Annual Report 2025

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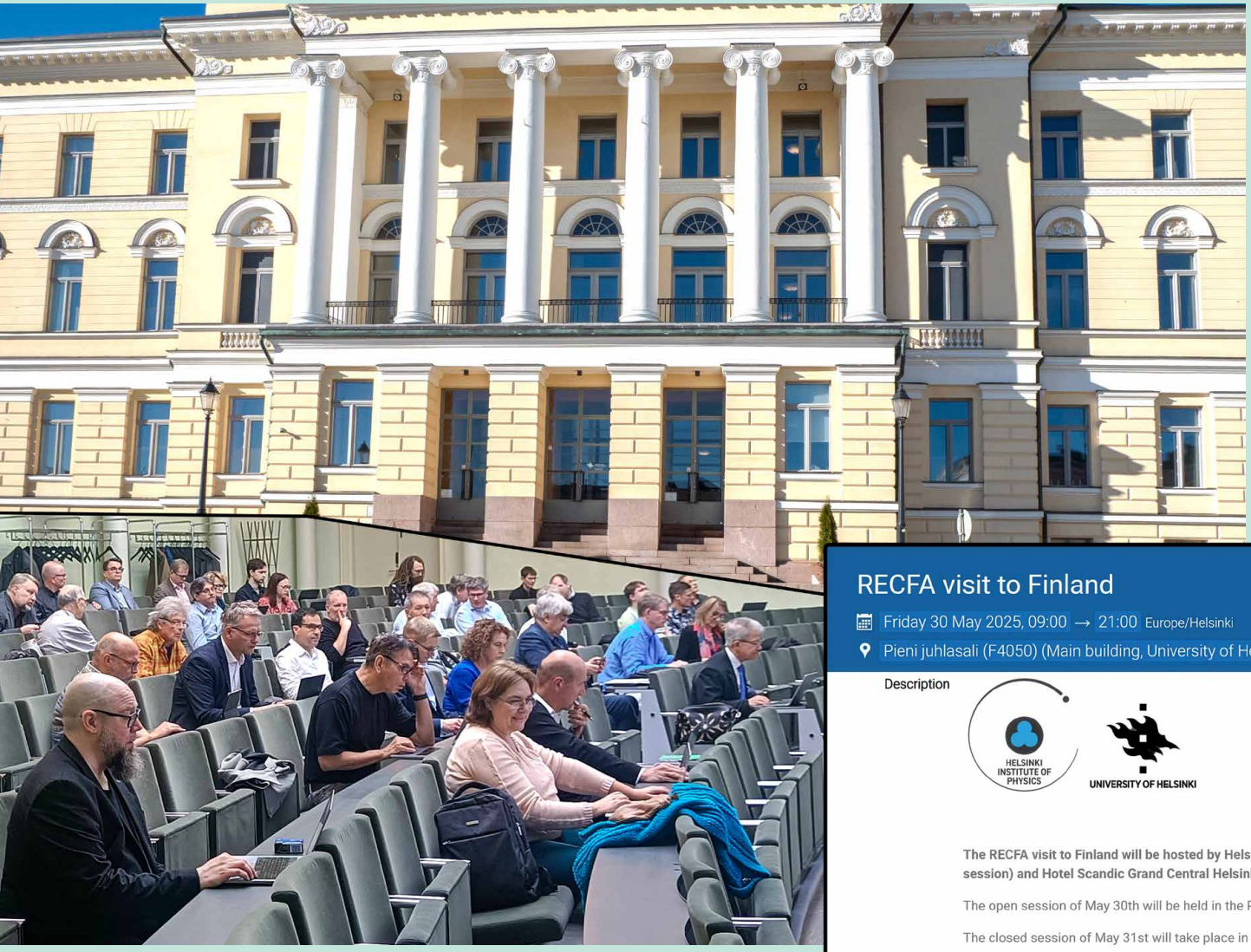

After their previous visit in 2017 the high-level committee RECFA (Restricted European Committee for Future Accelerators) visited Finland at the end of May.
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RECFA visit to Finland

Friday 30 May 2025, 09:00 → 21:00 Europe/Helsinki

Pieni juhlasali (F4050) (Main building, University of Helsinki)

Description

HELSINKI INSTITUTE OF PHYSICS

UNIVERSITY OF HELSINKI

The RECFA visit to Finland will be hosted by Helsinki Insti
session) and Hotel Scandic Grand Central Helsinki May 3

The open session of May 30th will be held in the Pieni juhla

The closed session of May 31st will take place in the Hote

Local organizers recfa-finland-LO@cern.ch

Registration: Registration

Participants: 74 View full list

09:00 → 09:05 **Welcome by the Vice-Rector of the University of Helsinki**
Speaker: Kai Nordlund

09:05 → 09:30 **HEP in Finland (20+5)**
Speakers: Prof. Katri Huitu (Helsinki Institute of Physics (FI)), Katri Huitu (Univer
KH_HEP_in_Finla...

09:30 → 09:55 **CMS Experiment (20+5)**
Speaker: Mikko Voutilainen (Helsinki Institute of Physics (FI))
recfa_2025_05_3...

09:55 → 10:15 **ALICE Experiment (15+5)**
Speakers: Sami Sakari Rasanen (University of Jyvaskyla (FI)), Sami Sakari Ras
250530-SamiRas...

10:15 → 10:35 **Welcome by Research Council of Finland (15+5)**
Speakers: Paula Eerola (Research Council of Finland), Paula Eerola (Helsinki Inst
RCF-general-3005... RCF-general-3005...

10:35 → 11:05 **Coffee break**

11:05 → 11:30 **Accelerator Technology and Applications, FCC, CLIC (20+5)**
Speaker: Dr Flyura Djurabekova (Helsinki Institute of Physics (FI))

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, Jyväskylä, and Tampere, Aalto University, and Lappeenranta-Lahti University of Technology LUT. The Finnish Radiation and Nuclear Safety Authority (STUK) has been an interim member of HIP since 2018. Hosted by the University of Helsinki, HIP addresses fundamental science questions from quarks to Cosmos as well as technologies from semiconductors to medical applications and climate research. It 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 Laboratory for Particle Physics CERN in Geneva and with the Facility for Antiproton and Ion Research FAIR GmbH, which is under construction in Darmstadt.

In 2025, the research activities of HIP consisted of four research programmes: 1) the Theory Programme; 2) the CMS Programme including computing for the LHC (Large Hadron Collider) experiments; 3) the Nuclear Matter Programme including involvements in the ALICE (A Large Ion Collider Experiment) and ISOLDE (Isotope Separator On Line DEvice) experiments, and the FAIR facility; and 4) the Technology Programme. In addition, there were three stand-alone research projects: CLOUD; Education and Open Data; and Euclid. The Detector Laboratory served as a general facility for the Institute.

Several evaluations of HIP research were conducted in 2025. The Restricted European Committee for Future Accelerators (RECFA) visited Finland in May. RECFA's evaluation of particle physics and related science in Finland was quite positive, and they sent their findings to the Ministry of Education and Culture and to the Research Council of Finland. In spring and summer, six of HIP's nineteen research projects as well as the Detector Laboratory were evaluated. All the evaluated projects, as well as the Laboratory, were found well worth supporting. As usual, the Scientific Advisory Board (SAB) visited in August and noted that the activities of HIP remain internationally very good. HIP also participated in the research assessment of the University of Helsinki, the outcome of which is not known at the time of writing.

Two projects of the Theory Programme, namely *Theoretical Cosmology* and *Topological Matter*, ended in 2025. Consequently, two new theory projects were selected to start in 2026, namely *Cosmology and Astroparticle Physics*, which connects the Helsinki and Jyväskylä cosmology communities, and *Pioneering Beyond Born-Oppenheimer Physics in Solids*, which is an innovative approach for solid-state physics. A new Centre of Excellence (CoE) *Neutron-Star Physics*, led by Theory Programme Director A. Vuorinen, was announced in November. Topological Matter project leader T. Ojanen will be a PI in the starting *Quantum Materials* CoE. In late November, a European Research Council (ERC) Consolidator Grant for R. Paatelainen from the Phases of Strongly Interacting Matter project was announced.

The CMS and ALICE experiments received a record amount of data. In CMS analysis the activities in machine learning and quantum computing have been increasing, the latter being a SAB recommendation. For LHC computing, developments with HPC computing are ongoing. The Research Council of Finland Infrastructure Committee granted the High-Luminosity LHC (HL-LHC) a Roadmap status and funding with which the in-kind contributions for CMS and ALICE are possible. For the ALICE work, collaboration with VTT was agreed.

The Research Council of Finland organised a dedicated application round for FAIR, and with the granted funding the in-kind contributions which were agreed in the FAIR convention are possible to build.

A new Technology Programme project, *AlN-on-Si Quantum Emitters and Sensors*, started in 2025; single photon emitters are studied in the project. The personnel in the Programme received several grants during the year related to this and other activities.

A. Vuorinen started as Theory Programme Director in January 2025. *FAIR* project leader T. Grahn was promoted to a Professor position and *ALICE* project leader S. Räsänen to an Associate Professor position, both at the University of Jyväskylä. HIP visiting Professor P. Dendooven will continue for another three-year period. D. Weir from the Theoretical Cosmology project started as Chair of the Physics Wellbeing group in Helsinki. S. Lehti received the Golden Medal of service after 30 years at the University of Helsinki.

Another HIP community related change is the transfer of representation of Finland in the Nuclear Physics European Collaboration Committee (NuPECC) from the Research Council of Finland to HIP from the start of 2026. After this change, HIP represents communities of NuPECC, the European Committee for Future Accelerators (ECFA), and the Astroparticle Physics European Consortium (APPEC). An ECFA-related lengthy process in 2025 was the preparation for the European Strategy of Particle Physics Update. The community in Finland discussed its preferred option for the CERN flagship collider project after HL-LHC at the Particle Physics Days in 2024 and in 2025, and in three Nordic meetings. The recommendation by the community was the 91 km long Future Circular Collider, FCC-ee. A related annual conference, ”FCC Week”, will be organised in Helsinki in June 2026.

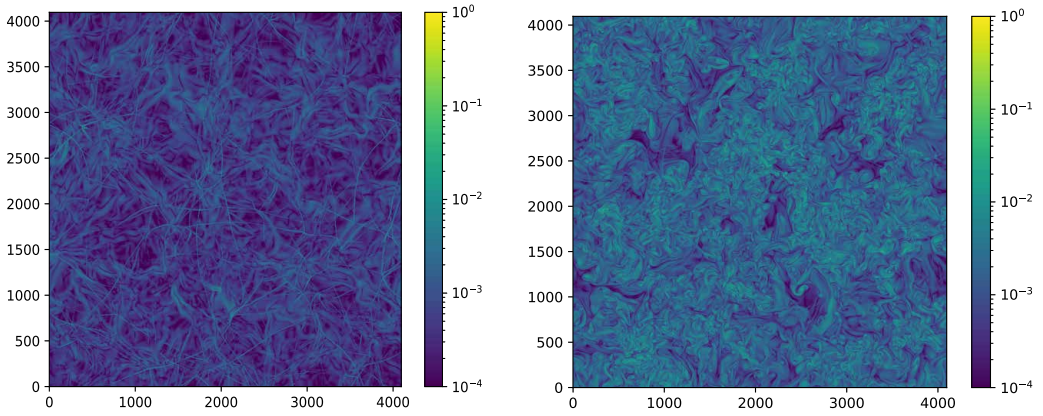
HIGHLIGHTS OF RESEARCH RESULTS

Theory Programme

The HIP Theory Programme comprises four independent projects that study physical phenomena at all length and energy scales in nature. For two of the four projects - *Topological Matter* and *Theoretical Cosmology* - 2025 marked the final year of their six-year term, while *Phases of Strongly Interacting Matter* and *Fundamental Particle Interactions Beyond the Standard Model* both underwent external evaluations during 2025 and were renewed for another three years.

A focal point of research in the *Theoretical Cosmology* project was the study of gravitational-wave production in strong first-order phase transitions with large-scale, long-running simulations. This enabled detailed investigations of the power spectra of velocity and shear stress, and, for the first time, their time decorrelation.

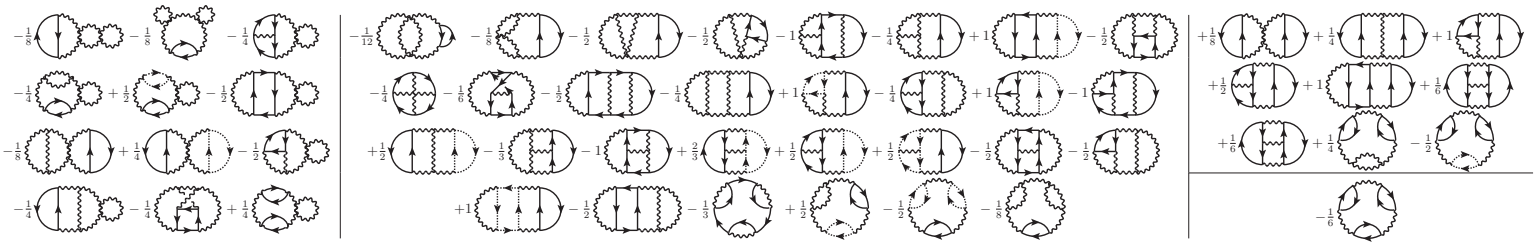
[J. Correia, M. Hindmarsh, K. Rummukainen, and D. J. Weir, Phys. Rev. D 112 (2025) 123546]



In *Topological Matter*, attention shifted towards the practical use of quantum computers in research, including the development of a new protocol to share many-body quantum states via entanglement swapping.

Phases of Strongly Interacting Matter showed how the infrared problems plaguing the perturbative thermodynamics of cold quark matter can be resolved at four-loop order, and how vacuum diagrams can be efficiently computed using the novel dense Loop Tree Duality method.

Finally, recent highlight results of the *Fundamental Particle Interactions Beyond the Standard Model* project include the development of a novel theory of neutrino oscillations. Here, flavour neutrinos interact weakly as kinematically massless particles but mix and oscillate by acquiring a refractive mass while propagating in the quantum vacuum.

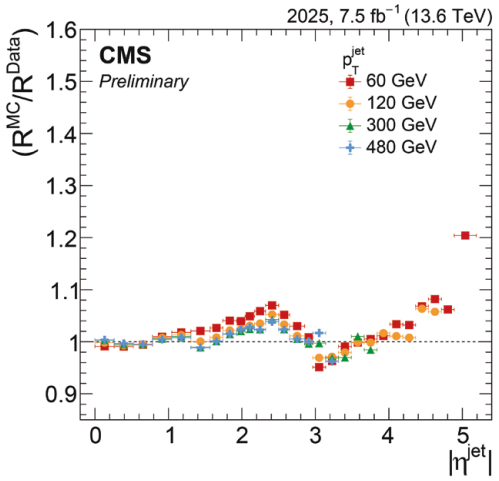


[A. Kärkkäinen et al., Phys. Rev. Lett. 135 (2025) 021901]

CMS Programme

CMS is a LHC general-purpose experiment. 2025 was another exceptional year for the LHC, enabling CMS to collect 125.7 fb^{-1} of high-quality data. A highlight achieved together with ATLAS involved reaching within a factor two of Standard Model di-Higgs production for the combined expected limit using only Run 2 data, in view of accessing the Higgs potential shape.

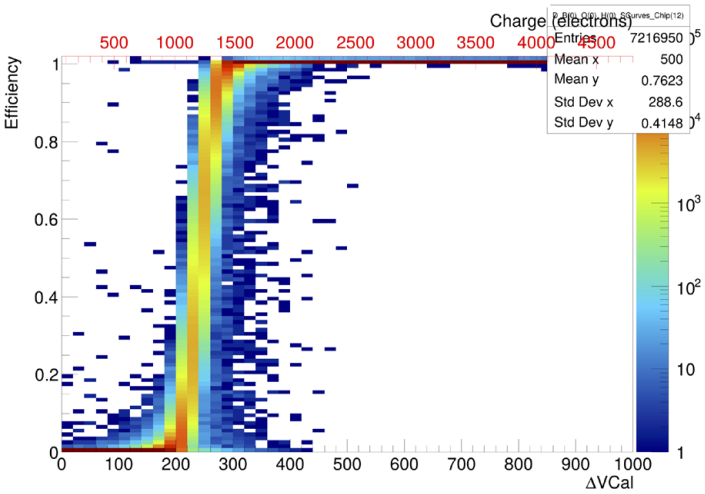
HIP contributed to Higgs, top quark mass, strong coupling α_s, and vector boson scattering (VBS) measurements. The HIP team provided jet energy corrections (JEC) early in 2025, allowing a close follow-up of the incoming data and improved low-energy calorimeter calibrations. A prototype of the JEC-for-Prompt monitoring stream was commissioned, and quantum machine learning first tested for Higgs searches and VBS analysis. As recognition of the HIP efforts, M. Voutilainen started as End-to-End Optimization, N. Norjoharuddeen as Jet and Missing Energy (JME), P. Inkaew as scouting, and B. Lehtelä as JME-Trigger convener.

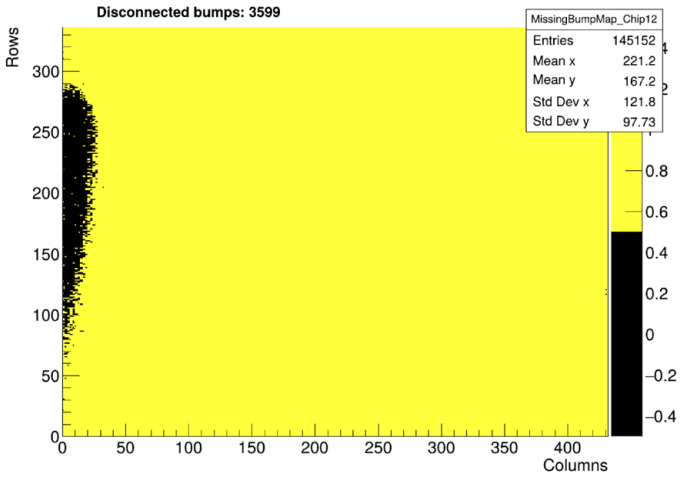


© CMS Collaboration

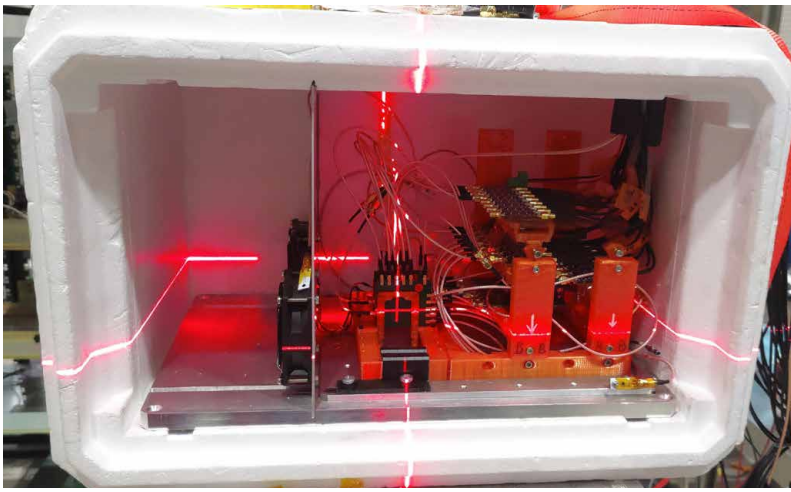
The upgrade team focussed on the High-Luminosity LHC (HL-LHC) endcap pixel tracker in 2025, with the module pre-production batch successfully wire-bonded and tested. HIP also became a quality control centre for Low Gain Avalanche Detectors (LGAD) production sensors for the Endcap Timing Layer. Detector development continued for beam monitoring for BNCT facilities and gamma emission tomography of used nuclear fuel.

TOTEM was a LHC forward physics experiment, with total proton-proton cross section and ρ measurements at 900 GeV as 2025 highlights. The HIP group operated the CMS Proton Precision Spectrometer time-of-flight detector and contributed to the LGAD sensor testing for its HL-LHC upgrade. In 2025, K. Österberg was elected PPS Institutional Board Chair and Resources Manager.

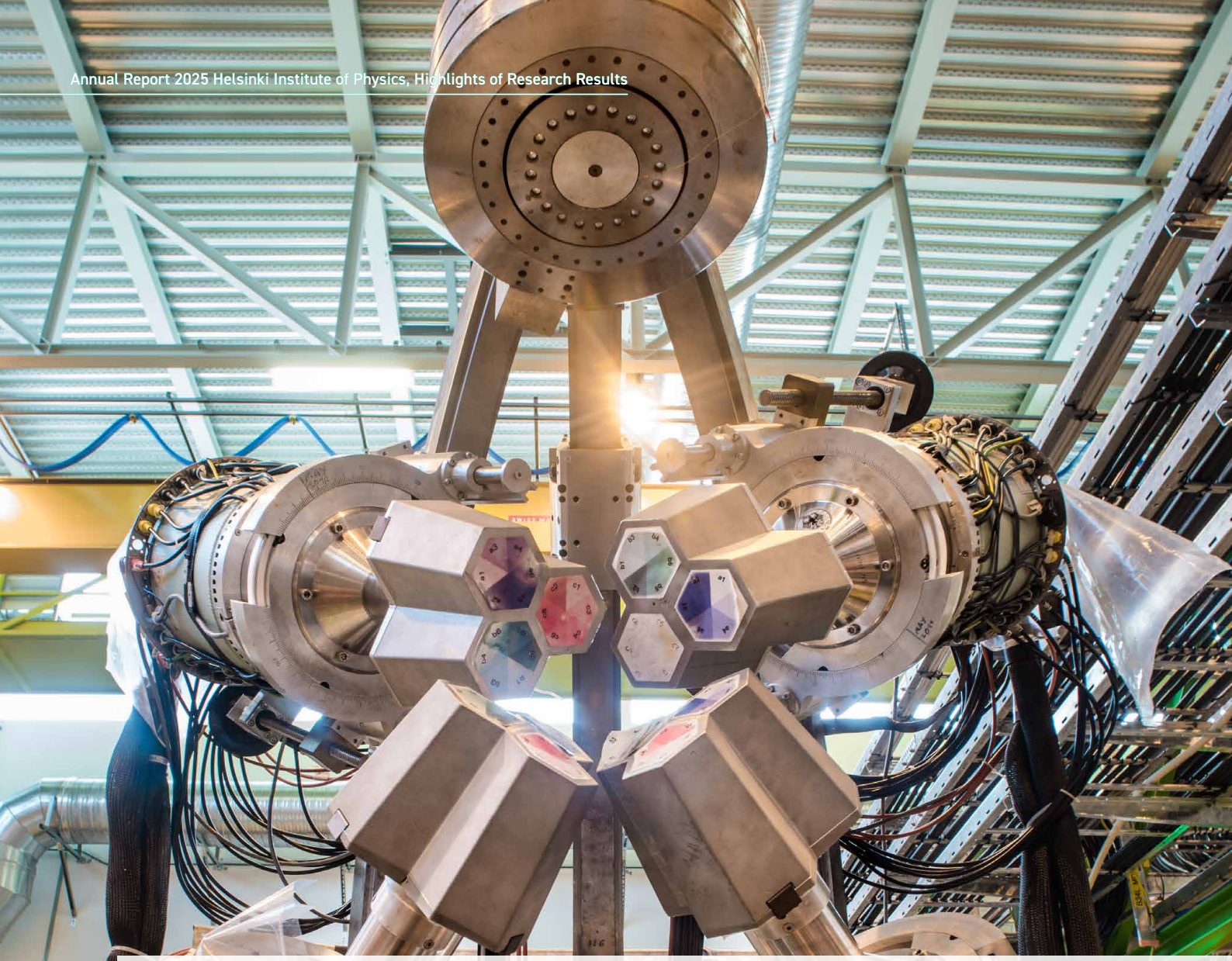




Credit: H. Badran



Credit: F. Garcia



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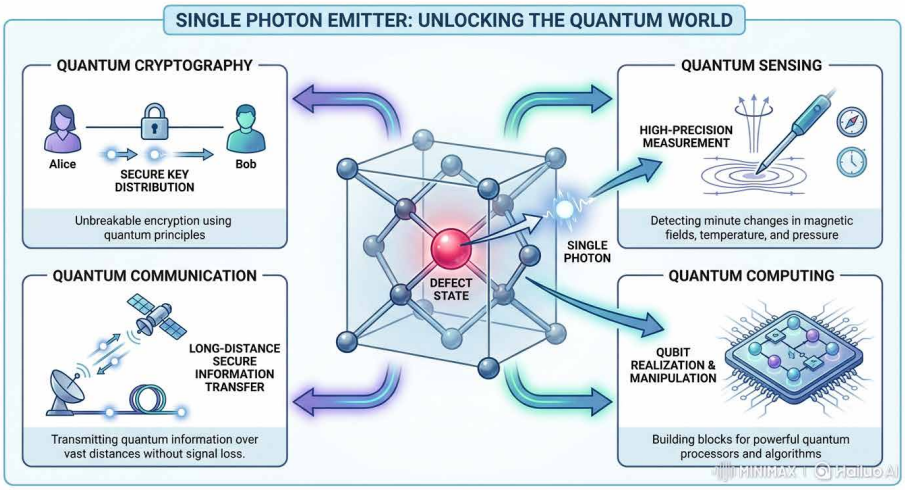
Nuclear Matter Programme

One of the highlights at ALICE was new beams delivered by the LHC. The LHC collided p-O, O-O, and Ne-Ne beams, which were eagerly awaited by the community, as lighter systems help probe the limits of QGP production. The Finnish ALICE team contributed to one of the first ALICE light-ion papers, searching for limits of jet quenching, and to a new paper on flow correlators constraining QGP properties.

The year 2025 has been extremely productive, resulting in many high-impact publications covering diverse physics disciplines. Laser spectroscopy measurements on the short-lived radium monofluoride molecule in the CRIS experiment were published in *Science*. The first measurement of the spectroscopic quadrupole moment of the first excited 2^+ state in ^{110}Sn using Coulomb excitation with the Miniball γ-ray spectrometer was published in *Physical Review Letters 2025*. HIP researchers participated in studies of laser spectroscopy and CP-violation sensitivity of actinium monofluoride, which were published in *Nature*. In addition to these, "*Electron correlation and relativistic effects in the excited states of radium monofluoride*" and "*Enhanced sensitivity for electron affinity measurements of rare elements*" were both published in *Nature Communication*.

The main focus of the Finnish FAIR project has been on the completion of accelerator components as a Finnish in-kind contribution, but our participation in the FAIR Phase-0 experiments has resulted in new data on, for example, atomic masses of $N = 126$ nuclei and neutron skin thickness around doubly magic ^{132}Sn. Such measurements are relevant for a more comprehensive understanding of the r-process nucleosynthesis and nuclear matter equation of state.

