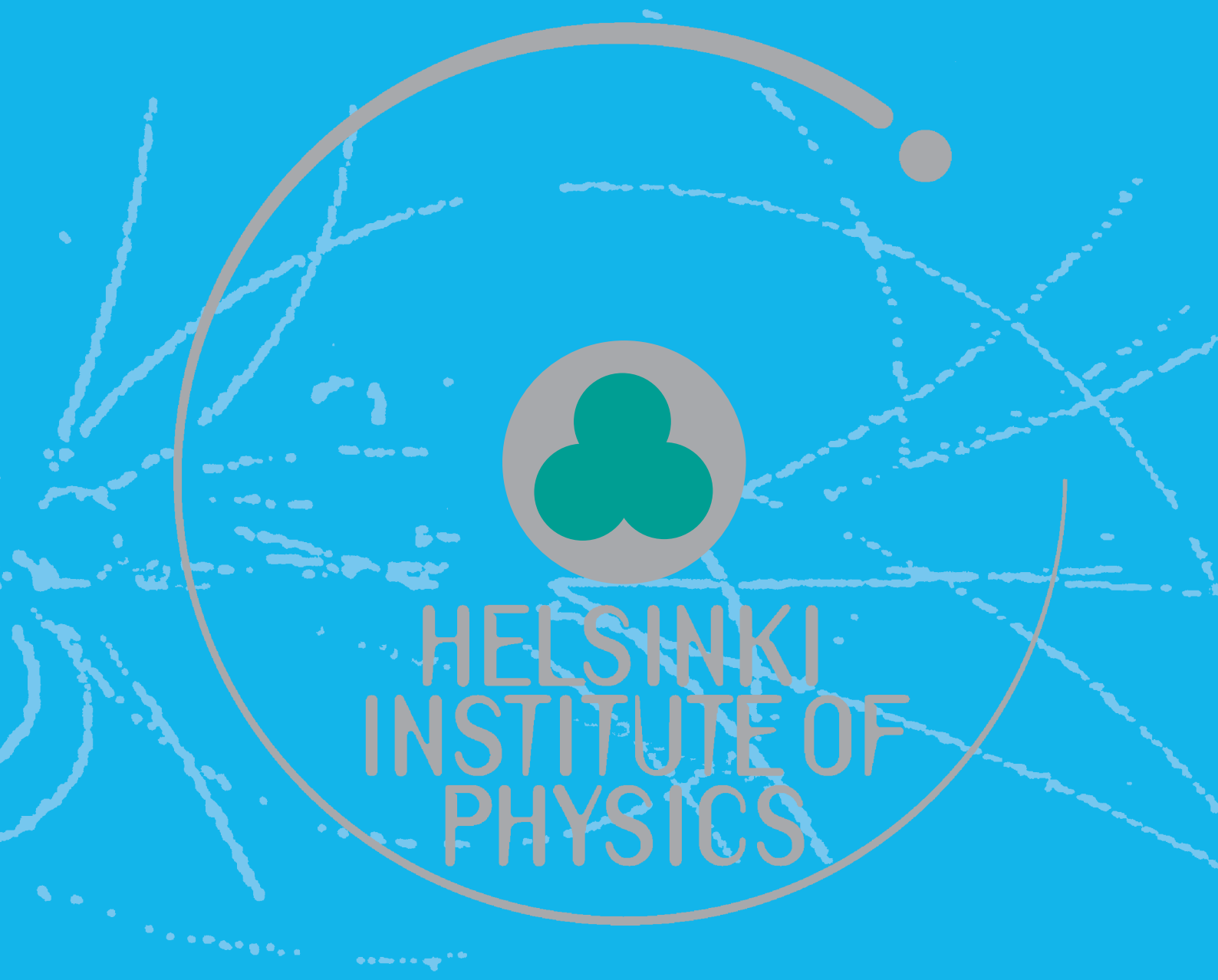
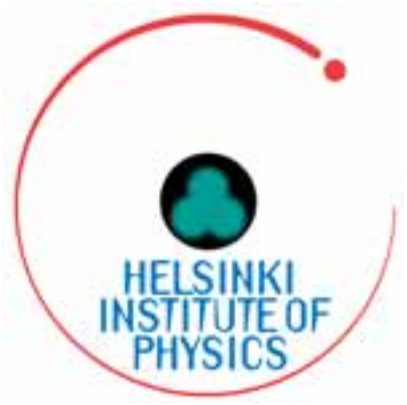
Annual Report 2003



HELSINKI INSTITUTE OF PHYSICS



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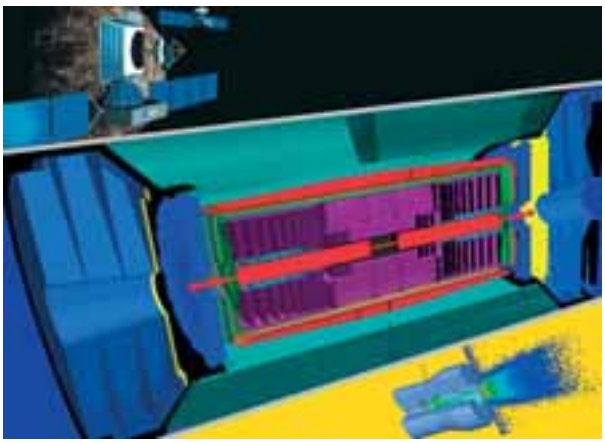


Geant4 simulated detector pictures. (Cortesy Geant4, CMS, ESA, INFN.)

Annual Report 2003 Helsinki Institute of Physics

Contents

Introduction

Dan-Olof Riska

The Helsinki Institute of Physics (HIP) is a national Finnish institute for research in physics and physics related technology development. The Institute is operated jointly by the Universities of Helsinki and Jyväskylä and the Helsinki University of Technology. The Institute has a mandate from the Finnish Ministry of Education for co-ordinating the Finnish research at CERN.

The modus operandi of the Institute is to carry out time limited significant research projects that are either too resource intensive or too cross disciplinary or novel to fit into the standard framework of academic research funding. An important goal of the Institute is to support the research and teaching departments in its member universities by means of joint research projects and by graduate training within these research projects. An example of the success of this collaboration is the fact that 10 project leaders and researchers of the Institute have in the past 5 years been appointed to professorial positions at several different universities.

During the year 2003 the research activities at HIP fell into 5 separate research programmes: (1) the "Theory Programme", (2) the "High Energy Physics Programme", (3) the "CMS Programme", (4) the "Nuclear Matter Programme" and (5) the "Technology Programme".

The Theory Programme serves as a Finnish project oriented national institute for theoretical physics. Three new theory projects were started at the beginning of 2002. These projects concern (1) string theory and quantum field theory, (2) the physics of biological systems and (3) the theory of ultrarelativistic heavy ion collisions. During the year 2003 the earlier highly successful project on laser physics and quantum optics was brought to completion. The projects on cosmology and particle physics phenomenology, which were reviewed during the year and received high marks, were subsequently granted continuation for a second 3-year period by the Board of the Institute. The Theory Programme of the Institute has enjoyed prolonged and fruitful visits by Professors Ulf Lindström (Uppsala) and Finn Ravndal (Oslo).

During the year the Physics of Biological Systems project was selected by the Helsinki University of Technology as a "top research project".

The High Energy Physics Programme during the year continued its projects for detector development for forward proton-proton physics study at the LHC at CERN and at the CDF-II experiment at the Tevatron accelerator at the Fermi National Accelerator Laboratory. The collaboration between HIP and the Low Temperature Laboratory in the ongoing COMPASS experiment at CERN continued during 2003 both in target operation and off-line physics analysis. The analysis of the data accumulated by the completed DELPHI experiment at the former "LEP" collider at CERN continued.

The CMS Programme is divided into two projects: one for the development of the tracker and the trigger of the CMS detector at the LHC and the other for software development for the CMS data analysis.

The Nuclear Matter Programme of the Institute is divided into a low energy nuclear physics project at the ISOLDE facility at CERN and a project for instrumentation for the ALICE detector for relativistic heavy ion collisions at the LHC.

The Institute is the Finnish partner of the LHC Computing Grid Project at CERN (LCG-1) for the establishment of the distributed high-throughput computing capacity that will be required by the analysis of the data acquired by the LHC detectors.

The Technology Programme of the Institute aims at developing industrial applications of CERN generated innovations in technology. During 2003 the focus of the Technology Programme was on software development for distributed data-intensive Grid computation. The sabbatical visit by Professor Francois Grey of the Danish Microelectronics Center led to his being retained by CERN as the manager of the new OpenLab project. The sabbatical visit by Professor Erkko Autio of the Helsinki University of Technology led to his initiation and successful completion of the high-tech industry CERN supplier survey project. The survey report revealed that CERN has a notable role as a driver of the development of commercially successful high technology equipment.

The Institute has continued its strong efforts in graduate student training in frontline research. This activity is supported in part by the research projects themselves, and in part by the national graduate school programmes. The graduate training efforts were greatly strengthened by generous grants by several Finnish foundations, first and foremost by the Magnus Ehrnrooth Foundation. During 2003 7 PhD and DSc degrees and 8 MA and MSc degrees were awarded on the basis of research conducted within the research projects of the Institute.

The summer student programme at CERN continues to be a highly significant component of the educational efforts of the Institute. The Institute continued its support of the "Open Learning Environment" project of the Tampere University of Technology which was brought to completion during the year. During the year the Institute hosted 11 visits by groups of students and 4 visits by teachers of Finnish high schools to CERN.

During the year 2003 a national strategy for the Finnish collaboration with CERN was laid out. This strategy spells out the goals of the research that HIP conducts at CERN, and defines the role of the project of the National Technology Agency TEKES for collaboration between Finnish industry and CERN. The project, which has been extraordinarily successful during the past 4 years, is carried out in close collaboration with HIP.

The Restricted European Committee on Future Accelerators RECFA visited HIP on September 26, and heard presentations by representatives of all the different Finnish research groups which are active in subatomic physics. On the basis of this review RECFA has made some valuable recommendations to the Finnish Ministry of Education. The Finnish research funding agency, the Academy of Finland, completed an overall survey of the conditions and level of scientific research in Finland. The recommendations in the report for strengthening the nationwide physics research effort are that ventures into new and timely research topics should be stimulated, that the funds for equipment should be increased and that the Finnish activities at CERN, especially in experimental particle physics, should be strengthened. All of these recommendations are both supportive of and in line with the research programme of the Helsinki Institute of Physics.

HIP was governed by a tripartite board appointed by the universities that operate the Institute. The Board has been chaired by Vice Rector Ilkka Niiniluoto of the University of Helsinki until he was elected Rector of the University. He was succeeded by Vice Rector Marja Makarow as chair of the Board of HIP. The scientific activities of the Institute were overseen by an international Scientific Advisory Board, which was chaired by Professor Hans Falk Hoffmann, Director of scientific computing and technology transfer at CERN. The Institute is indebted to the outgoing members of the Scientific Advisory Board, Professors Hans Falk Hoffmann (CERN), Albrecht Wagner (DESY) and Gabriele Veneziano (CERN).

The Institute looks forward to a fruitful collaboration with the new members of the Scientific Advisory Board, Professors Jos Engelen (Nikhef, CERN), Heinrich Leutwyler (Bern) and Wolf-Dieter Schlatter (CERN).

HELSINKI INSTITUTE OF PHYSICS

Highlights of Research Results

Theory Programme

In Cosmology we suggested that the flat directions of the minimally supersymmetric theories could provide the density perturbations through the curvaton mechanism. We also showed that the holographic principle might yield interesting constraints on inflation. WMAP bounds on the isocurvature fluctuations were re-analysed, taking the isocurvature-adiabatic correlations properly into account. In collaboration with the Department of Physical Sciences, the Cosmology project continued to participate in the Finnish Planck Surveyor Consortium.

The highly successful Laser Physics and Quantum Optics project had its final year at HIP. The main results for 2003 involve atomic and molecular Bose-Einstein condensates. Specifically, our research has shown that contrary to expections, in anharmonic potentials one can have vortices in condensates with attractive atomic interactions. More importantly, we also show that such a condensate can display centre-of-mass rotation, this has not been predicted or seen for condensates so far. We also examined the creation of a Fermi-degenerate gas of molecules via a laser-induced photoassociation or magnetic field generated Feshbach resonance applied to a degenerate Bose-Fermi mixture of atoms.

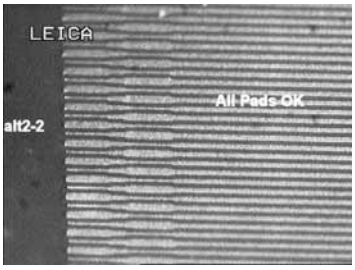
In Particle Physics Phenomenology, the disentagling of the Higgs boson from Higgs-like scalars in an extra-dimensional model and in a supersymmetric model was investigated at the LHC and linear colliders, and practical methods were proposed. Supersymmetric chargino contributions to the CP asymmetry of $B \to \phi K_S$ were analysed; we found that they can account for the large experimental deviation from the Standard Model.

In Biophysics, extensive atomic-level simulations were employed to shed light on cationic lipid membrane mixtures that are known to form compact complexes with DNA and to be effective as gene delivery agents. The team consisting of the Biophysics group at HIP (HUT), and the group at the Laboratory of Computational Engineering (HUT) was selected as a Helsinki University of Technology Young Center of Excellence for 2004 – 2005.

In String Theory and Quantum Field Theory, tests of string theory in time-dependent backgrounds have continued. In one particular model, a priori plagued by closed causal curves and associated instabilities, it was demonstrated that surprisingly these pitfalls can be avoided by a proper definition of time and by an explicit backreaction calculation in string theory.

The Heavy Ion project has successfully described the bulk of the hadron spectra in Au+Au collisions at the Relativistic Heavy Ion Collider (RHIC) within the perturbative QCD + saturation + hydrodynamics model. The classical Yang-Mills equations of motion for primary gluon production have been solved correctly for the first time. Several significant and extremely demanding computations have been carried out: the pressure of hot QCD up to $g^6\ln(1/g)$, the four-loop vacuum energy density of $SU(N_c)$ + adjoint Higgs theory and the complete set of four-loop master vacuum diagrams are now known.

High Energy Physics Programme



In 2004 the Helsinki group made important contributions to the Technical Design Report (TDR) of the TOTEM/LHC experiment at CERN, e.g., by providing an assessment of the accuracy of the total cross-section measurement in pp scattering as well as of the acceptance and resolution of diffractively scattered protons. Also detailed studies on possible trigger scenarios were performed for the possible exploitation of Higgs production Double Pomeron exchange processes.

The Helsinki group significantly improved the process of producing very long kapton cables for connecting silicon sensors of the innermost layer of the planned SVXII for the CDF experiments to the front-end readout chips situated outside the tracking volume for radiation tolerance reasons.

In the Detector Laboratory the first sealed prototype of a Gas Electron Multiplier (GEM) detector was designed, and a Peltier-element based system for fast reliability assessment of microelectronic devices was developed in collaboration with the Electronics Research Unit of the Department of Physical Sciences of the University of Helsinki and the Nokia Research Center.

CMS Programme

After many years of effort the evaluation of the physics discovery potential and the preparation for physics analysis of the CMS experiment are converging towards a stable picture. Realistic detector simulations, with the implementation of the test beam data accumulated and with improved theoretical estimates for the cross sections of the discovery channels, have contributed to the consolidation of the discovery limits of the experiment. As an interim milestone towards the Physics Technical Report due in 2006, the CMS collaboration in 2003 made a full review of the results of the studies on its potential to discover the Higgs boson(s). The summary covers the main discovery channels and the potential is given for the discovery of the Standard Model Higgs boson as well as the Higgs bosons of the Minimal Supersymmetric Standard Model (MSSM). The HIP Physics team had the responsibility to prepare the review and to update the existing studies for detector dependent issues to correspond to the latest information available. The HIP team also had the responsibility to write the CMS Note on the review. The studies show that in the mass range from 150 to 500 GeV the Higgs boson can be discovered with an integrated luminosity of 10 fb^{-1}, i.e. during the first year of LHC running if the conditions are as planned. An additional 20–30 fb^{-1} will be needed for the full mass range from 100 to 1000 GeV.

An interesting extension of the Higgs studies was the measurement of the tanβ parameter in the MSSM. The precision of the measurement was estimated by the HIP Physics team using the $\tau\tau$ and $\tau\nu$ decay modes of the heavy neutral and charged MSSM Higgs bosons. Assuming 20% theoretical uncertainty for the production rate, the value of tanβ can be measured with a precision better than 25% within the expected 5σ-discovery reach.

The HIP team published results on the conversion of photons in the CMS Tracker, where the converting photons are reconstructed with inward track building. The efficiency for finding both electron tracks for the converted photon was found to be 72% in the central part of the detector. This is an important tool for the Higgs $\rightarrow \gamma\gamma$ channel where the position of the primary vertex needs to be determined with the tracks.

Another interesting achievement of the HIP Software team was the development of the interdisciplinary simulation toolkit GEANT4. An improved version of the Bertini intra-nuclear cascade model was included in the GEANT4 6.0 release and added to the hadronic physics lists for a "typical" HEP collider detector. Compared to the standard 1-10 GeV hadronic models available in GEANT3, our model was estimated to provide, in some cases, significantly better physics performance. Consequently, CMS and other major experiments, such as ATLAS and BaBar, are currently evaluating and considering the use of the Bertini cascade for nucleon and pion induced reactions.

The computing potential at HIP was increased significantly during the year 2003 with the installation of a new Linux cluster ("mill") at the Kumpula Computing Unit (KUKA). Mill is a joint project between the University of Helsinki Department of Physical Sciences and HIP. It consists of 64+2 CPUs. Each node of the cluster has dual 2.133 GHz AMD Athlon CPUs with 1 GB of memory and dual 80 GB ATA disks. In total the system has 33 GB of memory and 2.5 TB of local mirrored disk space. The mill cluster will do Monte Carlo production for the CMS Data Challenge 04.

The assembly work of the support structures of the Tracker Outer Barrel at the Physicum Laboratories in Kumpula entered the serial production phase. The first serial production rod frames were delivered to CERN at the beginning of the summer. Altogether 15 frames were delivered by the end of the year with another 40 frames ready for delivery. The rate of production is being adjusted so that the full amount of 688 rod frames will be delivered by the beginning of 2005.

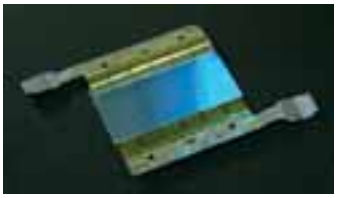
Excellent results were achieved on the radiation hardness of the tracking detectors processed on Czochralski silicon, in studies pursued at CERN and in Helsinki. The studies have been of considerable interest to the scientific community, and the CERN RD50 collaboration, in which HIP is a member laboratory, has launched a comprehensive common project on detailed studies of the Cz-Si material supplied by the Finnish silicon manufacturer, Okmetic Ltd.

The project leader of the HIP CMS Tracker project, Eija Tuominen, defended her thesis on the development of the Czochralski silicon detectors and on their comparison with standard float zone devices in October 2003 at the Helsinki University of Technology. The opponent was Professor Mara Bruzzi from the University of Florence.

Nuclear Matter Programme

The Nuclear Matter Programme focuses on two aspects of nuclear matter, the cold exotic matter with extreme composition of its proton and neutron numbers studied at ISOLDE and the hot and dense matter created in relativistic heavy ion collisions to be studied with the ALICE detector of the LHC.

The research carried out at ISOLDE has its physics motivation in studies of exotic nuclei with special emphases on weak interaction phenomena and nuclear astrophysics. In these efforts continuous development of novel instrumentation is of prime importance. In 2003, the Si-Ball, a multidetector array for charged particle spectroscopy, was applied in various configurations with other detector set-ups. Apart from resulting in a vast amount of nuclear data these experiments have provided data for optimising the Si-ball set-up itself, which will be applied in experiments at JYFL and at ISOLDE in 2004. We have also continued our studies to improve yields of key isotopes far from stability, like neutron deficient Kr and heavy Fr-isotopes. The first one resulted in a new design for the thick target and a theoretical model, which allows characterization of different transport phenomena in thick targets. Such data are also of key importance for the next generation radioactive ion beam facilities, such as EURISOL. Parallel to the yield studies of heavy Fr-isotopes, we performed spectroscopic investigation of the decay scheme of ^{232}Fr, the heaviest Fr-isotope studied so far in such detail.



The ALICE SSD group in Helsinki became the first of the participating laboratories to be fully ready for the mass production of the Silicon Strip Detector modules. The full assembly scheme of the SSD modules was demonstrated for the first time including fully automatic bonding and automated protecting of the assemblies. The modules that were assembled at the Kumpula Detector Laboratory were also successfully tested in-beam at CERN. The production speed of 35 chips/day was reached with the final assembly yield of 93%. In addition, aging studies of the assembled components were performed indicating a highly reliable nature of the TAB interconnections used. In the T0 project the prototypes of all the key electronic modules have produced excellent results in in-beam tests at CERN. On the software front the preliminary results emerging from the simulations indicate that the Time Projection Chamber, which is the main tracking detector of ALICE, should allow for successful identification of charged kaons and neutral strange particles. If confirmed it means that ALICE will indeed be able to follow her fairytale namesake into the world of strangeness.

Technology Programme

Most of the contributions of the Programme are closely related with the overall DataGrid activity in Europe. The main contribution has been in the EU DataGrid (EDG) project and more specifically within the Security Task under the Data Management work package (WP2), where the Programme has been developing security solutions for the EDG consortium. In 2003 the Programme also contributed to physics applications (WP8) and bio-medical applications (WP10). During 2003 the team finished the flexible authentication system and integrated it into the overall EDG Java software.

At the same time the Programme has been running, maintaining and providing Grid services to other sciences. Our focus has been centred on developing cluster proficiency, training younger scientists, evaluating different Grid technologies and providing demonstrations. During 2003 several user groups have gained experience from the use of increased computing-cycles in their daily work. This work has been associated also with the Nordic dimension of the Grid activity, where the Technology Programme has been in close collaboration with HIP's CMS Programme and the Center for Scientific Computing, together with the other partners in NorduGrid.

Another achievement has been the launch of the GridBlocks portal, which allows physics jobs to be sent to various computing clusters on the Grid and then to control and manage the results as they arrive from the Grid. The portal makes it easier to send a large number of, e.g., physics simulation jobs with different parameters and to manage the simulation results. Through the portal, users can access their Grid jobs from any location using a web browser in an easy and secure way. The system has been adopted by the NorduGrid community.

In 2003 the HIP Technology Programme succeeded in establishing and financing one of the first industrial Grid research projects between Finnish academic and industry partners. This project is entitled "Network Identity, Grid enabled services and Trust networks" (NetGest), and it is funded by several industrial partners and the Finnish National Technology Agency (TEKES). The thrust of the work in this project is to be allocated over to the year 2004.

A major survey study on technology transfer and technological learning through CERN's procurement activity was finished and reported on during 2003. Altogether 178 valid answers from 154 suppliers were received from the main European countries that had participated in CERN's technologically oriented procurement activity during the period 1997–2001. The main results of this survey indicate that CERN provides its technologically oriented suppliers with multiple benefits, which contribute to technological, organizational and market learning at the supplier companies. It was also shown that these learning benefits occur together, leading to the development of new businesses, products and service, boosting the internationalisation of sales and marketing operations, and improving quality.

