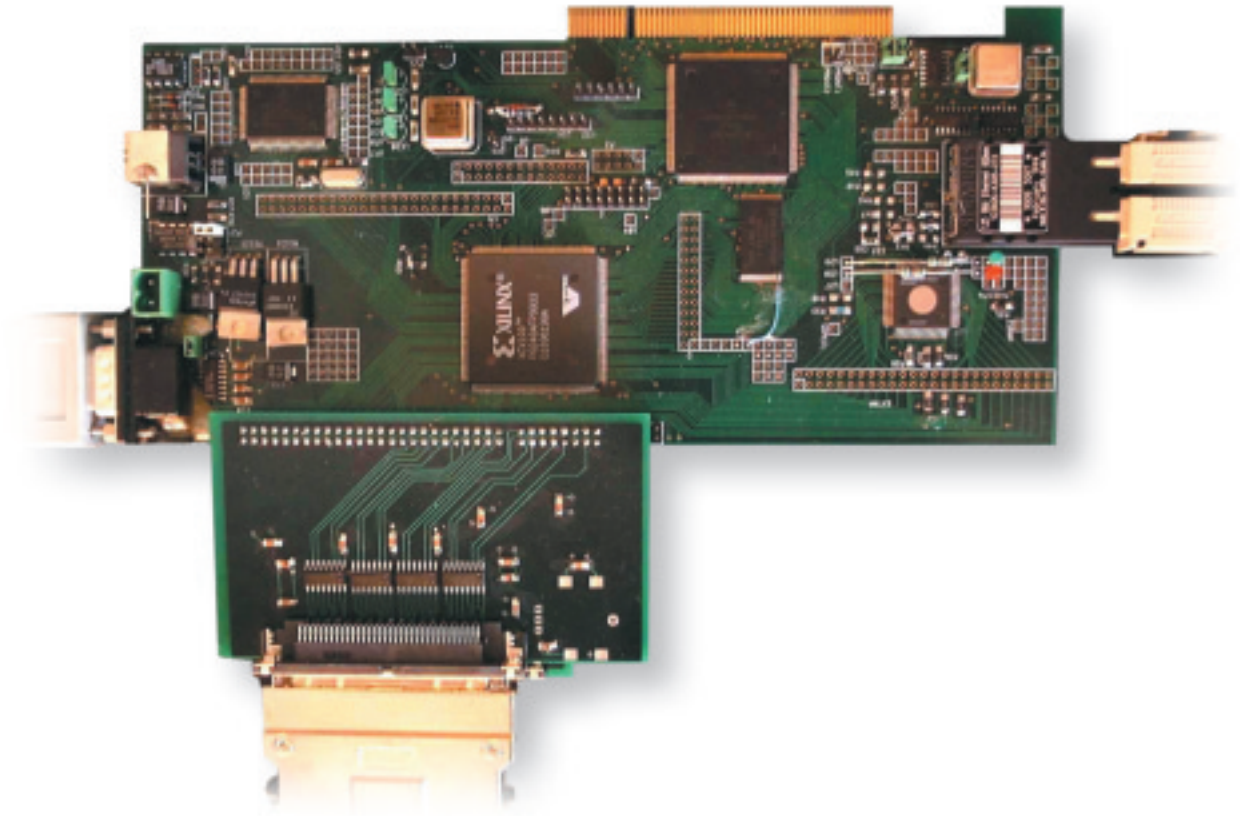


Fig. 2. **Part of the prototype readout chain for the CMS RPC detector: a LINX module and an LVDS adapter card are used to emulate the RPC front-end electronics. The LINX module contains a state-of-the-art field programmable gate array, a high-speed fibre optic link and a signal processor.**

Technology Programme

Ari-Pekka Hameri

Expansion and the search for new activities have marked the year 1999. The global Engineering Data Management Service (EDMS) at CERN and the TUOVI technologies have established themselves as the solution for accessing the main engineering data repositories at CERN. This has involved us in increasingly closer collaboration with end-users and system support people within the HEP community. This activity will intensify, as the challenge will eventually be to manage all information generated throughout the LHC Project's life cycle. Along with the growing robustness of developed technology, we have studied several applications for it in access various physics databases here at CERN. Collaborative activity has been triggered with the CMS and the first results are to be expected in the future. Two national industrial collaboration initiatives were successfully finished in the Process and Quality Control Project, which naturally ended this project within the programme, although Scandinavian collaboration continues until autumn 2000.

Distributed Document Management

The year 1999 was characterized by increased focus on and co-operation with the CERN EDMS Project. The TUOVI team at CERN has repositioned itself clearly as a technology, systems and solutions provider for the CERN EDMS project. Along with the growing usage and increasing user requirements in the EDMS user community, the focus is shifting more towards support and customization of the EDMS infrastructure, rather than its development. This clear-cut distinction between core software developmental activities on the TUOVI team's side and software integration, operations and end-user support on the CERN side lays down the path for true synergy of both teams in the future. The year 1999 was a year of overcoming barriers to cooperation and a year of building synergy with the CERN EDMS Project. The year 2000 will start off on fertile ground seeded in 1999 with the aim of further focusing the TUOVI effort in critical mission tasks in cooperation with CERN client projects.

The year 1999 has been a year of revolution in terms of new software development. TuoviWDM 2.0 was released and integrated into the CERN EDMS and contract follow-up (CFU) client projects. The new version of the system is built around a component framework allowing full customization of system appearance (user-interface) and end-user functionality. The TuoviWDM 2.0 middleware allows extension and customization of data-access (read and write) according to the requirements of the systems environment into which TuoviWDM is deployed. Focus on standard data-access components for connectivity to databases and commercial engineering systems have been built to satisfy the CERN client projects. In addition, the new version includes for the first time the ability to connect globally distributed installations with each other to form truly distributed and global TuoviWDM installations.

TuoviWDM development is driven by state-of-the-art world-class standard technologies. Attending leading international conferences has enhanced crucial technological know-how of the TUOVI team. Team members have participated in conferences on several facets of the core TUOVI development platform, namely the WWW and related technologies. Keeping up with the fast-paced evolution of these technologies is critical in ensuring that system development occurs smoothly. A close eye has also been kept on what is occurring in EDMS markets in general to ensure that the latest trends and visions can be anticipated and prepared for. XML technology, which is anticipated to revolutionize the use of the WWW, has been thoroughly studied while preparing for version 3.0 of TuoviWDM as an open and embeddable web application among millions of other XML applications, which will form the backbone of intelligent WWW in the years to come.

Project tools

To enhance the functions of TuoviWDM the Project Pools Project has concentrated on programming and implementing tools around the main system, which provides end-users with further value-added features. These tools can be classified into two groups:

• Project Management Tools, which include tools for visualizing project status through document usage and lifecycles combined with project schedules. The interactive graphs enable project managers to monitor progress and act proactively to remove possible near-future pitfalls. An advanced notification tool has also been implemented, which

