HELSINKI INSTITUTE OF PHYSICS

Annual Report 2018

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Vice-Rector Sari Lindblom unveiling the portrait of the former HIP Director, Vice-Rector Paula Eerola.

CONTENTS

KATRI HUITU
Helsinki Institute of Physics director

PREFACE

The Helsinki Institute of Physics (HIP) is a joint research institute of the Universities of Helsinki and Jyväskylä, Aalto University, Tampere University of Technology, and Lappeenranta-Lahti University of Technology LUT. The Finnish Radiation and Nuclear Safety Authority is an interim member of HIP for 2018–2019. The University of Helsinki is the host organisation of HIP. HIP addresses fundamental science questions from quarks to the Cosmos as well as technologies from semiconductors to medical applications and climate research. The Institute serves as a national institute for Finnish physics and related technology research and development at international accelerator laboratories. By mandate of the Finnish Ministry of Education and Culture, HIP is responsible for the Finnish research collaboration with the European Organization for Nuclear Research CERN and the Facility for Antiproton and Ion Research FAIR GmbH, which is under construction at the GSI Accelerator Laboratory in Darmstadt.

The research activities of HIP in 2018 consisted of four research programmes: the Theory Programme; the CMS Programme including the CMS and TOTEM experiments; the Nuclear Matter Programme including involvements in the ALICE experiment, ISOLDE, and the FAIR facility; and the Technology Programme, with seven applied research projects. In addition, there were three independent research projects: CLOUD, Education and Open Data, and Planck-Euclid. The Detector Laboratory served as a general facility for the Institute.

The Scientific Advisory Board had its annual visit in August, this time in Jyväskylä. They found the HIP scientific activity good, and gave some recommendations for the future. One of the recommendations was to organise the application rounds of the theory projects in such a way that half of the projects are applied for every three years, not only every six years as has so far been the case. The current very successful 3+3 year theory projects have been running for 5 years by the end of 2018. To achieve the staging, in the application round of 2019 the old projects can apply to be continued for another three years.

As for the experimental physics programmes, Run 2 of the LHC came to the end at the beginning of December. Run 2 produced a large amount of data, some 160 fb^{-1} for CMS and ATLAS. During the next couple of years ALICE, CMS, and TOTEM will analyse the collected data, as well as prepare for Run 3, which will start in 2021. The ISOLDE experiments also concentrate on analyses of previous data during this so-called Long Shutdown 2. In Germany, the FAIR construction is in full swing, and the so-called Phase-0 experiments will start in 2019.

The Technology Programme was renewed in 2018. Two new projects started at the beginning of the year, and one project was divided into two. In the Technology Programme, one of the focus areas has been fostering connections to industry. Currently, a few projects with support from Business Finland are starting.

An important change in the personnel is that Professor Risto Orava retired at the beginning of October after a long career, during which he has participated in several

particle physics experiments. Many of Professor Orava's former students are professors either in Helsinki or abroad.

The chair of the HIP Board, Dean Paula Eerola, was nominated Vice-Rector of the University of Helsinki in August. Dean Eerola's portrait was revealed in September among the portraits of the other previous Directors of HIP. The project leader of the Theory project QCD and Strongly Interacting Gauge Theory, Tuomas Lappi, was nominated Professor at the University of Jyväskylä in January, and the project leader of the Theory project Domain Wall Dynamics, Lasse Laurson, started in September as a tenure track Professor at Tampere University of Technology. In January Professor Filip Tuomisto from Aalto University started as Technology Programme Director, and Research Co-ordinator Panja-Riina Luukka as Chair of the CMS Tracker Institution Board.

A number of workshops and schools were organised by HIP. Among the schools were the CERN Accelerator School in which around one hundred students participated for a two-week period in June, and the Nordic Course on Instrumentation took place in late autumn. Outreach was active as usual. In very many outreach events in the Helsinki region, the Detector Laboratory personnel presented physics with their equipment. A new type of activity was the BootCamp organised in June at CERN, in which twenty students from Haaga-Helia, Laurea, and Metropolia Universities of Applied Science participated. Another BootCamp will be organised in 2019.

This year the Helsinki part of HIP and the Department of Physics at the University of Helsinki joint wellbeing group began. It has already proven to be important. The group has wiki pages, it organises colloquia and is a contact point for any issue which has to do with wellbeing. Another new group is the communication group at HIP. One of the initiatives of the group is the HIP Blog, which started in December and publishes new blog articles once a month on various issues important to HIP staff in Finnish, English or in Swedish.

The achievements of HIP scientists were recognised by several prizes and acknowledgements during 2018.

The Planck team received the 2018 Gruber Cosmology Prize for definite measurements of the properties of the expanding universe. Nine of the 337 members of the team were from HIP. Doctoral students Jaana Heikkilä and Santeri Laurila received the LHC experiment's CMS Achievement Award "for their exceptional work in establishing and running the Level-1 trigger Data Certification team". CLOUD project leader Academician Markku Kulmala was awarded Commander First Class of the Order of the Lion of Finland, as well as the Friendship Award 2018 from the Nanjing University and the City of Helsinki Science Award. Markku Kulmala and Jonathan Duplissy also belong to the list of Highly Cited Scientists, which recognises world-class researchers selected for their exceptional research performance, demonstrated by production of multiple highly cited papers that rank in the top 1% by citations for field and year in Web of Science.

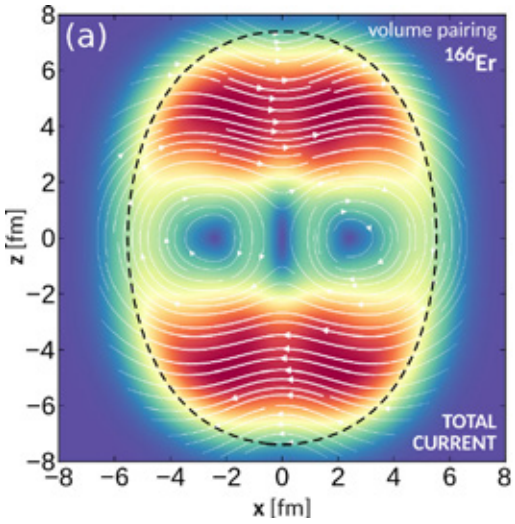
Another new activity at HIP during 2018 has been the internal meetings of the programmes. The CMS and Technology Programme meetings were in 2018, and the meetings of the Theory and Nuclear Matter Programmes at the beginning of 2019. Later in 2019 we will have a town meeting for the whole HIP community.

HIGHLIGHTS OF RESEARCH RESULTS

Theory Programme

The HIP Theory Programme conducts research in a broad range of physical topics under five research projects: Nuclear Structure for Weak and Astrophysical Processes, QCD and Strongly Interacting Gauge Theory, Cosmology of the Early and Late Universe, Domain Wall Dynamics and High Energy Phenomenology in the LHC Era. In the following we select a few highlights from the research.

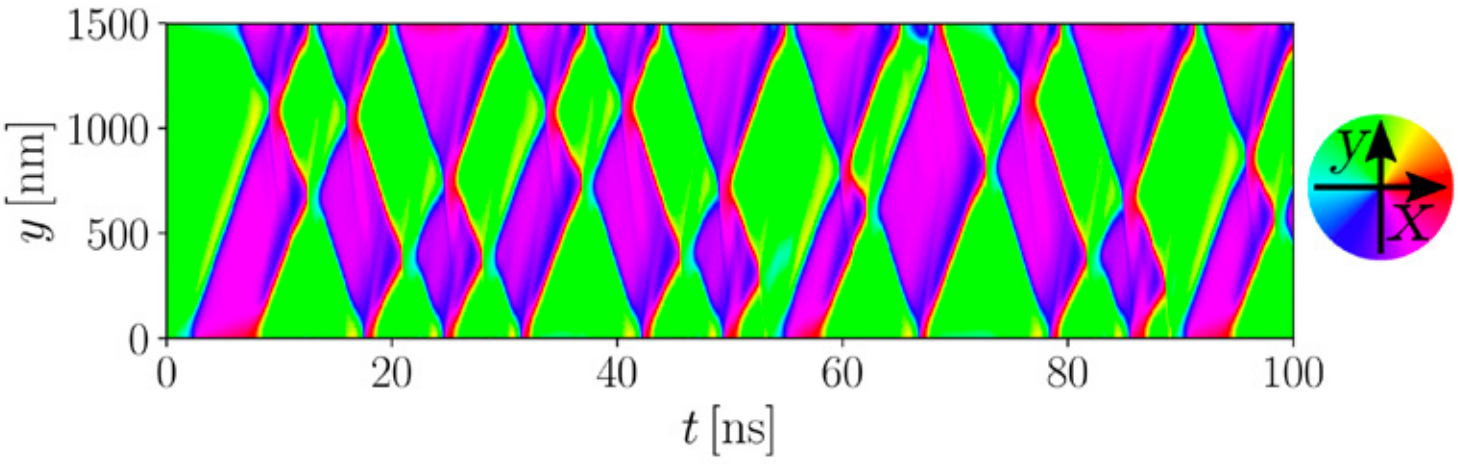
In the Nuclear Structure project we developed a computational method, based on linear response theory, to calculate the moment of inertia in superfluid atomic nuclei. A very interesting aspect of the superfluidity is its irrotational flow character, shown in the picture to the right, in the case of an Erbium-166 nucleus.



In heavy-ion collision experiments, two atomic nuclei are collided with high energy. The initial stages of the collision form a far-from-equilibrium gluonic system, which can be characterized as a classical colour field. We have developed a new numerical linear response method to measure the quasiparticle properties of this medium, and used it to obtain their dispersion relations, effective mass, plasmon frequency, damping rate and further structures in the spectral and statistical functions.

The Two Higgs Doublet Model (2HDM) is one of the leading candidates for an extension of the Standard Model of particle physics. In the High Energy Phenomenology project we studied the phase diagram of the model. The results demonstrate that there are sizable regions of the parameter space where there is a strong first order transition, which is an important prerequisite of both a successful baryogenesis process and the generation of gravitational waves, possibly detectable by the forthcoming Laser Interferometer Space Antenna mission.

In the Domain Wall Dynamics project one of the main topics of study are magnetisation domain walls in 2-dimensional ferromagnets. In the figure below we show a space-time map describing the time evolution of the internal domain wall magnetisation, corresponding to one of the Bloch line excitation modes responsible for the multistep nature of the Walker breakdown for long domain walls.

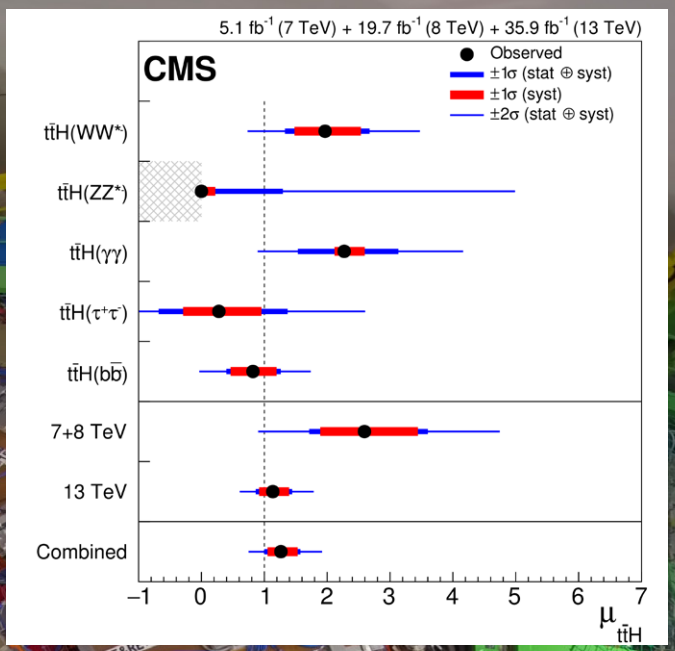


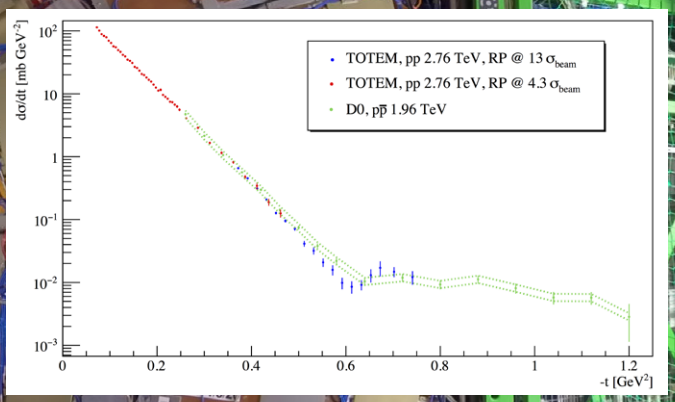
CMS Programme

The Compact Muon Solenoid (CMS) is a general purpose experiment at CERN's Large Hadron Collider (LHC). The LHC Run 1 (2010-2012) culminated with the Higgs boson discovery. The LHC Run 2 (2015-18) ended with *a new CMS delivered luminosity record* of 68 fb^{-1}, resulting in a total Run 2 proton-proton (*pp*) luminosity of 163 fb^{-1}. Two 2018 physics highlights were t*he confirmation of the Higgs boson coupling to the top quark (tt̄H)* and *the observation of single top quark production in association with a Z boson (tZq)*. In 2018, CMS published 140 physics papers, a record number, adding up to a total number of 840 published CMS physics papers by the end of 2018.

HIP contributed to *new physics searches* (Higgs bosons and supersymmetry) *and precision physics with jets* (top quark mass m_t and strong coupling constant α_s). HIP highlights were the first public results with 2016 data for the Run 2 Jet Energy Scale and the charged Higgs (H^+) search at 13 TeV. PhD students J. Heikkilä and S. Laurila received the CMS Achievement Award "for their exceptional work in establishing and running the Level-1 trigger Data Certification team". Regarding CMS detector upgrades, HIP has taken an active role in the R&D for the new Endcap Minimum Ionizing Particle Timing Detector (MTD-ETL). In 2018, an R&D for developing multispectral photon counting detectors for medical imaging and beam characterization funded through the Academy of Finland RADDESS Programme started together with several other research groups.

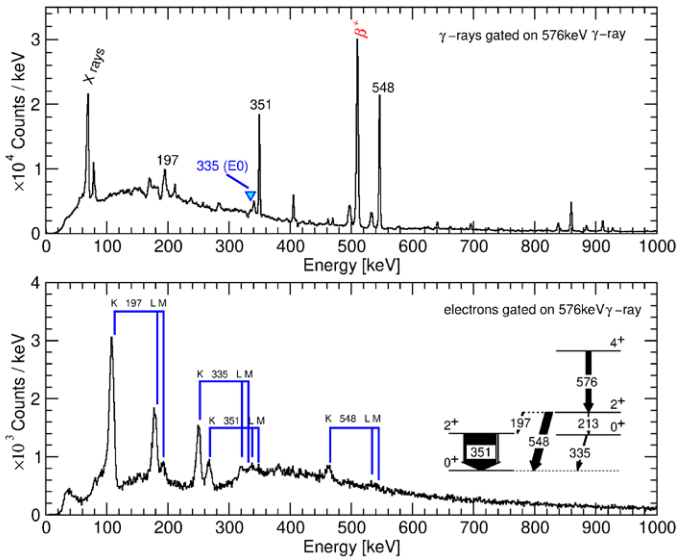
TOTEM is a forward physics experiment at LHC focusing on elastic scattering, total cross section and diffractive and exclusive process studies. As the 2018 highlight, TOTEM presented, with HIP involvement, the elastic *pp* differential cross section (dσ/d*t*) at 2.76 TeV, which contrary to a similar measurement in proton antiproton ($p\bar{p}$) by D0 at 1.96 TeV, has a diffractive minimum ("dip"). Such a significant difference between the elastic dσ/d*t*'s of *pp* and $p\bar{p}$ at the TeV scale, where gluonic exchanges dominate, is regarded as *evidence for the existence of t-channel exchange of a colourless 3-gluon bound state* in elastic scattering.





Nuclear Matter Programme

The ALICE project reached an important milestone in 2018. A tedious work on quality assurance of about 128 m^2 of Gas Electron Multiplier (GEM) foils for the new TPC readout chambers for ALICE was successfully completed in summer 2018. The fast timing detector T0, largely designed and built by Finnish researchers, was dismantled in December 2018 after very successful running. T0 provided, for example, collision timing for time-of-flight, online luminosity information and vertexing. Finland leads the Fast Interaction Trigger (FIT) project, the successor of T0 that will be the main trigger detector in ALICE starting Run 3.



Highlights from ISOLDE include stable beam commissioning and a physics programme employing radioactive ion beams at the ISOLDE Solenoidal Spectrometer (ISS) and the employment of the SPEDE spectrometer at the ISOLDE Decay Station (IDS) in its first experiment. Moreover, the first publication resulting from HIE-ISOLDE experiments emerged providing the first direct evidence for the ^{132}Sn nucleus being doubly magic, a result that was published in *Physical Review Letters* [Phys. Rev. Lett. 121 (2018) 252501].

The Finnish in-kind projects for FAIR are steadily progressing. Our contribution to the Modular Neutron time-of-flight Spectrometer (MONSTER) was assembled in the Accelerator Laboratory in Jyväskylä in 2018. The detectors will stay there for future tests and physics experiments before their final installation in the FAIR facility.

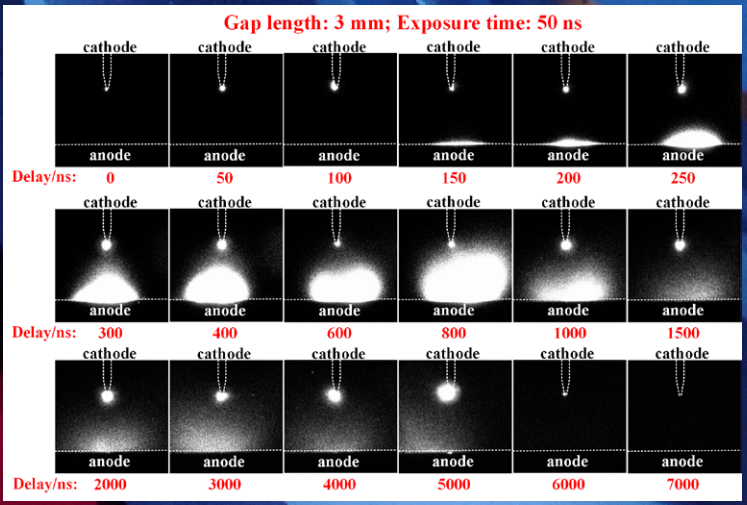
Technology Programme

The Technology Programme aims to integrate in the same programme HIP projects that have significant technology development, transfer and pre-commercialisation activities. In addition, the research activities performed within the programme are designed to seek synergies with big science initiatives at large. The programme is structured into three thematic areas: systems, materials and technology, each consisting of several small projects. Several projects have been successful in raising external funding for the R&D work, strengthening the impact of the programme.

Within the detector system development activities, a proof-of-concept 3-detector coincidence setup for positron lifetime spectroscopy in radioactive materials has been designed, constructed and tested. Further, a wide variety of novel detector technologies have been tested and screened for reduction of the patient dose in computer tomography.

The materials projects have generated significant breakthroughs in the understanding of the role of electrodes in the formation of conducting channels during the breakdown process in high electric fields. In addition, the effect of geometric enhancements on electron emission currents prior to a breakdown event has been elucidated.

An important highlight of the technology development is the design of a PNAR (Passive Neutron Albedo Reactivity) instrument to measure fuel assembly neutron multiplication which was finalised in close collaboration with STUK. Three CERN-related co-creation projects, funded by Business Finland, started during 2018, with the aim of identifying new business opportunities primarily for Finnish high-tech start-ups.



THEORY PROGRAMME

The HIP Theory Programme consists of five fixed-term projects: Cosmology of the Early and Late Universe (leader Syksy Räsänen, University of Helsinki), High Energy Phenomenology in the LHC Era (leader Aleksi Vuorinen, University of Helsinki), QCD and Strongly Interacting Gauge Theory (leader Tuomas Lappi, University of Jyväskylä), Nuclear Structure for Weak and Astrophysical Processes (leader Markus Kortelainen, University of Jyväskylä), and Domain Wall Dynamics (leader Lasse Laurson, Aalto University). In addition, Professor Mark Hindmarsh (Sussex University) is continuing as Visiting Professor in Helsinki, a position shared by HIP and the Department of Physics.

KARI RUMMUKAINEN
Theory Programme director

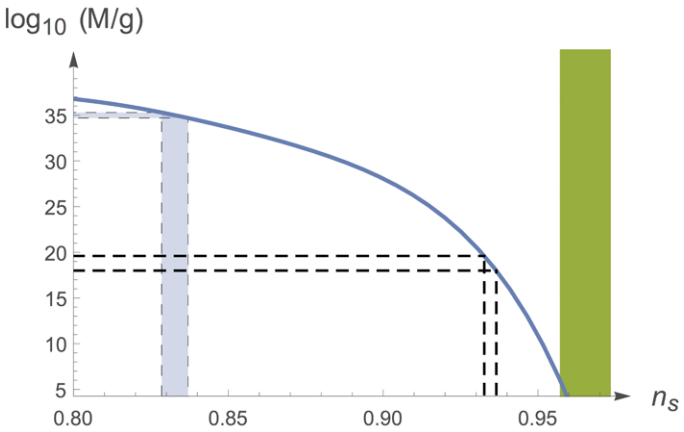
SYKSY RÄSÄNEN
Cosmology of the Early and Late Universe project leader

Cosmology of the Early and Late Universe

Inflation and LHC cosmology, gravitational waves: In 2018, we expanded the work on Higgs and inflation. We showed that when the Standard Model Higgs is non-minimally coupled to gravity, quantum corrections can lead to successful hilltop inflation. We also studied adding a Ricci tensor squared term to the Higgs action. We studied the possibility that features in the Higgs potential generated by loop corrections lead to the production of black holes as dark matter. We showed that for the Standard Model the only possibility is Planck-scale relics. We also calculated the enhancement in black hole production due to the QCD phase transition for general scenarios. A common thread of the Higgs inflation studies has been the treatment of the metric and Palatini formulations on equal ground, and we also studied changes to the Higgs potential that are unique to the Palatini case.

We used non-minimal coupling to gravity to study a dark matter candidate produced gravitationally during reheating and without non-gravitational couplings, as well as a candidate that is both the inflaton and dark matter, and coupled with the Higgs portal.

During 2018, we also computed the one-loop improved potential for the Standard Model in curved spacetime, and showed it is important for vacuum stability. We showed



The plot shows a correlation between the CMB spectral index and the black hole mass. The green band represents Planck observations, showing that black holes have to be so small as to have evaporated down to the Planck scale by today.

how a trilinear interaction between the Higgs and the inflaton can stabilise the electroweak vacuum by increasing the Higgs self-coupling and enable a direct search of the inflaton at the LHC. Furthermore, we investigated slow-roll corrections in multi-field inflation, and showed that the imprints of spectator fields in the primordial power spectrum generated by alternatives to inflation can be mimicked by interactions during inflation.
We carried out large-scale field theory simulations of monopoles and semipoles confined to cosmic strings, and the background of gravitational waves from a global cosmic string network in quintessential inflation was also studied.

Late universe inhomogeneities and observational cosmology: We computed the full-sky bispectrum of galaxy number counts at tree-level and estimated for the first time the effect of redshift-space distortions.

The star formation rate and stellar mass of the brightest group galaxies and their relative contribution to the total baryon budget was also studied, and we searched for galaxy clusters and groups in the COSMOS field using X-ray observations from XMM-Newton and Chandra.

Other: In 2018, we calculated the rate of pair production of electrons and positrons in a strong electric field and a thermal bath, and proposed an experiment to observe it. We contributed to the analysis of magnetic monopoles in a proposal to the European Particle Physics Strategy Update 2018-2020 for heavy-ion runs at the LHC to look for new physics.

We also discussed the cosmology in a biscalar-tensor theory constructed on the basis of scale symmetry and volume-preserving diffeomorphisms.

