Annual Report 2001

HELSINKI INSTITUTE OF PHYSICS

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The CMS detector under construction in the surface hall of CMS. The large red rings form the return yoke of the magnetic field. The holes in the rings will host the muon detector units. The large steel cylinder inside the yoke is the outer wall of the vacuum tank of the superconducting solenoid that will create the magnetic field of 4 Tesla. The large cylindrical structure in the foreground is the hadron calorimeter that will be fitted in the space inside the magnet coil.

Annual Report 2001 Helsinki Institute of Physics

Contents

Introduction

Dan-Olof Riska

The year 2001 was a year of change for the Helsinki Institute of Physics, which serves as a national Finnish project oriented institute for theoretical physics and as the co-ordinating institute for Finnish research at various international accelerator laboratories, the first and foremost being CERN. The changes and associated challenges took place at several different levels.

The most obvious change was the move of the Helsinki Institute of Physics from the old physics block in the Kruununhaka district of downtown Helsinki to the new Physicum building within the campus of the exact sciences of the University of Helsinki in the Kumpula district. The modern and efficient office and laboratory space made it possible to bring research groups that were working in Helsinki and Espoo together in one joint site. A joint inauguration symposium for all the institutes in the new Physicum building was organised in September 2001. The physics programme of the symposium was opened by Robert A. Eisenstein, Assistant Director for Mathematical and Physical Sciences of the U.S. National Science Foundation, with a presentation on "The Future of the Physical Sciences". The inauguration ceremony was attended by the Minister of Education Ms. Maija Rask.

The administrative structure of the Helsinki Institute of Physics changed in 2001 with the replacement of the previous statutes of the Institute with a joint agreement of the Universities of Helsinki and Jyväskylä and the Helsinki University of Technology to operate the Institute. This agreement came into force on January 1, 2002. The mandate of the Institute remains unchanged, however.

The year 2001 saw the implementation of the new budget structure of the Helsinki Institute of Physics, by which the Ministry of Education now only provides a core part, rather than all the budget as it did before, and with the member universities now providing the remainder. The implementation of this new structure of financing regrettably brought with it a significant budget cut, the effect of which was fortunately to some extent ameliorated by successful raising of external research grants by the research groups of the Institute.

The renewal of the Theoretical Physics Programme of the Institute began in 2001 with an open call for letters-of-intent for new theory projects. This call brought 9 proposals, which were evaluated by an expert committee. Upon subsequent recommendation by the Scientific Advisory Board of the Institute the financing of three new 3 year projects beginning in 2002 was approved by the Board of the Institute. The three new projects are (1) String theory and quantum field theory, (2) Physics of biological systems and (3) Ultrarelativistic heavy ion collisions.

In 2001 the Helsinki Institute of Physics began a collaboration with the Low Temperature Laboratory of the Helsinki University of Technology to pursue a physics research programme within the COMPASS experiment at CERN. The Low Temperature Laboratory has contributed significantly to the instrumentation of that experiment.

During the year, the Academy of Finland (the Finnish research funding agency) carried out a comprehensive evaluation of Finnish CERN activities since 1991, when Finland joined CERN. The review panel, which was chaired by Professor Peter Paul, Deputy Director of Brookhaven National Laboratory, presented its findings in May

("Evaluation of the Finnish CERN Activities", Academy of Finland 3/01). The overall very positive report contains a number of constructive recommendations, which will provide guidelines for the future course of the Helsinki Institute of Physics.

During 2001 the Technology Programme of the Helsinki Institute of Physics was reoriented from its earlier focus on internet-based distributed data management towards development of high throughput data-intensive Grid-type computing. A grant from the Magnus Ehrnrooth Foundation made it possible to construct a PC-cluster for Grid computing at the Institute. The fruitful co-operation between the Technology Programme of the Institute and CERNTECH, which co-ordinates collaboration between Finnish industry and CERN has continued and strengthened.

During 2001 the Board of the Institute approved a new research programme on "Nuclear Matter" to begin in 2002. This programme expands the earlier project with the same name within the LHC Programme of the Institute, and is focused on the ALICE and ISOLDE collaborations at CERN.

During the year 2001 the research activity of the Institute was organised into the following main research programmes: (1) the "Theory Programme", (2) the "High Energy Physics Programme", (3) the "Large Hadron Collider (LHC) Programme" and (4) the "Technology Programme". These research programmes were supported by a budget of about 22 MFIM, which was composed of a base budget from the Finnish Ministry of Education and contributions from the member universities of the Institute, as well as by external funds from different sources raised by the leaders responsible for specific tasks and research collaborations. The Institute is an assistant contractor of the European Data Grid project of the European Union.

The Theoretical Physics Programme was divided into projects on mathematical physics, statistical physics and materials science, laser physics and quantum optics, cosmology and phenomenological particle physics. The High Energy Physics Programme was divided into projects on electron-positron physics, small angle proton-proton scattering and development of luminosity detectors for the LHC experiments and instrumentation for the COMPASS experiment of CERN. The LHC Programme was divided into projects for development of the CMS tracker and software for the CMS data analysis. The Nuclear Matter project within the LHC Programme fell into subprojects for experimental work at the ISOLDE facility at CERN and instrumentation for the ALICE detector at the LHC as well as on the theory of relativistic heavy ion collisions. The main effort of the Technology Programme was made in software development for Grid-type high performance supercomputing, and included the establishment of a PC-cluster for Grid Computation. These research programmes are described in detail in this Annual Report.

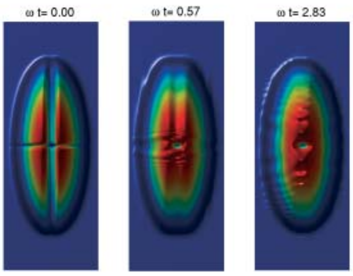
Graduate training in physics and applied physics was carried out within graduate schools supported by the Academy of Finland, as well as by support for graduate student research within the research projects of the Institute. The Institute also arranged joint colloquia with the departments of physics of the member universities. An important educational activity is the summer student programme at CERN, which the Institute has continued to support. The Institute has participated in the CERN component of the "Open Learning Environment" pilot project of the Tampere University of Technology and funded by the National Technology Agency, TEKES. The project has developed Internet based educational programmes from CERN to Finnish high schools and universities.

The activities of the Institute were overseen by a Scientific Advisory Board that was chaired by Professor Hans Falk Hoffmann, CERN. On the recommendation of the Scientific Advisory Board an expert review of the small angle proton-proton scattering project of the High Energy Physics Programme was carried out. This review, which was conducted by Professor John Dainton, Liverpool, and Professor Günter Wolf, DESY, suggested several new opportunities for the project to be implemented in 2002.

HELSINKI INSTITUTE OF PHYSICS

Highlights of Research Results

Theory Programme



In cosmology a novel alternative to inflation, the ekpyrotic universe which is based on brane collisions in five dimensions, was studied in collaboration with the Mathematical Physics group. In laser physics it was shown how in a spinor Bose-Einstein condensate one can create a stable topological monopole structure. The project leader Kalle-Antti Suominen received the Magnus Ehrnrooth Prize in March 2001 for his work on the laser cooling and trapping of atoms and cold collisions. In mathematical physics, a no-go theorem for noncommutative gauge field theories was formulated and a noncommutative version of the Standard Model was proposed. The work of the Particle Physics Theory group was closely connected with extra dimensional models; it was pointed out that the mixing of the Higgs with the radion of extra dimensional models may require change in the Higgs detection strategy at LHC. In statistical physics the focus was on the dynamics in strongly interacting many-body systems. New extrapolation methods for finding saddle points and transition rates were developed, and applied to a variety of problems including atomic dynamics on surfaces, growth, and chemical reactions.

High Energy Physics Programme

During the past year the High Energy Physics Programme comprised the following research activities: (1) electron-positron physics, (2) proton-proton forward physics, (3) the COMPASS experiment and (4) generic detector research for applications in demanding environments.

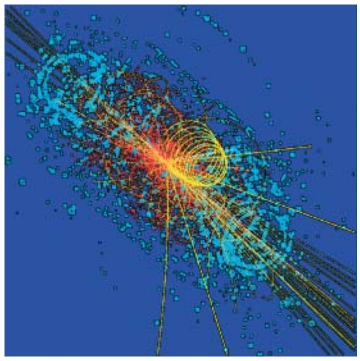
In electron-positron physics, the Helsinki group has probed into until then unexplored domains of masses for new physics in analysing the LEP data, among them the theoretically favoured region for the Higgs boson. The group has had a co-ordinating role in the overall DELPHI experiment activity on charged Higgs bosons, in the final analysis of the Z^0 decay data as well as in data obtained at record breaking centre-of-mass energies in excess of 207 GeV. The most recent results exclude mass values almost up to the W mass. The group has also completed a conceptual design of a vertex tracker based on a novel type of silicon pixel detectors with capacitive charge sharing.

Options for a second-generation experiment on forward physics and luminosity studies at LHC were presented at CERN to an Expert Review Group, as proposed by the HIP Scientific Advisory Board (SAB). The review report is positive, and recommends that the project be oriented, in addition to the CDF collaboration at Fermilab (USA), towards contributions to the TOTEM collaboration at the LHC/CERN. The proposal of the Helsinki group to join the CDF experiment was accepted in the CDF collaboration during their Executive Board meeting of 15 November, 2001. The engineering prototype of a novel small-angle detector system, called the *μstation* was completed in November 2001.

The COMPASS experiment at CERN made significant progress during the year 2001, e.g. the target reached a world record polarisation of +58% and -48% at 2.5 T field.

LHC Programme

The CMS detector system has taken visible shape in 2001, as its most massive parts,



the magnet yoke and the hadron calorimeter are being put together in the surface hall of the CMS experimental site at the LHC accelerator ring.

In the CMS Tracker project a major milestone was the procurement of the 80 000 silicon strip detectors from industry. Similarly, the procurement of the Tracker Outer Barrel support structures, designed by the HIP CMS team, was completed and the construction of the TOB can now be started.

In detector research an important development took place when the LHC Programme joined the Microelectronics Centre of the Helsinki University of Technology. This appreciably strengthens the means of the HIP CMS R&D project to develop novel radiation hard silicon detectors. This capability was successfully demonstrated in 2001 with the manufacturing of a good number of high quality devices.

In the CMS RPC project an important milestone was reached as the first prototypes of the Optical Links for the RPC trigger were built and tested for synchronous operation in a CERN test beam with an LHC-like time structure.

The CMS simulation package CMSIM, maintained by the HIP Software team, played a key role in detector optimisation and physics studies. Several million events were simulated with CMSIM in production runs distributed to Regional Centres in Europe and the USA using GRID tools. The package is an important component in the CMS DataGrid validation studies. Significant progress was made in the Object Oriented modelling of the hadronic interactions on nuclei as well as in the detector alignment software (the DALI package).

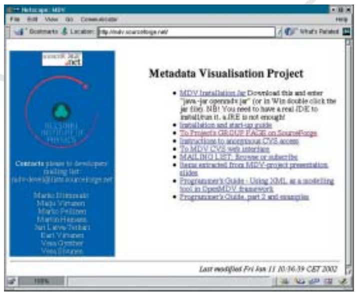
An important breakthrough in physics simulation was achieved by the HIP Physics team in the development of the τ-identification algorithms. It was demonstrated that the expected precision in the measurement of the impact parameters of the τ decay leptons and of the reconstructed τ secondary vertex will allow good efficiencies in τ-identification.

In the Nuclear Matter project the HIP-JYFL ALICE team was given Project Leader status for the T0 detector in recognition of their experience in fast timing and in managing experimental collaborations at JYFL.

At ISOLDE a continuation of high-precision measurements on the beta decay of ^{74}Rb have resulted in an upper limit, $\delta_{IM} < 0.07\%$, for the Coulomb mixing for the excited 0^+ state in ^{74}Kr. The obtained value is the most important correction for deriving the precise value on charge dependent corrections for the up-down quark mixing matrix element V_{ud} in the Cabibbo-Kobayashi-Maskawa matrix.

Technology Programme

The global DataGrid initiative which aims to develop and implement the massive data storage and computing resource for the LHC Programme and other scientific research, has formed the very essence of the Technology Programme during the year 2001. The two projects of the Programme have focused both on software development and on establishing the hardware environment to harness the alternative technologies available to tackle the near future computing challenge. The overall DataGrid effort follows the open-source policy, and by respecting this spirit the Programme has released various software packages that can be used on top of the Grid technologies. A major effort has been made to establish the hardware cluster in Otaniemi and initiate the training of young computer experts. This work and the collaboration with the Center for Scientific Computing under the EU-DataGrid umbrella got a head start as the necessary infrastructure was set up, paving the road towards research on how to manage several clusters at the same time. Under the EU-funded initiative the Programme has established a strong position within the DataGrid-security community, which is heading towards its own initiative. Apart from the direct DataGrid-related initiative, the Programme has been actively jointly looking for applications with industry that could benefit from the novel technologies that are being developed. This has led to several initiatives with nanotechnology researchers and dermatologists to manage massive amounts of data and images using Grid technologies.



Theory Programme

Kari Enqvist

The Theory Programme provides a platform for the project leaders to conduct high-profile research in a few selected subject fields. The projects are fixed term with a default duration of 3+3 years. They are chosen on the basis of their scientific merit and complement the research in experimental physics at the Institute, as well as at the physics departments of the Member Universities. In 2001 there were five projects: Cosmology; Laser Physics and Quantum Optics; Mathematical Physics and Field Theory; Particle Physics Theory; Statistical Physics and Materials Science. A selection of new projects, starting in 2002, was made in the spring 2001. It is expected that the project leaders will be able to secure considerable external funding for their projects; in this regard 2001 was a quite successful year.

Cosmology

The Cosmology project continued to participate in the Finnish Planck Surveyor Consortium, funded mainly by the Academy of Finland Antares space programme. The activity has centred on concrete issues in map making and on theoretical considerations regarding the role of isocurvature perturbations in the power spectrum. We participate in the CTP working group, the purpose of which is to establish ways to estimate the temperature and polarization spectra of CMB. The isocurvature perturbations were for open and closed universes, allowing for a large spectral tilt and scanning the parameter space for the best fit to the COBE, Boomerang, and Maxima-1 data. We found that the current data strongly disfavour pure isocurvature perturbations. This seems to indicate that pre-Big Bang models, which are alternatives to inflation, are also disfavoured since they predict a pure isocurvature spectrum. However, we have pointed out that adiabatic fluctuations could still be a possibility in pre-Big Bang models with decaying axions.

Work on another topical alternative to inflation, ekpyrosis, was also carried out in col-

John Calsamiglia (on left) defended his Ph.D. thesis on Quantum information processing in December 2001, with Stig Stenholm (KTH, Stockholm) as the opponent.

laboration with the HIP Mathematical Physics project. We showed that in order to obtain standard gravity on the visible brane, its tension should be positive. If the sizes of both the fifth dimension and the Calabi-Yau threefold are fixed, time-dependent brane matter is not allowed.

Ekpyrosis is just part of the efforts devoted to the cosmological consequences of extra dimensions. We investigated bulk and brane matter in the Randall-Sundrum model. If the radion has stabilized by dissipating its energy into the bulk in the form of some unspecified matter, only the stiff ideal fluid equation of state is allowed. In collaboration with the HIP Particle Physics Theory project, we investigated the g-2 of the muon in SUSY models with gauge multiplets in the bulk of extra-dimensions. We also described a simple Affleck-Dine-type scenario for baryogenesis in theories with large extra dimensions. Baryogenesis was pursued in four dimensions by studying numerically the fragmentation of the Affleck-Dine condensate and the subsequent formation of Q-balls. We also noted that a recent suggestion that Q-balls could be self-interacting dark matter is not easy to realise in realistic models.

The main part of the Cosmology activity is funded by sources external to HIP which are administered by the University of Helsinki Department of Physical Sciences.

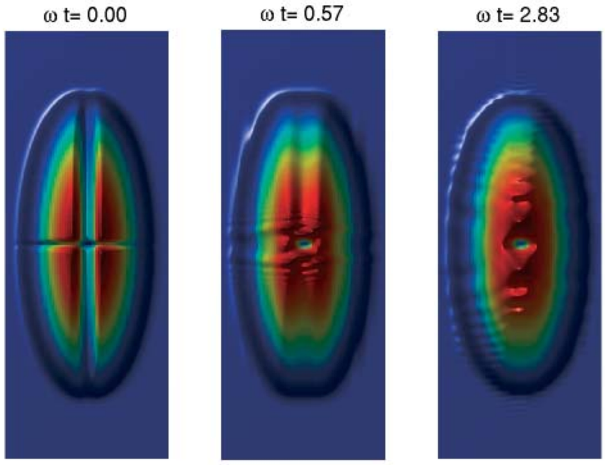
Laser Physics and Quantum Optics

The first experimental observation of a Bose-Einstein condensation in dilute atomic gases was in 1995, and those involved with this achievement were awarded the 2001 Nobel Prize in Physics. A few years earlier, 1997, the Nobel Prize was awarded for the laser cooling and trapping of atomic gases, which is an important part of the road towards Bose-Einstein condensation. Among other things, these methods have made it possible to study the quantum nature of atoms and their interactions, which is revealed at low temperatures in traps where atomic motion becomes strongly quantized.