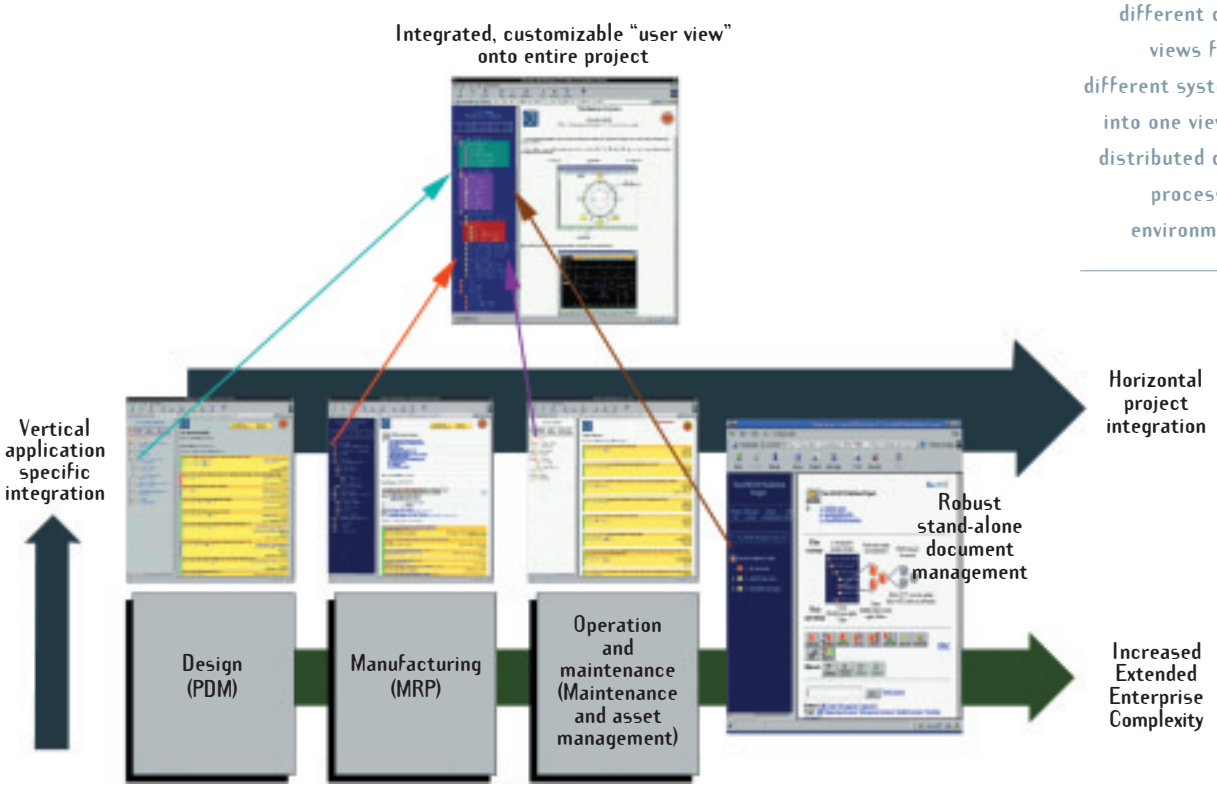


Fig. 1. TuoviWDM integrating different data views from different systems into one view in distributed data processing environment.

enables increasingly more targeted messaging between users and changes in the document statuses.

• Tools for System Integration enable linkage of TuoviWDM with other systems, hosting not only engineering- and document-based information, but also any information important for efficient project management. A special tool has been developed to import directory structures and archived data directly into the TuoviWDM system, which speeds up system initiation and improves data management in an organization. An e-mail interface with TuoviWDM has also been completed, which enables the submission of documents to the system via e-mail and can also record an e-mail conversation as a set of documents when a copy of each message is forwarded to the system. These features are especially handy for geographically distributed operations.

Following these lines of integration with other systems, the project has developed within the Nordic collaboration project a prototype integration between TuoviWDM and a ship-modelling system, which is being tested in a Finnish shipyard. Integration of these tools with the main TUOVI system is still under way and will continue year 2000.

Process and quality control

This project was ended in autumn when both national research projects termed MYKO- and FIT-PRO with industry ended. The focus of the process and quality control project was to convey and enhance research results obtained from distributed data management in HEP collaboration with domestic industry and to establish applied research results. Joint research work had been carried out with nine Finnish companies, with a multitude of results and cultural exchange. The main results of these projects were:

• Document flows and their use in a multi-partner project delivery of a complex system product formed the focus of the MYKO Project. The four companies involved were all concerned with large-scale make-to-order deliveries with several external parties. It was discovered that interfaces between organizations form the bottlenecks for fluent project management. WWW technologies developed by HIP were tested to study how structured document management could be achieved such an industrial environment. Results from piloting the novel technologies received very positive feedback and increased awareness of the potential embedded

in WWW-based applications for managing distributed operations.

• A product-oriented approach to industrial project management was the focus of the FIT-PRO project, which served as a state-of-the-art study of current project management practices in five leading Finnish project companies. By using a case approach, the project developed new product-oriented management models and practices in close cooperation with industrial companies and the TAI Research Centre within the Helsinki University of Technology. One of the novel ideas was based on the sharp distinction between single and multiproject management, which in turn should be distinguished from product and process management and general company management. The experience obtained from industry has been partially used at CERN to complement the documents defining project and configuration management processes.

In addition, these intense collaborations between a research team located at CERN and Finnish industrial consortia show that modern information technology overcomes problems generated by distance. The work has established cross-cultural activities, generating mutual benefits both for industry and basic research at CERN. As a legacy from these activities the Connecting Distributed Competencies (CoDisCo, Nordisk Industrifond project no. 98082) Project is still active and continues to integrate wider industrial initiatives with experience generated at CERN and its configuration and information management activities in distributed engineering processes. The project has provided CERN with three students supporting the configuration management routines, who have been documenting and actually processing the engineering changes within the LHC Project.

