Research domain	**1. Higgs physics at the LHC**
Number of employees	1
Job description	Data analysis in the context of searching for a charged Higgs boson in CMS
Preferred student profile	Person interested in experimental particle physics.
Special skills required	Basic knowledge of particle physics, computing skills, familiar with UNIX/linux environment, OO-programming in C++ and python.
Training period	1.6. - 31.8.2024
Contact person	Sami Lehti, supervisor Tel. +358 50 448 5621/+41 22 767 8595 Email: sami.lehti@cern.ch

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Research domain	**2. Jet physics at the LHC**
Number of employees	1
Job description	Data analysis of jets (sprays of particles produced by quarks and gluons) produced in the high energy collisions in CMS experiment. We will use Monte Carlo simulations and high energy collision data to extract high-precision calibrations for light quark, gluon and bottom quark jets. These results are used for precise top quark mass and strong coupling constant measurements in order to better understand vacuum metastability.
Preferred student profile	Physics or applied/engineering physics student; three years or more of studies; interest to proactively work in a truly international team of researchers.
Special skills required	Programming experience, preferably c/c++; familiar with UNIX/linux
Training period	1.6. - 31.8.2024 (or as agreed)
Contact person	Mikko Voutilainen, supervisor Tel. +358 2 941 50565 Email: mikko.voutilainen@cern.ch

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Research domain	**3. Higgs physics with boosted jets at the LHC**
Number of employees	1
Job description	By studying proton-proton collisions where two Higgs bosons are produced together, we can obtain valuable information about the Higgs potential and how the Higgs boson interacts with other particles. In this project, modern data analysis techniques, including machine learning (ML) tools, are applied to improve the sensitivity and/or extend the range of these "di-Higgs" measurements. The student will learn the basics of data analysis tools used in experimental high-energy physics, and contribute to the ongoing research as part of an international research team. Depending on the interests and competencies of the student, possible contributions include: (1) improving the event classification algorithms to better identify di-Higgs events, (2) modifying an existing di-Higgs analysis to search for new exotic signatures, such as heavy resonances, or (3) designing ultrafast FPGA-based preselection algorithms to identify di-Higgs events during future LHC runs.
Preferred student profile	Physics, data science, or computer science student curious about particle physics, preferably with three years of studies or more. Good communication skills and a proactive attitude are beneficial when working in an international research environment.
Special skills required	Familiarity with Linux/UNIX environment. Basic skills in Python, C++, or both. Experience in software development or ML is a plus
Training period	1.6. - 31.8.2024 (exact dates are negotiable)
Contact person	Santeri Laurila, supervisor Tel. +358 44 2630 995 email: Santeri.laurila@cern.ch

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Research domain	**4. Vector boson scattering and machine learning at the LHC**
Number of employees	1

Job description	Vector Boson Scattering (VBS) processes at the Large Hadron Collider offer a pathway to test the symmetry breaking mechanism in the Standard Model (SM) of Particle Physics. Measurements of these processess are difficult due to their low rate of production and the large rate of background processes which can mimic the signature of VBS processes. Our group is actively involved in analyzing CMS data to measure VBS processes in the all-hadronic final state. The student will be able to contribute to the analysis in the following possible topics: 1) VBS vs background events discrimination: Investigate new approaches to improve the purity of signal all-hadronic VBS process. 2) Hadronic jet identification: Develop new techniques to identify jets from hadronically-decaying vector bosons of different polarizing states and also to discriminate them from jets originating from other processes.
Preferred student profile	Physics, data science, or computer science student with an interest in particle physics, preferably with three years of studies or more. You should be ready to take own initiative and communicate with other stakeholders at CERN.
Special skills required	Familiarity with Linux/UNIX environment. Basic skills in Python. Experience in software development or ML is a plus
Training period	1.6. - 31.8.2024 (exact dates are negotiable)
Contact person	Henning Kirschenmann, supervisor Nurfikri Norjoharuddeen, supervisor Tel. +358 2 941 50564 Email: henning.kirschenmann@cern.ch nurfikri.bin.norjoharuddeen@cern.ch

