Summer Student Projects Submission 2023

Report of Contributions

https://indico.desy.de/e/sumstud23

Contribution ID: **2** Type: **not specified**

Response of a Transition Edge Sensor to Single Photons of Different Wavelenghts

The Any Light Particle Search II (ALPS II) is a Light-Shining-through-a-Wall experiment at DESY, Hamburg probing the existence of Axions and Axion-Like Particles (ALPs), which are possible candidates for dark matter. In the ALPS II region of study, a rate of photons reconverting from Axions/ALPs on the order of 10−5 cps is expected. This requires a detection system capable of measuring low-energy photons (1.165 eV) with high efficiency and a low dark count rate.

We investigate a tungsten Transition Edge Sensor (TES) system as a photon-counting detector that promises to meet these requirements.
Within this summer student project the student will participate in the characterization of the ALPS TES by testing its response to photons of different wavelength.

Field

B3: Development of experimental particle physics equipment (hardware-oriented)

DESY Place

Hamburg

DESY Division

FH

DESY Group

ALPS

Special Qualifications:

Basic lab experience and programming skills (preferably python) are expected. Experience with optical setups/vacuum/cryogenic systems would be an asset.

Primary authors: SCHWEMMBAUER, Christina (ALPS (ALPS _ Any Light Particle Search)); JANUSCHEK, Friederike (DESY); RUBIERA GIMENO, Jose Alejandro (ALPS)

Co-author: LINDNER, Axel (ALPS (ALPS _ Any Light Particle Search))

Contribution ID: **3** Type: **not specified**

Semantic Segmentation Of Pileup Particle Identification In The ATLAS Detector using Graph Neural Networks

Simulating pileup at the Large Hadron Collider (LHC) involves the simulation of multiple proton interactions via soft QCD Monte Carlo models that are then overlaid onto a single primary interaction (or hard scatter event). This poses a significant challenge moving into the high luminosity era due to the increased average number of interactions per bunch crossing, and the growing complexity of the detector. In tandem these two factors lead to a rapid growth in the computational resources required to generate simulated datasets. To combat this problem, generative machine learning models are currently in development that aim to replace parts of the detector simulation with fast and efficient algorithms in order to reduce the CPU required to generate a single event.

One of these projects is the simulation of the ATLAS calorimeter using a generative machine learning model trained on LHC zero-bias data in order to more accurately replicate multi-proton pileup. Whilst such models can be trained to emulate calorimeter layer images on average, localised calorimeter cell activity driven by charged and neutral particles is potentially lost. The proposed project is to develop particle identification algorithms (e.g. Pileup Per-Particle Identification [1]) to associate localised cell activity in zero-bias data to charged/neutral particles originating from proton collisions. With this identification information, graph neural network architectures can then be developed to augment the generative models by encoding layer-to-layer cell correlations arising due to particle flight paths.

In summary the project aims to improve the emulation of calorimeter layer images generated via generative machine learning models by encoding particle flight information between layers using graph neural networks, which requires particle identification algorithms in zero-bias data to be developed.

FTE applied to topics:
Physics: 40%
Statistical/Machine Learning: 40%
Computing: 20%

Field

B1: Particle physics analysis (software-oriented)

DESY Place

Hamburg

DESY Division

FH

DESY Group

ATLAS

Special Qualifications:

Primary authors: JIGGINS, Stephen (ATLAS (ATLAS-Experiment)); KATZY, judith (desy)

Contribution ID: **4** Type: **not specified**

Tackling LUXE challenges with Key4hep

The FTX Software (SFT) group is very actively involved in the Key4hep project, which aims to develop common software for future experiments. While the main target are future collider projects, also smaller experiments can profit from these efforts by using the Key4hep software stack. One of these experiments is the planned Laser und XFEL Experiment (LUXE) at DESY.

This summerstudent project aims at investigating ways of further integrating the LUXE and Key4hep software stacks. A special focus in this case will be on the silicon based positron tracker of LUXE, where detector occupancies varying by orders of magnitude provide a challenging simulation and reconstruction environment. Several things could be tackled in this project; benchmarking existing approaches in different experimental conditions, and potentially improving them afterwards, investigating possible new approaches for tackling the challenges that come with extreme occupancies but also developing tools to facilitate integrating new approaches into the larger software ecosystem. The choice of the task in the end depends on the interests of the student. This is an ideal opportunity to peek behind the curtain of what is involved in an experiment on the software side on the still accessible scale of LUXE.

Field

B2: Data processing (software-oriented)

DESY Place

Hamburg

DESY Division

FH

DESY Group

FTX

Special Qualifications:

Experience in programming with either C++ or python is required. Basic knowledge of statistics and some experience in the python scientific libraries (or ROOT) is definitely useful but not strictly necessary.

Primary author: MADLENER, Thomas (FLC (FTX Fachgruppe SFT))

Co-authors: GAEDE, Frank (FTX (FTX Fachgruppe SFT)); YAP, Yee Chinn (FTX (FTX Fachgruppe SLB))

Contribution ID: **5** Type: **not specified**

Automated Electron Beam Tuning at FLASHForward

The FLASHForward experiment is a beam-driven plasma-wakefield accelerator at the FEL user facility FLASH in Hamburg. The long-term goal is to produce efficiently high-quality electrons bunches with high accelerating gradients >1 GV/m at MHz repetition rate. To achieve this, an important and time-consuming task is the preparation of the FLASH electron beam before the actual injection into the plasma which needs precise control of various parameters.

In this project the tuning of final focus of the electron beam into the plasma cell should automated to setup and/or recover the optimal state. It can be broken down into three sub-tasks: (1) particle tracking and plasma particle-in-cell simulations to mimic the available beam diagnostics, (2) isolation of the most sensitive tuning parameters and their signature in the diagnostics and (3) using machine learning to identify potential states and to tune the final focus.

Field

B4: Research on Accelerators

DESY Place

Hamburg

DESY Division

FH

DESY Group

FTX

Special Qualifications:

interested in plasma wakefield accelerators, eager to learn, experience in Python programming, first experience with machine learning is welcomed

Primary author: BOULTON, Lewis (None)

Co-authors: Dr BJOERKLUND SVENSSON, Jonas Halfdan (FTX (FTX Fachgruppe AST)); Mr WESCH, Stephan (DESY-FTX-AST)

Contribution ID: **6** Type: **not specified**

Finding displaced decays at future Higgs factories.

The next big particle collider project is foreseen to be an e+e- Higgs factory. Various detector concepts with advanced detector technologies have been proposed for such colliders, aiming to probe the Standard Model to unprecedented precision. In order to optimise the physics performance of these detectors, sophisticated reconstruction algorithms are being developed and bench-marked on detailed simulations.

One such algorithm is the identification of in-flight decays of neutral particles, so called V0s, in the sensitive volume of gaseous trackers, which offer continuous tracking and thus significant advantages in pattern recognition with respect to a silicon tracker.
A summer student joining our Software&Analysis team will assess the performance of the current, somewhat basic implementation of the V0-Finder, in a generic calibration case as well as with physics samples.
They will then adapt the V0-Finder to find a particular SUSY signature - chargino decay to neutralino and a single track inside the tracker - and use it to assess the discovery/exclusion limit for this signature at one future Higgs factory.
If time allows, the student will finally compare the simple V0-Finder with a more complex vertexing framework and study their interactions in the current default reconstruction chain.

Physics / Computing / Engineering Content of the project : 33% / 67% / 0%
- Computing: Studying advanced reconstruction algorithms in particle detectors, making connections between state-of-the-art detector technologies and reconstruction performance
- Physics: Applying these algorithms to a physics case to show its impact

Field

B1: Particle physics analysis (software-oriented)

DESY Place

Hamburg

DESY Division

FH

DESY Group

FTX/SLB

Special Qualifications:

Basic skills programming (C++ or python) to perform a data analysis

Primary author: EINHAUS, Ulrich (FTX (Fachgruppe SLB))

Co-author: DUDAR, Bohdan (FTX (FTX Fachgruppe SLB))

Contribution ID: **7** Type: **not specified**

Incorporating energy-loss into the fast detector simulation program SGV

The next big particle collider project is foreseen to be an e+e- Higgs factory. Various detector concepts with advanced detector technologies have been proposed for such colliders, aiming to probe the Standard Model to unprecedented precision. In order to optimise the physics performance of these detectors, sophisticated reconstruction algorithms are being developed and bench-marked on detailed simulations.

However, also fast detector simulation and reconstruction is needed. Such programs should be several orders of magnitude faster than the full simulation, to allow to produce enough statistics also in very high cross-section background processes. Also, in order to serve as a testing-bed for modified or new detector concepts they should be able to well simulate the detector response without the need to have pre-existing fully simulated samples to parameterise.

A program fulfilling these needs is SGV, developed and maintained at DESY. Currently, elastic scattering of charged particles as the pass through the detector material is included in SGV, but not the energy-loss. The project consists of adding a correct treatment of this effect into SGV.

