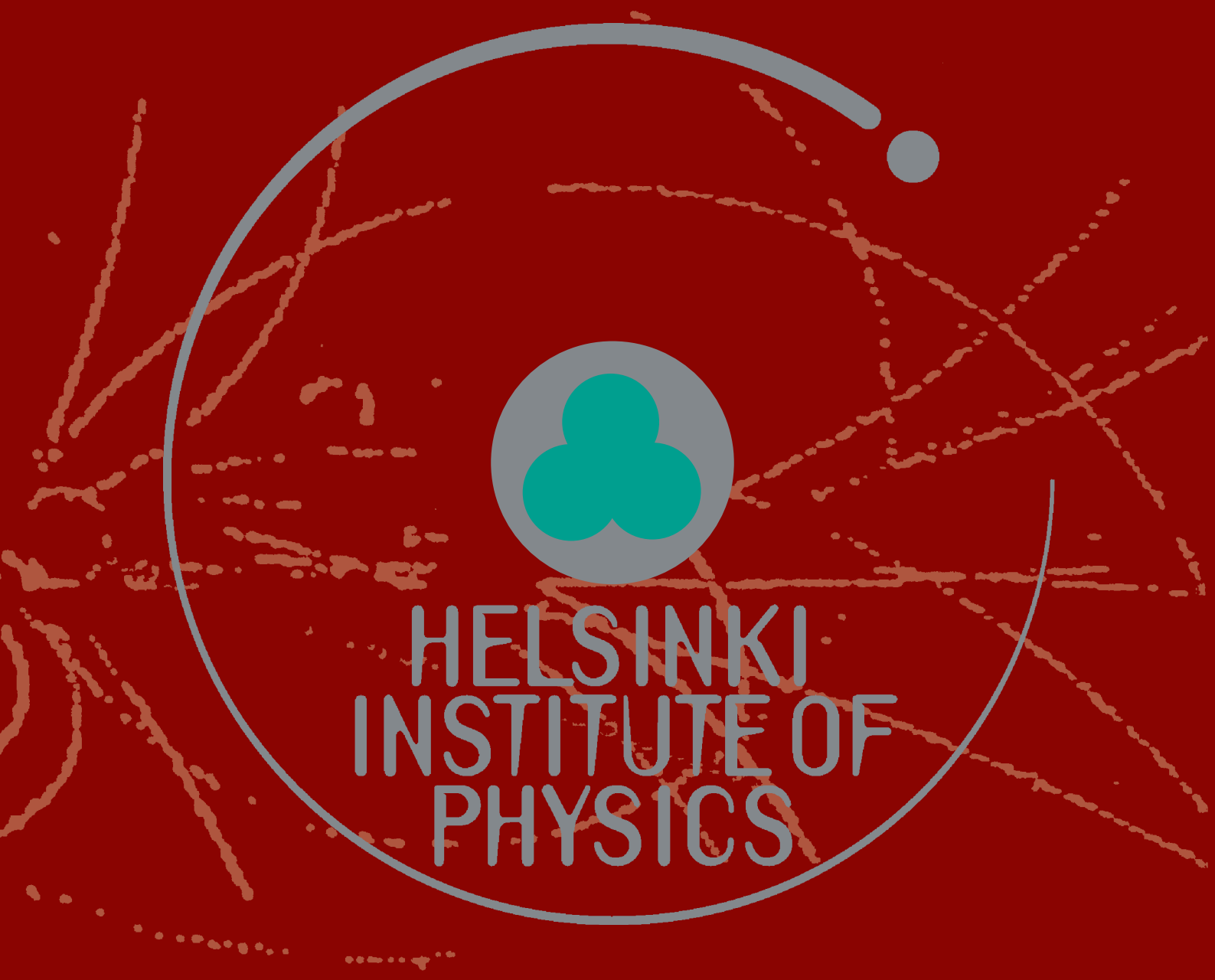
# Annual Report 2002



# HELSINKI INSTITUTE OF PHYSICS


# Annual Report 2002

Life-size prototype of the $TO_R$ array.
The TO detector is the main timing and (fast) trigger detector for ALICE.

Annual Report 2002 Helsinki Institute of Physics

# Contents

# Introduction

Dan-Olof Riska

The Helsinki Institute of Physics (HIP) is a national Finnish institute for physics research and physics related technology development, which since the beginning of the year 2002 has been operated jointly by the Universities of Helsinki and Jyväskylä and the Helsinki University of Technology. The main component of the mandate of HIP is responsibility for Finnish research at CERN.

The operating principle 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 its research projects. An example of this collaboration is the fact that 8 project leaders and researchers in the research projects of the Institute have in the past 5 years been appointed to professorial positions at several different universities.



The research activities at HIP fall 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 the earlier highly successful project on statistical physics and materials science was brought to completion. The projects on cosmology and particle physics phenomenology continue and will be reviewed during the year 2003 for possible continuation for a further 3-year period.

During the year, the High Energy Physics Programme 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 2002 both in target operation and off-line physics analysis. The analysis of the data accumulated by the completed DELPHI experiment at the previous LEP collider at CERN continued. Finally the High Energy Physics Programme continued to operate the Detector Laboratory of HIP on behalf of all the experimental programmes of HIP.

At the beginning of 2002 the former LHC Programme of the Institute was separated into two programmes. The first of these, the CMS Programme, is formed of two projects: one for the development of the tracker of the CMS detector at the LHC and the other for software development for the CMS data analysis.

The second of the two separate programmes, the Nuclear Matter Programme, 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.

During the year the Institute joined the LHC Computing Grid project at CERN for the establishment of the distributed computing capacity that will be required for 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 2002 the focus of the Technology Programme was on software development for distributed data-intensive grid computation. The Technology Programme hosted sabbatical visits by professor Francois Grey of the Danish Microelectronics Center and professor Erkko Autio of the Helsinki University of Technology.

The Institute has continued its active promotion of graduate student training in frontline research. This activity is supported both by the research projects themselves, and 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 2002 6 PhD and DSc degrees and 9 MA and MSc degrees were awarded on the basis of research conducted within the research projects of the Institute.



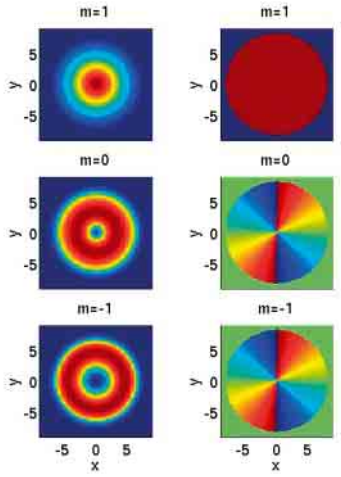
The summer student programme at CERN continues to be a highly significant component of the educational efforts of the Institute. The Institute continued its support of the "Open Learning Environment" project of the Tampere University of Technology, which has mainly been funded by the National Technology Agency, TEKES. During the year the Institute hosted 10 visits by groups of students in Finnish high schools to CERN.

During the year 2002 the Academy of Finland (the Finnish state agency for research funding) appointed a working group to draft a national strategy for the Finnish collaboration with CERN. This strategy spells out the goals of the research that HIP conducts at CERN, and defines the role of the CERNTECH project of the National Technology Agency TEKES for collaboration between Finnish industry and CERN. The CERNTECH project, which has been extraordinarily successful during the past few years, is carried out in close collaboration with HIP.

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. 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.

HELSINKI INSTITUTE OF PHYSICS

# Highlights of Research Results



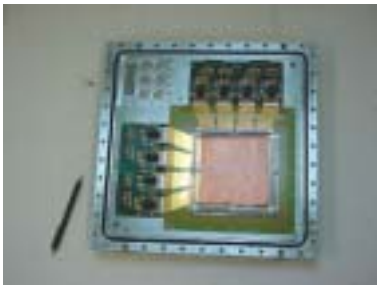



## Theory Programme

In Cosmology inflation was studied within the curvaton scenario and a treatment of the transplanckian effects was proposed. A major review article on the cosmological consequences of the flat directions in supersymmetric theories was produced. Active participation in the Planck Surveyor Mission preparatory work continued. In Laser Physics and Quantum Optics the research has shown that a coreless vortex is the ground state of a trapped rotating three-component Bose-Einstein condensate. We have also proposed that Feshbach-enhanced Raman photoproduction can be used to turn an atomic Bose-Einstein condensate into a stable molecular condensate. In the Particle Physics Phenomenology group, ways to separate between supersymmetry (SUSY) breaking scenarios have been investigated. A characteristic and clean signal for anomaly mediated SUSY breaking has been discovered. In higher dimensional models it has been found that while the virtual photon effect on fermion pair production in electron positron colliders vanishes, both angular and polarization asymmetries are modified. In Hadron Physics, nucleon-nucleon interaction models, pion scattering and many-quark systems have been studied. The spectrum of systems formed of 4 constituent quarks and one antiquark was calculated with a flavour-spin dependent hyperfine interaction, which organizes the spectrum of 3-quark systems in agreement with the empirical baryon spectrum. The Biological Physics and Soft Matter group focused on atomic-level studies of membrane systems. It has made progress at a rapid pace, and co-organized a summer school "Soft-Simu2002 - Novel Methods in Soft Matter Simulations". In String Theory and Quantum Field Theory, one of the first real calculational tests of the validity of perturbative string theory has been performed for mild big bang/big crunch type backgrounds as a result of a collaboration study between HIP string theorists and the University of Pennsylvania. We showed that perturbative string theory can avoid potential problems such as states with negative norm. The Heavy Ion project has sucessfully described the spectra of hadrons formed in collisions of two ultrarelativistic gold nuclei at the Relativistic Heavy Ion Collider (RHIC) within the framework of a semiphenomenological model based on perturbative QCD + saturation + hydrodynamics. On the theory side, the pressure of hot QCD has been computed up to the last perturbatively calculable term in the expansion in the strong coupling constant.

## High Energy Physics Programme

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



In electron-positron physics, the analysis of LEP data by the Helsinki group has probed still unexplored domains of masses in data obtained at record breaking centre-of-mass energies in excess of 209 GeV. 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. The DELPHI measurement will provide information on the description of the kinematics inside the B hadron and therefore reduce the modelling errors related to the extraction of the $|V_{cb}|$ quark mixing matrix element from the measurement of the semileptonic B branching fraction at LEP, and thus constraining the b-quark sector CP-violation. The group is also involved in physics feasibility studies both for a "medium" energy (0.5-0.8 TeV) linear collider (e.g. TESLA at DESY) and a "high" energy (2-5 TeV) linear collider (e.g. CLIC at CERN), focusing on fully reconstructing final states with a large number of jets (six or more) being crucial at future $e^+e^-$ machines.

In January 2002, the Helsinki group joined the CDF collaboration at Fermilab and has made its first contributions to the trigger and slow control systems of the Run II phase of the experiment. A series of microstation prototype structures, aimed for an extension to the CMS/TOTEM experiment at the LHC, has been constructed for testing the mechanical structure and vacuum compatibility.



The COMPASS experiment at CERN made significant progress during the year 2002, e.g. about 260 TBytes of physics data was taken achieving high average target spin polarizations of +54% and -46% in both longitudinal and transverse modes.

The GEM detector was further developed, as a part of the Detector Laboratory activities. A two foil GEM detector was obtained for the first time by inserting a second GEM foil in the same chamber space. Preliminary results have shown that in this new assembly a gas gain of ten thousand is easily achieved.

## CMS Programme

As a part of the preparation for the CMS experiment at the CERN LHC the HIP CMS Programme organized two major international workshops in May-June 2002: the "3rd NorduGrid Workshop" and the "Workshop on B/Tau Physics at the LHC". The NorduGrid workshop was attended by some 40 participants from Nordic countries and from the USA. The programme consisted of an internal meeting of NorduGrid developers as well as several interesting talks on the Grid software tools for the analysis of the LHC experiments. In the "Workshop on B/Tau Physics at LHC" there were some 30 participants of 12 different nationalities, most of them from the CMS and ATLAS experiments. The programme consisted of various aspects of physics with B-hadron and tau-lepton signals from detector design to calibration methods and from physics simulation results to phenomenology and theory. The list of speakers in both workshops was impressive, which shows the recognition the HIP CMS Programme is enjoying in the LHC physics community. Another example of this recognition is the invitation of a member of the Software and Physics project (R. Kinnunen) to give a plenary talk in one of the main HEP conferences, namely at the 10th International Conference on Supersymmetry and Unification of Fundamental Interactions in Hamburg.

In 2002 the CMS Programme was organized into two projects; 1) the CMS Software and Physics project and 2) the CMS Tracker project.

A major milestone in the Software and Physics project was the introduction of the Object oriented Reconstruction programme for CMS Analysis (ORCA) in physics simulation studies. This software contains a realistic, full simulation of the CMS detector design. It is very important that the earlier results obtained by the Helsinki team with fast simulation e.g. on the tau-tau decay channels of the Higgs bosons were confirmed with ORCA.

As a part of the first step of CMS towards full data analysis, the Software and Physics team participated in the production of about 20 TB of simulated data for the preparation of the Data Acquisition Technical Design Report (DAQ TDR) during the first four months of 2002. It included simulation of primary proton-proton interactions, secondary interactions in the detector, the response of the sensitive elements, pile-up of events, and the first-pass analysis. This worldwide data production effort involved more than 30 persons and 20 sites. The DAQ TDR was completed in autumn 2002.



An important milestone in the preparation of the local computing resources for the CMS analysis in Kumpula was the design and installation of a 1.4 TB disk server, which will serve as a data storage for Grid and CMS production activities in Helsinki. This is planned to be part of a Linux PC cluster with a few tens of nodes to be installed at the Kumpula Computing Unit (KuKa). The design of this cluster has been completed. Another element in the preparation for the CMS analysis were the initial tests of the CMS software on the public Kumpula Mosix night cluster.

In the Tracker project a major research result was the demonstration of the suitability of Czochralski Silicon as particle detector material. The Cz-Si detectors were processed at the Microelectronics Centre of the University of Technology, where the CMS Programme has member status, from novel silicon material made available to us by Okmetic Oyj. In summer 2002 the detectors were tested in the H2 test beam at CERN, using the HIP beam telescope. The tests proved that Cz-Si detectors perform in a comparable way to the existing silicon detectors. This is the first time full size Czochralski detectors have ever been processed and tested. The main interest in this research is to determine the extent to which Czochralski silicon is more radiation resistant than the materials used at present for manufacturing silicon detectors for particle physics experiments. The processed Cz-Si detectors and test structures were irradiated with proton and neutron beams at the Accelerator Laboratory of the University of Jyväskylä. According to the preliminary results, the radiation hardness of the Cz-Si is outstanding. Our results have already attracted wide international interest.

A major milestone in the construction responsibilities of HIP in CMS was the commencement of the manufacture of rods, which form one of the critical parts of the CMS Tracker Outer Barrel support structure. The production of the special carbon fibre profiles needed is ongoing at Exel Oyj and the assembly of the rods has been started at the HIP/FLT Kumpula laboratories.

## Nuclear Matter Programme

The Nuclear Matter Programme focuses on two aspects of nuclear and hadronic matter. These are cold exotic matter with extreme composition of its proton and neutron numbers studied at ISOLDE and 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 the exotic structures of nuclei with special emphases on weak interaction phenomena and nuclear astrophysics. In these efforts continuous development of novel instrumentation is of prime importance. In 2002, R&D efforts have included the construction of a Si-Ball, a multidetector array for charged particle spectroscopy, the design of an ion beam cooler and buncher for the ISOLDE main beam line as well as a series of studies on new radioactive beams at the ISOLDE PS Booster Facility. As far as the physics issues are concerned, the main studies in 2002 concentrated on the study of the symmetry between the weak and strong interaction as population mechanisms of $1^+$ Gamow-Teller states in the A=58 system. In nuclear astrophysics, a series of experiments were carried out to determine the binding energies of key nuclei in the rapid rp-process. These experiments have included the determination of the mass of $^{72}$Kr and the search for the proton unbound $^{69}$Br isotope via the beta-decay of $^{69}$Kr.

The aim of the ALICE project is to study the phase transitions of hadronic matter and possible signatures for a new form of matter, the quark-gluon plasma. An important milestone was reached when the Kumpula Detector Laboratory was equipped during the spring and as early as the summer of 2002 the first HAL25 front-end chips were bonded using the single-point Tape-Automated Bonding (TAB) technique. Bonded chips were then sent to Strasbourg where in October the first complete SSD (Silicon Strip Detector) module was assembled. A realistic date for the start of the mass production can now be set as the spring of 2003. A third of the 2000 SDD modules that will have to be assembled and fully tested by October 2005, are scheduled to be produced in Helsinki. Another responsibility has been the construction of the T0 detector - the main timing and (fast) trigger detector for ALICE. Perhaps the most visible achievement during 2002 was the construction of a full-scale model of $T0_R$ properly equipped with PMT tubes, HV bases, quartz radiators, cables and optical fibres for laser calibrations. The model will also serve as the ideal detector support for in-beam tests at CERN, which are scheduled for 2003. The first tests with laser and pulse generators indicate that for each prototype we were able to reach less than 50 ps time walk over nearly 3 orders of magnitude of input amplitude. The third field of activity of our team is software. Over the past year we have worked in two directions: software design and maintenance, and the development of algorithms and benchmark studies of detector performance for the Inner Tracking System (ITS) of ALICE.



## Technology Programme

Within the European DataGrid project our researchers have established themselves as critical contributors to the Grid security technologies. Authentication, access control and security in general play key roles in making Grid technologies industrially useful. Along these lines the Programme has managed to pull together one of the first industrial consortia to exploit and study the Grid technologies as part of the product offering. This domestic industrial consortium is mainly composed of companies and institutes developing and producing services and products for the wireless market. Collaboration with other Scandinavian companies has been gaining momentum and technologies are shared and tested on common bases in the Nordic region. The student programme has been extensive; the Programme has involved supervising numerous summer students not only at CERN, but also sharing them with other Scandinavian research institutes. On the physics side, the cluster in Finland has been used to run various simulation systems and a collaboration with the LHC Grid has been launched.

# Theory Programme

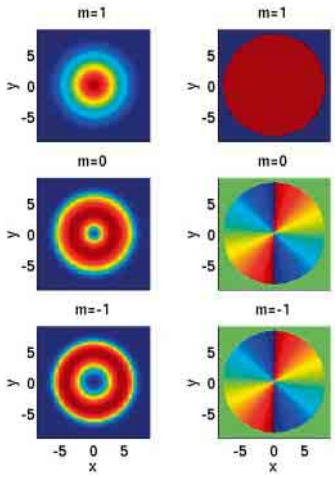
Kari Enqvist

The Theory Programme provides a platform for the project leaders to conduct high-profile research in a few selected subject fields. The projects are fixed term with a default duration of 3+3 years. They are chosen on the basis of their scientific merit and complement the research in experimental physics at the Institute, as well as at the physics departments of the Member Universities. The project leaders are expected to be able to secure considerable external funding for their projects; in this regard 2002 was a quite successful year. In 2002 there were six projects: Cosmology; Laser Physics and Quantum Optics; Particle Physics Phenomenology; Physics of Biological Systems (new project); String Theory and Quantum Field Theory (new project); and Ultrarelativistic Heavy Ion Collisions (new project). A long-running project in Statistical Physics and Materials Science ended in 2002. In addition to the projects, there is also research activity in hadron physics.



## Cosmology

In a trapped three-component ferromagnetic spinor atomic Bose-Einstein condensate a coreless vortex structure is created when the condensate is rotated at a low frequency. On the left are the densities and on the right the phase structures of different components. The uppermost component has no vortex, the middle one has a simple vortex and the lowest one a vortex with double winding.




The Cosmology project continued to participate in the Finnish Planck Surveyor Consortium, funded mainly by the Academy of Finland Antares space programme. We participate in the CTP working group, the purpose of which is to establish ways to estimate the temperature and polarization spectra of the CMB. The activity has centred on concrete issues in map making, in particular destriping (Elina Keihänen, Hannu Kurki-Suonio, and Torsti Poutanen). In Planck, instrument noise appears as stripes in the CMB maps. The basic idea in destriping is to model the noise stream by a linear combination of simple arithmetic functions. The amplitudes of these component functions are determined with the help of those points on the sky which are monitored several times during the mission. In its simplest form destriping involves fitting uniform baselines. During the year 2002 we have developed an improved destriping algorithm, which is more efficient in removing instrument noise from the CMB maps, as compared to the original method.

The fragmentation of the Affleck-Dine condensate and the subsequent formation of Q-balls were studied numerically. We also produced a first major review on the topic, which will appear in Physics Reports.

We studied the decay of the inflaton field and pointed out that in certain models it may form long-lived solitons. We also proposed a new model in which the inflaton is coupled to ordinary matter only gravitationally and decays into a completely hidden sector. In this scenario both baryonic and dark matter originate from the decay of a flat direction of the Minimal Supersymmetric Standard Model (MSSM), which is shown to generate the desired adiabatic perturbation spectrum via the curvaton mechanism. The curvaton was also studied in pre-Big Bang models.

In string theories the space-momentum uncertainty relation may be modified. The consequences were studied in a free scalar field theory that describes density perturbations in flat Robertson-Walker space-time. We found a non-linear time-dependent dispersion relation that encodes the effects of Planck scale physics during the inflationary epoch.