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 of fixed term with a default duration of 3+3 years. They are chosen on the basis of their scientific merits and complement the research in experimental physics at the Institute, as well as research at the member universities. The project leaders are expected to be able to secure considerable external funding for their projects; in fact all the present project leaders get their salaries from sources external to HIP. In 2003 there were six projects: Cosmology; Laser Physics and Quantum Optics (final year); Particle Physics Phenomenology; Physics of Biological Systems; String Theory and Quantum Field Theory; and Ultrarelativistic Heavy Ion Collisions. Outside the projects, there is also research activity in hadron physics.

Cosmology

The evolution of the MSSM flat directions after inflation and their cosmological consequences were addressed in several papers. We derived a formalism for a class of gauge invariant polynomials which result in a multifield description of the MSSM flat directions. We showed that in the multifield case the field space has an intrinsic curvature and hence unsuppressed non-minimal kinetic terms for the flat direction scalars arise. We produced a review on the subject in a Physics Reports article, and suggested that the MSSM flat directions could provide the density perturbations through the curvaton mechanism. This was found to be possible for certain flat directions but requires that the inflaton is completely in a hidden sector. In that case the MSSM flat direction can come to dominate the energy density of the universe before it decays. If the dark energy responsible for inflation is deposited into extra dimensions outside our observable universe, reheating and all matter could be obtained from the MSSM flat direction condensate involving only the Higgses. In that case the spectral index turns out to be very close to 1 and has a weak dependence on the Higgs potential.

Fluctuations in the values of coupling constants, which arise if they depend on a vev of some light moduli field, were also discussed as the source for density perturbations. We pointed out that non-renormalizable operators play an important role and may give rise to a considerable damping.

Curvatons were studied also in a string theory context. In addition, the implications of the modification of the space-momentum uncertainty relation in the trans-planckian regime were considered. The holographic principle was shown to yield interesting constraints on inflation if the entanglement entropy is a natural measure of the entropy of the quantum perturbations. Then holography gives rise to a UV cut-off for the perturbation modes, which may have interesting ramifications for inflation.

In collaboration with the Department of Physical Sciences, the Cosmology project continued to participate in the Finnish Planck Surveyor Consortium, funded mainly by the Academy of Finland Antares space programme. We are active members in the CTP working group, the purpose of which is to establish ways to estimate the temperature and polarization spectra of CMB. The activity has centred on concrete issues in map making, in particular destriping (Elina Keihänen, Hannu Kurki-Suonio, and Torsti Poutanen), which is a tool for removing different kinds of systematic effects in CMB

experiments. The basic idea in destriping is to model the noise stream by a linear combination of simple arithmetic functions. During the year 2003 we have developed an improved destriping algorithm using a maximum-likelihood approach.

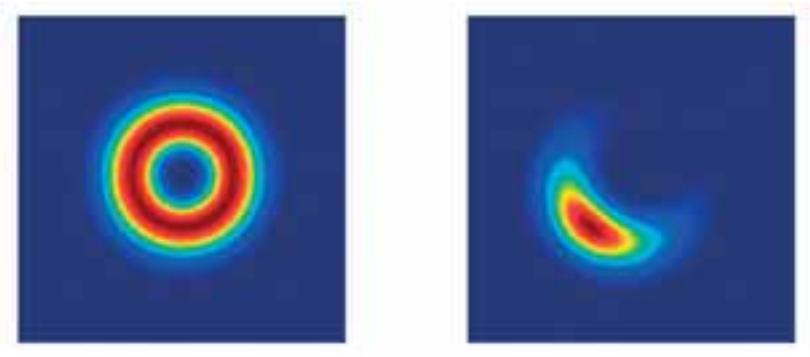
Two PhDs graduated within the project (Asko Jokinen and Martin Sloth). The activity of the Cosmology project is also funded by sources external to HIP which are administered by the University of Helsinki Department of Physical Sciences.

Laser Physics and Quantum Optics

The year 2003 was the official final year for the Laser Physics and Quantum Optics project. As before, our research concentrated on cold atoms and molecules. Several subtopics have been investigated.

As a part of the European Union RTM network "CAUAC" we performed Monte Carlo studies on interacting laser-cooled atoms, and showed that the heating due to the radiative collisions for alkaline earth atoms (Mg, Sr, Ca) is not an impediment for reaching the Doppler limit of laser cooling. These studies were in general the first ones where the three-dimensional nature of collisions was taken into account by a simultaneous treatment of strongly coupled partial waves.

Vortices in atomic Bose-Einstein condensates have recently been under strong scrutiny both experimentally and theoretically. Such studies have concentrated on situations where the condensate is very stable due to the presence of an electromagnetic trap and repulsive atomic interactions. Although condensates with attractive atomic interactions are stable for small numbers of atoms, and display interesting soliton behaviour, they have not been expected to have vortex structures. Our research has shown that on the contrary, in anharmonic potentials one can have vortices in condensates with attractive atomic interactions. More importantly, we also show that such a condensate can display centre-of-mass rotation, this has not been predicted or seen for condensates so far.



Density plot of a rotating Bose-Einstein condensate with attractive interactions. The condensate is confined in an anharmonic trap. For weak interactions the ground state is a multiply quantized vortex (on the left) while for stronger attraction a centre-of-mass rotational state (on the right) appears.

Cold and trapped fermionic atoms and their mixtures with bosonic atoms are at the moment another hot research topic. We have examined the creation of a Fermi-degenerate gas of molecules via a laser-induced photoassociation or magnetic field generated Feshbach resonance applied to a degenerate Bose-Fermi mixture of atoms. This problem is interesting because, unlike bosons, fermions in general do not behave co-operatively, so that the collective conversion of, say, two million atoms into one million molecules is not to be expected. Nevertheless, we have found that the coupled Fermi system displays collective Rabi-like oscillations and adiabatic passage between atoms and molecules, thereby mimicking Bose-Einstein statistics. Co-operative association of a degenerate mixture of Bose and Fermi gases could therefore serve as a shortcut to a degenerate gas of Fermi molecules.

First introduced to explain superconductivity, anomalous quantum correlations between degenerate electrons with equal and opposite momentum, i.e., Cooper pairs, are due physically to an electron-electron attraction mediated by the exchange of lattice-vibration-generated phonons. Cooper-like pairing between different chemical species was immediately suggested to explain the larger excitation energy for nuclei with even-rather-than-odd numbers of nucleons, although unambiguous evidence for proton-neutron pairs never manifested. Our research on cold bosonic and fermionic atoms indicate a prospect of Cooper pairing between different chemical species in a degenerate Fermi atom-molecule mixture submerged in a Bose condensate of atoms, a state enabled via two-color Raman photoassociation of a Bose-Fermi mixture of degenerate atoms. Condensate density fluctuations replace the vibrating

ion lattice of the superconductor, and phonon exchange induces atom-molecule Cooper pairing at about a third of the Fermi temperature.

Particle Physics Phenomenology

The focus of the research in Particle Physics Phenomenology has been on signals for Beyond the Standard Model Physics. The frameworks which have mostly been used are the supersymmetric models and higher dimensional models.

The search for the Higgs boson is the primary goal for the LHC. Thus any signal which may interfere with Higgs detection is of major importance for the experiments. Neutral Higgs-like scalars are present in many popular theories beyond the Standard Model. Examples are sneutrinos in supersymmetric models, and radions in extra-dimensional models. We studied the production of sneutrinos in a supersymmetric model, where R-parity is broken. Breaking of R-parity makes it possible to produce sneutrinos singly, thus enlarging the kinematic range of a collider. We found that a similar hadronic decay channel, which is typical for a Higgs scalar, is promising for the detection of sneutrinos at the LHC. Separation between a Higgs boson and a sneutrino would require a detailed knowledge of the branching ratios, as is possible in linear colliders. We investigated disentangling a Higgs boson from a radion by the use of the gluon decay channel of the scalars in a linear collider, and found it to be possible.

It may be possible to get information on the electroweak symmetry breaking sector of the model from a simple measure connected to the production. As such a measure we suggested the coupling of the Higgs boson to two gauge bosons. This coupling is essential both in the production and decay of the Higgs boson at the LHC, and in a gauge model it is always present when the symmetry is broken via the Higgs mechanism. It may also be a good method to disentangle radion and Higgs, as we have shown.

In supersymmetric theories the method of breaking supersymmetry has been one of the main problems for quite some time. Within some supersymmetry breaking models, we have considered the lightest supersymmetric particles, neutralinos, which will be present in all the decays of supersymmetric particles, and found their mass limits. In a general supersymmetric model we considered the production of sleptons in a gauge boson fusion process. The signal and leading backgrounds were analysed in detail, and the mass reach at the LHC for sleptons was established.

In the framework of supersymmetric models with non-minimal flavour violation, we analysed the chargino contributions to the CP asymmetries in $B \to J/\psi K_S$ and $B \to \phi K_S$. We adopted a model independent approach based on the mass insertion approximation. The main result of our analysis is that chargino contributions can in principle account for large and negative deviations (from SM predictions) of CP asymmetry in $B \to \phi K_S$, as indicated by recent experimental results.

In the framework of scenarios with quantum gravity propagating in large extra dimensions, we analysed the effects of virtual Kaluza-Klein graviton exchanges in the resonant kinematical regions of the Standard Model, in particular, at the Z pole via the four fermion process $e^+e^- \to f\bar{f}$, and in the resonant Higgs production at next linear colliders. The main result is that in resonant regions the virtual graviton effects are finite and predictable in terms of the fundamental Planck mass scale in D-dimensional space.

We continued the study of DIS and hard scattering dynamics, and in particular effects due to the rescattering of the struck parton. This provides a qualitative understanding of diffractive DIS, i.e., events with rapidity gaps. The exchange of a longitudinal gluon within the coherence time of the hard scattering can shield the color charge of the struck parton, resulting in color singlet exchange and a rapidity gap.

The perturbative expansion depends, in addition to the interactions specified by the Lagrangian, on the field configuration that one expands around. The standard assumption of an empty perturbative vacuum is unlikely to work in QCD, the ground state of which is complex. The presence of gluons in the perturbative

vacuum modifies the imaginary part of the free gluon propagator. We studied the effects of this for the quark and photon propagators. For background gluons with vanishing momenta both Lorentz and gauge invariance are maintained, and the quark propagator acquires a novel structure.

We studied the astrophysics implication of the Minimal Supersymmetric scenario via neutralino searches as a possible candidate for cold dark matter. In particular we analysed the low energy neutralino-nucleon cross section which is relevant for the present dark matter detectors. In this analysis the most updated constraints on the SUSY particle spectrum have been taken into account, as well as the constraints that the charge and color breaking minima are absent. We found that the full SUSY parameter space corresponding to $\tan\beta < 20$ can be ruled out.

Hadron Physics Activity. The quark structure of the recently discovered $\theta^+(1530)$ pentaquark was analysed. It was noted that positive parity of the pentaquark requires that one of the light flavour quarks in the $uudd\bar{s}$ pentaquark has to be in the *P*-shell and that this requires that the spin-dependence of the hyperfine interaction between the quarks be sufficiently strong to move the lowest states in the *P*-shell below the states in the *S*-shell.

The Poincaré covariant quark model was developed using three different subgroups of the Poincaré group as the kinematic subgroup. It was shown that the description of the electromagnetic form factors of the nucleons with the corresponding three forms of kinematics leads to widely different structures for the nucleon wave functions.

The "point-limit" of the description of hadrons with point form kinematics was defined and analysed in detail. The limit may be defined equivalently as the zero constituent mass limit or the zero range limit. It was shown that hadron form factors have non-trivial behaviour in the point limit, which is invariant under unitary scale transformations, but which depends on the shape of the wave function. In the point limit hadron form factors have power law behaviour at large values of momentum transfer, where the power depends on the number of constituents, but not on the wave function.

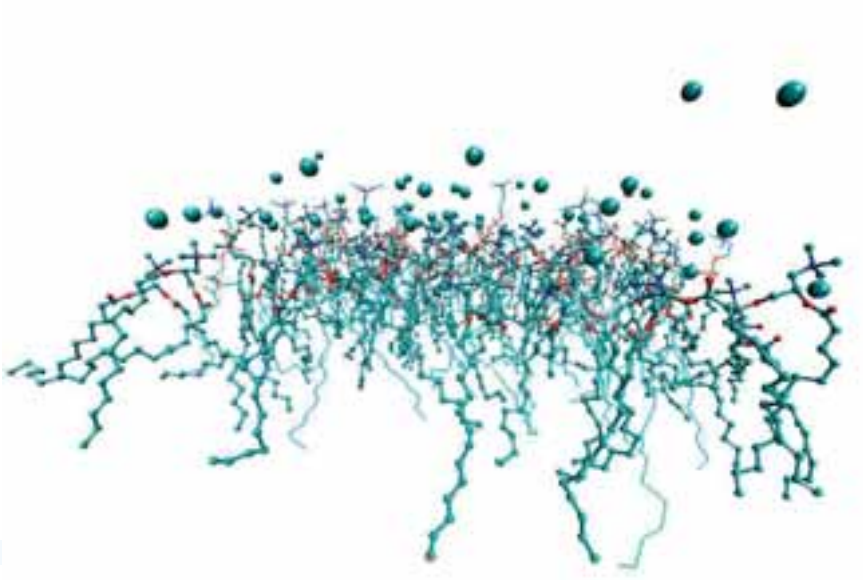
A consistent quantization of the spin-isospin degrees of freedom of the deuteron was carried out in the rational map approximation to Skyrme's topological soliton model. The quantized model was applied to the calculation of the electromagnetic observables of the deuteron.

Physics of Biological Systems

The activities of the Biological Physics and Soft Matter (BIO) group focus on the theory and computational modelling of biologically relevant soft-matter systems. This work is guided by the idea of combining the methods and ideas of statistical physics with novel computational techniques to deal with topical problems of complex soft-matter systems. Since the field is very cross disciplinary, the research is done in collaboration with various groups whose fields range from medical sciences to chemistry, physics, and computational sciences.

The BIO group was initiated at the Laboratory of Physics (HUT) in January 2001 and it joined the Theory Programme of the Helsinki Institute of Physics (HIP) (www.hip.fi) in January 2002. The BIO group therefore operates jointly at both HUT and as part of HIP. The group is part of the SIMU network (funded by the European Science Foundation) and is an active organizer of meetings and further activities in the field of soft matter and biological physics. The summer school "SoftSimu2002 - Novel Methods in Soft Matter Simulations" organized in 2002 serves as a good example of these activities, as the lecture notes comprising the main themes of the school will be published by Springer-Verlag in 2004 (in press). The biophysics conference "Hairy Interfaces" organized by the Center of Biomembrane Research (Odense, Denmark) in August 2003 is another example of activities where the BIO group has been acting as a co-organizer.

Together with a number of domestic and foreign collaborators, the BIO group has been able to establish its position in the field. To a large extent, this is due to a very close and



Cationic liposomes are often used for gene delivery through cell membranes. The system above is part of a cationic lipid bilayer studied through molecular dynamics simulations. For clarity, water and the other half of the bilayer are not shown here. (Courtesy of Andrei Gurtovenko.)

highly active collaboration with Dr. Mikko Karttunen's group at the Laboratory of Computational Engineering (HUT). The BIO group at the Laboratory of Physics and Helsinki Institute of Physics and Mikko Karttunen's group at the Laboratory of Computational Engineering have created a team of roughly 20 people working on the same campus and focusing on a wide range of issues related to biologically relevant soft-matter systems. In December 2003, the team was selected as a Helsinki University of Technology Young Center of Excellence for 2004 – 2005.

The research of the BIO group consists of three main themes that complement each other. First, we focus on the development of novel techniques for studies of soft-matter systems. Second, we apply these techniques to characterize small-scale (microscopic) properties of individual molecules as well as collective units of many-component systems. Third, we focus on multi-scale modelling to get insights into the large-scale properties of complex soft-matter systems.

The development of new techniques is an essential part of our work since processes taking place in biological soft-matter systems are characterized by a wide range of length and time scales. At the same time, coarse graining is one of the key issues in soft-matter research in general. While the microscopic and macroscopic limits are doable by the present methods, there remains a gap between the two limits where new approaches are called for. We have used the "bottom-up" approach, where the objective is to first develop coarse-graining techniques, and second to apply them to coarse grain microscopic descriptions of soft-matter systems in such a fashion that only the most relevant degrees of freedom are retained. When this approach is coupled to novel simulation techniques such as dissipative particle dynamics and the Malevanets-Kapral method, the computational aspects of which we have developed together with our collaborators, it provides a means to consider large-scale properties of soft-matter systems while preserving a bridge to the underlying microscopic world. So far, we have used these ideas and methods to coarse grain and model lipid bilayer and polymer systems over mesoscopic time and length scales, and the work is continuing to focus more closely on biologically relevant many-component systems.

The small-scale properties of systems composed of polymers, proteins, lipids, and DNA have been studied through both analytical and computational techniques. The aim is to understand the mechanisms that govern the structure and dynamics of biologically relevant molecules in the atomic regime. Lipid bilayers that serve as basic models of biological cell membranes have been one of the corner stones in this respect. We have examined the properties of single-component lipid bilayers composed of phosphatidylcholines (PC's) and sphingolipids, and done extensive work on two-component systems composed of PC's and cholesterol. We have further investigated the properties of lipid bilayer mixtures of zwitterionic PC's and cationic lipids, since cationic liposomes are one of the promising non-viral techniques for gene delivery. Besides this work, we have clarified the role of electrostatic interactions and their modelling requirements in soft-matter systems, and started to work on the properties and influence of antibiotics and other solutes on biomembranes. These as well as many other related topics in the atomic regime will be our key areas in 2004.

The third theme of the BIO group is related to large-scale properties of soft-matter

systems over a wide range of length and time scales. Thus, we are dealing with multi-scale modelling where coarse-grained and phenomenological approaches are called for. So far, the research has focused, e.g., on mesoscopic studies of single-molecule properties by clarifying the scaling anomaly of polymer dynamics in 2D and the role of hydrodynamics on the diffusion of 2D colloids in an explicit solvent. We have further investigated certain technologically relevant protein systems and considered structural transformations in DNA (work in progress). Other issues that are being pursued at the moment include, e.g., dielectrophoresis, dendrimers, and many-component lipid membranes using coarse-grained descriptions to allow large-scale studies of the structure and dynamics of these systems.

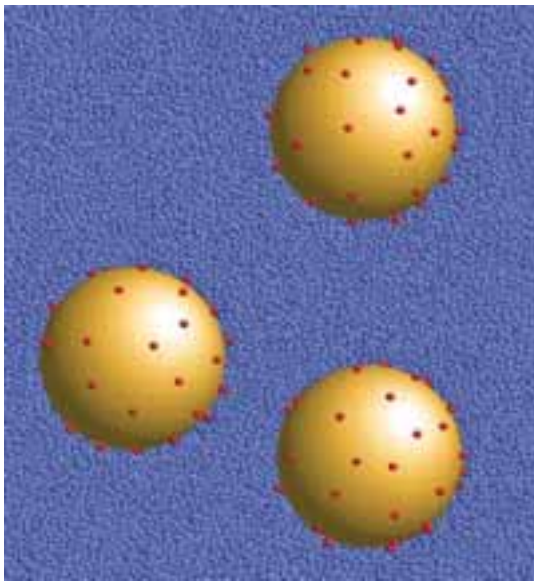
String Theory and Quantum Field Theory

In 2003, the group continued its exploration of string theory in time-dependent backgrounds, along with diversions to modern ideas in cosmology and quantum field theory.

In the famous series of string workshops at the Aspen Center of Physics, USA, featured, e.g., in a New York Times article, 2003 was devoted to "Time and String Theory". E. Keski-Vakkuri was one of the co-organizers. The year before, string theorists world wide had begun to examine new models of time-dependent backgrounds. Almost all of these models featured regions where causality would appear to be violated. In the light of Hawking's chronology protection conjecture, one would then doubt the stability of these space-times when backreaction effects are included. In a HIP-CERN-Illinois collaboration, we studied one such example which would a priori feature closed causal curves through every point in space-time. However, it turned out that after the notion of time has been carefully defined, the closed causal curves disappear. Further, quantum field theory could be defined and the backreaction analysis (both in QFT and string theory) showed no trace of worrisome instabilities.

In a related direction, there has been interest in exploring the consequences of the holograhic principle for cosmological models. In collaboration with the Cosmology project, we studied holography in the context of the inflationary density perturbations. There had been claims of potentially observable effects, on the other hand previous studies of holography had been limited to a classical treatment of the entropy of the preturbations. We showed how the entropy can arise from the built-in quantum entanglement across the horizon in the initial state, and re-examined previous bounds on new effects. We found that the scale of the new effects is too high for observations.

The group has also progressed towards an axiomatic approach to QFT on noncommutative space-time, tackling in this framework the CPT and spin-statistics theorems using the Wightman functions. Also, the analytical properties, the Jost-Lehmann-Dyson representation, the Lehmann-Martin ellipse and dispersion relations for such theories have been investigated, finally obtaining an analog of the Froissart-Martin bound in the noncommutative case. We have also studied supersymmetric theories in Minkowskian non-anticommuting superspace. We have defined N=1 deformed supersymmetry algebra and construct corresponding field theories. Namely, we have shown that ordinary N=1 supersymmetric theories such as the Wess-Zumino model and super-Yang-Mills are compatible with the deformed supersymmetry. Another line of research was the investigation of the holographic super-Weyl anomaly of a supersymmetric gauge theory in the context of the celebrated AdS/CFT correspondence.



Dielectrophoretic motion of large (yellow) colloids surrounded by (red) counter-ions and an explicit (blue) solvent. (Courtesy of Emppu Salonen.)

Ultrarelativistic Heavy Ion Collisions

The studies of QCD matter and its two phases, quark-gluon plasma (QGP) and hadron gas, form a subfield of particle and nuclear physics with an active interplay between experimental and theoretical research. The RHIC collider at Brookhaven successfully brought the field of ultrarelativistic heavy ion collisions (URHIC) into a collider era in summer 2000, and even more exciting possibilities are offered by the ALICE experiment at the CERN-LHC, operating from 2007 onwards. The URHIC project in the HIP Theory Programme started in 2002. We are located at the Department of Physics, University of Jyväskylä, and at HIP and the Department of Physical Sciences, University of Helsinki. We focus (1) on the phenomenology of URHIC by making calculations for observables measurable in the experiments at the CERN-SPS, BNL-RHIC and CERN-LHC/ALICE, and (2) on studying the properties of the QCD matter through first-principle calculations. We participate actively in the work of international theory collaborations such as the CERN Hard Probes.