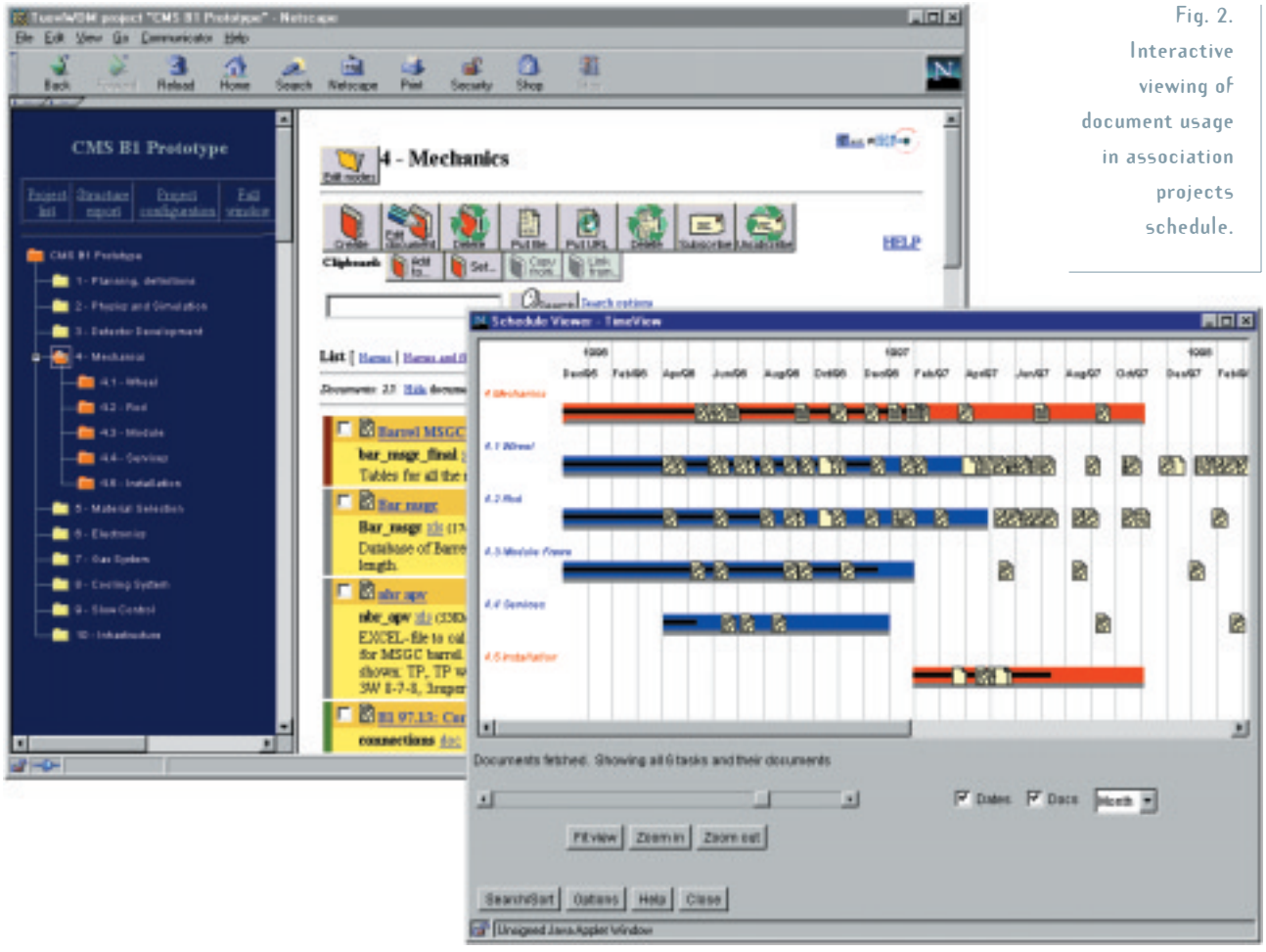


Fig. 2. Interactive viewing of document usage in association projects schedule.

Administration

Mikko Sainio

Research is, of course, the main activity of HIP, but a sizeable effort has also been invested in upkeep of the research infrastructure and other supportive activities. Beyond research, another obligation is the furthering of graduate study in the Institute. HIP is not a degree-granting institution; that is the task of universities, but a large number of graduate students do their research in HIP-affiliated groups. An increasing number of students join the Institute already as undergraduates and finish their Masters' theses in HIP projects. During 1997-1999 11 doctoral and 32 Masters' degrees have been earned by HIP students in different universities in Finland and abroad. The senior staff of HIP also participates in teaching at the universities and contributes to the different graduate schools in the country.

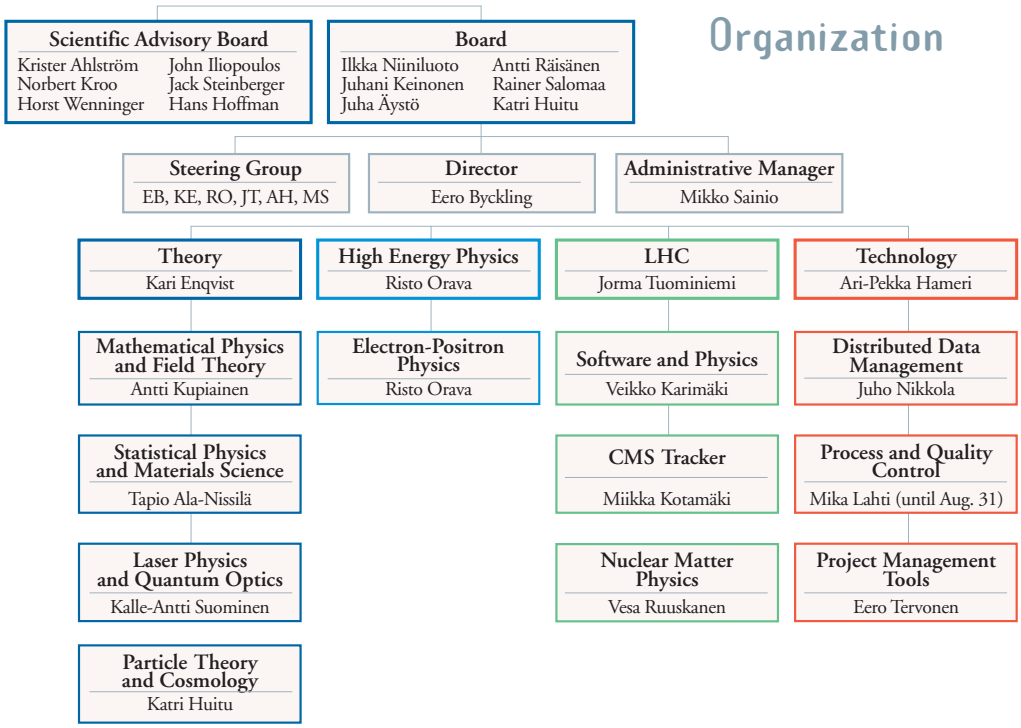
In early 2001 the administration and parts of the research personnel of the Institute will be moving to Physicum, the new physics building of the University of Helsinki presently under construction in Kumpula about 3 km from the current premises. In addition to the office space, HIP will in Kumpula have joint laboratory space and clean rooms with the Physics Department.

As part of the CERN activity, HIP participates in a research project aiming at creating a computer-based Open Learning Environment, led by the Digital Media Institute of Tampere University of Technology and funded by TEKES. The particular project, with which HIP is involved, is the WU, which is an international pilot based on the concept of a virtual university, where distant participants communicate over high-speed networks using applications such as the WWW, multicast, interactive videoconferencing and video-on-demand. The pilot uses national research networks and European-wide high-speed Internet connections provided by the European Commission. The WU enables physics researchers to update their knowledge by participating interactively in CERN seminars and experiments from their personal workstations. The WU began in 1995 as a collaborative pilot between CERN and Finland by communicating the latest results of high-energy physics directly to universities. The WU teaching is interactive and it targets, in principle, researchers and university students, but some courses in physics and information technology have also been offered to special groups, such as journalists and the general public.

In matters regarding technological and commercial cooperation, HIP collaborates with Cerntech, which is an independent programme providing services to Finnish companies with international Big Science projects such as CERN. Cerntech is part of the company Finntech Oy and is mainly financed by TEKES.

Organization and Personnel

Organization



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Vice Chairman	**Antti Räisänen,** Vice Rector (Helsinki University of Technology)
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	Rainer Salomaa, Professor (Helsinki University of Technology) (until Aug. 31)
	Peter Lund, Professor (Helsinki University of Technology) (starting Sept.1)
	Juha Äystö, Professor (University of Jyväskylä, Appointed by the Ministry of Education)
	Katri Huitu, Docent (Chosen by personnel of HIP)

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Norbert Kroo, Director Institute for Solid State Physics of the Hungarian Academy of Sciences)

Jack Steinberger, Professor (CERN, Nobel Prize in Physics in 1988)

Personnel

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K. Rummukainen,
prof., adj. senior scientist

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N. Lütkenhaus, senior scientist
N. Vitanov, senior scientist
P. Törmä, scientist
M. Havukainen, scientist
J. Calsamiglia, grad. student
J.-P. Martikainen, grad. student
J. Piilo, grad. student
M. Rodriguez, grad. student
A. Collin, student
M. Jahma, student
T. Maila, student
O. Pakarinen, student

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A. Schenkel, senior scientist
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J. Lukkarinen, grad. student
O. Pasanen, grad. student

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T. Hjelt, scientist
M. Rost, senior scientist
P. Salo, scientist
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M. Kuittu, grad. student
E. Kuusela, grad. student
J. Lahtinen, grad. student
R. Linna, grad. student
S. Majaniemi, grad. student
M. Rusanen, grad. student
E. Falck, student
A. Gynther, student
J. Hirvonen, student
J. Kallunki, student
T. Lappi, student
A. Mankila, student
P. Nikunen, student
A. Nummenmaa, student
H. Pasanen, student

High Energy Physics Programme

R. Orava, prof., programme director

Electron-Positron Physics

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K. Österberg, adj. senior scientist (at CERN)
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A. Kiiskinen, grad. student (at CERN)
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J. Ojala, researcher
S. Rovio, researcher
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J. Petrelius, student
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J. Klem, post doc scientist (at CERN)
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C. Williams, scientist (at CERN)
A. Heikkinen, grad. student (at CERN)
M. Haapakorpi, student (at CERN)
T. Lampén, student (at CERN)
K. Anderson, summer trainee (at CERN)
J. Heinonen, summer trainee (at CERN)
E. Pulliainen, summer trainee (at CERN)
S. Rantala, summer trainee (at CERN)
L. Wendland, summer trainee (at CERN)