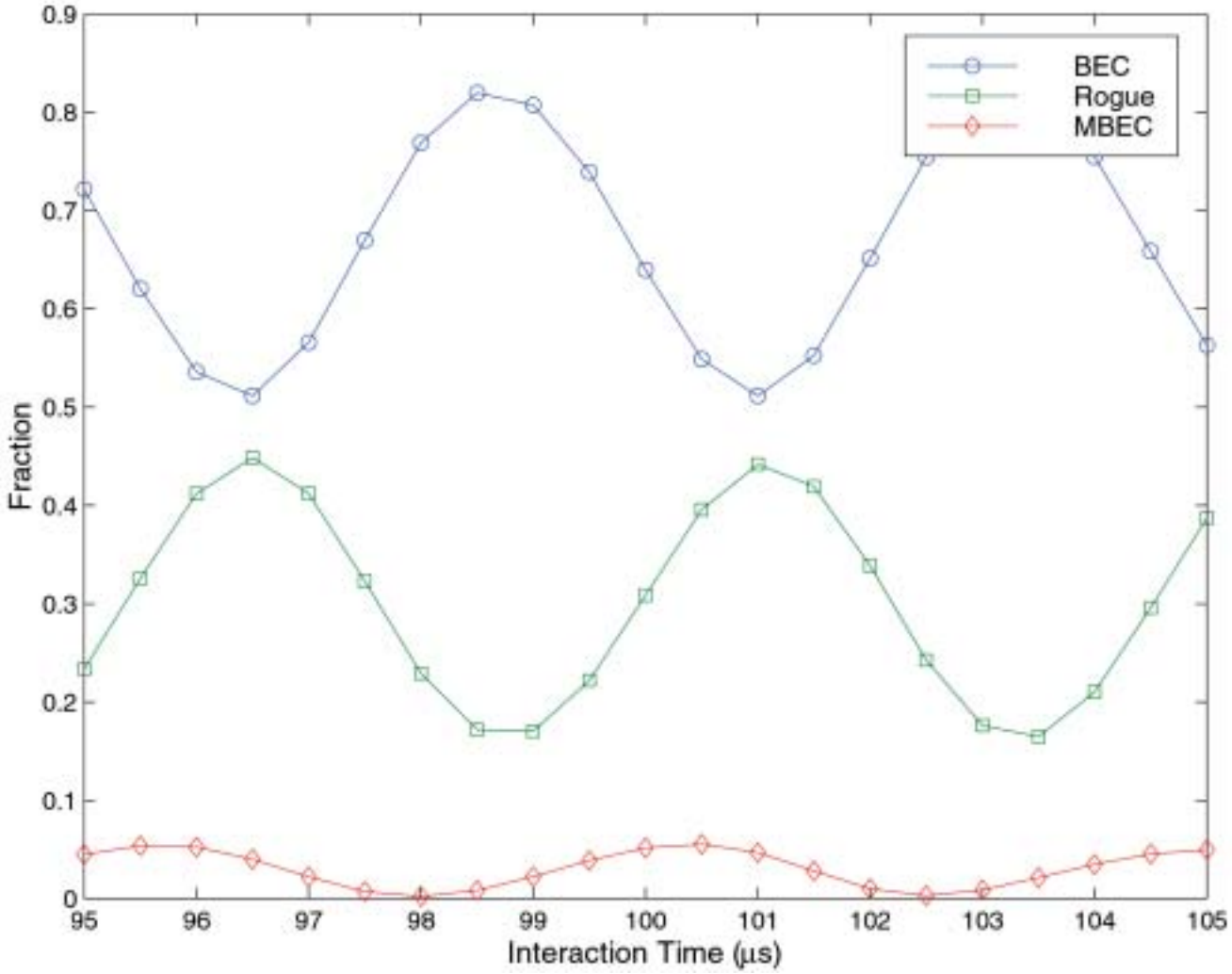
Within the project there were 3 Masters' degrees and 2 PhD's (Antti Sorri and Syksy Räsänen, the latter jointly with the HIP String Theory project). The activity of the Cosmology project is also funded by sources external to HIP, which are administered by the University of Helsinki Department of Physical Sciences.

## Laser Physics and Quantum Optics

The main topic for the theoretical work done in the Laser Physics and Quantum Optics project has been the dynamics and interactions between cold atoms, especially when the dilute-gas atoms undergo laser cooling and trapping, or form a Bose-Einstein condensate.

Since atoms have spin, one can use the position dependence and the multicomponent form of the condensate wave function to prepare topological objects. We have shown that for a suitably fast rotating three-component condensate the ground state corresponds to a coreless vortex. Also, our numerical studies show that for single-component condensates the zero temperature time-dependent theory predicts for rotating condensates the nucleation of vortices (as also seen in experiments), whereas previously it has been assumed that one needs non-zero temperature effects. We have been able to develop a semiclassical model that qualitatively accounts for the numerical results.

Another important aspect with the atomic Bose-Einstein condensates is that atoms can be combined coherently into molecules via photo-association. The analogous process of magneto-association, which involves a Zeeman-shifted molecular level on Feshbach resonance with a colliding atom pair, has an identical formalism. If the initial atoms belong to a Bose-Einstein condensate (BEC), then the molecules will too (MBEC). We have thus proposed Feshbach-enhanced Raman photoproduction as a means to deliver stable MBEC with near-unit efficiency despite the dephasing effects of particle collisions. As it happens, near-unit efficient STIRAP is also possible without Feshbach-enhancement. Meanwhile, rogue dissociation, i.e., molecular dissociation to non-condensate atom pairs, is predicted to impose a rate limit for atom-molecule conversion in a BEC, and allow for coherent oscillations between BEC and rogue pairs. This work led to an explana-




Model of Ramsey fringes observed in the collapse and explosion of a Feshbach-resonant $^{85}$Rb Bose-Einstein condensate (BEC), where the BEC (rogue) mode describes the remnant (burst). The amplitude of the molecular condensate (MBEC) fringe is consistent with the experimental fraction of missing atoms (as observed recently at JIL, Boulder, Colorado), and the fringe frequencies are compatible with the molecular binding energy, which together provide indirect evidence for the formation of a molecular condensate.

A collapsed (folded) polymer chain comprised of hydrophilic (blue) and hydrophobic (red) monomers. Water particles are not shown here. Courtesy of Ilpo Vattulainen.

tion of experiments at JILA on the collapse and explosion of Feshbach-resonant $^{85}$Rb condensates. To date the fraction of MBEC formed in the JILA experiments is necessarily small, but a proper sweep across the Feshbach resonance should allow near-unit conversion; however, the non-linear atom-molecule interaction means that the probability of a BEC-MBEC transition does not obey the standard Landau-Zener formula.

## Particle Physics Phenomenology

The main focus of the project has been on studies in the Beyond the Standard Model Physics. In addition to some general aspects of the Higgs sector, mainly supersymmetric models and higher dimensional models have been investigated.

The unknown mechanism of the supersymmetry breaking is one of the most important uncertainties in supersymmetric models. For the presumably lightest supersymmetric particle, the lightest neutralino, mass limits in several supersymmetry breaking models have been studied.

The properties of the spectra of different anomaly mediated supersymmetry breaking (AMSB) scenarios have been studied using sum rules. These can be used to differentiate both between the AMSB models and between AMSB and other types of supersymmetry breaking models. For the anomaly mediated supersymmetry breaking mechanism a novel signal for the detection of the supersymmetric partners of leptons at the LHC has been proposed. This one lepton signal is very clean and characteristic for AMSB.

Using the framework of nonuniversal SUSY breaking scenarios the effects in the flavour changing neutral current (FCNC) decays of $B$ mesons, such as $B \to X_s \ell^+ \ell^-$, $B_d - \bar{B}_d$ mixing and CP asymmetries have been studied. For these scenarios, the neutralino-nucleon cross section has been calculated, since it is relevant for the present Dark Matter detectors. In the analysis the most updated constraints on the SUSY particle spectrum, FCNC constraints, such as $b \to s\gamma$ and $B_d - \bar{B}_d$ mixing, and recent measurements on the anomalous magnetic moment of the muon, have been taken into account.

If higher dimensional models, accessible to collider experiments, exist, they will lead to many interesting implications in future experiments. In the framework of scenarios with quantum gravity propagating in large extra dimensions, the Kaluza-Klein graviton emissions in the main decays of heavy particles, including the main decay of the $Z$, the top quark, and the Higgs boson in the Standard Model have been studied. Strong upper bounds on the fundamental quantum gravity scale in D dimensions have been set from LEP1 data, by means of negative searches of graviton emission in the main $Z$ decay channels in two fermions. Moreover, the effects of virtual KK graviton exchanges to the four fermion process $e^+e^- \to f\bar{f}$ in the resonant kinematical region of the $Z$ pole have been studied. Interestingly, the leading effects of the graviton exchange at the $Z$ pole in an $e^+e^-$ collision vanish in the total cross section.

In a model with universal extra dimensions the effects on $B^0 - \bar{B}^0$ mixing have been investigated. The effects of these universal extra dimensions are felt in the four-dimensional theory by the presence of infinite towers of Kaluza-Klein modes of all the SM fields. The lower bound on the compactification scale has been estimated from $B^0 - \bar{B}^0$ mixing within the present range of the CKM parameters at $1\sigma$ level.

*Hadron Physics Activity*. At large $N_C$ an analysis of the modern realistic phenomenological nucleon-nucleon interaction models revealed that the magnitude of their components is consistent with the large $N_C$ scaling of their operator structure.

The spectrum of systems formed of 4 constituent quarks and one antiquark was calculated with a flavour-spin dependent hyperfine interaction, which organizes the spectrum of 3-quark systems in agreement with the empirical baryon spectrum. These states model the mesonic cloud components of the baryon resonances. The spectrum of the 5-quark systems was shown to be numerically dense and to begin in the region of the low-lying positive resonances.

A study of pion rescattering in two-pion decay of heavy quarkonia was carried out. The structure of the empirical pion spectra was shown to be very sensitive to the presence of pion rescattering.

The coupling of $\eta$ mesons to quarks and baryons was determined by a quark model calculation of neutral pion decay of the charmed strange vector meson $D_s^*$.

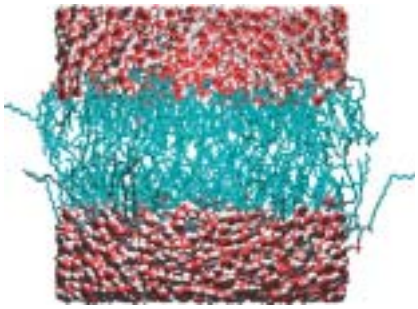
The work on pion-nucleon partial wave analysis has continued with the aim of determining the value of the sigma-term and the pion-nucleon coupling strength.

## Physics of Biological Systems

The activities of the Biological Physics and Soft Matter (BIO) group focus on the theory and computer simulations of the structure and dynamics 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 timely problems of complex soft-matter systems. Since the topic is highly cross disciplinary, the research is done in collaboration with many domestic and international groups whose expertise ranges from biology to various other fields including medical sciences, physical chemistry, and computational sciences.

The activities of the BIO group were initiated in January 2001, and the group joined the activities of HIP in January 2002. The BIO group is part of the SIMU network (funded by the European Science Foundation) and, despite its young age, has been active in organizing international conferences and summer schools in the field of biophysics and soft-matter sciences.

The research of the BIO group consists of three main themes, which complement each other. First, we have focused on the development of novel techniques for studies of soft-matter systems. This is due to the fact that processes taking place in biological soft-matter systems are characterized by a wide range of length and time scales. While the microscopic and macroscopic limits can be studied 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 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, the computational aspects of which we have developed together with our collaborators, it provides a means to consider the large-scale properties of soft-matter systems while preserving a bridge to the underlying microscopic world. We have used these ideas and methods to coarse-grain and model electrolyte systems over mesoscopic time and length scales, and the work is being continued by focusing more closely on biologically relevant lipid systems such as micelles and lipid bilayers.



Lipid bilayer of DPPC molecules surrounded by water. Lipid bilayers are models of actual cell membranes. Courtesy of Michael Patra.

Secondly, we have studied the properties of individual biological molecules such as lipids and chain-like polymers in an explicit solvent through analytical methods combined with classical molecular dynamics and coarse-grained simulation techniques. This approach provides one with a means to study the properties of biological molecules over a full range from the microscopic to the mesoscopic level, and thus opens up a window to better understand the mechanisms that govern the structure and dynamics of biologically relevant molecules over a wide range of length and time scales. The research has focused on mesoscopic studies of single-molecule properties, both with respect to equilibrium and non-equilibrium. We have clarified the scaling anomaly of polymer dynamics in 2D, and continue our work on the dynamics of polymer collapse that describes the dynamics of a polymer chain under conditions that are related to the well-known protein-folding problem.

The third main theme of the group is related to the fact that soft-matter systems should often be considered as units with a collective nature, rather than as a collection of

distinct molecules. For example, the structure and function of proteins depend strongly on the environment in which they are embedded, such as the structure of a lipid bilayer or the quality of a solvent. Further, soft-matter systems are strongly influenced by thermal fluctuations as they are governed by weak interactions of the order of the thermal energy. This leads to a substantial entropy content, implying that processes in biological systems are characterized by free energy changes that determine how the system behaves as whole. We have examined the collective aspects of systems comprised of biological molecules through a number of overlapping projects. Lipid bilayers that serve as basic models of biological cell membranes have been one of the cornerstones in this respect. We have examined the properties of single-component lipid bilayers, and in particular clarified the role of electrostatic interactions and their modelling requirements in this context. More recently, we have started working on lipid bilayer mixtures with varying molecular features.

## Statistical Physics and Materials Science

The activities of the Statistical Physics and Materials Science project focus on the theory of equilibrium and non-equilibrium behaviour and dynamics in strongly interacting many-body systems, with applications in condensed matter physics and related fields. This extremely successful project has now come to an end at HIP, the year 2002 being the last year of funding. The project continues its operation at the Laboratory of Physics, Helsinki University of Technology, where T. Ala-Nissilä is a Professor of Physics and a member of the COMP Center of Excellence of the Academy of Finland.

During 2002, the group has undergone several major changes. In addition to the HIP funding being terminated, there are several projects that have come to an end or are at a juncture. In part this is due to the unusually large number of students (four) who finished their PhD degrees during the latter part of 2002 and early 2003. Significant milestones during 2002 include two major review articles, and several projects carried out in collaboration with experimental groups in Germany and in China:

(i) We have written two major review articles. The first one is a comprehensive review on the theory of single-particle and collective diffusion on surfaces and interfaces. This work has appeared in Advances in Physics in 2002. The second article summarizes recent work on the phase-field modelling of interface dynamics and kinetic roughening in non-equilibrium (driven) systems. This paper will appear in a book published by Springer.

(ii) In collaboration with an experimental group in China, we have studied the dynamical behaviour of H adatoms on the W(100) surface which undergoes a reconstructive phase transition at a certain temperature. This problem is of fundamental theoretical interest due to the nontrivial coupling between critical fluctuations and dynamical correlations, and may have important consequences in e.g. some catalytic reaction systems on metal surfaces. The aim of this work was to test our earlier theoretical prediction that there would be a so-called diffusion anomaly at the phase transition. The experiments verified these predictions and the results were published in Physical Review Letters.

(iii) In collaboration with an experimental group in Germany, we have studied the vibrational dynamics of adsorbed H atoms on the Pt(111) surface. The aim has been to study both experimentally (through time-resolved He scattering techniques) and theoretically (using full quantum-mechanical first principles calculations based on density functional theory) the appearance of quantum effects for H at sufficiently low temperatures. This problem is of fundamental interest, and has remained controversial up to date. From the theoretical calculations we have been able to show that the vibrational properties of H on this surface cannot be explained by the standard (localised) harmonic oscillator picture, but the H atoms are delocalised and the excited state energies are determined by the vibrational band structure. We have also shown that it is essential to use the full (anharmonic) 3D adiabatic potential surface to determine the bands. Both the

theoretical calculations and the corresponding experimental data have been published in Physical Review Letters.

(iv) In collaboration with another experimental group in Germany, we have examined the problem of the dynamics and kinetic roughening of liquid fronts in random media. Such a problem is of fundamental interest in the field of non-equilibrium statistical physics, and has important applications in e.g. oil recovery from sandstone. We have made specific predictions for this problem a few years ago, concerning the case where a liquid front propagates through a disordered, porous medium in 2D. Interestingly enough, the experimental results published in Physical Review Letters remain somewhat inconclusive, perhaps because the experimental system studied was significantly different from that considered in the theoretical modelling work.

In the group, there are also a number of other ongoing projects, which have produced some very interesting results. Many of these projects span several years and are done in collaboration with groups in Europe, and in South and North America:

- analytic solution for kinetic roughening of driven fronts in fractal random media,
- analytic solution of steady-state distributions for some driven growth models,
- explanation for non-monotonic settling velocity for fibre-like particles in steady-state sedimentation,
- explanation for non-gaussian velocity fluctuations in steady-state sedimentation,
- systematic development of coarse-graining methods and projected equations of motion for phase-field models,
- explanation for kinetic step edge instabilities under Molecular Beam Epitaxy growth conditions on surfaces,
- explanation for dislocation nucleation mechanisms and the tensile-compressive asymmetry in the case of strained overlayers in 2D.

Finally, we have a very active and fruitful collaboration with the group of I. Vattulainen concerning numerical coarse-graining methods and their application to systems with hydrodynamic degrees of freedom. We have studied the dynamical behaviour of two important model cases in 2D, namely a many-particle colloidal system and a polymer in a good solvent.

## String Theory and Quantum Field Theory

The research in the String Theory and Quantum Field Theory project has been focusing on the interface of string theory, general relativity and cosmology, and on higher dimensional theories.

Recent advances in cosmology have revitalised the interest in understanding time-dependent backgrounds and spacelike singularities in string theory. In the year 2002, the first real calculational tests of the validity of perturbative string theory were performed in mild big bang/big crunch type backgrounds. In these studies, such backgrounds were constructed as so-called Lorentzian orbifolds. One of the first models and tests was a result of research collaboration between HIP string theorists and their colleagues at the University of Pennsylvania. We examined an orbifold of Minkowski space-time where space-time points were identified under time and space reflection, resulting in a conical space-time with an initial spacelike singularity. We showed that perturbative string theory avoids potential problems like states with negative norm. This amounts to a first proof of a no-ghost theorem in a time-dependent background. We also showed that the theory can be modular invariant, so that one of the first tests of a consistent path-integral formulation was passed. Further, more involved, tests of the background are in progress.

In a related direction, involving HIP-UCLA collaboration, we examined string theory in a 2+1 dimensional black hole background in the context of AdS/CFT correspondence. Another important question associated with spacelike singularities is if string theory can resolve singularities hidden behind the horizons of black holes. In the context of the Holographic

Principle (HP), the problem can be viewed as a question of if and how the region behind the horizon can be projected onto the lower dimensional theory on the holographic screen. Using AdS/CFT correspondence as a concrete model of HP, the simplest model to study this is the BTZ black hole in 2+1 dimensional anti-de Sitter space. Together with Prof. Per Kraus at UCLA, we studied the holographic projection of the different co-ordinate patches of the extended BTZ space-time onto the lower dimensional theory consisting of copies of conformal theories on disjoint asymptotic regions. We developed rules for computing correlation functions between different regions, and showed how the correspondence between the bulk space-time and boundary works nicely if one chooses appropriate natural entangled states in the conformal field theory description.

M. Chaichian and A. Kobakhidze have examined Kaluza-Klein (KK) compactification of higher dimensional theories. Contrary to the standard KK compactification, the spectrum of KK modes of higher-dimensional fields and their interactions are drastically changed when Lorentz/translational invariance is broken in extra space-time. This accounts for all currently popular realistic higher-dimensional models such as models with orbifold compactification and brane world models with large or warped extra dimensions. The appearance of certain light KK modes, suppression of effective couplings with higher KK modes, KK-number violating new interactions are among the salient features of a large class of realistic theories. These open new phenomenological implications of higher-dimensional theories in particle physics, astrophysics and cosmology as well as provide significant modifications of the collider phenomenology of extra dimensions.

As examples of collaboration between HIP projects, the year 2002 included a PhD degree by Syksy Räsänen as a result of joint research with the Cosmology project, and another joint investigation, on the role of possible modified space-time uncertainty relations in the context of density perturbations in the Early Universe.

## Ultrarelativistic Heavy Ion Collisions

The study of the QCD phase transition from a quark-gluon plasma (QGP) to a gas of hadrons is a subfield of particle and nuclear physics with an active interplay between the experimental and theoretical research. The Relativistic Heavy Ion Collider RHIC 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 and NorFa network of particle physics and cosmology.

The initial densities of the QGP produced in AA collisions at RHIC and the LHC can be estimated on the basis of calculable parton production. Especially, the obtained energy densities lean on next-to-leading order perturbative QCD (pQCD). At sufficiently high gluon densities the production of gluons of smaller momenta becomes inhibited by gluon fusion; a dynamically generating saturation scale of 1...2 GeV governs the initial parton production.

An approach complementary to the pQCD+saturation model is the use of classical equations of motion of the gluon fields, applicable in the region of large occupation numbers. The relevant equations of motion can only be solved numerically and code for doing this has now been written. Results on the initial multiplicities and transverse energies are to be reported. *(Collaboration with NORDITA.)*

Further evolution of the produced dense

system can be described by relativistic hydrodynamics. Within the framework of pQCD + saturation + hydrodynamics we have correctly predicted the multiplicities at several cms-energies at RHIC, and made predictions for the LHC/ALICE as well. We have also shown that the $p_T$-spectra of pions, kaons and (anti)protons come out correctly with just a single decoupling temperature $T_{dec}$=150...160 MeV, indicating a shorter hadron gas phase than previously expected. Also rapidity distributions have been studied and the applicability region of the approach charted.

