Announcement n. 27536

DOE-INFN Summer Students Exchange Program 2025 Edition

The US Department of Energy (DOE) and the Istituto Nazionale di Fisica Nucleare of Italy (INFN) announce the 2025 edition of the Summer Exchange Program dedicated to promote the exchange of students in science between the two countries.

INFN (http://www.infn.it) is one of the leading organization worldwide promoting basic scientific research and has tight connections with DOE activities in many areas of interest: Particle Physics, Astroparticle Physics, Nuclear Physics, Theoretical Physics and Detector Physics.

We call for applications of US students willing to join a INFN research team in Italy for a two-month period between June 1st and October 31st, 2025.

There are 11 positions available. Applicants can choose among 16 different INFN sites and 50 research projects.

Grants amount to €6.000,00 to cover travel and living expenses.

To qualify for the fellowship, it is mandatory, that each university student to undertake an insurance policy, at their own expense, covering medical, assistance, accident and illness expenses for the duration of the fellowship.

Eligible candidates must be enrolled as students at a US university and they must have begun, at the time of application, at least the third year of a US University curriculum in physics, engineering or computing science, or planning to start the third year in 2025.

Applications, in electronic form, must be sent to INFN not later than March 7th, 2025 (11.59 pm CET) through the website: https://reclutamento.dsi.infn.it/.

The application should include:

- a short CV following the template provided in the recruitment site, describing the applicant's academic and research experience. Only PDF files will be accepted.
- a list of the University courses and scores. Only PDF files will be accepted.
- the three preferred INFN sites and the research projects chosen among those listed in the Annex I.
- the motivation for applying to this program and a statement on research interests, specifying and justifying the selected projects.

Candidates will be excluded from participation in this call if they submit their application later than the indicated deadline.

Incomplete applications (lack of information or missing files) will not be considered.

Direzione Risorse Umane

Selection of participants will be carried out by the Selection Committee which will establish the evaluation criteria before having seen the applicant's documentation.

The selection of the candidates will be based on:
- the statement on research interests;
- the curriculum vitae and studiorum.

At the end of the selection process, the results of the selection will be published on the INFN website (Job Opportunities – Details of the announcement). Successful candidates will then receive an official communication from the INFN administration Offices.

Selected students are also requested to send their official University transcript by e-mail (digital scanned copy) before accepting the appointment with INFN.

Since September 2010, citizens of countries like US may enter Italy for a period of up to 90 days without a visa, to take part in the exchange program (please check here http://vistoperitalia.esteri.it/home/en).

In accordance with the provisions of Art. 13 of the EU Regulation 2016/679, the personal data requested will be collected and processed, also with the use of multiple IT tools, exclusively within the call and in compliance with the legal regulation for these activities. All information candidates provide will be treated confidentially to establish their eligibility and qualifications; if not provided, candidates will be excluded from the selection process. Data shall be kept just for the selection period and subsequently retained for storage purposes only.
INFN guarantees that candidates can access to their personal data concerning, as well as their rectification, deletion and limitation and the right to object to the personal data processing; it also guarantees the right to file a complaint with the Data Processing Authority regarding the processing carried out.
For other issues not covered by this announcement, reference is made to the Disciplinary for the conferral of INFN Scholarships of April 28th, 2023 which is an integral part of this announcement and is available on the website: https://jobs.dsi.infn.it

Data Controller: National Institute of Nuclear Physics: email address: presidenza@presid.infn.it.

Data Protection Officer email address: dpo@infn.it.

Rome, February 5th, 2025

ISTITUTO NAZIONALE DI FISICA NUCLEARE
Il PRESIDENTE
(Prof. Antonio Zoccoli)[1]

RC/ADV

[1] Documento informatico firmato digitalmente ai sensi della legge 241/90 art. 15 c 2, del testo unico D.P.R. 28 dicembre 2000, n. 445, del D.Lgs. 7 marzo 2005, n. 82, e norme collegate, il quale sostituisce il testo cartaceo e la firma autografa

ANNEX 1

INFN Sections and Laboratories	Research Projects
1 Bari	1. FERMI-LAT - Gamma-ray analysis of transient sources at high energies
1 Bari	2. CTA - Characterization and test of the frontend electronics for the prototype Schwarzschild Couder Telescope for CTA
1 Bari	3. DRD1 - Characterization of new-generation Resistive Plate Chambers operated with eco-friendly gas mixtures for future HEP applications
1 Bari	4. LHCb - Study of the performance of innovative Micro Pattern Gaseous detectors for the future upgrade of the LHCb Muon detector
2 Bologna	5. EPIC - SiPM photodetector development and beam test for the ePIC-dRICH detector at the EIC
3 Catania	6. CMS - Machine Learning models development for data quality of the CMS Pixel detector
4 Ferrara	7. BESIII 1 - Charmonium measurement at BESIII
4 Ferrara	8. BESIII 2 - Study of calibration data of BESIII CGEM-IT
4 Ferrara	9. DUNE - Cryogenic characterization of the Silicon Photomultipliers (SiPMs) sensors for the DUNE Far Detector experiment
4 Ferrara	10. LHCb 1 - The Ring Imaging Cherenkov (RICH) detector upgrade project of the LHCb experiment for the High-Luminosity LHC: R&D activities and characterization of fast-timing and radiation-hard single-photon detectors and electronics
4. Ferrara	11. LHCb 2 - A hunt for exotic multiquarks with LHCb data
4. Ferrara	12. LHCb 3 - Parallel simulation of the propagation of optical photons with the NVIDIA ray-tracing software OptiX on GPU
4. Ferrara	13. Medipix/Timepix - Characterization of state-of-the-art hybrid pixel detectors for applications in fundamental physics, life sciences and outreach
4 Ferrara	14. R&D activities for very high energy gamma-ray astronomy - Development of a high-performance, ultra-compact spaceborne satellite detector utilizing oriented crystals to pave the way for advancements in high-energy (HE) and very-high-energy (VHE) gamma-ray astronomy
4 Ferrara	15. RD_FCC - uRWELL for muon detector development for muon detector of the IDEA spectrometer
5 Firenze	16. GAMMA - Analysis of the experiment "Multiple Shape Coexistence in 118Sn Investigated via Spectroscopy of Internal Conversion Electrons"
5 Firenze	17. GAMMA and NUCLEX - Study of innovative solid-state and scintillator detectors for nuclear physics experiments and applications
5. Firenze	18. NUCLEX - Exploring heavy ion collision with the FAZIA detector
6 Genova	19. ATLAS - Pixel Detector for the ATLAS Upgrade at HL-LHC
6 Genova	20. ePIC-EIC-SRO - Streaming DAQ for the future ePIC detector at the Electron-Ion Collider
6 Genova	21. ePIC-EIC-TAG - Interaction tagger detector for dRICH at the future ePIC detector at the Electron-Ion Collider
6 Genova	22. JLAB12-BDX - JLAB12-BDX detector assembly and commissioning
6 Genova	23. JLAB12-HI-LUMI - JLAB12-CLAS12 HI-LUMI upgrade
7 Lecce	24. ATLAS -The ATLAS Pixel Detector for HL-LHC: on site production and certification
8 LNF	25. Belle II - Optimization of reconstruction and identification of *KL* mesons in Belle2 with Machine Learning techniques
8 LNF	26. SIDDHARTA - Kaonic atoms at the DAFNE collider - Kaonic Atoms with the SIDDHARTA-2 Experiment at the DAFNE Collider: A Strangeness Adventure!
8 LNF	27. VIP - Testing Quantum Foundations Underground - Exploring Quantum Frontiers Underground: Probing Pauli Exclusion Principle Violation and Gravity-Related Collapse Models
8 LNF	28. JLAB12 - Kaon electroproduction with the CLAS12 detector
8 LNF	29. CYGNO - 3D reconstruction of low energy electron track in a CYGNO Dark Matter detector prototype
8 LNF	30. LHCb - R&D activities for the fixed target at LHCb
8 LNF	31. LHCb Semileptonics - Search for New Physics in semileptonic decays of the B_s meson

9 LNGS	32. LUNA 12C12C - Direct measurement of the 12C+12C fusion cross section inside the LNGS underground laboratory
9 LNGS	33. LUNA EASY -Installation and commissioning of the setup for the study of the 22Ne(α,γ)26Mg reaction at the LNGS underground laboratory
10 Padova	34. LHCb - Identification of heavy-flavour jets at LHCb using Graph Neural Networks
10 Padova	35. Muon Collider - Study of b- and c- jet identification with advanced machine learning algorithms at 10 TeV muon collider
10 Padova	36. ICARUS – SBN - Studies on the neutrino events collected in the ICARUS T600 detector at FERMILAB
10 Padova	37. LUNA - Experimental Design for Nuclear Astrophysics at LUNA
11 Perugia	38. BELLE II - The upgrade of the electromagnetic calorimeter (ECL) of the Belle II detector at SuperKEKB
11 Perugia	39. FERMI-LAT - Application of machine learning methods on Fermi-LAT counts-map images
12 Pisa	40. VIRGO - Development of seismic attenuation systems for current and next-generation gravitational wave detectors
12 Pisa	41. GW VIRGO-ET - Geometric approach for attenuation of seismic noise
12 Pisa	42. VIRGO/ET - Development of a data analysis pipeline for current and next-generation gravitational wave detectors and implication for astrophysics, cosmology and fundamental physics
13 Roma	43. JLAB12 - Time and amplitude characterization of a plastic scintillator and photodetectors system as a neutron TOF counter for the measurement of the $e + p \rightarrow n + ve$ reaction.
14 Roma Tor Vergata	44. VIRGO/EINSTEIN TELESCOPE - Development and Characterization of Advanced Optical Systems for Thermal Compensation in Gravitational Wave Detectors
14 Roma Tor Vergata	45. EINSTEIN TELESCOPE - Design and Testing of Cryogenic Systems for Investigating Materials, Monitoring Mirror Surfaces, and Characterizing Specialized Sensors for Future Cryogenic Gravitational Wave Detectors
15 Torino	46. TASP/Fermi-LAT - Search for gamma-ray emission around Galactic pulsar wind nebulae
16 Trieste	47. ePIC hardware - Characterization of single photon sensors for Cherenkov imaging applications
16 Trieste	48. ePIC simulation - Studies of dRICH performance by using the ePIC simulation framework
16 Trieste	49. ITS3 - 65 nm CMOS process MAPS detector characterization
16 Trieste	50. BELLE II - Performance optimization of the Belle II diamond-detector

1. BARI

1. FERMI-LAT

Title: Gamma-ray analysis of transient sources at high energies

Description: Gamma-ray emissions in our Universe are clear signatures of non-thermal and/or catastrophic events happening in or outside our Galaxy. The gamma-ray sky is in constant evolution, being characterized by a number of variable or transient sources, such as flaring Active Galactic Nuclei (AGN) or Gamma-ray Bursts (GRBs). In its almost 15 years of operation, the Large Area Telescope (LAT) onboard the Fermi satellite proved to be an ideal instrument to monitor the gamma-ray sky thanks to its high sensitivity and wide field of view. In this project, a selection of variable sources will be analyzed with Fermi-LAT data, in order to detect its gamma-ray emission and study the mechanisms originating this emission.

Activities: The student will learn how to analyze Fermi-LAT data using the tools fermitools and fermipy. The most important data products, such as light curves and spectra, will be obtained. A detailed study of the emission mechanisms will be conducted, in order to derive an interpretation model to study the origin of the gamma-ray emission.

