LNF projects available for summer student grants 2023

LNF Summer Student Program and DOE-INFN Summer Student Program

LNF-INFN

PROJECT: a-C coatings for EIC

Title: SEY investigation of a-C coatings

Description: Electron cloud is a serious issue for EIC proton beam. Electrons, produced by ionization of the residual gas by the passage of short spaced high-intensity bunches, can be accelerated toward the vacuum chamber walls by the proton beam, thereby releasing more electrons from the walls. This can create an electron avalanche that builds up rapidly in the beam vacuum chamber (that is electron cloud). This can cause detrimental effects (as heat load, gas desorption, vacuum degradation, …) giving rise to beam instabilities.
The key parameter governing the electron cloud formation is the Secondary Electron Yield (SEY, which is the number of electrons emitted per incident one). To prevent electron cloud buildup, the choice of the vacuum chamber' surface material is crucial and a SEY close to (or below) 1 is needed. SEY, indeed, is an intrinsic material property, highly sensitive to surface modifications. Then, when working at cryogenic temperature, the physisorption of residual gas species in the vacuum system may strongly affect SEY characteristics, especially in the low energy region of the spectrum.
It is known that an amorphous carbon (a-C) layer on Cu substrate can reduce SEY down to a value ~1. In the beampipe of the RHIC superconducting magnets, a Cu plated screen coated with a-C is planned to be installed. Chemical, structural, and morphological characteristics of the a-C coating may affect the SEY and low temperature behavior. In close collaboration with Brookhaven National Laboratory (BNL), this project aims to test and validate various material surfaces proposed to be used in the EIC hadron ring vacuum chamber using all the surface science spectroscopies available in the laboratory (SEY, XPS, RGA). SEY investigations will be made at room and cryogenic temperatures, with physisorbed gas monolayers and as a function of electron irradiation at various electron impacting energies to investigate any induced modification.

Activities: Experimental activities

Tutors: Roberto Cimino (Roberto.Cimino@lnf.infn.it),
Marco Angelucci (Marco.Angelucci@lnf.infn.it), Luisa Spallino (Luisa.Spallino@lnf.infn.it)

Activity period: June-July or September-October 2023

Local Secretariat: Maria Cristina D'Amato (maria.cristina.damato@lnf.infn.it)

Other information:

Accommodation: students may be accommodated, free of charge, in the LNF guesthouse (for information: http://www.lnf.infn.it/funz/concorsi/foresterie.html).
Lunches at the LNF canteen (Monday-Friday) are free of charge.
LNF Summer closing period: 7-18 August 2023.

Local web page: http://user.lnf.infn.it/summer-student-opportunities/

LNF-INFN

Project: Exotic atoms measurements with SIDDHARTA-2 at DAFNE

Title: Kaonic atoms measurements at the DAFNE collider with the SIDDHARTA-2 experiment from particles to neutron stars!

Description: SIDDHARTA-2 experiment aims to perform the first measurement in the world of the X-ray transitions in the kaonic deuterium exotic atom, which will help to understand the strong interaction described by the Quantum ChromoDynamics (QCD) theory in the non-perturbative regime in systems with "strangeness" (i.e., with strange quarks). The SIDDHARTA-2 experiment will measure the X rays produced in the de-excitations of kaonic deuterium by using new Silicon Drift Detectors developed to perform precision X-ray spectroscopy and which can have applications going from physics and astrophysics to industry and medicine. SIDDHARTA-2 is installed on DAFNE, an electron-positron collider delivering kaons, and will be in data taking in 2023, a very exciting period for a student! The kaonic deuterium measurement plays a fundamental role in understanding how QCD works, with implications going from particle and nuclear physics to astrophysics (equation of state of neutron stars).

Activities: The student will be involved in all the exciting phases of the experiment, from the data taking of SIDDHARTA-2 on the DAFNE collider, one of the very few working colliders in the world, to optimizations of various detector sub-systems and of the data taking chain, along the run and data analyses. He/she will be also introduced to data analyses and advanced Monte Carlo simulations

Reference: The modern era of light kaonic atom experiments, C. Curceanu et al., Rev. Mod. Phys. 91, 025006 (2019)

Tutor: Catalina Curceanu (catalina.curceanu@lnf.infn.it)

Activity Period: June-July or September-October 2023

Local Secretariat: Maria Cristina D'Amato (maria.cristina.damato@lnf.infn.it)

Other information:

Accommodation: students may be accommodated, free of charge, in the LNF guesthouse (for information: http://www.lnf.infn.it/funz/concorsi/foresterie.html).
Lunches at the LNF canteen (Monday-Friday) are free of charge.
LNF Summer closing period: 7-18 August 2023.