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K. Tammi, grad. student (at CERN)
T. Vanhala, grad. student (at CERN)
B. McCartney, student
T. Mäenpää, student
M. Hämäläinen, summer trainee (at CERN)
H. Katajisto, summer trainee (at CERN)
T. Salomäki, summer trainee (at CERN)

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W. Trzaska, adj. Senior scientist

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M. Asplund, scientist (at CERN)
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K. Lönnqvist, scientist
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J. Rehn, scientist
M. Tuisku, scientist (at CERN)
M. Heikkurinen, scientist (at CERN)
T. Anttonen, scientist
J. Leppänen, scientist
T. Siekkinen, scientist
M. Viitala, scientist (at CERN)
M. Minkkinen, summer trainee (at CERN)
K. Nurminen, summer trainee (at CERN)

Administration and Support

E. Byckling, prof., director
M. Sainio, doc., adm. manager
H. Luutonen, financial manager
M. Flygar, secretary (at CERN)
T. Jokinen, secretary
K. Kraappa, secretary
C. Sivori, secretary (at CERN)
O. Vuola, tech. coordinator
T. Rautanen, researcher (at CERN)
R. Rinta-Filppula, researcher (at CERN)
A. Korhonen, researcher (at CERN)
M. Myllymäki, senior system analyst
T. Vehviläinen, lab. engineer

Seminars

Seminars held in Helsinki

January 7th E. Keski-Vakkuri (Uppsala University, Sweden)
BTZ black holes and Maldacena's conjecture

January 19th K. Kajantie (Department of Physics)
Superconductivity phenomena in electroweak matter in the early universe

January 28th J. C. Polkinghorne (Cambridge, UK)
Physics and the meaning of the universe

February 2nd T. Linden (Department of Physics / SEFO)
Strangelet search with the experiment NA52

February 9th A. Heikkinen (HIP/CERN)
The compact muon solenoid experiment for the large hadron collider

February 10th S. Bose (Imperial College, London)
Generalizations and applications of entanglement swapping

February 11th P. Pandita (Shillong, India)
The light Higgs boson in supersymmetric models

February 23rd K. Enqvist (Department of Physics / HIP)
Recent progress with cosmic microwave background radiation

March 2nd K. Sneppen (Nordita)
Cooperativity and function in the biological nanoworld

March 11th P. M. Kluit (NIKHEF, Amsterdam)
A search for heavy stable particles at LEP2

March 12th M. Battaglia (Dept. of Physics / HIP)
Silicon detector R&D activities and a Finnish design of a vertex tracker for future colliders

March 16th M. Wikström (Institute of Biomedical Sciences, University of Helsinki)
The respiratory enzyme - a molecular machine

March 23rd R. Kashaev (Academy of Finland / HIP)
Liouville central charge in quantum Teichmüller theory

March 30th T. Hjelt (HIP)
Dynamics of polymer chains on surfaces

April 13th M. Rost (HIP)
Insect population dynamics — an interacting many-body system in nature

April 15th K. Rummukainen (Nordita)
Baryon number violation and hard thermal loops on the lattice

April 20th Some highlights of recent conferences and meetings
J. Asikainen (HIP),
Monte Carlo and structure optimization methods for biology, chemistry, and physics,
Florida State University, Tallahassee, March 20-30.
H. Kurki-Suonio (HIP),
Planck low frequency instrument consortium meeting, Florence, March 25-26

May 4th M. Havukainen (HIP)
Numerical cavity QED simulations in 2-dimensions

May 11th A. Schenkel (HIP)
Phase transition in random resistor networks

May 18th D. Olive (University of Wales, Swansea)
Aspects of Electromagnetic duality

May 20th P. Muratore-Ginanneschi (Centre for Chaos And Turbulence Studies-NBI, Copenhagen)
Shell model approach to turbulence

May 25th M. Tanimoto (Ehime University, Japan)
Neutrino masses and mixings in gauge theories with flavor symmetry

June 1st J. Cleymans (Universities of Cape Town and Bielefeld)
Unified description of freeze-out parameters in relativistic heavy ion collisions

June 2nd Z. Yu (Vienna, Austria)
Probing R-parity violation in the production of $t\bar{c}$ (and $c\bar{t}$) on the lepton colliders

June 3rd Y. Schröder (DESY)
Infrared problems of the static QCD potential

June 8th J. Hintikka (Boston University, USA)
A logic for quantum theory

June 8th C. E. Carlson (The College of William and Mary, USA)
Excited baryons in large N_C QCD

June 10th K. G. Selivanov (ITEP, Moscow)
Post-classicism in tree amplitudes

June 15th J. Javanainen (University of Connecticut)
Field theory for coherent photoassociation of a Bose-Einstein condensate

June 18th S. Roy (Allahabad, India)
Some aspects of R-parity violating supersymmetry

June 21st A. Kobakhidze (Tbilisi, Georgia)
Beyond the minimal SU(5) GUT

June 29th M. Noga (Bratislava, Slovakia)
Macroscopic structures in interacting electron systems

August 3rd A. Rajantie (University of Sussex, UK)
Non-equilibrium dynamics of the Abelian Higgs model

August 17th N. Manton (DAMTP, Cambridge, UK)
Multi-monopole geometry

August 24th J. Kalkkinen (SISSA, Trieste)
AdS/CFT correspondence and non-critical type 0 strings

September 2nd Z. Chvoj (Institute of Physics, Academy of Sciences of the Czech Republic/ Technical University, Prague)
Interrelation between collective surface diffusion and surface morphology

September 3rd H. Arenhövel (Mainz, Germany)
Electromagnetic reactions on the two-nucleon system in the intermediate energy region

September 7th P. Huovinen (Jyväskylä)
Thermal electromagnetic emission in ultrarelativistic heavy-ion collisions

September 14th Conference reports
C. Montonen (HIP), **Strings 99 at Potsdam.**
K. Puolamäki (HIP), **SUSY 99 at Fermi Lab**

September 21st F. Montalenti (Physics Department, University of Genova, Italy)
Diffusion on channeled metal surfaces

October 5th A. Mezincescu (Bucharest, Romania)
Inverse approach to semiconductor heterostructure design

October 12th P. Kinnunen (Department of Medical Chemistry, Institute of Biomedicine)
The physics of life

October 19th P. Pennanen (Nordita, Denmark)
Meson-meson interaction on a lattice: Exotica and string breaking

October 26th V. Khoze (INFN-LNF/CERN)
Top quark and W-boson studies at future colliders

November 2nd R.Orava (HIP)
Colour connections at LEP

November 9th O. S. Trushin (Institute of Microelectronics of RAS Yaroslavl, Russia / HIP / HUT)
Molecular-dynamics simulations of atomic mechanisms of epitaxy in metal/metal systems

November 16th R. Chehab (Laboratoire de l'Accelerateur Lineair Universite Paris-Sud)
Positron sources for linear colliders: the channeling approach

November 23rd P. Janhunen (FMI/GEO)
Magnetohydrodynamic simulations in space plasmas

November 30th V. Mangazeev (Australian National University, Canberra)
Bethe-Ansatz for the three-layer Zamolodchikov model

December 7th N. V. Antonov (St Petersburg University, Russia)
Renormalization group and anomalous scaling in "toy models" of advect passive scalar

December 14th L. Faddeev (Academy of Finland/ Steklov Inst., St. Petersburg, Russia)
Present day status of infra-red parametrizations of the Yang-Mills field

Visitors

Theory Programme

Laser Physics and Quantum Optics

S. Bose (UK) 8. - 14.2.
D. Bruß (Germany) 24.2 - 3.3.
J. Javanainen (USA) 14. - 17.7.
P. Törmä (Austria) 21. - 24.6.
M. Dusek (Czech Republic) 27.7. - 7.8.
M. Rodriguez (Spain) 1.8. - 30.9.
K. Mølmer (Denmark) 8.-10.10.
S. Paraoanu (USA) 3.-11.12.

