Announcement n. 28477

DOE-INFN Summer Students Exchange Program 2026 Edition

In accordance with Resolution no. 14512 of January 15th, 2026

The US Department of Energy (DOE) and the Istituto Nazionale di Fisica Nucleare of Italy (INFN) announce the 2026 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, 2026.

There are 11 positions available. Applicants can choose among 16 different INFN sites and 46 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 2026.

Applications, in electronic form, must be sent to INFN not later than **March 5th, 2026 (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.

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 of July 1st, 2025 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.

For information please send an e-mail to ac.dru.assegni.borse@lists.infn.it

Rome, 3rd February 2026

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 ADAPT - Characterization of fast digitizers for the readout electronics of the Antartic Demonstrator for the Astroparticle Physics Telescope (ADAPT)
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	9 NPQCD - Data-Driven Reduced Order Modeling for Fluid Dynamics
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4 Genova	11 LUNA - Development of simulation codes for low energy nuclear astrophysics experiments at LUNA (Laboratory for Underground Nuclear Astrophysics)
	12 Phenomenology and ATLAS - Theoretical and Experimental Studies of Heavy Flavours at the LHC
	13 ATLAS - Pixel Detector for the ATLAS Upgrade at HL-LHC
	14 ePIC-EIC-SRO -Streaming DAQ for the future ePIC detector at the Electron-Ion Collider
	15 ePIC-EIC-TAG Interaction Tagger Detector for the dRICH at the Future ePIC Detector at the Electron–Ion Collider
	16 JLAB12-A(i)DAPT - Generative AI for data analysis and preservation
5 LNF - Frascati National Labratory	17 VIP - Is Quantum Mechanics Exact? Testing the Foundations of Quantum Mechanics Underground: The VIP Experiment
	18 SIDDHARTA-2 - Kaonic Atoms and Advanced Radiation Detectors: Probing Fundamental Interactions with Exotic Atoms
	19 FLASH/GravNet - Development of Advanced Signal Processing and Machine Learning Techniques for High- Frequency Gravitational Wave Detection with the FLASH Experiment
	20 Belle II - Optimization of the Belle II detector glass Resistive Plate Chambers in avalanche operation mode
	21 Mu2e - Commissioning and performance of the Mu2e detectors
	22 LHCb Semileptonics - Search for New Physics in semileptonic decays of the B_s meson
6 LNGS – Gran Sasso National Laboratory	23 LUNA - Direct measurement of the 12C+12C fusion cross section inside the LNGS underground laboratory
7 LNS – South National Laboratory	24 KM3Net - Acoustic Positioning for the deep sea neutrino telescope KM3NeT-ARCA
8 Milano Bicocca	25 CUPID_1 - Analysis of CUPID Demonstrator Data and Comparison with MC simulations
	26 -CUPID_2 - CUPID R&D Activities for Advanced Light Detectors
9 Napoli	27 DUNE - Tests of Cryogenic Photosensors for an Innovative Photon Detection System for the Third Far Detector Module of the DUNE Experiment
	28 SND@LHC - Classification of shower events with the SND@LHC detector in the HL-LHC run
	29 MEMPHYS - Radiation-hardened-by-design FPGAs for Readout of Nuclear Trackers
	30 LEGEND - Data analysis of the liquid argon scintillation light in the LEXenDAryno prototype
	31 DarkSide-20k – DarkSide-Proto0 -Technological Development and Testing for DarkSide-20k

10 Padova	32 MUON COLLIDER - Study of muon ionizing cooling to produce low emittance muon beams
	33 LUNA - Study of the 27Al(p,a)24Mg for Nuclear Astrophysics at LUNA
	34 - ET/Virgo Scattered light noise in Gravitational Wave detectors
11 Pavia	35- RD_FCC / HiDRa - Energy response and resolution of a fibre sampling dual-readout calorimeter protoype
12 Pisa	36 SEISMIC - Seismic isolation systems, from Virgo to the next-generation gravitational wave detectors
	37 ET Studies and tests on new Magnetic Anti-Spring for passive filtering of seismic noise
13 Roma	38 LUNA - Experimental Gamma-Ray Spectroscopy for Nuclear Astrophysics applied at the $22Ne(\alpha,\gamma)^{26}Mg$ reaction
14 TIFPA	39 Monstre - Quantum Simulation of nuclear dynamics with Similarity Renormalization Group
	40 NuPhys_BNS - NuPhys_BNS -- Neutrino Physics in Binary Neutron Star mergers
15 Torino	41 FERMI - Classification of Gamma-ray Bursts from Fermi Prompt Observations with advance unsupervised machine learning
16 Trieste	42 ePIC_1 - Characterization of single photon sensors for Cherenkov imaging applications
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	45 ITS3 - 65 nm CMOS process MAPS detector characterization
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1. **BARI**

1. **ADAPT**

Title: Characterization of fast digitizers for the readout electronics of the Antartic Demonstrator for the Astroparticle Physics Telescope (ADAPT)

Description: The MeV sky is poorly explored and at present there are no scientific missions dedicated to the study of the Universe in this energy band. Hence the necessity of a new satellite instrument optimized for the MeV energy range. ADAPT will serve as demonstrator of a new concept of MeV space telescope based on scintillator crystals and fiber readout. In this project, the readout electronics based on fast digitizers to be employed on the ADAPT balloon will be characterized. The digitizers consist of the HDSoC ASICs, based on switched buffer arrays able to sample fast signals with sampling frequency up to 1 GSa/s. The digitizers ASICs will be coupled to Silicon Photomultipliers illuminated with pulsed LED light and to a dedicated preamplifier ASIC, called SMART.

Activities: The student will characterize the electronics boards developed for ADAPT, testing the entire readout channels from photosensors to digitized signals and optimizing the ASIC parameters to reach the best performance in terms of signal to noise ratio. The student will learn the basics of data acquisition systems, using different programming languages, such as *python* and *LabVIEW*.

Tutor (s): L. Di Venere (**leonardo.divenere@ba.infn.it**)

Activity period: June-July 2026

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

Other information: The Department will be closed in August 2026

1. **BARI**

2. **LHCb**

Title: Exploring the performance of environmentally friendly Micro Pattern Gaseous Detectors for the future upgrade of the LHCb muon system.

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 investigating the detector's performance when operated with different gas mixtures. He/she will take part in the research activity at INFN Bari LHCb Laboratory, gaining experience in detector operation, Monte Carlo simulation and data analysis.
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 2026

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

1. **BARI**

3. **TANGO_RD**

Title: Characterization of innovative Resistive Cylindrical Chambers for future HEP applications and beyond.

Description: The development of new, high-performance gaseous detectors featuring advanced designs, novel materials and eco-friendly gas mixtures stands as a key challenge for future High Energy Physics experiments and related applications.
In the framework of ongoing R&D activities, the Resistive Cylindrical Chamber (RCC) has been proposed as an innovative extension of the RPC planar detector to the cylindrical geometry, being studied at INFN Bari, LNF, ToV and at CERN.
The student will become familiar with this detector and will analyze data collected during beam test campaigns at CERN. He/she will take part in the research activity at INFN Bari RCC Lab, gaining experience in detector operation, data acquisition and analysis 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 2026

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

1. **BARI**

4. **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 18 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 2026

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

Other information: The Department is usually closed in August 2026

2. BOLOGNA

5. EPIC

Title: Fast and intelligent methods for the reconstruction of the ePIC-dRICH beam test data

Description: Following the successful development and beam-test validation of large-area SiPM-based photodetector prototypes for the ePIC-dRICH detector at the Electron-Ion Collider (EIC), the R&D project enters a new and decisive phase with the preparation and execution of the 2026 beam test, featuring the latest readout electronics and a real-scale detector prototype. The upcoming beam test will represent the first full-system validation of the final technological choices for the ePIC-dRICH detector, integrating upgraded SiPM photodetectors, newly developed custom readout boards and a complete data acquisition chain operating under close-to-realistic experimental conditions. A large and complex dataset is expected to be collected, requiring advanced, scalable and high-performance analysis tools.