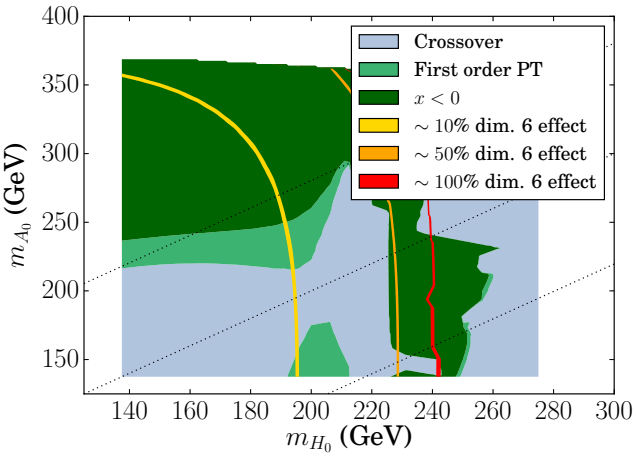
High Energy Phenomenology in the LHC Era

ALEKSI VUORINEN
High Energy Phenomenology in the LHC Era project leader

The High Energy Phenomenology project performs cutting-edge research on a variety of problems within theoretical particle physics, guided and motivated by recent observational advances. No preselected topic of primary interest exists, but attention is given to many different research fields, including, e.g., collider phenomenology, gauge/gravity duality, and the physics of the strong interaction, with emphases that vary somewhat with time.

With the second Long Shutdown period of the Large Hadron Collider (LHC) looming at the end of 2018, vigorous experimental work has been carried out during the year to find traces of physics beyond the Standard Model (BSM) of particle physics. With no clear signs of success, a lot of attention in the field of theoretical BSM physics has been (temporarily) shifting away from collider physics and towards other complementary laboratories of high energy phenomena. An important upcoming experiment will be the Laser Interferometer Space Antenna (LISA), expected to be launched in 2034, which will look for signs of gravitational waves (GWs) from possible first order phase transitions in the early universe.

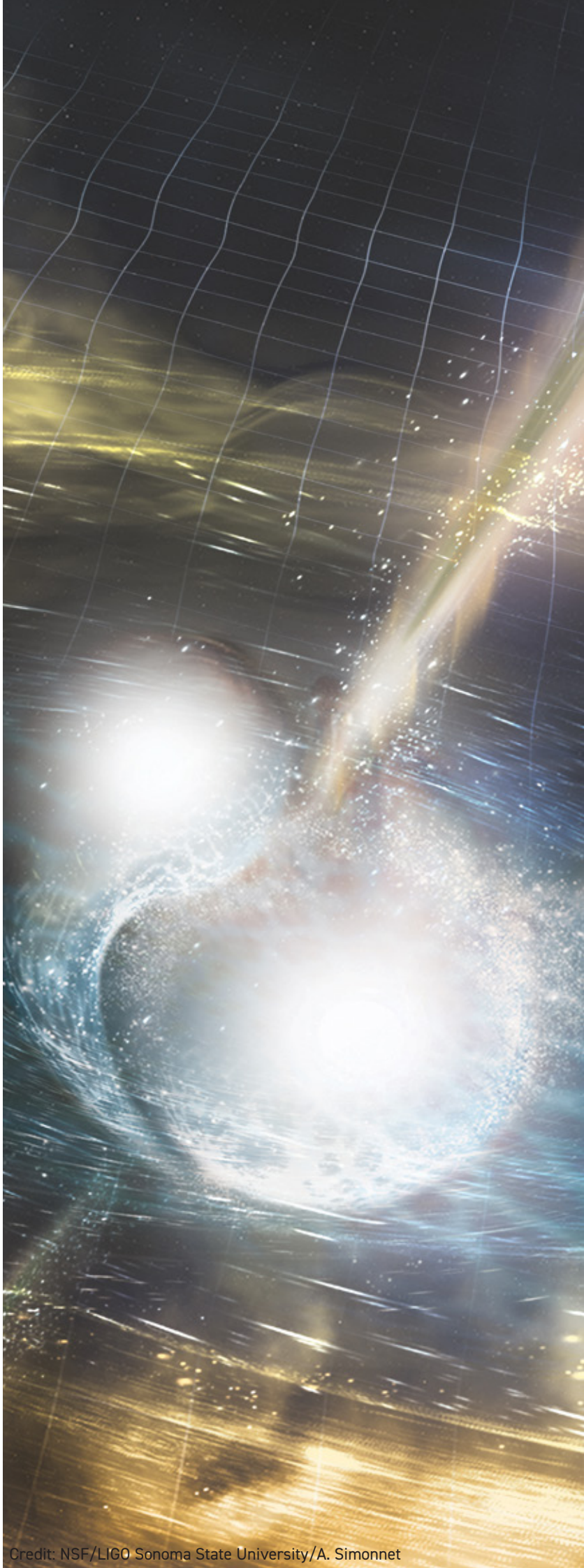
The LISA mission provides ample motivation for the study of BSM models that feature new light scalar degrees of freedom: if the extra scalar fields were active during the electroweak phase transition (EWPT), they may have turned it into a first order one, thereby sourcing GWs and possibly even facilitating the generation of the matter-antimatter asymmetry observed in the present-day universe. To this end, members of the HEP project, including T. Gorda, L. Niemi, T. Tenkanen, and A. Vuorinen, formed a collaboration with local (D. Weir) and international colleagues to non-perturbatively study the EWPT in the Two Higgs Doublet Model. Their study, which was published in *Physical Review Letters* (PRL) in October 2018, revealed phenomenologically viable regions of the model's parameter space that



A diagram indicating the order of the electroweak phase transition in the Two Higgs Doublet Model as a function of the masses of the extra CP-even and CP-odd scalar fields H_0 and A_0, for a particular choice of the other parameters of the model [Phys. Rev. Lett. 121 (2018) 191802].

exhibit a strong first order transition, providing further motivation to study this promising model.

In another recent PRL from the HEP project, Gorda, Vuorinen and M. Säppi joined A. Kurkela and P. Romatschke to derive the first new term in the weak coupling expansion of cold and dense quark matter in 40 years. This work was motivated by recent advances in the field of observational neutron star (NS) physics, including the famous LIGO detection of GWs from a NS merger. Owing to these developments, it has become a feasible goal to pinpoint the material properties of dense Quantum Chromodynamics (QCD) matter, assuming that our theoretical understanding of the microphysics is at a sufficient level. A key component in this process is clearly obtaining accurate information about the deconfined phase of QCD, which can be approached with resummed perturbation theory. This field has witnessed rapid development in recent years, with the HEP project playing a crucial role in the advances. ●



Credit: NSF/LIGO Sonoma State University/A. Simonnet

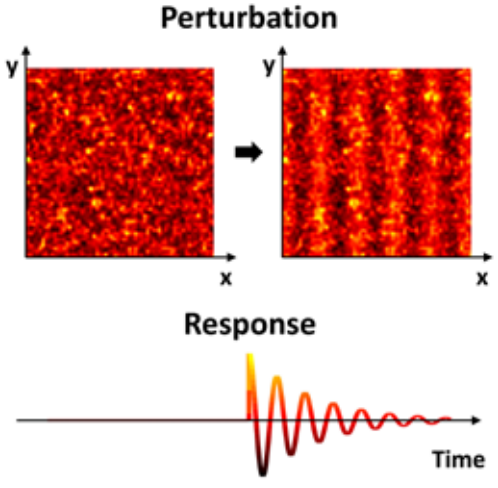
QCD and Strongly Interacting Gauge Theory

Our work revolves around different aspects of QCD at high energy and density. In addition to the phenomenology of high energy nuclear collisions at the LHC and RHIC, we are involved with physics studies for planned next generation DIS experiments. We use weak coupling QCD renormalisation group equations to understand the energy and virtuality dependence of the partonic structure of hadrons and nuclei. An important specialty is using this information to understand and model the formation of a thermalized quark gluon plasma. The subsequent evolution of this plasma can then be modelled using relativistic hydrodynamics.

The DGLAP equations describe the scale dependence of proton and nuclear parton distributions (PDFs). In 2018 we focused on developing methods to consistently calculate heavy-quark observables such as inclusive D-meson production at the LHC and, in ultra-peripheral collisions, photon-induced exclusive quarkonium and inclusive dijet production. This is needed to eventually include all such data in global PDF fits. Using our PDF-reweighting analysis, we also demonstrated the impact of the CMS dijets on gluon PDFs. We have also continued our analysis of dijets measured by CMS, and their impact on gluon PDFs. The BK and JIMWLK evolution equations, in turn, describe the energy dependence of QCD scattering cross sections at high energy. We continued developing the BK formalism for deep inelastic scattering cross sections to next-to-leading order in perturbation theory, working towards a fit of HERA data and the inclusion of heavy quarks.

We use two complementary QCD approaches to describe the formation of quark gluon plasma. In the Colour Glass Condensate picture, the early stage of a heavy ion collision is described in terms of a strong classical gluon field. We studied the dynamics of the infrared sector of overoccupied gluonic systems far from equilibrium using our linear numerical algorithm that enables for the first time a controlled linear response analysis for them. Here we concentrated on demonstrating the existence of quasiparticles in this gluon plasma, and determining their dispersion relations and damping rates. We also model the initial stages of heavy ion collisions starting from perturbative quark and gluon scattering, and using a saturation conjecture to control multiparticle production. Applying such initial conditions in our event-by-event hydrodynamical studies of heavy ion collisions, we continued to analyse hydrodynamical flow related observables. In particular, we extended our framework to collisions of deformed Xenon nuclei recently measured at the LHC, and also studied the effect of uncertainty in the equation of state on the determination of QGP shear viscosity.

TUOMAS LAPPI
QCD and Strongly Interacting Gauge Theory project leader



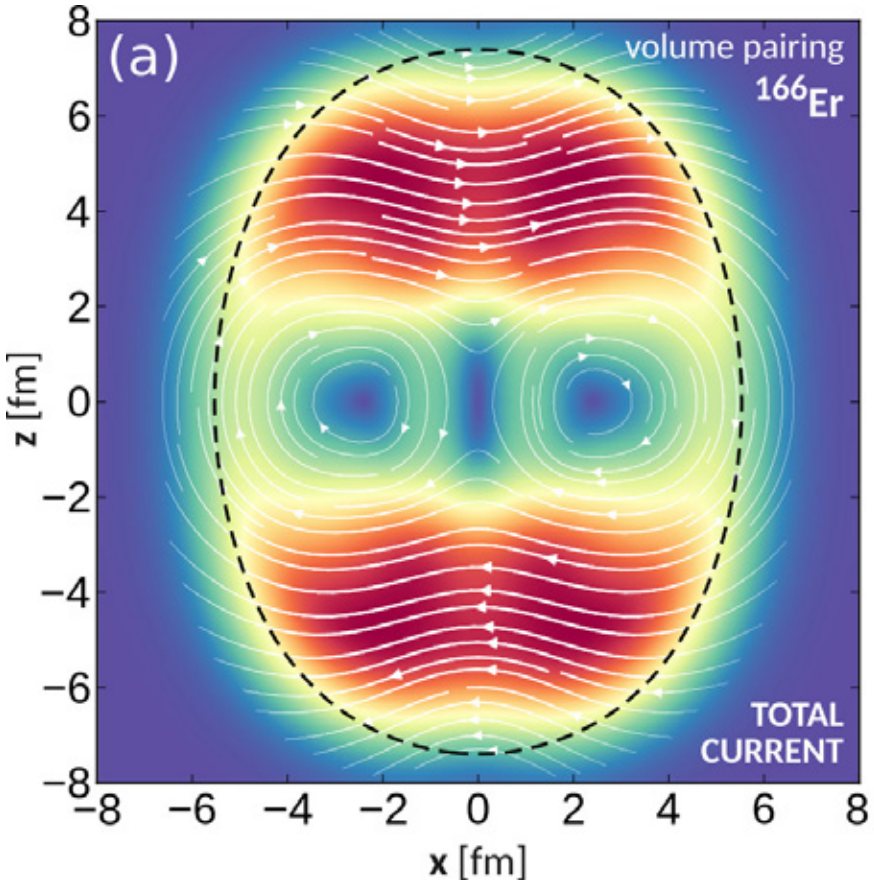
Linear perturbation of the colour field configuration and its time development, showing the quasiparticle frequency and damping.

MARKUS KORTELAINEN
Nuclear Structure for Weak and Astrophysical Processes project leader

Nuclear Structure for Weak and Astrophysical Processes

Isospin-symmetry breaking nuclear forces: The concept of nuclear isospin symmetry stems from the similarity between the neutron-neutron (nn), proton-proton (pp), and neutron-proton (np) nuclear forces, known as charge symmetry. Apart from Coulomb interaction, there is, however, a small violation in charge independence, known as charge-symmetry breaking (the difference between the nn and pp interaction) and charge-independence breaking (the difference between the np and the average of nn and pp interactions). The most pronounced isospin-symmetry breaking (ISB) effect is the mirror displacement energy (MDE) defined as the differences between the binding energies of two mirror nuclei. Another effect caused by ISB is the triplet displacement energy (TDE), which measures the binding-energy curvatures within the isospin triplets. We have shown that by adding two small ISB interaction terms, the experimental values of MDEs and TDEs can be well reproduced.

Calculated rotational superfluid flow in ^{166}Er.



Thouless-Valatin moment of inertia from linear response theory: The emergent phenomenon of superfluidity has a vast impact on many microscopic systems and plays an essential role in revealing important information about their properties. Because of its universality, it represents a fundamental link that connects seemingly distinct fields of research and helps to establish mutually beneficial relations. One interesting aspect is the irrotational character of the superfluid flow. Compared to a normal rigid rotor, rotating superfluid has a reduced moment of inertia. In our work, we have for the first time successfully extended the linear response formalism in order to investigate the rotational Thouless-Valatin moment of inertia in a superfluid nucleus. When applied to selected isotopic chains of rare-earth and actinide nuclei, we found a good correspondence to the experimental moment of inertia. Computationally, this is a faster method compared to traditional cranking calculations.

Correlating nuclear octupole moment and Schiff moment: A possible observation of a non-zero electric dipole moment (EDM) would indicate violation of time-reversal (T) symmetry. This, in any realistic field theory, implies the violation of charge-parity (CP) symmetry. Many models going beyond the standard model predict a large enough CP-violation to produce an observable atomic EDM. Due to screening effects, the relevant nuclear quantity for the atomic EDM is the nuclear Schiff moment. In octupole deformed nuclei, with the presence of a low-lying parity-doublet state, the magnitude of the Schiff moment becomes enhanced. We have shown that the nuclear Schiff moment is strongly correlated with an intrinsic octupole moment of a neighbouring even-even nucleus in light actinides. A measurement of these octupole properties would help to improve the precision of nuclear physics input in the search for the atomic EDM.

Domain Wall Dynamics

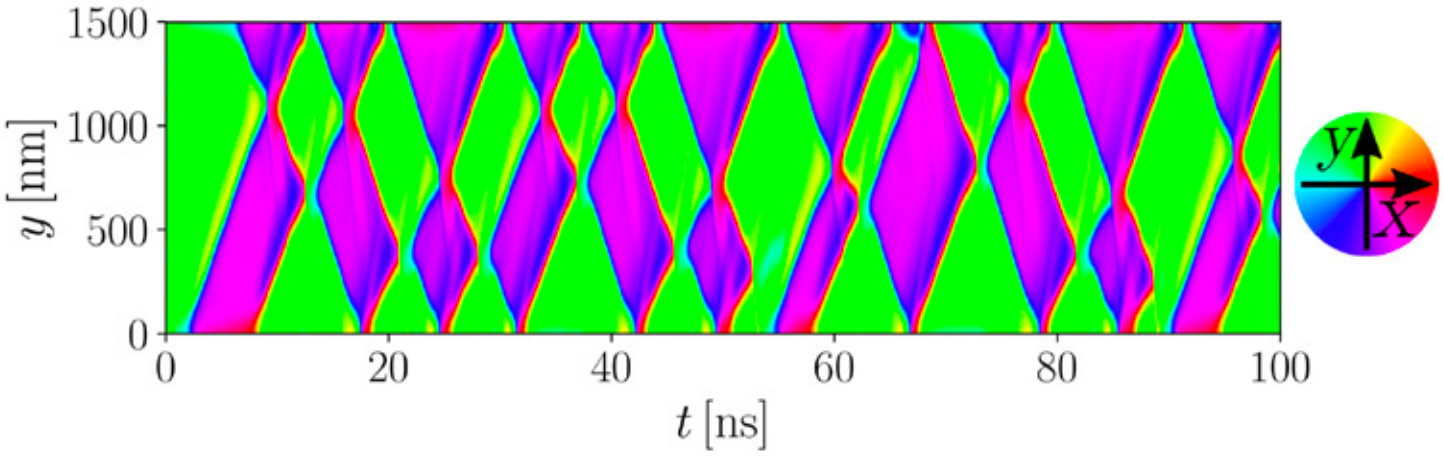
Domain wall dynamics in low-dimensional ferromagnetic structures is an active field of research driven by both numerous promising technological applications as well as fundamental physics interests. During 2018, we have made progress in understanding several key issues of domain walls (DWs) and their dynamics in various one- and two-dimensional systems. In addition, the project reached two milestones: T. Herranen defended his PhD thesis in September 2018, resulting in the first doctoral degree of the project. Moreover, the project leader obtained a tenure track position at Tampere University, and consequently the project is now operating at both Aalto University and Tampere University.

Multistep Walker breakdown: One of the key phenomena in domain wall dynamics is the Walker breakdown, i.e., the onset of precession of the domain wall magnetisation above a threshold driving field, resulting in an abrupt drop of the domain wall propagation velocity. We have shown that in wide enough ferromagnetic strips with long enough domain walls Walker breakdown is a multistep process, with multiple distinct velocity drops due to nucleation of different numbers of Bloch lines within the domain wall.

Magnetic friction: Following the method paper published in early 2018 on our implementation of smooth linear motion in a finite difference-based micromagnetic simulation code, we have used the developed methodology to study magnetic non-contact friction in various simple geometries with magnetic bodies involving domain walls. We have investigated both ring-down setups as well as the linear relative motion of the two bodies.

Barkhausen noise in the precessional regime: Barkhausen noise, or jerky field-driven propagation of domain walls in disordered ferromagnets, is a prime example of a system exhibiting crackling noise. We studied this effect in a system where the domain walls propagate in the precessional regime where repeated nucleation, propagation and annihilation of Bloch lines take place within the domain wall simultaneously with domain wall propagation. Remarkably, the internal Bloch line dynamics was found to exhibit crackling noise, with a magnitude exceeding that related to domain wall propagation.

LASSE LAURSON
Domain Wall Dynamics project leader



Space-time map describing the time evolution of the internal domain wall magnetisation, corresponding to one of the Bloch line excitation modes responsible for the multistep nature of the Walker breakdown for long domain walls.

CMS PROGRAMME

The HIP CMS programme is responsible for co-ordinating the Finnish participation in the CMS and TOTEM experiments at the Large Hadron Collider (LHC). The Compact Muon Solenoid (CMS) is a general purpose experiment covering precision measurements of particles and interactions, the origin of electroweak symmetry breaking (Higgs bosons), and the search for signatures of new physics. TOTEM is a dedicated forward physics experiment, located at the same LHC interaction point as CMS, focusing on elastic scattering, total cross section, and diffractive and exclusive processes. The programme is divided into four projects: the CMS experiment, responsible for physics analysis and operations, the CMS upgrade, responsible for the Finnish upgrade contributions, the Tier-2 and the TOTEM projects. The Finnish groups in CMS are: HIP (currently 15 authors), the Department of Physics at the University of Helsinki (4 authors), and Lappeenranta University of Technology (1 author). TOTEM currently has 8 HIP authors, out of which 5 are also affiliated with the Department of Physics at the University of Helsinki.

KENNETH ÖSTERBERG
CMS Programme director

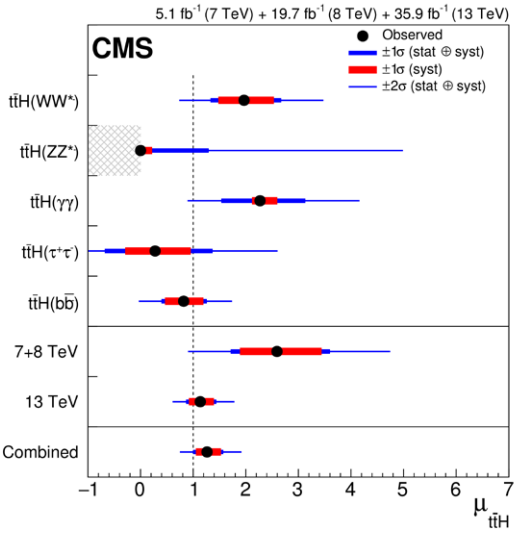
MIKKO VOUTILAINEN
CMS Experiment project leader

CMS Experiment

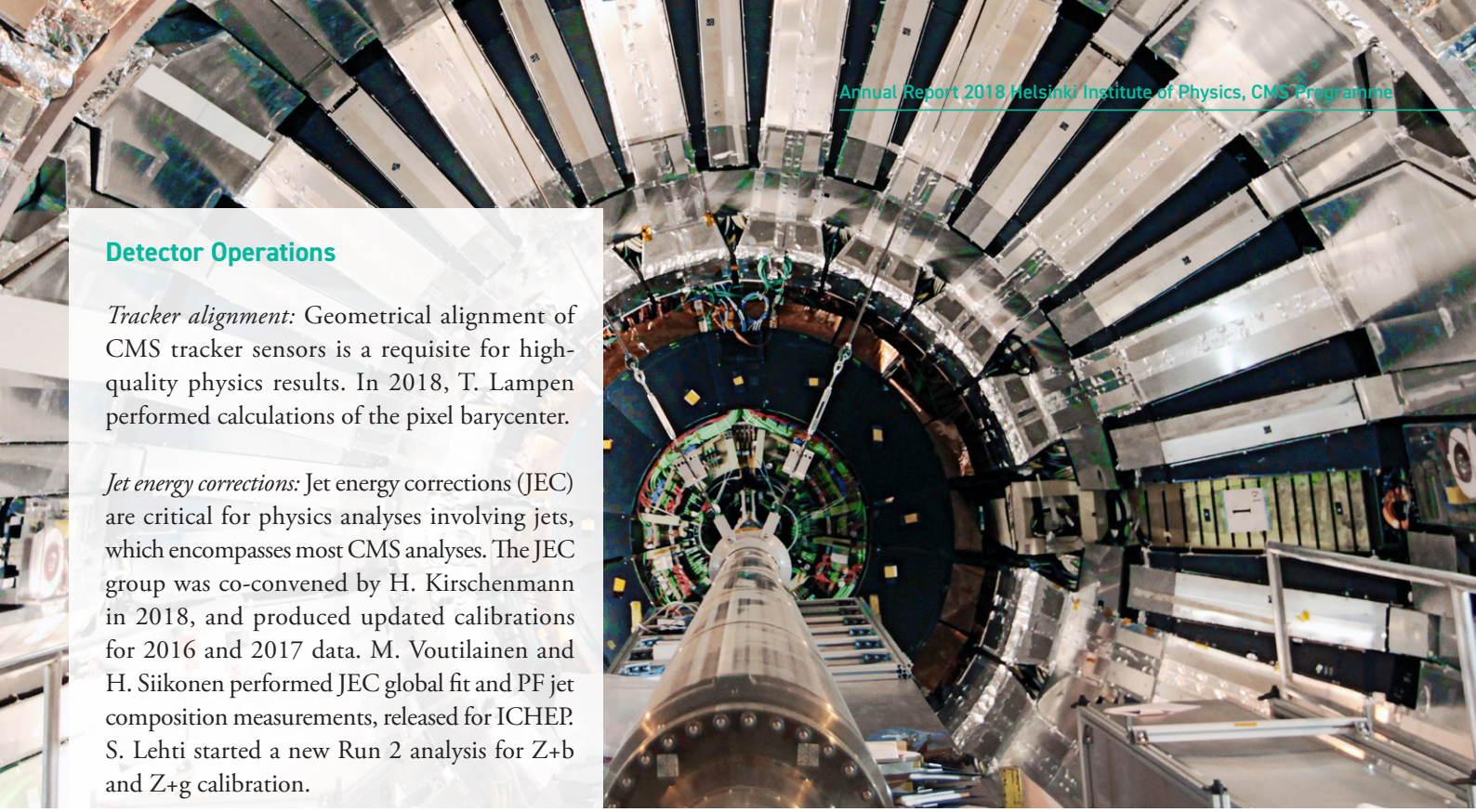
Introduction

The CMS experiment project is involved with detector operations on tracker alignment, jet energy corrections and the L1 trigger, and develops deep learning applications in HEP. The physics analyses focus on new physics searches (heavy Higgs bosons and SUSY) and on precision measurements with jets (m_t, α_s). CMS recorded 68 fb^{-1} of a total of 163 fb^{-1} of high-quality pp data in Run 2 that finished in 2018, and submitted a record 140 papers.