The hadron spectra computed at freeze-out at RHIC and the LHC will be compared with the spectra at larger $p_T$, obtained from pQCD using collinear factorization, nuclear parton distribution functions and fragmentation functions. These two limits shed more light to the studies of the energy losses of fast partons traversing the QGP, one of the hot topics in the field. *(Collaboration with CERN/TH.)*

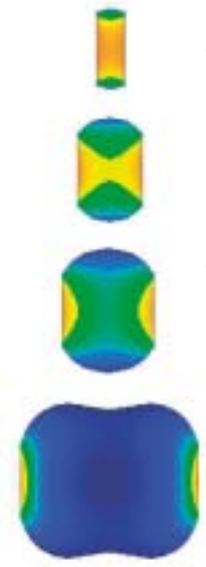
Once the hadron spectra in AA are under control, the space-time evolution of the system is constrained and the electromagnetic probes of the QGP can be considered. We have studied Pb+Pb collisions at the CERN-SPS by applying the recently completed thermal photon rates; the results for RHIC and the LHC will follow. *(Collaboration with LAPP/Annecy has started.)* Also the work for relaxing the simplifications of azimuthal and longitudinal boost symmetry in the hydro codes is in progress, with the aim to study asymmetric (elliptic) flow in non-central collisions and rapidity distributions in detail. *(Collaboration with University of Minnesota.)*

We have also carried on the studies of nuclear parton distribution functions (nPDF) needed in the computation of factorizable hard processes in nuclear collisions. A global pQCD (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 data. Saturation issues and new evolution equations have also been considered. *(Collaboration with CERN/TH, Iowa SU and Regensburg University.)*

The project of computing the free energy of hot quark-gluon plasma nonperturbatively at any energy has advanced significantly by the computation of the coefficient of the $g^6\log(g)$ term in the perturbative expansion of the free energy. This is actually the last coefficient calculable by perturbative means; beyond that fully numerical methods seem to be the only way of obtaining first principle results. *(Collaboration with CERN/TH and MIT.)* Historically, it is notable that the previous and the only other logarithmic term, of order $g^4\log(g)$, was also computed in Helsinki by T. Toimela as early as 1983. New progress was only possible due to the development of new techniques of symbolic computation.

The quark number susceptibility of hot quark-gluon plasma physically characterizes how easy it is to produce quark-antiquark pairs. For the theoretical analysis of its measurements by numerical lattice Monte Carlo techniques one needs its perturbative expansion. This has been known only up to order $g^4\log(g)$, also thanks to T. Toimela. Now the terms of order $g^4$, $g^5$ and $g^6\log(g)$ have been computed in one clean sweep.





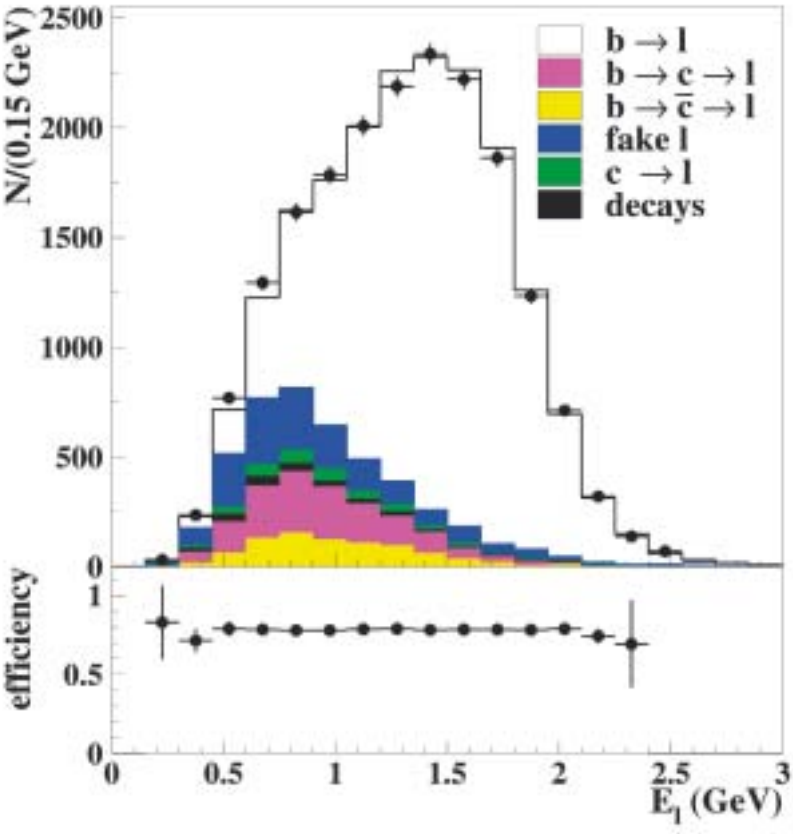
Hydrodynamical evolution of the strongly interacting system created in a central Pb+Pb collision at the LHC, shown at t=3, 7, 10, 19.5 fm/c in the z,x-plane. Red and yellow correspond to the QGP, green to the mixed phase, and blue to the hadron gas.

# High Energy Physics Programme

Heimo Saarikko

In January 2002, the Helsinki group joined the CDF collaboration at Fermilab, consequently the group started to integrate into the environment of the CDF experiment and made its first contributions to the Run II phase of the experiment. Operating at the energy frontier the Tevatron represents a research facility with a high discovery potential. Furthermore, participation in the CDF experiment prepares the Helsinki group for a realistic Forward Physics Programme at the LHC. 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 analysis of LEP/DELPHI data has been continued concentrating in the field of heavy flavour physics, especially semileptonic B decays. However, the emphasis has been in looking for signs of possible extensions of the Standard Model and to understand in detail the decay of hadrons containing heavy quarks. Furthermore, the group is involved in physics feasibility studies aimed at future linear $e^+e^-$ colliders. The COMPASS group's role is maintaining, operating and developing the dilution refrigerator in the experiment, which is essential for a properly functioning target. In addition, a remarkable contribution is made in off-line analysis of data stability and software tools development. The activities of the Detector Laboratory were concentrated in supporting large experimental programmes, as well as in GEM detector development and aging studies. New equipment have been purchased and installed in the joint clean room premises thus further improving their measuring capabilities and reducing the demands for external services.






Above: the reconstructed spectrum of the charged lepton energy in the B hadron rest frame for semileptonic B hadron decays at DELPHI (dots) with the contributions from the different sources highlighted as estimated from simulations. Below: the signal selection efficiency as function of true charged lepton energy in the B rest frame.

## Electron – Positron Physics

The group's analyses of the data taken 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 record breaking 209 GeV, probe our current understanding of elementary particle interactions, the Standard Model, the emphasis being to look for signs of possible extensions of the Standard Model and to understand in detail the decay of hadrons containing heavy quarks. Furthermore, the group is involved in physics feasibility studies aimed at future linear $e^+e^-$ colliders.

In the field of heavy flavour physics, the group is pursuing an inclusive measurement of the lepton momentum spectra in semileptonic B decays based on the large set of $Z^0$ decays collected by DELPHI during 1991-95 using recently achieved significant improvements of the B hadron reconstruction algorithms at LEP. Such an inclusive measurement is very dif-

ficult to do at the B-factories despite the larger statistics of B hadrons decays available, due to difficulties in reconstructing decays with small lepton momenta. Since at LEP the produced B hadrons are largely boosted, the lepton momentum spectra can be reconstructed over essentially the whole momentum range with similar efficiency and hence the theoretical uncertainties can be minimised. A preliminary measurement based on the 1994-95 data was presented at several conferences in 2002 and a publication based on the whole data is in preparation.

The DELPHI measurement will provide information on the description of the kinematics inside the B hadron and therefore reduce the modelling errors related to the extraction of the $|V_{cb}|$ quark mixing matrix element from the measurement of the semileptonic B branching fraction at LEP. $|V_{cb}|$ is proportional to one of the sides of the unitarity triangle and hence will complement the angle measurements of the unitarity triangle, made at B-factories, in constraining the b-quark sector CP-violation.

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 concerning the 1998-99 data was published in Physics Letters B in 2002 and a publication concerning the 2000 data that includes the final DELPHI charged Higgs results will be published very soon.

With the LEP analysis being finalised, the focus of high energy $e^+e^-$ physics is moving towards high luminosity linear colliders. The group is involved in physics feasibility studies both for a "medium" energy (0.5-0.8 TeV) linear collider (e.g. TESLA at DESY) and a "high" energy (2-5 TeV) linear collider (e.g. CLIC at CERN). The group's focus is on fully reconstructing final states with a large number of jets (six or more) that will be crucial at future $e^+e^-$ machines since at least on average the higher the energy is the larger the number of final state jets will be. In addition many new physics processes predict final states with a large number of jets. The studies so far have included the decay of a pair of top quarks and a pair of charged Higgs bosons. They have concentrated on how well such final states could be reconstructed and with what precision physics observables could be measured. The results have been presented at several linear collider workshops during 2002.

## 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 are complementary to the base line CMS, and include leading protons, rapidity gaps and particle production beyond the acceptance limit of the base line detectors. In addition to the strong interaction processes, such as elastic scattering, diffractive excitation and total cross section measurement, these signatures will serve as important tools in the search for new physics.

*Forward Detector System at the LHC.* 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 the past two years, the Helsinki group has developed a basic detector concept that meets these challenges. A series of prototype structures of microstations has been constructed for testing the mechanical structure and vacuum compatibility. The design and construction of a fully functional prototype is in progress. This prototype, together with a silicon sensor and its readout electronics, has to be validated in a test beam.

*CDF activity.* In January 2002, the Helsinki group joined the CDF collaboration at Fermilab. During the past year the group started to integrate into the environment of the CDF experiment and made its first contributions, through co-operation with the Pohjois-Savo Polytechnical Institute, to the trigger and slow control systems of the Run II phase of the experiment. As the current collider of the energy frontier, the Tevatron represents a research facility with a high discovery potential. In addition, participation in the CDF experiment prepares the Helsinki group for a realistic Forward Physics Programme at the LHC. The experience gained in the Run II phase of the CDF experiment at Tevatron will be used for learning about the challenges of physics at a hadron collider, especially in the forward region, by using the real data of an active experiment, as the past experience of the group is mostly with $e^+e^-$ collisions at LEP.

## The COMPASS experiment

The participation of HIP in the COMPASS group at CERN is mainly through the LTL of HUT. The group's role in the experiment is maintaining, operating and developing the dilution refrigerator, which is essential for a properly functioning target. The target group consists of about 25 members from 7 institutes from Finland, France, Germany, Japan, and Switzerland. There are less than ten members permanently at CERN and the number varies all the time. The COMPASS target is described at http://wwwcompass.cern.ch/compass/detector/target/welcome.html whereas the homepage of COMPASS can be found at http://wwwcompass.cern.ch/.

In 2002 the personnel contribution was augmented by 1 person as Kenneth Gustafsson joined Jaakko Koivuniemi at CERN. The Finnish COMPASS group presently consists of Peter Berglund, Jaakko Koivuniemi (target co-ordinator) and Kenneth Gustafsson. After successfully contributing to the target activity Kenneth shifted his interests in September from the target towards off-line analysis of data stability and software tools development.

During the run of 2002 about 260 TBytes of physics data was taken between 27th of May and 18th of September. High average target spin polarizations of +54% and -46% were achieved in both longitudinal and transverse modes. The target operated well during the 100 days of physics data acquisition. In 2003 the same target material $^6$LiD will be used. The material has been produced at Bochum and has high effective polarization per nucleus with high density of deuterons.

The COMPASS experiment has two main physics subprogrammes: the presently active muon programme and the future hadron programme. Both physics subprogrammes have multiple physics goals. The main physics goal of the muon programme is measuring the contribution of the gluons to the spin of the nucleon, the so-called $\Delta G/G$ quantity. The photon-gluon-fusion (PGF) is the favoured process.

A second physics goal of the muon programme is measuring the so-called "transversity" of the nucleon (main interest of K. Gustafsson). Transversity, i.e. the transverse spin distribution of the quarks of the nucleon ($\Delta_T q$), has never been measured before. The expected precision of the transversity measurement is presently lower as the old smaller acceptance SMC magnet is used instead of the planned Oxford Instrument Systems magnet. However, there exists much interest in measuring transversity in the particle physics community. This interest has been fueled by the progress being made on the theory side in the past decade. The transition from Deep Inelastic Scattering (DIS) to semi-inclusive DIS presently enables transversity measurements at both the DESY-Hermes experiment and at COMPASS. In practice transversity is measured by detecting the scattered muon and the leading pion (current fragment) in the transverse mode. The azimuthal angle of the pion distribution carries information on the transverse spin of the struck quark of the nucleon.

*Year 2002 activity at SLAC.* K. Gustafsson made a visit to SLAC in October. During the visit he took part in 10 shifts being available to the Collaboration to function as Target Co-ordinator. Due to the shift of responsibility from Caltech to SLAC combined with the rock stable

performance of the cryotarget, he did not need to carry out this responsibility. A Nuclear Instruments and Methods A paper on the E158 cryotarget was written in 2002 as a combined effort with Dr. Juncai Gao (Caltech).

## Detector Laboratory

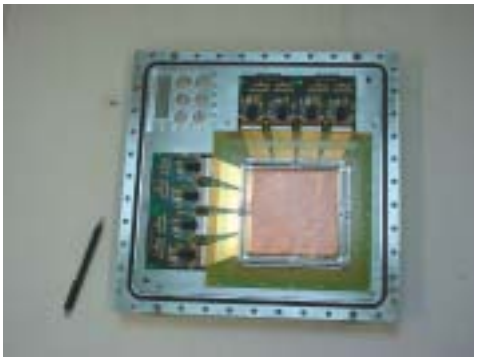
*GEM detectors.* During the year 2002 the R&D work on the GEM detectors was further carried out within the Antares project together with the Observatory and Metorex International Ltd to determine the possibilities of GEM detectors for use in X-ray astronomy.

Measurements with an upgraded single foil GEM detector have been done to study the characteristics of the GEM. These included e.g. energy resolution, overall gas gain capabilities and the uniformity of the gas gain along the whole detection area. At the end of the year this detector was developed one step more by inserting a second GEM foil in the same chamber space to get the first two-foil GEM detector. Preliminary results show that in this new assembly a gas gain of ten thousand is easily achieved.

A new double foil GEM detector with two-dimensional readout has been designed and constructed. In this structure the front-end electronics together with the ASIC preamplifier chips are now installed inside the gas volume. The data acquisition system based on these HELIX 128 channel preamplifier chips and a following ADC/DSP measuring chain is now in the test phase.

*Aging studies.* To examine the aging properties of the GEM detectors a new SGE CHIS - apparatus for the study of outgassing of various construction materials of these detectors has been obtained and tested. Instead of a cryogenic sample concentration used before with CG/MS this novel system utilises a thermal desorption tube with an absorbant (Tenax®) for an alternative concentration method at several temperatures.

Materials analysed in this way so far include e.g. polyimides (Kapton HN®, Espanex®, Imidex®, Apical®), polyester (Mylar®), polyamide (Rilsan®) and some commonly used composite materials (FR4, Stesalit®). Several other polymers, epoxies, fully fabricated PCB and eventually the whole assembled detector will be tested in a similar way. The effects of the observed reactive compounds on the detector performance will be studied separately in accelerated aging tests by injecting con-trolled amounts of them into the gas mixture.



A double-foil GEM detector with two-dimensional readout, upper cover lid and the radiation window removed. The front-end electronics is inside the gas volume.

*Clean room facilities.* A couple of new items of equipment have been purchased and installed in the joint clean room premises thus further improving their measuring capabilities and reducing the demands for external services. These new precision instruments include the motorized analytical probe station (MI PS150-200) for accurate testing of various electrical characteristics of radiation sensors and the profiler (KLA Tencor P15) for exact 2-D and 3-D surface analyses for e.g. different foils and their coating structures.

Clean rooms: class 1000 and class 100 (in the background). A view from the service corridor. Note the many kinds of pipelines on the outside walls (for different gases, vacuum, cooling water etc.).

Following the decision of assembling about one third of altogether 2000 Silicon Strip Detector (SSD) modules for the ALICE/CERN experiment at the premises of HIP, some parts of the Detector Laboratory have been prepared for these purposes. Particularly, during 2003-2005 the project will occupy a significant part of the Kumpula clean rooms. At the moment, the most visible sign of the project is the ESD protected working places in the largest class 1000 clean room.

The main activities of the HIP CMS Programme at the Detector Laboratory are manufacture and testing of detector support structures, so called rods, for the CMS Tracker Outer Barrel (TOB). Additionally, characterizations of silicon detectors have been done at the clean room. In the future, testing set-up for the CMS Tracker silicon detector modules will be installed at the Detector Laboratory premises.

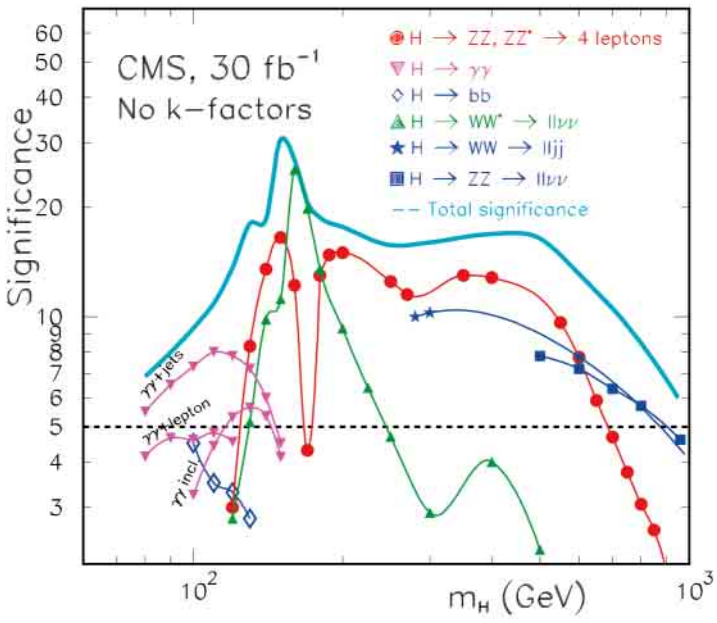
The new profiler for 3-D surface analyses.

# 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 supersymmetry particles, and the creation of the quark-gluon plasma. In addition, there are other 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 from the beginning the Finnish team has played an important role in its development. 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 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. At present, the CMS detector system is in full construction and the preparation for its physics analysis is well advanced. 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 has responsibilities for the design, construction and testing of the central tracking detector as well as of the CMS muon trigger.






Expected statistical significance for the SM Higgs boson in the CMS detector for 30 fb$^{-1}$ as a function of $m_H$.

## Software and Physics

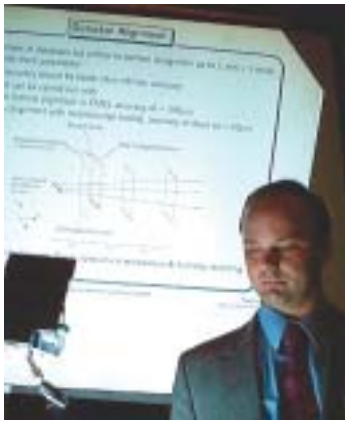
*Grid computing.* The computing activities of the HIP Software group have proceeded in two frontiers: (i) participation in Grid initiatives and (ii) contributions to distributed CMS mass-productions with Grid applications. HIP participates in the NorduGrid project, which is also a part of the European DataGrid (EDG) testbed. Group members represented Finland and HIP at various meetings and workshops. A test platform on the Kumpula campus was connected to NorduGrid. This was the first step in building a fully NorduGrid compatible system for HIP, which will also be an efficient system for the CMS production activities. The next important step achieved in 2002 was the design and installation of a 1.4 TB disk server (silo.hip.fi), which will serve as a data storage for Grid and CMS production activities in Helsinki. It was also decided to build a Linux

PC cluster with a few tens of nodes. A detailed planning of this cluster was completed by the end of the year. A dual CPU front-end machine for the cluster was designed and tested. Initial tests of the CMS software on the OpenMosix night cluster were performed.

On the mass-productions frontier, the CMS Monte Carlo Production team produced about 20 TB of data for the preparation of the Data Acquisition Technical Design Report (DAQ TDR) during the first four months of 2002. It included the simulation of primary proton-proton interactions, secondary interactions in the detector, response of the sensitive elements, pile-up of events, and first-pass analysis. The data were written into the Objectivity Data Base ODBMS. This was a worldwide production involving more than 30 persons and 20 sites. The reference production database system (RefDB) and the Batch Object Submission System (BOSS) were brought into the production system for the first time making it much more automatised than before. The production team started working for even more automatisation, in order to be ready to start using Grid resources when available. The CMS Computing Data Challenge is foreseen for the beginning of 2004, for which about 50 million events need to be produced and digitized during the second half of 2003.

*Organization of conferences.* The HIP Software group organized two international workshops in May-June 2002: the "3rd NorduGrid Workshop" and the "Workshop on B/Tau Physics at the LHC". The "Nordu Grid Workshop" was attended by some 40 participants from the Nordic countries and from the USA. The programme consisted of a NorduGrid developers' internal meeting, status reports of EDG and NorduGrid initiatives, a report on GLOBUS middleware as well as a number of interesting talks on the details of NorduGrid software, for the first time in the series of these workshops. In the "Workshop on B/Tau Physics at the LHC" there were some 30 participants of 12 different nationalities, most of them from the CMS and ATLAS experiments. The programme included various aspects of physics with B-mesons and Tau-leptons in the final state, from detector design to calibration methods and from physics simulation results to phenomenology and theory. In addition the participants enjoyed several interesting topical presentations on subjects like cosmology, supersymmetry and the status of the LHC construction.

*Simulation and event reconstruction.* The HIP Software group continued to be responsible for maintaining the FORTRAN and GEANT3 based CMS detector simulation package CMSIM. Up to the end of 2002 this package has played an important role in the CMS event simulation. In the future CMSIM will provide an important reference for the development of the new C++ and GEANT4 based CMS simulation tool OSCAR. Three major releases of CMSIM were issued during the year 2002. The upgrades included the follow-up of the design changes in the detector description as well as several refinements necessary for the massive productions of simulated events. HIP contributed to the development of the interdisciplinary simulation toolkit *Geant4* as a member institute of the collaboration building the software. A new Bertini intranuclear cascade model was included in the GEANT4 5.0 release. The cascade model implementation for medium energy range (10 MeV - 10 GeV) is based on re-engineering the existing INUCL code. The HIP Software



Tapio Lampén from the local organizing committee of the LHC B/Tau Physics Workshop presenting results from detector alignment studies.