The core objective of this project is the development of modern and fast data analysis frameworks to support the reconstruction and performance evaluation of the 2026 beam test data. Particular emphasis can be placed on efficient reconstruction of Cherenkov rings, precise timing and spatial characterisation of detected photons and detailed studies of detector performance at full scale. The analysis strategy will combine classical pattern-recognition and reconstruction techniques (such as Hough-transform-based ring finding and geometrical reconstruction algorithms) with state-of-the-art approaches based on artificial intelligence and deep machine learning. Special attention will be devoted to the optimisation of algorithms for parallel execution, exploiting modern computing architectures and GPU acceleration, with the long-term goal of enabling near–real-time or online feedback during data taking.

The person joining this project will actively contribute to the design, implementation and validation of these analysis tools, working on both simulated data and real beam-test data as they become available. A solid understanding of the detector hardware and readout electronics will be an integral part of the activity, ensuring a tight connection between detector operation, data quality, and reconstruction performance. Depending on the project timeline, the activity may also include direct participation in the 2026 beam-test operations, offering hands-on experience with detector commissioning, data-taking procedures, and online monitoring at the CERN-PS facility.

Activities: Data analysis of beam-test data from the ePIC-dRICH SiPM detector prototype. Development of fast reconstruction algorithms for Cherenkov ring reconstruction. Application of machine learning techniques for pattern recognition, event reconstruction and performance optimisation. Parallelisation of reconstruction and analysis workflows, including GPU acceleration. Possible participation in detector commissioning and data-taking operations at CERN-PS.

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

Activity period: June-July or September-October

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

Other information: The activity will be carried out at the INFN-Bologna laboratories. Depending on the final schedule of the 2026 beam test, the candidate may be involved primarily in advanced data analysis activities or may also participate directly in beam-test operations.

3. FERRARA

6. CRYSTAL

Title: Crystal Physics for Next-Generation Detectors: Dark Matter Searches and VHE Gamma-Ray Polarimetry

Description:
Crystal physics opens the door to unique opportunities across several areas of modern physics. Because crystals have an ordered lattice, they can be oriented to exploit anisotropic interaction properties and to design detectors that are more compact and efficient than conventional ones.
In dark-matter experiments, an electromagnetic calorimeter made of oriented scintillating crystals produces a significantly compact shower development. This compactness increases the probability that dark-matter candidates traverse the detector without being absorbed, while suppressing backgrounds from penetrating photons that mimic the dark-photon signatures. The combined effect is an improved experimental sensitivity to rare dark-matter events.
In astrophysics, several sources of very-high-energy (VHE) photons from the Galactic Center remain unidentified, partly because their photon energies extend beyond the optimal operating range of many standard space-borne detectors. A polarimeter based on an oriented crystal could be implemented on a satellite to address this limitation. In such a device, the conversion probability of an incoming photon depends on its polarization state, enabling polarization measurements at energies where current space instruments face strong constraints. These measurements would provide new information about the emission mechanisms of VHE sources.

Activities: Students may join one of several research tracks, tailored to their interests and prior experience. Possible activities include:

- Crystal materials characterization in the University of Ferrara laboratories, including optical interferometry and surface profilometry measurements.
- Data analysis and software development, using Python and/or C++/ROOT to process and interpret experimental datasets.
- Realistic experiment simulations, developing detailed detector and beamline models with the Geant4 toolkit.

<u>Available Project Topics:</u>

- Oriented-crystal electromagnetic calorimetry for particle physics and dark-matter searches.
- Oriented-crystal gamma-ray polarimetry for the study of very-high-energy photon sources, with applications to space-borne satellite missions.

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
Projects web-page: https://crystalab.unife.it/home-page

3. FERRARA

7. LHCb_1

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 more than 20 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 in B-hadron decays to fully hadronic final states.

Activities: The candidate will learn the statistical and computational tools used in High Energy Physics data analysis. They will 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.

Tutor: 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

3. FERRARA

8. LHCb_2

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 (RICH1 and RICH2). 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.

Activities: The student, joining the Ferrara group in Summer 2026, 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: Giovanni Cavallero (giovanni.cavallero@cern.ch), Massimiliano Fiorini (fiorini@fe.infn.it), Marco Guarise (guarise@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

3. FERRARA

9. NPQCD

Title: Data-Driven Reduced Order Modeling for Fluid Dynamics

Description: Bridging length and time scales is a long-standing challenge in computational fluid dynamics and, more broadly, in computational physics. Many fluid dynamics problems of scientific and engineering relevance exhibit complex multi-scale behavior, making fully resolved numerical simulations computationally prohibitive. Reduced-order and coarse-grained models are therefore essential, but traditional approaches often rely on strong simplifying assumptions that limit their accuracy and predictive power.
This project focuses on the development of physics-informed, data-driven reduced-order models for fluid dynamics across multiple scales. The central idea is to embed established physical priciples such as conservation laws, symmetries, and governing equations, with modern Machine Learning techniques to learn effective models that faithfully capture unresolved dynamics. Flows in porous media provide a representative example, where pore-scale dynamics must be linked to effective continuum descriptions, but the methodologies developed in this project are general and applicable to a broad range of problems, including subgrid-scale modeling for turbulence and other multi-scale flow phenomena.
Throughout the project, the student will gain experience at the interface of fluid dynamics, numerical modeling, and scientific Machine Learning. They will learn how to embed physical structure into data-driven models, and assess the accuracy and generalization properties of learned reduced-order models.

Activities: Development and application of physics-informed data-driven reduced-order models for multi-scale fluid dynamics. Use of high-fidelity simulation data to learn coarse-grained or subgrid-scale descriptions, and benchmarking against standard Machine Learning-based surrogate and closure models. To efficiently handle the computational demands of the project, the student be provided with access to state-of-the-art high-performance computing GPU architectures.

Tutor: Alessandro Gabbana (agabbana@fe.infn.it), Enrico Calore (enrico.calore@fe.infn.it), Sebastiano Fabio Schifano (schifano@fe.infn.it)

Activity period: September-October

Local Secretariat: Paola Fabbri (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.

3. FERRARA

10. 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 2026, 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 2026

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. GENOVA

11. LUNA

Title: Development of simulation codes for low energy nuclear astrophysics experiments at LUNA (Laboratory for Underground Nuclear Astrophysics)

Description: The **L**aboratory for **U**nderground **N**uclear **A**strophysics (LUNA) is an experiment located deep underground at Gran Sasso National Laboratories (LNGS), aimed to study charged-particle-induced nuclear reactions of astrophysical interest. The proposed activity will focus on the development of simulation codes suited to characterize the experimental setups needed for some of the reactions under study both at the LUNA-400kV and at the IBF 3,5MV facility. A simulation infrastructure (SimLUNA-open) has been already developed by the collaboration on the base of the Cern toolkit GEANT4 but it needs to be specialized for specific reactions of interest. As example, the proposed activity could focus on a possible particle detectors array to be coupled to a large HpGe for the measurement of the $^{12}C+^{12}C$ reaction. Carbon burning is a key stage of stellar evolution determining the final destiny of massive stars. Due to the extremely small cross sections, direct experiments are challenging already at energies above 2.2 MeV but successful modelling of supernovae requires the cross sections to be known down to around 1.5 MeV. The $^{12}C+^{12}C$ reaction proceeds primarily through the $^{12}C(^{12}C,\alpha)^{20}Ne^*$ and the $^{12}C(^{12}C,p)^{23}Na^*$ channels. The measure is presently in progress at the IBF-3.5 MV facility by detecting the γ rays generated by the decay of the ^{23}Na and ^{20}Ne excited states with a large high purity germanium. A particle detector array coupled to the HpGe could be useful in a second phase to exploit coincidences between particles and photons emitted in the same fusion event. The candidate will work to find the best design to maximize the detection efficiency and the background reduction. The work will be done at INFN Genoa with several visits to LNGS.