Local web page: http://user.lnf.infn.it/summer-student-opportunities/

LNF-INFN

Project: Quantum Mechanics: tests of the Quantum Gravity (via the Pauli Exclusion principle) and of quantum collapse models

Title: Tests of Quantum Mechanics within the VIP experiment: violation of the Pauli Exclusion principle and gravity related collapse models

Description: The VIP experiment, installed at the Gran Sasso underground laboratory, LNGS-INFN, is performing experimental searches of signals coming from possible violations of standard quantum mechanics, such as atomic transitions violating the Pauli Exclusion Principle (PEP) and spontaneous radiation coming from modified Schroedinger equation within the so-called collapse models. The VIP collaboration developed a series of radiation detectors and data analyses methods which allowed to set extremely competitive limits on PEP violation and collapse models. Presently, the experimental apparata are under optimization, in parallel with the data taking and data analyses, to either set even stronger limits or find signals of violations of standard quantum mechanics, which, of course, would be initiating a revolution. The obtained results are also important for quantum technologies.

Activity: The student will be involved in all the exciting phases of the experiment, from the preparation and testing of detector systems to data analyses using advances statistical analyses methods and machine learning. He/she will be also introduced to interpretation of results in the framework of modern theories, including gravity related collapse models and quantum gravity models.

References: Underground test of gravity-related wave function collapse, A. Donadi et al., Nature Physics volume 17, pages 74–78 (2021) and Experimental test of noncommutative quantum gravity by VIP-2 Lead, K. Piscicchia et al., Phys. Rev. D 107, 026002 – Published 4 January 2023

Tutor: Catalina Curceanu (catalina.curceanu@lnf.infn.it)

Activity Period: June-July or September-October 2023

Local Secretariat: Maria Cristina D'Amato (maria.cristina.damato@lnf.infn.it)

Other information:

Accommodation: students may be accommodated, free of charge, in the LNF guesthouse (for information: http://www.lnf.infn.it/funz/concorsi/foresterie.html).
Lunches at the LNF canteen (Monday-Friday) are free of charge.
LNF Summer closing period: 7-18 August 2023.

Local web page: http://user.lnf.infn.it/summer-student-opportunities/

LNF-INFN

Project: LHCb experiment at CERN

Title: Analysis of Run 2 and current Run 3 LHCb data

Description: The LHCb experiment is one of the four large detectors on the Large Hadron Collider (LHC) accelerator at CERN, and its primary purpose is to search for new physics through studies of CP-violation and rare decays of heavy-flavour hadrons. Although LHCb was designed primarily for precision measurements in heavy-flavour physics, the experiment has demonstrated excellent capabilities in many other domains ranging from electroweak physics to heavy ion and fixed target physics. LHCb has been successfully operated from 2010 to 2018 during the LHC Run 1 (2010–2012) and Run 2 (2015–2018) with excellent performances. Between 2019 and 2022, the LHCb detector has been almost fully renewed to allow running at an instantaneous luminosity five times larger than that of the previous experiment. In addition, an all-software trigger will allow to fully reconstruct the events at the maximum LHC bunch crossing rate of 30 MHz, and to select the physics signals in real time. From Spring 2022, with the start of LHC Run 3, LHCb is commissioning the upgraded detector. A bunch of data has been collected at the end of 2022 and are being analysed while preparing the restart of data taking in Spring 2023.

The large LHCb Frascati group is deeply involved in all the ongoing experimental activities. These range from the operation of the detector to the data analysis for flagship measurements (in particular of semileptonic and rare B-decays which provide sensitive probes to search for new particles beyond the Standard Model), from the commissioning of the upgrade (in particular of the Muon System and the first internal fixed gas target at the LHC, called SMOG2) to the R&D in view of possible future upgrades after LS3 and LS4 of the LHC.