Among our specialities is the computation of the initial densities of the QGP produced in AA collisions, obtained on the basis of calculable parton production. The calculated energy densities in particular are based on next-to-leading order perturbative QCD (pQCD). At sufficiently high gluon densities the production of smaller momentum gluons becomes inhibited by gluon fusion; a dynamically generated saturation scale of 1...2 GeV governs the primary parton production. In this framework, we have also studied the initial fermion content, especially the fermion deficit, of the QGP. *(Collaboration with CERN Hard Probes.)*

An approach complementary to the pQCD + saturation model is the lattice evaluation of classical Yang-Mills equations of motion of the gluon fields, applicable in the region of large occupation numbers. These equations have only now been solved correctly for the first time (T. Lappi), and phenomenologically relevant results on the initial multiplicities and transverse energies reported. Studies of quark-antiquark production are in progress. *(Collaboration with Saclay.)*

Further evolution of the produced dense system is describable by relativistic hydrodynamics. Within the framework of pQCD + saturation + hydrodynamics we have correctly predicted the multiplicities in central Au+Au collisions at RHIC. We have also shown that the bulk of the p_T-spectra of identified hadrons at RHIC come out correctly with just a single decoupling temperature $T_{dec} \sim 150$ MeV, indicating a shorter hadron gas phase than previously expected. The dynamics of the decoupling process will be studied further and predictions for the bulk hadron p_T-spectra at the LHC will follow. Also studied are the azimuthally asymmetric spectra in non-central collisions, and the work towards a fully 3+1 dimensional hydro code is in progress. Kink-kink collisions in classical and quantum scalar field models have been numerically studied as a model of nucleus-nucleus collisions.

One of the most exciting results from RHIC so far is the clear suppression of high-p_T hadrons, one of the proposed QGP signals. We study the origin of such suppression by using factorized pQCD cross sections, nuclear parton distributions, fragmentation functions and parton energy loss probabilities. Comparison with the RHIC data and the hydrodynamic bulk results are being made, and quantitative predictions for the phenomenon at the LHC computed. *(Collaboration with CERN/TH.)*

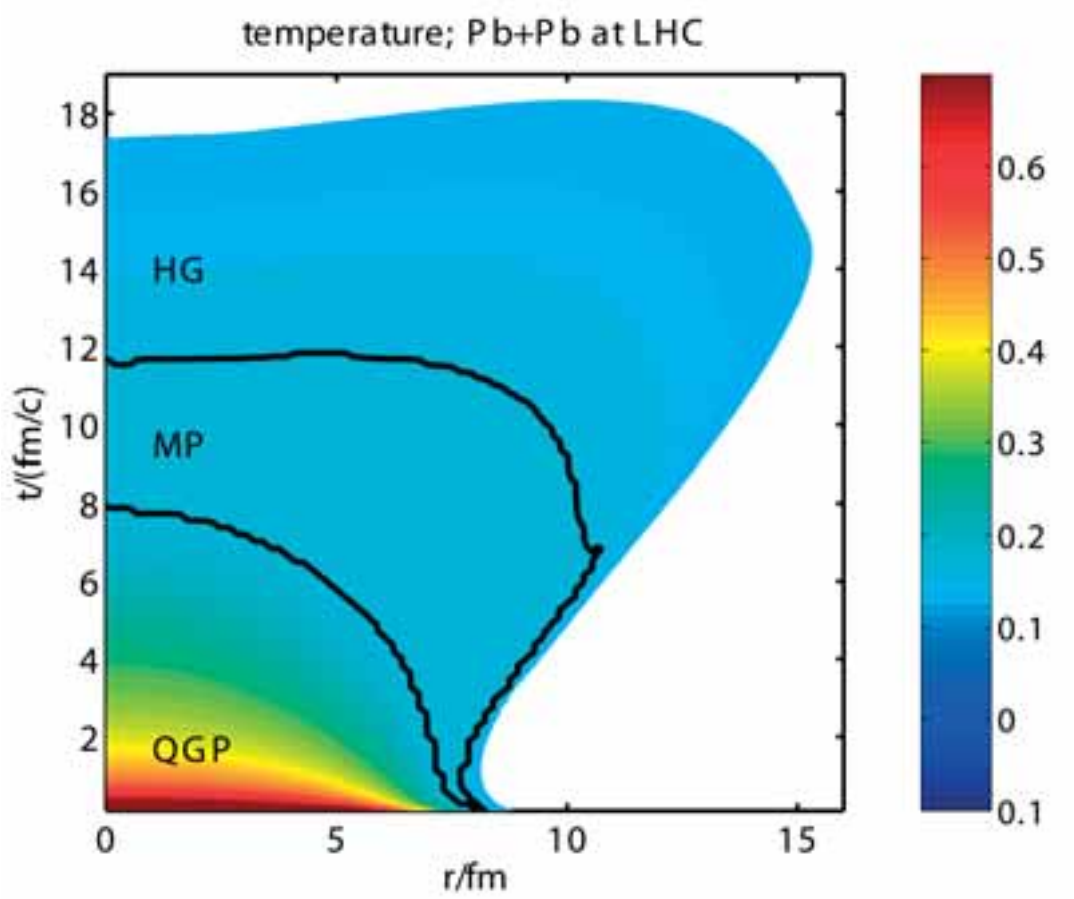
When the space-time evolution of the system is under control, the electromagnetic probes of the QGP can be computed. By applying the recently published thermal photon rates, we have, for the CERN Hard Probes in particular, computed the thermal photon spectra in Au+Au at RHIC and Pb+Pb at the LHC. A special new feature is the chemically equilibrating QGP. *(Collaboration with LAPPTH/Annecy and Saclay.)*

We have also carried further the pQCD studies of nuclear parton distribution functions (nPDF) needed in the computation of factorizable hard processes in nuclear collisions. A global DGLAP analysis of nPDF, similar to that for the free proton and the extension to

NLO are in progress. We have also studied the effects of non-linear corrections to the DGLAP evolution in light of the recent HERA ep data and shown that the number of gluons at small momenta and few GeV scales is clearly enhanced relative to the standard PDF sets. Consequences for heavy quark production at the LHC have been reported. Gluon saturation issues and new evolution equations have also been considered. *(Collaboration with CERN/TH, Hard Probes, Iowa SU, LBNL, ALICE and Regensburg.)*

In order to understand the properties and the space-time evolution of the QGP, its equation of state must be known. The project of computing the free energy of hot QGP nonperturbatively at all temperatures has been advanced significantly by the computation of the coefficient of the $g^6\log(g)$ term in its perturbative expansion. This is the last coefficient calculable by perturbative means; beyond that fully numerical methods seem to be the only way for obtaining first-principle results. In the expansion of the pressure at finite chemical potentials the terms of orders g^4, g^5 and $g^6\log(g)$ have been computed for the first time. This also gives, to the same order, the quark number susceptibilities of QCD, characterizing how easy it is to produce quark-antiquark pairs. The four-loop vacuum energy density of the SU(N_c) + adjoint Higgs theory has now been computed in three dimensions, and the four-loop master vacuum diagrams have been numerically evaluated to high precision. This progress has only been possible due to the development of new techniques for symbolic computation. *(Collaboration with CERN/TH, Bielefeld, MIT and Vienna.)*

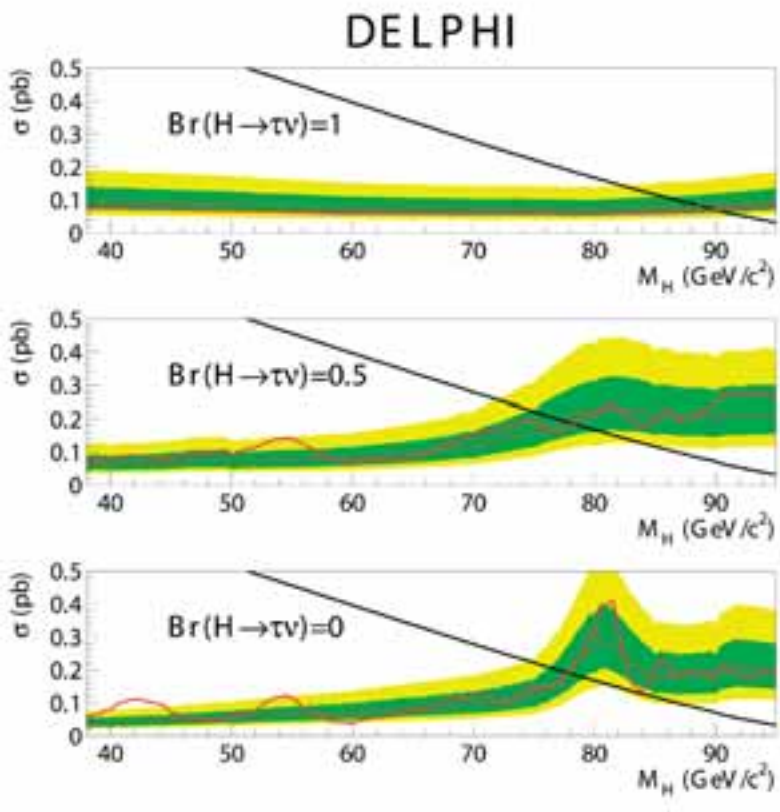
Hydrodynamic space-time evolution of the QGP in central Pb+Pb collisions at the LHC. Axes: transverse co-ordinate and time. Color coding: temperature in GeV. The thick solid lines show the phase boundaries.



High Energy Physics Programme

Heimo Saarikko

In 2003 the main emphasis in the High Energy Physics Programme was set on the Forward Physics project participation in the Fermilab Tevatron and CERN LHC Collider experiments. In addition to the participation in the CDF experiment, the group is one of the major participants in the TOTEM experiment. In Forward Physics the goal is to provide measurements of strong interaction processes, such as elastic scattering, diffractive excitation and total cross section, but also to provide novel types of searches for new particles production such as the Higgs boson, as well as to perform important measurements of strong interaction effects at the highest available energies. In the Electron-Positron Physics project the main focus of the group is on analysis of electron-positron annihilation data, taken at the highest achieved energies (up to 209 GeV) for an e^+e^- collider so far. The high energy e^+e^- data is analysed both for signs of possible extensions of the Standard Model and for a detailed understanding of the decay of hadrons containing heavy quarks. With the final LEP results being published, the attention of high energy e^+e^- physics is moving towards high luminosity linear colliders. In the COMPASS experiment the target operation was stable and efficient during the 2003 physics data acquisition. A sizeable contribution in the off-line data and physics analysis was made by the group. In 2003 the Detector Laboratory was tuned more towards a general support organization, acting in close collaboration with the Electronics Research Unit (ERU) of the Department of Physical Sciences of the University of Helsinki, available as a resource for the experimental projects using the premises on the Kumpula campus. Preparations were made for the strong occupation of the Laboratory by the activities of the ALICE and CMS experiments at CERN/LHC. The long-standing expertise in the generic detector development originating already from the 80's continued to form the basis for the other activities.



Upper limits on the cross section for charged Higgs boson pair production at 95% confidence level, for different $Br(H^- \to \tau^- \bar{\nu}_\tau)$, in e^+e^- collisions at $\sqrt{s}$ = 206.6 GeV. The dashed red curve shows the expected upper limit, the solid red curve the observed upper limit of the cross section and the solid black curve the model prediction. The bottom plot is the result of the Helsinki analysis.

Electron – Positron Physics

The focus of the group is on analysis of electron-positron annihilation data, taken at the highest achieved energies for an e^+e^- collider so far. The data, collected by the DELPHI experiment at the Large Electron Positron (LEP) collider during 1989–2000 with centre-of-mass energies ranging from the Z^0 boson mass up to 209 GeV, is analysed both for signs of possible extensions of the Standard Model and for a detailed understanding of the decay of hadrons containing heavy quarks. The two PhD students of the group, Ari Kiiskinen and Laura Salmi, have devoted a large fraction of their time during 2003 to studies and thesis preparation and are expected to graduate in early 2004 and early 2005, respectively. In addition to the DELPHI analysis, the group is participating in physics feasibility studies for a future linear e^+e^- collider.

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. The DELPHI analysis has a precision that is almost comparable to that of the B-factory experiments on the determination of the non-perturbative parameters of B hadron decay models despite the significantly smaller sample. This is mostly due to the fact that at LEP (but not at the B-factories) the lepton momentum spectra can be reconstructed over essentially the whole momentum range with similar efficiency since the produced B hadrons are largely boosted and thus the theoretical uncertainties on the extracted B hadron decay model parameters are smaller. A preliminary measurement based on the 1994–95 data with its interpretation within B hadron decay models was presented at many conferences in 2003. A DELPHI publication on the subject is in preparation.

The group has also looked in the high energy LEP2 data for pair-produced charged Higgs bosons, predicted by several extensions of the Standard Model, in the four jet final state. No signs of production of charged Higgs bosons have been found and the most recent results exclude mass values up to the W mass. A publication on all LEP2 high energy data that included the final DELPHI charged Higgs results and an interpretation of the results within a general two Higgs doublet model was finalised and submitted to the European Physics Journal C in 2003.

With the final LEP results being published, the attention of high energy e^+e^- physics is moving towards high luminosity linear colliders. The group has performed physics feasibility studies for both a "medium" energy (0.5–0.8 TeV, e.g., TESLA at DESY) and a "high" energy (2–5 TeV, e.g., CLIC at CERN) linear collider. The group has put emphasis on full reconstruction of final states with a large number of jets (six or more). Such final states are expected from many new physics processes and thus assumed to be important at future e^+e^- colliders. The studies so far have included the decay of a pair of top quarks and a pair of charged Higgs bosons. Group members have also participated in the work of the Outreach Subcommittee of the European Linear Collider Steering Committee to increase the public awareness of the scientific case for a future linear e^+e^- collider.

Forward Physics at Tevatron and LHC

Background. The Forward Physics project aims at providing an extension to the CMS experiment at the LHC in order to facilitate novel types of searches for new particles such as the Higgs boson and important measurements of strong interaction effects at the highest available energies. The physics signatures covered by TOTEM (where the group is one of the major participants) are complementary to the baseline CMS, and include leading protons, rapidity gaps and particle production beyond the acceptance limit of the baseline CMS detectors. In addition to providing measurements of strong interaction processes, such as elastic scattering, diffractive excitation and total cross section, these signatures will serve as important tools in the search for new physics. The group has been successful both in developing novel instrumentation and in contributing to the physics goals. However, the group suffers, for the third year in a row, from the lack of investment funds.

Forward Detector System at the LHC. The LHC activities concentrate on the refinement of a novel type of instrumentation for the forward region and on the study of the expected performance for physics measurements. In the latter category, the group has made important contributions to the Technical Design Report of the TOTEM experiment, providing an assessment of the accuracy of the total cross section measurement in pp scattering, due to the precision achievable on the elastic scattering. Furthermore, the group has been actively studying the acceptance and resolution of diffractively scattered protons, including the Double Pomeron exchange (DPE) process,

Participants of the Xth Blois Workshop on Elastic and Diffractive Scattering held in Hanasaari in June 2003.

which offers complementary capabilities to measure new physics. For the latter, also detailed studies on possible trigger scenarios have been performed, these are mandatory for the possible exploitation of Higgs production in DPE processes.

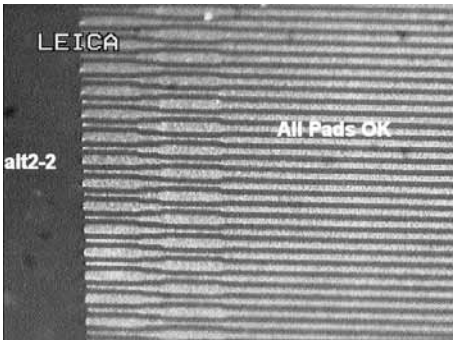
A realistic design of the forward detector system has to address the challenges posed by the need to carry out measurements close to the beam. The detectors have to operate in an intense radiation environment, be movable during beam injection, not interfere with the accelerator operation, meet the constraints 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 2003, the Helsinki group continued the refinement of the original microstation design (leading to the production of two prototypes) and developed a new version of the microstation. This design incorporates a shielding vacuum within the original construction for which a series of prototype structures have been constructed for testing the mechanical structure and vacuum compatibility. The design and construction of a fully functional prototype is in progress. This prototype, together with a silicon sensor and its readout electronics, will be validated in a test beam by the end of 2004. In addition, as part of a thesis work, simulations of the expected behaviour of a new type of silicon detector (3D sensor structure), which is one of the best options as of today for measurements close to the beam, have been performed.

The group is one of the leaders in the field of micropattern detector development (GEM's), and it could play a key role in development and construction of the T2 tracking telescope of the TOTEM experiment. The GEM technology is being considered by TOTEM as one of the most promising options for the technology choice for the T2 telescope, in order to precisely tag and measure inelastic events. Here the expertise and capabilities of the Detector Laboratory would be a very valuable asset.

In June 2003, the group organized the Xth meeting of the international conference series of the "Blois Workshop on Elastic and Diffractive Scattering", where the emphasis was put on the discussion of the physics potential for the LHC and the challenges for instrumentation.

CDF activity. Being the current high energy frontier, the Tevatron collider and the CDF experiment represents a research facility with an excellent capability of making many interesting physics measurements. In addition, active participation in the CDF experiment constitutes the best possible preparation of students for the LHC physics programme, especially with real data hands on experience. In 2003, the contribution of the group to the Run II phase of the experiment was mainly in the planned



CDF L0 microcable prototype processed with a glass mask. It is to be noticed that pads are not rectangular which helps manufacturing the cable.

central silicon detector upgrade (SVXII), the operation of CDF during running periods and in the development for the upcoming trigger upgrade.

The group significantly improved the process of making (and also refined the design) of the very long kapton cables for connecting the silicon sensors of the innermost layer of SVXII to the front-end readout chips situated outside the tracking volume for radiation tolerance reasons. Prototype cables with final specifications were successfully made but due to worse than expected performance of the collider itself and to Fermilab budgetary constraints, the SVXII upgrade was cancelled. During 2003, the group participated in the operation of CDF by making data acquisition shifts and in co-operation with the Rovaniemi Polytechnic contributing to the software development to improve the access and updating of the CDF on-line and off-line databases. Finally there has been a significant contribution both in software and firmware by the group in co-operation with the Pohjois-Savo Polytechnic in the development of the Pulsar board, a multipurpose VME interface primarily designed for the upgrade of the CDF Level 2 trigger that must be done to cope with the projected increase in luminosity of the Tevatron irrespective of the fate of the SVXII.

The COMPASS experiment

A total of 462 eight-hour COMPASS target shifts were done during run 2003, including participation of the HIP group members doing shifts. The pre-cooling of the superconducting magnet started on April 17 and the ^{6}LiD target material was loaded on April 25 at 100 K. The first polarization on May 13 reached high values up to +56% and -52%. The target operation was stable as early as SPS period P1A but it was not used for physics data acquisition. After the SPS scrubbing run the target operation was stable and efficient during the physics data acquisition of the SPS periods P2A – P2E. There were few problems due to the CERN infrastructure, like power failures and air-conditioner failure, which led to loss of polarization. The north area of the SPS accelerator suffered from a serious vacuum problem in periods P2B and P2C, which lowered the COMPASS data acquisition efficiency significantly. The beam efficiency for 2003 was 63% while it was 89% in 2002. The spectrometer efficiency was high 83% during the 2003 run and 270 TBytes of data were recorded at the central data recording. Two weeks of data was taken with transverse spin polarization in period P2D. The run ended on September 17.

The physics analysis of the 2002 data progressed well. The D^0 and D^* peaks were seen for the first time in the summer. They are needed to determine the gluon contribution to the nucleon spin. The properties of the COMPASS spectrometer are being better understood, but the signal-to-noise ratio does not yet allow us to determine the gluon polarization with the desired accuracy. At the same time the analysis group is working intensively on a few other topics such as asymmetry and transversity. In early 2003 the computation of the dilution factor f, naively expressed as the number of polarized nucleons divided by the number of

all nucleons, was started in collaboration with Professor B. Badelek. This work was completed by the end of the summer resulting in a COMPASS Note. In addition, the old SMC analysis code was used as the basis for new COMPASS routines for computing *R(x,Q2)*, the ratio of the absorption cross section on the nucleon/nucleus of the longitudinal virtual photon to the transverse virtual photon, *D(x,Q2)*, the depolarization factor, i.e., the polarization transfer from the incident polarized lepton to the exchanged virtual photon, and *F2(x,Q2)*, the unpolarized structure function of the proton.

Detector Laboratory

A slight organizational change in the Detector Laboratory (DL) took place in 2003, as the nature of the Laboratory was tuned more towards a general support organization for the experimental projects using the premises on the Kumpula campus. In the close future the premises of the Laboratory will be strongly occupied by the participation in the ALICE and CMS experiments at CERN/LHC, in addition to the more traditional detector development for the future detector concepts. The long-standing expertise in the generic detector development originating already from the 80's continued to form the basis for the latter activities. In addition, close relations with the Electronics Research Unit (ERU) of the Department of Physical Sciences of the University of Helsinki were strengthened even more. An example of the collaboration between the Laboratory and ERU was the development of a Peltier-element based system for fast reliability assessment of microelectronics devices. The project was funded by the Nokia Research Center and coordinated jointly by the DL and ERU.

Since all assemblies for the CERN/LHC need to last for more than a decade of operation, the long-term reliability plays a significant role in the quality control. Keeping this in mind, an application to the Academy of Finland for enhancing the Laboratory infrastructure was prepared jointly with several groups at the Department of Physical Sciences (University of Helsinki) and the Department of Physics (University of Jyväskylä). Collaboration with the Finnish Meteorological Institute was also launched concentrating on the life-time acceleration studies of the ALICE SSD components.

Due to a decision to assemble one-third of the ALICE SSD modules in the Detector Laboratory, the ALICE SSD project occupies a large part of the HIP clean rooms. During the year 2003 the project has invested a significant sum to equip the premises to reach the standards needed for such microelectronics assembly. The basis has been laid by creating a working environment protected against electrostatic discharges. The most important individual investment is the automatic wire bonder F&K Delvotec 6400. For economical, productive and collaborative reasons the model has been chosen to be identical to those in the collaborating institutes (Strasbourg, Torino and CERN). This bonder, presently modified to perform single-point tape-automated bonding (TAB), will be a key-instrument also in the future microelectronics assembly projects in the Laboratory due to its versatile nature. Other investments include microscopes, a memory-card controllable oven, an N_2 chamber and prepared working places. During November 2003 the readiness of the Laboratory in assembling the SSD components with mass-production speed was reached.

The main activity of the HIP CMS Tracker project at the Kumpula Detector Laboratory is the construction of high-precision lightweight support structures, or rods, for the CMS tracking detector. The construction covers the assembly work of rod frames and their quality assurance. The first serial production rod frames were delivered to CERN at the beginning of the summer 2003. Detailed tooling design and tooling manufacture were conducted parallel to

manufacture. A second technician joined the group just before the end of the year, and thus the assembly rate can now be speeded up to 3-4 rod frames per day. Additionally, electrical measurements (e.g., current-voltage and capacitance-voltage) have been performed on silicon detectors and test samples at the Kumpula Laboratories. The objective of the silicon detector research of the HIP Tracker project is to develop new sensor solutions for future high-energy physics (HEP) experiments, including the upgrading of the CMS Tracker.