Activities: Attività (optional)

Tutor: Sandra Zavatarelli (sandra.zavatarelli@ge.infn.it)

Activity period: giugno-luglio

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

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

4. GENOVA

12. Phenomenology and ATLAS

Title: “Theoretical and Experimental Studies of Heavy Flavours at the LHC

Description:
Flavour physics studies the relations between different species of particles in the Standard Model. For instance, it aims to find a mechanism that can explain the strong hierarchy between the particles' masses. It also allows for stringent tests of the theory and, indeed, some of the most intriguing discrepancies between theory and experiment are the so-called flavour anomalies. This project pursues a novel approach for the interrogation of the LHC high-energy collision data that are sensitive to quark flavour differences. We aim to study new algorithms that exploit both theory-inspired observables and novel machine-learning techniques and test them on realistic simulation of the data collected with the ATLAS detector.

Activities: Attività (optional)

Tutors: Federico Sforza (federico.sforza@unige.it) and Simone Marzani (simone.marzani@ge.infn.it)

Activity period: 1st September – 31st October 2026

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

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

4. GENOVA

13. 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 Spring, early Summer we will have 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

4. GENOVA

14. 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 2026

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

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

4. GENOVA

15. ePIC-EIC-TAG

Title: Interaction Tagger Detector for the dRICH at the Future ePIC Detector at the Electron–Ion Collider

Description: The dual-ring imaging Cherenkov (dRICH) detector of the ePIC experiment provides hadron identification in the forward region ($1.5 < \eta < 3.5$), with excellent particle discrimination over a momentum range from 1 GeV/c to 50 GeV/c. The detector readout consists of more than 300,000 SiPM channels operated at very low thresholds (< 1 photoelectron) in streaming mode to detect the faint Cherenkov light. To reduce the large data throughput from the front-end electronics, Cherenkov signals will be correlated in tight time coincidence with a bunch-crossing reference provided by a dedicated **dRICH Interaction Tagger**. Precise timing of charged hadrons produced in e–A interactions will be achieved using a segmented plastic-scintillator hodoscope read out by SiPMs.

Activities: During this project, the student will contribute to the design, construction, and testing of prototypes for the dRICH Interaction Tagger. A small-scale prototype will be available for cosmic-ray tests. The performance of the complete system (detector, SiPM-based front-end, and back-end data reduction) will be evaluated to identify the most suitable solution for the final detector.

Tutor: Marco Battaglieri, Mikhail Osipenko, Simone Vallarino

Activity period: June-July 2026

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

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

4. GENOVA

16. JLAB12-A(i)DAPT

Title: Generative AI for data analysis and preservation

Description: Recent advances in Generative Artificial Intelligence (AI) have demonstrated its strong potential to address long-standing challenges in nuclear and particle physics data analysis. In particular, generative models such as **Generative Adversarial Networks (GANs)** and **Diffusion Models** can be used to model the full detector response and to mitigate detector effects, including finite acceptance, inefficiencies, and limited resolution. By learning the multidimensional mapping between "true" and "measured" observables, these models enable event-by-event corrections that go beyond traditional unfolding or bin-based techniques. Once trained on simulated and/or experimental data, the generative network can produce high-fidelity synthetic replicas of the original data set, preserving correlations among kinematic variables and detector responses.
Beyond their practical use in data correction, the internal structure of the trained neural networks (e.g. latent representations and learned weights) can be investigated to gain insight into the underlying physical mechanisms and detector effects, potentially revealing non-trivial correlations that are difficult to capture with conventional methods.

Activities: During the internship, the student will be introduced to the fundamental concepts of Generative Artificial Intelligence, with particular emphasis on Generative Adversarial Networks and Diffusion Models and their application to experimental nuclear and particle physics. The student will work with both simulated and experimental data from exclusive electro-production and photo-production reactions collected at Jefferson Lab, learning how to train, validate, and benchmark generative models that reproduce detector-level observables. The activity will include applying the trained networks to perform event-by-event corrections for detector acceptance and resolution, and comparing the AI-based approach with standard analysis and unfolding techniques. In addition, the student will explore the latent representations and learned features of the neural networks to investigate correlations induced by detector effects and underlying physics processes, gaining hands-on experience at the interface between modern AI methods and high-precision experimental data analysis.

Tutor: Marco Battaglieri, Marco Spreafico, Simone Vallarino

Activity period: June-July 2026

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

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

5. LNF – FRASCATI NATIONAL LABORATORY

17. VIP

Title: Is Quantum Mechanics Exact? Testing the Foundations of Quantum Mechanics Underground: The VIP Experiment

Description: Are you fascinated by quantum mechanics and curious about its possible limits? Join the VIP experiment, hosted at the Gran Sasso National Laboratory (LNGS–INFN), one of the world's most advanced underground research facilities, and closely connected to detector development and data-analysis activities at INFN–Laboratori Nazionali di Frascati (INFN-LNF). VIP provides a unique environment to probe the foundations of quantum physics with ultra-low background conditions and cutting-edge technologies.
The VIP experiment is dedicated to testing some of the most fundamental principles of quantum mechanics. Its core mission is the search for possible violations of the Pauli Exclusion Principle (PEP), investigated through the detection of atomic transitions strictly forbidden by standard quantum theory. In parallel, VIP searches for spontaneous radiation predicted by quantum collapse models, theoretical frameworks introduced to address one of the deepest open problems in physics: the quantum measurement problem, exemplified by the Schrödinger's cat paradox.
The VIP collaboration, with main contributions from INFN-LNF, has developed state-of-the-art radiation detectors and Machine-Learning-based data analysis techniques, achieving world-leading constraints on PEP violation probabilities and on predictions of collapse models. As the experiment continues to optimize its apparatus and analyze new data, the goal is to further tighten these limits, or potentially uncover the first experimental evidence of new physics. The impact of these studies extends beyond fundamental science, with important connections to quantum technologies and precision measurement.

Activities: As part of this project, the student will be involved in all major aspects of the VIP experiment, in particular detector development and analysis activities at INFN-LNF. This includes preparing, characterizing, and testing advanced radiation detector systems, as well as analyzing experimental data using modern statistical methods and Machine Learning techniques. The student will also contribute to the theoretical interpretation of the results, within extensions of the Standard Model and beyond-Standard-Model frameworks, including gravity-related collapse models and scenarios inspired by quantum gravity. This is a unique opportunity to participate directly in one of the most ambitious and intellectually exciting experimental programs 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 2026

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: https://personale.lnf.infn.it/ufficio-concorsi/guesthouse/).
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/

5. LNF – FRASCATI NATIONAL LABORATORY

18. SIDDHARTA-2

Title: Kaonic Atoms and Advanced Radiation Detectors: Probing Fundamental Interactions with Exotic Atoms

Description: Are you ready to explore the fundamental laws of Nature using exotic atoms and state-of-the-art radiation detectors? Join the SIDDHARTA-2 experiment, a world-leading research program at the DAΦNE collider (INFN–LNF, Frascati), the only facility worldwide capable of performing precision spectroscopy of kaonic atoms. In these unique systems, one electron is replaced by a kaon, a particle containing a strange quark, providing a powerful laboratory to study the strong interaction at low energies. Using the very low-energy kaon beam, SIDDHARTA-2 measured X-ray transitions in various kaonic atoms, enabling unprecedented investigations of the strong interaction in the strangeness sector. The experiment employs cutting-edge Silicon Drift Detectors (SDDs) for high-precision X-ray spectroscopy, complemented by advanced detector technologies such as CdZnTe (CZT) and High-Purity Germanium (HPGe) detectors.
SIDDHARTA-2 is the first experiment to measure kaonic deuterium as well as in heavier kaonic atoms, including neon, fluorine, and lead. These measurements provide unique constraints on strong and bound-state quantum electrodynamics, with far-reaching implications, from particle and nuclear physics to the physics of neutron stars and even search of physics beyond the Standard Model.
With data analysis and theoretical interpretation intensifying in 2026, including the application of Machine Learning techniques, together with the development and testing of novel radiation detectors for future kaonic-atom experiments in Italy and Japan and for societal applications (in medicine), this is an ideal moment for a motivated student to enter this exciting field and make a meaningful contribution.