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Research domain	**5. Operation and Calibration of CMS Experiment at LHC**
Number of employees	1
Job description	Calibration is a key element for success in cutting-edge scientific measurements and research. In this summer job, the student will learn aspects of calibration and monitoring of the CMS detector and its various subdetectors. In particular, the work is related to the automatic Prompt Calibration Loop in CMS, which aims to provides up-to-the-minute calibration conditions, thus ensuring reliable high-quality data-taking and physics performance for CMS.
Preferred student profile	Physics or applied/engineering physics student; three years of studies (or more); interest to proactively work in a truly

	international team of researchers.
Special skills required	Programming experience, preferably c/c++; experience with python and git is appreciated
Training period	1.6. - 31.8.2024 (or as agreed)
Contact person	Tapio Lampén, supervisor Tel. +358 2 941 50597 Email: tapio.lampen@cern.ch

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Research domain	**6. Research and development for instrumentation in nuclear and material physics at ISOLDE**
Number of employees	1 - 2
Job description	**Project 1: Laser spectroscopy of cadmium isotopes with MIRACLS** MIRACLS is a novel collinear laser spectroscopy instrument with increased sensitivity to study the structure of radioactive atomic nuclei. This new technique is based on an ion trap (Multi-Reflection Time-of-Flight device) which allows extended observation times and hence, makes radioactive nuclei far away from stability accessible. The student will assist in preparing the experimental setup for measuring the nuclear charge radii of the 98,132Cd isotopes. This involves preparing the laser system with 217nm laser light, performing preparation measurements with offline ion source and taking part in the online experiment. **Projects 2: Accurate moments and hyperfine structure of unstable nuclei at VITO** The VITO setup is used for polarizing nuclear spins with laser light and then using the polarized nuclei for a versatile research program ranging from nuclear physics to chemistry and biology. In this project, the student will help in optimizing the experimental setup devoted to a ppm measurement of magnetic moments and hyperfine structure of different short-lived nuclei, starting with 11Be. Moments will be determined using □ -NMR in liquid samples. **Project 3: Beta-gamma angular correlations from laser-polarized radioactive beams at VITO** The setup is used for polarizing nuclear spins with laser light and then using the polarized nuclei for a versatile research program ranging from nuclear physics to chemistry and biology. In this project, the student will assist in the assembly of a setup for angular correlations between beta and gamma radiation emitted by

polarized beams. Beta and gamma detectors will be mounted and tested with sources, before possible tests with polarized beams.

Project 4: Production of long-lived Xe isomers for a new medical diagnosis technique, gamma-MRI
In this project, we aim to produce strong and pure sources of long-lived 129m,131m,133mXe isomers at ISOLDE and in nuclear reactors, so that they are used in the gamma-MRI project. The produced samples will be either extracted from foils or collected from quartz ampoules. They will be characterized for activity and purity, and will be shipped to our collaborators in Geneva. The student will help with preparing the production runs, setting up the gamma-detector, and helping with sample characterization and opening.

Project 5: Decay spectroscopy experiments of exotic nuclei
The ISOLDE Decay Station (IDS) is a flexible and versatile array of gamma, charged-particle and neutron detectors used for beta-decay spectroscopic studies of the low-energy radioactive beams delivered by ISOLDE. The present project aims to implement the upgraded mechanical support frame geometry of IDS in to the Geant4 simulation package. The HPGe, LaBr3(Ce) detectors and the SPEDE spectrometer will be characterized using calibration sources and compared with existing simulations. Finally, the detectors will be virtually placed within the new mechanical frame and the absolute detection efficiency curves will be simulated for various geometries. The project will require basic knowledge of detection techniques and, optionally, programming experience with C++ and ROOT.

Preferred student profile	In general, these project are aimed for third year students with basic courses in physics and interest to work in a laboratory environment with an international team of researchers. Students that like experimental physics, assembling and testing of experimental new equipment at the hardware level are preferred.
Training period	1.6. - 31.8.2024 (flexible)
Contact person	Janne Pakarinen Tel. +358 40 805 4900 Email: janne.pakarinen@jyu.fi The individual projects will be supervised by local researchers within ISOLDE.

