HELSINKI INSTITUTE OF PHYSICS

Annual Report 2008

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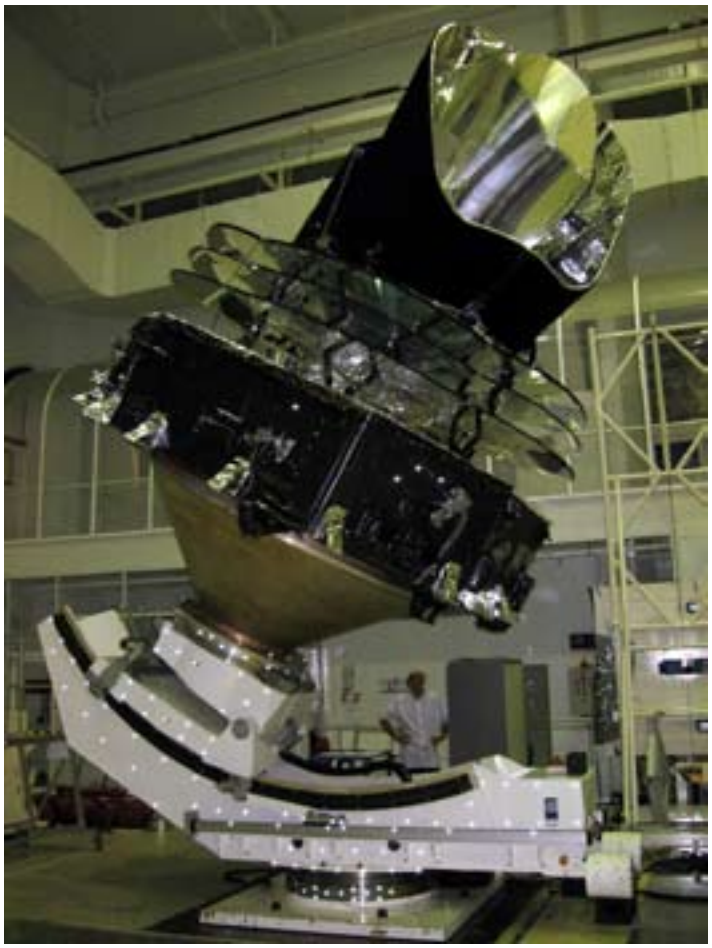

The Planck satellite in attitude tests, March 2008 (courtesy of Thales Alenia Space and ESA).

Annual Report 2008 Helsinki Institute of Physics

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Introduction

Dan-Olof Riska

A major development in 2008 at the Helsinki Institute of Physics (HIP) was the joining of Tampere University of Technology as an operating partner of the Institute in addition to our previous partners, the Universities of Helsinki and Jyväskylä and Helsinki and Lappeenranta Universities of Technology. Another major event was the beginning of the construction of a "Tier-2" Grid computing facility as a joint effort of HIP and the Finnish IT Center for Science, CSC. The Tier-2 facility forms part of the CERN Worldwide LHC Grid computing project WLCG. A third related major event was the well publicized first start-up of the Large Hadron Collider LHC and the beginning of data collection at the ALICE and CMS detectors at CERN in September.

HIP's main mandate of the Finnish Ministry of Education is the co-ordination of the collaboration between CERN and Finland. The second mandate is the planning and construction of the Finnish contribution to the Facility for Antiproton and Ion Research FAIR, whose construction will begin in Darmstadt in 2009. The realization of these mandates is done 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 in theoretical physics and in accelerator based research and associated technology development, which are too resource intensive or too cross disciplinary to fit into the standard framework of academic research funding 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 in ongoing research. An example of the success of this collaboration is the fact that 19 project leaders and researchers of the Institute have been appointed to professorial positions at several different universities both in Finland and abroad.

The research activities of the Helsinki Institute of Physics in 2008 fell into 5 research programmes and 2 special research projects. The research programmes are (1) the Theory Programme, (2) the High Energy Physics Programme, (3) the CMS Programme, (4) the Nuclear Matter Programme and (5) the Technology Programme. The special projects are (a) the CLOUD experiment project at CERN, which aims at the determination of the role of cosmic radiation in climate warming and (b) the Planck project for the analysis of the data from the Planck satellite, which will be launched in 2009. At the beginning of 2008 the Theory Programme began 5 new projects: (1) Cosmophysics, (2) Laws of nature and condensed particle matter phenomenology at LHC, (3) Low-dimensional quantum systems (4) String theory and mathematical physics and (5) Radiation damage in particle accelerator materials. The last one of these is related to the HIP engagement in the development project for the future CLIC collider at CERN.

The High Energy Physics Programme continued its projects for detector construction for forward proton-proton physics study in the TOTEM experiment at the Large Hadron Collider (LHC) at CERN and the study of top quark physics by proton-

antiproton collisions at the CDF-II experiment at the Tevatron collider at the Fermi National Accelerator Laboratory. The engagement in accelerating structures study for the future CLIC accelerator project complements the theory project on microscopic simulation of surface RF breakdown phenomena.

The CMS Programme continued in two projects: one for the commissioning and operation of the tracker and the trigger of the CMS detector at the LHC and the other for software development for the CMS data analysis and Monte Carlo studies of the discovery potential of CMS. The Institute welcomed Professor Paula Eerola as a new senior member in this programme in September.

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. In 2008 HIP joined the NuPNET network for nuclear research as the Finnish partner.

On December 9 Ambassador Hannu Himanen decorated the outgoing Director General of CERN, Dr. Robert Aymar, with the Commander's Cross I Class of the Order of the Lion of Finland at the Permanent Finnish Mission in Geneva, after the award had been made by the President of the Republic, H. E. Ms Tarja Halonen.

The Technology Programme of the Institute continues the development of industrial applications of CERN generated innovations. During 2008 one 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. The Programme is responsible for the construction of the Tier-2 Grid computing facility. During the year the project participated in the CMS data transfer effort, which has transferred more than 25 TBs of data between different Tier-1 centres and the transfer links to the Finnish Tier-2 centre. The Finnish Tier-2 centre has also been part of the ALICE Tier-1 network.

The Institute has continued its strong efforts in training graduate students for frontline research. This activity is supported in part by the national graduate school programmes. The graduate training efforts were greatly strengthened by generous grants by several Finnish foundations. During 2008 new record numbers of both PhD and DSc degrees (11) and MSc and MSc (engineering) degrees (17) were awarded on the basis of research conducted within the research projects of the Institute.

The summer student programme at CERN represents a key educational effort. During the summer of 2008, 14 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 2008 the Institute hosted 15 study "camps" by Finnish high school students and 2 training sessions for teachers in Finnish gymnasiums at CERN.

The Institute continued its active engagement both in research and administration at CERN. Our Director served as a delegate to CERN Council and as a member of the Governing Board of the CERN Pension Fund. Juha Äystö served as a member of the CERN Scientific Policy Committee. At the end of the year the personnel secretary at the HIP office at CERN, Ms Marika Flygar, took up the position as assistant to the Director General of CERN. The Institute remains indebted to her for outstanding service for over more than a decade.

During 2008 the Board of HIP was chaired by Vice Rector Johanna Björkroth 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.

HELSINKI INSTITUTE OF PHYSICS

Highlights of Research Results

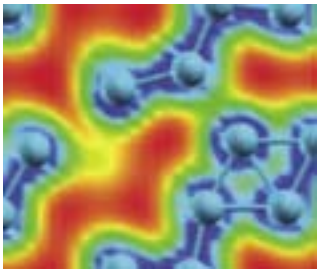
Theory Programme

In the Cosmophysics group we have shown that in the generic curvaton models the observable non-Gaussian features of the fluctuation spectrum may be encoded in the trispectrum instead of the bispectrum. It was also shown that in problems with particular symmetries the information on non-local quantum coherence is encoded into singularities at off-shell momenta. This observation was used to derive quantum transport equations for bosonic and fermionic systems including non-local coherence either in space or in time, including decohering collisions.

Regarding the Laws of Nature and Condensed Particle Matter Phenomenology at the LHC, relic densities and collider signatures of dark matter candidates both in supersymmetric and non-supersymmetric extensions of the Standard Model have been investigated. Large scale lattice simulations of the minimal walking technicolour -model were carried out and these provided new evidence for the phenomenological viability of this model. Global QCD-analysis of nuclear parton distributions was augmented with RHIC data, improved error estimates and next-to-leading order evolution.

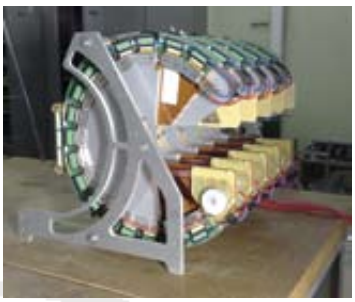
The String Theory and Mathematical Physics project investigated the duality of strongly coupled dynamics at finite temperature and gravitational systems involving a black hole in higher space-time dimensions. We modelled the scaling properties of an expanding fireball of quark-gluon matter by relating it to a gravitational system, allowing for an elegant framework to analyse the symmetries and various thermodynamic aspects. We also showed how an effective field theory for fractional quantum Hall plateaus can be derived from a gravitational system involving a black hole in four-dimensional space-time. This work has generated much worldwide interest. The twisted Poincaré symmetry, discovered by the group, has by now established itself as a symmetry principle in constructing non-commutative theories, including gravity. A special case is the recently obtained realization of Cohen-Glashow Very Special Relativity.

In its first year, the Low Dimensional Quantum Systems project has focused on graphene and two-dimensional semiconductor quantum dots. As an example of our research, we have proposed a spin-droplet phase that can unstabilize the paired quantum Hall state with possibly non-Abelian quasiparticles in a confined quantum Hall system.



Within the Radiation Damage in Particle Accelerator Materials group, several new activities were initiated in 2008. We developed the first hybrid electrodynamic - molecular dynamics concurrent simulation model to enable direct simulation of the onset of sparking in compact linear accelerator components. Classical molecular dynamics simulations coupled to a plasma physics simulation method allowed us to show that surface damage by sparking is caused by ballistic nuclear collisions and not only evaporation as previously assumed. A combined experimental and theoretical study showed that swift heavy ion tracks in silica are underdense in the core.

High Energy Physics Programme



An intense five-year period of design, construction, testing and validation of the first T2 detector section, delivered for the CERN LHC TOTEM experiment by the Helsinki group of HIP was completed, and - most importantly - on schedule. A quarter of the T2 detector was installed at IP5 in August 2008. The Helsinki group has led the preparation of the analysis of TOTEM data from the *TOTEM early physics* runs, in close collaboration with the other groups involved in TOTEM.

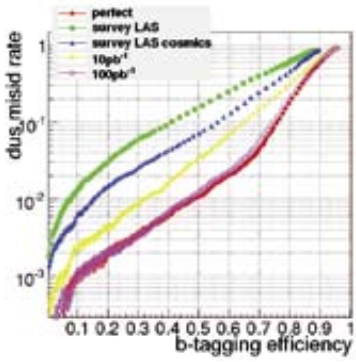
The Fermilab Tevatron Collider reached peak luminosities up to $380*10^{30}$ $cm^{-2}s^{-1}$ in the high luminosity mode after the summer 2008 shutdown, and the CDF experiment recorded data with 90% efficiency. A new top quark mass measurement was performed in the all-hadronic channel during 2008 (Petteri Mehtälä). A standard model Higgs boson with 170 GeV is now excluded at 95% confidence level. The Helsinki group concentrated on Higgs searches in associated production with the W-boson (Timo Aaltonen). The first measurements of exclusive $\gamma\gamma$ processes were reported in the Cern Courier; these studies have been continued by the group (Erik Brücken). An exciting, albeit controversial, observation of multimuon events was reported and referenced in top journals such as Nature. These may indicate novel long lived fundamental particles which may be produced in high energy hadron-hadron interactions.

In the Linear Collider Research project several milestones were achieved during 2008 by setting the parameter specifications for the CLIC module interconnections and for the cooling of the two most essential components of the CLIC module; the accelerating structures and the power extraction and transfer structures.

During 2008, the Detector Laboratory of the High Energy Physics Programme supported successfully also the activities of other HIP programmes: e.g., the first cosmic muon tracks were measured with the FinnCRack set-up of the CMS Programme and the Super-FRS gas detector development was launched in the framework of the FAIR co-operation of the Nuclear Matter Programme.

CMS Programme

The commissioning of the CMS detector system was successfully completed by the end of the summer and the apparatus was ready for collisions in LHC in September. The HIP CMS team participated actively in the commissioning. It recorded the first signs of the proton beams that were circulated in LHC on September 10th. Due to the incident in a superconducting spline between two LHC magnets and the consequent delay in the start-up, CMS concentrated on recording tracks of cosmic rays, which allows testing the apparatus and exercising the physics analysis workflows and tools. Some 300 million cosmic muon events were recorded at full magnetic field in November. These data are valuable for the calibration and testing of the full apparatus.



The cosmic runs were also used for the alignment of the CMS detectors with tracks, a necessary addition to the alignment with the collision events. The Hit and Impact Point algorithm developed in the HIP CMS Programme was extensively used for this purpose.

In the preparation for the physics analysis a promising result was obtained in the study of the rejection of the hadronic jet background to tau-jets in the important MSSM Higgs discovery channel $tg \rightarrow tH^{\pm}$, $H^{\pm} \rightarrow \tau\nu$. A luminosity-independent optimisation of kinematic cuts led to the suppression of the QCD multi-jet background by a factor of ~10^5. At the same time the tau identification algorithm was adjusted to exploit the different helicity correlations in the $H^{\pm} \rightarrow \tau\nu$ and $W^{\pm} \rightarrow \tau\nu$ decays, making possible a significant suppression of the ttbar and W+jet

backgrounds as well. This result indicates good prospects for the $H^{\pm}$ searches in the $H^{\pm} \rightarrow \tau\nu$ decay channel with the CMS detector.

An important highlight in the HIP CMS Programme was the rapid commissioning of the Tier-2 (T2) Grid computing centre at the Finnish IT Center for Science (CSC) in spring 2008 and its immediate, very successful use for the CMS Computing Software and Analysis exercise (CSA08) in spring 2008. The T2 centre has since operated as a stable part of the CMS Grid computing system and allowed CMS physics analysis over the Grid.

Important new results were achieved during the summer 2008 test beam period at CERN, when irradiated silicon sensors processed by the magnetic Czochralski silicon (MCz-Si) method were tested at the Silicon Beam Telescope (SiBT) facility as part of the CMS Tracker upgrade programme for the CERN Super-LHC. The collected data indicate that the MCz-Si detectors can still be operated after an irradiation of $1.6*10^{15}$ neutron equivalent / cm^2, which is 10 times higher than what the silicon detectors in the innermost strip detector layers of the CMS Tracker will receive over 10 years of operation of LHC. Hence, MCz-Si is a valid candidate for detector material for the future upgrades of the CMS silicon tracker. Another highlight was the first successful demonstration of the functioning of an irradiated full-sized Current Injection Detector (CID), a novel silicon detector type designed in the framework of the CERN RD39 programme. The CID detector as well as the MCz-Si detectors was processed at the Micro and Nanofabrication Centre (Micronova) of Helsinki University of Technology.

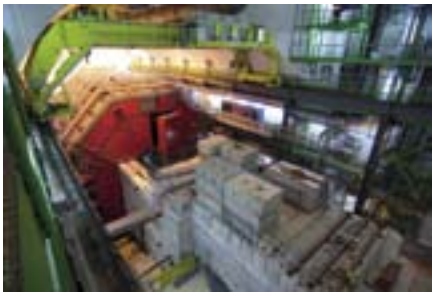
The cosmic muon telescope at the Kumpula Detector Laboratory (FinnCRack) was established as an operational part of the infrastructure of the Laboratory. The first article about the measurements of cosmic muon tracks was submitted to a conference in autumn 2008.

The research staff of the CMS Programme was strengthened by a new senior faculty member as Prof. Paula Eerola was nominated as a professor in experimental particle physics at the University of Helsinki Department of Physics and at HIP on September 1st and as the Deputy Programme Director of the HIP CMS Programme. CMS has appointed her as an incoming co-ordinator of the CMS B-physics Analysis group for 2009–2010.

Nuclear Matter Programme

The Nuclear Matter Programme provides participation for 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 is co-ordinating the Finnish participation in the FAIR project at GSI.

Despite the special year at CERN with the start-up of LHC, the ISOLDE laboratory has continued its research in various fields from fundamental interactions to material science and biophysical applications. REX-ISOLDE is a unique facility in the world, as it can deliver reaccelerated radioactive beams of exotic nuclei. In 2008 studies were extended to neutron deficient ^{202,204}Rn nuclei (Z=86) in order to study shape coexistence in neutron-deficient nuclei with Z>82. As another highlight, the ISOLTRAP Penning trap facility was employed to perform precision mass measurements of neutron-rich zinc isotopes including ^{81}Zn to map the robustness of the N=50 shell gap and study astrophysical r-process synthesis of heavy elements.



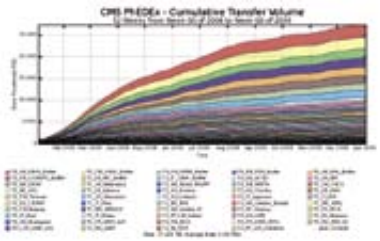
As in the previous years the main focus of the ALICE group in 2008 was on the preparation for the first data taking scheduled for late summer 2008. J. Rak was asked

to serve as a run-period co-ordinator for the June-November period and thus the group played an important role at CERN during, probably, the most important phase in the ALICE commissioning. Activities of the ALICE/Finland group in 2008 can be divided into the following areas: preparation of the data analysis chain for the first physics; participation in the ALICE run co-ordination; participation in the cosmic data taking and contributing to the detector calibration tasks; taking part in preparation and development of the ALICE central triggering scheme; development and preparation of EMCAL trigger units (TRU) including the development of the FPGA firmware, TRU prototype tests, production and commissioning; and commissioning of the T0 detector.

Preparatory work for FAIR (Facility for Antiproton and Ion Research) was started in 2006 and continued through 2008. The main contributions are devoted to the construction of the experimental equipment within the NUSTAR Collaboration and the Superconducting Fragment Separator (SFRS). The start of the commissioning of the Super-FRS has been estimated to start in fall 2014. Several industrial projects are also being worked on with the help of Finpro.

Technology Programme

The main highlights of the Technology Programme in 2008 concern the collaboration with the CERN Grid community and CSC, the Finnish IT Center for Science. Through the construction of physical computing infrastructure and participation in several global tests this collaboration has proven to be ready to take on the real LHC data challenge. Work with the EU-funded EGEE-III project has continued with additional responsibilities. The Programme has continued 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

The Theory Programme provides a platform for the project leaders to conduct high-profile research in a few selected subject fields. The projects are fixed term with a default duration of 3+3 years. They are chosen on the basis of their scientific 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. The old projects came to their end at the end of 2007, and from the beginning of 2008, the Theory Programme now has five new projects: Cosmophysics; Laws of Nature and Condensed Particle Matter Phenomenology at the LHC; String Theory and Mathematical Physics; Low Dimensional Quantum Systems; and Radiation Damage in Particle Accelerator Materials.

Kimmo Kainulainen,
Cosmophysics
project leader

Cosmophysics

One of the main fields of study of the Cosmophysics project has been inflation and studies have been conducted on several fronts. First, we continued our studies of the supergravity origin of the low energy scale MSSM inflationary model. In particular a class of Kahler potentials, of similar form as in various string theory compactifications, was found; these can provide a slow roll MSSM inflation with no fine tuning of the soft supersymmetry breaking parameters. We also examined a wide class of multi-field inflationary models on the string theory landscape. It has been argued, and shown explicitly in special cases that the preheating mechanism fails to work in case of multi-field inflation (N-flation) models due to dephasing of different inflaton oscillations. Thus more involved mechanisms, such as tachyonic preheating may be necessary to reheat the universe in these models. We also studied the consequences of disappearing inflatons during multi-field inflation. Standard slow roll results and the case of a dynamically relaxing cosmological constant were shown to emerge in the appropriate limits. In addition, it was shown that isocurvature modes are generically suppressed during inflation for these models and, as a consequence, perturbations are adiabatic and nearly Gaussian.

We have also studied the effects of eternal inflation on cosmological observables such as the power spectrum of primordial perturbations and non-Gaussianities. We have found, for example, that eternal inflation provides a natural cut-off for IR diverging loop corrections to inflationary non-Gaussianities. This result is of extreme importance for both cosmological applications and gauge/gravity duality, where eternal inflation corresponds to a phase transition at low energies in the dual gauge theory. We also discuss inflatory scenarios with curvaton fields. We show that the curvaton decay takes place most naturally by way of a broad parametric resonance and that its observable signatures may include stochastic gravitational waves. We also show that in curvaton models whose potential includes non-quadratic terms, the non-Gaussian features of the fluctuation spectrum are encoded in the non-reducible non-linearity parameter g_{NL} of the trispectrum, rather than in the bispectrum. Moreover, for reasonable choices of potentials g_{NL} can have values that will be accessible by future observations. Finally, we have studied the Schrodinger picture propagator for cosmological perturbations and their infrared divergences for inflation.