With the discovery of the ttH and tZq channels, 2018 was the year of the Yukawa couplings. HIP scientists continued their significant contributions, with M. Voutilainen nominated as TOP-mass and H. Kirschenmann as SMP-hadronic convener, and J. Heikkilä and S. Laurila jointly winning the CMS Achievement Award.



Observation of the $t\bar{t}H$ coupling by CMS. The figure shows the best fit value of the $t\bar{t}H$ signal strength relative to the Standard Model expectation, $\mu_{t\bar{t}H}$, for the five individual Higgs decay channels considered (upper section), for the Higgs five decay channels combined at separate collision energies (middle section), and the overall combined result (lower section).



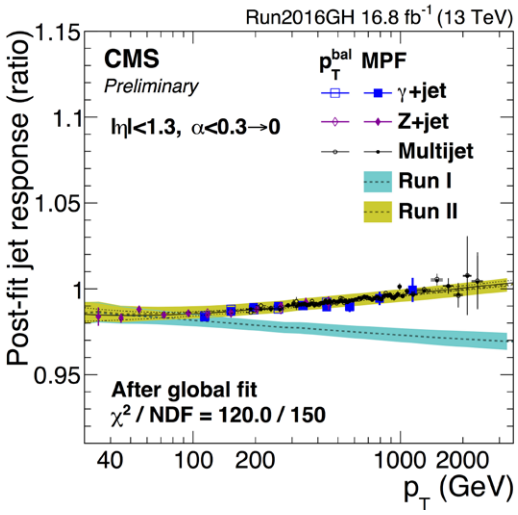
Detector Operations

Tracker alignment: Geometrical alignment of CMS tracker sensors is a requisite for high-quality physics results. In 2018, T. Lampen performed calculations of the pixel barycenter.

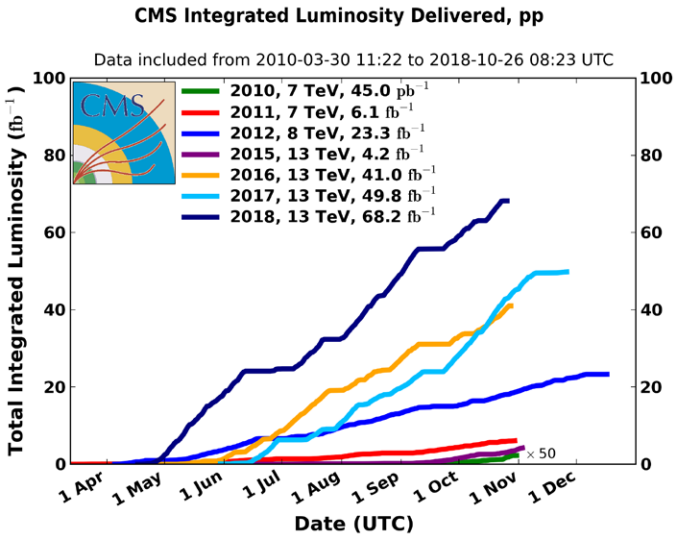
Jet energy corrections: Jet energy corrections (JEC) are critical for physics analyses involving jets, which encompasses most CMS analyses. The JEC group was co-convened by H. Kirschenmann in 2018, and produced updated calibrations for 2016 and 2017 data. M. Voutilainen and H. Siikonen performed JEC global fit and PF jet composition measurements, released for ICHEP. S. Lehti started a new Run 2 analysis for Z+b and Z+g calibration.

L1 trigger: HIP had an active role in the L1 Trigger group, with J. Heikkilä and S. Laurila as Level-1 Offline Certification Co-Coordinators and recipients of the CMS Achievement Award from PPD and L1Trig co-ordination areas. The HIP participation will continue in LS2 with M. Lotti joining the effort.

Deep learning applications: J. Havukainen and K. Kallonen were involved in several machine learning (ML) projects, such as improving track quality evaluation, H^+ event selection and jet flavour identification. The HIP team collaborated with Professor K. Puolamäki from HIIT. H. Kirschenmann and M. Voutilainen participated in two ITN applications with an ML component (SMARTHEP, HIMALAYA), and T. Lampén applied for Academy funding.



The global fit to part of the 2016 data of the CMS jet energy correction as a function of the jet transverse momentum (p_T). Values closer to one indicate smaller residual corrections due to data-simulation differences. The Run 1 fit on 8 TeV data from 2012 with a systematic uncertainty band is shown for comparison.



Integrated proton-proton luminosity delivered by the LHC per year along the year for Run 1 (2010–12) and Run 2 (2015–18).

Precision Measurements

HIP participates in measurements of the top quark mass (H. Siikonen), the inclusive jet cross section (L. Martikainen) and the gluon jet cross section (with O. Atakisi and O. Ozturk, ERASMUS MSc, from the University of Marmara, Turkey). M. Voutilainen and H. Kirschenmann started to co-convene the TOP-mass and SMP-hadronic groups, respectively, after retiring from SMP-jet and JERC convenorships.

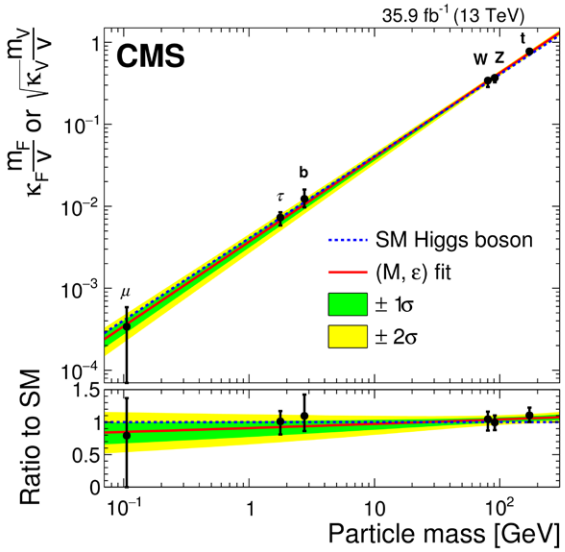
The overarching goals for HIP are measurements of proton structure, the strong coupling constant α_s and the top quark mass m_t, in exploration of SM vacuum stability and physics up to the Planck scale. In 2018, the team focused on calibrating and understanding the quality of the full Run 2 data, in preparation for high precision measurements during LS2, and completed recruitment of visiting scientist M. Kim from South Korea for two years.

T. Mäkelä worked on his MSc thesis to reproduce the b-jet calibration used in the D0 m_t measurement that differs from CMS by 3 GeV and circa 3σ, and presented the preliminary findings at the biannual LHC TOP WG Open Meeting.

Charged Higgs bosons: The first results of the search for H^+ at 13 TeV with data recorded in 2016 were shown publicly. The team (S. Lehti, S. Laurila, J. Havukainen, and M. Lotti) continues the search with all data recorded in 2016-18, exploiting machine learning, concerning which J. Havukainen is doing an internship at Apple in California. The team was also responsible for the development of the τ + MET trigger for 2018 data taking, used in the H^+, W', and boosted WH searches.

Neutral Higgs bosons: The search for the neutral Higgs bosons in the $A \to Zh \to 2\ell 2\tau$ channel was performed by J. Heikkilä under the supervision of G. Petrucciani (CERN) and in collaboration with the University of Wisconsin-Madison. The analysis of 2016 data was pre-approved in 2018, and will be published in 2019.

SUSY: H. Kirschenmann and K. Kallonen participated in searching for a gluino pair decaying to tttt in the most sensitive single lepton final state, in collaboration with Athens, CERN, DESY and Fermilab, and using advanced ML techniques for search region definition on full Run 2 data. ●



The coupling of fermions (F) and vector bosons (V) to the Higgs boson as measured by CMS at 13 TeV as a function of the particle mass compared to the Standard Model expectation (dashed blue line). The result of a phenomenological mass-coupling (M, ε) fit to the measured CMS values is overlaid.

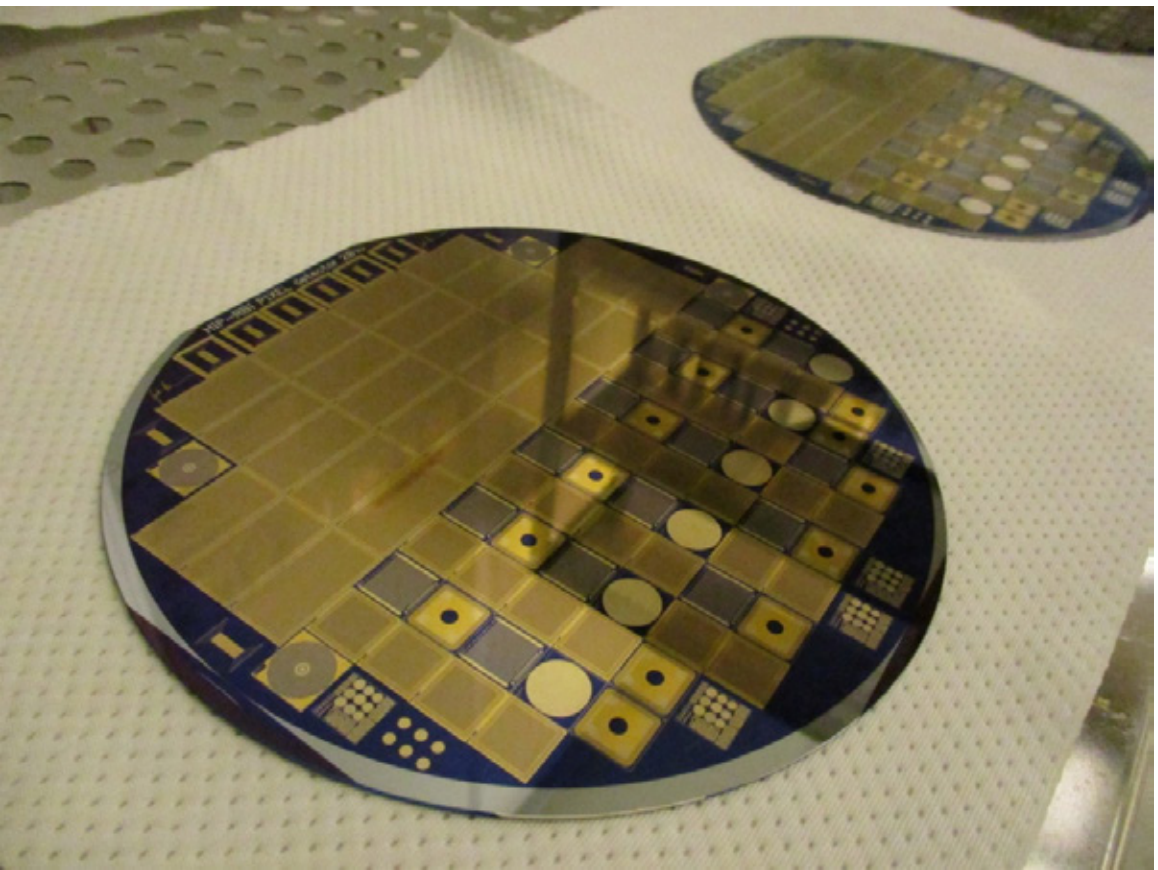
CMS Upgrade

The HIP CMS Upgrade project is responsible for the Finnish hardware contribution to the CMS experiment. The luminosity of the LHC will significantly increase in the coming years and consequently, radiation induced defects will severely affect the silicon sensor performance especially in the pixel region. In addition, detector occupancy will play a substantial role, and thus, the requirements for the detector granularity will significantly increase. One way of improving the quality of the tracking is to have detectors with higher segmentation to reduce the risk of having several particles on the same readout channel, another way is to add information about the precise time of the arrival of the particles to the detector. To meet the set goals for the high-quality physics data taking, the CMS detector has thus to go through several upgrades in the coming years.

The most comprehensive upgrade including the upgrades of several CMS sub-detectors, the Phase 2 upgrade, will happen during the Long Shutdown 3 (LS3) in 2024-26. In this upgrade, Finland will participate in the upgrade of the Tracker pixel detector and in the building of the new Minimum Ionizing Particle Timing Detector Endcap Timing Layer (MTD-ETL). The latter was approved as part of CMS in November 2017. In 2018, the CMS Upgrade group has taken an active role in the detector R&D for this new detector. As a continuation of the CMS Tracker Phase 2 upgrade studies, the group has also continued research on novel detector and interconnection technologies utilising Atomic Layer Deposition (ALD) grown thin films as active and passive layers in the silicon detectors with very fine segmentation. In 2018, the HIP CMS Upgrade group also started an R&D project together with research groups from the Finnish Radiation and Nuclear Safety Authority (STUK), Aalto University and Lappeenranta University of Technology within the framework of the Academy of Finland RADDESS programme for developing multispectral photon counting detectors for medical imaging and beam characterization. The goal is to develop an imaging system based on the detector solutions and readout electronics originally designed for the CMS experiment.

In December 2017, P. Luukka was elected to one of the most important management positions in the CMS Tracker, the Tracker Institution Board Chair. In addition, Luukka has been chairing the Tracker Conference Committee and co-chairing the CMS Career Committee in 2018.

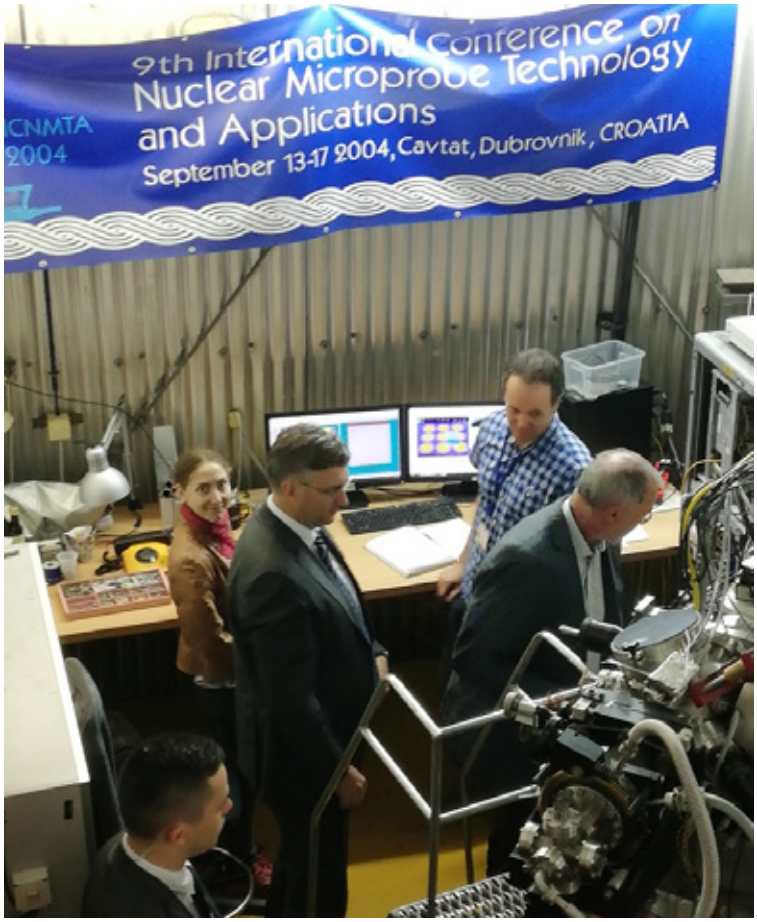
PANJA-RIINA LUUKKA
CMS Upgrade project leader



As-processed silicon pixel detector wafers from the latest detector R&D processing run for the CMS Phase 2 pixel detector upgrade in Micronova Nanofabrication Centre, Finland.

TOMAS LINDÉN
Tier-2 Operations project leader

Lappeenranta activity: In 2018, the CMS group at Lappeenranta University of Technology (LUT), led by Professor T. Tuuva, has actively participated in the construction of the electronics and data acquisition system for the CMS GE1/1 station. The GE1/1 using Gas Electron Multiplier (GEM) technology is one of the four new muon detector stations at the CMS forward trigger system, needed due to the increasing LHC luminosity. The contribution of LUT consists of the production of 90 wedge-shaped GEM on-detector electronic boards (GEBs), half of the total number of the GEBs to be installed in the GE1/1 muon station. All the electrical components have been manufactured, tested and commissioned in Lappeenranta and at CERN. The boards will be installed into CMS during LS2, which has just started at the end of 2018. ●



The Microprobe Measurement facility at Ruđer Bošković Institute. CMS Upgrade doctoral student J. Ott and Dr. M. Kalliokoski are presenting the measurement setup to the Croatian Prime Minister Andrej Plenković.

Tier-2

CMS 13 TeV analysis and simulation jobs were running on the HIP Tier-2 site during the last year of the LHC Run 2 with good availability ensured by the collaboration between HIP, CSC (IT Center for Science Ltd) and the Nordic e-Infrastructure Collaboration (NeIC) Nordic Data Grid Facility (NDGF). T. Lindén represented HIP as chairman in the NeIC Nordic LHC Computing Grid steering committee.

CMS jobs were run on the Linux clusters Kale (1784 cores, 2015/12) and Alcyone (840 cores, 2011). Work continued to take the CMS 5.5 M billing unit allocation on the Kajaani CSC cPouta cloud system into use.

The dCache services at CSC ran very stably.

An application to the Academy of Finland to upgrade the disk system was submitted.

The collaboration between HIP and the UH Department of Computer Science continued in 2018 by studying the feasibility of running CMS jobs on the ARM architecture.

The Tier-2 resources are operated, maintained and monitored by HIP, CSC and NDGF to spot problems early with Site Availability Monitoring jobs. According to the statistics, the Tier-2 resources were in the "ready" state 76.5% of the time (81.0% in 2017). The "No Info" status was 0.7% (0.0% in 2017). There were 26 GGUS tickets (34 in 2017) concerning HIP.

PhEDEx moved 5294 TB of production data (3061 TB in 2017) and 167 TB of test data (362 TB in 2017) to HIP. 2081 TB of production data (1409 TB in 2017) and 168 TB of test data (211 TB in 2017) were moved from HIP to elsewhere. In total, PhEDEx moved 7710 TB of data on the Wide Area Network (5043 TB in 2017).

A total of 0.83M CMS grid jobs (0.65M in 2017) using 14.2 MHS06 CPU hours (13.1 MHS06 CPU hours in 2017) were run with an average CPU efficiency of 52.2% (70.7% in 2017). ●

TOTEM

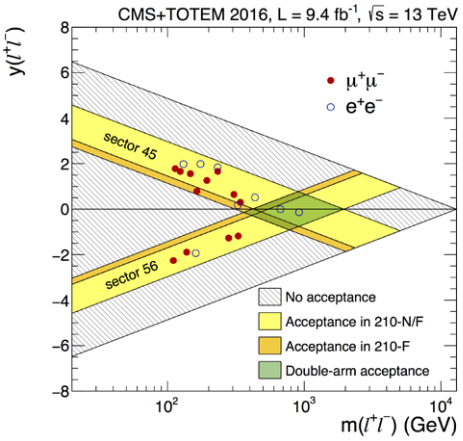
The TOTEM project is responsible for the Finnish contribution to the CMS and TOTEM forward physics. The group consisted at the end of 2018 of Professor K. Österberg, Professor Emer. H. Saarikko, scientist F. García, post-doc L. Forthomme, and PhD students T. Naaranoja and F. Oljemark. In 2018, the high luminosity part of TOTEM, the Proton Precision Spectrometer (PPS), focusing on high mass exclusive processes, became part of CMS. The low luminosity part, concerned with special LHC runs, will continue as an independent experiment until the end of 2021, to make a total cross-section (σ_{tot}) measurement at 14 TeV. The group members had important responsibilities like TOTEM physics (K. Österberg) and CMS PPS test beam co-ordination (F. García).

During 2018, the PPS collected ~58 fb^{-1}, resulting in a total Run 2 PPS luminosity of ~110 fb^{-1}. The first PPS physics result, the evidence of proton-tagged semi-exclusive dilepton production at high mass, was also published. Furthermore, TOTEM successfully took data in special LHC runs for a measurement of ρ and σ_{tot} at 900 GeV and together with CMS for glueball studies in low-mass exclusive processes increasing the available data for such studies by a factor 10 (~5 pb^{-1} vs ~0.4 pb^{-1}).

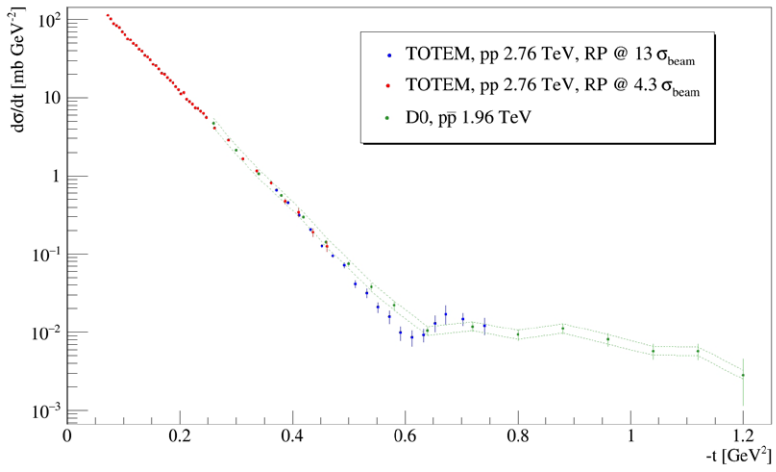
In 2018, TOTEM presented the elastic proton proton (pp) differential cross section ($d\sigma/dt$) at 2.76 TeV with a diffractive minimum ("dip"). Combined with similar 7 and 13 TeV measurements, it shows that in pp the dip position moves to smaller |t|-values with increasing energy, while the cross-section ratio between the secondary maximum and the dip, called R, stays approximately constant at 1.8. However, in the elastic proton antiproton ($p\bar{p}$) $d\sigma/dt$ measured by D0 at 1.96 TeV, no dip and R = 1 is observed. Modulo the energy difference between the TOTEM and D0 measurements, these results show a significant difference between the elastic $d\sigma/dt$'s of pp and $p\bar{p}$ at the TeV scale, where gluonic exchanges dominate. Such a difference is regarded as evidence for the existence of t-channel exchange of a colourless 3-gluon bound state, the so-called Odderon, in elastic scattering.

HIP is involved in Odderon (K. Österberg), glueball (K. Österberg and M. Berretti) and single diffractive studies (F. Oljemark). Regarding PPS physics, L. Forthomme plays a leading role in the 2016 data based exclusive diphoton analysis and feasibility studies of low-mass supersymmetry searches. Furthermore, HIP (M. Berretti, F. García, R. Turpeinen and L. Forthomme) contributed significantly to the proton time-of-flight detector construction and offline software. In addition, T. Naaranoja is studying the radiation performance of diamond. Finally, F. García participates in the design of a new T2 detector, to be installed for Run 3, for a σ_{tot} measurement at 14 TeV.

KENNETH ÖSTERBERG
TOTEM
project leader



Semi-exclusive dimuon (closed circles) and dielectron (open circles) production, pp → p$\ell^+\ell^-$X or X$\ell^+\ell^-$p, candidates at high mass with one proton measured in the PPS, displayed in the dilepton rapidity vs invariant mass plane with the expected acceptance regions overlaid.



The elastic differential cross section in proton-proton (pp) and proton-antiproton ($p\bar{p}$) collisions at 2.76 and 1.96 TeV, respectively, as a function of the momentum transfer t. The pp data show a clear diffractive minimum ("dip") at t about 0.6 GeV^2 that is absent in the $p\bar{p}$ data. Any significant difference between the pp and $p\bar{p}$ cross section at the same energy in the TeV range is regarded as evidence for t-channel exchange of a colourless three-gluon bound state, the "Odderon".