Activities: The student will be deeply involved on key aspects of the data analysis. Depending on his/her interests and when he/she will be with us, the work can focus on:

- ***Semileptonic B-decays***: developments of novel algorithms to control the selection efficiencies; optimisation of control samples to study the most dangerous backgrounds; improvements of the resolution of the signal kinematic using Machine Learning techniques.
- ***Rare B-decays***: studies to reduce the background due to the mis-identification of the charged particles using data control samples and new techniques, including modern machine learning (background reduction is of paramount importance to improve the rare B-decays results that can be achieved with the upcoming Run 3 data).
- ***Software Trigger***: GPU software development for real-time muon identification in the first level of the trigger (HLT1).
- ***Fixed target***: analysis of the first data collected in 2023 will allow to have the first hints of Transverse Momentum Distribution (TMD) measurements by performing some comparison with the future Electron-Ion Collider (EIC) potentialities.

Some knowledges in computing (e.g. python, C++, root) are desirable but not mandatory.

Tutor:
Barbara Sciascia (barbara.sciascia@lnf.infn.it) LHCb group leader; the student will actually work with one or more of the LHCb researchers depending on the specific item.

Activity period: 5 June – 4 August 2023 or 4 September – 3 November 2023

Local Secretariat: Maria Cristina D'Amato (maria.cristina.damato@lnf.infn.it)

Other information:

Accommodation: students may be accommodated, free of charge, in the LNF guesthouse (for information: http://www.lnf.infn.it/funz/concorsi/foresterie.html).
Lunches at the LNF canteen (Monday-Friday) are free of charge.
LNF Summer closing period: 7-18 August 2023.

Local web page: http://user.lnf.infn.it/summer-student-opportunities/

LNF-INFN

Project: CLAS12 RICH

Title: Physics analysis with the CLAS12 RICH

Description: The Thomas Jefferson National Accelerator Facility (Jefferson Lab), in Newport News, VA (USA), is one of the leading facilities in the study of the internal structure of the nucleon. High intensity and high polarization electron beams are scattered by hydrogen or nuclear targets, producing various particles in the final state. The accurate measurement of the rate and angular distributions of these particles allows to extract information on the quark and gluon structure of the nucleon. The CLAS12 detector in Hall B at Jefferson Lab is able to perform these measurements over a wide kinematic acceptance. Two Ring Imaging CHerenkov (RICH) detectors have been built by INFN to extend the particle identification capabilities of CLAS12 to kaons in the momentum range between 3 and 8 GeV/*c*. This is allowing CLAS12 to extend to study of the nucleon structure in kinematic regions otherwise not accessible. A wealth amount of data has been collected so far and more measurements are underway.
The student will perform the physics analysis of channels involving charged kaons in the final state in the so-called Deep Inelastic Scattering region. The work will involve the analysis of single hadron (example: $ep \rightarrow eK^+X$ and eK^-X) channels and can be extended to di-hadron channels (example $ep \rightarrow epKX$) channels.

Activities: The student will perform the physics analysis of channels involving charged kaons in the final state using the two RICH detectors for particle identification. Comparison of kaon identification with and without the RICH will provide pion/kaon misidentification ratios for the four out of six CLAS12 sectors not instrumented with RICH. By the end of this internship, benchmark observables (like for example the beam spin asymmetry) will be extracted in a fully multidimensional analysis.

Tutor: Marco Mirazita (marco.mirazita@lnf.infn.it)

Activity period: June-July 2023

Local Secretariat: Maria Cristina D'Amato (maria.cristina.damato@lnf.infn.it)

Other information:

Accommodation: students may be accommodated, free of charge, in the LNF guesthouse (for information: http://www.lnf.infn.it/funz/concorsi/foresterie.html).
Lunches at the LNF canteen (Monday-Friday) are free of charge.
LNF Summer closing period: 7-18 August 2023.

Local web page: http://user.lnf.infn.it/summer-student-opportunities/

LNF-INFN

Project: PADME

Title: Search for the X17 anomaly in positron-electron annihilation events with the PADME experiment

Description: Studying the de-excitation, via electron-positron pairs production, of some light nuclear systems, a research group based at the ATOMKI of Debrecem has recently observed an anomaly that can be explained postulating the existence of a proto-phobic boson of mass 17 MeV/c^2 (X17). If confirmed, this new particle would represent the first evidence of a dark matter signal.
The Positron Annihilation into Dark Matter Experiment (PADME) was conceived to search for invisible decays of a dark photon produced in the process $e^+e^- \rightarrow \gamma$ A', with the A' undetected. By changing the energy of the incoming positron beam, PADME can try to produce resonantly the X17 boson. The data taking devoted to this study took place in the second half of 2022 and now the PADME collaboration is performing the analysis to confirm/disprove the existence of this new state.