Tomas Lindén working with the fileserver silo, which has a net capacity of 1.4 Terabytes. This allows the storage of approximately one million full CMS Monte Carlo events.

and Physics project was responsible for implementing the intra-nuclear cascade model with exitons, a pre-equilibrium model, a nucleus explosion model, a fission model and an evaporation model.

The responsibilities of the CMS institutes in developing the software for the CMS Tracker are defined and agreed on in the Tracker Software Memorandum of Understanding. One of the main responsibilities of the HIP Software and Physics project is the Tracker detector alignment with straight particle trajectories. The HIP group continued the development of the stand-alone program for detector alignment (DALI) and also participated in the development of the misalignment package of ORCA, the Object oriented Reconstruction program for CMS data Analysis. The ORCA misalignment package is used to introduce simulated misalignments to various structural elements of the CMS tracker. The corresponding corrections should then be found with the alignment algorithm, which is to be implemented in ORCA and will be based on the DALI program. An important result was obtained proving that the Pixel alignment can be performed quasi independently of the rest of the CMS detector: only crude track curvature information from the full, even misaligned, Tracker is sufficient for the Pixel internal alignment.

In the event reconstruction, the main activities in 2002 were the development of algorithms for the high level triggers, for the photon conversion studies and for the isolation studies of electrons and photons. The DAQ TDR was completed in 2002, including the updated results on the high-level trigger algorithms (CMS NOTE 2002/039). The ”pixel match” algorithm, developed by the HIP group and included in the ORCA framework offers a high background rejection (only one background event in ten passes the selection criteria) conserving a high efficiency for the signal electrons (92% of electrons are accepted) even at high luminosity running.

After the important milestone of the DAQ TDR, the electron and photon reconstruction activities in CMS concentrate on the optimal identification and measurement of the signal and further reduction of the background. Our group is active in the studies of the photon conversions, and it has been shown that in 70% of the converted photons at least one track from the electron-positron pair can be measured. These tracks can be used to find the event vertex in the important Higgs $\rightarrow\gamma\gamma$ channel, where two measurement points are needed to reconstruct the photon momenta and thus the mass of the Higgs particle.

Algorithms have been developed and implemented in ORCA by the HIP team for isolation studies of electrons and positrons. The isolation algorithms are able to separate the signal (where the signal electron or photon comes from the event vertex with no other particles around it) from the background (where the fake electron or photon candidate is surrounded by other particles originating from the same event vertex). These algorithms will be extensively used in many discovery channels where an isolated electron or photon is required in the final state. Furthermore, at high luminosity, where large background rejection is needed at the earliest possible stage, they will be part of the high-level trigger chain.

*Work with test beams*. The 2002 test beam activities of the group included development and maintenance of the on-line and off-line software for the HIP Silicon Beam Telescope (SiBT). Very fast on-line software (up to 50 times faster than the previous version) was developed to control the read-out of a new independent data acquisition system, autonomous for the SiBT. The new software allows the SiBT data acquisition to cope with the rates of the other detectors involved in the test beam. As a common project between the HIP Tracker and Software groups a new type of a silicon detector was tested in the beam. This detector was processed with the Czochralski method and successfully tested for the first time for this type of a detector. The Software group did the off-line analysis of the test data and the results were presented in autumn in the Siena conference on particle and radiation detectors.

*CMS physics simulation.* The main research subjects of the HIP CMS physics simulation team have been the following: (i) a full simulation study for the $\tau$-jet identification in $H_{SUSY} \rightarrow \tau\tau \rightarrow 2\tau$-*jets*, (ii) a full simulation

study for $\tau$ impact parameter tagging in $H_{SUSY} \rightarrow \tau\tau \rightarrow \ell\ell+X$ and in $H_{SUSY} \rightarrow \tau\tau \rightarrow 2\tau$-*jets*, (iii) investigation of the Higgs boson discovery potential in the channel $pp \rightarrow qqH$, $H \rightarrow \mu\mu$ and (iv) an update of the Standard Model Higgs boson discovery limits for CMS.

The earlier fast simulation studies of the Helsinki team have shown that the discovery range for the heavy MSSM Higgs bosons can be significantly extended towards large masses using the purely hadronic final states in the decay process $H_{SUSY} \rightarrow \tau\tau \rightarrow 2\tau$-*jets*. Thanks to an efficient hadronic $\tau$ trigger based on Level-1 calorimeter selection, Level-2 electromagnetic calorimeter isolation and collimation and a Level-3 tracking (isolation) in the pixel detector the $\tan\beta$ reach at low masses, $m_A \sim 200$ GeV, is also significantly extended. During 2002 a full simulation and off-line track reconstruction study was performed for the $H_{SUSY} \rightarrow \tau\tau \rightarrow 2\tau$-*jets* channel. To suppress the dominant QCD background (approximately $10^{12}$ QCD jet events with $E_T^{jet} > 60$ GeV are expected for 60 fb$^{-1}$) an efficient $\tau$-jet identification algorithm was developed based on the narrow shape, isolation and low multiplicity of the $\tau$-jet in $H_{SUSY} \rightarrow \tau\tau \rightarrow 2\tau$-*jets*.

The trigger simulation and the event reconstruction were performed with the ORCA6 package. The leading charged track was first looked for in the center of the $\tau$-jet candidate given by the High Level Tau Trigger. The 3-prong $\tau$ decays were included in a narrow signal cone required to be well isolated within a much larger isolation cone. With the present limited Monte Carlo statistics the level of the QCD background could be only estimated using a rejection factor as a function of $E_T^{jet}$. This off-line $\tau$-jet identification, requiring one or three tracks in the signal cone and including the $\tau$ trigger simulation, was found to provide a total suppression of $\sim 10^6$ against the QCD jet background and a total efficiency of $\simeq 0.8\%$ and $\simeq 9\%$ for the signal at $m_A = 200$ GeV and 500 GeV, respectively, in good agreement with the earlier fast simulation results.

It has been shown earlier by the HIP physics team that the impact parameter measurement for the hard tracks from $\tau$ can be used to suppress backgrounds where the leptons originate from $W$ or $Z$ decay for the $\ell\ell$ final states and to further reduce the QCD background for the 2 $\tau$-jet final states. To better exploit the (short) $\tau$ lifetime the impact parameter measurements were combined into one variable: $\sigma_{12} = \sqrt{\sigma_{ip}(\tau_1)^2 + \sigma_{ip}(\tau_2)^2}$ where $\sigma_{ip}(\tau_1)$ and $\sigma_{ip}(\tau_2)$ are the impact parameter significances for the leading tracks in the two $\tau$-jets. The method was found to provide a further rejection of $\sim 5$ against the QCD background and an efficiency of $\sim 60\%$ for the $H_{SUSY} \rightarrow \tau\tau \rightarrow 2\tau$-*jets* events.

An update of the signal to background ratios for $H_{SUSY} \rightarrow \tau\tau \rightarrow 2\tau$-*jets* and for $H_{SUSY} \rightarrow \tau\tau \rightarrow \ell\ell+X$ was also evaluated with $E_T^{miss}$ measurement, Higgs boson mass reconstruction and b-tagging in the associated production processes. The discovery ranges in the $m_A$,$\tan\beta$ parameter space were presented and investigated as a function of SUSY parameters.

The Higgs boson discovery prospects in the $pp \rightarrow qqH$, $H \rightarrow \mu\mu$ channel were investigated using fast simulation. The branching ratio for $H \rightarrow \mu\mu$ is very small, $\sim O(10^{-4})$, but the excellent muon momentum resolution makes the channel nevertheless interesting. Tagging of the associated energetic forward jets was used to suppress the large $Z,\gamma^* \rightarrow \mu\mu$ background and the central jet veto, exploiting the expected low jet activity between the forward jets in the signal events, to suppress the other main background $t\bar{t}$. The signal rate was found to be too low to allow for a discovery in this channel alone even with the ultimate luminosities.

One other responsibility of the Helsinki group has been the compilation of the simulation results for the SM and MSSM Higgs bosons into expected discovery ranges in CMS. During 2002 this work was revised for the SM Higgs boson.

## CMS Tracker

The HIP LHC Tracker project includes research activities related to mechanics, silicon sensor technology and electronics. The HIP contribution to the CERN CMS experiment is mainly focused on the construction of the Tracker sub-detector. CMS Tracker activities include responsibilities in the design and in the

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

construction of the mechanical support structure for the Tracker Outer Barrel (TOB), in the development of radiation hard silicon detectors for detector upgrade, in the operation of the HIP Silicon Beam Telescope for testing detectors in LHC-like conditions, and in quality testing of Tracker silicon detector modules. In addition, the HIP Tracker project participates in the CMS Trigger and Data Acquisition (Tridas) project, where the HIP group has responsibilities for the design of the fibre optic links for the RPC (Resistive Plate Chamber) muon detector trigger.

*Tracker Outer Barrel Mechanics.* The HIP Mechanics team is responsible for the design and manufacture of the detector support structure of the Tracker Outer Barrel (TOB). During 2002 the main activity was to make preparations for the production of TOB rods, the special support structures for the detector modules. A precision-tool mechanic joined the personnel in April 2002. His responsibilities are for the design and manufacture of the assembly tooling and for assembly work and testing.

A space of 25 $m^2$ has been reserved for the assembly work, test benches, and storages, and part of the laboratory tooling and facilities have been acquired. Among the projects carried out during the year were development, manufacture, and testing of efficient assembly tooling for the TOB rods. The measuring device needed for geometrical verification of the rods was also constructed. At CERN the TOB wheel cooling segment set-up was manufactured, and preliminary coolant distribution tests have been accomplished. A contract with the manufacturer of the composite profile pieces used for the TOB rod support structures was established (Exel oyj). Production is in progress and some 30% of the pieces have been delivered already. Offers for the second major component purchases, the TOB rod inserts, were received before the end of the year.

The HIP Mechanics team has also participated in the design of the housings for the CMS RPC Trigger Link Boards. Participating groups have worked on establishing specifications defining the interfaces of the boxes. The enclosure itself, cooling, cable entries, and the standard card frame with back plane connectors are kept as separate parts so that the precision requirements for the later housing assembly are not strict. This design also guarantees a good connection between a Link Board and back plane. Several cooling tests have been carried out on the full-scale Link Board prototype enclosure to estimate the cooling efficiency.

Silicon strip detectors being processed at the HUT MEC clean room (diffusion furnace).

*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 high luminosity upgrade of the LHC. The radiation tolerance issues of silicon devices are at present of major interest in the High Energy Physics (HEP) community. During 2002 the CMS Tracker group joined two new research collaborations with the aim to improve the radiation hardness of particle detectors, namely the RD39 and RD50 projects at CERN.

In 2002 we started the study of radiation hardness of strip detectors processed on silicon wafers grown by the magnetic Czochralski method. We processed the detectors at the Helsinki University of Technology Microelectronics Centre, where HIP has membership status. The electrical characteristics of the Cz-Si detectors were verified at the Microelectronics Lab of the University of Oulu and at CERN. They were found to be appropriate for particle detection. The detectors were then put into the CERN H2 test beam and tested with the help of the HIP Silicon Beam Telescope. Their detection performance was found to be fully comparable to the existing silicon strip detectors. The radiation hardness properties of the detectors were studied in two sets of irradiation tests at the

Accelerator Laboratory of the University of Jyväskylä. According to the preliminary analysis, Czochralski silicon is extremely radiation hard compared to the materials traditionally used in high-energy physics experiments. This is the first time a full size Czochralski detector has ever been processed and tested. It has become possible due to the recent developments in crystal growth technologies by Okmetic oyj. Our results have already achieved wide international interest. The test structures processed by us and irradiated at Jyväskylä are at present being characterized at CERN, at the Brookhaven National Laboratory, at the Ioffe Institute in Moscow, at Glasgow University and at the University of Hamburg.

Together with the research programme, educational activities related to silicon detectors were started during 2002. In collaboration with the Electron Physics Laboratory and the Microelectronics Centre, both at the Helsinki University of Technology, the Tracker Project organized a post-graduate laboratory course of 5 credits in strip detector manufacturing technology. Under the supervision of Dr. Jaakko Härkönen, four HIP post-graduate students participated in the course.

*Quality Testing of Tracker Detector Modules.* The silicon detector modules inside the CMS Tracker must meet certain tight requirements during the running of the experiment. Therefore, prior to the installation of the silicon modules into the CMS, the functionality of these modules must be extensively tested. Several CMS laboratories will participate in these long-term tests, one of them being the HIP/FTL Kumpula Laboratory.

During 2002, the module test set-up of HIP was made operational at CERN. Silicon modules were tested and the development of the system was done in close co-operation with the CERN Tracker group. With the present set-up, the modules were tested one at a time, housed in metallic boxes. The HIP group also participated in testing the Tracker module behaviour when they have been mounted on the rod, the module support structure in the Tracker Outer Barrel.

New low voltage supplies for the Tracker rod tests were designed and constructed. These voltage supplies will be further developed to become the final power supplies in the CMS Tracker. Work was also done in the development of the control systems of the CMS Tracker.

*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 the high-resolution tracks of the incoming beam particles. It offers a reference track measurement for the needs of the HIP CMS Tracker group as well as for other CMS research groups testing the spatial resolution and the efficiency of their detectors.

SiBT is based on position sensitive Silicon strip detectors read out by a readout electronics and data acquisition system designed and built by HIP. During the 2002 beam tests the SiBT updated with a new PC-based Data Acquisition System including a commercial analog-to-digital ADC VME converter module. The SiBT was successfully used for measuring resolutions, efficiencies and signal-to-noise ratios of the novel Czochralski detectors.

*RPC Trigger.* The main activity of the HIP CMS 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). The work is being done in close collaboration with the Warsaw University CMS group. Closely connected to the PACT project is the University of Bari CMS group, responsible for the RPC front-end electronics. The first level muon trigger is one of the most important aspects in the CMS detector design for the discovery of new physics.

During the year 2002, we studied the preproduction prototypes of all boards needed for the optical link system. First and second prototypes of the optical daughter card were designed, manufactured and tested. Additionally, the first prototype of the Control Board for Detector Slow Control was designed and manufactured. Irradiation testing of the components chosen for the final Link Board was done at the Jyväskylä Accelerator Laboratory.

RADEF beam line at the University of Jyväskylä Accelerator Laboratory.

# Nuclear Matter Programme

Juha Äystö

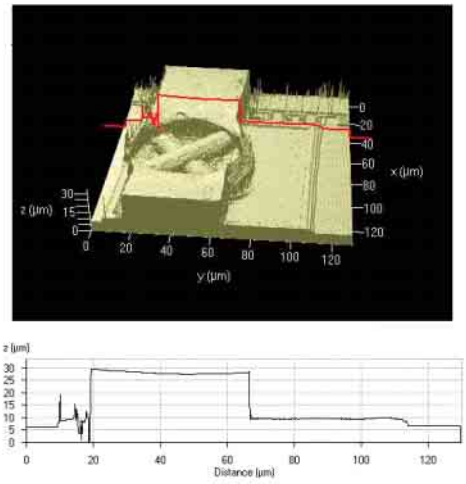
The Nuclear Matter Programme was formed in the beginning of 2002 to provide full participation of the Finnish teams in studies of two aspects of nuclear and hadronic matter. These are cold exotic matter with extreme composition of its proton and neutron numbers and hot and dense matter created in relativistic 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 a special emphasis 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-gluon plasma. The project leaders of these two projects are Doc. Ari Jokinen, currently at CERN ISOLDE and Doc. Wladyslaw Trzaska, currently at JYFL, for ALICE. 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

The year 2002 has marked two major organizational changes of our ALICE-centred research. The first was the elevation of our work within the internal HIP structures to the project level. The second more important change was the final approval by the ALICE collaboration of the new scheme of our core contribution. The core contribution, the direct hardware investment in the detector by each participating country, in the case of Finland was fixed at 1 million Swiss Francs. According to the initial agreement 90% of this amount was to be used for buying services from industry to bond the components of the Inner Tracker System (ITS). The remaining 10% are cash contributions to the common fund, which is required from all the participants. When the agreement was made the industrial option was the only viable solution. The completion of a suitable clean room on the Kumpula campus in 2001 combined with the delays in the bonding schedule have opened a new - albeit very daring – possibility: to move the Finnish share of bonding from the commercial companies to the Detector Laboratory at Kumpula. To make it possible, three main goals had to be achieved: equipping of the new laboratory on time, finding highly qualified people, and winning of final approval by the collaboration partners. We were able to achieve all of these goals.

The laboratory was equipped during spring and already in the summer of 2002 the first HAL25 front-end chips were bonded in Kumpula using a single-point Tape Automated Bonding (TAB) technique. Crucial help for the project came from our Ukrainian collaborators who are currently the world experts in this field. Bonded chips were further sent to Strasbourg where in October the first complete SSD (Silicon Strip Detector) module was assembled. This was an important success for the ITS community after suffering big delays due to various manufacturing problems, mostly with the HAL25 chip. Only now could a realistic date for the start of mass production be set as the spring of 2003. Of the 2000 SDD modules




An example of a TAB contact visualised with Laser Scanning Microscopy. The aluminum lead on top of a polyimide microcable is bonded into an aluminum bonding pad in a component with an X-shaped bonding tool. The lower picture shows the profile of the contact along the red line in the upper picture. The higher Al lead and the lower bonding pad are clearly seen.

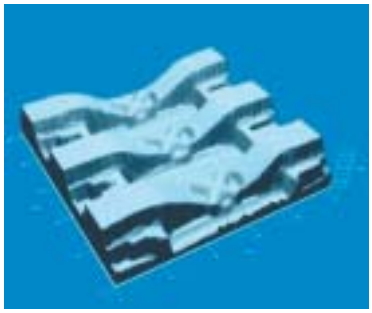
that will have to be assembled and fully tested by October 2005, one third are scheduled to be produced in Helsinki - a great achievement for our team and for the laboratory that did not even exist a year before. The remaining 2/3 will be shared by Strasbourg and Trieste - laboratories which have a long tradition and expertise in bonding.

The ITS components not only have to be bonded with very high yield and precision but they also have to last over the entire life span of the ALICE experiment. Therefore, together with the work on the SSD assembly, we have launched reliability investigations of the bonded components. Since the typical TAB contact is an interface between 5 different materials with diverse thermal expansion coefficients, thermal stress is usually the leading cause of long-term failures. To get a basis for thermo-mechanical modelling we have analyzed the profiles of the TAB contacts with Laser Scanning Microscopy and with Scanning White-Light Interferometry at the Electronics Research Unit (ERU) of the University of Helsinki. Our work on failure modes has also benefited from close contacts with Helsinki University of Technology and with Nokia. Both have well-developed industrial methologies for studying failure modes of TAB contacts. Our aim is to make a sound estimate of the long-term reliability of the assembled SSD modules and to enhance expertise at the Detector Laboratory and at ERU.

The change in the bonding scheme generated considerable savings in the core expenditure. The savings could partially be used for funding of the T0 detector - the main timing and (fast) trigger detector for ALICE. In the present version T0 will consist of two arrays of 12 Cherenkov detectors with quartz radiators coupled to fine-mesh PMT tubes located at the opposite sides of the interaction point, close to the beam pipe. Due to extreme space constraints on the muon absorber side the two arrays cannot be placed symmetrically but will have the distance ratio of about 6:1 giving a pseudorapidity coverage of $2.9 < \eta < 3.3$ for the closer array ($T0_R$), and $-5 < \eta < -4.5$ for the further array ($T0_L$). For the same reason the minimum distance for the fast analogue front-end electronics is about 5 m from the array. The toughest requirements in the design of T0 are associated with the ability to operate in the 0.5 T field of the L3 magnet and to produce very good on-line timing with high efficiency not only for central Pb - Pb collisions but also for p - p collisions and minimum bias events. The former (operation in the magnetic field) limits the choice of PMT manufacturers to just two companies. The latter imposes a large (at least 1:200) dynamic range on the fast electronics and requires a very low threshold level of about 120 photoelectrons.

Perhaps the most visible achievement during 2002 was the construction of a full-scale model of $T0_R$ properly equipped with PMT tubes, HV bases, quartz radiators, cables and optical fibres for laser calibrations. The model was built to optimize the light-weight carbon fibre construction, to perform the necessary weight-load tests on it, and to aid in the integration of the other detectors and services in the congested space between the interaction point and the muon absorber. The model will also serve as the ideal detector support for in-beam tests at CERN, which are scheduled for 2003. There was also a major progress in the design of the front-end electronics. The T0 collaboration has completed 3 independent prototypes of the amplifier/discriminator stage. The first tests with laser and pulse generators indicate that for each prototype we were able to reach less than 50 ps time walk over nearly 3 orders of magnitude of input amplitude. The design work and tests will continue throughout next year as well.

The third field of activity of our team is software. Over the past year we have worked in two directions: software design and maintenance, and development of algorithms and benchmark studies of detector performance for the Inner Tracking System (ITS) of ALICE. As physics analysis is our final goal we have gradually shifted our efforts towards the development of algorithms for the reconstruction of the kink decays (in TPC). This will lead naturally to the evaluation of how well the ALICE detector can measure the strange particle production which in turn plays an important role in revealing the production mechanisms in relativistic heavy ion collisions.



TAB contacts visualised with Laser Scanning Microscopy.



Life-size prototype of the $T0_R$ array.