Tutor: E. Bissaldi (elisabetta.bissaldi@ba.infn.it)

Activity period: June-July 2025

Local Secretariat: Sig. Antonio Silvestri - 0805442332 - (tonio.silvestri@ba.infn.it)

Other information: The Department is usually closed in August 2025

1. **BARI**

2. **CTA**

Title: characterization and test of the frontend electronics for the prototype Schwarzschild Couder Telescope for CTA

Description: The Schwarzschild-Couder Telescope (SCT) is a dual mirror telescope proposed for the Cherenkov Telescope Array (CTA) Observatory to detect very high energy astrophysical gamma rays. The design of the telescope is based on a dual mirror optics and a high resolution SiPM focal plane, which allow an increased sensitivity and angular resolution compared to similar single-mirror telescopes. A prototype (pSCT) is installed and being commissioned at the Fred Lawrence Whipple Observatory (FLWO) in Arizona, USA. An upgrade of the current camera is ongoing.

Activities: The student will learn the main functionalities of the frontend electronics (FEE) modules developed for the pSCT upgraded camera, based on the SMART ASIC, used for the SiPM signals preamplification, and the CTC and CT5TEA ASICs, for the signal digitization and trigger generation respectively. He/she will learn the basic concepts of data acquisition systems, using different programming languages, such as python and LabVIEW. The student will perform the basic measurements for the FEE module calibration procedure, studying the FEE performance as a function of the operating temperature and will be involved in the quality control tests on the new produced boards.

Tutor:
L. Di Venere (leonardo.divenere@ba.infn.it)
S. Loporchio (serena.loporchio@ba.infn.it)

Activity period: June-July 2025 or September-October 2025

Local Secretariat: Sig. Antonio Silvestri - 0805442332 - (tonio.silvestri@ba.infn.it)

Other information: The Department is usually closed in August 2025

1. **BARI**

3. **DRD1**

Title: Characterization of new-generation Resistive Plate Chambers operated with eco-friendly gas mixtures for future HEP applications.

Description: One of the challenges for future applications of gaseous detectors is the use of ecological gas mixtures with low impact on the environment, preserving their excellent performance for future applications in High Energy Physics experiments.
In the framework of ongoing R&D activities, new generation RPCs are being tested at INFN Bari and at CERN.
The student will get familiar with this detector technology and will analyze data collected during beam test campaigns at CERN. He/she will characterize the detector performance operated with different gas mixtures in different irradiation conditions. He/she will take part in the research activity at INFN Bari RPC Lab, gaining experience in detector operation, data acquisition and electronics.
Basic knowledge of C++/Python programming is required.

Tutor:
Marilisa De Serio (marilisa.deserio@ba.infn.it)
Alessandra Pastore (alessandra.pastore@ba.infn.it)

Activity period: June-July 2025

Local Secretariat: Antonio Silvestri (tonio.silvestri@ba.infn.it)

1. **BARI**

4. **LHCb**

Title: Study of the performance of innovative Micro Pattern Gaseous detectors for the future upgrade of the LHCb Muon detector.

Description: In the framework of the ongoing R&D activities for the Muon System of the LHCb experiment, new detector technologies are being studied in view of the future High-Luminosity LHC upgrade. Innovative MPGDs have been selected as baseline option for the internal region of the LHCb Muon System given their optimal performances at very high rates.
The student will gain experience with the micro-Resistive-WELL (muRWELL) detectors, analyzing data collected during beam test campaigns at CERN. He/she will characterize the detector performance in different working conditions. He/she will take part in the research activity at INFN Bari LHCb Laboratory, gaining experience in detector operation, data acquisition and electronics.
Basic knowledge of C++/Python programming is required.

Tutor:
Marilisa De Serio (marilisa.deserio@ba.infn.it)
Alessandra Pastore (alessandra.pastore@ba.infn.it)

Activity period: June-July 2025

Local Secretariat: Antonio Silvestri (tonio.silvestri@ba.infn.it)

2. **BOLOGNA**

5. **EPIC**

Title: SiPM photodetector development and beam test for the ePIC-dRICH detector at the EIC

Description: In the past years, a large-area SiPM-based photodetector prototype readout plane for the ePIC-dRICH detector at the EIC has been developed and constructed at INFN Bologna. The prototype photodetector was equipped with a complete readout chain of electronics, reaching a total of 2048 readout channels that successfully collected data in October 2023 and May 2024 with particle beams at the CERN-PS T10 test beam facility. A large set of data from the beam tests is available for analysis. INFN Bologna has developed a new custom readout board (RDO) for the ePIC-dRICH detector. During the early months of 2025, the first samples of the RDO prototype board will be received and are expected to be utilised for the readout of the SiPM photodetector prototype in an upcoming beam test at CERN in the Summer/Fall of 2025.

The person joining this project will have the opportunity to actively participate in the preparation of the upgraded detector prototype and in the commissioning operations by helping local scientists to finalise the assembly of the prototype with the upgraded electronics, to develop applications to monitor and support the data-taking operations, and eventually to analyse the output data collected. Depending on the actual dates of the beam test and the start of the activity period, the project might also include the possibility of participating in the preparations for the beam test itself, including the installation and operations of the detector at CERN-PS.

The successful candidate will also be offered the opportunity to contribute to current efforts in the analysis of the beam test data, which include both the use of classical pattern recognition and reconstruction algorithms (e.g., Hough transformation for ring detection) and the application of modern strategies exploiting artificial intelligence, such as deep machine learning approaches.

Activities: Preparation of the hardware of the SiPM readout and electronics for the beam test of the ePIC-dRICH detector at the EIC. Development of the data acquisition and readout software for the new Readout Board (RDO) module of the detector. Development of online event-selection algorithms exploiting parallelisation on GPU and machine learning. Data analysis of the ePIC-dRICH SiPM detector prototype.

Tutor: Roberto Preghenella (roberto.preghenella@bo.infn.it)

Activity period: June-July or September-October

Local Secretariat: Elena Amadei (elena.amadei@bo.infn.it)

Other information: The activity will be carried out in the INFN-Bologna laboratories either before or after the Summer closure period. Depending on the selected activity period and the actual schedule of the beam test, the candidate will have the possibility to carry out activities in preparation for the beam test or for the data analysis if the collected data.

3. **CATANIA**

6. **CMS**

Title: Machine Learning models development for data quality of the CMS Pixel detector

Description: Tracks are an essential component of any physics analysis. The tracking system of the CMS experiment is made up of thousands of silicon modules. Because of the aging of the detector, and all other possible incidents that may happen during operations, there is the need for constant monitoring of the detector components, in order to guarantee the best data quality in terms of tracking and vertexing.
The CMS Tracker Data Quality Monitoring group has developed tools to check the quality of the recorded data, with the aim of spotting potential detector issues and certify the data as good for usage in physics analyses.
To support the work of the human shifters and to further increase the efficacy of the process, machine learning models are being trained on data to identify detector anomalies.

Activities: The student will contribute to the development (both in terms of training and evaluation) of AutoEncoder machine learning models for Pixel detector data. Moreover, the student will learn the structure and operation of the CMS Pixel detector and the CMS Data Quality process.

Tutor: Alessandro Lapertosa (alessandro.lapertosa@ct.infn.it)

Activity period: June-July or September-October

Local Secretariat:

Other information: www.ct.infn.it

4. **FERRARA**

7. **BESIII 1**

Title: Charmonium measurement at BESIII

Description: The discovery of the charmonium spectrum, a system that resembled the hydrogen atom, but composed of quark-antiquark pairs, opened a new era in the study of hadron spectroscopy. In the past 40 years, many results have been achieved with incredible precision. Below the DDbar threshold the spectrum is well understood, while above this energy (3.770 GeV) the situation is far more complex. Among those states, the $h_c(2P)$ is still unmeasured. Using the large statistics at high energy of BESIII, and with the extended capabilities after the upgrade, the possibility to observe it for the first time is at reach. A feasibility study with one of the most favored decay and production mode will be performed.

Activities: The activities will be focus on the development of the analysis code, the study of the selection efficiencies and the background rejection. Study of the resolution will be performed, as well as check on the inclusive MC. Given the remaining time, possibility to look at few percent of data will be investigated. All the work will be performed inside the BESIII official software releases.

Tutor: Gianluigi Cibinetto, Marco Scodeggio, Isabella Garzia, Giulio Mezzadri

Activity period: June-July, September-October

Local Secretariat: Paola Fabbri paola@fe.infn.it;

Other information: The department is closed in August, usually in the week of August 15. Ferrara has a large tradition of touristic city, so plenty of apartments are available, as well as some rooms from university dorm shall be available.

4. **FERRARA**

8. **BESIII 2**

Title: Study of calibration data of BESIII CGEM-IT

Description: The BESIII experiment program has been recently extended up to the 2030s together with an upgrade plan to both the detector and the accelerator. The CGEM-IT (Cylindrical Gas Electron Multiplies Inner Tracker) has been installed in the second half of 2024 to replace the innermost part of the present drift chamber to increase radiation tolerance and rate capability, and improve spatial resolution along the beam axis for better vertex reconstruction and background rejection in complex topology decays. While the data will be collected, it is crucial to calibrate the detector response. The candidate will work with CGEM-IT software experts to perform calibration studies for both time and position measurement to assess the CGEM-IT performance and boost its capabilities.

Activities: The activities will be focus on the development of the analysis code to extract the most interesting features for the CGEM-IT calibration with the official BESIII software release. The candidate will work with C++ and will increase their knowledge on how the detector performance influences the physics analyses.

Tutor: Gianluigi Cibinetto, Giulio Mezzadri, Isabella Garzia

Activity period: Both periods (June-July or September-October) are available.

Local Secretariat: paola@fe.infn.it;

Other information: The department is closed in August, usually in the week of August 15. Ferrara has a large tradition of touristic city, so plenty of apartments are available, as well as some rooms from university dorm shall be available.

4. **FERRARA**

9. **DUNE**

Title: Cryogenic characterization of the Silicon Photomultipliers (SiPMs) sensors for the DUNE Far Detector experiment

Description: The Deep Underground Neutrino Experiment (DUNE) is an international experiment for neutrino science that will use different neutrino detectors placed in the world's most intense neutrino beam. DUNE first phase program and R&D for upgrades represent one of the major suggestions of the 2023 Particle Physics Project Prioritization Panel (P5) about the recommendations at the DOE for the future program of particle physics. A complex of detectors (SAND, ND-LAr, ND-GAr) will measure the neutrino parameters in the proximity of the source of the neutrino beam, at the Fermi National Accelerator Laboratory (FNAL) in Batavia, Illinois. A second, much larger, detector will be installed more than a kilometer underground at the Sanford Underground Research (SURF) Laboratory in Lead, South Dakota, at a distance of about 800 miles from the source. The main goal of DUNE is the investigation of neutrino oscillations to test Charge-Parity (CP) violation in the lepton sector, which is a key factor in the comprehension of why the Universe is made of matter. The DUNE Far Detector (FD) modules will be a liquid Argon Time Projection Chamber (LArTPC) with a total volume of 70-kilotons of liquid Argon located about 1 mile under the surface. This detector will take advantage of both charge and light signals coming from neutrino interaction in Argon. In particular, the light will be collected in opportune sub-modules called X-Arapuca and will be read by Silicon Photomultiplier detectors. The Ferrara University and INFN group is involved in the photodetection consortium of the FD and in particular we coordinate the quality assurance (QA) of the SiPM sensors that will be installed in the detector. We developed an ancillary system which is capable to test and characterize more that 100 sensors in a single measure. Furthermore our group is involved in the simulation and reconstruction working group of the SAND detector.

Activities: The student, joining the Ferrara group in Summer 2025, will have the opportunity to collaborate with the group and participate to the laboratory activities and to detector simulations and data analysis.