GEM detectors. The three-year Antares collaboration project together with the Observatory and Metorex International Ltd funded by TEKES to develop GEM detectors as space applicable instruments in X-ray astronomy was continued in 2003. Test measurements with a two-foil GEM prototype detector have been further carried out and based on these results several improvements have been designed and executed. The most significant modification has been the development of a new type of readout boards. VTT has processed two-dimensional cross-strip boards on silicon with a thin insulating layer. Possibilities to use ceramic materials in the manufacturing of readout boards have also been studied. The first experiences with both materials seemed quite promising but due to some defects observed in the geometrical and electrical properties (measured with our own precision profiler and probe station in the clean rooms of the Detector Laboratory) these new techniques still need additional development.

A new 128 channel preamplifier chip (ASIC) for the readout electronics has been designed together with Photonix Oy containing features not available in commercial chips or the chips used with semiconductor detectors. The first measurements with this new chip integrated with the whole data acquisition system will be made in the spring of 2004.

During the year, the first sealed prototype of a GEM detector has been designed and its components manufactured by Metorex. The previous prototypes were flow counters. To minimize weight the housing and the GEM foil supporting structures are made of titanium in the sealed counter. A thin (75 µm) beryllium foil is used as an irradiation window for the detector. The first test results are still to come with this new design.

The *aging* properties of the GEM detectors are even more crucial in connection with the sealed counters. Therefore several compounds outgassing from detector materials, which have earlier been identified as possible hazards for the operation of the detector, have been studied in circumstances simulating the actual conditions. For this purpose controlled amounts of these compounds have been simultaneously injected into the gas mixture of a proportional test chamber system specially designed for accelerated aging tests. The test results showed that some organic compounds previously observed to outgas from detector materials did actually cause considerable aging effects even with a quite small amount of irradiation (less than 1 mC/cm total charge).

Towards the end of 2003 an opportunity emerged to install GEM detectors also in the LHC/TOTEM experiment. The possible role of the Detector Laboratory GEM expertise in this collaboration is under discussion.

CMS Programme

Jorma Tuominiemi

The HIP CMS Programme is responsible for the Finnish participation in the Compact Muon Solenoid (CMS) experiment at the CERN Large Hadron Collider (LHC). The CMS experiment is designed to study proton-proton collisions and also heavy ion collisions at the LHC. Its main scientific goal is the clarification of the three big open questions in High Energy Particle Physics today: the mechanism of the spontaneous breaking of the electroweak symmetry (Higgs bosons), the existence of supersymmetric particles, and the creation of the quark-gluon plasma. In addition, there are new fundamental questions that can be studied, like the existence of extra dimensions in the Universe. The CMS detector concept was first proposed in 1990, and the Finnish team has played an important role in its development from the beginning. The HIP CMS team hence has an extensive and thorough knowledge of the key features of the experiment. With the CMS experiment, HIP will be in the frontline of High Energy Physics research to take the next fundamentally important step in understanding the basic structure of matter and the origin of the Universe. The LHC experiments are scheduled to begin in summer 2007. In 2003 the CMS detector system was in full construction and the preparation for its physics analysis was advancing on a broad front. HIP has participated in both these activities. The HIP CMS Programme is divided into two 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.

Software and Physics

Organized meetings and workshops

The Software and Physics group took care of the practical organization of the meeting of the Restricted ECFA (European Committee for Future Accelerators) in September 2003 in Helsinki on the Kumpula campus. The meeting was part of the "country visit" programme of RECFA, where RECFA is investigating the health of the Particle Physics programme in the CERN member states and makes recommendations on its conduct to the science administration of the visited country. This was the third time that RECFA visited Finland to review research in High Energy Physics. The research activities in subatomar physics in Finland were presented by some twenty speakers to the RECFA members during the open session in the Physicum building. RECFA members met the following day in the University main building for a closed session.

The group organized an international Geant4 Workshop in October 2003. This was the first workshop of its kind organized in Finland. It was attended by some 20 participants interested in particle and detector simulation. Participants with a wide range of different backgrounds, such as underground cosmic ray experiments and nuclear physics, attended.

Computing activities

New Linux cluster. The HIP computing potential was increased significantly during the year 2003 with the installation of the *mill* Linux cluster in the Kumpula Computing Unit (KUKA) machine room. Mill is a joint project between the University of Helsinki Department of Physical Sciences and HIP and it consists of 64+2 CPUs. Each node of the cluster has dual 2.133 GHz AMD Athlon CPUs with 1 GB of memory and dual 80 GB ATA disks. In total the system has 33 GB of memory and 2.5 TB

The new Linux cluster mill with 66 CPUs.

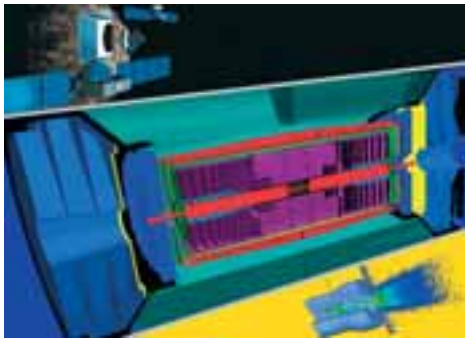
of local mirrored disk space. The hardware of the system has worked well. The NPACI Rocks cluster distribution was installed on the system and it was found to be a very good tool for cluster installation, configuration, monitoring and maintenance. The mill cluster will run Monte Carlo production for the CMS Data Challenge 04 and Molecular Dynamics simulations for the Material Science groups of the Department of Physical Sciences and HIP.

Grid computing. HIP participates in the NorduGrid project, which is also part of the European DataGrid (EDG) testbed. The HIP Software group members represented Finland and HIP in various meetings and workshops. A small Linux cluster, called *testbed0,* with one front-end and one node was installed for testing, configuring and developing software for the mill cluster. The NPACI Rocks cluster distribution was also installed on testbed0. In collaboration with the Technology Programme of HIP the NorduGrid middleware toolkit was integrated with the Rocks software to prepare for the installation on mill. Production NorduGrid jobs have been successfully run on testbed0 demonstrating the success of the installation work.

Monte Carlo production. The HIP Software team continued its participation in the CMS Monte Carlo production activities. Mass production of the simulated events started in summer 2003 as a preparation for the CMS Data Challenge 2004 (DC04). In the first phase some 50 million events were produced by the CMS Monte Carlo production team through the program chains CMKIN and CMSIM. The total amount of these events comprise almost 100 TB of mass storage. The produced event samples will serve as a basis for the Physics Technical Design Report (TDR) due by the end of 2005.

Detector simulation

GEANT4 development. The HIP Software team continued the development of the interdisciplinary simulation toolkit GEANT4. An improved version of the Bertini intra-nuclear cascade model was included in the GEANT4 6.0 release and added to the hadronic physics lists for a "typical" HEP collider detector. Compared to standard 1-10 GeV hadronic models available in GEANT3, our model was estimated to provide, in some cases, significantly better physics performance. Consequently, major experiments, such as CMS, ATLAS and BaBar, are currently evaluating and considering the use of the Bertini cascade for nucleon and pion induced reactions.



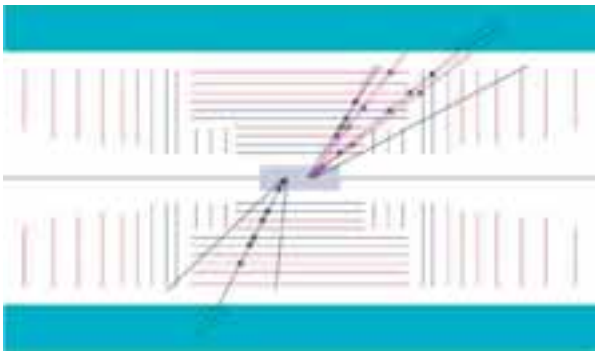
Geant4 simulated detector pictures. (Cortesy Geant4, CMS, ESA, INFN.)

CMS core software. Three activities have been under the responsibility of the HIP group: i) maintenance and development of the CMKIN package, an interface between physics generators and detector simulation, ii) maintenance of the detector simulation package CMSIM, and iii) co-ordination of CMS Monte Carlo productions and development of the production systems software. CMKIN is now a separate package extracted from CMSIM which will soon become obsolete. CMKIN employs about 10 different generators including CompHEP, Tauola, Alpgen, MadGraph and TopREX that were interfaced in 2003. CMSIM was still fully utilized in the 2003 productions for DC04, but was starting to be replaced by the Object Oriented detector simulation package OSCAR towards the end of the year 2003.

Our group participated in the validation of the CMSIM to OSCAR transition. A detailed study of the electromagnetic showers in the two software packages was completed. The resolution and the shape of the showers were compared first in a simplified case where all the detector effects, apart from the shower development in the lead tungstate crystals, were excluded and, secondly, with the complete CMS reconstruction chain. The cuts used in the simulation were optimised to the point where no difference in the results was seen by further lowering them. Important feedback was given to the OSCAR team for the time consumption of the program.

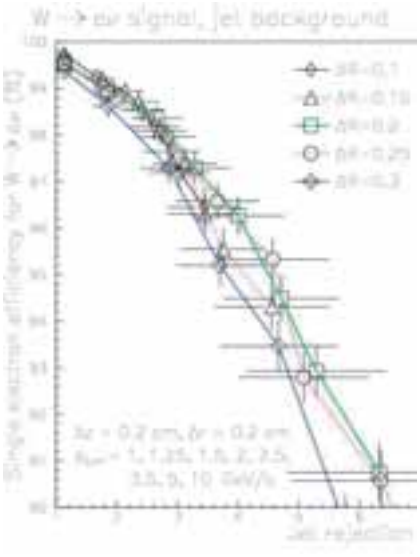
Calibration and event reconstruction

Alignment calibration. An important mission of the HIP Software and Physics project is to develop software for the calibration of the sensor positions in the Pixel and Silicon Strip Tracker detector systems. This calibration task, called detector alignment, is based on reconstructed tracks and aims at finding corrections to sensor positions and orientations so that the optimal trajectory reconstruction is obtained. The method developed by the HIP team was published in the CHEP03 conference in La Jolla, California, in March 2003. A major application achievement was to show that the algorithm is capable of aligning the full Pixel detector system with a reference to only one sensor out of 384 in total. The group was also involved in the geometric precision measurements of the rod frames of the CMS Tracker support structure and developed Quality Assurance software for the approval of the precision gluing of the sensor supports and pins, in collaboration with the HIP Tracker project.



The main components of the algorithm are the electron track and the isolation region shown in the figure.

Event reconstruction. The team published results on the conversion of photons in the CMS Tracker, where the converting photons are reconstructed with inward track building. The efficiency for finding both electron tracks for the converted photon was found to be 72% in the central part of the detector. This is an important tool for the Higgs $\rightarrow \gamma\gamma$ channel where the position of the primary vertex needs to be determined with the tracks. It was shown that this can be done with a sufficient precision in cases where the conversion happens before the last two stereo layers of the Tracker.



Signal efficiency versus background rejection.

Another important result was the development of a track isolation algorithm, published in a CMS Note. The importance of such an algorithm is to reduce the background by separating the signal – electron or photons – from the background, i.e. particles mimicking electrons or photons but originating from the partonic activity of the event and thus surrounded by other particles. The signal efficiency versus the background rejection was presented and the CPU usage of the algorithm was studied.

Physics analysis

The main research subjects of the Physics Simulation group of HIP in CMS have been the following: detailed studies of the two-jet and lepton+jet final states of the H/A $\rightarrow \tau\tau$ decay channel, study of the tanβ measurement precision in the H/A $\rightarrow \tau\tau$ and $H^{\pm} \rightarrow \tau\nu$ decay modes, study of the H $\rightarrow \mu\mu$ decay channel for the SM Higgs boson, evaluation of the discovery potential for the light scalar MSSM Higgs boson, update of the Standard Model Higgs boson discovery limits and writing the summary of the CMS potential for the Higgs boson discovery.

The two-jet final state of the H/A $\rightarrow \tau\tau$ decay channel, the trigger (hadronic τ trigger) and the τ-jet off-line identification were studied with the full detector simulation and complete reconstruction software of CMS. An algorithm was developed for the off-line τ jet identification exploiting the narrowness, low multiplicity and isolation of the τ jets from H/A $\rightarrow \tau\tau$. A detailed fast simulation study was performed for the same channel with lepton+jet final states. A similar τ jet identification like that for the two-jet final state was used. Impact parameter measurements for the lepton and the hadrons from the decays of the two τ's were used to further suppress the background. The updated 5σ-discovery potential extends to m_A = 650 GeV/c^2 at large tanβ.

The precision of the tanβ measurement was estimated using the $\tau\tau$ and $\tau\nu$ decay modes of the heavy neutral and charged MSSM Higgs bosons. Assuming 20% theoretical uncertainty for the production rate, the value of tanβ can be measured with a precision better than 25% within the expected 5σ-discovery reach. The uncertainty is reduced to about 20% when

the two-lepton and two-jet final states are included.

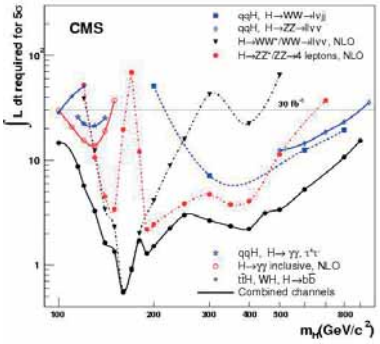
The discovery potential of the SM Higgs boson in the H → μμ decay channel with m_H = 120 GeV/c^2 was investigated in the inclusive production mode and in the weak gauge boson fusion process with forward jet tagging and central jet veto. The Higgs boson mass resolution and selection efficiency in H → μμ was studied with full simulation. Despite the good mass resolution (1.2%) a 5σ-discovery potential cannot be reached in this channel even with the ultimate luminosities of 300 fb^{-1}. The discovery potential of the light scalar MSSM Higgs boson was evaluated with the latest theoretical cross sections and branching fractions. The results from the simulation studies for a light SM Higgs boson were used for the experimental sensitivities. The sensitivity to the SUSY parameters, in particular to the stop quark mixing and stop quark mass, was also studied.

The team also continues the study of the background processes for the Higgs → γγ channel. The background rates given by the event generator used in the CMS studies were compared with those given by programs including a full theoretical computation of higher order effects. A comparison had been made earlier by our team for processes where there is a photon and an isolated neutral pion in the final state, and a good agreement found. In 2003, we also have started the study of the final states with two isolated neutral pions. The first results indicate that the rates used in CMS are lower than those given by the higher order calculations.

All studies for the Higgs boson searches so far in CMS were summarized in a CMS Note "Summary of the CMS potential for the Higgs boson discovery" (2003/033). The HIP Physics team took the responsibility in checking that all detector dependent issues like mass resolutions and efficiencies for reconstruction and b-tagging corresponded to the best knowledge available. The team also had the responsibility for writing the Note.

CMS Tracker

The HIP CMS Tracker project has research activities related to the support mechanics of particle detectors, to silicon detector technology and to detector readout electronics. Its activities include the responsibility for the design and construction of the mechanical support structure for the Tracker Outer Barrel (TOB), development of radiation hard silicon detectors for detector upgrade, operation of the HIP Silicon Beam Telescope for testing detectors in LHC-like conditions, and quality testing of Tracker silicon detector modules. In addition, the HIP Tracker project has participated in the CMS Trigger and Data Acquisition (Tridas) project, where the HIP group has had responsibilities for the design of fibre optic links for the RPC (Resistive Plate Chamber) muon detector trigger.



Required integrated luminosity for Higgs discovery with five sigma significance for different mechanisms as a function of m_H.

Tracker Outer Barrel Mechanics

The main activity of the HIP Mechanics group is the construction of high-precision lightweight support structures, rods, for the CMS tracking detector. Construction covers the assembly work of rod frames and their quality assurance. In addition, the group is responsible for the design and manufacture of the electronics boxes for the CMS Resistive Plate Chamber (RPC) Link Boards.

The assembly work is being done at the Physicum Laboratories in Kumpula. The first 3 serial production rod frames were delivered to CERN at the beginning of the summer. Another 12 frames were delivered at the end of the year and 40 more were being delivered. Detailed tooling design and tooling manufacture were conducted parallel to manufacture.

Support structure for the CMS Tracker Outer Barrel silicon detector modules being assembled at the Kumpula Laboratories.

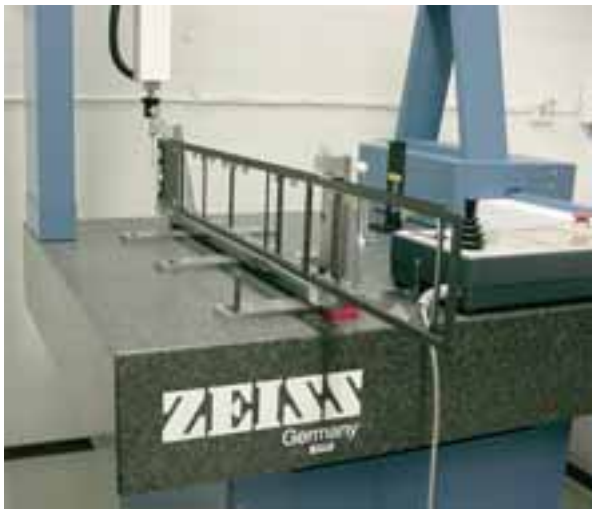
Mara Bruzzi and Jorma Tuominiemi, guided by Jaakko Salonen from VTT, visiting the clean room of the VTT Microelectronics Centre.

A second technician joined the group just before the end of the year, and thus the assembly rate can be speeded up to 3–4 rod frames per day, which is estimated to guarantee the production of the full 688 rod frames by April 2005.

Part of the rod frame quality control is performed at the assembly laboratory. Rod frames undergo a thermal shock of -30°C in a deep-freezer. Visual inspection follows to study flaws etc. After a thermal cycle, the performance of each rod frame cooling system is measured. In addition, the quality assurance includes the measurement of functional physical dimensions of the assembled rod frames. A contacting measurement machine and special tooling were earlier introduced for this operation. The measurements take place at the Laboratory of Machine Design of the Helsinki University of Technology. The measurement results are analysed with an on-line algorithm developed together with the CMS Software and Physics group.

The RPC Link Board box prototype was delivered to the CMS Integration Group in November. It meets the strict space and maintenance constraints, and provides practical service routings. The housing provides the means for the precise LB attachment/detachment. Well-engineered thermal management ensures low temperatures at the component level. A total of 12 LB boxes that will be mounted on the nose of the CMS end-caps will be manufactured during the next year.

Physical dimensions of an assembled TOB rod frame being studied by a contacting measurement machine at Helsinki University of Technology.



Silicon Detector Development

The objective of the HIP CMS Tracker silicon detector research is to develop radiation hard sensor solutions for the CMS detector upgrade and for the planned high luminosity super-LHC. The radiation tolerance issues of silicon detectors are of major interest to the High Energy Physics community at present. The CMS Tracker group is a member of two international research collaborations aiming to improve the radiation hardness of particle detectors, namely RD39 and RD50. These R&D programmes, each including more than 60 member institutes, have official CERN statuses.

The HIP team has demonstrated in different ways the radiation hardness of strip detectors processed on silicon wafers grown by the magnetic Czochralski method (Cz-Si). The detectors were processed at the Helsinki University of Technology Microelectronics Centre, where the HIP CMS Programme has membership status. The electrical characteristics of the detectors were verified using the facilities of our CERN RD50 collaborators. The radiation hardness properties of the detectors have been

Silicon detectors being processed at the new clean room premises of the HUT Microelectronics Centre.

studied in several irradiation campaigns, e.g., at the Accelerator Laboratory of the University of Jyväskylä, at the CERN 20 GeV Proton Synchrotron (PS), and at the Brookhaven National Laboratory. All results show that Cz-Si is a much more radiation hard material than the silicon traditionally used in High Energy Physics experiments. Our results have received considerable interest in the scientific community, and the RD50 collaboration has launched a comprehensive common project concentrating on further studies of the Cz-Si material supplied by the Finnish silicon manufacturer, Okmetic Ltd.

Quality Testing of Tracker Detector Modules

Silicon detector modules inside the CMS Tracker must fulfil tight requirements during the running of the experiment. Therefore, prior to the installation of the modules into the CMS Tracker, their functionality must be extensively tested. Several CMS institutes have set up test laboratories for these tests. The HIP Tracker team has built a small test set-up at CERN in close co-operation with the CERN Tracker group. With the present set-up, the modules can be tested one at a time, housed in metallic boxes. This set-up has also been used to test cryogenic silicon detector modules in the framework of the CERN RD39 collaboration. The plan is that the HIP set-up will be developed into a facility capable of testing full rods, to be operated in Helsinki at the Kumpula Detector Laboratory.

The qualified modules will be assembled into rods and shipped to CERN. After these stages each of the rods must be inspected and characterized. Due to high number of rods and limited time scale, an automated rod test station is needed. HIP has participated in producing a test station at CERN, which can characterize up to three rods at a time. The acquired versatile set of parameters is automatically stored in a database.

HIP has also participated in the design, development and production of test, control, monitoring and safety systems for the CMS Tracker. The most important activity in 2003 has been the production of high voltage supply units for tests and calibration of the silicon detector modules and their front-end electronics for the CMS Tracker groups. The HIP team has developed a special power supply unit with highly improved non-standard specifications. The first 12 of a total number of 60 have already been built.

Electronics at HIP silicon beam telescope at CERN

Silicon Beam Telescope

HIP has operated the Silicon Beam Telescope (SiBT) at the CERN H2 test beam for several years. The telescope is used to measure high-resolution tracks of the incoming beam particles. It offers a reference track measurement for the needs of the HIP CMS Tracker group testing the spatial resolution and the efficiency of detectors. SiBT is based on position sensitive silicon detectors attached to adequate readout electronics and a data acquisition system with a commercial Analog-to-Digital Converter. During the summer 2003 beam tests, the telescope was further developed for measurements of cooled down irradiated silicon detectors.

RPC Trigger

The main activity of the HIP Tridas team has been the design of fibre optic links for the Pattern Comparator Trigger (PACT) system of the CMS Resistive Plate Muon Chambers (RPC). During the year 2003, we studied the pre-production prototypes as well as the final prototypes of all boards needed for the optical link system. Prototypes of the Link Board card were designed, manufactured and tested. Additionally, a prototype of the Control Board for the Detector Control System was designed and tested, first under irradiation at the University of Jyväskylä Accelerator Laboratory and then during a 25 ns bunched beam test at CERN. In this test, the Link Board and the Control Board prototypes were tested together for the first time.

Nuclear Matter Programme

Juha Äystö

The Nuclear Matter Programme provides full participation of the Finnish teams at CERN in studies of two aspects of nuclear and hadronic matter. These are cold exotic matter with extreme composition of its proton and neutron numbers and hot and dense matter created in relativistic heavy ion collisions. The first project is carried out at the ISOLDE facility and the second one concentrates on the construction of certain parts of the ALICE detector for the LHC machine as well as on the relevant physics issues. The ISOLDE project has its physics motivation in studies of exotic structures of nuclei, with special emphases on weak interaction phenomena and nuclear astrophysics. The ALICE project aims to study the phase transitions of hadronic matter and possible signatures for a new form of matter, the quark and gluon plasma. The project leaders of these two projects are Docent Ari Jokinen for ISOLDE and Docent Wladyslaw Trzaska for ALICE, both currently at JYFL. In addition, Dr. Markku Oinonen has been acting as the co-ordinator of our bonding project for the inner tracker of ALICE as well as the HIP Detector Laboratory at Kumpula.