Activities: The candidate will participate to the data analysis devoted to the search of the X17 particle.

Tutor: Paola Gianotti (paola.gianotti@lnf.infn.it)

Activity period: June-July or September-October 2023

Local Secretariat: Maria Cristina D'Amato (maria.cristina.damato@lnf.infn.it)

Other information:

Accommodation: students may be accommodated, free of charge, in the LNF guesthouse (for information: http://www.lnf.infn.it/funz/concorsi/foresterie.html).
Lunches at the LNF canteen (Monday-Friday) are free of charge.
LNF Summer closing period: 7-18 August 2023.

Local web page: http://user.lnf.infn.it/summer-student-opportunities/

LNF-INFN

Project: CYGNO/INITIUM

Title: R&D for CYGNO/INITIUM experiment

Description: LIME, part of the CYGNO/INITIUM roadmap, is the first prototype of the CYGNO experiment (https://web.infn.it/cygnus/) dedicated to the development of a large gas Time Projection Chamber with optical read-out dedicated to the search of dark matter and the study of solar neutrinos. LIME has been installed at the LNGS of the INFN and is collecting data available for analysis to define and optimise preliminary algorithms from DM and Neutrino search.

Moreover, at the LNF, some prototypes are under testing for the final choice of materials and low radioactivity components (GEM, cathode, fried cage, etc) for the final detector CYGNO04 that will be installed at LNGS in 2015.

Activities: The candidate, depending on them skills and interests, will be included in the R&D activity of the LNF group by participating in the laboratory tests and in the implementation of the experimental setup, calibration and data taking and analysis from the LNGS. Keywords: scientific CMOS sensors, Optical Read Out, Gas Electron Multiplier, low radioactivity components, Python, clustering, PID.

Tutor: Giovanni Mazzitelli (giovanni.mazzitelli@lnf.infn.it)

Activity period: June-July 2023.

Local Secretariat: Maria Cristina D'Amato (maria.cristina.damato@lnf.infn.it)

Other information:

Accommodation: students may be accommodated, free of charge, in the LNF guesthouse (for information: http://www.lnf.infn.it/funz/concorsi/foresterie.html).
Lunches at the LNF canteen (Monday-Friday) are free of charge.
LNF Summer closing period: 7-18 August 2023.

Local web page: http://user.lnf.infn.it/summer-student-opportunities/

LNF-INFN

Project: SPARC-LAB

Title: Measurement and tests of electro-optical femtosecond synchronization system for an electron linear accelerator (SPARC_LAB).

Description: The student will be involved in the activities of the Radiofrequency group of the Accelerator Division of LNF concerning the synchronization system upgrade. Tests on fast photodetectors, fiber lasers, optical and radiofrequency devices, fast locking electronics (PLLs) will be carried out during the stay.

Tutor: Luca Piersanti (luca.piersanti@lnf.infn.it), Marco Bellaveglia (marco.bellaveglia@lnf.infn.it)

Activity period: September-October 2023

Local Secretariat: Maria Rita Ferrazza, ad.secretariat@lists.lnf.infn.it

Other information:

Accommodation: students may be accommodated, free of charge, in the LNF guesthouse (for information: http://www.lnf.infn.it/funz/concorsi/foresterie.html).
Lunches at the LNF canteen (Monday-Friday) are free of charge.
LNF Summer closing period: 7-18 August 2023.

Local web page: http://user.lnf.infn.it/summer-student-opportunities/

LNF-INFN

Project: ATLAS Analysis in the H-> ZZ*-> 4l decay channel

Title: Study of the Higgs Boson properties in the H->ZZ*->4l decay channel using early Run 3 data collected by the ATLAS detector at LHC

Description: The Higgs boson is a fundamental particle in the Standard Model and precision measurements are of outmost importance in High Energy Physics. Within the project, the candidate will work together with the H-> ZZ*-> 4l analysis team, learning how to study the Higgs boson properties using the most recent analysis techniques and produce results on their own.

Activities: Analysis coding, machine learning, team building, presenting at ATLAS CERN internal meetings.

