HIP SUMMER JOBS IN 2023

INTERNATIONAL OPPORTUNITIES AT CERN AND AT ESRF

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. - 31.8.2023
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. - 31.8.2023 (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. - 31.8.2023 (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. Realtime data analysis and machine learning at the LHC**
Number of employees	1
Job description	The Large Hadron Collider is quickly accumulating data since the restart of operations in 2022. You will have the opportunity to work with the data at the trigger level that is reconstructed in almost real-time after data-taking and becoming more and more

	useful also for sophisticated analyses. Our group is working on improved calibration of jets and identification of objects such as b-jets and Higgs bosons on this data, also applying machine learning techniques. You will get to use and further develop a fully Python-based columnar analysis workflow leveraging the scientific python ecosystem instead of very domain-specific tools.
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. - 31.8.2023 (exact dates are negotiable)
Contact person	Henning Kirschenmann, supervisor Tel. +358 2 941 50564 Email: henning.kirschenmann@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 (PCL) of CMS, which provides almost up-to-the-minute calibration conditions for reconstruction of collision events provided by the LHC collider. This ensures reliable and high-quality 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. - 31.8.2023 (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: Development of a Geant4 simulation of the Miniball γ-ray spectrometer** The Miniball γ-ray spectrometer, comprising eight assemblies of three hyper-pure germanium crystals, investigates nuclear structure of fast-moving exotic nuclei. Complimenting Miniball are silicon detectors for charged-particle spectroscopy. Of particular note is the SPEDE array, developed at the University of Jyväskylä, Finland, capable of inferring the existence of erstwhile undetectable nuclear states. This project will focus on the development of a detailed Geant4 simulation of Miniball and its ancillary detectors. Key will be reproducing the position resolution of γ-ray interactions in Miniball, which is required for accurate Doppler-correction of γ-ray energy. The simulation will be tested against standard source measurements and stable beam measurements that will be lead by the project student. **Project 2: Testing the eMIL and eMMA Setups: a versatile tool for material science** The eMIL-Setup is an advanced emission Mössbauer spectrometer for measurements in versatile conditions of several classes of materials, including multiferroics thanks to the emission Magnetic Mössbauer Analyzer (eMMA) extension. We are looking for a highly motivated student to join our team dedicated to the commissioning and test of the setup in the beamline using multiferroic materials. Multiferroics are a material class in which order arises for at least two order parameters. Order parameters can be strain, electric polarization, magnetization or toroidal forms of the three. The increasing interest in using multiferroic materials in high-tech applications requires that the underlying physical phenomena are studied at the atomic scale by using variously state-of-the-art techniques such as TDPAC, which is available at ISOLDE-CERN. **Project 3: On-line Perturbed Angular Correlations with Short- Lived Isotopes (PAC-SLI)** Measurements of quadrupole moments and/or electric field gradients on solid state samples are aimed at on-line PAC experiments with short lived isotopes. A new setup dedicated to these experiments has been commissioned and is mounted at the ISOLDE LA1 beam line for tests. The following tasks are planned: 1) -hardware work- tests and calibration of the thermal annealing on-line sample-holder to remove implantation defects;

2) -software work- optimization of constant fraction timing algorithms of digitized output signals from scintillator detectors, as produced by multichannel digitizers;
3) -experimental work- participation on first tests performed with 119In/Sn (144s), 124In/Sn (3.7s) and 22Mg/Na (3.88 s) ions

Projects 4: 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 β-NMR in liquid samples.

Project 5: 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

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. - 31.8.2023
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 either Python or C++ is definitely a plus. Knowledge of data analysis frame work ROOT is an additional plus. Basic knowledge of statistical methods and data analysis is also an advantage.
Training period	1.6. - 31.8.2023 (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 of the operation of an Optical Time Projection Chamber (OTPC) in low pressure, investigations of the stable operation with different gasses and wavelength shifting properties
Preferred student profile	Physics Student – with interest in electronics, programming and material sciences.
Special skills required	Master student with 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. - 31.8.2023
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 basic 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 but not required.
Training period	1.6. - 31.8.2023
Contact person	Sami Räsänen, supervisor Tel. +358 40 805 4725 Email: sami.s.rasanen@jyu.fi DongJo Kim, supervisor Tel. +358 50 3137868 Email: djkim@cern.ch