# ISOLDE

Assuming that isospin is a good quantum number one would expect 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 due to a recent high-resolution $^{58}$Ni($^3$He, t)$^{58}$Cu study in Osaka and access to laser ionised $^{58}$Zn, which decays to excited states in $^{58}$Cu. 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 2002 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 a novel Si-ball array which is discussed below.

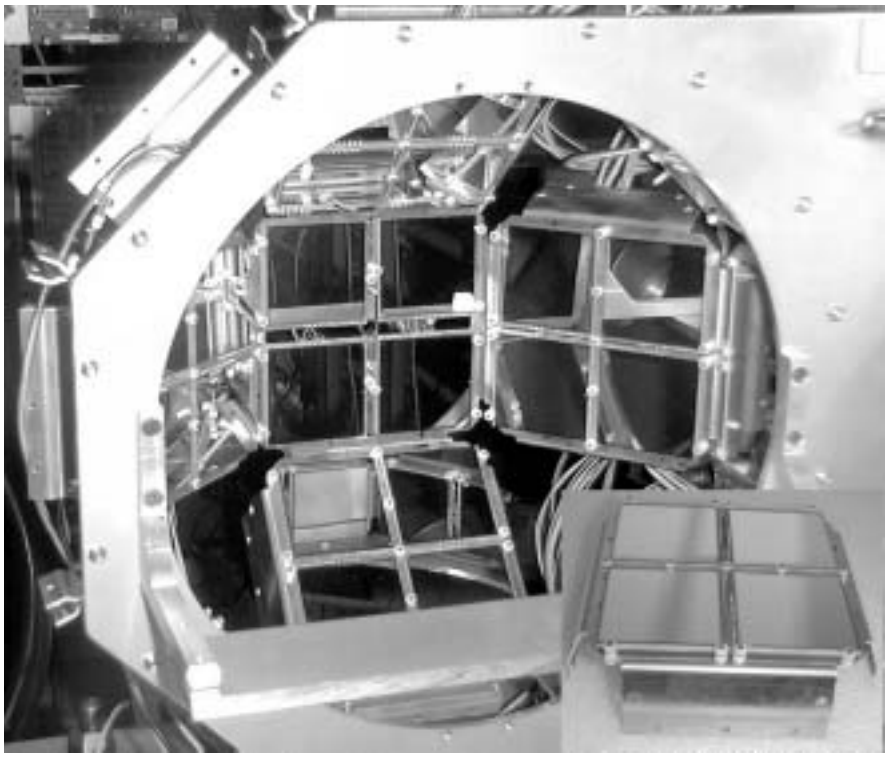
A rapid proton capture (rp) process is part of explosive hydrogen burning occurring in special astrophysical events, like an accretion in a close binary system. At high temperatures it may continue until the fuel for nuclear burning is exhausted. The typical time scale for the event, known as X-ray burst, 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 of our studies of $^{72,71,70}$Kr, we have performed a beta-delayed proton decay study of $^{69}$Kr, which gives access to proton unbound states in $^{69}$Br. Due to the very low production cross section for such an exotic nucleus, only a few events may be expected after careful analysis, which is in progress at the University of Jyväskylä.

In the target and ion source sector, off-line release rates of Be, Mg, S, Cl, Ar, K, Ca, Sc, Mn, Ga, Br, Kr and Sn from refractory materials were studied to optimize the production of the most exotic nuclei - a key issue in research far from stability. In addition, a complete Monte Carlo code to study and optimize ISOL-type targets was finalised. The latter task is related to the EU-funded study project EURISOL, where a new generation radioactive ion beam facility to be constructed in Europe is outlined.

In connection with the neutron converter target, 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 this connection we also explored decay properties of neutron-rich Fr isotopes up to mass A=232 by impinging the primary beam directly to the UC-target, thus resulting in enhanced spallation production.

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 a rhombicuboctahedron geometry made of squares and triangles. The detector provides very high geometrical efficiency close to 100%, wide energy range with very low energy threshold and high enough granularity for angular distribution measurements between emitted particles. The first half of the Si-ball was commissioned successfully in 2002, and the array was applied in the beta-delayed proton decay study of $^{58}$Zn mentioned above.

Finally, an ion cooler and buncher development has concentrated on simulations which provide a basis for the technical design starting in the beginning of 2003. The operational parameters of the RFQ and the deceleration section have been optimized. Due to the very different acceptance of the RFQ and the emittance of the ion beam before the RFQ, a special matching section with an electrostatic quadrupole triplet has also been designed.



Si-ball detector array developed and built at CERN in collaboration with the CERN ISOLDE Physics group, the University of Madrid and the University of Aarhus.

# Technology Programme

Ari-Pekka Hameri

Due to the increased momentum around Grid computing technologies, the DataGrid project became the sole project of the Technology Programme in the year 2002. The Programme seeks synergy from combining all research efforts into building one core technology base, which then serves the four different focus areas of the Programme. These focus areas include the contribution to the European DataGrid (EDG) project in the form of Grid security solutions. The research team has built a flexible authentication and authorization framework for various Grid services. The second focus area concerns cluster activities, where the Programme has provided other than physics users with the possibility to test emerging Grid technologies. These computing resources have also been successfully connected to the NorduGrid pool of clusters around Scandinavia. On the physics side, the third focus area, the Programme is actively working with the LHC Computing Grid (LCG) and NorduGrid in order to provide high level user interfaces to access lower level Grid resources. The fourth focus area involves industrial collaboration and technology transfer. The Programme has succeeded in forming the first industrial Grid research collaboration with academic and industrial partners from Finland. In addition to the Grid development, the Programme is playing a crucial role in executing a large-scale survey on the learning benefits stemming for CERN's supplier companies when interacting with the Big Science centre. A sample, covering suppliers from 6 European countries, has been detected and surveyed, the analysis is underway and the first results are expected to come out in spring 2003.



## Data security

The main HIP contribution to the European Union DataGrid (EDG) project has been participating and leading the Security Task under the Data Management work package. This task provides security solutions for the whole EDG consortium. The main achievement of this task was the completion of the Grid Security Infrastructure (GSI) authentication module prototype for the CERN Advanced Storage System (CASTOR), which incorporates high storage tapes. The GSI is a Public Key Infrastructure (PKI) implementation based on verifying the identity of users in a globally distributed Grid. Following the completion of this module the support and further development of the software were handed over to the Mass Storage Management work package of the EDG project.

Other vital applications have also been developed based on the GSI library. One of these is the TrustManager – handling access, user and data authentication both on the client and the server side. The application is nearing its completion and a new certificate delegation mechanism is under development in order to improve both performance and security. The TrustManager is being integrated into the Data Management software produced in the work package. Later on this application will be further integrated with the other work packages of the EDG project, notably with the information and monitoring software. In this manner, the


Visit by the personnel of the Technology Programme and summer students to IBM's Zurich research center.

EDG project will deliver the overall DataGrid prototype by the end of 2003.

At the same time the authorization framework has been developed based on a modularized architecture. This was done in co-operation with the Swedish Research Council. The modularization allows great flexibility in interfacing to several kinds of storages for authorization information by changing the access module. The modularization also makes possible the use of the same authorization mechanism in different environments by simply changing the thin interface module. This authorization package is also being integrated into the Data Management software.

As the leader of the security task, the Technology Programme has actively participated in security-related meetings, workshops and conferences throughout the year. HIP has also joined the Liberty Alliance consortium, which is developing open standards for single sign-on and federated network identity.

## Cluster activities and NorduGrid

The Technology Programme continues to operate and maintain 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. Focus has been on developing the cluster to evaluate different Grid technologies, training younger scientists and providing researchers outside of physics with access to exploit Grid technologies. The cluster currently comprises 10 computing nodes with a fully automatic installation (FAI) system with simultaneous support of two mainstream Linux distributions. As for applications in other sciences than physics, the cluster has been used for growing virtual cattle by a research group from the University of Zaragoza. In a similar manner the Finnish Environmental Institute (SYKE) has been preparing to test the cluster in order to study remote sensing data analysis of satellite data and error characteristics of the real measurements concerning the health of Finnish lakes.

On the Scandinavian dimension the cluster has been linked to the NorduGrid resource network. It is now possible for NorduGrid users to see the computing resources of the Technology Programme, and in this way the first steps towards Scandinavian-wide Grid resources have been taken.

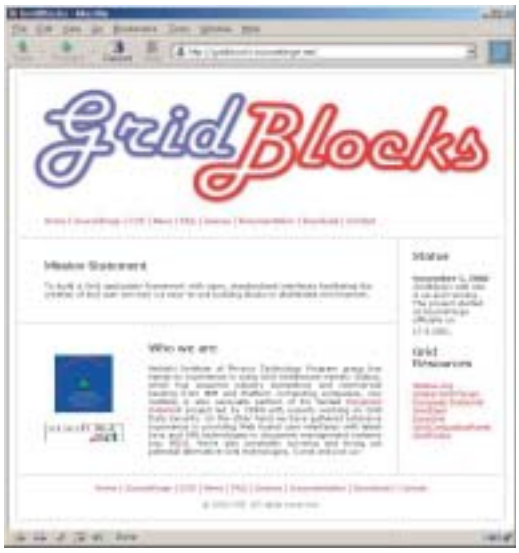
The cluster has also been used as a forum to train young students. Altogether eight students have been trained to be fully competent in maintaining Grid technologies and supporting users that want to exploit them. This work is vital, as in the near future there will be a growing demand for skilled people to operate clusters not only for the needs of the LHC project, but also for the seemingly growing demand from other sciences.

## CMS software, Physics and LHC Grid

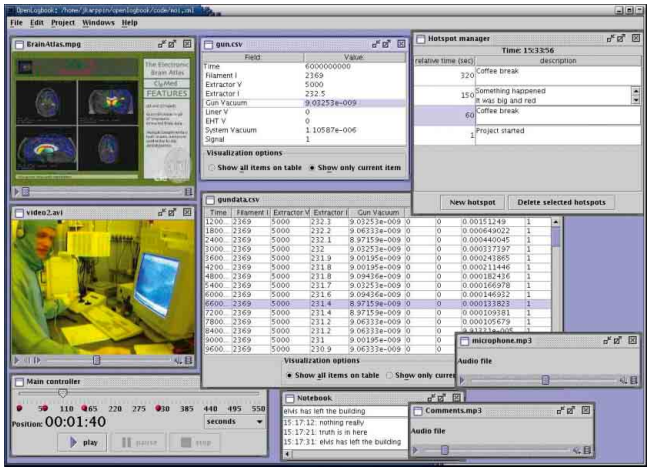
Several CMS software packages (e.g. CMSIM, ORCA, OSCAR) and other physics software (e.g. ROOT, LHCXX) have been made available through the nodes of the cluster. This was done in collaboration with researchers in the LHC Programme at HIP. At the same time the NorduGrid tools have been used to test the submission of physics analysis jobs. The results produced with simulations, like the beam-beam effect in the LHC, were much appreciated by the physicists at CERN.

The Programme has successfully demonstrated a NorduGrid compliant Grid portal prototype, which can be used as a user-friendly interface to Grid resources. Past experience from the development of web-based user interfaces and portals will be exploited when further developing the new Grid portal by using GridBlocks components. GridBlocks, the Grid building blocks, form a coherent and easy-to-use package containing EDG Grid security solutions and several value added Grid application components. It is disseminated and managed as Open Source software through the Sourceforge service (http://gridblocks.sourceforge.net) since November 2002.

The Mobile Analyzer concept was generalized during




The new GridBlocks application framework will combine existing and new Open Source software modules. It is available at http://gridblocks.sourceforge.net.



OpenLogbook is an e-science application that keeps record of synchronous multimedia and metadata management for easy retrieval and storage.



the year to allow the operation of other types of applications than the ones used in physics. The application was already used for the distributed aggregation calculations of OLAP databases and neural network based distribution optimizations. The software has since been promoted to the GridBlocks framework, where the work continues to provide Grid users with a flexible web service based on a distributed agent tool. Interoperation between the Grid portal and the Mobile Analyzer has also been demonstrated during the year.

## Industrial collaboration

The increased interest in the Grid technologies combined with the emerging consensus about the basic structure of the Grid solutions have created a suitable environment for exchange and testing of ideas between academia and industry. Following this trend the Technology Programme has been active in disseminating information about Grid technologies and their development to industrial parties outside the scientific world. A contact network towards the industry has been established through public presentations and numerous face-to-face visits to companies in Finland and in Switzerland.

The main result of these discussions has been the formation of a domestic project consortium with three academic and six industrial participants. The aim of the project is to share know-how on Grid technologies with industry and to provide industrial companies with a possibility to test the technologies in practice. Special focus is being placed on reviewing the impact of the Grid on the current and near-future solutions provided by the companies focusing on information and communications technologies (ICT). In addition to the technological solutions, the study also aims at trying to gain an understanding of the possible effect of the Grid in the business models of various players in the ICT cluster. Other activities that have strengthened the technology transfer activities around the Grid are the following:

- As mentioned earlier HIP applied and was granted an affiliate membership in the Liberty Alliance project. This offers an excellent possibility to learn about the industrial security standardization work and the rationale directing it. Understanding the concerns in this context is of paramount importance for the success of the dissemination work related to the Grid security issues.
- Participation in the CERN OpenLab initiative, which is an interactive forum to establish collaboration between CERN and industrial partners around data-intensive problems in Grid environment.
- Tight collaboration with CERN and the National Micro- and Nanotechnology Research Center in Denmark (MIC) resulted in an extensive student exchange programme during summer 2002 (partially funded by the Magnus Ehrnrooth Foundation). This collaboration has also established collaborative contact with SMEs in Denmark and generated a business plan, which was entered into the Venture Cup Finland competition.

As always the summer student programme of HIP was well exploited by the group. Eight new university students from Finland and Denmark together with four students of the previous year took part in a collaboration with the initiative for nanotechnologies and contributed to Grid software development work. The results of this collaboration are now being leveraged as an example in planning CERN's OpenLab student programme. One of the results of this collaboration is called the OpenLogbook, which is an e-science application to keep a record of synchronous multimedia and metadata management for easy retrieval and storage. The Technology Programme continues to work together with CERN OpenLab to facilitate similar technology spin-offs on a larger scale.

# 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 the most fruitful way of recruiting graduate students. In particular, the summer jobs at CERN are extremely efficient in this respect. During 1998-2002 19 doctoral degrees and 49 Masters' degrees have been earned in HIP research projects.



The Web University (WU) activity at CERN has continued. HIP has participated in the Open Learning Environment project led by Tampere University of Technology. The project has been funded by the Finnish National Technology Agency (TEKES). WU works as a virtual university, in which distant audiences participate in CERN seminars from their own countries. WU has also successfully continued Finland's Particle Physics Outreach Programme. In 2002 WU organized several 3-5 day schools at CERN for high school students and 140 students and 30 teachers from 20 different schools participated in those activities. In addition, one learning period at CERN was organized for high school physics teachers with 15 participants.

The National Board of Education (Opetushallitus) started in collaboration with HIP and the city of Jyväskylä a CERN co-operation school network, which 40 schools and 16 partners from universities, physics institutes and teacher training centres have joined. The main aim is to develop the role of particle physics in school curricula in co-operation with CERN.

The Institute has now operated for its first full year in the new building, Physicum, on the Kumpula campus. Most of the matters related to the move and setting up the research infrastructure have gradually been settled. However, a number of things still remain to be done. Connected with the move and the new laboratories additional resources for laboratory equipment (in addition to the normal budget) have been received. In 2000-2002 this totalled about 191,000 euros. The procurement of acquisitions has almost finished.

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

# Organization and Personnel

## Organization

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

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Ilkka Niiniluoto, Antti Kupiainen, Timo Tiihonen, Juhani Keinonen, Peter Lund, Katri Huitu, Mauri Airila, Rauno Julin

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Mikko Sainio

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- Statistical Physics and Materials Science — Tapio Ala-Nissilä
- 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**
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- 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
- Distributed Data Management — Miika Tuisku
- Data Grid — Matti Heikkurinen



The Board: Julin, Lund, Airila, Näsi, Niiniluoto, Huitu, Kupiainen, Keinonen.

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**Juhani Keinonen**, Professor (University of Helsinki)
**Antti Kupiainen**, Professor (University of Helsinki)
**Peter Lund**, Professor (Helsinki University of Technology)
**Salme Näsi**, Vice Rector (until 13.11.2002) (University of Jyväskylä)
**Timo Tiihonen**, Vice Rector (from 14.11.2002) (University of Jyväskylä)
**Katri Huitu**, Docent (Chosen by personnel of HIP) by the Ministry of Education)

## The Scientific Advisory Board

Chairman: **Hans Hoffmann**, Professor (CERN)

Members:

**Martti Mäenpää**, Director General (Federation of Finnish Metal, Engineering and Electrotechnical Industries – MET)

**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
J. Koponen, grad. student
T. Lähde, grad. student

### Cosmology

K. Enqvist, prof., proj. leader
S. Kasuya, scientist
J. Högdahl, grad. student
A. Jokinen, grad. student
V. Muhonen, grad. student
T. Poutanen, grad. student
S. Räsänen, grad. student
M. Sloth, grad. student
A. Sorri, 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.-P. Martikainen, scientist
A. Collin, grad. student
O. Dannenberg, grad. student
J. Piilo, 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
D. Chakraverty, scientist
A. Datta, scientist
J. Laamanen, grad. student
T. Rüppell, grad. student
E. Brücken, student
A. Syriniotis, student

### Physics of Biological Systems

I. Vattulainen, proj. leader
M. Hyvönen, scientist
E. Terämä, grad. student
M. Heikelä, student
P. Lindqvist, student
O. Punkkinen, student
T. Riipinen, student

### Statistical Physics and Materials Science

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J. Lahtinen, grad. student
O. Ajanki, student
T. Laurila, student
T. Timonen, student

### String Theory and Quantum Field Theory

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

### Ultrarelativistic Heavy Ion Collisions

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

## High Energy Physics Programme

H. Saarikko, prof., programme director

### Electron-Positron Physics

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

### 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)
T. Mäki, student

### COMPASS

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

### Detector Laboratory

K. Kurvinen, lab. manager
J. Heino, 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
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K. Lassila-Perini, senior scientist (at CERN)
V. Lefébure, senior scientist (at CERN)
S. Lehti, senior scientist
T. Lindén, senior scientist
M. Arenius, scientist (at CERN)
A. Heikkinen, grad. student
T. Lampén, grad. student
J. Nysten, grad. student (at CERN)
M. Voutilainen, student (at CERN)
L. Wendland, student
P. Mehtälä, summer trainee (at CERN)
A. Zibellini, summer trainee (at CERN)

### CMS Tracker

E. Tuominen, proj. leader (at CERN)
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J. Härkönen, senior scientist (at CERN)
S. Nummela, senior scientist (at CERN)
P.-O. Friman, scientist (at CERN)
P. Johansson, scientist (at CERN)
H. Katajisto, scientist
K. Banzuzi, grad. student (at CERN)
D. Ungaro, grad. student (at CERN)
P. Luukka, student (at CERN)
E. Tuovinen, student
P. Mehtälä, summer trainee (at CERN)
J. Niku, summer trainee (at CERN)
T. Olenius, summer trainee (at CERN)
J. Simpura, summer trainee (at CERN)
T. Vaarala, summer trainee (at CERN)

## Nuclear Matter Programme

J. Äystö, prof., programme director

### ALICE

W. Trzaska, docent, proj. leader
V. Ruuskanen, prof., senior scientist
M. Oinonen, senior scientist
Z. Radivojevic, scientist
M. Bondila, grad. student
M. Komogorov, grad. student
H. Seppänen, grad. student
T. Kalliokoski, 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)

### Distributed Data Management

M. Tuisku, proj. leader (at CERN)
M. Silander, scientist (at CERN)

### DataGrid

M. Heikkurinen, proj. leader (at CERN)
M. Gindonis, scientist (at CERN)
J. Hahkala, scientist (at CERN)
J. Herrala, scientist (at CERN)
J. Klem, scientist (at CERN)
M. Käki, scientist (at CERN)
M. Niinimäki, 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. Teräs, student

## Administration and Support

D.-O. Riska, prof., director
M. Sainio, docent, adm. manager
T. Sandelin (Kalpio), financial manager
M. Flygar, secretary (at CERN)
T. Hardén, secretary
T. Karppinen, secretary (at CERN)
P. Lehto, secretary
S. Niemi, secretary (18.1.-15.6.)
M. Riska, secretary, summer trainee
A. Heikkilä, tech. coordinator
R. Rinta-Filppula, researcher (at CERN)
J. Kokkonen, grad. student
T. Koskenvaara, student (at CERN)
N. Jiganova, senior system analyst
T. Vehviläinen, lab. engineer

# Seminars

## Seminars held in Helsinki

January 15th L. Bonora (SISSA, Italy)
**Why noncommutativity?**

January 22nd E. Keski-Vakkuri (HIP)
**On the bosonic string spectrum in a black hole background**

January 28th (Colloquium) A. Annila (Dept. of Physical Sciences, University of Helsinki)
**Biofysiikka Helsingin yliopistossa**

January 29th E. Somersalo (HUT)
**Near infrared optical tomography and anisotropies**

February 4th (Colloquium) W. Oelert (KFA Jülich)
**Antimatter - production of hot and cold antihydrogen atoms**

February 11th (Colloquium) K. P. Lieb (II. Physical Institute, University of Göttingen)
**Ion beams and thin films**

February 12th R. Vainio (Dept. of Physical Sciences, University of Helsinki/Dept. of Physics, University of Turku)
**Acceleration of energetic ions in solar events**

February 19th D. Rischke (Frankfurt, Germany)
**Color superconductivity in cold, dense quark matter**

February 21st M. Sallé (ITP, Amsterdam)
**Quantum fields out of equilibrium: kinks in the Hartree approximation**

February 26th M. Nakahara (Materials Physics Laboratory, HUT)
**Topological creation of a vortex in a BEC of alkali atoms**