Tutor: Luca Tomassetti (tomassetti@fe.infn.it), Marco Guarise (marco.guarise@fe.infn.it)

Activity period: June-July 2025

Local Secretariat: Paola Fabbri, phone +39-0532-974280, email: paola@fe.infn.it

Other information: Cheap accommodations are available in town. A Canteen and a lunch room are available in the University.

4. FERRARA

10. LHCb 1

Title: The Ring Imaging Cherenkov (RICH) detector upgrade project of the LHCb experiment for the High-Luminosity LHC: R&D activities and characterization of fast-timing and radiation-hard single-photon detectors and electronics

Description: LHCb is one of the main experiments at the Large Hadron Collider (LHC) accelerator at CERN. Its primary goal is to study with high accuracy b and c quark decays to improve the knowledge of the Standard Model or to reveal the contributions of New Physics to the decay processes. One of the main features of the LHCb experiment is the capability to identify the particles produced in the final state. Several detectors are dedicated to this purpose. In particular the separation between pions, kaons and protons is provided by two Cherenkov imaging detectors (RICH-1 and RICH-2). The identification of muon particles is performed using a dedicated (Muon) detector. LHCb has upgraded many of its sub-detectors and the entire read-out and data acquisition chain during the Long Shutdown 2 (2019-2022), to cope with a five-fold increase in the instantaneous luminosity. LHCb is also proposing a new upgrade to take full advantage of the flavour physics opportunities at the High-Luminosity LHC, operating (a decade from now) with a ten-fold increase in instantaneous luminosity compared to the current one ($1\text{-}2\times10^{34}$ $cm^{-2}s^{-1}$). The design of a very challenging RICH detector is being evaluated by the Collaboration and dedicated R&Ds have started, focused on high granularity single-photon detectors with excellent timing resolution (few tens of ps) and fast read-out electronics with time-stamping capabilities. This effort is also promoted in the recommendations 1 and 3 of the 2023 Particle Physics Project Prioritization Panel (P5). P5 recommend the investment and the support of the DOE at the ongoing experiments at High-Luminosity LHC such as LHCb.

Activities: The student, joining the Ferrara group in Summer 2025, will have the opportunity to participate to the different R&D activities: test and characterization of novel fast-timing single-photon detectors; test and characterization of front-end electronics; detector simulations.

Tutor: Massimiliano Fiorini (fiorini@fe.infn.it), Giovanni Cavallero (cavallero@fe.infn.it), Marco Guarise (guarise@fe.infn.it)

Activity period: June-July 2025

Local Secretariat: Paola Fabbri, phone +39-0532-974280, email: paola@fe.infn.it
Other information: Cheap accommodation available in town or in the University guest house. Local web-page: http://www.fe.infn.it/doe

4. FERRARA

11. LHCb 2

Title: A hunt for exotic multiquarks with LHCb data

Description: Since the first observation of the X(3872) state in 2003, physicists have started studying a new class of particles called “exotic”, due to the fact that they do not fit within the expected pattern and present unusual properties. It is believed now that exotic particles are composed by four (tetraquarks) or five (pentaquarks) valence quarks/antiquarks. Many experiments have reported the observation of dozens of new exotic hadrons in the past 20 years, and many more are expected to exist. The LHCb experiment at CERN has observed 21 new such states and it is today one of the major players in the field of exotic spectroscopy. The Ferrara group is involved in a search for exotic particles contributing to the process $pp \rightarrow J/\psi\ \pi\ \pi\ \gamma$. To improve the mass resolution and remove combinatorial background, the photon is selected through its conversion to an electron-positron pair after having interacted with the detector materials.

Activities: The candidate will learn the statistical and computational tools used in High Energy Physics data analysis. They work with experts in the field of exotic spectroscopy to train and test multivariate machine learning algorithms and develop part of the analysis code to search for new exotic particles in the process $pp \rightarrow J/\psi\ \pi\ \pi\ \gamma$.

Tutor: Lorenzo Capriotti (lorenzo.capriotti@fe.infn.it)
Giovanni Cavallero (giovanni.cavallero@cern.ch)

Activity period: Both periods (June-July or September-October) are available.

Local Secretariat: Paola Fabbri, phone +39-0532-974280, email: paola@fe.infn.it

Other information: The department is closed in August, usually in the week of August 15th. Cheap accommodation available in town or in the University guest house.
Local web-page: http://www.fe.infn.it/doe

4. **FERRARA**

12. **LHCb 3**

Title: Parallel simulation of the propagation of optical photons with the NVIDIA ray-tracing software OptiX on GPU

Description: The analysis of optical photons is crucial in the technological development of various particle detectors in many different contexts such as high energy physics, neutrino physics or medical imaging. The simulation of those processes is today one of the most critical steps in terms of time and resources necessary. In the LHCb Ring-Imaging Cherenkov (RICH) detector, a single charged particle can generate up to O(1000) Cherenkov photons, which must be transported individually within the material volume before they reach the PMTs and are converted into a signal. A possible solution to this problem lies in a massive parallelisation of the photon transportation. The library Opticks allows to interface the Geant4 simulation software, widely used in high energy physics, with the NVIDIA ray-tracing software OptiX running on GPUs with RTX platform.

Activities: The canjdidate will learn the basics of CUDA programming and study the performances of simulations generated with Geant4 and OptiX.

Tutor: Lorenzo Capriotti (lorenzo.capriotti@fe.infn.it)

Activity period: Both periods (June-July or September-October) are available.

Local Secretariat: Paola Fabbri, phone +39-0532-974280, email: paola@fe.infn.it

Other information: The department is closed in August, usually in the week of August 15th. Cheap accommodation available in town or in the University guest house.
Local web-page: http://www.fe.infn.it/doe

4. FERRARA

13. Medipix/Timepix

Title: Characterization of state-of-the-art hybrid pixel detectors for applications in fundamental physics, life sciences and outreach

Description: The Medipix Collaboration at CERN designed and produced the first Medipix chip in 1998. This Application Specific Integrated Circuit (ASIC) was aimed at providing noise-free particle imaging by incorporating a counter on each pixel and combining the sensitive pixel matrix with a shutter-based camera-type of read-out. Since then, the Medipix family of pixel detector readout chips has grown in size and complexity, reaching the fourth generation with the Medipix4 Collaboration. The aim of the Medipix4 Collaboration, launched in 2016, is the design of two ASICs: Timepix4, which provides particle detection with excellent spatial and timing precision at high rates, and Medipix4, that targets spectroscopic X-ray imaging at rates compatible with medical CT scans. These ASICs are designed to be fully prepared for Through-Silicon Via (TSV) processing and may be tiled on all four sides, enabling large area detectors.
The Ferrara group is developing a new kind of hybrid photodetector based on a vacuum tube encompassing a photocatode, a microchannel plate and the Timepix4 ASIC. This detector will be used both in particle physics and in life science applications. Within this project, funded by the European Research Council, the group is carrying out activities related to the Timepix4 characterization. Among those: detector performance tests; measurement of time, position and energy resolutions; pixel calibration as a function of the energy; characterization of the Timepix4 analog front-end and digital signal processing electronics chain.
Moreover, the Ferrara group is also developing a custom data acquisition system, including an FPGA-based board and a software framework for the Timepix4 configuration and data acquisition.

Activities: The student, joining the Ferrara group in Summer 2025, will have the opportunity to participate to the different R&D activities: test and characterization of novel pixel detectors based on the Timepix4 ASIC bump-bonded to Silicon sensors; test and characterization of front-end electronics and data acquisition system; imaging for medical physics applications and outreach activities

Tutors: Massimiliano Fiorini (fiorini@fe.infn.it), Paolo Cardarelli (cardarelli@fe.infn.it), Nicolò Biesuz (biesuz@fe.infn.it), Riccardo Bolzonella (rbolzonella@fe.infn.it)

Activity period: June-July 2025

Local Secretariat: Paola Fabbri, phone +39-0532-974280, email: paola@fe.infn.it

Other information: Cheap accommodation available in town or in the University guest house. Local web-page: http://www.fe.infn.it/doe

4. FERRARA

14. R&D activities for very high energy gamma-ray astronomy

Title: Development of a high-performance, ultra-compact spaceborne satellite detector utilizing oriented crystals to pave the way for advancements in high-energy (HE) and very-high-energy (VHE) gamma-ray astronomy.

Description: The observation of gamma-ray sources offers a direct glimpse into the most extreme environments in the universe. The use of oriented crystals in satellite-based gamma-ray detectors can significantly improve the performance of state-of-the-art instruments, such as the Large Area Telescope (LAT) on the Fermi mission. These improvements come from the fact that high energy electrons, positrons and photons incident along the axis of an oriented crystal experience an intense electromagnetic field, much stronger than the average field generated inside ordinary materials. This results in an increase of the bremsstrahlung and pair-production cross-sections and thus in a strong reduction of the shower radiation length. Such an effect could be exploited to design a novel satellite-based gamma-ray detector, capable of containing the electromagnetic shower at the same level as the LAT calorimeter but with a reduced longitudinal dimension. This would allow to either increase the detector's effective area without increasing the overall instrument weight or to reduce the latter without decreasing the detector sensitivity and energy resolution. ditionally, the pair-production cross-section of a linearly polarized high-energy photon incident on the axis of an oriented crystal depends strongly on the relative angle between the crystal axis and the photon polarization vector. This means that oriented crystals could be exploited to develop a novel class of detectors, potentially sensitive to the polarization of gamma-rays with energy well above few GeV. Since the polarization of high-energy gamma-rays depends on the process underlying their emission, this opens the possibility of characterizing the nature and structure of astrophysical sources in a domain never explored before, since current polarimeters are sensitive only to photons with energies up to few hundreds of MeV.

Activities: The student can choose to contribute to the design strategy of the satellite (tracker + calorimeter) using the Geant4 toolkit and/or focus on the data analysis of experimental tests conducted at CERN on the detector prototype, which is based on oriented scintillator crystals developed by the OREO collaboration. In both cases, the student will develop an expertise in data analysis relevant for both particle and astroparticle physics, choosing as instrument for the activity a programming language such as Python or ROOT.

Tutor: Dr. Laura Bandiera (bandiera@fe.infn.it), Mr. Pierluigi Fedeli (pierluigi.fedeli@fe.infn.it)

Activity period: Both periods (June-July or September-October) are available.

Local Secretariat: Paola Fabbri, phone +39-0532-974280, email: paola@fe.infn.it

Other information: The department is closed in August, usually in the week of August 15th.
Cheap accommodation available in town or in the University guest house.
Local web-page: http://www.fe.infn.it/doe
Group web-page: https://crystalab.unife.it/index.php/en/

4. FERRARA

15. RD_FCC

Title: uRWELL for muon detector development for muon detector of the IDEA spectrometer

Description: The IDEA detector is one of the proposed spectrometers for the Future Circular Collider, the CERN-based proposal for the future Higgs factory. Muons come from both the Higgs decay and from the Z boson in ZH production, so their reconstruction is crucial for the success of the FCC physics program. Moreover, the muon detector can play a crucial role in searching for Long-Lived Particles (LLP), a family of Beyond Standard Model particles that decays away from the interaction point. In IDEA, muon detectors are constituted by microRWELL detector, an innovative resistive Micro Pattern Gas Detector that provides high efficiency and resolution for the reconstruction of these particles. In Ferrara, the candidate will work on the uRWELL with experts both in hardware and software developments, to further increase the readiness of this technology for the FCC challenges.

Activities: The activities will be discussed with the candidate based on the time of their arrival. Some hardware (test with planar uRWELL prototypes) and software (data analysis of test beam or cosmic data) are available. The candidate will work in C++, with ROOT software and/or with GEANT4.

Tutor: Gianluigi Cibinetto, Federico Matias Melendi, Emma Di Fiore

Activity period: June-July, September-October.