NUCLEAR MATTER PROGRAMME

ARI JOKINEN
Nuclear Matter Programme director

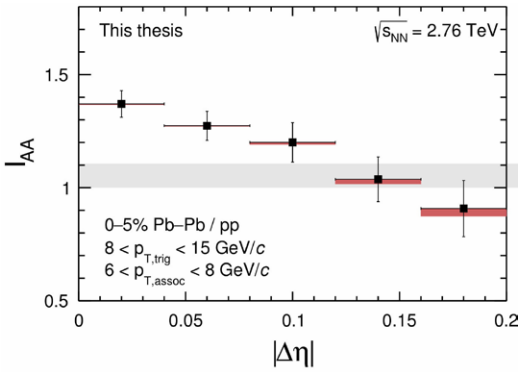
The Nuclear Matter Programme involves the participation of Finnish teams at CERN in studies of two aspects of nuclear and hadronic matter. These are cold exotic matter with the extreme composition of its proton and neutron numbers on the one hand, and dense matter created in relativistic heavy ion collisions on the other. Exotic nuclei are studied at the ISOLDE facility while the study of quark gluon plasma and related phenomena takes place at ALICE. Since the beginning of 2015, the Nuclear Matter Programme has also included the ALICE-Forward physics project. The Nuclear Matter Programme has also continued co-ordinating the Finnish participation in the planning and construction of the FAIR project in Darmstadt. The Finnish involvement in FAIR includes participation in the construction of the Super-FRS facility and in the NUSTAR Collaboration for nuclear structure, reaction and astrophysics studies.

JAN RAK
ALICE project leader

ALICE

2018 ended with the very successful Run 2 at the CERN LHC. From the ALICE point of view, the lead-lead campaign was the most important data taking period in 2018. ALICE gathered a data sample of 908 μb^{-1} during the lead-lead running, containing for example an 8.5 times larger central event sample as compared to 2015. At the end of Run 2, the LHC entered the second long shutdown (LS2) for the next two years. The LS2 is very significant for heavy ion physics because we enter into high-luminosity running in Run 3 starting 2021.

High luminosity running will require a very significant upgrade of the ALICE experiment. The main Finnish contribution to the upgrade will go into the new Fast Interaction Trigger (FIT) -detector that will be the main trigger detector in ALICE after the LS2. FIT will also provide online luminosity information and give estimates for the collisions centrality and the event plane, both vital for many physics analyses. The CERN project leader of FIT, W. Trzaska, was also the project leader of the fast timing detector T0 that finished with the data taking at the end of Run 2. The T0 was a very reliable detector that provided precise collision time to Time-of-Flight measurements, served as a luminometer and participated in the trigger.



The ratio of jet associated yields measured in heavy ion and pp collisions as a function of rapidity separation of pairs in two-particle correlations. The lowering trend indicates a narrowing of the jet.

In the data analysis, our group continued to concentrate on jet physics and studies on collective flow. In December 2018, M. Vargyas defended his PhD thesis, where he found that hard jets are narrower in heavy ion collisions as compared to proton-proton collisions. This somewhat surprising observation may lend support to a picture where gluons are more strongly suppressed by the medium and this would enrich the amount of naturally narrower quark jets in the final state. The flow harmonics studies continued with high-precision measurements of linear and non-linear decomposition of the flow modes. These highly

appreciated studies help to pin down the shear viscosity of the QCD matter and they were very visible in the major conferences. Also, D. J. Kim was selected as new convener of the ALICE Physics Analysis Group on flow.

The main tracking device in ALICE is the world's largest Time Projection Chamber (TPC) that is to be upgraded to high rate running. The new TPC readout is based on Gas Electron Multiplier (GEM) foils. The HIP Detector Laboratory in Helsinki was responsible from the tedious work of performing the Quality Assurance of roughly 128 m^2 of GEM foils to be used in the ALICE TPC. This work was successfully finished in summer 2018. ●

ISOLDE

The HIE-ISOLDE upgrade for radioactive ion beams (RIBs) reached the final step and delivered beams for a very successful physics campaign. In total, 12 different experiments were performed amounting to more than 1,180 hours of post-accelerated radioactive beam on target. Together with a multidisciplinary physics programme at low energy, a total of 418 shifts was completed. Highlights from 2018 include stable beam commissioning and a physics programme employing RIBs at the ISOLDE Solenoidal Spectrometer (ISS) and the employment of the SPEDE spectrometer at the ISOLDE Decay Station (IDS) in its first experiment. Moreover, the first publication resulting from the HIE-ISOLDE experiments emerged. The team of researchers, led by D. Rosiak together with the MINIBALL Collaboration, provided the first direct evidence for the ^{132}Sn nucleus being doubly magic, a result that was published in *Physical Review Letters* [Phys. Rev. Lett. 121 (2018) 252501].

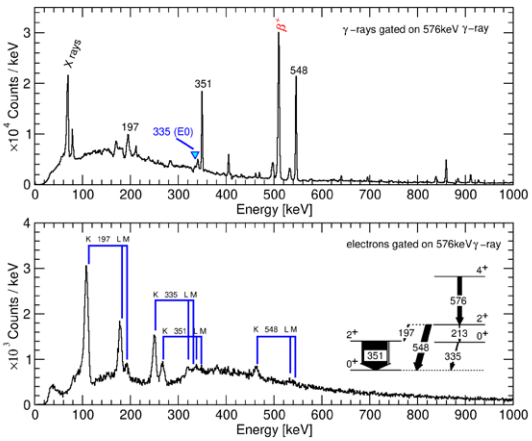
The SISIN Academy of Finland project post-doctoral researcher S. Szwec was involved in the campaign at ISS. Measurements using both light (e.g., ^{28}Mg) and heavy (e.g., ^{206}Hg) radioactive beams in one-neutron transfer reactions demonstrated stable operation of ISS in two different mass regions. Especially the success of the latter was an important milestone as it showed that the evolution of single-particle structure can be investigated in the lead region with ISS. In the ISOLDE workshop, Szwec presented a poster entitled "*Studying shape coexistence in the neutron-deficient lead region with few-nucleon transfer reactions*", that completes the first step (i.e., feasibility study) of the SISIN project (PI J. Pakarinen).

The HIP contribution in the MINIBALL campaign included a summer student project, in which V. Virtanen performed a study of "*Calibration and particle reconstruction for double-sided silicon detectors*".

First Experiment Employing the SPEDE Spectrometer

Our contribution to physics at IDS got stronger through addition of the SPEDE spectrometer to the IDS ancillary detectors arsenal. Redesigning parts of SPEDE allowed for performing the first SPEDE experiment where the low-lying excited states in ^{182,184,186}Hg were populated through β decay of ^{182,184,186}Tl. The experiment did not only assess the structure of low-lying states in Hg isotopes, but it also provided essential information for the planned Coulomb excitation experiments at HIE-ISOLDE. Preliminary data is shown below. ●

JANNE PAKARINEN
ISOLDE
project leader



Gamma-ray and electron energy spectra gated on the 576 keV γ-ray transition measured for the ^{182}Hg isotope in the IS641 experiment. A partial level scheme is shown in the inset of the bottom spectrum. The most prominent peaks have been labelled according to the corresponding transition energy and the position of the 335 keV E0 transition is also indicated in the γ-ray energy spectrum.

TUOMAS GRAHN
FAIR project leader

FAIR (Facility for Antiproton and Ion Research in Europe GmbH) Operations

Preparation of the Finnish in-kind contributions to FAIR progressed smoothly in 2018. Two new in-kind contracts were signed and the development of energy-loss detectors for the Super-FRS proceeded to its final design phase. Civil construction of FAIR in Darmstadt is moving ahead as scheduled, being one of the largest construction projects in science. The most visible part is the concrete structure of the SIS100 synchrotron tunnel.

The FAIR Phase-0 experiment campaign that was supposed to start in summer 2018 was shifted to 2019 and 2020. This was caused by an unfortunate fire incident at the injector accelerator complex and the clean-up efforts that followed.

MONSTER Neutron Detectors

Studies of beta-delayed neutron emission in nuclei far from stability are one of the goals of the NUSTAR experiment of FAIR. The knowledge of the beta-decay properties contributes not only to the understanding of nuclear structure, but is also essential in the understanding of the astrophysical heavy-element nucleosynthesis.

In order to determine neutron emission properties, time-of-flight measurements using liquid scintillator counters will be carried out. For such studies, the modular MONSTER neutron detector array consisting of one hundred detectors will be constructed. Eight MONSTER modules will be provided in-kind by Finland and have been assembled at the University of Jyväskylä. The partial assembly of the MONSTER array is ready for experiments at the Accelerator Laboratory of the University of Jyväskylä as part of the FAIR Phase-0 experimental campaign. The in-kind contract of the MONSTER detectors was signed in 2018.

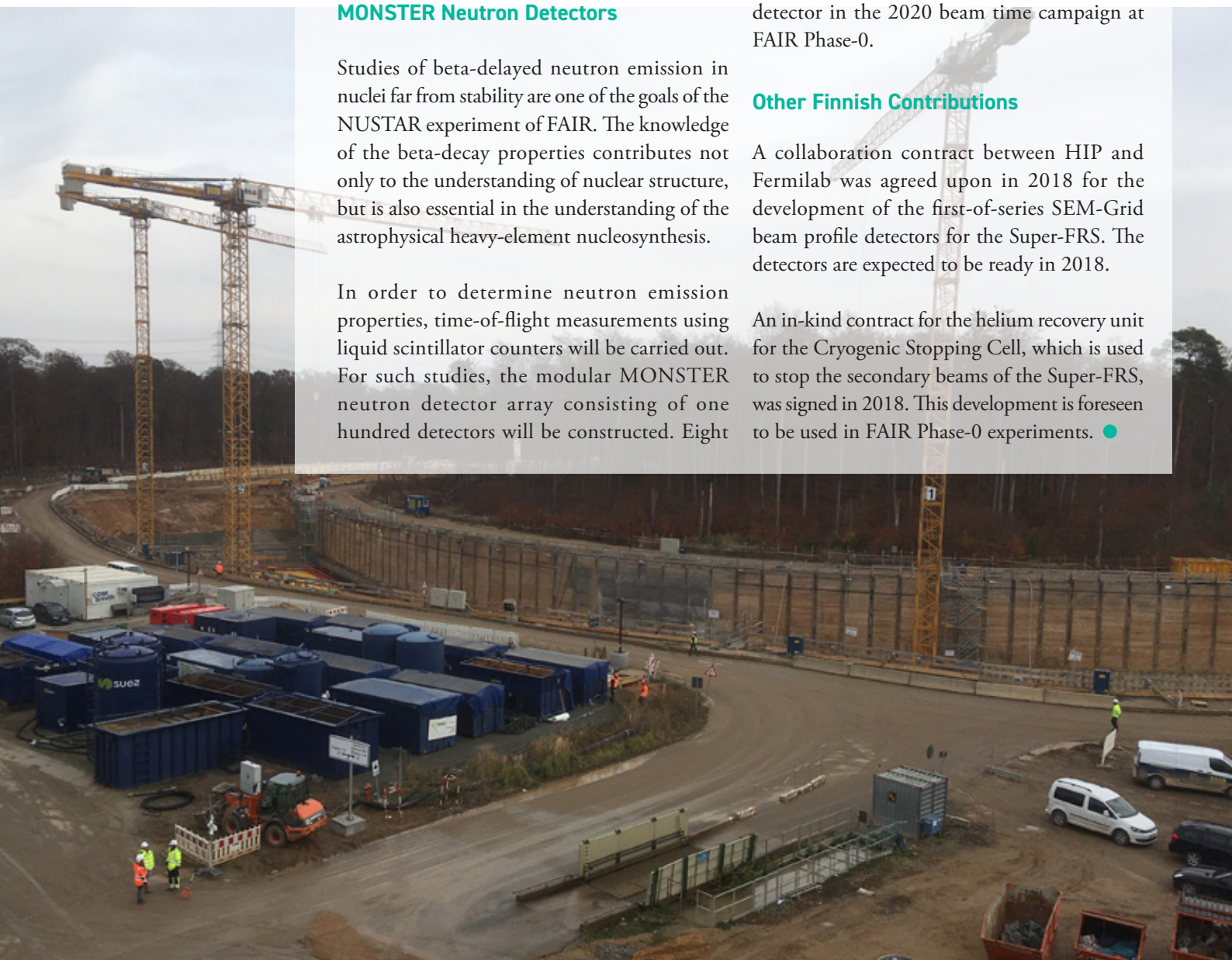
MUSIC Energy-Loss Detector of Super-FRS

Development of the MUSIC energy-loss detectors that will be used for the atomic number Z identification of the beam particles at the Super-FRS fragment separator proceeded as planned. The Conceptual Design Report was reviewed in November 2018. This is a joint development between HIP, the University of Jyväskylä and the detector laboratory of GSI/FAIR. The aim is to test the first-of-series detector in the 2020 beam time campaign at FAIR Phase-0.

Other Finnish Contributions

A collaboration contract between HIP and Fermilab was agreed upon in 2018 for the development of the first-of-series SEM-Grid beam profile detectors for the Super-FRS. The detectors are expected to be ready in 2018.

An in-kind contract for the helium recovery unit for the Cryogenic Stopping Cell, which is used to stop the secondary beams of the Super-FRS, was signed in 2018. This development is foreseen to be used in FAIR Phase-0 experiments.



Construction of the SIS100 accelerator tunnel at FAIR in Darmstadt.

Forward Physics in ALICE at the LHC

The Helsinki Forward Physics group concentrates on studies of the space-time structure of high energy hadron collisions. The ALICE experiment at CERN provides an ideal framework for these studies based on the set of central and forward detectors with their excellent tracking, particle identification, rapidity and transverse momentum coverage. Moreover, during the normal high luminosity proton-proton runs at the LHC, ALICE can continue collecting precious forward physics data due to its special optics arrangement, while the larger general purpose experiments, ATLAS and CMS, have to cope with large amounts of simultaneous collisions during the same bunch cross-overs (pile-up). In 2018, publications on inclusive diffractive cross sections, glueball analysis and partial wave analysis had been completed, and several major conference presentations were given. By the end of the 2018 run periods, ALICE had collected about 5.5 pb^{-1} of pp Double Gap events for the analysis of glueballs and exotic central states.

M. Mieskolainen introduced the GRANIITTI Monte Carlo event generator and algorithmic engine for high energy diffraction simulation and analysis, and DeepEfficiency - the first Deep Learning based optimal detector efficiency inversion algorithm, both redefining the state-of-the-art. The first fiducial combinatorial cross section measurement of inclusive diffraction at the LHC and the first multivariate Maximum Likelihood extraction of the effective Pomeron intercept and diffraction component cross sections were finished in ALICE, using the developed simple incidence algebra structure and logic. All calculations, simulations, algorithms and analysis frameworks are Open Source, for accelerating science.

Using the LHC Ring for Tagging Forward Physics Events

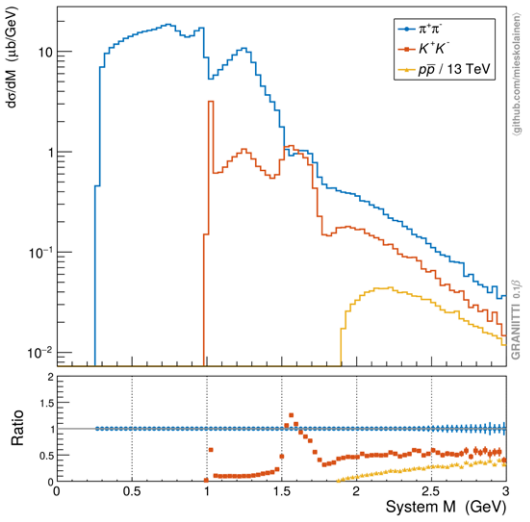
As a proposal for using the LHC ring in forward physics event tagging had been completed, several major conference presentations were given in 2018. The proposal aims at configuring a new physics search facility based on existing instrumentation of the LHC ring and the LHC experiments. The approach is novel, and uses the LHC Beam Loss Monitoring (BLM) and other LHC beam instrumentation devices for tagging the new physics event candidates in a model independent way. The physics potential of the proposed facility is huge.

A number of selected physics processes, based mainly on Central Exclusive Production (CEP) are studied. The CEP processes provide an ideal test ground for the proposal, with a pair of coincident final state protons - exiting the LHC beam vacuum chamber - being used to tag the event candidates. The fractional momenta of the final state protons are directly related to the invariant mass of the centrally produced system.

Forward Detector R&D

The group has participated in the development of novel particle detection techniques for the benefit of forward physics studies in ALICE (the AD and FIT projects).

The Helsinki group is also involved in the CERN experiment MoEDAL, searching for magnetic monopoles, and the CDF experiment at the Fermilab Tevatron.



GRANIITTI Monte Carlo simulation of interfering resonance structures and continuum in low-mass exclusive diffraction within ALICE fiducial phase space *[M. Mieskolainen, Diffraction and Low-x 18, Reggio Calabria, Italy, August 2018, arXiv:1811.01730] [M. Mieskolainen, under GPL-3.0 and MIT Licenses at www.mv.helsinki.fi/home/mmieskol and github.com/mieskolainen].*

RISTO ORAVA
ALICE-Forward project leader

TECHNOLOGY PROGRAMME

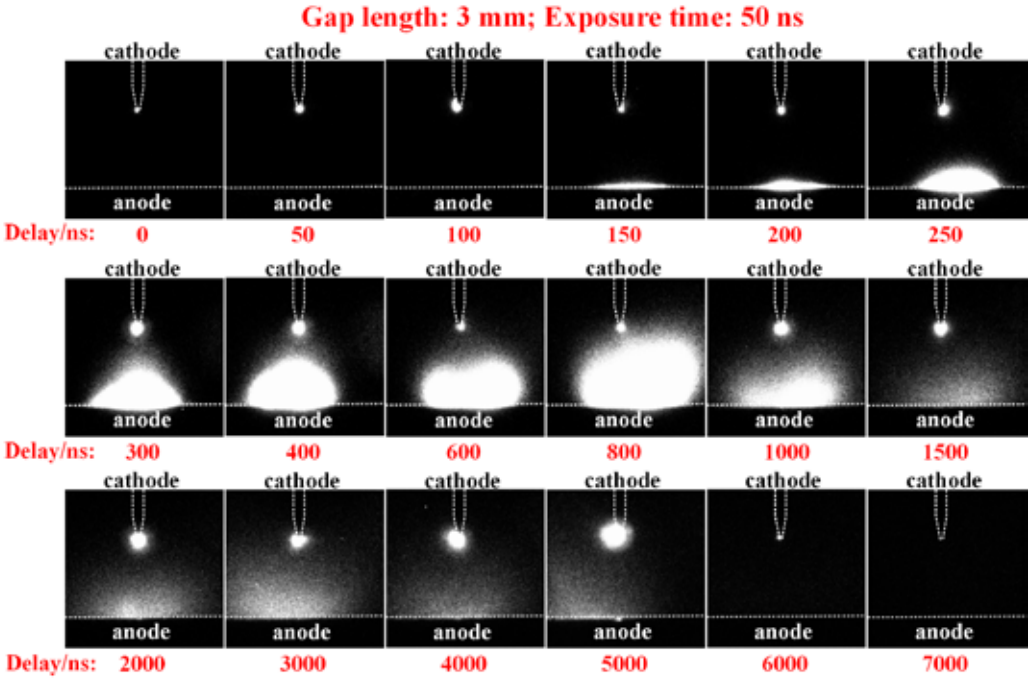
The Technology Programme aims to integrate in the same programme HIP projects that have significant technology development, transfer and pre-commercialisation activities. In addition, the research activities performed within the programme are designed to seek synergies with big science initiatives at large. The programme is structured into three thematic areas: systems, materials, and technology, each consisting of several small projects. Several projects have been successful in raising external funding for the R&D work, strengthening the impact of the programme.

FILIP TUOMISTO
Technology Programme director

FLYURA DJURABEKOVA
Materials for Accelerator Technology (MAT) project leader

Materials for Accelerator Technology (MAT)

The project Materials for Accelerator Technology (MAT) deals with problems mainly related to the performance of a well-conducting material (Cu) in the operational condition of accelerating structures of linear accelerators. The structures are developed to withstand high-gradient electromagnetic fields, which results in frequent sparks near the surface disturbing bunches of accelerated particles. This problem strongly limits performance of the accelerating structures designed for the Compact LInear Collider (CLIC). In the group, we develop multiscale computer simulation models to describe the behaviour of metals under a high electric field. On the other hand, strongly accelerated particles may cause significant damage if they impact surrounding materials. Since in this case, the energy is mainly deposited to the electronic subsystem, the modelling of how the energy is translated in the radiation damage is also the focus of the group. We develop a multiscale model to span from electronic properties of metal surfaces, using density functional theory methods, to microscopic mechanical behaviour of surfaces in response to loads of cyclic tensile stress due to interaction between an electric field and a charged metal



Nanosecond-time-resolved light emission of the vacuum arcing process. The gap is 3 mm and the pulse length 5 µs. The electrodes are outlined by white dashed lines (the cathode in the shape of a thin long tip and the anode as a large flat surface). The numbers under each frame denote the delay time Δt. The camera exposure time is t_w = 50 ns.

surface, using atomistic simulations methods combined with continuous electrodynamic models. The highlight of the research carried out in 2018 is the clear understanding of the role of electrodes in the formation of conducting channels during the breakdown process and understanding the effect of geometric enhancements on the electron emission currents prior to a breakdown event. We also performed statistical analysis of experimentally measured breakdowns and found clear correlations of the probability of breakdown and voltage increase during the voltage ramping process. In our research we collaborate closely with Dr. W. Wünsch (CERN), Prof. Y. Ashkenazy (Hebrew University of Jerusalem), Dr. V. Zadin (Tartu University) and Dr. Zh. Wang (Xi'an Jiaotong University). The group consists of the project leader (Dr. F. Djurabekova), two postdoctoral researchers (Dr. V. Jansson and Dr. A. Kyritsakis) and four graduate students (E. Baibuz, M. Veske, A. Saressalo and J. Lahtinen), and two undergraduate students (H. Toijala and J. Romppainen).

More details can be found at: http://research.hip.fi/hwp/acctech/accelerator-technology/m-a-t/

In August 2018, R. Montonen successfully defended his PhD thesis on the development of a non-destructive micron precision measurement method for the internal shape of the CLIC accelerating structure. In the picture, Montonen together with Custos Professor E. Hæggström and Opponent Professor W. Osten.

Accelerator Technology: Module, Structures and Manufacturing (MSM)

The Accelerator Technology: Module, Structures and Manufacturing project (MSM) collaborates strongly with various groups and projects at CERN: e.g., the Compact LInear Collider (CLIC) study at CERN is developing a two-beam technology for a multi-TeV electron positron collider. The CLIC study has entered a new phase of technical development and optimisation that has led to a Project Implementation Plan in 2018 as a basis for the European strategy update in 2019.

The focus of the HIP contribution is on a) R&D for the manufacturing of CLIC RF structures and the re-engineering of the so-called CLIC module (the smallest modular entity containing all sub-systems of the accelerator); b) an R&D activity on a cooling system for Beam Instrumentation in close collaboration with the BI group at CERN; c) taking part in CompactLight (an EU project on the design of future normal conducting FELs); d) ramping up a common project with high precision detector mechanics.

The work is executed in close collaboration with the CERN CLIC accelerating structures group of Dr. W. Wünsch and the CLIC module team of Dr. S. Döbert (co-led by Dr. M. Aicheler), and several Finnish industrial and academic partners. In 2018, the project had one researcher (J. Väinölä) and the project leader (Dr. M. Aicheler) at CERN plus three PhD students (A. Meriläinen, R. Montonen and A. Holmström) based in Helsinki.