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Research domain	**7. Discovery physics with CMS-TOTEM at the LHC**

Number of employees	1
Job description	A rather novel way to search for new physics phenomena is by detecting intact protons scattered only very little in the proton-proton collision and combine their information with particle systems measured using the central part of the experiment. The task would be to participate in physics analysis of the data taken with the CMS and TOTEM experiments at the Large Hadron Collider (LHC) focusing on physics signals containing very forward protons. The work will consist of analysis of real data together with simulating corresponding processes with dedicated software.
Preferred student profile	Physics (or physics interested computer science) student eager to learn new things.
Special skills required	Basic programming skills are necessary, knowledge of Python is recommended. Knowledge of C++ and/or data analysis framework ROOT is a plus. Basic knowledge of statistical methods and data analysis is also an advantage.
Training period	1.6. - 31.8.2024 (the dates are flexible)
Contact persons	Kenneth Österberg, supervisor Tel. +358 50 522 5166 Email: kenneth.osterberg@helsinki.fi

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Research domain	**8. R & D of gaseous detectors**
Number of employees	1
Job description	Generic development and testing of Micro Pattern gaseous detectors. Hands-on in gaseous detectors, including laboratory tests. A core task will be the studies for the operation of a Time Projection Chamber, used for the tracking of low energy muons with a standard readout plane and a pixellated ASIC readout.
Preferred student profile	Physics Student – with interest in electronics and programming.
Special skills required	Master student with basic knowledge of interaction of radiation with matter, programming C++, statistics methods, and electronics and very well motivated to work in a multicultural environment.
Training period	1.6. - 31.8.2024
Contact person	Francisco García, supervisor

Tel. +358 50 559 9570
Email: Francisco.Garcia@helsinki.fi

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Research domain	**9. Experimental particle physics in ALICE**
Number of employees	1 - 2
Job description	We offer a summer trainee position within the ALICE experiment where the main goal is to study the deconfined QCD matter produced in relativistic lead-lead collisions at the LHC. The selected candidate will participate into data analysis or to detector performance studies. In the data analysis, we study the transport properties of the quark-gluon plasma, created in PbPb collisions, either utilizing measurements of collective flow or modification of jets by the dense medium. The flow analysis resembles the harmonic analysis of the cosmic microwave background and jet modifications have similarities to tomography studies. In the detector performance studies, the candidate would participate into performance studies of the new forward calorimeter (FoCal) upgrade of the ALICE experiment.
Preferred student profile	Physics student who has studied basics of particle physics and is interested in data-analysis.
Special skills required:	Programming skills (C/C++) and basic knowledge of Unix-like OS help in getting into work. Prior experience in using the ROOT data analysis framework is appreciated.
Training period	1.6. - 31.8.2024
Contact person	Sami Räsänen, supervisor Tel. +358 40 805 4725 Email: sami.s.rasanen@jyu.fi DongJo Kim, supervisor Tel. +358 50 313 7868 Email: djkim@cern.ch

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Research domain	**10. Mechanical engineering engineering (Design, Manufacture, Testing)**
Number of employees	1
Job description	Design, manufacture and testing of light-mass mechanical structures and tooling for the upgrade of CERN's CMS experiment. A new high-precision detector system is being constructed in carbon composite materials, light metals, plastics and thin-walled cooling pipes. The trainee will work in a multi-disciplinary team in the CERN EP-DT group, https://ep-dep-

	dt.web.cern.ch/. Depending on the trainee's profile and interests, the tasks will consist of one or several amongst the following areas: CAD modelling and drawing preparation, engineering calculations, part manufacture, assembly, quality control and testing of equipment. Note: After the trainee period there may be other similar job opportunities in the CERN groups in charge of the CMS tracker project.
Preferred student profile	University students in mechanical engineering. The tasks will be chosen and tuned following the study background, experience and interests of the trainee.
Training period	3 months, 1.6. - 31.8.2024 (the exact dates can be adjusted)
Contact person	Antti Onnela, supervisor, CERN EP-DT Tel. +41 75 411 0673 Email: antti.onnela@cern.ch