If time allows, a second topic would be to modify SGV such that it can call the event generator Whizard internally, thereby avoiding the need to externally store - potentially huge - samples of generated events.

Physics / Computing / Engineering Content of the project : 50% / 50% / 0%

- Physics: Understanding the process of energy-loss of charged particles passing matter in particular the fluctuations of the loss. How this depends on both the properties of the particle, and the detector material.
- Computing: Understanding and implementing quite complex algorithms based on their mathematical formulation.

Field

B1: Particle physics analysis (software-oriented)

DESY Place

Hamburg

DESY Division

FH

DESY Group

FTX/SLB

Special Qualifications:

Basic skills programming. Knowledge of Root and modern Fortran will
be helpful, but not required. Good knowledge in linear algebra and in statistics/probability theory

Primary author: BERGGREN, Carl Mikael (FLC (FTX Fachgruppe SLB))

Co-author: NUNEZ PARDO DE VERA, Maria Teresa (FS-EC (Experimente Control))

Contribution ID: **8** Type: **not specified**

Primordial black holes and induced gravitational waves in non-standard cosmologies

Project sketch:
Primordial black holes (PBHs) are hypothetical dark matter candidates that could have formed in the early Universe by mechanisms other than the usual stellar collapse, in particular via gravitational collapse induced by large density fluctuations produced during inflation. The fact that PBH formation requires a large scalar power spectrum leads to an enhancement of the second-order tensor modes of the metric, which are sourced by terms quadratic in first-order scalars in Einstein' s equations. If these PBHs form during a radiation-dominated era and comprise the entirety of the observed dark matter, then this stochastic gravitational wave background could potentially be observed by future space-based interferometers such as LISA and DECIGO. Since the abundance and mass of the black holes, as well as the amplitude of the density fluctuations required for collapse to be induced, are known to depend on the equation of state of the Universe at the time of collapse, it is not clear whether the above conclusions remain true if the PBHs do not form during a radiation era. These PBH formation scenarios can be realized, for instance, by varying the equation of state parameter during reheating after inflation. Moreover, the signal is also expected to change depending on how abrupt the transition between reheating and the radiation era is. The focus of the project is to explore these possibilities and compute the stochastic gravitational wave signal produced in each scenario.

Rough fraction of physics/software work that is expected:
A working knowledge of how to solve ordinary differential equations using Green's functions is expected, as well as basic Mathematica coding skills. Some basic knowledge about GR (in particular gravitational waves) would be useful, but not required.

Field

B5: Theory of Elementary Particles

DESY Place

Hamburg

DESY Division

FH

DESY Group

Theory

Special Qualifications:

Primary author: REY, Julian (IFT-UAM)

Contribution ID: **9** Type: **not specified**

Tachyonic Instability and Dynamics of Spontaneous Symmetry Breaking

Project sketch:
In the very early universe, the Higgs could have existed in some unstable regime due to quantum fluctuations during a period of high scale inflation.
The project of this internship will be to study tachyonic instabilities and dynamics of spontaneous symmetry breaking in general, for an arbitrary scalar field, not necessarily the Higgs. This branches to many interesting physics aspects of the scalar field dynamics. One implication is preheating at the end of cosmological inflation and possible observational signatures in gravitational waves. Another distinct aspect is the dynamics of the Higgs at the electroweak phase transition, well after inflation, inside the radiation era, with baryogenesis as an application.

Rough fraction of physics/software work that is expected:
Both analytical work and some numerical calculations using Mathematica/Python.

Field

B5: Theory of Elementary Particles

DESY Place

Hamburg

DESY Division

FH

DESY Group

Theory

Special Qualifications:

basic knowledge in quantum field theory, particle physics and cosmology

Primary authors: CHATRCHYAN, Aleksandr (T (Cosmology)); SHAKYA, Bibhushan (T (Cosmology)); SERVANT, Geraldine (T (Cosmology))

Contribution ID: **10** Type: **not specified**

Searching for ultralight dark matter with interferometers

Project sketch:
Ultralight dark matter is a compelling dark matter. It certainly participates in gravitational interaction, but it may also participate in non-gravitational interaction. The purpose of the project is to investigate the interaction between ultralight dark matter and interferometers and to explore possibilities if interferometers can be used for ultralight dark matter search.

Field

B5: Theory of Elementary Particles

DESY Place

Hamburg

DESY Division

FH

DESY Group

Theory

Special Qualifications:

Primary author: KIM, Hyungjin (T (Cosmology))

Contribution ID: **11** Type: **not specified**

Realistic models of Electroweak Symmetry Breaking with Gegenbauer polynomials

In this project, BSM models based on potentials with so-called Gegenbauer polynomials, shall be constructed and studied. A UFO model for a simulation of such models at colliders shall be developed. Also models with a Gegenbauer-type Twin Higgs mechanism can be investigated.

Field

B5: Theory of Elementary Particles

DESY Place

Hamburg

DESY Division

FH

DESY Group

Theory

Special Qualifications:

Primary author: REUTER, Juergen (DESY)

Contribution ID: **12** Type: **not specified**

ITk System Test / Endcap Integration

Context of the project

The ATLAS detector is one of the four LHC experiments and will be upgraded for the upcoming high luminosity runs. The inner detector is going to be entirely replaced by an all-silicon tracker (ITk). The System Test is the main testbench for detector modules. The goal is to have a realistic environment close the the real detector in terms of electrical noise, atmosphere, cooling and detector systems.

Scope of work

The student will have the opportunity to work on the cooling, powering and readout systems of the System Test. This includes work on topics such as performing noise scans on petals, study of the CO2 cooling performance and measuring the performance of the powering chain of the detector. Students should already have some basic experience with Python as well as basic electronics. Also, there will be an opportunity to test the first silicon detector elements once they arrive at DESY.

Depending on the project state at their arrival, they can also perform one or more of the following studies:

1. Measuring pedestals & noise in different detector positions and mapping the electrical noise environment of the ST
2. Simulation of cosmic muon measurements with the ST structure
3. In-detail tests on the detector safety system regarding HV, CO2 cooling and atmospheric safety
4. CO2 cooling measurements (e.g. maximum power, lowest temperature, cooling cycle times, …)

Field

B3: Development of experimental particle physics equipment (hardware-oriented)

DESY Place

Hamburg

DESY Division

FH

DESY Group

ATLAS

Special Qualifications:

Python, basic experience in Hardware / Lab work / electronics

Primary author: CASPAR, Maximilian Felix (ATLAS (ATLAS-Experiment))

Co-author: FRANCONI, Laura (ATLAS (ATLAS-Experiment))

Contribution ID: **13** Type: **not specified**

Tests of SiPM-on-Tile modules for the CMS HGCAL

Our group works on the development of highly granular hadronic calorimeters based on small scintillator tiles read out by Silicon Photomultipliers (SiPMs). This "SiPM-on-tile" technology will be used for the upgrade of the calorimeter endcap of the CMS detector for HL-LHC. An important ingredient for these calorimeters is the readout electronics, which is fully integrated into the detector layers.
During this year we expect to build and test the first active detector elements with design and components as foreseen for the final detector. The tests comprise basic electronics tests in the lab, tests in a climate chamber at -30 degree C and tests with particles in beam.

The student is supposed to contribute to these tests.

Field

B3: Development of experimental particle physics equipment (hardware-oriented)

DESY Place

Hamburg

DESY Division

FH

DESY Group

FTX-DTA

Special Qualifications:

enjoy working with hardware and electronics; prior experience is an advantage, but not necessary

Primary author: KRUEGER, Katja (DESY (FTX Fachgruppe DTA))

Co-author: REINECKE, Mathias (FE (FEB Analog Electronik))

Contribution ID: **14** Type: **not specified**

Monte Carlo Simulations of monolithic CMOS sensors with Allpix Squared

Monolithic CMOS sensors enable the development of detectors with low material budget and a low fabrication cost. Besides, using a small collection electrode results in a small sensor capacitance, a low analogue power consumption, and a large signal-to-noise ratio. TCAD Device simulations are used to model the highly non-linear electric field inside this type of sensor. These electric fields can be imported into the Allpix Squared framework, which simulates the full response of the sensor under particle interaction, accounting for the effects like Landau fluctuations in the energy deposition stage, formation of delta-electrons, and propagation of charges via drift and diffusion. Thus, the combination of TCAD and Allpix Squared allows for precise and high-statistics simulations needed for sensor characterization.

`The summer student will join the Tangerine team and work on Monte Carlo simulations of the H2M`

Field

B3: Development of experimental particle physics equipment (hardware-oriented)

DESY Place

Hamburg

DESY Division

FH

DESY Group

ATLAS

Special Qualifications:

Prerequisites: Basics in Linux, ROOT, Unix shell
Nice to have: simulation/silicon experience, Geant4 basics

Primary authors: WENNLÖF, Håkan (ATLAS (ATLAS-Experiment)); RUIZ DAZA, Sara (ATLAS (ATLAS Upgrade))

Contribution ID: **15** Type: **not specified**

Particle track reconstruction using quantum computing algorithms

Quantum computing algorithms holds the potential to solve combinatorial problems more efficiently than classical techniques, thus saving resources and time.The summer student will learn about the basics of track reconstruction. Insights about state of the art track reconstruction techniques, including a brief overview of commonly used frameworks are provided. The student will learn to use real gate-based quantum computers using IBM's Qiskit toolkit and how to apply quantum computing algorithms to solve real-world problems (e.g., tracking for the LUXE experiment). The student will use simulated data from GEANT4 to reconstruct charged particle tracks and will run benchmarks on real IBM devices for data subsets.