March 5th I. Vattulainen (HIP)
**Towards coarse grained descriptions of biological membrane systems**

March 12th J. Evslin (Dept. of Mathematics, University of California, Berkeley)
**On the K-theory classification of D-branes**

March 18th (Colloquium) A. de Roeck (CERN)
**Physics at linear e+e- collider projects**

March 22nd T. Lähde (HIP)
**Pion rescattering in two-pion decay of heavy quarkonia**

March 26th S. Stenholm (Physics Department, KTH, Sweden)
**The issue of phase in quantum mechanics**

April 4th S. N. Solodukhin (Ludwig-Maximilians U., Munich)
**Horizon holography**

April 8th (Colloquium) B. Schoch (University of Bonn)
**Experimental studies of the structure of the nucleon**

April 9th J. Einasto (Tarto University)
**Structure of superclusters from Sloan and Las Campanas surveys**

April 11th V. A. Petrov (IHEP, Protvino, Russia)
**High-energy behaviour in four and more dimensions**

April 16th S. Maniscalco (Dipartimento di Scienze Fisiche ed Astronomiche, Palermo University, Italy)
**Coherent manipulation of single quantum systems: the physics of trapped ions**

April 23rd S. Räsänen (HIP)
**The ekpyrotic scenario: year one**

April 30th J. Mickelsson (KTH, Stockholm)
**Anomalies in NCG field theory models and generalized traces**

May 7th A. Carey (University of Canberra, Australia)
**Gerbes and string theory**

May 14th N. N. Achasov (Novosibirsk, Russia)
**Radiative decays of the $\phi$-meson and the nature of the lightest scalar mesons**

May 21st A. Sorri (Graduate School)
**Active-sterile neutrino oscillation and lepton asymmetry in the early universe**

May 22nd G. Giudice (CERN)
**Transplanckian collisions at the LHC and beyond**

May 23rd-24th 3rd NorduGrid Workshop
May 23rd:
J. Karppinen, **Introduction to the Mobile analyzer**
C. Loomis, **Status of the European DataGrid**
O. Mulmo, **GLOBUS: Status and future plans**
A. Wäänänen, **Architecture overview**
A. Konstantinov, **Grid Manager**
B. Konya, **Information system**
M. Ellert, **User interface**
O. Smirnova, **Resource specification language**
B. Konya, **User management**
A. Wäänänen, **Software packaging and dissemination**
O. Smirnova, **Applications examples**
May 24th:
L. Johnsson, **Presentation of the Nordic Grid Consortium**
J. Renner Hansen, **Discussion on collaboration between NorduGrid and the Nordic Grid Consortium**
F. Ould-Saada, **Data challenges coordination**
A. Teräs, **Fully Automatic Installation in the Hirmu cluster**
T. Ekelöf, **A Swedish Grid testbed**
V. Karimäki, **Computing in CMS**
J. Klem, **Status of HIP (NorduGrid) Grid Portal**

May 23rd-25th Fifth Nordic LHC Workshop
May 24th:
G. Eigen, **Results from BABAR/BELLE on radiative penguin decays and their implication on new physics**
C. Driouichi, **Prospect for $B_c$ physics at the LHC**
K. Österberg, **Prospects for new physics studies in diffractive processes at the LHC**
P. Osland, **CP violation in the two-Higgs-doublet model**
W. Khater, **Higgs-generated CP violation in top-pair production**
K. Myklevoll, **Possibility of measuring the CP-property of a Higgs boson at the LHC**
F. Sannino, **Bulk Majorons: accelerators versus supernovae constraints**
J. Renner Hansen, **NorduGrid: summary and future plans**
May 25th:
A. Datta, **SUSY search via gauge boson fusion at the LHC**
E. Gabrielli, **On the $B \to X_s l^+ l^-$ decays in general supersymmetric models**
P. Skands, **Baryon number violating SUSY decays**
A. Kobakhidze, **Nonstandard Kaluza-Klein decomposition in higher-dimensional theories**
E. Dvergsnes, **Bremsstrahlung within scenarios of extra dimensions**
E. Lipartia, **Effective field theoretical approach to black hole production**
S. Lehti, **Latest results of MSSM Higgs studies in CMS**
B. K. Gjelsten, **Trilinear Higgs couplings**
U. Fuskeland, **Prospects for $H \to \gamma\gamma$ with ATLAS at LHC**

May 28th J. Soffer (CPT, Marseilles)
**A statistical approach for polarized parton distributions**

May 30th A. Niemi (Uppsala University)
**Aspects of strings and Yang-Mills theories**

May 30th - June 1st Workshop on B/Tau Physics at the LHC
May 30th:
K. Huitu, **Review of SUSY Higgs scenarios**
J. Tuominiemi, **Status of the LHC contruction**
M. Mannelli, **CMS tracker design**
L. Silvestris, **CMS tracker software**
M. Gruwe, **SUSY using b- and τ- signatures at LHC**
J. Kanzaki, **Higgs searches with ATLAS using b- and τ- signatures**
R. Kinnunen, **Review of Higgs searches in CMS**
S. Lehti, **Tau tagging using impact parameter in $H_{SUSY} \rightarrow \tau\tau$ in CMS**
H. Kurki-Suonio, **Status of cosmology today**
May 31st:
J. Brooke, **Overview of the CMS Level-1 Trigger**
T. Todorov, **Track reconstruction for HLT and off-line**
D. Kotlinski, **CMS pixel track reconstruction, optimization of the pixel detector**
A. Nikitenko, **Tau trigger optimization in CMS, Calorimeter**
G. Bagliesi, **τ trigger optimization in CMS, Tracker**
K. Lassila-Perini, **Electron reconstruction and selection in CMS High Level Trigger, Electron triggers in $H \rightarrow \tau\tau \rightarrow eX$**
P. Vanlaer, **Vertex reconstruction in CMS**
L. Wendland, **MSSM $H^0 \rightarrow \tau\tau \rightarrow$ 3 prong using vertexing at CMS**
F. Palla, **b Tagging in CMS**
R. Aleksan, **Status of B physics today**
June 1st:
E. Tuominen, **CMS detector resolution**
P. Luukka, **CMS TOB support structure: tolerances**
A. Ostaptchouk, **CMS Tracker hardware alignment**
V. Karimäki, **Software alignment of the CMS tracker**
T. Lampén, **Detector alignment by reconstructed tracks**

June 6th D. Choudhury (HRI, Allahabad, India)
**Heavy Higgs at a linear collider**

June 10th Presenting HIP to the NORDITA Board
D.-O. Riska, **Overview of HIP**
K. Enqvist, **Theoretical physics in Helsinki**
I. Vattulainen, **Biophysics**
K. J. Eskola, **Ultrarelativistic heavy ion collisions**
E. Keski-Vakkuri, **String theory**
K. Huitu, **Phenomenological particle physics**
E. Lundh, **Laser physics and quantum optics**
K. Enqvist, **Cosmology**

June 11th T. Kuo (Stony Brook, USA)
**New developments in the nuclear interaction**

June 11th L. Thorlacius (Reykjavik University)
**Cosmological models and renormalization group flow**

June 13th Z. Berezhiani (University of L'Aquila and INFN, Italy)
**Baryon asymmetry and dark matter from hidden sector**

June 18th B. Mukhopadhyaya (Allahabad, India)
**Gauge boson fusion and supersymmetry searches**

June 25th S. Kawai (Department of Theoretical Physics, Oxford)
**Coulomb-gas method in boundary CFT**

June 28th M. Shaposhnikov (University of Lausanne)
**Effective field theories from higher-dimensional defects**

July 2nd D. Birmingham (University College Dublin)
**Exact results for the BTZ black hole**

August 13th R. Lebed (Arizona State University)
**Predictions from gauge theories with noncommutative spacetime**

August 27th C. Amsler (Physik-Institut, Universität Zürich)
**New results in proton-antiproton annihilation and the status of glueballs**

September 3rd K. Kajantie (Dept. of Physical Sciences, University of Helsinki)
**Cosmological matter in the laboratory?**

September 9th (Colloquium) C. Frenk (Institute of Computational Cosmology, University of Durham)
**The cold dark matter paradigm**

September 17th Theory "Two-minute meeting"

September 19th Y. Schröder (MIT)
**Four-loop logarithms in 3d gauge+Higgs theory**

September 23rd (Colloquium) K. Eskola (Dept. of Physical Sciences, University of Helsinki)
**Neljä vuosikymmentä eksoottisia ytimiä tutkimassa!**

September 24th M. Noga (Department of Theoretical Physics, Comenius University, Bratislava, Slovakia)
**The microscopic theory of superconductivity in layered structures (high temperature supeconductors)**

September 24th C. Royon (Saclay, France)
**Diffractive Higgs production at Tevatron and LHC**

October 1st P. Hoyer (Dept. of Physical Sciences, University of Helsinki)
**Challenges of hadron physics**

October 8th E. Falck (COMP, Laboratory of Physics, HUT)
**Dynamic polymer systems on mesoscopic scales**

October 15th H. Snellman (Division of Mathematical Physics, Department of Physics, KTH - SCFAB)
**Neutrino oscillations with matter effects**

October 22nd R. Rapp (NORDITA)
**The quest for the quark-gluon plasma with heavy ions**

October 28th (Colloquium) K. Gottfried (Cornell)
**P.A.M. Dirac and the discovery of quantum mechanics**

October 29th S. Khalil (Durham, UK)
**CP violation in supersymmetric and string theories**

October 29th L. Salmi (HIP)
**Determination of heavy quark model parameters from semileptonic B decays at DELPHI**

October 31st V. Abaev (St. Petersburg)
**Some problems of the elastic Pi-N phase shift analysis**

November 5th E. Gabrielli (HIP)
**Quantum gravity and extra dimensions at collider physics**

November 19th T. Lähde (HIP)
**Electromagnetic transitions in heavy flavor mesons**

November 25th F. Sannino (NORDITA)
**General structure of relativistic vector condensation**

November 26th J. Javanainen (University of Connecticut)
**Atom-molecule Bose-Einstein condensate**

December 3rd C. Hanhart (Jülich, Germany)
**Supernovae as particle physics labs**

December 5th I. Andric (R. Boskovic Institute, Zagreb, Croatia)
**Duality in the low dimensional field theory**

December 10th T. Neuhaus (Bielefeld, Germany)
**Field theory study of scalar electrodynamics and superconductivity**

December 12th P. Kolb (Stony Brook, USA)
**Elliptic flow and rapid thermalization**

December 17th A. Jokinen (HIP)
**Baryogenesis through Affleck-Dine mechanism**

# Visitors

## Theory Programme

### Cosmology

J. Einasto (Estonia) 8.-9.4.
M. Einasto (Estonia) 8.-9.4.
A. Mazumdar (Italy) 8.4.-8.5.
R. Allahverdi (Germany) 23.-28.4.
A. Mazumdar (Italy) 24.8.-4.9.
F. Ravndal (Norway) 3.9.-13.9.

### Laser Physics and Quantum Optics

F. Haug (Germany) 1.1.-30.6.
S. Maniscalco (Italy) 9.3.-19.5.

### Particle Physics Phenomenology

W. F. Chen (Canada) 27.1.-28.2.
D. Choudhury (India) 8.5.-16.6.
P. Pandita (India) 13.-22.5.
G. Giudice (Switzerland) 21.-24.5.
L. Alvarez-Gaume (Switzerland) 22.-26.5.
A. Parker (UK) 23.-24.5.
B. Mukhopadhyaya (India) 27.5.-24.7.
A. Cabo (Cuba) 23.9.-12.10.
J. Chkareuli (Georgia) 2.10.-1.11.
S. Khalil (UK) 27.10.-3.11.
P. Keränen (Denmark) 20.12.-7.1.2003

**Hadron Physics Activity**
E. Norvaišas (Lithuania) 28.1.-1.2.
W. Oelert (Germany) 2.-4.2.
B. Schoch (Germany) 6.-9.2.
R. Lebed (USA) 7.-15.8.
T. Peña (Portugal) 18.-28.8.
A. Stadler (Portugal) 18.-28.8.
K. Gottfried (USA) 27.-28.10.
V. Abaev (Russia) 28.10.-2.11.
F. Gross (USA) 11.-15.12.

### Physics of Biological Systems

A. P. Hynninen (The Netherlands) 29.5.-7.6.
J. M. Polson (Canada) 30.5.-30.6.
A. Laaksonen (Sweden) 31.5.-6.6.
A. Lyubartsev (Sweden) 31.5.-6.6.
L. Miao (Denmark) 6.-8.6.
P. Niemelä (Finland) 6.-7.8.
A. Gurtovenko (Russia) 17.-18.10.
P. Niemelä (Finland) 31.10.-2.11.
A. Bunker (UK) 28.11.-8.12.

### Statistical Physics and Materials Science

K. Elder (USA) 3.1.-30.4.
O. Trushin (Russia) 7.-11.1.
M. Castro (Spain) 17.-24.3.
R. Cuerno (Spain) 17.-24.3.
V. Bochkarev (Russia) 6.-10.5.
Z. Chvoj (The Czech Republic) 6.-18.5.
O. Trushin (Russia) 6.-17.5.
S. Badescu (USA) 19.5.-30.6.
T. S. Rahman (USA) 26.5.-22.6.
A. Karim (USA) 4.6.-30.6.
S. C. Ying (USA) 13.-23.6.
E. Granato (Brazil) 14.-27.6.
O. Trushin (Russia) 17.6.-12.7.
O. Trushin (Russia) 15.-20.12.
V. Bochkarev (Russia) 16.-20.12.

### String Theory and Quantum Field Theory

W. Chen (Canada) 27.1.-28.2.
J. Evslin (USA) 3.-13.3.
P. Prešnajder (Slovakia) 18.3.-18.5.
V. Petrov (Russia) 30.3.-14.4.
S. Solodukhin (Germany) 2.-8.4.
Y. Liao (Germany) 7.-27.4.
A. Carey (Australia) 27.4.-11.5.
J. Mickelsson (Sweden) 27.4.-11.5.
K. Nishijima (Japan) 15.5.-4.6.
P. Kulish (Russia) 16.-19.5.
Z. Berezhiani (Italy) 1.-30.6.
P. Berglund (USA) 4.-10.6.
D. Ghoshal (India) 13.-24.6.
S. Kawai (UK) 18.-26.6.
I. Sachs (Ireland) 20.-30.6.
D. Birmingham (Ireland) 25.6.-1.7.
P. Prešnajder (Slovakia) 12.8.-12.9.
D. Ellinas (Greece) 17.8-1.9.
A. Cabo (Switzerland) 21.9.-12.10.
J. Chkareuli (Georgia) 2.10-1.11.
Y. Vernov (Russia) 16.11.-7.12.
M. Mnatsakanova (Russia) 16.11.-7.12.
I. Andric (Croatia) 24.11.-6.12.
P. Prešnajder (Slovakia) 25.11.-13.12.
W. Chen (Canada) 4.-31.12.

### Ultrarelativistic Heavy Ion Collisions

P. Huovinen (USA) 9.-11.1.
C. Salgado (Switzerland) 19.-26.1.
M. Sallé (The Netherlands) 17.-24.2.
D. Rischke (Germany) 18.-24.2.
N. Armesto (Spain) 17.3.-6.4.
K. Tuominen (Denmark) 3.-7.6.
M. Strickland (USA) 11.-17.6.
M. Shaposhnikov (Switzerland) 27.-28.6.
P. Huovinen (USA) 12.8.-2.9.
Y. Schröder (USA) 14.-22.9.
H. Weigert (Germany) 2.-9.10.
B. Zakharov (Russia) 14.-20.10.
R. Rapp (Denmark) 19.-25.10.
K. Tuominen (Denmark) 11.-23.11.
F. Sannino (Denmark) 25.-27.11.
T. Neuhaus (Germany) 2.-20.12.
P. Kolb (USA) 8.-13.12.
Y. Schröder (USA) 17.-20.12.

## CMS Programme

### Software and Physics

A. Nikitenko (UK) 30.5.-1.6.
L. Silvestris (Italy) 30.5.-1.6.
T. Todorov (France) 30.5.-1.6.
A. Hector (Estonia) 1.-31.12.

### CMS Tracker

M. Mannelli (Switzerland) 30.5.-1.6.
R. Aleksan (France) 31.5.-1.6.
K. Bunkowski (Poland) 9.-13.12.
D. Rybka (Poland) 9.-13.12.
W. Zabolotny (Poland) 9.-13.12.

## Nuclear Matter Programme

F. Guber (Russia) 27.-29.5.
S. Igolkin (Russia) 27.-29.5.
V. Borschchov (Ukraine) 25.7.-1.8.
A. Kurilov (Ukraine) 25.7.-1.8.
G. Zinovjev (Ukraine) 25.7.-1.8.
N. Chernykova (Ukraine) 27.8.-10.9.
A. Kurilov (Ukraine) 27.8.-10.9.
M. Zinovjev (Ukraine) 27.8.-10.9.
Y. Panebratsev (Russia) 15.-19.12.

## Technology Programme

F. Grey (Denmark) 1.1.-30.10.
T. Niemi (Finland) 1.4.-31.12.

# Conference participation, Talks and Visits by Personnel

## Theory Programme

### Cosmology

**Spåtind 2002, 17th Nordic Particle Physics Meeting,**
4-10 January, Spåtind, Norway (talk by M. Sloth, talk by R. Sturani, talk by J. Väliviita)

**1st NorFa Network Meeting, Theoretical Particle Physics and Cosmology,**
25-26 January, Copenhagen, Denmark (K. Enqvist, V. Muhonen, talk by S. Räsänen, talk by R. Sturani)

**CTP Working Meeting,**
3-5 February, Paris, France (E. Keihänen, T. Poutanen)

**Nordic Project on Astroparticle Physics and Cosmology,**
1-2 March, Copenhagen, Denmark (K. Enqvist, J. Högdahl, V. Muhonen, A. Väihkönen, talk by J. Väliviita)

**General Meeting of the EURO-GDR SUSY Network,**
April, Durham, UK (talk by R. Sturani)

**EuroConference on Supersymmetry, Gravity and Quantum Cosmology,**
1-6 June, Bad Herrenalb, Germany (M. Sloth)

**Cosmoseismology and Entropy Perturbations,**
18-20 June, Portsmouth, UK (J. Väliviita)

**CTP Working Meeting,**
24-28 June, Cambridge, UK (talk by E. Keihänen, talk by T. Poutanen)

**YITP Workshop 2002, Progress in Particle Physics,**
8-11 July, Kyoto, Japan (talk by S. Kasuya)

**UNESCO International Conference on Theoretical Physics,**
22-27 July, Paris, France (J. Väliviita)

**Summer School on Cosmology and the High-Redshift Universe,**
5-15 August, Abisko, Sweden (J. Högdahl, V. Muhonen, A. Väihkönen)

**International School of Space Sciences,**
30 August - 7 September, L'Aquila, Italy (J. Väliviita)

**Lammi Summer School,**
1-4 September, Lammi, Finland (talk by K. Enqvist)

**Autumn Meeting of the Physical Society of Japan,**
13-16 September, Tokyo, Japan (talk by S. Kasuya)

**International Workshop on Particle Physics and the Early Universe (COSMO-02),**
18-21 September, Chicago, USA (talk by S. Kasuya)

**EU SUSY and The Early Universe Network Mid-Term Meeting,**
26-28 September, Oxford, UK (talk by K. Enqvist, S. Räsänen, talk by M. Sloth, R. Sturani)

**Planck Joint Consortium Meeting 2002,**
14-16 October, Santander, Spain (V. Muhonen, T. Poutanen)

**2nd NorFA Network Meeting, Theoretical Particle Physics and Cosmology,**
24-26 October, Uppsala, Sweden (J. Högdahl, V. Muhonen, talk by M. Sloth, R. Sturani, A. Väihkönen, J. Väliviita)

**Cospar and Antares Meetings,**
30 October - 1 November, Oulu, Finland (talk by K. Enqvist, talk by E. Keihänen)

### Laser Physics and Quantum Optics

**Cold Molecules 2002: Ultracold Molecules and Bose-Einstein Condensation,**
3-8 March, Les Houches, France (M. Mackie)

**The Annual Meeting of the Finnish Physical Society,**
14-16 March, Joensuu, Finland (A. Collin, O. Dannenberg, and K.-A. Suominen)

**CATS, European Science Foundation Exploratory Workshop on 'Collisions in Atom Traps',**
7-11 April, Sandbjerg, Denmark (invited talk by J. Piilo)

**YAO 2002, Young Atom Optician Conference,**
13-18 April, Volterra (Pisa), Italy (A. Collin, F. Haug)

**The Annual Meeting of the Finnish Optical Society,**
24-26 April, Kajaani, Finland (K.-A. Suominen)

**COSLAB-Workshop on Quantum-vacuum properties in condensed-matter physics and cosmology,**
17-20 May, Tours, France (invited talk by K.-A. Suominen)

**DAMOP,**
28 May - 1 June, Williamsburg, VA, USA (M. Mackie)

**EGAS 34,**
9-12 July, Sofia, Bulgaria (M. Mackie)

**ICAP 2002,**
28 July - 2 August, Cambridge, MA, USA (J. Piilo)

**DICE2002,**
2-6 September, Piombino, Italy (O. Dannenberg, J. Piilo)

**Interactions in Ultracold Gases: from Atoms to Molecules,**
9-13 September, Heidelberg, Germany (talk by M. Mackie)

**IQING, Informal Quantum INformation Gathering,**
19-22 September, Imperial College, London, UK (talk by O. Dannenberg)

**EuroConference on Quantum Atom Optics: From Quantum Science to Technology,**
21-26 September, San Feliu de Guixols, Spain (A. Collin, J. Piilo, invited talk by K.-A. Suominen)

**7th International Workshop on Atom Optics and Interferometry,**
28 September - 2 October, Lunteren, The Netherlands (invited talk by E. Lundh)