Another topic has been dark energy. We have considered alternatives to dark energy in f(R) gravity, on which we have found constraints from stellar dynamics and the Solar system. Using our generalized Tolman-Oppenheimer-Volkoff equations for a static spherically symmetric star for f(R) gravity, we have shown that all metric f(R) theories, tailored to contain solutions consistent with the Solar system gravity field, suffer from very serious fine-tuning problems. We have also continued our efforts with inhomogeneous alternatives to dark energy and the modifications of the Einstein equation due to the averaged back reaction.

We have also developed quantum transport theory for systems in non-trivial temporal and spatial backgrounds including non-local coherence effects, and used these theories to study, for example, coherent particle production in the early universe. We have shown that in systems with certain space-time symmetries (homogenous, and stationary planar symmetric cases) the coherence information is encoded in singular shells in the phase space of the dynamical two-point function. This singular structure was found for both fermionic and bosonic fields and for both of the above mentioned symmetry classes, and transport equations were derived for the physical density matrices or moment functions. The novelty of the approach is that it allows computing the collision integrals explicitly in terms of the density matrix. The resulting equations were then used to compute coherent production of both unstable fermionic and bosonic fields during phase transitions in the early universe. We have also outlined how the planar symmetric problem can be extended to interacting fields; when completed, this formalism will allow us to compute accurately the baryon asymmetry generated during the electroweak phase transition. On a related note, it was shown that supersymmetric thermal leptogenesis can provide a qualitatively consistent scheme for baryogenesis free of gravitino constraints, given non-thermally produced heavy right-handed particles, whose CP-violating decay eventually creates the observed asymmetry.

Laws of Nature and Condensed Particle Matter Phenomenology at the LHC

Kimmo Tuominen, Laws of Nature and Condensed Particle Matter Phenomenology at the LHC project leader

The LNCPMP project in the HIP Theory Programme is located at the Department of Physics, University of Jyväskylä, at HIP, and at the Department of Physics, University of Helsinki. Our focus is on (1) electroweak symmetry breaking mechanisms and associated Beyond the Standard Model (BSM) phenomenology and (2) properties of hot and dense QCD matter and ultrarelativistic heavy ion collision (URHIC) phenomenology. We are in research collaboration with various international colleagues, we organize and participate in international conferences and workshops, European graduate school activities and EU networks. We are also in close contact with local CMS (Helsinki) and ALICE (Jyväskylä) experimental groups. This project, started in 2008, continues the successful traditions of past HIP-URHIC and HIP-Particle Phenomenology projects which both ended in 2007.

EWSB and BSM phenomenology: During 2008 one of our central topics has been the study of relic densities and collider signatures of plausible dark matter candidates in different BSM scenarios. For example, in supersymmetric R-parity preserving theories we have studied the composition of the lightest neutralino in non-universal gaugino mass cases from the SU(5) and SO(10) unification. Related to this, we organized a two-month programme "TeV scale physics and dark matter" at NORDITA, Stockholm on 1.6.–31.7. and participated in organization of a workshop "LHC and Beyond" in Stockholm on 12.–14.6.

Neutrinos are difficult to study because of their extremely weak interactions. We have studied the mixing of supersymmetric partners of neutrinos, sneutrinos, which can provide information on the neutrino parameter space in a model where neutrinos have non-zero Majorana masses. Possible observable signals carrying information of the neutrino masses

and mixing angles at a linear collider and also at the LHC have been studied. Such a signal can be experimentally observable under certain conditions accessible in an anomaly-mediated supersymmetry breaking scenario.

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 the LHC and at a linear collider. The production of these exotics could provide a spectacular signal for a new underlying symmetry and for physics beyond the minimal supersymmetric standard model.

Earlier, within the HIP Theory Programme, we have proposed a class of novel technicolour models which we also showed to be consistent with all current electroweak precision data. For successful phenomenology, these models should be infrared conformal. We have now completed a large scale lattice analysis of the minimal model (SU(2) gauge theory with two adjoint (techni)fermion flavours). The analysis lends strong support for the fact that this theory is indeed almost or exactly conformal in the infrared. These results strengthen the phenomenological viability of the model at LHC.

QCD matter: One of our pioneering specialties is a comprehensive description of URHIC, where the initial densities are computed from perturbative QCD (pQCD), collinear factorization and gluon saturation, and where the space-time evolution of the produced system is described by relativistic hydrodynamics. After successful tests against BNL-RHIC data, we have predicted the bulk hadron multiplicities and p_T spectra for central Pb+Pb collisions at the LHC. Most recently, we have prepared a detailed study of elliptic flow in non-central collisions, and also developed the decoupling treatment further.

High-p_T particle production in URHIC is an important class of QCD matter probes. The measurements are currently being extended from single-hadron spectra and few-particle correlations to the observation of full hadronic jets. In order to make contact with this important development, which will also be a crucial part of the LHC heavy-ion programme, we are currently developing Monte Carlo simulations for QCD parton showering in a hydrodynamically evolving QCD medium as well as for describing collisional energy loss of high-p_T partons. The first comparisons with both single-hadron spectra and preliminary results on jet structure look promising, but a more systematic study is needed to identify the dynamics of parton-medium interaction. Using effective models, which are constrained by lattice data and observed vacuum properties, we have analysed QCD thermodynamics at temperatures and densities relevant for URHIC dynamics.

Nuclear parton distribution functions (nPDFs) are needed for the computation of all collinearly factorizable hard-process cross sections in nuclear collisions. Our pioneering contribution in the global pQCD analysis of nPDFs, the set EKS98, is now a standard reference in the field. After developing the global fit procedure further, and also including RHIC data for the first time in such analysis, we have now released a new nPDF set, EPS08. We are currently extending the study to next-to-leading order pQCD, and preparing a detailed error analysis by which one can estimate the nPDF-originated uncertainties in, e.g., those hard cross sections which are relevant for the determination of the QCD matter properties.

Hadron Physics Activity. The recent dynamical QCD lattice calculation result, which found that the axial charge of the N(1535) resonance is very small, if not zero, is shown to have a natural interpretation in the quark model as a consequence of a cancellation between an anomalously small and negative qqq component value and the positive contribution from explicit qqqq-antiquark configurations.

By a calculation of the pion charge form factor in an extended covariant quark model, which contains both quark-antiquark and 2-quark and 2-antiquark configurations it was found that the empirical form factor is very in-

sensitive to the relative proportion of the sea-quark configurations.

In the study of B_s mesons on the lattice the energy spectrum of the mesons was extracted up to L=2 states. Particular attention was paid to the spin-orbit splittings.

The study of pion-nucleon partial wave amplitudes with fixed-t constraints has continued.

String Theory and Mathematical Physics

The String Theory and Mathematical Physics project has two main missions. It investigates frontier problems at the interface of string theory, mathematics and other areas of physics, where a lot of creative and surprising new approaches are emerging. On the other hand, the project acts as a bridge between various groups studying mathematical applications to physical problems, in the physics and mathematics communities at Kumpula campus and elsewhere.

The group includes physicists and members from the Department of Mathematics and Statistics at the University of Helsinki, including a postdoctoral fellow supported by the University of Helsinki interdepartmental fellowship. The project begun in 2008 and has thus completed its first year.

One surprising connection between different physical systems is the duality between strongly coupled gauge theories at finite temperature and gravitational systems involving a black hole in five space-time dimensions. This connection has found a very concrete context as a framework to understand the formation and properties of dense quark-gluon matter created in the RHIC collider in Brookhaven in the ultrarelativistic collision of gold ions. Graduate student Touko Tahkokallio has investigated the expansion of the fireball, and modelled the scaling properties in the expansion by relating it to a gravitational system, allowing for an elegant framework to analyse the symmetries and various thermodynamic properties.

Even more surprisingly, it has been shown that this connection can be extended to other strongly interacting fluids, such as the Hall fluid in (fractional) quantum Hall systems. This connection was pioneered in 2008 by project leader Esko Keski-Vakkuri and Prof. Per Kraus from UCLA, who showed how an effective field theory for fractional quantum Hall plateaus can be derived from a gravitational system involving a black hole in four-dimensional space-time. This work has generated much interest worldwide, as it is right at the frontier of emerging condensed matter physics applications of gauge-gravity duality. Several workshops at major international centres of research will be held in 2009 focused on this new theme.

We also investigated the role of randomness in two different contexts: in an inflationary universe where the vacuum is selected from a random landscape of possibilities, and in the decay of unstable branes in string theory, where the theory of random matrices and Coulomb gas electrostatics was applied to analyse multi-string emission. Other topics investigated in 2008 include BPS D0–D6 brane systems in supergravity, preheating after multi-field inflation, and non-commutative geometry.

The activity in the field of non-commutative geometry has continued on its successful path: the group has clarified controversial aspects in the field by constructing non-commutative fields and actions covariant under the twisted Poincaré symmetry, starting from first principles. This led us to obtain a consistent realization of the Cohen-Glashow Very Special Relativity as light-like non-commutative quantum field theory. The topic of non-commutative gravity has been approached from different angles, exploring principally the possibility of its formulation as a gauge theory of the twisted Poincaré symmetry, satisfying the requirement of covariance under general coordinate transformations. Various aspects of non-commutative gauge theories and the axiomatic approach to non-commutative quantum field theory, as well

Esko Keski-Vakkuri, String Theory and Mathematical Physics project leader

Ari Harju,
Low Dimensional
Quantum Systems
project leader

as the problem of gauge invariance in a variant of confinement, have also been studied.

Low Dimensional Quantum Systems

The field of nanoscale two-dimensional quantum physics forms an interface between hard-core theoretical physics and traditional condensed matter physics. The lowered dimensionality both enhances correlation effects - in many cases necessitating the use and development of non-perturbative methods - and allows for powerful analytical techniques such as bosonization and Bethe ansatz. Recent advances in experimental techniques have promoted strongly correlated low-dimensional models from being mere toy models of particle physics into systems of experimental interest. Low-dimensional nanosystems lie in an interesting crossing point of theoretically inspiring and fundamentally novel findings (e.g., the fractional quantum Hall effect) and technological applications (e.g., quantum-dot based devices).

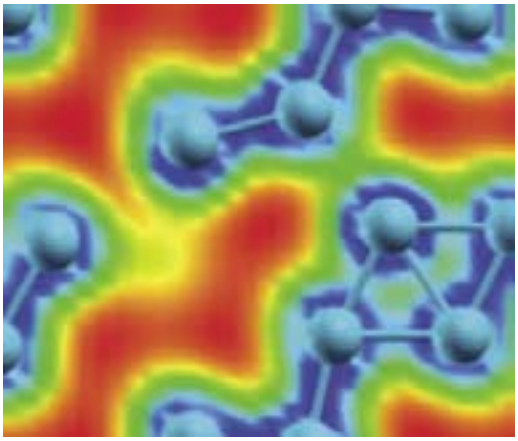
The main focus of the project has been on studies of two-dimensional semiconductor quantum dots in strong magnetic fields. In these structures, a controllable number of electrons are confined to a quantum dot. Besides applications in quantum information and quantum computing, quantum dots are interesting in their own right as an example of strongly correlated interacting quantum systems, in which the strong influence of the magnetic field entails prominent diverseness. Moreover, the results extrapolated from computationally feasible few electron droplets are frequently used to understand macroscopic quantum phenomena such as the quantum Hall effects.

As a first example of our studies on this, we have studied the properties of the hard-wall quantum dots. This model shows fractional Aharonov-Bohm oscillations as a function of the magnetic field, caused by the strong electron-electron interactions. We have shown that the physics of this system can be explained by the simple lattice model with neighbour and next-nearest neighbour hoppings. This suggests a possibility to coarse-grain the quantum Hall physics in a similar fashion.

As a second example on quantum dots, we have simulated the spin dynamics in a case where two one-electron quantum dots are coupled together. This is relevant for quantum information processing, as spin in a quantum dot is one of the strongest candidates for a qubit. The main focus in this is to study the decoherence. Decoherence is always a significant obstacle in quantum computing. In semiconductor quantum dots decoherence is mainly caused by the hyperfine interaction with the lattice nuclei. Our simulations for the spin dynamics agree well with the experimental findings.

Finally, we have studied the quantum dots in a regime where one could find paired electron states with non-Abelian excitations. Our study shows a high overlap of the paired Pfaffian state with the exact diagonalization wave function. However, the half-filled second Landau level of the Pfaffian state has a relatively high angular momentum, which may lead to its instability in the quantum dot case.

In addition to quantum dots, we have worked on graphene, a single layer of graphite. For graphene, the trend to reduce the dimensions of the conducting elements of electronics has, unexpectedly, led into a new world of peculiar physical properties, not encountered in standard electronic materials. Despite being only one-atom thick, graphene is chemically and thermally stable, so that graphene-based devices, such as field-effect transistors have already been manufactured, and they withstand ambient conditions. It has been understood theoretically, and confirmed experimentally, that graphene is a gapless semiconductor, with peculiar properties of charge carriers. A gap can be generated by forming a ribbon of graphene. We have studied the transport properties of the graphene ribbons. Specifically, we have shown that cutting a notch on the ribbon edge leads to well-defined spin-dependent transport properties.



Electron density of states surrounding a defective state in silicon. Such defective states determine the performance of silicon-based particle based detectors in LHC, and understanding of their behaviour is crucial for the development of detectors with better radiation tolerance and performance for use in the Super-LHC.

Radiation Damage in Particle Accelerator Materials

The development of particle physics requires accelerators which produce particle beams with increasingly high energy and intensity. This leads unavoidably to increasingly large demands on the materials surrounding the particle beam. In future accelerator concepts such as the compact linear collider CLIC, the accelerating components themselves are subject to damage due to instabilities in the intense radiofrequency fields used to accelerate the beam. Already in the LHC, the enormous amounts of particles produced in the particle reactions will cause great radiation damage to the very same solid state detectors which are used to detect them.

This HIP Theory Programme activity during 2008–2013 utilizes the wide existing know-how of Prof. Kai Nordlund and Dr. Flyura Djurabekova in the fields of radiation effects in metals and semiconductors to examine the radiation damage in present and future particle accelerators. We examine the fundamental mechanisms by which the damage in the accelerator components form, with the aim to use the increased understanding to design materials and components which will withstand the damage optimally well. We also study the properties of nanocrystals embedded in solids with respect to their mechanical, optical and thermodynamic properties.

Kai Nordlund, Radiation Damage in Particle Accelerator Materials project leader

High Energy Physics Programme

Heimo Saarikko,
High Energy Physics
Programme director

The activities of the High Energy Physics Programme in 2008 concentrated on top quark measurement and Higgs production studies in the CDF experiment at the Fermilab Tevatron antiproton-proton collider, and on construction, testing and validation of the first T2 detector section for the TOTEM forward physics experiment, as well as leading the preparation of the analysis of TOTEM data from the early LHC runs. Helsinki is one of the leading groups for the CDF experiment in the top mass measurement, and is contributing significantly to Higgs searches. 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 2008 the group concentrated on construction, testing and commissioning of the GEMs for the TOTEM T2 spectrometer. This strained our resources, personnel, finances and infrastructures to the maximum. The first TOTEM T2 detector quarter was completed and installed on schedule. A vigorous R&D effort continued, to demonstrate the feasibility of the Compact LInear Collider (CLIC) -technology, in view of a decision on the future direction of the high energy frontier in 2010–2012. In 2008 the Detector Laboratory activities have supported the major experiments of HIP, TOTEM and CMS at CERN and NUSTAR/SUPER-FRS at FAIR, to a very significant extent. Intense educational programmes were carried out in connection with the research activities and otherwise, both at the undergraduate and graduate levels.

Risto Orava,
Forward Physics
project leader

Forward Physics Project

In 2008, the group focused on physics analysis of the 2 TeV proton-antiproton collision data collected in the CDF experiment at the Fermilab Tevatron, and in testing, adjusting and commissioning of the T2 spectrometer for the TOTEM forward physics experiment at the CERN LHC collider. The group is one of the core contributors in top quark studies ('all-hadronic' decay channel), Higgs search ('WH' associated production), and in exclusive photon-photon studies in CDF, and continues to be among the leaders in planning the strategies for optimal coverage of forward physics at the LHC.

TOTEM Experiment

T2 Spectrometer. In September 2008, the first proton beams were circulated in the LHC Collider (see: http://press.web.cern.ch/press/). The first TOTEM T2 detector section, delivered by the Helsinki group of HIP and the Division of Elementary Particle Physics (AFO) at the University of Helsinki, was ready for data taking. The intense five-year period of design, construction, testing and validation was completed, and - most importantly - on schedule.

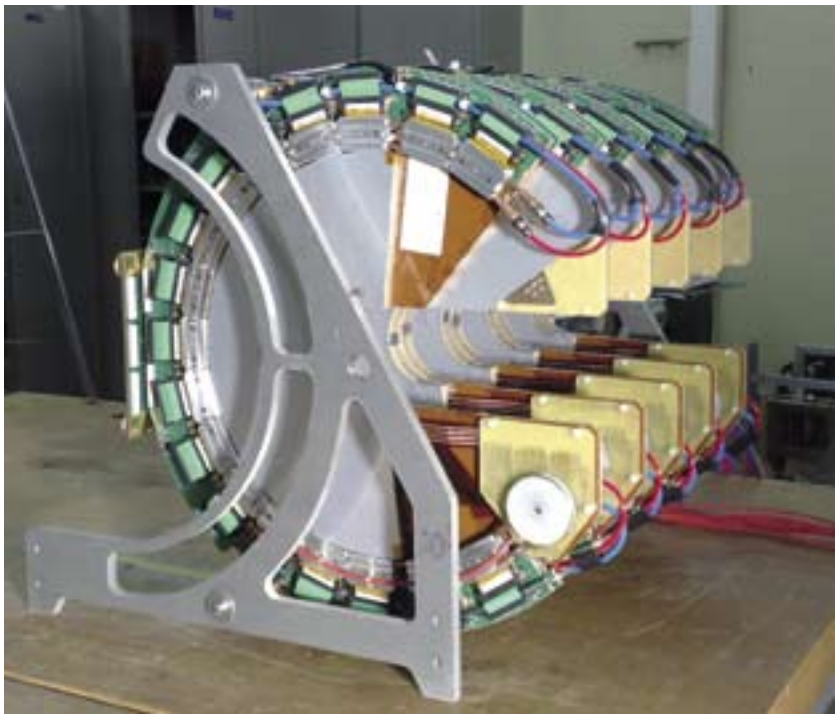
By the end of 2008 altogether 20 T2 GEM detectors provided with the front electronics and the cooling system were completed, tested and validated. Several beam tests with the final readout chips at the H8 experimental hall at CERN indicated that more hermetic EMI shielding is required to lower the level of pick-up noise detected by the DAQ. The first quarter of the T2 telescope: a set of 10 GEM detectors was installed in their final destination at the LHC Intersection Point 5 (IP5) of the TOTEM experiment.

The TOTEM Helsinki group has continued the final assembly and testing of the GEM de-

tectors by, e.g., designing and mounting new HV-supply boards thus enabling cooling and better power rating of the resistors on board; designing and setting aluminium and copper foils on top of the surfaces of GEMs for electromagnetic shielding; attaching the VFAT chip based readout electronic boards onto the GEMs; fixing the cooling pipe system around the detectors and covering the HV-boards and -strips with additional conformal coating for preventing possible leakage current problems with moisture.

Off-line software. The TOTEM off-line software, which includes simulation, reconstruction, calibration, alignment and analysis, is based on the CMSSW framework. Due to the modular structure of this CMS software, the TOTEM related packages can be incorporated in it, allowing in the future combined TOTEM/CMS detector simulation and analysis. The first release of the TOTEM off-line software that included the simulation and the reconstruction for all three TOTEM detectors was issued at the end of 2008. The major missing component of the software is the simulation of the Level-1 trigger response whose development will be finalized during spring 2009. The Helsinki group has actively contributed to this development during 2008, especially to the T2 telescope simulation and the geometrical description of the material in the T2 region. The former requires T2 telescope data from LHC collisions for its final tuning. Also the first part of the simulation of the Level-1 T2 trigger, i.e., the coincidence chip, was finalized by the Helsinki group during 2008.

TOTEM early physics. The early LHC runs will be at low β^* with beams at lower energies having a reduced number of bunches and a lower number of protons per bunch giving TOTEM ample opportunities to make its first physics studies: high-|t| elastic scattering, high mass central and single diffraction, inelastic rates and forward charged particle production in inelastic events. In addition, TOTEM is preparing for the possibility of shorter $\beta^* = 90$ m runs aiming at an early total cross section measurement with 4–5% relative precision as well as studies of soft diffraction at any diffractive mass value. The Helsinki group has led the preparation of the analysis of TOTEM data from these runs in close collaboration with the other groups involved in TOTEM. The Helsinki group is focusing on measurement of diffractive processes, especially on high mass central and single diffraction in the early runs.