As previously, the main topic for the theoretical work done at HIP has been the dynamics and interactions between cold atoms. In recognition of the high quality of our work, the project leader Kalle-Antti Suominen received the Magnus Ehrnrooth Prize in March 2001. Also, a former project member, Päivi Törmä, was appointed professor in electronics at the University of Jyväskylä in 2001. Both events illustrate the strong local tradition in research into modern optics and quantum mechanics, as established by Stig Stenholm. Perhaps as a prelude to a possible Nobel Prize, HIP partially supported the Nordic School on Atomic Quantum Gases and Matter Wave Optics, organised by Chris Pethick and Kalle-Antti Suominen on Kakskerta Island, Turku, Finland, on May 21-31, with Randall Hulet, Gordon Baym, Tilman Esslinger and many others as lecturers. The school attracted about 40 participants from the Nordic and Baltic countries.

Since the atoms in the condensate have a spin, one can use the position dependence and the multicomponent form of the condensate wave function to prepare topological objects such as monopoles. Experimentally the condensates are easily manipulated with external electromagnetic fields. We have shown that one can in fact create a monopole structure by combining a soliton and one or two vortices, existing in different spin components. Such a structure appears to be more stable than its constituents. We have also studied the dynamics of monopoles. This work formed the final part of Jani Martikainen's Ph.D. thesis, which was successfully defended in December 2001.

Another important aspect of atomic Bose-Einstein condensates is that atoms can be combined coherently into molecules via photoasso-

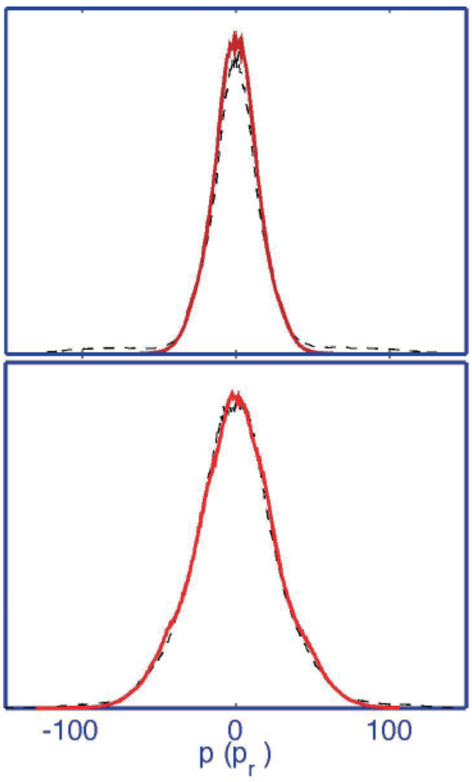


The time evolution of the total density of a two-component Bose-Einstein condensate in a cigar shaped optical trap. Initially, a vortex has been created in one component (perpendicular line) and a soliton in another (horizontal line). These imprints form a monopole with the core lying in the center of the condensate.

ciation. We have studied how photoassociation techniques can be used to produce a macroscopic quantum superposition of atoms and molecules in a condensate. Such an object allows one to study the borderline between classical and quantum mechanics. Similarly, we have shown that using photoassociation, superfluidity can also be introduced.

In studies of optical collisions we showed earlier that in red-detuned lattices the inelastic collisions are enhanced by the lattice laser field. We have now studied the blue-detuned case, and shown that the emerging optical shielding effect makes the collisions practically elastic. In our international collaboration on atomic clocks and collisions of alkaline earth atoms within the EU CAUAC network we finished the first studies on laser-induced loss of cold atoms from magneto-optical traps. Interestingly, we found that at very low temperatures the molecular vibrational states should be observable in the laser frequency dependence of the loss rate, and the linewidths of these states would be clearly smaller than the expected thermal width, due to a quantum mechanical suppression effect.

In quantum information we have studied the adaptive absorption of photons, and how to use it as an attack mechanism in quantum cryptography. We have also continued our earlier studies of Bell measurements. Together with the above-mentioned macroscopic atom-molecule superposition this work forms a major part of John Calsamiglia's Ph.D. thesis, which was successfully defended in December 2001. Finally, we have looked into the question of decoherence appearing in closed and finite quantum systems.



Atomic collisions in an optical lattice built with a blue-detuned laser field for a typical laser cooled alkali atom situation. The figure shows atomic momentum distributions (the solid red lines are the initial ones, and the dashed black ones the final ones). For weak laser fields (upper frame) some heating of atoms occurs, which is seen as the appearance of small wings after repeated collisions. For stronger fields optical shielding dominates and makes the collisions elastic (lower frame).

Mathematical Physics and Field Theory

The Mathematical Physics and Field Theory group has a broad area of research interests.

One of the interesting directions, in string theory, is to understand the properties of quantum strings in generic curved background spacetimes. Of particular interest is the quantization of string theory in asymptotically anti-de Sitter spacetimes, as it has been proposed by J. Maldacena that these theories are dual to conformal theories in one less dimension. In the case of 2+1 dimensions, string theory in an AdS background can be formulated as an SL(2,R) Wess-Zumino-Witten model. In the year 2000, long-standing puzzles about the spectrum of the model were solved by J. Maldacena and H. Ooguri, using the so-called spectral flow symmetry of the model. One of the important questions is how to extend this work to black holes in 2+1 anti-de Sitter spaces, which are Z orbifolds of the AdS spacetime. Last year, Samuli Hemming and Esko Keski-Vakkuri showed how to construct the spectral flow symmetry for strings in 2+1 AdS black hole backgrounds. They showed how the spectral flow generates the so-called twisted sectors, analysed the spacetime spectrum of bosonic string excitations, and showed how the orbifold projection of the model is realized in the spectrum. This opens up new ways to study properties of strings in black hole backgrounds.

The formalism of brane-like states appears to have an important significance in the attempts to understand the non-perturbative physics of strings and branes. In the paper "BRST properties of Brane like states" (Polyakov) we have given a detailed and rigorous proof that the brane-like states are physical, i.e.

BRST non-trivial and BRST-invariant. In addition, we have presented a proof that the low-energy effective action corresponding to the brane-like vertex operators is given by the Dirac-Born-Infeld expression, i.e. the world-volume action for D-branes. The derivation of the low-energy effective action gives precise evidence of the relevance of the brane-like states to non-perturbative p-brane physics and M-theory. Interesting applications of the brane-like formalism were considered in a work by M. Chaichian, A. Kobakhidze and D. Polyakov. In this paper we considered the tachyonic brane-like states (called ghost tachyons), the phenomenon of their condensation on D-branes and the application of this phenomenon to brane phenomenology and extra dimensions.

We have shown that the ghost tachyons condense on D-branes, created by massless brane-like states. Thus the vacuum stability is achieved dynamically, as the effective ghost tachyon potential exactly cancels the D-brane tension, in full analogy with Sen's mechanism of the conventional tachyon condensation. As a result, from the perturbative NSR model point of view, massless and tachyonic brane-like states appear to live in a parallel world, as the brane is screened by the tachyonic veil. We have extended the analysis to the brane-anti-brane pair in AdS space and shown that in this case due to the effect of the ghost tachyon condensation one can construct extra time-dimensional phenomenological models without tachyons and antibranes. We argued that the phenomenon of the ghost tachyon condensation may also prove useful to formulate the NSR superstring theory without the GSO projection.

The noncommutative quantum field theories and their implications are one of the main focuses of the group. Studying the general structure of the noncommutative local groups, we have proved in a paper (Chaichian, Prešnajder, Sheikh-Jabbari and Tureanu) a no-go theorem for NC gauge theories. According to this theorem, the closure condition of the gauge algebra implies that: 1) the local NC *u(n) algebra* only admits the irreducible *n x n* matrix-representation. Hence the gauge fields are in n by n matrix form, while the matter fields *can only be* in fundamental, adjoint or singlet states; 2) for any gauge group consisting of several simple-group factors, the matter fields can transform nontrivially under *at most two* NC group factors. This no-go theorem imposes strong restrictions on the NC version of the Standard Model and in resolving the standing problem of charge quantization in noncommutative QED. Mainly based on these results, we have constructed a noncommutative version of the usual electroweak theory. We have discussed how to overcome the two major problems: 1) although we can have noncommutative *U(n)* (denoted by $U_*(n)$) gauge theory we cannot have noncommutative *SU(n)* and 2) the charges in noncommutative QED are quantized to just 0, ±1. The problem with charge quantization, as well as with the gauge group, can be resolved by taking the $U_*(3) \times U_*(2) \times U_*(1)$ gauge group and reducing the extra *U(1)* factors in an appropriate way. Then we proceed with building the noncommutative version of the Standard Model by specifying the proper representations for the entire particle content of the theory, the gauge bosons, the fermions and Higgs and presenting the full action for the noncommutative Standard Model (NCSM). In addition, among several peculiar features of our model, we have addressed the *inherent* CP violation and new neutrino interactions.

Another main theme of the group are the higher-dimensional theories. It has been found

The Laser Physics and Quantum Optics project took part in organising the Nordic School on Atomic Quantum Gases and Matter Wave Optics on Kakskerta Island, Turku, Finland, on May 21-31, 2001. The school was organised by Kalle-Antti Suominen (HIP/Univ. of Turku) and Chris Pethick (Nordita), and Gordon Baym (Univ. of Illinois) was one of the lecturers.

(Chaichian and Kobakhidze) that in a certain class of such theories, like Brane World models, with quasi-localized non-Abelian gauge fields the vacuum structure turns out to be trivial. Since the gauge theory behaves at large distances as a 4+n-dimensional one and thus the topology of the infinity is that of S^{3+n} rather than S^3, the set of gauge mappings is homotopically trivial and the CP-violating θ-term vanishes on the brane world-volume. Also, there are no contributions to the θ-term from the higher-dimensional solitonic configurations. In this way, the strong CP problem is absent in the models with quasi-localized gluons.

Particle Physics Theory

In the Particle Physics Theory project, the main focus has been on the consequences of electroweak symmetry breaking, the supersymmetric models, and the models with extra dimensions.

One of the most important unsolved problems concerning supersymmetry is the mechanism of supersymmetry breaking. Several new proposals have been made in recent years, perhaps the most interesting ones are those made in connection with extra dimensions. We have constrained the parameter space of these supersymmetry breaking models by requiring that the electroweak vacuum corresponds to the deepest minimum of the scalar potential. We found extensive regions of the parameter spaces of the models which are ruled out.

The electroweak symmetry breaking and the Higgs boson connected with it is the main target of the planned collider experiments. Thus any differences to the standard scenarios, which have been studied, are of great interest. It turns out that a particle called the radion, present in extra dimensional models, can mix with the Higgs boson. The mixing was studied in the group in the dominant production process, gluon-gluon fusion, at the LHC. We found that the radion can be detected in a large part of the parameter space, and the mixing can affect the production and decay of the Higgs boson in a significant way.

The masses of unknown particles in supersymmetric and extra dimensional models are not known, but possibly they are heavy compared to the masses in the Standard Model. Thus, it is advantageous to lower the production threshold by considering single production of previously unobserved particles. We have studied the single production of the radion of the extra dimensional models, as well as the sneutrino and gluino of the supersymmetric models at future collider experiments.

The supersymmetric particles can be produced singly only if the so-called R-parity symmetry is broken. Breakdown of a symmetry is most natural, if there is a dynamical reason for it. We have investigated bounds from tree-level and one-loop processes in generic supersymmetric models with spontaneous R-parity breaking in the superpotential. The bounds are applicable both for all models with spontaneous R-parity violation and for explicit bilinear R-parity violation based on general lepton-chargino and neutrino-neutralino mixings.

We have analysed different phenomenological aspects of extra dimensional D-brane constructions. The scenarios with the gauge group and particle content of the supersymmetric Standard Model lead naturally to intermediate values for the string scale, in order to reproduce the value of gauge couplings deduced from experiments. The soft terms, which are generically non universal, and Yukawa couplings of these scenarios are studied in detail. The neutralino-nucleon cross section was computed. Cross-sections exist, where current dark matter experiments are sensitive.

Hadron Physics Activity. The common theme of the research of the Hadron Physics group (D.-O. Riska, M. Sainio, T. Lähde and C. Helminen) during 2001 was the determination of the pion coupling to constituent quarks. By studying the different pionic decay modes of the excited charm (D) mesons it was found that the chiral quark model form for the coupling gives a satisfactory description of the empirical branching ratios and overall decay rates. This result fits very well with earlier work by the group on the role of the pion. The pion decay width of the $D_1(2420)$ meson was found to provide strong evidence for suppression of the axial charge of constituent light flavor quarks, a result, which is analogous to the corresponding suppression of M1 decay rates of heavy flavor quarks that is caused by the effective confining interaction.

In the work on baryon and nuclear structure the strength of the coupling of vector mesons to orbitally excited baryon resonances was determined by means of the chiral quark model. The canonically quantized Skyrme model was employed in a calculation of the electromagnetic and axial form factors of the nucleon.

The pion-nucleon interaction was investigated with the aim of solving the long-standing problems of the coupling strength of pion to nucleon and the chiral symmetry breaking parameter, the sigma-term.

Finally, a study was made of the role of nuclear short range dynamics on eta-meson production in nucleon-nucleon collisions. The short range interaction was determined from realistic phenomenological interaction models.

The research of the group was supported in part by the Academy of Finland, and was carried out in collaboration with colleagues at the State University of New York at Stony Brook, the Institute of Theoretical Physics and Astronomy (Vilnius) and the Instituto Superior Technico (Lisbon).

Statistical Physics and Materials Science

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

We have continued our studies of diffusion of many-particle systems in and out of equilibrium. Our previously developed formalism has been applied to the diffusive properties of hard spherical particles on surfaces with a periodic potential, where we have examined the validity of commonly used approximations such as the lattice-gas theory. In nonequilibrium cases, we have studied in detail the interplay between domain growth and diffusion under the diffusive spreading of density profiles on surfaces. We have also continued to develop and test novel methods for finding transition paths and rates in many-particle systems. In particular, we have obtained new results from applying a path integral formalism to find transition paths and associated rates for many-particle systems. Case studies include the diffusion of 2D nanoscopic clusters on surfaces, stability of strained overlayers, and molecular reactions on surfaces. We have also studied the nature of ledge instabilities in crystal growth under non-equilibrium conditions.

We have continued our work on the properties of disordered fibre networks, and on the dynamics of fronts in such systems. We have further developed a continuum phase-field model to describe the dynamics and kinetic roughening of wetting fronts in porous media. We have also completed our studies of kinetic roughening of slow combustion fronts in paper. Most recently, we have found an analytic solution to the kinetic roughening of driven fronts in fractal media.

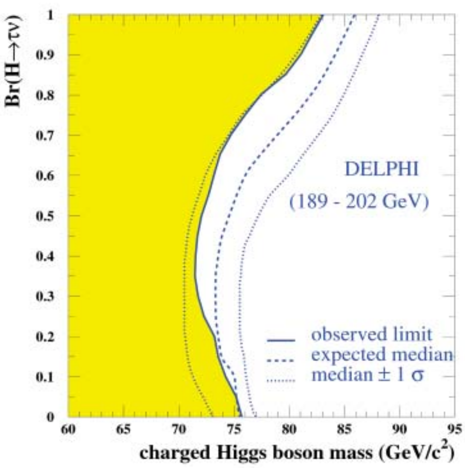
We have continued first principles calculations for metallic alloys and alloy surfaces. We have performed a comparison between different approximations to the density functional theory in the case of adatom diffusion on Al(100). Atomic relaxations and S adsorption on stepped Pd surfaces were studied using the first principles methods. These methods were also used for the interpretation of the STM data for Pd doped Ag surfaces. We have also applied the ab initio and nudged elastic band methods to the oxidation of CO on the Pd(111) surface. Moreover, we performed a systematic study for the compound formation between Al and 4d transition metals.

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. We have studied the evolution of various initial conditions, including twisted rings (un-knots), linked rings and twisted vortices. The results have been visualized by plotting certain gauge-invariant iso-surfaces which helps us to investigate and analyse the elementary processes which lead to the modification of a specific system from one configuration to another.

High Energy Physics Programme

Heimo Saarikko

Encouraged by the positive statements and recommendations presented in the Panel Report (2001) of the Evaluation of the Finnish CERN Activities and in the Report (2001) of the Expert Review Group of the Forward Physics Proposal, the focus of the High Energy Physics Programme was shifted during the year 2001 from the DELPHI experiment to Hadron Colliders, i.e. to the Tevatron Collider at Fermilab/USA and in parallel to the Large Hadron Collider (LHC) at CERN. After nearly twenty years of very successful operation, the CERN LEP Collider was dismantled in 2001. The analysis of LEP data, however, continues probing still unexplored domains of masses for new physics. Plans for the study of Forward Physics at the pp(bar) colliders, aiming at the measurement of fundamental quantities in the uncharted domain of multi-TeV cms energies, were also actively put forward. The proposal of the Helsinki group to join the Fermilab/CDF experiment was accepted by the CDF Collaboration at the end of the year 2001. Final steps for joining the CDF and TOTEM Collaborations are expected to take place during the year 2002. The COMPASS experiment at CERN has also made significant progress: intensive tuning and setting-up work resulted in getting the spectrometer running with a world record polarisation of +58% and -48% at 2.5 T field. Removal of the Detector Laboratory and Clean Rooms to the new premises (Physicum) at the Kumpula campus has been a demanding task, but at the end of the year 2001 this work was successfully completed.



