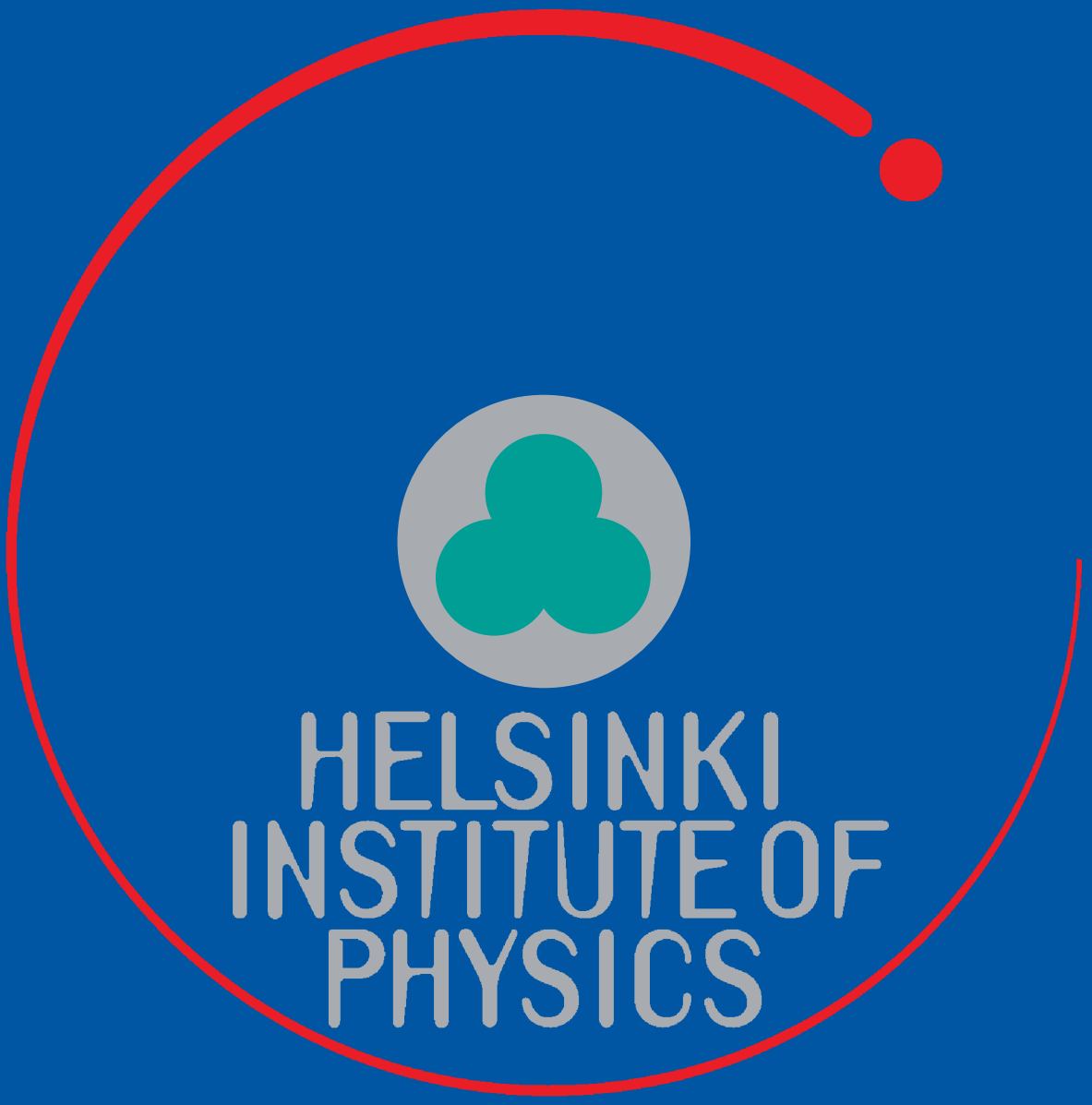

HELSINKI INSTITUTE OF PHYSICS

Annual Report 2007

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Installation of the T0 detector in the central region of ALICE.

Annual Report 2007 Helsinki Institute of Physics

Contents

Introduction

Dan-Olof Riska

The year 2007 brought two major developments with impact on the Helsinki Institute of Physics (HIP), which is a joint institute of the Universities of Helsinki and Jyväskylä and the Helsinki and Lappeenranta Universities of Technology. The first was the long awaited decision by the Finnish Ministry of Education to allocate funding for a Grid computing facility in Finland, which will first and foremost be used for processing and analysing the data that will begin to be produced by the Large Hadron Collider (LHC) at its start-up in 2008. The second was the declaration by the Finnish Minister of Education that Finland intends to join the Facility for Antiproton and Ion Research (FAIR) that is to be constructed in Darmstadt beginning in 2009.

HIP has a continuing mandate by the Finnish Ministry of Education for the planning of the Finnish contribution to FAIR. The main mandate of the Institute continues to be the co-ordination of the collaboration between CERN and Finland. These mandates are realized in close collaboration with the Finpro association, which co-ordinates the collaboration between the international accelerator laboratories and Finnish industry.

The modus operandi of the Institute is to carry out such research projects, which are too resource intensive or too cross disciplinary to fit into the standard framework of funding academic research in Finland. An important task of the Institute is to support the research and teaching departments in its member universities by means of joint research projects and by graduate training within these research projects. An example of the success of this collaboration is the fact that 17 project leaders and researchers of the Institute have been appointed to professorial positions at several universities both in Finland and abroad.

During the year 2007 the research activities at HIP fell into the following 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. In addition the Institute maintains a separate project for the CLOUD experiment at CERN, the aim of which is to determine the possible role of cosmic radiation on climate warming.

The Theory Programme serves as a Finnish project oriented national institute for theoretical physics. During the year the Programme comprised the following five projects: (1) string theory and quantum field theory, (2) the physics of biological systems, (3) the theory of ultrarelativistic heavy ion collisions, (4) cosmology and (5) particle physics phenomenology. These projects were brought to a successful completion at the end of the year.

The High Energy Physics Programme continued its projects for detector development for forward proton-proton physics study in the TOTEM experiment at the Large Hadron Collider LHC at CERN and proton-antiproton collisions at the CDF-II experiment at the Tevatron collider at the Fermi National Accelerator Laboratory. The memorandum-of-understanding for the TOTEM experiment collaboration was signed during the year.

The CMS Programme was divided into two projects: one for the development of the tracker and the trigger of the CMS detector at the LHC and the other for software development for the CMS data analysis. The CMS tracker construction project was brought to completion at the end of the year. The project was reviewed by an external expert panel, which gave a very satisfactory report. On the basis of this review the

Board of the Institute continued this activity for 2008 for commissioning and starting the operation of the tracker in 2008 with the start of data taking at the LHC.

The Nuclear Matter Programme of the Institute was divided into two projects. The first is a nuclear structure research project at the ISOLDE facility at CERN. The second is a project for physics analysis at, and instrumentation for the ALICE detector for relativistic heavy ion collisions at the LHC. In addition the Programme contained a special project for the planning of the Finnish contribution to the FAIR project. During 2007 the contributing partners to FAIR continued the memorandum-of-understanding for the planning phase of FAIR into 2008, when FAIR GmbH will be established.

Kimmo Koski (CSC) and Dan-Olof Riska signing the contract for the construction and operation of the Finnish Tier-2 Grid computing facility on November 13th, 2007.

The Technology Programme of the Institute develops industrial applications of CERN generated innovations. During 2007 the focus of the Programme was on software development for distributed data-intensive Grid computation. The Programme is a member of the European Union funded Enabling Grids for E-sciencE project and an associate of the CERN Openlab for Grid applications project. The Programme runs the Netgate-II project for the development of Grid technology for industry, with the support of Finnish business enterprises and the National Technology Agency of Finland TEKES.

In 2007 the memorandum-of-understanding with the Worldwide LHC Grid computing collaboration WLCG was signed at CERN. Concomitantly HIP signed an agreement with the Finnish IT Center for Science CSC to build and operate the Finnish Tier-2 Grid computing facility, which is part of the distributed high-throughput computing capacity that will be required by the analysis of the data taken by the LHC detectors.

In 2007 there were several indications of the high impact of the scientific research at the Institute. In June Thomson Scientific, which operates the Science Citation Index, published a note that HIP had reached the top 1 per cent of most cited physics research institutes worldwide. Another indication was that in the citation made by the Royal Academy of Science for the Nobel Prize in Chemistry 2007 for Gerhard Ertl, in which an article co-authored in 2002 by the then leader of the HIP project on statistical physics and materials science, Professor Tapio Ala-Nissilä was cited.

The Institute has continued its vigorous efforts in training graduate students for frontline research. This activity is partly supported by the national graduate school programmes. The graduate training efforts were greatly strengthened by generous grants by several Finnish foundations. During 2007, 4 PhD and DSc degrees and 14 MSc and MSc (engineering) degrees were awarded on the basis of research conducted within the research projects of the Institute.

The summer student programmes at CERN represent a key educational effort. During the summer of 2007, 15 Finnish students worked at CERN in HIP research programmes. The science education sessions for Finnish high schools at CERN represent a significant outreach activity. In 2007 the Institute hosted a record 15 study "camps" by Finnish high school students and 3 training sessions for teachers in Finnish gymnasiums at CERN. In addition a CERN visit was arranged for a group of study guides and rectors of Finnish gymnasiums.

In 2007 several senior HIP staff received scientific awards. Professor Kari Enqvist received the J. V. Snellman Award of the University of Helsinki. Professor Jorma Tuominiemi received the Theodor Homén Prize for experimental physics of the Finnish Society of Sciences and Letters and Professor Kari J. Eskola received the Väisälä Prize of the Finnish Academy of Science and Letters. Finally, Professor Ilpo Vattulainen received the research prize of the Alfred Kordelin Foundation.

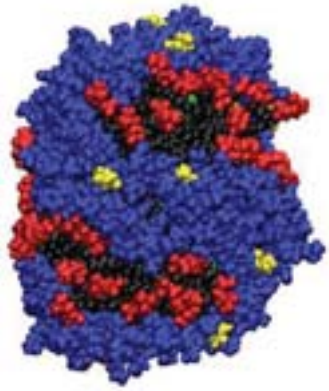
During 2007 the Board of HIP was chaired by Vice Rector Marja Makarow of the University of Helsinki. The scientific activities of the Institute were overseen by an international scientific advisory board, which was chaired by Dr. Wolf-Dieter Schlatter of CERN. The Institute is indebted to Vice Rector Makarow, who left this position at the end of the year for her active and comitted service.

Highlights of Research Results

Theory Programme

In Cosmology we have established the supergravity foundations of a novel model inflation, based on the flat directions of the Minimally Supersymmetric Standard Model, which are gauge invariant combinations of squarks and sleptons. We also considered alternative explanations of dark energy by studying f(R) models as well as the effects of inhomogeneities, arguing that a natural physical interpretation of dark energy can be found simply by taking into consideration the fact that the mostly empty regions detectable light traverses expand faster than average. As a consequence, expansion can then accelerate along our line of sight, giving rise to a model that fits cosmological data with 90% dark matter and 10% baryons. In collaboration with the Department of Physical Sciences at the University of Helsinki, the Cosmology project continued to participate in the Finnish Planck Surveyor Consortium.

In Particle Physics Phenomenology dark matter was considered in certain classes of supersymmetric models. The parameter regions which provided at least some of the dark matter of the universe were mapped. This analysis was combined with a realistic simulation searching for the Higgs bosons. This is of great interest, considering that it is generally expected that LHC will soon discover the Higgs boson, whence the so far unknown dark matter particle could be studied in the laboratory environment. In addition, the novel idea of the year, so called unparticles, was studied. If the planned linear collider materializes, we showed that they can be identified under certain favourable conditions.



In its final year, the Biological Physics group has been partially based at Tampere University of Technology (Finland). The Biological Physics group has continued active research into the dynamics of cell membranes and in that regard has clarified the mechanisms of lipid diffusion and pore formation in membranes. What is more, it has initiated major projects to work out the structures of lipoproteins which are known to be carriers of cholesterol, and the effects of nanomaterials on cell membranes, with some very exciting results.

The String Theory and Quantum Field Theory project celebrates its delightfully successful six years at HIP, now coming to completion. In addition to many research contributions of the highest level, we have enjoyed playing our own part to help the HIP Theory group establish its internationally acclaimed reputation. In 2007, the group continued its pioneering investigations of the connection between decay of unstable D-branes in string theory and the phase structure of low-dimensional Coulomb plasma thermodynamics. We invented new analytic techniques, making use of less known topics in mathematical analysis such as the theory of confluent Vandermonde determinants.

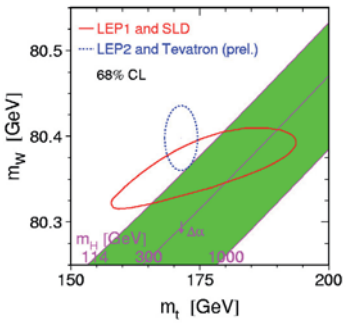
The Heavy Ion project has studied the prospects of probing QCD matter properties and dynamics in A+A collisions via high-p_T hadron suppression and via 2- and 3-particle angular correlations at RHIC and LHC. The project has also actively participated in the CERN contest for LHC heavy-ion predictions. RHIC data has now been included in the global QCD-analysis of nuclear parton distributions for the very first time, obtaining better-constrained nuclear gluon distributions than before. An exact solution of the AdS3 gravity equations representing the collision of two extended systems has been found and used to model heavy ion collisions in the boundary theory: conformal matter is observed to be very opaque. Also, a dark matter candidate from a minimal technicolour theory proposed in the project has been reported.

High Energy Physics Programme

First observation of $B_s^0 - \overline{B}_s^0$ *oscillations.* The oscillation of the B_s^0 meson (a particle containing a b quark and an anti-s quark) to its antiparticle, the $\overline{B}_s^0$ meson (and vice-versa) was first observed in 2006 by the CDF experiment. The more than 5 standard deviation significance was extracted from a time-dependent measurement of the $B_s^0 - \overline{B}_s^0$ oscillation frequency, Δm_s. The measured oscillation frequency value is Δm_s = 17.17 ± 0.10 (stat.) ± 0.07 (syst.) ps^{-1}. The measurement is an important ingredient in constraining the unitarity triangle for CP violation in the b quark sector in the Standard Model for particle physics. The unitarity triangle is in turn intimately related to understanding the creation of the imbalance between matter and antimatter in the early universe.

Discovery of four new heavy baryons $\Sigma_b^{\pm}$ *and* $\Sigma_b^{*\pm}$. Using a sample of 3125 ± 62 (stat.) $\Lambda_b^0 \to \Lambda_c^+ \pi^-$ candidates reconstructed in 1.1 fb^{-1} of data, resonant $\Lambda_b^0 \pi$ states were searched for. A significant signal of four states whose properties are consistent with the lowest-lying charged $\Sigma_b^{(*)\pm}$ baryons, Σ_b^+, Σ_b^-, Σ_b^{*+} and Σ_b^{*-}, was observed.

First measurement of the W boson mass with CDF in Run II. The W boson mass was measured from fits to its transverse mass (see figure), transverse momentum and transverse missing energy distributions of $W \to e\nu$ and $W \to \mu\nu$. Using a 200 pb^{-1} dataset and combining all six mass results yielded a W boson mass value of m_W = 80413 ± 34 (stat.) ± 34 (syst.) MeV/c^2 = 80413 ± 48 MeV/c^2. This measurement represents the single most precise m_W measurement to date and improves the world average to m_W = 80.398 ± 0.025 GeV/c^2. As can be seen in the figure, a new Higgs mass estimate including this measurement is $m_H = 80^{+36}_{-26}$ GeV/c^2.



CMS Programme

The year 2007 came to an end with a great final success in the installation of the CMS Silicon Strip Tracker. The apparatus was transported to the underground experimental hall of CMS (UXC) and positioned in the centre of CMS in December. Prior to this great event, commissioning and testing of the Tracker proceeded perfectly smoothly during the first part of the year in the Tracker Installation Facility (TIF). It now remains to connect the apparatus to the services and to the CMS readout system in UXC. The contribution of the Finnish technical team in the commissioning of the Tracker has been very much appreciated by CMS.

The Tracker project of the CMS Programme was reviewed in March 2007 by two international experts in the field. The outcome of the evaluation was very positive as can be seen from the following quote from the referees' summary: "We were impressed by the scientific achievements of the HIP project team over the last 3 years. It can be difficult for a relatively small team to make an impact and achieve visibility in such a large project as CMS and the team should be congratulated on what they have achieved – with leading contributions to the design, construction and assembly of the silicon tracker support structure, the silicon telescope for detailed performance studies, the trigger electronics and the pioneering work on the development of radiation hard silicon sensors". Based on the evaluators' recommendations, the Scientific Advisory Board of HIP advised and the HIP Board approved continuation of the Tracker project for the years 2008–2010 under the name "Operation of the CMS Tracker". The achievements in the R&D project were acknowledged also in Finland as Jaakko Härkönen got a five-year position as a Research Fellow of the Academy of Finland.

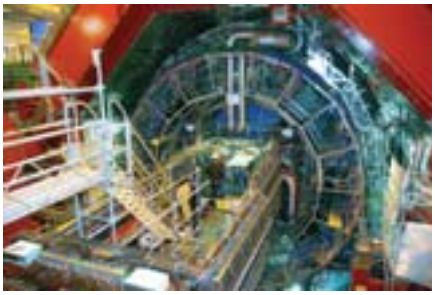
A particularly important milestone for the CMS Programme in 2007 was the decision of the Ministry of Education to grant funding for building a Tier-2 level Grid computing centre at the Finnish IT Center for Science (CSC) in 2008–2010. This was the last necessary building block which would allow a fully fledged physics analysis of the CMS experiment to take place at the Kumpula Campus in Helsinki. CSC has accelerated the setting up of the comput-

ing facilities by handing over part of its existing computing infrastructure to HIP. This will make possible the participation of HIP in the CMS Computing, Simulation and Analysis exercise (CSA08) in May 2008. This is very important for the preparation of the analysis resources in Kumpula, before the LHC starts its operation and data taking commences during the second part of the year.

In the R&D activities an important development was the full upgrade of the HIP Beam Telescope (SiBT) at CERN. The upgraded telescope was used at the H2 test beam to measure the performance of novel silicon strip detectors processed with the magnetic Czochralski Technique, this has been shown to be more radiation resistant than the detectors processed up to now. The processing of the detectors was done by the Tracker project at the Helsinki University of Technology (HUT) Micro and Nanofabrication Center (MINFAB). Owing to the successful commissioning of the telescope and the first beam tests with proton irradiated MCz-Si detectors, SiBT was approved as part of the CMS Super-LHC upgrade programme in December 2007.

In alignment activities an algorithm implemented by the HIP team was applied to SiBT as well as to the CSA07 exercise and to the partial alignment of the CMS with cosmic muon data. A comprehensive set of easy-to-use misalignment scenarios for the CMS Tracker was implemented by the HIP team to serve both physics studies and future alignment work.

Nuclear Matter Programme



The Nuclear Matter Programme provides participation of the Finnish teams at CERN in studies of nuclear and hadronic matter explored at the ISOLDE and ALICE experiments, respectively. In addition, the Nuclear Matter Programme has been co-ordinating the Finnish participation in the planning of the FAIR project at GSI.

The main focus of the ALICE group in 2007 was on the preparation for the first data taking scheduled for late summer 2008 and on finishing the T0 detector. Construction of the trigger and fast timing detector T0 for the ALICE experiment at CERN has reached several important milestones in 2007. The first events to be seen by the ALICE experiment will be the proton+proton collisions at $\sqrt{s}$ = 14 TeV. In the tremendously high centre of mass energy regime at the LHC the transversal size of the nucleon wave function is expected to grow far beyond the "low-energy" value of 1 fm.

There was a major progress in the year 2007 in the availability of the computing resources for the ALICE data analysis framework. This computing facility was used primarily for the ALICE full data simulation used for the correlation physics and study of the performance of the T0 detector. Since the physics interests of the Finnish/ALICE group are tightly related to high-p_T photon and jet production we decided to extend our hardware involvement in the ALICE experiment. The electromagnetic calorimeter plays a crucial role for photon and π^0 identification and also serves as a reliable high-p_T trigger. We are developing the FPGA code for PHOS (Photon Spectrometer) and for the new EM-calorimeter (US-France-Italy-Finland collaboration) trigger boards.

At ISOLDE the main focus in 2007 was devoted to finishing and commissioning of the ion cooler and buncher (ISCOOL). Various commissioning tests both off-line and on-line were performed to characterize and optimize the instrument. Longitudinal cooling of the ion beam with a background suppression factor of 10^4 was demonstrated. A full exploitation of this device in collinear laser spectroscopy of exotic nuclei is foreseen in 2008. Another highlight from the ISOLDE physics programme in 2007 was the first Coulomb excitation experiment with REX-ISOLDE on the low lying ex-

cited states of radioactive ^{182,184}Hg isotope beams accelerated to 3 MeV/u energy. This experiment is for determining the role of shape co-existence in the light Hg region and the mixing of states.

In 2007 Finland made an important decision to join in the construction of the FAIR facility with a contribution of at least 0.5% of the total construction costs. The Finnish involvement in FAIR includes participation in two experimental collaborations which are PANDA for antiproton driven hadron research and NUSTAR for nuclear structure and astrophysics studies. Industrial participation in constructing the FAIR facility is being explored in collaboration with Finpro. The first projects will start already in 2008 and the planned construction phase will last five years.

Technology Programme

The main highlights of the Technology Programme include increased responsibilities in the EU-funded EGEE-II project, intensified collaboration with the Finnish IT Center for Science CSC and the completion of a four-year cycle of continuing Grid-related Netgate projects with Finnish industry. Especially, the collaboration with CSC, which was sealed with a collaboration agreement, is vital in order to prepare Finland to fulfil its expectations as part of the global Grid computing initiative for high energy physics. Backed with the funding from the Ministry of Education this work has advanced rapidly. The Programme has also initiated highly visible events to disseminate Grid technologies and practical know-how among the computing community and students. The researchers have been active in international conferences and numerous masters' theses have been produced.

Theory Programme

Kari Enqvist,
Theory Programme director,
Cosmology project leader

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 default durations of 3+3 years. They are chosen on the basis of their scientific merits and complement the research in experimental physics at the Institute, as well as research at the host universities. The project leaders are expected to be able to secure considerable external funding for their projects. In 2007 there were five projects, which all came to their conclusion at the end of the year: Cosmology; Particle Physics Phenomenology; Physics of Biological Systems; String Theory and Quantum Field Theory; and Ultrarelativistic Heavy Ion Collisions. Outside the projects, there has also been research activity in hadronic physics.

Cosmology

One of the main fields of study of the Cosmology project has been inflation. We have considered the supergravity origin of the recently proposed MSSM inflationary model, which relies on the existence of a saddle point along a dimension six flat direction. We have derived the conditions that the Kahler potential has to satisfy for the saddle point to exist irrespective of the hidden sector vevs. We showed that these conditions are satisfied by a simple class of Kahler potentials, which we found to have a similar form as in various string theory compactifications. For these potentials, slow roll MSSM inflation requires no fine tuning of the soft supersymmetry breaking parameters. We also pointed out that the constraints on the Kahler potentials in these models are considerably relaxed when the location of the saddle point is treated as a free variable. For typical field values we found the spectral index n to be in the range 0.92 ... 0.94.

