HIP SUMMER JOBS IN 2022

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. - 31.8.2022
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 at 13 TeV 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. - 31.8.2022 (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. Silicon pixel detector characterization at CERN DSF**
Number of employees	2
Job description	HIP CMS Upgrade group is currently preparing laboratories for the CMS Pixel Phase-2 upgrade at CERN DSF facility. The summer student will work in this laboratory with silicon detectors and readout electronics. In addition, the student participates into developing and fine tuning the test setups and analyzing the measurement data. The tasks require basic knowledge of object oriented programming.
Preferred student profile	Student of engineering physics, electrical engineering or particle physics with some laboratory experience.
Special skills required	Basic knowledge of object oriented programming (e.g. C++/Java/Python), knowledge of LabVIEW is a plus. Interest in experimental physics instrumentation.
Training period	1.6. - 31.8.2022 (negotiable)
Contact person	Prof. Panja Luukka, supervisor Tel. +41 75 411 4299 Email: panja.luukka@cern.ch

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Research domain	**4. Di-Higgs physics with machine learning 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 machine learning (ML) techniques are applied to improve the sensitivity 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) developing new ML classifiers to better identify di-Higgs events (2) producing updated estimates about future experimental sensitivity for di-Higgs production, 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. - 31.8.2022 (exact dates are negotiable)
Contact person	Santeri Laurila, supervisor Tel. +41 22 767 1534 email: Santeri.laurila@cern.ch

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Research domain	**5. Exploring first data from LHC Run 3**
Number of employees	1
Job description	The Large Hadron Collider has been in "long shutdown" since end of 2018 and – after significant upgrades – is now about to come back to life, with first stable beams expected in late spring 2022. You will have the unique opportunity to be among the first to look at the new data in detail and provide important insight during this start-up period. In particular, we will perform full scans of the detector using jets and look for anomalous events in this first data, possibly using machine learning. 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. - 31.8.2022 (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	**6. Calibration of CMS Experiment at LHC**
Number of employees	1
Job description	Calibration is a key element in scientific measurements, also in experimental particle physics. We participate in monitoring, operation and development of the automatic Prompt Calibration Loop (PCL) of CMS, which provides almost up-to-the-minute calibration conditions for reconstruction of collision events. 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. - 31.8.2022 (or as agreed)
Contact person	Tapio Lampén, supervisor Tel. +358 2 941 50597 Email: tapio.lampen@cern.ch

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Research domain	**7. Research and development for instrumentation in nuclear and material physics at ISOLDE**
Number of employees	1 - 2
Job description	Project 1: Molecular formation/dissociation with ion beams. ISOLDE provides experimental programs with a selection of radioactive isotopes that spans the nuclear chart. Some elements are particularly challenging to deliver as beams, requiring development from the targets and ion sources before they can be delivered to experiments. Molecular beams offer a method to volatilize and extract these challenging elements. Moreover, they offer a way to access new information about nuclear, atomic, and molecular physics. The student will assist experiments on

molecular ion beam development by in-target and/or in-trap molecular formation at the ISOLDE offline facilities.

Project 2: Extension of the RILIS wavelength cover from nonlinear processes in crystals.
The Resonance Ionization Laser Ion Source (RILIS) is widely used in both ISOLDE and MEDICIS facilities to ionize a wide range of isotopes with high efficiency and selectivity, for fundamental and medical research. In order to access the array of ionization schemes for different elements, the lasers must provide a wide and continuous wavelength tuning range, from the UV to the infrared. The project will consist of developing and characterizing alternative frequency-mixing configurations, which will be used to investigate resonance ionization schemes that are not readily accessible with the current laser system.

Projects 3: 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 4: 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 5: Preparations for the gammaMRI medical modality.
GammaMRI is a pan-European project aiming to develop a new medical imaging technique that combines the physics principle behind MRI and SPECT/PET. The student will be involved in the production, characterization, and purification of the radioactive tracers for gammaMRI. The student will help putting together a small experimental setup, as well as setting up, calibrating, and operating gamma detectors, and analysis of the data obtained.

Project 6: MINIBALL electronics upgrade.
The MINIBALL digital electronics upgrade will be finalized in 2022. It is foreseen to be tested with stable ion beams with the SPEDE electron spectrometer prior to its first experimental

	campaign with radioactive beams. The project also involves mechanical assembly and vacuum tests.
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. - 31.8.2022
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	**8. Discovery physics with CMS-TOTEM at the LHC**
Number of employees	1
Job description	A 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 a measurement of the central system using the central part of the experiment. The task would be to participate in physics analysis of the data taken with the CMS and/or the TOTEM experiment at the Large Hadron Collider (LHC) focusing on such physics signals. The work will consist of analysis of data and/or simulations.
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 or C++ as well as ROOT and/or data analysis frameworks is a big plus. Basic knowledge of statistical methods and data analysis is an advantage
Training period	1.6. - 31.8.2022 (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	**9. R & D of gas detectors**
Number of employees	1
Job description	Generic development and testing of Micro Pattern gaseous detectors. Hands-on in detectors, including laboratory tests. A core task will be divided in two parts; first with the implementation of the event builder algorithm for a GEM-TPC into the Scalable Readout System (SRS) Data Acquisition systems (DAQ) using VMM3 ASIC and second to carry out characterization of new photocathodes with the ASSET setup
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Preferred student profile	Physics Student – with interest in electronics, programming and material sciences.
Special skills required	Basic knowledge of interaction of radiation with matter, programming C++, statistics methods and electronics and very well motivated.
Training period	1.6. - 31.8.2022
Contact person	Francisco García, supervisor Tel. +358 50 559 9570 Email: Francisco.Garcia@helsinki.fi

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Research domain	**10. 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 lead-lead collisions in the ultra-relativistic energy regime at the LHC. The selected candidate will participate in the data analysis our to detector performance analysis. In the data analysis, we study the transport properties of the quark-gluon plasma, created in these 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 will study how neutral pion or isolated photons can be extracted from signals in the planned new forward calorimeter that will be installed in ALICE during the next LHC long shutdown period.