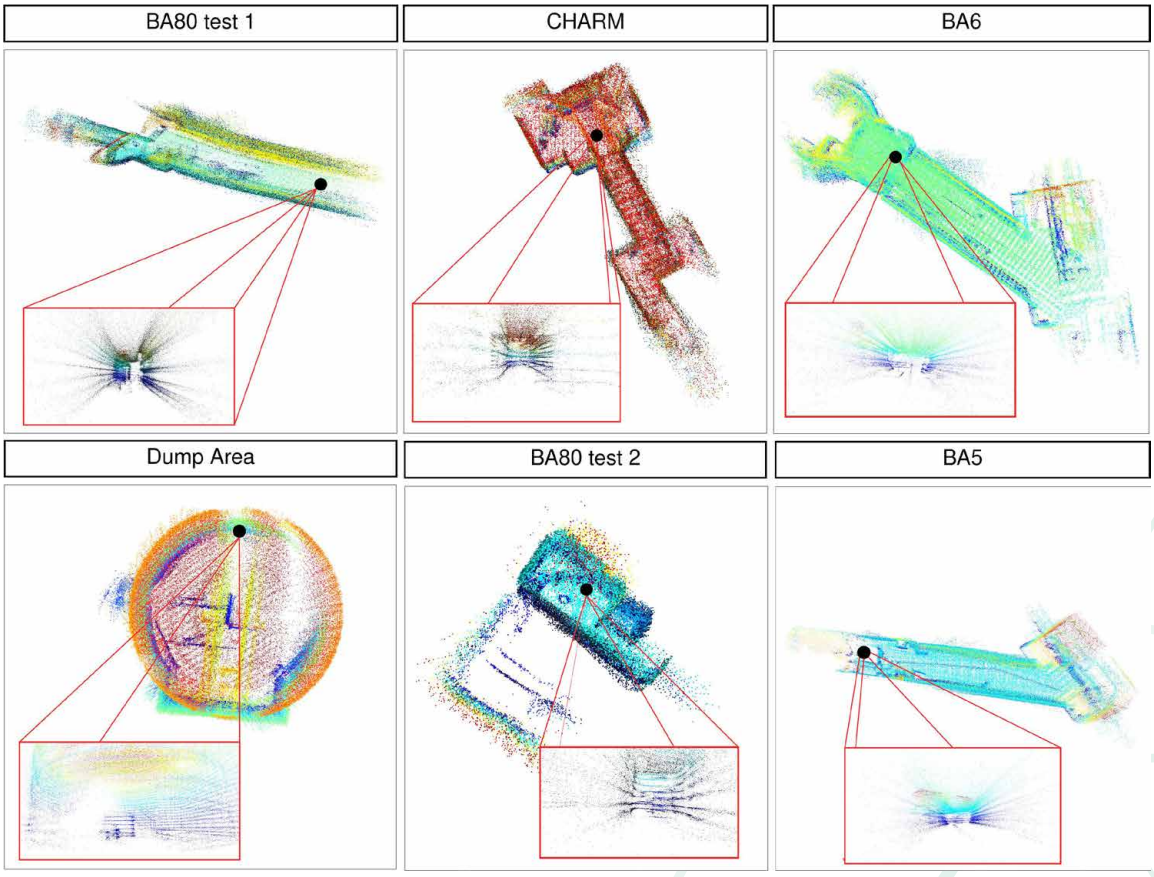
Technology Programme



The Technology Programme aims to integrate HIP projects with significant technology development, transfer, and pre-commercialisation activities into the same programme. In addition, the research activities performed within the programme are designed to seek synergies with big science initiatives at large. 2025 saw the start of the AQUES project that investigates and develops single photon emitters embedded in AlN-on-Si platforms. This project is at the core of the programme's quantum technology initiative. The first three-year periods of the RAD3S and ROBOT projects came to an end. Their future scopes have been adjusted based on internal and external evaluations.

In the ROBOT project, the intense collaboration with the CERN robotics team has continued in the field of mobile robot mapping. The developed framework based on spatial-context-aware LiDAR registration was evaluated in multiple CERN environments, including tunnels, laboratories, and dome-shaped chambers. Significant reductions in registration error were obtained.

Important advances have been made in the MAT project in developing the multiscale modelling of vacuum arcing at the surfaces of CLIC-based RF-accelerating structures intended for a future muon collider (IMCC Collaboration). Significant contributions to the quality improvement of HiPIMS-deposited superconducting thin films for FCC have been made by using large-scale molecular dynamics simulations.



THEORY PROGRAMME

The HIP Theory Programme conducts cutting-edge theoretical research through four independent projects: Fundamental Particle Interactions Beyond the Standard Model; Phases of Strongly Interacting Matter; Theoretical Cosmology; and Topological Matter. This activity supports the experimental research co-ordinated by HIP, with particularly close connections to the particle- and nuclear-physics experiments conducted at CERN and FAIR, as well as to the Euclid and LISA satellite missions of the European Space Agency. The Theory Programme also co-ordinates Finnish involvement in the COSINUS experiment, which aims at the direct detection of dark-matter particles.

ALEKSI VUORINEN
Theory Programme director

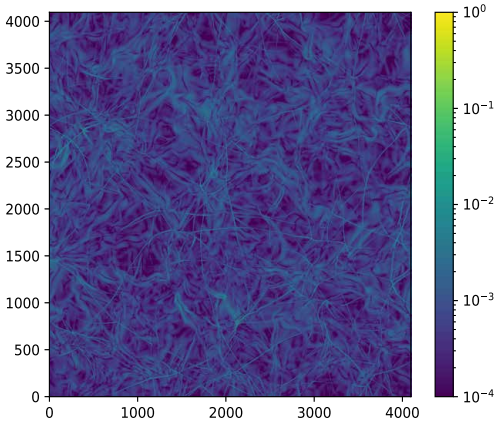
SAMI NURMI
Theoretical Cosmology project leader

Theoretical Cosmology

We study the origin and evolution of the universe, and connections between cosmology and particle physics. Our research topics involve inflation, dark matter, primordial out-of-equilibrium quantum processes, early universe phase transitions, large scale structures of the universe, and gravitational waves. We test microscopical models against the data from cosmological and collider surveys, searching for deeper understanding of the most fundamental properties of matter and gravity. We are part of the LISA Consortium, the LISA Distributed Data Processing Centre, and the LISA Astrophysics and Cosmology Working Groups. Along with the Finnish Euclid Science Data Center (SDC-FI), Finnish involvement in the LISA Distributed Data Processing Centre is facilitated by the FIRI-funded Cosmology Data Centre Finland, CDC-FI.

We work broadly on the origin of structures and matter in the early universe. The structures are most likely seeded by inflation, an extremely early period of accelerated expansion. This year we continued to investigate how stochasticity of inflation affects primordial black hole formation, showing that it has a major impact on their abundance and mass. We also investigated gravitational wave (GW) signals sourced by inflationary fluctuations of the Higgs field and began studying impacts of the discreteness of matter on GW propagation. We are developing quantum transport theory methods for precision modelling of out-of-equilibrium quantum systems during inflation and later in the history of the universe. This year we have applied these tools to study dark matter particle production during reheating in setups with coherent quantum fields, tachyonic instabilities and non-linear momentum transferring interactions.

We explore GW signals over the entire history of the universe. We work broadly



Simulation slices showing the magnitude of the curl of the fluid velocity. The left panel shows results for detonation at time $t = 5000/T_c$ and the right panel for deflagration at time $t = 7700/T_c$. [*J. Correia, M. Hindmarsh, K. Rummukainen, and D. J. Weir, Phys. Rev. D 112 (2025) 123546*].

on phase transitions in the early universe. This year we ran precision simulations of bubble collisions in strong first order phase transitions and their aftermath, accurately determining the efficiency of GW production. We also simulated magnetic monopoles in the expanding universe and performed the largest fixed-grid simulations to date of dark matter axion production by strings in the post-inflationary scenario. We are experts in studying GW signals sourced by supermassive black holes in galactic centres. This year we have also been running numerical simulations using the locally developed KETJU code, which can accurately simulate galactic-scale dynamical and gaseous astrophysical processes, while simultaneously solving the dynamics of supermassive black holes, black hole binaries and the surrounding stellar systems at small scales.

Fundamental Particle Interactions Beyond the Standard Model

ANCA TUREANU
Fundamental Particle Interactions Beyond the Standard Model project leader

This project is dedicated to the exploration of important topics of physics beyond the Standard Model, from the phenomenological and quantum field theoretical perspective, while exploring the synergies of dedicated experiments at the high energy and high intensity frontier.

One of our central research foci is the consistent formulation of neutrino oscillations. We examined the central tenet of the current standard theory of neutrino oscillations, that neutrinos are emitted and detected as flavour neutrino states, which are coherent superposition of massive neutrino states of different masses. We proved that all the quantum mechanical and quantum field theoretical arguments, including the invocation of the uncertainty principle and the wave packet description of massive neutrinos, entail the production of neutrinos as statistical ensembles of massive neutrino states. As the states in a statistical ensemble do not interfere, neutrino oscillations cannot be explained by superposition of massive states. This result invalidates the standard description of neutrino oscillations and provides a strong motivation for the novel, consistent, approach to this phenomenon that we proposed during 2024. Our ongoing work concentrates on the propagation of neutrino waves in matter.

Modelling dark matter and developing methodologies for studying dark matter both using astrophysical signals and direct detection were focus topics for the particle cosmology group. In the former we have investigated axions and their dynamics in neutron star magnetospheres and, in the latter, first principle and numerical materials physics computations to determine the response of different target materials to scattering of dark matter particles with sub-GeV masses.

We have studied the inflationary production of fermions in realistic cosmological settings. The central result of our studies is the prediction of gravitational quark, lepton, and right-handed neutrino production during cosmological inflation. We found that the resulting particle abundance exceeds naive estimates by up to twenty orders of magnitude. An important implication of our analysis is that feebly coupled right-handed neutrinos can be copiously produced via inflation and potentially constitute all the dark matter in the universe.

Finally, we generalised quantum measurement theory to holographic systems, revealing a concrete link between information extraction and gravitational dynamics, advancing our understanding of quantum gravity and measurement in strongly coupled relativistic systems.

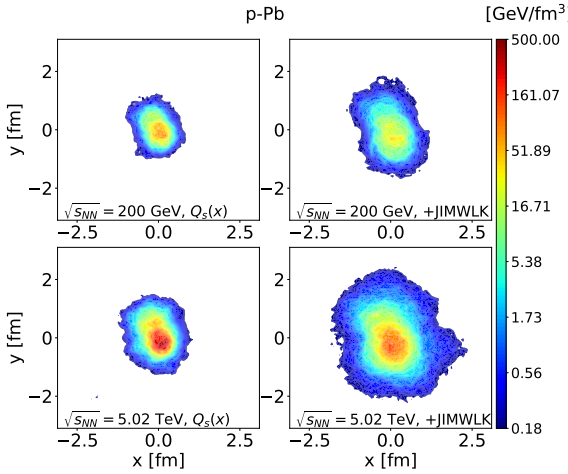
Credit: Illustris Collaboration / Illustris Simulation

HEIKKI MÄNTYSAARI
Phases of Strongly Interacting Matter project leader

Phases of Strongly Interacting Matter

Our project focusses on quantum chromodynamics (QCD) in both a collider environment and in an astrophysical context. We are also involved in physics studies for future colliders, such as the EIC and FCC.

At the end of 2025, we received exciting news: R. Paatelainen, leader of the neutron star equation of state (EoS) part of this project, was awarded an ERC Consolidator Grant. With the recently awarded Centre of Excellence in Neutron-Star Physics, where we are heavily involved, these will expand our activities in uncovering the properties of QCD matter in the high-density regime. In 2025, we demonstrated that the QCD matter pressure at four loops can be computed using our dense Loop Tree Duality technique.



The initial energy density profiles in p+Pb collisions at RHIC (top) and LHC (bottom) energies. The left column shows the profile when the small-x evolution is approximated by an energy-dependent saturation scale. The right column shows the corresponding energy density profiles obtained by solving the JIMWLK evolution equation. *[H. Mäntysaari et al., Phys. Rev. Lett. 135 (2025) 022302].*

In collider physics we, e.g., develop initial-state descriptions for heavy-ion collisions by applying both collinear factorisation and the Colour Glass Condensate (CGC). This year, we have developed a new collinear factorisation- and saturation-based Monte Carlo EKRT model that provides a full 3+1-dimensional partonic initial state for hydrodynamical evolution. We have also developed a novel neural-network-enhanced approach for a global Bayesian analysis that will allow the extraction of Quark Gluon Plasma (QGP) properties from heavy-ion data by orders of magnitude faster than before.

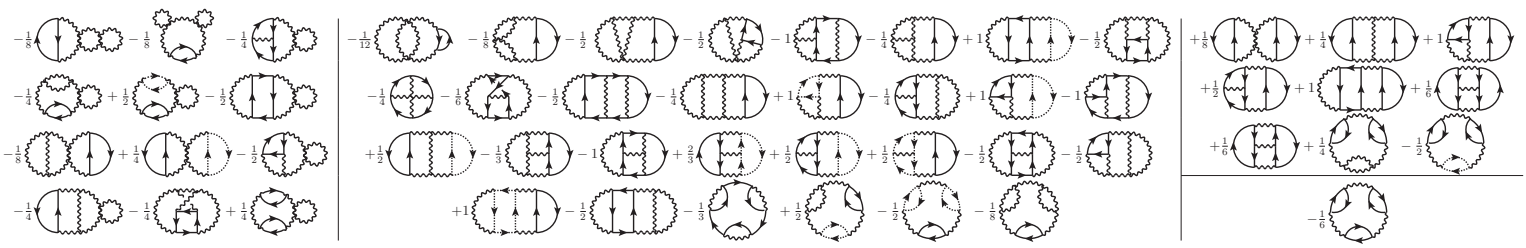
On the CGC side, we integrated perturbative high-energy evolution equations into the IP-Glasma model, which allows us to describe the initial state evolution from RHIC to LHC energies. We also presented Bayesian analyses that infer initial conditions for the high-energy evolution equations at both leading and next-to-leading order accuracy and determined how D^0 meson photoproduction in ultraperipheral collisions can probe gluon saturation effects.

Diagram	ε^{-2}	ε^{-1}	$\varepsilon^0_{\text{traditional}}$	$\varepsilon^0_{\text{dLTD}}$	N [10^6]	[μs]
$-\frac{1}{12}$	0	$\frac{3}{4}$	12.375	12.36(4)	110	7.1
$-\frac{1}{8}$	$\frac{27}{4}$	$\frac{189}{2}$	716.38	716.32(7)	120	6.5

Four-loop vacuum QCD diagrams computed using the dense Loop Tree Duality (dLTD) method, compared to the results obtained using traditional methods. *[A. Kärkkäinen et al., Phys. Rev. Lett. 135 (2025) 021901].*

In 2025, we participated in the publication of a new polarized proton PDF set NNPDFpol2.0 and developed an improved method to constrain the proton strange quark content based on neutrino-nucleus data. We also developed an improved description of multi-jet events in DIS with the general-purpose Monte Carlo event generator Pythia by applying modern merging algorithms.

On the holographic dense-matter side, we developed a probabilistic framework for the QCD critical endpoint and the beta-equilibrated equation of state by combining our V-QCD model with an effective description of nuclear matter. Confronting the resulting EOS ensemble with neutron-star data, we obtained quantitative posteriors for the first-order deconfinement transition and the critical endpoint location, demonstrating that holographically informed EOS modelling can now be directly integrated into astrophysical inference.



All four-loop diagrams computed as a part of R. Paatelainen's ERC project during the second half of this project in order to obtain the QCD matter pressure at a new perturbative order. *[A. Kärkkäinen et al., Phys. Rev. Lett. 135 (2025) 021901].*

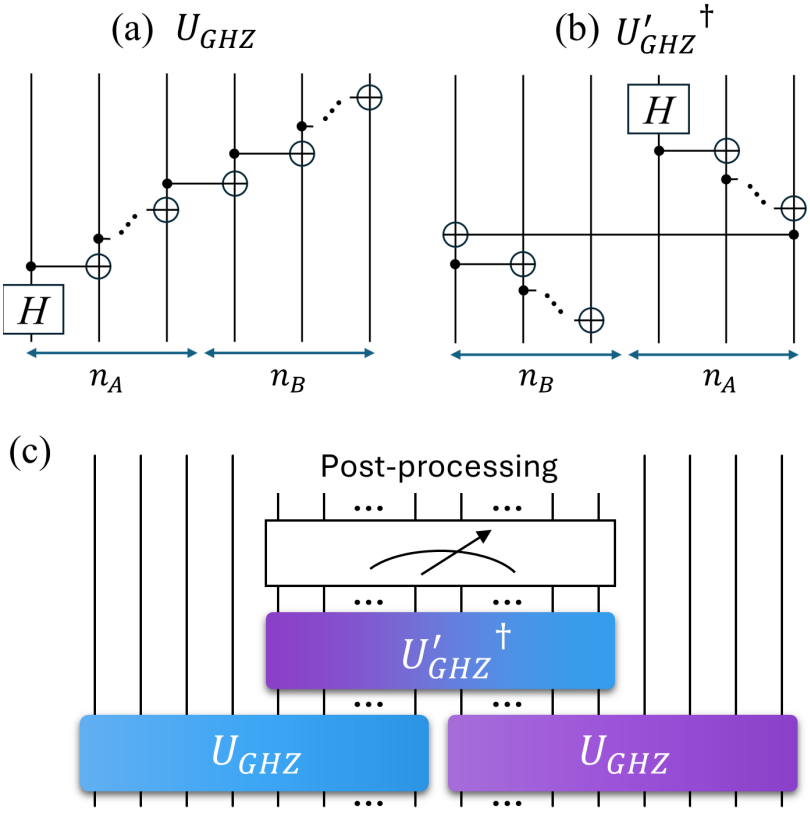
Topological Matter

TEEMU OJANEN
Topological Matter project leader

During its sixth and final year, the Topological Matter project has focussed on topics at the interface of many-body physics and quantum information. The most significant new development has been the adoption of quantum simulations on real quantum hardware as a new research methodology. This highlights the evolution of the original condensed matter theory project into a broader initiative that explores a wide variety of complex quantum phenomena through the lens of quantum information.

The main research focus in 2025 was the adoption of IBM and domestic CSC quantum computing resources to our research method toolbox. Present-day quantum computers are severely affected by random noise, which limits their uses to shallow circuits and modest system sizes. While quantum simulation is still not the main driving force in understanding many-body systems, it can be employed in proof-of-principle type demonstrations of increasingly complex phenomena and quantum algorithms. We developed a new protocol to share many-body quantum states via entanglement swapping and employed IBM quantum hardware to demonstrate the protocol in practice (see the figure below). The quantum simulation results were in excellent agreement with our theoretical predictions, providing an encouraging start to practical quantum simulation.

Other significant research directions included understanding the role of ground state entanglement in the linear response of fermion systems, extracting Fock space entanglement from a small number of correlation functions using machine learning methods, and establishing bounds for multifractal behaviour of complex fermion systems. Additionally, we started developing new algorithms and protocols for quantum simulation of complex systems.



Quantum circuit for sharing multiqubit GHZ states. This circuit was executed in a quantum computer to provide a proof-of-principle of the developed many-body swapping protocol. *[S. Huhtanen, Y. Mafi, A. G. Moghaddam, and T. Ojanen, arXiv:2506.22430].*

CMS PROGRAMME

The HIP CMS Programme co-ordinates the Finnish participation in the CMS and TOTEM Collaborations at the Large Hadron Collider (LHC). The Compact Muon Solenoid (CMS) is a general-purpose experiment with a broad physics programme covering precision measurements of particles and interactions, the origin of electroweak symmetry breaking (Higgs bosons), and the search for new physics. TOTEM focussed on elastic scattering, total cross section, diffractive and exclusive processes, and completed its data taking at the LHC in 2023. The programme has four projects: 1) the CMS Experiment project for physics analysis and operations; 2) the CMS Upgrade project for detector upgrades; 3) the Tier-2 Operations project for LHC computing; and 4) the CMS Forward Physics project for forward physics and the completion of the TOTEM physics programme. The Finnish CMS groups are HIP (15 authors); the Department of Physics at the University of Helsinki (4 authors); and Lappeenranta-Lahti University of Technology (4 authors). TOTEM has 7 HIP authors, 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

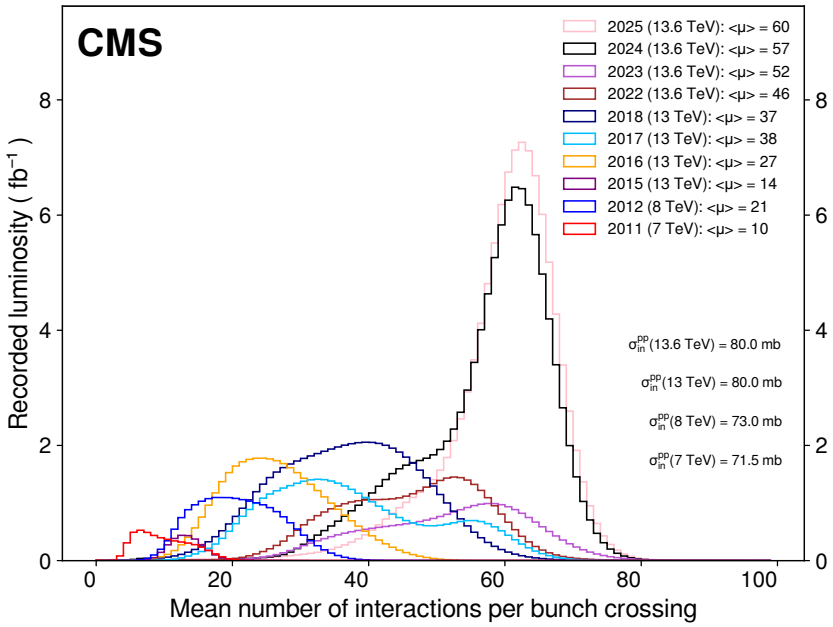
CMS Experiment

Introduction and Highlights

The LHC is in a unique position to explore the origins of the universe. The HIP CMS Experiment project is focussed on analysis of the LHC data, especially on precision measurements with jets, electroweak symmetry breaking, and Higgs bosons. These are supported by our strong involvement in detector operations through jet energy corrections (JEC), trigger, and machine learning (ML) applications, but also by new forays into quantum computing.

CMS had another exceptional year in 2025, collecting a record of 125.7 fb^{-1} of very uniform and high-quality data, and our team led the effort to further improve the data reconstruction. We were granted a new Research Council of Finland (RCF) Consortium project "JEC4Prompt" to increase these efforts and hired a new post-doc and a PhD student in December. We co-organised the Finnish Particle Physics Days at Hyytiälä Research Station and held our own Winter Workshop there as well.

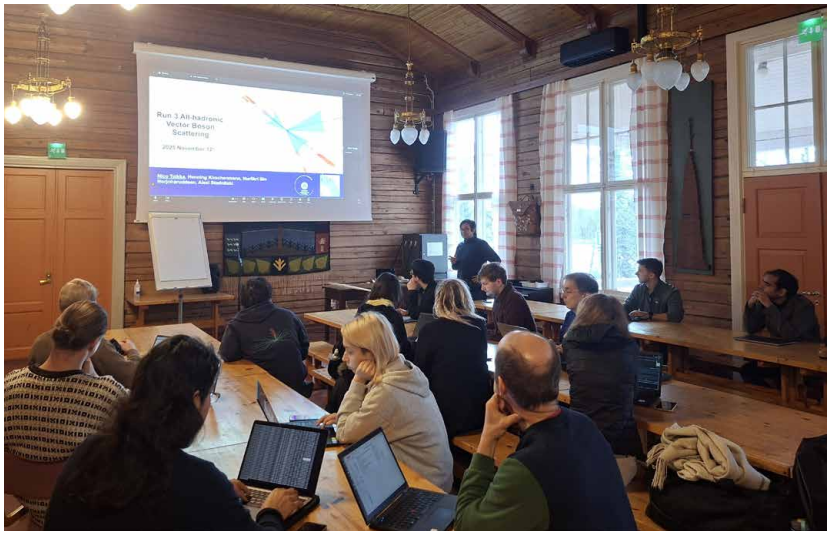
HIP held a record of five L2 and five L3 leader positions in CMS in 2025: M. Voutilainen moved from Physics Data sets and Monte Carlo Validation (PdmV) L2 to L2 convener of a new End-to-End Optimization group,



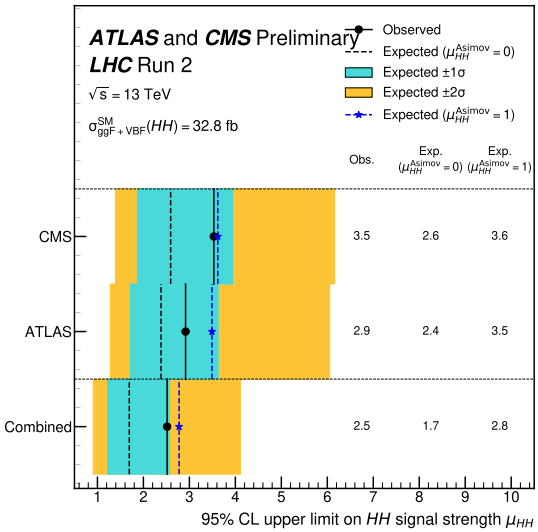
The distribution of the mean number of proton-proton interactions per bunch crossing as measured by the CMS experiment. Most of the 2025 data was taken with a mean larger than 60. © *CMS Collaboration.*

N. Norjoharuddeen was promoted from Jet and Missing Energy (JME) / B-tagging and vertexing (BTV)-Software L3 to JME L2 convener, P. Inkaew to Scouting L2 convener and B. Lehtelä to JME-Trigger L3 convener, while R. Verma continued as JME-Jet Energy Resolution and Correction (JERC) L3 convener and T. Lampén as PdmV-Validation L3. S. Laurila completed Level-1 Trigger L2 and S. Lehti JME-Trigger L3.

Overall, the highlights of the year at CMS included exceeding 500 fb^{-1} in total collected data, operating at steady 60+ simultaneous collisions, and together with ATLAS reaching within a factor two of Standard Model di-Higgs production for the combined expected limits on Run 2 data (CMS-PAS-HIG-25-014).



CMS project members at the CMS Winter Physics Workshop at Hyytiälä prior to the Particle Physics Days.
Credit: H. Kirschenmann.



The combined limits on Standard Model di-Higgs production from the ATLAS and CMS experiments using Run 2 data only. © *ATLAS and CMS Collaborations.*

The attendants of the Particle Physics Days 2025 outside the old main building of Hyytiälä Research Station.
Credit: S. Laurila.

Detector Operations

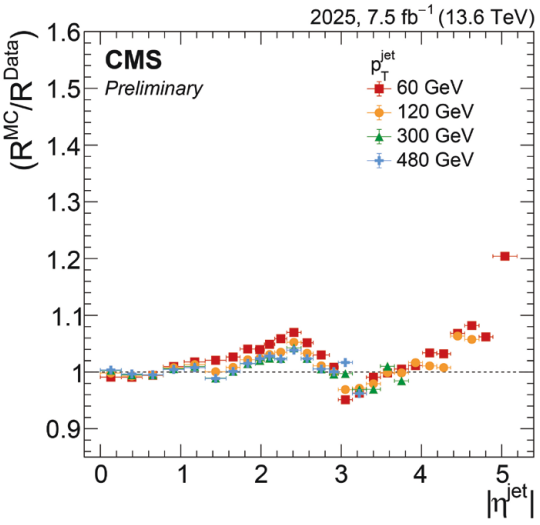
Our established JEC team provided early corrections in 2025, allowing us to closely study the new data and to provide the HCAL group with improved low-level calibrations for 2026. The first prototype of the JEC-for-Prompt monitoring stream was commissioned in 2025, and HIP contributed to trigger operations in L1, HLT, and scouting. The ML team provided new quark/gluon tagging scale factors. We also started a collaboration with LUT's computer vision team on edge ML algorithms for CMS trigger upgrade, closely linked to COST Action CA24153 "EPIGRAPHY".

Precision Measurements with Jets

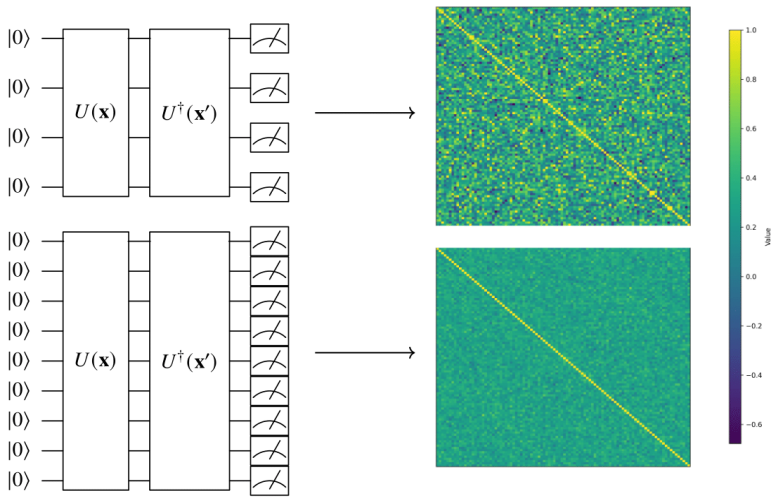
Precision measurements of the top quark mass m_t and the strong coupling constant α_s aim at exploring the Standard Model vacuum stability. The m_t measurement (M. Myllymäki, E. Veikkola) started in the Analysis Review Committee and made its first internal unblinding steps. Jet measurements for α_s (N. Mancilla Xinto, V. D. Le) progressed on new Run 3 data collected in 2024-2025. Efforts on toponium decays into diphotons were formalised with the TOP group (B. Lehtelä).