Activities: As part of the team, the student will play a key role in analyzing data to identify kaonic atoms signals, and interpret the data in the framework of theories within and beyond the Standard Model. In particular, his/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 radiation detector systems designed for future kaonic atom measurements and for societal applications (such as imaging in medicine).
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 2026

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: https://personale.lnf.infn.it/ufficio-concorsi/guesthouse/).
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/

5. LNF – FRASCATI NATIONAL LABORATORY

19. FLASH/GravNet

Title: Development of Advanced Signal Processing and Machine Learning Techniques for High-Frequency Gravitational Wave Detection with the FLASH Experiment

Description: The Laboratori Nazionali di Frascati (LNF) plan to host a new detector for the search for High-Frequency Gravitational Waves (HFGWs), named FLASH. The detector exploits the haloscope technology originally developed for axion searches and is based on a large radio-frequency cavity, cooled to cryogenic temperatures and immersed in a strong magnetic field of 1.1 T.
Although the expected sensitivity may not be sufficient for guaranteed detection, the main potential sources include the stochastic gravitational-wave background and primordial black holes, which would manifest in the detector as spurious signals at the cavity resonance frequency.
The signal data acquisition and processing pipeline is currently under development and testing at LNF using a smaller haloscope experiment, QUAX. In 2026, additional tests are foreseen using a room-temperature cavity, which will allow the production of real experimental data to validate and optimize both the pre-analysis and post-analysis data processing chains.
The project aims to exploit online signal filtering techniques and machine learning methods to enhance the sensitivity to possible candidate signals. The selected candidate will be actively involved in the design, implementation, and testing of the data filtering and analysis chain, contributing to the development of advanced techniques for signal extraction in high-noise environments.

Activities: Although the activity will be mainly focused on software development and the implementation of online filters, it cannot be carried out without a solid understanding of the detector. Therefore, the work will require direct involvement in laboratory activities, including data acquisition and subsequent data analysis.

Tutor: Giovanni Mazzitelli, giovanni.mazzitelli@lnf.infn.it / Giorgio Dho, giorgio.dho@lnf.infn.it

Activity period: preferably September-October 2026

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: https://personale.lnf.infn.it/ufficio-concorsi/guesthouse/).
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/

5. LNF – FRASCATI NATIONAL LABORATORY

20. Belle II

Title: Optimization of the Belle II detector glass Resistive Plate Chambers in avalanche operation mode.

Description: The Belle II experiment runs at the e^+e^- SuperKEKB collider in Japan. SuperKEKB, currently holding the world record of instantaneous luminosity, aims to reach in 2026 the unprecedented luminosity $10^{35}\text{cm}^{-2}\text{s}^{-1}$, which will allow Belle II to collect a huge-statistics dataset of B, D and τ decays (among others).
An ambitious upgrade program of SuperKEKB and Belle II to further increase the luminosity is foreseen in the coming years. One of the possible upgrade options for the K_L and muon detector (KLM) is to operate its glass RPC (Resistive Plate Chambers) in avalanche rather than in streamer mode, as done in the current detector to reduce the dead time and the sensitivity to high neutron fluxes. The Frascati group, which together with the Roma3 INFN group has built and commissioned the RPC readout electronics, is now engaged in an R&D program to determine the optimal working point for the glass RPCs operating in avalanche regime.

Activities: The student will work in the test experimental apparatus set up in our group laboratory in Frascati, with the aim of studying different gas mixtures, High Voltage settings, and Front-End Electronics characteristics for the glass RPCs operated in avalanche mode. He/she will operate the system, collect and analyse data from cosmic rays and possibly from radioactive sources.
Finally, simulation of the detector properties with Monte Carlo (MC) programs and comparison of simulation with real data will also be a qualifying part of the program.

Basic laboratory skills are requested, as well as good knowledge of the C++ and python programming languages and ROOT analysis package, to analyse the data and use the MC simulation programs.

Tutor: Giuseppe Finocchiaro, giuseppe.finocchiaro@lnf.infn.it

Activity period: September-October 2026

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: https://personale.lnf.infn.it/ufficio-concorsi/guesthouse/).
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/

5. LNF – FRASCATI NATIONAL LABORATORY

21. Mu2e

Title: Commissioning and performance of the Mu2e detectors

Description: Starting from spring 2026, the Mu2e detector will be fully installed in the so-called extracted position (i.e. outside of the Detector Solenoids) over its installation rails. The detector consists of a fast and precise CsI+SiPM calorimeter, a 3-meter-long tracker with 20000 straws, and a portion (25 m^2) of the Cosmic Ray Veto system made of long scintillation counters readout by SiPMs. Throughout the summer and until the end of the year, a combined data taking with all three detectors will take place. This will support the preparation for beam data taking, foreseen in 2027, in several ways: calibration of individual detectors will be performed using cosmic rays events and specialized systems (Calorimeter Laser, Calorimeter source, Tracker Pulse, CRV gain runs), enabling final adjustments and fine tuning of the detectors; performance studies (resolutions, linearity, alignment) of the detectors will be conducted, with particular focus on cross-calibration among systems, such as tracker to calorimeter (or CRV) alignment, using track extrapolation. These studies will provide time and position calibration that will inform the future PID algorithms and other specialized studies, like the calibration of the calorimeter response along the crystal axis.

Activities: The activity will be focused on detector calibration and reconstruction, data analysis using ROOT and/or Python, detector monitoring and data-quality checks. The candidate will acquire technical competence on electromagnetic calorimetry and its calibration techniques, and expertise in professional software coding in C++, Python and ROOT.

Tutor: Simona Giovannella, simona.giovannella@lnf.infn.it

Activity period: September-October 2026

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: https://personale.lnf.infn.it/ufficio-concorsi/guesthouse/).
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/

5. LNF – FRASCATI NATIONAL LABORATORY

22. 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 2025. Depending on her/his interests and when she/he will be with us, the work can focus on:

- The optimization of signal selection to reduce the most dangerous backgrounds using Neural Networks or other Machine Learning approaches.
- The search of CP violation in these decays from an angular analysis of these decays.
- The measurements of the relative branching fractions of semileptonic B_s decays into various excited D-mesons in the final state.

Some knowledge in computing (e.g. Python, C++) 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 2026

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: https://personale.lnf.infn.it/ufficio-concorsi/guesthouse/).
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/

6. LNGS – GRAN SASSO NATIONAL LABORATORY

23. LUNA

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) and segmented Sodium Iodide (NaI) 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 2026 – each activity period is intended for a 2-month stay (about 9 weeks)

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: 2 open positions (1 in June-July and 1 in September-October), further information on LUNA: https://luna.lngs.infn.it/

7. LNS – SOUTH NATIONAL LABORATORY

24. KM3Net

Title: Acoustic Positioning for the deep sea neutrino telescope KM3NeT-ARCA

Description: Data analysis of the Long Baseline of the Positioning System for the KM3NeT-ARCA neutrino Telescope

Activities: use of acoustic DSP techniques and developement and use of analysis and monitoring tools for the positioning system of the KM3NeT-ARCA detector.