Local Secretariat: Paola Fabbri paola@fe.infn.it;

Other information: The department is closed in August, usually in the week of August 15. Ferrara has a large tradition of touristic city, so plenty of apartments are available, as well as some rooms from university dorm shall be available.

5. FIRENZE

16. GAMMA

Title: Analysis of the experiment "Multiple Shape Coexistence in ^{118}Sn Investigated via Spectroscopy of Internal Conversion Electrons"

Description: The primary goal of this internship is to engage the student in hands-on research focused on analyzing data from a nuclear physics experiment conducted using the SLICES setup.
SLICES is an innovative magnetic spectrometer developed by the GAMMA group in Florence to measure internal conversion electrons. It is currently installed at the National Laboratories of Legnaro. The apparatus consists of a large lithium-drifted silicon detector (Si(Li)) coupled with a magnetic transport system. This system includes permanent magnets designed to focus electrons onto the Si(Li) detector, along with a central absorber that reduces the number of incident gamma rays, which would otherwise produce a high background in the electron energy spectra. The configuration of the magnetic lens is modular and can be adjusted depending on the energy of the electrons being studied. In the experiment related to this internship, the configuration of the magnets is entirely new, making it essential to characterize the magnetic field and extract the detection efficiency of SLICES as a function of electron energy.
The data to be analyzed was collected last year as part of an experiment aimed at measuring internal conversion electrons in the nucleus ^{118}Sn. Studying this nucleus is crucial for understanding the evolution of nuclear interactions and nuclear shapes in the tin isotopic chain, a topic of extensive experimental and theoretical research.
This internship offers the student a valuable opportunity to gain practical experience in nuclear physics research while actively contributing to an ongoing analysis.

Activities:
- Mapping of the magnetic field of SLICES
- Comparison between measured and calculated magnetic fields
- Determination of the SLICES efficiency
- Preliminary analysis of the electron spectra using the Root software

Tutor: Naomi Marchini (marchini@fi.infn.it) and Adriana Nannini (nannini@fi.infn.it)

Activity period: 2 months - September-October 2025

Local Secretariat: Giulia Scarlini (giulia.scarlini@fi.infn.it)

Other information: https://web.infn.it/nuclear_physics_firenze

5. FIRENZE

17. GAMMA and NUCLEX

Title: Study of innovative solid-state and scintillator detectors for nuclear physics experiments and applications

Description: The primary goal of this internship is to engage the student in hands-on research focused on studying and characterizing detectors used and developed by the nuclear physics group in Florence.
The group is involved in several activities involving a large variety of instruments, particularly detectors for γ-rays and heavy ions such as high-purity germanium detectors (HPGe), lithium drifted silicon detectors [Si(Li)], segmented silicon detectors, and scintillators. The researchers in Florence actively participate in the development of the FAZIA telescope array, a state-of-the-art instrument for the detection of heavy ions and the study of nuclear reactions. Also, the group is deeply involved in activities with the AGATA γ-ray spectrometer, the most advanced detection system for γ-rays (together with its twin spectrometer GRETA in the US). The SPIDER detector was specifically designed in Florence and is currently used with AGATA to measure heavy ions in coincidence with γ-rays. The group also developed the SLICES spectrometer, for spectroscopy with internal conversion electrons. These instruments are used by the group in the framework of international collaborations to study the structure of nuclear matter and nuclear reactions under extreme conditions.

The nuclear physics group in Florence is currently maintaining and developing different setups. Specifically, we are studying an upgrade of FAZIA to lower the detection thresholds, we are performing an experimental campaign using SPIDER and AGATA at the INFN Legnaro National Laboratories, and we are developing a new detection system called BeGam for applications in nuclear medicine.

In this internship, we offer the applicant the opportunity to deepen their knowledge of nuclear technologies, specifically the usage of radiation detection systems in fundamental and applied nuclear physics and participate in our activities related to solid-state and scintillator detectors.

Activities:
The specific activities will be decided together with the student based on their personal preference and the needs of the group at the time of the internship, among the following topics:

- Characterization and repair (using “annealing” procedures) of the segmented silicon detectors of SPIDER
- Study of the response of CsI scintillators for medical applications in the framework of the BeGam project
- Characterization of a very thin silicon strip detector (20-um thick)
- Study on a new FAZIA-like telescope with a thin silicon strip detector and scintillators

Tutor: Alberto Camaiani (camaiani@fi.infn.it) and Marco Rocchini (rocchini@fi.infn.it)

Activity period: 2 months - September-October 2025

Local Secretariat: Giulia Scarlini (giulia.scarlini@fi.infn.it)

Other information: https://web.infn.it/nuclear_physics_firenze

5. **FIRENZE**

18. **NUCLEX**

Title: Exploring heavy ion collision with the FAZIA detector

Description*:* Heavy ion collisions are the only terrestrial probes to investigate the properties of nuclear matter, and in turn to explore astrophysical object such as neutron stars. Durning the collision, a large zoology of particles and fragments are produced and their identification, due to interaction between projectile and targe. Their identification, possibly both in charge and mass, is crucial to extract information on the ongoing interaction.
The NUCLEX collaboration is well assessed in this panorama, as for instance the TexasAM and the FRIB (US) research teams, working with the NIMROD and HIRA+LANA detectors, respectively. Since 2015, thanks to the FAZIA detector, a detector with charge and mass identification capabilities up to Z=25, the NUCLEX collaboration performs experiments in the main Italian and European facilities. To date, twelve blocks of FAZIA are coupled with the INDRA multi-detector in GANIL (FR). Two new experiments will run in GANIL during spring 2025, making collide 12C+12C at 12.5 MeV/u and Zn+Fe 35 MeV/u, thus producing from Hydrogen (H) to Tin (Sn), covering for each element a broad mass range.

Activities: Future activities at FRIB laboratories are foreseen by the NUCLEX in collaboration with the local research team. This internship offers a hands-on opportunity for students interested to these physics topics. The students will learn how a solid-state detector for heavy ions collision works and what are the methods to identify, in charge and mass, the detected fragments. The students will learn DE-E technique and Pulse Shape analysis methods: how to produce identification matrices, how to identify fragments, and how to produce a reliable energy calibration of the detectors.

Tutor: Alberto Camaiani (camaiani@fi.infn.it)

Activity period: 2 months - September-October 2025

Local Secretariat: Giulia Scarlini (giulia.scarlini@fi.infn.it)

Other information: https://web.infn.it/nuclear_physics_firenze

6. GENOVA

19. ATLAS

Title: Pixel Detector for the ATLAS Upgrade at HL-LHC

Description: The program for LHC foresees an upgrade of the accelerator complex in the next long shutdown starting in 2026 that will allow to increase the integrated luminosity by a factor of 10 (High Luminosity LHC – HL-LHC). The present detectors of ATLAS have been designed according to the rates and radiation dose expected at the nominal LHC luminosity and the Inner Tracker system will be completely replaced for the HL-LHC by a fully Silicon tracker, with a Pixel detector in the innermost part and Strip detector in the outermost part. After several years of R&D's to develop a detector able to fit the even more demanding conditions than the actual ones, the Pixel detector collaboration is now stepping into the preproduction: the first parts produced need to be validated with several tests, to be sure that everything is ready before launching the massive production of the 13 mq large detector.
The Genova group has been involved in the last 20 years in the ATLAS pixel detector, and is now playing a key role in the construction of the new one for the high luminosity program. In particular, we are responsible for the 3D modules, the technology chosen for the innermost layer thanks to their intrinsic radiation tolerance, the production of the forward support structures and their electrical services, the loading of the modules on these structures. All these activities are shared with other institutes of the ITk collaboration, in particular from US laboratories and universities.

Activities: The student will have a chance to participate to the assembly and test of the 3D modules, analyze laboratory and test beam data to evaluate sensor and module performance. For the latter, over the Summer we will have the first data taking of irradiated 3D modules and the student may be able to focus on this data analysis.

Tutor: Claudia Gemme (claudia.gemme@ge.infn.it)

Activity period: June-July or September-October

Local Secretariat: Agnese Cresta (agnese.cresta@ge.infn.it)

Other information: cheap accommodation is available in town. – sito web locale: www.ge.infn.it

6. GENOVA

20. ePIC-EIC-SRO

Title: Streaming DAQ for the future ePIC detector at the Electron-Ion Collider

Description: Thanks to recent developments in computing and networking, the particle physics experiment trigger scheme based on FPGA is being replaced by streaming readout approaches, in which every detector channel is read out independently, and all data above a minimum threshold are transferred to a CPU farm for further processing. This scheme simplifies the trigger implementation since it can be developed using high-level programming languages (C++, JAVA, Python, ...) and increases the system's versatility in adapting to diverse experimental conditions.

Activities: During this stage, the student will participate in the validation tests of a prototype of a triggerless readout system designed for the readout of an electromagnetic calorimeter for the future Electron-Ion Collider in the US. The experimental activity will include the optimization of the setup consisting of a matrix of scintillating glasses, the streaming readout with commercial and custom digitizers, the data recording, and the implementation of different trigger conditions.

Tutor:
Marco Battaglieri, Marco Spreafico, Simone Vallarino

Activity period: June-July 2025

Local Secretariat: Agnese Cresta (agnese.cresta@ge.infn.it)

Other information: cheap accommodation is available in town. – sito web locale: www.ge.infn.it

6. **GENOVA**

21. **ePIC-EIC-TAG**

Title: Interaction tagger detector for dRICH at the future ePIC detector at the Electron-Ion Collider

Description:
The dual-ring imaging Cerenkov (dRICH) detector at ePIC provides hadron identification in the forward region (1.5 $<\eta<$ 3.5with excellent discrimination in the momentum range 1 GeV.c to 50 GeV/c. More than 300 thousand SiPMs composing the readout are operated at a low threshold (< 1pe) in streaming mode to detect the feeble Cerenkov light. To reduce the enormous amount of data produced by the front end, the Cerenkov signals will be combined in a tight time coincidence with a bunch-crossing signal provided by a dedicated dRICH Interaction Tagger detector. The precise time information of crossing of charged hadron produced in the e-A interaction will be obtained by a segmented plastic-scintillator hodoscope readout by SiPMs. Different options are currently under study.

Activities:
During this stage, the student will participate in the design and deployment of prototypes of the dRICH Interaction Tagger. Different small-scale prototypes based on different charged particle crossing detectors (scintillating fibers, scintillating tiles, scintillation paddles) will be available for cosmic ray testing. The performance of the full system (detector, siPM-based readout, and back-end data reduction) will be assessed defining the best option for the final detector.

Tutor:
Marco Battaglieri, Mikhail Osipenko, Simone Vallarino

Activity period: June-July 2025

Local Secretariat: Agnese Cresta (agnese.cresta@ge.infn.it)

Other information: cheap accommodation is available in town. – sito web locale: www.ge.infn.it

6. GENOVA

22. JLAB12-BDX

Title: JLAB12-BDX detector assembly and commissioning

Description:
Assembly, testing, and commissioning of components of Module-I of the Beam Dump eXperiment detector. BDX is a beam-dump, Light-Dark Matter search experiment scheduled to run at Jefferson Lab (VA) in the next few years. The detector, made from a PbWO4 electromagnetic calorimeter surrounded by two plastic scintillator veto layers, will be assessed using cosmic muons to measure veto layer inefficiency as a function of the energy deposited in the calorimeter crystals.

Activities:
Commission the detector (test and equalize sipm channels), use the EEE cosmic muon test facility to measure veto and ECal absolute efficiency, and run a cosmic test with the full prototype assembled to determine the veto inefficiency as a function of the energy deposited in the ECal crystals, data analysis and comparison to simulations.