The 95% confidence level observed and expected exlusion regions for $H^{\pm}$ in the plane Br($H \to \tau\nu_\tau$) vs. M_H obtained from a combination of the search results in the fully leptonic, hadronic and semileptonic decay channels at $\sqrt{s}$ = 189-202 GeV. The expected median of the lower mass limits has been obtained from a large number of simulated experiments. The median is the value which has 50% of the limits of the simulated experiments below it and the $\pm 1\sigma$ lines similarly correspond to 84% and 16% of the simulated experiments.

Electron – Positron Physics

At record breaking centre-of-mass energies in excess of 207 GeV, the data analysis of the Helsinki group probes still unexplored domains of masses for new physics, among them the theoretically favoured region for the Higgs boson. The group's final analysis of the Z^0 data and its contribution to the DELPHI charged Higgs analysis directly contribute to the present limits of the validity of the Standard Model. Furthermore the group has been an active participant in physics feasibility studies, detector design and R&D's aimed at future linear e^+e^- colliders (TESLA, CLIC).

Since the year 2000 marked the end of operation of the CERN LEP collider, the emphasis during 2001 has been to ensure that the LEP2 data obtained between 1996 and 2000 with the DELPHI experiment are reconstructed with the most optimal reconstruction algorithms and detector calibrations - this to obtain the most from the collected data and especially to answer the very entangling question of whether a light Higgs boson, which manifests the electroweak symmetry breaking, exists or not? Very preliminary results at the end of the year 2000 showed an excess of signal events as expected from a Standard Model Higgs boson with a mass of about 115 GeV. New preliminary results in summer 2001 confirmed this excess however with a slightly lower significance. Final LEP results on the Higgs search are expected in 2002. The sensitivity of the combined LEP data is not enough to claim a discovery so the final answer has to wait for sufficient data from either the LHC or the Tevatron.

In the field of heavy flavour physics, the group is pursuing an inclusive measurement of the lepton momentum spectra in semileptonic B decays based on the large set of Z^0 decays collected by DELPHI during 1991-95 using recently achieved significant improvements of the B hadron reconstruction algorithms at LEP. Such an inclusive measurement is very difficult to do at the B-factories despite the larger statistics of B hadrons decays available, and hence the DELPHI measurement provides complementary information on, for example, the extraction of the expectation value of the b quark kinetic energy operator inside the B hadron.

The group has actively studied QCD coherence phenomena and developed a novel method of reconstructing colour dipoles and partons in hard scattering final states. A publication, demonstrating for the first time the existence of the dead cone effect for gluon radiation in heavy quark final states, is in preparation.

The group has also looked for pair-produced charged Higgs bosons, predicted by several extensions of the Standard Model, in the high energy LEP2 data. The group has had a co-ordinating role in the overall DELPHI activity on charged Higgs bosons. The most recent results exclude mass values almost up to the W mass. The search effectively applies the algorithms for event colour structure reconstruction as well as jet flavour tagging that were both developed inside the group. The analysis of the 1999 data has been completed and published in 2001 and a publication on the 2000 data is in preparation including the final LEP charged Higgs results.

With the LEP analysis being finalised, the focus of high energy e^+e^- physics is moving towards a high luminosity linear collider, which will cover the energy range from the Z^0 pole up to about 800 GeV. Based on the experience gained from silicon vertex detectors and Higgs analysis contributions to DELPHI, the group has concentrated on defining the precision and discovery potential of the Higgs sector at such a collider. Precise investigations of the Higgs sector, beyond the discovery potential of the LHC or the Tevatron, are required for unambiguous identification of the mechanism responsible for electroweak symmetry breaking, which could be achieved at such a collider with the anticipated detector response.

The group has also completed a conceptual design of a vertex tracker based on a novel type of silicon pixel detectors with capacitive charge sharing. The working principle of these novel detectors has been proved within an R&D effort made in collaboration with the Milan, Krakow and Warsaw Universities. The group has also studied in detail the full reconstruction of the decays of a pair of charged Higgs bosons at such a collider. All these studies were performed in the framework of a series of European Committee for Future Accelerators (ECFA) and DESY sponsored workshops, and the results have been included in the Technical Design Report for the TESLA project, published in 2001. Furthermore, the group has been involved in feasibility studies for a few TeV linear collider at CERN (CLIC).

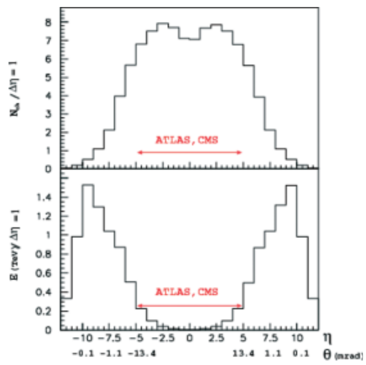
Forward physics and luminosity studies at LHC

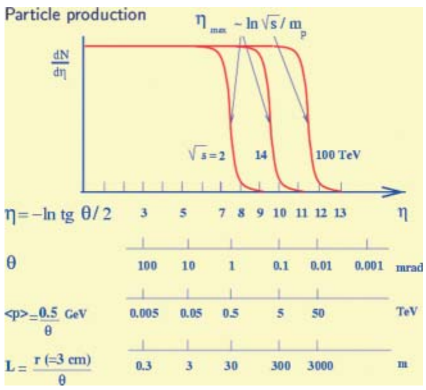
The Forward Physics project aims to provide an extension to a general-purpose experiment at the LHC in order to facilitate searches for new particles such as the Higgs boson and perform important measurements of strong interaction effects at the highest available energies. Physics signatures include leading protons, rapidity gaps and particle production beyond the acceptance limit of the general-purpose detectors. In addition to the strong interaction processes, such as elastic scattering, diffractive excitation and total cross-section measurement, these signatures will serve as important tools in the search for new physics. If new heavy particles are observed, their properties could be investigated in detail. Forward Physics is also an important ingredient in a precise luminosity determination.

A forward extension of a general purpose proton-proton (antiproton) experiment would have sensitivity to the exclusive production of

The microstation represents a novel detector concept designed to register leading protons within the beam vacuum chamber with maximal resolution and acceptance. The engineering model was completed in November 2001.

Higgs boson(s), large extra dimensions, supersymmetric particles (e.g. gluino pairs), glueballs, odderons, hybrids and new χ_c^0 and χ_b^0 decays. It can also do more orthodox QCD physics in unique ways, such as measuring the size of colour-singlet gluon pairs at low x_{Bj}. In addition to the searches for new physics it will enable systematic precision measurements of the double Pomeron exchange process. The proposed forward extension would, in fact, turn the LHC into a gluon factory with an estimated 100 000 high purity (q/g = 1/3000) gluon jets with $E_T > 50$ GeV per year of running at full luminosity. The gluon-gluon events could then be used as a "Pomeron-Pomeron" luminosity monitor. Moreover, a missing mass threshold scan could reveal supersymmetric states such as squarks or gluinos in a virtually background free environment.





Predictions for the number of charged particles (charged multiplicity) and the corresponding energy flow produced at the LHC as a function of the pseudorapidity $\eta = -\ln\tan(\theta/2)$, where θ = production angle with respect to the beam direction. Most of the energy flow is beyond the acceptance of the base line designs of the ATLAS and CMS experiments.

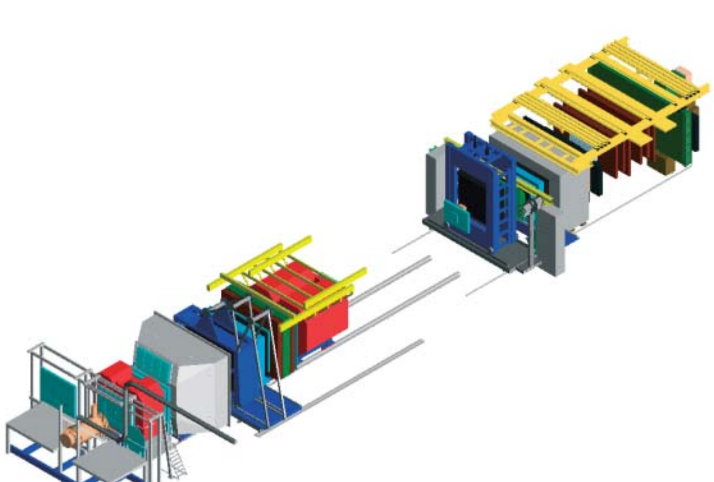
The above physics scenario is not covered by the base line designs of the general-purpose experiments at the LHC (ATLAS and CMS). New physics coverage could be achieved if a viable extension of these detectors in the forward region is provided. The planned extension would allow detection of leading protons and also cover charged particles produced beyond their acceptance limit of $|\eta|=5$. The high gluon-gluon luminosities of the LHC would then be available for physics studies in a unique region of the phase space - the LHC would be turned into a gluon factory. However, the TOTEM collaboration intends to address a part of the Forward Physics project, aiming at the detection of leading protons and of charged particles at large pseudo-rapidities.

A realistic design of such a forward detector system has to address the challenges posed by the need to carry out measurements close to the beam. Detectors have to operate in an intense radiation environment, be movable during beam injection, not interfere with the accelerator operation, meet the constraints due to the installation and access scenarios foreseen for the baseline experiment, and they have to fit in the limited amount of space available for additional detectors inside the experimental cavern.

During the past two years, the Helsinki group has developed a basic detector concept that meets these challenges. A series of prototype structures of microstations has been constructed for testing the mechanical structure and vacuum compatibility. The engineering prototype was completed in November 2001. The design and construction of a fully functional prototype is in progress. This prototype, together with a silicon sensor and its read-out electronics, has to be validated in a test beam.

The COMPASS experiment

The COMPASS experiment at CERN made significant progress during the year 2001. In-



The COMPASS experiment set-up.

tensive tuning and setting-up work was needed to get the spectrometer running. Some of the installation work continued until September in the experimental zone. The working spin polarised target made the acquisition of real physics data possible and also motivated the detector groups to accelerate their set-up work. One week of real physics data was measured at the end of October with the completed spectrometer in stable conditions. The target reached a world record polarisation of +58% and -48% in a 2.5 T field.

The situation of the target and the COMPASS collaboration one year ago was difficult. The superconducting magnet that had been ordered from Oxford Instruments had failed. There were problems in manufacturing the straw detectors at Dubna. However, with efficient collaboration inside CERN and with Saclay, the technical problems were solved.

During February and March the LHC/ECR/Cryolab participated in setting-up, construction, leak checking and testing of the pumping system consisting of 8 roots blowers in series for the ^{3}He circulation and a roots pump system for the ^{4}He cooling. The pumping lines from the pump room to the target platform were finished and leak tested. At the same time a mixture inventory was made. A total of 1387 litres of NTP ^{3}He gas and 7198 litres of NTP ^{4}He gas were found. The dilution cryostat was operated using test isolation vacuum with 80 K radiation shield only. It reached a minimum temperature of 0.25 K even in these conditions. In this test it became clear that the cryostat is superleak tight and no major problems were most likely to be expected in its operation. After the beam time the cooling power of the cryostat was measured to be about 30 mW at 0.1 K and 1 W at 0.4 K with still heating of 15 V. The behaviour is similar to the measurements in the SMC. Thus the performance of the heat exchangers had not deteriorated during the 3 years' storage of the dilution cryostat when the SMC experiment had finished.

The major problem for the target has been the superconducting magnet made by Oxford Instruments. The project has had serious technical problems and difficulties in filling the agreed specifications. It has been delayed by several years. In March it was clear that the Oxford magnet will not be ready for the 2001 run starting in the middle of July. Thus the collaboration decided to use the old magnet from the SMC experiment. The target acceptance was then compromised from 180 mrad (Oxford magnet) to 69 mrad. To use the SMC magnet the mechanical mounting on the target platform had to be modified. A new microwave cavity with a thin 0.1 mm Cu microwave stopper was manufactured at the CERN workshop. After major efforts between CERN and Saclay the testing and setting-up of the complete magnet system was finished at the beginning of August. The magnet was then cooled down to 100 K with LN2. After that the target material from Bochum (^{6}LiD) was loaded inside the dilution chamber. The magnet and dilution cryostats were both cooled to LHe temperature. The magnet was successfully operated at the end of August. Soon after this the target material was polarised for the first time. At the end of September routine polarisation reversal by field rotation was started with a frequency of 3 times/day.

After the beam time the thermal equilibrium signals were taken both at 0.97 K and 1.44 K for D, ^{6}Li and ^{7}Li for the calibration of the polarisation of the different spin materials in the target. In addition, electron paramagnetic resonance lines were taken. To check the validity of the equilibrium spin temperature theory, the NMR-signals from ^{6}Li, proton and ^{7}Li were taken at different deuterium polarisations.

Detector Laboratory

New premises. During the year 2001 the most prominent event in the radiation detector laboratory was the move to a new building (Physicum) and a new laboratory in the Kumpula campus area. The new laboratory consists of a large main laboratory with two smaller laboratory rooms (an irradiation room and a wet chemistry room) and a large clean room downstairs. The clean room is divided into several sections containing a small class 100 room, two larger class 1000 rooms, a service corridor and an entrance room. The use of the clean rooms is shared between the Helsinki Institute of Physics and the Department of Physical Sciences.

The gas analysis system was reassembled after the move to the Kumpula campus area. After the reassembling the system was tested and recalibrated. A new gas filtering system and oxygen meter were procured and tested. At the end of the year a new absorption unit was also purchased for outgassing studies of organic compounds.

Development of GEM detectors. The development work of GEM detectors can be divided into three different sectors; underway there is i) a study of a new detector design including double foil geometry and new channel production methods, ii) tests of a new readout electronics based on a ASIC preamplifier chip and iii) study of the aging characteristics of the GEM with gas chromatographic and mass spectrometric methods.

The design of a GEM detector with double foil and a two-dimensional readout board has been started. The present design encloses preamplifier chips inside the gas volume of the GEM.

Overview of the new joint Detector Laboratory of the Department of Physical Sciences and the Helsinki Institute of Physics at the Kumpula campus.

Characterisation of single foil GEM detectors has been continued in parallel with the new design work, e.g. initial gain variation and energy resolution as a function of water content of gas has been measured. The data acquisition system based on utilisation of a HELIX 128 channel preamplifier chip and VME ADC and sequencer modules has been constructed and tested. The complex gas analysis system including a GC-MS analyser equipped with a cryogenic sampling unit has been reassembled and tested in the new laboratory.

Development of the GEM detectors is currently carried out within the Antares project. The GEM section of the project is done in collaboration with the Observatory and Metorex International Ltd. The aim is to design and construct a GEM detector for use in X-ray astronomy. The ultimate goal is to produce a space quality instrument suitable for various space flights. Therefore, the design criteria include a sealed detector with efficient two-dimensional imaging capability, high reliability, low aging characteristics and low cost.

LHC Programme

Jorma Tuominiemi

The HIP LHC Programme is responsible for Finnish participation in the design and construction of the large detector system for the Compact Muon Solenoid (CMS) experiment at the CERN Large Hadron Collider (LHC) as well as in the preparation of its physics analysis. The CMS is designed to study proton-proton collisions and also high energy heavy ion collisions at LHC. The main scientific goal of the CMS experiment is the clarification of the three big open questions of High Energy Particle Physics today: the mechanism of the spontaneous breaking of the electroweak symmetry (Higgs bosons), the existence of supersymmetry particles, and the creation of the quark gluon plasma. The CMS detector concept was first proposed in 1990, and Finnish teams have been deeply involved in its development from the beginning. The HIP CMS team hence has an extensive and thorough knowledge of the key features of the experiment. The LHC Programme also contributes to the Finnish participation in the ALICE experiment, dedicated to the study of heavy ion collisions at LHC, as well as to the CERN ISOLDE nuclear physics programme. With the CMS and ALICE experiments HIP will be in the front-line of the campaign to take the next fundamentally important step in understanding the basic structure of matter and the origin of the Universe. The LHC experiments are planned to begin in 2006. The LHC Programme 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 experiment and to evaluate the discovery potential of the CMS detector design for new physics, 2) the CMS Tracker project that carries responsibilities in the design, construction and testing of the central tracking detector as well as of its data acquisition system, 3) the Nuclear Matter project contributing not only to the design and construction of the ALICE Inner Tracker system, to the heavy ion physics evaluation but also to the CERN ISOLDE programme.