Mathematical Physics and Field Theory

D. Olive (UK) 17.-22.5.
N. Manton (UK) 16.-18.8.
J. Kalkkinen (Italy) 1.-31.8.
P.Muratore-Gianneschi (Denmark) 15-21.5.
J.Bricmont (Belgium) 6-17.8., 29.11.-5.12., 16-22.12.
A. Volkov (Russia) 20.11.-20.12.
V. V. Mangazeev (Australia) December

Particle Theory and Cosmology

P.N. Pandita (India) 8.-15.2.
A. Demichev (Russia) 9.3.-8.5., 25.8.-24.10.
Z.-H. Yu (Vienna) 27.5.-5.6.
M. Raidal (Germany) 6.-15.7.
A. Kobakhidze (Georgia) 16.-25.6.
K. Selivanov (Russia) 6.-12.6.
M. Carena (USA) 6.-12.6.
S. Roy (India) 14.-26.6.
W. Chen (Canada) 9.7.-3.8.
S. Pallua (Croatia) 14.-29.7.
A. Wodecki (Poland) 2.-24.8.
K. Nishijima (Japan) 25.8.-7.9.
H. Perez Rojas (Havana) 10.9.-09.11.
A. Mezincescu (Bucharest) 26.9.-11.10.
P. Presnajder (Bratislava) 04.10. - 30.11.
P. Kulish (Russia) 03.11.-25.12.

Statistical Physics and Materials Science

M. Haataja (Canada) 6. - 12.1.
O. Trushin (Russia) 8. - 20.3.
I. Vattulainen (Denmark) 15.3. - 21.3.
11.5. - 17.5., 16.10. - 24.10., 18.11. - 21.11.
S. Badescu (USA) 5.5. - 31.7.
S. C. Ying (USA) 28.5. - 28.6., 19.11. - 25.11.
L. Y. Chen (USA) 28.5. - 5.6.
R. E. Watson (USA) 28.5. - 6.6.
V. N. Muthukumar (USA) 29.5. - 6.6.
Z. Chvoj (Czech Republic) 30.8. - 4.9.
E. Granato (Brazil) 1.8. - 21.8.
P. Eckle (Finland) 22.8. - 26.8.
F. Montalenti (Italy) 17.9.- 23.9.
K. Rummukainen (Denmark) 19.10. - 24.10.
T. Flugt (Holland) 19.10. - 24.10.
R. Toral (Spain) 19. - 24.10.
F. Baletto (Italy) 18. - 24.10.
T. Rahman (USA) 19. - 24.11.

LHC programme

Software and Physics

G.Snow (USA) 26.-27.7.
K. Laasonen (Finland) HIP/CERN 15.-17.11.

CMS Tracker

M. Kudla, K. Pozniak and R. Romaniuk (Poland) 29.-30.4.
T. Czyzew and M. Hojda (Poland) 3.2.-3.5.1999, 1.8.-30.9.
P. Foryt and T. Nakielski (Poland) 1.4.-30.6.
S. J. Hong and S. Park (Korea) 28.-29.10.

Nuclear Matter

V. Lyapin (Russia) several visits
A. Kolojvari (Russia) several visits
G. Zinovjev (Ukraine) 11.1-14.1
V. Borshchov (Ukraine) 11.1-14.1
S. Kiprich (Ukraine) 11.1-14.1
J. Pluta (Poland) 14.4-18.4.
S. Igolkine (Russia) 7.5.-10.5.
F. Duado (Italy) 7.5.-9.5.
G. Giraudo (Italy) 7.5.-9.5.
G.-J. Nooren (Holland) 7.5.-9.5.
J. Buskop (Holland) 7.5.-9.5.
M. Komogorov (Russia) 24.8.-20.9.
16.11-31.12.
H. Satz (Germany) 21.9.-27.9.
C. Salgado (Spain) 21.9.-1.10.
X.-N. Wang (USA) 22.9.29.9.
M. Rachev (Russia) 1.11.-19.11

Conference Participation, Talks and Visits by Personnel

Theory Programme

Laser Physics and Quantum Optics

University of Hanover,
19-28 January, Hanover, Germany
(talks by K.-A. Suominen)

Royal Institute of Technology,
2-6 February, Stockholm, Sweden
(talk by K.-A. Suominen)

The Annual Meeting of the Finnish Physical Society,
4-6 March, Turku, Finland (M. Havukainen, J.-P. Martikainen, J. Piilo, K.-A. Suominen)

Workshop on Atom Optics and Atom Interferometry,
8-11 March, Sylt, Germany (K.-A. Suominen)

Ørsted Laboratory, University of Copenhagen,
11-19 March, Copenhagen, Denmark (J. Piilo, K.-A. Suominen)

Frühjahrstagung der Deutschen Physikalischen Gesellschaft,
15-19 March, Heidelberg, Germany (invited talk by N. Lütkenhaus)

Department of Physics and Astronomy, University of Aarhus,
14-18 April, Århus, Denmark (N. Lütkenhaus)

Department of Optics, Palacky University,
26-30 April, Olomouc, Czech Republic
(N. Lütkenhaus)

Sixth Central-European Workshop on Quantum Optics,
30 April - 3 May, Olomouc, Czech Republic
(invited talk by N. Lütkenhaus)

Escolar '99,
1-4 May, Elounda, Crete (J. Piilo)

European Science Foundation,
8 May, Strasbourg, France (K.-A. Suominen)

NorFA Network School on Quantum Information
11-16 May, Århus, Denmark (J. Calsamiglia, lectures by N. Lütkenhaus and K.-A. Suominen)

University of Kaiserslautern,
11 May - 10 June, Kaiserslautern, Germany (talk by N. Vitanov)

Clarendon Laboratory, University of Oxford,
18-29 May, Oxford, U.K. (N. Lütkenhaus)

Minisymposium on Cold Atoms and Bose-Einstein Condensation,
2 June, Stockholm, Sweden (A. Collin, T. Maila, J. Martikainen, K.-A. Suominen)

Nordic Seminar on Atomic Physics: Light-Atom Interactions and Collisions,
22-28 June, Svalbard, Norway (J. Calsamiglia and J. Piilo)

Newton Institute Workshop on Complexity, Computation and the Physics of Information,
4-17 July, Cambridge, U.K. (talk by N. Lütkenhaus)

TMR School on Quantum Computation and Quantum Information Theory,
12-23 July, Turin, Italy, (J. Calsamiglia)

Nordita Master Class in Physics,
24-31 July, Copenhagen, Denmark (M. Jahma, T. Maila)

9th International Summer School,
2-13 August, Jyväskylä, Finland (J. Piilo)

Ørsted Laboratory, University of Copenhagen,
23-31 August, Copenhagen, Denmark
(K.-A. Suominen)

International Workshop on Atomic Interactions in Laser Fields,
1-3 September, Torun, Poland (invited talk by K.-A. Suominen)

Negotiations on the EQUIP proposal on EU IST programme,
21-23 September, Brussels, Belgium
(K.-A. Suominen)

European Research Conference on Bose-Einstein Condensation,
14-19 November, San Feliu de Guixols, Spain
(K.-A. Suominen)

European Research Conference on Quantum Optics X,
2-7 October, Mallorca, Spain (N. Lütkenhaus, K.-A. Suominen)