More details can be found at: http://research.hip.fi/hwp/acctech/accelerator-technology/m-s-m/

MARKUS AICHELER
Accelerator Technology: Module, Structures and Manufacturing (MSM) project leader

ILJA MAKKONEN
Materials for Big Science Installations (BIGS) project leader

Materials for Big Science Installations (BIGS)

The development and characterization of new materials for extreme environments is at the core of technological needs of Big Science. Large installations where the structural materials face physical and chemical environments that are extremely hostile - such as large particle accelerators, fusion experiment devices, or nuclear power plants - are either already facing or rapidly approaching the stage where ageing becomes a serious issue. Choosing and developing materials for next-generation facilities is critical for cost and environmental efficiency. To develop novel materials, it is crucially important to understand the coupling of the processes from atomistic to macroscopic scales. This HIP Technology project focuses on two classes of materials. Firstly, a novel materials class, the high-entropy alloys (HEAs) that can be tailored to suit multiple potential applications, and secondly, tungsten (W), an important plasma-facing material to be used in future fusion reactors.

High entropy alloys are a relatively new class of metallic alloys that contain five or more elements in nearly equivalent ratios, and research related to this group of materials is barely 12 years old. HEAs differ significantly from conventional metallic alloys such as steel-based Fe-C alloys, cupronickels and bronze, where there are one or two main elements with other alloying elements clearly in the minority. Global interest towards HEAs lies in the exceptional properties of these alloys such as unique corrosion or abrasion resistance, radiation hardness, or performance at extreme (either low or high) temperatures. HEA performance under extreme conditions (corrosive environments, particle radiation) is a global hot topic, while a fundamental understanding of these types of materials from the atomic scale to macroscale is currently missing from the scientific literature.

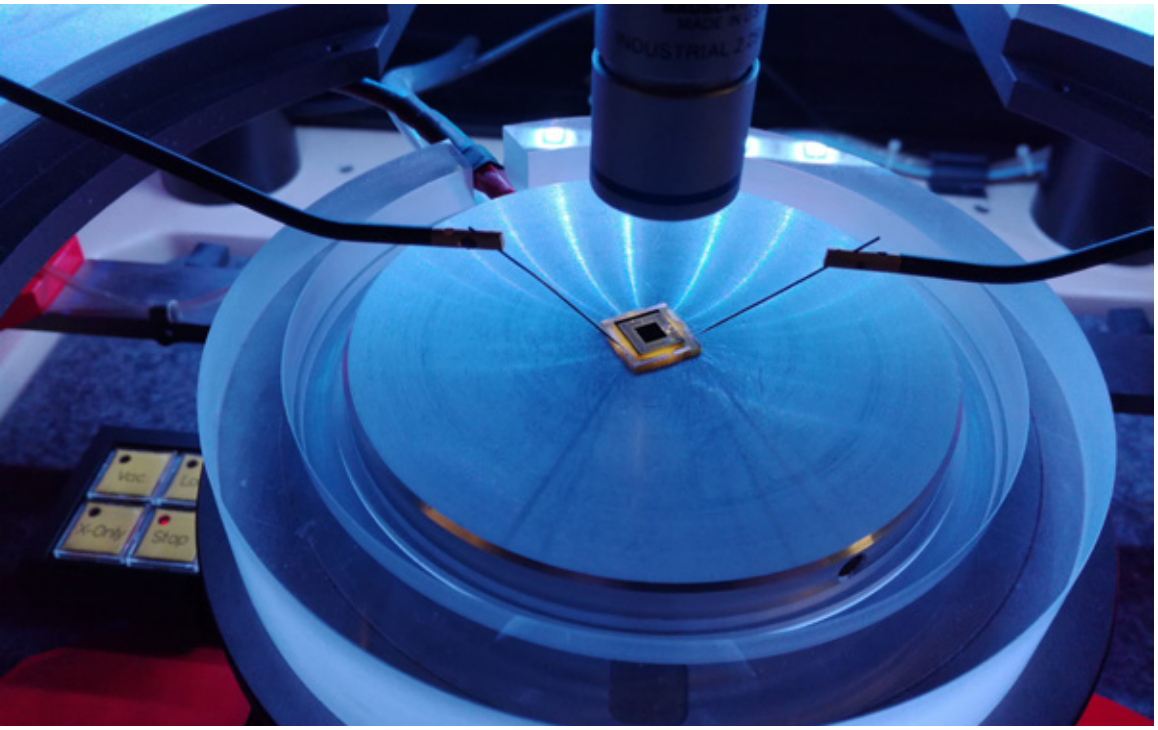
The main general goal is to advance the fundamental understanding of HEA and W properties through highest-quality internationally networked collaborative research.

There are two main aspects in the local research at Aalto University: experimental characterization using especially the positron annihilation technique, and first-principles calculations of the metals and metallic alloys as well as defects and defect clusters inside. The modelling can be used to predict such properties as defect formation energetics, diffusion and segregation of elements in the alloys, and also make a link between the microscopic defect structure of the alloys and the indirect information contained in the measured spectra. In 2018 the main focus of the project was on the experimental defect studies of irradiation-induced defects in a prototypical HEA alloy, the so-called Cantor alloy (FeCrMnNiCo). ●

TEEMU SIISKONEN
Radiation Metrology for Applications project leader

Radiation Metrology for Applications

The increasing frequency of computed tomography (CT) medical imaging calls for efficient patient exposure optimisation. This optimisation aims at as low a patient dose as possible, with the constraint that the required diagnostic information must be obtained from the acquired CT image. The Radiation Metrology for Applications project develops novel position sensitive photon counting detectors and the associated image reconstruction methods to perform CT scans with lower patient exposure and with improved image quality. Different detector technologies have been tested and characterized at the Secondary Standards Dosimetry Laboratory of the Finnish Radiation and Nuclear Safety Authority (STUK). These detectors include different scintillator materials combined with Si photodiode arrays and pixel detectors as well as CdTe pixel detectors. The detectors are also tested at high dose rates used in external beam radiation therapy, and the aim is to use the detectors in quality assurance of modern radiotherapy beams as well. The project partners are the Helsinki Institute of Physics, Aalto University, Lappeenranta University of Technology and STUK. The project receives funding from the Academy of Finland.



Quality assurance of a Si diode with the probe station.

In 2018 a new project Radiation Detection in Coincidence and List Mode (RADICAL) started. STUK and the University of Jyväskylä will develop multi-parameter list mode data acquisition methods and algorithms to be used in laboratory measurements at STUK. The research continues the R&D done earlier at STUK, when a device for simultaneous alpha, photon and beta radiation measurements (PANDA) was developed. ●

Finnish Business Incubation Center of CERN Technologies

The CERN Business Incubation Network aims to improve commercialisation, and therefore, social utilisation, of CERN-related technologies in each member state. The FBC (Finnish Business Incubation Center of CERN Technologies), the CERN BIC in Finland, was established in 2015. The FBC is operated under the Technology Programme at HIP.

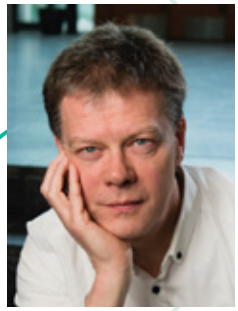
During 2018 the opportunities to organise FBC operations have been discussed with multiple partners nationally and the organising of activities has been discussed. In the light of these discussions, the aims of the project as part of HIP's Technology Programme has also been scrutinised.

The aim of the FBC is to support businesses and entrepreneurs in taking innovative CERN technologies from a technical concept to market reality. Specifically, the aim is to find, screen, support and pre-incubate pre-commercialisation and/or the early commercialisation phase of ideas and technologies.

We also investigate the industrialisation process of CERN technologies, and the societal impact of scientific projects and research centres as part of the whole R&D&I process.

The project as part of the Technology Programme has also supported a number of other R&D&I activities nationally and this has resulted in new research projects and activities with CERN. Namely, three new Business Finland -funded co-creation projects have started during 2018 and a few more are in preparation for 2019. ●

SAKU MÄKINEN
BIC project leader



PETER DENDOOVEN
NINS3
project leader

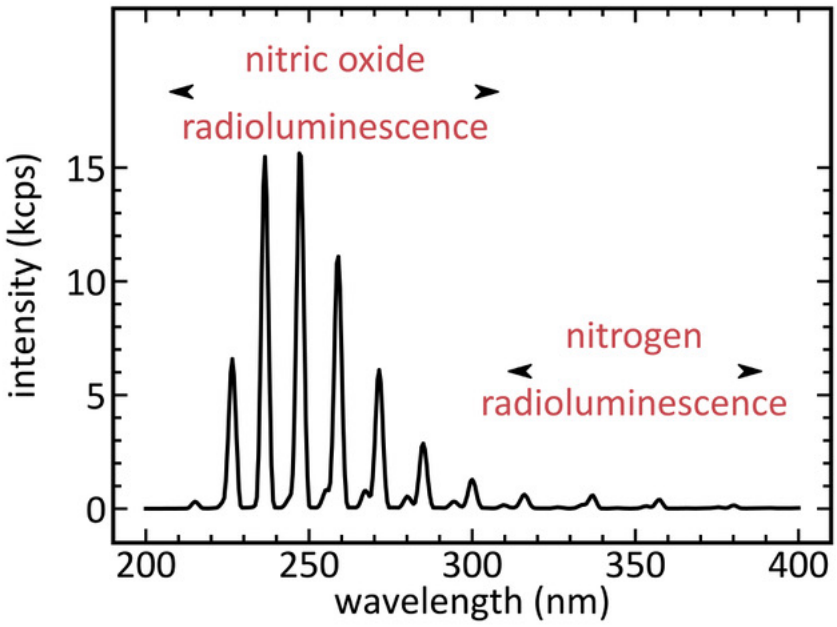
Novel Instrumentation for Nuclear Safety, Security and Safeguards (NINS3)

Good stewardship of nuclear materials and an adequate response to threats that potentially involve nuclear materials are essential now and far into the future. In this context, the "Novel instrumentation for Nuclear Safety, Security and Safeguards" (NINS3) project performs R&D on passive tomography of spent nuclear fuel, alpha-radiation threat detection and imaging from a distance, and active neutron interrogation of unknown objects. The project is an integral part of the National Radiation Safety Research Programme. The project partners are the Helsinki Institute of Physics, the Finnish Radiation and Nuclear Safety Authority STUK, Tampere University of Technology and a consortium of companies in Finland involved in or in need of radiation measurements.

Analysis of the gamma-ray imaging data taken with the PGET instrument at the Loviisa and Olkiluoto nuclear power plants in Finland has proceeded along two lines. More or less standard image reconstruction methods were used to investigate the image quality versus gamma-ray energy and versus the number of tomographic angles and measurement time per angle. We conclude that at least 144 angles are needed and that the total measurement time can be as low as 1 minute before losing image quality. In a collaboration with the Department of Mathematics and Statistics at the University of Helsinki (R. Backholm, T. Bubba, S. Siltanen) good progress was made in the development of a novel image reconstruction technique in which gamma-ray emission and attenuation are reconstructed simultaneously. This is important to avoid compromising the search for missing or replaced fuel rods.

The design of a PNAR (Passive Neutron Albedo Reactivity) instrument to measure fuel assembly neutron multiplication, in close collaboration with STUK and S. Tobin (on leave from Los Alamos National Laboratory), was finalised. A prototype device has been under construction in close collaboration between STUK and the HIP Detector Laboratory.

The germanium gamma-ray imaging spectrometer GeGI purchased from PHDS Co. was used in a field test of the international Border Monitoring Working Group. The development of data analysis and image reconstruction algorithms that are optimised for high-energy gamma rays is ongoing in close collaboration with PHDS Co.



Spectrum of the light that arises in an atmosphere where 50 ppm of nitric oxide is diluted in nitrogen. In this gas environment, light produced by alpha-excited nitric oxide is about 25 times more intense than that of the commonly used nitrogen. It is also located in the part of the electromagnetic spectrum that makes it possible to design systems that detect this light without interference by daylight.

Remote detection of alpha radiation has proceeded on two separate tracks. ICCD and EMCCD cameras have been employed to remotely detect and image alpha-induced luminescence exhibited from an alpha-active liquid. We measured the spectrum of the luminescence and made progress on exploring the physics that might give rise to this little studied but potentially useful phenomenon. At the same time, significant progress has been made to understand alpha-induced luminescence by nitric oxide. This type of luminescence overcomes two of the main challenges that can make it difficult to remotely detect alpha radiation by optical means. In situations where the gas environment can be controlled, this type of luminescence allows for remote alpha detection under daylight conditions with much higher sensitives.

Diagnostics: Novel Gamma-Ray Spectroscopy for Radioactive Materials Testing (GAMMA)

Securing sufficient and environmentally sustainable electricity production is one of the main challenges for the future. To this aim, nuclear reactors do not suffer from intermittencies observed in solar or wind resources and allow an efficient and flexible basis for the highly demanding electricity network, especially around big cities and industries. In such reactors, materials are held under extreme environments, so that maintaining their tailored properties during their lifetime requires building a perfect knowledge of the correlation between the microscopic and macroscopic scales. Our understanding of the local structure of atoms, as well as the impact of defects in the material is a key knowledge to assess such correlation and ensure safety. However, due to the high radioactivity of used materials, well established and efficient characterization methods for material characterization are, when possible, quite difficult to apply, and generally require specific and innovative instrumental developments. The GAMMA project aims to provide two of them, by developing new X-ray Absorption Spectroscopy (XAS) and Positron Annihilation Lifetime Spectroscopy (PALS) devices that allow the study of high radioactive matter in the laboratory.

The first technique, XAS, is sensitive to both the oxidation state of and the local environment around one given atom in materials, delivering direct information on the material structure. XAS measurements are possible despite the necessary but highly constraining confinement barrier arising from safety consideration. However, currently only available at synchrotron radiation facilities, XAS applicability to radioactive materials suffers from the finite and low success rate of synchrotron access, the high costs of radioactive sample shipment, and the low number of dedicated beamline accepting highly radioactive samples.

The second technique, PALS, is a well-known method to probe the nature of vacancy type defects, i.e., the absence of atom(s), in a given material structure. Widely applied on semiconductors and metals since decades, its application on radioactive materials has been limited due to their natural or irradiation induced high radioactivity background, leading to a distorted signal.

During 2018, the priority has been given to the design, mounting, testing and demonstration that the proposed device allows suppressing of the distortion of the signal when applied to highly radioactive materials. The main idea behind the innovative approach is to couple three scintillator detectors instead of two in state-of-the-art PALS setups and to add a new coincidence trigger in order to significantly reduce the background arising from radioactivity and distorting the lifetime measurement when detected. The proof of the concept has been achieved, leading to the commissioning and finalisation phases to be done in early 2019, along with the XAS device development.

RENÉ BÈS
GAMMA
project leader

DETECTOR LABORATORY

EIJA TUOMINEN
Detector Laboratory coordinator

The Helsinki Detector Laboratory is a national permanent infrastructure specialised in the **instrumentation** of particle and nuclear physics. It is a joint laboratory between the Helsinki Institute of Physics and the Department of Physics of the University of Helsinki. The Laboratory provides premises, equipment, expertise and technical support for research projects that develop detector technologies. The Laboratory team has extensive expertise in the modelling, design, construction and testing of semiconductor and gas-filled radiation detectors. Priorities are set by the Detector Laboratory Steering Board.

All the Detector Laboratory projects have the objective of providing reliable instruments for **large international physics experiments**. The Laboratory is specialised in the quality assurance of detectors and their components and in detector prototyping. In 2018, the Laboratory hosted projects participating in the instrumentation of the CMS, TOTEM and ALICE experiments at CERN, and the NUSTAR experiment at FAIR. In addition, the Laboratory hosted externally funded projects by the Academy of Finland and Business Finland. Furthermore, the Laboratory has a wide network of **national collaboration**, consisting of instrumentation laboratories and physics departments of all the HIP member universities.

Providing **education** in the instrumentation of physics is of outmost importance to the Detector Laboratory. In the framework of the Master's Programme for Particle Physics and Astrophysical

In 2018, the Detector Laboratory team completed the large quality assurance project for the CERN ALICE TPC detector.

The Detector Laboratory hosted a Nordic laboratory course in detector technologies.

Sciences (PARAS), the Laboratory offers a study module of instrumentation consisting of four different courses about detector technologies, including hands-on laboratory exercises. In addition, in 2018, the Laboratory organised a one-week research training course in detector technology for particle physics for Nordic post-graduate students. The Laboratory team also supervises the dissertation work of Doctoral and Master's students, especially in the framework of the Doctoral Programme in Particle Physics and Universe Sciences (PAPU).

In the Laboratory, special effort is devoted to **societal interaction** among young people. In 2018, about 250 high-school students visited the Laboratory. In addition, the team took part in several outreach events, e.g., CERN Master Class, Science Bazaar, EU Researchers' Night, Smart as Hel, and Bring-Your-Child-to-Work. A special outreach activity, led by the HIP director, was to visit a primary school for teaching particle physics to eight-year-old children and later invite the class to the Laboratory to work with instrumentation. Furthermore, two secondary school TET trainees and two Taksvärkki trainees did their practice in the Laboratory. Members of the Laboratory team have also been active in promoting wellbeing in the Faculty of Science. ●

CLOUD

MARKKU KULMALA
CLOUD
project leader

Background

Indirect observations and theoretical studies have suggested that galactic cosmic rays (GCR) may have influenced the Earth's cloud cover and climate, possibly by affecting the properties of aerosol particles. These tiny particles, floating in the atmosphere, influence the Earth's climate system via two mechanisms. First, they can directly reflect or absorb solar radiation, and second, they can act as seeds for the formation of cloud droplets or ice crystals and thereby affect the lifetime and precipitation of clouds. Measuring the underlying microphysics in controlled laboratory conditions is a key to understanding the dynamical behaviour of aerosol particles and cloud droplets, including the formation and growth processes of aerosols particles, cloud droplet activation and ice nucleation. The CLOUD (Cosmics Leaving OUtdoor Droplets) experiment at CERN is one of the most advanced laboratory setups for studying the formation and growth of atmospheric aerosol particles. The experiment aims to find the possible pathways of these phenomena and to evaluate their significance for example by using the CERN proton synchrotron to vary levels of GCR in the CLOUD experiment.

The CLOUD Collaboration comprises 21 institutes, with a strong Finnish contribution (the University of Helsinki, the Helsinki Institute of Physics, the University of Eastern Finland and the Finnish Meteorological Institute).

Experiments in 2018: The CLOUD13 Campaign

Since the building of the CLOUD chamber in 2009, 13 measurements campaigns have taken place. In 2018, CLOUD13 investigated particle formation in conditions relevant to the marine atmosphere, boreal forest, semi-urban and urban environments. The Finnish team

The CLOUD experiment, surrounded by detectors brought by the participating institutes.

made an important contribution by operating instruments such as particle counters and mass spectrometers.

Data Analysis, Education and Reporting of Results

Our 2 INAR CLOUD PhD students (from the third CLOUD MSCA ITN funding: CLOUD-MOTION) started their PhD positions in the Doctoral Programme of Atmospheric Sciences at the University of Helsinki and they additionally follow international training organised by the CLOUD-MOTION project during the course of their PhD studies.

In 2018, regular CLOUD workshops (Cascais, Portugal and Innsbruck, Austria) were organised to support the analysis. During this year, we published 6 peer-reviewed papers on new particle formation within CLOUD, which are summarised briefly here. Määttänen et al. (2018) developed a parameterisation of the formation rate of particles from sulphuric acid, while Kuerten et al. (2018) re-evaluated the CLOUD formation rate data of sulphuric acid and the DMA system. For an organic dominated atmospheric chemical system, Frege et al. (2018) studied the influence of temperature on the composition of organic ions, Sarnela et al. (2018) studied the effect of stabilised Criegee on the organic chemistry leading to new particle formation, and Stolzenburg et al. (2018) focused on the growth of these particles. Finally, Lehtipalo et al. (2018) resumed and improved the results from a multicomponent system on new particles formation, which summarised the Helsinki-led experiments on boreal forest new particle formation during CLOUD10 and CLOUD11. ●

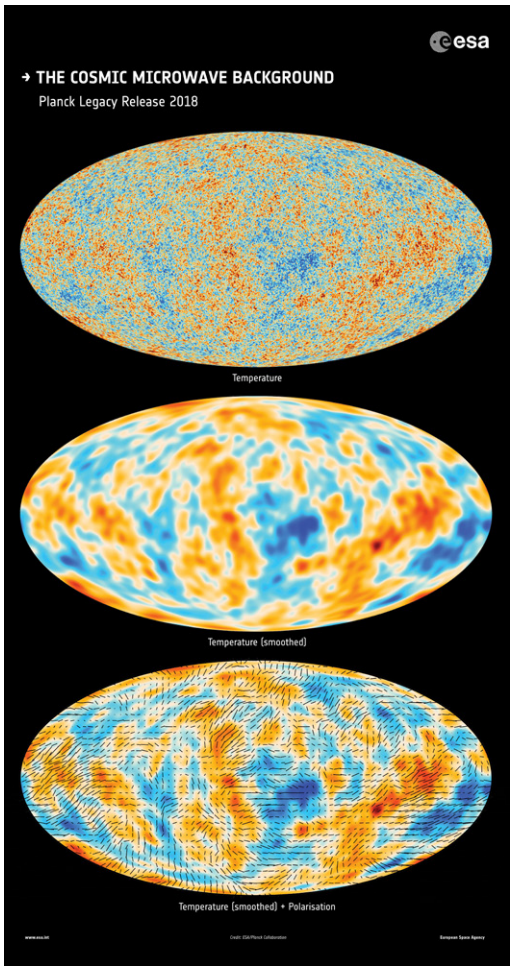
PLANCK-EUCLID

HANNU KURKI-SUONIO
Planck-Euclid project leader

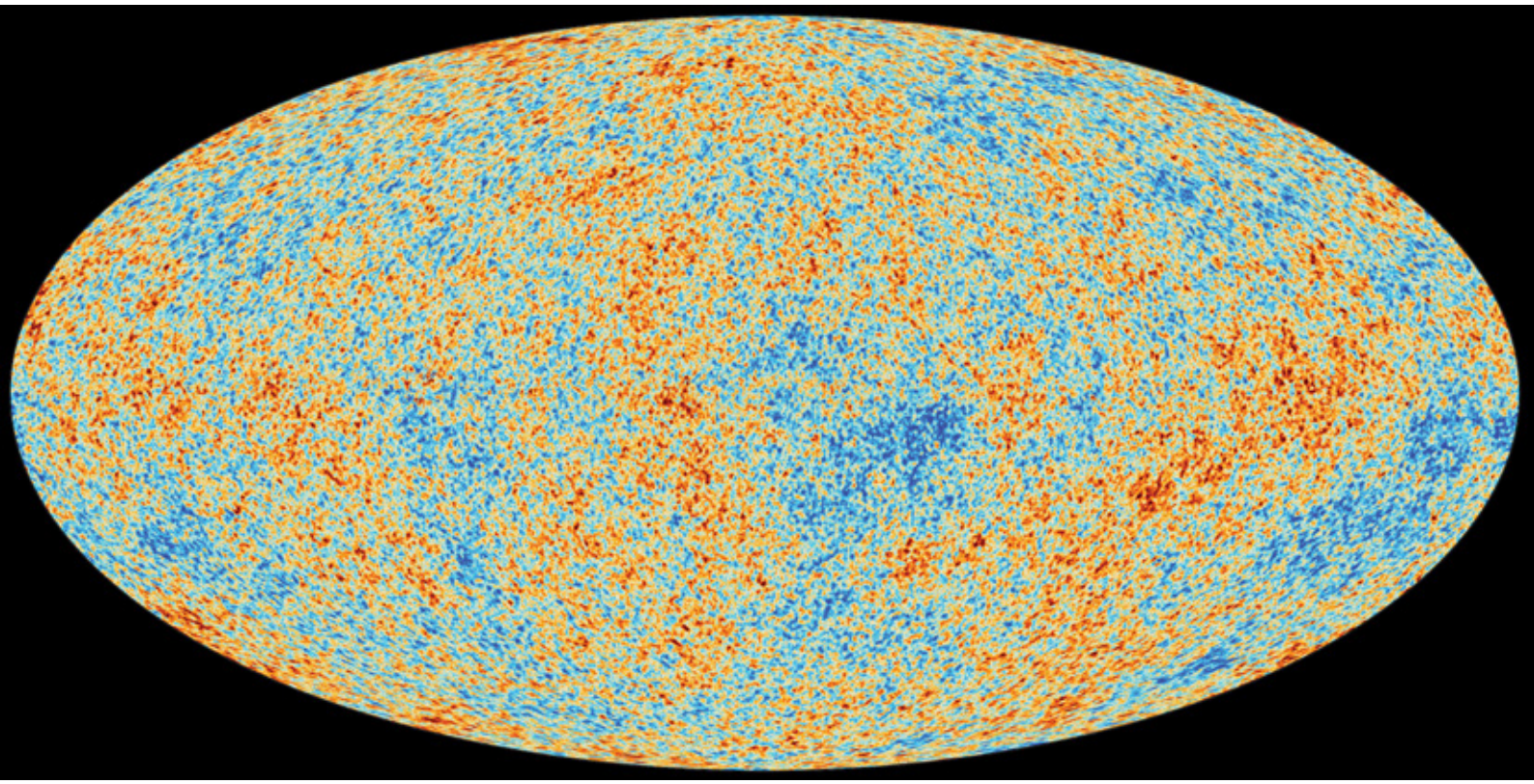
Planck and Euclid are the two cosmology missions of the European Space Agency. Planck measured the cosmic microwave background (CMB) with unprecedented accuracy to determine the properties of the universe. Euclid will study the "Dark Energy Question" - why is the expansion of the Universe accelerating? - surveying over one third of the sky obtaining images of over a billion galaxies and the spectra of tens of millions of galaxies. The Euclid Consortium will determine the 3-dimensional distribution of galaxies and dark matter in the universe, compare their statistics to cosmological models and thus constrain the law of gravity and the dark energy equation of state. Euclid and Planck complement each other in improving our understanding of the universe, its structure, composition, origin, and governing forces, Planck concentrating on the early universe and Euclid on its later evolution. Planck made observations from 2009 to 2013; Euclid will be launched in 2022 and will make observations for 6 years.