We also modelled the essential features of eternal inflation on the landscape of a dense discretuum of vacua and found that the diffusion of the probability distribution function of the inflaton expectation value in different Hubble patches may be suppressed due to an effect analogous to the Anderson localization in disordered quantum systems. As an alternative to conventional inflation, we investigated decaying D-branes as the origin of the thermal string gas of string gas cosmology. We found that there is a range in the weak string coupling and fast brane decay time regimes, where the initial configuration could drive the evolution of the dilaton field to values, where exactly three spacelike directions grow large.

Another main topic has been dark energy. We have searched for alternatives to dark energy in the Palatini formulation of f(R) gravity, on which we have found constraints from stellar dynamics and the Solar system. We derived a generalized Tolman-Oppenheimer-Volkoff and mass equation for a static, spherically symmetric star for f(R) gravity and compared the post-Newtonian parameters both for metric theories and in the Palatini version. For $f(R) = R-\mu^4/R$ models the latter case was shown to satisfy the Solar system constraints. Compact stars in the Palatini formalism were demonstrated to be consistent with polytropic equations of state.

We have also considered inhomogeneous alternatives to dark energy and the modifications of the Einstein equation due to the averaged back reaction. We have studied the role of scale dependence in the Buchert averaging method, using the flat Lemaitre-Tolman-Bondi model as a testing ground. Using an averaging scale R(z) that depends on the redshift of the objects, we found an O(1%) precision at $z<2$ in the averaged

luminosity and angular diameter distances as compared to their exact expressions. We also demonstrated that the running scale R(z) can mimic acceleration. Furthermore, we modelled the effect of the observed inhomogeneities by an extended Dyer-Roeder method that allows for two crucial physical properties of the universe: inhomogeneities in the expansion rate and the growth of non-linear structures. On large scales, the universe is homogeneous, but due to the initially smooth matter forming opaque clumps with time, the regions detectable light traverses get emptier and emptier compared to the average. The faster space expands the lower the local matter density, the expansion can then accelerate along our line of sight. This phenomenon provides both a natural physical interpretation and a quantitative match for the observations from the cosmic microwave background anisotropy, the position of the baryon oscillation peak, the magnitude-redshift relations of type Ia supernovae, the local Hubble flow and the nucleosynthesis, resulting in a concordant model with 90% dark matter, 10% baryons, no dark energy and 14.8 Gyr as the age of the universe.

Particle Physics Phenomenology

The focus in Particle Phenomenology research has been on signals beyond the Standard Model in future collider experiments.

So far the only experimental signal which is clearly beyond the Standard Model comes from the tiny but non-vanishing neutrino masses. Neutrinos are difficult to study because of their extremely weak interactions. We have studied the supersymmetric partners of neutrinos, sneutrinos, which can also give information on the neutrino parameter space. Sneutrino-antisneutrino mixing occurs in supersymmetric models, where neutrinos have so-called Majorana masses. We have investigated the possibility of observing lepton number violation in sneutrino-antisneutrino mixing at the LHC. Violation of CP-symmetry is one of the big mysteries in the Standard Model. We have constructed a supersymmetric model where violation of CP-symmetry and of R-parity is determined by the properties of the vacuum. With the broken R-parity, neutrinos have a tiny mass, as observed in experiments. We have studied the electroweak symmetry breaking sector, including the spectrum of scalars in the model. Due to spontaneous CP and R-parity violation, the neutrino sector is CP violating, and we have calculated the corresponding phase. We have also studied the CP violation parameter ε_K in the kaon system and showed that we obtain results consistent with the experimental value.

Another signal which is indirect, but informs about physics beyond the Standard Model, is dark matter, which is needed to keep galaxies from disintegrating. Supersymmetric models offer candidates for dark matter particles. In R-parity preserving theories such a candidate is the lightest supersymmetric particle (LSP). We have studied the composition of the neutralino LSP in non-universal gaugino mass cases, and the implications for the dark matter. The parameter regions, where thermal relic density agrees with WMAP were found. The possibility to observe the neutral MSSM Higgs bosons (h/H/A) at the LHC via neutralino cascades when the lightest neutralino is dark matter is discussed, and the connection to dark matter is established.

Several extended supersymmetric models, motivated by either grand unification, or by neutrino mass generation, predict light doubly charged higgsinos. We have studied the production of a single doubly charged higgsino and its decay channels at a linear collider. We included the Standard Model background and discussed how kinematic cuts could be used effectively to limit this background. Single production of these exotics could provide a spectacular signal for a new underlying symmetry and for physics beyond the Minimal Supersymmetric Standard Model. Detection of supersymmetric partners of doubly charged particles is under study. We are especially investigating separation at LHC of the signal from similar final state signals in the Minimal Supersymmetric Standard Model.

The recently proposed idea of unparticles arising due to a scale invariant sector in the

Katri Huitu, Particle Physics Phenomenology project leader

theory can give rise to effective operators with different Lorentz structures. We have showed that by using the different polarization options at future linear colliders, the nature of these effective operators can be easily understood. The special feature of a complex phase in the propagator of the unparticle can also be understood uniquely for the different spins by exploiting the initial beam polarizations at a linear collider.

Hadron Physics Activity. It has been shown that the covariant constituent quark model allows a phenomenological description of the neutron electric form factor in the impulse approximation, provided that the wave function contains minor (~ 3%) admixtures of the lowest energy sea-quark configurations.

The work on pion-nucleon phase shift analysis with fixed-t constraints has continued. In particular, the Goldberger-Miyazawa-Oehme sum rule has been evaluated.

To confirm earlier results on the P-wave spin-orbit splitting in heavy-light mesons, the work has been extended to other types of lattice configurations.

The study of deeply bound KNN and KNNN states has been further refined.

Physics of Biological Systems

Ilpo Vattulainen, Physics of Biological Systems project leader

The Biological Physics and Soft Matter (BIO) group focuses on the theory and computational modelling of biologically relevant soft-matter. This work is guided by the idea of combining the methods and ideas of statistical physics with novel computational techniques to deal with topical problems of complex soft-matter systems.

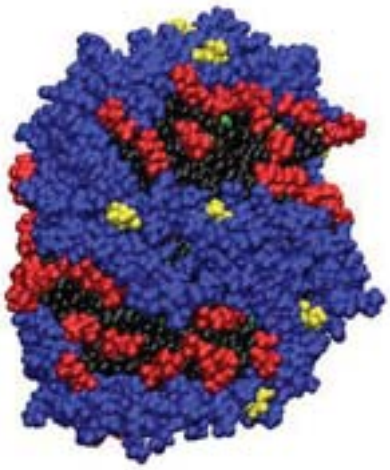
The BIO group was initiated at the Laboratory of Physics (Helsinki University of Technology/HUT) in January 2001 and it joined the Theory Programme of the Helsinki Institute of Physics (HIP) (www.hip.fi) in January 2002. Consequently, the BIO group operates as a joint project between HUT and HIP. More recently, the BIO group has expanded to Tampere University of Technology, where it is also co-ordinating substantial research activities in the field of biological physics.

The BIO group is part of various networks, including SimBioMa (ESF), MOLSIMU (COST), FuncDyn (ESF), and the NORDITA network on biological physics. In 2007, the group published 20 articles in international high-quality journals, 7 articles are in press, and many under review. The BIO group is also part of the Computational Condensed Matter and Complex Materials Group (COMP) at the Laboratory of Physics in HUT, which in 2005 was selected as a Centre of Excellence by the Academy of Finland for 2006–2011. Further, the group is an associate member of the MEMPHYS biophysics group in Odense, Denmark, which is a Centre of Excellence chosen by the Danish National Research Foundation.

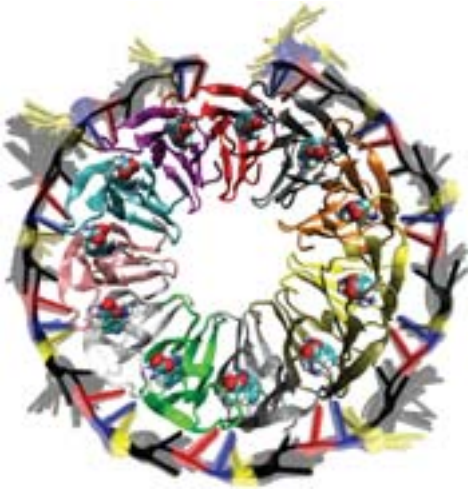
Overall, the activities of the BIO group are comprehensive and strongly networked including numerous experimental and theoretical collaborators with varying backgrounds. In particular, the BIO group works very closely with Dr. Mikko Karttunen's group at The University of Western Ontario (Canada).

The research of the BIO group consists of three main themes that complement each other. First, we develop novel techniques for studies of soft matter. Second, we apply these methods to characterize atom-scale properties of biomolecular systems. Third, we employ multi-scale modelling to gain insights into the large-scale properties of given systems.

The development of new theoretical and modelling techniques is keenly focused on the coarse graining of soft-matter systems. We have used the "bottom-up" approach, with an objective to develop coarse-graining techniques that allow one to simplify atomistic descriptions of soft-matter systems in a systematic fashion. The systematic nature of coarse graining means that the effective intermolecular interactions used in the coarse grained model are systematically derived from detailed atom-scale MD simulations or experimental data using, e.g., the Inverse Monte Carlo technique. When this approach is coupled to novel mesoscale simulation techniques, it provides a means for considering the large-scale properties of soft matter while preserving a bridge to the underlying microscopic world. We have used this approach to coarse grain and model many-component lipid membrane systems and lipoproteins, among other topics. In this manner, one finds a speed-up of up to seven



Atomistic model for spherical high density lipoprotein ("bad" cholesterol) based on molecular dynamics simulations. (Courtesy of A. Catte)



Visualization of the flexibility of an RNA strand bound to trp RNA-binding attenuation protein. (Courtesy of T. Murtola)

orders of magnitude compared to atomistic simulations.

In the atomistic limit, we have considered a variety of different systems comprised of proteins, lipids, and DNA. The aim is to understand the mechanisms that govern the structure and dynamics of these systems using both analytical and computational techniques. As for lipid membranes, we have clarified the dynamic mechanisms of lateral diffusion and pore formation in lipid membranes under physiological conditions. What is more, we have elucidated properties of lipid rafts composed of saturated glycerophospholipids, sphingomyelin, and cholesterol. Lipid rafts have been shown to play an important role in a variety of cellular processes such as signal transduction and protein sorting. Additionally, we have investigated the role of the lateral pressure profile on membrane protein functionality, and considered the unique structure-function relationship of cholesterol with respect to other sterols. Closely coupled to experiments, we have further addressed questions related to the structure of lipoproteins and the interplay of drugs such as antibiotics with lipid membranes, and the influence of small molecules such as alcohols on membrane systems. Most recently, we have initiated strong activities to characterize the effects of nanomaterials on cells and their life cycle.

String Theory and Quantum Field Theory

The String Theory and Quantum Field Theory project celebrates the completion of six very successful years at HIP.

In 2007, the group investigated a diverse collection of frontline problems. We continued pioneering investigations of the relation between two processes of very different character: the dynamic, time-dependent decay of unstable D-branes in string theory, and the static phase structure of low-dimensional Coulomb plasma equilibrium thermodynamics. We showed that the non-neutral two-component Coulomb plasma can be mapped to the worldsheet theory of time reflection symmetric brane formation and decay processes. In particular, the partition function of the grand canonical ensemble computes the worldsheet disk partition function, with singularities of the partition function determining the lifetime of the brane. We also invented new analytic techniques, making use of less known topics in mathematical analysis such as the theory of confluent Vandermonde determinants, and presented an analytic computation of the partition function of a one-dimensional multi-component Coulomb plasma. In collaboration with the Cosmology project, we proposed an application of decaying branes to string gas cosmology, as a natural candidate for a low-entropy initial state which evolves into the hot gas.

Research concerning the relationship between supersymmetric non-linear sigma models and geometry also continued. In particular, we found a way to describe generalized Kahler geometry (GKG) as a quotient from a higher-dimensional sigma model. We also presented our solution of GKG in a mathematical setting, to be published in "Handbook of pseudo-Riemannian geometry". In related work, preparing for new quotient constructions, new N=2 gauge multiplets were described

Esko Keski-Vakkuri, String Theory and Quantum Field Theory project leader

along with their use in gauging. The work on projective superspace, a superspace tailored for N=2 theories, continued. In particular we managed to describe all hyperkähler metrics on tangent and cotangent bundles of hermitean symmetric spaces. Finally, in collaboration with Paul Howe at King's College and a former student, we continued to explore our superembedding formalism and found a classic version of supersymmetric non-abelian Born-Infeld theory.

In noncommutative quantum field theory, the group has continued work on the construction of a noncommutative (NC) version of the Standard Model and the MSSM which required bypassing the restrictions of the no-go theorem on NC gauge theories. Various aspects of circumventing this theorem using Wilson lines have been investigated. The axiomatic approach has been continued by finding the space of test functions in NC QFT and thus refuting the allegations in the literature about the identity of commutative and NC QFT. The fundamental issue of causality in NC QFT has been studied from the point of view of the twisted Poincaré symmetry found by the group, which has become one of the key directions of development in the literature. In NC gauge theory of gravity, the Schwarzschild and Reissner-Nordström solutions were found, with and without the cosmological constant. Corrections to thermodynamical quantities of the corresponding black holes and to the radii of different horizons have been determined. An interesting local disturbance of the geometry around the source was found. Research on colour confinement, based on BRST symmetry and its relation to asymptotic freedom, has continued in connection with the gauge dependence of the approach.

Kari J. Eskola, Ultrarelativistic Heavy Ion Collisions project leader

Ultrarelativistic Heavy Ion Collisions

The studies of QCD matter and its phases, quark-gluon plasma (QGP) and hadron gas, form a subfield of particle and nuclear physics with an active interplay between experimental and theoretical research. The BNL-RHIC collider has collected an impressive amount of high-quality data from ultrarelativistic heavy ion collisions (URHIC), revealing a number of QGP signatures. Even more exciting possibilities for probing the QGP properties and QCD dynamics will soon be offered by the ALICE experiment at the CERN-LHC. The URHIC project in the HIP Theory Programme is located at the Department of Physics, University of Jyväskylä, at HIP, and at the Department of Physical Sciences, University of Helsinki. We focus (1) on URHIC phenomenology by making calculations for observables measurable at RHIC and LHC, and (2) on studying the QCD matter properties through first-principle calculations. We organise and participate in international conferences and workshops, European graduate school activities and EU networks. Our collaborators come from, e.g., Bielefeld, BNL, CERN, Duke University, Frankfurt, Odense, LBNL, McGill University, Nagoya, Nottingham, Rome and Wien. We are also in a close contact with the local ALICE group. After two successful 3-year terms, the HIP-URHIC theory project now ends in 2007.

One of our specialties has been the development of a comprehensive description of URHIC, where the initial QGP densities are computed in a closed framework based on perturbative QCD (pQCD), collinear factorization and gluon saturation, and the space-time evolution of the produced system is described by relativistic hydrodynamics. The latest improvement here is a dynamical decoupling procedure, based on comparing the rates of QCD-matter expansion and pion scattering. After successful tests against RHIC data, we have computed the bulk hadron multiplicities and p_T spectra, and net-baryon number for central Pb+Pb collisions at the LHC, as well as the amount of elliptic flow in non-central collisions. These results were presented in the CERN workshop for "Last call for LHC predictions" in May.

The QCD-medium modifications of high-p_T particle production, representing one

class of QCD matter probes and seen both in hard single-hadron spectra and in different correlations with the hard trigger-particle, remain hot topics in URHIC phenomenology. Our prediction for the high-p_T single-hadron suppression caused by the hydrodynamically evolving QCD medium in central Pb+Pb collisions at the LHC, was reported, e.g., in the CERN meeting mentioned above. Together with our collaborators, using a 3d hydro code, we have extended these studies to the angular dependence of the suppression in non-central collisions at RHIC. In addition to the radiative eikonal processes considered in the above analyses, a Monte Carlo study with finite kinematics which also includes elastic energy loss mechanism is in progress. Using parton shower simulations, we have also predicted the pattern for back-to-back correlations of two high-p_T hadrons in Pb+Pb collisions at the LHC. Model studies of low-p_T hadron correlations with the hard trigger-hadron, generated by energy-loss-induced Mach cone-like shock waves at RHIC, have been developed further by considering 3-particle correlations. Regarding the electromagnetic QCD matter signals, we have shown that the high-precision CERN-SPS NA60 dimuon data from In+In collisions sets rather stringent constraints on the matter flow field and temperature evolution. A similar analysis for RHIC is in progress.

Nuclear parton distribution functions (nPDFs) are needed for the computation of all collinearly factorizable hard-process cross sections in nuclear collisions. While our old results (EKS98) from the first global pQCD analysis of nPDFs are becoming a standard reference in the field, we have also made major progress in 2007: for the very first time, we have now included the RHIC d+Au data on large-p_T hadron production in the global analysis and thereby obtained more stringent constraints for the gluon content in nuclei than in any of the previous similar analyses. Also error estimates on the nPDFs have been published.

Using effective models, which are constrained by lattice data and observed vacuum properties, we have analysed QCD thermodynamics in temperatures and densities relevant for URHIC dynamics. The dark matter candidates in the minimal walking technicolour model developed in the project have been identified and their relic densities have been evaluated. We have demonstrated that while compatible with current precision electroweak measurements, this model is also able to account for the observed dark matter abundance.

The idea of gauge/gravity duality is to obtain information on a quantum gauge theory in the strongly coupled domain from classical gravity in a space with one more spatial dimension. We have applied this to a gauge theory with one time and one space coordinate by finding an exact solution of the AdS3 gravity equations. The solution represents the collision of two extended systems and can be used to model heavy ion collisions in the boundary theory. Conformal matter is observed to be very opaque.

High Energy Physics Programme

Heimo Saarikko,
High Energy Physics
Programme director

The activities of the High Energy Physics Programme concentrated in 2007 on top quark studies in the CDF experiment at the Tevatron antiproton-proton collider at Fermilab, and on preparations for the forward physics experiment TOTEM at the CERN LHC proton-proton collider. In 2007, Helsinki became one of the leading groups in the top mass measurement using the all-hadronic decay channel and has significantly contributed to the top mass measurement in the di-leptonic decay channel. In addition, the group has developed efficient data analysis algorithms for the CDF silicon detector system. The group is one of the major contributors to the TOTEM forward spectrometer and in the development of a competitive physics programme for it. In 2007 the group concentrated on construction, testing and commissioning of the TOTEM T2 spectrometer detectors. This strained the resources, personnel, finances and infrastructures to the maximum. By the end of 2007, all (not yet including the reserve) of the triple-GEM detectors for the T2 telescope, the group's main responsibility, were manufactured. In November 2007, a first set of nine GEM detectors with appropriate digital readout electronics were tested with success in a test beam at CERN. A vigorous R&D effort is ongoing to demonstrate by 2010 the technical feasibility of an electron positron collider, the Compact LInear Collider (CLIC), capable of reaching into the multi-TeV energy domain. Since the LHC is aiming to start taking data in 2008, the year 2007 in the Detector Laboratory was characterized by an active participation in the detector module construction: a highly visible project that continued throughout the year has been the above mentioned assembly of the Gaseous Electron Multipliers (GEMs) for the TOTEM experiment. Intense educational programmes were carried out, both at the undergraduate and graduate levels, in connection with the research activities.

Risto Orava,
LHC Forward
Physics project
leader

Forward Physics Project

Background

During 2007, the TOTEM team of the Forward Physics project continued to be heavily committed to the construction of the TOTEM T2 spectrometer, to be commissioned by the LHC start-up in 2008. In physics analysis, the Forward Physics project concentrated on top quark and Higgs physics at CDF/Tevatron and on preparations of the forward physics programme at TOTEM/LHC.

The CDF top quark analysis and Higgs boson search continued to be supported by an Academy of Finland research grant in 2007. For the years 2008–2010, a new Academy grant was awarded to the group leader.

In connection with the research activities, the Helsinki group carried out educational programmes both at the undergraduate and graduate levels.

CDF-experiment: Top Quark Analysis

During the past years the Helsinki group has systematically built up its presence in the CDF top analysis activities. In 2007, Helsinki produced the most precise measurement of the top quark mass in the dilepton channel. This analysis uses a novel technique to improve the mass measurement by including a cross-section constraint in the mass determination. This measurement was published in Physical Review Letters (Phys. Rev. Lett. 100, 062005 (2008)). In addition, the group made a significant contribution to the $t\bar{t}$ cross-section measurement in the dilepton decay channel, and the top quark mass measurement in the all-hadronic channel.

The group has a major responsibility in improving the data analysis efficiency of the CDF vertex detector (SVX) and in the run control of the detector.

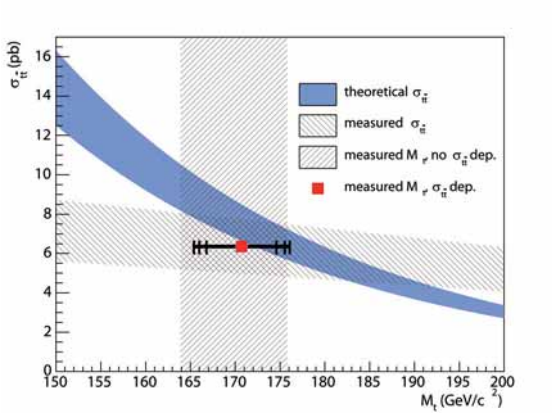
The CDF team of the Helsinki group (members & advisors): Timo Aaltonen (PhD student,

jet energy calibration), Valery Khoze (advisor, top quark mass), Petteri Mehtälä (PhD student, top quark mass, 'all-hadronic' channel), Tuula Mäki (PhD student, top quark mass, 'dileptonic' channel), Risto Orava (Helsinki group leader), Nick van Remortel (post doc, top mass measurement), Heimo Saarikko (HIP Programme leader), Kenneth Österberg (university lecturer, SVX software).

The main responsibilities of the Helsinki group in CDF are: (1) precision measurements of the top quark mass, (2) search for the Higgs boson.

The CDF responsibilities and intended contributions to the CDF experiment include:

* Support for the operation of the Run II detector.
* Participation in off-line SVXII calibration.
* Participation in validating the jet energy scale calibration.
* Postdocs, senior group members and graduate students participate as Aces, CO's and SciCO's.
* Physics: top mass analysis in the all-hadronic and dileptonic channels, CP asymmetry measurement in the semileptonic top channel, Higgs task force.



The most precise measurement of the top quark mass in the dilepton channel shown in the $M_t - \sigma_{t\bar{t}}$ plane. The hatched areas mark the traditional top mass measurement and the $\sigma_{t\bar{t}}$ measurement in the dilepton channel with statistical + systematic uncertainties.