Tutor:
Marco Battaglieri, Marco Spreafico, Simone Vallarino

Activity period: June-July 2025

Local Secretariat: Agnese Cresta (agnese.cresta@ge.infn.it)

Other information: cheap accommodation is available in town. – sito web locale: www.ge.infn.it

6. GENOVA

23. JLAB12-HI-LUMI

Title: JLAB12-CLAS12 HI-LUMI upgrade

Description:
The CLAS12 is a large acceptance detector operating in the experimental Hall-B of Jefferson Lab. The detector is based on a toroidal magnetic field for precise measurement of leptons and hadrons momenta produced in the collision of the 11 GeV electron beam with fixed proton/nuclear targets. A combination of Drift Chambers, Silicon Vertex detectors, electromagnetic calorimeters, and Cerenkov and TOF counters provides excellent momentum resolution and particle identification in a wide range of kinematics. To increase the already high luminosity of the experiment, an upgrade of the tracking system is currently under study. A new tracker layer, based on the novel uRWELL technology, will complement the DC information, reducing the low-energy particle background, increasing by a factor of 2 the current peak luminosity. A prototype of the future large-area uRWELL detector is currently under test at Jefferson Lab.

Activities:
During this stage, the student will test a small (10x10 cm2) uRWELL chamber that uses the same technology adopted by the CLAS12 HIU-LUMI upgrade. The cosmic test station is based on a plastic scintillator telescope for coarse cosmic muons tracking and DAQ triggering, Different front-end options based on the well-established APV25 and the new VMM3 chip are installed and ready to be tested. Cosmic tests will be useful to design and plan on-beam tests to assess the ultimate performance of the detector.

Tutor:
Marco Battaglieri, Marco Spreafico, Simone Vallarino

Activity period: June-July 2025

Local Secretariat: Agnese Cresta (agnese.cresta@ge.infn.it)

Other information: cheap accommodation is available in town. – sito web locale: www.ge.infn.it

7. LECCE

24. ATLAS

Title: The ATLAS Pixel Detector for HL-LHC: on site production and certification

Description: The High-Luminosity run of the Large Hadron Collider (LH-LHC), planned to last for over a decade starting from 2030, will allow an increase in the size of the data sample collected by the ATLAS experiment by a factor of 10 after raising the accelerator instantaneous luminosity by a factor of about seven. The ATLAS detector will undergo a significant upgrade to cope with the interaction rate and radiation dose foreseen for this ultimate and challenging run of the world's most powerful accelerator in operation. The core of the upgraded detector is a new full silicon inner tracker system (ITk). Its Pixel Detector consists of a barrel section and two end-caps, providing large acceptance and high granularity for optimal track and vertex reconstruction.
The ATLAS Lecce group is committed to assembling and certifying the Half-Ring components of the Pixel end-caps of ITk in direct collaboration with other ATLAS groups from INFN Genova, Oxford University, and Rutherford Appleton Laboratory. In 2025, this activity will enter the pre-production phase.
The local laboratories host a clean room facility where the precision and automated assembly of the pixel sensors onto the mechanical supports takes place, as well as two test stations where data acquisition and detector control systems run to ensure quality control of the production components and procedures. Overall, hundreds of silicon pixel modules, each with over $3x10^5$ advanced front-end electronic channels, will be assembled and tested individually at reception time and after mounting on the Half-Rings via calibration procedures similar to those that will be used for the entire Pixel Detector in ATLAS.
The student will contribute to the stream of pre-production activities, concentrating on detector testing or module assembly according to his/her attitude and considering the current focus of the group activity. The technologies involved, the scope of the project and the scientific collaboration will allow him/her to gain practical experience in cutting-edge research within the field of experimental particle physics.

Activities:
- Equipment setup and control;
- Critical review, documentation, and run of production-ready procedures;
- Data taking and analysis;
- Measurement and result reporting in the local group and collaboration meetings.

Tutor: Gabriele Chiodini (gabriele.ghiodini@le.infn.it), Francesco Martina (francesco.martina@le.infn.it), Stefania Spagnolo (stefania.spagnolo@le.infn.it)

Activity period: 2 months: September-October 2025

Local Secretariat: Debora De Falco (debora.defalco@le.infn.it)

Other information: The activity will be carried out in the INFN-Lecce laboratories after the summer closure period. Local web page: https://web.le.infn.it/ and https://web.le.infn.it/atlas-itk/

8. LNF – FRASCATI NATIONAL LABORATORY

25. Belle II

Title: Optimization of reconstruction and identification of K_L mesons in Belle2 with Machine Learning techniques.

Description: The Belle II experiment runs at the e^+e^- SuperKEKB collider in Japan. SuperKEKB currently holds the world record of instantaneous luminosity and aims to reach by early 2026 the unprecedented luminosity 10^{35}cm^{-2}s^{-1}, which will allow Belle II to collect a huge-statistics dataset of B, D and τ decays (among others).
The reconstruction and particle identification of K_L mesons is key in Belle II for time-dependent charmonium or charmless decays such as $B^0 \to J/\psi K_L$ and $B^0 \to \eta' K_L$. The optimization of detector and analysis performance of K_L mesons is also crucial to control systematic uncertainties in analyses such as dark matter searches or decays with neutrinos in the final state, which are sensitive probes of New Physics and are unique to Belle II.

Activities: The student will perform the analysis of data collected by the Belle II detector, including those from $e^+e^- \to D_{(s)}{}^{*+} D_{(s)}{}^{*-}$ decays, to measure and optimize the K_L reconstruction and particle identification in an ample range of K_L momenta. This will involve a deep understanding of the electromagnetic and hadronic calorimetry used to the detect the K_L mesons, as well as the use and development of sophisticated machine-learning techniques to improve the identification efficiency and reduce contamination from unwanted sources. Knowledge of the Python and C++ programming languages is required.

Tutor: Giuseppe Finocchiaro (giuseppe.finocchiaro@lnf.infn.it)

Activity period: June-July or September-October 2025

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: one week in mid-August.
Local web page: http://user.lnf.infn.it/summer-student-opportunities/

8. LNF – FRASCATI NATIONAL LABORATORY

26. SIDDHARTA - Kaonic atoms at the DAFNE collider

Title: Kaonic Atoms with the SIDDHARTA-2 Experiment at the DAFNE Collider: A Strangeness Adventure!

Description: Are you ready to embark on a journey into the world of strangeness? Join the SIDDHARTA-2 experiment, a groundbreaking effort to study and explore kaonic atoms at the DAFNE collider, the only one of its kind in the world! Using a kaon beam, SIDDHARTA-2 is making history by measuring X-ray transitions in kaonic atoms (atoms where electrons were replaced by kaons – i.e. particles containing the "strange" quark), unveiling the secrets of strong interaction in systems with strange quarks.
Equipped with cutting-edge Silicon Drift Detectors for precision X-ray spectroscopy, alongside advanced detectors like CdZnTe and HPGe, the experiment is not only probing for the first time kaonic deuterium but also heavier kaonic atoms such as carbon and lead. The results will provide unprecedented insights into the strong interaction and its implications, ranging from the microcosm of particle and nuclear physics to the cosmic scale of neutron stars.
With data analysis and theoretical interpretation ramping up in 2025, including the use of Machine Learning techniques, together with tests of brand-new radiation detectors for future kaonic atoms measurements (in Italy and/or Japan) this is the perfect moment for a student to dive into this thrilling field and make a real impact.

Activities: As part of the team, the student will play a key role in analyzing data to identify kaonic deuterium signals, a crucial step toward determining isospin-dependent antikaon-nucleon scattering lengths. Hie/her contributions will deepen our understanding of the strong interaction in the strangeness sector and open windows into its implications for the physics of neutron stars.
The student will gain hands-on experience with advanced data analysis tools, including Machine Learning, and advanced Monte Carlo simulations. As if that weren't enough, he/she will help test pioneering detector systems designed for future kaonic atom measurements. This is more than just a summer project—it's a genuine strangeness adventure!

Reference: The modern era of light kaonic atom experiments, C. Curceanu et al., Rev. Mod. Phys. 91, 025006 (2019); Kaonic atoms at the DAϕNE collider: a strangeness adventure, C. Curceanu et al., Front.in Phys. 11 (2023) 1240250

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

Activity period: June-July or September-October 2025

Local Secretariat: Alessandra Tamborrino Orsini (alessandra.tamborrinoorsini@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: one week in mid-August.
Local web page: http://user.lnf.infn.it/summer-student-opportunities/

8. LNF – FRASCATI NATIONAL LABORATORY

27. VIP - Testing Quantum Foundations Underground

Title: Exploring Quantum Frontiers Underground: Probing Pauli Exclusion Principle Violation and Gravity-Related Collapse Models

Description: Are you intrigued by the fascinating quantum mechanics and its possible limits? Join the VIP experiment, located in the underground laboratory of the Gran Sasso National Laboratory (LNGS-INFN), where we explore the frontiers of physics by testing fundamental quantum principles. Our mission includes searching for violations of the Pauli Exclusion Principle (PEP), through atomic transitions prohibited by PEP, and detecting spontaneous radiation predicted by quantum collapse models, which aim to address the biggest problem of quantum physics: the measurement problem, related to the Schrödinger cat paradox. These investigations are at the cutting edge of quantum mechanics, with the potential to uncover signals that could revolutionize whole science.
The VIP collaboration has developed state-of-the-art radiation detectors and Machine Learning-based data analysis methods, achieving world-leading constraints on PEP violation probabilities and collapse model predictions. As we optimize our experimental apparatus and analyze data, we strive to push these limits even further—or, perhaps, reveal the first signs of new physics. The implications extend beyond fundamental science, offering insights relevant to emerging quantum technologies.
Activity: As part of this project, the student will dive into every exciting aspect of the VIP experiment. From preparing and testing cutting-edge detector systems to analyzing data with advanced statistical tools and Machine Learning, he/she will gain hands-on experience at the forefront of experimental physics.
The student will also contribute to interpret the results within modern and beyond the Standard Model theoretical frameworks, including gravity-related collapse models and quantum gravity scenarios. This is real and unique chance to contribute to one of the most fascinating and groundbreaking endeavors in quantum foundations!

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 2025

Local Secretariat: Alessandra Tamborrino Orsini (alessandra.tamborrinoorsini@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: one week in mid-August.
Local web page: http://user.lnf.infn.it/summer-student-opportunities/

8. LNF – FRASCATI NATIONAL LABORATORY

28. JLAB12

Title: Kaon electroproduction with the CLAS12 detector

Description: The Thomas Jefferson National Accelerator Facility, in Newport News, VA (USA), with its high intensity and high polarization electron beam, is one of the world leading facilities in the study of the internal structure of the nucleon. The Hall B of the Lab is equipped with various, unpolarized as well as polarized, targets and with the CLAS12 spectrometer, that allows the identification of charged and neutral particles in a wide kinematic acceptance.
In recent years, the electroproduction of two hadrons in the Deep Inelastic Scattering region has emerged as one of the most interesting reactions to investigate the partonic distributions functions of the nucleons. In particular, if one of the two detected hadrons is a kaon (as for example in $ep \rightarrow epKX$) one can get access to the distribution functions of the strange quarks, poorly known so far.
The identification of charged kaons in CLAS12 is performed by the two modules of the RICH detector, whose design, construction and installation has been completed in a project lead by INFN scientists.