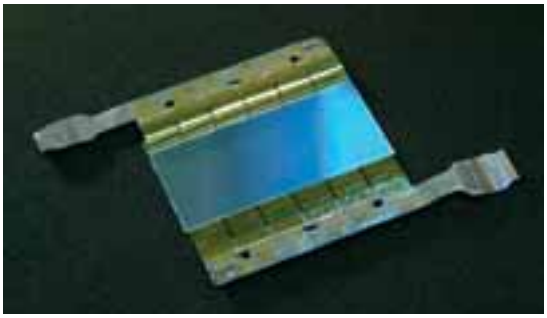
ALICE

ALICE/ITS/SSD module assembly

The two largest layers of the ALICE Inner Tracking System (layers 5 & 6) will contain about 2000 Silicon Strip Detector (SSD) modules. The production of these modules is shared between France, Italy and Finland. The assembly of the Finnish share of SSD modules (about one-third of all the modules) will be done in the Detector Laboratory located at the Kumpula campus in Helsinki.

In the past years the entire SSD project has suffered considerable delays caused by the lack of components, redesign of the entire electronics to radiation hard technology and various manufacturing problems at commercial companies. As a result there is no contingency left within the project. It imposes on us very tight planning and demands efficient work. Fortunately, we were able to keep up with the stringent schedule. The first successful assembly of prototype components, still with the semiautomatic bonding machine, was completed in Helsinki in the summer of 2002. Since then, two very significant steps forward have been taken. In the spring of 2003 a fully automatic bonding machine (F&K Delvotec 6400) was installed in the Kumpula clean room and in June 2003 a testing facility to perform detailed electrical tests for the HAL25 front-end chips started taking data. These developments allowed us to assemble and test altogether 44 HAL25 front-end chips within the first half of 2003. This was the first time in the history of the ALICE experiment that a fully automatic bonding scheme for the HAL25 front-end chips had been successfully demonstrated.

A complete Silicon Strip Detector module for the Inner Tracking System of the ALICE experiment.



By August 2003 the first two SDD modules were assembled in Helsinki. In September 2003 they were tested in-beam at CERN together with 2 other modules manufactured by our colleagues at Strasbourg. The 4 modules were combined to make a mini-tracker. In the run with a 7-GeV proton beam we have evaluated the tracking capabilities of the modules, their

spatial resolution, charge matching properties and signal-to-noise ratios (S/N). The results were well in accordance with our expectations. For instance, S/N was around 65 for the P-side and 40 for the N-side of the detectors.

In November 2003, we were ready to check our capability to assemble HAL25 chips with high speed and yield. A set of 122 chips was bonded to assemble 4 hybrids and 2 modules. We were able to ramp-up the production speed to about 35 chips/day with the single-sweep bonding yield of 84%. After the re-bonding phase (to correct the non-connected traces) we could reach the final bonding yield of nearly 100%. The final assembly yield, due to chip-related failures, was 77% and 93% (after re-bonding). Without the skill and the know-how of our Ukrainian collaborators we would not have been able to achieve such excellent results so quickly in Helsinki.

Along with the prototype production for the SSD assembly, our group has addressed the reliability issues. A typical TAB contact is an interface between 5 different materials with different coefficients of thermal expansion. Even at a constant ambient temperature the flow of current through the bonds causes thermal stress leading, in the long run, to possible failures. To test it a set of assembled HAL25 front-end chips was exposed to temperature cycles varying from -20°C to +100°C for a period of 1 month and about 1000 cycles. Only two bonds were destroyed out of 900 monitored. In fact the destroyed bonds were diagnosed as partially broken already at the start of the test. This indicates a very reliable nature of the Al-Al bonds used in the ALICE SSD modules. These tests will continue during the first quarter of 2004. In this way we hope to detect and remove all of the assembly failures and to estimate the lifetime of the ALICE SSD modules under the actual LHC conditions.

All in all, 2003 has been very successful for the ALICE SSD group in Helsinki. Thanks to a lot of hard work and a little good luck we were the first Laboratory to be fully ready for the mass production of the Silicon Strip Detector modules for the ALICE experiment.

ALICE T0 Detector

T0 is one of the smallest sub-detectors in ALICE but it is also one of the few detectors that are absolutely crucial to the operation of the whole experiment. It will give the key trigger- and timing signals, measure on-line vertex position and give rough centrality. Among its many technical challenges are: a total dead time below 25 μs (including digitization and readout), a count rate of up to 10 MHz, a required time resolution better than 50 ps, radiation hardness of up to 500 krad, operation in the 0.5 Tesla magnetic field, compact design, high reliability and maintenance-free operation during the entire lifetime of ALICE.

None of the off-the-shelf products can fulfil these requirements. Practically all of the components and in particular the entire set of front-end electronics must be custom designed and built. We have made a lot of progress in that respect. By the summer of 2003 the first prototypes of all the key electronics modules were ready for in-beam testing at CERN. Although PS beams cannot reproduce the LHC conditions in which T0 will have to operate, a test in the actual accelerator environment (interference from other detectors and devices, real signals passing over the realistic lengths of cables, etc.) was absolutely essential. It was reassuring to realize that all of our components have worked well. For instance, we could reach the time resolution of 37 ps (sigma), our T0 Vertex Module prototype gave a position resolution of 1.3 cm with 98% efficiency and the Mean Timer prototype gave consistent readings to within ±10 ps

An in-depth technical document called TDR (Technical Design Report) is an important milestone marking the end of the main R&D phase of any sub-detector of ALICE. Prior to the approval, several expert groups within ALICE and CERN review the TDR and give feedback to the research groups pointing out possible weak points in the design or scheduling. A joint TDR for all of the front detectors (including T0) is now nearing its completion. Finalizing the technical details, making the necessary Monte Carlo simulations, compiling the results of all the key measurements

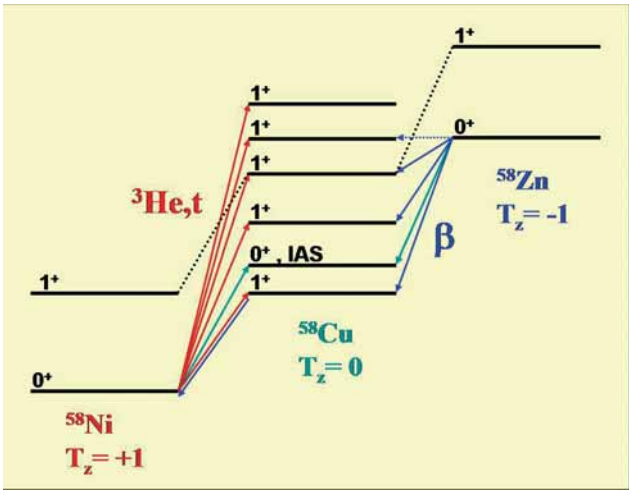
followed by writing the reports and editing has been only a part of this work. There is also immense challenge in designing the readout and DSC (detector slow control) for T0. We are working hard to complete the TDR in time for the March 2004 LHCC Review.

ALICE Tracking

Production of strange particles in heavy-ion collisions is one of the main research goals of the ALICE experiment. In the central (head-on) collisions of lead nuclei, each accelerated at the LHC to the energy of 1.4 PeV (1.4×10^{15} eV), it should be possible to reach, for the first time since the Big Bang, sufficient densities of quark-gluon plasma where the density of strange quarks would approach that of the light ones. This in turn should result in a boost in the production of strange particles. Unfortunately, positive identification of strange particles is very difficult. It is done, for instance, by the detection of their decay products. These products would not originate from the main vertex (collision point) but from the decay points of the short-lived strange particles, therefore slightly off the main vertex.

One of our achievements was to derive a procedure to reconstruct and identify secondary vertices. Preliminary estimations of the reconstruction efficiency and precision against the realistic background conditions are very encouraging. These methods have been developed and tested on the basis of Monte Carlo simulations using ALIROOT (the ALICE software framework). In order to reconstruct hyperons and identify kaons via their decay topologies we look for their products in the tracking system and find the decay vertices. For this we had to develop a method for finding secondary vertices and kinematical reconstruction of the decay. Coping with the high background (high track density) resulting from the large number of particles expected to originate from Pb-Pb collisions at the LHC energies is the main challenge in our work. Nevertheless, the first results, based on the detailed simulations, indicate the possibility of the successful identification of charged kaons and neutral strange particles using the Time Projection Chamber – the main tracking detector of ALICE.

A comparison of isospin symmetric transitions as extracted from charge-exchange reactions and the beta decay.



ISOLDE

Assuming that isospin is a good quantum number one expects symmetry between transitions from T=1, $T_z=\pm1$ nuclei to the common excited states in the $T_z=0$ nucleus between them. Such a symmetry test can be performed by comparing the strengths of Gamow-Teller (GT) transitions obtained from (p,n)-type charge-exchange reactions with those obtained from the beta decay. Mass A=58 provides an ideal case for such a comparison, since the same states in ^{58}Cu can be populated in the charge-exchange reaction ^{58}Ni(^{3}He,t)^{58}Cu and in the beta decay of ^{58}Zn. The charge-exchange reaction has been studied in great detail in Osaka and the beta decay of ^{58}Zn was observed by our group for the first time at ISOLDE in 1998, and the decay was revisited in a series of experiments in 2002 and 2003 with an improved experimental set-up. These studies involved high efficiency beta-gamma spectroscopy as well as a dedicated search for proton decay from higher lying excited states in ^{58}Cu. The latter part of the experiment applied the Si-ball array to be discussed below. In 2003 we have analysed the data from the beta-gamma spectroscopy part and the data from beta-delayed proton spectroscopy is under evaluation.

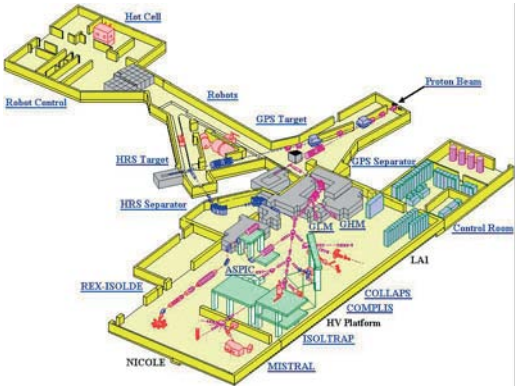
In connection with neutron converter target tests, which aims for the enhanced production of fission fragments compared to spallation products, we performed a spectroscopic study on the beta decay of neutron-rich Cs-isotopes

extending to mass A=150. In connection with the same study we also explored decay properties of neutron-rich Fr isotopes up to mass A=232, these were produced by impinging the primary beam directly to a UC-target thus resulting in enhanced spallation production. In 2003 the data of the latter experiment was analysed resulting in an extended decay scheme of the very neutron-rich ^{232}Fr isotope. The data obtained also provides an important addition to yield information on Fr isotopes from the spallation reaction which is of interest for the future European radioactive ion beam facility EURISOL. This project has selected Fr isotopes as one of the key isotopes, since they offer interesting possibilities to study the atomic parity non-conservation which is closely related to lepton-quark interactions through Z^0 gauge boson exchange at small momentum transfer.

A rapid proton capture (rp) process is a part of the explosive hydrogen burning occurring in special astrophysical events, like an accretion in close binary systems. At high temperatures it may continue until the fuel for nuclear burning is exhausted. The typical time scale for the event, known as X-ray burst, is 10-100 s. The rp-process flow proceeds quickly in the neutron-deficient side of the nuclide chart to a mass region A $\sim$ 70, where it slows down or terminates depending on the nuclear properties. As a continuation to our studies for ^{72,71,70}Kr, we have performed a beta-delayed proton decay study of ^{69}Kr, which gives access to proton unbound states in ^{69}Br. The data from this experiment has been analysed and the results were reported in the RNB6 Conference with results from Monte Carlo calculations for a new design of a thick spallation target at ISOLDE. We have also continued research to find an optimum way to produce a pure beam of ^{68}Se for high-precision mass measurement of this isotope.

Parallel to 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. The full detector consists of 104 detectors in rhombicuboctahedron geometry made of squares and triangles. The detector provides very high geometrical efficiency close to 100%, wide energy range with a very low energy threshold and high enough granularity for angular distribution measurements between emitted particles. The first half of the Si-ball was successfully commissioned in 2002, and the array was applied in the beta-delayed proton decay study of ^{58}Zn in 2002 and 2003. In 2003 further tests were carried out to characterize each individual detector in terms of leakage current, dead layer and resolution.

Finally, an ion cooler and buncher development has concentrated on the technical design and manufacturing drawings. At the end of 2003, construction of the test bench for the ion cooler with a 60 kV HV platform and test ion source was also started. In addition to the original research project we have initiated a new project for laser spectroscopy of cooled ion beams at ISOLDE.



Layout of the ISOLDE facility. A variety of spectroscopy stations in the measurement hall is indicated. Two target stations and attached isotope sepators are also illustrated (GSP and HRS).

Technology Programme

Ari-Pekka Hameri

During 2003, the DataGrid project continued to be the main effort of the Technology Programme. The momentum of global research and development activity around Grid technologies has increased and the first applications have been delivered. In order to respond to the technological challenges the Programme has been divided into four focus areas. Work on Grid related security technologies under the European Union (EU) DataGrid initiative continues to be the main area of the Programme. Operating and maintaining a commodity cluster and testbed for Grid related software development and testing aims towards practical implementation and use of the technology. Contributions to the LHC Computing Grid and Nordic Grid initiatives serve as development for the future needs of Particle Physics research. The fourth focus area concerns collaboration with industry, as the Programme has been involved with a domestic research project with participants from the field of Information and Communication Technology (ICT). In addition to Grid activities the Programme has finished a major survey among CERN's suppliers on their marketing and technological learning stemming from the interaction with a Big Science laboratory.

Security work in European Grid projects

Since 2001 the Helsinki Institute of Physics (HIP) Technology Programme has been actively participating in the EU DataGrid (EDG) project. Increased efforts in the EDG totalled half of the Programme's manpower. The main contribution to the project has been in the Data Management work package (WP2), and more specifically within the Security Task with the aim to provide the EDG consortium with security solutions. In 2003 the Programme also contributed to physics applications (WP8) and bio-medical applications (WP10). In WP2 HIP's researchers have been responsible from the beginning of the project for developing the Java security middleware, and in 2003 the team also acquired responsibility for the development of the database access software.

During 2003, the team finished the flexible authentication system and integrated into the overall EDG Java software. The module supports different language platforms. The authorization system was expanded and support for virtual organizations was completed. The main focus has been to improve the user friendliness of the security software, while completing related documentation and integration with the EDG software at large. The researchers have also given support to other developers and end-users in implementing and using these security tools.

In the Metadata Management Task, HIP personnel have prepared and released Spitfire for the EDG project's final release. The Spitfire software is a general Grid enabled Web Service to access relational databases. The software's performance has been tested and the related documents have been released as part of EDG deliverables. The service can be exploited equally well from both Java and C-language clients, these are the platforms supported by the EDG project consortium. As for outreach, researchers have been attending EDG project conferences in Barcelona and Heidelberg and have also actively participated in the EDG security co-ordination group events.

The EU DataGrid remains the biggest EU funded software research and development project in history. The EU sees Grid computing as one of the key strategic technologies in the coming years. In order to keep up the momentum a follow-up project has been planned. In the EU 6th Framework Programme and its call on integrated infrastructure a total of 100 Million euros is earmarked for the next four years to build an operational pan-European Grid facility to support the European Research Area. CERN is taking decisive steps in becoming a leading player in this field as it will take charge

in co-ordinating this major effort known as Enabling Grids for eScience in Europe, in short EGEE. This project aims to create a seamless European Grid infrastructure and its consortium has 72 partners, among which one finds HIP's Technology Programme.

Cluster activities and the Nordic Grid Facility

The HIP Technology Programme has researched cluster computing in practice by operating and maintaining a small Linux cluster in Otaniemi, Finland. This cluster has been funded by the Magnus Ehrnrooth Foundation with a three-year project that started in 2001. Our focus has been in developing cluster proficiency, training younger scientists, evaluating different Grid technologies and providing demonstrations. During 2003 several user groups have gained experience from the use of increased computing-cycles in their daily work. Among them are the University of Zaragoza in Spain, The Finnish Environmental Institute and the Helsinki Institute of Information Technology (HIIT). The latter institute and its Complex System Computation Group have been working on the cluster to study next generation information retrieval techniques, and by using Grid technologies to make their indexing software able to exploit distributed Grid resources in parallel.

In the Nordic countries the national and regional Grid activities are well advanced and in 2005 the decision to finance the Nordic Grid Facility to serve multi-scientific purposes will be taken by the Nordic Science Councils and the Academy of Finland. For the Technology Programme this has meant ever closer collaboration with HIP's CMS Programme and the Center for Scientific Computing, together with the other partners in NorduGrid. In order to increase the substance for the emerging national Grid in Finland, the Technology Programme has joined in two funding applications for the procurement of modern 64-bit cluster hardware.

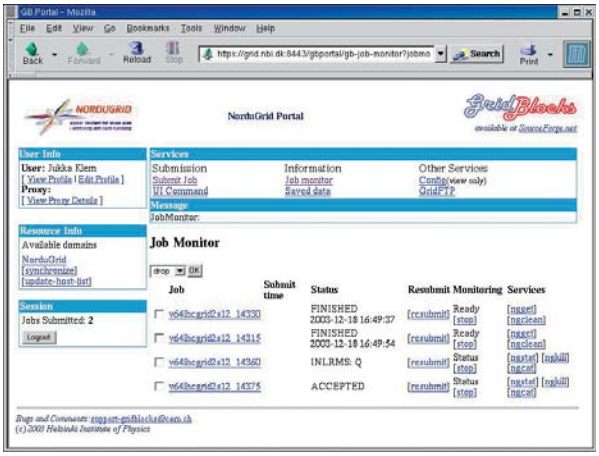
CMS Software, Physics and LHC Grid

The LHC Computing Grid Project (LCG) aims to develop the computing infrastructure for the simulation, processing and analysis of the LHC experimental data. The LCG Grid Deployment Board manages the deployment and operation of LCG Grid technology. The Technology Programme has been representing Finland in the Grid Deployment Board. As for the practical contribution to this effort the Programme has been involved with the LCG application area, where the project also studies user interfaces to physics applications. The GridBlocks portal, developed by HIP, allows physics jobs to be sent to various clusters on the Grid and the results retrieved. The portal makes it easier to send a large number of, e.g., physics simulation jobs with different parameters and to manage the simulation results. Through the portal, users can access their Grid jobs from any location using a web browser in an easy and secure way. The NorduGrid resources can be accessed via an instance of the GridBlocks portal at www.nordugrid.org.

The GridBlocks portal has been used for many purposes on the NorduGrid production Grid infrastructure, this currently holds more than one thousand CPUs distributed in several countries. For physics kinematics generation and detector simulation the jobs are described in resource specification language which defines, e.g., in which storage element on the Grid the input and output files are located. This job description can be constructed in the portal or loaded from an external file. CMS simulation jobs based on CMKIN and CMS-specific software have been described in this way and submitted from the portal. After job submission, the progress of the simulations can be monitored at any time and the simulation results can be stored at the desired location.

In 2003 the portal was also used by Atlas researchers during

The GridBlocks portal provides a user-friendly interface to access Grid resources. The derived version of the framework works together with NorduGrid middleware.



The GBAgent running on a mobile phone and showing the results from a histogram analysis.

Data Challenge 1 to perform simulations that downloaded large files (roughly 1 GB) from a Grid storage element, ran the simulation and uploaded the resulting files to another storage element. The researchers appreciated the fact that they could follow the progress of their simulation jobs from any web browser during the runs that can last more than 24 hours. In a similar manner simulations based on the well-established SixTrack program have been submitted from the GridBlocks portal to NorduGrid in order to study the behaviour of protons in the LHC collider. It should also be noted that the GridBlocks Agent in its latest incarnation runs on a Java-enabled mobile phone. Grid users can authenticate with their own Grid certificates and create new distributed jobs, query status information and receive results using a mobile phone.

Software packages used by the CMS experiment have been installed in HIP's computer clusters in collaboration with researchers of the CMS Programme. A testbed for a new NorduGrid cluster facility has also been developed, this has allowed testing of the new cluster management tools together with Grid software.

Industrial collaboration

In 2003 the HIP Technology Programme succeeded in establishing and financing one of the first industrial Grid research projects between Finnish academic and industry partners. This project is entitled "Network Identity, Grid enabled services and Trust networks" (NetGest), and it is funded by industrial partners and the Finnish National Technology Agency (TEKES).

This project explores how to integrate Grid technologies with known solutions and best practices in Web & Mobile environments in the ICT sector. This project has a special focus on how users are authenticated and authorized and how resource management is handled in a distributed infrastructure. In addition to the technological solutions, the project also studies potential business issues related to the Grid technologies. The Technology Programme works together with two other research partners in the project, namely Wirlab Research Center (University of Tampere) and Telecom Business Research Center (Lappeenranta University of Technology). The project is financed by Cygate Networks Oy, Nokia Mobile Phones, Nokia Research Center, Vaasan Läänin Puhelin and Alajärven Puhelin Osuuskunta, both telecom operators and Valimo Wireless Oy, a software company enabling secure applications in mobile networks.

The HIP Technology Programme, acting as a link to international Grid research at CERN, invited all interested NetGest partners to join the EGEE Industry Forum that arranged a kick-off event in October at CERN. The main objective of the EGEE Industry Forum is to help transfer Grid concepts towards industry. Furthermore, in December the Programme helped to gather a panel of Grid experts from CERN and prominent IT companies from the Geneva and Lausanne regions to brainstorm on future scenarios of Grid business.

At CERN the HIP Technology Programme is in close co-operation with the CERN OpenLab initiative. The CERN OpenLab is a consortium of industrial partners aimed at solving data-intensive problems in Grid environment together with CERN. During 2003, the Technology Programme's researcher and former project manager, Matti Heikkurinen, extended personally these ties by starting as a CERN OpenLab development officer. At the CERN OpenLab he has initially contributed to Grid dissemination activities through the EU Gridstart project as a HIP adjoint scientist. At the same time two HIP summer students participated in the first CERN OpenLab summer student programme that gathered a group of a dozen students from around Europe. The model of the CERN OpenLab summer student programme was derived from the corresponding programme at HIP. The students took part in a joint development project called OpenLogbook and attended numerous activities such as visits to the IBM Research Lab in Zurich and the HP Labs in Grenoble.

HIP Technology Programme students and researchers with the CERN OpenLab summer student programme at the HP Labs in Grenoble this summer.

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 Masters' thesis work at the Institute. This has turned out to be a very fruitful way of recruiting graduate students. In particular, the summer jobs at CERN are extremely efficient in this respect. During 1999–2003 24 doctoral degrees and 48 Masters' degrees have been earned in HIP research projects.

The Web University (WU) activity at CERN has been completed. HIP participated in the Open Learning Environment project led by the Tampere University of Technology. The project was funded by the Finnish National Technology Agency (TEKES).