Field

B2: Data processing (software-oriented)

DESY Place

Hamburg

DESY Division

FH

DESY Group

ATLAS

Special Qualifications:

Basic-to-intermediate knowledge of python would be desired

Primary author: MELONI, Federico (ATLAS (ATLAS SM and Beyond))

Co-authors: SPATARO, David (FTX (FTX Fachgruppe SLB)); YAP, Yee Chinn (FTX (FTX Fachgruppe SLB))

Contribution ID: **16** Type: **not specified**

Improve event selection of H->lly with Machine Learning

After finding evidence for the very rare Higgs decay to two leptons and a photon in 2021, we are now starting to re-optimize the analysis for the LHC Run 3. The previous analysis was completely based on rectangular cut-based selections and event classifications. We suggest having a summer student try out a BDT or NN to improve this. We would start with simulated samples, and with a simple ggF vs VBF classification to improve the sensitivity. Further categories and more realistic background can be added if there is time.

Breakdown: 90% physics, 10% computing

Field

B1: Particle physics analysis (software-oriented)

DESY Place

Hamburg

DESY Division

FH

DESY Group

ATLAS

Special Qualifications:

Prerequisites: Some coding experience.

Primary author: OJEDA, Martina Laura (ATLAS (ATLAS Higgs Physics))

Co-authors: STAPF, Birgit (ATLAS (ATLAS Higgs Physics)); HEIM, Sarah (DESY)

Contribution ID: **17** Type: **not specified**

Refurbishment of the H1 SPACAL for LUXE-NPOD

The LUXE experiment at the DESY will study strong-field quantum electrodynamics in the interactions of a beam of electrons or photons with a high intensity laser. The photons produced in the primary interactions can be directed to a beam dump to search for axion-like particles (ALPs). Axions are hypothetical particles that are not included in the standard model of particle physics. They could be a possible explanation for longstanding problems in physics.

The ALPs are long-lived and can escape the dump before decaying into two photons. A detector capable of accurately measuring the energy, direction, and time of the photon energy depositions must be developed. An available option on-site at DESY is the backward spaghetti calorimeter SPACAL used in the H1 detector at the HERA collider. It was decommissioned in 2007. Even though the SPACAL does not fully meet the criteria for the new detector, it may be possible to upgrade.

The goal of this summer school project is to participate in the feasibility study of the SPACAL for the new physics search. This could include the extraction and characterization of one submodule of the electromagnetic calorimeter. Furthermore, possible upgrade options could be planned and prepared.

Physics / Computing / Engineering Content of the project : 33% / 33% / 33%
- Engineering: Study and Characterise SPACAL detector module.
- Computing: Aquire data with SPACAL module. Study response in Geant4 simulation.
- Physics: Understand impact of SPACAL on ALPS signal reconstruction.

Field

B3: Development of experimental particle physics equipment (hardware-oriented)

DESY Place

Hamburg

DESY Division

FH

DESY Group

FTX

Special Qualifications:

Basic skills programming (C++ or python) to perform a data analysis. Lab experience is a plus.

Primary author: Dr SCHULTHESS, Ivo (DESY - FTX)

Co-author: HELARY, Louis (DESY - FTX)

Contribution ID: **18** Type: **not specified**

Laboratory characterization of a digital-SiPM

Silicon Photomultipliers (SiPMs) are well known as excellent light detectors in the ultraviolet to visible energy range with sub-nanosecond time resolution. Due to their unique characteristics, these devices are increasingly used in high-energy physics, medical and commercial applications. Most SiPMs are implemented as large arrays of Single Photon Avalanche Diodes (SPAD) in a parallel circuit, serving as photon counters.

In recent years, SPADs have been integrated into standard high-volume CMOS processes. This not only allows the production of large volumes of SiPMs at a relatively low cost but also offers the possibility of combining the excellent light detection efficiency and time resolution of SPADs with the flexibility and possibilities offered by CMOS imaging technology. The implementation of CMOS circuitry, extends the properties of standard SiPMs with features such as detailed event hit map, masking of noisy SPADs and in-chip trigger logic and digitalisation. These devices are known as digital SiPMs.

A prototype of a digital SiPM with per-pixel CMOS circuitry was fully developed at DESY in a 150 nm CMOS technology offered by LFoundry. The chip consists of a 32 x 32 pixels main dSiPM, and additional test structures for specific characterisation.

Several studies are in progress on the prototypes and many laboratory measurements are planned. In particular, the sensor response will be studied as the number of active pixels in the digital SiPM array changes. This study will allow a detailed characterization of SPAD arrays not easily accessible using standard SiPMs.

The student will learn how to use the versatile Caribou DAQ system for data acquisition, and will be guided in the operation of the necessary setups for performing Detailed Current/Voltage (IV) and Dark Count Rate (DCR) studies in a temperature and humidity controlled environment. C++ and/or Python will be used for data analysis.

- Physics work: 60%
- Computing work: 40%
- Engineering work 0%

Field

B3: Development of experimental particle physics equipment (hardware-oriented)

DESY Place

Hamburg

DESY Division

FH

DESY Group

ATLAS

Special Qualifications:

Prior knowledge in Linux, shell, C++, Python and ROOT will be helpful but are not required.

Primary author: FEINDT, Finn (ATLAS (ATLAS-Experiment))

Co-author: VIGNOLA, Gianpiero (ATLAS (ATLAS-Experiment))

Contribution ID: **19** Type: **not specified**

Search for Hexaquarks in CMS at the LHC – feasibility study

The quark model, developed in 1964 by Gell-Mann [1] and Zweig [2], explains structure of mesons (quark-antiquark pairs) and baryons (3-quark states), such as protons and neutrons. The initial idea has been extended to 4-quark states (tetraquarks) in 1976 by Jeffe [3] and then in 1987 also to 5-quark states (pentaquarks) by Lipkin [4].

All of the above particles have been extensively studied, with baryons and mesons being standard objects in any modern particle physics experiment, pentaquarks being discovered in 2015 by LHCb [5] and tetraquark candidates showing up in various experiments, with statistically significant discoveries consistent with the tetraquark hypothesis recently reported by LHCb [6] and ATLAS in 2020-2022.

A natural question following the development of the quark model and associated experimental discoveries is: do states composed of more than 5 quarks exist? Hexaquarks, sexaquarks or di-baryons are all names for 6-quark states, which can differ in internal structure.

In this project we would like to focus on hexaquarks containing 3 quarks and 3 antiquarks, and decaying to 3 particles. Hints of existence of such states have been showing up in experiments from the ‘80s [7][8]. In 2020 measurements of the characteristics of the strong interaction from ALICE [9] confirmed that baryons and antibaryons form bound states. However, to this day, no direct, statistically significant measurement of hexaquarks has been performed.

The goal of the project would be to implement Monte Carlo generation of various hexaquark states with multiple decay channels. Simple feasibility study would be carried out, testing which states would result in events passing CMS triggers, as well as verifying that background (combinatorial and coming from associated known particles’ decays) can be sufficiently reduced. Finally, expected signal significance for different hexaquark states would be estimated, providing a foundation for a discovery of hexaquarks.

Special Qualifications expected from the student (Computing,…) :
- general particle physics knowledge,
- python or C++ programming skills,
- familiarity with Monte Carlo generators would be a plus.

Field

B1: Particle physics analysis (software-oriented)

DESY Place

Hamburg

DESY Division

FH

DESY Group

CMS

Special Qualifications:

Special Qualifications expected from the student (Computing,…) : - general particle physics knowledge, - python or C++ programming skills, - familiarity with Monte Carlo generators would be a plus.

Primary authors: NIEDZIELA, Jeremi; ALIMENA, Juliette (CMS (CMS Fachgruppe Searches))

Contribution ID: **20** Type: **not specified**

Electroweak Transverse Momentum Dependent PDFs

At the Large Hadron Collider (LHC), studies on the weak vector-boson scattering and weak vectorboson fusion processes becomes increasingly
revalent. In high energy colliders where masses do not play a role, such as HE-LHC or multi-TeV Muon collider, the Electroweak (EW) PDFs should be adopted as the proper description for partonic collisions of the initial states. We will obtain collinear and Transverse Momentum Dependent (TMD) EW
densities based at variable flavour number scheme. We will use UPDFEVOLV package to produce the kernels and then with xFitter both collinear and TMD PDFs can be acheived.
- Learn about the principles of MC event generators and the physics behind.
- Learn how to extract information from MC event generators
Special Qualifications expected from the student (Computing,…) :
- Basisc knowledge in computing, (Linux, C++) is of advantage, but we will give also an introduction so that everybody can contribute.