Software and Physics

Simulation and event reconstruction. In 2001 HIP joined as a participating institute the world wide Geant4 collaboration with the major responsibility for development and maintenance of the nuclear evaporation and intra-nuclear cascade processes. The conversion of the hadronic evaporation processes of the HETC code to GEANT4 was completed in 2001 and good progress was made in the Object Oriented implementation of the intra-nuclear cascade processes. For another important nuclear Monte Carlo code, INUCL, an object oriented model was prepared, containing models for intra-nuclear cascade, pre-equilibrium state, fission and evaporation.

The HIP Software group participated in the summer 2001 test-beam activity with the Helsinki Silicon Beam Telescope. The test-beam data were analysed with the SiBTOO program written in C++ by the group; for the first time the OO program replaced completely the old FORTRAN based analysis code. During the tests the data quality was controlled by the interactive monitoring program written by the group and utilising the *Histoscope* toolkit for histogramming and the *Qt* toolkit for the graphical user interface.

In 2001 the responsibilities of the CMS institutes in developing the software for the CMS Tracker were defined and agreed on in the Tracker Software Memorandum of Understanding. One of the main responsibilities of the HIP team is the Tracker detector alignment with energetic particle trajectories. The HIP group continued the development of this software and completed the first version of the alignment code in C++. This forms part of the DALI package (Detector ALIgnment) being also developed by the Helsinki group. The DALI package is a stand-alone program to investigate various alignment problems independently of the rather heavy CMS reconstruction program ORCA.

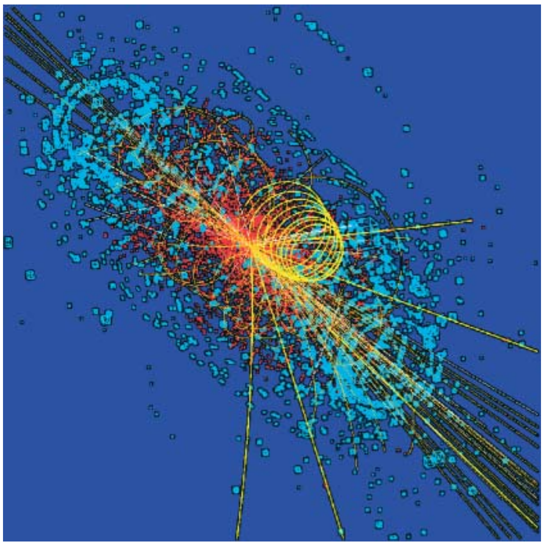
The HIP Software group continued to be responsible for maintaining the CMS detector simulation package CMSIM. The FORTRAN based package still plays an important role in the CMS event simulation due to delays in the development of the corresponding C++ and GEANT4 based simulation code OSCAR. Three releases of CMSIM were issued during the year 2001. The major upgrades included the follow-up of the design changes in the detector description as well as several refinements necessary for the massive event production.

Distributed computing. The GRID activities were continued in the context of the European DataGrid initiative, co-ordinated by CERN and partially funded by the European Union. The huge volume of data processing that is needed to reach the physics goals of the LHC experiments can only be handled with a world wide distributed computing system. The CMS collaboration is actively participating in the initiative developing and testing GRID tools in massive Monte Carlo event production, distributed over the network in Europe and the USA. The HIP Software group has been establishing one of the nodes of the CMS GRID in Finland. The goal is to prepare for production and analysis of the CMS events in a Finnish Tier1 or Tier2 Regional Centre. Amongst the main achievements of the year was the contribution to the CMS Monte Carlo production. In 2001 HIP participated in this effort running CMSIM on the Unix clusters at the Center for Scientific Computing (CSC) in Finland. Some 78 000 events were produced, which were transferred to CERN and Fermilab. In 2000 and 2001 HIP has produced a total of 0.128 million events out of the 9.2 million produced in CMS. The results from these full detector simulations are used to study the physics performance of the detector and to optimise it for the studies of the Higgs boson discovery channels.

HIP has two projects with GRID interests. The Software and Physics project of the LHC Programme is interested in adapting the existing and emerging GRID tools to solve the problems in distributed detector simulation and physics analysis within CMS, while the DataGrid project of the Technology Programme is developing general GRID tools and technologies also of interest to CMS. Obviously there is a large overlap between the projects and much room for useful collaboration. A meeting together with the Department of Physical Sciences, the Kumpula Campus Computation Unit (KuKa) and the CSC was organised in December to co-ordinate the future common DataGrid activities. An example of the collaboration is the HIP participation in the NorduGrid project, which will be a part of the European DataGrid testbed. Both Programmes have represented Finland and HIP in various meetings, and will continue this collaboration in 2002. Commissioning of the HIP Linux cluster funded by the Magnus Ehrnrooth Foundation was started in 2001 with one of its goals being the ability to run the full OO-chain of CMS production software and the corresponding CMS GRID tools in 2002.

In event reconstruction, the main activities in 2001 concerned the code for the electron identification in the CMS high level trigger (HLT) phase, as well as for the photon conversion identification. In both tasks, the key issue is to combine the data and the reconstruction methods of two different detectors: the Electromagnetic Calorimeter and the Tracker. The algorithm to identify the electrons and to reject the jet background of the electron candidates was finalised and integrated into the CMS reconstruction package. It is now an integral part of the HLT chain and successfully used in the reconstruction studies. First results on the identification of the photon conversions were obtained and new methods were developed for their analysis. The clusters formed in the Electromagnetic Calorimeter by converting photons were studied with detailed simulations and the correlation between the cluster

A simulated Higgs event with H (m=150 GeV) decaying into four muons in the CMS detector.



properties and the conversion position was deduced. The electron and positron tracks pointing to the cluster were successfully reconstructed. Work is continuing to validate the algorithm.

CMS physics simulation. In the physics simulation the main research subjects of the HIP physics team were the following: 1) the level-3 τ trigger, 2) measurement of the transverse missing energy using ORCA, 3) development of τ- and b-tagging algorithms to tag the τ leptons and the associated b-jets in the $H_{SUSY} \to \tau\tau \to \ell^+\ell^-$ events, 4) the level-1 trigger for the $gg \to tH^+$, $H^\pm \to \tau\nu$ channel with hadronic τ and top decays, 5) discovery potential for the charged Higgs boson in the process $gg \to tH^+$, $H^\pm \to tb$ and for the SM Higgs boson in the process $pp \to qqH$, $H \to WW \to \ell+\nu+2jets$, 6) rare top decays and 7) sensitivity of the SUSY Higgs production to the MSSM parameters.

An algorithm for the Level-3 τ trigger was developed to identify the τ-jet using the Pixel Detector alone requiring one hard isolated track with good matching with the calorimeter τ-jet found at Level-1 and Level-2. A rejection factor of ~ 5 was obtained for the QCD jets that pass the lower level τ triggers and an event reconstruction efficiency of ~ 75% for the $H_{SUSY} \to \tau\tau \to 2\tau jet$ events for $m_H \geq 200$ GeV, all with high luminosity running conditions.

A method to correct for the calorimeter non-linearity effects on the missing transverse energy (E_t^{miss}) measurement was investigated using Monte Carlo jets to get the jet energy corrections. An improvement of about a factor of two is obtained for the Higgs mass reconstruction efficiency in the $H_{SUSY} \to \tau\tau \to 2\tau jets$ events.

A detailed study on the Higgs production in the decay channel $A, H \to \tau\tau$ with $e+\mu$ and $\ell^+\ell^-$ final states in the Minimal Supersymmetric Standard Model (MSSM) was finalised (doctoral thesis of Sami Lehti). Reconstruction of the Higgs boson mass, impact parameter tagging of the τ leptons and tagging of the associated b-jets were investigated with detailed simulations. It was shown that the lifetime of the τ lepton ($c\tau \sim 90$ μm) can be exploited in the CMS Tracker to use the impact parameter measurement for the hard leptons from the τ decays to identify the τ and to reduce the background from events where the leptons originate from W or Z. At high values of the MSSM parameter tanβ the Higgs bosons are produced predominantly in association with b-quarks, which fragment forming b-jets. Detecting these b-jets can serve to suppress the otherwise irreducible $Z + jet$ background. However, the associated b-jets are soft and uniformly distributed in the central and endcap areas of the CMS Tracker making their tagging a difficult task. The study shows that a b tagging efficiency of ~ 35% can still be obtained for these b-jets keeping the mistagging rate in the $Z + jets$ events at a level under 1%.

The secondary vertex method for τ tagging was investigated with full (ORCA) track reconstruction for the 3-prong τ decays. Including the 3-prong decays increases the signal statistics by a factor of ~ 1.7 for the $H_{SUSY} \to \tau\tau \to 2\tau jets + X$ channel but deteriorates significantly the QCD jet rejection. Promising results were obtained indicating that a rejection factor of ~ 5 can be obtained with the secondary vertex method against the 3-prong QCD jets with a reconstruction efficiency of ~ 70% for the τ jets.

A search for the charged Higgs boson at LHC is essential for the understanding of the nature of the Higgs sector. The Level-1 trigger was investigated for the $H^\pm \to \tau\nu$ channel with a hadronic τ. The other important decay channel of the charged Higgs, $H^\pm \to tb$, was investigated in $gb \to tH^\pm$ production. This channel efficiently tests the b-tagging performance as three b-jets have to be identified in the presence of large hadronic activity.

Extracting the SM Higgs signal in the channel $pp \to qqH$, $H \to WW \to \ell+\nu+2jets$ with jets and missing energy as the final decay products is in general considered useful only for the large mass range ($m_H \gtrsim 800$ GeV). However, it was shown that with an efficient forward jet tagging and central jet veto the Higgs boson discovery range in this channel can be extended down to masses as low as $m_H \sim 300$ GeV.

The rare top decays $t \to \gamma q, Zq$ were investigated with an improved signal generator and an improved treatment of the relevant backgrounds. It was shown that with optimised topological cuts the CMS sensitivity to the $Br(t \to \gamma q)$ will be at the level of 2×10^{-5} (about 10^{-4} to the $Br(t \to Zq)$) for the integrated luminosity of 100 fb^{-1}.

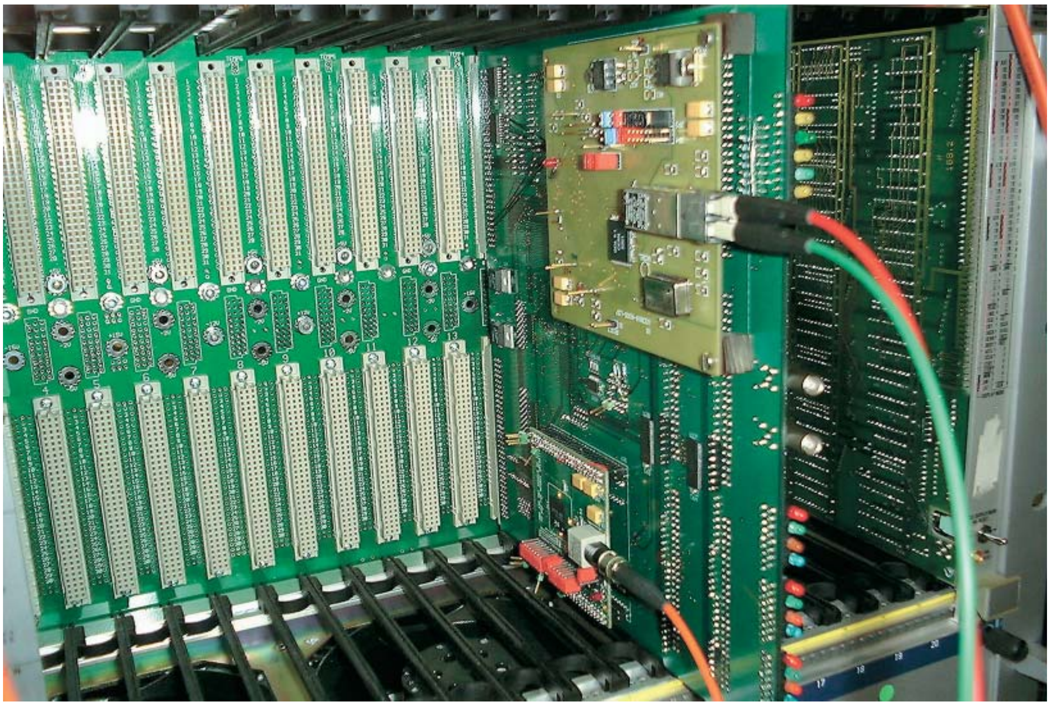
The sensitivity of the MSSM Higgs boson production cross section on the SUSY parameters like the stop mixing angle and the Higgsino mass was investigated taking into account the recent bounds from the LEPII and other experiments. The $H_{SUSY} \to \tau\tau$ channels were found to be particularly stable against variations in the parameters for the general MSSM. For an integrated luminosity of 60 fb^{-1} the whole MSSM parameter space not excluded by LEP is expected to be covered with the light Higgs decay modes $h \to \gamma\gamma$ and $h \to b\bar{b}$ and at high $\tan\beta$ values ($\gtrsim 10$) with several decay channels of the heavy MSSM Higgses ($H, A \to \mu\mu$ and $H, A \to \tau\tau$, $H^{\pm} \to \tau\nu$, $H^{\pm} \to tb$).

CMS Tracker

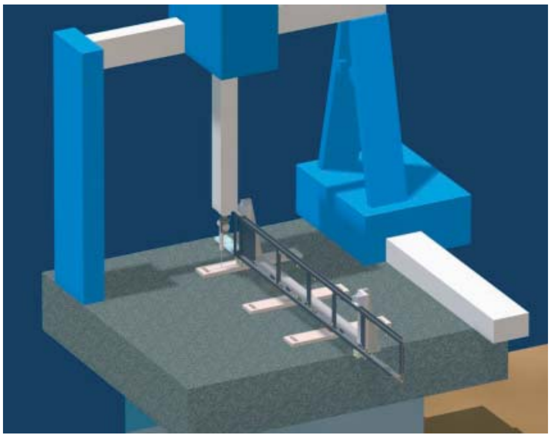
The activities of the HIP CMS Tracker project in 2001 included testing of the prototype for the support structure of the CMS Tracker Outer Barrel detector (TOB), development of radiation hard silicon detectors, operation of the HIP Silicon Beam Telescope and testing of silicon detector modules for TOB. In addition, the HIP Tracker project participated in the CMS Trigger and Data Acquisition (Tridas) project, where the HIP group carries responsibilities in the design of the fiber optic link for the read-out chain of the RPC (Resistive Plate Chamber) muon detectors.

Tracker Outer Barrel Mechanics. The HIP Mechanics group is responsible for the design and manufacture of the Tracker Outer Barrel (TOB) mechanics. The modal parameters of the CMS Tracker prototype, the so-called Big Wheel, were measured experimentally during the years 2000-2001. The importance of these measurements was to understand the response of the structure to the possible dynamic loading excited by cooling, ventilation and vibrations that are transmitted through the support structure, and thus to estimate how dimensionally stable the final tracking detector system would be. Natural frequencies were very low due to the low bending stiffness of the barrel disks, which must be taken into account in the construction of the final detector system.

During the year 2001 three full-size prototypes of the TOB silicon detector support rods were successfully manufactured and tested. This included development of the assembly tooling, which will later form a part of



First RPC Link prototype: Optical functionalities are on a separate Board.



Tool for TOB rod quality measurements. Quality assurance of the geometrical dimensions comprises some 50 000 individual co-ordinate measurements for the batch size of 700 rods. A robust jig together with the 3D co-ordinate measurement device provide the means for this activity in the minimum time.

the final rod production tooling. Numerous experimental cooling tests at the CMS Tracker operating temperature (~ -10°C) have been carried out on rod prototypes to make sure that the critical cooling efficiency is achieved, and that the structures can withstand the internal loads induced by the mismatch of the thermal expansion coefficients of the different materials used in the construction. Also the performance of the coolant distribution system must be validated. Preparations for the manufacture and test of one cooling segment have been started. The assembly of the TOB rod components at the HIP Kumpula premises will start during the first half of 2002. Potential manufacturing techniques and industrial manufactures have been identified, and offers for the first major component purchases were already received. In co-operation with the Laboratory of Machine Design, Helsinki University of Technology, a robust 3D measurement system has been designed for the quality assurance of the geometrical tolerances of the rods.

The HIP Mechanics group is also involved in the design and production of the support structures for the CMS RPC detector Link Boards (LB). The LB enclosure has several functions: to house the LBs, to remove the substantial heat load produced by the electronics, and to act as an electromagnetic shield between the LBs and their surroundings. In addition, there are huge amounts of cables to be routed, and the available space for the enclosure is minimal. Materials, dimensions, and manufacturing techniques have been identified, and the complete solution should be developed so that the LB enclosure deliveries can start in the later part of 2002.

Silicon Detector Development. The objective of the HIP CMS Tracker silicon detector research is to develop radiation hard sensor solutions for the high luminosity upgrade of the LHC. The radiation tolerance issues of silicon devices are at present of major interest to the High Energy Physics (HEP) community.