The National Board of Education (Opetushallitus) has in collaboration with HIP and the city of Jyväskylä started a CERN co-operation high school network which 72 high schools and 24 partners from universities, physics institutes, teacher training centres and polytechnics have joined. The main aim is to develop the role of particle physics in school curricula in co-operation with CERN. In 2003 this programme attracted 207 Finnish and 19 French students and 35 of their teachers. Another related programme has been to bring to CERN high school physics teachers participating in continuing education courses organized by the Universities of Jyväskylä and Joensuu; in 2003 there were a total of 52 teachers.

The Institute has now operated for the second full year in the new building, Physicum, on the Kumpula campus. Connected with the move and the new laboratories additional resources for laboratory equipment (in addition to the normal budget) have been received. Such acquisitions have totalled about 150,000 euros in 2000–2003.

In matters of technological and commercial co-operation HIP collaborates with Finpro, which is an independent association providing services to Finnish companies, e.g., with international Big Science projects such as CERN. The Finpro co-operation at CERN is financed by TEKES.

Organization and Personnel

Organization

Scientific Advisory Board
Hans Hoffmann, Martti Mäenpää, Maurice Rice, Hans Specht, Albrecht Wagner, Gabriele Veneziano

Board
Marja Makarow, Antti Kupiainen, Timo Tiihonen, Juhani Keinonen, Peter Lund, Katri Huitu, Mauri Airila, Rauno Julin

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DOR, KE, HS, JT, JÄ, AH, MS

Director
Dan-Olof Riska

Administrative Manager
Mikko Sainio

- **Theory** — Kari Enqvist
  - String Theory and QFT — Esko Keski-Vakkuri
  - Laser Physics and Quantum Optics — Kalle-Antti Suominen
  - Particle Physics Phenomenology — Katri Huitu
  - Cosmology — Kari Enqvist
  - Physics of Biological Systems — Ilpo Vattulainen
  - Ultrarelativistic Heavy Ion Collisions — Kari J. Eskola
- **High Energy Physics** — Heimo Saarikko
  - Electron-Positron Physics — Kenneth Österberg
  - LHC Foward Physics — Risto Orava
  - COMPASS — Peter Berglund
- **CMS** — Jorma Tuominiemi
  - Software and Physics — Veikko Karimäki
  - CMS Tracker — Eija Tuominen
- **Nuclear Matter Physics** — Juha Äystö
  - ALICE — Wladyslaw Trzaska
  - ISOLDE — Ari Jokinen
- **Technology** — Ari-Pekka Hameri
  - Data Grid — Miika Tuisku

The Board: Niiniluoto, Keinonen, Huitu, Julin, Lund.

The Institute Board

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	Marja Makarow, Vice Rector (from 1.8.2003) (University of Helsinki)
Vice Chairman	**Mauri Airila**, Vice Rector (Helsinki University of Technology)
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	Juhani Keinonen, Professor (University of Helsinki)
	Antti Kupiainen, Professor (University of Helsinki)
	Peter Lund, Professor (Helsinki University of Technology)
	Timo Tiihonen, Vice Rector (University of Jyväskylä)
	Katri Huitu, Docent (Chosen by personnel of HIP)

The Scientific Advisory Board

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Martti Mäenpää, Director General (Technology Industries of Finland)

Maurice Rice, Professor (ETHZ)

Hans Specht, Professor (U. Heidelberg)

Gabriele Veneziano, Professor (CERN)

Albrecht Wagner, Director General (DESY)

Personnel

Theory Programme

K. Enqvist, prof., programme director
A. Green, prof., adj. senior scientist
T. Lähde, scientist
J. Koponen, grad. student

Cosmology

K. Enqvist, prof., proj. leader
A. Jokinen, scientist
S. Kasuya, scientist
M. Sloth, scientist
J. Högdahl, grad. student
V. Muhonen, grad. student
T. Poutanen, grad. student
A. Väihkönen, grad. student

Laser Physics and Quantum Optics

K.-A. Suominen, prof., proj. leader
M. Mackie, senior scientist
E. Lundh, scientist
J. Piilo, scientist
A. Collin, grad. student
O. Dannenberg, grad. student

Particle Physics Phenomenology

K. Huitu, docent, proj. leader
P. Hoyer, prof., adj. senior scientist
J. Maalampi, prof., adj. senior scientist
E. Gabrielli, senior scientist
M. Aoki, scientist
D. Chakraverty, scientist
A. Datta, scientist
B. Juliá-Díaz, scientist
S. Roy, scientist
E. Brücken, grad. student
J. Laamanen, grad. student
T. Rüppell, grad. student

Physics of Biological Systems

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J. Asikainen, scientist
M. Hyvönen, scientist
E. Salonen, scientist
E. Falck, grad. student
E. Terämä, grad. student
M. Heikelä, student
P. Lindqvist, student
O. Punkkinen, student

String Theory and Quantum Field Theory

E. Keski-Vakkuri, docent, proj. leader
M. Chaichian, prof., senior scientist
J. Hietarinta, prof., adj. senior scientist
A. Niemi, prof., adj. senior scientist
B. Carneiro da Cunha, scientist
W. Chen, scientist
S. Kawai, scientist
A. Kobakhidze, scientist
D. Polyakov, scientist
S. Hemming, grad. student
K. Larjo, grad. student
O. Pasanen, grad. student
A. Tureanu, grad. student
M. Zarroug, grad. student

Ultrarelativistic Heavy Ion Collisions

K. J. Eskola, docent, proj. leader
K. Kajantie, prof., senior scientist
V. Ruuskanen, prof., senior scientist
K. Rummukainen, prof., adj. scientist
P. Huovinen, scientist
M. Sallé, scientist
A. Hietanen, grad. student
H. Honkanen, grad. student
T. Lappi, grad. student
M. Vepsäläinen, grad. student

High Energy Physics Programme

H. Saarikko, prof., programme director

Electron-Positron Physics

K. Österberg, proj. leader
A. Kiiskinen, grad. student
L. Salmi, grad. student

LHC Forward Physics

R. Orava, prof., proj. leader
J. Lamsa, senior scientist (at CERN)
S. Tapprogge, senior scientist (at CERN)
P. Cwetanski, scientist (at CERN)
V. Avati, grad. student (at CERN)
V. Bergholm, student
J. Kalliopuska, student
T. Mäki, student
F. Oljemark, student
E. Goussev, summer trainee (at CERN)
M. Järvinen, summer trainee (at CERN)

COMPASS

P. Berglund, docent, proj. leader
J. Koivuniemi, tech. coordinator (at CERN)
K. Gustafsson, scientist (at CERN)

Detector Laboratory

M. Oinonen, lab. coordinator
F. Garcia, scientist
J. Heino, lab. engineer
K. Kurvinen, lab. engineer
R. Lauhakangas, lab. engineer
J. Ojala, researcher
A. Numminen, lab. technician

CMS Programme

J. Tuominiemi, prof., programme director

Software and Physics

V. Karimäki, docent, proj. leader
R. Kinnunen, senior scientist (at CERN until 30.6.)
K. Lassila-Perini, senior scientist (at CERN)
V. Lefébure, senior scientist (at CERN)
S. Lehti, senior scientist (at CERN from 1.9.)
T. Lindén, senior scientist
M. Arenius, scientist (at CERN)
A. Hektor, adj. scientist
P. Salmi, adj. scientist
A. Heikkinen, grad. student
T. Lampén, grad. student
J. Nysten, grad. student (at CERN)
M. Voutilainen, grad. student
L. Wendland, student
N. Jokela, summer trainee (at CERN)
T. Järvi, summer trainee (at CERN)
P. Mehtälä, summer trainee (at CERN)
V. Vaskelainen, summer trainee (at CERN)
A. Zibellini, summer trainee (at CERN)

CMS Tracker

E. Tuominen, proj. leader
S. Czellar, senior scientist (at CERN)
J. Härkönen, senior scientist (at CERN)
I. Kassamakov, senior scientist
H. Katajisto, scientist
P. Luukka, grad. student (at CERN)
T. Mäenpää, grad. student
E. Tuovinen, grad. student
D. Ungaro, grad. student (at CERN)
T. Laihomäki, student
J. Kortesmaa, lab. technician
A. Kuronen, lab. technician
E. Lääniläinen, summer trainee (at CERN)
H. Stenbäck, summer trainee (at CERN)
J. Tanskanen, summer trainee (at CERN)
P. Ukkonen, summer trainee (at CERN)
J. Wagner, summer trainee (at CERN)

Nuclear Matter Programme

J. Äystö, prof., programme director

ALICE

W. Trzaska, docent, proj. leader
V. Ruuskanen, prof., senior scientist
I. Kassamakov, senior scientist
M. Oinonen, senior scientist
Z. Radivojevic, scientist
M. Bondila, grad. student
H. Seppänen, grad. student
V. Lyapin, engineer

ISOLDE

A. Jokinen, docent, proj. leader
J. Äystö, prof.

Technology Programme

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

DataGrid

M. Tuisku, proj. leader (at CERN)
M. Gindonis, scientist (at CERN)
J. Hahkala, scientist (at CERN)
M. Heikkurinen, scientist (at CERN)
J. Herrala, scientist (at CERN)
J. Klem, scientist (at CERN)
M. Niinimäki, scientist (at CERN)
M. Silander, scientist (at CERN)
V. Sivunen, scientist (at CERN)
J. White, scientist (at CERN)
M. Happonen, engineer
M. Fallenius, student
N. Karlsson, student
J. Karppinen, student
H. Mikkonen, student
V. Nenonen, student
T. Nissi, student
L. Porri, student
A. Ukkonen, student

Administration and Support

D.-O. Riska, prof., director
M. Sainio, docent, adm. manager
T. Sandelin, financial manager
M. Flygar, secretary (at CERN)
T. Hardén, secretary
T. Karppinen, secretary (at CERN)
P. Lehto, secretary
A. Heikkilä, tech. coordinator (at CERN)
R. Rinta-Filppula, researcher (at CERN)
C. Helminen, scientist
N. Jiganova, senior system analyst
T. Vehviläinen, lab. engineer (until 30.6.)
J. Aaltonen, lab. engineer (from 1.10.)
J. Vähäkangas, trainee (16.4.-30.9.)

Seminars

Seminars held in Helsinki

January 14th E. Lundh (HIP)
Vortices in trapped Bose-Einstein condensates

January 21st J. Honkonen (National Defence College)
Transport processes in random media and the field-theoretic renormalization group

January 28th R. Leigh (Univ. of Illinois at Urbana-Champaign, USA)
DeSitter holography and the cosmic microwave background

February 3rd (Colloquium) J. Tuominiemi (HIP)
20 years from the discovery of W

February 4th A. Vuorinen (TFO)
QCD thermodynamics at 4-loop order: quark number susceptibilities

February 11th F. Gelis (Saclay, France)
Proton-nucleus collisions in the color glass condensate model

February 17th Per Osland (Bergen, Norway)
CP violation in top quark production at the LHC and two-Higgs-doublet models

February 18th F. Ravndal (University of Oslo, Norway)
Gunnar Nordstrom and extra dimensions: scalar fields in theories of gravitation

February 21st D. Rischke (Frankfurt, Germany)
Are quark stars spin-1 color superconductors?

February 24th (Colloquium) F. Stenman (Department of Physical Sciences)
As time goes by - fysiikkaa ja tekniikkaa vuosituhannelta toiselle

February 25th K. Huitu (HIP)
On new particles in the Beyond the Standard Model phenomenology

March 4th K. Rummukainen (Department of Physical Sciences)
Higgs mechanism without Higgs particle using warped extra dimensions?

March 18th A. Polosa (CERN, Switzerland)
The Alpgen project

March 20th-22nd
37th Annual Meeting of the Finnish Physical Society

March 24th (Colloquium) R. Orava (Department of Physical Sciences)
Forward physics with the future machines

March 25th S. Gupta (Tata Institute, Mumbai, India)
Off the wall – chemical potential without sweat

March 31st (Colloquium) A. M. Green (Department of Physical Sciences/HIP)
Why I did what I did – in physics

April 7th (Colloquium) V. Metag (Universität Giessen, Germany)
Probing matter with antimatter – new perspectives for hadron physics with antiprotons at the future international accelerator facility at GSI

April 8th M. L. Marshak (University of Minnesota, USA)
Underground science: opportunities and challenges

April 15th A. Gynther (TFO)
The electroweak thermodynamics at finite density

April 24th W. Henning (GSI, Germany)
The future GSI facility and its programs

April 29th M. Rho (Saclay, France)
The vector manifestation of chiral symmetry and a non-standard QCD phase structure

April 30th A. Sibirtsev (Jülich, Germany)
Eta-prime photoproduction from the proton

May 6th E. Keski-Vakkuri (HIP)
Taming closed time-like curves

May 13th S. Peigné (LAPTH Annecy, France)
Accessing confinement effects using QCD perturbation theory

May 20th F. Ravndal (University of Oslo, Norway)
A modern approach to low-energy pp scattering and fusion

May 26th (Colloquium) G. Pancheri (INFN - Frascati National Laboratories, Italy)
Women in physics: their presence in the scientific institutions and their future

May 27th G. Pancheri (INFN - Frascati National Laboratories, Italy)
Perturbative QCD and the energy dependence of total cross-sections

June 3rd M. Strickland (Vienna, Austria)
Collective modes of an anisotropic quark-gluon plasma

June 10th J. Haidenbauer (Jülich, Germany)
Eta-meson production in nucleon-nucleon collisions

June 16th H. Leutwyler (Bern, Switzerland)
Experimental evidence for the quark condensate

June 17th R. Godbole (Bangalore, India)
Supersymmetric 'invisible Higgs': collider and cosmological implications

June 19th R. Godbole (Bangalore, India)
R-parity violating supersymmetric theories and colliders

June 26th S. Maniscalco (University of Palermo, Italy)
A new analytic approach to the exact dynamics of quantum Brownian motion

July 4th J. Comfort (Arizona State University, USA)
Physics with the Crystal Ball

August 12th R. Sturani (HIP)
D-branes thermodynamics and cosmology

August 19th L. Magnea (University of Torino, Italy)
String techniques for the computation of scattering amplitudes in field theory

August 22nd J. Randrup (Lawrence Berkeley National Laboratory, USA)
Color filamentation in the early parton plasma?

August 22nd R. Vogt (Lawrence Berkeley National Laboratory/UC Davis, USA)
Threshold effects in heavy quark production

August 26th R. Tammelo (University of Tartu, Estonia)
A new method for solving covariant wave equations by means of higher-order fundamental solutions with some applications

August 27th-30th
The Gunnar Nordström Symposium on Theoretical Physics

September 1st (Colloquium) P. G. O. Freund (Chicago, USA)
The way we play the game – a physicist's narratives

September 2nd U. van Kolck (Arizona, USA)
EFT approach to halo nuclei

September 9th M. Noga (Comenius University, Bratislava, Slovak Republic)
Analytic properties of the grand-canonical potential for the interacting electron gas

September 12th A. Brandt (University of Texas, Arlington, USA)
Diffraction at D0

September 16th M. Aoki (HIP)
Lifting the degeneracy in the parameters of the neutrino oscillation with future long baseline experiments

September 18th M. Nishimura (MIT, USA)
On Supersymmetry in noncommutative field theories

September 23rd M. S. Sloth (HIP)
Cosmology as a window to trans-Planckian physics

September 25th J. Barrow (Cambridge, UK)
Varying constants

September 30th K. Lassila-Perini (CERN, Switzerland)
Physics reached in the 1st year of the LHC

October 2nd G. Lifschytz (Haifa, Israel)
Black hole physics from gauge theory

October 7th A. Kiiskinen (HIP)
Searches for charged Higgs bosons at e+e- colliders

October 14th A. Datta (HIP)
A new avenue for supersymmetry search at the Large Hadron Collider

October 21st D. Chakraverty (HIP)
Phenomenology of universal extra dimensions

October 28th J. Mickelsson (Stockholm, Sweden)
Supersymmetric Wess-Zumino-Witten model and (twisted) K-theory

October 28th (Colloquium) P. Sinervo (Toronto, Canada)
The search for truth

November 4th E. Kuusela (TKK)
Sedimentation of non-Brownian spheroidal particles

November 11th B. Juliá-Díaz (HIP)
Baryon form factors in instant, point and front form kinematics

November 17th (Colloquium) Sir M. Rees - Astronomer Royal (Cambridge, UK)
Current issues in cosmology and galaxy formation

November 18th S. Khalil (Durham, UK)
Fermion masses and mixing in four and more dimensions

November 24th (Colloquium) B. Thijsse (Delft University of Technology, The Netherlands)
Processes at surfaces: atomic-scale modeling

December 2nd A. Carey (Canberra, Australia)
Analytic formulae for spectral flow

December 9th K. Tuominen (Jyväskylä)
Critical behavior of non-order parameter fields

December 12th M. Sadler (Abilene, USA)
Experiments in baryon spectroscopy with the Crystal Ball

December 15th Particle Physics Day
R. Kinnunen, **CMS potential for Higgs boson searches**
M. Voutilainen, **Electron isolation algorithm for CMS data-analysis**
V. Bergholm, **L1 triggering for exclusive DPE Higgs events at the LHC**
M. Järvinen, **Study of elastic scattering for the TOTEM experiment at LHC**
L. Salmi, ***tt̄* cross-section and forward-backward asymmetry at CLIC**
S. Roy, **Single sneutrino production at hadron colliders**
J. Laamanen, **Invisible Higgs in extra dimensions**
V. Kolhinen, **Enhancement of charm quark production due to nonlinear corrections to the DGLAP equations**
P. Huovinen, **Rate equation network for baryon production in high energy nuclear collisions**
H. Honkanen, **High-p_T hadron spectra with parton energy loss through multiple soft scattering**
S. Räsänen, **Predictions for hadron spectra at the LHC**
V. Ginzburg, **On superconductivity and superfluidity (what I have and have not managed to do) as well as on the 'physics minimum' at the beginning of the 21st century** (Nobel lecture)
A. Leggett, **Superfluid 3-He: the early days as seen by a theorist** (Nobel lecture)
M. Järvinen, **Lorentz contraction of bound states in 1+1 dimensional QCD**
M. Aoki, **Sensitivity to parameter degeneracies of an experiment at neutrino factory**
J. Sarkamo, **Physics of a long baseline neutrino experiment: from CERN to Pyhäsalmi**
M. Vepsäläinen, **Mesonic correlation lengths in high-temperature QCD**
J. Väliviita, **The current status of initial conditions of the cosmic microwave background fluctuations**
S. Hemming, **Free field realizations of boundary CFTs**
T. Lindén, **Building a Linux cluster for Monte Carlo computations using the NPACI rocks cluster distribution**

Visitors

Theory Programme

Cosmology

A. Mazumdar (Canada) 2.-10.2.
F. Ravndal (Norway) 2.-22.2.
F. Takahashi (Japan) 20.-23.8.
A. Mazumdar (Canada) 31.8.-5.9.
M. Kawasaki (Japan) 2.-6.10.
F. Ravndal (Norway) 19.-22.11.

Laser Physics and Quantum Optics

S. Maniscalco (Italy) 7.-12.1.
J. Dalibard (France) 9.1.
S. Maniscalco (Italy) 25.6.-6.7.
E. Lundh (Sweden) 19.-20.8.

Particle Physics Phenomenology

P. Keränen (Denmark) 1.-7.1.
W. F. Chen (Canada) 1.-28.2.
P. Osland (Norway) 13.-18.2.
S. Peigné (France) 28.4.-31.5.
M. Raidal (Estonia) 22.5.
R. Godbole (India) 15.6.-1.7.
I. Andriz (Croatia) 16.-29.8.
L. Magnea (Italy) 18.-21.8.
J. Randrup (USA) 21.-24.8.
R. Vogt (USA) 21.-24.8.
M. Nishimura (USA) 18.-19.9.
M. Raidal (Estonia) 7.11.
S. Khalil (UK) 16.-22.11.
A. Carey (Australia) 29.11.-5.12.
P. N. Pandita (India) 30.11.-7.12.
P. Kulish (Russia) 2.-7.12.

Hadron Physics Activity
A. Polosa (Switzerland) 15.-23.3.
V. Metag (Germany) 7.-8.4.
M. Rho (France) 23.-30.4.
W. Henning (Germany) 24.4.
E. Norvaišas (Lithuania) 11.-17.5.
G. Pancheri (Italy) 24.-27.5.
H. Leutwyler (Switzerland) 5.-27.6.
D. Ashery (Israel) 26.-27.6.
J. Comfort (USA) 4.-5.7.
U. van Kolck (USA) 31.8.-7.9.
S. Wycech (Poland) 30.10.-29.11.
M. Rees (UK) 17.11.
V. Abaev (Russia) 17.-22.11.
M. Sadler (USA) 11.-12.12.

Physics of Biological Systems

S. Lyulin (Russia) 13.-15.4.
M. Laradji (USA) 25.-31.5.
J. Repakova (Czech Republic) 1.6.-30.11.
A.-P. Hynninen (The Nertherlands) 1.-4.9.
A. Manz (UK) 27.-28.10.
S. Lyulin (Russia) 27.10.-8.11.
P.-L. Hansen (Denmark) 12.-16.11.
O. G. Mouritsen (Denmark) 12.-16.11.
A. Darinskii (Russia) 17.12.

String Theory and Quantum Field Theory

W. Chen (Canada) 1.1.-15.12.
R. G. Leigh (USA and Switzerland) 27.1-2.2.
B. Carneiro da Cunha (USA) 3.-16.6.
K. Igi (Japan) 21.-29.6.
I. Andric (Croatia) 16.-29.8.
M. Mnatsakanova (Russia) 15.9.-14.10.
Y. Vernov (Russia)15.9.-14.10.
G. Lifschytz (Israel) 29.9.-8.10.
D. Kochan (Slovakia) 6.10.-16.12.
P. Prešnajder (Slovakia) 6.10.-31.12.
A. Carey (Australia) 29.11.-5.12.
P. Kulish (Russia) 2.-7.12.

Ultrarelativistic Heavy Ion Collisions

P. Huovinen (USA) 7.-10.1.
F. Gelis (France) 2.-15.2.
D. Rischke (Germany) 15.-22.2.
S. Gupta (India) 24.3.-11.4.
P. Huovinen (USA) 7.-17.4.
K. Tuominen (Denmark) 14.-16.4.
M. Strickland (Austria) 31.5.-7.6.
J. Randrup (USA) 3.-30.8.
R. Vogt (USA) 3.-30.8.
M. Laine (Germany) 7.- 8.8.
A. Dainese (Italy) 24.-27.11.
F. Sannino (Denmark) 28.-30.11.
A. Rebhan (Austria) 18.-22.12.
K. Rummukainen (Switzerland) 19.-24.12.
M. Laine (Germany) 29.-31.12.
A. Rajantie (UK) 29.-31.12.

CMS Programme

Software and Physics

M. Grazia Pia (Italy) 30.-31.10.
P. Nieminen (The Netherlands) 30.-31.10.

Nuclear Matter Programme

ALICE

P. Kuijer (The Netherlands) 15.-17.6.
O. Chykalov (Ukraine) 15.-30.6.
S. Kiprich (Ukraine) 15.-30.6.
N. Chernykova (Ukraine) 4.-23.8.
O. Chykalov (Ukraine) 4.-23.8.
L. Klymova (Ukraine) 4.-23.8.
A. Kurylov (Ukraine) 4.-23.8.
S. Kiprich (Ukraine) 27.10.-25.11.
S. Pankov (Ukraine) 27.10.-25.11.
I. Tymchuk (Ukraine) 27.10.-25.11.
V. Zhupinsky (Ukraine) 27.10.-25.11.