Electroweak Symmetry Breaking and Higgs Bosons

Vector boson scattering is an integral test of electroweak symmetry breaking, and the HIP contribution (N. Toikka, A. Stadnitski) continued through the RCF "ForVVard" project and the COST action "COMETA" (CA22130), with the ultimate goal to measure fully polarized WW scattering in an all-hadronic final state with full Run 3 data. Future di-Higgs measurements provide access to the shape of the Higgs potential, with promising development made on new techniques using boosted Higgs bosons, ML, and scouting (P. Inkaew). Quantum computing was tested for the first time in the charged Higgs bosons searches (A. Kössi) and VBS measurements (V. Mehtola). Quantum ML algorithms were applied to process CMS data both in quantum computing simulation and in the 50-qubit hardware at VTT.



The jet energy corrections as a function of the jet pseudorapidity for the CMS prompt 2025 data set. The correction effort is led by the HIP team. *© CMS Collaboration.*



Visualisation of the concentration of information for a 4 (top) and 9 (bottom) qubit quantum machine learning algorithm. *Credit: V. Mehtola.*

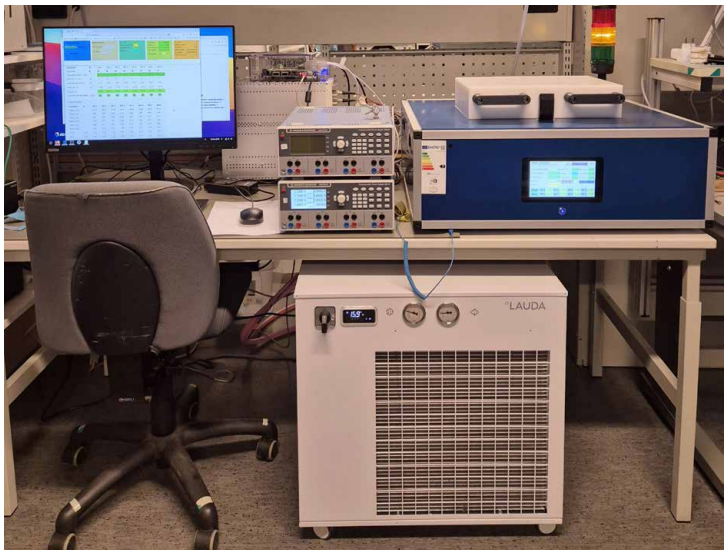
CMS Upgrade

ERIK BRÜCKEN
CMS Upgrade project leader

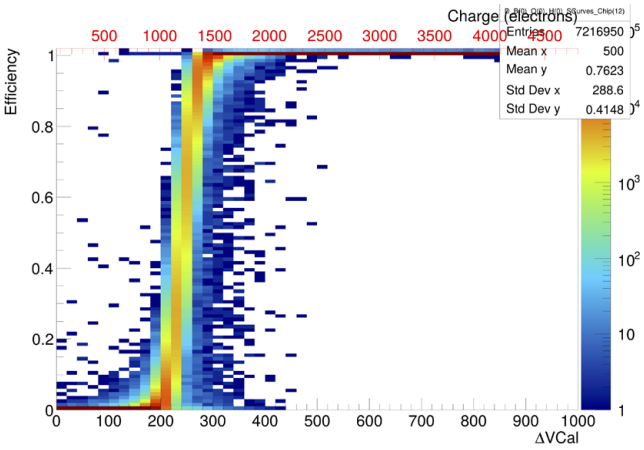
During the year before the LHC Long Shutdown 3 (LS3), the cornerstones of the project were contributions to the CMS experimental apparatus for the High-Luminosity LHC (HL-LHC): the upgrade of the inner tracking detector, the construction of the Minimum Ionizing Particle Timing Detector (MTD), and contribution to the outer tracking detector mechanics. Local R&D projects were also performed with the purpose of developing local expertise in HEP instrumentation and to support and instruct students.

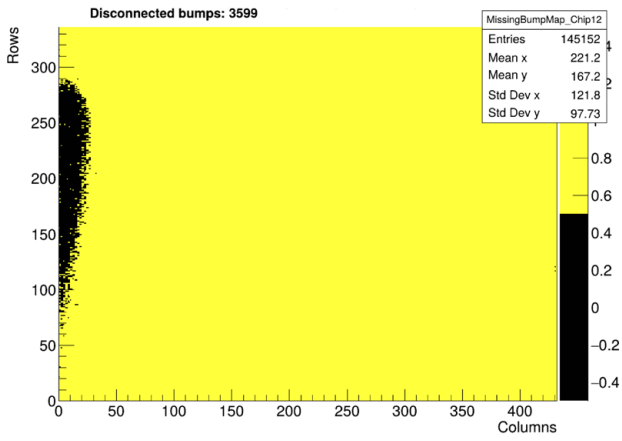
The pre-production of pixel modules for the inner tracking detector continued. For the HL-LHC CMS tracker, we are committed to producing and qualifying at least 250 pixel modules. At the beginning of the year new personnel were hired for this project: a technician for the module assembly process and a postdoctoral researcher to perform Quality Control (QC) tasks.

By winter 2025, 21 modules belonging to the pre-production batch were successfully wire-bonded and extensively tested. With the beginning of 2026, we will shift into full production phase.

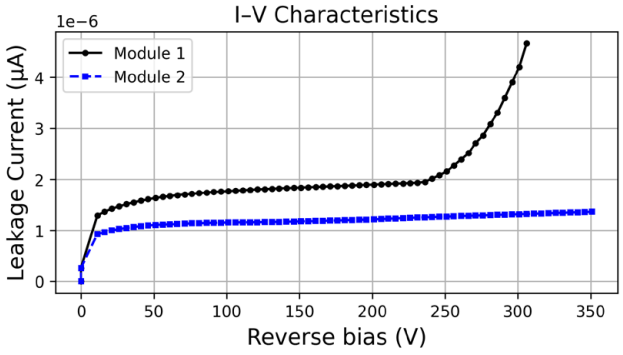


A quality control setup to test locally manufactured CMS inner tracker pixel modules. *Credit: H. Badran.*





Typical S-curve obtained from a tested CMS inner tracker pixel module showing threshold and noise distribution (top). Disconnected bump bonds between the sensor and the readout chip observed in a tested CMS inner tracker pixel module (bottom). *Credit: H. Badran.*



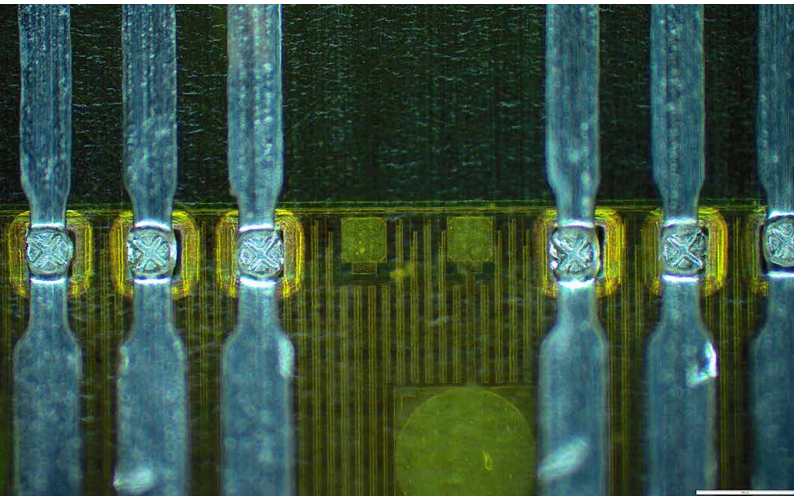
Characteristic current voltage curve of a good and a bad CMS inner tracker pixel module. *Credit: H. Badran.*

Our group also produces pixel modules layers for the FoCal detector of the ALICE experiment. Here, Single-Point Tape Automated Bonding is used to connect the pixel chips to the electrical readout circuits.

The MTD, a new timing layer outside the tracking detector, enables 4D tracking, essential for efficient track assignment in HL-LHC runs. Low Gain Avalanche Detectors (LGAD) are used for the Endcap Timing Layer, where we made earlier significant R&D contributions. In 2025, HIP became a full QC centre for production sensors. Funding was received from the RCF FIRI roadmap application to prepare the Laboratory for the production start in 2026. Among others, a probe station was procured that allows QC measurements down to -60 ℃.

Concerning local R&D, the Nordic Nuclear Safety Research (NKS) project ”Poseidon” on position-sensitive detectors for nuclear fuel imaging continued with another year of funding. The focus was on simulations for a new passive gamma tomography concept for spent fuel assemblies, including measurements at Uppsala University. The RD50/DRD3 project ”Partial Activation of Boron to enhance radiation tolerance of the gain implant”, in which we participate, started LGAD sensor production in 2025; the first samples are expected in spring 2026. Within the Boron Neutron Capture Therapy (BNCT) prompt gamma instrumentation activity, we built a neutron beam line at the local accelerator laboratory and characterized it.

Doctoral students A. Anumah and S. Saariokari measuring a mockup of a spent nuclear fuel assembly using a position sensitive CZT detector at Uppsala University.
Credit: P. Andersson, Uppsala University, Sweden.



Excerpt of Single-point Tape Automated Bonding (SpTAB) of a chip-cable to an ALIPDE sensor for the ALICE FoCal detector.
Credit: P. Koponen.

The first Single-point Tape Automated Bonding (SpTAB) attempts on the HIP cleanroom premises by P. Koponen.
Credit: A. Nikkanen.

Group picture after a successful neutron beam characterization measurement campaign at the local accelerator laboratory. *Credit: E. Brücken.*

Setup of the neutron beam characterization measurement at the local accelerator laboratory. *Credit: E. Brücken.*

TOMAS LINDÉN
Tier-2 Operations project leader

Tier-2 Operations

The HIP Worldwide LHC Computing Grid (WLCG) resources are run together between HIP, CSC (IT Center for Science Ltd), and the Nordic DataGrid Facility. HIP CMS analysis and simulation jobs were run in 2025 with very good availability. The CMS Site Readiness Status was 92% (93% in 2024). T. Lindén represented HIP in the Nordic LHC Computing Grid committee. S. Lehti and M. Myllymäki worked 10% in the Tier-2 Operations project.

CMS jobs were run on the 672 core ARC 6 Linux cluster Kale (2015) and since March on the recycled 1024 core ARC 7 cluster alcyone-cms v2 with 8 GB of RAM/core. Kale was taken down for upgrade in September. The dCache services run by CSC were stable.

The CSC Puhti and Mahti HPCs and cPouta have been used for development work to enable CVMFS on LUMI for ATLAS and CMS usage using the tool fapptainer. The status of running on Puhti, Mahti, and LUMI with fapptainer was presented at the ACAT and HEPiX Autumn 2025 Workshops. An abstract on fapptainer usage was submitted to the CHEP 2025 Conference. The missing memory and CPU usage information of jobs run with fapptainer is the remaining known fapptainer CMS issue since a job local alien CVMFS cache was configured.

An ATLAS and CMS pilot usage application for the CSC Roihu HPC was submitted. Roihu will replace Puhti and Mahti in 2026 and will have node local NVMe storage for CVMFS.

FTS transferred 2763 TB of data to HIP (4360 TB in 2024) and 1005 TB from HIP to elsewhere (1020 TB in 2024).

A total of 0.377 million CMS jobs (0.355 million in 2024) using 138 MHS06 CPU hours (75 MHS06 in 2024) were run with an average CPU efficiency of 75% (67% in 2024).

CMS Forward Physics

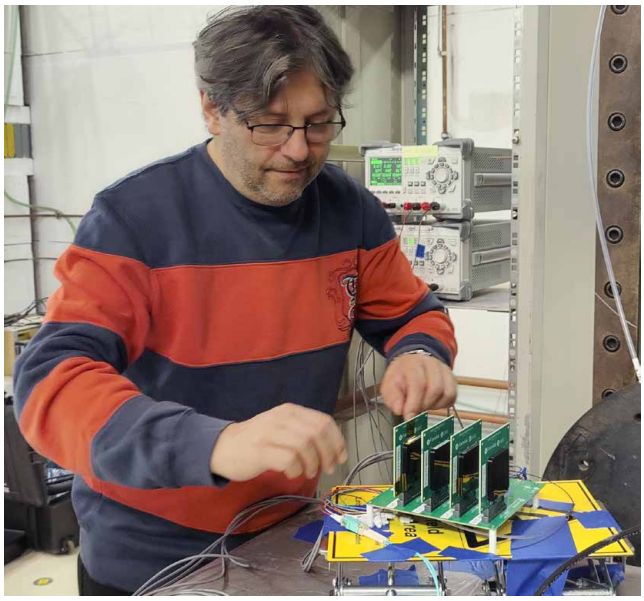
KENNETH ÖSTERBERG
CMS Forward Physics project leader

The CMS Forward Physics project is responsible for the Finnish contributions to CMS forward physics and the TOTEM experiment. The project's focus in 2025 was the operation of the CMS Proton Precision Spectrometer (PPS) time-of-flight (TOF) detector, the validation of the PPS Run 3 data, the preparation of the PPS HL-LHC upgrade (PPS2) and the completion of the TOTEM physics analyses. K. Österberg continued as TOTEM physics co-ordinator and F. Garcia as responsible for the PPS TOF detector operation and PPS2 TOF detector upgrade. In 2025, K. Österberg was elected PPS Institutional Board Chair and Resources Manager.

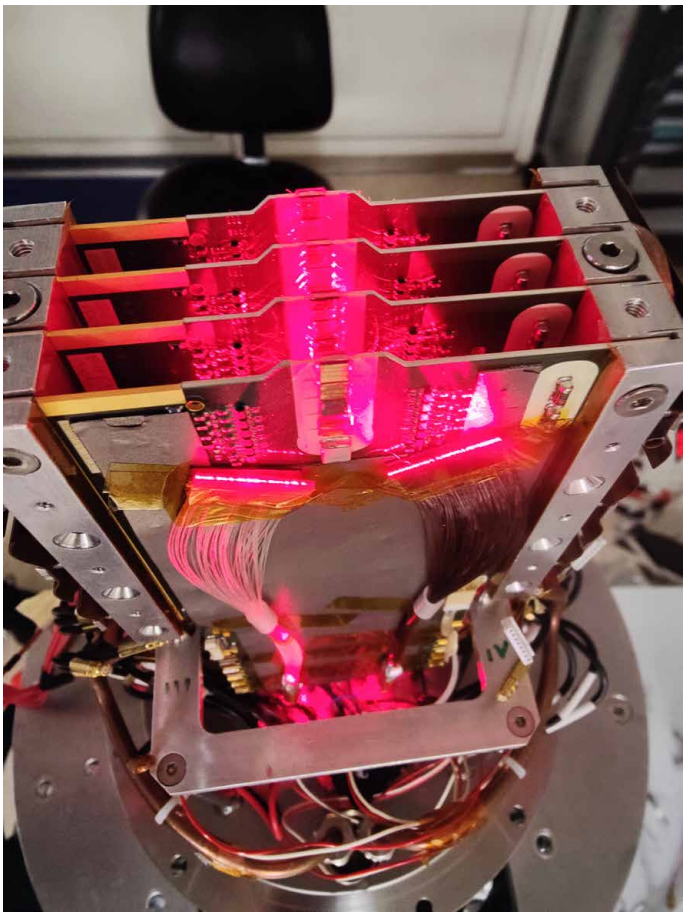
PPS Detector

HIP made a significant contribution to the Run 3 PPS TOF detector reconstruction. Despite efforts to mitigate the efficiency loss due to polarization of the TOF diamond sensors from the high particle flux in the PPS Roman Pots by shining with red lasers on the diamonds during the 2025 data taking (F. Garcia), a good TOF efficiency for standard LHC operation with high pileup and a large number of proton bunches could not be achieved. In parallel, studies of the polarization, its mitigation, and the radiation hardness of diamond sensors were continuing (M.-M. Rantanen).

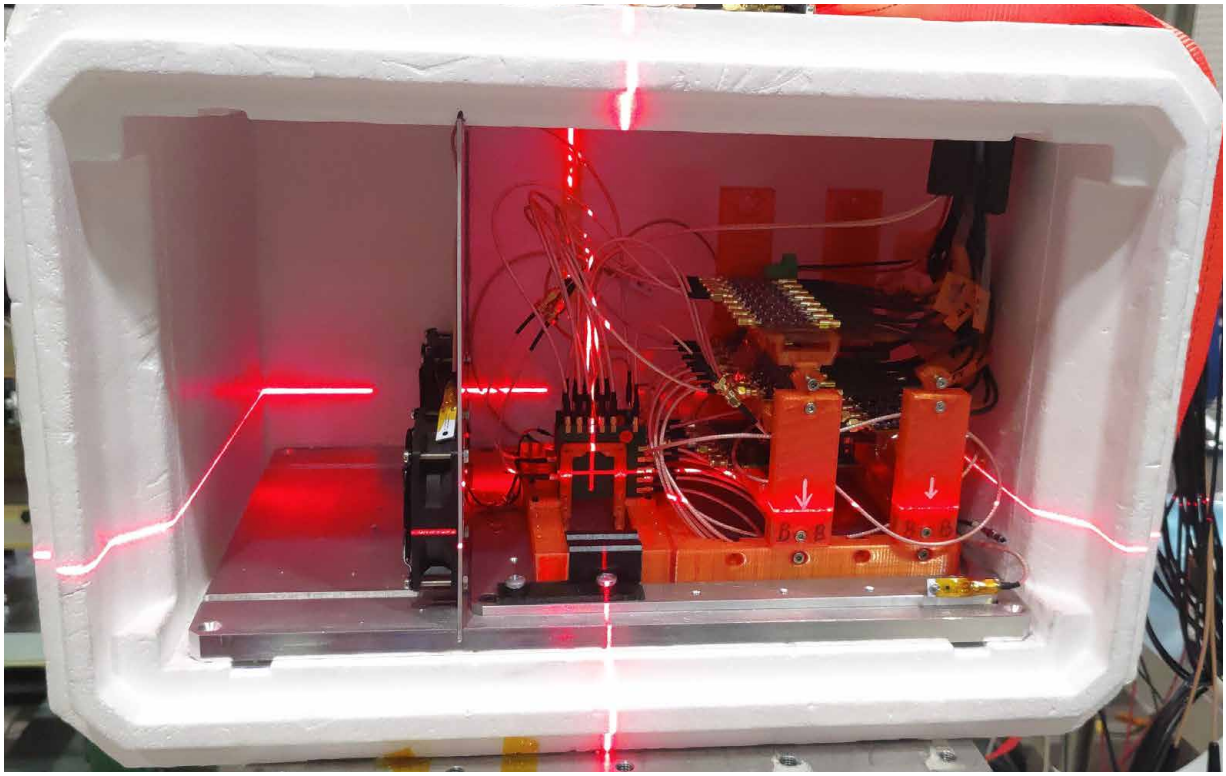
The PPS Run 3 tracking detector alignment and the LHC optics are being validated using central exclusive dilepton events (A. Milieva, F. Musonov). In 2025, HIP contributed to PPS2 by testing the LGAD sensors and their readout for the new TOF detector (F. Garcia) and planning the QC of pixel modules for the new tracking detectors (E. Brücken). Both contributions have large synergies with the CMS Upgrade project's contributions to the CMS Tracker and MTD detectors.



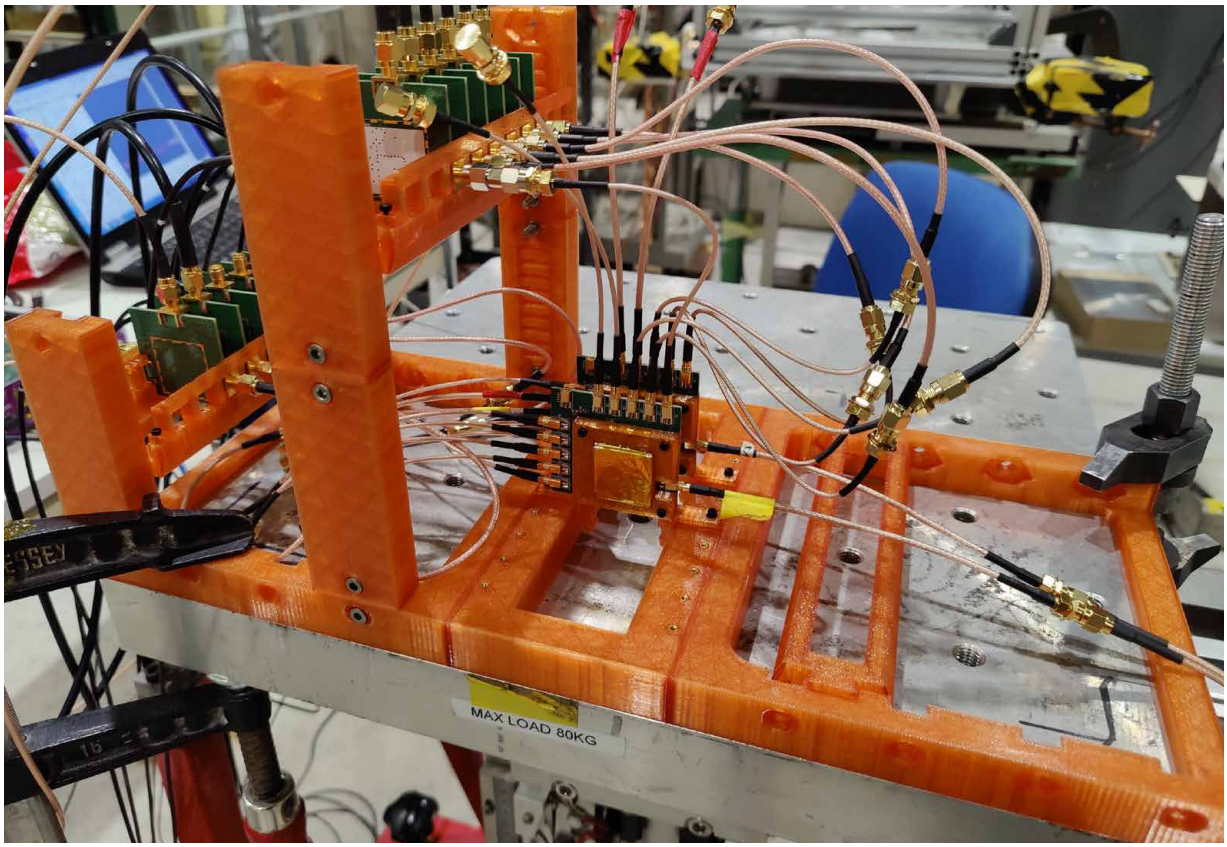
The FinETROC telescope for testing prototype CMS PPS2 LGAD modules. *Credit: F. Garcia.*



A refurbished CMS PPS time-of-flight detector package with red lasers added to mitigate diamond polarisation. *Credit: F. Garcia.*



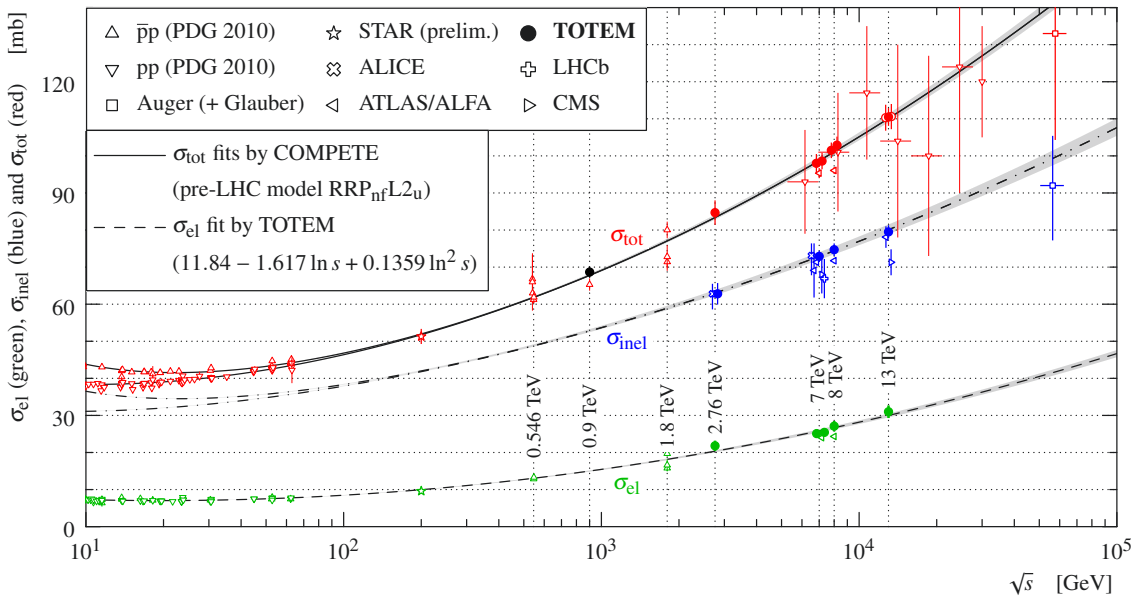
Non-uniformly irradiated LGADs tested in a beam test at the SPS H6 beamline in August 2025. *Credit: F. Garcia.*



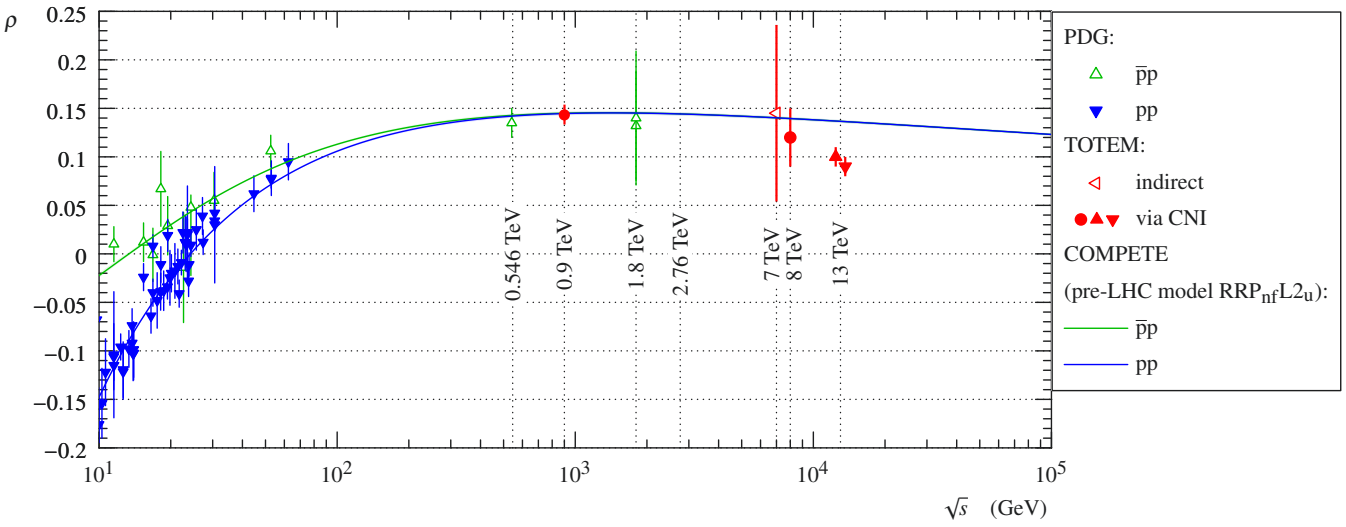
Standard and trench isolated LGADs tested in a test beam at the SPS H8 beamline in May 2025. *Credit: F. Garcia.*

Physics

In 2025, TOTEM presented total proton-proton cross section and ρ parameter measurements at 900 GeV that indicate an increased effect with energy of Odderon exchange contributions. A paper with an update of the observation of Odderon exchange in elastic scattering is in preparation (K. Österberg). An elastic scattering analysis of the 13.6 TeV data is progressing to have the final ingredient for a total cross section measurement (F. Oljemark). Also, the study of glueball candidates in low mass exclusive meson production continued in close collaboration with the CERN and University of Kansas groups. Regarding PPS physics, the PPS data validation using high mass exclusive dilepton events is being extended to cross section measurements for all three charged lepton species as well as an analysis probing the anomalous electromagnetic moments of the tau lepton (A. Kokko, A. Milieva, F. Musonov, K. Österberg) in close collaboration with the CMS Experiment project (S. Lehti).