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Research domain	**10. Mechanical engineering (Design, Materials, Production)**
Number of employees	1
Job description	Mechanical engineering on a particle tracking system for the upgrade of the CMS experiment, https://cms.cern/detector. The new CMS tracker will comprise state-of-the-art composite materials, light metals, plastics and two-phase CO2 cooling. Another possible field of work is participation to the upgrade of the CLOUD experiment, https://home.cern/science/experiments/cloud. In both cases the trainee will work in a multi-disciplinary team in the CERN EP-DT group, https://ep-dep.web.cern.ch/organisation/dt. Depending on the trainee's profile and interests, the tasks may consist of CAD design, structural/thermal (FE) analysis, as well

	as participation in manufacture, assembly and testing of high-performance equipment. Note: There may be further job opportunities (including Thesis work) in these projects.
Preferred student profile	Technical University engineering student (Engineering Design, Engineering Materials, Production Engineering, Aeronautics, Applied Thermodynamics, Mechatronics, Instrumentation, etc.). The tasks will be chosen and tuned following the study background and interests of the trainee.
Training period	1.6. - 31.8.2023 (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. Technology Programme, Academia-Industry Collaboration** The Technology Programme is one of the major research programs of Helsinki Institute of Physics (HIP). Our focus areas are Accelerator technologies, Materials for accelerators and other big science installations, Radiation detection technologies as well as Academic and Industrial collaboration.
Number of employees	1
Job description	The MQXF quadrupoles for the HL-LHC upgrade of the LHC will be the first Nb3Sn magnets installed in an accelerator. One of the key parameters for field quality is the capability to accurate position the conductors in the coil cross section, which is particularly challenging for Nb3Sn due to the conductor dimensional changes during reaction heat treatment. The objective of this work is to study of the precision on the conductor position in Nb3Sn coils through the analysis of cross section images of MQXF quadrupole magnets and quantify, if existing, differences among manufacturing lines and procedures.
Preferred student profile	Independent, with a systematic way of working, research or R&D oriented technical MSc student majoring in Electrical or Mechanical engineering. Interested in participating in international R&D&I projects. Good synthetizing and documentation skills in English are particularly needed.
Special skills required	Good written/spoken communication skills in English, knowledge of other languages, in particular French, an asset. On the wish list, experience in scription with Python, Matlab or a similar tool and analytical mind-set.
Training period	1.6. - 31.8.2023 (some flexibility on dates possible)

Contact person	Tiina Salmi, Academy Research Fellow Tampere University Tel. +358 40 849 0415 Email: tiina.salmi (at) tuni.fi Susana Izquierdo-Bermudez, Staff Scientist/CERN Email: susana.izquierdo.bermudez (at) cern.ch

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Research domain	**12. Open data in use**
Number of employees	1 - 2
Job description	The CMS experiment at the LHC at CERN has released particle physics data for public use. These data are in use in research and education. At the research level, smooth access to all data assets and easy implementation of example workflows is the key to usability. In education, in high schools and in undergraduate education, easy-to-use online programming platforms such as jupyter notebooks are in use. We are looking for enthusiastic students • either with a teaching background/interest to generate ideas for teaching content based on these open data and to develop them further, • or for students with IT skills to facilitate access to these data in research. The task can be adapted depending on the applicant profile.
Preferred student profile	Physics teacher student with interest in open data, or physics or IT student with interest in IT challenges for open data accessibility and reusability
Special skills required	Interest in open data and education, or in IT challenges in the open data domain. Familiarity with python or other programming languages, knowledge of git is an advantage, but can be learned during the traineeship
Training period:	1.6. - 31.8.2023 (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	**13. 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. **Miniature diffractometer development** In this project, a very compact diffractometer for sample characterization using synchrotron beam will be designed, integrated into the control system of ESRF beamline ID20, and tested. The miniature diffractometer is based on an Advacam x-ray camera that is based on a Medipix family chip, and the control software uses Linux and Python scripts for data acquisition. **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.
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. - 31.8.2023 (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