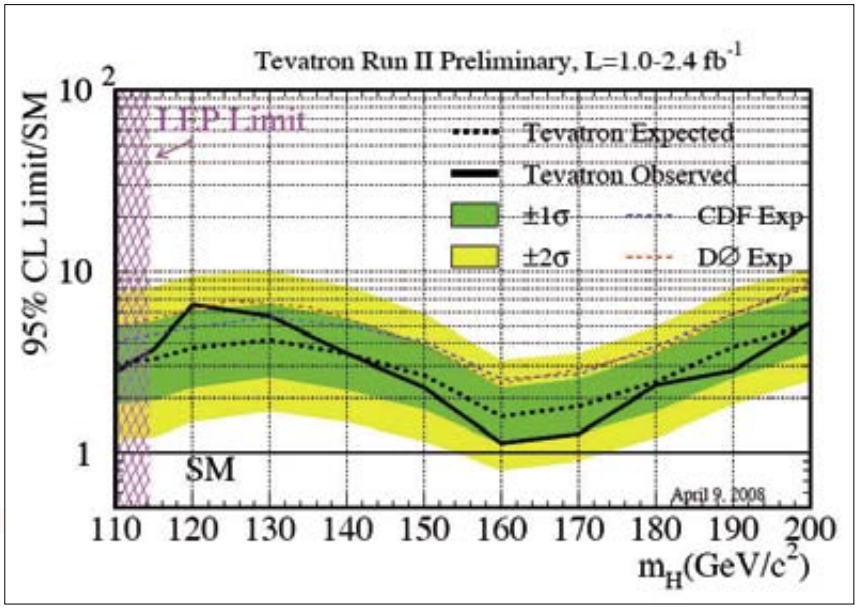
The first quarter of TOTEM T2 spectrometer ready for installation.

The **responsibilities** and contributions of the Helsinki group in the TOTEM experiment in 2008 include:

*T2 spectrometer GEM detector construction (see the work package description: PH/DT2-PH/TOT, 14/April/05).
*T2 spectrometer data analysis & trigger scenarios.
*Rapidity gap, diffractive and forward particle measurement.
*Planning for forward physics strategies and analyses at the LHC.
*TOTEM service contributions: participation in testing and validating the T2 GEM detectors.

CDF Experiment

After the summer 2008 shutdown, the Tevatron was switched into high luminosity mode. Peak luminosities up to $380*10^{30}$ $cm^{-2}s^{-1}$ were



During 2008 the CDF analysis on limits for the Standard Model Higgs boson resulted in exclusion of the Higgs boson in a narrow region around 170 GeV/c^2. The Helsinki group has participated in the direct searches for the Higgs boson at CDF in the WH channel and in setting constraints on its mass indirectly by performing top quark mass measurements in the fully hadronic and dileptonic channels.

Kenneth Österberg, Linear Collider Research project leader

reached. The CDF experiment recorded data with 90% efficiency. A new top quark mass measurement was performed in 2008 (Petteri Mehtälä). The method uses in-situ jet energy scale calibration with the well measured W-boson mass as a reference. A standard model Higgs boson with 170 GeV is now excluded with 95% confidence limits. The Helsinki group concentrated on Higgs searches in associated production with the W-boson (Timo Aaltonen). The first measurements of exclusive $\gamma\gamma$ processes were reported in the Cern Courier; these studies have been continued by the group (Erik Brücken). This process is similar to the diffractive production of a light Higgs boson via gluon-gluon fusion. A measurement of the exclusive photon-pair cross section at Tevatron therefore will improve the cross section prediction for diffractive Higgs at LHC. Even though indication of the existence of this process was found at CDF in 2007, an observation could not be claimed due to low statistics. The aim of this analysis is to clearly observe this process not only by benefiting from a larger dataset and newly introduced trigger with a lower energy threshold, but by refining the analysis methods entirely. An exciting, albeit controversial, observation of multimuon events was reported and referenced in top journals such as Nature. These may indicate novel long lived fundamental particles which may be produced in high energy hadron-hadron interactions.

The **responsibilities** and contributions of the Helsinki group in the CDF experiment include:

*Support for the Run II detector; SVXII DAQ board testing and maintenance & daily operational responsibilities of the silicon detector.

*Participation in off-line SVXII calibration.

*Participation in validating the jet energy scale calibration.

*Participation in operating the CDF experiment as shift responsibles.

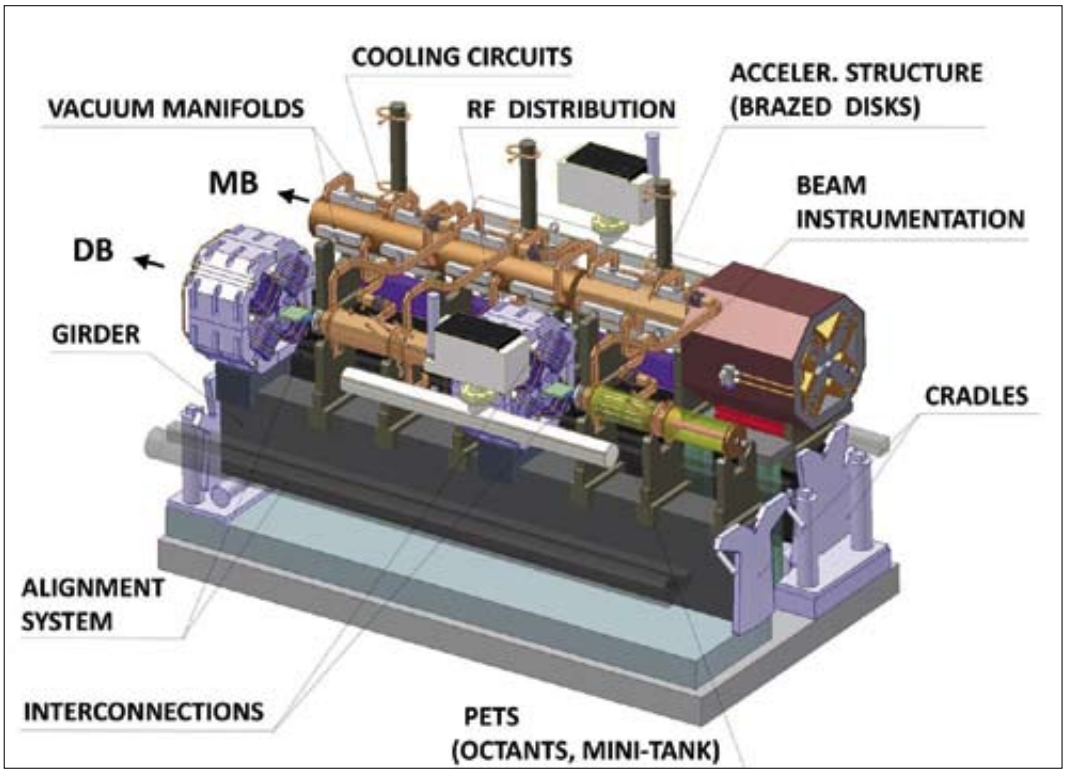
*Top quark mass analysis in the 'all-hadronic' channel.

*Higgs search in association with the W-boson (WH-channel) and in Vector Boson Fusion (VBF).

Linear Collider Research Project

The main activity in 2008 was participation in the 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 the future direction of the high energy frontier in 2010–2012. The focuses were on the development of accelerating structures for CLIC and on the integration of all the accelerator components into a CLIC module with a viable alignment, support, and cooling system. The project had two researchers in 2008, R. Nousiainen based at CERN and J. Huopana based in Oulu who makes frequent visits to CERN. The research was done in close collaboration with the CERN CLIC group, notably Drs W. Wünsch and G. Riddone, and Finnish industrial and academic partners, notably the Technical Research Centre of Finland (VTT). On the Scandinavian level, we collaborated with the Uppsala and Oslo groups in the NorduCLIC network.

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 in the order of ±5 μm



The layout of the CLIC module, an approximately 2 m long section of CLIC, with the main components shown. MB = main beam, DB = drive beam, PETS = power extraction and transfer structures.

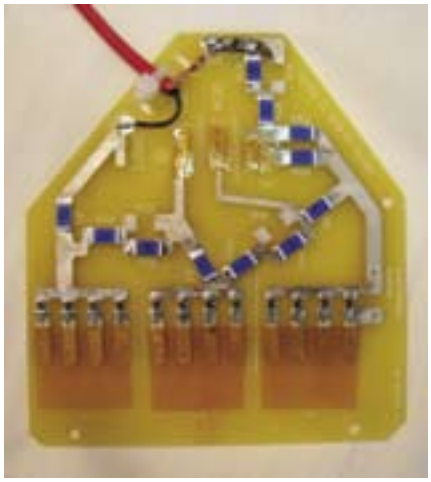
for the most critical parts and it is partly limited by the uncertainties in the shape of the tool. One of the focal points of the research is to improve the machining precision via novel methods like tool compensation without significant increase of the production costs for the structures, in close collaboration with VTT and Finnish micro machining industry. The first results of tests of tool compensation obtained during 2008 are encouraging and will be pursued.

Not only the machining precision is important for the performance of the accelerating structure but also the alignment precision of the full accelerating structure assembly and the relative alignment accuracy between adjacent accelerating structures that must meet tight mm level requirements. In 2008, a decision was taken to concentrate the development effort on accelerating structures assembled from disks to achieve the goals set for the 2010 Conceptual Design Report. A second focal point of the research was therefore development of the assembly method for the accelerating structures made out of disks with damping waveguides and other different geometrical features.

The assembled structures need further to be integrated into the full CLIC module maintaining μm precision. The third focal point of the research was the requirements and specifications for the CLIC module and the integration of the different parts into a viable module design. Here several milestones were achieved during 2008 by setting the parameter specifications for the module interconnections, for the cooling of the accelerating structures and for the cooling of the power extraction and transfer structures (CLIC/EDMS documents 975234, 964717 and 964715).

Another key issue 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 breakdowns most probably originate from sharpened peaks on the surface of the accelerating structure which result in an increased electric field. We are closely collaborating with Prof. K. Nordlund and his group that pursues atomistic simulations of the breakdown process to be able to minimize the effects of breakdowns by appropriate choice of material, preparation and design for the accelerating structures.

Final construction of a single TOTEM T2 GEM detector.



New HV supply boards for the TOTEM T2 GEM detectors were designed at the Detector Laboratory.

Detector Laboratory

Eija Tuominen, Detector Laboratory coordinator

The Detector Laboratory supports Finnish experimental research on collider-based physics. It is a joint laboratory between Helsinki Institute of Physics and the Department of Physics 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 acquired a vast amount 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 NUSTAR/SUPER-FRS experiment at FAIR. In addition, the Laboratory offers support for projects at the Electronics Research Laboratory of the Department of Physics of the University of Helsinki. Furthermore, according to available resources, the Laboratory also provides services for outside users.

Support for the TOTEM experiment

During the year 2008 the work with the semicircular GEM detectors for the TOTEM T2 telescope continued in the Detector Laboratory. The work concentrated on the finishing of the GEMs assembled already earlier in the Laboratory with the final mechanics and electronics. These final features consisted of new HV (High Voltage) -supply boards, extra electromagnetic shielding foils, readout PC boards with digital VFAT chips, cooling pipe structure, and additional moisture preventive coating for critical parts exposed to HV.

Also the final electric testing for the assembled GEM detectors continued to meet the design criteria. In this context one new characterization set-up was introduced and one was modified, both of them are related to monitoring the risk of extra leakage currents or pulses caused by humidity. The new set-up made use of the environmental test chamber available in the Laboratory to record these large leakage current pulses in different humidity conditions for the detectors under the N_2 flow and normal operational HV. The HV test for the GEMs filled with N_2 gas was further developed to incorporate four detectors at the same time. The basic characteristic measurements of the GEMs included gas gain and energy resolution measurements with different bias voltages over the 17 readout sectors. Every detector was also HV tested with a gas amplification value which was one order of magnitude higher than the normal operational value. Stability runs over long periods of time with a gas gain of 8 000 were done to finalize the validation process for each detector.

To facilitate detector development for the forward protons, the group participates

in an EU sponsored detector R&D project, EUDET.

Support for the CMS Tracker Operations project

The CMS Tracker Operations project has the Finnish Cosmic Rack (FinnCRack) as well as adjacent electrical equipment and cooling system installed on the premises of the Detector Laboratory. FinnCRack is a telescope built from eight layers of CMS silicon detectors measuring the 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 Operations project. During 2008, the first cosmic muon tracks were measured and reconstructed by FinnCRack.

The CMS Tracker Operations project has greatly profited from the selection of equipment of the Detector Laboratory. Using the wafer/chip probing station situated in the clean rooms of the Detector Laboratory essential electrical properties, e.g., current-voltage and capacitance-voltage characteristics were measured for the silicon detectors directly after their manufacture at the semiconductor processing line at Helsinki University of Technology Micronova and after the irradiations. Some of these detectors have also been connected to electronics using the versatile bonding equipment at the clean rooms. In addition, the common project between the CMS Tracker Operations project and the Accelerator Laboratory of the Department of Physics at the University of Helsinki is greatly benefiting from the electrical equipment of the Detector Laboratory. Furthermore, the construction of the set-up to measure CCE (Charge Collection Efficiency) and TCT (Transient Current Technique) started in 2008. These measurements will provide all the necessary information for the studies of the properties of silicon detectors.

Support for FAIR SUPER-FRS experiment

FAIR (Facility for Antiproton and Ion Research) is an international accelerator research facility to study nuclear physics. It is being built in Darmstadt, Germany as an extension to the current GSI research institute. Finland is an official member of FAIR. HIP is co-ordinating the Finnish participation of which the major part is conducted at the University of Jyväskylä, but the Detector Laboratory has also a group of scientists active in the FAIR projects.

The Detector Laboratory participated previously in the PANDA (antiProton ANnihilations at DArmstadt) experiment at FAIR, but since 2008 all the Finnish effort has been concentrated on the NUSTAR (NUclear STructure, Astrophysics and Reactions) experiment the focus was changed specifically to the production of detectors for the fragment separator, i.e., Super-FRS.

During 2008 the activities for the PANDA experiment in the Detector Laboratory were concluded. Contacts and work plans with the GSI group were made for the Super-FRS. Design work for the GEM-TPC prototype for the diagnostics of the fragment separator was started. This prototype is intended to be built in the first half of 2009 and during the following years it will serve as the basis for the design, development and manufacture of a total of 40

FinnCRack silicon reference telescope is operational at the Detector Laboratory.

similar GEM-TPC detectors in the Detector Laboratory.

Support for wire bonding projects

In 2008, the Detector Laboratory has successfully participated in the so called Electric Sail 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 spacecraft. The sail is made of several long tethers that are built from 25-50 micrometers thin metal wires. Constructing the tethers requires a novel wire connection method. However, the first wire-to-wire bonding experiments using 25 micrometer round wires have been successfully performed in the Laboratory.

During 2008 module assembly experiments have continued for the silicon tracker of the Phenix experiment at Brookhaven National Laboratory. The studies in 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.

The Detector Laboratory has very close contacts with the Electronics Research Laboratory of the Department of Physics of the University of Helsinki. 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, and the *Detector Laboratory* also serves as the basis of education and training in experimental high energy physics. Summer student and technical training programmes at CERN and Fermilab have been continued, in collaboration with a number of Finnish Polytechnic Institutes, e.g., including estab-

In autumn 2008 the personnel of the Detector Laboratory tutored the exercises of a group of Nordic postgraduate students during the Nordforsk course on detector technologies.

lished R&D and training programmes with the Polytechnics in Kuopio and Rovaniemi. In connection with the research activities, educational programmes both at the undergraduate and graduate levels have been established. During 2008 one student from Savonia AMK had a six month training period working on the TOTEM database project. Two 2008 CERN summer students from Helsinki University of Technology worked on the GEM detector assembly and final installation in IP5 of the TOTEM experiment.

In November 2008, the *Detector Laboratory* hosted a research training course for 20 postgraduate Nordic students. The extensive infrastructure of the Laboratory and the wide know-how of its personnel provided an exceptional opportunity for organizing a practical hands-on detector course for the students of high energy physics. The course was supervised by Professor Paula Eerola and financed by Nordforsk. During the two-week intensive period, the students studied gas and silicon detector technologies through extensive laboratory exercises. All the personnel of the Laboratory participated in the teaching and supervision of the practical laboratory works. In addition, Finnish Academy Fellow Jaakko Härkönen, Dr. Michael Moll from CERN and Dr. Leonard Spiegel from Fermilab gave talks about silicon detector technologies and their application to high energy physics experiments.

During the course, the students spent several days in a successful effort to construct a single-wire proportional counter and to measure energy spectra of irradiation sources with their own hand-made detectors. In addition, under the supervision of the visiting professor Richard Brenner from the University of Uppsala, the students constructed a measurement set-up and measured responses of irradiation sources with silicon detectors. Furthermore, the laboratory tasks included data taking and data analysis with the FinnCRack telescope and characterization of the properties of radiation tolerance of irradiated silicon diodes under the supervision of the scientists from the CMS Tracker Operations project. Furthermore, the students visited the clean rooms of Micronova Centre for Micro and Nanotechnology at Otaniemi and familiarized themselves with the full silicon detector process.

In spring 2008, one of the Helsinki group members, Tuula Mäki, completed her PhD on top quark mass measurement in the di-lepton decay channel and immediately received a CERN Fellowship.

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

CMS Programme

Jorma Tuominiemi,
CMS Programme director

The HIP CMS Programme has been responsible for the Finnish participation in the Compact Muon Solenoid (CMS) experiment at the CERN Large Hadron Collider (LHC) since 1996. The CMS experiment is designed to study proton-proton collisions at a collision energy of 14 TeV and also heavy ion collisions at the LHC. The main scientific goals of CMS and the LHC involve a search for the mechanism of the spontaneous breaking of the electroweak symmetry in the Standard Model of the basic structure of matter, i.e., a search for Higgs bosons, 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. The Finnish team was one of the founding groups of CMS and has played an important role in its development and construction. The HIP CMS team hence has an extensive and thorough knowledge of the key features of the experiment. With the CMS experiment HIP is 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 now scheduled to start in 2009 after a delay in the commissioning of the LHC in autumn 2008. The year 2008 was the year of commissioning for the CMS, with the active participation of the HIP CMS group. All its subdetectors are in place and taking cosmic ray data. The data acquisition and the trigger systems have been installed and tested with cosmic muons. The Computing Software and Analysis exercise (CSA08) using the CMS Tier0-Tier1-Tier2 system was performed with the design event rate in spring with the simulated data generated for this purpose. The system performed well and tuning the system to meet its final performance requirements is being pursued. Several experiments using the cosmic rays were performed over the year, the last one in November with a full magnetic field, in which 300 million cosmic muon events were recorded. The analysis of these data are in progress but the results already show that all the subdetectors, the trigger system and the data acquisition system are meeting their design specifications. Preparation for the physics analysis has continued with full strength. Within CSA08 several analysis projects were successfully performed. A number of analysis projects aiming at published papers with 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 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 Operations project, which has carried responsibilities for the completion of the Outer Barrel part of the silicon tracking detector as well as for its testing and which has been an important player in the CERN R&D activity to develop silicon tracking detectors for future experiments.

Veikko Karimäki,
CMS Physics
Analysis project
leader

CMS Physics Analysis

Introduction

The construction of the CMS apparatus to take the first LHC data was completed in August 2008. The first LHC beam events were observed in September as planned, before the incident that happened at the LHC, which postponed the start of the pp collisions by about a year. Recording of cosmic muon events was continued during the autumn after the incident.

A major activity in computing and detector simulation was the CSA08 exercise (Computing Software and Analysis challenge 2008) in which 150 million events were simulated and processed. The purpose of the exercise was to test the CMS Grid computing system and software, and the principal focus was on the calibration

and alignment of the detector modules. The HIP alignment algorithm was successfully used and the Finnish Tier2 centre was challenged in the exercise. The measurement of cosmic data was divided into two parts: CRUZET (Cosmic Running at Zero Tesla) and CRAFT (Cosmic Run At Four Tesla). A total of about 700 million events were recorded. The HIP activity was focused on the usage of cosmic muons for the CMS tracker alignment.

In the field of physics analysis the HIP team continued to take the responsibility for the analysis of the MSSM Higgs bosons in the τ lepton decay channel. A new major activity, measurement of the Level-1 τ trigger efficiencies, was started. Improvements in the τ lepton identification algorithm were achieved. Parallel computing based analysis methods using the ROOT-based PROOF package were developed and the activity on using the Toolkit for Multivariate Analysis (TMVA) continued. Our responsibility for user support of the CMS software package CMSSW was another important HIP activity issue.

The CMS Physics Analysis project was considerably strengthened when Prof. Paula Eerola joined the activity. In CMS she was nominated as the new co-convener of the B-physics working group and as a member of the CMS Physics Coordination from January 1st, 2009. Prof. Eerola is also co-ordinating a Joint Nordic Infrastructure project "LHC and Beyond", funded by NordForsk 2008–2010 (see http://www.hep.lu.se/staff/eerola/LHCBeyond.htm). The aim of this project is to maximize the physics outcome of LHC for the Nordic scientific community, and to plan for the next steps beyond the LHC. As a part of this project a research training course on Detector Technology was organized for Nordic graduate students by Prof. Eerola in 2008.

The activities during the year 2008 are described in more detail below.

Physics analysis and simulation

Work on Higgs searches. The preparative study on the searches of charged MSSM Higgs bosons in the $gb \to tH^{\pm}$, $H^{\pm} \to \tau\nu$ channel with the fully hadronic final state was one of the main responsibilities of the HIP group in preparation for data taking with the LHC collider. The channel studied is the major discovery channel for the heavy charged Higgs bosons. During 2008 the identification of the energetic τ jet from $H^{\pm}$ and development of data driven background estimation methods were the main activities in this project. Other major responsibilities were the preparation and study of the measurement of the Level-1 τ trigger efficiencies from data, validation of the official CMS Summer08 Monte Carlo production to have the correct τ polarization included, and development of the software and computing facilities with the local GRID cluster.