A summary of the proton-proton and proton-antiproton total cross section measurements for different collision energies with the new 0.9 TeV TOTEM measurement highlighted as black dot. © *TOTEM Collaboration.*



A summary of the proton-proton and proton-antiproton ρ parameter measurements for different collision energies with the new 0.9 TeV TOTEM measurement highlighted as red dot. © *TOTEM Collaboration.*

NUCLEAR MATTER PROGRAMME

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. The Nuclear Matter Programme has also continued co-ordinating Finnish participation in the planning and construction of the FAIR project in Darmstadt. The Finnish involvement in the FAIR scientific programme concentrates on the NUSTAR Collaboration for nuclear structure, reaction, and astrophysics studies.

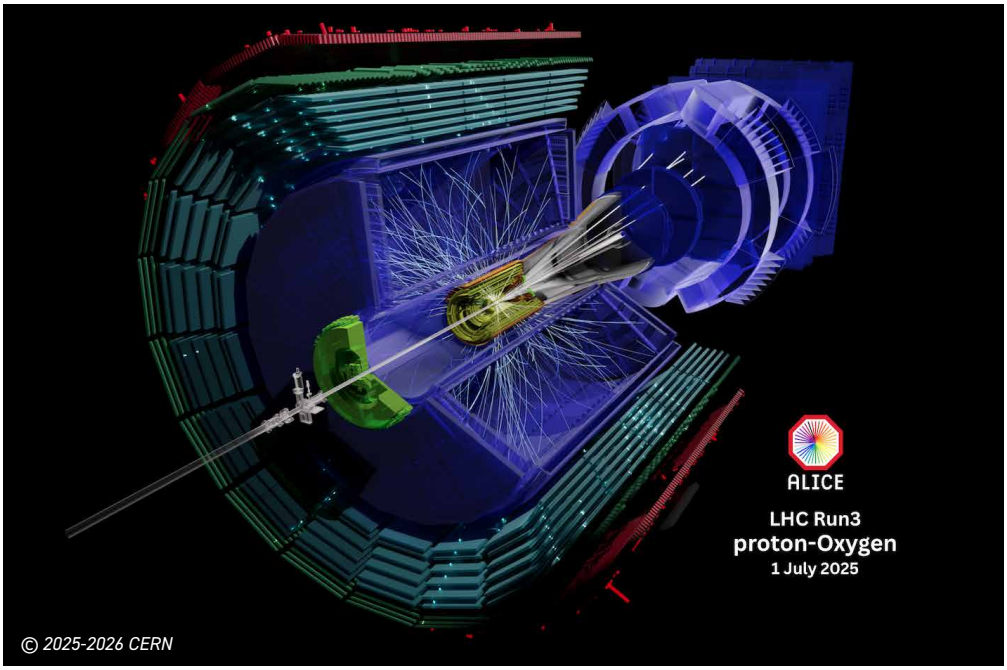
ARI JOKINEN
Nuclear Matter Programme director

SAMI RÄSÄNEN
ALICE project leader

ALICE

ALICE (A Large Ion Collider Experiment) is the dedicated heavy-ion experiment at the Large Hadron Collider (LHC). The experiment is optimised for excellent momentum resolution and particle identification in high track-density environments, which are essential for studying the properties of the quark gluon plasma (QGP), the deconfined state of strongly interacting matter.

In 2025, in addition to pp, the LHC collided p-O, O-O, and Ne-Ne. These new beams were eagerly anticipated in the community, as lighter systems help probe the limits of QGP production. All 2025 runs were a success. For instance, ALICE collected ten times the expected luminosity in O-O collisions. The data were promptly prepared for analysis, and the initial results have already been published. In Pb-Pb collisions, ALICE had to reduce the maximum rate due to TPC field-cage instabilities. Still, we have reached the planned integrated luminosity through efficient data-taking, longer fills, and luminosity levelling.

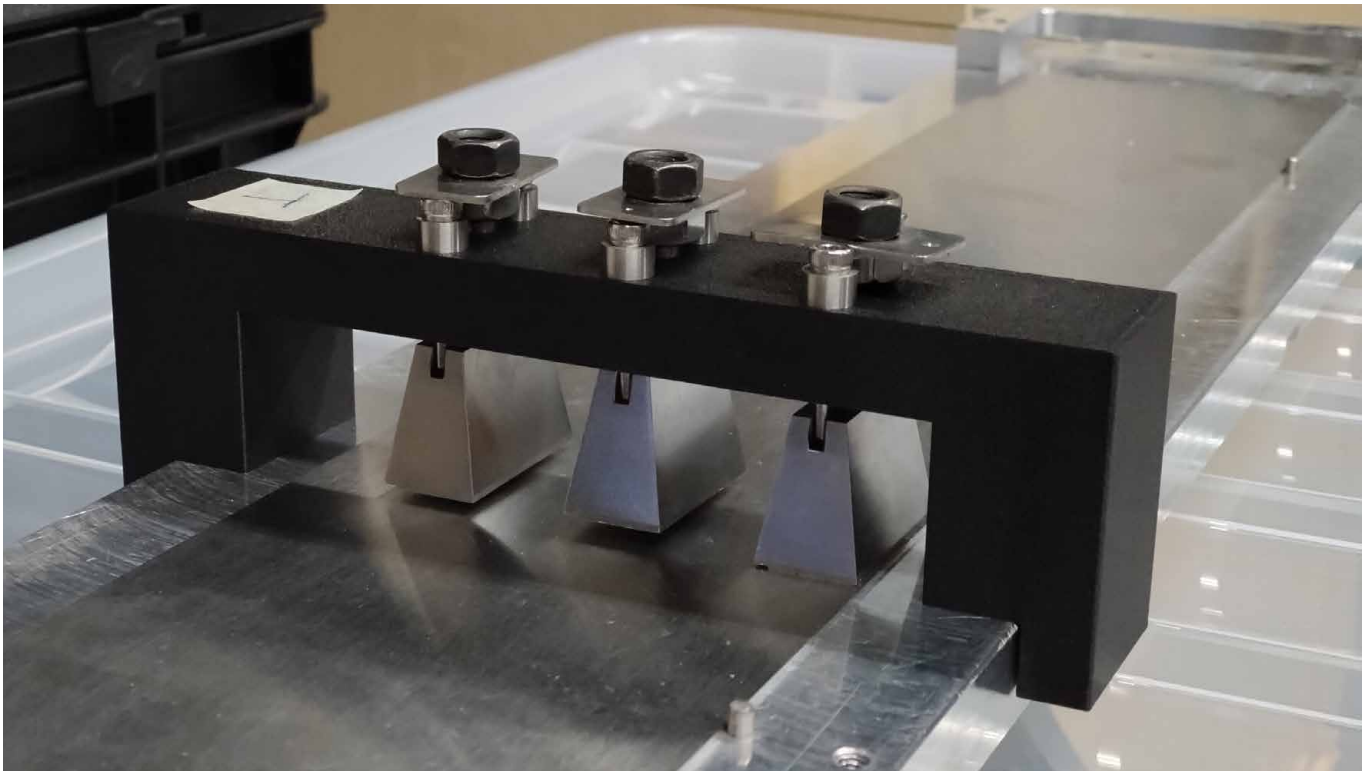


We celebrated the completion of two PhD projects in 2025. M. Virta defended his thesis on flow analysis and Bayesian analysis in November, followed by L. Huhta's defence on dijets in the central barrel and FoCal performance in jets at forward rapidities. We contributed to one of the first ALICE light-ion papers, searching for limits of jet quenching, and to a new paper on flow correlators constraining QGP properties. We also continued Bayesian studies on QGP matter properties.

The Fast Interaction Trigger (FIT) detector is vital for ALICE operation. FIT provides triggers, online luminosity monitoring, precise collision timing, and an unbiased sample of forward multiplicity used to determine centrality and the reaction plane in heavy-ion collisions. Y. Melikyan served as the technical co-ordinator for FT0, the FIT timing detector. In preparation for a major refurbishment of FT0 during the next LHC Long Shutdown, we have purchased and are characterising the replacement photosensors.

For the FoCal upgrade, we prepared the HIP Detector Laboratory for bonding the pixel layers and conducted the first bonding tests. Unfortunately, deliveries of materials from Ukraine have been delayed, so the comprehensive tests and process developments had to be postponed. In other FoCal activities, we measured the radiation tolerance of the new SiPM candidate and scintillation fibres for the hadronic calorimeter. Our postdoctoral researcher, H. Hassan, continued to serve as software co-ordinator for FoCal until he moved to a new position at the University of Tsukuba in the summer.

We initiated concrete activities for the ALICE3 upgrade, where we will contribute to the industrialisation of the Outer Tracker (OT) module production. The module production studies are conducted in collaboration with VTT Ltd, which is exploring solutions to a broad range of technological and scientific challenges. Given the ultra-low material budget required in the OT, our first step is to investigate how to lower the temperature needed for flip-chip bonding to prevent damage to the very thin chips and FPCs.



Detail of a glueing jig prototype for the production of the pixel module layers for the ALICE FoCal detector. *Credit: A. Nikkanen.*

JANNE PAKARINEN
ISOLDE
project leader

ISOLDE

In 2025, ISOLDE remained a central experimental facility within the CERN complex, providing 450 experimental shifts, with one third conducted at HIE-ISOLDE. At ISOLDE, radioactive nuclides are produced through spallation, fission, or fragmentation reactions in a thick target, irradiated with a proton beam from the Proton Synchrotron Booster. This process has enabled the production of over one thousand isotopes of 74 elements, with half-lives down to milliseconds, at intensities reaching up to 10^{11} atoms. The wide availability of diverse radioactive species supports comprehensive, systematic investigations of nuclear, atomic, and molecular properties in systems involving unstable nuclei.

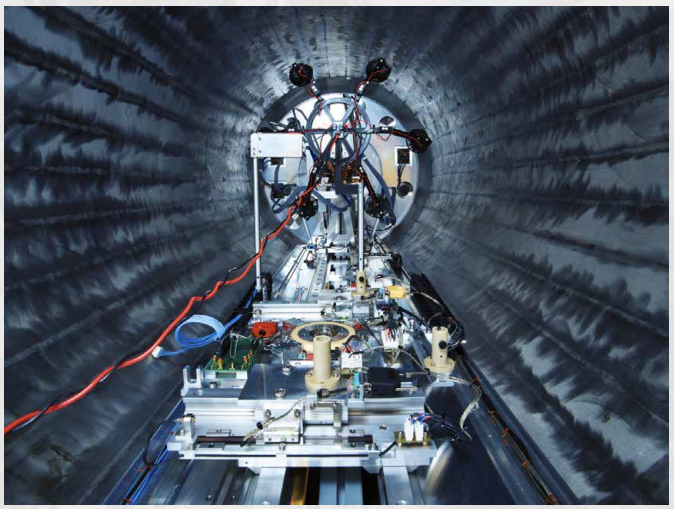
ISOLDE researchers were involved in many high-impact publications covering diverse physics disciplines. As part of an international research team, S. Kujanpää contributed to laser spectroscopy measurements on the short-lived radium monofluoride molecule in the CRIS experiment. These measurements, published in *Science*, enabled detailed characterization of its hyperfine structure and, together with theoretical modelling, allowed the team to test models describing the magnetisation distribution within the heavy isotope ^{225}Ra. The method developed allows for high precision molecular spectroscopy and provides new opportunities for studying symmetry violations in fundamental physics.

The SPEDE spectrometer at the ISODLE decay station was employed to study competing shapes in neutron-rich strontium isotopes. *Credit: J. Pakarinen.*

A. Illana and J. Pakarinen contributed to a major study that achieved the first measurement of the spectroscopic quadrupole moment of the first excited 2^+ state in ^{110}Sn using Coulomb excitation with the Miniball γ-ray spectrometer, revealing an oblate deformation that is consistent with modern shell model predictions. This work, published in *Physical Review Letters*, provides an important benchmark for nuclear structure theory and highlights the key role of Miniball and ISOLDE in advancing studies of rare isotopes.

Contributions from the HIP-ISOLDE affiliated researchers extended beyond these highlights. Studies of laser spectroscopy and CP-violation sensitivity of actinium monofluoride were published in *Nature*, while "*Electron correlation and relativistic effects in the excited states of radium monofluoride*" and "*Enhanced sensitivity for electron affinity measurements of rare elements*" were both published in *Nature Communication*.

"*Mapping single-particle neutron strength towards the mid-shell in semi-magic lead isotopes*", with J. Ojala from JYU as spokesperson, was one of the last experiments performed prior to the third long shutdown. J. Pakarinen was selected for a three-year term as chair of the ISOLDE Collaboration Committee. V. Pesonen from JYU participated as a HIP summer student in the Miniball project.



The ISOLDE Solenoidal Spectrometer at HIE-ISOLDE was used in the experiment "Mapping single-particle neutron strength towards the mid-shell in semi-magic lead isotopes" at HIE-ISOLDE. *© 2022-2026 CERN (J. M. Ordan).*

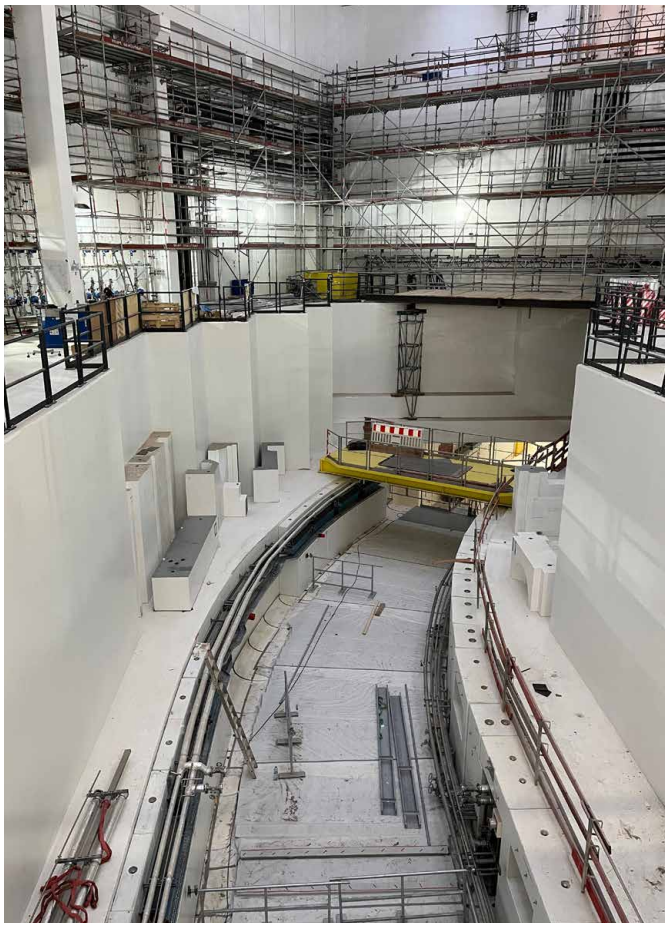
© J. M. Ordan, 2017-2026 CERN

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

TUOMAS GRAHN
FAIR
project leader

The FAIR accelerator laboratory (https://fair-center.eu/) is set to begin operations with new accelerators at the end of 2027. Currently, the installation of the SIS100 synchrotron components is ongoing, and the civil construction of experimental areas of the NUSTAR and CBM experiments is finished. The installation of the Super-FRS magnets has also begun.

After its commission, FAIR will accelerate high-energy particle and antiparticle beams up to 99% of the speed of light, serving the four experiments (or *pillars*) that are NUSTAR, CBM, PANDA and APPA. Together they will cover multidisciplinary science cases of nuclear physics and astrophysics, elementary particles, material physics and medical applications.



Super-FRS target area under construction at FAIR.

Finland is mainly participating in the NUSTAR experiment in studies of nuclear physics. The main instrument of NUSTAR, the Super-FRS separator-spectrometer (see the figure to the left), will be the priority in FAIR commissioning. Finland will deliver important components and instrumentation for the Super-FRS and the NUSTAR experiment and therefore our role in FAIR commissioning is highlighted. The beam particle identification depends largely on the in-kind contributions of Finland.

Naturally, the completion of accelerator components has been a key focus of the programme in 2025. The beam diagnostic and tracking detector package of the Super-FRS is largely the responsibility of Finland. For instance, the final design of the GEM-TPC tracking detectors and their readout electronics is progressing, together with the mechanical insertion devices (designed in collaboration with the University of Jyväskylä).

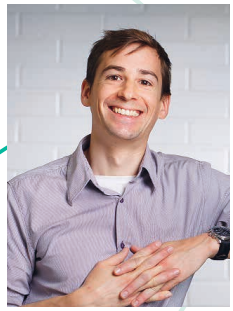
The FAIR Phase-0 experimental programme, which is carried out using the existing infrastructure, continued providing beam time for experiments. HIP researchers were involved in several of them within the NUSTAR Collaboration. For instance, atomic masses of $N = 126$ nuclei were probed and neutron skin thickness around doubly magic ^{132}Sn was studied. Such measurements are relevant for a more comprehensive understanding of the r-process nucleosynthesis and nuclear matter equation of state.

An example of a 2025 highlight is a newly approved experiment with Finnish researcher A. Kankainen as a spokesperson. We aim to produce and measure masses of several neutron-rich nuclei around and beyond the $Z = 82$ shell closure. In addition, we are continuing our project of measurements of production cross sections of heavy neutron-deficient nuclei following high-energy fragmentation reactions. Both projects are examples of larger programmes to map atomic masses and production of different nuclei in fragmentation reactions, respectively. The data will be used to benchmark and improve theoretical models.

TECHNOLOGY PROGRAMME

FILIP TUOMISTO
Technology Programme director

The Technology Programme aims to integrate HIP projects with significant technology development, transfer, and pre-commercialisation activities into the same programme. In addition, the research activities performed within the programme are designed to seek synergies with big science initiatives at large. The programme consists of two larger projects dealing with materials technology challenges in existing and new large accelerators, as well as radiation and nuclear safety, security, and safeguards. In addition, the programme hosts three medium or smaller projects that focus on robotics for monitoring and intervention purposes in accelerator tunnel conditions, radiation detection technologies in close co-operation with CEA (France), and the development of quantum emitters in AlN-on-Si systems. Most of the projects have strong connections with CERN and STUK. Several projects have been successful in raising external funding for the R&D work, strengthening the impact of the programme.



ROEL PIETERS
Robotics and AI for Monitoring and Intervention (ROBOT) project leader

Robotics and AI for Monitoring and Intervention (ROBOT)

The ROBOT project of HIP's Technology Programme aims to utilise robotics and AI for assistance in monitoring and intervention of CERN's accelerator infrastructure.

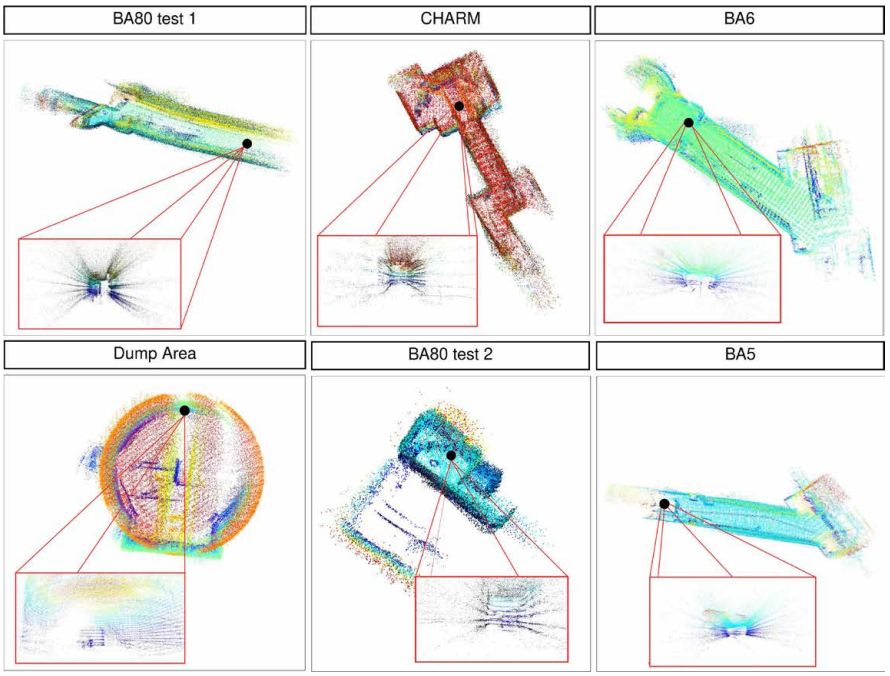
1. *Perception for robot manipulation.* TAU has continued research on visual perception approaches for extracting relevant information from RGB and depth sensors for automatic robot assembly actions. The approach proposes a keypoint-based modular learning framework to employ assembly cognition to a robot to perform an autonomous assembly task given RGB and Depth input images of an assembly scene. The assembly pose estimation method utilises semantic segmentation and point cloud registration between target and source point clouds and is evaluated with suitable metrics on two simulated gear assembly datasets, which indicates that point cloud registration is well capable of estimating 6D assembly poses for object assemblies. As collecting real data is time-consuming and costly, a simulation-based approach generates the data needed to train the models. This work is part of K. Samarawickrama's doctoral studies and currently under review under the title "Cognition for Robotic Assembly: A Keypoints-based Approach".

2. *Mobile robot mapping and navigation.* As a continuation of his work at CERN, doctoral student P. Habibiroudkenar has continued collaborating with the CERN robotics team on mobile robot mapping. His research has focussed on a standalone LiDAR scan-matching and mapping method for non-repetitive scanning systems, addressing the limitations of traditional registration techniques that rely on repetitive scan patterns. The proposed spatial-context-aware LiDAR registration framework improves generalised ICP under non-repetitive scan constraints by leveraging geometric feature extraction and adaptive pose estimation without requiring accumulated scans. The method was evaluated in multiple CERN environments, including tunnels, laboratories, and dome-shaped chambers, showing significant reductions in registration error (up to 85% RMSE) and improved map

TAU delegation next to the CLOUD experiment on 3 October 2025.

quality compared to baseline methods. This work is currently under review under the title ”Non-Repetitive Scan Correction for LiDAR Odometry via Spatial Analysis in CERN Facilities”.

Additionally, Aalto University and Tampere University have initiated a joint effort on mission-based planning for robotic manipulators aimed at irradiated material removal. The project is in its early stages, with current work focussed on developing a simulation environment.



Examples of the maps created at six geometrically distinct CERN facilities using the developed spatial-context-aware LiDAR registration framework.

Improved Detection for Elemental Analysis at Laboratory (IDEAL)

RENÉ BÈS
Improved Detection for Elemental Analysis at Laboratory (IDEAL) project leader

X-ray Absorption Spectroscopy (XAS) is a non-destructive method allowing the direct characterization of the degrees of oxidation and the local environment of a given element in any kind of sample. XAS is an essential approach for the elemental analysis of complex materials and has therefore successfully been used in many fields of science, ranging from physics and chemistry to materials science, medicine, and biology. However, contrary to other structure elucidation methods such as, e.g., X-ray Diffraction (XRD) or X-ray Photoelectron Spectroscopy (XPS), the XAS measurements are performed almost exclusively at synchrotron radiation sources.

The recent renewal of laboratory XAS instruments provides performance complementing the synchrotrons and overcomes the most serious disadvantage of synchrotron radiation research: its very limited access, which often renders it difficult to measure samples relevant to current research within an acceptable time and excludes de facto routine experiments. Despite their quickly demonstrated performance and versatility, one main issue restrains the laboratory-based spectrometers: the non-simultaneous data collection of both the incoming and sample transmitted photon intensities. These are usually collected separately by laboratory-based instruments by performing the experiment sequentially: with and without a sample. This strategy assumes the inherent stability and repeatability of the incident flux, owing to the stability of the radiation spectrum and flux of modern X-ray tubes. However, requiring two separate measurements increases the overall data collection time as well as the risk that any instability remains unnoted or wrongly attributed to the sample.

The main reason behind this two-step approach is the limited number of available photons produced by X-ray tubes. All photons spared for the actual measurements are important to keep the data collection time reasonable. More efficient detectors are thus required, but detectors having an energy resolution worse than 400 eV are excluded due to the presence of harmonics arising from the use of single Bragg’s optic.

The IDEAL project aims to investigate potential answers to this limitation, focussing on the development of new design for the detection system. We started in 2024 by evaluating alternative detection solutions, including the opportunity of ultra-thin SDD design. In 2025, thanks to the expertise of the HIP Detector Laboratory, we moved towards the aim of first prototypes to be tested by the end of the IDEAL project.

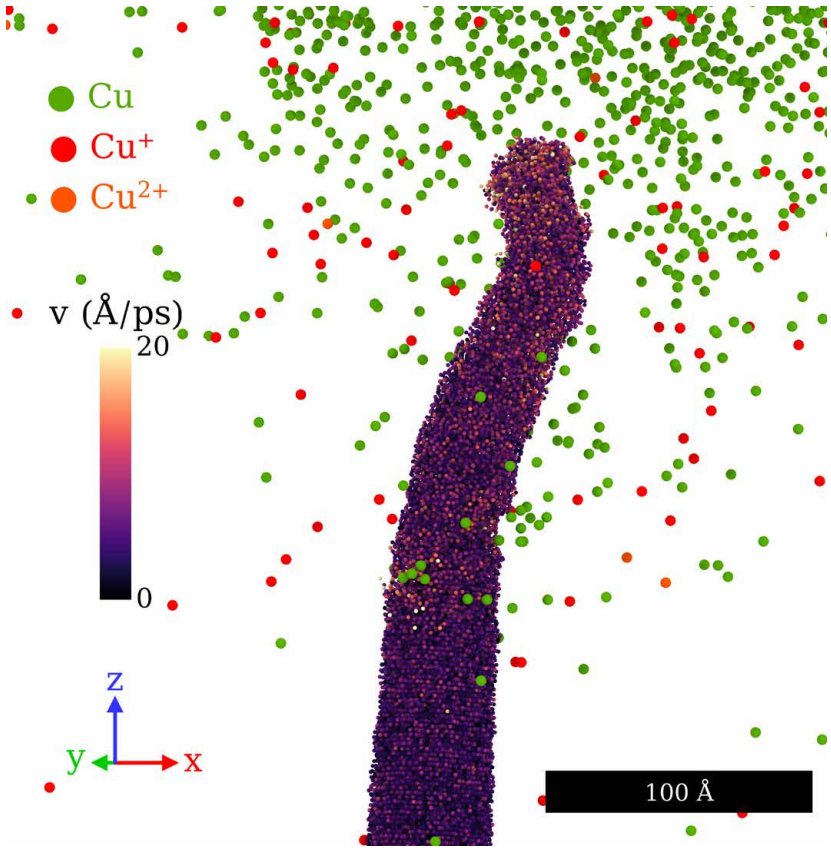
FLYURA DJURABEKOVA
Materials for Accelerator Technology (MAT) project leader

Materials for Accelerator Technology (MAT)

The Materials for Accelerator Technology (MAT) project addresses materials-related challenges in particle accelerators, with a particular focus on vacuum arcing - a long-standing issue in the RF-accelerating structures of the CLIC electron-positron collider at CERN. Our multiscale approach integrates many of the involved physical processes spanning different time and length scales. The research highlight in 2025 includes the further refinement of our model. While previously we examined isolated aspects - field emission, heating, plasma initiation, and surface modification - our current work couples particle-in-cell (PIC) plasma simulations with molecular dynamics (MD) to capture how these mechanisms interact. Surface morphology affects emission and heating, thereby influencing plasma evolution, while ion bombardment from the plasma alters the surface through sputtering and related processes. The PIC-MD link is achieved through particle exchange between the two simulations.