In 2001 the HIP LHC Programme became a member of the Helsinki University of Technology Microelectronics Centre (MEC). The MEC provides clean room facilities and equipment for a complete semiconductor processing for its member laboratories. This together with the successful recruitment of skilled staff is a major improvement in the competence of HIP in detector research. The capability to produce silicon detectors and test structures tailored to the needs of the project is exceptional in the HEP community. During 2001 about 40 silicon strip detectors, both standard detectors and detectors with high oxygen concentration, were processed. The most important electrical parameter of the detectors, the leakage current, was found to be comparable to the values of commercial manufactures. The project was conducted in collaboration with other Finnish universities. The electrical measurements of the detectors were done at the Microelectronics Instrumentation Laboratory of the University of Oulu, whereas the radiation hardness of the detectors was studied with irradiation tests at the Jyväskylä University Accelerator Laboratory.

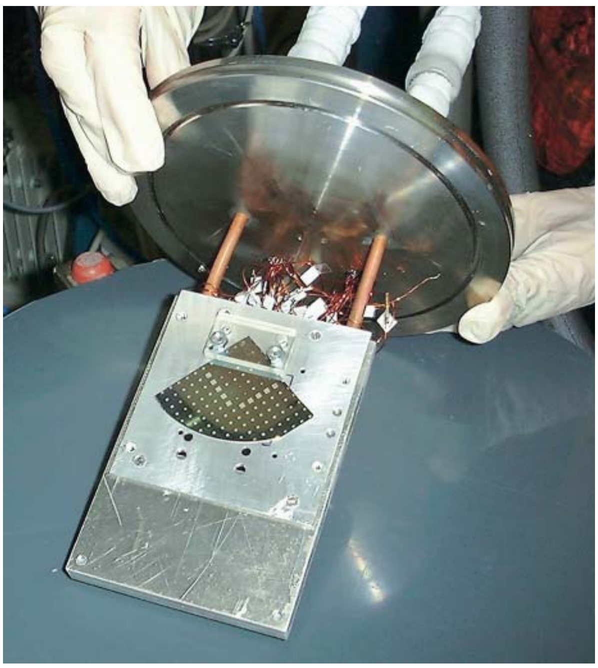
Quality Testing of Tracker Detector Modules. The silicon detector modules in the CMS Tracker should remain operational for long periods of time without the need for intervention during the operation of the LHC accelerator. Therefore, prior to the installation of silicon modules into the CMS, the functionality of these modules must be extensively tested. A number of CMS institutes will embark on performing long-term tests of the modules, one of them being the HIP Kumpula Laboratory. The Kumpula set-up has been assigned by the CMS as a test station that can be flexibly used for specific, comprehensive tests during the Tracker module production flow.

The first CMS Tracker module prototypes were tested at CERN in September-October 2001. The HIP CMS group participated in the electrical as well as in the test beam measurements of the modules. The group also participated in the design and construction of the final module test set-up at CERN, to gain know-how and experience to build and operate a similar set-up in Helsinki. The HIP group has also participated in testing the composite support structures (the rods) for the Tracker modules of the TOB. During the running of the CMS experiments the modules will be cooled by an internal rod cooling system. Therefore, the performance of the cooling system must be tested thoroughly. Additionally, the rods have been irradiated at the Louvain-la-Neuve Catholic University in Belgium in order to obtain information about the effects of radiation on the cooling performance and overall mechanical durability.

Silicon Beam Telescope. HIP has operated the Helsinki Silicon Beam Telescope (SiBT) at the CERN H2 test beam for several years. The telescope, built by the HIP team and based on position sensitive silicon strip detectors, is used to measure high-resolution tracks of the incoming beam particles. SiBT offers a reference track measurement for the needs of the HIP CMS detector group as well as for other CMS research groups testing the spatial resolution and the efficiency of their detectors. During the summer 2001 beam tests the SiBT was updated with a new front-end electronics and a new PC-based Data Acquisition system, built together with the HIP/CMS Software and Physics group.

RPC Trigger. The main activity of the HIP TRIDAS team has been the design of the fiber optic links for the Pattern Comparator Trigger (PACT) system of the CMS Resistive Plate Muon chambers (RPC). The work has already been going on in close collaboration with the Warsaw University CMS group for three years. Closely connected with the PACT project are also the University of Bari CMS group, responsible for the RPC front-end electronics and the Seoul National University group, responsible for the receiving end of the fiber optic link. The first level muon trigger is one of the most important aspects in the CMS detector design for the discovery of new physics.

A prototype link with a reduced functionality Link Board (LBrf) and on-line monitoring software was built for the test beam experiments with an LHC-like time structure at CERN in October 2001. In this test the main focus was on the synchronization and diagnostics features of the Link Board. The fiber optic link was implemented on a daughter card. Although the HIP team has already shown that AMCC Gigabit Ethernet components are suitable for the fiber optic link, another option based on the 1.6 Gbit/s GOL ASIC developed at CERN was studied. The advantages of GOL are its guaranteed radiation tolerance and low power consumption. In these tests HIP was responsible for the PACT Optical Communication System whereas Warsaw took care of the trigger processor part.



Nuclear Matter

The Nuclear Matter project is conducted in collaboration with the Department of Physics of the University of Jyväskylä. It involves research both in high energy heavy ion physics in the ALICE collaboration and in low energy nuclear physics at the CERN ISOLDE facility.

Silicon sample attached to vacuum chamber head at the Jyväskylä University Accelerator Laboratory. When they are being irradiated the samples are kept in vacuum at -10°C.

The Nuclear Matter project contribution to the *ALICE experiment* is focused on the Inner Tracking System (ITS) and on the T0 detector, the latter providing the start signal of the event for ALICE. An important decision concerning ITS was taken in 2001 to shift a significant part of the bonding of Silicon Strip Detector (SSD) modules to the Detector Laboratory of the Helsinki Institute of Physics. The SSD modules cover the two outermost layers of the ITS with a total area of nearly 6 m^2. The module assembly chain consists of several phases and the most critical phases require the use of the unique single-point tape-automated bonding (TAB) technique.

The second major contribution of the HIP-JYFL team is the T0 detector for ALICE. It will provide pre-trigger timing, a high quality start signal, and rough but rapid determination of the longitudinal vertex position. It will also work as the back-up for the main multiplicity detector. Until 2001 several design options for T0 were being developed in parallel. The HIP-JYFL group made a significant contribution to the most challenging version based on microchannel plates (MCP). Finally, a more conservative and less expensive solution was chosen. It will use Cherenkov radiators coupled to photo-multiplier tubes (PMT). Nevertheless, the R&D work done was not in vain. All the fast electronics developed for MCP is necessary and will work with PMT pulses as well. Also, in collaboration with the Applied Physics group at JYFL, the HIP-JYFL ALICE team made a major breakthrough in the measurement of energy loss of charged ions in thin absorbers. In recognition of our experience in fast timing and in managing experimental collaborations at JYFL, the HIP-JYFL team was given Project Leader status for the T0 detector. This work is carried out in close collaboration with the Russian ALICE teams and with the representatives of all the other forward detectors and with the TOF detector. Recently, a team from Houston (USA) has expressed their interest in joining our work on T0.

Parallel to the hardware development, the HIP-JYFL team is involved in the ALICE software development. Our main interests are in the data analysis of ITS test experiments and in the creation of a sound architecture for the ITS software. In 2001 our representative (Mariana Bondila) was a member of the ALICE Software Board.

The Nuclear physics programme at ISOLDE has largely centred on nuclei with nearly equal numbers of protons and neutrons (Z=N nuclei), which provides access to charge dependent effects and other fundamental symmetries. Investigation of the superallowed beta decay of ^{74}Rb has been completed providing new data on the role of charge dependent effects, such as Coulomb mixing, in superallowed beta decay. These, in turn, together with the muon decay data, presently give the most precise value for the up-down quark mixing matrix element V_{ud} in the Cabibbo-Kobayashi-Maskawa matrix. The measured half-life is consistent with earlier measurements, but the accuracy of the measurement has been improved by a factor of five. Accurate data were also obtained on the non-analog decay branch and decay energy. As a first result, the magnitude of the Coulomb mixing was found to be of the same order of magnitude as in lighter isotopes, in clear disagreement with all theoretical predictions which indicated a strong Z-dependence for this correction.

Beta decay between mirror nuclei with respect to the N=Z line provides a special case among allowed decays. It satisfies the selection rules of the Fermi and Gamow-Teller decay. Since the Fermi component of the transition strength is a constant, the Gamow-Teller part can be extracted by subtracting the Fermi part from the measured total transition strength. The obtained Gamow-Teller strength reflects directly the properties of the underlying nuclear wave functions. The systematics of mirror transitions is well established among the light nuclei up to ^{59}Zn. As reported earlier, we have recently extended the systematics of mirror decays to ^{71}Kr. In 2001 we have made an improved decay study on mirror beta decays of ^{61}Ga and ^{75}Sr. The accuracy of the data for ^{61}Ga was improved significantly and the decay of ^{75}Sr is the heaviest mirror decay studied so far with a meaningful accuracy.

In parallel with the ongoing research programme the Finnish group at ISOLDE has initiated a Si-ball R&D detector project and developed new means to produce and manipulate radioactive ions at ISOLDE. The Si-ball project aims for a high-granularity charged particle detector array for spectroscopic studies of exotic nuclei and their complex decay modes. Presently, prototype detectors from different companies are being tested providing the basis for the selection of detector supplier for the whole detector assembly. In the target and ion source sector new materials, like ZrO_2, Y_2O_3 and $SrZrO_3$ in different forms (foils, powders and felt), are tested to optimise the production of the most exotic nuclei – a key issue in research far from stability. Finally, a new project for cooling and bunching radioactive ion beams has been started at ISOLDE. A goal of the project co-ordinated by the Finnish team is to produce a general purpose device for improving the quality of radioactive ion beams.

Technology Programme

Ari-Pekka Hameri

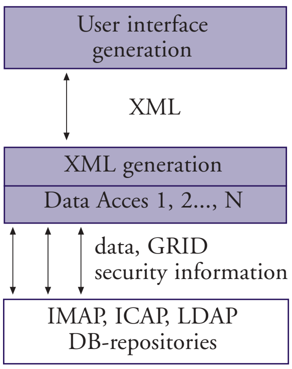
All the resources and activities of the Technology Programme have been directed in one way or another on the DataGrid activity. The Programme is part of this global initiative, which aims to develop a computing and storage platform that exploits the massive parallel computing power of thousands of computing resources arranged in several clusters around the world. The first true test of this platform will emerge once the Large Hadron Collider (LHC) starts to produce massive amounts of collision data. Managing and computing data related to particle collisions is one of the main objectives of the DataGrid initiative, yet the whole project aims to develop a service for all research disciplines needing computing power to study problems that may be solved with the developed service. This has brought other scientific disciplines like biotech, geophysics and image handling into the project. The Programme is divided into two projects, one of which is Distributed Data Management focusing on interfaces and mechanisms to access the data residing in the DataGrid, and the other one, DataGrid, focuses on the development of Grid technologies and heads the Finnish contribution in the EU-DataGrid project. With the support from the Magnus Ehrnrooth Foundation the Programme has established a small-scale computing cluster in Otaniemi, which is closely operating with CSC, the Finnish centre for high-performance computing, and with other Scandinavian institutes contributing to the initiative. Also first contacts with Finnish industry have been established to ensure the generality of the results anticipated from the overall Grid activity. In addition to their scientific value, the commercial and technological potential of CERN and DataGrid are significant and are mainly realized through spin-off activity, knowledge spill-overs, and direct interaction with industrial supplier companies. A study focusing on the maximisation of such benefits was started during autumn, and it will continue throughout 2002. The study is funded jointly by the Finnish National Fund for R&D Sitra and the Technology Development Centre TEKES.

Distributed Data Management

The Distributed Data Management project has continued to develop easy-to-use interfaces and applications to access diverse and multi-dimensional information. Although the development tools and computing environment have changed, the approach adopted date back to the mid-1990s, when the project was focusing on engineering data management. During the year 2001 the focus has been on the development of interfaces that enable easy access to services provided by the DataGrid platform. To achieve this, the project has designed an open source interface layer, that can be used to view the data stored in DataGrid or in databases in general. Through this layer users are enabled to view information in such a way that the raw data residing in the DataGrid can be easily retrieved, studied and managed.

Officially this Meta Data Visualisation (MDV) collaboration was launched in March 2001, as a project between the development team at CERN and a Finnish consortium comprising partners from academia and industry. The initiative received support from the National Technology Agency, TEKES. In Finland, the software is used and configured in connection with the Wireless Internet Laboratory (WIRLAB) at Seinäjoki, thus combining the resources of modern wireless networks with advanced meta data visualisation. The aim of the MDV project is to offer a flexible framework for categorising, manipulating and combining large amounts of data that can reside in several distinct storage systems with architectures that are different from each other. Thus a portal

A block diagram of the components of MDV. The repositories can be distributed between several computers.

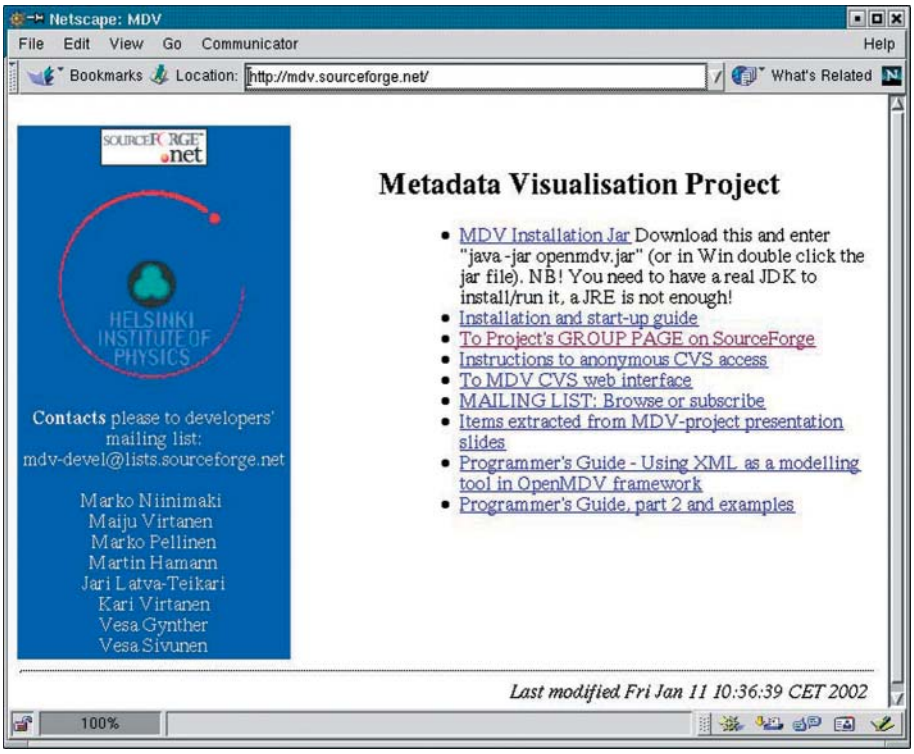


built by using the MDV software may contain access to IMAP email, ICAP calendar and LDAP directory containing information about files accessible through various Grid services and the contents of the files themselves.

Altogether the initiative has involved five researchers together with collaborative contributions from the Institute for Extension Studies Seinäjoki Centre of the University of Tampere and the Technical University of Denmark. The platform has grown to a flexible presentation tool, which can be easily extended to various data management tasks. The software utilises the Grid in two ways. On one hand, the users are able to use their personal certificates to authorise and authenticate them with the resources residing in the Grid. In practice this is not so trivial, as the information to be accessed may be scattered in various physical locations, where the user may have different access rights. On the other hand, the users will be able to use MDV as a user interface to the GLOBUS toolkit, a de facto standard for low level Grid services in most of the Grid projects, including the EU-DataGrid. This user interface is easier to use than the one provided by the GLOBUS toolkit. MDV is Open Source software, which is made available with an easy installation package at http://mdv.sourceforge.net. Since its release in late-2001 the application has been downloaded several hundred times.

DataGrid

During the year 2001 the official contribution of the Technology Programme to the global DataGrid effort was focused on the “Security and Transparent Access” task. This Grid platform development task is part of the Data Management work package of the EU-DataGrid project. Mika Silander from the Technology Programme took responsibility for managing this task in autumn 2001. In this role HIP has contributed to the creation of the DataGrid-wide security structure by collaborating with the DataGrid Security Group, which was established to resolve global organisational issues in the DataGrid activities. An increased in-



The MDV software is Open Source and made available through the http:// mdv.sourceforge.net.

terest in security has resulted in the forming of the SecureGrid project collaboration with an aim of creating a companion project to the EU-DataGrid to study issues related to security on a wider level (http://www.securegrid.org/). The Programme produced the first Grid Security Infrastructure (GSI) compliant software, which was implemented to make the CERN Advanced Storage Manager (CASTOR) software to support GSI. During the year 2001 the size of this security task grew from a team of two to a collaboration of 10 people from four different institutes in four different countries.