TOTEM Experiment

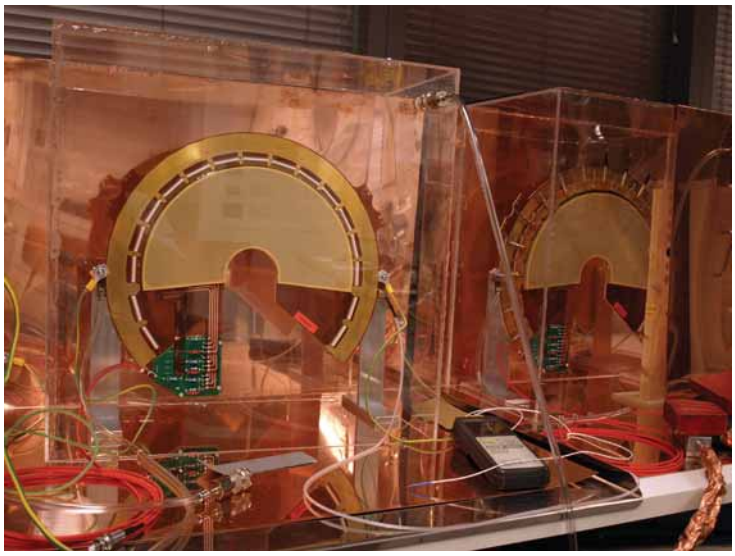
As the T2 spectrometer of TOTEM is its responsibility, the Helsinki group concentrated on construction, testing and commissioning of the T2 detectors. This strained the resources, personnel, finances and infrastructures to the maximum.

The physics scenario of TOTEM/CMS is based on (1) short special high statistics runs which begin during the running-in stages of the machine and (2) forward physics runs in conjunction with the CMS experiment with the nominal low-β^* machine conditions. Investigations of QCD can be carried out at relatively modest luminosities, and large statistics gluon studies will become available at the beginning of the TOTEM/CMS runs.

At later stages of LHC operation, the Central Exclusive Diffraction interaction: $pp \rightarrow p + H + p$ is considered a benchmark process, with exclusive access to the J^{PC} structure of the Higgs boson. With the leading proton tagging (and a possible later extension to the 420 meter region) and the T1 and T2 spectrometers, a threshold scan is done for spin-parity selected new particle states, including the Higgs boson, SUSY particle states, radions, extra dimensions etc.

TOTEM T2 Construction in Helsinki. From the year 2006 on, construction of the Gas Electron Multiplier (GEM) detectors was the main activity of the Detector Laboratory of the Helsinki Institute of Physics. The Forward Physics group of HIP is responsible for constructing and maintaining the T2 tracking station. Kari Kurvinen of the HIP Detector Laboratory serves as the co-ordinator of TOTEM T2 manufacturing. More than 40 individual semi-circular GEM detector planes, 33 of them in 2007, were manufactured for the TOTEM T2-tracker in Finland.

The production of GEM detector planes is carried out in the HIP clean rooms (class 1000 and 100) and in a separate laboratory which is specially equipped for testing and validating the detectors. The T2 manufacturing phase requires a major effort from the group and has occupied most of the Laboratory resources in 2006–2008. The testing of the detectors includes X-ray irradiation in a tailor made test bench. The long term stability and sparking sensitivity is analysed by alpha irradiation induced by radon gas injected into the fill gas of the detectors. Development of UV laser technology is continued for producing the miniscule holes needed in the GEM electrodes.



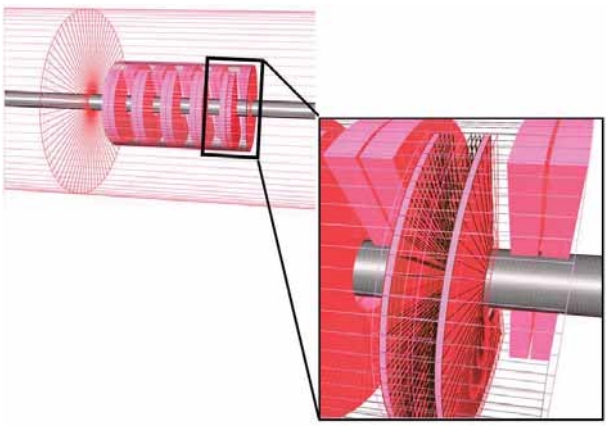
Final electric tests for TOTEM T2 GEM detectors are carried out in shielded dry boxes in the Detector Laboratory.

TOTEM T2 Simulation Software. Since the year 2006 the Helsinki TOTEM group has taken over the implementation of the simulation and reconstruction software for the T2 telescope. This has been a major effort undertaken together with other TOTEM groups. The software created has been embedded into the CMSSW framework and consists of the full digitisation and reconstruction modules for the T2 telescope. During the last year the digitisation module has been produced and this module includes signal induction and noise response according to the readout geometry and electronics. In addition to this the implementation of a realistic geometry description of the T2 telescope has played a major role and as a result studies related to the acceptance and tracking reconstruction efficiency can be performed.

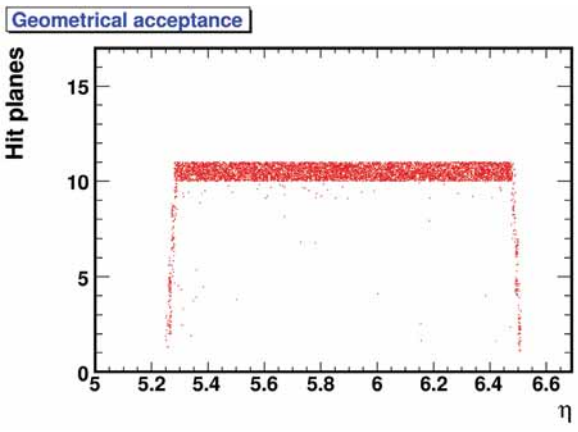
The plans for the near future are the creation of the pattern recognition and the trigger modules, thus the full T2 simulation software will be ready to perform TOTEM related and common physics studies with CMS as well.

The TOTEM team of the Helsinki group (members & advisors): Erik Brücken (PhD student, T2 simulation, single diffractive scattering), Francisco Garcia (post doc, T2 detector simulation), Jouni Heino (detector physicist, T2 construction and testing), Timo Hilden (PhD student, T2 quality control), Juha Kalliopuska (PhD student, Si-detectors), Valery Khoze (advisor, forward physics), Kari Kurvinen (detector physicist, T2 construction responsible), Rauno Lauhakangas (detector physicist, T2 DAQ and DCS), Jerry Lamsa (advisor, leading proton simulation), Fredrik Oljemark (PhD student, central diffraction), Risto Orava (Helsinki group leader), Mikael Ottela (leading proton simulation, central diffractive scattering), Nick van Remortel (post doc, diffractive physics), Heimo Saarikko (HIP Programme leader), and Kenneth Österberg (software co-ordinator).

The main responsibility of the Helsinki group in TOTEM centres around the *T2 spectrometer* and, in particular, its GEM detectors. The TOTEM team concentrates on



T2 telescope Geometry implemented in CMSSW.



Acceptance of the T2 telescope in pseudorapidity η.

both hardware and software (*reconstruction*) contributions to T2. The team has for a long time worked on *leading proton detection at the LHC* and can be considered as the world expert on the subject. It is in the group's interest to continue the work on leading proton detectors and studies on their performance vs. different LHC optics scenarios.

Nine finished GEMs were transported to CERN in November for a beam test. The main goal of the test was to check the compatibility of the readout electronics and the GEM operation. The readout electronics of the T2 telescope is based on a fully digital readout chip, VFAT, which was designed by the CERN-MIC group. The data collected from the pads and strips of four GEMs in the beam test confirmed the compatibility and full production of the chips and the GEMs according to the present design may be carried on.

The TOTEM responsibilities and intended contributions include:

* T2 spectrometer GEM detector construction, data analysis & trigger scenarios.
* Leading proton measurement – detectors & reconstruction, performance studies vs. LHC optics options.
* Low p_T jet reconstruction in combined CMS/TOTEM data taking.
* TOTEM physics potential – central diffraction & single diffraction.
* TOTEM physics scenarios.
* TOTEM service contributions: beam test participation, analysis of beam test data, on-line and off-line software development.

Electron – Positron Physics Project

The project's main activity in 2007 was participation in the accelerated Compact LInear Collider (CLIC) R&D programme, whose main aim is to demonstrate the feasibility of the CLIC-technology in view of a decision on a future linear collider in 2010. The focus was on the development of the accelerating structures for CLIC as well as the full integration of all the components into a CLIC module. The research work is done in close collaboration with the CERN CLIC group and Finnish industrial and academic partners, notably the Technical Research Centre of Finland (VTT).

To achieve sufficient beam stability in CLIC, the accelerating structures need to be produced, assembled and integrated into a CLIC module with µm precision. Finnish firms have over the years contributed significantly to the development of suitable machining techniques for producing the accelerating structures. At the moment, the best achieved machining accuracy is ±5 µm for the most critical parts and it is mainly limited by the uncertainties in the shape of the tool. The achieved machining precision should be maintained when four quadrants are assembled to a full accelerating structure as well as aligned with previous and following structure. In a Master's thesis completed in 2007, the achievable accuracy for several possible assembly methods was modelled taking into account tolerances, loads and constraints. The next step is to verify the results with a prototype assembly. Furthermore, the project continued to support the active involvement of Finnish firms in the high precision machining of CLIC structures by investigating the possibility of compensating for machining errors.

The assembled accelerating structures need to be integrated into a CLIC module still maintaining µm precision. The subject of another Master's thesis within the project has been setting the specifications for all the components of a CLIC module (~ 2 m long part of CLIC) as well as making a system design for its support, alignment and stabilisation. In parallel, a study of cooling strategies and system design of the CLIC cooling has been made.

One of the key issues for CLIC is to limit the RF breakdown ("sparking") probability in the accelerating structures to achieve a stable beam with a sufficiently high accelerating gradient (> 100 MV/m). The origin of the breakdowns is not well known but a possible explanation is surface roughness of the accelerating structure that is sharpened due to the applied alternating electric field leading to a strongly increased local electric field. Our group has started to collaborate with Prof. K. Nordlund and his group that aims to atomistically simulate the RF breakdown and shed some light on the underlying processes that lead to increased breakdown probability.

Kenneth Österberg, Electron-Positron Physics project leader

Eija Tuominen, Detector Laboratory coordinator

Detector Laboratory

The Detector Laboratory supports Finnish experimental research on collider-based physics. It is a joint laboratory between HIP and the Department of Physical Sciences of the University of Helsinki. The Laboratory provides premises, equipment and know-how for research projects developing radiation detectors for international particle and nuclear physics experiments. During the execution of the past projects, the scientists working within the Laboratory have gained a great deal of knowledge on the design, construction and testing of gaseous and semiconductor detectors. Presently, the Laboratory hosts active projects concentrating on the CMS and TOTEM experiments at CERN, and the PANDA experiment at FAIR/GSI. In addition, the Laboratory offers support for projects at the Electronics Research Unit of the Department of Physical Sciences of the University of Helsinki. Furthermore, according to available resources, the Laboratory also provides services for outside users.

Support for CERN TOTEM Experiment

Experimental set-up for leakage current measurements of the GEM foils inside desiccator chambers.

During the year 2007 the major activity in the Detector Laboratory was assembling of the TOTEM T2 GEM detectors. Most of the entire clean room complex was taken over by the task, including a room of class 100, two rooms of class 1000 and even the kitchen/coffee room between the clean rooms. The laboratory itself was also filled by several test set-ups for characterization of the T2 GEMs assembled. The finishing manufacturing phases were done in the Laboratory as well.

A total number of 33 GEMs were assembled in the Laboratory during the year, within the schedule specified by the collaboration. It was decided to assemble seven detectors later, to fulfil the total amount of 50 GEMs required (including ten spare ones). The assembling, consisting of 17 different manufacturing stages, was done according to the TOTEM specifications presented and approved in the EDR meeting in the previous year. All of the components, various assembling procedures and test results were recorded in a database for further reference.

During recent years, the TOTEM T2 GEM detector project has developed several new methods and instruments for the Detector Laboratory to be used for the testing of gaseous radiation detectors. These include automated scanning of broken or short-circuited strips and pads, a sensitive leakage current recorder and gas tightness check by measuring the oxygen concentration of the gas. For the first time all the GEM foils were also scanned by an optical scanner for detecting defects and artifacts on the foils. Special software was developed and optimized for measuring the variation of the size of the holes over the foil areas. The method aroused great interest at CERN and in several other detector groups. The new methods and a high overall quality control covering the entire manufacturing process form a good basis for new projects, where large area gaseous detectors are required.

Support for CERN CMS Tracker

The CMS Tracker project has the Finnish Cosmic Rack (FinnCRack) as well as adjacent electrical equipment and cooling system installed at the Laboratory premises of the Detector Laboratory. FinnCRack is a telescope built from eight layers of CMS silicon detectors measuring tracks of cosmic particles. It is used as a test station providing real data for testing the CMS Tracker Outer Barrel (TOB) functionality as well as for development of TOB software. FinnCRack also provides a platform for the testing of the novel radiation hard detectors being developed in the CMS Tracker project.

In addition, the CMS Tracker project has

greatly profited from the wafer/chip probing station situated in the clean rooms of the Detector Laboratory. Using the probe station essential electrical properties, e.g., current-voltage characteristics, can be measured from the silicon detectors directly after their manufacture at the semiconductor processing line at Micronova. Some of these detectors have also been connected to electronics using the versatile bonding equipment at the clean rooms. In addition, the CMS Tracker project has continuously used the basic electrical measurement equipment possessed by the Detector Laboratory.

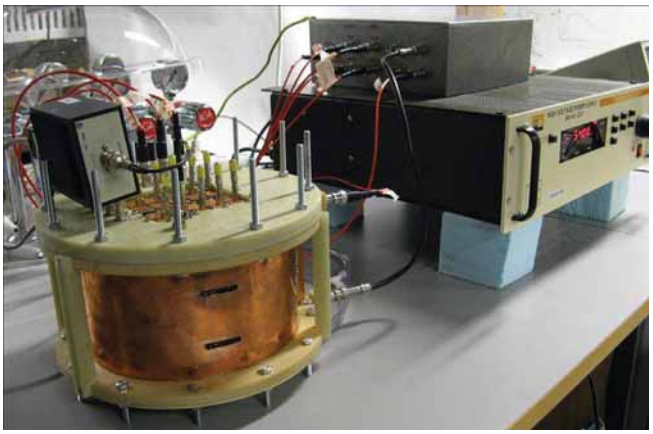
Finnish Cosmic Muon Rack at the Detector Laboratory.

Support for GSI FAIR PANDA Experiment

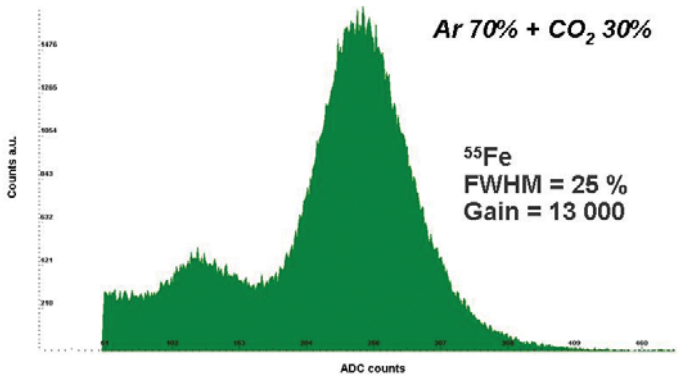
PANDA (antiProton ANnihilations at DArmstardt) is one of the large experiments at FAIR (Facility for Antiproton and Ion Research in Europe). FAIR is an international research facility to study nuclear physics and it is being built in Darmstadt, Germany, in the GSI research institute.

The PANDA collaboration plans to build a state-of-the-art universal detector for strong interaction studies on the high-energy storage ring HESR at the FAIR facility. The detector is designed to take advantage of the extraordinary physics potential, which will be available utilising high intensity, phase space cooled antiproton beams. The PANDA detector has a sophisticated particle identification system and an almost full coverage of the solid angle, which is achieved by a combination of the target and forward spectrometers. The detector arrangement will assure the measurement of complete sets of parameters and signatures by means of charged particle tracking together with a high-resolution electromagnetic calorimeter needed in spectroscopy experiments. During the last century, spectroscopy has been a prime tool for physics and has played a leading role in the development of quantum mechanics and the Standard Model of physics. Quantum Chromo Dynamics (QCD) is generally accepted to be the correct underlying theory of the strong interaction. However, our knowledge of the behaviour at large distances is still rather primitive. These types of experiments within hadron physics are the tools to investigate both the dynamics governing the interaction of fundamental particles and the existence of new forms of matter. The latter could consist of gluonic degrees of freedom, like glueballs

Detector Laboratory researchers in the clean room with a PANDA TPC-GEM prototype.



A TPC-GEM prototype being tested at the Detector Laboratory.



TPC-GEM response measured by a Fe55 source.

and hybrids, previously undiscovered charmonium states, the extension of the nuclear chart into the strangeness dimension, or particles produced inside nuclear matter. The PANDA detector can warrant a robust and redundant physics reconstruction which is considered particularly important in a high-luminosity environment.

During 2007 Finland has officially joined the FAIR project. This has given momentum to the Finnish contribution to PANDA and, furthermore, reshaped the plans for the future HIP participation. The main activity during 2007 has been the continuation of the design and development of a large-size GEM-based Time Projection Chamber (TPC). This prototype is intended to be used to prove the concept and to support the decision-making in favour of the GEM-based TPC as a solution for the outer tracker in the PANDA Target Spectrometer.

Additionally, development and a full test of a small-size prototype of the GEM-based TPC have been completed. The aim of this activity has mainly been to get familiar with TPC detectors and also to test GEM technology as the electron amplification stage. The creation of a GEANT4 model has been successfully done and used to better understand the detector capabilities and response. The geometry description of such a model was directly imported from the 3D CAD models, thus making it possible to introduce a realistic detector geometry description into a Monte Carlo simulation engine. Complementary to this, tests of stability and energy resolution with radioactive sources like ^{55}Fe has been performed in the Detector Laboratory. These results have already been presented to a wide international community.

New Projects

Based on the success of the previous CERN ALICE Silicon Strip Detector (SSD) Construction project at the Detector Laboratory, several international research groups have shown interest in the assembling capabilities of the Laboratory. Thus, possibilities to launch large scale detector assembly projects are being continuously examined.

During 2007, first module assembly experiments have been conducted for the silicon tracker of the future Phenix experiment at Brookhaven National Laboratory. The first studies at the Detector Laboratory using Phenix sensors and module accessories have concentrated on finding the correct parameters for high quality assembly work, in other words, the parameters for trustworthy bonding work with high expectancy for a long bonding lifetime. This has included the optimization

of ultrasound, time, power, and parallel force in order to obtain the highest possible pulling strength for the bonding wires.

Another new project in the Detector Laboratory during 2007 has been the participation in the SolarSail project co-ordinated by the Finnish Meteorological Institute. The aim of this international research activity is to develop a method to harness the solar wind as a power source for spacecrafts. It is proposed that the sail itself should be built from a net of 25 micrometers thin metal wires. Constructing such a net requires a novel wire connection method. However, first wire-to-wire bonding experiments using round wires have been successfully performed in the Detector Laboratory.

The Detector Laboratory has very close contacts with the Electronics Research Unit of the University of Helsinki Department of Physical Sciences. Their common interests include studies of non-destructive quality control techniques for ultrasonic bonds and investigation of the ultrasonic bond process in general.

Education

The research and experimentation activities at CERN and Fermilab constitute a platform for educating and training students in physics and technology. The Detector Laboratory also serves as the basis of education and training in experimental high energy physics. The group members are responsible for basically all the graduate level university education of high energy experimentalists in Finland. In addition, the group has established summer student and technical training programmes at CERN and Fermilab in connection with its own research projects. The group collaborates with a number of Finnish Polytechnic Institutes and has established R&D and training programmes with the Polytechnics in Kuopio and Rovaniemi.

In connection with the research activities, the Helsinki group carried out educational programmes both at the undergraduate and graduate levels. To facilitate detector development for the forward protons, the group participates in an EU sponsored detector R&D project, EUDET. Domestic summer student and technical trainee programmes, intended for university and polytechnic students, are continuing both at CERN and at Fermilab.

In 2007 in the Forward Physics project, one PhD degree was completed within the group at the University of Helsinki (Juha Kalliopuska) and in early spring 2008, a second one will be defended at Helsinki University of Technology (Tuula Mäki). In the Electron-Positron Physics project one Master's thesis was completed and another is proceeding well.

The group was involved in organising a national event for the "European Master Classes for High School Students: Hands on Particle Physics". This event was arranged jointly in more than 60 European university departments from about 20 countries. The programme of the Master Classes event included high standard lectures in Modern Physics, visits and experimental work in local laboratories, as well as a common European video conference, where results of the experimentation were collected and experiences of the day exchanged among participants in other European universities.

CMS Programme

Jorma Tuominiemi,
CMS Programme director

The HIP CMS Programme carries the responsibility 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 at 14 TeV collision energy at LHC and also heavy ion collisions. The main scientific goals of CMS are the study of the mechanism of the spontaneous breaking of the electroweak symmetry (search for Higgs bosons) in the Standard Model of the basic structure of matter and the quest for new physics beyond the Standard Model, such as supersymmetry and extra dimensions. It also includes a heavy ion research programme, searching for quark gluon plasma. The CMS detector concept was first proposed in 1990, and the Finnish team has played an important role in its development from the beginning. The HIP CMS team hence has an extensive and thorough knowledge of the key features of the experiment. With the CMS experiment HIP will be in the frontline of High Energy Physics research which will 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 2008. The year 2007 was the final year for the completion of the CMS subdetectors. The Tracker was successfully integrated and commissioned in the Tracker Installation Facility in Hall B186 in March. To test the apparatus, more than five million cosmic muon events were recorded during the following months. Their analysis has shown that the detector perfectly meets the design specifications. At the end of the year the Tracker was successfully lowered into the underground cave (UXC) and installed in the CMS apparatus. Now all the subdetectors except the end-caps of the electromagnetic calorimeter and the pixel detectors are in place. The data acquisition and the trigger systems have been installed and are being tested with cosmic muons. The Computing, Simulation and Analysis exercise (CSA07) using the CMS Tier0-Tier1-Tier2 system at a level of 50% of the final event rate was done in autumn. The system performed well and tuning to the final performance is advancing. Preparation for the physics analysis continued in many ways. Within CSA07 several analysis projects were done with success. A number of analysis projects aiming at a published paper on the first data to be collected were conducted to test the reconstruction and analysis tools with simulated data. The HIP CMS Programme was divided into two projects: 1) the new CMS Physics Analysis project, the goal of which is to develop simulation and analysis software for the CMS experiment, and to perform the physics analysis once the data taking starts, 2) the CMS Tracker project which has carried responsibilities in the completion of the Outer Barrel part of the silicon tracking detector as well as its testing and research and development on radiation hard silicon sensors for future tracking detectors.

Veikko Karimäki,
CMS Physics
Analysis project
leader

CMS Physics Analysis

Introduction

With the LHC start-up approaching, the work in the project focused more and more on the physics analysis and simulation. Yet a considerable amount of work in 2007 was devoted to the experimental support and services. The physics analysis work concentrated on the studies of MSSM Higgs searches for which HIP was assigned responsibility for the specific channel $gb \rightarrow tH^{\pm}$, $H^{\pm} \rightarrow \tau\nu$, with fully hadronic t and τ decays. HIP continues the important co-ordination work on the computing and off-line software support for the CMS users worldwide. The LHC data handling in Finland experienced a major breakthrough in 2007, when the Ministry of Education granted funding for Tier2 computing for the years

2008–2009. The development work of hadronic shower simulation for Geant4 continued. In the field of detector alignment, work using the HIP algorithm made steady progress. The test beam analysis work on the Helsinki Silicon Beam Telescope was recovered in terms of the CMSSW package. A more detailed description of all these activities is presented below.