Conference participation, Talks and Visits by Personnel

Theory Programme

Cosmology

PASCOS03 IXth International Symposium on Particles, Strings and Cosmology,
3-8 January, Mumbai-Bombay, India (A. Jokinen)

Planck/CTP Working Group Meeting,
22-26 January, Cambridge, UK (talk by T. Poutanen)

The Davis Meeting on Cosmic Inflation,
22-25 March, Davis, CA, USA (A. Väihkönen)

Planck Surveyor Mission Co-I Meeting,
24 April, Bologna, Italy (K. Enqvist)

Nordic Project on Astroparticle Physics and Cosmology,
2-3 May, Copenhagen, Denmark (K. Enqvist, J. Högdahl, A. Jokinen, talk by V. Muhonen, M. Sloth, A. Väihkönen, J. Väliviita)

15th Rencontres de Blois: New Results in Cosmology and the Coherence of the Standard Model,
15-20 June, Blois, France (talk by J. Väliviita)

EURESCO Conference,
12-17 July, Piran, Slovenia (talk by M. Sloth)

Nordic course in string theories,
29 July - 7 August, NORDITA, Copenhagen, Denmark (M. Sloth)

Nobel Symposium 2003, "Cosmology & String Theory",
14-19 August, Sigtuna, Sweden (K. Enqvist)

International Workshop on Particle Physics and the Early Universe (COSMO-03),
25-29 August, Ambleside, UK (talks by K. Enqvist, J. Högdahl, A. Jokinen, S. Kasuya, V. Muhonen, M. Sloth, J. Väliviita)

The Gunnar Nordström Symposium on Theoretical Physics,
27-30 August, Helsinki, Finland (talk by K. Enqvist, M. Sloth)

Villa Mondragone International School on Gravitation and Cosmology,
6-11 September, Rome, Italy (V. Muhonen, J. Väliviita)

Planck/CTP Working Group Meeting,
6-12 September, Garching, Germany (T. Poutanen)

Antares Final Seminar,
30 October, Helsinki, Finland (talks by K. Enqvist, V. Muhonen, T. Poutanen)

Mini Workshop on Brane World,
30-31 October, Tokyo, Japan (S. Kasuya)

NorFA Network Meeting on Particle Physics and Cosmology,
30-31 October, Oslo, Norway (J. Högdahl, A. Väihkönen)

The 6th RESCEU International Symposium "Frontier in Astroparticle Physics and Cosmology",
4-7 November, Tokyo, Japan (talk by S. Kasuya)

Dark Matter and Dark Energy Meeting,
8-11 December, Bad Honnef, Germany (talk by K. Enqvist)

SpacePart 2003, Second International Conference on Particle and Fundamental Physics in Space,
9-12 December, Washington D.C., USA (J. Högdahl)

Laser Physics and Quantum Optics

NORDITA Subcommittee Meeting,
27 January, Copenhagen, Denmark (K.-A. Suominen)

University of Utrecht,
10-16 February, Utrecht, The Netherlands (M. Mackie)

Obergurgl Quantum Optics Meeting 2003,
23 February - 1 March, Obergurgl, Austria (E. Lundh)

The Annual Meeting of the Finnish Physical Society,
20-22 March, Helsinki, Finland (A. Collin, O. Dannenberg, talk by J. Piilo)

University of Palermo,
23 March - 13 April, Palermo, Italy (talk by J. Piilo)

University of Freiburg,
14-17 May, Freiburg, Germany (J. Piilo)

University of Kaiserslautern,
17-20 May, Kaiserslautern, Germany (J. Piilo)

34th Meeting of the Division of Atomic, Molecular and Optical Physics,
20-24 May, Boulder, CO, USA (talk by M. Mackie)

University of Connecticut,
25 May - 14 June, Storrs, CT, USA (M. Mackie)

University of Umeå,
2-5 June, Umeå, Sweden (talk by J. Piilo)

Young Atom Opticians Conference YAO 2003,
3-8 June, Amsterdam, The Netherlands (A. Collin, talk by E. Lundh)

Theory of Quantum Gases and Quantum Coherence, The Second International Workshop,
12-14 June, Trento, Italy (talk by E. Lundh)

Gordon Research Conference on Atomic Physics,
15-20 June, Tilton, NH, USA (M. Mackie)

Northern Optics 2003,
16-18 June, Espoo, Finland (J. Piilo, K.-A. Suominen, program committee chair)

Second Workshop on Cold Alkaline-Earth Atoms,
11-13 September, Copenhagen, Denmark (K.-A. Suominen, program committee member)

Bose-Einstein Condensation: EuroConference on the New Trends in Physics of Quantum Gases,
13-18 September, San Feliu de Guixols, Spain (A. Collin, O. Dannenberg)

CAUAC Network Meeting,
10-12 October, Braunschweig, Germany (K.-A. Suominen)

Particle Physics Phenomenology

41. Internationale Universitätswochen für Theoretische Physik,
22-28 February, Schladming, Austria (talk by D. Chakraverty, T. Rüppell)

The Annual Meeting of the Finnish Physical Society,
20-22 March, Helsinki, Finland (D. Chakraverty, A. Datta, K. Huitu, J. Laamanen, T. Rüppell)

ECFA DESY, LinearCollider Workshop,
1-4 April, Amsterdam, The Netherlands (talks by A. Datta, by E. Gabrielli, and by K. Huitu)

7th Nordic LHC Physics Workshop,
8-10 May, Bergen, Norway (J. Laamanen)

Planck 03, From the Planck Scale to the Electroweak Scale,
26-31 May, Madrid, Spain (talk by E. Gabrielli, T. Rüppell)

Flavor Physics and CP Violation 2003,
3-6 June, Paris, France (T. Rüppell)

SUSY 2003, Supersymmetry in the Desert,
5-10 June, Tucson, AZ, USA (talk by A. Datta, J. Laamanen)

CAPP 2003, Workshop on Cosmology and Particle Physics,
12-17 June, CERN, Geneva, Switzerland (E. Gabrielli)

University of Bologna,
18 June, Bologna, Italy (talk by E. Gabrielli)

University of Padova,
19 June, Padova, Italy (talk by E. Gabrielli)

DESY Theory Workshop,
22-25 September, Hamburg, Germany (talk by K. Huitu)

International Workshop on Weak Interactions,
4-12 October, Lake Geneva, WI, USA (talks by K. Huitu)

The 8th Nordic LHC Physics Workshop,
28-29 November, Lund, Sweden (talks by K. Huitu, by J. Laamanen, and by S. Roy)

University of Roma III,
1-7 December, Rome, Italy (talk by E. Gabrielli)

Hadron Physics Activity

California Institute of Technology,
13-24 January, Pasadena, CA, USA (invited talk by D.-O. Riska)

NuPECC Town Meeting,
30 January - 1 February, GSI, Darmstadt, Germany (M. Sainio)

European Graduate School Copenhagen-Giessen,
24-28 February, Trento, Italy (invited talk by D.-O. Riska)

The Annual Meeting of the Finnish Physical Society,
20-22 March, Helsinki, Finland (M. Sainio)

Argonne National Laboratory,
1-2 April, Argonne, IL, USA (D.-O. Riska)

University of Kentucky,
2-3 April, Lexington, KY, USA (invited talk by D.-O. Riska)

The Gunnar Nordström Symposium on Theoretical Physics,
27-30 August, Helsinki, Finland (M. Sainio)

X International Conference on Hadron Spectroscopy,
5 September, Aschaffenburg, Germany (invited talk by D.-O. Riska)

Chiral Dynamics 2003: Theory and Experiment,
8-12 September, Bonn, Germany (M. Sainio)

Workshop on Hadronic Atoms,
13-17 October, Trento, Italy (invited talk by M. Sainio)

Arizona State University,
28-29 October, Tempe, AZ, USA (invited talk by D.-O. Riska)

Institute of Theoretical Physics, University of Bern,
3-5 and 28-29 November, Bern, Switzerland (M. Sainio)

Physics of Biological Systems

Science Forum (Tieteen päivät),
8-10 January, Helsinki, Finland (invited talk by I. Vattulainen together with M. Karttunen)

University of Southern Denmark,
11-15 January, Odense, Denmark (I. Vattulainen)

Workshop on Soft Matter Sciences: Researcher Training and Ethics,
20-22 January, Himos, Finland (J. Asikainen, E. Falck, A. Gurtovenko, M. Heikelä, M. T. Hyvönen, I. Vattulainen)

The Annual Meeting of the Finnish Physical Society,
20-22 March, Helsinki, Finland (talk by E. Falck, M. Heikelä, P. Niemelä, O. Punkkinen, E. Terämä, I. Vattulainen)

NATO Advanced Study Institute: Forces, Growth and Form in Soft Condensed Matter: At the Interface between Physics and Biology,
23 March - 3 April, Geilo, Norway (P. Niemelä)

Third Annual Stockholm-Helsinki Meeting on Biomolecular Modeling,
9-10 April, Helsinki, Finland (talk by E. Falck, talk by A. Gurtovenko, T. Murtola, P. Niemelä, E. Terämä, talk by I. Vattulainen)

University of Freiburg,
11-24 May, Freiburg, Germany (A. Gurtovenko)

University of Southern Denmark,
17-21 May, Odense, Denmark (I. Vattulainen)

University of Southern Denmark,
18-21 May, Odense, Denmark (O. Punkkinen)

Summer School "Understanding Molecular Simulations",
2-13 June, Amsterdam, The Netherlands (P. Niemelä)

Hydrogen in Condensed Matter 2003,
25-28 June, Helsinki, Finland (E. Salonen)

Eurobiophysics03,
5-9 July, Alicante, Spain (I. Vattulainen)

ASEVA Summer School WS-14: Physical and chemical processes in reactive hydrocarbon plasmas in contact with surfaces,
22-25 July, Avila, Spain (invited talk by E. Salonen)

Nordita Master Class in Physics 2003,
3-10 August, Hillerød, Denmark (T. Murtola)

University of Southern Denmark,
11-22 August, Odense, Denmark (I. Vattulainen)

Hairy Interfaces and Stringy Molecules - Summer School and Workshop on Colloids and Biophysics,
13-17 August, Odense, Denmark (E. Falck, A. Gurtovenko, M. Heikelä, P. Niemelä, E. Salonen, E. Terämä, I. Vattulainen)

The 13th Jyväskylä Summer School,
17-26 August, Jyväskylä, Finland (T. Murtola)

Fundamental and Practical Applications of Surface Diffusion,
14-17 September, Trest, Czech Republic (invited talk by I. Vattulainen)

MCM-2003: 4th IMACS Seminar on Monte Carlo Methods,
15-19 September, Berlin, Germany (invited talk by I. Vattulainen)

Carbon-10, 10th International Workshop on Carbon Materials for Fusion Application,
17-19 September, Jülich, Germany (invited talk by E. Salonen)

University of Southern Denmark,
13-31 October, Odense, Denmark (O. Punkkinen)

Computational Chemistry Workshop at CSC,
20-21 October, Espoo, Finland (A. Gurtovenko, P. Niemelä)

Turku Lipid Meeting,
18 November, Turku, Finland (E. Falck, M. T. Hyvönen, P. Niemelä)

University of Freiburg,
24 November - 7 December, Freiburg, Germany (A. Gurtovenko)

String Theory and Quantum Field Theory

"Holography and the AdS/CFT Correspondence" Conference,
12-14 March, Galveston, TX, USA (E. Keski-Vakkuri)

University of Pennsylvania,
14-23 March, Philadelphia, PA, USA (talk by E. Keski-Vakkuri)

Yukawa Institute for Theoretical Physics, Kyoto; Tokyo University of Technology; University of Osaka; University of Kanagawa; University of Nagoya; University of Hiroshima,
23 March - 13 April, Japan (talks by M. Chaichian)

Spring School on Superstrings and Related Matters,
31 March - 8 April, Trieste, Italy (K. Larjo)

7th UK Meeting on Integrable Models and Conformal Field Theory,
24-26 April, York, UK (talk by S. Kawai)

University of Oxford,
27-30 April, Oxford, UK (talk by S. Kawai)

The Clay Mathematics Institute International Conference and Spring School "Noncommutative Geometry and Applications",
2-13 May, Nashville, TN, USA (talk by A. Tureanu)

17th Nordic String Meeting,
8-10 May, Oslo, Norway (talks by S. Hemming and S. Kawai)

Wallyfest - Symposium in the Honour of O. W. Greenberg's 70th Anniversary,
9 May, College Park, MD, USA (invited talk by M. Chaichian)

College of William and Mary,
11 May, Williamsburg, VA, USA (talk by M. Chaichian)

UCLA,
12-24 May, Los Angeles, CA, USA (M. Chaichian)

CERN Theory Division,
18-20 May, Geneva, Switzerland (talk by E. Keski-Vakkuri)

Summer School in Cosmology,
27 May, Nurmijärvi, Finland (lecture by E. Keski-Vakkuri)

"String Theory and Quantum Gravity" Workshop,
15-22 June, Amsterdam, The Netherlands (E. Keski-Vakkuri)

University of Heidelberg,
20-21 June, Heidelberg, Germany (M. Chaichian)

Strings 2003,
6-11 July, Kyoto, Japan (S. Hemming, S. Kawai)

"Time and String Theory" Workshop,
11 August - 9 September, Aspen, CO, USA (E. Keski-Vakkuri, co-organizer)

Balkan Workshop 2003,
29 August - 2 September, Vrnjacka Banja, Serbia (invited talk by M. Chaichian, A. Tureanu)

9th Adriatic Meeting,
4-14 September, Dubrovnik, Croatia (A. Tureanu)

CERN Theory Division,
26 November - 2 December, Geneva, Switzerland (M. Chaichian)

Hagedorn Memorial Meeting,
28 November, CERN, Geneva, Switzerland (invited talk by M. Chaichian)

Mathematical Physics Seminar,
3 December, Helsinki, Finland (talk by E. Keski-Vakkuri)

ICIMAF, Cuban Academy of Sciences,
15 December 2003 - 5 January 2004, Havana, Cuba (talk by M. Chaichian)

Ultrarelativistic Heavy Ion Collisions

3rd Nordic Winter School on Particle Physics and Cosmology,
4-10 January, Gausdal, Norway (A. Gynther, A. Hietanen, T. Lappi, organizer K. Rummukainen, M. Vepsäläinen)

Marie Curie Research and Training Network Meeting,
25-28 January, Paris, France (K. Kajantie)

CERN,
2-14 March, Geneva, Switzerland (M. Vepsäläinen)

The Annual Meeting of the Finnish Physical Society,
20-22 March, Helsinki, Finland (talk by H. Honkanen, K. Kajantie, V. J. Kolhinen, H. Niemi, V. Ruuskanen, S. S. Räsänen)

Service de Physique Theorique, Saclay,
25-30 April, Paris, France (K. Kajantie)

BNL,
13-28 May, Upton, NY, USA (K. Rummukainen)

MIT,
18-25 May, Cambridge, MA, USA (talk by A. Vuorinen)

BNL,
26-29 May, Upton, NY, USA (talk by A. Vuorinen)

MIT,
29 May - 14 June, Cambridge, MA, USA (K. Rummukainen)

CERN,
5-15 June, Geneva, Switzerland (K. Kajantie)

Color Glass Condensate and Parton Percolation,
22-29 June, Trento, Italy (talk by T. Lappi)

Nordic course in string theories,
29 July - 7 August, Copenhagen, Denmark (S. S. Räsänen)

CERN,
1-27 August, Geneva, Switzerland (talk by K. Kajantie)

Cosmo -03,
25-29 August, Ambleside, UK (talk by A. Gynther)

Quantum fields in and out of equilibrium,
23-27 September, Bielefeld, Germany (A. Gynther, A. Hietanen, T. Lappi, H. Niemi, M. Sallé, M. Vepsäläinen)

RECFA Meeting,
26 September, Helsinki, Finland (talk by K. J. Eskola)

Service de Physique Theorique, Saclay,
26 October - 1 November, Paris, France (talk by T. Lappi)

Collective flow and QGP properties, a RIKEN-BNL Workshop,
17-19 November, BNL, Upton, NY, USA (invited talk by P. Huovinen)

Hagedorn Memorial Meeting,
26 November - 1 December, CERN, Geneva, Switzerland (invited talk by K. Kajantie)

MIT,
9-14 December, Cambridge, MA, USA (A. Vuorinen)

High Energy Physics Programme

Electron-Positron Physics

The Annual Meeting of the Finnish Physical Society,
20-23 March, Helsinki, Finland (A. Kiiskinen, K. Osterberg, talk by L. Salmi)

Xth Blois Workshop on Elastic and Diffractive Scattering,
23-27 June, Helsinki, Finland (A. Kiiskinen, talk by K. Osterberg)

QCD03,
2-9 July, Montpellier, France (talk by L. Salmi)

Meeting of the Outreach Subcommittee of the European Linear Collider Steering Committee,
18-20 July, Aachen, Germany (A. Kiiskinen)

11th Lomonosov Conference on Elementary Particle Physics,
21-27 August, Moscow, Russia (talk by A. Kiiskinen)

Small X and Diffraction 2003,
17-20 September, Fermilab, Batavia, IL, USA (invited talk by K. Osterberg)

Physics with Forward Proton Taggers at the Tevatron and LHC,
14-16 December, Manchester, UK (invited talk by K. Osterberg)

Workshop of EU Research and Training Network "Probe for New Physics",
18-20 December, Barcelona, Spain (A. Kiiskinen)

LHC Forward Physics

3rd Nordic Winter School on Particle Physics and Cosmology,
4-10 January, Gausdal, Norway (talk by T. Mäki)

TOTEM Collaboration Meeting,
17 January, CERN, Switzerland (invited talk by R. Orava)

SVXII Group Meeting/CDF Collaboration,
22 January, Batavia, IL, USA (invited talk by R. Orava)

Phenomenology Seminar,
5 March, Helsinki, Finland (talk by R. Orava)

The Annual Meeting of the Finnish Physical Society,
20-22 March, Helsinki, Finland (talk by T. Mäki, R. Orava)

CTEQ Summer School on QCD Analysis and Phenomenology,
22-30 May, Sant Feliu de Guixols, Spain (T. Mäki)

Open Workshop on Roman Pot Detector Technologies at LHC,
2 June, Geneva, Switzerland (invited talk by S. Tapprogge)

Xth Blois Workshop on Elastic and Diffractive Scattering,
23-27 June, Helsinki, Finland (T. Mäki, invited talk by S. Tapprogge)

CERN Workshop,
27 August, CERN, Switzerland (invited talk by R. Orava)

Orsay Workshop,
29 September, Orsay, France (invited talk by R. Orava)

Physics with Forward Proton Taggers at the Tevatron and LHC,
14-16 December, Manchester, UK (invited talks by R. Orava)

COMPASS

COMPASS Meeting,
2 October, Lisbon, Portugal (talk by J. Koivuniemi)

9th International Workshop on Polarized Solid Targets and Techniques,
28 October, Bad Honnef, Germany (talk by J. Koivuniemi)

Detector Laboratory

IEEE Nuclear Science Symposium 2003,
18-25 October, Portland, OR, USA (talk by K. Kurvinen)

Antares Final Seminar,
30 October, Helsinki, Finland (talk by K. Kurvinen)

CMS Programme

Software and Physics

Zoltan Institute of Physics,
23-25 January, Warsaw, Poland (J. Tuominiemi)

CMS SPROM Meeting,
3 February, CERN, Switzerland (talk by V. Karimäki)

CERN,
24-28 February, Geneva, Switzerland (T. Lindén)

CMS Week, CMS Pixel Meeting,
26 February, CERN, Switzerland (talk by V. Karimäki)

The Finnish Physical Society Particle Physics Division Meeting,
20 March, Helsinki, Finland (talk by T. Lindén)

The Annual Meeting of the Finnish Physical Society,
20-22 March, Helsinki, Finland (A. Heikkinen, V. Karimäki, invited talk by R. Kinnunen, T. Lampén, S. Lehti, T. Lindén, P. Salmi, L. Wendland)

Computing in High Energy Physics,
22-28 March, La Jolla, CA, USA (talk by A. Heikkinen, talk by V. Karimäki, T. Lampén, talk by V. Lefébure)

STUK,
11 April, Helsinki, Finland (talk by A. Heikkinen)

IV International Symposium on LHC Physics and Detectors,
1-3 May, Fermilab, Batavia, IL, USA (S. Lehti)

CPT Week,
5 May, CERN, Switzerland (talk by K. Lassila-Perini)

CERN,
5-9 May, Geneva, Switzerland (T. Lindén)

Physics at TeV Colliders Workshop,
27 May - 6 June, Les Houches, France (talk by S. Lehti)

CERN, CMS Experiment,
2 June - 1 July, Geneva, Switzerland (A. Heikkinen)

CERN, CMS Experiment,
1 July - 31 August, Geneva, Switzerland (talk by T. Lampén)

Physics at LHC Workshop,
6-12 July, Prague, Czech Republic (invited talk by R. Kinnunen)

Tracker Outer Barrel Meeting,
20 August, CERN, Switzerland (talk by T. Lampén)

Higgs Meeting,
21 August, CERN, Switzerland (talk by T. Järvi, talk by P. Mehtälä)

CERN School of Computing 2003,
24 August - 6 September, Krems an der Donau, Austria (J. Nysten, L. Wendland)

GEANT4 2003 Workshop,
2-6 September, Vancouver, BC, Canada (talk by A. Heikkinen)

Langinkosken lukio,
5 September, Kotka, Finland (invited talk by J. Tuominiemi)

CMS Week, Higgs Meeting,
16 September, CERN, Switzerland (talk by R. Kinnunen, talk by S. Lehti)

CMS Week, ECAL-egamma Meeting,
17 September, CERN, Switzerland (talk by J. Nysten)

CMS Week, Pixel Meeting,
17 September, CERN, Switzerland (talk by V. Karimäki)

International Conference on Supercomputing in Nuclear Applications,
22-24 September, Paris, France (A. Heikkinen)

4th Annual Workshop on Linux Clusters for Super Computing,
22-24 October, Linköping, Sweden (invited talk by T. Lindén)

Tracker Week General Meeting,
24 October, CERN, Switzerland (talk by T. Lampén)

CPT Week, PRS sessions,
4 November, CERN, Switzerland (talk by S. Lehti)

"What is Happening in High Energy Physics?" - Seminar Series,
5 November, Helsinki, Finland (talk by T. Lampén)

CPT Week, CMS physics Meeting,
6 November, CERN, Switzerland (talk by J. Nysten)

Heinäveden lukio,
12 November, Heinävesi, Finland (invited talk by R. Kinnunen)

"What is Happening in High Energy Physics?" - Seminar Series,
12 November, Helsinki, Finland (talk by A. Heikkinen)

6th NorduGrid Workshop,
27 November, Lund, Sweden (talk by T. Lindén)

8th Nordic LHC Workshop,
28-29 November, Lund, Sweden (invited talk by T. Lindén)