Field

B1: Particle physics analysis (software-oriented)

DESY Place

Hamburg

DESY Division

FH

DESY Group

CMS

Special Qualifications:

- Basic knowledge in computing, (Linux, C++) is of advantage, but we will give also an introduction so that everybody can contribute.

Primary authors: JUNG, Hannes (DESY); MORAL FIGUEROA, Keila (CMS (CMS Fachgruppe QCD)); TAHERI MONFARED, Sara (DESY)

Contribution ID: **21** Type: **not specified**

CMS Tracker Module Testing

We offer a project related to the CMS Outer Tracker Upgrade. At DESY, we will produce 1200 PS modules, whose components have to be tested prior to assembly.
Moreover, assembly procedure are currently being verified as well as the testing procedures for final modules. The student will involved in these activities working in the Detector Assembly Facility.

Field

B3: Development of experimental particle physics equipment (hardware-oriented)

DESY Place

Hamburg

DESY Division

FH

DESY Group

CMS

Special Qualifications:

Primary authors: NUERNBERG, Andreas (CMS (CMS Fachgruppe Detektor)); ECKSTEIN, Doris (CMS (CMS Fachgruppe Detektor))

Contribution ID: **22** Type: **not specified**

Calibration of the new CMS luminosity detector BCM1F

The BCM1F detector of the CMS experiment consists of 48 silicon pad sensors situated close to the beam pipe on both sides of the interaction point. The detector provides an online, quasi-real-time measurement of the instantaneous luminosity the CMS and the LHC control rooms. For the Run-3 data taking, BCM1F was completely refurbished.
The topic of the Summer Student project is data analysis and calibration of the detector using the new Run-3 data, recorded in Spring and Summer 2022. The results of the analysis will be implemented in the online software calculation of the instantaneous luminosity of the LHC.

Field

B3: Development of experimental particle physics equipment (hardware-oriented)

DESY Place

Hamburg

DESY Division

FH

DESY Group

CMS

Special Qualifications:

Primary authors: MEYER, Andreas (DESY); GUTHOFF, Moritz (DESY)

Contribution ID: **23** Type: **not specified**

GPUs 4 top quarks

Top quarks are important particles that, due to their large mass, provide a direct probe to the Higgs sector and possible extensions of the standard model of particle physics. At the LHC, the standard model predicts top quarks to be produced in pairs, alone, or in groups of four, of which the CMS experiment recently observed evidence. The production of three top quarks is another order of magnitude rarer than the production of four top quarks.
The reconstruction of multiple top quarks from events with many jets, leptons, and missing transverse energy is challenging at the LHC. In particular, disentangling the individual neutrino momenta from the measured momentum imbalance is crucial for reconstructing the mass of new, exotic particles decaying to top quarks. The method of choice to solve such problems is kinematic fitting yet the currently available tools, developed primarily for top quark pair production, are computationally inadequate for handling the increased complexity of final states with 3 or 4 top quarks.
The project consists of a novel implementation of kinematic fitting for reconstructing events with multiple top quarks by harnessing the parallelization capabilities of modern GPUs. Technically, the task will be solved by repurposing existing frameworks and minimization algorithms developed initially for training neural networks. Hence no detailed knowledge of GPU computing is required. If successful, the resulting kinematic fitting framework will open entirely new analysis channels to search for beyond the standard model physics.

Field

B2: Data processing (software-oriented)

DESY Place

Hamburg

DESY Division

FH

DESY Group

CMS

Special Qualifications:

Python

Primary authors: BLEKMAN, Freya (DESY/University of Hamburg); KOMM, Matthias (CMS (CMS Fachgruppe Searches))

Contribution ID: **25** Type: **not specified**

Discrimination between tWZ and ttZ production using Machine Learning

The production of a single top quark in association with a W and a Z boson is a very rare process in the SM. One of the challenges for its
identification, besides the small cross section, is the overlap with the ttZ process that has same final state but a cross section 5 times larger.
For this reason it is necessary to develop a machine learning algorithm to increase the discrimination of tWZ against ttZ with compared to
traditional methods.
The student will develop a binary classifier performing the feature selection (starting from a set of promising variables already selected), the
hyper-parameter tuning and the evaluation of the results obtained from the model. The first step will be a test on parton level variables to gauge
the achievable separation power. As a next step, the model will be employed at the particle and reconstruction levels, trying to obtain an
efficiency as close as possible to the one obtained at parton level. Depending to the time available, the project can be extended to learn the
features of other backgrounds apart from ttZ.

Field

B1: Particle physics analysis (software-oriented)

DESY Place

Hamburg

DESY Division

FH

DESY Group

CMS

Special Qualifications:

Basic knowledge of Python and coding.
Knowledge in Machine Learning would be an asset.

Primary authors: BELVEDERE, Alberto (CMS (CMS Fachgruppe QCD)); KOGLER, Roman (DESY FH, CMS)

Contribution ID: **26** Type: **not specified**

CMS Phase-2 Tracker Integration

he student will participate in various activities related to the integration of the CMS Phase-2 Tracker Endcap.
The integration of detector modules onto the supporting mechanical structure brings various challenges that have to be addressed. The thermal coupling of the PS detector modules using a thermal interface material has to be established. Candidate materials are being studied. The thermal and mechanical properties are evaluated and material application techniques have to be developed und conjunction with a module integration procedure that needs to be established. The quantification of the thermal conductivity of various materials used in the detector construction is needed, using a dedicated measurement setup. Module integration needs to be exercised including service routing. These ongoing activities provide ample opportunities for a student to engage in hands on activities in the detector construction. Exact task descriptions have to be defined close in time depending on the progress of the project.

Field

B3: Development of experimental particle physics equipment (hardware-oriented)

DESY Place

Hamburg

DESY Division

FH

DESY Group

CMS

Special Qualifications:

Primary authors: VELYKA, Anastasiia (DESY); GUTHOFF, Moritz (DESY)

Contribution ID: **27** Type: **not specified**

Exploring Higgs physics beyond the Standard Model (3 projects)

project sketches:

(1)
After the discovery of a Higgs boson with a mass of about 125 GeV, the structure of the Higgs sector and the actual form of the Higgs potential still remain to a large extent uncharted. In this project, we will probe extended Higgs sectors, which could for instance be suitable for providing a possible candidate for dark matter and for explaining the matter-antimatter asymmetry of the Universe. Predictions for Higgs couplings and their phenomenological applications will be investigated.

(2)
After the discovery of a Higgs boson with a mass of about 125 GeV, the structure of the Higgs sector and the actual form of the Higgs potential still remain to a large extent uncharted. In this project, we will probe extended Higgs sectors, which could for instance be suitable for providing a possible candidate for dark matter and for explaining the matter-antimatter asymmetry of the Universe. Predictions for precision observables and their phenomenological applications will be investigated.

(3)
After the discovery of a Higgs boson with a mass of about 125 GeV, the structure of the Higgs sector and the actual form of the Higgs potential still remain to a large extent uncharted. In this project, we will probe extended Higgs sectors, which could for instance be suitable for providing a possible candidate for dark matter and for explaining the matter-antimatter asymmetry of the Universe. Predictions for signatures at present and future colliders and their phenomenological applications will be investigated.

Field

B5: Theory of Elementary Particles

DESY Place

Hamburg

DESY Division

FH

DESY Group

Theory

Special Qualifications:

Primary authors: WEIGLEIN, Georg (T (Phenomenology)); BRAATHEN, Johannes (T (Phenomenology)); GABELMANN, Martin (T (Phenomenology)); LOESCHNER, Maximilian (T (Phenomenology)); STYLIANOU, Panagiotis (T (Phenomenology))

Contribution ID: **28** Type: **not specified**

Inclusive production of WbWb

The student will join a physics measurement of the inclusive production of WbWb at the ATLAS experiment. The analysis is interesting as there are currently no models easily accessible to the LHC experiments that can accurately estimate this final state. The goal of the analysis is to measure various distributions in final states with one lepton as accurately as possible.

The student will learn the about the physics processes yielding WbWb —par top production and an associate production of the top quark with a W boson where one additional bottom quark is produced (tWb). Furthermore student will be involved in one of the analysis tasks. This will involve processing ATLAS data and simulation and making histograms, which the student will also learn how to interpret. Potential tasks include studies on usage of different simulated samples, different reconstruction algorithms and optimising methods to estimate non-prompt lepton backgrounds.

As an ATLAS analysis requires processing of large amounts of data, the expected composition is 50% physics, 50% working with analysis software (ROOT, C++, python).