The project team consisted of seven PhD physicists V. Karimäki, R. Kinnunen, T. Lampén, K. Lassila-Perini, S. Lehti, T. Lindén, J. Tuominiemi, four PhD students A. Heikkinen, M. Kortelainen, L. Wendland, M. Voutilainen (adjoint member) and an undergraduate student P. Kaitaniemi.

Physics analysis and simulation

In 2007 the HIP group took responsibility for performing the detailed preparative analysis for the search of the charged MSSM Higgs bosons in the $gb \rightarrow tH^{\pm}$, $H^{\pm} \rightarrow \tau\nu$ channel with fully hadronic final state assuming an integrated luminosity of 100 pb^{-1}. The work published in 2006 in the second volume of the Technical Design Report on Physics serves as a basic guideline for the analysis. The working group was enlarged to contain physicists from TIFR (Mumbai), Imperial College (London), the University of Pisa, the University of Florida and DESY (Hamburg). The HIP group has also responsibility for testing and maintaining the single-Tau trigger aimed to choose the hadronic $H^{\pm} \rightarrow \tau\nu$ decay mode for the searches of charged Higgs bosons.

The $gb \rightarrow tH^{\pm}$, $H^{\pm} \rightarrow \tau\nu$ channel is subject to large backgrounds from ttbar, W+jet and QCD multi-jet events. Analysis for measuring these backgrounds exploiting the muons from W decays in ttbar and W+jet events and the production of QCD multi-jet events with the early LHC data was started in 2007. This analysis is very challenging due to uncertainties associated with the missing transverse energy measurement and the possibility of fake energetic tracks in the jets. Further difficulties arise from the many possible sources of missing transverse energy in ttbar events and events from the Breit-Wigner tail of W in W+jet events being a potential background source. Work was started to improve the identification of the energetic τ jet from the $H^{\pm} \rightarrow \tau\nu$ decay with the Particle Flow methods and with combined calorimetric and tracker methods in collaboration with the CERN Particle Flow group. The effect of misalignment of the tracker modules for τ identification was investigated with different misalignment scenarios. It was found that the impact of the tracker misalignment changes the signal acceptance and background rejection with only a few per cent.

The group also participated in the Higgs boson physics in non-standard scenarios. The production of the MSSM Higgs bosons was investigated in collaboration with the HIP Phenomenology group. The SUSY cascade models with non-universal gaugino masses at the unification scale were used and a CMS analysis note was written on the possible discovery. Prospects for finding the very light NMSSM Higgs bosons were studied with theorists in $H \rightarrow AA \rightarrow 4\tau$ final state. The signature for this channel is two τ jets with oppositely charged muons in the τ reconstruction cones, which allows effective suppression of potential backgrounds.

The group was active in the development of new tools and methods for data analysis: a ROOT-based analysis package was written to facilitate the CMS data analysis in remote laboratories. The newly founded Physics Analysis Task Force of CMS is one of the projects. Multivariate analysis tools (TMVA) were tested with b-tagging jets in the backgrounds for the $H \rightarrow \tau\tau$ channel.The b-tagging efficiency was estimated with several methods available in the ROOT-based TMVA package, and compared with the traditional cut-based track counting b-tagging method.

The results were presented regularly in the working group meetings at CERN and in group meetings and seminars in HIP. The group members participated in international conferences and workshops giving talks on the Higgs boson discovery potential at the LHC.

User support co-ordination

The HIP team continued the all-CMS co-ordination of the user support for physicists using the CMSSW package for data analysis. In 2007, the CMS Software Documentation Policy was written. It defines the different actors and their responsibilities in the CMS Software Documentation and its maintenance. The CMSSW documentation consists of three main elements: (i) the CMS Offline WorkBook, (ii) the CMS Offline Guide and (iii) the CMSSW Reference Manual. The WorkBook contains the instructions on accessing computing resources and using the software to perform analysis within the CMS collaboration. This document has been constantly updated during 2007, and a major review is planned for early 2008.

Ametisti was upgraded with 128 additional CPUs in 2007. Here the first of the two racks is moved into the machine room.

The Offline Guide gives full details of CMS Software including descriptions of algorithms and software architecture, instructions for analysis and validation and common items such as developers' guide, trouble shooting guide, FAQ lists, and instructions for code optimization. The structure for this document was established in 2007, and most documentation material has been moved in this structure.

The Reference Manual contains the release dependent technical documentation such as C++ class lists, a brief description of contents and purpose of each package and default configuration files and sequences. A documentation plan was drafted to guide the work towards a complete CMSSW documentation suite. As the first step, documentation contact persons were nominated in each off-line and physics subproject, and the priorities were set up. This work will continue in 2008, with the aim to complete the main areas of the CMS Offline Guide.

Computing activities

The major breakthrough in 2007 was that annual funding for LHC computing resources of 800 kEUR/year was granted in 2007 by the Ministry of Education for the years 2008, 2009 and 2010. HIP and CSC signed a contract to formalize the LHC computing project collaboration and the acquisition of computing resources with the 2.4 MEUR funding obtained and to set up a new common project to carry out the needed work. The work on preparing and obtaining LHC computing resources was made in a very close collaboration between the HIP CMS and Technology Programmes, CSC, and NDGF. This close collaboration resulted in several advances in many areas of CMS computing that are summarized here, for further details see also the Technology Programme chapter.

Hardware activities. An agreement was reached between HIP and CSC that the *Sepeli* cluster at CSC would be turned over gradually to HIP in 2007–2008 for LHC computing usage, so that it would be dedicated for LHC computing by the summer of 2008. CSC started acquisition of a 170 TB dCache disk system to be available in 2008 for LHC computing. CSC and the HIP Technology Programme created each independent dCache test systems. The *Ametisti* cluster in Kumpula was upgraded with 128 CPUs on loan from CSC from the old part of *Sepeli*.

Software activities. CMSSW evolved so that it could be installed directly on 64-bit machines on the M-Grid at CSC and in Kumpula. Runtime environments for CMSSW and ROOT were created for enabling M-Grid usage of these applications. An ARC-plugin for the CMS Monte Carlo production tool ProdAgent was created as a contribution by NDGF. PhEDEx was upgraded and configured on the *Silo3* file server in Kumpula to use the three available dCache test systems at CSC, at the Technology Programme and in Kumpula (a dCache pool connected to the NDGF test dCache server). The operating system on *Mill* and *Testbed1* was upgraded to Rocks 4.3. A temperature monitoring tool for the *Ametisti* nodes was developed and taken

into usage allowing automatic shutdown in case of machine room cooling problems. The Technology Programme maintained ARC on the Grid resources.

A tutorial on the CMS software framework, CMSSW was organised in Kumpula on the 19th of March 2007 using the *Mill* cluster with almost 20 participants, including the teachers.

Tracker alignment

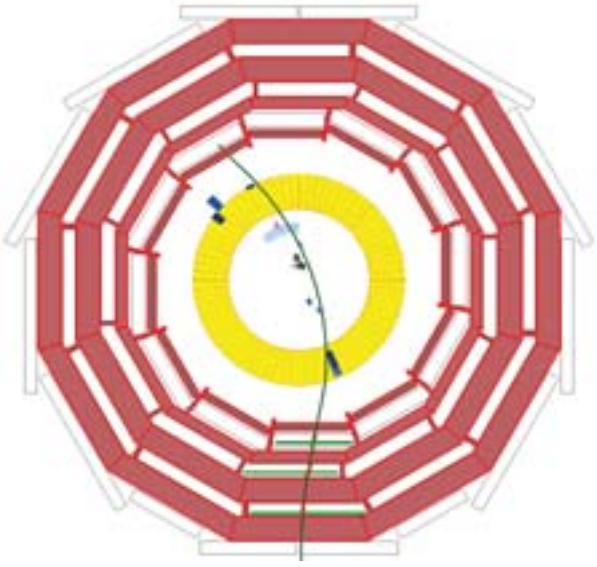
The team continued to work on the track-based calibration of the sensor positions in the CMS Pixel and Strip detectors. This calibration task, called detector alignment, aims at finding corrections to sensor positions and orientations to achieve the optimal trajectory reconstruction. It will have a great importance for the physics performance of the CMS. The HIP team has participated actively in the work of the CMS Tracker alignment group, especially in developing alignment methods and strategies for the Pixel detector.

Responsibilities of the team included also a comprehensive revision of the misalignment scenarios for the CMS Tracker. The alignment algorithm implemented by the HIP team has been widely used by the CMS alignment group. In addition to its earlier use, it has now been applied also to the CSA07 exercise as well as to the partial alignment of the CMS with cosmic muon data recorded in the spring and summer of 2007. The HIP team has also applied the algorithm to the data analysis of the upgraded FinnCRack in Helsinki together with the HIP Tracker project.

Geant4 development

The Geant4 version 9.1 was released in December with significant improvements in hadronic physics, such as enhanced modelling of the pre-compound and evaporation phases. Development of the Bertini models included improvements in the cross-section and in the Coulomb barrier treatment. In a systematic validation study of all Geant4 hadronic models applied to a hadron treatment with 60 MeV protons, the Bertini models were found to provide the best agreement with experimental data.

The release also included the first fully functional versions of the INCL hadronic cascade and ABLA evaporation codes. The models passed the Geant4 system tests and a detailed physics validation started. The new simulation features provided by these physics models are needed to ensure accurate hadronic shower calibration for the next generation of calorimeters. Furthermore, INCL extends the intranuclear cascades to ion-ion processes. The development of INCL and ABLA models for



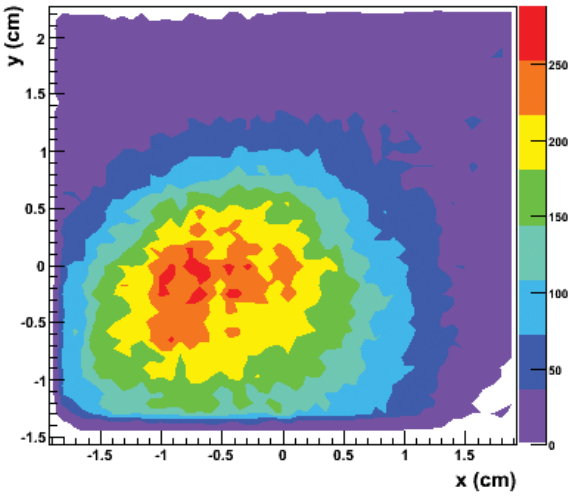
Cosmic ray measurement in the CMS detector.

Eija Tuominen, CMS Tracker project leader

Geant4 takes place in a close collaboration with the original developers as a common project between HIP and CEA, Saclay (Commissariat à l'Énergie Atomique). Being theoretically motivated the introduced Geant4 models of hadronic interactions are now more and more frequently used for the CMS detector simulation, replacing a more traditional approach which relies on the parameterization of experimental data.

Test beam off-line data analysis

The test beam activities included code development for the off-line data analysis of the HIP Silicon Beam Telescope (SiBT) in a close collaboration with the CMS Tracker project. The analysis code was successfully implemented in the CMSSW framework. The alignment and a detailed analysis of the reference telescope were successfully achieved.



SiBT beam transverse profile.

Outreach activities

The group members were active in introducing CERN and the LHC experiments to visitor groups from Finland. The groups included high school students and members of the Finnish Parliament. The group also approached the general public by writing popular articles on the status and goals of the LHC experiments. A series of popularizing articles about particle physics topics and the construction of the CMS experiment was published on the Internet for high school students. An initiative was realized to form a meeting place for the rapidly growing Geant4 medical user community of Europe. It is an Internet based collaborative platform for "The Geant4 European Medical User Organization", G4EMU.

CMS Tracker

In March 2007, the achievements of the CMS Tracker project 2001–2007 were evaluated by two experts, Prof. Mike Tyndel from Rutherford Appleton Laboratory and Dr. Christian Joram from CERN. The evaluators summarized their observations with the words: "We were impressed by the scientific achievements of the HIP project team over the last 3 years. It can be difficult for a relatively small team to make an impact and achieve visibility in such a large project as CMS and the team should be congratulated on what they have achieved – with leading contributions to the design, construction and assembly of the silicon tracker support structure, the silicon telescope for detailed performance studies, the trigger electronics and the pioneering work on the development of radiation hard silicon sensors". Based on the evaluators' recommendations, the HIP Scientific Advisory Board recommended and the HIP Board accepted the continuation of the Tracker project for the years 2008–2010 under the name "Operation of CMS Tracker".

In 2007, the HIP CMS Tracker project concentrated on three main activities, all related to the development of silicon tracking detectors: 1) commissioning of the CMS Tracker at CERN, 2) testing of silicon detectors using the Finnish Cosmic Muon Rack (FinnCRack) and 3) development of radiation hard silicon detectors for future high energy physics experiments. Among the main achievements during the past year were the final installation of the CMS Tracker inside the CMS and the upgrade and successful beam tests of the Helsinki Silicon Beam Telescope (SiBT).

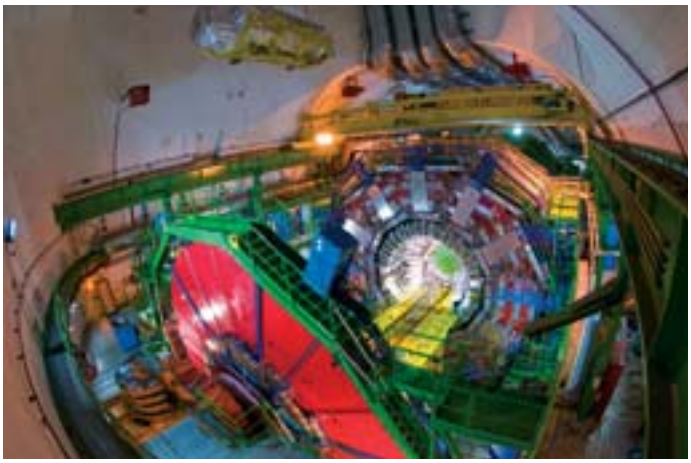
Commissioning of the CMS Tracker

During 2007, the Finnish Mechanics team at CERN, consisting of one engineer and three technicians, participated in the installation and commissioning of the CMS Tracker. In early 2007 all the Tracker subdetectors were installed inside the Support Tube, the Tracker was sealed and a 15% slice of the detector was connected to cooling and to final hardware for powering and readout. During summer 2007, many scientists from the HIP CMS Tracker project participated in the cosmic muon test runs in the Tracker Integration Facility.

In July 2007, the Tracker slice test was disconnected and preparations for transport and installation started. During the year the CMS YB0 in the CMS cavern was also prepared to receive the Tracker: cables and cooling pipes were installed from outside the CMS to the patch panels inside the magnet and from that point on the empty service channels were installed up to the Tracker level. During the year, studies had been made of the thermal behaviour of the Tracker patch panels and service channels; accordingly a thermal stabilization system had been developed and was installed to maintain good temperatures in them in different working conditions. Also tools, working methods and pre-made components, especially for the cooling pipe work and thermal insulation, were developed to make the coming connection and checkout work efficient.

In December, the CMS Tracker was successfully transported to LHC Point 5, lowered into the CMS cave and fixed to its final position in the CMS.

Tracker Project participates in the outreach activities in CMS cavern.



CMS Tracker lowering 16.12.2007.

Silicon Tracker inside CMS.

Finnish Cosmic Rack (FinnCRack)

The Finnish Cosmic Rack (FinnCRack) is a telescope built from eight layers of CMS silicon detectors measuring tracks of cosmic particles. FinnCRack is constructed using components of the CMS Tracker Outer Barrel (TOB), mimicking a six degree (in azimuth) sector of the TOB barrel structure. It is used as a test station providing data for testing of the TOB subsystem level functionality as well as for development of TOB software, e.g., analysis software (CMSSW), software alignment code, on-line software, and run control software.

Assembling silicon detector rods inside FinnCRack.

It also provides a platform for the testing of the novel radiation hard detectors for the CMS upgrade and for future collider experiments.

FinnCRack was initially constructed and tested at CERN as a joint effort with the CERN (TOB) group. In 2006 it was transported to the Kumpula Detector Laboratory and recommissioned there. In 2007, the facility for the cooling of the FinnCRack silicon detector modules was finally installed and commissioned. The cooling system includes both a cooling house and cooling-liquid-circulation for the detector modules. In addition, work has been proceeding for the upgrade of the FinnCRack electronics, i.e., trigger system, control and monitoring electronics, and high and low voltage power supplies. FinnCRack also now features accurate flow meters to control the temperature, humidity and coolant flow. Automatic interlog system hardware have been installed to allow continuous operation during nights and weekends.

In 2007, FinnCRack became an operational part of the infrastructure of the Kumpula Detector Laboratory. It is an essential both in the operation of the current CMS Tracker and in the development of novel detectors for the CMS Tracker Upgrade.

Development of Radiation Hard Silicon Detectors, including the Silicon Beam Telescope (SiBT)

During 2007, the research on radiation hard silicon detectors continued in the framework of the CMS Upgrade programme and of the CERN RD39 (60 members, 15 institutes) and RD50 (280 members, 55 institutes) research programmes. This network links together practically all important research groups worldwide in this field and provides access to a wide selection of characterization and simulation tools. In addition, the close collaboration with the University of Helsinki (HU) Accelerator Laboratory continued for detector irradiations and for the development of a simultaneous cryogenic current-capacitance-voltage measurement system. Furthermore, electrical detector characterizations were done at the HIP Detector Laboratory. Some detector characterization was also done in co-operation with the Laboratory of Electrical Engineering of Lappeenranta University of Technology (LUT).

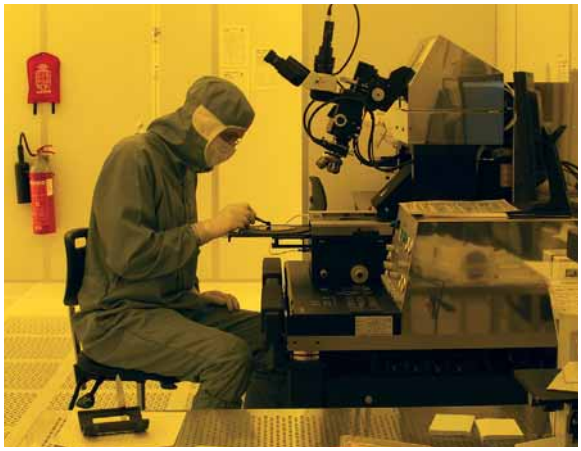
In 2007, the Helsinki Silicon Beam Telescope (SiBT) at the CERN SPS H2 test beam area was completely rebuilt in collaboration with the Fermilab, University of Karslruhe and University of Rochester CMS groups. The SiBT is a reference telescope that accurately measures the tracks of energetic particles for comparison with the measurements from the detector to be tested. The readout electronics and data acquisition (DAQ) of the upgraded SiBT consists of CMS Tracker Outer Barrel hybrids and prototype CMS Tracker data acquisition cards. The telescope contains eight reference detector planes in ±45 degree orientation and has two slots for the devices to be tested. The reference sensors are originally designed for the Fermilab D0 Run IIb. The telescope can be cooled down to a temperature of -20°C, which is very beneficial when studying highly irradiated sensors. The interpolated position resolution of the rebuilt SiBT is 9 µm, the signal-to-noise-ratio (S/N) of the reference detectors is 25 and the active area 4 × 4 cm^2.

During the summer 2007 SiBT beam period, several magnetic Czochralski silicon (MCz-Si) sensors were tested. These detectors were manufactured by our group at the Micro and Nanofabrication Center (MINFAB) of Helsinki University of Technology (HUT). The test results were in close agreement with the predictions of the numerical simulations done by our team. The preliminary data analysis indicates a S/N of 41 for a non-irradiated sensor, S/N

of 25 for a sensor irradiated with 1E14 cm^{-2} 1 MeV neutron equivalent proton fluence and a S/N of 19.5 with a 5E14 cm^{-2} 1 MeV neutron equivalent proton fluence. These results are measured at 0°C.

Based on the summer 2007 SiBT beam test results, it can be concluded that MCz-Si is a promising material for the Super-LHC Outer Strip Tracker (fluence 2×10E15) but not for the Super-LHC Inner Pixel Tracker (fluence 1×10E16), where a more radiation hard solution should be found. To this end, our group is developing a CID (Current Injected Detector) concept together with the CERN RD39 R&D Programme and St. Petersburg Ioffe Institute. In this R&D work, a cryogenic TCT measurement set-up built by our group for RD39 is an important tool. During 2007, this cryo-TCT was upgraded with adjustable low-noise and high-frequency electronics as well as with new test control and calibration instruments. In the collaboration between Ioffe Institute and HIP, our group has also participated in the dicing of TOTEM edgeless silicon detectors at MINFAB.

One of the consequences of the successful commissioning of the telescope and the first beam tests with proton irradiated MCz-Si detectors, was that SiBT was approved as part of the official CMS Super-LHC Upgrade programme in December 2007.



Processing detectors by optical lithography at Micronova clean room.

divided into 96 strip chambers. RPC detectors are very fast and the Link Boards are used to compress and multiplex the data before it is sent to the Level-1 trigger and Data Acquisition (DAS) via 1.6 GB/s optical links.

The last batch of seven boxes consisting Link Boards were delivered to CERN during spring 2007. Each box contained 60 Link Boards. Most of the crates and boards were installed and tested in situ at SX5. The CCU ring originally designed for the CMS Tracker had some ground loop problems which were measured and cured. A special isolation transformer was designed and tested to operate in the high magnetic field.

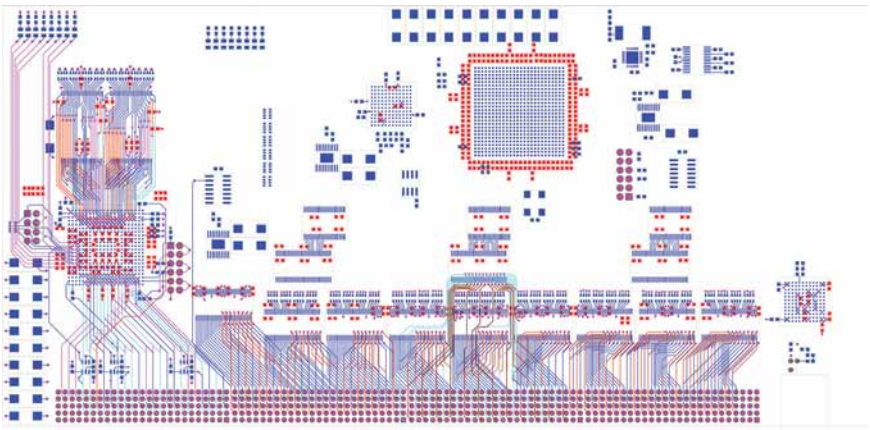
Design work of the RE1/1 Link Boards was started and is continuing. These boards are needed in the CMS forward direction. The boards have smaller layouts and use liquid cooling. These boards will be mounted into special boxes designed previously by the HIP CMS Tracker Mechanics group. The boxes had prior to this been mounted into CMS due to the mechanical construction of the experiment.