Tutor: Giorgio Riccobene, riccobene@lns.infn.it; Salvatore Viola, sviola@lns.infn.it

Activity period: June 1-August 1, 2026 or September 7 – November 7, 2026

Local Secretariat: Nunzio Saitta, saitta@lns.infn.it

Other information: Ticket Lunch 7€/day offered by INFN-LNS. Bnd Accomodation at regulated fares

8. MILANO BICOCCA

25. CUPID_1

Title: Analysis of CUPID Demonstrator Data and Comparison with MC simulations

Description:
CUPID (CUORE Upgrade with Particle IDentification) is a next-generation cryogenic experiment designed for the search for neutrinoless double beta decay using scintillating bolometers operated at millikelvin temperatures. Building on the experience of CUORE, CUPID represents a key step toward a future ton-scale experiment, with enhanced background rejection and sensitivity capable of fully probing the inverted neutrino mass ordering. Currently the prototype of a single CUPID tower is data taking at the Gran Sasso National Laboratories, providing fundamental information for the optimization of the final detector design.

Activities:
The student's activity will focus on the analysis of data collected with the CUPID prototype, consisting of a single tower of scintillating cryogenic calorimeters operated around 10 mK. The work includes the reconstruction of heat and light signals, the characterization of detector performance in terms of energy resolution, noise, pulse-shape parameters, and particle-identification capabilities. Experimental results will be compared with detailed Monte Carlo simulations to validate the detector response model, assess background rejection efficiency, and evaluate the agreement between measured and expected performance. The outcome of this study will provide essential input for the optimization of the CUPID detector design and for sensitivity projections of the full experiment.

Tutor: Mattia Beretta, Matteo Biassoni, Irene Nutini

Activity period: June/July and September/October

Local Secretariat: Annalisa Cucchiarini, annalisa.cucchiarini@mib.infn.it

Other information: Altre informazioni (es. periodo di chiusura estivo, sistemazioni economiche o convenzionate, sito web locale, ecc..) (optional)

8. MILANO BICOCCA

26. CUPID_2

Title: CUPID R&D Activities for Advanced Light Detectors

Description:
CUPID is a cryogenic bolometric experiment under development at LNGS, designed to combine excellent energy resolution with particle identification through simultaneous heat and light readout. The ongoing R&D program within CUPID is driven by the goal of scaling the technology to a ton-scale detector, requiring an improvement of light detector performance in terms of light detection efficiency, Signal to noise ratio and time resolution.

Activities:
The student's activity will be dedicated to R&D studies performed in the Milano-Bicocca cryostat, aimed at the development and optimization of novel cryogenic light detectors for the CUPID experiment. The work will focus on characterizing different detector designs to quantify improvements in noise level, light detection efficiency and time resolution. Since these detectors will be equipped with electrodes to implement Neganov–Trofimov–Luke amplification, dedicated measurements will be carried out to characterize the attainable signal to noise ratio. The results will contribute to the selection of the best light detector designs, capable of enhancing particle identification and background suppression in future CUPID iterations.

Tutor: Mattia Beretta, Matteo Biassoni, Elena Ferri

Activity period: June/July and September/October

Local Secretariat: Annalisa Cucchiarini, annalisa.cucchiarini@mib.infn.it

Other information: Altre informazioni (es. periodo di chiusura estivo, sistemazioni economiche o convenzionate, sito web locale, ecc..) (optional)

9. NAPOLI

27. DUNE

Title: Tests of Cryogenic Photosensors for an Innovative Photon Detection System for the Third Far Detector Module of the DUNE Experiment

Description: The Deep Underground Neutrino Experiment (DUNE) will address a wide range of fundamental questions through its extensive science program, using advanced liquid argon (LAr) detector technology. Key areas of investigation include the dominance of matter over antimatter in the early Universe, the mechanisms behind supernova neutrino bursts (SNBs), and the potential decay of protons. DUNE will feature two neutrino detectors positioned within a powerful neutrino beam generated at Fermi National Accelerator Laboratory (FNAL). The first near detector (ND), located at the FNAL, will record particle interactions near the beam's
origin. The second, significantly larger far detector (FDs), initially composed of two large modules, will be situated more than a kilometer underground at the Sanford Underground Research Laboratory (SURF), 1300 kilometers downstream from the neutrino source. Construction of the first project phase (Phase I) is well underway, with ongoing assembly of detector components for the Far Detectors. Phase II of DUNE includes an upgraded of the neutrino beam, and two additional far detector modules. The Photon Detection System (PDS) is a crucial part of the detector, essential for improving the DUNE low energy physics program. To enhance the performance of the PDS for the third far detector module at low incremental cost, an attractive solution involves the use of fully silicon-based large light-collection units with an area of approximately 100 cm^2, large panels of wavelength-shifting polyethylene naphthalate (PEN) foils, and large reflective foil panels.

Activities: The selected student will participate in experimental activities at the Napoli laboratories, focusing on performance tests of different SiPMs to be used in the new Photon Detection System concept for DUNE Phase II. The tests will be conducted at cryogenic temperatures, where the photosensors will be illuminated using a pulsed laser source. These measurements aim to characterize key parameters such as gain, photon detection efficiency, timing resolution, and noise behavior under operating conditions comparable to those expected in the experiment.

Tutor: Francesco Di Capua, Nicola Canci

Activity period:
June 1 – July 31, 2026
September 1 – October 30, 2026

Local Secretariat: Giosuè De Micco, demicco@na.infn.it**, +39 081676987**

9. NAPOLI

28. SND@LHC

Title: Classification of shower events with the SND@LHC detector in the HL-LHC run

Description: The project develops within the SND@LHC experiment, an experiment studying all three types of neutrinos at the LHC since 2022 at unprecedented energies. In June 2025, the upgrade of the experiment to run in the High Luminosity era of the LHC was approved. The detector, based on the silicon microstrip technology, consists of a high-granularity and high-sampling calorimeter in the neutrino target region followed by a magnetized tracking calorimeter. The instrumented target region provides the measurement of the energy deposited therein and the reconstruction of the neutrino vertex with the necessary spatial resolution to efficiently contribute to the identification of the tau lepton. The magnetized tracking calorimeter is designed to measure the hadronic energy, identify muons produced in $\nu\mu$ charged current interactions and in the muonic decay of tau leptons, and measure their energy. This project intends to study the response of the upgraded detector to particle showers. In analyses of Run 3 SND@LHC data, hit density and hit spatial anisotropy have been shown to be effective discriminators between electromagnetic and hadronic showers, thus discriminating between electron neutrinos and neutral current interactions. The increased size and granularity of the Run 4 detector allow for a more detailed observation of shower development. The student will adapt these observables to the Run 4 detector geometry and software framework and study their behaviour using simulated muons, pions, electrons, and interactions of neutrinos. The project will provide the selected student with practical experience in a modern particle physics experiment, including the analysis of particle interactions, the efficient use of computing tools, and collaborative work in an active research environment.

The technical skills to advance a successful candidate are listed below.
Software: Python and/or C++, ROOT
Tools: Git

Activities: Attività (optional)

Tutor: Giovanni De Lellis

Activity period: Period of 2 months (about 9 weeks): June-July or September-October

Local Secretariat: Giosuè De Micco, demicco@na.infn.it **- 081676987**

Other information: Institute closed from August 8th to 22nd, www.na.infn.it

9. NAPOLI

29. MEMPHYS

Title: Radiation-hardened-by-design FPGAs for Readout of Nuclear Trackers

Description: The proposal is framed within the synergy between novel neutron detection technology projects hosted by the University of Illinois Urbana-Champaign (UIUC) and the MEMristive-CMOS hybrid electronics for experimental PHYSics experiment (MEMPHYS) of INFN Commissione Scientifica Nazionale 5 (CSN5).
The research activities at UIUC include neutron detectors developed for operation in extreme radiation, thermal, and electromagnetic environments typical of large-scale research facilities. In particular, position-sensitive boron-coated straw (PS-BCS) detectors and high-temperature-rated (up to 600 °C) fission chambers are among the technologies that will be available at the University of Illinois at the time of the project. PS-BCS detectors offer a unique advantage, as they can determine the axial position of neutron interactions along the length of a straw and feature a 4-channel readout for an array of 16 detectors, eliminating the need for multi-detector imaging.
An FPGA-based system, derived from the MEMPHYS hadron-fluence sensor board, will be used as a front-end digitizer and real-time digital signal processor operating in the radiation area. The use of an FPGA provides high flexibility and performance, enabling automated gain adjustment over a neutron-flux dynamic range spanning six orders of magnitude. However, operation in a radiation environment poses significant challenges. For this reason, radiation-hardening-by-design techniques will be applied at the printed circuit board level, as well as at the FPGA firmware, layout, and configuration levels.
The successful candidate will contribute to the design and bench testing of the abovementioned FPGA-based radiation-hardened data acquisition system for the readout of PS-BCS detectors.