The prospects for finding the charged Higgs bosons with the $gb \to tH^{\pm}$, $H^{\pm} \to \tau\nu$ channel are based on an efficient identification of energetic τ-jets against the hadronic jets. A detailed study was performed on the τ-jet identification with luminosity-independent optimisation of the cuts against the backgrounds. The one-and three-prong τ-jets were optimised separately. The optimisation was performed primarily against the hadronic jets to obtain a factor of ~10^5 suppression of the QCD multi-jet background. At the same time the identification algorithm was adjusted to exploit the helicity correlations in the $H^{\pm} \to \tau\nu$ and $W^{\pm} \to \tau\nu$ decays making possible a significant suppression of the ttbar and W+jet backgrounds as well. Methods for measuring the residual ttbar and W+jet and QCD multi-jet backgrounds from data were developed. The ttbar and W+jet background events falling in the signal area are expected to be mainly due to resolution effects of the missing E_T measurement. The data driven method developed is based on the clean muon measurement in the muonic multi-jet events. Transformation from the muonic measurement to the signal-type events is obtained replacing the measured energetic isolated muon with a generated τ jet with the same kinematics. Work on a general and public CMSSW method for the muon replacement is in progress. Measurement of the associated W and top masses is one of the important methods in the background estimation. A ki-

nematic fitting package for W and top reconstruction was introduced and tested. The study of the missing E_T measurement in the QCD multi-jet background was also continued.

The τ trigger efficiencies will be measured with the early LHC data first in the multi-jet events and later with genuine τ jets from W and Z decays. Methods needed for these measurements are being developed with simulated Monte Carlo data. A contribution to the CMS shift work was initiated in the test runs with cosmic muons within the on-line data quality control group.

Work on software and computing, and the development work for new tools and methods for data analysis were continued. The ROOT-based analysis package, HipProofAnalysis, was developed further also to contain support for Grid and PROOF analysis. The activities for the multivariate analysis tools (TMVA) were also continued.

The study of the production of the MSSM Higgs bosons in the SUSY cascades in a model of non-universal gaugino masses at the unification scale was finalized and published in collaboration with the HIP Phenomenology group. Similarly, the study on the search for the very light NMSSM Higgs bosons with the $H \to AA \to 4\tau$ final state was finalized and published with the theoretical collaborators. A study on searches of the charged Higgs bosons in the $gb \to tH^{\pm}$, $H^{\pm} \to \mu\nu$ channel was started as a summer student project for the high luminosity option of the LHC in the complicated environment of a large event pile-up.

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

Work on B-physics. B-physics analyses have been started as a new physics activity in the CMS Programme. It is led by Paula Eerola, the new professor in experimental particle physics at the Department of Physics of the University of Helsinki and HIP, who was installed in 2008. The LHC provides extremely high rates of B-hadrons due to the high b-production cross section, favourable signal-to-background ratio, and high luminosity. B-physics is a timely field in particular during the first years of data taking at the LHC, when the luminosity will be relatively low, providing a clean event environment and low trigger thresholds. The J/Ψ and Υ mesons will be among the first physics analysis topics. Furthermore, they also serve as crucial standard candles for the calibration of the mass and momentum scale of the Tracker and the muon system (misalignment, magnetic field distortions).

CMS computing and off-line user support

The HIP team continues the co-ordination of the user support to CMS physicists. In 2008, the consolidation of the CMS Software Documentation Suite was carried out, the highlights being: (i) the yearly review of the "WorkBook" containing essential instructions and basic and more advanced tutorials in February 2008, and (ii) planning and preparation of a comprehensive review of the "Offline Software Guide" containing full details of the CMS Software. The latter was prepared with the help of expertise in technical writing from the University of Turku. In this context, several usability test sessions of the documentation suite were carried out to identify any problems of accessibility and availability of the information. The results of these tests will be used in the review to improve the usability of the documentation.

For the user training, several tutorial sessions were organized. These sessions have been very well appreciated and attended, but short tutorial sessions do not allow users to put into practice what they learn in the context of their own analysis. Therefore, an e-learning course "Using Physics Analysis Toolkit in your analysis" was prepared in the latter half of 2008. The aim of the training is to produce good quality analysis code and an adequate expertise in the use of the tools. The first course will start in 2009.

Grid computing activities

Computing for the LHC experiments at HIP took a big step forward largely due to the annual funding of 800 kEUR/year that the Ministry of Education has granted for the years 2008, 2009 and 2010. The funding will be exploited according to the guidelines defined in the contract signed by HIP and the CSC (IT Center for Science Ltd) and the work has been carried out in close collaboration between the HIP CMS and Technology Programmes, CSC and Nordic DataGrid Facility (NDGF). This close collaboration resulted in several advances in many areas of CMS computing that are summarized here.

Hardware. The Sepeli computing cluster, situated on the CSC premises, was fully devoted to HIP for LHC computing usage as from mid-April 2008. A 170 TB disk system using the dCache software was connected to Sepeli for ALICE and CMS usage. The CMS CPU resources consist of Sepeli maintained by CSC and Ametisti maintained partly by HIP which have a total of 512 and 260 cores respectively. A new 10 Gb/s Optical Private Network (OPN) for Nordic LHC computing was created and one endpoint was created at CSC. The dCache system is able to saturate the 1 Gb/s interfaces it presently has to the dedicated LHC OPN. A hardware temperature monitoring tool for the Ametisti nodes was developed and installed allowing automatic shutdown in case of machine room cooling problems. A new shared Linux cluster, Korundi, was acquired together with the Departments of Chemistry and Physics. There are 400 cores on Korundi and 992 GB of RAM in total and 56 TB of raw disk. A 64-bit Rocks 5.1 cluster, tb64, was built using new and recycled hardware for development work on Korundi.

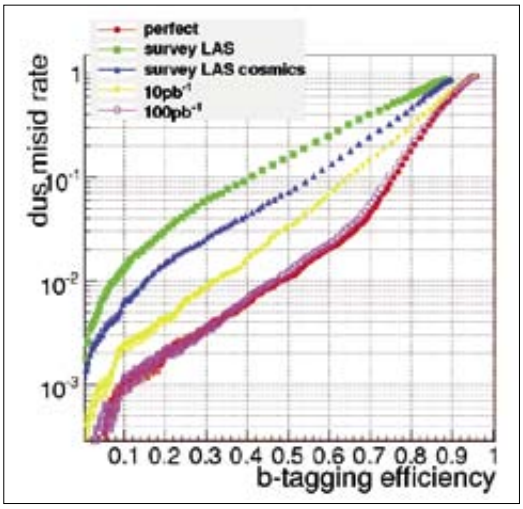
Software. The new manpower available due to the dedicated LHC computing funding enabled several major breakthroughs towards creating a commissioned Finnish CMS Tier-2 resource. NDGF and the Finnish national Grid infrastructure M-Grid uses the Advanced Resource Connector (ARC) middleware, so it was decided to continue the development of interfaces to the ARC middleware for CMS software services to benefit from the available expertise and common solutions. The problem of submitting CMS Remote Analysis Builder (CRAB) jobs to ARC Computing Elements (CEs) was solved by using and developing further the gLite-ARC interoperability work carried out during the last few years. HIP contributed to the CSA08 Analysis Commissioning in May-June 2008 by using gLite-ARC interoperability to run CRAB jobs submitted with both the glidein Workload Management System (WMS) and the new gLite WMS at CERN to ARC resources. The gLite-ARC interoperability has been improved and the job submission failure rate is about one percent or less. Work on a dedicated ARC plug-in for CRAB continued.

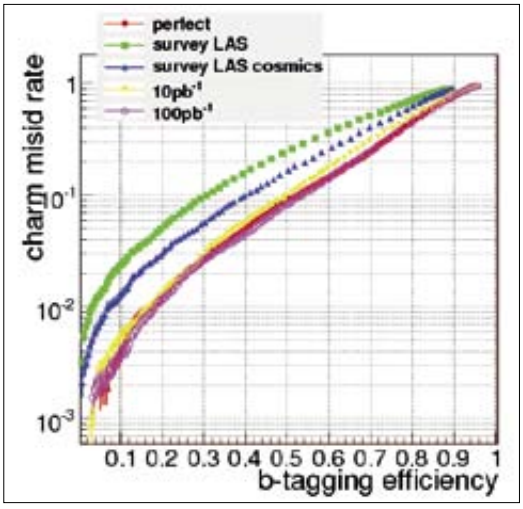
Operations. The ProdAgent ARC plug-in for Monte Carlo production developed by CSC and NDGF has been validated with workflows of several million events and it is now ready for production. The CMS SAM SRM tests were run on the dCache Storage Elements (SEs). NDGF implemented WLCG Site Availability Monitoring (SAM) tests for ARC CEs and these were configured to run on Sepeli and Ametisti and on the dCache SEs. According to the data collected by WLCG the availability and reliability of the Finnish CMS Tier-2 resource in November 2008 was 100% and 99% respectively. This excellent result is due to the efficient monitoring and problem resolution of CSC and NDGF. Reporting of WLCG Accounting data was implemented by CSC and NDGF, so that the CMS resource usage is injected to the APEL database. The CMS PhEDEx and Frontier services were run on silo3 in Kumpula by the HIP Technology Programme, see the Technology Programme text for details. PhEDEx links to all CMS Tier-1 centres were created by the HIP Technology Programme and this enabled the Finnish CMS Tier-2 resources to obtain commissioned status. More than 310 TB (Monte Carlo and test) of data were transferred with PhEDEx to Finland. A total of 49 thousand CMS Grid jobs using 87 thousand SI2k CPU hours were run in 2008. In addition to this local jobs were also run.

Tracker alignment

One of the most demanding calibration activities for the CMS Tracker is the geometrical alignment of its 15 148 modules with respect to each other. The work aims at the determination of some 100 000 calibration parameters which need to be recomputed in regular time intervals. Most of the parameters are determined by analysing computed particle trajectories in order to optimise the reconstruction precision. The detector alignment is a highly important issue in view of physics discoveries. As an example, the figure below demonstrates the importance of the alignment for mistagging rates.

In 2008 a large number of cosmic events were recorded for the first time in CMS and used for alignment. As part of the CMS Tracker alignment group, the HIP team participated in this work which culminated in the CSA08, CRUZET and CRAFT exercises. Various alignment algorithms were used. The HIP alignment algorithm, originally introduced by our team, was very competitive in comparison with the others. Work on the calibration for non-planarity of sensors was started.





Estimated effect of misalignment on light flavour (up) and charm quark (down) mistagging probabilities as a function of b-tag efficiency for ttbar events. Cases of ideal alignment, use of survey data, laser alignment (LAS) and cosmics data as well as early collision data are presented.

Geant4 development

The contribution of HIP in the Geant4 hadronic physics development was focused on the INCL intra-nuclear cascade code in collaboration with a group at the Commissariat à l'Énergie Atomique, Saclay. A new version of the code, including ABLA fission and evaporation models, was released in the Geant4 version 9.2. These models can be used for incident p, n, d, t, He-3, alpha and pions on nuclei ranging from carbon to uranium with projectile energies from 200 MeV up to 3 GeV. The latest extension include support for incident Carbon-12 ions.

The Bertini cascade code, used widely in detector simulation of the LHC experiments, now includes a new Coulomb barrier penetration model. Two-body internal pion cross sections above 7 GeV have been brought up to Particle Data Group values. The validation efforts for the hadronic interaction models included a comparison of simulations against 8–10 GeV/c projectile data from the HARP (Hadron Production Experiment at the CERN PS) collaboration, and joining the IAEA co-ordinated research project 'Heavy charged-particle interaction data for radiotherapy'.

Test beam off-line data analysis

The development of the CMSSW-based off-line analysis code for the SiBT (Silicon Beam Telescope) collaboration continued together with the CMS Tracker Operations project. In the beam tests of summer 2008, our project was responsible for the on-site data quality monitoring tools, which were a subset of the off-line analysis code. Detailed off-line data analysis continued later in 2008.

Outreach activities

The group members were active in presenting CERN and the LHC experiments to visitor groups from Finland. The groups included high school students and a group of high school teachers. The members also approached the general public by writing popular articles and giving popular talks, by giving interviews and by maintaining a blog describing 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.

CMS Tracker Operations

In 2008, the Tracker Operations project concentrated on two main activities, namely the operation of the CMS Tracker at CERN and the development of silicon tracking detectors for future high energy physics experiments. Among the main achievements during the past year were the participation in the start of the CMS experiment at CERN, the successful commissioning of the Finnish Cosmic Muon Rack (FinnCRack) at the HIP Detector Laboratory, irradiation campaigns in co-operation with the Physics Department of the University of Helsinki, and the successful beam tests of the novel Magnetic Czochralski Detectors and Current Injected Detectors (CID) using the Silicon Beam Telescope (SiBT) at the CERN H2 test beam. In addition, outreach activities in the form of guiding student groups at CERN have continued. Furthermore, in December 2008 we participated in organizing an international Detector Technology course funded by Nordforsk. The course was held at the HIP Detector Laboratory and at the Micro and Nanofabrication Centre (Micronova) of Helsinki University of Technology. The course was attended by 20 postgraduate students. This course was part of the Joint Nordic Infrastructure project "LHC and Beyond" coordinated by Prof. Paula Eerola.

Operation of the CERN CMS Tracker

Since the beginning of 2008, while waiting for the collisions at LHC, the CMS Tracker has been measuring tracks of cosmic muons. Several members of the team have taken part in the shift work operating the Tracker during these measurements. Dr. Panja Luukka has been trained as a CMS SLIMOS (Shift Leader In the Matters Of Safety), in charge of safety at CMS during the LHC runs. Heikki Viljanen was participating in the operation of CMS during the historic day of first beams of LHC.

Dr. Sandor Czellár has been responsible for the design and manufacture of a monitoring system for the CMS CAEN power supplies of the Tracker in the experimental cavern (UXC).

Finnish Cosmic Rack (FinnCRack)

The Finnish Cosmic Rack (FinnCRack) is a telescope comprising eight layers of baseline CMS silicon detectors, which measures the 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. It also provides a platform for the testing of the novel radiation hard detectors for the CMS upgrade and for future collider experiments. In 2008, the FinnCRack has become an operational part of the infrastructure of the Kumpula Detector Laboratory. It is a stable measurement system that can be operated continuously for 24 hours a day. The first article about the measurements of cosmic muon tracks was submitted to a conference in autumn 2008.

Eija Tuominen, CMS Tracker Operations project leader

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

During 2008, 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. Academy Research Fellow Jaakko Härkönen continues as the RD39 spokesperson. The network of these RD programmes 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, detector irradiation campaigns were continued at the Accelerator Laboratory of the University of Helsinki (HU) in close collaboration with the local group. Furthermore, electrical detector characterizations were done at the HIP Detector Laboratory.

In 2008, tests of novel detectors processed at Helsinki University of Technology were continued with the Silicon Beam Telescope (SiBT) at the CERN SPS H2 test beam in collaboration with Fermilab and with the Universities of Karslruhe, Rochester, Louvain, Brown, and Padua. In addition, beam tests of 3-dimensional (3D) detectors were performed in collaboration with the University of Freiburg and the University of Glasgow. The SiBT is a telescope that accurately measures reference tracks of beam particles. The readout electronics and data acquisition (DAQ) system of SiBT consists of baseline CMS Tracker Outer Barrel hybrids and CMS Tracker data acquisition cards. The telescope consists of eight reference detector planes and of two slots for the detectors to be tested. The telescope can be cooled down to -20°C. During 2008, the data collection rate of the DAQ was increased by a factor of eight, the on-line monitoring system was improved and an external cold-finger cooling box was constructed for detector measurements at temperatures down to -50°C.

During the summer 2008 SiBT beam test period, magnetic Czochralski silicon (MCz-Si) sensors were tested as part of the CMS Tracker upgrade programme for the CERN Super-

Samuli Väyrynen installing our silicon detector for irradiations at the HU Accelerator Laboratory.

Dr. Panja Luukka by the SiBT reference telescope at the CERN H2 test station during the summer 2008 beam tests.

LHC. The SiBT data analysis indicates that the MCz-Si detectors are operational after an irradiation of $1.6*10^{15}$ neutron equivalent / cm^2, which is 10 times higher than what the silicon detectors will receive during 10 years of LHC operation in the innermost strip detector layers of the current CMS Tracker. Therefore, the MCz-Si is a promising choice for the detector material for future upgrades of the CMS silicon tracker.

During 2008, segmented full-size Current Injected Detectors (CID) were tested for the first time at SiBT. The results indicate a 50% Charge Collection Efficiency after the Super-LHC fluence of $3*10^{15}$ neutron equivalent / cm^2. It is worth emphasizing that as yet no other system scale demonstration exists for novel detector concepts at such a high fluence. Within the CERN RD39 Collaboration work is going on to establish the radiation hardness of CID's up to $1*10^{16}$ neutron equivalent / cm^2, which is required for the innermost pixel layers of future upgrades of the LHC tracking systems.

Both the MCz-Si and CID detectors were manufactured by our group at the Helsinki University of Technology Micro and Nanofabrication Centre (Micronova), where our group is a member laboratory. During 2008, a doctoral degree was obtained for work on the development of silicon detector processing.

Prof. Ulrich Parzefall from the University of Freiburg at Micronova Clean Room working with our silicon samples.

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 2008 on developing the Finnish Physics Programme for ALICE. 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 ISOLDE project has its physics motivation in studies of exotic structures of nuclei, with a special emphasis on weak interaction phenomena and nuclear astrophysics and reaccelerated radioactive beams. 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 continued co-ordinating the Finnish participation in the planning of the FAIR project at GSI. FAIR stands for Facility for Antiproton and Ion Research. The Finnish involvement in FAIR includes participation in the construction of the Super-FRS facility and the NUSTAR Collaboration for nuclear structure and astrophysics studies. Industrial participation in constructing the FAIR facility is being explored in collaboration with Finpro.

ALICE

Jan Rak, ALICE
project leader

General

The activities of the ALICE/Finland group in 2008 can be divided into the following areas:

1. Preparation of the data analysis chain for the first physics.
2. Participation in the ALICE run co-ordination.
3. Participation in the cosmic data taking and contributing to the detector calibration tasks.
4. Taking part in preparation/development of the ALICE central triggering scheme.
5. Development and preparation of EMCAL trigger units (TRU) including the development of the FPGA firmware, TRU prototype tests, production and commissioning.
6. Commissioning of the T0 detector.

As in the previous years the main focus of the ALICE group in 2008 was on the preparation for the first data taking scheduled for late summer 2008. Since June 2008 most of the group moved to CERN to be directly involved in the above listed activities. J. Rak was asked to serve as a run-period co-ordinator for the June-November period and thus the group played an important role at CERN during a very important phase in the ALICE commissioning.

As it is known the bus bar superconducting failure on September 19th led to an unforeseen interruption of the LHC start-up. Unfortunately we were not able to take a short $\sqrt{s}$ = 900 GeV run nor $\sqrt{s}$ = 10 TeV data. However, we made use of various injection tests (a 450 GeV low intensity beam injected into one or two LHC sectors) where we often saw dense muonic showers from the beam dump. Muons were used to calibrate the timing of trigger signals and detector alignments. Important information about the overall ALICE performance was also extracted from the analysis of the beam-gas events seen when the single beam was circulated in the LHC tunnel.

High-p_T particle correlations

Besides the main focus of the ALICE collaboration to issue a “day one” first LHC paper on soft particle multiplicity and rapidity dis-

tributions we are exploring the potential of an analysis of high-p_T trigger associated yields. In 2008 we spent a lot of time in preparation of the analysis tools including the large-scale Grid data analysis discussed in the following section. We developed the scheme partially adopted from the analysis of di-hadron correlation that we have been doing within the PHENIX experiment. We focus on the shape analysis of high-p_T π^0 and direct photon associated yield. We presented some of the results based on analysis of the Monte Carlo simulated data in the poster session of the Quark Matter conference 2008 in Jaipur, India. Sami Räsänen and Jan Rak developed a new analytical frame to account for gamma-jet momentum smearing due to the presence of parton intrinsic transverse momenta. This is a very key issue for the analysis of the modification of the fragmentation function due the parton energy loss in the QCD medium.

Computing and ALICE data analysis

Two computing facilities have been successfully integrated into the ALICE Grid analysis environment at CERN since 2007. The "Opaali" cluster in Jyväskylä has provided 52 cores and 5 TB of disk space for the ALICE production, while the "Sepeli" cluster in Helsinki has offered 144 cores and 70 TB of disk space during 2008. We were able to provide the full pledged numbers to CERN by the MoU agreement between CERN and Finland. The maintenance and upgrade will continue with the CSC and HIP collaborations. The two sites were up and running for most of the time. The big success of the Grid contribution in 2008, in addition to the continuous production of simulated data, was the real cosmic and the beam injection data analysis. Results from this analysis were used for the geometrical alignment and calibration of various ALICE subdetectors.

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, in 2007 we joined the USA-France-Italy EMCAL project. The Electro-Magnetic Calorimeter is an important addition to the ALICE experiment and it extends the ALICE physics scope quite substantially. The major role of EMCAL is to provide a fast level-0 (L0) single photon and L1 jet trigger. EMCAL is crucial for photon and π^0 identification, main signatures of the existence of the dense and opaque QCD medium observed at RHIC.