RPC Trigger

Trigger data Link Boards (LB) for the CMS Resistive Plate Chambers (RPCs) have been designed, constructed and tested by the HIP group at the Microelectronics Laboratory and Electronics Design Center of Lappeenranta University of Technology (LUT). The boards have been assembled at Electro Hill Ltd. Altogether 906 Slave-LBs, 510 Master-LBs (ML), 220 Control Boards (CB) and 220 Front Plane Boards (FB) have been produced.

RPCs will be used in the CMS as dedicated trigger detectors both in the barrel and in the end-caps. There are altogether some 200,000 channels in the CMS RPC system,

Layout of the RE1/1 Link Board.



Nuclear Matter Programme

Juha Äystö,
Nuclear Matter
Programme director

The Nuclear Matter Programme provides full participation of the Finnish teams at CERN in studies of two aspects of nuclear and hadronic matter. These are cold exotic matter with the 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 has concentrated in 2007 on the finishing of certain parts of the ALICE detector for the LHC machine and on developing the Finnish Physics Programme for ALICE. 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 of a new form of matter, the quark and gluon plasma. The project leaders of these two projects are Docent Ari Jokinen for ISOLDE and Dr. Jan Rak for ALICE. In addition, the Nuclear Matter Programme has been co-ordinating the Finnish participation in the planning of the FAIR project at GSI. FAIR stands for Facility for Antiproton and Ion Research. In 2007 Finland decided to participate in the construction of the FAIR facility with a contribution of at least 0.5% of the total construction costs. The Finnish involvement in FAIR includes participation in two experimental collaborations which are PANDA for antiproton driven hadron research and NUSTAR for nuclear structure and astrophysics studies. Industrial participation in constructing the FAIR facility is being explored in collaboration with Finpro. The first projects will start already in 2008 and the planned construction phase will last five years.

Jan Rak, ALICE
project leader

ALICE

General

The main focus of the ALICE group in 2007 was on the preparation for the first data taking scheduled for late summer 2008. According to the Large Hadron Collider (LHC) beam use proposal, the first events to be seen by the ALICE experiment will be the proton+proton collisions at $\sqrt{s}$ = 14 TeV. Exploration of the p+p collision in this unprecedented energy regime provides the vast variety of physics topics to be addressed. The Finnish/ALICE group concentrates on the basic pQCD phenomena related to parton properties like intrinsic parton momentum (k_T) distribution in di-jet and photon-jet events, fragmentation function and heavy quarks production. Detailed analysis of the above-mentioned phenomena is crucial for the understanding of the nonperturbative sector of QCD at this unexplored energy regime but it also serves as the reference measurement for the study of the nuclear modification in heavy ion collisions.

High-p_T particle correlations

The data provided by the Relativistic Heavy Ion Collider (RHIC) at $\sqrt{s}$ = 200 GeV left behind many opened questions. The strong jet quenching seen by all RHIC experiments is expected to be accompanied by k_T broadening as observed in the deep inelastic scattering. However, the data reveal a small broadening which questions, at least, some of the models describing the data. We explored the methods to study the average k_T magnitude in two hadron and photon-hadron correlations. Some of these studies were presented at international conferences including the major conference in the field – Quark Matter 2008 in India.

In this tremendously high centre of mass energy regime, the transversal size of the

nucleon wave function is expected to grow far beyond the "low-energy" value of 1 fm. There are interesting suggestions to study typical heavy ion phenomena like centrality, elliptic flow and jet quenching in p+p collisions. We were exploring a possibility to measure the centrality (impact parameter) and orientation of the reaction plane using the forward multiplicity detectors in ALICE. We exploited the new computing facilities provided by CSC (the Finnish IT Center for Science) to generate a large amount of the full Monte Carlo data. It allowed us also to exercise the analysis code on the "real" data.

We were (and are) actively involved in the ALICE high-p_T physics working group were the results of our analyses are regularly presented and scrutinized.

Installation of the T0 detector in the central region of ALICE.

Computing and massive data analysis

There was a major progress in the year 2007 in the availability of the computing resources for the ALICE data analysis framework. The CSC institute kindly provided us with 64 CPUs resided in the "opaali" cluster at Jyväskylä, and later in the year we received another 200 CPUs located at CSC. We purchased 5 TB of the disc space and another 10 TB were partially installed at CSC. This computing facility was used primarily for the ALICE full data simulation used for the correlation physics and study of the performance of the T0 detector (see next paragraph).

T0

Construction of the trigger and fast timing detector for the ALICE experiment at CERN has reached several important milestones in 2007. They include installation of T0-C and T0-A arrays around the beryllium beam pipe of the LHC collider and moving of the front-end electronics from the test lab to its final location at Point2. There the commissioning continued in the real environment using a fast blue laser as the source of light for the photo multipliers. By the end of the year the detector and electronics were sufficiently integrated with ALICE control, trigger and acquisition being among the first detectors included in the global cosmic run of ALICE. There is still plenty of work to do before our detector and the rest of ALICE will be ready for the first collisions, but the end of the commissioning and the start of the normal operation are already in sight.

Electromagnetic Calorimeter and high-p_T trigger

Since the physics interests of the Finnish/ALICE group are tightly related to high-p_T photon and jet production we decided to extend our hardware involvement in the ALICE experiment. The electromagnetic calorimeter plays a crucial role for photon and π^0 identification and also serves as a reliable high-p_T trigger. We are developing the FPGA code for PHOS (Photon Spectrometer) and for the new EM-calorimeter (US-France-Italy-Finland collaboration) trigger boards. The code evaluates the analog sum of 2×2 towers in a sliding window and compares it to

Ari Jokinen, ISOLDE project leader

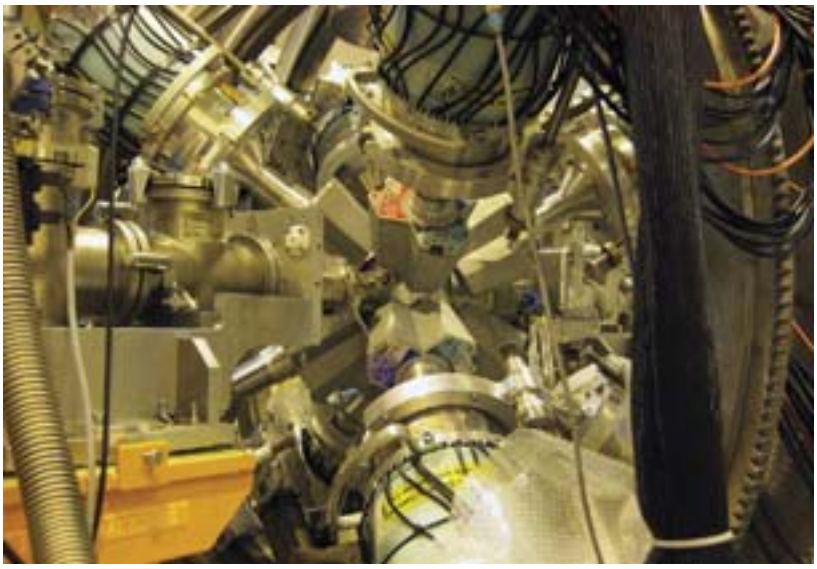
various trigger thresholds. All these relatively complicated procedures have to be performed within a 100 ns level-0 trigger window and thus they require the use of the high-tech FPGA processors.

ISOLDE

Research with radioactive post-accelerated beams – Coulomb excitation of light Hg isotopes

The aim of this campaign was to measure, for the first time, the low lying excited states of ^{182,184}Hg via Coulomb excitation, with the view of obtaining the B(E2) values. These values would be complemented by lifetime measurements of ^{180,182}Hg performed at Jyväskylä and would allow us to assign a sign to the magnitude one would obtain from lifetimes alone. We would therefore, from this experiment, be able to determine the role of shape co-existence in the light Hg region and the mixing of states. Because of yield issues we were not able to observe the low lying excited states of ^{182}Hg. We instead concentrated our efforts on ^{184,186,188}Hg. We were successful in observing the 2^+ states in each of these nuclei, which will allow us to obtain matrix elements for all three nuclei. An addendum will be submitted to the ISOLDE PAC concerning ^{182}Hg and we believe this will be accepted and scheduled to run in the summer 2008 campaign. We also intend to make lifetime measurements of ^{184,186,188}Hg to improve upon those found in the literature, these will give more accurate matrix elements for the nuclei when the Coulomb excitation data is analysed.

Ge-array MINIBALL installed around the target position after the post-accelerator REX-ISOLDE.

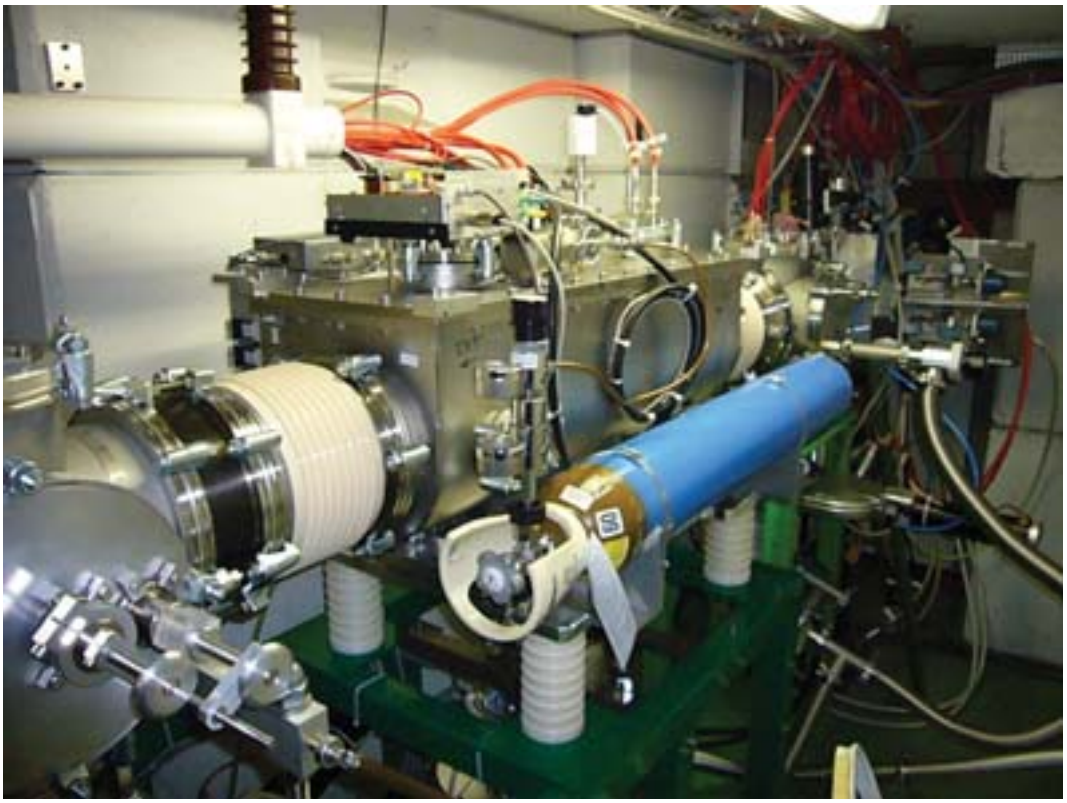


Solid state physics

Due to technical problems at ISOLDE, the planned implantations of ^{56}Co had to be postponed and will be performed sometime in the future. Fortunately, data from ^{132}Sn implantations from the previous experimental period could be exploited resulting in two new publications.

Research and instrumentation of ion beam preparation and manipulation

An ion cooler and buncher (ISCOOL) was installed after the focal plane of the second dipole of the High-Resolution Separator at ISOLDE. This device was started under supervision of Ari Jokinen and many HIP students have participated in the construction of the device during the last few years. Various commissioning tests both off-line and on-line in its final location were performed to characterize and optimize the instrument. Despite the tightly scheduled installation, the performance of the instrument turned out to be satisfactory. Cooling and bunching of the ion beam was demonstrated and the transverse emittance of the radioactive ion beams was measured to be 2.2 π·mm·mrad, which corresponds to the reduction of a factor of ten compared to the injected beam. The efficiency of the ISCOOL was determined to be about 75–80% for medium and heavy masses. Below A=40 the efficiency gradually reduces due to an inefficiency of gas cooling for light ions, as expected. Longitudinal cooling of the ion beam was also demonstrated by collinear laser spectroscopy resulting in an energy spread of the order of 1 eV and a bunched width of the order of 10 μs. The background suppression for laser spectroscopy of ^{85}Rb and ^{44}K was 10^4.



ISCOOL installed in the beam line after the HRS.

All in all, the installation of ISCOOL was a success and its full exploitation in the physics programme is foreseen in 2008.

At ISOLDE Pekka Suominen was part of the technical team developing targets and ion sources participating in three projects: a design for a new tape-station, a design for a new mass spectrometer needed in testing actinide targets and design, construction and test of a beam energy measurement device. Apart from target group activities, he started a project to develop a new type of radiation hard Electron Cyclotron Resonance Ion Source (ECRIS) based on arc-shaped coils. The new type source is interesting for radioactive ion-beam production and for (stable) highly-charged heavy-ion beam production. The developed device could become an on-line source for multiply charged radioactive ion-beams for future projects such as EURISOL and a Beta-Beam facility. At the end of 2007, Pekka Suominen has become involved in a Finnish-German industry/research consortium to develop power supplies for fast pulsed accelerator magnets employing a Superconducting Magnetic Energy Storage (SMES) system.

Technology Programme

Ari-Pekka Hameri,
Technology Programme
director

The Large Hadron Collider (LHC) project has been progressing and its launch is foreseen during the year 2008. Given this fact, the year 2007 was filled with activities to prepare for the immense data challenge the collider will set for the global Grid community. In Finland HIP has signed a collaboration agreement with CSC, the Finnish IT Center for Science, and this has fostered the organizational structure that will fulfil the Tier-2 computing responsibilities set for Finland in 2008. This collaboration is in full swing and, backed by the funding from the Ministry of Education, has already progressed in setting up the necessary computing infrastructure needed in 2008. The Technology Programme has continued its contributions within the EU-funded EGEE-II initiative to such an extent that its responsibilities have been increasing significantly during the year. At the same time the Programme finished successfully a 4-year industrial collaboration project funded by TEKES and the participating Finnish high-tech and software companies. Various other events have been organised to disseminate Grid-related expertise. These initiatives include participation in an annual computing "Assembly" with around 5,000 participants testing Grid technologies, and the preparation for the first Grid seminar for the IT students at Helsinki University of Technology. The Programme produced several masters' theses and publications during the year 2007.

Miika Tuisku,
DataGrid project
leader

Grid middleware development

The experts of the HIP Technology Programme continued their work in the EU-funded EGEE-II project that is preparing for the data challenges to be faced through CERN's new physics experiments that will be operational in 2008. The HIP Technology Programme's responsibilities included the roles of deputy middleware manager and security middleware coordinator as well as direct responsibilities for various security software components. In the second year of EGEE-II, the E-SciencE flagship project, the personnel of the HIP Technology Programme have continued to determine the development course of the security middleware through their participation in the Technical Coordination Group and other technical management bodies of the project.

Northern part of EU-EGEE Grid.

The software development effort has focused on bug-fixing, hardening and upgrading the security middleware software according to user requirements. The Programme received an additional request and the resources to produce a security software module needed by the bio-medical research partners. Another new software development took place in close co-operation with the CERN Data Management team aiming to produce a secure metadata service for the high-security bio-medical researchers. The HIP Technology Programme has been responsible for producing a complete project deliverable with numerous reports and other peer-reviewed publications. During 2007 and in co-operation with CSC the Programme organised and held a major Grid expert meeting in Helsinki.

Despite the fact that EGEE-II is spread out in numerous sub-federations throughout Europe, CERN remains the key competence centre in the field. The presence of the HIP Technology Programme at CERN has helped to increase its responsibilities in the project. This has also led to elevated responsibilities in the proposed EGEE-III project for the years 2008–9.

Physics and Cluster Computing

Physics Grid

Summer 2008 will most probably witness the launch of the Large Hadron Collider (LHC). The purpose of this accelerator is to provide new information on the fundamental structure of matter. From the computing point of view, the experiment will produce around 15 Petabytes of data in a year. One copy of this data is stored at CERN, known as the Tier-0 site, and another copy is distributed to 11 Tier-1 level sites around the world. The responsibility of the Tier-1 sites is to provide computing and storage facilities for the vital physics data analysis. From Tier-1 sites the data is also forwarded to Tier-2 sites where simulations and user specific analyses are performed.

The Nordic Data Grid Facility (NDGF) provides one distributed Tier-1 site jointly with the Scandinavian countries. The Ministry of Education granted HIP with considerable funds for the years 2008–10 to build and organise the operations in a new high performance computing cluster in order to fulfil the requirements set for the distributed Tier-1 site of NDGF. In addition to this distributed Tier-1 site, the grant is also used to provide a Tier-2 site for the CMS experiment in Finland. In order to tackle this challenge HIP is collaborating with the Finnish IT Center for Science, CSC. The collaboration agreement, valid till 2010, was reached between HIP and CSC in November 2007 and the programme is co-ordinating the acquisition of the required computing resources.

The current plan is that HIP will provide computing power of 606,000 units according to the SPECint2000 benchmark and 170 Terabytes of storage in 2008. In 2009 the corresponding numbers are 946,000 SpecINT2000 and 300 TB. From the software point of view, the Technology Programme has deployed the current version of the CMS data transfer system PhEDEx (Physics Experiment Data Export) in Finland. PhEDEx allows the transfer of large physics datasets in a reliable way over wide area networks. Another important service for CMS computing is the dCache data storage system, which is installed at the Technology Programme premises in Espoo. This storage system, funded by the Magnus Ehrnrooth foundation, has 15 TB of storage. The PhEDEx and dCache systems have allowed Finland to participate in the data transfers experiment between the other CMS computing centres around the world. As a part of these data transfers, the first CMS PhEDEx transfer tests using a new version of the SRM protocol were carried out. This work has given valuable experience in preparing to handle the LHC data at the Finnish Tier-2 centre.

The Technology Programme is represented on the LCG Grid Deployment Board and in the NDGF CERN Advisory committee that defines the CERN and LHC physics needs for Nordic computing centres. It also has provided EGEE a small test cluster for middleware development.

Grid Cluster activities in Finland

In 2007 the Technology Programme continued its collaboration with CSC – the Finnish IT Center for Science. This collaboration has been defined in a joint memorandum-of-understanding agreement. The work has produced practical results concerning the data storage of the LHC Tier-2 project and training of people in both organizations. The M-Grid project continued with stronger focus on Grid usage. HIP has been actively involved in the M-Grid project, most notably with the security work in the Security Working Group. Since CSC is managing the M-Grid project, the HIP-CSC collaboration further increased HIP's involvement in the M-Grid project.

In the second half of 2007 the Technology Programme started collaboration with the Institute of Biotechnology of the University of Helsinki. The group studies 3D modelling of viruses based on electron microscope images. This work requires significant computing resources, thus being a suitable project for testing Grid computation with relevant and scientifically challenging data. A student of

the Technology Programme is preparing his master's thesis on adapting these computational challenges to the Grid framework. The project will provide valuable information on Grid adoption in new scientific areas.

As a member of the FennoGrid ry association one of the most visible events of the Technology Programme was participation in the Finnish Demo Party – Assembly Summer '07. Assembly is a computing event arranged twice a year with almost 5,000 attendees with their personal computers. The three-day-event is filled with gaming, coding and designing of software. The Technology Programme participated in the event by sending in a team of people to give a lecture about distributed computing and Grid. The Programme also hosted an event, in which over 2,000 people competed in a 2D space shoot-out game and took part in distributed rendering of a small 3D animation. The events succeeded well and the team was invited to come again in 2008. In addition, participation in a high-profile event like this spawned numerous articles in various on- and off-line magazines, domestically as well as internationally. Articles were published by IT media, like digitoday.fi, Mikrobitti, International Science Grid This Week among others.

HIP Technology Programme promoted the Grid at Assembly Summer '07 Finnish Demo Party.

Grid Applications and Industrial Collaboration Projects

NetGate-II

The second phase of the NetGate, an industrial research project co-ordinated by the HIP Technology Programme, started in 2006 and was completed in September 2007. The project exploited national and international research on Grid technologies to leverage these research results in Finnish industry. The focus areas were: Security, Terminal Grid computing, and Grid business research.

During 2007 around five researchers worked in the project. The project consortium consisted of six Finnish companies and two other universities in addition to HIP (the Technology Business Research Center of Lappeenranta University of Technology, and the Department of Computer Sciences of the University of Tampere). The project was financed by the Finnish National Technology Agency (TEKES) and the participating companies. In addition to technical development, the second phase of the project produced three MSc theses. The security work package implemented, among others results, an authentication method combining Web and Grid authentication. The developed technology is now applied within the EU EGEE-II project. Another result of the project was a prototype of the Grid Intrusion Detection System (IDS), which triggered strong interest among industrial companies and other Grid projects.

The Terminal Grid computing, often called Server Based Computing (SBC), work package produced methods to apply Grid methodology on desktop computing and studied how security components developed in the project could be integrated to work with common desktop applications. The work was validated by the following pilot systems: at the University of Tampere, in both the offices of the HIP Technology Programme, and in the CERN library. The first results of these pilots have been very promising and the technology has been taken into permanent use at the pilot sites. Finally, the NetGate-II project studied possible business models of various service scenarios in terms of earnings logic opportunities, roles in the value network, and general functionality of the value network. The study was done by interviewing about thirty people from Finnish companies and research institutes.

The NetGate-II project included parallel activities with CERN Openlab and two Finnish IT-security companies under the Open Security project with CERN. This was also the first

time in the Technology Programme's DataGrid project, when technology transfer was successfully accomplished from Finnish industry to CERN Grid operations. This collaboration brought new insights into holistic information security protection at the network perimeter and client services in Grid environments. This could be seen as a new research area which is expected to continue in 2008 with new industrial projects.

Summer Student Programme

The 2007 summer student programme welcomed four students from Helsinki University of Technology. One of them participated in the CERN Openlab project which aims at developing a digital pen logbook application for CERN experiments. This work has been continued as a MSc thesis project, as well as another thesis project focusing on Grid computing in medical image analysis. In addition to Finnish students, the group hosted two foreign summer students in collaboration with CERN Openlab and Finpro. These students worked in two projects: combining peer-to-peer and Grid technologies and developing Grid applications for financial computing.

HIP Technology Programme stand at Talent-IT recruitment fair in Dipoli.

Other Collaboration

The Technology Programme's industrial research collaboration venues apart from EGEE and CERN Openlab included also JBoss Federation, the Planet-Lab initiative, and the Finnish Grid association, FennoGrid ry. The Finnish partners that have signed the collaboration agreement with the Technology Programme such as Finpro Big Science and CSC have played and will continue to play an important role in the future. The most important of these collaboration projects is the building of the Finnish LHC Tier-2 computing facility with CSC and preparing for industrial collaboration with the GSI-FAIR acceleration centre in Germany. Other Finnish collaboration partners include Helsinki University of Technology – HUT, Helsinki Institute for Information Technology – HIIT, VTT, the University of Tampere, Lappeenranta University of Technology, and several Finnish IT companies. The collaboration with HUT included, for example, preparation work for the first Grid seminar for students that will take place in February 2008. The aim of the seminar is to share accumulated knowledge on computing clusters, and to provide students with a crash course in cluster administration.