Activities:
1. **Design and implementation of radiation-tolerant FPGA firmware.** The successful candidate will build upon existing platforms at the host institution and configure frame-level and logic-level redundancy, implement configuration-memory scrubbing, and structure modular firmware blocks capable of isolating and recovering from single-event upsets.
2. **Assembly and testing of the complete acquisition chain**. The successful candidate will assemble an acquisition chain from detector front-end signals through digitization, real-time processing, and data output. Testing will be performed with emulated signals at INFN Napoli. Upon demonstrated feasibility, and following completion of the period at INFN, the system will be further tested with neutron sources at UIUC and at partner DOE National Laboratories collaborating on ongoing efforts involving the program tutors.

Tutors: Prof. Raffaele Giordano – Universita' di Napoli Federico II e Sezione INFN di Napoli
Prof. Angela Di Fulvio – University of Illinois Urbana-Champaign

Activity period: September-October 2026

Local Secretariat: Giosuè De Micco - demicco@na.infn.it

Other information: Website: **www.na.infn.it**,
Summer closure: August 1 to 30, 2026

9. NAPOLI

30. LEGEND

Title: Data analysis of the liquid argon scintillation light in the LEXenDAryno prototype

Description: Neutrinoless double-beta decay ($0\nu\beta\beta$) is a hypothesized process forbidden by the Standard Model due to lepton number violation. Its discovery would clarify the matter-antimatter asymmetry, test if neutrinos are Majorana particles, reveal neutrino mass origins, and enable measurement of the absolute neutrino mass scale.
LEGEND (Large Enriched Germanium Experiment for Neutrinoless $\beta\beta$ Decay) is one of the most promising international projects dedicated to searching for neutrinoless double beta decay through the detection of the ^{76}Ge $0\nu\beta\beta$ decay. Two phases are foreseen for this experimental project: LEGEND-200, the initial phase, is currently collecting data at the INFN Gran Sasso National Laboratory in Italy; LEGEND-1000 will represent the next phase and will be designed to probe the entire inverted neutrino mass ordering region.
The LEGEND-1000 experiment will be equipped with an outer liquid argon detector to reject cosmogenic isotopes by identifying sibling neutrons (those captured on nuclei other than ^{76}Ge). Within this framework, the LEXenDAryno R&D prototype will be assembled at INFN-Naples to characterize the scintillation light properties in liquid argon doped with varying xenon concentrations, determining key parameters like yield, timing, and light collection efficiency. This technology holds potential for application and improvements in the LEGEND-1000 liquid argon outer detector.

Activities: The candidate will have the opportunity to perform measurements using a single-phase liquid argon detector combined with a dedicated system for injecting precise amounts of xenon, and to analyze the acquired data to study key parameters of purified liquid argon, including decay time constants, relative intensities, light yield, and purity.

Tutor: Dr. Nicola Canci (INFN-Sezione di Napoli) – Prof- F. Di Capua (Physics Dept. - Università degli Studi di Napoli “Federico II”)

Activity period: Approximately June 15th - July 17th and/or Sep 7th - Oct 30th, 2026

Local Secretariat: Dr. Giosuè De Micco, demicco@na.infn.it, +39 081676987

9. NAPOLI

31. DarkSide-20k – DarkSide-Proto0

Title: Technological Development and Testing for DarkSide-20k

Description: DarkSide-Proto0 (Proto0) is a dual-phase liquid-argon TPC prototype operated at INFN Naples to study and optimize the formation of the secondary ionization signal (S2) in controlled and reproducible conditions. Its unique mechanical design enables a systematic investigation of electron extraction and electroluminescence as a function of geometry and electric fields. Proto0 also integrates the same 20×20 cm^2 Photon Detector Units (PDU) foreseen for DarkSide-20k, providing a realistic test bench to validate optical readout performance and to benchmark simulation and reconstruction tools, with direct impact on the final DS-20k TPC design.

Activities:

- Participation in commissioning shifts and basic detector operations / monitoring.
- Analysis of Proto0 datasets acquired at different gas-region geometries and field configurations.
- Extraction of key S2 observables (light yield, pulse shape, stability, resolution) and comparison across configurations.

Tutor: Giuliana Fiorillo (giuliana.fiorillo@na.infn.it)

Activity period: June–July 2026

Local Secretariat: Giosuè De Micco – demicco@na.infn.it

Other information: None

10. PADOVA

32. MUON COLLIDER

Title: Study of muon ionizing cooling to produce low emittance muon beams

Description: One of the main challenges in preparing muon beams arises from their production mechanism. Muons are generated through the decay of pions, which themselves are produced when high-energy protons strike a target. As a consequence, the resulting muon beam exhibits a large spread in both momentum and spatial distribution. Conventional beam-cooling techniques cannot be applied effectively because of the muon's short lifetime. For this reason, ionization cooling is proposed as a viable method to reduce the beam emittance. In this technique, muons pass through an energy-absorbing material, where they lose momentum through ionization energy loss. The longitudinal momentum is subsequently restored using radio-frequency cavities, while the entire system is immersed in a strong magnetic field that focuses the beam and maintains transverse confinement. This process results in an overall reduction of the transverse beam size.

During this internship, the trainee will be introduced to beam cooling techniques, in particular on muon ionization cooling. The trainee will then learn to use simulation software to study the performance of a system consisting of a ionizing cooling module. The optimal placement of detectors for measuring beam properties will be determined, and the final beam emittance will be evaluated.

During this period, the trainee will acquire the fundamental knowledge required to work in the study of new particle accelerators for High Energy Physics. He/she will develop the skills necessary to propose new technologies and detector concepts, as well as to test ideas and evaluate their performance. In addition, the trainee will gain experience with basic data analysis software, such as ROOT and/or Python.

Activities: Study of beam cooling techniques and muon ionizing cooling. Development and application of simulation software to position detectors to determine muon beam emittance.

Tutor: Donatella Lucchesi, Davide Zuliani and Alessio Gianelle

Activity period: June-July or September-October

Local Secretariat: **segreterieinfn@lists.pd.infn.it**

10. PADOVA

33. LUNA

Title: Study of the $^{27}Al(p,a)^{24}Mg$ 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.
At LUNA, we have the unique capability to directly measure nuclear reactions 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 the $^{27}Al(p,a)^{24}Mg$ 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.