We (mainly Norbert Novitzky and Jiri Kral) are participating in construction of trigger units boards (TRU) and development of the FPGA firmware for TRUs. This firmware evaluates the analog sum of 2x2 towers in a sliding window and compares it to various trigger thresholds. All of this relatively complicated procedure has to be performed within a 100 ns L0 trigger window and thus it requires the use of the high-tech FPGA processors. In 2008 we produced the first two prototypes of the TRU boards (partially in Finland) and performed an extensive test of its basic performance, internal signals synchronization and communication with outer electronics (front-end input and L1 summary trigger units developed at Grenoble) at CERN. The goal was to finalize all the design details to be ready to launch a final production of 6 TRU at the beginning of 2009. These boards together with the two EMCAL super-modules (the complete EMCAL will consist of 12 super-modules) should be ready for the first real ALICE run in summer 2009.

Jan Rak seated in the "driver's seat" of ALICE serving as run-period co-ordinator during the dramatic moments in the fall of 2008.

T0

A lot of progress in the Finish group was made in the preparation for the first physics and completion of the ALICE hardware. The later includes, besides the development of EMCAL TRUs, commissioning of the T0 detector. Our

ALICE just before the first beam.

team was at CERN during all the critical periods of testing and operation. The most dramatic moments were during the injection tests when ALICE was hit by dense muon showers from a 450 GeV beam dumped in the vicinity of our detector. There was no damage to the detectors and we have used these events to calibrate the timing of the trigger signals and for cross checking of the alignment. The bulk of the alignment data came from the cosmic rays tracks accumulated in several dedicated runs; all with our participation both as a team and as a subdetector (T0). After the mishap at LHC, radiation shielding around ALICE and part of the detectors on the A-side were dismantled to allow for maintenance, improvements in the set-up and installation of the missing modules. Next spring, before the start of cosmic runs and the new beam trials, we will be facing one more round of installation and commissioning and we hope that this time our efforts will be crowned with the collision data.

Ari Jokinen, ISOLDE project leader

ISOLDE

Despite the special year at CERN with the start-up of the LHC, the ISOLDE laboratory has continued steadily its rewarding experimental programme serving scientists all over the world in various fields from fundamental interactions to material science and biophysical applications. Traditionally we have employed the ISOLDE facility for solid state physics and sub-atomic physics. Finnish solid state physicists concentrated in 2008 on analysing and publishing the results from the previous years. Thus we will report only highlights of the experimental programme in nuclear physics and research and development in instrumentation in 2008.

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

REX-ISOLDE is a unique facility in the world, as it can deliver radioactive beams of very neutron-deficient heavy nuclei near Z=82. This is the region where several types of collective and non-collective coexisting nuclear structures compete at low excitation energy. Studies of these structures by employing in-beam spectroscopic methods have formed one of the main research projects in the Accelerator Laboratory of the University of Jyväskylä. The availability of these nuclei as radioactive beams at ISOLDE now enables us to probe these structures via Coulomb excitation. They are excited via impinging on a target, typically 2 mg/cm^2 thick metallic Sn or Ag foil. The scattered projectiles and recoils are detected by a CD detector in coincidence with gamma rays emitted in the de-excitation process and detected by the MINIBALL array of large highly segmented Ge- cluster detectors.

In the first two experiments light ^{182,184,186,188}Hg isotopes (Z=80) were studied. Analysis of the collected data is in progress. The data enable several E2 matrix elements to be determined and prolate or oblate structure to be assigned to these Hg nuclei. New light will be shed on the mixing of oblate and prolate shapes at low excitation energy.

In 2008 similar studies were extended to neutron-deficient Rn nuclei (Z=86). Radioactive beams of ^{202,204}Rn were accelerated to the energy of 2.9 MeV/u by the REX-ISOLDE linear accelerator. Intensities of radioactive ^{204}Rn and ^{202}Rn beams delivered onto a ^{109}Ag secondary target were 2x10^5 and 3x10^4, respectively. The

principal goal of the experiment was to extract quadrupole moments and transition probabilities for the first excited states in these nuclei in order to study shape coexistence in neutron-deficient nuclei with Z>82.

A proposal for Coulomb excitation studies of light ^{198,200,202}Po isotopes (Z=84) was recently approved by the ISOLDE PAC. Development of Po beams from REX-ISOLDE is in progress. A proposal for studies of octupole properties of ^{220,222}Rn (Z=86) and ^{222,224}Ra (Z=88) nuclei in similar Coulomb excitation experiments at REX-ISOLDE has also been approved. A new proposal for studies of light Pb nuclei (Z=82) will be submitted for the next ISOLDE PAC meeting.

Mass measurements probing the N=50 shell gap

The ISOLTRAP Penning trap facility was employed to perform precision mass measurements of neutron-rich zinc isotopes including ^{81}Zn, whose mass was determined for the first time. A neutron separation energy and Q-value of ^{80}Zn, one of the waiting points for the astrophysical rapid neutron capture process, were also determined experimentally. Data can be used to precisely map astrophysical conditions and abundance of this waiting point. In addition, this measurement also confirms the robustness of the N=50 shell gap.

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 the supervision of Ari Jokinen and many students supported by HIP have participated in the construction of the device over a few years. After successful off-line and on-line testing in 2007, ISCOOL started to serve experiments in 2008. One of the highlights of ISCOOL applications in 2008 was an optical spectroscopy of $^{67-80}$Ga-isotopes. Background suppression due to ISCOOL was determined to be four orders of magnitude allowing a determination of spins, moments and isotopes shifts for isotopes of interest. Interpretation of the data is still in progress and will be reported in the future.

In addition to the scientific programme the year 2008 was a time for a new initiative, namely to start a project together with Tampere University of Technology to design a remote handling maintenance system for ISOLDE target areas. A project was initiated in spring 2008 by individual contacts resulting in a project plan, which was presented to the ISOLDE Collaboration Committee in autumn 2008.

FAIR (Facility for Antiproton and Ion Research)

Preparatory work for FAIR (Facility for Antiproton and Ion Research) has started in 2006 and has continued through 2008. The Ministry of Education has awarded HIP 1 M€ in 2008 and 1.25 M€ for 2009 towards the Finnish in-kind contributions for the construction of the FAIR facility. The main contributions will be spent for the construction of the experimental equipment within the NUSTAR Collaboration and the Superconducting Fragment Separator (SFRS). The original plan also included participation in the PANDA Collaboration. However, mainly due to the time profile of the allocated budget, a decision was made to postpone the PANDA contributions to later stages and instead focus all Finnish activities in the first phase of FAIR, e.g., the Super-FRS and NUSTAR experiments. The start of the commissioning of the Super-FRS has been estimated to be in fall 2013.

Several industrial projects are also being worked on with the help of Finpro. They include a superconducting magnetic energy storage system (SMES), a state-of-the-art desktop computing environment with Grid capabilities and radiation hard Si-strip detector technology for the CBM detector. These activities are being carried out independently by the industrial partners and TEKES.

Technology Programme

Ari-Pekka Hameri,
Technology Programme
director

The year 2008 witnessed the first full scale LHC data challenge test for the global Grid community. This test proved that HIP along with the other collaborators, notably CSC, the Finnish IT Center for Science, were able to transfer and store up to 10 petabytes of data as part of the CMS and ALICE collaborations. The required national Grid infrastructure is in place as planned and the delay in the LHC schedule has been accommodated accordingly. Our contribution to the EU-funded EGEE-III initiative has continued with the emphasis on Grid security. New initiatives have been launched among others related to energy efficient cluster computing where the first tests have been performed to study how job allocation affects energy consumption in a Grid facility. Several collaboration initiatives with Finnish industry have been launched. Moreover the first Grid seminar course for IT students and researchers at Helsinki University of Technology was organised in spring 2008.

Antti Pirinen,
GridCluster
project leader

Physics and Cluster Computing

The Finnish Tier computing project was officially started at the beginning of 2008. This project is performed in collaboration with CSC and financially backed by the Ministry of Education to build, operate and maintain a Grid computing centre in Finland. The raison d'être of the GridCluster project is to coordinate Finnish Tier activities and to provide assistance for CMS and ALICE experiments.

Physics Computing

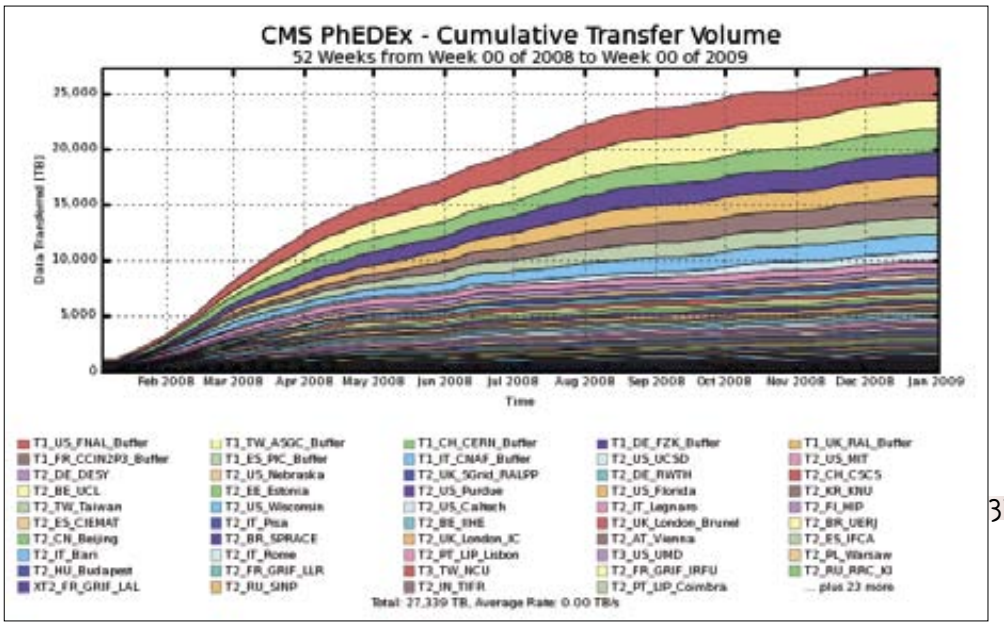
The Finnish Tier facility holds more than 700 processor cores, over 170 terabytes of disk and around 64 terabytes of tape space for the Worldwide Large Hadron Collider (LHC) Computing Grid (WLCG). The system is connected to the main hub at CERN via a 10 gigabits per second Optical Private Network (OPN). This connection is managed and maintained in close collaboration with CSC. On the software side the ARC Grid middleware has been chosen for the CMS computing and through interoperability with the gLite middleware stack the program provides the community with various services for CMS computing.

The decision to use the Nordic ARC middleware in CMS at the Finnish Tier-2 facility has led to a challenge, since the CMS software has mainly been built around the EGEE developed gLite middleware stack. The earlier interoperability work in the EGEE-II project produced only a demonstration on the interoperability between these two, and thus the researchers of the GridCluster project have been working in close contact with different parties, including EGEE-III members, Nordic DataGrid Facility (NDGF), CMS and American Grid developers, to develop and build the needed interoperability up to the level required in production use. This work was successful and HIP participated in The Common Computing Readiness Challenge of 2008 (CCRC08) in spring 2008. All improvements made by HIP's developers will be included in the official gLite middleware stack allowing wider joint gLite-ARC usage, not only for the CMS applications, but for all Grid users.

The GridCluster project has provided CMS computing with the necessary services needed to qualify for a Tier-2 centre. These services include, among others, FroNTier which provides the conditions data (i.e., detector calibration, alignment etc.) for CMS jobs, and the CMS data transfer system (PhEDEx), which has been used to transfer the physics data needed by Finnish and other CMS physics groups using computing resources located in Finland. All data transfer links from the CMS Tier-1 sites have been tested and this work has been essential in obtaining the status of being commissioned

for the Finnish Tier-2 centre. The GridCluster project has also taken care of the CMS Data Manager duties in Finland.

The project has had a representative in the Debugging Data Transfers (DDT) program in the CMS experiment. The DDT group tests and improves data transfer links between all CMS centres, which is vital for the production use of the system once LHC is operational. The GridCluster project has also operated data transfers during the CCRC08 data challenge for the CMS experiment. As a result of all the DDT and CCRC08 efforts more than 25 000 terabytes of data have been transferred between different CMS centres. The goals set for the DDT group have been met during 2008 and now the project has a representative in the new CMS Analysis Task Force in order to support distributed analysis of CMS data.



2008 CMS Data volumes transferred between Tier centres, including HIP in Finland.

Finnish Cluster Activities

The GridCluster project has been continuing its industrial and academic collaboration in Finland. The main partner has been CSC. Consequently HIP has offered its expertise in Grid security to help, support and develop CSC's Grid services. This collaboration has produced a prototype for a nationwide user certificate infrastructure for academic research. The system will lower the threshold for Grid use, which hopefully will have a positive impact on Grid utilisation. In addition to this, there have been other intangible benefits of the collaboration, which include increased communication between the parties, and ideas for further work.

The other important collaboration effort has been the work with the Macromolecular Structure and Assembly group of the Institute of Biology at the University of Helsinki. The main focus has been to Grid enable or to "gridify" Auto3dem, an application for studying three-dimensional structures of icosahedral viruses. Today, Auto3dem can be run in the clusters located in Finland. The Grid platform enables researchers to produce higher resolution models of viruses in less time than before. The project has gained valuable insights on how to port other than physics related scientific applications to exploit Grid resources. In addition the project has a permanent representative in the M-Grid security working group. Also the work in the national FennoGrid association has been active in disseminating Grid related news and information.

Grid Middleware Development

Miika Tuisku, DataGrid project leader

The Grid experts of the HIP Technology Programme's DataGrid project contributed towards the completion of the EGEE-II project and its successful final review. As a result of this work, the project now plays an important role in the subsequent EGEE-III project. These roles include deputy middleware manager, security middleware co-ordinator, and the work involves research, development and support for various important security components. The project continues to hold a decisive role in security middleware development through participation in the technical co-ordination groups and other technical management bodies of the project.

In EGEE-II, the software related effort of the Programme delivered the security module with the pseudo-anonymity service, which is based on controlled metadata service required

The EGEE-III project attracted numerous participants to the Istanbul conference in fall 2008.

especially by the risk averse bio-medical users. As in EGEE-II, the work in EGEE-III continues to focus on the security middleware with special emphasis on bug-fixing, hardening and upgrading software in response to user requirements. In addition, the Programme has now assumed a role in the testing and certification process of EGEE-III development work. Several important software packages have been certified and are currently in production use on the EGEE Grid.

In addition to the EU projects, Grid security research activities have continued under the NorduGrid collaboration, mainly in the Nordunet co-funded NGIn project (Innovative tools and services for NorduGrid). Within this scope an implementation of a prototype of a novel Grid security component was initiated. Once ready it will considerably speed up the distribution of Grid certificate revocation information and makes authentication of Grid users and services more reliable. During 2009, the aim is to incorporate the component into the ARC Grid middleware distribution.

Grid Applications and Industrial Collaboration Projects

The Programme has continued to integrate Grid security components with new technology standards providing new use cases benefiting both academic and industrial users. Research on digital identities for persons has already produced publications and the work continues in 2009. The key focus areas are related to strong authentication and single sign-on in environments supporting large numbers of devices like mobile phones. The digital identities for hosts, services and other entities will also be included in the research.

A new issue arising in high performance and cluster computing is energy consumption. When taking into account the whole lifetime of the hardware the electricity costs can easily exceed the initial investment costs. Inspired by this the Programme started a new research track on green computing. The practical aim is to develop software tools and operational practices to reduce energy used in Grid computing clusters and in this way to enable more energy efficient computing of the LHC data. Our initial studies on green computing aspects in a Grid computing cluster showed that optimising the system configuration can both decrease energy consumption and increase the total efficiency. In fact these tests showed that the savings can reach up to 25% during high load. In 2009 this research will be one of the focus areas of the Programme.

Research on applying Grid technologies to the mobile Internet led to several publications. The goal of this research is to apply Grid technologies to mobile applications and to make ap-

Tampere University of Technology delegation visits CERN prior to joining HIP in 2009.

plication development easier. The work has been done in co-operation with the Department of Communications and Networking at Helsinki University of Technology (HUT). Moreover one concrete Grid computing application in the Programme was data analysis using Semantic Web/Grid technologies. This research aims to develop novel methods for analysing data stored on the Internet by combining the computing power of the Grid with intelligent methods of the Semantic Web.

Collaboration

The exploitation of emerging new innovations around Grid and Cloud technologies requires close collaboration with industry and other research organizations. The fact that Tampere University of Technology (TUT) joined the Helsinki Institute of Physics in late 2008 opened new possibilities both for research and industrial collaboration in Finland. Initially the projects with TUT in 2009 will focus on Web/Grid security, tools and methods for interactive Grid/Cloud computing, Grid for signal processing, and green computing. The Technology Programme will continue to collaborate with several IT business experts in both academia and industry. These partners most likely include the Helsinki Institute of Information Technology (HIIT), the Technical Research Centre of Finland (VTT), Lappeenranta Technology Business Research Center (TBRC), the University of Lausanne HEC, Ecole Polytechnique Fédérale de Lausanne (EPFL), the Canton of Geneva, CERN Openlab and the Finpro Big Sciences unit. We also welcome the opening of Nokia's new research lab at the EPFL campus in Lausanne, not far from CERN, as a prospective Finnish partner.

The Programme has started its first collaboration activities with the GSI-FAIR particle physics centre in Germany by joining in an EU proposal co-ordinated by GSI-FAIR. The planned activities include development of data security and data management activities for the future FAIR accelerator. With the close ties between the IT-department of the Canton of Geneva and CERN, HIP Technology Programme has collaborated and helped to scout potential open source solutions to be used in the canton. These include areas such as eGovernment, secure remote access and server based solutions for language laboratories which overlapped with the group's domain of expertise. The Programme also contributed to medical Grid research together with the University Hospital of Geneva.

CLOUD

Background

Markku Kulmala, CLOUD project leader

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 an 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 the 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 2008 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 a 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 optimising 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 the formation of over 2 nm ions, this occurs when sulphuric acid concentrations are at their 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.

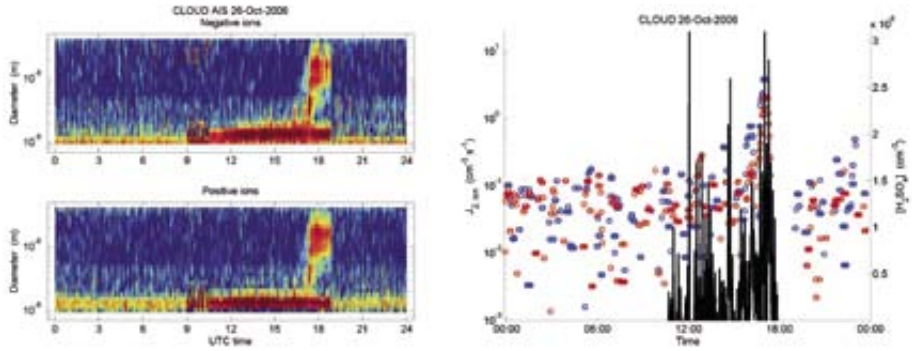


Figure 1. Formation event of charged particles (left) and simultaneous sulphuric acid measurements (right). Formation rate of ions (indicated in the plot on the right with blue and red marks for negative and positive ions, respectively) increases at the same time as sulphuric acid concentration rises.

On ion induced nucleation. Interestingly we were able to observe different kinds of new particle formation events (see Figure 2). Some of the events are related to ion induced nucleation and ion-ion recombination to form neutral clusters. In these cases, about 20–60% of new particle formation can be explained by ion processes. However, during some nucleation events less than 1% of new particle formation can be explained by ion processes.

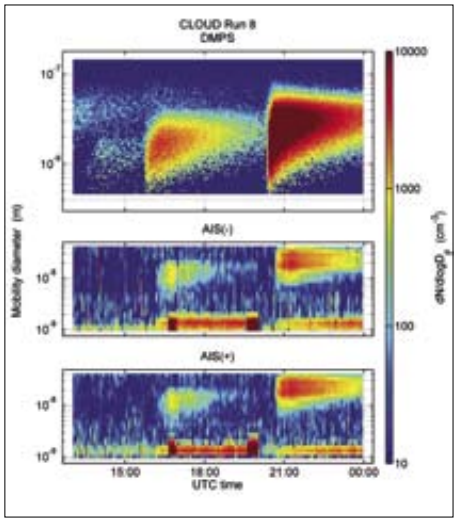


Figure 2. Two separate nucleation events measured using SMPS (upper panel) and AIS (lower two panels). During the first event ion processes are substantial, but negligible in the second event.