Local collaboration in the Geneva area (e.g., the University Hospital of Geneva and the Technology Observatory of the Canton of Geneva) has opened up new possibilities for technology transfer through CERN activities. Both of the cantonal organizations have shown strong interest to exploit the Grid technologies and the plans in 2007 are to materialize in practical collaborations during the year 2008.

CLOUD

Markku Kulmala, CLOUD project leader

Background

Atmospheric aerosol particles play an important role in atmospheric physics and chemistry. They influence the climate by two distinct mechanisms: the direct reflection of solar radiation by aerosols, and the indirect increase in cloud reflectivity caused by greater numbers of cloud condensation nuclei. Understanding the dynamical behaviour of ambient aerosol particles requires understanding of the formation and growth processes of aerosols.

The CLOUD (Cosmics Leaving OUtdoor Droplets) experiment is motivated by numerous indirect observations and theoretical studies that suggest galactic cosmic rays (GCRs) may exert a significant influence on the Earth's cloud cover and climate. The observed variation of low clouds by about 1.7% in absolute units over one solar cycle corresponds to a change in the Earth's radiation budget of about 1.2 Wm^{-2}. This is comparable with the estimated radiative forcing due to anthropogenic greenhouse gas emissions (2.64 Wm^{-2} in 2005). The main proposed mechanisms are ion-induced nucleation, enhancing production of new aerosol particles which can act as cloud condensation nuclei, and enhanced ice particle formation due to ionization by GCRs. However, none of these mechanisms have been experimentally verified. The CLOUD experiment aims to accurately determine the pathways and significance of the phenomenon. The CLOUD Collaboration comprises 21 institutes from 9 countries with a strong Finnish contribution.

Data analysis

During the year 2007 the results from the first experiments performed in 2006 in the prototype reactor on the CERN PS beam line have been analysed. The Finnish team made significant contribution to the analysis work that yielded information for the design work of the final CLOUD detector. The analysis also gave a first insight into the processes behind the hypothesis.

The aerosol particle growth rates. Aerosol particle growth rates were calculated for all experiment runs. In certain runs, it was impossible to get growth rates either because no particles at sizes bigger than 3 nm were observed, either because the particles appeared simultaneously at all sizes, or because it was impossible to tell the beam induced particle formation from other particle formation. These growth rates have been calculated from CPCB (Condensation Particle Counter – Battery) data. These results are preliminary and give an idea of the growth rates. It also is a good base to compare the different runs with each other. This will be improved in the next experiment by improving the accuracy of determining the CPC cut off sizes and by optimizing the concentration change when turning the beam on.

Growth rates as calculated from the CPC-battery for each time the beam was turned on. Runs where no data is given (--) are runs for which it is impossible to get growth rates.

	3nm → 4nm (nm/h)	4nm → 7nm (nm/h)	7nm → 9nm (nm/h)	Total 3nm → 9nm (nm/h)
Run 28	--	--	--	--
Run 29-1	1.1	22.5	0.9	1.9
Run 29-2	--	--	--	--
Run 30-1	0.6	4.74	2.86	1.9
Run 30-2	--	--	--	--
Run 31	0.7	8.6	2.3	2.2
Run 34	--	--	--	--
Run 35-1	3.8	90.0	15.0	13.8
Run 35-2	225	36	40	45
Run 35-3	--	--	--	--

Those runs have been analysed for other aspects too, especially run 35. Other instruments such as the SMPS (Scanning Mobility Particle Sizer), the Air Ion Spectrometer and different gas detectors were used to combine many aspects of the experiment. It seems that turning on the beam leads to increasing particle concentration. However no growth of particles was observed on that particular run from the SMPS and the AIS.

The role of sulphuric acid. Sulphuric acid is known to have a role in new particle formation in the atmosphere. To investigate the possible connections between sulphuric acid and ion-induced nucleation and the influence of cosmic radiation on this, sulphuric acid concentrations were measured together with ion size distributions. Figure 1 shows an example of formation of over 2 nm ions that occurs at the same time as sulphuric acid concentrations are highest. During this short formation burst both the formation rate (approximately 1 $cm^{-3}s^{-1}$) and the growth rate of the newly formed particles (~ 4 nm/h for negative and 9 nm/h for positive ions) are quite high compared to what is normally seen in atmospheric measurements.

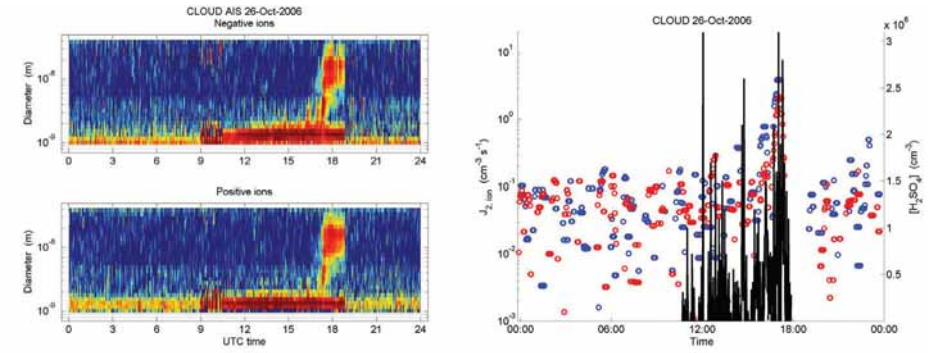


Figure 1. Formation event of charged particles (left) and simultaneous sulphuric acid measurements (right). Formation rate of ions (indicated in the plot on the right with blue and red marks for negative and positive ions, respectively) increases at the same time as sulphuric acid concentration rises.

Instrument design and development

The design work and instrument development for the final CLOUD detector has been continuing. The detector will comprise a fully temperature and pressure controlled reactor chamber and an expansion cloud chamber with relevant external and internal analyzers and gas and aerosol system. The basic idea behind the detector design is in fact the same as in C. T. R. Wilson's cloud chamber widely used as a particle detector decades ago. The difference is that while in Wilson's cloud chamber "cloud" formation was used to study subatomic particles, the CLOUD experiment uses particles to study aerosol and cloud processes. With the CLOUD detector the full scale of atmospheric conditions (from boundary layer to upper troposphere) can be simulated. A π/μ secondary beam from CERN PS will be used as an artificial source of cosmic rays. The physical processes to be studied during the CLOUD experiment are highly non-linear. Therefore, it is important to re-create experimental conditions that are as close to natural as possible and extremely well known. This demand puts a great strain on the detector to be constructed.

The Finnish team is responsible for ion mobility distribution measurements and partly for aerosol size distribution measurements with related instrument development. Air ion spectrometer (AIS, Airel ltd., Tartu, Estonia) development and laboratory testing has been continuing in close co-operation with the University of Tartu. A prototype instrument for operation at the low pressures and low temperatures of the final reactor chamber has been constructed and should be operational in spring 2008.

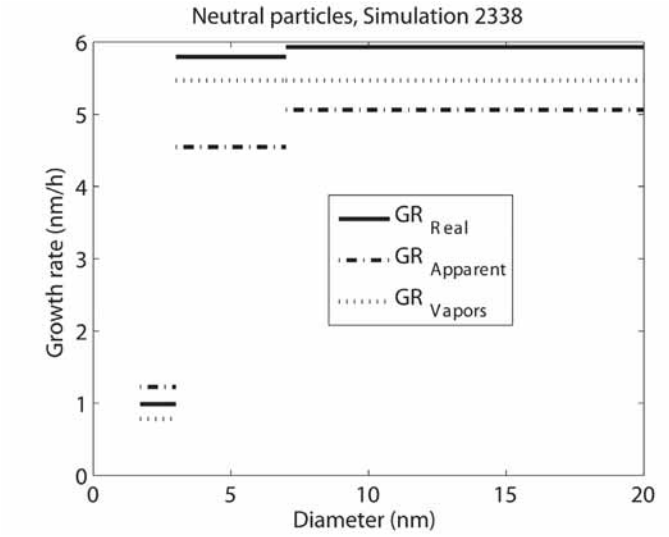


Figure 2. The growth rates of neutral particles as a function of particle diameter analysed from simulations carried out by ion-UHMA model. Different curves in the figure represent growth rates obtained 1) directly from model 2) by analysing method used for experimental data 3) directly from model input vapour concentrations.

Effort has been put on the evolution of aerosol particle detectors with the aim being to extend the detectable particle size range towards the molecular sizes. By the end of year 2007 this size range had been extended from 3 nm aerosol particles below 2 nm in diameter. Instruments have been tested in the field and they have, for the first time, revealed the initial steps of aerosol particle formation. The Finnish team made a major contribution to this progress.

An Ion-DMPS will be deployed in the future CLOUD experiments in order to assess the charging state of particle populations. The Ion-DMPS was measuring in Hyytiälä (SMEAR II) station in Finland. These measurements have allowed a fine tuning of the analysis methods. Some techniques for treating the Ion-DMPS data have been developed as well as an analytical equation that enables us to extrapolate the charging state to smaller sizes.

Modelling

In order to understand experimental ion-related results both in laboratory and field measurements, we have developed a novel aerosol dynamics model, ion-UHMA. It takes into account, in addition to basic aerosol dynamics, all electrical effects like ion-induced nucleation, ion-aerosol attachment, condensation growth enhanced by Coulomb interactions and changes in coagulation rate due to interaction forces.

Currently, the model is well-tested and we are applying it for the first case study related to growth of particles observed by differential mobility particle sizer (DMPS) and ion spectrometers (AIS, NAIS, BSMA), see Figure 2. In the future, we will apply this model to the interpretation of experimental results from the CLOUD experiment.

Publications

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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 the Graduate School in Particle and Nuclear Physics (GRASPANP) sponsored by the Ministry of Education. In addition to the graduate students that are supported by the graduate school and by the Institute, a fair number of undergraduate students also join the research groups and complete their Masters' thesis work in the Institute. Many of these students have continued as graduate students in the Institute projects upon graduation. In particular, the popular summer student jobs at CERN have attracted students to graduate studies. During the period 2003–2007 31 doctoral degrees and 56 Masters' degrees have been earned in HIP research projects.

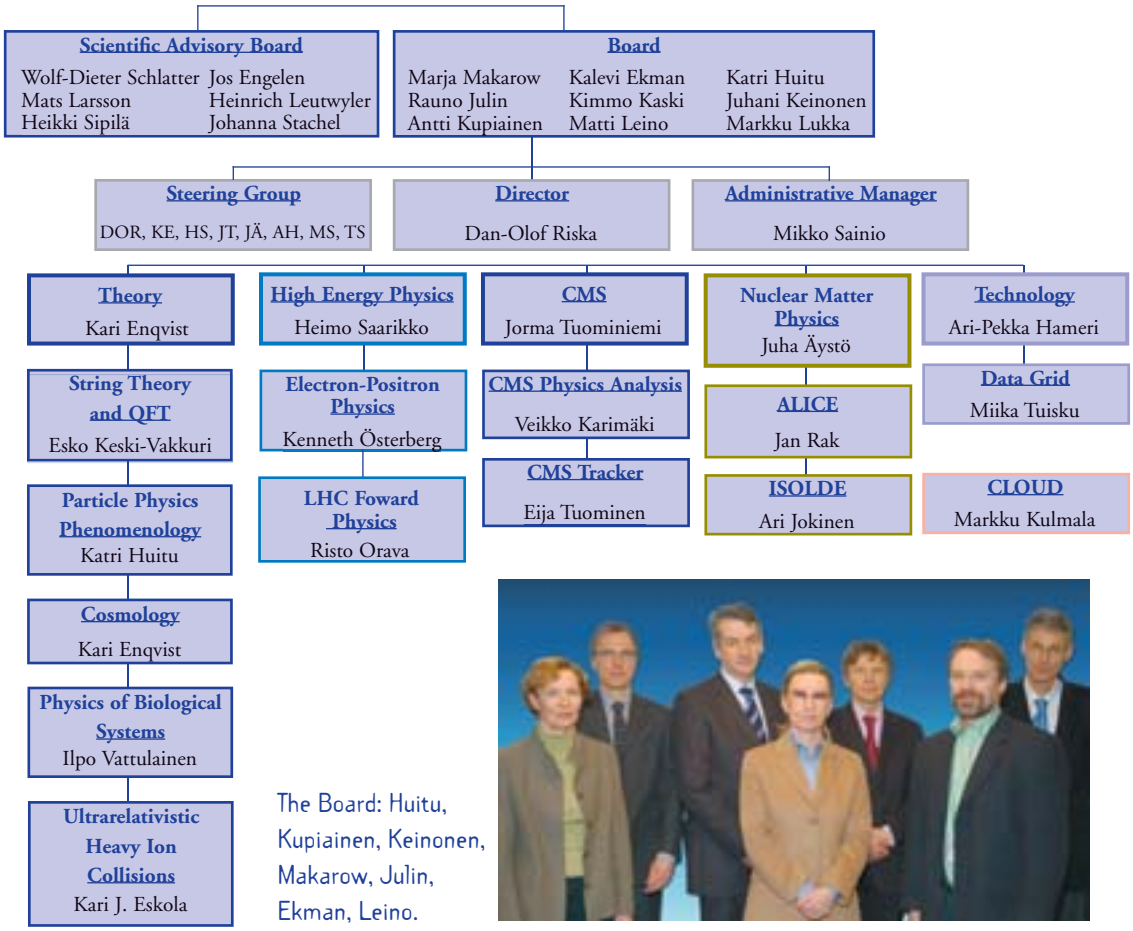
The National Board of Education (Opetushallitus) has continued its collaboration with HIP and the municipality of Jyväskylä in the CERN co-operation high school network and the collaboration with the city of Tampere in the TekNatur/CERN network for Swedish speaking high school students. The aim is to develop the role of subatomic physics in school curricula in co-operation with CERN. In 2007 this programme attracted 308 Finnish students and 50 of their teachers. A related programme has been to bring high school physics teachers to CERN. They participate in continuing education courses. In 2007, 47 teachers participated in this programme. In addition, a shorter visit to CERN was made by a group of 9 high school principals. These visits have generated considerable coverage in local newspapers all over the country: about 30 articles in total in 2007. In addition, the network published in September a magazine on CERN science studies at schools.

The year 2007 was the first full year of activity in HIP of Lappeenranta University of Technology. LUT has participated in the HIP research of the CMS and Technology Programmes for several years already.

The technological and commercial co-operation between Finnish industry and CERN is co-ordinated by HIP in collaboration with Finpro, which is an independent association that provides services to the Finnish export industry. The Finpro project at CERN is financed by TEKES.

Organization and Personnel

Organization



The Board: Huitu, Kupiainen, Keinonen, Makarow, Julin, Ekman, Leino.

The Institute Board

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Vice Chairman	**Kalevi Ekman**, Vice Rector (Helsinki University of Technology)
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G. Rigopoulos, scientist
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A. Ferrantelli, grad. student
J. Högdahl, grad. student
T. Mattsson, grad. student
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V. Reijonen, grad. student
M. Ronkainen, student

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T. Rüppell, grad. student
P. Tiitola, grad. student
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J.-T. Yee, scientist
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T. Jouttenus, student
T. Liimatainen, student

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K. Rummukainen, prof., adj. scientist
T. Renk, scientist
K. Tuominen, adj. scientist
J. Auvinen, grad. student
M. Heikinheimo, grad. student
A. Hietanen, grad. student
T. Kähärä, grad. student
H. Niemi, grad. student
H. Paukkunen, grad. student
T. Tahkokallio, grad. student
J. Virkajärvi, grad. student
H. Holopainen, student
T. Karavirta, student

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Electron-Positron Physics

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F. Oljemark, grad. student
J. Huopana, student
B. Moelgaard, student
R. Nousiainen, student

LHC Forward Physics

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K. Kurvinen, lab. engineer
T. Aaltonen, grad. student
E. Brücken, grad. student
T. Hilden, grad. student
J. Kalliopuska, grad. student
P. Mehtälä, grad. student
T. Mäki, grad. student (Fermilab)
J. Petäjäjärvi, student (at CERN)

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H. Saarikko, lab. director
E. Tuominen, lab. coordinator
F. Garcia, scientist
M. Oinonen, adj. scientist
M. Kalliokoski, grad. student
J. Heino, lab. engineer
R. Lauhakangas, lab. engineer
A. Numminen, lab. technician

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J. Tuominiemi, prof., programme director

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K. Lassila-Perini, senior scientist (at CERN)
S. Lehti, senior scientist
T. Lindén, senior scientist, grid coordinator
T. Lampén, scientist
A. Heikkinen, grad. student
M. Kortelainen, grad. student
P. Metsä, grad. student
J. Nysten, grad. student (at CERN)
M. Voutilainen, grad. student (Fermilab)
L. Wendland, grad. student
P. Kaitaniemi, student
O. Aspi, summer trainee (at CERN)

CMS Tracker

E. Tuominen, proj. leader
S. Czellar, senior scientist (at CERN)
J. Härkönen, senior scientist (at CERN)
I. Kassamakov, senior scientist
P. Luukka, scientist (at CERN)
D. Ungaro, scientist (at CERN)
A. Korpela, grad. student (at Lappeenranta)
T. Mäenpää, grad. student
E. Tuovinen, grad. student
E. Anttila, engineer (at CERN)
M. Autioniemi, engineer
J. Kortesmaa, lab. technician (at CERN)
H. Moilanen, student
H. Viljanen, student
T. Haggren, summer trainee (at CERN)
P. Hoang, summer trainee (at CERN)
H. Koski, summer trainee (at CERN)
S. Rantonen, summer trainee (at CERN)

Nuclear Matter Programme

J. Äystö, prof., programme director
W. Trzaska, docent, vice director

ALICE

J. Rak, proj. leader
P. V. Ruuskanen, prof. emer., senior scientist
M. Bondila, scientist
R. Diaz, grad. student
H. Seppänen, grad. student
A. Kaskela, student
N. Novitzky, student

ISOLDE

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

Technology Programme

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

DataGrid

M. Tuisku, proj. leader (at CERN)
J. Klem, senior scientist (at CERN)
T. Niemi, senior scientist, coordinator (at CERN)
J. White, senior scientist (at CERN)
J. Dahlblom, scientist
J. Hahkala, scientist (at CERN)
K. Happonen, scientist
J. Karppinen, scientist (at CERN)
A. Krüger, scientist (at CERN)
H. Mikkonen, scientist (at CERN)
A. Pirinen, scientist, coordinator
M. Punceva, scientist (at CERN)
V. Ryynänen, scientist (at CERN)
M. Niinimäki, adj. scientist
M. Pitkänen, grad. student (at CERN)
M. Silander, grad. student
M. Bärlund, student (at CERN)
K. Defée, student
T. Eloranta, student
J. Koivumäki, student
J. Kommeri, student (at CERN)
K. Lundahn, student
M. Närjänen, student
V. Pankakoski, student
O. Porkka, student
I. Stenberg, student
J. Bergström, summer trainee
M. Christoforaki, summer trainee (at CERN)

CLOUD

M. Kulmala, prof., proj. leader
M. Sipilä, grad. student

Administration and Support

D.-O. Riska, prof., director
M. Sainio, docent, adm. manager
T. Sandelin, financial manager
M. Flygar, secretary (at CERN)
T. Hardén, secretary
T. Karppinen, secretary (at CERN)
P. Lehto, secretary
A. Heikkilä, tech. coordinator (at CERN)
R. Rinta-Filppula, researcher (at CERN)
N. Jiganova, IT specialist
J. Aaltonen, lab. engineer

Seminars

Seminars held in Helsinki

January 16th A. Kurkela (Department of Physical Sciences, University of Helsinki)
Non-perturbative pressure of hot QCD

January 23rd J. Rak
(University of Jyväskylä/HIP)
Relativistic heavy ion physics at RHIC and LHC era

January 25th E. Gabrielli (HIP)
Higgs boson production in association with a photon in vector boson fusion at LHC

January 30th M. O. Järvinen (Department of Physical Sciences, University of Helsinki)
Single spin asymmetry at large x_F and k_T

February 13th V. Karimäki (HIP)
Preparations in CMS experiment for the LHC start-up

February 20th M. Frank (Concordia University, Montreal, Canada)
Flavour changing neutral currents in top quark decay and single top production at LHC/ILC

February 27th T. Renk (University of Jyväskylä/HIP)
High p_T processes as a tool to probe bulk matter in heavy ion collisions

March 8th – 9th
Finnish-Japanese Workshop on Particle Cosmology

March 13th S. K. Rai (HIP)
Graviton resonances in $e^+e^- \rightarrow \mu^+ \mu^-$ at linear colliders with beamstrahlung and ISR effects

March 20th B. Hegner (DESY, Hamburg, Germany)
Top measurements in CMS

March 21st Y. Schröder (Bielefeld University, Germany)
Computation and applications of 4-loop bubbles

March 22nd S. Brodsky (SLAC, Stanford University, USA)
AdS/CFT and the conformal approximation to QCD

March 27th K. Kajantie (Department of Physical Sciences, University of Helsinki)
Expanding systems in gauge theory/gravity duality

April 17th A. Tureanu (Department of Physical Sciences, University of Helsinki)
Quantum nature of space-time and the twisted Poincaré symmetry

April 19th J. Schieck (Max-Planck-Institut für Physik, Munich, Germany)
JADE analysis in the new millenium

April 23rd R. Roser (Fermilab, Batavia, USA)
The Tevatron physics program – marching toward the Higgs

April 24th P. Hoyer (Department of Physical Sciences, University of Helsinki)
Dynamics of gauge theory with a condensate

April 26th D. Diakonov (St. Petersburg, Russia)
Ensemble of dyons

May 22nd P. Lahti (University of Turku)
Heisenberg's uncertainty principle

May 25th G. Mikenberg (Weizmann Institute, Israel)
Status of the ATLAS experiment

May 29th D. Ungaro (CERN, Switzerland)
Hadrontherapy: the new frontier of cancer radiation therapy

June 5th S. Sasaki (University of Helsinki)
Deformed super Yang-Mills theories in R-R backgrounds

June 7th F. Sannino (Odense, Denmark)
Minimal walking technicolor theories: from LHC to cosmology

June 26th – 29th
The 4th International Pion-Nucleon PWA Workshop

August 24th S. Khalil (Cairo, Egypt)
TeV scale B-L extension of the standard model

August 27th P. Kraus (UCLA, Los Angeles, USA)
Stringy black holes in five dimensions

August 28th K. Koyama (Portsmouth, UK)
Primordial perturbations in the new ekpyrotic model

August 29th – September 1st
Low x Workshop

August 30th J. Louko (Nottingham, UK)
How often does an accelerated particle detector click?