Tutors: Prof. Antonio Caciolli (antonio.caciolli@pd.infn.it) and Dr. Denise Piatti (denise.piatti@pd.infn.it)

Activity period: June – July or September – October 2026

Local Secretariat: Segreterie Scientifiche INFN

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

10. PADOVA

34. ET/Virgo

Title: Scattered light noise in Gravitational Wave detectors

Description: Stray light represents a significant challenge for the LIGO–Virgo Gravitational Wave (GW) interferometers, affecting the sensitivity in the low-frequency region, and stray light noise is also relevant in future gravitational wave detectors, such as the Einstein Telescope (ET). Effective monitoring and mitigation of stray light sources are therefore essential.
Stray light noise is due to scattered light that leaves the laser beam for a variety of reasons (imperfect anti-reflection coatings; surface roughness; presence of dust contamination...), and later recombines with the main optical path, carrying with it extra phase noise acquired because of reflection off of vibrating surfaces.
At INFN Padova, the ET and Virgo group is active on the experimental study of stray light in GW detectors and in particular on the effects of surface contamination by dust particles. The group carries out a dust monitoring campaing for the Virgo detector at EGO and operates an experimental facility for angle-resolved light scattering measurements to characterize coatings and materials. The group studies also the impact of dust-related scattered light noise in GW interferometers, including the Einstein Telescope, setting requirements on the cleanliness.

Activities: The student will join the experimental activities of the ET/Virgo Padova Stray Light group. They may participate in measurements of the Bidirectional Scattering Distribution Function and Total Integrated Scattering on new samples of interest for gravitational-wave detectors, and contribute to the characterization and/or upgrade of the scattering measurement facility.
In parallel, the student may take part in the Virgo dust-monitoring campaign. By imaging exposed witness samples with an optical microscope and processing the resulting images, the student will help characterize dust particle fallout in different environments at EGO, providing experimental input for studies of dust-induced stray-light noise in current and future gravitational-wave detectors.

Tutors: Conti Livia, Flocco Francesco

Activity period: June-July

Local Secretariat: segreterieinfn@pd.infn.it

Other information:

11. PAVIA

35. RD_FCC / HiDRa

Title: Energy response and resolution of a fibre sampling dual-readout calorimeter protoype

Description: HiDRa is an advanced dual-readout calorimeter prototype developed within the INFN RD_FCC R&D effort as a demonstrator for future high-precision calorimetry in collider experiments. Its design goals are tied to the need for outstanding jet and hadron energy resolution. The assembly of the demonstrator was carried out at the INFN facilities of Pavia, Italy, and the prototype was partially commissioned with test-beam campaigns at the CERN SPS in 2024 and 2025. Further data taking is planned in the middle of 2026 to fully characterise the detector performance with electron, muon, and pion beams, building on and addressing the lessons learned during the past months. A comprehensive data set will become available in the second half of this year, prividing a highly instructive opportunity to study the energy response, resolution and spatial resolution of this state-of-the-art prototype. The comparison between measured data and simulation will keep playing a central role, with data used to validate the simulation and the simulation guiding the interpretation of the measurements.

Activities: The student will collaborate in the analysis of the data collected during the HiDRa test-beam campaigns. They will have the opportunity to apply essential data-analysis techniques based on ROOT and Python, working on real experimental data and gaining an overall view of the complete data-production chain, from detector hardware to reconstruction software. Depending on interest and motivation, there will also be the possibility to contribute to detector simulation activities.

Tutor: Nicolò Valle (nicolo.valle@pv.infn.it)

Activity period: September-October 2026

Local Secretariat: Angelica Vitali (angelica.vitali@pv.infn.it – 0382 98.7432)

12. PISA

36. SEISMIC

Title: Seismic isolation systems, from Virgo to the next-generation gravitational wave detectors

Description: Ground-based, km-scale interferometers Avanced LIGO, Advanced Virgo and KAGRA are the key playeers in the international network for gravitational-wave detectors. Four observing runs have been successfully carried on, and in the meantime, there is a growing activity toward the development of third-generation detectors, such as the Einstein Telescope in Europe and Cosmic Explorer in the US. A crucial aspect in ground-based detection of gravitational waves 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 the development of innovative seismic isolation systems for the Einstein Telescope. During the stay we will offer the student the possibility of participating actively in the experimental work related to the development, monitoring and data analysis of seismic isolation systems, with particular attention to the simulations, characterization, electronics, and control system.

Activities: Attività (optional)

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

Activity period: Settembre-Ottobre

Local Secretariat: direzione@pi.infn.it

12. PISA

37. ET

Title: Studies and tests on new Magnetic Anti-Spring for passive filtering of seismic noise

Description: At INFN Pisa Laboratory a diffused R&D program is going on aimed to implement Seismic Isolation System (SIS) for next generation interferometers like ET. In particular, the experimental group deeply involved in the conceptual design of the future detector for Gravitational Waves observation, is developing a new Superattenuator for filtering seismic noise and local disturbances. The project is based on mechanical filters equipped with new Magnetic Anti-Spring (nMAS) in accordance with scheme of the traditional Virgo-like cascade of second order low pass filters. This new version has been studied to improve the passive attenuation performance along the vertical degree of freedom reducing the total load of the movable apparatus of each filter. The magnetic matrices support are made of Aluminium populated with rare earth permanent magnets (SmCo) assembled in repulsive configuration with high magnetic field (up to 0.8T).
The activity of this project is focused on the assembling of the nMAS with different number of magnets and/or configuration, installation on the movable apparatus of a mechanical filter and then a measurement campaign to be performed for the characterization of a single passive attenuation stage (one mechanical filter).
The activity will be carried on in clean room and within the VIRGO Laboratory of the INFN site structure located in Pisa downtown adjacent to the Department of Physics at the Pisa University.

Activities: Experimental activity to be performed in clean room and dedicated laboratory

Tutor: Franco Frasconi (franco.frasconi@pi.infn.it)

Activity period: September-October 2026 (about 8 weeks total)

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

13. ROMA1

38. LUNA

Title: Experimental Gamma-Ray Spectroscopy for Nuclear Astrophysics applied at the $22Ne(\alpha,\gamma)^{26}Mg$ reaction

Description: The reaction $22Ne(\alpha,\gamma)^{26}Mg$ is a radiative capture reaction of major importance in nuclear astrophysics**,** as it competes with the neutron-producing reaction $22Ne(\alpha,n)^{25}Mg$, which is a key neutron source for the s-process**.** At the low energies of astrophysical interest, the cross section is extremely small and often dominated by narrow resonances, making its experimental determination particularly challenging.

Activities: A NaI(Tl) scintillation detector is used to detect the gamma rays emitted following the capture of an α particle by 22Ne and the subsequent de-excitation of the compound nucleus 26Mg. In the proposed activity, the candidate will gain confidence with the instrumentation and techniques of gamma-ray spectroscopy.

Tutor: Alba Formicola - Carlo Gustavino

Activity period: September /October

Local Secretariat: Segreteria di direzione, direzione@roma1.infn.it

Other information:

14. TIFPA

39. MONSTRE

Title: Quantum Simulation of nuclear dynamics with Similarity Renormalization Group

Description: The description of low energy properties of atomic nuclei is of great interest for the science program of both INFN and DOE. In particular, the development of ab-initio simulation techniques is of fundamental importance as it allows to guide phenomenological models in regions where experimental data is scarce. One of the most popular method of the past decade is the Similarity Renormalization Group (SRG) method, an efficient technique that allowed to explore ab-initio the ground state properties of heavy nuclei like tin. In this project we want to explore the use of the techniques that make SRG possible in the context of simulations of nuclear dynamics with the long term goal of simplifying the study of nuclear reaction on quantum computers.

Activities: The student coming to TIFPA will be involved in the development of the numerical simulations where we will employ Gradient Flow, the technique on which SRG is based on, to remove the high energy components of simple nuclear interactions. The resulting Hamiltonian will then be used to study low energy dynamics of simple few body nuclear systems employing a combination of classical simulation techniques as well as quantum algorithms for current and near term digital quantum computers.