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. - 31.8.2022
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	**11. 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/news/new-paradigms-cms-phase-2-upgrades. 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. - 31.8.2022 (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	**12. Remote and autonomous controlled vehicles**
Number of employees	1
Job description	Development and testing of accurate mobile-robot localization software in accelerator's tunnel utilizing multiple sensor technologies and artificial intelligence techniques. Goal is to improve maneuvering precision and increase autonomous operation. Sensor and training data is obtained online (in real tunnels) or offline (in simulation).
Preferred student profile	Computer science or engineering student with prior knowhow on some of the following areas : robotics, localisation (SLAM), robot operating system (ROS), and programming
Training period	1.6. - 31.8.2022 (or as agreed)
Contact person	Kari Tammi, supervisor Tel. +358 50 3487902 Email: kari.tammi@aalto.fi

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Research domain	**13. Open data in education**
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 e.g. in cloud computing environment, as well as in high schools and in undergraduate education through easy-to-use online programming platforms such as jupyter notebooks. We are looking for enthusiastic students • Either with 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 the 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. - 31.8.2022 (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	**14. Research at the synchrotron light source ESRF (www.esrf.eu)**
Number of employees	1
Job description	These projects will be done at the European Synchrotron Radiation Facility in Grenoble, France.

ESRF 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 high-energy beamline for x-ray scattering and imaging, ID31 (http://bit.ly/2gxpC87) and/or beamline ID20 (https://tinyurl.com/y3jj2aq9) for inelastic x-ray scattering. The scientific aim of the beamline is to study heterogeneous devices such as fuel cells, organic solar cells, rechargeable batteries, catalytic materials, etc. The beamlines use hard x-ray synchrotron methods for studying both fundamental physics, materials science, as well as real devices under operating conditions and idealized model systems under precisely controlled environments.

The projects can and will be tailored to student's interests and skills. The following are examples of possible projects. Please don't hesitate to ask for our other projects. All projects involve also either software development or intensive data analysis work and thus can also be tailored to be done remotely. Our aim is that the project work would result in a scientific peer-reviewed publication.

Project (1): pyBIB - software tool for data visualization and analysis.
The student will develop a python graphical software package and jupyter notebooks for data visualization and analysis using machine learning. The main building blocks will be taken from silx

which is a custom library at ESRF. The student should have a basic knowledge of python or a willingness to learn it, and will collaborate with the ESRF data analysis unit.

Project (2): Hybrid battery ultracapacitors.
This project is part of a European initiative (TEESMAT) focused on advanced characterization of next-gen energy storage technologies together with industry partners.
Opportunities for this project include: (i) learning the energy storage mechanisms and structure-performance relationships of advanced battery materials; (ii) mastering the basics of X-ray crystallography towards microstructure analysis; (iii) fabricating high performance batteries and evaluating their performance using electrochemical techniques; (iv) working together with our nanomicroscopy team to combine high-resolution imaging with chemical/crystallographic information from diffraction.

Project (3): Hydrogen Fuel cell tailored for X-ray absorption measurements.
The knowledge about the movement of catalysts' alloying element (Ni, Co) inside the working fuel cell is a detrimental to the fuel cell performance. The aim of the project is to use X-ray absorption Spectroscopy to follow this movement during operation and determine the extent of poisoning effect inside the proton conductive membrane. As part of this project the student will characterize a newly developed hydrogen fuel cell, find the stable operating conditions, perform experiment at ID26 beamline and help with data analysis.

Project (4): Development of new chemically sensitive x-ray imaging methods.
New non-destructive 3D imaging methods are capable of using chemistry of materials as a contrast mechanism (Huotari et al., Nature Materials, https://www.nature.com/articles/nmat3031). Recently, a new concept for a novel, faster and high-resolution imaging method has been proposed and experimental design for it will be constructed and tested. The student can participate in one or more of the following: design of the experimental imaging setup, initial experiments with synchrotron beam, and data analysis.

Project (5): Structural investigation of the cathode-electrolyte interface for all-solid state batteries.
The solid state batteries are next generation of energy storage devices with increased capacity, safety and ease of use. The heart of this technology is a solid electrolyte able to conduct Li ions at room temperature. The student will participate in the cell preparation and tests for the cycling procedures prior the operando measurement of the all-solid-state cell. The student will take part to the experiment and will be engaged in the data

	analysis, with the purpose of investigating the interface between solid state electrolyte and cathode material. Project (6): Residual strain/stress measurement in metallic components using high energy X-ray diffraction. Residual stress is the stress that remains in a body that is stationary when all applied stresses have been removed. These stresses were identified as main reason the premature failure of the metallic component. In the framework of this project, residual stresses will be measured on different industrial metallic components by high energy X-ray diffraction. Firstly, the candidate will participate to the strain/stress measurement campaign on industrial components provided by industrial collaborators. Secondly, the trainee will participate on writing python scripts to analyse the data in order to extract strain/stress from the acquired diffraction raw data. Finally, he/she will participate to the interpretation of the results and writing reports.
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. - 31.8.2022 (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.