Instrument design and development

The design work and instrument development for the second generation CLOUD detector have mostly been finished during 2008. The construction of the reaction is now starting on the PS accelerator T11 beam line. Data taking will start in May 2009. The new reactor is a ca 27 m^3 cylindrical stainless steel chamber equipped with gas supply systems, UV light sources, field cage, mixing fans and thermal housing. The reactor is designed to cope with slight over pressure as well as sudden pressure drops allowing cloud droplet activation experiments by adiabatic expansion. Gas detectors, and particle and ion detectors as well as sensors for temperature, pressure etc. will be integrated in the reaction chamber. 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 par-

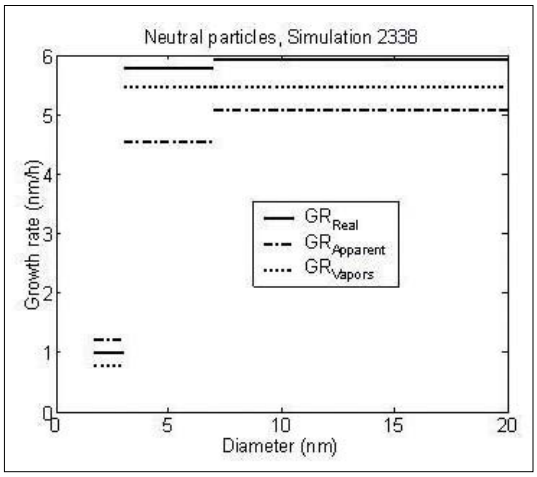
ticles to study aerosol and cloud processes. With the CLOUD detector the full scale of atmospheric conditions (from the boundary layer to the upper troposphere) can be simulated. A π/μ secondary beam from CERN PS will be used as an artificial source of cosmic rays. The physical processes to be studied 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 which will 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 and Neutral cluster and Air ion spectrometer (AIS and NAIS, Airel ltd., Tartu, Estonia) development and laboratory testing have been continuing in close co-operation with the University of Tartu (Asmi et al., 2009). A prototype instrument for operation at the low pressures and low temperatures of the final reactor chamber has been constructed and tested on board a jet aircraft in upper tropospheric conditions. This instrument will be applied in the 2009 CLOUD experiment.

Besides ion spectrometers a lot of effort has been put on the evolution of condensation based aerosol particle detectors with an aim to extend the detectable particle size range towards molecular sizes. By the end of the year 2008 this size range had been extended from ca 2 nm down to molecular sizes (Sipilä et al., 2009). These instruments have revealed the initial steps of aerosol particle formation (Sipilä et al., 2008; Lehtipalo et al., 2008). During 2008 further tests and measurements at different field stations (Hyytiälä, Finland and Mace Head, Ireland) and laboratory facilities (UHEL, FMI and IfT Leipzig, Germany) have been performed. A completely new particle detector has been designed and constructed and is currently under laboratory tests. The Finnish team made a major contribution to this progress.

An Ion-DMPS will be deployed in future CLOUD experiments in order to assess the charging state of particle populations. The Ion-DMPS was measuring in the 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.

Figure 3. 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.



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 the growth of particles observed by the differential mobility particle sizer (DMPS) and ion spectrometers (AIS, NAIS, BSMA), see Figure 3. In the future, we will apply this model to the interpretation of experimental results from the CLOUD experiment.

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Planck

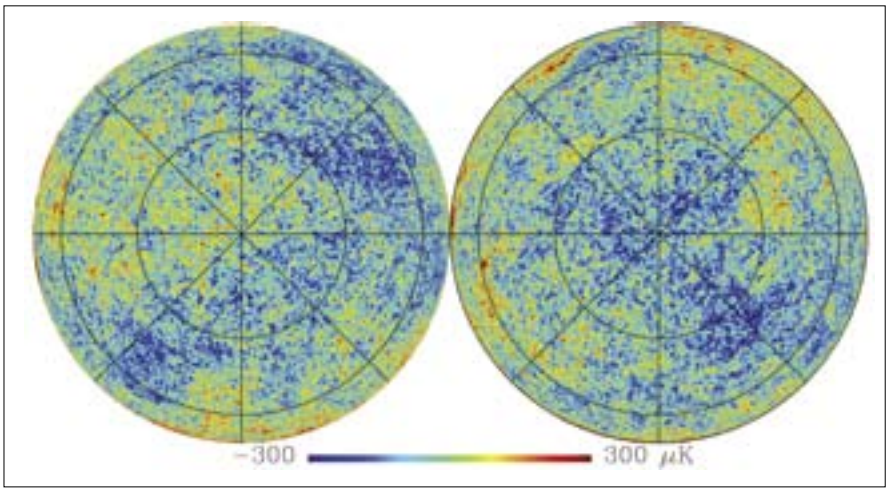
Background

Hannu Kurki-Suonio, Planck project leader

The cosmic microwave background (CMB) is radiation coming from the early universe. It was emitted when the universe was about 400 000 years old. Its intensity and polarization varies over the sky, and these variations reflect the properties and structure of the early universe as well as the later history of the universe through which this radiation has travelled.

CMB provides us with the most important observational data in cosmology. Unlike other cosmological data, where complicated astrophysics lies between the fundamental cosmological quantities and what is observed, in the CMB we observe cosmological quantities directly. The anisotropy and polarization of the CMB have a rich structure affected by many cosmological quantities. Therefore accurate CMB measurements are capable of simultaneously determining many cosmological parameters to a high accuracy.

CMB measurements are demanding because the anisotropy and polarization signals are weak. They require extremely sensitive instruments, ideal observational conditions, and sophisticated data analysis to bring out their full potential. However, the weakness of the signal is a reflection of an important property of the CMB: we are observing perturbations in the early universe, which are still small enough, so that their evolution has been linear. Thus their evolution can be calculated backwards to the original primordial perturbations generated in the very early universe. The CMB is practically the only observational window to the extremely high energy physics of the very early universe, where these seeds for the structure of the universe were generated.



Simulated 70 GHz intensity map in galactic coordinates (produced using the HEALPix software package and the Planck Reference Sky Model).

Planck is a European Space Agency (ESA) satellite whose purpose is to observe the CMB over the whole celestial sphere with high resolution and sensitivity and extensive frequency coverage. Planck is a collaboration of over 10 European countries, the U.S., and Canada.

CMB measurements are contaminated by microwave radiation from our own galaxy and extragalactic objects. To be able to remove this "foreground", the observations are carried out at nine different frequencies. While being a nuisance to cosmology, this foreground is of great interest to astronomers. The detectors for the different frequencies are divided into two instruments, the Low-Frequency Instrument (LFI: 30 GHz, 44 GHz, and 70 GHz channels), and the High-Frequency Instrument (HFI: six channels from 100 GHz to 857 GHz), which use different technologies. To achieve the high sensitivity, the instruments will be actively cooled, LFI to 20 K and HFI to 0.1 K. This limits the lifetime of the mission to a few years.

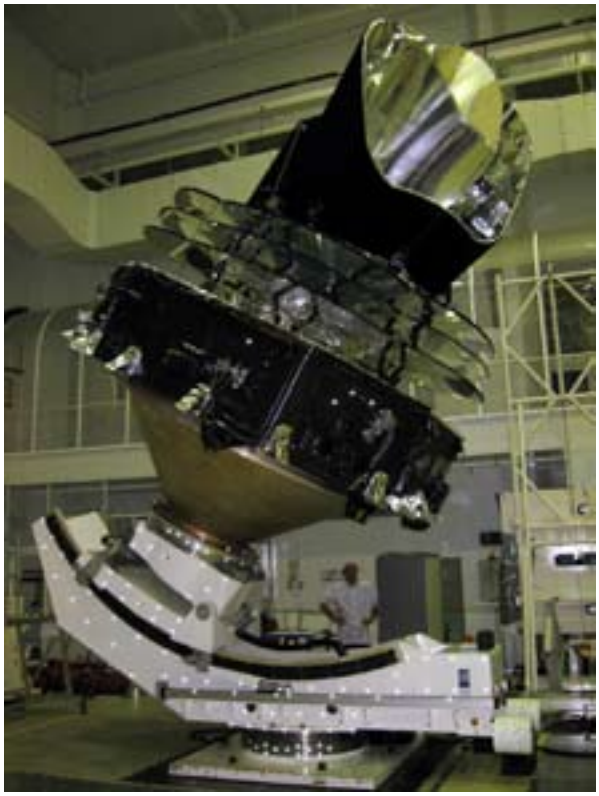
Planck will be launched in 2009. It takes about 4 months for Planck to reach its observing location, around the L2 point of the Sun-Earth system, to cool down the instruments, to calibrate them and to verify their performance. The actual observing programme (two full-sky surveys) lasts 14 months. The Planck data will be made public two

years after completion of the mission. Prior to this, during the proprietary period, the data is analysed carefully and used within the Planck collaboration to obtain the scientific results of the project. There is a possibility to extend the observing programme by two additional full-sky surveys.

A cornerstone of Finnish participation in Planck is the set of 70 GHz radiometers developed and built in Finland by Ylinen Electronics and MilliLab (VTT). This 70 GHz channel is one of the most important of the 9 frequency channels in Planck, since the foreground contamination is the smallest at this frequency.

Instrument testing

The completed Planck satellite was tested under cryogenic (near-space) conditions in Centre Spatial de Liege (CSL) during summer 2008. The test results have been carefully analysed to have a good understanding of the instrument properties, like the bandwidth and the noise spectrum.



The Planck satellite in attitude tests, March 2008 (courtesy of Thales Alenia Space and ESA).

Data analysis

The analysis begins by pre-processing and cleaning the data from various artefacts and systematic effects. The signal is then calibrated using the Doppler effect from the motion of the satellite. The outcome of this is the time-ordered data (TOD) from each detector.

Then frequency maps are constructed for each of the 9 frequency channels. Because of the extreme weakness of the signal this is a non-trivial task. A naive mapping of the TOD on the sky would be dominated by noise, and the signal has to be extracted from the data using statistical methods. Correlated noise can be removed utilizing the fact that the same point on the sky is repeatedly observed over many different timescales. To do this as well as possible requires working simultaneously with all the data pertaining to the same frequency.

In component separation, component maps (CMB and various foreground components) are extracted from the frequency maps utilizing the different frequency dependence of the components. The foreground components are then delivered to the astronomical working groups for further study.

From the CMB temperature and polarization maps, the angular power spectra are determined. Cosmological parameters are estimated from these spectra. There will be many different determinations corresponding to more restricted and more general cosmological models, with different numbers of relevant cosmological parameters. Many cosmological hypotheses will be tested this way.

If the primordial perturbations are Gaussian, all cosmological information is contained in the angular power spectra. Otherwise the CMB maps will contain additional information. Different cosmological models predict Gaussianity to a different degree; and for some models the deviation will be observable by Planck.

To model the propagation of noise and systematic errors in the data analysis sequence the correlation properties of noise have to be characterized in each step and large Monte Carlo (MC) studies with simulated data are needed.

The map-making code Madam developed by the Finnish team is the main map-making code for the LFI instrument. During 2008 the code has been further developed to take into account various realities of the actual Planck data and changes in the planned scanning strategy. The code has now also been installed at the HFI Data Processing Centre (DPC).

Significant progress has now been made in characterizing the residual noise properties in Madam maps and their pixel-to-pixel correlations.

The maps are slightly distorted due to the instrument beam shape. This also causes some signal to leak from the intensity maps to the polarization maps. Methods to remove or correct this effect either in the maps themselves (deconvolution map-making) or in their angular power spectra have been studied. For CMB studies it may be better to do this in the angular power spectra, since deconvolution map-making affects the noise properties of the maps in a complicated way.

An MC pipeline for simulating and analysing the LFI data has been under development. Currently the MC pipeline has been set up at the NERSC supercomputer centre in the U.S. and preliminary MC runs have been made there.

The first phase of the end-to-end (E2E) tests of the LFI DPC data analysis pipeline was completed in early 2008. In spring and summer 2008 much development went into the Planck simulation package to incorporate many additional systematic effects to be included in Phase 2. In fall 2008 Phase 2 "pre-simulations" were analysed at the LFI DPC to validate the simulation package.

Quick Detection System

Planck observations can be used to detect interesting events in point sources such as active galactic nuclei (AGNs), but only if the data are analysed as they become available, typically within a few days of transmission to Earth. This is because AGNs are rapidly variable, in the timescale of a few days to a few weeks. However, the Planck data will be analysed according to a considerably slower schedule, optimised for the CMB signal. Also the first, preliminary point source catalogue, the Early Release Compact Source Catalog (ERCSC) will be released only approximately nine months after the first full sky observation cycle has been completed. To accomplish the detection of rapid events in AGNs, a software package called the Quick Detection System (QDS) was developed. QDS will analyse the Planck time-ordered data stream daily to detect point sources, by filtering the data with a filter defined by the Mexican hat wavelet (MHW). An alert for virtually simultaneous multifrequency follow-up observations at other frequencies, with both ground-based and spaceborne instruments, can then be triggered if the detection of the source was found to be interesting enough according to pre-defined criteria given to the software. The software has been developed at Metsähovi Radio Observatory, Helsinki University of Technology (TKK), in co-operation with Tuorla Observatory, University of Turku.

The software was integrated into the Planck LFI DPC in 2006. After that, some features and enhancements have been added. In 2008 the MHW2 filter was also tested, but it turned out not to be as good as the MHW. The software will be further tested and modified as needed before launch, and also as soon as satellite data are available.

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 at 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 2004–2008 35 doctoral degrees and 64 Masters' degrees have been earned in HIP research projects.

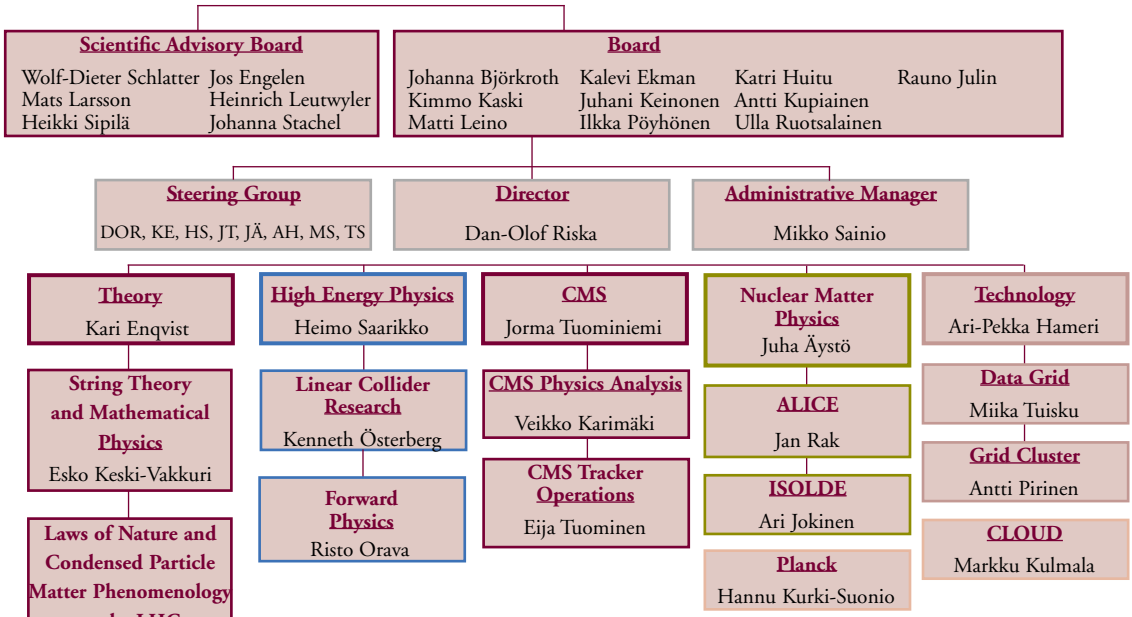
The National Board of Education (Opetushallitus) has continued its collaboration with HIP and the municipality of Jyväskylä in the CERN co-operation high school network and the collaboration with the city of Tampere in the TekNatur/CERN network for Swedish speaking high school students. The aim is to develop the role of subatomic physics in school curricula in co-operation with CERN. In 2008 this programme attracted 303 Finnish students and 44 of their teachers. A related programme has been to bring high school physics teachers to CERN. They participate in continuing education courses. In 2008, 32 teachers participated in this programme. These visits have generated considerable coverage in local newspapers all over the country: about 30 articles in total in 2008.

In 2008 Tampere University of Technology joined HIP as a partner university. However, TUT students have been participating in HIP activities 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: Pöyhönen, Huitu, Keinonen, Björkroth, Leino, Ekman, Keskinen (substitute member), Kupiainen.

The Institute Board

Chairman	**Johanna Björkroth,** Vice Rector (University of Helsinki)
Vice Chairman	**Kalevi Ekman,** Vice Rector (Helsinki University of Technology)
Members	**Katri Huitu,** Professor (Chosen by personnel of HIP)
	Rauno Julin, Professor (University of Jyväskylä)
	Kimmo Kaski, Professor (Helsinki University of Technology)
	Juhani Keinonen, Professor (University of Helsinki)
	Antti Kupiainen, Professor (University of Helsinki)
	Matti Leino, Vice Rector (University of Jyväskylä)
	Markku Lukka, Rector (until 31.7.2008) (Lappeenranta University of Technology)
	Ilkka Pöyhönen, Rector (starting 1.8.2008) (Lappeenranta University of Technology)
	Ulla Ruotsalainen, Dean (starting 13.11.2008) (Tampere University of Technology)

The Scientific Advisory Board

Chairman: Wolf-Dieter Schlatter, Professor (CERN)

Members:

Jos Engelen, CSO (CERN)

Mats Larsson, Professor (U. Stockholm)

Heinrich Leutwyler, Professor (U. Bern)

Heikki Sipilä, Chief Scientist (Oxford Instruments Analytical Oy)

Johanna Stachel, Professor (U. Heidelberg)

Personnel

Theory Programme

K. Enqvist, prof., programme director
C. Cronström, prof., adj. senior scientist
K. Kajantie, prof., adj. senior scientist
O. Dannenberg, grad. student
J. Koponen, grad. student

Cosmophysics

K. Kainulainen, docent, proj. leader
D. Battefeld, scientist
V. Marra, scientist
D. Podolsky, scientist
G. Rigopoulos, scientist
A. Ferrantelli, grad. student
M. Herranen, grad. student
J. Högdahl, grad. student
T. Mattsson, grad. student
L. Mether, grad. student
V. Muhonen, grad. student
S. Nurmi, grad. student
P. Rahkila, grad. student
V. Reijonen, grad. student
M. Ronkainen, grad. student
D. Sunhede, grad. student
J. Virkajärvi, grad. student

Laws of Nature and Condensed Particle Matter Phenomenology at the LHC

K. Tuominen, docent, proj. leader
K. J. Eskola, prof., adj. senior scientist
P. Hoyer, prof., adj. senior scientist
K. Huitu, prof., adj. senior scientist
J. Maalampi, prof., adj. senior scientist
O. Antipin, scientist
S. K. Rai, scientist
K. Rao, scientist
T. Renk, scientist
M. Antola, grad. student
J. Auvinen, grad. student
M. Heikinheimo, grad. student
A. Hietanen, grad. student
T. Honkavaara, grad. student
T. Karavirta, grad. student
T. Kähärä, grad. student
L. Leinonen, grad. student
H. Paukkunen, grad. student
T. Rüppell, grad. student
A. Sabanci, grad. student
P. Tiitola, grad. student

String Theory and Mathematical Physics

E. Keski-Vakkuri, docent, proj. leader
M. Chaichian, prof., senior scientist
M. Arai, scientist
S. Kawai, scientist
J. Majumder, scientist
N. Uekusa, scientist
J.-T. Yee, scientist
K. P. Yogendran, scientist
S. Nowling, adj. scientist
A. Tureanu, adj. scientist
N. Jokela, grad. student

Low Dimensional Quantum Systems

A. Harju, docent, proj. leader
E. Tölö, student
C. Webb, student

Radiation Damage in Particle Accelerator Materials

K. Nordlund, prof., proj. leader
F. Djurabekova, scientist
O. Pakarinen, adj. scientist
M. Backman, student
E. Holmström, student

High Energy Physics Programme

H. Saarikko, prof., programme director

Forward Physics

R. Orava, prof., proj. leader
F. García, scientist
N. van Remortel, adj. scientist
K. Kurvinen, lab. engineer
T. Aaltonen, grad. student
E. Brücken, grad. student
T. Hilden, grad. student
P. Mehtälä, grad. student
T. Mäki, grad. student
J. Petäjäjärvi, student (at CERN)

Linear Collider Research

K. Österberg, docent, proj. leader
J. Huopana, grad. student
F. Oljemark, grad. student
R. Nousiainen, researcher

Detector Laboratory

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

CMS Programme

J. Tuominiemi, prof., programme director
P. Eerola, prof., vice director

CMS Physics Analysis

V. Karimäki, docent, proj. leader
R. Kinnunen, senior scientist
K. Lassila-Perini, senior scientist (at CERN)
S. Lehti, senior scientist
T. Lindén, senior scientist, grid coordinator
T. Lampén, scientist
M. Voutilainen, scientist (at CERN)
A. Heikkinen, grad. student
P. Kaitaniemi, grad. student (in Saclay)
M. Kortelainen, grad. student
L. Wendland, grad. student
I. Helenius, summer trainee (at CERN)

CMS Tracker Operations

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
T. Mäenpää, grad. student
E. Tuovinen, grad. student
E. Anttila, engineer (at CERN)
J. Kortesmaa, lab. technician (at CERN)
M. Maksimow, student
H. Moilanen, student
H. Viljanen, student
J. Huusko, summer trainee (at CERN)
P. Virtanen, summer trainee (at CERN)

Nuclear Matter Programme

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

ALICE

J. Rak, proj. leader
S. Räsänen, scientist
R. Diaz Valdes, grad. student
T. Kalliokoski, grad. 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)
T. Niemi, senior scientist, coordinator (at CERN)
J. White, senior scientist (at CERN)
J. Hahkala, scientist (at CERN)
A. Krüger, scientist (at CERN)
H. Mikkonen, scientist (at CERN)
M. Punceva, scientist (at CERN)
V. Ryynänen, scientist (at CERN)
M. Niinimäki, adj. scientist (at CERN)
M. Pitkänen, grad. student
M. Silander, grad. student
M. Bärlund, student (at CERN)
K. Defée, student
T. Eloranta, student
J. Kommeri, student (at CERN)
K. Lundahn, student
V. Pankakoski, student
O. Porkka, student
I. Stenberg, student

GridCluster

A. Pirinen, proj. leader
J. Klem, senior scientist (at CERN)
J. Dahlblom, scientist
K. Happonen, scientist (at CERN)
J. Koivumäki, student
M. Närjänen, student

CLOUD

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

Planck

H. Kurki-Suonio, docent, proj. leader
A. Lähteenmäki, adj. senior scientist
T. Poutanen, scientist
R. Keskitalo, 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)
K.-M. Karttunen, secretary (starting 1.5.)
P. Lehto, secretary (until 2.4.)
A. Heikkilä, tech. coordinator (at CERN)
R. Rinta-Filppula, researcher (at CERN)
J. Aaltonen, lab. engineer
K. Hanhijärvi, lab. engineer (3.3. - 14.8.)