Field

B1: Particle physics analysis (software-oriented)

DESY Place

Hamburg

DESY Division

FH

DESY Group

ATLAS

Special Qualifications:

Primary author: NOVAK, Tadej (ATLAS (ATLAS SM and Beyond))

Co-author: MELONI, Federico (ATLAS (ATLAS SM and Beyond))

Contribution ID: **29** Type: **not specified**

bootsted ttH analysis in full hadronic final state

The discovery of the Higgs boson in 2012 was a major success for the Large Hadron Collider (LHC) at CERN. With higher luminosity in stages of Run2 and Run3, the precise measurements of Higgs boson properties are possible, which play an important role in the complement of SM and the search for the BSM. In the 13 TeV proton-proton collision at LHC, the Higgs boson can be produced via various modes, e.g., gluon-gluon fusion (ggF), vector boson fusion (VBF), association production with a pair of top quarks (ttH), etc. In particular, the ttH production allows a direct measurement of the top Yukawa coupling, which is a very large coupling in SM due to the large top quark mass. For probing the Higgs boson, its decay products are explored, the most favourable decay mode is H->bb, with an SM BR of 58.4%.

The analysis aims at the search of the fully hadronic ttH(bb) signal, where the Higgs boson decays into a pair of b-quarks and the two top quarks decay hadronically. This process has a challenging 4b final state, in the typical resolved analysis, they are reconstructed as small radius (R=0.4) jets and identified with the dedicated b-tagging algorithm in ATLAS. In the special boosted area where the Higgs boson carries a larger transverse momentum (typically higher than 300 GeV), the two b-jets become collimated and can be reconstructed as a large radius (R=1) jet. Such kind of boosted Higgs boson signal is important for BSM searches since many BSM theories predict potentially increased sensitivity at large pt. Besides, the analysis results can be interpreted with the effective field theories framework, where the BSM physics effects are parameterized with high dimensional operators.

In this program, the student is supposed to work on the application of the large radius jet reconstruction algorithm to identify boosted Higgs decaying into a pair of b-quarks, the exploration of the signal-enhanced phase space and the optimization of the event selection. The dominant background in this analysis is the ttbb process, one can test the performance of the large radius jet reconstruction on the background and investigate possible dependence of the algorithm on the event topology.

Field

B1: Particle physics analysis (software-oriented)

DESY Place

Hamburg

DESY Division

FH

DESY Group

ATLAS

Special Qualifications:

Experience with one of the items, Boosted algorithms or B-tagging, would be beneficial.

Primary author: KATZY, Judith (ATLAS (ATLAS Top Physics))

Co-author: GUO, Linghua (None)

Contribution ID: **30** Type: **not specified**

Laboratory Characterisation and Threshold trimming of a fast trigger plane for the EUDET-style telescopes

The TelePix is a HV-CMOS based upgrade for for the EUDET-style tele- scopes within the DESY II Test Beam facility. The fast monolithic sensor will provide region of interest triggering and precise track timing, overcoming ambi- guities provided by multiple particles transversing the telescope within a single readout frame, which lasts up to 230µs for the MIMOSA26-based telescopes. At current beam intensities, this leads to an average of 6 tracks per event.
Within the project, the summer student will work on laboratory character- isation of the final chip to be deployed at the test beam. The main objective is to correct for pixel-to-pixel fluctuations by adjusting the individual thresh- old voltage per pixel, the so-called trimming. A very homogeneous response to charge is essential to provide stable and precise timing, two core features of a timing plane. These studies can be done with an oscilloscope and single pixels or with a digital data stream for all pixels in parallel.
The student will work within the existing DAQ and implement the required routines to calibrate the sensors and analyse the obtained data. If possible, the influence of the trimming on the timing will be studied at the DESY II Test Beam facility.

Field

B3: Development of experimental particle physics equipment (hardware-oriented)

DESY Place

Hamburg

DESY Division

FH

DESY Group

ATLAS

Special Qualifications:

Basic root, c++ and silicon detector knowledge is welcome. First Lab experience is a plus.

Primary author: WINTLE, Arianna (FTX (FTX Fachgruppe TBT))

Co-author: HUTH, Lennart (DESY)

Contribution ID: **31** Type: **not specified**

Study of the performance for identification of charged kaons in the Belle II experiment

Collisions produced in the interaction region of the Belle II experiment produce as final states charged and neutral particles that travel across the different subdetectors. A proper charged particle identification system is a critical requirement for the success of the physics program at Belle II. In particular, the tau lepton physics program require the identification of charged kaons from reconstructed tracks keeping fake rates low. In the proposed project, the student will use data collected from collisions between 2019-2022 at the Belle II experiment for tagging tau pair events containing a kaon, and compare the efficiency between data and simulations of the global kaonID calculated from information produced in the subdetectors, aiming to determine correction factors for simulated collisions.

Field

B1: Particle physics analysis (software-oriented)

DESY Place

Hamburg

DESY Division

FH

DESY Group

BELLE II

Special Qualifications:

Basic knowledge of Python and notions of machine learning are desired but not required.

Primary author: HERNANDEZ VILLANUEVA, Michel (BELLE (BELLE Gruppe))

Contribution ID: **32** Type: **not specified**

Studies of Tau Lepton properties: mass, lifetime, or branching fractions, with Belle II data

Studies of Tau Lepton properties: mass, lifetime, or branching fractions, with Belle II data

Field

B1: Particle physics analysis (software-oriented)

DESY Place

Hamburg

DESY Division

FH

DESY Group

BELLE II

Special Qualifications:

Primary author: PITZL, Daniel (DESY FH/Belle II)

Contribution ID: **33** Type: **not specified**

3D printing accelerator structures

The development of compact millimeter-scale structures has broad applications in accelerator science including particle acceleration, diagnostics, beam manipulation and wakefield generation. The student will support the development of such structures via simulations backed with production and structure testing using our radiofrequency and laser based THz sources. The student will participate and work amongst other students, postdocs and staff to gain experience in a real accelerator laboratory at REGAE while carrying out this research which will be implemented in the accelerator.

Field

A5: Lasers and optics (methodology oriented)

DESY Place

Hamburg

DESY Division

M

DESY Group

MXL

Special Qualifications:

Understanding of electromagnetics, and simulation experience would be useful.

Primary author: LEMERY, Francois (MXL (XFEL))

Contribution ID: **34** Type: **not specified**

Electro-optical bunch length detection at FLASH

Electro-optically active crystals change their birefringence in electromagnetic fields. As the Coulomb field around a relativistic electron bunch resembles the current profile, probing the induced birefringence with a laser provides a non-invasive measurement of the temporal profile of fast changing fields, or the temporal profile of electron bunches in accelerators.

A newly installed setup for electro-optical bunch length detection is installed at FLASH and will be commissioned this summer. The student will take part in the final steps of the commissioning and first measurements, which includes lasts tests (and fixes…) of the used electronics and laser optics as well as test of the integration into the accelerator control system and first measurements from the accelerator control room, as well as measurements at the existing setup ay the EuropeanXFEL.

Further information on the EO setup: Rev. Sci. Instrum. 91, 045123 (2020); https://doi.org/10.1063/1.5142833

Field

B4: Research on Accelerators

DESY Place

Hamburg

DESY Division

M

DESY Group

MSK

Special Qualifications:

Prerequisites:

Interest in and (some knowledge on) optics and lasers is needed. Some programming skills are helpful, but not mandatory.

Primary author: STEFFEN, Bernd (MSK (Strahlkontrollen))

Contribution ID: **35** Type: **not specified**

Longitudinal beam stability at XFEL and FLASH

The Bunch Arrival Time Monitors (BAM) at XFEL and FLASH are one of the principal longitudinal beam diagnostic devices. They obtain information on the timing of the beam down to units of fs. The measurement device itself is a combination of high frequency electronics, laser optics, and support control electronics that ensures a proper working environment for the high-tech part. The proposed summer student project concerns work mainly on the support electronics and partially on the laser chain. The student will ensure monitoring and control of the stabilized power/temperature/humidity environment and monitoring of the laser chain, and will experiment on finding the optimal working point. Work in laboratory, and carrying out measurements from the Accelerator Control Room are also expected.

Field

B4: Research on Accelerators

DESY Place

Hamburg

DESY Division

M

DESY Group

MSK

Special Qualifications:

Prerequisities:
- python programming
- basic electronics and microcontrollers
- capability to analyze laboratory data

Primary authors: STEFFEN, Bernd (MSK (Strahlkontrollen)); KRAL, Jiri (MSK (Strahlkontrollen))

Contribution ID: **36** Type: **not specified**

untitled CMI theoretical/computing project

N/A

Field

A6: Theory and computing

DESY Place

Hamburg

DESY Division

FS

DESY Group

FS-CFEL-CMI

Special Qualifications:

Primary author: YACHMENEV, Andrey (FS-CFEL-1-CMI (CFEL-CMI Controlled Molecular Imaging))

Contribution ID: **37** Type: **not specified**

TimePix4 detector development

N/A

Field

A4: Development of experimental techniques (methodology oriented)

DESY Place

Hamburg

DESY Division

FS

DESY Group

FS-DS

Special Qualifications:

Primary author: GRAAFSMA, Heinz (FS-DS (Detektorsysteme))

Co-author: JACK, Stefanie (FS-DS, DESY Hamburg)

Contribution ID: **38** Type: **not specified**

Cordia detector development

N/A

Field

A4: Development of experimental techniques (methodology oriented)

DESY Place

Hamburg

DESY Division

FS

DESY Group

FS-DS

Special Qualifications:

Primary author: GRAAFSMA, Heinz (FS-DS (Detektorsysteme))

Co-author: JACK, Stefanie (FS-DS, DESY Hamburg)

Contribution ID: **39** Type: **not specified**

X-ray optics through additive manufacturing

Innovative X-ray optics paves the way for cutting-edge imaging techniques. Designing and fabricating optical elements requires high precision and careful modeling. Novel additive manufacturing techniques such as 3D printing based on two-photon polymerization enable quick and flexible manufacturing of complex-shaped optics. Offered design freedom helps create various optics and waveguides, allowing for achromatic focusing and X-ray guiding.