University of Geneva,
11-17 October, Geneva, Switzerland (N. Lütkenhaus)

Department of Physics, University of Hanover,
29 October - 8 November, Hanover, Germany
(J. Calsamiglia, N. Lütkenhaus)

Department of Theoretical Physics, University of Hanover,
1 November, Hanover, Germany
(talk by N. Lütkenhaus)

Conference on Quantum Control, Coherence and Information,
14-19 November, Nof-Genossar, Israel (invited talk by K.-A. Suominen)

University of Marburg,
24-28 November, Marburg, Germany
(M. Havukainen)

Ørsted Laboratory, University of Copenhagen,
29 November - 10 December, Copenhagen, Denmark (K.-A. Suominen)

Los Alamos National Laboratory,
30 November - 4 December, New Mexico, USA (talk by N. Lütkenhaus)

Workshop on Quantum Information Processing,
4-12 December, Montreal, Canada (N. Lütkenhaus)
NEC Workshop on Quantum Cryptography,
12-15 December, New Jersey, USA (invited talk by N. Lütkenhaus)

Mathematical Physics and Field Theory

Mittag-Leffler Institute, Royal Academy of Science,
January - May, Stockholm, Sweden (A. Niemi)

Mittag-Leffler Institute, Royal Swedish Academy of Sciences,
15 February - 30 March, Stockholm, Sweden (lectures by L. Faddeev, C. Montonen)

German-Israeli Meeting on Turbulence,
15-22 February, Tel-Aviv, Israel (invited talk by A. Kupiainen)

The Annual Meeting of the Finnish Physical Society,
4-6 March, Turku, Finland (talk by J. Lukkarinen)

Royal Institute of Technology,
17 March, Stockholm, Sweden
(talk by C. Montonen)

University of Uppsala,
22 March, Uppsala, Sweden, (talk by C. Montonen)

Royal Institute of Technology
April, Stockholm, Sweden (talk by A. Niemi)

Gordon Research Conference "Modern Developments in Thermodynamics",
18-23 April, Il Ciocco, Italy (J. Lukkarinen)

MIT
15 May, Cambridge, USA (talk by L. Faddeev)

C. N. Yang Conference,
18 - 21 May, New York, USA (invited talk by L. Faddeev)

NYU Courant Institute,
23 May, New York, USA (talk by L. Faddeev)

Hamiltonian Mechanics and Small Divisors in Partial Differential Equations, ICMS,
24 May - 4 June, Edinburg, UK, (A. Schenkel, invited talk by A. Kupiainen)

Royal Society of Science,
May Stockholm, Sweden (lecture by A. Niemi)

Volkswagen Programme Workshop,
17-21 June, Berlin, Germany, (invited talk by L. Faddeev)

Dynamics Days,
17-23 June, Como, Italy (invited talk by A. Kupiainen)

Lattice '99,
29 June-3 July, Pisa, Italy (J. Lukkarinen)

International Europhysics Conference, High Energy Physics 99,
15-21 July, Tampere, Finland (S. Hemming, J. Lukkarinen, talk by C. Montonen, O.Pasanen)

Strings 99,
19-25 July, Potsdam, Germany (C. Montonen)

Brasilian Mathematical Colloquium,
25 July - 30 July, Rio de Janeiro, Brazil, (lectures by L. Faddeev)

University of Ioannina,
July, Crete, Greece (A. Niemi)

NATO ASI summer school, Quantum Geometry
9-21 August, Akureyri, Iceland (O. Pasanen)

Visions in Mathematics,
25 August - 3 September, Tel-Aviv, Israel (invited talk by A. Kupiainen)

International School of Subnuclear Physics, 37th Course,
28 August - 8 September, Erice, Italy (O. Pasanen)

Moshe Flato Memorial, University of Bourgogne,
5-9 September, Dijon, France (invited talk by L. Faddeev)

EU Workshop on Finite Temperature Quantum Field Theories,
September, Corfu, Greece (lectures by A. Niemi)

Erwin Schroedinger Institute,
October, Vienna, Austria (talk by A. Niemi)

Cambridge University and Isaac Newton Institute of Mathematics,
October, Cambridge, UK (A. Niemi)

H. Lehmann Memorial Conference, DESY
3-5 November, Hamburg, Germany (invited talk by L. Faddeev)

Mathematical Quantum Field Theory,
9-12 November, Sao Paolo, Brazil (talk by A. Kupiainen)

University of Uppsala,
13-16 November and 16-19 December Uppsala, Sweden (E. Keski-Vakkuri)

University of Reykjavik,
November, Reykjavik, Iceland (lecture by A. Niemi)

MIT and Yale University,
November, Cambridge and New Haven, USA (A. Niemi)

Nordic Network Meeting on Supersymmetric Field and String Theories,
2-4 December, Helsinki, Finland (invited talk by E. Keski-Vakkuri, organized by C. Montonen, O. Pasanen)

Cambridge University,
December, Cambridge, UK (lecture by A. Niemi)

Yale-TMU Symposium,
December, Tokyo, Japan (lecture by A. Niemi)

Tokyo University and KEK,
December, Tokyo, Japan (lectures by A. Niemi)

Particle Physics Theory and Cosmology

New York University,
23-31 January, New York, USA, (M. Chaichian)

ACCU-meetings, CERN,
1-4 March, 14-16 September, 7-10 December, Geneva, Switzerland, (K. Huitu)

The Annual Meeting of the Finnish Physical Society,
4-6 March, Turku, Finland (K. Huitu, H. Kurki-Suonio, J. Laitinen, talk by K. Puolamäki, T. Rüppell, and talk by E. Sihvola)

Astronomical Observatory of Trieste,
6-30 April, Trieste, Italy (E. Sihvola)

First Arctic Workshop on Cosmolet,
26-28 April, Sodankylä, Finland (M. Chaichian)

Physics and Experiments with Future Linear e+e- Colliders,
28 April-5 May, Sitges, Spain (talk by K. Huitu)

Metsähovi Radio Observatory, Helsinki University of Technology,
11 May, Espoo, Finland (invited talk by H. Kurki-Suonio)

Tuorla Observatory, University of Turku,
21 May, Piikkiö, Finland (invited talk by H. Kurki-Suonio)

Beyond the Desert '99,
6-12 June, Tegernsee, Germany (invited talk by K. Huitu)

SUSY 99,
June 14-19, Fermilab, Batavia, Illinois (talk by K. Puolamäki)

ICTP Summer School,
21 June - 9 July, Trieste, Italy (J. Laitinen and T. Rüppell)

International Europhysics Conference, High Energy Physics 99,
15-21 July, Tampere, Finland (talk by M. Chaichian, K. Huitu, talk by T. Kobayashi, H. Kurki-Suonio, T. Rüppell, and E. Sihvola)

The XIX International Symposium on Lepton and Photon Interactions at High Energies,
9-15 August, Stanford University, California, US, (M. Chaichian)

ICPS '99 meeting,
11 August, Helsinki (invited talk by K. Enqvist)

Cosmology Summer School,
30 August - 3 September, Nurmijärvi, Finland (lectures by H. Kurki-Suonio)

CERN,
1 September-31 October, Geneve, Switzerland (K. Enqvist)

COSMO99,
September, Trieste, Italy (invited talk by K. Enqvist)

The XIV Max Born Symposium "New Symmetries and Integrable Systems",
20-24 September, Karpacz, (invited talk by M. Chaichian)

CERN,
23-24 September, Geneva, Switzerland, (M. Chaichian)

Workshop on the Development of Future Linear Electron-Positron Colliders for Particle Physics Studies and for Research Using Free Electron Lasers,
23-26 September, Lund, Sweden (invited talk by K. Huitu)

Planck Low Frequency Instrument Consortium Meeting,
7-9 October, Capri, Italy (talk by H. Kurki-Suonio and E. Sihvola)