Seminars

Seminars held in Helsinki

January 15th K. Tuominen (U. of Jyväskylä and HIP)
Technicolor - a competitive mechanism for electroweak symmetry breaking

January 22nd S. Nowling (HIP)
Entanglement entropy in Chern-Simons field theories

January 29th V. Reijonen (HIP)
Static, spherically symmetric spacetimes in f(R) gravity models

February 12th T. Tahkokallio (HIP)
Applications of AdS/CFT duality to heavy ion collisions

February 26th T. Marrodan Undagoitia (Technische Universität München, Germany)
Lena: a multipurpose detector for low energy neutrino astronomy

March 11th A. Ali (Desy, Germany)
Theoretical interest in B-meson physics at the B factories, Tevatron and the LHC

March 14th H. Kurki-Suonio (FL and HIP)
WMAP 5-year results

March 18th T. Battefeld (Princeton U., USA)
Non-Gaussianities in multi-field inflation

March 25th A. Lytle (U. of Washington, USA)
Nonperturbative renormalization using staggered quarks

April 15th S. Nurmi (U. of Helsinki)
Inflation in the Minimal supersymmetric standard model

April 22nd M. Krusius (Helsinki U. of Technology)
Condensed matter hype: cosmic strings from brane annihilations?

April 29th S. J. Brodsky (SLAC, Stanford, USA)
Hadron phenomenology from AdS/QCD

May 9th S. Räsänen (U. of Geneva, Switzerland)
The effect of structure formation on the expansion of the universe

May 15th S. Kwan (Fermilab, USA)
CMS Tracker and the upgrade plan

May 15th S. Hands (Swansea, UK)
Two color matters

May 16th V. Jejjala (IHES, France)
SQCD: a geometric aperçu

May 20th F. Larsen (U. of Michigan, USA and CERN, Switzerland)
The non-supersymmetric black holes in four dimensions

May 22nd R. G. Leigh (U. of Illinois at Urbana-Champaign, USA)
Mottness and strong coupling

May 26th K. Ghosh (Ahmedabad, India)
Unparticles and some collider related phenomenology

May 29th K. P. Yogendran (Hanyang U. and CQUeST, Republic of Korea)
"Winding" strings in the 2-D Lorentzian black hole

June 2nd A. Vuorinen (CERN, Switzerland)
QCD-like heavy-light spectrum from AdS/CFT

June 3rd C. E. Carlson (The College of William & Mary, Virginia, USA)
Gravitational form factors of mesons in an AdS/QCD model

June 17th D. Abbaneo (CERN, Switzerland)
LHC and its detectors: the frontier of particle physics

June 24th E. Keski-Vakkuri (FL and HIP)
AdS/QHE

July 2nd S. Terashima (Kyoto, Japan)
On membrane actions

September 9th S. Roy (IACS, Kolkata, India)
Neutrino masses and mixing in a TeV scale SUSY seesaw model

September 18th M. Shifman (William I. Fine Theoretical Physics Institute, U. of Minnesota, USA)
Supersymmetry and how it helps us understand strong interactions

September 23rd S. Saxell (FL)
On general properties of Lorentz-invariant formulation of noncommutative quantum field theory

September 29th A. Niemi (Uppsala U., Sweden, LMPT, Tours, France, and CIM, China)
Gauge theory approach to protein folding landscape

September 30th T. Paananen (FL)
Superfluid Fermi gas in optical lattices

October 14th K. Hämäläinen (FL)
From pictures to movies - in situ studies of structural dynamics with future radiation sources

October 28th T. Prokopec (Utrecht U., the Netherlands)
Cosmological constant and quantum backreaction

November 11th A. Kundu (U. of Calcutta, Kolkata, India)
Universal extra dimensions

November 18th K. Hashimoto (RIKEN, Japan)
Toward a proof of Montonen-Olive duality via multiple M2-branes

November 25th K. Tuominen (U. of Jyväskylä and HIP)
Walking Technicolor on the lattice

December 2nd L. Mether (HIP)
Leptogenesis: the correct way of creating the net baryon number of the Universe?

December 9th E. Keski-Vakkuri (FL and HIP)
Issues of string theory

December 16th M. Valtonen (U. of Turku)
Tests of general relativity under strong fields

Visitors

Theory Programme

Cosmophysics

S. Kasuya (Japan) 31.1.
S. Katsanevas (France) 31.1.
K. Nakayama (Japan) 22.2.-4.3.
T. Sekiguchi (Japan) 22.2.-4.3.
T. Battefeld (USA) 29.2.-26.3., 4.-8.8.
S. Räsänen (Switzerland) 9.4.
C. Burgess (Canada) 1.-3.5.
T. Takahashi (Japan) 18.6.
A. Tranberg (Finland) 12.-15.8.
T. Prokopec (the Netherlands) 27.-31.10.

Laws of Nature and Condensed Particle Matter Phenomenology at the LHC

K. Österberg (Finland) 1.2.
D. Rischke (Germany) 11.-22.2.
A. Tranberg (Finland) 12.-13.2.
A. Kurkela (Finland) 25.-27.2.
S. Peigne (France) 14.4.-4.5.
S. Brodsky (USA) 27.4.-4.5.

Hadron Physics Activity

C. S. An (China) 25.1.-18.4.
V. Abaev (Russia) 10.3.-11.4., 27.10.-22.11.
C. Carlson (USA) 2.-5.6.
O. W. Greenberg (USA) 31.7.-5.9.

String Theory and Mathematical Physics

M. Arai (Republic of Korea) 1.1.-29.2.
G. Zet (Romania) 1.3.-30.4.
A. Ali (Germany) 10.-15.3.
M. Mnatsakanova (Russia) 3.-28.4., 3.11.-13.12.
Y. Vernov (Russia) 3.-28.4., 3.11.-13.12.
M. Järvinen (Denmark) 13.-20.5.
R. G. Leigh (USA) 15.-23.5.
F. Larsen (USA and CERN) 18.-21.5.
N. Pidokrajt (Sweden) 19.5.
J. Louko (UK) 25.-31.5.
K. P. Yogendran (Republic of Korea) 25.5.-5.6.
S. Ghosh (India) 4.-18.6.
A. Naqvi (UK) 23.-26.6.
S. Terashima (Japan) 26.6.-3.7.
L. Laperashvili (Russia) 15.9.-14.10.
K. Hashimoto (Japan) 16.-26.11.
B. Aneva (Bulgaria) 21.11.-6.12.

High Energy Physics Programme

Detector Laboratory

R. Brenner (Sweden) 24.-28.11.
M. Moll (Switzerland) 1.-3.12.
L. Spiegel (USA) 1.-4.12.

CMS Programme

CMS Physics Analysis

D. Abbaneo (Switzerland) 16.-18.6.
L. Salmi (Finland) 5.-7.11.
R. Brenner (Sweden) 24.-28.11.
M. Moll (Switzerland) 1.-3.12.
L. Spiegel (USA) 1.-3.12.

CMS Tracker Operations

D. Abbaneo (Switzerland) 15.-18.6.
U. Parzefall (Germany) 29.10.-1.11.

Conference participation, Talks and Visits by Personnel

Theory Programme

Cosmophysics

20th Nordic Particle Physics Meeting,
3-7 January, Spåtind, Norway (talk by J. Virkajärvi)

2nd Asian Winter School on String Theory,
15-25 January, Kusatsu-Machi, Agatsuma-Gun Gunma, Japan (talk by V. Muhonen)

Department of Astronomy, University of Helsinki,
22 January, Helsinki, Finland (talk by T. Mattsson)

LPT - Paris XI Orsay,
27 January - 5 February, Paris, France (talk by D. Podolsky)

University of Jyväskylä,
28-30 January, Jyväskylä, Finland (talk by T. Mattsson)

Institute of Cosmic Ray Research, University of Tokyo,
28-30 January, Tokyo, Japan (talk by V. Muhonen)

Yukawa Institute for Theoretical Physics, University of Kyoto,
31 January - 8 February, Kyoto, Japan (V. Muhonen)

University of Oxford,
3-6 February, Oxford, UK (talk by T. Mattsson, M. Ronkainen)

ICTP,
25 March - 4 April, Trieste, Italy (S. Nurmi)

The Annual Meeting of the Finnish Physical Society,
27-29 March, Turku, Finland (M. Herranen, K. Kainulainen, P. M. Rahkila, talks by A. Ferrantelli and J. Virkajärvi)

University of Jyväskylä,
11-12 April, Jyväskylä, Finland (talk by S. Nurmi)

University of Durham,
13-15 April, Durham, UK (talk by V. Reijonen)

University of Jyväskylä,
14-17 April, Jyväskylä, Finland (talk by A. Ferrantelli)

University of Sheffield,
16-18 April, Sheffield, UK (talk by V. Reijonen)

PONT d'Avignon 2008 - Progress on Old and New Themes in Cosmology,
21-25 April, Avignon, France (L. Mether, G. Rigopoulos)

Franco-Japanese Conference on Cosmology,
16-18 May, Nikko, Japan (talk by D. Battefeld)

PLANCK 2008 - From the Planck Scale to the ElectroWeak Scale,
19-23 May, Barcelona, Spain (talks by A. Ferrantelli and D. Podolsky)

First Finnish Cosmophysics Meeting,
22-23 May, Turku, Finland (K. Enqvist, talk by M. Herranen, talk by K. Kainulainen, talk by T. Mattson, L. Mether, V. Muhonen, talk by S. Nurmi, P. Rahkila, V. Reijonen, talk by G. Rigopoulos, talk by M. Ronkainen)

Lancaster University,
8-20 June, Lancaster, UK (talk by A. Ferrantelli)

CERN,
10 June - 12 August, 1-15 September, 7-24 November, Geneva, Switzerland (L. Mether)

Summer School, Theory and Particle Physics: the LHC perpective and beyond,
15 June - 29 July, Cargese, France (talk by D. Battefeld)

International Conference RUSGRAV-13,
23-25 June, Moscow, Russia (talk by D. Podolsky)

Sheffield Summer Institute,
26 June - 7 July, Sheffeld, UK (V. Reijonen)

International Conference Dark Energy and Dark Matter,
6-7 July, Lyon, France (T. Mattsson)

London Imperial College,
8 July, London, UK (talk by V. Reijonen)

ICTP Summer School in Cosmology,
21 July - 1 August, Trieste, Italy (S. Nurmi)

Nordita Summer School on de Sitter Cosmology,
10-14 August, Nordita, Stockholm, Sweden (V. Reijonen)

Strings 2008,
17-23 August, CERN, Geneva, Switzerland (L. Mether, D. Podolsky)

Cosmo 08,
23-28 August, Madison, WI, USA (talks by D. Battefeld, L. Mether, S. Nurmi and D. Sunhede)

Strong and ElectroWeak Matter 2008,
26-29 August, Amsterdam, the Netherlands (M. Herranen, talk by K. Kainulainen, P. M. Rahkila)

DAMTP, University of Cambridge,
1-10 September, Cambridge, UK (G. Rigopoulos)

Non-Gaussianity from Fundamental Physics Workshop,
10-12 September, DAMTP, University of Cambridge, UK (talk by G. Rigopoulos)

Lancaster University,
14-21 September, Lancaster, UK (A. Ferrantelli)

APC,
15 September - 15 December, Paris, France (D. Battefeld)

Second UniverseNet Meeting and Mid Term Review,
22-27 September, Oxford, UK (talk by D. Battefeld, K. Enqvist, talk by A. Ferrantelli, talk by L. Mether, talk by S. Nurmi, talk by V. Reijonen, talk by G. Rigopoulos)

University of Tokyo and University of Kyoto,
20 November - 4 December, Tokyo and Kyoto, Japan (talk by G. Rigopoulos)

Princeton University,
15 December - 31 January 2009, Princeton, NJ, USA (D. Battefeld)

Laws of Nature and Condensed Particle Matter Phenomenology at the LHC

20th Nordic Particle Physics Meeting,
3-7 January, Spåtind, Norway (K. Huitu, talk by H. Paukkunen, talk by S. K. Rai, K. Tuominen)

STAR Collaboration Meeting,
28 January - 2 February, Mumbai, India (T. Renk)

PDF4LHC Meeting,
22-23 February, CERN, Geneva, Switzerland (talk by H. Paukkunen)

Lecture Week of European Graduate School HANUC ("Complex Systems of Hadrons and Nuclei"),
3-7 March, Copenhagen, Denmark (M. Antola, M. Heikinheimo, P. Hoyer)

3rd International Workshop on High-pT Physics at LHC,
16-19 March, Tokaj, Hungary (J. Auvinen, H. Paukkunen, talk by K. J. Eskola)

The Annual Meeting of the Finnish Physical Society,
27-29 March, Turku, Finland (K. J. Eskola, T. Honkavaara, talk by K. Huitu, talk by T. Kähärä, talk by H. Paukkunen)

TECHQM Meeting,
5-8 May, Brookhaven National Laboratory, Upton, NY, USA (T. Renk)

Workshop on Hadron Electromagnetic Form Factors,
11-17 May, ECT*, Trento, Italy (talk by P. Hoyer)

Prague University,
22-24 May, Prague, Czech Republic (talk by T. Renk)

GSI,
27 May, Darmstadt, Germany (talk by P. Hoyer)

TeV Scale Physics and Dark Matter,
1 June - 31 July, Nordita, Stockholm, Sweden (K. Huitu, L. Leinonen, talk by S. K. Rai, talk by T. Rüppell)

Nuclear Medium Effects on the Quark and Gluon Structure of Hadrons,
3-7 June, Trento, Italy (talk by H. Paukkunen)

University of Jyväskylä,
4-6 June, 13-15 October, Jyväskylä, Finland (M. Antola)

Hard Probes 2008,
8-14 June, Illa da Toxa, Spain (talk by T. Renk)

Workshop on Hard Exclusive Reactions,
9-13 June, ECT*, Trento, Italy (talk by P. Hoyer)

Nordic Workshop on LHC and Beyond,
12-14 June, Albanova, Stockholm, Sweden (K. Huitu, talk by S. K. Rai, T. Rüppell)

SUSY 08,
16-21 June, Seoul, Republic of Korea (T. Honkavaara, talk by S. K. Rai, T. Rüppell)

ECT* Doctoral Training Programme 2008: Nuclear Matter under Extreme Conditions,
16 June - 7 July, Trento, Italy (J. Auvinen)

Mini-Workshop on Hot and Dense QCD,
26-28 June, Oulu, Finland (talk by K. Kajantie, talk by K. Tuominen)

PKU-RBC Workshop on Transverse Spin Physics,
30 June - 4 July, Peking University, Beijing, China (talk by P. Hoyer)

PSI Zuoz Summer School on New Ideas in Particle Physics,
14-18 July, Zuoz, Switzerland (M. Heikinheimo)

Lattice 2008,
14-19 July, College of William and Mary, Williamsburg, VA, USA (talk by A. Hietanen)

Lecture Week of European Graduate School HANUC ("Complex systems of Hadrons and Nuclei"),
25-29 August, Jyväskylä, Finland (talk by M. Heikinheimo, talk by P. Hoyer, talk by T. Kähärä, talk by K. Tuominen)

Strong and ElectroWeak Matter,
26-29 August, Amsterdam, the Netherlands (K. Kajantie)

Workshop of the European Network SIM (I3H),
8-12 September, Villasimius, Sardinia, Italy (talk by K. J. Eskola)

Workshop on Dynamical Electroweak Symmetry Breaking,
9-13 September, Odense, Denmark (M. Antola, M. Heikinheimo)

Workshop on the LHC and Related Physics RECAPP,
25 September - 1 October, Allahabad, India (talk by S. K. Rai)

Physics at LHC,
29 September - 1 October, Split, Croatia (talk by K. Huitu)

Tata Institute of Fundamental Research,
20-22 October, Mumbai, India (talk by S. K. Rai)

Finnish Physical Society, Particle Physics Day,
24 October, Helsinki, Finland (talk by T. Honkavaara)

University of Southern Denmark (SDU),
26 October - 5 November, Odense, Denmark (M. Antola, M. Heikinheimo)

University of Santiago de Compostela,
17-21 November, Santiago de Compostela, Spain (talk by H. Paukkunen)

Johann Wolfgang Goethe University,
4 December, Frankfurt am Main, Germany (talk by T. Renk)

University of Oulu,
8-10 December, Oulu, Finland (K. Tuominen)

SLAC,
8-11 December, Menlo Park, CA, USA (talk by P. Hoyer)

Technical University of Munich,
10 December, Munich, Germany (talk by T. Renk)

LBNL,
12-19 December, Berkeley, CA, USA (talk by P. Hoyer)

Hadron Physics Activity

Institute of Theoretical Physics, University of Bern,
27-28 February, Bern, Switzerland (M. Sainio)

The Annual Meeting of the Finnish Physical Society,
27-29 March, Turku, Finland (M. Sainio)

From Quarks to the Nuclear Many Body Problem,
21-24 May, Oslo, Norway (talk by D. O. Riska)

FlaviAnet Kaon Workshop,
12-14 June, Anacapri, Italy (M. Sainio)

International Conference on Exotic Atoms and Related Topics (EXA08),
15-18 September, Vienna, Austria (M. Sainio)

ECT* - A Fifteen Year Perspective,
24-25 September, Trento, Italy (M. Sainio)

String Theory and Mathematical Physics

Séminaire Transalpin de Physique,
10-15 February, Valpré, Lyon, France (invited lecture by A. Tureanu)

LPTHE, Universite Paris 6,
22-28 February, Paris, France (invited seminar by E. Keski-Vakkuri)

Workshop on "The geometry and integrability of topological QFT and string theory", University of Warwick,
30 March - 6 April, Coventry, UK (S. Kawai)

University of California,
2-6 June, Los Angeles, CA, USA (seminar by E. Keski-Vakkuri)

California Institute of Technology,
4 June, Pasadena, CA, USA (seminar by E. Keski-Vakkuri)

CERN,
29 June - 2 July, Geneva, Switzerland (M. Chaichian)

Yukawa Institute, University of Kyoto,
22 July - 4 August, Kyoto, Japan (S. Kawai)

Workshop "Aspects of Quantum Integrability", Yukawa Institute, University of Kyoto,
24-25 July, Kyoto, Japan (talk by S. Kawai)

Workshop "Developments of Quantum Field Theory and String Theory", Yukawa Institute, University of Kyoto,
28 July - 1 August, Kyoto, Japan (talk by S. Kawai)

34th International Conference on High Energy Physics (ICHEP08),
28 July - 2 August, Philadelphia, PA, USA (M. Chaichian)

34th International Conference on High Energy Physics (ICHEP08),
29 July - 5 August, Philadelphia, PA, USA (A. Tureanu)

New York University,
2-6 August, New York, NY, USA (M. Chaichian)

27th International Colloquium on Group Theoretical Methods in Physics,
13-20 August, Yerevan, Armenia (talk by A. Tureanu)

27th International Colloquium on Group Theoretical Methods in Physics,
15-18 August, Yerevan, Armenia (talk by M. Chaichian)

Strings 2008,
18-22 August, Geneva, Switzerland (S. Kawai, E. Keski-Vakkuri, S. Nowling)

Moscow State University and Russian Academy of Sciences,
1-15 September, Moscow, Russia (seminars by M. Chaichian)

Moscow State University and Russian Academy of Sciences,
4-12 September, Moscow, Russia (seminars by A. Tureanu)

International Conference on "Quantum Space-Time and Noncommutative Geometry",
29 September - 4 October, Rome, Italy (S. Saxell, invited talk by A. Tureanu)

University of Jyväskylä,
17 October, Jyväskylä, Finland (invited colloquium by E. Keski-Vakkuri)

Memorial Conference to honor Julius Wess,
5-8 November, Munich, Germany (A. Tureanu)

Memorial Conference to honor Julius Wess,
6-7 November, Munich, Germany (M. Chaichian)

NORDITA,
26 November, Stockholm, Sweden (invited talk by E. Keski-Vakkuri)