Planck

The final official Planck results were released in July 2018. The Planck data is openly available in the Planck Legacy Archive. Planck determined the properties of the universe with high precision. For example, the age of the universe is 13.8 billion years, the energy density of the universe is dominated by dark energy, ordinary matter making up only 4.8% and cold dark matter, consisting of unknown particles, 26.7% of the total. Planck results support the standard model of cosmology, the LambdaCDM model, which is the simplest model that fits the data; and provide tight constraints to any deviations from this model. For example, the large-scale geometry of the observable part of the universe deviates from "flat" (Euclidean) by less than 2%. We participate in BeyondPlanck,



The Cosmic Microwave Background temperature and polarisation.



Planck's view of the cosmic microwave background.

an initiative funded through the Horizon 2020 programme of the EU. We reprocess Planck data through an iterative approach where calibration, map-making and component separation are performed jointly. The goal is to achieve better separation of CMB and astrophysical components, and ultimately, more accurate estimation of cosmological parameters.

Euclid

We operate one of the nine Euclid Science Data Centers, SDC-FI, which will eventually analyse Euclid data and are now being prepared for this. It runs on virtual machines at the CSC Kajaani Data Center. In 2018 the capacity of SDC-FI was increased to 1536 virtual CPUs (848 physical computer cores). We participated in the production of simulated Euclid data for the Euclid SDC Science Challenge 4/5/6, where the current version of the Euclid data analysis pipeline is tested. We have the main responsibility in Euclid for validating the code to estimate the 2-point correlation function (2PCF) of the galaxy distribution, one of the main cosmology products of Euclid, and this task has occupied most of the SDC-FI computing capacity. We have introduced improvements in the 2PCF estimation algorithm and its implementation.

EDUCATION AND OPEN DATA

KATRI LASSILA-PERINI
Education and Open Data project leader

The Education and Open Data project covers and connects two activities: the Finnish high-school visit programme at CERN and the data preservation and open access to CMS data. The project is led by K. Lassila-Perini, who also acts as the Data preservation and Open Access co-ordinator of the CMS experiment.

High School Visits

In 2018, 18 high-school groups from Finland, with a total of 351 students and 59 teachers, attended a three-day visit to CERN. The visits are preceded by extensive studies in schools, preparing students for an intensive lecture and visit programme at CERN. The programme is partly subsidised by the Finnish National Agency for Education, and co-ordinated by the national CERN high-school network. A two-day course for rectors and study counsellors and a one-week course for teachers were organised at CERN in 2018. The feedback from these visits was overwhelmingly positive, the students greatly appreciating the direct contact with the researchers and their enthusiasm, and the visits encouraged the students to join various scientific branches for their further studies.

CMS Data Preservation and Open Data Releases

After the third data release in 2017, including the data having contributed to the Higgs boson discovery in 2012, CMS is now consolidating the reusability of all Run1 legacy data. All tools and information will be publicly available for scientific or educational use of released data. Furthermore, virtual machine or containerised computing environments can be used to reconstruct raw data in a format appropriate for analysis and to generate new simulated data corresponding to Run1 detector and beam conditions. HIP summer students and trainees made important contributions in these areas, A. Lintuluoto testing an analysis by the HIP CMS experiment group on open data, and H. de Bittencourt consolidating the extraction of metadata of simulated data, and the search mechanisms on the CERN Open Data Portal. The next release, with data appropriate for machine learning studies, including a sample prepared by the HIP CMS group, is under preparation.

Open Data Training

A two-day course for the use of open data in schools, combining the two aspects of the project, was organised at the Jyväskylä Teacher Training School in September 2018, after the first successful training in 2017. The goal is to get familiar with CMS Open Data and prepare teaching material using them. The course was attended by 14 teachers and the feedback was very encouraging. In particular, the participants appreciated the ease of use of the suggested material in the form of jupyter notebooks and the possibility of extending and adapting the material for their own curriculum. The courseware is based on the work of HIP summer students during 2016-2017, further extended by two HIP summer students in 2018. The material was piloted during the CERN three-week teacher programme and the international two-week summer camp for high-school students. Use of open data in a real teaching situation is now being studied by P. Veteli, a 2018 summer student, preparing his Master's Thesis at the University of Helsinki. P. Rikkilä is finalising his Master's Thesis on using open data in physics practical work at the university level at the University of Jyväskylä. The exercise is now in use and has been well received by physics students.

JOINT ACTIVITIES

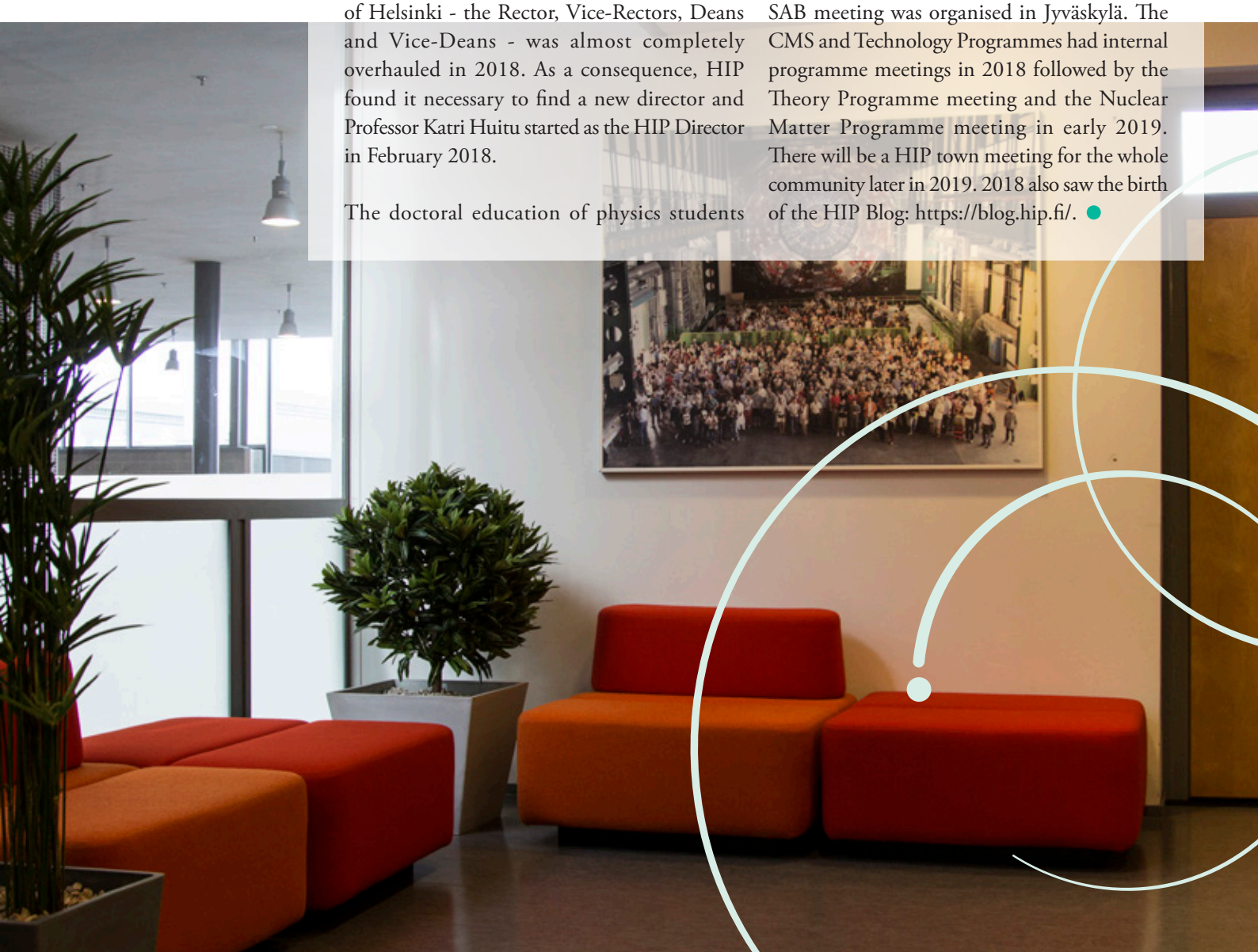
ANTTI VÄIHKÖNEN
Research coordinator

HIP is a joint institute of five universities. The Finnish Radiation and Nuclear Safety Authority (STUK) is an interim member of HIP for 2018-2019. The term of the HIP Board ended on 31st March 2018 and the member Universities and STUK appointed their representatives to the succeeding Board. The election of the personnel's representative was carried out in early March.

Several changes took place at the University of Helsinki, the host organisation of HIP, in 2018. At the start of the year the departments of the faculties at the University of Helsinki ceased to exist as financially independent units leaving HIP the only unit within the Faculty of Science retaining its financial independence. The Regulations of the University changed at the turn of 2018. The directorate of the University of Helsinki - the Rector, Vice-Rectors, Deans and Vice-Deans - was almost completely overhauled in 2018. As a consequence, HIP found it necessary to find a new director and Professor Katri Huitu started as the HIP Director in February 2018.

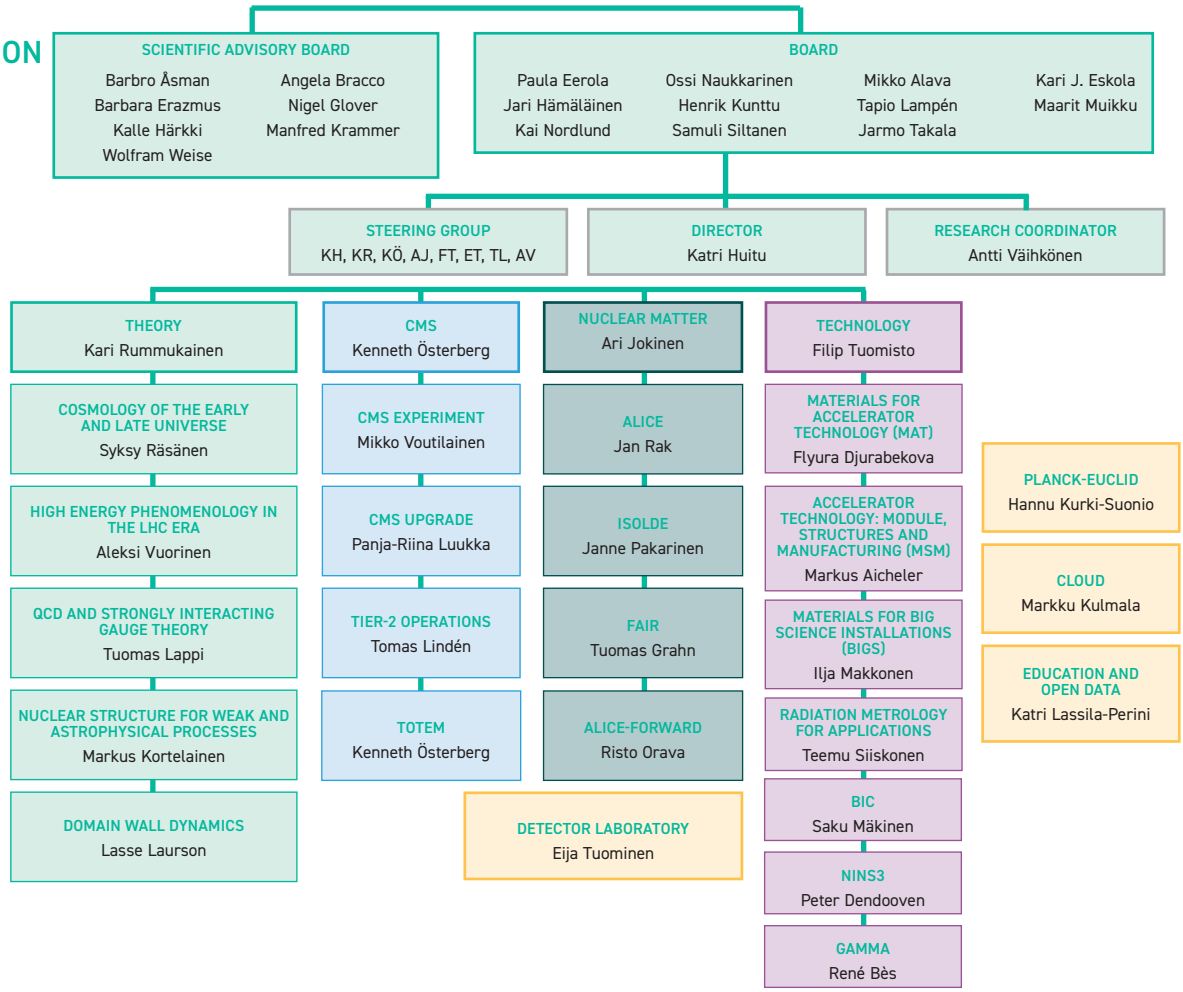
The doctoral education of physics students continues to be one of the main tasks of the Institute. In addition to the doctoral students, a fair number of undergraduate students have joined the research groups and are completing their Master's theses at the Institute. Many of them are continuing as doctoral students in the Institute projects. In 2018 the traditional CERN summer student programme included positions at ESRF in Grenoble for the third year running. During the period 2014-2018, 42 doctoral degrees and 60 Master's degrees have been earned in HIP research projects.

The effort to enhance HIP community awareness both within and outside HIP was increased in 2018. A Steering group meeting was held at Aalto University with a plan to maintain contacts and visits with other member universities. The SAB meeting was organised in Jyväskylä. The CMS and Technology Programmes had internal programme meetings in 2018 followed by the Theory Programme meeting and the Nuclear Matter Programme meeting in early 2019. There will be a HIP town meeting for the whole community later in 2019. 2018 also saw the birth of the HIP Blog: https://blog.hip.fi/.



ORGANIZATION AND PERSONNEL

ORGANIZATION



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The Board: Kari J. Eskola, Kai Nordlund, Tapio Lampén, Mikko Alava, Paula Eerola, Erkki Lähderanta (substitute member), Samuli Siltanen, Maarit Muikku, Ari Jokinen (substitute member).

THE SCIENTIFIC ADVISORY BOARD

CHAIR

Barbro Åsman, Professor (U. Stockholm)

MEMBERS

Angela Bracco, Professor (U. Milano and INFN)

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Nigel Glover, Professor (Durham U.)

Kalle Härkki, Executive Vice President, Dr. (Outotec)

Manfred Krammer, Department Head, Dr. (CERN)

Wolfram Weise, Professor (TU München)

PERSONNEL

Theory Programme

K. Rummukainen, prof., programme director

Cosmology of the Early and Late Universe

S. Räsänen, docent, proj. leader
K. Enqvist, prof., adj. senior scientist
A. Finoguenov, prof., adj. senior scientist
M. Hindmarsh, prof., adj. senior scientist
K. Kainulainen, prof., adj. senior scientist
O. Gould, scientist
S. Koksbang, scientist
A. Lopez-Eiguren, scientist
F. Montanari, scientist
J. Rubio, scientist
M. Karčiauskas, adj. scientist
S. Nurmi, adj. scientist
D. Weir, adj. scientist
J. Dahl, grad. student
V.-M. Enckell, grad. student
H. Jukkala, grad. student
O. Koskivaara, grad. student
L. Laulumaa, grad. student
J. Leskinen, grad. student
J.-M. Ojanperä, grad. student
S. Raatikainen, grad. student
P. M. Rahkila, grad. student
L. Tenhu, grad. student
E. Tomberg, grad. student
N. Venkatesan, grad. student
P. Wahlman, grad. student

High Energy Phenomenology in the LHC Era

A. Vuorinen, ass. prof., proj. leader
K. Huitu, prof., senior scientist
K. Kajantie, prof., adj. senior scientist
O. Lebedev, prof., adj. senior scientist
E. Keski-Vakkuri, adj. senior scientist
M. Sainio, adj. senior scientist
K. Tuominen, adj. senior scientist
M. Heikinheimo, scientist
T. Rindlisbacher, scientist
J. Tarrio, scientist
B. DiNunno, adj. scientist
T. Gorda, adj. scientist
C. Gross, adj. scientist
O. Henriksson, adj. scientist
N. Jokela, adj. scientist
V. Keränen, adj. scientist
V. Keus, adj. scientist
R. Paatelainen, adj. scientist
E. Annala, grad. student
N. Koivunen, grad. student
T. Kärkkäinen, grad. student
L. Niemi, grad. student
A. Pönni, grad. student
J. Remes, grad. student
M. Säppi, grad. student
T. Tenkanen, grad. student

QCD and Strongly Interacting Gauge Theory

T. Lappi, prof., proj. leader
K. J. Eskola, prof., adj. senior scientist
H. Niemi, adj. senior scientist
V. Guzey, scientist
H. Paukkunen, adj. scientist
S. Demirci, grad. student
H. Hänninen, grad. student
M. Kuha, grad. student
T. Löytäinen, grad. student
P. Paakkinen, grad. student
J. Peuron, grad. student
A. Ramnath, grad. student
A. Rantalaiho, grad. student
J. Suorsa, grad. student

Nuclear Structure for Weak and Astrophysical Processes

M. Kortelainen, Dr., proj. leader
J. Dobaczewski, prof., adj. senior scientist
W. Satuła, prof., adj. senior scientist
J. Toivanen, senior scientist
K. Bennaceur, adj. senior scientist
J. Niskanen, adj. senior scientist
T. Haverinen, grad. student

Domain Wall Dynamics

L. Laurson, Dr., proj. leader
T. Herranen, grad. student
I. Rissanen, grad. student

CMS Programme

K. Österberg, prof., programme director

CMS Experiment

M. Voutilainen, ass. prof., proj. leader
P. Eerola, prof., senior scientist
M. Kim, senior scientist
T. Lampén, senior scientist
K. Lassila-Perini, senior scientist (at CERN)
S. Lehti, senior scientist
J. Tuominiemi, adj. senior scientist
H. Kirschenmann, scientist
M. Kortelainen, scientist
J. Pekkanen, adj. scientist
T. Lindén, lab. engineer
J. Havukainen, grad. student
J. Heikkilä, grad. student
T. Järvinen, grad. student
K. Kallonen, grad. student
S. Laurila, grad. student
M. Lotti, grad. student
H. Siikonen, grad. student
T. Mäkelä, student

CMS Upgrade

P.-R. Luukka, Dr., proj. leader
E. Tuominen, senior scientist
I. Kassamakov, adj. senior scientist
E. Brücken, scientist
A. Winkler, scientist
T. Arsenovich, grad. student
M. Golovleva, grad. student
A. Gädda, grad. student
S. Kirschenmann, grad. student
L. Martikainen, grad. student
J. Ott, grad. student
V. Pyykkönen, grad. student
J. Tikkanen, grad. student

Tier-2 Operations

T. Lindén, Dr., proj. leader, grid coordinator

TOTEM

K. Österberg, prof., proj. leader
H. Saarikko, prof. emeritus, adj. senior scientist
M. Berretti, scientist
L. Forthomme, scientist
F. García, lab. engineer
T. Naaranoja, grad. student
F. Oljemark, grad. student

Nuclear Matter Programme

A. Jokinen, prof., programme director

ALICE

J. Rak, prof., proj. leader
D. J. Kim, adj. senior scientist
S. S. Räsänen, adj. senior scientist
W. Trzaska, adj. senior scientist
E. Brücken, scientist
T. Hildén, scientist
J. Viinikainen, scientist
J. Parkkila, grad. student
T. Snellman, grad. student
M. Vargyas, grad. student

ISOLDE

J. Pakarinen, Dr., proj. leader
P. Greenlees, prof., adj. senior scientist
A. Jokinen, prof., adj. senior scientist
I. Moore, prof., adj. senior scientist
T. Grahn, adj. senior scientist
K. Helariutta, adj. senior scientist
R. de Groote, adj. scientist
U. Jakobsson, adj. scientist
P. Rahkila, adj. scientist
M. Reponen, adj. scientist
P. Ruotsalainen, adj. scientist
S. Szwec, adj. scientist
J. Ojala, adj. grad. student

FAIR

T. Grahn, docent, proj. leader
E. Tuominen, docent, proj. coordinator
J. Äystö, prof., director emeritus, adj. senior scientist
A. Jokinen, prof., adj. scientist
I. Moore, prof., adj. scientist
H. Penttilä, adj. senior scientist
S. Rinta-Antila, adj. senior scientist
F. García, lab. engineer
M. Luoma, grad. student

ALICE-Forward

R. Orava, prof., proj. leader
M. Mieskolainen, grad. student

Technology Programme

F. Tuomisto, prof., programme director

Materials for Accelerator Technology (MAT)

F. Djurabekova, docent, proj. leader
K. Nordlund, prof., adj. senior scientist
T. Ahlgren, adj. senior scientist
A. Kuronen, adj. senior scientist
V. Jansson, scientist
A. Kyritsakis, scientist
V. Zadin, adj. scientist
E. Baibuz, grad. student
J. Kimari, grad. student
J. Lahtinen, grad. student
A. Saressalo, grad. student
H. Vázquez Muíños, grad. student
M. Veske, grad. student

Accelerator Technology: Module, Structures and Manufacturing (MSM)

M. Aicheler, Dr., proj. leader
E. Hæggström, prof., adj. senior scientist
K. Österberg, prof., adj. senior scientist
I. Kassamakov, adj. senior scientist
A. Meriläinen, grad. student
R. Montonen, grad. student
J. Väinölä, grad. student (at CERN)
A. Holmström, student

Materials for Big Science Installations (BIGS)

I. Makkonen, Dr., proj. leader
J. Ala-Heikkilä, scientist
E. Lu, scientist
J. Slotte, scientist
U. Vainio, scientist

Radiation Metrology for Applications (RADMET)

T. Siiskonen, Dr., proj. leader (at STUK)
J. Tikkanen, grad. student

Finnish Business Incubation Center of CERN Technologies (BIC)

S. Mäkinen, prof., proj. leader
P. Kauttu, grad. student

Novel Instrumentation for Nuclear Safety, Security and Safeguards (NINS3)

P. Dendooven, prof., proj. leader
C. Bélanger-Champagne, scientist
S. Ihantola, scientist (at STUK)
V. Litichevskyi, scientist
P. Peura, scientist
T. Kerst, grad. student
R. Backholm, student

Diagnostics: Novel Gamma-Ray Spectroscopy for Radioactive Materials Testing (GAMMA)

R. Bès, Dr., proj. leader
J. Ala-Heikkilä, scientist
J. Slotte, scientist
U. Vainio, scientist
A. Vancraeyenest, scientist
A. Karjalainen, grad. student
V. Prozheevam, grad. student

Detector Laboratory

E. Tuominen, senior engineer, lab. coordinator
T. Hildén, scientist
F. García, lab. engineer
J. Heino, lab. engineer
P. Koponen, lab. engineer
E. Kangasaho, lab. technician
R. Turpeinen, lab. technician

CLOUD

M. Kulmala, prof., Academician, proj. leader
J. Duplissy, scientist

Planck-Euclid

H. Kurki-Suonio, docent, proj. leader
E. Keihänen, scientist
A.-S. Suur-Uski, scientist
J. Väliviita, scientist
G. Gozaliasl, adj. scientist
C. Kirkpatrick, adj. scientist
K. Kiiveri, grad. student
V. Lindholm, grad. student
A. Viitanen, grad. student

Education and Open Data

K. Lassila-Perini, Dr., proj. leader (at CERN)
P. Veteli, grad. student

Administration and Support

K. Huitu, prof., director
A. Väihkönen, research coordinator
J. Aaltonen, lab. engineer

University Services administration team including:
T. Laurila, admin. manager
H. Kinnunen, controller
T. Hardén, service coordinator
T. Savolainen, HR coordinator
T. Heikkilä, secretary
T. Karppinen, secretary (at CERN)
T. Onnela, secretary (at CERN)

SEMINARS

Seminars held in Helsinki

18th January A. Kurkela (CERN, Stavanger)
Gravitational-wave constraints on the QCD equation of state

23rd January T. Kärkkäinen (Helsinki)
Neutrinos beyond the standard model

30th January J. Rantaharju (Swansea)
A lattice realization of Ideal Walking

6th March K. Österberg (Helsinki)
Recent TOTEM results - probing the existence of a colourless 3-gluon bound state

13th March J. Pata (ETH Zürich)
Searching for the direct top-Higgs coupling at CMS using the matrix element method

20th March M. Seidel (CERN)
Top mass and subtle QCD effects

22nd March B. Stefanski (CU London)
The protected closed string spectrum of AdS3/CFT2 from integrability

27th March K. Kajantie (Helsinki)
Memory effect, supertranslations and symmetries at null infinity

28th March J. Fumagalli (NIKHEF Amsterdam)
Unitarity and predictiveness of Higgs inflationary models

5th April M. Marquard (CERN/ALICE)
Two ways to study heavy-ion collisions

10th April M. Attems (Barcelona)
Non-conformal holographic fluid relaxation

11th April F. Ferrer (Washington U., St. Louis)
Cosmology of axionic string-wall networks

12th April A. Calandri (Marseille)
Search for the standard model Higgs boson produced in association with top quarks in the H → bb final state - b-jet idenfication and reconstruction in ATLAS

17th April P. Hoyer (Helsinki)
Bound states and QCD

25th April T. Tenkanen (Queen Mary University of London)
Primordial black holes as dark matter

27th April T. Arsenovich (Helsinki)
Reliability and quality assurance methods for the development of radiation hard particle detectors

8th May T. Markkanen (Imperial College, London)
Evaporation of de Sitter space

8th May J. Ellis (King's College, London)
What are we? Where do we come from? Where are we going?