GEANT4 Workshop,
30-31 November, Helsinki, Finland (K. Gustafsson, talk by A. Heikkinen, talk by A. Hektor, talk by V. Karimäki, talk by T. Lampén, T. Lindén)

ACAT03, IX International Workshop on Advanced Computing and Analysis Techniques in Physics Research,
1-5 December, Tsukuba, Japan (invited talk by J. Nysten)

Physicists Network December Meeting,
8 December, Espoo, Finland (talk by T. Lindén)

CMS Week Production Meeting
9 December, CERN, Switzerland (talk by T. Lindén)

Particle Physics Day,
15 December, Helsinki, Finland (A. Heikkinen, V. Karimäki, talk by R. Kinnunen, T. Lampén, talk by T. Lindén, talk by M. Voutilainen)

Linux Cluster and Grid Seminar,
16 December, Tallinn, Estonia (invited talk by T. Lindén)

Kumpula Computing Contact- and Support Persons Meeting,
18 December, Helsinki, Finland (invited talk by 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,
20-22 March, Helsinki, Finland (talk by J. Härkönen, talk by D. Ungaro)

Semicon Europa 2003,
1-3 April, Munich, Germany (J. Härkönen)

2nd RD50 Workshop on Radiation hard semiconductor devices for very high luminosity colliders,
18-20 May, CERN, Geneva, Switzerland (J. Härkönen, talk by P. Luukka, E. Tuominen, talk by E. Tuovinen)

RD39 Collaboration Meeting,
21-22 May, CERN, Geneva, Switzerland (talk by J. Härkönen, P. Luukka, E. Tuominen, E. Tuovinen)

9th Pisa Meeting on Advanced Detectors,
25-31 May, Isola d'Elba, Italy (talk by J. Härkönen)

2003 IEEE Nuclear and Space Radiation Effects Conference,
21-25 July, Monterey, CA, USA (talk by E. Tuovinen)

20th Nordic Semiconductor Meeting,
25-27 August, Tampere, Finland (talk by J. Härkönen)

6th International Conference on Large Scale Applications and Radiation Hardness of Semiconductor Detectors,
29 September - 1 October, Florence, Italy (invited talk by P. Luukka, talk by P. Luukka)

3rd RD50 Workshop on Radiation hard semiconductor devices for very high luminosity colliders,
3-5 November, CERN, Geneva, Switzerland (J. Härkönen, P. Luukka, E. Tuominen, talk by E. Tuovinen)

RD39 Collaboration Meeting,
6-7 November, CERN, Geneva, Switzerland (talk by J. Härkönen, talk by P. Luukka, E. Tuominen, E. Tuovinen)

Irradiation campaigns at the University of Jyväskylä Accelerator Laboratory,
Jyväskylä, Finland (J. Härkönen, I. Kassamakov, P. Mehtälä, T. Mäenpää, J. Nysten, K. Lassila-Perini, P. Luukka, E. Tuominen, E. Tuovinen, D. Ungaro)

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

Working visit to University of Warsaw,
Warsaw, Poland (I. Kassamakov, H. Katajisto, T. Mäenpää, E. Tuominen, D. Ungaro)

Nuclear Matter Programme

ALICE

CERN,
11 March, Geneva, Switzerland (talks by W. H. Trzaska)

ALICE Forum,
12 March, CERN, Geneva, Switzerland (talk by W. H. Trzaska)

The Annual Meeting of the Finnish Physical Society,
20-22 March, Helsinki, Finland (talk by M. Bondila, I. Kassamakov, V. Lyapin, M. Oinonen, Z. Radivojevic, H. Seppänen, talk by W. H. Trzaska, J. Äystö)

LHCC 3rd Comprehensive Review,
26 March, CERN, Geneva, Switzerland (talk by W. H. Trzaska)

JYFL,
29 April, Jyväskylä, Finland (talk by W. H. Trzaska)

Universidad Autonoma de Madrid,
9 May, Madrid, Spain (talk by W. H. Trzaska)

Pyhäjärvi Summer School on Underground Physics,
12 June, Pyhäjärvi, Finland (talk by W. H. Trzaska)

Kirchhoff-Institut für Physik,
10 September, Heidelberg, Germany (talk by W. H. Trzaska)

Seminar on Fission,
16-19 September, Pont d'Oye, Belgium (talk by W. H. Trzaska)

RECFA Meeting,
26 September, Helsinki, Finland (talk by W. H. Trzaska)

JYFL,
3 October, Jyväskylä, Finland (talk by W. H. Trzaska)

Second Warsaw Meeting on Particle Correlations and Resonances,
15-18 October, Warsaw, Poland (invited talk by W. H. Trzaska)

ISOLDE

International Symposium on Proton-Emitting Nuclei, Procon-2003,
12-15 February, Padova, Italy (invited talk by A. Jokinen)

University of Jyväskylä,
21 February, Jyväskylä, Finland (talk by A. Jokinen)

The Annual Meeting of the Finnish Physical Society,
20 March, Helsinki, Finland (talk by A. Jokinen)

ISOLDE and Neutron-Time-of-Flight Committee,
19 May, CERN, Geneva, Switzerland (talk by A. Jokinen)

Gordon Research Conference, Nuclear Chemistry, Nuclear Structure,
15-20 June, New London, NH, USA (J. Äystö, invited discussion leader)

The Sixth International Conference on Radioactive Nuclear Beams, RNB6,
22-26 September, Argonne, IL, USA (A. Jokinen)

2nd International Workshop on the Future Accelerator Facility for Beams of Ions and Antiprotons,
14-17 October, GSI, Darmstadt, Germany (J. Äystö)

Technology Programme

University of Tampere,
10 February, Tampere, Finland (invited talk by M. Heikkurinen)

The First European Across Grids Conference,
13-14 February, Santiago de Compostela, Spain (M. Tuisku)

ICEIS 2003, the 5th International Conference on Enterprise Information Systems,
23-26 April, Angers, France (talk by V. Sivunen)

6th EU DataGrid Internal Project Conference,
12-15 May, Barcelona, Spain (J. Hahkala, talk by M. Silander)

CCGrid 2003, The 3rd IEEE/ACM International Symposium on Cluster Computing and the Grid,
12-16 May, Tokyo, Japan (M. Niinimäki)

IMKB 2003, The 13th European - Japanese Conference on Information Modelling and Knowledge Bases,
3-6 June, Kitakyushu, Japan (talks by M. Niinimäki)

9th Annual International LinuxTag 2003 Conference,
10-13 July, Karlsruhe, Germany (M. Gindonis)

ECDL, The 7th European Conference on Research and Advanced Technology for Digital Libraries,
17-22 August, Trondheim, Norway (V. Sivunen)

ISICT 2003, International Symposium on Information and Communication Technologies,
24-26 September, Dublin, Ireland (talks by M. Niinimäki, V. Sivunen)

7th EU DataGrid Internal Project Conference,
26 September - 1 October, Heidelberg, Germany (J. Hahkala)

Second International Symposium on Parallel and Distributed Computing 2003,
13 October, Ljubljana, Slovenia (talk by J. White)

4th Annual Workshop on Linux Clusters for Super Computing,
22-24 October, Linköping, Sweden (M. Gindonis)

Strategic Management Society - SMS 24th Annual Conference,
31 October - 3 November, Baltimore, MD, USA (E. Autio, A.-P. Hameri)

University of Victoria,
26 November, Victoria, BC, Canada (invited talk by J. White)

6th NorduGrid Workshop,
27-29 November, Lund, Sweden (talk by M. Tuisku)

TRIUMF,
3 December, Vancouver, BC, Canada (invited talk by J. White)

Administration and Support

EPP Outreach Meeting,
4-5 April, CERN, Geneva, Switzerland (R. Rinta-Filppula)

CERN Co-operation High School Network Seminar,
12 September, Jyväskylä, Finland (invited talk by R. Rinta-Filppula)

EMINENT 2003 Conference,
9-10 October, Geneva, Switzerland (R. Rinta-Filppula)

Publications

Theory Programme

Cosmology

K. Enqvist, A. Jokinen, S. Kasuya, and A. Mazumdar,
Minimal supersymmetric standard model flat direction as a curvaton,
Phys. Rev. D 68 (2003) 103507

K. Enqvist, S. Kasuya, and A. Mazumdar,
Adiabatic density perturbations and matter generation from the minimal supersymmetric standard model,
Phys. Rev. Lett. 90 (2003) 091302

K. Enqvist and M. Laine,
Q-ball dynamics from atomic Bose-Einstein condensates,
J. Cosmol. Astropart. Phys. 08 (2003) 003

K. Enqvist, A. Mazumdar,
Cosmological consequences of MSSM flat directions,
Phys. Rep. 380 (2003) 99

K. Enqvist, A. Mazumdar, M. Postma,
Challenges in generating density perturbations from a fluctuating inflaton coupling,
Phys. Rev. D 67 (2003) 121303(R)

S. F. Hassan, M. S. Sloth,
Trans-Planckian effects in inflationary cosmology and the modified uncertainty principle,
Nucl. Phys. B 674 (2003) 434

S. Kasuya, M. Kawasaki, F. Takahashi,
I-balls,
Phys. Lett. B 559 (2003) 99

S. Kasuya, M. Kawasaki and F. Takahashi,
Affleck-Dine mechanism with a negative thermal logarithmic potential,
Phys. Rev. D 68 (2003) 023501

E. Keski-Vakkuri and M. S. Sloth,
Holographic bounds on the UV cutoff scale in inflationary cosmology,
J. Cosmol. Astropart. Phys. 08 (2003) 001

M. S. Sloth,
Superhorizon curvaton amplitude in inflation and pre-big bang cosmology,
Nucl. Phys. B 656 (2003) 239

J. Väliviita and V. Muhonen,
Correlated adiabatic and isocurvature cosmic microwave background fluctuations in the wake of the results from the Wilkinson Microwave Anisotropy Probe,
Phys. Rev. Lett. 91 (2003) 131302

Laser Physics and Quantum Optics

O. Dannenberg, M. Mackie, and K.-A. Suominen,
Shortcut to a Fermi-degenerate gas of molecules via cooperative association,
Phys. Rev. Lett. 91 (2003) 210404

B. M. Garraway and K.-A. Suominen,
Robustness of coherent control with light induced potentials,
Fortschr. Phys. 51 (2003) 128

F. Intravaia, S. Maniscalco, J. Piilo, A. Messina,
Quantum theory of heating of a single trapped ion,
Phys. Lett. A 308 (2003) 6

A. Ishkhanyan and K.-A. Suominen,
New solutions of Heun's general equation,
J. Phys. A: Math. Gen. 36 (2003) L81

A. Ishkhanyan and K.-A. Suominen,
Three-level models solvable in terms of the Clausen function,
J. Phys. A: Math. Gen. 36 (2003) 7331

E. Lundh, J.-P. Martikainen, and K.-A. Suominen,
Vortex nucleation in Bose-Einstein condensates in time-dependent traps,
Phys. Rev. A 67 (2003) 063604

M. Mackie, A. Collin, K.-A. Suominen and J. Javanainen,
Density-optimized efficiency for magneto-optical production of a stable molecular Bose-Einstein condensate,
New J. Phys. 5 (2003) 110.1

H. Mäkelä, Y. Zhang and K.-A. Suominen,
Topological defects in spinor condensates,
J. Phys. A: Math. Gen. 36 (2003) 8555

J. Piilo,
Collision rates in near-resonant optical lattices,
J. Opt. Soc. Am. B 20 (2003) 1135

Particle Physics Phenomenology

D. G. Cerdeño, E. Gabrielli, M. E. Gomez, C. Muñoz,
Neutralino-nucleon cross section and charge and colour breaking constraints,
J. High Energy Phys. 06 (2003) 030

D. Chakraverty, E. Gabrielli, K. Huitu, and S. Khalil,
Chargino contributions to the CP Asymmetry in $B \to \phi K_S$ decay,
Phys. Rev. D 68 (2003) 095004

D. Chakraverty, K. Huitu, A. Kundu,
Effects of universal extra dimensions on B^0—$\bar{B}^0$ mixing,
Phys. Lett. B 558 (2003) 173

D. Choudhury, A. Datta, K. Huitu,
ZZH coupling : a probe to the origin of EWSB?,
Nucl. Phys. B 673 (2003) 385

D. Choudhury, A. Datta, K. Huitu, P. Konar, S. Moretti, and B. Mukhopadhyaya,
Slepton production from gauge boson fusion,
Phys. Rev. D 68 (2003) 075007

A. Datta, E. Gabrielli, B. Mele,
Large extra dimension effects in Higgs boson production at linear colliders and Higgs factories,
J. High Energy Phys. 10 (2003) 003

A. Datta, E. Gabrielli, B. Mele,
Virtual graviton exchanges at the Z pole in large extra dimensions,
Phys. Lett. B 552 (2003) 237

A. Datta and K. Huitu,
Characteristic slepton signal in anomaly mediated supersymmetry breaking models via gauge boson fusion at the CERN Large Hadron Collider,
Phys. Rev. D 67 (2003) 115006

E. Gabrielli, S. Khalil,
Constraining supersymmetric models from B_d—$\bar{B}_d$ mixing and the $B_d \to J/\psi K_S$ asymmetry,
Phys. Rev. D 67 (2003) 015008

P. Hoyer,
Filling perturbative ground states,
Acta Phys. Polon. B 34 (2003) 3121

K. Huitu,
Phenomenology of radions,
Pramana 60 (2003) 209

K. Huitu, J. Laamanen, P. N. Pandita,
Upper bounds on the mass of the lightest neutralino,
Phys. Rev. D 67 (2003) 115009

P. Keränen, J. Maalampi, M. Myyryläinen, J. Riittinen,
Effects of sterile neutrinos on the ultrahigh-energy cosmic neutrino flux,
Phys. Lett. B 574 (2003) 162

Hadron Physics Activity

F. Coester, D. O. Riska,
Scaling of hadronic form factors in point form kinematics,
Nucl. Phys. A 728 (2003) 439

A. M. Green, J. Koponen, P. Pennanen, C. Michael,
The charge and matter radial distributions of heavy-light mesons calculated on a lattice with dynamical fermions,
Eur. Phys. J. C 28 (2003) 79

A. M. Green, S. Wycech,
η—π mixing close to the η—helium threshold,
Phys. Rev. C 68 (2003) 061601(R)

D. O. Riska,
Nuclear exchange currents,
Nucl. Phys. News 13 (2003) 11

Fl. Stancu, D. O. Riska,
Stable uuddb̄ pentaquarks in the constituent quark model,
Phys. Lett. B 575 (2003) 242

Physics of Biological Systems

E. Falck, O. Punkkinen, I. Vattulainen, and T. Ala-Nissila,
Dynamics and scaling of two-dimensional polymers in a dilute solution,
Phys. Rev. E 68 (2003) 050102(R)

A. A. Gurtovenko, D. A. Markelov, Yu. Ya. Gotlib, A. Blumen,
Dynamics of dendrimer-based polymer networks,
J. Chem. Phys. 119 (2003) 7579

M. T. Hyvönen and P. T. Kovanen,
Molecular dynamics simulation of sphingomyelin bilayer,
J. Phys. Chem. B 107 (2003) 9102

M. Mašín, I. Vattulainen, T. Ala-Nissila, Z. Chvoj,
Non-equilibrium effects in profile spreading on stepped surfaces,
Surf. Sci. 529 (2003) L256

M. Mašín, I. Vattulainen, T. Ala-Nissila, and Z. Chvoj,
Diffusion and mobility of interacting particles on stepped surfaces,
Surf. Sci. 544 (2003) L703

P. Nikunen, M. Karttunen, I. Vattulainen,
How would you integrate the equations of motion in dissipative particle dynamics simulations?,
Comput. Phys. Commun. 153 (2003) 407

M. Patra, M. Karttunen, M. T. Hyvönen, E. Falck, P. Lindqvist, and I. Vattulainen,
Molecular dynamics simulations of lipid bilayers: major artifacts due to truncating electrostatic interactions,
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String Theory and Quantum Field Theory

V. Balasubramanian, S. F. Hassan, E. Keski-Vakkuri, A. Naqvi,
Space-time orbifold: a toy model for a cosmological singularity,
Phys. Rev. D 67 (2003) 026003

A. F. Caldeira, S. Kawai, J. F. Wheater,
Free boson formulation of boundary states in W_3 minimal models and the critical Potts model,
J. High Energy Phys. 08 (2003) 041

M. Chaichian, M. N. Mnatsakanova, A. Tureanu, Yu. S. Vernov,
Analyticity and forward dispersion relations in noncommutative quantum field theory,
Nucl. Phys. B 673 (2003) 476

M. Chaichian, C. Montonen, A. Tureanu,
Tree unitarity and partial wave expansion in noncommutative quantum field theory,
Phys. Lett. B 566 (2003) 263

M. Chaichian, K. Nishijima, A. Tureanu,
Spin-statistics and CPT theorems in noncommutative field theory,
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M. Chaichian, D. Polyakov, A. Tureanu,
Non-commutativity and Ramond-Ramond fields,
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M. Chaichian, P. Prešnajder, M. M. Sheikh-Jabbari, A. Tureanu,
Non-commutative standard model: model building,
Eur. Phys. J. C 29 (2003) 413

S. Kawai,
Logarithmic conformal field theory with boundary,
Int. J. Mod. Phys. A 18 (2003) 4655

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Free-field realization of boundary states and boundary correlation functions of minimal models,
J. Phys. A: Math. Gen. 36 (2003) 6875

E. Keski-Vakkuri and M. Sloth,
Holographic bounds on the UV cutoff scale in inflationary cosmology,
J. Cosmol. Astropart. Phys. 08 (2003) 001

I. I. Kogan and D. Polyakov,
DBI action from closed strings and D-brane second quantization,
Int. J. Mod. Phys. A 18 (2003) 1827

I. I. Kogan and D. Polyakov,
Feigenbaum universality in string theory,
JETP Lett. 77 (2003) 260

Ultrarelativistic Heavy Ion Collisions

K. J. Eskola, H. Honkanen,
A perturbative QCD analysis of charged-particle distributions in hadronic and nuclear collisions,
Nucl. Phys. A 713 (2003) 167

K. J. Eskola, H. Honkanen, V. J. Kolhinen, J. w. Qiu, C. A. Salgado,
Nonlinear corrections to the DGLAP equations in view of the HERA data,
Nucl. Phys. B 660 (2003) 211

K. J. Eskola, H. Niemi, P. V. Ruuskanen, S. S. Räsänen,
Dependence of hadron spectra on decoupling temperature and resonance contributions,
Phys. Lett. B 566 (2003) 187

K. Kajantie, M. Laine, K. Rummukainen, Y. Schröder,
Four-loop vacuum energy density of the SU(N_c) + adjoint Higgs theory,
J. High Energy Phys. 04 (2003) 036

T. Lappi,
Production of gluons in the classical field model for heavy ion collisions,
Phys. Rev. C 67 (2003) 054903

M. Sallé and J. Smit,
Hartree ensemble approximation revisited: the "symmetric phase",
Phys. Rev. D 67 (2003) 116006

High Energy Physics Programme

Electron-Positron Physics

(A. Kiiskinen, R. Orava, K. Osterberg, L. Salmi in J. Abdallah et al.)

J. Abdallah et al.,
Search for an LSP gluino at LEP with the DELPHI detector,
Eur. Phys. J. C 26 (2003) 505

J. Abdallah et al.,
Search for supersymmetric particles in light gravitino scenarios and sleptons NLSP,
Eur. Phys. J. C 27 (2003) 153

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Search for resonant $\tilde{\nu}$ production at $\sqrt{s}$ = 183 to 208 GeV,
Eur. Phys. J. C 28 (2003) 15

J. Abdallah et al.,
Search for B^0_s— $\bar{B}^0_s$ oscillations and a measurement of B^0_d— $\bar{B}^0_d$ oscillations using events with an inclusively reconstructed vertex,
Eur. Phys. J. C 28 (2003) 155

J. Abdallah et al.,
A study of the energy evolution of event shape distributions and their means with the DELPHI detector at LEP,
Eur. Phys. J. C 29 (2003) 285

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ZZ production in e^+e^- interactions at $\sqrt{s}$ = 183 - 209 GeV,
Eur. Phys. J. C 30 (2003) 447

J. Abdallah et al.,
Measurement of the $e^+e^- \to W^+W^-\gamma$ cross-section and limits on anomalous quartic gauge couplings with DELPHI,
Eur. Phys. J. C 31 (2003) 139

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The $\eta_c(2980)$ formation in two-photon collisions at LEP energies,
Eur. Phys. J. C 31 (2003) 481

J. Abdallah et al.,
Search for doubly charged Higgs bosons at LEP2,
Phys. Lett. B 552 (2003) 127

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Inclusive b decays to wrong sign charmed mesons,
Phys. Lett. B 561 (2003) 26

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Study of inclusive J/ψ production in two-photon collisions at LEP II with the DELPHI detector,
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Measurement of inclusive $f_1(1285)$ and $f_1(1420)$ production in Z decays with the DELPHI detector,
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Search for the Standard Model Higgs boson at LEP,
Phys. Lett. B 565 (2003) 61

L. Salmi with M. Battaglia et al.,
Heavy quark parameters and $|V_{cb}|$ from spectral moments in semileptonic B decays,
Phys. Lett. B 556 (2003) 41

LHC Forward Physics

R. Lauhakangas, R. Orava, H. Saarikko, S. Tapprogge and K. Österberg with D. Acosta et al.,
Measurement of the mass difference $m(D_s^+)$—$m(D^+)$ at CDF II,
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R. Lauhakangas, R. Orava, H. Saarikko, S. Tapprogge and K. Österberg with D. Acosta et al.,
Search for the flavor-changing neutral current decay $D^0 \to \mu^+\mu^-$ in $p\bar{p}$ collisions at $\sqrt{s}$ = 1.96 TeV,
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Measurement of prompt charm meson production cross sections in $p\bar{p}$ collisions at $\sqrt{s}$ = 1.96 TeV,
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COMPASS

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First results of the large COMPASS ^{6}Li polarized target,
Nucl. Instr. Meth. A 498 (2003) 101

K. Gustafsson with J. Gao et al.,
A liquid hydrogen target for the precision measurement of the weak mixing angle in Møller scattering at SLAC,
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Detector Laboratory

H. Andersson, T. Andersson, J. Heino, J. Huovelin, K. Kurvinen, R. Lauhakangas, S. Nenonen, J. Ojala, R. Orava, J. Shultz, H. Sipilä, O. Vilhu,
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CMS Programme

Software and Physics

A. Heikkinen and T. Lampén with S. Agostinelli et al.,
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R. Arsenescu, C. Baglin, H. P. Beck, K. Borer, A. Bussière, K. Elsener, Ph. Gorodetzky, J. P. Guillaud, S. Kabana, R. Klingenberg, G. Lehmann, T. Lindén, K. D. Lohmann, R. Mommsen, U. Moser, K. Pretzl, J. Schacher, R. Spiwoks, J. Tuominiemi and M. Weber,
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Nucl. Phys. B Proc. Suppl. 125 (2003) 169

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Nucl. Instr. Meth. B 204 (2003) 86

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Suomi ja Cern,
Arkhimedes 5 (2003) 15

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