The student will work on:
- Designing and modeling optical elements through scripting
- Printing the microstructures in the cleanroom environment
- Testing the x-ray optical elements in the laboratory X-ray setup

Field

A4: Development of experimental techniques (methodology oriented)

DESY Place

Hamburg

DESY Division

FS

DESY Group

FS-ML

Special Qualifications:

Primary authors: DRESSELHAUS, Jan Lukas (FS-ML (Multilayer)); ZAKHAROVA, Margarita (FS-ML (Multilayer)); BAJT, Sasa; BAJT, Sasa (FS-ML (Multilayer))

Contribution ID: **40** Type: **not specified**

Ionization and fragmentation of biomolecules in an electrospray ionization source

The biological functions and physico-chemical properties of peptides and proteins are intrinsically linked to their tridimensional structure. To extract the intrinsic physical properties of those molecules without any interference with other molecules we transfer them into the gas phase and into vacuum. Therefore, we use electrospray ionization (ESI), a Nobel Prize-winning technique developed by John Fenn that enables us to study the molecules in a well-defined state and using mass spectrometric and trapping techniques to study them further with photons.
In this project you will investigate the ionization and fragmentation of biomolecules such as peptides and proteins using ESI and mass spectrometry.

Field

A2: Molecular sciences (application oriented)

DESY Place

Hamburg

DESY Division

FS

DESY Group

FS-BIG

Special Qualifications:

Primary author: BARI, Sadia (FS-BIG (Biomolekuele in Gasphase))

Co-author: LEROUX, Juliette (FS-SCS (Strukturdynamik Chemischer Systeme))

Contribution ID: **41** Type: **not specified**

Laser interferometry on extremely short time and length scales

A main focus of our research is the analysis and control of light-induced many-body quantum mechanical wave packets in complex molecular systems represented by coherent superpositions of electronic states dressed by vibrational excitations [1]. The observed coherences on atomic length and timescales by means of advanced optical and coherent x-ray laser spectroscopy reveal rich information on the many-body quantum system including ultrafast decay and site-specific couplings [2]. A detailed knowledge of energy, charge, and information transport at the nanoscale is of great relevance for future applications, e.g. in radiotherapy or quantum technology. The summer student will be involved in related experimental activities.

[1] Science Advances 8, eabn6848 (2022)
[2] Struct. Dyn. 9, 064301 (2022)

Field

A4: Development of experimental techniques (methodology oriented)

DESY Place

Hamburg

DESY Division

FS

DESY Group

FS-PS-FCP

Special Qualifications:

Primary author: LAARMANN, Tim (FS-PS (FS-PS Fachgruppe FCP))

Contribution ID: **42** Type: **not specified**

Realtime observation of ultrafast dynamics in nano structured samples and 2D materials

Ultrafast dynamics in nano structured samples and 2D materials are of special interest in the fields of energy conversion, semiconductor and quantum technologies. For instance, during the relaxation of a light-induced plasmon oscillation, free electrons can be injected to an adjacent semiconductor for efficient charge generation. In this project, you will use a femtosecond laser and perform transient absorption spectroscopy measurements in order to unravel the mechanisms underlying ultrafast processes in nanosized systems. Your work will include the development of the optical setup, the measurement and the analysis of the experimental data obtained using the unique light sources developed by the CFEL-ATTO group.

Field

A5: Lasers and optics (methodology oriented)

DESY Place

Hamburg

DESY Division

FS

DESY Group

FS-ATTO

Special Qualifications:

Primary authors: CALEGARI, Francesca (FS-ATTO (Attosecond Science and Technology)); WANIE, Vincent (FS-ATTO (Attosecond Science and Technology))

Co-authors: TRABATTONI, Andrea (FS (Forschung mit Synchrotronstrahlung)); MAANSSON, Erik (FS-ATTO (Attosecond Science and Technology))

Contribution ID: **43** Type: **not specified**

Modelling of nonlinear light up-conversion from intense femtosecond laser pulses

The interaction of intense femtosecond light pulses with a gaseous medium gives rise to highly nonlinear processes such as harmonic generation, where the initial frequency of a laser can be up-converted. The CFEL-ATTO group uses this technique to produce one of the shortest ultraviolet (UV) light pulses to date. Such pulses allow us to investigate in real-time how bio-relevant molecules react upon UV excitation. In this project you will be part of a team developing numerical tools for reproducing the experimental conditions for generating few-femtosecond UV pulses. You will also explore a large array of parameters in order to optimize specific properties of the UV pulses such as spectrum, energy and duration. These conditions will be tested in the CFEL-ATTO laboratory and the resulting UV pulses will be used for investigating ultrafast molecular dynamics.

Field

A5: Lasers and optics (methodology oriented)

DESY Place

Hamburg

DESY Division

FS

DESY Group

FS-ATTO

Special Qualifications:

Primary authors: CALEGARI, Francesca (FS-ATTO (Attosecond Science and Technology)); WANIE, Vincent (FS-ATTO (Attosecond Science and Technology))

Co-authors: TRABATTONI, Andrea (FS (Forschung mit Synchrotronstrahlung)); MAANSSON, Erik (FS-ATTO (Attosecond Science and Technology))

Contribution ID: **44** Type: **not specified**

Modeling the Spatial separation of neutral bio-macromolecular conformers in an inhomogeneous electric field

NA

DESY Division

FS

DESY Group

FS-CFEL-CMI

Special Qualifications:

Field

A6: Theory and computing

DESY Place

Hamburg

Primary author: Prof. KÜPPER, Jochen (FS-CFEL-CMI)

Contribution ID: **46** Type: **not specified**

Structural imaging of polar domains inside ferroelectric thin films with the use of tightly focused coherent x-ray nanoprobes and TEM

Ferroelectric thin films demonstrate spontaneous patterns of electric polarization, which can be manipulated with the use of electric fields and used for fast memory storage applications. The structural properties of such systems are greatly influenced by the presence of imperfections inside the crystal lattice. To date, our knowledge of the formation of imperfections and crystalline defects is partial and empirically related to crystal growth. Our focus is to develop novel coherent x-ray imaging tools that allow materials characterization at the nanoscale. We plan to use experimentally measured coherent x-ray nanodiffraction data from epitaxially grown SrTiO3 thin films and compare them with transmission electron microscopy (TEM) images and modeling.

Field

A4: Development of experimental techniques (methodology oriented)

DESY Place

Hamburg

DESY Division

FS

DESY Group

FS-CFEL-1

Special Qualifications:

Primary authors: Dr PATERAS, Anastasios (FS-CFEL-1 (Forschung mit Photonen Experimente 1)); BARTHELMESS, Miriam (FS-CFEL-1 (Forschung mit Photonen Experimente 1))

Co-author: CHAPMAN, Henry (FS-CFEL-1 (Forschung mit Photonen Experimente 1))

Contribution ID: **47** Type: **not specified**

X-ray optics for imaging fast processes in 3D

The student will work at the European XFEL with scientists developing a novel system to make movies of fast, microscopic processes taking place in materials, such as the propagation of cracks or formation of defects in materials under impulsive forces, as well as for the study of turbulent flow and laser-processing or 3D printing. This is achieved by a method of tomoscopy, with time-synchronised beams impinging the sample from multiple directions.

Field

A4: Development of experimental techniques (methodology oriented)

DESY Place

Hamburg

DESY Division

other

DESY Group

XFEL

Special Qualifications:

Primary author: Dr VAGOVIC, Patrik (Center for Free Electron Laser Science)

Co-author: CHAPMAN, Henry (FS-CFEL-1 (Forschung mit Photonen Experimente 1))

Contribution ID: **48** Type: **not specified**

Generating cryogenically cooled beams of proteins and time-of-flight mass spectrometry based characterization

NA

Field

A2: Molecular sciences (application oriented)

DESY Place

Hamburg

DESY Division

FS

DESY Group

FS-CFEL-CMI

Special Qualifications:

Primary author: SAMANTA, Amit Kumar (FS-CFEL-1-CMI (FS-CFEL-1 Fachgruppe CMI))

Co-author: Prof. KÜPPER, Jochen (FS-CFEL-CMI)

Contribution ID: **49** Type: **not specified**

Analysis of ultra-short XUV FEL pulses

In our group at FLASH, we measure the temporal duration of the free-electron laser pulses by terahertz streaking. Photo-electrons are generated in the interaction of the XUV FEL pulse and noble gases like neon. If the ionization takes place in the presence of a THz field, the photo-electron spectrum is altered and contains information about the arrival time and the temporal duration of the FEL pulse. We use different analytical methods to evaluate our THz streaking data, therefore we are looking for an intern to join our effort in the experiment and data analysis and bring new ideas to analyze and visualize the data.