9th May J. Ellis (King's College, London)
Global standard model effective field theory fit to LHC and electroweak data

15th May I. Baldes (DESY)
Residual annihilations and self-interactions of asymmetric dark matter

17th May M. Frank (Montreal)
E6 inspired U(1)-extended MSSM: from dark matter to LHC

22nd May J. Tarrio (Brussels)
Holography, cold dense matter and color superconductivity

23rd May *(at Aalto University)* F. Wilczek (MIT, Stockholm)
Emergent axions, and the challenging search for real ones

23rd May J. Rubio (U. Heidelberg, ITP)
Higgs-dilaton cosmology: an inflation-dark-energy connection

24th May F. Wilczek (MIT, Stockholm)
The strange, unfinished story of time reversal

5th June K. Boguslavski (Jyväskylä)
Spectral function from real-time lattice gauge simulations

6th June N. Barrie (IPMU)
Pendulum leptogenesis

7th June L. Forthomme (HIP)
Central exclusive processes in the LHC era

12th June K. Nordlund (Helsinki)
Using molecular dynamics to aid dark matter searches

18th July A. Ito (Kobe U.)
A strategy for detecting the bispectrum of stochastic gravitational waves

7th August M. Laine (Bern)
On the quantum statistical physics of dark matter freeze-out

14th August A. Zee (Santa Barbara)
Some speculations on the cosmological constant paradox

15th August J. Järvelä (Helsinki)
On the capacity of entanglement

22nd August W. Weise (TU München)
Chiral EFT approach to nuclear many-body systems - with implications for neutron stars

29th August T. Sekiguchi (University of Tokyo)
Simulation of the axion electrodynamics and some cosmological applications

3rd September M. Mulders (CERN)
Top quark mass - the road toward ultimate precision?

4th September C. Bélanger-Champagne (Helsinki)
Nuclear fuel safeguards - the Finnish deep geological repository

12th September E. Villa (CTP Warsaw)
Relativistic perturbation theory in ΛCDM and beyond: effects on cosmological dynamics and observations

18th September T. Ishii (Utrecht)
Black resonators in AdS5

2nd October K. Fujikawa (RIKEN)
Chiral anomaly and Berry's phase

9th October S. Kawai (Suwon, Korea)
Gauss-Bonnet Chern-Simons gravitational wave leptogenesis

10th October A. Hektor (KBFI, Tallinn)
Speculations of new physics on the EDGES 21cm anomaly

30th October D. Croon (TRIUMF)
Gravitational waves signatures of dark matter

6th November A. Kurkela (CERN, Stavanger)
Emerging collectivity in pp, p-Pb, and Pb-Pb collisions at the LHC

8th November U. Danielsson (Uppsala)
Reflections on the dS swampland

13th November M. Ramsey-Musolf (UMass Amherst)
TeV scale lepton number violation: neutrinoless double beta decay and the LHC

20th November J. Braden (University College London)
A new real-time picture of vacuum decay

22nd November V. Keränen (OP Corporate Bank)
What does a theoretical physicist do in a bank?

27th November J. M. Penín Ascariz (Santiago de Compostela)
Anisotropic D3-D5 black holes with unquenched flavors

11th December J. Rantaharju (Swansea)
Fermion bags in lattice field theory

VISITORS

Theory Programme

Cosmology of the Early and Late Universe

T. Garratt (Germany) 15.-19.1., 7.-17.5.
K. Tuominen (Finland) 30.1.-1.2., 13.-21.3., 27.-31.8.
D. Cutting (UK) 12.2.-6.7., 29.11.-7.12.
D. Weir (Finland) 13.3.
T. Markkanen (UK) 16.-18.4.
W. Porod (Germany) 7.-11.5.
I. Baldes (Germany) 14.-16.5.
K. Kainulainen (Finland) 24.-25.5., 5.-6.11.
G. Tasinato (UK) 18.-19.6.
K. Ala-Miettinen (Finland) 27.-31.8.
D. Croon (Canada) 29.10.-1.11.
M. Ramsey-Musolf (USA) 12.-16.11.
J. Braden (Canada) 19.-21.11.
P. Auclair (France) 26.-30.11.
T. Takahashi (Japan) 2.-6.12.
T. Tenkanen (Switzerland) 18.-21.12.

High Energy Phenomenology in the LHC Era

A. Kurkela (Switzerland) 17.-18.1.
J. Rantaharju (UK) 29.1.-2.2., 10.-14.12.
B. Stefanski (UK) 22.-23.3.
M. Attems (Spain) 1.-22.4., 22.11.-17.12.
J. Ellis (UK) 8.-10.5.
J. Tarrio (Belgium) 21.-24.5.
K. Boguslavski (Finland) 4.-6.6.
D. Sokolowska (Poland) 26.6.-3.7.
M. Laine (Switzerland) 7.-8.8.
W. Weise (Germany) 22.8.
J. Penin (Spain) 1.9.-31.11.
T. Ishii (the Netherlands) 17.9.
S. Kawai (South Korea) 3.-22.10.
A. Kurkela (Switzerland, Norway) 5.-6.11.
U. Danielsson (Sweden) 7.-8.11.
M. Ramsey-Musolf (USA) 12.-16.11.

QCD and Strongly Interacting Gauge Theory

A. Piñeiro Orioli (Germany) 15.-19.1.
R. Paatelainen (Finland) 22.-26.1., 2.-4.4., 13.-17.8.
D. Müller (Austria) 12.2.-12.5.
E. Molnar (Germany) 13.-21.2., 10.-14.12.
D. Rischke (Germany) 13.-23.2.
P. Huovinen (Poland) 6.4., 9.8., 17.-21.8.
I. Helenius (Germany) 4.5.
K. Kajantie (Finland) 6.6., 15.8., 14.12.
A. Vuorinen (Finland) 6.6.
A. Tranberg (Norway) 6.-7.8.
C. Salgado (Spain) 6.-19.8.
N. Müller (USA) 8.-10.8.
J. Nagle (USA) 12.-15.8.
M. Attems (Spain) 4.12.
P. Huovinen (Serbia) 17.-21.12.

Nuclear Structure for Weak and Astrophysical Processes

N. Hinohara (Japan) 7.-28.3.

Domain Wall Dynamics

G. Durin (Italy) 6.-8.9.

CMS Programme

M. Giunta (Switzerland) 27.-28.2.
D. Ungaro (Switzerland) 27.-28.2.
J. Pata (Switzerland) 13.3.
M. Seidel (Switzerland) 20.3.
M. Marquard (Germany) 4.-5.4.
A. Calandri (France) 12.4.
L. Forthomme (Switzerland) 5.-8.6., 3.-24.11.
M. Mulders (Switzerland) 3.9.

Technology Programme

Materials for Accelerator Technology (MAT)

G. Meng (China) 5.-7.11.

Materials for Big Science Installations (BIGS)

Z. Li (Germany) 18.-20.1.

Detector Laboratory

M. Kalliokoski (Croatia) 29.10.-2.11.
A. Karadzhinova-Ferrer (Croatia) 29.10.-2.11.

Planck-Euclid

K. J. Andersen (Norway) 25.-27.4.

CONFERENCE PARTICIPATION, TALKS AND VISITS BY PERSONNEL

Theory Programme

Cosmology of the Early and Late Universe

2nd IBS-KIAS Joint Workshop,
7-10 January, High 1, South Korea (talk by M. Hindmarsh)

Institute for Basic Sciences,
10-12 January, Daejeon, South Korea
(seminar by M. Hindmarsh)

Yukawa Institute for Theoretical Physics,
15-17 January, Kyoto, Japan (seminar by M. Hindmarsh)

RESCEU (Research Centre for the Early Universe),
17-19 January, Tokyo, Japan (seminar by M. Hindmarsh)

DESY,
19-21 February, Hamburg, Germany (seminar by D. Weir)

Max Planck Institute for Gravitational Physics,
27 February - 2 March, Potsdam, Germany
(seminar by D. Weir)

The Rencontres de Moriond,
17-24 March, La Thuile, Italy (talk by M. Karčiauskas)

McGill University,
19-21 March, Montreal, QC, Canada (seminar by D. Weir)

Dartmouth College,
22-23 March, Hanover, NH, USA (seminar by D. Weir)

Perimeter Institute,
26-27 March, Waterloo, ON, Canada (seminar by D. Weir)

XIIIth Iberian Cosmology Meeting,
26-28 March, Lisbon, Portugal (talk by A. Lopez-Eiguren)

Dalhousie University,
28-29 March, Halifax, NS, Canada (seminar by D. Weir)

Euclid Theory Working Group Meeting,
16-17 April, Paris, France (talk by F. Montanari)

Particle Cosmology Meeting,
19-20 April, Tampere, Finland (talk by O. Koskivaara, F. Montanari, S. Räsänen, talk by E. Tomberg, talk by L.-P. Wahlman)

Kosmologietag Graduate School,
2-3 May, Bielefeld, Germany (lecture by M. Hindmarsh)

IFT UAM/CSIC,
7-14 May, Madrid, Spain (talk by F. Montanari)

Primordial Versus Astrophysical Origin of Black Holes,
14-18 May, CERN, Geneva, Switzerland (F. Montanari)

CosmoBack,
28-31 May, Marseille, France (talk by F. Montanari, talk by S. Räsänen)

PRACEdays 2018,
28-31 May, Ljubljana, Slovenia (talk by D. Weir)

Cosmology Summer School,
29 May - 1 June, Nuuksio, Espoo, Finland (organisers K. Kainulainen, O. Koskivaara, L. Laulumaa, S. Nurmi)

LISA Cosmology Working Group Meeting,
11-15 June, Helsinki, Finland (K. Enqvist, O. Gould, talk by M. Hindmarsh, K. Kainulainen, A. Lopez-Eiguren, S. Räsänen, talk by D. Weir)

PACTS 2018: Particle, Astroparticle and Cosmology Tallinn Symposium,
18-22 June, Tallinn, Estonia (O. Gould, talk by M. Hindmarsh, K. Kainulainen, L. Laulumaa, J. Leskinen, A. Lopez-Eiguren, S. Nurmi, S. Räsänen, E. Tomberg)

9th MoEDAL Collaboration Meeting,
23-25 June, Vaasa, Finland (talk by O. Gould)

Strong and Electroweak Matter 2018,
25-29 June, Barcelona, Spain (O. Koskivaara)

12th LISA Symposium,
9-13 July, Chicago, IL, USA (talk by D. Weir)

Science Foo Camp 2018,
22-24 July, Mountain View, CA, USA (D. Weir)

Sussex University,
30 July - 3 August, Brighton, UK (D. Weir)

Sussex University,
7-14 August, Brighton, UK (talk by A. Lopez-Eiguren)

COSMO-18: The 22nd Annual International Conference on Particle Physics and Cosmology,
27-31 August, Daejeon, South Korea
(talk by A. Lopez-Eiguren, talk by E. Tomberg)

Aspen Center for Physics Summer Program,
27 August - 14 September, Aspen, CO, USA
(talk by D. Weir)

Birzeit University,
1 September - 20 December, Birzeit, Palestine
(lecture course by S. Räsänen)

University of Würzburg,
2-14 September, Würzburg, Germany (O. Koskivaara)

Heraeus Summer School,
18-21 September, Heigenbrücken, Germany
(lecture series by M. Hindmarsh)

The Universe as a Quantum Lab,
19-21 September, Paris, France (K. Kainulainen, S. Nurmi, S. Räsänen)

CHARGED2018,
25-28 September, Uppsala, Sweden (talk by D. Weir)

CERN,
29 September - 3 October, Geneva, Switzerland
(K. Kainulainen)

Workshop, Interdisciplinary Approach to QCD-Like Composite Dark Matter,
1-5 October, ECT*, Trento, Italy (talk by D. Weir)

Lorentz Center Workshop on Cosmic Topological Defects,
22-26 October, Leiden, the Netherlands
(M. Hindmarsh, talk by A. Lopez-Eiguren, talk by D. Weir)

Pair Production Mini-Workshop,
29-30 October, Jena, Germany (talks by O. Gould)

2nd Workshop on Current Challenges in Cosmology: LSS, Dark Energy and Modified Gravity,
29 October - 2 November, Bogota, Colombia
(talk by J. Rubio)

KU Leuven,
4-9 November, Leuven, Belgium (talk by S. Räsänen)

JGRG 28 (General Relativity and Gravity Japan),
5-9 November, Tokyo, Japan (talk by M. Hindmarsh)

Universidad del Valle,
5-9 November, Cali, Colombia (seminar by J. Rubio)

Particle Physics Day 2018,
23 November, Jyväskylä, Finland (talk by A. Lopez-Eiguren, S. Raatikainen)

Heavy Ions and New Physics,
4-5 December, Louvain-la-Neuve, Belgium
(talk by O. Gould)

12th Tonale Winter School on Cosmology,
10-14 December, Passo del Tonale, Italy
(co-organised by J. Rubio)

II Cosmological Olentzero Workshop,
19 December, Leioa, Basque Country, Spain
(talk by A. Lopez-Eiguren)

Visits to University of the Basque Country,
Leioa, Basque Country, Spain (A. Lopez-Eiguren)

High Energy Phenomenology in the LHC Era

Harvard University,
5-8 March, Cambridge, MA, USA
(N. Jokela, colloquium talk by A. Vuorinen)

Long Island University,
8-9 March, Brooklyn, NY, USA (N. Jokela)

Physics Days 2018,
21-23 March, Turku, Finland (T. Kärkkäinen)

Fire and Ice: Hot QCD Meets Cold and Dense Matter,
3-7 April, Saariselkä, Finland (talk by T. Gorda, N. Jokela, K. Kajantie, R. Paatelainen, J. Remes, talk by T. Rindlisbacher, talk by M. Säppi, organised by A. Vuorinen)

Particle Cosmology Meeting 2018,
19-20 April, Tampere, Finland (talk by T. Kärkkäinen, talk by L. Niemi, talk by T. Tenkanen, A. Vuorinen)

Quark Matter 2018,
13-15 May, Venice, Italy (talk by A. Vuorinen)

Solvay Workshop on Infrared Physics,
16-18 May, Brussels, Belgium (O. Henriksson, N. Jokela, K. Kajantie)

Planck 2018: 21st International Conference From the Planck Scale to the Electroweak Scale,
21-25 May, Bethe Center for Theoretical Physics, Bonn, Germany (talk by V. Keus, N. Koivunen, K. Tuominen)

Probing QCD at the High Energy Frontier,
21-25 May, Trento, Italy (talk by R. Paatelainen)

Summer School QCD Under Extreme Conditions,
28 May - 2 June, Trento, Italy (lectures by A. Vuorinen)

New Frontiers in QCD 2018 & Recent Developments in Quark-Hadron Sciences,
28 May - 15 June, Kyoto, Japan (talk by M. Säppi, talk by A. Vuorinen)

Solvalla Cosmology Summer School,
29 May - 1 June, Espoo, Finland (lectures by V. Keus)

Particle, Astroparticle and Cosmology Tallinn Symposium, PACTS 2018,
18-22 June, Tallinn, Estonia (talks by M. Heikinheimo, L. Niemi, T. Tenkanen, talk by K. Tuominen)

Strong and ElectroWeak Matter Conference,
25-29 June, Barcelona, Spain (L. Niemi, T. Tenkanen)

Universidad de Oviedo,
27 June - 1 July, Oviedo, Spain (talk by O. Henriksson, N. Jokela)

HoloQuark 2018,
1-6 July, Santiago de Compostela, Spain (O. Henriksson, talk by N. Jokela)

Mass: From Higgs to Cosmology 2018,
9-21 July, Cargese, France (talk by T. Kärkkäinen)

Gauge/Gravity Duality 2018,
30 July - 3 August, Würzburg, Germany (talk by O. Henriksson)

XIIIth Quark Confinement and the Hadron Spectrum,
31 July - 6 August, Maynooth, Ireland (talk by M. Säppi, talk by A. Vuorinen)

Bounding Transport and Chaos in Condensed Matter and Holography,
10-14 September, Stockholm, Sweden (O. Henriksson, talk by N. Jokela)

DKPI Summer School,
17-21 September, Hirschwang, Austria
(lectures by A. Vuorinen)

Reunion Groupes de Travail GdR Resanet et OG,
24-25 September, Observatoire de Paris, Paris, France
(talk by N. Jokela)

APC Paris,
26-28 September, Paris, France (N. Jokela)

CERN,
2-19 October, Geneva, Switzerland (E. Annala, M. Säppi, A. Vuorinen)

IFT,
5-9 November, Madrid, Spain (O. Henriksson)

Particle Physics Day 2018,
23 November, Jyväskylä, Finland (talk by M. Heikinheimo, talk by O. Henriksson, N. Jokela, V. Keus, T. Kärkkäinen, J. Tarrio, A. Vuorinen)

Harmonia Consortium Meeting,
6-8 December, Warsaw, Poland (M. Heikinheimo, talk by V. Keus, N. Koivunen, K. Tuominen)

NuPHys 2018: Prospects in Neutrino Physics,
19-21 December, London, UK (T. Kärkkäinen)

QCD and Strongly Interacting Gauge Theory

The 25th Nordic Particle Physics Meeting (Spåtind 2018),
2-7 January, Gausdal, Norway (T. Lappi)

Polarized Light Ion Physics with EIC,
5-9 February, Ghent University, Ghent, Belgium
(talk by V. Guzey)

XLIX Arbeitstreffen Kernphysik,
15-22 February, Schleching, Germany (talk by V. Guzey)

8th International Conference on Physics Opportunities at an ElecTron-Ion-Collider,
19-23 March, Regensburg, Germany (talk by H. Hänninen, talk by T. Lappi, talk by H. Paukkunen, talk by A. Ramnath)

PDF4LHC Meeting,
28 March, CERN, Geneva, Switzerland
(talk by H. Paukkunen)

Fire and Ice: Hot QCD Meets Cold and Dense Matter,
3-7 April, Saariselkä, Finland (talk by T. Lappi)

CERN,
3-11 April, Geneva, Switzerland (J. Peuron)

J. W. Goethe University,
9-21 April, Frankfurt, Germany (H. Niemi)

XXVI International Workshop on Deep Inelastic Scattering and Related Subjects,
16-20 April, Kobe, Japan (talk by H. Hänninen, talk by P. Paakkinen)

Low-x Gluon Structure of Nuclei and Signals of Saturation at LHC,
27 April, CERN, Geneva, Switzerland (talk by V. Guzey)

The 27th International Conference on Ultrarelativistic Nucleus-Nucleus Collisions,
13-19 May, Venice, Italy (K. J. Eskola in IAC, talk by T. Lappi, talk by H. Niemi, P. Paakkinen, J. Peuron, A. Ramnath)

Probing QCD at the High Energy Frontier,
21-25 May, ECT*, Trento, Italy (T. Lappi in organising committee, talk by A. Ramnath)

QCD Under Extreme Conditions (ECT* DTP),
28 May - 22 June, ECT*, Trento, Italy (talk by M. Kuha, lectures by T. Lappi, talk by J. Peuron)

Next-Generation GPD Studies with Exclusive Meson Production at EIC,
4-6 June, CFNS, Stony Brook University, Stony Brook, NY, USA (talk by V. Guzey)

J. W. Goethe University,
18 June - 1 July, Frankfurt, Germany (H. Niemi)

Strong and Electroweak Matter (SEWM 2018),
25-29 June, Barcelona, Spain (talk by J. Peuron)

Electron-Ion Collider User Group Meeting 2018,
30 July - 2 August, The Catholic University of America, Washington, DC, USA (V. Guzey as session convener, talk by P. Paakkinen)

Hadron Structure and QCD: From Low to High Energies (HSQCD-2018),
6-10 August, NRC KI - PNPI, Gatchina, Russia
(talk by V. Guzey)

Indian-Summer School of Physics Phenomenology of Hot and Dense Matter for Future Accelerators,
3-7 September, Prague, Czech Republic (lectures by T. Lappi)

PNPI,
3-7 September, Gatchina, Russia (V. Guzey)

Hard Probes 2018: International Conference on Hard and Electromagnetic Probes of High-Energy Nuclear Collisions,
30 September - 5 October, Aix-Les-Bains, France (K. J. Eskola in IAC, talk by H. Hänninen, M. Kuha, talk by P. Paakkinen, talks by H. Paukkunen)

INT Program INT-18-3 "Probing Nucleons and Nuclei in High Energy",
1 October - 16 November, Seattle, WA, USA
(talk by V. Guzey, talk by T. Lappi)

University of Münster,
1-30 November, Münster, Germany (V. Guzey)

IV International Conference on Particle Physics and Astrophysics (ICPPA-2018),
22-26 November, MEPhI, Moscow, Russia
(talk by V. Guzey)

Nuclear Structure for Weak and Astrophysical Processes

14th Nordic Meeting on Nuclear Physics,
22-25 May, Longyearbyen, Spitsbergen, Norway
(talk by M. Kortelainen)

15th International Workshop on Meson Physics,
7-12 June, Cracow, Poland (talk by J. A. Niskanen)

Zakopane Conference on Nuclear Physics,
26 August - 2 September, Zakopane, Poland
(talk by T. Haverinen)

PKU-CUSTIPEN Workshop on "Low-Energy Dynamics and Effective Nuclear Interactions",
17-19 September, Beijing, China
(invited talk by M. Kortelainen)

IPNL,
17 September - 14 December, Lyon, France (T. Haverinen)

ISOLDE/CERN,
21 November, Geneva, Switzerland
(invited talk by T. Haverinen)