**EU CAUAC Network Meeting,**
2-3 October, Lunteren, The Netherlands (E. Lundh, K.-A. Suominen)

**NORDITA,**
11-15 December, Copenhagen, Denmark (M. Mackie)

### Particle Physics Phenomenology

**CERN,**
1 January - 7 April, Geneva, Switzerland (E. Gabrielli)

**WHEPP-7 Workshop,**
3-15 January, Allahabad, India (talk by K. Huitu)

**Institute of Theoretical Physics,**
February, Madrid, Spain (E. Gabrielli)

**The Annual Meeting of the Finnish Physical Society,**
14-16 March, Joensuu, Finland (K. Huitu, J. Laamanen, T. Rüppell)

**Fifth Nordic LHC Physics Workshop and Norfa Training Course,**
23-25 May, Helsinki, Finland (talk by A. Datta, talk by E. Gabrielli, J. Laamanen, T. Rüppell)

**Workshop on B/Tau Physics at the LHC,**
30 May - 1 June, Helsinki, Finland (talk by K. Huitu)

**CERN,**
3-4 June, Geneva, Switzerland (K. Huitu)

**Beyond the Desert 02,**
3-7 June, Oulu, Finland (J. Laamanen, T. Rüppell)

**International Conference on High Energy Physics,**
24-31 July, Amsterdam, The Netherlands (E. Gabrielli, K. Huitu)

**Lammi Summer School,**
1-4 September, Lammi, Finland (talks by K. Huitu)

**School on Neutrino and Astroparticle Physics,**
September, ICTP, Trieste, Italy (D. Chakraverty, A. Datta)

**Department of Physics, University of Roma, La-Sapienza,**
30 September - 4 October, Rome, Italy (E. Gabrielli)

**Department of Physics, University of Roma, La-Sapienza,**
3-5 October, Rome, Italy (talk by A. Datta)

**Department of Physics, University of Vienna,**
7-9 October, Vienna, Austria (talk by A. Datta)

**Particle Physics Day,**
25 October, Jyväskylä, Finland (talk by D. Chakraverty, talk by A. Datta, K. Huitu, talk by J. Laamanen, T. Rüppell)

**6th Nordic LHC Physics Workshop,**
12-13 November, Uppsala, Sweden (talk by D. Chakraverty, talk by A. Datta, talk by E. Gabrielli, talk by J. Laamanen)

**Department of Physics, University of Roma, La-Sapienza,**
14-22 December, Rome, Italy (talk by E. Gabrielli)

### Hadron Physics Activity

**California Institute of Technology,**
1-8 January, Pasadena, CA, USA (talk by D.-O. Riska)

**The Annual Meeting of the Finnish Physical Society,**
14-16 March, Joensuu, Finland (T. Lähde, M. Sainio)

**International Workshop on the Physics of the Roper Resonance,**
8-12 April, ECT*, Trento, Italy (invited talk by D.-O. Riska)

**DPF 2002,**
24-28 May, Williamsburg, VA, USA (talk by T. Lähde)

**MESON 2002, 7th International Workshop on Meson Production, Properties and Interaction,**
24-28 May, Cracow, Poland (M. Sainio)

**International Workshop on Parity Violation in Hadronic Structure,**
5-8 June, Mainz, Germany (invited talk by D.-O. Riska)

**International Conference on Quark Nuclear Physics,**
9-14 June, Forschungszentrum Jülich, Germany (invited talk by D.-O. Riska)

**Electron-Nucleus Scattering VII,**
23-28 June, Marciana Marina, Italy (invited talk by D.-O. Riska)

**Institute of Theoretical Physics, University of Bern,**
1-6 July, Bern, Switzerland (M. Sainio)

**Instituto Superior Technico,**
17-20 July, Lisbon, Portugal (talk by D.-O. Riska)

**Workshop on Hadron Structure and GeV Electroweak Reactions,**
29 July - 2 August, Argonne National Laboratory, USA (invited talk by D.-O. Riska)

**Summer School on COSY Physics,**
28-30 August, Forschungszentrum Jülich, Germany (invited talk by D.-O. Riska)

**XVIII European Conference on Few-Body Physics,**
8-14 September, Bled, Slovenia (talk by T. Lähde, invited talk by D.-O. Riska)

**XVI International Conference on Particles and Nuclei,**
30 September - 4 October, Osaka, Japan (M. Sainio)

**3rd Workshop on Hadronic Atoms,**
14-15 October, CERN, Geneva, Switzerland (M. Sainio)

**EURIDICE Collaboration Meeting,**
18-20 October, Frascati, Italy (talk by T. Lähde, talk by M. Sainio)

**CFIF Fall Meeting 2002, Nuclear dynamics: from quarks to nuclei,**
31 October - 2 November, Lisbon, Portugal (invited talk by D.-O. Riska)

## Physics of Biological Systems

**FOM Institute for Atomic and Molecular Physics (AMOLF),**
13-27 February, Amsterdam, The Netherlands (I. Vattulainen)

**The Annual Meeting of the Finnish Physical Society,**
14-16 March, Joensuu, Finland (talk by E. Falck, E. Terämä, I. Vattulainen)

**Modern Methods in Molecular and Cellular Biophysics,**
18-20 March, Turku, Finland (I. Vattulainen)

**Second Annual Stockholm-Helsinki Micro-Meso Multiscale Simulation Miniconference,**
4-5 April, Stockholm, Sweden (talk by E. Falck, M. Hyvönen, O. Punkkinen, talk by E. Terämä, talk by I. Vattulainen)

**Understanding Molecular Simulations 2002,**
8-19 April, Amsterdam, The Netherlands (E. Falck, E. Terämä)

**Department of Physics, University of Southern Denmark,**
25-28 May, Odense, Denmark (I. Vattulainen)

**SoftSimu2002 - Novel Methods in Soft Matter Simulations,**
31 May - 6 June, Espoo / Helsinki, Finland (E. Falck, O. Punkkinen, E. Terämä, I. Vattulainen)

**Polyelectrolytes 2002, 4th International Symposia on Polyelectrolytes (ISP),**
15-19 June, Lund, Sweden (E. Terämä)

**Department of Physics, University of Prince Edward Island,**
1-22 July, Charlottetown, Canada (E. Falck)

**Nordita MasterClass in Physics,**
19-27 July, Copenhagen, Denmark (O. Punkkinen)

**Department of Chemistry, University of Toronto,**
23-30 July, Toronto, Canada (E. Falck)

**5th Annual Symposium on Bioinformatics and Functional Genomics,**
18-19 August, Turku, Finland (I. Vattulainen)

**EURESCO Conferences: Biophysics from first principles: from the electronic to the mesoscale,**
7-12 September, San Feliu de Guixols, Spain (M. Hyvönen, I. Vattulainen)

## Statistical Physics and Materials Science

**SoftSimu2002 - Novel Methods in Soft Matter Simulations,**
31 May - 6 June, Espoo / Helsinki, Finland (invited lectures by T. Ala-Nissilä, E. Falck, E. Kuusela, J. Lahtinen)

**35th IUVSTA Workshop on Pattern Formation and Atomic Processes in Epitaxial Growth and Ion Erosion,**
9-13 June, Trofaiach, Austria (invited talk by T. Ala-Nissilä, M. Rusanen)

**Department of Physics, McGill University,**
6 September - 7 November, Montreal, Canada (T. Ala-Nissilä)

**2002 McGill Workshop on Advanced Materials for Nano-Science and Nano-Technology,**
4-6 October, Montreal, Canada (T. Ala-Nissilä)

**Czech Academy of Sciences,**
2-8 December, Prague, The Czech Republic (T. Ala-Nissilä)

## String Theory and Quantum Field Theory

**University of Valencia and Autonomous Univerity of Madrid,**
12-20 January, Valencia and Madrid, Spain (talks by D. Polyakov)

**1st NorFa Network Meeting, Theoretical Particle Physics and Cosmology,**
25-26 January, Copenhagen, Denmark (talk by S. Räsänen)

**John Archil Wheeler Symposium,**
15-19 March, Princeton, USA (M. Chaichian)

**Spring School on Superstrings and Related Matters,**
18-26 March, Trieste, Italy (S. Hemming)

**Uppsala University,**
15-18 April, Uppsala, Sweden (talk by E. Keski-Vakkuri)

**IHES and University of Rennes,**
15 April - 15 May, Bures-sur-Yvette and Rennes, France (talks by D. Polyakov)

**IPM String School & Workshop,**
17 April - 3 May, Shiraz, Iran (invited lectures by S. F. Hassan)

**Stanford Linear Accelerator and Stanford University,**
23 April - 14 May, Stanford, USA (A. Tureanu)

**University of California at Los Angeles,**
4-11 May, Los Angeles, USA (talk by E. Keski-Vakkuri)

**Nordic Network Meeting on Fields, Strings and Branes,**
9-11 May, Karlstad, Sweden (S. Hemming and O. Pasanen)

**Rockefeller University,**
22 May - 3 June, New York, USA (talk by D. Polyakov)

**Fifth Nordic LHC Physics Workshop and Norfa Training Course,**
23-25 May, Helsinki, Finland (M. Chaichian, member of Organizing Committee, talk by A. Kobakhidze)

**XXV International Workshop on the Fundamental Problems of High Energy Physics,**
20-30 June, Protvino, Russia (invited talk by M. Chaichian)

**3rd Sakharov International Conference,**
20 June - 1 July, Moscow, Russia (invited talk by M. Chaichian, talk by D. Polyakov)

**"Al. I. Cuza" University of Iasi,**
25 June - 17 July, Iasi, Romania (A. Tureanu)

**Wigner Centennial Conference,**
7-14 July, Pecs, Hungary (invited talk by M. Chaichian)

**8th Gran Sasso Summer Institute: New Dimensions in Astroparticle Physics,**
9-18 July, Assergi, Italy (talk by A. Kobakhidze)

**4th Amsterdam Summer Workshop on String Theory,**
22-28 July, Amsterdam, The Netherlands (E. Keski-Vakkuri)

**UNESCO International Conference on Theoretical Physics,**
23-28 July, Paris, France (talk by D. Polyakov)

**Lammi Summer School,**
2-6 September, Lammi, Finland (lecture by A. Kobakhidze)

**2nd ISPM Workshop on Particles and Cosmology: Modern Trends in Gravity, Cosmology and Particle Physics,**
6-14 September, Tbilisi, Georgia (invited talk by M. Chaichian, talk by A. Kobakhidze)

**Institute of Physics, Georgian Academy of Sciences,**
6-14 September, Tbilisi, Georgia (M. Chaichian)

**EU SUSY and The Early Universe Network Mid-Term Meeting,**
26-28 September, Oxford, UK (S. Räsänen)

**CERN Theory Division,**
3-11 October, Geneva, Switzerland (M. Chaichian)

**ICFA (International Committee for Future Accelerators) Seminar on "Future Perspectives in High Energy Physics",**
8-11 October, Geneva, Switzerland (M. Chaichian)

**2nd NorFA Network Meeting, Theoretical Particle Physics and Cosmology,**
24-26 October, Uppsala, Sweden (invited talk by E. Keski-Vakkuri)

**University of Amsterdam,**
22 November - 4 December, Amsterdam, The Netherlands (talk by D. Polyakov)

**University of Oxford,**
4 December - 8 December, Oxford, UK (talk by D. Polyakov)

**University of Uppsala,**
8 December - 15 December, Uppsala, Sweden (talk by D. Polyakov)

### Ultrarelativistic Heavy Ion Collisions

**Spåtind 2002, 17th Nordic Particle Physics Meeting,**
4-10 January, Spåtind, Norway (T. Lappi, M. Vepsäläinen)

**1st NorFA Network Meeting, Theoretical Particle Physics and Cosmology,**
25-26 January, Copenhagen, Denmark (K. Kajantie)

**LAPPTH,**
6-9 March, Annecy, France, (P. V. Ruuskanen)

**CERN Workshop of Hard Probes in Heavy Ion Collisions at the LHC,**
11-15 March, CERN, Geneva, Switzerland, (subgroup convenor K. J. Eskola, H. Honkanen, V. J. Kolhinen, P. V. Ruuskanen)

**The Annual Meeting of the Finnish Physical Society,**
14-16 March, Joensuu, Finland (K. Kajantie, A. Gynther, talk by S. S. Räsänen)

**QCD and Gauge Theory Dynamics in the RHIC Era,**
1 April - 28 June, Santa Barbara, USA (invited talk by K. Kajantie 1 April-18 June, T. Lappi 13-30 May)

**Lawrence Berkeley National Laboratory,**
29-30 April, Berkeley, CA, USA (talk by K. Kajantie)

**CTEQ Summer School on QCD Analysis and Phenomenology,**
2-10 June, Madison, WI, USA (H. Honkanen)

**CERN,**
11 June - 30 September, Geneva, Switzerland (H. Niemi)

**ECT*,**
1-31 July, Trento, Italy (S. S. Räsänen)

**Quark Matter 2002, XVI International Conference on Ultrarelativistic Nucleus-Nucleus Collisions,**
18-24 July, Nantes, France (K. J. Eskola, A. Gynther, H. Honkanen, invited talk by K. Kajantie, T. Lappi, parallel session convenor and talk by P. V. Ruuskanen, talk by S. S. Räsänen)

**CERN,**
24-30 August, Geneva, Switzerland (M. Vepsäläinen)

**Loops and Legs in Quantum Field Theory,**
8-13 September, Kloster Banz, Germany (A. Vuorinen)

**International Workshop "Strong and Electroweak Matter 2002",**
2-5 October, Heidelberg, Germany (A. Gynther, invited talk by K. Kajantie, T. Lappi, M. Vepsäläinen and A. Vuorinen)

**LAPPTH,**
2-5 October, Annecy, France (P. V. Ruuskanen)

**CERN Workshop of Hard Probes in Heavy Ion Collisions at the LHC,**
7-11 October, CERN, Geneva, Switzerland (subgroup convenor K. J. Eskola, invited talk by V. J. Kolhinen, invited talk by P. V. Ruuskanen)

**Coherent Effects at RHIC and LHC: Initial Conditions and Hard Probes,**
14-25 October, ECT*, Trento, Italy (talk by T. Lappi, talk by S. S. Räsänen)

**2nd NorFA Network Meeting, Theoretical Particle Physics and Cosmology,**
24-26 October, Uppsala, Sweden (organizer K. Rummukainen)

**Particle Physics Day,**
25 October, Jyväskylä, Finland (organizer K. J. Eskola, talk by A. Gynther, talk by V. J. Kolhinen, H. Niemi, organizer P. V. Ruuskanen)

**Saclay, Service de physique theorique,**
2-9 November, Paris, France (talk by K. Kajantie)

**Open Collaboration Meeting of the Finnish ALICE Team,**
29 November, Jyväskylä (K. J. Eskola, H. Honkanen, H. Niemi, talk by P. V. Ruuskanen, talk by S. S. Räsänen)

## High Energy Physics Programme

### Electron-Positron Physics

**Workshop on the CKM Unitarity Triangle,**
13-16 February, CERN, Geneva, Switzerland (L. Salmi)

**The Annual Meeting of the Finnish Physical Society,**
14-16 March, Joensuu, Finland (talk by K. Österberg)

**10th International Conference on Calorimetry in High Energy Physics,**
25-29 March, Pasadena, CA, USA (talk by A. Kiiskinen)

**DELPHI General Meeting,**
25 April, CERN, Geneva, Switzerland (talk by L. Salmi)

**Fifth Nordic LHC Physics Workshop,**
23-25 May, Helsinki, Finland (talk by K. Österberg)

**DPF 2002,**
24-28 May, Williamsburg, VA, USA (talk by L. Salmi)

**5th Meeting of the CLIC Physics Study Group,**
4 July, CERN, Geneva, Switzerland (talk by L. Salmi)

**LCWS 2002 - International Workshop on Linear Colliders,**
26-30 August, Jeju Island, South Korea (talk by L. Salmi)

**Particle Physics Day,**
25 October, Jyväskylä, Finland (talks by K. Österberg and L. Salmi)

### LHC Forward Physics

**LISHEP 2002 - Workshop on Diffractive Physics,**
4-8 February, Rio de Janeiro, Brazil (invited talk by R. Orava)

**CMS-Totem Workshop at CERN,**
8 March, Geneva, Switzerland (invited talk by R. Orava)

**Open Session of the Large Hadron Collider Committee (LHCC),**
13 March, Geneva, Switzerland (talk by S. Tapprogge)

**Low-x Workshop,**
16-20 April, Antwerp, Belgium (invited talk by R. Orava)

**NEEDS Workshop on Needs from Accelerator Experiments for the Understanding of High-Energy Extensive Air-Showers,**
18-20 April, Karlsruhe, Germany (invited talk by S. Tapprogge)

**DIS2002 - Deep Inelastic Scattering 2002,**
27 April - 4 May, Cracow, Poland (invited talk by R. Orava)

**Project Review for the Scientific Advisory Board of HIP,**
3 June, CERN, Geneva, Switzerland (invited talk by R. Orava)

**IPPP Workshop on Ultra High Energy Cosmic Rays,**
21 June, Durham, UK (invited talk by S. Tapprogge)

**Forward Physics Workshop during ATLAS Collaboration Meeting,**
22-28 June, Clermont-Ferrand, France (talk by S. Tapprogge)

**CMS-Totem Workshop at CERN,**
6 December, Geneva, Switzerland (invited talk by R. Orava)

### Detector Laboratory

**The Annual Meeting of the Finnish Physical Society,**
14-16 March, Joensuu, Finland (J. Heino, K. Kurvinen)

**Sixth International Conference on Position Sensitive Detectors,**
9-13 September, Leicester, UK (K. Kurvinen)

## CMS Programme

### Software and Physics

**CSC Grid Seminar,**
6 March, Espoo, Finland (talk by T. Lindén)

**The Annual Meeting of the Finnish Physical Society,**
14-16 March, Joensuu, Finland (A. Heikkinen, T. Lampén, talk by K. Lassila-Perini, S. Lehti)

**3rd NorduGrid Workshop,**
23-24 May, Helsinki, Finland (talk by V. Karimäki, T. Lampén, T. Lindén)

**Fifth Nordic LHC Physics Workshop,**
23-25 May, Helsinki, Finland (talk by S. Lehti, T. Lindén)

**Workshop on B/Tau Physics at the LHC,**
30 May - 1 June, Helsinki, Finland (A. Heikkinen, talk by V. Karimäki, talk by R. Kinnunen, talk by T. Lampén, talk by K. Lassila-Perini, talk by S. Lehti, T. Lindén, J. Nysten, talk by J. Tuominiemi, talk by L. Wendland)

**9th CTEQ Summer School in QCD Analysis and Phenomenology,**
1-11 June, Madison, WI, USA (S. Lehti)

**Praha-Spin-02 - Advanced Study Institute on Symmetries and Spin,**
14-27 June, Prague, The Czech Republic (talk by K. Lassila-Perini)

**PARA'02 - Conference on Applied Parallel Computing,**
15-18 June, Espoo, Finland (T. Lindén)

**9th European Symposium on Semiconductor detectors: New Developments on Radiation Detectors,**
17-23 June, Schloss Elmau, Germany (A. Heikkinen)

**SUSY02, 10th International Conference on Supersymmetry and Unification of Fundamental Interactions,**
22-23 June, DESY, Hamburg, Germany (invited talk by R. Kinnunen)

**CERN, CMS Experiment,**
25 June - 10 August, Geneva, Switzerland (talk by T. Lampén)

**Nordic Grid Workshop,**
28 August - 1 September, Bergen, Norway (talk by T. Lindén)

**Lammi Summer School,**
4 September, Lammi, Finland (talk by S. Lehti)

**CERN School of Computing 2002,**
15-28 September, Vico Equense, Italy (T. Lampén)

**Computing Seminar, CERN IT Division,**
25 September, Geneva, Switzerland (talk by V. Lefébure)

**2002 LHC Days in Split,**
8-12 October, Split, Croatia (invited talk by R. Kinnunen, invited talk by V. Lefébure)

**Particle Physics Day,**
25 October, Jyväskylä, Finland (talk by A. Heikkinen, talk by T. Lindén)

**CERN, GEANT4 Collaboration,**
4-29 November, Geneva, Switzerland (A. Heikkinen)

**4th NorduGrid Workshop,**
11-12 November, Uppsala, Sweden (talk by T. Lindén)

**Kumpula Computing Contact- and Support Persons Meeting,**
14 November, Helsinki, Finland (talk by T. Lindén)

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

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

### CMS Tracker

**The Annual Meeting of the Finnish Physical Society,**
14-16 March, Joensuu, Finland (talk by J. Härkönen, talk by S. Nummela)

**International Conference on Women in Physics,**
7-9 April, Paris, France (K. Banzuzi)

**Semicon Europa 2002 Exposition,**
24-26 April, Munich, Germany (J. Härkönen)

**Photonics and Web Engineering Symposium,**
23-26 May, Wilga Village, Poland (talk K. Banzuzi, talk by D. Ungaro)

**Workshop on B/Tau Physics at the LHC,**
30 May - 1 June, Helsinki, Finland (talk by P. Luukka, talk by E. Tuominen)

**LHC Experiments Joint Controls Project Third Workshop JCOP-III,**
5-6 June, CERN, Geneva, Switzerland (K. Banzuzi, D. Ungaro)

**9th European Symposium on Semiconductor Detectors,**
23-27 June, Schloss Elmau, Germany (talk by A. Heikkinen, talk by J. Härkönen)

**RD39 Collaboration Workshop,**
8 July, CERN, Geneva, Switzerland (talk by J. Härkönen, E. Tuominen)

**4th International Conference on Radiation Effects on Semiconductor Materials Detectors and Devices,**
10-12 July, Florence, Italy (talk by J. Härkönen)