Indian Strings Meeting 2008,
6-13 December, Pondicherry, India (K. P. Yogendran)

Radiation Damage in Particle Accelerator Materials

Australian National University,
10-18 April, Canberra, Australia (F. Djurabekova, K. Nordlund)

CLIC Workshop,
18-21 May, CERN, Geneva, Switzerland (talk by F. Djurabekova)

Ion Beam Modification of Materials,
29 August - 5 September, Dresden, Germany (talk by F. Djurabekova, O. Pakarinen)

Computer Simulation of Radiation Effects in Solids,
12-17 October, Beijing, China (talks by F. Djurabekova and K. Nordlund)

Towards Reality in Simulation of Nanoscale Materials,
2-5 December, Levi, Finland (talk by F. Djurabekova, M. Backman)

High Energy Physics Programme

Forward Physics

Top Mass Meeting,
16 January, Fermilab, Batavia, IL, USA (talk by P. Mehtälä)

Top Group Meeting,
14 February, 28 February, 12 March, 2 April, 17 July, Fermilab, Batavia, IL, USA (talks by P. Mehtälä)

Fermilab CDF,
17 February - 1 March, Batavia, IL, USA (H. Saarikko)

The Annual Meeting of the Finnish Physical Society,
27-29 March, Turku, Finland (H. Saarikko)

Particle Physics Seminar Series, University of Helsinki,
4 April, Helsinki, Finland (talk by P. Mehtälä)

XVI International Workshop on Deep-Inelastic Scattering and Related Topics (DIS 08),
7-11 April, London, UK (talk by P. Mehtälä)

TOTEM Software Meetings,
10 April, 8 May, 22 May, 5 June, 23 October, CERN, Geneva, Switzerland (talks by E. Brücken)

Photon Group Meeting,
7 May, Fermilab, Batavia, IL, USA (talk by E. Brücken)

10th International Workshop on Radiation Imaging Detectors,
29 June - 3 July, Helsinki, Finland (members of the organization committee E. Brücken, P. Mehtälä, R. Orava)

Low-x Workshop 2008,
5-12 July, Kolymbari, Crete (invited talk by R. Orava)

Top Mass Group Meeting,
16 July, 10 September, 24 September, 29 October, Fermilab, Batavia, IL, USA (talks by P. Mehtälä)

34th International Conference on High Energy Physics (ICHEP08),
30 July - 5 August, Philadelphia, PA, USA (talk by P. Mehtälä, H. Saarikko)

Diffraction 2008,
9-14 September, La Londe-les-Maures, France (lecture by R. Orava)

RHIC 08',
24-28 November, Budapest, Hungary (invited talk by R. Orava)

Linear Collider Research

Colloquium, University of Jyväskylä,
1 February, Jyväskylä, Finland (talk by K. Österberg)

Forward Physics at LHC with TOTEM,
28-30 April, State College, PA, USA (talks by K. Österberg)

2nd X-Band Accelerator Structure Design and Test-Program Collaboration Meeting,
13-15 May, KEK, Tsukuba, Japan (talk by R. Nousiainen)

HERA and the LHC, 4th Workshop,
26-30 May, CERN, Switzerland (invited talk by K. Österberg)

European Committee for Future Accelerators,
18 July, DESY, Germany (invited plenary talk by K. Österberg)

CLIC'08 Workshop,
14-17 October, CERN, Switzerland (talk by J. Huopana, talks by R. Nousiainen, K. Österberg)

Finnish Physical Society, Particle Physics Day,
24 October, Helsinki, Finland (talk by K. Österberg)

EuCARD Kick-off Meeting,
5 December, CERN, Switzerland (K. Österberg)

Detector Laboratory

5th Geant4 Space Users' Workshop,
12-15 February, Tokyo, Japan (talk by F. García)

PANDA Collaboration Meeting,
3-8 March, GSI, Darmstadt, Germany, 23-27 June, Cracow, Poland (talk by F. García)

ILC Vertex Workshop,
21-24 April, Como, Italy (F. García)

EURORIB'08,
9-13 June, Giens, France (F. García, E. Tuominen)

10th International Workshop on Radiation Imaging Detectors,
29 June - 3 July, Helsinki, Finland (talk by F. García)

One day Workshop on the Finnish Contribution for the FAIR Facility,
6 October, Helsinki, Finland (co-organiser, talk by F. García, E. Tuominen)

CMS Programme

CMS Physics Analysis

20th Nordic Particle Physics Meeting,
3-8 January, Spåtind, Norway (V. Karimäki)

Joint ICTP-IAEA Advanced Workshop on Model Codes for Spallation Reactions,
4-8 February, Trieste, Italy (P. Kaitaniemi)

CEA Saclay,
4-9 February, 2-6 July, Paris, France (talks by M. Voutilainen)

Joint Experimental-Theoretical Seminar,
12-17 February, Fermilab, Batavia, IL, USA (invited talk by M. Voutilainen)

The Annual Meeting of the Finnish Physical Society,
27-29 March, Turku, Finland (P. Kaitaniemi, talk by M. Kortelainen)

XVI International Workshop on Deep-Inelastic Scattering,
7-11 April, London, UK (talk by M. Voutilainen)

Particle Physics Seminar Series, University of Helsinki,
25 April, Helsinki, Finland (talk by S. Lehti)

CEA Saclay,
13-15 May, Paris, France (M. Voutilainen)

10th International Workshop on Radiation Imaging Detectors (iWoRiD),
29 June - 3 July, Helsinki, Finland (co-organiser A. Heikkinen)

CERN School of Computing,
25 August - 5 September, Gjovik, Norway (invited talk by A. Heikkinen, M. Kortelainen)

Albanova and University of Stockholm,
7-10 September, Stockholm, Sweden (talk by P. Eerola)

NordForsk Detector Technology Course,
8-12 September, Stockholm, Sweden (M. Kortelainen)

Prospects for Charged Higgs Discovery at Colliders,
16-19 September, Uppsala, Sweden (invited talk by R. Kinnunen, talk by L. Wendland)

MSSM Higgs Mini Workshop,
6-11 October, Santander, Spain (invited talk by S. Lehti)

13th Geant4 Collaboration Workshop,
6-11 October, Kobe, Japan (talk by A. Heikkinen, talk by P. Kaitaniemi)

LHC - a Window to the Universe,
25 October, Helsinki, Finland (talk by P. Eerola)

B-tagging Workshop,
29-31 October, CERN, Geneva, Switzerland (talk by M. Voutilainen)

Kumpula Campus Colloquium,
2 December, Helsinki, Finland (invited talk by J. Tuominiemi)

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

CMS Tracker Operations

CMS Tracker Upgrade -Sensor Working Group Meeting,
8-9 February, 7 May, CERN, Geneva, Switzerland (talks by P. Luukka)

The Annual Meeting of the Finnish Physical Society,
27-29 March, Turku, Finland (talks by H. Moilanen)

3rd Workshop on Advanced Silicon Radiation Detectors (3-D and P-type Technologies),
14-16 April, Barcelona, Spain (talk by J. Härkönen, talk by P. Luukka)

12th RD50 - Workshop on Radiation Hard Semiconductor Devices for Very High Luminosity Colliders,
2-4 June, Ljubljana, Slovenia (talk by J. Härkönen, talk by P. Luukka, E. Tuominen, E. Tuovinen)

I-2008 Workshop on Cryogenic Tracking Detectors,
5-6 June, Ljubljana, Slovenia (talk by J. Härkönen, P. Luukka, talk by E. Tuominen, E. Tuovinen)

6th International Forum on Advanced Material Science and Technology IFAMST6,
10-13 June, Hong Kong, China (session chair and talk by J. Härkönen, session chair and talk by P. Luukka)

10th International Workshop on Radiation Imaging Detectors,
29 June - 3 July, Helsinki, Finland (talk by J. Härkönen)

The 8th International Conference on Position Sensitive Detectors (PSD8),
1-5 September, Glasgow, UK (talk by P. Luukka, talk by T. Mäenpää)

RADECS 2008 - The 2008 European Workshop on Radiation Effects on Components and Systems,
10-12 September, Jyväskylä, Finland (talk by E. Tuominen, E. Tuovinen)

Workshop on the Finnish Contribution for the NUSTAR Experiment in the Framework of the FAIR Facility,
6 October, Helsinki, Finland (talk by J. Härkönen)

RESMDD'08 7th International Conference on Radiation Effects on Semiconductor Materials, Detectors and Devices,
15-17 October, Firenze, Italy (talk by P. Luukka, talk by E. Tuominen)

Finnish Physical Society, Particle Physics Day,
24 October, Helsinki, Finland (talk by E. Tuominen)

13th RD50 - Workshop on Radiation Hard Semiconductor Devices for Very High Luminosity Colliders,
10-12 November, CERN, Geneva, Switzerland (talk by J. Härkönen, talk by P. Luukka, E. Tuominen, E. Tuovinen)

II-2008 Workshop on Cryogenic Tracking Detectors,
13-14 November, CERN, Geneva, Switzerland (talk by J. Härkönen, talk by P. Luukka, talk by E. Tuominen, E. Tuovinen)

CMS Upgrade Workshop,
19-21 November, Fermilab, Batavia, IL, USA (talk by P. Luukka)

Nuclear Matter Programme

ALICE

4th and 5th Workshop on ALICE Installation and Commissioning,
14 January and 1 April, CERN, Geneva, Switzerland (talks by W. H. Trzaska)

ACS Conference,
2 February, New Orleans, LA, USA (talk by J. Rak)

Quark Matter 2008,
6 February, Jaipur, India (R. Diaz Valdes)

Workshop on Parton Fragmentation,
25 February, Trento, Italy (talk by J. Rak)

ALICE Physics Week 2008,
3 March, Prague, Czech Republic (talk by S. Räsänen)

Diffraction 2008,
9 September, La Londe-les-Maures, France (talk by J. Rak)

Finnish Physical Society, Particle Physics Day,
24 October, Helsinki, Finland (talk by J. Rak)

IAEA Focused Workshop of Safeguard Applications,
28 October, Vienna, Austria (talk by W. H. Trzaska)

General LAGUNA Meeting,
7 November, Bucharest, Romania (talk by W. H. Trzaska)

Technology Programme

CMS Data and Workload Management Workshop,
21-25 January, IN2P3/CNRS Computing Centre, Lyon, France (J. Klem)

International Symposium on Grid Computing (ISGC) 2008,
7-11 April, Taipei, Taiwan (invited talk by J. White)

EGEE Security Middleware: Present and Future Nordunet 2008,
9-11 April, Espoo, Finland (talks by M. Silander and J. White)

NORDUnet2008 Biosphere of Grids and Networks,
9-11 April, Espoo (Helsinki), Finland (talk by J. Klem)

Grid Security, InfraHIP-II Open Seminar Day,
23 April, Espoo, Finland (invited talk by M. Silander)

The 3rd Rutgers, Helsinki PhD Workshop,
5-9 May, Rutgers, The State University of New Jersey, NJ, USA (talk by M. Pitkänen)

LinuxDays 2008,
21-22 May, Geneva, Switzerland (talk by K. Happonen)

The 23 Open Grid Forum OGF23,
2-6 June, Barcelona, Spain (M. Silander)

The 2008 High Performance Computing & Simulation Conference (HPCS 2008),
3-6 June, Nicosia, Cyprus (talk by H. Mikkonen)

The 21th IEEE International Symposium on Computer-based Medical Systems,
17-19 June, Jyväskylä, Finland (talk by M. Pitkänen)

The IEEE International Symposium on a World of Wireless, Mobile and Multimedia Networks (WOWMOM 2008),
23-26 June, Newport Beach, CA, USA (talk by M. Pitkänen)

The 24th Open Grid Forum - OGF24,
15-19 September, Singapore (J. Hahkala)

Smart Event '08,
16-19 September, Sophia Antipolis, France (H. Mikkonen)

EGEE 08 Conference,
22-26 September, Istanbul, Turkey (J. Hahkala, talk by K. Happonen, J. White)

The Second International Conference on Mobile Ubiquitous Computing Systems Services and Technologies (UBICOMM 2008),
29 September - 4 October, Valencia, Spain (H. Mikkonen, talk by M. Pitkänen)

NorduGrid 2008,
27-31 October, Budapest, Hungary (talk by A. Pirinen)

SuperComputing08,
15-21 November, Austin, TX, USA (J. Klem)

Planck

LFI Core Team Meeting,
14-15 February, 7-8 July, Bologna, Italy (talks by R. Keskitalo, talk by H. Kurki-Suonio, talks by T. Poutanen)

Nordic Cosmology Workshop 2008,
10-11 March, Oslo, Norway (invited talk by H. Kurki-Suonio)

Planck Working Group 3 Meeting,
14-18 March, Randsvangen, Norway (R. Keskitalo, H. Kurki-Suonio, invited talk by T. Poutanen)

The Annual Meeting of the Finnish Physical Society,
27-29 March, Turku, Finland (talk by R. Keskitalo)

Workshop on AGN and Related Fundamental Physics in High-Energy Gamma Astronomy,
30 March - 4 April, Jerisjärvi, Finland (invited talk by A. Lähteenmäki)

Planck Joint Core Team Meeting,
5-9 May, Paris, France (invited talk by R. Keskitalo, talk by H. Kurki-Suonio, A. Lähteenmäki)

First Finnish Cosmophysics Meeting,
22-23 May, Turku, Finland (talk by R. Keskitalo, talk by T. Poutanen)

HFI Data Processing Center,
9-15 June, Paris, France (R. Keskitalo)

Jet Propulsion Laboratory,
4-17 August, Pasadena, CA, USA (R. Keskitalo)

LFI Core Team Meeting,
4-5 September, Santander, Spain (H. Kurki-Suonio, invited talk by T. Poutanen)

Joint Planck Core Team Meeting,
3-5 November, Bologna, Italy (talk by R. Keskitalo, A. Lähteenmäki, talk by T. Poutanen)

Planck Working Group 6 Meeting,
6-7 November, Bologna, Italy (talk by A. Lähteenmäki)

XXXI Finnish URSI Convention on Radio,
28 November, Espoo, Finland (invited talk by A. Lähteenmäki)

Administration and Support

EPPOG Meeting,
18-19 April, Prague, Czech Republic (R. Rinta-Filppula)

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

EPPOG Meeting,
3 October, CERN, Switzerland (R. Rinta-Filppula)

Publications

Theory Programme

Cosmophysics

D. Battefeld, T. Battefeld, and A.-C. Davis,
Staggered multi-field inflation,
J. Cosmol. Astropart. Phys. 0810 (2008) 032

D. Battefeld and S. Kawai,
Preheating after *N*-flation,
Phys. Rev. D 77 (2008) 123507

K. Enqvist,
Lemaitre-Tolman-Bondi model and accelerating expansion,
Gen. Relativ. Gravit. 40 (2008) 451

K. Enqvist, S. Nurmi, D. Podolsky, and G. I. Rigopoulos,
On the divergences of inflationary superhorizon perturbations,
J. Cosmol. Astropart. Phys. 0804 (2008) 025

K. Enqvist, S. Nurmi, and G. I. Rigopoulos,
Parametric decay of the curvaton,
J. Cosmol. Astropart. Phys. 0810 (2008) 013

K. Enqvist and T. Takahashi,
Signatures of non-Gaussianity in the curvaton model,
J. Cosmol. Astropart. Phys. 0809 (2008) 012

G. F. Giudice, L. Mether, A. Riotto, and F. Riva,
Supersymmetric leptogenesis and the gravitino bound,
Phys. Lett. B 664 (2008) 21

M. Herranen, K. Kainulainen, and P. M. Rahkila,
Quantum kinetic theory for fermions in temporally varying backrounds,
J. High Energy Phys. 0809 (2008) 032

K. Kainulainen and D. Sunhede,
Stability of spherically symmetric spacetimes in metric *f(R)* gravity,
Phys. Rev. D 78 (2008) 063511

T. Koivisto and D. F. Mota,
Accelerating cosmologies with an anisotropic equation of state,
Astrophys. J. 679 (2008) 1

J. F. Koksma, T. Prokopec, and G. I. Rigopoulos,
The scalar field kernel in cosmological spaces,
Class. Quantum Grav. 25 (2008) 125009

T. Mattsson and M. Ronkainen,
Exploiting scale dependence in cosmological averaging,
J. Cosmol. Astropart. Phys. 0802 (2008) 004

S. Nurmi,
Kähler potentials for the minimally supersymmetric standard model inflation and the spectral index,
J. Cosmol. Astropart. Phys. 0801 (2008) 016

D. Podolsky, J. Majumder, and N. Jokela,
Disorder on the landscape,
J. Cosmol. Astropart. Phys. 0805 (2008) 024

Laws of Nature and Condensed Particle Matter Phenomenology at the LHC

B. Bhattacherjee, A. Kundu, S. K. Rai, and S. Raychaudhuri,
Universal extra dimensions, radiative returns and the inverse problem at a linear e^+e^- collider,
Phys. Rev. D 78 (2008) 115005

D. A. Demir, M. Frank, K. Huitu, S. K. Rai, and I. Turan,
Signals of doubly-charged Higgsinos at the CERN Large Hadron Collider,
Phys. Rev. D 78 (2008) 035013

K. J. Eskola, H. Paukkunen, and C. A. Salgado,
An improved global analysis of nuclear parton distribution functions including RHIC data,
J. High Energy Phys. 0807 (2008) 102

M. Frank, K. Huitu, and S. K. Rai,
Single production of doubly charged Higgsinos at linear e^-e^- colliders,
Phys. Rev. D 77 (2008) 015006

S. Gabriel, B. Mukhopadhyaya, S. Nandi, and S. K. Rai,
Inverted neutrino mass hierarchy and new signals of a chromophobic charged Higgs at the Large Hadron Collider,
Phys. Lett. B 669 (2008) 180

E. Gabrielli and L. Trentadue,
Light mesons and muon radiative decays and photon polarization asymmetry,
Nucl. Phys. B 792 (2008) 48

A. Hietanen and K. Rummukainen,
The diagonal and off-diagonal quark number susceptibility of high temperature and finite density QCD,
J. High Energy Phys. 0804 (2008) 078

P. Hoyer, M. Järvinen, and S. Kurki,
Factorization at fixed $Q^2(1\text{-}x)$,
J. High Energy Phys. 0810 (2008) 086

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Disentangling the unparticles with polarized beams at e^+e^- colliders,
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K. Kajantie, J. Louko, and T. Tahkokallio,
Gravity dual of conformal matter collisions in 1 + 1 dimensions,
Phys. Rev. D 77 (2008) 066001

K. Kajantie, J. Louko, and T. Tahkokallio,
Isotropic AdS/CFT fireball,
Phys. Rev. D 78 (2008) 126011

K. Kajantie, J. Louko, and T. Tahkokallio,
Casimir energy in the gauge/gravity description of Bjorken flow?,
Phys. Rev. D 78 (2008) 126012

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Degrees of freedom and the phase transitions of two-flavor QCD,
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Effects of universal extra dimensions on Higgs signals at LHC,
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Associated photons and new physics signals at linear colliders,
Mod. Phys. Lett. A 23 (2008) 73

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Flavour physics of leptons and dipole moments,
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Difficulty of extracting energy loss probability distributions from R_{AA},
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Energy deposition in hard dihadron triggered events in heavy-ion collisions,
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Angular variation of hard back-to-back hadron suppression in heavy-ion collisions,
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T. Renk,
Parton shower evolution in a 3D hydrodynamical medium,
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Expectations for dihadron correlation measurements extrapolated to 5.5*A* TeV,
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Low mass dimuons produced in relativistic nuclear collisions,
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Hadron Physics Activity

C. S. An and D. O. Riska,
The small axial charge of the N(1535)-resonance,
Eur. Phys. J. A 37 (2008) 263

J. Koponen,
Energies of B_s meson excited states: A lattice study,
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Q. B. Li and D. O. Riska,
Sea-quark effects in the pion charge form factor,
Phys. Rev. C 77 (2008) 045207

String Theory and Mathematical Physics

B. Aneva, M. Chaichian, and P. P. Kulish,
From quantum affine symmetry to the boundary Askey-Wilson algebra and the reflection equation,
J. Phys. A 41 (2008) 135201

M. Arai, C. Montonen, S. Sasaki, and N. Okada,
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J. Phys. A 41 (2008) 015402

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E. Keski-Vakkuri and P. Kraus,
Effective theory of the quantum Hall effect in AdS/CFT,
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U. Lindström, M. Roček, I. Ryb, R. von Unge, and M. Zabzine,
T-duality and generalized Kähler geometry,
J. High Energy Phys. 0802 (2008) 056

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Gauge dependence of Green's functions in QCD and QED,
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M. M. Sheikh-Jabbari and A. Tureanu,
Realization of Cohen-Glashow very special relativity on noncommutative space-time,
Phys. Rev. Lett. 101 (2008) 261601

N. Uekusa,
Gauge and Yukawa couplings in 6D supersymmetric SU(6) models,
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N. Uekusa,
Supersymmetry breaking by constant superpotentials and O'Raifeartaigh model in warped space,
Mod. Phys. Lett. A 23 (2008) 603

Low Dimensional Quantum Systems

Y. Hancock, K. Saloriutta, A. Uppstu, A. Harju, and M. J. Puska,
Spin-dependence in asymmetric, V-shaped-notched graphene nanoribbons,
J. Low. Temp. Phys. 153 (2008) 393

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