Field

A4: Development of experimental techniques (methodology oriented)

DESY Place

Hamburg

DESY Division

FS

DESY Group

FS-FLASH-D

Special Qualifications:

Experience in programming
Atomic physics knowledge
Good team skills
Good English language skills

Primary author: MOHAMMADI BIDHENDI, Mahdi (FS-FLASH-D (FLASH Photon Diagnostics and Controls))

Co-author: DUESTERER, Stefan (FS-FLASH-D (FLASH Photon Diagnostics and Controls))

Contribution ID: **50** Type: **not specified**

Design and optimization of Self-Seeded Orbital Angular Momentum (SSOAM) from FELs

NA

Field

B4: Research on Accelerators

DESY Place

Hamburg

DESY Division

other

DESY Group

XFEL-E2-FP

Special Qualifications:

Primary author: YAN, Jiawei (XFEL-E2-FP)

Co-author: GELONI, Gianluca Aldo (Eur.XFEL (European XFEL))

Contribution ID: **51** Type: **not specified**

Ultrafast time-resolved optical absorption spectroscopy studies on solvated molecules

NA

Field

A2: Molecular sciences (application oriented)

DESY Division

other

DESY Group

XFEL-SF-ALO

Special Qualifications:

DESY Place

Hamburg

Primary author: KUBICEK, Katharina (Eur.GPEX)

Co-author: Prof. BRESSLER, Christian (EuXFEL)

Contribution ID: **52** Type: **not specified**

Dispersion characterization of apodized chirped Bragg gratings and mode-locked laser cavities using white light interferometry setup

Apodized Chirped Bragg Gratings (ACGs) optical component is a reflecting Bragg grating with a period gradually varying along the direction of beam propagation. We designed and fabricated apodized chirped Bragg gratings in a silicon nitride-on-insulator platform for dispersion compensation in on-chip mode-locked lasers (MLLs) operating in the short-wave infrared wavelength band. To measure the dispersion, we developed a white light interferometry setup. White light interferometry is an experimental technique generally used to study the dispersive properties of mirrors. Here, we apply this technique to integrated photonics. With this technique, we obtain dispersion information from the measured interference pattern called „interferogram“. The student will learn about integrated silicon photonics, ACGs, and on-chip MLLs. He will be testing ACGs using white light interferometry and work on the development of the setup for dispersion characterization of mode-locked laser cavities.

Field

A5: Lasers and optics (methodology oriented)

DESY Place

Hamburg

DESY Division

FS

DESY Group

FS-CFEL-2

Special Qualifications:

Primary author: Dr SINOBAD, Milan (FS-CFEL-2 (Ultrafast X-rays Group))

Co-author: KAERTNER, Franz (FS-CFEL-2 (Ultrafast X-rays Group))

Contribution ID: **53** Type: **not specified**

Characterization and optimization of ultraviolet trigger pulses for a femtosecond RF photogun

A miniature radio frequency (RF) pulsed photoelectron gun capable of producing high energy (180 kV) femtosecond electron pulses at a diffraction target has been built at FS-CFEL-2. A unique advantage of this RF gun concept is the self-compressing nature of the emitted electron bunches, allowing for very short electron pulse durations even at high pulse charge. In order to achieve optimal electron bunch parameters, the ultraviolet (UV) trigger pulses at the photocathode must be shaped appropriately in space and time, requiring the development of appropriate UV pulse characterization devices. This project entails building and testing a UV cross correlator as well as optimizing our existing UV spatial profilometer, eventually demonstrating the generation of truncated Gaussian beam profiles in both space and time. Depending on progress, there is also scope for studying generated electron bunch profiles as a function of UV trigger input.

Field

A5: Lasers and optics (methodology oriented)

DESY Place

Hamburg

DESY Division

FS

DESY Group

FS-CFEL-2

Special Qualifications:

Primary author: KASSIER, Günther (FS-CFEL-2)

Co-author: KAERTNER, Franz (FS-CFEL-2 (Ultrafast X-rays Group))

Contribution ID: **54** Type: **not specified**

How far electrons can spread in the material after the X-ray shot?

Modern X-ray free-electron lasers (XFELs) produce femtosecond X-ray pulses sufficiently intense to modify material properties or damage the target. On the femtosecond timescales, energetic photoelectrons and Auger electrons trigger secondary electron cascades, which can spread the damage beyond the laser spot. We simulate these cascades using an in-house classical Monte Carlo code XCASCADE-3D [1-3], which can provide temporal and spatial characteristics of the excited electrons, including their energy distribution.

In this work, the student would perform XCASCADE-3D simulations to investigate spatial and temporal electron distribution in irradiated targets under various irradiation conditions. The results should help to interpret recent experimental data and to guide further experimental efforts.

Field

A6: Theory and computing

DESY Place

Hamburg

DESY Division

FS

DESY Group

FS-CFEL-XM

Special Qualifications:

Primary authors: TKACHENKO, Victor (XFEL-E2-THE); LIPP, Vladimir (FS-CFEL-XM (Gruppe CFEL-XM))

Co-author: ZIAJA-MOTYKA, Beata (FS-CFEL-X (Gruppe CFEL-XM))

Contribution ID: **55** Type: **not specified**

Recyclable cellulose-based solar cells using fully sprayed all-layer materials

Cellulose nanomaterials, which is a kind of emerging high-value nanoparticles extracted from plants, are abundant in nature, renewable and sustainable, providing endless possibility in polymer solar cells. Charge carrier transfer layers and metal electrodes fabricated with traditional processes such as atom layer deposition and thermal evaporation are difficult to recycle. Therefore, here we aim to utilize spray-coating with solution-processable materials for each layer including electrode.
In the first step of this project, inks that can be used for spraying will be prepared and the different functional inks will be sprayed onto the substrate layer by layer. In the second step, the film morphology and microstructure are controlled by optimizing various parameters such as coating parameters and post-treatment as well as solvent engineering. In the last step, the electronic properties and the structural properties of the film will be investigated using a four-point-measurement, atomic force microscope and ellipsometry as well as grazing incidence wide-angle X-ray scattering.

Literature: C.J. Brett, N. Mittal, W. Ohm, M. Gensch, L. P. Kreuzer, V. Körstgens, M. Månsson, H. Frielinghaus, P. Müller-Buschbaum, L.D. Söderberg, and S. V. Roth: "Water-Induced Structural Rearrangements on the Nanoscale in Ultrathin Nanocellulose Films", Macromolecules 52, 4721 (2019)

Field

A1: Solid-state physics and nanoscience (application oriented)

DESY Place

Hamburg

DESY Division

FS

DESY Group

FS-SMA

Special Qualifications:

Primary author: XIONG, Shuxian (FS-SMA)

Co-author: ROTH, Stephan (FS-SMA (Sustainable Materials))

Contribution ID: **56** Type: **not specified**

Adhesion of coinage metals on thin polymer films

High Power Impulse Magnetron Sputtering (HiPIMS) is an emerging physical vapor deposition technique in industry and research, which allows the creation of novel polymer-metal composites. One reason is its higher ionized fraction of ions during deposition compared to conventional sputter and evaporation techniques. First results in the literature show a big advantage over conventional sputter or evaporation processes: Metal layer deposited by HiPIMS have shown an increased adhesion compared to conventional deposition techniques. It does not require any post and pretreatments, which are usually detrimental for polymer films, e.g. in solar cells. Yet, the microscopic reasons for the increased adhesion remains unknown.
In this project you are going to prepare polymer thin films on silicon with certain thicknesses via spin coating, which will be sputter-coated with coinage metals. Afterwards, you are going to characterize the samples with atomic force microscope (AFM), electric conductivity, optical microscopy, ellipsometry, X-ray reflectometry (XRR), grazing incidence small angle x-ray scattering (GISAXS) and grazing incidence wide-angle scattering (GIWAXS).

Field

A1: Solid-state physics and nanoscience (application oriented)

DESY Place

Hamburg

DESY Division

FS

DESY Group

FS-SMA

Special Qualifications:

Primary author: BULUT, Yusuf (FS-PETRA-D (FS-PET-D Fachgruppe P03))

Co-author: ROTH, Stephan (FS-SMA (Sustainable Materials))

Contribution ID: **57** Type: **not specified**

Noble metal sputter deposition on nanostructured polymer templates

Vacuum deposition of functional thin films has applications in numerous fields ranging from structural materials to solar cells, sensors, catalysis and medicine. Time-resolved X-ray scattering under high-speed industrial conditions in combination with spectroscopic methods provide ultimate insights to answer crucial questions about structure-property relationships. This knowledge is essential for the known understanding and design of next-generation nanomaterials with specific properties.