These activities were tightly coupled with the DataGrid contribution of the Center for Scientific Computing (CSC), which jointly form the Finnish contribution to the EU-DataGrid project. In order to speed up the propagation of Grid technologies to a level of practical applications, the Programme received funding for three years from the Magnus Ehrnrooth Foundation for a cluster project. The initial hardware installations were completed by the end of 2001, by which time the basic cluster management software was also functional. Close collaboration was set with the LHC Programme in order to test the installation with the simulated data on collisions tracked by the CMS. Before the end of the year the CSC test software was installed in the system and collaboration with the Finnish Environmental institute (SYKE) was initiated. This work concerns the combining of satellite data with simulation of different environmental variables. The knowledge gained has been and will be actively shared with the other HIP Programmes and the Department of Physical Sciences through regular meetings. The cluster has also been prepared to be used as a part of a test environment in a CSC project studying different aspects of multi-site clusters.

Along with the domestic activities the Programme contributed to the NorduGrid project, together with the LHC Programme. The NorduGrid project is establishing a Grid testbed covering Finland, Sweden, Denmark and Norway. Within this project both the Technology and the LHC Programmes have been preparing to use the physics software from the LHC experiments as test cases. One of the most visible results of the NorduGrid project was that a committee was appointed to work towards the Nordic Tier1 computing centre. Finally, the Technology Programme has been active in additional projects and collaborations using Grid technologies. These projects include:

- The Openlab collaboration is an international consortium with partners from US, Swiss and Danish research institutes. The goal of the project is to study applications integrating virtual reality, nanotechnology and Grid technologies.
- Collaboration with the National Micro- and Nanotechnology Research Center in Denmark, aiming to use Grid-enabled MDV architecture allowing the sharing of nano-level images on the Internet.
- The Nevi-portal has been developed jointly with the dermatologists at Geneva's Cantonal Hospital. The system enables the secure sharing of skin lesion images between experts and researchers.

The Otaniemi cluster and its young developers.

Administration

Mikko Sainio

The graduate education of physics students continues to be one of the main tasks of the Institute. During the past year HIP has collaborated with two graduate schools sponsored by the Ministry of Education: The Graduate School in Particle and Nuclear Physics (GRASPANP) and the Graduate School of Modern Optics and Photonics. A large number of undergraduate students also join the research groups and complete their Master thesis-work at the Institute. This has turned out to be a most fruitful way of recruiting graduate students. In particular, summer jobs at CERN are extremely efficient in this respect. During 1997-2001 16 doctoral degrees and 52 Masters' degrees have been earned by members of HIP research groups.

The Web University (WU) activity at CERN has continued. HIP participates in the Open Learning Environment-project led by the Tampere University of Technology and which is funded by the Finnish National Technology Agency (TEKES). The WU works as a virtual university, in which distant audiences participate in CERN seminars from their own countries. The WU has also successfully continued Finland's Particle Physics Outreach Programme. In 2001 the WU organised six 3-5 day schools at CERN for high school students interested in particle physics. Also, educational programmes for high school teachers were started.

The move from Siltavuorenpenger to the new premises at the Kumpula campus took place mainly during week 10. The move was followed by an intensive period of setting up the research infrastructure. The computer systems were operational almost immediately, and so, in particular, the theoretical work could continue without much delay. A number of things, however, still remain to be done. Connected with the move and the new laboratory space additional resources for laboratory equipment (in addition to the normal budget) have been received. In 2001 this totalled 0.59 MFIM.

In matters of technological and commercial co-operation HIP collaborates with CERNTECH, which is an independent programme providing services to Finnish companies with international Big Science projects such as CERN. CERNTECH is mainly financed by TEKES.

Organization and Personnel

Organization

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- **COMPASS** – Peter Berglund

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- **CMS Tracker** – Eija Tuominen
- **Nuclear Matter Physics** – Vesa Ruuskanen

Technology – Ari-Pekka Hameri
- **Distributed Data Management** – Marko Niinimäki
- **Data Grid** – Matti Heikkurinen

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Gabriele Veneziano, Professor (CERN)

Albrecht Wagner, Director General (DESY)

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A. Green, prof., adj. senior scientist
K. Rummukainen, prof., adj. scientist
J. Koponen, grad. student
T. Lähde, grad. student

Cosmology

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M. Sloth, grad. student

Laser Physics and Quantum Optics

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A. Collin, grad. student
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J.-P. Martikainen, grad. student
J. Piilo, grad. student

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A. Niemi, prof., adj. senior scientist
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F. Hassan, scientist
A. Kobakhidze, scientist
D. Polyakov, scientist
S. Hemming, grad. student
O. Pasanen, grad. student
A. Tureanu, grad. student

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E. Gabrielli, senior scientist
Z.-H. Yu, scientist
J. Laamanen, grad. student
T. Rüppell, student

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P. Salo, scientist
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S. Majaniemi, adj. grad. student
M. Rusanen, adj. grad. student
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J. Hirvonen, student
T. Laurila, student
C. Seppänen, student
E. Terämä, student
T. Timonen, student

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H. Saarikko, prof., programme director

Electron-Positron Physics

K. Österberg, proj. leader (at CERN)
A. Kiiskinen, grad. student (at CERN)
L. Salmi, grad. student (at CERN)
J. Heiskala, student (at CERN)

LHC Forward Physics

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V. Khoze, senior scientist (at CERN)
J. Lamsa, senior scientist (at CERN)
S. Tapprogge, senior scientist (at CERN)
P. Cwetanski, scientist (at CERN)

COMPASS

P. Berglund, docent, proj. leader
J. Koivuniemi, tech. coordinator

Detector Laboratory

K. Kurvinen, lab. manager
J. Heino, lab. engineer
R. Lauhakangas, lab. engineer
J. Ojala, researcher
A. Numminen, lab. technician

LHC Programme

J. Tuominiemi, docent, programme director

Software and Physics

V. Karimäki, docent, proj. leader
R. Kinnunen, senior scientist (at CERN)
N. Stepanov, senior scientist (at CERN)
M. Arenius, scientist (at CERN)
K. Lassila-Perini, scientist (at CERN)
V. Léfebure, scientist (at CERN)
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T. Lindén, scientist
A. Heikkinen, grad. student
T. Lampén, grad. student
J. Nysten, grad. student (at CERN)
J. V. Heinonen, student
L. Wendland, student (at CERN)
L. Lahti, summer trainee (at CERN)
P. Salmi, summer trainee (at CERN)
L. Tillikainen, summer trainee (at CERN)

CMS Tracker

E. Tuominen, proj. leader (at CERN)
S. Czellar, senior scientist (at CERN)
A. Honkanen, senior scientist (at CERN)
J. Härkönen, senior scientist (at CERN)
S. Nummela, senior scientist (at CERN)
E. Pietarinen, senior scientist
P.-O. Friman, scientist (at CERN)
H. Katajisto, scientist
T. Vanhala, scientist (at CERN)
A. Ylinampa, scientist (at CERN)
K. Banzuzi, grad. student (at CERN)
D. Ungaro, grad. student
A. Heikkilä, student
P. Johansson, student (at CERN)
J. Li, student
P. Luukka, student (at CERN)
E. Tuovinen, student
M. Leppänen, summer trainee (at CERN)
T. Taponen, summer trainee (at CERN)
J. Tuisku, summer trainee (at CERN)

Nuclear Matter Physics

V. Ruuskanen, prof., proj. leader
J. Äystö, prof., adj. senior scientist
K. J. Eskola, adj. senior scientist
A. Jokinen, adj. senior scientist
W. Trzaska, adj. senior scientist
M. Oinonen, scientist (at CERN)
T. Siiskonen, scientist (at CERN)
M. Komogorov, grad. student
V. Lyapin, engineer

Technology Programme

A.-P. Hameri, prof., programme director (at CERN)
E. Autio, prof., senior scientist (at CERN)

Distributed Data Management

M. Niinimäki, proj. leader (at CERN)
J. Hahkala, scientist (at CERN)
V. Sivunen, scientist (at CERN)
J. Suokuutti, scientist (at CERN)
M. Tuisku, scientist (at CERN)

DataGrid

M. Heikkurinen, proj. leader (at CERN)
M. Gindonis, scientist (at CERN)
J. Klem, scientist (at CERN)
M. Käki, scientist (at CERN)
M. Silander, scientist (at CERN)
J. White, scientist (at CERN)
M. Happonen, engineer
M. Fallenius, student
N. Karlsson, student
J. Karppinen, student
V. Nenonen, student
L. Porri, student
A. Teräs, student

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M. Sainio, docent, adm. manager
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T. Jokinen, secretary (until 6.4.2001)
T. Karppinen, secretary (at CERN)
P. Lehto, secretary (starting 1.5.2001)
H. Myllykangas, secretary (starting 1.9.2001)
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R. Rinta-Filppula, researcher (at CERN)
N. Jiganova, senior system analyst
T. Vehviläinen, lab. engineer
P. Pennanen, trainee
J. Kokkonen, grad. student

Seminars

Seminars held in Helsinki

January 16th J. Heinonen (Helsinki University of Technology)
Island diffusion on metal fcc(100) surfaces

January 23rd K. R. S. Balaji (Institute of Mathematical Sciences, Chennai, India)
Model independent mechanisms for flavor mixings

January 30th J. Lukkarinen (Rolf Nevanlinna Institute, University of Helsinki)
Definition and practical computations in generalized microcanonical quantum statistics

February 8th H. V. Klapdor-Kleingrothaus (Max Planck Institut für Kernphysik, Heidelberg)
Double beta decay and dark matter as windows to new physics

February 13th K. Kajantie (Department of Physics, Theory Division)
RHIC: new heavy ion collider, new data, new physics?

February 20th S. F. Hassan (HIP)
Supersymmetry and the systematics of T-duality in string theory

February 27th E. M. N. Cirillo (University of Rome, Italy)
Metastability in spin systems

March 27th J. Vermaseren (NIKHEF, Holland)
How to compute three loop QCD structure functions

April 2nd (Colloquium) D. Bugg (Queen Mary College, UK)
The spectra of light mesons and glueballs

April 9th (Colloquium) D. Drechsel (Johannes Gutenberg-Universität, Mainz, Germany)
The spin structure of the nucleon in the resonance region

April 19th K. Österberg (HIP)
Some highlights of Higgs searches at LEP2

April 24th E. Sihvola (Physics Department)
Big bang nucleosynthesis and antimatter

May 2nd A. Rajantie (Cambridge, UK)
Baryogenesis and electroweak-scale inflation

May 4th HIP Special Theory Seminar
I. Vattulainen, **Physics of biological systems**
K. J. Eskola, **Ultrarelativistic heavy ion collisions**
M. Alava, **Statistical physics and computing**
K. Nordlund, **Atomistic modeling of far-from-equilibrium processes in materials**
E. Keski-Vakkuri, **String theory and quantum field theory**

May 8th M. Frank (Montreal, Canada)
Lepton flavor violation in left-right supersymmetric models

May 14th (Colloquium) G. Bali (University of Glasgow, UK)
Glueballs and hybrids: perspectives from the lattice

May 17th R. Sturani (Oxford, UK)
String cosmology

May 22nd S. Roy (Tata Institute of Fundamental Research, Mumbai, India)
Anomaly mediated supersymmetry breaking and its test in a linear collider

May 28th A. Fayyazuddin (Stockholm University)
N=2 and N=1 supergravity duals of supersymmetric gauge theories

May 29th E. Gabrielli (HIP)
Recent results on *g*-2 of the muon

May 31st A. Datta (Allahabad, India)
Some non-standard effects at a neutrino factory

June 5th Y. Farzan (SISSA, Trieste)
Neutrino mass spectrum and future tritium beta decay experiments

June 6th G. Nardulli (CERN and Bari, Italy)
QCD at very high density: an effective lagrangian approach

June 7th S. Sheikh-Jabbari (ICTP, Trieste)
Quantum Hall physics and noncommutative Chern-Simons theories

June 8th D. Chakraverty (Allahabad, India)
Effects of leptoquarks or diquarks on the muon anomalous magnetic moment or $B \rightarrow X_s\gamma$

June 18th V. Balasubramanian (University of Pennsylvania, USA)
Conical defects and the origin of gravitational entropy

June 19th J. Chkareuli (Institute of Physics, Georgia)
Actual mixing of quarks and leptons: is there any in the chiral limit?

June 26th S. Ross (Durham University, UK)
The enhancon and consistency of excision

August 14th R. Schiavilla (JLab, USA)
A random walk in the physics of light nuclei

August 21st M. Noga (Comenius University, Slovakia)
Thermodynamic anomalies of high temperature superconductors

August 28th S. Doplicher (Rome, Italy)
Quantum spacetime

September 4th L. Faddeev (Steklov Inst., St. Petersburg, Russia)
The use of compact parameters in the parametrisation of the field variables and its application in condensed matter and relativistic field theory

September 11th Y. Schröder (TFO)
The free energy of hot QCD

September 18th F. Bastianelli (Bologna University, Italy)
Path integrals for 1D nonlinear sigma models and trace anomalies

September 20th F. Bastianelli (Bologna University, Italy)
2- and 3-point functions of universal scalar operators in maximally supersymmetric CFTs in the AdS/CFT correspondence

September 25th S. Kasuya (University of Tokyo, Japan)
Cosmological aspects of the large Q-ball formation in the gauge-mediated SUSY breaking

October 2nd J. Martikainen (HIP)
Monopoles and skyrmions in a Bose-Einstein condensate

October 4th J. Haidenbauer (Jülich, Germany)
Meson production in nucleon-nucleon scattering

October 8th (Colloquium) J. Speth (Jülich, Germany)
Pions in hadron physics

October 11th K.-A. Suominen (HIP/University of Turku)
Bose-Einstein condensation: the 2001 Nobel Prize in

physics

October 15th (Colloquium) H. Rubinstein (SCFAB Stockholm)
The physics of music

October 16th M. Mackie (HIP)
Photoassociation of quantum degenerate gases

October 18th S. Schneider (Jülich, Germany)
The reaction π + N to π + π + N in a meson exchange model

October 23rd H. Pérez Rojas (ICIMAF, Havana, Cuba)
Magnetic collapse of a neutron gas

October 29th (Colloquium) B. Holstein (University of Massachusetts, USA)
Aristotle was right - heavier objects fall faster

October 30th P. Pandita (Shillong, India)
Baryon and lepton number nonconservation

November 5th Particle Physics Day at Kumpula
K. Lassila-Perini, **Higgs physics at the LHC**
A. Heikkinen, **Modelling hadronic processes in Geant 4**
T. Lampén, **Studies on detector alignment by reconstructed tracks**
J. Härkönen, **Development of radiation hard silicon detectors**
R. Orava, **Tagged forward proton physics at LHC**
M. Ottela, **Simulation studies in forward direction at LHC**
K. J. Eskola, **Ultrarelativistic heavy ion collisions at LHC**
A. Kiiskinen, **Higgs searches at LEP**
P. Hoyer, **Probing QCD with electromagnetic probes**
A. Kobakhidze, **Higher dimensional theories and the problem of strong CP violation**
A. Kalliomäki, **Phenomenology of sterile neutrinos**
J. Laamanen, **Sparticle spectrum in anomaly mediated supersymmetry breaking models**
A. Tureanu, **Noncommutative gauge field theories: a no-go theorem**
M. Roos, **Quintessence cosmology**
S. Räsänen, **The ekpyrotic scenario - a new framework for cosmology**
M. Sloth, **Adiabatic CMB perturbations in pre-big bang string cosmology**
N. Törnqvist, **The lightest scalar mesons**
T. Lähde, **π and $\pi\pi$ decays of excited charm mesons**
J. Peltoniemi, **Underground update**

November 13th S. Lehti (HIP)
Prospects for the detection of neutral MSSM Higgs bosons decaying into tau leptons in the CMS detector

November 19th (Colloquium) J. Bijnens (Lund)
Hadronic contributions to the muon anomalous magnetic moment

November 27th M. Seppälä (Department of Mathematics)
Computer assisted mathematics

November 29th S. Moch (Karlsruhe, Germany)
Loops and legs in perturbation theory at higher orders

December 3rd (Colloquium) C. H. Wu (Garching, Germany)
The prospective and problem of fusion

December 4th J. Calsamiglia (HIP)
Quantum information processing and its linear-optical implementation

December 11th M. Mojžiš (Bratislava, Slovakia)
How strange is the nucleon?

Visitors

Theory Programme

Cosmology

A. Mazumdar (Italy) 7.-18.5.
R. Sturani (Italy) 16.-20.5.
L. Bergström (Sweden) 19.-21.6.
A. Mazumdar (Italy) 30.8.-7.9.
S. Kasuya (Japan) 30.8.-28.9.

Laser Physics and Quantum Optics

A. Ishkhanyan (Armenia) 1.2.-30.4.
S. Maniscalco (Italy) 19.5.-5.6.
U. Al-Khawaja (The Netherlands) 6.-10.8.
F. Haug (Germany) 3.9.-31.12.
E. Lundh (Sweden) 29.11.-2.12.
C. Pethick (Denmark) 18.-20.12.
S. Stenholm (Sweden) 21.12.