Activities: The student will perform the physics analysis of channels involving one proton and one charged kaon in the final state. Machine Learning techniques will be used to analyze the data, to increase the detection efficiency and suppress the contamination from misidentified particles. Detailed studies of the kaon identification with the RICH detector with real and simulated data, which is one of the most relevant ingredients of this analysis, will be done.
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 2025

Local Secretariat: Alessandra Tamborrino Orsini (alessandra.tamborrinoorsini@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: one week in mid-August.
Local web page: http://user.lnf.infn.it/summer-student-opportunities/

8. LNF – FRASCATI NATIONAL LABORATORY

29. CYGNO

Title: 3D reconstruction of low energy electron track in a CYGNO Dark Matter detector prototype.

Description: The CYGNO project aims to enhance the detection capabilities of dark matter through the development of a directional detector by means of a high-precision gas Time Projection Chamber (TPC), read out optically by an sCMOS camera and multiple photomultipliers. The information from these devices is merged to retrieve the three-dimensional shape of the particle track. The proposed activity focuses on the three-dimensional reconstruction of low-energy electron tracks within the CYGNO detector prototype. Utilizing advanced algorithms based on machine learning, the candidate will work to determine spatial resolution and directional sensitivity and to demonstrate the ability to accurately reconstruct electron tracks with energies as low as a few keV.

Activities: data acquisition in laboratory, analysis of the data collected, participation to the activity of the CYGNO experiment.

Tutor:
Giovanni Mazzitelli (giovanni.mazzitelli@lnf.infn.it)
Giorgio Dho (giorgio.dho@lnf.infn.it)

Activity period: June-July or September-October 2025

Local Secretariat: Maddalena Legramante (maddalena.legramante@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: one week in mid-August.
Local web page: http://user.lnf.infn.it/summer-student-opportunities/

8. LNF – FRASCATI NATIONAL LABORATORY

30. LHCb

Title: R&D activities for the fixed target at LHCb

Description: The internal gas target at LHCb offers exceptional opportunities for an extensive physics program spanning heavy-ion, hadron, spin, and astroparticle physics. The combination of a storage cell placed in the LHC primary vacuum, an advanced Gas Feed System, the availability of multi-TeV proton and ion beams, and the recent upgrade of the LHCb detector make this project unique worldwide. In 2024, LHCb collected exceptional beam-gas data, demonstrating that fixed-target collisions can occur simultaneously with collider mode operations without compromising efficient data acquisition and high-quality reconstruction of beam-gas and beam-beam interactions.

Activities: The current fixed target system provides unpolarized collisions. The ongoing R&D efforts aims to upgrading the system to a polarized target system, which would be the only way to achieve polarized collisions at the LHC. The student's activity will focus on understanding and studying the polarized Atomic Beam Source and addressing other key aspects to ensure the system's compliance with the LHC.

Tutor:
Pasquale Di Nezza (pasquale.dinezza@lnf.infn.it)
Marco Santimaria (marco.santimaria@lnf.infn.it)

Activity period: June-July or September-October 2025 (preferred)

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: one week in mid-August.
Local web page: http://user.lnf.infn.it/summer-student-opportunities/

8. LNF – FRASCATI NATIONAL LABORATORY

31. LHCb Semileptonics

Title: Search for New Physics in semileptonic decays of the B_s meson

Description: LHCb is one of the main experiments collecting data at the Large Hadron Collider accelerator. One of its primary goals is to accurately study the properties of b-hadrons copiously produced in the proton-proton collisions at LHC. The semileptonic decays of the B mesons have been studied with great precision at B-Factories. These decays are processes like B—>Dmu nu_mu, where the b-quark inside the B meson transforms in a c-quark (giving the D meson in the final state) with the emission of a virtual W-boson, which subsequently couples to the muon and the anti-neutrino in the final state. At present, there are various puzzles and anomalies observed in studying semileptonic decays of these mesons. Some of these anomalies could be hints of Physics Beyond the Standard Model. It is paramount to study semileptonic decays in other b-hadron species to check these anomalies in alternative environments and to access other observables very sensitive to new physics contributions. The LHCb group in Frascati is deeply involved in the study of semileptonic decays of B_s mesons. The B_s mesons (contain an anti-b quark and a s-quark instead of a u- or d-quark, as in ordinary B meson) are interesting because they offer various advantages compared with the B mesons on both the experimental and theoretical side.

Activities: The student will be deeply involved in key aspects of the data analysis using data collected in 2024 and the beginning of 2025, and also part of older data collected in 2016-2018. Depending on her/his interests and when she/he will be with us, the work can focus on:

- The development of novel algorithms to control the soft photon efficiency, which is required by some of the measurements we are interested in;
- The optimization of signal selection to reduce the most dangerous backgrounds using Neural Networks or other Machine Learning approaches;
- The final multi-dimensional fit to extract the parameters of interest from data unfolded for resolution and corrected for efficiencies.

Some knowledge in computing (e.g. Python, C++, root) is desirable but not mandatory.

Tutor:
Marcello Rotondo (marcello.rotondo@lnf.infn.it)
Elisa Minucci (elisa.minucci@lnf.infn.it)
Patrizia de Simone (patrizia.desimone@lnf.infn.it)

Activity period: June-July or September-October 2025

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: one week in mid-August.
Local web page: http://user.lnf.infn.it/summer-student-opportunities/

9. LNGS - GRAN SASSO NATIONAL LABORATORY

32. LUNA 12C12C

Title: Direct measurement of the $^{12}C+^{12}C$ fusion cross section inside the LNGS underground laboratory.

Description: Fusion reactions are essential for understanding energy production, nucleosynthesis, and the evolution of massive stars. $^{12}C+^{12}C$ fusion is the primary process driving carbon burning in the late stages of stellar evolution, influencing the formation of heavier elements and the fate of these stars. The LUNA (Laboratory for Underground Nuclear Astrophysics) collaboration aims to study the $^{12}C+^{12}C$ fusion via photon detection at the new "Bellotti" Ion Beam Facility, located inside the LNGS (Laboratori Nazionali del Gran Sasso) underground laboratory in Italy.

Activities: This internship is intended to introduce the successful applicant to Nuclear Astrophysics, including both the theoretical background and the experimental techniques needed to perform cutting-edge research in this field, with particular attention to High Purity Germanium (HPGe) detectors. The student will be involved in the real experiment and will contribute to the implementation and the use of advanced analysis techniques to determine the reaction cross section.

Tutor: Federico Ferraro (federico.ferraro@lngs.infn.it)

Activity period: June-July OR September-October 2025

LNGS UserOffice: Vincenzo Fantozzi and Serena Cavalcante (useroffice@lngs.infn.it)
Local LNGS site https://www.lngs.infn.it/en
LNGS Summer Students Program site https://www.lngs.infn.it/it/summer-student-lngs

Other information: open positions: 1, further information on LUNA: https://luna.lngs.infn.it/

9. LNGS - GRAN SASSO NATIONAL LABORATORY

33. LUNA EASY

Title: Installation and commissioning of the setup for the study of the $^{22}Ne(\alpha,\gamma)^{26}Mg$ reaction at the LNGS underground laboratory

Description: The LUNA (Laboratory for Underground Nuclear Astrophysics) collaboration aims to study the $^{22}Ne(\alpha,\gamma)^{26}Mg$ reaction via gamma-ray detection at the new "Belotti" Ion Beam Facility, located inside the LNGS (Laboratori Nazionali del Gran Sasso) underground laboratory in Italy. An essential component of this experiment is the installation and operation of six sodium-iodide (NaI) detectors in a new array designed to surround an existing recirculating gas target where the reaction will take place. The detectors will be shielded in 5 cm thick lead shielding to suppress environmental background and improve the detection sensitivity.

Activities: The goal of this internship is to actively participate in the construction and commissioning of the setup that will be used in the study of the $^{22}Ne(\alpha,\gamma)^{26}Mg$ reaction. This will include the study of environmental background, analysis of calibration data, development of online monitoring tools, and participation in functionality tests with alpha beams.

Tutor: Thomas Chillery (thomas.chillery@lngs.infn.it)

Activity period: June-July OR September-October 2025

LNGS UserOffice: Vincenzo Fantozzi and Serena Cavalcante (useroffice@lngs.infn.it)
Local LNGS site https://www.lngs.infn.it/en
LNGS Summer Students Program site https://www.lngs.infn.it/it/summer-student-lngs

Other information: open positions: 1, further information on LUNA: https://luna.lngs.infn.it/

10. PADOVA

34. LHCb

Title: Identification of heavy-flavour jets at LHCb using Graph Neural Networks.

Description: The LHCb experiment is a spectrometer that covers the forward region of proton-proton collisions, in the pseudorapidity range from 2 to 5. Thanks to its excellent vertex reconstruction system, it has already demonstrated the capability to identify heavy-flavor jets. Moreover, c-jet identification (c-tagging) is a crucial ingredient for the search for $H \rightarrow cc$ at LHCb. Despite the good performance of current algorithms, the jet identification performance for c-jets remains suboptimal. New Machine Learning algorithms, such as Graph Neural Networks (GNNs), could improve this performance by using jet substructure information and potentially provide new insights into several physics channels.

In this internship, the trainee will develop a GNN to identify jets produced by b and c quarks. They will study the properties of jets originating from heavy and light flavors using simulated jet events produced with the official LHCb simulation framework. The performance of the GNN will be evaluated and compared with standard LHCb tools and state-of-the-art Machine Learning algorithms. During this period, the trainee will gain basic knowledge of working in a High Energy Physics experiment and develop the computing skills necessary for data analysis. The software ROOT and typical Python Machine Learning libraries will be used to achieve various goals. Additionally, the trainee will learn how advanced Machine Learning techniques work and how to apply them to High Energy Physics problems.

Activities: Development and application of advanced machine learning algorithms to study jet sub-structure. Use of jets samples produced by official LHCb simulation framework.

Tutor: Davide Zuliani, Donatella Lucchesi and Alessio Gianelle

Activity period: June-July or September-October

Local Secretariat: segreterieinfn@pd.infn.it

Other information:

10. PADOVA

35. Muon Collider

Title: Study of b- and c- jet identification with advanced machine learning algorithms at 10 TeV muon collider

Description: The Muon Collider is one of the most promising machines for the future of particle physics with accelerators. Muon collisions at multi-TeV center of mass energies are the ideal place to perform precison physics measurements like the study of the Higgs boson properties, and to search for new high mass particles. Jets play a crucial role in both researches and dedicated algorithms for their identification have to be developed and optimized.
The main challenge is the treatment of the contribution of the beam-induced background, that is produced by the decay in flight of muons of the beams and subsequent interactions with the environment. This background poses potential limitations on the jets and tracks reconstruction. Beam-induced background hits in the tracker system increase the number of fake tracks that jeopardize the identification of secondary vertices due to heavy hadrons decay.

In this internship, the trainee will be introduced to the muon collider simulation as well as to advanced machine learning algorithms. He/she will study the properties of jets originated by heavy and light flavors by using simulated jet events produced in muon collisions at 10 TeV center of mass.
During this period, the trainee will gain the basic knowledge for working in an High Energy Physics experiment, and he/she will develop the computing skills that are necessary to analyse data, mainly using the software ROOT and/or Python. He/she will also learn how advanced machine learning techniques work and how to apply them to High Energy Physics problems.

Activities: Development and application of advanced machine learning algorithms to study jet sub-structure. Use of jets produced in muon collisions at 10 TeV center of mass energy.