September 25th G. Hiller (Dortmund, Germany)
Minimal flavor violation and the LHC

October 5th J. Virdee (CERN, Switzerland)
The CMS experiment at the Large Hadron Collider: status and prospects

October 9th M. Doser (CERN, Switzerland)
Experiments on antihydrogen: status and outlook

October 30th C. Aulakh (Chandigarh, India)
Deciphering Ourobouros: pinning down the NMSGUT

November 20th T. Mäki (University of Helsinki and HIP)
Top quark mass measurement in dilepton channel

November 27th A. Rajantie (Imperial College, UK)
Lattice calculation of non-Gaussianity from preheating

December 3rd F. Wilczek (MIT and Nordita)
The Universe is a strange place

December 3rd F. Wilczek (MIT and Nordita)
Anticipating a new golden age

December 4th A. A. Starobinsky (Landau Institute for Theoretical Physics, Russia)
Scalar-tensor and f(R) models of dark energy

December 11th T. Mattsson (HIP)
Dark energy as a mirage

December 14th J. Väliviita (IGC, Portsmouth, UK)
Unexpected blow-up of perturbations in coupled dark energy and matter fluid models

December 18th T. Lappi (Saclay, France)
The initial state of the little bang at RHIC and LHC

Visitors

Theory Programme

Cosmology

M. Tsumagari (UK) 5.12.2006 - 21.2.
M. Sloth (Denmark) 5.-9.3.
J. McDonald (UK) 26.3.-1.4.
A. Mazumdar (Denmark) 23.-25.5.
M. Douspis (France) 7.-16.6.
T. Battefeld (USA) 27.-29.8.
T. Suyama (Japan) 27.-31.8.
K. Koyama (UK) 28.8.
T. Battefeld (USA) 22.-25.10.
A. Starobinsky (Russia) 25.11.-15.12.
A. Rajantie (UK) 26.-27.11.
M. Douspis (France) 26.-30.11.

Particle Physics Phenomenology

M. Frank (Canada) 19.-24.2.
D. K. Ghosh (India) 15.-31.5.
F. Sannino (Denmark) 7.-9.6.
G. Faisel (Egypt) 1.7.-30.8.
S. Khalil (Egypt) 1.7.-30.8.
G. Hiller (Germany) 23.-28.9.
C. S. Aulakh (India) 25.10.-25.11.
S. Roy (India) 15.11.-1.12.
P. N. Pandita (India) 29.11.-10.12.
J. Laamanen (Germany) 14.-21.12.

Hadron Physics Activity

B. Juliá-Díaz (Spain) 19.1.-8.2.
V. Abaev (Russia) 5.-17.2.
M. Sadler (USA) 24.-29.6.
L. Tiator (Germany) 24.-30.6.
S. Watson (USA) 24.-30.6.
V. Abaev (Russia) 25.-30.6.
S. Ceci (Croatia) 25.6.-1.7.
M. Hadzimehmedovic (Bosnia) 25.6.-1.7.
H. Osmanovic (Bosnia) 25.6.-1.7.
J. Stahov (Bosnia) 25.6.-1.7.
A. Švarc (Croatia) 25.6.-1.7.
B. Zauner (Croatia) 25.6.-1.7.
T. Lähde (USA) 17.-28.9.
S. Wycech (Poland) 24.-31.10.
E. Widmann (Austria) 25.-27.11.

Physics of Biological Systems

A. Laaksonen (Sweden) 1.-4.1.
C. Jesudason (Malesia) 6.1.-5.6.
M. Franova (Czech Republic) 18.-23.2.
P. C. Ke (USA) 18.-21.3.
S. Lyulin (Russia) 3.-6.4.
M. Karttunen (Canada) 13.-17.4.
A. Videcoq (France) 23.4.-29.6.
C. Xing (USA) 11.5.-20.6.
M. Karttunen (Canada) 1.6.-31.8.
R. Faller (USA) 18.-24.6.
P. C. Ke (USA) 25.-27.6.
R. Faller (USA) 1.-3.9.
H. Grubmuller (Germany) 1.-3.9.
E. Lindahl (Sweden) 1.-3.9.
A. Sum (USA) 1.-3.9.
M. Tarek (France) 1.-3.9.
A. Tervo (Sweden) 1.-3.9.
P. Tieleman (Canada) 1.-3.9.
D. van der Spoel (Sweden) 1.-3.9.
H. Martinez-Seara (Spain) 23.9.-23.12.
P. Liljeroth (Switzerland) 30.-31.10.

String Theory and Quantum Field Theory

A. Zheltukhin (Sweden) 6.2.-8.3.
S. Ketov (Japan) 29.4.-8.5.
M. Mnatsakanova (Russia) 16.5.-15.6.
Y. Vernov (Russia) 16.5.-15.6.
J. Madore (France) 6.-20.6.
P. Prešnajder (Slovakia) 6.-20.6.
P. Prešnajder (Slovakia) 6.-31.8.
P. Kraus (USA) 23.-29.8.
K. Nishijima (Japan) 31.8.-24.9.
X. Zhang (China) 10.9.-10.11.
R. Zhang (Australia) 11.9.-10.11.
M. Schnabl (USA) 28.9.
M. Mnatsakanova (Russia) 14.11.-31.12.
Y. Vernov (Russia) 14.11.-31.12.

Ultrarelativistic Heavy Ion Collisions

M. Laine (Germany) 2.-3.1.
D. H. Rischke (Germany) 15.-24.2.
I. Vitev (USA) 22.-28.2.
X.-N. Wang (USA) 22.-28.2.
Y. Schröder (Germany) 20.-22.3.
D. Diakonov (Russia) 26.4.
F. Sannino (Denmark) 3.-6.6.
P. de Forcrand (Switzerland) 27.-30.6.
A. Dumitru (Germany) 6.-15.10.
T. Lappi (France) 17.-20.12.

CMS Programme

CMS Physics Analysis

B. Hegner (Germany) 19.-20.3.
M. Pioppi (Switzerland) 19.-20.3.
J. Schieck (Germany) 18.-21.4.
M. Doser (Switzerland) 9.-10.9.
J. Virdee (Switzerland) 4.-5.10.

Technology Programme

V. Ryynänen (Finland) 30.6.-30.9.

Conference participation, Talks and Visits by Personnel

Theory Programme

De finlandssvenska Fysikdagarna,
20-22 October, Helsinki, Finland - Stockholm, Sweden (talk by C. Cronström)

Cosmology

5th Nordic Winter School on Particle Physics and Cosmology,
7-12 January, Gausdal, Norway (A. Ferrantelli, V. Reijonen)

RTN Winter School on Strings, Supergravity and Gauge Theories,
13-20 January, CERN, Geneva, Switzerland (L. Mether)

Finnish-Japanese Workshop on Particle Cosmology,
8-9 March, Helsinki, Finland (A. Ferrantelli, talk by D. Podolsky)

The Annual Meeting of the Finnish Physical Society,
15-17 March, Tallinn, Estonia (A. Ferrantelli, J. Högdahl, V. Muhonen, V. Reijonen)

Computing in High Energy Physics,
22-28 March, La Jolla, CA, USA (L. Mether)

Low Temperature Laboratory, Helsinki Institute of Technology,
12 April, Espoo, Finland (talk by D. Podolsky)

High Energy/Cosmology Seminar,
20 April, Helsinki, Finland (talk by D. Podolsky)

Cosmology, Strings and Phenomenology Workshop,
11-15 June, Stockholm, Sweden (talk by D. Podolsky)

Cosmology, Strings and Phenomenology Workshop and Conference,
15-22 June, Stockholm, Sweden (L. Mether)

Cosmology, Strings, and Phenomenology Conference,
17-20 June, Stockholm, Sweden (invited talk by K. Enqvist, A. Ferrantelli, J. Högdahl, V. Muhonen, V. Reijonen)

Strings 07,
24-30 June, Madrid, Spain (L. Mether)

13th International Symposium on Particles, Strings and Cosmology (PASCOS-07),
1-7 July, London, UK (V. Reijonen)

Les Houches session 87: String Theory and the Real World,
2-27 July, Les Houches, France (L. Mether)

Helmholtz International Summer School on Modern Mathematical Physics,
22-30 July, Dubna, Russia (invited lectures by D. Podolsky)

15th International Conference on Supersymmetry and the Unification of Fundamental Interactions (SUSY07),
22 July - 1 August, Karlsruhe, Germany (A. Ferrantelli)

Cargèse Summer School: Cosmology and Particle Physics Beyond the Standard Models,
30 July - 11 August, Corsica, France (L. Mether)

COSMO-07: International Workshop on Particle Physics and the Early Universe,
21-25 August, Brighton, UK (K. Enqvist, talk by V. Muhonen, talk by D. Podolsky, V. Reijonen)

International Workshop "Initial Conditions For Cosmology",
3-8 September, Würzburg, Germany (talk by D. Podolsky)

High Energy/Cosmology Seminar,
14 September, Helsinki, Finland (talk V. Muhonen)

High Energy/Cosmology Seminar,
21 September, Helsinki, Finland (talk by D. Battefeld)

First Annual School of EU Network "UniverseNet" - The Origin of the Universe,
24-29 September, Mytilene, Greece (K. Enqvist, A. Ferrantelli, J. Högdahl, L. Mether, talk by V. Muhonen, V. Reijonen)

De finlandssvenska Fysikdagarna,
20-22 October, Helsinki, Finland - Stockholm, Sweden (L. Mether)

Lancaster University,
26 October, Lancaster, UK (talk by D. Podolsky)

Lancaster University,
25 November - 2 December, Lancaster, UK (A. Ferrantelli)

High Energy/Cosmology Seminar,
12 December, Helsinki, Finland (talk by D. Podolsky)

Particle Physics Phenomenology

RTN Winter School on Strings, Supergravity and Gauge Theories,
15-19 January, Geneva, Switzerland (P. Tiitola)

RECFA Meeting,
8-10 March, Prague, Czech Republic (K. Huitu)

The Annual Meeting of the Finnish Physical Society,
15-17 March, Tallinn, Estonia (T. Honkavaara, K. Huitu, T. Rüppell)

Flavour in the era of LHC Workshop,
25-28 March, Geneva, Switzerland (K. Huitu)

Dissertation Committee,
26-27 April, Uppsala, Sweden (K. Huitu)

RECFA Meeting,
10-13 May, London, UK (K. Huitu)

XIV Nordic LHC Workshop,
14-16 May, Stockholm, Sweden (S. K. Rai, talk by T. Rüppell)

From the Planck Scale to the Electroweak Scale,
8-13 June, Warsaw, Poland (talk by K. Huitu)

Würzburg,
28-29 June, Würzburg, Germany (talk by K. Huitu)

The 15th International Conference on Supersymmetry and the Unification of Fundamental Interactions (SUSY07),
26 July - 1 August, Karlsruhe, Germany (talks by T. Honkavaara, by J. Laamanen, and by S. K. Rai, T. Rüppell, P. Tiitola)

RECFA Meeting,
2-5 December, Geneva, Switzerland (K. Huitu)

Particle Physics Day,
20 December, Jyväskylä, Finland (T. Honkavaara, talk by T. Rüppell)

Hadron Physics Activity

The Annual Meeting of the Finnish Physical Society,
15-17 March, Tallinn, Estonia (J. Koponen, invited talk by D. O. Riska, M. Sainio)

Subnuclear Journey Symposium,
19-21 April, Lexington, KY, USA (invited talk by D. O. Riska)

The 4th International Pion-Nucleon PWA Workshop,
26-29 June, Helsinki, Finland (invited talk by A. M. Green, invited talk by D. O. Riska, invited talk by M. Sainio)

Lattice 2007, the XXV International Symposium on Lattice Field Theory,
29 July - 4 August, Regensburg, Germany (J. Koponen)

11th International Conference on Meson-Nucleon Physics and the Structure of the Nucleon,
10-14 September, Juelich, Germany (talk by M. Sainio)

Physics of Biological Systems

Groeningen University,
24-27 January, Groeningen, The Netherlands (talk by I. Vattulainen)

Gromacs Workshop,
27 February - 1 March, Finnish IT Center for Science, Espoo, Finland (M. Hyvönen, S. Pöyry, I. Vattulainen)

Biophysical Society Meeting,
1-7 March, Baltimore, MD, USA (I. Vattulainen)

4th Tissue Engineering Symposium,
12-14 March, Tampere, Finland (talk by I. Vattulainen)

Supercomputing Workshop,
13-14 March, Finnish IT Center for Scientific Computing, Espoo, Finland (M. Hyvönen, talk by I. Vattulainen)

Annual Meeting of the Finnish Physical Society,
15-17 March, Tallinn, Estonia (S. Pöyry, I. Vattulainen)

Annual Meeting of the Finnish Atherosclerosis Society,
16 March, Helsinki, Finland (M. Hyvönen)

ESF Workshop on Colloids, Polymers, Liquid Crystals,
22-24 March, Konstanz, Germany (talk by I. Vattulainen)

FuncDyn ESF Workshop Meeting,
2-5 May, Haslev, Denmark (talk by I. Vattulainen)

76th Annual Congress of the European Atherosclerosis Society,
10-13 June, Helsinki, Finland (M. Hyvönen)

European Summer University: The Physics of Living Matter,
24-30 June, Strasbourg, France (S. Pöyry)

IVC17 Conference,
1-6 July, Stockholm, Sweden (talk by I. Vattulainen)

Research visit,
6-17 August, Odense, Denmark (I. Vattulainen)

Workshop on Polyunsaturated Lipids,
9 August, Valby, Denmark (I. Vattulainen)

Summer School: Computational Modeling of Carbohydrates and Proteins in Lipid Membranes,
2-3 September, Espoo, Finland (T. Apajalahti, M. Hyvönen, S. Pöyry, A. Salonen, chair I. Vattulainen, T. Vuorela)

The 48th International Conference on the Bioscience of Lipids,
4-8 September, Turku, Finland (M. Hyvönen, S. Pöyry, co-organiser I. Vattulainen)

EU Evaluation,
21-27 October, Brussels, Belgium (I. Vattulainen)

Pathway Analysis Workshop,
12 November, Finnish IT Center for Science, Espoo, Finland (M. Hyvönen)

String Theory and Quantum Field Theory

Institute of Physics (IOP), Bhubaneswar,
28 December 2006 - 2 January, Bhubaneswar, India (invited talk by J. Majumder)

Indian Association for the Cultivation of Science (IACS),
4-5 January, Kolkata, India (invited talk by J. Majumder)

Saha Institute of Nuclear Physics (SINP),
8-9 January, Kolkata, India (invited talk by J. Majumder)

Stockholm University,
12-14 February, Stockholm, Sweden (E. Keski-Vakkuri)

The 21st Nordic Network Meeting,
15-17 February, Stockholm, Sweden (talk by N. Jokela)

Finnish-Japanese Workshop on Particle Cosmology,
8-9 March, Helsinki, Finland (organiser and talk by N. Jokela)

The Annual Meeting of the Finnish Physical Society,
17-19 March, Tallinn, Estonia (talk by N. Jokela, invited plenary talk by E. Keski-Vakkuri)

Institute for Theoretical Physics, Cuban Academy of Science,
18 March - 4 April, Havana, Cuba (M. Chaichian)

University of Tartu,
28-29 March, Tartu, Estonia (invited talk by N. Jokela)

Technical University "Gh. Asachi",
18-24 April, Iasi, Romania (A. Tureanu)

Institute for Nuclear Research and Moscow State University,
3-13 May, Moscow, Russia (M. Chaichian)

Cosmology, Strings and Phenomenology Conference,
16-20 June, Stockholm, Sweden (N. Jokela)

The 12th Claude Itzykson Meeting,
18-22 June, Saclay, France (S. Kawai)

Strings 2007,
25-29 June, Madrid, Spain (N. Jokela, J. Majumder)

International School/Seminar Quantum Field Theory and Gravity,
1-9 July, Tomsk, Russia (invited talks by M. Chaichian, A. Tureanu)

Workshop on Cosmology and Strings,
9-13 July, ICTP, Trieste, Italy (J. Majumder)

Visit at the High Energy, Cosmology and Astroparticle Physics Group (HECAP),
13 July - 1 August, ICTP, Trieste, Italy (J. Majumder)

15th International Conference on Supersymmetry and the Unification of Fundamental Interactions (SUSY07),
26 July - 1 August, Karlsruhe, Germany (talk by N. Uekusa)

University of California,
27 July - 10 August, Los Angeles, CA, USA (M. Chaichian)

Carnegie Mellon University,
4-7 August, Pittsburgh, PA, USA (invited talk by N. Jokela)

University of Illinois,
7-21 August, Urbana-Champaign, IL, USA (N. Jokela)

DESY,
16-19 August, Hamburg, Germany (M. Chaichian, A. Tureanu)

1st UniverseNet Network Meeting,
23-30 September, Mytilene, Greece (S. Kawai)

ETH Zurich, ITP,
16-18 October, Zurich, Switzerland (invited talk by E. Keski-Vakkuri)

University "Al. I. Cuza",
19-30 October, Iasi, Romania (A. Tureanu)

University of Southern Denmark,
23-28 November, Odense, Denmark (talk by N. Jokela)

Erwin Schrödinger Institute,
29 November - 6 December, Vienna, Austria (A. Tureanu)

European Seminar on Particle Physics and Quantum Field Theory,
30 November - 2 December, Vienna, Austria (invited talk by M. Chaichian, talk by A. Tureanu)

University of Bratislava,
2-5 December, Bratislava, Slovakia (M. Chaichian)

Ultrarelativistic Heavy Ion Collisions

Southern Denmark University,
29 January - 9 February, Odense, Denmark (talk by K. Tuominen)

University of Oulu,
5-16 February, Oulu, Finland (A. Hietanen)

Lecture Week of the European Graduate School on Complex Systems of Hadrons and Nuclei,
12-16 February, Weilburg, Germany (H. Paukkunen)

Mini-Workshop "Strongly Coupled Quark-Gluon Plasma: SPS, RHIC and LHC",
16-18 February, Nagoya, Japan (talk by T. Renk)

Winter School on Conceptual and Numerical Challenges in Femto- and Peta-Scale Physics,
24 February - 3 March, Schladming, Austria (A. Hietanen)

Stony Brook,
28 February - 1 March, Stony Brook, NY, USA (talk by T. Renk)

Brookhaven National Laboratory,
1-6 March, Upton, NY, USA (talk by T. Renk)

Department of Physical Sciences, University of Helsinki,
5-6 March, Helsinki, Finland (K. Tuominen)

Finnish-Japanese Workshop on Particle Cosmology,
8-9 March, Helsinki, Finland (talk by K. Kajantie)

High-pT Physics at LHC,
23-27 March, JYFL, Jyväskylä, Finland (J. Auvinen, co-organiser and talk by K. J. Eskola, M. Heikinheimo, K. Kajantie, T. Kähärä, H. Niemi, H. Paukkunen, talk by T. Renk, P. V. Ruuskanen, K. Tuominen)

University of Rome and INFN,
2-6 April, Rome, Italy (H. Paukkunen)

Workshop on Hydrodynamics,
17-20 April, Frankfurt, Germany (H. Niemi)

Spring school on Physics and Techniques of Event Generators, 1st MCnet School,
18-20 April, IPPP, Durham, UK (J. Auvinen)

Perimeter Institute,
13-25 May, Waterloo, Canada (K. Kajantie)

Workshop on "Heavy Ion Collisions at the LHC: Last Call for Predictions",
14 May - 8 June, CERN, Geneva, Switzerland (talk by K. J. Eskola, talk by H. Niemi, talk by T. Renk)

URHIC/ALICE Seminar,
18 May, Jyväskylä, Finland (talk by J. Auvinen)

Exotic States of Hot and Dense Matter and their Dual Description,
22-25 May, Waterloo, Canada (talk by K. Kajantie, T. Tahkokallio)

University of Washington,
28-31 May, Seattle, WA, USA (talk by T. Tahkokallio)

Deisa Training Session,
30 May - 1 June, Finnish IT Center for Science, Espoo, Finland (talk by A. Hietanen)

CTEQ Summer School on QCD Analysis and Phenomenology,
30 May - 7 June, Madison, WI, USA (H. Paukkunen)

McGill University,
13 June, Montreal, Canada (talk by T. Renk)

Workshop on "Electromagnetic Probes of Strongly Interacting Matter",
18 Jun - 22 June, ETC*, Trento, Italy (talk by T. Renk)

Conference on "Early Time Dynamics in Heavy Ion Collisions",
16-19 July, Montreal, Canada (talk by T. Renk)

The 2007 Europhysics Conference on High Energy Physics,
19-25 July, Manchester, UK (talk by H. Paukkunen)

Lattice 2007,
30 July - 4 August, Regensburg, Germany (A. Hietanen)

Institut fur Theoretische Physik, J.W. Goethe- Universität,
7-12 August, Frankfurt, Germany (talk by K. J. Eskola)

The 17th Jyväskylä Summer School,
8-24 August, JYFL, Jyväskylä, Finland (J. Auvinen, M. Heikinheimo, T. Kähärä, H. Paukkunen)

JYFL, University of Jyväskylä,
3-5 September, Jyväskylä, Finland (talk by T. Tahkokallio)

Department of Physical Sciences, University of Oulu,
10-12 September, Oulu, Finland (K. Tuominen)

Analytic Methods for Quantum Fields at High Temperatures,
10-14 September, Bielefeld, Germany (lectures by K. Kajantie)

JYFL Colloquium,
14 September, JYFL, Jyväskylä, Finland (talk by T. Renk)

Lecture Week of the European Graduate School on Complex Systems of Hadrons and Nuclei,
1-5 October, Obergurgl, Austria (talk by J. Auvinen, M. Heikinheimo, T. Kähärä)

JYFL,
11 October, Jyväskylä, Finland (K. Kajantie)

Southern Denmark University,
16-22 October, Odense, Denmark (K. Tuominen)

URHIC/ALICE Seminar,
30 October, JYFL, Jyväskylä, Finland (talk by K. Tuominen)

JYFL Colloquium,
23 November, JYFL, Jyväskylä, Finland (talk by K. Tuominen)

Department of Physical Sciences, University of Oulu,
26-29 November, Oulu, Finland (K. Tuominen)

University of Rome and INFN,
1-9 December, Rome, Italy (H. Paukkunen)

URHIC/ALICE Seminar,
4 December, JYFL, Jyväskylä, Finland (talk by T. Renk)

Department of Physical Sciences, University of Helsinki,
10 December, Helsinki, Finland (K. J. Eskola)

Annual Meeting of the Finnish Academy of Science and Letters,
10 December, Helsinki, Finland (talk by K. J. Eskola)

Workshop on "Electromagnetic Radiation in Nuclear Collisions",
17-19 December, CERN, Geneva, Switzerland (talk by T. Renk)

URHIC/ALICE Seminar,
18 December, JYFL, Jyväskylä, Finland (talk by K. Tuominen)

Particle Physics Day,
20 December, JYFL, Jyväskylä, Finland (J. Auvinen, K. J. Eskola, M. Heikinheimo, T. Kähärä, H. Niemi, talk by H. Paukkunen, P. V. Ruuskanen, organiser K. Tuominen)

High Energy Physics Programme

Electron-Positron Physics

3rd HERA and the LHC Workshop,
12-16 March, Hamburg, Germany (invited talk by K. Österberg)

The Annual Meeting of the Finnish Physical Society,
15-17 March, Tallinn, Estonia (F. Oljemark, K. Österberg)

The X-Band Accelerating Structure Design and Test-Program Workshop,
18-19 June, CERN, Geneva, Switzerland (J. Huopana, R. Nousiainen)

European Physical Society Conference of High Energy Physics 2007,
19-25 July, Manchester, UK (talks by K. Österberg)

15th Low x Meeting,
29 August - 1 September, Helsinki, Finland (F. Oljemark, invited talk by K. Österberg)

Swedish Research Council,
9-12 September, Stockholm, Sweden (K. Österberg)

CLIC'07 Workshop,
16-18 October, CERN, Geneva, Switzerland (talks by R. Nousiainen, K. Österberg)