Using our FEMOCS code, we simulate plasma formation around a nanotip (see the figure to the left) and the resulting surface changes, aiming to clarify the processes driving vacuum arcing and support the development of strategies to mitigate breakdown in accelerator components. In the figure, the copper atoms as a part of the field-emitting tip are shown in brown, while particles that become part of the PIC simulation domain are shown in red and green.

We also focus on improving the quality of the superconducting thin films that are deposited via a more advanced thin film deposition technique also known as HiPIMS (High-Power Impulse Magnetron Sputtering) for the superconducting cavities in the Future Circular Collider. Using large-scale molecular dynamics simulations, we analyse how HiPIMS deposition parameters - ion energy and ionized flux fraction - affect Nb growth on Cu(111). Higher ion energies and ionization fractions produce pronounced surface roughening, consistent with experiments. This behaviour arises from the formation and rapid crystallization of a metastable amorphous Nb-Cu interlayer. We further identify a nonmonotonic relationship between the interlayer composition and residual vacancy concentration: defect density is minimized at ~45% Cu and increases when the Cu content deviates from this value. These results show that optimising SRF cavity performance requires not only high energy ion deposition but also precise control of deposition conditions to achieve the ideal interfacial composition and reduce performance limiting defects.



Combined PIC-MD model of plasma onset. Here the atoms in brown belong to the field emitting tip (only the top is shown), while the atoms which become a part of the PIC simulation domain are shown in red and green.

Radiation and Nuclear Metrology, Safety, Security and Safeguards Applications (RAD3S)

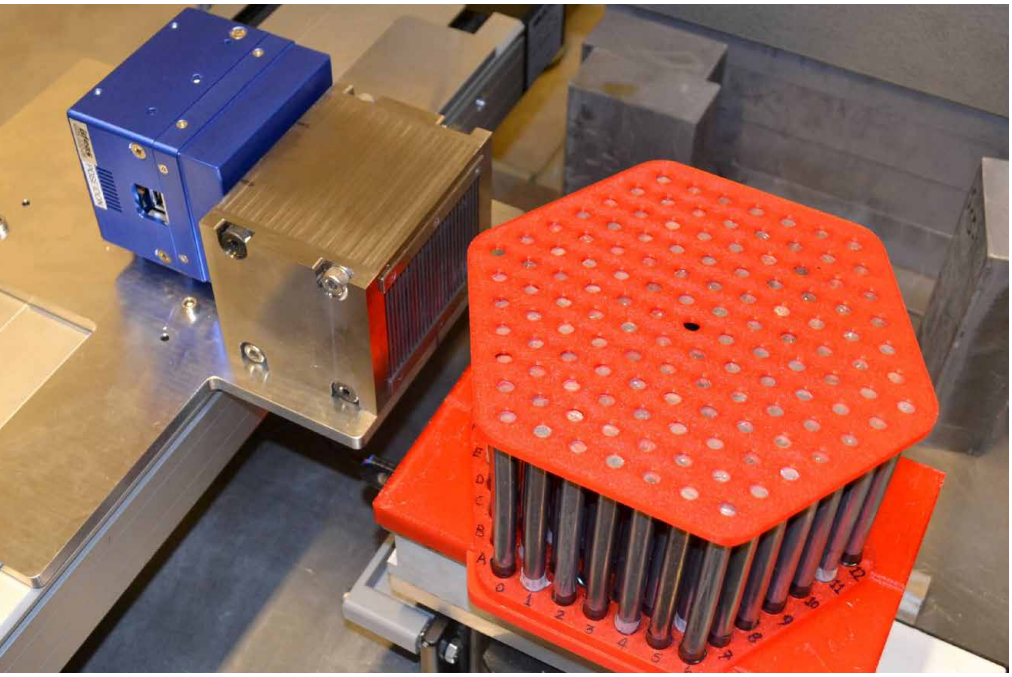
TEEMU SIISKONEN
Radiation and Nuclear Metrology, Safety, Security and Safeguards Applications (RAD3S) project leader

The RAD3S project develops new measurement and analysis methods, produces physical data, and uses computational methods to foster radiation and nuclear safety, security, and safeguards.

In medical applications, our focus was on the safety and efficacy of external beam radiotherapy. Novel pixel detectors from the high-energy ALICE experiment were tested for their ability to monitor therapeutic proton and heavy-ion beams. To enhance neutron irradiation and calibration capability in the Nordic countries a neutron irradiation facility was designed and built at the University of Helsinki Accelerator Laboratory. The neutron beam was characterized in collaboration with STUK and Instituto Nazionale di Fisica Nucleare (INFN). Deep learning methods were developed to improve patient specific dosimetry in medical imaging, including automated segmentation of patient organs from a CT image. This work was partly carried out in the EU-funded SONORA project, where models for pregnant radiotherapy patients were developed.

We are investigating, both experimentally and via Monte Carlo simulations, the use of large position-sensitive semiconductor gamma ray detectors for Passive Gamma Emission Tomography (PGET) of spent nuclear fuel, and potentially other applications. Successful tomographic measurements performed at Uppsala University and Geant4-based simulations show the suitability of large cadmium-zinc-telluride (CZT) detectors for PGET. A new project investigates the benefit of neural networks to deduce the gamma ray interaction position from the signals from the grid of readout pixels of the same CZT detectors. On the mathematics side, we are improving the image reconstruction algorithms, focussing on the simultaneous use of information from two gamma ray energy windows, where the higher energy promises to provide better image quality for the centre of a fuel assembly.

For environmental surveillance we have continued to develop state-of-the-art detection systems and methods to improve the handling and analysis of environmental samples. Work has continued on the development of a hand-held radiation identification device with the capability to discriminate alpha, beta, gamma and neutron radiation and indicate the direction of the source of the activity. Examples of research related to radiation safety and environmental surveillance include: an investigation of the possibilities to employ commercially available air purifiers to remove radon and its radioactive decay products from the atmosphere in households; and improving the processes for handling, separation, and imaging of radioactive particles collected in air filters from sampling devices. These lines of research will produce a PhD thesis and several publications in 2026.



Setup at Uppsala University for gamma emission tomographic measurements. The blue box contains two large position-sensitive cadmium-zinc-telluride (CZT) gamma ray detectors. The red hexagon, containing a few 137Cs-containing rods amongst an array of lead rods, mimics a spent VVER-440 nuclear fuel assembly. In between the detectors and surrogate fuel assembly is a multi-slit collimator identical to the one in the PGET device approved for nuclear safeguards inspections by IAEA. *Credit: P. Andersson.*

NIKHILENDU TIWARY
AlN-on-Si Quantum Emitters and Sensors (AQUES) project leader

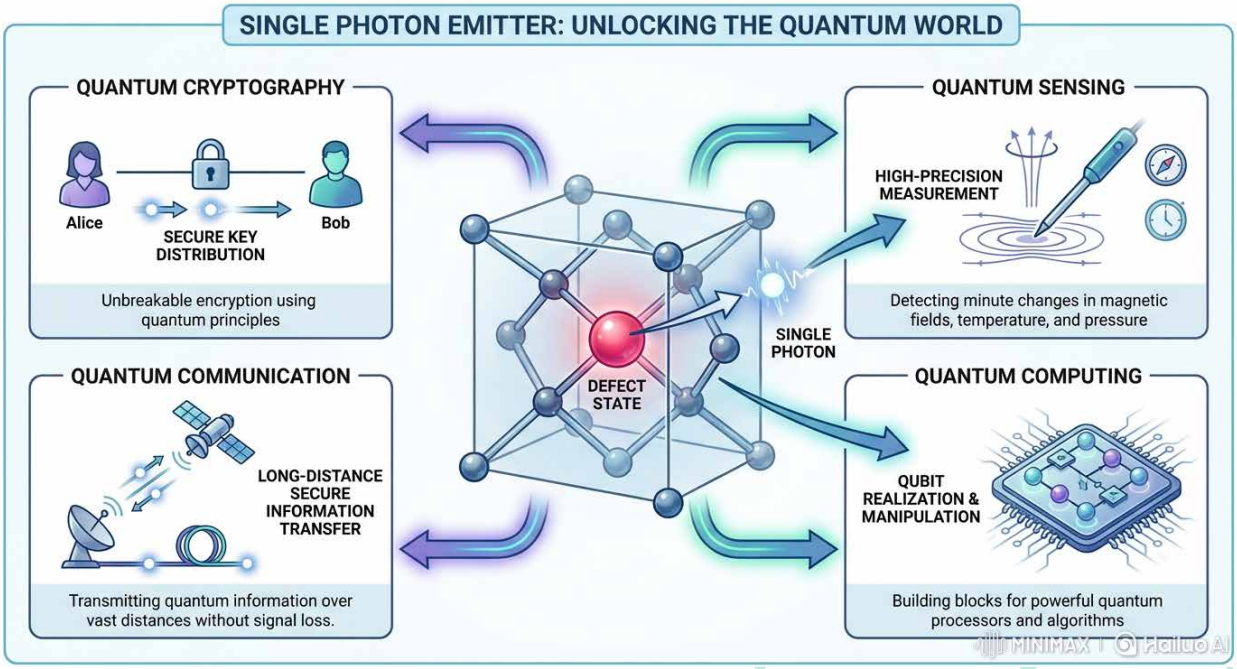
AlN-on-Si Quantum Emitters and Sensors (AQUES)

Single photon emitters (SPEs) are quantum light sources that produce individual photons with high precision and on demand. The **AQUES (AlN-on-Si for Quantum Emitters and Sensors)** project started in 2025, focussing on engineering point defects with single-photon emission capabilities in aluminium nitride (AlN) grown using metal organic vapor phase epitaxy (MOVPE). Unlike SPEs based on quantum dots and trapped ions which requires cryogenic temperatures for operation, defect centres in ultra-wide bandgap (UWBG) materials, such as AlN, offer room-temperature (RT) operation, enabling robust and practical applications in quantum technologies (see the figure below).

SPEs have been reported to be found in epitaxially grown AlN films on different substrates with emission in the visible to near infrared at RT. However, these emitters are randomly distributed, presenting challenges in terms of predictability and manufacturing. It is crucial to engineer specific defect formations which can be achieved through ion implantation followed by thermal annealing to activate the defects.

Engineering point defects requires a thorough understanding of their formation and relation to the MOVPE growth process parameters. Using Aalto University's Aixtron MOVPE reactor, high-purity single-crystal AlN will be grown on Si(111) substrates. MOVPE offers significant freedom in tailoring the material properties with enhanced control over contamination, surface roughness, and defects. Prior to ion implantation experiments, an in-depth characterization of the films is essential to assess the film quality, identify inherent defects, impurities, and determine their charge states which will be investigated using advance electrical and material characterization techniques available at Aalto University and the Accelerator Laboratory of the University of Helsinki. After MOVPE process optimisation and film characterization, samples with various AlN thicknesses will be prepared. Ion implantation at the Accelerator Laboratory will introduce various dopants into these optimised AlN films with the aim of engineering specific defect formations. Exploring a broad range of ion species, energies, and fluences will pinpoint optimal processing conditions. Subsequently optical characterizations, including continuous wave and pulsed autocorrelation measurements, will evaluate the photon emission capabilities of these engineered defects.

If successful, the research efforts in AQUES will pave the way for more practical and robust applications in the quantum world with SPEs.



Solid state single photon emitters based on defect states and their potential applications in the quantum world.

OTHER PROJECTS

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CLOUD

MARKKU KULMALA
CLOUD
project leader

The Cosmics Leaving Outdoor Droplets (CLOUD) experiment at CERN is dedicated to unravelling aerosol particle formation and cloud processes and their role in climate. Aerosols are a key component of the Earth's climate system. They influence the planet's energy balance directly by scattering or absorbing sunlight and indirectly by acting as seeds for cloud droplets or ice crystals. These processes affect how clouds form, how long they persist, and how much sunlight they reflect, which in turn impacts the Earth's overall reflectivity. By improving our knowledge of aerosol formation and their interactions with the atmosphere, the CLOUD experiment is helping to refine climate models and inform strategies for mitigating environmental changes. The CLOUD project is a collaborative effort involving more than 20 leading research institutions worldwide, with a strong contribution from Finland.

The CLOUD chamber at CERN is one of the world's most advanced laboratory facilities capable of studying aerosol particle formation under highly controlled atmospheric conditions. It operates with exceptionally low levels of contamination and with a wide array of cutting-edge instruments that allow us to precisely isolate and examine the complex mechanisms driving aerosol formation from various chemical precursors under different environmental conditions. The effect of galactic cosmic rays (GCR) is studied by using CERN's proton synchrotron, which can be used to simulate the GCR ionization at different atmospheric altitudes.

Since its inception in 2009, CLOUD has uncovered several key mechanisms behind aerosol particle formation, earning widespread recognition within the scientific community and significantly advancing the field of atmospheric science. For instance, recent experiments in the CLOUD chamber demonstrated that, in addition to sulfuric acid and alpha-pinene, iodine oxoacids (HIO_X) can rapidly drive new particle formation and play a critical role in marine and polar aerosol processes [*He et al. 2021*; *2023 Science*], and that that isoprene released from tropical forests is a major compound responsible for forming particles in the upper troposphere [*Shen et al. 2024 Nature*].

During 2025, we performed the CLOUD18 campaign at CERN in September-November and investigated several topics related to aerosol formation and cloud processes, including particle formation and growth processes in complex multi-component chemical systems, as well as gas-aerosol-cloud interactions inside supercooled clouds. The collaboration resulted in the publication of several peer-reviewed papers in 2025. Among them, *Russell et al.* [*Nature Communications*] explained isoprene chemistry in upper tropospheric conditions, *Xiao et al.* [*Nature Geoscience*] revealed how anthropogenic organic aerosols are mainly formed through second-generation oxidation processes, and *Xenofontos et al.* [*Proceeding of the National Academy of Sciences*] revealed the significant impact of ammonia emissions on upper tropospheric aerosol formation globally.

ELINA SIHVOLA
Euclid project leader

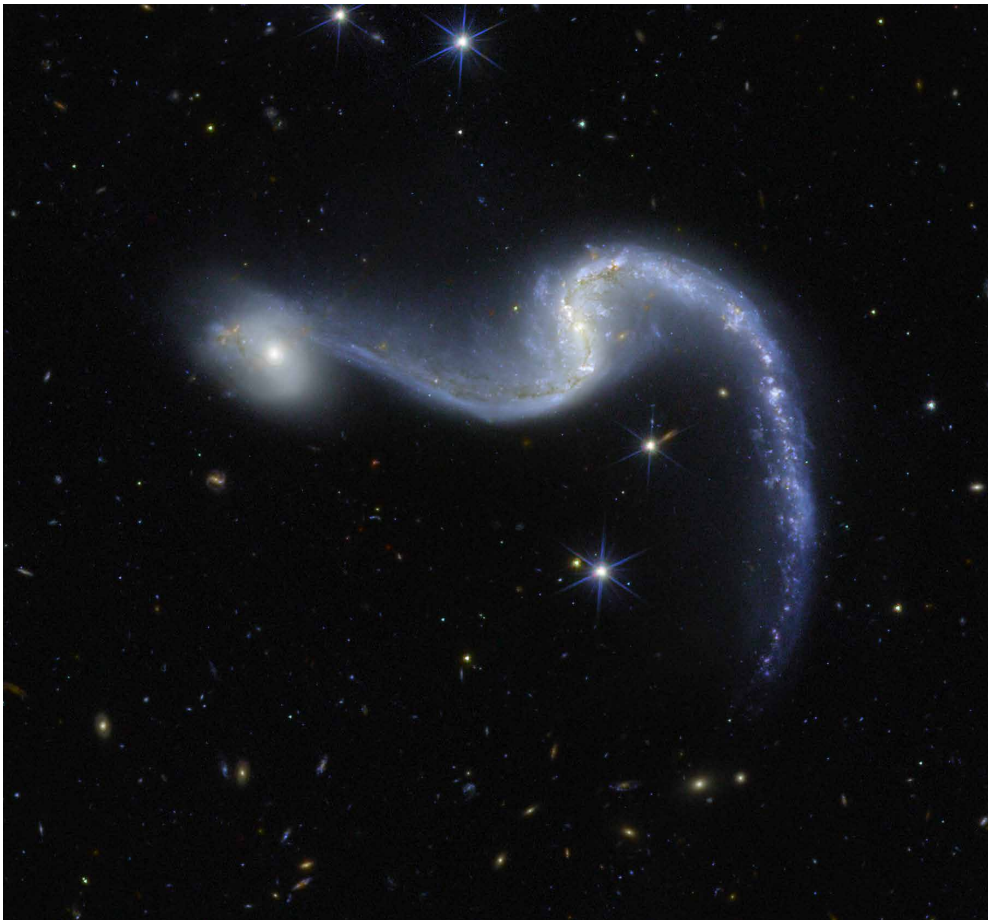
Euclid

Euclid is a European Space Agency (ESA) mission launched on 1 July 2023 to investigate the nature of dark matter and dark energy, which together make up about 95% of the universe. Operating from the Sun-Earth L2 point, the telescope is designed to map the large-scale structure of the universe by observing billions of galaxies across more than one-third of the sky. The mission uses two instruments to measure galaxy shapes and distances with unprecedented precision: a visible imager and a near-infrared spectrometer and photometer.

The main goals of *Euclid* are to measure the influence of dark energy on the expansion of the universe and to map the distribution of dark matter using gravitational lensing. The Finnish participation in the *Euclid* mission is led by Dr. E. Sihvola, who also represents Finland on the *Euclid* Consortium Board.

In March 2025, ESA released Quick Release 1 (Q1), the first major scientific dataset from *Euclid*. The observed sky area of 63 square degrees is equivalent to more than 300 times the full Moon, or the size of 2.3 Finlands on the surface of Earth. Although covering only about 0.4% of the planned full survey, it included images and measurements of 26 million galaxies, reaching distances of up to 10 billion light-years. A detailed catalogue of over 380 000 galaxies was also published, showcasing the telescope's ability to classify galaxy shapes and structures.

The 2025 data revealed striking examples of gravitational lensing, including Einstein rings, allowing researchers to trace dark matter around galaxies and clusters. Early analyses also demonstrated *Euclid*'s capability to map large-scale cosmic structures with exceptional clarity.



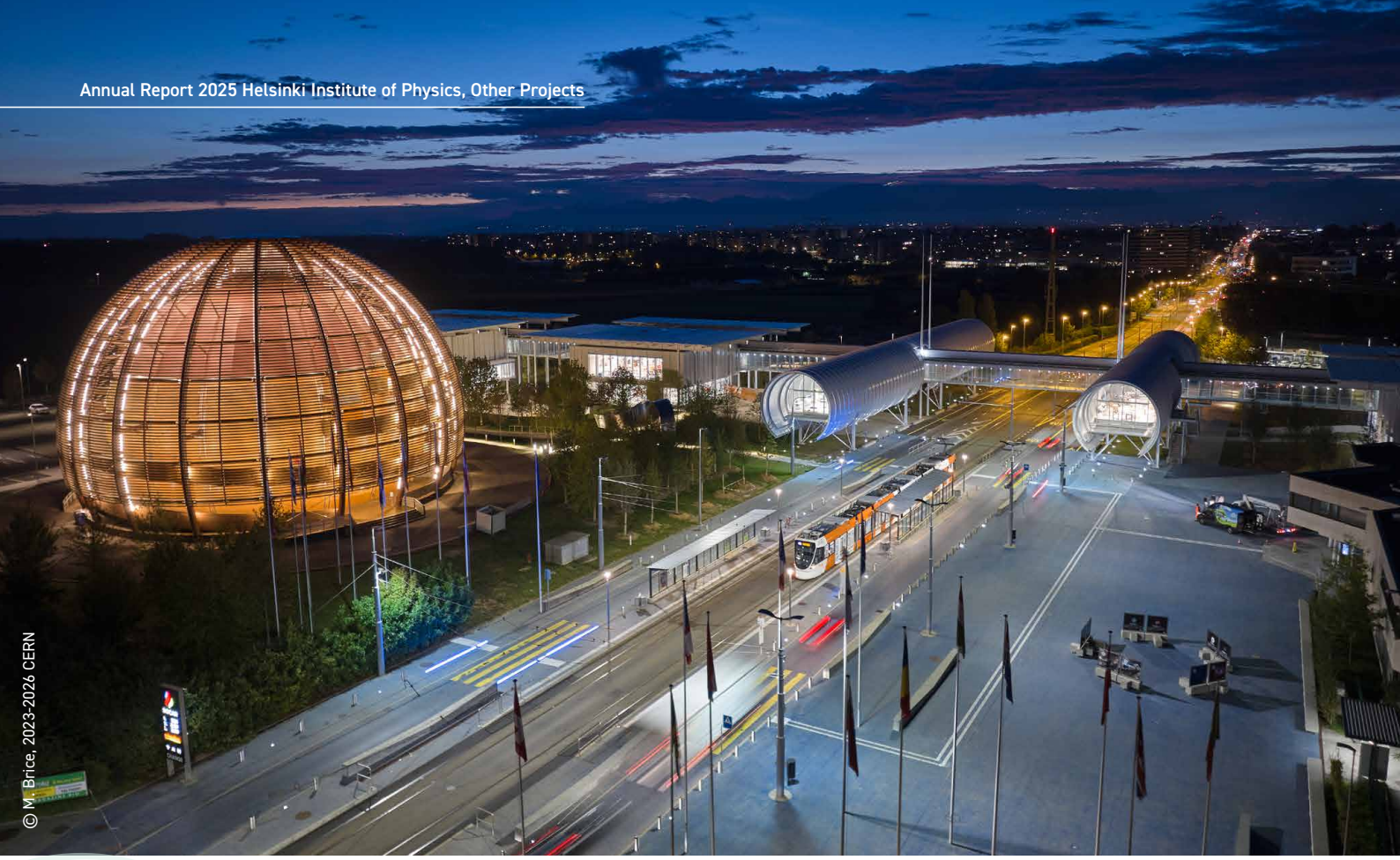
Euclid's galaxy garland. *Credit: ESA/Euclid/Euclid Consortium/NASA, image processing by the Euclid Science Ground Segment and M. Schirmer (MPIA).*

The data processing is handled at nine Science Data Centers (SDC), one of which is provided by Finland. The Finnish SDC (SDC-FI) is hosted by the IT Center for Science (CSC), with hardware located in Kajaani. SDC-FI is operated by HIP scientists, in co-operation with experts from the University of Helsinki, Aalto University, and CSC. Scientific analysis is carried out by the *Euclid* Consortium, involving more than 2000 scientists from hundreds of institutions worldwide.

The first full data release (DR1) is planned for 2026, with progressively larger releases expected throughout the mission. The results obtained in 2025 confirm that *Euclid* is performing as expected and is well-positioned to deliver transformative insights into the dark universe.

To exploit the wide-sky nature of *Euclid* and other observations, the Helsinki group developed, tested by simulations, and released to the public in 2025 the spherical-geometry-based FuGa3D code for full-sky analysis of galaxy clustering and galaxy shape observables. We also demonstrated the suitability of the fast linear-construction covariance method for cosmological parameter estimation. We developed the method itself already in 2022.

Euclid Deep Field South. *Credit: ESA/Euclid/Euclid Consortium/ NASA, image processing by J.-C. Cuillandre, E. Bertin, G. Anselmi.*



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KATRI LASSILA-PERINI
Education and Open Data project leader

Education and Open Data

The Education and Open Data project, led by K. Lassila-Perini, covers and connects the Finnish high-school visits to CERN, and the research and educational use of CMS experiment open data. P. Veteli leads activities promoting the use of open data in schools.

High School Visits

In 2025, a teacher training week and fifteen high-school group visits to CERN were organised. The programme consists of lectures and laboratory visits during which students and teachers can engage with and learn from scientists at CERN. A hands-on laboratory and exhibition at the Science Gateway enrich the three-day visit programme. Feedback is collected with the vision of assessing the long-term impact of the programme.

Open Data in Research

K. Lassila-Perini leads the ICFA Data Lifecycle panel, bringing previous expertise gained while leading open data activities in CMS to a wider context. The panel's mandate is to promote practices that improve how scientists collect, use, and share data in particle physics.

In 2025, the panel, with a group of experts in the field, produced comprehensive best practice recommendations for data preservation and open science in high-energy physics. These recommendations were published as an open-access report and as a web application. Preparations began for follow-up actions to assess their implementation.

Activities in CMS for open science and FAIR practices continued. A two-day analysis preservation bootcamp was organised for the HIP CMS Experiment project in Kumpula in August.

Open Data in Education

The project promotes using open data in schools with "Jupyter Notebooks" and common Python libraries through teacher trainings, student workshops, and hands-on help with regular school courses. An ever-expanding collection of materials and guides are available on the project's website https://opendata-education.github.io/ in Finnish, Swedish and English.

Co-operation with high schools and research groups like INAR and ICOS was prominent throughout the year. We participated in the design and execution of several courses, held workshops for teachers and students in multiple schools, and hosted school visit activities at Kumpula campus. Many of these are set to continue in 2026. Active engagement with in-service and pre-service teachers' events included school courses and trips around Finland as well as a field course in teacher education at the Tvärminne Research Station.

PhD researcher P. Veteli's project produced one publication in 2025 and included active participation and presentations in scientific conferences like GIREP-EPEC (Leiden) and STEM Education Research Days 2025 (Helsinki). This work is made possible through a grant from the Magnus Ehrnrooth Foundation.

Twenty students at a Helsinki Upper Secondary School of Natural Sciences Sustainability course, 7.4.-21.5.2025. Instructed by P. Veteli, the students worked on their own climate research questions in co-operation with ICOS researchers and their teachers. *Credit: M. Luhtaniemi.*

DETECTOR LABORATORY

MATTI KALLIOKOSKI
Detector Laboratory director

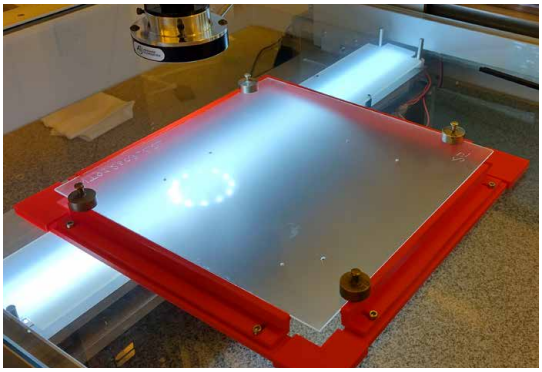
The Detector Laboratory specialises in the instrumentation for particle and nuclear physics. It is a joint laboratory of HIP and the UH Department of Physics, particularly the Division of Particle and Astrophysics (PAP).

In 2025, the renovation of the Physicum building had an impact on Laboratory operations. These disruptions will continue into 2026, as the clean rooms are renovated. Nevertheless, the production phase for several Laboratory-hosted projects commenced, including detector assemblies and testing for the CMS and ALICE experiments and activities for the FAIR facility. All projects required active participation from the Laboratory staff.

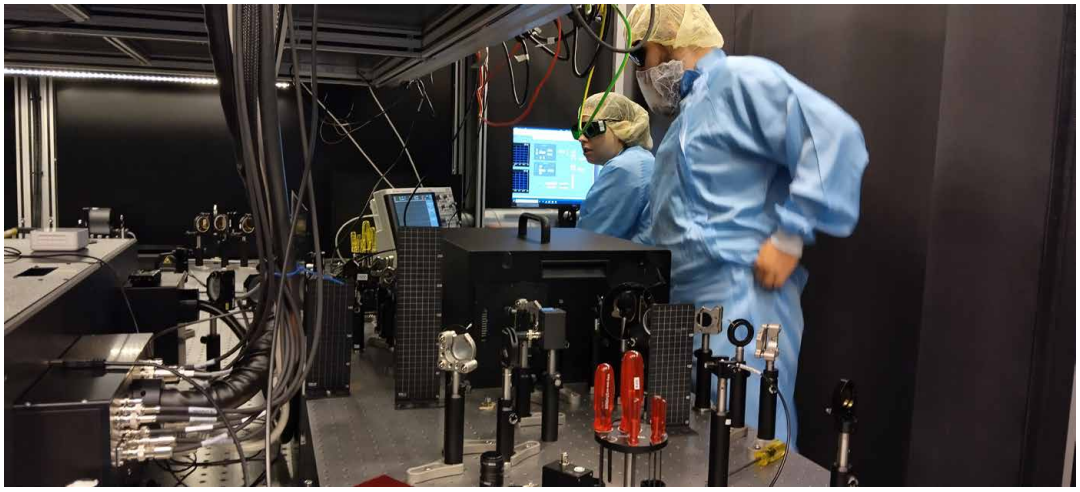
Scanning of the MoEDAL nuclear track detectors made significant progress in 2025. Over ten square meters of CR39 foils were analysed at a resolution of a few micrometres. This required about 400 000 images to be acquired and analysed using various machine-vision techniques. In the summer of 2025, we also hosted the 23rd MoEDAL-MAPP Collaboration Meeting in Helsinki.