Tutor: Donatella Lucchesi, Davide Zuliani and Alessio Gianelle

Activity period: June-July or September-October

Local Secretariat: segreterieinfn@pd.infn.it

Other information:

10. PADOVA

36. ICARUS – SBN

Title*:* Studies on the neutrino events collected in the ICARUS T600 detector at FERMILAB

Description: The ICARUS T600 LAr-TPC detector is presently taking data at Fermilab exposed to the Booster Neutrino Beam (BNB). Within the SBN program ICARUS will definitively clarify the open questions of the presently-observed neutrino anomalies hinting at the possible existence of sterile neutrinos. The T600 is taking data at shallow-depth, exposed to a large flux of cosmic muons that cross the detector and randomly overlap each triggered event during its 1-ms drift time window. Neutrino interactions should be disentangled from the overlapping particles and recognized among the millions of events triggered by cosmics. It is then necessary to deploy suitable automatic tools for the identification, selection and measurement of the neutrino events and for the rejection of the incoming cosmic muons.
The student will be involved in the analysis of the neutrino events collected. The student will contribute to the development of the event selection tools to automatically recognize the neutrino interactions, focusing on the identification of both electron and muon neutrinos. The developed tools will be applied on the simulated and recorded events associated to both the BNB and NuMI beams and a visual study of neutrino events will be also performed in order to validate and improve the developed tools and evaluate their performance.
This activity offers to the student the unique opportunity to participate to a modern large-scale neutrino experiment and to gain a significant experimental experience.

Tutor: Christian Farnese, Maria Artero Pons

Activity period: September/October 2025

Local Secretariat: Segreterie Scientifiche INFN   segreterieinfn@pd.infn.it

10. PADOVA

37. LUNA

Title: Experimental Design for Nuclear Astrophysics at LUNA

Description: LUNA (Laboratory for Underground Nuclear Astrophysics) is an experiment dedicated to studying nuclear reactions of astrophysical interest. Its deep underground location at the Gran Sasso National Laboratories (LNGS) ensures an environmental background level orders of magnitude lower than above ground, enabling reaction measurements to be performed at astrophysically relevant energies.
Recently, a new accelerator (the "Bellotti" Ion Beam Facility) has been installed at LNGS with outstanding beam (H+, He+ and 12C+,++) stability and intensity features. Among the reactions to be investigated within the dense program of the new facility is the 12C+12C reaction. This reaction plays a crucial role in determining the fate of massive stars and the nucleosynthesis of elements in stellar environments. It is a key process in stellar evolution, influencing the transition from carbon burning to more advanced burning stages in massive stars, and ultimately affecting supernova explosions and the chemical enrichment of the universe.
At LUNA, we have the unique capability to directly measure this reaction at the lowest possible energies, covering an important region of the Gamow peak. This achievement will provide unprecedented insight into stellar processes and help refine our understanding of stellar evolution and nucleosynthesis.
The study of this reaction will be conducted by the LUNA collaboration, whose efforts will cover all aspects of the experimental design and measurement fulfillment: from target preparation, detector installation and characterization to data taking and analysis.
The candidate will focus on the experimental design, working on the characterization of the setup with the LUNA simulation code and on the outline of the experimental campaign. Moreover, the candidate will participate in target preparation and characterization at two different INFN National Laboratories: LNL (close to Padua) and LNGS. This candidate will have the opportunity to participate in all phases of the experimental campaign.

Tutor: Prof. Antonio Caciolli (antonio.caciolli@pd.infn.it)

Activity period: June – July or September – October 2025

Local Secretariat: segreterieinfn@pd.infn.it

Other information: https://www.pd.infn.it/eng/luna/

11. PERUGIA

38. BELLE II

Title: The upgrade of the electromagnetic calorimeter (ECL) of the Belle II detector at SuperKEKB

Description: The current detector limitations are due to insensitivity to the incident photon direction and to possible deterioration of the energy resolution due to the signals pileup that can be produced under severe background conditions. Some upgrade options have been discussed in order to cope with the high occupancy and background rate and to maintain good particle reconstruction performances. Since CsI(Tl) crystals scintillation decay time is relatively long, ~ 1 μs, the increase of beam background would results in a larger pileup noise that would deteriorate the detector energy resolution. This effect is particularly relevant for neutral particles with respect to electron and positrons, as they are measured only in the ECL, without taking advantage of a good precise momentum measurement performed in the tracking detector. To control the pile-up in condition of high background it is possible to use a high gain photodetector to perform an accurate measurement of the timing exploiting the large amount of light emitted by the CsI(Tl) crystals. SiPM's are a very good option thanks to their fast response, high gain and simplicity in use. Some preliminary studies have been done trying to understand the actual possibility of using these photodetectors for timing measurement, keeping the PiN diodes for the signal amplitude measurement.

Activities: The project is devoted to continuing this R&D study in particular in selecting the best possible option for the photodetector together with developing the read out front end electronics matching the required performance for the ECL detector.

Tutor: Claudia Cecchi

Activity period: september-october

Local Secretariat: Ilaria Binaglia, email: ilaria.binaglia@pg.infn.it

Other information:

11. PERUGIA

39. FERMI-LAT

Title: Application of machine learning methods on Fermi-LAT counts-map images.

Description: Gamma-ray radiation in our universe is an indicator of non-thermal emissions and ca-tastrophic events occurring within or beyond our galaxy. The gamma-ray sky is restless, and over several years of observation, we have been able to detect different class of sources, such as Active Galactic Nuclei, Pulsars, and transient events as Gamma-ray burst. During its nearly 17-year opera-tional period, the Large Area Telescope (LAT) on board the Fermi satellite has identified more than 7,000 gamma-ray sources, shedding light on the emission mechanisms behind billions of high-ener-gy photons collected.

Activity: The student will analyze Fermi-LAT count map images to develop new detection methods for gamma-ray sources using Machine Learning techniques directly on the images (e.g., YOLO or fully convolutional neural networks) to optimize the detection process and improve the de-blending of gamma-ray sources.

Tutor: Sara Cutini (sara.cutini@pg.infn.it) and Stefano Germani (stefano.germani@pg.infn.it)

Activity period: June-July

Local Secretariat: Ilaria Binaglia, email: ilaria.binaglia@pg.infn.it

Other information:

Website of Department: http://www.fisica.unipg.it/fisgejo/index.php/it/

Students useful information: https://www.adisu.umbria.it/

Leisure: https://www.umbriajazz.it/, https://www.itinerarinellarte.it/it/mostre/umbria, https://www.quintana.it/

12. PISA

40. VIRGO

Title: Development of seismic attenuation systems for current and next-generation gravitational wave detectors

Description: The search for gravitational waves is being pursued at present with large interferometers in Europe, US and Japan. Advanced Virgo is the interferometric gravitational wave detector, located at the European Gravitational Observatory near Pisa, Italy. Furthermore, there is an increasing activity toward the development of third-generation detectors, such as the Einstein Telescope in Europe and Cosmic Explorer in the US.One of the key aspects of experimental development of new detectors is the attenuation of seismic noise to improve sensitivity at low frequencies. The research group at INFN-Pisa and University of Pisa has a longstanding tradition in experimental gravitational wave physics, thanks to its key role in the design, construction and operations of the Superattenuators of Virgo. The group is also active in development of seismic isolation systems for the Einstein Telescope. During the stay we will offer to the student the possibility to participate actively in the experimental work related to the development of super attenuators, with particular attention to the simulations, characterization, electronics and control system.

Tutor: Francesco Fidecaro (francesco.fidecaro@unipi.it)
Massimiliano Razzano (massimiliano.razzano@unipi.it)

Activity period: June-July or September-October

Local Secretariat: Giacomo Betti giacomo.betti@pi.infn.it

Other information:

12. PISA

41. GW VIRGO-ET

Title: Geometric approach for attenuation of seismic noise.

Description: Advanced VIRGO is the interferometric gravitational wave detector located at the European Gravitational Observatory (EGO) near Pisa, Italy. It is part of the LIGO-Virgo-KAGRA network that is currently pursuing the search and studying of gravitational waves signals.
Seismic motion limits the sensitivity of these ground based detectors at low frequencies because it induces vibrations on optical components of the interferometer that can mimic the effect of gravitational waves.
One of the key aspects in the experimental development for new detectors is the attenuation of seismic noise improving the sensitivity at low frequencies. The modern filtering structure adopted to inhibit seismic noise transmission at the optical level is, indeed, based on mechanical systems which act as chains of harmonic oscillators. The required attenuation factor, up to 14 orders of magnitude in the detection band, is obtained by cascading mechanical filters (harmonic oscillators) having resonant frequencies as low as possible.
The Virgo-ET research group at INFN Pisa has a longstanding tradition in this field, thanks to the implementation of the Virgo Superattenuators and its operation as Seismic Isolation System for the modern interferometers of Gravitational Waves detectors. These are based on a multi-stages pendulum chain for horizontal attenuation and on vertical oscillators for the vertical degree of freedom implemented within the same mechanical structure. In the first case low resonant frequencies are obtained by choosing a long enough pendulum, in the second one by integrating into the system, a magnetic device acting as an elastic element with negative stiffness (magnetic anti-springs). An alternative solution is represented by the use of a custom-designed mechanical element acting as negative spring, or with a very low stiffness on the base of their peculiar geometry (geometric anti-spring; see https://doi.org/10.1016/j.nima.2004.10.042).
In this project the student will be involved in the exploration of new solutions, both for the vertical or/and the horizontal degrees of freedom, starting from the geometric anti-spring concept, in a tentative way to improve even the filtering performance of the present systems and looking at the future of the second and third-generation detectors. Several figures of merit will be considered to characterize the new custom-geometry: attenuation performances, compactness, robustness, stability, etc.. The different solutions will be studied and evaluated with appropriate simulation codes exploring the different geometric configurations.

Activities: Numerical simulation of elastic lines and exploration of their configuration and parameter space. If time permits, implementation of prototypes and cross validation of the simulation results with laboratory measurements.

Tutor: Giancarlo Cella (giancarlo.cella@pi.infn.it) Franco Frasconi (franco.frasconi@pi.infn.it)

Activity period: September-October

Local Secretariat: Giacomo Betti giacomo.betti@pi.infn.it

12. PISA

42. VIRGO/ET

Title: Development of a data analysis pipeline for current and next-generation gravitational wave detectors and implication for astrophysics, cosmology and fundamental physics.

Description: The search for gravitational waves is being pursued at present with large interferometers in Europe, US and Japan. Advanced Virgo is the interferometric gravitational wave detector, located at the European Gravitational Observatory near Pisa, Italy. Furthermore, there is an increasing activity toward the development of third-generation detectors, such as the Einstein Telescope in Europe and Cosmic Explorer in the US.
One of the key aspects of development of new detectors is the ongoing improvement in the data analysis pipeline. The research group at INFN-Pisa and University of Pisa has a longstanding tradition in gravitational wave data analysis with implications for astrophysics, cosmology and fundamental physics.
During the stay, we will provide the student with the opportunity to actively participate in developing a project focused on data analysis of gravitational wave sources and their implications for cosmology and astrophysics using the latest available LVK data, as well as forecasts for future detectors like the Einstein Telescope (ET). The student will also have the chance to closely collaborate with the experimental group and interact with people involved in simulations, characterization, electronics, and control systems of the Virgo detector.

Tutor: Angelo Ricciardone

Activity period: Two-months period (~9 weeks) to choose between june-july or September/October

Local Secretariat: Local secretary:

13. ROMA 1

43. JLAB12

Title: Time and amplitude characterization of a plastic scintillator and photodetectors system as a neutron TOF counter for the measurement of the $e + p \rightarrow n + \nu_e$ reaction.

Description: An experimental proposal for the extraction of the proton axial form factor by means of the $e + p \rightarrow n + \nu_e$ reaction measurement at Jefferson Lab is in development, a joint effort of Jefferson Lab with American universities and INFN JLab12 Collaboration. The construction of a neutron TOF wall is devised as key equipment complementary to the SuperBigBite spectrometer (SBS), in use for the measurement of the electromagnetic nucleon form factors in HallA at Jefferson Lab.
An R&D program for the optimization of 1 GeV neutron detection efficiency and time of flight resolution is under development.