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Research domain	**11. Benchmarking CMS open data processing on public cloud Kubernetes engine**
Number of employees	1 - 2
Job description	The CMS experiment at the LHC at CERN has released particle physics data for public use. At the research level, smooth access to all data assets and easy implementation of example workflows is the key to usability. In this task, we will evaluate and compare various job configurations on the Google Cloud Platform's Kubernetes Engine with a focus on processing time and cost. The goal of this project is to create an online tutorial that serves as a practical guide for optimizing the use of public cloud resources when working with CMS open data. Note that machine learning (ML) or artificial intelligence (AI) applications are not within the scope of this task.
Preferred student profile	IT or physics student with interest in IT challenges for open data accessibility and reusability
Special skills required	Familiarity with linux shell, version control with git, container technology and basic knowlegde of Kubernetes.
Training period:	27.5. - 26.8.2024 (or as agreed)
Contact person	Kati Lassila-Perini, supervisor Tel. +41 22 767 9354 Email: kati.lassila-perini@cern.ch

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Research domain	**12. Research at the synchrotron light source ESRF (www.esrf.eu)**
Number of employees	1
Job description	ESRF (www.esrf.eu) is a highly sophisticated accelerator facility that produces high-energy x-rays with extremely high brilliance. The x-rays are used for studies in different fields in physics and materials science. Within the following projects the student will participate in the development of the new beamline ID20 (https://tinyurl.com/y3jj2aq9) for inelastic x-ray scattering. The beamline uses hard x-ray synchrotron methods, chiefly inelastic x-ray scattering, x-ray absorption and emission spectroscopies, and x-ray diffraction, for studying both fundamental physics, materials science, as well as real devices for catalysis, energy storage and conversion under operating conditions as well as their idealized model systems under precisely controlled environments. The projects can and will be tailored to the student's interests and skills. The following are examples of possible projects. Please don't hesitate to ask for our other projects as well. Our aim is that the project work would result in a Master's thesis and a scientific peer-reviewed publication. **Electronic structure of the f-electron systems** The project's goal is to advance the fundamental understanding of f-electron systems (specifically lanthanides (Ln) and actinides (An)) by assessing their electronic structure. This goal will be achieved by performing X-ray Spectroscopy experiments in high energy resolution mode at the Rossendorf Beamline of ESRF (Grenoble, France) and analysing the data with the help of electronic structure calculations. a) Providing essential fingerprint information regarding the An/Ln oxidation state and ground state configuration. b) Probing the 4f/5f occupancy, non-stoichiometry, defects, and the ligand/metal ratio. c) Investigating local symmetry and the effects of the crystal field. You will learn to analyse the experimental data and to use codes to calculate the electronic structure and spectra of f-electron systems. **Electrochemical flow cell** In a common lithium ion rechargeable battery, the negative and positive electrodes are typically sandwiched together with a separator – a porous membrane in which an ion-conducting electrolyte solution is embedded. For avoiding radiation damage to the electrolyte solution during synchrotron beam experiments, a flow cell will be designed where the electrolyte solution is continuously streamed through the separator. The project will consist of the design, realization and testing the cell in experiments using synchrotron light, especially in inelastic x-ray scattering experiments.

	X-ray spectroscopy on fuel cell materials In fuel cell catalysts, the performance is closely tied to the active sites. X-ray spectroscopy can help identify and characterize these active sites, providing information on the electronic and geometric structure that influences catalytic activity. This information is crucial for understanding the chemical reactions that take place in fuel cells, where oxygen reduction and evolution reactions play a central role. X-ray spectroscopy can be conducted under in situ conditions, allowing us to study the dynamic changes in the material during fuel cell operation. This is essential for understanding the electrochemical processes and degradation mechanisms in real-world conditions. Your project would be to participate in experiments to characterize the oxygen K edge spectra in a fuel cell catalyst, perform data analysis and learn how to simulate the spectra using electronic structure calculations.
Preferred student profile	In general, these project are aimed for third year students with basic courses in physics, chemistry or related field, and interest to work in a laboratory environment with an international team of researchers.
Training period	1.6. - 31.8.2024 (or as agreed)
Contact person	Simo Huotari, supervisor Tel. +358 2941 50638 Email: simo.huotari@helsinki.fi The individual projects will be supervised by local researchers at ESRF