HIP SUMMER JOBS IN 2021

INTERNATIONAL OPPORTUNITIES AT CERN AND AT ESRF

Research domain	**1. 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. - 31.8.2021 (or as agreed)
Contact person	Mikko Voutilainen, supervisor Tel. +358 2 941 50565 Email: mikko.voutilainen@cern.ch

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Research domain	**2. 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) modifying an existing data analysis code to also cover cases where previously unknown, heavy particles are involved in di-Higgs production (2) developing new ML cassifiers to better identify di-Higgs events, (3) benchmarking the analysis software performance and improving it e.g. with parallelization, or (4) 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. - 31.8.2021 (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	**3. Research and development for instrumentation in nuclear and material physics at ISOLDE**
Number of employees	1 - 2
Job description	**Project 1: ISOLDE decay station upgrade** The ISOLDE Decay Station (IDS) is a flexible and versatile array of gamma, charged particles 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 and LaBr3(Ce) detectors, previously implemented in Geant4 within the old support structure 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 gamma-ray detection efficiency curve will be simulated for various geometries, with the aim to find the optimal placement. The project will

require basic knowledge of gamma-ray detection techniques and, optionally, programming experience with C++ and ROOT.

Project 2: Determination of Solid Angle Attenuation factors for BaF2, LaBr3(Ce) and CeBr3 detectors.
Time dependent perturbed angular correlations technique is regularly used at ISOLDE in the context of material's, soft matter and biophysics experiments. The quantitative capabilities of the technique depend on a properly calibrated maximum observable anisotropy factor. Unfortunately, analytically simulated values with current programs always underestimate the attenuation, particularly due to ignored misalignment and source size effects. Additionally, a parametrization experiment can not always be performed to find experimental anisotropy attenuation factors. In this context, the proposed work consists of implementing generators of the anisotropy attenuation factors, taking in consideration dependencies such as shape, size and misalignment of the source. The project interplays between nuclear spectroscopy methods, computation tools and strategies regularly used in physics analysis and simulations.

Projects 3: The VITO experiment upgrade
VITO (Versatile Ion polarisation Techniques Online) is in the middle of a major upgrade of all the systems, from detectors to superconducting magnets and ion beam manipulation devices, and is looking for enthusiastic students to be part of the project during the summer 'Run time'; when the systems must be ready for data taking and the student(s) will have the opportunity to be a part of the operations. Ideal candidates should have an experimental background, an understanding of electronics and some experience (or a will to learn) LabVIEW integrated systems.

Project 4: Laser-polarization and β-NMR setup at VITO
The project will take place at the laser-polarization and β-NMR setup, which is part of the VITO beam line at CERN-ISOLDE. 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. To study the interactions of radioactive nuclei in high magnetic fields with applications in (bio-)chemistry, liquids are a necessity. Therefore very demanding solvents for vacuum conditions are needed. The student will be part of the team studying the behavior of these various solvents, including ionic liquids, organic solvents and water mixtures in vacuum conditions using nuclear magnetic resonance spectroscopy.

Project 5: Preparations for the gammaMRI
GammaMRI is dedicated to the development of a new medical imaging technique combing the physics principle behind MRI and SPECT/PET. Summer-time 2020 will be the time dedicated to the preparations of the radioactive tracers for gammaMRI, assembling

	and testing of new equipment and software simulations. The xenon isomers, which are the radiotracers of our choice, will be produced with at least one of the selected methods: iodine-131 decay, neutron or proton beams irradiation. The software simulations will be devoted to the analysis of nuclear spin orientation with respect to the asymmetric spatial distribution of beta/gamma radiation emission.
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. - 31.8.2021
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	**4. New physics searches 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 with the central part of the CMS experiment. The task would be to participate in the physics analysis of the data taken with the CMS experiment at the Large Hadron Collider (LHC) and combine it with a leading proton measurement either by CMS or TOTEM. The work will consist of analysis of data and/or simulations related to such searches for new phenomena.
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. - 31.8.2021 (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	**5. R & D of gas detectors**
Number of employees	1
Job description	Generic development and testing of Micro Pattern gaseous detectors. Hands-on in detectors and carry out studies of components, including laboratory tests. A core task will be divided in two parts; first with the implementation of a GEM-TPC into the Scalable Readout System (SRS) Data Acquisition systems (DAQ) using VMM3 ASIC and second with the studies of photocathode performance 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. - 31.8.2021
Contact person	Francisco García, supervisor Tel. +358 50 5599570 Email: Francisco.Garcia@helsinki.fi

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Research domain	**6. Experimental particle physics in ALICE**
Number of employees	1
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 in our group. We study the transport properties of the quark-gluon plasma (QGP), created in these collisions, trough flow fluctuation analysis. This analysis resembles harmonic analysis of cosmic microwave background, the early universe sound harmonics. Second main branch of the analysis in our group is to study how jets are modified in heavy ion environment. For example, the soft QCD radiation emitted by the high-energy parton can be modified while it traverses the QGP. As a third alternative, student could participate into analysis of the performance of future detectors in ALICE.

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. - 31.8.2021
Contact person	Sami Räsänen, supervisor Tel. +358 50 355 7082 Email: sami.s.rasanen@jyu.fi DongJo Kim, supervisor Tel. +358 50 3137868 Email: djkim@cern.ch

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Research domain	**7. CLIC module**
Number of employees	1
Job description	Position for a mechanical engineering summer trainee is available in the framework of the conceptual module design for future particle accelerator Compact Linear Collider (CLIC) located at CERN, Geneva, Switzerland. (http:/clic-study.web.cern.ch/) CLIC module is a two meter long assembly group containing all of the necessary subsystems for the potential future particle accelerator still in conceptual design phase. The best possible integration for the accelerating structure into the CLIC module, together with its connection to every sub-system needs to be guaranteed for proper functioning. The student will participate to R&D tasks of CLIC module and its subsystems conceptual design update. The work tasks are including drafting and design work of adjustable high precision systems, manufacturing optimisation or analysing the behaviour of such systems by the means of thermo-mechanical measurements and simulation. The exact job description will be adjusted to the interests and competences of the student.
Preferred student profile	Mechanical engineering (preferably 2 years or more). The student should be interested in challenging multidisciplinary product development.
Special skills required	3D CAD skills required, thermal/structural analysis skills advantage. (CATIA and ANSYS are used at CERN)
Training period	1.6. - 31.8.2021 (exact dates are negotiable)

Contact persons	Markus Aicheler, supervisor markus.aicheler@cern.ch Tel. + 41 22 766 2182

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Research domain	**8. 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. 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. - 31.8.2021 (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	**9. Technology Programme, Academia-Industry Collaboration** (**Cancelled**)
Number of employees	1
Job description	

Preferred student profile

Special skills required

Training period

Contact persons

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Research domain	**10. 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.-31.8.2021 (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	**11. 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 for data visualization and analysis. 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): Lithium ion battery research.
The student will test and commission new lithium ion battery materials and designs compatible with X-ray scattering, diffraction and imaging. The student can participate in one or more of the following: assembling battery cells, participate in synchroton X-ray experiments, and analyze the scattering and imaging data and relate it to the battery performance.

Project (3): Operando Characterization of Distorted Nanocatalysts for Clean Energy Production and Storage.
The student will take part in operando X-ray measurements of new generation electrocatalysts operating in a hydrogen fuel cell

	device. Student will be involved in both practical experimental work and 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.
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. - 31.8.2021 (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.