Mathematical Physics and Field Theory

A. Demichev (Russia) 12.2.-11.5.
P. Prešnajder (Slovakia) 1.3.-15.5.
D. Polyakov (Japan) 20.-26.4.
M. Tsulaia (Russia) 5.5.-10.6.
Y. Farzan (Italy) 28.5.-11.6.
M. M. Sheikh-Jabbari (Italy) 28.5.-11.6.
V. Balasubramanian (USA) 15.-30.6.
S. Ross (UK) 17.6.-10.7.
J. Chkareuli (Georgia) 17.6.-23.7.
M. Ioffe (Russia) 20.7.-6.8.
D. Polyakov (Japan) 23.7.-11.8.
R. González Felipe (Portugal) 5.-21.8.
S. Doplicher (Italy) 23.-30.8.
H. Miyazawa (Japan) 24.-31.8.
K. Nishijima (Japan) 4.-27.9.
H. Pérez Rojas (Cuba) 4.9.-1.12.
M. Mnatsakanova (Russia) 15.9.-14.10.
Y. Vernov (Russia) 15.9.-14.10.
H. Rubinstein (Sweden) 14.-16.10.
M. Tsulaia (Russia) 1.-30.11.
P. Prešnajder (Slovakia) 5.-31.11.

Particle Physics Theory

V. Savrin (Russia) 6.-20.1.
S. Roy (Israel) 15.4.-15.7.
M. Frank (Canada) 6.-12.5.
A. Datta (India) 21.5.-1.7.
D. Chakraverty (India) 2.-17.6.
M. Raidal (Switzerland) 22.-23.8.
F. Bastianelli (Italy) 18.-21.9.
P. N. Pandita (India) 20.9.-15.11.
M. Dubinin (Russia) 2.11.-1.12.

Hadron Physics Activity

E. Cirillo (Italy) 22.2.-3.3.
D. Bugg (UK) 1.-3.4.
D. Drechsel (Germany) 7.-11.4.
R. Schiavilla (USA) 7.-16.8.
E. Cirillo (Italy) 6.-16.9.
J. Speth (Germany) 7.-9.10.
B. Holstein (USA) 28.-29.10.
S. Wycech (Poland) 31.10.-30.11.
J. Bijnens (Sweden) 17.-20.11.
M. Mojžiš (Slovakia) 8.-16.12.

Statistical Physics and Materials Science

T. S. Rahman (USA) 1.-4.1.
C. Ghosh (USA) 1.-12.1.
S. C. Ying (USA) 16.-21.1.
O. Trushin (Russia) 16.-27.1.
T. S. Rahman (USA) 20.-24.1.
T. L. Einstein (USA) 23.-28.1.

Z. Chvoj (Czech Republic) 25.-28.1.
M. Abramowski (UK) 6.2.
S. Badescu (HIP/USA) 6.-25.2.
O. Trushin (Russia) 1.3.-6.4.
Z. Chvoj (Czech Republic) 26.3.-7.4.
M. Rost (Germany) 17.-28.4.
T. S. Rahman (USA) 22.-28.4.
C. Ghosh (USA) 22.-29.4.
O. Trushin (Russia) 23.-27.4.
M. Dubé (Canada) 4.-21.5.
A. Karim (USA) 1.-30.6.
S. Badescu (HIP/USA) 1.-31.8.
J. M. Kosterlitz (USA) 6.-25.8.
Z. Chvoj (Czech Republic) 17.9.-5.10.

High Energy Physics Programme

V. Khoze (UK) 1.6.-30.11.
S. Zimmermann (USA) 15.-19.9.
J. Lamsa (USA) 1.10.-31.12.

LHC Programme

CMS Tracker

M. Kudla (Poland) 28.-30.6.
F. Loddo (Italy) 28.-30.6.
A. Ranieri (Italy) 28.-30.6.
W. Zabolotny (Poland) 28.-30.6.

Nuclear Matter

N. Amelin (Russia) 1.1.-15.5.
J.-R. Lutz (France) 4.-7.1.
A. de Haas (The Netherlands) 5.-6.1.
N. Grion (Italy) 5.-7.1.
P. Kuijer (The Netherlands) 5.-7.1.
A. Kulikova (Russia) 23.1.-16.2.
A. Kolojvari (Russia) 1.-30.7.
N. Amelin (Russia) 1.9.-30.11.
J.-P. Coffin (France) 6.-8.9.
P. Kuijer (The Netherlands) 6.-8.9.
J.-R. Lutz (France) 6.-8.9.
V. Borshchov (Ukraine) 6.-9.9.
N. Grion (Italy) 6.-9.9.
G.-J. Nooren (The Netherlands) 6.-9.9.
G. Zinoviev (Ukraine) 6.-9.9.
C. Williams (Switzerland) 3.-6.11.
V. Grigoriev (Russia) 3.-9.11.
G. Kapline (Russia) 3.-9.11.
O. Karavitchev (Russia) 3.-9.11.
T. Karavitcheva (Russia) 3.-9.11.
V. Longinov (Russia) 3.-9.11.
V. Martin (Russia) 3.-9.11.
E. Melechko (Russia) 3.-9.11.
J.-Y. Grossiord (France) 4.-7.11.
L. Pinsky (USA) 4.-7.11.

Conference participation, Talks and Visits by Personnel

Theory Programme

Cosmology

Workshop on physics in extra dimensions,
10-17 February, Warsaw, Poland (talk by S. Räsänen)

The Annual Meeting of the Finnish Physical Society,
22-24 March, Jyväskylä, Finland (K. Enqvist, talk by S. Räsänen)

CERN,
26-27 March, Geneva, Switzerland (K. Enqvist)

Supersymmetry in the early universe Network Meeting,
18-21 April, CERN, Geneva, Switzerland (K. Enqvist, talk by S. Räsänen)

CERN,
7-9 June, Geneva, Switzerland (K. Enqvist)

ESA,
13-14 June, Paris, France (K. Enqvist)

Norwegian Physical Society Annual Meeting,
15 June, Trondheim, Norway (invited talk by K. Enqvist)

COSMO-01, International Workshop on Particle Physics and the Early Universe,
30 August - 4 September, Rovaniemi, Finland (K. Enqvist, talk by S. Räsänen)

DESY Theory Workshop: Gravity and Particle Physics,
9-12 October, Hamburg, Germany (talk by S. Räsänen)

ESA,
13-14 November, Paris, France (K. Enqvist)

Tartu Observatory,
15-16 November, Tartu, Estonia (K. Enqvist)

NORDITA,
29 November - 2 December, Copenhagen, Denmark (K. Enqvist)

Workshop on the ekpyrotic universe,
10-11 December, Annecy, France (talk by S. Räsänen)

Laser Physics and Quantum Optics

QUIP,
10-14 January, Amsterdam, The Netherlands (J. Calsamiglia)

Winter Seminar of the Graduate School for Materials Science,
11-12 January, Jyväskylä, Finland (invited talk by K.-A. Suominen)

Winter School on Laser Spectroscopy and Applications,
19 February - 2 March, Trieste, Italy (J. Piilo)

The Annual Meeting of the Finnish Physical Society,
22-24 March, Jyväskylä, Finland (A. Collin, O. Lindroos, J.-P. Martikainen and K.-A. Suominen)

NORDITA,
25-29 April, Copenhagen, Denmark (M. Mackie)

DAMOP,
15-19 May, London, Canada (M. Mackie)

Nordic School on Atomic Quantum Gases and Matter Wave Optics,
21-31 May, Turku, Finland (J. Calsamiglia, A. Collin, M. Mackie, J.-P. Martikainen, J. Piilo, K.-A. Suominen)

Delaware State University,
10-16 June, Dover, DE, USA (M. Mackie)

Gordon Research Conference on Atomic Physics,
17-22 June, Albany, NY, USA (M. Mackie)

ITAMP, Harvard-Smithsonian Institute,
23-26 June, Cambridge, MA, USA (M. Mackie)

Ørsted Laboratory, University of Copenhagen,
25-30 June, Copenhagen, Denmark (K.-A. Suominen)

NIST,
27-30 June, Gaithersburg, MD, USA (M. Mackie)

AMOLF,
8-15 July, Amsterdam, The Netherlands (M. Mackie)

ENS,
15-25 July, Paris, France (M. Mackie)

The 16th International Conference for Physics Students,
10-16 August, Dublin, Ireland (A. Collin)

Institute for Theoretical Physics, University of Hannover,
23-31 August, Hannover, Germany (A. Collin, M. Mackie, J.-P. Martikainen)

EOFT IX Autumn Theoretical Physics School: Quantum Information,
3-14 September, Santiago de Compostela, Spain (J. Calsamiglia)

University of Aarhus,
14 September, Aarhus, Denmark (K.-A. Suominen)

EURESCO Meeting on Bose-Einstein Condensation 2001,
15-20 September, San Feliu des Guixols, Spain (M. Mackie)

CAUAC Network Meeting,
23-25 September, Sandbjerg, Denmark (J. Piilo, K.-A. Suominen)

University of Connecticut,
4-18 December, Storrs, CT, USA (M. Mackie)

Mathematical Physics and Field Theory

Strings 2001 Conference,
5-10 January, TIFR, Mumbai, India (E. Keski-Vakkuri)

Nordic Winter School on Particle Physics and Cosmology,
6-12 January, Gausdal, Norway (O. Pasanen)

International Conference on High Energy Physics,
8-20 January, Cairo, Egypt (invited talk by M. Chaichian)

University of Pennsylvania,
17-27 April, Philadelphia, PA, USA (seminar talk by E. Keski-Vakkuri)

Nordic Network Meeting on Supersymmetric Field and String Theories,
3-5 May, Uppsala, Sweden (F. Hassan, O. Pasanen)

International Centre for Theoretical Physics,
16-26 May, Trieste, Italy (A. Tureanu)

Moscow State University,
18-24 May, Moscow, Russia (M. Chaichian)

Institute for High Energy Physics,
25-28 May, Protvino, Russia (M. Chaichian)

Complementary Physics Training Course 2001 - Modern Physics,
7 June, University of Helsinki, Helsinki, Finland (talk by M. Chaichian)

The 9th International Conference on Supersymmetry and Unification of Fundamental Interactions,
11-17 June, Dubna, Russia (talk by A. Kobakhidze)

Department of Physical Sciences, University of Helsinki,
12 June, Helsinki, Finland (seminar talk by E. Keski-Vakkuri)

Lisbon School on Superstrings II,
13-17 July, Lisbon, Portugal (F. Hassan)

COSMO-01, International Workshop on Particle Physics and the Early Universe,
30 August - 4 September, Rovaniemi, Finland (E. Keski-Vakkuri)

University of Stockholm,
28 September, Stockholm, Sweden (seminar talk by F. Hassan)

DESY Theory Workshop: Gravity and Particle Physics,
9-12 October, Hamburg, Germany (talk by D. Polyakov)

University of Heidelberg,
26-28 October, Heidelberg, Germany (M. Chaichian)

JHS/60, A meeting to celebrate 60 years of John H. Schwarz,
3-4 November, Pasadena, CA, USA (E. Keski-Vakkuri)

California Institute of Technology,
4-6 November, Pasadena, CA, USA (E. Keski-Vakkuri)

University of Pennsylvania,
6-16 November, Philadelphia, PA, USA (seminar talk by E. Keski-Vakkuri)

Nordic Network Meeting on Supersymmetric Field and String Theories,
15-17 November, Stockholm, Sweden (F. Hassan, O. Pasanen, talk by D. Polyakov)

University of Turku,
26 November, Turku, Finland (colloquium by E. Keski-Vakkuri)

University of Adelaide,
2-18 December, Adelaide, Australia (talks by M. Chaichian)

Gran Sasso Laboratory,
10 December, Gran Sasso, INFN, Italy (talk by A. Kobakhidze)

Frascati Laboratory,
17 December, Frascati, INFN, Italy (talk by A. Kobakhidze)

University of Melbourne,
20-24 December, Melbourne, Australia (M. Chaichian)

University of Sidney,
27-30 December, Sidney, Australia (M. Chaichian)

Particle Physics Theory

Department of Physical Sciences, University of Helsinki,
16 February, Helsinki, Finland (seminar talk by K. Huitu)

Meeting on EU-Network,
19-25 February, CERN, Geneva, Switzerland (E. Gabrielli)

Third Nordic LHC Physics Workshop,
16-17 March, Oslo, Norway (talk by E. Gabrielli, K. Huitu, J. Laamanen, Z.-H. Yu)

The Annual Meeting of the Finnish Physical Society,
22-24 March, Jyväskylä, Finland (K. Huitu)

Cosmo-Particle Meeting,
19-23 April, CERN, Geneva, Switzerland (talk by E. Gabrielli)

Institute of Theoretical Physics,
24-28 April, Madrid, Spain (talk by E. Gabrielli)

University of Beijing,
25 May - 5 June, Beijing, China (Z.-H. Yu)

Department of Physics, Bologna University,
4-8 June, Bologna, Italy (talk by E. Gabrielli)

The 9th International Conference on Supersymmetry and Unification of Fundamental Interactions,
11-17 June, Dubna, Russia (talk by K. Huitu)

Summer School on Particle Physics,
17 June - 7 July, Miramare, Trieste, Italy (J. Laamanen)

University of Beijing,
10-21 August, Beijing, China (talk by Z.-H. Yu)

COSMO-01, International Workshop on Particle Physics and the Early Universe,
2-5 September, Rovaniemi, Finland (K. Huitu)

CERN,
22 September - 31 December, Geneva, Switzerland (E. Gabrielli)

NorFa training course,
22-23 November, Stockholm, Sweden (J. Laamanen)

Fourth Nordic LHC Physics Workshop,
23-24 November, Stockholm, Sweden (talk by K. Huitu, talk by J. Laamanen)

Hadron Physics Activity

California Institute of Technology,
17-29 January, Pasadena, CA, USA (talk by D.-O. Riska)

XI EURODAPHNE Collaboration Meeting,
8-10 February, Marseille, France (M. Sainio)

Workshop on the Physics of Excited Nucleons,
7-10 March, Mainz, Germany (T. Lähde, invited talk by

D.-O. Riska)

The Annual Meeting of the Finnish Physical Society,
22-24 March, Jyväskylä, Finland (M. Sainio)

North-West Europe Nuclear Physics Conference,
17-20 April, Bergen, Norway (invited talk by D.-O. Riska)

Third International Conference on Perspective in Hadronic Physics,
7-11 May, Trieste, Italy (invited talk by D.-O. Riska)

Institute of Theoretical Physics, University of Bern,
6-8 June, Bern, Switzerland (M. Sainio)

Fifth Workshop on Electromagnetically Induced Two-Hadron Emission,
13-16 June, Lund, Sweden (invited talk by D.-O. Riska)

9th International Symposium on Meson-Nucleon Physics and the Structure of the Nucleon,
26-31 July, Washington, DC, USA (talk by T. Lähde, invited talk by D.-O. Riska, invited talk by M. Sainio)

Department of Physics, Brookhaven National Laboratory,
3 August, Upton, USA (M. Sainio)

Review of the Proton-Proton Forward Physics Project of the Helsinki Institute of Physics,
11 October, CERN, Geneva, Switzerland (D.-O. Riska)

2nd Workshop on Hadronic Atoms,
11-12 October, Bern, Switzerland (invited talk by M. Sainio)

Thomas Jefferson National Accelerator Facility,
3-11 November, Newport News, VA, USA (talk by D.-O. Riska)

Effective Field Theories of QCD,
26-30 November, Bad Honnef, Germany (M. Sainio)

Statistical Physics and Materials Science

International Workshop on Wetting,
12-14 February, Bonn, Germany (invited talk by T. Ala-Nissilä, S. Majaniemi, M.-P. Kuittu, E. Kuusela)

Department of Physics, Brown University,
6-11 March, Providence, USA (T. Ala-Nissilä and O. Trushin)

The American Physical Society March Meeting,
12-16 March, Seattle, WA, USA (T. Ala-Nissilä, E. Falck, J. M. Lahtinen, S. Majaniemi, M. Rusanen, O. Trushin)

The Annual Meeting of the Finnish Physical Society,
22-24 March, Jyväskylä, Finland (M. Alatalo, J. Asikainen, A.-P. Hynninen, E. Kuusela, S. Majaniemi, M. Rusanen, P. Salo, E. Terämä)

Department of Physics, Brown University,
3 April - 5 May, Providence, USA (A.-P. Hynninen)

Department of Physics, Tampere University of Technology,
5 April, Tampere, Finland (seminar talk by T. Ala-Nissilä)

Czech Academy of Sciences,
20-29 May, Prague, The Czech Republic (T. Ala-Nissilä)

Fritz Haber Institut,
26 May - 6 June, Berlin, Germany (M. Rusanen)

International Workshop on Modern Problems in the Physics of Surfaces and Nanostructures,
18-21 June, Yaroslavl, Russia (invited talk by T. Ala-Nissilä, talks by E. Kuusela, J. M. Lahtinen and A.-P. Hynninen)

Methods in Molecular Simulation,
1-10 July, UMIST, Manchester, UK (E. Falck, E. Terämä)

DV-Xa International Workshop '01 RIKEN,
31 July - 3 August, Saitama, Japan (invited talk by M. Alatalo)