In the field of room-temperature semiconductor research, we conducted two measurement campaigns at the ELI Beamlines laser facility. These activities included unprecedented two-photon absorption measurements of cadmium telluride materials. In addition, we conducted a detailed irradiation campaign to study material activation in various radiation environments. An upgrade of our laser measurement capabilities was also commissioned and will be further developed in 2026.

The Scintillator Apparatus at Hyytiälä for the Total Ionization measurements (SAHTI) project for the SMEAR II station was installed at the beginning of February. Analysis of the first year of measurements already provides results on the radiation and ionization levels at the station. The system will be further developed in 2026.



MoEDAL Nuclear Track Detector foil being analysed at the Detector Laboratory. *Credit: M. Kalliokoski.*



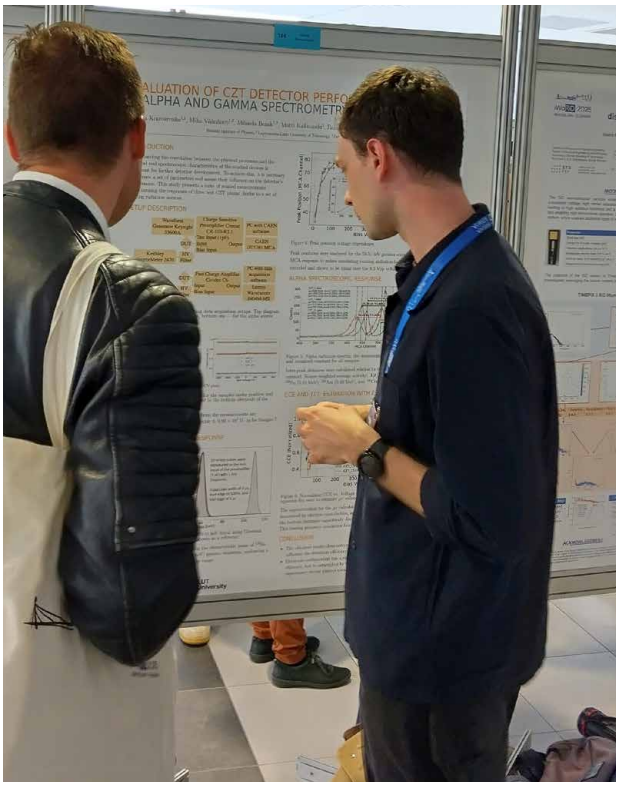
Laboratory engineer M. Bezak and Doctoral researcher M. Väänänen setting up the TPA measurements at the ELI beamlines. *Credit: M. Kalliokoski.*

Laboratory staff and users preparing for the Researchers' Night event at the Observatory. *Credit: J. Aaltonen.*

The Balloon-borne Instrument for Spectral Scanning of high-altitude Environments (BISSE) was flown for the first time. Although the device was carried by a drone instead of a balloon, the tests allowed us to revise the design of the setup in preparation for the first balloon flight in 2026.

The Laboratory supports teaching in the PARAS programme. The main contribution is to the Laboratory Course in Instrumentation, where students actively work in the Laboratory, but also to other courses requiring experimental measurements. In addition, several doctoral researchers and master's and bachelor's students worked in the Laboratory during 2025.

Special effort was devoted to societal interaction. In 2025, the Laboratory participated in the EU Researchers' Night at the Observatory building of UH. In addition, we hosted a robot-building course of the neighbouring Helsinki Upper Secondary School of Natural Sciences.

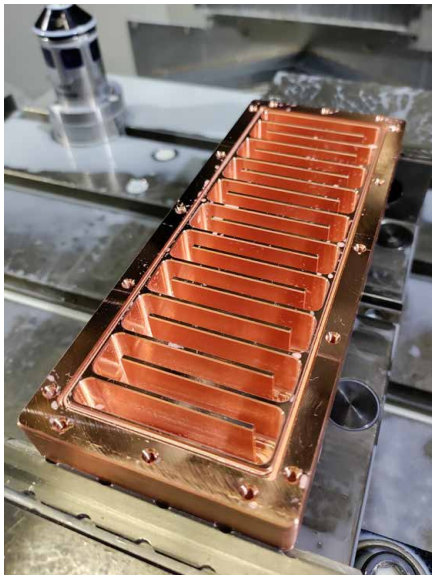


N. Kramarenko presenting results of CZT research done at the Detector Laboratory, and members of the staff of the Laboratory taking part in detailed discussions about instrumentation at the iWoRiD 2025 Conference.
Credit, right image: M. Kalliokoski, left image: R. Turpeinen.

Doctoral researchers N. Kramarenko and M. Väänänen presenting the research done at the Detector Laboratory at the 2025 IEEE Nuclear Science Symposium. *Credit: M. Kalliokoski.*

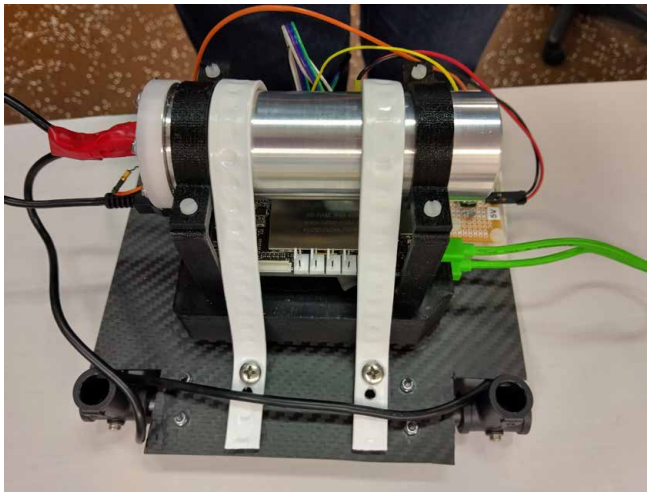
Doctoral researcher A. Stendahl making sure that the support structures of the COSINUS water tank are sturdy during the installation of the flux-gate sensors and control system at the Gran Sasso Laboratory. *Credit: M. Kalliokoski.*

GEM-TPC elements being prepared at the workshop in Kumpula by R. Turpeinen. *Credit: R. Turpeinen.*



Copper cooler that was machined for the electronics testing system by R. Turpeinen. *Credit: R. Turpeinen.*

Detector Laboratory personnel and users installing the SAHTI measurement system at the SMEAR II station. *Credit: M. Kalliokoski.*



The Light-BISSE spectrometer being flown beneath a hexacopter in Jokioinen. *Credit: M. Kalliokoski.*

It is a wrap. The Detector Laboratory during the renovation. *Credit: J. Aaltonen.*

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JOINT ACTIVITIES

ANTTI VÄIHKÖNEN
Research coordinator

HIP is a joint institute of five universities with the University of Helsinki as the host, with the Finnish Radiation and Nuclear Safety Authority (STUK) as an interim member since 2018, and the present membership agreement continuing until 2027. Due to its core mission, many of the research activities of HIP take place at CERN and FAIR. The distributed nature of HIP brings its own flavour and challenges.

2025 was a solid and stable year of scientific activities with no significant disruptions. The Institute's core funding stayed at the previously agreed level. Unfortunately, the increasing price levels, especially rents and collaboration costs, reduced available research funding. On the positive side, researchers at HIP were successful in securing external funding.

The Institute's planning and strategy work continued in 2025. Several HIP projects and the Detector Laboratory were evaluated by external experts. RECFA (Restricted European Committee for Future Accelerators) visited Finland in May - eight years since their previous visit - and submitted a report of their findings to the Research Council of Finland and the Ministry of Education and Culture. The HIP Steering Group visited Tampere University in mid-August, and the Scientific Advisory Board visited HIP later in August.

There were changes in the working environment at the Kumpula campus in 2025. The Physicum building underwent renovations which caused interruptions to the operations of the Detector Laboratory and affected office work. The University Services of the University of Helsinki prepared and partially implemented an organisational renewal.

The Institute's scientific output continued strongly, in both quality and quantity. The most common ranking for HIP publications is Jufo 3, the highest in the national publication forum ranking system. Well more than 95% of HIP publications are open access.

Doctoral education is one of the main tasks of the Institute. Many undergraduate students joined the research groups, often continuing as doctoral researchers in HIP projects. During the period 2021-2025, 53 doctoral degrees and 68 Master's degrees were completed in connection with HIP research projects. There were eight National Doctoral Education Pilot researchers working in connection with HIP projects in 2025. The CERN BootCamp was unfortunately not organised in 2025, as the funding could not be secured in time. The HIP summer student programme at CERN and ESRF continued successfully in 2025.

SUSTAINABILITY AND RESPONSIBILITY

HIP advances sustainability and responsibility through materials research on energy production technologies. We also participate in CERN's CLOUD experiment, which investigates atmospheric processes relevant to climate change.

HIP also promotes sustainability expertise. HIP has organised the CERN BootCamp course for several years in collaboration with three Universities of Applied Sciences and CERN. The course concentrates on resolving current problems related to the UN sustainability goals. Due to funding issues, the BootCamp was not organised in 2025, but the intention is to resume it if funding can be secured. The University of Helsinki, the host organization of HIP, also offers sustainability education that provides students with academic knowledge and practical skills.

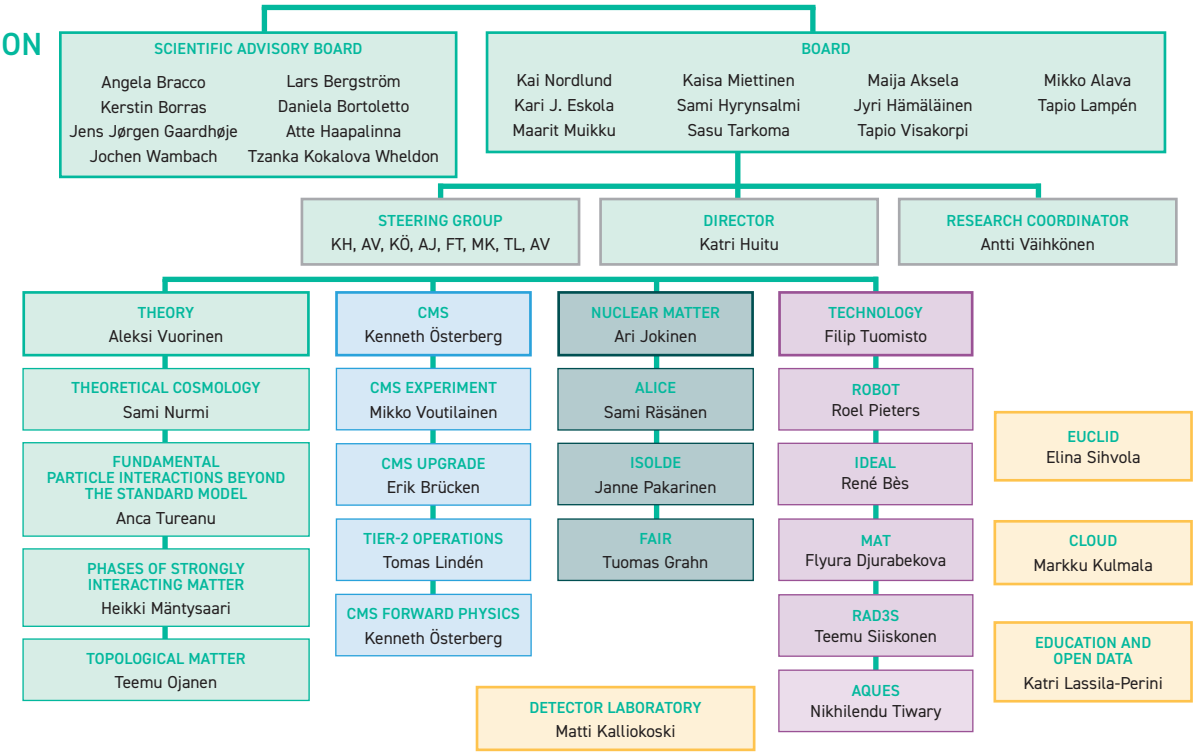
Open access to research results is an important part of the responsibility and sustainability of scientific work. Year by year, well over 95% of HIP publications are open access. Researchers at HIP have for many years been in key positions in opening data from the LHC experiments and making tools for utilising it. One important objective of HIP's Education and Open Data project has been to develop discipline-independent open science tools and teach their use to school pupils and teachers.

In 2025, HIP continued to advance sustainability by using digital tools to facilitate research and to promote a sense of community and inclusivity by enhancing accessibility. The easy-to-use streaming and hybrid meeting capabilities of the HIP seminar and meeting rooms were maintained in good condition, were in good use, and worked well. This also decreases the need to travel and reduces HIP's carbon footprint.

Work wellbeing and responsible leadership are important and interlinked parts of workplace sustainability. HIP has performed consistently well in the wellbeing surveys on supervision. The traditional HIP Leaders' Afternoon workshop was organised in May, and the HIP Summer Excursion in June. The University of Helsinki continued its methodical supervisor training also for HIP leaders in 2025. Gatherings for the summer workers and trainees were organised both in Helsinki and at CERN. The joint wellbeing group of HIP and the University of Helsinki Physics Department underwent personnel changes, including its chair, and continues its work with renewed energy.

ORGANIZATION AND PERSONNEL

ORGANIZATION



The HIP Board Meeting in the Main Building of the University of Helsinki on 1 April. In the picture from left to right: Kaisa Miettinen, Lasse Laurson (subst.), Jyri Hämäläinen, Kari J. Eskola, Kai Nordlund, Sasu Tarkoma, Tapio Lampén, Panja-Riina Luukka, Maarit Muikku.
Credit: J. Aaltonen/HIP.

THE INSTITUTE BOARD

CHAIR **Kai Nordlund,** Vice Rector (University of Helsinki)

VICE CHAIR **Kaisa Miettinen**, Vice Rector (University of Jyväskylä)

MEMBERS **Maija Aksela**, Professor (University of Helsinki)
Mikko Alava, Professor (Aalto University)
Kari J. Eskola, Professor (University of Jyväskylä)
Sami Hyrynsalmi, Dean (starting 1.6.2025) (Lappeenranta-Lahti University of Technology LUT)
Jari Hämäläinen, Vice Rector (until 31.5.2025) (Lappeenranta-Lahti University of Technology LUT)
Jyri Hämäläinen, Vice Rector (Aalto University)
Tapio Lampén (Chosen by personnel of HIP)
Maarit Muikku, Head of Laboratory (STUK)
Sasu Tarkoma, Dean (University of Helsinki)
Tapio Visakorpi, Vice Rector (Tampere University)

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Atte Haapalinna, CTO, Dr. (Okmetic Oy)

Jochen Wambach, Professor (TU Darmstadt)

Tzanka Kokalova Wheldon, Professor (U. Birmingham)

Personnel

Theory Programme

A. Vuorinen, prof., programme director

Theoretical Cosmology

S. Nurmi, senior lecturer, proj. leader
M. Hindmarsh, prof., adj. senior scientist
P. Johansson, prof., adj. senior scientist
K. Kainulainen, prof., adj. senior scientist
K. Rummukainen, prof.,
adj. senior scientist
D. Weir, prof., Acad. Res. Fellow
S. Räsänen, adj. senior scientist
D. Hooper, scientist
G. Rácz, scientist
B. Reinoso, scientist
T. Tuominen, scientist
J. Correia, adj. scientist
D. Karamitros, adj. scientist
T. Sawala, adj. scientist
T. Tenkanen, adj. scientist
J. Annala, doctoral researcher
M. Benaco, doctoral researcher
J. Dahl, doctoral researcher
L. Giombi, doctoral researcher
A. Hassan, doctoral researcher
J. Häkkinen, doctoral researcher
A. Keitaanranta, doctoral researcher
A. Kormu, doctoral researcher
M. Mattero, doctoral researcher
T. Minkkinen, doctoral researcher
M. Mäki, doctoral researcher
J.-M. Ojanperä, doctoral researcher
H. Parkkinen, doctoral researcher
A. Rawlings, doctoral researcher
R. Seppä, doctoral researcher
S. Sukuvaara, doctoral researcher
N. Venkatesan, doctoral researcher
O. Väisänen, doctoral researcher
M. Ferrus, adj. doctoral researcher

Fundamental Particle Interactions Beyond the Standard Model

A. Tureanu, prof., proj. leader
K. Huitu, prof., senior scientist
M. Voutilainen, prof., senior scientist
M. Chaichian, prof. emer., senior scientist
O. Lebedev, prof., adj. senior scientist
K. Tuominen, prof., adj. senior scientist
M. Heikinheimo, adj. senior scientist
E. Keski-Vakkuri, adj. senior scientist
M. Oksanen, adj. senior scientist
W. Trzaska, adj. senior scientist
T. Gupta, scientist
T. Kupiainen, adj. scientist
A. Al-Adulrazzaq, doctoral researcher
D. Feiteira, doctoral researcher
H. Lempiäinen, doctoral researcher
T. Nerdi, doctoral researcher
N. Pranzini, doctoral researcher
T. Sirkiä, doctoral researcher
A. Stendahl, doctoral researcher
N. Stirling, doctoral researcher
O. Veltheim, doctoral researcher
N. Zimmermann, doctoral researcher
J. Wagner, visiting scientist
J. Schymiczek, student

Phases of Strongly Interacting Matter

H. Mäntysaari, assoc. prof., proj. leader
A. Vuorinen, prof.
K. Kajantie, prof. emer.
K. J. Eskola, prof., adj. senior scientist
T. Lappi, prof., adj. senior scientist
J. Nättilä, prof., adj. senior scientist
R. Paatelainen, Acad. Res. Fellow,
senior scientist
N. Jokela, senior scientist
I. Helenius, Acad. Res. Fellow,
adj. senior scientist
J. Auvinen, adj. senior scientist
V. Guzey, adj. senior scientist
O. Henriksson, adj. senior scientist
H. Niemi, adj. senior scientist
H. Paukkunen, adj. senior scientist
M. Sainio, adj. senior scientist
L. Fernandez, scientist
F. Hekhorn, adj. scientist
A. D. Le, adj. scientist
S. Mulani, adj. scientist
P. Paakkinen, adj. scientist
I. Soudi, adj. scientist
X. Tong, adj. scientist
D. Avramescu, doctoral researcher
M. Bertilsson, doctoral researcher
C. Casuga, doctoral researcher
M. Chithirasreemadam,
doctoral researcher
P. Gimeno Estivill, doctoral researcher
A. Hippeläinen, doctoral researcher
J. Hirvonen, doctoral researcher
A. Kaushik, doctoral researcher
A. Kärkkäinen, doctoral researcher
T. Lappeteläinen, doctoral researcher
J. Laulainen, doctoral researcher
J. Li, doctoral researcher
X. Li, doctoral researcher
N. Mallick, doctoral researcher
P. Navarrete, doctoral researcher
M. Nurmela, doctoral researcher
A. Piispa, doctoral researcher
Pooja, doctoral researcher
A. Rajala, doctoral researcher
P. Runko, doctoral researcher
H. Ruotsalainen, doctoral researcher
M. Seppälä, doctoral researcher
K. Seppänen, doctoral researcher
F. Smits, doctoral researcher
M. Tevio, doctoral researcher
S. Yrjänheikki, doctoral researcher
J. Österman, doctoral researcher
V. Alanko, adj. doctoral researcher
K. Kukkonen, adj. doctoral researcher

Topological Matter

T. Ojanen, prof., proj. leader
H. Cheragi, adj. scientist
A. Moghaddam, adj. scientist
T. Vanhala, adj. scientist
M. Mustonen, doctoral researcher
I. Sahlberg, doctoral researcher

CMS Programme

K. Österberg, prof., programme director

CMS Experiment

M. Voutilainen, prof., proj. leader
H. Kirschenmann, adj. prof.
M. Kim, ass. prof., adj. senior scientist
T. Lampén, senior scientist
K. Lassila-Perini, senior scientist
(at CERN)
S. Laurila, senior scientist
S. Lehti, senior scientist
J. Tuominiemi, adj. senior scientist
N. Norjoharuddeen, scientist
R. Verma, scientist
J. Heikkilä, adj. scientist
M. Kortelainen, adj. scientist
L. Martikainen, adj. scientist
J. Pekkanen, adj. scientist
P. Inkaew, doctoral researcher
B. Lehtelä, doctoral researcher
N. Mancilla Xinto, doctoral researcher
M. Myllymäki, doctoral researcher
N. Toikka, doctoral researcher
E. Veikkola, doctoral researcher
A. Kössi, student
V. Mehtola, student
J. Mäki-Ikola, student
D. Näsman, student
A. Stadnitski, student
R. Öhrnberg, student

CMS Upgrade

E. Brücken, doc., proj. leader
P.-R. Luukka, adj. prof.
T. Hildén, senior scientist
E. Tuominen, adj. senior scientist
H. Badran, scientist
A. Gädda, adj. scientist
A. Karadzhinova-Ferrer, adj. scientist
A. Karjalainen, adj. scientist
S. Kirschenmann, adj. scientist
A. Winkler, adj. scientist
M. Bezak, lab. engineer
N. Kramarenko, doctoral researcher
M. Myllymäki, doctoral researcher
S. Saariokari, doctoral researcher
M. Väänänen, doctoral researcher

Tier-2 Operations

T. Lindén, Dr., proj. leader,
grid coordinator
S. Lehti, senior scientist
M. Myllymäki, doctoral researcher

CMS Forward Physics

K. Österberg, prof., proj. leader
H. Saarikko, prof. emer.,
adj. senior scientist
F. Oljemark, scientist
F. García, lab. engineer
A. Milieva, doctoral researcher
F. Musonov, doctoral researcher
M.-M. Rantanen, doctoral researcher
Y. Shaikh, student

Nuclear Matter Programme

A. Jokinen, prof., programme director

ALICE

S. Räsänen, Dr., proj. leader
D. J. Kim, adj. senior scientist
W. Trzaska, adj. senior scientist
Y. Melikyan, scientist
H. Hassan, adj. scientist
C. Mordasini, adj. scientist
U. Aslam, doctoral researcher
L. Huhta, doctoral researcher
N. Mallick, doctoral researcher
A. Molander, doctoral researcher
H. Rytkönen, doctoral researcher
O. Saarimäki, doctoral researcher
H. Sharif, doctoral researcher
F. Smits, doctoral researcher
M. Virta, doctoral researcher
A. Önnerstad, doctoral researcher

ISOLDE

J. Pakarinen, Dr., proj. leader
P. Greenlees, prof., adj. senior scientist
A. Jokinen, prof., adj. senior scientist
A. Kankainen, prof., adj. senior scientist
I. Moore, prof., adj. senior scientist
T. Grahn, ass. prof., adj. senior scientist
P. Rahkila, adj. senior scientist
P. Ruotsalainen, adj. senior scientist
J. Ojala, postdoctoral researcher
M. Mougeot, adj. scientist
M. Reponen, adj. scientist
M. Stryjczyk, adj. scientist
H. Kokkonen, doctoral researcher
E. Uusikylä, doctoral researcher
S. Chinthakayala, adj. doctoral researcher

FAIR

T. Grahn, ass. prof., proj. leader
J. Äystö, prof., director emer.,
adj. senior scientist
A. Jokinen, prof., adj. senior scientist
A. Kankainen, prof., adj. senior scientist
M. Kortelainen, prof., adj. senior scientist
I. Moore, prof., adj. senior scientist
M. Kalliokoski, senior scientist
T. Eronen, adj. senior scientist
H. Penttilä, adj. senior scientist
S. Rinta-Antila, adj. senior scientist
D. Nesterenko, adj. scientist
J. Tuunanen, adj. scientist
F. García, lab. engineer
V. Virtanen, doctoral researcher

Technology Programme

F. Tuomisto, prof., programme director
P. Dendooven, visiting prof.
T. Salmi, adj. senior scientist
R. Virta, adj. scientist (at STUK)
P. Kauttu, doctoral researcher

Robotics and AI for Monitoring and Intervention (ROBOT)

R. Pieters, ass. prof., proj. leader
K. Tammi, prof., adj. scientist
R. Ojala, ass. prof.
E. Rahtu, ass. prof., adj. scientist
K. Samarawickrama, adj. scientist
P. Habibiroudkenar, doctoral researcher

Improved Detection for Elemental Analysis at Laboratory (IDEAL)

R. Bès, Dr., proj. leader
S. Huotari, prof., adj. scientist
E. Brücken, senior scientist
S. Orlat, doctoral researcher

Materials for Accelerator Technology (MAT)

F. Djurabekova, prof., proj. leader
K. Nordlund, prof., adj. senior scientist
V. Zadin, prof., adj. scientist
A. Kyritsakis, adj. ass. prof.
J. Kimari, adj. scientist
A. Leino, adj. scientist
M. Fernandez Bouvier, doctoral researcher
M. Ghaemikermani, doctoral researcher
L. Miola, doctoral researcher
M. Toktaganova, doctoral researcher
A. Zverev, doctoral researcher
R. Koitermaa, adj. doctoral researcher

Radiation and Nuclear Metrology, Safety, Security and Safeguards Applications (RAD3S)

T. Siiskonen, prof. of practice (UH), proj. leader (at STUK)
P. Dendooven, visiting prof.
P.-R. Luukka, prof.
P. Greenlees, prof., adj. senior scientist
K. Peräjärvi, prof. of practice (JyU), scientist (at STUK)
E. Brücken, senior scientist
M. Kalliokoski, senior scientist
K. Helariutta, adj. senior scientist
M. Nyman, adj. senior scientist
P. Rahkila, adj. senior scientist
M. Muikku, scientist (at STUK)
R. Pöllänen, scientist (at STUK)
J. Turunen, scientist (at STUK)
M. Laassiri, adj. scientist
I. Makkonen, adj. scientist
A. Anumah, doctoral researcher
V. Bogdanoff, doctoral researcher
H. Jutila, doctoral researcher
H. Li, doctoral researcher
S. Saariokari, doctoral researcher
J. Tikkanen, doctoral researcher
R. Virta, doctoral researcher

AlN-on-Si Quantum Emitters and Sensors (AQUES)

N. Tiwary, Dr., proj. leader
F. Tuomisto, prof., senior scientist
M. Paulasto-Kröckel, prof., adj. senior scientist
M. Kalliokoski, senior scientist
I. Makkonen, adj. scientist
J. Stevanus, adj. doctoral researcher
W. Xi, adj. doctoral researcher

Other projects

CLOUD

M. Kulmala, prof., Academician, proj. leader
K. Lehtipalo, prof.
D. Worsnop, prof.
X. He, scientist
J. Shen, doctoral researcher
W. Yu, doctoral researcher

Euclid

E. Sihvola, senior scientist, proj. leader
H. Kurki-Suonio, prof. emer., senior scientist
J. Väliviita, adj. senior scientist
V. Lindholm, scientist
G. Gozaliasl, adj. scientist
K. Kiiveri, doctoral researcher
A. Viitanen, doctoral researcher
J. Haapala, student
S. Rissanen, student

Education and Open Data

K. Lassila-Perini, Dr., proj. leader (at CERN)
P. Veteli, doctoral researcher

Detector Laboratory

M. Kalliokoski, doc., laboratory director
M. Bezak, lab. engineer
F. García, lab. engineer
P. Koponen, lab. engineer
R. Turpeinen, senior lab. technician
A. Nikkanen, lab. technician