De finlandssvenska Fysikdagarna,
20-22 October, Helsinki, Finland - Stockholm, Sweden (invited talk by K. Österberg)

Forward Physics

The Annual Meeting of the Finnish Physical Society,
15-17 March, Tallinn, Estonia (talk by T. Mäki)

American Physical Society: April Meeting,
14-17 April, Jacksonville, FL, USA (talk by T. Mäki)

The 2007 Europhysics Conference on High Energy Physics,
19-25 July, Manchester, UK (talk by T. Mäki)

IEEE Nuclear Science Symposium and Medical Imaging Conference,
27 October - 3 November, Honolulu, HI, USA (K. Kurvinen)

Detector Laboratory

PGEM-TPC Meeting "Towards a proposal for FP7",
8-9 February, Vienna, Austria (talk by F. Garcia)

Particle Physics Seminar,
16 February, Helsinki, Finland (talk by F. Garcia)

XX PANDA Collaboration Meeting,
26-28 March, INFN/Università di Genova, Italy (F. Garcia)

GEM Meeting for FOPI TPC Prototype,
20 May, Munich, Germany (talk by F. Garcia)

XXI PANDA Collaboration Meeting,
2 July, Dubna, Russia (F. Garcia)

IEEE Nuclear Science Symposium and Medical Imaging Conference,
27 October - 3 November, Honolulu, HI, USA (F. Garcia, J. Heino)

XXIII PANDA Collaboration Meeting,
10-14 December, GSI, Darmstadt, Germany (F. Garcia, E. Tuominen)

CMS Programme

CMS Physics Analysis

Worldwide LHC Computing Grid Collaboration Workshop,
21-26 January, CERN, Geneva, Switzerland (T. Lindén)

NDGF CERN Advisory Committee Meeting,
1 February, Copenhagen, Denmark (T. Lindén)

User Support Workshop for VOs,
1-2 March, Karlsruhe, Germany (talk by K. Lassila-Perini)

Meeting of EPS HEPP Board,
2 March, CERN, Geneva, Switzerland (J. Tuominiemi)

Supersymmetry at the LHC; Theoretical and Experimental Aspects,
10-16 March, Cairo, Egypt (invited talk by R. Kinnunen)

Annual Meeting of the Finnish Physical Society,
15-17 March, Tallinn, Estonia (P. Kaitaniemi, V. Karimäki, T. Lampén, K. Lassila-Perini, invited talks by J. Tuominiemi, M. Voutilainen)

M-grid Administrators Meeting,
21 March, Turku, Finland (T. Lindén)

CNRS Geant4 Tutorial,
28-31 March, Strasbourg, France (invited talk by A. Heikkinen)

University of Helsinki,
13 April, Helsinki, Finland (talk by T. Lampén)

American Physical Society Meeting,
14-17 April, Jacksonville, FL, USA (talk by M. Voutilainen)

XI International Workshop on Advanced Computing and Analysis Techniques in Physics Research (ACAT07),
23-27 April, Amsterdam, The Netherlands (A. Heikkinen)

CEA Saclay,
2-19 May, Paris, France (M. Voutilainen)

M-grid Administrators Meeting,
24 May, Espoo, Finland (T. Lindén)

CMS Tracker Alignment Workshop,
29-30 May, DESY, Hamburg, Germany (T. Lampén)

Ministère de la Recherche Geant4 Tutorial,
4-8 June, Paris, France (invited talk by A. Heikkinen)

CMS Tau Workshop,
7 June, Pisa, Italy (talk by R. Kinnunen, talk by S. Lehti)

Les Houches 2007 Workshop: Physics at TeV Colliders,
11-29 June, Les Houches, France (talk by S. Lehti)

2nd LHC Detector Alignment Workshop,
25-26 June, CERN, Geneva, Switzerland (T. Lampén)

Geant4 Evaporation Workshop,
15-21 July, CERN, Geneva, Switzerland (talk by A. Heikkinen)

HEP 2007 International Europhysics Conference on High Energy Physics,
19-25 July, Manchester, UK (J. Tuominiemi)

Meeting of EPS HEPP Board,
24 July, Manchester, UK (J. Tuominiemi)

NDGF CERN Advisory Committee Meeting,
28 August, Copenhagen, Denmark (talk by T. Lindén)

Worldwide LHC Computing Grid Collaboration Workshop,
1-2 September, Victoria, BC, Canada (T. Lindén)

International Conference on Computing in High Energy and Nuclear Physics 2007,
2-7 September, Victoria, BC, Canada (A. Heikkinen, T. Lampén, T. Lindén)

12th Geant4 Collaboration Workshop,
12-20 September, Hebden Bridge, UK (talk by A. Heikkinen)

Meeting of EPS HEPP Board,
19 October, CERN, Geneva, Switzerland (J. Tuominiemi)

TIF Alignment Camp,
5-16 November, CERN, Geneva, Switzerland (V. Karimäki, T. Lampén)

M-grid Administrators Meeting,
22 November, Espoo, Finland (T. Lindén)

NDGF CERN Advisory Committee Meeting,
27 November, Copenhagen, Denmark (T. Lindén)

D0 Collaboration Meeting,
7 December, Fermilab, Batavia, IL, USA (plenary talk by M. Voutilainen)

Meeting of EPS HEPP Board,
7 December, CERN, Geneva, Switzerland (J. Tuominiemi)

Working visits to CERN,
Geneva, Switzerland (talk by A. Heikkinen, talk by V. Karimäki, talk by R. Kinnunen, talk by S. Lehti, talk by L.Wendland)

Meetings of CMS Management Board, Finance Board, Collaboration Board, Resource Review Board,
CERN, Geneva, Switzerland (J. Tuominiemi)

CMS Tracker

Tracker Upgrade Workshop,
8-9 February, CERN, Geneva, Switzerland (talk by P. Luukka)

11th Vienna Conference on Instrumentation,
19-24 February, Vienna, Austria (talk by J. Härkönen, talk by P. Luukka)

Annual Meeting of Finnish Physical Society,
15-17 March, Tallinn, Estonia (talk by J. Härkönen, talk by H. Moilanen)

Common ATLAS CMS Electronics Workshop,
19-21 March, CERN, Geneva, Switzerland (P. Luukka)

CMS Tracker upgrade sensor working group,
23 March, CERN, Geneva, Switzerland (talk by J. Härkönen)

Workshop on Silicon Detector Systems for the CBM Experiment at FAIR,
18-20 April, GSI, Darmstadt, Germany (talk by J. Härkönen)

Infineon GmbH,
20 April, Munich, Germany (talk by J. Härkönen)

10th RD50 Workshop on Radiation hard semiconductor devices for very high luminosity colliders,
4-6 June, Vilnius, Lithuania (talk by J. Härkönen, talk by E. Tuominen, E. Tuovinen)

RD39 Cryogenic Tracking Detectors Workshop I-2007,
7-8 June, Vilnius, Lithuania (talk by J. Härkönen, talk by E. Tuominen, E. Tuovinen)

Summer School of EU FP6 ADVANCE - Project: Advanced Training for Women in Scientific Research,
23 June - 3 August, 7-9 September, Krems, Austria (E. Tuominen)

11th RD50 - Workshop on Radiation hard semiconductor devices for very high luminosity colliders,
12-14 November, CERN, Geneva, Switzerland (talk by J. Härkönen, talk by P. Luukka, E. Tuominen, E. Tuovinen)

RD39 Cryogenic Tracking Detectors Workshop II-2007,
15-16 November, CERN, Geneva, Switzerland (talk by J. Härkönen, talk by P. Luukka, E. Tuominen, E. Tuovinen)

91st LHC Committee Open Session,
21-22 November, CERN, Geneva, Switzerland (talk by J. Härkönen)

CMS Tracker upgrade sensor working group,
7 December, CERN, Geneva, Switzerland (talk by P. Luukka)

Particle Physics Day,
20 December, Jyväskylä, Finland (talk by H. Moilanen, talk by E. Tuovinen)

Nuclear Matter Programme

ALICE

HIP,
23 January, Helsinki, Finland (invited talk by J. Rak)

DCS Workshop,
6 February, CERN, Geneva, Switzerland (invited talk by W. H. Trzaska)

ALICE Physics Week 2007,
15 February, Munich, Germany (talk by J. Rak)

ALICE Week,
8 March, CERN, Geneva, Switzerland (invited talk by W. H. Trzaska)

The Annual Meeting of the Finnish Physical Society,
15-17 March, Tallinn, Estonia (R. Diaz)

University of Jyväskylä,
17 April, Jyväskylä, Finland (talk by W. H. Trzaska)

CUPP,
3 May, Pyhäsalmi, Finland (talks by W. H. Trzaska)

STOP Meeting,
7 May, Odense, Denmark (invited talk by W. H. Trzaska)

Luminosity Meeting,
11 May, CERN, Geneva, Switzerland (invited talk by W. H. Trzaska)

EMMA Collaboration Meeting,
17-18 May, Pyhäsalmi, Finland (talks by W. H. Trzaska)

Hadron Collider Physics Symposium 2007,
24 May, La Biodola, Isola d'Elba, Italy (invited talk by J. Rak)

International Nuclear Physics Conference INPC07,
5 June, Tokyo, Japan (talk by J. Rak)

CUPP,
20 June, Pyhäsalmi, Finland (talk by W. H. Trzaska)

Zimányi 75 Memorial Workshop on Hadronic and Quark Matter,
3 July, Budapest, Hungary (invited talk by J. Rak)

CERN,
4 July, Geneva, Switzerland (invited talk by W. H. Trzaska)

INFN,
6 July, Catania, Italy (invited talk by W. H. Trzaska)

The 2007 Europhysics Conference on High Energy Physics,
25 July, Manchester, UK (invited talks by J. Rak)

Collaboration Meeting,
2 August, Jyväskylä, Finland (talk by W. H. Trzaska)

Nordic Nuclear Meeting 2007,
14 August, Gilleleje, Denmark (invited talk by J. Rak)

Luminosity Meeting,
1 October, CERN, Geneva, Switzerland (invited talk by W. H. Trzaska)

Cornell University,
31 October - 1 November, Ithaca, NY, USA (invited talks by J. Rak)

Brookhaven National Laboratory,
8-9 November, Upton, NY, USA (invited talks by J. Rak)

Warsaw University of Technology, Department of Physics,
20 November, Warsaw, Poland (invited talk by W. H. Trzaska)

FNSPE (FJFI), Czech Technical University,
26-27 November, Prague, Czech Republic (invited talks by J. Rak)

First Physics with LHC,
14 December, CERN, Geneva, Switzerland (invited talk by W. H. Trzaska)

ISOLDE

11th Nordic Meeting on Nuclear Physics,
13-17 August, Gilleleje, Denmark (invited talk by J. Äystö)

Technology Programme

IASTED International Conference on Parallel and Distributed Computing Networks (PDCN) 2007,
15 February, Innsbruck, Austria (talk by M. Silander)

EGEE-II JRA1 All-Hands Meeting,
7-9 March, Catania, Italy (talks by J. Hahkala, J. White)

NDGF dCache Workshop,
27-28 March, Copenhagen, Denmark (J. Dahlblom)

The 20th Open Grid Forum - OGF20/EGEE 2nd User Forum,
7-11 May, Manchester, UK (J. Dahlblom, K. Happonen, J. Klem, J. Koivumäki)

IEEE Workshop on Autonomic and Opportunistic Commincations AOC 2007,
18 June, Espoo, Finland (M. Pitkänen)

EGEE-II JRA1 All-Hands Meeting,
18-20 June, Helsinki, Finland (talks by J. Hahkala, H. Mikkonen, J. White)

The 2nd International Workshop on Real Overlays And Distributed Systems (ROADS),
11-12 July, Warsaw, Poland (J. Dahlblom, K. Happonen)

MobiArch Workshop at ACM SIGCOMM 2007,
27 August, Kyoto, Japan (M. Pitkänen)

3rd Pan-Galactic Workshop on BOINC,
5-6 September, Geneva, Switzerland (T. Niemi)

IEEE Cluster 2007,
17-20 September, Austin, TX, USA (A. Pirinen)

The 8th IEEE/ACM International Conference on Grid Computing (Grid 2007),
19-21 September, Austin, TX, USA (A. Pirinen)

Nordgrid Conference,
24-28 September, Copenhagen, Denmark (J. Koivumäki, M. Närjänen)

EGEE'07 Conference,
1-5 October, Budapest, Hungary (talk by H. Mikkonen)

Fall 2007 Internet2 Member Meeting,
8-11 October, San Diego, CA, USA (H. Mikkonen)

EGEE-II JRA1 All-Hands Meeting,
24-26 October, CERN, Geneva, Switzerland (talk by J. White)

14th Middleware Security Group Meeting,
6-7 December, Berkeley, CA, USA (talks by J. Hahkala, H. Mikkonen)

Administration and Support

EPPOG Meeting,
29-30 May, Lisbon, Portugal (R. Rinta-Filppula)

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

Publications

Theory Programme

Cosmology

R. Allahverdi, K. Enqvist, J. Garcia-Bellido, A. Jokinen, and A. Mazumdar,
MSSM flat direction inflation: slow roll, stability, fine-tuning and reheating,
J. Cosmol. Astropart. Phys. 0706 (2007) 019

K. Enqvist, S. Hannestad, and M. S. Sloth,
Seesaw mechanism for scalar fields as possible basis for dark energy,
Phys. Rev. Lett. 99 (2007) 031301

K. Enqvist, J. Högdahl, S. Nurmi, and F. Vernizzi,
Covariant generalization of cosmological perturbation theory,
Phys. Rev. D 75 (2007) 023515

K. Enqvist, N. Jokela, E. Keski-Vakkuri, and L. Mether,
On the origin of thermal string gas,
J. Cosmol. Astropart. Phys. 0710 (2007) 001

K. Enqvist and T. Mattsson,
The effect of inhomogeneous expansion on the supernova observations,
J. Cosmol. Astropart. Phys. 0702 (2007) 019

K. Enqvist, L. Mether, and S. Nurmi,
On the supergravity origin of the minimally supersymmetric standard model inflation,
J. Cosmol. Astropart. Phys. 0711 (2007) 014

K. Kainulainen, J. Piilonen, V. Reijonen, and D. Sunhede,
Spherically symmetric spacetimes in *f(R)* gravity theories,
Phys. Rev. D 76 (2007) 024020

K. Kainulainen, V. Reijonen, and D. Sunhede,
Interior spacetimes of stars in Palatini *f(R)* gravity,
Phys. Rev. D 76 (2007) 043503

R. Keskitalo, H. Kurki-Suonio, V. Muhonen, and J. Väliviita,
Hints of isocurvature perturbations in the cosmic microwave background?,
J. Cosmol. Astropart. Phys. 0709 (2007) 008

T. Koivisto,
Viable Palatini-*f(R)* cosmologies with generalized dark matter,
Phys. Rev. D 76 (2007) 043527

T. Koivisto and D. F. Mota,
Gauss-Bonnet quintessence: Background evolution, large scale structure, and cosmological constraints,
Phys. Rev. D 75 (2007) 023518

T. Koivisto and D. F. Mota,
Cosmology and astrophysical constraints of Gauss-Bonnet dark energy,
Phys. Lett. B 644 (2007) 104

D. Langlois and F. Vernizzi,
Non-linear perturbations of cosmological scalar fields,
J. Cosmol. Astropart. Phys. 0702 (2007) 017

Laser Physics and Quantum Optics

H. Inamori, N. Lütkenhaus, and D. Mayers,
Unconditional security of practical quantum key distribution,
Eur. Phys. J. D 41 (2007) 599

Particle Physics Phenomenology

D. G. Cerdeño, E. Gabrielli, D. E. López-Fogliani, C. Muñoz, and A. M. Teixeira,
Phenomenological viability of neutralino dark matter in the next-to-minimal supersymmetric standard model,
J. Cosmol. Astropart. Phys. 0706 (2007) 008

D. D. Dietrich, P. Hoyer, M. Järvinen, and S. Peigné,
Perturbative gauge theory in a background,
J. High Energy Phys. 0703 (2007) 105

M. Frank, K. Huitu, and T. Rüppell,
Higgs and neutrino sector, EDM and ε_K in a spontaneously CP and *R*-parity breaking supersymmetric model,
Eur. Phys. J. C 52 (2007) 413

E. Gabrielli, F. Maltoni, B. Mele, M. Moretti, F. Piccinini, and R. Pittau,
Higgs boson production in association with a photon in vector boson fusion at the LHC,
Nucl. Phys. B 781 (2007) 64

P. Hoyer and M. Järvinen,
Single spin asymmetry at large x_F and $k_\perp$,
J. High Energy Phys. 0702 (2007) 039

P. Hoyer and H. Virtanen,
Semi-exclusive deeply virtual Compton scattering,
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K. Huitu, J. Laamanen, P. N. Pandita, and S. Roy,
Phenomenology of non-universal gaugino masses and implications for the Higgs boson decay,
Pramana 69 (2007) 823

A. Ibarra and S. Roy,
Lepton flavour violation in future linear colliders in the long-lived stau NLSP scenario,
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Hadron Physics Activity

V. V. Abaev, P. Metsä, and M. E. Sainio,
The Goldberger-Miyazawa-Oehme sum rule revisited,
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Q. B. Li and D. O. Riska,
The role of 5-quark components on the nucleon form factors,
Nucl. Phys. A 791 (2007) 406

D. O. Riska,
Quark model analysis of the strangeness form factors of the proton,
Eur. Phys. J. A 32 (2007) 389

Physics of Biological Systems

J. Aittoniemi, P. S. Niemelä, M. T. Hyvönen, M. Karttunen, and I. Vattulainen,
Insight into the putative specific interactions between cholesterol, sphingomyelin and palmitoyl-oleoyl phosphatidylcholine,
Biophys. J. 92 (2007) 1125

J. Čurdová, P. Čapková, J. Plášek, J. Repáková, and I. Vattulainen,
Free pyrene probes in gel and fluid membranes: perspective through atomistic simulations,
J. Phys. Chem. B 111 (2007) 3640

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Ion leakage through transient water pores in protein-free lipid membranes driven by transmembrane ionic charge imbalance,
Biophys. J. 92 (2007) 1878

H. Martinez-Seara, T. Róg, M. Pasenkiewicz-Gierula, I. Vattulainen, M. Karttunen, and R. Reigada,
Effect of double bond position on lipid bilayer properties: Insight through atomistic simulations,
J. Phys. Chem. B 111 (2007) 11162

M. Mašín, I. Vattulainen, T. Ala-Nissila, and Z. Chvoj,
Interplay between steps and nonequilibrium effects surface diffusion for a lattice-gas model of O/W(110),
J. Chem. Phys. 126 (2007) 114705

T. Murtola, E. Falck, M. Karttunen, and I. Vattulainen,
Coarse-grained model for phospholipid/cholesterol bilayer employing inverse Monte Carlo with thermodynamic constraints,
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Conformational analysis of lipid molecules by self-organizing maps,
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Assessing the nature of lipid raft membranes,
PLoS Computat. Biol. 3 (2007) 0304

P. Nikunen, I. Vattulainen, and M. Karttunen,
Reptational dynamics in dissipative particle dynamics simulations of polymer melts,
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S. Ollila, M. T. Hyvönen, and I. Vattulainen,
Polyunsaturation in lipid membranes: dynamic properties and lateral pressure profiles,
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O. H. S. Ollila, T. Róg, M. Karttunen, and I. Vattulainen,
Role of sterol type on lateral pressure profiles of lipid membranes affecting membrane protein functionality: Comparison between cholesterol, desmosterol, 7-dehydrocholesterol and ketosterol,
J. Struct. Biol. 159 (2007) 311

M. Patra, M. T. Hyvönen, E. Falck, M. Sabouri-Ghomi, I. Vattulainen, and M. Karttunen,
Long-range interactions and parallel scalability in molecular simulations,
Comput. Phys. Commun. 176 (2007) 14

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What happens if cholesterol is made smoother: importance of methyl substituents in cholesterol ring structure on phosphatidylcholine-sterol interaction,
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Effect of the porous structure of graphite on atomic hydrogen diffusion and inventory,
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W. Zhao, T. Róg, A. A. Gurtovenko, I. Vattulainen, and M. Karttunen,
Atomic-scale structure and electrostatics of anionic palmitoyloleoylphosphatidylglycerol lipid bilayers with Na^+ counterions,
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String Theory and Quantum Field Theory

M. Arai, S. M. Kuzenko, and U. Lindström,
Hyperkähler sigma models on cotangent bundles of Hermitian symmetric spaces using projective superspace,
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M. Arai, S. M. Kuzenko, and U. Lindström,
Polar supermultiplets, hermitian symmetric spaces and hyperkähler metrics,
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M. Arai, C. Montonen, N. Okada, S. Sasaki,
Metastable vacuum in spontaneously broken $N = 2$ supersymmetric gauge theory,
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P. Howe, U. Lindström, and L. Wulff,
On the covariance of the Dirac-Born-Infeld-Myers action,
J. High Energy Phys. 0702 (2007) 070

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Kappa-symmetry for coincident D-branes,
J. High Energy Phys. 0709 (2007) 010

K. Ito, H. Nakajima, and S. Sasaki,
Deformation of super Yang-Mills theories in R-R 3-form background,
J. High Energy Phys. 0707 (2007) 068

U. Lindström, M. Roček, I. Ryb, R. von Unge, and M. Zabzine,
New $N = (2,2)$ vector multiplets,
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U. Lindström, M. Roček, R. von Unge, and M. Zabzine,
Generalized Kähler manifolds and off-shell supersymmetry,
Commun. Math. Phys. 269 (2007) 833

U. Lindström, M. Roček, R. von Unge, and M. Zabzine,
Linearizing generalized Kähler geometry,
J. High Energy Phys. 0704 (2007) 061

N. Maru, N. Sakai, and N. Uekusa,
Radius stabilization by constant boundary superpotentials in warped space,
Phys. Rev. D 75 (2007) 125014

N. Uekusa,
Dependence of SU(N) coupling behavior on the size of extra dimensions,
Phys. Rev. D 75 (2007) 064014

Ultrarelativistic Heavy Ion Collisions

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Hard and soft probe-medium interactions in a 3D hydro+micro approach at RHIC,
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A global reanalysis of nuclear parton distribution functions,
J. High Energy Phys. 0705 (2007) 002

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Weakly interacting dark matter particle of a minimal technicolor theory,
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Gravity dual of 1 + 1 dimensional Bjorken expansion,
Phys. Rev. D 76 (2007) 106006

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Spherically expanding matter in AdS/CFT correspondence,
Phys. Rev. D 75 (2007) 066003

K. Kajantie, T. Tahkokallio, and J.-T. Yee,
Thermodynamics of AdS/QCD,
J. High Energy Phys. 0701 (2007) 019

T. Renk,
Signatures of Mach shocks at RHIC,
Eur. Phys. J. C 49 (2007) 13

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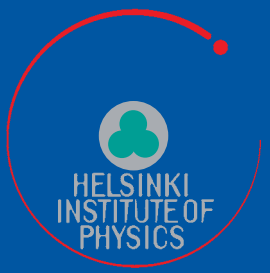
Edited by Christina Helminen

Design Päivi Talonpoika-Ukkonen
Layout Oona Loman
Printed by Yliopistopaino



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