International Summer School: Physics of Biomembranes and Complexation,
15-16 August, Espoo, Finland (E. Falck, A.-P. Hynninen, E. Kuusela, E. Terämä)

International Conference: From Biomembranes to Cationic Liposomes,
17-19 August, Espoo, Finland (T. Ala-Nissilä, E. Falck, A.-P. Hynninen, E. Kuusela, E. Terämä)

International Summer School: Fundamental Problems in Statistical Physics X,
20 August - 2 September, Altenberg, Germany (E. Kuusela)

Coarse Graining in Time and Space: From Microscopics to Macroscopics,
27-30 August, Sjökulla, Finland (T. Ala-Nissilä, E. Falck, A.-P. Hynninen, M. Rusanen, E. Terämä)

The XX European Conference on Surface Science,
3-7 September, Krakow, Poland (J. M. Lahtinen, M. Rusanen)

Insitute of Computer Aplications, University of Stuttgart,
3-8 September, Stuttgart, Germany (E. Kuusela)

SIMU Workshop on Bridging the Time and Length Scales,
10-13 September, Konstanz, Germany (T. Ala-Nissilä, E. Falck, E. Kuusela)

Czech Academy of Sciences,
12-16 November, Prague, The Czech Republic (J. M. Lahtinen)

High Energy Physics Programme

Electron-Positron Physics

The Annual Meeting of the Finnish Physical Society,
22-24 March, Jyväskylä, Finland (invited talk by R. Orava, H. Saarikko, talk by L. Salmi)

TESLA Colloquium,
23-24 March, DESY, Hamburg, Germany (A. Kiiskinen)

LEP Higgs Workshop,
11-12 May, Evian, France (A. Kiiskinen)

Snowmass 2001, The Future of Particle Physics,
6-21 July, Snowmass Village, CO, USA (talks by A. Kiiskinen)

International Europhysics Conference on High Energy Physics,
12-18 July, Budapest, Hungary (H. Saarikko, talk by K. Österberg)

29th SLAC Summer Institute on Particle Physics,
13-24 August, Stanford, CA, USA (L. Salmi)

DELPHI Symposium,
19-26 September, Delfi, Greece (talk by L. Salmi)

Forward Physics

XV Rencontres de Physique de la Vallee d'Aoste,
4-10 March, La Thuile, Italy (talk by S. Tapprogge)

2nd International Workshop on Very High Multiplicity Physics,
7-9 April, Dubna, Russia (invited talk by S. Tapprogge)

IX Blois Workshop on Elastic and Diffractive Scattering,
9-15 June, Pruhonice, The Czech Republic (invited talk by R. Orava)

International Europhysics Conference on High Energy Physics,
12-18 July, Budapest, Hungary (talk by S. Tapprogge)

International Conference on The Structure and Interactions of the Photon (PHOTON2001),
2-7 September, Ascona, Switzerland (talk by S. Tapprogge)

7th Workshop on Electronics for LHC Experiments,
10-14 September, Stockholm, Sweden (K. Österberg)

IPPP Workshop on Diffractive Physics at the Tevatron and LHC,
20-21 September, Durham, UK (talk by S. Tapprogge, K. Österberg)

Review of the Proton-Proton Forward Physics Project of the Helsinki Institute of Physics,
11 October, CERN, Geneva, Switzerland (R. Orava, M. Ryynänen, H. Saarikko, S. Tapprogge, K. Österberg)

The 4th Nordic LHC Workshop,
22-24 November, Stockholm, Sweden (invited talk by R. Orava)

Workshop on Luminosity for and Forward Physics with ATLAS,
26-27 November, Valencia, Spain (S. Tapprogge, talk by K. Österberg)

IPPP Workshop on Multiparticle Production in QCD Jets,
12-15 December, Durham, UK (talk by S. Tapprogge)

Detector Laboratory

The International Workshop on Aging Phenomena in Gaseous Detectors,
2-5 October, DESY, Hamburg, Germany (J. Heino, talk by K. Kurvinen)

LHC Programme

Software and Physics

Third Nordic LHC Physics Workshop,
16-17 March, Oslo, Norway (invited talk by R. Kinnunen, talk by S. Lehti)

Workshop on Higgs and Supersymmetry,
19-22 March, Orsay, France (invited talk by R. Kinnunen)

The Annual Meeting of the Finnish Physical Society,
22-24 March, Jyväskylä, Finland (A. Heikkinen, T. Lampén, talk by S. Lehti, talk by J. Nysten)

Btau tagging and Jet/MET Workshop,
6-8 June, CERN, Geneva, Switzerland (invited talk by R. Kinnunen)

International Europhysics Conference on High Energy Physics,
12-18 July, Budapest, Hungary (T. Lindén)

8th Adriatic Meeting, Particle Physics in the New Millennium,
4-14 September, Dubrovnik, Croatia (invited talk by R. Kinnunen)

CMS Annual Review,
18 September, CERN, Geneva, Switzerland (invited talk by V. Léfebure)

III International Symposium on LHC: Physics and Detectors,
25-27 October, Chia, Sardinia, Italy (invited talk by K. Lassila-Perini)

Working visits to CERN,
Geneva, Switzerland (A. Heikkinen, talk by V. Karimäki, T. Lampén, talk by S. Lehti, T. Lindén)

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

CMS Tracker

The Annual Meeting of the Finnish Physical Society,
22-24 March, Jyväskylä, Finland (talk by T. Vanhala)

JEC Composites Show,
27-29 March, Paris, France (H. Katajisto)

Semicon Europa 2001 Exposition,
24-26 April, Munich, Germany (J. Härkönen)

Workshop on Physics with CMS at the LHC,
16-22 June, Catania, Italy (K. Banzuzi, E. Tuominen, D. Ungaro, T. Vanhala)

6th International Conference on Large Scale Applications and radiation Hardness of Semiconductor Detectors,
3-7 July, Florence, Italy (talk by J. Härkönen)

Working visit to Seoul National University,
Seoul, Korea (E. Pietarinen, E. Tuominen)

Working visit to University of Oulu, Microelectronics Instrumentation Laboratory,
Kemi, Finland (J. Härkönen, K. Lassila-Perini, E. Tuominen)

Working visits to University of Jyväskylä, Department of Physics,
Jyväskylä, Finland (J. Härkönen, S. Nummela, J. Nysten, K. Lassila-Perini, E. Tuominen, E. Tuovinen)

Working visits to University of Bari,
Bari, Italy (D. Ungaro)

Working visits to University of Marseille,
Marseille, France (K. Banzuzi, E. Tuominen, D. Ungaro)

Working visit to Universite Catholique de Louvain-la-Neuve,
Louvain-la-Neuve, Belgium (P. Luukka)

Working visits to CERN,
Geneva, Switzerland (A. Heikkilä, H. Katajisto, E. Pietarinen, D. Ungaro)

Working visit to Finnish Composite Industry,
Helsinki University of Technology, Volar Plastic, FY-Composites, Patria Finavitec, HT Vesileikkaus
(H. Katajisto, E. Tuominen, T. Vanhala)

Nuclear Matter

The ISOL'01 Conference,
11-14 March, Oak Ridge, TN, USA (invited talk by J. Äystö)

The Annual Meeting of the Finnish Physical Society,
22-24 March, Jyväskylä, Finland (M. Bondila, A. Kolozhvari, V. Lyapin, talk by W. H. Trzaska, invited talk by J. Äystö)

ECT* Workshop on Radioactive Muonic and Antiprotonic Atoms,
22-26 May, Trento, Italy (talk by A. Jokinen, talk by J. Äystö)

PS-Seminar,
20 June, CERN, Geneva, Switzerland (talk by A. Jokinen)

CERN Summer Student Lecture,
2 August, Geneva, Switzerland (talk by J. Äystö)

STOP 2001,
5-8 August, Odense, Denmark (talk by W. H. Trzaska)

Symposium on RADIOACTIVE BEAM RESEARCH. Status and Future in a Fifty-Year Perspective,
23-24 November, Copenhagen, Denmark (invited talk by J. Äystö)

EXOTRAPS/EUROTRAPS Collaboration Meeting,
CERN, Geneva, Switzerland (talk by A. Jokinen)

ISOLDE User's Workshop,
CERN, Geneva, Switzerland (talk by A. Jokinen)

Technology Programme

1st NorduGrid Workshop,
5-6 February, Lund, Sweden (talk by M. Heikkurinen)

NOS-N, Expert Seminar on DataGrid matters,
23 February, Stockholm, Sweden (talk by M. Heikkurinen)

NanoLab Concept Workshop,
2 April, Lausanne, Switzerland (M. Heikkurinen, M. Käki, M. Niinimäki)

The Economist IT Strategy Summit,
24-25 April, Scottsdale, AZ, USA (talk by A.-P. Hameri)

Conference on Knowledge Basis and Modeling,
28 May - 1 June, Maribor, Slovenia (M. Niinimäki)

Annual Conference of Association of Japanese Business Studies,
11-13 June, Seinäjoki, Finland (talk by A.-P. Hameri)

CSC Seminar, Grid - A New Form of Information Technology,
12 June, Helsinki, Finland (talk by M. Heikkurinen)

Beyond Scientific Applications: Industrial Grid,
27-29 June, Paris, France (M. Gindonis, M. Heikkurinen, J. White)

Academy of Management Conference,
5-8 August, Washington, DC, USA (talk by E. Autio)

The Global Computer Workshop,
16 August, Copenhagen, Denmark (F. Gray)

Family Business Network World Conference,
4-6 October, Rome, Italy (talk by E. Autio)

Global Grid Forum 3,
7-10 October, Frascati, Italy (M. Heikkurinen, J. White)

Strategic Management Society World Conference,
21-24 October, San Francisco, USA (talk by E. Autio)

NanoLab Concept Workshop,
26 October, Chapel Hill, NC, USA (M. Heikkurinen, M. Niinimäki)

2nd NorduGrid Workshop,
1-2 November, Oslo, Norway (talk by J. White)

IUMI, Délocalisation d'activités industrielles et sourcing international,
27 November, Lausanne, Switzerland (talk by A.-P. Hameri)

Administration and Support

Review of Finnish CERN Activities at CERN,
25-27 February, CERN, Geneva, Switzerland (invited talk by R. Rinta-Filppula)

The Annual Meeting of the Finnish Physical Society,
22-24 March, Jyväskylä, Finland (invited talk by R. Rinta-Filppula)

"Interaktiivinen teknologia koulutuksessa" Conference,
19-21 April, Aulanko, Hämeenlinna, Finland (invited talks by R. Rinta-Filppula)

EPP Outreach Meeting,
27-28 April, CERN, Geneva, Switzerland (invited talk by R. Rinta-Filppula)

ED-MEDIA, World Conference on Educational Multimedia, Hypermedia / Telecommunications,
25-30 June, Tampere, Finland (invited talk by M. Draper and R. Rinta-Filppula)

EPP Outreach Meeting,
19-20 October, CERN, Geneva, Switzerland (R. Rinta-Filppula)

Publications

Theory Programme

Cosmology

R. Allahverdi, K. Enqvist, A. Mazumdar, and A. Pérez-Lorenzana,
Baryogenesis in theories with large extra spatial dimensions,
Nucl. Phys. B 618 (2001) 277

K. Enqvist, E. Gabrielli, and K. Huitu,
***g*-2 of the muon in SUSY models with gauge multiplets in the bulk of extra dimensions,**
Phys. Lett. B 512 (2001) 107

K. Enqvist, A. Jokinen, T. Multamaki, and I. Vilja,
Numerical simulations of fragmentation of the Affleck-Dine condensate,
Phys. Rev. D 63 (2001) 083501

K. Enqvist, K. Kainulainen, and A. Sorri,
Creation of large spatial fluctuations in neutrino asymmetry by neutrino oscillations,
J. High Energy Phys. 04 (2001) 012

K. Enqvist, E. Keski-Vakkuri, and S. Räsänen,
Hubble law and brane matter after ekpyrosis,
Nucl. Phys. B 614 (2001) 388

K. Enqvist, E. Keski-Vakkuri, and S. Räsänen,
Constraints on the brane and bulk ideal fluid in Randall-Sundrum cosmologies,
Phys. Rev. D 64 (2001) 044017

Laser Physics and Quantum Optics

D. Bruß, J. Calsamiglia, and N. Lütkenhaus,
Quantum cloning and distributed measurements,
Phys. Rev. A 63 (2001) 042308

J. Calsamiglia, S. M. Barnett, N. Lütkenhaus, and K.-A. Suominen,
Removal of a single photon by adaptive absorption,
Phys. Rev. A 64 (2001) 043814

J. Calsamiglia and N. Lütkenhaus,
Maximum efficiency of a linear-optical Bell-state analyzer,
Appl. Phys. B 72 (2001) 67

J. Calsamiglia, M. Mackie, and K.-A. Suominen,
Superposition of macroscopic numbers of atoms and molecules,
Phys. Rev. Lett. 87 (2001) 160403

A. Ishkhanyan and K.-A. Suominen,
Solutions of the two-level problem in terms of biconfluent Heun functions,
J. Phys. A: Math. Gen. 34 (2001) 6301

M. Machholm, P. S. Julienne, and K.-A. Suominen,
Calculations of collisions between cold alkaline-earth-metal atoms in a weak laser field,
Phys. Rev. A 64 (2001) 033425

M. Mackie, E. Timmermans, R. Cote, and J. Javanainen,
Driving superfluidity with photoassociation,
Opt. Express 8 (2001) 118

J.-P. Martikainen,
Bose-Einstein condensation in shallow traps,
Phys. Rev. A 63 (2001) 043602

J.-P. Martikainen, M. Mackie, and K.-A. Suominen,
Comment on "Bose-Einstein condensation with magnetic dipole-dipole forces",
Phys. Rev. A 64 (2001) 037601

J.-P. Martikainen and K.-A. Suominen,
Collective excitations in an $F = 2$ Bose-Einstein condensate,
J. Phys. B: At. Mol. Opt. Phys. 34 (2001) 4091

J.-P. Martikainen, K.-A. Suominen, L. Santos, T. Schulte, and A. Sanpera,
Generation and evolution of vortex-antivortex pairs in Bose-Einstein condensates,
Phys. Rev. A 64 (2001) 063602

J. Piilo, K.-A. Suominen, and K. Berg-Sørensen,
Cold collisions between atoms in optical lattices,
J. Phys. B: At. Mol. Opt. Phys. 34 (2001) L231

K.-A. Suominen, M. Machholm, and P. S. Julienne,
Cold collisions between laser-cooled magnesium atoms,
Physica Scripta T95 (2001) 58

R. G. Unanyan, N. V. Vitanov, and K. Bergmann,
Preparation of entangled states by adiabatic passage,
Phys. Rev. Lett. 87 (2001) 137902

N. V. Vitanov, T. Halfmann, B. W. Shore, and K. Bergmann,
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Mathematical Physics and Field Theory

V. Balasubramanian, J. de Boer, E. Keski-Vakkuri, and S. F. Ross,
Supersymmetric conical defects: Towards a string theoretic description of black hole formation,
Phys. Rev. D 64 (2001) 064011

Z. Berezhiani, M. Chaichian, A. B. Kobakhidze, and Z.-H. Yu,
Vanishing of cosmological constant and fully localized gravity in a brane world with extra time(s),
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Z. Berezhiani, I. Gogoladze, and A. Kobakhidze,
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M. Chaichian and W. F. Chen,
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M. Chaichian, W. F. Chen, and R. González Felipe,
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M. Chaichian, W. F. Chen, and C. Montonen,
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M. Chaichian, A. Demichev, P. Prešnajder, M. M. Sheikh-Jabbari, and A. Tureanu,
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Noncommutative quantum field theory: unitarity and discrete time,
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Phys. Lett. B 515 (2001) 65

M. Chaichian, K. Huitu, S. Roy, and Z.-H. Yu,
Single sneutrino production in $\gamma\gamma$ collisions,
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Single superparticle production via $\gamma\gamma$ collision with explicit R-parity violation,
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M. Chaichian and A. B. Kobakhidze,
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G. Barenboim, K. Huitu, and M. Raidal,
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Determination of the string scale in D-brane scenarios and dark matter implications,
Nucl. Phys. B 603 (2001) 231

D. G. Cerdeño, E. Gabrielli, S. Khalil, C. Muñoz, and E. Torrente-Lujan,
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Neutrinos confronting large extra dimensions,
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Hadron Physics Activity

A. Acus, E. Norvaišas, and D. O. Riska,
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Physica Scripta 64 (2001) 113

K. O. E. Henriksson, T. A. Lähde, C. J. Nyfält, and D. O. Riska,
Pion decay widths of D mesons,
Nucl. Phys. A 686 (2001) 355

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Two-pion decay widths of excited charm mesons,
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M. T. Peña, H. Garcilazo, and D. O. Riska,
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Nucleon resonance transition couplings to vector mesons,
Nucl. Phys. A 679 (2001) 577

Statistical Physics and Materials Science

S. C. Badescu, S. C. Ying, and T. Ala-Nissila,
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High Energy Physics Programme

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LHC Programme

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