GEO, Finnish Meteorological Institute,
29 October, Helsinki, Finland (invited talk by H. Kurki-Suonio)

IAU Symposium 198: The Light Elements and Their Evolution,
22-27 November, Natal, Brazil (invited talk by H. Kurki-Suonio)

Seminar, Physics Department, Univ. of Jyväskylä,
24 November, Jyväskylä (invited talk by K. Enqvist)

Statistical Physics and Materials Science

Würzburg University
January, Würzburg, Germany (M. Rost)

Essen University
January and August, Essen, Germany (talk by M. Rost)

9th International Workshop on Computational Materials Science
14-16 January, Trieste, Italy (M. Alatalo)

MATRA Workshop
21 January, Espoo, Finland (organized by T. Ala-Nissilä, talk by M. Kuittu)

The Hebrew University, Jerusalem and Weizmann Institute of Science, Rehovot
31st January - 14th February, Israel (talks by S. Majaniemi)

The Technical University of Denmark,
30 January, Lyngby, Denmark (T. Ala-Nissilä)

COSA Workshop
30-31 January, Tvärminne, Finland (T. Ala-Nissilä, M. Dube, M. Kuittu, S. Majaniemi, talk by M. Rost)

Nordita
1-2 February, Copenhagen, Denmark (T. Ala-Nissilä)

East-West Surface Science Workshop,
20-26 February, Pamporovo, Bulgaria (M. Dubé, J. Heinonen, J. Kallunki, M. Rusanen)

The Annual Meeting of the Finnish Physical Society,
4-6 March, Turku, Finland (T. Ala-Nissilä, J. Asikainen, T. Hjelt, P. Nikunen, M. Rusanen, P. Salo; talk by J. Heinonen, M. Kuittu, and S. Majaniemi)

North Carolina State University
16-20 March, Raleigh, USA (T. Ala-Nissilä)

The American Physical Society March Meeting
20-27 March, Atlanta, USA (talk by T. Ala-Nissilä, talk by S. Majaniemi, talk by M. Rost)

Monte Carlo and Structure Optimization Methods for Biology, Chemistry and Physics
28-30 March, Tallahassee, Florida, USA (J. Asikainen)

Kyushu Kyoritsu University
5-22 May, Kyushu, Japan (J. Heinonen)

CECAM Workshop on Dynamical Correlations in Single Particles and Collective Diffusion on Surfaces
26-28 May, Lyon, France (organized by T. Ala-Nissilä, J. Heinonen, T. Hjelt, E. Kuusela, M. Rusanen)

Summer School on the Physics of Metals and Metal Surfaces: From Theory to Experiments
1-4 June, Seili, Finland (organized by T. Ala-Nissilä, M. Alatalo, P. Salo; talks by E. Falck, A. Gynther, J. Hirvonen, T. Lappi, P. Nikunen, A. Nummenmaa; S. Badescu, J. Lahtinen)

4th Liquid Matter Conference,
3-7 July 1999, Granada, Spain (M. kuittu)

The 9th Jyväskylä Summer School
2-13 August, Jyväskylä, Finland (T. Ala-Nissilä, M. Rusanen)

COSA Workshop, University of Jyväskylä,
7-8 August, Jyväskylä, Finland (organized by T. Ala-Nissilä; talk by S. Majaniemi and M. Rost)

COSTP3 Workshop
9-10 September, Espoo, Finland (T. Ala-Nissilä; talk by J. Heinonen and T. Hjelt)

NORDITA Workshop on Non-Equilibrium Physics
23-25 September, Copenhagen, Denmark (talk by M. Kuittu, talk M. Rost, M. Rusanen)

Summer School on Monte Carlo Methods
20-23 October, Espoo, Finland (organized by T. Ala-Nissilä, M. Alatalo, and P. Salo; talks by J. Asikainen, E. Falck, T. Hjelt, E. Kuusela, J. Lahtinen, and M. Rusanen; lecture by J. Heinonen)

Kyushu Kyoritsu and Chubu University
29 October - 7 November, Kyushu, Japan (talks by T. Ala-Nissilä)

Tohwa StatPhys Meeting
8-12 November, Fukuoka, Japan (talk by T. Ala-Nissilä)

MECA Project Annual Seminar
9-10 December, Turku, Finland (talks by M. Alatalo, P. Salo; J. Lahtinen)

High Energy Physics Programme

DELPHI Running Review,
11 February, CERN, Switzerland (talk by K. Österberg)

XXVII SLAC Summer Institute on Particle Physics,
7-16 July, Stanford, USA (A. Kiiskinen)

International Europhysics Conference, High Energy Physics 99,
15-21 July, Tampere, Finland (talk by V. Nomokonov, talk by K. Österberg)

European Conference of Radiology, ECR99,
6 March, Vienna, Austria (invited talk by R. Orava, talk by M. Sarakinos)

International Conference, Science and Technology for Development, 2nd Caribbean Workshop,
22-26 March, Havana, Cuba, (invited talk by R. Orava)

CMS Tracker Seminar,
4 May, CERN, Switzerland (talk by K. Österberg)

8th International Workshop on Vertex Detectors VERTEX'99,
20-25 June, Texel, Netherlands (invited talk by K. Österberg)

Medical Physics 1999,
1-4 September, Patras, Greece (talk by M. Sarakinos)

DELPHI Week,
16-21 September, Cracow, Poland (talk by A. Kiiskinen, talk by K. Österberg)

2nd ECFA/DESY Linear Collider Workshop,
17 October, Obernai, France, (talk by A. Kiiskinen)

LHC Programme

Software and Physics

The Annual Meeting of the Finnish Physical Society,
4-6 March, Turku, Finland (A. Heikkinen, talk by V. Karimäki, C. Williams)

Workshop on Physics at TeV Colliders,
8-18 June, Les Houches, France (invited talk by R. Kinnunen, invited talk by A. Nikitenko)

International Europhysics Conference, High Energy Physics 99,
15-21 July, Tampere, Finland (talk by A. Heikkinen, V. Karimäki, invited talk by R. Kinnunen)

The 1999 European School of High-Energy Physics,
22 August-4 September, Casta Papiernicka, Slovakia (A. Heikkinen)

CERN School of Computing,
12-25 September, Stare Jablonki, Poland (J. V. Heinonen)

CMS Collaboration meeting,
13-17 September, Villigen, Switzerland (V. Karimäki, R. Kinnunen, A. Nikitenko)

GEANT4 Workshop at ESTEC,
20-24 September, Noorwijk, The Netherlands (talk by A. Heikkinen)

3rd LHC Computing Workshop,
28 September-1 October, Marseille, France (A. Heikkinen)

2nd ECFA/DESY Study on Physics and Detectors for a Linear Electron- Positron Collider,
16-19 October, Obernai, France (invited talk by R. Kinnunen)

CMS Tracker

The Second Workshop on Optical Readout Technologies for ATLAS
7-8 January, Oxford, UK (K. Banzuzi)

University of Jyväskylä Accelerator Laboratory
1-3 July, Jyväskylä, Finland (K. Banzuzi, B. McCartney, E. Pietarinen)

The Fifth Workshop on Electronics for LHC Experiments
20-24 September, Snowmass, Colorado, USA (talk by K. Banzuzi)

International Workshop on Accelerator Alignment,
18-21 October, Grenoble, France (talk by K. Tammi, M.Kotamäki, A.Onnela, T.Vanhala)

Warsaw University and Warsaw University of Technology
25-29 November, Warsaw, Poland (K. Banzuzi, E. Pietarinen)

Several visits to CERN
(K. Banzuzi, E. Pietarinen, T. Mäenpää)

Nuclear Matter

The Annual Meeting of the Finnish Physical Society,
4-6 March, Turku, Finland (talk by S. Hankonen)