**6th World Multiconference on Systemics, Cybernetics and Informatics,**
14-18 July, Orlando, FL, USA (talk by K. Banzuzi)

**2002 IEEE Nuclear and Space Radiation Effects Conference,**
15-19 July, Phoenix, AZ, USA (talk by E. Tuovinen)

**The 2002 European School of High-Energy Physics,**
25 August - 7 September, Pylos, Greece (K. Banzuzi)

**1st RD50 Workshop on Radiation Hard Semiconductor Devices for Very High Luminosity Colliders,**
2-4 October, CERN, Geneva, Switzerland (J. Härkönen, P. Luukka, talk by E. Tuominen)

**8th Topical Seminar on Innovative Particle and Radiation Detectors,**
21-24 October, Siena, Italy (talks by E. Tuominen)

**Particle Physics Day,**
25 October, Jyväskylä, Finland (talk by E. Tuovinen)

**Detector Course by J. Härkönen at Helsinki University of Technology,**
Espoo, Finland (K. Banzuzi, P. Luukka, S. Nummela, J. Nysten, E. Tuominen, D. Ungaro)

**Working visits to University of Jyväskylä, Department of Physics,**
Jyväskylä, Finland (J. Härkönen, S. Nummela, P. Mehtälä, J. Nysten, K. Lassila-Perini, P. Luukka, E. Tuominen, E. Tuovinen, D. Ungaro, A. Zibellini)

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

**Working visit to University of Warsaw,**
Warsaw, Poland (K. Banzuzi, H. Katajisto, D. Ungaro)

**Working visits to CERN,**
Geneva, Switzerland (H. Katajisto)

## Nuclear Matter Programme

### ALICE

**Soltan Institute for Nuclear Studies,**
26 February, Warsaw, Poland (talk by W. Trzaska)

**The Annual Meeting of the Finnish Physical Society,**
14-16 March, Joensuu, Finland (talks by W. Trzaska, M. Bondila, M. Komogorov, V. Lyapin, M. Oinonen, Z. Radivojevic)

**CERN, SAB Meeting,**
3 June, Geneva, Switzerland (talk by W. Trzaska)

**WE-Heraeus-Seminar Symposium on Nuclear clusters: from light exotic to superheavy nuclei**
5-9 August, Rauischholzhausen, Germany (invited talk by W. Trzaska)

**Warsaw University of Technology,**
4 October, Warsaw, Poland (talk by W. Trzaska)

**Particle Physics Day,**
24 October, Jyväskylä, Finland (talk by W. Trzaska)

**Texas A&M University,**
11 November, College Station, USA (talk by W. Trzaska)

**CAARI 2002,**
12-16 November, Denton, USA (invited talk by W. Trzaska)

**CERN, ALICE Technical Board Meeting,**
27 November, Geneva, Switzerland (talk by W. Trzaska)

**Open Collaboration Meeting of the Finnish ALICE Team,**
29 November, Jyväskylä, Finland (talks by all the participants: J. Äystö, V. Ruuskanen, W. Trzaska (2), M. Oinonen, Z. Radivojevic, S. Räsänen, H. Seppänen, V. Lyapin, M. Komogorov, M. Bondila)

### ISOLDE

**14th Nordic Meeting on Intermediate and High Energy Nuclear Physics,**
5-10 January, Gräftåvallen, Sweden (A. Jokinen)

**Ludwig-Maximilians-Universität München**
19 February, Munich, Germany (talk by A. Jokinen)

**DESY Colloquium,**
12 March, Hamburg, Germany (talk by J. Äystö)

**DESY Zeuthen,**
12 March, Zeuthen-Berlin, Germany (talk by J. Äystö)

**EMIS XIV,**
6-10 May, Victoria, Canada (A. Jokinen)

**NIPNET + ION CATCHER Annual Meeting,**
23-25 May, Groningen, The Netherlands (talks by A. Jokinen and J. Äystö)

**International Conference on Trapped Charged Particles and Fundamental Interactions,**
23-28 August, Wildbad Kreuth, Germany (J. Äystö)

**3rd International Conference on Fission and Properties of Neutron-Rich Nuclei,**
3-9 November, Sanibel Islands, USA (talk by A. Jokinen)

## Technology Programme

**Global Grid Forum 4,**
17-20 February, Toronto, Canada (M. Gindonis)

**CSC Grid Seminar,**
6 March, Espoo, Finland (talk by M. Heikkurinen)

**NLANR Grid Portal/CMS Meeting,**
3 April, CERN, Geneva, Switzerland (talk by J. White)

**EURAM´s 2nd Conference on Innovative Research in Management,**
9-11 May, Stockholm, Sweden (talk by K. Artto, A.-P. Hameri)

**European Academy of Management Conference,**
14-16 May, Stockholm, Sweden (talk by E. Autio)

**3rd NorduGrid Workshop,**
23-24 May, Helsinki, Finland (talk by J. Karppinen)

**12th European-Japanese Conference on Information Modeling and Knowledge Bases,**
27-30 May, Swiss Saxony, Germany (talk by T. Niemi)

**Babson-Kauffman Conference on Research in Entrepreneurship,**
5-8 June, Boulder, CO, USA (talk by E. Autio)

**PARA'02 - Conference on Applied Parallel Computing,**
15-18 June, Espoo, Finland (tutorial by A. Teräs)

**EU DG XII Strategy Workshop on Future Innovation Policies,**
11 July, Brussels, Belgium (talk by E. Autio)

**Academy of Management Conference,**
5-8 August, Denver, CO, USA (talk by E. Autio)

**Metal and Marine Industry Seminar,**
22 August, Turku, Finland (talk by A.-P. Hameri)

**Nordic Grid Workshop,**
29-30 August, Bergen, Norway (talk by M. Heikkurinen)

**Family Business Network World Conference,**
12-15 September, Helsinki, Finland (talk by E. Autio)

**22nd Strategic Management Conference,**
18-20 September, Paris, France (talk by E. Autio)

**1st FT @ CERN: Grid Technologies: scientific and industrial prospects,**
27 September, Geneva, Switzerland (elevator pitch by M. Heikkurinen)

**3rd Annual Workshop on Linux Clusters for Super Computing*,**
23-25 October, Linköping, Sweden (talk by M. Gindonis)

# Publications

**DOLAP 2002, ACM Fifth International Workshop on Data Warehousing and OLAP,**
8 November, McLean, VA, USA (talk by T. Niemi)

**4th NorduGrid Workshop,**
11-13 November, Uppsala, Sweden (talk by M. Tuisku)

## Administration and Support

**LUMA Board Meeting,**
30 January, Helsinki, Finland (invited talk by R. Rinta-Filppula)

**The Annual Meeting of the Finnish Physical Society,**
14-16 March, Joensuu, Finland (invited talk by R. Rinta-Filppula)

**Seminar of SMFL,**
16 March, Joensuu, Finland (invited talk by R. Rinta-Filppula)

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

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

**National Megaconference,**
15 May, Videoconference of the Finnish Virtual University (invited talk by R. Rinta-Filppula)

**Starting Seminar for the CERN Network of Schools,**
13 September, Jyväskylä, Finland (invited talk by R. Rinta-Filppula)

**Fall Meeting of MAOL,**
4-6 October, Riihimäki, Finland (invited talk by R. Rinta-Filppula)

**EPP Outreach Meeting,**
11-12 October, Pisa, Italy (invited talk by R. Rinta-Filppula)

## Theory Programme

### Cosmology

*R. Allahverdi, K. Enqvist, A. Mazumdar,*
**Possible astrophysical signatures of heavy stable neutral relics in supergravity models,**
Phys. Rev. D 65 (2002) 103519

*K. Enqvist, A. Jokinen, T. Multamäki, I. Vilja,*
**Constraints on self-interacting Q-ball dark matter,**
Phys. Lett. B 526 (2002) 9

*K. Enqvist, S. Kasuya, A. Mazumdar,*
**Inflatonic solitons in running mass inflation,**
Phys. Rev. D 66 (2002) 043505

*K. Enqvist, S. Kasuya, A. Mazumdar,*
**Reheating as a surface effect,**
Phys. Rev. Lett. 89 (2002) 091301

*K. Enqvist, H. Kurki-Suonio, J. Väliviita,*
**Open and closed CDM isocurvature models contrasted with the CMB data,**
Phys. Rev. D 65 (2002) 043002

*K. Enqvist, M. S. Sloth,*
**Adiabatic CMB perturbations in pre-Big-Bang string cosmology,**
Nucl. Phys. B 626 (2002) 395

*K. Kainulainen, A. Sorri,*
**Oscillation induced neutrino asymmetry growth in the early universe,**
J. High Energy Phys. 0202 (2002) 020

*S. Räsänen,*
**On ekpyrotic brane collisions,**
Nucl. Phys. B 626 (2002) 183

### Laser Physics and Quantum Optics

*J. Calsamiglia,*
**Generalized measurements by linear elements,**
Phys. Rev. A 65 (2002) 030301(R)

*J. Calsamiglia, S. M. Barnett, and N. Lütkenhaus,*
**Conditional beam-splitting attack on quantum key distribution**,
Phys. Rev. A 65 (2002) 012312

*B. M. Garraway and K.-A. Suominen,*
**Wave packet dynamics in molecules,**
Contemp. Phys. 43 (2002) 97

*A. Ishkhanyan and K.-A. Suominen,*
**Three-level system driven by delayed pulses of finite duration,**
Phys. Rev. A 65 (2002) 051403(R)

*J. Javanainen and M. Mackie,*
**Rate limit for photoassociation of a Bose-Einstein condensate,**
Phys. Rev. Lett. 88 (2002) 090403

*M. Machholm, P. S. Julienne, and K.-A. Suominen,*
**Subthermal linewidths in photoassociation spectra of cold alkaline-earth-metal atoms,**
Phys. Rev. A 65 (2002) 023401

*M. Mackie,*
**Feshbach-stimulated photoproduction of a stable molecular Bose-Einstein condensate,**
Phys. Rev. A 66 (2002) 043613

*M. Mackie, K.-A. Suominen, and J. Javanainen,*
**Mean-field theory of Feshbach-resonant interactions in $^{85}$Rb condensates,**
Phys. Rev. Lett. 89 (2002) 180403

*J.-P. Martikainen, A. Collin, and K.-A. Suominen,*
**Coreless vortex ground state of the rotating spinor condensate,**
Phys. Rev. A 66 (2002) 053604

*J.-P. Martikainen, A. Collin, and K.-A. Suominen,*
**Creation of a monopole in a spinor condensate,**
Phys. Rev. Lett. 88 (2002) 090404

*J. Piilo and K.-A. Suominen,*
**Optical shielding of cold collisions in blue-detuned near-resonant optical lattices,**
Phys. Rev. A 66 (2002) 013401

*J. Piilo, K.-A. Suominen, and K. Berg-Sørensen,*
**Atomic collision dynamics in optical lattices,**
Phys. Rev. A 65 (2002) 033411

## Particle Physics Phenomenology

*K. R. S. Balaji, A. Kalliomäki, J. Maalampi,*
**Revisiting pseudo-Dirac neutrinos,**
Phys. Lett. B 524 (2002)153

*M. Chaichian, A. Datta, K. Huitu, and Z. Yu,*
**Radion and Higgs mixing at the LHC,**
Phys. Lett. B 524 (2002) 161

*E. Gabrielli, K. Huitu, S. Roy,*
**Vacuum stability bounds in anomaly and gaugino mediated supersymmetry breaking models,**
Phys. Rev. D 65 (2002) 075005

*E. Gabrielli and S. Khalil,*
**On the $B \to X_s l^+ l^-$ decays in general supersymmetric models,**
Phys. Lett. B 530 (2002) 133

*E. Gabrielli and B. Mele,*
**Gravitational decays of heavy particles in large extra dimensions,**
Nucl. Phys. B 647 (2002) 319

*K. Huitu, J. Laamanen, P. N. Pandita,*
**Sparticle spectrum and constraints in anomaly mediated supersymmetry breaking models,**
Phys. Rev. D 65 (2002) 115003

*J. Maalampi and N. Romanenko,*
**Single production of doubly charged Higgs bosons at hadron colliders,**
Phys. Lett. B 532 (2002) 202

**Hadron Physics Activity**

*A. M. Green, J. Koponen, C. Michael and P. Pennanen,*
**Charge and matter radial distributions of heavy-light mesons calculated on a lattice,**
Phys. Rev. D 65 (2002) 014512

*C. Helminen and D. O. Riska,*
**Low-lying $qqqq\bar{q}$ states in the baryon spectrum,**
Nucl. Phys. A 699 (2002) 624

*T. A. Lähde and D. O. Riska,*
**Pion rescattering in two-pion decay of heavy quarkonia,**
Nucl. Phys. A 707 (2002) 425

*T. A. Lähde and D. O. Riska,*
**The coupling of $\eta$ mesons to quarks and baryons from $D_s^* \to D_s \pi^0$ decay,**
Nucl. Phys. A 710 (2002) 99

*D. O. Riska,*
**Dynamical interpretation of the nucleon-nucleon interaction and exchange currents in the large $N_c$ limit,**
Nucl. Phys. A 710 (2002) 55

## Physics of Biological Systems

*M. Karttunen, I. Vattulainen, and A. Lukkarinen,*
**SoftSimu2002 - novel methods in soft matter simulations,**
Appl. Rheol. 12 (2002) 200

*A. P. Lyubartsev, M. Karttunen, I. Vattulainen, and A. Laaksonen,*
**On coarse-graining by the inverse Monte Carlo method: Dissipative particle dynamics simulations made to a precise tool in soft matter modeling,**
Soft Materials 1 (2002) 121

*P. Nikunen, I. Vattulainen, and T. Ala-Nissila,*
**Effects of quenched impurities on surface diffusion, spreading, and ordering of O/W(110),**
J. Chem. Phys. 117 (2002) 6757

*I. Vattulainen, M. Karttunen, G. Besold, and J. M. Polson,*
**Integration schemes for dissipative particle dynamics simulations: From softly interacting systems towards hybrid models,**
J. Chem. Phys. 116 (2002) 3967

## Statistical Physics and Materials Science

*T. Ala-Nissila, R. Ferrando, and S. C. Ying,*
**Collective and single particle diffusion on surfaces,**
Advances in Physics 51 (2002) 949

*J. Asikainen, J. Heinonen, and T. Ala-Nissila,*
**Exact and efficient discrete random walk method for time-dependent two-dimensional environments,**
Phys. Rev. E 66 (2002) 066706

*J. Asikainen, S. Majaniemi, M. Dubé, and T. Ala-Nissila,*
**Interface dynamics and kinetic roughening in fractals,**
Phys. Rev. E 65 (2002) 052104

*J. Asikainen, S. Majaniemi, M. Dubé, J. Heinonen, and T. Ala-Nissila,*
**Dynamical scaling and kinetic roughening of single valued fronts propagating in fractal media,**
Eur. Phys. J. B 30 (2002) 253

*S. C. Badescu, P. Salo, T. Ala-Nissila, S. C. Ying, K. Jacobi, Y. Wang, K. Bedürftig, and G. Ertl,*
**Energetics and vibrational states for hydrogen on Pt(111),**
Phys. Rev. Lett. 88 (2002) 136101

*L. Cai, M. S. Altman, E. Granato, T. Ala-Nissila, S. C. Ying, and X. Xiao,*
**Surface diffusion anomaly near a substrate phase transition: H on W(100),**
Phys. Rev. Lett. 88 (2002) 226105

*L. Y. Chen, S. C. Ying, and T. Ala-Nissila,*
**Finding transition paths and rate coefficients through accelerated Langevin dynamics,**
Phys. Rev. E 65 (2002) 042101

*J. M. Lahtinen, M. Mašin, T. Laurila, T. Ala-Nissila, and Z. Chvoj,*
**Many-particle diffusion in continuum: Influence of a periodic surface potential,**
J. Chem. Phys. 116 (2002) 7666

*P. Nikunen, I. Vattulainen, and T. Ala-Nissila,*
**Effects of quenched impurities on surface diffusion, spreading, and ordering of O/W(110),**
J. Chem. Phys. 117 (2002) 6757

*M. Rusanen, I. T. Koponen, and T. Ala-Nissila,*
**Meandering instability of curved step edges on growth of a crystalline cone,**
Surf. Sci. 507-510 (2002) 305

*M. Rusanen, I. T. Koponen, T. Ala-Nissila, C. Ghosh, and T. S. Rahman,*
**Morphology of ledge patterns during step flow growth of metal surfaces vicinal to fcc(001),**
Phys. Rev. B 65 (2002) 041404(R)

*O. Trushin, E. Granato, J. M. Kosterlitz, S. C. Ying, T. Ala-Nissila, and P. Salo,*
**Surface instability and dislocation nucleation in strained epitaxial layers,**
Braz. J. Phys. 32 (2002) 369

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**Minimum energy paths for dislocation nucleation in strained epitaxial layers,**
Phys. Rev. B 65 (2002) 241408(R)

*O. Trushin, E. Granato, S. C. Ying, P. Salo, and T. Ala-Nissila,*
**Mechanisms of dislocation nucleation in strained epitaxial layers,**
Phys. Stat. Sol. (b) 232 (2002) 100

### String Theory and Quantum Field Theory

*M. Chaichian, J. L. Chkareuli and A. Kobakhidze,*
**Composite quarks and leptons in higher space-time dimensions,**
Phys. Rev. D 66 (2002) 095013

*M. Chaichian, A. Datta, K. Huitu and Z. Yu,*
**Radion and Higgs mixing at the LHC,**
Phys. Lett. B 524 (2002) 161

*M. Chaichian and D. Polyakov,*
**Noncommutativity in string theory and D-branes,**
Phys. Lett. B 535 (2002) 321

*M. Chaichian, P. Prešnajder, M. M. Sheikh-Jabbari and A. Tureanu,*
**Aharonov-Bohm effect in noncommutative spaces,**
Phys. Lett. B 527 (2002) 149

*M. Chaichian, P. Prešnajder, M. M. Sheikh-Jabbari and A. Tureanu,*
**Noncommutative gauge field theories: a no-go theorem,**
Phys. Lett. B 526 (2002) 132

*S. Hemming and E. Keski-Vakkuri,*
**The spectrum of strings on BTZ black holes and spectral flow in the SL(2,R) WZW model,**
Nucl. Phys. B 626 (2002) 363

*S. Hemming, E. Keski-Vakkuri and P. Kraus,*
**Strings in the extended BTZ spacetime,**
J. High Energy Phys. 0210 (2002) 006

*D. Polyakov,*
**Becchi-Rouet-Stora-Tyutin properties of new superstring states,**
Phys. Rev. D 65 (2002) 084041

### Ultrarelativistic Heavy Ion Collisions

*K. J. Eskola,*
**Initial state of the QGP from perturbative QCD + saturation,**
Nucl. Phys. A 702 (2002) 249c

*K. J. Eskola, H. Honkanen, V. J. Kolhinen and C. A. Salgado,*
**Constraints for nuclear gluon shadowing from DIS data,**
Phys. Lett. B 532 (2002) 222

*K. J. Eskola, K. Kajantie, P. V. Ruuskanen and K. Tuominen,*
**Rapidity dependence of particle production in ultrarelativistic nuclear collisions,**
Phys. Lett. B 543 (2002) 208

*K. J. Eskola, K. Kajantie and K. Tuominen,*
**Heavy-ion collision multiplicities and gluon distribution functions,**
Nucl. Phys. A 700 (2002) 509

## High Energy Physics Programme

### Electron-Positron Physics

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

*J. Abdallah et al.,*
**Searches for neutral Higgs bosons in $e^+e^-$ collisions from $\sqrt{s}$ =191.6 to 201.7 GeV,**
Eur. Phys. J. C 23 (2002) 409

*J. Abdallah et al.,*
**Search for charged Higgs bosons in $e^+e^-$ collisions at $\sqrt{s}$ =189-202 GeV,**
Phys. Lett. B 525 (2002) 17

*J. Abdallah et al.,*
**Rapidity-alignment and $p_T$ compensation of particle pairs in hadronic $Z^0$ decays,**
Phys. Lett. B 533 (2002) 243

### Forward Physics

*R. Orava with A. Ageev et al.,*
**A full-acceptance detector at the LHC (FELIX),**
J. Phys. G: Nucl. Part. Phys. 28 (2002) R117

*S. Tapprogge with G. Azuelos et al.,*
**Impact of energy and luminosity upgrades at LHC on the physics programme of ATLAS,**
J. Phys. G: Nucl. Part. Phys. 28 (2002) 2453

*S. Tapprogge with R. Blair et al.,*
**The ATLAS Level-2 Trigger pilot project,**
IEEE Trans. Nucl. Sci. 49 (2002) 851

*R. Orava with A. De Roeck, V. A. Khoze, A. D. Martin and M. G. Ryskin,*
**Ways to detect a light Higgs boson at the LHC,**
Eur. Phys. J. C 25 (2002) 391

*S. Tapprogge with A. Radu et al.,*
**High-level triggers in ATLAS,**
IEEE Trans. Nucl. Sci. 49 (2002) 377, Erratum-ibid. 49 (2002) 2037

## CMS Programme

### Software and Physics

*S. Abdullin, Ž. Antunović, F. Charles, D. Denegri, U. Dydak, M. Dželalija, V. Genchev, D. Graham, I. Iashvili, A. Kharchilava, R. Kinnunen, S. Kunori, K. Mazumdar, C. Racca, L. Rurua, N. Stepanov and J. Womersley,*
**Discovery potential for supersymmetry in CMS,**
J. Phys. G: Nucl. Part. Phys. 28 (2002) 469

*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,*
**Search for strangelets in Pb + Pb collisions at 158 A GeV/c,**
New J. Phys. 4 (2002) 96.1

*V. Karimaki with C. Civinini et al.,*
**CMS silicon tracker developments,**
Nucl. Instr. Meth. A 477 (2002) 440

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