IPNL,
7 December, Lyon, France (invited talk by T. Haverinen)

Tsukuba-CCS Workshop on "Microscopic Theories of Nuclear Structure and Dynamics",
10-12 December, Tsukuba, Japan
(invited talk by M. Kortelainen)

University of Tsukuba, CCS,
14 December, Tsukuba, Japan
(invited talk by M. Kortelainen)

JYFL Nuclear Theory Meeting,
19 December, Jyväskylä, Finland (talk by T. Haverinen)

Domain Wall Dynamics

2nd IEEE Conference on Advances in Magnetics,
4-7 February, La Thuile, Italy (I. Rissanen)

NORDITA Scientific Program "Crackling Noise in Materials",
30 April - 11 May, Stockholm, Sweden
(organised by L. Laurson, talk by L. Laurson)

Politecnico di Torino,
17-18 September, Turin, Italy (L. Laurson)

The 9th International Conference on Multiscale Materials Modeling,
28 October - 2 November, Osaka, Japan
(invited talk by L. Laurson)

CMS Programme

CMS Experiment

The 25th Nordic Particle Physics Meeting (Spåtind 2018),
2-7 January, Gausdal, Norway (J. Havukainen, K. Kallonen, H. Kirschenmann, talk by S. Laurila, M. Lotti)

KTH,
19 January, Stockholm, Sweden (M. Voutilainen opponent)

SMP-J Workshop,
23-24 January, CERN, Switzerland
(M. Voutilainen co-organiser)

CMS Week,
5-9 February, CERN, Geneva, Switzerland
(talk by H. Kirschenmann, K. Lassila-Perini, S. Laurila, S. Lehti, J. Tuominiemi)

Lake Louise Winter Institute,
18-24 February, Lake Louise, AB, Canada (J. Pekkanen)

LHCC133,
28 February, CERN, Geneva, Switzerland (J. Heikkilä)

Spring School "Electroweak Symmetry Breaking",
15-21 April, Maratea, Italy (J. Havukainen. K. Kallonen, M. Lotti)

DIS 2018,
16-20 April, Kobe, Japan
(M. Voutilainen session co-convener)

CMS Week,
16-20 April, CERN, Geneva, Switzerland (H. Kirschenmann, K. Lassila-Perini, S. Laurila, J. Tuominiemi)

LHC TOP WG Open Meeting,
15-16 May, CERN, Geneva, Switzerland (M. Voutilainen)

LHC EW WG: Jets and EW Bosons,
13 June, CERN, Geneva, Switzerland
(talk by M. Voutilainen)

CMS SUSY Workshop,
13-15 June, Vienna, Austria (talk by H. Kirschenmann)

2nd VBSCan Annual Meeting,
19-21 June, Thessaloniki, Greece (talk by K. Kallonen, talk by H. Kirschenmann)

LHC Electroweak WG Meeting,
21-22 June, CERN, Geneva, Switzerland
(talk by M. Voutilainen)

CMS Week,
25-29 June, CERN, Geneva, Switzerland
(K. Lassila-Perini, S. Laurila, M. Voutilainen)

ICHEP 2018,
4-11 July, Seoul, South Korea (talks by H. Kirschenmann, talk by S. Laurila)

BOOST 2018,
16-20 July, Paris, France (J. Havukainen, K. Kallonen)

Plenary ECFA,
19-20 July, ALBA, Barcelona, Spain (K. Lassila-Perini)

Higgs Hunting 2018,
23-25 July, Paris, France (talk by S. Laurila)

HCPSS 2018,
20-31 August, Fermi National Accelerator Laboratory, Batavia, IL, USA (J. Heikkilä)

HIP Scientific Advisory Board,
23-24 August, Jyväskylä, Finland (T. Lampén, talk by M. Voutilainen)

CMSDAS 2018,
10-14 September, Hamburg, Germany (K. Kallonen)

TOP 2018,
16-21 September, Bad-Neuenahr, Germany (T. Mäkelä)

TWEPP 2018,
17-21 September, Antwerp, Belgium (J. Heikkilä)

Prospects for Charged Higgs Discovery at Colliders,
25-28 September, Uppsala, Sweden (S. Laurila, M. Lotti)

CMS Week,
1-5 October, Budapest, Hungary (talk by H. Kirschenmann, S. Laurila, J. Pekkanen)

Research Training Course in Detector Technology for Particle Physics,
15-19 October, Copenhagen, Denmark (S. Laurila, M. Lotti)

New Techniques in Particle Reconstruction for VBS,
22-24 October, Cracow, Poland (talk by H. Kirschenmann, co-organiser)

CMS TOP Group Workshop 2018,
6-7 November, CERN, Geneva, Switzerland
(talks by M. Voutilainen)

Plenary ECFA,
15-16 November, CERN, Geneva, Switzerland
(K. Lassila-Perini, M. Voutilainen)

LHC TOP WG Open Meeting,
20-21 November, CERN, Geneva, Switzerland
(talk by T. Mäkelä)

Particle Physics Day 2018,
23 November, Jyväskylä, Finland (talk by M. Kim, talk by H. Kirschenmann, J. Tuominiemi, M. Voutilainen)

CMS Week,
3-7 December, CERN, Geneva, Switzerland
(K. Lassila-Perini, S. Laurila, J. Tuominiemi, M. Voutilainen)

CMS Upgrade

CMS Data Analysis School,
8-12 January, Fermi National Accelerator Laboratory, Batavia, IL, USA (L. Martikainen)

CMS Week,
5-9 February, CERN, Geneva, Switzerland (talk by P. Luukka)

CMS Tracker Week,
12-16 March, CERN, Geneva, Switzerland (P. Luukka chair)

Timing Days,
22-23 March, Milano, Italy (P. Luukka, J. Ott)

CMS Week,
16-20 April, CERN, Geneva, Switzerland
(P. Luukka chair, J. Ott)

15th IPPOG Meeting,
19-21 April, Pisa, Italy (J. Ott)

Radiation Effects at the LHC Experiments and Impact on Operation Performance,
23-24 April, CERN, Geneva, Switzerland (P. Luukka, J. Ott)

LHC Resources Review Board,
23-25 April, CERN, Geneva, Switzerland (P. Luukka)

Academy of Finland RADDESS Opening Seminar,
3-4 May, Hanasaari, Espoo, Finland (talk by P. Luukka)

CMS Tracker Week,
14-18 May, CERN, Geneva, Switzerland (P. Luukka chair)

32rd RD50 Workshop,
4-6 June, CERN, Geneva, Switzerland (T. Arsenovich, J. Ott)

Ruđer Bošković Institute,
10-14 June, Zagreb, Croatia (E. Brücken)

CMS Week,
25-29 June, CERN, Geneva, Switzerland (P. Luukka chair)

CMS Tracker Week,
16-20 July, CERN, Geneva, Switzerland (P. Luukka chair)

Second Workshop of Semiconductor Radiation Detectors and International High Level Forum,
13-15 August, Xiangtan, China (invited talk by E. Brücken)

HIP Scientific Advisory Board,
23-24 August, Jyväskylä, Finland (talk by P. Luukka)

CERN School of Computing,
1-14 October, Tel Aviv, Israel (L. Martikainen)

Ruđer Bošković Institute,
9-14 October, Zagreb, Croatia (J. Ott)

Conference of the Nordic Network for Diversity in Physics - NORNDiP,
24-25 October, Stockholm, Sweden
(invited talk by P. Luukka)

LHC Resources Review Board,
29-31 October, CERN, Geneva, Switzerland (P. Luukka)

CMS Tracker Week,
5-9 November, CERN, Geneva, Switzerland
(E. Brücken, P. Luukka chair)

33rd RD50 Workshop,
26-28 November, CERN, Geneva, Switzerland
(P. Luukka, talk by J. Ott)

CMS Week,
3-7 December, CERN, Geneva, Switzerland
(P. Luukka chair, J. Ott)

Tier-2 Operations

Physics Days 2018,
21-23 March, Turku, Finland (talk T. Lindén)

Joint WLCG & HSF Workshop 2018,
26-29 March, Naples, Italy (T. Lindén)

FinnFusion 2018,
4 June, Espoo, Finland (T. Lindén)

23rd International Conference on Computing in High Energy and Nuclear Physics 2018,
9-13 July, Sofia, Bulgaria (T. Lindén)

Fall18 Offline and Computing Week,
23-26 October, CERN, Geneva, Switzerland (T. Lindén)

TOTEM

CERN,
15-26 January, Geneva, Switzerland (F. García)

6th Beam Telescopes and Test Beams Workshop 2018 (BTTB6),
16-19 January, Zurich, Switzerland (talk by T. Naaranoja)

CLIC Workshop 2018,
22-26 January, CERN, Geneva, Switzerland (K. Österberg)

Compass Seminar,
24 January, CERN, Prevessin, France
(invited talk by K. Österberg)

CERN,
5-19 February, Geneva, Switzerland (F. García)

TOTEM Collaboration and LHCC Referees Meeting,
26 February - 1 March, CERN, Geneva, Switzerland
(talks by M. Berretti and T. Naaranoja, talks and chairing by K. Österberg)

Physics Days 2018,
21-23 March, Turku, Finland
(T. Naaranoja, talk by K. Österberg)

CERN,
9 April - 2 May, Geneva, Switzerland (F. García)

LHC Resources Review Board,
23-25 April, CERN, Geneva, Switzerland (K. Österberg)

11th Workshop on Picosecond Timing Detectors for Physics and Medical Applications,
16-18 May, Turin, Italy (T. Naaranoja)

TOTEM Collaboration Meeting,
21-23 May, La Biodola, Elba, Italy (talk by T. Naaranoja, talk and chairing by K. Österberg)

4th Elba Workshop on Forward Physics @ LHC Energy,
24-26 May, La Biodola, Elba, Italy (T. Naaranoja, K. Österberg chair and co-organiser)

Inauguration of New Professors, University of Helsinki,
30 May, Helsinki, Finland (talk by K. Österberg)

CERN,
10-21 June, Geneva, Switzerland (F. García, T. Naaranoja)

RD51 Collaboration Meeting,
22 June, Munich, Germany (talk by F. García)

CERN,
23 July - 3 August, Geneva, Switzerland (T. Naaranoja)

HIP Scientific Advisory Board,
23-24 August, Jyväskylä, Finland (talk by K. Österberg)

29th International Conference on Diamond and Carbon Materials,
2-6 September, Dubrovnik, Croatia (T. Naaranoja)

TOTEM Collaboration and LHCC Referees Meeting,
10-13 September, CERN, Geneva, Switzerland
(talk by L. Forthomme, talks and chairing by K. Österberg)

CERN,
12-24 September, Geneva, Switzerland (F. García)

Charles University,
25 September, Prague, Czech republic (K. Österberg opponent)

CERN,
22 October - 5 November, Geneva, Switzerland (F. García)

LHC Resources Review Board,
29-31 October, CERN, Geneva, Switzerland (K. Österberg)

Particle Physics Day 2018,
23 November, Jyväskylä, Finland (talk by F. Oljemark)

TOTEM Collaboration and LHCC Referees Meeting,
26-30 November, CERN, Geneva, Switzerland
(talk by F. García, talk and chairing by K. Österberg)

LHCC Open Session,
28 November, CERN, Geneva, Switzerland
(invited talk by K. Österberg)

CERN,
1-5 December, Geneva, Switzerland (F. García, T. Naaranoja)

LHC Working Group on Forward Physics and Diffraction,
18 December, CERN, Geneva, Switzerland
(talk by K. Österberg)

Nuclear Matter Programme

ISOLDE

81st ISOLDE Collaboration Committee Meeting,
6 February, Geneva, Switzerland (J. Pakarinen)

ISOLDE and Neutron Time-of-Flight Experiments Committee Meeting,
7-8 February, Geneva, Switzerland
(talk by J. Pakarinen, I. D. Moore)

Porous Semiconductors Science and Technology (PSST) Conference,
11-16 March, La Grande Motte, France (U. Jakobsson)

Physics Days 2018,
21-23 March, Turku, Finland (talk by K. Helariutta)

Spring APS Meeting,
11-23 April, Columbus, OH, USA (talk by R. de Groote)

Nuclear Physics Seminar,
19 April, Jyväskylä, Finland (talk by S. Szwec)

14th Nordic Meeting on Nuclear Physics,
22-25 May, Longyearbyen, Spitsbergen, Norway
(talk by R. de Groote, talk by U. Jakobsson)

CERN,
28 May - 5 June, 18-27 August, 10-22 December,
Geneva, Switzerland (R. de Groote)

CERN,
26-29 June, Geneva, Switzerland (U. Jakobsson)

ISOLDE and Neutron Time-of-Flight Experiments Committee Meeting,
27-28 June, 7-8 November, Geneva, Switzerland
(I. D. Moore)

CERN,
8-13 July, 25-28 November, Geneva, Switzerland
(J. Pakarinen)

CERN,
24 July - 7 August, 14-24 September, 17-23 October,
Geneva, Switzerland (J. Ojala)

82nd ISOLDE Collaboration Committee Meeting,
26 July, Geneva, Switzerland (J. Pakarinen)

ISOLDE Seminar,
17 August, Geneva, Switzerland (talk by M. Reponen)

CERN,
17-20 August, Geneva, Switzerland (M. Reponen)

HIP SAB Meeting,
23 August, Jyväskylä, Finland (talk by J. Pakarinen)

CERN,
8-15 October, Geneva, Switzerland (S. Szwec)

83rd ISOLDE Collaboration Committee Meeting,
6 November, Geneva, Switzerland (J. Pakarinen)

Shapes and Symmetries in Nuclei: from Experiment to Theory,
6-9 November, Gif-sur-Yvette, France (talk by J. Pakarinen)

CERN,
9-11 November, Geneva, Switzerland (I. D. Moore)

ISOLDE Decay Station Collaboration Meeting,
4 December, Geneva, Switzerland (J. Pakarinen)

MINIBALL Steering Committee Meeting,
5 December, Geneva, Switzerland (J. Pakarinen)

ISOLDE Workshop,
5-7 December, Geneva, Switzerland (J. Pakarinen, S. Szwec)

FAIR

Super-FRS Gas Cell Workshop,
14-15 February, Giessen, Germany (A. Jokinen, I. D. Moore)

NUSTAR Annual Meeting,
27 February - 1 March, Darmstadt, Germany (A. Jokinen)

The Fourth European In-Kind Best Practice Workshop,
24-25 April, Caen, France (T. Grahn)

Super-FRS Collaboration Meeting,
2-4 May, Walldorf, Germany (T. Grahn, A. Jokinen, J. Äystö)

14th Nordic Meeting on Nuclear Physics,
22-25 May, Longyearbyen, Spitsbergen, Norway
(talk by T. Grahn)

NUSTAR Week,
26-27 September, Milan, Italy (T. Grahn, talk by A. Jokinen, I. D. Moore)

FAIR Resource Review Board,
26-27 November, Darmstadt, Germany
(T. Grahn, A. Jokinen)

FAIR Experiments and Accelerators Workshop,
14 December, Darmstadt, Germany (T. Grahn)

ALICE-Forward

CERN,
1 March - 30 September, Geneva, Switzerland (R. Orava)

Diffraction and Low-x 18,
26 August - 1 September, Reggio Calabria, Italy (talk by M. Mieskolainen)

Technology Programme

Materials for Accelerator Technology (MAT)

CERN,
15 January - 2 February, Geneva, Switzerland (A. Kyritsakis)

Annual CLIC Meeting,
21-24 January, Geneva, Switzerland (talk by F. Djurabekova, talk by A. Kyritsakis)

Institute of Physics and Institute of Technology, University of Tartu,
28 January - 23 February, Tartu, Estonia (V. Jansson)

Workshop on Mechanisms of Vacuum Arc (MeVArc),
20-24 May, San Juan, Puerto Rico, USA (talk by F. Djurabekova, talk by V. Jansson, J. Kimari, talk by A. Kyritsakis, talk by K. Nordlund, talk by A. Saressalo, talk by M. Veske)

International Workshop on Breakdown Science and High Gradient Technology,
31 May - 8 June, Shanghai, China (talk by F. Djurabekova)

Xi'an Jiaotong University,
2-7 June, Xi'an, China (F. Djurabekova, A. Kyritsakis, M. Veske)

Atom Probe Tomography and Microscopy,
10-15 June, Gaithersburg, MD, USA
(invited talk by F. Djurabekova)

Computer Simulations of Radiation Effects in Solids (COSIRES),
18-22 June, Shanghai, China (talk by V. Jansson)

Ion Beam Modification of Materials Conference,
24-30 June, San Antonio, TX, USA
(invited talk by F. Djurabekova)

Nanotexnology,
3-6 July, Thessaloniki, Greece (V. Jansson)

International Vacuum Nanoelectronics Conference (IVNC),
9-13 July, Kyoto, Japan (A. Kyritsakis)

RADECS Conference,
16-18 September, Gothenburg, Sweden (F. Djurabekova)

ISDEIV,
24-26 October, Greifswald, Germany
(F. Djurabekova as panel discussion leader)

ARIES Workshop,
28-31 October, Valetta, Malta
(invited talk by F. Djurabekova)

Mini MeVArc Meeting,
13-14 November, Uppsala, Sweden (talk by F. Djurabekova, talk by V. Jansson, talk by J. Kimari, talk by A. Kyritsakis, talk by A. Saressalo, M. Veske)

Materials for Big Science Installations (BIGS)

THERMEC'2018, International Conference on Processing & Manufacturing of Advanced Materials, Processing, Fabrication, Properties, Applications,
8-13 July, Paris, France (talk by I. Makkonen)

18th International Conference on Positron Annihilation,
19-24 August, Orlando, FL, USA (talk by I. Makkonen)

ICHEM 2018, The 2nd International Conference on High-Entropy Materials,
8-13 December, Jeju, South Korea (talk by E. Lu)

Radiation Metrology for Applications

IUPESM (World Congress on Medical Physics & Biomedical Engineering) 2018,
3-8 June, Prague, Czech Republic (talk by J. Tikkanen)

Novel Instrumentation for Nuclear Safety, Security and Safeguards (NINS3)

Physics Days 2018,
21-23 March, Turku, Finland (talk by C. Bélanger-Champagne, P. Dendooven, talk by V. Litichevskyi)

Conference on Lasers and Electro-Optics (CLEO),
13-18 May, San Jose, CA, USA (talk by T. Kerst)

ESARDA 40th Annual Meeting and NDA Workshop,
14-17 May, Luxemburg, Luxemburg
(talk by C. Bélanger-Champagne, P. Dendooven)

Border Monitoring Working Group, JRC Karlsruhe,
28 May - 1 June, Karlsruhe, Germany (P. Dendooven)

JRC Karlsruhe,
3-16 July, Karlsruhe, Germany (T. Kerst)

Institute of Nuclear Materials Management (INMM) 59th Annual Meeting,
22-26 July, Baltimore, MD, USA
(talk by C. Bélanger-Champagne)

JRC Karlsruhe,
16-27 September, Karlsruhe, Germany (T. Kerst)

MIRION Technologies Technical Workshop,
20 September, Amsterdam, the Netherlands (P. Dendooven)

IAEA Symposium on International Safeguards,
5-8 November, Vienna, Austria (P. Dendooven)

IEEE Nuclear Science Symposium and Medical Imaging Conference (NSS-MIC),
10-17 November, Sydney, Australia (R. Backholm)

Symposium on Future Prospects of Photonics,
20-22 November, Helsinki, Finland - Stockholm, Sweden
(T. Kerst)

24th Inverse Days,
11-13 December, Helsinki, Finland
(R. Backholm, P. Dendooven)

Detector Laboratory

AAPT Winter Meeting 2018,
6-9 January, San Diego, CA, USA
(invited talk by E. Brücken)

TOTEM / Roman Pot Installation,
15-26 January, 6-15 February, CERN, Geneva, Switzerland
(R. Turpeinen)

Physics Days 2018,
21-23 March, Turku, Finland (talk by E. Tuominen)

Callio Lab Seminar,
19 April, Oulu, Finland (E. Tuominen)

32nd RD50 Workshop,
4-6 June, Hamburg, Germany (E. Tuominen)

TOTEM Beam Tests,
10-16 June, CERN, Geneva, Switzerland (P. Koponen)

Second LERU Gender Conference,
14-15 June, Zurich, Switzerland (E. Tuominen)

10th European Conference on Gender Equality in Higher Education,
20-22 August, Dublin, Ireland (talk by E. Tuominen)

HIP SAB Meeting,
23 August, Jyväskylä, Finland (talk by E. Tuominen)

CORES Symposium,
5-6 September, Tampere, Finland (E. Tuominen)

Terminal Beach Video Installation,
5 October, Turku, Finland (E. Brücken, J. Heino, P. Koponen, E. Tuominen)

Conference of the Nordic Network for Diversity in Physics - NORNDIP,
24-25 October, Stockholm, Sweden (talk by E. Tuominen)

33rd RD50 Workshop,
26-28 November CERN, Geneva, Switzerland (E. Tuominen)

CLOUD

NOSA-FAAR Symposium 2018,
26-28 March, Helsinki, Finland
(J. Duplissy, talk by M. Kulmala)

Planck-Euclid

Euclid Science Challenge 4/5/6 Kick-Off Meeting,
18-19 January, Leiden, the Netherlands
(H. Kurki-Suonio, V. Lindholm)

MPE,
22-26 January, 2-13 July, Garching, Germany
(C. Kirkpatrick)

Euclid Consortium Board Meeting,
30 January, Paris, France (H. Kurki-Suonio)

Oslo University,
1-3 February, 26-28 November, Oslo, Norway (E. Keihänen)

Euclid LE3 Meeting,
14-16 February, Nice, France (talk by H. Kurki-Suonio)

Scuola Normale Superiore di Pisa,
4-11 March, 22 October - 17 November, Pisa, Italy
(A. Viitanen)

BeyondPlanck Kickoff,
5-9 March, Oslo, Norway (talk by E. Keihänen, A.-S. Suur-Uski)

IAP and CEA,
5-7 April, Paris-Saclay, France (G. Gozaliasl)

LAM,
7-14 April, Marseille, France (G. Gozaliasl)

Euclid Infrastructure Meeting,
19-20 April, 12-13 September, Paris, France
(C. Kirkpatrick, H. Kurki-Suonio, V. Lindholm)

Universitäts-Sternwarte Munich,
4-7 June, Munich, Germany (G. Gozaliasl)

MPE,
7-10 June, Garching, Germany (G. Gozaliasl)

Euclid Consortium Meeting,
11-14 June, Bonn, Germany (G. Gozaliasl, E. Keihänen, K. Kiiveri, talk by H. Kurki-Suonio, A. Viitanen)

COSMOS 2018 Meeting,
28-30 June, Copenhagen, Denmark (G. Gozaliasl)

SPIDERS Meeting,
3-5 July, Max Planck Institute for Astrophysics, Garching, Germany (K. Kiiveri)

CPPM,
17-18 September, Marseille, France (C. Kirkpatrick)

BeyondPlanck 2nd Consortium Meeting,
17-21 September, Helsinki, Finland (talk by E. Keihänen, talk by A.-S. Suur-Uski)

IRAP,
19-21 September, Toulouse, France (C. Kirkpatrick)

Euclid Consortium Board Meeting,
27 September, Paris, France (talk by H. Kurki-Suonio)

Euclid Developers Workshop 5,
6-9 November, Groningen, the Netherlands
(talk by G. Gozaliasl, E. Keihänen, A.-S. Suur-Uski)

INAF-Osservatorio Astronomico di Brera,
8-9 November, Milan, Italy (C. Kirkpatrick)

Euclid VIS PF Meeting,
10-14 November, Paris, France (G. Gozaliasl)

Oscar Klein Centre,
12-15 November, Stockholm, Sweden (K. Kiiveri)

AHEAD X-Ray and Multiwavelength Surveys School,
19-23 November, Garching, Germany (A. Viitanen)

Particle Physics Day 2018,
23 November, Jyväskylä, Finland (talk by E. Keihänen)

XII Tonale Winter School in Cosmology,
10-14 December, Passo del Tonale, Italy (A. Viitanen)

Euclid Science Challenge 4/5/6 Meeting,
11-13 December, Garching, Germany
(H. Kurki-Suonio, V. Lindholm)

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CMS Programme

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