Tutor: Chiara Arcangeletti (chiara.arcangeletti@lnf.infn.it), Giada Mancini (giada.mancini@lnf.infn.it), Mario Antonelli (mario.antonelli@lnf.infn.it)

Activity period: June-July or September-October 2023

Local Secretariat: Maria Cristina D'Amato (maria.cristina.damato@lnf.infn.it)

Other information:

Accommodation: students may be accommodated, free of charge, in the LNF guesthouse (for information: http://www.lnf.infn.it/funz/concorsi/foresterie.html).
Lunches at the LNF canteen (Monday-Friday) are free of charge.
LNF Summer closing period: 7-18 August 2023.

Local web page: http://user.lnf.infn.it/summer-student-opportunities/

LNF-INFN

Project: ATLAS Cosmic Ray Stand with MDTs

Title: Test of the performances of the ATLAS MDT detectors at the Cosmic Ray Stand (CRS).

Description: Candidate will have the opportunity to work in a fully working Cosmic Ray Stand to reconstruct muon tracks via highly performing gas detectors such as the ATLAS Monitored Drift Tubes (MDTs). MDTs were produced at LNF and are still working in the ATLAS experiment at CERN. One of the most interesting parts will be to understand how to run a detector, to acquire and analyze data. Such points are of fundamental importance and the candidate will be able to understand and follow the full chain up to the data acquisition and analysis. Concerning the analysis, the final step would be to use the MDT CRS for tomography of a brick. Using gas detector telescopes for tomography is a recent technology developed for archeological and geological purposes. For the broadness of the arguments touched and for its complete view of a detector running, we really encourage students to take part to this activity.

Activities: working in a laboratory, understanding how to run a detector, analysis coding, team building.

Tutor: Giada Mancini (giada.mancini@lnf.infn.it), Matteo Beretta (matteo.beretta@lnf.infn.it), Chiara Arcangeletti (chiara.arcangeletti@lnf.infn.it), Mario Antonelli (mario.antonelli@lnf.infn.it)

Activity period: June-July or September-October 2023

Local Secretariat: Maria Cristina D'Amato (maria.cristina.damato@lnf.infn.it)

Other information:

Accommodation: students may be accommodated, free of charge, in the LNF guesthouse (for information: http://www.lnf.infn.it/funz/concorsi/foresterie.html).
Lunches at the LNF canteen (Monday-Friday) are free of charge.
LNF Summer closing period: 7-18 August 2023.

Local web page: http://user.lnf.infn.it/summer-student-opportunities/

LNF-INFN

Project: GGM

Title: Gas Gain Monitor (GGM) for the RPC detector of the CMS experiment at CERN

Description: the candidate will collaborate in the upgrade of the GGM both in the hardware and both in the software part of the system.

Activities: programming (C, C++)

Tutor: Luigi Benussi (luigi.benussi@lnf.infn.it)

Activity period: June-July or September-October 2023

Local Secretariat: Maria Cristina D'Amato (maria.cristina.damato@lnf.infn.it)

Other information:

Accommodation: students may be accommodated, free of charge, in the LNF guesthouse (for information: http://www.lnf.infn.it/funz/concorsi/foresterie.html).
Lunches at the LNF canteen (Monday-Friday) are free of charge.
LNF Summer closing period: 7-18 August 2023.

Local web page: http://user.lnf.infn.it/summer-student-opportunities/

Project available only in the framework of the LNF Summer Student Program

Progetto: PEROV Gr5

Titolo: Caratterizzazione di sensori di perovskite

Descrizione delle attività:

L'attività si inserisce del progetto PEROV che ha lo scopo di osservare la moltiplicazione a valanga in sensori basati sui semiconduttori di perovskite e di studiare la loro stabilità.

Lo studente dovrà svolgere delle misure su sensori di perovskite, di diversi spessori e aree, prodotti con diverse tecnologie: film policristallini di 300 nm, monocristalli in forma di canali micrometrici e monocristalli di forma cubica spessi qualche centinaio di micron.

Le misure da svolgere sono:

- curve IV in continua, in condizione di buio e di luce
- misure di efficienza quantica
- misure di stabilità della risposta al variare del tempo e della tensione di bias
- acquisizioni di segnali da luce impulsata e studio delle forme d'onda
- confronto tra campioni

Parte dei setup per le misure sono presenti a LNF, altri a Roma1 e Roma2, che partecipano al progetto PEROV, con cui lo studente collaborerà.

Periodo: Giugno – Luglio, Settembre – Ottobre, da concordare

Tutor: M. Testa (marianna.testa@lnf.infn.it)

Referente segreteria locale: L. Natoli (laura.natoli@lnf.infn.it)