Administration and Support

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

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

HIP SEMINARS

21 January E. Gabrielli (Trieste)
Quantum entanglement and Bell inequality violation at high energies

4 February L. Jeppe (DESY)
Searching for new scalars, pseudoscalars and top quark pair bound states at CMS

20 February O. Komoltsev (Stavanger)
QCD in the cores of neutron stars

25 February S. Autti (Lancaster)
From a universe in a helium droplet to that droplet observing the universe

27 February A. Chakraborty (Crakow)
Holographic study of confining QCD-like theory on non-SUSY D2 brane and partial deconfinement

4 March M. Campbell (CERN)
Hybrid pixel detectors

17 April J. Ghiglieri (Nantes)
Thermal axion production in the early universe

6 May A. Schmitt (Southampton)
Dense QCD matter and neutron stars from holography

8 May B. Garbrecht (Munich)
CP conservation in the strong interactions

13 May V. Grishin (European Spallation Source, Lund)
European Spallation Source: the beam diagnostics and current beam commissioning results

20 May H. Ruotsalainen (Helsinki)
Entanglement-based holographic measures

31 May European Committee for Future Accelerators Meeting

K. Huitu (HIP, Helsinki) - **HEP in Finland**
M. Voutilainen (HIP) - **CMS experiment**
S. S. Räsänen (HIP, Jyväskylä) - **ALICE experiment**
F. Djurabekova (HIP) - **Accelerator technology and applications, FCC, CLIC**
T. Salmi (Tampere University of Technology) - **Magnets for Accelerators**
J. E. Brücken (HIP) - **LHC upgrades and detector technology and applications**
A. Jokinen (Jyväskylä) - **Nuclear physics at JYFL-ACCLAB, ISOLDE and FAIR**
A. Vuorinen (Helsinki) - **Theory**
D. Weir (Helsinki) - **Cosmology, astroparticle physics, neutrinos**
T. Siiskonen (STUK) - **Applications to radiation safety**
K. Lehtipalo (Helsinki) - **Application to climate science, CLOUD**
K. Lassila-Perini (HIP) - **School activities, societal impact, and open science**
K. Tuominen (Helsinki) - **Diversity, equity, and inclusion**
L. Huhta (Jyväskylä) - **Perspectives from early career researchers**

3 June Z. Fodor (Wuppertal)
The magnetic moment of the muon: a status report

10 June R. Keskitalo (Berkeley)
Next ten years of CMB observations from the Chilean high desert

17 June S. Säppi (Barcelona)
Probing heavy-quark physics with thermal chromoelectric correlators in pQCD

12 August M. Afrasiar (Pohang)
Probing confinement via holographic timelike entanglement and constraints in non-relativistic theories

19 August V. Mukhanov (LMU Munich)
Gravitationally dominated instantons

27 August M. Milgrom (Weizmann Institute of Science)
The Bekenstein Memorial Lecture on his 10th Anniversary: Parting with dark matter by departing from Newton and Einstein - modifying the dynamics as an alternative to dark matter

9 September J. L. Hernández (Barcelona)
Bulk viscous dissipation in strange quark stars and mergers

18 September E. Guilloton (Warwick)
Looking for BSM physics with H → tautau differential cross-section measurement at ATLAS

23 September C. Lewis (Seattle)
Search for resonant and non-resonant Higgs boson pair production in the bbbb final state

25 September T. Chatzistavrou (Athens)
Studying jet triggers and single top quark mass with the CMS experiment

4 November M. Giliberti (Florence)
Probing confinement observables with numerical holography in quiver field theories

11 November T. Jha (HIP, Helsinki)
Symmetries and blind spots in the dark

18 November X. Li (Helsinki)
Splitting of doubly and quadruply quantized vortices in holographic superfluids

25 November M. Myllymäki (Helsinki)
Precision top quark mass measurement at CMS using the profile likelihood method

9 December T. Lappi (Jyväskylä)
Dipole picture diffractive structure function at NLO

VISITORS

Theory Programme

Theoretical Cosmology

D. Werth (France) 14.-17.1.
P. S. Cole (UK) 11.-16.2.
S. Blasi (Germany) 17.-22.2.
V. Oliveira (Sweden, Portugal) 24.2.-1.3.
J. Sanchez Almeida (Spain) 4.-7.3.
D. Cabo Almeida (Spain) 7.-12.4.
G. Lavaux (France) 7.-16.4.
J. Baldes (France) 22.-25.4.
M. O. Olea-Romacho (UK) 7.-8.5.
I. G. Moss (UK) 12.-16.5.
N. Korsakova (France) 19.-23.5.
T. Boybeyi (USA) 2.-6.6.
D. Cruces (China) 10.-11.6.
T. Takahashi (Japan) 15.-19.6.
R. Wright (Australia) 7.-30.7.
I. Musco (Slovenia) 7.-9.8.
H. J. Macpherson (USA) 20.8.
H. Zheng (China) 24.-26.8.
S. Liao (China) 24.-27.8.
J. Thomson-Cooke (Denmark) 5.-9.10.
L. Zheng (Estonia) 14.-16.10.
H. Mansour (Germany) 29.10.
L. Gil (Spain) 5.11.
Z. Ren (Spain) 6.11.
T. R. Gray (Sweden) 19.11.
V. Vaskonen (Estonia, Italy) 19.-21.11.
M. Shaposhnikov (Switzerland) 3.12.

Fundamental Particle Interactions Beyond the Standard Model

V. Oliveira (Sweden, Portugal) 24.-28.2.
V. Mukhanov (Germany) 17.-22.8.
E. Dudas (France) 17.-24.8.
I. Brevik (Norway) 23.-30.9.
M. Shaposhnikov (Switzerland) 2.-5.12.

Phases of Strongly Interacting Matter

P. Huovinen (Poland) 7.1.
Y.-L. Lyu (China) 8.1.-10.6.
A. Chakraborty (Poland) 24.2.-24.3.
D. H. Rischke (Germany) 26.2.-9.3.
J. Ghiglieri (France) 15.-16.4.
P. Zurita (Spain) 28.4.-23.5.
I. Schienbein (France) 20.-24.5.
F. Salazar (USA) 4.-6.6.
M. Afrasiar (South Korea) 7.-15.7.
M. Järvinen (South Korea) 23.-26.9.
M. Giliberti (Italy) 3.-7.11.
S. Kawai (Japan) 22.12.

Topological Matter

S. Abedinpour (Iran) 5.10.-31.12.

CMS Programme

L. Jeppe (Germany) 3.-4.2.
J. Kleist (Denmark) 12.-13.5.
R. Begdoni (Italy) 19.-23.5.
M. A. Caballero Pacheco (Spain) 19.-23.5.
A. I. Castro Campoy (Mexico) 19.-23.5.
P. Newman (UK) 2.-3.6.
E. Guilloton (UK) 17.-18.9.
C. Lewis (USA) 22.-23.9.
T. Chatzistavrou (Greece) 24.-25.9.
N. Cartiglia (Italy) 12.-13.10.
J. Pekkanen (Switzerland) 13.-14.11.

Nuclear Matter Programme

ALICE

M. Spousta (Czech Republic) 2.-4.6., 4.-6.12.
S. Jeon (Canada) 25.10.

ISOLDE

J. Warbinek (Germany) 8.-19.1., 6.-17.10.

Technology Programme

Robotics and AI for Monitoring and Intervention (ROBOT)

L. Nalpantidis (Denmark) 17.-18.6.

Detector Laboratory

V. Grishin (Sweden) 12.-13.5.
A. Maulik (Italy) 24.11.-3.12.

CONFERENCE PARTICIPATION, TALKS AND VISITS BY PERSONNEL

Theory Programme

Theoretical Cosmology

Getting Ready to Descend the Slippery Slope of Multi-Messenger Cosmological Black Holes Data,
10-14 February, Sexten Center for Astrophysics Riccardo Giacconi, Sexten, Italy (talk by P. Johansson)

Cosmic WISPers,
13-14 February, Heidelberg, Germany (talk by M. Hindmarsh)

Åbo Akademi Physics Seminar,
20 February, Åbo Akademi, Turku, Finland (seminar by D. Hooper)

2nd Nordic Cosmology Meeting,
12-14 March, University of Helsinki, Helsinki, Finland (talk by J. Correia, lightning talk by L. Giombi, organiser, M. Hindmarsh, organiser, talk by D. Hooper, A. Kormu, organiser, lightning talk by T. Minkkinen, lightning talk by M. Mäki, S. Nurmi, organiser, K. Rummukainen, S. Räsänen, organiser, S. Sukuvaara, organiser, T. Tenkanen, D. Weir, organiser)

CUNEF Mathematics Seminar,
20 March, CUNEF Universidad, Madrid, Spain (talk by S. Räsänen)

Imperial College Particle Cosmology Seminar,
21 March, Imperial College London, London, UK (talk by A. Kormu)

Particle and Nuclear Physics Graduate Student Retreat,
21-22 March, Hyytiälä, Finland (talk by M. Mäki)

Seminar,
24 March, University of Sussex, Brighton, UK (talk by A. Kormu)

Seminar and Collaboration Visit,
25 March - 3 April, University of Nottingham, Nottingham, UK (talk by A. Kormu)

Physics Days 2025,
26-28 March, University of Oulu, Oulu, Finland (talk by R. Seppä, talk by S. Sukuvaara)

Dark Matter and Neutrinos,
5-23 May, Paris, France (talk by H. Parkkinen)

Graduate Days,
15-16 May, University of Graz, Graz, Austria (lectures by D. Weir)

NEHOP 2025,
19-22 May, Université Libre de Bruxelles, Brussels, Belgium (talk by S. Räsänen)

Unveiling Massive Black Hole Evolution with Gravitational Waves and Light,
19-23 May, Paris, France (talk by P. Johansson)

Nordic Lattice Meeting,
2-4 June, CERN, Geneva, Switzerland (talk by R. Seppä)

LISA Cosmology Working Group Workshop,
2-6 June, Estonian Academy of Sciences, Tallinn, Estonia (J. Correia, J. Dahl, talk by M. Hindmarsh, talk by D. Hooper, talk by T. Minkkinen)

Institute of Theoretical Astrophysics Seminar,
4 June, Institute of Theoretical Astrophysics, Oslo, Norway (talk by S. Räsänen)

Dancing in the Dark - When Galaxies Shape Galaxies,
16-20 June, Sexten Center for Astrophysics Riccardo Giacconi, Sexten, Italy (talk by P. Johansson)

Cosmology Beyond the Analytic Lamppost (CoBALt),
16 June - 4 July, Paris, France (talk by O. Väisänen)

Gravitational Wave Probes of Physics Beyond Standard Model 4,
23-27 June, Warsaw, Poland (talk by M. Benaco)

CSC Summer School in High-Performance Computing,
24 June - 3 July, Nuuksio, Espoo, Finland (M. Mäki)

MIAPbP Workshop "Enabling Future Gravitational Wave Astrophysics in the Milli-Hertz Regime",
30 June - 25 July, Munich Institute for Astro-, Particle and BioPhysics, Munich, Germany (T. Minkkinen)

Cargèse 2025 International Summer School "BSM Odyssey: Turns and Twists in Particle Theory",
21 July - 2 August, Institute for Scientific Studies, Cargèse, Corsica, France (talk by R. Seppä, talk by S. Sukuvaara)

Advancing Massive Black Hole Modelling across Galactic Scales,
28-30 July, Helsinki, Finland (talk by P. Johansson, organiser)

NORDITA Program "Numerical Simulations of Early Universe Sources of Gravitational Waves",
28 July - 15 August, NORDITA, Stockholm, Sweden (talk by J. Correia, talk by M. Hindmarsh, talk by M. Mäki, D. Weir, organiser)

Numerical Simulations of Gravitational Wave Sources in the Early Universe,
4-15 August, Stockholm, Sweden (J. Correia, talk by M. Hindmarsh)

CERN Workshop "Advancing Gravitational Wave Predictions from Cosmological First-Order Phase Transitions",
25-29 August, CERN, Geneva, Switerland (talk by J. Dahl, talk by M. Hindmarsh, talk by A. Kormu, talk by M. Mäki, colloquium by K. Rummukainen)

The Dynamic Universe Workshop,
1-5 September, Seeon, Germany (talk by P. Johansson)

Tampere Cosmology Meeting,
4-5 September, Tampere, Finland (talk by M. Benaco, talk by M. Ferrus, M. Hindmarsh, D. Hooper, K. Kainulainen, talk by M. Mäki, S. Nurmi, organiser, K. Rummukainen, talk by S. Sukuvaara, talk by O. Väisänen, D. Weir)

Massive Black Holes across Cosmic Time,
8-12 September, Cambridge, UK (talk by P. Johansson)

Methods of Effective Field Theory and Lattice Field Theory,
14-27 September, Benasque Science Center, Benasque, Spain (R. Seppä)

ENS Cosmology Seminar,
15 September, ENS, Paris, France (talk by S. Räsänen)

LISA School for Early-Career Scientists,
6-17 October, Les Houches, France
(T. Minkkinen, M. Mäki)

La Neuvième Assemblée Générale du GdR Ondes Gravitationnelles,
13-14 October, LPENS, Paris, France (talk by S. Räsänen)

Theory, Universe, Gravitation,
14-16 October, IPhT, Saclay, France (S. Räsänen)

Institut d'Astrophysique de Paris GReCO Seminar,
20 October, Paris, France (talk by S. Räsänen)

APC Theory Seminar,
21 October, APC Paris, France (talk by S. Räsänen)

LUX Seminar,
30 October, Meudon Paris Observatory, Paris, France
(talk by S. Räsänen)

Queen Mary Cosmology Seminar,
5 November, Queen Mary University of London, London, UK (talk by S. Räsänen)

Imperial College Particle Cosmology Seminar,
7 November, Imperial College, London, UK
(talk by S. Räsänen)

Particle Physics Days 2025,
13-14 November, Hyytiälä, Finland
(S. Nurmi, talk by O. Väisänen)

Queen Mary Astronomy Unit Seminar,
14 November, Queen Mary University of London, London, UK (talk by S. Räsänen)

Inflation 2025,
1-5 December, Paris, France (lightning talk by M. Benaco, lightning talk by O. Väisänen)

King's College Theoretical Particle Physics & Cosmology Seminar,
10 December, King's College, London, UK
(talk by S. Räsänen)

Fundamental Particle Interactions Beyond the Standard Model

Nordic Quantum Meeting,
19-21 January, Oslo, Norway (E. Keski-Vakkuri)

2nd Nordic Cosmology Meeting,
12-14 March, Helsinki, Finland
(talk by T. Gupta, H. Lempiäinen)

12th COSINUS Collaboration Meeting,
7-9 April, L'Aquila, Italy (M. Heikinheimo, talk by N. Zimmermann)

EMS-IAMP Spring School Symmetry and Measurement in Quantum Field Theory,
7-11 April, York, UK (N. Pranzini)

Quantum Information Structure of Spacetime,
13-17 April, Vienna, Austria (E. Keski-Vakkuri)

My Favorite Dark Matter Model,
14-17 April, Azores, Portugal (talk by O. Lebedev)

SISSA,
18-25 May, Trieste, Italy (talk by E. Keski-Vakkuri)

UK Astroparticle Physics Phenomenology,
2 June, London, UK (talk by D. Feiteira)

Time in Quantum Theory 2025,
17-20 June, Genoa, Italy (talk by N. Pranzini)

Relativistic Quantum Information North 2025,
23-27 June, Naples, Italy (talk by N. Pranzini)

Dark Side of the Universe (DSU) 2025,
7-11 July, Montreal, Canada (talk by D. Feiteira, talk by T. Gupta, talk by N. Zimmermann)

Dark Matter and Stars (ICDMS) 2025,
14-17 July, Kingston, Canada
(talk by T. Gupta, N. Zimmermann)

COSINUS,
22 July - 6 August, L'Aquila & LNGS, Italy
(N. Zimmermann)

Quantum Phases of Strong Dynamics,
26-28 August, Odense, Denmark (K. Tuominen)

Invisibles25,
1-5 September, CERN, Geneva, Switzerland
(talk by A. Al-Adulrazzaq, talk by D. Feiteira, talk by N. Stirling, N. Zimmermann)

Tampere Cosmology Meeting,
4-5 September, Tampere, Finland (talk by T. Gupta, M. Heikinheimo, talk by H. Lempiäinen, talk by J. Schymiczek)

Benasque Summer School on Methods of Effective Field Theory and Lattice Field Theory,
15-26 September, Benasque Science Center, Benasque, Spain (talk by H. Lempiäinen)

Scalars,
22-26 September, Warsaw, Poland (talk by O. Lebedev)

Simons Center for Geometry and Physics Program: 50 Years of Black Hole Information Paradox,
6-18 October, Stony Brook, NY, USA
(E. Keski-Vakkuri, invited participant)

University of Florence,
10 October, Florence, Italy (talk by N. Pranzini)

Tokyo University,
19-21 October, Tokyo, Japan (talk by N. Pranzini)

Kobe University,
22-24 October, Kobe, Japan (talk by N. Pranzini)

Extreme Universe International Workshop 2025 at YITP,
27 October - 1 November, Kyoto, Japan
(E. Keski-Vakkuri, N. Pranzini)

Astroparticle Symposium,
10-15 November, Orsay, France (talk by O. Lebedev)

Particle Physics Days 2025,
13-14 November, Hyytiälä, Finland (A. Al-Adulrazzaq, M. Heikinheimo, talk by N. Zimmermann)

The Dark Universe in Phase Space Workshop,
17-21 November, Trieste, Italy (M. Heikinheimo, talk by O. Lebedev)

IFJ-PAN,
8-15 December, Crakow, Poland (talk by T. Gupta)

Phases of Strongly Interacting Matter

Spåtind 2025 - Nordic Conference on Particle Physics,
2-7 January, Skeikampen, Norway (M. Bertilsson, talk by P. Gimeno Estivill, I. Helenius, organiser, T. Lappi, organiser, talk by J. Laulainen, H. Paukkunen, organiser)

Quarkonia As Tools 2025,
5-11 January, Centre Paul Langevin, Aussois, France
(invited talk by V. Guzey)

Workshop on Double Parton Scattering and the 3D Structure of Hadrons,
11-15 January, Centre Paul Langevin, Aussois, France
(invited talk by V. Guzey)

Cold Nuclear Matter Effects: From LHC to EIC,
13-16 January, Stony Brook, NY, USA
(invited talk by H. Paukkunen)

TU Wien,
15-17 January, Vienna, Austria
(T. Lappi, member of PhD jury)

University of Bern,
3-7 February, Bern, Switzerland (A. Rajala)

POETIC 2025, Physics Opportunities at an Electron-Ion Collider XI,
24-28 February, Miami, FL, USA
(invited talk by I. Helenius)

University of Oviedo,
26 February - 13 March, Oviedo, Spain
(talk by A. Hippeläinen)

University of Helsinki,
27 February, Helsinki, Finland (H. Mäntysaari)

NORDITA,
4-6 March, Stockholm, Sweden
(invited seminar by N. Jokela)

Particle and Nuclear Physics Graduate Student Retreat,
21-22 March, Hyytiälä, Finland (M. Bertilsson, M. Chithirasreemadam, N. Jokela, organiser, A. Kärkkäinen, T. Lappi, organiser, J. Li, X. Li, A. Rajala)

Holographic Perspectives on Chiral Transport and Spin Dynamics,
23-28 March, Trento, Italy (invited talk by N. Jokela)

Probing the CGC and QCD Matter at Hadron Colliders,
24-27 March, Galileo Galilei Institute, Florence, Italy
(invited talk by P. Gimeno Estivill, invited talk by T. Lappi)

DIS2025: 32nd International Workshop on Deep-Inelastic Scattering and Related Subjects,
24-28 March, Cape Town, South Africa (talk by C. Casuga, talk by A. D. Le, talk by S. Yrjänheikki)

Physics Days 2025,
26-28 March, University of Oulu, Oulu, Finland
(talk by I. Helenius, H. Mäntysaari, session convener)

59th Rencontres de Moriond 2025: QCD & High Energy Interactions,
30 March - 6 April, La Thuile, Italy (talk by F. Hekhorn)

High Energy Probes of the Initial Stages,
31 March - 4 April, CERN, Geneva, Switzerland
(invited talk by D. Avramescu)

HIP Board Meeting,
1 April, Helsinki, Finland (K. J. Eskola)

Quark Matter 2025,
6-12 April, Frankfurt am Main, Germany (J. Auvinen, flash talk by D. Avramescu, K. J. Eskola, member of the International Advisory Committee, talk by T. Lappi, N. Mallick, talk by H. Mäntysaari, talk by H. Niemi, Pooja, invited plenary talk by I. Soudi)

HIP Theory Project Review,
15-16 April, Jyväskylä, Finland (N. Jokela, R. Paatelainen, A. Piispa, M. Seppälä)

QFT in Curved Spacetimes Workshop,
5-6 May, Stockholm, Sweden (Gong-show talk by J. Li)

Extracting the Strong Coupling at the EIC and other Future Colliders,
5-7 May, Stony Brook, NY, USA (F. Hekhorn (online))

Pythia Week Spring 2025,
12-16 May, Lund, Sweden (I. Helenius, sessions chair, seminar by J. Laulainen)

European Strategy for Particle Physics - Strong Interactions Open WG Meeting,
14 May (online) (invited talk by H. Paukkunen)

Challenges in Theoretical Physics Education in Nordic Countries 2025,
15-16 May, Stockholm, Sweden (O. Henriksson)

2nd Workshop on Modern Equations of State and Spectroscopy in Neutron-Star Matter,
26-28 May, Alcalá de Henares, Spain
(invited talk by N. Jokela)

RECFA Meeting in Finland,
30 May, Helsinki, Finland (K. J. Eskola, P. Paakkinen)

Nordic Lattice Meeting,
2-4 June, CERN, Geneva, Switzerland (talk by A. Rajala)

UPC2025: The Second International Workshop on the Physics of Ultra Peripheral Collisions,
9-13 June, Saariselkä, Finland (M. Bertilsson, local organising committee member, M. Chithirasreemadam, local organising committee member, K. J. Eskola, local organising committee member, talk by P. Gimeno Estivill, invited talk by V. Guzey, local organising committee member, invited talk by I. Helenius, local organising committee chair, invited talk by T. Lappi, international program committee co-chair, local organising committee member, H. Mäntysaari, local organising committee chair, P. Paakkinen, local organising committee member, H. Paukkunen, local organising committee member, P. Runko, local organising committee member, talk by X. Tong)

65. Jubilee Cracow School of Theoretical Pysics,
14-21 June, Zakopane, Poland (invited lecture by T. Lappi)

YoctoLHC Meeting,
16-18 June, Santiago de Compostela, Spain
(talk by H. Niemi, talk by I. Soudi)

New Insights in Black Hole Physics from Holography,
16-20 June, Madrid, Spain (J. Li)

Summer School "Light-Ion Physics in the EIC Era: From Nuclear Structure to High-Energy Processes",
19-27 June, Florida International University, Miami, FL, USA (lecture by V. Guzey (online))

2nd European School on the Physics of the EIC and Related Topics,
22 June - 2 July, Benicàssim, Spain (talk by M. Bertilsson, talk by M. Chithirasreemadam, lecture by T. Lappi, J. Laulainen, talk by P. Runko, talk by S. Yrjänheikki)

International HPC Summer School,
6-11 July, Lisbon, Portugal (A. Rajala)

MC4EIC 2025,
9-11 July, JLab, Newport News, VA, USA (invited talk by I. Helenius, organising committee member)

Holographic Applications: from Quantum Realms to the Big Bang,
11-19 July, Beijing, China (invited talk by N. Jokela)

EIC User Group & ePIC Joint Collaboration Meeting,
14-18 July, JLab, Newport News, VA, USA
(invited talk by I. Helenius)

Integrability in Gauge and String Theory 2025,
21-25 July, London, UK (J. Li)

High Energy QCD: from the LHC to the EIC,
3-16 August, Benasque Science Center, Benasque, Spain
(talk by P. Gimeno Estivill, talk by T. Lappi, talk by M. Tevio)

Network for University Physics Education Meeting,
12 August, University of Tampere, Tampere, Finland
(H. Mäntysaari)

HIP Scientific Advisory Board Meeting,
25-26 August, Helsinki, Finland (K. J. Eskola, talk by H. Mäntysaari)

Eurostrings 2025,
25-28 August, Stockholm, Sweden (O. Henriksson)

Saalburg Summer School 2025,
1-12 September, Bayrischzell, Germany (J. Li)

University of Bern,
3-4 September, Bern, Switzerland (M. Sainio)

Tampere Cosmology Meeting,
4-5 September, Tampere, Finland (N. Jokela, K. Kajantie)

The VIIIth International Conference on the Initial Stages of High-Energy Nuclear Collisions: Initial Stages 2025,
7-12 September, Taipei, Taiwan (invited plenary talk by D. Avramescu, session convener, M. Bertilsson, talk by C. Casuga, talk by M. Chithirasreemadam, talks by H. Mäntysaari, session convener, S. Yrjänheikki)

Benasque Summer School on Methods of Effective Field Theory and Lattice Field Theory,
14-27 September, Benasque Science Center, Benasque, Spain (A. Rajala)

Second Holography and Dense Matter Workshop,
16-20 September, Paris, France (invited talk by N. Jokela)

Two Days on Inverse Problems and Minimal Surfaces,
21-23 September, Lyon, France (invited talk by N. Jokela)

4th Annual Retreat of the Jyväskylä Centre of Excellence in Quark Matter,
2-3 October, Konnevesi Research Station, Konnevesi, Finland (talk by V. Alanko, D. Avramescu, talk by M. Bertilsson, C. Casuga, M. Chithirasreemadam, talk by K. J. Eskola, V. Guzey, F. Hekhorn, talk by I. Helenius, organiser, talk by A. Kaushik, K. Kukkonen, T. Lappeteläinen, talk by T. Lappi, organiser, J. Laulainen, talk by S. Mulani, talk by H. Mäntysaari, organiser, talk by H. Paukkunen, Pooja, talk by P. Runko, X. Tong, S. Yrjänheikki)

LHC Monte Carlo WG Plenary Meeting,
8-9 October, CERN, Geneva, Switzerland
(talk by I. Helenius, J. Laulainen)

PhD Thesis Defense,
8-11 October, Santiago de Compostela, Spain
(N. Jokela, committee chair)

MCnet Open Meeting,
10 October, CERN, Geneva, Switzerland
(I. Helenius, talk by J. Laulainen)

The 42nd International Symposium on Lattice Field Theory,
2-8 November, TIFR, Mumbai, India (A. Rajala)

Particle Physics Days 2025,
13-14 November, Hyytiälä, Finland (V. Alanko, talk by M. Bertilsson, M. Chithirasreemadam, K. J. Eskola, P. Gimeno Estivill, talk by V. Guzey, I. Helenius, session convener, A. Kaushik, K. Kukkonen, T. Lappi, J. Laulainen, A. D. Le, S. Mulani, H. Mäntysaari, talk by H. Niemi, talk by P. Paakkinen, Pooja, P. Runko, organising committee member, F. Smits, X. Tong)

Terascale Monte Carlo School 2025,
24-28 November, DESY, Hamburg, Germany
(invited lecture by J. Laulainen)

Indian Strings Meeting 2025,
9-14 December, Bhubaneswar, India
(invited talk by N. Jokela)

University of Jyväskylä,
11-12 December, Jyväskylä, Finland
(R. Paatelainen, M. Seppälä)

Topological Matter

APS Global Physics Summit,
16-21 March, Anaheim, CA, USA (T. Ojanen)

CMS Programme

CMS Experiment

Spåtind 2025 - Nordic Conference on Particle Physics,
2-7 January, Skeikampen, Norway (H. Kirschenmann, organiser, S. Laurila, organiser, M. Myllymäki, talk by N. Norjoharuddeen, talk by N. Toikka)

CMS TOP PAG Workshop,
29-31 January, Ghent, Belgium (talk by M. Myllymäki)

February CMS Week,
10-14 February, Geneva, Switzerland (plenary talk by P. Inkaew, S. Lehti, plenary talk by N. Norjoharuddeen)