Activities: During the two months period, the candidate will participate into both an experimental characterization of the scintillator+photodetector prototype system, and Monte Carlo validation of the results.

Tutor: Evaristo Cisbani

Activity period: June-July 2025

Local Secretariat: Mauro Mancini

Other information:

14. ROMA TOR VERGATA

44. VIRGO/EINSTEIN TELESCOPE

Title: Development and Characterization of Advanced Optical Systems for Thermal Compensation in Gravitational Wave Detectors

Description: In the era of multi-messenger astronomy, gravitational wave detection has become a cornerstone of modern astrophysics, enabling unprecedented insights into the universe.
Collaborative efforts involving a global network of detectors have unlocked new scientific opportunities, leveraging large-scale interferometers in Europe and the United States. Among these, **Virgo**—situated at the European Gravitational Observatory in Cascina (Pisa, Italy)—and the future **Einstein Telescope** represent key instruments in this field.
The proposed research program focuses on the **development and characterization of advanced optical systems for aberration control and thermal compensation**, a critical aspect in enhancing the sensitivity of both current and next-generation gravitational wave detectors. The work will involve **adaptive optics techniques**, including the study and characterization of high-power lasers, high-finesse optical cavities, and thermal compensation mechanisms for actuation and sensing. Participants will have the unique opportunity to engage in experimental activities at INFN Roma Tor Vergata and University of Roma Tor Vergata laboratories, gaining hands-on experience with state-of-the-art optical systems and contributing to cutting-edge research in gravitational wave science, directly contributing to this critical research area, gaining expertise in experimental techniques, numerical analysis, and optical systems design.

Activities:

- Design of optical setups for characterization of actuators and sensors for correction of optical aberrations.
- Assembly and characterization of optical system, including the study of laser beam quality and power and temperature stabilization.
- Development, analysis and optimization of high-finesse optical cavities.
- Numerical analysis of images acquired with specialized tools to validate experimental results.

Tutors:
Maria Cifaldi (maria.cifaldi@roma2.infn.it)
Elisabetta Cesarini (elisabetta.cesarini@roma2.infn.it)

Activity Period:
June/July 2025 or September/October 2025

Local Secretariat:
Elettra Perfetti
elettra.perfetti@roma2.infn.it
dir@roma2.infn.it
Tel: +39 06 72594570

Other Information:
The institute will be closed from August 12 to 22, 2025.

14. ROMA TOR VERGATA

45. EINSTEIN TELESCOPE

Title: Design and Testing of Cryogenic Systems for Investigating Materials, Monitoring Mirror Surfaces, and Characterizing Specialized Sensors for Future Cryogenic Gravitational Wave Detectors

Description: In the era of multi-messenger astronomy, gravitational wave detection has become a fundamental tool for exploring and understanding the universe. The coordinated operation of a global network of detectors has opened up unprecedented opportunities for scientific discovery. This research focuses on large interferometers in Europe and the United States, with a particular emphasis on the **Einstein Telescope**, a next-generation gravitational wave observatory currently under development in Europe.
The proposed research program offers participants the chance to engage in **experimental activities** at Roma Tor Vergata University, aimed at advancing the sensitivity of next-generation gravitational wave detectors. The program emphasizes **cryogenic systems**, where participants will work with test cryostats and design experimental setups capable of operating at cryogenic temperatures. They will characterize materials and sensors and study their performance under these conditions.

Activities:

- Design, installation, and functional testing of cryogenic chambers.
- Assembly and characterization of experimental setups, including:
    - Motorized nodal suspensions for measuring material dissipation.
    - Infrared/visible fiber-optic sensors.
    - High-finesse optical cavities.
- Development of control systems for position, temperature, and power regulation.

Tutors:
Maria Cifaldi (maria.cifaldi@roma2.infn.it)
Elisabetta Cesarini (elisabetta.cesarini@roma2.infn.it)

Activity Period:
June/July 2025 or September/October 2025

Local Secretariat:
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Tel: +39 06 72594570

Other Information:
The institute will be closed from August 12 to 22, 2025.

15. TORINO

46. TASP/Fermi-LAT

Title: Search for gamma-ray emission around Galactic pulsar wind nebulae

Description: Pulsars and their nebulae are among the most powerful accelerators of Galactic electrons and positrons. The AMS-02 experiment aboard the International Space Station has detected a flux of very-high-energy positrons significantly exceeding the expected levels from canonical astrophysical secondary production. This phenomenon, known as the positron excess, could potentially be explained by pulsar wind nebulae. This hypothesis is supported by the detection of extended gamma-ray halos around a few of the most powerful and nearby pulsars by HAWC, MILAGRO, and HESS at energies above 1 TeV.
In this project, we will select pulsars from radio and gamma-ray catalogs that could plausibly emit gamma rays detectable in Fermi-LAT data. We will then search for a combined signal from these sources. Detecting a gamma-ray flux from pulsars in Fermi-LAT data could provide crucial insights into the mechanisms of positron acceleration in these sources and their contribution to the observed positron excess.

Activities: The student will learn to analyze Fermi-LAT data around pulsars using the official tools, Fermitools and Fermipy. Specifically, they will gain expertise in modeling the background, optimizing the position and spectrum of sources, and obtaining the resulting spectra. Additionally, the student will learn to perform a combined analysis of gamma-ray emission from a list of pulsars and interpret the data within the framework of a given astrophysical model.

Tutor: Mattia Di Mauro

Activity period: Periodo di 2 mesi (circa 9 settimane) scegliendo giugno-luglio e/o settembre-ottobre

Local Secretariat: Rosella ASTI, Tel. +39 011 670 7270, e-mail: rosella.asti@to.infn.it

Other information: INFN in Torino is hosted in the Physics Department (Via Pietro Giuria 1, 10125) that is closed for the summer season for two weeks before and after August 15th. This is the website of the astroparticle group in Torio https://www.astroparticle.to.infn.it/

16. TRIESTE

47. ePIC hardware

Title: Characterization of single photon sensors for Cherenkov imaging applications

Description: The dual radiator RICH (dRICH) will equip the forward endcap of the ePIC detector, making use of aerogel and gas. The photosensors are SiPMs. Trieste is evaluating in parallel the performance of MCP-based detectors, the large-area HRPPDs. The Trieste ePIC laboratory is fully equipped for photosensor evaluation and ample expertise is available based on the experience with COMPASS RICH and developments of innovative photosensor technology. The ongoing studies qualify the SiPM response with particular attention to the photon trajectories. HRPPDs are studied to access their ageing properties and performance in magnetic field.

Activities: The student will be integrated within the dedicated team (4 scientists) and will contribute to the above characterization measurements. He/she will be assigned a specific exercise and, then, he/she will report in an ePIC dRICH meeting. The outcome will be part of the overall qualification of photosensors for the RICHes of the ePIC experiment.

Tutor: Fulvio Tessarotto (fulvio.tessarotto@ts.infn.it)

Activity period: period of 2 months, preferred June-July 2025

Local Secretariat: Alessandra Filippi (alessandra.filippi@ts.infn.it , phone: +39 040 558 3375)

Other information:

16. TRIESTE

48. ePIC simulation

Title: Studies of dRICH performance by using the ePIC simulation framework

Description: The dual radiator RICH (dRICH) will equip the forward endcap of the ePIC detector, making use of aerogel and gas. The photosensors are SiPMs. The detector is fully implemented in the ePIC simulation framework, by which optimization studies are ongoing. The parameters being tuned include the mirror geometry, the sensor placement, the aerogel and gas characteristics. New reconstruction algorithms are qualified by comparative evaluation.

Activities: The student will be guided to the use of the ePIC simulation framework and he/she will perform a portion of the optimization studies in the context of the local dedicated team (three scientists are focusing on dRICH simulation exercises). The results of the student's effort will be presented by the student him/herself in an ePIC dRICH meeting and will become part of the global assessment of the dRICH performance.

Tutor: Chandradoy Chatterjee (chandradoy.chatterjee@ts.infn.it)

Activity period: period of 2 months, preferred June-July 2025

Local Secretariat: Alessandra Filippi (alessandra.filippi@ts.infn.it , phone: +39 040 558 3375)

Other information:

16. TRIESTE

49. ITS3

Title: 65 nm CMOS process MAPS detector characterization

Description:
A quasi-massless, truly cylindrical silicon detector based on Monolithic Active Pixel Sensors (MAPS) technology is being currently developed. Such a detector, named ITS3, will upgrade the Inner Tracking System for the ALICE detector at LHC in 2027. The same technology has been chosen as the baseline for the Silicon Vertex Tracker (SVT) of the ePIC detector at EIC, and is considered for the future ALICE 3 experiment at LHC.
To achieve the target performance, the design of a new large-area (~25 cm x 10 cm), extremely reduced thickness (< 50 microns) monolithic pixel sensor based on 65 nm CMOS process, is now ongoing, with the goal of building a series of curved silicon layers with minimal infrastructures in the active area. The first large-area chips featuring a stitched design are now under characterization.

Activities:
In Trieste, the ITS3 R&D for 2025 will focus on the characterization in laboratory of the 65 nm CMOS process test structures and stitched chip single units and will extend to sensors in curved geometry. The student will participate in the tests, contribute to the development of test procedures and software, gain experience in the interpretation of the results and learn how the sensor design affects the sensor performance. The work will train the student to conduct independent tests of the CMOS sensors.

Tutors:
Giacomo Contin (giacomo.contin@ts.infn.it)
Paolo Camerini (paolo.camerini@ts.infn.it)

Activity period:
Preferably June-July 2025 or September-October 2025.

Local Secretariat:
Alessandra Filippi (alessandra.filippi@ts.infn.it)

Other information:
- Affordable accommodation can be arranged with adequate notice.
- The local INFN website: https://www.ts.infn.it/en/
- Practical information about the Trieste Science System: http://www.welcomeoffice.fvg.it/

16. TRIESTE

50. BELLE II

Title: Performance optimization of the Belle II diamond-detector"

Description: The project focuses on the optimization of the working-point of the diamond-detector system of the Belle II experiment at the SuperKEKB collider at KEK. Electron-positron beam intensities needed for the Belle II physics program expose the detector to risks of damages from sudden large radiation doses due to losses of instable beams. Diamond sensors read-out by purpose--built electronics are installed around the interaction region to measure radiation and prevent damage. The sensors operate as solid-state ionization chambers, providing measurements of pA to nA currents proportional to the radiation-dose rates received thus (i) monitoring instantaneous radiation dose-rates (ii) recording integrated radiation-doses, and (iii) triggering beam aborts in case of excessive risk. Achieving the optimal working point that maximizes data-taking efficiency under safe conditions is challenging as collision conditions may change rapidly and impredictably.
The student will join our lab activities in Trieste, which develop along three thrusts: measurements of diamond-sensor gains to identify the optimal bias voltage (1-2 weeks); tests of the custom readout electronic board to calibrate precisely the digitized response (1-2 weeks); dedicated studies with a picoscope to define quantities useful for setting the optimal injection gate (4-6 weeks). The student will learn some basic experimental aspects of collider physics and diamond detectors, she/he will familiarize with usage of standard lab instrumentation and measurements and will ultimately contribute to optimize the operations of the Belle II detector.

Activities: Attività (optional)

Tutor: Kieran Amos, Lorenzo Vitale, Livio Lanceri

Activity period: Any 8 weeks between June and October 2025

Local Secretariat: Alessandra Filippi, alessandra.filippi@ts.infn.it, +39 040 5583375

Other information: the INFN Trieste labs are open throughout summer. They have a cafeteria where lunch or take-out meals are available at reasonable prices and a Guesthouse where convenient accommodation is available for temporary stays.