In this summer student project you will:
- Fabricate metal-polymer thin film nanocomposites for optical applications (20%)
- Perform noble metal co-deposition on nanostructured polymer templates (20%)
- Characterize thin film morphology using X-rays and AFM (20%)
- Correlate thin film nanostructures to optical properties using Ellipsometry and UV-Vis spectroscopy (20%)
- Perform acquisition, analysis and simulation of X-ray and optical data (20%)

Field

A1: Solid-state physics and nanoscience (application oriented)

DESY Place

Hamburg

DESY Division

FS

DESY Group

FS-PETRA-D

Special Qualifications:

Primary author: Dr SCHWARTZKOPF, Matthias (FS-PETRA-D (P03))

Contribution ID: **58** Type: **not specified**

SQS project

The student will have the opportunity to join a user beamtime where the X-ray imaging spectrometer of the SQS instrument is being used. He/she will participate in the preparation of the beamtime, and will also have the chance to get first experience with data analysis. Moreover, we will set up a new section of the beamline in the summer, the downstream diagnostics unit, where the student will be able to do some more hands-on hardware work.

Field

A4: Development of experimental techniques (methodology oriented)

DESY Place

Hamburg

DESY Division

other

DESY Group

XFEL-E2-SQS

Special Qualifications:

Primary author: BOLL, Rebecca (Eur.XFEL (European XFEL))

Co-author: MEYER, Michael (Eur.XFEL (European XFEL))

Contribution ID: **59** Type: **not specified**

Multi-beam X-ray Ptychography Development

Ptychography is a robust computational imaging method for phase retrieval. Our group is currently expanding this method with multi-beam to address the compromise between high resolution and a large field of view of the sample. We have already demonstrated the efficiency of this method, but there are still many open questions to discover, such as the upper limit of the number of probes, the lowest requirement of overlapping rates, etc.
Through this project, students will gain knowledge about multi-beam Ptychography (MBP) experiment setup, dataset simulation, and reconstruction. They will explore the dataset from experiments to analyze how much efficiency can be improved and perform numerical studies on MBP.

Field

A4: Development of experimental techniques (methodology oriented)

DESY Place

Hamburg

DESY Division

FS

DESY Group

FS-PETRA

Special Qualifications:

Primary author: LI, Tang (FS-PETRA (PETRA III))

Co-authors: SCHROER, Christian (FS-PETRA (PETRA III)); LYUBOMIRSKIY, Mikhail (FS-PETRA (PETRA III))

Contribution ID: **60** Type: **not specified**

Tackling the noise in x-ray holograms

X-ray holography is a method for implementing full-field X-ray microscopy. It offers high sensitivity, especially for low absorbing samples, because the phase-shifting part of the sample is used to form an image of the sample instead of its absorption. To obtain this image, the phase of the hologram must be recovered. This process can be affected by noise in the measured holograms. The aim of this project is to investigate some readily available denoising schemes and test their compatibility with phase retrieval.

Field

A6: Theory and computing

DESY Place

Hamburg

DESY Division

FS

DESY Group

FS-PETRA

Special Qualifications:

Primary author: HAGEMANN, Johannes (FS-PETRA (PETRA III))

Co-author: SCHROER, Christian (FS-PETRA (PETRA III))

Contribution ID: **61** Type: **not specified**

Developing X-ray optics made by laser ablation

Diamond x-ray lenses are novel optics for synchrotron sources and free-electron lasers to focus extremely intense x-ray beams to nanometer dimensions. We will use ultrafast laser ablation to fabricate parabolic and aspherical x-ray lenses. The surface shape will be analyzed by confocal laser scanning microscopy. The data will be used to design and fabricate an optical element to correct optical aberration of the diamond lenses.

Field

A5: Lasers and optics (methodology oriented)

DESY Place

Hamburg

DESY Division

FS

DESY Group

FS-PETRA

Special Qualifications:

Primary author: SEIBOTH, Frank (FS-PETRA (PETRA III))

Co-author: SCHROER, Christian (FS-PETRA (PETRA III))

Contribution ID: **62** Type: **not specified**

Handling “big data”: Processing petabytes of diffraction patterns

Modern x-ray facilities such as 3rd and 4th generation synchrotrons and Free Electron Lasers (FELs) combined with the modern detectors can generate thousands of diffraction patterns per second. This allows studying of very complex system and also capturing the dynamical processes. But it also results in up to petabytes of data for a single experiment. Such data volume has to be efficiently processed and educed for long-term storage. Our group is strongly involved in the development of the strategies for handling such “big data”, especially in the field of serial femtosecond crystallography (SFX). The summer student would learn how to deal with huge volume of diffraction data and would master the efficient parallel processing of data using DESY computer cluster.

Field

A6: Theory and computing

DESY Place

Hamburg

DESY Division

FS

DESY Group

FS-CFEL-1

Special Qualifications:

Primary author: YEFANOV, Oleksandr (FS-CFEL-1 (Forschung mit Photonen Experimente 1))

Co-author: CHAPMAN, Henry (FS-CFEL-1 (Forschung mit Photonen Experimente 1))

Contribution ID: **63** Type: **not specified**

CMS Open Data Analysis

The student will analyse open data from CMS and possibly other experiments.

Field

B1: Particle physics analysis (software-oriented)

DESY Place

Hamburg

DESY Division

FH

DESY Group

CMS

Special Qualifications:

C++

Primary author: GEISER, Achim (CMS (CMS Fachgruppe QCD))

Contribution ID: **64** Type: **not specified**

Improving electron resonstruction speed at CMS using GPUs

Electron reconstruction at CMS uses a special tracking algorithm called Gaussian Sum Filter (GSF) to account for radiative loss from brehmsstrahlung photons. The GSF algorithm is highly CPU intensive and thus cannot be run over all hits in the tracker. Hence the GSF tracking is run with only those hit patterns (seeds) that are compatible with an electron trajectory. These seeds are identified by matching hits in the pixel detector to the energy deposit of an electron in the electromagnetic calorimeter. Since the pixel matching procedure requires trying out all possible pixel hit combinations in the luminous region, it is currently the most time-consuming step of electron reconstruction. Hence is is important to speed up this step especially for high level triggers in Phase-2, where one will have a very high particle multiplicity (and consequently a huge number of pixel hits). One way of improving the pixel matching speed would be to port the algorithm to GPUs in a parallelizable manner. This project will involve developing and optimizing a GPU-compatible version of the the pixel matching algorithm, and studing its performance under Phase-2 scenarios.

Field

B2: Data processing (software-oriented)

DESY Place

Hamburg

DESY Division

FH

DESY Group

CMS

Special Qualifications:

Must: C++ and Python
Great to have: introduction to GPU programming
Nice to Have: basic knowledge of Physics objects

Primary author: BHATTACHARYA, Soham (CMS (CMS Fachgruppe Searches))

Contribution ID: **65** Type: **not specified**

Probe position and line shift correction for non-coherent scanning microscopy

At the P06 beamline of PETRAIII we sometimes see shifted lines in our scanning microscopy images, presumably stemming from mechanical imperfections in our scanning equipment. The magnitude of the line shifting is somewhat larger than the size of our probe, and is therefore limiting our image resolution/quality. As we deal with a wide verity of samples at P06, we would like the summer student to focus on correction methods that do not rely on assumptions about the sample, but rather on the measured properties of the probe.

Field

A4: Development of experimental techniques (methodology oriented)

DESY Place

Hamburg

DESY Division

FS

DESY Group

FS-PETRA-S

Special Qualifications:

Primary author: FALCH, Ken Vidar (FS-PETRA-S (FS-PET-S Fachgruppe P06))

Contribution ID: **66** Type: **not specified**

CMS physics data analysis project

CMS physics data analysis project

Field

B1: Particle physics analysis (software-oriented)

DESY Place

Hamburg

DESY Division

FH

DESY Group

CMS

Special Qualifications:

Primary authors: NIGAMOVA, Aliya (University of Hamburg); MANKEL, Rainer (DESY)

Contribution ID: **67** Type: **not specified**

Pulse Characterization in Free-Electron Laser Facility FLASH

Free-electron lasers (FELs) offer short pulses ranging from X-Ray to THz spectral region which enable direct probing the dynamics of structural and electronic changes in complex materials. Ultrafast dynamics of such systems can be explored when FEL pulses are employed in a pump-probe scheme. To perform such experiments, precise characterization of laser pulses is required. The student will participate and work amongst other postdocs and senior scientists to gain experience in pulse characterization in FLASH FEL facility.

Field

A5: Lasers and optics (methodology oriented)

DESY Place

Hamburg

DESY Division

FS

DESY Group

FS-LA

Special Qualifications:

Basic understanding of nonlinear optics, laboratory experience with lasers

Primary author: CANKAYA, Hueseyin (FS-LA (FLASH 2020+ flexible pump probe lasers))

Co-author: HARTL, Ingmar (FS-LA (Lasergruppe))