Tutor: prof. Alessandro Roggero

Activity period: June-July

Local Secretariat: Isabella Martire, isabella.martire@tifpa.unitn.it, +39 0461 282182

Other information:

14. TIFPA

40. NuPhys_BNS

Title: NuPhys_BNS -- Neutrino Physics in Binary Neutron Star mergers

Description: Neutrinos physics is one of the main ingredients in the modeling of binary neutron star mergers. In these extreme astrophysical events, degenerate and semi-degenerate nuclear matter emits copious amounts of neutrinos of all flavors, having an impact on many different observables, including the stability of the remnant, the gravitational wave signal, the composition of the expelled matter (ejecta) and the properties of the kilonova signal. Detailed and accurate neutrino rates represent a mandatory element of sophisticated, ab-initio numerical models having the ambition of predicting and interpreting present and futute multimessenger signals from these cosmic collisions. Deep inside the merger remnant, magnetic fields are amplified by several magneto-hydrodynamics (MHD) mechanisms and instabilities. The resulting strength could be so large ($10^{15\text{-}16}$ Gauss) that Landau quantization can affect the energy levels of electrons and positrons, affecting neutrino emissivity and mean free path (see e.g.). These effects are usually neglected in merger simulations, also due to the paucity of numerical models featuring at the same time magnetic fields and detailed neutrino transport. Additionally, the resulting dense neutrino gases can produce collective neutrino flavor conversions of different kinds inside and immediately above the remnant, including the fast flavor instabilities, a specific class of collective oscillations. The inclusion of their effects in merger simulations is highly non-trivial and only recently a few effective attempts have been performed.
In this project, we want to improve neutrino rates inside binary neutron star merger models by taking into account the effects of magnetic fields on their rates. At the same time, we want to implement a simple, but effective treatment for neutrino flavor conversions based on the Bhatnagar–Gross–Krook operator (BGK) method inside a state-of-art Numerical Relativity (NR) code.

Activities: The project will be conducted within the TEONGRAV initiative at TIFPA. It will start with the implementation of the semi-analytic approximation presented in [1], capturing the effect of magnetic fields on the emission and absorption of neutrinos at the conditions expected to be relevant in neutron star mergers. This implementation will be then included inside BNS_NURATES, a publicly available numerical library developed at TIFPA and specifically designed for neutrino modeling in compact binary mergers [2]. The effects of these more accurate rates could be immediately tested using AthenaK [3], a portable and very efficient NR code for astrophysical applications featuring a MHD solver and a two-moment neutrino transport scheme coupled to the BNS_NURATES library. This code is presently run on GPUs by people at TIFPA on the Leonardo-BOOSTER HPC cluster. After that, the BGK implementation already done inside the WhiskyTHC code [4] will be ported to AthenaK, with the goal of performing simulations including flavor conversions in the presence of magnetic fields and very efficiently, thanks to the impressive performance of AthenaK.

[1] Kumamoto & Welch, Physical Review D, Volume 111, Issue 6, id.063009 (2025)
[3] Chiesa *et al*, Physical Review D, Volume 111, Issue 6, id.063053 (2025)
[3] Fields *et al*, The Astrophysical Journal Supplement Series, Volume 276, Issue 2, id.35 (2025)
[4] Qiu *et al*, Physical Review D, Volume 112, Issue 12, id.123039 (2025)

Tutor: Albino Perego (albino.perego@tifpa.infn.it)

Activity period: first choice: September-October, second choice: June-July

Local Secretariat: Isabella Martire, isabella.martire@tifpa.infn.it

Other information:

- website: https://www.tifpa.infn.it/ ;
- Plausible summer closure: 10-23 August (no overlap with the expected period);
- possibility to stay in a nearby B&B and hotels with special prices; large availability of other B&B (also with kitchen) and hotel accomodations;
- In the September-October period, possibility of attending the ECT* workshop *Magnetic fields and Nucleosynthesis*

15. TORINO

41. FERMI

Title: Classification of Gamma-ray Bursts from Fermi Prompt Observations with advance unsupervised machine learning

Description: Gamma-ray bursts are the events of interest for the proposed work. They are most easily discovered in their prompt phase, appearing as flashes of gamma-rays with durations from 0.01 s to 10,000 s. After the prompt phase, telescopes across and beyond the electromagnetic spectrum study these events, to understand the physical origin of the gamma-ray bursts. They can arise from the death of massive stars, the merging of two neutron stars, starquakes on neutron stars which have the strongest magnetic fields in the cosmos, or the disruption of a star as it falls into a massive black hole. A holy grail in this field is to predict the origin of a given gamma-ray burst from only the initial prompt signal, as this would allow greater understanding of these events and the proper use of telescopes worldwide, including Hubble and James Webb. We have recently demonstrated the most promising approach to physical classification of gamma-ray bursts utilizing only prompt information provided by the gamma-ray burst monitor on board of *Fermi*. This workflow requires the integration of numerous pieces, many of which are currently being advanced through other works. What is missing is a final classification assignment on the output of the machine learning algorithm. The proposed work would be to fill this gap, with the student taking full ownership of this portion. It will give them direct research experience in astrophysics, networks with NASA scientists, and a strong background in machine learning, which will serve them well in their future career.

Activities:

Tutor: Simone Maldera

Activity period: giugno-luglio e/o settembre-ottobre

Local Secretariat: Valentina Lissia, Tel. 0116707271, e-mail: valentina.lissia@to.infn.it

Other information:

16. TRIESTE

42. ePIC_1

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 2026

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

16. TRIESTE

43. ePIC_3

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: Andrea Bressan (andrea.bressan@ts.infn.it)

Activity period: period of 2 months, preferred June-July 2026

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

16. TRIESTE

44. ePIC_2

Title: Characterization of high-speed data links for the ePIC Silicon Vertex Tracker

Description:
A large area low mass Silicon Vertex Tracker (SVT) is being developed by the ePIC collaboration to exploit the physics program of the Electron-Ion Collider (EIC) at the Brookhaven National Laboratory (BNL). The ePIC experiment will start data taking in the mid-2030s. The ePIC SVT is based on the MAPS sensor technology developed for the ITS3 for high position resolution measurements. Data links, cooling and power infrastructure, and mechanical support are designed with lightweight technologies to minimize multiple scattering and achieve the required vertexing capability and momentum resolution.
Data transmission is achieved through a combination of electrical and optical links. Electrical links are implemented in the form of Flexible Printed Circuits (FPC) with aluminum traces. Aluminum based FPC technology offers lower material budget with respect to copper based FPCs. Development of these FPCs is currently ongoing with the first prototypes becoming available for testing at the beginning of 2026.

Activities:
In Trieste, the ePIC activities for 2026 will focus on the characterization of FPC prototypes designed to measure signal integrity of electrical links at speed up to 10 Gbps. The student will be involved in the development of test procedures, data acquisition and analysis tools. Through the evaluation of the collected data samples, the student will assess the prototype performance against specifications. This work will train the student to conduct independent testing of high-speed data links using industry-standard methods for signal integrity evaluation.

Tutors:
Laura Gonella (laura.gonella@ts.infn.it)
Giacomo Contin (giacomo.contin@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

45. 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 during the Long Shutdown 3 (2026-2030). The same technology has been chosen for the Silicon Vertex Tracker (SVT) of the ePIC detector at EIC, and is inspiring the sensor development 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 final large-area sensor is now under production and will be ready for characterization from Spring 2026.

Activities:
In Trieste, the ITS3 R&D for 2026 will focus on the characterization in laboratory of the 65 nm CMOS process chips, in the prototype and final versions. 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 and bus design affects the detector 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)
Laura Gonella (laura.gonella@ts.infn.it)

Activity period:
Preferably June-July 2026.

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

46. GRAPH NEURAL NETWORK

Title: GNN Optimization for emerging/semi visible jet signatures in dark sector models

Description: the candidate will directly work in validating and possibly improving performances of an emerging/semivisible jet tagger based on graph neural networks in the contest of dark sector models.

Activities: validation and training of a graph neural network using INFN resources; studies of performances. Optimisation.

Tutor: Giancarlo Panizzo (giancarlo.panizzo@ts.infn.it), Giulia Cossutti

Activity period: 2 months to be agreed within June and October 2026.

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