Polarized Perspectives: Tagging and Learning in the SM,
20-21 February, Vienna, Austria (N. Norjoharuddeen, N. Toikka)

CMS JetMET Workshop,
4-7 March, Hamburg, Germany (P. Inkaew, H. Kirschenmann, B. Lehtelä, N. Mancilla Xinto, talk by M. Myllymäki, talk by N. Norjoharuddeen, talk by R. Verma, talk by M. Voutilainen)

Physics Days 2025,
26-28 March, University of Oulu, Oulu, Finland
(talk by S. Laurila)

CMS Level-1 Trigger Workshop 2025,
1-4 April, Oviedo, Spain (talk by S. Laurila)

Nordic ESPP Meeting,
7-8 May, Uppsala, Sweden (H. Kirschenmann, M. Myllymäki (online))

Higgs Paris Workshop 2025,
11-17 May, Elba, Italy (talk by S. Laurila)

CERN,
12 May - 28 June, Geneva, Switzerland (N. Mancilla Xinto)

CERN,
26 May - 26 June, Geneva, Switzerland (B. Lehtelä)

CERN,
26 May - 28 June, Geneva, Switzerland
(N. Norjoharuddeen)

RECFA Meeting in Finland,
30 May, Helsinki, Finland (talk by M. Voutilainen)

June CMS Week,
9-14 June, Geneva, Switzerland (plenary talk by B. Lehtelä, S. Lehti, plenary talk by M. Voutilainen)

CERN,
15 June - 5 July, Geneva, Switzerland (S. Lehti)

HIP Scientific Advisory Board Meeting,
25-26 August, Helsinki, Finland (talk by M. Voutilainen)

Low-x 2025,
8-12 September, Medulin, Croatia (talk by N. Toikka)

SMARTHEP Annual Meeting,
15-19 September, Dortmund, Germany (P. Inkaew, H. Kirschenmann)

September CMS Week,
29 September - 3 October, Geneva, Switzerland
(talk by B. Lehtelä, plenary talk by N. Norjoharuddeen, talk by M. Voutilainen)

Second Nordic ESPP Meeting,
22 October (online) (M. Myllymäki)

2nd Winter HIP CMS Experiment Workshop and Particle Physics Days 2025,
12-14 November, Hyytiälä, Finland (P. Inkaew, H. Kirschenmann, organiser, T. Lampén, talk by S. Laurila, B. Lehtelä, N. Mancilla Xinto, talk by M. Myllymäki, talk by N. Norjoharuddeen, A. Stadnitski, N. Toikka, E. Veikkola, R. Verma, M. Voutilainen)

CMS Upgrade

CMS Tracker Week,
27-31 January, CERN, Geneva, Switzerland (E. Brücken)

TREDI 2025 Workshop,
4-6 February, Trento, Italy (E. Brücken, N. Kramarenko)

European Spallation Source (ESS),
28-29 March, Lund, Sweden (E. Brücken, T. Hildén)

Nordic ESPP Meeting,
7-8 May, Uppsala, Sweden (P.-R. Luukka)

CMS Tracker Week,
12-16 May, CERN, Geneva, Switzerland (H. Badran, E. Brücken, T. Hildén)

RECFA Meeting in Finland,
30 May, Helsinki, Finland (talk by E. Brücken)

3rd DRD3 Collaboration Meeting,
2-6 June, Amsterdam, Netherlands (E. Brücken (online))

ISOTDAQ 2025 - International School of Trigger and Data AcQuisition,
17-27 June, Vilnius, Lithuania (S. Saariokari)

IEEE NPSS Prague Summer School (PEISS),
30 June - 6 July, Prague, Czech Republic (N. Kramarenko, tutor, M. Myllymäki)

IWORID 2025 - 26th International Workshop on Radiation Imaging Detectors,
6 -10 July, Bratislava, Slovakia (N. Kramarenko, M. Myllymäki)

CMS Tracker Week,
21-25 July, Kolmar, France (H. Badran)

HIP Scientific Advisory Board Meeting,
25-26 August, Helsinki, Finland (talk by E. Brücken, P.-R. Luukka)

University of Turin, Physics Department,
22-23 September, Turin, Italy (E. Brücken)

2nd DRD3 TCT School,
23-25 September, CERN, Geneva, Switzerland (N. Kramarenko, M. Väänänen, tutor)

MTD Days 2025,
24-26 September, CERN, Geneva, Switzerland (E. Brücken, N. Kramarenko)

Uppsala University, Ångström Laboratory,
13-17 October, Uppsala, Sweden (E. Brücken, seminar by S. Saariokari)

Finnish Nuclear Science and Technology Symposium 2025,
21-22 October, Espoo, Finland (talk by E. Brücken)

2025 IEEE Nuclear Science Symposium, Medical Imaging Conference, and Room Temperature Semiconductor Detectors Symposium,
1-8 November, Yokohama, Japan (talk by N. Kramarenko (online), S. Saariokari, talk by M. Väänänen)

CMS Tracker Week,
3-7 November, CERN, Geneva, Switzerland (H. Badran, E. Brücken (online), T. Hildén)

European Spallation Source (ESS),
10-12 November, Lund, Sweden (E. Brücken, T. Hildén, M. Myllymäki)

4th DRD3 Collaboration Meeting,
10-14 November, CERN, Geneva, Switzerland (E. Brücken (online), N. Kramarenko (online))

Particle Physics Days 2025,
13-14 November, Hyytiälä, Finland (H. Badran, talks by E. Brücken, talk by P.-R. Luukka)

CERN,
24 November - 8 December, Geneva, Switzerland (S. Saariokari)

ISIS Neutron and Muon Source,
15-17 December, Didcot, UK (M. Myllymäki)

Tier-2 Operations

HEP/HPC Strategy Meeting - All Regions,
30-31 January, Geneva, Switzerland (T. Lindén)

Winter 2025 Offline Software and Computing Week,
3-7 February, Geneva, Switzerland (T. Lindén)

HEPiX Spring 2025 Workshop,
31 March - 4 April, Lugano, Switzerland (T. Lindén)

FUNET Technical Days,
22-23 May, Espoo, Finland (T. Lindén)

HIP Scientific Advisory Board Meeting,
25-26 August, Helsinki, Finland (T. Lindén)

23rd International Workshop on Advanced Computing and Analysis Techniques in Physics Research,
8-12 September, Hamburg, Germany (T. Lindén)

Nordic Fusion Forum,
20 October, Espoo, Finland (T. Lindén)

Finnish Nuclear Science and Technology Symposium 2025,
21-22 October, Espoo, Finland (talk by T. Lindén)

Canadian Workshop on Fusion Energy Science and Technology (CWFEST) 2025,
2-3 December (online) (T. Lindén)

Fusion Power Associates 46th Annual Meeting and Symposium,
9-10 December, Washington, DC, USA (T. Lindén (online))

CMS Forward Physics

Spåtind 2025 - Nordic Conference on Particle Physics,
2-7 January, Skeikampen, Norway (F. Oljemark)

CERN,
15-31 January, 11-21 February, 5-21 March, 1-11 April, 13-23 May, 11-29 June, 10 July - 2 August, 27 August - 12 September, 15-24 October, 19 November - 3 December, 5-15 December, Geneva, Switzerland (F. Garcia)

PPS General Meeting,
11 February, Geneva, Switzerland (talk by F. Garcia, K. Österberg (online))

European Spallation Source (ESS),
28-29 March, Lund, Sweden (K. Österberg)

Nordic ESPP Meeting,
7-8 May, Uppsala, Sweden (K. Österberg)

CMS Week,
9-14 June, 29 September - 3 October, Geneva, Switzerland (K. Österberg)

PPS General Meeting,
10 June, 30 September, Geneva, Switzerland (talks by F. Garcia, K. Österberg)

PPS2 Meeting,
11 June, Geneva, Switzerland (F. Garcia, K. Österberg)

CERN,
13 July - 8 August, Geneva, Switzerland (A. Milieva)

HIP Scientific Advisory Board Meeting,
25-26 August, Helsinki, Finland (talk by K. Österberg)

CERN,
25 August - 10 September, Geneva, Switzerland (F. Musonov)

PPS2 Meeting,
9 October, Geneva, Switzerland (talk by F. Garcia, K. Österberg)

CMS Data Analysis School,
13-17 October, Hamburg, Germany (F. Musonov)

LHC RRB Meeting,
27-30 October, Geneva, Switzerland (K. Österberg)

University of Stockholm,
5-7 November, Stockholm, Sweden (F. Oljemark, Y. Shaikh)

2nd Winter HIP CMS Experiment Workshop and Particle Physics Days 2025,
12-14 November, Hyytiälä, Finland (A. Milieva, F. Oljemark, K. Österberg)

PPS General and Institution Board Meeting,
9 December, Geneva, Switzerland (F. Garcia, K. Österberg, chair)

Nuclear Matter Programme

ALICE

Spåtind 2025 - Nordic Conference on Particle Physics,
2-7 January, Skeikampen, Norway (talks by L. Huhta, S. Räsänen)

ATHIC 2025,
13-16 January, Gopalpur-On-Sea, India (D. J. Kim, talk by N. Mallick, M. Virta)

Nicolaus Copernicus Astronomical Centre, Polish Academy of Sciences,
22-25 January, Warsaw, Poland (W. Trzaska, opponent at PhD defence)

ALICE3 Days,
17-19 February, 19-21 May, CERN, Geneva, Switzerland (S. Räsänen)

FIT, ALICE Week and Astroparticle Physics,
3-24 March, CERN, Geneva, Switzerland (W. Trzaska)

ALICE Week,
17-21 March, CERN, Geneva, Switzerland (S. Räsänen)

Physics Days 2025,
26-28 March, University of Oulu, Oulu, Finland (L. Huhta, S. Räsänen)

CERN,
31 March - 19 April, 2-24 November, Geneva, Switzerland (A. Molander)

STUK,
2 April, Helsinki, Finland (S. Räsänen)

Quark Matter 2025,
6-12 April, Frankfurt am Main, Germany (L. Huhta, D. J. Kim, N. Mallick, M. Virta)

LHC RRB,
28-29 April, CERN, Geneva, Switzerland (S. Räsänen)

INPC 2025,
25-30 May, Daejeon, South Korea (D. J. Kim, talk by M. Virta)

RECFA Meeting in Finland,
30 May, Helsinki, Finland (S. Räsänen)

HIP ALICE Project Review,
1-4 June, Helsinki and Jyväskylä, Finland (Y. Melikyan)

HIP ALICE Project Review,
2 June, Helsinki, Finland (S. Räsänen)

UPC2025: The Second International Workshop on the Physics of Ultra Peripheral Collisions,
9-13 June, Saariselkä, Finland (N. Mallick, talk by S. Räsänen)

CERN,
23 June - 19 July, Geneva, Switzerland (M. Virta)

FIT, ALICE Week, FIT Performance Paper,
7-26 July, CERN, Geneva, Switzerland (W. Trzaska)

Oulu VTT,
9-10 July, Oulu, Finland (S. Räsänen)

ALICE Week,
14-18 July, CERN, Geneva, Switzerland (S. Räsänen, talk by M. Virta)

Wigner Research Center,
10-23 August, Budapest, Hungary (N. Mallick)

HIP SAB Meeting,
25-26 August, Helsinki, Finland (S. Räsänen)

The VIIIth International Conference on the Initial Stages of High-Energy Nuclear Collisions: Initial Stages 2025,
7-12 September, Taipei, Taiwan (D. J. Kim, talk by M. Virta)

RICH-2025 Conference,
14-20 Sepember, Mainz, Germany (talk by Y. Melikyan)

CERN,
18 September - 15 October, Geneva, Switzerland (L. Huhta)

CERN,
26 September - 20 October, Geneva, Switzerland (N. Mallick)

ALICE Upgrade Week,
6-10 October, Burghausen, Germany (S. Räsänen)

Baryon 2025 and ExHIC,
7-19 November, Jeju, South Korea (talk by D. J. Kim)

FIT, ALICE Week, FIT Performance Paper,
9 November - 12 December, CERN, Geneva, Switzerland (W. Trzaska)

Particle Physics Days 2025,
13-14 November, Hyytiälä, Finland (talk by L. Huhta, N. Mallick, S. Räsänen, F. Smits)

ALICE Week,
8-12 December, CERN, Geneva, Switzerland (S. Räsänen)

ISOLDE

CERN,
12-16 June, Geneva, Switzerland (E. Uusikylä)

CERN,
18-25 June, 9-12 September, 28 September - 1 October, 25-31 October, Geneva, Switzerland (J. Pakarinen)

CERN,
13-18 August, 25-31 October, Geneva, Switzerland (J. Ojala)

HIP SAB Meeting,
25-26 August, Helsinki, Finland (A. Jokinen, talk by J. Pakarinen)

CERN,
13-20 September, Geneva, Switzerland (S. Chinthakayala)

CERN,
25-31 October, Geneva, Switzerland (P. Rahkila)

ISOLDE Workshop and Users Meeting,
1-6 December, CERN, Geneva, Switzerland
(talk by I. Moore, J. Pakarinen)

FAIR

NUSTAR Annual Meeting,
24-28 February, Darmstadt, Germany (T. Eronen)

HIP SAB Meeting,
25-26 August, Helsinki, Finland (talk by T. Grahn)

Super-FRS Experiment Collaboration Meeting,
16-19 September, Walldorf, Germany
(T. Grahn, talk by M. Kortelainen)

NUSTAR Week 2025,
29 September - 2 October, Prague, Czech Republic
(T. Eronen, T. Grahn)

Technology Programme

Robotics and AI for Monitoring and Intervention (ROBOT)

CERN,
2-3 October, Geneva, Switzerland (R. Pieters)

University of Jyväskylä,
24 October, Jyväskylä, Finland (talk by R. Ojala)

Materials for Accelerator Technology (MAT)

Joint ICTP-IAEA-MAMBA School on Materials Irradiation: from Basics to Applications,
16-18 February, Trieste, Italy (lecture by F. Djurabekova)

Future Circular Collider Week,
20-23 May, Vienna, Austria (F. Djurabekova, M. Ghaemikermani)

Mechanisms of Vacuum Arcing Workshop,
1-5 June, Uppsala, Sweden (F. Djurabekova, R. Koitermaa, L. Miola, M. Toktaganova)

Radiation Effects in Insulators (REI-23),
7-14 June, Madrid, Spain (F. Djurabekova, A. Leino)

Workshop MultIChem-ISACC 2025: Irradiation Driven Processes in Molecular Systems and Related Technologies,
15-18 July, Heidelberg, Germany (F. Djurabekova)

33rd International Materials Research Congress 2025,
19-24 August, Cancun, Mexico (F. Djurabekova)

Annual Workshop on Ion and Particle Beams,
22-24 August, GSI Helmholtz Centre for Heavy Ion Research, Darmstadt, Germany (A. Leino)

Xi'an Jiatong University,
18 September, Xi'an, China (invited lecture by F. Djurabekova)

Lanzhou University,
19 September, Lanzhou, China (invited lecture by F. Djurabekova)

31st International Symposium on Discharges and Electrical Insulation in Vacuum (ISDEIV),
21-26 September, Chengdu, China (F. Djurabekova)

Institut Lumière Matière,
Claude Bernard University Lyon 1,
12-18 October, Lyon, France (R. Koitermaa)

Radiation and Nuclear Metrology, Safety, Security and Safeguards (RAD3S)

Workshop "Industry Connect: Matchmaking in Intelligent Work Machines & Mathematics of Sensing, Image, and Modelling",
5 February, Tampere, Finland (A. Anumah, H. Li)

NKS Seminar "Nordic Nuclear Collaboration: Adapting To New Realities",
21-22 May, Stockholm, Sweden (invited talk by P. Dendooven)

Workshop for Research and Industry Collaboration: Building Strong Nordic Connections in the NKS-B Programme,
23 May, Solna, Sweden (talk by P. Dendooven)

Summer School "Mathematics and Machine Learning for Image Analysis",
3-11 June, Bologna, Italy (A. Anumah, H. Li)

34th Jyväskylä Summer School,
11-15 August, Jyväskylä, Finland (H. Li)

Uppsala University,
13-17 October, Uppsala, Sweden (A. Anumah, E. Brücken, P. Dendooven, S. Saariokari)

Uppsala University,
17 October, Uppsala, Sweden (seminar by S. Saariokari)

Nuclear Science and Technology Symposium - SYP2025,
21-22 October, Espoo, Finland (talk by E. Brücken)

2025 IEEE Nuclear Science Symposium, Medical Imaging Conference, and Room Temperature Semiconductor Detectors Symposium,
1-8 November, Yokohama, Japan (A. Anumah, P. Dendooven, S. Saariokari)

Particle Physics Days 2025,
13-14 November, Hyytiälä, Finland (talk by E. Brücken)

Inverse Days 2025,
15-17 December, Helsinki, Finland (talk by H. Li)

Other projects

CLOUD

CLOUD Data Workshop,
24-28 February, Mainz, Germany (talk by X. He, talk by K. Lehtipalo, talk by J. Shen, talk by W. Yu)

RECFA Meeting in Finland,
30 May, Helsinki, Finland (talk by K. Lehtipalo)

International Conference of Nucleation and Atmospheric Aerosols,
24-28 August, Vienna, Austria (J. Shen, talk by W. Yu)

CLOUD Collaboration Meeting,
22-24 October, CERN, Geneva, Switzerland (talk by X. He, talk by K. Lehtipalo, talk by J. Shen, talk by W. Yu)

Euclid

Galaxy Clustering Science Working Group Meeting,
20-24 January, Garching, Germany (talk by V. Lindholm, talk by E. Sihvola)

2nd Nordic Cosmology Meeting,
12-14 March, Helsinki, Finland (talk by E. Sihvola)

Euclid Consortium Meeting,
24-27 March, Leiden, Netherlands (J. Haapala, V. Lindholm, S. Rissanen, E. Sihvola and J. Väliviita (online))

Tampere Cosmology Meeting,
4-5 September, Tampere, Finand (J. Haapala, V. Lindholm, talk by S. Rissanen, E. Sihvola, J. Väliviita)

Euclid System Team Meeting,
7-8 October, Garching, Germany (V. Lindholm)

Education and Open Data

Analysis Preservation Bootcamp PSI,
22-23 February, PSI, Villigen, Switzerland (talk by K. Lassila-Perini)

LHC Reinterpretation Forum (RIF) Workshop,
25-28 February, CERN, Geneva, Switzerland (talk by K. Lassila-Perini)

RECFA Meeting in Finland,
30 May, Helsinki, Finland (talk by K. Lassila-Perini)

GIREP-EPEC 2025,
30 June - 4 July, Leiden, Netherlands (talk by P. Veteli (online))

ICFA Data Lifecycle Panel Editorial Workshop,
8-10 July, CERN, Geneva, Switzerland (led by K. Lassila-Perini)

HIP Analysis Preservation and Workflow Automation Bootcamp,
18-19 August, Helsinki, Finland (led by K. Lassila-Perini)

European Nuclear Physics Conference,
25 September, Caen, France (panel discussion K. Lassila-Perini)

LHC Reinterpretation Forum (RIF) Seminar,
30 October, CERN, Geneva, Switzerland (talk by K. Lassila-Perini)

STEM Education Research Days,
30-31 October, Helsinki, Finland (talk by P. Veteli)

Detector Laboratory

International Conference on Quantum Technology for High-Energy Physics,
20-23 January, CERN, Geneva, Switzerland (M. Kalliokoski)

SMEAR II Station,
5-6 February, Juupajoki, Finland (M. Kalliokoski)

FMI Jokioinen Observatory,
7 February, Jokioinen, Finland (M. Kalliokoski)

DRD5 / RDquantum Collaboration Meeting,
17-19 February, CERN, Geneva, Switzerland (M. Kalliokoski)

HEXITEC User Workshop 2025,
20 February, London, UK (M. Bezak, M. Kalliokoski)

HiZPAD 2025 Workshop,
21 February, London, UK (talk by M. Bezak, M. Kalliokoski)

Gran Sasso National Laboratory,
9-14 March, L'Aquila, Italy (M. Kalliokoski)

Medipix Collaboration Meeting,
12-13 March, CERN, Geneva, Switzerland (M. Bezak (online))

Physics Days 2025,
26-28 March, University of Oulu, Oulu, Finland (talk by M. Kalliokoski)

Nordic ESPP Meeting,
7-8 May, Uppsala, Sweden (M. Bezak (online))

3rd DRD3 Week on Solid State Detectors R&D,
2-6 June, Amsterdam, Netherlands (M. Bezak (online), M. Kalliokoski)

23rd MoEDAL-MAPP Collaboration Meeting,
16-18 June, Helsinki, Finland (talk by M. Kalliokoski)

Chair of Dissertation Defence Committee,
26-28 June, Valencia, Spain (M. Kalliokoski)

IWORID 2025 - 26th International Workshop on Radiation Imaging Detectors,
6-10 July, Bratislava, Slovakia (M. Kalliokoski, R. Turpeinen)

ELI Beamlines Laser Center,
28 July - 8 August, Dolní Břežany, Czech Republic (M. Bezak)

ELI Beamlines Laser Center,
29 September - 10 October, Dolní Břežany, Czech Republic (M. Bezak, M. Kalliokoski)

CERN Test Beam Platform for Quantum Technologies,
29 October, CERN, Geneva, Switzerland (M. Kalliokoski)

DRD5 Collaboration Meeting,
30-31 October, CERN, Geneva, Switzerland (M. Kalliokoski)

2025 IEEE Nuclear Science Symposium, Medical Imaging Conference, and Room Temperature Semiconductor Detectors Symposium,
1-8 November, Yokohama, Japan (M. Kalliokoski)

4th DRD3 Week on Solid State Detectors R&D,
10-14 November, CERN, Geneva, Switzerland (M. Bezak)

Particle Physics Days 2025,
13-14 November, Hyytiälä, Finland (talk by M. Kalliokoski)

24th MoEDAL-MAPP Collaboration Meeting,
15-17 December, CERN, Geneva, Switzerland (talk by M. Kalliokoski)

PUBLICATIONS

Theory Programme

Theoretical Cosmology

M. Hindmarsh in N. Aggarwal et al.,
Challenges and opportunities of gravitational-wave searches above 10 kHz,
Living Rev. Relativ. 28 (2025) 10

T. V. I. Tenkanen in F. Bernardo et al.,
Higher-dimensional operators at finite temperature affect gravitational-wave predictions,
J. High Energy Phys. 08 (2025) 109

S. Capozziello, S. Zare, L. M. Nieto, and H. Hassanabadi,
Modified Kerr black holes surrounded by dark matter spike,
Phys. Dark Univ. 50 (2025) 102065

J. Correia, M. Hindmarsh, J. Lizarraga, A. Lopez-Eiguren, K. Rummukainen, and J. Urrestilla,
Scaling density of axion strings in terasite simulations,
Phys. Rev. D 111 (2025) 063532

J. Correia, M. Hindmarsh, K. Rummukainen, and D. J. Weir,
Gravitational waves from strong first-order phase transitions,
Phys. Rev. D 112 (2025) 123546

V. Keus in A. Dey et al.,
On the CP properties of spin-0 dark matter,
J. High Energy Phys. 06 (2025) 206

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The CosmoVerse White Paper: Addressing observational tensions in cosmology with systematics and fundamental physics,
Phys. Dark Univ. 49 (2025) 101965

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Signatures of the speed of sound on the gravitational wave power spectrum from sound waves,
J. Cosmol. Astropart. Phys. 01 (2025) 100

O. Gould, A. Kormu, and D. J. Weir,
Nonperturbative test of nucleation calculations for strong phase transitions,
Phys. Rev. D 111 (2025) L051901

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Inflation with the Chern-Simons term in the Palatini formulation,
J. Cosmol. Astropart. Phys. 01 (2025) 087

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Phys. Rev. D 111 (2025) 123550

M. Hindmarsh, D. C. Hooper, T. Minkkinen, and D. J. Weir,
Recovering a phase transition signal in simulated LISA data with a modulated galactic foreground,
J. Cosmol. Astropart. Phys. 04 (2025) 052

J. Hällfors and K. Rummukainen,
Expanded ensemble method for bubble nucleation,
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Baryogenesis from primordial CP violation,
J. High Energy Phys. 07 (2025) 156

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Finite-temperature bubble nucleation with shifting scale hierarchies,
J. High Energy Phys. 07 (2025) 153

S. Zare in L. M. Nieto et al.,
Accretion disk luminosity and topological characteristics for a Schwarzschild black hole surrounded by a Hernquist dark matter halo,
Phys. Dark Univ. 50 (2025) 102151

Fundamental Particle Interactions Beyond the Standard Model

M. Heikinheimo, K. Huitu, and A. Stendahl in G. Angloher et al. (COSINUS Collaboration),
Neutrino flux sensitivity to the next galactic core-collapse supernova in COSINUS,
J. Cosmol. Astropart. Phys. 03 (2025) 037

M. Heikinheimo, K. Huitu, and A. Stendahl in G. Angloher et al. (COSINUS Collaboration),
COSINUS model-independent sensitivity to the DAMA/LIBRA dark matter signal,
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Astron. Astrophys. 697 (2025) A5

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Astron. Astrophys. 697 (2025) A2

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Astron. Astrophys. 697 (2025) A11

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Astron. Astrophys. 702 (2025) A155

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Astron. Astrophys. 700 (2025) A78

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Astron. Astrophys. 697 (2025) A85

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Astron. Astrophys. 698 (2025) A134

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Astron. Astrophys. 701 (2025) A40

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Astron. Astrophys. 702 (2025) A74

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Astron. Astrophys. 697 (2025) A9

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Astron. Astrophys. 695 (2025) A280

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Astron. Astrophys. 697 (2025) A13

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Astron. Astrophys. 695 (2025) A284

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LXXI. Simulations and nonlinearities beyond ΛCDM. 3. Constraints on *f*(R) models from the photometric primary probes,
Astron. Astrophys. 698 (2025) A233

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***Euclid*: Star clusters in IC 342, NGC 2403, and Holmberg II,**
Astron. Astrophys. 703 (2025) A113

E. Keihänen, H. Kurki-Suonio, and V. Lindholm in F. Lepori et al. (Euclid Consortium),
***Euclid*: Relativistic effects in the dipole of the two-point correlation function,**
Astron. Astrophys. 694 (2025) A321

E. Keihänen, H. Kurki-Suonio, V. Lindholm, C. C. Kirkpatrick, and J. Valiviita in J. Lesgourgues et al. (Euclid Collaboration),
***Euclid* preparation**
LVI. Sensitivity to non-standard particle dark matter models,
Astron. Astrophys. 693 (2025) A249

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Power spectrum of the CODEX clusters,
Astron. Astrophys. 697 (2025) A93

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Astron. Astrophys. 693 (2025) A210

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Astron. Astrophys. 697 (2025) A7

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LXIV. The Cosmic Dawn Survey (DAWN) of the Euclid Deep and Auxiliary Fields,
Astron. Astrophys. 695 (2025) A259

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Astron. Astrophys. 697 (2025) A1

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Astron. Astrophys. 704 (2025) A306

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Astron. Astrophys. 699 (2025) A214

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Astron. Astrophys. 694 (2025) A116

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Astron. Astrophys. 695 (2025) A232

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Astron. Astrophys. 695 (2025) A282

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Astron. Astrophys. 697 (2025) A10

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Astron. Astrophys. 703 (2025) A184

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Astron. Astrophys. 694 (2025) A262

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***Euclid* preparation**
LVII. Observational expectations for redshift z < 7 active galactic nuclei in the Euclid Wide and Deep surveys,
Astron. Astrophys. 693 (2025) A250

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***Euclid* preparation**
LIX. Angular power spectra from discrete observations,
Astron. Astrophys. 694 (2025) A141

E. Keihänen, H. Kurki-Suonio, and V. Lindholm in M. Urbano et al. (Euclid Consortium),
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Astron. Astrophys. 700 (2025) A104

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Astron. Astrophys. 693 (2025) A251

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Astron. Astrophys. 697 (2025) A16

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Astron. Astrophys. 695 (2025) A229

Detector Laboratory

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EPJ Quantum Technol. 12 (2025) 42

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