The Beta Decay, from Weak Interaction to Nuclear Structure,
17-19 March, Strasbourg, France (talk by S. Hankonen)

Halo Joint Study Weekend,
28-30 May, Copenhagen, Denmark (talk by S. Hankonen)

ECT* Workshop in "Advances in shell model studies in nuclei far from stability"
14-25 June, Trento, Italy (invited talk by A. Jokinen)

International Europhysics Conference, High Energy Physics 99,
15-21 July, Tampere, Finland (invited talk by Kari J. Eskola)

Autumn Workshop
16-18 October, Jyväskylä, Finland (talk by W.H.Trzaska)

ALICE Physics and Technical Board Meeting
18 November, CERN, Switzerland (talk by W.H.Trzaska)

Finnish Science Days in Poland, Nuclear Physics Symposium
29 November - 4 December, Warsaw, Poland (invited talk by W.H.Trzaska)

International Symposium on Proton-Emitting Nuclei
7-9 October, Oak Ridge, Tennessee, USA (invited talk by A. Jokinen)

Technology Programme

Connecting Distributed Competences Workshop,
18-19 January, Oslo, Norway (talk by A.-P. Hameri and J. Rehn)

CIMdata PDM Conference '99,
20-22 April, Atlanta, Georgia, USA (E. Tervonen)

12th International Software Quality Week, QW'99,
24-28 May, San Jose, California, USA (T. Kunnas)

Open Source Convention,
21-24 August, Monterey, California, USA (M. Asplund)

Connecting Distributed Competences Workshop,
6-7 September, Reyðarfjörður, Island (talk by A.-P. Hameri and J. Rehn)

Comprehensive Test Ban Treaty Organization (CTBTO),
5-24 September, Vienna, Austria (T. Hakulinen)

NORDNET'99 Managing Business by Projects,
15-18, September, Helsinki, Finland (A.-P. Hameri, N. Høimyr, talk by J. Meklin, talk by M. Lahti, Artto K., and M. Arenius)

CIMdata Europe '99,
12-14 October, Nice Acropolis, France (M. Viitala)

XML One Fall '99,
8-11 November, Santa Clara, California, USA (R. Puittinen)

15th Annual Computer Security Applications Conference, ACSAC'99,
6-10 December, Phoenix, Arizona, USA (T. Kunnas)

Administration and Support

ETÄKAMU Conference
21-22 January, Tampere, Finland (invited talk by R. Rinta-Filppula)

CERN,
1-3 February, 28 March - 1 April, 26 April - 29 April, 19 - 21 July, 16 - 22 September, 24 - 28 October, 8 - 11 November, Geneva, Switzerland, (E. Byckling)

Interaktiivinen teknologia seminar,
15-17 April, Hämeenlinna, Finland (invited talk by R. Rinta-Filppula)

EPP Outreach meeting,
29-30 April, CERN, Switzerland, (talk by R. Rinta-Filppula)

IFIP ComNEd '99,
13-18 June, Hämeenlinna, Finland, (invited talk by R. Rinta-Filppula)

ED-MEDIA'99,
19-24 June, Seattle, USA (invited talk by R. Rinta-Filppula)

International Europhysics Conference, High Energy Physics 99,
15-21 July, Tampere, Finland (E. Byckling, M. Sainio)

8th International Symposium on Meson-Nucleon Physics and the Structure of the Nucleon,
15-21 August, Zuoz, Switzerland (invited talk by M. Sainio)

Institute of Theoretical Physics, University of Bern,
23-24 August, Bern, Switzerland (M. Sainio)

EPP Outreach meeting,
4-5 November, CERN, Switzerland
(R. Rinta-Filppula)

MindTrek'99,
15-21 November, Tampere, Finland (invited talk by R. Rinta-Filppula)

IST'99,
22-24 November, Helsinki, Finland (R. Rinta-Filppula)

FUNET meeting,
8 December, Espoo, Finland (distance talk by R. Rinta-Filppula and T. Rautanen)

Publications

Theory Programme

Laser Physics and Quantum Optics

V. Buzek, G. Drobny, M. G. Kim, M. Havukainen, and P. L. Knight,
Numerical simulations of atomic decay in cavities and material media,
Phys. Rev. A 60 (1999) 582

J. Calsamiglia, S. W. Kennedy, A. Chatterjee, A. Ruina, and J. T. Jenkins,
Anomalous frictional behavior in collisions of thin disks,
Journal of Applied Mechanics 66 (1999) 146

M. Havukainen, G. Dobny, S. Stenholm, and V. Buzek,
Quantum simulations of optical systems,
J. Mod. Opt. 46 (1999) 1343

M. Havukainen and S. Stenholm,
Coherence properties of the stochastic oscillator,
Phys. Rev. A 60 (1999) 621

N. Lütkenhaus,
Estimates for practical quantum cryptography,
Phys. Rev. A 59 (1999) 3301

N. Lütkenhaus, J. Calsamiglia, and K.-A. Suominen,
Bell measurements for teleportation,
Phys. Rev. A 59 (1999) 3295

M. Machholm, P.S. Julienne, and K.-A. Suominen,
Collisions of cold magnesium atoms in a weak laser field,
Phys. Rev. A 59 (1999) R4113

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The validity of the Landau-Zener model for output coupling of Bose condensates,
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S. Stenholm and N. V. Vitanov,
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N. V. Vitanov,
Transition times in the Landau-Zener model,
Phys. Rev. A 59 (1999) 988

N. V. Vitanov,
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Phys. Rev. A 60 (1999) 3308

N. V. Vitanov and K.-A. Suominen,
Nonlinear level-crossing models,
Phys. Rev. A 59 (1999) 4580

N.V. Vitanov, K.-A. Suominen, and B. W. Shore,
Creation of coherent atomic superpositions by fractional stimulated Raman adiabatic passage,
J. Phys. B 32 (1999) 4535

N. V. Vitanov and S. Stenholm,
Adiabatic population transfer via multiple intermediate states,
Phys. Rev. A 60 (1999) 3820

N. Lütkenhaus,
Quantum key distribution: theory for application,
Appl. Phys. B 69 (1999) 395

Mathematical Physics and Field Theory

M.P. Brenner, P. Constantin, L.P. Kadanoff, A. Schenkel, and S. Venkataramani,
Diffusion, attraction and collapse,
Nonlinearity 12 (1999) 1071

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Nucl. Phys. B 537 (1999) 161

L. Faddeev and A. J. Niemi,
Decomposing the Yang-Mills field,
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L. Faddeev and A. J. Niemi,
Partially dual variables in SU(2) Yang-Mills theory,
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Partial duality in SU(N) Yang-Mills theory,
Phys. Lett. B 449 (1999) 214

A. Kupiainen, J. Bricmont, and K. Gawedzki,
KAM theorem and quantum field theory,
Commun. Math Phys 201 (1999) 699

A. Kupiainen, J. Bricmont, J. Taskinen,
Stability of Cahn-Hilliard fronts,
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E. Langmann and A. J. Niemi,
Towards a string representation of infrared SU(2) Yang-Mills theory,
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A precise measurement of the partial decay width ratio $R_b^0=\Gamma_{b\bar{b}}/\Gamma_{had}$,
E. Phys. J. C 10 (1999) 415

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Measurements of the leptonic branching fractions of the tau,
E. Phys. J. C 10 (1999) 201

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Search for charginos nearly mass-degenerate with the lightest neutralino,
Eur. Phys. J. C 11 (1999) 1

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Measurement of the lifetime of b-baryons,
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Measurement of the forward backward asymmetry of c and b quarks at the Z pole using reconstructed D mesons,
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Search for neutral Higgs bosons in e^+e^- collisions at $\sqrt{s}$ = 183 GeV,
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Nuclear Matter

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